SHAKER LANDING
PUMP STATION O & M MANUAL
VOLUME III
MANUFACTURER'S O&M MANUALS

LANDING ROAD

ROUTE 4A SEWER EXTENSION PROJECT
ENFIELD, NEW HAMPSHIRE
GRAFTON COUNTY
NHDES CWSRF PROJECT NUMBER CS-330167-04
USDA RURAL DEVELOPMENT PROJECT

DECEMBER 7, 2018
(Project No. 10068-05)

Prepared by

Pathways Consulting, LLC
Project No. 10068-05

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VOLUME III

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 1

EBARA SUBMERSIBLE SEWAGE PUMP

EBARA SUBMERSIBLE PUMPS DLFU

PERFORMANCE TEST DATA

Test Number:	18002-01	Customer:	Pump System		Project:		
Serial Number:	C97249/1/1	GPM:	120	TDH:	29	HP:	3
Operation Time:	1819 sec.	Tested by:	DT	Checked by:	SPB	Date:	1/10/2018

Pump Model:	Solid Dia. (in)	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design
80DLMFMU62.22	3	1740	3	-	188	-	188

Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)	Locked Rotor Current (Amps)	FL Eff. (%)	FL Power Factor (%)
	4	230	3	9.2	63	71.3	84.0

Full Speed Data Points

TEST NO.	1	2	3	4	5	6	7
DISCHARGE (GPM)	0.0	40.4	90.3	133.6	174.6	219.9	254.2
PUMP TDH (Ft)	54.7	47.4	41.5	35.4	28.1	18.7	10.8
WATER POWER (Hp)	0.0	0.5	0.9	1.2	1.2	1.0	0.7
POWER INPUT (kw)	2.0	2.2	2.4	2.6	2.6	2.5	2.7
POWER INPUT (Hp)	2.7	3.0	3.2	3.5	3.4	3.4	3.6
CURRENT (A)	7.1	7.5	7.8	8.2	8.1	8.1	8.4
OVERALL EFF. (%)	0.0	16.2	29.3	34.1	35.9	30.5	19.3
MOTOR EFF. (%)	63.4	65.8	67.4	68.9	68.6	68.4	69.4
PUMP BHP (Hp)	1.7	2.0	2.2	2.4	2.4	2.3	2.5
PUMP Eff. %	0.0	24.7	43.4	49.5	52.4	44.6	27.8

Calculated Reduced Speed Data Points Speed (rpm) 1580

TEST NO.	1	2	3	4	5	6	7
DISCHARGE (GPM)	0.0	36.7	82.0	121.3	158.6	199.7	230.8
PUMP TDH (Ft)	45.1	39.1	34.2	29.2	23.2	15.4	8.9
OVERALL EFF. (%)	0.0	16.2	29.3	34.1	35.9	30.5	19.3
PUMP BHP (Hp)	1.3	1.5	1.6	1.8	1.8	1.7	1.9
PUMP Eff. %	0.0	24.7	43.4	49.5	52.4	44.6	27.8

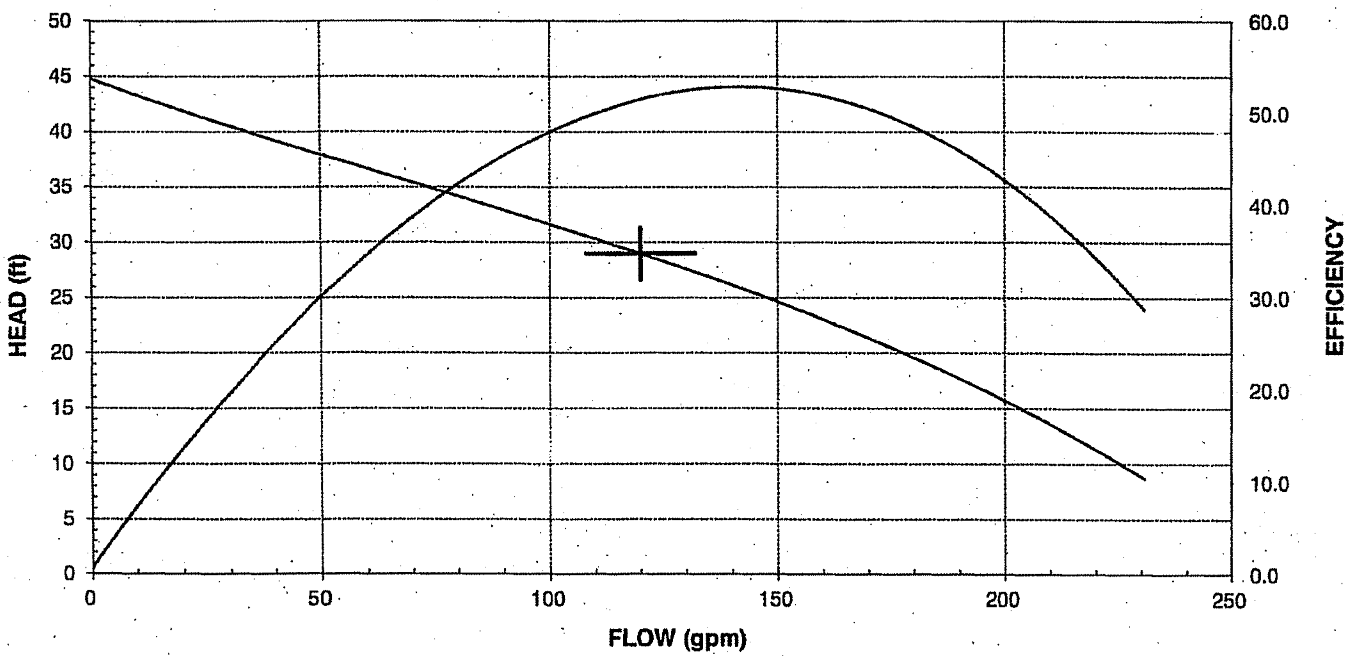
EBARA **SUBMERSIBLE PUMPS** **DLFU**

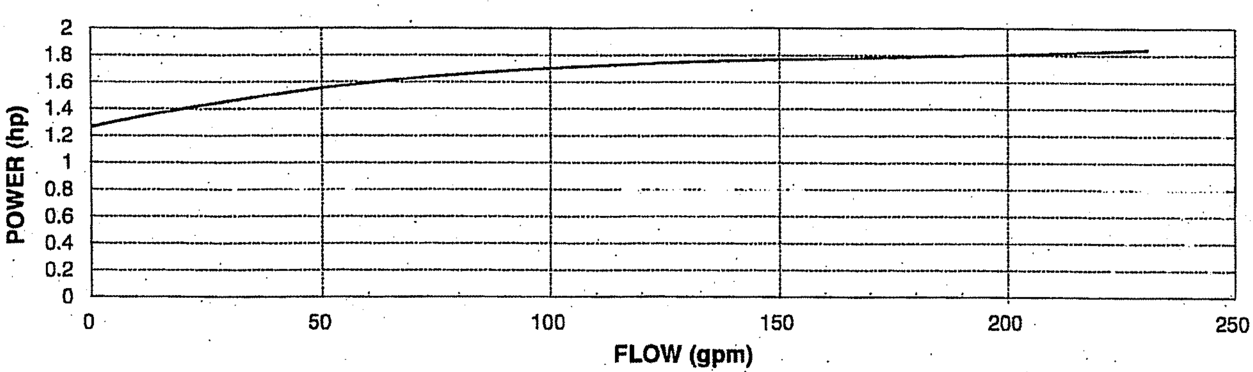
REDUCED SPEED CURVE

Test Number: **18002-01** Customer: **Pump System** Project:

Serial Number: **C97249/1/1** GPM: **120** TDH: **29** HP: **3** CHEK'D: **SPB** DATE: **1/10/2018**

Pump Model:		Motor HP	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design	Solid Dia. (in)
80DLMFMU62.22		3	1580	3	-	188	-	188	3
Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)		Locked Rotor Current (Amps)		FL Eff. (%)	FL Power Factor (%)
	4	230	3	9.2		63		71.3	84.0





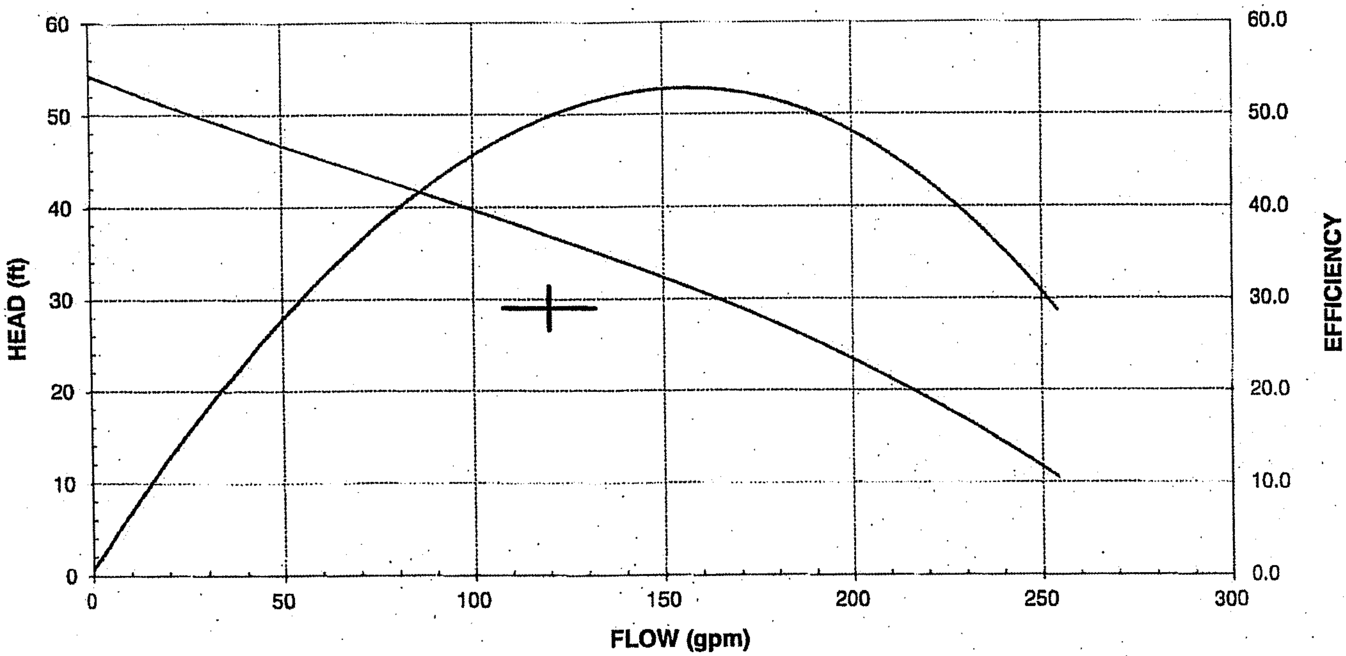
EBARA SUBMERSIBLE PUMPS DLFU

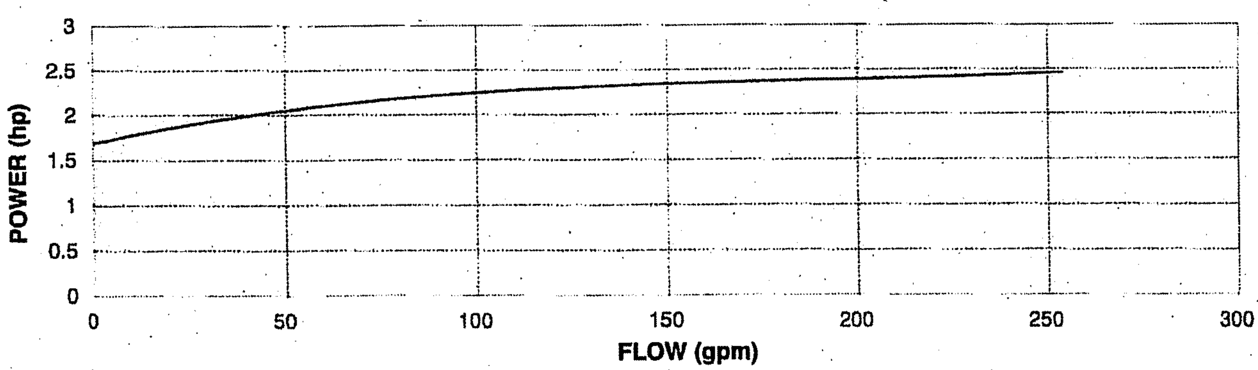
PERFORMANCE TEST CURVE

Test Number: 18002-01 Customer: Pump System Project:

Serial Number: C97249/1/1 GPM: 120 TDH: 29 HP: 3 CHEK'D: SPB DATE: 1/10/2018

Pump Model:		Motor HP	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design	Solid Dia. (in)
80DLMFMU62.22		3	1740	3	-	188	-	188	3
Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)		Locked Rotor Current (Amps)		FL Eff. (%)	FL Power Factor (%)
	4	230	3	9.2		63		71.3	84.0





EBARA **SUBMERSIBLE PUMPS** **DLFU**

PERFORMANCE TEST DATA

Test Number:	**18003-01**	Customer:	**Pump System**	Project:			
Serial Number:	**C97249/1/2**	GPM:	**120**	TDH:	**29**	HP:	**3**
Operation Time:	**1751 sec.**	Tested by:	**DT**	Checked by:	**SPB**	Date:	**1/10/2018**

Pump Model:	Solid Dia. (in)	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design
80DLMFMU62.22	**3**	**1740**	**3**	**-**	**188**	**-**	**188**

Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)	Locked Rotor Current (Amps)	FL Eff. (%)	FL Power Factor (%)
	4	**230**	**3**	**9.2**	**63**	**71.3**	**84.0**

Full Speed Data Points

TEST NO.	1	2	3	4	5	6	7
DISCHARGE (GPM)	0.0	49.5	99.5	138.4	178.3	211.7	249.6
PUMP TDH (Ft)	55.8	46.8	40.9	35.0	28.5	20.5	12.9
WATER POWER (Hp)	0.0	0.6	1.0	1.2	1.3	1.1	0.8
POWER INPUT (kw)	2.1	2.3	2.5	2.6	2.7	2.6	2.7
POWER INPUT (Hp)	2.8	3.1	3.3	3.5	3.6	3.5	3.7
CURRENT (A)	7.1	7.6	8.0	8.2	8.4	8.1	8.4
OVERALL EFF. (%)	0.0	19.2	31.0	35.1	35.6	31.5	22.1
MOTOR EFF. (%)	64.0	66.3	67.9	68.8	69.4	68.7	69.6
PUMP BHP (Hp)	1.8	2.0	2.2	2.4	2.5	2.4	2.6
PUMP Eff. %	0.0	28.9	45.7	51.0	51.3	45.9	31.7

Calculated Reduced Speed Data Points Speed (rpm) **1580**

TEST NO.	1	2	3	4	5	6	7
DISCHARGE (GPM)	0.0	45.0	90.3	125.7	161.9	192.3	226.6
PUMP TDH (Ft)	46.0	38.6	33.7	28.9	23.5	16.9	10.6
OVERALL EFF. (%)	0.0	19.2	31.0	35.1	35.6	31.5	22.1
PUMP BHP (Hp)	1.3	1.5	1.7	1.8	1.9	1.8	1.9
PUMP Eff. %	0.0	28.9	45.7	51.0	51.3	45.9	31.7

EBARA SUBMERSIBLE PUMPS **DLFU**

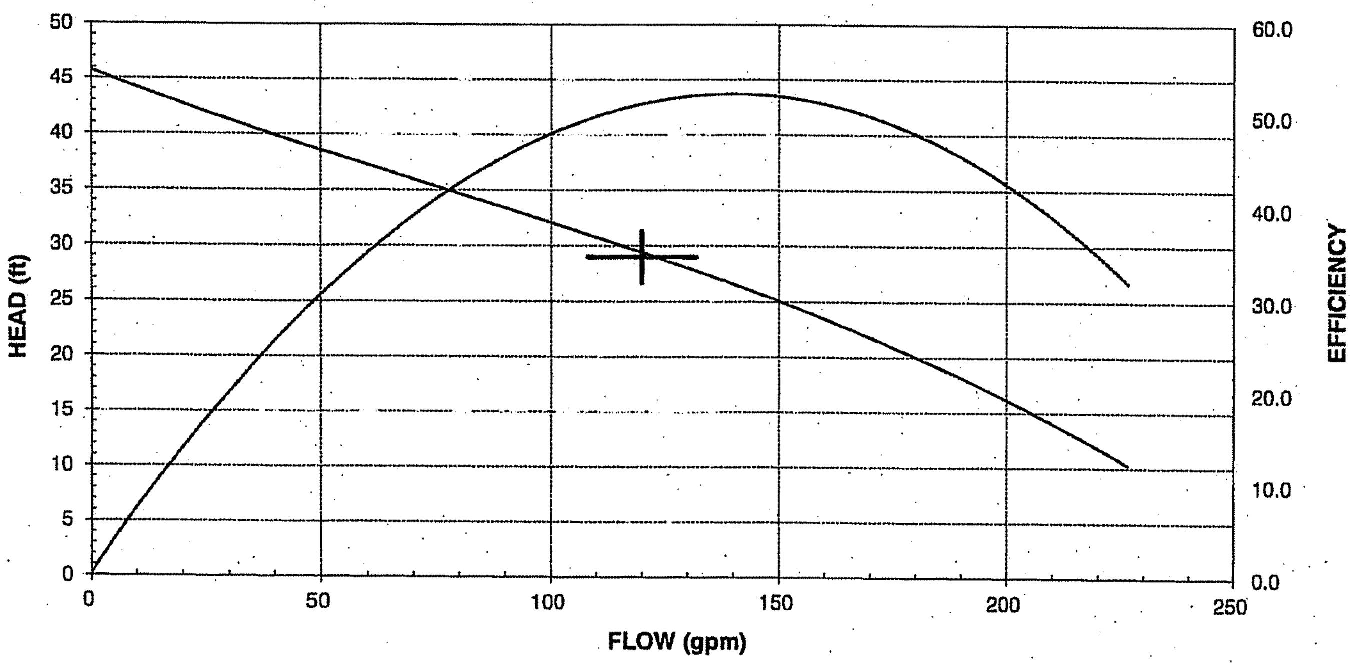
REDUCED SPEED CURVE

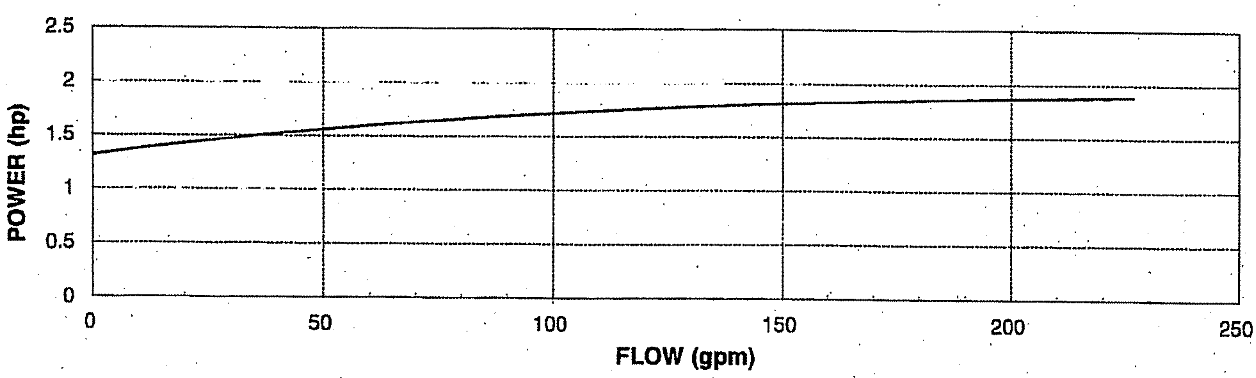
Test Number: **18003-01** Customer: **Pump System** Project:

Serial Number: **C97249/1/2** GPM: **120** TDH: **29** HP: **3** CHEK'D: **SPB** DATE: **1/10/2018**

Pump Model:	Motor HP	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design	Solid Dia. (in)
80DLMFMU62.22	3	1580	3	-	188	-	188	3

Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)	Locked Rotor Current (Amps)	FL Eff. (%)	FL Power Factor (%)
	4	230	3	9.2	63	71.3	84.0





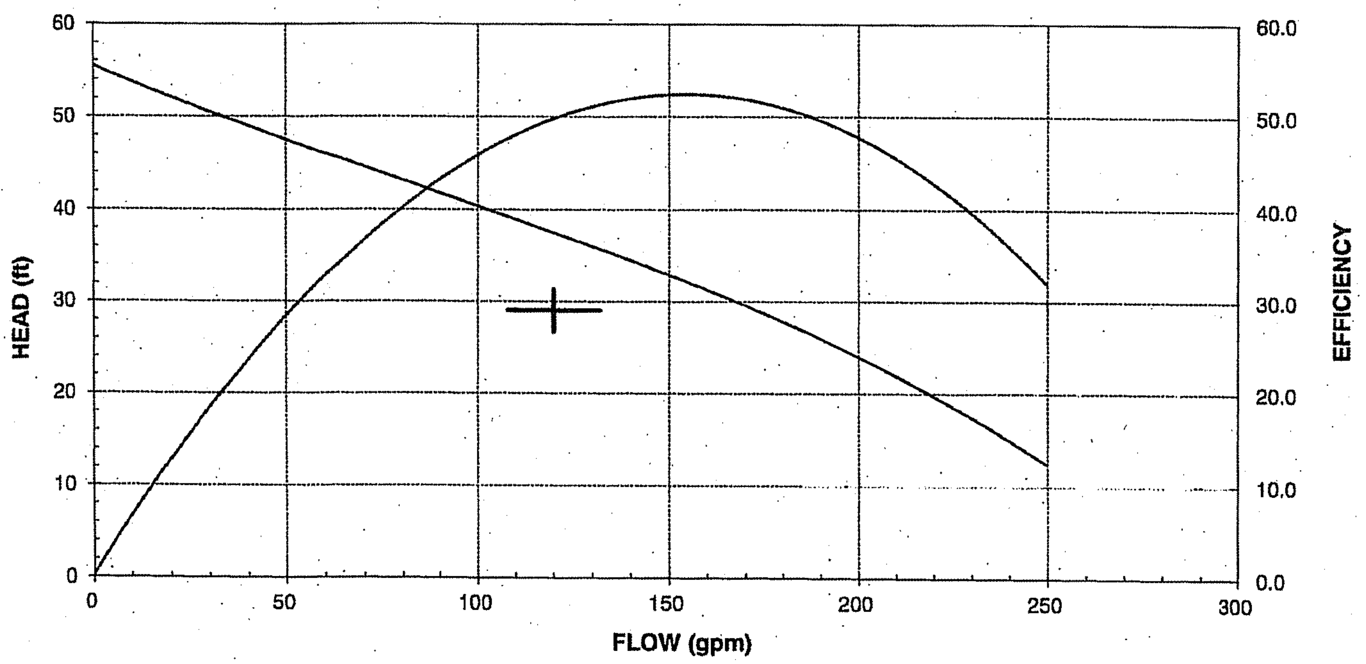
EBARA SUBMERSIBLE PUMPS DLFU

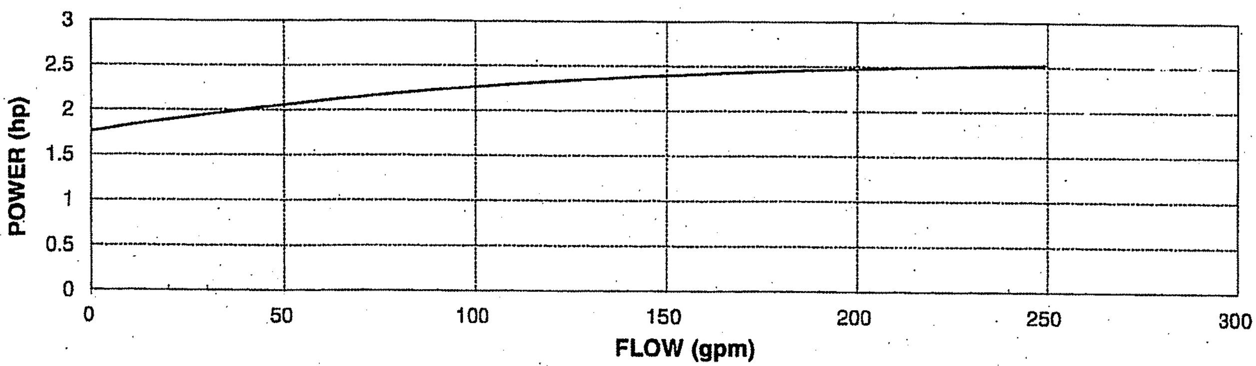
PERFORMANCE TEST CURVE

Test Number:	18003-01	Customer:	Pump System	Project:	

Serial Number:	C97249/1/2	GPM: 120	TDH: 29	HP:	3	CHEK'D:	SPB	DATE:	1/10/2018

Pump Model:		Motor HP	Speed (rpm)	Discharge Size (in)	Suction Size (in)	Impeller Trim Max	Impeller Trim Min	Impeller Trim Design	Solid Dia. (in)
80DLMFMU62.22		3	1740	3	-	188	-	188	3
Motor Data:	Poles #	Voltage (V)	Phase (hz)	Full Load Current (Amps)		Locked Rotor Current (Amps)		FL Eff. (%)	FL Power Factor (%)
	4	230	3	9.2		63		71.3	84.0





Submersible Wastewater, Sewage Pump

Model DLFU
Model DLFMU
Model DLKFU
Model DLKFMU

Operating Instructions, Installation & Maintenance Manual

EBARA

EBARA International Corporation, Fluid Handling Division

Contents

Section **Page**

Safety Information and Introduction

WARNING

Before handling this pump, always disconnect the power first. Do not use sparkable electrical devices or flames in a septic (gaseous) or possible septic sump.

Do not work under heavy suspended object unless there is a positive support under it to stop its fall in event of sling or hoist failure. Disregard of this warning could result in personal injury.

This pump should only be serviced by qualified or factory trained personnel.

CAUTION

This instruction manual includes necessary items for installation, operation and maintenance. Read this manual carefully to ensure correct installation, operation and maintenance.

Be sure to keep this instruction manual on hand for future reference.

Design of this EBARA pump is based on superior engineering and long experience. To prevent trouble and provide satisfactory operation and long life, it is important to understand the EBARA pump thoroughly by careful study of this manual. If any questions arise regarding this manual, please direct them to EBARA INTERNATIONAL CORPORATION.

Specifications

CAUTION

Be careful not to exceed the given specifications in the use of your products.

Check the nameplate for your pump's head (HEAD), discharge volume (CAPACITY), speed (SPEED), motor voltage and current. Other specifications are noted in the chart below.

Item		Specifications
Liquid handled	Type	Sewage, waste water, miscellaneous drain water
	Temperature	32 - 104° F
Materials	Casing	Cast iron
	Impeller	Cast iron
	Shaft	Stainless Steel
Motor type		Air filled submersible motor
Shaft seal lubrication oil		Turbine No. 32 ISO VG - 32
Maximum water depth		65 ft
Installation		with Quick Discharge Connector or floor mounted

Pump Checks

1. Check the following points upon receipt of your pump:

(1) Check the name plate to confirm that it is the pump ordered.
(2) Ensure that the pump voltage is the same as the power at your location.
(3) Check oil level at oil plug.
(4) Check that all plugs and fastening bolts are properly tightened.
(5) Check that the pump has not been damaged and the cable glands and cables are in a satisfactory condition.
(6) Check accessories and spare parts against the packing list.
(7) Check that the impeller turns smoothly by hand.

2. Precautions when operation is suspended:

(1) If operation is to be suspended for 30 days with the pump immersed in water, measure the insulation resistance of the motor.
If resistance is over 1 mega ohm, operate pump to prevent rust from developing on moving parts. Follow the instructions under OPERATION when pump operation is to be resumed.
(2) For dry storage, clean out pump and store in a dry place. Follow the instructions under INSTALLATION and OPERATION when pump operation is to be resumed.

Installation

1. Check the following before beginning installation:

WARNING

Before insulation resistance measurement, always disconnect the power first.

All electrical work should be performed by a qualified electrician and all national and local electrical codes must be observed.

CAUTION

When measuring the insulation resistance with meggar for motor windings do not test overload protection.

MINIATURE THERMAL PROTECTION (MTP) AND LEAKAGE DETECTOR (LD) ARE USED FOR MOTOR PROTECTION. MTP AND LD CABLES MUST BE INSTALLED IN CONTROL CIRCUIT.

Insulation resistance measurement:
(1) For three phase motor:
With the motor and cable (excluding the power supply connections) immersed in water, use a meggar to measure the insulation resistance between, the ground wire and each phase of the motor.

CAUTION

Measure the insulation resistance. The value should be more than I mega ohm. While making the measurement, keep the power supply cable off the ground.

Installation

2. Pump Installation

WARNING

When lifting the pump, use appropriate crane (or hoist) and lift system, check position and tightness of lift system so that weight of the pump is not UNBALANCED.
Failure to observe this precaution can result in serious accidents.
Handle the cables very carefully. If they are bent or pulled excessively, the cable and the cable entry may be damaged, resulting in insulation failure. Also, care is needed to protect cable ends against water intrusion.

CAUTION

Before installation check rotation. Correct rotation is clockwise when viewed from top of motor. Read ELECTRICAL WIRING.

1. Clean the installation area.
2. Under no circumstances should the cable be pulled while the pump is being transported or installed. Attach a chain or rope to the grip and install the pump.
3. This pump must not be installed on its side. Ensure that it is installed upright on a secure base.
4. Install the pump at a location in the tank where there is the least turbulence.
5. If there is a flow of liquid inside the tank, support the cable where appropriate (See Fig. 1).
6. Install piping so that air will not be entrapped. If piping must be installed in such a way that air pockets are unavoidable, install an air release valve wherever such air pockets are most likely to develop.
7. Do not permit end of discharge piping to be submerged, as backflow will result when the pump is shut down.
8. Non-automatic pumps (model DLFU, DLMFU) do not have an automatic operating system based on built-in floats. Do not operate the pump for a long time with the water level near the minimum operating level as the automatic cut-off switch incorporated inside the motor will be activated.

   To avoid dry operation, install an automatic operating system, as shown in Fig. 2 and maintain a safe operating water level.

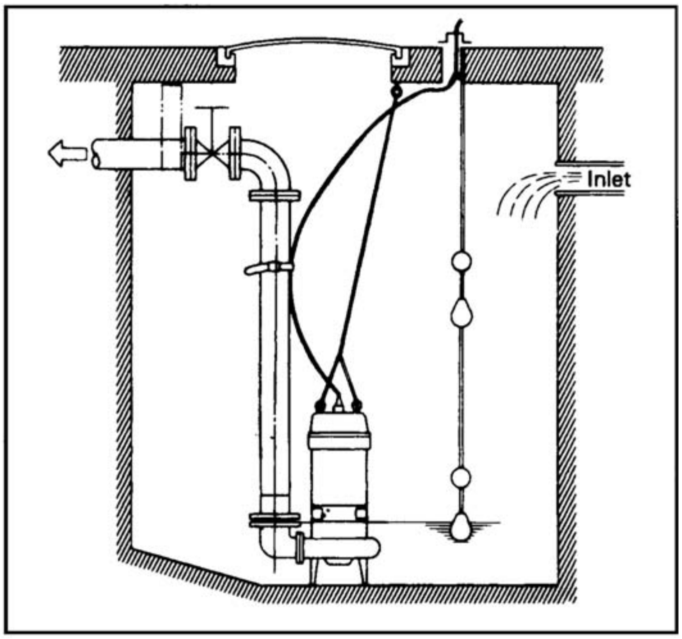


Fig. 1

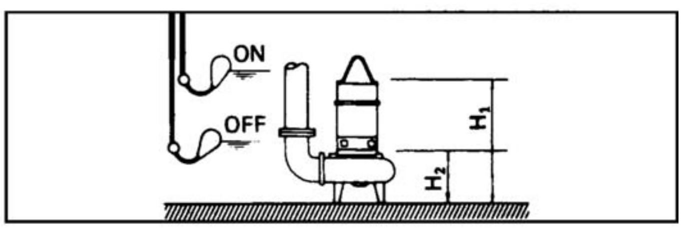


Fig. 2

H_1: Operating water level
This must be above the top of the motor.

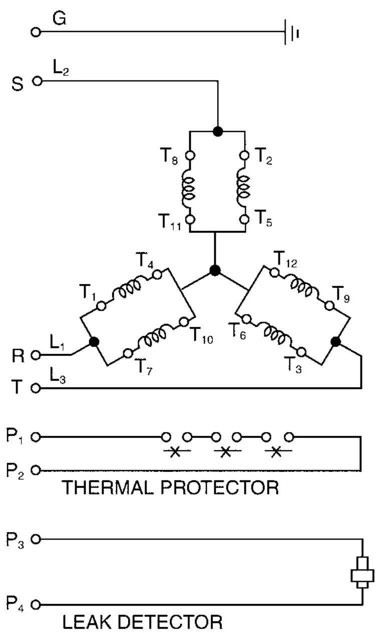
H_2: Lowest water level (motor flange)

Installation
3. Electrical Wiring:

⚠ WARNING
Check that the power is locked off and disconnected before working on pump. All electrical work should be performed by a qualified electrician and all national and local electrical codes must be observed.

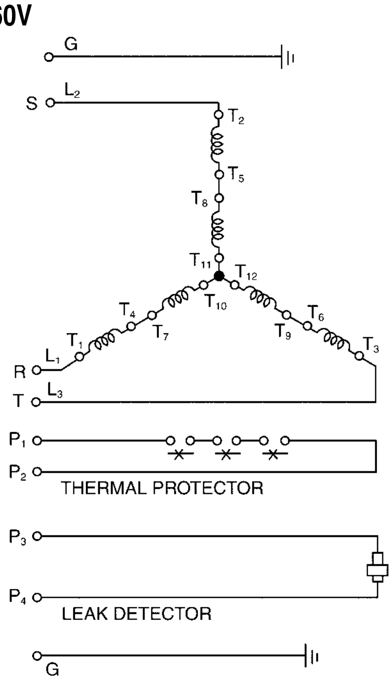
(1) Wiring
a) Wire as indicated for the appropriate start system as shown in Fig. 3.
b) Loose connections will stop the pump. Make sure all electrical connections are secure.

Output 2 to 5HP
208/230V



G – GRN
L_1 – RED – T_1 – T_7
L_2 – WHT – T_2 – T_8
L_3 – BLK – T_3 – T_9
T_4 – T_5 – T_6 – T_{10} – T_{11} – T_{12}
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – OR
G – GRN

460V

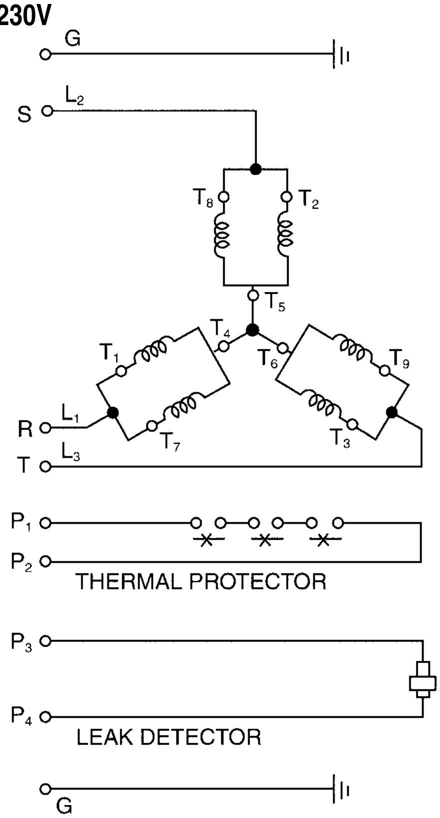


G – GRN
L_1 – RED – T_1
L_2 – WHT – T_2
L_3 – BLK – T_3
T_4 – T_7
T_5 – T_8
T_6 – T_9
T_{10} – T_{11} – T_{12}
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

Installation – Electrical Wiring

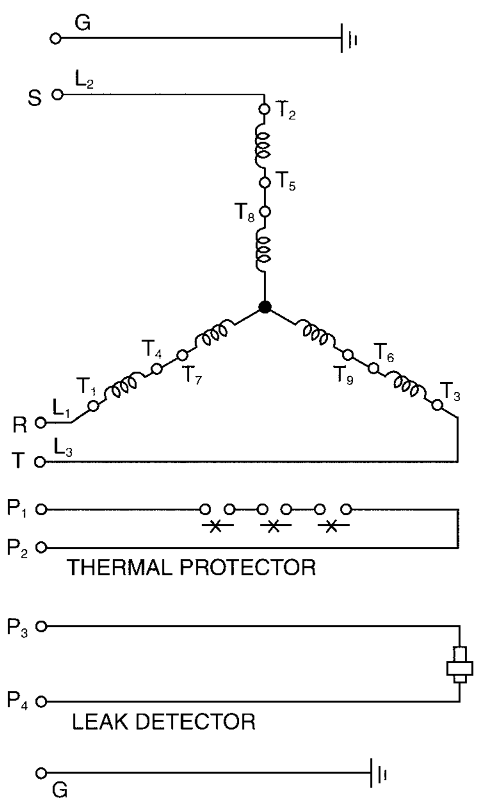
Output 7.5 to 10HP

208/230V



G – GRN
L_1 – RED – T_1 – T_7
L_2 – WHT – T_2 – T_8
L_3 – BLK – T_3 – T_9
T_4 – T_5 – T_6
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

460V

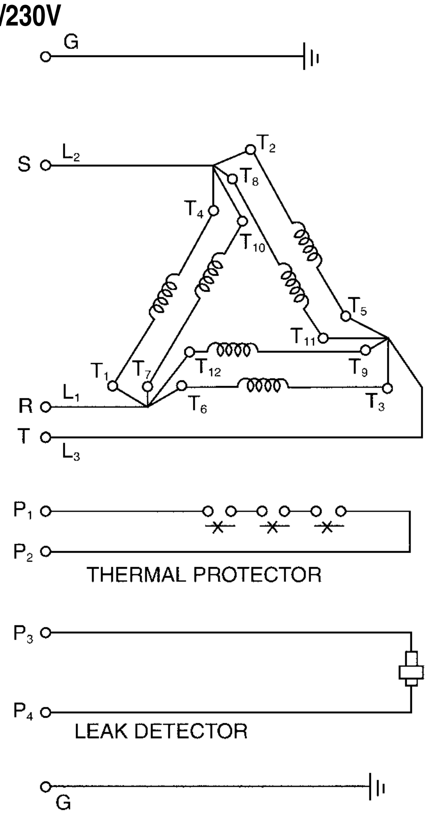


G – GRN
L_1 – RED – T_1
L_2 – WHT – T_2
L_3 – BLK – T_3
T_4 – T_7
T_5 – T_8
T_6 – T_9
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

Installation – Electrical Wiring

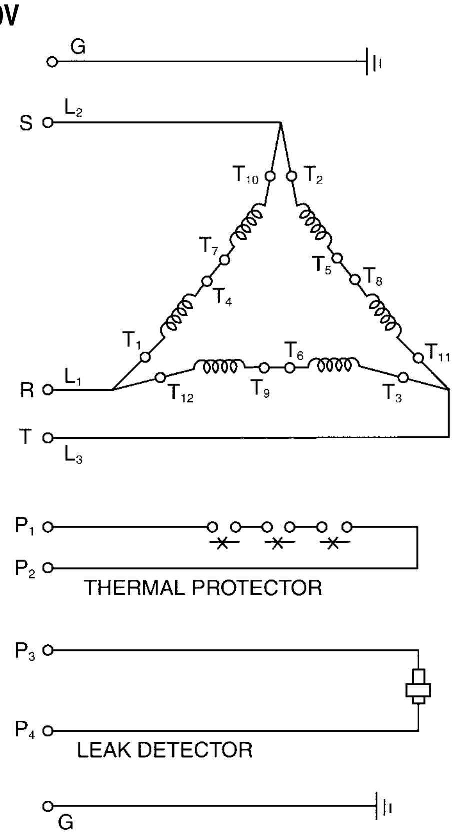
Output 15 to 30HP

208/230V



G – GRN
L_1 – RED – T_1 – T_7 – T_6 – T_{12}
L_2 – WHT – T_4 – T_8 – T_2 – T_{10}
L_3 – BLK – T_3 – T_9 – T_5 – T_{11}
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

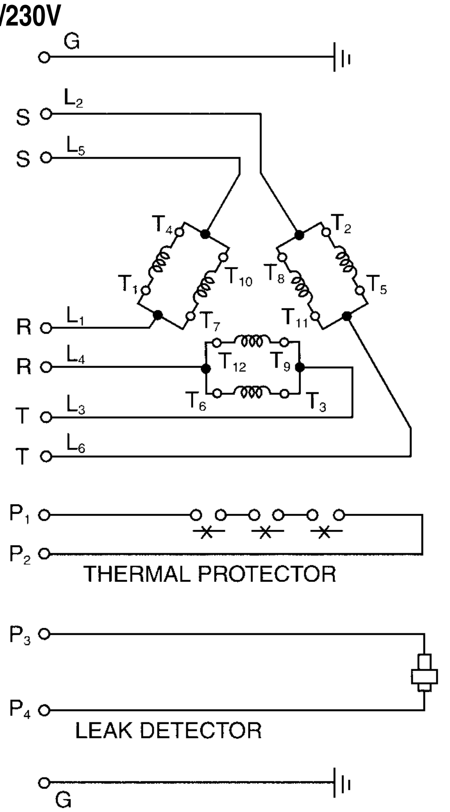
460V



G – GRN
L_1 – RED – T_1 – T_{12}
L_2 – WHT – T_2 – T_{10}
L_3 – BLK – T_3 – T_{11}
T_4 – T_7
T_5 – T_8
T_6 – T_9
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

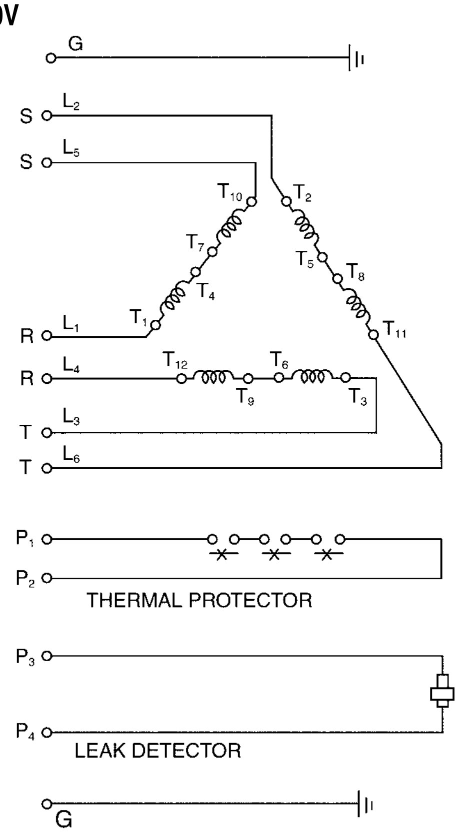
Installation – Electrical Wiring

Output 40 to 60HP
208/230V



G – GRN
L_1 – RED – T_1 – T_7
L_2 – WHT – T_2 – T_8
L_3 – BLK – T_3 – T_9
L_5 – WHT – T_4 – T_{10}
L_6 – BLK – T_5 – T_{11}
L_4 – RED – T_6 – T_{12}
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – ORG
G – GRN

460V



G – GRN
L_1 – RED – T_1
L_2 – WHT – T_2
L_3 – BLK – T_3
L_5 – WHT – T_{10}
L_6 – BLK – T_{11}
L_4 – RED – T_{12}
T_4 – T_7
T_5 – T_8
T_6 – T_9
P_1 – RED
P_2 – WHT
P_3 – BLK
P_4 – OR
G – GRN

Installation

(2) Cable
- a) Never let the end of the cable contact water
- b) If the cable is extended, do not immerse the splice in water.
- c) Fasten the cable to the discharge piping with tape or vinyl strips.
- d) Install the cable so that it will not overheat. Overheating is caused by coiling the cable and exposing it to direct sunlight.

(3) Grounding
As shown in Fig. 4 ground the green wire (label E). Under no circumstances should the green wire be connected to the power supply.

(4) Use short circuit breakers to prevent danger of electrical shock.

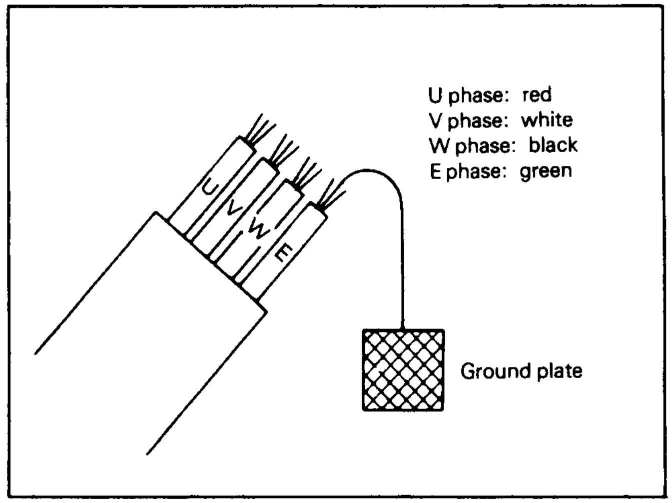


Fig. 4

Operation

1. Before starting the pump:

(1) After completing installation, measure the insulation resistance again as described in INSTALLATION.
(2) Check water level.
If the pump is operated continuously for an extended period of time in a dry condition or at the lowest water level, the thermal protector will be activated.
Constant repetition of this action will shorten pump service life. Do not start the pump again in such a situation until after the motor has completely cooled.

2. Test Operation:

⚠ CAUTION
Check rotation. Correct rotation is clockwise when viewed from top of motor. Pump should be started with gate valve closed, and then the operator should open the valve gradually.

(1) Model DL(K)FU, DL(K)MFU
- a) Turn the operating switch on and off a couple of times to check for normal pump start.
- b) Check the direction of rotation. If discharge volume is low or unusual sounds are heard when the pump is operating, rotation has been reversed. When this happens, reverse two of the three wires.
- c) Check amperage, voltage, and head pressure.

Maintenance and Service

⚠ WARNING
Disconnect power cable from power source before servicing unit.
Normal maintenance should be done by qualified personnel.

Check pressure, output, voltage, current, vibration, and other specifications. Unusual readings may indicate a problem requiring immediate service. Contact your local EBARA INTERNATIONAL CORPORATION representative as soon as possible.

Maintenance and Service

1. **Daily inspections:**
   (1) Check current and ammeter fluctuation daily. If ammeter fluctuation is great, even though within the limits of pump rating, foreign matter may be clogging the pump. If the quantity of liquid discharged falls suddenly, foreign matter may be blocking the suction inlet.
2. **Regular inspections:**
   (1) Monthly inspections
   Measure the insulation resistance. The value should be more than 1 mega ohm. If resistance starts to fall rapidly even with an initial indication of over 1 mega ohm, this may be an indication of trouble and repair work is required.
   (2) Every 6 months
   Check the mechanical seal every six months. If you notice water mixed with the oil or cloudy texture of the oil, these may be indications of a defective mechanical seal requiring replacement. The service life of the mechanical seal can be prolonged by replacing the oil in the mechanical seal chamber once a year. When replacing the oil, lay the pump on its side, with filler plug on top as shown in Fig. 5.

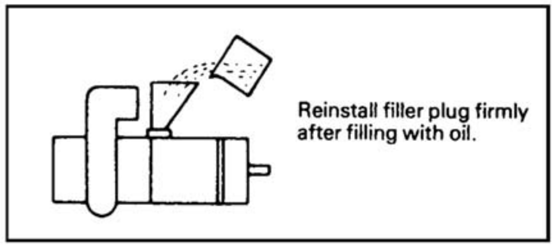


Fig. 5

Oil Capacities for DLF/DLFMU pumps

HP	Oil	HP	Oil
2	31 ozs	20	120 ozs
3	42 ozs	25	115 ozs
5	47 ozs	30	120 ozs
7 1/2	75 ozs	40	220 ozs
10	75 ozs	50	240 ozs
15	75 ozs	60	240 ozs

Table 1

   (3) Preventive maintenance yearly
   Conduct an overhaul of the pump annually. These intervals will reduce the possibility of future trouble.

3. Parts that will need to be replaced:
Replace the appropriate part when the following conditions are apparent.

Replaceable Part	Mechanical Seal	Oil Filter plug gasket	Lubricating oil	O-ring
Replacement guide	Whenever oil in mechanical seal chamber is clouded	Whenever oil is replaced or inspected	Whenever clouded or dirty	Whenever pump is overhauled
Frequency	Annually	Annually	Annually	Annually

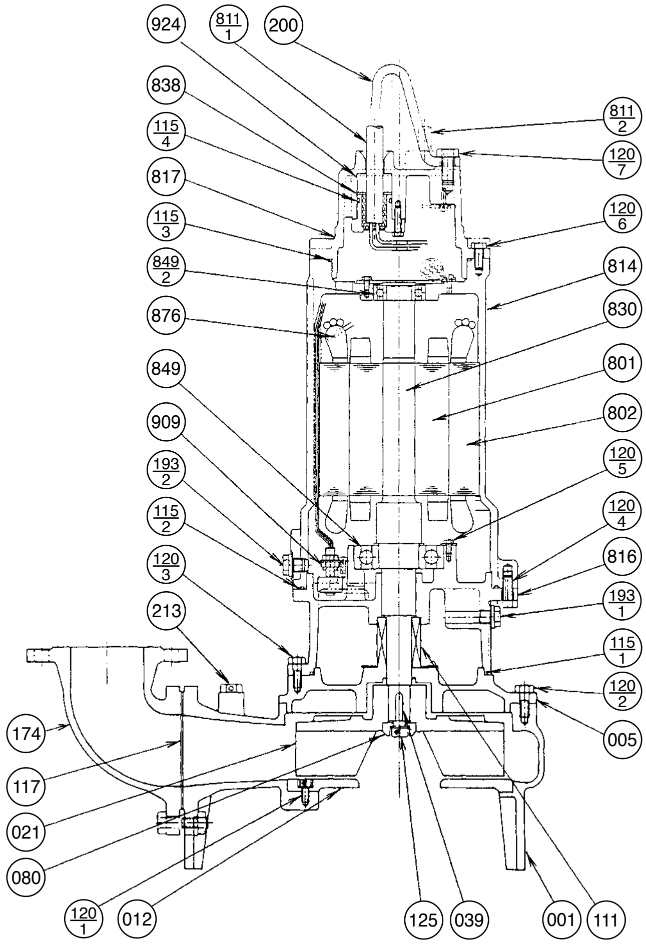
Above replacement schedule is based on normal operating conditions.

Troubleshooting

CAUTION
All service should be done by factory trained or qualified personnel only.

Trouble	Cause	Remedy
Does not start. Starts, but immediately stops.	(1) Power failure (2) Large discrepancy between power source and voltage (3) Significant drop in voltage (4) Motor phase malfunction (5) Electric circuit connection faulty (6) Faulty connection of control circuit (7) Blown fuse (8) Faulty magnetic switch (9) Water is not at level indicated by float (10) Float is not in appropriate level (11) Float defective (12) Short circuit breaker is functioning (13) Foreign matter clogging pump (14) Motor burned out (15) Motor bearing broken	(1)-(3) Contact electric power company; devise counter-measures (4) Inspect connections and magnetic switch (5) Inspect electric circuit (6) Correct wiring (7) Replace with correct type of fuse (8) Replace with correct type of magnetic switch (9) Raise water level (10) Move float to an appropriate starting level (11) Repair or replace (12) Repair location of short circuit (13) Remove foreign matter (14) Repair or replace (15) Repair or replace
Operates, but stops after a while.	(1) Prolonged dry operation has activated motor protector and caused pump to stop (2) High liquid temperature has activated motor protector and caused pump to stop	(1) Raise stop water level (2) Lower liquid temperature
Does not pump. Inadequate volume.	(1) Reverse rotation (2) Significant drop in voltage (3) Operating a 60Hz pump on 50Hz (4) Discharge head is high (5) Large piping loss (6) Low operating water level causes air suction (7) Leaking from discharge piping (8) Clogging of discharge piping (9) Foreign Matter in suction inlet (10) Foreign matter clogging pump (11) Worn impeller	(1) Correct rotation (see Operation 2, (3)) (2) Contact electric power company and devise counter-measures (3) Check nameplate (4) Recalculate and adjust (5) Recalculate and adjust (6) Raise water level or lower pump (7) Inspect, repair (8) Remove foreign matter (9) Remove foreign matter (10) Disassemble and remove foreign matter (11) Replace impeller
Over current	(1) Unbalanced current and voltage (2) Significant voltage drop (3) Motor phase malfunction (4) Operating 50HZ pump on 60Hz (5) Reverse rotation (6) Low head; excessive volume of water (7) Foreign matter clogging pump (8) Motor bearing is worn or damaged	(1) Contact electric power company and devise counter-measure (2) Contact electric power company and devise counter-measure (3) Inspect connections and magnetic switch (4) Check nameplate (5) Correct rotation (see Operation 2. (3)) (6) Replace pump with low head pump (7) Disassemble and remove foreign matter (8) Replace bearing
Pump vibrates; excessive operating noise.	(1) Reverse rotation (2) Pump clogged with foreign matter (3) Piping resonates (4) Gate valve is closed too far	(1) Correct rotation (2) Disassemble and remove foreign matter (3) Improve piping (4) Open gate valve

2 to 5HP

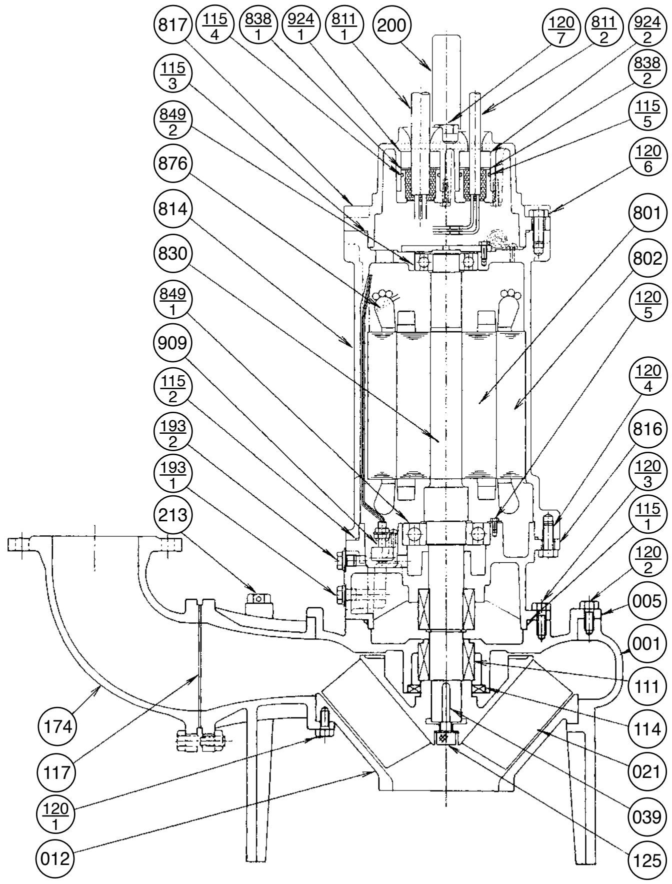


PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
001	CASING	CAST IRON	A48 Class 30	1
005	INTERMEDIATE CASING	CAST IRON	A48 Class 30	1
†012	SUCTION COVER	CAST IRON	A48 Class 30	1
†021	IMPELLER	CAST IRON	A48 Class 30	1
039	KEY	420 STAINLESS	AISI420	1
080	BUSHING	STEEL	A283 Grade D	1
†111	MECHANICAL SEAL	–		1 SET
†115-1	O-RING	RUBBER (NBR)		1
†115-2	O-RING	RUBBER (NBR)		1
†115-3	O-RING	RUBBER (NBR)		1
†115-4	O-RING	RUBBER (NBR)		2
†117	GASKET			1
120-1	BOLT	304 STAINLESS	AISI304	4
120-2	BOLT	304 STAINLESS	AISI304	8
120-3	BOLT	304 STAINLESS	AISI304	4
120-4	BOLT	304 STAINLESS	AISI304	4
120-5	BOLT	304 STAINLESS	AISI304	3
120-6	BOLT	304 STAINLESS	AISI304	4
120-7	BOLT	304 STAINLESS	AISI304	2
125	BOLT	304 STAINLESS	AISI304	1

PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
174	DISCHARGE ELBOW	CAST IRON	A48 Class 30	1
193-1	PLUG	304 STAINLESS	AISI304	1
193-2	PLUG	304 STAINLESS	AISI304	1
200	LIFTING HANGER	STEEL	A283 Grade D	1
213	AIR VENT VALVE	BRASS	B36 No. 272	1
801	ROTOR	–		1
802	STATOR	–		1
811-1	POWER CABLE	–		1
811-2	CONTROL CABLE	–		1
814	MOTOR COVER	CAST IRON	A48 Class 30	1
816	BRACKET	CAST IRON	A48 Class 30	1
817	BRACKET	CAST IRON	A48 Class 30	1
830	SHAFT	403 STAINLESS	AISI403	1
838	WASHER	304 STAINLESS	AISI304	2
†849-1	BALL BEARING	–		1
†849-2	BALL BEARING	–		1
876	MOTOR PROTECTOR	–		3
909	LEAKAGE DETECTOR	–		1
924	PACKING	RUBBER (NBR)		2

Motors are purchased as a complete unit
†: Recommended spare parts

7½ to 10HP

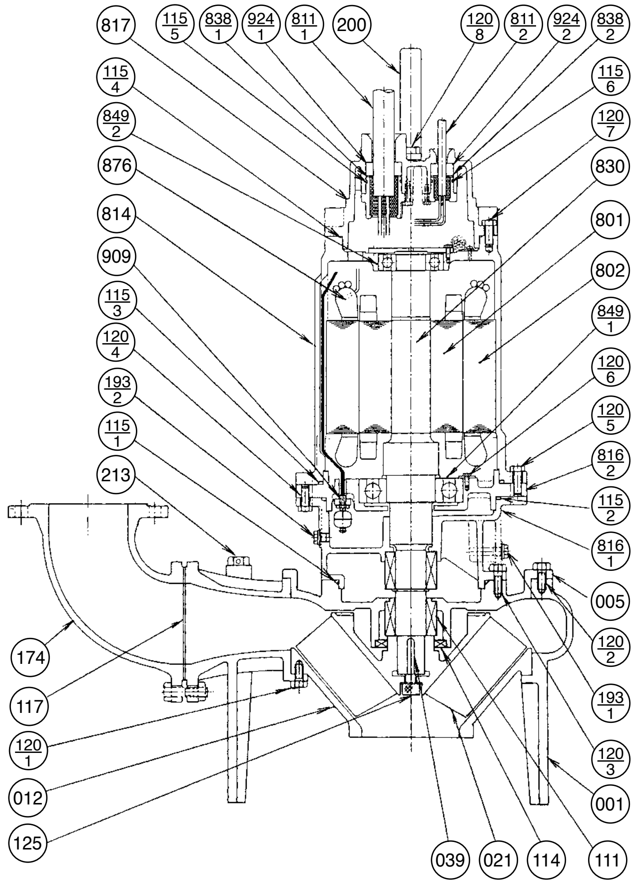


PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
001	CASING	CAST IRON	A48 Class 30	1
005	INTERMEDIATE CASING	CAST IRON	A48 Class 30	1
†012	SUCTION COVER	CAST IRON	A48 Class 30	1
†021	IMPELLER	CAST IRON	A48 Class 30	1
039	KEY	420 STAINLESS	AISI420	1
†111	MECHANICAL SEAL	–		1 SET
†114	OIL SEAL	RUBBER (NBR)		1
†115-1	O-RING	RUBBER (NBR)		1
†115-2	O-RING	RUBBER (NBR)		1
†115-3	O-RING	RUBBER (NBR)		1
†115-4	O-RING	RUBBER (NBR)		1
†115-5	O-RING	RUBBER (NBR)		1
†117	GASKET			1
120-1	BOLT	304 STAINLESS	AISI304	4
120-2	BOLT	304 STAINLESS	AISI304	8
120-3	BOLT	304 STAINLESS	AISI304	4
120-4	BOLT	304 STAINLESS	AISI304	6
120-5	BOLT	304 STAINLESS	AISI304	3
120-6	BOLT	304 STAINLESS	AISI304	4
120-7	BOLT	304 STAINLESS	AISI304	2
125	BOLT	304 STAINLESS	AISI304	1

PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
174	DISCHARGE ELBOW	CAST IRON	A48 Class 30	1
193-1	PLUG	304 STAINLESS	AISI304	1
193-2	PLUG	304 STAINLESS	AISI304	1
200	LIFTING HANGER	STEEL	A283 Grade D	1
213	AIR VENT VALVE	BRASS	B36 No. 272	1
801	ROTOR	–		1
802	STATOR	–		1
811-1	POWER CABLE	–		1
811-2	CONTROL CABLE	–		1
814	MOTOR COVER	CAST IRON	A48 Class 30	1
816	BRACKET	CAST IRON	A48 Class 30	1
817	BRACKET	CAST IRON	A48 Class 30	1
830	SHAFT	420J2 STAINLESS	AISI420	1
838-1	WASHER	304 STAINLESS	AISI304	1
838-2	WASHER	304 STAINLESS	AISI304	1
†849-1	BALL BEARING	–		1
†849-2	BALL BEARING	–		1
876	MOTOR PROTECTOR	–		3
909	LEAKAGE DETECTOR	–		1
924-1	PACKING	RUBBER (NBR)		1
924-2	PACKING	RUBBER (NBR)		1

Motors are purchased as a complete unit
†: Recommended spare parts

15 to 30HP

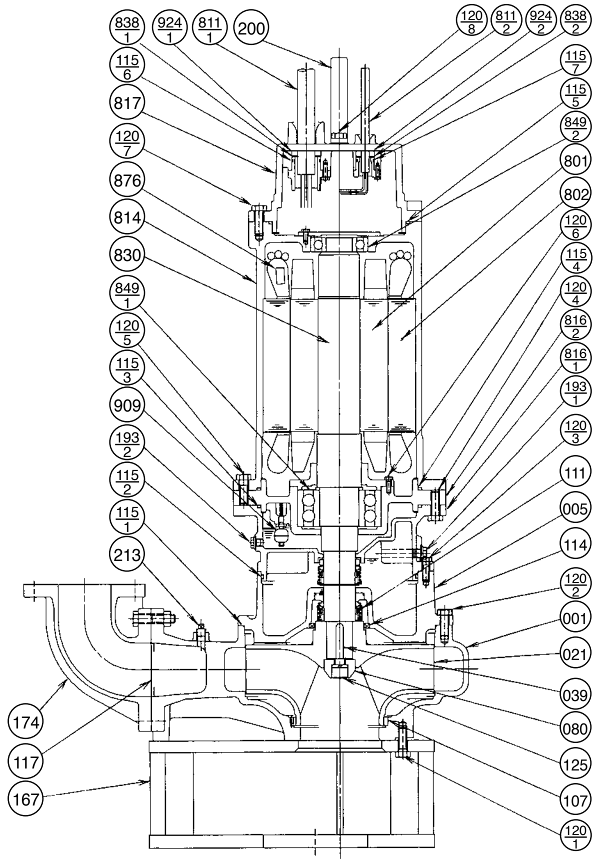


PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
001	CASING	CAST IRON	A48 Class 30	1
005	INTERMEDIATE CASING	CAST IRON	A48 Class 30	1
†012	SUCTION COVER	CAST IRON	A48 Class 30	1
†021	IMPELLER	CAST IRON	A48 Class 30	1
039	KEY	420 STAINLESS	AISI420	1
†111	MECHANICAL SEAL	–		1 SET
†114	OIL SEAL	RUBBER (NBR)		1
†115-1	O-RING	RUBBER (NBR)		1
†115-2	O-RING	RUBBER (NBR)		1
†115-3	O-RING	RUBBER (NBR)		1
†115-4	O-RING	RUBBER (NBR)		1
†115-5	O-RING	RUBBER (NBR)		1
†115-6	O-RING	RUBBER (NBR)		1
†117	GASKET			1
120-1	BOLT	304 STAINLESS	AISI304	4
120-2	BOLT	304 STAINLESS	AISI304	8
120-3	BOLT	304 STAINLESS	AISI304	4
120-4	BOLT	304 STAINLESS	AISI304	6
120-5	BOLT	304 STAINLESS	AISI304	6
120-6	BOLT	304 STAINLESS	AISI304	3
120-7	BOLT	304 STAINLESS	AISI304	6
120-8	BOLT	304 STAINLESS	AISI304	2
125	BOLT	304 STAINLESS	AISI304	1

PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
174	DISCHARGE ELBOW	CAST IRON	A48 Class 30	1
193-1	PLUG	304 STAINLESS	AISI304	1
193-2	PLUG	304 STAINLESS	AISI304	1
200	LIFTING HANGER	STEEL	A283 Grade D	1
213	AIR VENT VALVE	BRASS	B36 No. 272	1
801	ROTOR	–		1
802	STATOR	–		1
811-1	POWER CABLE	–		1
811-2	CONTROL CABLE	–		1
814	MOTOR COVER	CAST IRON	A48 Class 30	1
816-1	BRACKET	CAST IRON	A48 Class 30	1
816-2	BRACKET	CAST IRON	A48 Class 30	1
817	BRACKET	CAST IRON	A48 Class 30	1
830	SHAFT	420J2 STAINLESS	AISI420	1
838-1	WASHER	304 STAINLESS	AISI304	1
838-2	WASHER	304 STAINLESS	AISI304	1
†849-1	BALL BEARING	–		1
†849-2	BALL BEARING	–		1
876	MOTOR PROTECTOR	–		3
909	LEAKAGE DETECTOR	–		1
924-1	PACKING	RUBBER (NBR)		1
924-2	PACKING	RUBBER (NBR)		1

Motors are purchased as a complete unit
†: Recommended spare parts

40 to 60HP
100DLFU

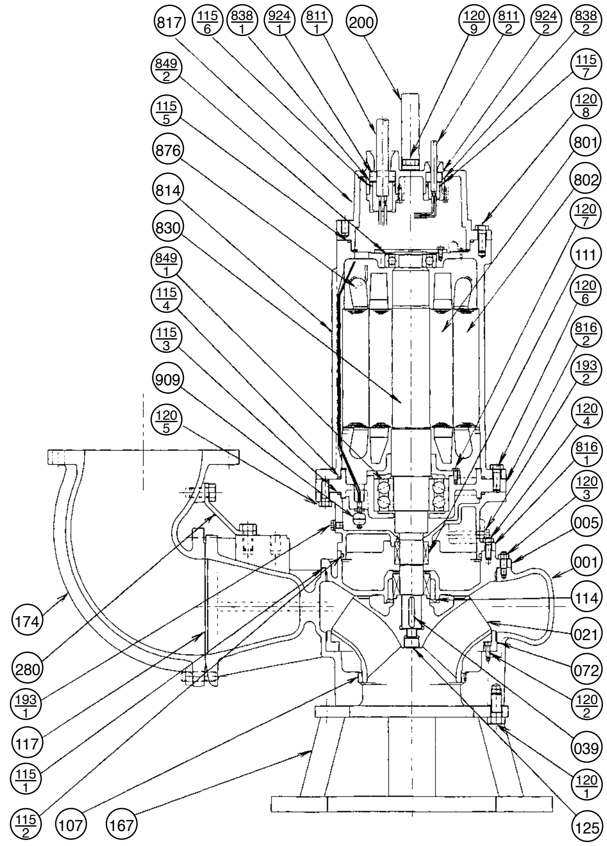


PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
001	CASING	CAST IRON	A48 Class 30	1
005	INTERMEDIATE CASING	CAST IRON	A48 Class 30	1
†021	IMPELLER	CAST IRON	A48 Class 30	1
039	KEY	420 STAINLESS	AISI420	1
080	BUSHING	304 STAINLESS	AISI 304	1
†107	WEARING RING	304 STAINLESS	AISI 304	1
†111	MECHANICAL SEAL	–		1 SET
†114	OIL SEAL	RUBBER (NBR)		1
†115-1	O-RING	RUBBER (NBR)		1
†115-2	O-RING	RUBBER (NBR)		1
†115-3	O-RING	RUBBER (NBR)		1
†115-4	O-RING	RUBBER (NBR)		1
†115-5	O-RING	RUBBER (NBR)		1
†115-6	O-RING	RUBBER (NBR)		2
†115-7	O-RING	RUBBER (NBR)		1
†117	GASKET			1
120-1	BOLT	304 STAINLESS	AISI304	8
120-2	BOLT	304 STAINLESS	AISI304	8
120-3	BOLT	304 STAINLESS	AISI304	8
120-4	BOLT	304 STAINLESS	AISI304	8
120-5	BOLT	304 STAINLESS	AISI304	6
120-6	BOLT	304 STAINLESS	AISI304	4
120-7	BOLT	304 STAINLESS	AISI304	6
120-8	BOLT	304 STAINLESS	AISI304	2

PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
125	BOLT	304 STAINLESS	AISI304	1
*167	BASE	STEEL	A283 Grade D	1
174	DISCHARGE ELBOW	CAST IRON	A48 Class 30	1
193-1	PLUG	304 STAINLESS	AISI304	1
193-2	PLUG	304 STAINLESS	AISI304	1
200	LIFTING HANGER	STEEL	A283 Grade D	1
213	AIR VENT VALVE	BRASS	B36 No. 272	1
801	ROTOR	–		1
802	STATOR	–		1
811-1	POWER CABLE	–		2
811-2	CONTROL CABLE	–		1
814	MOTOR COVER	CAST IRON	A48 Class 30	1
816-1	BRACKET	CAST IRON	A48 Class 30	1
816-2	BRACKET	CAST IRON	A48 Class 30	1
817	BRACKET	CAST IRON	A48 Class 30	1
830	SHAFT	420J2 STAINLESS	AISI420	1
838-1	WASHER	304 STAINLESS	AISI304	2
838-2	WASHER	304 STAINLESS	AISI304	1
†849-1	BALL BEARING	–		1 SET
†849-2	BALL BEARING	–		1
876	MOTOR PROTECTOR	–		3
909	LEAKAGE DETECTOR	–		1
924-1	PACKING	RUBBER (NBR)		2
924-2	PACKING	RUBBER (NBR)		1

Motors are purchased as a complete unit
†: Recommended spare parts
*: Option for hard-piped installations

40 to 60HP
150DLFU
200DLFU
250DLFU
300DLFU



PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
001	CASING	CAST IRON	A48 Class 30	1
005	INTERMEDIATE CASING	CAST IRON	A48 Class 30	1
†021	IMPELLER	DUCTILE IRON	A536 60-40-18	1
039	KEY	420 STAINLESS	AISI420	1
†072	SIDE RING	CAST IRON	A48 Class 30	1
†107	WEARING RING	304 STAINLESS	AISI304	1
†111	MECHANICAL SEAL	–		1 SET
†114	OIL SEAL	RUBBER (NBR)		1
†115-1	O-RING	RUBBER (NBR)		1
†115-2	O-RING	RUBBER (NBR)		1
†115-3	O-RING	RUBBER (NBR)		1
†115-4	O-RING	RUBBER (NBR)		1
†115-5	O-RING	RUBBER (NBR)		1
†115-6	O-RING	RUBBER (NBR)		2
†115-7	O-RING	RUBBER (NBR)		1
†117	GASKET			1
120-1	BOLT	304 STAINLESS	AISI304	3/4
120-2	BOLT	304 STAINLESS	AISI304	4
120-3	BOLT	304 STAINLESS	AISI304	8
120-4	BOLT	304 STAINLESS	AISI304	4
120-5	BOLT	304 STAINLESS	AISI304	8
120-6	BOLT	304 STAINLESS	AISI304	8
120-7	BOLT	304 STAINLESS	AISI304	4
120-8	BOLT	304 STAINLESS	AISI304	6
120-9	BOLT	304 STAINLESS	AISI304	2

PART NO.	PART NAME	MATERIAL	ASTM, AISI CODE	NO. FOR 1 UNIT
125	BOLT	304 STAINLESS	AISI304	1
*167	BASE	STEEL	A283 Grade D	1
174	DISCHARGE ELBOW	CAST IRON	A48 Class 30	1
193-1	PLUG	304 STAINLESS	AISI304	1
193-2	PLUG	304 STAINLESS	AISI304	1
200	LIFTING HANGER	STEEL	A283 Grade D	1
280	ELBOW SUPPORT	STEEL	A283 Grade D	2
801	ROTOR	–		1
802	STATOR	–		1
811-1	POWER CABLE	–		2
811-2	CONTROL CABLE	–		1
814	MOTOR COVER	CAST IRON	A48 Class 30	1
816-1	BRACKET	CAST IRON	A48 Class 30	1
816-2	BRACKET	CAST IRON	A48 Class 30	1
817	BRACKET	CAST IRON	A48 Class 30	1
830	SHAFT	420J2 STAINLESS	AISI420	1
838-1	WASHER	304 STAINLESS	AISI304	2
838-2	WASHER	304 STAINLESS	AISI304	1
†849-1	BALL BEARING	–		1 SET
†849-2	BALL BEARING	–		1
876	MOTOR PROTECTOR	–		3
909	LEAKAGE DETECTOR	–		1
924-1	PACKING	RUBBER (NBR)		2
924-2	PACKING	RUBBER (NBR)		1

Motors are purchased as a complete unit
†: Recommended spare parts
*: Option for hard-piped installations

Maintenance and Service

6. Disassembly and Assembly:

⚠ CAUTION

All service should be done by factory trained or qualified personnel only.
Be sure to cut off power source before beginning disassembly.

Please contact the following for assistance:
Ebara International Corporation
Customer Service Manager
1651 Cedar Line Drive
Rock Hill, South Carolina 29730

Thermal Protection

The motor shall be equipped with a protector such as automatic cut-off device and thermal protector. The motors described below shall incorporate Miniature Thermal Protectors (MTP) which are embedded in the windings.

When temperature of the winding raises and reaches the MTP acting point, the motor protection circuit is activated to protect motor from over heat.

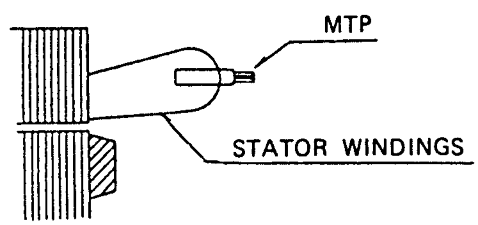
1. **Applicable model**
   Model: DGFU, DL(K)FU, DVFU, DDLFU

2. **MTP Specifications:**

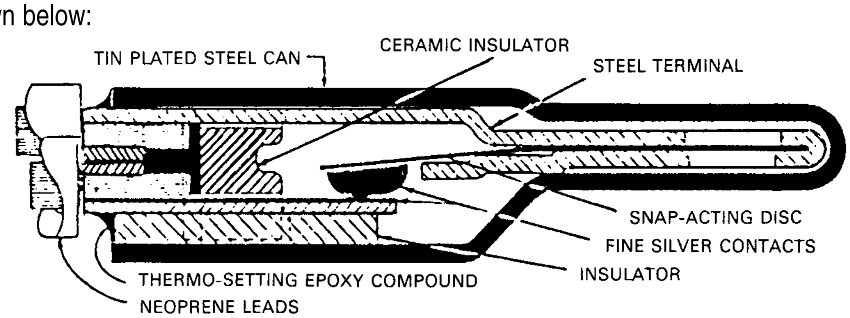
Model	KLIXON 9700K-66-215
Type of Contact	b (Normally-Closed contact Acting-open)
Acting Temperature	140±5 C (284±9 F)
Re-setting Temperature	85±10 C (185±18 F)
Capacity of Contact	

Voltage (V)	DC 24	AC 115	AC 230	AC 460
Amperage (A)	18	18	13	5.5

3. **Installation:**
   MTP shall be embedded in the stator windings as shown at right –



4. Construction:
Construction of the MTP is as shown below:



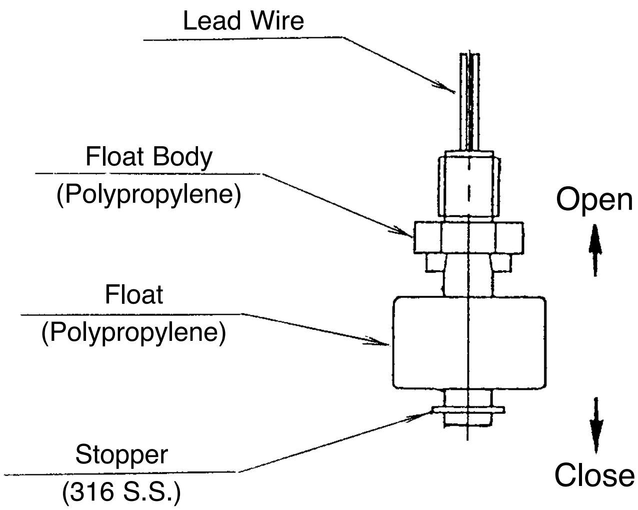
Leakage Detector

1. **Construction:**

   Each switch has a magnet-containing float which senses the liquid level and magnetically actuates a dry reed switch encapsulated within a stem. The switch opens on rise of liquid.

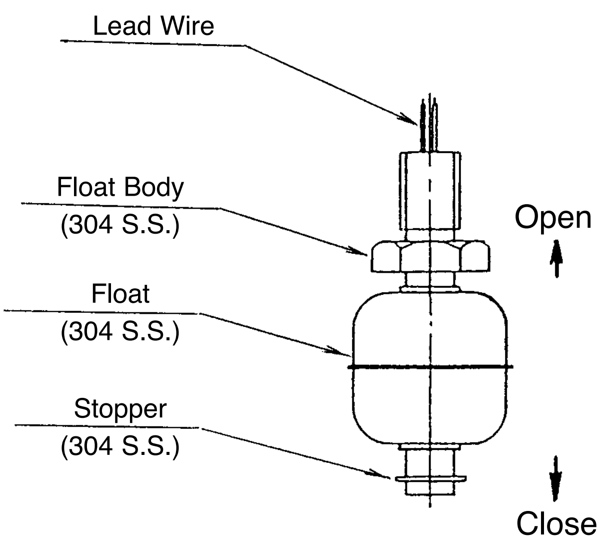
2. **Specifications**

   - Apply to 2 to 30HP



Breaking Capacity	: AC50VA, DC50W
Max. Breaking Current	: AC0.5A, DC0.5A
Max. Operating Voltage	: AC300V, DC300V

   - Apply to 40 to 60HP



Breaking Capacity	: AC12VA, DC10W
Max. Breaking Current	: AC0.6A, DC0.5A
Max. Operating Voltage	: AC200V, DC200V

Limited Warranty

1. **All specifications subject to change without notice**

2. **Limited warranty:**
EIC warrants for a period of twelve months from the date of initial startup or eighteen months from the date of shipment, whichever shall first occur (the "Warranty Period") the EIC Products to be delivered hereunder against defects in material and workmanship, under normal use and service when installed, used and maintained in accordance with instructions supplied by EIC. This is EIC's sole and exclusive warranty. It applies only to EIC Products and specifically excludes Other Equipment, whether or not such Other Equipment is included in EIC's scope of supply hereunder. Such Other Equipment is warranted only by its manufacturer. If such a defect appears in EIC Products within the Warranty Period and Purchaser has given EIC immediate written notice of same, EIC will either repair the part, or at its option replace the part, by shipping a similar part F.O.B. EIC's shipping point, or at its option refund an equitable portion of the purchase price. EIC may require the return of the defective part, transportation prepaid, to establish the claim. All costs of removal, reinstallation, field labor and transportation shall be borne by the Purchaser. No allowance will be made for repairs without EIC's written consent or approval, and the Warranty Period shall not be suspended upon stopping operation for warranty repairs, nor recommence upon completion of the warranty repairs, but shall run continuously from commencement until normal expiration. Repair parts shall carry no greater warranty than the remaining balance of the underlying EIC Product into which they may be installed, expiring at the same time as said underlying warranty.

Any descriptions of the EIC Products or Other Equipment, any specifications, and any samples, models, bulletins, or similar material used in connection with this sale are for the sole purpose of identifying the said Equipment and are not to be construed as express or implied warranties. Unless during the warranty period all repairs or replacements or parts or components for EIC Products are with EIC-approved parts or components, and all warranty service is performed by EIC or its authorized distributor or representative, the warranty responsibility of EIC shall immediately terminate.

EIC MAKES NO OTHER WARRANTY OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED; AND ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED BY EIC AND EXCLUDED FROM THESE CONDITIONS. The Purchaser's sole and exclusive remedy, whether upon warranty, contract or tort, including negligence, will be to proceed under this warranty. All liability of EIC shall terminate no later than the expiration of the Warranty Period.

Contact your dealer or supplier
for more information about other EBARA products:

EBARA International Corporation
Fluid Handling Division
1651 Cedar Line Drive, Rock Hill, SC 29730
t (803) 327-5005 | f (803) 327-5097
www.pumpsebara.com

Submersible Wastewater, Sewage Pump

Model DLFU
Model DVFU
Model DDLFU

water | wastewater | flood control

EBARA

EBARA Fluid Handling

an EBARA International Corporation company

Model DLFU, DLKFU, DDLFU

Standard Specifications

Design	Discharge	2, 3, 4, 6, 8, 10, 12 inch
	Horsepower	2 to 60
	Capacity	13 to 4000 GPM
	Total head	7 to 243 feet
	Max.Liquid temp.	104°F/40°C
Speed		1800 RPM
Materials	Casing	Cast Iron
	Impeller	Cast Iron (2 to 60HP)
		Ductile Iron (150-300DLFU, 40 to 60HP)
	Shaft	403 Stainless Steel, 2 to 5HP
		420 Stainless Steel, 7$^1/_2$ to 60HP
	Motor Frame	Cast Iron
	Fastener	304 Stainless Steel
Construction	**Mechanical Seal**	Double Mechanical Seal
	Material – Upper	Carbon/Ceramic
		Optional: Tungsten Carbide/Tungsten/Carbide
	Material – Lower	Silicon Carbide/Silicon Carbide, 2 to 60HP
		Optional: Tungsten Carbide/Tungsten/Carbide
		Tungsten Carbide/Tungsten Carbide, 150-300DLFU, 50 & 60 HP
	Impeller Type	Semi-open, 2 to 30HP
		Enclosed, 40 to 60HP
	Bearing	Prelubricated Ball Bearing
	Motor	2-5hp= Class F Insulation, 7.5-60hp= Class H Insulation
		Optional: FM Explosion Proof Class 1, Division 1, Group C, D
	Three Phase	208/230V, 460V
	Service Factor	1.15
	Motor Protection	Built-in Thermal Detector - Klixon
		Mechanical Seal Leakage - Float Switch
Submersible Cable		2 to 5HP - 33 ft. standard cable length
		7$^1/_2$ to 60HP - 40 ft. standard cable length
		Optional _____ ft. (customer specified)
Accessories		Optional QDC System

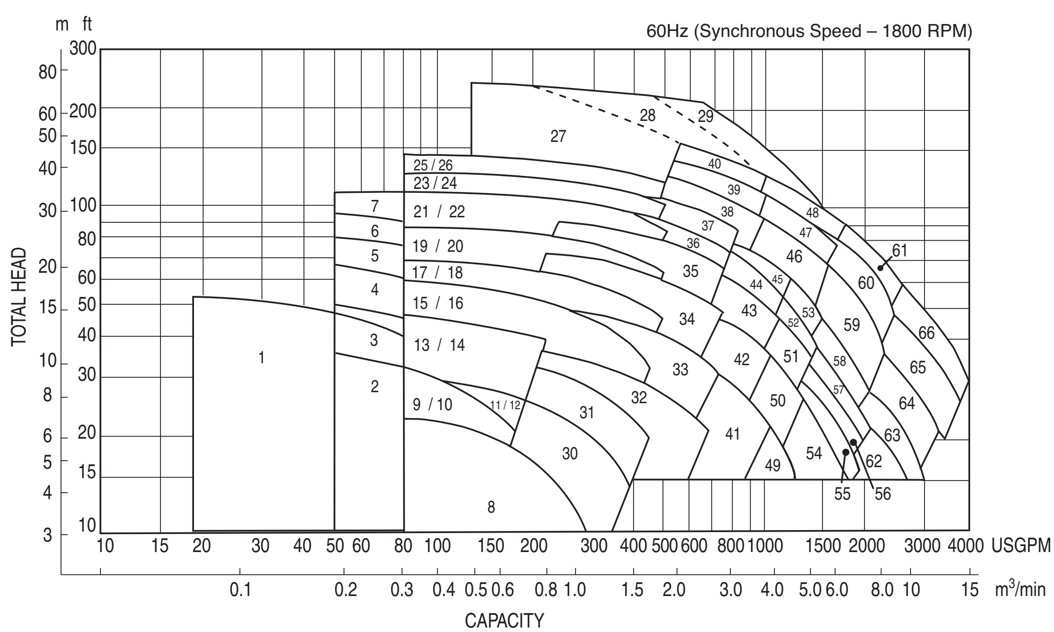
K-Series, Model DLKFU – Features

Model DLKFU series pumps are designed to tackle clogging challenges with enhanced passage capabilities for handling of fibrous waste. The design features address the most common reasons for clogging caused by fibrous materials:

- Reduces material caught on the vane tips
- Increases inlet pressure which keeps debris moving instead of recirculating
- E-liminator groove disrupts the accumulation of fibrous debris.

DLFU selection chart

1	50DLFU61.5 2HP	34	100DLFU611 15HP
2	80DLMFU61.5 2HP	35	100DLFU615 20HP
3	80DLMFU62.2 3HP	36	100DLFU618 25HP
4	80DLMFU63.7 5HP	37	100DLFU622 30HP
5	80DLMFU65.5 7½HP	38	150DLFU630 40HP
6	80DLCMFU67.5 10HP	39	150DLFU637 50HP
7	80DLCMFU611 15HP	40	150DLFU645 60HP
8	100DLFU61.5 2HP	41	150DLFU67.5 10HP
9	80DLFU61.5 2HP	42	150DLFU611 15HP
10	100DLMFU61.5 2HP	43	150DLFU615 20HP
11	80DLFU62.2 3HP	44	150DLFU618 25HP
12	100DLMFU62.2 3HP	45	150DLFU622 30HP
13	80DLFU63.7 5HP	46	200DLFU630 40HP
14	100DLMFU63.7 5HP	47	200DLFU637 50HP
15	80DLFU65.5 7½HP	48	200DLFU645 60HP
16	100DLMFU65.5 7½HP	49	200DLFU67.5 10HP
17	80DLFU67.5 10HP	50	200DLFU611 15HP
18	100DLMFU67.5 10HP	51	200DLFU615 20HP
19	80DLFU611 15HP	52	200DLFU618 25HP
20	100DLMFU611 15HP	53	200DLFU622 30HP
21	80DLFU615 20HP	54	250DLFU611 15HP
22	100DLMFU615 20HP	55	250DLBFU615 20HP
23	80DLFU618 25HP	56	250DLCFU615 20HP
24	100DLMFU618 25HP	57	250DLFU618 25HP
25	80DLFU622 30HP	58	250DLFU622 30HP
26	100DLMFU622 30HP	59	250DLFU630 40HP
27	100DLFU630 40HP	60	250DLFU637 50HP
28	100DLFU637 50HP	61	250DLFU645 60HP
29	100DLFU645 60HP	62	300DLFU618 25HP
30	100DLFU62.2 3HP	63	300DLFU622 30HP
31	100DLFU63.7 5HP	64	300DLFU630 40HP
32	100DLFU65.5 7½HP	65	300DLFU637 50HP
33	100DLFU67.5 10HP	66	300DLFU645 60HP



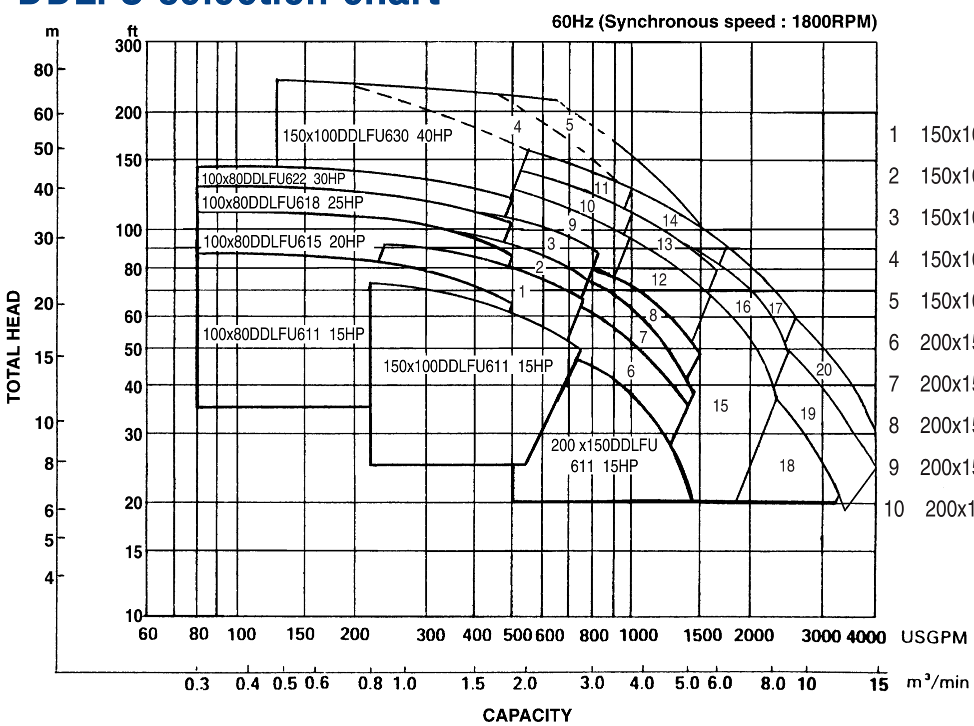
Please note: *Overlap in coverage is designated by the two numbers; for example "9 / 10". Refer to the legend left for the specific model numbers.*

Model DDLFU

Standard Specifications

Design	Discharge	4"×3", 6"×4", 8"×6", 8"×8", 10"×10", 12"×12"
	Horsepower	15 to 60HP
	Capacity	80 to 4000 GPM
	Total head	20 to 243 feet
	Max.Liquid temp.	104°F/40°C
Speed		1800 RPM
Materials	Casing	Cast Iron
	Impeller	Cast Iron
	Shaft	420 Stainless Steel
	Motor Frame	Cast Iron
	Fastener	304 Stainless Steel
Construction	**Mechanical Seal**	
	Double Mechanical Seal – Tandem Arrangement	
	Material – Upper	Carbon/Ceramic
		Optional: Tungsten Carbide/Tungsten/Carbide
	Material – Lower	Silicon Carbide/Silicon Carbide
		Optional: Tungsten Carbide/Tungsten/Carbide
		Tungsten Carbide/Tungsten Carbide
		(200×150DDLFU and greater, 50 & 60 HP only)
	Impeller Type	Semi-open for 15 to 30HP
		Enclosed for 40 to 60HP
	Bearing	Prelubricated Ball Bearing
	Motor	2-5hp=Class F Insulation, 7.5-60hp=Class H Insulation
		Optional: FM Explosion Proof Class 1, Division 1, Group C, D
	Three Phase	208/230V, 460V
	Service Factor	1.15
	Motor Protection	Built-in Thermal Detector - Klixon
		Mechanical Seal Leakage - Float Switch
Submersible Cable		40 ft. standard cable length, Optional 66 ft.
		Optional _____ ft. (customer specified)

DDLFU selection chart



1 150x100DDLFU615 20HP
2 150x100DDLFU618 25HP
3 150x100DDLFU622 30HP
4 150x100DDLFU637 50HP
5 150x100DDLFU645 60HP
6 200x150DDLFU615 20HP
7 200x150DDLFU618 25HP
8 200x150DDLFU622 30HP
9 200x150DDLFU630 40HP
10 200x150DDLFU637 50HP
11 200x150DDLFU645 60HP
12 200x200DDLFU630 40HP
13 200x200DDLFU637 50HP
14 200x200DDLFU645 60HP
15 250x250DDLFU630 40HP
16 250x250DDLFU637 50HP
17 250x250DDLFU645 60HP
18 300x300DDLFU630 40HP
19 300x300DDLFU637 50HP
20 300x300DDLFU645 60HP

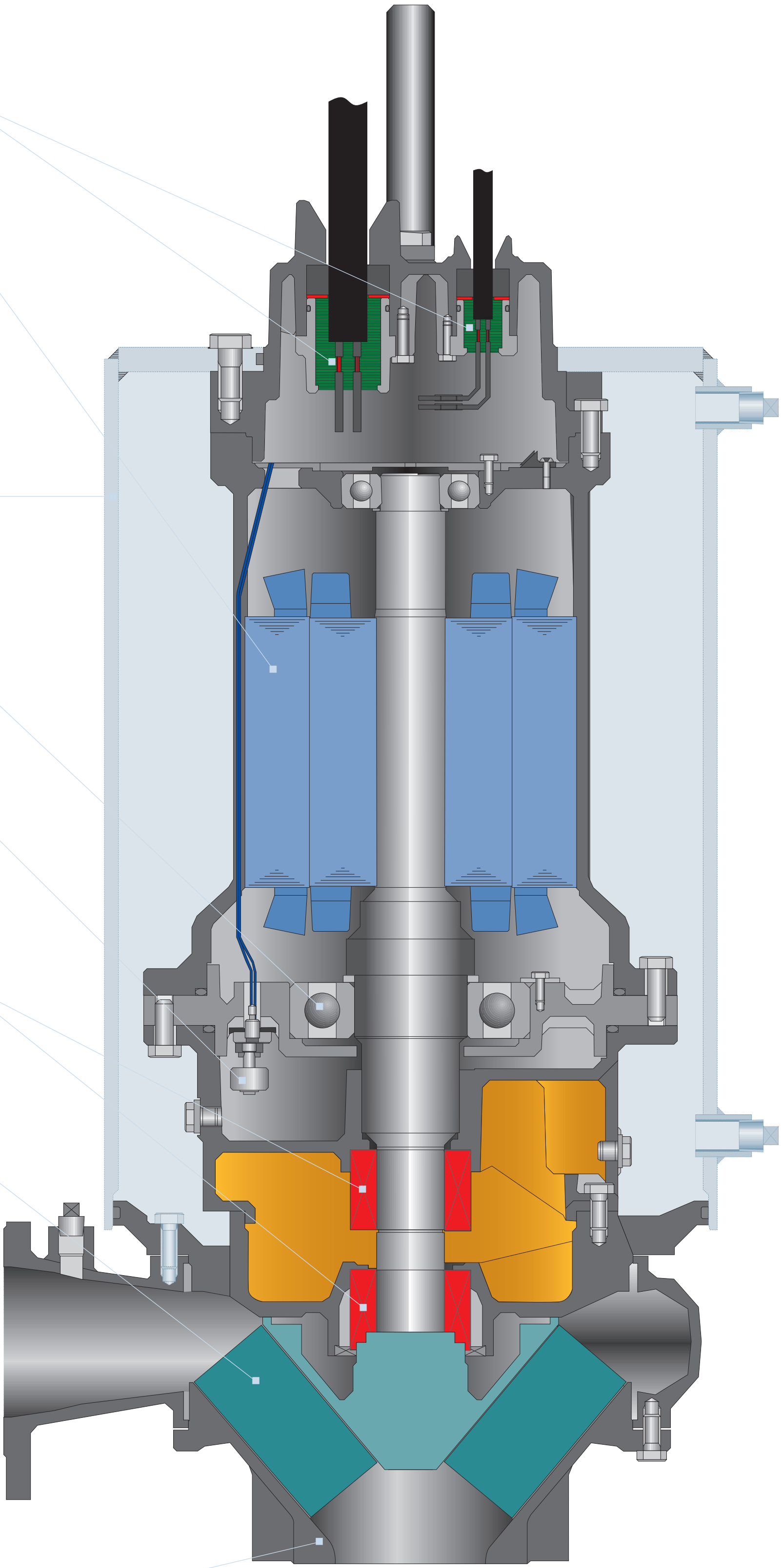
Model DLFU, DLKFU, DDLFU

Features

- **Watertight cable entry system** prevents capillary action and protects against moisture; reduces maintenance costs
- **Heavy duty, high efficiency, air filled** motor dissipates heat easily; thermal protection in each phase of windings protects; operates cooler with higher efficiencies; longer service life with lower operating costs
- **Self cooling jacket** (Model DDLFU) eliminates the need for external pumping devices or special heat transfer fluids; offers simplicity and high reliability by effectively dissipating heat in dry pit applications only
- **Single and double row thrust bearings** carries thrust loads with L-10 life of 60,000 hours; ensures long, dependable operation and lowers maintenance costs
- **Mechanically actuated float switch** provides early warning of mechanical seal failure; avoids costly motor repairs
- **Double mechanical seals – silicon carbide lower seals, carbon/ceramic upper** – hard faced upper and lower seals operate in an oil bath; providing longer service life and lower maintenance costs
- **High efficiency impellers** pass large solids with high outputs and reduces power consumption; impellers are optimized for hydraulic coverage; lowers operating costs

Model DLKFU series pumps are designed to tackle clogging challenges with enhanced passage capabilities for handling of fibrous waste.The design features address the most common reasons for clogging caused by fibrous materials: Reduces material caught on the vane tips, increases inlet pressure which keeps debris moving instead of recirculating and E-liminator groove disrupts the accumulation of fibrous debris

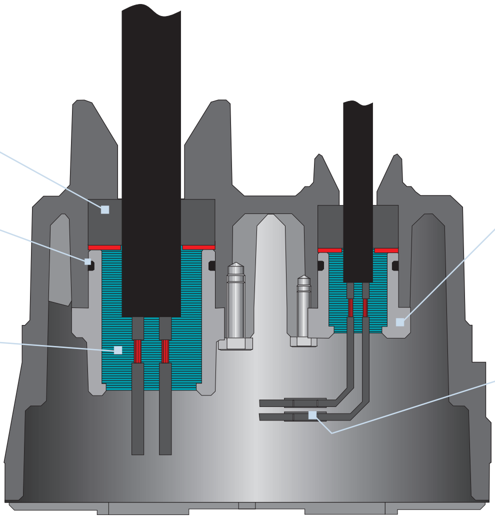
- **Replaceable wear components** maintains working clearances while reducing casing and volute costs



Model DLFU, DLKFU, DDLFU

Cable Entry System

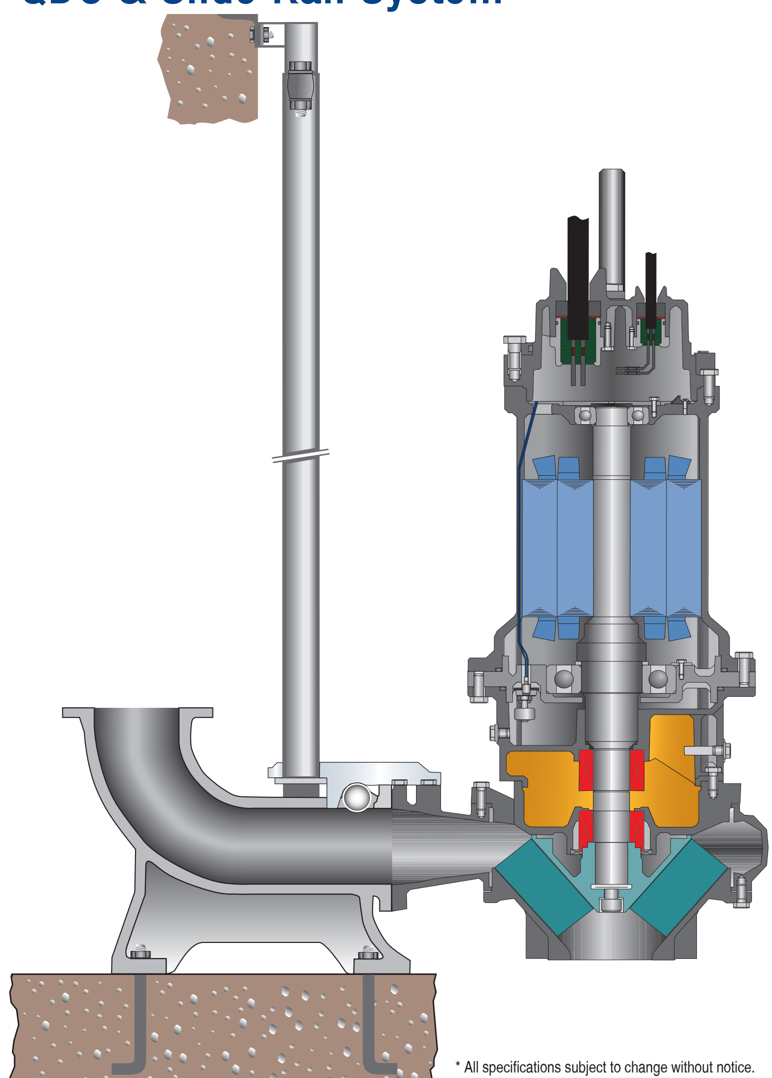
- **Primary seal** – grommet (NBR)
- **Secondary sealing** – O-rings (NBR)
- **Epoxy resin** – prevents capillary action
- **Solid joint butt connector** (copper)



- **Cable gland** (grey cast iron)
- **Solid joint butt connector** (copper)

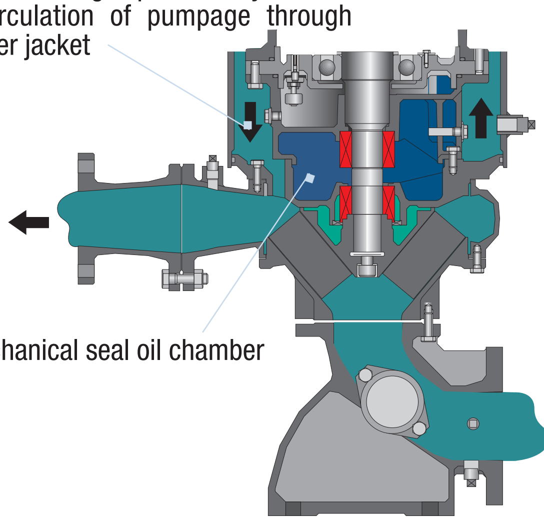
Note: Entry system is the same for both power and control cables.

QDC & Slide Rail System



DDLFU Dry Pit Design

- Motor cooling is provided by internal recirculation of pumpage through water jacket
- Mechanical seal oil chamber



EBARA Fluid Handling
1651 Cedar Line Drive • Rock Hill, SC 29730 • t (803) 327 - 5005 • f (803) 327 - 5097
www.pumpsebara.com

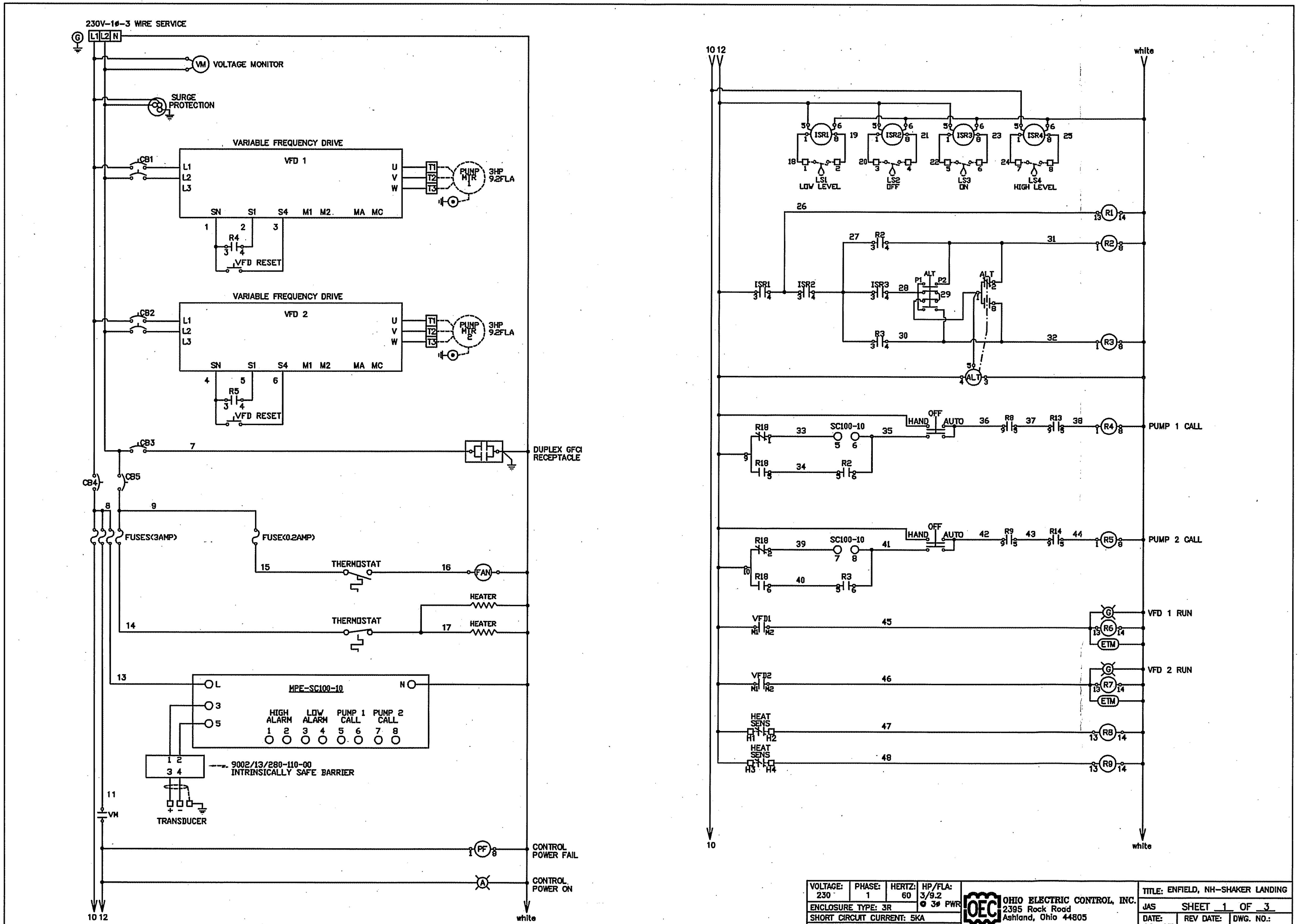
EFHDLFU1011

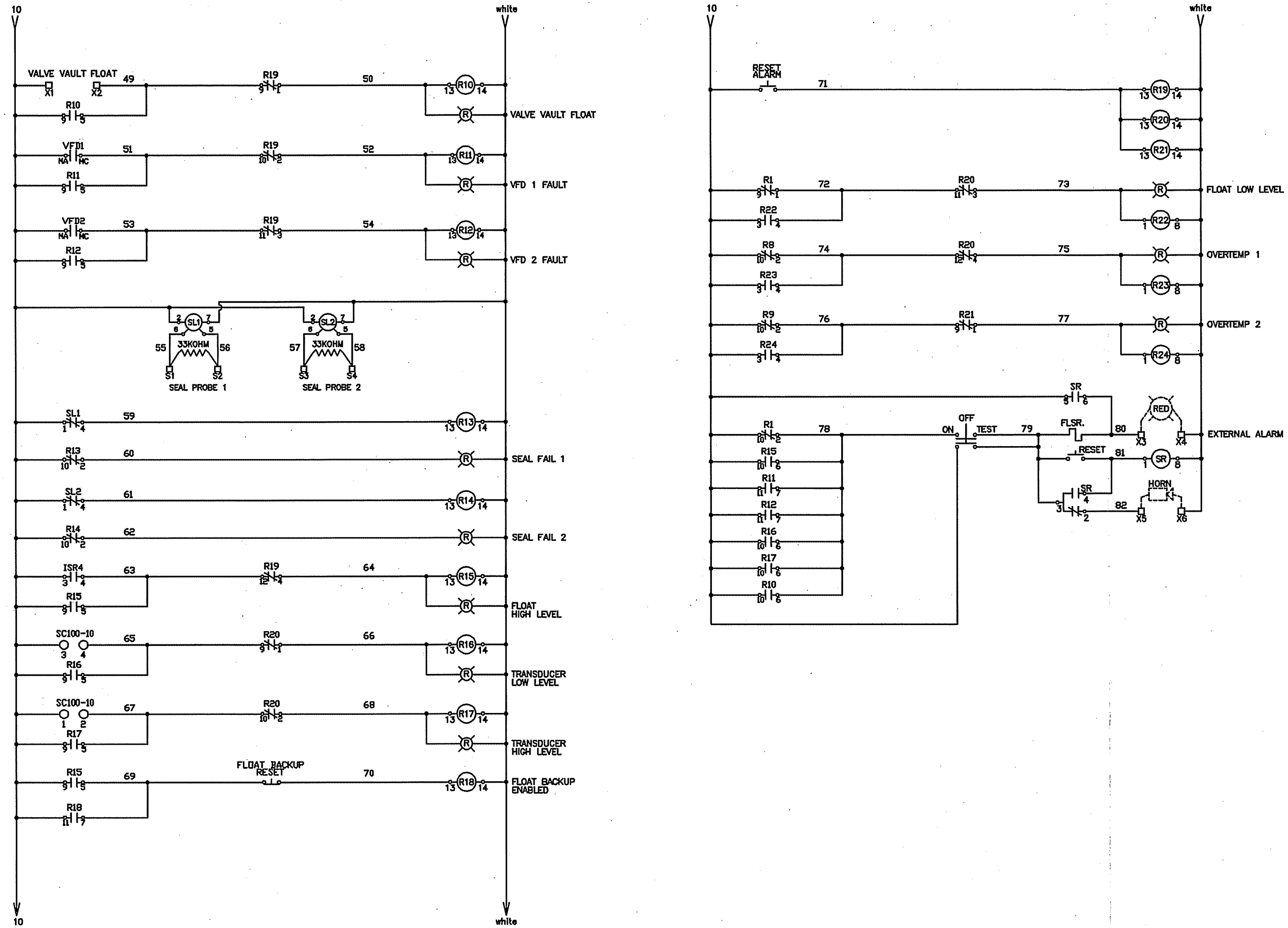
OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 2

PUMP CONTROL WIRING DIAGRAMS
PUMP CONTROL PANEL SPECIFICATION
MPE SC 100 WET WELL CONTROLLER


230V-1ø-3 WIRE SERVICE
G L1 L2 N
VOLTAGE MONITOR
SURGE PROTECTION
VARIABLE FREQUENCY DRIVE
VFD 1
L1 L2 L3 U V W
SN S1 S4 M1 M2 MA MC
PUMP MTR 1
3HP 9.2FLA
R4
VFD RESET
VARIABLE FREQUENCY DRIVE
VFD 2
PUMP MTR 2
3HP 9.2FLA
R5
VFD RESET
CB1
CB2
CB3
CB4
CB5
DUPLEX GFCI RECEPTACLE
FUSES(3AMP)
FUSE(0.2AMP)
THERMOSTAT
FAN
HEATER
THERMOSTAT
HEATER
MPE-SC100-10
HIGH ALARM
LOW ALARM
PUMP 1 CALL
PUMP 2 CALL
9002/13/280-110-00 INTRINSICALLY SAFE BARRIER
TRANSDUCER
VM
CONTROL POWER FAIL
CONTROL POWER ON
white
ISR1 ISR2 ISR3 ISR4
LS1 LOW LEVEL
LS2 OFF
LS3 ON
LS4 HIGH LEVEL
ALT
HAND OFF AUTO
SC100-10
PUMP 1 CALL
PUMP 2 CALL
VFD 1 RUN
VFD 2 RUN
ETM
HEAT SENS
VOLTAGE: 230
PHASE: 1
HERTZ: 60
HP/FLA: 3/9.2 @ 3ø PWR
ENCLOSURE TYPE: 3R
SHORT CIRCUIT CURRENT: 5KA
RMS SYMMETRICAL, 240V MAXIMUM
OEC
OHIO ELECTRIC CONTROL, INC.
2395 Rock Road
Ashland, Ohio 44805
TITLE: ENFIELD, NH-SHAKER LANDING
JAS
SHEET 1 OF 3
DATE: 10-17
REV DATE:
DWG. NO.: 170324JD04A

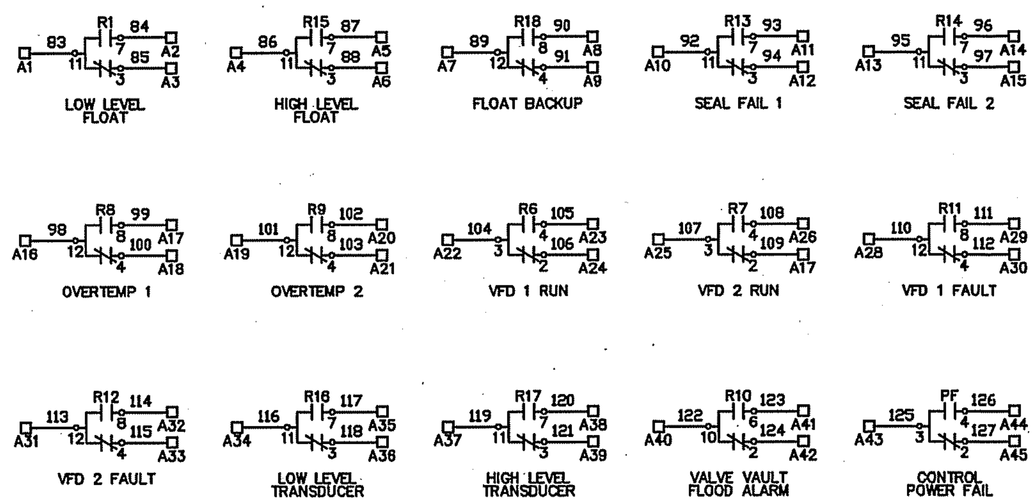


VOLTAGE: 230	PHASE: 1	HERTZ: 60	HP/FLA: 3/9.2 @ 3φ PWR
ENCLOSURE TYPE: 3R			
SHORT CIRCUIT CURRENT: 5KA			
RMS SYMMETRICAL, 240V MAXIMUM			

OEC OHIO ELECTRIC CONTROL, INC.
2395 Rock Road
Ashland, Ohio 44805

TITLE: ENFIELD, NH-SHAKER LANDING		
JAS	SHEET 2 OF 3	
DATE: 10-17	REV DATE:	DWG. NO.: 170324JD04A

AUX ALARM CONTACTS



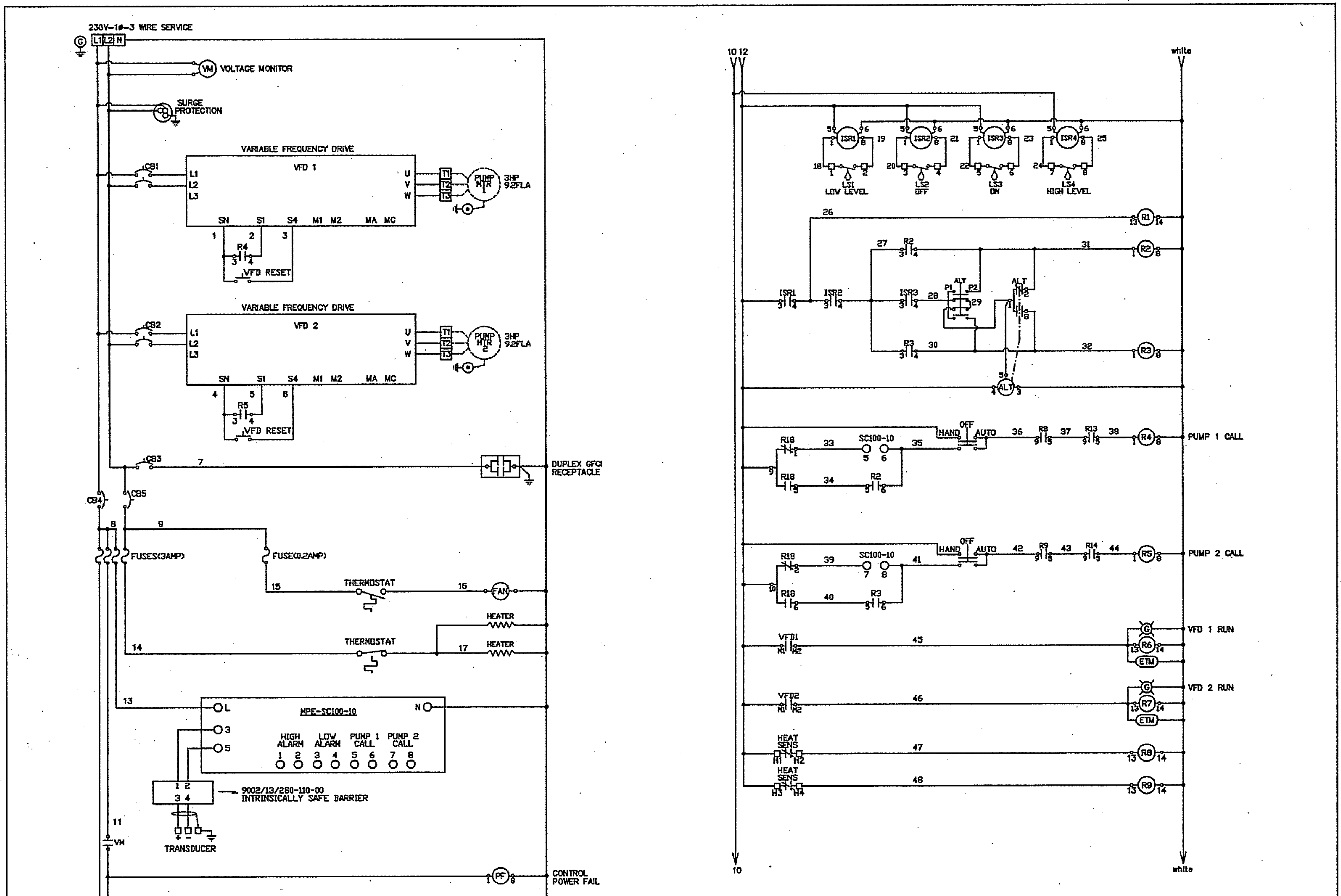
WARNING
TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.

NOTES:
1.) FLOAT SWITCHES MUST BE RATED A MINIMUM OF 2 AMPS AT 115 VOLTS.
2.) TORQUE ALL WHITE 1/2" WIRING TERMINALS TO THE PROPER TORQUE AS FOLLOWS:
FOR: #4-#18 AWG WIRE, TORQUE TO 20 IN.LBS.
3.) TORQUE ALL BLACK DEAD FRONT TERMINAL BLOCKS TO 16 IN.LBS.
4.) TORQUE ALL GREY 3/8" WIRING TERMINALS TO 16 IN.LBS.
5.) USE 60°C COPPER WIRE ONLY MINIMUM FOR LESS THAN 100 AMPS. USE 75°C COPPER WIRE ONLY MINIMUM FOR 100 AMPS OR GREATER.
6.) --------- = NOT SUPPLIED IN PANEL.
7.) ALL PENETRATIONS MUST MEET THE ENCLOSURE TYPE RATING INDICATED ON THE "UL" INFORMATION LABEL.

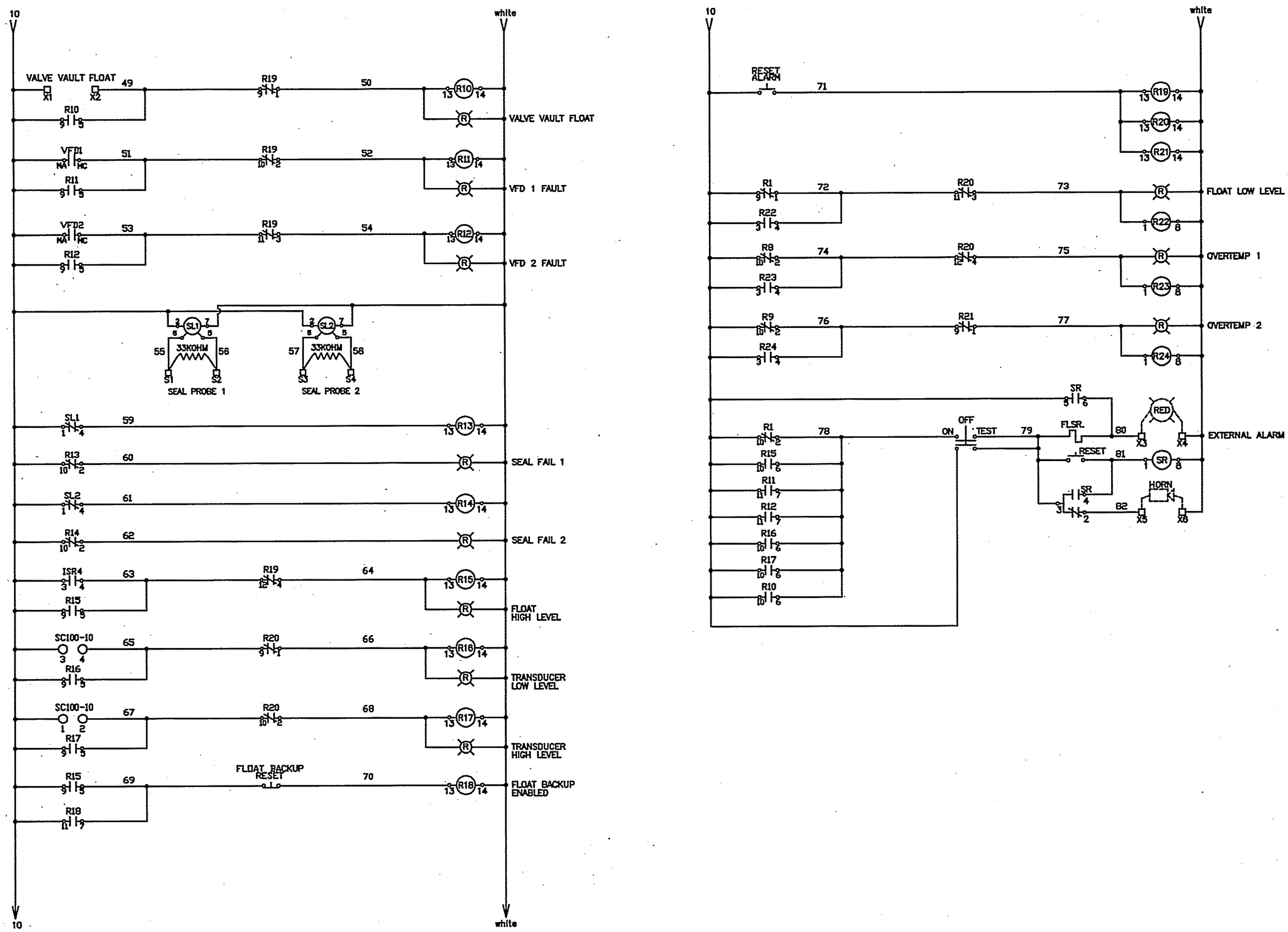
VOLTAGE:	PHASE:	HERTZ:	HP/FLA:
230	1	60	3/9.2 @ 3φ PWR
ENCLOSURE TYPE: 3R			
SHORT CIRCUIT CURRENT: 5KA			
RMS SYMMETRICAL, 240V MAXIMUM			

OEC OHIO ELECTRIC CONTROL, INC.
2395 Rock Road
Ashland, Ohio 44805

TITLE: ENFIELD, NH-SHAKER LANDING		
JAS	SHEET 3 OF 3	
DATE: 10-17	REV DATE:	DWG. NO.: 170324JD04A

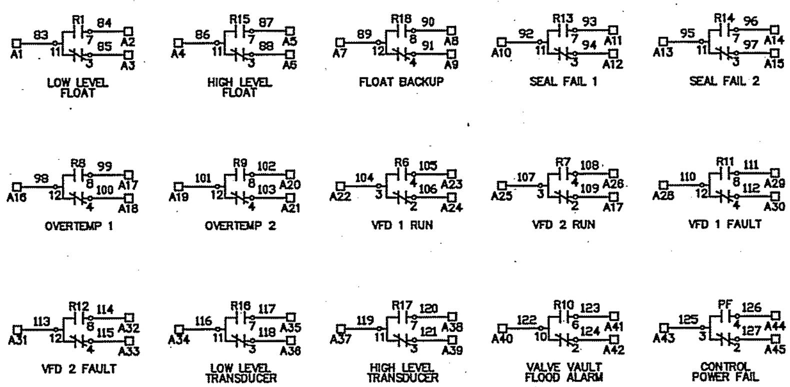


VOLTAGE: 230	PHASE: 1	HERTZ: 60	HP/FLA: 3/9.2 @ 3ø PWR	OHIO ELECTRIC CONTROL, INC. 2395 Rock Road Ashland, Ohio 44805	TITLE: ENFIELD, NH-SHAKER LANDING		
ENCLOSURE TYPE: 3R					JAS	SHEET 1 OF 3	
SHORT CIRCUIT CURRENT: 5KA					DATE: 10-17	REV DATE:	DWG. NO.: 170324JD04A
RMS SYMMETRICAL, 240V MAXIMUM							



VOLTAGE: 230	PHASE: 1	HERTZ: 60	HP/FLA: 3/9.2 @ 3ø PWR	OHIO ELECTRIC CONTROL, INC. 2395 Rock Road Ashland, Ohio 44805	TITLE: ENFIELD, NH-SHAKER LANDING		
ENCLOSURE TYPE: 3R					JAS	SHEET 2 OF 3	
SHORT CIRCUIT CURRENT: 5KA					DATE: 10-17	REV DATE:	DWG. NO.: 170324JD04A
RMS SYMMETRICAL 240V MAXIMUM							

AUX ALARM CONTACTS



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FOR: #4-#18 AWG WIRE, TORQUE TO 20 IN.LBS.
3.) TORQUE ALL BLACK DEAD FRONT TERMINAL BLOCKS TO 16 IN.LBS.
4.) TORQUE ALL GREY 3/8" WIRING TERMINALS TO 16 IN.LBS.
5.) USE 60°C COPPER WIRE ONLY MINIMUM FOR LESS THAN 100 AMPS.
USE 75°C COPPER WIRE ONLY MINIMUM FOR 100 AMPS OR GREATER.
6.) ---------- = NOT SUPPLIED IN PANEL.
7.) ALL PENETRATIONS MUST MEET THE ENCLOSURE TYPE RATING INDICATED ON THE "UL" INFORMATION LABEL.

VOLTAGE: 230	PHASE: 1	HERTZ: 60	HP/FLA: 3/9.2 @ 3Ø PWR
ENCLOSURE TYPE: 3R			
SHORT CIRCUIT CURRENT: 5KA			
RMS SYMMETRICAL 240V MAXIMUM			

OEC OHIO ELECTRIC CONTROL, INC.
2395 Rock Road
Ashland, Ohio 44805

TITLE: ENFIELD, NH-SHAKER LANDING		
JAS	SHEET 3 OF 3	
DATE: 10-17	REV DATE:	DWG. NO.: 170324JD04A

OHIO ELECTRIC CONTROL, INC.
2395 ROCK ROAD
ASHLAND, OHIO 44805
PH 419-289-1553
FAX 419-289-5555

Control Panel Customer Submittal Form

Quote Number: 170324JD04A

Company: Pump Systems
Contact Name: John Benham
Phone Number: (603) 934-7100
Cell Number: 603-455-2071
E-mail / Fax: (603) 934-0317
Job Name: Enfield, NH-Shaker Landing

Quoted By: John Park

CONTROL PANEL SPECIFICATIONS:

Station Type: Duplex
Pump Model: Ebara - 3Hp @ 9.2FLA
Panel Voltage: 230V, 1Ø To 230V, 3Ø
SCCR Minimum Rating: 5000 Amps
UL Listed: 698A
)F Specs Attached: Yes

OTHER REQUIREMENTS:

Quantity	Part Number	Part Description	Construction Notes	Manufacturer
1.0	A48R3616HCR	PAINTED STEEL ENCLOSURE	TYPE 3R GALVANIZED STEEL - 48" X 36" X 16"	HOFFMAN
1.0	AFK1216	FLOOR STAND KIT	12" HIGH	HOFFMAN
1.0	A48P36	STEEL BACK PANEL		HOFFMAN
1.0	OEC48SD36A	ALUMINUM SUB DOOR		
1.0	11642154055	INTAKE FAN - PF 42500	MOUNTED IN EXTERIOR LOWER RIGHT SIDE OF ENCLOSURE	PFANNENBERG
1.0	11740004055	EXHAUST FILTER - PFA 40000	MOUNTED IN EXTERIOR UPPER RIGHT SIDE OF ENCLOSURE	PFANNENBERG
2.0	18102000015	RAIN HOOD - PF-RH-40000-GY	TYPE 3R	PFANNENBERG
2.0	18102000022	MESH & SNOW PLUG KIT - PF-RH-40000-KIT	INSTALL MESH, SHIP SNOW PLUG LOOSE	PFANNENBERG
1.0	1403401	POWER BLOCK	MAIN INCOMING POWER - L1, L2, N	MARATHON
2.0	985GP3	PUMP T-BLOCK		MARATHON
8.0	6G38TSF	PUMP SENSOR T-BLOCK	HEAT SENSOR/MOISTURE FLOAT(N.C.)	MARATHON
1.0	1783790000	TRANSDUCER T-BLOCK	4-20MA SIGNAL FROM WET WELL	WIELAND
1.0	1783800000	END PLATE		WEIDMULLER
8.0	6G38TSF	FLOAT T-BLOCK	4 FLOAT BACKUP SYSTEM - 1. LOW LEVEL, 2.OFF, 3. ON, 4. HIGH LEVEL	MARATHON

2.0	6G38TSF	VALVE FAULT FLOAT T-BLOCK	FLOOD ALARM FROM VALVE VAULT	MARATHON
1.0	NOTE	NOTE ->	FLOAT SWITCHES ARE NOT INCLUDED IN PANEL PRICE.	OEC
4.0	6G38TSF	ALARM T-BLOCK	FOR REMOTE MOUNTED ALARM LIGHT & HORN	MARATHON
36.0	6G38TSF	AUX T-BLOCK	FORM C DRY CONTACT FOR AUX ALARM	MARATHON
1.0	ML1-0-L4	GROUND LUG	MAIN INCOMING POWER	LUGS DIRECT
1.0	GL4717	GROUND BAR	5 POSITIONS FOR PUMPS	LUGS DIRECT
2.0	QCR2025	PUMP CB - 25 AMP	CB1/CB2	CUTLER HAMMER
1.0	QCR1010	CONTROL CB - 10 AMP	CB4	CUTLER HAMMER
1.0	QCR1015	GFCI RECEPTACLE CB - 15 AMP	CB3	CUTLER HAMMER
1.0	QCR1010	CLIMATE CB - 10 AMP	CB5	CUTLER HAMMER
1.0	VBA240ALA	VOLTAGE MONITOR	VM	MARSH
1.0	D120V2P	SURGE PROTECTIVE DEVICE	MAIN INCOMING POWER	APT
2.0	CIMRPU2A0018FAA	VARIABLE FREQUENCY DRIVE	5HP, 17.5 AMP MAX, 5 YEAR WARRANTY	YASKAWA
2.0	UUX000527	REMOTE KEYPAD	MOUNTED ON SUB DOOR	YASKAWA
4.0	MDL3R	CONTROL/ALARM/HEATER(2) FUSES	3 AMP	BUSSMANN
4.0	MDL3R	SPARE FUSES	3 AMP, SHIPPED LOOSE	BUSSMANN
1.0	MDL.2R	FAN FUSE	0.2 AMP	BUSSMANN
1.0	MDL.2R	SPARE FUSE	0.2 AMP, SHIPPED LOOSE	BUSSMANN
5.0	S82021	FUSE BLOCK		BUSSMANN
1.0	SC100-10	SC100 STATION CONTROLLER	WITH 5 YEAR WARRANTY, MOUNTED IN SUB DOOR	MPE
1.0	900213280110001	INTRINSICALLY SAFE BARRIER		R STAHL
1.0	S00022	INSULATED STAND-OFFS		R STAHL
4.0	ISS101	INTRINSICALLY SAFE RELAY	ISR1 THRU ISR4	SYMCOM
1.0	RJ2SCA120	CONTROL POWER FAIL RELAY	PF	IDEC
1.0	ALT12010S	FLOAT BACKUP ALTERNATING RELAY	ALT	OEC
1.0	RU4SCA110	LOW LEVEL FLOAT RELAY	R1	IDEC
1.0	RJ2SCA120	LATCHING RELAY	R22	IDEC
1.0	RU4SCA110	HIGH LEVEL FLOAT RELAY	R15	IDEC
2.0	RU4SCA110	FLOAT BACKUP CALL RELAY	R2/R3	IDEC
1.0	RU4SCA110	FLOAT BACKUP RELAY	R15	IDEC
2.0	SFP120A100	SEAL FAILURE RELAY	SL1/SL2	MACROMATIC

2.0	RU4SCA110	SEAL FAIL ALARM RELAY	R13/R14	IDEC
2.0	RU4SCA110	OVERTEMP ALARM RELAY	R8/R9	IDEC
2.0	RJ2SCA120	LATCHING RELAY	R23/R24	IDEC
2.0	RY2SUAC120	VFD CALL RELAY	R4/R5	IDEC
2.0	RY2SUAC120	VFD RUNNING RELAY	R6/R7	IDEC
2.0	RU4SCA110	VFD FAULT RELAY	R11/R12	IDEC
1.0	RU4SCA110	TRANSDUCER LOW LEVEL RELAY	R16	IDEC
1.0	RU4SCA110	TRANSDUCER HIGH LEVEL RELAY	R17	IDEC
1.0	RU4SCA110	VALVE VAULT FLOOD RELAY	R10	IDEC
3.0	RU4SCA110	UNLATCHING RELAY	R19/R20/R21	IDEC
1.0	RJ2SCA120	ACKNOWLEDGE/SILENCE RELAY	SR	IDEC
3.0	SR2P06	8 PIN RELAY SOCKET		IDEC
13.0	SJ2S05BW	RJ RELAY SOCKET		IDEC
4.0	SY2S05	RY RELAY SOCKET		IDEC
15.0	SY4S05	RU RELAY SOCKET		IDEC
2.0	HW1S3TF20	PUMP HAND/OFF/AUTO SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1S3TF22	PUMP 1/ALT/PUMP 2 SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1S3TF20	ALARM ON/OFF/TEST SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	HW1BM1F10B	VFD FAULT RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM1F01R	FLOAT BACKUP RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM1F01R	ALARM RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM1F10B	SILENCE/ACKNOWLEDGE PUSHBUTTON	22MM OIL TIGHT MOUNTED IN EXTERIOR RIGHT SIDE OF ENCLOSURE	IDEC
2.0	HW1P2FQDG120	PUMP RUN LAMP - GREEN	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	HW1P2FQDR120	SEAL FAIL LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	HW1P2FQDR120	OVERTEMP LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	HW1P2FQDR120	VFD FAULT LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1P2FQDR120	TRANSDUCER LOW LEVEL LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1P2FQDR120	TRANSDUCER HIGH LEVEL LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1P2FQDR120	FLOAT LOW LEVEL LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1P2FQDR120	FLOAT HIGH LEVEL LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1P2FQDR120	VALVE VAULT FLOOD LAMP - RED	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC

1.0	HW1P2FQDA120	CONTROL POWER ON LAMP - AMBER	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	7220004-5003011	ELAPSED TIME METER	MOUNTED IN SUB DOOR	
1.0	VXBR100DG	VAPOR PROOF ALARM LIGHT	WITH CONDUIT BOX, SHIPPED LOOSE FOR REMOTE MOUNTING	RAB
1.0	GL100R	RED GLASS GLOBE	SHIPPED LOOSE	RAB
1.0	TEKRU075CW	FLASHER		AIROTRONICS
1.0	876N5	ALARM HORN	SHIPPED LOOSE FOR REMOTE MOUNTING	EDWARDS & CO
1.0	1597	GFCI RECEPTACLE - 15 AMP	MOUNTED IN SUB DOOR	PASS SEYMOUR
2.0	EFHSH5X105115	CONDENSATION HEATER	STRIP HEATER, 120V, 250 WATT	ELECTRO FLEX
1.0	17111000010	HEATING THERMOSTAT	FLZ 520 32-140°F	PFANNENBERG
1.0	17121000010	COOLING THERMOSTAT	FLZ 530 32-140°F	PFANNENBERG
31.0	BLACK W/ WHITE	ENGRAVED LEGEND PLATES	BLACK W/ WHITE LETTERS	
1.0	698A	I-SAFE UL LABEL		UL
1.0	WARRANTY	EXTENDED WARRANTY	ADDITIONAL FOUR YEARS, FOR A TOTAL OF FIVE YEARS ON PARTS FROM DATE OF SHIP.	
1.0	WW	WIRE WAY		PANDUIT
1.0	WIRE NUMBERS	WIRE NUMBERS		
1.0	MISC SHOP MATERIALS	WIRING HARNESS		
1.0	NOTE	WIRE COLOR CODE ->	COLOR CODE IS AS FOLLOWS:	OEC
1.0	NOTE	->	BLACK - AC POWER	OEC
1.0	NOTE	->	RED - AC CONTROL	OEC
1.0	NOTE	->	BLUE - DC CONTROL	OEC
1.0	NOTE	->	WHITE - AC NEUTRAL	OEC
1.0	NOTE	->	GREEN - GROUND	OEC
1.0	NOTE	->	YELLOW - POWERED FROM AN EXTERNAL SOURCE	OEC
1.0	NOTE	AUXILIARY DRY CONTACTS ->	FORM C DRY CONTACTS ARE AS FOLLOWS:	OEC
1.0	NOTE	->	CONTROL POWER FAILURE ALARM	OEC
1.0	NOTE	->	LOW LEVEL ALARM(TRANSDUCER & FLOAT)	OEC
1.0	NOTE	->	HIGH LEVEL ALARM(TRANSDUCER & FLOAT)	OEC
1.0	NOTE	->	FLOAT BACKUP ENABLED ALARM	OEC
1.0	NOTE	->	VALVE VAULT FLOOD ALARM	OEC
2.0	NOTE	->	SEAL FAILURE ALARM	OEC
2.0	NOTE	->	OVERTEMP ALARM	OEC
2.0	NOTE	->	VFD FAULT ALARM	OEC
2.0	NOTE	->	PUMP RUN STATUS	OEC

1.0	NOTE	SCHEMATIC ->	LAMINATED SCHEMATIC PROVIDED ON ENCLOSURE DOOR.	OEC
1.0	NOTE	CUSTOMER SUPPLIED DEVICES ->	DEVICES MUST MEET UL REQUIREMENTS.	OEC

OHIO ELECTRIC CONTROL, INC.
2395 ROCK ROAD
ASHLAND, OHIO 44805
PH 419-289-1553
FAX 419-289-5555

Control Panel Customer Submittal Form

Quote Number: 170324JD04A

Company: Pump Systems
Contact Name: John Benham
Phone Number: (603) 934-7100
Cell Number: 603-455-2071
E-mail / Fax: (603) 934-0317
Job Name: Enfield, NH-Shaker Landing

Quoted By: John Park

CONTROL PANEL SPECIFICATIONS:

Station Type: Duplex
Pump Model: Ebara - 3Hp @ 9.2FLA
Panel Voltage: 230V, 1Ø To 230V, 3Ø
SCCR Minimum Rating: 5000 Amps
UL Listed: 698A
)F Specs Attached: Yes

OTHER REQUIREMENTS:

Quantity	Part Number	Part Description	Construction Notes	Manufacturer
1.0	A48R3616HCR	PAINTED STEEL ENCLOSURE	TYPE 3R GALVANIZED STEEL - 48" X 36" X 16"	HOFFMAN
1.0	AFK1216	FLOOR STAND KIT	12" HIGH	HOFFMAN
1.0	A48P36	STEEL BACK PANEL		HOFFMAN
1.0	OEC48SD36A	ALUMINUM SUB DOOR		
1.0	11642154055	INTAKE FAN - PF 42500	MOUNTED IN EXTERIOR LOWER RIGHT SIDE OF ENCLOSURE	PFANNENBERG
1.0	11740004055	EXHAUST FILTER - PFA 40000	MOUNTED IN EXTERIOR UPPER RIGHT SIDE OF ENCLOSURE	PFANNENBERG
2.0	18102000015	RAIN HOOD - PF-RH-40000-GY	TYPE 3R	PFANNENBERG
2.0	18102000022	MESH & SNOW PLUG KIT - PF-RH-40000-KIT	INSTALL MESH, SHIP SNOW PLUG LOOSE	PFANNENBERG
1.0	1403401	POWER BLOCK	MAIN INCOMING POWER - L1, L2, N	MARATHON
2.0	985GP3	PUMP T-BLOCK		MARATHON
8.0	6G38TSF	PUMP SENSOR T-BLOCK	HEAT SENSOR/MOISTURE FLOAT(N.C.)	MARATHON
1.0	1783790000	TRANSDUCER T-BLOCK	4-20MA SIGNAL FROM WET WELL	WIELAND
1.0	1783800000	END PLATE		WEIDMULLER
8.0	6G38TSF	FLOAT T-BLOCK	4 FLOAT BACKUP SYSTEM - 1. LOW LEVEL, 2.OFF, 3. ON, 4. HIGH LEVEL	MARATHON

2.0	6G38TSF	VALVE FAULT FLOAT T-BLOCK	FLOOD ALARM FROM VALVE VAULT	MARATHON
1.0	NOTE	NOTE ->	FLOAT SWITCHES ARE NOT INCLUDED IN PANEL PRICE.	OEC
4.0	6G38TSF	ALARM T-BLOCK	FOR REMOTE MOUNTED ALARM LIGHT & HORN	MARATHON
36.0	6G38TSF	AUX T-BLOCK	FORM C DRY CONTACT FOR AUX ALARM	MARATHON
1.0	ML1-0-L4	GROUND LUG	MAIN INCOMING POWER	LUGS DIRECT
1.0	GL4717	GROUND BAR	5 POSITIONS FOR PUMPS	LUGS DIRECT
2.0	QCR2025	PUMP CB - 25 AMP	CB1/CB2	CUTLER HAMMER
1.0	QCR1010	CONTROL CB - 10 AMP	CB4	CUTLER HAMMER
1.0	QCR1015	GFCI RECEPTACLE CB - 15 AMP	CB3	CUTLER HAMMER
1.0	QCR1010	CLIMATE CB - 10 AMP	CB5	CUTLER HAMMER
1.0	VBA240ALA	VOLTAGE MONITOR	VM	MARSH
1.0	D120V2P	SURGE PROTECTIVE DEVICE	MAIN INCOMING POWER	APT
2.0	CIMRPU2A0018FAA	VARIABLE FREQUENCY DRIVE	5HP, 17.5 AMP MAX, 5 YEAR WARRANTY	YASKAWA
2.0	UUX000527	REMOTE KEYPAD	MOUNTED ON SUB DOOR	YASKAWA
4.0	MDL3R	CONTROL/ALARM/HEATER(2) FUSES	3 AMP	BUSSMANN
4.0	MDL3R	SPARE FUSES	3 AMP, SHIPPED LOOSE	BUSSMANN
1.0	MDL.2R	FAN FUSE	0.2 AMP	BUSSMANN
1.0	MDL.2R	SPARE FUSE	0.2 AMP, SHIPPED LOOSE	BUSSMANN
5.0	S82021	FUSE BLOCK		BUSSMANN
1.0	SC100-10	SC100 STATION CONTROLLER	WITH 5 YEAR WARRANTY, MOUNTED IN SUB DOOR	MPE
1.0	900213280110001	INTRINSICALLY SAFE BARRIER		R STAHL
1.0	S00022	INSULATED STAND-OFFS		R STAHL
4.0	ISS101	INTRINSICALLY SAFE RELAY	ISR1 THRU ISR4	SYMCOM
1.0	RJ2SCA120	CONTROL POWER FAIL RELAY	PF	IDEC
1.0	ALT12010S	FLOAT BACKUP ALTERNATING RELAY	ALT	OEC
1.0	RU4SCA110	LOW LEVEL FLOAT RELAY	R1	IDEC
1.0	RJ2SCA120	LATCHING RELAY	R22	IDEC
1.0	RU4SCA110	HIGH LEVEL FLOAT RELAY	R15	IDEC
2.0	RU4SCA110	FLOAT BACKUP CALL RELAY	R2/R3	IDEC
1.0	RU4SCA110	FLOAT BACKUP RELAY	R15	IDEC
2.0	SFP120A100	SEAL FAILURE RELAY	SL1/SL2	MACROMATIC

2.0	RU4SCA110	SEAL FAIL ALARM RELAY	R13/R14	IDEC
2.0	RU4SCA110	OVERTEMP ALARM RELAY	R8/R9	IDEC
2.0	RJ2SCA120	LATCHING RELAY	R23/R24	IDEC
2.0	RY2SUAC120	VFD CALL RELAY	R4/R5	IDEC
2.0	RY2SUAC120	VFD RUNNING RELAY	R6/R7	IDEC
2.0	RU4SCA110	VFD FAULT RELAY	R11/R12	IDEC
1.0	RU4SCA110	TRANSDUCER LOW LEVEL RELAY	R16	IDEC
1.0	RU4SCA110	TRANSDUCER HIGH LEVEL RELAY	R17	IDEC
1.0	RU4SCA110	VALVE VAULT FLOOD RELAY	R10	IDEC
3.0	RU4SCA110	UNLATCHING RELAY	R19/R20/R21	IDEC
1.0	RJ2SCA120	ACKNOWLEDGE/SILENCE RELAY	SR	IDEC
3.0	SR2P06	8 PIN RELAY SOCKET		IDEC
13.0	SJ2S05BW	RJ RELAY SOCKET		IDEC
4.0	SY2S05	RY RELAY SOCKET		IDEC
15.0	SY4S05	RU RELAY SOCKET		IDEC
2.0	HW1S3TF20	PUMP HAND/OFF/AUTO SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1S3TF22	PUMP 1/ALT/PUMP 2 SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1S3TF20	ALARM ON/OFF/TEST SWITCH	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
2.0	HW1BM1F10B	VFD FAULT RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM1F01R	FLOAT BACKUP RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM1F01R	ALARM RESET PUSHBUTTON	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
1.0	HW1BM~~1F10B~~	SILENCE/ACKNOWLEDGE PUSHBUTTON	22MM OIL TIGHT MOUNTED IN EXTERIOR RIGHT SIDE OF ENCLOSURE	IDEC
2.0	HW1P2FQDG120	PUMP RUN LAMP - GREEN	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
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1.0	HW1P2FQDA120	CONTROL POWER ON LAMP - AMBER	22MM OIL TIGHT MOUNTED IN SUB DOOR	IDEC
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1.0	GL100R	RED GLASS GLOBE	SHIPPED LOOSE	RAB
1.0	TEKRU075CW	FLASHER		AIROTRONICS
1.0	876N5	ALARM HORN	SHIPPED LOOSE FOR REMOTE MOUNTING	EDWARDS & CO
1.0	1597	GFCI RECEPTACLE - 15 AMP	MOUNTED IN SUB DOOR	PASS SEYMOUR
2.0	EFHSH5X105115	CONDENSATION HEATER	STRIP HEATER, 120V, 250 WATT	ELECTRO FLEX
1.0	17111000010	HEATING THERMOSTAT	FLZ 520 32-140°F	PFANNENBERG
1.0	17121000010	COOLING THERMOSTAT	FLZ 530 32-140°F	PFANNENBERG
31.0	BLACK W/ WHITE	ENGRAVED LEGEND PLATES	BLACK W/ WHITE LETTERS	
1.0	698A	I-SAFE UL LABEL		UL
1.0	WARRANTY	EXTENDED WARRANTY	ADDITIONAL FOUR YEARS, FOR A TOTAL OF FIVE YEARS ON PARTS FROM DATE OF SHIP.	
1.0	WW	WIRE WAY		PANDUIT
1.0	WIRE NUMBERS	WIRE NUMBERS		
1.0	MISC SHOP MATERIALS	WIRING HARNESS		
1.0	NOTE	WIRE COLOR CODE ->	COLOR CODE IS AS FOLLOWS:	OEC
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1.0	NOTE	->	RED - AC CONTROL	OEC
1.0	NOTE	->	BLUE - DC CONTROL	OEC
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1.0	NOTE	->	GREEN - GROUND	OEC
1.0	NOTE	->	YELLOW - POWERED FROM AN EXTERNAL SOURCE	OEC
1.0	NOTE	AUXILIARY DRY CONTACTS ->	FORM C DRY CONTACTS ARE AS FOLLOWS:	OEC
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1.0	NOTE	->	HIGH LEVEL ALARM(TRANSDUCER & FLOAT)	OEC
1.0	NOTE	->	FLOAT BACKUP ENABLED ALARM	OEC
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2.0	NOTE	->	OVERTEMP ALARM	OEC
2.0	NOTE	->	VFD FAULT ALARM	OEC
2.0	NOTE	->	PUMP RUN STATUS	OEC

1.0	NOTE	SCHEMATIC ->	LAMINATED SCHEMATIC PROVIDED ON ENCLOSURE DOOR.	OEC
1.0	NOTE	CUSTOMER SUPPLIED DEVICES ->	DEVICES MUST MEET UL REQUIREMENTS.	OEC

SC100

INSTRUCTION MANUAL

MOTOR PROTECTION ELECTRONICS, INC.

2464 Vulcan Road
Apopka, Florida 32703

Phone: (407) 299-3825
Website: www.mpelectronics.com

Operating Program Revision: 1 **Revision Date: 4-2-18**

STATION CONTROLLER SC100

APPLICATIONS

- Simplex or Duplex Liquid Level Control
- Pump Down (Empty a Tank) or Pump Up (Fill a Tank)

STANDARD FEATURES

- 4 Digit, 7 Segment LED Level Display with Selectable Decimal Point Position
- All Setup Parameters Values may be viewed or changed from the front of the unit
- Level Input Source: Analog Level Input (4-20 mA from Pressure Transducer)
- Level Input Zero and Span Calibration Parameters for Field Calibration
- Provides +24 VDC Power for Analog Level Input
- Two Pump Call Relay Outputs with Status Indication
- High and Low Level Alarm Relay Outputs with Status Indication
- 10 Second Power Up Delay (the first pump call is delayed by 10 seconds after a power interruption)
- Adjustable Lag Pump Delay for Pump Call Output
- Automatic Pump Alternation or Fixed Sequence: 1 - 2 or 2 - 1
- Level Simulation (Automatically ends after 60 seconds)
- Level Input Signal Conditioning Parameter (May be used to dampen out fluctuations in the Level Input Signal)
- Stores all Setup Parameter values in EEPROM (Does not require a backup battery)

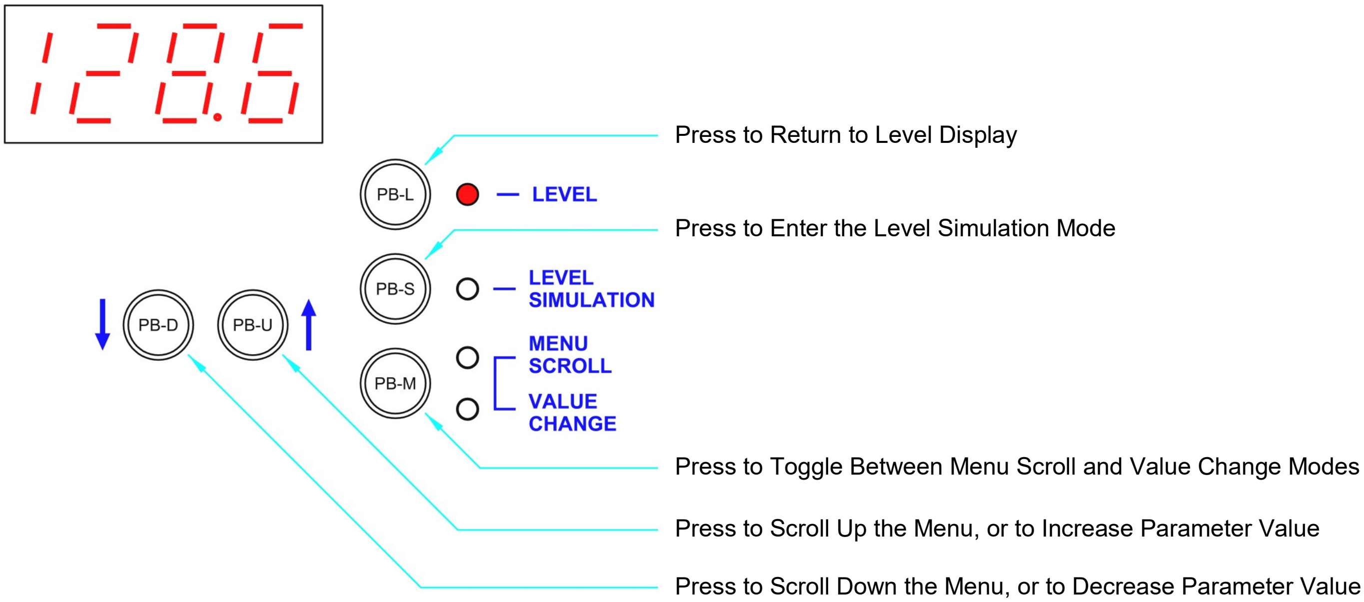
SPECIFICATIONS

• Supply Power:	120 VAC ±10%, 7.8 VA max
• Enclosure Dimensions:	6.10” x 7.70” x 2.78” (H x W x D)
• Enclosure Material:	Aluminum
• Faceplate Color:	White with Blue Lettering
• Agency Approval:	UL 508, CAN/CSA UL FILE #: E101681
• Ambient Operating Temperature:	-20 °C to +65 °C (-4 °F to +149 °F)
• Storage Temperature:	-45 °C to +85 °C (-49 °F to +185 °F)
• 4 Digit, 7 Segment LED Display Range:	0 - 2310 (Selectable Decimal Point Position)
• Indicators:	Red LED
• Relay Outputs:	10 A Resistive @ 120 VAC 3.6 A Inductive @ 120 VAC
• Analog Level Input:	4-20 mA, 147 Ω Load, Transient Protected
• Power for Analog Level Input:	24 VDC, Overload and Transient Protected

ORDERING INFORMATION

Part Number: SC100

OPERATOR INTERFACE FUNCTIONS



Note: To Prevent the Accidental Changing of a Parameter Value, there is a 4 second Delay Before a Parameter Value will Change.
(The PB-D or PB-U Push-Button must be Held Down for the Entire 4 second Delay.)

How to View a Setup Parameter Value

1. Press push-button PB-M until the Menu Scroll Mode indicator comes on.
2. Press push-button PB-D or PB-U as needed to arrive at the Parameter you wish to view.
3. Press push-button PB-M until the Value Change Mode indicator comes on.
4. The current value of the Parameter may then be viewed on the display.

How to Change a Setup Parameter Value

1. Press push-button PB-M until the Menu Scroll Mode indicator comes on.
2. Press push-button PB-D or PB-U as needed to arrive at the Parameter you wish to change.
3. Press push-button PB-M until the Value Change Mode indicator comes on.
4. The current value of the Parameter may then be viewed on the display.
5. Press and hold for 4 seconds, either push-button PB-D or PB-U, to change the Parameter to the desired new value.
6. Press push-button PB-M or PB-L to exit the Value Change Mode.

How to Simulate Levels

1. Press push-button PB-S.
   Note: The Simulation starts from the actual level displayed prior to entering the Level Simulation mode.
2. Press push-button PB-D or PB-U as needed to change the simulated level.
3. To end the level simulation press push-button PB-L.
   Note: If you do not exit the Level Simulation mode, normal operation will resume automatically 60 seconds after the last time the PB-U, PB-D, or PB-S push-buttons were pressed.

MENU - SYSTEM SETUP

Parameter	Default Value	Current Value	Setting Definitions
LoAL	2.0		Low Level Alarm Range: 0.1 - 231.0
PoFF	3.0		Pump 0ff Level Range: 0.2 - 231.0
1Pon	6.0		1st Pump 0n Level Range: 0.2 - 231.0
2Pon	7.0		2nd Pump 0n Level Range: 0.2 - 231.0
HI AL	10.0		High Level Alarm Range: 0.5 - 231.0
			Note: Decimal Point Position for above Parameters is set by Parameter P-21.
LAGd	5 sec.		Lag Delay Range: 1 - 100 seconds
ZEro	0.0		Level Input Calibration - Zero Notes: 1. 4.0mA is Typically Applied to the Process Input while Setting the Zero. 2. Parameter ZEro Shows the Level Input, while allowing the Up & Down Push-buttons to Change the Internal Number used to Zero the Displayed Value. 3. Decimal Point Position is set by Parameter P-21. See Page: 4.
SPAn	11.5		Level Input Calibration - Span Range: 0.9 - 231.0 Notes: 1. 20mA is Typically Applied to the Process Input while Setting the Span. 2. Parameter SPAn Shows the Level Input, while allowing the Up & Down Push-buttons to Change the Internal Number used to Calculate the Displayed Value. 3. Decimal Point Position is set by Parameter P-21. See Page: 4.
P-13	2		Number of Pumps Present 1 = 1 Pump 2 = 2 Pumps
P-19	1		Pump Up or Down Mode 1 = Pump Down - Empty a Tank 2 = Pump Up - Fill a Tank Note: When Parameter P-19 is Changed New Default Pump On and Off Level Parameter Values will be loaded.
P-20	0		Forced Lead Pump Position 0 = Normal Alternation 1 = Pump as 1 Lead 2 = Pump as 2 Lead
P-21	1		Level Display Decimal Point Position 0 = No Decimal Point 1 = XXX.X 2 = XX.XX 3 = X.XXX
P-22	240		Level Input - Signal Conditioning Control Range: 1 - 254 10 = Very Slow 100 = Slow 240 = Normal 250 = Fast
oPr	-		Operating Program Revision Number

High Level Alarm

- Upon a High Level Alarm, the indicator will come on, the relay will de-energize and the contacts will close.
- The High Level Alarm relay contacts will be closed when there is no power on the controller.

Low Level Alarm

- Upon a Low Level Alarm, the indicator will come on, the relay will energize and the contacts will close.
- The Low Level Alarm relay contacts will be open when there is no power on the controller.
- A Low Level Alarm is delayed for 10 seconds after power is applied.

LEVEL INPUT (4-20mA Input) – CALIBRATION PROCEDURE

Notes:

1. Do not attempt to change the Span or Zero calibration using Parameters ZEro and SPAn without first applying the appropriate 4-20mA signal to the Analog Level Input during each step of the calibration procedure.
2. The rate of change of the displayed Level may be customized using Parameter P - 22.

LEVEL INPUT ZERO - Parameter ZERo

This Parameter is used to make the Level Display read zero with a Level Input of 4.0mA.

Calibration Procedure:

1. Apply a 4.0mA signal to the Analog Level Input.
   (Alternate Procedure - Pull the pressure transducer out of the water, or disconnect the bubbler tube.)
2. Scroll in the menu to Parameter ZERo and press push-button PB-M to view the Level.
3. Press and hold down the “UP” or “DOWN” push-buttons as need to make the display read zero.
   Note: It is slow to change at first.
4. Perform the procedure below to calibrate the Span.

LEVEL INPUT SPAN - Parameter SPAn

This Parameter is used to establish what the Level Display should show with a Level Input of 20mA.

Calibration Procedure:

1. Apply a 20mA signal to the Analog Level Input.
   (Alternate Procedure – Subject the Transducer to a known condition (for example under 6.0 feet of water).
2. Scroll in the menu to Parameter SPAn and press push-button PB-M to view the Level.
3. Press and hold down the “UP” or “DOWN” push-buttons as need to make the display read the span of the Pressure Transducer. Note: It is slow to change at first.
   (Alternate Procedure – Use the Up / Down push-buttons to make the display read the same as the current level of liquid in the wet well (for example 6.0 feet of water).

LEVEL INPUT SPAN in Feet Of Water Versus TRANSDUCER CALIBRATION in PSI

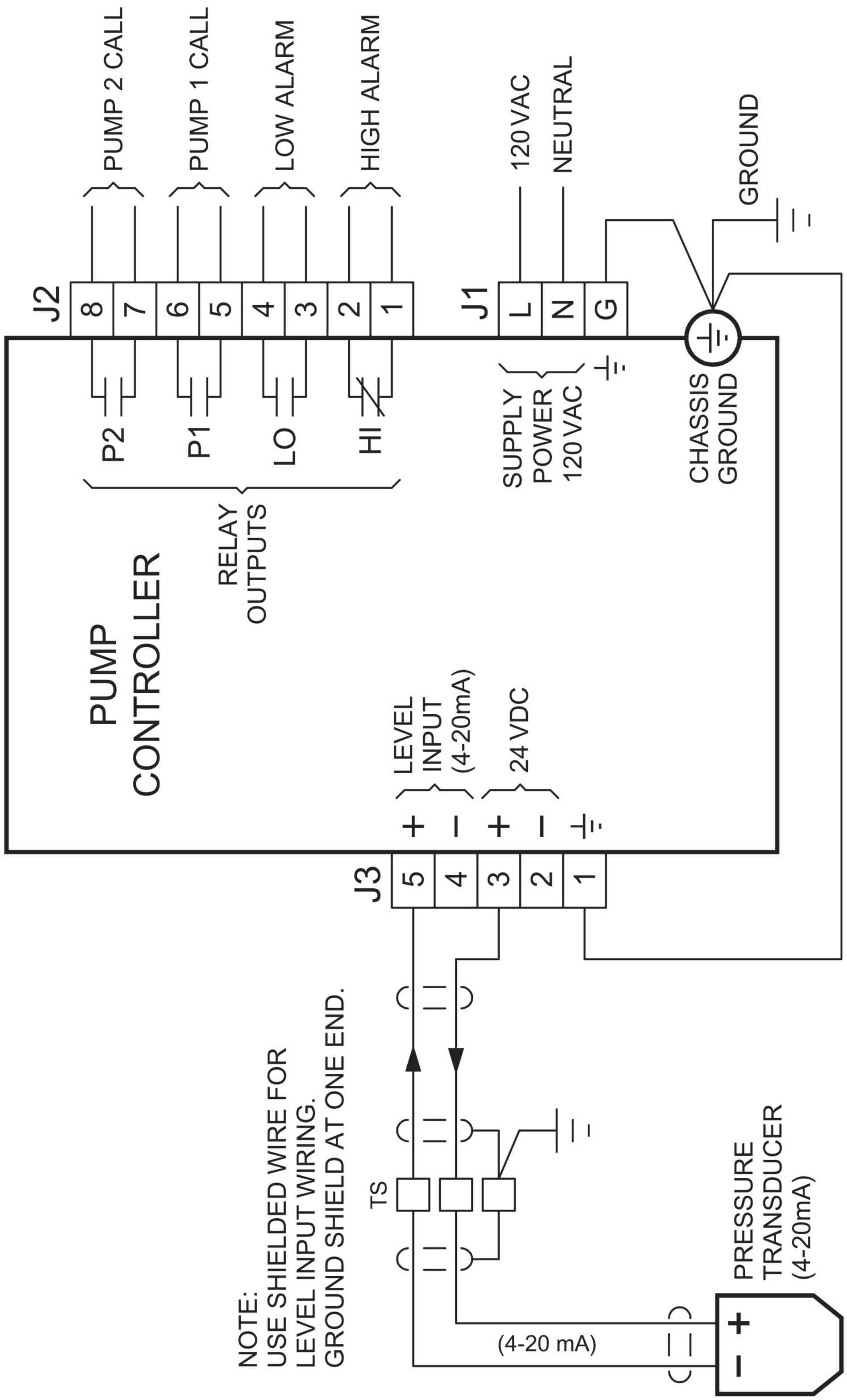
	Transducer Calibration						
	5.0psi @ 20mA	10psi @ 20mA	15psi @ 20mA	30psi @ 20mA	60psi @ 20mA	100psi @ 20mA	
Level Input Span	-	-	-	-	139 feet	231 feet	**P - 21 = 0**
	11.5 feet	23.1 feet	34.6 feet	69.3 feet	139.0 feet	231.0 feet	**P - 21 = 1**
	11.50 feet	23.10 feet	-	-	-	-	**P - 21 = 2**

Notes:

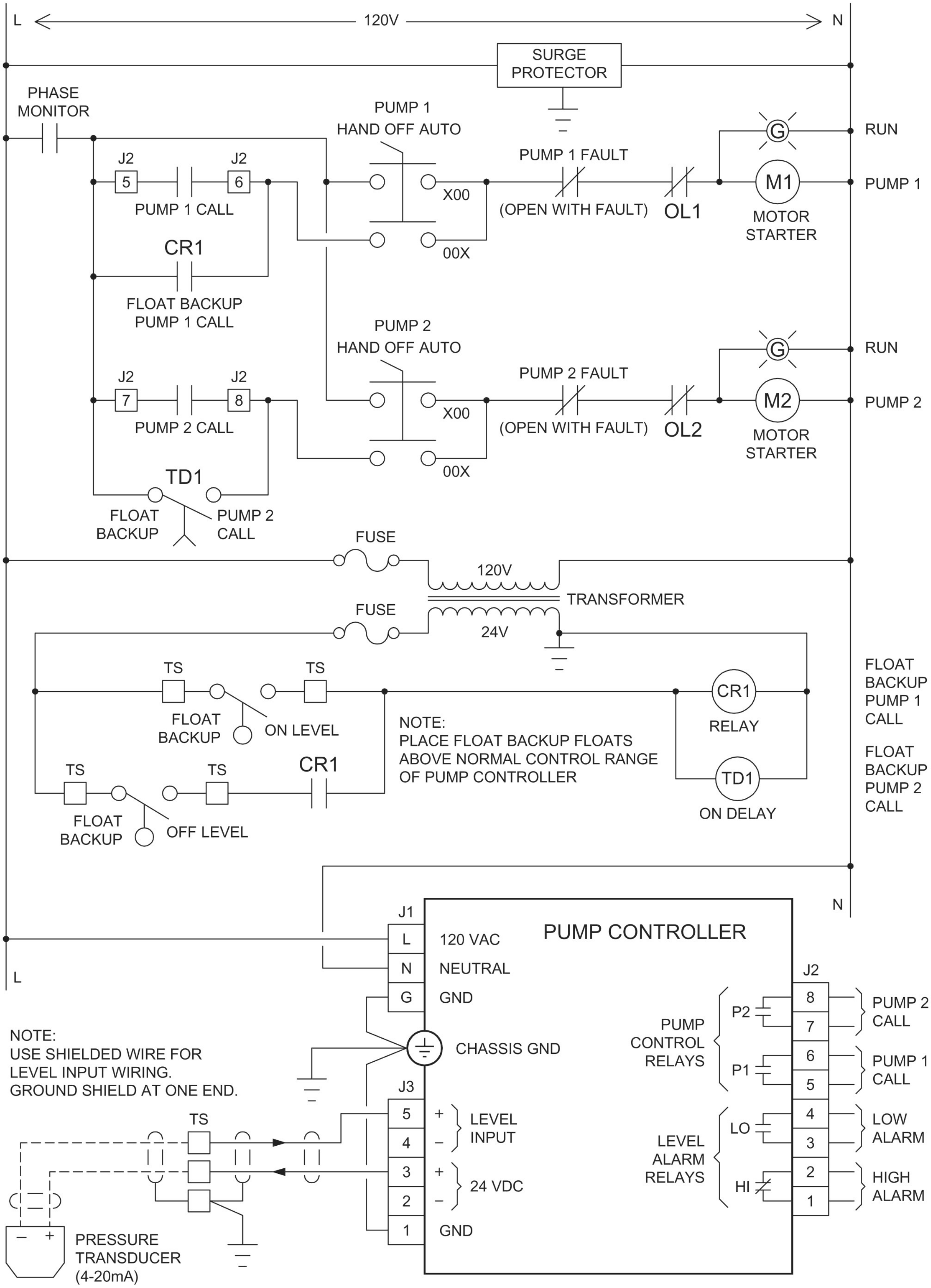
1. Parameter P - 21 is used to set the decimal point position.
2. To find the Span Setting for other transducers use the following equation:

Pressure (psi) x 2.309 = Level (feet of water)

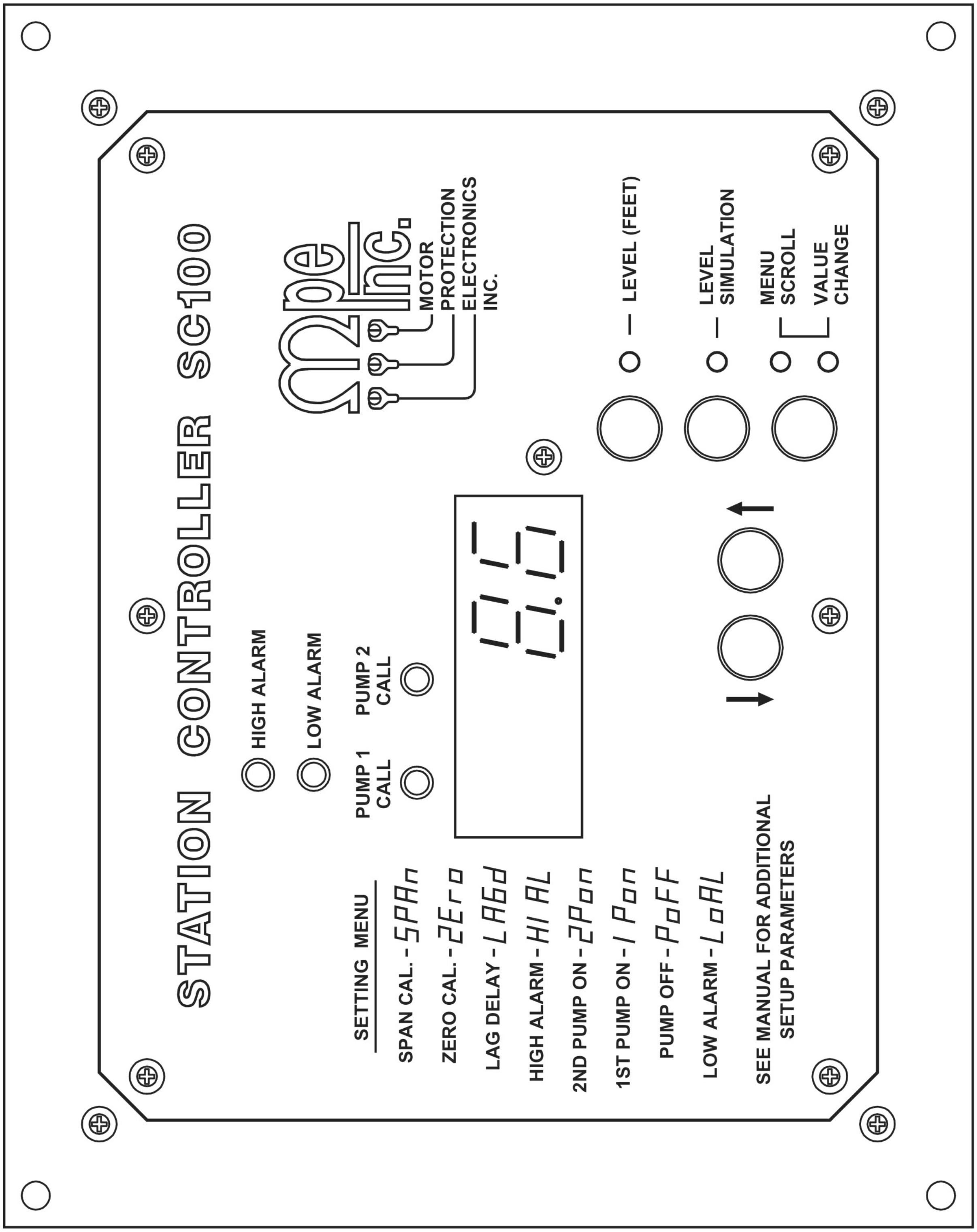
CONNECTION DIAGRAM



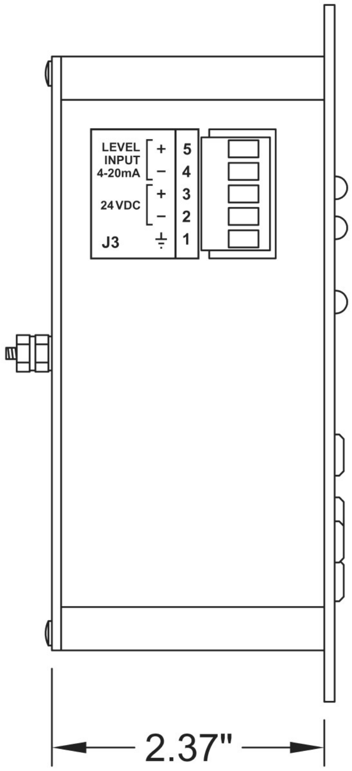
CONTROL SCHEMATIC EXAMPLE - Duplex with 24V Float Backup



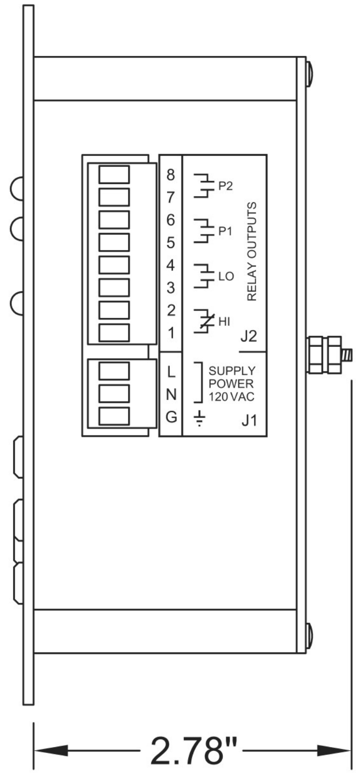
OPERATOR INTERFACE



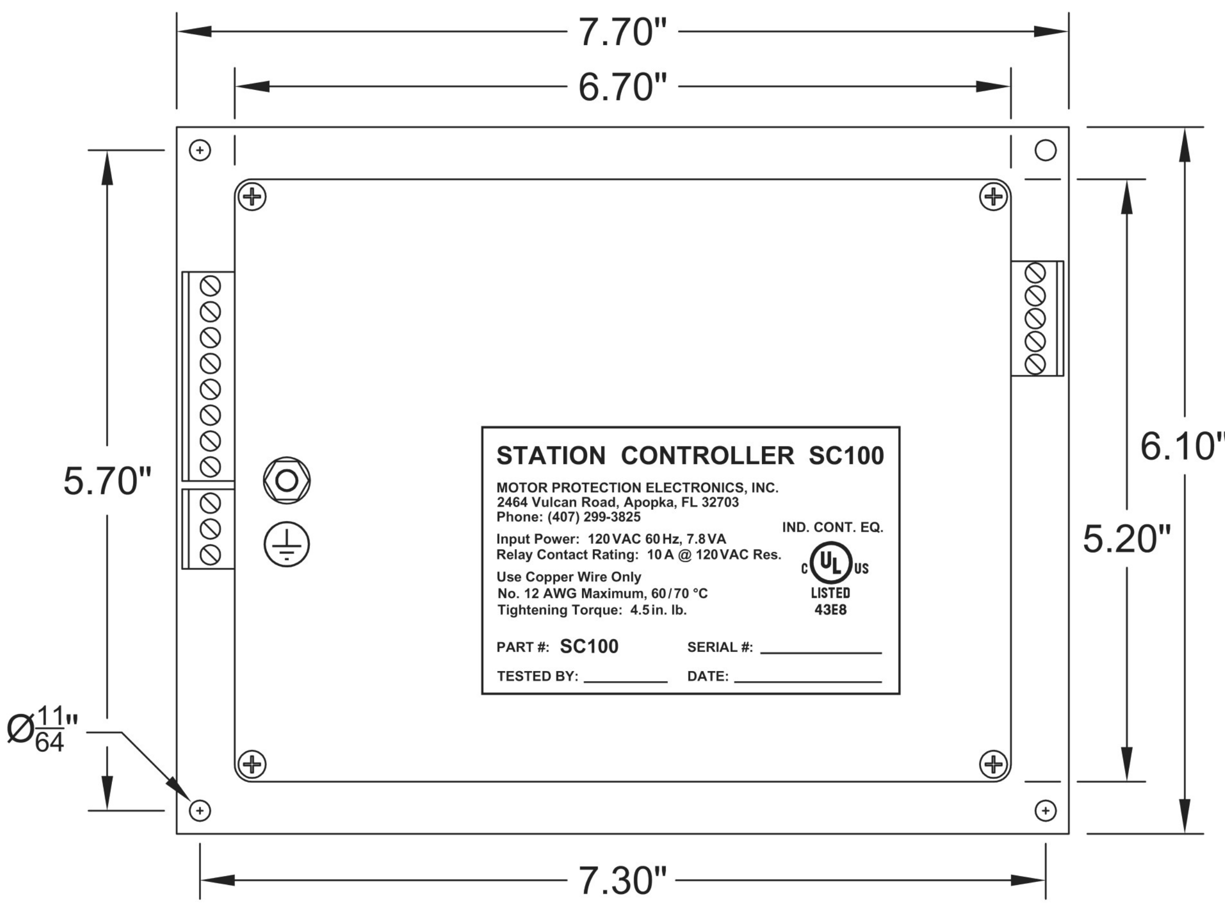
ENCLOSURE MECHANICAL LAYOUT



Left Side

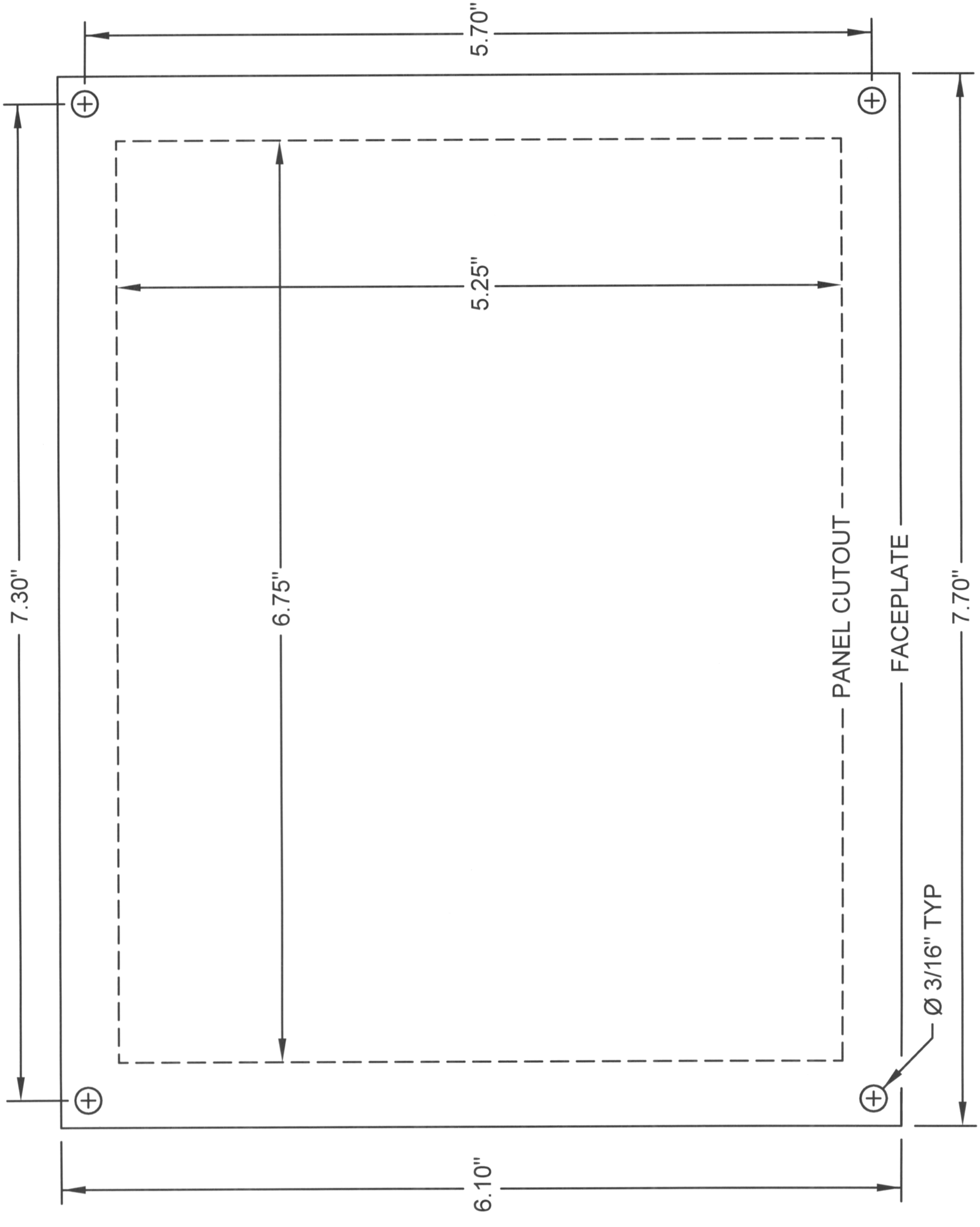


Right Side



Rear View

PANEL CUTOUT



OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 3

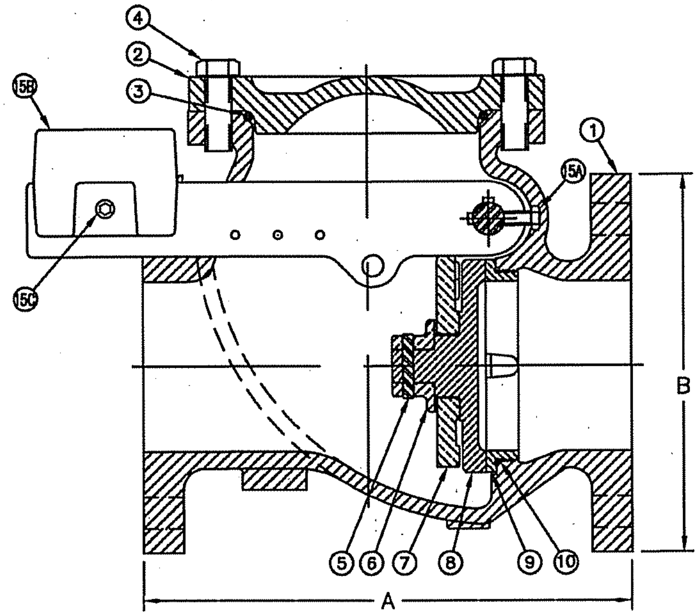
SWING CHECK VALVES

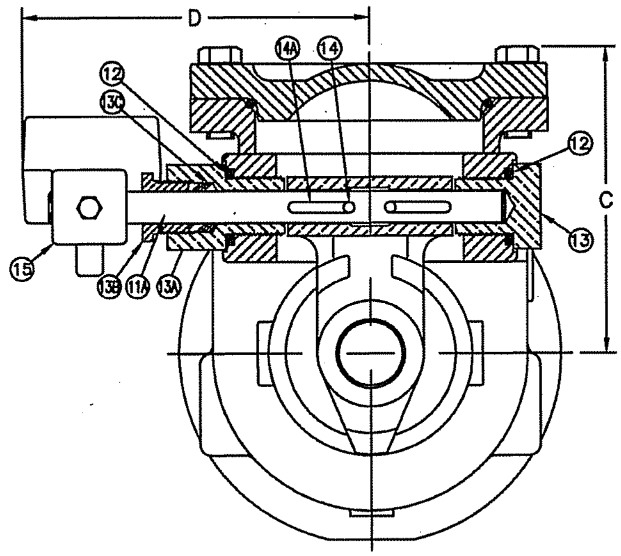
Swing Check Valve 125# Flange Model 92LW FLOMATIC®

Sizes 4" & 6" / 100 mm & 150 mm

Flomatic Corporation

Materials (Lever & Weight)





Item #	Qty	Description	Material	ASTM	Item #	Qty	Description	Material	ASTM
1	1	Body*	Cast Iron	A126	12	2	Bearing O'Ring	Buna-n	——
2	1	Cover*	Cast Iron	A126	13	1	Shaft Support Bearing	Bronze	B140
3	1	Cover O'Ring	Buna-n	——	13A	1	Open End Support Shaft Bearing	Bronze	B140
4	4	Cover Bolt	Stainless Steel	18-8	13B	1	Shaft Packing Nut	Bronze	B140
5	1	Flapper End Cap Pin	Stainless Steel	18-8	13C	4	Teflon Packing	Teflon	——
6	1	Flapper End Cap	Federalloy	I-836-FL	14	1	Screw	Stainless Steel	18-8
7	1	Hinge Lever Arm	Federalloy	I-836-FL	14A	3	Key Stock	Stainless Steel	18-8
8	1	Flapper Plate	Federalloy	I-836-FL	15	1	Lever Arm*	Ductile Iron	65-45-12
9	1	Seat Ring	Federalloy	I-836-FL	15A	1	Bolt	Stainless Steel	18-8
10	1	Seat Ring O'Ring	Buna-n	——	15B	1	Weight*	Cast Iron	A126
11A	1	Flapper Support Shaft	Stainless Steel	17-4	15C	1	Bolt	Stainless Steel	18-8

*Epoxy Coated
Optional resilient seat (Nitrile) available, add "R" to end of part number

MANUFACTURED IN COMPLIANCE WITH AWWA C508 STANDARD

Dimensions

Size		Part #	A		B		C		D		Weight	
Inch	mm		Inch	mm	Inch	mm	Inch	mm	Inch	mm	lbs	kg
4	100	3707LW	11-1/2	292	8-57/64	226	7-7/32	183	8-3/16	208	125	57
6	150	3709LW	14	356	10-3/4	273	8-17/32	217	9-7/32	234	224	102

FLOMATIC CORPORATION
GLENS FALLS, N.Y. 12801
PHONE (518) 761-9797
FAX (518) 761-9798

November 19, 2004
Dwg No:S3707LW Rev A (5/11)

FLOMATIC®

Swing Check Valve 125# Flange Model 92LW FLOMATIC®

Sizes 4" & 6" / 100 mm & 150 mm

Flomatic Corporation

INSTALATION OPERATION & MAINTENANCE INSTRUCTION FOR FLOMATIC SERIES 4" & 6" 92, 92LW, 92LS SWING CHECK VALVES

INSTALLTION INSTRUCTIONS:

1. INSURE ALL SHIPPING WEDGES ARE REMOVED FROM GATE ASSEMBLY.
2. CHECK VALVE FOR OPERATION BY LIFTING LEVER ARM OR GATE ASSEMBLY.
3. INSTALL CHECK VALVE WITH FLOW ARROW IN DIRECTION OF FLOW.
4. VALVE MAY BE INSTALLED VERTICALLY OR HORIZONTALLY.

INSPECTION DISASSEMBLY:

1. ISOLATE VALVE FROM SYSTEM PRESSURE BY CLOSING UPSTREAM AND DOWNSTREAM SHUT–OFF VALVES.
2. REMOVE COVER BOLTS.
3. REMOVE COVER AND O–RING.
4. LIFT GATE ASSEMBLY AND INSPECT VALVE SEAT RING AND GATE ASSEMBLY FOR DAMAGE. REPLACE PARTS IF NECESSARY.

VALVE REASSEMBLY:

1. AFTER REPLACEMENT OR INSPECTION OF INTERNAL COMPONENTS, REASSEMBLE VALVE IN REVERSE ORDER OF DISASSEMBLY INSTRUCTIONS.
2. IF VALVE LEAKS AROUND SHAFT PACKING, TURN PACKING NUT CLOCKWISE UNTIL LEAKING HALTS.

RECOMMENDED SPARE PARTS FOR FLOMATIC 4" & 6" SERIES 92, 92LW, 92LS

DESCRIPTION	***QUANTITY***
DISC	1
SEAT RING	1
PACKING	1
SHAFT KEY	3
COVER O–RING	1
SHAFT (BEARING) O–RING	2
SEAT RING O–RING	1

MANUFACTURED IN COMPLIANCE WITH AWWA C508 STANDARD

FLOMATIC CORPORATION
GLENS FALLS, N.Y. 12801
PHONE (518) 761-9797
FAX (518) 761-9798

November 19, 2004
Dwg No:S3707LW Rev A (5/11)

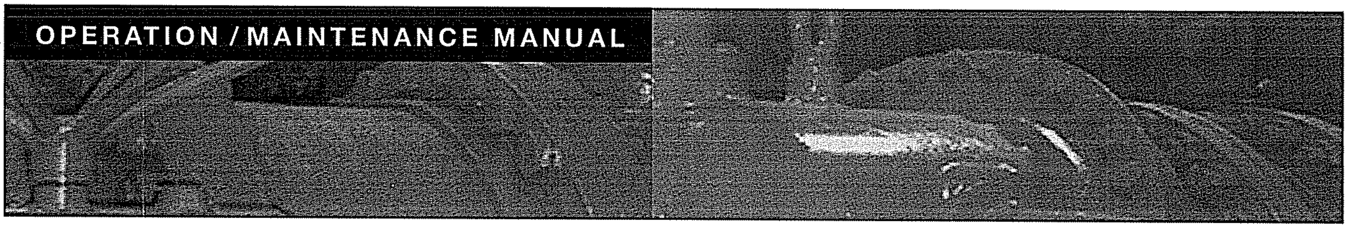
FLOMATIC®

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 4

BALLCENTRIC PLUG VALVES



PRATT®

Ballcentric® Plug Valve

TABLE OF CONTENTS PAGE

⚠ WARNING:

1. Read all applicable directions and instructions prior to any maintenance, troubleshooting or installation.

2. Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of pipeline material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous pipeline materials.

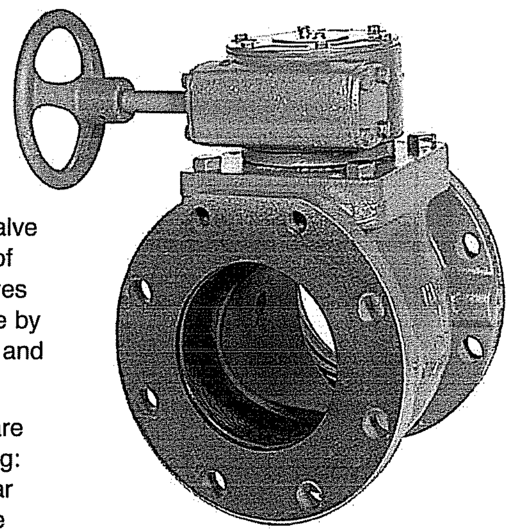
3. Order parts from your local Pratt sales representative or directly from Henry Pratt Company. When ordering parts, please include the serial number located on the valve tag.

NOTE: "WARNING" and "CAUTION" messages (flagged with an exclamation symbol) indicate procedures that must be followed exactly to avoid equipment damage, physical injury, or death.

HENRY PRATT COMPANY
Customer Service
401 South Highland Avenue
Aurora, IL 60506
877.436.7977
www.henrypratt.com
moreinfo@henrypratt.com

FUNCTIONAL DESCRIPTION

Plug valves are designed with eccentric rubber disc seating surfaces. The plug rotates 1/4 turn to provide shutoff in pipes. The eccentric seating action provides for tighter shutoff as the actuator is adjusted to provide for more rotation. The valve can be adjusted to a maximum of 10 degrees over travel. The valves can be used to regulate flow rate by positioning the plug between 15 and 90 degrees open.



Manually operated plug valves are powered with one of the following: 2" direct nut, lever handle or gear actuators, which convert multiple handwheel, chainwheel, or nut input turns into 1/4 turn valve operation. The travel of the valve plug is limited by physical stops in the torque collar for wrench operated valves.

⚠CAUTION: Forcing the handwheel, chainwheel or nut against the stops will not provide tighter shutoff of the valve and may damage the actuator. Only actuator adjustments will affect valve shutoff.

Motor Operated Valve

Motor operated valves are powered with gear actuators, which convert multiple motor input turns into 1/4 turn valve operation. The travel of the valve plug is limited by limit switches in the motor housing and physical stop in the actuator housing. Valve shutoff is affected by limit switch and physical stop settings.

⚠CAUTION: Improperly set limit switches and/or physical stops may damage the motor and/or actuator.

Hydraulically operated valves are powered with a gear box and double acting cylinder. The linear stroke of the cylinder is converted to 1/4 turns operation by the gear box. Auxiliary controls are provided to direct hydraulic power to the cylinder and to control the operating speed of the cylinder.

INSTALLATION

When installing the plug valves, the seat end should be noted. The seat end of the valve is cast in raised letters on the appropriate flange of the valve. Generally, straightway valves should be installed with the highest pressure applied from the opposite end from the seat. This will tend to push the plug into the seat On pump discharge installations the seat end should be towards the pump.

In cases where shut-off is required in both directions, the valve should be installed so that the highest differential pressure at shut-off is opposite the seat end.

When the service is of a clogging type, with suspended solids likely to build up in the valve body, it is recommended that the valve be installed with the media entering the seat end first. In extreme cases, the valve should be installed with the plug horizontal and rotating upward into the top portion of the valve body cavity to open. See Page 6 for recommended installation options.

Class 125 flanged end valves have ANSI B16.1 flat faced 125/150 flanges. Standard ANSI B16.21 flanges and gaskets should be used to install the valves in the pipeline.

Certain size valves utilize tapped holes on the top and bottom of the flange where a backing nut is not possible. Please check specific drawings for detailed information on sizes and quantities of hexagon head screws required on these valves.

Prior to installing valves, they should be cycled open and closed several times to ensure they are in good working order and have not been damaged during shipment or storage.

INSTALLATION OPTIONS

The type of materials carried in the pipeline and the location of the valve determine the correct installation orientation.

Liquids Without Suspended Solids

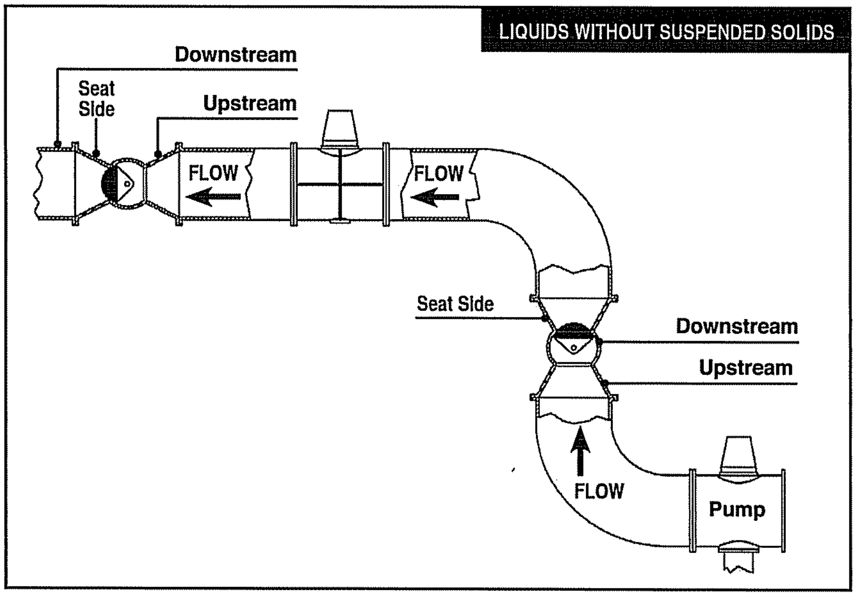
Valve may be installed with plug shaft vertical or horizontal. For vertical pipe installations, install valve with seat facing downstream.

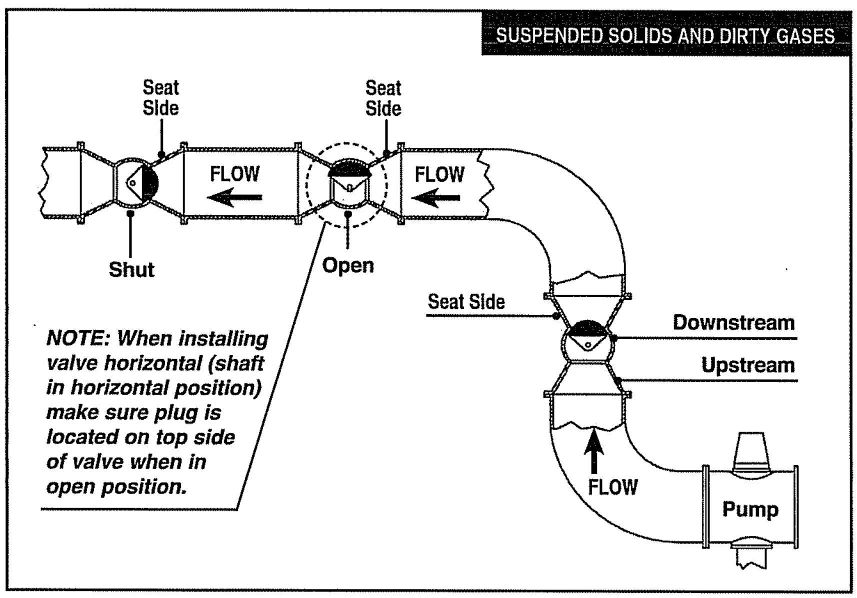
Before installation, blow out pipeline to remove all foreign materials.

Suspended Solids and Dirty Gases

Install valve with plug facing upstream. Ensure plug rotates up to the fully open position thus preventing plug from sweeping through settled debris.

NOTE: For pump isolation service install the discharge valve with the seat downstream from the pump and with the plug rotating to the top of the pipeline in the open position.





WRENCH OPERATED PLUG VALVES

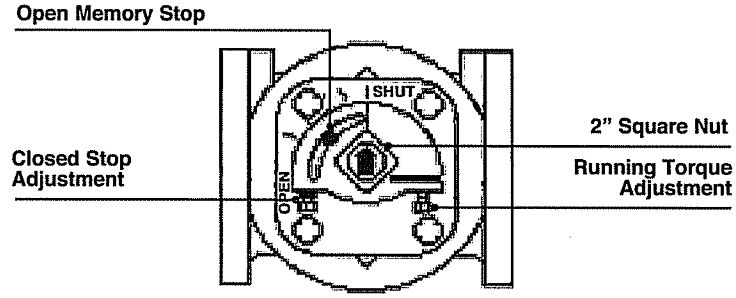
Do not permit use and operation of a Wrench operated eccentric plug valves close by turning the valve 90 degrees clockwise. All wrench operated eccentric valves are equipped with a multifunction device referred to here as a torque collar. This device serves as:

1. Wrench Adapter – 2" Square
2. Position Indicator
3. Open Memory Stop
4. Closed Memory Stop
5. Running Torque Adjustment

Position Indicator: The top of the plug has an indicator plate to show the approximate plug position. Cast onto the torque collar is an indicator mark which corresponds to a graduated scale cast on the bonnet of the valve. This scale is divided into 15 degree lines and indicates the exact valve opening from full open to full closed.

Open Memory Stop: The torque collar also incorporates an open memory stop feature. The plug can be set by tightening the open memory stop adjustment bolt after the correct flow is achieved. The valve can then be closed for maintenance and reopened to the proper position without resetting the flow.

WRENCH OPERATED VALVE WITH TORQUE COLLAR



Closed Memory Stop: The closed memory stop is provided to allow for adjustment to compensate for wear of either the plug coating or the seat. The closed stop is pre-set at the factory and should not require readjustment unless wear occurs.

To adjust the plug for excess plug or seat wear simply rotate the closed stop two turns counter-clockwise then rotate the plug (clockwise) further into the seat and check the flow. Should this movement fail to shut off the flow repeat the above step. Afterward re-set the lock nut to prevent the position from being altered.

Running Torque Adjustment: The nature of eccentric plug valves "camming" action eliminates the majority of the torque prior to seating. To prevent the plug from creeping open or slamming closed, the torque collar maintains a constant drag on the shoulder of the valve bonnet. This component is factory adjusted. However, once the valve has been installed, it is recommended that the torque adjustment nut be further tightened to assure proper friction exists to prevent unwanted closure.

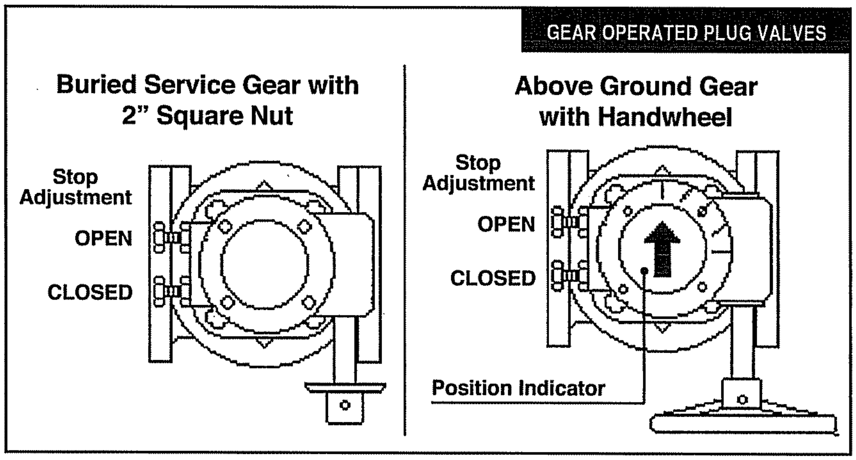
To prevent the plug from unnecessary movement, rotate the hex head bolt clockwise until there is a substantial drag on the plug but not so much as to prevent the movement of the plug with the supplied wrench.

GEAR OPERATED PLUG VALVES

Gear operated eccentric valves close by turning the gear input shaft clockwise until closed.

Position Indicator (above ground units only): The top of the gear operator has an indicator plate to show the plug position. This scale, cast onto the gear housing, is divided into 15 degree lines and indicates the exact valve opening from full open to full closed. Buried service units are totally enclosed and sealed for use below grade.

Open and Closed Memory Stops: The closed memory stop is provided to allow for adjustment to compensate for wear of either the plug coating or the seat. The closed stop is pre-set at the factory and should not require readjustment unless wear occurs.



To adjust the plug for excess plug or seat wear simply rotate the closed stop two turns counterclockwise then rotate the handwheel or nut (clockwise) to move the plug further into the seat and check the flow.

Should movement fail to shut off the flow repeat the above step. Afterward re-set the lock nut to prevent the position from being altered.

ACTUATED PLUG VALVES

Described below are the operating instructions for an eccentric plug valve equipped with an electric motor actuator. General arrangement drawings are provided in conjunction with this manual to illustrate the fitup and installation of the valve and wiring of the motor. Specific wiring details are contained in the electric motor actuator manual. As with any plug valve, the actuator will cause the valve plug to rotate through 1/4 turn to open or close the valve.

The output motion of the actuator is limited to about 100 degrees of output rotation by mechanical stops in the gearing. These are factory set and should not need adjustment. The actual positioning of the valve plug will be done by limit switches in the motor actuator.

The switches are also set at the factory, but adjustment is sometimes required if the motor unit is installed on a separate mounting base or floor stand. Detailed procedures are given in the motor manual if adjustment is needed for the mechanical stops or the limit switches. The wiring and power requirements are noted on the wiring diagrams included with this instruction manual.

MAINTENANCE

The eccentric valve is designed and manufactured to be a long life valve under normal circumstances. It does not require any routine maintenance. Cycling the valve from full open to full closed on an annual basis will increase the life of the valve and operator components. However, if maintenance is required due to unusual wear or service conditions, the following procedure should be followed:

⚠CAUTION: Valve should be depressurized for all maintenance activities

Disassembly Procedure

Body: The plug valve is a top entry valve; therefore the body can remain in line during this operation.

Gear Operated Valves: Remove the bolts holding the gear operator housing cover in place. Remove the housing cover and the internal bolts holding the gear operator to the valve body. Remove the gear operator and set aside.

Wrench Operated Valves: Remove the star washer fastening the torque collar to the plug stem. Remove the torque collar and set aside. With the valve de-pressurized, remove the hexagonal head cap screws that hold the bonnet to the valve body.

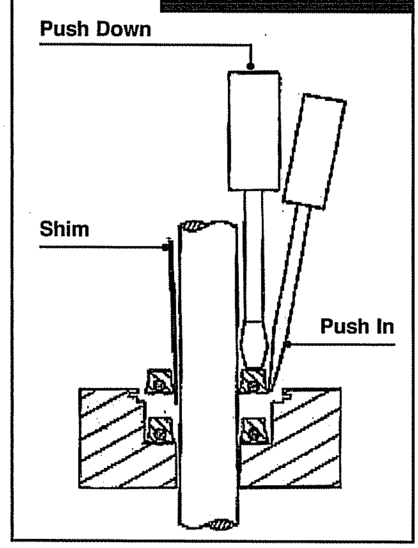
Remove the bonnet, leaving the plug in the body. At this point, the plug, PTFE thrust washers, journal bearings and bonnet stem seals are accessible and can be removed and replaced.

Reverse the above process for reassembling the valve only. For stem seal replacement follow procedure below.

Stem Seals: With the valve de-pressurized, using internal snap ring pliers, remove the snap ring and thrust washer. The "U" cup seals can now be pried out of the seal cavity. To replace, reverse the above process.

"U" Cup Seals: To replace "U" cup seals on actuated eccentric plug valves, depressurize the valve, remove the actuator, and remove internal bolts fastening the actuator to the valve body. Remove the actuator and set aside. Remove the internal snap ring using snap ring pliers. Remove thrust washer. The "U" cup seals are now visible. Using a screwdriver, pry out the old seals. Apply a small amount of silicone or grease to the new "U" cup seals. This will help them slide in the packing cavity. Put a piece of shim stock into the cavity and put the "U" cup over it. Slide the "U" cup over the stem with shim stock

"U" CUP SEAL DIAGRAM



against the stem. This will let any trapped air out of the packing cavity. Now, using two screwdrivers, coax the outer lip of the "U" cup into the cavity while pressing down on the top of the "U" cup with the other screwdriver (see above diagram). Continue to do this all the way around until the "U" cup is at the bottom of the packing cavity.

Repeat the procedure with the second "U" cup, and replace the thrust washer and snap ring. Now you can remount the actuator on the valve.

TROUBLESHOOTING

Wrench Operated Plug Valve

PROBLEM	CAUSE	SOLUTION
Valve will not open	• broken or misadjusted torque collar • obstruction in line • excessive line pressure • elastomer damage	• adjust or replace torque collar • remove obstruction • reduce pressure • replace plug
Valve will not close	• broken or misadjusted torque collar • obstruction in line • excessive line pressure • elastomer damage	• adjust or replace torque collar • remove obstruction • reduce pressure • replace plug
Valve will not shutoff flow	• improper stop adjustment • obstruction in line • excessive line pressure • elastomer damage	• adjust closed stop • remove obstruction • reduce pressure • replace plug
Valve leaks at plug stem	• damaged "U" cup seal	• replace "U" cups

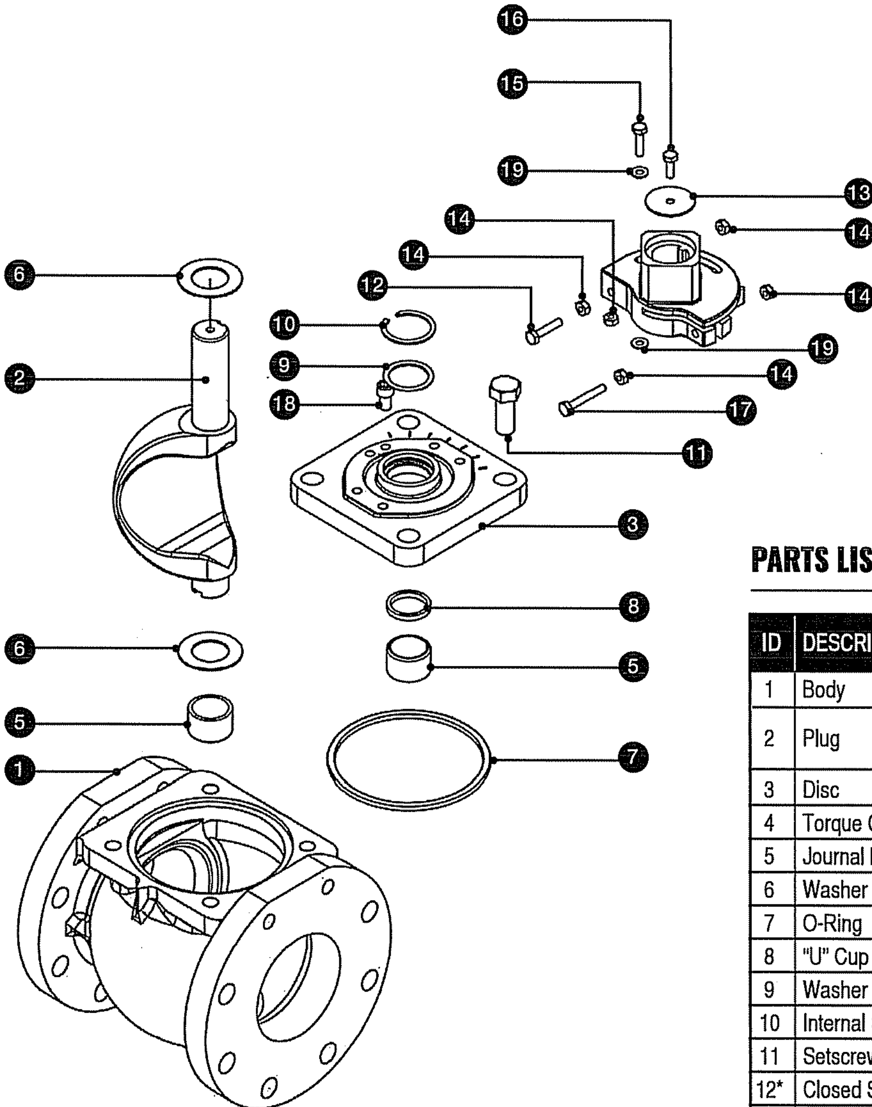
Gear Operated Plug Valve

PROBLEM	CAUSE	SOLUTION
Valve will not open	• bent input shaft • obstruction in line • excessive line pressure • elastomer damage	• replace worn shaft • remove obstruction • reduce pressure • replace plug
Valve will not close	• bent input shaft • obstruction in line • excessive line pressure • elastomer damage	• replace worn shaft • remove obstruction • reduce pressure • replace plug
Valve will not shut off flow	• improper stop adjustment • obstruction in line • excessive line pressure • elastomer damage	• adjust closed stop • remove obstruction • reduce pressure • replace plug
Valve leaks at plug stem	• damaged "U" cup seal	• replace "U" cups

Actuated Plug Valve

PROBLEM	CAUSE	SOLUTION
Valve will not close/open	• no power source • improper signal • burned out or impaired component	• check incoming power source and/or replace fuses • check actuating signal sequence • check and repair or replace motor or relay devices
Valve will not shut off flow	• improper stop adjustment • actuator torques out	• re-set limit switch • check for obstructions in valve

2" – 12" Ballcentric Plug Valve Parts



PARTS LIST

ID	DESCRIPTION	MATERIAL
1	Body	Cast Iron ASTM A-126 Class B
2	Plug	Rubber Coated Ductile Iron ASTM A-536
3	Disc	Cast Iron ASTM A-126 Class B
4	Torque Collar	Ductile Iron ASTM A-536
5	Journal Bearing	303 Stainless Steel
6	Washer (Grit Seal)	PTFE
7	O-Ring	Elas. as Spec.
8	"U" Cup Seal	Elas. as Spec
9	Washer	Brass – ASTM B138-675
10	Internal Snap Ring	Spring Steel
11	Setscrew	Steel (Zinc Plated)
12*	Closed Stop	Steel (Zinc Plated)
13*	Locking Washer	Steel
14*	Nut	Steel (Zinc Plated)
15*	Open Stop	Steel (Zinc Plated)
16*	Set Screw	Steel (Zinc Plated)
17*	Torque Bolt	Steel (Zinc Plated)
18*	Travel Stop	Steel
19*	Washer	Steel

*Torque Collar Assembly on 8" and Smaller

TO ORDER: Contact our Parts Department.
Henry Pratt Company
401 South Highland Avenue
Aurora, IL 60506-5563
(630) 844-4000

When ordering parts, please include the serial no. located on the valve tag and the part description.

Mueller Co.
Reliable Connections®

Henry Pratt Company
1.630.844.4000
www.henrypratt.com
moreinfo@henrypratt.com

International
1.423.490.9555
www.mueller-international.com
international@muellercompany.com

Form 13810 - 02/17

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 5

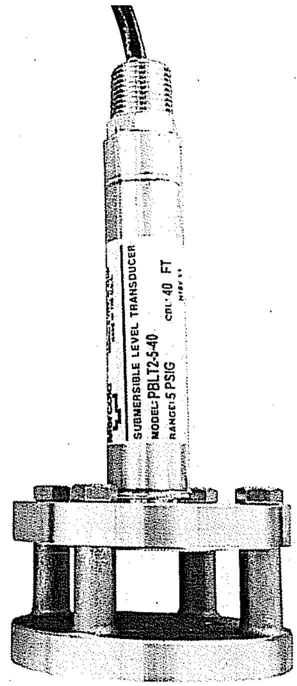
DWYER LEVEL TRANSDUCER

SERIES PBLT2 & PBLTX | MERCOID SUBMERSIBLE LEVEL TRANSMITTERS

FEATURES/BENEFITS

- **Durable cage design with large diameter 316 SS diaphragm seal that is non-clogging and damage resistant to floating solids**
- **Incorporates lightning and surge protection utilizing dual arrestor technology, grounded to case, eliminating both power supply surges and lightning ground strike transients (surge protection is not guaranteed and is not covered by warranty) on PBLT2 models**
- **Maintenance free filter eliminates particulate or water droplets from entering anddamaging the transducer**
- **UL approved intrinsically safe on PBLTX models for use in hazardous locations when used with proper barrier**
- **Excellent chemical compatibility for wide application use**
- **NPT connection allows the unit to be rigidly installed in a pipe/conduit, or the addition of a A-625 hanging loop for attaching a chain for pulling out of the installation**
- **Standard 72 hour lead time ensures minimal downtime**

NOW WITH 72 HOUR OUT OF STOCK LEAD TIME!



APPLICATIONS

- Wastewater
- Sludge pits, clarifiers, digesters
- Alum tanks
- Chemical storage tanks
- Oil tanks
- Lime slurry
- Sumps
- Reservoirs

DESCRIPTION

The **SERIES PBLT2 & PBLTX** Submersible Level Transmitters are manufactured for years of trouble free service in the harshest applications. This Series measures the height of liquid above the position in the tank referenced to atmospheric pressure. The transmitter consists of a piezoresistive sensing element, encased in a 316 SS housing with cage and large diameter 316 SS diaphragm seal.

SPECIFICATIONS

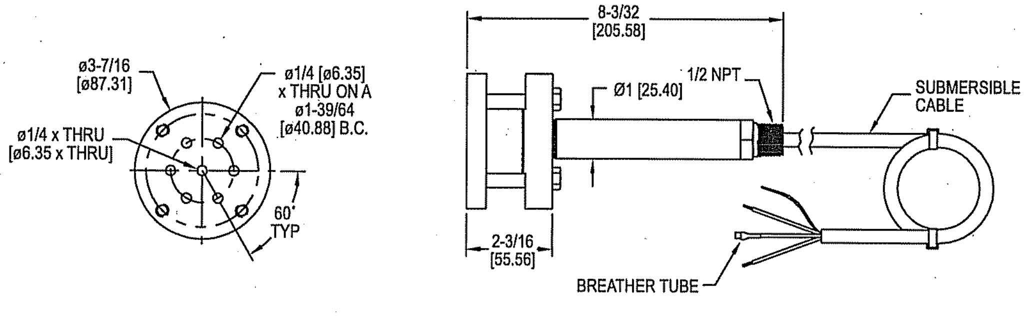
Service	Compatible liquids.
Wetted Materials	316 SS, 316L SS, epoxy, cable: ETFE or polyurethane.
Accuracy	±0.25% FS (includes linearity, hysteresis, and repeatability)*.
Temperature Limit	PBLT2: 0 to 200°F (-18 to 93°C); PBLTX: 0 to 176°F (-18 to 80°C).
Compensated Temperature Range	PBLT2: 0 to 180°F (-18 to 82°C); PBLTX: 0 to 176°F (-18 to 80°C).
Thermal Effect	±0.02% FS/°F.
Pressure Limit	2X FS.
Power Requirement	PBLT2: 13 to 30 VDC, PBLTX: 10 to 28 VDC.
Output Signal	4 to 20 mA DC, two wire.
Response Time	50 ms.
Loop Resistance	900 Ω.
Electrical Connection	Wire pigtail.
Mounting Orientation	Suspended in tank below level being measured.
Electrical Protection	PBLT2: Lightning and surge protection, PBLTX: none.
Weight	4.3 lb (2.0 kg).
Agency Approvals	PBLT2: CE, PBLTX: CE, cULus intrinsically safe for Class I, Div. 1, Groups A, B, C, D; Class II, Div. 1, Groups E, F, G; Class III, Div. 1. (According to control drawing 01-700797-00)**.

*Configured ranges below 5 psi (11.54 ft w.c.) (3.52 m w.c.) ±1% FS accuracy

**Up to 196 ft (59.5 m) for ETFE cable; Up to 333 ft (101.5 m) for polyurethane cable

DWYER INSTRUMENTS, INC.
T: 219-879-8000 | F: 219-872-9057 | info@dwyermail.com
800-872-9141

DIMENSIONS



PBLT2/PBLTX

HOW TO ORDER

Use the **bold** characters from the chart below to construct a product code.

PBLT2 -5 -40 -PU

SERIES
PBLT2: Submersible level transmitter
~~**PBLTX:** Submersible level transmitter (i~~ntrinsically safe)

CABLE TYPE
BLANK: ETFE
~~**-PU:** Polyurethane~~

***RANGE psi (ft w.c.) [m w.c.]**
~~**-5:** 5 (11.54) [3.52]~~
-10: 10 (23.09) [7.04]
~~**-15:** 15 (34.63) [10.56]~~
-20: 20 (46.18) [14.08]
-3.5M: 4.97 (11.48) [3.5]
-5M: 7.11 (16.40) [5]
-10M: 14.21 (32.81) [10]

*Additional pressure ranges available, consult factory

****CABLE LENGTH ft (m)**
-40: 40 (12.2)
~~**-60:** 60 (18.3)~~
-5M: 16.40 (5)
-10M: 32.81 (10)
-18M: 59.06 (18)

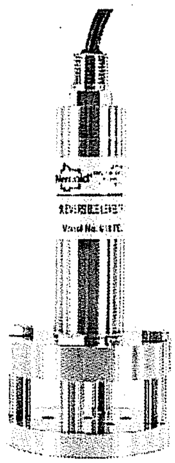
**Configured cable lengths available from 10 to 2000 ft (3 to 610 m)

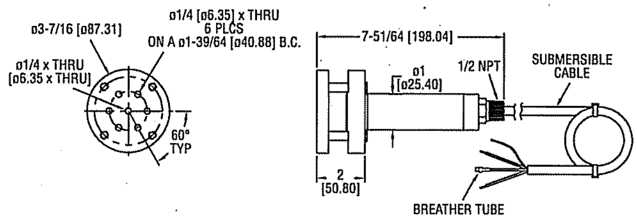
ACCESSORIES

Model	Description
MTL5041	Intrinsically safe galvanic isolator
MTL7706	Intrinsically safe zener barrier
A-297	Dessicant filter for vent tube. Removes humidity for protection of the sensor. Changes color to show saturation
A-625	316 SS cable hanger for attaching chain for easy pulling out of application

Series PBLT2 Submersible Level Transducer

Specifications - Installation and Operating Instructions





The PBLT2 Submersible Level Transducer is manufactured for years of trouble free service in the harshest applications. The PBLT2 measures the height of liquid above its position in the tank referenced to atmospheric pressure. The transducer consists of a piezoresistive sensing element, encased in a 316 SS housing. Perfect for wastewater and slurry applications with features to protect the unit from these demanding applications. Superior lightning and surge protection utilizing dual arrestor technology, grounded to case, eliminating both power supply surges and lightning ground strike transients (surge protection is not guaranteed and is not covered by warranty). Large diameter 316 SS diaphragm seal is non-clogging and damage resistant to floating solids.

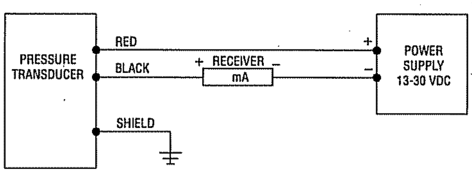
Comes equipped with a 270-pound tensile strength, shielded, vented cable. Ventilation tube in the cable automatically compensates for changes in atmospheric pressure above the tank. The vent tube has a filter attached to the end that will block particles, such as dust, dirt, and water droplets, from entering the tube.

APPLICATIONS

• Wastewater: sludge pits, clarifiers, digesters; Alum tanks; Chemical storage tanks; Oil tanks; Lime slurry; Sumps; Reservoirs.

ELECTRICAL INSTALLATION

An external power supply delivering 13-30 VDC with minimum current capability of 40 mA DC (per transmitter) is required to power the control loop. See figure below for connection of the power supply, transmitter and receiver.



The maximum receiver load resistance (RLmax) for the DC power supply voltage (Vsup) is expressed by the formula:

$$RLmax = \frac{Vsup - 13V}{0.02A}$$

Shielded cable is recommended for control loop wiring.

SPECIFICATIONS

Service: Compatible liquids.
Wetted Materials: 316 SS, 316L SS, epoxy adhesive; Cable: Polyether polyurethane or ETFE.
Accuracy: ±.25% full scale.
Temperature Limits: 0 to 200°F (-18 to 93°C).
Compensated Temperature Range: 0 to 180°F (-18 to 82°C).
Thermal Effect: Less than ±.02%/°F.
Pressure Limit: 2X full scale.
Power Requirement: 13 to 30 VDC.
Output Signal: 4 to 20 mA DC, two wire.
Response Time: 50 msec.
Loop Resistance: 850 ohms at 30 VDC.
Electrical Connection: Wire pigtail.
Mounting Orientation: Suspended in tank below level being measured. Can be placed on the bottom of the tank on its side.
Weight: 4.3 lb (2.0 kg).
Electrical Protection: Lightning and surge protection.
Agency Approvals: CE.

WARNING:

A voltage potential between the ground wire of the unit and the ground of other equipment can lead to electrolytic corrosion. Always ensure the grounding system provides an equipotential between the transmitter and the earthing ground connection. Avoid using the power system protective ground since this will often have a significant potential difference to the transmitter ground. Also note that dissimiliar metals in the ground system may cause electrolysis corrosion of the transmitter or other components in the ground system.

During installation, connect a voltmeter or ammeter between the shield ground wire and the grounding connection. If there is a measurable voltage or current electrolytic corrosion may be a serious possibility. If there is a potential difference then some isolation system will be required. Improper grounding may lead to damage or poor signal integrity.

Model Number Guide

Example	PBLT2	20	40		PBLT2-20-40
Construction	PBLT2				Cage style submersible level transmitter, ETFE cable
Range		XXX			In psi (5000 psi maximum)
Cable Length			XXX		In feet (1500 feet maximum)
Options				PU	Polyurethane cable

Printed in U.S.A. 2/15

FR# 443430-00 Rev. 8

MERCOID DIVISION
DWYER INSTRUMENTS, INC.
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OPERATION AND MAINTENANCE MANUAL

VOLUME III

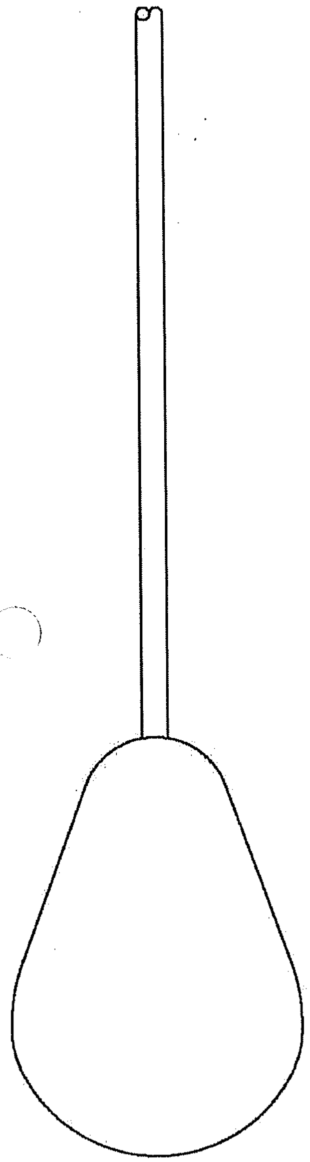
TAB 6

NON-MERCURY FLOAT SWITCHES

CONERY
MFG. INC.

NON-MERCURY FLOAT SWITCH - CONTROL DUTY

2900-B8 MECHANICAL SERIES - WIDE ANGLE FLOAT SWITCH



GENERAL

DESIGNED FOR ACCURATE LIQUID LEVEL CONTROL IN MANY APPLICATIONS INCLUDING POTABLE WATER OR SEWAGE ENVIRONMENTS. THE FLOAT SWITCH CAN BE UTILIZED TO SIGNIFY SPECIFIC WATER LEVELS OR FOR DIRECT ALARM ACTUATION.

SWITCH VARIATIONS

NORMALLY OPEN (N/O) - GREEN SHELL

THE CONTACTS ARE OPEN (OR OFF) IN THE HANGING POSITION. AS THE FLOAT RISES 45° ABOVE HORIZONTAL, THE CONTACTS BECOME CLOSED AND ACTUATE (TURN ON) THE SWITCH. THIS FLOAT IS GENERALLY USED IN PUMP DOWN APPLICATIONS.

NORMALLY CLOSED (N/C) - GREEN/RED SHELL

THE CONTACTS ARE CLOSED (OR ON) IN THE HANGING POSITION. AS THE FLOAT RISES 45° ABOVE HORIZONTAL, THE CONTACTS BECOME OPEN AND ACTUATE (TURN OFF) THE SWITCH. THIS FLOAT IS GENERALLY USED IN PUMP UP APPLICATIONS.

SINGLE POLE, DOUBLE THROW (SPDT) - GREEN/BLUE SHELL

A VARIATION OF THE PREVIOUSLY LISTED SWITCHES. THIS FLOAT SWITCH CAN BE WIRED TO OPERATE AS EITHER (BUT NOT BOTH) A NORMALLY OPEN OR NORMALLY CLOSED SWITCH BASED ON THE USER'S NEED.

SWITCH SPECIFICATIONS

2900 SERIES MECHANICAL FLOAT SWITCHES ARE DESIGNED TO OPERATE UNDER THE FOLLOWING PARAMETERS.

MINIMUM OPERATING TEMPERATURE	-	32 DEGREES F.
MAXIMUM OPERATING TEMPERATURE	-	170 DEGREES F.

13 AMPS @ 120 VAC FOR 1/2 H.P. AND 1 H.P. @ 240 VAC
15 AMPS @ 120 VAC FOR 1 H.P. AND 2 H.P. @ 240 VAC

POWER CORD SPECIFICATIONS

	CONDUCTOR CORD - PHYSICAL	-	CHLORINATED POLY ETHYLENE.
30 foot	ELECTRICAL FOR N/O OR N/C SWITCH	-	16 AWG 2, TYPE SJOOW - 300 V.
	ELECTRICAL FOR SPDT SWITCH	-	16 AWG 3, TYPE SJOOW - 300 V.
	ELECTRICAL FOR 1 H.P./2 H.P. SWITCH	-	14 AWG 2, TYPE SJOOW - 300 V.

OPTIONAL 120 VAC OR 240 VAC PIGGY BACK PLUG

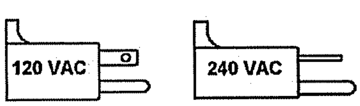
FLOAT SPECIFICATIONS

DURABLE POLYPROPYLENE MATERIAL CONSTRUCTION.
SOLID POLYURETHANE FOAM INTERIOR.
LEAK PROOF, SHOCK PROOF, AND IMPACT RESISTANT.
RESISTANT TO SEWAGE AND WASTEWATER APPLICATIONS.

OPTIONAL CORD MOUNTING ASSEMBLIES AVAILABLE (NOT SHOW)

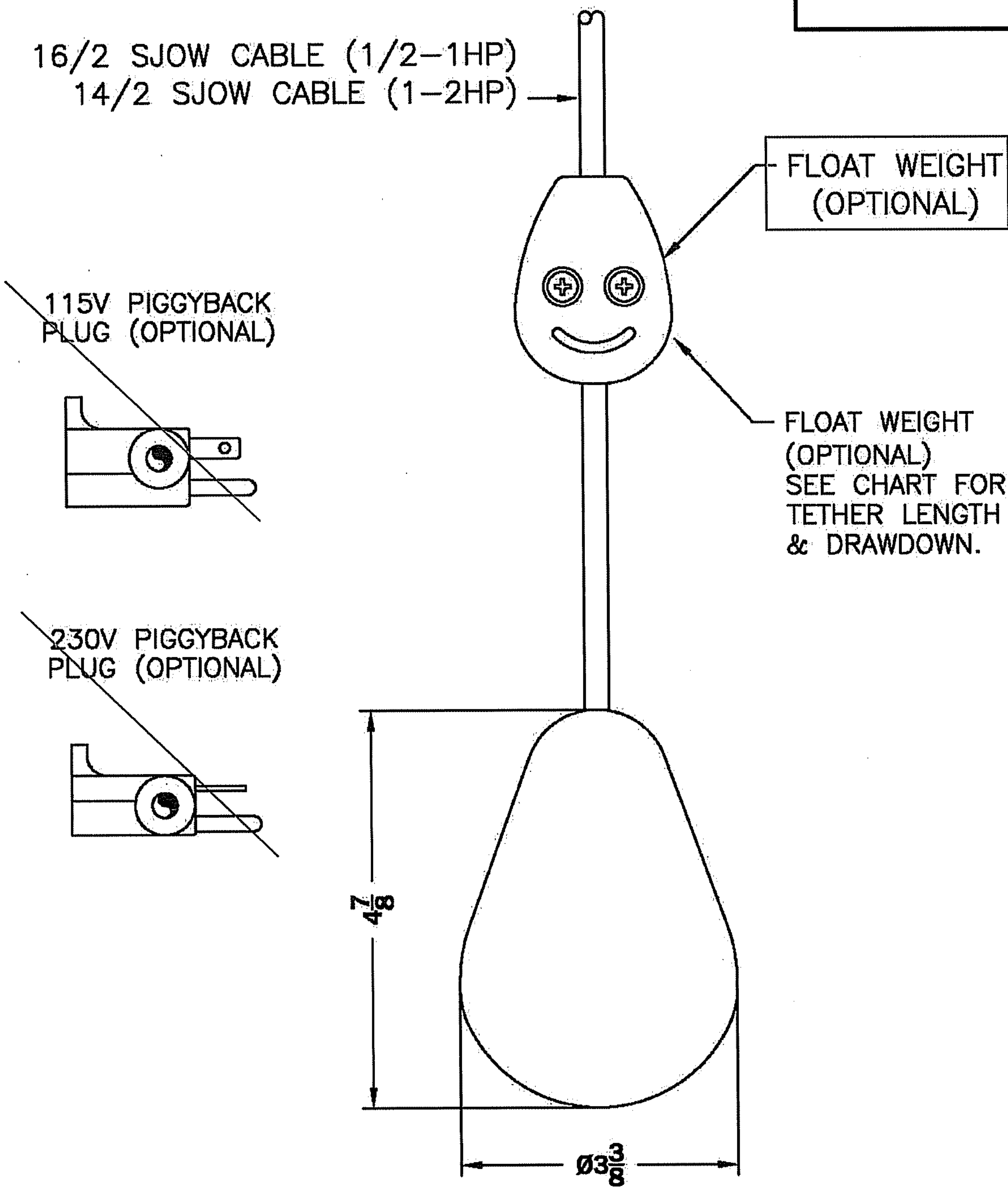
ZINC PLATED CAST IRON - 1.22 LBS.

POLYPROPYLENE CABLE CLAMP WITH STAINLESS STEEL BAND



US C US
LISTED
Ind. Cont. Eq.
47UF

CONERY MFG INC
info@conerymfg.com
1380 ENTERPRISE PKWY
PH (419) 289-1444
ASHLAND, OH 44805
FAX (419) 281-0366



CONERY MFG INC

SPECIFICATION SHEET
MECHANICAL FLOAT

CHANGES	TOLERANCES	DRAWN BY	DATE
F	DECIMALS .XXX = ±.005 .XX = ±.010	D. MIDDLETON	07/30/09
E	FRACTIONAL X/X = ±.1/64	MATERIAL SPECIFICATION:	
D	ANGLES X° = ±1/2°		
C			
B			
A			

SCALE: HALF

2900 SERIES B8
NON–MERCURY

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 7

MYERS SUBMERSIBLE SUMP PUMP – VALVE VAULT

PENTAIR

MYERS®

OWNER'S MANUAL

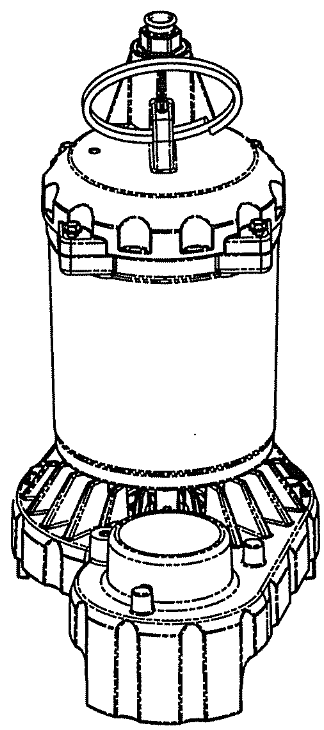
Submersible Cast Iron and Zinc Sump Pump

NOTICE D'UTILISATION

Pompe de puisard submersible en fonte et zinc

MANUAL DEL USUARIO

Bomba de sumidero sumergible, en hierro fundido y zinc



MS33D, MS50D, MS33M, MS50M, MS33T, MS50T, MS33V, MS50V

Installation/Operation/Parts

For further operating, installation, or maintenance assistance:

Call 1-888-987-8677

Installation/Fonctionnement/Pièces

Pour plus de renseignements concernant l'utilisation, l'installation oul'entretien :

Composer le 1 (888) 987-8677

Instalación/Operación/Piezas

Para mayor información sobre el funcionamiento, instalación o mantenimiento de la bomba:

Llame al 1-888-987-8677

MY999 (Rev. 02/09/18)

Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during installation, operation, and maintenance of the product.

⚠ This is the safety alert symbol. When you see this symbol on your pump or in this manual, look for one of the following signal words and be alert to the potential for personal injury!

⚠ DANGER indicates a hazard which, if not avoided, will result in death or serious injury.

⚠ WARNING indicates a hazard which, if not avoided, could result in death or serious injury.

⚠ CAUTION indicates a hazard which, if not avoided, could result in minor or moderate injury.

NOTICE addresses practices not related to personal injury.

Carefully read and follow all safety instructions in this manual and on pump.

Keep safety labels in good condition. Replace missing or damaged safety labels.

California Proposition 65 Warning

⚠ WARNING This product contains chemicals known to the State of California to cause cancer or birth defects or other reproductive harm.

NOTICE This unit is not designed as a waterfall or fountain pump, or for applications involving salt water or brine! Use with waterfalls, fountains, salt water or brine will void warranty.

Do not use where water recirculates.

Not designed for use in swimming pools.

NOTICE Read this Owner's Manual for installation, operation, and safety information.

1. Know the pump application, limitations, and potential hazards.
2. Do not use in water with fish present. If any oil leaks out of the motor it can kill fish.
3. Disconnect power before servicing.
4. Release all pressure within system before servicing any component.
5. Drain all water from system before servicing.
6. Secure discharge line before starting pump. An unsecured discharge line will whip, possibly causing personal injury and/or property damage.
7. Check hoses for weak or worn condition before each use, making certain that all connections are secure.
8. Periodically inspect sump, pump and system components. Keep free of debris and foreign objects. Perform routine maintenance as required.
9. Provide means of pressure relief for pumps whose discharge line can be shut-off or obstructed.
10. Personal Safety:
    a. Wear safety glasses at all times when working with pumps.
    b. Keep work area clean, uncluttered and properly lighted – replace all unused tools and equipment.
    c. Keep visitors at a safe distance from work area.
    d. Make workshop child-proof – with padlocks, master switches, and by removing starter keys.
11. When wiring an electrically driven pump, follow all electrical and safety codes that apply.
12. This equipment is only for use on 115 volt (single phase) and is equipped with an approved 3-conductor cord and 3-prong, grounding-type plug.

⚠ WARNING **Risk of electric shock.** Can shock, burn or kill. This pump has not been investigated for use in swimming pool areas. Pump is supplied with a grounding conductor and grounding-type attachment plug. Be sure it is connected only to a properly grounded grounding-type receptacle.

Specifications

Power supply required....................................115V, 60 HZ.
Liquid Temp. Range..........................32°F to 70°F(0°-21°C)
Individual Branch Circuit Required (min.).............15 Amps
Discharge...1-1/2" FNPT

NOTICE Do not reduce size of discharge pipe or hose below 1-1/4" diameter. If discharge is too small, pump will overheat and fail prematurely.

This pump is designed for use in a residential sump only. Only pump water with this pump.

Performance

GPM (LPM) at total feet (m) of lift						
Series	HP	5 (1.5m)	10 (3m)	15 (4.6m)	20 (6.1m)	No flow at height shown below
Capacity Gallons(L)/Minute						
MS33	1/3	53	45	36	24	25 (7.6)
MS50	1/2	66	56	44	28	

Electrical & Switch Specifications

Series	HP	Motor Full Load Amps	Individual Branch Circuit Req. (Amps)	Automatic Switch Type	Switch Setting in inches Water Level For: On	Off
MS33V	1/3	3.9	15A 115 VAC	Vertical Switch	7-1/2"	3"
MS50V	1/2	4.1				
MS33T	1/3	3.9		Tethered Switch	14"	5"
MS50T	1/2	4.1				
MS33D	1/3	3.9		Diaphragm Switch	9-1/2"	5"
MS50D	1/2	4.1				
MS33M	1/3	3.9		Non-Automatic Option. No switch included.		
MS50M	1/2	4.1				

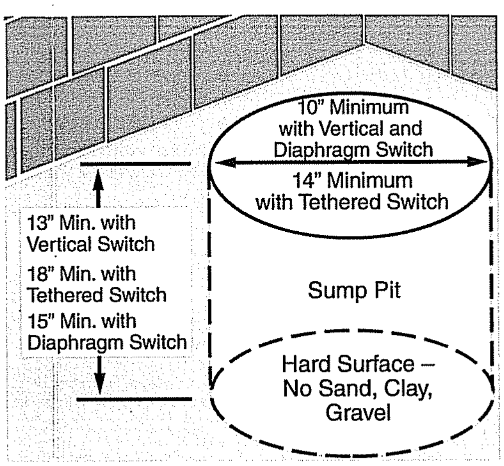
Where a 2-prong wall receptacle is encountered, it must be replaced with properly grounded 3-prong receptacle installed in accordance with codes and ordinances that apply.

13. All wiring should be performed by a qualified electrician.
14. Make certain power source conforms to requirements of your equipment.
15. Protect electrical cord from sharp objects, hot surfaces, oil, and chemicals. Avoid kinking cord. Replace or repair damaged or worn cords immediately.
16. Do not touch an operating motor. Modern motors can operate at high temperatures.
17. Do not handle pump or pump motor with wet hands or when standing on wet or damp surface, or in water.

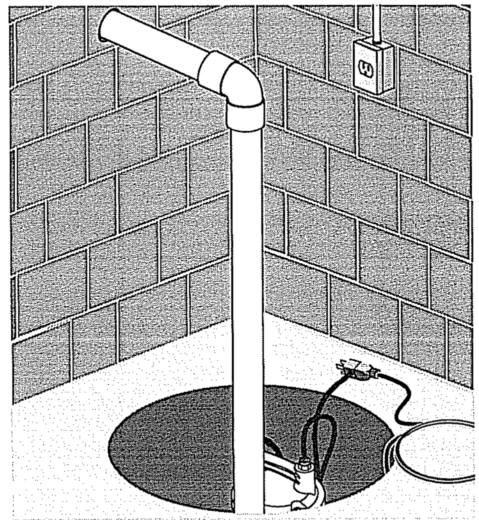
⚠WARNING **Risk of electric shock.** Can shock, burn or kill. If your basement has water or moisture on floor, do not walk on wet area until all power has been turned off. If shut-off box is in basement, call electric company or hydro authority to shut-off service to house, or call your local fire department for instructions. Remove pump and repair or replace. Failure to follow this warning can result in fatal electrical shock.

Do not lift pump by power cord.

Installation



1. Install pump in sump pit with minimum diameter of 10" (254mm) for models equipped with vertical switches and 14" (356mm) for tethered float switch models. Sump depth should be 18" (457mm) for tethered models and 13" (330mm) for vertically switched models. Construct sump pit of tile, concrete, steel or plastic. Check local codes for approved materials and for proper installation.
2. Install pump in pit so that switch operating mechanism has maximum possible clearance.
3. Pump should not be installed on clay, earth or sand surfaces. Clean sump pit of small stones and gravel which could clog pump. Keep pump inlet screen clear.



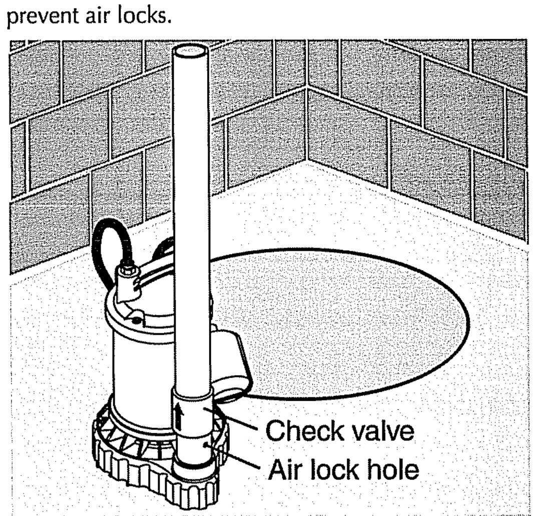
NOTICE Do not use ordinary pipe joint compound on plastic pipe. Pipe joint compound can attack plastics.

4. Install discharge plumbing. Use rigid plastic pipe and wrap threads with PTFE pipe thread sealant tape. Screw pipe into pump hand tight plus 1-1/2 turns.

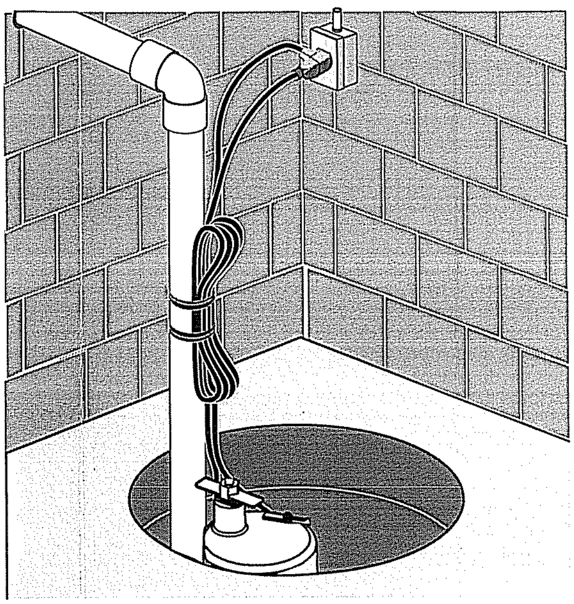
⚠ CAUTION **Risk of flooding.** Can cause personal injury and/or property damage. If a flexible discharge hose is used, make sure pump is secured in sump to prevent movement. Failure to secure pump may allow pump movement, switch interference and prevent pump from starting or stopping.

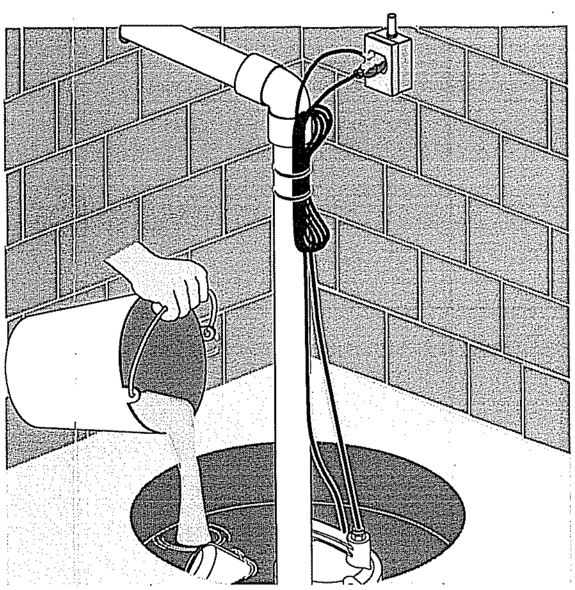
5. To reduce motor noise and vibrations, a short length of rubber hose (1-7/8" (47.6mm) I.D., e.g. radiator hose) can be connected into discharge line near pump using suitable clamps.
6. Install an in-line check valve or an in-pump check valve to prevent flow backwards through pump when pump shuts off.

NOTICE If your check valve is not equipped with an air bleed hole to prevent airlocking pump, drill a 1/8" (3.2 mm) hole in discharge pipe just above where the discharge pipe screws into the pump discharge. Be sure the hole is below the waterline and the check valve to prevent air locks.



7. Power Supply: Pump is designed for 115 V., 60 Hz., operation and requires a minimum 15 amp individual branch circuit. Both pump and switch are supplied with 3-wire cord sets with grounding-type plugs. Switch plug is inserted directly into outlet and pump plug inserts into opposite end of switch plug.





⚠ WARNING **Risk of electric shock.** Can shock, burn or kill. Pump should always be electrically grounded to a suitable electrical ground such as a grounded water pipe or a properly grounded metallic raceway, or ground wire system. Do not cut off round ground pin.

8. If pump discharge line is exposed to outside sub-freezing atmosphere, portion of line exposed must be installed so any water remaining in pipe will drain to the outfall by gravity. Failure to do this can cause water trapped in discharge to freeze which could result in damage to pump.
9. After piping, check valve and float switch have been installed, the unit is ready for operation.
10. Secure power cords to the discharge pipe so they are out of the way for proper float switch operation, prior to testing the unit.
11. Check the pump operation by filling sump with water and observing pump operation through one complete cycle. For switch settings see the Electrical and Switch Specifications chart.

⚠ CAUTION **Risk of flooding.** Can cause personal injury and/or property damage. Failure to make this operational check may lead to improper operation, premature failure, and flooding.

Operation

⚠WARNING **Risk of electric shock.** Can shock, burn or kill. Do not handle a pump or pump motor with wet hands or when standing on wet or damp surface, or in water.

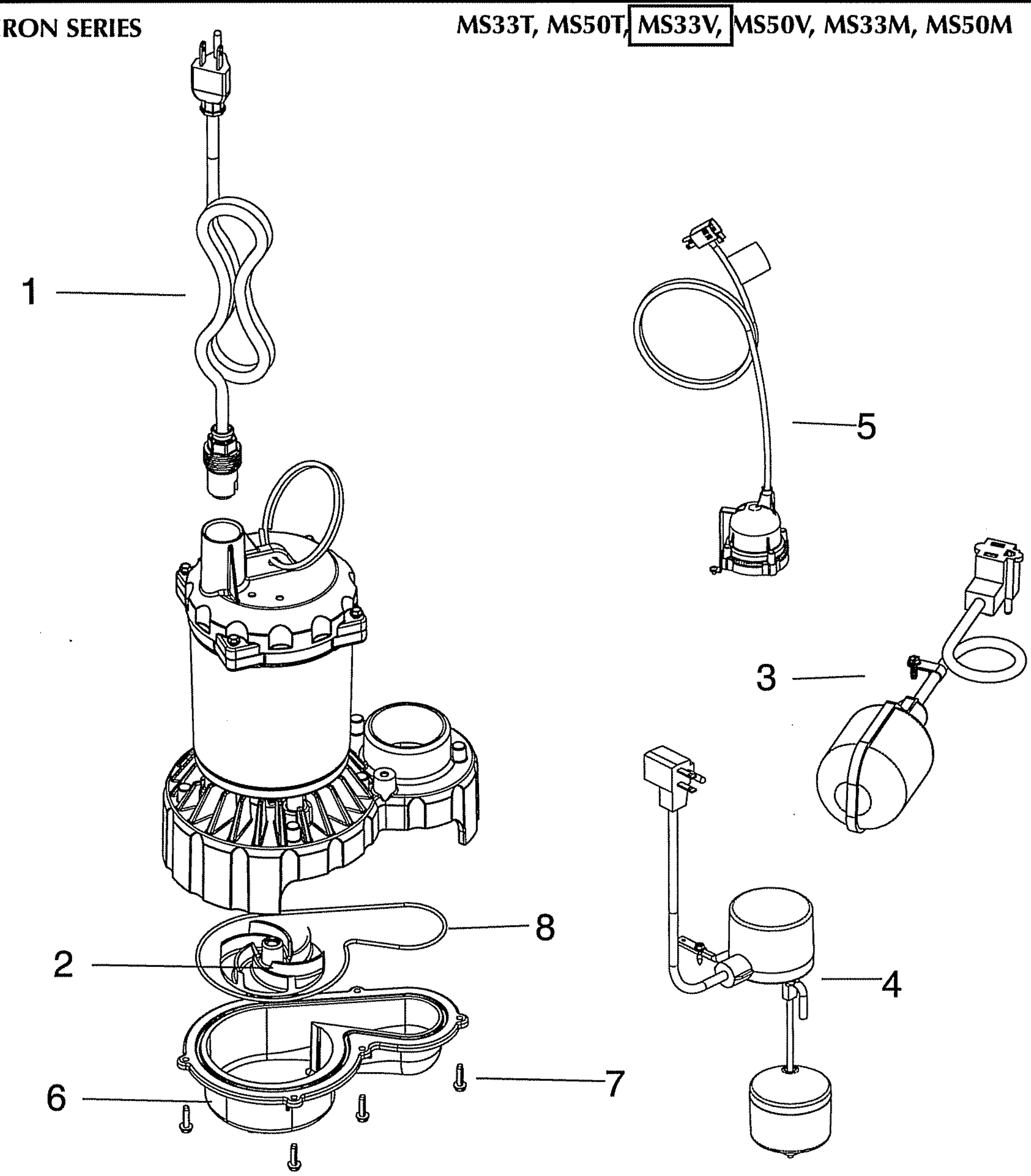
1. Shaft seal depends on water for lubrication. Do not operate pump unless it is submerged in water as seal may be damaged if allowed to run dry.
2. Motor is equipped with automatic reset thermal protector. If temperature in motor should rise excessively, switch will cut off all power before damage can be done to motor. When motor has cooled sufficiently, switch will reset automatically and restart motor. If protector trips repeatedly, pump should be removed and checked as to cause of difficulty. Low voltage, long extension cords, clogged impeller, very low head or lift, or a plugged or frozen discharge pipe, etc., could cause cycling.
3. Pump will not remove all water. If operating a pump manually, and suddenly no water comes out of the discharge hose, shut off the unit immediately. The water level is probably very low and the unit has broken prime.

⚠WARNING **Risk of electric shock.** Can shock, burn or kill. Before attempting to check why unit has stopped operating, disconnect power from unit.

Troubleshooting

Symptom	Possible Cause(s)	Corrective Action
Pump won't start or run	Pump is not plugged in	Check and see if pump is plugged into a proper outlet.
	Blown fuse	If blown, replace with fuse of proper size.
	Low line voltage	If voltage under recommended minimum, check size of wiring from main switch on property. If OK, contact power company or hydro authority.
	Defective motor	Replace pump.
	Defective float switch	Replace float switch.
	Impeller	If impeller won't turn, remove lower pump body and locate source of binding.
	Float obstructed	Remove obstruction.
Pump starts and stops too often	Backflow of water from piping	Install or replace check-valve.
	Faulty float switch	Replace float switch.
Pump won't shut off	Defective float switch	Replace float switch.
	Restricted discharge (obstacle or ice in piping)	Remove pump and clean pump and piping.
	Float obstructed	Remove obstructed.
	Restricted intake screen	Remove the pump and clean the intake screen and the impeller.
Pump operates but delivers little or no water	Low line voltage	If voltage under recommended minimum, check size of wiring from main switch on property. If OK, contact power company or hydro authority.
	Something caught in impeller	Remove the pump and clean out the impeller.
	Worn or defective parts or plugged impeller	Clean impeller if plugged; otherwise replace pump.
	Check valve installed without vent hole	Drill a 1/16" - 1/8" (1.6mm-3.2mm) dia. hole between pump discharge & check valve (1-2" above where the discharge pipe screws into the pump discharge and below the waterline).
	Restricted intake screen	Remove the pump and clean out the intake screen.
	Check valve is installed either backward or upside down	Be sure check valve is installed correctly.

CAST IRON SERIES MS33T, MS50T, MS33V, MS50V, MS33M, MS50M



Ref.	1	2	3	4	5	6	7	8
Model #	Power Cord Assembly	Impeller	Tethered Float Switch	Vertical Float Switch	Diaphragm Switch	Lower Volute	Screw #8-32 x 1/2" (6 pcs)	O-ring - 162 Buna - N 5.75 x 3/32
MS33V10	PW17-281	PS5-285		PS117-2126		PS1-326	U30-1047SS	U9-470
MS33V20	PS17-2121	PS5-285		PS117-2127				
MS50V10	PW17-281	PS5-286		PS117-2126				
MS50V20	PS17-2121	PS5-286		PS117-2127				
MS33T10	PW17-281	PS5-285	PS17-91					
MS33T20	PS17-2121	PS5-285	PS17-93					
MS50T10	PW17-281	PS5-286	PS17-91					
MS50T20	PS17-2121	PS5-286	PS17-93					
MS33D10	PW17-281	PS5-285			149740005-01			
MS33D20	PS17-2121	PS5-285			149740015-01			
MS50D10	PW17-281	PS5-286			149740005-01			
MS50D20	PS17-2121	PS5-286			149740015-01			
MS33M20	PS17-2121	PS5-285						
MS50M20	PS17-2121	PS5-286						

*Purchase locally | **If motor fails, replace entire pump

Limited Warranty

Myers® warrants to the original consumer purchaser ("Purchaser" or "You") of the products listed below, that they will be free from defects in material and workmanship for the Warranty Period shown below.

Product	Warranty Period whichever occurs first:
Jet pumps, small centrifugal pumps, submersible pumps and related accessories	12 months from date of original installation, or 18 months from date of manufacture
Fibrewound Tanks	5 years from date of original installation
Steel Pressure Tanks	5 years from date of original installation
Sump/Sewage/Effluent Products	12 months from date of original installation, or 36 months from date of manufacture
Battery Backup Units	
MBSP-2, MBSP-2C	12 months from date of original installation, or 18 months from date of manufacture
MBSP-3, MBSP-3C	24 months from date of original installation, or 30 months from date of manufacture
Wastewater Solids Handling Pumps	12 months from date of shipment from factory or 18 months from date of manufacture

Our warranty applies only where such products are used in compliance with the requirements of the applicable product catalog and/or manuals. For additional information, please refer to the applicable standard limited warranty featured in the product manual.

Our warranty will not apply to any product that, in our sole judgement, has been subject to negligence, misapplication, improper installation, or improper maintenance. Without limiting the foregoing, operating a three phase motor with single phase power through a phase converter will void the warranty. Note also that three phase motors must be protected by three-leg, ambient compensated, extra-quick trip overload relays of the recommended size or the warranty is void.

Your only remedy, and MYERS's only duty, is that MYERS repair or replace defective products (at MYERS's choice). You must pay all labor and shipping charges associated with this warranty and must request warranty service through the installing dealer as soon as a problem is discovered. No request for service will be accepted if received after the Warranty Period has expired. This warranty is not transferable.

MYERS SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR CONTINGENT DAMAGES WHATSOEVER.

THE FOREGOING LIMITED WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE FOREGOING LIMITED WARRANTIES SHALL NOT EXTEND BEYOND THE DURATION PROVIDED HEREIN.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitations on the duration of an implied warranty, so the above limitations or exclusions may not apply to You. This warranty gives You specific legal rights and You may also have other rights which vary from state to state.

This Limited Warranty is effective April 1, 2014 and replaces all undated warranties and warranties dated before April 1, 2014.

F.E. MYERS
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Phone: 888-987-8677 • Fax: 800-426-9446 • www.femyers.com

In Canada: 490 Pinebush Road, Unit 4, Cambridge, Ontario NIT 0A5
Phone: 800-363-7867 • Fax: 888-606-5484

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 8

HALLIDAY WET WELL TRASH BASKET

SERIES BB TRASH BASKETS

TABLE OF CONTENTS

VENDOR DATA

HALLIDAY PRODUCTS, INC.
6401 Edgewater Drive
Orlando, FL 32810

Phone: 407-298-4470 - Fax: 407-298-4534

Toll Free: 800-298-1027

Email: marketing@HallidayProducts.com

Web Site at www.HallidayProducts.com

Armond Bordeau, Contact

BB Series Bar Screen Basket

APPLICATION:

Bar Screen style baskets are used to screen out solids that may otherwise damage pumping equipment in wet wells. This style basket is for heavy-duty applications, screening up to a 36 inch influent pipe. Standard baskets are manufactured of aluminum or stainless steel and are used in conjunction with a heavy-duty aluminum or stainless steel channel rail system. Units are supplied with solid aluminum or stainless steel wheels. Standard bar spacing for the front, back and bottom of the basket is 2 inches with other spacing available. The basket sides are solid but can be perforated if required. The standard rail system doubles as a ladder or can be manufactured as a guide rail system only if required. Trash baskets are used with portable hoists, which are used to raise and lower the basket for cleaning purposes.

SPECIFICATION:

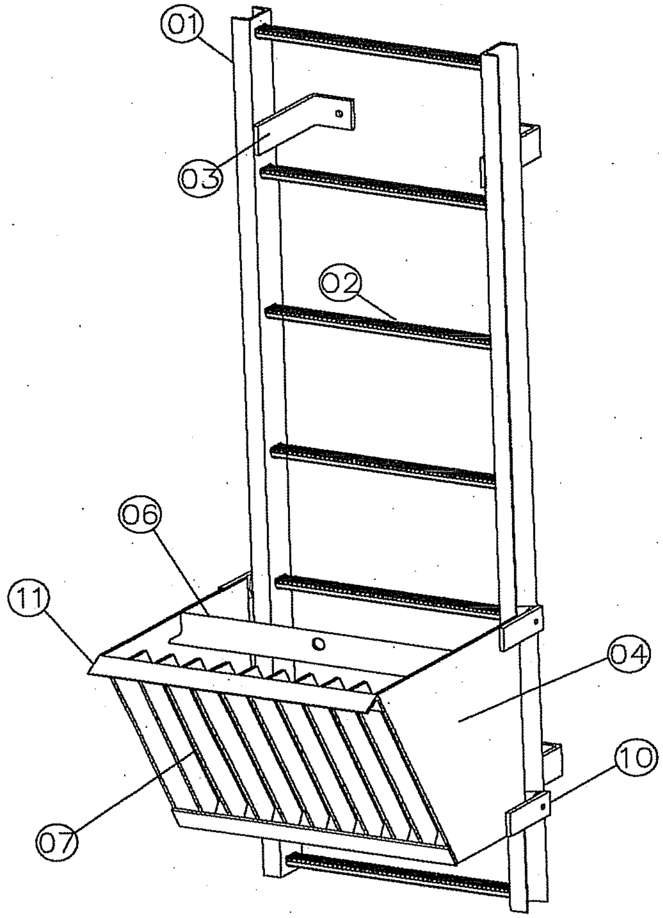
B1B (Aluminum) Plate 5052-H32 Bars & Rail 6061-T6 & 6063-T5
B4B (T304 Stainless Steel)
B6B (T316 Stainless Steel)

The basket systems, as manufactured by Halliday Products, Inc. of Orlando, Florida, shall be of the bar screen style basket, having 2" clear opening between ¼" thick bars and solid sides. The heavy duty ladder/guide rail system shall be of 3" structural channel and incorporate slip resistant rungs 12" on center. For ease of operation, the basket will have (4) 2-½" solid wheels with ½" stainless steel axles. A basket stop shall be supplied loose for field mounting to insure proper basket position.

HALLIDAY PRODUCTS

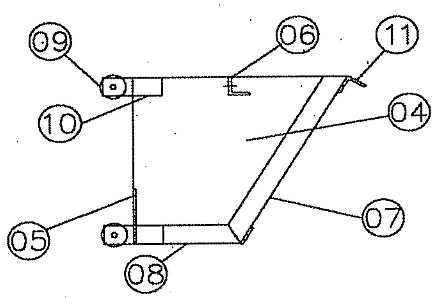
SERIES B1B, B4B, B6B

(RAIL AND BASKET SYSTEM)

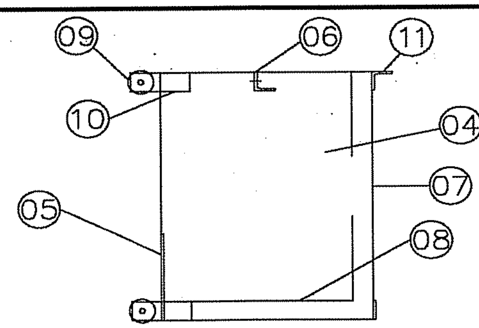


STANDARD COMPONENT PARTS

- 01 CHANNEL RAIL
- 02 LADDER RUNG
- 03 STANDOFF
- 04 BASKET SIDE PLATE
- 05 BASKET BACK PLATE
- 06 BAIL
- 07 BASKET FRONT BARS
- 08 BASKET BOTTOM BARS
- 09 WHEEL
- 10 WHEEL TABS
- 11 BASKET FRONT ANGLE



STANDARD BASKET



SQUARE BASKET (OPTIONAL)

Installation and Maintenance

INSTALLATION:

For proper installation, Halliday Products, Inc. recommends the following:

1. Rail system must be set plumb and with rails straddling the influent pipe.

2. Rails must be secured to the tank wall at standoff locations with anchor bolts.

3. To insure optimum screening, the influent pipe should be located within 1-inch of the rail system. The basket stop should be placed approximately 12-inches below the invert.

4. Basket should be gently lowered into position. Never drop the basket into position.

MAINTENANCE:

Because Bar Screen baskets and rail systems manufactured by Halliday Products, Inc. are of all aluminum and stainless steel construction, they require minimal maintenance. For optimum product life the manufacturer recommends the following procedures be taken annually:

1. Check and tighten any loose anchor bolts and the basket stop attaching hardware.

2. Check and maintain hoisting cable connection.

3. Remove debris from basket and rails when required.

HALLIDAY PRODUCTS

LIMITED WARRANTY

Halliday Products, Inc., a Florida Corporation ("Company") warrants to the original customer the aluminum and stainless steel trash basket assemblies will be free from defective material or faulty workmanship for a period of three (3) years from date of purchase by Customer. In the event of malfunction or other indication of failure attributable directly to defective material or faulty workmanship, Company will, upon receipt of a written notification from customer of such defective material or faulty workmanship, at its option and expense, repair or replace the defective trash basket assembly, or a component thereof, to whatever extent Company shall deem necessary to restore the trash basket assembly, or a component thereof, to proper operating condition. Company may replace the defective trash basket assembly, or a component thereof, with either a new or remanufactured, functionally equivalent trash basket assembly or component thereof at the Company's option. **THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER OR NOT STATUTORY, OR EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE EXCLUSIVE REMEDY FOR DEFECTIVE TRASH BASKET ASSEMBLY SHALL BE ONLY IN CONTRACT, WHETHER OR NOT CAUSED BY A DEFECTIVE TRASH BASKET ASSEMBLY, OR NEGLIGENCE. COMPANY' S LIABILITY FOR LOSS OR DAMAGES SHALL NOT EXCEED THE PRICE PAID BY CUSTOMER FOR THE TRASH BASKET ASSEMBLY, REGARDLESS OF THE FORM OF ANY CLAIM. IN NO EVENT SHALL COMPANY BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, CONSEQUENTIAL, OR PUNITIVE DAMAGES WHATSOEVER RESULTING FROM ANY DEFECTIVE TRASH BASKET ASSEMBLY OR COMPONENT THEREOF. IF MODIFICATION OR ALTERATION IS MADE TO THE TRASH BASKET ASSEMBLY OR COMPONENT THEREOF BY OTHER THAN COMPANY AUTHORIZED PERSONS, OR IF IT IS INSTALLED IMPROPERLY, OR MISUSED, ABUSED AND/OR NEGLECTED, THIS LIMITED WARRANTY IS NULL AND VOID AND OF NO EFFECT. THIS LIMITED WARRANTY DOES NOT APPLY AND THE COMPANY WILL HAVE NO RESPONSIBILITY HEREUNDER FOR NORMAL WEAR AND TEAR.**

Halliday Products, Inc.
6401 Edgewater Dr
Orlando, FL 32810
Toll Free: 800-298-1027
Fax: 407-298-4534
Email: Info@HallidayProducts.com

OPERATION AND MAINTENANCE MANUAL

VOLUME III

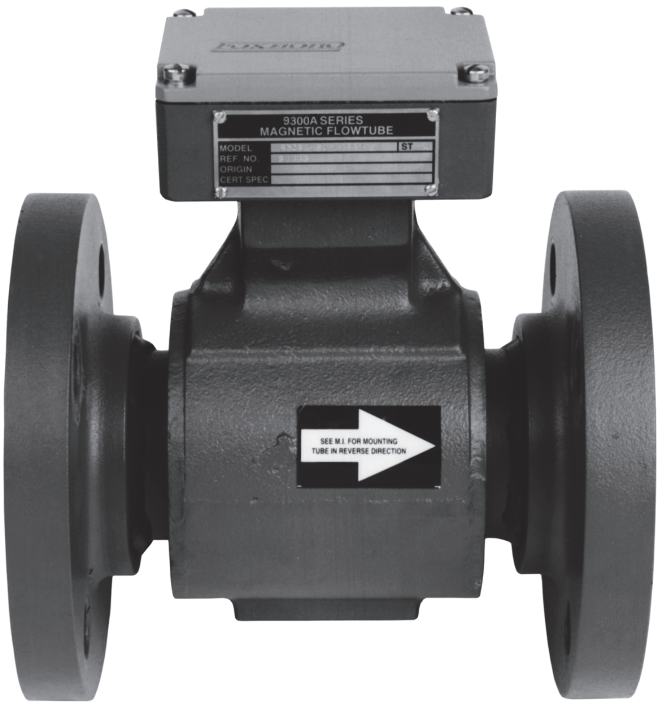
TAB 9

FOXBORO 9300A FLOW METER
FOXBORO METER READER

Foxboro® by Schneider Electric

PSS 1-6F4 A

9300A Series Flanged Magnetic Flowtubes
PFA Lined, 25 to 300 mm (1 to 12 in) Sizes
PTFE Lined, 15 to 400 mm (1/2 to 16 in) Sizes
Polyurethane Lined, 200 to 400 mm (8 to 16 in) Sizes



These PFA, PTFE, and polyurethane-lined compact, flanged magnetic flowtubes, together with an IMT25 Magnetic Flow Transmitter combine to form an easy-to-use versatile, dc pulsed Magnetic Flowmeter. The flowmeter measures electrically conductive liquids and produces a measurement signal directly proportional to volumetric flow rate. As symbolized by the CE logo marking on the product, the flowtube conforms to the applicable European Union directives.

FEATURES

- PFA withstands effects of severely corrosive and mildly abrasive fluids, has excellent blistering resistance, and can withstand the extremes of pressure and temperature.
- PTFE withstands effects of severely corrosive and mildly abrasive fluids.
- Polyurethane withstands effects of highly abrasive fluids.
- Rugged integral design ideal for installation in harsh in-plant or outdoor environments.
- Compact design with face-to-face overall lengths that meet ISO/DIS 13359.
- Proven electrode seal design withstands severe temperature cycling and high pressure surges.
- Metric PN10 to PN40, or ANSI Class 150 and 300 flanges in carbon or stainless steel.

- Transmitter can be mounted in a remote location, or integrally mounted to the flowtube.
- NEMA 4 enclosure for PTFE-lined 15 to 150 mm (1/2 to 6 in) sizes; and NEMA 4X enclosure for all other flowtube linings and sizes.
- Total/Accidental submergence housing construction offered with all Flowtubes.
- Numerous options and accessories offered, as applicable to enhance flowmeter capability; including grounding rings, cable glands, PTFE/PFA lining protectors, and electrode cleaning.
- Total Quality Management, including ISO 9001 Certification and Conformance to applicable European Community standards.
- Standard 2-Year Warranty.

RUGGED INTEGRAL DESIGN

The welded housing design of the 9300A flowtubes provides a very rugged and environmentally superior flowtube assembly that can be installed in harsh in-plant or outdoor environments. The flowtube enclosure is weatherproof, as defined by IEC IP66, and provides watertight and corrosion-resistant protection of NEMA 4X for all tubes except 15 to 150 mm (1/2 to 6 in) sizes PTFE lined, which are NEMA 4. The flowtube is also capable of total submergence when used with a remote mounted transmitter.

The permanently attached and retained PFA lined flowtube is sufficiently stable to withstand applications involving high temperatures, severe temperature cycling, strong pipeline vibration, and severe pressure cycling, including full vacuum.

The PTFE lined flowtube is more cost effective than PFA and can withstand severe corrosion and/or mild abrasion.

The polyurethane lined flowtube is also more cost effective than PFA in larger size meters, and can withstand mild corrosion and/or severe abrasion.

Refer to TI 27-71f which lists recommended liner material compatibility with over 150 common process fluids.

COMPACT FLOWTUBE

The 9300A has a compact design that provides face-to-face overall lengths in each size that conform to recommended flowtube dimensions contained in ISO/DIS 13359.

PULSED DC FLOWTUBES USED WITH REMOTE OR INTEGRALLY MOUNTED TRANSMITTERS

The 9300A Series Magnetic Flowtubes are calibrated for use with pulsed dc coil excitation. The intelligent I/A Series IMT25 Magnetic Flow Transmitter is offered for use with these flowtubes. The IMT25 may be integrally mounted to the flowtube itself, or remote mounted (on a pipe or flat surface) for distances up to 300 m (1000 ft).

FLOWTUBE CALIBRATION

All flowtubes are wet calibrated to verify their specified accuracy with traceability to the U.S. National Institute of Science and Technology (NIST).

PED QUALIFICATION

These flowtubes are PED qualified in EU applications for SEP (Standard Engineering Practice) Category 1 with Group 2 fluids (nonhazardous).

SELECTION OF FLOWTUBE SIZES, FLANGES, AND ELECTRODES

The 9300A flowtubes are offered in 15, 25, 40, 50, 80, 100, 150, 200, 250, 300, 250, and 400 mm (1/2, 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, and 16 in) line sizes.

They are available with PN10 to PN40 or ANSI Class 150 and 300 flanged end connections, in carbon or stainless steel, as applicable.

Electrode material selections for PFA- and PTFE-lined flowtubes include 316 ss, Hastelloy C, Titanium, Tantalum-Tungsten, or Platinum-Iridium. Polyurethane-lined flowtubes are available with 316 ss electrodes only. Refer to TI 27-71f which lists the recommended electrode material compatibility with over 150 common process fluids.

CONICAL ELECTRODES

Conical electrodes are offered in both 316 ss and Hastelloy C with PFA- and PTFE-lined flowtubes sizes 25 to 150 mm (1 to 6 in). These are excellent selections for applications which coat conventional flush-with-lining electrodes. Conical electrodes extend into the process where the natural sweeping action of the fluid across the electrode face produces a self-cleaning action.

CE COMPLIANCE

The 9300A Series flowtubes conform to the applicable European Community Standards when used in conjunction with IMT25 Series transmitters.

FLOWEXPERTPRO™

FlowExpertPro is a program primarily used to size Foxboro flowmeters. It also ensures that the user has selected the proper flowmeter type for his application.This meter selection tool is available as a free web site to all users, without the need for registration. In addition to flowmeter selection and sizing, FlowExpertPro includes the following features:

- Incorporates a large library of the physical properties of typical process fluids.
- Displays results in tabular or graphic format.
- Allows user to save, print, or E-mail results.
- Provides reference to applicable flowmeter PSSs and other related flowmeter documentation.

The program calculates minimum and maximum flow rates, rangeability, pressure loss, and Reynolds Number, using established flow equations. It also allows for material and flange selection, and provides ANSI or metric flange recommendations for predicted flow pressure and temperature. You are invited to visit www.FlowExpertPro.com to access this program, or contact Global Customer Support for further information, and technical support.

OPERATING CONDITIONS

PFA-Lined Flanged Tubes (Remote Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C (77°F)	–40 to +70°C (–40 to +158°F)	–40 to +70°C (–40 to +158°F)
Process Temperature 25 to 150 mm (1 to 6 in)	25°C (77°F)	–40 to +180°C (–40 to +356°F)	–40 to +180°C (–40 to +356°F)
Process Temperature 200 to 400 mm (8 to 12 in)	25°C (77°F)	–40 to +120°C (–40 to +250°F)	–40 to +120°C (–40 to +250°F)
Process Pressure 25 to 150 mm (1 to 6 in)	0.528 MPa (75 psi)	Full Vacuum to 5.1 MPa at 38°C (to 740 psi at 100°F) Full Vacuum to 4.4 MPa at 180°C (to 645 psi at 356°F)	5.1 MPa at 38°C (740 psi at 100°F) 4.4 MPa at 180°C (645 psi at 356°F)
Process Pressure 200 to 400 mm (8 to 12 in)	0.528 MPa (75 psi)	Full Vacuum to 5.1 MPa at 38°C (to 740 psi at 100°F) Full Vacuum to 4.7 MPa at 120°C (to 665 psi at 250°F)	5.1 MPa at 38°C (740 psi at 100°F) 4.7 MPa at 120°C (665 psi at 250°F)

(a) Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Pressure-Temperature Limits of 9300A Flowtubes in Table 1.

PTFE-Lined Flanged Tubes (Remote Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limit
Ambient Temperature	25°C (77°F)	–40 to +70°C (–40 to +158°F)	–40 to +70°C (–40 to +158°F)
Process Temperature	25°C (77°F)	–40 to +180°C (–40 to +356°F)	–40 to +180°C (–40 to +356°F)
Process Pressure 25 to 150 (1/2 to 16 in)	0.525 MPa (75 psi)	No vacuum to 2.0 MPa at 38°C (to 285 psi at 100°F) No vacuum to 1.5 MPa at 180°C (to 213 psi at 356°F)	2.0 MPa at 38°C (285 psi at 100°F) 1.5 MPa at 180°C (213 psi at 356°F)

(a) Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Pressure-Temperature Limits of 9300A Flowtubes in Table 1.

Polyurethane Lined Flanged Tubes (Remote Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limit
Ambient Temperature	25°C (77°F)	–29 to +70°C (–20 to +158°F)	–29 and +70°C (–20 and +158°F)
Process Temperature	25°C (77°F)	–29 to +71°C (–20 to +160°F)	–29 to +71°C (–20 to +160°F)
Process Pressure 200 to 400 mm (8 to 16 in)	0.525 MPa (75 psi)	Full Vacuum to 2.0 MPa at 38°C (to 285 psi at 100°F) Full Vacuum to 1.9 MPa at 71°C (to 270 psi at 160°F)	2.0 MPa at 38°C (285 psi at 100°F) 1.9 MPa at 71°C (270 psi at 160°F)

(a) Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Pressure-Temperature Limits of 9300A Flowtubes in Table 1.

PFA-Lined Flanged Tubes (Tube Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C (77°F)	–20°C to +55°C (–4°F to +131°F)	–30°C to +70°C (b) (–22°F to +158°F)
Process Temperature	25°C (77°F)	–40 to +120°C (–40 to +250°F)	–40 to +120°C (–40 to +250°F)
Process Pressure 25 to 300 mm (1 to 12 in)	0.525 MPa (75 psi)	Full Vacuum to 5.1 MPa at 38°C (to 740 psi at 100°F) Full Vacuum to 4.7 MPa at 120°C (to 665 psi at 250°F)	5.1 MPa at 38°C (740 psi at 100°F) 4.7 MPa at 120°C (665 psi at 250°F)

(a) Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Pressure-Temperature Limits of 9300A Flowtubes in Table 1.
(b) With the IMT25 Integral LCD Indicator (with pushbuttons) selection, the lower operating limit is -20°C (-4°F).

PTFE-Lined Flanged Tubes (Tube Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limit
Ambient Temperature	25°C (77°F)	–20°C to +55°C (–4°F to +131°F)	–30°C to +70°C (b) (–22°F to +158°F)
Process Temperature	25°C (77°F)	–40 to +120°C (–40 to +250°F)	–40 to +120°C (–40 to +250°F)
Process Pressure 25 to 400 (1/2 to 16 in)	0.525 MPa (75 psi)	No vacuum to 2.0 MPa at 38°C (to 285 psi at 100°F) No vacuum to 1.7 MPa at 120°C (to 245 psi at 250°F)	2.0 MPa at 38°C (285 psi at 100°F) 1.7 MPa at 120°C (245 psi at 250°F)

(a) Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Pressure-Temperature Limits of 9300A Flowtubes in Table 1.
(b) With the IMT25 Integral LCD Indicator (with pushbuttons) selection, lower operating limit is -20°C (-4°F).

Polyurethane Lined Flanged Tubes (Tube Mounted Transmitter) (a)

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limit
Ambient Temperature	25°C (77°F)	–20°C to +55°C (–4°F to +131°F)	–30°C to +55°C (b) (–22°F to +158°F)
Process Temperature	25°C (77°F)	–20 to +71°C (–4 to +160°F)	–20 to +71°C (–4 to +160°F)
Process Pressure 200 to 400 mm (8 to 16 in)	0.525 MPa (75 psi)	Full Vacuum to 2.0 MPa at 38°C (to 285 psi at 100°F) Full Vacuum to 1.9 MPa at 71°C to (270 psi at 160°F)	2.0 MPa at 38°C (285 psi at 100°F) 1.9 MPa at 71°C (270 psi at 160°F)

a. Flowtube must be ordered with the correct flanges to achieve desired pressure and temperature rating. See Table 1.

b. With the IMT25 LCD Indicator (with pushbuttons) selection, the lower operating limit is -20°C (-4°F).

PERFORMANCE SPECIFICATIONS

(Combined Flowtube and Transmitter System Under Reference Operating Conditions)

Flowmeter System	Refer to
9300A Flowtube with Model IMT25 Transmitter (HART)	PSS 1-6F5 A

FUNCTIONAL SPECIFICATIONS

Nominal Line Sizes

15, 25, 40, 50, 80, 100, 200, 250, 300, 350, 400 mm (1/2, 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16 in)

End Connections

ANSI and Metric PN flanges. Refer to Model Code section for flange types and ratings available.

Process Pressure and Temperature Limits

Refer to Table 1.

Minimum and Maximum Upper Range Flow Rates and Velocities

See Table 2. In this table, the minimum upper range value (URV) is not the lowest flow rate that the flowtube can measure; it is the lowest flow rate which can correspond to the 20 mA signal. For example: for the 25 mm (1 in) flowtube, the minimum range is 0 to 3.5 U.S. gpm, and this generates 4 to 20 mA.

Process Fluid Conductivity and Signal Cable Length

The maximum allowable cable length is a function of the cable type, process fluid conductivity, and whether the cables are in the same or separate conduits. Standard system accuracy is maintained when the installations are in accordance with the requirements specified in Table 4.

Installation Requirements

Flowtube must be mounted so the electrodes are not in a vertical plane, the minimum upstream straight pipe length recommended is five pipe diameters, and the minimum downstream straight pipe length is three diameters. The pipe length is measured outward from the center of the flowtube. During measurement, the flowtube must remain full with the process fluid to achieve the stated performance. Installation in a vertical pipe with flow going upward is ideal.

Flowtube Replacement

For installations presently with 8300 Series flowtubes, the 9300A Series can be used as a direct replacement. However, because of the shorter face-to-face dimensions of the 9300A flowtubes, a spool piece or equivalent spacer is required when replacing an 8300 with a 9300A flowtube. See Table 3.

Table 1. Pressure-Temperature Limits of 9300A Flowtubes

Flange Rating	Liners (a)	Maximum Permissible Operating Pressure at Process Temperature Listed (b)							
		316 ss Stainless Steel				Carbon Steel (ASME/ANSI Group No. 1.1)			
DIN		–40°C	50°C	100°C	180°C	–28°C (c)	50°C	100°C	180°C
PN10	A,P,T	9.0 bar	9.0 bar	7.8 bar	7.1 bar	10.0 bar	10.0 bar	10.0 bar	8.4 bar
PN16	P	14.2 bar	14.2 bar	12.5 bar	11.5 bar	16.0 bar	16.0 bar	16.0 bar	15.3 bar
PN25	A,P,T	22.3 bar	22.3 bar	19.5 bar	17.9 bar	25.0 bar	25.0 bar	25.0 bar	20.2 bar
PN40	P	37.4 bar	37.4 bar	31.2 bar	28.6 bar	40.0 bar	40.0 bar	40.0 bar	38.3 bar
ANSI		–40°F	100°F	200°F	356°F	–20°F (c)	100°F	200°F	356°F
Class 150	A,P,T	275 psig	275 psig	240 psig	205 psig	285 psig	285 psig	260 psig	213 psig
Class 300	P	720 psig	720 psig	620 psig	538 psig	740 psig	740 psig	675 psig	644 psig

a. A = Polyurethane sizes 200 to 400 mm (8 to 16 in); temperature limits are -29 to +71°C (-20 to +160°F).
P = PFA sizes 25 to 300 mm (1 to 12 in); temperature limits are:
sizes 25 to 300 mm (1 to 6 in) -40 to +180°C (-40 to +356°F);
sizes 25 to 150 mm (8 to 12 in) -40 to +120°C (-40 to +250°F).
T = PTFE sizes 15 to 400 mm (0.5 to 16 in); temperature limits are -40 to +180°C (-40 to +356°F).

b. For process temperatures >120°C (>250°F), the transmitter must be remotely mounted in a remote location.

c. For process temperatures < -28°C (-20°F), stainless steel flanges must be used.

Table 2. Minimum and Maximum Upper Range Values

Nominal Line Size		Nominal Tube I.D.		Flange Selection (a)	Liner Selection (a)	Flow Rate Minimum and Maximum URV	
mm	in	mm	in			L/min (a)	U.S. gpm (b)
15	1/2	12.2	.48	--	PTFE	3.8 and 76	1.0 and 20
25	1	22.1	.87	--	PFA/PTFE	13.2 and 265	3.5 and 70
40	1-1/2	37.1	1.46	--	PFA/PTFE	34.1 and 644	9.0 and 170
50	2	45	1.77	--	PFA/PTFE	49 and 946	13 and 250
80	3	70.6	2.78	--	PFA/PTFE	117 and 2,366	31 and 625
100	4	93	3.66	--	PFA/PTFE	208 and 4,164	55 and 1,100
150	6	138.7	5.46	--	PFA/PTFE	462 and 9,236	122 and 2,440
200	8	206	8.11	BA, BB, ZD, ZE, ZL, ZM	PFA	1,003 and 20,060	265 and 5,300
		197	7.76	BC, BD, ZF, ZG, ZN, ZP	PFA	927 and 18,546	245 and 4,900
		202	7.95	--	PTFE	965 and 19,303	255 and 5,100
		193	7.59	--	poly	890 and 17,790	235 and 4,700
250	10	259	10.21	BA, BB, ZD, ZE, ZL, ZM	PFA	1,590 and 31,794	420 and 8,400
		249	9.81	BC, BD, ZF, ZG, ZN, ZP	PFA	1,476 and 29,523	390 and 7,800
		255	10.05	--	PTFE	1,552 and 31,037	410 and 8,200
		246	9.69	--	poly	1,438 and 28,766	380 and 7,600

Table 2. Minimum and Maximum Upper Range Values (Continued)

Nominal Line Size		Nominal Tube I.D.		Flange Selection (a)	Liner Selection (a)	Flow Rate Minimum and Maximum URV	
mm	in	mm	in			L/min (a)	U.S. gpm (b)
300	12	309	12.18	BA, BB, ZD, ZE, ZL, ZM	PFA	2,270 and 45,420	600 and 12,000
		299	11.79	BC, BD, ZF, ZG, ZN, ZP	PFA	2,120 and 42,392	560 and 11,200
		305	12.02	--	PTFE	2,215 and 44,285	585 and 11,700
		296	11.66	--	poly	2,082 and 41,635	550 and 11,000
350	14	341	13.42	--	PTFE	2,763 and 55,261	730 and 14,600
		328	12.90	--	poly	2,555 and 51,098	675 and 13,500
400	16	392	15.42	--	PTFE	3,634 and 72,672	960 and 19,200
		378	14.90	--	poly	3,407 and 68,130	900 and 18,000

a. Refer to Model Code for flange and liner selection available with each flowtube size.
b. Flow rates for minimum and maximum upper range values (URVs) correspond to process flow velocities of approximately 1.64 ft/s (0.5 m/s) and 33 ft/s (10 m/s).

Table 3. Face-to-Face Dimensions, 9300A vs. 8300 Series Flowtubes, and Spool Length

Nominal Line Size		Face-to-Face Dimensions					
		9300A, PFA/PTFE Lining		8300, PTFE Lining		Spool Length	
mm	in	mm	in	mm	in	mm	in
15	1/2	200	7.87	365	14.4	165	6.5
25	1	200	7.87	365	14.4	165	6.5
40	1-1/2	200	7.87	365	14.4	165	6.5
50	2	200	7.87	365	14.4	165	6.5
80	3	200	7.87	418	16.4	218	8.6
100	4	250	9.84	418	16.4	168	6.6
150	6	300	11.81	522	20.6	222	8.7
200	8	350	13.8	624	24.6	274	10.8
250	10	450	17.7	726	28.6	277	10.9
300	12	500	19.7	828	32.6	329	12.9
350	14	550	21.7	724	28.5	173	6.8
400	16	600	23.6	775	30.5	175	6.9

Table 4. Process Fluid Conductivity and Cabling (a)

Maximum Cable Length	Minimum Fluid Conductivity	Signal and Coil Drive Cables
300 m (1000 ft)	5 μS/cm	Signal and coil drive cables in separate conduit. Signal Cable to be Part No. R0101ZS (feet) or B4017TE (meters).
225 m (700 ft)	5 μS/cm	Signal and coil drive cables in same conduit. Signal Cable to be Part No. R0101ZS (feet) or B4017TE (meters).
150 m (500 ft)	20 μS/cm	Signal cable may be in same conduit as coil drive cable. Signal cable to be good quality twisted shielded pair, preferable no smaller than 1.0 mm^2 (or 18 AWG) for mechanical considerations (Belden 8760 or 9318, Alpha 5610/1801 or 5611/1801, or equivalent).

a. Values in table are fluid conductivity minimums, and maximum distance between transmitter and flowtube. Refer to TI 027-072 for conductivities of various process liquids.

ELECTRICAL SAFETY SPECIFICATIONS

Testing Laboratory, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
CSA for use in Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2 hazardous locations.	Temperature Class T6.	L
FM nonincendive Class I, Division 2, Groups A, B, C, and D; suitable for Class II and III, Division 2, Groups F and G hazardous locations.	Temperature Class T6. Ta=70°C. For use on non-hazardous process only.	N
No Certification	—	Z

PHYSICAL SPECIFICATIONS

HOUSING CONSTRUCTION

These flowtubes are offered with a selection of the following housing construction: a Weatherproof construction housing and a Total/Accidental Submergence housing. See paragraphs below.

Weatherproof Housing

This housing is designed for harsh in-plant or outdoor environments. The 15 to 150 mm (1/2 to 6 in) PTFE-lined flowtubes are NEMA 4, and all other flowtubes are NEMA 4X. Select Housing Code -G if with a remote mounted transmitter; and select Housing Code -I if with an integrally mounted transmitter.

Total/Accidental Submergence Housing

Only offered when transmitter is mounted in a remote location. The weatherproof flowtube housing is factory sealed for accidental or continuous operation under water up to a maximum depth of 9 m (30 ft). A field kit is provided to the customer for final sealing after site installation. Select Housing Code -N.

Flowtube Material

15 mm (1/2 in) SIZE

Cast 304 ss (CF8) or 305 ss, exceeds Schedule 10 wall thickness

25 to 150 mm (1 to 6 in) sizes

Cast 304 ss (CF8) or 305 ss, exceeds Schedule 40 wall thickness

200 to 400 mm (8 to 16 in) sizes

304 ss Schedule 10 or 40 wall thickness

Flowtube Housing Material

15 to 150 mm (1/2 to 6 in) - Ductile Iron

Finish provides the environmental and corrosion resistant requirements of NEMA 4X (PFA lined) or NEMA 4 (PTFE lined).

200 to 900 mm (8 to 16 in) - CARBON STEEL

Carbon steel housing. Finish provides the environmental and corrosion resistant requirements of NEMA 4X.

Liner Material

PFA, PTFE, or polyurethane. Designed to be permanently retained within flowtube without slipping, rotating, collapsing, or other movement.

See Model Codes section for availability.

Electrode Materials

Tantalum-Tungsten, Hastelloy C, Platinum-Iridium, 316L ss, or Titanium, as specified. The Hastelloy C and 316L ss electrodes are also available in a conical configuration. Polyurethane-lined tubes are available with 316L ss electrodes only.

Junction Box Materials (Integral to Flowtube)

Cast aluminum housing mounted and sealed to top surface of flowtube with cork-silicon rubber gasket.

The junction box cover is sealed to junction box with silicone sponge rubber gasket.

Flanges

ANSI Class 150, 300; or Metric PN10, PN16, PN25, and PN40, in either carbon steel or 316 ss.

Flange Gaskets

Provided by user.

Mounting Position

Flowtube can be mounted in any orientation only if it remains full of fluid, and the electrodes are not in a vertical plane. Installation in a vertical line with flow going up is ideal. Recommended straight run of pipe is five pipe diameters upstream and three pipe diameter downstream.

Electrical Connections

With Remote-Mounted Transmitter

Junction box on top surface of flowtube provides for signal, power, and fluid ground connections. Holes tapped for 1/2 NPT conduit, or optional cable glands for nonconduit applications. Simply remove junction box cover to access wiring. All unused conduit holes must be plugged to maintain the electrical and environmental integrity of the transmitter.

With Integrally-Mounted Transmitter

Transmitter mounted to top surface of flowtube. All field wiring is connected to the transmitter. Refer to transmitter documents.

Approximate Mass - Flowtube with ANSI Class 150 Flanges (a)

Nominal Line Size		Approximate Mass		Nominal Line Size		Approximate Mass	
mm	in	kg	lb	mm	in	kg	lb
15	1/2	2.8	6.2	150	6	34	75
25	1	5.1	11.3	200	8	47.6	105
40	1 1/2	8.0	17.5	250	10	65.3	144
50	2	10.5	23.2	300	12	90.7	200
80	3	14.2	31.3	350	14	128	283
100	4	22.7	50	400	16	154	339

a. Add applicable transmitter mass when transmitter is mounted to flowtube.

OPTIONAL SELECTIONS AND ACCESSORIES

Option -G: Cable Glands

Used to provide rain tight, strain relieved entrance for 6.8 to 12.2 mm (0.27 to 0.48 in) diameter cable. External 1/2 NPT threads into internal 1/2 NPT thread on flowtube junction box surface. Body and seal nut are nylon, and compression gland is neoprene. Select Model Code Option -G.

Grounding (Protective) Rings

Two grounding rings are required, one on each end of the flowtube, if mating piping is lined or nonmetallic. For 316 ss grounding rings, see table below. Not available with 9308A to 9316A flowtubes.

316 ss Grounding Rings

Line Size		Ring Thickness		Part Number (a)	
mm	in	mm	in	PFA Liner	PTFE Liner
15	1/2	3.2	0.125	L0118SB	A0129PD
25	1	3.2	0.125	L0118SC	A0129NA
40	1 1/2	3.2	0.125	L0118SD	A0129NB
50	2	3.2	0.125	L0118SE	A0129NC
80	3	3.2	0.125	A0129NE	A0129NE
100	4	3.2	0.125	A0129NF	A0129NF
150	6	3.2	0.125	A0129NK	A0129NK

(a) Part number represents 1 grounding ring.

NOTE

For Hastelloy C, Monel, Tantalum, or Titanium grounding rings, contact Global Customer Support.

9304A-SIBA-TTJ-GN

MODEL CODE - PTFE-LINED FLOWTUBES

Description	Code
Nominal Flowtube Size	
15 mm (1/2 in) Line Size, Flanged	930HA
25 mm (1 in) Line Size, Flanged	9301A
40 mm (1 1/2 in) Line Size, Flanged	931HA
50 mm (2 in) Line Size, Flanged	9302A
80 mm (3 in) Line Size, Flanged	9303A
100 mm (4 in) Line Size, Flanged	9304A
150 mm (6 in) Line Size, Flanged	9306A
200 mm (8 in) Line Size, Flanged	9308A
250 mm (10 in) Line Size, Flanged	9310A
300 mm (12 in) Line Size, Flanged	9312A
350 mm (14 in) Line Size, Flanged	9314A
400 mm (16 in) Line Size, Flanged	9316A
Tube Construction	
AISI Type 304 or 305 ss; Face-to-Face Dimensions Conform to ISO/DIS 13359	–SI
End Connections	
ANSI Class 150 Carbon Steel Flange	BA
ANSI Class 150, 316 ss Flange	BB
Metric PN 10 Carbon Steel Flange (a)	ZD
Metric PN 16 Carbon Steel Flange (a)	ZE
Metric PN 10, 316 ss Flange (a)	ZL
Metric PN 16, 316 ss Flange (a)	ZM
Lining Material	
PTFE (polytetrafluoroethylene)	–T
Electrodes	
Tantalum-Tungsten	B
Conical 316L ss (9301A through 9306A only)	C
Hastelloy C	H
Conical Hastelloy C (9301A through 9306A only)	K
Platinum-Iridium	P
316L ss	S
Titanium	T
Coil Drive/Supply	
Pulsed dc	J
Housing Construction/Transmitter Mounting	
NEMA 4/NEMA 4X Construction; Remote-Mounted Transmitter (b)	–G
Total/Accidental Submergence Housing; Remote-Mounted Transmitter (c)	–N
NEMA 4/NEMA 4X Construction; Integrally Mounted to IMT25 Transmitter (b)	–I
Electrical Safety (Also see Electrical Safety Specifications section)	
CSA, Class I, II, III; Division 2	L
FM, nonincendive, Class I, II, III; Division 2	N
No Testing Laboratory Certification or Approval Required	Z
Optional Selections	
Cable Glands for Nonconduit Applications (d)	–G
Grounding Electrode (9308A-9316A only) (e)	–E
PTFE Lining Protector (a)	–T

a. Optional Selection -T not available with metric End Connections.

b. NEMA 4 housing for 930HA to 9306A sizes; and NEMA 4X housing for 9308A to 9316A sizes.

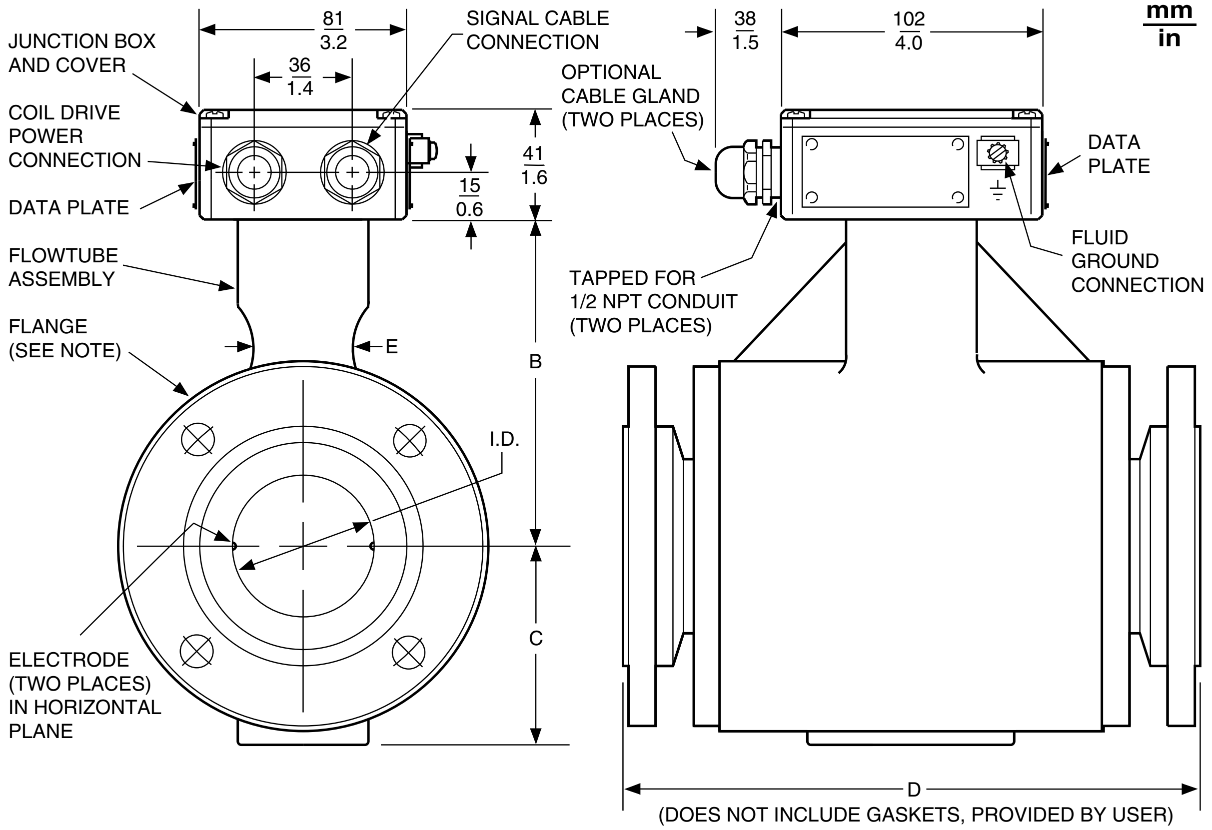
c. Sealed for accidental or continuous operation under water up to 9 m (30 ft) deep. Supplied with a field kit for sealing after installation.

d. The cable glands (-G option) provide a sealed cable entry for field wiring to the flowtube junction box, and are generally specified in nonconduit applications. For flowtubes with integrally-mounted transmitters (-I Housing), cable glands may be specified with the transmitter options (not for Electrical Safety Codes L and N).

e. The -E option is supplied in same material as selected for electrodes. This option is used in lieu of grounding rings.

DIMENSIONS-NOMINAL

9302A TO 9306A FLANGED FLOWTUBES USED WITH REMOTE-MOUNTED TRANSMITTERS

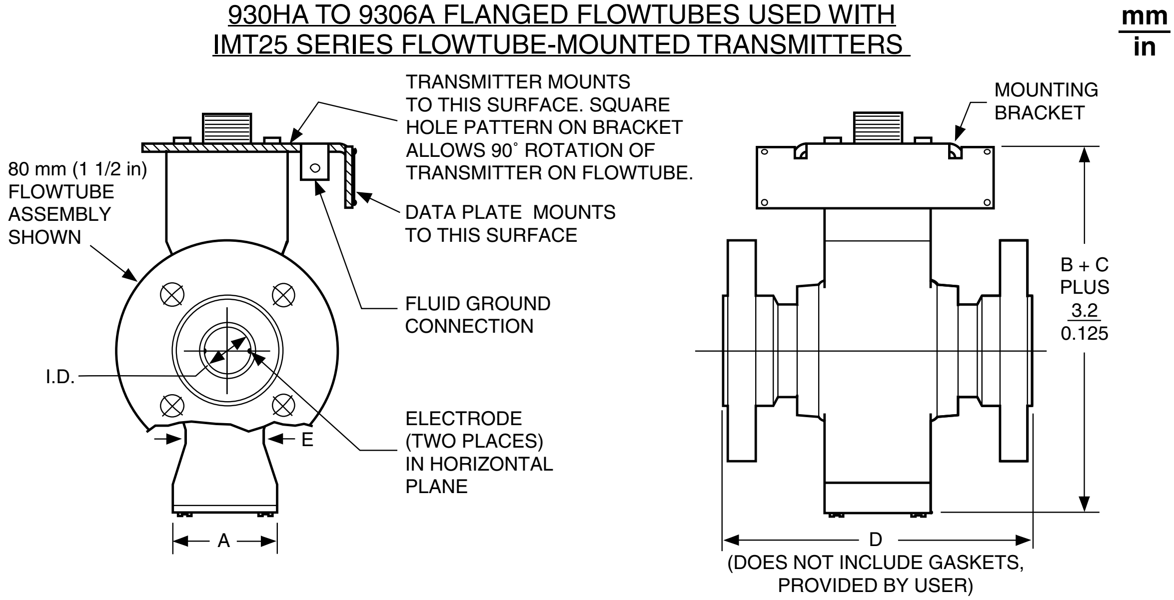


NOTE: Flowtube mounts between the following pipeline flanges: Metric PN 10, PN 16, PN 25, and PN 40; and ANSI Classes 150 and 300.

Flowtube Model	Nominal Line Size		Actual Flowtube I.D.	Dimensions B	C	D (a)	E
9302A	50 mm	2 in	45.6 / 1.77	91 / 3.6	61 / 2.4	200 / 7.87	28 / 1.1
9303A	80 mm	3 in	70.6 / 2.78	107 / 4.2	76 / 3.0	200 / 7.87	41 / 1.6
9304A	100 mm	4 in	93.0 / 3.66	135 / 5.3	89 / 3.5	250 / 9.84	41 / 1.6
9306A	150 mm	6 in	138.7 / 5.46	165 / 6.5	114 / 4.5	300 / 11.81	48 / 1.9

a. D length increases by approximately 25 mm (1 inch) when flowtube has optional lining protection (Suffix -T). For PTFE-lined flowtubes, Dimension D applies only when end flanges are clamped in place.

930HA TO 9306A FLANGED FLOWTUBES USED WITH IMT25 SERIES FLOWTUBE-MOUNTED TRANSMITTERS



NOTE: SEE PREVIOUS PAGES FOR FLOWTUBE DIMENSIONS.

ORDERING INSTRUCTIONS

1 Model Number.
2 Flow Rate and Engineering Units. Value Specified must be within Minimum and Maximum Values listed in Table 1.
3 Process Pressure-Temperature Range. Specify Minimal, Nominal, and Maximum Values.
4 Process Composition and Conductivity.
5 Grounding Rings (if Mating Piping is Nonmetallic or Lined Metallic Piping), if needed.
6 Other Options or Accessories not Listed in Model Number.
7 User Tag Data.

FLOWEXPERTPRO SIZING APPLICATION

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Mobile application

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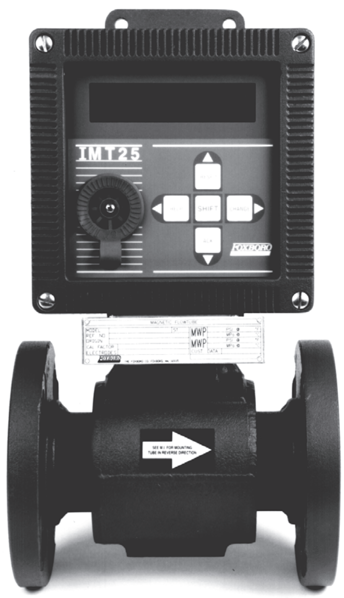
Instruction

MI 021-386
December 2016

9300A Series
Flanged Magnetic Flowtubes
PFA-Lined, 1- through 12-inch Sizes
PTFE-Lined, 1/2- through 16-inch Sizes
or Polyurethane-Lined, 8- through 16-inch Sizes

Installation



FLANGED BODY FLOWTUBE
WITH FLOWTUBE-MOUNTED TRANSMITTER

FLANGED BODY FLOWTUBE
WITH REMOTE TRANSMITTER

Foxboro®
by Schneider Electric

Contents

Figures

Tables

1. Introduction

The 9300A Series Flanged Magnetic Flowtube, in conjunction with an IMT25 Magnetic Flow Transmitter, form a magnetic flowmeter system. The flowtube can be used with most common fluids, from everyday conductive liquids to very difficult-to-handle conductive liquids.

The flowtubes are available in PFA-lined 25 to 300 mm (1 to 12 in), polyurethane-lined 200 to 400 mm (8 to 16 in) sizes, and PTFE-lined 15 to 400 mm (1/2 to 16 in) sizes.The transmitter can mount directly to the 15 to 150 mm (1/2 to 6 in) wafer-body flowtube. The transmitter can mount directly to the flowtube, or can be mounted in a remote location to a surface or pipe. In remote transmitter applications, the allowable cable length, up to a maximum length of 300 m (1000 ft), is a function of the cable type, process fluid conductivity, and whether the cables are in the same or separate conduits.

The transmitter uses a pulsed-dc technique to energize the flux-producing coils of the flowtube. As the process liquid passes through the magnetic field in the flowtube, low-level voltage pulses are developed across a pair of electrodes. The voltage level of these pulses is directly proportional to the average velocity of the liquid. The transmitters convert the voltage pulse to both a standard 4 to 20 mA and pulse output signal. The 4 to 20 mA signal is used with a suitable receiver to indicate, record, and/or control a variable. The proportional pulse output can be used for totalization, and can be configured for either a high-rate or low-rate pulse. A digital output signal (HART or FOUNDATION Fieldbus communication protocol) is also provided for flowmeters serving as a primary device in an I/A Series system. Details of the output signals are given in the transmitter instruction.

This instruction (MI 021-386) relates to the installation of the flowtube portion of a magnetic flowmeter system. For installation, wiring, operation, configuration, and maintenance details relating to the flowmeter system, refer to the applicable transmitter documents.

Reference Documents

Table 1. Reference Documents

Document	Description
DP 021-364	Dimensional Print - 9300A Series Flanged Magnetic Flowtube
MI 021-387	IMT25 Series Transmitters, Installation and Wiring
MI 021-391	IMT25 Series Transmitters, System Maintenance
TI 27-71f	Magnetic Flowtube Materials Selection Guide
TI 027-072	Magnetic Flowmeter Liquid Conductivity Tables
PL 008-742	Parts List - 9300A Series Flanged Magnetic Flowtube

Standard Specifications

Minimum and Maximum Upper Range Values (URV) and Nominal Calibration Factors

In Table 2, the minimum upper range value is **not** the flow rate that the flowtube can measure; it is the lowest flow rate that can correspond to the 4 to 20 mA signal. For example, for the 930HA, the minimum range is 0 to 1.0 U.S. gpm. This will generate 4 to 20 mA.

Table 2. Minimum and Maximum Upper Range Values and Nominal Calibration Factors

Nominal Flowtube Size		Flowtube Model Codes (a)	Minimum and Maximum Upper Range Values		Nominal Calibration Factor
mm	in		L/m	U.S. gpm	Unitless
15	1/2	930HA	3.8 and 76	1.0 and 20	220
25	1	9301A	13.2 and 265	3.5 and 70	60
40	1-1/2	931HA	34.1 and 643	9.0 and 170	17
50	2	9302A	49 and 946	13 and 250	12
80	3	9303A	117 and 2366	31 and 625	5.8
100	4	9304A	208 and 4164	55 and 1100	3.0
150	6	9306A	462 and 9235	122 and 2440	1.1
200	8	9308A-..BA/BB-P 9308A-..ZD/ZE-P 9308A-..ZL/ZM-P	1003 and 20060	265 and 5300	0.39
		9308A-..BD/BC-P 9308A-..ZF/ZG-P 9308A-..ZN/ZP-P	927 and 18546	245 and 4900	0.39
		9308A-....-T	965 and 19303	255 and 5100	0.39
		9308A-....-A	890 and 17790	235 and 4700	0.39
250	10	9310A-..BA/BB-P 9310A-..ZD/ZE-P 9310A-..ZL/ZM-P	1590 and 31794	420 and 8400	0.24
		9310A-..BD/BC-P 9310A-..ZF/ZG-P 9310A-..ZN/ZP-P	1476 and 29523	390 and 7800	0.24
		9310A-....-T	1552 and 31037	410 and 8200	0.24
		9310A-....-A	1438 and 28766	380 and 7600	0.24
300	12	9312A-..BA/BB-P 9312A-..ZD/ZE-P 9312A-..ZL/ZM-P	2270 and 45420	600 and 12000	0.13
		9312A-..BD/BC-P 9312A-..ZF/ZG-P 9312A-..ZN/ZP-P	2120 and 42392	560 and 11200	0.13
		9312A-....-T	2215 and 44285	585 and 11700	0.13
		9312A-....-A	2082 and 41635	550 and 11000	0.13
350	14	9314A-....-T 9314A-....-A	2763 and 55261 2555 and 51098	730 and 14600 675 and 13500	0.090
400	16	9316A-....-T 9316A-....-A	3634 and 72672 3407 and 68130	960 and 19200 900 and 18000	0.057

a. Lining code: P = PFA, T = PTFE, A = Polyurethane.

Maximum Signal Cable Length

The maximum allowable cable length is a function of the cable type, process fluid conductivity, and whether the cables are in the same or separate conduits. Standard system accuracy will be maintained when the installations are in accordance with Table 3.

Table 3. Cable Requirements

Maximum Cable Length (a)	Minimum Fluid Conductivity (b)	Signal and Coil Drive Cables
300 m (1000 ft)	5 μS/cm	Signal and Coil Drive Cables in separate conduit. Signal Cable to be Foxboro Part No. R0101ZS (feet) or B4017TE (meters).
225 m (750 ft)	5 μS/cm	Signal and Coil drive cables in same conduit. Signal Cable to be Foxboro Part No. R0101ZS (feet) or B4017TE (meters).
150 m (500 ft)	20 μS/cm	Signal cable may be in same conduit as coil drive cable. Signal cable to be good quality twisted shielded pair, preferable no smaller than 1.0 mm^2 (or 18 AWG) for mechanical considerations (Belden 8760 or 9318, Alpha 5610/1801 or 5611/1801, or equivalent).

a. Values in table are fluid conductivity minimums, and maximum distance between transmitter and flowtube.

b. Refer to TI 27-072 for conductivities of various process liquids.

Power Consumption

Less than 24 W when used with IMT25 at reference voltage and frequency.

Materials

Flowtube Housing	(1/2 to 6 in) Ductile Iron with epoxy coating
	(8 to 16 in) Carbon Steel
Junction Box	Cast Aluminum
Junction Box/Cover Gasket	Silicone Sponge Rubber
Junction Box/Housing Gasket	Cork/Silicone Rubber
Flowtube Material	
15 mm (1/2 in)	Cast 304 ss (CF8) or 305 ss, exceeds Schedule 10 wall thk.
25 to 150 mm (1 to 6 in)	Cast 304 ss (CF8) or 305 ss, exceeds Schedule 10 wall thk.
200 to 400 mm (8 to 16 in)	Cast 304 ss, schedule 10 or 40 wall thickness.
Flowtube Liner	PFA, PTFE, or polyurethane
Electrodes (PFA or PTFE)	316L ss, Platinum-Iridium, Hastelloy C, Titanium, Tantalum-Tungsten. Also Conical 316L ss and Hastelloy C
Electrodes (Polyurethane	316L ss
Gaskets	No special gasket required, customer to supply.

Enclosure

The enclosure is finished with epoxy powder coat (15 - 150 mm [1/2 - 6 in] sizes) and with polyurethane paint (200 - 400 mm [8 - 16 in] sizes). It is designed to meet the requirements of IEC IP66, and to provide the watertight and corrosion-resistant protection of NEMA 4X for all tubes except NEMA 4 for 15 - 150 mm (1/2 - 6 in) sizes with PTFE-lining.

End Connections

Metric PN 10, 16, 25, or 40 flanges; or ANSI Class 150 or 300 flanges in either steel or stainless steel as specified.

Approximate Mass

Table 4. Approximate Mass

Flowtube Size		Flowtube Mass with ANSI Class 150 Flanges (a)	
mm	in	kg	lb
15	1/2	2.8	6.2
25	1	5.1	11.3
40	1-1/2	8.0	17.5
50	2	10.5	23.2
80	3	14.2	31.3
100	4	22.7	50.0
150	6	34.0	74.7
200	8	47.6	105
250	10	65.3	144
300	12	90.7	200
350	14	128	283
400	16	154	339

a. Mass represents that of flowtube only. When mounted to IMT25 Transmitter, add 2.9 kg (6.5 lb) for a single compartment transmitter and 3.9 kg (8.7 lb) for a dual compartment transmitter.

Lining Application Guide

PFA

PFA provides excellent corrosion, chemical, stress crack, thermal shock and hydrolysis resistance. It is also suitable for applications requiring high/low temperatures, anti-stick and high purity properties. Refer to TI 27-71f for liner material recommendations for common process fluids.

— NOTE —

The PFA liner may be non-uniform in appearance, having dark and light shading. This condition is inherent in the natural PFA molding process and does not in any way affect the durability or performance of the tube. There is no coloring or fillers that could leach into the process.

PTFE

PTFE withstands effects of severely corrosive and mildly abrasive fluids. Refer to TI 27-71f for detailed liner recommendations for common process fluids.

Polyurethane

Polyurethane withstands effects of highly abrasive fluids. Refer to TI 27-71f for detailed liner recommendations for common process fluids.

Temperature and Pressure Limits

See Tables 5 through 10 for ambient temperature and process pressure/temperature limits of flowtubes with various linings.

See Table 11 for process/temperature limits of flowtubes with various end connections.

Transmitter Remote Mounted PFA-Lined Flowtubes

Table 5. Transmitter Remote Mounted PFA-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-40 to +70°C (a) -40 to +158°F (a)	-40 and +70°C (a) -40 and +158°F (a)
Process Temperature			
1 to 6 in	25°C 77°F	-40 to +180°C (a) -40 to +356°F (a)	-40 and +180°C (a) -40 and +356°F (a)
8 to 12 in		-40 to +120°C (a) -40 to +250°F (a)	-40 to +120°C (a) -40 to +250°F (a)
Process Pressure			
1 to 6 in	0.525 MPa 75 psi	Full Vacuum to 5.1 MPa at 38°C (740 psi at 100°F) Full Vacuum to 4.4 MPa at 180°C (645 psi at 356°F)	5.1 MPa at 38°C (740 psi at 100°F) 4.4 MPa at 180°C (645 psi at 356°F)
8 to 12 in		Full Vacuum to 5.1 MPa at 38°C (740 psi at 100°F) Full Vacuum to 4.7 MPa at 120°C (665 psi at 250°F)	5.1 MPa at 38°C (740 psi at 100°F) 4.7 MPa at 100°C (665 psi at 250°F)

a. For temperatures below -29°C (-20°F), stainless steel flanges must be used.

Table 6. Transmitter Remote Mounted PTFE-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-40 to +70°C (a) -40 to +158°F (a)	-40 and +70°C (a) -40 and +158°F (a)
Process Temperature	25°C 77°F	-40 to +180°C (a) -40 to +356°F (a)	-40 and +180°C (a) -40 and +356°F (a)
Process Pressure	0.525 MPa 75 psi	No vacuum to 2.0 MPa at 38°C (285 psi at 100°F)	2.0 MPa at 38°C (285 psi at 100°F)
		No vacuum to 1.5 MPa at 180°C (213 psi at 356°F)	1.5 MPa at 180°C (213 psi at 356°F)

a. For temperatures below -29°C (-20°F), stainless steel flanges must be used.

Table 7. Transmitter Remote Mounted Polyurethane-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-29 to +70°C -20 to +158°F	-29 and +70°C -20 and +158°F
Process Temperature	25°C 77°F	-29 to +71°C -20 to +160°F	-29 and +71°C -20 and +160°F
Process Pressure	0.525 MPa 75 psi	Full Vacuum to 2.0 MPa at 38°C (285 psi at 100°F)	2.0 MPa at 38°C (285 psi at 100°F)
		Full Vacuum to 1.9 MPa at 71°C (270 psi at 160°F)	1.9 MPa at 71°C (270 psi at 160°F)

Table 8. Transmitter Integrally Mounted PFA-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-20 to +55°C -4 to +131°F	-30 and +70°C (a) -22 and +158°F (a)
Process Temperature	25°C 77°F	-40 to +120°C (a) -40 to +250°F (a)	-40 and +120°C (a) -40 and +250°F (a)
Process Pressure	0.525 MPa 75 psi	Full Vacuum to 5.1 MPa at 38°C (740 psi at 100°F)	5.1 MPa at 38°C (740 psi at 100°F)
		Full Vacuum to 4.7 MPa at 120°C (665 psi at 250°F)	4.7 MPa at 120°C (665 psi at 250°F)

a. For temperatures below -29°C (-20°F), stainless steel flanges must be used.

Table 9. Transmitter Integrally Mounted PTFE-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-20 to +55°C -4 to +131°F	-30 and +70°C (a) -22 and +158°F (a)
Process Temperature	25°C 77°F	-40 to +120°C (a) -40 to +250°F (a)	-40 and +120°C (a) -40 and +250°F (a)
Process Pressure	0.525 MPa 75 psi	No vacuum to 2.0 MPa at 38°C (285 psi at 100°F)	2.0 MPa at 38°C (285 psi at 100°F)
		No vacuum to 1.7 MPa at 120°C (245 psi at 250°F)	1.7 MPa at 120°C (245 psi at 250°F)

a. For temperatures below -29°C (-20°F), stainless steel flanges must be used.

Table 10. Transmitter Integrally Mounted Polyurethane-Lined Flowtubes

Influence	Reference Operating Conditions	Normal Operating Conditions	Operating Limits
Ambient Temperature	25°C 77°F	-20 to +55°C -4 to +131°F	-30 and +70°C (a) -22 and +158°F (a)
Process Temperature	25°C 77°F	-20 to +71°C -4 to +160°F	-20 and +71°C -4 and +160°F
Process Pressure	0.525 MPa 75 psi	Full Vacuum to 2.0 MPa at 38°C (285 psi at 100°F)	2.0 MPa at 38°C (285 psi at 100°F)
		Full Vacuum to 1.9 MPa at 71°C (270 psi at 160°F)	1.9 MPa at 71°C (270 psi at 160°F)

a. For temperatures below -29°C (-20°F), stainless steel flanges must be used.

Table 11. Flange Pressure-Temperature Limits for PFA-Lined/PTFE-lined Flowtubes

DIN Flange Rating	Maximum Permissible Operating Pressure at Temperature Listed							
	316 ss Stainless Steel				Carbon Steel (ASME/ANSI Group No. 1.1)			
	–40°C	50°C	100°C	180°C	–28°C	50°C	100°C	180°C
PN 10	9.0 bar	9.0 bar	7.8 bar	7.1 bar	10.0 bar	10.0 bar	10.0 bar	8.4 bar
PN 16	14.2 bar	14.2 bar	12.5 bar	11.5 bar	16 bar	16 bar	16 bar	15.3 bar
PN 25	22.36 bar	22.3 bar	19.5 bar	17.9 bar	25.0 bar	25.0 bar	25.0 bar	20.2 bar
PN 40	37.4 bar	37.4 bar	31.2 bar	28.6 bar	40 bar	40 bar	40 bar	38.3 bar
ANSI Flange Rating	**–40°F**	**100°F**	**200°F**	**356°F**	**–20°F**	**100°F**	**200°F**	**356°F**
Class 150	275 psig	275 psig	240 psig	205 psig	285 psig	285 psig	260 psig	213 psig
Class 300	720 psig	720 psig	620 psig	538 psig	740 psig	740 psig	675 psig	644 psig

— NOTE —

For process temperatures >120°C (>250°F), the transmitter must be remotely mounted.

PED Compliance

The 9300A Series Magnetic Flowtubes are fully compliant with the European Pressure Equipment Directive as process piping devices for Fluid Group 2 liquids only. The resulting product category classifications are either SEP or Category I, depending on line size and pressure rating, and as such, the product data labels carry the CE mark only (with no notifying body number).

Electrical Safety Specifications

— NOTE —

These flowtubes have been designed to meet the electrical safety descriptions listed in Table 12. For detailed information, or status of testing laboratory approvals/certifications, contact Global Customer Support.

Table 12. Electrical Classification

Testing Laboratory, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
CSA for use in Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2 hazardous locations.	Temperature Class T6.	L
FM nonincendive Class I, Division 2, Groups A, B, C, and D; suitable for Class II and III, Division 2, Groups F and G hazardous locations	Temperature Class T6. Ta =70°C.	N
No Certification		Z

Flowtube Identification

The flowtube can be identified by the data and plates located on the flowtube. Typical data plates are shown in Figures 1 and 2. Refer to MI 021-387 for information regarding transmitter data plates.

Figure 1. Sample Data Plates for Flowtube with Remote Mounted Transmitter

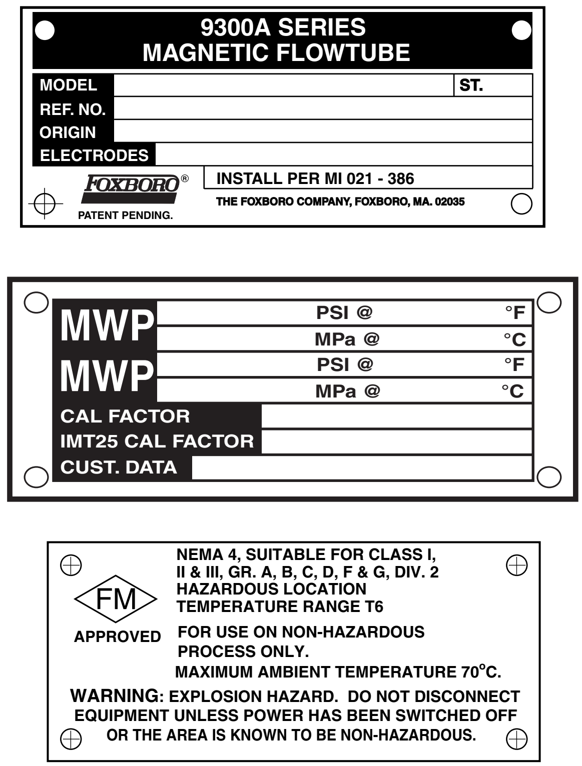
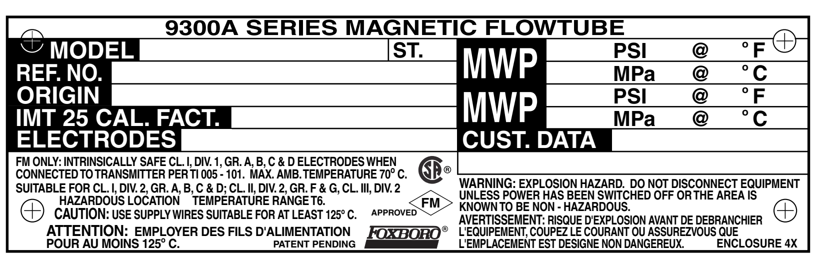


Figure 2. Sample Data Plate for Flowtube with Integrally Mounted Transmitter



2. Installation

Unpacking and Handling Procedure

After removing flowmeter from its shipping carton, inspect it for visible damage. If any damage is observed, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier.

NOTICE

Avoid touching the electrodes with fingers or any material that can contaminate the electrodes. A deposit on the electrodes will result in a high-impedance boundary between the electrodes and conductive fluid. If the electrodes have been touched, clean them with isopropyl alcohol.

Installation Guidelines

When properly installed, these magflow tubes are capable of providing high accuracy and durability while operating under real life conditions. To get maximum performance from the tube, select an appropriate location in the pipeline and avoid the factors that create bending loads at the flowtube. These factors are highlighted below in general terms and covered specifically in the detailed installation instructions.

It is very important that:

- A location be selected that will ensure a full flowtube under all operating conditions.
- The pipe line and flanges are aligned per the detailed instructions.
- Gaskets are centered on the ends of the tube.
- Flange bolts are tightened carefully to produce a uniform, well-centered load on the tube.
- Torque limits are not exceeded. (By following the installation instruction details, reliable joints can be made without exceeding these limits.)
- You allow approximately 5 pipe diameters of straight pipe upstream of the flowtube and 3 pipe diameters downstream.
- If mating pipe is lined, metal or plastic grounding rings be installed on each end of the flowtube.

Selecting a Location for the Flowtube

The flowtube can be installed in plastic or metal (magnetic or non-magnetic) piping. Usually the flowtube tube can be placed at any convenient location in the pipeline, but to insure good performance, the location should be reviewed relative to the factors listed below:

- It is essential for accuracy that the tube be completely full during operation. Horizontal, vertical, or sloping positions are acceptable, but some positions require special attention to be sure that the tube remains full. In addition to obvious problem locations such as down flowing vertical runs, consider areas where air pockets may form and where siphoning action or low pressure areas could create voids.
- The effects of upstream disturbances, such as valves and elbows, are difficult to predict, but in nearly all cases, standard accuracy will be realized if there are at least 5 pipe diameters of straight pipe upstream of the flowtube. Downstream disturbances that are 3 or more pipe diameters from the center of the tube do not affect the measurement accuracy. The inside diameter of the piping should be the same as, or larger than, the nominal size of the flowtube. Flowtubes can be placed in larger nominal size pipelines by using tapered conical reducers. The small ends of the reducers can be directly coupled to the flowtube and have a maximum included angle of 16°.
- If the flowtube is to be used to measure a slurry flow, it is important for accuracy to select a location where the velocities of the slurry components will be nearly equal and high enough to ensure good mixing.

To ensure good service life:

- Avoid areas that may have large stresses, such as water hammer or severe shaking of the pipeline.
- Provide protection from freezing.
- With slurries, do not position the electrodes in such a way that a bend or other pipeline feature would cause large solid particles to strike the electrodes.
- The tube enclosure is rated for NEMA 4X, NEMA 4, or IEC IP66 protection and has wide ambient temperature limits, but the tube should be protected from chemical spills and direct exposure to high temperature radiant heat sources.

Select a site with good accessibility for installation.

Mounting Positions

After a location is selected in the pipeline for the flowtube, the mounting position of the tube at that location still has to be determined. The choices are: (1) position of the conduit connections, (2) electrode position, and (3) convenience. Performance of the flowtube is not affected by the direction of the flow through the tube. This permits the tube to be installed in the direction that provides the best location for the wiring connections. **If the actual flow direction does not agree with the “direction-of-flow” arrow on the tube, just reverse the polarity of the coil drive wire connections. The IMT25 Transmitter can also be configured for reverse flow.**

The flowtube can be mounted at any position without degrading performance. The only requirement is that the flowtube be completely full with the process liquid during measurement, and that the electrodes be in the horizontal plane.

If the flowtube is not mounted in a vertical position, it is recommended that it be turned so that the electrodes are not near the top and bottom of the pipe. This is to avoid the possibility of losing electrode-to-fluid contact, either because of bubbles (at top), or sediment (at bottom) of the flowtube.

Figure 3. Flowtube Mounted Vertically

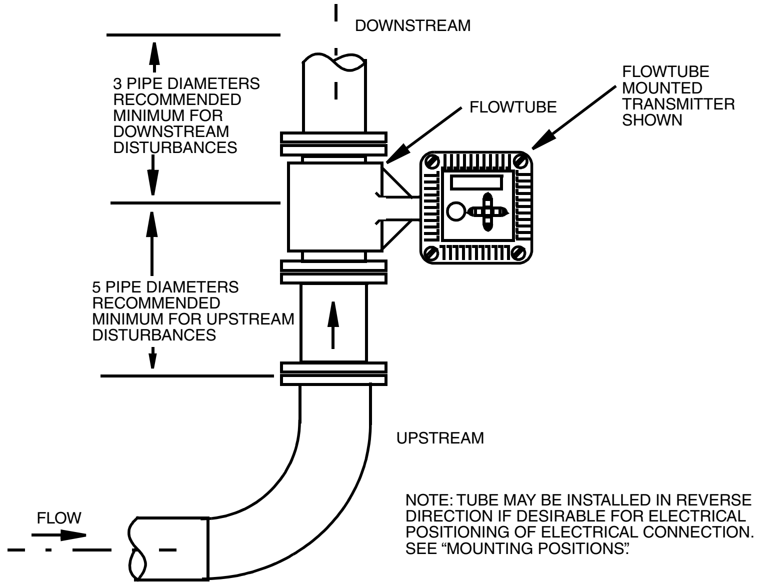
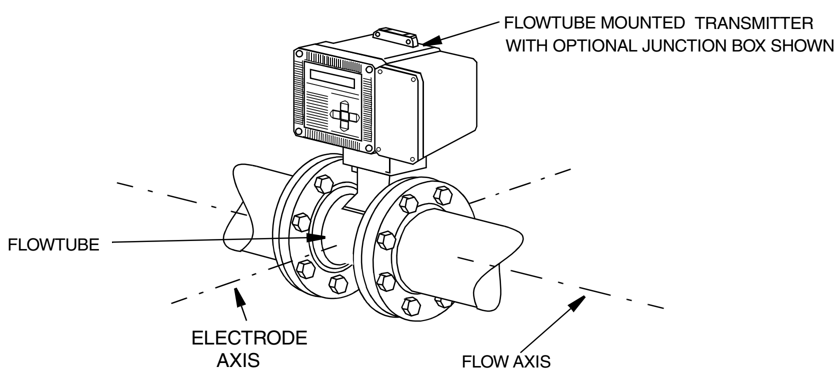


Figure 4. Flowtube Mounted Horizontally



If the flowtube has an integrally mounted transmitter, it may be desirable to adjust the orientation of the transmitter relative to the flowtube. To turn the transmitter, remove the four transmitter screws and washers. Turn the transmitter ±90° to the desired orientation and mount it back on the flowtube. If this does not give a satisfactory mounting position for the transmitter, reinstall the flowtube rotated 180° (flowtube direction reversed). This permits mounting the transmitter in the desired position. If installed in this manner, with flow direction reversed, you must either have to change the coil connections to the transmitter or modify the transmitter configuration to accommodate the change in flow direction.

NOTICE

When turning the transmitter, do not separate it from the flowtube. Separating the transmitter from the flowtube may cause interconnecting wires to be damaged.

Transmitter covers can also be turned in 90° increments so that the display and data plate can be easily read. Unscrew the four captive screws and turn cover to desired position. Refer to MI 020-387 for detailed IMT25 Transmitter instructions.

NOTICE

Do not separate cover from transmitter any more than required to turn it. Excessive separation can cause any of the interconnecting electrical wires to be damaged.

Pipeline Preparation

Flowtube Dimensions

Refer to DP 021-364.

Flange Types and Materials

The pipe and flange material can be magnetic, non-magnetic metal, or plastic without affecting the accuracy of the flowtube. To help control the stresses on the liner flanged ends, it is best to use a flange type that has a raised face I.D. equal to the pipeline I.D., such as a welding neck or socket welding flange. This assures full gasket contact for more even loading of the liner ends of the flowtube and permits higher bolting torques without over-compressing the gasket. Flange types that do not provide full surface contact with the gasket can be used, but with reduced bolt torques and careful attention to alignment.

Pipeline Support and Alignment

Adequately support the pipeline to carry its weight when full and to control pipeline motions such as can be caused by water hammer or other disturbances within the piping system.

In cases where temperature differences occur, make provisions to accommodate thermal expansions in a way that preserve the initial alignment of the piping at the flowtube.

It is important to align the pipeline flanges so that they make flat contact with the flowtube flanges. Bolt torque in excess of the maximum recommended values or misaligned flanges that cause an uneven flange clamping force can crush the liner. To prevent liner damage due to an uneven flange clamping force, align the flange well enough to allow full face contact to be made without exceeding 25% of the recommended maximum torque in any of the flange bolts. See Table 14.

Flowtube Grounding

For proper system performance, it is necessary to establish a fluid reference signal. Additional grounding details are given in MI 021-387.

When the flowtube is mounted between unlined metal pipes, the flange bolts provide the electrical connection from the flowtube to the pipeline and, therefore, the fluid.

When the flowtube is mounted between nonmetal or lined metal pipe, installation of grounding rings on each pipe flange is required as shown in Figures 5 and 6. Continuity is provided by connecting grounding wires from the flowtube to the grounding rings.

A third electrode for grounding is optionally available for 8- to 16-inch sizes.

Figure 5. Use of Grounding Rings when Transmitter is in Remote Location

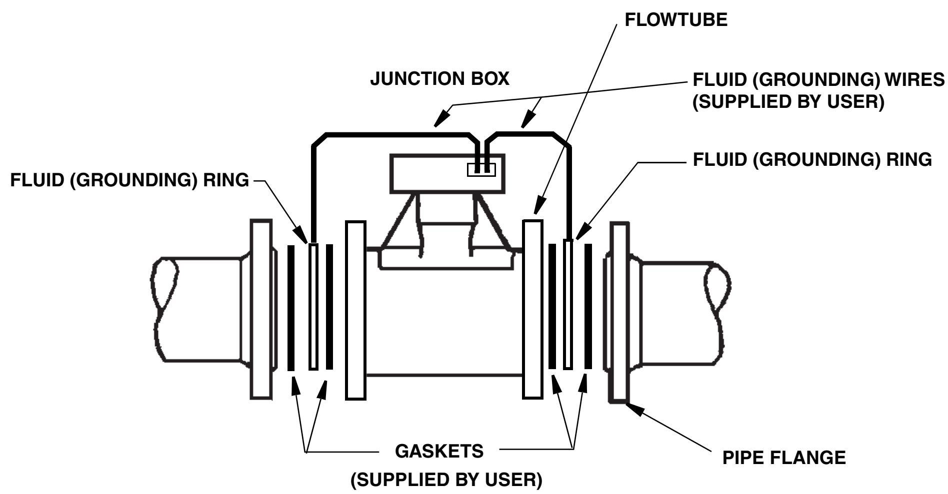


Figure 6. Use of Grounding Rings when Transmitter is Mounted to Flowtube

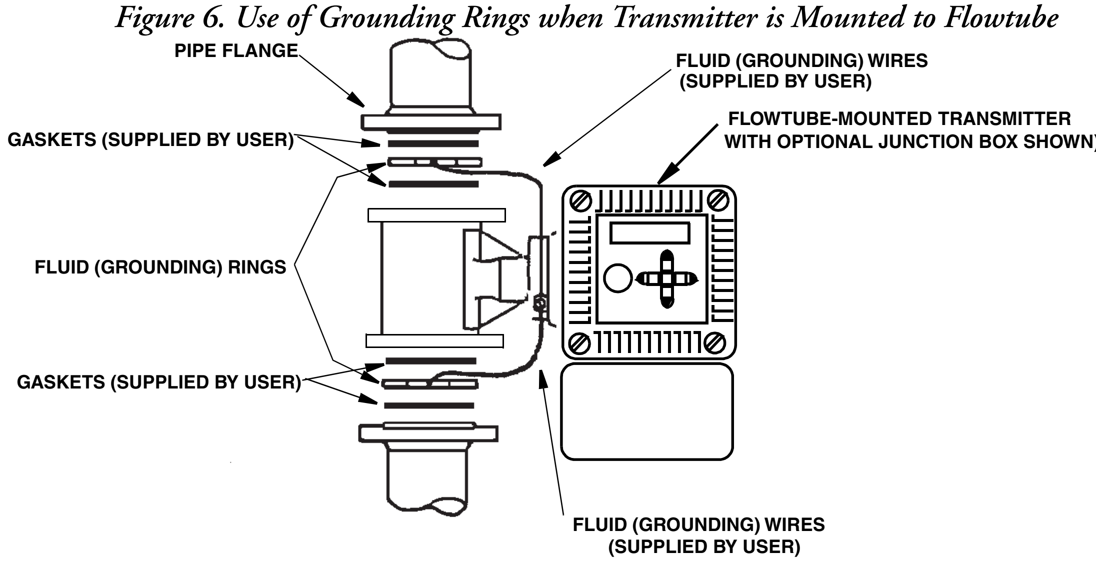


Table 13. Inside Diameters of Grounding Rings

Nominal Flowtube Size		Flowtube Model Codes (a)	Grounding Ring Inside Diameter	
mm	in		mm	in
15	1/2	930HA	11.1	0.437
25	1	9301A	21.4	0.843
40	1-1/2	931HA	36.5	1.437
50	2	9302A	48.4	1.906
80	3	9303A	75.4	2.97
100	4	9304A	100.8	3.97
150	6	9306A	152	5.98
200	8	9308A-..BA/BB-P 9308A-..ZD/ZE-P 9308A-..ZL/ZM-P	206	8.11
		9308A-..BD/BC-P 9308A-..ZF/ZG-P 9308A-..ZN/ZP-P	197	7.76
		9308A-....-T	202	7.95
		9308A-....-A	196	7.70
250	10	9310A-..BA/BB-P 9310A-..ZD/ZE-P 9310A-..ZL/ZM-P	259	10.21
		9310A-..BD/BC-P 9310A-..ZF/ZG-P 9310A-..ZN/ZP-P	249	9.81
		9310A-....-T	255	10.05
		9310A-....-A	249	9.80
300	12	9312A-..BA/BB-P 9312A-..ZD/ZE-P 9312A-..ZL/ZM-P	309	12.18
		9312A-..BD/BC-P 9312A-..ZF/ZG-P 9312A-..ZN/ZP-P	299	11.79
		9312A-....-T	305	12.02
		9312A-....-A	299	11.77
350	14	9314A-....-T 9314A-....-A	341 330	13.42 13.01
400	16	9316A-....-T 9316A-....-A	392 381	15.42 15.01

a. Lining code: P = PFA, T = PTFE, A = Polyurethane.

Installation Procedure Details

1. Review the guidelines on page 20 for selecting a location for the flowtube.
2. Prepare the pipeline for the flowtube, per “Pipeline Preparation” on page 22.
3. Review Flowtube Grounding requirements on page 23.
4. Locate and remove all foreign objects from the piping. If possible, make up and install a section of pipe (spool piece) in the space provided for the flowtube and flush the pipeline.
5. Center the gaskets on the tube ends.
6. Place the flowtube in the pipeline. Note that the tube can be installed with the “direction-of-flow” arrow reversed to the actual flow direction. This does not affect performance and should be done if it places the electrical connections in a better position. (Refer to “Mounting Positions” on page 20.)
7. If grounding rings are being used, position them between flowtube ends and pipe flanges. Use additional suitable gasket material between the grounding rings and the flanges.
8. Begin tightening the flanges to the flowtube. Initially, this should be done by lightly tightening the nuts in an order that will bring the flanges flat against the flowtube gaskets.
9. Tightening the flange nuts requires special care — first, to create a uniform clamping load on the tube, and second, to avoid over-compressing the flared ends. Begin by bringing the flanges into full-face contact with the gaskets, using minimum possible torque. This should be done by tightening the nuts adjacent to the largest flange-to-gasket gaps until full circle contact is made. Then, with all nuts at least finger-tight, proceed to tighten the nuts, basically following a diametrically opposite pattern. Turn the first nut 1/6 of a turn, then move to the next nut and tighten it 1/6 of a turn. Continue this sequence until one nut on each bolt has made one complete turn, or until the maximum torque specification has been reached.

Table 14. Maximum Mounting-Nut Torques for Flanged-Body Flowtubes

Flowtube Size		No. of Bolts in Flange	Max. Mounting Nut Torque	
mm	in		N•m	lb•ft
15	1/2	4	7	5
25	1	4	14	10
40	1-1/2	4	27	20
50	2	4	75	55
		8	40	30
80	3	4	80	60
		8	54	40
100	4	8	54	40
150	6	8	95	70
		12	75	55
200	8	8	115	85
		12	95	70
250	10	12	122	90
		16	108	80
300	12	12	163	120
		16	176	130
350	14	12	219	160
		16	163	120
400	16	16	204	150

⚠ CAUTION

The torque values in the table are for metal flanges. If plastic flanges are used, torque nuts to lower value of table limits or flange limits.

Transmitter Installation and System Wiring

For instructions on the installation of a remote transmitter and system wiring details into and out of the transmitter, refer to MI 021-387.

System Maintenance

System maintenance information is located in MI 021-391. For flowtube parts, refer to PL 008-742.

ISSUE DATES

OCT 1995	DEC 1997	DEC 2016
MAY 1996	AUG 2001	
MAR 1997	DEC 2008	
OCT 1997	DEC 2015	

Vertical lines to the right of text or illustrations indicate areas changed at last issue date.

Foxboro®
by Schneider Electric

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Website: http://support.ips.invensys.com

1216

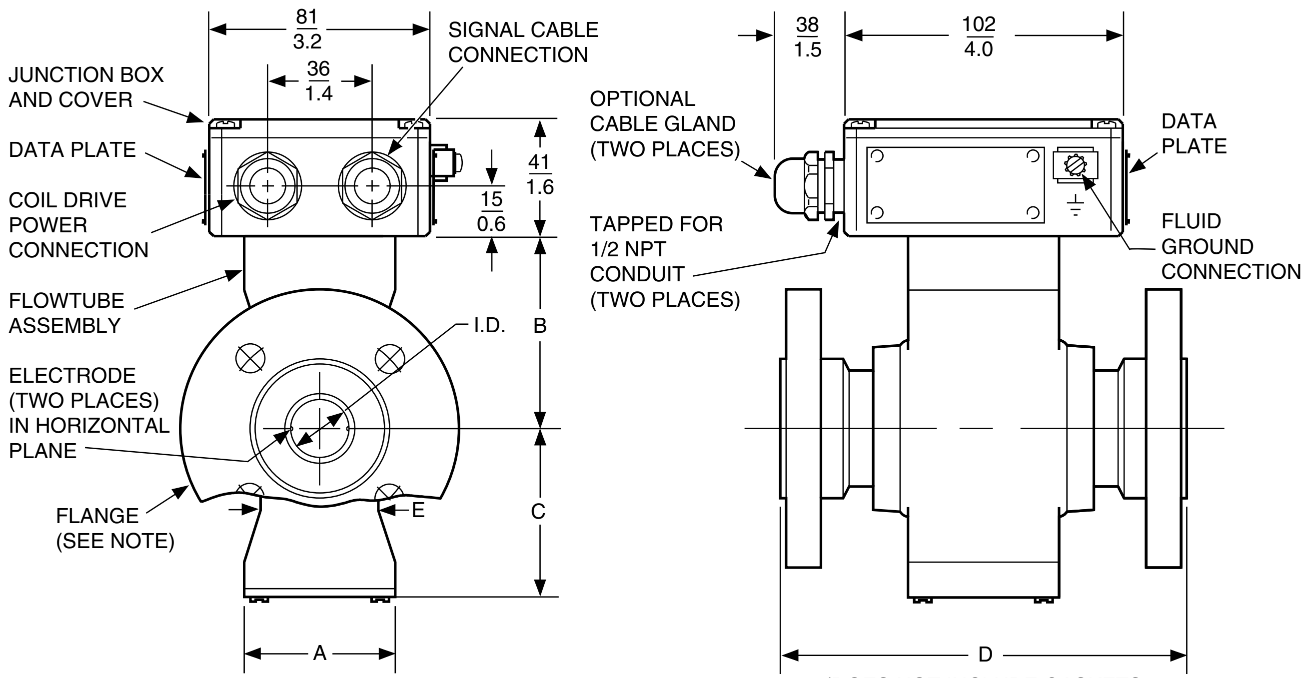
Dimensional Print

DP 021-364
March 2016

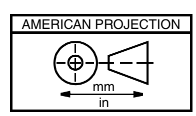
9300A Series Flanged Magnetic Flowtube

1/2 to 6 inch Sizes; PTFE-Lined
1 to 6 inch Sizes; PFA-Lined
8 to 16 inch Sizes; PFA, PTFE, or Polyurethane-Lined

930HA TO 931HA FLANGED FLOWTUBES USED WITH REMOTE-MOUNTED TRANSMITTERS



For dimensional information specific to your sales order, contact your sales representative to order a Certified Dimensional Print (CDP).



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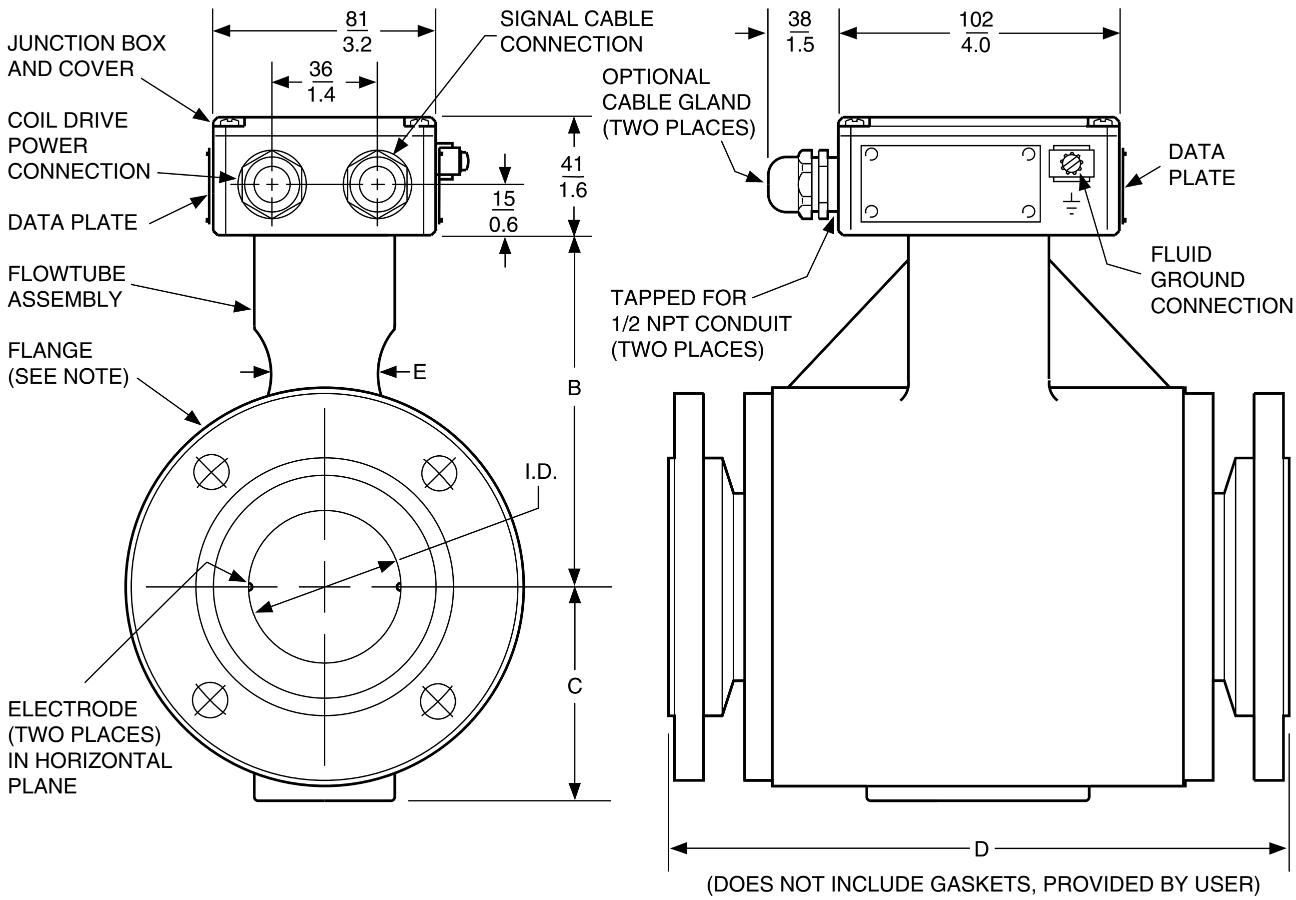
Flowtube Model	Nominal Line Size		Actual Flowtube I.D.	Dimensions				
	mm	in		A	B	C	D	E
930HA	15	1/2	12.19 0.480	53 2.1	61 2.4	58 2.3	200 7.87	28 1.1
9301A	25	1	22.10 0.870	53 2.1	69 2.7	66 2.6	200 7.87	41 1.6
931HA	40	1 1/2	37.08 1.46	53 2.1	84 3.3	76 3.0	200 7.87	53 2.1

NOTES

1. Flowtube mounts between the following pipeline flanges: Metric PN 10, PN 16, PN 25, and PN 40, and ANSI Classes 150 and 300.
2. For PTFE-lined flowtubes, Dimension D applies only when end flanges are clamped in place.
3. D length increases by approximately 25 mm (1 inch) when flowtube has optional lining protection (Suffix -T).

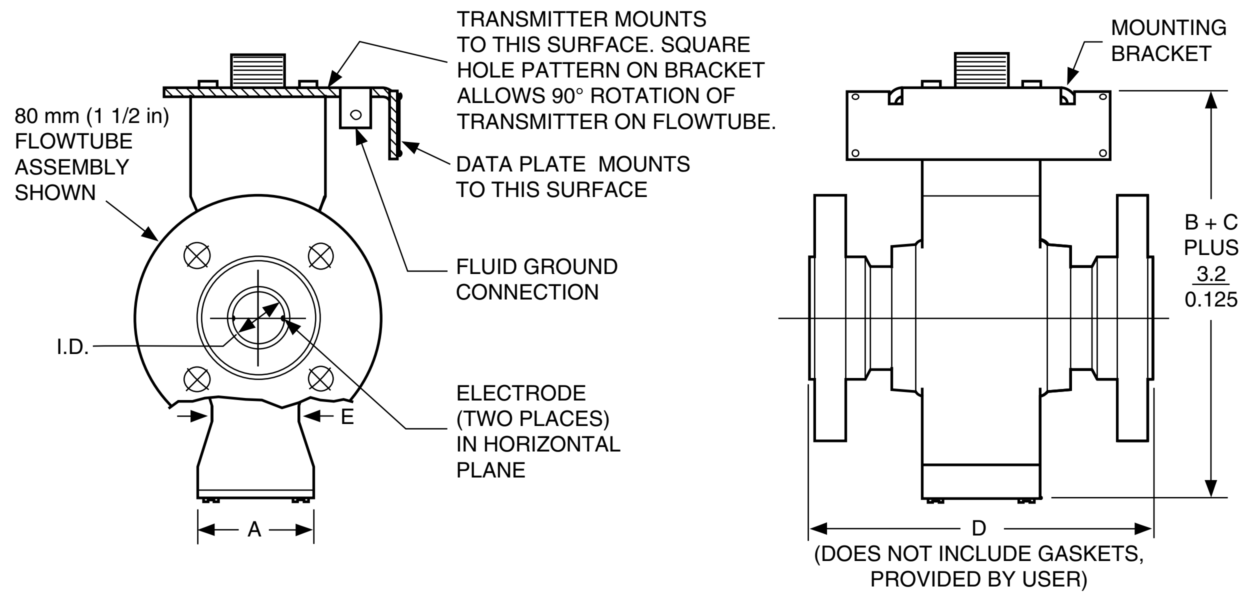
9302A TO 9306A FLANGED FLOWTUBES USED WITH REMOTE-MOUNTED TRANSMITTERS



Flowtube Model	Nominal Line Size		Actual Flowtube I.D.	Dimensions			
	mm	in		B	C	D	E
9302A	50	2	45.6 / 1.77	91 / 3.6	61 / 2.4	200 / 7.87	28 / 1.1
9303A	80	3	70.6 / 2.78	107 / 4.2	76 / 3.0	200 / 7.87	41 / 1.6
9304A	100	4	93.0 / 3.66	135 / 5.3	89 / 3.5	250 / 9.84	41 / 1.6
9306A	150	6	138.7 / 5.46	165 / 6.5	114 / 4.5	300 / 11.81	48 / 1.9

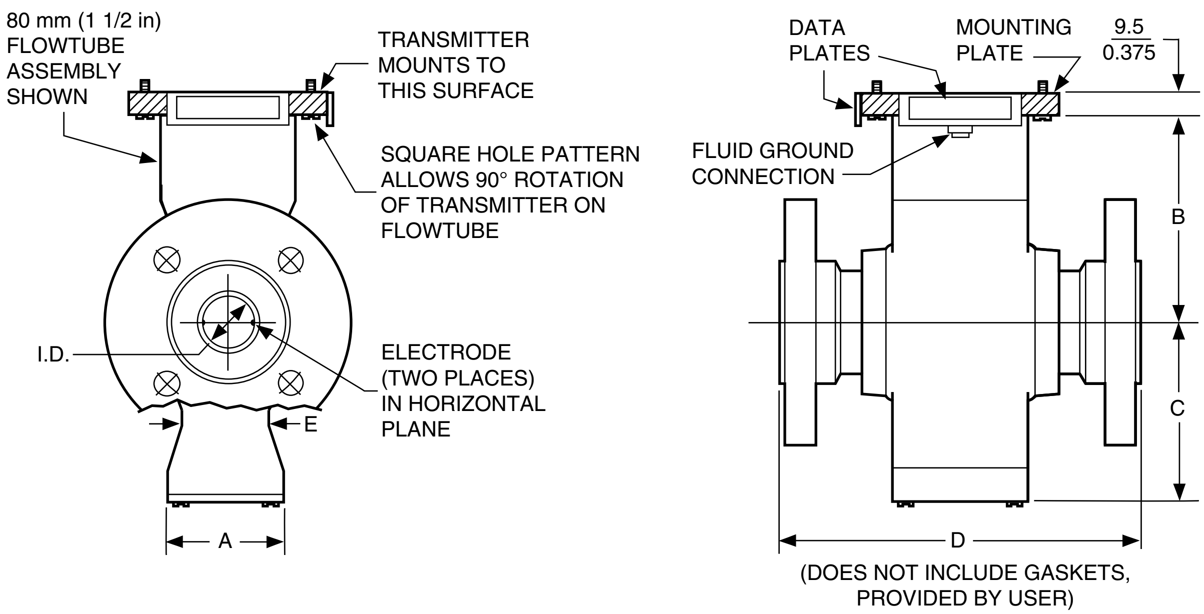
NOTES
1. Flowtube mounts between the following pipeline flanges: Metric PN 10, PN 16, PN 25, and PN 40, and ANSI Classes 150 and 300.
2. For PTFE-lined flowtubes, Dimension D applies only when end flanges are clamped in place.
3. D length increases by approximately 25 mm (1 inch) when flowtube has optional lining protection (Suffix -T).

930HA TO 9306A FLANGED FLOWTUBES USED WITH IMT25 SERIES FLOWTUBE-MOUNTED TRANSMITTERS



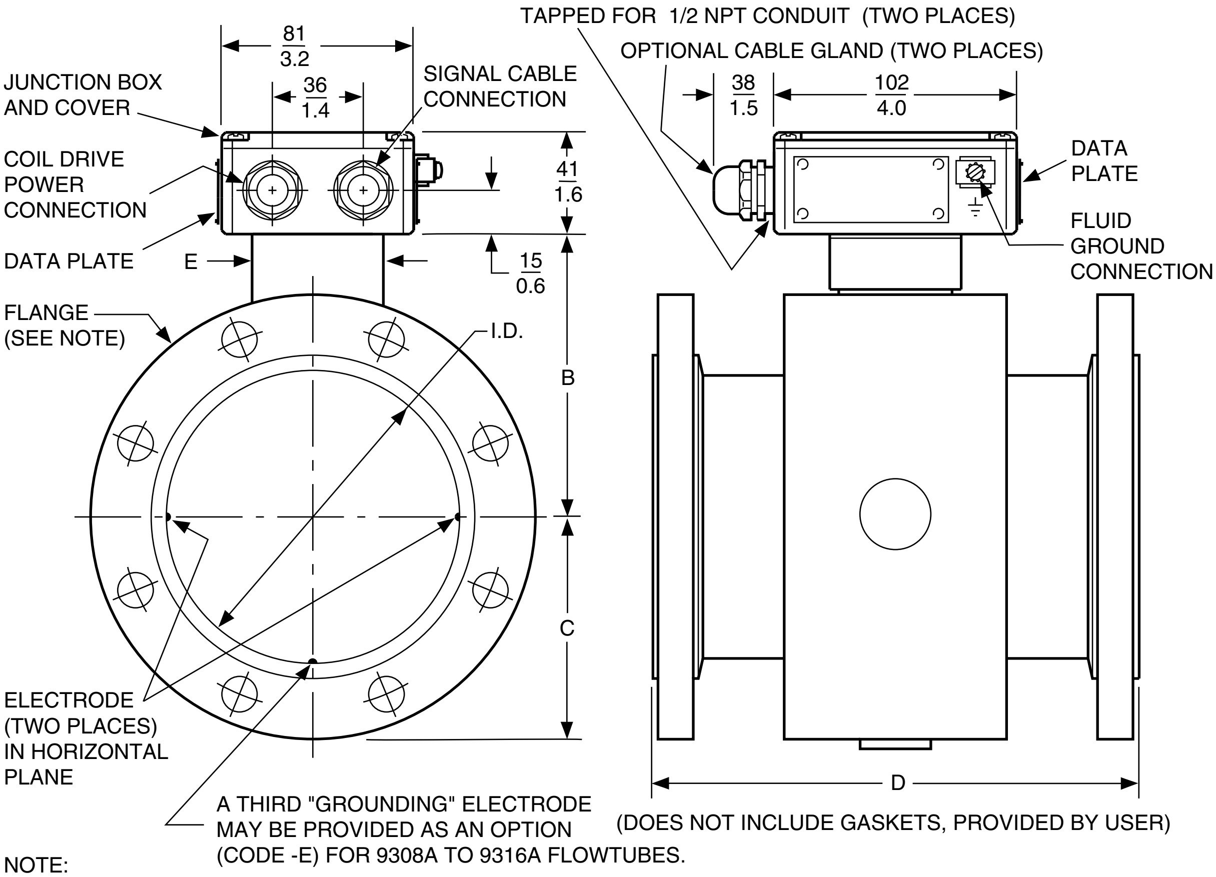
NOTES
1. See previous pages for flowtube dimensions.
2. See applicable transmitter DP for transmitter dimensions.
3. Field wiring is through transmitter conduit holes. See transmitter DP.

930HA TO 9306A FLANGED FLOWTUBES USED WITH MODELS 8000, IMT10 AND IMT20 FLOWTUBE-MOUNTED TRANSMITTERS



NOTES
1. See previous pages for flowtube dimensions.
2. See applicable transmitter DP for transmitter dimensions.
3. Field wiring is through transmitter conduit holes. See transmitter DP.

9308A TO 9316A FLANGED FLOWTUBES USED WITH REMOTE-MOUNTED TRANSMITTERS



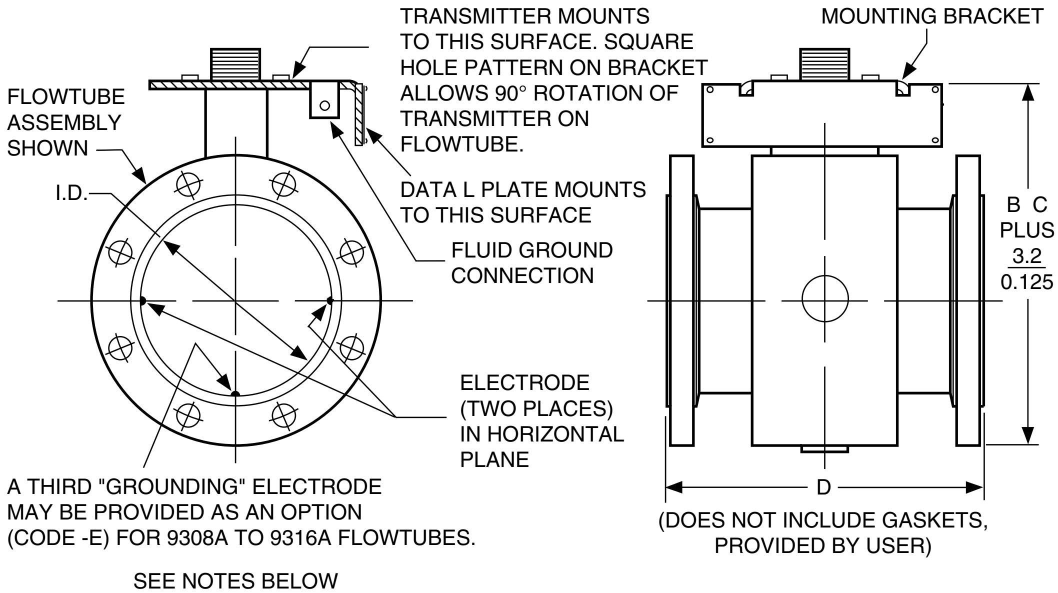
NOTE:
SEE ADJACENT PAGE FOR DIMENSIONS "B" THROUGH "E".

DIMENSIONS OF 9308A TO 9316A FLOWTUBES

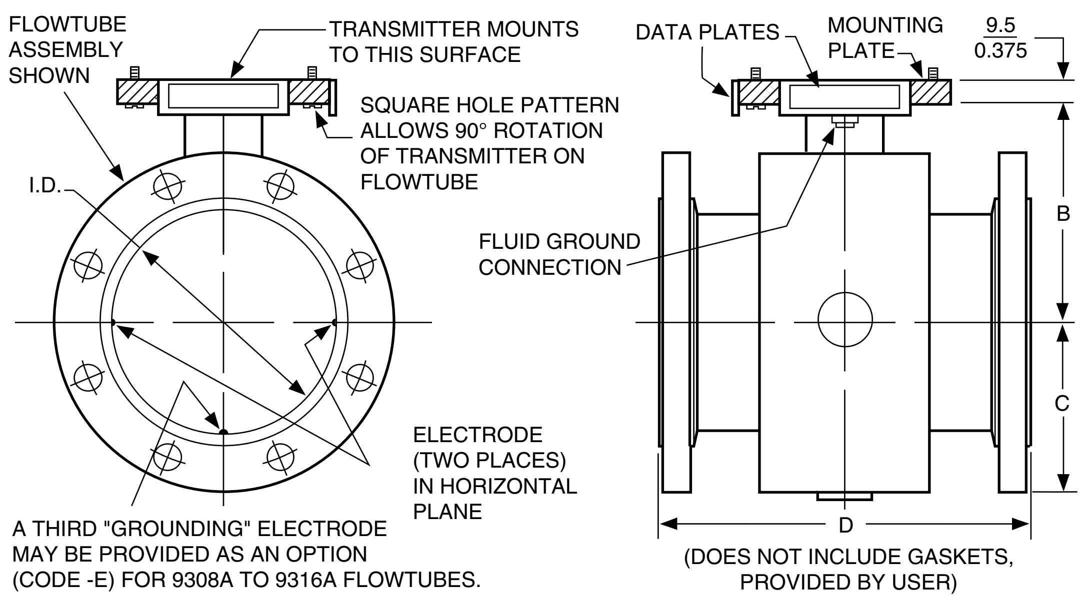
Flowtube Model	Nominal Line Size mm	Nominal Line Size in	Liner	Actual Flowtube I.D. Sch. 10	Actual Flowtube I.D. Sch. 40	Nom. Dim. B	Nominal Dimension C (ANSI Class) (150)	Nominal Dimension C (ANSI Class) (300)	Nominal Dimension C (Metric PN) (10)	Nominal Dimension C (Metric PN) (16)	Nominal Dimension C (Metric PN) (25)	Nominal Dimension C (Metric PN) (40)	Nom. Dim. D	Nom. Dim. E
9308A	200	8	PFA	206 / 8.11	197 / 7.76	187 / 7.4	171 / 6.7	191 / 7.5	169 / 6.7	169 / 6.7	180 / 7.1	187 / 7.4	350 / 13.8	72 / 2.8
			PTFE	202 / 7.59	N/A									
			Poly	193 / 7.59	N/A									
9310A	250	10	PFA	259 / 10.21	2.49 / 9.81	214 / 8.4	202 / 8.0	222 / 8.8	197 / 7.8	202 / 7.59	213 / 8.4	225 / 8.9	450 / 17.7	72 / 2.8
			PTFE	255 / 10.05	N/A									
			Poly	246 / 9.69	N/A									
9312A	300	12	PFA	309 / 12.18	299 / 11.79	239 / 9.4	241 / 9.5	260 / 10.3	222 / 8.7	229 / 9.0	243 / 9.6	258 / 10.1	500 / 19.7	72 / 2.8
			PTFE	305 / 12.05	N/A									
			Poly	296 / 11.66	N/A									
9314A	350	14	PTFE	341 / 13.42	N/A	255 / 10.0	266 / 10.5	N/A	252 / 9.9	259 / 10.2	N/A	N/A	550 / 21.7	72 / 2.8
			Poly	328 / 12.90	N/A									
9316A	400	16	PTFE	392 / 15.42	N/A	280 / 11.0	298 / 11.7	N/A	282 / 11.1	289 / 11.4	N/A	N/A	600 / 23.6	72 / 2.8
			Poly PTFE	378 / 14.90	N/A									

NOTES
1. For PTFE-lined flowtubes, dimension D applies only when end flanges are clamped in place.
2. D length increases by approximately 25 mm (1 in) when flowtube has optional lining protector (suffix -T).

<u>9308A TO 9316A FLANGED FLOWTUBES</u>
<u>USED WITH IMT25 SERIES FLOWTUBE-MOUNTED TRANSMITTERS</u>



<u>9308A TO 9316A FLANGED FLOWTUBES</u>
<u>USED WITH MODELS 8000, IMT10 AND IMT20 FLOWTUBE-MOUNTED TRANSMITTERS</u>



<u>NOTES</u>
1. See previous pages for flowtube dimensions.
2. See applicable transmitter DP for transmitter dimensions.
3. Field wiring is through transmitter conduit holes. See transmitter DP.

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Website: http://support.ips.invensys.com

0316

Parts List

PL 008-742
February 2016

9300A Series Flanged Magnetic Flowtubes

1 to 12 Inch Sizes pfa-Lined
8 to 16 Inch Sizes Polyurethane-Lined
1/2 to 16 Inch Sizes ptfe-Lined

Style A

Give instrument Model Code when ordering.
*Parts preceded by an asterisk are recommended spare parts.
See Recommended Spare Parts Summary section for quantities.

TO ORDER PARTS, CALL 1-866-746-6477.

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MODEL CODES

pfa Lined Flowtubes

Description	Model
Nominal Flowtube Size	
25 mm (1 in) Line Size, Flanged	9301A
40 mm (1 1/2 in) Line Size, Flanged	931HA
50 mm (2 in) Line Size, Flanged	9302A
80 mm (3 in) Line Size, Flanged	9303A
100 mm (4 in) Line Size, Flanged	9304A
150 mm (6 in) Line Size, Flanged	9306A
200 mm (8 in) Line Size, Flanged	9308A
250 mm (10 in) Line Size, Flanged	9310A
300 mm (12 in) Line Size, Flanged	9312A
Tube Construction	
AISI Type 304 or 305 ss; Face-to-Face Dimensions Conform to ISO/DIS 13359	–SI
End Connections	
ANSI Class 150 Carbon Steel Flange	BA
ANSI Class 150, 316 ss Flange	BB
ANSI Class 300 Carbon Steel Flange	BD
ANSI Class 300, 316 ss Flange	BC
Metric PN 10 Carbon Steel Flange (a)	ZD
Metric PN 16 Carbon Steel Flange (a)	ZE
Metric PN 25 Carbon Steel Flange (a)	ZF
Metric PN 40 Carbon Steel Flange (a)	ZG
Metric PN 10, 316 ss Flange (a)	ZL
Metric PN 16, 316 ss Flange (a)	ZM
Metric PN 25, 316 ss Flange (a)	ZN
Metric PN 40, 316 ss Flange (a)	ZP
Lining Material	
pfa	–P
Electrodes	
Tantalum-Tungsten	B
Conical 316L ss (9301A through 9306A only)	C
Hastelloy C	H
Conical Hastelloy C (9301A through 9306A only)	K
Platinum-Iridium	P
316L ss	S
Titanium	T
Coil Drive/Supply	
Pulsed dc	J
Housing Construction/Transmitter Mounting	
NEMA 4X Housing Construction; Remote-Mounted Transmitter	–G
Total/Accidental Submergence Housing, Remote-Mounted Transmitter (b)	–N
NEMA 4X Housing, Integrally Mounted to IMT25 or IMT25L Transmitter (c)	–I
Electrical Safety	
CSA, Class I, II, and III; Division 2	L
FM, nonincendive, Class I, II, and III; Division 2	N

MODEL CODES

Description	Model
Nominal Flowtube Size	
CENELEC, EEx e ia, IIC, Zone 1	S
European, Nonincendive, Zone 2	U
No Testing Laboratory Certification or Approval Required	Z
Optional Selections	
Cable Glands for Nonconduit Applications (d)	–G
Grounding Electrode (9308A-9312A only) (e)	–E
Teflon Lining Protector (a)	–T

(a)The Optional Selection -T not available with metric End Connections.
(b)Sealed for accidental or continuous operation under water up to 9 m (30 ft) deep. Supplied with a field kit for sealing after installation.
(c)Not available with Electrical Safety Code S.
(d)The cable glands (-G option) provide a sealed cable entry for field wiring to the flowtube junction box, and are generally specified in nonconduit applications. For flowtubes with integrally-mounted transmitters (-I Housing), cable glands may be specified with the transmitter options (not for Electrical Safety Codes -L and -N).
(e)The -E option is supplied in same material as selected for electrodes. This option is used in lieu of grounding rings.

ptfe Lined Flowtubes

Description	Model
Nominal Flowtube Size	
15 mm (1/2 in) Line Size, Flanged	930HA
25 mm (1 in) Line Size, Flanged	9301A
40 mm (1 1/2 in) Line Size, Flanged	931HA
50 mm (2 in) Line Size, Flanged	9302A
80 mm (3 in) Line Size, Flanged	9303A
100 mm (4 in) Line Size, Flanged	9304A
150 mm (6 in) Line Size, Flanged	9306A
200 mm (8 in) Line Size, Flanged	9308A
250 mm (10 in) Line Size, Flanged	9310A
300 mm (12 in) Line Size, Flanged	9312A
350 mm (14 in) Line Size, Flanged	9314A
400 mm (16 in) Line Size, Flanged	9316A
Tube Construction	
AISI Type 304 or 305 ss; Face-to-Face Dimensions Conform to ISO/DIS 13359	–SI
End Connections	
ANSI Class 150 Carbon Steel Flange	BA
ANSI Class 150, 316 ss Flange	BB
Metric PN 10 Carbon Steel Flange (a)	ZD
Metric PN 16 Carbon Steel Flange (a)	ZE
Metric PN 10, 316 ss Flange (a)	ZL
Metric PN 16, 316 ss Flange (a)	ZM
Lining Material	
ptfe	–T
Electrodes	
Tantalum-Tungsten	B
Conical 316L ss (9301A through 9306A only)	C
Hastelloy C	H
Conical Hastelloy C (9301A through 9306A only)	K
Platinum-Iridium	P
316L ss	S
Titanium	T

Description	Model
Nominal Flowtube Size	
Coil Drive/Supply	
Pulsed dc	J
Housing Construction/Transmitter Mounting	
NEMA 4/NEMA 4X Construction; Remote-Mounted Transmitter (f)	–G
Total/Accidental Submergence Housing; Remote-Mounted Transmitter (b)	–N
NEMA 4/NEMA 4X Construction; Integrally Mounted to IMT25 Transmitter or IMT25L Transmitters (c)(f)	–I
Electrical Safety	
CSA, Class I, II, III; Division 2	L
FM, nonincendive, Class I, II, III; Division 2	N
CENELEC, EEx e ia IIC, Zone 1	S
European, Nonincendive, Zone 2	U
No Testing Laboratory Certification or Approval Required	Z
Optional Selections	
Cable Glands for Nonconduit Applications (d)	–G
Grounding Electrode (9308A-9316A only) (e)	–E
Teflon Lining Protector (a)	–T

(a)The Optional Selection -T not available with metric End Connections.
(b)Sealed for accidental or continuous operation under water up to 9 m (30 ft) deep. Supplied with a field kit for sealing after installation.
(c)Not available with Electrical Safety Code S.
(d)The cable glands (-G option) provide a sealed cable entry for field wiring to the flowtube junction box, and are generally specified in nonconduit applications. For flowtubes with integrally-mounted transmitters (-I Housing), cable glands may be specified with the transmitter options (not for Electrical Safety Codes L and N).
(e)The -E option is supplied in same material as selected for electrodes. This option is used in lieu of grounding rings.
(f)NEMA 4 housing for 930HA to 9306A sizes; and NEMA 4X housing for 9308A to 9316A sizes.

Polyurethane LIned Flowtubes

Description	Model
Nominal Flowtube Size	
200 mm (8 in) Line Size, Flanged	9308A
250 mm (10 in) Line Size, Flanged	9310A
300 mm (12 in) Line Size, Flanged	9312A
350 mm (14 in) Line Size, Flanged	9314A
400 mm (16 in) Line Size, Flanged	9316A
Tube Construction	
AISI Type 304 or 305 ss; Face-to-Face Dimensions Conform to ISO/DIS 13359	–SI
End Connections	
ANSI Class 150 Carbon Steel Flange	BA
ANSI Class 150, 316 ss Flange	BB
Metric PN 10 Carbon Steel Flange (a)	ZD
Metric PN 16 Carbon Steel Flange (a)	ZE
Metric PN 10, 316 ss Flange (a)	ZL
Metric PN 16, 316 ss Flange (a)	ZM

MODEL CODES

Description	Model
Nominal Flowtube Size	
Lining Material	
Polyurethane	–A
Electrodes	
316L ss	S
Coil Drive/Supply	
Pulsed dc	J
Housing Construction/Transmitter Mounting	
NEMA 4X Housing Construction; Remote-Mounted Transmitter	–G
Total/Accidental Submergence Housing; Remote-Mounted Transmitter (b)	–N
NEMA 4X Housing; Integrally Mounted to IMT25 or IMT25L Transmitter (c)	–I
Electrical Safety	
CSA, Class I, II, and III; Division 2	L
FM, nonincendive, Class I, II, and III; Division 2	N
CENELEC, EEx e, ia IIC, Zone 1	S
European, Nonincendive, Zone 2	U
No Testing Laboratory Certification or Approval Required	Z
Optional Selection	
Cable Glands for Nonconduit Applications (d)	–G
Grounding Electrode (e)	–E

(a)The Optional Selection -T not available with metric End Connections.
(b)Sealed for accidental or continuous operation under water up to 9 m (30 ft) deep. Supplied with a field kit for sealing after installation.
(c)Not available with Electrical Safety Code S.
(d)The cable glands (-G option) provide a sealed cable entry for field wiring to the flowtube junction box, and are generally specified in nonconduit applications. For flowtubes with integrally-mounted transmitters (-I Housing), cable glands may be specified with the transmitter options (not for Electrical Safety Codes L and N).
(e)The -E option is supplied in same material as selected for electrodes. This option is used in lieu of grounding rings.

PARTS

FLANGED MAGNETIC FLOWTUBE ASSEMBLY

Figure 1. Flowtube with Transmitter Mounted in Remote Location

15 to 40 mm (1/2 to 1 1/2 in) Sizes Shown

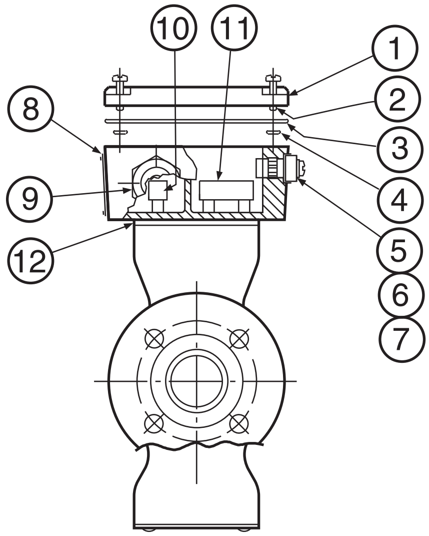
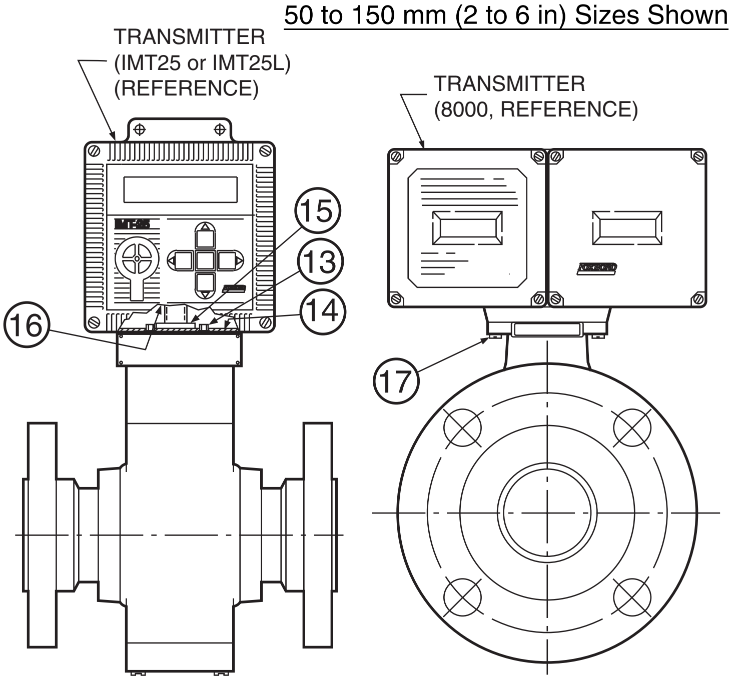


Figure 2. Flowtube with Transmitter Mounted Integral to Flowtube

50 to 150 mm (2 to 6 in) Sizes Shown



Item	Part No.	Qty.	Part Name
1	D0146PY	1	Cover
2	X0127FP	4	Screw, 0.190-32 x 0.750
*3	D0164VD	1	Gasket (Silicone Sponge Rubber)
*4	C0127CM	4	O-Ring
5	B0138YS	1	Clamp
6	X0143SB	1	Washer, Ext. Tooth, 0.164
7	X0124FZ	1	Screw, 0.164-32 x 0.375
8	X0161CT	8	Screw, Self-Tapping, 0.086-56 x 0.187
9	X0172WG	2	Cable Gland (Optional)
10	P0175AM	1	Terminal Block (2 pos)
11	P0175AN	1	Terminal Block (4 pos)
--	D0128GY	1	Sealing Kit (for Housing Code -N)
12	Below		Gasket (Cork/Silicone Rubber)
	D0164VA	1	Line Sizes 1/2 to 6 in
	D0172BQ	1	Line Sizes 8 to 16 in
13	X0128QQ	4	Screw, Hexhd, 0.250-20 x 0.50
14	0036504	4	Washer, Ext. Tooth, 0.250
15	L0123AT	1	Bracket

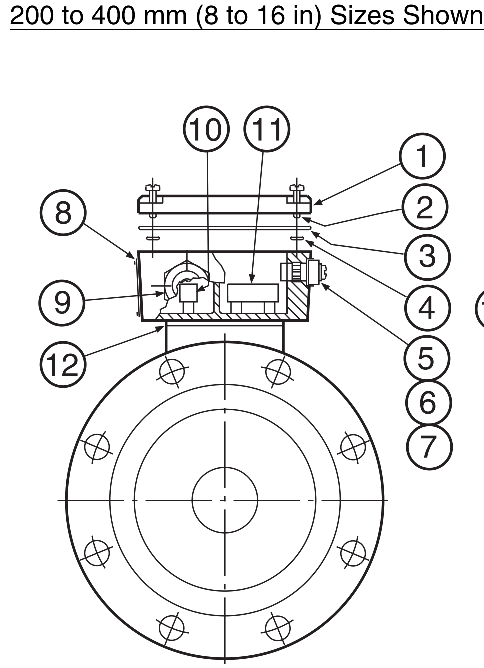
Item	Part No.	Qty.	Part Name
16	L0123BD	1	Nut, 1/2 NPS (Mounts transmitter to flowtube)
--	X0143SL	1	Washer, Ext. Tooth, 0.875 (Used with Item 16)
17	X0128QT	4	Screw, Hexhd 0.250-20 x 0.88

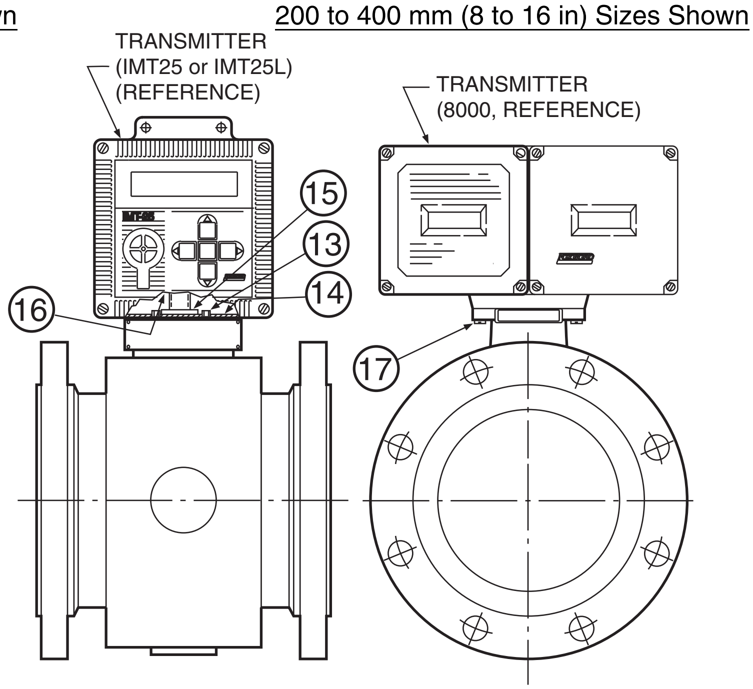
— NOTE —
Flange gaskets are supplied by user.

FLANGED MAGNETIC FLOWTUBE ASSEMBLY

Figure 3. Flowtube with Transmitter Mounted in Remote Location

Figure 4. Flowtube with Transmitter Mounted Integral to Flowtube





Item	Part No.	Qty.	Part Name
1	D0146PY	1	Cover
2	X0127FP	4	Screw, 0.190-32 x 0.750
*3	D0164VD	1	Gasket (Silicone Sponge Rubber)
*4	C0127CM	4	O-Ring
5	B0138YS	1	Clamp
6	X0143SB	1	Washer, Ext. Tooth, 0.164
7	X0124FZ	1	Screw, 0.164-32 x 0.375
8	X0161CT	8	Screw, Self-Tapping, 0.086-56 x 0.187
9	X0172WG	2	Cable Gland (Optional)
10	P0175AM	1	Terminal Block (2 pos)

Item	Part No.	Qty.	Part Name
11	P0175AN	1	Terminal Block (4 pos)
--	D0128GY	1	Sealing Kit (for Housing Code -N)
12	Below	1	Gasket (Cork/Silicone Rubber)
	D0164VA		Line Sizes 1/2 to 6 in
	D0172BQ	1	Line Sizes 8 to 16 in
13	X0128QQ	4	Screw, Hexhd, 0.250-20 x 0.50
14	0036504	4	Washer, Ext. Tooth, 0.250
15	L0123AT	1	Bracket
16	L0123BD	1	Nut, 1/2 NPS (Mounts transmitter to flowtube)
--	X0143SL	1	Washer, Ext. Tooth, 0.875 (Used with Item 16)
17	X0128QT	4	Screw, Hexhd 0.250-20 x 0.88

— NOTE —

Flange gaskets are supplied by user.

OPTIONAL TEFLON LINING PROTECTORS – OPTION -T (NOT SHOWN)

Teflon Lining Protectors (Not Shown) – Option -T					
Flowtube Size		Flange Size (Class)	Part Name	Part Number	Qty.
15 mm	1/2 in	150	Ring Gasket	D0178CP K0126HM	2 2
25 mm	1 in	150	Ring Gasket	D0178CQ K0126HN	2 2
40 mm	1 1/2 in	150	Ring Gasket	D0178CR K0126HP	2 2
50 mm	2 in	150	Ring Gasket	D0178CS K0126HQ	2 2
80 mm	3 in	150	Ring Gasket	D0178CT K0126HR	2 2
100 mm	4 in	150	Ring Gasket	D0178CU K0126HS	2 2
150 mm	6 in	150	Ring Gasket	D0178CV K0126HU	2 2
200 mm	8 in	150 300	Ring Gasket	K0126HJ K0126HV	2 2
250 mm	10 in	150 300	Ring Gasket	K0126HK K0126HW	2 2
300 mm	12 in	150 300	Ring Gasket	K0126HL K0126HX	2 2
350 mm	14 in	150	Ring Gasket	D0172WU D0172WV	2 2
400 mm	16 in	150	Ring Gasket	D0172WW D0172WX	2 2

RECOMMENDED SPARE PARTS SUMMARY

Figure Number	Item Number	Part Number	Part Name	Number of Parts Recommended for		
				1 Inst.	5 Inst.	20 Inst.
1	3	D0164VD	Gasket (Silicone Sponge Rubber)	1	1	1
	4	C0127CM	O-Ring	1	1	1

Invensys Systems, Inc.
38 Neponset Avenue
Foxboro, MA 02035
United States of America
http://www.fielddevices.foxboro.com

Global Customer Support
Inside U.S.: 1-866-746-6477
Outside U.S.: 1-508-549-2424
Website: http://support.ips.invensys.com

0216

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 10

SENSAPHONE O&M

(5) The date of the plans that were originally approved as part of the AOT permit and the date of the most recent amendment of such plans, if any;

(6) The date of the originally-approved source control plan and the date of the most recent revision of such plan, if any;

(7) As applicable, certification that:

a. No changes have occurred in the storage, handling, or use of regulated substance or to the structural or non-structural controls as described in the most recently-approved source control plan;

b. Activities that expose regulated substances to precipitation or runoff that were not identified in the most recently-approved source control plan are now occurring, and:

1. An updated source control plan was submitted to the department, with the date of such submission; or

2. An updated source control plan is attached to the certification; or

c. There are no longer any activities on the property that expose regulated substances to precipitation or runoff and so a source control plan is no longer required; and

(8) Certification that:

a. The information provided on or otherwise submitted with the certification form is true, complete, and not misleading to the knowledge and belief of the signer; and

b. The signer understands that if the information is untrue, incomplete, or misleading, the signer is subject to the penalties specified in New Hampshire law for falsification in official matters, currently RSA 641.

Source. (See RN1 at p. v) #9343, eff 1-1-09; (See RN2 at p. v) renumbered by #9817-A (formerly Env-Wq 1504.07); ss by #12342, eff 8-15-17 (See RN3 at p. v)

Env-Wq 1504.09 Stormwater Drainage Report; Drainage Area Plans; Hydrologic Soil Group Plans. A stormwater drainage report, associated drainage area plans, and associated hydrologic soil group plans shall include the following:

(a) A narrative with the following information:

(1) A description of the pre-development and post-development conditions affecting drainage;

(2) The total impervious area assumed per lot, as applicable;

(3) A discussion of how the proposed development is likely to impact downstream surface waters and properties;

(4) A comparison between the pre-development peak discharge rates and the post-development peak discharge rates, for the one-year, 2-year, 10-year, and 50-year, 24-hour storms;

(5) A discussion of how treatment criteria will be met in accordance with Env-Wq 1507.03; and

(6) A discussion of how groundwater recharge is met in accordance with Env-Wq 1507.04;

(b) Calculations for pre- and post-construction stormwater drainage, for 24-hour duration storms with minimum return frequencies of once in one year, 2 years, 10 years, and 50 years using the NRCS "National Engineering Handbook", part 630, hydrology, dated November 2015 or Win TR-20, version 3.10, as developed by the NRCS for determining the rate of runoff, both available as noted in Appendix B, subject to the following:

(1) Depth of precipitation shall be determined using either of the following, both available as noted in Appendix B:

a. "Extreme Precipitation in a Changing Climate for New York and the New England States", version 1.12, published by the USDA, NRCS and Cornell University's Northeast Regional Climate Center; or

b. "NOAA Atlas 14, Precipitation-Frequency Atlas of the United States", Volume 10, Version 2.0, 2015, published by the National Oceanic and Atmospheric Administration, National Weather Service;

(2) The time of concentration shall be determined as follows:

a. If using the Lag method for determining the time of concentration, identify the hydraulic length in feet and provide calculations for determining the average land slope in percent for each sub-basin;

b. If using the velocity method for determining the time of concentration, identify the sheet flow path(s), the shallow concentrated flow path(s), and the channel flow path(s) for each sub-basin; and

c. Sheet flow shall be limited to 100 feet;

(3) The curve number for each sub-basin shall be calculated as follows:

a. For proposed areas of disturbance, including lot development, the hydrologic condition for woods, meadows, or pastures shall be assumed to be "good";

b. For proposed areas of disturbance, including lot development, soil types shall be identified in accordance with the Society of Soil Scientists of Northern New England (SSSNNE) Special Publication No. 3, Site-Specific Soil Mapping Standards for New Hampshire and Vermont, February 2011, available as noted in Appendix B; and

c. For all other areas that contribute runoff to the project site, soil types shall be:

1. Taken from the NRCS county-wide web soil survey at http://websoilsurvey.nrcs.usda.gov; or

2. Identified in accordance with SSSNNE Special Publication No. 3, Site-Specific Soil Mapping Standards for New Hampshire and Vermont, February 2011, available as noted in Appendix B; and

(4) If the calculations are done using software that provides error messages, warnings, or other such indicators, such as HydroCAD®, a copy of the calculations shall be submitted that shows all error messages, warnings, and other such indicators;

(c) WQV, WQF, and GRV calculations;

(d) Calculations for designing outlet protection;

(e) Drainage area plans for pre- and post-construction that delineate each sub-basin, including off-site areas which flow onto the project area, at a scale for off-site areas of one inch equals 100 feet, or at a scale of one inch equals 2,000 feet if delineated from a USGS map, and at a scale of one inch equals 50 feet for on-site areas, identifying the following:

(1) The location of sub-basins, reaches, ponds, and all points of interest, as modeled in the stormwater drainage report;

(2) The hydraulic length or time of concentration flow path;

(3) Contours for on-site areas at the same intervals as the plans prepared pursuant to Env-Wq 1504.02 through Env-Wq 1504.05, as applicable, and contours for off-site areas at the same interval or at the intervals on the applicable USGS map;

(4) Roadway station numbering, if applicable; and

(5) Drainage structures such as detention basins, culverts, and treatment practices;

(f) If the plans prepared pursuant to (e), above, for the on-site areas comprise more than 3 sheets at the specified scale, an overview sheet which shows the location of each 50-foot scale sheet and an outline of the area to be impacted by the proposed project; and

(g) Hydrologic soil group plans for pre- and post-construction that delineate each sub-basin, including off-site areas which flow onto the project area, identifying the following:

(1) The location of sub-basins, as modeled in the stormwater drainage report;

(2) If hydrologic soil groups are determined in accordance with (b)(3)b. or (b)(3)c.2., above, the locations of the different soil groups using the following color-coding:

a. Hydrologic soil group A soils shall be shaded green;

b. Hydrologic soil group B soils shall be shaded yellow;

c. Hydrologic soil group C soils shall be shaded orange;

d. Hydrologic soil group D soils shall be shaded red;

e. Open water features shall be shaded blue; and

f. Impervious cover shall be shaded gray;

(3) If hydrologic soil groups are determined in accordance with (b)(3)c.1., the locations of the different soil groups using the color-coding assigned by the NRCS;

(4) The map symbol identifying the soil mapped; and

(5) A map legend.

Source. (See RN1 at p. v) #9343, eff 1-1-09; (See RN2 at p. v) amd by #9817-A, eff 12-1-10 (formerly Env-Wq 1504.08); ss by #12342, eff 8-15-17 (See RN3 at p. v)

Env-Wq 1504.10 Calculation of Water Quality Volume (WQV). Water quality volume (WQV) shall be calculated using the Unified Sizing Criteria as follows:

(a) "P" means one inch of rainfall;

(b) "A" means the total area draining to the design structure;

(c) "I" means the percent impervious area draining to the design structure, in decimal form;

(d) "Rv" means the unit-less runoff coefficient calculated as the sum of 0.05 plus the product of I multiplied by 0.9, as in the formula below:

$$Rv = 0.05 + (0.9 \times I)$$

(e) To calculate the WQV, the applicant shall multiply the product of Rv and A by P, as shown in the formula below:

$$WQV = P \times A \times Rv$$

Source. (See RN1 at p. v) #9343, eff 1-1-09; (See RN2 at p. v) renumbered by #9817-A (formerly Env-Wq 1504.09); ss by #12342, eff 8-15-17 (See RN3 at p. v)

Env-Wq 1504.11 Calculation of Water Quality Flow (WQF).

(a) "WQV" means water quality volume calculated in accordance with Env-Wq 1504.10.

(b) "q_u" means the unit peak discharge from exhibits 4-II and 4-III of TR-55, Urban Hydrology for Small Watersheds, NRCS, June 1986 (TR-55), available as noted in Appendix B, using the values for P, A, Q, CN, S, and Ia as described in (c) through (h), below.

SENSAPHONE®

Sensaphone 1400 User's Manual

LIT-0110

www.sensaphone.com

SENSAPHONE®

1400

Environmental Monitoring System

User's Manual

Version 2.0

First Edition, version 2.0, January 2017

Written and produced by Phonetics, Inc.

Please address comments on this publication to:

Phonetics, Inc.
901 Tryens Road
Aston, PA 19014

Important Safety Instructions

Your Sensaphone 1400 has been carefully designed to give you years of safe, reliable performance. As with all electrical equipment, however, there are a few basic precautions you should take to avoid hurting yourself or damaging the unit:

- Read the installation and operating instructions in this manual carefully. Be sure to save it for future reference.
- Read and follow all warning and instruction labels on the product itself.
- To protect the Sensaphone 1400 from overheating, make sure all openings on the unit are not blocked. Do not place on or near a heat source, such as a radiator or heat register.
- Do not use your Sensaphone 1400 near water, or spill liquid of any kind into it.
- Be certain that your power source matches the rating listed on the AC power transformer. If you're not sure of the type of power supply to your facility, consult your dealer or local power company.
- Do not allow anything to rest on the power cord. Do not locate this product where the cord will be abused by persons walking on it.
- Do not overload wall outlets and extension cords, as this can result in the risk of fire or electric shock.
- Never push objects of any kind into this product through ventilation holes as they may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock.
- To reduce the risk of electric shock, do not disassemble this product, but return it to Sensaphone Customer Service or another approved repair facility when any service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect reassembly can cause electric shock when the unit is subsequently used.
- If anything happens that indicates that your Sensaphone 1400 is not working properly or has been damaged, unplug it immediately and follow the procedures in the manual for having it serviced. Return the unit for servicing under the following conditions:
  1. The power cord or plug is frayed or damaged.
  2. Liquid has been spilled into the product or it has been exposed to water.
  3. The unit has been dropped, or the enclosure is damaged.
  4. The unit doesn't function normally when you're following the operating instructions.
- Avoid using a telephone (other than a cordless type) during an electrical storm. There may be a remote risk of electric shock from lightning.

- Do not use the telephone to report a gas leak in the vicinity of the leak.

CAUTION: To reduce the risk of fire or injury to persons, read and follow these instructions:

1. Replace the battery only with the same or equivalent type recommended by the manufacturer.
2. Do not dispose of the battery in a fire. The cell may explode. Check with local codes for possible special disposal instructions.
3. Do not open or mutilate the battery. Released electrolyte is corrosive and may cause damage to the eyes or skin. It may be toxic if swallowed.
4. Exercise care in handling battery in order not to short the battery with conducting materials such as rings, bracelets, and keys. The battery or conductor may overheat and cause burns.

FCC Requirements

Part 68: The Sensaphone 1400 complies with 47 CFR, Part 68 of the rules. On the back of the unit there is a label that contains, among other information, the Certification Number and the Ringer Equivalence Number (REN) for this equipment. You must, upon request, provide this information to your local telephone company.

The REN is useful to determine the quantity of devices that you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all areas, the sum of the REN's of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices that you may connect to your line, you may want to contact your local telephone company to determine the maximum REN for your calling area.

The applicable certification jack USOC for this equipment is: RJ11C. The facility interface code (FIC) for this equipment is: 02LS2.

A compliant telephone cord and modular plug are provided with equipment. This equipment is designated to be connected to the telephone network or premises wiring using a compatible modular jack which is Part 68 compliant. See Installation Instructions for details.

This equipment may not be used on coin service units provided by the telephone company. Connection to party lines is subject to state tariffs. Contact the state public utility commission, public service commission or corporation commission for information.

Should the 1400 cause harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice isn't practical, the telephone company may temporarily discontinue service without notice and you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC. The telephone company may make changes in its facilities, equipment, operations, or procedures where such action is reasonably required in the operation of its business and is not inconsistent with the rules and regulations of the FCC that could affect the proper functioning of your equimenpt. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with the 1400, or you need information on obtaining service or repairs, please contact:

Phonetics, Inc.

901 Tryens Road

Aston, PA 19014

Toll-Free: 1-877-373-2700

FAX: 610-558-0222

If the equipment is causing harm to the telephone network, the telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or until you are sure that the equipment is not malfunctioning.

Part 15: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

General Requirements for all Automatic Dialers

When programming emergency numbers and (or) making test calls to emergency numbers:

1. Remain on the line and briefly explain to the dispatcher the reason for the call.
2. Perform such activities in the off-peak hours, such as early morning or late evenings.

Canadian Department of Communications Statement

Notice: The Canadian Department of Communications label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective operational and safety requirements. The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single line individual service may be extended by means of a certified connector assembly (telephone extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

> **CAUTION**: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The Ringer Equivalence Number (REN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device to prevent overloading. The termination on a loop may consist of any combination of devices subject only to the requirement that the total of the Ringer Equivalent Numbers of all the devices does not exceed 5.0. For Sensaphone 1400, the AC Ringer Equivalent Number is 0.6B.

2 YEAR LIMITED WARRANTY

PLEASE READ THIS WARRANTY CAREFULLY BEFORE USING THE PRODUCT.

THIS LIMITED WARRANTY CONTAINS SENSAPHONE'S STANDARD TERMS AND CONDITIONS. WHERE PERMITTED BY THE APPLICABLE LAW, BY KEEPING YOUR SENSAPHONE PRODUCT BEYOND THIRTY (30) DAYS AFTER THE DATE OF DELIVERY, YOU FULLY ACCEPT THE TERMS AND CONDITIONS SET FORTH IN THIS LIMITED WARRANTY.

IN ADDITION, WHERE PERMITTED BY THE APPLICABLE LAW, YOUR INSTALLATION AND/OR USE OF THE PRODUCT CONSTITUTES FULL ACCEPTANCE OF THE TERMS AND CONDITIONS OF THIS LIMITED WARRANTY (HEREINAFTER REFERRED TO AS "LIMITED WARRANTY OR WARRANTY"). IF YOU DO NOT AGREE TO THE TERMS AND CONDITIONS OF THIS WARRANTY, INCLUDING ANY LIMITATIONS OF WARRANTY, INDEMNIFICATION TERMS OR LIMITATION OF LIABILITY, THEN YOU SHOULD NOT USE THE PRODUCT AND SHOULD RETURN IT TO THE SELLER FOR A REFUND OF THE PURCHASE PRICE. THE LAW MAY VARY BY JURISDICTION AS TO THE APPLICABILITY OF YOUR INSTALLATION OR USE ACTUALLY CONSTITUTING ACCEPTANCE OF THE TERMS AND CONDITIONS HEREIN AND AS TO THE APPLICABILITY OF ANY LIMITATION OF WARRANTY, INDEMNIFICATION TERMS OR LIMITATIONS OF LIABILITY.

1. WARRANTOR: In this Warranty, Warrantor shall mean "Dealer, Distributor, and/or Manufacturer."

2. ELEMENTS OF WARRANTY: This Product is warranted to be free from defects in materials and craftsmanship with only the limitations and exclusions set out below.

3. WARRANTY AND REMEDY: Two-Year Warranty — In the event that the Product does not conform to this warranty at any time during the time of two years from original purchase, warrantor will repair the defect and return it to you at no charge.

This warranty shall terminate and be of no further effect at the time the product is: (1) damaged by extraneous cause such as fire, water, lightning, etc. or not maintained as reasonable and necessary; or (2) modified; or (3) improperly installed; or (4) misused; or (5) repaired or serviced by someone other than Warrantors' authorized personnel or someone expressly authorized by Warrantor's to make such service or repairs; (6) used in a manner or purpose for which the product was not intended; or (7) sold by original purchaser.

LIMITED WARRANTY, LIMITATION OF DAMAGES AND DISCLAIMER OF LIABILITY FOR DAMAGES: THE WARRANTOR'S OBLIGATION

UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AT THE WARRANTOR'S OPTION AS TO REPAIR OR REPLACEMENT. IN NO EVENT SHALL WARRANTORS BE LIABLE OR RESPONSIBLE FOR PAYMENT OF ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL AND/OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO ANY LABOR COSTS, PRODUCT COSTS, LOST REVENUE, BUSINESS INTERRUTPION LOSSES, LOST PROFITS, LOSS OF BUSINESS, LOSS OF DATA OR INFORMATION, OR FINANCIAL LOSS, FOR CLAIMS OF ANY NATURE, INCLUDING BUT NOT LIMITED TO CLAIMS IN CONTRACT, BREACH OF WARRANTY OR TORT, AND WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE. IN THE EVENT THAT IT IS DETERMINED IN ANY ADJUDICATION THAT THE LIMITED WARRANTIES OF REPAIR OR REPLACEMENT ARE INAPPLICABLE, THEN THE PURCHASER'S SOLE REMEDY SHALL BE PAYMENT TO THE PURCHASER OF THE ORIGINAL COST OF THE PRODUCT, AND IN NO EVENT SHALL WARRANTORS BE LIABLE OR RESPONSIBLE FOR PAYMENT OF ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL AND/OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO ANY LOST REVENUE, BUSINESS INTERRUTPION LOSSES, LOST PROFITS, LOSS OF BUSINESS, LOSS OF DATA OR INFORMATION, OR FINANCIAL LOSS, FOR CLAIMS OF ANY NATURE, INCLUDING BUT NOT LIMITED TO CLAIMS IN CONTRACT, BREACH OF WARRANTY OR TORT, AND WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE.

WITHOUT WAIVING ANY PROVISION IN THIS LIMITED WARRANTY, IF A CIRCUMSTANCE ARISES WHERE WARRANTORS ARE FOUND TO BE LIABLE FOR ANY LOSS OR DAMAGE ARISING OUT OF MISTAKES, NEGLIGENCE, OMISSIONS, INTERRUPTIONS, DELAYS, ERRORS OR DEFECTS IN WARRANTORS' PRODUCTS OR SERVICES, SUCH LIABILITY SHALL NOT EXCEED THE TOTAL AMOUNT PAID BY THE CUSTOMER FOR WARRANTORS' PRODUCT AND SERVICES OR $250.00, WHICHEVER IS GREATER. YOU HEREBY RELEASE WARRANTORS FROM ANY AND ALL OBLIGATIONS, LIABILITIES AND CLAIMS IN EXCESS OF THIS LIMITATION.

INDEMNIFICATION AND COVENANT NOT TO SUE: YOU WILL INDEMNIFY, DEFEND AND HOLD HARMLESS WARRANTORS, THEIR OWNERS, DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, SUPPLIERS OR AFFILIATED COMPANIES, AGAINST ANY AND ALL CLAIMS, DEMANDS OR ACTIONS BASED UPON ANY LOSSES, LIABILITIES, DAMAGES OR COSTS, INCLUDING BUT NOT LIMITED TO DAMAGES THAT ARE DIRECT OR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, AND INCLUDING ATTORNEYS FEES AND LEGAL COSTS, THAT MAY RESULT FROM THE INSTALLATION, OPERATION, USE OF, OR INABILITY TO USE WARRANTORS' PRODUCTS AND SERVICES, OR FROM THE FAILURE OF THE WARRANTORS' SYSTEM

TO REPORT A GIVEN EVENT OR CONDITION, WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE.

YOU AGREE TO RELEASE, WAIVE, DISCHARGE AND COVENANT NOT TO SUE WARRANTORS, THEIR OWNERS, DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, SUPPLIERS OR AFFILIATED COMPANIES, FOR ANY AND ALL LIABILITIES POTENTIALLY ARISING FROM ANY CLAIM, DEMAND OR ACTION BASED UPON ANY LOSSES, LIABILITIES, DAMAGES OR COSTS, INCLUDING BUT NOT LIMITED TO DAMAGES THAT ARE DIRECT OR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, AND INCLUDING ATTORNEYS FEES AND LEGAL COSTS, THAT MAY RESULT FROM THE INSTALLATION, OPERATION, USE OF, OR INABILITY TO USE WARRANTORS' PRODUCTS AND SERVICES, OR FROM THE FAILURE OF THE WARRANTORS' SYSTEM TO REPORT A GIVEN EVENT OR CONDITION, WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE, EXCEPT AS NECESSARY TO ENFORCE THE EXPRESS TERMS OF THIS LIMITED WARRANTY.

EXCLUSIVE WARRANTY: THE LIMITED WARRANTY OR WARRANTIES DESCRIBED HEREIN CONSTITUTE THE SOLE WARRANTY OR WARRANTIES TO THE PURCHASER. ALL IMPLIED WARRANTIES ARE EXPRESSLY DISCLAIMED, INCLUDING: THE WARRANTY OF MERCHANTIBILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR USE AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND THE WARRANTY OF NON-INFRINGEMENT AND/OR ANY WARRANTY ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

It must be clear that the Warrantors are not insuring your premises or business or guaranteeing that there will not be damage to your person or property or business if you use this Product. You should maintain insurance coverage sufficient to provide compensation for any loss, damage, or expense that may arise in connection with the use of products or services, even if caused by Warrantors' negligence. The warrantors assume no liability for installation of the Product and/or interruptions of the service due to strikes, riots, floods, fire, and/or any cause beyond Seller's control, further subject to the limitations expressed in any License Agreement or other Agreement provided by Warrantors to purchaser.

The agreement between the Warrantors and the Purchaser, including but not limited to the terms and conditions herein shall not be governed by the Convention for the International Sale of Goods. Where applicable, the Uniform Commercial Code as adopted by the State of Delaware shall apply.

4. PROCEDURE FOR OBTAINING PERFORMANCE OF WARRANTY: In the event that the Product does not conform to this warranty, the Product should be shipped or delivered freight prepaid to a Warrantor with evidence of original purchase.

5. LEGAL REMEDIES AND DISCLAIMER: Some jurisdictions may not allow, or may place limits upon, the exclusion and/or limitation of implied warranties, incidental damages and/or consequential damages for some types of goods or products sold to consumers and/or the use of indemnification terms. Thus, the exclusions, indemnification terms and limitations set out above may not apply, or may be limited in their application, to you. If the implied warranties can not be excluded, and the applicable law permits limiting the duration of implied warranties, then the implied warranties herein are to be limited to the same duration as the applicable written warranty or warranties herein. The warranty or warranties herein may give you specific legal rights that will depend upon the applicable law. You may also have other legal rights depending upon the law in your jurisdiction.

6. CHOICE OF FORUM AND CHOICE OF LAW: In the event that a dispute arises out of or in connection with this Limited Warranty, then any claims or suits of any kind concerning such disputes shall only and exclusively be brought in either the Court of Common Pleas of Delaware County, Pennsylvania or the United States District Court for the Eastern District of Pennsylvania.

Regardless of the place of contracting or performance, this Limited Warranty and all questions relating to its validity, interpretation, performance and enforcement shall be governed by and construed in accordance with the laws of the State of Delaware, without regard to the principles of conflicts of law.

Effective date 08/01/2005

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Table of Contents

CHAPTER 1: INTRODUCTION

Congratulations on your purchase of the Sensaphone 1400. The 1400 is a powerful monitoring, alarm, and event logging system. It can monitor equipment and environmental conditions using four universal Zones with scaleable range, built-in power failure detection, sound level monitoring, and one relay output for manual control, or automatic control from alarms. The Sensaphone 1400 also features user-recordable voice for ID and all monitored zones, numeric paging, and built-in line seizure.

The Sensaphone 1400 is a fully programmable environmental monitoring system for unattended or remote applications. The unit will monitor and alarm on four zones: these can be N.O./ N.C.(Normally Open or Normally Closed) contact, 4–20mA, or 2.8K or 10K thermistor (temperature sensor). The unit will also monitor AC power, sound level, and battery condition. On the front of the unit are LED indicators to show the operating status. Each zone (including power, sound and battery) has a status LED indicating the alarm status of the Zone. There is also an LED to indicate if the Output is On, an LED for Phone In-Use status and an LED for System-On status.

The unit is programmed using the built-in keypad and voice response menus. All programming is stored in nonvolatile memory so that all programming is retained even without power. The unit is capable of performing alarm event logging of the four universal Zones, power, and sound. The event logging (history) is also stored in nonvolatile memory. A battery-backed real-time clock is also included to time-stamp logged events. The alarm event history can be heard through the built-in speaker or remotely over the telephone. A complete status report of all monitored conditions can also be heard simply by calling the 1400.

The unit comes in a plastic NEMA-4 enclosure with tabs for wall or panel mounting. Terminal connections for Zones, outputs and power are easily accessible from the front of the unit. The 1400 is powered by a plug-in adapter and has a 6V 1.3AH rechargeable backup battery located behind the panel. Circuitry in the unit will maintain precise charging of the battery system. The unit also includes built-in Line Seizure capability to ensure that the telephone line is available when necesssary.

FEATURES

The Sensaphone 1400 Includes the following features:

- Four Zones configurable as temperature, 4–20mA, or dry contact
- Scaleable Range for 4–20mA Zones
- Calibration for each Zone
- Each Zone can be individually enabled or disabled
- Power monitor
- Fully automatic input configuration. No Jumpers!
- High sound-level monitor (w/optional external mic)
- 1 relay output (manual or automatic control)
- 10 status LEDs
- Dial out to eight telephone numbers
- User-recordable voice messages
- Alarm dialout via voice and numeric pager
- Built-in Line Seizure
- Microphone for on-site listen-in (w/optional external mic)
- Time-stamped Alarm History
- Surge protection on all Zones, telephone line and power supply
- Rechargeable battery backup
- NEMA-4 enclosure

LAYOUT

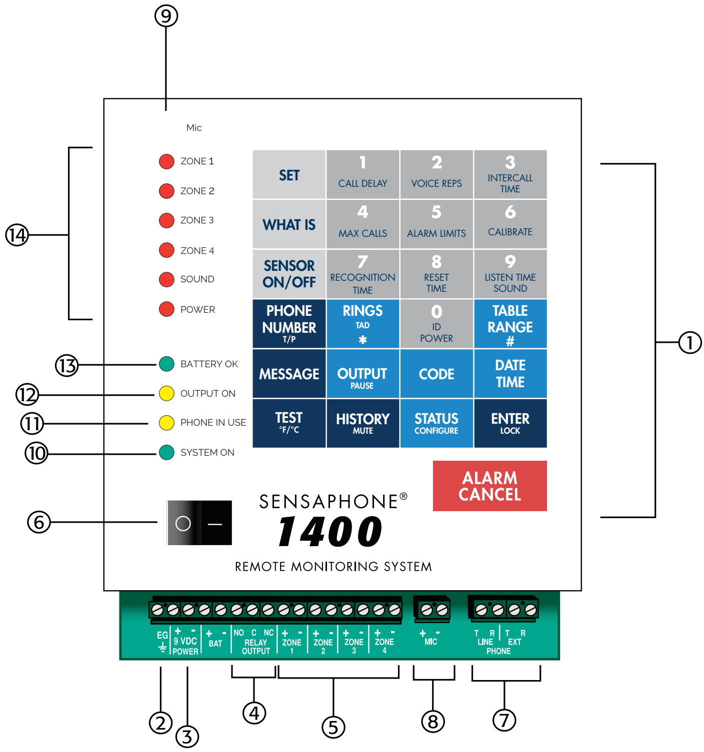


Figure 1: 1400 diagram

1. Programming Keypad
2. Grounding Terminal
3. 9-12VDC Power Terminals
4. N.O./N.C. Relay Output Terminals
5. 4 Zone Terminals
6. Power Button
7. Phone Network/Extension Terminals
8. External Mic Terminals
9. Built-in Condenser Mic
10. System On LED
11. Phone-in-use LED
12. Output On LED
13. Battery OK LED
14. Zone Alarm LEDs

TECHNICAL SUPPORT

Reading this instruction manual will help you install and program the 1400 easily. Programming and voice recording are performed locally using the built-in keypad. Some programming can also be accessed via touch-tone phone.

If there are any questions or problems that arise upon installation or operation, please contact Technical Support at:

SENSAPHONE
901 Tryens Road
Aston, PA 19014
Toll-Free Phone: 1-877-373-2700
FAX: 610-558-0222
support@sensaphone.com

CHAPTER 2: INSTALLATION

OPERATING ENVIRONMENT

The Sensaphone 1400 should be mounted and operated in a clean, dry environment. The unit is microprocessor-controlled and as a result it should not be installed near devices that generate strong electromagnetic fields. Such interference is typically generated by power switching equipment such as relays or contactors. A poor operating environment may result in unwanted system resets and/or system lockup. The temperature range the unit can operate in is 32°F to 122°F (0°C to 50°C). If the unit needs to operate below freezing, a heater should be installed nearby.

Mounting the 1400

The NEMA-4 enclosure comes with hardware for wall or panel mounting. The four tabs are attached by screwing the round bubble-end of a tab to each of the four rear corners of the enclosure. Then mount the unit in a position that allows easy access to the Zone terminal block and keypad. Also, there must be a power outlet and telephone jack close to the unit.

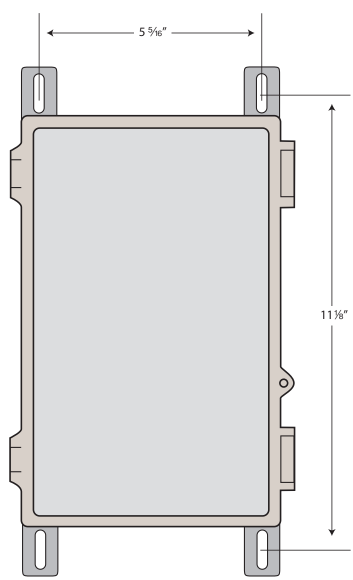


Figure 1: Mounting Dimensions

Locking the Enclosure

The 1400 enclosure can be locked by installing a small luggage-style padlock through the loop on the front door of the enclosure. See Figure below.

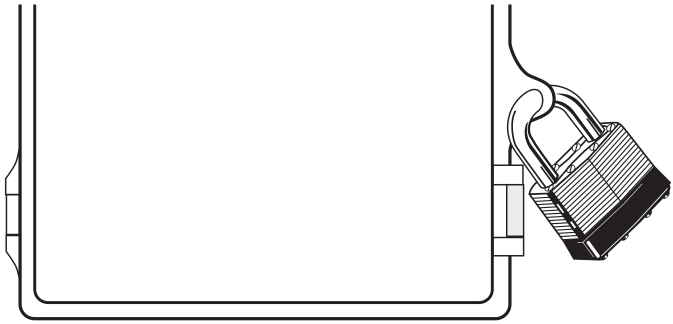


Figure 2: Locking the Enclosure

Grounding

Connect a heavy gauge (#14AWG) copper wire to the earth ground terminal on the left end of the panel and connect the other end to a ground rod or metal cold water pipe (See Figure 3). It is extremely important that the earth ground connection be as short as possible. The ground rod should have sufficient depth to provide a low impedance connection to earth. This connection is required for the surge/lightning protection circuits to function properly.

> **NOTE**: Proper earth grounding of the 1400 is required for warranty coverage.

Ground rods can typically be found at local electrical supply houses and/or hardware stores. Be sure to contact your state *"Call before you dig"* hotline at least **two** days before you install your ground rod, to insure that it is safe to install the ground rod in a chosen area.

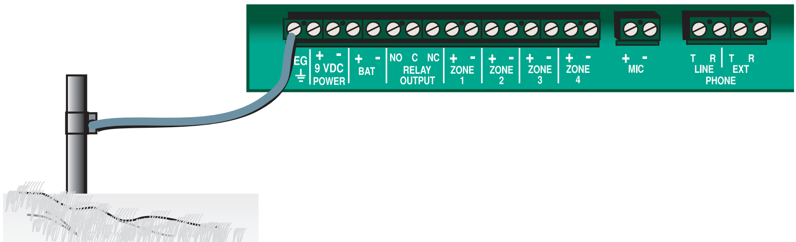


Figure 3: Grounding the 1400

Wiring Connectors

The 1400 includes compression-type liquid-tight connectors for routing wires into the enclosure. To use these connectors, turn them *counter-clockwise to loosen* (or open-up) the compression washer. Insert all cables through the two connectors. When finished turn them *clockwise to secure and seal* the 1400 from the outside environment. If you don't have enough cables to obtain a snug fit you can insert a small piece of soft PVC insulation or rubber tubing to take up the extra space.

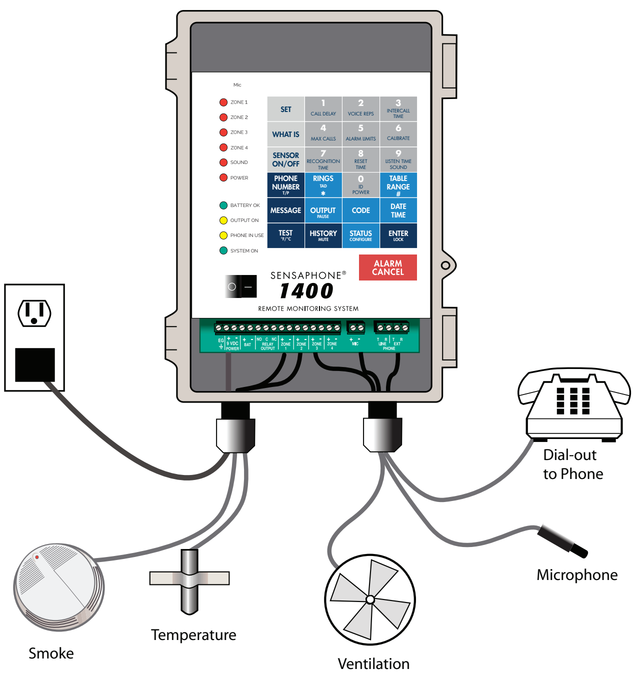


Figure 4: Typical connections from 1400

TURNING THE 1400 ON

Plug the unit's transformer into a 120VAC 60Hz outlet. Toggle the power switch on to start the unit. The System-On LED should glow steadily and the unit will say "Hello." The unit will not turn on if AC power is not present, regardless of the state of the battery.

Note that when the unit is turned off, all programming is retained in non-volatile memory.

Backup Battery

The Sensaphone 1400 includes a 6V 1.3AH sealed lead-acid gel-cell rechargeable battery for system back-up in the event of a power failure. The battery will provide approximately 24 hours of backup time. Actual backup time will depend upon the temperature, battery age, dialing activity, and state of the relay output. The battery is located behind the main panel.

The 1400 will automatically charge the battery whenever the power switch is turned on and the power transformer is plugged in. The battery should provide 3–5 years of service, depending on temperature and charge/discharge cycles, before needing replacement. See Appendix B for battery replacement instructions.

The 1400 also includes a 3V lithium battery to retain the date and time when main power is off. The lithium battery should provide 8-10 years of service life.

> **NOTE**: Have batteries serviced by qualified service personnel only.

TELEPHONE LINE

Connect the 1400's Phone jack to a standard 2-wire analog phone line. The unit dials using pulse or tone, with loop start only. The 1400 will recognize ringer frequencies from 16 to 60 Hz and will operate with all standard analog telephone systems that accept pulse or tone dialing.

Certain private telephone systems and public switching equipment may not accept the unit's dialing or may generate an unacceptable ring signal. In those cases, a dedicated line may be required for the unit. Consult the supplier of your telephone system if you encounter problems.

> **CAUTION**: Never install telephone wiring during a lightning storm. Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations. Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface. Use caution when installing or modifying telephone lines.

Line Seizure

Line seizure gives the 1400 the ability to "seize" the telephone line when it needs to dial out. For example, if an emergency occurs which puts the 1400 in alarm mode, the unit will be able to dial out even if a telephone has been left off the hook. To the right of the LINE terminals is another set of terminals labeled EXT. These terminals can be used to share the line with other devices (telephone, fax machine, modem) and to give the 1400 priority in the event of an emergency. To make use of this feature you must have all the extension devices originate from the EXT terminals. Whenever the unit must make an alarm phone call, the unit will disconnect any current phone calls and seize the line for its own use. The unit will continue to seize the line until the alarm has been acknowledged. To ease installation, an optional accessory is available (FGD-0060 Line Seizure Kit) which provides an RJ31x modular wall jack, cable, and wiring instructions.

> **NOTE**: The Line Seizure Kit is *not* required for the 1400 seizure capability to function correctly. The Kit allows the disconnection of the 1400 system from the telephone line while ensuring continued telephone operation—useful if the 1400 is, for instance, temporarily removed for service.

WIRING SENSORS AND TRANSDUCERS

The 1400 Zones are compatible with NO/NC dry contacts, 2.8K and 10K thermistors, and 4–20mA transducers. To prevent an alarm from occurring while wiring the sensors, it is recommended that the zone alarm be disabled [SENSOR ON/OFF] + [Zone #1–4]. After wiring all of your sensors you will need to configure the zones using the [SET] + [CONFIGURE] command. *See Chapter Four for more information on Disabling Zone alarms and Configuring Zones.*

Recommended sequence for adding a new sensor:

1. Disable the Zone's alarm.
2. Wire up the sensor.
3. Configure the Zone.
4. Enable the Zone.

> **NOTE**: If a false alarm occurs while wiring a sensor, you can quickly acknowledge it by pressing the [ALARM/CANCEL] key. See Chapter Five for more information on User Acknowledgment Codes.

Temperature: The unit will accept 2.8K or 10K thermistors. These should be wired to a Zone terminal and the adjacent ground terminal. For recommended thermistors check the accessory list or thermistor data in the appendices. Thermistor temperature range:

2.8K: -109°F to 115°F (-85°C to 57°)
10K: -87ºF to 168ºF (-66ºC to 76ºC)

Dry Contacts: Only contacts which have no voltage or current applied may be used. Connect the contact to a Zone terminal and an adjacent ground terminal. Do NOT try to monitor a contact that switches 120VAC. This will permanently damage the unit.

4–20mA: A 4–20mA transducer requires you to have an external DC power supply for the transducer. Connect the positive wire of your transducer to the positive terminal of your DC power supply. Connect the negative terminal of the transducer to a Zone terminal on the Sensaphone 1400. Connect the negative terminal from your power supply to the adjacent ground terminal on the 1400.

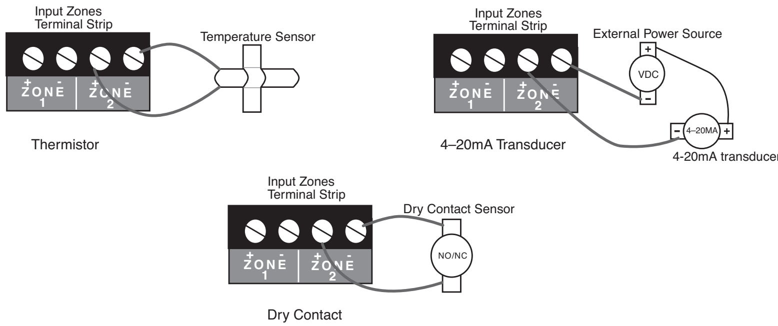


Figure 5: Different Sensor Types connected to the Terminal Block

External Microphone

An (optional) external microphone may be connected to the MIC terminals to allow remote listen-in capabilities and high sound level detection. (**NOTE**: The built-in microphone is for message recording only.) An external microphone with a 25' cable may be ordered from your Sensaphone supplier: Part number FGD-0057. The microphone connects to the terminals labeled MIC. Be sure to observe proper polarity when connecting the microphone: Red wire to + and Black wire to – . *See Chapter Five for information on programming the Listen-in Time, High Sound Alarm Recognition Time, and Sound Level Sensitivity (calibration).*

Wiring Recommendations

The 1400 will work fine in indoor environments using unshielded cable. When wiring will be subject to long lengths (>250') or if run outdoors, it is highly recommended that shielded cable be used and that the shield be connected to an earth ground. Also, be sure to use the appropriate gauge wire based on the distance and sensor type. See chart below:

Wire Gauge	Thermistor	NO/NC Contact & 4–20mA
#24	250'	1000'
#22	500'	2000'
#20	1000'	4000'

When preparing wire for connection to the terminal blocks, strip ¼" of insulation from the conductor (see figure below).

Figure 6: Wire stripped for connection

LED INDICATORS

The LEDs provide on-site alarm and status information. Listed below are descriptions of how the LEDs work.

Zones 1–4, Power and Sound:

LED Off: Zone OK

LED Blinking Fast: Alarm condition exists but recognition time has not been met

LED Blinking Slowly: Unacknowledged alarm exists

LED On: Acknowledged alarm exists

Battery:

LED On: Battery OK

LED Blinking: Battery condition low

LED Off: No battery/critically low battery condition

Output On:

LED On: Output relay on

LED Off : Output relay off

Phone-In-Use:

LED On: Unit is communicating on the phone line

LED Off: Unit is not using the phone line

System-On:

LED On: System power on

LED Off : System power off

CHAPTER 3: QUICK START GUIDE

This section presents a brief guide and some helpful hints for first-time users of the 1400. Follow the instructions for installation before attempting to program the unit.

HOW THE KEYPAD COMMANDS WORK

The 1400 uses simple keypad commands to program and check all pertinent parameters. All of the keypad commands begin with either the SET, WHAT IS, or SENSOR ON/OFF keys. The SET key is used to program parameters. When performing a programming sequence, the command will typically require the SET key followed by the parameter to be programmed, followed by a value, and then the ENTER key at the end. For example, to program the Call Delay you would press [SET] + [CALL DELAY] + [value] + [ENTER]. To check your programming , you would press the WHAT IS key followed by the parameter (in this case, [WHAT IS] + [CALL DELAY].

The SENSOR ON/OFF key is generally used to enable and disable functions or to toggle a function on and off. For example, to disable a Zone you would press [SENSOR ON/OFF] + [Zone #] or to turn the speaker Mute on you would press [SENSOR ON/OFF] + [HISTORY/MUTE].

ABORTING A COMMAND

If you are in the middle of a command and you make a mistake, you can abort the command by either pressing the ALARM CANCEL key or by simply waiting for the command to time out (typically 30 seconds). When you abort a command, the unit will say “Error 1” to indicate that the command has not been executed successfully.

ERROR MESSAGES

When programming parameters in the 1400 you may get an error message if you inadvertently enter an incorrect value. If the unit says “Error 1,” it means that you entered a value that is out of range or have aborted the command. If Remote Programming Security

Code is enabled *(see Chapter Five)*, and you enter the incorrect security code, the unit will answer with “Error 2” and offer you a second chance to enter the correct code.

ACKNOWLEDGING A FALSE ALARM

While programming the unit you may inadvertently set off an alarm. Once an alarm occurs, the unit will start its alarm processing routine, which will prevent you from performing any other keypad function until the alarm is acknowledged. To acknowledge an alarm and stop the unit from making any phone calls, press [ALARM CANCEL]. This will acknowledge the alarm *(assuming that you have not entered any custom acknowledgment codes)*. If you have entered one or more custom acknowledgment codes, then enter the code as required.

RECOMMENDED PROGRAMMING STEPS

Listed below are the basic programming steps to get you up and running. The chapters that follow provide detailed programming instructions as well as additional options to customize the operation of your 1400.

Parameter	Chapter #
1. Set the Date & Time	5
2. Configure Zones	4
3. Set Alarm Limits	4
4. Record Zone voice messages	5
5. Record ID voice message	5
6. Set ID number	5
7. Set dialout telephone numbers	5

CHAPTER 4: ZONE PROGRAMMING

This chapter explains the keyboard commands for the monitoring functions of the Sensaphone 1400. This includes:

- Configure Zone Type
- Enable/Disable Zones
- Temperature Scale
- Table Range for 4-20mA sensors
- Alarm Recognition Time
- Alarm Limits
- Zone Calibration
- AC Power Monitoring Enable/Disable
- AC Power Recognition Time
- Sound Level Monitoring Enable/Disable
- Sound Level Recognition Time
- Sound Level Calibration

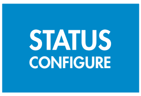
AUTOMATIC ZONE CONFIGURATION

The 1400 is compatible with normally open, normally closed, 2.8K thermistor (temperature), 10K thermistor (temperature), and 4-20mA type sensors. All of the Zones are configured simultaneously by keying in a simple key sequence after connecting all of your sensors. Make sure all sensors are in their normal state. All 4–20mA transducers should be powered on.

> **NOTE**: New temperature sensors will default configure to 2.8K. If you are connecting any 10K sensors to the 1400, these **must** be configured manually. Any sensor that was previously configured as either 2.8K or 10K will maintain proper thermistor type. *(See the Manual Configuration section)*

1. Press the SET key.

2. Press the CONFIGURE key.



The 1400 will prompt, “Enter 0 for automatic configuration, enter zone number for manual configuration.” If you press “0”, the 1400 will scan each Zone input and determine the input type.

The Zones are now considered normal. If a *normally closed* Zone becomes open, an alarm will occur. If a *normally open* Zone becomes closed, an alarm will occur.

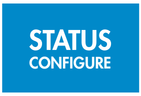
MANUAL ZONE CONFIGURATION

If you would like to program the Zone type (NO, NC, temperature, 4–20mA) without going through the automatic process that scans all Zones, this command will allow you to configure a single Zone. This command is useful if you have alarms on other channels and cannot use the automatic configuration process, or if you wish to configure the Zone type without actually connecting the sensor.

> **NOTE**: You **MUST** use manual configuration for any zone connecting to a 10K temperature sensor.

1. Press the SET key.

2. Press the CONFIGURE key.



The 1400 will prompt, “Enter 0 for automatic configuration, enter zone number for manual configuration.”

3. Press the corresponding Zone key (1–4).

The 1400 will say “Enter Mode.”

4. Press the key which corresponds to the type of Zone according to the table below:

   1: NO Dry Contact
   2: NC Dry Contact
   3: 2.8K Thermistor (temperature sensor)
   4: 10K Thermistor (temperature sensor)
   5: 4–20mA

5. Press ENTER.

The 1400 will recite the programmed Zone input configuration.

ENABLE/DISABLE ZONE ALARMS

This function allows you to enable or disable a Zone (1-4) for dialout during an alarm. An enabled Zone will respond to an alarm and allow dialout. A disabled Zone will not initiate a dialout, but it will still be included in the status report, preceded by the word “disabled.” This command is useful while you are wiring your Zones or at any other time you would like the alarms to be ignored. The default setting for all Zones is enabled *(on)*.

1. Press the SENSOR ON/OFF key.

SENSOR ON/OFF

2. Press the corresponding number key (1–4) of the Zone you want to enable/disable. 1400 will say “Zone (1–4) Alarm On/Off” to indicate enabled or disabled respectively.

1 CALL DELAY	2 VOICE REPS	3 INTERCALL TIME
4 MAX CALLS		

3. Repeat key sequence to change.

ENABLE/DISABLE SOUND LEVEL ALARM

This function allows you to enable or disable the sound alarm for dialout. When enabled, a high sound level at the remote microphone (optional)—*that meets the programmed recognition time and level*—will trip a sound alarm and the unit will dial out. Disabling sound will prevent a sound alarm dialout. The default setting is enabled *(on)*.

1. Press the SENSOR ON/OFF key.

SENSOR ON/OFF

2. Press the Sound Alarm key (9). 1400 will say “Sound Alarm

On/Off" to indicate enabled or disabled respectively.

9
LISTEN TIME
SOUND

3. Repeat the steps to change.

ENABLE/DISABLE POWER

This function allows you to enable or disable AC power failure monitoring (0). Enabled AC power monitoring will respond to an alarm and allow dialout. Disabled AC power monitoring will not initiate a dialout alarm. The default setting is enabled *(on)*.

1. Press the SENSOR ON/OFF key.

SENSOR
ON/OFF

2. Press the power key (0) to enable/disable. 1400 will say "Power Alarm On/Off" to indicate enabled/disabled.

0
ID
POWER

3. Repeat the steps to change.

CONFIGURE TEMPERATURE SCALE

The 1400 can read temperature in degrees Fahrenheit or Celsius. The default is degrees Fahrenheit.

SENSOR
ON/OFF

2. Press the F/C key.

TEST
°F/°C

The 1400 will say "degrees Fahrenheit" or "degrees Celsius" to indicate the current setting. Repeat the key sequence to change.

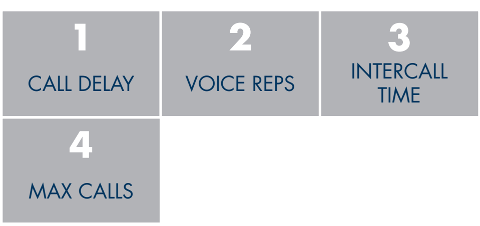
CONFIGURE TABLE RANGE FOR 4–20MA SENSORS

The 1400 allows you to create a unique linear table for each 4–20mA sensor. The Table Low (4mA) and Table High (20mA) values are used to define the lower and upper range of your 4–20mA sensor. For example, suppose you are using a 4–20mA transducer to measure the depth of water in a 15 foot well. Simply enter a Table Low value of 0 and a Table High value of 15 and the 1400 will scale the Zone to read between 0 and 15. The low and high table range can be set from -10,000 to +10,000 [Defaults: low=0, high=100]. To make a value negative, precede the value with the [RINGS/TAD/*] key.

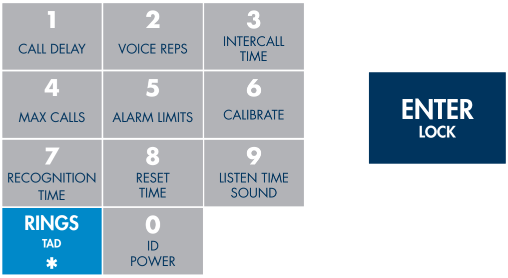
1. Press the SET key.

2. Press the TABLE RANGE key. 1400 will say "Enter Zone Number."

3. Press the corresponding Zone number (1–4). 1400 will say "Enter Low Number."

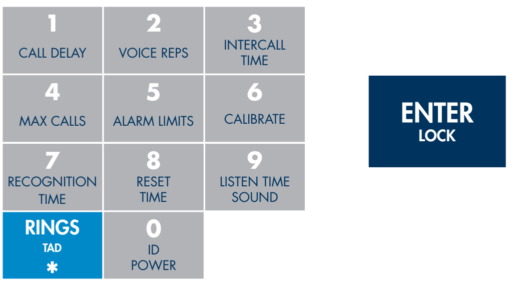


4. Using the number keys, enter the Table Low value, then press ENTER.



The 1400 will say "Enter High Number."

5. Using the number keys, enter the Table High value and press ENTER.

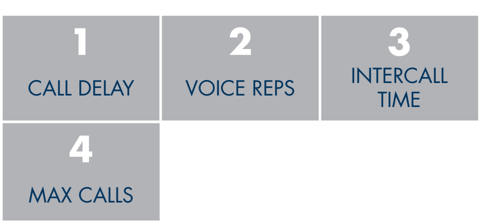


The 1400 will say "OK."

1. Press the WHAT IS key.

2. Press the TABLE RANGE key. 1400 will say "Enter Zone Number."

3) Press the corresponding Zone number (1–4).



The 1400 will say "Low" and speak the low table value, then it will say "High" and speak the high table value.

ALARM RECOGNITION TIME

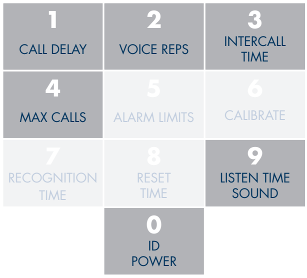
The Alarm Recognition Time is the length of time an alert condition must be present before a valid alarm exists and dial-out is activated. If a condition exists and then clears within the recognition time, it is not considered an alarm. This is useful to prevent nuisance dialouts for momentary alarm conditions or on self-correcting equipment. Each Zone can be programmed with a different recognition time, including Power Alarms and Sound Level Alarms. The default recognition time is 3 seconds for *Zones*, 5 minutes for *Power*, and 8 seconds for *Sound* level. You may program the recognition time for Zone and Power Alarms from 0 seconds up to 540 minutes. Sound Level Alarms may be programmed from 5 to 60 seconds.

> **NOTE**: When the main power fails, the 1400 will announce out loud "Power is OFF" every 15 seconds. It will do this regardless of the programmed recognition time. As a result, when the programmed recognition time is finally met, the unit will dial immediately and not wait the programmed Call Delay time. The Power Alarm is the *only* one treated in this fashion.

1. Press the SET key.

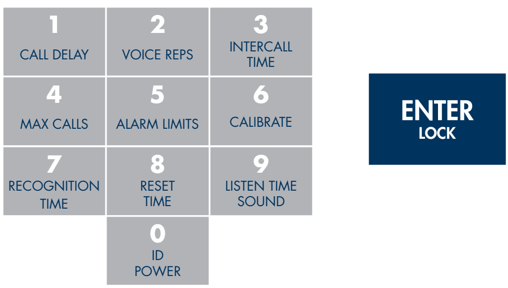
2. Press the REC TIME key. 1400 will say "Enter Zone Number."

3. Press the corresponding Zone key (1–4), Power(0), or Sound(9).



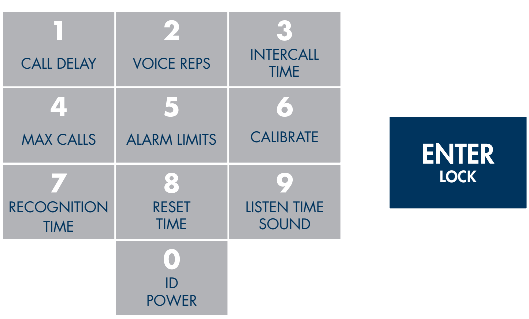
The 1400 will say “Enter minutes.”

4. Using the number keys, enter minutes. Then press ENTER.



The 1400 will say “OK, enter seconds.”

5. Using the number keys, enter seconds. Then press ENTER.



1400 will say “OK.”

1. Press the WHAT IS key.

2. Press the REC TIME key.

1400 will say “Enter Zone Number.”

3. Press the corresponding Zone key (1–4), Power(0), or Sound (9).

The 1400 will recite the programmed recognition time for that Zone.

ALARM LIMITS

The Alarm Limits determine the level at which a temperature or 4–20mA Zone has reached the alarm threshold. The input value must exceed the Alarm Limit to trip an alarm. Each Zone has a programmable Low and High Alarm Limit. The default settings are Low Limit=0 and High Limit=100. The range of programming for 2.8K thermistors is -109° to 115°F (-85° to 57°C). The range of programming for 10K thermistors is -87° to 168°F (-66° to 76°C). For zones configured as 4–20mA, the range of programming is -10,000 to 10,000. To make a value negative, precede the value with the [RINGS/TAD/*]key.

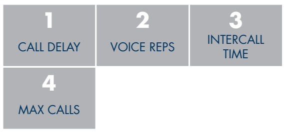
Only Zones configured as temperature or 4–20mA can have Alarm Limits programmed.

1. Press the SET key.

2. Press the ALARM LIMITS key.

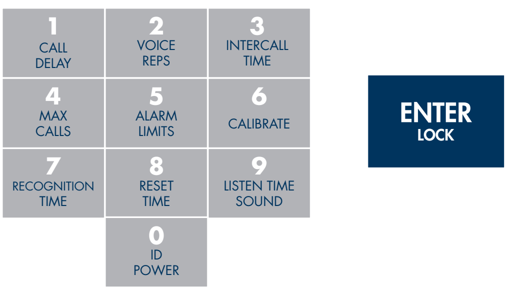
The 1400 will say “Enter Zone Number.”

3. Press the corresponding Zone key (1–4)).



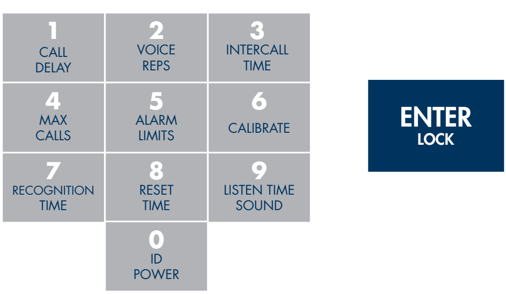
The 1400 will say “Enter Low Alarm Limit.”

4. Using the number keys, enter a value. Then press ENTER.



The 1400 will say “Enter High Alarm Limit.”

5. Using the number keys, enter a value. Then press ENTER.



To check the alarm limits:

1. Press the WHAT IS key.

WHAT IS

2. Press the ALARM LIMITS key. 1400 will say "Enter Zone Number."

5
ALARM
LIMITS

3. Press the corresponding Zone key (1–4). 1400 will say the programmed value.

1 CALL DELAY	**2** VOICE REPS	**3** INTERCALL TIME
4 MAX CALLS		

RESET TIME

The Reset Time allows your Sensaphone to reset the dialing sequence if an alarm continues to exist well after it has been acknowledged. For example, suppose the Reset Time for Zone 1 is programmed for 2 hours. If an alarm occurs on Zone 1 at 6PM and is acknowledged at 6:15PM and the alarm condition is never corrected, then at 8:15PM (2 hours later) the Sensaphone will "reset" the alarm and begin the notification process all over again. This feature should be used for all critical monitoring applications where a prolonged alarm condition could cause catastrophic results.

The Reset Time can be programmed between 30 and 1440 minutes for each zone. The default setting is 0 minutes - which disables the feature. The reset time is defined as the time allowed for an acknowledged alarm's fault condition to be corrected before the alarm resets and begins the message delivery process all over again.

The Reset Time must be programmed individually for each Zone, including the Power and Sound alarm.

1. Press the SET key.

2. Press the RESET TIME key.

The 1400 will say "Enter Zone Number."

3. Press the corresponding Zone key (1-4), Power (0), or Sound (9).

The 1400 will say "Enter minutes."

4. Using the number keys, enter minutes. Then press ENTER.

The 1400 will say "OK."

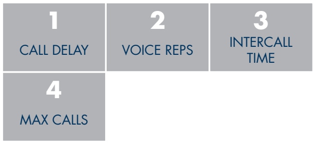
To check the programmed RESET TIME:

1. Press the WHAT IS key.

2. Press the RESET TIME key.

The 1400 will say "Enter Zone Number."

3. Press the corresponding Zone key (1-4), Power (0), or Sound (9).



The 1400 will recite the programmed Reset Time for that Zone. If the Reset Time is set to 0 minutes the 1800 will say "Disabled".

ZONE CALIBRATION

Due to tolerance variations or other factors, you may need to program an offset to calibrate the sensor. The offset can range from -15 to +15 for Zones configured as temperature, and -100 to +100 for Zones configured as 4–20mA. Setting a positive number will add that number to the Zone reading. Setting a negative number will subtract the programmed value from the Zone reading. For instance, if a temperature sensor consistently read two degrees high, you could use the calibration feature to adjust that temperature down two degrees. To make a value negative, precede the value with the [RINGS/TAD/*] Key.

1. Press the SET key.

2. Press the CALIBRATE key.

The 1400 will say "Enter Zone Number."

3. Press the corresponding Zone key (1–4).

The 1400 will say "Enter Number."

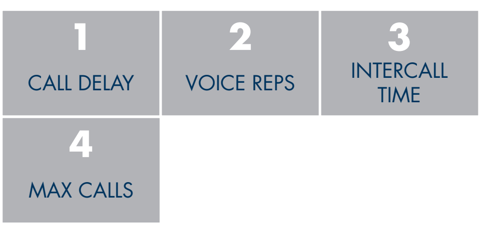
4. Enter the number. Then press ENTER.

The 1400 will say "OK."

1. Press the WHAT IS key.

2. Press the CALIBRATE key. 1400 will say "Enter Zone Number."

3. Press the corresponding Zone key (1–4).



The 1400 will recite the programmed calibration.

SOUND LEVEL CALIBRATION

This feature allows you to program the level of sound that will cause the 1400 to respond to an alarm and dial out. **NOTE**: This applies *only* to the (optional) external microphone. It may be useful to desensitize the 1400 to sound if installed in an area with a relatively high noise level, or where a loud noise occurs frequently but is not associated with an alarm. In some applications, it may be desirable to increase sound sensitivity to low sound levels. The sensitivity setting (calibration) for Sound Alarm monitoring ranges from 1 to 160. A value of 1 makes the microphone the MOST sensitive to changes in sound. The value 160 makes the microphone the LEAST sensitive to sound. The default value is 32.

1. Press the SET key.

2. Press the CALIBRATE key.

The 1400 will say, “Enter Zone Number.”

3. Press the SOUND key.

The 1400 responds: “Enter number.”

4. Using the number keys, enter a value for sound calibration and press ENTER.

The 1400 will say, “OK.”

1. Press the WHAT IS key.

2. Press the CALIBRATE key. 1400 will say “Enter Zone

Number."

3. Press the SOUND key.

The 1400 will recite the programmed sound sensitivity level.

DESIGNATING A ZONE AS UNUSED

This feature allows you to mark selected Zones, Power, or Sound as unused, which will prohibit them from going into alarm and will also leave them out of the status report. Note that programming for the selected Zone will be preserved when the Zone is marked as "unusued" and will not be reconfigured if automatic Zone configuration is activated.

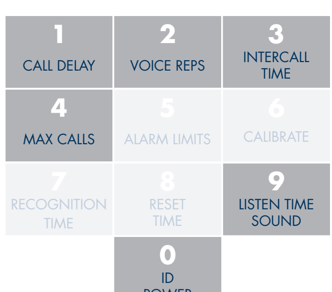
If the sensor is configured as *not used*, the unit will respond "Error the zone is off". Refer to section 5.13 to designate as used.

1. Press the SENSOR ON/OFF key.

2. Press the SET key.

The 1400 will say "Enter Zone Number."

3. Press the corresponding number of the Zone you wish to mark as unused.



The 1400 will respond by saying Zone 1–4, Power, or Sound "Off/On." Repeat the key sequence to place the Zone back in use.

EXIT DELAY

The Exit Delay feature is useful when you are using your 1400 for security monitoring. This feature allows you to exit a building without tripping a security alarm. When tripping an alarm is unavoidable, yet a true alert condition has not actually occurred, the alarm response—including dial-out—can be temporarily suppressed.

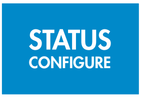
The 1400 is able to suppress and then reset its dial-out function automatically through use of the Status Report. This is especially convenient when an alert condition is created upon exiting a monitored door, and there is no way to cancel from the local keypad.

> **Note**: The Exit Delay feature applies only to Zones configured as NO/NC.

Example: You are planning to exit through a monitored door. Prior to exiting, you initiate a Status Report recitation at the 1400 keypad by pressing [WHAT IS], followed by [STATUS], (key sequence shown below). This allows you the duration of the status report to exit without activating the 1400's programmed response to an alarm. At the conclusion of the status report, normal alarm response is reactivated.

1. Press WHAT IS.

2. Press STATUS.



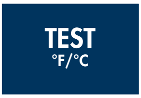
The 1400 recites the full Status Report; during this time, you are able to exit the monitored area without tripping an alarm.

TEMPERATURE-ONLY STATUS REPORT

You can receive a limited status report that only includes inputs configured as temperature. This can be useful when you don't care to listen to the entire status report.

1. Press the WHAT IS key

2. Press the TEST key.



CHAPTER 5: COMMUNICATION PROGRAMMING

This chapter explains the keyboard commands for programming the communications functions of the 400. This includes programming, interrogating and/or resetting of:

- Date and Time
- Voice Messages
- ID Number
- Alarm Dial-out Telephone Numbers
- Special Dialing Options
- Dial-out Test Mode
- Tone or Pulse Dialing
- Rings Until Answer
- Call Delay Time
- Intercall Time
- Call Progress
- Voice Repetitions
- Maximum Number of Calls
- Telephone Answering Device Compatibility
- Listen-in Time
- Programming Security Code
- Speaker Mute
- Callback Acknowledgment

DATE and TIME

The 1400 has an internal clock/calendar that is used to time-stamp events and maintain alarm history. To program the date and time:

1. Press SET, followed by the DATE/TIME key.

   SET **DATE TIME**

2. The unit will say "Enter the date." Enter the date in month/day/year (mm/dd/yy) format using two digits for each. For example, if the date was January 7, 2017 you would enter 010717, then press ENTER.

   ENTER LOCK

3. Next, the unit will say "OK, enter the time." Enter the time in 24-hour format (e.g. 3:00PM = 15:00) using hours/minutes (hh/mm) format. For example, if the time was 1:30PM you would enter 1330, then press ENTER.

   ENTER LOCK

4. To check the date and time press WHAT IS, followed by DATE/TIME. The unit will announce the date and time.

   WHAT IS **DATE TIME**

> **NOTE**: The internal clock is powered by an onboard lithium battery which should provide 8–10 years of service life.

To program only the Date or only the Time, you can simply press the ENTER key when prompted and the unit will keep its current value. For example, to program a new TIME but keep the current DATE, press [ENTER] when prompted for the Date. The unit will keep the current setting and then prompt you to enter the new Time.

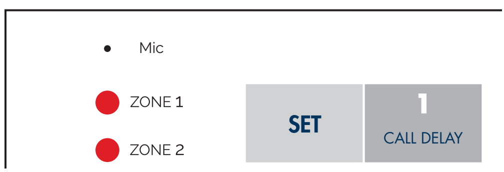
VOICE MESSAGES

The 1400's digital speech recording feature allows you to record custom messages for each of the four Zones and an ID Message. This means that when the 1400 calls you during an alarm, you will hear a personalized Voice Message identifying the unit and telling you exactly what alarm condition exists. You can record a separate message for each of the four Zones. The message can run a maximum of 5 seconds. The ID Message can be a maximum of 8 seconds. You can shorten the message length by pressing the ENTER key after reciting the message.

The **ID Message** is used to identify the unit. This could be a particular building name, its location (address or city), or some other identifier.

To program the ID Message:

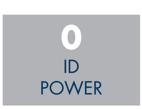
1. Locate the condenser mic.



2. Press the SET key.

3. Press the MESSAGE key. The 1400 will say "Enter Message Number."

4. Press the ID key (number 0 key).



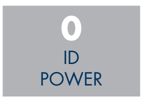
5. When the unit beeps, begin speaking your message into the microphone. The unit will say "OK," when the recording time has elapsed; then it will play back your recorded message.

To play back the ID Message:

1. Press the WHAT IS key.

2. Press the MESSAGE key.

3. Press the ID key (number 0 key).

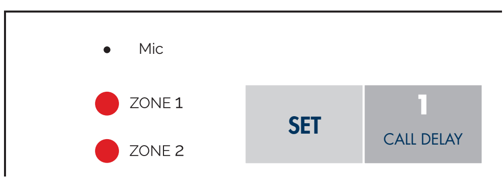


The 1400 will play back your recorded message.

The **Zone Messages** are used to identify the device or condition being monitored such as temperature, humidity, equipment alarms, security alarms, etc.

To program the Voice Message for a Zone:

1. Locate the condenser mic.



2. Press the SET key.

3. Press the MESSAGE key. The 1400 will say, “Enter Message Number.”

4. Press the number key for the corresponding Zone.

1 CALL DELAY	2 VOICE REPS	3 INTERCALL TIME
4 MAX CALLS		

5. When the unit beeps, begin speaking your message into the microphone. The unit will say "OK," when the recording time has elapsed; then it will play back your recorded message.

To play back the message for a Zone:

1. Press the WHAT IS key.

WHAT IS

2. Press the MESSAGE key.

MESSAGE

3. Press the corresponding Zone number key.

1 CALL DELAY	2 VOICE REPS	3 INTERCALL TIME
4 MAX CALLS		

The 1400 will play back your recorded message.

To erase a Zone or ID message:

1. Press the SENSOR ON/OFF key.

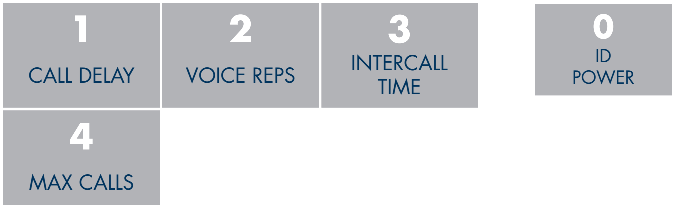
SENSOR ON/OFF

2. Press the MESSAGE key.

MESSAGE

The 1400 will say "Enter message number."

3. Press the Zone Number or ID key.



The 1400 will say, “Message erased.”

ID NUMBER

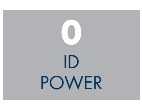
The ID Number is the identification number of the 1400. This number is typically the telephone number where the unit is installed, or it may be designated using any number that best suits your application. The purpose of the ID Number is to immediately provide the source of any alarm, especially when using multiple 1400 units in a complex monitoring system. The ID number is announced during voice alarm messages and displayed on pagers. The ID Number can be up to 16 digits long.

When the 1400 is called from a remote location, it always begins its message with the identification number: “Hello, this is (ID Number).” If no ID Number is programmed, the unit will say, “Hello, this is Sensaphone 1400.”

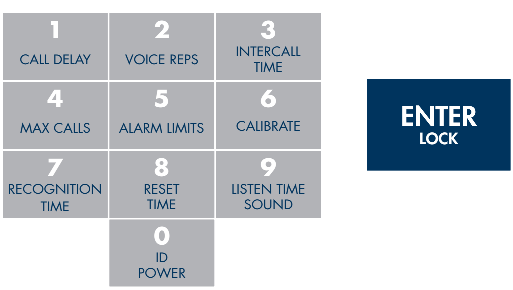
To program the ID Number:

1. Press the SET key.

2. Press the ID key (number 0 key).



3. The unit will say “Enter ID number.” Using the number keys, enter the unit’s phone number, then press ENTER.

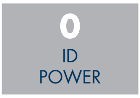


If the number was accepted, the 1400 will say “OK.”

To play back the ID Number:

1. Press the WHAT IS key.

2. Press the ID key (number 0 key).

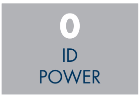


The 1400 will recite the ID Number.

To erase the ID Number:

1. Press the SET key.

2. Press the ID key (number 0 key).



The 1400 will say “Enter ID Number.”

3. Press the ENTER key.

The 1400 will say “ID Number erased.”

ALARM DIAL-OUT TELEPHONE NUMBERS

The Sensaphone 1400 will dial up to eight 48-digit phone numbers to report alarm conditions. These are the numbers that will be called during an alarm dial-out. The unit can deliver an alarm message via voice telephone call or numeric page. The telephone numbers are dialed sequentially 1 through 8. Therefore, program the first number you want called as Phone #1, the second one as Phone #2, and so on. A pause, pound or asterisk can be added to the phone number to access different phone and beeper systems (see special dialing options). Once the alarm is acknowledged, all dial-out stops.

Voice Dialout

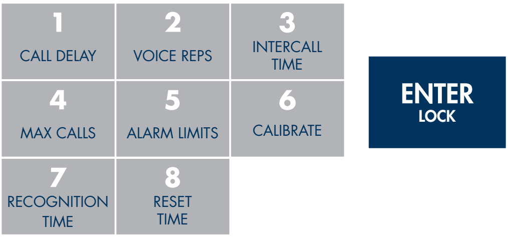
When 1400 calls in Voice mode it will announce the ID Message and the alarm message. Afterward it will ask for the acknowledgement code. If a correct code is entered, the unit will stop dialout. If the wrong code is entered it will hang up and continue dialing the next number.

To program a VOICE dial-out telephone number:

1. Press the SET key.

2. Press the PHONE NUMBER key. The 1400 will say "Enter Number."

3. Select which Phone number to program. Press any unassigned number key (keys 1–8) to represent the new telephone number entry. 1400 will respond "Enter number."



4. Enter the phone number using the number keys, and then press ENTER. Be sure to enter "1" + area code if required. If installed on a PBX system, be sure to enter a "9" if required.

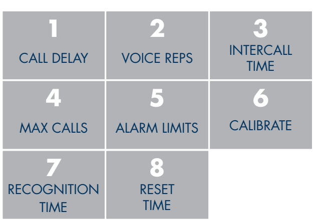
1400 will say "OK."

To play back a programmed dial-out telephone number:

1. Press the WHAT IS key

2. Press the PHONE NUMBER key. 1400 will say "Enter Number."

3. Select an assigned Phone number (keys 1–8).



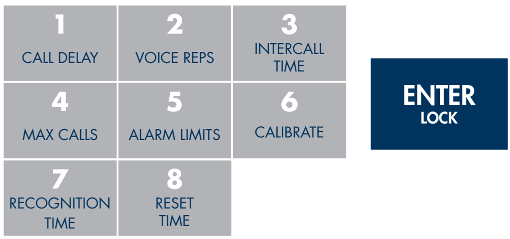
The 1400 will recite the number programmed. If there is no number programmed, 1400 will say "No number."

To erase a dial-out telephone number:

1. Press the SET key.

2. Press the PHONE NUMBER key. The 1400 will say "Enter Number."

3. Select an assigned Phone Number (keys 1–8), and press ENTER.



The 1400 will say "Number (1–8) erased."

Numeric Pager Dialout

When programming the 1400 to dial a Numeric pager there are two methods that can be used: **Automatic** mode and **Manual** mode.

The only difference is that in Automatic mode the 1400 will automatically try to sense when the call has been answered and then send the ID Number and zone numbers. In some instances, the automatic answer detection and timing from the 1400 is incompatible with the paging service, and the Manual mode must be used.

> **NOTE**: If your phone system requires you to dial a '9' followed by a pause to get an outside line, you *must* use **Manual** mode and insert *pauses* at the end of the number.

When the 1400 calls your Numeric Pager it will leave the programmed ID Number along with the Zone number that is in alarm. If it's reporting a Power alarm, it will send the ID Number followed by the number "0"; if it's reporting a Sound alarm, the 1400 will send the ID Number followed by the number "9". To acknowledge the alarm you will have to call the unit back and enter an acknowledgement code, otherwise the unit will continue dialing the remaining numbers.

To program a NUMERIC PAGER using AUTOMATIC Mode:

1. Press the SET key

2. Press the PHONE NUMBER key. 1400 will say "Enter Number."

3. Select which Phone number to program. Press any unassigned number key (keys 1–8) to represent the new telephone number entry. 1400 will respond "Enter number."

4. Press CODE 1 (This tells 1400 this is a Numeric Pager call).

The 1400 will say "Pager."

5. Enter the pager number using the number keys. Then press ENTER.

The 1400 will say "OK."

To program a NUMERIC PAGER using the MANUAL Mode:

1. Press the SET key

2. Press the PHONE NUMBER key. 1400 will say “Enter Number.”

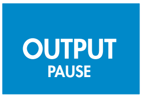
3. Select which Phone number to program. Press any unassigned number key (keys 1–8) to represent the new telephone number entry. 1400 will respond: “Enter number.”

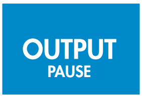
4. Press CODE 1 (This tells 1400 this is a Numeric pager call).

The 1400 will say “Pager.”

5. Enter the pager telephone number using the number keys.

6. Press the PAUSE key twice.





NOTE: Depending on your pager service, you may need to insert a longer or shorter delay (additional/ fewer pauses). Two pauses is the recommended starting point. Use the Dial-out Test Mode to help determine the proper number of pauses for your pager service. When it is programmed properly, you will hear the 1400 dial your pager service, then wait (based on the number of pauses) until the call has been answered, and then send another series of Touch-Tones and hang up.

7. Press the ENTER key.

To play back a NUMERIC PAGER number:

1. Press WHAT IS

2. Press the PHONE NUMBER key

3. Select the programmed Phone Number from the number keys (keys 1–8). The 1400 will recite the type of call, “pager,” followed by the pager number assigned to that key.

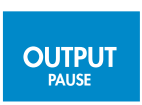
SPECIAL DIALING OPTIONS

The 1400 has provisions for special dialing requirements. These including dialing a * or #, inserting a two-second pause, or forcing the system to wait for the called party to answer. These options are typically used when: (a) the unit is connected to a PBX and must dial a prefix such as ‘9’ or extension to reach an outside line; (b) when dialing a business and stepping through menus to reach a specific extension; or (c) when a pager service is answered by a voice menu. The special dialing commands can be inserted as part of the dialout telephone number. Valid commands are listed below.

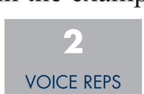
- A # tone can be dialed by inserting the TABLE RANGE/# key in the telephone number.

- The * tone can be dialed by inserting the RINGS/TAD/* key in the telephone number.

- A two-second pause can be inserted in the dialout telephone number by pressing the PAUSE key.



- The 1400 can be instructed to wait for the call to be answered before dialing additional digits. This is useful if you need to call a company’s main number and then dial additional digits to go to a specific extension (Example: 888-555-1200—wait for answer—227). Note that the unit will automatically wait for answer after dialing the last programmed digit. Press CODE 2 to make the unit wait for an answer, as in the example.



Change to Touch-Tone Dialing

In a situation where you must use pulse dialing, pressing CODE 3 will change all following digits to Touch-Tone.

Special Dialing Code Summary

Special Dialing Codes for the 1400 are:

Code 1: Numeric pager type
Code 2: Wait for answer
Code 3: Change to Touch-Tone

DIAL-OUT TEST MODE

The 1400 allows you to test your telephone programming by simulating an alarm dialout to any programmed telephone number. This can be a valuable tool for insuring that your programming is correct and also for troubleshooting dialing problems. In this mode all signals on the telephone line are audible through the local speaker.

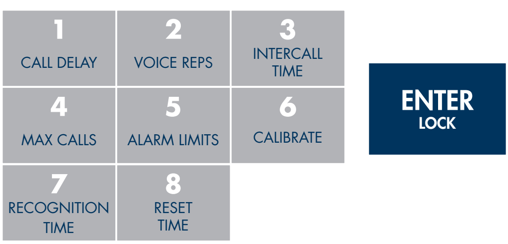
To test a dialout phone number:

1. Press the SET key.

2. Press the TEST key.

The 1400 will say "Enter Number."

3. Press a number key (1–8) corresponding to the phone number entry you wish to test, and press ENTER.



The 1400 will dial the number and announce the date and time for voice calls, or send its ID number for pager calls.

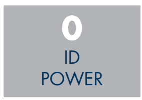
To manually dial a phone number:

1. Press the SET key.

2. Press the TEST key.

The 1400 will say "Enter number."

3. Press 0, then ENTER to enter manual dialing mode. The 1400 will go off-hook and you should hear a dial tone through the speaker. Press any number keys to dial a telephone number.



4. Press ALARM CANCEL to hang up and exit the test.

ALARM ACKNOWLEDGMENT CODES

When the 1400 detects an alarm, it starts dialing each telephone number until it receives acknowledgment or reaches the maximum number of calls. There are two acknowledgment modes: The default, Single-User mode is for users who are not concerned with knowing who responds to and acknowledges the alarm. In this mode, the default code of "555" is used. In Single-User mode an alarm can be acknowledged by pressing the ALARM CANCEL button on the keypad, or by entering the *Acknowledgment Code* of 555 over the telephone using touch tones.

In Multiple-User mode, up to 8 custom Acknowledgment Codes can be created in order to track who acknowledges alarms. These are 5-digit custom codes, replacing the default "555." The 5-digit Acknowledgment Code comprises the user's entry number (1–8) plus a four-digit number. Up to eight different Acknowledgment Codes may be programmed into the unit to identify individual users in the Alarm History Log.

When the unit makes a telephone call in *Voice* mode it will prompt the user to enter an Acknowledgment Code. If this is entered correctly, the 1400 will say "Alarm Acknowledged." When an alarm message is sent to a *pager*, the person who receives the page will have to call the unit back to acknowledge the alarm. In Single-User mode, the user must enter "555" to acknowledge the alarm. In Multiple-User mode, the user must enter his or her 5-digit Acknowledgment Code.

To Program Multiple-User Acknowledgment Codes:

1. Press SET

2. Press CODE

The 1400 will say "Enter Code Number."

3. Press a number (1–8) to assign the user.

The 1400 will say “Enter code.”

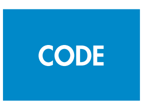
4. Enter the additional four digits of your personal code.

The 1400 will say “OK.”

To play back an Acknowledgment Code:

1. Press WHAT IS

2. Press CODE



3. Press an assigned number entry 1–8.

The 1400 will recite the Acknowledgment Code for the selected telephone number entry.

> **Note**: In default Single-User mode, the unit will announce “555” immediately after pressing the CODE key.

To erase an Acknowledgment Code:

1. Press the SET key.

2. Press the CODE key.

The 1400 will say “Enter Code Number.”

3. Press an assigned user number, 1–8.

4. Press the ENTER key.

The 1400 will say “Code [number] Erased.”

> **Note**: If no User Codes are programmed, the unit automatically defaults to Single-User mode (i.e., the default code of “555”).

ALARM HISTORY

The 1400 will retain historical information on the last 10 alarms. The information retained includes: Zone number, the time/date that the alarm occurred, and the User number that acknowledged the alarm.

To hear the Alarm History:

1. Press the WHAT IS key.

   WHAT IS

2. Press the HISTORY key.

   HISTORY
   MUTE

The unit will recite the history for the last 10 alarms. A sample report is shown below:

"Zone 1 (custom message) alarm high at 3:31PM April 8, 2017 acknowledged by number 4"

"Zone 3 (custom message) alarm low at 2:35AM March 27, 2017 acknowledged by number 1"

In Single-User mode, the report will state "Alarm acknowledged" for alarms acknowledged via telephone. It will state "Manual acknowledgment" for alarms acknowledged at the keypad. In Multiple-User mode, the report will state the user number that acknowledged the alarm. If the maximum number of calls have been made, the report will state "Automatic acknowledgment."

Deleting the Alarm History:

The Alarm History can be deleted by pressing SET, then HISTORY.

SET **HISTORY** **MUTE**

The 1400 will say "Erased."

TONE OR PULSE DIALING

The 1400 can dial out in pulse or touch-tones. All numbers will be called using the chosen dialing method. The default is TONE.

To program as either Tone or Pulse:

1. Press the SENSOR ON/OFF key.

SENSOR ON/OFF

2. Press the PHONE NUMBER(T/P) key.

PHONE NUMBER T/P

The unit will say "Tone" to indicate that Tone dialing is enabled, it will say "Pulse" when pulse dialing is enabled.

RINGS UNTIL ANSWER

The Rings Until Answer is the number of rings that must occur before 1400 answers the phone. This value can be from 1 to 15. The default value is 4.

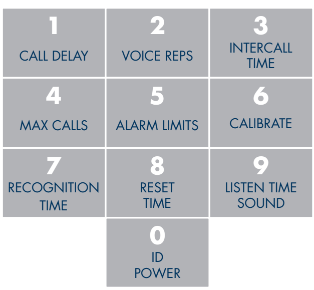
To program Rings Until Answer:

1. Press the SET key

2. Press the RINGS key.

The 1400 will say “Enter number.”

3. Using the number keys, enter a value and press ENTER.



The 1400 will say “OK.”

To play back the Rings Until Answer:

1. Press the WHAT IS key

2. Press the RINGS key.

The 1400 will recite the programmed value.

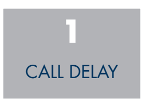
CALL DELAY TIME

The call delay time is the length of time the 1400 will announce an alarm before it starts the dial-out sequence. This only applies to the first call. To set delay time *between* calls, see INTERCALL TIME. The default call delay time is 30 seconds. It can be programmed from 0 to 60 minutes. The purpose of Call Delay is to allow time for personnel at the 1400's installation site to respond to and cancel an alarm before dial-out begins. During this time, the unit will audibly repeat its "alarm" message and the front panel alarm LED will blink.

To program call delay time:

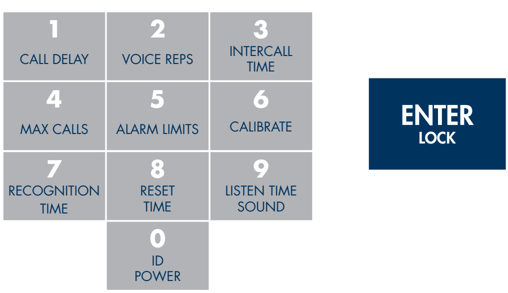
1. Press the SET key.

2. Press the CALL DELAY key.



The 1400 will say "Enter minutes."

3. Enter the number of minutes using the number keys. Then press ENTER. To keep the previous setting, just press ENTER.



The 1400 will say "Enter Seconds."

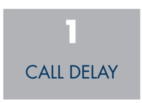
4. Using the number keys, enter the number of seconds, and then press ENTER. To keep the previous setting, just press ENTER.

The 1400 will say "OK."

To play back the call delay time:

1. Press the WHAT IS key

2. Press the CALL DELAY key



The 1400 will recite the programmed time.

INTERCALL TIME

The Intercall Time is the programmable period of time the 1400 waits between making alarm phone calls. Intercall Time is activated ***only after alarm dial-out to the first telephone number fails to be acknowledged.*** This period can be programmed from 10 seconds to 60 minutes. The default Intercall Time is 30 seconds.

> **TIP**: When the 1400 is programmed to make calls to pagers, make sure the intercall delay time is long enough to give the person carrying the pager some time to get to a phone to call the unit back.

If an incoming telephone call is received by the 1400 during the Intercall Time (in between dialing of subsequent telephone numbers to report an alarm), it will answer the incoming call and immediately report any existing alarms. The manner in which the incoming call is answered depends upon whether or not TAD is enabled or disabled *(See Telephone Answering Device (TAD) compatibility):*

If TAD is disabled (default), Rings Until Answer will be the programmed number of rings.

If TAD (Telephone Answering Device) is enabled, Rings Until Answer will be **1**.

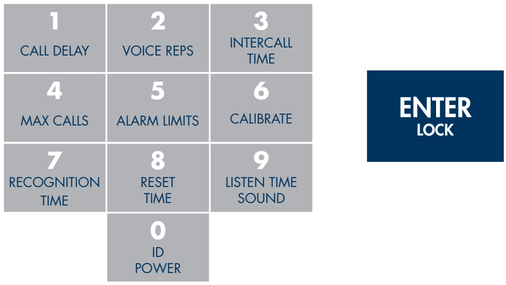
To program intercall time:

1. Press the SET key.

2. Press the INTERCALL TIME key.

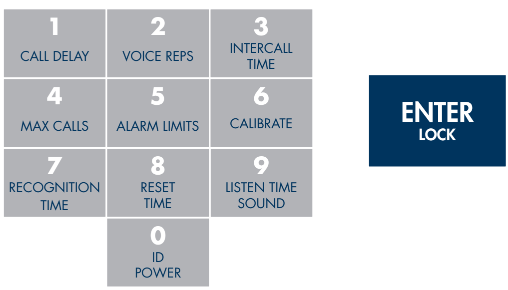
The 1400 will say “Enter minutes.”

3. Using the number keys, enter the number of minutes, and then press ENTER. To keep the previous setting, just press ENTER.



The 1400 will say “Enter seconds.”

4. Using the number keys, enter the number of seconds, and press ENTER. To keep the previous setting, just press ENTER.



The 1400 will say “OK.”

To play back the Intercall Time:

1. Press the WHAT IS key

2. Press the INTERCALL TIME key

The 1400 will recite the programmed time.

CALL PROGRESS

The 1400 monitors call progress when it dials out for an alarm. If 1400 encounters a busy signal or receives no answer after ten rings, the unit hangs up, waits the programmed intercall time and then dials the next phone number. When dialing some beeper/pager services, the line may be answered before receiving a ringback. This may interfere with the call progress detection and result in a failed call to certain phone systems or beeper/pager services. If this occurs, disable call progress detection. Default setting is *Enabled*.

To enable/disable call progress detection:

1. Press the SENSOR ON/OFF key.

2. Press the STATUS/CONFIG key.

The 1400 will respond “Call Progress Enabled/Disabled” to indicate that call progress has been turned on or off respectively.

3. Repeat key sequence to change.

VOICE REPETITIONS

The voice repetitions is the number of times the 1400 will recite the alarm message per phone call when it dials out. This can be programmed from 1 to 10 repetitions. The default value is 3 repetitions.

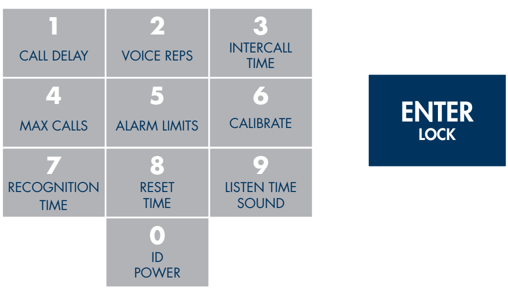
To program the voice repetitions:

1. Press the SET key

2. Press the VOICE REPS key.

The 1400 will say, “Enter number.”

3. Using the number keys, enter a value and then press ENTER.

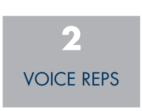


The 1400 will say “OK.”

To play back the number of voice repetitions:

1. Press the WHAT IS key.

2. Press the VOICE REPS key.



The 1400 will recite the number programmed.

MAX CALLS

The 1400 has the ability to acknowledge itself by using the Max Calls function. The unit keeps a count of the number of phone calls it makes for a particular alarm. Once the number of calls made reaches Max Calls, the 1400 will acknowledge the alarm and stop the dialout process. The unit indicates it has reached max calls by saying “alarm acknowledged by (ID Number).” The max calls can be programmed from 0 to to 255. The default is 100.

> **NOTE**: If only one Phone Number is programmed, 1400 will dial a maximum of 15 times, regardless of the programmed value of max calls, as required by FCC rules.

To program Max Calls:

1. Press the SET key.

2. Press the MAX CALLS key.

1400 will say “Enter number.”

3. Using the number keys, enter a value, then press ENTER.

The 1400 will say “OK.”

To play back Max Calls:

1. Press the WHAT IS key.

   WHAT IS

2. Press the MAX CALLS key

   4
   MAX CALLS

The 1400 will recite the value of max calls.

TELEPHONE ANSWERING DEVICE (TAD) COMPATIBILITY

The 1400 can be used on the same telephone line as a telephone answering device, such as an answering machine, fax machine, or modem. This feature allows you to call in to the 1400 and bypass the answering device. Default setting is *Off [disabled]*.

To use TAD:

1. Program the 1400's Rings Until Answer to a greater number than the rings until answer for your answering device. For example, 1400 RINGS = 5, device rings = 3.

2. Press the SENSOR ON/OFF key.

3. Press the TAD key.

The 1400 will say "TAD On." (If the 1400 says "TAD Off" repeat steps 2 and 3.)

4. Once TAD is on, allow the phone to ring once when you call the unit and then hang up. The 1400 recognizes that a call was made and activates a 30 second internal timer. This allows you 30 seconds to call the 1400 back.

5. Call back within 30 seconds. The 1400 will override the answering device on this incoming call and answer the phone on the first ring. The 1400 resets the TAD timer after one incoming call is received. If you want to call the unit again, you must repeat steps 4 and 5.

LISTEN-IN TIME

The Listen-In Time is the amount of time you can listen to sounds at the unit's location during a status call-in. An external microphone (optional) is required to listen in to on-site sounds. The programmable range is 0 to 255 seconds. The default setting is 0 seconds (disabled).

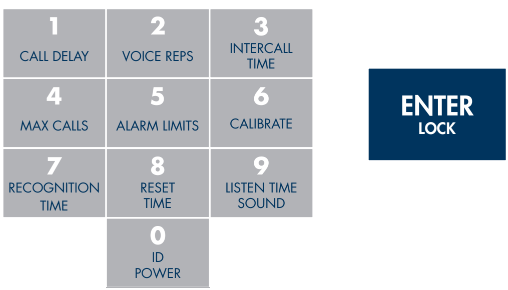
To program the Listen-In Time:

1. Press the SET key.

2. Press the LISTEN TIME key.

The 1400 will say "Enter seconds."

3. Using the number keys, enter the seconds, then press ENTER.



The 1400 will say "OK."

To play back the Listen-in Time:

1. Press the WHAT IS key.

2. Press the LISTEN TIME key

The 1400 will recite the time programmed.

REMOTE PROGRAMMING SECURITY CODE (LOCK)

The 1400 can be locked to prevent unauthorized call-in access to its programming. You may, however, listen to a status report without unlocking the 1400. To remotely edit programming parameters or record messages, you must call in and unlock the 1400 by entering the four-digit lock/unlock code.

If you enter the correct code, you will gain access to the 1400 to use the phone commands. If you enter the incorrect code, the 1400 will say “Error 2” and allow you a second chance to enter the correct code. If the second attempt is also wrong, the unit will say “Error 2, good-bye” and disconnect. You cannot program or change the lock code remotely.

For an explanation of how to use remote programming, see Chapter Seven.

To set the security code:

1. Press the SET key.

2. Press the LOCK key.

The 1400 will say “Enter security code.”

3. Using the number keys, enter 4 digits, and press ENTER.

The 1400 will say “OK.”

To play back the security code:

1. Press the WHAT IS key.

WHAT IS

2. Press the LOCK key.

ENTER
LOCK

The 1400 will recite the security code.

To remove the security code:

1. Press the SET key.

SET

2. Press the LOCK key.

ENTER
LOCK

The 1400 will say “Enter security code.”

3. Press ENTER.

ENTER
LOCK

The 1400 will say “Security code erased.”

SPEAKER MUTE

When the 1400 dials out with an alarm, it recites the alarm message over the phone and at the monitor site. The Speaker Mute command allows you to silence the 1400 at the monitor site.

To Mute the speaker:

1. Press the SENSOR ON/OFF key.

SENSOR
ON/OFF

2. Press the MUTE key

HISTORY
MUTE

The 1400 will say "Mute On" to indicate that the speaker mute is on. It will say "Mute Off" to indicate when the speaker mute is off.

3. Repeat key sequence to change.

CALLBACK ACKNOWLEDGMENT

This is an optional feature that can be enabled using the keypad *(default=disabled)*. It allows an alarm to be acknowledged simply by calling the unit and letting the line ring 10 times. When this feature is enabled it will temporarily make the Rings Until Answer set to 10 when an unacknowledged alarm exists. If you receive a call via Voice or Pager and are unable to send touch-tones, you can call the unit back, let the line ring 10 times, and the unit will answer and say "...Alarm Acknowledged."

> **NOTE**: If TAD is also enabled, then you must call the 1400, let it ring once, hang up, and then call the unit back within 30 seconds. The unit will answer on 1 ring and acknowledge the alarm.

To Enable the Callback Acknowledgment Feature:

1. Press SENSOR ON/OFF.

   SENSOR ON/OFF

2. Press CODE.

   CODE

The 1400 will say "Callback Acknowledgment Enabled/Disabled" to indicate that Callback Acknowledgment is enabled. Repeat the key sequence to disable.

CHAPTER 6: CONTROLLING THE OUTPUT

The 1400 includes a relay output that can be used to control a light, siren, or other device. The output is a Form-C Normally Open/ Normally Closed mechanical relay and is rated for up to 120VAC 2A. A sample wiring diagram is shown below:

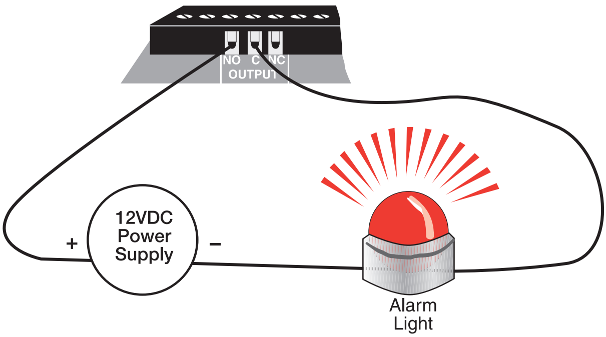


Figure 1: Relay output connected to alarm

The output can be programmed to operate in one of 7 automatic modes or it can operate in manual mode (default). The 7 *automatic* modes allow the output to automatically turn on and off based on individual alarms or any alarm. In *manual* mode the output is controlled via keypad command or remotely via touch-tone phone *(See Chapter 7)*. A description of each mode is shown below:

AUTOMATIC MODES

Mode 1: Output on when zone 1 goes into alarm. Off when alarm is acknowledged.

Mode 2: Output on when zone 2 goes into alarm. Off when alarm is acknowledged.

Mode 3: Output on when zone 3 goes into alarm. Off when alarm is acknowledged.

Mode 4: Output on when zone 4 goes into alarm. Off when alarm is acknowledged.

Mode 5: Output on when a Sound alarm occurs. Off when alarm is acknowledged.

Mode 6: Output on when a Power alarm occurs. Off when alarm is acknowledged.

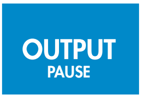
Mode 7: Output on when any alarm occurs. Off when all alarms are acknowledged.

MANUAL MODE

Mode 0: Output controlled manually via keypad command or touch-tone telephone.

When programmed for Manual mode, the command to switch the output is:

SENSOR ON/OFF + OUTPUT.



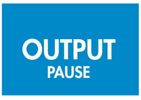
The 1400 will respond "ON" or "OFF" to indicate the state of the output.

> **Note**: If the 1400 says "Error," the output is not programmed for manual mode.

To program the Output Mode:

1. Press the SET key.

2. Press the OUTPUT key.



The 1400 will say "Enter output mode."

3. Using the number keys, enter a value for the output mode.

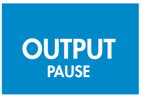
4. Press the ENTER key.

The 1400 will say "OK" and recite a description of the mode selected, such as "Automatic on Zone 1" or "Manual." Note that when *Mode 7* is selected, the 1400 will simply say "Automatic on Alarm," meaning that the output will automatically turn on when any alarm occurs.

To play back the programmed Output Mode:

1. Press WHAT IS.

2. Press OUTPUT.



The 1400 will recite the programmed output mode.

CHAPTER 7: OPERATION

After installation and programming have been completed, the Sensaphone 1400 is fully operational. This chapter explains how the 1400 operates.

ALARM DIALOUT AND ACKNOWLEDGMENT

There are three stages to a complete alarm event: 1) Alarm Recognition, 2) Alarm Notification, 3) Acknowledgment. Note that not all alert conditions will go through each stage. For example, some may not meet the recognition time.

Alarm Recognition

1. The 1400 monitors four zones plus sound level and power failure. When the status of a zone changes or exceeds user-programmed limits, it causes an alert condition.
2. If the alert condition lasts long enough to meet its programmed recognition time, the alert condition becomes an alarm and the 1400 begins the alarm notification sequence.

Alarm Notification

The 1400 can make two types of phone calls: Voice and Numeric Pager.

Dialout Note: Call Progress

The 1400 monitors call progress when dialing out. If the 1400 dials out and encounters a busy signal or no answer after 10 rings, the unit hangs up, waits the programmed intercall delay time, and then dials the next phone number.

> **NOTE**: Dial-tone and call-progress detection may optionally be disabled.

Alarm Dialout—Voice

When dialing out to a destination programmed as “voice,” the 1400 waits for the phone to be answered, then recites its user-recorded identification message, then the message identifying the zone or zones that have gone into alarm.

Below is an example of what the 1400 might say during a typical "voice" dialout:

> "Hello, this is 555-2278, 'Acme Medical Laboratory,' Zone One, 'Temperature in Refrigerator One,' a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds."
>
> "Hello, this is 555-2278, 'Acme Medical Laboratory,' Zone One, 'Temperature in Refrigerator One,' a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds."
>
> "Hello, this is 555-2278, 'Acme Medical Laboratory,' Zone One, 'Temperature in Refrigerator One,' a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds."
>
> "Enter acknowledgment code."

In this example, the number of Voice Message Repetitions was set to three.

> **NOTE**: If the call reaches an answering machine, the message will be recorded, but the 1400 will be talking over your outgoing message, so you will probably lose part of the first alarm message repetition.

Alarm Dialout—Pager

When dialing out to a destination programmed as "Numeric Pager," the 1400 leaves its programmed ID number on the display of a numeric pager along with the zone number(s) in alarm.

> **IMPORTANT**: When dialing out to a phone number programmed as "Numeric Pager," the 1400 DOES NOT speak a voice message. It calls the pager company or service, enters the number to be displayed on the beeper, then hangs up.

ALARM ACKNOWLEDGMENT

Alarm Acknowledgment—Voice Dialout

Repeated below is the same example of what the 1400 might say during a typical “voice” dialout:

> “Hello, this is 555-2278, ‘Acme Medical Laboratory,’ Zone One, ‘Temperature in Refrigerator One,’ a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds.”
>
> “Hello, this is 555-2278, ‘Acme Medical Laboratory,’ Zone One, ‘Temperature in Refrigerator One,’ a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds.”
>
> “Hello, this is 555-2278, ‘Acme Medical Laboratory,’ Zone One, ‘Temperature in Refrigerator One,’ a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds.”
>
> “Enter acknowledgment code.”

1400 will now wait 10 seconds for a Touch-Tone acknowledgment code to be entered. After the last digit of the acknowledgment code has been received, the 1400 will respond by saying: “Alarm Acknowledged.” The alarm has been acknowledged and the unit will hang up. Once the alarm has been acknowledged, the dialout process stops.

If a Touch-Tone acknowledgment code is not received, the 1400 will offer you a second chance to enter it, responding with: “beep,” “error,” “Enter acknowledgment code.” If the acknowledgement code is still not received, then the 1400 will respond by saying: “beep,” “error,” “goodbye.” The alarm has not been acknowledged. The 1400 will hang up and wait the programmed INTERCALL TIME before making the next phone call. During this time you may call the unit back from a Touch-Tone phone and the unit will give a voice report. Once you receive the complete report, enter the code to acknowledge the alarm.

> **NOTE**: An alarm cannot be acknowledged using a pulse (rotary) telephone unless the *Callback Acknowledgment* feature is enabled.

Alarm Acknowledgment—Numeric Pager Dialout

The 1400 will dial out to your pager service and leave a number on the display of your beeper. *(See Chapter Five)* The unit will then hang up without speaking a voice message and wait for you to call back and enter an acknowledgment code. This waiting period is called the INTERCALL TIME. During this time you may call the unit back from a Touch-Tone phone to receive a report of the alarm condition and acknowledge the alarm by entering the acknowledgment code.

> **NOTE**: An alarm cannot be acknowledged using a pulse (rotary) telephone unless the *Callback Acknowledgment* feature is enabled.

Below is an example of what the 1400 will say when you call it back to acknowledge a typical alarm:

> "Hello, this is 555-2278, 'Acme Medical Laboratory,' Zone One, 'Temperature in Refrigerator One,' a high temperature alarm exists, it is now 50 degrees Fahrenheit, too high. Listen to sound for ten seconds."
>
> "Enter acknowledgment code."

The 1400 will now wait 10 seconds for a Touch-Tone acknowledgment code to be entered. After the last digit of the acknowledgment code has been received, the 1400 will respond by saying: "Alarm Acknowledged." The alarm has been acknowledged and the unit will hang up. Once the alarm has been acknowledged, the dialout process stops.

If a Touch-Tone acknowledgment code is not received, the 1400 will offer you a second chance to enter it, responding with: "beep," "error," "Enter acknowledgment code." If an acknowledgement code is still not received, then the 1400 will respond by saying: "beep," "error," "goodbye." The alarm has not been acknowledged. The 1400 will hang up and wait for you to call back and enter the acknowledgment code. This waiting period is called the INTERCALL TIME. During this time you may call the unit back from a Touch-Tone phone and the unit will give a voice report. Once you receive the complete report, enter the code to acknowledge the alarm.

NOTE: An alarm cannot be acknowledged using a pulse (rotary) telephone unless the *Callback Acknowledgment* feature is enabled.

TIP: When the 1400 is programmed to make calls to pagers, make sure the intercall delay time is long enough to give the person carrying the pager some time to get to a phone to call the unit back.

Alarm Acknowledgment—Automatic (Max Calls)

The 1400 has the ability to acknowledge itself by using the Max Calls function. The unit keeps a count of the number of phone calls it makes for a particular alarm. Once the number of calls made reaches Max Calls, the 1400 will acknowledge the alarm and stop the dialout process. The default setting for Max Calls is 100.

CALL-IN STATUS

You can also call into the 1400 using a Touch-Tone telephone to obtain a status report. After answering, the 1400 will recite a status report. Immediately following the status report, the 1400 allows you to use Touch-Tone commands to enable/disable zones, change limits, control the output, etc. See the next section, Remote Commands via Touch-Tone Phone.

Below is an example of a voice status report:

"Hello, this is 555-2278, 'Acme Medical Laboratory'

"Zone one, 'Temperature in refrigerator one,' 38 degrees Fahrenheit, OK

"Zone two, 'Temperature in refrigerator two,' 40 degrees Fahrenheit, OK

"Zone three, 'Water pressure monitor,' OK

"Zone four, 'Nitrogen gas tank level in percent,' 15, too low, acknowledged alarm exists

"Sound is OK"

"Power is ON"

"Battery is OK"

"Output is off."

"Good-Bye"

REMOTE COMMANDS VIA TOUCH-TONE PHONE

You can issue a number of commands to the 1400 remotely using a Touch-Tone telephone. This command mode can be entered at any time during the status report. Simply press a Touch-Tone and the unit will halt the report and respond with "OK." You are now in Touch-Tone command mode. Commands are available to perform the following functions:

- Enable and disable zones, power monitoring, and sound monitoring
- Recite/Set High and Low alarm limits
- Recite/Set telephone numbers
- Record/Play custom voice messages
- Recite/Set the relay output
- Activate the microphone for listen-in
- Recite status report
- Recite alarm history

The commands are put together based on the letters of a touch-tone telephone. See typical telephone keypad layout below.

Figure 1: A telephone keypad

Many of the commands use three letters that represent an abbreviation of the selected command. For example, to Set a High limit on Zone 1 you would press S + H + 1 (or in numeric form 7 + 4 + 1)

The tables below list all of the touch-tone commands that are supported. Commands are listed in both character and numeric formats. The # key is used as an ENTER key. Use the * key to represent a negative sign or to represent the [CODE] key when programming telephone numbers.

Enable/Disable Zones

This command will toggle the selected zone between the enabled or disabled state.

Description	Touch-Tone Command
Enable/Disable Zone	* + Z(0) + (zone number)

Set and Recite High & Low Alarm Limits

The following commands are used to set or recite the Low Alarm Limit for any Zone.

Description	Touch-Tone Command
Set Zone Low Limit	S(7) + L(5) + (zone number) + (value) + #

Description	Touch-Tone Command
What Is Zone Low Limit	W(9) + L(5) + (zone number)

The following commands are used to set or recite the High Alarm Limit for any Zone.

Description	Touch-Tone Command
Set Zone High Limit	S(7) + H(4) + (zone number) + (value)+ #

Description	Touch-Tone Command
What Is Zone High Limit	W(9) + H(4) + (zone number)

Set and Recite Telephone Numbers

The following commands will allow you to program and recite dialout telephone numbers. You may need to use the Special Dialing Codes below.

Special Dialing Codes Summary

Code 1: Numeric pager type
Code 2: Wait for answer
Code 3: Change to Touch-Tone
Code 4: Pause
Code 5: *
Code 6: #

Description	Touch-Tone Command
Setting a phone number	S(7) + T(8) + (entry 1–8) + (telephone number) + #

Description	Touch-Tone Command
Reciting a phone number	W(9) + T(8) + (entry 1–8)

Record and Play Custom Voice Messages

The following commands will allow you to record and play back custom voice messages for the ID message (0) and each zone (1–4).

Description	Touch-Tone Command
Record a Message	S(7) + M(6) + (entry 0–4)

Description	Touch-Tone Command
Play a Message	W(9) + M(6) + (entry 0–4)

Control the Relay Output

The following commands will allow you to check the status of the relay output and to toggle the Relay Output On and Off.

Description	Touch-Tone Command
Reciting the Output Status	W(9) + R(7) + O(6)

Description	Touch-Tone Command
Switching the Output	S(7) + R(7) + O(6)

Activate Microphone Listen-in

The following command will allow you to activate the microphone listen-in for the programmed duration.

Description	Touch-Tone Command
Activate Mic Listen-in	M(6) + I(4) + C(2)

Request Status Report

The following command will initiate a status report.

Description	Touch-Tone Command
Recite status report	W(9) + S(7) + R(7)

Request Alarm History

The following command will recite the alarm history.

Description	Touch-Tone Command
Recite alarm history	H(4) + I(4) + S(7)

Hang-up

The following command will make the 1400 hang up the telephone line.

Description	Touch-Tone Command
Hang-up the phone line	B(2) + Y(9) + E(3)

NOTE: If a security code is enabled, the 1400 will prompt you with "Enter security code." Enter the four-digit keypad security code plus "#" to enter touch-tone command mode. If entered correctly, the 1400 will respond with "OK" and you can proceed to enter the commands. If entered incorrectly, the unit will give you one more chance. If it is incorrect a second time, the unit will say "Error, goodbye" and hang up.

APPENDIX A: Checking Your Sensaphone 1400 for Proper Operation

We recommend that you test your Sensaphone 1400 weekly to be sure it is functioning properly. This will ensure that when a problem arises the 1400 will be ready to alert the appropriate personnel. Phonetics, Inc. also recommends you keep a log of performed tests, and has provided you with a Test Log template at the back of this manual.

There are several tests that can be performed:

1. Call the unit and listen to the Status Report. This will test the unit's ability to answer the phone and speak a message. It will also verify that the inputs are reading properly, the alarm conditions are OK, the electricity is on, the microphone is functioning (optional), and that the batteries are OK.
2. Create a test alarm on each input and allow the unit to contact all programmed telephone numbers. This will make sure that the 1400 is programmed properly. It will also prepare personnel to respond appropriately when they receive a call from the 1400. Listed below are suggestions on how to trip test alarms:

   • Temperature sensors: Heat or cool the sensor.

   • Motion sensors: Have someone walk in front of the sensor.

   • Door/window sensors: open the door/window.

   • Water sensors: Apply a small amount of water beneath the sensor or use a wet towel and touch it to the sensor probes.

   • Humidity sensors: Raise the humidity around the sensor by holding a cup of very hot water beneath the sensor.

   • NO/NC Contacts: Open or close the contact.

Allow the unit to contact all programmed telephone numbers. This will make sure that the 1400 is programmed properly. It will also prepare personnel to respond appropriately when they receive a call from the 1400.

3. Test the batteries by unplugging the AC adapter and making sure that the 1400 continues to function. Check that the BATTERY OK LED remains on steady. Press WHAT IS, then STATUS on the keypad, and listen to the status report. Make sure the report states that “power is off” and “battery is OK.” Keep the AC adapter unplugged so that a Power Failure alarm occurs. Allow the unit to dial all programmed telephone numbers while running on battery backup. Plug in the AC adapter after the unit has finished dialing all of the telephone numbers.

APPENDIX B: Replacing the Back-up Battery

The back-up battery will provide about 3–5 years of service life depending on usage and temperature. After 5 years (or when back-up time is insufficient) the battery should be replaced. Replacement batteries can be ordered from Sensaphone *(Part number BAT-0020).* To replace the battery, follow the instructions below:

> **WARNING**: When removing and replacing the battery, be careful not to short out the battery terminals on the bracket or back panel. A large spark and/or battery damage could result.

1. Turn the power switch off and unplug the power transformer.
2. Loosen the compression wiring connectors and allow 6-10" of cable slack to come into the enclosure. This will make it easier to turn the panel over.
3. Remove the four corner screws securing the keypad/pcb panel and turn the panel over.
4. Remove the connectors from the battery by carefully pulling and wiggling the connectors from the battery tabs.
5. Remove the screws holding the battery bracket and remove the bracket.
6. Dispose/Recycle the old battery following local disposal regulations for lead batteries.
7. Attach the battery connector at the end of the BLACK wire to the -(negative) terminal of the new battery.
8. Attach the battery connector at the end of the RED wire to the +(positive) terminal of the new battery.
9. Insert the new replacement battery into the slot and replace the bracket. Secure the bracket with the two screws.
10. Place the main panel over the four metal stand-offs and reattach the four corner screws.

11. Readjust the cables through the compression connectors and secure the fittings.

12. Plug the power transformer into the outlet and turn on the power switch.

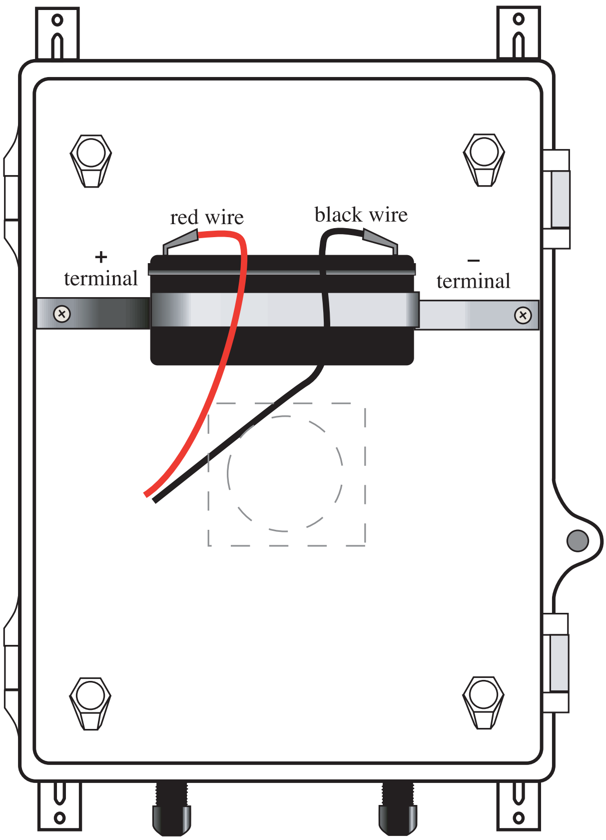


Figure 1: Back-up Battery placement

APPENDIX C: Troubleshooting the 1400

In the event that a problem is encountered, this section will assist you in determining the cause so you can return the unit to its normal monitoring routine with minimal interruption.

Most problems with the 1400 are easy to identify and quickly corrected. See the information under the following general headings:

- Communications/Dialout functions
- Temperature monitoring
- 4–20mA monitoring
- Sound level monitoring
- Other monitoring functions

If you have tried the solutions outlined in this section and are not satisfied with the results, call Sensaphone Technical Support toll-free at 1-877-373-2700. If it is determined that your 1400 requires repair please follow the instructions in Appendix H for returning your unit for service.

COMMUNICATIONS/DIAL-OUT:

Problem 1

The 1400 fails to dial out.

Cause	Solution
a) The telephone number may be incorrectly programmed.	Recheck programming steps and use the dial-out test mode to listen to the unit dial. Refer to Chapter 5.
b) Tone or pulse (the current dialing method) is not compatible with the telephone line on which the 1400 is installed.	Switch from the current setting: from tone to pulse, or from pulse to tone. Refer to Chapter 5.
c) Recognition Time is too long. An alert condition does not remain in effect long enough to become a valid alarm.	Reprogram Recognition Time. Set the Recognition Time to the minimum duration required to create a valid alarm. If possible, test the new setting by deliberately creating an alert condition. Refer to Chapter 4.
d) Max Calls is set to zero.	Reprogram Max Calls. It is a good idea to set your Max Calls to at least equal the number of dial-out telephone numbers programmed. Refer to Chapter 5.
e) The 1400 is connected to an incompatible telephone line.	The 1400 must be connected to a standard (2-wire analog) telephone line, not a digital extension to a phone system. If the unit will not dial out and the factors previously listed have been ruled out, try connecting the unit to a standard residential telephone line.

Problem 2

The 1400 will not answer the telephone when called for a Status Report or alarm acknowledgment.

Cause	Solution
a) Rings Until Answer is incorrectly programmed.	Recheck programming of Rings Until Answer. Refer to Chapter 5.
b) The 1400 is connected to an incompatible telephone line.	Some telephone systems will not allow the telephone to ring beyond 4 rings. If your 1400's Rings Until Answer is set at more than 4 rings, you may not be able to access the unit. Try setting the Rings Until Answer to less than 4 rings. If this does not correct the problem, it may indicate telephone line incompatibility. In this case, try connecting the 1400 to a standard, residential telephone line.

Problem 3

The 1400 will not answer the telephone for Callback Acknowledgment.

Cause	Solution
You did not allow the telephone to ring 10 times. Note: If the TAD (telephone answering device) is disabled, the telephone rings ten times before the 1400 answers. If the TAD is enabled, you must call and let the line ring once; hang up and call back again within 30 seconds. The 1400 will answer on the first ring and acknowledge the alarm.	When calling the 1400, and the TAD is disabled, allow the telephone to ring 10 times. Refer to Chapter 5.

COMMUNICATIONS/DIAL-OUT *(continued)*

Problem 4

The 1400 recites the alarm message or Status Report over the telephone, but is silent at the installation site.

Cause	Solution
The local voice mute feature is in effect.	Deactivate local voice mute. Refer to the programming steps in Chapter 5.

Problem 5

The 1400 and telephone answering device (sharing the same line) answer incoming calls simultaneously.

Cause	Solution
The 1400's number of Rings Until Answer is set to equal the number of rings set for the telephone answering device.	Change the number of Rings Until Answer for the 1400. Refer to Chapter 5.

TEMPERATURE MONITORING:

Problem 1

Can't program temperature limits; or the unit won't read the temperature sensor.

Cause	Solution
The zone isn't configured to read a temperature sensor.	Press SET and CONFIGURE to program the zone. For 10K thermistor, you must manually configure. See Chapter 4.

Problem 2

The temperature reading is -121° F or -85° C [2.8K]; or -87° F or -85° C [10K].

Cause	Solution
The temperature sensor has been disconnected or has broken wires.	Examine the wires to temperature sensor and connect or replace wiring.

Problem 3

The temperature reading is 115° F or 57° C [2.8K]; or 168° F or 76° C [10K].

Cause	Solution
Temperature sensor wires are touching or have shorted.	Verify and correct wiring.

TEMPERATURE MONITORING *(continued)*

Problem 4

Temperature reading is inaccurate.

Cause	Solution
a) The zone is configured for the wrong type of thermistor (i.e., 2.8k vs. 10k)	Manually configure the zone as described in Chapter 4.
b) Temperature sensing may be affected by a source of ambient heat (ie., direct sunlight, or heat duct proximity).	Try moving the sensor to a different location.
c) Temperature may require calibration.	After moving or placing the sensor away from ambient heat sources, the temperature may be calibrated to offset inaccurate normal reading by several degrees. Refer to Chapter 4.
d) The unit is using the wrong temperature scale (Fahrenheit vs. Celsius).	Verify temperature scale. Refer to Chapter 4.

4–20mA MONITORING:

Problem 1

Can't program 4–20mA range; or the unit won't read the 4–20mA sensor.

Cause	Solution
The zone isn't configured to read a 4–20mA sensor.	Press SET and CONFIGURE to program the zone. See Chapter 4 for information on zone configuration.

Problem 2

The zone input is not reading correctly.

Cause	Solution
a) No power connected to the transducer.	Connect a power supply as shown in Chapter 2.
b) Incorrect wiring.	Inspect wiring. Make sure polarity is correct as shown in Chapter 2.
c) The table range is incorrectly programmed.	Program the table range for the cailibrated range of the transducer.
d) The input is not configured for 4–20mA.	Configure the zone for 4–20mA. Refer to Chapter 4.
e) Multiple devices connected in loop.	The 1400's zone is single-ended and terminates to ground. Because of this, the 1400 must be the last device in the loop, and in some cases the ONLY device. For certain installations, it may be necessary to use a signal isolator.

SOUND LEVEL MONITORING:

Problem 1

False high sound alarms occur frequently.

Cause	Solution
a) The programmed sound sensitivity results in over-sensitivity to non-alarm sound as well as alarm sound.	Reprogram the sound sensitivity (calibration). Refer to Chapter 4.
b) Sound Recognition Time is too short.	Lengthen the sound Recognition Time. Refer to Chapter 4.

Problem 2

High sound does not cause an alarm.

Cause	Solution
a) The microphone is not close enough to the high sound source, or the programmed sound setting results in a lack of sensitivity to high sound.	Move the microphone closer or reprogram the sound sensitivity. Refer to Chapter 4.
b) No remote microphone (optional) connected to the unit.	Connect a remote microphone to the Mic terminals.

OTHER MONITORING:

Problem 1

Alarm status of a zone is incorrect.

Cause	Solution
Incorrect zone configuration.	Reconfigure the zone. See Chapter 4.

Problem 2

False power-out alarms.

Cause	Solution
Programmed Recognition Time is too short.	AC power may be subject to brief interruptions. To avoid frequent, false alarms, increase the power Recognition Time. Refer to Chapter 4.

Problem 3

The 1400 does not recognize power failure.

Cause	Solution
a) Battery is either incorrectly installed or drained.	To verify proper battery function, unplug the unit and verify continued operation using battery only. If unit ceases to function, replace the battery. Refer to Appendix B.
b) Recognition time setting is too long.	Reprogram Recognition Time. Set the Recognition Time to the minimum required before a valid alarm occurs. If possible, test the condition by deliberately creating an alert condition. Refer to Chapter 4.

OTHER MONITORING (continued)

Problem 4

The 1400 does not recognize any alarm.

Cause	Solution
a) Zones for alarm are disabled.	Enable the zones for alarm. See Chapter 4.
b) Programmed Recognition Time is too long.	Reprogram Recognition Time. Set the Recognition Time to the minimum required for a monitored condition to become a valid alarm. If possible, test the condition by deliberately creating an alert condition. Refer to Chapter 4.

Problem 5

The batteries drain prematurely.

Cause	Solution
The unit's AC transformer is unplugged or for some other reason full AC power is not available to the unit.	The batteries will take over powering the unit when the AC transformer is unplugged from the 120 VAC outlet. When storing the unit, be sure to turn the power switch off.

If the solutions offered above do not appear to correct the problem, apply the following steps, in the order shown.

- Turn the power switch off.
- Wait one minute for the 1400 to completely power down.
- Turn the power switch on.
- Reconfigure the zones. Refer to Chapter 4.

Refer to Chapter 2, Installation, for additional information on batteries and installation procedures. Contact Sensaphone Technical Support toll-free at 1-877-373-2700.

APPENDIX D: 2.8 and 10K Thermistor Tables

2.8K Thermistor Data

Degrees Celsius	Resistance (Ohms)
-50	187,625
-40	94,206
-30	49,549
-20	27,180
-10	15,491
0	9,142
10	5,572
20	3,498
30	2,256
40	1,491
50	1,009
60	697
70	490
80	351

10K Thermistor Data

Degrees Celsius	Resistance (Ohms)
-30	135.2K
-20	78.91K
-10	47.54
0	29.49K
10	18.79K
20	12.25K
30	8,194
40	5,592
50	3,893
60	2,760
70	1,990

APPENDIX E: 1400 Technical Specifications

Environmental Inputs

Number of Zones: 4

Zone Connector: terminal block

Zone Types: N.O./N.C. contact, 2.8K (-109° to 115° F; -85° to 57° C), and 10K thermistor (-87° to 168° F; -66° to 76° C), and 4–20mA (-10,000 to 10,000)

Zone characteristics: 28KΩ to 2.5V (temperature/contact) or 250 Ohms to ground (4–20mA)

A/D Converter Resolution: 10 bits ±2 LSB

Zone Protection: Metal oxide varistors, and fast-acting diode clamps

Microphone

Internal: for recording custom voice messages

External (optional): For listening in to on-site sounds and high sound level alarms

- Mic Connector: terminal block
- Mic Type: Electret Condenser
- Mic Impedance: 2.2KΩ

Phone Interface

Terminals for connection to a two-wire analog telephone line

Line seizure terminals for connecting extension telephone devices

LED Indicators: (4) Zone Alarms, Sound, Power, Battery OK, Phone in Use, Output On, and System On

Relay Output: 2A 120VAC/2A 24VDC—Programmable for automatic or manual switching

Power Supply

Power Supply: 120VAC/12VDC 60Hz 6W wall plug-in transformer (230VAC/12VDC 50/60Hz power supply optional)

Power Consumption: 5 Watts

Power Protection: Metal Oxide Varistor

Battery Backup: 6V 1.3 AH sealed gel cell, provides up to 24 hours of back-up time

Environmental

Operating Temperature: 32–122 deg F (0–50 deg C)

Operating Humidity: 0–90% RH non-condensing

Storage Temperature: 32–140 deg F

Physical

Dimensions: 12.1"h x 7.3"w x 4.5"d

Weight: 5 lbs.

Enclosures:

• Solid Door Enclosure: ABS/PC Blended Plastic, UL94-5VB Flammability rating, NEMA Type 1, 2, 3, 3R, 4, 4X, 12 & 13, IEC529, IP66.

• Clear Door Enclosure: ABS/PC blended plastic, UL94–5VB flammability rating; UV stabilized. NEMA Type 1, 2, 3, 3R, 4, 4X, 12 &13, IEC529–IP65.

Standards

- FCC Part 15 Class A, USA Emission Standards

- FCC Part 68 (47 C.F.R. Part 68), USA Telecommunications Standards

- ICES-003 Issue 4 Class A, Canadian Emission Standards

- Complies with CS-03 Issue 8, Canadian Telecommunications Standards

- NRTL Listed for compliance to UL60950-1, USA Safety Standards

- NRTL Listed for compliance to CSA C22.2 No. 60950-1, Canadian Safety Standards

Specifications subject to change

APPENDIX F: 1400 Quick Reference Guide

Communications

ID Number
Identification number of the 1400
[SET] or [WHAT IS] + [ID/POWER]
Range=0–16 digits, Default=blank

ID Message
Custom message identifying the 1400
[SET] or [WHAT IS] + [MESSAGE] + [ID/POWER]
Max: 8 seconds Default=N/A

Zone Message
Message identifying the zone in alarm
[SET] or [WHAT IS] + [MESSAGE] + [zone #]
Max:5 seconds Default=N/A

Voice Repetitions
Number of times alarm message is repeated over the phone
[SET] or [WHAT IS] + [VOICE REPS]
Min: 1 reps, Max: 10 reps Default=3 reps

Dial-Out Phone Numbers
Phone numbers dialed to report alarm conditions
[SET] or [WHAT IS] +[PHONE NUMBER] + [number 1–8]
Max: 8 numbers, 48 digits each Default=N/A

Call Delay
Time delay until first call is made
[SET] or [WHAT IS] + [CALL DELAY] (min:sec)
Min: 00:00 Max: 60:00 Default=00:30

Intercall Time
Time delay between phone calls
[SET] or [WHAT IS] + [INTERCALL TIME](min:sec)
Min: 00:10, Max: 60:00 Default=00:30

Max Calls
Number of calls until unit self-acknowledges
[SET] or [WHAT IS] + [MAX CALLS]
Min: 0 calls, Max: 255 calls Default=100 calls

(TAD) Answering Device Compatibility
Allows 1400 to bypass answering devices on the same line
[SENSOR ON/OFF] + [RINGS/TAD/*]
On or Off, Default=Off

Rings Until Answer
Number of rings until unit answers an incoming call
[SET] or [WHAT IS] + [RINGS/TAD/*]
Min: 1 ring, Max: 15 rings DEFAULT=4 rings

Speaker Mute
Turns off the speaker during alarm conditions
[SENSOR ON/OFF] + [MESSAGE/MUTE]
On or Off Default=Off

Call Progress
Disables call progress detection feature
[SENSOR ON/OFF] + [STATUS/CONFIGURE]
On or Off Default=On

Callback Acknowledgment	Allows alarm acknowledgment with 10 rings [SENSOR ON/OFF] + [CODE] On or Off Default=Disabled *(off)*
Tone or Pulse Dialing	Dialing method—touch-tone or pulse [SENSOR ON/OFF] + [PHONE NUMBER T/P] Tone or Pulse Default=Tone

Alarm Programming

Temp Alarm Limits	High and low temperature alarm limits [SET] or [WHAT IS] + [ALARM LIMITS]+[zone #] Min: -109°F/-65°C Max:168°F/76°C Default=Low: 0°F; High:100°F
4–20mA Table Range	Defines upper and lower range of 4–20mA sensor [SET] or [WHAT IS] + [TABLE RANGE] + [zone #] Min: -10,000, Max: 10,000 Default=Low: 0, High:100
4–20mA Alarm Limits	High and low alarm limits [SET] or [WHAT IS] + [ALARM LIMITS] + [zone #] Min: -10,000, Max: 10,000 Default=Low: 0, High: 100
Zone Calibrate	Offset correction factor [temp/4-20mA] [SET] or [WHAT IS] + [CALIBRATE] + [zone #] Min: -15°/-100, Max: 15°/100 Default=0
Auto. Zone Configuration	Automatically configures all zones. [SET] + [STATUS/CONFIGURE] + 0 Default=n/a
Manual Zone Configuration	To configure an individual zone type (r*equired* for 10K Temp) [SET] + [STATUS/CONFIGURE] + [zone #] + [type] 1 = NO, 2 = NC, 3 = 2.8K Temp, 4 = 10K 5 = 4–20mA Default=n/a
Recognition Time Zones 1–4	Length of time a fault condition must exist to trip an alarm [SET] or [WHAT IS] + [REC TIME] + [zone #] Min:00:00, Max: 540:00 Default=00:03 (min:sec)
Rec Time: Power Failure	Length of time the power must be off to trip an alarm [SET] or [WHAT IS] + [REC TIME] + [POWER] Min: 00:00, Max: 540:00 Default=05:00 (min:sec)
Rec Time: High Sound Level	Length of time the sound must be high to trip an alarm [SET] or [WHAT IS] + [REC TIME] + [SOUND] Min: 00:05, Max: 00:60 Default=00:08 (min:sec)
Sound Level Alarm Sensitivity	Microphone sensitivity for high noise level alarm [SET] or [WHAT IS] + [CALIBRATE] + [SOUND] Min: 1 (most), Max: 160 (least) Default=32
Enable/Disable Zone	Turns zone alarm detection on or off [SENSOR ON/OFF] + [zone #] On or Off Default=Enabled *(on)*

Reset Time	Length of time until an alarm resets [SET] or [WHAT IS] + [RESET TIME] + [Zone #] 0=(disabled) Min:30, Max:1440, Default = 0
Power Alarm Enable/Disable	Turns power alarm detection on or off [SENSOR ON/OFF] + [POWER] On or Off Default=Enabled *(on)*
Sound Alarm Enable/Disable	Turns high sound level alarm detection on or off [SENSOR ON/OFF] + [SOUND] On or Off Default=Enabled *(on)*
Temperature Scale	Selects between Fahrenheit and Celsius [SENSOR ON/OFF] + [TEST/°F/°C] Fahrenheit or Celsius Default=Fahrenheit
Temperature-Only Status Report	A limited status report that only includes inputs configured as temperature. [WHAT IS] + [TEST]
Designating a Zone Unused	Removes zone from status and alarm reports [SENSOR ON/OFF] + [SET] + [zone #] On or Off Default=on

Special Functions

Dial-Out Test Mode	Simulates alarm to test telephone programming [SET] + [TEST] + [# key 1–8] Default=none
Listen-In Time	Length of listen-in time during call-in status report [SET] or [WHAT IS] + [LISTEN TIME] Min: 0 sec, Max: 255 sec Default=00:00 (min:sec)
Acknowledgment Code	To create an individual user's 4-digit acknowledgment code [SET] + [CODE] + [# key 1–8] Default=555 for single-user mode
Date & Time	Internal clock/calendar [SET] or [WHAT IS] + [DATE/TIME/#] Date: mmddyy, Time: hhmm Default=none
Alarm History	Recites last 10 alarms [WHAT IS] + [HISTORY] Default=n/a
Reset History	Clears the alarm history [SET] + [HISTORY] Default=n/a
Switch Output	Turns output relay on or off (in manual mode) [SENSOR ON/OFF] + [OUTPUT] On or Off Default=off

Output Mode	Program relay output as manual or automatic for specific zone [SET] or [WHAT IS] + [OUTPUT] + [mode number] Default=none
Remote Security	Prohibits programming changes via telephone [SET] or [WHAT IS] + [ENTER/LOCK] + [4 digit code] Default=unlocked

Press [ENTER] after all Key Sequences starting with [SET].

Use [SET] to establish parameters, [WHAT IS] to verify them.

SPECIAL KEY FUNCTIONS

RING/TAD/*

Used to enter a minus sign for negative alarm limits or calibrations.

DIALOUT CODES

CODE 1 Numeric pager call type

CODE 2 Inserts a "Wait for answer"

CODE 3 Change to Touch-Tone dialing

CODE 4 Pause

CODE 5 *

CODE 6 #

APPENDIX G: Accessories

The sensors and accessories listed below are available from Phonetics, Inc., and represent the most commonly used devices. Other dry contact sensors or 4–20mA transducers, designed for more specialized applications, may also be used. Commercial or industrial electrical supply houses can provide devices to monitor virtually any condition. For further information, contact a Sensaphone Sales Associate toll-free at 1-877-373-2700.

PART NUMBER	SENSOR/ SWITCH
FGD-0006	Magnetic Reed Switch
FGD-0007	Passive Infra-Red Detector
FGD-0010	50' two-conductor #22AWG shielded accessory Cable
FGD-0013	Spot Water Detector
FGD-0022	Temp° Alert
FGD-0023	ISOTEL Surge Protector
FGD-0027	Humidistat
FGD-0049	Smoke Detector with Built-in Relay
FGD-0052	Humidity Transmitter
FGD-0053	24VDC Power Supply
FGD-0054	Power-Out Alert™
FGD-0056	Zone Water Detector w/Water Rope
FGD-0057	External Microphone
FGD-0060	Line Seizure Kit
FGD-0063	10' additional Water Rope for FGD-0056
FGD-0100	2.8K Remote Temperature Sensor
FGD-0101	2.8K Weatherproof Temperature Probe
FGD-0102	10K Weatherproof Temperature Probe
FGD-0205	Multipoint Wireless I/O System

APPENDIX H: Returning Your 1400 for Repair

In the event that the 1400 does not function properly, we suggest that you do the following:

1. Record your observations regarding the 1400's malfunction.
2. Call Sensaphone Technical Support toll-free at 1-877-373-2700 or e-mail support@sensaphone.com prior to sending the unit to Sensaphone for repair. Our product support specialists are able to diagnose and correct many unit setup and programming problems over the phone.

If the unit must be sent to Phonetics, Inc. for Servicing, please do the following:

1. Turn the power switch Off, disconnect all wiring and unplug the unit.
2. Carefully pack the unit to avoid damage in transit. Use the original container (if available) or a sturdy shipping box.
3. To avoid shipping delays, you must include the following information:

   a) Your name, address and telephone number.

   b) A note explaining the problem.

A convenient form is available for sending your unit in for repair. Just go to *www.sensaphone.com* and click *Support*, then *Repair Services.*

4. Ship your package to the address below:

   SERVICE DEPARTMENT
   Phonetics, Inc.
   901 Tryens Road
   Aston, PA 19014

5. Ship prepaid and insured via UPS or US Mail to ensure a traceable shipment with recourse for damage or replacement.

1400 Index

T

W

Z

Test Log

Date	Inputs	Dialout	Call-In	Battery		Tested By
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
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OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 11

VFD 1000 PARTIAL

YASKAWA

YASKAWA AC Drive P1000

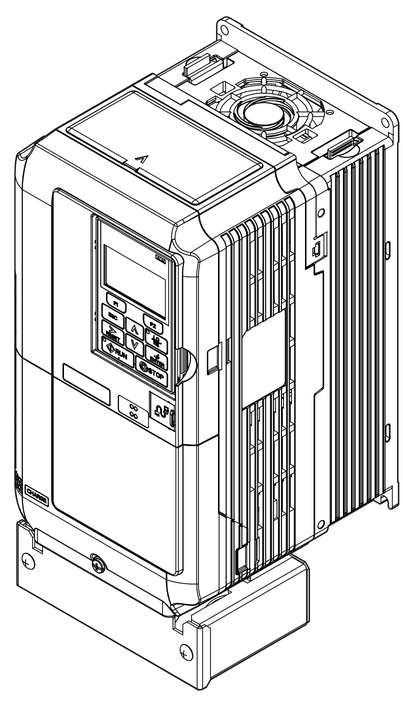
Industrial Fan and Pump Drive

Technical Manual

Type: CIMR-PU□A □

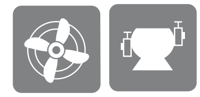
Models: 200 V Class: 3/4 to 175 HP ND
400 V Class: 3/4 to 500 HP ND
600 V Class: 2 to 250 HP ND

To properly use the product, read this manual thoroughly and retain for easy reference, inspection, and maintenance. Ensure the end user receives this manual.



MANUAL NO. SIEP YAIP1U 01A

◆ Quick Reference

Easily Set Parameters for Specific Applications	
Preset parameter defaults are available for setting up applications. ***Refer to Application Selection on page 116***.	

Perform Auto-Tuning
Automatic tuning sets motor parameters. ***Refer to Auto-Tuning on page 119***.

Maintenance Check Using Drive Monitors
Use drive monitors to check if fans, capacitors, or other components require maintenance. ***Refer to Performance Life Monitors Maintenance Monitors on page 327***.

Fault Display and Troubleshooting
Refer to Drive Alarms, Faults, and Errors on page 277 and ***Refer to Troubleshooting without Fault Display on page 312***.

Standards Compliance	
Refer to European Standards on page 498 and ***Refer to UL and CSA Standards on page 505*** <1> .	CE c UL US LISTED SA

<1> CE marking applies to 200 V class and 400 V class models only.

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Table of Contents

Preface & General Safety

This section provides safety messages pertinent to this product that, if not heeded, may result in fatality, personal injury, or equipment damage. Yaskawa is not responsible for the consequences of ignoring these instructions.

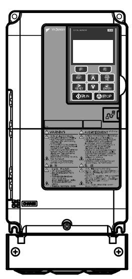
i.1 Preface

Yaskawa manufactures products used as components in a wide variety of industrial systems and equipment. The selection and application of Yaskawa products remain the responsibility of the equipment manufacturer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any Yaskawa product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All systems or equipment designed to incorporate a product manufactured by Yaskawa must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by Yaskawa must be promptly provided to the end user. Yaskawa offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the Yaskawa manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. Yaskawa assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

This manual is designed to ensure correct and suitable application of drives. Read this manual before attempting to install, operate, maintain, or inspect a drive and keep it in a safe, convenient location for future reference. Be sure you understand all precautions and safety information before attempting application.

◆ Applicable Documentation

The following manuals are available for P1000 series drives:

	P1000 Series AC Drive Technical Manual (SIEPYAIP1U01)
	This manual provides detailed information on parameter settings, drive functions, and MEMOBUS/ Modbus specifications. Use this manual to expand drive functionality and to take advantage of higher performance features. This manual is available for download on our documentation website, www.yaskawa.com.
	P1000 Series AC Drive Quick Start Guide (TOEPYAIP1U01)
	Read this guide first. This guide is packaged together with the product and contains basic information required to install and wire the drive. It also gives an overview of fault diagnostics, maintenance, and parameter settings. The purpose of this guide is to prepare the drive for a trial run with an application and for basic operation. This manual is available for download on our documentation website, www.yaskawa.com.

◆ Symbols

Note: Indicates a supplement or precaution that does not cause drive damage.

TERMS **Indicates a term or definition used in this manual.**

◆ Terms and Abbreviations

TERMS
- **Drive:** Yaskawa P1000-Series Drive
- **BCD:** Binary Coded Decimal
- **H:** Hexadecimal Number Format
- **IGBT:** Insulated Gate Bipolar Transistor
- **kbps:** Kilobits per Second
- **MAC:** Media Access Control
- **Mbps:** Megabits per Second
- **r/min:** Revolutions per Minute
- **V/f:** V/f Control

◆ Trademarks

- CANopen is a trademark of CAN in Automation (CiA).
- CC-Link is a trademark of CC-Link Partner Association (CLPA).
- DeviceNet is a trademark of Open DeviceNet Vendor Association, Inc. (ODVA).
- PROFIBUS-DP is a trademark of PROFIBUS International (PI).
- MECHATROLINK-I/MECHATROLINK-II are trademarks of MECHATROLINK Members Association (MMA).
- Other companies and product names mentioned in this manual are trademarks of those companies.

i.2 General Safety

◆ Supplemental Safety Information

General Precautions
• The diagrams in this manual may be indicated without covers or safety shields to show details. Replace the covers or shields before operating the drive and run the drive according to the instructions described in this manual. • Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable. • The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual. • When ordering a new copy of the manual due to damage or loss, contact your Yaskawa representative or the nearest Yaskawa sales office and provide the manual number shown on the front cover. • If nameplate becomes worn or damaged, order a replacement from your Yaskawa representative or the nearest Yaskawa sales office.

WARNING
Read and understand this manual before installing, operating or servicing this drive. The drive must be installed according to this manual and local codes. The following conventions are used to indicate safety messages in this manual. Failure to heed these messages could result in serious or fatal injury or damage to the products or to related equipment and systems.

DANGER
Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.

WARNING
Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

WARNING! *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

CAUTION
Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.

CAUTION! *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

NOTICE
Indicates a property damage message.

NOTICE: *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

◆ Safety Messages

⚠ DANGER

Heed the safety messages in this manual.

Failure to comply will result in death or serious injury.

The operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply will result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.

⚠ WARNING

Sudden Movement Hazard

System may start unexpectedly upon application of power, resulting in death or serious injury.

Clear all personnel from the drive, motor and machine area before applying power. Secure covers, couplings, shaft keys and machine loads before applying power to the drive.

Electrical Shock Hazard

Do not attempt to modify or alter the drive in any way not explained in this manual.

Failure to comply could result in death or serious injury.

Yaskawa is not responsible for any modification of the product made by the user. This product must not be modified.

Do not allow unqualified personnel to use equipment.

Failure to comply could result in death or serious injury.

Maintenance, inspection, and replacement of parts must be performed only by authorized personnel familiar with installation, adjustment and maintenance of AC drives.

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Make sure the protective earthing conductor complies with technical standards and local safety regulations.

Because the leakage current exceeds 3.5 mA in models 4A0414 and larger, IEC 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.

Always use appropriate equipment for Ground Fault Circuit Interrupters (GFCIs).

The drive can cause a residual current with a DC component in the protective earthing conductor. Where a residual current operated protective or monitoring device is used for protection in case of direct or indirect contact, always use a type B GFCI according to IEC 60755.

Fire Hazard

Do not use an improper voltage source.

Failure to comply could result in death or serious injury by fire.

Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.

⚠ WARNING

Install adequate branch circuit protection according to applicable local codes and this Installation Manual. Failure to comply could result in fire and damage to the drive or injury to personnel.

The device is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V class) and 480 Vac maximum (400 V class), and 600 Vac maximum (600 V class) when protected by branch circuit protection devices specified in this supplement.

Crush Hazard

Do not use this drive in lifting applications without installing external safety circuitry to prevent accidental dropping of the load.

The drive does not possess built-in load drop protection for lifting applications.

Failure to comply could result in death or serious injury from falling loads.

Install electrical and/or mechanical safety circuit mechanisms independent of drive circuitry.

⚠ CAUTION

Crush Hazard

Do not carry the drive by the front cover.

Failure to comply may result in minor or moderate injury from the main body of the drive falling.

NOTICE

Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards.

Failure to comply may result in ESD damage to the drive circuitry.

Do not perform a withstand voltage test on any part of the drive.

Failure to comply could result in damage to the sensitive devices within the drive.

Do not operate damaged equipment.

Failure to comply could result in further damage to the equipment.

Do not connect or operate any equipment with visible damage or missing parts.

If a fuse is blown or a Ground Fault Circuit Interrupter (GFCI) is tripped, check the wiring and the selection of the peripheral devices.

Contact your supplier if the cause cannot be identified after checking the above.

Do not restart the drive immediately operate the peripheral devices if a fuse is blown or a GFCI is tripped.

Check the wiring and the selection of peripheral devices to identify the cause. Contact your supplier before restarting the drive or the peripheral devices if the cause cannot be identified.

Install adequate branch circuit short circuit protection per applicable codes.

Failure to comply could result in damage to the drive.

The drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240 Vac maximum (200 V Class), 480 Vac maximum (400 V Class), and 600 Vac maximum (600 V Class) when protected by Bussmann Type FWH or FWP fuses as specified in ***Factory Recommended Branch Circuit Protection*** on page ***498***.

Do not expose the drive to halogen group disinfectants.

Failure to comply may cause damage to the electrical components in the drive.

Do not pack the drive in wooden materials that have been fumigated or sterilized.

Do not sterilize the entire package after the product is packed.

◆ General Application Precautions

■ Selection

Installing a Reactor

Use an AC reactor or DC link choke in the following situations:

- to suppress harmonic current.
- to smooth peak current that results from capacitor switching.
- when the power supply is above 600 kVA.
- when the drive is running from a power supply system with thyristor converters.

Note: A DC link choke is built in to drive models 2A0110 to 2A0415 and 4A0058 to 4A0675.

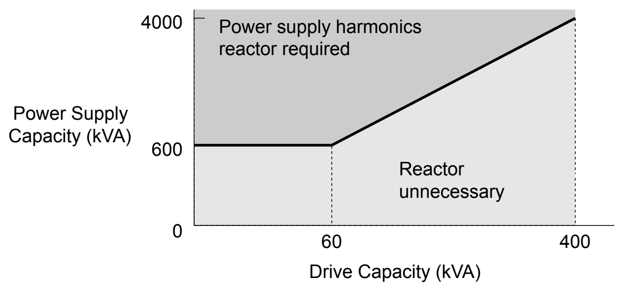


Figure i.1 Installing a Reactor

Drive Capacity

For specialized motors, make sure that the motor rated current is less than the rated output current for the drive.

When running more than one motor in parallel from a single drive, the capacity of the drive should be larger than [total motor rated current × 1.1].

Starting Torque

The overload rating for the drive determines the starting and accelerating characteristics of the motor. Expect lower torque than when running from line power. To get more starting torque, use a larger drive or increase both the motor and drive capacity.

Emergency Stop

During a drive fault condition, the output shuts off but the motor does not stop immediately. A mechanical brake may be required when it is necessary to stop the motor faster than the ability of the Fast Stop function of the drive.

Options

NOTICE: *The B1, B2, , –, +1, +2, and +3 terminals are used to connect optional drive-specific compatible devices only. Connecting non-Yaskawa-approved devices to these terminals may damage the drive.*

Repetitive Starting/Stopping

Laundry machines, punching presses, and other applications with frequent starts and stops often approach 150% of their rated current values. Heat stress generated from repetitive high current will shorten the life span of the IGBTs.

Yaskawa recommends lowering the carrier frequency, particularly when audible noise is not a concern. It is beneficial to reduce the load, increase the acceleration and deceleration times, or switch to a larger drive to help keep peak current levels under 150%. Be sure to check the peak current levels when starting and stopping repeatedly during the initial test run, and make adjustments accordingly.

■ Installation

Enclosure Panels

Keep the drive in a clean environment by installing the drive in an enclosure panel or selecting an installation area free of airborne dust, lint, and oil mist. Be sure to leave the required space between drives to provide for cooling, and take proper measures so the ambient temperature remains within allowable limits and keep flammable materials away from the drive. Yaskawa offers protective designs for drives that must be used in areas subjected to oil mist and excessive vibration. Contact Yaskawa or your Yaskawa agent for details.

Installation Direction

NOTICE: *Install the drive upright as specified in the manual.* ***Refer to Mechanical Installation on page 46*** *for more information on installation. Failure to comply may damage the drive due to improper cooling.*

■ Settings

Upper Limits

NOTICE: *The drive is capable of running the motor up to 400 Hz. Be sure to set the upper limit for the frequency of the drive to prevent the possible danger of accidentally operating equipment at higher than rated speed. The default setting for the maximum output frequency is 60 Hz.*

DC Injection Braking

NOTICE: *Excessive current during DC Injection Braking and excessive duration of DC Injection Braking can cause motor overheat.*

Acceleration/Deceleration Times

Acceleration and deceleration times are affected by the amount of torque generated by the motor, the load torque, and the inertia moment. Set a longer accel/decel time when Stall Prevention is enabled. The accel/decel times are lengthened for as long as the Stall Prevention function is in operation. Install one of the available braking options or increase the capacity of the drive for faster acceleration and deceleration.

■ General Handling

Wiring Check

NOTICE: *Do not connect power supply lines to output terminals U/T1, V/T2, or W/T3. Failure to comply will destroy the drive. Be sure to perform a final check of all sequence wiring and other connections before turning on the power and also check for short circuits on the control terminals, which may damage the drive.*

Selecting a Circuit Breaker or Circuit Interrupter

Yaskawa recommends installing a Ground Fault Circuit Interrupter (GFCI) to the power supply side. The GFCI should be designed for use with AC drives (e.g., Type B according to IEC 60755).

Select a Molded Case Circuit Breaker (MCCB) or GFCI with a rated current 1.5 to 2 times higher than the drive rated current to avoid nuisance trips caused by harmonics in the drive input current. ***Refer to Installing a Molded Case Circuit Breaker (MCCB) or Ground Fault Circuit Interrupter (GFCI) on page 364*** for more information.

Magnetic Contactor Installation

WARNING! *Fire Hazard. Shut off the drive with a magnetic contactor (MC) when a fault occurs in any external equipment such as braking resistors.* ***Refer to Installing a Magnetic Contactor at the Power Supply Side on page 364****. Failure to comply may cause resistor overheating, fire, and injury to personnel.*

NOTICE: *To get the full performance life out of the electrolytic capacitors and circuit relays, refrain from switching the drive power supply off and on more than once every 30 minutes. Frequent use can damage the drive. Use the drive to stop and start the motor.*

Inspection and Maintenance

WARNING! *Electrical Shock Hazard. Capacitors in the drive do not immediately discharge after shutting off the power. Wait for at least the amount of time specified on the drive before touching any components after shutting off the power. Failure to comply may cause injury to personnel from electrical shock.*

WARNING! *Burn Hazard. Because the heatsink can get very hot during operation, take proper precautions to prevent burns. When replacing the cooling fan, shut off the power and wait at least 15 minutes to be sure that the heatsink has cooled down. Failure to comply may cause burn injury to personnel.*

Wiring

Yaskawa recommends using ring terminals on all drive models. Drive models 2A0069 to 2A0415 and 4A0058 to 4A0675 require the use of use ring terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

Transporting the Drive

NOTICE: *Never steam clean the drive. During transport, keep the drive from coming into contact with salts, fluorine, bromine, phthalate ester, and other such harmful chemicals.*

◆ Motor Application Precautions

■ Standard Induction Motors

Low-Speed Range

The cooling fan of a standard motor should sufficiently cool the motor at the rated speed. As the self-cooling capability of such a motor reduces with the speed, applying full torque at low speed will possibly damage the motor. Reduce the load torque as the motor slows to prevent motor damage from overheat. ***Figure i.2*** shows the allowable load characteristics for a Yaskawa standard motor. Use a motor designed specifically for operation with a drive when 100% continuous torque is needed at low speeds.

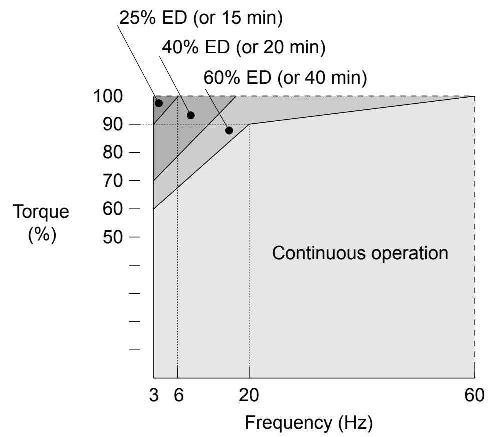


Figure i.2 Allowable Load Characteristics for a Yaskawa Motor

Insulation Tolerance

NOTICE: *Consider motor voltage tolerance levels and motor insulation in applications with an input voltage of over 440 V or particularly long wiring distances.*

High-Speed Operation

NOTICE: *Problems may occur with the motor bearings and dynamic balance of the machine when operating a motor beyond its rated speed. Contact the motor or machine manufacturer.*

Torque Characteristics

Torque characteristics differ compared to operating the motor directly from line power. The user should have a full understanding of the load torque characteristics for the application.

Vibration and Shock

The drive allows selection of high carrier PWM control and low carrier PWM. Selecting high carrier PWM can help reduce motor oscillation.

Take particular caution when adding a variable speed drive to an application running a motor from line power at a constant speed. If resonance occurs, install shock-absorbing rubber around the base of the motor and enable the Jump frequency selection to prevent continuous operation in the resonant frequency range.

Audible Noise

Noise created during run varies by the carrier frequency setting. When using a high carrier frequency, audible noise from the motor is comparable to the motor noise generated when running from line power. Operating above the rated motor speed can create unpleasant motor noise.

■ Synchronous Motors

- Contact Yaskawa or a Yaskawa agent when planning to use a synchronous motor not endorsed by Yaskawa.
- Use a standard induction motor when running multiple synchronous motors simultaneously. A single drive does not have this capability.
- A synchronous motor may rotate slightly in the opposite direction of the Run command at start depending on parameter settings and rotor position.
- The amount of generated starting torque differs depending on the control mode and motor type. Set up the motor with the drive after verifying the starting torque, allowable load characteristics, impact load tolerance, and speed control range.

  Contact Yaskawa or a Yaskawa agent when planning to use a motor that does not fall within these specifications:
- To restart a coasting motor rotating over 200 Hz while in V/f Control, first use the Short Circuit Braking function to bring the motor to a stop. Short Circuit Braking requires a special braking resistor. Contact Yaskawa or a Yaskawa agent for details.
- To restart a coasting motor rotating below 200 Hz, use the Speed Search function if the motor cable is not too long. If the motor cable is relatively long, stop the motor using Short Circuit Braking.

■ Specialized Motors

Multi-Pole Motor

The rated current of a multi-pole motor differs from that of a standard motor, so be sure to check the maximum current when selecting a drive. Always stop the motor before switching between the number of motor poles. The motor will coast to stop if a regen overvoltage (ov) fault occurs or if overcurrent (oC) protection is triggered.

Submersible Motor

The rated current of a submersible motor is greater than that of a standard motor, so select the drive capacity accordingly. Use a motor cable large enough to avoid decreasing the maximum torque level from voltage drop caused by a long motor cable.

Explosion-Proof Motor

The motor and the drive must be tested together to be certified as explosion-proof. The drive is not designed for explosion-proof areas.

When attaching an encoder to an explosion-proof motor, make sure the encoder is also explosion-proof. Use an insulating signal converter to connect the encoder signal lines to the speed feedback option card.

Geared Motor

Make sure that the gear and the lubricant are rated for the desired speed range to avoid gear damage when operating at low speeds or very high speeds. Consult with the manufacturer for applications that require operation outside the rated speed range of the motor or gear box.

Single-Phase Motor

Variable speed drives are not designed to operate with single phase motors. Using capacitors to start the motor causes excessive current to flow and can damage drive components. A split-phase start or a repulsion start can burn out the starter coils because the internal centrifugal switch is not activated. The drive is for use with three-phase motors only.

Motor with Brake

Take caution when using the drive to operate a motor with a built-in holding brake. If the brake is connected to the output side of the drive, it may not release at start due to low voltage levels, so be sure to install a separate power supply for the motor brake. Note that motors with built-in brakes tend to generate a fair amount of noise when running at low speeds.

■ Notes on Power Transmission Machinery

Installing an AC drive in machinery that was previously connected directly to the power supply will allow the machine to operate at variable speeds. Continuous operation outside of the rated speeds can wear on lubrication material in gear boxes and other power transmission parts. Make sure that lubrication is sufficient within the entire speed range to avoid machine damage. Note that operation above the rated speed can increase the noise generated by the machine.

◆ Drive Label Warning Example

Always heed the warning information listed in ***Figure i.3*** in the position shown in ***Figure i.4***.

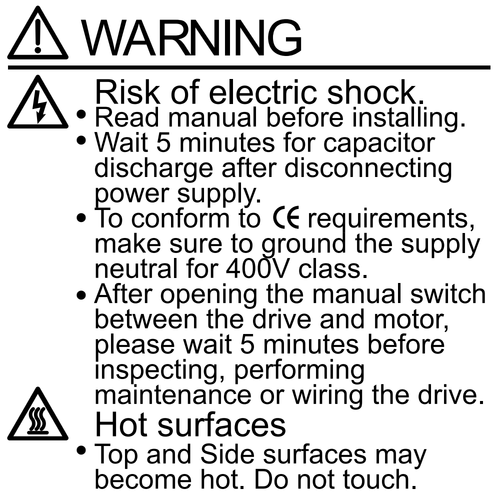


Figure i.3 Warning Information Example

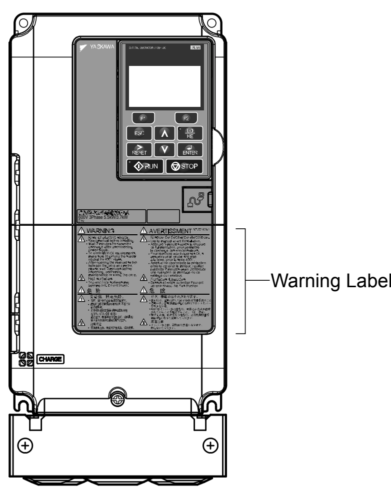


Figure i.4 Warning Information Position

◆ Warranty Information

■ Restrictions

The drive is not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.

Customers who intend to use the product described in this manual for devices or systems relating to transportation, health care, space aviation, atomic power, electric power, or in underwater applications must first contact their Yaskawa representatives or the nearest Yaskawa sales office.

WARNING! *Injury to Personnel. This product has been manufactured under strict quality-control guidelines. However, if this product is to be installed in any location where failure of this product could involve or result in a life-and-death situation or loss of human life or in a facility where failure may cause a serious accident or physical injury, safety devices must be installed to minimize the likelihood of any accident.*

1

Receiving

This chapter explains how to inspect the drive upon receipt, and gives an overview of the different enclosure types and components.

1.1 Section Safety

⚠ CAUTION
Do not carry the drive by the front cover or the terminal cover. Failure to comply may cause the main body of the drive to fall, resulting in minor or moderate injury.

NOTICE
Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards. Failure to comply may result in ESD damage to the drive circuitry. **A motor connected to a PWM drive may operate at a higher temperature than a utility-fed motor and the operating speed range may reduce motor cooling capacity.** Ensure that the motor is suitable for drive duty and/or the motor service factor is adequate to accommodate the additional heating with the intended operating conditions.

1.2 General Description

◆ P1000 Model Selection

Refer to *Table 1.1* for drive selection depending on motor power.

Note: The models and capacities in shown here are based on standard settings and operation conditions. Higher carrier frequencies and higher ambient temperatures require derating.

Table 1.1 P1000 Models

Motor Power HP	Three-Phase 200 V Class		Three-Phase 400 V Class		Three-Phase 600 V Class	
	Drive Model	Rated Output Current (A) <1>	Drive Model	Rated Output Current (A) <1>	Drive Model	Rated Output Current (A) <1>
0.75	2A0004	3.5	4A0002	2.1	–	–
1	2A0006	6	–		–	–
2	2A0008	8	4A0004	4.1	5A0003	2.7
	–	–	–	–	–	–
3	–	–	–	–	–	–
	2A0010	9.6	4A0005	5.4	5A0004	3.9
	2A0012	12	4A0007	6.9	–	–
5	–	–	–	–	–	–
	2A0018	17.5	4A0009	8.8	5A0006	6.1
7.5	2A0021	21	4A0011	11.1	5A0009	9
10	2A0030	30	4A0018	17.5	5A0011	11
15	2A0040	40	4A0023	23	5A0017	17
20	2A0056	56	4A0031	31	5A0022	22
25	2A0069	69	4A0038	38	5A0027	27
25-30	–	–	–	–	–	–
	–	–	–	–	–	–
30	2A0081	81	4A0044	44	5A0032	32
40	2A0110	110	4A0058	58	5A0041	41
50	2A0138	138	4A0072	72	5A0052	52
50-60	–	–	–	–	–	–
	–	–	–	–	–	–
60	2A0169	169	4A0088	88	5A0062	62
75	2A0211	211	4A0103	103	5A0077	77
100	2A0250	250	4A0139	139	5A0099	99
125	2A0312	312	4A0165	165	5A0125	125
125-150	–	–	–	–	–	–
150	2A0360	360	4A0208	208	5A0145	145
175	2A0415	415	–	–	–	–
200	–	–	4A0250	250	5A0192	192
250	–	–	4A0296	296	5A0242	242
300	–	–	4A0362	362	–	–
350	–	–	4A0414	414	–	–
400-450	–	–	4A0515	515	–	–
400-450-500	–	–	–	–	–	–
500-550	–	–	4A0675	675	–	–

<1> These values assume the carrier frequency is set to 2 kHz.

Note: Current derating is required when setting the carrier frequency higher. *Refer to Drive Derating Data on page 385* for details.

◆ Control Mode Details

Table 1.2 gives an overview of the various P1000 control mode features.

Table 1.2 Control Mode Details

Motor Type		Induction Motors	Comments
Control Mode		V/f	–
Basic Description		V/f control	–
Type of Applications	**Motor Type**	IM	–
	Multi Motor	YES	–
	Motor data unknown	YES	–
Control Characteristics	**Speed Control Range**	1:40	May fluctuate with characteristics and motor temperature.
	Speed Accuracy	±2 to 3%	Speed deviation when operating at constant speed may fluctuate with characteristics and motor temperature.
	Speed Response	3 Hz (approx.)	Max. frequency of a speed reference signal that the drive can follow may fluctuate with characteristics and motor temperature.
	Starting Torque	150% at 3 Hz	Starting torque may fluctuate with characteristics and motor temperature. Performance may differ by capacity.
Application-Specific	**Auto-Tuning**	• Energy Saving Tuning • Line to line resistance	Automatically adjusts parameter settings that concern electrical characteristics of the motor.
Application-Specific	**Speed Search**	YES	Bi-directional speed detection of a coasting motor to restart it without stopping.
	Energy-Saving Control	YES	Saves energy by always operating the motor at its maximum efficiency.
	High Slip Braking	YES	Increases motor loss to allow for faster deceleration than normal without a braking resistor. Effectiveness may vary based on motor characteristics.
	Kinetic Energy Buffering	YES	Decelerates the drive to allow it to ride through a momentary power loss and continue operation.
	Over-excitation Deceleration	YES	Provides fast deceleration without using a braking resistor.
	Overvoltage Suppression	YES	Prevents overvoltage by increasing speed during regeneration.

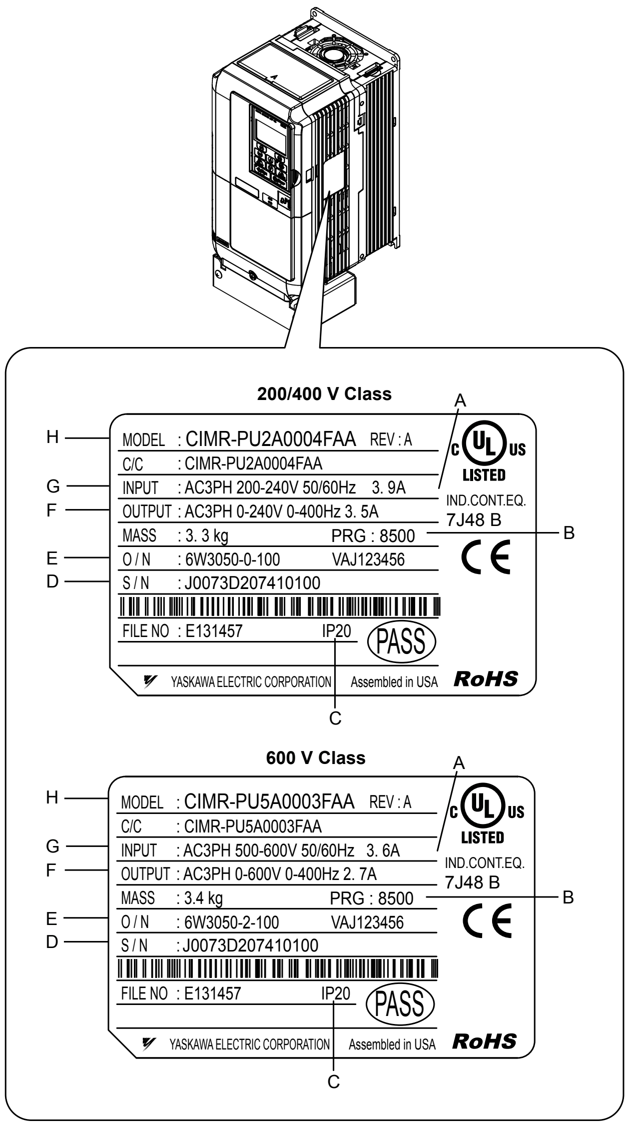
1.3 Model Number and Nameplate Check

Please perform the following tasks after receiving the drive:

- Inspect the drive for damage.

  If the drive appears damaged upon receipt, contact the shipper immediately.
- Verify receipt of the correct model by checking the information on the nameplate.
- If you have received the wrong model or the drive does not function properly, contact your supplier.

◆ Nameplate

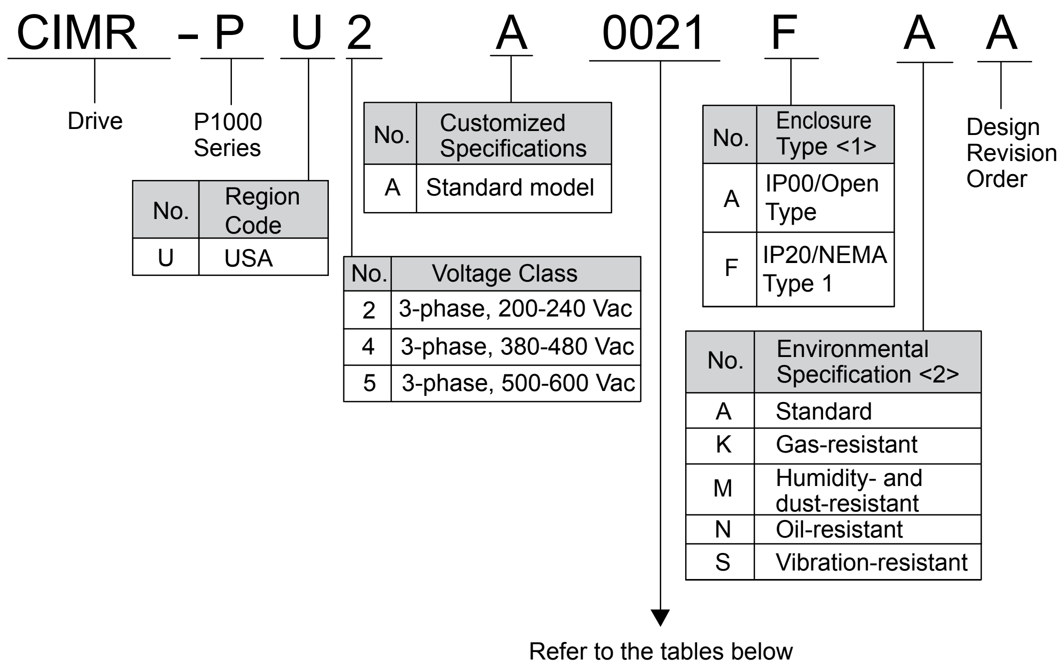


A – Normal Duty Amps
B – Software version
C – Enclosure type
D – Serial number
E – Lot number
F – Output specifications
G – Input specifications
H – AC drive model

Figure 1.1 Nameplate Information Example

Receiving

1



<1> *Refer to Drive Models and Enclosure Types on page 32* for differences regarding enclosure protection types and component descriptions.

<2> Drives with these specifications do not guarantee complete protection for the environmental conditions indicated.

■ Three-Phase 200 V

Table 1.3 Model Number and Specifications (200 V)

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
2A0004	0.75 (0.75)	3.5
2A0006	1.1 (1)	6.0
2A0008	1.5 (2)	8.0
2A0010	2.2 (3)	9.6
2A0012	3.0 (3)	12
2A0018	3.7 (5)	17.5
2A0021	5.5 (7.5)	21
2A0030	7.5 (10)	30
2A0040	11 (15)	40
2A0056	15 (20)	56
2A0069	18.5 (25)	69
2A0081	22 (30)	81
2A0110	30 (40)	110
2A0138	37 (50)	138
2A0169	45 (60)	169
2A0211	55 (75)	211
2A0250	75 (100)	250
2A0312	90 (125)	312
2A0360	110 (150)	360
2A0415	110 (175)	415

■ Three-Phase 400 V

Table 1.4 Model Number and Specifications (400 V)

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
4A0002	0.75 (0.75)	2.1
4A0004	1.5 (2)	4.1
4A0005	2.2 (3)	5.4
4A0007	3.0 (3)	6.9
4A0009	3.7 (5)	8.8
4A0011	5.5 (7.5)	11.1
4A0018	7.5 (10)	17.5
4A0023	11 (15)	23
4A0031	15 (20)	31
4A0038	18.5 (25)	38
4A0044	22 (30)	44
4A0058	30 (40)	58
4A0072	37 (50)	72
4A0088	45 (60)	88
4A0103	55 (75)	103
4A0139	75 (100)	139
4A0165	90 (125)	165
4A0208	110 (150)	208
4A0250	132 (200)	250
4A0296	160 (250)	296
4A0362	185 (300)	362
4A0414	220 (350)	414
4A0515	250 (400-450)	515
4A0675	355 (500-550)	675

■ Three-Phase 600 V

Table 1.5 Model Number and Specifications (600 V)

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
5A0003	1.5 (2)	2.7
5A0004	2.2 (3)	3.9
5A0006	3.7 (5)	6.1
5A0009	5.5 (7.5)	9
5A0011	7.5 (10)	11
5A0017	11 (15)	17
5A0022	15 (20)	22
5A0027	18.5 (25)	27
5A0032	22 (30)	32
5A0041	30 (40)	41
5A0052	37 (50)	52
5A0062	45 (60)	62
5A0077	55 (75)	77
5A0099	75 (100)	99
5A0125	90 (125)	125
5A0145	110 (150)	145
5A0192	160 (200)	192
5A0242	185 (250)	242

1.4 Drive Models and Enclosure Types

Two types of enclosures are offered for P1000 drives:

- IP20/NEMA Type 1 enclosure models mount to an indoor wall or in an enclosure panel.
- IP00/Open Type enclosure models are designed for installation in an enclosure panel that serves to protect personnel from injury caused by accidentally touching live parts.

Table 1.6 describes drive enclosures and models.

Table 1.6 Drive Models and Enclosure Types

Voltage Class	Enclosure Type	
	IP20/NEMA Type 1 Enclosure <1> Drive Model Number	IP00/Open Type Enclosure Drive Model Number
Three-Phase 200 V Class	2A0004F	<1>
	2A0006F	<1>
	2A0008F	<1>
	2A0010F	<1>
	2A0012F	<1>
	2A0018F	<1>
	2A0021F	<1>
	2A0030F	<1>
	2A0040F	<1>
	2A0056F	<1>
	2A0069F	<1>
	2A0081F	<1>
	2A0110F	<1>
	2A0138F	<1>
	2A0169F	<1>
	2A0211F	<1>
	<2>	2A0250A
	<2>	2A0312A
	<2>	2A0360A
	<3>	2A0415A
Three-Phase 400 V Class	4A0002F	<1>
	4A0004F	<1>
	4A0005F	<1>
	4A0007F	<1>
	4A0009F	<1>
	4A0011F	<1>
	4A0018F	<1>
	4A0023F	<1>
	4A0031F	<1>
	4A0038F	<1>
	4A0044F	<1>
	4A0058F	<1>

Voltage Class	Enclosure Type	
	IP20/NEMA Type 1 Enclosure <1> Drive Model Number	IP00/Open Type Enclosure Drive Model Number
Three-Phase 400 V Class	4A0072F	<1>
	4A0088F	<1>
	4A0103F	<1>
	4A0139F	<1>
	4A0165F	<1>
	<2>	4A0208A
	<2>	4A0250A
	<2>	4A0296A
	<2>	4A0362A
	<3>	4A0414A
	<3>	4A0515A
	<3>	4A0675A
Three-Phase 600 V Class	5A0003F	<1>
	5A0004F	<1>
	5A0006F	<1>
	5A0009F	<1>
	5A0011F	<1>
	5A0017F	<1>
	5A0022F	<1>
	5A0027F	<1>
	5A0032F	<1>
	5A0041F	<1>
	5A0052F	<1>
	5A0062F	<1>
	5A0077F	<1>
	5A0099F	<1>
	<2>	5A0125A
	<2>	5A0145A
	<2>	5A0192A
	<2>	5A0242A

<1> Removing the top protective cover from a IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while retaining IP20 conformity.

<2> Customers may convert these models to IP20/NEMA Type 1 enclosures using an IP20/NEMA Type 1 Kit. ***Refer to IP20/NEMA Type 1 Kit Selection on page 58*** to select the appropriate kit.

<3> Contact a Yaskawa representative for IP20/NEMA Type 1 Kit availability for these models.

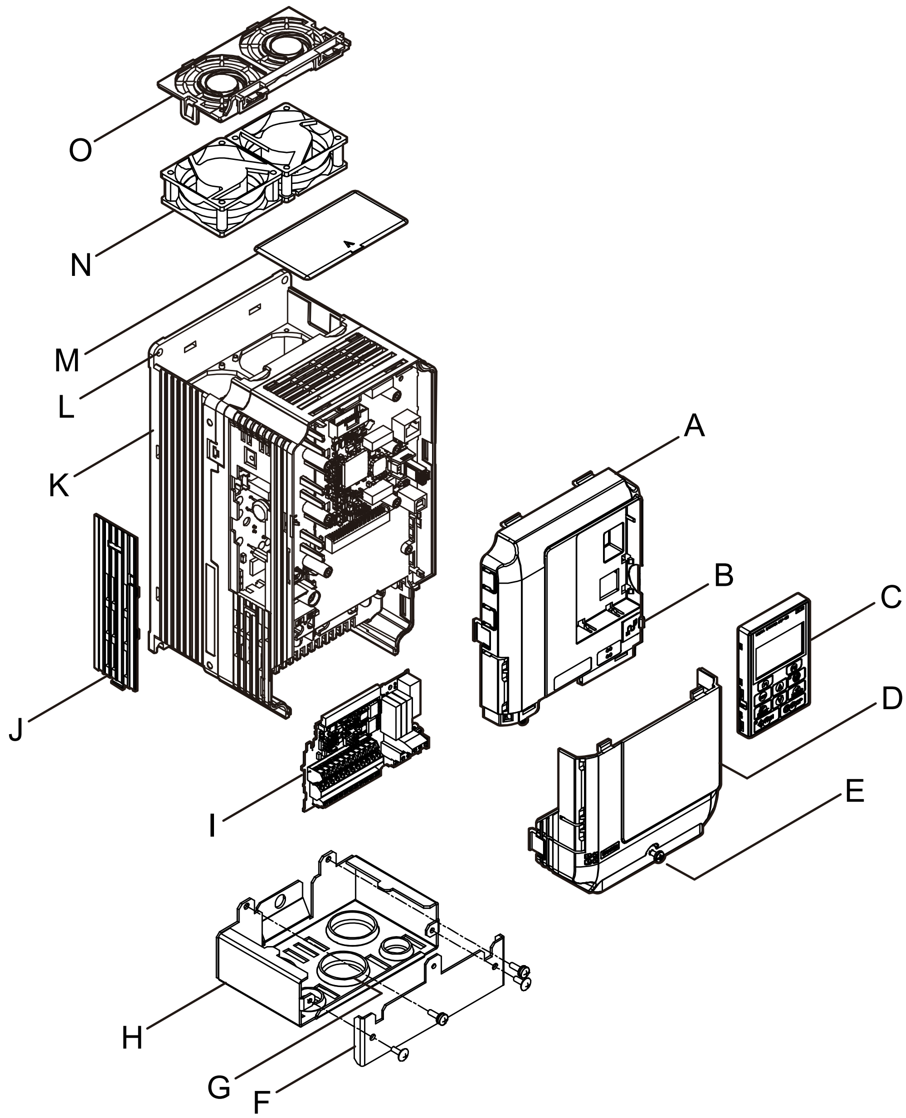
1.5 Component Names

This section gives an overview of the drive components described in this manual.

Note: 1. *Refer to Using the Digital Operator on page 99* for a description of the operator keypad.
2. The drive may have no cooling fans or up to two cooling fans depending on the model.

◆ IP20/NEMA Type 1 Enclosure

■ Three-Phase AC 200 V Models 2A0004F to 2A0081F Three-Phase AC 400 V Models 4A0002F to 4A0044F Three-Phase AC 600 V Models 5A0003F to 5A0032F

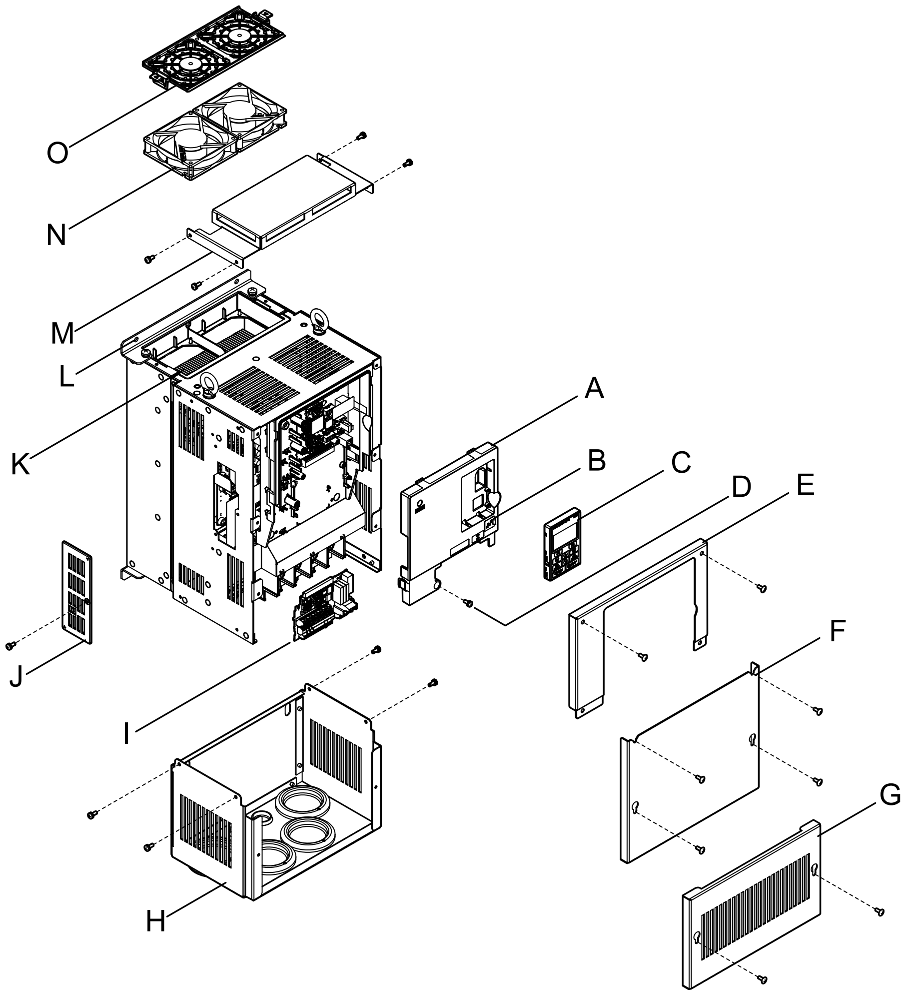


A – Front cover
B – USB port (type-B)
C – Digital operator
D – Terminal cover
E – Terminal cover screw
F – Conduit bracket front cover
G – Rubber bushing
H – Conduit bracket
I – Terminal board
J – Optional 24 V DC power supply connector cover
K – Heatsink
L – Mounting hole
M – Top protective cover
N – Cooling fan <1>
O – Fan finger guard <1>

Figure 1.2 Exploded View of IP20/NEMA Type 1 Components (Model 2A0030F)

<1> Drive models 2A0018, 2A0021, 4A0007 to 4A0011, 5A0006F, and 5A0009F have a single cooling fan. Drive models 2A0004 to 2A0012, 4A0002 to 4A0005, 5A0003F, and 5A0004F do not have a cooling fan or a fan finger guard.

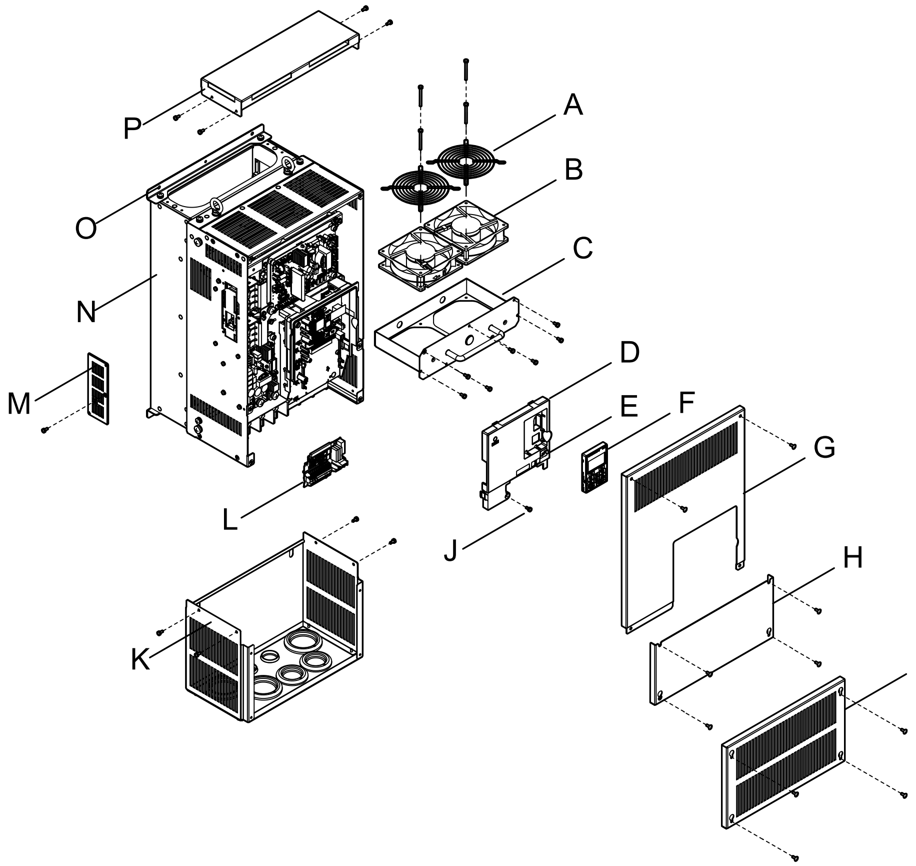
■ Three-Phase AC 200 V Models 2A0110F, 2A0138F Three-Phase AC 400 V Models 4A0058F to 4A0103F Three-Phase AC 600 V Models 5A0041F, 5A0052F



A – Front cover	I – Terminal board
B – USB port (type-B)	J – Optional 24 V DC power supply connector cover
C – Digital operator	K – Heatsink
D – Front cover screw	L – Mounting hole
E – Drive cover	M – Top protective cover
F – Terminal cover	N – Cooling fan
G – Conduit bracket front cover	O – Fan finger guard
H – Conduit bracket	

Figure 1.3 Exploded View of IP20 Enclosure Components (Model 2A0110F)

■ Three-Phase AC 200 V Models 2A0169F, 2A0211F Three-Phase AC 400 V Models 4A0139F to 4A0165F Three-Phase AC 600 V Models 5A0062F to 5A0099F

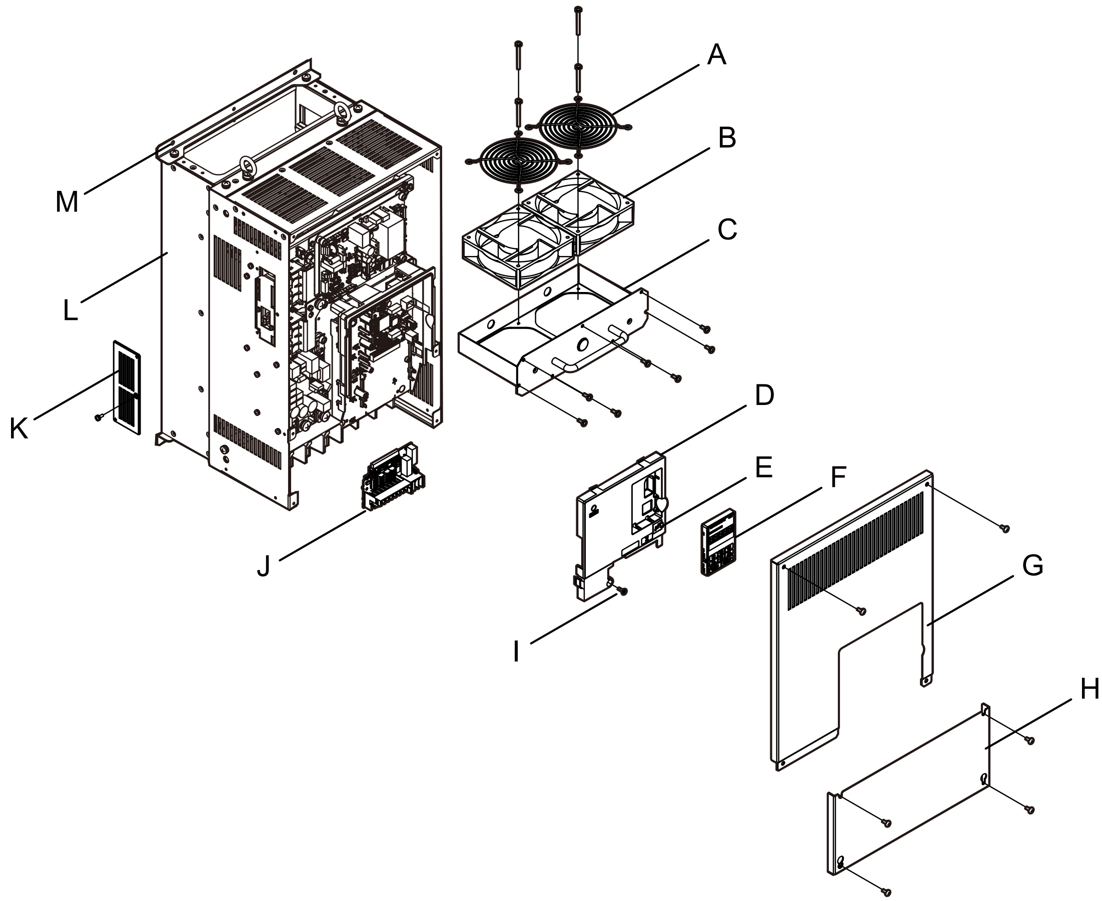


A – Fan guard
B – Cooling fan
C – Fan bracket
D – Front cover
E – USB port (type-B)
F – Digital operator
G – Drive cover
H – Terminal cover
I – Conduit bracket front cover
J – Front cover
K – Conduit bracket
L – Terminal board
M – Optional 24 V DC power supply connector cover
N – Heatsink
O – Mounting hole
P – Top protective cover

Figure 1.4 Exploded View of IP20/NEMA Type 1 Enclosure Components (Model 4A0165F)

◆ IP00/Open Type Enclosure

■ Three-Phase AC 200 V Models 2A0250A, 2A0312A
Three-Phase AC 400 V Model 4A0208A
Three-Phase AC 600 V Models 5A0125A, 5A0145A



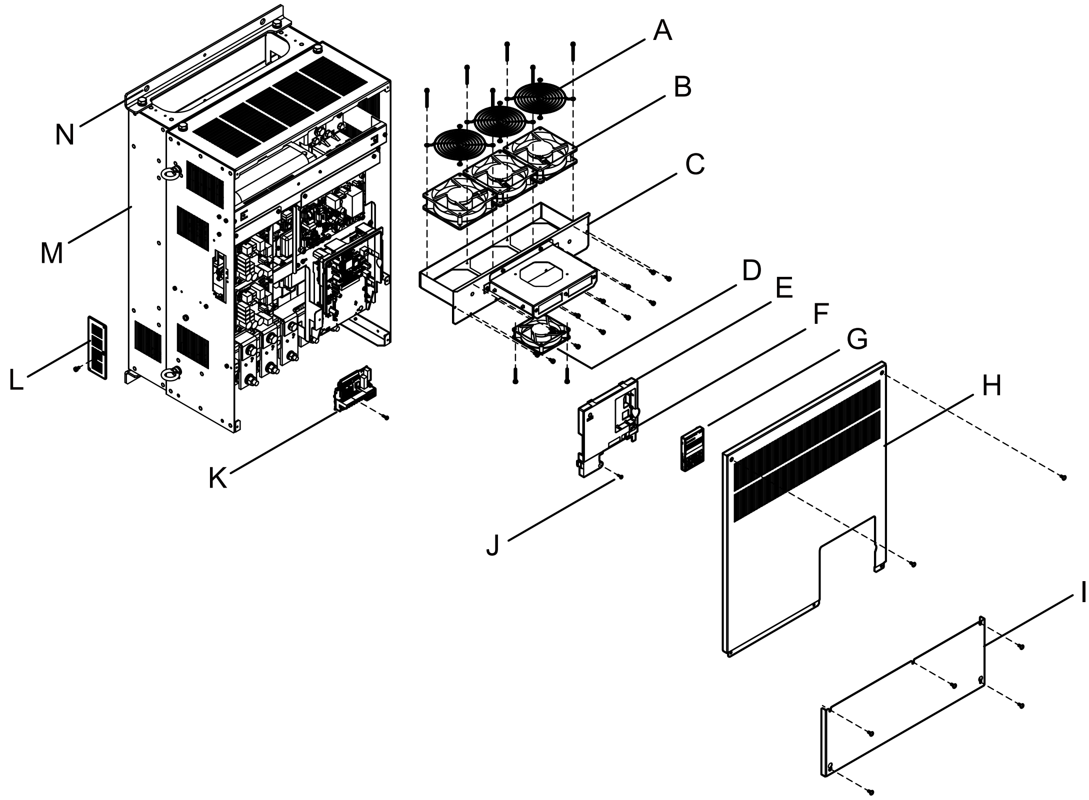
A – Fan guard
B – Cooling fan
C – Fan bracket
D – Front cover
E – USB port (type-B)
F – Digital operator
G – Drive cover
H – Terminal cover
I – Front cover screw
J – Terminal board
K – Optional 24 V DC power supply connector cover
L – Heatsink
M – Mounting hole

Figure 1.5 Exploded view of IP00/Open Type Enclosure Components (Model 4A0208A)

Receiving

1

■ Three-Phase AC 200 V Models 2A0360A, 2A0415A Three-Phase AC 400 V Models 4A0250A to 4A0362A Three-Phase AC 600 V Models 5A0192A, 5A0242A

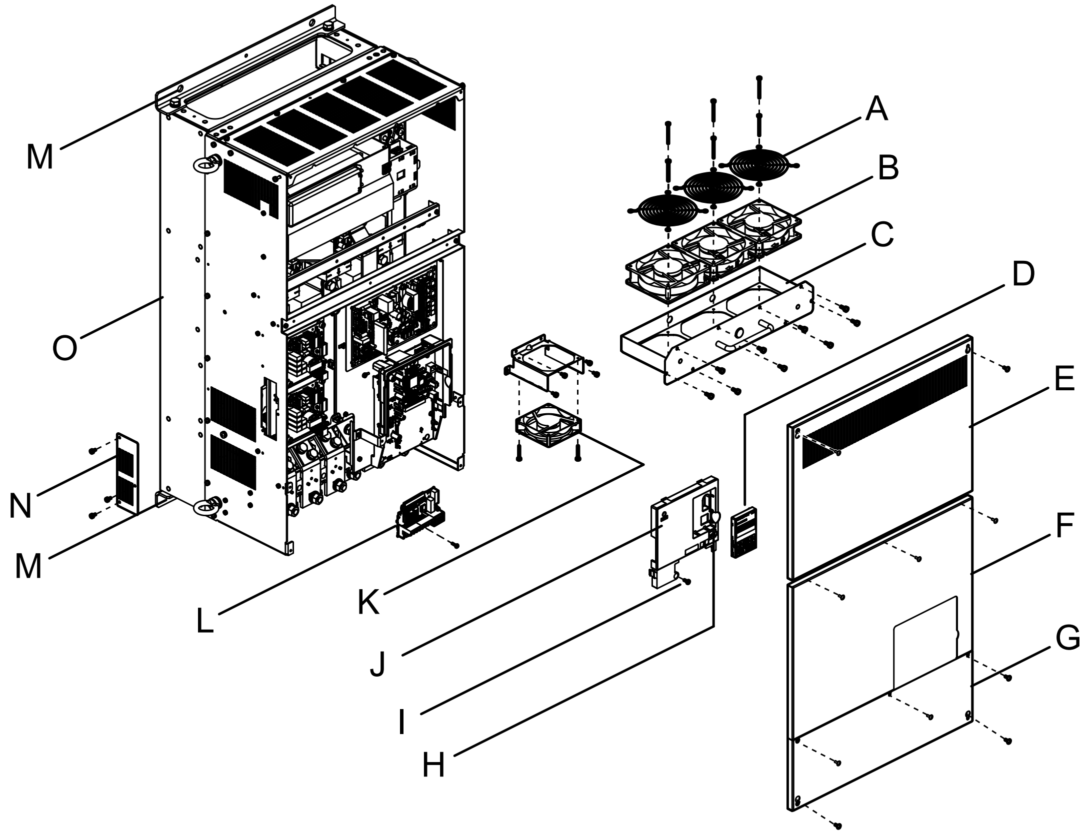


A – Fan guard
B – Cooling fan
C – Fan bracket
D – Circulation fan <1>
E – Front cover
F – USB port (type-B)
G – Digital operator
H – Drive cover
I – Terminal cover
J – Front cover screw
K – Terminal board
L – Optional 24 V DC power supply connector cover
M – Heatsink
N – Mounting hole

Figure 1.6 Exploded view of IP00/Open Type Enclosure Components (Model 4A0362A)

<1> Drive models 2A0360, 2A0415, and 4A0362 have a built-in circulation fan.

■ Three-Phase AC 400 V Model 4A0414A



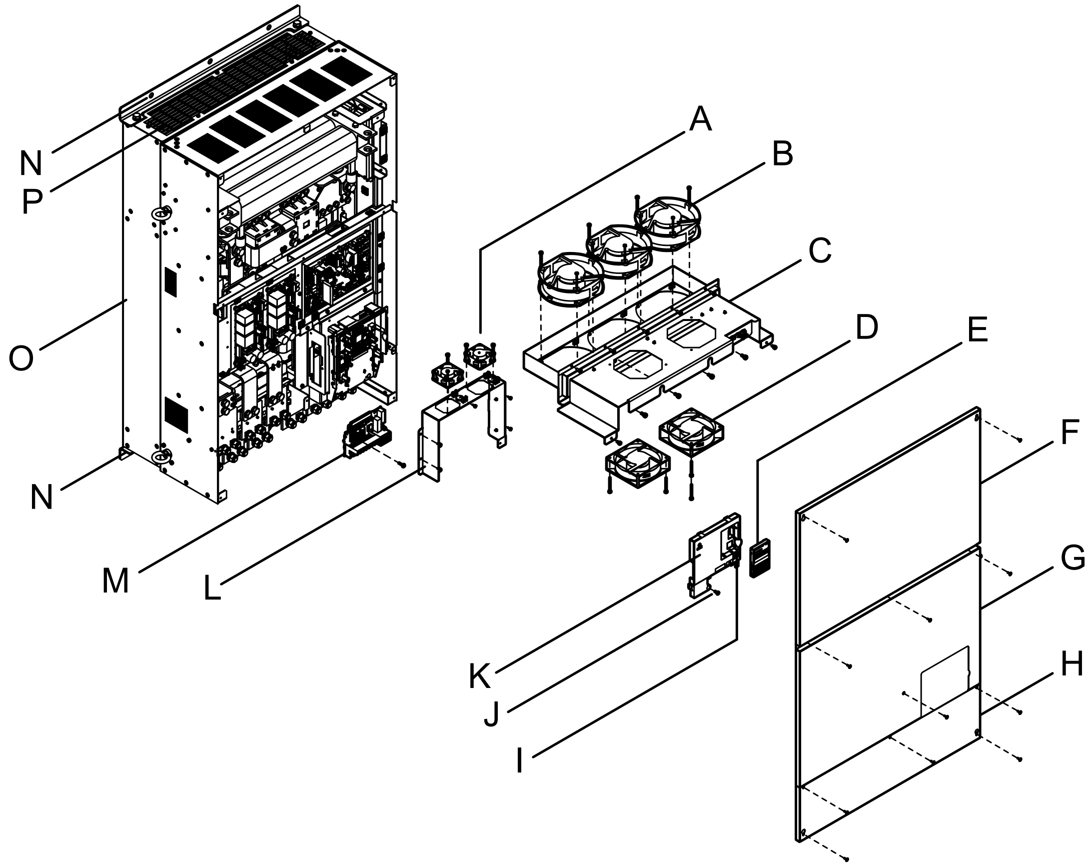
A – Fan guard
B – Cooling fan
C – Fan bracket
D – Digital operator
E – Drive cover 1
F – Drive cover 2
G – Terminal cover
H – USB port (type-B)
I – Front cover screw
J – Front cover
K – Circulation fan
L – Terminal board
M – Mounting hole
N – Optional 24 V DC power supply connector cover
O – Heatsink

Figure 1.7 Exploded view of IP00/Open Type Enclosure Components (Model 4A0414A)

Receiving

1

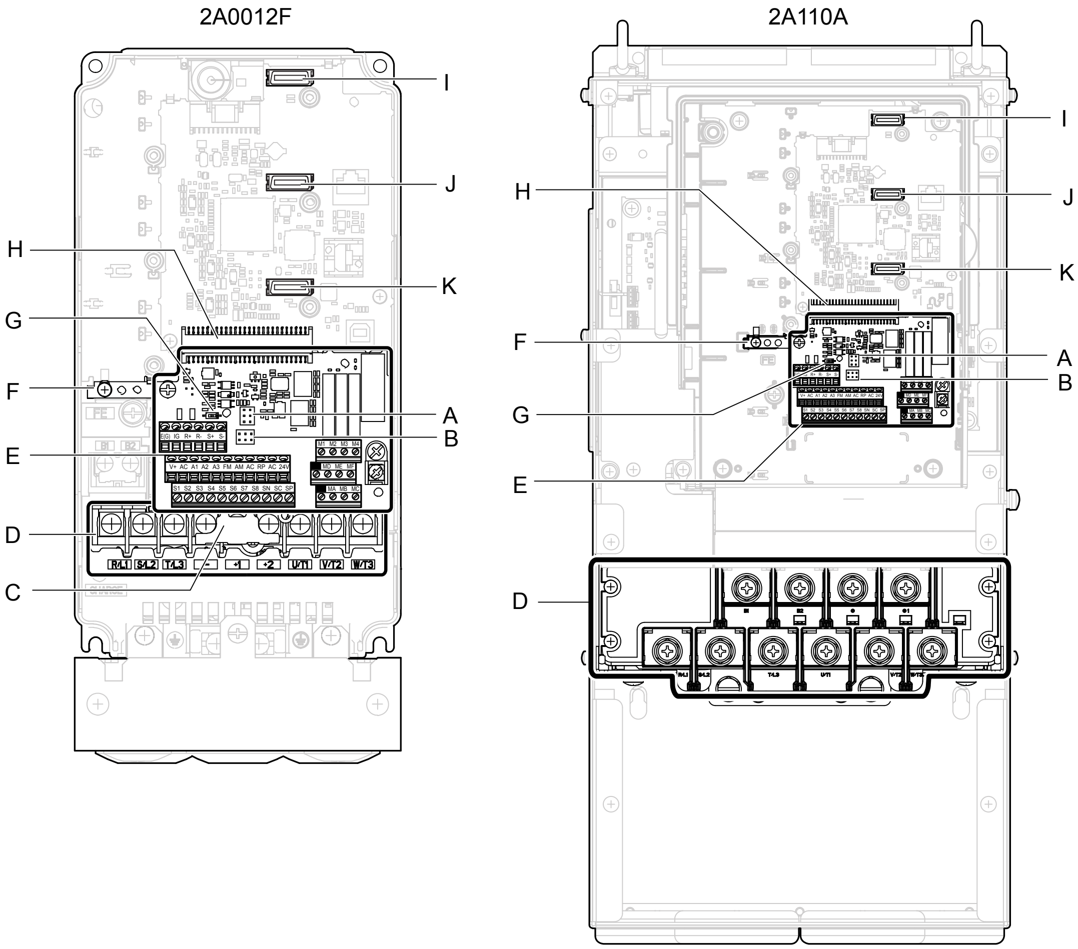
■ Three-Phase AC 400 V Models 4A0515A, 4A0675A



A – Circuit board cooling fan
B – Cooling fan
C – Fan bracket
D – Circulation Fan
E – Digital operator
F – Drive cover 1
G – Drive cover 2
H – Terminal cover
I – USB port (type-B)
J – Front cover screw
K – Front cover
L – Circuit board cooling fan unit case
M – Terminal board
N – Mounting hole
O – Heatsink
P – Fan guard

Figure 1.8 Exploded view of IP00/Open Type Enclosure Components (Model 4A0675A)

◆ Front Views



A – Jumper S5 (Refer to Terminal AM/FM Signal Selection on page 93)
B – Jumper S1 (Refer to Terminals A1, A2, and A3 Input Signal Selection on page 92)
C – Protective cover to prevent miswiring
D – Main circuit terminal (Refer to Wiring the Main Circuit Terminal on page 84)
E – Terminal board (Refer to Control Circuit Wiring on page 86)
F – Ground terminal
G – DIP switch S2 (Refer to MEMOBUS/Modbus Termination on page 93)
H – Terminal board connector
I – Option card connector (CN5-C)
J – Option card connector (CN5-B)
K – Option card connector (CN5-A)

Figure 1.9 Front View of Drives

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2

Mechanical Installation

This chapter explains how to properly mount and install the drive.

2.1 Section Safety

⚠ WARNING

Fire Hazard

Provide sufficient cooling when installing the drive inside an enclosed panel or cabinet.

Failure to comply could result in overheating and fire.

When multiple drives are placed inside the same enclosure panel, install proper cooling to ensure air entering the enclosure does not exceed 40 °C.

Crush Hazard

Use a dedicated lifter when transporting the drive by a lifter.

Failure to comply may result in serious injury or death from falling equipment.

Only use vertical suspension to temporarily lift the drive during installation to an enclosure panel. Do not use vertical suspension to transport the drive.

Failure to comply may result in serious injury or death from falling equipment.

Use screws to securely affix the drive front cover, terminal blocks, and other drive components prior to vertical suspension.

Failure to comply may result in serious injury or death from falling equipment.

Do not subject the drive to vibration or impact greater than 1.96 m/s^2 (0.2 G) while it is suspended by the cables.

Failure to comply may result in serious injury or death from falling equipment.

Do not attempt to flip the drive over or leave the drive unattended while it is suspended by the wires.

Failure to comply may result in serious injury or death from falling equipment.

⚠ CAUTION

Crush Hazard

Do not carry the drive by the front cover or the terminal cover.

Failure to comply may result in minor or moderate injury from the main body of the drive falling.

NOTICE

Equipment Hazard

Prevent foreign matter such as metal shavings or wire clippings from falling into the drive during drive installation and project construction.

Failure to comply could result in damage to the drive. Place a temporary cover over the top during installation. Be sure to remove the temporary cover before start-up, as the cover will reduce ventilation and cause the unit to overheat.

Observe proper electrostatic discharge (ESD) procedures when handling the drive.

Failure to comply could result in ESD damage to the drive circuitry.

Operating the motor in the low-speed range diminishes the cooling effects, increases motor temperature, and may lead to motor damage by overheating.

Reduce the motor torque in the low-speed range whenever using a standard blower cooled motor. If 100% torque is required continuously at low speed, consider using a special drive or vector-control motor. Select a motor that is compatible with the required load torque and operating speed range.

The speed range for continuous operation differs according to the lubrication method and motor manufacturer.

If the motor is to be operated at a speed higher than the rated speed, consult with the manufacturer.

Continuously operating an oil-lubricated motor in the low-speed range may result in burning.

NOTICE

When the input voltage is 440 V or higher or the wiring distance is greater than 100 meters, pay special attention to the motor insulation voltage or use a drive-rated motor with reinforced insulation.

Failure to comply could lead to motor winding failure.

Motor vibration may increase when operating a machine in variable-speed mode, if that machine previously operated at a constant speed.

Install vibration-proof rubber on the motor base or use the frequency jump function to skip a frequency resonating the machine.

The motor may require more acceleration torque with drive operation than with a commercial power supply.

Set a proper V/f pattern by checking the load torque characteristics of the machine to be used with the motor.

The rated input current of submersible motors is higher than the rated input current of standard motors.

Select an appropriate drive according to its rated output current. When the distance between the motor and drive is long, use a cable thick enough to connect the motor to the drive to prevent motor torque reduction.

The current rating differs for a motor with variable pole pitches differs from a standard motor.

Check the maximum current of the motor before selecting the drive capacity. Only switch motor poles when the motor is stopped. Switching between motor during run will trigger overcurrent protection circuitry or result in overvoltage from regeneration, and the motor will simply coast to stop.

When using an explosion-proof motor, it must be subject to an explosion-proof test in conjunction with the drive.

This is also applicable when an existing explosion-proof motor is to be operated with the drive. Since the drive itself is not explosion-proof, always install it in a safe place.

Never lift the drive up while the cover is removed.

This can damage the terminal board and other components.

2.2 Mechanical Installation

This section outlines specifications, procedures, and the environment for proper mechanical installation of the drive.

◆ Installation Environment

Install the drive in an environment matching the specifications in *Table 2.1* to help prolong the optimum performance life of the drive.

Table 2.1 Installation Environment

Environment	Conditions
Installation Area	Indoors
Ambient Temperature	-10 °C to +40 °C (IP20/NEMA Type 1 enclosure) -10 °C to +50 °C (IP00/Open Type enclosure) Drive reliability improves in environments without wide temperature fluctuations. When using the drive in an enclosure panel, install a cooling fan or air conditioner in the area to ensure that the air temperature inside the enclosure does not exceed the specified levels. Do not allow ice to develop on the drive.
Humidity	95% RH or less and free of condensation
Storage Temperature	-20 to +60 °C
Surrounding Area	Install the drive in an area free from: • oil mist and dust • metal shavings, oil, water, or other foreign materials • radioactive materials • combustible materials (e.g., wood) • harmful gases and liquids • excessive vibration • chlorides • direct sunlight.
Altitude	1000 m or lower, up to 3000 m with derating. *Refer to Drive Derating Data on page 385* for details.
Vibration	10 to 20 Hz at 9.8 m/s^2 20 to 55 Hz at 5.9 m/s^2 (Models 2A0004 to 2A0211, 4A0002 to 4A0165, and 5A0003 to 5A0099) or 2.0 m/s^2 (Models 2A0250 to 2A0415, 4A0208 to 4A0675, and 5A0125 to 5A0242)
Orientation	Install the drive vertically to maintain maximum cooling effects.

NOTICE: *Avoid placing drive peripheral devices, transformers, or other electronics near the drive as the noise created can lead to erroneous operation. If such devices must be used in close proximity to the drive, take proper steps to shield the drive from noise.*

NOTICE: *Prevent foreign matter such as metal shavings and wire clippings from falling into the drive during installation. Failure to comply could result in damage to the drive. Place a temporary cover over the top of the drive during installation. Remove the temporary cover before drive start-up, as the cover will reduce ventilation and cause the drive to overheat.*

◆ Installation Orientation and Spacing

Install the drive upright as illustrated in *Figure 2.1* to maintain proper cooling.

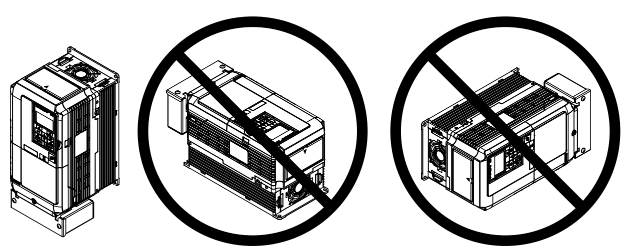
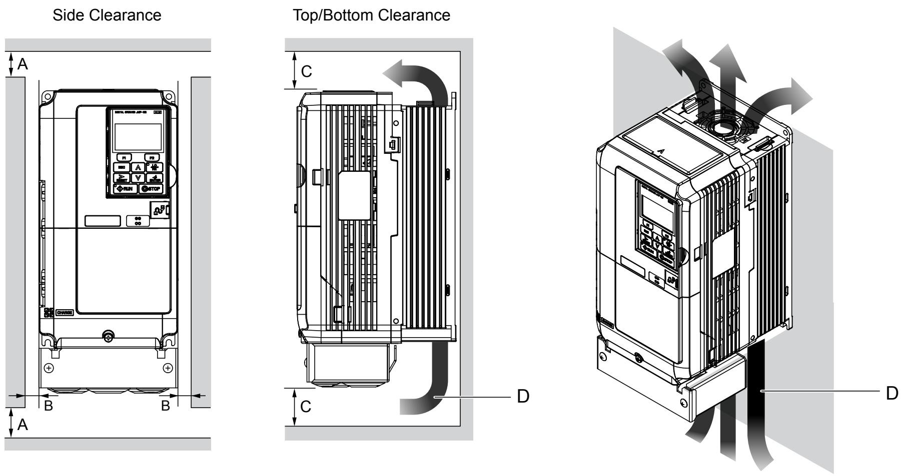


Figure 2.1 Correct Installation Orientation

■ Single Drive Installation

Figure 2.2 shows the installation distance required to maintain sufficient space for airflow and wiring. Install the heatsink against a closed surface to avoid diverting cooling air around the heatsink.



A – 50 mm minimum
B – 30 mm minimum
C – 120 mm minimum
D – Airflow direction

Figure 2.2 Correct Installation Spacing

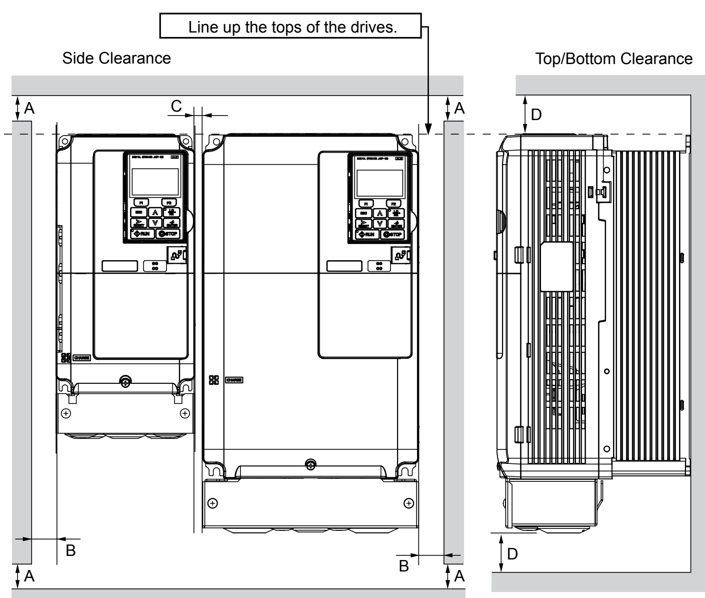
Note: IP20/NEMA Type 1 enclosure and IP00/Open Type enclosure models require the same amount of space above and below the drive for installation.

■ Multiple Drive Installation (Side-by-Side Installation)

Models 2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032 can take advantage of Side-by-Side installation.

When installing multiple drives into the same enclosure panel, mount the drives according to ***Figure 2.2***.

When mounting drives with the minimum clearance of 2 mm according to ***Figure 2.3***, set parameter L8-35 to 1 while considering derating. ***Refer to L8-35: Installation Method Selection on page 247*** for details.



A – 50 mm minimum
B – 30 mm minimum
C – 2 mm minimum
D – 120 mm minimum

Figure 2.3 Space Between Drives (Side-by-Side Mounting)

Note: Align the tops of the drives when installing drives of different heights in the same enclosure panel. Leave space between the tops and bottoms of stacked drives for easier cooling fan replacement.

Remove the top protective covers of all drives as shown in ***Figure 2.4*** when mounting IP20/NEMA Type 1 enclosure drives side-by-side. ***Refer to Top Protective Cover on page 74*** to remove and reattach the top protective cover.

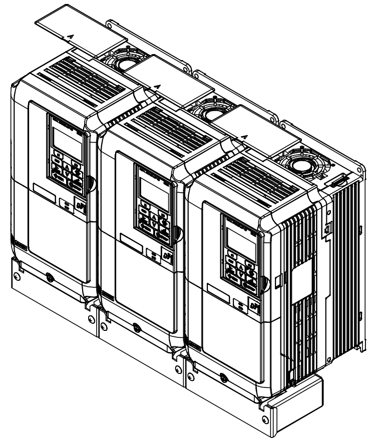


Figure 2.4 IP20/NEMA 1 Side-by-Side Mounting in Enclosure

◆ Digital Operator Remote Usage

■ Remote Operation

The digital operator mounted on the drive can be removed and connected to the drive using an extension cable up to 3 m long to facilitate operation when the drive is installed in a location where it can not be easily accessed.

The digital operator can also be permanently mounted remote locations such as panel doors using an extension cable and an installation support set (depending on the installation type).

Note: *Refer to Drive Options and Peripheral Devices on page 353* for information on extension cables and installation support sets.

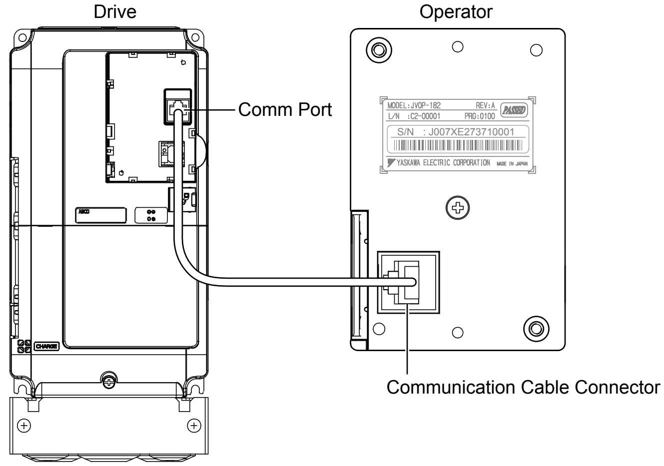


Figure 2.5 Communication Cable Connection

■ Digital Operator Remote Installation

Digital Operator Dimensions

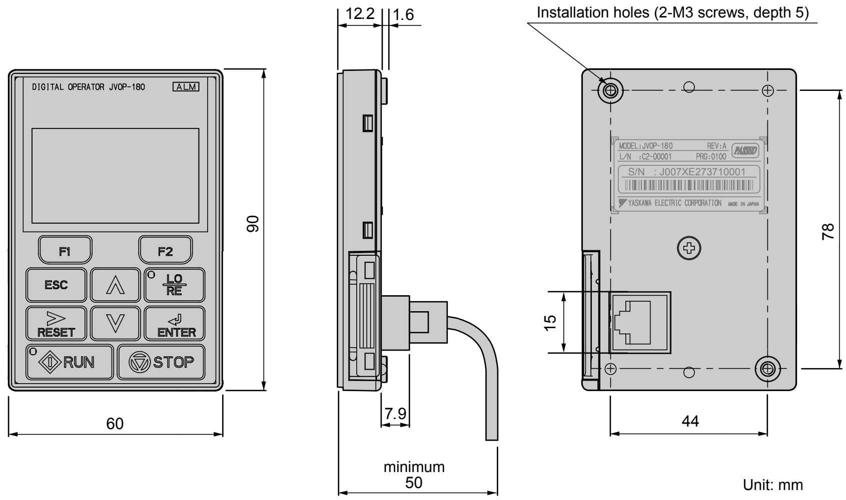


Figure 2.6 Digital Operator Dimensions

NEMA Keypad Kits

Yaskawa offers keypad kits that provide the functionality of the digital operator on enclosures designed for NEMA Type 1, 3R, 4, 4X, 12, or IPX6 environments. These kits are for use with digital operator models JVOP-180 and JVOP-182.

Table 2.2 Installation Environment

Keypad Kit Model	Description
UUX000526	Blank label on the front.
UUX000527	Yaskawa brand label on the front.

Installation Types and Required Materials

The digital operator mounts to an enclosure two different ways:

- **External/face-mount** installs the operator outside the enclosure panel
- **Internal/flush-mount** installs the operator inside the enclosure panel

Table 2.3 Digital Operator Installation Methods and Required Tools

Installation Method	Description	Installation Support Sets	Model	Required Tools
External/ Face-Mount	Simplified installation with the digital operator is mounted on the outside of the panel with two screws.	–	–	Phillips screwdriver (#1)
Internal/ Flush-Mount	Encloses the digital operator in the panel. The front of the digital operator is flush with the outside of the panel.	Installation Support Set A (for mounting with screws through holes in the panel)	EZZ020642A	Phillips screwdriver (#1, #2)
		Installation Support Set B (for use with threaded studs that are fixed to the panel)	EZZ020642B	Phillips screwdriver (#1) Wrench (7 mm)

NOTICE: *Prevent foreign matter such as metal shavings or wire clippings from falling into the drive during installation and project construction. Failure to comply could result in damage to the drive. Place a temporary cover over the top of the drive during installation. Remove the temporary cover before drive start-up, as the cover will reduce ventilation and cause the drive to overheat.*

External/Face-Mount

1. Cut an opening in the enclosure panel for the digital operator as shown in *Figure 2.8*.
2. Position the digital operator so the display faces outwards, and mount it to the enclosure panel as shown in *Figure 2.7*.

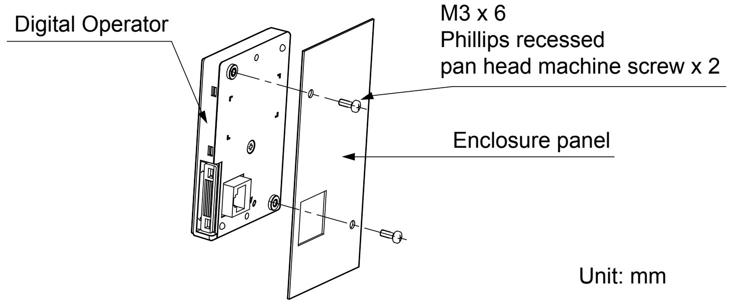


Figure 2.7 External/Face-Mount Installation

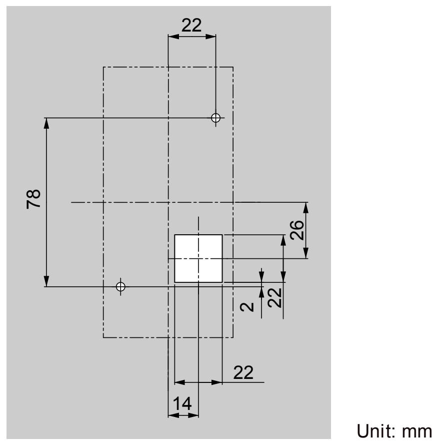


Figure 2.8 Panel Cut-Out Dimensions (External/Face-Mount Installation)

Internal/Flush-Mount

An internal flush-mount requires an installation support set that must be purchased separately. Contact a Yaskawa representative to order an installation support set and mounting hardware. *Figure 2.9* illustrates how to attach the Installation Support Set A.

1. Cut an opening in the enclosure panel for the digital operator as shown in *Figure 2.10*.
2. Mount the digital operator to the installation support.
3. Mount the installation support set and digital operator to the enclosure panel.

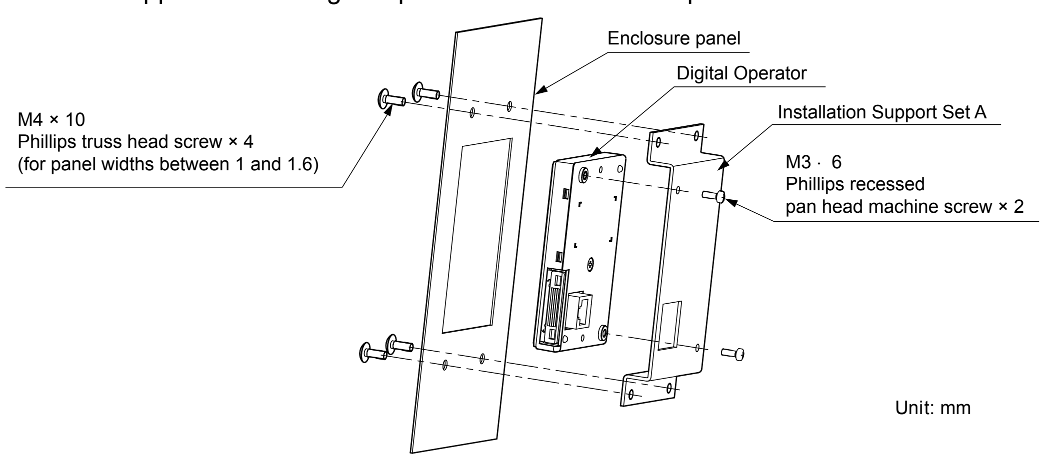
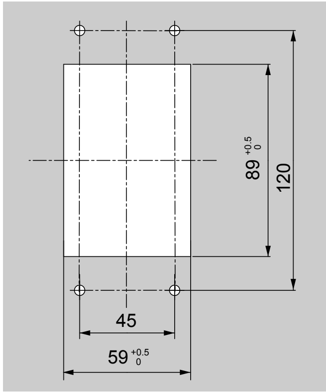


Figure 2.9 Internal/Flush Mount Installation

Note: Use a gasket between the enclosure panel and the digital operator in environments with a significant amount of dust or other airborne debris.



Unit : mm

Figure 2.10 Panel Cut-Out Dimensions (Internal/Flush-Mount Installation)

◆ Exterior and Mounting Dimensions

Table 2.4 Drive Models and Types

Protective Design	Drive Model			Page
	Three-Phase 200 V Class	Three-Phase 400 V Class	Three-Phase 600 V Class	
IP20/NEMA Type 1 Enclosure	2A0004F 2A0006F 2A0008F 2A0010F 2A0012F 2A0018F 2A0021F 2A0030F 2A0040F 2A0056F 2A0069F 2A0081F 2A0110F 2A0138F 2A0169F 2A0211F	4A0002F 4A0004F 4A0005F 4A0007F 4A0009F 4A0011F 4A0018F 4A0023F 4A0031F 4A0038F 4A0044F 4A0058F 4A0072F 4A0088F 4A0103F 4A0139F 4A0165F	5A0003F 5A0004F 5A0006F 5A0009F 5A0011F 5A0017F 5A0022F 5A0027F 5A0032F 5A0041F 5A0052F 5A0062F 5A0077F 5A0099F	*52*
IP00/Open Type Enclosure	2A0250A <1> 2A0312A <1> 2A0360A <1> 2A0415A <2>	4A0208A <1> 4A0250A <1> 4A0296A <1> 4A0362A <1> 4A0414A <2> 4A0515A <2> 4A0675A <2>	5A0125A <1> 5A0145A <1> 5A0192A <1> 5A0242A <1>	*56*

<1> Customers may convert these models to IP20/NEMA Type 1 enclosures using an IP20/NEMA Type 1 Kit. ***Refer to IP20/NEMA Type 1 Kit Selection on page 58*** to select the appropriate kit.

<2> Contact a Yaskawa representative for IP20/NEMA Type 1 Kit availability for these models.

■ IP20/NEMA Type 1 Enclosure Drives

Note: Removing the top protective cover or bottom conduit bracket from an IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while maintaining IP20 conformity.

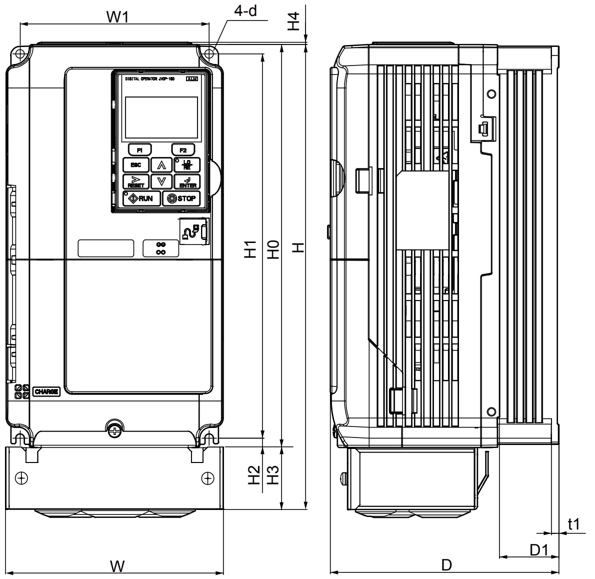


Figure 1

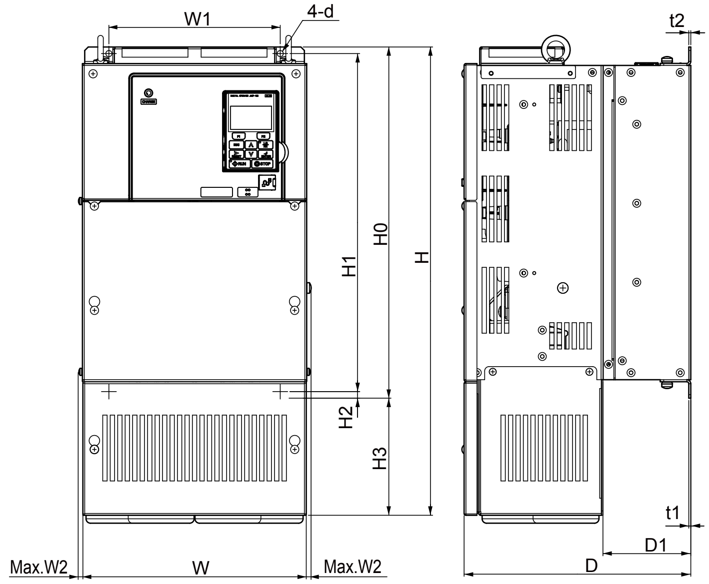


Figure 2

Table 2.5 Dimensions for IP20/NEMA Type 1 Enclosure: 200 V Class

Drive Model	Dimensions (in)														
	Figure	W	H	D	W1	W2	H0	H1	H2	H3	H4	D1	t1	t2	d	Wt. (lb)
2A0004F	1 <1>	5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.3
2A0006F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.3
2A0008F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
2A0010F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
2A0012F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
2A0018F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
2A0021F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
2A0030F		5.51	11.81	6.57	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	9.3
2A0040F		5.51	11.81	6.57	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	9.3
2A0056F		7.09	13.39	7.36	6.30	–	11.81	11.18	0.31	1.57	0.06	2.95	0.20	–	M5	13.0
2A0069F		8.66	15.75	7.76	7.56	–	13.78	13.19	0.31	1.97	0.06	3.07	0.20	–	M6	20.1
2A0081F		8.66	15.75	7.76	7.56	–	13.78	13.19	0.31	1.97	0.06	3.07	0.20	–	M6	22.0
2A0110F	2 <1>	10.00	21.02	10.16	7.68	0.31	15.75	15.16	0.30	5.28	–	3.94	0.09	0.09	M6	50.7
2A0138F		10.98	24.17	10.16	8.66	0.31	17.72	17.13	0.30	6.46	–	3.94	0.09	0.09	M6	61.7
2A0169F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	90.4
2A0211F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	92.6
Dimensions below are the dimensions of IP00/Open Type models after customer installation of the appropriate IP20/NEMA Type 1 Kit.																
2A0250A	2	17.95	37.80	12.99	12.80	0.31	27.76	26.77	0.49	10.04	–	5.12	0.13	0.13	M10	183.0
2A0312A		17.95	37.80	12.99	12.80	0.31	27.76	26.77	0.49	10.04	–	5.12	0.13	0.13	M10	194.0
2A0360A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	238.1

<1> Removing the top protective cover from a IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while retaining IP20 conformity.

Table 2.6 Dimensions for IP20/NEMA Type 1 Enclosure: 400 V Class

Drive Model	Dimensions (in)														
	Figure	W	H	D	W1	W2	H0	H1	H2	H3	H4	D1	t1	t2	d	Wt. (lb)
4A0002F	1 <1>	5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
4A0004F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
4A0005F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
4A0007F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	7.9
4A0009F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
4A0011F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
4A0018F		5.51	11.81	6.57	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	9.0
4A0023F		5.51	11.81	6.57	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	9.0
4A0031F		7.09	13.39	6.57	6.30	–	11.81	11.18	0.31	1.57	0.06	2.17	0.20	–	M5	12.6
4A0038F		7.09	13.39	7.36	6.30	–	11.81	11.18	0.31	1.57	0.06	2.95	0.20	–	M5	13.2
4A0044F		8.66	15.75	7.76	7.56	–	13.78	13.19	0.31	1.97	0.06	3.07	0.20	–	M6	19.2
4A0058F	2 <1>	10.00	18.31	10.16	7.68	0.31	15.75	15.16	0.30	2.56	–	3.94	0.09	0.09	M6	50.7
4A0072F		10.98	20.28	10.16	8.66	0.31	17.72	17.13	0.30	2.56	–	3.94	0.09	0.09	M6	59.5
4A0088F		12.95	24.80	10.16	10.24	0.31	20.08	19.49	0.30	4.72	–	4.13	0.09	0.13	M6	86.0
4A0103F		12.95	24.80	10.16	10.24	0.31	20.08	19.49	0.30	4.72	–	4.13	0.09	0.13	M6	86.0
4A0139F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	99.2
4A0165F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	101.4
Dimensions below are the dimensions of IP00/Open Type models after customer installation of the appropriate IP20/NEMA Type 1 Kit.																
4A0208A	2	17.95	37.80	12.99	12.80	0.31	27.76	26.77	0.49	10.04	–	5.12	0.13	0.13	M10	191.8
4A0250A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	233.7
4A0296A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	246.9
4A0362A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	257.9

<1> Removing the top protective cover from a IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while retaining IP20 conformity.

Table 2.7 Dimensions for IP20/NEMA Type 1 Enclosure: 600 V Class

Drive Model	Dimensions (in)														
	Figure	W	H	D	W1	W2	H0	H1	H2	H3	H4	D1	t1	t2	d	Wt. (lb)
5A0003F	1 <1>	5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
5A0004F		5.51	11.81	5.79	4.80	–	10.24	9.76	0.24	1.57	0.06	1.50	0.20	–	M5	7.5
5A0006F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
5A0009F		5.51	11.81	6.46	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	8.2
5A0011F		5.51	11.81	6.57	4.80	–	10.24	9.76	0.24	1.57	0.06	2.17	0.20	–	M5	9.0
5A0017F		7.09	13.39	7.36	6.30	–	11.81	11.18	0.31	1.57	0.06	2.95	0.20	–	M5	13.2
5A0022F		7.09	13.39	7.36	6.30	–	11.81	11.18	0.31	1.57	0.06	2.95	0.20	–	M5	13.2
5A0027F		8.66	15.75	7.76	7.56	–	13.78	13.19	0.31	1.97	0.06	3.07	0.20	–	M6	19.2
5A0032F		8.66	15.75	7.76	7.56	–	13.78	13.19	0.31	1.97	0.06	3.07	0.20	–	M6	19.2
5A0041F	2	10.98	20.28	10.16	8.66	0.31	17.72	17.13	0.30	2.56	–	3.94	0.09	0.09	M6	59.5
5A0052F		10.98	20.28	10.16	8.66	0.31	17.72	17.13	0.30	2.56	–	3.94	0.09	0.09	M6	59.5
5A0062F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	99.2
5A0077F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	99.2
5A0099F		12.95	28.74	11.14	10.24	0.31	21.65	21.06	0.30	7.09	–	4.33	0.09	0.09	M6	99.2
Dimensions below are the dimensions of IP00/Open Type models after customer installation of the appropriate IP20/NEMA Type 1 Kit.																
5A0125A	2	17.95	37.80	12.99	12.80	0.31	27.76	26.77	0.49	10.04	–	5.12	0.13	0.13	M10	191.8
5A0145A		17.95	37.80	12.99	12.80	0.31	27.76	26.77	0.49	10.04	–	5.12	0.13	0.13	M10	191.8
5A0192A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	233.7
5A0242A		19.84	45.98	13.78	14.57	0.31	31.50	30.43	0.51	14.49	–	5.12	0.18	0.18	M12	257.9

<1> Removing the top protective cover or bottom conduit bracket from an IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while maintaining IP20 conformity.

IP20/NEMA Type 1 Enclosure Conduit Bracket Dimensions

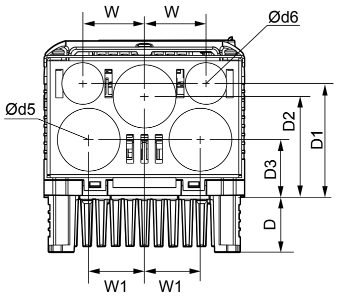


Figure 1

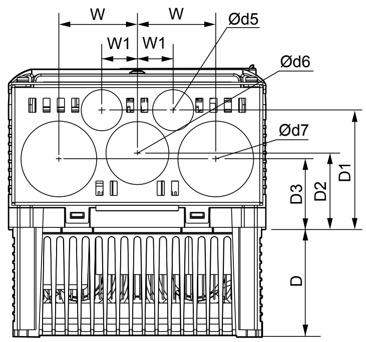


Figure 2

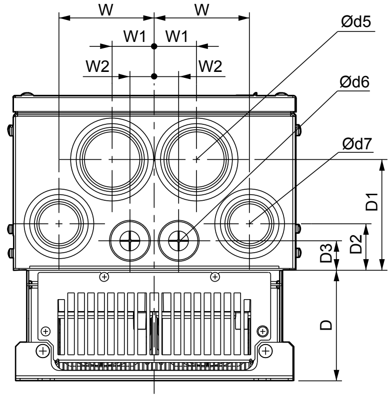


Figure 3

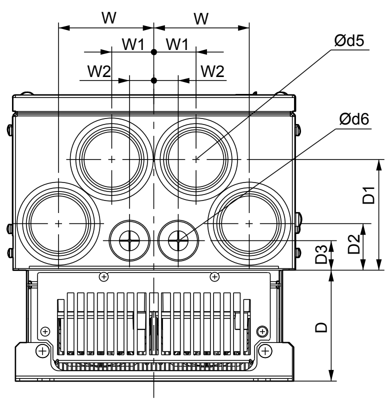


Figure 4

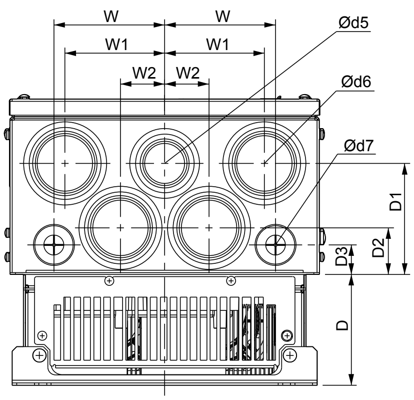


Figure 5

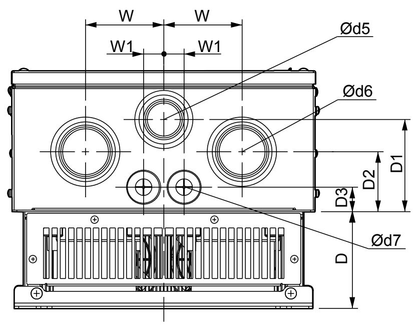


Figure 6

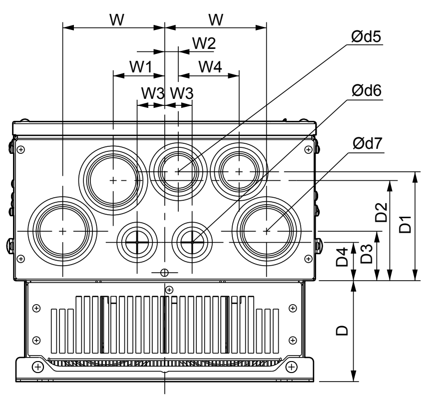


Figure 7

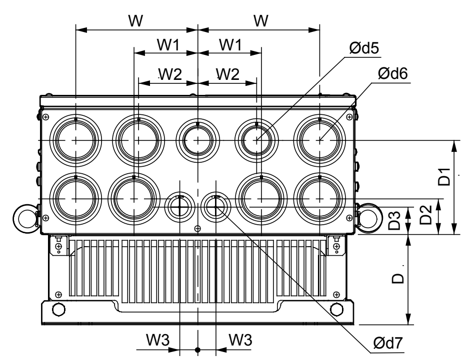


Figure 8

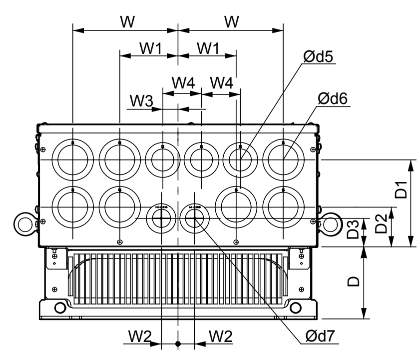


Figure 9

Table 2.8 Conduit Bracket Dimensions for IP20/NEMA Type 1

Drive Model	Dimensions (in)										Diameter (in)		
	Figure	W	D	W1	W2	W3	W4	D1	D2	D3	D4	d5	d6	d7
200 V Class														
2A0004F	1	1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
2A0006F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
2A0008F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	–	–	–
2A0010F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
2A0012F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–

Drive Model	Dimensions (in)											Diameter (in)		
	Figure	W	D	W1	W2	W3	W4	D1	D2	D3	D4	d5	d6	d7
2A0018F	2	1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	1.4	0.9	1.7
2A0021F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	1.4	0.9	1.7
2A0030F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	1.4	0.9	1.7
2A0040F		1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
2A0056F		1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
2A0069F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
2A0081F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
2A0110F	4	3.4	3.9	1.5	0.9	–	–	3.9	1.7	1.0	–	2.4	1.1	–
2A0138F	5	3.9	3.9	3.5	1.6	–	–	3.9	1.7	1.0	–	2.0	2.4	1.1
2A0169F	7	4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
2A0211F		4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
2A0250A	8	6.9	5.1	3.6	3.3	1.0	–	5.4	2.0	1.6	–	2.0	2.4	1.4
2A0312A		6.9	5.1	3.6	3.3	1.0	–	5.4	2.0	1.6	–	2.0	2.4	1.4
2A0360A	9	7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7
400 V Class														
4A0002F	1	1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0004F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0005F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0007F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0009F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0011F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0018F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
4A0023F	2	1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
4A0031F		1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
4A0038F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
4A0044F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
4A0058F	3	3.4	3.9	1.5	0.9	–	–	3.9	1.7	1.0	–	2.4	1.1	2.0
4A0072F		3.5	3.9	1.6	0.9	–	–	3.9	1.7	1.0	–	2.4	1.1	2.0
4A0088F	6	3.3	4.1	0.9	–	–	–	3.9	2.6	1.0	–	2.0	2.4	1.1
4A0103F		3.3	4.1	0.9	–	–	–	3.9	2.6	1.0	–	2.0	2.4	1.1
4A0139F	7	4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
4A0165F		4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
4A0208A	8	6.9	5.1	3.6	3.3	1.0	–	5.4	2.0	1.6	–	2.0	2.4	1.4
4A0250A	9	7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7
4A0296A		7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7
4A0362A		7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7
600 V Class														
5A0003F	1	1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
5A0004F		1.7	1.5	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
5A0006F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
5A0009F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–
5A0011F		1.7	2.2	1.5	–	–	–	1.6	2.8	3.1	–	0.9	1.4	–

Drive Model	Dimensions (in)											Diameter (in)		
	Figure	W	D	W1	W2	W3	W4	D1	D2	D3	D4	d5	d6	d7
5A0017F	2	1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
5A0022F		1	3	2.2	–	–	–	1.9	3.3	2.1	–	1.4	0.9	1.7
5A0027F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
5A0032F		1.1	3.1	2.5	–	–	–	2	3.4	2.2	–	1.4	0.9	1.7
5A0041F	3	3.5	3.9	1.6	0.9	–	–	3.9	1.7	1.0	–	2.4	1.1	2.0
5A0052F		3.5	3.9	1.6	0.9	–	–	3.9	1.7	1.0	–	2.4	1.1	2.0
5A0062F	7	4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
5A0077F		4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
5A0099F		4.4	4.3	2.2	0.6	1.2	2.6	4.7	4.3	2.1	1.6	2.0	1.4	2.4
5A0125A	8	6.9	5.1	3.6	3.3	1.0	–	5.4	2.0	1.6	–	2.0	2.4	1.4
5A0145A		6.9	5.1	3.6	3.3	1.0	–	5.4	2.0	1.6	–	2.0	2.4	1.4
5A0192A	9	7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7
5A0242A		7.5	5.1	4.1	1.2	1.1	2.8	6.2	2.8	2.0	–	2.0	2.4	1.7

Note: Removing the top protective cover or bottom conduit bracket from an IP20/NEMA Type 1 enclosure drive voids NEMA Type 1 protection while maintaining IP20 conformity.

■ IP00/Open Type Enclosure Drives

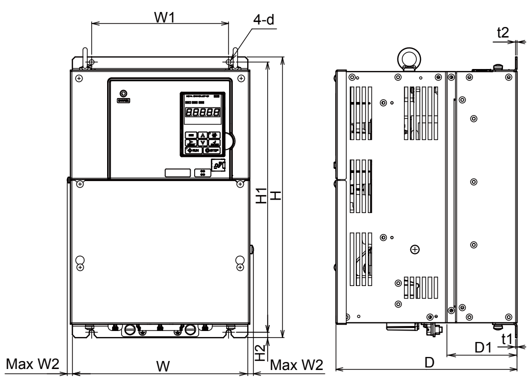


Figure 1

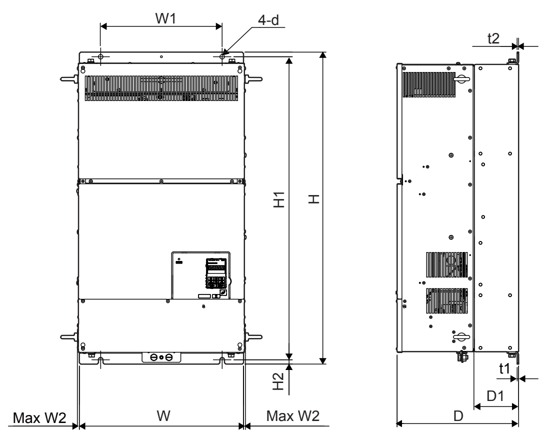


Figure 2

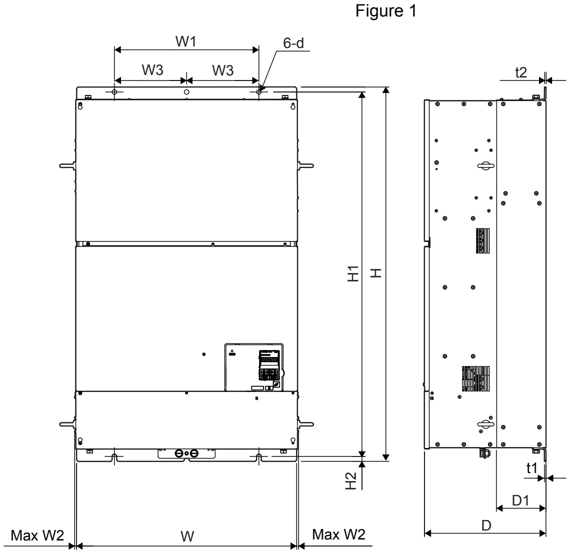


Figure 3

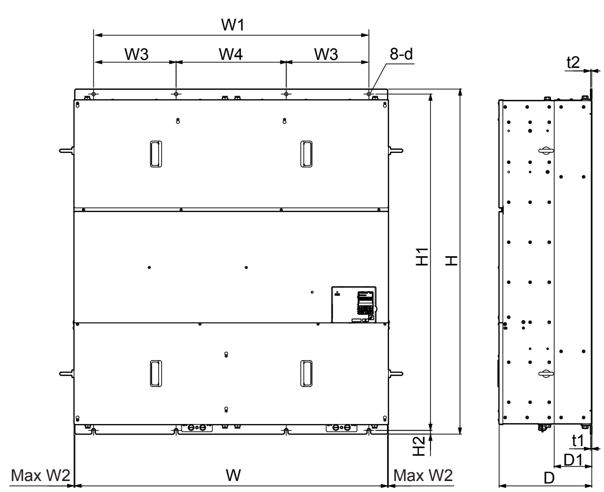


Figure 4

Table 2.9 Dimensions for IP00/Open Type Enclosure: 200 V Class

Drive Model	Dimensions (in)											
	Figure	W	H	D	W1	W2	H1	H2	D1	t1	t2	d	Wt. (lb)
2A0250A <1>	1	17.72	27.76	12.99	12.80	0.39	26.77	0.49	5.12	0.13	0.13	M10	167.6
2A0312A <1>		17.72	27.76	12.99	12.80	0.39	26.77	0.49	5.12	0.13	0.13	M10	176.4
2A0360A <1>		19.69	31.50	13.78	14.57	0.39	30.43	0.51	5.12	0.18	0.18	M12	216.1
2A0415A		19.69	31.50	13.78	14.57	0.39	30.43	0.51	5.12	0.18	0.18	M12	218.3

<1> Customers may convert these models to IP20/NEMA Type 1 enclosures using an IP20/NEMA Type 1 Kit. ***Refer to IP20/NEMA Type 1 Kit Selection on page 58*** to select the appropriate kit.

Table 2.10 Dimensions for IP00/Open Type Enclosure: 400 V Class

Drive Model	Dimensions (in)													
	Figure	W	H	D	W1	W2	W3	W4	H1	H2	D1	t1	t2	d	Wt. (lb)
4A0208A <1>	1	17.72	27.76	12.99	12.80	0.39	–	–	26.77	0.49	5.12	0.13	0.13	M10	174.2
4A0250A <1>		19.69	31.50	13.78	14.57	0.39	–	–	30.43	0.51	5.12	0.18	0.18	M12	211.6
4A0296A <1>		19.69	31.50	13.78	14.57	0.39	–	–	30.43	0.51	5.12	0.18	0.18	M12	224.9
4A0362A <1>		19.69	31.50	13.78	14.57	0.39	–	–	30.43	0.51	5.12	0.18	0.18	M12	235.9
4A0414A	2	19.69	37.40	14.57	14.57	0.31	–	–	36.34	0.51	5.31	0.18	0.18	M12	275.6
4A0515A	3	26.38	44.88	14.57	17.32	0.24	8.66	–	43.70	0.59	5.91	0.18	0.18	M12	476.2
4A0675A		26.38	44.88	14.57	17.32	0.24	8.66	–	43.70	0.59	5.91	0.18	0.18	M12	487.2

<1> Customers may convert these models to IP20/NEMA Type 1 enclosures using an IP20/NEMA Type 1 Kit. ***Refer to IP20/NEMA Type 1 Kit Selection on page 58*** to select the appropriate kit.

Table 2.11 Dimensions for IP00/Open Type Enclosure: 600 V Class

Drive Model	Dimensions (in)													
	Figure	W	H	D	W1	W2	W3	W4	H1	H2	D1	t1	t2	d	Wt. (lb)
5A0125A <1>	1	17.72	27.76	12.99	12.80	0.39	–	–	26.77	0.49	5.12	0.13	0.13	M10	174.2
5A0145A <1>		17.72	27.76	12.99	12.80	0.39	–	–	26.77	0.49	5.12	0.13	0.13	M10	174.2
5A0192A <1>		19.69	31.50	13.78	14.57	0.39	–	–	30.43	0.51	5.12	0.18	0.18	M12	235.9
5A0242A <1>		19.69	31.50	13.78	14.57	0.39	–	–	30.43	0.51	5.12	0.18	0.18	M12	235.9

<1> Customers may convert these models to IP20/NEMA Type 1 enclosures using an IP20/NEMA Type 1 Kit. ***Refer to IP20/NEMA Type 1 Kit Selection on page 58*** to select the appropriate kit.

IP20/NEMA Type 1 Kit Selection

Customers may convert IP00/Open Type models to IP20/NEMA Type 1 enclosures. Refer to ***Table 2.12*** to select the appropriate IP20/NEMA Type 1 Kit when performing the conversion.

Contact a Yaskawa representative for IP20/NEMA Type 1 Kit availability for IP00/Open Type models not listed.

Table 2.12 IP20/NEMA Type 1 Kit Selection

IP00/Open Type Drive Model	IP20/NEMA Type 1 Kit Code	Comments
2A0250A	100-054-503	***Refer to IP20/NEMA Type 1 Enclosure Drives on page 52*** for drive dimensions with the IP20/NEMA Type 1 Kit installed.
2A0312A		
2A0360A		
4A0208A		
4A0250A	100-054-504	
4A0296A		
4A0362A		
5A0125A	100-054-503	
5A0145A		
5A0192A	100-054-504	
5A0242A		

3

Electrical Installation

This chapter explains proper procedures for wiring the control circuit terminals, motor, and power supply.

3.1 Section Safety

⚠ DANGER

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply will result in death or serious injury.

⚠ WARNING

Electrical Shock Hazard

Do not operate equipment with covers removed.

Failure to comply could result in death or serious injury.

The diagrams in this section may show drives without covers or safety shields to show details. Be sure to reinstall covers or shields before operating the drives and run the drives according to the instructions described in this manual.

Make sure the protective earthing conductor complies with technical standards and local safety regulations.

Because the leakage current exceeds 3.5 mA in models 4A0414 and larger, IEC 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.

Always use appropriate equipment for Ground Fault Circuit Interrupters (GFCIs).

The drive can cause a residual current with a DC component in the protective earthing conductor. Where a residual current operated protective or monitoring device is used for protection in case of direct or indirect contact, always use a type B GFCI according to IEC 60755.

Always ground the motor-side grounding terminal.

Improper equipment grounding could result in death or serious injury by contacting the motor case.

Do not perform work on the drive while wearing loose clothing, jewelry or without eye protection.

Failure to comply could result in death or serious injury.

Remove all metal objects such as watches and rings, secure loose clothing, and wear eye protection before beginning work on the drive.

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Do not allow unqualified personnel to perform work on the drive.

Failure to comply could result in death or serious injury.

Installation, maintenance, inspection, and servicing must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of AC drives.

Do not touch any terminals before the capacitors have fully discharged.

Failure to comply could result in death or serious injury.

Before wiring terminals, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.

Fire Hazard

Tighten all terminal screws to the specified tightening torque.

Loose electrical connections could result in death or serious injury by fire due to overheating of electrical connections.

Do not use improper combustible materials.

Failure to comply could result in death or serious injury by fire.

Do not install the drive to a combustible surface. Never place combustible materials on the drive.

WARNING

Do not use an improper voltage source.

Failure to comply could result in death or serious injury by fire.

Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.

When installing dynamic braking options, perform all wiring exactly as specified in the wiring diagrams provided.

Failure to do so can result in fire. Improper wiring may damage braking components.

CAUTION

Do not carry the drive by the front cover or the terminal cover.

Failure to comply may cause the main body of the drive to fall, resulting in minor or moderate injury.

NOTICE

Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards.

Failure to comply may result in ESD damage to the drive circuitry.

Never connect or disconnect the motor from the drive while the drive is outputting voltage.

Improper equipment sequencing could result in damage to the drive.

Do not use unshielded cable for control wiring.

Failure to comply may cause electrical interference resulting in poor system performance. Use shielded, twisted-pair wires and ground the shield to the ground terminal of the drive.

Do not allow unqualified personnel to use the product.

Failure to comply could result in damage to the drive or braking circuit.

Carefully review instruction manual TOBPC72060000 or TOBPC72060001 when connecting a dynamic braking option to the drive.

Do not modify the drive circuitry.

Failure to comply could result in damage to the drive and will void warranty.

Yaskawa is not responsible for any modification of the product made by the user. This product must not be modified.

Check all the wiring to ensure that all connections are correct after installing the drive and connecting any other devices.

Failure to comply could result in damage to the drive.

3.2 Standard Connection Diagram

Connect the drive and peripheral devices as shown in ***Figure 3.1***. It is possible to set and run the drive via the digital operator without connecting digital I/O wiring. This section does not discuss drive operation; ***Refer to Start-Up Programming & Operation on page 97*** for instructions on operating the drive.

NOTICE: *Inadequate wiring could result in damage to the drive. Install adequate branch circuit short circuit protection per applicable codes. The drive is suitable for circuits capable of delivering not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V class), 480 Vac maximum (400 V class), 600 Vac maximum (600 V class).*

NOTICE: *When the input voltage is 440 V or higher or the wiring distance is greater than 100 meters, pay special attention to the motor insulation voltage or use a drive duty motor. Failure to comply could lead to motor insulation breakdown.*

NOTICE: *Do not connect AC control circuit ground to drive enclosure. Improper drive grounding can cause control circuit malfunction.*

Note: The minimum load for the relay outputs M1-M2, M3-M4, MA-MB-MC, and MD-ME-MF is 10 mA.

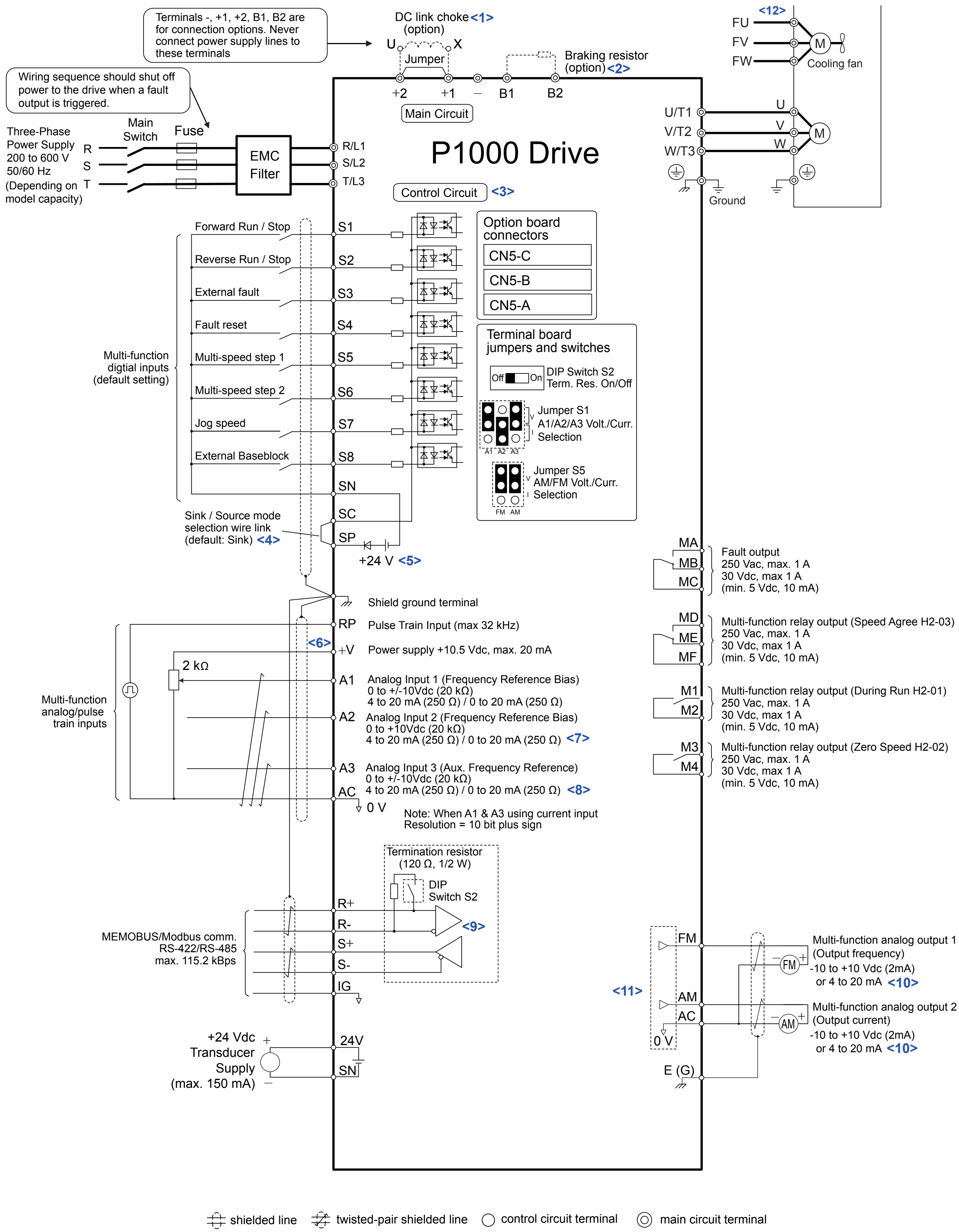


Figure 3.1 Drive Standard Connection Diagram (example: model 2A0040)

<1> Remove the jumper when installing a DC link choke. Models 2A0110 to 2A0415 and 4A0058 to 4A0675 come with a built-in DC link choke.

<2> Set L8-55 to 0 to disable the protection function of the built-in braking transistor of the drive when using an optional regenerative converter or dynamic braking option. Leaving L8-55 enabled may cause a braking resistor fault (rF). Additionally, disable Stall Prevention (L3-04 = 0) when using an optional regenerative converter, regenerative or braking units, or dynamic braking option. Leaving If L3-04 enabled may prevent the drive from stopping within the specified deceleration time.

<3> Supplying power to the control circuit separately from the main circuit requires 24 V power supply (option).

<4> This figure illustrates an example of a sequence input to S1 through S8 using a non-powered relay or an NPN transistor. Install the wire link between terminals SC-SP for Sink mode, between SC-SN for Source mode, or leave the link out for external power supply. Never short terminals SP and SN, as it will damage the drive.

<5> This voltage source supplies a maximum current of 150 mA.

<6> The maximum output current capacity for the +V terminal on the control circuit is 20 mA. Never short terminals +V and AC, as it can cause erroneous operation or damage the drive.

<7> Set jumper S1 to select between a voltage or current input signal to terminal A2. The default setting is for current input.

<8> Set jumper S1 to select between a voltage or current input signal to terminal A1 and A3. The default setting is for voltage input.

<9> Set DIP switch S2 to the ON position to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.

<10> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters, and wattmeters. They are not intended for use as a feedback-type signal.

<11> Use jumper S5 to select between voltage or current output signals at terminals AM and FM. Set parameters H4-07 and H4-08 accordingly.

<12> Self-cooling motors do not require the same wiring necessary for motors with cooling fans.

WARNING! *Sudden Movement Hazard. Do not close the wiring for the control circuit unless the multifunction input terminal parameters are properly set. Improper sequencing of run/stop circuitry could result in death or serious injury from moving equipment.*

WARNING! *Sudden Movement Hazard. Ensure start/stop and safety circuits are wired properly and in the correct state before energizing the drive. Failure to comply could result in death or serious injury from moving equipment. When programmed for 3-Wire control, a momentary closure on terminal S1 may cause the drive to start.*

WARNING! *Sudden Movement Hazard. When using a 3-Wire sequence, set the drive to 3-Wire sequence prior to wiring the control terminals and set parameter b1-17 to 0 so the drive will not accept a Run command at power up (default). If the drive is wired for a 3-Wire sequence but set up for a 2-Wire sequence (default), and parameter b1-17 is set to 1 so the drive accepts a Run command at power up, the motor will rotate in reverse direction at drive power up and may cause injury.*

WARNING! *Sudden Movement Hazard. Confirm the drive I/O signals and external sequence before executing the application preset function. Executing the application preset function or setting A1-03 ≠ 0 will change the drive I/O terminal functions and may cause unexpected equipment operation. Failure to comply may cause death or serious injury.*

NOTICE: *When using the automatic fault restart function with wiring designed to shut off the power supply upon drive fault, make sure the drive does not trigger a fault output during fault restart (L5-02 = 0, default). Failure to comply will prevent the automatic fault restart function from working properly.*

3.3 Main Circuit Connection Diagram

Refer to diagrams in this section when wiring the main circuit of the drive. Connections may vary based on drive capacity. The DC power supply for the main circuit also provides power to the control circuit.

NOTICE: *Do not use the negative DC bus terminal "–" as a ground terminal. This terminal is at high DC voltage potential. Improper wiring connections could damage the drive.*

◆ Three-Phase 200 V Class Models 2A0004 to 2A0081 Three-Phase 400 V Class Models 4A0002 to 4A0044 Three-Phase 600 V Class Models 5A0003 to 5A0032

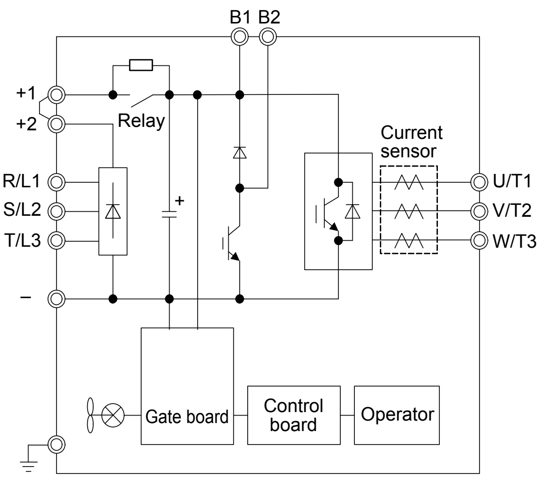


Figure 3.2 Connecting Main Circuit Terminals

◆ Three-Phase 200 V Class Models 2A0110, 2A0138 Three-Phase 400 V Class Models 4A0058, 4A0072 Three-Phase 600 V Class Models 5A0041, 5A0052

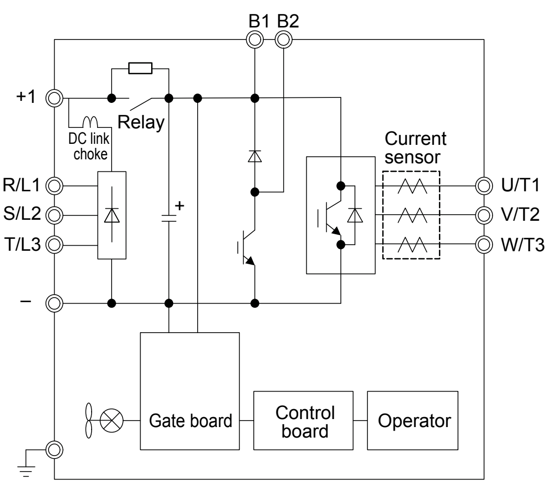


Figure 3.3 Connecting Main Circuit Terminals

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◆ Three-Phase 200 V Class Models 2A0169 to 2A0211
Three-Phase 400 V Class Models 4A0088 to 4A0139
Three-Phase 600 V Class Models 5A0062 to 5A0099

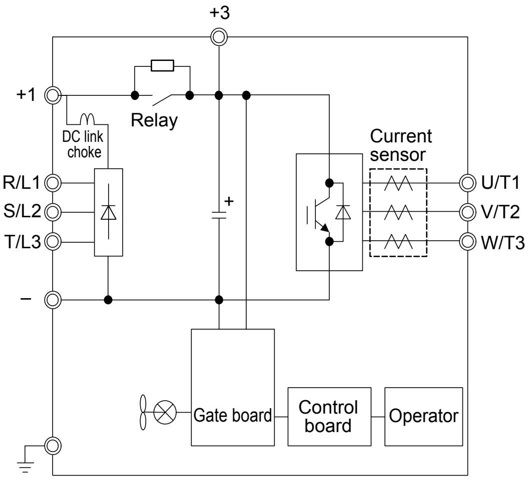

Figure 3.4 Connecting Main Circuit Terminals

◆ Three-Phase 200 V Class Models 2A0250 to 2A0415
Three-Phase 400 V Class Models 4A0165 to 4A0675
Three-Phase 600 V Class Models 5A0125 to 5A0242

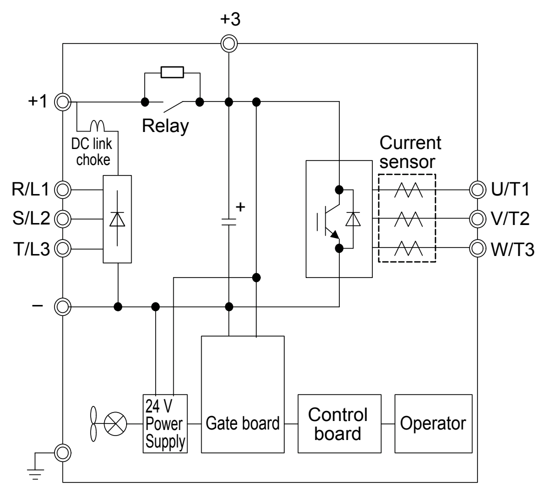

Figure 3.5 Connecting Main Circuit Terminals

3.4 Terminal Block Configuration

Figure 3.6 and *Figure 3.7* show the different main circuit terminal arrangements for the drive capacities.

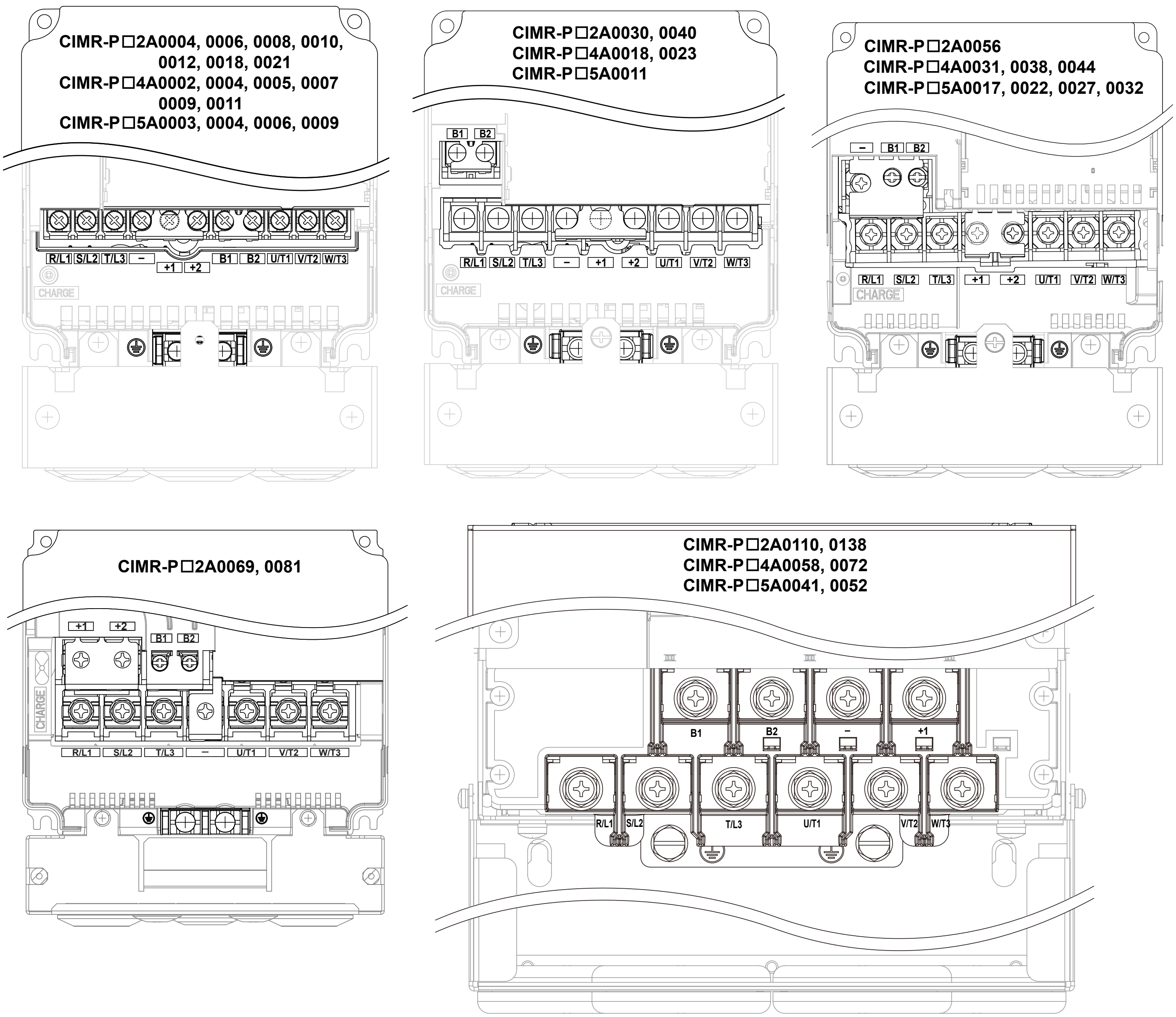

Figure 3.6 Main Circuit Terminal Block Configuration

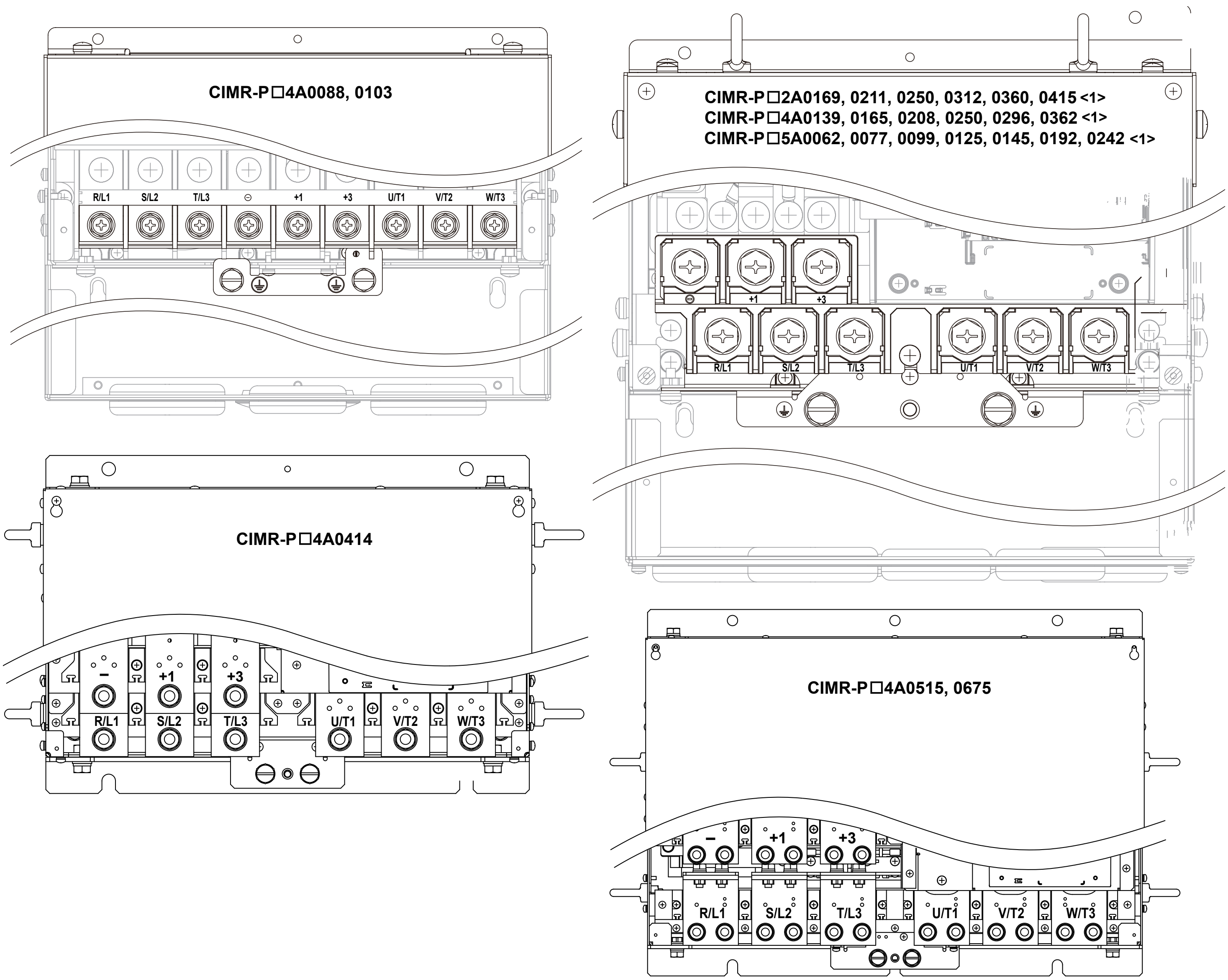

Figure 3.7 Main Circuit Terminal Block Configuration (continued)

<1> Terminal block design differs slightly for models 2A0250 to 2A0415, 4A0208 to 4A0362, and 5A0125 to 5A0242.

3.5 Terminal Cover

Follow the procedure below to remove the terminal cover for wiring and to reattach the terminal cover after wiring is complete.

◆ Models 2A0004 to 2A0081, 4A0002 to 4A0044, 5A0003 to 5A0032 (IP20/NEMA Type 1 Enclosure)

■ Removing the Terminal Cover

1. Loosen the terminal cover screw using a #2 Phillips screwdriver. Screw sizes vary by drive model.

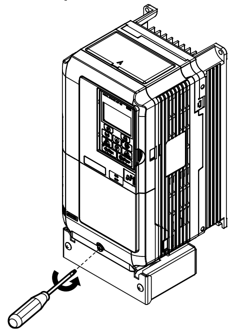

Figure 3.8 Removing the Terminal Cover on an IP20/NEMA Type 1 Enclosure Drive

2. Push in on the tab located on the bottom of the terminal cover and gently pull forward to remove the terminal cover.

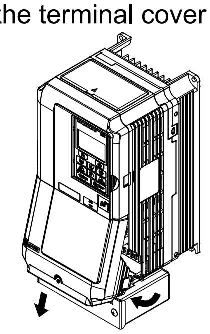

Figure 3.9 Removing the Terminal Cover on an IP20/NEMA Type 1 Enclosure Drive

■ Reattaching the Terminal Cover

Power lines and signal wiring should pass through the opening provided. ***Refer to Wiring the Main Circuit Terminal on page 84*** and ***Wiring the Control Circuit Terminal*** on page ***89*** for details on wiring.

Reattach the terminal cover after completing the wiring to the drive and other devices.

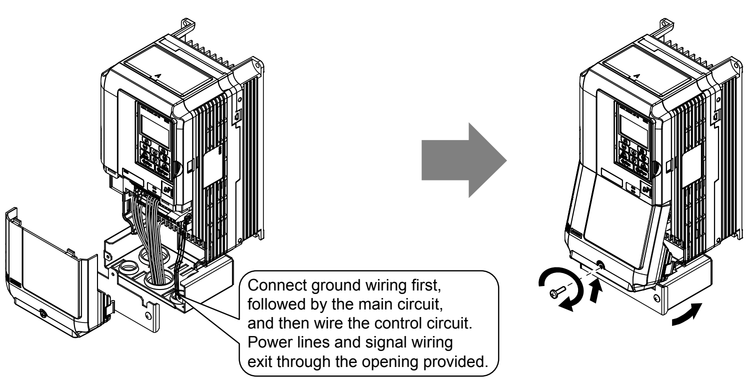

Figure 3.10 Reattaching the Terminal Cover on an IP20/NEMA Type 1 Enclosure Drive

◆ Models 2A0110 to 2A0250, 4A0208 to 4A0675, and 5A0125 to 5A0242 (IP00/Open Type Enclosure)

■ Removing the Terminal Cover

1. Loosen the screws on the terminal cover, then pull down on the cover.

Note: The terminal cover and the number of terminal cover screws differ depending on the drive model. *Refer to Component Names on page 34* for details.

CAUTION! *Do not completely remove the cover screws, just loosen them. If the cover screws are removed completely, the terminal cover may fall off causing an injury.*

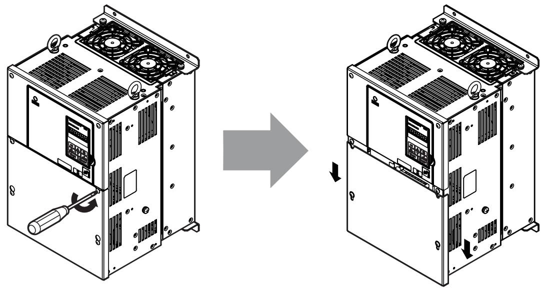

Figure 3.11 Removing the Terminal Cover on an IP00/Open Type Enclosure Drive

2. Pull forward on the terminal cover to free it from the drive.

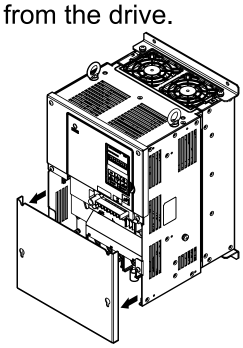

Figure 3.12 Removing the Terminal Cover on an IP00/Open Type Enclosure Drive

■ Reattaching the Terminal Cover

After wiring the terminal board and other devices, double-check connections and reattach the terminal cover. *Refer to Wiring the Main Circuit Terminal on page 84* and *Wiring the Control Circuit Terminal* on page *89* for details on wiring.

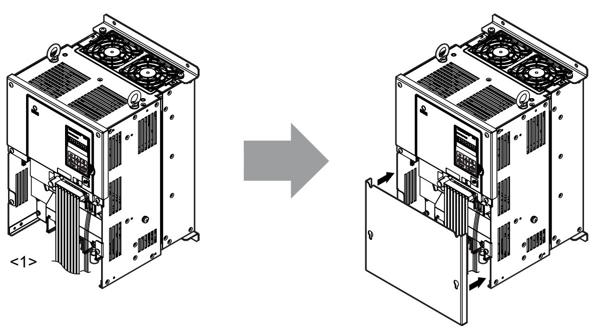

Figure 3.13 Reattaching the Terminal Cover on an IP00/Open Type Enclosure Drive

<1> Connect the ground wiring first, then the main circuit wiring, and finally the control circuit wiring.

3.6 Digital Operator and Front Cover

Detach the digital operator from the drive for remote operation or when opening the front cover to install an option card.

NOTICE: *Be sure to remove the digital operator prior to opening or reattaching the front cover. Leaving the digital operator plugged into the drive when removing the front cover can result in erroneous operation caused by a poor connection. Firmly fasten the front cover back into place before reattaching the digital operator.*

◆ Removing/Reattaching the Digital Operator

■ Removing the Digital Operator

While pressing on the tab located on the right side of the digital operator, pull the digital operator forward to remove it from the drive.

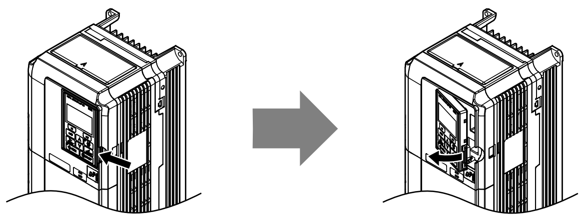

Figure 3.14 Removing the Digital Operator

■ Reattaching the Digital Operator

Insert the digital operator into the opening in the top cover while aligning it with the notches on the left side of the opening. Next, press gently on the right side of the operator until it clicks into place.

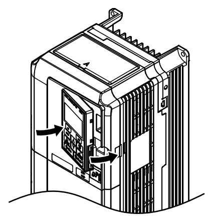

Figure 3.15 Reattaching the Digital Operator

◆ Removing/Reattaching the Front Cover

■ Removing the Front Cover

Models 2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032

After removing the terminal cover and the digital operator, loosen the screw that affixes the front cover (models 2A0056, 4A0038, 5A0022, and 5A0027 do not use a screw to affix the front cover) . Pinch in on the tabs found on each side of the front cover, then pull forward to remove it from the drive.

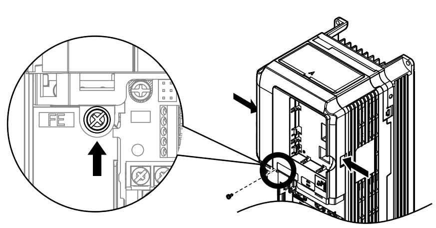

Figure 3.16 Remove the Front Cover (2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032)

Models 2A0110 to 2A0415 and 4A0058 to 4A0675

1. Remove the terminal cover and the digital operator.
2. Loosen the installation screw on the front cover.
3. Use a straight-edge screwdriver to loosen the hooks on each side of the cover that hold it in place.

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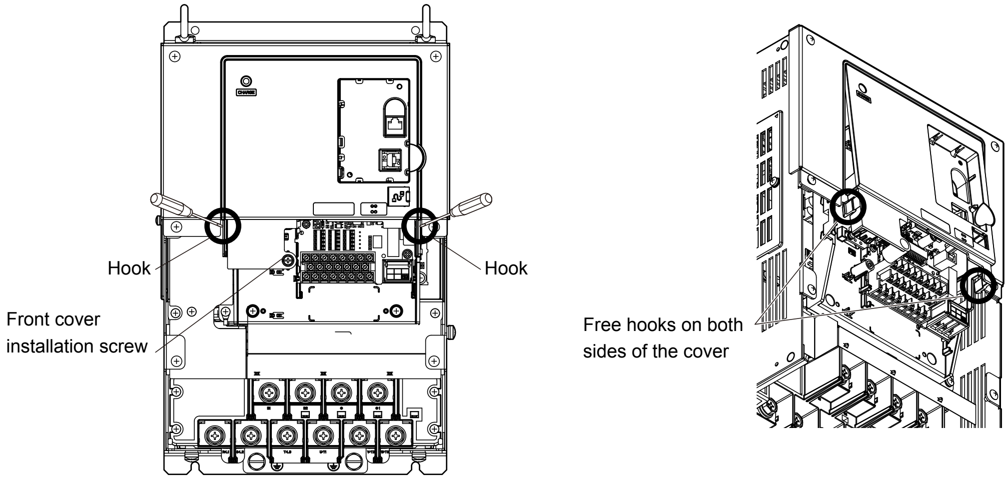

Figure 3.17 Remove the Front Cover (2A0010 to 2A0415 and 4A0058 to 4A0675)

4. Unhook the left side of the front cover then swing the left side towards you as shown in *Figure 3.18* until the cover comes off.

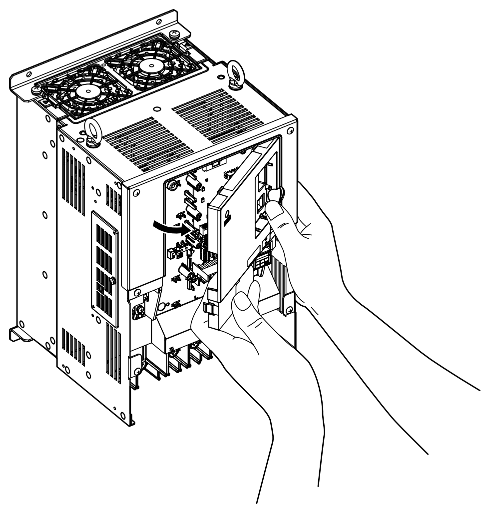

Figure 3.18 Remove the Front Cover (2A0010 to 2A0415 and 4A0058 to 4A0675)

■ Reattaching the Front Cover

Models 2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032

Reverse the instructions given in *Remove the Front Cover (2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032)* on page 71 to reattach the front cover. Pinch inwards on the hooks found on each side of the front cover while guiding it back into the drive. Make sure it clicks firmly into place.

Models 2A0110 to 2A0415 and 4A0058 to 4A0675

1. Slide the front cover so the hooks on the top connect to the drive.

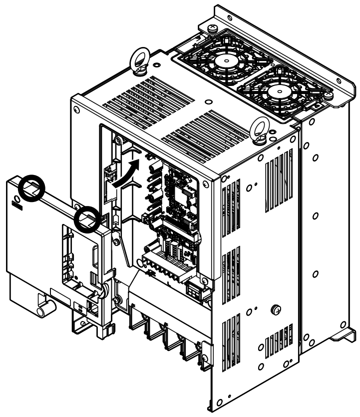

Figure 3.19 Reattach the Front Cover (2A0110 to 2A0415 and 4A0058 to 4A0675)

2. After connecting the hooks to the drive, press firmly on the cover to lock it into place.

3.7 Top Protective Cover

Drive models 2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032 are designed to IP20/NEMA Type 1 specifications with a protective cover on the top. Removing this top protective cover or the bottom conduit bracket from an IP20/NEMA Type 1 enclosure drive voids the NEMA Type 1 protection while maintaining IP20 conformity.

◆ Removing the Top Protective Cover

Insert the tip of a straight-edge screwdriver into the small opening located on the front edge of the top protective cover. Gently apply pressure as shown in the figure below to free the cover from the drive.

Note: Removing the top protective cover or the bottom conduit bracket from an IP20/NEMA Type 1 enclosure drive voids the NEMA Type 1 protection while maintaining IP20 conformity.

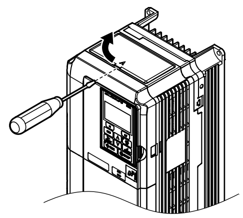

Figure 3.20 Removing the Top Protective Cover

◆ Reattaching the Top Protective Cover

Insert the two small protruding hooks on the rear side of the top protective cover into the provided mounting holes near the back of the drive, then press down on the front side of the top protective cover to fasten the cover into place.

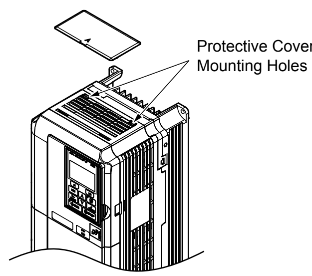

Figure 3.21 Reattaching the Protective Cover

3.8 Main Circuit Wiring

This section describes the functions, specifications, and procedures required to safely and properly wire the main circuit in the drive.

NOTICE: *Do not solder the ends of wire connections to the drive. Soldered wiring connections can loosen over time. Improper wiring practices could result in drive malfunction due to loose terminal connections.*

NOTICE: *Do not switch the drive input to start or stop the motor. Frequently switching the drive on and off shortens the life of the DC bus charge circuit and the DC bus capacitors, and can cause premature drive failures. For the full performance life, refrain from switching the drive on and off more than once every 30 minutes.*

Refer to Input Fuse Installation on page 516 for details on fuse selection.

◆ Main Circuit Terminal Functions

Table 3.1 Main Circuit Terminal Functions

<table>
<tr><th colspan="2">Terminal</th><th colspan="3">Type</th><th rowspan="4">Function</th><th rowspan="4">Page</th></tr>
<tr><th>200 V Class</th><th rowspan="3">Drive Model</th><th>2A0004 to 2A0081</th><th>2A0110 to 2A0138</th><th>2A0169 to 2A0415</th></tr>
<tr><th>400 V Class</th><th>4A0002 to 4A0044</th><th>4A0058, 4A0072</th><th>4A0088 to 4A0675</th></tr>
<tr><th>600 V Class</th><th>5A0003 to 5A0032</th><th>5A0041 to 5A0052</th><th>5A0062 to 5A0242</th></tr>
<tr><td colspan="2">R/L1</td><td colspan="3" rowspan="3">Main circuit power supply input</td><td rowspan="3">Connects line power to the drive</td><td rowspan="3">63</td></tr>
<tr><td colspan="2">S/L2</td></tr>
<tr><td colspan="2">T/L3</td></tr>
<tr><td colspan="2">U/T1</td><td colspan="3" rowspan="3">Drive output</td><td rowspan="3">Connects to the motor</td><td rowspan="3">63</td></tr>
<tr><td colspan="2">V/T2</td></tr>
<tr><td colspan="2">W/T3</td></tr>
<tr><td colspan="2">B1</td><td colspan="2" rowspan="2">Braking resistor</td><td rowspan="2">Not available</td><td rowspan="2">Available for connecting a braking resistor or a braking resistor unit option</td><td rowspan="2">361</td></tr>
<tr><td colspan="2">B2</td></tr>
<tr><td colspan="2">+2</td><td rowspan="3">• DC link choke connection (+1, +2) (remove the shorting bar between +1 and +2)
• DC power supply input (+1, −)</td><td colspan="2">Not available</td><td rowspan="4">For connecting:
• the drive to a DC power supply (terminals +1 and – are not EU/CE or UL approved)
• dynamic braking options
• a DC link choke</td><td rowspan="4">365</td></tr>
<tr><td colspan="2">+1</td><td rowspan="2">DC power supply input (+1, −)</td><td rowspan="3">• DC power supply input (+1, −)
• Braking unit connection (+3, −)</td></tr>
<tr><td colspan="2">–</td></tr>
<tr><td colspan="2">+3</td><td colspan="2">Not available</td></tr>
<tr><td colspan="2">⏚</td><td colspan="3">For 200 V class: 100 Ω or less
For 400 V class: 10 Ω or less
For 600 V class: 10 Ω or less</td><td>Grounding terminal</td><td>84</td></tr>
</table>

Note: Use terminals B1 and – when installing a CDBR-type braking unit on drives with built-in braking transistors (Models 2A0004 to 2A0138, 4A0002 to 4A0072, and 5A0003 to 5A0052).

◆ Protecting Main Circuit Terminals

■ Insulation Caps or Sleeves

Use insulation caps or sleeves when wiring the drive with crimp terminals. Take particular care to ensure that the wiring does not touch nearby terminals or the surrounding case.

■ Insulation Barrier

Insulation barriers are packaged with drive models 4A0414 through 4A0675 to provide added protection between terminals. Yaskawa recommends using the provided insulation barriers to ensure proper wiring. Refer to *Figure 3.22* for instructions on placement of the insulation barriers.

Electrical Installation

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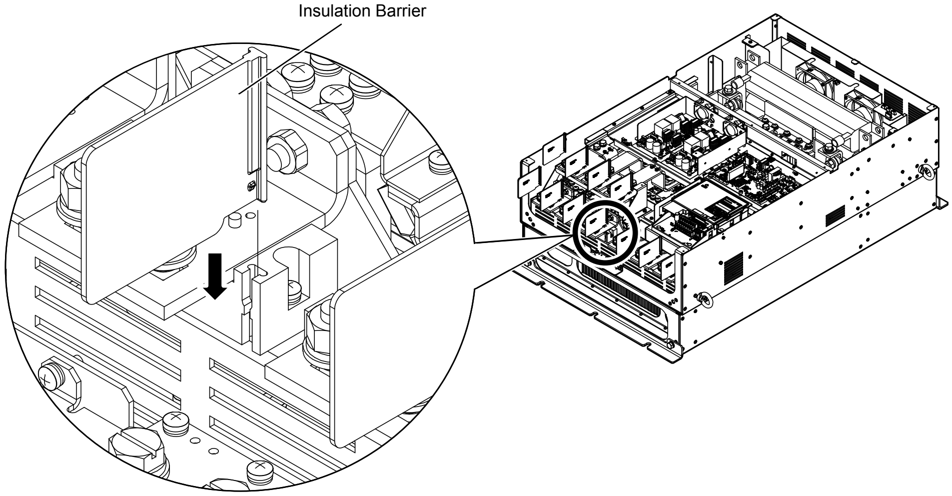


Figure 3.22 Installing Insulation Barriers

◆ Wire Gauges and Tightening Torque

Use the tables in this section to select the appropriate wires and crimp terminals.

Gauges listed in the tables are for use in the United States.

Note:
1. Wire gauge recommendations based on drive continuous current ratings (ND) using 75 °C 600 Vac vinyl-sheathed wire assuming ambient temperature within 40 °C and wiring distance less than 100 m.
2. Terminals +1, +2, +3, –, B1 and B2 are for connecting optional devices such as a DC link choke or braking resistor. Do not connect other nonspecific devices to these terminals.

- Consider the amount of voltage drop when selecting wire gauges. Increase the wire gauge when the voltage drop is greater than 2% of motor rated voltage. Ensure the wire gauge is suitable for the terminal block. Use the following formula to calculate the amount of voltage drop:

  Line drop voltage (V) = $\sqrt{3}$ × wire resistance (Ω/km) × wire length (m) × current (A) × 10^{-3}
- Refer to instruction manual TOBP C720600 00 for braking transistor option or braking resistor option wire gauges.
- Use terminals +1 and – when connecting a regenerative converter or a regen unit.

  NOTICE: *Do not connect a braking resistor to terminals +1 or –. Failure to comply may cause damage to the drive circuitry.*
- Use terminals B1 and – when installing a CDBR-type braking unit on drives with built-in braking transistors (models 2A0004 to 2A0138, 4A0002 to 4A0072, and 5A0003 to 5A0052).

  NOTICE: *Do not connect a braking resistor to terminals +1 or –. Failure to comply may cause damage to the drive circuitry.*
- ***Refer to UL Standards Compliance on page 505*** for information on UL compliance.

Yaskawa recommends using closed-loop crimp terminals on all drive models. UL/cUL approval requires the use of closed-loop crimp terminals when wiring the drive main circuit terminals on models 2A0110 to 2A0415 and 4A0058 to 4A0675. Use only the tools recommended by the terminal manufacturer for crimping. ***Refer to Closed-Loop Crimp Terminal Size on page 512*** for closed-loop crimp terminal recommendations.

The wire gauges listed in the following tables are Yaskawa recommendations. Refer to local codes for proper wire gauge selections.

■ Three-Phase 200 V Class

Table 3.2 Wire Gauge and Torque Specifications (Three-Phase 200 V Class)

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
2A0004 2A0006 2A0008 2A0010	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10 <1>	14 to 10		
2A0012	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10 <1>	14 to 10		
2A0018	R/L1, S/L2, T/L3	10	12 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	10	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10 <1>	14 to 10		
2A0021	R/L1, S/L2, T/L3	10	12 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	10	12 to 10		
	–, +1, +2	–	12 to 10		
	B1, B2	–	14 to 10		
	⏚	10 <1>	12 to 10		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
2A0030	R/L1, S/L2, T/L3	8	10 to 6	M4	2.1 to 2.3 (18.4 to 20.4)
	U/T1, V/T2, W/T3	8	10 to 6		
	–, +1, +2	–	10 to 6		
	B1, B2	–	14 to 10		
	⏚	8 <1>	10 to 8	M5	2 to 2.5 (17.7 to 22.1)
2A0040	R/L1, S/L2, T/L3	6	8 to 6	M4	2.1 to 2.3 (18.4 to 20.4)
	U/T1, V/T2, W/T3	8	8 to 6		
	–, +1, +2	–	6		
	B1, B2	–	12 to 10		
	⏚	8 <1>	10 to 8	M5	2 to 2.5 (17.7 to 22.1)
2A0056	R/L1, S/L2, T/L3	4	6 to 4	M6	5.4 to 6.0 (47.8 to 53.1)
	U/T1, V/T2, W/T3	4	6 to 4		
	–, +1, +2	–	6 to 4		
	B1, B2	–	10 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	8 to 6	M6	4 to 6 (35.4 to 53.1)
2A0069	R/L1, S/L2, T/L3	3	4 to 3	M8	9.9 to 11.0 (87.6 to 97.4)
	U/T1, V/T2, W/T3	3	4 to 3		
	–, +1, +2	–	4 to 3		
	B1, B2	–	8 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	6 to 4	M6	4 to 6 (35.4 to 53.1)
2A0081	R/L1, S/L2, T/L3	2	3 to 2	M8	9.9 to 11.0 (87.6 to 97.4)
	U/T1, V/T2, W/T3	2	3 to 2		
	–, +1, +2	–	3 to 2		
	B1, B2	–	6	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	6 to 4	M6	4 to 6 (35.4 to 53.1)
2A0110 <2>	R/L1, S/L2, T/L3	1/0	3 to 1/0	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	1/0	3 to 1/0		
	–, +1	–	2 to 1/0		
	B1, B2	–	6 to 1/0		
	⏚	6	6 to 4		
2A0138 <2>	R/L1, S/L2, T/L3	2/0	1 to 2/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	2/0	1 to 2/0		
	–, +1	–	1/0 to 3/0		
	B1, B2	–	4 to 2/0		
	⏚	4	4	M8	9 to 11 (79.7 to 97.4)
2A0169 <2>	R/L1, S/L2, T/L3	4/0	2/0 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	4/0	3/0 to 4/0		
	–, +1	–	1 to 4/0		
	+3	–	1/0 to 4/0		
	⏚	4	4 to 2		
2A0211 <2>	R/L1, S/L2, T/L3	1/0 × 2P	1/0 to 2/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	1/0 × 2P	1/0 to 2/0		
	–, +1	–	1 to 4/0		
	+3	–	1/0 to 4/0		
	⏚	4	4 to 1/0		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
2A0250 <2>	R/L1, S/L2, T/L3	3/0 × 2P	3/0 to 300	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	3/0 × 2P	3/0 to 300		
	–, +1	–	3/0 to 300		
	+3	–	2 to 300	M10	18 to 23 (159 to 204)
	⏚	3	3 to 300	M12	32 to 40 (283 to 354)
2A0312 <2>	R/L1, S/L2, T/L3	4/0 × 2P	3/0 to 300	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	3/0 × 2P	3/0 to 300		
	–, +1	–	3/0 to 300		
	+3	–	3/0 to 300	M10	18 to 23 (159 to 204)
	⏚	2	2 to 300	M12	32 to 40 (283 to 354)
2A0360 <2>	R/L1, S/L2, T/L3	250 × 2P	4/0 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	4/0 × 2P	4/0 to 600		
	–, +1	–	250 to 600		
	+3	–	3/0 to 600	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)
2A0415 <2>	R/L1, S/L2, T/L3	350 × 2P	250 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	300 × 2P	300 to 600		
	–, +1	–	300 to 600		
	+3	–	3/0 to 600	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)

<1> When installing an EMC filter, additional measures must be taken to comply with IEC61800-5-1. ***Refer to EMC Filter Installation on page 500*** for details.

<2> Drive models 2A0110 to 2A0415 require the use of UL-Listed closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

■ Three-Phase 400 V Class

Table 3.3 Wire Gauge and Torque Specifications (Three-Phase 400 V Class)

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0002 4A0004	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	12	14 to 12		
4A0005 4A0007 4A0009	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
4A0011	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0018	R/L1, S/L2, T/L3	10	12 to 6	M4	2.1 to 2.3 (18.4 to 20.4)
	U/T1, V/T2, W/T3	10	12 to 6		
	–, +1, +2	–	12 to 6		
	B1, B2	–	12 to 10		
	⏚	10	14 to 10	M5	2 to 2.5 (17.7 to 22.1)
4A0023	R/L1, S/L2, T/L3	10	10 to 6	M4	2.1 to 2.3 (18.4 to 20.4)
	U/T1, V/T2, W/T3	10	10 to 6		
	–, +1, +2	–	12 to 6		
	B1, B2	–	12 to 10		
	⏚	10	12 to 10	M5	2 to 2.5 (17.7 to 22.1)
4A0031	R/L1, S/L2, T/L3	8	8 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	U/T1, V/T2, W/T3	8	10 to 6		
	–, +1, +2	–	10 to 6		
	B1, B2	–	10 to 8	M5	
	⏚	8	10 to 8	M6	4 to 6 (35.4 to 53.1)
4A0038	R/L1, S/L2, T/L3	6	8 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	U/T1, V/T2, W/T3	8	8 to 6		
	–, +1, +2	–	6		
	B1, B2	–	10 to 8	M5	
	⏚	6	10 to 6	M6	4 to 6 (35.4 to 53.1)
4A0044	R/L1, S/L2, T/L3	6	6 to 4	M6	5.4 to 6.0 (47.8 to 53.1)
	U/T1, V/T2, W/T3	6	6 to 4		
	–, +1, +2	–	6 to 4		
	B1, B2	–	10 to 8	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	8 to 6	M6	4 to 6 (35.4 to 53.1)
4A0058 <1>	R/L1, S/L2, T/L3	4	6 to 4	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	4	6 to 4		
	–, +1	–	6 to 1		
	B1, B2	–	8 to 4		
	⏚	6	8 to 6		
4A0072 <1>	R/L1, S/L2, T/L3	3	4 to 3	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	3	4 to 3		
	–, +1	–	4 to 1		
	B1, B2	–	6 to 3		
	⏚	6	6		
4A0088 <1>	R/L1, S/L2, T/L3	2	3 to 1/0	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	2	3 to 1/0		
	–, +1	–	3 to 1/0		
	+3	–	6 to 1/0		
	⏚	4	6 to 4		
4A0103 <1>	R/L1, S/L2, T/L3	1/0	2 to 1/0	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	1	2 to 1/0		
	–, +1	–	3 to 1/0		
	+3	–	4 to 1/0		
	⏚	4	6 to 4		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0139 <1>	R/L1, S/L2, T/L3	3/0	1/0 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	2/0	1/0 to 4/0		
	–, +1	–	1/0 to 4/0		
	+3	–	3 to 4/0		
	⏚	4	4		
4A0165 <1>	R/L1, S/L2, T/L3	4/0	3/0 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	4/0	3/0 to 4/0		
	–,+1	–	1 to 4/0		
	+3	–	1/0 to 4/0		
	⏚	4	4 to 2		
4A0208 <1>	R/L1, S/L2, T/L3	300	2 to 300	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	300	2 to 300		
	–,+1	–	1 to 250		
	+3	–	3 to 3/0		
	⏚	4	4 to 300		
4A0250 <1>	R/L1, S/L2, T/L3	400	1 to 600	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	400	1/0 to 600		
	–,+1	–	3/0 to 600		
	+3	–	1 to 325		
	⏚	2	2 to 350		
4A0296 <1>	R/L1, S/L2, T/L3	500	2/0 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	500	2/0 to 600		
	–,+1	–	3/0 to 600		
	+3	–	1 to 325	M10	18 to 23 (159 to 204)
	⏚	2	2 to 350	M12	32 to 40 (283 to 354)
4A0362 <1>	R/L1, S/L2, T/L3	4/0 × 2P	3/0 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	4/0 × 2P	3/0 to 600		
	–,+1	–	4/0 to 600		
	+3	–	3/0 to 600	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)
4A0414 <1> <2>	R/L1, S/L2, T/L3	300 × 2P	4/0 to 300	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	300 × 2P	4/0 to 300		
	–,+1	–	3/0 to 300		
	+3	–	3/0 to 300		
	⏚	1	1 to 3/0		
4A0515 <1> <2>	R/L1, S/L2, T/L3	3/0 × 4P	3/0 to 300	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	4/0 × 4P	3/0 to 300		
	–,+1	–	1/0 to 300		
	+3	–	1/0 to 300		
	⏚	1/0	1/0 to 300		
4A0675 <1> <2>	R/L1, S/L2, T/L3	300 × 4P	4/0 to 300	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	300 × 4P	4/0 to 300		
	–,+1	–	1/0 to 300		
	+3	–	1/0 to 300		
	⏚	2/0	2/0 to 300		

<1> Drive models 4A0058 to 4A0675 require the use of UL-Listed closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

<2> When installing an EMC filter, additional measures must be taken to comply with IEC61800-5-1. *Refer to EMC Filter Installation on page 500* for details.

■ Three-Phase 600 V Class

Table 3.4 Wire Gauge and Torque Specifications (Three-Phase 600 V Class)

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
5A0003 5A0004 5A0006	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
5A0009	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	–, +1, +2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	12 to 10		
5A0011	R/L1, S/L2, T/L3	10	14 to 6	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 6		
	–, +1, +2	–	14 to 6		
	B1, B2	–	14 to 10		
	⏚	8	12 to 8	M5	2 to 2.5 (17.7 to 22.1)
5A0017	R/L1, S/L2, T/L3	10	10 to 6	M5	2 to 2.5 (17.7 to 22.1)
	U/T1, V/T2, W/T3	10	10 to 6		
	–, +1, +2	–	10 to 6		
	B1, B2	–	10 to 8		
	⏚	8	12 to 8	M6	4 to 6 (35.4 to 53.1)
5A0022	R/L1, S/L2, T/L3	8	10 to 6	M5	2 to 2.5 (17.7 to 22.1)
	U/T1, V/T2, W/T3	10	10 to 6		
	–, +1, +2	–	10 to 6		
	B1, B2	–	10 to 8		
	⏚	8	10 to 6	M6	4 to 6 (35.4 to 53.1)
5A0027 5A0032	R/L1, S/L2, T/L3	6	6 to 4	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	6	6 to 4		
	–, +1, +2	–	6 to 4		
	B1, B2	–	10 to 8	M5	2 to 2.5 (17.7 to 22.1)
	⏚	6	10 to 6	M6	4 to 6 (35.4 to 53.1)
5A0041	R/L1, S/L2, T/L3	6	10 to 3	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	6	10 to 3		
	–, +1	–	6 to 1		
	B1, B2	–	12 to 3		
	⏚	6	6		
5A0052	R/L1, S/L2, T/L3	4	10 to 3	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	6	10 to 3		
	–, +1	–	6 to 1		
	B1, B2	–	8 to 3		
	⏚	6	6		
5A0062	R/L1, S/L2, T/L3	4	10 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	4	10 to 4/0		
	–, +1	–	4 to 4/0		
	+3	–	6 to 4/0		
	⏚	4	4		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
5A0077	R/L1, S/L2, T/L3	3	10 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	3	10 to 4/0		
	–, +1	–	3 to 4/0		
	+3	–	6 to 4/0		
	⏚	4	4		
5A0099	R/L1, S/L2, T/L3	1/0	10 to 4/0	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	1	10 to 4/0		
	–, +1	–	2 to 4/0		
	+3	–	4 to 4/0		
	⏚	4	4		
5A0125	R/L1, S/L2, T/L3	2/0	1 to 300	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	2/0	1 to 300		
	–, +1	–	2/0 to 3/0		
	+3	–	1 to 1/0		
	⏚	3	4 to 300		
5A0145	R/L1, S/L2, T/L3	3/0	2/0 to 300	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	3/0	2/0 to 300		
	–, +1	–	3/0 to 4/0		
	+3	–	1/0 to 2/0		
	⏚	3	4 to 300		
5A0192	R/L1, S/L2, T/L3	300	2/0 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	250	2/0 to 600		
	–, +1	–	2/0 to 400		
	+3	–	2/0 to 250	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)
5A0242	R/L1, S/L2, T/L3	400	2/0 to 600	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	350	2/0 to 600		
	–, +1	–	2/0 to 500		
	+3	–	250 to 300	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)

◆ Main Circuit Terminal and Motor Wiring

This section outlines the various steps, precautions, and checkpoints for wiring the main circuit terminals and motor terminals.

WARNING! *Electrical Shock Hazard. Do not connect the AC power line to the output terminals of the drive. Failure to comply could result in death or serious injury by fire as a result of drive damage from line voltage application to output terminals.*

NOTICE: *When connecting the motor to the drive output terminals U/T1, V/T2, and W/T3, the phase order for the drive and motor should match. Failure to comply with proper wiring practices may cause the motor to run in reverse if the phase order is backward.*

NOTICE: *Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits. Failure to comply could result in damage to the drive, phase-advancing capacitors, LC/RC noise filters or ground fault circuit interrupters.*

■ Cable Length Between Drive and Motor

Voltage drop along the motor cable may cause reduced motor torque when the wiring between the drive and the motor is too long, especially at low frequency output. This can also be a problem when motors are connected in parallel with a fairly long motor cable. Drive output current will increase as the leakage current from the cable increases. An increase in leakage current may trigger an overcurrent situation and weaken the accuracy of the current detection.

Adjust the drive carrier frequency according to ***Table 3.5***. If the motor wiring distance exceeds 100 m because of the system configuration, reduce the ground currents. ***Refer to C6-02: Carrier Frequency Selection on page 169***.

Table 3.5 Cable Length Between Drive and Motor

Cable Length	50 m or less	100 m or less	Greater than 100 m
Carrier Frequency	15 kHz or less	5 kHz or less	2 kHz or less

Note: When setting carrier frequency for drives running multiple motors, calculate cable length as the total wiring distance to all connected motors.

■ Ground Wiring

Follow the precautions below when wiring the ground for one drive or a series of drives.

WARNING! *Electrical Shock Hazard. Make sure the protective earthing conductor complies with technical standards and local safety regulations. Because the leakage current exceeds 3.5 mA in models 4A0414 and larger, IEC 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.*

WARNING! *Electrical Shock Hazard. Always use a ground wire that complies with technical standards on electrical equipment and minimize the length of the ground wire. Improper equipment grounding may cause dangerous electrical potentials on equipment chassis, which could result in death or serious injury.*

WARNING! *Electrical Shock Hazard. Be sure to ground the drive ground terminal (200 V class: ground to 100 Ω or less; 400 V class: ground to 10 Ω or less; 600 V class: ground to 10 Ω or less). Improper equipment grounding could result in death or serious injury by contacting ungrounded electrical equipment.*

NOTICE: *Do not share the ground wire with other devices such as welding machines or large-current electrical equipment. Improper equipment grounding could result in drive or equipment malfunction due to electrical interference.*

NOTICE: *When using more than one drive, ground multiple drives according to instructions. Improper equipment grounding could result in abnormal operation of drive or equipment.*

Refer to ***Figure 3.23*** when using multiple drives. Do not loop the ground wire.

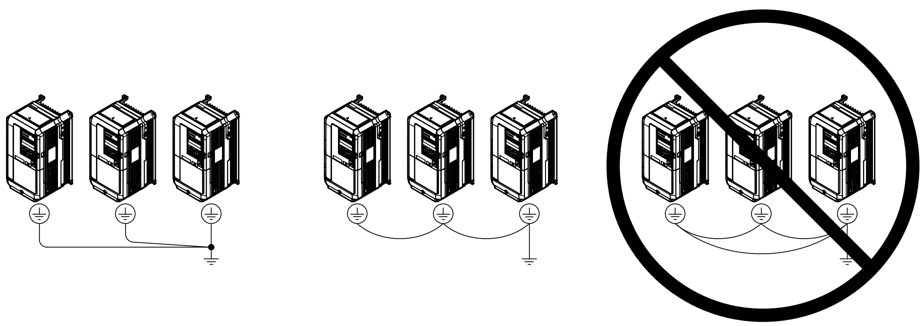


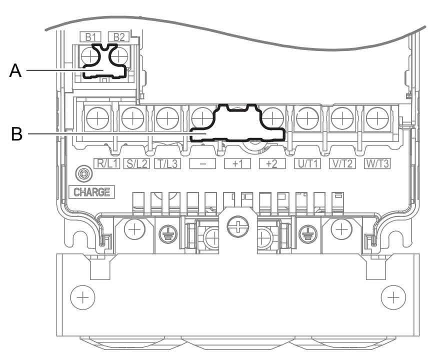
Figure 3.23 Multiple Drive Wiring

■ Wiring the Main Circuit Terminal

WARNING! *Electrical Shock Hazard. Shut off the power supply to the drive before wiring the main circuit terminals. Failure to comply may result in death or serious injury.*

Wire the main circuit terminals after the terminal board has been properly grounded.

Models 2A0004 to 2A0081, 4A0002 to 4A0044, and 5A0003 to 5A0032 have a cover placed over the DC bus and braking circuit terminals prior to shipment to help prevent miswiring. Use wire cutters to cut away covers as needed for terminals.



A – Braking circuit protective cover **B – DC bus protective cover**

Figure 3.24 Protecting Cover to Prevent Miswiring (Model 5A0011)

■ Main Circuit Connection Diagram

Refer to Main Circuit Connection Diagram on page 65 when wiring terminals on the main power circuit of the drive.

WARNING! *Fire Hazard. The braking resistor connection terminals are B1 and B2. Do not connect braking resistors to any other terminals. Improper wiring connections could cause the braking resistor to overheat and cause death or serious injury by fire. Failure to comply may result in damage to the braking circuit or drive.*

3.9 Control Circuit Wiring

◆ Control Circuit Connection Diagram

Refer to *Figure 3.1* on page *63* when wiring terminals on the drive control circuit.

◆ Control Circuit Terminal Block Functions

Drive parameters determine which functions apply to the multi-function digital inputs (S1 to S8), multi-function digital outputs (M1 to M4), multi-function analog inputs (A1 to A3), and multi-function analog monitor output (FM, AM). The default setting is listed next to each terminal in *Figure 3.1* on page *63*.

WARNING! *Sudden Movement Hazard. Always check the operation and wiring of control circuits after being wired. Operating a drive with untested control circuits could result in death or serious injury.*

WARNING! *Sudden Movement Hazard. Confirm the drive I/O signals and external sequence before starting test run. Setting parameter A1-03 may change the I/O terminal function automatically from the factory setting.* ***Refer to Application Selection on page 116****. Failure to comply may result in death or serious injury.*

■ Input Terminals

Table 3.6 lists the input terminals on the drive. Text in parenthesis indicates the default setting for each multi-function input.

Table 3.6 Control Circuit Input Terminals

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting	Page
Multi-Function Digital Inputs	S1	Multi-function input 1 (Closed: Forward run, Open: Stop)	• Photocoupler • 24 Vdc, 8 mA • *Refer to Sinking/Sourcing Mode Switch for Digital Inputs on page 92*.	194
	S2	Multi-function input 2 (Closed: Reverse run, Open: Stop)		
	S3	Multi-function input 3 (External fault, N.O.)		
	S4	Multi-function input 4 (Fault reset)		
	S5	Multi-function input 5 (Multi-step speed reference 1)		
	S6	Multi-function input 6 (Multi-step speed reference 2)		
	S7	Multi-function input 7 (Jog reference)		
	S8	Multi-function input 8 (Baseblock command (N.O.))		
	SC	Multi-function input common	Multi-function input common	
	SP	Digital input power supply +24 Vdc	24 Vdc power supply for digital inputs, 150 mA max	92
	SN	Digital input power supply 0 V 24 V transducer power supply 0 V	**NOTICE:** *Do not jumper or short terminals SP and SN. Failure to comply will damage the drive.*	92

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting	Page
Analog Inputs / Pulse Train Input	RP	Multi-function pulse train input (Frequency reference)	• Input frequency range: 0 to 32 kHz • Signal Duty Cycle: 30 to 70% • High level: 3.5 to 13.2 Vdc, low level: 0.0 to 0.8 Vdc • Input impedance: 3 kΩ	*138* *221*
	+V	Power supply for analog inputs	10.5 Vdc (max allowable current 20 mA)	*137*
	24 V	+24 Vdc transducer power supply for customer use	150 mA maximum capacity	–
	A1	Multi-function analog input 1 (Frequency reference bias)	• -10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) • 4 to 20 mA, 0 to 20 mA (input impedance: 250 Ω) • Voltage or current input must be selected by jumper S1 and H3-01.	*137* *214*
	A2	Multi-function analog input 2 (Frequency reference bias)	• -10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) • 4 to 20 mA, 0 to 20 mA (input impedance: 250 Ω) • Voltage or current input must be selected by jumper S1 and H3-09.	*137* *137* *215*
	A3	Multi-function analog input 3 (Frequency reference bias)	• -10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) • 4 to 20 mA, 0 to 20 mA (input impedance: 250 Ω) • Voltage or current input must be selected by jumper S1 and H3-05.	*137*
	AC	Frequency reference common	0 V	*137*
	E (G)	Ground for shielded lines and option cards	–	–

■ Output Terminals

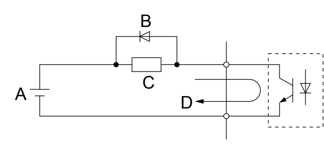
Table 3.7 lists the output terminals on the drive. Text in parenthesis indicates the default setting for each multi-function output.

Table 3.7 Control Circuit Output Terminals

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting	Page
Fault Relay Output	MA	N.O.	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA	*204*
	MB	N.C. output		
	MC	Fault output common		
Multi-Function Digital Output *<1>*	MD	N.O.	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA	*204*
	ME	N.C. Output		
	MF	Common (Speed agree)		
	M1	Multi-function digital output (During run)	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA	
	M2			
	M3	Multi-function digital output (Zero speed)		
	M4			
Monitor Output	FM	Analog monitor output 1 (Output frequency)	-10 to +10 Vdc, or 0 to +10 Vdc	*219*
	AM	Analog monitor output 2 (Output current)		
	AC	Monitor common	0 V	–

<1> Refrain from assigning functions to digital relay outputs that involve frequent switching, as doing so may shorten relay performance life. Switching life is estimated at 200,000 times (assumes 1 A, resistive load).

Connect a suppression diode as shown in *Figure 3.25* when driving a reactive load such as a relay coil. Ensure the diode rating is greater than the circuit voltage.



A – External power, 48 V max.
B – Suppression diode
C – Coil
D – 50 mA or less

Figure 3.25 Connecting a Suppression Diode

Serial Communication Terminals

Table 3.8 Control Circuit Terminals: Serial Communications

Type	No.	Signal Name	Function (Signal Level)	
MEMOBUS/Modbus Communication <1>	R+	Communications input (+)	MEMOBUS/Modbus communication: Use an RS-422 or RS-485 cable to connect the drive.	RS-422/RS-485 MEMOBUS/Modbus communication protocol 115.2 kbps (max.)
	R-	Communications input (-)		
	S+	Communications output (+)		
	S-	Communications output (-)		
	IG	Shield ground	0 V	

<1> Enable the termination resistor in the last drive in a MEMOBUS/Modbus network by setting DIP switch S2 to the ON position. *Refer to Control I/O Connections on page 92* for more information on the termination resistor.

Terminal Configuration

The control circuit terminals are arranged as shown in *Figure 3.26*.

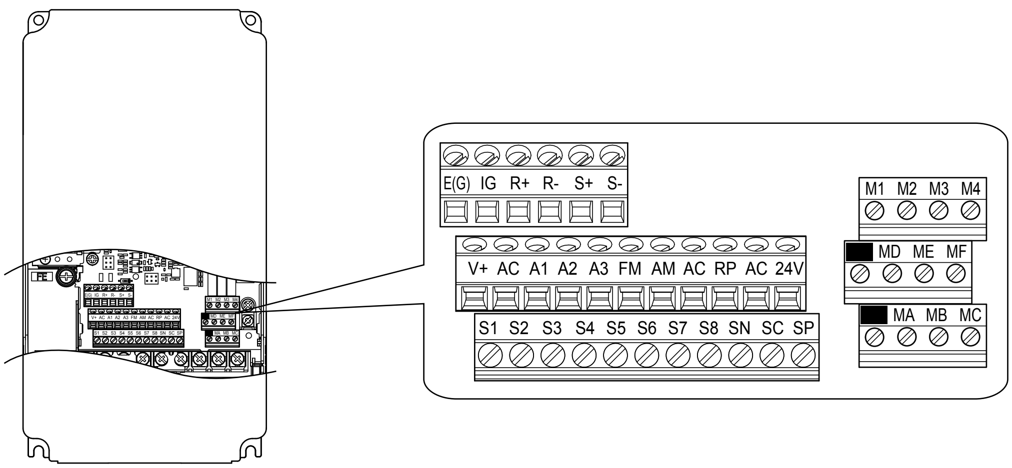


Figure 3.26 Control Circuit Terminal Arrangement

Wire Size and Torque Specifications

Select appropriate wire type and gauges from *Table 3.9*. For simpler and more reliable wiring, use crimp ferrules on the wire ends. Refer to *Table 3.10* for ferrule terminal types and sizes.

Table 3.9 Wire Gauges

Terminal	Screw Size	Tightening Torque N•m (lb. in)	Bare Wire Terminal		Ferrule-Type Terminal		Wire Type
			Applicable wire size mm^2 (AWG)	Recomm. wire size mm^2 (AWG)	Applicable wire size mm^2 (AWG)	Recomm. wire size mm^2 (AWG)	
S1-S8, SC, SN, SP	M3	0.5 to 0.6 (4.4 to 5.3)	Stranded wire: 0.2 to 1.0 (24 to 16) Solid wire: 0.2 to 1.5 (24 to 16)	0.75 (18)	0.25 to 0.5 (24 to 20)	0.5 (20)	Shielded wire, etc.
RP, V+, A1, A2, A3, AC, 24 V							
MA, MB, MC, MD, ME, MF							
M1-M4							
FM, AM, AC							
R+, R-, S+, S-, IG							

■ Ferrule-Type Wire Terminals

Yaskawa recommends using CRIMPFOX 6, a crimping tool manufactured by PHOENIX CONTACT, to prepare wire ends with insulated sleeves before connecting to the drive. See ***Table 3.10*** for dimensions.

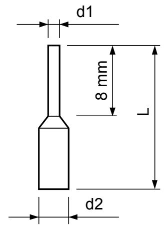


Figure 3.27 Ferrule Dimensions

Table 3.10 Ferrule Terminal Types and Sizes

Size mm^2 (AWG)	Type	L (mm)	d1 (mm)	d2 (mm)	Manufacturer
0.25 (24)	AI 0.25-8YE	12.5	0.8	1.8	PHOENIX CONTACT
0.34 (22)	AI 0.34-8TQ	10.5	0.8	1.8	
0.5 (20)	AI 0.5-8WH or AI 0.5-8OG	14	1.1	2.5	

◆ Wiring the Control Circuit Terminal

This section describes the proper procedures and preparations for wiring the control terminals.

WARNING! *Electrical Shock Hazard. Do not remove covers or touch the circuit boards while the power is on. Failure to comply could result in death or serious injury.*

NOTICE: *Separate control circuit wiring from main circuit wiring (terminals R/L1, S/L2, T/L3, B1, B2, U/T1, V/T2, W/T3, -, +1, +2) and other high-power lines. Improper wiring practices could result in drive malfunction due to electrical interference.*

NOTICE: *Separate wiring for digital output terminals MA, MB, MC, MD, ME, MF and M1 to M4 from wiring to other control circuit lines. Improper wiring practices could result in drive or equipment malfunction or nuisance trips.*

NOTICE: *Use a class 2 power supply when connecting to the control terminals. Improper application of peripheral devices could result in drive performance degradation due to improper power supply. Refer to NEC Article 725 Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power Limited Circuits for requirements concerning class 2 power supplies.*

NOTICE: *Insulate shields with tape or shrink tubing to prevent contact with other signal lines and equipment. Improper wiring practices could result in drive or equipment malfunction due to short circuit.*

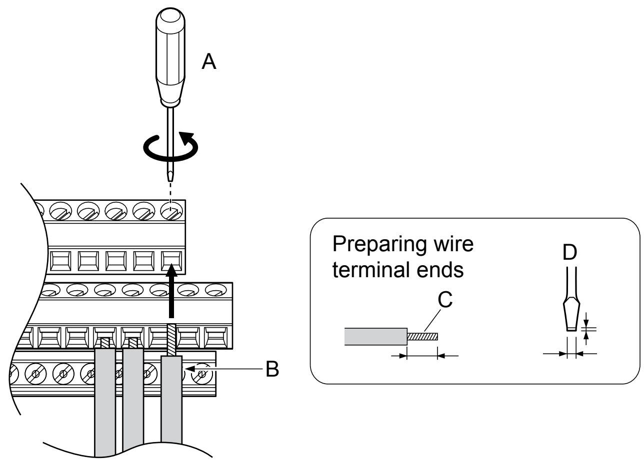
NOTICE: *Connect the shield of shielded cable to the appropriate ground terminal. Improper equipment grounding could result in drive or equipment malfunction or nuisance trips.*

Wire the control circuit only after terminals have been properly grounded and main circuit wiring is complete. ***Refer to Terminal Board Wiring Guide on page 90*** for details. Prepare the ends of the control circuit wiring as shown in ***Figure 3.30***. ***Refer to Wire Gauges on page 88***.

NOTICE: *Do not tighten screws beyond the specified tightening torque. Failure to comply may result in erroneous operation, damage to the terminal block, or cause a fire.*

NOTICE: *Use shielded twisted-pair cables as indicated to prevent operating faults. Improper wiring practices could result in drive or equipment malfunction due to electrical interference.*

Connect control wires as shown in ***Figure 3.28*** and ***Figure 3.29***.



A – Loosen screw to insert wire.
B – Single wire or stranded wire
C – Avoid fraying wire strands when stripping insulation from wire. Strip length 5.5 mm.
D – Blade depth of 0.4 mm or less Blade width of 2.5 mm or less

Figure 3.28 Terminal Board Wiring Guide

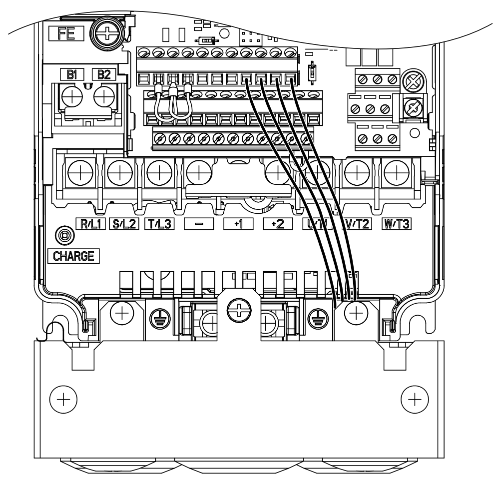
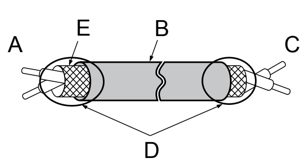


Figure 3.29 Terminal Board Location Inside the Drive

When setting the frequency by analog reference from an external potentiometer, use shielded twisted-pair wires (preparing wire ends as shown in *Figure 3.30*) and connect the shield to the ground terminal of the drive.



A – Drive side
B – Insulation
C – Control device side
D – Shield sheath (insulate with tape)
E – Shield

Figure 3.30 Preparing the Ends of Shielded Cables

NOTICE: *The analog signal wiring between the drive and the operator station or peripheral equipment should not exceed 50 meters when using an analog signal from a remote source to supply the frequency reference. Failure to comply could result in poor system performance.*

◆ Switches and Jumpers on the Terminal Board

The terminal board is equipped with several switches used to adapt the drive I/Os to the external control signals. ***Figure 3.31*** shows the location of these switches. ***Refer to Control I/O Connections on page 92*** for setting instructions.

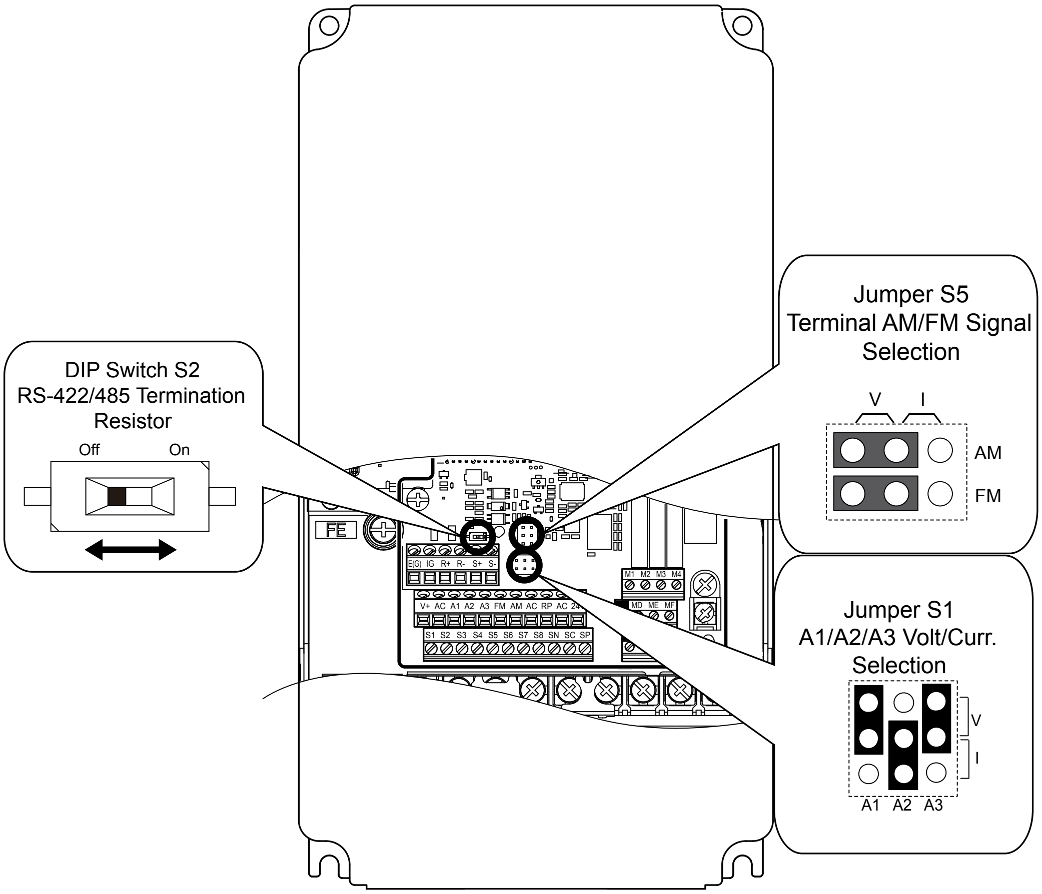


Figure 3.31 Locations of Jumpers and Switches on the Terminal Board

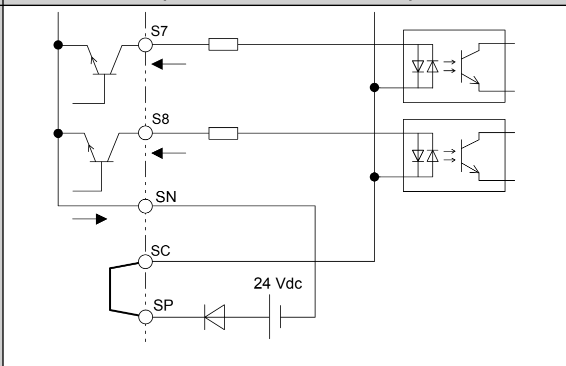
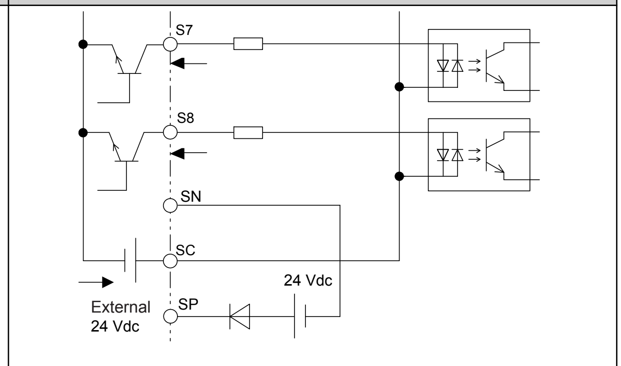
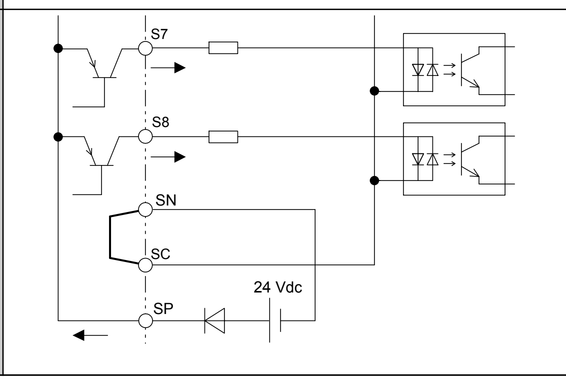
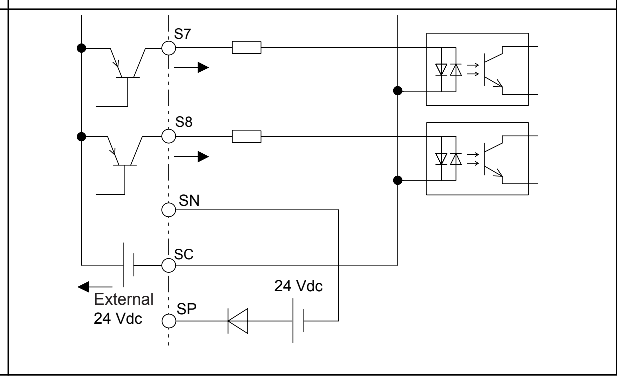
3.10 Control I/O Connections

◆ Sinking/Sourcing Mode Switch for Digital Inputs

Use the wire jumper between terminals SC and SP or SC and SN to select between Sink mode, Source mode or external power supply for the digital inputs S1 to S8 as shown in *Table 3.11* (Default: Sink mode, internal power supply).

NOTICE: *Do not short terminals SP and SN. Failure to comply will damage the drive.*

Table 3.11 Digital Input Sink/Source/External Power Supply Selection

Mode	Drive Internal Power Supply (Terminals SN and SP)	External 24 Vdc Power Supply
Sinking Mode (NPN)		
Sourcing Mode (PNP)		

◆ Terminals A1, A2, and A3 Input Signal Selection

Terminals A1, A2, and A3 can be used to input either a voltage or a current signal. Select the signal type using jumper S1 as explained in *Table 3.12*. Set parameters H3-01, H3-05, and H3-09 accordingly as shown in *Table 3.13*. *Refer to Switches and Jumpers on the Terminal Board on page 91* for locating jumper S1.

Note: If terminals A1 and A2 are both set for frequency bias (H3-02 = 0 and H3-10 = 0), both input values will be combined to create the frequency reference.

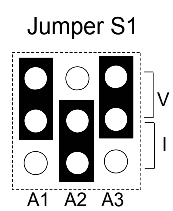


Figure 3.32 Terminal A2 Set to Current Input; A1 and A3 Set to Voltage Input

Table 3.12 Jumper S1 Settings

Setting	Description
V (top position)	Voltage input (-10 to +10 V or 0 to 10 V)
I (bottom position)	Current input (4 to 20 mA or 0 to 20 mA)

Table 3.13 Voltage/Current Selection Parameter Details

No.	Parameter Name	Description	Setting Range	Default Setting
H3-01	Terminal A1 signal level selection	Selects the signal level for terminal A1. 0: 0 to 10 Vdc 1: -10 to 10 Vdc 2: 4 to 20 mA 3: 0 to 20 mA	0 to 3	0
H3-05	Terminal A3 signal level selection	Selects the signal level for terminal A3. 0: 0 to 10 Vdc 1: -10 to 10 Vdc 2: 4 to 20 mA 3: 0 to 20 mA	0 to 3	2
H3-09	Terminal A2 signal level selection	Selects the signal level for terminal A2. 0: 0 to 10 Vdc 1: -10 to 10 Vdc 2: 4 to 20 mA 3: 0 to 20 mA	0 to 3	0

◆ Terminal AM/FM Signal Selection

The signal type for terminals AM and FM can be set to either voltage or current output using jumper S5 on the terminal board as explained in ***Table 3.14***. When changing the setting of jumper S5, parameters H4-07 and H4-08 must be set accordingly. The default selection is voltage output for both terminals. ***Refer to Switches and Jumpers on the Terminal Board on page 91*** for locating jumper S5.

Table 3.14 Jumper S5 Settings

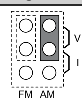
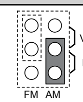
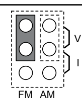
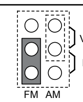
Terminal	Voltage Output	Current Output
Terminal AM		
Terminal FM		

Table 3.15 Parameter H4-07 and H4-08 Details

No.	Parameter Name	Description	Setting Range	Default Setting
H4-07	Terminal AM signal level selection	0: 0 to 10 Vdc 1: -10 to 10 Vdc 2: 4 to 20 mA	0 to 2	0
H4-08	Terminal FM signal level selection			

◆ MEMOBUS/Modbus Termination

This drive is equipped with a built-in termination resistor for the RS-422/485 communication port. DIP switch S2 enables or disabled the termination resistor as shown in ***Table 3.16***. The OFF position is the default. The termination resistor should be placed to the ON position when the drive is the last in a series of slave drives. ***Refer to Switches and Jumpers on the Terminal Board on page 91*** to locate switch S2.

Table 3.16 MEMOBUS/Modbus Switch Settings

S2 Position	Description
ON	Internal termination resistor ON
OFF	Internal termination resistor OFF (default setting)

Note: ***Refer to MEMOBUS/Modbus Communications on page 461*** for details on MEMOBUS/Modbus.

3.11 Connect to a PC

This drive is equipped with a USB port (type-B).

The drive can connect to a USB port on a PC using a USB 2.0, AB-type cable (sold separately). After connecting the drive to a PC, Yaskawa DriveWizard Industrial software can be used to monitor drive performance and manage parameter settings. Contact Yaskawa for more information on DriveWizard Industrial.

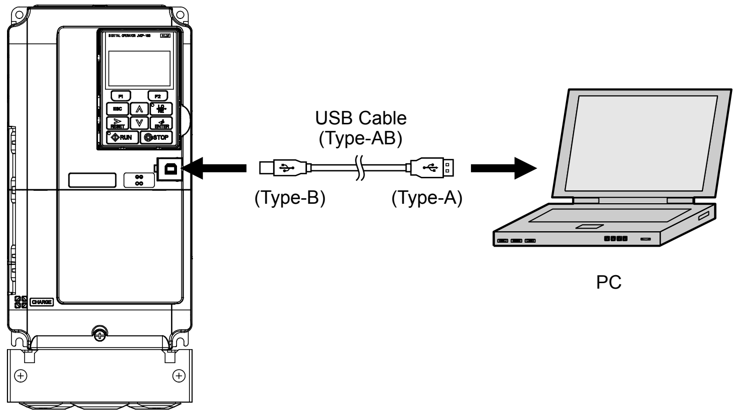


Figure 3.33 Connecting to a PC (USB)

3.12 External Interlock

Systems that may be affected during drive fault conditions should be interlocked with the drive fault output and ready signal.

◆ Drive Ready

When the "Drive ready" signal has been set to one of the multi-function contact outputs, that output will close whenever the drive is ready to accept a Run command or is already running. Under the following conditions the Drive ready signal will switch off and remain off, even if a Run command is entered:

- when the power supply is shut off
- during a fault
- when there is problem with the control power supply
- when a parameter setting error makes the drive unable to run even if a Run command has been entered
- when a fault such as overvoltage or undervoltage is triggered as soon as the Run command is entered
- when the drive is in the Programming mode and will not accept a Run command even when entered

■ Interlock Circuit Example

Two drives running a single application might interlock with the controller using the Drive Ready and Fault output signals as shown below. *Figure 3.34* illustrates how the application would not be able to run if either drive experiences a fault or is unable to supply a Drive Ready signal.

Terminal	Output Signal	Parameter Setting
MA, MB, MC	Fault	–
M1-M2	Drive Ready	H2-01 = 06

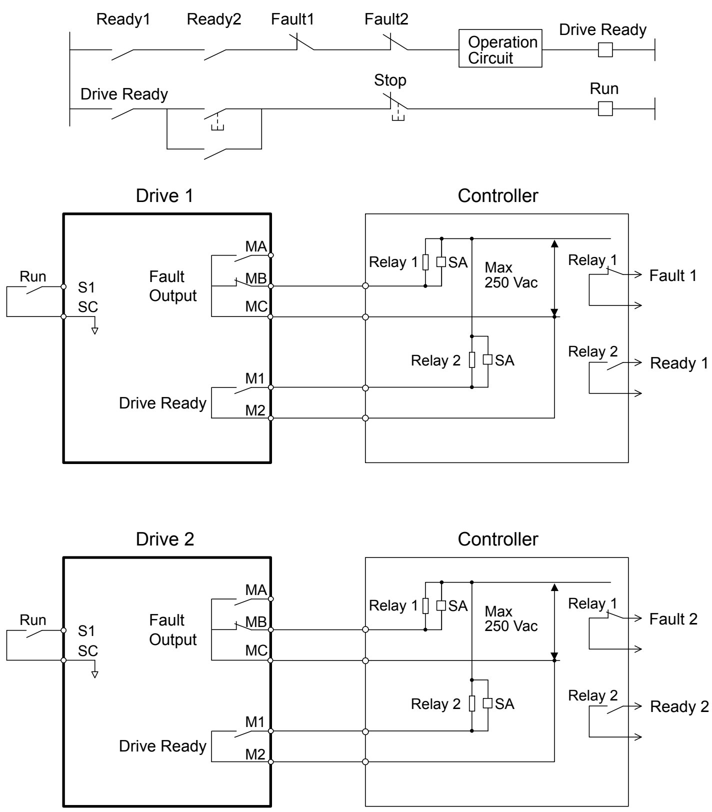
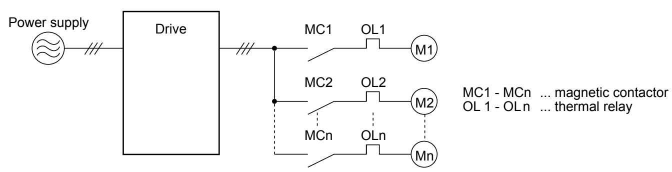


Figure 3.34 Interlock Circuit Example

3.13 Wiring Checklist

☑	No.	Item	Page(s)
		Drive, Peripherals, Option Cards	
☐	1	Check drive model number to ensure receipt of correct model.	*29*
☐	2	Make sure you have the correct braking resistors, DC link chokes, noise filters, and other peripheral devices.	*353*
☐	3	Check the option card model number.	*353*
		Installation Area and Physical Setup	
☐	4	Ensure that the area surrounding the drive complies with specifications.	*46*
		Power Supply Voltage, Output Voltage	
☐	5	The voltage from the power supply should be within the input voltage specification range of the drive.	*180*
☐	6	The voltage rating for the motor should match the drive output specifications.	*29* *270*
☐	7	Verify that the drive is properly sized to run the motor.	
		Main Circuit Wiring	
☐	8	Confirm proper branch circuit protection as specified by national and local codes.	*62*
☐	9	Properly wire the power supply to drive terminals R/L1, S/L2, and T/L3.	*65*
☐	10	Properly wire the drive and motor together. The motor lines and drive output terminals R/T1, V/T2, and W/T3 should match in order to produce the desired phase order. If the phase order is incorrect, the drive will rotate in the opposite direction.	*83*
☐	11	Use 600 Vac vinyl-sheathed wire for the power supply and motor lines.	*77*
☐	12	Use the correct wire gauges for the main circuit. ***Refer to Wire Gauges and Tightening Torque on page 77***. • Consider the amount of voltage drop when selecting wire gauges. Increase the wire gauge when the voltage drop is greater than 2% of motor rated voltage. Ensure the wire gauge is suitable for the terminal block. Use the following formula to calculate the amount of voltage drop: Line drop voltage (V) = $\sqrt{3}$ × wire resistance (Ω/km) × wire length (m) × current (A) × 10^{-3} • If the cable between the drive and motor exceeds 50 m, adjust the carrier frequency set to C6-02 accordingly.	*77* *84*
☐	13	Properly ground the drive. Review page *84*.	*84*
☐	14	Tighten control circuit and grounding terminal screws. ***Refer to Wire Gauges and Tightening Torque on page 77***.	*77*
☐	15	Set up overload protection circuits when running multiple motors from a single drive.  **Note:** Close MC1 – MCn before operating the drive. MC1 – MCn cannot be switched off during run.	–
☐	16	Install a magnetic contactor when using a dynamic braking option. Properly install the resistor and ensure that overload protection shuts off the power supply using the magnetic contactor.	*361*
☐	17	Verify phase advancing capacitors, input noise filters, or GFCIs are NOT installed on the output side of the drive.	–
		Control Circuit Wiring	
☐	18	Use twisted-pair line for all drive control circuit wiring.	*89*
☐	19	Ground the shields of shielded wiring to the GND ⏚ terminal.	*89*
☐	20	For 3-Wire sequence, set parameters for multi-function contact input terminals S1 – S8, and wire control circuits.	–
☐	21	Properly wire any option cards.	*89*
☐	22	Check for any other wiring mistakes. Only use a multimeter to check wiring.	–
☐	23	Properly fasten drive control circuit terminal screws. ***Refer to Wire Gauges and Tightening Torque on page 77***.	*77*
☐	24	Pick up all wire clippings.	–
☐	25	Ensure that no frayed wires on the terminal block are touching other terminals or connections.	–
☐	26	Properly separate control circuit wiring and main circuit wiring.	–
☐	27	Analog signal line wiring should not exceed 50 m.	–
☐	28	Safe Disable input wiring should not exceed 30 m.	–

4

Start-Up Programming & Operation

This chapter explains the functions of the digital operator and how to program the drive for initial operation.

4.1 Section Safety

⚠ DANGER

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply will result in death or serious injury.

⚠ WARNING

Electrical Shock Hazard

Do not operate equipment with covers removed.

Failure to comply could result in death or serious injury.

The diagrams in this section may include drives without covers or safety shields to illustrate details. Be sure to reinstall covers or shields before operating the drives and run the drives according to the instructions described in this manual.

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Prepare a separate holding brake.

Wire the holding brake so when a fault occurs, it is activated by an external sequence and shuts the power off or triggers an emergency switch. Failure to comply could result in death or serious injury.

4.2 Using the Digital Operator

Use the digital operator to enter Run and Stop commands, edit parameters, and display data including fault and alarm information.

◆ Keys and Displays

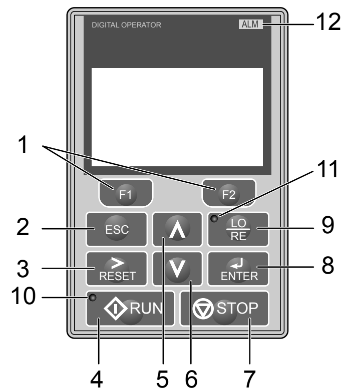


Figure 4.1 Keys and Displays on the Digital Operator

No.	Display	Name	Function
1	F1 F2	Function Key (F1, F2)	The functions assigned to F1 and F2 vary depending on the currently displayed menu. The name of each function appears in the lower half of the display window.
2	ESC	ESC Key	• Returns to the previous display. • Moves the cursor one space to the left. • Pressing and holding this button will return to the Frequency Reference display.
3	RESET	RESET Key	• Moves the cursor to the right. • Resets the drive to clear a fault situation.
4	RUN	RUN Key	Starts the drive in LOCAL mode.
5	∧	Up Arrow Key	Scrolls up to display the next item, selects parameter numbers, and increments setting values.
6	∨	Down Arrow Key	Scrolls down to display the previous item, selects parameter numbers, and decrements setting values.
7	STOP	STOP Key *<1>*	Stops drive operation.
8	ENTER	ENTER Key	• Enters parameter values and settings. • Selects a menu item to move between displays
9	LO RE	LO/RE Selection Key *<2>*	Switches drive control between the operator (LOCAL) and an external source (REMOTE) for the Run command and frequency reference.
10	RUN	RUN Light	Lit while the drive is operating the motor. Refer to page ***101*** for details.
11	LO RE	LO/RE Light	Lit while the operator is selected to run the drive (LOCAL mode). Refer to page ***101*** for details.
12	ALM	ALM LED Light	***Refer to ALARM (ALM) LED Displays on page 101***.

<1> The STOP key has highest priority. Pressing the STOP key will always cause the drive to stop the motor, even if a Run command is active at any external Run command source. To disable the STOP key priority, set parameter o2-02 to 0.

<2> The LO/RE key can only switch between LOCAL and REMOTE when the drive is stopped. To disable the LO/RE key to prohibit switching between LOCAL and REMOTE, set parameter o2-01 to 0.

◆ LCD Display

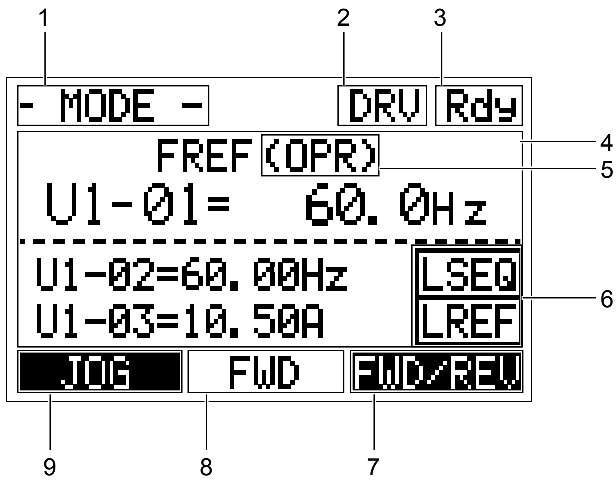


Figure 4.2 LCD Display

Table 4.1 Display and Contents

No.	Name	Display	Content
1	Operation Mode Menus	MODE	Displayed when in Mode Selection.
		MONITR	Displayed when in Monitor Mode.
		VERIFY	Indicates the Verify Menu.
		PRMSET	Displayed when in Parameter Setting Mode.
		A.TUNE	Displayed during Auto-Tuning.
		SETUP	Displayed when in Setup Mode.
2	Mode Display Area	DRV	Displayed when in Drive Mode.
		PRG	Displayed when in Programming Mode.
3	Ready	Rdy	Indicates the drive is ready to run.
4	Data Display	—	Displays specific data and operation data.
5	Frequency Reference Assignment <1>	OPR	Displayed when the frequency reference is assigned to the LCD Operator Option.
		AI	Displayed when the frequency reference is assigned to the Analog Input of the drive.
		COM	Displayed when the frequency reference is assigned to the MEMOBUS/Modbus Communication Inputs of the drive.
		OP	Displayed when the frequency reference is assigned to an Option Unit of the drive.
		RP	Displayed when the frequency reference is assigned to the Pulse Train Input of the drive.
6	LO/RE Display <2>	RSEQ	Displayed when the run command is supplied from a remote source.
		LSEQ	Displayed when the run command is supplied from the operator keypad.
		RREF	Displayed when the run command is supplied from a remote source.
		LREF	Displayed when the run command is supplied from the operator keypad.
7	Function Key 2 (F2)	FWD/REV	Pressing F2 switches between forward and reverse.
		DATA	Pressing F2 scrolls to the next display.
		→	Pressing F2 scrolls the cursor to the right.
		RESET	Pressing F2 resets the existing drive fault error.
8	FWD/REV	FWD	Indicates forward motor operation.
		REV	Indicates reverse motor operation.

No.	Name	Display	Content
9	Function Key 1 (F1)	JOG	Pressing F1 executes the Jog function.
		HELP	Pressing F1 displays the Help menu.
		←	Pressing F1 scrolls the cursor to the left.
		HOME	Pressing F1 returns to the top menu (Frequency Reference).
		ESC	Pressing F1 returns to the previous display.

<1> Displayed when in Frequency Reference Mode.

<2> Displayed when in Frequency Reference Mode and Monitor Mode.

◆ ALARM (ALM) LED Displays

Table 4.2 ALARM (ALM) LED Status and Contents

State	Content	Display
Illuminated	When the drive detects an alarm or error.	ALM
Flashing	• When an alarm occurs. • When an oPE is detected. • When a fault or error occurs during Auto-Tuning.	ALM
Off	Normal operation (no fault or alarm).	ALM

◆ LO/RE LED and RUN LED Indications

Table 4.3 LO/RE LED and RUN LED Indications

LED	Lit	Flashing	Flashing Quickly <1>	Off
LO RE	When the operator is selected for Run command and frequency reference control (LOCAL)	—	—	When a device other than the operator is selected for Run command and frequency reference control (REMOTE)
RUN	During run	• During deceleration to stop • When a Run command is input and frequency reference is 0 Hz	• While the drive was set to LOCAL, a Run command was entered to the input terminals then the drive was switched to REMOTE. • A Run command was entered via the input terminals while the drive was not in Drive Mode. • During deceleration when a Fast Stop command was entered. • The drive output is shut off by the Safe Disable function. • The STOP key was pressed while drive was running in REMOTE. • The drive was powered up with b1-17 = 0 (default) while the Run command is active.	During stop
Examples	RUN	RUN	RUN	RUN

<1> Refer to *Figure 4.3* for the difference between "flashing" and "flashing quickly".

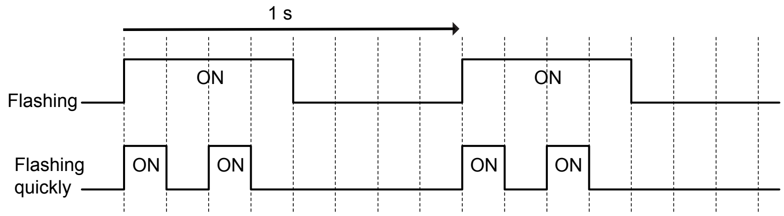


Figure 4.3 RUN LED Status and Meaning

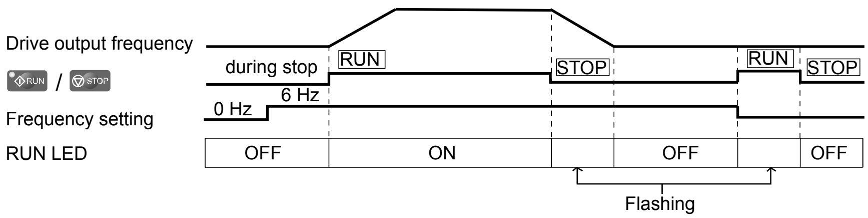


Figure 4.4 RUN LED and Drive Operation

◆ Menu Structure for Digital Operator

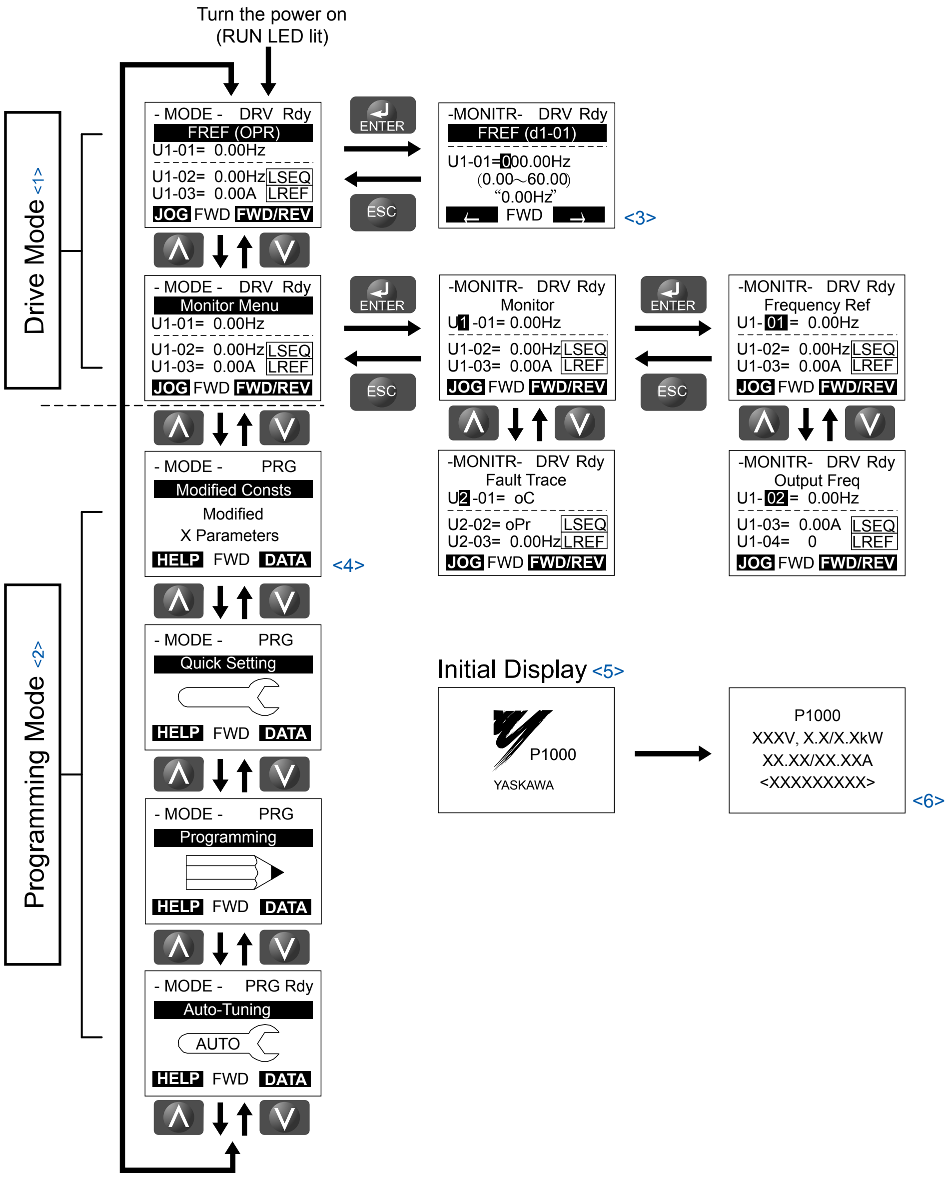


Figure 4.5 Digital Operator Menu and Screen Structure

<1> Pressing RUN will start the motor.
<2> Drive cannot operate motor.
<3> Flashing characters are shown as 0.
<4> “X” characters are used as examples in this manual. The LCD Operator will display the actual setting values.
<5> The Frequency Reference appears after the initial display that shows the product name.
<6> The information that appears on the display will vary depending on the drive.

4.3 The Drive, Programming, and Clock Adjustment Modes

The drive has a Drive Mode to operate the motor, a Programming Mode to edit parameter settings, and a Clock Adjustment Mode to adjust the Real Time Clock.

Drive Mode: In Drive Mode the user can operate the motor and observe U Monitor parameters. Parameter settings cannot be edited or changed when in Drive Mode.

Programming Mode: In Programming Mode the user can edit and verify parameter settings and perform Auto-Tuning. When the drive is in Programming Mode it will not accept a Run command unless b1-08 is set to 1.

Note:
1. If b1-08 is set to 0, the drive will only accept a Run command in Drive Mode. After editing parameters, the user must exit the Programming Mode and enter Drive Mode before operating the motor.
2. Set b1-08 to 1 to allow motor operation from the drive while in Programming Mode.

◆ Real-Time Clock (RTC)

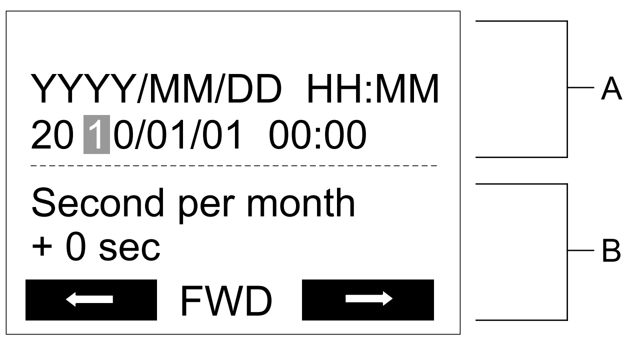
The drive has a Clock Adjustment Mode to set and adjust the Real-Time Clock.

Clock Adjustment Mode: When o4-17 is set to 1, the digital operator will show the Clock Adjustment display. In Clock Adjustment Mode, the user can adjust the Real-Time Clock. When the drive is in Clock Adjustment Mode, it will not accept a Run command.

◆ Clock Adjustment

The digital operator will display the Real Time Clock Adjustment Display in ***Figure 4.6*** when the drive is powered up for the first time. ***Refer to Manual Clock Adjustment Procedure by Setting o4-17 to 1 on page 105*** for the Real-Time Clock setting procedure.

Note: Setting the Real-Time Clock will clear a "TIM" alarm.



A – Real Time Clock Setting Display B – Gain/Loss Adjustment Display

Figure 4.6 Real Time Clock Adjustment Display

Display	Description
YYYY	Set the year with the last two digits.
MM	Set the month with two digits.
DD	Set the day with two digits.
HH:MM	Set the hours and minutes, with two digits for each.
Second per month	Set the gain or loss in seconds per month.

Moving the Cursor

Pressing the F2 key or the RESET key will move the cursor to the digit on the right. Pressing the F1 key will move the cursor to the left.

Changing Settings

- **Changing YYYY/MM/DD HH:MM:** Pressing the up arrow key will increase the number selected by the cursor from 0 to 9. Pressing the down arrow key will decrease the number selected by the cursor from 0 to 9.
- **Setting the Seconds per Month:** Pressing the up arrow key will increase the number selected by the cursor from -504 to +488 in increments of 8. Pressing the down arrow key will decrease the number selected by the cursor from -504 to +488 in increments of 8.

Verifying the New Time Setting

After pressing ENTER , the display will indicate “Entry accepted” and the new time value will be saved to the Real-Time Clock (RTC).

If there is a problem with the entered time, the operator will indicate “Input error” and the screen will return to the time setting display.

Canceling the Input

Pressing the ESC key will display “Aborted” on the operator, and no value will be saved to the RTC. Pressing OFF will abort the setting process without any display, and no setting changes will be saved to the RTC.

Exiting from the Time Setting Screen Without Making Any Changes

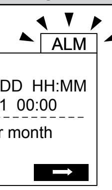
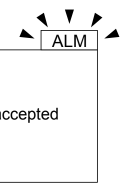
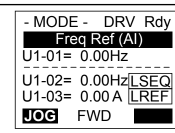
If no changes are entered, the display will exit Real Time Clock Adjustment Display after a few seconds and no changes will be saved.

■ Real-Time Clock Setting at Initial Power-up of a New Drive

Setting the Real-time clock is required at power-up of a new drive or after digital operatr battery replacement.

Table 4.4 illustrates how to set the Real-Time Clock at initial power-up of a new drive.

Table 4.4 Clock Adjustment Procedure at Power-up of a New Drive

Procedure			Display
1	Turn the power on. The Real Time Clock Adjustment Display will appear. Use the right arrow key to select the desired digit, then set the correct date and time using the up and down arrow keys.	➡	
2	After entering the Real-Time Clock data, press the ENTER key to save the changes. The display will indicate “Entry Accepted” and return to the initial display in step 3 and the alarm LED will be OFF.	➡	
3	Initial display.	➡	

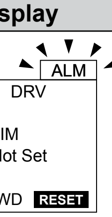
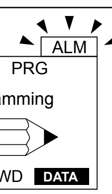
■ Manual Clock Adjustment by Setting o4-17 to 1

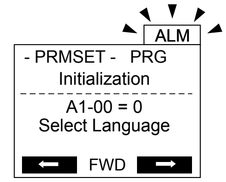
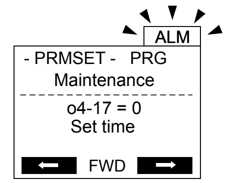
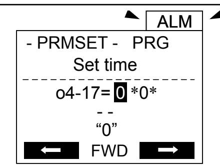
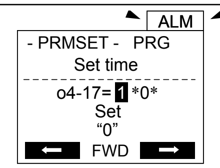
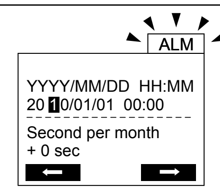
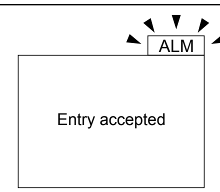
The following actions are possible in the Clock Adjustment Mode:

- Set the current time
- Check the time set to the drive Real-Time Clock

Table 4.5 illustrates how to set the Real-Time Clock manually.

Table 4.5 Manual Clock Adjustment Procedure by Setting o4-17 to 1

Procedure			Display
1	The “Time Not Set” (TIM) display will appear if the Real-Time Clock data is not entered within 30 seconds of power-up on a new drive. Refer to *292* for details on the TIM display.	➡	
2	Use the up and down arrow keys to scroll through display menu until the screen shows “Programming”.	➡	

Procedure			Display
3	Press the ENTER key to enter select the parameter setting mode.	➡	
4	Use the up and down arrow keys to scroll through display menu until parameter o4-17 appears.	➡	
5	Press the ENTER key until “0” flashes.	➡	
6	Press the up arrow key so that the display changes to “1”.	➡	
7	Press the ENTER key and the time setting screen will appear. Use the right arrow key to select the desired digit, then set the correct date and time using the up and down arrow keys.	➡	
8	After entering the correct time, press the ENTER key to save the changes. The display will return to the display shown in step 5 and the alarm LED will be OFF.	➡	

■ o4-17: Real-Time Clock Setting

No. (Addr. Hex)	Name	Description	Values
o4-17 (3100)	Set/Reset Real-time Clock Set Time	Sets the current date and time for the Real-Time Clock. 0: — — No Setting 0: — — 1: Real-Time Clock Set 1: Set 2: Real-Time Clock Reset 2: Reset	Default: 0 Range: 0 to 2

Setting 0: — —

No Setting (Default)

Setting 1: Set

When o4-17 is set to 1, the digital operator will show the Clock Adjustment display. In Clock Adjustment Mode the user can adjust the Real-Time Clock.

Setting 2: Reset

When o4-17 is set to 2, the Real-Time Clock data is cleared. A TIM fault will occur until o4-17 is set to 1 and the Real-Time Clock is set.

◆ Navigating the Drive and Programming Modes

The drive is set to operate in Drive Mode when it is first powered up. Switch between display screens by using the Λ and V keys.

Mode	Contents	Operator Display	Description
Power Up	Frequency Reference (default)	- MODE - DRV Rdy FREF (OPR) U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV	This display screen allows the user to monitor and change the frequency reference while the drive is running. *Refer to The Drive, Programming, and Clock Adjustment Modes on page 104*. **Note:** The user can select the data displayed when the drive is first powered up with parameter o1-02.
Drive Mode		Λ ↓↑ V	
	Monitor Display	- MODE - DRV Rdy Monitor Menu U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV	Lists the monitor parameters (U□-□□ parameters) available in the drive. Press the Enter Key and then use the Up, Down, ESC, and Reset keys to navigate through the drive monitors.
Programming Mode		Λ ↓↑ V	
	Verify Menu	- MODE - PRG Modified Consts Modified X Parameters HELP FWD DATA	Lists all parameters that have been edited or changed from default settings.➜ *Refer to Verifying Parameter Changes: Verify Menu on page 110*.
		Λ ↓↑ V	
	Setup Group	- MODE - PRG Quick Setting HELP FWD DATA	A select list of parameters necessary to get the drive operating quickly.➜ *Refer to Using the Setup Groups on page 111*. **Note:** Parameters listed in the Setup Group differ depending the Application Preset in parameter A1-06. *Refer to Application Selection on page 116*.
		Λ ↓↑ V	
	Parameter Setting Mode	- MODE - PRG Programming HELP FWD DATA	Allows the user to access and edit all parameter settings.➜ *Refer to Parameter List on page 389*.
		Λ ↓↑ V	
	Auto-Tuning Mode	- MODE - PRG Rdy Auto-Tuning AUTO HELP FWD DATA	Motor parameters are calculated and set automatically.➜ *Refer to Auto-Tuning on page 119*.
		Λ ↓↑ V	
Drive Mode	Frequency Reference	- MODE - DRV Rdy FREF (OPR) U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV	Returns to the frequency reference display screen.

■ Drive Mode Details

The following actions are possible in the Drive Mode:

- Run and stop the drive
- Monitor the operation status of the drive (frequency reference, output frequency, output current, output voltage, etc.)
- View information on an alarm
- View a history of alarms that have occurred

Figure 4.7 illustrates how to change the frequency reference from F 0.00 (0 Hz) to F 6.00 (6 Hz) while in the Drive Mode. This example assumes the drive is set to LOCAL.

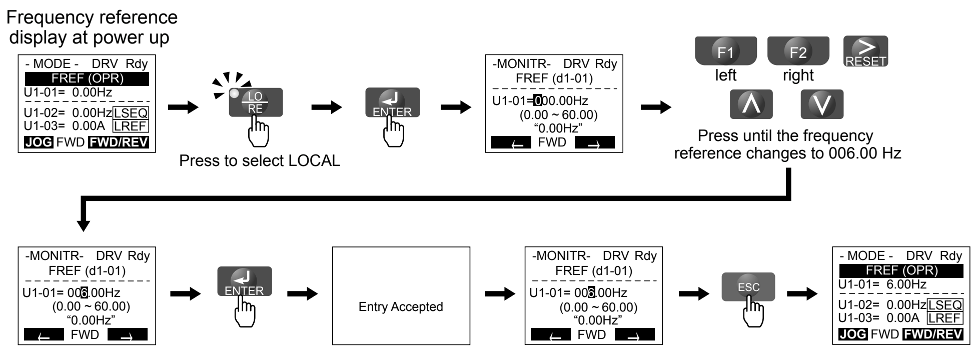


Figure 4.7 Setting the Frequency Reference while in the Drive Mode

Note: The drive will not accept a change to the frequency reference until the ENTER key is pressed after the frequency reference is entered. This feature prevents accidental setting of the frequency reference. To have the drive accept changes to the frequency reference as soon as changes are made without requiring the ENTER key, set o2-05 to 1.

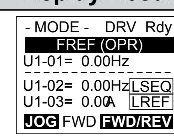
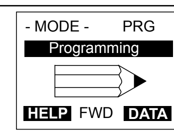
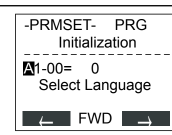
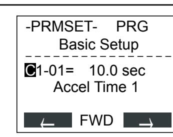
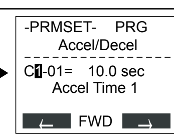
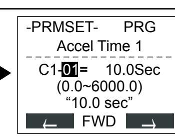
■ Programming Mode Details

The following actions are possible in the Programming Mode:

- **Parameter Setting Mode:** Access and edit all parameter settings.
- **Verify Menu:** View a list of parameters that have been changed from the default values.
- **Setup Group:** Access a list of commonly used parameters to simplify setup (*Refer to Simplified Setup Using the Setup Groups on page 111*).
- **Auto-Tuning Mode:** Automatically calculate and set motor parameters to optimize drive performance.

◆ Changing Parameter Settings or Values

This example explains changing C1-02 (Deceleration Time 1) from 10.0 seconds (default) to 20.0 seconds.

Step			Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	
2.	Press ∧ or ∨ until the Parameter Setting Mode screen appears.	➡	
3.	Press ENTER to enter the parameter menu tree.	➡	
4.	Press ∧ or ∨ to select the C parameter group.	➡	
5.	Press ENTER two times.		➡  ➡ 

Step			Display/Result
6.	Press ∧ or ∨ to select parameter C1-02.	➡	-PRMSET- PRG Decel Time 1 C1-02= 10.0Sec (0.0~6000.0) “10.0 sec” ← FWD →
7.	Press ENTER to view the current setting value (10.0 s). The leftmost digit flashes.	➡	-PRMSET- PRG Decel Time 1 C1-02= 0010.0Sec (0.0~6000.0) “10.0 sec” ← FWD →
8.	Press F1, F2, or RESET until the desired number is selected. “1” flashes.	➡	-PRMSET- PRG Decel Time 1 C1-02=0010.0Sec (0.0~6000.0) “10.0 sec” ← FWD →
9.	Press ∧ and enter 0020.0.	➡	-PRMSET- PRG Decel Time 1 C1-02=0020.0Sec (0.0~6000.0) “10.0 sec” ← FWD →
10.	Press ENTER to confirm the change.	➡	Entry Accepted
11.	The display automatically returns to the screen shown in Step 4.	➡	-PRMSET- PRG Decel Time 1 C1-02= 20.0Sec (0.0~6000.0) “10.0 sec” ← FWD →
12.	Press ESC as many times as necessary to return to the initial display.	➡	- MODE - DRV Rdy FREF (OPR) U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV

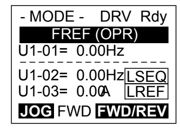
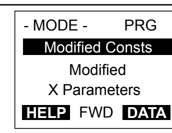
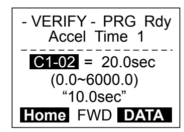
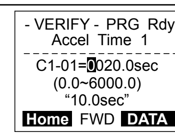
◆ Verifying Parameter Changes: Verify Menu

The Verify Menu lists edited parameters from the Programming Mode or as a result of Auto-Tuning. The Verify Menu helps determine which settings have been changed, and is particularly useful when replacing a drive. If no settings have been changed, the Verify Menu will read “None”. The Verify Menu also allows users to quickly access and re-edit any parameter settings that have been changed.

Note: The Verify Menu will not display parameters from the A1 group (except for A1-02) even if those parameters have been changed from their default settings.

The following example is a continuation of the steps above. Here, parameter C1-02 is accessed using the Verify Menu, and is changed again from 10.0 s to 20.0 s.

To check the list of edited parameters:

Step			Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	
2.	Press ∧ or ∨ until the display shows the top of the Verify Menu.	➡	
3.	Press ENTER to enter the list of parameters that have been edited from their original default settings. If parameters other than C1-02 have been changed, use ∧ or ∨ to scroll until C1-02 appears.	➡	
4.	Press ENTER to access the setting value. Left digit flashes.	➡	

◆ Simplified Setup Using the Setup Groups

The Setup Groups list the basic parameters necessary to set up the drive for a given application. Setup groups expedite the startup process for an application by showing only the most important parameters for the application.

■ Using the Setup Groups

Figure 4.8 illustrates how to enter and how to change parameters in the Setup Group.

The default setting for the Setup Group is a group of parameters most commonly use in general-purpose applications. *Refer to Application Selection on page 116* to select an Application Preset and change the Setup Group to parameters optimal for the application selected. .

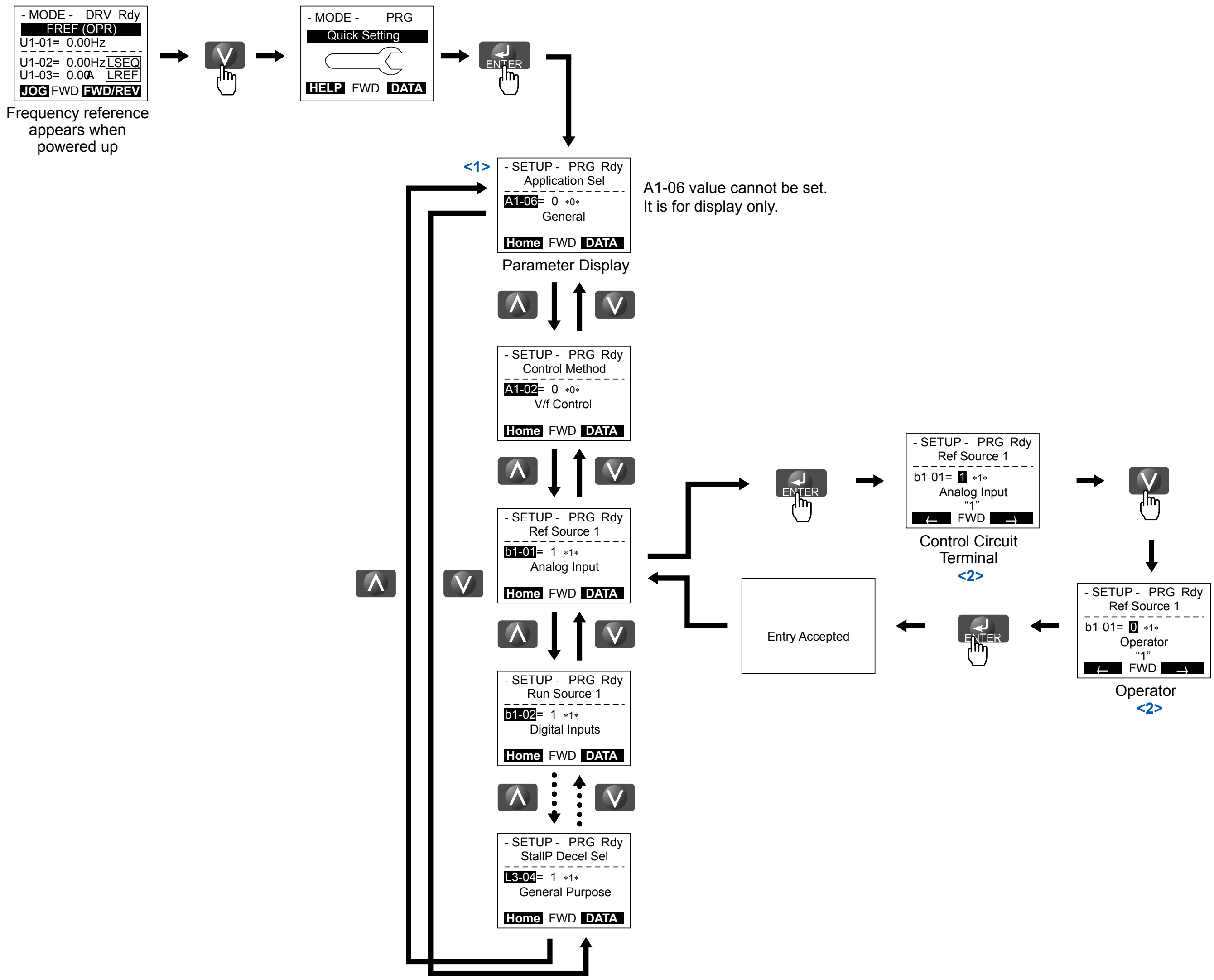


Figure 4.8 Setup Group Example

<1> Use the up and down arrow keys to scroll through the Setup Group. Press the ENTER key to view or change parameter settings.

<2> To return to the previous menu without saving changes, press the ESC key.

■ Setup Group Parameters

Table 4.6 lists the parameters available by default in the Setup Group. Selecting an Application Preset in through initialization in parameter A1-03 automatically changes the parameters selected for the Setup Group. *Refer to Application Selection on page 116* for details on parameters and default values for the fan and pump Setup Groups.

No.	Parameter Name	Setting Range	Default
A1-03	Initialize Parameters	0, 1110, 2220, 3330, 5550, 8008, 8009, 8010, 8011	0

Setting 0: No initialization (default)

Setting 1110: User Initialize (parameter values must be stored using parameter o2-03)

Setting 2220: 2-Wire Initialize

Setting 3330: 3-Wire Initialize

Setting 5550: Terminal/Control Initialize

Setting 8008: Pump

Setting 8009: Pump w/ PI

Setting 8010: Fan

Setting 8011: Fan w/ PI

Use the Programming Mode to access parameters not displayed in the Setup Group.

Table 4.6 General Purpose Application Setup Group Parameters (A1-03 = 0)

Parameter	Name	Parameter	Name
A1-06	Application Preset Selection (Monitor only)	E2-01	Motor Rated Current
b1-01	Frequency Reference Selection 1	L2-01	Momentary Power Loss Operation Selection
b1-02	Run Command Selection 1	L5-01	Number of Auto Restart Attempts
b1-03	Stopping Method Selection	L6-01	Torque Detection 1 Selection
b1-04	Reverse Operation Selection	L6-02	Torque Detection 1 Level
C1-01	Acceleration Time 1	L6-03	Torque Detection 1 Time
C1-02	Deceleration Time 1	o1-06	User Monitor Selection Mode
d1-01	Frequency Reference 1	o1-07	Second Line Monitor Selection
d2-01	Frequency Reference Upper Limit	o1-08	Third Line Monitor Selection
d2-02	Frequency Reference Lower Limit		

◆ Switching Between LOCAL and REMOTE

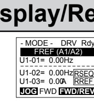
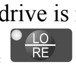
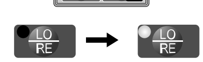
LOCAL mode is when the drive is set to accept the Run command from the digital operator RUN key. REMOTE mode is when the drive is set to accept the Run command from an external device (i.e., input terminals or serial communications).

WARNING! *Sudden Movement Hazard. The drive may start unexpectedly if the Run command is already applied when switching from LOCAL mode to REMOTE mode when b1-07 = 1, resulting in death or serious injury. Be sure all personnel are clear of rotating machinery.*

Switch the operation between LOCAL and REMOTE using the LO/RE key on the digital operator or via a digital input.

Note:
1. After selecting LOCAL, the LO/RE light will remain lit.
2. The drive will not allow the user to switch between LOCAL and REMOTE during run.

■ Using the LO/RE Key on the Digital Operator

	Step		Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	
2.	Press . The LO/RE light will light up. The drive is now in LOCAL. To set the drive for REMOTE operation, press the  key again.	➡	 

■ Using Input Terminals S1 through S8 to Switch between LOCAL and REMOTE

It is possible to switch between LOCAL and REMOTE modes using one of the digital input terminals S1 through S8 (set the corresponding parameter H1-☐☐ to “1”).

Setting H1-☐☐ to 1 disables the LO/RE key on the digital operator. ***Refer to H1: Multi-Function Digital Inputs on page 194*** for details.

4.4 Start-Up Flowchart

Figure 4.9 summarizes steps required to start the drive and gives quick references to help familiarize the user with start-up procedures.

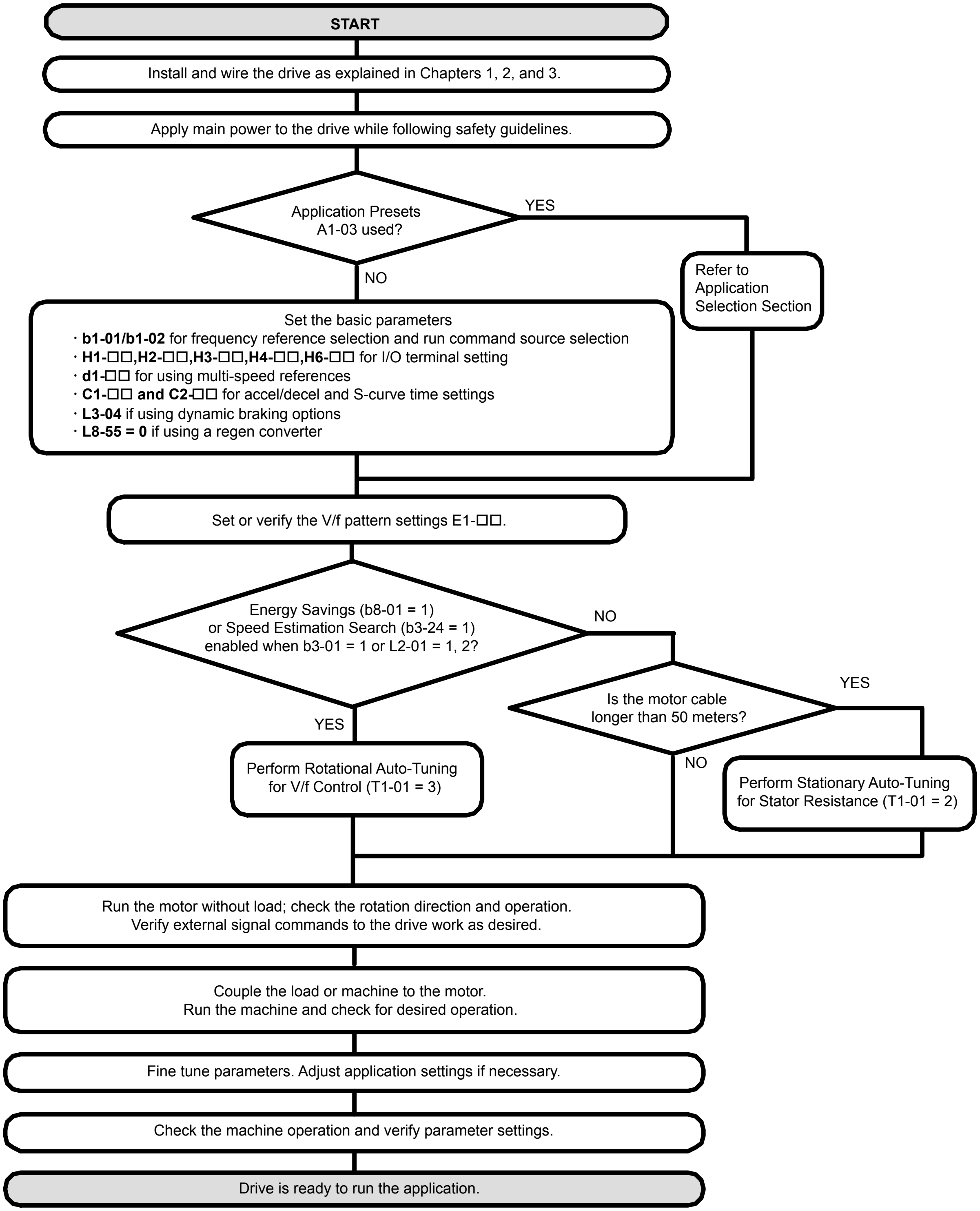


Figure 4.9 Simple Setup with Energy Savings or Speed Search

Note:
1. Execute Stationary Auto-Tuning for Line-to-Line Resistance if the drive has been Auto-Tuned and then moved to a different location where the motor cable length exceeds 50 m.
2. Perform Auto-Tuning again after installing an AC reactor or other such components to the output side of the drive.

4.5 Powering Up the Drive

◆ Powering Up the Drive and Operation Status Display

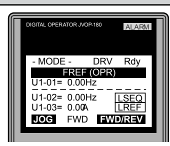
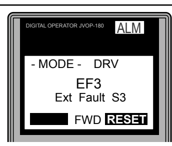
■ Powering Up the Drive

Review the following checklist before turning the power on.

Item to Check	Description
Power supply voltage	200 V class: Three-phase 200 to 240 Vac 50/60 Hz 400 V class: Three-phase 380 to 480 Vac 50/60 Hz 600 V class: Three-phase 500 to 600 Vac 50/60 Hz
	Properly wire the power supply input terminals (R/L1, S/L2, T/L3).
	Check for proper grounding of drive and motor.
Drive output terminals and motor terminals	Properly wire drive output terminals U/T1, V/T2, and W/T3 with motor terminals U, V, and W.
Control circuit terminals	Check control circuit terminal connections.
Drive control terminal status	Open all control circuit terminals (off).
Status of the load and connected machinery	Decouple the motor from the load.

■ Status Display

When the power supply to the drive is turned on, the digital operator lights will appear as follows:

Status	Name	Description
Normal Operation		The data display area displays the frequency reference. DRV is lit.
Fault	 External fault (example)	Data displayed varies by the type of fault. ***Refer to Fault Displays, Causes, and Possible Solutions on page 281*** for more information. ALM and DRV are lit.

4.6 Application Selection

Application Presets are available to facilitate drive setup for commonly used applications. Selecting one of these Application Presets automatically assigns functions to the input and output terminals and sets a predefined group of parameters to values appropriate for the selected application.

In addition, the parameters most likely to be changed are assigned to the group of User Parameters, A2-01 through A2-16. User Parameters are part of the Setup Group, which provides quicker access by eliminating the need to scroll through multiple menus.

Note:
1. Application Presets can only be selected if all drive parameters are at their original default settings.
2. Entering a value to A1-03 to enable an Application Preset will fix that value to the parameter. The value cannot be changed without first setting A1-03 to 2220 or 3330 to initialize the drive.

WARNING! *Sudden Movement Hazard. Confirm the drive I/O signals and external sequence before performing a test run. Setting parameter A1-03 may automatically change the I/O terminal function from the default setting. Failure to comply may result in death or serious injury.*

No.	Parameter Name	Settings	Default
A1-03	Initialize Parameters	0: No initialization (default) 1110: User Initialize (parameter values must be stored using parameter o2-03) 2220: 2-Wire Initialize 3330: 3-Wire Initialize 5550: Terminal/Control Initialize 8008: Pump 8009: Pump w/ PI 8010: Fan 8011: Fan w/ PI	0
A1-06	Application Presets (monitor only)	0: Disabled 8: Pump 9: Pump w/ PI 10: Fan 11: Fan w/ PI	0

◆ A1-03 = 8008: Pump

Table 4.7 Pump Application Parameters

Parameter	Name	Page
A1-06	Application Preset Selection (monitor only)	116
b1-01	Frequency Reference Selection	137
b1-02	Run Command Selection	138
b1-03	Stopping Method Selection	139
b1-04	Reverse Operation Selection	141
C1-01	Acceleration Time 1	166
C1-02	Deceleration Time 1	166
d1-01	Frequency Reference 1	171
E2-01	Motor Rated Current	184
L2-01	Momentary Power Loss Operation Selection	227
L5-01	Number of Auto Restart Attempts	241
L5-04	Fault Reset Interval Time	241
o1-06	User Monitor Selection Mode	252
o1-07	Second Line Monitor Selection	253
o1-08	Third Line Monitor Selection	253

◆ A1-03 = 8009: Pump w/ PI

Table 4.8 Pump w/ PI Application Parameters

Parameter	Name	Page
A1-06	Application Preset Selection (monitor only)	116
b1-02	Run Command Selection	138

Parameter	Name	Page
b1-03	Stopping Method Selection	139
b1-04	Reverse Operation Selection	141
b5-19	PID Setpoint Value	157
b5-38	PID Setpoint User Display	159
b5-39	PID Setpoint Display Digits	159
b5-46	PID Unit Selection	159
b5-90	EZ Sleep Unit	160
b5-91	EZ Minimum Speed	160
b5-92	EZ Sleep Level	160
b5-94	EZ Wake-up Level	160
C1-01	Acceleration Time 1	166
C1-02	Deceleration Time 1	166
E2-01	Motor Rated Current	184
H3-09	Terminal A2 Signal Level Selection	215
L5-01	Number of Auto Restart Attempts	241
L5-04	Fault Reset Interval Time	241
o1-07	Second Line Monitor Selection	253
o1-08	Third Line Monitor Selection	253

◆ A1-03 = 8010: Fan

Table 4.9 Fan Application Parameters

Parameter	Name	Page
A1-06	Application Preset Selection (monitor only)	116
b1-01	Frequency Reference Selection	137
b1-02	Run Command Selection	138
b1-03	Stopping Method Selection	139
b1-04	Reverse Operation Selection	141
C1-01	Acceleration Time 1	166
C1-02	Deceleration Time 1	166
d1-01	Frequency Reference 1	171
d2-01	Frequency Reference Upper Limit	173
d2-02	Frequency Reference Lower Limit	173
E2-01	Motor Rated Current	184
L5-01	Number of Auto Restart Attempts	241
L5-04	Fault Reset Interval Time	241
o1-06	User Monitor Selection Mode	252
o1-07	Second Line Monitor Selection	253
o1-08	Third Line Monitor Selection	253

◆ A1-03 = 8011: Fan w/ PI

Table 4.10 Fan Application Parameters

Parameter	Name	Page
A1-06	Application Preset Selection (monitor only)	116
b1-02	Run Command Selection	138
b1-03	Stopping Method Selection	139
b1-04	Reverse Operation Selection	141
b5-12	PI Feedback Loss Detection Selection	155
b5-19	PID Setpoint Value	157
b5-38	PID Setpoint User Display	159

Parameter	Name	Page
b5-39	PID Setpoint Display Digits	*159*
b5-46	PID Unit Selection	*159*
b5-90	EZ Sleep Unit	*160*
b5-91	EZ Minimum Speed	*160*
b5-92	EZ Sleep Level	*160*
b5-94	EZ Wake-up Level	*160*
C1-01	Acceleration Time 1	*166*
C1-02	Deceleration Time 1	*166*
E2-01	Motor Rated Current	*184*
H3-09	Terminal A2 Signal Level Selection	*215*
L5-01	Number of Auto Restart Attempts	*241*
L5-04	Fault Reset Interval Time	*241*
o1-07	Second Line Monitor Selection	*253*
o1-08	Third Line Monitor Selection	*253*

◆ Default Values for Fan and Pump Applications

Table 4.11 Fan and Pump Application Defaults

	A1-03 Setting			
Parameter	**8008**	**8009**	**8010**	**8011**
A1-02	0: V/f Control	0: V/f Control	0: V/f Control	0: V/f Control
b1-04	–	–	1: Reverse Disabled	1: Reverse Disabled
b3-05	–	–	10.0 s	10.0 s
b5-01	–	1: PID Enabled	–	1: PID Enabled
b5-03	–	–	–	5.0 s
b5-08	–	–	–	2.00 s
b5-13	–	–	–	2%
b5-14	–	–	–	25.0 s
b5-18	–	1: Enabled (b5-19)	–	1: Enabled (b5-19)
b5-20	–	3: User Set	–	3: User Set
b5-46	–	–	–	1: PSI
b5-89	–	1: EZ Sleep/Wake Up	–	1: EZ Sleep/Wake Up
C1-01	–	–	90.0 s	60.0 s
C1-02	–	–	90.0 s	60.0 s
C2-01	–	–	5.00 s	5.00 s
C2-02	–	–	5.00 s	5.00 s
C2-03	–	–	5.00 s	5.00 s
C2-04	–	–	5.00 s	5.00 s
H3-10	–	B: PID Feedback		B: PID Feedback
L2-01	2: CPU Active	2: CPU Active	2: CPU Active	2: CPU Active
L3-02	–	–	110%	110%
L3-06	–	–	100%	100%
L4-05	–	–	0: Stop	–
L5-04	–	–	180.0 s	180.0 s
L5-05	1: L5-04 Interval	1: L5-04 Interval	1: L5-04 Interval	1: L5-04 Interval
o1-06	–	1: Selectable	–	1: Selectable
o1-07	–	102: Output Frequency	–	102: Output Frequency
o1-08	–	501: Feedback	–	501: Feedback

4.7 Auto-Tuning

◆ Types of Auto-Tuning

The drive offers different types of Auto-Tuning for induction motors. Refer to the tables below to select the type of Auto-Tuning that bests suits the application. *Refer to Start-Up Flowchart on page 114* for directions on executing Auto-Tuning.

■ Auto-Tuning for Induction Motors

This feature automatically sets the V/f pattern and motor parameters E1-□□ and E2-□□ for an induction motor.

Table 4.12 Types of Auto-Tuning for Induction Motors

Type	Setting	Application Conditions and Benefits
Stationary Auto-Tuning for Line-to-Line Resistance	T1-01 = 2	• The drive is used in V/f Control and other Auto-Tuning selections are not possible. • Perform when entering motor data manually while using motor cables longer than 50 m. • Drive and motor capacities differ. • Tunes the drive after the cable between the drive and motor has been replaced with a cable over 50 m long. Assumes Auto-Tuning has already been performed.
Rotational Auto-Tuning for V/f Control	T1-01 = 3	• Recommended for applications using Speed Estimation Speed Search or using the Energy Saving function in V/f Control. • Assumes motor can rotate while Auto-Tuning is executed. Increases accuracy for certain functions like torque compensation, slip compensation, Energy Saving, and Speed Search.

Table 4.13 lists the data that must be entered for Auto-Tuning. Make sure this data is available before starting Auto-Tuning. The necessary information is usually listed on the motor nameplate or in the motor test report provided by the motor manufacturer. *Refer to Start-Up Flowchart on page 114* for details on the Auto-Tuning process.

Table 4.13 Auto-Tuning Input Data

Input Value	Input Parameter	Unit	Tuning Type (T1-01)	
			2 Line-to-Line Resistance	3 Rotational for V/f Control
Motor rated power	T1-02	kW	YES	YES
Motor rated voltage	T1-03	Vac	–	YES
Motor rated current	T1-04	A	YES	YES
Motor rated frequency	T1-05	Hz	–	YES
Number of motor poles	T1-06	-	–	YES
Motor rated Speed	T1-07	r/min	–	YES
Motor iron loss	T1-11	W	–	YES

◆ Before Auto-Tuning the Drive

Check the items below before Auto-Tuning the drive.

■ Basic Auto-Tuning Preparations

- Auto-Tuning requires the user to input data from the motor nameplate or motor test report. Make sure this data is available before Auto-Tuning the drive.
- For best performance, the drive input supply voltage must be at least equal to or greater than the motor rated voltage.

  Note: Better performance is possible when using a motor with a base voltage that is lower than the input supply voltage (20 V for 200 V class models, 40 V for 400 V class models, and 60 V for 600 V class models). This is particularly important when operating the motor above 90% of base speed, where high torque precision is required.

- To cancel Auto-Tuning, press the STOP key on the digital operator.
- When using a motor contactor, make sure it is closed throughout the Auto-Tuning process.

Table 4.14 describes digital input and output terminal operation while Auto-Tuning is executed.

Table 4.14 Auto-Tuning Input Data

Motor Type	Auto-Tuning Type	Digital Input	Digital Output
IM Motor	Stationary Auto-Tuning for Line-to-Line Resistance	Digital input functions are disabled.	Digital output functions are disabled.
	Rotational Auto-Tuning for V/f Control		Functions the same as during normal operation

■ Notes on Rotational Auto-Tuning

- Decouple the load from the motor to achieve optimal performance from Rotational Auto-Tuning. Rotational Auto-Tuning is best suited for applications requiring high performance over a wide speed range.
- If it is not possible to decouple the motor and load, reduce the load so it is less than 30% of the rated load. Performing Rotational Auto-Tuning with a higher load will set motor parameters incorrectly, and can cause irregular motor rotation.
- Ensure the motor-mounted brake is fully released, if installed.
- Connected machinery should be allowed to rotate the motor.

■ Notes on Stationary Auto-Tuning

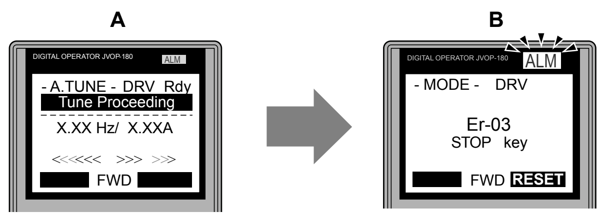
Stationary Auto-Tuning modes analyze motor characteristics by injecting current into the motor for approximately one minute.

WARNING! *Electrical Shock Hazard. When executing stationary Auto-Tuning, the motor does not rotate but power is applied. Do not touch the motor until Auto-Tuning is completed. Failure to comply may result in injury or death from electrical shock.*

WARNING! *Sudden Movement Hazard. If installed, do not release the mechanical brake during Stationary Auto-Tuning. Inadvertent brake release may cause damage to equipment or injury to personnel. Ensure that the mechanical brake release circuit is not controlled by the drive multi-function digital outputs.*

◆ Auto-Tuning Interruption and Fault Codes

If tuning results are abnormal or the STOP key is pressed before completion, Auto-Tuning will be interrupted and a fault code will appear on the digital operator.



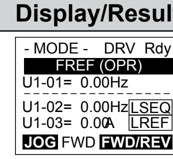
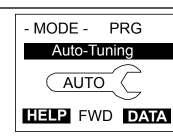
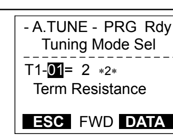
A – During Auto-Tuning **B – Auto-Tuning Aborted**

Figure 4.10 Auto-Tuning Aborted Display

◆ Auto-Tuning Operation Example

The following example demonstrates Stationary Auto-Tuning for Line-to-Line Resistance.

■ Selecting the Type of Auto-Tuning

	Step		Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	
2.	Press ∧ or ∨ until the Auto-Tuning display appears.	➡	
3.	Press ENTER to begin setting parameters.	➡	

Step			Display/Result
4.	Press ENTER to display the value for T1-01.	➡	- A.TUNE - PRG Rdy Tuning Mode Sel T1-01= 2 *2* Term Resistance "2" ← FWD →
5.	Save the setting by pressing ENTER.	➡	Entry Accepted
6.	The display automatically returns to the display shown in Step 3.	➡	- A.TUNE - PRG Rdy Tuning Mode Sel T1-01= 2 *2* Term Resistance ESC FWD DATA

■ Enter Data from the Motor Nameplate

After selecting the type of Auto-Tuning, enter the data required from the motor nameplate.

Note: These instructions continue from Step 6 in "Selecting the Type of Auto-Tuning".

Step			Display/Result
1.	Press ∧ to access the motor output power parameter T1-02.	➡	- A.TUNE - PRG Rdy Mtr Rated Power T1-02= 0.75kW (0.00 ~ 650.00) "0.75kW" ESC FWD DATA
2.	Press ENTER to view the default setting.	➡	- A.TUNE - PRG Rdy Mtr Rated Power T1-02= 000.75kW (0.00 ~ 650.00) "0.75kW" ← FWD →
3.	Press F1 left, F2 right, > RESET, ∧, and ∨ to enter the motor power nameplate data in kW.	➡	- A.TUNE - PRG Rdy Mtr Rated Power T1-02= 000.40kW (0.00 ~ 650.00) "0.75kW" ← FWD →
4.	Press ENTER to save the setting.	➡	Entry Accepted
5.	The display automatically returns to the display in Step 1.	➡	- A.TUNE - PRG Rdy Mtr Rated Power T1-02= 0.40kW (0.00 ~ 650.00) "0.75kW" ESC FWD DATA
6.	Repeat Steps 1 through 5 to set the following parameters: • T1-03, Motor Rated Voltage (Rotational Auto-Tuning for V/f Control only) • T1-04, Motor Rated Current • T1-05, Motor Base Frequency (Rotational Auto-Tuning for V/f Control only) • T1-06, Number of Motor Poles (Rotational Auto-Tuning for V/f Control only) • T1-07, Motor Base Frequency (Rotational Auto-Tuning for V/f Control only)	➡	- A.TUNE - PRG Rated Voltage T1-03= 200.0VAC (0.0 ~ 255.0) "200.0VAC" ESC FWD DATA ⋮ - A.TUNE - PRG Rated Current T1-04= X.XX A (0.35 ~ 7.00) "X.XX A" ESC FWD DATA

■ Starting Auto-Tuning

WARNING! *Sudden Movement Hazard. The drive and motor may start unexpectedly during Auto-Tuning, which could result in death or serious injury. Ensure the area surrounding the drive motor and load are clear before proceeding with Auto-Tuning.*

WARNING! *Electrical Shock Hazard. High voltage will be supplied to the motor when Stationary Auto-Tuning is performed even with the motor stopped, which could result in death or serious injury. Do not touch the motor until Auto-Tuning has been completed.*

NOTICE: *Rotational Auto-Tuning will not function properly if a holding brake is engaged on the load. Failure to comply could result in improper operation of the drive. Ensure the motor can freely spin before beginning Auto-Tuning.*

Enter the required information from the motor nameplate. Press ∧ to proceed to the Auto-Tuning start display.

Note: These instructions continue from Step 6 in "Enter Data from the Motor Nameplate".

	Step		Display/Result
1.	After entering the data listed on the motor nameplate, press ∧ to confirm.	➡	- A.TUNE - DRV Rdy Auto-Tuning 0.00 Hz/ 0.00A Tuning Ready ? Press RUN key ESC FWD
2.	Press RUN to activate Auto-Tuning. DRV flashes. The drive begins by injecting current into the motor for about 1 min, and then starts to rotate the motor. **Note:** The first digit on the display indicates which motor is undergoing Auto-Tuning. The second digit indicates the type of Auto-Tuning being performed.	➡	- A.TUNE - DRV Rdy Tune Proceeding X.XX Hz/ X.XXA <<<<< >>> >> FWD
3.	Auto-Tuning finishes in approximately one to two minutes.	➡	- MODE - DRV End Tune Successful FWD RESET

◆ T1: Parameter Settings during Induction Motor Auto-Tuning

The T1-□□ parameters set the Auto-Tuning input data for induction motor tuning.

Note: For motors operating in the field weakening range, first perform the Auto-Tuning with the base data. After Auto-Tuning is complete, change E1-04, Maximum Output Frequency, to the desired value.

■ T1-01: Auto-Tuning Mode Selection

Sets the type of Auto-Tuning to be used. *Refer to Auto-Tuning for Induction Motors on page 119* for details on the different types of Auto-Tuning.

No.	Name	Setting Range	Default
T1-01	Auto-Tuning Mode Selection	2, 3	2

Setting 2: Stationary Auto-Tuning for Line-to-Line Resistance

Setting 3: Rotational Auto-Tuning for V/f Control

■ T1-02: Motor Rated Power

Sets the motor rated power according to the motor nameplate value.

No.	Name	Setting Range	Default
T1-02	Motor Rated Power	0.00 to 650.00 kW	Determined by o2-04

■ T1-03: Motor Rated Voltage (T1-01 = 3)

Sets the motor rated voltage according to the motor nameplate value. Enter the voltage base speed here if the motor is operating above base speed.

Enter the voltage needed to operate the motor under no-load conditions at rated speed to T1-03 for better control precision around rated speed when using a vector control mode. The no-load voltage can usually be found in the motor test report available from the manufacturer. If the motor test report is not available, enter approximately 90% of the rated voltage printed on the motor nameplate. This may increase the output current and reduce the overload margin.

No.	Name	Setting Range	Default
T1-03	Motor Rated Voltage	0.0 to 255.5 V <1>	200.0 V <1>

<1> Values shown are specific to 200 V class drives. Double value for 400 V class drives. Multiply value by 2.875 for 600 V class drives.

■ T1-04: Motor Rated Current

Sets the motor rated current according to the motor nameplate value. Enter the current at the motor base speed.

No.	Name	Setting Range	Default
T1-04	Motor Rated Current	10 to 200% of drive rated current	o2-04

■ T1-05: Motor Base Frequency (T1-01 = 2)

Sets the motor rated frequency according to the motor nameplate value. If a motor with an extended speed range is used or the motor is used in the field weakening area, enter the maximum frequency to E1-04 after Auto-Tuning is complete.

No.	Name	Setting Range	Default
T1-05	Motor Base Frequency	0.0 to 400.0 Hz	60.0 Hz

■ T1-06: Number of Motor Poles (T1-01 = 3)

Sets the number of motor poles according to the motor nameplate value.

No.	Name	Setting Range	Default
T1-06	Number of Motor Poles	2 to 48	4

■ T1-07: Motor Base Speed (T1-01 = 3)

Sets the motor rated speed according to the motor nameplate value. Enter the speed at base frequency when using a motor with an extended speed range or if using the motor in the field weakening area.

No.	Name	Setting Range	Default
T1-07	Motor Base Speed		1750 r/min

■ T1-11: Motor Iron Loss (T1-01 = 3)

Provides iron loss information to determine the Energy Saving coefficient. T1-11 will first display the value for the motor iron loss that the drive automatically calculated the when motor capacity was entered to T1-02. Enter the motor iron loss value listed to T1-11 if the motor test report is available.

No.	Name	Setting Range	Default
T1-11	Motor Iron Loss	0 to 65535 W	14 W Differs depending on motor code and motor parameter settings.

4.8 No-Load Operation Test Run

◆ No-Load Operation Test Run

This section explains how to operate the drive with the motor decoupled from the load during a test run.

■ Before Starting the Motor

Check the following items before operation:

- Ensure the area around the motor is safe.
- Ensure external emergency stop circuitry is working properly and other safety precautions have been taken.

■ During Operation

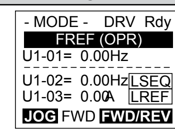
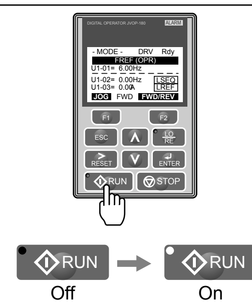
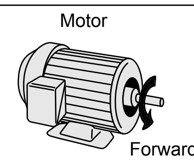
Check the following items during operation:

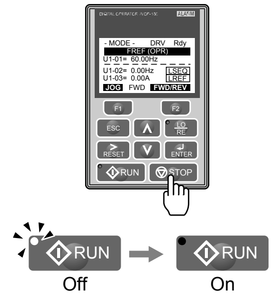
- The motor should rotate smoothly (i.e., no abnormal noise or oscillation).
- The motor should accelerate and decelerate smoothly.

■ No-Load Operation Instructions

The following example illustrates a test run procedure using the digital operator.

Note: Before starting the motor, set the frequency reference d1-01 to 6 Hz.

Step			Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	
2.	Press  to select LOCAL. The LO/RE light will turn on.	➡	
3.	Press  to give the drive a Run command. RUN will light and the motor will rotate at 6 Hz.	➡	
4.	Ensure the motor is rotating in the correct direction and that no faults or alarms occur.	➡	
5.	If there is no error in step 4, press  to increase the frequency reference. Increase the frequency in increments of 10 Hz, verifying smooth operation at all speeds. For each frequency, check the drive output current using monitor U1-03. The current should be well below the motor rated current.	–	–

Step			Display/Result
6.	The drive should operate normally. Press  to stop the motor. RUN flashes until the motor comes to a complete stop.	➡	

4.9 Test Run with Load Connected

◆ Test Run with the Load Connected

After performing a no-load test run, connect the motor and proceed to run the motor and load together.

■ Precautions for Connected Machinery

WARNING! *Sudden Movement Hazard. Clear all personnel from the drive, motor, and machine area before applying power. System may start unexpectedly upon application of power, causing death or serious injury.*

WARNING! *Sudden Movement Hazard. Always check the operation of any fast stop circuits after they are wired. Fast stop circuits are required to provide safe and quick shutdown of the drive. Prepare to initiate an emergency stop during the test run. Operating a drive with untested emergency circuits could result in death or serious injury.*

- The motor should come to a complete stop without problems.
- Connect the load and machinery to the motor.
- Fasten all installation screws properly and check that the motor and connected machinery are held in place.

■ Checklist Before Operation

- The motor should rotate in the proper direction.
- The motor should accelerate and decelerate smoothly.

■ Operating the Motor under Loaded Conditions

Test run the application similarly to the no-load test procedure when connecting the machinery to the motor.

- Monitor U1-03 for overcurrent during operation.
- If the application permits running the load in the reverse direction, change the motor direction and the frequency reference while watching for abnormal motor oscillation or vibration.
- Correct any problems that occur with hunting, oscillation, and other control-related issues.

4.10 Verifying Parameter Settings and Backing Up Changes

Use the Verify Menu to check all changes to parameter settings. ***Refer to Verifying Parameter Changes: Verify Menu on page 110***.

Save the verified parameter settings. Change the access level or set a password to the drive to prevent accidental modification of parameter settings.

◆ Backing Up Parameter Values: o2-03

Setting o2-03 to 1 saves all parameter settings before resetting o2-03 to 0. The drive can now recall all the saved parameters by performing a User Initialization (A1-03 = 1110).

No.	Parameter Name	Description	Setting Range	Default Setting
o2-03	User Defaults	Lets the user create a set of default settings for a User Initialization. 0: Saved/Not Set 1: Set Defaults - Saves current parameter settings as the default values for a User Initialization. 2: Clear All - Clears the currently saved user settings. After saving the user parameter set value, the items of 1110 (User Initialization) are displayed in A1-03 (User Parameter Default Value).	0 to 2	0
A1-03	Initialize Parameters	Selects a method to initialize the parameters. 0: No initialization 1110: User Initialize (parameter values must be stored using parameter o2-03) 2220: 2-Wire Initialize (parameter initialized prior to shipment) 3330: 3-Wire Initialize 5550: Terminal/Control Initialize 8008: Pump 8009: Pump w/ PI 8010: Fan 8011: Fan w/ PI	0 to 8011	0

◆ Parameter Access Level: A1-01

Setting the Access Level for "Operation only" (A1-01 = 0) allows the user to access parameters A1-□□ and U□-□□ only. Other parameters are not displayed.

Setting the Access Level for "User Parameters" (A1-01 = 1) allows the user to access only the parameters that have been previously saved as User Parameters. This is helpful when displaying only the relevant parameters for a specific application.

No.	Parameter Name	Description	Setting Range	Default
A1-01	Access Level Selection	1: User Parameters. Only recently changed parameters from application parameters A2-01 to A2-16 and A2-17 to A2 -32 can be set and monitored. 2: Advanced Access Level. All parameters can be set and monitored.	0 to 2	2
A2-01 to A2-32	User Parameters 1 to 32	Parameters selected by the user are saved as User Parameters, including recently viewed parameters and parameters specifically selected for quick access. If parameter A2-33 is set to 1, recently viewed parameters will be listed between A2-17 and A2-32. Parameters A2-01 through A2-16 must be manually selected by the user. If A2-33 is set to 0, recently viewed parameters will not be saved to the group of User Parameters. A2-□□ parameters are now available for manual programming.	b1-01 to o□-□□	–
A2-33	User Parameter Automatic Selection	0: Parameters A2-01 through A2-32 are reserved for the user to create a group of User Parameters. 1: Save history of recently viewed parameters. Recently edited parameters will be saved to A2-17 through A2-32 for quick access. The most recently changed parameter is saved to A2-17. The second most recently changed parameter is saved to A2-18, etc.	0, 1	0

◆ Password Settings: A1-04, A1-05

The user can set a password in parameter A1-05 to restrict access to the drive. The password must be entered to A1-04 to unlock parameter access (i.e., parameter setting A1-04 must match the value programmed into A1-05). The following parameters cannot be viewed or edited until the value entered to A1-04 correctly matches the value set to A1-05: A1-01, A1-03, A1-06, and A2-01 through A2-33.

Note: Parameter A1-05 is hidden from view. To display A1-05, access parameter A1-04 and press STOP and ∧ simultaneously.

◆ Copy Function

Parameter settings can be copied to another drive to simplify parameter restoration or multiple drive setup. The drive supports the following copy options:

- **LCD Operator (standard in all models)**

  The LCD operator used to operate the drive supports copying, importing, and verifying parameter settings and contains a Real Time Clock.***Refer to o3: Copy Function on page 257*** for details.

- **USB Copy Unit and CopyUnitManager**

  The copy unit is an external option connected to the drive to copy parameter settings from one drive and save those settings to another drive. Refer to the manual supplied with the USB Copy Unit for instructions.

  The CopyUnitManager is a PC software tool. It allows the user to load parameter settings from the Copy Unit onto a PC, or from the PC onto a Copy Unit. This is useful when managing parameters for various drives or applications. Refer to the manual supplied with the CopyUnitManager for instructions.

- **DriveWizard Industrial**

  DriveWizard Industrial is a PC software tool for parameter management, monitoring, and diagnosis. DriveWizard Industrial can load, store, and copy drive parameter settings. For details, refer to Help in the DriveWizard Industrial software.

4.11 Test Run Checklist

Review the checklist before performing a test run. Check each item that applies.

☑	No.	Checklist	Page
☐	1	Thoroughly read the manual before performing a test run.	–
☐	2	Turn the power on.	*115*
☐	3	Set the voltage for the power supply to E1-01.	*180*

Check the items that correspond to the control mode being used.

WARNING! *Sudden Movement Hazard. Ensure start/stop and safety circuits are wired properly and in the correct state before energizing the drive. Failure to comply could result in death or serious injury from moving equipment. When programmed for 3-Wire control, a momentary closure on terminal S1 may cause the drive to start.*

☑	No.	Checklist	Page
☐	4	Select the best V/f pattern according to the application and motor characteristics.	–
☐	5	Select Stationary Auto-Tuning for Line-to-Line Resistance or Rotational Auto-Tuning for V/f Control if using Energy Saving functions.	*119*
☐	6	Decouple the motor for Rotational Auto-Tuning for V/f Control.	*119*
☐	7	Enter the following data depending on Auto-Tuning method according to the information listed on the motor nameplate: • Motor rated power to T1-02 (kW) • Motor rated voltage to T1-03 (V) • Motor rated current to T1-04 (A) • Motor base frequency to T1-05 (Hz) • Number of motor poles to T1-06 • Motor base speed to T1-07 (r/min)	–
☐	8	The DRV should light after giving a Run command.	–
☐	9	To give Run command and frequency reference from the digital operator, press "LO/RE" key to set to LOCAL.	*112*
☐	10	If the motor rotates in the opposite direction during test run, switch two of U/T1, V/T2, W/T3, or change b1-14.	*115*
☐	11	Set motor rated current (E2-01) and motor protection (L1-01) values for motor thermal protection.	–
☐	12	Set the drive for REMOTE when control circuit terminals provide the Run command and frequency reference.	*112*
☐	13	If the control circuit terminals should supply the frequency reference, select the correct voltage input signal level (0 to +10 V or -10 to +10 V) or the correct current input signal level (4 to 20 mA or 0 to 20 mA).	*137*
☐	14	Set the proper signal level to terminals A1, A2, A3 (0 to 20 mA, 4to 20 mA, 0 to +10 V or -10 to +10 V).	*137*
☐	15	For A1, A2, and A3, when current input is used, switch the jumper on S1 from the V-side to I-side. Set the level for current signal used with parameter H3-01 for terminal A1, H3-09 for terminal A2, H3-05 for terminal A3, (set "2" for 4 to 20 mA, or "3" for 0 to 20 mA). V = Voltage, I = Current analog input signal.	*137*
☐	16	If an analog input supplies the frequency reference, make sure it produces the desired frequency reference. Make the following adjustments if the drive does not operate as expected: Gain adjustment: Set the maximum voltage/current signal and adjust the analog input gain (H3-03 for A1, H3-11 for A2, H3-07 for A3) until the frequency reference value reaches the desired value. Bias adjustment: Set the minimum voltage/current signal and adjust the analog input bias (H3-04 for A1, H3-12 for A2, H3-08 for A3) until the frequency reference value reaches the desired minimum value.	–

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5

Parameter Details

5.1 A: Initialization

The initialization group contains parameters associated with initial drive setup, including parameters involving the display language, access levels, initialization, and password.

◆ A1: Initialization

■ A1-00: Language Selection

Selects the display language for the digital operator.

Note: This parameter is not reset when the drive is initialized using parameter A1-03.

No.	Parameter Name	Setting Range	Default
A1-00	Language Selection	0 to 7	0

Setting 0: English

Setting 1: Japanese

Setting 2: German

Setting 3: French

Setting 4: Italian

Setting 5: Spanish

Setting 6: Portuguese

Setting 7: Chinese

■ A1-01: Access Level Selection

Allows or restricts access to drive parameters.

No.	Parameter Name	Setting Range	Default
A1-01	Access Level Selection	0 to 2	2

Setting 0: Operation only

Access to only parameters A1-01, A1-04, and all U monitor parameters.

Setting 1: User Parameters

Access to only a specific list of parameters set to A2-01 through A2-32. These User Parameters can be accessed using the Setup Mode of the digital operator.

Setting 2: Advanced Access Level (A) and Setup Access Level (S)

All parameters can be viewed and edited.

Notes on Parameter Access

- If the drive parameters are password protected by A1-04 and A1-05, parameters A1-00 through A1-03, A1-06, and all A2 parameters cannot be modified.
- If a digital input terminal programmed for “Program lockout” (H1-□□ = 1B) is enabled, parameter values cannot be modified, even if A1-01 is set to 1 or 2.
- If parameters are changed via serial communication, it will not be possible to edit or change parameter settings with the digital operator until an Enter command is issued to the drive from the serial communication.

■ A1-03: Initialize Parameters

Resets parameters to default values or performs an Application Preset for fan or pump applications. After initialization, the setting for A1-03 automatically returns to 0.

No.	Parameter Name	Setting Range	Default
A1-03	Initialize Parameters	0, 1110, 2220, 3330, 5550, 8008, 8009, 8010, 8011	0

Setting 1110: User Initialize

Resets parameters to the values selected by the user as User Settings. User Settings are stored when parameter o2-03 is set to "1: Set defaults".

Note: User Initialization resets all parameters to a user-defined set of default values previously saved to the drive. Set parameter o2-03 to 2 to clear the user-defined default values.

Setting 2220: 2-Wire Initialization

Resets parameters to default settings with digital inputs S1 and S2 configured as Forward run and Reverse run, respectively. *Refer to Setting 40, 41: Forward Run, Reverse Run Command for 2-Wire Sequence on page 201* for more information on digital input functions.

Setting 3330: 3-Wire Initialization

Resets parameters to default settings with digital inputs S1, S2, and S5 configured as Run, Stop, and Forward/Reverse respectively. *Refer to Setting 0: 3-Wire Sequence on page 195* for more information on digital input functions.

Notes on Parameter Initialization

The parameters shown in *Table 5.1* will not be reset when the drive is initialized by setting A1-03 = 2220 or 3330.

Table 5.1 Parameters Not Changed by Drive Initialization

No.	Parameter Name
A1-00	Language Selection
E1-03	V/f Pattern Selection
F6-08	Communication Parameter Reset
L8-35	Installation Selection
o2-04	Drive/kVA Selection

Setting 5550: Terminal/Control Initialize

An oPE04 error appears on the digital operator when a terminal block with settings saved to its built-in memory is installed in a drive that has edited parameters. Set A1-03 to 5550 to use the parameter settings saved to the terminal block memory.

Setting 8008: Pump

Application Preset for pump applications. *Refer to Application Selection on page 116* for a list of parameters and default values for this Application Preset.

Setting 8009: Pump w/ PI

Application Preset for pump applications. *Refer to Application Selection on page 116* for a list of parameters and default values for this Application Preset.

Setting 8010: Fan

Application Preset for pump applications. *Refer to Application Selection on page 116* for a list of parameters and default values for this Application Preset.

Setting 8011: Fan w/ PI

Application Preset for pump applications. *Refer to Application Selection on page 116* for a list of parameters and default values for this Application Preset.

■ A1-04, A1-05: Password and Password Setting

Parameter A1-04 enters the password when the drive is locked; parameter A1-05 is a hidden parameter that sets the password.

No.	Parameter Name	Setting Range	Default
A1-04	Password	0000 to 9999	0000
A1-05	Password Setting		

How to Use the Password

The user can set a password in parameter A1-05 to restrict access to the drive. The password must be entered to A1-04 to unlock parameter access (i.e., parameter setting A1-04 must match the value programmed into A1-05). The following parameters cannot be viewed or edited until the value entered to A1-04 correctly matches the value set to A1-05: A1-01,A1-03, A1-06, and A2-01 through A2-33.

The instructions below demonstrate how to set password "1234". An explanation follows on how to enter that password to unlock the parameters.

Table 5.2 Setting the Password for Parameter Lock

	Step		Display/Result
1.	Turn on the power to the drive. The initial display appears.	➡	- MODE - DRV Rdy Freq Ref (AI) U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00 A LREF JOG FWD
2.	Press ∧ or ∨ until the Parameter Setting Mode screen appears.	➡	- MODE - PRG Programming HELP FWD DATA
3.	Press ENTER to enter the parameter menu tree.	➡	-PRMSET- PRG Initialization A1-00= 0 Select Language ← FWD →
4.	Select the flashing digits by pressing F1, F2, or RESET.	➡	-PRMSET- PRG Select Language A1-00= 0 *0* English ← FWD →
5.	Select A1-04 by pressing ∧ .	➡	-PRMSET- PRG Enter Password A1- 04 = 0 (0~9999) “0” ← FWD →
6.	Press ∧ while holding down OFF at the same time. A1-05 will appear. **Note:** A1-05 is hidden and will not display by pressing only ∧ .	➡	-PRMSET- PRG Select Password A1- 05 = 0 (0~9999) “0” ← FWD →
7.	Press ENTER.	➡	-PRMSET- PRG Select Password A1- 05 = 0000 (0~9999) “0” ← FWD →
8.	Use F1, F2, RESET, ∨ and ∧ to enter the password.	➡	-PRMSET- PRG Select Password A1- 05 = 1234 (0~9999) “0” ← FWD →
9.	Press ENTER to save what was entered.	➡	Entry Accepted
10.	The display automatically returns to the display shown in step 6.	➡	-PRMSET- PRG Select Password A1- 05 = 0 (0~9999) “0” ← FWD →

Table 5.3 Check if A1-03 Init Parameters is Locked (continuing from step 10 above)

	Step		Display/Result
1.	Press ∨ to display A1-03.	➡	-PRMSET- PRG Init Parameters A1-03= 0 *0* No Initialize ← FWD →
2.	Press ENTER, making sure that the setting values cannot be changed.		

	Step		Display/Result
3.	Press ESC to return to the first display.	➡	- MODE - PRG Programming HELP FWD DATA

Table 5.4 Enter the Password to Unlock Parameters (continuing from step 3 above)

	Step		Display/Result
1.	Press ENTER to enter the parameter setup display.	➡	-PRMSET- PRG Initialization A1-00= 0 Select Language ← FWD →
2.	Press F1, F2, RESET to select the flashing digits as shown.	➡	-PRMSET- PRG Select Language A1-00= 0 *0* English ← FWD →
3.	Press ∧ to scroll to A1-04 and ENTER.	➡	-PRMSET- PRG Enter Password A1- 04 = 0 (0~9999) "0" ← FWD →
4.	Enter the password "1234".	➡	-PRMSET- PRG Enter Password A1-04= 1234 V/f Control ← FWD →
5.	Press ENTER to save the new password.	➡	Entry Accepted
6.	Drive returns to the parameter display.	➡	-PRMSET- PRG Enter Password A1- 04 = 0 (0~9999) "0" ← FWD →
7.	Press ∨ and scroll to A1-03.	➡	-PRMSET- PRG Init Parameters A1-03= 0 *0* No Initialize ← FWD →
8.	Press ENTER to display the value set to A1-03. If the first "0" blinks, parameter settings are unlocked.	➡	-PRMSET- PRG Init Parameters A1-03= 0 *0* No Initialize ← FWD →
9.	Use RESET and ∧ to change the value if desired (though changing the Init Parameters at this point is not typically done).	➡	-PRMSET- PRG Init Parameters A1-03= 2220 *0* 2-Wire Initial "0" ← FWD →
10.	Press ENTER to save the setting, or press ESC to return to the previous display without saving changes.	➡	Entry Accepted
11.	The display automatically returns to the parameter display.	➡	-PRMSET- PRG Init Parameters A1-03= 0 *0* No Initialize ← FWD →

Note: **1.** Parameter settings can be edited after entering the correct password.
2. Performing a 2-Wire or 3-Wire initialization resets the password to "0000".

■ A1-06: Application Preset

Several Application Presets are available to facilitate drive setup for commonly used applications. Selecting one of these Application Presets automatically assigns functions to the input and output terminals and sets a predefined group of parameters to values appropriate for the selected application.

In addition, the parameters most likely to be changed are assigned to the group of User Parameters, A2-01 through A2-16. User Parameters are part of the Setup Group, which provides quicker access by eliminating the need to scroll through multiple menus.

◆ A2: User Parameters

■ A2-01 to A2-32: User Parameters 1 to 32

The user can select up to 32 parameters and assign them to parameters A2-01 through A2-32 to provide quicker access by eliminating the need to scroll through multiple menus. The User Parameter list can also save the most recently edited parameters.

No.	Parameter Name	Setting Range	Default
A2-01 to A2-32	User Parameters 1 to 32	b1-01 to s6–07	Determined by A1-03

Saving User Parameters

To save specific parameters to A2-01 through A2-32, set parameter A1-01 to 2 to allow access to all parameters, then enter the parameter number to one of the A2-☐☐ parameters to assign it to the list of User Parameters. Finally, set A1-01 to 1 to restrict access so users can only set and refer to the parameters saved as User Parameters.

■ A2-33: User Parameter Automatic Selection

Determines whether recently edited parameters are saved to the second half of the User Parameters (A2-17 to A2-32) for quicker access.

No.	Parameter Name	Setting Range	Default
A2-33	User Parameter Automatic Selection	0, 1	0

Setting 0: Do not save list of recently edited parameters

Set A2-33 to 0 to manually select the parameters listed in the User Parameter group.

Setting 1: Save list of recently edited parameters

Set A2-33 to 1 to automatically save recently edited parameters to A2-17 through A2-32. A total of 16 parameters are saved with the most recently edited parameter set to A2-17, the second most recently to A2-18, and so on. Access the User Parameters using the Setup Mode of the digital operator.

5.2 b: Application

◆ b1: Operation Mode Selection

■ b1-01: Frequency Reference Selection 1

Selects the frequency reference source 1 for the REMOTE mode.

Note:
1. If a Run command is input to the drive but the frequency reference entered is 0 or below the minimum frequency, the RUN indicator LED on the digital operator will light and the STOP indicator will flash.
2. Press the LO/RE key to set the drive to LOCAL and use the operator keypad to enter the frequency reference.

No.	Parameter Name	Setting Range	Default
b1-01	Frequency Reference Selection 1	0 to 4	1

Setting 0: Operator keypad

Using this setting, the frequency reference can be input by:
- switching between the multi-speed references in the d1-☐☐ parameters.
- entering the frequency reference on the operator keypad.

Setting 1: Terminals (analog input terminals)

Using this setting, an analog frequency reference can be entered as a voltage or current signal from terminals A1, A2, or A3.

Voltage Input

Voltage input can be used at any of the three analog input terminals. Make the settings as described in ***Table 5.5*** for the input used.

Table 5.5 Analog Input Settings for Frequency Reference Using Voltage Signals

Terminal	Signal Level	Parameter Settings				Notes
		Signal Level Selection	Function Selection	Gain	Bias	
A1	0 to 10 Vdc	H3-01 = 0	H3-02 = 0 (Frequency Reference Bias)	H3-03	H3-04	–
	-10 to +10 Vdc	H3-01 = 1				
A2	0 to 10 Vdc	H3-09 = 0	H3-10 = 0 (Frequency Reference Bias)	H3-11	H3-12	Set jumper S1 on the terminal board to “V” for voltage input.
	-10 to +10 Vdc	H3-09 = 1				
A3	0 to 10 Vdc	H3-05 = 0	H3-06 = 0 (Frequency Reference Bias)	H3-07	H3-08	Set DIP switch S4 on the terminal board to “AI”.
	-10 to +10 Vdc	H3-05 = 1				

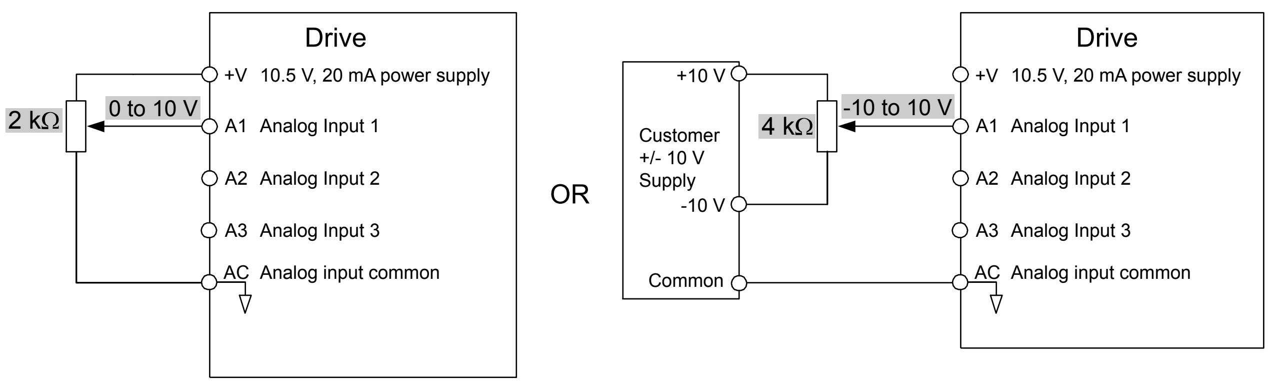

Figure 5.1 Setting the Frequency Reference as a Voltage Signal at Terminal A1

Current Input

Input terminals, A1, A2, and A3 can accept a current input signal. Refer to ***Table 5.6*** for an example to set terminal A2 for current input.

Parameter Details

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Table 5.6 Analog Input Settings for Frequency Reference Using a Current Signal

Terminal	Signal Level	Parameter Settings				Notes
		Signal Level Selection	Function Selection	Gain	Bias	
A2	4 to 20 mA	H3-09 = 2	H3-10 = 0 (Frequency Bias)	H3-11	H3-12	Make sure to set jumper S1 on the terminal board to “I” for current input.
	0 to 20 mA	H3-09 = 3				

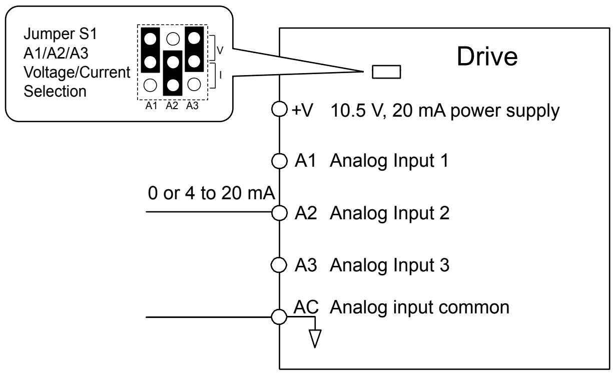


Figure 5.2 Setting the Frequency Reference as a Current Signal to Terminal A2

Switching between Main/Auxiliary Frequency References

The frequency reference input can be switched between the analog terminals A1, A2, and A3 using multi-speed inputs. ***Refer to Multi-Step Speed Selection on page 171*** for details on using this function.

Setting 2: MEMOBUS/Modbus Communications

This setting requires entering the frequency reference via the RS-485/422 serial communications port (control terminals R+, R-, S+, S-). ***Refer to MEMOBUS/Modbus Configuration on page 462*** for instructions.

Setting 3: Option card

This setting requires entering the frequency reference via an option board plugged into connector CN5-A on the drive control board. Consult the option board manual for instructions on integrating the drive with the communication system.

Note: If the frequency reference source is set for Option PCB (b1-01 = 3), but an option board is not installed, an oPE05 Operator Programming Error will be displayed on the digital operator and the drive will not run.

Setting 4: Pulse Train Input

This setting requires a pulse train signal to terminal RP to provide the frequency reference. Follow the directions below to verify that the pulse signal is working properly.

Verifying the Pulse Train is Working Properly

- Set b1-04 to 4 and set H6-01 to 0.
- Set the H6-02 to the pulse train frequency value that equals 100% of the frequency reference.
- Enter a pulse train signal to terminal RP and check for the correct frequency reference on the display.

■ b1-02: Run Command Selection 1

Determines the Run command source 1 in the REMOTE mode.

No.	Parameter Name	Setting Range	Default
b1-02	Run Command Selection 1	0 to 3	1

Setting 0: Operator

This setting requires entering the Run command via the digital operator RUN key and also illuminates the LO/RE indicator on the digital operator.

Setting 1: Control Circuit Terminal

This setting requires entering the Run command via the digital input terminals using one of following sequences:

- 2-Wire sequence 1:

Two inputs (FWD/Stop-REV/Stop). Set A1-03 to 2220 to initialize the drive and preset terminals S1 and S2 to these functions. This is the default setting of the drive. *Refer to Setting 40, 41: Forward Run, Reverse Run Command for 2-Wire Sequence on page 201*.

- 2-Wire sequence 2:

Two inputs (Start/Stop-FWD/REV). *Refer to Setting 42, 43: Run and Direction Command for 2-Wire Sequence 2 on page 201*.

- 3-Wire sequence:

Three inputs (Start-Stop-FWD/REV). Set A1-03 to 3330 to initialize the drive and preset terminals S1, S2, and S5 to these functions. *Refer to Setting 0: 3-Wire Sequence on page 195*.

Setting 2: MEMOBUS/Modbus Communications

This setting requires entering the Run command via serial communications by connecting the RS-485/422 serial communication cable to control terminals R+, R-, S+, and S- on the removable terminal block. *Refer to MEMOBUS/Modbus Configuration on page 462* for instructions.

Setting 3: Option Card

This setting requires entering the Run command via the communication option board by plugging a communication option board into the CN5-A port on the control PCB. Refer to the option board manual for instructions on integrating the drive into the communication system.

Note: If b1-02 is set to 3, but an option board is not installed in CN5-A, an oPE05 operator programming error will be displayed on the digital operator and the drive will not run.

■ b1-03: Stopping Method Selection

Selects how the drive stops the motor when the Run command is removed or when a Stop command is entered.

No.	Parameter Name	Setting Range	Default
b1-03	Stopping Method Selection	0 to 3	0

Setting 0: Ramp to Stop

When the Run command is removed, the drive will decelerate the motor to stop. The deceleration rate is determined by the active deceleration time. The default deceleration time is set to parameter C1-02.

When the output frequency falls below the level set in parameter b2-01, the drive will start DC injection, Zero Speed Control, or Short Circuit Braking. *Refer to b2-01: DC Injection Braking Start Frequency on page 142* for details.

Setting 1: Coast to Stop

When the Run command is removed, the drive will shut off its output and the motor will coast (uncontrolled deceleration) to stop. The stopping time is determined by the inertia and the friction in the driven system.

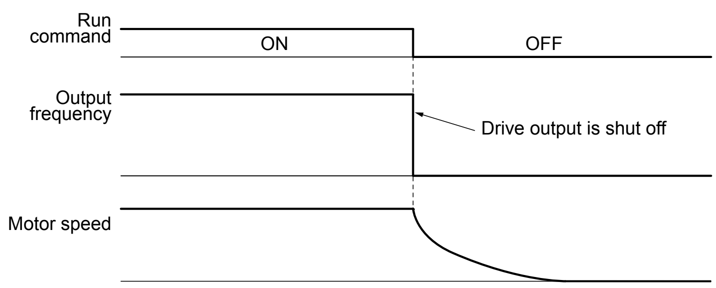


Figure 5.3 Coast to Stop

Note: After a stop is initiated, any subsequent Run command entered will be ignored until the minimum baseblock time (L2-03) has expired. Do not enter Run command until it has come to a complete stop. Use DC Injection at Start (*Refer to b2-03: DC Injection Braking Time at Start on page 143*) or Speed Search (*Refer to b3: Speed Search on page 143*) to restart the motor before it has completely stopped.

Setting 2: DC Injection Braking to Stop

When the Run command is removed, the drive will enter baseblock (turn off its output) for the minimum baseblock time (L2-03). When the minimum baseblock time has expired, the drive will inject the amount DC Injection Braking is set in parameter b2-02 into the motor windings to brake the motor. The stopping time in DC Injection Braking to Stop is significantly faster compared to Coast to Stop.

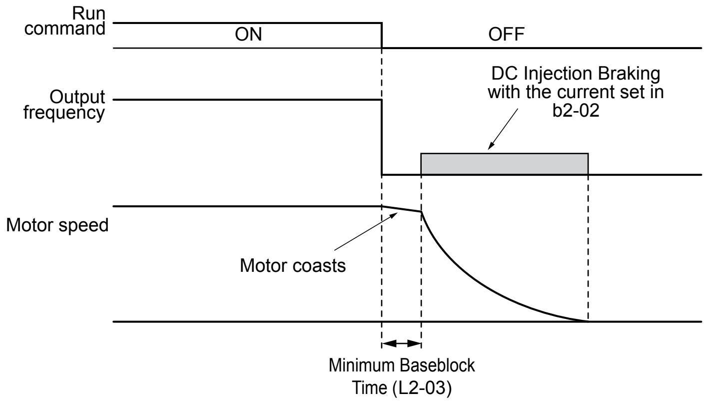


Figure 5.4 DC Injection Braking to Stop

DC Injection Braking time is determined by the value set to b2-04 and the output frequency at the time the Run command is removed. It can be calculated by:

$$\text{DC Injection brake time} = \frac{\text{(b2-04) x 10 x Output frequency}}{\text{Max. output frequency (E1-04)}}$$

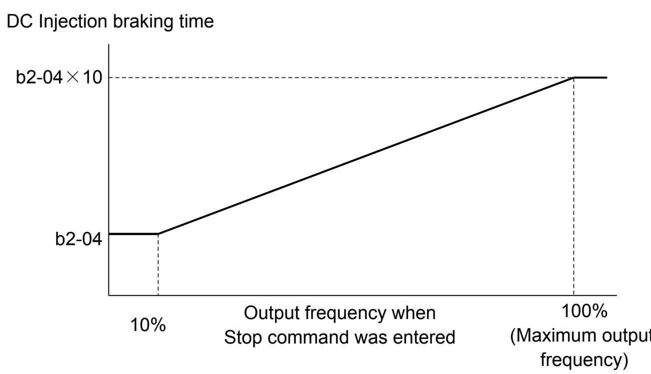


Figure 5.5 DC Injection Braking Time Depending on Output Frequency

Note: If an overcurrent (oC) fault occurs during DC Injection Braking to Stop, lengthen the minimum baseblock time (L2-03) until the fault no longer occurs.

Setting 3: Coast to Stop with Timer

When the Run command is removed, the drive will turn off its output and the motor will coast to stop. The drive will not start if a Run command is input before the time t (C1-02) has expired. Cycle the Run command that was activated during time t after t has expired to start the drive.

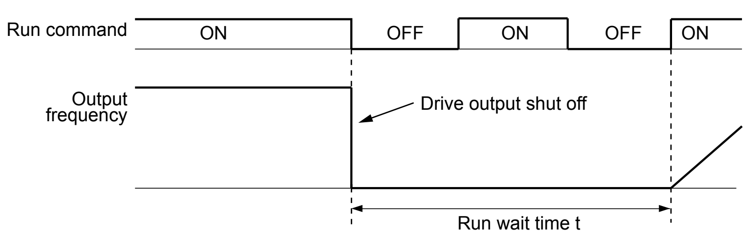


Figure 5.6 Coast to Stop with Timer

The wait time t is determined by the output frequency when the Run command is removed and by the active deceleration time.

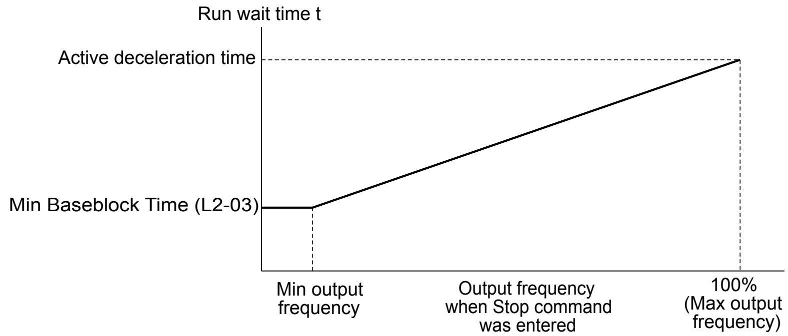


Figure 5.7 Run Wait Time Depending on Output Frequency

■ b1-04: Reverse Operation Selection

Enables and disables Reverse operation. For some applications, reverse motor rotation is not appropriate and may cause problems (e.g., air handling units, pumps, etc.).

No.	Parameter Name	Setting Range	Default
b1-04	Reverse Operation Selection	0, 1	0

Setting 0: Reverse operation enabled

Possible to operate the motor in both forward and reverse directions.

Setting 1: Reverse operation disabled

Drive disregards a Reverse run command or a negative frequency reference.

■ b1-07: LOCAL/REMOTE Run Selection

The drive has three separate control sources that can be switched using digital inputs (H1-□□ = 1 (LOCAL/REMOTE Selection) or 2 (External reference 1/2)) or the LO/RE key on the digital operator. ***Refer to Setting 1: LOCAL/REMOTE Selection on page 195***, ***Refer to Setting 2: External Reference 1/2 Selection on page 196*** and ***Refer to o2-01: LO/RE (LOCAL/REMOTE) Key Function Selection on page 254*** for details.

- LOCAL: Digital operator. The digital operator sets the frequency reference and Run command.
- REMOTE: External reference 1. The frequency reference and Run command source are set by b1-01 and b1-02.
- REMOTE: External reference 2. The frequency reference and Run command source are set by b1-15 and b1-16.

When switching from LOCAL to REMOTE, or between External reference 1 and External reference 2, the Run command may already be present at the location at which the source is being switched. In this case, use parameter b1-07 to determine how the Run command is treated.

No.	Parameter Name	Setting Range	Default
b1-07	LOCAL/REMOTE Run Selection	0, 1	0

Setting 0: Run command must be cycled

When the Run command source differs between the old source and the new source (e.g., the old source was the terminals and the new source is serial communication), and the Run command is active at the new source as the switchover occurs, the drive will not start or the drive will stop operation if it was previously running. The Run command must be cycled at the new source to restart the drive.

Setting 1: Accept Run command at the new source

When the Run command is active at the new source, the drive starts or continues operation if it was previously running.

WARNING! *Sudden Movement Hazard. The drive may start unexpectedly if switching control sources when b1-07 = 1. Clear all personnel from rotating machinery and electrical connections prior to switching control sources. Failure to comply may cause death or serious injury.*

■ b1-08: Run command selection while in Programming Mode

As a safety precaution, the drive will not normally respond to a Run command input when the digital operator is being used to adjust parameters in Programming Mode (Verify Menu, Setup Mode, Parameter Settings Mode, and Auto-Tuning Mode). If required by the application, set b1-08 to allow the drive to run while in Programming Mode.

No.	Parameter Name	Setting Range	Default
b1-08	Run Command Selection while in Programming Mode	0 to 2	0

Setting 0: Disabled

A Run command is not accepted while the digital operator is in Programming Mode.

Setting 1: Enabled

A Run command is accepted in any digital operator mode.

Setting 2: Prohibit programming during run

It is not possible to enter the Programming Mode as long as the drive output is active. The Programming Mode cannot be displayed during Run.

■ b1-11: Drive Delay Time Setting

If a time is set to b1-11, the drive will delay executing a Run command until the set time has expired. During Drive Delay Time execution, the digital operator keypad will display “WrUn”. Both Alarm and Run indicators will blink while the drive waits to execute the Run command.

No.	Parameter Name	Setting Range	Default
b1-11	Drive Delay Time Setting	0 to 600 s	0

■ b1-14: Phase Order Selection

Sets the phase order for drive output terminals U/T1, V/T2, and W/T3.

Switching motor phases will reverse the direction of the motor.

No.	Parameter Name	Setting Range	Default
b1-14	Phase Order Selection	0, 1	0

■ b1-15: Frequency Reference Selection 2

Enabled when H1-□□ = 2 and the terminal is closed. ***Refer to Setting 2: External Reference 1/2 Selection on page 196*** and ***Refer to b1-02: Run Command Selection 1 on page 138*** for details.

No.	Parameter Name	Setting Range	Default
b1-15	Frequency Reference Selection 2	0 to 4	0

■ b1-16: Run Command Selection 2

Enabled when H1-□□ = 2 and the terminal is closed. ***Refer to Setting 2: External Reference 1/2 Selection on page 196*** and ***Refer to b1-01: Frequency Reference Selection 1 on page 137*** for details.

No.	Parameter Name	Setting Range	Default
b1-16	Run Command Selection 2	0 to 3	0

■ b1-17: Run Command at Power Up

Determines whether an external Run command that is active during power up will start the drive.

No.	Parameter Name	Setting Range	Default
b1-17	Run Command at Power Up	0, 1	

◆ b2: DC Injection Braking and Short Circuit Braking

These parameters determine operation of the DC Injection Braking, Zero Speed Control, and Short Circuit Braking features.

■ b2-01: DC Injection Braking Start Frequency

Active when “Ramp to Stop” is selected as the stopping method (b1-03 = 0).

No.	Name	Setting Range	Default
b2-01	DC Injection Braking Start Frequency	0.0 to 10.0 Hz	0.5

V/f Control

Sets the starting frequency for DC Injection Braking at Stop. When the output frequency falls below the setting of b2-01, DC Injection Braking is enabled for the time set in parameter b2-04.

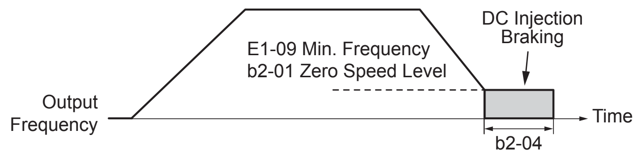


Figure 5.8 DC Injection Braking at Stop for V/f

Note: If b2-01 is set to a smaller value than E1-09 (Minimum Frequency), then DC Injection Braking will begin when the frequency falls to the E1-09 value.

■ b2-02: DC Injection Braking Current

Sets the DC Injection Braking current as a percentage of the drive rated current. The carrier frequency is automatically reduced to 1 kHz when this parameter is set to more than 50%.

No.	Name	Setting Range	Default
b2-02	DC Injection Braking Current	0 to 100%	50%

■ b2-03: DC Injection Braking Time at Start

Sets DC Injection Braking time at start. Disabled when set to 0.00 s.

No.	Name	Setting Range	Default
b2-03	DC Injection Braking Time at Start	0.00 to 10.00 s	0.00 s

■ b2-04: DC Injection Braking Time at Stop

Sets DC Injection Braking time at stop.

No.	Name	Setting Range	Default
b2-04	DC Injection Braking Time at Stop	0.00 to 10.00 s	0.50 s

◆ b3: Speed Search

The Speed Search function allows the drive to detect the speed of a rotating motor shaft that is driven by external forces and start the motor operation directly from the detected speed without first stopping the machine.

Example: When a momentary loss of power occurs, the drive output shuts off and the motor coasts. When power returns, the drive can find the speed of the coasting motor and restart it directly.

For induction motors, the drive offers two types of Speed Search than can be selected by parameter b3-24 (Speed Estimation and Current Detection). Both methods are explained below and followed by a description of all relevant parameters.

■ Current Detection Speed Search (b3-24 = 0)

Current Detection Speed Search detects the motor speed by looking at motor current in IM motors. When Speed Search is started it reduces the output frequency starting from either the maximum output frequency or the frequency reference while increasing the output voltage using the time set in parameter L2-04. As long as the current is higher than the level set to b3-02, the output frequency is lowered using the time constant set to b3-03. If the current falls below b3-02, the drive assumes that the output frequency and motor speed are the same and accelerates or decelerates to the frequency reference.

Be aware that sudden acceleration may occur when using this method of Speed Search with relatively light loads.

Figure 5.9 illustrates Current Detection Speed Search operation after a momentary power loss (L2-01 must be set to 1 or 2):

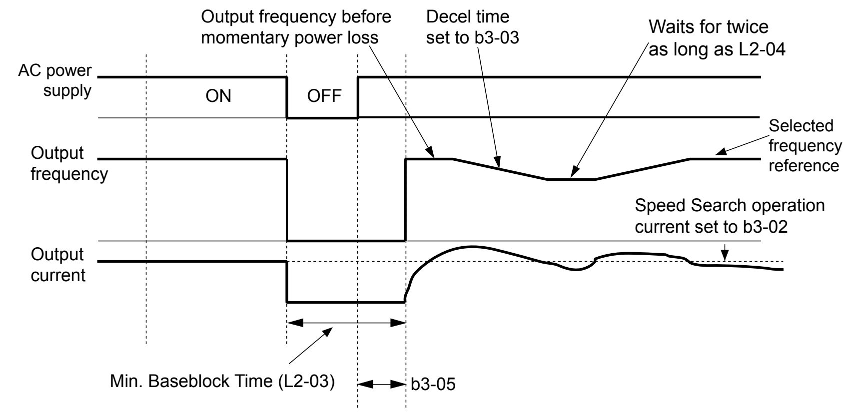


Figure 5.9 Current Detection Speed Search after Power Loss

Note: After power is restored, the drive waits until the time set to b3-05 has passed before performing Speed Search. Thereby the Speed Search may start not at the end of L2-03 but even later.

When Speed Search is applied automatically with the Run command, the drive waits for the minimum baseblock time set to L2-03 before starting Speed Search. If L2-03 is lower than the time set to parameter b3-05, then b3-05 is used as the wait time.

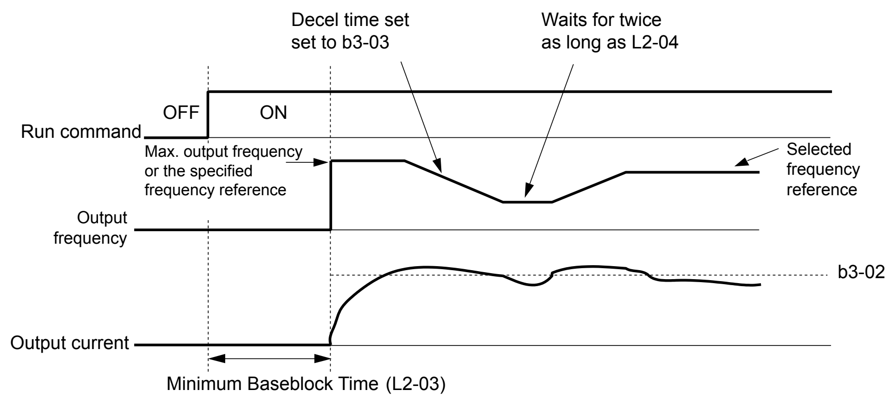


Figure 5.10 Current Detection Speed Search at Start or Speed Search Command by Digital Input

Notes on Using Current Detection Type Speed Search

- Shorten the Speed Search deceleration time set to b3-03 if an oL1 fault occurs while performing Current Detection Speed Search.
- Increase the minimum baseblock time set to L2-03 if an overcurrent or overvoltage fault occurs when performing Speed Search after power is restored following a momentary power loss.

■ Speed Estimation Type Speed Search (b3-24 = 1)

This method can be used for a single induction motor connected to a drive. Do not use this method if the motor is one or more frame size smaller than the drive, at motor speeds above 200 Hz, or when using a single drive to operate more than one motor.

Speed Estimation is executed in the two steps described below:

Step 1: Back EMF Voltage Estimation

This method is used by Speed Search after baseblock (e.g., a power loss where the drive CPU continued to run and the Run command was kept active). Here, the drive estimates the motor speed by analyzing the back EMF voltage and outputs the estimated frequency and increases the voltage using the time constant set in parameter L2-04. After that, the motor is accelerated or decelerated to the frequency reference starting from the detected speed. If there is not enough residual voltage in the motor windings to perform the calculations described above, the drive will automatically proceed to step 2.

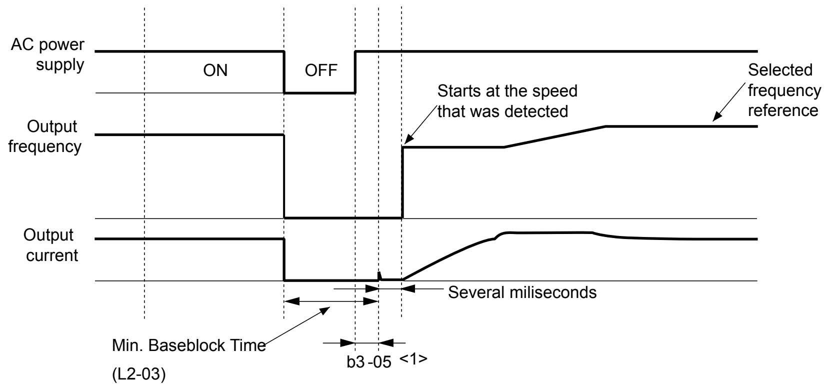


Figure 5.11 Speed Search after Baseblock

<1> After AC power is restored, the drive will wait for at least the time set to b3-05. If the power interruption is longer than the minimum baseblock time set to L2-03, the drive will wait until the time set to b3-05 has passed after power is restored before starting Speed Search.

Step 2: Current Injection

Current Injection is performed when there is insufficient residual voltage in the motor after extended power losses, when Speed Search is applied with the Run command (b3-01 = 1), or when an External search command is used.

This feature injects the amount of DC current set to b3-06 to the motor and detects the speed by measuring the current feedback. The drive then outputs the detected frequency and increases the voltage using the time constant set to parameter L2-04 while looking at the motor current.

The output frequency is reduced if the current is higher than the level in b3-02. When the current falls below b3-02, the motor speed is assumed to be found and the drive starts to accelerate or decelerate to the frequency reference.

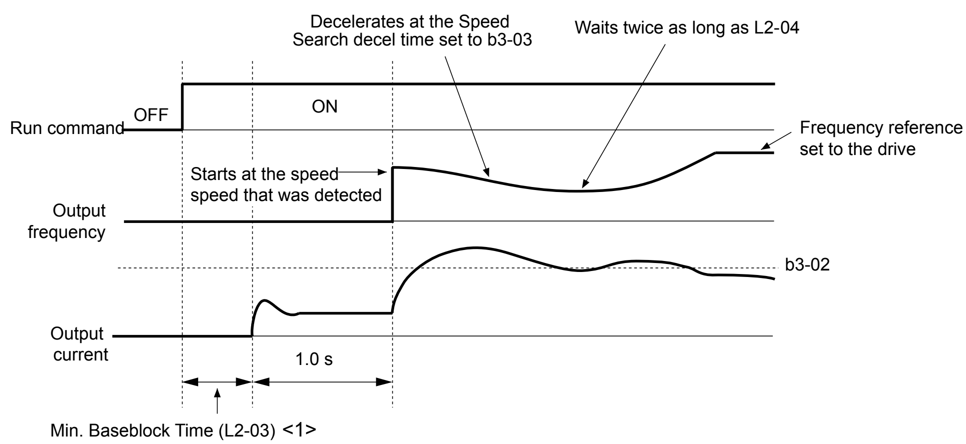


Figure 5.12 Speed Search at Start

<1> The wait time for Speed Search (b3-05) determines the lower limit.

Notes on Using Speed Estimation Speed Search

- Perform Rotational Auto-Tuning for V/f Control (T1-01 = 3) prior to using Speed Estimation in V/f Control and perform Stationary Auto-Tuning for Line-to-Line Resistance (T1-01 = 2) again if the there is a change in the cable length between the drive and motor.
- Use Current Detection to search for speeds beyond 200 Hz if the application is running multiple motors from the same drive or if the motor is considerably smaller than the capacity of the drive.
- Speed Estimation may have trouble finding the actual speed if the motor cable is very long. Use Current Detection in these instances.
- Use Current Detection instead of Speed Estimation when operating motors smaller than 1.5 kW because Speed Estimation might not be able to detect the speed or rotation of these smaller motors, in which case Speed Estimation would stop the motor.

Speed Search Activation

Speed Search can be activated using any of the methods 1 through 5 described below. The Speed Search type must be selected in parameter b3-24 independent of the activation method.

Method 1. Automatically activate Speed Search with every Run command. External Speed Search commands are ignored.

Method 2. Activate Speed Search using the digital input terminals.

Use the input functions for H1-☐☐ in *Table 5.7*.

Table 5.7 Speed Search Activation by Digital Inputs

Setting	Description	b3-24 = 0	b3-24 = 1
61	External Search Command 1	Closed: Activate Current Detection Speed Search from the maximum output frequency (E1-04).	Activate Speed Estimation Speed Search
62	External Search Command 2	Closed: Activate Current Detection Speed Search from the frequency reference.	

To activate Speed Search by a digital input, the input must be set together with the Run command or the Run command must be entered after giving the Speed Search command.

Method 3. After automatic fault restart.

When the number of maximum fault restarts in parameter L5-01 is set higher than 0, the drive will automatically perform Speed Search as specified by b3-24 following a fault.

Method 4. After momentary power loss.

This mode requires that the Power Loss Ride-Thru function is enabled during CPU operation (L2-01 = 1 or 2). *Refer to L2-01: Momentary Power Loss Operation Selection on page 227*.

Method 5. After external baseblock is released.

The drive will resume the operation starting with Speed Search if the Run command is present and the output frequency is above the minimum frequency when the Baseblock command (H1-☐☐ = 8 or 9) is released. For this operation mode, set the operation during an external Baseblock command to hold the output frequency (H1-13 = 0).

b3-01: Speed Search Selection at Start

Determines if Speed Search is automatically performed when a Run command is issued.

No.	Parameter Name	Setting Range	Default
b3-01	Speed Search Selection at Start	0, 1	0

Setting 0: Disabled

This setting starts operating the drive at the minimum output frequency when the Run command is entered. If external Speed Search 1 or 2 is already enabled by a digital input, the drive will start operating with Speed Search.

Setting 1: Enabled

This setting performs Speed Search when the Run command is entered. The drive begins running the motor after Speed Search is complete.

b3-02: Speed Search Deactivation Current

Sets the operating current for Speed Search as a percentage of the drive rated current. Normally there is no need to change this setting. Lower this value if the drive has trouble restarting.

No.	Name	Setting Range	Default
b3-02	Speed Search Deactivation Current	0 to 200%	120%

b3-03: Speed Search Deceleration Time

Sets the output frequency reduction ramp used by Current Detection Speed Search (b3-24 = 0) and by the Current Injection Method of Speed Estimation (b3-24 = 1). The time entered into b3-03 will be the time to decelerate from maximum frequency (E1-04) to minimum frequency (E1-09).

No.	Name	Setting Range	Default
b3-03	Speed Search Deceleration Time	0.1 to 10.0 s	2.0 s

■ b3-04: V/f Gain During Speed Search

During Speed Search, the output voltage calculated from the V/f pattern is multiplied with this value. Changing this value can help reduce the output current during Speed Search.

No.	Name	Setting Range	Default
b3-04	V/f Gain During Speed Search	10 to 100%	Determined by o2-04

■ b3-05: Speed Search Delay Time

In cases where an output contactor is used between the drive and the motor, the contactor must be closed before Speed Search can be performed. This parameter can be used to delay the Speed Search operation, giving the contactor enough time to close completely.

No.	Name	Setting Range	Default
b3-05	Speed Search Delay Time	0.0 to 100.0 s	0.2 s

■ b3-06: Output Current 1 During Speed Search

Sets the current injected to the motor at the beginning of Speed Estimation Speed Search as a coefficient for the motor rated current.

No.	Name	Setting Range	Default
b3-06	Output Current 1 during Speed Search	0.0 to 2.0	Determined by o2-04

■ b3-07: Output Current 2 during Speed Search (Speed Estimation Type)

Sets the amount of output current during Speed Estimation Speed Search as a coefficient for the no-load current. Output current during Speed Search is automatically limited by the drive rated current. Increase this setting value in increments of 0.1 if the drive fails to perform Speed Estimation

No.	Name	Setting Range	Default
b3-07	Output Current 2 during Speed Search (Speed Estimation Type)	0.0 to 5.0	Determined by o2-04

■ b3-08: Current Control Gain during Speed Search (Speed Estimation Type)

Sets the proportional gain for the current controller during Speed Search.

No.	Name	Setting Range	Default
b3-08	Current Control Gain during Speed Search (Speed Estimation Type)	0.00 to 6.00	0.8

■ b3-10: Speed Search Detection Compensation Gain

Sets the gain for the detected motor speed of the Speed Estimation Speed Search. Increase the setting only if an overvoltage fault occurs when the drive restarts the motor.

No.	Name	Setting Range	Default
b3-10	Speed Search Detection Compensation Gain	1.00 to 1.20	1.05

■ b3-12: Minimum Current Detection Level during Speed Search

Sets the minimum current detection level during Speed Search. Increase this setting value in increments of 0.1 if the drive fails to perform Speed Estimation.

No.	Name	Setting Range	Default
b3-12	Minimum Current Detection Level during Speed Search	2.0 to 10.0	6.0

■ b3-14: Bi-Directional Speed Search Selection

Sets how the drive determines the motor rotation direction when performing Speed Estimation Speed Search.

No.	Parameter Name	Setting Range	Default
b3-14	Bi-Directional Speed Search Selection	0, 1	1

Setting 0: Disabled

The drive uses the frequency reference to determine the direction of motor rotation to restart the motor.

Setting 1: Enabled

The drive detects the motor rotation direction to restart the motor.

■ b3-17: Speed Search Restart Current Level

Sets the current level at which Speed Estimation is restarted as a percentage of drive rated current to avoid overcurrent and overvoltage problems since a large current can flow into the drive if the difference between the estimated frequency and the actual motor speed is too big when performing Speed Estimation.

No.	Name	Setting Range	Default
b3-17	Speed Search Restart Current Level	0 to 200%	

■ b3-18: Speed Search Restart Detection Time

Sets the time for which the current must be above the level set in b3-17 before restarting Speed Search.

No.	Name	Setting Range	Default
b3-18	Speed Search Restart Detection Time	0.00 to 1.00 s	0.10 s

■ b3-19: Number of Speed Search Restarts

Sets the number of times the drive should attempt to find the speed and restart the motor. If the number of restart attempts exceeds the value set to b3-19, the SEr fault will occur and the drive will stop.

No.	Name	Setting Range	Default
b3-19	Number of Speed Search Restarts	0 to 10	3

■ b3-24: Speed Search Method Selection

Sets the Speed Search method used.

No.	Parameter Name	Setting Range	Default
b3-24	Speed Search Method Selection	0, 1	0

■ b3-25: Speed Search Wait Time

Sets the wait time between Speed Search restarts. Increase the wait time if problems occur with overcurrent, overvoltage, or if the SEr fault occurs.

No.	Name	Setting Range	Default
b3-25	Speed Search Wait Time	0.0 to 30.0 s	0.5 s

■ b3-26: Direction Determining Level

Sets the level that determines the direction of motor rotation. Increase this value if the drive fails to detect the direction of the motor correctly.

No.	Name	Setting Range	Default
b3-26	Direction Determining Level	40 to 60000	Determined by o2-04

■ b3-27: Start Speed Search Select

Selects a condition to activate Speed Search Selection at Start (b3-01) or External Speed Search Command 1 or 2 from the multi-function input.

No.	Name	Setting Range	Default
b3-27	Start Speed Search Select	0, 1	0

Setting 0: Triggered when a Run Command Is Issued (Normal)

Setting 1: Triggered when an External Baseblock Is Released

◆ b4: Delay Timers

The timer function is independent of drive operation and can delay the switching of a digital output triggered by a digital input signal and help eliminate chattering switch noise from sensors. An on-delay and off-delay can be set separately.

To enable the timer function, set a multi-function input to “Timer input” (H1-☐☐ = 18) and set a multi-function output to “Timer output” (H2-☐☐ = 12). Only one timer can be used.

■ b4-01, b4-02: Timer Function On-Delay, Off-Delay Time

b4-01 sets the on-delay time for switching the timer output. b4-02 sets the off-delay time for switching the timer output.

No.	Name	Setting Range	Default
b4-01	Timer Function On-Delay Time	0.0 to 3000.0 s	0.0 s
b4-02	Timer Function Off-Delay Time	0.0 to 3000.0 s	0.0 s

■ Timer Function Operation

The timer function switches on when the timer function input closes for longer than the value set to b4-01. The timer function switches off when the timer function input is open for longer than the value set to b4-02. *Figure 5.13* illustrates the timer function operation:

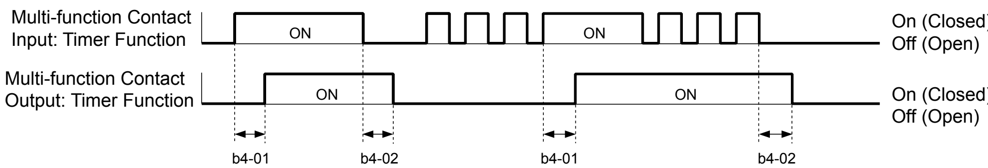


Figure 5.13 Timer Operation

◆ b5: PID Control

The drive has a built-in Proportional + Integral + Derivative (PID) controller that uses the difference between the target value and the feedback value to adjust the drive output frequency to minimize deviation and provide accurate closed loop control of system variables such as pressure or temperature.

■ P Control

The output of P control is the product of the deviation and the P gain so that it follows the deviation directly and linearly. With P control, only an offset between the target and feedback remains.

■ I Control

The output of I control is the integral of the deviation. It minimizes the offset between target and feedback value that typically remains when pure P control is used. The integral time (I time) constant determines how fast the offset is eliminated.

■ D Control

D control predicts the deviation signal by multiplying its derivative (slope of the deviation) with a time constant, then adds this value to the PID input. This way the D portion of a PID controller provides a braking action to the controller response and can reduce the tendency to oscillate and overshoot.

D control tends to amplify noise on the deviation signal, which can result in control instability. Only use D control when absolutely necessary.

■ PID Operation

To better demonstrate PID functionality, *Figure 5.14* illustrates how the PID output changes when the PID input (deviation) jumps from 0 to a constant level.

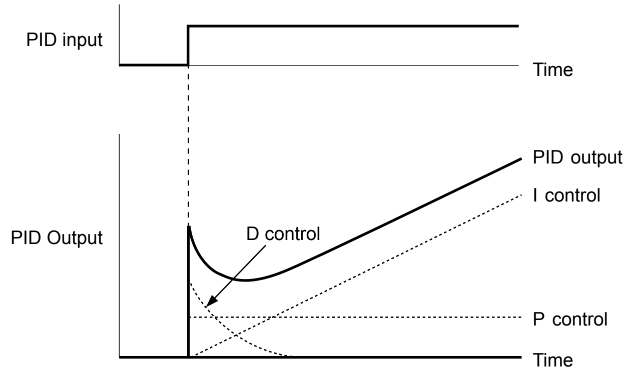


Figure 5.14 PID Operation

■ Using PID Control

Applications for PID control are listed in ***Table 5.8***.

Table 5.8 Using PID Control

Application	Description	Sensors Used
Speed Control	Machinery speed is fed back and adjusted to meet the target value. Synchronous control is performed using speed data from other machinery as the target value	Tachometer
Pressure	Maintains constant pressure using pressure feedback.	Pressure sensor
Fluid Control	Keeps flow at a constant level by feeding back flow data.	Flow rate sensor
Temperature Control	Maintains a constant temperature by controlling a fan with a thermostat.	Thermocoupler, Thermistor

■ PID Setpoint Input Methods

The PID setpoint input depends on the PID function setting in parameter b5-01.

If parameter b5-01 is set to 1 or 2, the frequency reference in b1-01 (or b1-15) or one of the inputs listed in ***Table 5.9*** becomes the PID setpoint.

If b5-01 is set to 3 or 4, then the PID setpoint can be input from one of the sources listed in ***Table 5.9***.

Table 5.9 PID Setpoint Sources

PID Setpoint Source	Settings
Analog Input A1	Set H3-02 = C
Analog Input A2	Set H3-10 = C
Analog Input A3	Set H3-06 = C
MEMOBUS/Modbus Register 0006 H	Set bit 1 in register 000F H to 1 and input the setpoint to register 0006 H
Pulse Input RP	Set H6-01 = 2
Parameter b5-19	Set parameter b5-18 = 1 and input the PID setpoint to b5-19

Note: A duplicate allocation of the PID setpoint input will cause an oPE alarm.

■ PID Feedback Input Methods

Input one feedback signal for normal PID control or input two feedback signals can for controlling a differential process value.

Normal PID Feedback

Input the PID feedback signal from one of the sources listed in ***Table 5.10***:

Table 5.10 PID Feedback Sources

PID Feedback Source	Settings
Analog Input A1	Set H3-02 = B
Analog Input A2	Set H3-10 = B
Analog Input A3	Set H3-06 = B

PID Feedback Source	Settings
Pulse Input RP	Set H6-01 = 1

Note: A duplicate allocation of the PID feedback input will cause an oPE alarm.

Differential Feedback

The second PID feedback signal for differential feedback can come from the sources listed in *Table 5.11*. The differential feedback function is automatically enabled when a differential feedback input is assigned.

Table 5.11 PID Differential Feedback Sources

PID Differential Feedback Source	Settings
Analog Input A1	Set H3-02 = 16
Analog Input A2	Set H3-10 = 16
Analog Input A3	Set H3-06 = 16

Note: A duplicate allocation of the PID differential feedback input will cause an oPE alarm.

■ PID Block Diagram

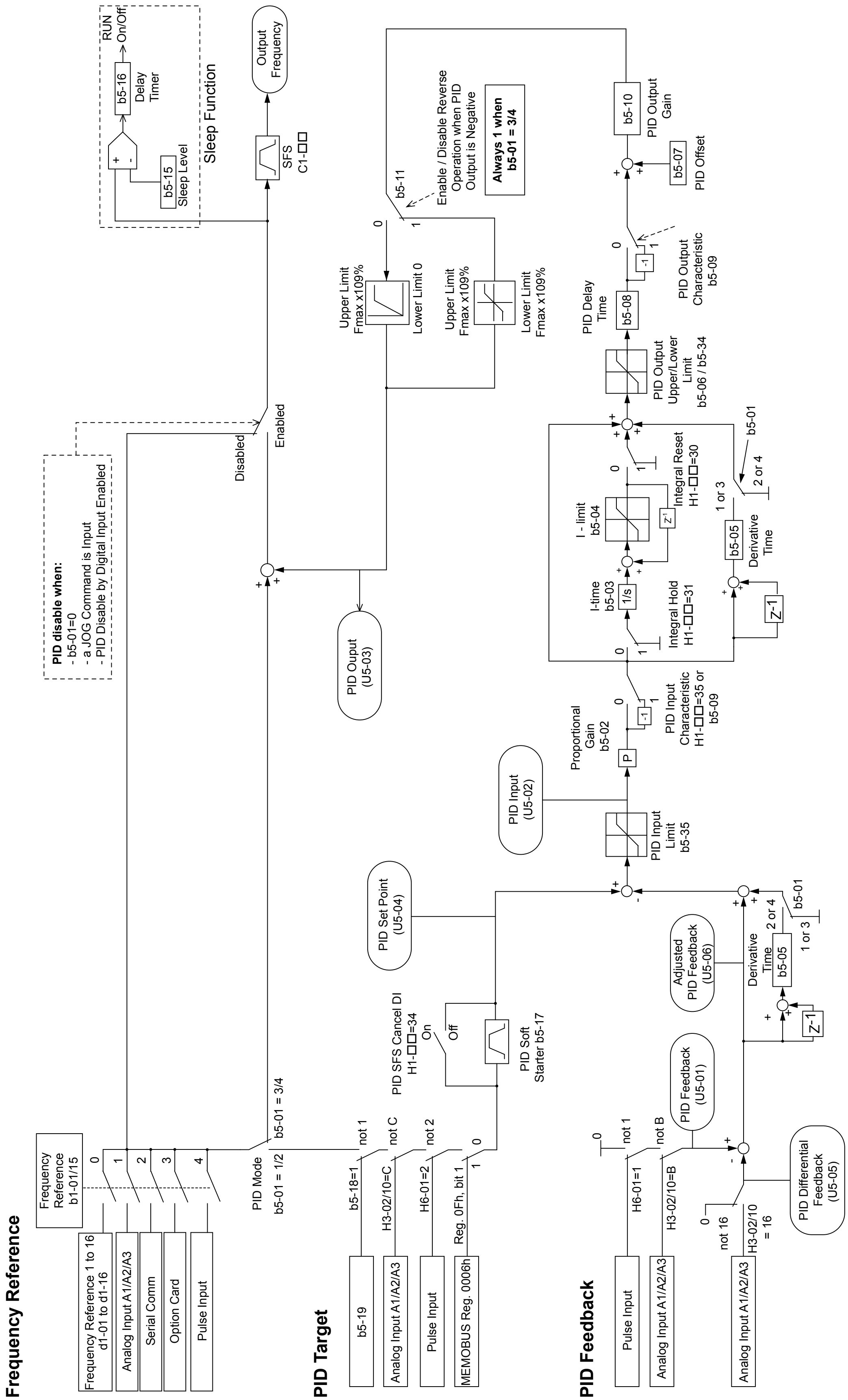


Figure 5.15 PID Block Diagram

■ b5-01: PID Function Setting

Enables and disables the PID operation and selects the PID operation mode.

No.	Parameter Name	Setting Range	Default
b5-01	PID Function Setting	0, 1	0

Setting 0: PID disabled

Setting 1: Output frequency = PID output 1

The PID controller is enabled and the PID output builds the frequency reference. The PID input is D controlled.

■ b5-02: Proportional Gain Setting (P)

Sets the P gain applied to the PID input. Larger values will tend to reduce the error but may cause oscillations if set too high, while lower values may allow too much offset between the setpoint and feedback.

No.	Name	Setting Range	Default
b5-02	Proportional Gain Setting (P)	0.00 to 25.00	1.00

■ b5-03: Integral Time Setting (I)

Sets the time constant used to calculate the integral of the PID input. The shorter the integral time set to b5-03, the faster the offset will be eliminated. If the integral time is set too short, however, overshoot or oscillation may occur. To turn off the integral time, set b5-03 to 0.00.

No.	Name	Setting Range	Default
b5-03	Integral Time Setting (I)	0.0 to 360.0 s	1.0 s

■ b5-04: Integral Limit Setting

Sets the maximum output possible from the integral block as a percentage of the maximum frequency (E1-04).

No.	Name	Setting Range	Default
b5-04	Integral Limit Setting	0.0 to 100.0%	100.0%

Note: On some applications, especially those with rapidly varying loads, the output of the PID function may show a fair amount of oscillation. Program b5-04 to apply a limit to the integral output and suppress this oscillation.

■ b5-05: Derivative Time (D)

Sets the time the drive predicts the PID input/PID feedback signal based on the derivative of the PID input/PID feedback. Longer time settings improve the response but can cause vibrations, while shorter time settings reduce the overshoot but reduce controller responsiveness. D control is disabled by setting b5-05 to zero seconds.

No.	Name	Setting Range	Default
b5-05	Derivative Time (D)	0.00 to 10.00 s	0.00 s

■ b5-06: PID Output Limit

Sets the maximum output possible from the entire PID controller as a percentage of the maximum frequency (E1-04).

No.	Name	Setting Range	Default
b5-06	PID Output Limit	0.0 to 100.0%	100.0%

■ b5-07: PID Offset Adjustment

Sets the offset added to the PID controller output as a percentage of the maximum frequency (E1-04).

No.	Name	Setting Range	Default
b5-07	PID Offset Adjustment	-100.0 to 100.0%	0.0%

■ b5-08: PID Primary Delay Time Constant

Sets the time constant for the filter applied to the output of the PID controller. Normally, change is not required.

No.	Name	Setting Range	Default
b5-08	PID Primary Delay Time Constant	0.00 to 10.00 s	0.00 s

Note: Useful when there is a fair amount of oscillation or when rigidity is low. Set to a value larger than the cycle of the resonant frequency. Increasing this time constant may reduce the responsiveness of the drive.

■ b5-09: PID Output Level Selection

Reverses the sign of the PID controller output signal. Normally a positive PID input (feedback smaller than setpoint) leads to positive PID output.

No.	Parameter Name	Setting Range	Default
b5-09	PID Output Level Selection	0, 1	0

Setting 0: Normal Output

A positive PID input causes an increase in the PID output (direct acting).

Setting 1: Reverse Output

A positive PID input causes a decrease in the PID output (reverse acting).

■ b5-10: PID Output Gain Setting

Applies a gain to the PID output and can be helpful when the PID function is used to trim the frequency reference (b5-01 = 3 or 4).

No.	Name	Setting Range	Default
b5-10	PID Output Gain Setting	0.00 to 25.00	1.00

■ b5-11: PID Output Reverse Selection

Determines whether a negative PID output reverses the direction of drive operation. This parameter has no effect when the PID function trims the frequency reference (b5-01 = 3 or 4) and the PID output will not be limited (same as b5-11 = 1).

Note: When using setting 1, make sure reverse operation is permitted by b1–04.

No.	Parameter Name	Setting Range	Default
b5-11	PID Output Reverse Selection	0, 1	0

Setting 0: Reverse Disabled

Negative PID output will be limited to 0 and the drive output will be stopped.

Setting 1: Reverse Enabled

Negative PID output will cause the drive to run in the opposite direction.

■ PID Feedback Loss Detection

The PID feedback loss detection function detects broken sensors or broken sensor wiring. It should be used when PID control is enabled to prevent critical machine conditions (e.g., acceleration to max. frequency) caused by a feedback loss.

Feedback loss can be detected in two ways:

- **Feedback Low Detection**

  Detected when the feedback falls below a certain level for longer than the specified time. This function is set up using parameters b5-12 to b5-14.

- **Feedback High Detection**

  Detected when the feedback rises above a certain level for longer than the specified time. This function is set up using parameters b5-12, b5-36, and b5-37.

The following figure illustrates the working principle of feedback loss detection when the feedback signal is too low. Feedback high detection works in the same way.

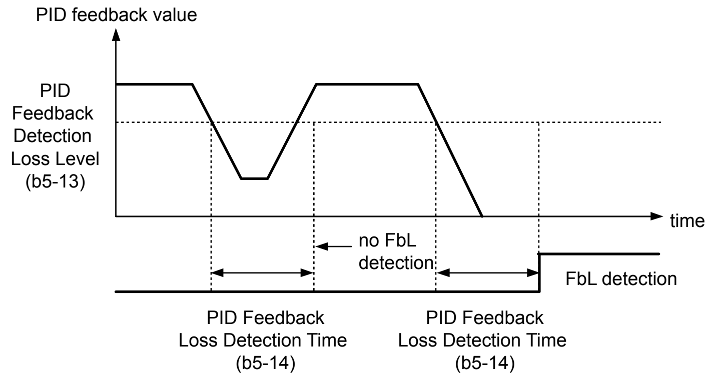


Figure 5.16 PID Feedback Loss Detection

■ b5-12: PID Feedback Loss Detection Selection

Enables or disables the feedback loss detection and sets the operation when a feedback loss is detected.

No.	Parameter Name	Setting Range	Default
b5-12	PID Feedback Loss Detection Selection	0 to 5	0

Setting 0: Digital Output Only

A digital output set for “PID feedback low” (H2-□□ = 3E) will be triggered if the PID feedback value is below the detection level set to b5-13 for the time set to b5-14 or longer. A digital output set for “PID feedback high” (H2-□□ = 3F) will be triggered if the PID feedback value is beyond the detection level set to b5-36 for longer than the time set to b5-37. Neither a fault nor an alarm is displayed on the digital operator and the drive will continue operation. The output resets when the feedback value leaves the loss detection range.

Setting 1: Feedback Loss Alarm

If the PID feedback value falls below the level set to b5-13 for longer than the time set to b5-14, a “FBL - Feedback Low” alarm will be displayed and a digital output set for “PID feedback low” (H2-□□ = 3E) will be triggered. If the PID feedback value exceeds the level set to b5-36 for longer than the time set to b5-37, a “FBH - Feedback High” alarm will be displayed and a digital output set for “PID feedback high” (H2-□□ = 3F) will be triggered. Both events trigger an alarm output (H1-□□ = 10). The drive will continue operation. The alarm and outputs reset when the feedback value leaves the loss detection range.

Setting 2: Feedback Loss Fault

If the PID feedback value falls below the level set to b5-13 for longer than the time set to b5-14, a “FbL - Feedback Low” fault will be displayed. If the PID feedback value exceeds the level set to b5-36 for longer than the time set to b5-37, a “FbH - Feedback High” fault will be displayed. Both events trigger a fault output (H1-□□ = E) and cause the drive to stop the motor.

Setting 3: Digital output only, even if PID is disabled by digital input

Same as b5-12 = 0. Detection remains active when PID is disabled by a digital input (H1-□□ = 19).

Setting 4: Feedback loss alarm, even if PID is disabled by digital input

Same as b5-12 = 1. Detection remains active when PID is disabled by a digital input (H1-□□ = 19).

Setting 5: Feedback loss fault, even if PID is disabled by digital input

Same as b5-12 = 2. Detection remains active when PID is disabled by a digital input (H1-□□ = 19).

■ b5-13: PID Feedback Low Detection Level

Sets the feedback level used for PID feedback low detection. The PID feedback must fall below this level for longer than the time set to b5-14 before feedback loss is detected.

No.	Name	Setting Range	Default
b5-13	PID Feedback Low Detection Level	0 to 100%	0%

■ b5-14: PID Feedback Low Detection Time

Sets the time that the PID feedback has to fall below b5-13 before feedback loss is detected.

No.	Name	Setting Range	Default
b5-14	PID Feedback Loss Detection Time	0.0 to 25.5 s	1.0 s

■ b5-36: PID Feedback High Detection Level

Sets the feedback level used for PID feedback high detection. The PID feedback must exceed this level for longer than the time set to b5-37 before feedback loss is detected.

No.	Name	Setting Range	Default
b5-36	PID Feedback High Detection Level	0 to 100%	100%

■ b5-37: PID Feedback High Detection Time

Sets the time that the PID feedback must exceed the value set to b5-36 before feedback loss is detected.

No.	Name	Setting Range	Default
b5-37	PID Feedback High Detection Time	0.0 to 25.5 s	1.0 s

■ PID Sleep

The PID Sleep function stops the drive when the PID output or the frequency reference falls below the PID Sleep operation level for a certain time. The drive will resume operating when the PID output or frequency reference rise above the PID Sleep operation level for the specified time. An example of PID Sleep operation appears in the figure below.

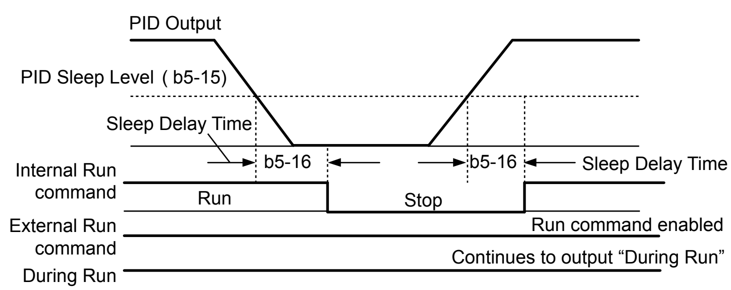


Figure 5.17 PID Sleep Operation

Notes on using the PID Sleep function

- The PID Sleep function is active even when PID control is disabled.
- The PID Sleep function stops the motor according to the stopping method set to b1-03.

The parameters necessary to control the PID Sleep function are explained below.

■ b5-15: PID Sleep Function Start Level

Sets the level that triggers PID Sleep.

The drive goes into Sleep mode if the PID output or frequency reference is smaller than b5-15 for longer than the time set to b5-16. The drive resumes operation when the PID output or frequency reference is above b5-15 for longer than the time set to b5-16.

No.	Name	Setting Range	Default
b5-15	PID Sleep Function Start Level	0.0 to 400.0 Hz	0.0 Hz

■ b5-16: PID Sleep Delay Time

Sets the delay time to activate or deactivate the PID Sleep function.

No.	Name	Setting Range	Default
b5-16	PID Sleep Delay Time	0.0 to 25.5 s	0.0 s

■ b5-17: PID Accel/Decel Time

The PID acceleration/deceleration time is applied on the PID setpoint value.

When the setpoint changes quickly, the normal C1-□□ acceleration times reduce the responsiveness of the system as they are applied after the PID output. The PID accel/decel time helps avoid the hunting and overshoot and undershoot that can result from the reduced responsiveness.

The PID acceleration/deceleration time can be canceled using a digital input programmed for “PID SFS cancel” (H1-☐☐ = 34).

No.	Name	Setting Range	Default
b5-17	PID Accel/Decel Time	0.0 to 6000.0 s	0.0 s

■ b5-18: PID Setpoint Selection

Enables or disables parameter b5-19 for PID setpoint.

Refer to *Figure 5.18* for the digital operator home screen display when PID is enabled and b5-18 is set to 1, enabling PID Setpoint Selection.

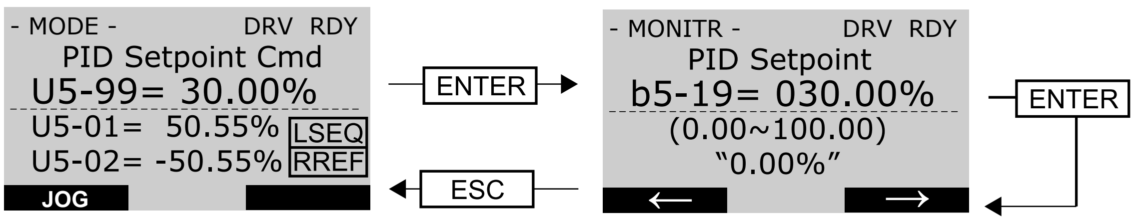


Figure 5.18 PID Setpoint Selection Display

No.	Parameter Name	Setting Range	Default
b5-18	PID Setpoint Selection	0, 1	0

Setting 0: Disabled

Parameter b5-19 is not used as the PID setpoint.

Setting 1: Enabled

Parameter b5-19 is used as PID setpoint.

■ b5-19: PID Setpoint Value

Used as the PID setpoint if parameter b5-18 = 1.

Note: Values set above b5–38 will be internally limited to b5–38.

No.	Name	Setting Range	Default
b5-19	PID Setpoint Value	0.00 to 600.00%	0.00%

◆ EZ Sleep/Wake-up Function

To enable EZ Sleep/Wake-up functionality on the drive, first set parameter b5-89 to 1. The default setting for b5-89 is 0, which disables the EZ Sleep functionality and related parameters, except for parameter b5-91, EZ Sleep Minimum Speed.

Setting b5-89 to 1 disables the existing PID Sleep function (b5-15) and enables the EZ Sleep/Wake-up functionality.

EZ Sleep and Minimum Speed Units

Parameter b5-90, EZ Sleep Unit, determines the unit, range, and resolution of parameters b5-92 and b5-93. When set to Hz, the range is 0.1 to 400.0 Hz. When set to RPM, the range is 0 to 24000 RPM. Changing b5-90 will NOT automatically re-scale the values of b5-92 and b5-93.

Minimum Speed

Parameter b5-91, EZ Minimum Speed, acts as a lower limit on the PID output. This value is internally limited to the higher value between b5-34 or d2-02 and is active regardless of the b5-89 setting. When this limit is active, the PID integrator will be held to avoid integral wind-up. Parameter b5-90 determines whether the value is input in Hz or RPM.

Sleep

When the output frequency (or speed) is at or below the EZ Sleep Level (b5-92) for the time set in EZ Sleep Time (b5-93), the drive will sleep. The EZ Sleep Level is internally lower limited to the b5-92 setting.

Wake-up using Absolute Level (b5-95 = 0)

For Normal Acting PID, the PID Feedback must drop below the EZ Wake-up Level (b5-94) for the time set in EZ Wake-up Time (b5-96) in order for the drive to wake-up.

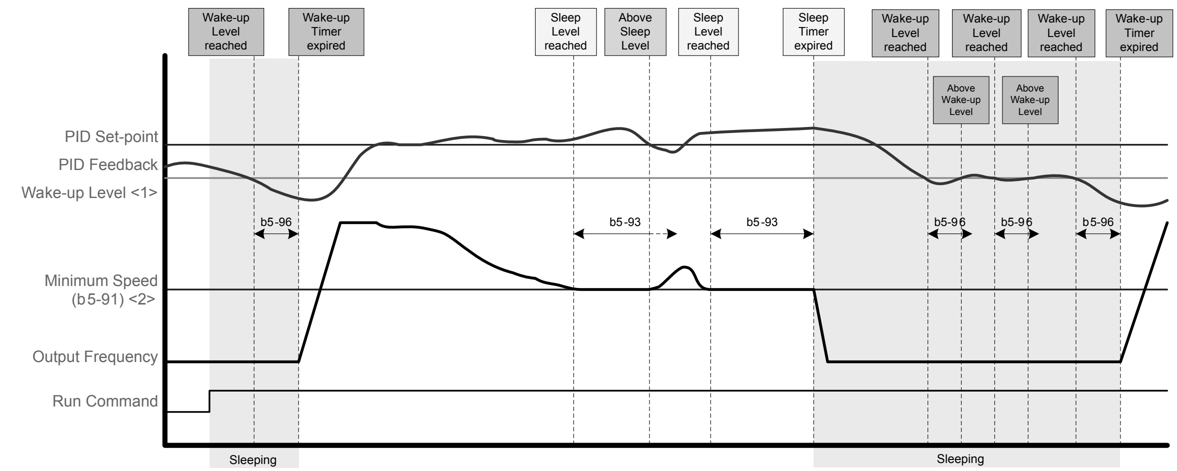
For Reverse Acting PID, the PID Feedback must rise above the b5-94 level for the time set in b5-96 in order for the drive to wake-up.

Wake-up using Setpoint Delta Level (b5-95 = 1)

For Normal Acting PID, the wake-up level is determined by the PID Setpoint minus the b5-94 level. The PID Feedback must drop below the wake-up level for the time set in b5-96 in order for the drive to wake-up

For Reverse Acting PID, the wake-up level is determined by the PID Setpoint plus the b5-94 level. The PID Feedback must rise above the wake-up level for the time set in b5-96 in order for the drive to wake-up.

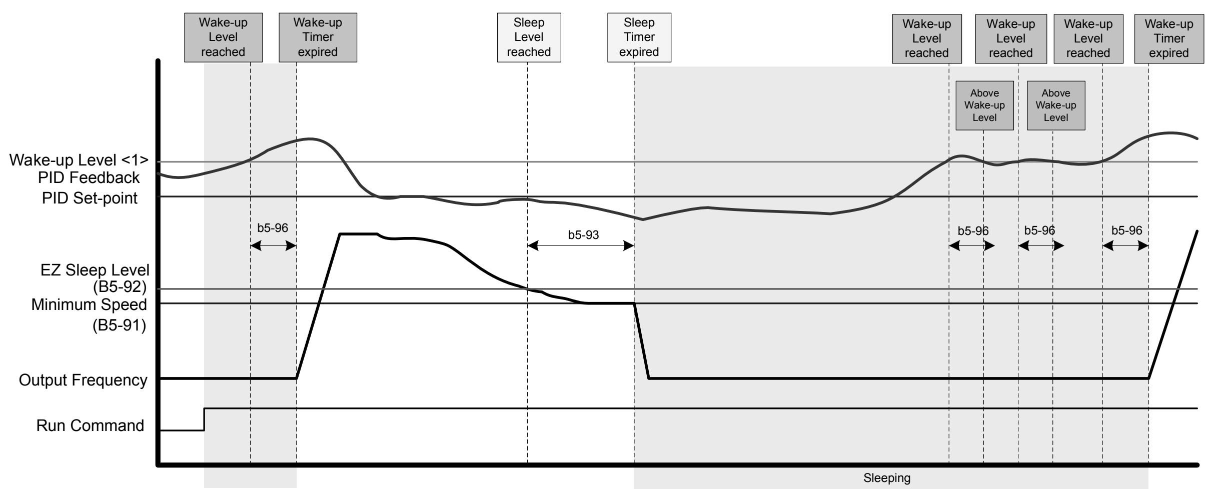
Refer to ***Figure 5.19*** and ***Figure 5.20*** for detailed diagrams of EZ Sleep/Wake-up functions.



<1> Determined by EZ Wake-up Level (b5-94) and EZ Wake-up Mode (b5-95)

<2> EZ Sleep Level (b5-92) is left at default (0.0 Hz), thus effectively making b5-91 the Sleep Level

Figure 5.19 EZ Sleep/Wake-up with Normal Acting PID and b5-92 = 0.0 Hz



<1> Determined by EZ Wake-up Level (B5-94) and EZ Wake-up Mode (B5-95)

Figure 5.20 EZ Sleep/Wake-up with Reverse Acting PID and b5-92 > b5-91

■ b5-20: PID Setpoint Scaling

Determines the units for the PID Setpoint Value (b5-19) and monitors U5-01 and U5-04.

No.	Parameter Name	Setting Range	Default
b5-20	PID Setpoint Scaling	0 to 3	1

Setting 0: 0.01 Hz

The setpoint and PID monitors are displayed in Hz with a resolution of 0.01 Hz.

Setting 1: 0.01% (100.00%: Maximum Frequency)

The setpoint and PID monitors are displayed as a percentage with a resolution of 0.01%.

Setting 2: r/min (Set the Motor Poles)

The setpoint and PID monitors are displayed in r/min with a resolution of 1 r/min.

Setting 3: User Defined (Determined by b5-38 and b5-39)

Parameters b5-38 and b5-39 determine the units based on b5-46 setting.

■ b5-38, b5-39: PID Setpoint User Display, PID Setpoint Display Digits

When parameter b5-20 is set to 3, parameters b5-38 and b5-39 set a user-defined display for the PID setpoint (b5-19) and PID feedback monitors (U5-01, U5-04).

Parameter b5-38 determines the display value when the maximum frequency is output and parameter b5-39 determines the number of digits. The setting value is equal to the number of decimal places.

No.	Name	Setting Range	Default
b5-38	PID Setpoint User Display	1 to 60000	10000
b5-39	PID Setpoint Display Digits	0 to 3	2

Setting 0: No decimal places

Setting 1: One decimal place

Setting 2: Two decimal places

Setting 3: Three decimal places

■ b5-46: PID Setpoint Monitor Unit Selection

Sets the digital operator display units in U5-01 and U5-04 when b5-20 is set to 3.

No.	Name	Setting Range	Default
b5-46	PI Setpoint Monitor Unit Selection	0 to 15; 25	0

Setting 0: WC (Inch of Water)

Setting 1: PSI (Pounds per Square Inch)

Setting 2: GPM (Gallons per Minute)

Setting 3: F (Degrees Fahrenheit)

Setting 4: CFM (Cubic Feet per Minute)

Setting 5: CMH (Cubic Meters per Hour)

Setting 6: LPH (Liters per Hour)

Setting 7: LPS (Liters per Second)

Setting 8: Bar (Bar)

Setting 9: Pa (Pascal)

Setting 10: C (Degrees Celsius)

Setting 11: Mtr (Meters)

Setting 12: Ft (Feet)

Setting 13: LPN (Liters per Minute)

Setting 14: CMM (Cubic Meters per Minute)

Setting 15: “Hg (Inches of Mercury)

Setting 25: None

■ b5-89: Sleep Method Selection

Determines how the drive sleeps and wakes-up when using PID.

No.	Name	Setting Range	Default
b5-89	Sleep Method Selection	0, 1	0

Setting 0: Standard

Setting 1: EZ Sleep/Wake-up

■ b5-90: EZ Sleep Unit

Sets the unit, range, and resolution of parameters b5-91 and b5-92.

No.	Name	Setting Range	Default
b5-90	EZ Sleep Unit	0, 1 <1>	0

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

Setting 0: Hz

Setting 1: RPM (number of motor poles must be entered)

■ b5-91: EZ Minimum Speed

Sets the PID minimum speed and integral lower limit.

The lower limit of the internal value is the higher of b5-34 and d2-02.

No.	Name	Setting Range	Default
b5-91	EZ Minimum Speed	0.0 to 400.0 Hz <1> or 0 to 24000 RPM	0.0

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

■ b5-92: EZ Sleep Level

When the drive output frequency (or speed) is at or below this level for the time set in b5-93, the drive will go to sleep.

The internal lower limit of this parameter is b5-91 (EZ Min Speed) + 1 Hz.

No.	Name	Setting Range	Default
b5-92	EZ Sleep Level	0.0 to 400.0 Hz <1> or 0 to 24000 RPM	0.0

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

■ b5-93: EZ Sleep Time

The drive will go to sleep when the drive output frequency is at or below the level set to b5-92 for the time set in this parameter.

No.	Name	Setting Range	Default
b5-93	EZ Sleep Tim	0.0 to 10000.0 <1>	5.0 s

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

■ b5-94: EZ Wake-up Level

If b5-95 is set to 0 (Absolute), the drive wakes-up when the PID Feedback (H3-□□ = 20) drops below this level for the time set in b5-96. For reverse-acting, the PID Feedback has to be above this level for the time set in b5-96.

If b5-95 is set to 1 (Setpoint Delta), the drive wakes-up when the PID Feedback (H3-□□ = 20) drops below the PID Setpoint minus this level (for normal acting PID) for the time set in b5-96. For reverse-acting, Wake-up level is PID Setpoint plus this level. The PID Feedback has to be above the wake-up level for the time set in b5-96.

No.	Name	Setting Range	Default
b5-94	EZ Wake-up Level	0.00 to 600.00% <1>	0.00

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

■ b5-95: EZ Wake-up Mode

Sets how the wake-up level is determined.

No.	Name	Setting Range	Default
b5-95	EZ Wake-up Mode	0, 1 <1>	0

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

Setting 0: Absolute

Setting 1: Setpoint Data

■ b5-96: EZ Wake-up Time

The drive will wake up when the PID Feedback drops below the b5–94, EZ Wake-up Level for the time set in this parameter.

No.	Name	Setting Range	Default
b5-96	EZ Wake-up Time	0.0 to 1000.0 <1>	1.0 s

<1> Unit and resolution are determined by b5-20, b5-39, and b5-46. Internally limited to b5-38. Changing b5-20, b5-38 and b5-39 will not automatically update the value of this parameter.

Setting 0: Absolute

Setting 1: Setpoint Data

■ b5-34: PID Output Lower Limit

Sets the minimum possible PID controller output as a percentage of the maximum output frequency (E1-04). The lower limit is disabled when set to 0.00%

No.	Name	Setting Range	Default
b5-34	PID Output Lower Limit	-100.0 to 100.0%	0.00%

■ b5-35: PID Input Limit

Sets the maximum allowed PID input as a percentage of the maximum output frequency (E1-04). Parameter b5-35 acts as a bipolar limit.

No.	Name	Setting Range	Default
b5-35	PID Input Limit	0 to 1000.0%	1000.0%

■ b5-40: Frequency Reference Monitor Content During PID

Sets the content of the frequency reference monitor display (U1-01) when PID control is active.

No.	Name	Setting Range	Default
b5-40	Frequency Reference Monitor Content During PID	0, 1	0

Setting 0: Frequency Reference after PID

Monitor U1-01 displays the frequency reference increased or reduced for the PID output.

Setting 1: Frequency Reference

Monitor U1-01 displays the frequency reference value.

■ b5-41: PI Unit Selection

Sets the display units in U5-14 and U5-15.

No.	Name	Setting Range	Default
b5-41	PI Output 2 Unit Selection	0 to 15; 25	0

Setting 0: WC (Inch of Water)
Setting 1: PSI (Pounds per Square Inch)
Setting 2: GPM (Gallons per Minute)
Setting 3: F (Degrees Fahrenheit)
Setting 4: CFM (Cubic Feet per Minute)
Setting 5: CMH (Cubic Meters per Hour)
Setting 6: LPH (Liters per Hour)
Setting 7: LPS (Liters per Second)
Setting 8: Bar (Bar)
Setting 9: Pa (Pascal)
Setting 10: C (Degrees Celsius)
Setting 11: Mtr (Meters)
Setting 12: Ft (Feet)
Setting 13: LPM (Liters per Minute)
Setting 14: CMM (Cubic Meters per Minute)
Setting 15: Hg (Inches of Mercury)
Setting 25: None

■ b5-42: PI Output Monitor Calculation Method

No.	Name	Setting Range	Default
b5-42	PI Output Monitor Calculation Method	0 to 3	0

Setting 0: Linear

The monitor displays PID output.

Setting 1: Square Root

The monitor displays square root PID output.

Setting 2: Quadratic

The monitor displays 1/(PID output)^2

Setting 3: Cubic

The monitor displays 1/(PID output)^3

Note: Used for U5-14 and U5-15 only.

■ b5-43/b5-44: Custom PI Output Monitor Setting 1/2

Set the maximum monitor value at maximum frequency. U5-14 and U5-15 show Custom PI output. U5-14 shows the upper 4 digits and U5-15 shows the lower 4 digits. It shows 999999.99 maximum.

No.	Name	Setting Range	Default
b5-43	PI Output 2 Monitor Max Upper 4 Digits	0 to 9999	0
b5-44	PI Output 2 Monitor Max Lower 4 Digits	0 to 99.99	0

Note: Used for U5-14 and U5-15 only.

■ b5-45: PI Output 2 Monitor Minimum

b5-14 shows Custom PI Output. b5-45 sets the minimum display value at zero speed. This function is effective when b5-42 is set to 0 (Linear).

No.	Name	Setting Range	Default
b5-45	PI Output 2 Monitor Minimum	0 to 999.9	0

Note: Used for U5-14 and U5-15 only.

■ b5-47: PID Output Reverse Selection 2

Determines whether a negative PID output reverses the direction of drive operation. When the PID function is used to trim the frequency reference (b5-01 = 3 or 4), this parameter has no effect and the PID output will not be limited (same as b5-11 = 1).

No.	Name	Setting Range	Default
b5-47	PID Output Reverse Selection 2	0, 1	1

Setting 0: Reverse Disabled

Negative PID output will be limited to 0 and the drive output will be stopped.

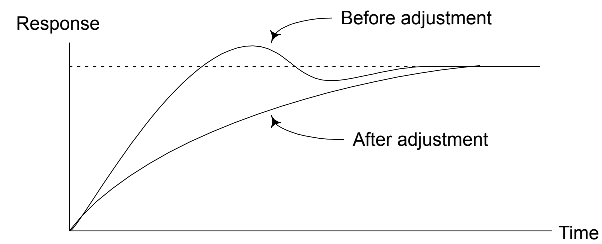
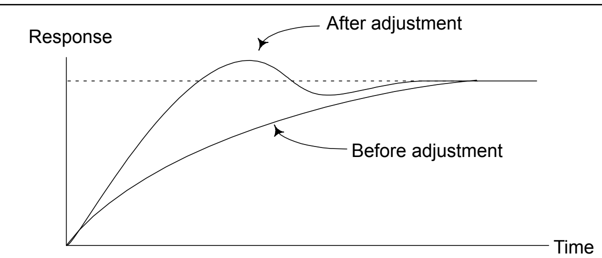
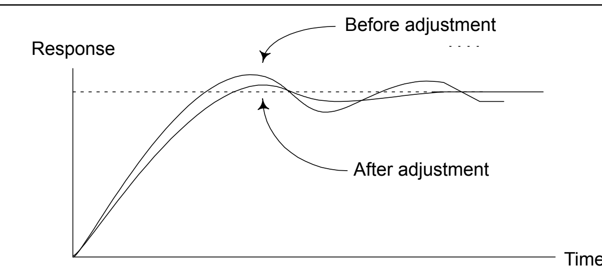
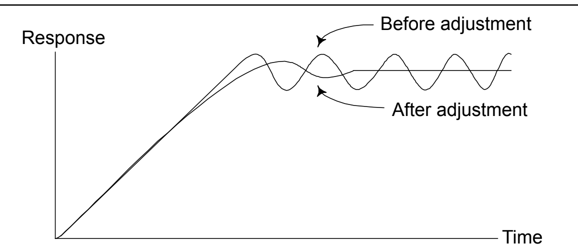
Setting 1: Reverse Enabled

Negative PID output will cause the drive to run in the opposite direction.

■ Fine-Tuning PID

Follow the directions below to fine tune PID control parameters:

Table 5.12 PID Fine Tuning

Goal	Tuning Procedure	Result
Suppress overshoot	• Reduce the derivative time (b5-05) • Increase the integral time (b5-03)	
Achieve stability quickly while allowing some overshoot	• Decrease the integral time (b5-03) • Increase the derivative time (b5-05)	
Suppress long cycle oscillations (longer than the integral time setting)	Increase the integral time (b5-03)	
Suppress short cycle oscillations	• If oscillation cycle time is close to the derivative time, reduce the derivative time (b5-05). • If the derivative time is set to 0.00 s and oscillations are still a problem, reduce the proportional gain (b5-02) or increase the PID primary delay time (b5-08)	

◆ b6: Dwell Function

The Dwell function temporarily holds the frequency reference at a predefined value for a set time then continues accelerating or decelerating.

The Dwell function helps prevent speed loss when starting and stopping a heavy load with induction motors.

Figure 5.21 illustrates how the Dwell function works.

Note: Set the stopping method to "Ramp to Stop" (b1-03 = 0) to use the Dwell function.

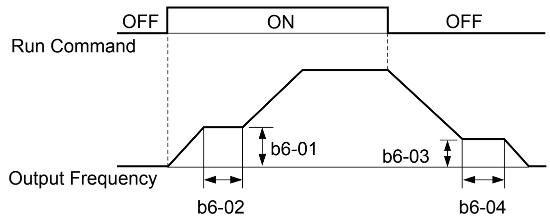


Figure 5.21 Dwell Function at Start and Stop

■ b6-01, b6-02: Dwell Reference, Dwell Time at Start

Parameter b6-01 determines the frequency that is held for the time set in b6-02 during acceleration.

No.	Name	Setting Range	Default
b6-01	Dwell Reference at Start	0.0 to 400.0 Hz	0.0 Hz
b6-02	Dwell Time at Start	0.0 to 10.0 s	0.0 s

■ b6-03, b6-04: Dwell Reference, Dwell Time at Stop

Parameter b6-03 determines the frequency that is held for the time set in b6-04 during deceleration.

No.	Name	Setting Range	Default
b6-03	Dwell Reference at Stop	0.0 to 400.0 Hz	0.0 Hz
b6-04	Dwell Time at Stop	0.0 to 10.0 s	0.0 s

◆ b8: Energy Saving

The Energy Saving feature improves overall system operating efficiency by operating the motor at its most efficient level.

Note:
1. Energy Saving is not designed for applications that experience instantaneous heavy loads or applications that rarely operate with light load conditions.
2. Energy Saving is designed for applications with variable torque (Normal Duty) and is not appropriate for applications where the load may suddenly increase.
3. The performance of the Energy Saving function depends on the accuracy of the motor data. Always perform Auto-Tuning and correctly enter the motor data before using this function.

■ b8-01: Energy Saving Control Selection

Enables or disables the Energy Saving function.

No.	Parameter Name	Setting Range	Default
b8-01	Energy Saving Control Selection	0, 1	0

Setting 0: Disabled

Setting 1: Enabled

■ b8-04: Energy Saving Coefficient Value

Determines the level of maximum motor efficiency. Setting range is 0.0 to 2000.0 for drives 3.7 kW and smaller. The display resolution depends on the rated output power of the drive.

No.	Name	Setting Range	Default
b8-04	Energy Saving Coefficient Value	0.00 to 655.00	Determined by E2-11, and o2-04

Note: The default value changes if the motor rated capacity set to E2-11 is changed. The Energy Saving coefficient is set automatically when Auto-Tuning for Energy Saving is performed (*Refer to Auto-Tuning on page 119*).

■ b8-05: Power Detection Filter Time

Determines how often in milliseconds the output power is measured. The Energy Saving function continuously searches out the lowest output voltage to achieve minimum output power.

Reducing this setting increases the response time. If the filter time is too short, the motor may become unstable with a lighter load.

No.	Name	Setting Range	Default
b8-05	Power Detection Filter Time	0 to 2000 ms	20 ms

■ b8-06: Search Operation Voltage Limit

Sets the voltage limit for the Speed Search optimal output voltage detection as a percentage of the maximum output voltage. The drive will keep the output voltage above this level during the search operation to prevent motor stalling.

No.	Name	Setting Range	Default
b8-06	Search Operation Voltage Limit	0 to 100%	0%

5.3 C: Tuning

C parameters set the characteristics for acceleration, deceleration, and S-curves. Other parameters in the C group cover settings for slip compensation, torque compensation, and carrier frequency.

◆ C1: Acceleration and Deceleration Times

■ C1-01 to C1-04: Accel, Decel Times 1 and 2

Two different sets of acceleration and deceleration times can be set in the drive by digital inputs, motor selection, or switched automatically.

Acceleration time parameters always set the time to accelerate from 0 Hz to the maximum output frequency (E1-04). Deceleration time parameters always set the time to decelerate from maximum output frequency to 0 Hz. C1-01 and C1-02 are the default active accel/decel settings.

No.	Parameter Name	Setting Range	Default
C1-01	Acceleration Time 1	0.0 to 6000.0 s <1>	10.0 s
C1-02	Deceleration Time 1		
C1-03	Acceleration Time 2		
C1-04	Deceleration Time 2		

<1> The setting range for the acceleration and deceleration times is determined by the accel/decel time setting units in C1-10. For example, if the time is set in units of 0.01 s (C1-10 = 0), the setting range becomes 0.00 to 600.00 s.

Switching Acceleration Times by Digital Input

Accel/decel time 1 is active by default if no input is set. Activate accel/decel times 2, 3, and 4 by digital inputs (H1-□□ = 7 and 1A) as explained in *Table 5.13*.

Table 5.13 Accel/Decel Time Selection by Digital Input

Accel/Decel Time Sel. 1 H1-□□ = 7	Accel/Decel Time Sel. 2 H1-□□ = 1A	Active Times	
		Acceleration	Deceleration
0	0	C1-01	C1-02
1	0	C1-03	C1-04

Figure 5.22 shows an operation example for changing accel/decel. times. The example below requires that the stopping method be set for “Ramp to stop” (b1-03 = 0).

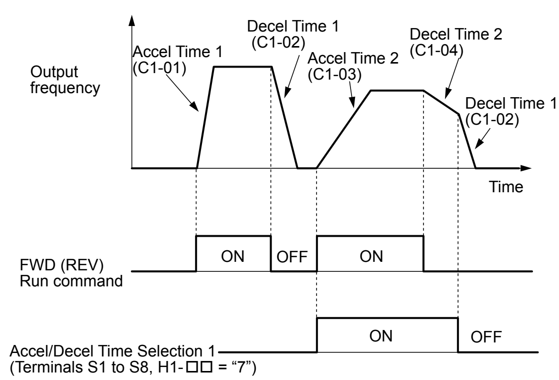


Figure 5.22 Timing Diagram of Accel/Decel Time Change

■ C1-11: Accel/Decel Time Switching Frequency

Sets the frequency at which the drive switches between accel/decel time settings.

No.	Parameter Name	Setting Range	Default
C1-11	Accel/Decel Time Switching Frequency	0.0 to 400.0 Hz	0.0 Hz

■ C1-09: Fast Stop Time

Sets a special deceleration used when a select group of faults occur (e.g., L8-03 Overheat Pre-Alarm Operation Selection) or when closing a digital input configured as H1-□□ = 15 (N.O. input) or 17 (N.C. input). A momentary closure of the digital input will trigger the Fast Stop operation; it does not have to be closed continuously.

The drive cannot be restarted after initiating a Fast Stop operation until after completing deceleration, clearing the Fast Stop input, and cycling the Run command.

A digital output programmed for "During Fast Stop" (H2-□□ = 4C) will be closed as long as Fast Stop is active.

No.	Parameter Name	Setting Range	Default
C1-09	Fast Stop Time	0.0 to 6000.0 s <1>	10.0 s

<1> The setting range for the acceleration and deceleration times is determined by the accel/decel time setting units in C1-10. For example, if the time is set in units of 0.01 s (C1-10 = 0), the setting range becomes 0.00 to 600.00 s

NOTICE: *Rapid deceleration can trigger an overvoltage fault. The drive output shuts off when faulted and the motor coasts. Set an appropriate Fast Stop time to C1-09 to avoid this uncontrolled motor state and to ensure that the motor stops quickly and safely.*

■ C1-10: Accel/Decel Time Setting Units

Determines the units for the acceleration and deceleration times set to C1-01 through C1-09 using parameter C1-10.

No.	Parameter Name	Setting Range	Default
C1-10	Accel/Decel Time Setting Units	0, 1	1

Setting 0: 0.01 s units

The accel/decel times are set in 0.01 s units. The setting range will be 0.00 to 600.00 s. C1-10 cannot be set to 0 if any of the parameters C1-01 to C1-09 are set to 600.1 seconds or more.

Setting 1: 0.1 s units

The accel/decel times are set in 0.1 s units. The setting range will be 0.0 to 6000.0 s.

◆ C2: S-Curve Characteristics

Use S-curve characteristics to smooth acceleration and deceleration and minimize abrupt shock to the load. Set S-curve characteristic time during acceleration/deceleration at start and acceleration/deceleration at stop.

■ C2-01 to C2-04: S-Curve Characteristics

C2-01 through C2-04 set separate S-curves for each section of the acceleration or deceleration.

No.	Parameter Name	Setting Range	Default
C2-01	S-Curve Characteristic at Accel Start	0.00 to 10.00 s	0.20 s
C2-02	S-Curve Characteristic at Accel End		0.20 s
C2-03	S-Curve Characteristic at Decel Start		0.20 s
C2-04	S-Curve Characteristic at Decel End		0.00 s

Figure 5.23 illustrates S-curve application.

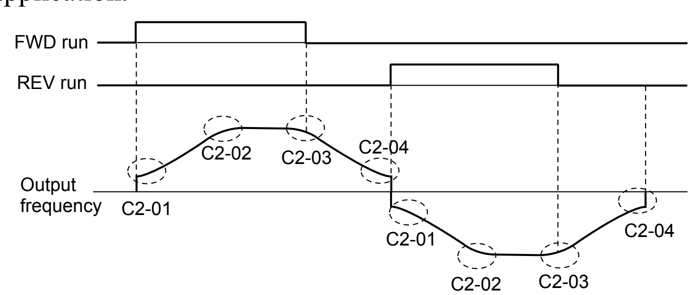


Figure 5.23 S-Curve Timing Diagram - FWD/REV Operation

Setting the S-curve will increase the acceleration and deceleration times.

- Actual accel time = accel time setting + (C2-01 + C2-02) / 2
- Actual decel time = decel time setting + (C2-03 + C2-04) / 2

◆ C3: Slip Compensation

The Slip Compensation function improves the speed accuracy of an induction motor. By adjusting the output frequency in accordance with the motor load, it compensates the slip and makes the motor speed equal to the frequency reference.

Note: Perform Auto-Tuning and make sure that the motor rated current (E2-01), the motor rated slip (E2-02), and the no-load current (E2-03) have all been set properly before making any adjustments to slip compensation parameters.

■ C3-01: Slip Compensation Gain

Sets the gain for the motor slip compensation function. Although this parameter rarely needs to be changed, adjustments may be necessary under the following circumstances:

- Increase the setting if the motor at constant speed is slower than the frequency reference.
- Decrease the setting if the motor at constant speed is faster than the frequency reference.

No.	Parameter Name	Setting Range	Default
C3-01	Slip Compensation Gain	0.0 to 2.5	0.0

■ C3-02: Slip Compensation Primary Delay Time

Adjusts the filter on the output side of the slip compensation function. Although this parameter rarely needs to be changed, adjustments may be necessary in the following situations:

- Decrease the setting when the slip compensation response is too slow.
- Increase this setting when speed is unstable.

No.	Parameter Name	Setting Range	Default
C3-02	Slip Compensation Primary Delay Time	0 to 10000 ms	2000 ms

■ C3-03: Slip Compensation Limit

Sets the upper limit for the slip compensation function as a percentage of the motor rated slip (E2-02).

No.	Parameter Name	Setting Range	Default
C3-03	Slip Compensation Limit	0 to 250%	200%

The slip compensation limit is constant throughout the constant torque range (frequency reference ≤ E1-06). In the constant power range (frequency reference ≥ E1-06), it is increased based on C3-03 and the output frequency as shown in the following diagram.

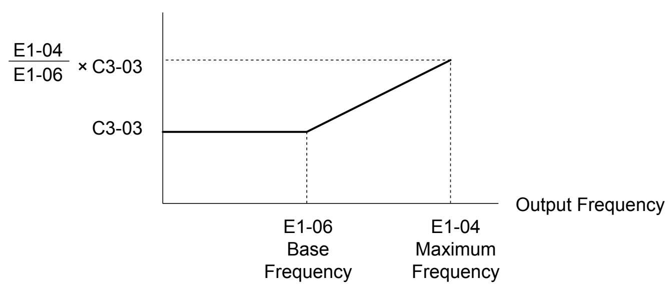


Figure 5.24 Slip Compensation Limit

■ C3-04: Slip Compensation Selection during Regeneration

Enables or disables slip compensation during regenerative operation. When slip compensation during regeneration has been activated and a regenerative load is applied, it might be necessary to use a dynamic braking option (braking resistor, braking resistor unit, or braking unit).

This function does not operate when the output frequency is too low, regardless of whether it has been enabled.

No.	Parameter Name	Setting Range	Default
C3-04	Slip Compensation Selection during Regeneration	0 to 2	0

Setting 0: Disabled

Slip compensation is not provided. Depending on the load and mode of operation, the actual motor speed will be lower or higher than the frequency reference.

Setting 1: Enabled (6 Hz and above)

Slip compensation is enabled during regenerative operation. It will not be active at output frequencies below 6 Hz.

Setting 2: Enabled (compensation provided wherever possible)

Slip compensation is enabled during regenerative operation and at frequencies as low as 2 Hz. The drive uses the motor rated slip set to E2-02 to automatically calculate the frequency range where compensation will be disabled.

◆ C4: Torque Compensation

The torque compensation function compensates for insufficient torque production at start-up or when a load is applied.

Note: Set the motor parameters and V/f pattern properly before setting torque compensation parameters.

■ C4-01: Torque Compensation Gain

Sets the gain for the torque compensation function.

No.	Parameter Name	Setting Range	Default
C4-01	Torque Compensation Gain	0.00 to 2.50	1.00

■ C4-02: Torque Compensation Primary Delay Time 1

Sets the delay time used for applying torque compensation.

No.	Parameter Name	Setting Range	Default
C4-02	Torque Compensation Primary Delay Time 1	0 to 60000 ms	200 ms

◆ C6: Carrier Frequency

■ C6-02: Carrier Frequency Selection

Sets the switching frequency of the drive output transistors. Changes to the switching frequency lower audible noise and reduce leakage current.

No.	Parameter Name	Setting Range	Default
C6-02	Carrier Frequency Selection	1 to 9; A, F	7

Settings:

C6-02	Carrier Frequency	C6-02	Carrier Frequency	C6-02	Carrier Frequency
1	2.0 kHz	5	12.5 kHz	9	Swing PWM 3
2	5.0 kHz	6	15.0 kHz	A	Swing PWM 4
3	8.0 kHz	7	Swing PWM 1	B to E:	No setting possible
4	10.0 kHz	8	Swing PWM 2	F	User defined (C6-03 to C6-05)

Note: Swing PWM uses a carrier frequency of 2.0 kHz as a base, then applies a special PWM pattern to reduce the audible noise.

Guidelines for Carrier Frequency Parameter Setup

Symptom	Remedy
Speed and torque are unstable at low speeds	Lower the carrier frequency.
Noise from the drive affects peripheral devices	
Excessive leakage current from the drive	
Wiring between the drive and motor is too long <1>	
Audible motor noise is too loud	Increase the carrier frequency or use Swing PWM. <2>

<1> The carrier frequency may need to be lowered if the motor cable is too long. Refer to ***Table 5.14***.

<2> The default carrier frequency is Swing PWM (C6-02 = 7), using a 2 kHz base. Increasing the carrier frequency is permissible , however the drive rated current is reduced when the carrier frequency is increased.

Table 5.14 Wiring Distance and Carrier Frequency

Wiring Distance	Up to 50 m	Up to 100 m	Greater than 100 m
Recommended setting value for C6-02	1 to F (up to 15 kHz)	1 to 2 (up to 5 kHz), 7 (Swing PWM)	1 (up to 2 kHz), 7 (Swing PWM)

Parameter Details

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■ C6-03, C6-04, C6-05: Carrier Frequency Upper Limit, Lower Limit, Proportional Gain

These parameters set a user-defined or a variable carrier frequency. Set C6-02 to F to set the upper and lower limits and the carrier frequency proportional gain.

No.	Parameter Name	Setting Range	Default
C6-03	Carrier Frequency Upper Limit	1.0 to 15.0 kHz	Determined by C6-02
C6-04	Carrier Frequency Lower Limit	1.0 to 15.0 kHz	
C6-05	Carrier Frequency Proportional Gain	0 to 99	

Setting a Fixed User Defined Carrier Frequency

A carrier frequency between the fixed selectable values can be entered in parameter C6-03 when C6-02 is set to F.
In V/f Control, adjust parameter C6-04 to the same value as C6-03.

Setting a Variable Carrier Frequency (V/f Control)

In V/f Control, the carrier frequency can be set up to change linearly with the output frequency by setting the upper and lower limits for the carrier frequency and the carrier frequency proportional gain (C6-03, C6-04, C6-05) as shown in ***Figure 5.25***.

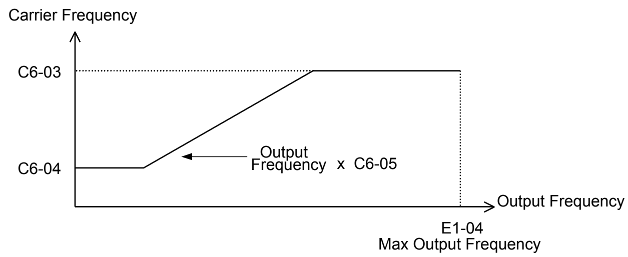

Figure 5.25 Carrier Frequency Changes Relative to Output Frequency

Note: When C6-05 is set lower than 7, C6-04 is disabled and the carrier frequency will be fixed to the value set in C6-03.

5.4 d: Reference Settings

The figure below gives an overview of the reference input, selections, and priorities.

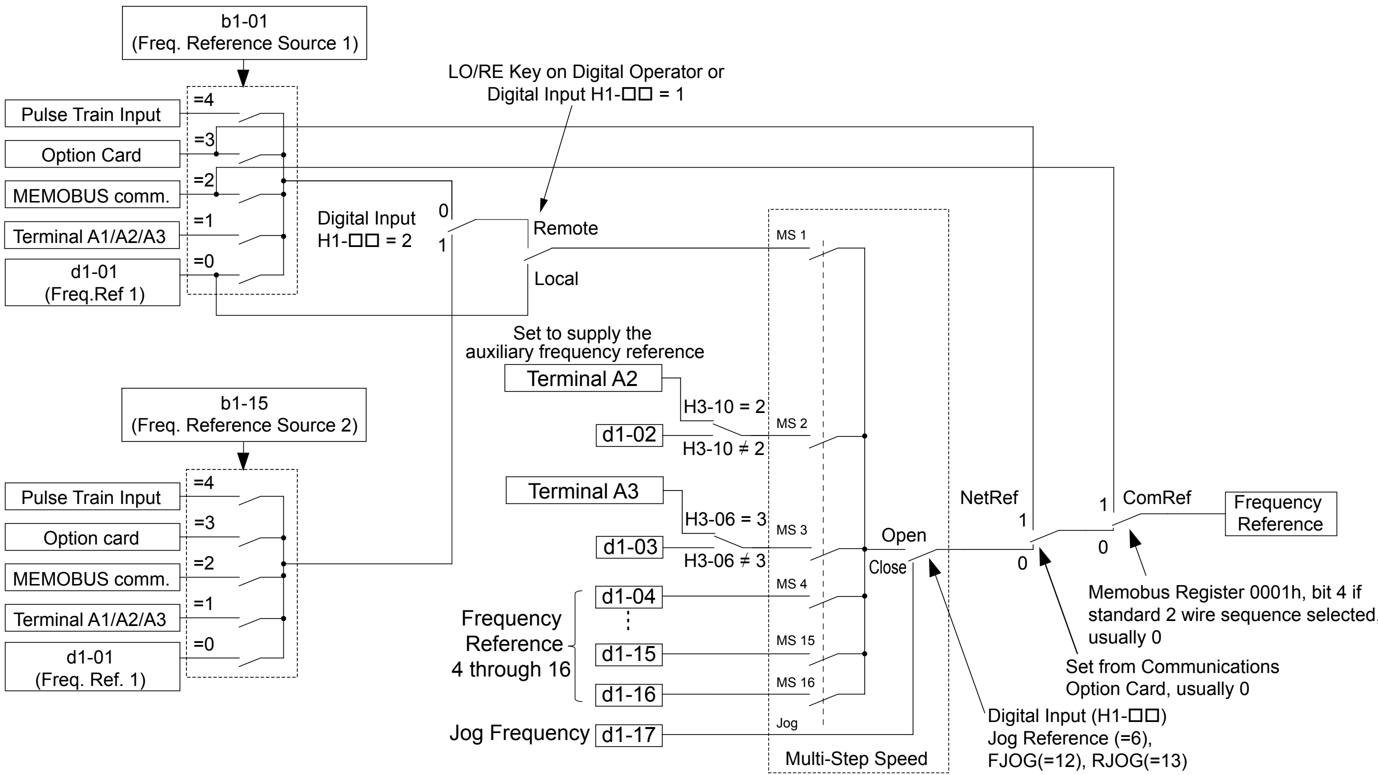

Figure 5.26 Frequency Reference Setting Hierarchy

◆ d1: Frequency Reference

■ d1-01 to d1-17: Frequency Reference 1 to 16 and Jog Frequency Reference

The drive lets the user switch between up to 17 preset frequency references during run (including the Jog reference) through the digital input terminals. The drive uses the acceleration and deceleration times that have been selected when switching between each frequency reference.

The Jog frequency overrides all other frequency references and must be selected by a separate digital input.

The multi-speed references 1, 2, and 3 can be provided by analog inputs.

No.	Parameter Name	Setting Range	Default
d1-01 to d1-16	Frequency Reference 1 to 16	0.00 to 400.00 Hz <1>	0.00 Hz
d1-17	Jog Frequency Reference	0.00 to 400.00 Hz <1>	6.00 Hz

<1> The upper limit is determined by the maximum output frequency (E1-04) and upper limit for the frequency reference (d2-01).

Multi-Step Speed Selection

To use several speed references for a multi-step speed sequence, set the H1-☐☐ parameters to 3, 4, 5, and 32. To assign the Jog reference to a digital input, set H1-☐☐ to 6.

Notes on using analog inputs as Multi-Speed 1, 2, and 3:

- **Multi-Step Speed 1**

  Set b1-01 to 1 to set terminal A1 analog input to Multi-Step Speed 1.

  Set b1-01 to 0 when setting d1-01, Frequency Reference 1, to Multi-Step Speed 1.

- **Multi-Step Speed 2**

  Set H3-06, Terminal A3 Function Selection, to 2 (Auxiliary Frequency Reference 1) when setting terminal A3 analog input to Multi-Step Speed 2.

Parameter Details

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Set H3-06 to F (Through mode) when setting d1-02, Frequency Reference 2, to Multi-Step Speed 2.

- **Multi-Step Speed 3**

Set H3-10, Terminal A2 Function Selection, to 3 (Auxiliary Frequency Reference 2) when setting terminal A2 analog input to Multi-Step Speed 3.

Set H3-10 to F (Through mode) when setting d1-03, Frequency Reference 3, to Multi-Step Speed 3.

Set H3-09 to 0 and set jumper S1 on the control circuit terminal board to V (voltage) for A2 when inputting 0 to 10 V to terminal A2 analog input.

Select the different speed references as shown in *Table 5.15*. *Figure 5.27* illustrates the multi-step speed selection.

Table 5.15 Multi-Step Speed Reference and Terminal Switch Combinations

Reference	Multi-Step Speed H1-□□ = 3	Multi-Step Speed 2 H1-□□ = 4	Multi-Step Speed 3 H1-□□ = 5	Multi-Step Speed 4 H1-□□ = 32	Jog Reference H1-□□ = 6
Frequency Reference 1 (set in b1-01)	OFF	OFF	OFF	OFF	OFF
Frequency Reference 2 (d1-02 or input terminal A1, A2, A3)	ON	OFF	OFF	OFF	OFF
Frequency Reference 3 (d1-03 or input terminal A1, A2, A3)	OFF	ON	OFF	OFF	OFF
Frequency Reference 4 (d1-04)	ON	ON	OFF	OFF	OFF
Frequency Reference 5 (d1-05)	OFF	OFF	ON	OFF	OFF
Frequency Reference 6 (d1-06)	ON	OFF	ON	OFF	OFF
Frequency Reference 7 (d1-07)	OFF	ON	ON	OFF	OFF
Frequency Reference 8 (d1-08)	ON	ON	ON	OFF	OFF
Frequency Reference 9 (d1-09)	OFF	OFF	OFF	ON	OFF
Frequency Reference 10 (d1-10)	ON	OFF	OFF	ON	OFF
Frequency Reference 11 (d1-11)	OFF	ON	OFF	ON	OFF
Frequency Reference 12 (d1-12)	ON	ON	OFF	ON	OFF
Frequency Reference 13 (d1-13)	OFF	OFF	ON	ON	OFF
Frequency Reference 14 (d1-14)	ON	OFF	ON	ON	OFF
Frequency Reference 15 (d1-15)	OFF	ON	ON	ON	OFF
Frequency Reference 16 (d1-16)	ON	ON	ON	ON	OFF
Jog Frequency Reference (d1-17) <1>	–	–	–	–	ON

<1> The Jog frequency overrides all other frequency references.

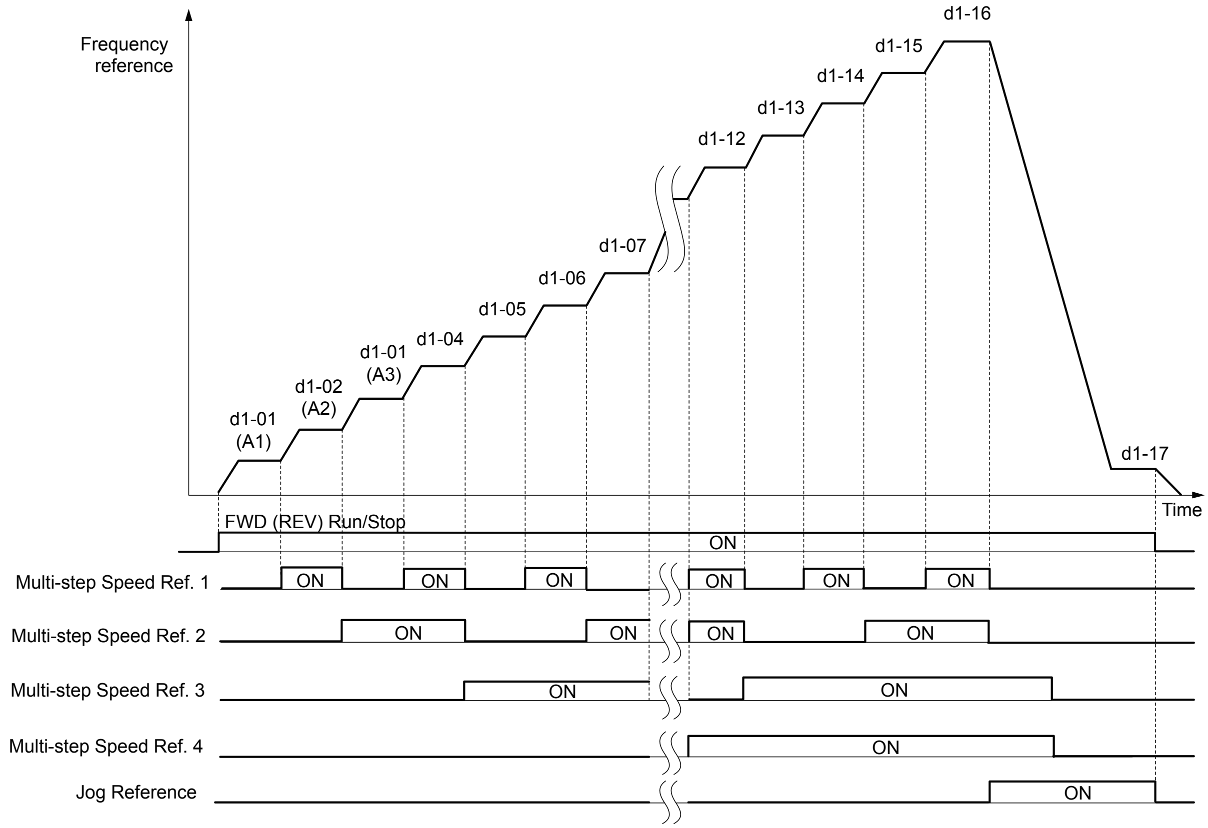


Figure 5.27 Preset Reference Timing Diagram

◆ d2: Frequency Upper/Lower Limits

Upper and lower frequency limits prevent motor speed from going above or below levels that may cause resonance or equipment damage.

■ d2-01: Frequency Reference Upper Limit

Sets the maximum frequency reference as a percentage of the maximum output frequency. This limit applies to all frequency references.

Even if the frequency reference is set to a higher value, the drive internal frequency reference will not exceed this value.

No.	Parameter Name	Setting Range	Default
d2-01	Frequency Reference Upper Limit	0.0 to 110.0%	100.0%

■ d2-02: Frequency Reference Lower Limit

Sets the minimum frequency reference as a percentage of the maximum output frequency. This limit applies to all frequency references.

If a lower reference than this value is entered, the drive will run at the limit set to d2-02. If the drive is started with a lower reference than d2-02, it will accelerate up to d2-02.

No.	Parameter Name	Setting Range	Default
d2-02	Frequency Reference Lower Limit	0.0 to 110.0%	0.0%

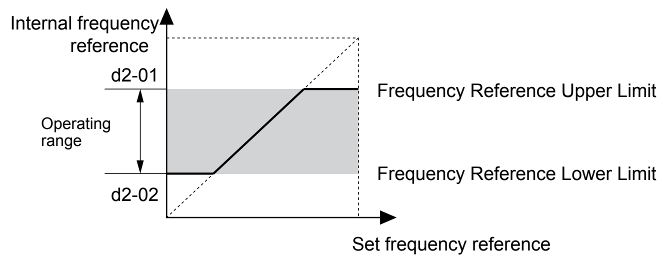


Figure 5.28 Frequency Reference: Upper and Lower Limits

■ d2-03: Master Speed Reference Lower Limit

Sets a lower limit as a percentage of the maximum output frequency that will only affect a frequency reference entered from the analog input terminals (A1, A2, or A3). This is unlike parameter d2-02, which affects all frequency references regardless of their source.

Note: When lower limits are set to both parameters d2-02 and d2-03, the drive uses the greater of those two values as the lower limit.

No.	Parameter Name	Setting Range	Default
d2-03	Master Speed Reference Lower Limit	0.0 to 110.0%	0.0%

◆ d3: Jump Frequency

■ d3-01 to d3-04: Jump Frequencies 1, 2, 3 and Jump Frequency Width

The Jump frequencies are frequency ranges at which the drive will not operate. The drive can be programmed with three separate Jump frequencies to avoid operating at speeds that cause resonance in driven machinery. If the speed reference falls within a Jump frequency dead band, the drive will clamp the frequency reference just below the dead band and only accelerate past it when the frequency reference rises above the upper end of the dead band.

Setting parameters d3-01 through d3-03 to 0.0 Hz disables the Jump frequency function.

No.	Parameter Name	Setting Range	Default
d3-01	Jump Frequency 1	0.0 to 400.0 Hz	0.0 Hz
d3-02	Jump Frequency 2	0.0 to 400.0 Hz	0.0 Hz
d3-03	Jump Frequency 3	0.0 to 400.0 Hz	0.0 Hz
d3-04	Jump Frequency Width	0.0 to 20.0 Hz	1.0 Hz

Figure 5.29 shows the relationship between the Jump frequency and the output frequency.

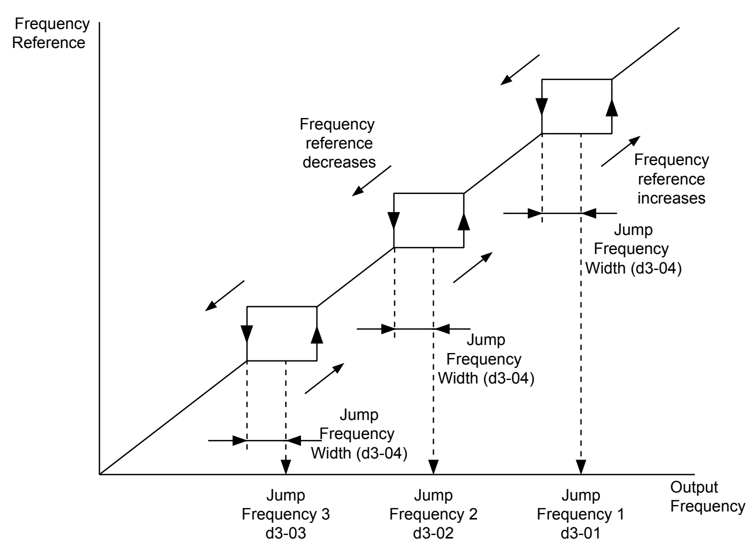


Figure 5.29 Jump Frequency Operation

Note: 1. The drive will use the active accel/decel time to pass through the specified dead band range, but will not allow continuous operation in that range.

2. When setting more than one Jump frequency, make sure that the parameters do not overlap.

◆ d4: Frequency Reference Hold and Up/Down 2 Function

■ d4-01: Frequency Reference Hold Function Selection

Determines whether the frequency reference or the frequency bias (Up/Down 2) value is saved when the Stop command is entered or the power supply is shut down. This parameter is effective when either of the digital input functions listed below are used:

- Accel/decel ramp hold function (H1-□□= A)
- Up/Down function (H1-□□ = 10 and 11)
- Up/Down 2 function (H1-□□ = 75 and 76)

No.	Parameter Name	Setting Range	Default
d4-01	Frequency Reference Hold Function Selection	0, 1	0

The operation depends on the function used with parameter d4-01.

Setting 0: Disabled

- Acceleration hold

  The hold value will be reset to 0 Hz when the Stop command is entered or the drive power is switched off. The active frequency reference will be the value the drive uses when it restarts.

- Up/Down

  The frequency reference value will be reset to 0 Hz when the Stop command is entered or the drive power is switched off. The drive will start from 0 Hz when it is restarted.

- Up/Down 2

  The frequency bias is not saved when the Stop command is entered, or 5 s after the Up/Down 2 command has been released. The Up/Down 2 function will start with a bias of 0% when the drive is restarted.

Setting 1: Enabled

- Acceleration hold

  The last hold value will be saved when the Run command or the drive power is switched off and the drive will use the saved value as the frequency reference when it restarts. Make sure to continuously enable the multi-function input terminal set for "Accel/decel ramp hold" (H1-□□ = A) or the hold value will be cleared when the power is switched on.

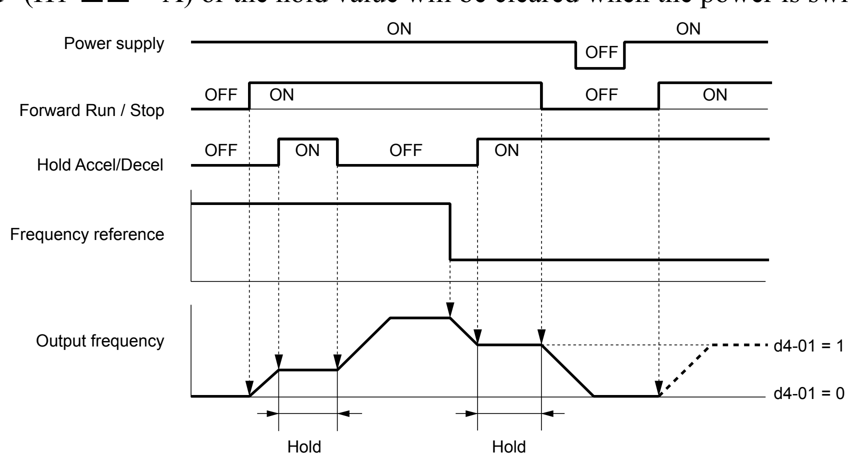


Figure 5.30 Frequency Reference Hold with Accel/Decel Hold Function

- Up/Down

  The frequency reference value will be saved when the Run command or the drive power is switched off. The drive will use the frequency reference that was saved when it restarts.

- Up/Down 2 with frequency reference from digital operator

  When a Run command is active and the Up/Down 2 command is released for longer than 5 s, the Up/Down 2 bias value is added to the frequency reference and then reset to 0. This new frequency reference is saved and will also be used to restart the drive after the power is cycled.

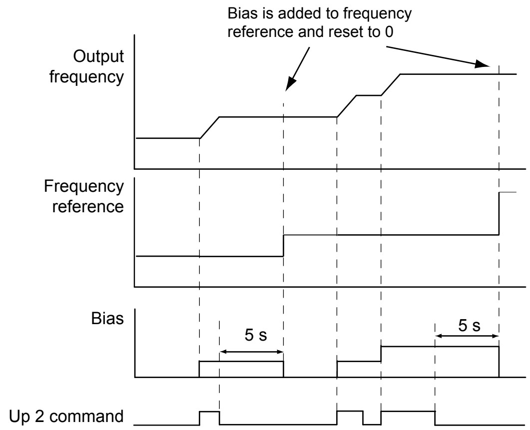


Figure 5.31 Up/Down 2 Example with Reference from Digital Operator and d4-01 = 1

- Up/Down 2 with frequency reference from input sources other than the digital operator

  When a Run command is active and the Up/Down 2 command is released for longer than 5 s, the bias value will be saved in parameter d4-06. When restarting after the power is switched off, the drive will add the value saved in d4-06 as a bias to the frequency reference.

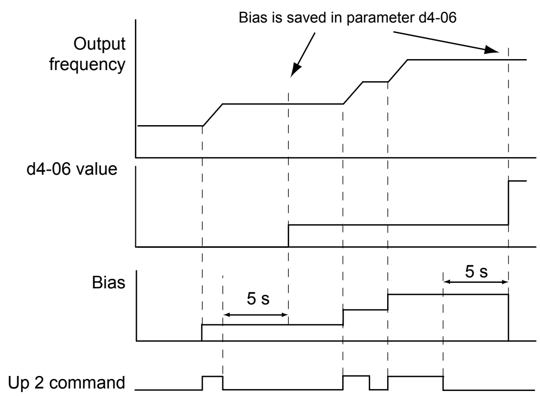


Figure 5.32 Up/Down 2 Example with Other Reference than Digital Operator and d4-01 = 1

Note: Set the limits for Up/Down 2 properly when using d4-01 = 1 in combination with the Up/Down 2 function. *Refer to d4-08: Frequency Reference Bias Upper Limit (Up/Down 2) on page 178* and *Refer to d4-09: Frequency Reference Bias Lower Limit (Up/Down 2) on page 178* for details on the limit settings.

Clearing the Saved Value

Depending on which function is used, it is possible to clear the saved frequency reference value by:

- Releasing the input programmed for Acceleration hold.
- Setting an Up or Down command while no Run command is active.
- Resetting parameter d4-06 to zero. *Refer to d4-06: Frequency Reference Bias (Up/Down 2) on page 178* for details.

■ d4-03: Frequency Reference Bias Step (Up/Down 2)

Sets the bias added to or subtracted from the frequency reference by the Up/Down 2 function.

No.	Parameter Name	Setting Range	Default
d4-03	Frequency Reference Bias Step (Up/Down 2)	0.00 to 99.99 Hz	0.00 Hz

The operation depends on the set value:

Setting d4-03 = 0.00 Hz

While the Up 2 or Down 2 command is enabled, the bias value is increased or decreased using the accel/decel times determined by parameter d4-04.

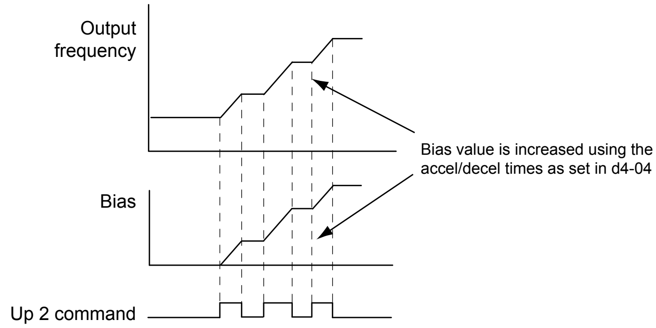


Figure 5.33 Up/Down 2 Bias when d4-03 = 0.00 Hz

Setting d4-03 ≠ 0.00 Hz

When an Up 2 or Down 2 command is enabled, the bias is increased or decreased in steps for the value set in d4-03. The frequency reference changes with the accel/decel times determined by parameter d4-04.

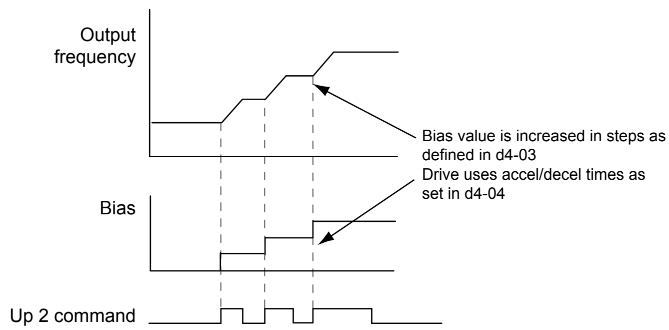


Figure 5.34 Up/Down 2 Bias when d4-03 > 0.00 Hz

■ d4-04: Frequency Reference Bias Accel/Decel (Up/Down 2)

Determines the accel/decel times used to increase or decrease the frequency reference or bias when using the Up/Down 2 function.

No.	Parameter Name	Setting Range	Default
d4-04	Frequency Reference Bias Accel/Decel (Up/Down 2)	0, 1	0

Setting 0: Current Accel/Decel Time

The drive uses the currently active accel/decel time.

Setting 1: Accel/Decel Time 4

The drive uses accel/decel time 4 set to parameters C1-07 and C1-08.

Note: The functionality of setting 1 is only accessible via MEMOBUS/Modbus communications.

■ d4-05: Frequency Reference Bias Operation Mode Selection (Up/Down 2)

Determines if the bias value is held when the Up/Down 2 inputs are both released or both enabled. The parameter is effective only when parameter d4-03 is set to 0.00.

No.	Parameter Name	Setting Range	Default
d4-05	Frequency Reference Bias Operation Mode Selection (Up/Down 2)	0, 1	0

Setting 0: Hold Bias Value

The bias value will be held if no input Up 2 or Down 2 is active.

Setting 1: Reset Bias Value

The bias is reset to 0% when inputs Up 2 and Down 2 are both on or both off. The drive will use the accel/decel time as selected in d4-04 to accelerate or decelerate to the frequency reference value.

■ d4-06: Frequency Reference Bias (Up/Down 2)

Saves the frequency reference bias value set by the Up/Down 2 function as a percentage of the maximum output frequency. The function of this parameter depends on the Up/Down 2 function configuration. This parameter is not normally used when the digital operator sets the frequency reference.

- The value set to d4-06 will be applied during run, however the value is reset when the frequency reference changes (including multi-step references) and is disabled when d4-01 = 0 and the Run command is removed.
- When d4-01 = 0 and the frequency reference is set by a source other than the digital operator, the value set in d4-06 is added to or subtracted from the frequency reference.
- When d4-01 = 1 and the frequency reference is set by a source other than the digital operator, the bias value adjusted with the Up/Down 2 inputs is stored in d4-06 when 5 s have passed after releasing the Up 2 or Down 2 command. The frequency reference will return to the value without the Up/Down 2 command.

No.	Parameter Name	Setting Range	Default
d4-06	Frequency Reference Bias (Up/Down 2)	-99.9 to 100.0%	0.0%

Conditions that Reset or Disable d4-06

- The Up/Down 2 function has not been assigned to the multi-function terminals.
- The frequency reference source has been changed (including LOCAL/REMOTE or External reference 1/2 switch over by digital inputs).
- d4-03 = 0 Hz, d4-05 = 1, and the Up/Down 2 commands are both open or both closed.
- Any changes to the maximum frequency set to E1-04.

■ d4-07: Analog Frequency Reference Fluctuation Limit (Up/Down 2)

Handles frequency reference changes while the Up 2 or Down 2 terminal is enabled. If the frequency reference changes for more than the level set to d4-07, then the bias value will be held,and the drive will accelerate or decelerate following the frequency reference. When the frequency reference is reached, the bias hold is released and the bias follows the Up/Down 2 input commands.

This parameter is applicable only if the frequency reference is set by an analog or pulse input.

No.	Parameter Name	Setting Range	Default
d4-07	Analog Frequency Reference Fluctuation Limit (Up/Down 2)	0.1 to 100.0%	0.01.%

■ d4-08: Frequency Reference Bias Upper Limit (Up/Down 2)

Sets the upper limit of the Up/Down 2 bias (monitor U6-20) and the value that can be saved in parameter d4-06. Set this parameter to an appropriate value before using the Up/Down 2 function.

Note: When the frequency reference is set by the digital operator (b1-01 = 0) and d4-01 = 1, the bias value will be added to the frequency reference if no Up/Down 2 command is received for 5 s, and will be reset to 0 afterwards. From that point, the bias can be increased up to the limit set in d4-08 again.

No.	Parameter Name	Setting Range	Default
d4-08	Frequency Reference Bias Upper Limit (Up/Down 2)	0.0 to 100.0%	1.0%

■ d4-09: Frequency Reference Bias Lower Limit (Up/Down 2)

Sets the lower limit of the Up/Down 2 bias (monitor U6-20) and the value that can be saved in parameter d4-06. Set this parameter to an appropriate value before using the Up/Down 2 function.

Note: When the frequency reference is set by the digital operator (b1-01 = 0) and d4-01 = 1, the bias value will be added to the frequency reference if no Up/Down 2 command is received for 5 s, and will be reset to 0 afterwards. If the bias is increased using the Up 2 command, it cannot be reduced with a Down 2 command when the limit set in d4-09 is 0. Set a negative lower limit in d4-09 to allow speed reduction in this situation.

No.	Parameter Name	Setting Range	Default
d4-09	Frequency Reference Bias Lower Limit (Up/Down 2)	-99.9 to 0.0%	0.0%

■ d4-10: Up/Down Frequency Reference Limit Selection

Selects how the lower frequency limit is set when using the Up/Down function. ***Refer to Setting 10, 11: Up/Down Function on page 197*** for details on the Up/Down function in combination with frequency reference limits.

No.	Parameter Name	Setting Range	Default
d4-10	Up/Down Frequency Reference Limit Selection	0, 1	0

Setting 0: Lower Limit is Determined by d2-02 or Analog Input

The higher value between d2-02 and an analog input programmed for Frequency bias (A1, A2, A3) determines the lower frequency reference limit.

Note: When using the External Reference 1/2 (H1-☐☐ = 2) to switch between the Up/Down function and an analog input as the reference source, the analog value becomes the lower reference limit when the Up/Down command is active. Set d4-10 to 1 to make the Up/Down function independent of the analog input value.

Setting 1: Lower Limit is Determined by d2-02

Only parameter d2-02 sets the lower frequency reference limit.

◆ d6: Field Weakening and Field Forcing

Field Weakening

The Field Weakening function reduces the output voltage to a predefined level to reduce the energy consumption of the motor. To activate the Field Weakening function, use a digital input programmed for H1-☐☐ = 63. Only use Field Weakening with a known and unchanging light load condition. Use the Energy Saving function (b8-☐☐ parameters) when Energy Saving for various different load conditions is required.

■ d6-01: Field Weakening Level

Sets the level to which the output voltage is reduced when Field Weakening is activated. Set as percentage of the maximum output voltage.

No.	Parameter Name	Setting Range	Default
d6-01	Field Weakening Level	0 to 100%	80%

■ d6-02: Field Weakening Frequency Limit

Sets the minimum output frequency at which field weakening can be activated. Field Weakening cannot be activated for frequencies below d6-02.

No.	Parameter Name	Setting Range	Default
d6-02	Field Weakening Frequency Limit	0 to 400.0 Hz	0.0 Hz

5.5 E: Motor Parameters

E parameters cover V/f pattern and motor data settings.

◆ E1: V/f Pattern for Motor 1

■ E1-01: Input Voltage Setting

Adjusts the levels of some protective features of the drive (overvoltage, Stall Prevention, etc.). Set this parameter to the nominal voltage of the AC power supply.

NOTICE: *Set parameter E1-01 to match the input voltage of the drive. Drive input voltage (not motor voltage) must be set in E1-01 for the protective features to function properly. Failure to set the correct drive input voltage will result in improper drive operation.*

No.	Parameter Name	Setting Range	Default
E1-01	Input Voltage Setting	155 to 255 V <1>	230 V <1>

<1> Values shown are specific to 200 V class drives. Double the value for 400 V class drives. Multiply the value by 2.875 for 600 V class drives.

E1-01 Related Values

The input voltage setting determines the overvoltage and undervoltage detection levels, the operation levels of the braking transistor, the KEB function, and the overvoltage suppression function.

Voltage	Setting Value of E1-01	ov Detection Level/Dynamic Braking Transistor Detection Level <1> (rr Detection Level)	(Approximate Values)		
			Uv Detection Level (L2-05)	Desired DC Bus Voltage during KEB (L2-11)	ov Suppression / Stall Prevention Level (L3-17)
200 V Class	All settings	410 V / 394 V	190 V	260 V	375 V
400 V Class	setting ≥ 400 V	820 V / 788 V	380 V	500 V	750 V
	setting < 400 V	820 V / 788 V	350 V	460 V	750 V
600 V Class	All settings	1178 V / 1132 V	475 V	635 V	930 V

<1> The braking transistor operation levels are valid for the drive internal braking transistor. When using a CDBR braking unit, refer to instruction manual TOBPC72060000 or TOBPC72060001.

■ V/f Pattern Settings (E1-03)

The drive uses a V/f pattern to adjust the output voltage relative to the frequency reference. There are 15 different predefined V/f patterns (setting 0 to E) from which to select, each with varying voltage profiles, saturation levels (frequency at which maximum voltage is reached), and maximum frequencies. Additionally, one custom V/f pattern is available (setting F) that requires the user to create the pattern using parameters E1-04 through E1-10.

■ E1-03: V/f Pattern Selection

Selects the V/f pattern for the drive and motor from 15 predefined patterns or creates a custom V/f pattern.

No.	Parameter Name	Setting Range	Default
E1-03	V/f Pattern Selection	0 to F	F <1>

<1> Parameter is not reset to the default value when the drive is initialized using A1-03.

Setting a Predefined V/f Pattern (Setting 0 to E)

Choose the V/f pattern that best meets the application demands from ***Table 5.16***. These settings are available only in V/f Control modes. Set the correct value to E1-03. Parameters E1-04 to E1-13 can only be monitored, not changed.

Note:
1. Setting an improper V/f pattern may result in low motor torque or increased current due to overexcitation.
2. Drive initialization does not reset parameter E1-03.

Table 5.16 Predefined V/f Patterns

Setting	Specification	Characteristic	Application
0	50 Hz	Constant torque	For general purpose applications. Torque remains constant regardless of changes to speed.
1	60 Hz		
2	60 Hz (with 50 Hz base)		
3	72 Hz (with 60 Hz base)		
4	50 Hz, Heavy Duty 2	Variable torque	For fans, pumps, and other applications where the required torque changes as a function of the speed.
5	50 Hz, Heavy Duty 1		
6	50 Hz, Heavy Duty 1		
7	50 Hz, Heavy Duty 2		
8	50 Hz, mid starting torque	High starting torque	Select high starting torque when: • Wiring between the drive and motor exceeds 150 m. • A large amount of starting torque is required. • An AC reactor is installed.
9	50 Hz, high starting torque		
A	60 Hz, mid starting torque		
B	60 Hz, high starting torque		
C	90 Hz (with 60 Hz base)	Constant output	Output voltage is constant when operating at greater than 60 Hz.
D	120 Hz (with 60 Hz base)		
E	180 Hz (with 60 Hz base)		
F <1>	60 Hz	Constant torque	For general purpose applications. Torque remains constant regardless of changes to speed.

<1> Setting F enables a custom V/f pattern by changing parameters E1-04 to E1-13. When the drive is shipped, the default values for parameters E1-04 to E1-13 are the same as those of setting 1.

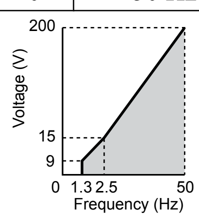
The following tables show details on predefined V/f patterns.

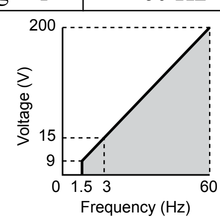
Predefined V/f Patterns for Models 2A0004 to 2A0021, 4A0002 to 4A0011, and 5A0003 to 5A0009

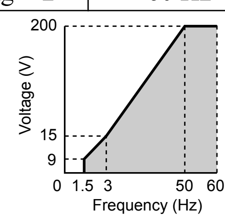
The values in the following graphs are specific to 200 V class drives. Double the values for 400 V class drives. Multiply the values by 2.875 for 600 V drives.

Table 5.17 Constant Torque Characteristics, Settings 0 to 3

Setting = 0	50 Hz	Setting = 1	60 Hz	Setting = 2	60 Hz	Setting = 3	72 Hz







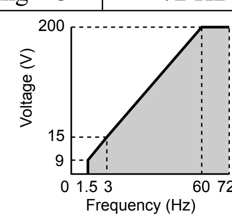
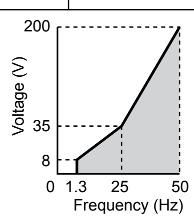
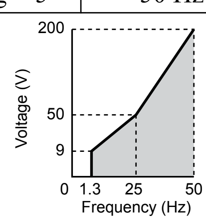
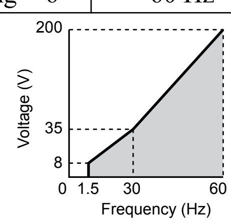


Table 5.18 Derated Torque Characteristics, Settings 4 to 7

Setting = 4	50 Hz	Setting = 5	50 Hz	Setting = 6	60 Hz	Setting = 7	60 Hz







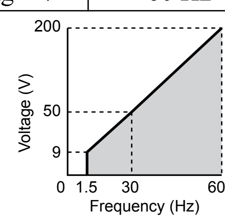
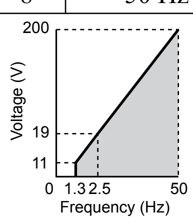
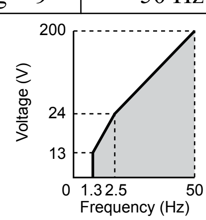
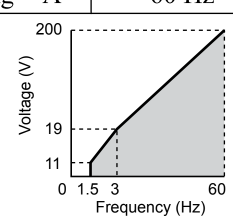


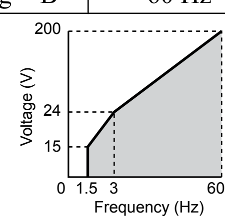
Table 5.19 High Starting Torque, Settings 8 to B

Setting = 8	50 Hz	Setting = 9	50 Hz	Setting = A	60 Hz	Setting = B	60 Hz





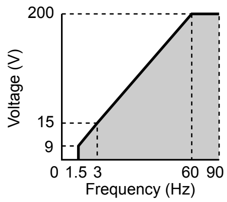
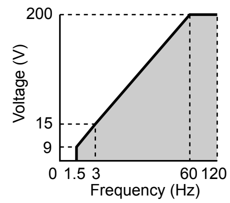
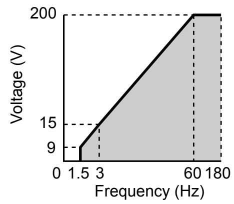
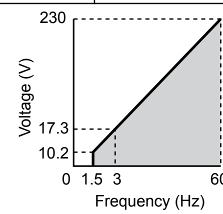




Parameter Details

5

Table 5.20 Rated Output Operation, Settings C to F

Setting = C	90 Hz	Setting = D	120 Hz	Setting = E	180 Hz	Setting = F	60 Hz
							

Predefined V/f Patterns for Models 2A0030 to 2A0211, 4A0018 to 4A0103, and 5A0011 to 5A0077

The values in the following graphs are specific to 200 V class drives. Double the values for 400 V class drives. Multiply the values by 2.875 for 600 V class drives.

Table 5.21 Rated Torque Characteristics, Settings 0 to 3

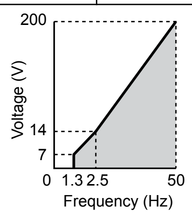
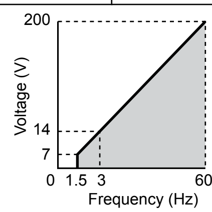
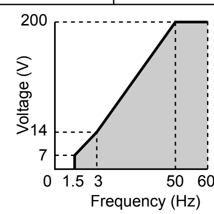
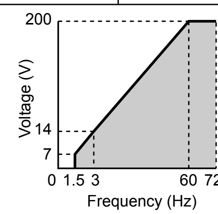
Setting = 0	50 Hz	Setting = 1	60 Hz	Setting = 2	60 Hz	Setting = 3	72 Hz
							

Table 5.22 Derated Torque Characteristics, Settings 4 to 7

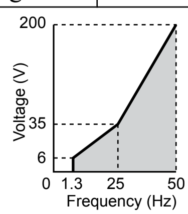
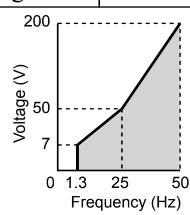
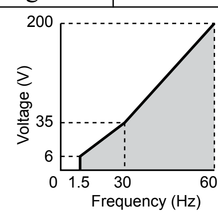
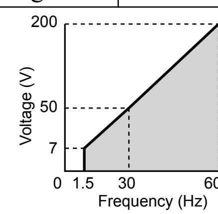
Setting = 4	50 Hz	Setting = 5	50 Hz	Setting = 6	60 Hz	Setting = 7	60 Hz
							

Table 5.23 High Starting Torque, Settings 8 to B

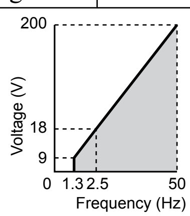
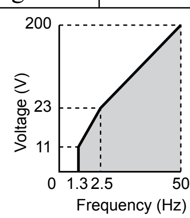
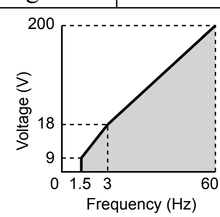
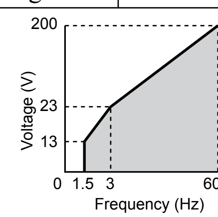
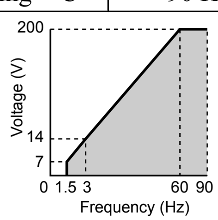
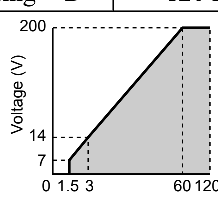
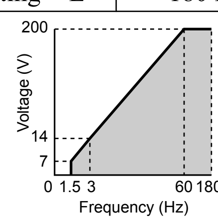
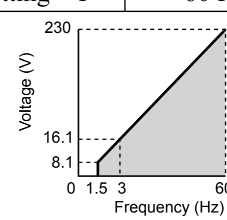
Setting = 8	50 Hz	Setting = 9	50 Hz	Setting = A	60 Hz	Setting = B	60 Hz
							

Table 5.24 Constant Output, Settings C to F

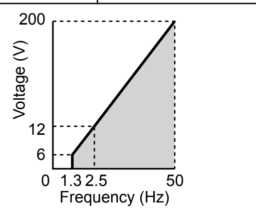
Setting = C	90 Hz	Setting = D	120 Hz	Setting = E	180 Hz	Setting = F	60 Hz
							

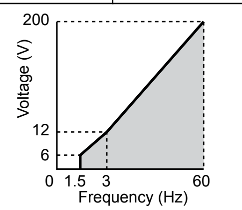
Predefined V/f Patterns for Models 2A0250 to 2A0415, 4A0139 to 4A0675, and 5A0099 to 5A0242

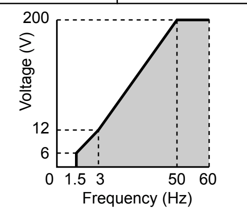
The values in the following graphs are specific to 200 V class drives. Double the values for 400 V class drives. Multiply the values by 2.875 for 600 V class drives.

Table 5.25 Rated Torque Characteristics, Settings 0 to 3

Setting = 0	50 Hz	Setting = 1	60 Hz	Setting = 2	60 Hz	Setting = 3	72 Hz







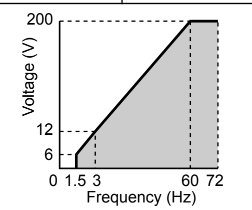
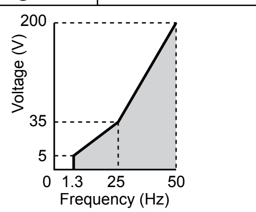
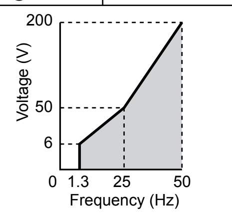
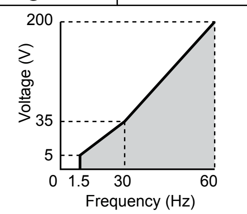


Table 5.26 Derated Torque Characteristics, Settings 4 to 7

Setting = 4	50 Hz	Setting = 5	50 Hz	Setting = 6	60 Hz	Setting = 7	60 Hz







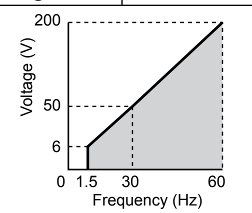
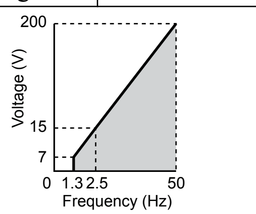
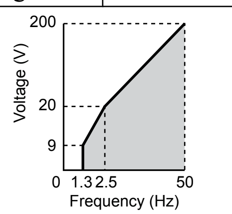
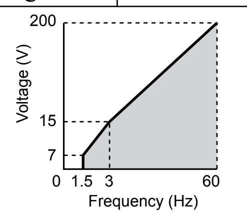


Table 5.27 High Starting Torque, Settings 8 to B

Setting = 8	50 Hz	Setting = 9	50 Hz	Setting = A	60 Hz	Setting = B	60 Hz







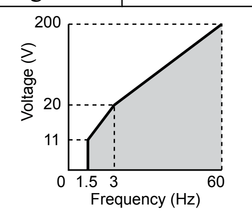
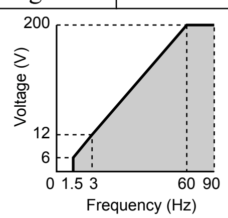
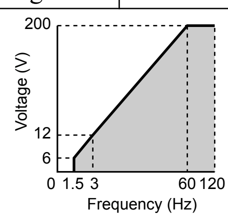
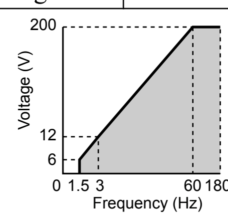


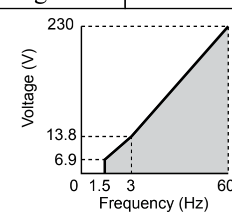
Table 5.28 Constant Output, Settings C to F

Setting = C	90 Hz	Setting = D	120 Hz	Setting = E	180 Hz	Setting = F	60 Hz









Setting a Custom V/f Pattern (Setting F: Default)

Setting parameter E1-03 to F allows the user to set up a custom V/f pattern by changing parameters E1-04 to E1-13.

When initialized, the default values for parameters E1-04 to E1-13 will be equal to Predefined V/f pattern 1.

■ V/f Pattern Settings E1-04 to E1-13

If E1-03 is set to a preset V/f pattern (i.e., a value other than F), the user can monitor the V/f pattern in parameters E1-04 through E1-13. To create a new V/f pattern, set E1-03 to F. *Refer to V/f Pattern on page 184* for an example custom V/f pattern.

No.	Parameter Name	Setting Range	Default
E1-04	Maximum Output Frequency	40.0 to 400.0 Hz	60.0 Hz
E1-05	Maximum Voltage	0.0 to 255.0 V <4>	575.0 V
E1-06	Base Frequency	0.0 to [E1-04]	60.0 Hz
E1-07	Middle Output Frequency	0.0 to [E1-04]	3.0 Hz
E1-08	Middle Output Frequency Voltage	0.0 to 255.0 V <4>	15.0 V
E1-09	Minimum Output Frequency	0.0 to [E1-04]	1.5 Hz
E1-10	Minimum Output Frequency Voltage	0.0 to 255.0 V <4>	9.0 V

Parameter Details

5

No.	Parameter Name	Setting Range	Default
E1-11	Middle Output Frequency 2	0.0 to [E1-04]	0.0 Hz <6>
E1-12	Middle Output Frequency Voltage 2	0.0 to 255.0 V <4>	0.0 V <5> <6>
E1-13	Base Voltage	0.0 to 255.0 V <4>	0.0 V <5> <7>

<4> Values shown are specific to 200 V class drives. Double the value for 400 V class drives. Multiply the value by 2.875 for 600 V class drives.
<5> The drive changes these settings when Auto-Tuning is performed (Rotational Auto-Tuning, Stationary Auto-Tuning 1, 2).
<6> Parameter ignored when E1-11 and E1-12 are set to 0.0.
<7> E1-13 and E1-05 are set to the same value when Auto-Tuning is performed.

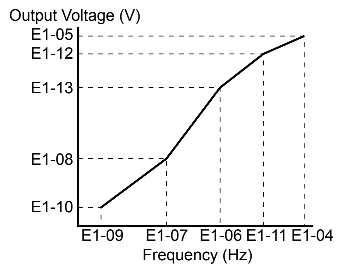


Figure 5.35 V/f Pattern

Note:
1. The following condition must be true when setting up the V/f pattern: E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04
2. To make the V/f pattern a straight line below E1-06, set E1-09 equal to E1-07. In this case the E1-08 setting is disregarded.
3. E1-03 is unaffected when the drive is initialized, but E1-04 through E1-13 return to their default values.
4. Only use E1-11, E1-12, and E1-13 to fine-tune the V/f pattern in the constant output range. These parameters rarely need to be changed.

◆ E2: Motor 1 Parameters

These parameters contain the motor data needed for motor 1. Performing Auto-Tuning (including Rotational Auto-Tuning and Stationary Auto-Tuning 1 and 2) automatically sets these parameters. ***Refer to Auto-Tuning Fault Detection on page 305*** for details if Auto-Tuning cannot be performed.

■ E2-01: Motor Rated Current

Provides motor control, protects the motor, and calculates torque limits. Set E2-01 to the full load amps (FLA) stamped on the motor nameplate. If Auto-Tuning completes successfully, the value entered to T1-04 will automatically be saved to E2-01.

No.	Parameter Name	Setting Range	Default
E2-01	Motor Rated Current	10% to 200% of the drive rated current	Determined by o2-04

Note:
1. The number of decimal places in the parameter value depends on the drive model. This value has two decimal places (0.01 A) if the drive is set for a maximum applicable motor capacity up to and including 11 kW, and one decimal place (0.1 A) if the maximum applicable motor capacity is higher than 11 kW. ***Refer to Power Ratings on page 372*** for details.
2. An oPE02 error will occur if the motor rated current in E2-01 is set lower than the motor no-load current in E2-03. Set E2-03 correctly to prevent this error.

■ E2-02: Motor Rated Slip

Sets the motor rated slip in Hz to provide motor control, protect the motor, and calculate torque limits. This value is automatically set during Auto-Tuning (Rotational Auto-Tuning, Stationary Auto-Tuning 1 and 2).

No.	Parameter Name	Setting Range	Default
E2-02	Motor Rated Slip	0.00 to 20.00 Hz	Determined by o2-04

If Auto-Tuning cannot be performed, calculate the motor rated slip using the information written on the motor nameplate and the formula below:

E2-02 = f - (n × p)/120

(f: rated frequency (Hz), n: rated motor speed (r/min), p: number of motor poles)

■ E2-03: Motor No-Load Current

Set the no-load current for the motor in amperes when operating at the rated frequency and the no-load voltage. The drive sets E2-03 during the Auto-Tuning process (Rotational Auto-Tuning and Stationary Auto-Tuning 1, 2). The motor no-load current listed in the motor test report can also be entered to E2-03 manually. Contact the motor manufacturer to receive a copy of the motor test report.

No.	Parameter Name	Setting Range	Default
E2-03	Motor No-Load Current	0 to [E2-01] (unit: 0.01 A)	Determined by o2-04

Note: The number of decimal places in the parameter value depends on the drive model 1. This value has two decimal places (0.01 A) if the drive is set for a maximum applicable motor capacity up to and including 11 kW, and one decimal place (0.1 A) if the maximum applicable motor capacity is higher than 11 kW. ***Refer to Power Ratings on page 372*** for details.

■ E2-04: Number of Motor Poles

Set the number of motor poles to E2-04. If Auto-Tuning completes successfully, the value entered to T1-06 will automatically be saved to E2-04.

No.	Parameter Name	Setting Range	Default
E2-04	Number of Motor Poles	2 to 48	4

■ E2-05: Motor Line-to-Line Resistance

Sets the line-to-line resistance of the motor stator winding. If Auto-Tuning completes successfully, this value is automatically calculated. Enter this value as line-to-line and not for each motor phase.

If Auto-Tuning is not possible, contact the motor manufacturer to find out the line-to-line resistance or measure it manually. When using the manufacturer motor test report, calculate E2-05 by one of the formulas below:

- E-type insulation: Multiply 0.92 times the resistance value (Ω) listed on the test report at 75 °C.
- B-type insulation: Multiply 0.92 times the resistance value (Ω) listed on the test report at 75 °C.
- F-type insulation: Multiply 0.87 times the resistance value (Ω) listed on the test report at 115 °C.

No.	Parameter Name	Setting Range	Default
E2-05	Motor Line-to-Line Resistance	0.000 to 65.000 mΩ	Determined by o2-04

■ E2-06: Motor Leakage Inductance

Sets the voltage drop due to motor leakage inductance as a percentage of motor rated voltage. This value is automatically set during Auto-Tuning (Rotational Auto-Tuning, Stationary Auto-Tuning 1, 2).

No.	Parameter Name	Setting Range	Default
E2-06	Motor Leakage Inductance	0.0 to 40.0%	Determined by o2-04

■ E2-10: Motor Iron Loss for Torque Compensation

Sets the motor iron loss in watts.

No.	Parameter Name	Setting Range	Default
E2-10	Motor Iron Loss for Torque Compensation	0 to 65535 W	Determined by o2-04

■ E2-11: Motor Rated Power

Sets the motor rated power in kW. If Auto-Tuning completes successfully, the value entered to T1-02 will automatically be saved to E2-11.

No.	Parameter Name	Setting Range	Default
E2-11	Motor Rated Power	0.00 to 650.00 kW	Determined by o2-04

■ Setting Motor Parameters Manually

Follow the instructions below when setting motor-related parameters manually instead of Auto-Tuning. Refer to the motor test report included with the motor to ensure the correct data is entered into the drive.

Set the Motor Rated Current

Enter the motor rated current listed on the nameplate of the motor to E2-01.

Set the Motor Rated Slip

Calculate the motor rated slip using the base speed listed on the motor nameplate. Refer to the formula below, then enter that value to E2-02.

Motor rated slip = rated frequency [Hz] – base speed [r/min] × (no. of motor poles) / 120

Set the No-Load Current

Enter the no-load current at rated frequency and rated voltage to E2-03. This information is not usually listed on the nameplate. Contact the motor manufacturer if the data cannot be found.

The default setting of the no-load current is for performance with a 4-pole Yaskawa motor.

Set the Line-to-Line Resistance

E2-05 is normally set during Auto-Tuning. If Auto-Tuning cannot be performed, contact the motor manufacturer to determine the correct resistance between motor lines. The motor test report can also be used to calculate this value using the formulas below:

- E-type insulation: Multiply 0.92 times the resistance value (Ω) listed on the test report at 75 °C.
- B-type insulation: Multiply 0.92 times the resistance value (Ω) listed on the test report at 75 °C.
- F-type insulation: Multiply 0.87 times the resistance value (Ω) listed on the test report at 115 °C.

Set the Motor Leakage Inductance

The motor leakage inductance set to E2-06 determines the amount of voltage drop relative to the motor rated voltage. Enter this value for motors with a low degree of inductance, such as high-speed motors. This information is usually not listed on the motor nameplate. Contact the motor manufacturer if the data cannot be found.

Set the Motor Iron-Core Saturation Coefficient 1, 2

E2-07 and E2-08 are set when Auto-Tuning is performed.

Set the Motor Iron Loss for Torque Compensation

Enter this value in watts to E2-10. The drive uses this setting to improve the precision of torque compensation.

5.6 F: Option Settings

◆ F4: Analog Monitor Card Settings

These parameters set the drive for operation with the analog output option card AO-A3. Refer to the instruction manual packaged with the option card for specific details on installation, wiring, input signal level selection, and parameter setup.

■ F4-01, F4-03: Terminal V1, V2 Monitor Selection

Selects the data to output from analog terminal V1. Enter the final three digits of U□-□□to determine which monitor data is output from the option card. Some monitors are only available in certain control modes.

No.	Parameter Name	Setting Range	Default
F4-01	Terminal V1 Monitor Selection	000 to 999	102
F4-03	Terminal V2 Monitor Selection	000 to 999	103

■ F4-02, F4-04, F4-05, F4-06: Terminal V1, V2 Monitor Gain and Bias

Parameters F4-02 and F4-04 determine the gain, while parameters F4-05 and F4-06 set the bias. These parameters are set as a percentage of the output signal from V1 and V2 where 100% equals 10 V output. The terminal output voltage is limited to 10 V.

No.	Parameter Name	Setting Range	Default
F4-02	Terminal V1 Monitor Gain	-999.9 to 999.9%	100.0%
F4-04	Terminal V2 Monitor Gain	-999.9 to 999.9%	50.0%
F4-05	Terminal V1 Monitor Bias	-999.9 to 999.9%	0.0%
F4-06	Terminal V2 Monitor Bias	-999.9 to 999.9%	0.0%

Using Gain and Bias to Adjust Output Signal Level

The output signal is adjustable while the drive is stopped.

Terminal V1

1. View the value set to F4-02 (Terminal V1 Monitor Gain) on the digital operator. A voltage equal to 100% of the parameter being set in F4-01 will be output from terminal V1.
2. Adjust F4-02 viewing the monitor connected to the terminal V1.
3. View the value set to F4-05 on the digital operator, terminal V1 will output a voltage equal to 0% of the parameter being set in F4-01.
4. Adjust F4-05 viewing the output signal on the terminal V1.

Terminal V2

1. View the value set to F4-02 (Terminal V2 Monitor Gain) on the digital operator. A voltage equal to 100% of the parameter being viewed in F4-03 will be output from terminal V2.
2. Adjust F4-04 viewing the monitor connected to the terminal V2.
3. View the value set to F4-06 on the digital operator, terminal V2 will output a voltage equal to 0% of the parameter being set in F4-03.
4. Adjust F4-06 viewing the output signal on the terminal V2.

■ F4-07, F4-08: Terminal V1, V2 Signal Level

Sets the output signal level for terminals V1 and V2.

No.	Parameter Name	Setting Range	Default
F4-07	Terminal V1 Signal Level	0, 1	0
F4-08	Terminal V2 Signal Level	0, 1	0

Setting 0: 0 to 10 V

Setting 1: -10 to 10 V

◆ F6: Communication Option Card

These parameters configure communication option cards and communication fault detection methods.

Some parameters apply to all communication option cards and some parameters apply to certain network options only. The option cards are applicable to the parameter rows marked with an “O”.

Parameter	Communication Protocol				
	CC-Link	MECHATROLINK-II	PROFIBUS-DP	CANopen	DeviceNet
F6-01 to F6-03, F6-06 to F6-08	O	O	O	O	O
F6-04, F6-10, F6-11, F6-14	O	–	–	–	–
F6-20 to F6-26	–	O	–	–	–
F6-30 to F6-32	–	–	O	–	–
F6-35 to F6-36	–	–	–	O	–
F6-50 to F6-63	–	–	–	–	O

■ F6-01: Communications Error Operation Selection

Determines drive operation when a communication error occurs.

No.	Parameter Name	Setting Range	Default
F6-01	Communications Error Operation Selection	0 to 3	1

Setting 0: Ramp to stop (uses the deceleration time set to C1-02)

Setting 1: Coast to stop

Setting 2: Fast Stop (uses the Fast Stop time set to C1-09)

Setting 3: Alarm only (continue operation)

■ F6-02: External Fault from Comm. Option Detection Selection

Determines the detection method of an external fault initiated by a communication option (EF0).

No.	Parameter Name	Setting Range	Default
F6-02	External Fault from Comm. Option Detection Selection	0, 1	0

Setting 0: Always detected

Setting 1: Detection during Run only

■ F6-03: External Fault from Comm. Option Operation Selection

Determines drive operation when an external fault is initiated by a communication option (EF0).

No.	Parameter Name	Setting Range	Default
F6-03	External Fault from Comm. Option Operation Selection	0 to 3	1

Setting 0: Ramp to stop

Setting 1: Coast to stop

Setting 2: Fast Stop

Setting 3: Alarm only (continue operation)

■ F6-07: NetRef/ComRef Function Selection

Selects the treatment of multi-step speed inputs when the NetRef command is set.

No.	Parameter Name	Setting Range	Default
F6-07	NetRef/ComRef Function Selection	0, 1	0

Setting 0: Multi-step speed operation disabled

Multi-step speed input frequency references are disabled when the NetRef command is selected.

Setting 1: Multi-step speed operation enabled

Multi-step speed inputs are still active and can override the frequency reference from the communications option even when the NetRef command is selected.

■ F6-08: Reset Communication Parameters

Determines whether F6-□□ communication-related parameters are reset after initialization.

No.	Parameter Name	Setting Range	Default
F6-08	Reset Communication Parameters	0, 1	0

Setting 0: Do not reset F6-□□ parameters after initialization using A1-03

Setting 1: Reset F6-□□ parameters after initialization using A1-03

Note: F6-08 is not reset when the drive is initialized.

◆ CC-Link Parameters

Parameters F6-04, F6-10, F6-11, and F6-14 set the drive to operate on a CC-Link network.

■ F6-04: bUS Error Detection Time

Sets the delay time for bUS error detection.

No.	Parameter Name	Setting Range	Default
F6-04	bUS Error Detection Time	0.0 to 5.0 s	2.0 s

■ F6-10: CC-Link Node Address

Sets the node address of a CC-Link option board.

No.	Parameter Name	Setting Range	Default
F6-10	CC-Link Node Address	0 to 64	0

■ F6-11: CC-Link Communication Speed

Sets the communication speed for a CC-Link option card.

No.	Parameter Name	Setting Range	Default
F6-11	CC-Link Communication Speed	0 to 4	0

Settings:

F6-11	Communication Speed	F6-11	Communication Speed
0	156 kbps	3	5 Mbps
1	625 kbps	4	10 Mbps
2	2.5 Mbps	–	–

■ F6-14: CC-Link bUS Error Auto Reset

Selects whether a bUS error can be automatically reset if automatic fault retry is enabled.

No.	Parameter Name	Setting Range	Default
F6-14	CC-Link bUS Error Auto Reset	0, 1	0

Setting 0: Disabled, auto reset not possible

Setting 1: Enabled, auto reset possible

◆ MECHATROLINK Parameters

Parameters F6-20 through F6-26 run the MECHATROLINK options.

■ F6–20: MECHATROLINK Station Address

No.	Parameter Name	Setting Range	Default
F6–20	MECHATROLINK Station Address	20, 3F	21

■ F6-21: MECHATROLINK Frame Size

No.	Parameter Name	Setting Range	Default
F6–21	MECHATROLINK Frame Size	0, 1	0

Setting 0: 32 byte

Setting 1: 17 byte

■ F6-22: MECHATROLINK Link Speed

No.	Parameter NamMECHATROLINK Frame Size	Setting Range	Default
F6–22	MECHATROLINK Link Speed	0, 1	0

Setting 0: 10 Mbps

Setting 1: 4 Mbps

■ F6-23 – F6-24: MECHATROLINK Monitor Selection

Sets the output signal level for terminals V1 and V2.

No.	Parameter Name	Setting Range	Default
F6–23	MECHATROLINK –II Monitor Selection (E)	0, FFFF	0
F6–24	MECHATROLINK –II Monitor Selection (F)	0, FFFF	0

■ F6-25: Operation Selection at Watchdog Timer Error

No.	Parameter Name	Setting Range	Default
F6–25	Operation Selection at Watchdog Timer Error (E5)	0 to 3	1

Setting 0: Ramp to stop. Decelerate using the deceleration time in C1-02.

Setting 1: Coast to stop.

Setting 2: Fast stop. Decelerate using the deceleration time in C1-09.

Setting 3: Alarm only

■ F6-26: MECHATROLINK bUS Errors Detected

Sets the number of option communicaiton errors (bUS).

No.	Parameter Name	Setting Range	Default
F6-26	MECHATROLINK bUS Errors Detected	2 to 10	2

◆ PROFIBUS-DP Parameters

Parameters F6-30 through F6-32 set the drive to run on a PROFIBUS-DP network.

■ F6-30: PROFIBUS-DP Node Address

Sets the node address of a PROFIBUS-DP option card.

No.	Parameter Name	Setting Range	Default
F6-30	PROFIBUS-DP Node Address	0 to 125	0

■ F6-31: PROFIBUS-DP Clear Mode Selection

Determines the operation when a Clear Mode command is received.

No.	Parameter Name	Setting Range	Default
F6-31	PROFIBUS-DP Clear Mode Selection	0, 1	0

Setting 0: Reset

Resets the drive operation (frequency reference, inputs, outputs etc.).

Setting 1: Maintain the previous state

Returns the drive status to the state prior to receiving the command.

■ F6-32: PROFIBUS-DP Data Format Selection

Selects the data format used for PROFIBUS-DP communication.

No.	Parameter Name	Setting Range	Default
F6-32	PROFIBUS-DP Data Format Selection	0, 1	0

Setting 0: PPO-type data format

Setting 1: Conventional data format

◆ CANopen Parameters

Parameters F6-35 and F6-36 set the drive to operate on a CANopen network.

■ F6-35: CANopen Node ID Selection

Selects the node ID of a CANopen option board.

No.	Parameter Name	Setting Range	Default
F6-35	CANopen Node ID Selection	0 to 126	0

■ F6-36: CANopen Communication Speed

Sets the communication speed for a CANopen option card.

No.	Parameter Name	Setting Range	Default
F6-36	CANopen Communication Speed	0 to 8	6

Settings:

F6-36	Communication Speed	F6-36	Communication Speed
0	Auto detection	5	250 kbps
1	10 kbps	6	500 kbps
2	20 kbps	7	800 kbps
3	50 kbps	8	1 Mbps
4	125 kbps	–	–

◆ DeviceNet Parameters

Parameters F6-50 through F6-63 set the drive to operate on a DeviceNet network.

■ F6-50: DeviceNet MAC Address

Sets the MAC address for a DeviceNet option card.

No.	Parameter Name	Setting Range	Default
F6-50	DeviceNet MAC Address	0 to 64	64

■ F6-51: DeviceNet Communication Speed

Sets the communication speed for a DeviceNet option card.

To assign the baud rate for the drive from the upper controller, set F6-51 = 3.

To make the drive detect the network speed, set F6-51 = 4. The drive will automatically adjust itself after detecting the network speed.

No.	Parameter Name	Setting Range	Default
F6-51	DeviceNet Communication Speed	0 to 4	4

Settings:

F6-51	Communication Speed	F6-51	Communication Speed
0	125 kbps	3	Adjustable from Network
1	250 kbps	4	Auto detection
2	500 kbps	–	–

■ F6-52: DeviceNet PCA Setting

Defines the format for data the drive receives from the DeviceNet master.

No.	Parameter Name	Setting Range	Default
F6-52	DeviceNet PCA Setting	0 to 255	21

■ F6-53: DeviceNet PPA Setting

Defines the format for data sent from the drive to the DeviceNet master.

No.	Parameter Name	Setting Range	Default
F6-53	DeviceNet PPA Setting	0 to 255	71

■ F6-54: DeviceNet Idle Mode Fault Detection

Determines whether the drive triggers an EF0 fault when no data is received from the master (e.g., when the master is idling).

No.	Parameter Name	Setting Range	Default
F6-54	DeviceNet Idle Mode Fault Detection	0, 1	0

Setting 0: Enabled

Setting 1: Disabled, no fault detection

■ F6-55: DeviceNet Baud Rate Monitor

Displays the baud rate currently being used for network communications. F6-55 is used only as a monitor.

No.	Parameter Name	Setting Range	Default
F6-55	DeviceNet Baud Rate Monitor	0 to 2 (read only)	0

Settings:

F6-55	Communication Speed	F6-55	Communication Speed
0	125 kbps	2	500 kbps
1	250 kbps	–	–

■ F6-56 to F6-61: DeviceNet Scaling Factors

These parameters define scaling factors for drive monitors in the DeviceNet Class ID 2AH - AC/DC Drive Object.

No.	Parameter Name	Setting Range	Default
F6-56	DeviceNet Speed Scaling	-15 to 15	0
F6-57	DeviceNet Current Scaling	-15 to 15	0
F6-58	DeviceNet Torque Scaling	-15 to 15	0
F6-59	DeviceNet Power Scaling	-15 to 15	0
F6-60	DeviceNet Voltage Scaling	-15 to 15	0
F6-61	DeviceNet Time Scaling	-15 to 15	0

Setting

The monitor value in the AC/DC Drive Object 2AH is calculated by:
AC/DC Drive Object 2AH Monitor = Drive Value × 2^{Scaling}

Example:

If the drive output frequency monitor (U1-02) is 5.00 and the scaling is set to F6-56 = 6, then the value in the AC/DC Drive Object 2AH, Instance 1, Attribute 7 would be 500 × 2^6 = 32000.

■ F6-62: DeviceNet Heartbeat Interval

Sets the heartbeat interval for DeviceNet communications. A setting of 0 disables the heartbeat function.

No.	Parameter Name	Setting Range	Default
F6-62	DeviceNet Heartbeat Interval	0 to 10	0

■ F6-63: DeviceNet Network MAC ID

Displays the MAC ID assigned to the drive. F6-63 is used only as a monitor.

No.	Parameter Name	Setting Range	Default
F6-63	DeviceNet Network MAC ID	0 to 63 (read only)	63

■ F6-64 to F6-71: Dynamic Assembly Parameters (Reserved)

5.7 H: Terminal Functions

H parameters assign functions to the external terminals.

◆ H1: Multi-Function Digital Inputs

■ H1-01 to H1-08: Functions for Terminals S1 to S8

These parameters assign functions to the multi-function digital inputs. The various functions and settings are listed in ***Table 5.29***.

No.	Parameter Name	Setting Range	Default
H1-01	Multi-Function Digital Input Terminal S1 Function Selection	1 to 9F	40 (F) <1> : Forward Run Command (2-Wire sequence)
H1-02	Multi-Function Digital Input Terminal S2 Function Selection	1 to 9F	41 (F) <1> : Reverse Run Command (2-Wire sequence)
H1-03	Multi-Function Digital Input Terminal S3 Function Selection	0 to 9F	24: External Fault
H1-04	Multi-Function Digital Input Terminal S4 Function Selection	0 to 9F	14: Fault Reset
H1-05	Multi-Function Digital Input Terminal S5 Function Selection	0 to 9F	3 (0) <1> : Multi-Step Speed Reference 1
H1-06	Multi-Function Digital Input Terminal S6 Function Selection	0 to 9F	4 (3) <1> : Multi-Step Speed Reference 2
H1-07	Multi-Function Digital Input Terminal S7 Function Selection	0 to 9F	6 (4) <1> : Jog Reference Selection
H1-08	Multi-Function Digital Input Terminal S8 Function Selection	0 to 9F	8: (6) <1> : External Baseblock Command

<1> Number appearing in parenthesis is the default value after performing a 3-Wire initialization (A1-03 = 3330).

Table 5.29 Multi-Function Digital Input Terminal Settings

Setting	Function	Page	Setting	Function	Page
0	3-Wire Sequence	*195*	32	Multi-Step Speed Reference 4	*200*
1	LOCAL/REMOTE Selection	*195*	34	PID Soft Starter Cancel	*200*
2	External Reference 1/2 Selection	*196*	35	PID Input Level Selection	*200*
3	Multi-Step Speed Reference 1	*196*	40	Forward Run Command (2-Wire sequence)	*201*
4	Multi-Step Speed Reference 2		41	Reverse Run Command (2-Wire sequence)	
5	Multi-Step Speed Reference 3		42	Run Command (2-Wire sequence 2)	*201*
6	Jog reference Selection	*196*	43	FWD/REV Command (2-Wire sequence 2)	
7	Accel/Decel Time Selection 1	*196*	47	Node Setup	*201*
8	Baseblock Command (N.O.)	*196*	51	Disable Sequence Timers	*201*
9	Baseblock Command (N.C.)		52	Cancel Active Sequence Timer	*201*
A	Accel/Decel Ramp Hold	*196*	60	DC Injection Braking Command	*201*
B	Drive Overheat Alarm (oH2)	*197*	61	External Speed Search Command 1	*201*
C	Analog Terminal Input Selection	*197*	62	External Speed Search Command 2	*201*
F	Through Mode	*197*	63	Field Weakening	*202*
10	Up Command	*197*	65	KEB Ride-Thru 1 (N.C.)	*202*
11	Down Command		66	KEB Ride-Thru 1 (N.O.)	
12	Forward Jog	*198*	67	Communications Test Mode	*202*
13	Reverse Jog		68	High Slip Braking (HSB)	*202*
14	Fault Reset	*198*	6A	Drive Enabled	*202*
15	Fast Stop (N.O.)	*198*	75	Up 2 Command	*202*
17	Fast Stop (N.C.)	*198*	76	Down 2 Command	
18	Timer Function Input	*199*	7A	KEB Ride-Thru 2 (N.C.)	*203*
19	PID Disable	*199*	7B	KEB Ride-Thru 2 (N.O.)	
1A	Accel/Decel Time Selection 2	*199*	A8	Secondary PI Disable (N.O.)	*203*
1B	Program Lockout	*199*	A9	Secondary PI Disable (N.C.)	*203*
1E	Reference Sample Hold	*199*	AA	Secondary PI Inverse Operation	*203*
20 to 2F	External Fault	*200*	AB	Secondary PI Integral Reset	*203*
30	PID Integral Reset	*200*	AC	Secondary PI Integral Hold	*203*
31	PID Integral Hold	*200*	AD	Select Secondary PI Parameters	*204*

Setting	Function	Page	Setting	Function	Page
AF	Emergency Override Forward Run	204	B0	Emergency Override Reverse Run	204

Setting 0: 3-Wire Sequence

The digital input programmed for 3-Wire control becomes the forward/reverse directional input, S1 becomes the Run command input, and S2 becomes the Stop command input.

The drive starts the motor when the input S1 set for the Run command closes for longer than 2 ms. The drive stops the operation when the Stop input S2 releases for 2 ms. When the digital input programmed for a forward/reverse operation is open, the drive is set for forward operation. When the digital input is closed, the drive is set for reverse operation.

Note: Input the Run and Stop commands via S1 and S2 when selecting a 3-Wire sequence.

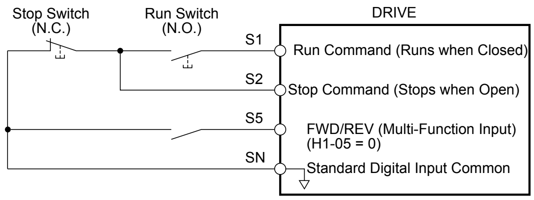


Figure 5.36 3-Wire Sequence Wiring Diagram

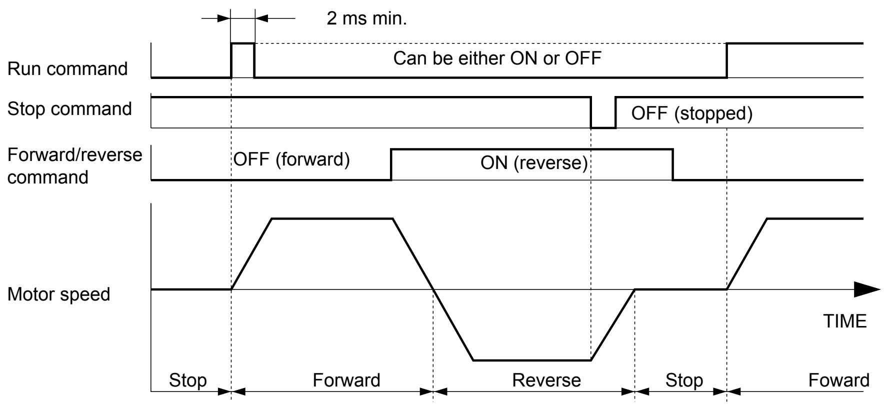


Figure 5.37 3-Wire Sequence

Note:
1. The Run command must be closed for more than 2 ms.
2. If the Run command is active at power up and b1-17 = 0 (Run command at power up not accepted), the Run LED will flash to indicate that protective functions are operating. If required by the application, set b1-17 to 1 to automatically issue the Run command upon drive power up.

WARNING! *Sudden Movement Hazard. Ensure start/stop and safety circuits are wired properly and in the correct state before applying power to the drive. Failure to comply could result in death or serious injury from moving equipment.*

WARNING! *Sudden Movement Hazard. The drive may start unexpectedly in reverse direction after power up if it is wired for 3-Wire sequence but set up for 2-Wire sequence (default). Make sure b1-17 is set to "0" (drive does not accept a Run command active at power up). When initializing the drive use 3-Wire initialization. Failure to comply could result in death or serious injury from moving equipment.*

Setting 1: LOCAL/REMOTE Selection

This setting allows the input terminal to determine if the drive will run in LOCAL mode or REMOTE mode.

Status	Description
Closed	LOCAL: Frequency reference and Run command are input from the digital operator.
Open	REMOTE: Frequency reference and Run command are input from the selected external reference. If a digital input set to H1-☐☐ = 2 is active, they will be read from external reference source 2 (b1-15 and b1-16). In all other cases they will be read from external reference source 1 (b1-01 and b1-02).

Note:
1. The LO/RE key on the digital operator is disabled when one of the multi-function input terminals is set to for LOCAL/REMOTE.
2. When the drive is set to LOCAL, the LO/RE LED will light.
3. The default setting of the drive does not allow switching between LOCAL and REMOTE during run. To allow the drive to switch between LOCAL and REMOTE during run, *Refer to b1-07: LOCAL/REMOTE Run Selection on page 141*.

Parameter Details

5

Setting 2: External Reference 1/2 Selection

This function switches the Run command and frequency reference source between External reference 1 and 2 if the drive is in the REMOTE mode.

Status	Description
Open	External reference 1 is used (defined by parameters b1-01 and b1-02)
Closed	External reference 2 is used (defined by parameters b1-15 and b1-16)

Note: Default drive settings do not allow switching between External reference 1 and 2 during run. *Refer to b1-07: LOCAL/REMOTE Run Selection on page 141* if this feature is required by the application.

Setting 3 to 5: Multi-Step Speed Reference 1 to 3

Switches multi-step speed frequency references d1-01 to d1-08 by digital inputs. *Refer to d1: Frequency Reference on page 171* for details.

Setting 6: Jog Reference Selection

The Jog frequency set in parameter d1-17 becomes the frequency reference when the input terminal closes. *Refer to d1: Frequency Reference on page 171* for details.

Setting 7: Accel/Decel Time Selection 1

Switches between accel/decel times 1 (C1-01 and C1-02) and 2 (C1-03 and C1-04). *Refer to C1-01 to C1-04: Accel, Decel Times 1 and 2 on page 166* for details.

Setting 8, 9: Baseblock Command (N.O., N.C.)

When the drive receives a baseblock command, the output transistors stop switching, the motor coasts to stop, and a bb alarm flashes on the digital operator to indicate baseblock. When baseblock ends while a Run command is active, the drive performs Speed Search to restart the motor.

DIgital Input Function	Drive Operation	
	Input Open	Input Closed
Setting 8 (N.C.)	Baseblock (Interrupt output)	Normal operation
Setting 9 (N.O.)	Normal operation	Baseblock (Interrupt output)

WARNING! *Sudden Movement Hazard. When using a mechanical holding brake with the drive in a lifting application, close the brake when the drive output is cut off by a baseblock command triggered by one of the input terminals. Failure to comply will result in a slipping load from the motor suddenly coasting when the baseblock command is entered and may cause serious injury or death.*

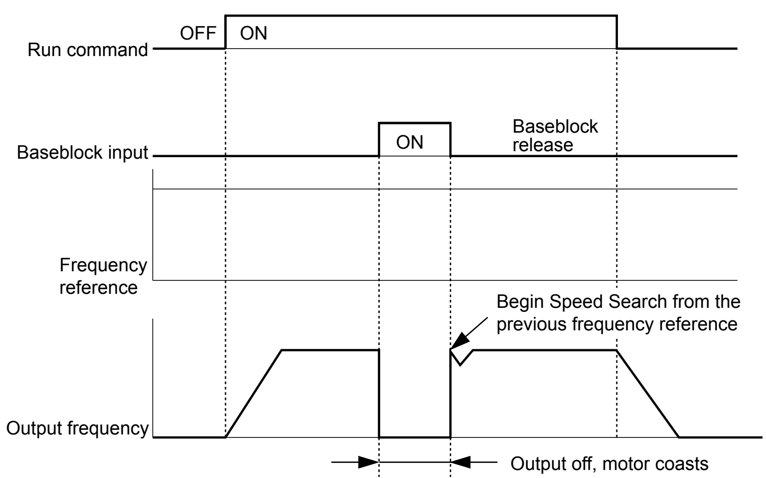


Figure 5.38 Baseblock Operation During Run

Setting A: Accel/Decel Ramp Hold

When the digital input programmed for the Accel/decel ramp hold function closes, the drive locks (holds) the output frequency. Acceleration or deceleration resumes when the input is reopened.

If the Accel/decel ramp hold function is enabled (d4-01 = 1), the drive saves the output frequency to memory when the Ramp Hold input is closed. When the drive is restarted after stop or after power supply interruption, the saved output frequency becomes the frequency reference (provided that the Accel/decel ramp hold input is still closed). *Refer to d4-01: Frequency Reference Hold Function Selection on page 175* for details.

Setting B: Drive Overheat Alarm (oH2)

Triggers an oH2 alarm when the contact closes. Drive operation is not affected because this is an alarm.

Setting C: Analog Terminal Input Selection (Terminal A1, A2, A3)

When closed, the terminals specified in H3-14 are enabled. When open, the drive disregards the input signal to the analog terminals.

Setting F: Through Mode

Select this setting when using the terminal in a pass-through mode. When set to F, an input does not trigger any function in the drive. Setting F, however, still allows the input status to be read out by a PLC via a communication option or MEMOBUS/Modbus communications.

Setting 10, 11: Up/Down Function

The Up/Down function allows the frequency reference to be set by two push buttons when one digital input is programmed as the Up input (H1-☐☐= 10) to increase the frequency reference and the other digital input is programmed as the Down input (H1-☐☐= 11) to decrease the frequency reference.

The Up/Down function takes priority over the frequency references from the digital operator, the analog inputs, and the pulse input (b1-01 = 0, 1, 4). When using the Up/Down function, references provided by these sources will be disregarded.

The inputs operate as shown in ***Table 5.30***:

Table 5.30 Up, Down Command

Status		Drive Operation
Up (10)	Down (11)	
Open	Open	Hold current frequency reference
Closed	Open	Increase frequency reference
Open	Closed	Decrease frequency reference
Closed	Closed	Hold current frequency reference

Note:
1. An oPE03 alarm occurs when only one of the Up/Down functions is programmed to a digital input.
2. An oPE03 alarm occurs when the Up/Down function is assigned to the terminals and a different digital input is programmed for the Accel/decel ramp hold function. For more information on alarms, ***Refer to Drive Alarms, Faults, and Errors on page 277***.
3. The Up/Down function can only be used for External reference 1. Consider this when using Up/Down and the external reference switching command (H1-☐☐ = 2).

Using the Up/Down Function with Frequency Reference Hold (d4-01)

- If the frequency reference hold function is disabled (d4-01 = 0), the Up/Down frequency reference will be reset to 0 when the Run command is cleared or the power is cycled.
- When d4-01 = 1, the drive will save the frequency reference set by the Up/Down function. When the Run command or the power is cycled, the drive will restart with the saved reference value. Close the Up or Down input without an active Run command to reset the saved value. ***Refer to d4-01: Frequency Reference Hold Function Selection on page 175***.

Using the Up/Down Function with Frequency Reference Limits

Parameter d2-01 determines the upper frequency reference limit.

The value for the lower frequency reference limit depends on the parameter d4-10 setting. This value can be set by an analog input or parameter d2-02. ***Refer to d4-10: Up/Down Frequency Reference Limit Selection on page 178*** for details. When a Run command is applied, the lower limits function as follows:

- If the lower limit is set by d2-02 only, the drive accelerates to this limit as soon as a Run command is entered.
- If the lower limit is determined by an analog input only, the drive accelerates to the limit when both the Run command and an Up or Down command are active. The drive will not start running if only the Run command is active.
- If the lower limit is set by both an analog input and d2-02, and the analog limit is higher than the d2-02 value, the drive accelerates to the d2-02 value when a Run command is input. When the d2-02 value is reached, the drive accelerates to the analog limit only if an Up or Down command is set.

Figure 5.39 shows an Up/Down function example with a lower frequency reference limit set by d2-02, and the frequency reference hold function both enabled and disabled.

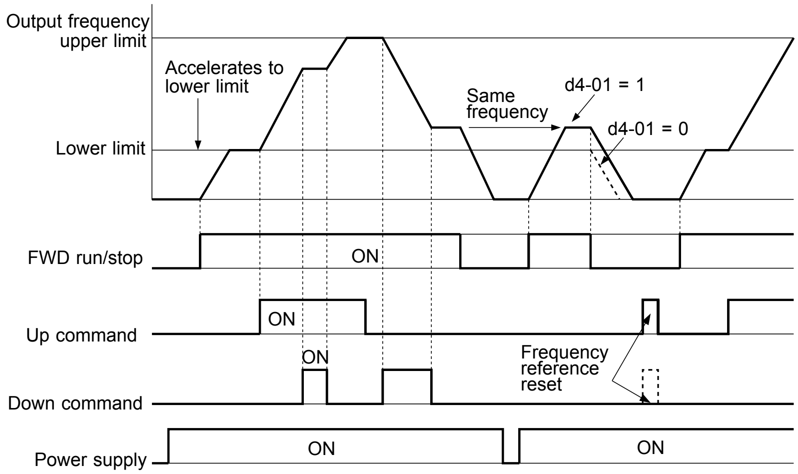


Figure 5.39 Up/Down Command Operation

Setting 12, 13: Forward Jog, Reverse Jog

Digital inputs programmed as Forward Jog (H1-☐☐ = 12) and Reverse Jog (H1-☐☐ = 13) will be Jog inputs that do not require a Run command. Closing the terminal set for Forward Jog input will cause the drive to ramp to the Jog frequency reference (d1-17) in the forward direction. The Reverse Jog will cause the same action in the reverse direction. The Forward Jog and Reverse Jog command can be set independently.

Note: The Forward Jog and Reverse Jog commands override all other frequency references. However, if the drive is set to prohibit reverse rotation (b1-04 = 1), activating Reverse Jog will have no effect. Inputting both the Forward Jog and Reverse Jog are simultaneously for 500 ms or longer will trigger an alarm will and the drive will ramp to stop.

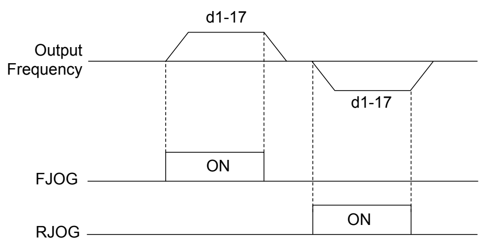


Figure 5.40 FJOG/RJOG Operation

Setting 14: Fault Reset

When the drive detects a fault condition, the fault output contact closes, the drive output shuts off, and the motor coasts to stop (specific stopping methods can be selected for some faults such as L1-04 for motor overheat). After removing the Run command, clear the fault either by pressing the RESET key on the digital operator or closing a digital input configured as a Fault Reset (H1-☐☐ = 14).

Note: Remove the Run command prior to resetting a fault. Fault Reset commands are ignored while the Run command is present.

Setting 15, 17: Fast Stop (N.O., N.C.)

The Fast Stop function operates similar to an emergency stop input to the drive. If a Fast Stop command is input while the drive is running, the drive decelerates to a stop in the deceleration time set to C1-09 (***Refer to C1-09: Fast Stop Time on page 167***). The drive can only be restarted after bringing the drive to a complete stop, turning off the Fast Stop input, and switching off the Run command.

- To trigger the Fast Stop function with an N.O. switch, set H1-☐☐ = 15.
- To trigger the Fast Stop function with an N.C. switch, set H1-☐☐ = 17.

Figure 5.41 shows an operation example of Fast Stop.

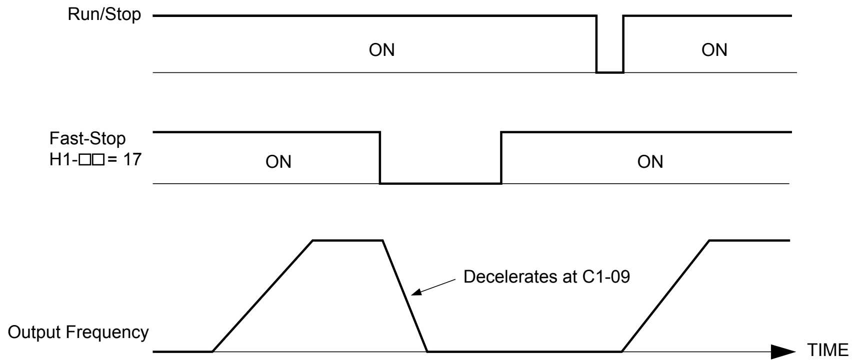


Figure 5.41 Fast Stop Sequence

NOTICE: *Rapid deceleration can trigger an overvoltage fault. When faulted, the drive output shuts off, and the motor coasts. To avoid this uncontrolled motor state and to ensure that the motor stops quickly and safely, set an appropriate Fast Stop time to C1-09.*

Setting 18: Timer Function Input

This setting configures a digital input terminal as the input for the timer function. Use this setting combination with the timer function output (H2-□□ = 12). ***Refer to b4: Delay Timers on page 149*** for details.

Setting 19: PID Disable

Close a digital input to indefinitely disable the PID function. When the input is released, the drive resumes PID operation. ***Refer to PID Block Diagram on page 152***.

Setting 1A: Accel/Decel Time Selection 2

Selects accel/decel times 1 to 4 in combination with the Accel/decel time selection 1 command. ***Refer to C1-01 to C1-04: Accel, Decel Times 1 and 2 on page 166*** for details.

Setting 1B: Program Lockout

Parameter values cannot be changed when an input is programmed for Program Lockout and the input is open. It is still possible, however, to view and monitor parameter settings.

Setting 1E: Reference Sample Hold

This function allows the user to sample an analog frequency reference signal being input to terminal A1, A2, or A3 and hold the frequency reference at the sampled level. When the Analog Frequency Reference Sample/Hold function is held for at least 100 ms, the drive reads the analog input and changes the frequency reference to the newly sampled speed as illustrated in ***Figure 5.42***.

When the power is shut off and the sampled analog frequency reference is cleared, the frequency reference is reset to 0.

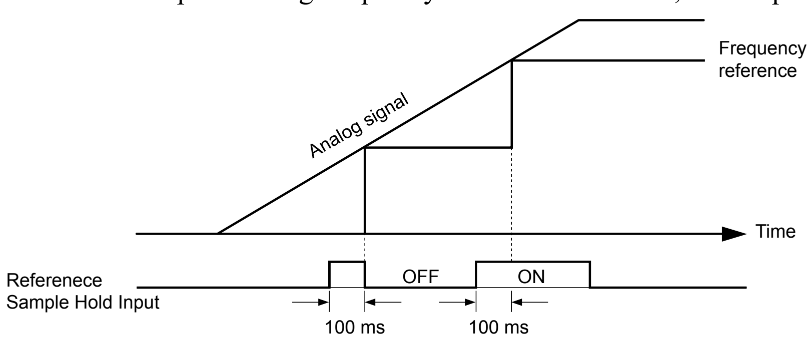


Figure 5.42 Analog Frequency Reference Sample/Hold

An oPE03 error will occur when one of the following functions is used simultaneously with the Analog frequency reference sample/hold command:

- Hold accel/decel stop (setting: A)
- Up command, Down command (setting: 10, 11)
- Offset frequency (setting: 44 to 46)
- Up or Down functions (setting: 75, 76)

Setting 20 to 2F: External Fault

The External fault command stops the drive when problems occur with external devices.

To use the External fault command, set one of the multi-function digital inputs to a value between 20 and 2F. The digital operator will display EF☐ where ☐ is the number of the terminal to which the external fault signal is assigned.

For example, if an external fault signal is input to terminal S3, “EF3” will be displayed.

Select the value to be set in H1-☐☐ from a combination of any of the following three conditions:

- Signal input level from peripheral devices (N.O., N.C.)
- External fault detection method
- Operation after external fault detection

Table 5.31 shows the relationship between the conditions and the value set to H1-☐☐:

Terminal statuses, detection conditions, and stopping methods marked with an “O” are applicable to the corresponding settings.

Table 5.31 Stopping Method for External Fault

Setting	Terminal Status <1>		Detection Conditions <2>		Stopping Method			
	N.O.	N.C.	Always Detected	Detected during Run only	Ramp to Stop (fault)	Coast to Stop (fault)	Fast Stop (fault)	Alarm Only (continue running)
20	O		O		O			
21		O	O		O			
22	O			O	O			
23		O		O	O			
24	O		O			O		
25		O	O			O		
26	O			O		O		
27		O		O		O		
28	O		O				O	
29		O	O				O	
2A	O			O			O	
2B		O		O			O	
2C	O		O					O
2D		O	O					O
2E	O			O				O
2F		O		O				O

<1> Determine the terminal status for each fault, i.e., whether the terminal is normally open or normally closed.

<2> Determine whether detection for each fault should be enabled only during run or always detected.

Setting 30: PID Integral Reset

Configuring one of the digital inputs for PID integral reset (H1-☐☐ = 30) resets the value of the integral component in PID control to 0 when the terminal is closed. *Refer to PID Block Diagram on page 152* for more details.

Setting 31: PID Integral Hold

Configuring a digital input for Integral Hold (H1-0☐ = 31) locks the value of the integral component of the PID control as long as the input is active. The PID controller resumes integral operation from the hold value as soon as the integral hold input is released. *Refer to PID Block Diagram on page 152* for more information on this function.

Setting 32: Multi-Step Speed Reference 4

Selects the multi-step speeds d1-09 to d1-16 in combination with the input terminal set for Multi-Step Speed 1, 2 and 3. *Refer to d1-01 to d1-17: Frequency Reference 1 to 16 and Jog Frequency Reference on page 171*.

Setting 34: PID Soft Starter Cancel

A digital input configured as a PID soft starter cancel input (H1-0☐ = 34) enables or disables the PID soft starter and cancels the PID accel/decel time (b5-17). *Refer to PID Block Diagram on page 152*.

Setting 35: PID Input Level Selection

Allows an input terminal to switch the sign of the PID input. *Refer to PID Block Diagram on page 152* for details.

Setting 40, 41: Forward Run, Reverse Run Command for 2-Wire Sequence

Configures the drive for a 2-Wire sequence.

When an input terminal set to 40 closes, the drive operates in the forward direction. When an input set for 41 closes, the drive operates in reverse. Closing both inputs simultaneously will result in an external fault.

Note:
1. This function cannot be used simultaneously with settings 42 and 43.
2. The same functions are assigned to terminals S1 and S2 when the drive is initialized for 2-Wire sequence.

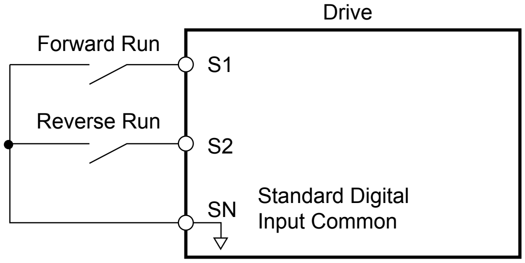


Figure 5.43 Example Wiring Diagram for 2-Wire Sequence

Setting 42, 43: Run and Direction Command for 2-Wire Sequence 2

Sets the drive for 2-Wire sequence 2.

When an input terminal programmed for 42 closes, the drive will operate in the selected direction. The drive will stop when the input opens.

The input programmed for 43 selects the direction. If the input is open, forward direction is selected. If the input is closed, reverse direction is selected.

Note: This function cannot be used simultaneously with settings 40 and 41.

Setting 47: Node Setup

If the SI-S3 option card is connected, closing this terminal sets a node address for operation on a CANopen network.

Setting 51: Sequence Timer Disable

Drive ignores sequence timers and runs normally (based on b1-02/b1-16 source).

Setting 52: Sequence Timer Cancel

The sequence timers are canceled.

Setting 60: DC Injection Braking Command

DC Injection Braking is activated when a DC Injection Braking command is input while the drive is stopped. DC Injection Braking is released when a Run command or a Jog command is input. ***Refer to b2: DC Injection Braking and Short Circuit Braking on page 142*** for details on setting up the DC Injection Braking function.

The diagram below illustrates DC Injection Braking:

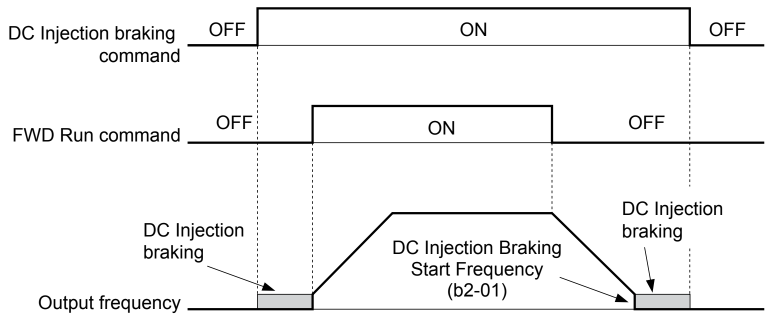


Figure 5.44 DC Injection Braking Input Timing Diagram

Setting 61, 62: External Speed Search Command 1, 2

These input functions enable Speed Search even if parameter b3-01 = 0 (no Speed Search at start). ***Refer to Speed Search Activation on page 146*** for details on how to use the input signals. ***Refer to b3: Speed Search on page 143*** for more about Speed Search.

Note: Simultaneously assigning Speed Search 1 and Speed Search 2 to the input terminals will trigger an oPE03 error.

Setting 63: Field Weakening

Enabled in V/f Control. When this input is closed, Field Weakening is performed. For details, see ***d6: Field Weakening and Field Forcing***.

Setting 65, 66: KEB Ride-Thru 1 (N.C.), 2 (N.O.)

Enables the KEB Ride-Thru function selected in parameter L2-29. ***Refer to KEB Ride-Thru Function on page 227*** for more information on this function.

DIgital Input Function	Drive Operation	
	Input Open	Input Closed
Setting 65 (N.C.)	KEB Ride-Thru Deceleration	Normal operation
Setting 66 (N.O.)	Normal operation	KEB Ride-Thru Deceleration

Note: Simultaneously assigning KEB Ride-Thru 1 and KEB Ride-Thru 2 to the input terminals will trigger an oPE03 error.

Setting 67: Communication Test Mode

The drive has a built-in function to self-diagnose serial communications operation. The test involves wiring the send and receive terminals of the RS-422/RS-485 port together. The drive transmits data and then confirms that the communications are received normally. ***Refer to Self-Diagnostics on page 494*** for details on how to use this function.

Setting 68: High Slip Braking (HSB)

Closing an input programmed for this function triggers High Slip Braking. After starting HSB, bring the drive to a complete stop and remove the HSB command before restarting. ***Refer to n3: High Slip Braking (HSB) and Overexcitation Braking on page 249***.

Setting 6A: Drive Enable

A digital input configured as a “Drive enable” (H1-□□ = 6A) will prevent the drive from executing a Run command until the input is closed. When the input is open, the digital operator will display “dnE” to indicate that the drive is disabled.

If a Run command is enabled before the terminal set for “Drive enable” closes, then the drive will not run until the Run command is cycled (i.e., a new Run command is required). If the input is opened while the drive is running, the drive will stop according to the stop method set to b1-03 (***Refer to b1-03: Stopping Method Selection on page 139***).

Setting 75, 76: Up 2/Down 2 Function

The Up/Down 2 function adds a bias to the frequency reference. The input programmed for 75 will increase the bias and the input programmed for 76 will decrease the bias. ***Table 5.32*** explains how the Up/Down 2 function works depending on the frequency reference source and parameters d4-01, d5-03, and d4-05. ***Refer to d4: Frequency Reference Hold and Up/Down 2 Function on page 175*** for detailed explanations of these and other Up/Down 2 related parameters.

Note:
1. The Up/Down 2 functions must be set as a pair.
2. When using the Up/Down 2 function, set appropriate bias limit values to parameters d4-08 and d4-09.

Table 5.32 Up/Down 2 Operations

Condition	Freq. Ref. Source	d4-03	d4-05	d4-01	Operation	Frequency Saved
1	Multi-Step Speed Reference	0	0	0	• Accelerates (increases the bias) while the Up 2 terminal is closed. • Decelerates (decreases the bias) while Down 2 is closed. • Holds output frequency (holds the bias) when no Up 2 or Down 2 input or both active. • Resets the bias when the reference changes. • Operates with the frequency reference in all other situations.	Not saved
2				1		If the bias and frequency reference are constant for 5 s, the bias is added to the active frequency reference and reset afterwards.
3			1	--	• Accelerates (increases the bias) while the Up 2 terminal is closed. • Decelerates (decreases the bias) while Down 2 is closed. • Otherwise operates at the frequency reference.	Not saved

Condition	Freq. Ref. Source	d4-03	d4-05	d4-01	Operation	Frequency Saved
4	Multi-Step Speed Reference	Value other than 0	--	0	• When the Up 2 is enabled, the drive accelerates to the frequency reference plus d4-03 (bias is increased for d4-03). • When Down 2 is enabled, the drive decelerates to the frequency reference minus d4-03 (bias is decreased for d4-03). • Holds output frequency (holds the bias) when neither Up/Down 2 inputs are active or both inputs are active. • Resets the bias when the reference changes. • Operates with the frequency reference in all other situations.	Not saved
5				1		If the bias and frequency reference are constant for 5 s, the bias is added to the active frequency reference and reset afterwards.
6	Other (analog comm., etc.)	0	0	0	• Accelerates (increases the bias) while the Up 2 terminal is closed. • Decelerates (decreases the bias) while Down 2 is closed. • Holds output frequency (holds the bias) when neither Up/Down 2 inputs are active or both inputs are active. • If the frequency reference changes for more than the time set to d4-07 during accel/decel, bias value is held until the output frequency meets the reference (speed agree).	Not saved
7				1		If the bias is constant for 5 s, it is saved to parameter d4-06. The frequency reference cannot be overwritten, so only the bias is saved.
8	Other (analog comm, etc.)	0	1	--	• Accelerates (increases the bias) while the Up 2 terminal is closed. • Decelerates (decreases the bias) while Down 2 is closed. • Otherwise operates at the frequency reference	Not saved
9		Value other than 0	--	0	• When Up 2 is enabled, drive accelerates to the frequency reference plus d4-03 (increases the bias for d4-03). • When Down 2 is enabled, drive decelerates to the frequency reference minus d4-03 (decreases the bias for d4-03). • If the frequency reference changes for more than d4-07 during accel/decel, bias value is held until the output frequency meets the reference (speed agree).	Not saved
10				1		If the bias is constant for 5 s, it is saved to parameter d4-06. The frequency reference cannot be overwritten, so only the bias is saved.

Setting 7A, 7B: KEB Ride-Thru 2 (N.C., N.O.)

An input terminal set to 7A or 7B can trigger Single Drive KEB Ride-Thru during deceleration. L2-29 is disregarded if this is enabled. *Refer to KEB Ride-Thru Function on page 227* for details.

Digital Input Function	Drive Operation	
	Input Open	Input Closed
Setting 7A (N.C.)	Single Drive KEB Ride-Thru 2	Normal operation
Setting 7B (N.O.)	Normal operation	Single Drive KEB Ride-Thru 2

Note: Simultaneously assigning KEB Ride-Thru 1 and KEB Ride-Thru 2 to the input terminals will trigger an oPE03 error.

Setting A8: PI2 Disable (N.O.)

Disables the secondary PI controller. Output behavior depends on the setting of S3-12

Setting A9: PI2 Disable (N.C.)

Enables the secondary PI controller (when open, output behavior depends on the setting of S3-12).

Setting AA: PI2 Inverse Operation

Changes the sign of the secondary PI controller input (reverse acting PI control).

Setting AB: PI2 Integral Reset

Resets the secondary PI controller integral value.

Setting AC: PI2 Integral Hold

Locks the value of the secondary PI controller integral value.

Setting AD: Select PI2 Parameters

Uses the secondary PI controller Proportional and Integral adjustments (S3-06 and S3-07) instead of the primary PI controller Proportional and Integral adjustments (b5-02 and b5-03). Only valid when S3-01 = 0 (secondary PI controller disabled).

Note: This multi-function input has no effect on the secondary PI controller. It is only used for the primary PI controller (b5-☐☐).

Emergency Override Function

The Emergency Override function is activated by closing the digital input programmed for Emergency Override Forward Run (H1-☐☐ = AF) or Emergency Override Reverse Run (H1-☐☐ = B0).

If H1-☐☐ = 6A (Drive Enable) is programmed, it must be opened to disable the drive for Emergency Override to take effect. Closing both Emergency Override digital inputs at the same time will trigger an External Fault (EF) error.

When the drive is in Emergency Override, the frequency reference source is dependent on parameter S6-02, Emergency Override Reference Selection. When S6-02 is set to 0 (Use S6-01 Reference), the drive will run at the S6-01 setting. When S6-02 is set to 1 (Use Frequency Ref), the drive will use the currently selected frequency reference (based on b1-01 and LOCAL/REMOTE) as the run speed.

An alarm will flash during Emergency Override indicating that the function is active and the direction the drive is commanded to run.

Resettable faults occurring when Emergency Override is activated will be cleared.

The drive will perform unlimited speed search retries during Emergency Override.

When Emergency Stop is active and Emergency Override is activated, the drive will run in Emergency Override mode.

The CALL (Serial Communication Error) mechanism is deactivated when Emergency Override is activated.

The Emergency Override function has priority over the PID Sleep feature (b5-15/b5-16).

Setting AF: Emergency Override Forward Run

Enables Emergency Override Forward Run (Enabled when S6-01 = 1).

Setting B0: Emergency Override Reverse Run

Enables Emergency Override Reverse Run (Enabled when S6-01 = 1).

◆ H2: Multi-Function Digital Outputs

■ H2-01 to H2-03: Terminal M1-M2, M3-M4, and MD-ME-MF Function Selection

The drive has three multi-function output terminals. *Table 5.33* lists the functions available for theses terminals using H2-01, H2-02, and H2-03.

No.	Parameter Name	Setting Range	Default
H2-01	Terminal M1-M2 Function Selection (relay)	0 to 192	0: During Run
H2-02	Terminal M3-M4 Function Selection (relay)	0 to 192	1: Zero Speed
H2-03	Terminal MD-ME-MF Function Selection (relay)	0 to 192	2: Speed agree 1

Table 5.33 Multi-Function Digital Output Terminal Settings

Setting	Function		Setting	Function	
0	During Run	205	E	Fault	208
1	Zero Speed	205	F	Through Mode	208
2	Speed Agree 1	205	10	Minor Fault	208
3	User-Set Speed Agree 1	206	11	Fault Reset Command Active	208
4	Frequency Detection 1	206	12	Timer Output	209
5	Frequency Detection 2	207	13	Speed Agree 2	209
6	Drive Ready	207	14	User-Set Speed Agree 2	209
7	DC Bus Undervoltage	207	15	Frequency Detection 3	210
8	During Baseblock (N.O.)	208	16	Frequency Detection 4	210
9	Frequency Reference Source	208	17	Torque Detection 1 (N.C.)	208
A	Run Command Source	208	18	Torque Detection 2 (N.O.)	
B	Torque Detection 1 (N.O.)	208	19	Torque Detection 2 (N.C.)	208
C	Frequency Reference Loss	208	1A	During Reverse	210
D	Braking Resistor Fault	208	1B	During Baseblock (N.C.)	211

Setting	Function	
1E	Restart Enabled	211
1F	Motor Overload Alarm (oL1)	211
20	Drive Overheat Pre-Alarm (oH)	211
22	Mechanical Weakening Detection	211
2F	Maintenance Period	211
37	During Frequency Output	211
38	Drive Enabled	212
39	Watt Hour Pulse Output	212
3C	LOCAL/REMOTE Status	212
3D	During Speed Search	212
3E	PID Feedback Low	212
3F	PID Feedback High	212
4A	During KEB Operation	212
4C	During Fast Stop	212
4D	oH Pre-Alarm Time Limit	212
4E <2>	Braking Transistor Fault (rr)	212
4F <2>	Braking Resistor Overheat (rH)	212
50	Waiting to Run	212
51	Sequence timer 1	213
52	Sequence timer 2	213
53	Sequence timer 3	213
54	Sequence timer 4	213
58	UL6 Detected	213
60	Internal Cooling Fan Alarm	212
71	Secondary PI Feedback Low	213
72	Secondary PI Feedback High	213
100 to 192	Functions 0 to 92 with Inverse Output	213

<2> Not available in models 2A0169 to 2A0415 and 4A0088 to 4A0675.

Setting 0: During Run

Output closes when the drive is outputting a voltage.

Status	Description
Open	Drive is stopped.
Closed	A Run command is input or the drive is in deceleration or DC injection.

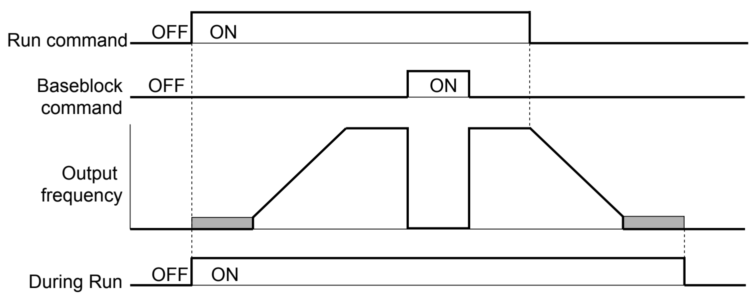


Figure 5.45 During Run Time Chart

Setting 1: Zero Speed

Terminal closes when the output frequency falls below the minimum output frequency set to E1-09 or b2-01.

Status	Description
Open	Output frequency is above the minimum output frequency set to E1-09 or b2-01
Closed	Output frequency is less than the minimum output frequency set to E1-09 or b2-01

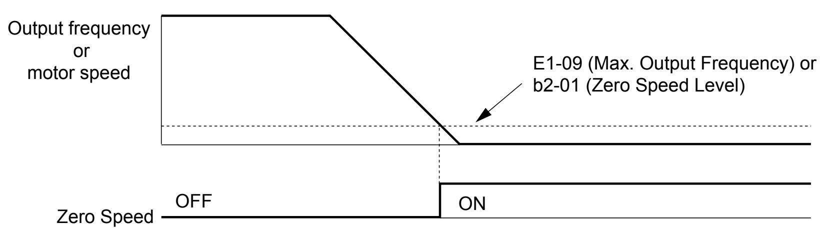


Figure 5.46 Zero-Speed Time Chart

Setting 2: Speed Agree 1 (f_{ref}/f_{out} Agree 1)

Closes when the actual output frequency is within the Speed Agree Width (L4-02) of the current frequency reference regardless of the direction.

Status	Description
Open	Output frequency or motor speed does not match the frequency reference while the drive is running.
Closed	Output frequency or motor speed is within the range of frequency reference ±L4-02.

Note: Detection works in forward and reverse.

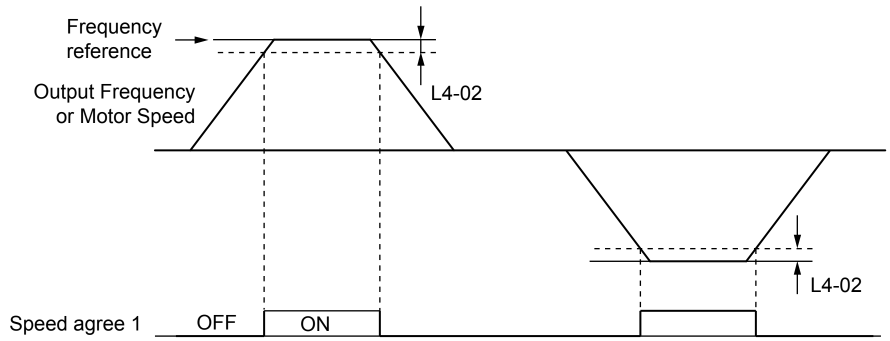


Figure 5.47 Speed Agree 1 Time Chart

Refer to L4-01, L4-02: Speed Agreement Detection Level and Detection Width on page 239 for more details.

Setting 3: User-Set Speed Agree 1 (f_{ref}/f_{set} Agree 1)

Closes when the actual output frequency and the frequency reference are within the speed agree width (L4-02) of the programmed speed agree level (L4-01).

Status	Description
Open	Output frequency or motor speed and frequency reference are not both within the range of L4-01 ±L4-02.
Closed	Output frequency or motor speed and the frequency reference are both within the range of L4-01 ±L4-02.

Note: Frequency detection works in forward and reverse. The value of L4-01 is used as the detection level for both directions.

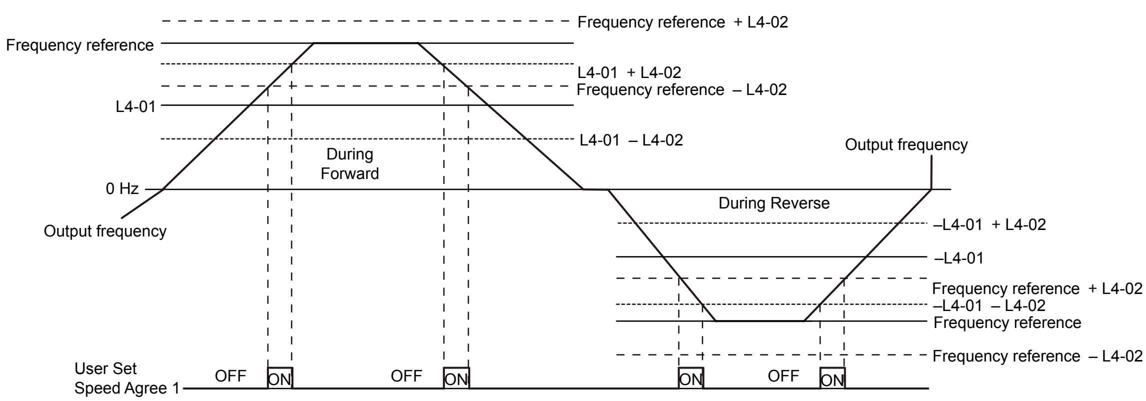


Figure 5.48 User Set Speed Agree 1 Time Chart

Refer to L4-01, L4-02: Speed Agreement Detection Level and Detection Width on page 239 for more instructions.

Setting 4: Frequency Detection 1

The output opens when the output frequency rises above the detection level set in L4-01 plus the detection width set in L4-02. The terminal remains open until the output frequency or motor speed fall below the level set in L4-01.

Status	Description
Open	Output frequency or motor speed exceeded L4-01 + L4-02.
Closed	Output frequency or motor speed is below L4-01 or has not exceeded L4-01 + L4-02.

Note: Frequency detection works in forward and reverse. The value of L4-01 is used as the detection level for both directions.

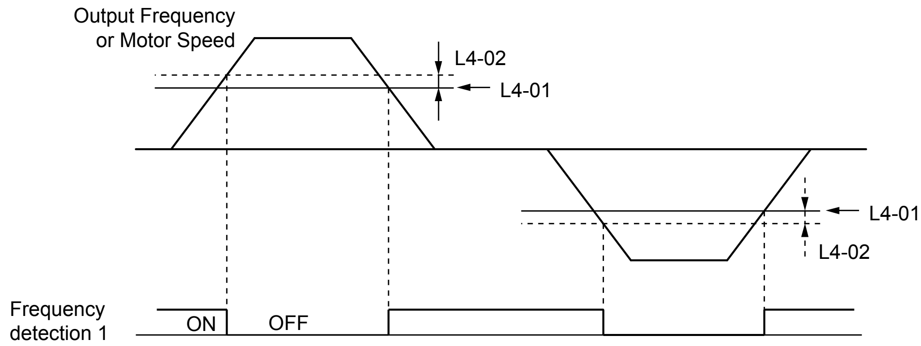


Figure 5.49 Frequency Detection 1 Time Chart

Refer to L4-01, L4-02: Speed Agreement Detection Level and Detection Width on page 239 for more details.

Setting 5: Frequency Detection 2

The output closes when the output frequency is above the detection level set in L4-01. The terminal remains closed until the output frequency or motor speed fall below L4-01 minus the setting of L4-02.

Status	Description
Open	Output frequency or motor speed is below L4-01 minus L4-02 or has not exceeded L4-01.
Closed	Output frequency or motor speed exceeded L4-01.

Note: Frequency detection works in forward and reverse. The value of L4-01 is used as the detection level for both directions.

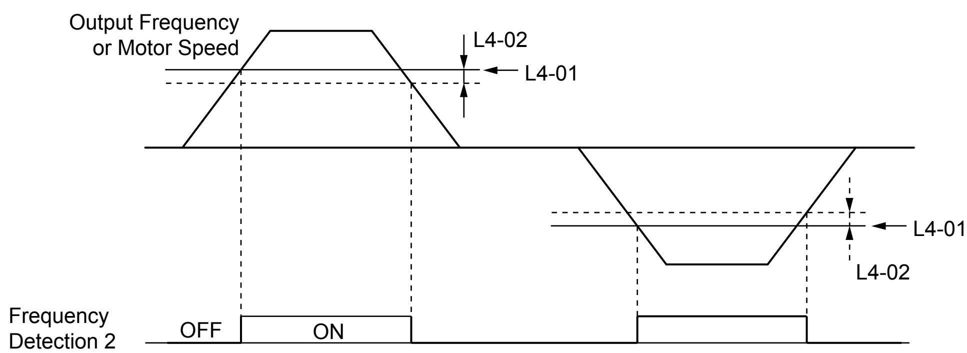


Figure 5.50 Frequency Detection 2 Time Chart

Refer to L4-01, L4-02: Speed Agreement Detection Level and Detection Width on page 239 for more details.

Setting 6: Drive Ready

The output closes when the drive is ready to operate the motor. The terminal will not close under the conditions listed below, and any Run commands will be disregarded.

- When the power is shut off
- During a fault
- When the internal power supply of the drive has malfunctioned
- When a parameter setting error makes it impossible to run
- Although stopped, an overvoltage or undervoltage situation occurs
- While editing a parameter in the Programming Mode (when b1-08 = 0)

Setting 7: DC Bus Undervoltage

The output closes when the DC bus voltage or control circuit power supply drops below the trip level set in L2-05. A fault in the DC bus circuit will also cause the terminal set for "DC bus undervoltage" to close.

Status	Description
Open	DC bus voltage is above the level set to L2-05.
Closed	DC bus voltage has fallen below the trip level set to L2-05.

Setting 8: During Baseblock (N.O.)

The output closes to indicate that the drive is in a baseblock state. While in baseblock, output transistors do not switch and no main circuit voltage is output.

Status	Description
Open	Drive is not in a baseblock state.
Closed	Baseblock is being executed.

Setting 9: Frequency Reference Source

Displays the currently selected frequency reference source.

Status	Description
Open	Frequency reference is provided from External reference 1 (b1-01) or External reference 2 (b1-15).
Closed	Frequency reference is being sourced from the digital operator.

Setting A: Run Command Source

Displays the currently selected Run command source.

Status	Description
Open	Run command is provided from External reference 1 (b1-02) or 2 (b1-16).
Closed	Run command is being sourced from the digital operator.

Setting B, 17, 18, 19: Torque Detection 1 (N.O., N.C.), Torque Detection 2 (N.O., N.C.)

These digital output functions signal an overtorque or undertorque situation to an external device.

Set up the torque detection levels and select the output function from the table below. ***Refer to L6: Torque Detection on page 241*** for details.

Setting	Status	Description
B	Closed	Torque detection 1 (N.O.): Output current/torque exceeds (overtorque detection) or is below (undertorque detection) the torque value set in parameter L6-02 for longer than the time specified in parameter L6-03.
17	Open	Torque detection 1 (N.C.): Output current/torque exceeds (overtorque detection) or is below (undertorque detection) the torque value set in parameter L6-02 for longer than the time specified in parameter L6-03.
18	Closed	Torque detection 2 (N.O.): Output current/torque exceeds (overtorque detection) or is below (undertorque detection) the torque value set in parameter L6-05 for longer than the time specified in parameter L6-06.
19	Open	Torque detection 2 (N.C.): Output current/torque exceeds (overtorque detection) or is below (undertorque detection) the torque value set in parameter L6-05 for longer than the time specified in parameter L6-06.

Setting C: Frequency Reference Loss

An output set for this function closes when frequency reference loss is detected. ***Refer to L4-05: Frequency Reference Loss Detection Selection on page 239*** for details.

Setting D: Braking Resistor Fault

An output programmed for this function closes when the dynamic braking resistor (DB) overheats or the braking transistor is in a fault condition.

Setting E: Fault

The output closes when the drive faults (excluding CPF00 and CPF01 faults).

Setting F: Through Mode

Select this setting when using the terminal in a pass-through mode. When set to F, an output does not trigger any function in the drive. Setting F, however, still allows the output status to be read by a PLC via a communication option or MEMOBUS/ Modbus communications.

Setting 10: Minor Fault

The output closes when a minor fault condition is present.

Setting 11: Fault Reset Command Active

The output closes when there is an attempt to reset a fault situation from the control circuit terminals, via serial communications, or using a communications option card.

Setting 12: Timer Output

This setting configures a digital output terminal as the output for the timer function. *Refer to b4: Delay Timers on page 149* for details.

Setting 13: Speed Agree 2 (f_{ref} /f_{out} Agree 2)

The output closes when the actual output frequency is within the speed agree width (L4-04) of the current frequency reference, regardless of the direction.

Status	Description
Open	Output frequency or motor speed does not match the frequency reference while the drive is running.
Closed	Output frequency or motor speed is within the range of frequency reference ±L4-04.

Note: Detection works in forward and reverse.

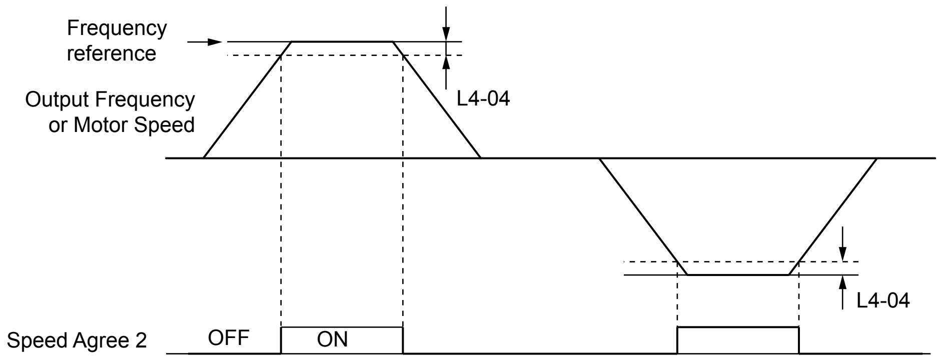


Figure 5.51 Speed Agree 2 Time Chart

Refer to L4-03, L4-04: Speed Agreement Detection Level and Detection Width (+/-) on page 239 for more details.

Setting 14: User-Set Speed Agree 2 (f_{ref} /f_{set} Agree 2)

The output closes when the actual output frequency and the frequency reference are within the speed agree width (L4-04) of the programmed speed agree level (L4-03).

Status	Description
Open	Output frequency or motor speed and frequency reference are both outside the range of L4-03 ±L4-04.
Closed	Output frequency or motor speed and the frequency reference are both within the range of L4-03 ±L4-04.

Note: The detection level L4-03 is a signed value; detection works in the specified direction only.

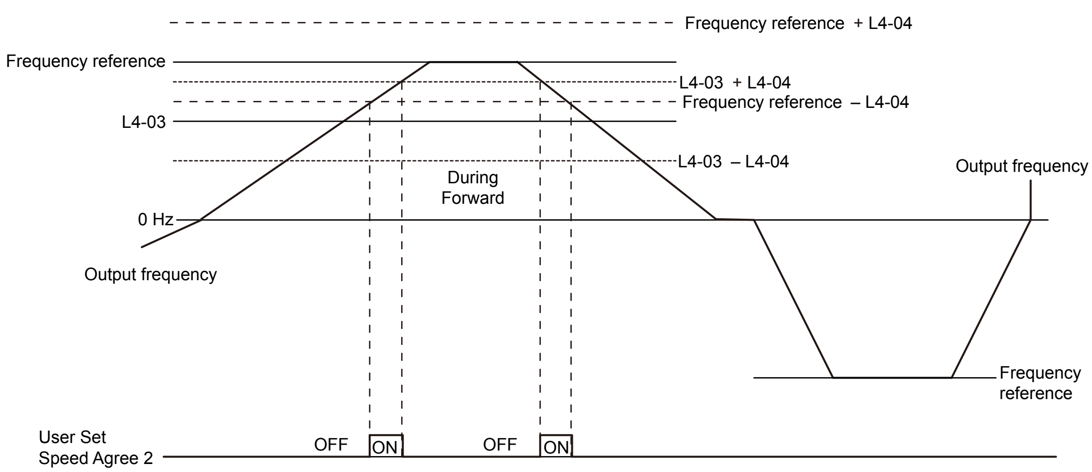


Figure 5.52 User-Set Speed Agree 2 Example with a Positive L3-04 Value

Refer to L4-03, L4-04: Speed Agreement Detection Level and Detection Width (+/-) on page 239 for more details.

Setting 15: Frequency Detection 3

The output opens when the output frequency rises above the detection level set in L4-03 plus the detection with set in L4-04. The terminal remains open until the output frequency or motor speed falls below the level set in L4-03. The detection level L4-03 is a signed value; detection works in the specified direction only.

Status	Description
Open	Output frequency or motor speed exceeded L4-03 plus L4-04.
Closed	Output frequency or motor speed is below L4-03 or has not exceeded L4-03 plus L4-04.

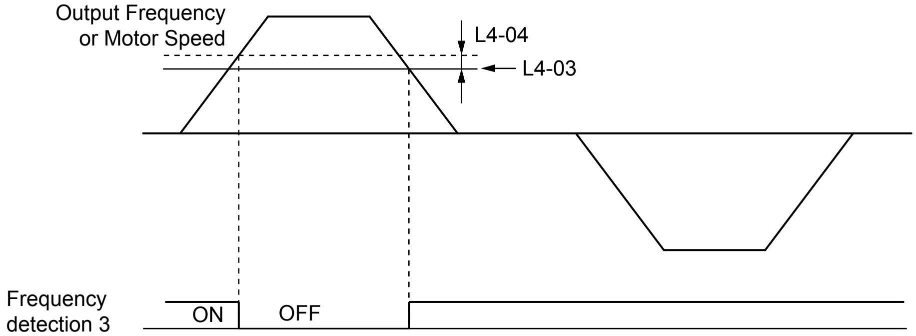


Figure 5.53 Frequency Detection 3 Example with a Positive L3-04 Value

Refer to L4-03, L4-04: Speed Agreement Detection Level and Detection Width (+/-) on page 239 for more details.

Setting 16: Frequency Detection 4

The output closes when the output frequency is above the detection level set in L4-03. The terminal remains closed until the output frequency or motor speed falls below L4-03 minus the setting of L4-04.

Status	Description
Open	Output frequency or motor speed is below L4-03 minus L4-04 or has not exceeded L4-03.
Closed	Output frequency or motor speed exceeded L4-03.

Note: The detection level L4-03 is a signed value; detection works in the specified direction only.

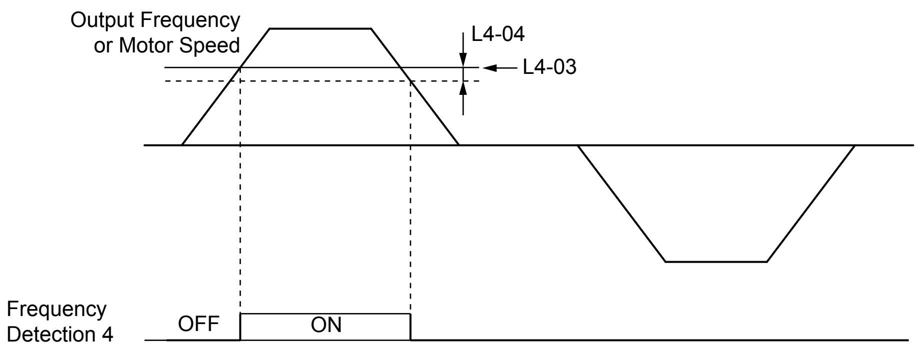


Figure 5.54 Frequency Detection 4 Example with Positive L3-04 Value

Refer to L4-03, L4-04: Speed Agreement Detection Level and Detection Width (+/-) on page 239 for more details.

Setting 1A: During Reverse

A digital output set for “During reverse” closes when the drive is running the motor in the reverse direction.

Status	Description
Open	Motor is being driven in the forward direction or stopped.
Closed	Motor is being driven in reverse.

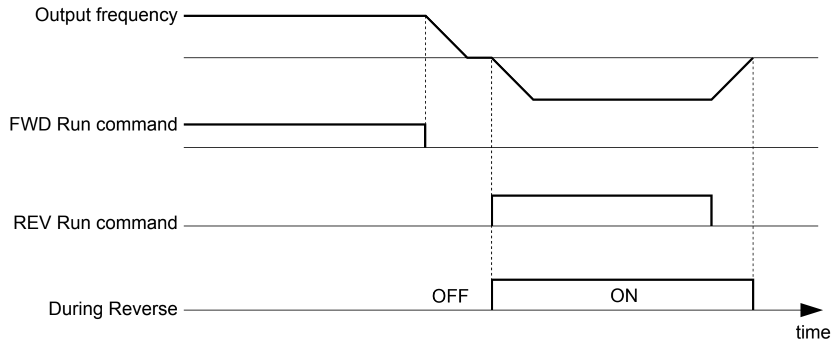


Figure 5.55 Reverse Direction Output Example Time Chart

Setting 1B: During Baseblock (N.C.)

The output opens to indicate that the drive is in a baseblock state. While Baseblock is executed, output transistors do not switch and no main circuit voltage is output.

Status	Description
Open	Baseblock is being executed.
Closed	Drive is not in a baseblock state.

Setting 1E: Restart Enabled

An output set for “Restart enabled” closes when the drive attempts to restart after a fault has occurred.

The fault restart function allows the drive to automatically clear a fault. The terminal set to 1E will close after the fault is cleared and the drive has attempted to restart. If the drive cannot successfully restart within the number of attempts permitted by L5-01, a fault will be triggered and the terminal set to 1E will open. ***Refer to L5: Fault Restart on page 240*** for details on automatic restart.

Setting 1F: Motor Overload Alarm (oL1)

The output closes when the motor overload level estimated by the oL1 fault detection exceeds 90% of the oL1 detection level. ***Refer to L1-01: Motor Overload Protection Selection on page 223***.

Setting 20: Drive Overheat Pre-Alarm (oH)

The output closes when the drive heatsink temperature reaches the level specified by parameter L8-02. ***Refer to L8-02: Overheat Alarm Level on page 243*** for details on drive overheat detection.

Setting 22: Mechanical Weakening Detection

The output closes when a mechanical weakening situation is detected.

Setting 2F: Maintenance Period

The output closes when the cooling fan, DC bus capacitors, or DC bus pre-charge relay may require maintenance as determined by the estimated performance life span of those components. Components performance life is displayed as a percentage on the digital operator screen. ***Refer to Periodic Maintenance on page 327***.

Setting 37: During Frequency Output

The output closes when the drive is outputting a frequency.

Status	Description
Open	Drive is stopped or one of the following functions is being performed: baseblock, DC Injection Braking, Short Circuit Braking.
Closed	Drive is outputting frequency.

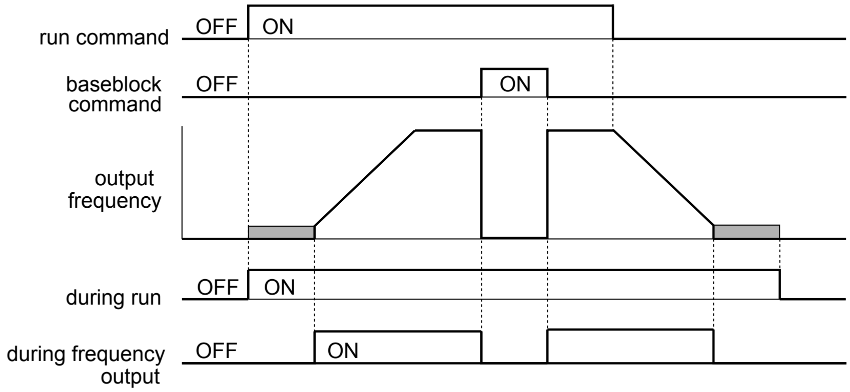


Figure 5.56 During Frequency Output Time Chart

Setting 38: Drive Enable

Reflects the status of a digital input configured as a "Drive enable" input (H1-□□ = 6A). If that digital input closes, then the digital output set for "Drive enable" will also close.

Setting 39: Watt Hour Pulse Output

Outputs a pulse to indicate the watt hours. *Refer to H2-06: Watt Hour Output Unit Selection on page 213* for details.

Setting 3C: LOCAL/REMOTE Status

The output terminal closes while the drive is set for LOCAL and opens when in REMOTE.

Status	Description
Open	REMOTE: The external reference that has been selected (either b1-01 and b1-02 or b1-15 and b1-16) is used as frequency reference and Run command source.
Closed	LOCAL: The digital operator is used as frequency reference and Run command source.

Setting 3D: During Speed Search

The output terminal closes while Speed Search is being performed. *Refer to b3: Speed Search on page 143* for details.

Setting 3E: PID Feedback Low

Output terminal closes when a PID feedback loss (FbL) is detected. The feedback is considered to be lost if it falls below the level set to b5-13 for longer than the time set to b5-14. *Refer to PID Feedback Loss Detection on page 154* for details.

Setting 3F: PID Feedback High

Output terminal closes when a PID feedback loss (FbH) is detected. The feedback is considered to be lost if it rises beyond the level set to b5-36 for longer than the time set to b5-37. *Refer to PID Feedback Loss Detection on page 154* for details.

Setting 4A: During KEB Operation

The output terminal closes while KEB is being performed. *Refer to KEB Ride-Thru Function on page 227* for a KEB function description.

Setting 4C: During Fast Stop

The output terminal closes when a Fast Stop is being executed. *Refer to Setting 15, 17: Fast Stop (N.O., N.C.) on page 198*.

Setting 4D: oH Pre-Alarm Time Limit

The output terminal closes when the drive is reducing the speed due to a drive overheat alarm (L8-03 = 4) and the overheat alarm has not disappeared after 10 frequency reduction operation cycles. *Refer to L8-03: Overheat Pre-Alarm Operation Selection on page 244* for a more detailed description.

Setting 4E: Braking Transistor Fault (rr)

The output closes if the internal braking transistor reaches the overheat level.

Setting 4F: Braking Resistor Overheat (rH)

The output closes when the braking resistor exceeds the overheat level. The braking resistor may overheat due to motor regeneration or short deceleration time setting.

Setting 50: Waiting to Run (WrUn)

The drive will delay executing a Run command until the time set to b1-11 has expired.

Setting 51: Sequence Timer 1 Active

Sequence Timer 1 is active.

Setting 52: Sequence Timer 2 Active

Sequence Timer 2 is active.

Setting 53: Sequence Timer 3 Active

Sequence Timer 3 is active.

Setting 54: Sequence Timer 4 Active

Sequence Timer 4 is active.

Setting 58: Underload Detection

Underload is detected when the output current falls below the underload detection level defined by L6-14 and L6-02.

Setting 60: Internal Cooling Fan Alarm

The output closes when the drive internal cooling fan has failed.

Setting 71: Secondary PI Feedback Low

The PI2 feedback level is too low.

Setting 72: Secondary PI Feedback High

The PI2 feedback level is too high.

Setting 100 to 192: Functions 0 to 92 with Inverse Output

These settings have the same function as settings 0 to 92 but with inverse output. Set as 1□□, where the “1” indicates inverse output and the last two digits specify the setting number of the function.

Examples:

- For inverse output of “8: During baseblock”, set 108.
- For inverse output of “4A: During KEB” set 14A.

■ H2-06: Watt Hour Output Unit Selection

When one of the multi-function terminals is set to output the number of watt hours (H2-01, H2-02, or H2-03 = 39), parameter H2-06 determines the units for the output signal.

This output function provides a watt hour meter or a PLC input by a 200 ms pulse signal. H2-06 determines the frequency that pulses are issued to keep track of the kWh for the drive.

No.	Parameter Name	Setting Range	Default
H2-06	Watt Hour Output Unit Selection	0: 0.1 kWh units 1: 1 kWh units 2: 10 kWh units 3: 100 kWh units 4: 1000 kWh units	0

Note:
1. A negative power output (i.e., regeneration) does not subtract from the total watt hours.
2. The drive keeps track of the watt hours as long as the control circuit has power. The value is reset when the power supply is shut off.

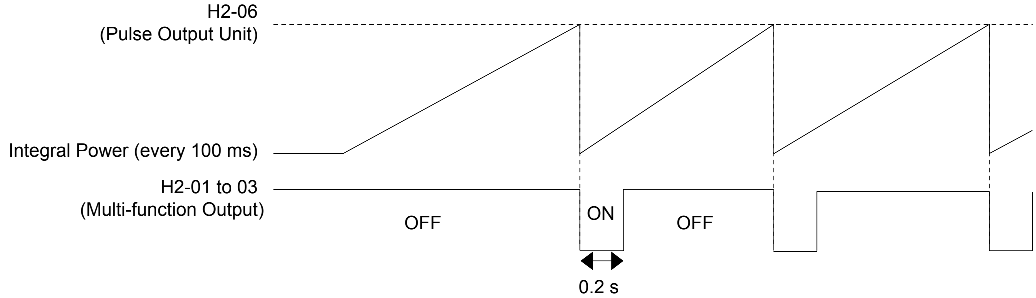


Figure 5.57 Watt Hour Output Example

Parameter Details
5

◆ H3: Multi-Function Analog Inputs

The drive is equipped with three multi-function analog input terminals: A1, A2, and A3. ***Refer to Multi-Function Analog Input Terminal Settings on page 217*** for a listing of the functions that can be set to these terminals.

■ H3-01: Terminal A1 Signal Level Selection

Selects the input signal level for analog input A1.

No.	Name	Setting Range	Default
H3-01	Terminal A1 Signal Level Selection	0 to 3	0

Setting 0: 0 to 10 Vdc

The input level is 0 to 10 Vdc. The minimum input level is limited to 0%, so that a negative input signal due to gain and bias settings will be read as 0%.

Setting 1: -10 to 10 Vdc

The input level is -10 to 10 Vdc. If the resulting voltage is negative after being adjusted by gain and bias settings, then the motor will rotate in reverse.

Setting 2: 4 to 20 mA

Setting 3: 0 to 20 mA

■ H3-02: Terminal A1 Function Selection

Selects the input signal level for analog input A3. ***Refer to Multi-Function Analog Input Terminal Settings on page 217*** for instructions on adjusting the signal level.

No.	Name	Setting Range	Default
H3-02	Terminal A1 Function Selection	0 to 32	0

■ H3-03, H3-04: Terminal A1 Gain and Bias Settings

Parameter H3-03 sets the level of the selected input value that is equal to 10 Vdc input at terminal A1 (gain).

Parameter H3-04 sets the level of the selected input value that is equal to 0 V input at terminal A1 (bias).

Use both parameters to adjust the characteristics of the analog input signal to terminal A1.

No.	Name	Setting Range	Default
H3-03	Terminal A1 Gain Setting	-999.9 to 999.9%	100.0%
H3-04	Terminal A1 Bias Setting	-999.9 to 999.9%	0.0%

Setting Examples

- Gain H3-03 = 200%, bias H3-04 = 0, terminal A1 as frequency reference input (H3-02 = 0):

  A 10 Vdc input is equivalent to a 200% frequency reference and 5 Vdc is equivalent to a 100% frequency reference. Since the drive output is limited by the maximum frequency parameter (E1-04), the frequency reference will be equal to E1-04 above 5 Vdc.

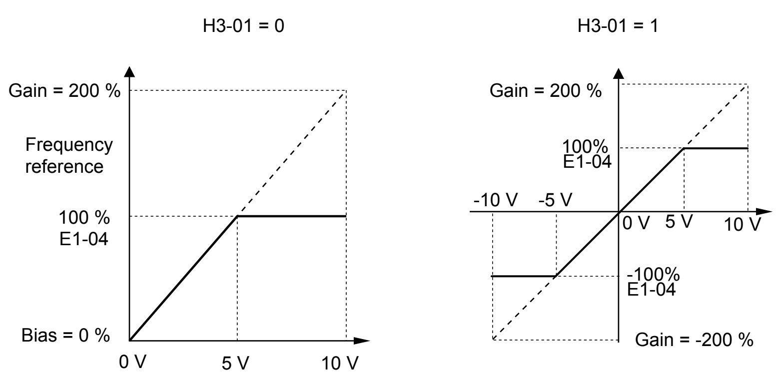


Figure 5.58 Frequency Reference Setting by Analog Input with Increased Gain

- Gain H3-03 = 100%, bias H3-04 = -25%, terminal A1 as frequency reference input:

  An input of 0 Vdc will be equivalent to a -25% frequency reference.

When parameter H3-01 = 0, the frequency reference is 0% between 0 and 2 Vdc input.

When parameter H3-01 = 1, the motor will rotate in reverse between -10 and 2 Vdc input.

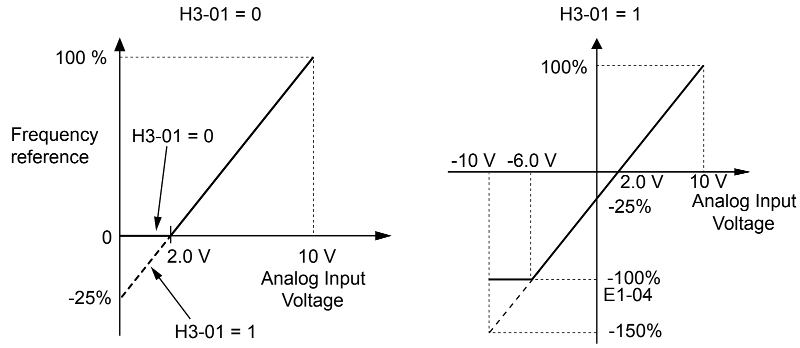


Figure 5.59 Frequency Reference Setting by Analog Input with Negative Bias

■ H3-05: Terminal A3 Signal Level Selection

Determines the function assigned to analog input terminal A3. *Refer to Multi-Function Analog Input Terminal Settings on page 217* for a list of functions and descriptions.

No.	Name	Setting Range	Default
H3-05	Terminal A3 Signal Level Selection	0 to 3	0

Setting 0: 0 to 10 Vdc

The input level is 0 to 10 Vdc. See the explanation provided for H3-01. *Refer to Setting 0: 0 to 10 Vdc on page 214*.

Setting 1: -10 to 10 Vdc

The input level is -10 to 10 Vdc. See the explanation provided for H3-01. *Refer to Setting 1: -10 to 10 Vdc on page 214*.

Setting 2: 4 to 20 mA

Setting 3: 0 to 20 mA

■ H3-06: Terminal A3 Function Selection

Determines the function assigned to analog input terminal A3. *Refer to Multi-Function Analog Input Terminal Settings on page 217* for a list of functions and descriptions.

No.	Name	Setting Range	Default
H3-06	Terminal A3 Function Selection	0 to 31	2

■ H3-07, H3-08: Terminal A3 Gain and Bias Setting

Parameter H3-07 sets the level of the selected input value that is equal to 10 Vdc input at terminal A3 (gain).

Parameter H3-08 sets the level of the selected input value that is equal to 0 V input at terminal A3 (bias).

No.	Name	Setting Range	Default
H3-07	Terminal A3 Gain Setting	-999.9 to 999.9%	100.0%
H3-08	Terminal A3 Bias Setting	-999.9 to 999.9%	0.0%

■ H3-09: Terminal A2 Signal Level Selection

Selects the input signal level for analog input A2. Set jumper S1 on the terminal board accordingly for a voltage input or current input.

No.	Name	Setting Range	Default
H3-09	Terminal A2 Signal Level Selection	0 to 3	2

Setting 0: 0 to 10 Vdc

The input level is 0 to 10 Vdc. *Refer to Setting 0: 0 to 10 Vdc on page 214*.

Setting 1: -10 to 10 Vdc

The input level is -10 to 10 Vdc. *Refer to Setting 1: -10 to 10 Vdc on page 214*.

Setting 2: 4 to 20 mA

The input level is 4 to 20 mA. Negative input values by negative bias or gain settings will be limited to 0%.

Setting 3: 0 to 20 mA

The input level is 0 to 20 mA. Negative input values by negative bias or gain settings will be limited to 0%.

■ H3-10: Terminal A2 Function Selection

Determines the function assigned to analog input terminal A2. ***Refer to Multi-Function Analog Input Terminal Settings on page 217*** for a list of functions and descriptions.

No.	Name	Setting Range	Default
H3-10	Terminal A2 Function Selection	0 to 32	0

■ H3-11, H3-12: Terminal A2 Gain and Bias Setting

Parameter H3-11 sets the level of the input value selected that is equal to 10 Vdc input or 20 mA input to terminal A2.

Parameter H3-12 sets the level of the input value selected that is equal to 0 V, 4 mA or 0 mA input at terminal A2.

Use both parameters to adjust the characteristics of the analog input signal to terminal A2. The setting works in the same way as parameters H3-03 and H3-04 for analog input A1.

No.	Name	Setting Range	Default
H3-11	Terminal A2 Gain Setting	-999.9 to 999.9%	100.0%
H3-12	Terminal A2 Bias Setting	-999.9 to 999.9%	0.0%

■ H3-13: Analog Input Filter Time Constant

Parameter H3-13 sets the time constant for a first order filter that will be applied to the analog inputs.

An analog input filter prevents erratic drive control when using a “noisy” analog reference. Drive operation becomes more stable as the programmed time becomes longer, but it also becomes less responsive to rapidly changing analog signals.

No.	Name	Setting Range	Default
H3-13	Analog Input Filter Time Constant	0.00 to 2.00 s	0.03 s

■ H3-14: Analog Input Terminal Enable Selection

When one of the multi-function digital input parameters is set for “Analog input enable” (H1-□□ = C), the value set to H3-14 determines which analog input terminals are enabled and which terminals are disabled when the input is closed. All analog input terminals will be enabled all of the time if H1-□□ is not set to C.

No.	Name	Setting Range	Default
H3-14	Analog Input Terminal Enable Selection	1 to 7	7

Setting 1: A1 only enabled

Setting 2: A2 only enabled

Setting 3: A1 and A2 only enabled

Setting 4: A3 only enabled

Setting 5: A1 and A3 only enabled

Setting 6: A2 and A3 only enabled

Setting 7: All analog input terminals enabled

■ H3-16 to H3-18: Terminal A1/A2/A3 Offset

Set the offset level of the selected input value to terminals A1, A2, or A3 that is equal to 0 Vdc input. These parameters rarely require adjustment.

No.	Name	Setting Range	Default
H3-16	Terminal A1 Offset	-500 to 500	0
H3-17	Terminal A2 Offset	-500 to 500	0
H3-18	Terminal A3 Offset	-500 to 500	0

■ Multi-Function Analog Input Terminal Settings

See *Table 5.34* for information on how H3-02, H3-10, and H3-06 determine functions for terminals A1, A2, and A3.

Note: The scaling of all input functions depends on the gain and bias settings for the analog inputs. Set these to appropriate values when selecting and adjusting analog input functions.

Table 5.34 Multi-Function Analog Input Terminal Settings

Setting	Function	Page	Setting	Function	Page
0	Frequency Bias	217	B	PID Feedback	218
1	Frequency Gain	217	C	PID Setpoint	218
2	Auxiliary Frequency Reference 1	217	D	Frequency Bias	218
3	Auxiliary Frequency Reference 2	217	E	Motor Temperature (PTC Input)	219
4	Output Voltage Bias	217	16	Differential PID Feedback	219
5	Accel/Decel Time Gain	217	17	Motor Thermistor (NTC)	219
6	DC Injection Braking Current	218	1F	Through Mode	219
7	Torque Detection Level	218	25	Secondary PI Setpoint	219
8	Stall Prevention Level During Run	218	26	Secondary PI Feedback	219
9	Output Frequency Lower Limit Level	218			

Setting 0: Frequency Bias

The input value of an analog input set to this function will be added to the analog frequency reference value. When the frequency reference is supplied by a different source other than the analog inputs, this function will have no effect. Use this setting also when only one of the analog inputs is used to supply the frequency reference.

By default, analog inputs A1 and A2 are set for this function. Simultaneously using A1 and A2 increases the frequency reference by the total of all inputs.

Example: If the analog frequency reference from analog input terminal A1 is 50% and a bias of 20% is applied by analog input terminal A2, the resulting frequency reference will be 70% of the maximum output frequency.

Setting 1: Frequency Gain

The input value of an analog input set to this function will be multiplied with the analog frequency reference value.

Example: If the analog frequency reference from analog input terminal A1 is 80% and a gain of 50% is applied from analog input terminal A2, the resulting frequency reference will be 40% of the maximum output frequency.

Setting 2: Auxiliary Reference 1

Sets the auxiliary frequency reference 1 when multi-step speed operation is selected. *Refer to Multi-Step Speed Selection on page 171* for details.

Setting 3: Auxiliary Reference 2

Sets the auxiliary frequency reference 2 when multi-step speed operation is selected. *Refer to Multi-Step Speed Selection on page 171* for details.

Setting 4: Output Voltage Bias

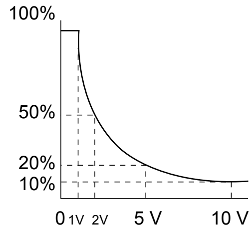
Voltage bias boosts the output voltage of the V/f curve as a percentage of the maximum output voltage (E1-05). Available only when using V/f Control.

Setting 5: Accel/Decel Time Gain

Adjusts the gain level for the acceleration and deceleration times set to parameters C1-01 through C1-04.

The drive acceleration time is calculated by multiplying the gain level to C1-☐☐ as follows:

C1-☐☐ × Accel/decel time gain = Drive accel/decel time



Acceleration/deceleration gain from 1 to 10 V

$$= \frac{(10\text{ V})}{\text{Input Voltage (V)}} \cdot 10\ (\%)$$

Figure 5.60 Accel/Decel Time Gain with Analog Input Terminal

Setting 6: DC Injection Braking Current

The current level used for DC Injection Braking is set as a percentage of the drive rated current.

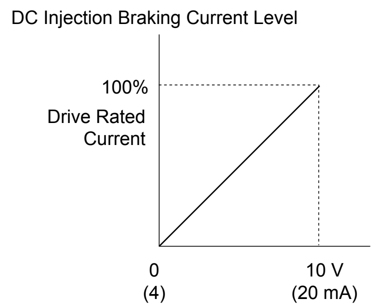


Figure 5.61 DC Injection Braking Current Using an Analog Input Terminal

Setting 7: Torque Detection Level

Using this setting, the overtorque/undertorque detection level for torque detection 1 (L6-01) can be set by an analog input. The analog input replaces the level set to L6-02. An analog input of 100% (10 V or 20 mA) sets a torque detection level equal to 100% drive rated current/motor rated torque. Adjust the analog input gain if higher detection level settings are required. ***Refer to L6: Torque Detection on page 241*** for details on torque detection.

Setting 8: Stall Prevention Level

Allows an analog input signal to adjust the Stall Prevention level. ***Figure 5.62*** shows the setting characteristics. The drive will use the lower value of the Stall Prevention level set to L3-06 or the level coming from the selected analog input terminal.

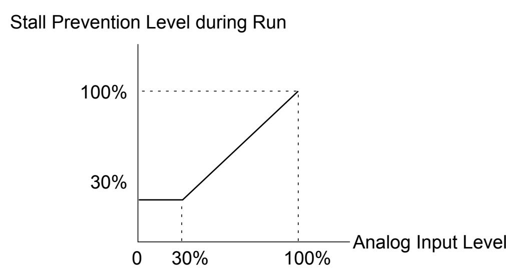


Figure 5.62 Stall Prevention During Run Using an Analog Input Terminal

Setting 9: Output Frequency Lower Limit Level

The user can adjust the lower limit of the output frequency using an analog input signal.

Setting B: PID Feedback

Supplies the PID feedback value. This setting requires PID operation to be enabled in b5-01. ***Refer to PID Feedback Input Methods on page 150***.

Setting C: PID Setpoint

Supplies the PID setpoint value and makes the frequency reference selected in parameter b1-01 no longer the PID setpoint. PID operation to be enabled in b5-01 to use this setting. ***Refer to PID Setpoint Input Methods on page 150***.

Setting D: Frequency Bias

The input value of an analog input set to this function will be added to the frequency reference. This function can be used with any frequency reference source.

Setting E: Motor Temperature

In addition to motor overload fault detection oL1, it is possible to use a Positive Temperature Coefficient (PTC) thermistor for motor insulation protection. *Refer to Motor Protection Using a Positive Temperature Coefficient (PTC) Thermistor on page 225* for a detailed explanation.

Setting 16: Differential PID Feedback

If an analog value is set for this function, the PID controller is set for differential feedback. The difference of the PID feedback input value and the differential feedback input value builds the feedback value used to calculate the PID input. *Refer to PID Feedback Input Methods on page 150*.

Setting 17: Motor Thermistor (NTC)

Used as a complement or a substitution for oL1. *Refer to Motor Protection Using an NTC Thermistor Input on page* for details.

Setting 1F: Through Mode

An input does not affect any drive function, but the input level can still be read out by a PLC via a communication option or MEMOBUS/Modbus communications.

Setting 25: Secondary PI Setpoint

10 V = S3-02 (maximum output frequency)

Setting 26: Secondary PI Feedback

10 V = S3-02 (maximum output frequency)

◆ H4: Multi-Function Analog Outputs

These parameters assign functions to analog output terminals FM and AM for monitoring a specific aspect of drive performance.

■ H4-01, H4-04: Multi-Function Analog Output Terminal FM, AM Monitor Selection

Sets the desired drive monitor parameter U□-□□ to output as an analog value via terminal FM and AM. *Refer to U: Monitor Parameters on page 271* for a list of all monitors. The "Analog Output Level" column indicates whether a monitor can be used for analog output.

Example: Enter "103" for U1-03.

No.	Name	Setting Range	Default
H4-01	Multi-Function Analog Output Terminal FM Monitor Selection	000 to 999	102
H4-04	Multi-Function Analog Output Terminal AM Monitor Selection	000 to 999	103

A setting of 031 or 000 applies no drive monitor to the analog output. With this setting, terminal functions as well as FM and AM output levels can be set by a PLC via a communication option or MEMOBUS/Modbus (through mode).

■ H4-02, H4-03: Multi-Function Analog Output Terminal FM Gain and Bias H4-05, H4-06: Multi-Function Analog Output Terminal AM Gain and Bias

Parameters H4-02 and H4-05 set the terminal FM and AM output signal level when the value of the selected monitor is at 100%. Parameters H4-03 and H4-06 set the terminal FM and AM output signal level when the value of the selected monitor is at 0%. Both are set as a percentage, where 100% equals 10 Vdc or 20 mA analog output and 0% equals 0 V or 4 mA. The output voltage of both terminals is limited to +/-10 Vdc.

The output signal range can be selected between 0 to +10 Vdc or -10 to +10 Vdc, or 4 to 20 mA using parameter H4-07 and H4-08. *Figure 5.63* illustrates how gain and bias settings work.

No.	Name	Setting Range	Default
H4-02	Multi-Function Analog Output Terminal FM Gain	-999.9 to 999.9%	100.0%
H4-03	Multi-Function Analog Output Terminal FM Bias	-999.9 to 999.9%	0.0%
H4-05	Multi-Function Analog Output Terminal AM Gain	-999.9 to 999.9%	50.0%
H4-06	Multi-Function Analog Output Terminal AM Bias	-999.9 to 999.9%	0.0%

Using Gain and Bias to Adjust Output Signal Level

The output signal is adjustable while the drive is stopped.

Terminal FM

1. View the value set to H4-02 (Terminal FM Monitor Gain) on the digital operator. A voltage equal to 100% of the parameter being set in H4-01 will be output from terminal FM.
2. Adjust H4-02 viewing the monitor connected to the terminal FM.
3. View the value set to H4-03 on the digital operator; terminal FM will output a voltage equal to 0% of the parameter being set in H4-01.
4. Adjust H4-03 viewing the output signal on the terminal FM.

Terminal AM

1. View the value set to H4-05 (Terminal AM Monitor Gain) on the digital operator. A voltage equal to 100% of the parameter being set in H4-04 will be output from terminal AM.
2. Adjust H4-05 viewing the monitor connected to the terminal AM.
3. View the value set to H4-06 on the digital operator; terminal AM will output a voltage equal to 0% of the parameter being set in H4-04.
4. Adjust H4-06 viewing the output signal on the terminal AM.

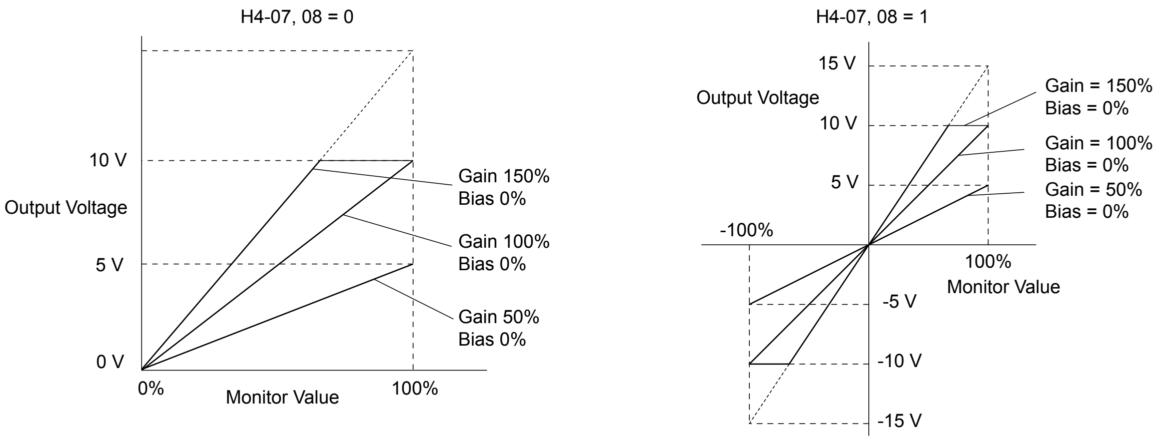


Figure 5.63 Analog Output Gain and Bias Setting Example 1 and 2

Set H4-03 to 30% for an output signal of 3 V at terminal FM when the monitored value is at 0%.

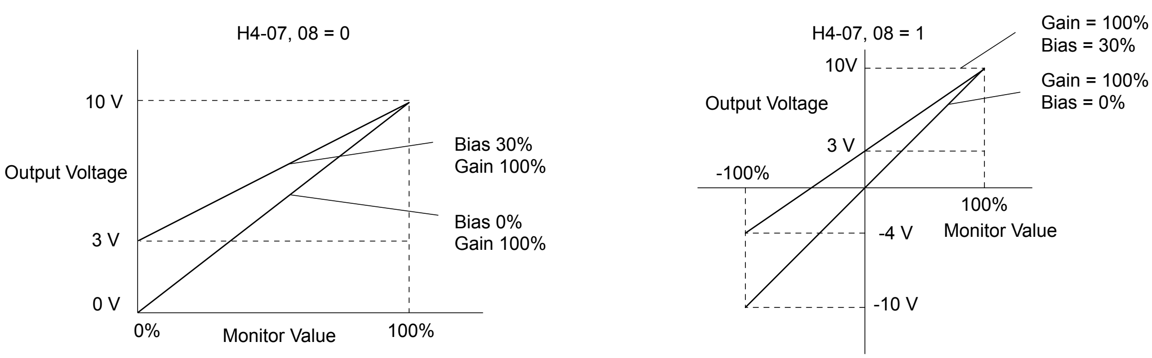


Figure 5.64 Analog Output Gain and Bias Setting Example 3

■ H4-07, H4-08: Multi-Function Analog Output Terminal FM, AM Signal Level Selection

Sets the voltage output level of U parameter (monitor parameter) data to terminal FM and terminal AM using parameters H4-07 and H4-08.

No.	Name	Setting Range	Default
H4-07	Multi-Function Analog Output Terminal FM Signal Level Selection	0 to 2	0
H4-08	Multi-Function Analog Output Terminal AM Signal Level Selection	0 to 2	0

Setting 0: 0 to 10 V

Setting 1: -10 V to 10 V

Setting 2: 4 to 20 mA

◆ H5: MEMOBUS/Modbus Serial Communication

Serial communication is possible in the drive using the built-in RS-422/485 port (terminals R+, R-, S+, S-) and programmable logic controllers (PLCs) or similar devices running the MEMOBUS/Modbus protocol.

The H5-☐☐ parameters set the drive for MEMOBUS/Modbus Communications. *Refer to MEMOBUS/Modbus Serial Communication on page 467* for detailed descriptions of the H5-☐☐ parameters.

◆ H6: Pulse Train Input

A one-track pulse train signal with a maximum frequency of 32 kHz can be input to the drive at terminal RP. This pulse train signal can be used as the frequency reference or for PID functions.

Use parameters H6-☐☐ to set the scale and other aspects of the pulse input terminal RP.

■ H6-01: Pulse Train Input Terminal RP Function Selection

Selects the function of pulse train input terminal RP.

No.	Name	Setting Range	Default
H6-01	Pulse Train Input Terminal RP Function Selection	0 to 2	0

Setting 0: Frequency reference

If the pulse input is set for this function and the frequency reference source is set to pulse input (b1-01, b1-15 = 4), the drive reads the frequency value from terminal RP.

Setting 1: PID feedback value

Using this setting, the feedback value for PID control can be supplied as a pulse signal at terminal RP. *Refer to b5: PID Control on page 149* for details on PID control.

Setting 2: PID setpoint value

Using this setting, the setpoint value for PID control can be supplied as a pulse signal at terminal RP. *Refer to b5: PID Control on page 149* for details on PID control.

■ H6-02: Pulse Train Input Scaling

Sets the pulse signal frequency that is equal to 100% of the input value selected in parameter H6-01.

No.	Name	Setting Range	Default
H6-02	Pulse Train Input Scaling	100 to 32000 Hz	1440 Hz

■ H6-03: Pulse Train Input Gain

Sets the level of the input value selected in H6-01 when a pulse train signal with the frequency set in H6-02 is input to terminal RP.

No.	Name	Setting Range	Default
H6-03	Pulse Train Input Gain	0.0 to 1000.0%	100.0%

■ H6-04: Pulse Train Input Bias

Sets the level of the input value selected in H6-01 when no signal (0 Hz) is input to terminal RP.

No.	Name	Setting Range	Default
H6-04	Pulse Train Input Bias	-100.0 to 100.0%	0.0%

■ H6-05: Pulse Train Input Filter Time

Sets the pulse train input filter time constant in seconds.

No.	Name	Setting Range	Default
H6-05	Pulse Train Input Filter Time	0.00 to 2.00 s	0.10 s

■ H6-08: Pulse Train Input Minimum Frequency

Sets the minimum output frequency detected by the pulse train input. Increasing this setting reduces the time the drive needs to react to changes in the input signal.

- The pulse input value becomes 0 when the pulse input frequency falls below this level.
- Enabled when H6-01 = 0, 1, or 2.
- When simple speed feedback in V/f Control is set as the function for terminal RP (H6-01 = 3), the minimum frequency becomes the detection time for PG disconnect (F1-14).

No.	Name	Setting Range	Default
H6-08	Pulse Train Input Minimum Frequency	0.1 to 1000.0 Hz	0.5 Hz

5.8 L: Protection Functions

◆ L1: Motor Protection

■ L1-01: Motor Overload Protection Selection

The drive has an electronic overload protection function that estimates the motor overload level based on output current, output frequency, thermal motor characteristics, and time. When the drive detects a motor overload an oL1 fault is triggered and the drive output shuts off.

L1-01 sets the overload protection function characteristics according to the motor being used.

No.	Name	Setting Range	Default
L1-01	Motor Overload Protection Selection	0 to 6	1

Note:
1. When the motor protection function is enabled (L1-01≠ 0), an oL1 alarm can be output through one of the multi-function outputs by setting H2-01 to 1F. The output closes when the motor overload level reaches 90% of the oL1 detection level.
2. Set L1-01 to a value between 1 and 6 when running a single motor from the drive to select a method to protect the motor from overheat. An external thermal relay is not necessary.

Setting 0: Disabled (motor overload protection is not provided)

Use this setting if no motor overheat protection is desired or if multiple motors are connected to a single drive. If multiple motors are connected to a single drive, install a thermal relay for each motor as shown in *Figure 5.65*.

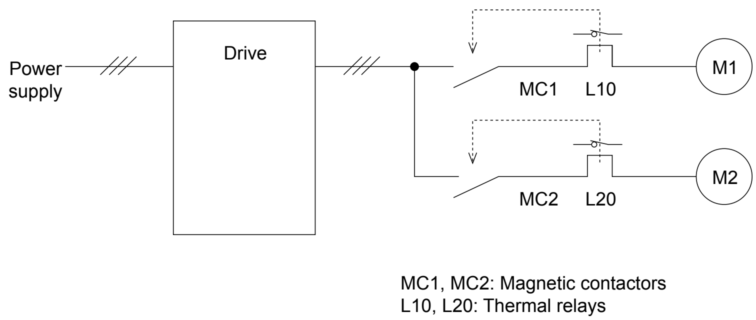


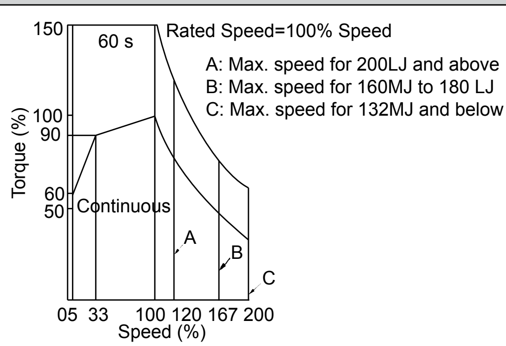
Figure 5.65 Example of Protection Circuit Design for Multiple Motors

NOTICE: *Thermal protection cannot be provided when running multi-motors simultaneously with the same drive, or when using motors with a relatively high current rating compared to other standard motors (such as a submersible motor). Failure to comply could result in motor damage. Disable the electronic overload protection of the drive (L1-01 = "0: Disabled") and protect each motor with individual motor thermal overloads.*

Note: Close MC1 and MC2 before operating the drive. MC1 and MC2 cannot be switched off during run.

Setting 1: General-purpose motor (standard self-cooled)

Because the motor is self-cooled, the overload tolerance drops when the motor speed is lowered. The drive appropriately adjusts the electrothermal trigger point according to the motor overload characteristics, protecting the motor from overheat throughout the entire speed range.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor designed to operate from line power. Motor cooling is most effective when running at rated base frequency (check the motor nameplate or specifications).	Continuous operation at less than line power frequency with 100% load can trigger motor overload protection (oL1). A fault is output and the motor will coast to stop.

Parameter Details

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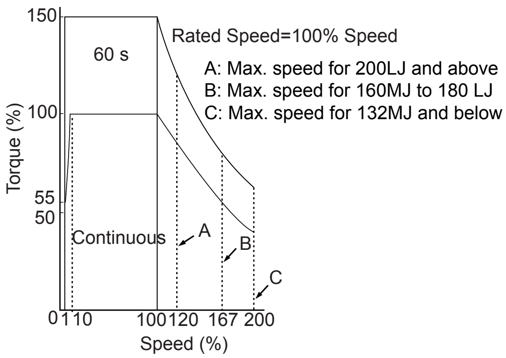
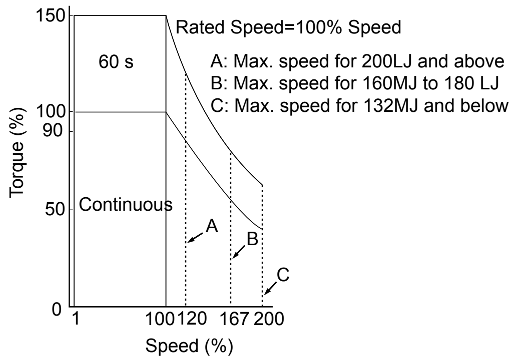
Setting 2: Drive dedicated motor (speed range for constant torque: 1:10)

Use this setting when operating a drive duty motor that allows constant torque in a speed range of 1:10. The drive will allow the motor to run with 100% load from 10% up to 100% speed. Running at slower speeds with full load can trigger an overload fault.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor is designed to effectively cool itself even at low speeds.	Continuous operation with 100% load from 6 Hz to E1-06, Motor Base Frequency.

Setting 3: Vector motor (speed range for constant torque: 1:100)

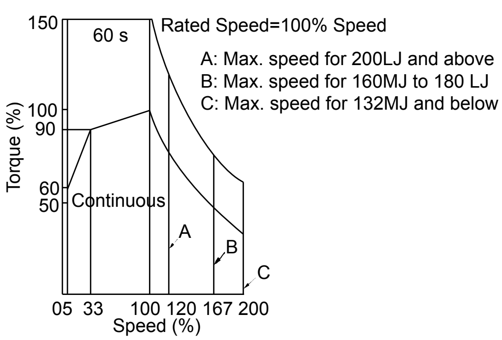
Use this setting when operating a drive-dedicated motor that allows constant torque in a speed range of 1:100. This motor type is allowed to run with 100% load from 1% up to 100% speed. Running slower speeds with full load can trigger an overload fault.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor is designed to effectively cool itself at speeds near 0.6 Hz.	Continuous operation with 100% load from 0.6 Hz to E1-06, Motor Base Frequency. Continuous operation below 0.6 Hz may cause an oL1 or oL2 fault.

Setting 6: General-purpose motor

Note: General-purpose motors are designed with a base speed that operates at line frequency (50/60 Hz depending on geographic region).

Because the motor is self-cooled, the overload tolerance drops when the motor speed is lowered. The drive appropriately adjusts the electrothermal trigger point according to the motor overload characteristics and protects the motor from overheat throughout the entire speed range.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor designed to operate from line power. Motor cooling is most effective when running at rated base frequency (check the motor nameplate or specifications)	Continuous operation at less than line power frequency with 100% load can trigger motor overload protection (oL1). A fault is output and the motor will coast to stop.

■ L1-02: Motor Overload Protection Time

Sets the detection time of motor overheat due to overload. This setting rarely requires adjustment, but should correlate with the motor overload tolerance protection time for performing a hot start.

No.	Name	Setting Range	Default
L1-02	Motor Overload Protection Time	0.1 to 5.0 minutes	1.0 minutes

Defaulted to operate with an allowance of 150% overload operation for one minute in a hot start.

Figure 5.66 illustrates an example of the electrothermal protection operation time using a general-purpose motor operating at the value of E1-06, Motor Base Speed, with L1-02 set to one minute.

During normal operation, motor overload protection operates in the area between a cold start and a hot start.

- Cold start: Motor protection operation time in response to an overload situation that was suddenly reached when starting a stationary motor.
- Hot start: Motor protection operation time in response to an overload situation that occurred during sustained operation at rated current.

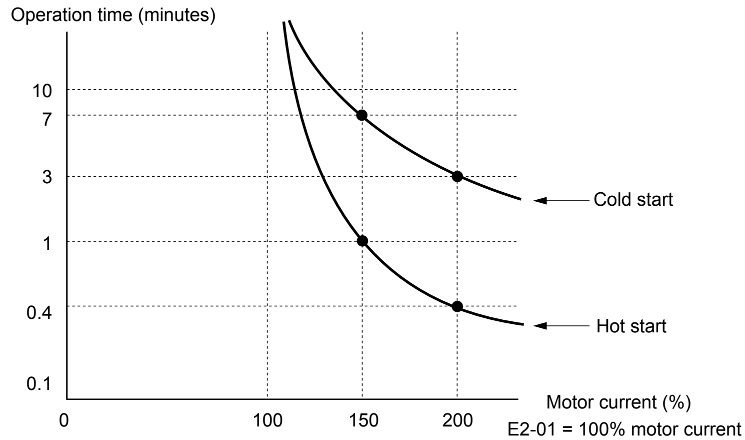


Figure 5.66 Motor Protection Operation Time

■ Motor Protection Using a Positive Temperature Coefficient (PTC) Thermistor

Connect a motor PTC can to an analog input of the drive for motor overheat protection.

The motor overheat alarm level triggers an oH3 alarm and the drive continues the operation selected in L1-03. The overheat fault level triggers an oH4 fault, outputs a fault signal, and the drive stops the motor using the stop method selected in L1-04.

Connect the PTC between terminals AC and A3 and set jumper S4 on the terminal board to “PTC” as shown in *Figure 5.67*. Set H3-05 to 0 and H3-06 to E.

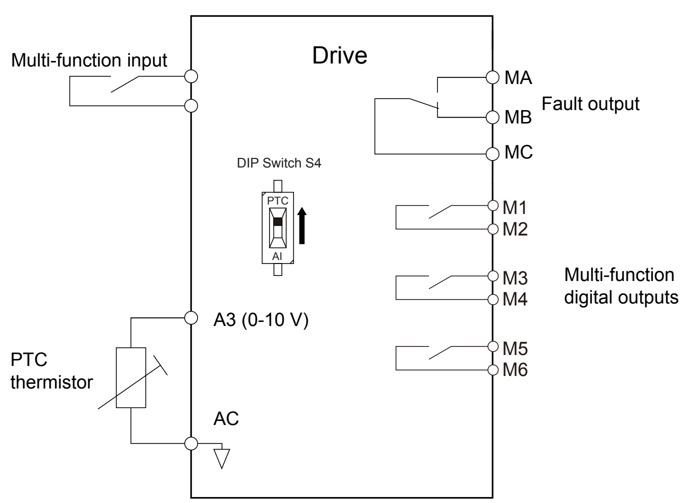


Figure 5.67 Connection of a Motor PTC

Parameter Details

5

The PTC must exhibit the characteristics shown in *Figure 5.68* in one motor phase. The motor overload protection of the drive expects 3 of these PTCs to be connected in a series.

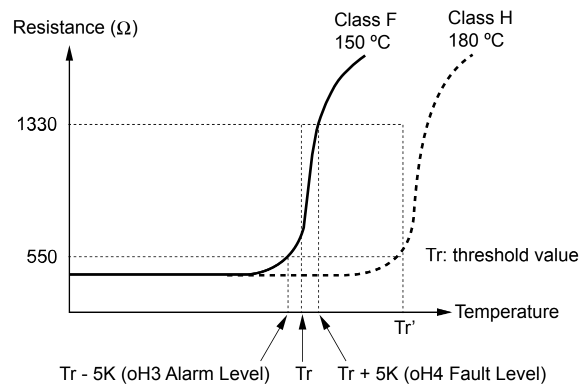


Figure 5.68 Motor PTC Characteristics

Set up overheat detection using a PTC using parameters L1-03, L1-04, and L1-05 as explained in the following sections.

■ L1-03: Motor Overheat Alarm Operation Selection (PTC input)

Sets the drive operation when the PTC input signal reaches the motor overheat alarm level (oH3).

No.	Name	Setting Range	Default
L1-03	Motor Overheat Alarm Operation Selection (PTC input)	0 to 3	3

Setting 0: Ramp to stop

The drive stops the motor using the deceleration time 1 set in parameter C1-02.

Setting 1: Coast to stop

The drive output is switched off and the motor coasts to stop.

Setting 2: Fast Stop

The drive stops the motor using the Fast Stop time set in parameter C1-09.

Setting 3: Alarm only

The operation is continued and an oH3 alarm is displayed on the digital operator.

■ L1-04: Motor Overheat Fault Operation Selection (PTC input)

Sets the drive operation when the PTC input signal reaches the motor overheat fault level (oH4).

No.	Name	Setting Range	Default
L1-04	Motor Overheat Fault Operation Selection (PTC input)	0 to 2	1

Setting 0: Ramp to Stop

The drive stops the motor using the deceleration time 1 set in parameter C1-02.

Setting 1: Coast to Stop

The drive output is switched off and the motor coasts to stop.

Setting 2: Fast Stop

The drive stops the motor using the Fast Stop time set in parameter C1-09.

■ L1-05: Motor Temperature Input Filter Time (PTC input)

Sets a filter on the PTC input signal to prevent erroneous detection of a motor overheat fault.

No.	Name	Setting Range	Default
L1-05	Motor Temperature Input Filter Time (PTC input)	0.00 to 10.00 s	0.20 s

■ L1-13: Continuous Electrothermal Operation Selection

Determines whether to hold the current value of the electrothermal motor protection (L1-01) when the power supply is interrupted.

No.	Name	Setting Range	Default
L1-13	Continuous Electrothermal Operation Selection	0 to 2	1

Setting 0: Disabled

Setting 1: Enabled

Setting 2: Enabled (RTC)

◆ L2: Momentary Power Loss Ride-Thru

■ L2-01: Momentary Power Loss Operation Selection

When a momentary power loss occurs (DC bus voltage falls below the level set in L2-05), the drive can automatically return to the operation it was performing prior to the power loss based on certain conditions.

No.	Name	Setting Range	Default
L2-01	Momentary Power Loss Operation Selection	0 to 5	2

Setting 0: Disabled (default)

If power is not restored within 15 ms, a Uv1 fault will result and the motor coasts to stop.

Setting 1: Recover within L2-02

When a momentary power loss occurs, the drive output will be shut off. If the power returns within the time set to parameter L2-02, the drive will perform Speed Search and attempt to resume operation. If power is not restored within this time (i.e., DC bus voltage level remains below Uv1 detection level L2-05), then a Uv1 fault is triggered and the drive will stop.

Setting 2: Recover as long as CPU has power

When a momentary power loss occurs, the drive output will be shut off. If the power returns and the drive control circuit has power, the drive will attempt to perform Speed Search and resume the operation. This will not trigger a Uv1 fault.

Setting 3: Kinetic Energy Backup (KEB) Ride-Thru operation within L2-02

The drive decelerates using regenerative energy from the motor until the time set in L2-02 has expired. It then tries to accelerate back to the frequency reference. If the power does not return within the time set to L2-02, it will trigger a Uv1 fault and the drive output will shut off. The type of KEB operation is determined by the L2-29 setting.

Setting 4: KEB Ride-Thru as long as CPU has power

The drive decelerates using regenerative energy from the motor until the power returns and then restarts. If the motor comes to a stop before the power returns, the drive loses control power and the drive output shuts off. A Uv1 fault is not triggered. The type of KEB operation is determined by the L2-29 setting.

Setting 5: Ramp to stop with KEB deceleration

The drive ramps to stop using the regenerative energy from the motor. Even if the power is restored, the drive will continue to decelerate until the motor comes to a complete stop. The type of KEB operation is determined by the L2-29 setting. If an input terminal set for KEB 1 (H1-□□ = 65, 66) is triggered while the drive is decelerating, it will accelerate back up to speed when the input is released.

Notes on Settings 1 through 5

- “Uv” will flash on the operator while the drive is attempting to recover from a momentary power loss. A fault signal is not output at this time.
- A Momentary Power Loss Unit is available to allow for a longer momentary power loss ride through time in models 2A0004 to 2A0056 and 4A0002 to 4A0031. This option makes it possible to continue running the drive after up to two seconds of power loss.
- When using a magnetic contactor between the motor and the drive, keep the magnetic contactor closed as long as the drive performs KEB operation or attempts to restart with Speed Search.
- Keep the Run command active during KEB operation or the drive cannot accelerate back to the frequency reference when the power returns.
- When L2-01 is set to 3, 4, or 5, KEB Ride-Thru will be executed as specified in L2-29.

■ KEB Ride-Thru Function

When the drive detects a power loss, KEB Ride-Thru decelerates the motor and uses regenerative energy to keep the main circuit operating. Despite power loss, the drive output is not interrupted.

Choose between Single Drive KEB Ride-Thru 1 and 2 (L2-29 = 0 or 1 for applications driven by a single drive.

Choose between System KEB Ride-Thru 1 and 2, (L2-29 = 2 or 3) for applications where multiple drives have to perform KEB operation while keeping a certain speed ratio.

Single Drive KEB Ride-Thru 1 (L2-29 = 0)

After KEB Ride-Thru begins, the drive uses regenerative energy from the motor to keep the DC bus voltage at the level set to L2-11 while adjusting the rate of deceleration based on the time set to L2-06. The user must set L2-06 properly to prevent Uv1 and ov faults.

Note: Shorten the KEB deceleration time (L2-06) if undervoltage (Uv1) occurs in the DC bus. Increase the KEB deceleration time if overvoltage (ov) occurs.

Single Drive KEB Ride-Thru 2 (L2-29 = 1)

The drive uses information about the inertia of the connected machinery to determine the deceleration rate necessary to keep the DC bus voltage at the level set in parameter L2-11. The resulting deceleration time is calculated based on the system inertia and cannot be adjusted.

System KEB Ride-Thru 1 (L2-29 = 2)

The drive decelerates at the KEB deceleration time set to L2-06. L2-06 is the time required to decelerate from the current frequency reference to 0. Using this setting, multiple drives can decelerate while keeping the speed ratio constant between those drives. This function requires a braking resistor and disregards the voltage level in the DC bus.

System KEB Ride-Thru 2 (L2-29 = 3)

The drive decelerates based on the KEB deceleration time set to L2-06 while monitoring the DC bus voltage. If the voltage level rises, the drive briefly holds the frequency before continuing to decelerate.

■ KEB Ride-Thru Start

KEB operation is triggered independently of the selected KEB operation mode. When the KEB function is selected as the function to be executed when power loss operation occurs (L2-01 = 3, 4, or 5), then KEB Ride-Thru will be activated if one of the following conditions becomes true:

- A digital input programmed for H1-☐☐ = 65 or 66 is activated. This will start KEB operation using the mode selected in parameter L2-29.
- A digital input programmed for H1-☐☐ = 7A or 7B is activated. This will automatically select Single KEB Ride-Thru 2, disregarding the setting of L2-29.
- The DC bus voltage fell below the level specified in L2-05. The KEB operation will start as specified in L2-29.

Note: Attempting to simultaneously assign KEB Ride-Thru 1 and 2 to input terminals will trigger an oPE3 error.

When using a digital input to trigger KEB operation and the device controlling the input acts relatively slow, set a minimum KEB operation time in parameter L2-10. In the example below, the DC bus voltage triggers KEB operation and a digital input triggers the Hold command.

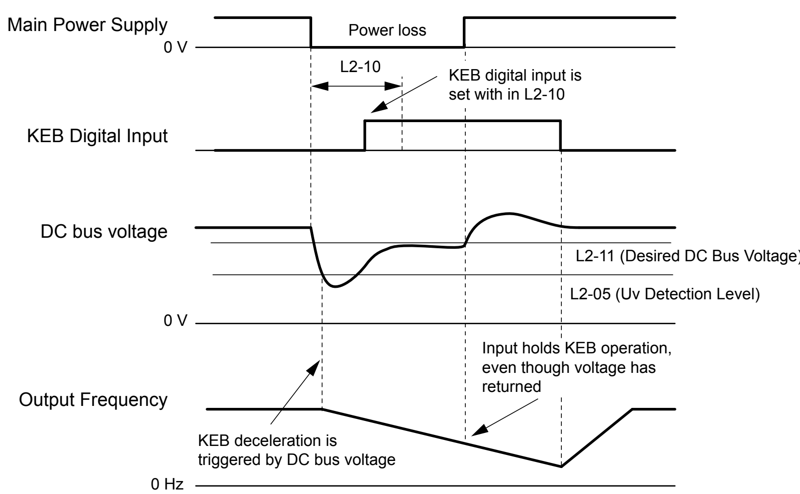


Figure 5.69 KEB Operation Using a KEB Input

■ KEB Ride-Thru End Detection

The KEB function end detection depends on the setting of parameter L2-01 and whether a digital input programmed for KEB (H1-☐☐ = 65, 66, 7A, 7B) is used.

KEB Ride-Thru Operation in L2-02, Input Terminals Not Used

Here, L2-01 = 3 and the input terminals have not been set for KEB Ride-Thru (H1-□□ does not equal 65, 66, 7A, 7B). After decelerating for the time set in parameter L2-02, the drive ends KEB operation and attempts to accelerate back to the frequency reference. A Uv1 fault occurs and the drive output shuts off if the power does not return within the time set to L2-02.

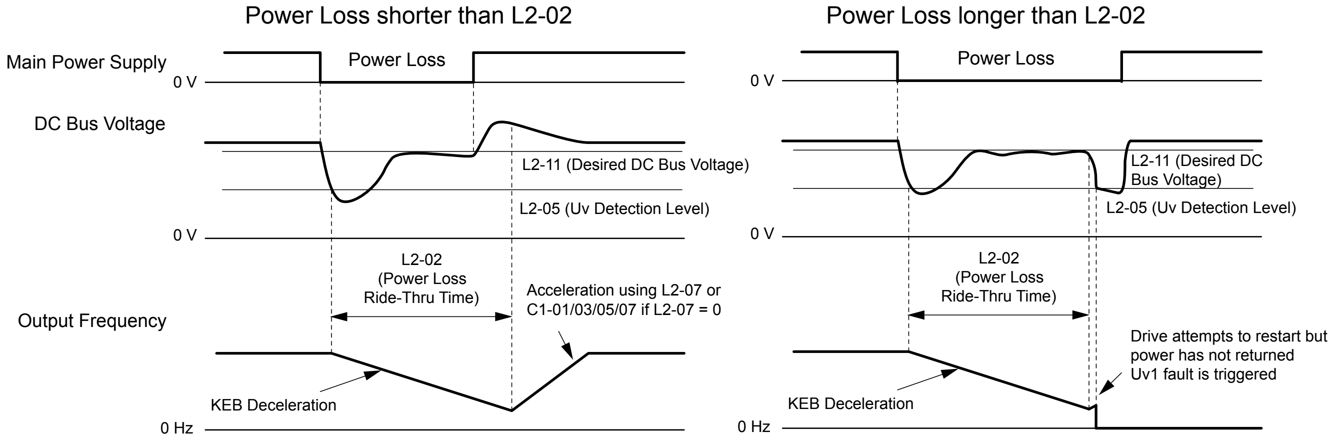


Figure 5.70 KEB Operation Using L2-02, Without KEB Input

KEB Ride-Thru Operation Within L2-02, Input Terminals Used

Here, L2-01 = 3 and an input terminal is set to issue KEB Ride-Thru (H1-□□ = 65, 66, 7A, 7B). After decelerating for the time set in parameter L2-02, the drive checks the DC bus voltage and the status of the digital input. If the DC bus voltage is still below the level set in L2-11 or if the KEB digital input is still active, KEB deceleration continues. If the voltage level has risen above the value set to L2-11, then normal operation is resumed.

Note: If L2-10 is set to a longer time than L2-02, the drive checks the DC bus voltage level and the status of the terminal assigned to KEB Ride-Thru after the time set to L2-02 passes. The drive will then try to restart.

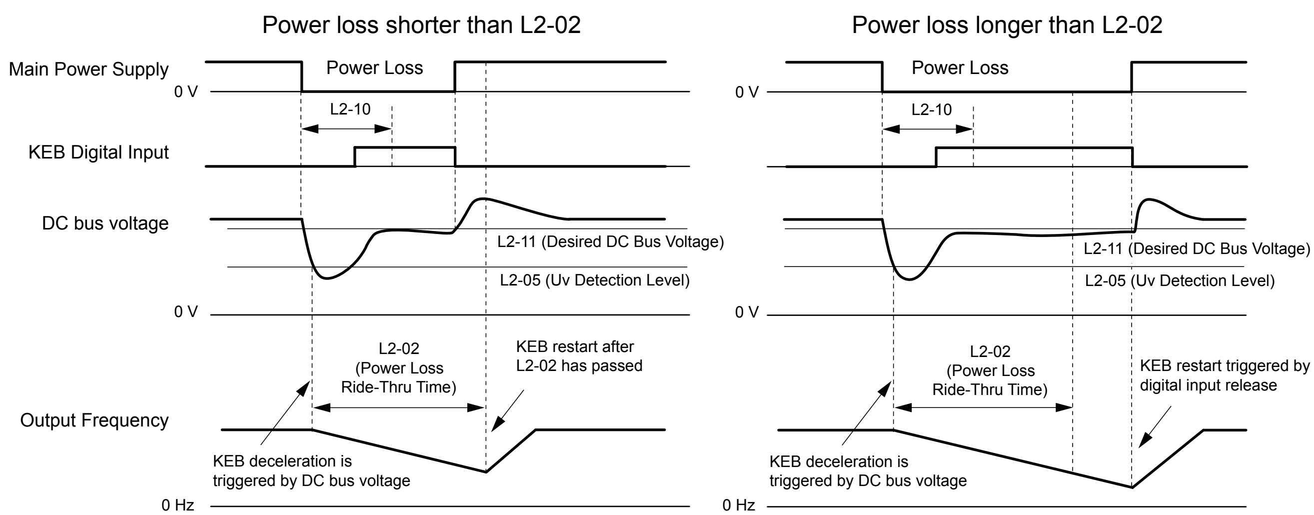


Figure 5.71 KEB Operation Using L2-02 and KEB Input

KEB Ride-Thru Operation as Long as CPU Has Power, KEB Input Not Used

Here, L2-01 = 4 and the input terminals have not been set for KEB Ride-Thru (H1-□□ does not equal 65, 66, 7A, 7B). After decelerating for the time set to parameter L2-10, the drive checks the DC bus voltage level. Deceleration continues if the DC bus voltage is lower than the level set in L2-11. Normal operation resumes when the DC bus voltage rises above the value of L2-11.

Parameter Details

5

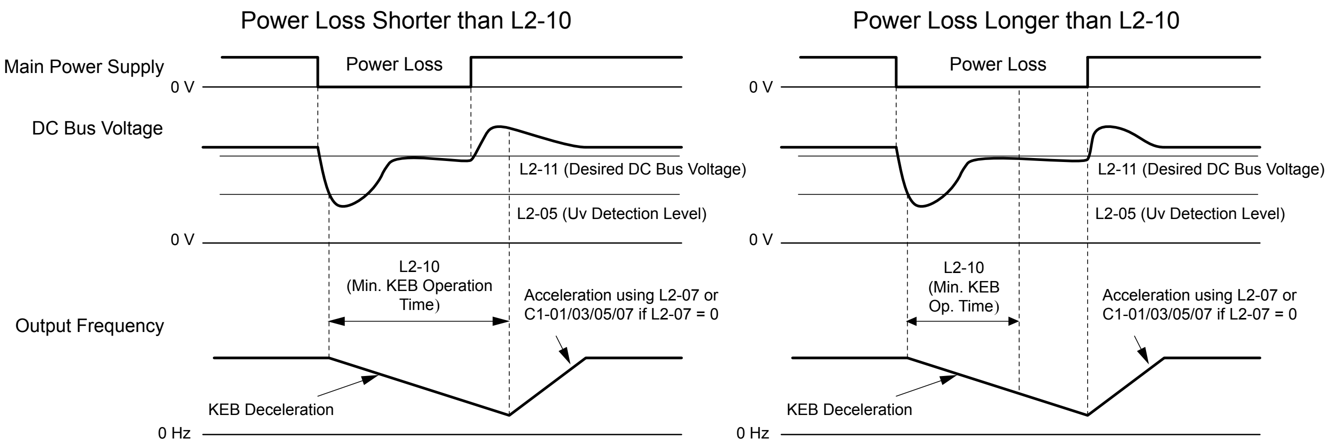


Figure 5.72 KEB Operation Using L2-10, Without KEB Input

KEB Ride-Thru Operation as Long as CPU Has Power, KEB Input Used

Here, L2-01 = 3 and an input terminal is set to issue KEB Ride-Thru (H1-□□ = 65, 66, 7A, 7B). After decelerating for the time set to parameter L2-10, the drive checks the DC bus voltage and the status of the digital input. Deceleration continues if the DC bus voltage is still below the level set in L2-11 or if the digital input assigned to KEB Ride-Thru is still active. Normal operation resumes when the DC bus voltage rises above the value of L2-11 and the terminal that initiated KEB Rid-Thru is released.

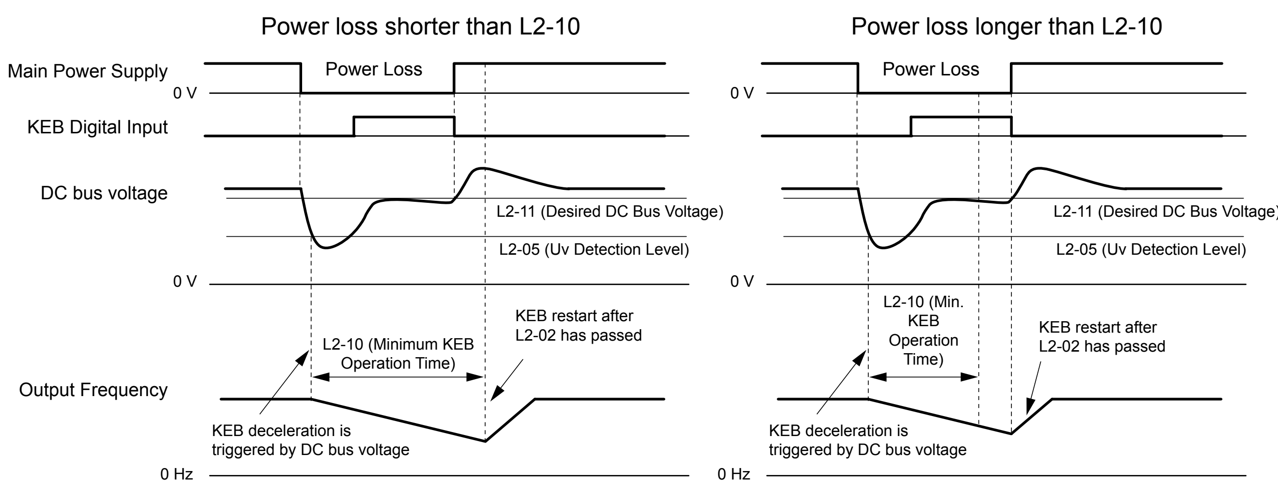


Figure 5.73 KEB Operation Using L2-10 and KEB Input

L2-01 = 5

KEB operation ends when the motor has come to a stop, even if the power returns and the digital input terminal that initiated KEB Ride-Thru is cleared.

■ KEB Operation Wiring Example

Figure 5.74 shows a wiring example to trigger the KEB Ride-Thru at power loss using an undervoltage relay. When a power loss occurs, the undervoltage relay triggers KEB Ride-Thru at terminal S6 (H1-06 = 65, 66, 7A, 7B). Note that using System KEB Ride-Thru requires an additional dynamic braking option.

Note:
1. Do not switch off the Run command during momentary power loss. If the Run command is shut off, the drive will not accelerate back to speed when the power is restored.
2. A dynamic braking option is required to use System KEB 1 (L2-29 = 2).

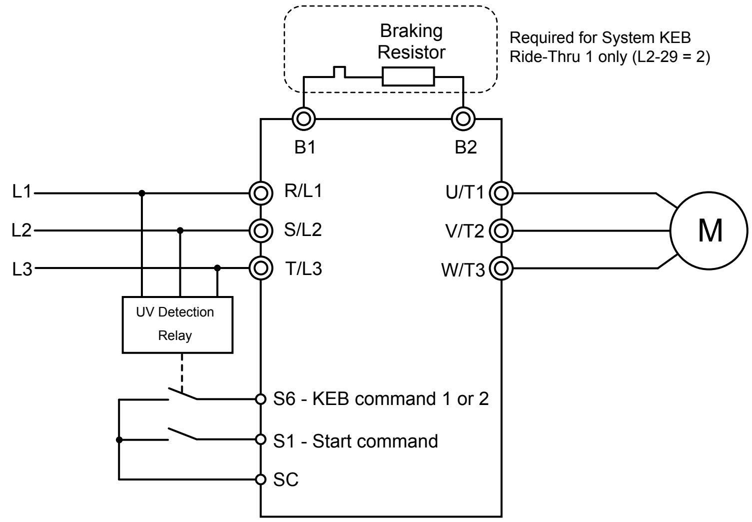


Figure 5.74 KEB Function Wiring Example

■ Parameters for KEB Ride-Thru

Table 5.35 lists parameters needed to set up KEB Ride-Thru depending on the type of KEB Ride-Thru selected in L2-29.

Table 5.35 KEB Function Related Adjustments

Parameter	Name	Setting Instructions	KEB Mode (L2-29)			
			0	1	2	3
C1-09	Fast Stop Time	• Increase if an overvoltage fault occurs during KEB deceleration. • Decrease if an undervoltage fault occurs during KEB deceleration.	YES	NO	NO	NO
C2-03	S-Curve at Deceleration Start	• Shorten if undervoltage occurs immediately after KEB Ride-Thru is triggered. • Lengthen this setting if overvoltage occurs immediately after KEB operation starts.	YES	NO	YES	YES
L2-05	Undervoltage Detection Level	Increase if an undervoltage fault occurs at KEB operation start to let the drive detect power loss more quickly.	YES	YES	YES	YES
L2-06	KEB Deceleration Time	• Increase if an overvoltage fault occurs during KEB deceleration • Decrease if an undervoltage fault occurs during KEB deceleration	NO	NO	YES	YES
L2-07	KEB Acceleration Time	Adjust to the desired acceleration time. If set to 0, standard acceleration times are used (C1-01, C1-03, C1-05, C1-07).	YES	YES	YES	YES
L2-08	Frequency Gain at KEB Start	• Increase if an undervoltage fault occurs immediately after KEB operation starts. • Decrease if an overvoltage fault occurs immediately after KEB operation starts.	YES	NO	YES	YES
L2-10	KEB Detection Time	• Increase when a digital input is set for KEB Ride-Thru and an undervoltage fault occurs after power was lost because the device controlling the input does not react quickly enough. • If the DC bus voltage overshoots after KEB Ride-Thru begins (and no input terminal is set to KEB Ride-Thru), increase L2-10 to longer than the overshoot.	YES	YES	YES	YES
L2-11	Desired DC Bus Voltage during KEB	• Set to approximately 1.22 times the input voltage for Single Drive KEB Ride-Thru 2. • Set to approximately 1.4 times the input voltage for Single Drive KEB Ride-Thru 1 and System KEB Ride-Thru modes.	YES	YES	YES	YES
L3-20	Main Circuit Adjustment Gain	• Increase this setting in steps of 0.1 if overvoltage or undervoltage occurs at the beginning of deceleration • Reduce if torque ripple occurs during deceleration while executing KEB Ride-Thru.	NO	YES	NO	NO

Parameter	Name	Setting Instructions	KEB Mode (L2-29)			
			0	1	2	3
L3-21	Accel/Decel Rate Calculation Gain	• Reduce L3-21 in steps of 0.05 if there is a fairly large speed or current ripple. • Decreasing this setting too much can cause a slow DC bus voltage control response, and may lead to problems with overvoltage or undervoltage.	NO	YES	NO	NO
L3-24	Motor Acceleration Time	Set the motor acceleration time as described on page 238.	NO	YES	NO	NO
L3-25	Load Inertia Ratio	Set the load/inertia ratio as described on page 238.	NO	YES	NO	NO

■ L2-02: Momentary Power Loss Ride-Thru Time

Sets the maximum time allowed to ride through a power loss. If power loss operation exceeds this time, the drive will attempt to accelerate back to the frequency reference. This parameter is valid if L2-01 = 1 or 3.

Note: The amount of time the drive is capable of recovering after a power loss is determined by the capacity of the drive. Drive capacity determines the upper limit for L2-02.

No.	Name	Setting Range	Default
L2-02	Momentary Power Loss Ride-Thru Time	0.0 to 25.5 s	Determined by o2-04

■ L2-03: Momentary Power Loss Minimum Baseblock Time

Sets the minimum baseblock time when power is restored following a momentary power loss. This determines the time the drive waits for the residual voltage in the motor to dissipate. Increase this setting if overcurrent or overvoltage occurs at the beginning of Speed Search, after a power loss, or during DC Injection Braking.

No.	Name	Setting Range	Default
L2-03	Momentary Power Loss Minimum Baseblock Time	0.1 to 5.0 s	Determined by o2-04

■ L2-04: Momentary Power Loss Voltage Recovery Ramp Time

Sets the time for the drive to restore the output voltage to the level specified by the V/f pattern after Speed Search. The setting value determines the time for the voltage to go from 0 V to the maximum voltage.

No.	Name	Setting Range	Default
L2-04	Momentary Power Loss Voltage Recovery Ramp Time	0.0 to 5.0 s	Determined by o2-04

■ L2-05: Undervoltage Detection Level (Uv)

Determines the voltage at which a Uv1 fault is triggered or at which the KEB function is activated. This setting rarely needs to be changed.

No.	Name	Setting Range	Default
L2-05	Undervoltage Detection Level	150 to 210 Vdc <1>	Determined by E1-01 <2>

<1> Values are specific to 200 V class drives. Double the value for 400 V class drives. Multiply the value by 2.875 for 600 V class drives.

<2> The default setting for 400 V class drives depends on whether the drive input voltage is over 400 V or under 400 V.

Note:
1. Install an AC reactor option on the input side of the power supply when setting L2-05 below the default value to prevent damage to drive circuitry.
2. If using KEB Ride-Thru and L2-05 is set too low, then undervoltage in the DC bus (Uv1) will be triggered before KEB Ride-Thru can be executed. Take caution not to set this value too low.

■ L2-06: KEB Deceleration Time

Sets the time to decelerate from the frequency reference at the time KEB Ride-Thru was initiated to zero speed. This setting can be used only when L2-29 = 2 (System KEB Ride-Thru 1).

No.	Name	Setting Range	Default
L2-06	KEB Deceleration Time	0.00 to 6000.0 s <1>	0.00 s

<1> Setting range is determined by the accel/decel time units set in C1-10. If the time is set in units of 0.01 s (C1-10 = 0), the setting range becomes 0.00 to 600.00 s.

■ L2-07: KEB Acceleration Time

Sets the time to reaccelerate from the speed when KEB was deactivated to the frequency reference.

When set to 0.0 s, the drive will accelerate to speed according to the active acceleration time set in C1-01 or C1-03.

No.	Name	Setting Range	Default
L2-07	KEB Acceleration Time	0.00 to 6000.0 s <1>	0.00 s

<1> Setting range is determined by the accel/decel time units set in C1-10. If the time is set in units of 0.01 s (C1-10 = 0), the setting range becomes 0.00 to 600.00 s.

■ L2-08: Frequency Gain at KEB Start

When the KEB Ride-Thru command is input, the output frequency is reduced in a single step to quickly get the motor into a regenerative state. Calculate the amount of this frequency reduction using the formula below. L2-08 can only be used with induction motors.

Amount of reduction = Slip frequency prior to KEB × (L2-08) × 2

No.	Name	Setting Range	Default
L2-08	Frequency Gain at KEB Start	0 to 300%	100%

■ L2-10: KEB Detection Time (Minimum KEB Time)

No.	Name	Setting Range	Default
L2-10	KEB Detection Time	0 to 2000 ms	50 ms

■ L2-11: DC Bus Voltage Setpoint during KEB

Determines the setpoint (target value) for the DC bus voltage during Single KEB Ride-Thru 2. For Single KEB Ride-Thru 1 and System KEB Ride-Thru, parameter L2-11 defines the voltage level to end KEB Ride-Thru.

No.	Name	Setting Range	Default
L2-11	DC Bus Voltage Setpoint during KEB	150 to 400 Vdc <1>	[E1-01] × 1.22

<1> Values are specific to 200 V class drives. Double the value for 400 V class drives. Multiply the value by 2.875 for 600 V class drives, but set the value below 1040 Vdc (overvoltage protection level).

■ L2-29: KEB Method Selection

Selects the way the Kinetic Energy Buffering function operates.

Note: If a multi function input is set for Single KEB Ride-Thru 2 (H1-□□ = 7A, 7B), the setting of L2-29 is disregarded and the KEB mode equal to L2-29 = 1 is automatically selected.

No.	Name	Setting Range	Default
L2-29	KEB Method Selection	0 to 3	0

Setting 0: Single Drive KEB Ride-Thru 1

Setting 1: Single Drive KEB Ride-Thru 2

Setting 2: System KEB Ride-Thru 1

Setting 3: System KEB Ride-Thru 2

Refer to KEB Ride-Thru Function on page 227 for detailed explanations.

◆ L3: Stall Prevention

The motor may experience excessive slip because it cannot keep up with the frequency reference when the load is too high or acceleration and deceleration times are too short. If the motor slips during acceleration, it usually causes an overcurrent fault (oC), drive overload (oL2), or motor overload (oL1). If the motor slips during deceleration, it can cause excessive regenerative power to flow back into the DC bus capacitors, and eventually cause the drive to fault out from overvoltage (oV). The Stall Prevention Function prevents the motor from stalling and while allowing the motor to reach the desired speed without requiring the user to change the acceleration or deceleration time settings. The Stall Prevention function can be set separately for acceleration, operating at constant speeds, and deceleration.

■ L3-01: Stall Prevention Selection during Acceleration

Stall Prevention during acceleration prevents tripping with overcurrent (oC), motor overload (oL1), or drive overload (oL2) faults common when accelerating with heavy loads.

L3-01 determines the type of Stall prevention the drive should use during acceleration.

No.	Name	Setting Range	Default
L3-01	Stall Prevention Selection during Acceleration	0 to 2	1

Setting 0: Disabled

No Stall Prevention is provided. If the acceleration time is too short, the drive may not be able to get the motor up to speed fast enough, causing an overload fault.

Setting 1: Enabled

Enables Stall Prevention during acceleration.

Acceleration is reduced when the output current value exceeds 85% of the level set to parameter L3-02 for a longer than the time set to L3-27. The acceleration stops when the current exceeds L3-02. Acceleration continues when the current falls below L3-02 for longer than the time set to L3-27.

The Stall Prevention level is automatically reduced in the constant power range. *Refer to L3-03: Stall Prevention Limit during Acceleration on page 234*.

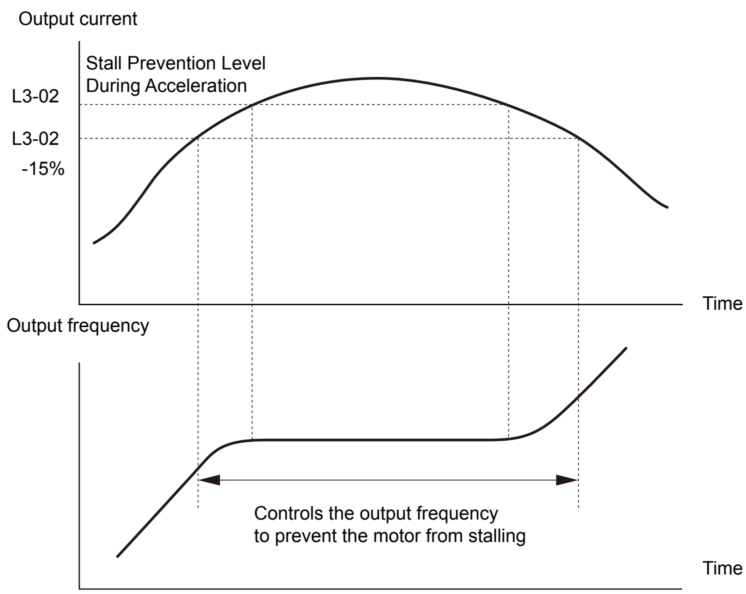


Figure 5.75 Stall Prevention During Acceleration for Induction Motors

Setting 2: Intelligent Stall Prevention

The drive disregards the selected acceleration time and attempts to accelerate in the minimum time. The acceleration rate is adjusted so the current does not exceed the value set to parameter L3-02.

■ L3-02: Stall Prevention Level during Acceleration

Sets the output current level at which the Stall Prevention during acceleration is activated.

No.	Name	Setting Range	Default
L3-02	Stall Prevention Level during Acceleration	0 to 150% <1>	<1>

<1> The upper limit and default value is determined by parameter L8-38, Carrier Frequency Reduction.

- Lower L3-02 if stalling occurs when using a motor that is relatively small compared to the drive.
- Also set parameter L3-03 when operating the motor in the constant power range.

■ L3-03: Stall Prevention Limit during Acceleration

The Stall Prevention level is automatically reduced when the motor is operated in the constant power range. L3-03 sets the lower limit for this reduction as a percentage of the drive rated current.

No.	Name	Setting Range	Default
L3-03	Stall Prevention Limit during Acceleration	0 to 100%	50%

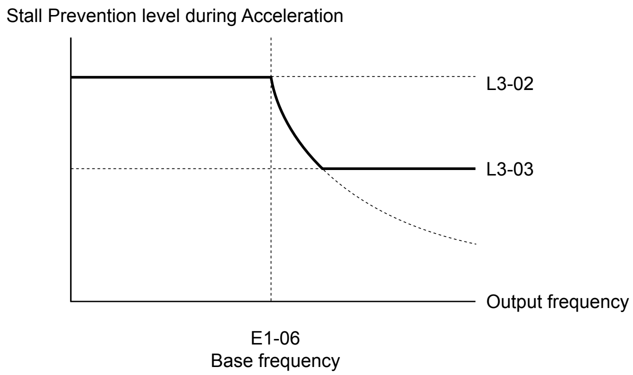


Figure 5.76 Stall Prevention Level and Limit During Acceleration

■ L3-04: Stall Prevention Selection during Deceleration

Stall Prevention during deceleration controls the deceleration based on the DC bus voltage and prevents an overvoltage fault caused by high inertia or rapid deceleration.

No.	Name	Setting Range	Default
L3-04	Stall Prevention Selection During Deceleration	0 to 5	1

Setting 0: Disabled

The drive decelerates according to the set deceleration time. With high inertia loads or rapid deceleration, an overvoltage fault may occur. If an overvoltage fault occurs, use dynamic braking options or switch to another L3-04 selection.

Setting 1: General-purpose Stall Prevention

The drive tries to decelerate within the set deceleration time. The drive pauses deceleration when the DC bus voltage exceeds the Stall Prevention level and then continues deceleration when the DC bus voltage drops below that level. Stall Prevention may be triggered repeatedly to avoid an overvoltage fault. The DC bus voltage level for Stall Prevention depends on the input voltage setting E1-01.

Drive Input Voltage	Stall Prevention Level during Deceleration
200 V Class	377 Vdc
400 V Class	754 Vdc
600 V Class	1084 Vdc

Note:
1. Do not use this setting in combination with a Dynamic Braking Resistor or other dynamic braking options. If Stall Prevention during deceleration is enabled, it will be triggered before the braking resistor option can operate.
2. This method may lengthen the total deceleration time compared to the set value. If this is not appropriate for the application consider using a dynamic braking option.

Figure 5.77 illustrates the function of Stall Prevention during deceleration.

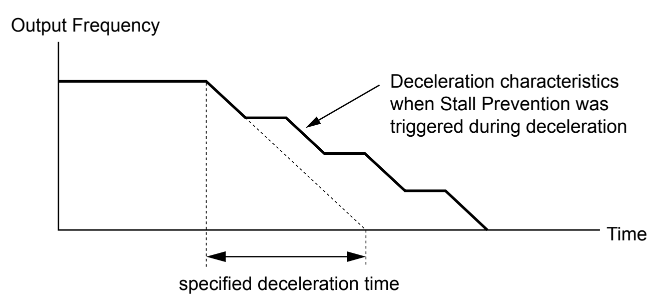


Figure 5.77 Stall Prevention During Deceleration

Parameter Details

5

Setting 2: Intelligent Stall Prevention

The drive adjusts the deceleration rate so the DC bus voltage is kept at the level set to parameter L3-17. This produces the shortest possible deceleration time while protecting the motor from stalling. The selected deceleration time is disregarded and the achievable deceleration time cannot be smaller than 1/10 of the set deceleration time.

This function uses the following parameters for adjusting the deceleration rate:

- DC bus voltage gain (L3-20)
- Deceleration rate calculations gain (L3-21)
- Inertia calculations for motor acceleration time (L3-24)
- Load inertia ratio (L3-25)

Note: The deceleration time is not constant. Do not use Intelligent Stall Prevention in applications where stopping accuracy is a concern. Use dynamic braking options instead.

Setting 3: Stall Prevention with dynamic braking option

Enables the Stall Prevention function while using a dynamic braking resistor.

Setting 4: Overexcitation Deceleration 1

Overexcitation Deceleration 1 (increasing the motor flux) is faster than deceleration with no Stall Prevention (L3-04 = 0). Setting 4 changes the selected decel time and functions to provide protection from an overvoltage trip. ***Refer to Overexcitation Deceleration (Induction Motors) on page 250*** for details.

Setting 5: Overexcitation Deceleration 2

Overexcitation Deceleration 2 slows down the motor while trying to maintain the DC bus voltage at the level set to parameter L3-17. This function shortens the achievable deceleration time more than by using Overexcitation Deceleration 1. Setting 5 will shorten/lengthen the decel time to maintain the L3-17 bus level. ***Refer to Overexcitation Deceleration (Induction Motors) on page 250*** for details.

■ L3-05: Stall Prevention Selection during Run

Determines how Stall Prevention works during Run. Stall Prevention during run prevents the motor from stalling by automatically reducing the speed when a transient overload occurs while the motor is running at constant speed.

No.	Name	Setting Range	Default
L3-05	Stall Prevention Selection During Run	0 to 2	1

Note: Stall Prevention during run is disabled when the output frequency is 6 Hz or lower regardless of the L3-05 and L3-06 settings.

Setting 0: Disabled

Drive runs at the set frequency reference. A heavy load may cause the motor to stall and trip the drive with an oC or oL fault.

Setting 1: Decelerate using C1-02

If the current exceeds the Stall Prevention level set in parameter L3-06, the drive will decelerate at decel time 1 (C1-02). When the current level drops below the value of L3-06 minus 2% for 100 ms, the drive accelerates back to the frequency reference at the active acceleration time.

Setting 2: Decelerate using C1-04

Same as setting 1 except the drive decelerates at decel time 2 (C1-04).

■ L3-06: Stall Prevention Level during Run

Sets the current level to trigger Stall Prevention during run. Depending on the setting of parameter L3-23, the level is automatically reduced in the constant power range (speed beyond base speed). A setting of 100% is equal to the drive rated current.

The Stall Prevention level can be adjusted using an analog input. ***Refer to Multi-Function Analog Input Terminal Settings on page 217*** for details.

No.	Name	Setting Range	Default
L3-06	Stall Prevention Level During Run	30 to 150% <1>	<1>

<1> The upper limit and default for this setting is determined by L8-38.

■ Overvoltage Suppression Function

Suppresses overvoltage faults by decreasing the regenerative torque limit and slightly increasing the output frequency when the DC bus voltage rises. This function can drive loads with cyclic regenerative operation, such as a punch press or other applications that involve repetitive crank movements.

The regenerative torque limit and the output frequency are adjusted during ov suppression so that the DC bus voltage does not exceed the level set to parameter L3-17. In addition to the parameters explained below, ov suppression also uses these settings for frequency adjustment:

- DC bus voltage gain (L3-20)
- Deceleration rate calculations gain (L3-21)
- Inertia calculations for motor acceleration time (L3-24)
- Load inertia ratio (L3-25)

Note:
1. The motor speed will exceed the frequency reference when overvoltage suppression is triggered. Consequently, overvoltage suppression is not appropriate in applications that require a perfect match between the frequency reference and the motor speed.
2. Disable overvoltage suppression when using a braking resistor.
3. Overvoltage may still occur if there is a sudden increase to a regenerative load.
4. This function is enabled only when operating just below the maximum frequency. Overvoltage suppression does not increase the output frequency beyond the maximum frequency. If the application requires this, increase the maximum frequency and change the base frequency setting.

■ L3-11: Overvoltage Suppression Function Selection

Enables or disables the overvoltage suppression function.

No.	Name	Setting Range	Default
L3-11	Overvoltage Suppression Function Selection	0, 1	0

Setting 0: Disabled

The regenerative torque limit and the output frequency are not adjusted. A regenerative load may trip the drive with an overvoltage fault. Use this setting if dynamic braking options are installed.

Setting 1: Enabled

When the DC bus voltage rises due to regenerative load, an overvoltage fault is prevented by decreasing the regenerative torque limit and increasing the output frequency.

■ L3-17: Target DC Bus Voltage for Overvoltage Suppression and Stall Prevention

Sets the target DC bus voltage level used by the overvoltage suppression function (L3-11 = 1), Intelligent Stall Prevention during deceleration (L3-04 = 2).

No.	Name	Setting Range	Default
L3-17	Target DC Bus Voltage for Overvoltage Suppression and Stall Prevention	150 to 400 Vdc <1>	375 Vdc <1> <2>

<1> Values are specific to 200 V class drives. Double the value for 400 V class drives. Multiply the value by 2.875 for 600 V class drives, but set the value below 1040 Vdc (overvoltage protection level).

<2> This value is initialized when E1-01 is changed.

■ L3-20: DC Bus Voltage Adjustment Gain

Determines the proportional gain used by overvoltage suppression (L3-11 = 1), Single Drive KEB 2 (L2-29 = 1), KEB Ride-Thru 2 (H1-□□ = 7A or 7B) ,and Intelligent Stall Prevention during deceleration (L3-04 = 2) to control the DC bus voltage.

No.	Name	Setting Range	Default
L3-20	DC Bus Voltage Adjustment Gain	0.00 to 5.00	1.00

Adjustment for Single Drive KEB 2 (L2-29 = 1) and Intelligent Stall Prevention During Deceleration

- Increase this setting slowly in steps of 0.1 if overvoltage or undervoltage occurs at the beginning of deceleration.
- Decrease this setting if there is a fair amount of speed or torque ripple.

Adjustment for Overvoltage Suppression

- Increase this setting slowly in steps of 0.1 if overvoltage suppression is enabled (L3-11 = 1) and a sudden increase in a regenerative load causes an overvoltage fault.
- Decrease this setting if there is a fair amount of speed or torque ripple.

■ L3-21: Accel/Decel Rate Calculation Gain

Determines the proportional gain used by overvoltage suppression (L3-11 = 1), Single Drive KEB 2 (L2-29 = 1), and Intelligent Stall Prevention during deceleration (L3-04 = 2) to calculate acceleration and deceleration rates.

Parameter Details

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No.	Name	Setting Range	Default
L3-21	Accel/Decel Rate Calculation Gain	0.10 to 10.00	1.00

Adjustment for Single Drive KEB 2 (L2-29 = 1) and Intelligent Stall Prevention During Deceleration

- Reduce L3-21 in steps of 0.05 if there is a fairly large speed or current ripple.
- Small reductions of L3-21 can help solve problems with overvoltage and overcurrent.
- Decreasing this setting too much can cause slow DC bus voltage control response and may also lengthen deceleration times beyond optimal levels.

Adjustment for Overvoltage Suppression

- Increase this setting in steps of 0.1 if overvoltage occurs as a result of a regenerative load when overvoltage suppression is enabled (L3-11 = 1).
- Decrease L3-21 in steps of 0.05 if there is a fairly large speed ripple when overvoltage suppression is enabled.

■ L3-23: Automatic Reduction Selection for Stall Prevention during Run

Reduces the Stall Prevention during run level in the constant power range.

No.	Name	Setting Range	Default
L3-23	Automatic Reduction Selection for Stall Prevention During Run	0, 1	0

Setting 0: Disabled

The level set in L3-06 is used throughout the entire speed range.

Setting 1: Enabled

The Stall Prevention level during run is reduced in the constant power range. The lower limit will be 40% of L3-06.

■ L3-24: Motor Acceleration Time for Inertia Calculations

Sets the time to accelerate the motor from stop to the maximum speed at motor rated torque. Set this parameter when using Single Drive KEB 2 (L2-29 = 1), Intelligent Stall Prevention during Deceleration (L3-04 = 2), or the Overvoltage Suppression function (L3-11 = 1).

No.	Name	Setting Range	Default
L3-24	Motor Acceleration Time for Inertia Calculations	0.001 to 10.000 s	Determined by o2-04 <1>

<1> Parameter L3-24 is defaulted for a Yaskawa standard 4-pole motor. During Auto-Tuning, L3-24 will be initialized to a Yaskawa standard 4-pole motor if parameter E2-11 is changed.

Manual Parameter Setup

Make the calculations in the formula below:

$$\text{L3-24} = \frac{2 \cdot \pi \cdot J\,[\text{kgm}^2] \cdot n_{rated}[\text{r/min}]}{60 \cdot T_{rated}[\text{Nm}]}$$

Calculate the rated torque in the formula below:

$$T_{rated}[\text{Nm}] = \frac{60 \cdot P_{Motor}[\text{kW}] \cdot 10^3}{2 \cdot \pi \cdot n_{rated}[\text{r/min}]}$$

■ L3-25: Load Inertia Ratio

Determines the ratio between the rotor inertia and the load. Set this parameter when using Single Drive KEB 2 (L2-29 = 1), Intelligent Stall Prevention during deceleration (L3-04 = 2), or the overvoltage suppression function (L3-11 = 1).

No.	Name	Setting Range	Default
L3-25	Load Inertia Ratio	1.0 to 1000.0	1.0

When set incorrectly, a fairly large current ripple can result during Single Drive KEB 2 (L2-29 = 1). This may cause overvoltage suppression (L3-11 = 1) or other faults such as ov, Uv1, and oC.

Manual Parameter Setup

Calculate parameter L3-25 in the formula below:

$$\text{L3-25} = \frac{\text{Machine Inertia}}{\text{Motor Inertia}}$$

■ L3-26: Additional DC Bus Capacitors

Sets the capacity of any additionally installed DC bus capacitors. This data is used in calculations for Single Drive KEB Ride-Thru 2. Adjust this setting only if external capacity is connected to the DC bus and Single Drive KEB 2 is used.

No.	Name	Setting Range	Default
L3-26	Additional DC Bus Capacitors	0 to 65000 μF	0 μF

■ L3-27: Stall Prevention Detection Time

Sets a delay time from when the Stall Prevention level is reached and the actual Stall Prevention function is activated.

No.	Name	Setting Range	Default
L3-27	Stall Prevention Detection Time	0 to 5000 ms	50 ms

◆ L4: Speed Detection

These parameters set up the speed agree and speed detection functions that can be assigned to the multi-function output terminals.

■ L4-01, L4-02: Speed Agreement Detection Level and Detection Width

Parameter L4-01 sets the detection level for the digital output functions Speed agree 1, User-set speed agree 1, Frequency detection 1, and Frequency detection 2.

Parameter L4-02 sets the hysteresis level for these functions.

No.	Name	Setting Range	Default
L4-01	Speed Agreement Detection Level	0.0 to 400.0 Hz	0.0 Hz
L4-02	Speed Agreement Detection Width	0.0 to 20.0 Hz	2.0 Hz

Refer to H2-01 to H2-03: Terminal M1-M2, M3-M4, and MD-ME-MF Function Selection on page 204, Settings 2, 3, 4, and 5.

■ L4-03, L4-04: Speed Agreement Detection Level and Detection Width (+/-)

Parameter L4-03 sets the detection level for the digital output functions Speed agree 2, User-set speed agree 2, Frequency detection 3, and Frequency detection 4.

Parameter L4-04 sets the hysteresis level for these functions.

No.	Name	Setting Range	Default
L4-03	Speed Agreement Detection Level (+/-)	-400.0 to 400.0 Hz	0.0 Hz
L4-04	Speed Agreement Detection Width (+/-)	0.0 to 20.0 Hz	2.0 Hz

Refer to H2-01 to H2-03: Terminal M1-M2, M3-M4, and MD-ME-MF Function Selection on page 204, Settings 13, 14, 15, and 16.

■ L4-05: Frequency Reference Loss Detection Selection

The drive can detect a loss of an analog frequency reference from input A1, A2, or A3. Frequency reference loss is detected when the frequency reference drops below 10% of the reference or below 5% of the maximum output frequency within 400 ms.

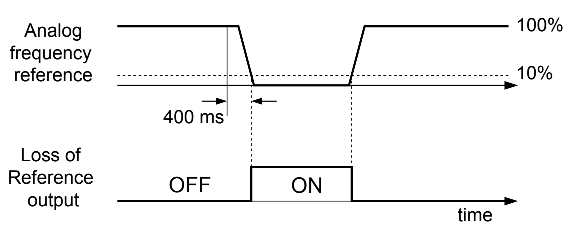


Figure 5.78 Loss of Reference Function

Set H2-01, H2-02, or H2-03 to C for a digital output to trigger when frequency reference loss occurs. ***Refer to Setting C: Frequency Reference Loss on page 208*** for details on setting the output function.

Parameter L4-05 selects the operation when a frequency reference loss is detected.

No.	Name	Setting Range	Default
L4-05	Frequency Reference Loss Detection Selection	0, 1	0

Setting 0: Stop

Drive follows the frequency reference (which is no longer present) and stops the motor.

Setting 1: Continue operation with reduced frequency reference

The drive will continue operation at the frequency reference value set to parameter L4-06. When the external frequency reference value is restored, the operation is continued with the frequency reference.

■ L4-06: Frequency Reference at Reference Loss

Sets the frequency reference level at which the drive runs when L4-05 = 1 and when detecting a reference loss. The value is set as a percentage of the frequency reference before the loss was detected.

No.	Name	Setting Range	Default
L4-06	Frequency Reference at Reference Loss	0.0 to 100.0%	80.0%

■ L4-07: Speed Agreement Detection Selection

Determines when frequency detection is active using parameters L4-01 through L4-04.

No.	Name	Setting Range	Default
L4-07	Speed Agreement Detection Selection	0, 1	0

Setting 0: No Detection during Baseblock

Setting 1: Detection always Enabled

◆ L5: Fault Restart

After a fault has occurred, Fault Restart attempts to automatically restart the motor and continue operation instead of stopping.

The drive can perform a self-diagnostic check and resume the operation after a fault has occurred. If the self-check is successful and the cause of the fault has disappeared, the drive restarts by first performing Speed Search (***Refer to b3: Speed Search on page 143*** for details).

Note:
1. The wiring sequence should remove the Forward/Reverse command when a fault is triggered and output is shut off.
2. When the Forward/Reverse command is removed, the drive can perform a self-diagnostic check and attempt to restart the fault automatically.

WARNING! *Sudden Movement Hazard. Do not use the fault restart function in lifting applications. Fault restart may cause the machine to drop the load, which could result in death or serious injury.*

The drive can attempt to restart itself following the faults listed below.

Fault	Name	Fault	Name
GF	Ground Fault	oL4	Overtorque 2
LF	Output Open Phase	ov	DC Bus Overvoltage
oC	Overcurrent	PF	Input Phase Loss
oH1	Drive Overheat	rH	Braking Resistor Fault
oL1	Motor Overload	rr	Braking Transistor Fault
oL2	Drive Overload	Uv1	DC Bus Undervoltage <1>
oL3	Overtorque 1		

<1> When L2-01 is set to 1 through 4 (continue operation during momentary power loss)

Use parameters L5-01 to L5-05 to set up automatic fault restart.

Set H2-01, H2-02, or H2-03 to 1E. to output a signal during fault restart.

■ L5-01: Number of Auto Restart Attempts

Sets the number of times that the drive may attempt to restart itself.

Parameter L5-05 determines the method of incrementing the restart counter. When the counter reaches the number set to L5-01, the operation stops and the fault must be manually cleared and reset.

The restart counter is incremented at each restart attempt, regardless of whether the attempt was successful. When the counter reaches the number set to L5-01, the operation stops and the fault must be manually cleared and reset.

The number of fault restarts is reset to zero when:
- The drive operates normally for 10 minutes following a fault restart.
- A fault is cleared manually after protective functions are triggered.
- The power supply is cycled.

No.	Name	Setting Range	Default
L5-01	Number of Auto Restart Attempts	0 to 10 Times	0 Times

■ L5-02: Auto Restart Fault Output Operation Selection

Determines if a fault output is triggered (H2-□□ = E) when the drive attempts to restart.

No.	Name	Setting Range	Default
L5-02	Auto Restart Fault Output Operation Selection	0, 1	0

Setting 0: No Fault Output

Setting 1: Fault Output Is Set

■ L5-04: Fault Reset Interval Time

Determines the amount of time to wait between restart attempts when parameter L5-05 is set to 1.

No.	Name	Setting Range	Default
L5-04	Fault Reset Interval Time	0.5 to 600.0 s	10.0 s

■ L5-05: Fault Reset Operation Selection

No.	Name	Setting Range	Default
L5-05	Fault Reset Operation Selection	0, 1	0

Setting 0: Count Successful Restarts

The drive will continuously attempt to restart. If it restarts successfully, the restart counter is increased. This operation is repeated each time a fault occurs until the counter reaches the value set to L5-01.

Setting 1: Count Restart Attempts

The drive will attempt to restart using the time interval set to parameter L5-04. A record is kept of the number of attempts to restart to the drive, regardless of whether those attempts were successful. When the number of attempted restarts exceeds the value set to L5-01, the drive stops attempting to restart.

◆ L6: Torque Detection

The drive provides two independent torque detection functions that trigger an alarm or fault signal when the load is too heavy (oL), or suddenly drops (UL). These functions are set up using the L6-□□ parameters. Program the digital outputs as shown below to indicate the underload or overload condition to an external device:

Note: When overtorque occurs in the application, the drive may stop due to overcurrent (oC) or overload (oL1). To prevent the drive from stopping, use torque detection to indicate an overload situation to the controller before oC or oL1 occur. Use undertorque detection to discover application problems like a torn belt, a pump shutting off, or other similar trouble.

H2-01, H2-02, H2-03 Setting	Description
B	Torque detection 1, N.O. (output closes when overload or underload is detected)
17	Torque detection 1, N.C. (output opens when overload or underload is detected)
18	Torque detection 2, N.O. (output closes when overload or underload is detected)
19	Torque detection 2, N.C. (output opens when overload or underload is detected)

Figure 5.79 and *Figure 5.80* illustrate the functions of overtorque and undertorque detection.

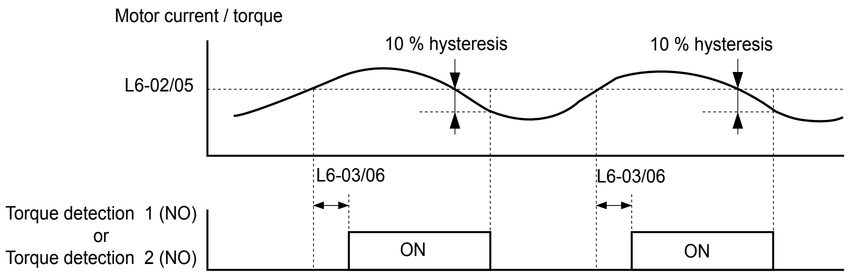


Figure 5.79 Overtorque Detection Operation

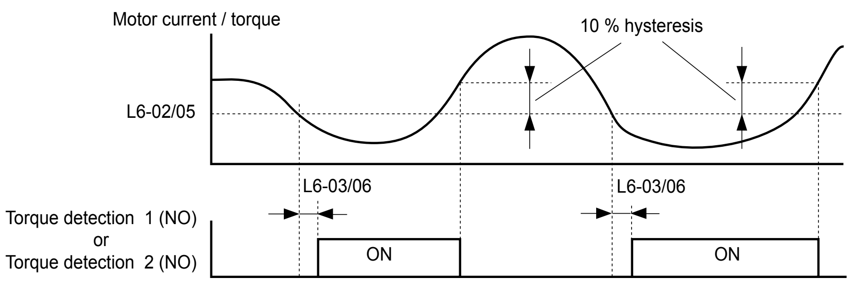


Figure 5.80 Undertorque Detection Operation

Note:
1. The torque detection function uses a hysteresis of 10% of the drive rated output current and motor rated torque.
2. The level is set as a percentage of the drive rated output current. .

■ L6-01, L6-04: Torque Detection Selection 1, 2

The torque detection function is triggered when the current or torque exceed the levels set to L6-02 and L6-05 for longer than the times set to L6-03 and L6-06. L6-01 and L6-04 select the conditions for detection and the operation that follows.

No.	Name	Setting Range	Default
L6-01	Torque Detection Selection 1	0 to 12	0
L6-04	Torque Detection Selection 2	0 to 8	0

Setting 0: Disabled

Setting 1: oL3, oL4 at speed agree (Alarm)

Overtorque detection is active only when the output speed is equal to the frequency reference (i.e., no detection during acceleration and deceleration). The operation continues after detecting overtorque and triggering an oL3/oL4 alarm.

Setting 2: oL3, oL4 at run (Alarm)

Overtorque detection works as long as the Run command is active. The operation continues after detecting overtorque and triggering an oL3/oL4 alarm.

Setting 3: oL3, oL4 at speed agree (Fault)

Overtorque detection is active only when the output speed is equal to the frequency reference, i.e., no detection during acceleration and deceleration. The operation stops and triggers an oL3/oL4 fault.

Setting 4: oL3, oL4 at run (Fault)

Overtorque detection works as long as a Run command is active. The operation stops and triggers an oL3/oL4 fault.

Setting 5: UL3, UL4 at speed agree (Alarm)

Undertorque detection is active only when the output speed is equal to the frequency reference, i.e., no detection during acceleration and deceleration. The operation continues after detecting overtorque and triggering a UL3/UL4 alarm.

Setting 6: UL3, UL4 at Run (Alarm)

Undertorque detection works as long as the Run command is active. The operation continues after detecting overtorque and triggering a UL3/UL4 alarm.

Setting 7: UL3, UL4 at Speed Agree (Fault)

Undertorque detection is active only when the output speed is equal to the frequency reference, i.e., no detection during acceleration and deceleration. The operation stops and triggers a UL3/UL4 fault.

Setting 8: UL3, UL4 at run (Fault)

Undertorque detection works as long as a Run command is active. The operation stops and triggers a UL3/UL4 fault.

Setting 9: UL6 at speed agree (Alarm)

Setting 10: UL6 during run (Alarm)

Setting 11: UL6 at speed agree (Fault)

Setting 12: UL6 during run (Fault)

■ L6-02, L6-05: Torque Detection Level 1, 2

These parameters set the detection levels for torque detection functions 1 and 2 as a percentage of the drive rated output current.

No.	Name	Setting Range	Default
L6-02	Torque Detection Level 1	0 to 300%	150%
L6-05	Torque Detection Level 2	0 to 300%	150%

Note: The torque detection level 1 (L6-02) can also be supplied by an analog input terminal set to H3-☐☐ = 7. Here, the analog value has priority and the setting in L6-02 is disregarded. Torque detection level 2 (L6-05) cannot be set by an analog input.

■ L6-03, L6-06: Torque Detection Time 1, 2

These parameters determine the time required to trigger an alarm or fault after exceeding the levels in L6-02 and L6-05.

No.	Name	Setting Range	Default
L6-03	Torque Detection Time 1	0.0 to 10.0 s	0.1 s
L6-06	Torque Detection Time 2	0.0 to 10.0 s	0.1 s

■ L6-13: Motor Underload Protection Selection

Sets the motor underload protection (UL6) based on motor load.

No.	Name	Setting Range	Default
L6-13	Motor Underload Protection Selection	0, 1	0

Setting 0: Base frequency enable

Setting 1: Max frequency enable

■ L6-14: Motor Underload Protection Level at Minimum Frequency

Sets the motor underload protection (UL6) based on motor load.

No.	Name	Setting Range	Default
L6-14	Motor Underload Protection Level at Minimum Frequency	0 to 300%	15%

◆ L8: Drive Protection

■ L8-01: Internal Dynamic Braking Resistor Protection Selection (ERF type)

Selects the dynamic braking resistor protection when using an optional heatsink mounted braking resistor (ERF type, 3% ED).

No.	Name	Setting Range	Default
L8-01	Internal Dynamic Braking Resistor Protection Selection (ERF type)	0, 1	0

Setting 0: Disabled

Disables braking resistor protection. Use this setting for any dynamic braking option other than the Yaskawa ERF-type resistor.

Setting 1: Enabled

Enables protection for Yaskawa ERF-type resistors.

■ L8-02: Overheat Alarm Level

Sets the overheat alarm (oH) detection level.

The drive outputs an alarm when the heatsink temperature exceeds the overheat alarm level. If the drive is set to continue operation after this alarm occurs (L8-03 = 4) and the temperature reaches the overheat fault level, the drive will trigger an oH1 fault and stop operation.

When an output terminal is set for the oH pre-alarm (H2-☐☐ = 20), the switch will close when the heatsink temperature rises above L8-02.

No.	Name	Setting Range	Default
L8-02	Overheat Alarm Level	50 to 150 °C	Determined by o2-04

■ L8-03: Overheat Pre-Alarm Operation Selection

Sets the operation when an overheat pre-alarm is detected.

Note: Change L8-03 setting only when necessary.

No.	Name	Setting Range	Default
L8-03	Overheat Pre-Alarm Operation Selection	0 to 4	3

Setting 0: Ramp to stop

If an overheat alarm occurs, the drive decelerates to stop using the currently selected deceleration time. If a digital output is programmed for “fault” (H2-☐☐ = E), this output will be triggered.

Setting 1: Coast to stop

If an overheat alarm occurs, the drive switches off the output and the motor coasts to stop. If a digital output is programmed for “fault” (H2-☐☐ = E), this output will be triggered.

Setting 2: Fast Stop

If an overheat alarm occurs, the drive decelerates to stop using the Fast Stop time (C1-09). If a digital output is programmed for “fault” (H2-☐☐ = E), this output will be triggered.

Setting 3: Alarm only

If an overheat alarm occurs, an alarm is output and the drive continues operation.

Setting 4: Operation with reduced speed

If an overheat alarm occurs, the operation continues with the speed reduced to the level set to parameter L8-19. If the oH alarm is still present after 10 s, the speed is reduced again. The amount of speed reduction depends on how often the alarm repeats. If the oH alarm disappears while the drive is operating at a reduced speed, the drive will switch to the previous speed in 10 s increments until reaching base frequency. *Figure 5.81* explains the operation with reduced speed during an oH alarm. A digital output programmed for 4D is switched when the oH alarm is still active after ten reduction cycles.

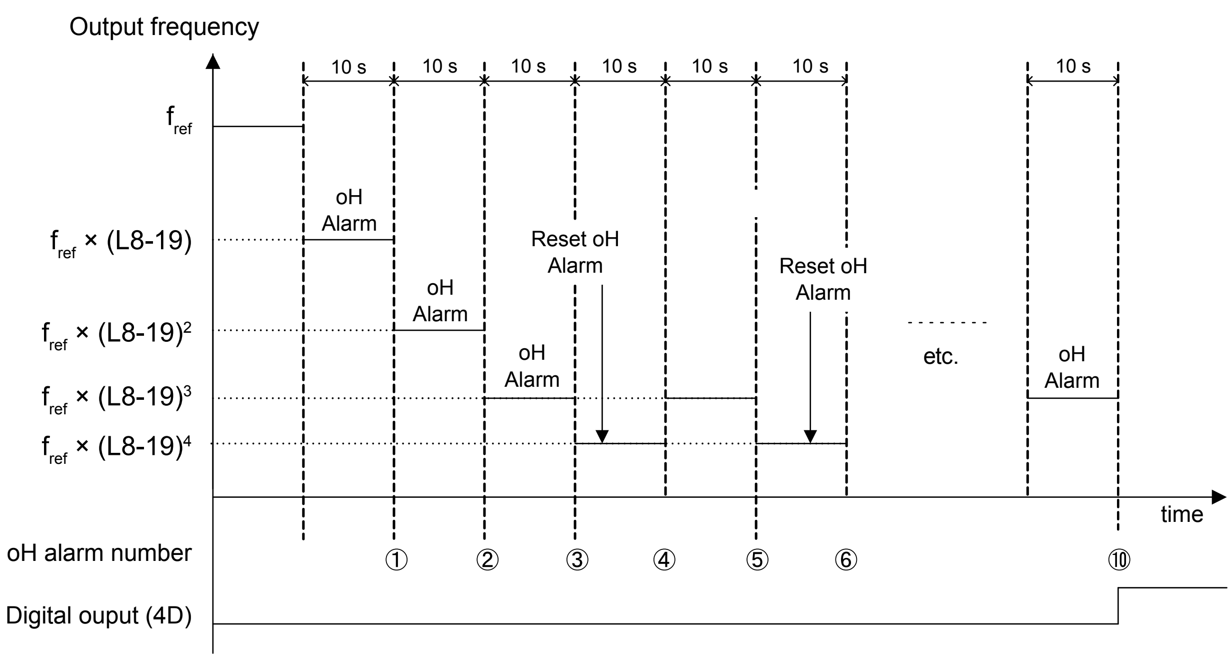


Figure 5.81 Output Frequency Reduction During Overheat Alarm

■ L8-19: Frequency Reduction Rate during Overheat Pre-Alarm

Specifies the output frequency reduction when L8-03 is set to 4 and an oH alarm is present. Set as a factor of the maximum output frequency.

No.	Name	Setting Range	Default
L8-19	Frequency Reduction Rate During Overheat Pre-Alarm	0.1 to 0.9	0.8

■ L8-05: Input Phase Loss Protection Selection

Enables or disables the input phase loss detection.

No.	Name	Setting Range	Default
L8-05	Input Phase Loss Protection Selection	0, 1	1

Setting 0: Disabled

Setting 1: Enabled

Enables input phase loss detection. Since measuring the DC bus ripple detects input phase loss, a power supply voltage imbalance or main circuit capacitor deterioration may also trigger a phase loss fault (PF).

Detection is disabled if:

- The drive is decelerating.
- No Run command is active.
- Output current is less than or equal to 30% of the drive rated current.

■ L8-07: Output Phase Loss Protection Selection

Enables or disables the output phase loss detection triggered when the output current falls below 5% of the drive rated current.

Note: Output phase loss detection can mistakenly be triggered if the motor rated current is very small compared to the drive rating. Disable this parameter in such cases.

No.	Name	Setting Range	Default
L8-07	Output Phase Loss Protection Selection	0 to 2	1

Setting 0: Disabled

Setting 1: Fault when One Phase Is Lost

An output phase loss fault (LF) is triggered when one output phase is lost. The output shuts off and the motor coasts to stop.

Setting 2: Fault when Two Phases Are Lost

An output phase loss fault (LF) is triggered when two or more output phases are lost. The output shuts off and the motor coasts to stop.

■ L8-09: Output Ground Fault Detection Selection

Enables or disables the output ground fault detection.

No.	Name	Setting Range	Default
L8-09	Output Ground Fault Detection Selection	0, 1	1

Setting 0: Disabled

Ground faults are not detected.

Setting 1: Enabled

A ground fault (GF) is triggered when high leakage current or a ground short circuit occurs in one or two output phases.

■ L8-10: Heatsink Cooling Fan Operation Selection

Selects the heatsink cooling fan operation.

No.	Name	Setting Range	Default
L8-10	Heatsink Cooling Fan Operation Selection	0, 1	0

Setting 0: Run with timer

The fan is switched on when a Run command is active and switched off with the delay set to parameter L8-11 after releasing the Run command. This setting extends the fan lifetime.

Setting 1: Run always

The fan runs when power is supplied to the drive.

■ L8-11: Heatsink Cooling Fan Off-Delay Time

Sets the cooling fan switch off-delay time if parameter L8-10 is set to 0.

No.	Name	Setting Range	Default
L8-11	Heatsink Cooling Fan Off-Delay Time	0 to 300 s	60 s

■ L8-12: Ambient Temperature Setting

Automatically adapts the drive rated current to safe values when used with parameter L8-35. This eliminates the need to reduce the drive rated current when the temperature where the drive is mounted is above the specified values. ***Refer to Temperature Derating on page 387*** for details.

No.	Name	Setting Range	Default
L8-12	Ambient Temperature Setting	-10 to +50 °C	40 °C

■ L8-15: oL2 Characteristics Selection at Low Speeds

Selects whether the drive overload capability (oL fault detection level) is reduced at low speeds to prevent premature output transistor failures.

Note: Contact Yaskawa for consultation before disabling this function. Disabling this function may shorten the operating life of the power transistors.

No.	Name	Setting Range	Default
L8-15	oL2 Characteristics Selection at Low Speed	0, 1	1

Setting 0: Protection Disabled at Low Speed

The overload protection level is not reduced. Frequently operating the drive with high output current at low speed can lead to premature drive faults.

Setting 1: Protection Enabled at Low Speed

The overload protection level (oL2 fault detection level) is automatically reduced at speeds below 6 Hz. At zero speed, the overload is derated by 50%.

■ L8-18: Software Current Limit Selection

Enables or disables the Software Current Limit (CLA) protection function to prevent main circuit transistor failures caused by high current.

Note: Do not change this setting unless absolutely necessary. Leave the Software CLA enabled for proper drive protection and operation.

No.	Name	Setting Range	Default
L8-18	Software Current Limit Selection	0, 1	0

Setting 0: Software CLA Disabled

The drive may trip on an oC fault if the load is too heavy or the acceleration is too short.

Setting 1: Software CLA Enabled

When the Software CLA current level is reached, the drive reduces the output voltage to reduce the current. Normal operation continues when the current level drops below the Software CLA level.

■ L8-32: Main Contactor and Cooling Fan Power Supply Failure Selection

Determines drive operation when a FAn fault occurs.

No.	Name	Setting Range	Default
L8-32	Main Contactor and Cooling Fan Power Supply Failure Selection	0 to 4	1

Setting 0: Ramp to stop

The drive stops the motor using the deceleration time set in parameter C1-02.

Setting 1: Coast to stop

The drive output is switched off and the motor coasts to a stop.

Setting 2: Fast stop

The drive stops the motor using the Fast stop time set in parameter C1-09.

Setting 3: Alarm only

The operation is continued and a FAn alarm is displayed on the digital operator.

Setting 4: Operation with reduced speed

The operation is continued, but the speed is reduced to the level set in parameter L8-19.

Note: "FAn" is detected as an error when Settings 0 or 2 are selected; it is detected as an alarm when Settings 3 or 4 are selected.

■ L8-35: Installation Method Selection

Selects the type of installation for the drive and changes the drive overload (oL2) limits accordingly. *Refer to Temperature Derating on page 387* for details.

Note:
1. Initialization does not reset this parameter.
2. The value is preset to the appropriate value when the drive is shipped. Change the value only when using Side-by-Side installation or when mounting a standard drive with the heatsink outside the cabinet.

No.	Name	Setting Range	Default
L8-35	Installation Method Selection	0 to 3	<1>

<1> Default setting is determined by drive model.
Setting 2: Model code 2A0004 to 2A0211, 4A0002 to 4A0165, and 5A0003 to 5A0242
Setting 0: Model code 2A0250 to 2A0415 and 4A0208 to 4A1200.

Setting 0: IP00/Open-Chassis enclosure

For an Open Type enclosure drive installed with at a minimum of 30 mm space to the next drive or a cabinet wall.

Setting 1: Side-by-Side mounting

For drives mounted according to Yaskawa Side-by-Side specifications (requires 2 mm between drives).

Setting 2: IP20/NEMA Type 1 enclosure

For drives compliant with IP20/NEMA Type 1 enclosure specifications.

Setting 3: Finless drive or external heatsink Installation

For finless drives or a standard drive mounted with the heatsink outside the cabinet or enclosure panel.

■ L8-38: Carrier Frequency Reduction Selection

Selects the operation of the carrier frequency reduction function. Reduces the carrier frequency when the output current exceeds a certain level. This temporarily increases the overload capability (oL2 detection), allowing the drive to run through transient load peaks without tripping.

No.	Name	Setting Range	Default
L8-38	Carrier Frequency Reduction Selection	0 to 2	2

Setting 0: Disabled

No carrier frequency reduction at high current.

Setting 1: Enabled for output frequencies below 6 Hz

The carrier frequency is reduced at speeds below 6 Hz when the current exceeds 100% of the drive rated current. The drive returns to the normal carrier frequency when the current falls below 88% or the output frequency exceeds 7 Hz.

Setting 2: Enabled for entire frequency range

The carrier frequency is reduced at the following speeds:

- Below 6 Hz when the current exceeds 100% of the drive rated current.
- Above 7 Hz when the current exceeds 112% of the drive rated current.

The drive uses the delay time set in parameter L8-40 and a hysteresis of 12% when switching the carrier frequency back to the set value.

■ L8-40: Carrier Frequency Reduction Off-Delay Time

Sets a hold time before returning to the original carrier frequency setting after the carrier frequency has been temporarily derated as determined by L8-38. The carrier frequency reduction function is disabled when this value is 0.00 s.

No.	Name	Setting Range	Default
L8-40	Carrier Frequency Reduction Off-Delay Time	0.00 to 2.00 s	0.50 s

■ L8-41: High Current Alarm Selection

Triggers a high current alarm (HCA) when the output current exceeds 150% of the drive rated current.

No.	Name	Setting Range	Default
L8-41	High Current Alarm Selection	0, 1	0

Setting 0: Disabled

No alarm is detected.

Setting 1: Enabled

An alarm is triggered when the output current exceeds 150% of the drive rated current. A digital output set for an alarm (H2-□□ = 10) will close.

■ L8-55: Internal Braking Transistor Protection

Enables or disables protection for the internal braking transistor.

Note: This parameter is not available in models 4A0930 and 4A1200.

No.	Name	Setting Range	Default
L8-55	Internal Braking Transistor Protection	0, 1	1

Setting 0: Disabled

Disable braking transistor protection when not using the internal braking transistor, including the following instances:

- When using a regen converter such as DC5.
- When using a regen unit such as RC5.
- When using external braking transistor options like CDBR units.
- When using the drive in common DC bus applications and the internal braking unit is not installed.

Enabling L8-55 under such conditions can incorrectly trigger a braking transistor fault (rr).

Setting 1: Enabled

Enable L8-55 when connecting a braking resistor or a braking resistor unit to the drive built-in braking transistor.

Models 2A0004 to 2A0138, 4A0002 to 4A0072, and 5A0003 to 5A0052 come with a built-in braking transistor.

■ L8-93: LSo Detection Time at Low Speed

Sets the amount of time until baseblock is executed after LSo has been detected at low speed.

A setting of 0.0 s disables this parameter.

No.	Name	Setting Range	Default
L8-93	LSo Detection Time at Low Speed	0.0 to 10.0 s	1.0 s

■ L8-94: LSo Detection Level at Low Speed

Determines the detection level of Sto at low speed. Set as a percentage of the maximum frequency (E1-04).

No.	Name	Setting Range	Default
L8-94	LSo Detection Level at Low Speed	0 to 10%	3%

■ L8-95: Average LSo Frequency at Low Speed

Sets the average number of times LSo can occur at low speed.

No.	Name	Setting Range	Default
L8-95	Average LSo Frequency at Low Speed	1 to 50 times	10 times

5.9 n: Special Adjustments

These parameters control a variety of specialized adjustments and functions, including Hunting Prevention, High Slip Braking, and Overexcitation Braking.

◆ n1: Hunting Prevention

Hunting Prevention prevents the drive from hunting as a result of low inertia and operating with light load. Hunting often occurs with a high carrier frequency and an output frequency below 30 Hz.

■ n1-01: Hunting Prevention Selection

Enables or disables the Hunting Prevention function.

Note: This function is available only when using V/f Control. Disable Hunting Prevention when drive response is more important than suppressing motor oscillation. This function may be disabled without problems in applications with high inertia loads or relatively heavy loads.

No.	Name	Setting Range	Default
n1-01	Hunting Prevention Selection	0, 1	1

Setting 0: Disabled

Setting 1: Enabled

■ n1-02: Hunting Prevention Gain Setting

Sets the gain for the Hunting Prevention Function.

No.	Name	Setting Range	Default
n1-02	Hunting Prevention Gain Setting	0.00 to 2.50	1.00

Although this parameter rarely needs to be changed, it may require adjustment in the following situations:
- If the motor vibrates while lightly loaded and n1-01 = 1, increase the gain by 0.1 until vibration ceases.
- If the motor stalls while n1-01 = 1, decrease the gain by 0.1 until the stalling ceases.

■ n1-03: Hunting Prevention Time Constant

Determines the responsiveness of the Hunting Prevention function (affects the primary delay time for Hunting Prevention).

No.	Name	Setting Range	Default
n1-03	Hunting Prevention Time Constant	0 to 500 ms	Determined by o2-04

Although this parameter rarely needs to be changed, it may require adjustment in the following situations:
- Increase this value for applications with a large load inertia. A higher setting leads to slower response, which can result in oscillation at lower frequencies.
- Lower this setting if oscillation occurs at low speed.

■ n1-05: Hunting Prevention Gain while in Reverse

This parameter functions the same as n1-02, except it is used when rotating in reverse. See the explanation for n1-02.

Note: n1-02 is enabled for forward and reverse operation when n1-05 = 0.0 ms.

No.	Name	Setting Range	Default
n1-05	Hunting Prevention Gain while in Reverse	0.00 to 2.50	0.00

◆ n3: High Slip Braking (HSB) and Overexcitation Braking

■ High Slip Braking (V/f)

HSB works in V/f Control only and decreases the stopping time compared to normal deceleration without using dynamic braking options. HSB reduces the output frequency in large steps to stop the motor and produce a high slip, which dissipates the regenerative energy created from decelerating the load in the motor windings. Due to the increased temperature of the motor windings, do not use HSB to frequently stop the motor. The duty cycle should be around 5% or lower.

Notes on using High Slip Braking

- The set deceleration time is ignored during HSB. Use Overexcitation Deceleration 1 (L3-04 = 4) or a dynamic braking option to stop the motor within a specified time.
- Braking time varies based on the load inertia and motor characteristics.
- Enabling HSB and KEB Ride-Thru simultaneously will trigger an oPE03 error.
- HSB must be triggered by a digital input set to H1-□□ = 68. After the HSB command is given, the drive will not restart until the motor is completely stopped and the Run command is cycled.
- Use parameters n3-01 through n3-04 to adjust HSB.

■ n3-01: High Slip Braking Deceleration Frequency Width

Sets the step width for frequency reduction during HSB. Increase n3-01 if DC bus overvoltage (ov) occurs during HSB.

No.	Name	Setting Range	Default
n3-01	High Slip Braking Deceleration Frequency Width	1 to 20%	5%

■ n3-02: High Slip Braking Current Limit

Sets the maximum current to be output during an HSB stop as a percentage of motor rated current (E2-01). Reducing the current limit increases the deceleration time. This value must not exceed the drive overload capacity.

- Lower this setting if overvoltage occurs during HSB.
- Lower this setting if motor current is too high during HSB. High current can damage the motor due to overheat.
- The default setting is 120% when the drive is set for Normal Duty.

No.	Name	Setting Range	Default
n3-02	High Slip Braking Current Limit	100 to 200%	Determined by L8-38

■ n3-03: High Slip Braking Dwell Time at Stop

When the motor reaches a relatively low speed at the end of HSB, the output frequency is kept at the minimum output frequency set to E1-09 for the time set to n3-03. Increase this time if the inertia is very high and the motor coasts after HSB is complete.

No.	Name	Setting Range	Default
n3-03	High Slip Braking Dwell Time at Stop	0.0 to 10.0 s	1.0 s

■ n3-04: High Slip Braking Overload Time

Sets the time required for an HSB overload fault (oL7) to occur when the drive output frequency does not change during an HSB stop due to excessive load inertia or the load rotating the motor. To protect the motor from overheat, the drive trips with an oL7 fault if these conditions last longer than the time set in n3-04.

No.	Name	Setting Range	Default
n3-04	High Slip Braking Overload Time	30 to 1200 s	40 s

■ Overexcitation Deceleration (Induction Motors)

Increases the flux during deceleration and allows shorter deceleration time settings without the use of a braking resistor. Enabled by setting L3-04 to 4 or 5. ***Refer to L3-04: Stall Prevention Selection during Deceleration on page 235***.

Notes on Overexcitation Deceleration

- Frequently applying Overexcitation Deceleration raises the motor temperature because regenerative energy is mainly dissipated as heat in the motor. In cases where frequent application is required, make sure the motor temperature does not exceed the maximum allowable value or consider using a braking resistor option in lieu of Overexcitation Deceleration.
- During Overexcitation Deceleration 2, Hunting Prevention in V/f Control is disabled.
- Do not use Overexcitation Deceleration in combination with a braking resistor option.

Parameter Adjustments

- Use parameters n3-13 through n3-23 to adjust Overexcitation Deceleration.
- When repetitive or long Overexcitation Deceleration causes motor overheat, lower the overexcitation gain (n3-13) and reduce the overslip suppression current level (n3-21).
- During Overexcitation Deceleration 1 (L3-04 = 4), the drive decelerates at the active deceleration time (C1-02 and C1-04). Set this time so no overvoltage (ov) fault occurs.

- During Overexcitation Deceleration 2 (L3-04 = 5), the drive decelerates using the active deceleration time while adjusting the deceleration rate to keep the DC bus voltage at the level set to L3-17. The actual stopping time will be longer or shorter than the set deceleration time depending on the motor characteristics and the load inertia. Increase the deceleration time if overvoltage occurs (ov).
- Entering a Run command during Overexcitation Deceleration cancels overexcitation operation and the drive reaccelerates to the specified speed.

■ n3-13: Overexcitation Deceleration Gain

Multiplies a gain to the V/f pattern output value during Overexcitation Deceleration to determine the level of overexcitation. The drive returns to the normal V/f value after the motor has stopped or when it is accelerating to the frequency reference.

No.	Name	Setting Range	Default
n3-13	Overexcitation Deceleration Gain	1.00 to 1.40	1.10

The optimum setting for n3-13 depends on the motor flux saturation characteristics.
- Gradually increase the gain to 1.25 to 1.30 to improve the braking power of Overexcitation Deceleration.
- Lower n3-13 when flux saturation characteristics cause overcurrent. A high setting sometimes causes overcurrent (oC), motor overload (oL1), or drive overload (oL2). Lowering n3-21 can also help remedy these problems.

■ n3-14: High Frequency Injection during Overexcitation Deceleration

Enables High Frequency Injection while Overexcitation Deceleration is executed. Injecting high frequency into the motor increases loss and shortens deceleration time. This function tends to increase audible noise from the motor, and may not be desirable in environments where motor noise is a concern.

No.	Name	Setting Range	Default
n3-14	High Frequency Injection During Overexcitation Deceleration	0, 1	0

Setting 0: Disabled

Setting 1: Enabled

■ n3-21: High Slip Suppression Current Level

If the motor current exceeds the value set to n3-21 during Overexcitation Deceleration due to flux saturation, the drive automatically reduces the overexcitation gain. Parameter n3-21 is set as a percentage of the drive rated current.

Set this parameter to a relatively low value to optimize deceleration. If overcurrent, oL1, or oL2 occur during Overexcitation Deceleration, reduce the high slip suppression current level.

No.	Name	Setting Range	Default
n3-21	High Slip Suppression Current Level	0 to 150%	100%

■ n3-23: Overexcitation Operation Selection

Limits the Overexcitation Deceleration operation selected in parameter L3-04 to forward only or reverse only.

No.	Name	Setting Range	Default
n3-23	Overexcitation Operation Selection	0 to 2	0

Setting 0: Overexcitation Operation as Selected in L3-04 in Forward and Reverse Direction

Setting 1: Overexcitation Operation as Selected in L3-04 in Forward Direction Only

Setting 2: Overexcitation Operation as Selected in L3-04 in Reverse Direction Only

5.10 o: Operator Related Settings

These parameters control the various functions, features, and display of the digital operator.

◆ o1: Digital Operator Display Selection

These parameters determine the data display on the digital operator.

■ o1-01: Drive Mode Unit Monitor Selection

The frequency reference display appears when the drive is powered up. Pressing the up arrow key will display the following data: frequency reference → rotational direction → output frequency → output current → o1-01 selection.

Parameter o1-01 selects the content of the last monitor in this sequence.

No.	Name	Setting Range	Default
o1-01	Drive Mode Unit Monitor Selection	104 to 809	106 (U1-06)

■ o1-02: User Monitor Selection after Power Up

Selects which monitor parameter is displayed upon power up by entering the 1- □□ part of U1-□□. Certain monitors are not available in some control modes. *Refer to U: Monitor Parameters on page 271* for a list of monitors.

No.	Name	Setting Range	Default
o1-02	User Monitor Selection after Power Up	1 to 5	1

Setting 1: Frequency reference (U1-01)

Setting 2: Motor direction

Setting 3: Output frequency (U1-02)

Setting 4: Output current (U1-03)

Setting 5: User-selected monitor (set by o1-01)

■ o1-03: Digital Operator Display Selection

Sets the units used to display the frequency reference and output frequency. Set o1-03 to 3 for user-set units before setting parameters o1-10 and o1-11.

No.	Name	Setting Range	Default
o1-03	Digital Operator Display Selection	0 to 3	0

Setting 0: 0.01 Hz units

Setting 1: 0.01% units (100% = max. output frequency)

Setting 2: r/min units (calculated by the max output frequency and the no. of motor poles)

Setting 3: User-set units (set by o1-09, o1-10, o1-11)

Set the value used for the maximum frequency reference to o1-10. Set the placement of the decimal point in this number to o1-11.

For example, to have the maximum output frequency displayed as “100.00”, set o1-10 to 1000 and o1-11 to 2 (i.e., 1000 with 2 decimal points).

Note:
1. Parameter o1-03 allows the programmer to change the units used in the following parameters and monitors:
   U1-01: frequency reference
   U1-02: output frequency
   U1-16: output frequency after softstarter (accel/decel ramp generator)
   d1-01 to d1-17: frequency references
2. Setting o1-03 to 2 requires entering the number of motor poles to E2-04.

■ o1-06: User Monitor Selection Mode

Select between standard sequential monitors or selectable monitors to be displayed on the 2nd and 3rd lines of the digital operator display.

Use parameters o1-07 and o1-08 to select and fix the second and third monitors shown in the Home (Frequency Reference) and Monitor screen to ensure that those monitors are always visible when scrolling through the monitor list.

No.	Name	Setting Range	Default
o1-06	User Monitor Selection Mode	0, 1	0

Setting 0: 3 Mon Sequential (displays the next 2 sequential monitors)

Setting 1: 3 Mon Selectable (set by o1-07 and o1-08)

■ o1-07: Second Line User Monitor Selection

Selects the monitor that is shown in the second line. Effective only when o1-06 is set to 1.

Enter the last three digits of the monitor parameter number to be displayed: U□-□□. For example, set “403” to display monitor parameter U4-03.

No.	Name	Setting Range	Default
o1-07	Second Line User Monitor Selection	101 to 799	102

■ o1-08: Third Line User Monitor Selection

Selects the monitor that is shown in the third line. Effective only when o1-06 is set to 1.

Enter the last three digits of the monitor parameter number to be displayed: U□-□□. For example, set “403” to display monitor parameter U4-03.

No.	Name	Setting Range	Default
o1-07	Second Line User Monitor Selection	101 to 799	103

■ o1-09: Frequency Reference Display Units

Selects the monitor that is shown in the third line. Enter the last three digits of the monitor parameter number to be displayed: U□-□□. For example, set "403" to display monitor parameter U4-03.

Note: Parameter is effective only when o1-06 is set to 1.

No.	Name	Setting Range	Default
o1-09	Frequency Reference Display Units	0 to 15; 24, 25	25

Setting 0: Inch of Water (WC)

Setting 1: Pounds per Square Inch (PSI)

Setting 2: Gallons per Minute (GPM)

Setting 3: Degrees Fahrenheit (F)

Setting 4: Cubic Feet per Minute (CFM)

Setting 5: Cubic Meters per Hour (CMH)

Setting 6: Liters per Hour (LPH)

Setting 7: Liters per Second (LPS)

Setting 8: Bar (Bar)

Setting 9: Pascals (Pa)

Setting 10: Degrees Celsius (C)

Setting 11: Meters (Mtr)

Setting 12: Feet (Ft)

Setting 13: Liters per Minute (LPN)

Setting 14: Cubic Meters per Minute (CMM)

Setting 15: Inches of Mercury (Hg)

Setting 24: Custom Units (determined by o1-13 to o1-15)

Setting 25: None

■ o1-10: User-Set Display Units Maximum Value

Determines the display value that is equal to the maximum output frequency.

No.	Name	Setting Range	Default
o1-10	User-Set Display Units Maximum Value	1 to 60000	Determined by o1-03

■ o1-11: User-Set Display Units Decimal Display

Determines how many decimal points should be used to set and display the frequency reference.

No.	Name	Setting Range	Default
o1-11	User-Set Display Units Decimal Display	0 to 3	Determined by o1-03

Setting 0: No Decimal Point

Setting 1: One Decimal Point

Setting 2: Two Decimal Points

Setting 3: Three Decimal Points

■ o1-13: Frequency Reference and Frequency Related Monitor Custom Units 1

Sets the first character of the customer-specified unit display when o1-03 is set to 3 and o1-09 is set to 24.

No.	Name	Setting Range	Default
o1-13	Frequency Reference and Frequency Related Monitor Custom Units 1	30 to 7A	41

■ o1-14: Frequency Reference and Frequency Related Monitor Custom Units 2

Sets the second character of the customer-specified unit display when o1-03 is set to 3 and o1-09 is set to 24.

No.	Name	Setting Range	Default
o1-14	Frequency Reference and Frequency Related Monitor Custom Units 2	30 to 7A	41

■ o1-15: Frequency Reference and Frequency Related Monitor Custom Units 3

Sets the third character of the customer-specified unit display when o1-03 is set to 3 and o1-09 is set to 24.

No.	Name	Setting Range	Default
o1-14	Frequency Reference and Frequency Related Monitor Custom Units 3	30 to 7A	41

◆ o2: Digital Operator Keypad Functions

These parameters determine the functions assigned to the operator keys.

■ o2-01: LO/RE (LOCAL/REMOTE) Key Function Selection

Determines whether the LO/RE key on the digital operator will be enabled for switching between LOCAL and REMOTE.

No.	Name	Setting Range	Default
o2-01	LO/RE Key Function Selection	0, 1	1

Setting 0: Disabled

The LO/RE key is disabled.

Setting 1: Enabled

The LO/RE switches between LOCAL and REMOTE operation. Switching is possible during stop only. When LOCAL is selected, the LED indicator on the LO/RE key will light up.

WARNING! *Sudden Movement Hazard. The drive may start unexpectedly if the Run command is already applied when switching from LOCAL mode to REMOTE mode when b1-07 = 1, resulting in death or serious injury. Check all mechanical or electrical connections thoroughly before making any setting changes to o2-01 and b1-07.* ***Table 5.36*** *lists the setting combinations for o2-01 and b1-07.*

Table 5.36 LO/RE Key and b1-07

o2-01	b1-07	Switch from LOCAL to REMOTE	Switch from REMOTE to LOCAL
0	0	Not possible	Not possible
	1	Not possible	Not possible
1	0	Will not run until a new Run command is entered.	Run not possible
	1	If a Run command is entered, the drive will start running as soon as the LO/RE key is pushed to change from LOCAL to REMOTE.	Run not possible

■ o2-02: STOP Key Function Selection

Determines if the STOP key on the digital operator will stop drive operation when the drive is controlled from a remote source (i.e., not from digital operator).

No.	Name	Setting Range	Default
o2-02	STOP Key Function Selection	0, 1	1

Setting 0: Disabled

Setting 1: Enabled

The STOP key will terminate drive operation even if the Run command source is not assigned to the digital operator. Cycle the Run command to restart the drive if the drive has been stopped by pressing the STOP key.

■ o2-03: User Parameter Default Value

After completely setting up drive parameters, save the values as user-set defaults with parameter o2-03. After saving the values, parameter A1-03 (Initialize Parameters) will offer the choice of "1110: User Initialize". Selecting 1110 resets all parameters to the user-set default values. *Refer to A1-03: Initialize Parameters on page 132* for details on drive initialization.

No.	Name	Setting Range	Default
o2-03	User Parameter Default Value	0 to 2	0

Setting 0: No Change (Awaiting Command)

Setting 1: Set User Initialize Values

The current parameter settings are saved as user-set default for a later User Initialization. Setting o2-03 to 1 and pressing the ENTER key saves the values and returns the display to 0.

Setting 2: Clear User Initialize Values

All user-set defaults for “User Initialize” are cleared. Setting o2-03 to 2 and pressing the ENTER key erases the values and returns the display to 0.

■ o2-04: Drive Model Selection

Set this parameter when replacing the control board or the terminal board. *Refer to Defaults by Drive Model on page 444* for information on drive model selection.

NOTICE: *Drive performance will suffer and protective functions will not operate properly if the correct drive capacity is not set to o2-04.*

No.	Name	Setting Range	Default
o2-04	Drive Model Selection	-	Determined by drive capacity

Note: Change o2-04 setting only when necessary.

■ o2-05: Frequency Reference Setting Method Selection

Determines if the ENTER key must be pressed after changing the frequency reference using the digital operator while in the Drive Mode.

No.	Name	Setting Range	Default
o2-05	Frequency Reference Setting Method Selection	0, 1	0

Setting 0: ENTER key required

The ENTER key must be pressed every time the frequency reference is changed using the digital operator for the drive to accept the change.

Setting 1: ENTER key not required

The output frequency changes immediately when the reference is changed by the up or down arrow keys on the digital operator. The ENTER key does not need to be pressed. The frequency reference (Fref) is saved to memory after remaining unchanged for 5 seconds.

■ o2-06: Operation Selection when Digital Operator is Disconnected

Determines whether the drive will stop when the digital operator is removed in LOCAL mode or when b1-02 or b1-16 is set to 0. When the operator is reconnected, the display will indicate that it was disconnected.

No.	Name	Setting Range	Default
o2-06	Digital Operator Disconnection Operation	0, 1	1

Setting 0: Continue operation

The operation continues.

Setting 1: Trigger a fault

The operation stops and triggers an oPr fault. The motor coasts to stop.

■ o2-07: Motor Direction at Power Up when Using Operator

Determines the direction the motor will rotate after the drive is powered up and the Run command is given from the digital operator.

Note: This parameter is effective only when the Run command is set to be given from the digital operator (b1-02, b1-16 = 0).

No.	Name	Setting Range	Default
o2-07	Motor Direction at Power Up when Using Operator	0, 1	0

Setting 0: Forward

Setting 1: Reverse

■ o2-20: Operator Run Save at Power Loss

When running during a power loss, the Run command is issued via the digital operator and the Run state is saved to the EEPROM.

When power is restored, the Run command is automatically applied if the LOCAL/REMOTE or FREF conditions have not changed in the drive.

When this parameter is set to 0 (disabled) the drive will ignore the Run state of the drive when power is lost. When this parameter is set to 1 (enabled), and the active Run source is from the digital operator, the drive will save the Run status during power-down.

When power is restored, and the drive is still in operator mode, the previous Run status will be loaded and will apply the Run command.

If the Run command was issued while the drive was running in LOCAL mode (triggered through the operator key) and power was cycled, the drive will not automatically run, as the default starting state is REMOTE operation.

Note: The Run Status is saved on the terminal board and on the control card. If the Run Status does not match (e.g., if the terminal board was replaced), the Run Status is reset and the drive will not run on the next power-up.

WARNING! *Sudden Movement Hazard. If o2-20 is set to 1 and o2-06 is set to 0, the drive will continue running when the digital operator is removed and may run automatically when power is cycled, resulting in death or serious injury. Clear all personnel from the drive, motor and machine area before applying power. Secure covers, couplings, shaft keys and machine loads before applying power to the drive.*

No.	Name	Setting Range	Default
o2-20	Operator Run Save at Power Loss	0, 1	0

Setting 0: Disabled

Setting 1: Enabled

◆ o3: Copy Function

These parameters control the Copy function of the digital operator. The Copy function stores parameter settings into the memory of the digital operator to facilitate the transfer of those settings to other drives that are the same model, capacity, and same control mode setting. *Refer to Copy Function Related Displays on page 308* for a description of errors and displays.

■ o3-01: Copy Function Selection

Instructs the drive to Read, Write, or Verify parameter settings.

No.	Name	Setting Range	Default
o3-01	Copy Function Selection	0 to 3	0

Setting 0: Copy Select (no function)

Setting 1: INV --> OP READ

Copies all parameters from the drive to the digital operator.

Note: The copy protection for the digital operator is enabled by default. Set o3-01 to 1 to unlock copy protection.

Setting 2: OP --> INV WRITE

Copies all parameters from the digital operator to the drive.

Setting 3: OP<-->INV VERIFY

Compares the parameters in the drive with the parameter settings saved on the digital operator for matches.

■ o3-02: Copy Allowed Selection

Allows and restricts the use of the Copy function.

No.	Name	Setting Range	Default
o3-02	Copy Allowed Selection	0, 1	0

Setting 0: Disabled

Setting 1: Enabled

◆ o4: Maintenance Monitor Settings

■ o4-01: Cumulative Operation Time Setting

Sets the cumulative operation time of the drive. The user can also manually set this parameter to begin keeping track of operation time from some desired value. Total operation time can be viewed in monitor U4-01.

Note: The value in o4-01 is set in 10 h units. For example, a setting of 30 will set the cumulative operation time counter to 300 h. 300 h will also be displayed in monitor U4-01.

No.	Name	Setting Range	Default
o4-01	Cumulative Operation Time Setting	0 to 9999	0

■ o4-02: Cumulative Operation Time Selection

Selects the conditions for how the drive keeps track of its total operation time. This time log can be viewed in monitor U4-01.

No.	Name	Setting Range	Default
o4-02	Cumulative Operation Time Selection	0, 1	0

Setting 0: Power on time

The drive logs the time it is connected to a power supply, regardless of whether the motor is running.

Setting 1: Run time

The drive logs the time that the output is active including when the Run command is active (even if the motor is not rotating) and when there is voltage output.

■ o4-03: Cooling Fan Operation Time Setting

Sets the value for how long the cooling fan has been operating. This value can be viewed in monitor U4-03. Parameter o4-03 also sets the base value used for the cooling fan maintenance, which is displayed in U4-04. Reset this parameter to 0 after replacing the cooling fan.

Note:
1. The value in o4-03 increases after every 10 hours of use. A setting of 30 will set the cooling fan operation time counter to 300 h. “300” will be displayed in monitor U4-03.
2. The cooling fan may require maintenance at an earlier date in harsher environments.

No.	Name	Setting Range	Default
o4-03	Cooling Fan Operation Time Setting	0 to 9999	0

■ o4-05: Capacitor Maintenance Setting

Sets value of the maintenance monitor for the DC bus capacitors displayed in U4-05 as a percentage of the total expected performance life. Reset this value to 0 after replacing the DC bus capacitors.

Note: The actual maintenance time will depend on the environment where the drive is used.

No.	Name	Setting Range	Default
o4-05	Capacitor Maintenance Setting	0 to 150%	0%

■ o4-07: DC Bus Pre-Charge Relay Maintenance Setting

Sets the value of the softcharge bypass relay maintenance time displayed in U4-06 as a percentage of the total expected performance life. Reset this value to 0 after replacing the bypass relay.

Note: The actual maintenance time will depend on the environment where the drive is used.

No.	Name	Setting Range	Default
o4-07	DC Bus Pre-charge Relay Maintenance Setting	0 to 150%	0%

■ o4-09: IGBT Maintenance Setting

Sets the value of the IGBT maintenance time displayed in U4-07 as a percentage of the total expected performance life. Reset this value to 0 after replacing the IGBTs.

Note: The actual maintenance time will depend on the environment where the drive is used.

No.	Name	Setting Range	Default
o4-09	IGBT Maintenance Setting	0 to 150%	0%

■ o4-11: U2, U3 Initialization

Resets the fault trace and fault history monitors (U2-□□ and U3-□□). Initializing the drive using A1-03 does not reset these monitors.

No.	Name	Setting Range	Default
o4-11	U2, U3 Initialization	0, 1	0

Setting 0: No Action

The drive keeps the previously saved record concerning fault trace and fault history.

Setting 1: Reset Fault Data

Resets the data for the U2-□□ and U3-□□ monitors. Setting o4-11 to 1 and pressing the ENTER key erases fault data and returns the display to 0.

■ o4-12: kWh Monitor Initialization

Resets the kWh monitors U4-10 and U4-11. Initializing the drive or cycling the power does not reset these monitors.

No.	Name	Setting Range	Default
o4-12	kWh Monitor Initialization	0, 1	0

Setting 0: No Action

The kWh data are maintained.

Setting 1: Reset kWh Data

Resets the kWh counter. The monitors U4-10 and U4-11 will display “0” after they are initialized. Setting o4-12 to 1 and pressing the ENTER erases kWh data and returns the display to 0.

■ o4-13: Number of Run Commands Counter Initialization

Resets the Run command counter displayed in U4-02. Initializing the drive or cycling the power does not reset this monitor.

No.	Name	Setting Range	Default
o4-13	Number of Run Commands Counter Initialization	0, 1	0

Setting 0: No Action

The Run command data are kept.

Setting 1: Number of Run Commands Counter

Resets the Run command counter. The monitor U4-02 will show 0. Setting o4-13 to 1 and pressing the ENTER key erases the counter value and returns the display to 0.

■ o4-17: Real-Time Clock Setting

No.	Name	Setting Range	Default
o4-17	Set/Reset Real-Time Clock	0 to 2	0

Setting 0: — —

No Setting (Default)

Setting 1: Set

When o4-17 is set to 1, the digital operator will show the Clock Adjustment display. In Clock Adjustment Mode the user can adjust the Real-Time Clock.

Setting 2: Reset

When o4-17 is set to 2, the Real-Time Clock data is cleared. A TIM fault will occur until o4-17 is set to 1 and the Real-Time Clock is set.

■ o4-20: Time Display Format

No.	Name	Setting Range	Default
o4-20	Time Display Format	0, 1	0

Sets the time display format.

Setting 0: 12-Hour

Setting 1: 24-Hour

5.11 S: Special Application

◆ S1: Dynamic Audible Noise Control Function

The Dynamic Audible Noise Control Function reduces audible noise by suppressing the output voltage.

This function is available when using V/f Control mode and can help to quickly restore output voltage after an impact has caused a sudden increase in the time constant. Dynamic Audible Noise Control is useful in applications where load impact is common.

Energy Saving (b8-01 = 1) and Dynamic Audible Noise Control (S1-01 = 1) cannot be used simultaneously.

Procedure

1. Set S1-01 to 1 to enable Dynamic Audible Noise Control.

   Note: 1. When S1-01 is set to 1, the tolerance to impact loading is reduced when compared to V/f Control (without Energy Saving).
   2. Disable Dynamic Audible Noise Control for applications without an impact load.

2. Responsiveness is increased because the addition of a load causes the level of the current to rise.

   Increase the value of S1-02. The flux will become stronger and the torque will rise, but load movement will be minimized by the Dynamic Audible Noise Control function.

   Set S1-03 and S1-04 to a small value. Voltage is recovered quicker during impact load conditions. Under certain conditions voltage stability may become poor.

   Lower the value of S1-05. The voltage level will drop and speed up voltage restoration when the load is increased.
3. Increase the value of S1-03 to increase the effectiveness of Dynamic Audible Noise Control if the output voltage remains high.
4. Decrease the value of S1-06 to increase drive response to an impact load.
5. When the output voltage is unstable, increase the difference between S1-03 and S1-04 and increase S1-05 and S1-06 to slow the load response.

■ S1-01: Dynamic Audible Noise Control Selection

Reduces audible noise by decreasing the output voltage in variable torque applications with light loads.

Note: Setting b8-01 to 1 and S1-01 to 1 will trigger an oPE16 error.

No.	Name	Setting Range	Default
S1-01	Dynamic Audible Noise Control Selection	0 or 1	1

Setting 0: Disabled

Setting 1: Enabled

■ S1-02: Voltage Reduction Rate

Sets the rate at which the output voltage will be reduced as a percentage of the V/f pattern when operating with no load.

No.	Name	Setting Range	Default
S1-02	Voltage Reduction Rate	50.0 to 100.0%	50.0%

■ S1-03: Voltage Restoration Level

Sets the level when the drive should start restoring the voltage as a percentage of the drive rated torque.

The voltage is reduced when the torque output has decreased to the level set in S1-03.

The method used to reduce the voltage level is selected in accordance with the characteristics of the voltage reduction rate defined by the S1-03 and S1-04 settings.

Note: Setting S1-04 to a value less than that of S1-03 + 10.0 will trigger an oPE02 error.

No.	Name	Setting Range	Default
S1-03	Voltage Restoration Level	0.0 to 90.0%	20.0%

S1-04: Voltage Restoration Complete Level

Sets the level at which voltage restoration for the V/f pattern is complete as a percentage of the drive rated torque. If the output torque rises above the value of S1-04, then the voltage will be controlled in a manner specified by the V/f pattern setting.

Note: Setting S1-04 to a value less than that of S1-03 + 10.0 will trigger an oPE02 error.

No.	Name	Setting Range	Default
S1-04	Voltage Restoration Complete Level	S1-03 + 10.0 to 100.0%	50.0%

S1-05: Voltage Restoration Sensitivity Time Constant

Sets the level of sensitivity of the output torque as well as that of the LPF time constant for the voltage reduction rate. The level of sensitivity can be adjusted in accordance with the load response.

The LPF time constant is used to calculate the value of the output torque sensitivity time constant.

The voltage reduction rate is based on the torque output. Select LPF to prevent voltage fluctuation.

The Dynamic Audible Noise Control Function outputs the rate of voltage reduction as a percentage within the allowable range (Max: 100%, Min: S1-02 value).

No.	Name	Setting Range	Default
S1-05	Voltage Restoration Sensitivity Time Constant	0.000 to 3.000 s	1.000 s

S1-06: Voltage Restoration Time Constant at Impact

Sets the voltage restoration time constant if an impact load is added.

Sets the time constant that enables the voltage level to rise if the speed suddenly changes upon impact.

No.	Name	Setting Range	Default
S1-06	Voltage Restoration Time Constant at Impact	0.000 to 1.000 s	0.050 s

S1-07: Output Phase Loss Level for Dynamic Noise Control

Reduces the output phase loss level when Dynamic Noise Control is active.

No.	Name	Setting Range	Default
S1-07	Output Phase Loss Level for Dynamic Noise Control	10.0 to 100.0%	100.0%

S2: Programmable Run Timers

Programmable Run Timers for Real Time Clock (RTC)

Programmable run timers allow the drive to start and stop automatically at specified times. The timers can be configured to run daily, on weekdays, on weekends, or only on specific days of the week.

Sequence Timer 1

When the current time reaches the value set in parameter S2-01 (Sequence Timer 1 Start Time), the drive will execute the action set in parameter S2-04 (Sequence Timer 1 Selection), provided the current day is selected via S2-03 (Sequence Timer 1 Day Selection). The drive will stop executing the S2-04 action when the S2-02 (Sequence Timer 1 Stop Time) is reached.

When S2-04 = 0 or the Disable Sequence Timers multi-function input (H1-□□= 51) is closed, Sequence Timer 1 has no effect on the drive Run command. The drive runs normally based on the status of the selected run source (b1-02/b1-16). If S2-04 = 1 or 2 and the Disable Sequence Timers input is open, the drive will run during the Sequence Timer 1 active time, provided the drive has a valid Run command. The frequency reference that is used is set by S2-05 (Sequence Timer 1 Reference Source). When S2-04 = 2, PI control is disabled.

If the Cancel Active Sequence Timer multi-function input (H1-□□ = 52) transitions from open to closed while Sequence Timer 1 is active, the timer will be disabled until the next scheduled sequence timer occurrence. Sequence Timer 1 can be re-enabled by cycling the drive Run command. The Sequence Timer 1 multi-function output (H2-□□ = 50) will close while Sequence Timer 1 is active regardless of the S2-04 selection.

When S2-01 = S2-02, Sequence Timer 1 is active continuously for the days selected in S2-03. The timer will start at the S2-01/S2-02 time on the first day and stop at the same time on the last day. If only one day is selected in S2-03, the timer will stop at 24:00 on that day. If “daily” is selected in S2-03, the timer will run from the start/stop time until 24:00 every day.

An S2-01 or S2-02 setting of 24:00 corresponds to midnight on the following day. For example, if S2-01 = 8:00, S2-02 = 24:00, and S2-03 = 9 (Saturday), Sequence Timer 1 will be active from 8:00 AM Saturday until 12:00 AM Sunday.

When S2-04 = 1 or 2, Sequence Timer 1 is active and the drive is running, the digital operator screen will appear as shown in *Figure 5.82*.

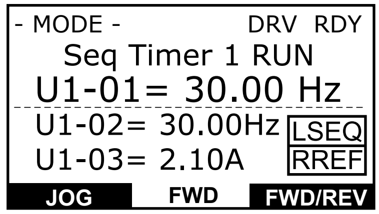


Figure 5.82 Sequence Timer 1 Run

When the drive has a run command, S2-04 = 1 or 2 and Sequence Timer 1 is not active, the digital operator will appear as shown in *262*.

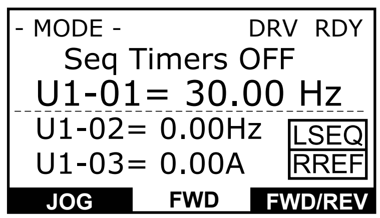


Figure 5.83 Sequence Timers Off

Sequence Timers 2 to 4

These timers operate identically to Sequence Timer 1. Parameters S2-06 to S2-20 configure Sequence Timers 2 to 4.

Priority

If multiple sequence timers overlap, the timer with the lowest number has priority.

Sequence Timer 1 = highest priority

Sequence Timer 4 = lowest priority

Note: Jog Forward/Reverse has higher priority than any of the Sequence Timers.

Examples of Sequence Timers

If multiple sequence timers overlap, the timer with the lowest number has priority.

Sequence Timer 1 = highest priority

Sequence Timer 4 = lowest priority

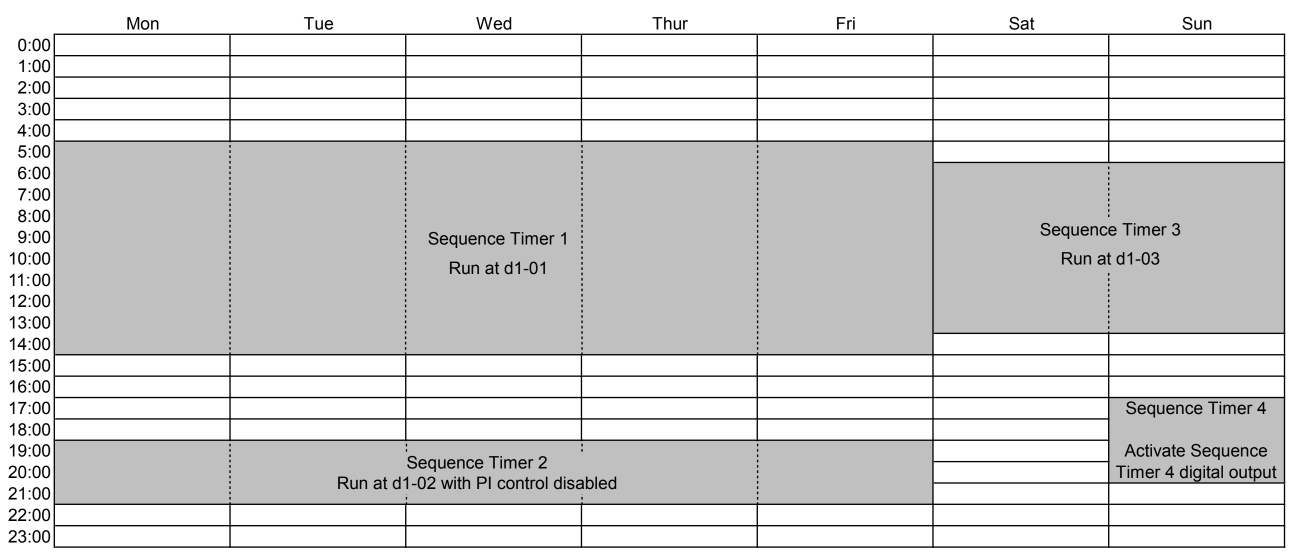


Figure 5.84 Sequence Timer Example 1

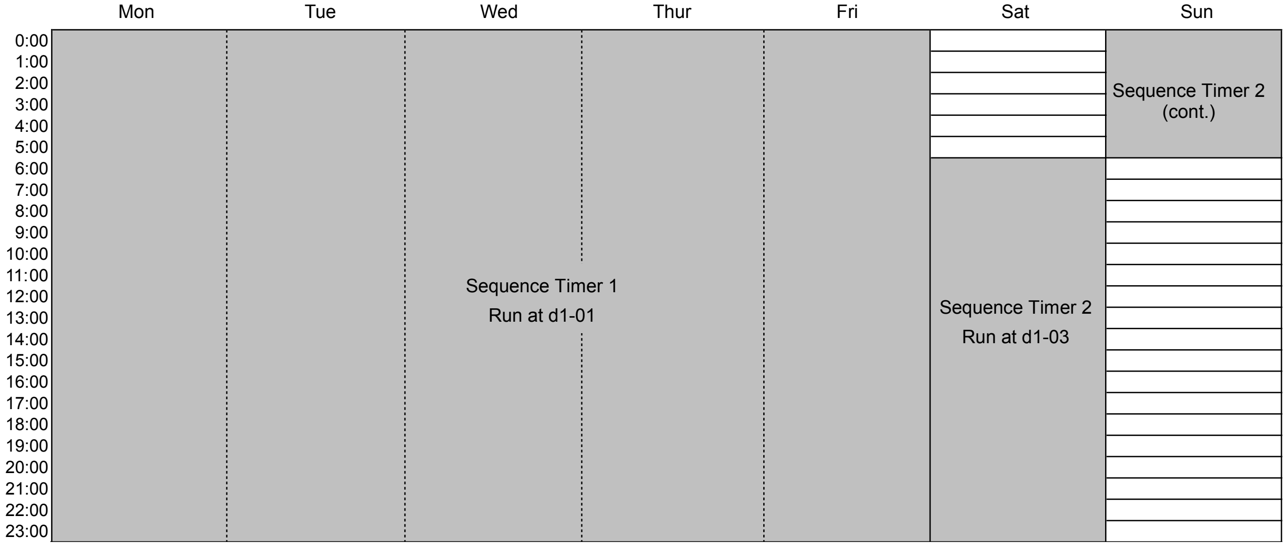


Figure 5.85 Sequence Timer Example 2

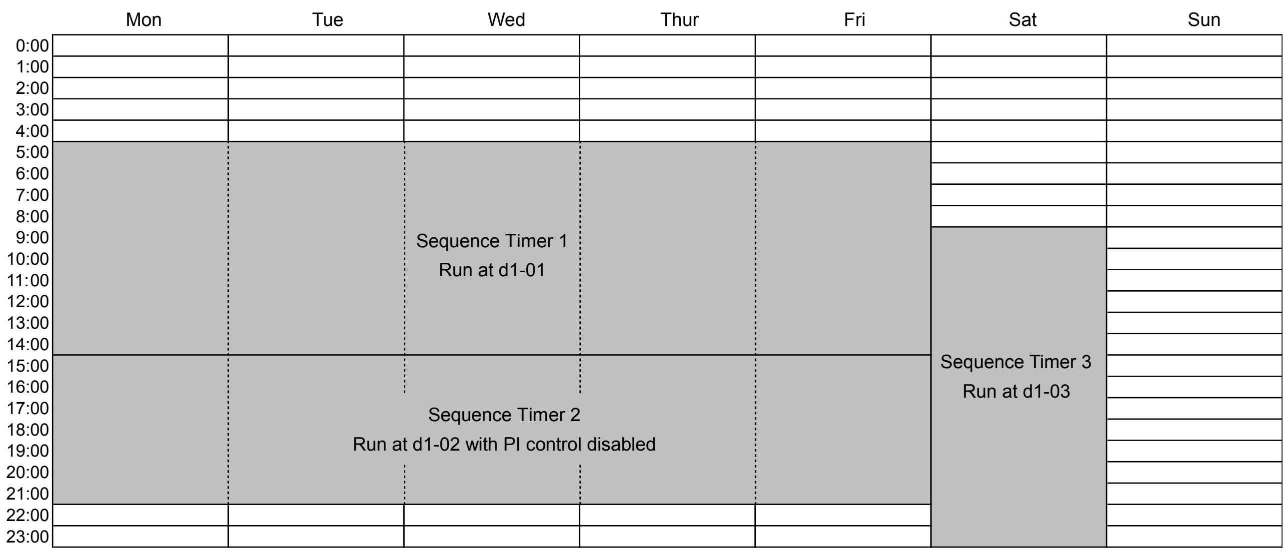


Figure 5.86 Sequence Timer Example 3

Timing Charts

In *Figure 5.87* S2-04 = 1, S2-05 = 0, S2-09 = 2, S2-10 = 1. It shows the effect of Run command and sequence timer disable input.

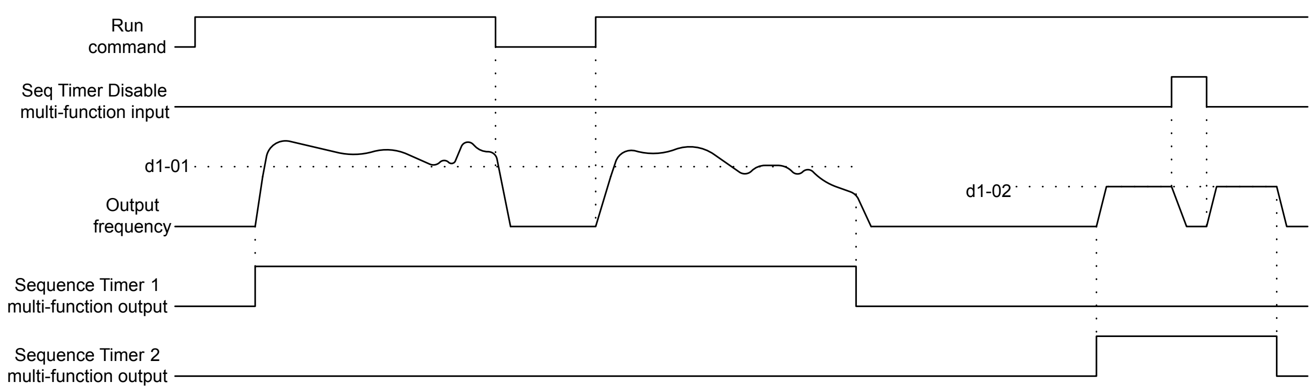


Figure 5.87 Timing Chart 1

In *Figure 5.88* S2-04 = 1, S2-05 = 0, S2-09 = 2, S2-10 = 1. It shows the effect of sequence timer disable input.

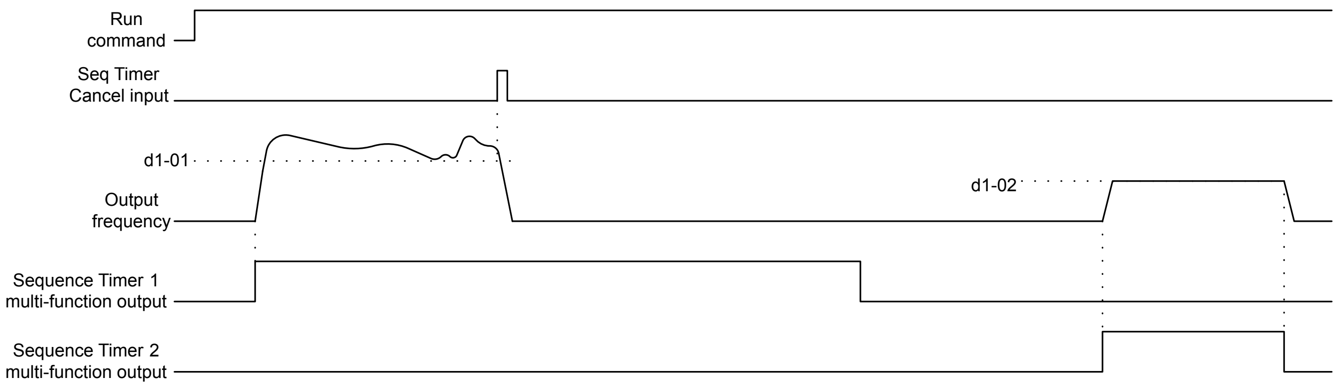


Figure 5.88 Timing Chart 2

In *Figure 5.89* S2-04 = 1, S2-05 = 0, S2-09 = 2, S2-10 = 1. It shows the effect of sequence timer cancel input with run re-cycle.

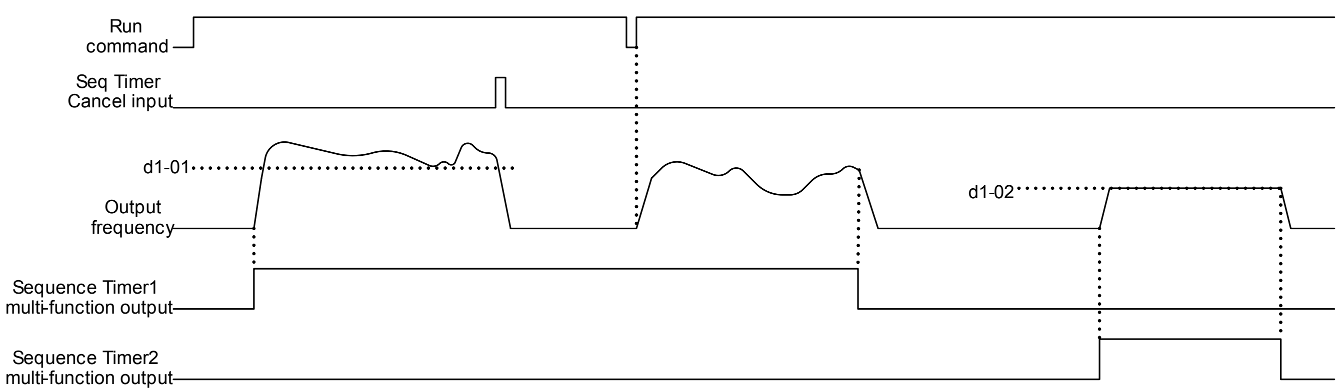


Figure 5.89 Timing Chart 3

In *Figure 5.90* S2-04 = 1, S2-05 = 0, S2-09 = 2, S2-10 = 1. It shows the effect of HAND mode.

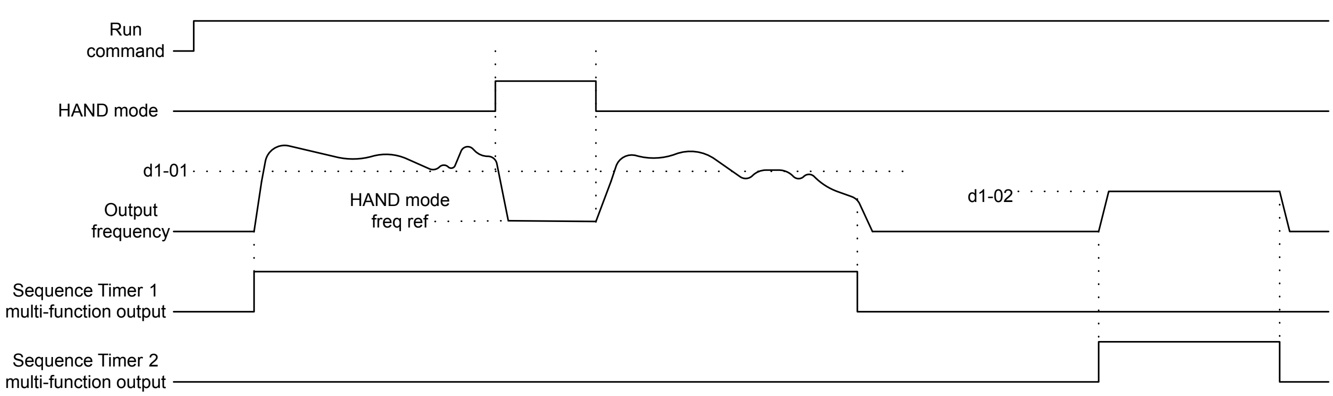


Figure 5.90 Timing Chart 4

■ S2-01/S2-06/S2-11/S2-16: Sequence Timers 1 to 4 Start Time

Sets the start times for timers 1 to 4. The values must be set less than or equal to S2-02/S2-07/S2-12/S2-17.

No.	Name	Setting Range	Default
S2-01	Sequence Timer 1 Start Time	00:00 to 24:00	00:00
S2-06	Sequence Timer 2 Start Time	00:00 to 24:00	00:00
S2-11	Sequence Timer 3 Start Time	00:00 to 24:00	00:00
S2-16	Sequence Timer 4 Start Time	00:00 to 24:00	00:00

■ S2-02/S2-07/S2-12/S2-17: Sequence Timers 1 to 4 Stop Time

Sets the stop times for timers 1 to 4. The values must be set greater than or equal to S2-01/S2-06/S2-11/S2-16.

No.	Name	Setting Range	Default
S2-02	Sequence Timer 1 Stop Time	00:00 to 24:00	00:00
S2-07	Sequence Timer 2 Stop Time	00:00 to 24:00	00:00
S2-12	Sequence Timer 3 Stop Time	00:00 to 24:00	00:00
S2-17	Sequence Timer 4 Stop Time	00:00 to 24:00	00:00

■ S2-03/S2-08/S2-13/S2-18: Sequence Timers 1 to 4 Day Selection

Sets the days for which sequence timers 1 to 4 are active.

No.	Name	Setting Range	Default
S2-03	Sequence Timer 1 Day Selection	0 to 10	0
S2-08	Sequence Timer 2 Day Selection	0 to 10	0
S2-13	Sequence Timer 3 Day Selection	0 to 10	0
S2-18	Sequence Timer 4 Day Selection	0 to 10	0

Setting 0: Timer Disabled

Setting 1: Daily

Setting 2: Mon - Fri

Setting 3: Sat - Sun

Setting 4: Monday

Setting 5: Tuesday

Setting 6: Wednesday

Setting 7: Thursday

Setting 8: Friday

Setting 9: Saturday

Setting 10: Sunday

■ S2-04/S2-09/S2-14/S2-19: Sequence Timers 1/2/3/4 Selection

Sets the action that occurs when sequence timers 1 to 4 are active.

No.	Name	Setting Range	Default
S2-04	Sequence Timer 1 Selection	0 to 2	0
S2-09	Sequence Timer 2 Selection	0 to 2	0
S2-14	Sequence Timer 3 Selection	0 to 2	0
S2-19	Sequence Timer 4 Selection	0 to 2	0

Setting 0: Digital Output Only

Setting 1: Run

Setting 2: Run - PI Disable

■ S2-05/S2-10/S2-15/S2-20: Sequence Timers 1/2/3/4 Reference Source

Selects the frequency reference source used for running the drive when sequence timers 1 to 4 are active (only applicable when S2-04/S2-09/S2-14/S2-19 are set to 1 or 2).

No.	Name	Setting Range	Default
S2-05	Sequence Timer 1 Reference Source	0 to 6	0
S2-10	Sequence Timer 2 Reference Source	0 to 6	0
S2-15	Sequence Timer 3 Reference Source	0 to 6	0
S2-20	Sequence Timer 4 Reference Source	0 to 6	0

Setting 0: Operator (d1-01)

Setting 1: Operator (d1-02)

Setting 2: Operator (d1-03)

Setting 3: Operator (d1-04)

Setting 4: Terminals

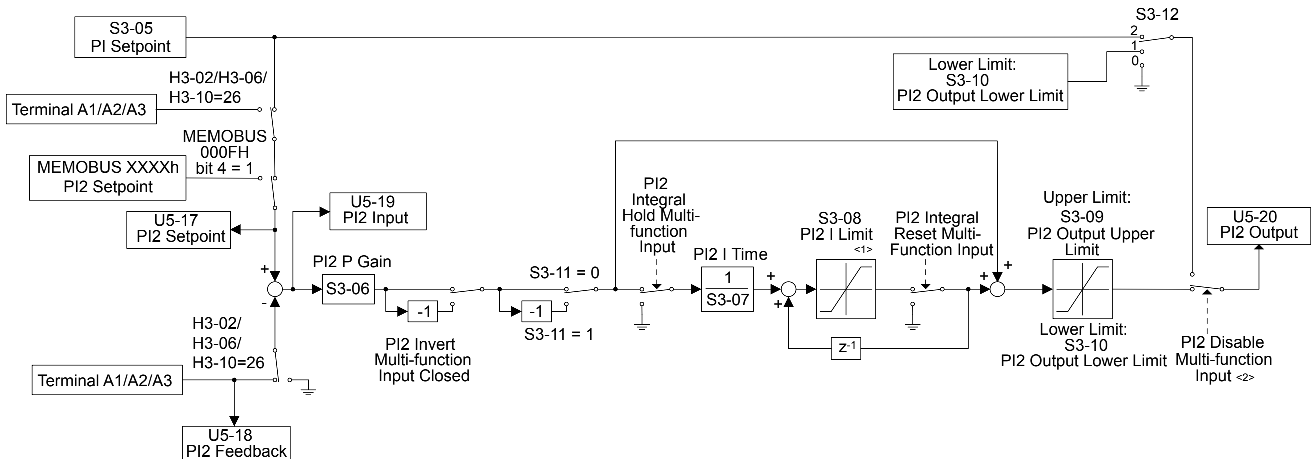
Setting 5: Serial Communication

Setting 6: Option Card

Setting 7: Pulse Input

◆ S3: Secondary PI (PI2) Control

The drive has a built in PI (Proportional + Integral) controller that can be used for closed loop control of system variables such as pressure or temperature. The difference between the target and the feedback value (deviation) is fed into the PI controller and the PI controller outputs the frequency to U5-☐☐ for monitoring. *Refer to b5: PID Control on page 149* for details.



<1> Actual integral limit is calculated as follows:
Upper limit = Min (S3-08, S3-09 - PI2 P portion)
Lower limit = Min (-S3-08, S3-10 - PI2 P portion)

<2> When PI2 Disable multi-function input is closed, set PI Integrator as follows:
S3-12 = 1: PI I Value = S3-10
S3-12 = 2: PI I Value = S3-05

Figure 5.91 PI2 Block Diagram

■ S3-01: Secondary PI Enable Selection

Determines when the secondary PI controller is enabled.

No.	Name	Setting Range	Default
S3-01	Secondary PI Enable Selection	0 to 3	0

Setting 0: Secondary PI Disabled

Setting 1: Always

Setting 2: Drive Running

Setting 3: Motor Running

Available when the drive is not at zero speed, not in base block, and not in DC injection.

■ S3-02: Secondary PI User Display

Sets the scale value of 100% PI input. The decimal place shifts based on S3-03.

No.	Name	Setting Range	Default
S3-02	Secondary PI User Display	0 to 60000	10000 <1>

<1> Unit is determined by S3-03.

■ S3-03: Secondary PI Display Digits

Sets the decimal place display for secondary PI units.

No.	Name	Setting Range	Default
S3-03	Secondary PI Display Digits	0 to 3	2

Setting 0: No Decimal Places

Setting 1: One Decimal Place

Setting 2: Two Decimal Places

Setting 3: Three Decimal Places

■ S3-04: Secondary PI Unit Selection

Sets units for secondary PI control function.

No.	Name	Setting Range	Default
S3-04	Secondary PI Unit Selection	0 to 15	15

Setting 0: Inch of Water (WC)

Setting 1: Pounds per Square Inch (PSI)

Setting 2: Gallons per Minute (GPM)

Setting 3: Degrees Fahrenheit (F)

Setting 4: Cubic Feet per Minute (CFM)

Setting 5: Cubic Meters per Hour (CMH)

Setting 6: Liters per Hour (LPH)

Setting 7: Liters per Second (LPS)

Setting 8: Bar (Bar)

Setting 9: Pascals (Pa)

Setting 10: Degrees Celsius (C)

Setting 11: Meters (Mtr) (Ft: Feet)

Setting 12: Liters per Minute (LPN)

Setting 13: Cubic Meters per Minute (CMM)

Setting 14: No Unit

Setting 15: Percentage (%)

■ S3-05: Secondary PI Setpoint Value

Sets the secondary PI controller target value

No.	Name	Setting Range	Default
S3-05	Secondary PI Setpoint Value	0.00 to 600.00 <1>	0.00 <2>

<1> Upper limit is S3-02, decimal place holder is determined by S3-03.

<2> Unit is determined by S3-04.

■ S3-06: Secondary PI Proportional Gain Setting

Sets the proportional gain of the secondary PI controller. A setting of 0.00 disables P control.

No.	Name	Setting Range	Default
S3-06	Secondary PI Proportional Gain Setting	0.00 to 25.00	1.00

■ S3-07: Secondary PI Integral Time Setting

Sets the integral time for the secondary PI controller. A setting of 0.0s disables integral control.

No.	Name	Setting Range	Default
S3-07	Secondary PI Integral Time Setting	0.0 to 360.0 s	1.0 s

■ S3-08: Secondary PI Integral Limit Setting

Sets the maximum output possible from the integrator.

No.	Name	Setting Range	Default
S3-08	Secondary PI Integral Limit Setting	0.0 to 100.0%	100.0%

■ S3-09: Secondary PI Output Upper Limit

Sets the maximum output possible from the secondary PI controller.

No.	Name	Setting Range	Default
S3-09	Secondary PI Output Upper Limit	0 to 100.0%	100.0%

■ S3-10: Secondary PI Output Lower Limit

Sets the minimum output possible from the secondary PI controller.

No.	Name	Setting Range	Default
S3-10	Secondary PI Output Lower Limit	-100.00 to 100.00	0.00%

■ S3-11: Secondary PI Output Level Selection

Sets the secondary PI controller output direction.

No.	Name	Setting Range	Default
S3-11	Secondary PI Output Level Selection	0 or 1	0

Setting 0: Normal Output (Direct Acting)

Setting 1: Reverse Output (Reverse Acting)

■ S3-12: Secondary PI Disable Mode

Selects the secondary PI controller output when disabled.

No.	Name	Setting Range	Default
S3-12	Secondary PI Disable Mode	0 to 2	0

Setting 0: No Output (0%)

Setting 1: Lower Limit (S3-10)

Setting 2: Setpoint

■ S3-13: Secondary PI Low Feedback Detection Level

Sets the secondary PI low feedback detection level.

No.	Name	Setting Range	Default
S3-13	Secondary PI Low Feedback Detection Level	0.00 to 600.00 <1>	0.00 <2>

<1> Upper limit is S3-02, decimal place holder is determined by S3-03.

<2> Unit is determined by S3-04.

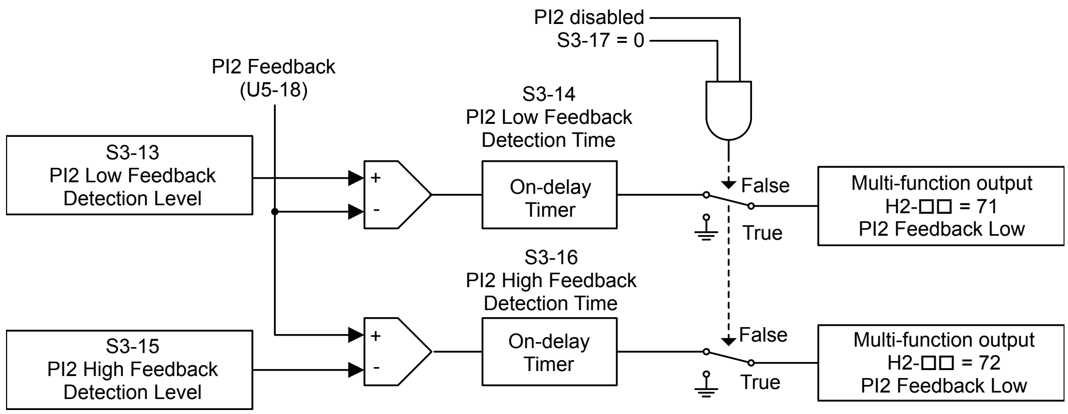


Figure 5.92 PI Low Feedback Detection Level

■ S3-14: Secondary PI Low Feedback Detection Time

Sets the secondary PI low feedback detection delay time in seconds.

No.	Name	Setting Range	Default
S3-14	Secondary PI Low Feedback Detection Time	0.0 to 25.5 s	1.0 s

■ S3-15: Secondary PI High Feedback Level

Sets the secondary PI high feedback detection level.

No.	Name	Setting Range	Default
S3-15	Secondary PI High Feedback Level	0.00 to 600.00 <1>	300.0 <2>

<1> Upper limit is S3-02, decimal place holder is determined by S3-03.

<2> Unit is determined by S3-04.

■ S3-16: Secondary PI High Feedback Detection Time

Sets the secondary PI high feedback detection delay time in seconds.

No.	Name	Setting Range	Default
S3-16	Secondary PI High Feedback Detection Time	0.0 to 25.5 s	1.0 s

■ S3-17: Secondary PI Feedback Detection Selection

Selects when secondary PI controller low and high feedback detection is active.

No.	Name	Setting Range	Default
S3-17	Secondary PI Feedback Detection Selection	0 or 1	0

Setting 0: Secondary PI Enabled

Setting 1: Always

◆ S6: P1000 Protection

■ S6-01: Emergency Override Speed

Sets the sped command used in emergency override mode when S6-02 = 0.

No.	Name	Setting Range	Default
S6-01	Emergency Override Speed	0.00 to 240.00 Hz	0.00 Hz

■ S6-02: Emergency Override Reference Selection

Selects the emergency override speed source.

No.	Name	Setting Range	Default
S6-02	Emergency Override Reference Selection	0, 1	0

Setting 0: Use S6-01 Reference

Setting 1: Use Frequency Reference

■ S6-07: Output Phase Loss Detection Level for Dynamic Audible Noise Control

Sets the output phase loss detection level for Dynamic Audible Noise Control. Decrease the setting in steps of 10% when output phase loss is detected erroneously. This setting rarely needs to be changed.

No.	Name	Setting Range	Default
S6-07	Output Phase Loss Detection Level for Dynamic Audible Noise Control	10.0 to 100.0%	100.0%

◆ T: Motor Tuning

Auto-Tuning automatically sets and tunes parameters required for optimal motor performance.

Refer to Auto-Tuning on page 119 for details on Auto-Tuning parameters.

5.12 U: Monitor Parameters

Monitor parameters let the user view various aspects of drive performance using the digital operator display. Some monitors can be output from terminals FM and AM by assigning the specific monitor parameter number (U□-□□) to H4-01 and H4-04. *Refer to H4-01, H4-04: Multi-Function Analog Output Terminal FM, AM Monitor Selection on page 219* for details on assigning functions to an analog output.

◆ U1: Operation Status Monitors

Status monitors display drive status data such as output frequency and output current. *Refer to U1: Operation Status Monitors on page 435* for a complete list of U1-□□ monitors and descriptions.

◆ U2: Fault Trace

Use these monitor parameters to view the status of various drive aspects when a fault occurs.

This information is helpful for determining the cause of a fault. *Refer to U2: Fault Trace on page 437* for a complete list of U2-□□ monitors and descriptions.

U2-□□ monitors are not reset when the drive is initialized. *Refer to o4-11: U2, U3 Initialization on page 258* for instructions on how to reset these monitor values.

Note: Fault histories are not kept when CPF00, CPF01, CPF06, CPF24, oFA00, oFb00, oFC00, Uv1, Uv2, or Uv3 occur.

◆ U3: Fault History

These parameters display faults that have occurred during operation as well as the drive operation time when those faults occurred. *Refer to U3: Fault History on page 438* for a complete list of U3-□□ monitors and descriptions.

U3-□□ monitors are not reset when the drive is initialized. *Refer to o4-11: U2, U3 Initialization on page 258* for instructions on how to reset these monitor values.

Note: Fault histories are not kept when CPF00, CPF01, CPF06, CPF24, oFA00, oFb00, oFC00, Uv1, Uv2, or Uv3 occur.

◆ U4: Maintenance Monitors

Maintenance monitors show:

- Runtime data of the drive and cooling fans and number of Run commands issued
- Maintenance data and replacement information for various drive components
- kWh data
- Highest peak current that has occurred and output frequency at the time the peak current occurred
- Motor overload status information
- Detailed information about the present Run command and frequency reference source selection

Refer to U4: Maintenance Monitors on page 439 for a complete list of U4-□□ monitors and descriptions.

◆ U5: PID Monitors

These monitors display various aspects of PID control. *Refer to PID Block Diagram on page 152* for details on how these monitors display PID data.

Refer to U5: PID Monitors on page 441 for a complete list of U5-□□ monitors and descriptions.

◆ U6: Operation Status Monitors

U6 Control monitors show motor secondary current data.

Refer to U6: Operation Status Monitors on page 442 for a complete list of U6-□□ monitors and descriptions.

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6

Troubleshooting

This chapter provides descriptions of the drive faults, alarms, errors, related displays, and guidance for troubleshooting. This chapter can also serve as a reference guide for tuning the drive during a trial run.

6.1 Section Safety

⚠ WARNING

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply could result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label; after all indicators are OFF, measure for unsafe voltages to confirm the drive is safe prior to servicing.

Do not operate equipment with covers removed.

Failure to comply could result in death or serious injury.

The diagrams in this section may illustrate drives without covers or safety shields to display details. Be sure to reinstall covers or shields before operating the drives and run the drives according to the instructions described in this manual.

Always ground the motor-side grounding terminal.

Improper equipment grounding could result in death or serious injury by contacting the motor case.

Do not touch terminals before the capacitors have fully discharged.

Failure to comply could result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label; after all indicators are OFF, measure for unsafe voltages to confirm the drive is safe prior to servicing.

After blowing a fuse or tripping a GFCI, do not attempt to restart the drive or operate peripheral devices until five minutes pass and CHARGE lamp is OFF.

Failure to comply could result in death, serious injury, and damage to the drive.

Check wiring and peripheral device ratings to identify the cause of trips.

Contact your supplier if the cause cannot be identified.

Do not allow unqualified personnel to perform work on the drive.

Failure to comply could result in death or serious injury.

Installation, maintenance, inspection and servicing must be performed only by authorized personnel familiar with installation, adjustment and maintenance of AC drives.

Do not perform work on the drive while wearing loose clothing, jewelry, or without eye protection.

Failure to comply could result in death or serious injury.

Remove all metal objects such as watches and rings, secure loose clothing and wear eye protection before beginning work on the drive.

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Fire Hazard

Tighten all terminal screws to the specified tightening torque.

Loose electrical connections could result in death or serious injury by fire due to overheating of electrical connections.

Do not use an improper voltage source.

Failure to comply could result in death or serious injury by fire.

Verify that the rated voltage of the drive matches the voltage of the incoming drive input power before applying power.

⚠ WARNING

Do not use improper combustible materials.

Failure to comply could result in death or serious injury by fire.

Attach the drive to metal or other noncombustible material.

NOTICE

Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards.

Failure to comply may result in ESD damage to the drive circuitry.

Never connect or disconnect the motor from the drive while the drive is outputting voltage.

Improper equipment sequencing could result in damage to the drive.

Do not use unshielded cable for control wiring.

Failure to comply may cause electrical interference resulting in poor system performance. Use shielded twisted-pair wires and ground the shield to the ground terminal of the drive.

Do not modify the drive circuitry.

Failure to comply could result in damage to the drive and will void warranty.

Yaskawa is not responsible for modification of the product made by the user.

Check all the wiring after installing the drive and connecting other devices to ensure that all connections are correct.

Failure to comply could result in damage to the drive.

6.2 Motor Performance Fine-Tuning

This section offers helpful information for counteracting oscillation, hunting, and other problems that occur while performing a trial run. Refer to the section below that corresponds to the motor control method used.

Note: This section describes commonly edited parameters that may be set incorrectly. Consult Yaskawa for more information on detailed settings and for fine-tuning the drive.

◆ Fine-Tuning V/f Control

Table 6.1 Parameters for Fine-Tuning Performance in V/f Control

Problem	Parameter No.	Corrective Action	Default	Suggested Setting
Motor hunting and oscillation at speeds between 10 and 40 Hz	Hunting Prevention Gain (n1-02)	• Reduce the setting if insufficient motor torque relative to the size of the load causes hunting. • Increase the setting when motor hunting and oscillation occur with a light load. • Reduce the setting if hunting occurs when using a motor with a relatively low inductance, such as a high-frequency motor or a motor with a larger frame size.	1.00	0.10 to 2.00
• Motor noise • Motor hunting and oscillation at speeds up to 40 Hz	Carrier Frequency Selection (C6-02)	• Increase the carrier frequency If the motor noise is too loud. • Lower the carrier frequency when motor hunting and oscillation occur at speeds up to 40 Hz. • The default setting for the carrier frequency depends on the drive capacity (o2-04).	1 (2 kHz)	1 to max. setting
• Poor torque or speed response • Motor hunting and oscillation	Torque Compensation Primary Delay Time (C4-02)	• Reduce the setting if motor torque and speed response are too slow. • Increase the setting if motor hunting and oscillation occur.	200 ms	100 to 1000 ms
• Poor motor torque at speeds below 10 Hz • Motor hunting and oscillation	Torque Compensation Gain (C4-01)	• Increase the setting if motor torque is insufficient at speeds below 10 Hz. • Reduce the setting if motor hunting and oscillation with a relatively light load.	1.00	0.50 to 1.50
• Poor motor torque at low speeds • Motor instability at motor start	Mid Output Voltage A (E1-08) Minimum Output Voltage (E1-10)	• Increase the setting if motor torque is insufficient at speeds below 10 Hz. • Reduce the setting If motor instability occurs at motor start.	Depends on o2-04, Drive Model Selection	Default setting ±5 V
Poor speed precision (V/f control)	Slip Compensation Gain (C3-01)	Set the motor-rated current (E2-01), motor-rated slip (E2-02), and motor no-load current (E2-03), then adjust the slip compensation gain (C3-01).	0.0 (no slip compen-sation)	0.5 to 1.5

◆ Parameters to Minimize Motor Hunting and Oscillation

In addition to the parameters discussed in table ***Table 6.1***, parameters in ***Table 6.2*** indirectly affect motor hunting and oscillation.

Table 6.2 Parameters that Affect Control Performance in Applications

Name (Parameter No.)	Application
Dwell Function (b6-01 through b6-04)	Prevents motor speed loss by maintaining the output frequency when working with heavy loads or when there is powerful backlash on the machine side.
Accel/Decel Time (C1-01 through C1-11)	Adjusting accel and decel times will affect the torque presented to the motor during acceleration or deceleration.
S-Curve Characteristics (C2-01 through C2-04)	Prevents shock at the beginning and end of acceleration and deceleration.
Jump Frequency (d3-01 through d3-04)	Skips over the resonant frequencies of connected machinery.
Analog Filter Time Constant (H3-13)	Prevents fluctuation in the analog input signal due to noise.
Stall Prevention (L3-01 through L3-06, L3-11)	• Prevents motor speed loss and overvoltage when the load is too heavy or during sudden acceleration/ deceleration. • Adjustment is not normally necessary because Stall Prevention is enabled as a default. Set L3-04 to 0 to disable Stall Prevention during deceleration when using a braking resistor.

6.3 Drive Alarms, Faults, and Errors

◆ Types of Alarms, Faults, and Errors

Check the digital operator for information about possible faults if the drive or motor fails to operate. *Refer to Using the Digital Operator on page 99*.

If problems occur that are not covered in this manual, contact the nearest Yaskawa representative with the following information:

- Drive model
- Software version
- Date of purchase
- Description of the problem

Table 6.3 contains descriptions of the various types of alarms, faults, and errors that may occur while operating the drive.

Table 6.3 Types of Alarms, Faults, and Errors

Type	Drive Response
Faults	When the drive detects a fault: • The digital operator displays text indicating the specific fault and the ALM indicator LED remains lit until the fault is reset. • The fault interrupts drive output and the motor coasts to a stop. • Some faults allow the user to select the stopping method when the fault occurs. • Fault output terminals MA-MC will close, and MB-MC will open. The drive will remain inoperable until the fault is cleared. *Refer to Fault Reset Methods on page 311*.
Minor Faults and Alarms	When the drive detects an alarm or a minor fault: • The digital operator displays text indicating the specific alarm or minor fault, and the ALM indicator LED flashes. • The drive continues running the motor, although some alarms allow the user to select a stopping method when the alarm occurs. • A multi-function contact output set to be tripped by a minor fault (H2- □□ = 10) closes. If the output is set to be tripped by an alarm, the contact will not close. • The digital operator displays text indicating a specific alarm and the ALM indicator LED flashes. Remove the cause of the problem to reset a minor fault or alarm.
Operation Errors	An operation error occurs when parameter settings conflict or do not match hardware settings (such as with an option card). When the drive detects an operation error: • The digital operator displays text indicating the specific error. • Multi-function contact outputs do not operate. The drive will not operate the motor until the error has been reset. Correct the settings that caused the operation error to clear the error.
Tuning Errors	Tuning errors occur while performing Auto-Tuning. When the drive detects a tuning error: • The digital operator displays text indicating the specific error. • Multi-function contact outputs do not operate. • Motor coasts to stop. Remove the cause of the error and repeat the Auto-Tuning process.
Copy Function Errors	Copy Function Errors occur when using the digital operator or the USB Copy Unit to copy, read, or verify parameter settings. • The digital operator displays text indicating the specific error. • Multi-function contact outputs do not operate. Pressing any key on the digital operator will clear the fault. Investigate the cause of the problem (such as model incompatibility) and try again.

◆ Alarm and Error Displays

■ Faults

Table 6.4 gives an overview of possible fault codes. Conditions such as overvoltages can trip faults and alarms. It is important to distinguish between faults and alarms to determine the proper corrective actions.

When the drive detects a fault, the ALM indicator LED lights, the fault code appears on the digital operator, and the fault contact MA-MB-MC triggers. An alarm is present if the ALM LED blinks and the fault code on the digital operator flashes. ***Refer to Minor Faults and Alarms on page 279*** for a list of alarm codes.

Table 6.4 Fault Displays

Digital Operator Display	Name	Page
bAT	Digital Operator Battery Voltage Low	281
boL	Braking Transistor Overload Fault	281
bUS	Option Communication Error	281
CE	MEMOBUS/Modbus Communication Error	281
CPF11 to CPF14 <1> <3>	Control Circuit Error	281
CPF16 to CPF19 <1> <3>	Control Circuit Error	281
CPF02	A/D Conversion Error	282
CPF03	Control Board Connection Error	282
CPF06 <3>	EEPROM Memory Data Error	282
CPF07, CPF08	Terminal Board Connection Error	282
CPF20, CPF21 <2>	Control Circuit Error	282
CPF22	Hybrid IC Error	282
CPF23	Control Board Connection Error	283
CPF24 <3>	Drive Unit Signal Fault	283
CPF25	Terminal Board Not Connected	283
CPF26 to CPF35, CPF40 to CPF43	Control Circuit Error	283
E5	SI-T3 Watchdog Timer Error	283
EF0	Option Card External Fault	283
EF1 to EF8	External Fault (input terminal S1 to S8)	283
Err	EEPROM Write Error	284
FAn	Internal Fan Fault	283
FbH	Excessive PID Feedback	284
FbL	PID Feedback Loss	285
GF	Ground Fault	285
LF	Output Phase Loss	285
nSE	Node Setup Error	285
oC	Overcurrent	285
oFA00 <3>	Option Card Connection Error (CN5-A)	286
oFA01	Option Card Fault (CN5-A)	286

Digital Operator Display	Name	Page
oFA03 to oFA06	Option Card Error (CN5-A)	286
oFA10, oFA11	Option Card Error (CN5-A)	286
oFA12 to oFA17	Option Card Connection Error (CN5-A)	286
oFA30 to oFA43	Comm Option Card Connection Error (CN5-A)	286
oFb00 <3>	Option Card Connection Error (CN5-B)	287
oFb01	Option Card Fault (CN5-B)	287
oFb02	Option Card Fault (CN5-B)	287
oFb03, oFb11	Option Card Error (CN5-B)	287
oFb12 to oFb17	Option Card Connection Error (CN5-B)	287
oFC00 <3>	Option Card Connection Error (CN5-C)	287
oFC01	Option Card Fault (CN5-C)	287
oFC02	Option Card Fault (CN5-C)	288
oFC03, oFC11	Option Card Error (CN5-C)	288
oFC12 to oFC17	Option Card Connection Error (CN5-C)	288
oFC50 to oFC55	Option Card Error (CN5-C)	288
oH	Heatsink Overheat	288
oH1	Heatsink Overheat	288
oH4	Motor Overheat Fault (PTC input)	299
oL1	Motor Overload	289
oL2	Drive Overload	289
oL3	Overtorque Detection 1	289
oL4	Overtorque Detection 2	290
oL7	High Slip Braking oL	290
oPr	Operator Connection Fault	290
ov	Overvoltage	290
PF	Input Phase Loss	291
rF	Braking Resistor Fault	291
rH	Dynamic Braking Resistor	291
rr	Dynamic Braking Transistor	292
SC	IGBT Short Circuit or Ground Fault	292
SEr	Too Many Speed Search Restarts	292
TdE	Time Data Error	292

Digital Operator Display	Name	Page
TIE	Time Interval Error	292
TIM	Time Not Set	292
UL3	Undertorque Detection 1	293
UL4	Undertorque Detection 2	293
UL6	Motor Underload	293
Uv1 <3>	Undervoltage	293
Uv2 <3>	Control Power Supply Undervoltage	294
Uv3 <3>	Soft Charge Circuit Fault	294
voF	Output Voltage Detection Fault	294
vToL	VT Overload	294

<1> Displayed as CPF00 when occurring at drive power up. When one of the faults occurs after successfully starting the drive, the display will show CPF01.

<2> Displayed as CPF20 when occurring at drive power up. When one of the faults occurs after successfully starting the drive, the display will show CPF21.

<3> Fault histories are not kept when CPF00, CPF01, CPF06, CPF24, oFA00, oFb00, oFC00, Uv1, Uv2, or Uv3 occur.

■ Minor Faults and Alarms

Refer to ***Table 6.5*** for an overview of possible alarm codes. Conditions such as overvoltages can trip faults and alarms. It is important to distinguish between faults and alarms to determine the proper corrective actions.

When the drive detects an alarm, the ALM indicator LED blinks and the alarm code display flashes. Most alarms trigger a digital output programmed for alarm output (H2-☐☐ = 10). A fault (not an alarm) is present if the ALM LED lights without blinking. ***Refer to Faults on page 278*** for information on fault codes.

Table 6.5 Minor Fault and Alarm Displays

Digital Operator Display	Name	Minor Fault Output (H2-☐☐ = 10)	Page
AEr	SI-T Station Number Setting Error (CC-Link, CANopen, MECHATROLINK-II)	YES	295
bAT	HOA Keypad Battery Voltage Low	YES	281
bb	Drive Baseblock	No output	295
boL	Braking Transistor Overload Fault	YES	295
bUS	Option Card Communications Error	YES	295
CALL	Serial Communication Transmission Error	YES	295
CE	MEMOBUS/Modbus Communication Error	YES	296
CrST	Cannot Reset	YES	296
dnE	Drive Disabled	YES	296
E5	SI-T3 Watchdog Timer Error	YES	283
EoF	Emergency Override Forward Run	YES	297
Eor	Emergency Override Reverse Run	YES	297
EF	Run Command Input Error	YES	296
EF0	Option Card External Fault	YES	296
EF1 to EF8	External Fault (input terminal S1 to S8)	YES	297
FbH	Excessive PID Feedback	YES	297
FbL	PID Feedback Loss	YES	298
HCA	Current Alarm	YES	298
LT-1	Cooling Fan Maintenance Time	No output <1>	298
LT-2	Capacitor Maintenance Time	No output <1>	298
LT-3	Soft Charge Bypass Relay Maintenance Time	No output <1>	298
LT-4	IGBT Maintenance Time (50%)	No output <1>	299
oH	Heatsink Overheat	YES	299
oH2	Drive Overheat	YES	299
oH3	Motor Overheat	YES	299
ov	Overvoltage	YES	300
PASS	MEMOBUS/Modbus Test Mode Complete	No output	300
rUn	During Run 2, Motor Switch Command Input	YES	300
SE	MEMOBUS/Modbus Test Mode Fault	YES	300
TdE	Time Data Error	YES	292
TIE	Time Interval Error	YES	292
TrPC	IGBT Maintenance Time (90%)	YES	300
UL6	Motor Underload	YES	293
Uv	Undervoltage	YES	301
wRUn	Run Delay Timer is Active	YES	301

<1> Output when H2-☐☐ = 2F.

Troubleshooting

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■ Operation Errors

Table 6.6 Operation Error Displays

Digital Operator Display	Name	Page	Digital Operator Display	Name	Page
oPE01	Drive Unit Setting Error	302	oPE09	PID Control Selection Error	304
oPE02	Parameter Setting Range Error	302	oPE10	V/f Data Setting Error	304
oPE03	Multi-Function Input Setting Error	302	oPE11	Carrier Frequency Setting Error	304
oPE04	Terminal Board Mismatch Error	303	oPE13	Pulse Train Monitor Selection Error	304
oPE05	Run Command Selection Error	303	oPE28	Sequence Timer Error	304
oPE07	Multi-Function Analog Input Selection Error	303			

■ Auto-Tuning Errors

Table 6.7 Auto-Tuning Error Displays

Digital Operator Display	Name	Page	Digital Operator Display	Name	Page
End1	Excessive V/f Setting	305	Er-03	STOP Button Input	306
End2	Motor Iron Core Saturation Coefficient Error	305	Er-04	Line-to-Line Resistance Error	306
End3	Rated Current Setting Alarm	305	Er-05	No-Load Current Error	306
End4	Adjusted Slip Value Fell Below Lower Limit	305	Er-08	Rated Slip Error	307
End5	Resistance Between Lines Error	305	Er-09	Acceleration Error	307
End6	Leakage Inductance Alarm	305	Er-11	Motor Speed Error	307
End7	No-Load Current Alarm	306	Er-12	Current Detection Error	307
Er-01	Motor Data Error	306	Er-13	Leakage Inductance Error	307
Er-02	Alarm	306	Er-17	Reverse Prohibited Error	307

■ Errors and Displays When Using the Copy Function

Table 6.8 Copy Errors

Digital Operator Display	Name	Page	Digital Operator Display	Name	Page
CoPy	Writing parameter settings (flashing)	308	ndAT	Model, voltage class, capacity mismatch	308
CPyE	Error writing data	308	rdEr	Error reading data	309
CSEr	Copy unit error	308	rEAd	Reading parameter settings (flashing)	309
dFPS	Drive model mismatch	308	vAEr	Voltage class, capacity mismatch	309
End	Task complete	308	vFyE	Parameter setting mismatch	309
iFEr	Communication error	308	vrFy	Comparing parameter settings (flashing)	309

6.4 Fault Detection

◆ Fault Displays, Causes, and Possible Solutions

Faults are detected for drive protection, and cause the drive to stop while triggering the fault output terminal MA-MB-MC. Remove the cause of the fault and manually clear the fault before attempting to run the drive again.

Table 6.9 Detailed Fault Displays, Causes, and Possible Solutions

Digital Operator Display		Fault Name
bAT	bAT	Digital Operator Battery Voltage Low
Cause		**Possible Solution**
The digital operator battery is low		Replace the digital operator battery.

Digital Operator Display		Fault Name
boL	boL	Braking Transistor Overload Fault
		The braking transistor reached its overload level.
Cause		**Possible Solution**
The wrong braking resistor is installed		Select the correct braking resistor.

Digital Operator Display		Fault Name
bUS	bUS	Option Communication Error
		• The connection was lost after establishing initial communication. • Only detected when the run command frequency reference is assigned to an option card.
Cause		**Possible Solution**
No signal was received from the PLC		• Check for faulty wiring. • Correct the wiring. • Check for disconnected cables and short circuits and repair as needed.
Faulty communications wiring or an existing short circuit		
Communication data error occurred due to noise		• Check the various options available to minimize the effects of noise. • Counteract noise in the control circuit, main circuit, and ground wiring. • Ensure that other equipment such as switches or relays do not cause noise. Use surge absorbers if necessary. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate all communication wiring from drive power lines. Install an EMC noise filter to the drive power supply input.
The option card is damaged		Replace the option card if there are no problems with the wiring and the error continues to occur.
The option card is not properly connected to the drive		• The connector pins on the option card do not line up properly with the connector pins on the drive. • Reinstall the option card.

Digital Operator Display		Fault Name
CE	CE	MEMOBUS/Modbus Communication Error
		Control data was not received for the CE detection time set to H5-09.
Cause		**Possible Solution**
Faulty communications wiring or an existing short circuit		• Check for faulty wiring. • Correct the wiring. • Check for disconnected cables and short circuits and repair as needed.
Communication data error occurred due to noise		• Check the various options available to minimize the effects of noise. • Counteract noise in the control circuit, main circuit, and ground wiring. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Ensure that other equipment such as switches or relays do not cause noise. Use surge suppressors if required. • Separate all communication wiring from drive power lines. Install an EMC noise filter to the drive power supply input.

Digital Operator Display		Fault Name
CPF00 or CPF01	CPF11 to CPF14 CPF16 to CPF19	Control Circuit Error

Cause	Possible Solution
There is a self-diagnostic error in the control circuit	• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.
Connector on the operator is damaged	Replace the operator.

Digital Operator Display		Fault Name
CPF02	CPF02	A/D Conversion Error An A/D conversion error or control circuit error occurred.
Cause		**Possible Solution**
Control circuit is damaged		• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
CPF03	CPF03	Control Board Connection Error Connection error between the control board and the drive
Cause		**Possible Solution**
There is a connection error		• Turn off the power and check the connection between the control board and the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.
Drive fails to operate properly due to noise interference		• Check the various options available to minimize the effects of noise. • Counteract noise in the control circuit, main circuit, and ground wiring. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Ensure that other equipment such as switches or relays do not cause noise. Use surge suppressors if required. • Separate all communication wiring from drive power lines. Install an EMC noise filter to the drive power supply input.

Digital Operator Display		Fault Name
CPF06	CPF06	EEPROM Memory Data Error Error in the data saved to EEPROM
Cause		**Possible Solution**
There is an error in EEPROM control circuit		• Turn off the power and check the connection between the control board and the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.
The power supply was switched off while parameters were being saved to the drive		Reinitialize the drive (A1-03 = 2220, 3330).

Digital Operator Display		Fault Name
CPF07	CPF07	Terminal Board Connection Error
CPF08	CPF08	
Cause		**Possible Solution**
There is a faulty connection between the terminal board and the control board		• Turn off the power and reconnect the terminal board. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
CPF20 or CPF21	CPF20 or CPF21	Control Circuit Error
Cause		**Possible Solution**
Hardware is damaged		• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
CPF22	CPF22	Hybrid IC Failure
Cause		**Possible Solution**

Hybrid IC failure on the power board	• Cycle power to the drive. • If the problem continues, replace the power board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the power board.

Digital Operator Display		Fault Name
CPF23	CPF23	Control Board Connection Error
		Connection error between the control board and the drive
Cause		**Possible Solution**
Hardware is damaged		• Turn off the power and check the connection between the control board and the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
CPF24	CPF24	Drive Unit Signal Fault
		The drive capacity cannot be detected correctly (drive capacity is checked when the drive is powered up).
Cause		**Possible Solution**
Hardware is damaged		If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
CPF25	CPF25	Terminal Board Not Connected
Cause		**Possible Solution**
Terminal board is not connected correctly		Reconnect the terminal board to the connector on the drive, then cycle the power to the drive.

Digital Operator Display		Fault Name
CPF26 to CPF35 CPF40 to CPF43	CPF26 to CPF35 CPF40 to CPF43	Control Circuit Error
		CPU error
Cause		**Possible Solution**
Hardware is damaged		If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
E5	E5	SI-T3 Watchdog Timer Error
		The watchdog timed out.
Cause		**Possible Solution**
Data has not been received from the PLC		Execute DISCONNECT or ALM_CLR, then issue a CONNECT command or SYNC_SET command and proceed to phase 3. Refer to the SI-T3 Option Technical Manual for more details on troubleshooting.

Digital Operator Display		Fault Name
EF0	EF0	Option Card External Fault
		An external fault condition is present.
Cause		**Possible Solution**
An external fault was received from the PLC and F6-03 is set to a value other than 3.		• Remove the cause of the external fault. • Remove the external fault input from the PLC.
Problem with the PLC program		Check the PLC program and correct problems.

Digital Operator Display		Fault Name
EF1	EF1	External Fault (input terminal S1)
		External fault at multi-function input terminal S1.
EF2	EF2	External Fault (input terminal S2)
		External fault at multi-function input terminal S2.
EF3	EF3	External Fault (input terminal S3)
		External fault at multi-function input terminal S3.
EF4	EF4	External Fault (input terminal S4)
		External fault at multi-function input terminal S4.

EF5	EF5	External Fault (input terminal S5)
		External fault at multi-function input terminal S5.
EF6	EF6	External Fault (input terminal S6)
		External fault at multi-function input terminal S6.
EF7	EF7	External Fault (input terminal S7)
		External fault at multi-function input terminal S7.
EF8	EF8	External Fault (input terminal S8)
		External fault at multi-function input terminal S8.
Cause		**Possible Solution**
An external device tripped an alarm function		Remove the cause of the external fault and reset the fault.
Wiring is incorrect		• Properly connect the signal lines to the terminals assigned for external fault detection (H1-□□ = 20 to 2B). • Reconnect the signal line.
Multi-function contact input setting is incorrect		• Check for unused terminals set for H1-□□ = 20 to 2B (External Fault). • Change the terminal settings.

Digital Operator Display		Fault Name
Err	Err	EEPROM Write Error
		Data cannot be written to the EEPROM
Cause		**Possible Solution**
Noise has corrupted data while writing to the EEPROM		• Press “ENTER” on the digital operator. • Correct the parameter setting. • Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.
Hardware problem		If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
FAn	FAn	Internal Fan Fault
		Fan or magnetic contactor failure
Cause		**Possible Solution**
Internal cooling fan has malfunctioned		• Cycle power to the drive. • Check for fan operation. • Verify the cumulative operation time of the fan with monitor U4-03, and verify the cumulative operation time of the fan maintenance timer with U4-04. • If the cooling fan has exceeded its expected performance life or is damaged in any other way, follow the replacement instructions in the ***Peripheral Devices & Options*** chapter.
Fault detected in the internal cooling fan or magnetic contactor to the power supply.		• Cycle power to the drive. • If the fault continues to occur, replace the power board/gate drive board or the entire drive. • Contact Yaskawa or a Yaskawa representative for instructions on replacing the power board/gate drive board.

Digital Operator Display		Fault Name
FbH	FbH	Excessive PID Feedback
		PID feedback input is greater than the level set to b5-36 for longer than the time set to b5-37. Set b5-12 to 2 or 5 to enable fault detection.
Cause		**Possible Solution**
Parameters are set inappropriately		Check b5-36 and b5-37 settings.
Incorrect PID feedback wiring		Correct the wiring.
There is a problem with the feedback sensor		• Check the sensor on the control side. • Replace the sensor if damaged.

Digital Operator Display		Fault Name
FbL	FbL	PID Feedback Loss
		PID feedback loss detection is programmed to trigger a fault (b5-12 = 2 or 5) and the PID feedback level is below the detection level set to b5-13 for longer than the time set to b5-14.
Cause		**Possible Solution**
Parameters are set inappropriately		Check b5-13 and b5-14 settings.
Incorrect PID feedback wiring		Correct the wiring.
There is a problem with the feedback sensor		• Check the sensor on the control side. • Replace the sensor if damaged.

Digital Operator Display		Fault Name
GF	GF	Ground Fault
		• A current short to ground exceeded 50% of rated current on the output side of the drive. • Setting L8-09 to 1 enables ground fault detection.
Cause		**Possible Solution**
Motor insulation is damaged		• Check the insulation resistance of the motor. • Replace the motor.
A damaged motor cable is creating a short circuit		• Check the motor cable. • Remove the short circuit and reapply power to the drive
		• Check the resistance between the cable and the ground terminal ⏚. • Replace the cable.
Excessive leakage current at the drive output		• Reduce the carrier frequency. • Reduce the amount of stray capacitance.
The drive started to run during a current offset fault or while coasting to a stop		• Set b3-01 to 1 to enable Speed Search at Start. • Perform Speed Search 1 or 2 (H1-□□ = 61 or 62) via one of the external terminals.
Hardware problem		If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
LF	LF	Output Phase Loss
		• Phase loss on the output side of the drive. • Setting L8-07 to 1 or 2 enables Phase Loss Detection.
Cause		**Possible Solution**
The output cable is disconnected		• Check for wiring errors and properly connect the output cable. • Correct the wiring.
The motor winding is damaged		• Check the resistance between motor lines. • Replace the motor if the winding is damaged.
The output terminal is loose		• Apply the tightening torque specified in this manual to fasten the terminals. ***Refer to Wire Gauges and Tightening Torque on page 77*** for details.
The rated current of the motor being used is less than 5% of the drive rated current		Check the drive and motor capacities.
An output transistor is damaged		If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.
A single-phase motor is being used		The drive cannot operate a single phase motor.

Digital Operator Display		Fault Name
nSE	nSE	Node Setup Error
		A terminal assigned to the node setup function closed during run.
Cause		**Possible Solution**
The node setup terminal closed during run.		Stop the drive when using the node setup function.
A Run command was issued while the node setup function was active.		

Digital Operator Display		Fault Name
oC	oC	Overcurrent
		Drive sensors detected an output current greater than the specified overcurrent level.

Cause	Possible Solution
The motor has been damaged due to overheating or the motor insulation is damaged	• Check the insulation resistance. • Replace the motor.
One of the motor cables has shorted out or there is a grounding problem	• Check the motor cables. • Remove the short circuit and reapply power to the drive.
	• Check the resistance between the motor cables and the ground terminal ⏚. • Replace damaged cables.
The load is too heavy	• Measure the current flowing into the motor. • Replace the drive with a larger capacity drive if the current value exceeds the rated current. • Determine if there is sudden fluctuation in the current level. • Reduce the load to avoid sudden changes in the current level or switch to a larger drive.
The acceleration or deceleration times are too short	Calculate the torque needed during acceleration relative to the load inertia and the specified acceleration time. If it is not possible to set the proper amount of torque, make the following changes: • Increase the acceleration time (C1-01, C1-03). • Increase the S-curve characteristics (C2-01 through C2-04). • Increase the capacity of the drive.
The drive is attempting to operate a specialized motor or a motor larger than the maximum size allowed	• Check the motor capacity. • Ensure that the rated capacity of the drive is greater than or equal to the capacity rating found on the motor nameplate.
Magnetic contactor (MC) on the output side of the drive has turned on or off	Set up the operation sequence so the MC does not trip while the drive is outputting current.
V/f setting is not operating as expected	• Check the ratios between the voltage and frequency. • Set parameters E1-04 through E1-10 appropriately. • Lower the voltage if it is too high relative to the frequency.
Excessive torque compensation	• Check the amount of torque compensation. • Reduce the torque compensation gain (C4-01) until there is no speed loss and less current.
Drive fails to operate properly due to noise interference	• Review the possible solutions provided for handling noise interference. • Review the section on handling noise interference on page 317 and check the control circuit lines, main circuit lines, and ground wiring.
Overexcitation gain is set too high	• Check if the fault occurs simultaneously with overexcitation function operation. • Consider motor flux saturation and reduce the value of n3-13 (Overexcitation Deceleration Gain).
Run command was applied while motor was coasting	• Set b3-01 to 1 to enable Speed Search at Start. • Program the Speed Search command input through one of the multi-function contact input terminals (H1-□□ = 61 or 62).
The rated output current of the drive is too small	Use a larger drive.

Digital Operator Display		Fault Name
oFA00	oFA00	Option Card Connection Error at Option Port CN5-A
		Option compatibility error
Cause		**Possible Solution**
The option card installed into port CN5-A is incompatible with the drive		Check if the drive supports the option card to be installed. Contact Yaskawa for assistance.

Digital Operator Display		Fault Name
oFA01	oFA01	Option Card Fault at Option Port CN5-A
		Option not properly connected
Cause		**Possible Solution**
The option card connection to port CN5-A is faulty		• Turn off the power and reconnect the option card. • Check if the option card is properly plugged into the option port. Make sure the card is fixed properly. • If the option is not a communication option card, try to use the card in a different option port. If the option card works properly in a different option port, CN5-A is damaged, and the drive requires replacement. If the error persists (oFb01 or oFC01 occur), replace the option card.

Digital Operator Display		Fault Name
oFA03 to oFA06	oFA03 to oFA06	Option Card Error Occurred at Option Port CN5-A
oFA10, oFA11	oFA10, oFA11	

oFA12 to oFA17	oFA12 to oFA17	Option Card Connection Error (CN5-A)
oFA30 to oFA43	oFA30 to oFA43	Communication Option Card Connection Error (CN5-A)
Cause		**Possible Solution**
Option card or hardware is damaged		• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
oFb00	oFb00	Option Card Fault at Option Port CN5-B
		Option compatibility error
Cause		**Possible Solution**
The option card installed into port CN5-B is incompatible with the drive		Make sure the drive supports the option card to be installed. Contact Yaskawa for assistance.
A communication option card has been installed in option port CN5-B		Communication option cards are only supported by option port CN5-A. It is not possible to install more than one communication option.

Digital Operator Display		Fault Name
oFb01	oFb01	Option Card Fault at Option Port CN5-B
		Option not properly connected
Cause		**Possible Solution**
The option card connection to port CN5-B is faulty		• Turn off the power and reconnect the option card. • Check if the option card is properly plugged into the option port. Make sure the card is fixed properly. • Try to use the card in a different option port. If the option card works properly in a different option port, CN5-B is damaged, and the drive requires replacement. If the error persists (oFA01 or oFC01 occur), replace the option card.

Digital Operator Display		Fault Name
oFb02	oFb02	Option Card Fault at Option Port CN5-B
		Same type of option card is currently connected
Cause		**Possible Solution**
An option card of the same type is already installed in option port CN5-A		Only one of each option card type can only be installed simultaneously. Make sure only one type of option card is connected.
An input option card is already installed in option port CN5-A		Install a communication option. More than one of the same type of card cannot be installed simultaneously.

Digital Operator Display		Fault Name
oFb03 to oFb11	oFb03 to oFb11	Option card error occurred at Option Port CN5-B
oFb12 to oFb17	oFb12 to oFb17	
Cause		**Possible Solution**
Option card or hardware is damaged		• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
oFC00	oFC00	Option Card Connection Error at Option Port CN5-C
		Option compatibility error
Cause		**Possible Solution**
The option card installed into port CN5-C is incompatible with the drive		Confirm that the drive supports the option card to be installed. Contact Yaskawa for assistance.
A communication option card has been installed in option port CN5-C		Communication option cards are only supported by option port CN5-A. It is not possible to install more than one communication option.

Digital Operator Display		Fault Name
oFC01	oFC01	Option Card Fault at Option Port CN5-C
		Option not properly connected
Cause		**Possible Solution**

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The option card connection to port CN5-C is faulty.	• Turn the power off and reconnect the option card. • Check if the option card is properly plugged into the option port. Make sure the card is fixed properly. • Try to use the card in a different option port. If the option card works properly in a different option port, CN5-C is damaged, and the drive requires replacement. If the error persists (oFA01 or oFb01 occur), replace the option card.

Digital Operator Display		Fault Name
oFC02	oFC02	Option Card Fault at Option Port CN5-C
		Same type of option card is currently connected
Cause		**Possible Solution**
An option card of the same type is already installed in option port CN5-A or CN5-B.		Only one of each option card type can only be installed simultaneously. Make sure only one type of option card is connected.
An input option card is already installed in option port CN5-A or CN5-B.		Install a communication option, a digital input option, or an analog input option. More than one of the same type of card cannot be installed simultaneously.

Digital Operator Display		Fault Name
oFC03 to oFC11	oFC03 to oFC11	Option Card Error Occurred at Option Port CN5-C
oFC12 to oFC17	oFC12 to oFC17	
Cause		**Possible Solution**
Option card or hardware is damaged		• Cycle power to the drive. • If the problem continues, replace the control board or the entire drive. Contact Yaskawa or a Yaskawa representative for instructions on replacing the control board.

Digital Operator Display		Fault Name
oFC50 to oFC55	oFC50 to oFC55	Option Card Error Occurred at Option Port CN5-C
Cause		**Possible Solution**
Option card or hardware is damaged		Refer to the option manual for details.

Digital Operator Display		Fault Name
oH	oH	Heatsink Overheat
		The heatsink temperature exceeded the overheat pre-alarm level set to L8-02. The default value for L8-02 is determined by drive capacity (o2-04).
Cause		**Possible Solution**
Surrounding temperature is too high		• Check the temperature surrounding the drive. Verify temperature is within drive specifications. • Improve the air circulation within the enclosure panel. • Install a fan or air conditioner to cool the surrounding area. • Remove anything near the drive that might be producing excessive heat.
Load is too heavy		• Measure the output current. • Decrease the load. • Lower the carrier frequency (C6-02).
Internal cooling fan is stopped		• Replace the cooling fan. ***Refer to Cooling Fan Replacement: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032 on page 331***. • After replacing the cooling fan, set parameter o4-03 to 0 to reset the cooling fan maintenance.

Digital Operator Display		Fault Name
oH1	oH1	Overheat 1 (Heatsink Overheat)
		The heatsink temperature exceeded the drive overheat level. Overheat level is determined by drive capacity (o2-04).
Cause		**Possible Solution**
Surrounding temperature is too high		• Check the temperature surrounding the drive. • Improve the air circulation within the enclosure panel. • Install a fan or air conditioner to cool the surrounding area. • Remove anything near the drive that might be producing excessive heat.
Load is too heavy		• Measure the output current. • Lower the carrier frequency (C6-02). • Reduce the load.

Digital Operator Display		Fault Name
oL1	oL1	Motor Overload
		The electronic motor overload protection tripped
Cause		**Possible Solution**
Load is too heavy		Reduce the load.
Cycle times are too short during acceleration and deceleration		Increase the acceleration and deceleration times (C1-01 through C1-04).
A general-purpose motor is driven below the rated speed with a high load		• Reduce the load. • Increase the speed. • If the motor is supposed to operate at low speeds, either increase the motor capacity or use a motor specifically designed to operate in the desired speed range.
The output voltage is too high		• Adjust the user-set V/f pattern (E1-04 through E1-10) by reducing E1-08 and E1-10. • Do not set E1-08 and E1-10 too low. This reduces load tolerance at low speeds.
The wrong motor rated current is set to E2-01		• Check the motor-rated current. • Enter the motor rated current to parameter E2-01 as indicated on the motor nameplate.
The base frequency is set incorrectly		• Check the rated frequency indicated on the motor nameplate. • Enter the rated frequency to E1-06 (Base Frequency).
The electrical thermal protection characteristics and motor overload characteristics do not match		• Check the motor characteristics. • Correct the type of motor protection that has been selected (L1-01). • Install an external thermal relay.
The electrical thermal relay is operating at the wrong level		• Check the current rating listed on the motor nameplate. • Check the value set for the motor rated current (E2-01).
Motor overheated by overexcitation operation		• Overexcitation increases the motor loss and the motor temperature. Excessive duration of overexcitation may cause motor damage. Prevent excessive overexcitation operation or apply proper cooling to the motor. • Reduce the excitation deceleration gain (n3-13). • Set L3-04 (Stall Prevention during Deceleration) to a value other than 4.
Parameters related to Speed Search are set incorrectly		• Check values set to Speed Search related parameters. • Adjust the Speed Search current and Speed Search deceleration times (b3-02 and b3-03 respectively). • After Auto-Tuning, set b3-24 to 1 to enable Speed Estimation Speed Search.
Output current fluctuation due to power supply loss		Check the power supply for phase loss.

Digital Operator Display		Fault Name
oL2	oL2	Drive Overload
		The thermal sensor of the drive triggered overload protection.
Cause		**Possible Solution**
Load is too heavy		Reduce the load.
Acceleration or deceleration time is too short		Increase the settings for the acceleration and deceleration times (C1-01 through C1-04).
The output voltage is too high		• Adjust the preset V/f pattern (E1-04 through E1-10) by reducing E1-08 and E1-10. • Do not lower E1-08 and E1-10 excessively. This reduces load tolerance at low speeds.
Drive capacity is too small		Replace the drive with a larger model.
Overload occurred when operating at low speeds		• Reduce the load when operating at low speeds. • Replace the drive with a model that is one frame size larger. • Lower the carrier frequency (C6-02).
Excessive torque compensation		Reduce the torque compensation gain in parameter C4-01 until there is no speed loss but less current.
Parameters related to Speed Search are set incorrectly		• Check the settings for all Speed Search related parameters. • Adjust the current used during Speed Search (b3-03) and the Speed Search deceleration time (b3-02). • After Auto-Tuning, set b3-24 to 1 to enable Speed Estimation Speed Search.
Output current fluctuation due to input phase loss		Check the power supply for phase loss.

Digital Operator Display		Fault Name
oL3	oL3	Overtorque Detection 1
		The current has exceeded the value set for torque detection (L6-02) for longer than the allowable time (L6-03).

Cause	Possible Solution
Parameter settings are not appropriate for the load	Check L6-02 and L6-03 settings.
Fault on the machine side (e.g., machine is locked up)	Check the status of the load. Remove the cause of the fault.

Digital Operator Display		Fault Name
oL4	oL4	Overtorque Detection 2
		The current has exceeded the value set for Overtorque Detection 2 (L6-05) for longer than the allowable time (L6-06).
Cause		Possible Solution
Parameter settings are not appropriate for the load		Check the settings of parameters L6-05 and L6-06.

Digital Operator Display		Fault Name
oL7	oL7	High Slip Braking oL
		The output frequency stayed constant for longer than the time set to n3-04 during High Slip Braking.
Cause		Possible Solution
Excessive load inertia		• Reduce deceleration times in parameters C1-02 and C1-04 for applications that do not use High Slip Braking. • Use a braking resistor to shorten deceleration time.
Motor is driven by the load		
Something on the load side is restricting deceleration		
The overload time during High Slip Braking is too short		• Increase parameter n3-04 (High-slip Braking Overload Time). • Install a thermal relay and increase the setting of n3-04 to maximum value.

Digital Operator Display		Fault Name
oPr	oPr	External Digital Operator Connection Fault
		The external operator has been disconnected from the drive. **Note:** An oPr fault will occur when all of the following conditions are true: • Output is interrupted when the operator is disconnected (o2-06 = 1). • The Run command is assigned to the operator (b1-02 = 0 and LOCAL has been selected).
Cause		Possible Solution
External operator is not properly connected to the drive		• Check the connection between the operator and the drive. • Replace the cable if damaged. • Turn off the drive input power and disconnect the operator. Reconnect the operator and reapply drive input power.

Digital Operator Display		Fault Name
ov	ov	Overvoltage
		Voltage in the DC bus has exceeded the overvoltage detection level. • For 200 V class drives: approximately 410 V • For 400 V class drives: approximately 820 V (740 V when E1-01 is less than 400) • For 600 V class drives: approximately 1040 V
Cause		Possible Solution
Deceleration time is too short and regenerative energy is flowing from the motor into the drive		• Increase the deceleration time (C1-02 and C1-04). • Install a dynamic braking resistor or a dynamic braking resistor unit. • Set L3-04 to 1 to enable stall prevention during deceleration. Stall Prevention is enabled as the default setting.
Fast acceleration time causes the motor to overshoot the speed reference		• Check if sudden drive acceleration triggers an overvoltage alarm. • Increase the acceleration time. • Use longer S-curve acceleration and deceleration times. • Enable the Overvoltage Suppression function (L3-11 = 1). • Lengthen the S-curve at acceleration end.
Excessive braking load		The braking torque was too high, causing regenerative energy to charge the DC bus. Reduce the braking torque, use a dynamic braking option, or lengthen decel time.

Surge voltage entering from the drive input power	Install a DC link choke. **Note:** Voltage surge can result from a thyristor convertor and phase advancing capacitor using the same input power supply.
Ground fault in the output circuit causes the DC bus capacitor to overcharge	• Check the motor wiring for ground faults. • Correct grounding shorts and reapply power.
Improper parameters related to Speed Search (including Speed Search after a momentary power loss and after a fault restart)	• Check the settings for Speed Search-related parameters. • Enable Speed Search restart function (b3-19 greater than or equal to 1 to 10). • Adjust the current level during Speed Search and the deceleration time (b3-02 and b3-03 respectively). • Perform Stationary Auto-Tuning for line-to-line resistance and then set b3-14 to 1 to enable Speed Estimation Speed Search.
Drive input power voltage is too high	• Check the voltage. • Lower drive input power voltage within the limits listed in the specifications.
The braking transistor or braking resistor are wired incorrectly	• Check braking transistor and braking resistor wiring for errors. • Properly rewire the braking resistor device.
Drive fails to operate properly due to noise interference	• Review the list of possible solutions provided for controlling noise. • Review the section on handling noise interference on page *317* and check the control circuit lines, main circuit lines, and ground wiring.
Load inertia is set incorrectly	• Check the load inertia settings when using KEB, overvoltage suppression, or Stall Prevention during deceleration. • Adjust the load inertia ratio in L3-25 to better match the load.
Motor hunting occurs	• Adjust the parameters that control hunting. • Set the gain for Hunting Prevention (n1-02). • Adjust the AFR time constant (n2-02 and n2-03).

Digital Operator Display		Fault Name
PF	PF	Input Phase Loss
		Drive input power has an open phase or has a large imbalance of voltage between phases. Detected when L8-05 is set 1 (enabled).
Cause		**Possible Solution**
There is phase loss in the drive input power		• Check for wiring errors in the main circuit drive input power. • Correct the wiring.
There is loose wiring in the drive input power terminals		• Ensure the terminals are tightened properly. • Apply the tightening torque as specified in this manual. ***Refer to Wire Gauges and Tightening Torque on page 77*** for details.
There is excessive fluctuation in the drive input power voltage		• Check the voltage from the drive input power. • Review the possible solutions for stabilizing the drive input power.
There is poor balance between voltage phases		Stabilize drive input power or disable phase loss detection.
The main circuit capacitors are worn		• Check the maintenance time for the capacitors (U4-05). • Replace the capacitor if U4-05 is greater than 90%. For instructions on replacing the capacitor, contact Yaskawa or a Yaskawa representative.
		Check for problems with the drive input power. If drive input power appears normal but the alarm continues to occur, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.

Digital Operator Display		Fault Name
rF	rF	Braking Resistor Fault
		The resistance of the braking resistor is too low.
Cause		**Possible Solution**
The proper braking resistor option has not been installed		Select a braking resistor option that it fits the drive braking transistor specification.
A regenerative converter, regenerative unit, or braking unit is being used		Set L8-55 to 0 to disable the braking transistor protection selection.

Digital Operator Display		Fault Name
rH	rH	Braking Resistor Overheat
		Braking resistor protection was triggered. Fault detection is enabled when L8-01 = 1 (disabled as a default).
Cause		**Possible Solution**

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Deceleration time is too short and excessive regenerative energy is flowing back into the drive	• Check the load, deceleration time, and speed. • Reduce the load inertia. • Increase the deceleration times (C1-01 to C1-04). • Replace the dynamic braking option with a larger device that can handle the power that is discharged.
The duty cycle is too high	Check the duty cycle. Maximum of 3% duty cycle is available when L8-01 = 1.
Excessive braking inertia	Recalculate braking load and braking power. Reduce the braking load by adjusting braking resistor settings.
The braking operation duty cycle is too high	Check the braking operation duty cycle. Braking resistor protection for ERF-type braking resistors (L8-01 = 1) allows a braking duty cycle of maximum 3%.
The proper braking resistor has not been installed	• Check the specifications and conditions for the braking resistor device. • Select the optimal braking resistor.
Note: The magnitude of the braking load trips the braking resistor overheat alarm, NOT the surface temperature. Using the braking resistor more frequently than its rating permits will trip the alarm even when the braking resistor surface is not very hot.	

Digital Operator Display		Fault Name
rr	rr	Dynamic Braking Transistor The built-in dynamic braking transistor failed.
Cause		**Possible Solution**
The braking transistor is damaged		• Cycle power to the drive and check for reoccurrence of the fault. • Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.
The control circuit is damaged		

Digital Operator Display		Fault Name
SC	SC	IGBT Short Circuit or Ground Fault
Cause		**Possible Solution**
IGBT fault		• Check motor wiring. • Turn off the power supply, then turn it on. If the problem continues, contact your Yaskawa representative or the nearest Yaskawa sales office.
IGBT short circuit detection circuit fault		
The drive is damaged		• Check the drive output side short circuit for a broken output transistor B1 and U/T1, V/T2, W/T3 – and U/T1, V/T2, W/T3 • Contact your Yaskawa representative or nearest Yaskawa sales office.

Digital Operator Display		Fault Name
SEr	SEr	Too Many Speed Search Restarts The number of Speed Search restarts exceeded the value set to b3-19.
Cause		**Possible Solution**
Parameters related to Speed Search are set to the wrong values		• Reduce the detection compensation gain during Speed Search (b3-10). • Increase the current level when attempting Speed Search (b3-17). • Increase the detection time during Speed Search (b3-18). • Repeat Auto-Tuning.
The motor is coasting in the opposite direction of the Run command		Set b3-14 to 1 to enable Bi-Directional Speed Search.

Digital Operator Display		Fault Name
TdE	TdE	Time Data Error
Cause		**Possible Solution**
An error has occurred in the Real-Clock Time function of the digital operator		Replace the digital operator. For instructions on replacing the digital operator, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Fault Name
TIE	TIE	Time Interval Error
Cause		**Possible Solution**
An error has occurred in the Real-Clock Time function of the digital operator		Replace the digital operator. For instructions on replacing the digital operator, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Fault Name
TIM	TIM	Time Not Set

Cause	Possible Solution
The Real-Time Clock for the digital operator is not set in parameter o4-17 • The drive is a new drive, first power-up condition • o4-17 was set to 2, Reset, by the user, manually clearing the Real-Time Clock data.	Set o4-17 to 1 to set the time for the digital operator. The drive will display the "TIM" alarm (Time Not Set) when the Real time Clock is not set . Additionally, at power up, if the "TIM" condition is present, the drive will automatically switch to the time setting screen (o4-17 = 1) for 30 seconds to prompt the user to set the Real-Time Clock.
The user did not set the Real Time Clock when prompted following power-up.	Cycle power to the drive and set the Real Time Clock within 30 seconds of power-up, or set the clock manually via parameter o4-17.
The digital operator battery is low or the battery has been replaced	Replace the digital operator battery and set the Real-Time Clock.
An error has occurred in the Real-Time Clock function of the digital operator	Replace the digital operator. For instructions on replacing the digital operator, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Fault Name
UL3	UL3	Undertorque Detection 1
		The current has fallen below the minimum value set for torque detection (L6-02) for longer than the allowable time (L6-03).
Cause		**Possible Solution**
Parameter settings are not appropriate for the load		Check the settings of parameters L6-02 and L6-03.
There is a fault on the machine side		Check the load for any problems.

Digital Operator Display		Fault Name
UL4	UL4	Undertorque Detection 2
		The current has fallen below the minimum value set for torque detection (L6-05) for longer than the allowable time (L6-06).
Cause		**Possible Solution**
Parameter settings are not appropriate for the load		Check L6-05 and L6-06 settings
There is a fault on the machine side		Check the load for any problems.

Digital Operator Display		Fault Name
UL6	UL6	Motor Underload
		The weight of the load has fallen below the underload curve defined in L6-14.
Cause		**Possible Solution**
The output current has fallen below the motor underload curve defined in L6-14 for longer than the time set to L6-03		Adjust the value set to L6-14 so that output current remains above the motor underload curve during normal operation.

Digital Operator Display		Fault Name
Uv1	Uv1	DC Bus Undervoltage
		One of the following conditions occurred while the drive was running: • Voltage in the DC bus fell below the undervoltage detection level (L2-05). • For 200 V class drives: approximately 190 V • For 400 V class drives: approximately 380 V (350 V when E1-01 is less than 400) • For 600 V class drives: approximately 475 V The fault is output only if L2-01 is set to 0 or 1 and the DC bus voltage has fallen below the level set to L2-05 for longer than the time set to L2-02.
Cause		**Possible Solution**
Input power phase loss		• The main circuit drive input power is wired incorrectly. • Correct the wiring.
One of the drive input power wiring terminals is loose		• Ensure there are no loose terminals. • Apply the tightening torque specified in this manual to fasten the terminals. ***Refer to Wire Gauges and Tightening Torque on page 77*** for details.

There is a problem with the voltage from the drive input power	• Check the voltage. • Correct the voltage to be within the range listed in drive input power specifications. • If there is no problem with the power supply to the main circuit, check for problems with the main circuit magnetic contactor.
The power has been interrupted	Correct the drive input power.
The main circuit capacitors are worn	• Check the maintenance time for the capacitors (U4-05). • Replace either the control board or the entire drive if U4-05 exceeds 90%. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.
The relay or contactor on the soft-charge bypass circuit is damaged	• Cycle power to the drive and see if the fault reoccurs. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative. • Check monitor U4-06 for the performance life of the soft-charge bypass. • Replace either the control board or the entire drive if U4-06 exceeds 90%. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.

Digital Operator Display		Fault Name
Uu2	Uv2	Control Power Supply Voltage Fault Voltage is too low for the control drive input power.
Cause		**Possible Solution**
In drive models 2A0004 to 2A0056 or 4A0002 to 4A0031, L2-02 was changed from its default value without installing a Momentary Power Loss Ride-Thru unit		Correct the setting to L2-02 or install an optional Momentary Power Loss Ride-Thru unit.
Control power supply wiring is damaged		• Cycle power to the drive. Check if the fault reoccurs. • If the problem continues, replace the control board, the entire drive, or the control power supply. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.
Internal circuitry is damaged		• Cycle power to the drive. Check if the fault reoccurs. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.

Digital Operator Display		Fault Name
Uu3	Uv3	Undervoltage 3 (Soft-Charge Bypass Circuit Fault) The soft-charge bypass circuit failed.
Cause		**Possible Solution**
The relay or contactor on the soft-charge bypass circuit is damaged		• Cycle power to the drive and see if the fault reoccurs. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative. • Check monitor U4-06 for the performance life of the soft-charge bypass. • Replace either the control board or the entire drive if U4-06 exceeds 90%. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.

Digital Operator Display		Fault Name
uoF	voF	Output Voltage Detection Fault Problem detected with the voltage on the output side of the drive.
Cause		**Possible Solution**
Hardware is damaged. Internal drive module MC / FAN overheat protection circuit board is due to abnormal ambient operating power.		• Lower ambient temperature. • Replace the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.

Digital Operator Display		Fault Name
utoL	vToL	VT Overload
Cause		**Possible Solution**
The output current of the drive has been elevated for a set length of time.		The application may not be suited for the drive • The application may not be suited for the drive • The drive is undersized for the load

6.5 Alarm Detection

◆ Alarm Codes, Causes, and Possible Solutions

Alarms are drive protection functions that do not necessarily cause the drive to stop. After removing the cause of an alarm, the drive will return to the same status is was before the alarm occurred.

When an alarm has been triggered, the ALM light on the digital operator display blinks and the alarm code display flashes. If a multi-function output is set for an alarm (H2-☐☐ = 10), that output terminal will be triggered.

Note: If a multi-function output is set to close when an alarm occurs (H2-☐☐ = 10), it will also close when maintenance periods are reached, triggering alarms LT-1 through LT-4 (triggered only if H2-☐☐ = 2F).

Table 6.10 Alarm Codes, Causes, and Possible Solutions

Digital Operator Display		Minor Fault Name
AEr	AEr	Communication Option Station Number Setting Error (CC-Link, CANopen, MECHATROLINK-II)
		Option card node address is outside of the acceptable setting range.
Cause		**Possible Solutions**
Station number is set outside the possible setting range.		• Set parameter F6-10 to the proper value when using a CC-Link option. • Set parameter F6-35 to the proper value when using a CANopen option.

Digital Operator Display		Minor Fault Name
bb	bb	Baseblock
		Drive output interrupted as indicated by an external baseblock signal.
Cause		**Possible Solutions**
External baseblock signal was entered via one of the multi-function input terminals (S1 to S8).		Check external sequence and baseblock signal input timing.

Digital Operator Display		Minor Fault Name
boL	boL	Braking Transistor Overload Fault
		The braking transistor in the drive has been overloaded.
Cause		**Possible Solutions**
The proper braking resistor has not been installed.		Select the proper braking resistor.

Digital Operator Display		Minor Fault Name
bUS	bUS	Option Communication Error
		• The connection was lost after initial communication was established. • Assign a Run command frequency reference to the option.
Cause		**Possible Solutions**
Connection is broken or master controller stopped communicating.		• Check for faulty wiring. • Correct the wiring. • Check for disconnected cables and short circuits. Repair as needed.
Option is damaged.		If there are no problems with the wiring and the fault continues to occur, replace the option.
The option is not properly connected to the drive.		• The connector pins on the option are not properly lined up with the connector pins on the drive. • Reinstall the option.
A data error occurred due to noise.		• Check options available to minimize the effects of noise. • Take steps to counteract noise in the control circuit wiring, main circuit lines and ground wiring. • Try to reduce noise on the controller side. • Use surge absorbers on magnetic contactors or other equipment causing the disturbance. • Use recommended cables or some other type of shielded line. Ground the shield to the controller side or on the input power side. • Separate the wiring for communication devices from the drive input power lines. Install an EMC noise filter to the drive input power.

Digital Operator Display		Minor Fault Name
CALL	CALL	Serial Communication Transmission Error
		Communication has not yet been established.

Cause	Possible Solutions
Communications wiring is faulty, there is a short circuit, or something is not connected properly.	• Check for wiring errors. • Correct the wiring. • Check for disconnected cables and short circuits. Repair as needed.
Programming error on the master side.	Check communications at start-up and correct programming errors.
Communications circuitry is damaged.	• Perform a self-diagnostics check. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.
Termination resistor setting is incorrect.	Install a termination resistor at both ends of a communication line. Set the internal termination resistor switch correctly on slave drives. Place DIP switch S2 to the ON position.

Digital Operator Display		Minor Fault Name
CE	CE	MEMOBUS/Modbus Communication Error
		Control data was not received correctly for two seconds.
Cause		**Possible Solutions**
A data error occurred due to noise.		• Check options available to minimize the effects of noise. • Take steps to counteract noise in the control circuit wiring, main circuit lines, and ground wiring. • Reduce noise on the controller side. • Use surge absorbers for the magnetic contactors or other components that may be causing the disturbance. • Use only recommended shielded line. Ground the shield on the controller side or on the drive input power side. • Separate all wiring for communication devices from drive input power lines. Install an EMC noise filter to the drive input power supply.
Communication protocol is incompatible.		• Check the H5 parameter settings and the protocol setting in the controller. • Ensure settings are compatible.
The CE detection time (H5-09) is set shorter than the time required for a communication cycle to take place.		• Check the PLC. • Change the software settings in the PLC. • Set a longer CE detection time using parameter H5-09.
Incompatible PLC software settings or there is a hardware problem.		• Check the PLC. • Remove the cause of the error on the controller side.
Communications cable is disconnected or damaged.		• Check the connector to make sure the cable has a signal. • Replace the communications cable.

Digital Operator Display		Minor Fault Name
CrST	CrST	Cannot Reset
Cause		**Possible Solutions**
Fault reset was being executed when a Run command was entered.		• Ensure that a Run command cannot be entered from the external terminals or option during fault reset. • Turn off the Run command.

Digital Operator Display		Minor Fault Name
dnE	dnE	Drive Disabled
Cause		**Possible Solutions**
“Drive Enable” is set to a multi-function contact input (H1-□□ = 6A) and that signal was switched off.		Check the operation sequence.

Digital Operator Display		Minor Fault Name
EF	EF	Forward/Reverse Run Command Input Error
		Both forward run and reverse run closed simultaneously for longer than 0.5 s.
Cause		**Possible Solutions**
Sequence error		Check the forward and reverse command sequence and correct the problem. **Note:** When minor fault EF detected, motor ramps to stop.

Digital Operator Display		Minor Fault Name
EF0	EF0	Option Card External Fault
		An external fault condition is present.
Cause		**Possible Solutions**

An external fault was received from the PLC with F6-03 set to 3, which allows the drive to continue running after an external fault occurs.	• Remove the cause of the external fault. • Remove the external fault input from the PLC.
There is a problem with the PLC program.	Check the PLC program and correct problems.

Digital Operator Display		Minor Fault Name
EF1	EF1	External Fault (Input Terminal S1)
		External fault at multi-function input terminal S1.
EF2	EF2	External fault (input terminal S2)
		External fault at multi-function input terminal S2.
EF3	EF3	External fault (input terminal S3)
		External fault at multi-function input terminal S3.
EF4	EF4	External fault (input terminal S4)
		External fault at multi-function input terminal S4.
EF5	EF5	External fault (input terminal S5)
		External fault at multi-function input terminal S5.
EF6	EF6	External fault (input terminal S6)
		External fault at multi-function input terminal S6.
EF7	EF7	External fault (input terminal S7)
		External fault at multi-function input terminal S7.
EF8	EF8	External fault (input terminal S8)
		External fault at multi-function input terminal S8.
Cause		**Possible Solutions**
An external device has tripped an alarm function.		Remove the cause of the external fault and reset the multi-function input value.
Wiring is incorrect.		• Ensure the signal lines have been connected properly to the terminals assigned for external fault detection (H1-□□ = 2C to 2F). • Reconnect the signal line.
Multi-function contact inputs are set incorrectly.		• Check if the unused terminals have been set for H1-□□ = 2C to 2F (External Fault). • Change the terminal settings.

Digital Operator Display		Minor Fault Name
EoF	EoF	Emergency Override Forward Run
Cause		**Possible Solution**
The multi-function digital input for EmergOverrideFWD (H1-□□ = AF) has been closed.		Open H1-□□ = AF if the emergency condition is no longer present

Digital Operator Display		Minor Fault Name
Eor	Eor	Emergency Override Reverse Run
Cause		**Possible Solution**
The multi-function digital input for EmergOverrideREV (H1-□□ = B0) has been closed.		Open H1-□□ = B0 if the emergency condition is no longer present

Digital Operator Display		Minor Fault Name
FbH	FbH	Excessive PID Feedback
		The PID feedback input is higher than the level set to b5-36 for longer than the time set to b5-37, and b5-12 is set to 1 or 4.
Cause		**Possible Solutions**
Parameter settings for b5-36 and b5-37 are incorrect.		Check parameters b5-36 and b5-37.
PID feedback wiring is faulty.		Correct the wiring.
Feedback sensor has malfunctioned.		Check the sensor and replace it if damaged.
Feedback input circuit is damaged.		Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Minor Fault Name
FbL	FbL	PID Feedback Loss
		The PID feedback input is lower than the level set to b5-13 for longer than the time set to b5-14.
Cause		**Possible Solutions**
Parameter settings for b5-13 and b5-14 are incorrect.		Check parameters b5-13 and b5-14.
PID feedback wiring is faulty.		Correct the wiring.
Feedback sensor has malfunctioned.		Check the sensor and replace it if damaged.
Feedback input circuit is damaged.		Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Minor Fault Name
HCA	HCA	Current Alarm
		Drive current exceeded overcurrent warning level (150% of the rated current).
Cause		**Possible Solutions**
Load is too heavy.		Reduce the load for applications with repetitive operations (i.e., stops and starts), or replace the drive.
Acceleration and deceleration times are too short.		• Calculate the torque required during acceleration and for the inertia moment. • If the torque level is not right for the load, take the following steps: • Increase the acceleration and deceleration times (C1-01 through C1-04). • Increase the capacity of the drive.
A special-purpose motor is being used, or the drive is attempting to run a motor greater than the maximum allowable capacity.		• Check the motor capacity. • Use a motor appropriate for the drive. Ensure the motor is within the allowable capacity range.
The current level increased due to Speed Search after a momentary power loss or while attempting to perform a fault restart.		The alarm will only appear briefly. There is no need to take action to prevent the alarm from occurring in such instances.

Digital Operator Display		Minor Fault Name
LT-1	LT-1	Cooling Fan Maintenance Time
		The cooling fan has reached its expected maintenance period and may need to be replaced. **Note:** An alarm output (H2-□□ = 10) will only be triggered if both (H2-□□ = 2F and H2-□□ = 10) are set.
Cause		**Possible Solutions**
The cooling fan has reached 90% of its expected performance life.		Replace the cooling fan and set o4-03 to 0 to reset the Maintenance Monitor.

Digital Operator Display		Minor Fault Name
LT-2	LT-2	Capacitor Maintenance Time
		The main circuit and control circuit capacitors are nearing the end of their expected performance life. **Note:** An alarm output (H2-□□ = 10) will only be triggered if H2-□□ = 2F.
Cause		**Possible Solutions**
The main circuit and control circuit capacitors have reached 90% of their expected performance lives.		Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Minor Fault Name
LT-3	LT-3	Soft Charge Bypass Relay Maintenance Time
		The DC bus soft charge relay is nearing the end of its expected performance life. **Note:** An alarm output (H2-□□ = 10) will only be triggered if H2-□□ = 2F.
Cause		**Possible Solutions**
The DC bus soft charge relay has reached 90% of expected performance life.		Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Minor Fault Name
LT-4	LT-4	IGBT Maintenance Time (50%)
		IGBTs have reached 50% of their expected performance life. **Note:** An alarm output (H2-□□ = 10) will only be triggered if H2-□□ = 2F.
Cause		**Possible Solutions**
IGBTs have reached 50% of their expected performance life.		Check the load, carrier frequency, and output frequency.

Digital Operator Display		Minor Fault Name
oH	oH	Heatsink Overheat
		The temperature of the heatsink exceeded the overheat pre-alarm level set to L8-02 (90-100 °C). Default value for L8-02 is determined by drive capacity (o2-04).
Cause		**Possible Solutions**
Surrounding temperature is too high		• Check the surrounding temperature. • Improve the air circulation within the enclosure panel. • Install a fan or air conditioner to cool surrounding area. • Remove anything near drive that may cause extra heat.
Internal cooling fan has stopped.		• Replace the cooling fan. *Refer to Cooling Fan Replacement: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032 on page 331*. • After replacing the drive, set parameter o4-03 to 0 to reset the cooling fan operation time.
Airflow around the drive is restricted.		• Provide proper installation space around the drive as indicated in the manual. *Refer to Installation Orientation and Spacing on page 46* for details. • Allow for the proper space and ensure that there is sufficient circulation around the control panel.
		• Check for dust or other foreign materials clogging the cooling fan. • Clear debris caught in the fan that restricts air circulation.

Digital Operator Display		Minor Fault Name
oH2	oH2	Drive Overheat Warning
		"Drive Overheat Warning" was input to a multi-function input terminal, S1 through S8 (H1-□□= B).
Cause		**Possible Solutions**
An external device triggered an overheat warning in the drive.		Search for the device that tripped the overheat warning. Remove the cause of the problem.

Digital Operator Display		Minor Fault Name
oH3	oH3	Motor Overheat
		The motor overheat signal entered to a multi-function analog input terminal exceeded the alarm level (H3-02, H3-06 or H3-10 = E).
Cause		**Possible Solutions**
Motor thermostat wiring is faulty (PTC input).		Repair the PTC input wiring.
There is a fault on the machine side (e.g., the machine is locked up).		• Check the status of the machine. • Remove the cause of the fault.
Motor has overheated.		• Check the load size, accel/decel times, and cycle times. • Decrease the load. • Increase accel and decel times (C1-01 to C1-04). • Adjust the preset V/f pattern (E1-04 through E1-10). This involves reducing E1-08 and E1-10. **Note:** Refrain from lowering E1-08 and E1-10 excessively to prevent a reduction in load tolerance at low speeds. • Check the motor-rated current. • Enter motor-rated current on motor nameplate (E2-01). • Ensure the motor cooling system is operating normally. • Repair or replace the motor cooling system.

Digital Operator Display		Fault Name
oH4	oH4	Motor Overheat Fault (PTC Input)
		• The motor overheat signal to analog input terminal A1, A2, or A3 exceeded the fault detection level. • Detection requires setting multi-function analog inputs H3-02, H3-10, or H3-06 to E.

Troubleshooting

6

Cause	Possible Solution
Motor has overheated	• Check the size of the load, the accel/decel times, and the cycle times. • Decrease the load. • Increase the acceleration and deceleration times (C1-01 through C1-04).
	• Adjust the preset V/f pattern (E1-04 through E1-10) by reducing E1-08 and E1-10. • Do not set E1-08 and E1-10 too low. This reduces load tolerance at low speeds.
	• Check the motor rated current. • Enter the motor rated current to parameter E2-01 as indicated on the motor nameplate. • Ensure the motor cooling system is operating normally. • Repair or replace the motor cooling system.

Digital Operator Display		Minor Fault Name
ou	ov	DC Bus Overvoltage
		The DC bus voltage exceeded the trip point. • For 200 V class drives: approximately 410 V • For 400 V class drives: approximately 820 V (740 V when E1-01 is less than 400) • For 600 V class drives: approximately 1040 V
Cause		**Possible Solutions**
Surge voltage present in the drive input power.		• Install a DC link choke or an AC reactor. • Voltage surge can result from a thyristor convertor and a phase advancing capacitor operating on the same drive input power system.
The motor is short-circuited.		• Check the motor power cable, relay terminals and motor terminal box for short circuits. • Correct grounding shorts and turn the power back on.
Ground current has overcharged the main circuit capacitors via the drive input power.		
Noise interference causes the drive to operate incorrectly.		• Review possible solutions for handling noise interference. • Review section on handling noise interference and check control circuit lines, main circuit lines and ground wiring. • If the magnetic contactor is identified as a source of noise, install a surge protector to the MC coil.
		Set number of fault restarts (L5-01) to a value other than 0.

Digital Operator Display		Minor Fault Name
PASS	PASS	MEMOBUS/Modbus Comm. Test Mode Complete
Cause		**Possible Solutions**
MEMOBUS/Modbus test has finished normally.		This verifies that the test was successful.

Digital Operator Display		Minor Fault Name
rUn	rUn	Motor Switch during Run
		A command to switch motors was entered during run.
Cause		**Possible Solutions**
A motor switch command was entered during run.		Change the operation pattern so that the motor switch command is entered while the drive is stopped.

Digital Operator Display		Minor Fault Name
SE	SE	MEMOBUS/Modbus Communication Test Mode Error **Note:** This alarm will not trigger a multi-function output terminal that is set for alarm output (H2-☐☐ = 10).
Cause		**Possible Solutions**
A digital input set to 67H (MEMOBUS/Modbus test) was closed while the drive was running.		Stop the drive and run the test again.

Digital Operator Display		Minor Fault Name
TrPC	TrPC	IGBT Maintenance Time (90%)
		IGBTs have reached 90% of their expected performance life.
Cause		**Possible Solutions**
IGBTs have reached 90% of their expected performance life.		Replace the drive.

Digital Operator Display		Minor Fault Name
Uv	Uv	Undervoltage
		One of the following conditions was true when the drive was stopped and a Run command was entered: • DC bus voltage dropped below the level specified in L2-05. • Contactor to suppress inrush current in the drive was opened. • Low voltage in the control drive input power. This alarm outputs only if L2-01 is not 0 and DC bus voltage is under L2-05.
Cause		**Possible Solutions**
Phase loss in the drive input power.		Check for wiring errors in the main circuit drive input power. Correct the wiring.
Loose wiring in the drive input power terminals.		• Ensure the terminals have been properly tightened. • Apply the tightening torque to the terminals as specified. ***Refer to Wire Gauges and Tightening Torque on page 77***.
There is a problem with the drive input power voltage.		• Check the voltage. • Lower the voltage of the drive input power so that it is within the limits listed in the specifications.
Drive internal circuitry is worn.		• Check the maintenance time for the capacitors (U4-05). • Replace either the control board or the entire drive if U4-05 exceeds 90%. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.
The drive input power transformer is too small and voltage drops when the power is switched on.		• Check for an alarm when the magnetic contactor, line breaker, and leakage breaker are closed. • Check the capacity of the drive input power transformer.
Air inside the drive is too hot.		Check the temperature inside the drive.
The CHARGE light is broken or disconnected.		Replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Minor Fault Name
WrUn	WrUn	Waiting for Run
Cause		**Possible Solutions**
The Run command has been applied and the b1-11 timer is active.		Adjust b1-11 to the desired delay time. The drive sill start normally after the b1-11 timer expires.

6.6 Operator Programming Errors

◆ Operator Programming Error Codes, Causes, and Possible Solutions

An Operator Programming Error (oPE) occurs when a contradictory parameter is set or an individual parameter is set to an inappropriate value.

The drive will not operate until the parameter or parameters causing the problem are set correctly. An oPE, however, does not trigger an alarm or fault output. If an oPE occurs, investigate the cause and refer to *Table 6.11* for the appropriate action. When an oPE appears on the operator display, press the ENTER button to view U1-18 and see which parameter is causing the oPE.

Table 6.11 oPE Codes, Causes, and Possible Solutions

<table>
<tr><th colspan="2">Digital Operator Display</th><th>Error Name</th></tr>
<tr><td rowspan="2">oPE01</td><td rowspan="2">oPE01</td><td>Drive Capacity Setting Fault</td></tr>
<tr><td>Drive capacity and the value set to o2-04 do not match.</td></tr>
<tr><th colspan="2">Cause</th><th>Possible Solutions</th></tr>
<tr><td colspan="2">The drive model selection (o2-04) and the actual capacity of the drive are not the same.</td><td>Correct the value set to o2-04.</td></tr>
</table>

<table>
<tr><th colspan="2">Digital Operator Display</th><th>Error Name</th></tr>
<tr><td rowspan="2">oPE02</td><td rowspan="2">oPE02</td><td>Parameter Range Setting Error</td></tr>
<tr><td>Use U1-18 to find parameters set outside the range.</td></tr>
<tr><th colspan="2">Cause</th><th>Possible Solutions</th></tr>
<tr><td colspan="2">Parameters were set outside the possible setting range.</td><td>Set parameters to the proper values.</td></tr>
<tr><td colspan="3">Note: When multiple errors occur simultaneously, other errors are given precedence over oPE02.</td></tr>
</table>

<table>
<tr><th colspan="2">Digital Operator Display</th><th>Error Name</th></tr>
<tr><td rowspan="2">oPE03</td><td rowspan="2">oPE03</td><td>Multi-Function Input Selection Error</td></tr>
<tr><td>A contradictory setting is assigned to multi-function contact inputs H1-01 to H1-08.</td></tr>
<tr><th colspan="2">Cause</th><th>Possible Solutions</th></tr>
<tr><td colspan="2">• The same function is assigned to two multi-function inputs.
• Excludes “Not used” and “External Fault.”</td><td>• Ensure all multi-function inputs are assigned to different functions.
• Re-enter the multi-function settings to ensure this does not occur.</td></tr>
<tr><td colspan="2">The Up command was set but the Down command was not, or vice versa (settings 10 vs. 11).</td><td rowspan="2">Properly set the functions that required for use in combination with other functions.</td></tr>
<tr><td colspan="2">The Up 2 command was set but the Down 2 command was not, or vice versa (settings 75 vs. 76).</td></tr>
<tr><td colspan="2">• Run/Stop command for a 2-wire sequence was set (H1-□□ = 42), but Forward/Reverse command (H1-□□ = 43) was not.
• “Drive Enable” is set to multi-function input S1 or S2 (H1-01 = 6A or H1-02 = 6A).</td><td>Properly set the functions that required for use in combination with other functions.</td></tr>
<tr><td colspan="2">Two of the following functions are set simultaneously:
• Up/Down Command (10 vs. 11)
• Up 2/Down 2 Command (75 vs. 76)
• Hold Accel/Decel Stop (A)
• Analog Frequency Reference Sample/Hold (1E)
• Offset Frequency 1, 2, 3 Calculations (44, 45, 46)</td><td>• Check if contradictory settings have simultaneously been assigned to the multi-function input terminals.
• Correct setting errors.</td></tr>
<tr><td colspan="2">The Up/Down command (10, 11) and PID control (b5-01) are enabled simultaneously.</td><td>Set b5-01 to 0 to disable control PID or disable the Up/Down command.</td></tr>
</table>

Settings for N.C. and N.O. input for the following functions were selected simultaneously: • External Search Command 1 and External Search Command 2 (61 vs. 62) • Fast Stop N.O. and Fast Stop N.C. (15 vs. 17) • KEB for Momentary Power Loss and High Slip Braking (65, 66, 7A, 7B vs. 68) • Motor Switch Command and Accel/Decel Time 2 (16 vs. 1A) • KEB Command 1 and KEB Command 2 (65, 66 vs. 7A, 7B) • FWD Run Command (or REV) and FWD/REV Run Command (2-wire) (40, 41 vs. 42, 43) • External DB Command and Drive Enable (60 vs. 6A) • Motor Switch Command and Up 2/Down 2 Command (16 vs. 75, 76)	• Check if contradictory settings have simultaneously been assigned to the multi-function input terminals. • Correct setting errors.
One of the following settings was entered while H1-□□ = 2 (External Reference 1/2): • b1-15 = 4 (Pulse Train Input) but the pulse train input selection is not set for the frequency reference (H6-01 > 0) • b1-15 or b1-16 set to 3 but no option card is connected • Although b1-15 = 1 (Analog Input) and H3-02 or H3-10 are set to 0 (Frequency Bias)	Correct the settings for the multi-function input terminal parameters.
H2-□□ is set to 38 (Drive Enabled) and H1-□□ is not set to 6A (Drive Enable).	

Digital Operator Display		Error Name
oPE04	oPE04	Initialization Required, Term <–> Ctrl Chg
Cause		**Possible Solutions**
The drive, control board, or terminal board have been replaced and the parameter settings between the control board and the terminal board no longer match.		Set A1-03 to 5550 to load the parameter settings stored in the terminal board to the drive. Initialize parameters after drive replacement by setting A1-03 to 1110 or 2220.

Digital Operator Display		Error Name
oPE05	oPE05	Run Command/Frequency Reference Source Selection Error
Cause		**Possible Solutions**
Frequency reference is assigned to an option card (b1-01 = 3) and an input option card is not connected to the drive.		Reconnect the input option card to the drive.
The Run command is assigned to an option card (b1-02 = 3) and an input option card is not connected to the drive.		
Frequency reference is assigned to the pulse train input (b1-01 = 4) and terminal RP is not set for frequency reference input (H6-01 > 0)		Set H6-01 to 0.

Digital Operator Display		Error Name
oPE07	oPE07	Multi-Function Analog Input Selection Error
		A contradictory setting is assigned to multi-function analog inputs H3-02, H3-10, or H3-06 and PID functions conflict.
Cause		**Possible Solutions**
At least two analog input terminals are set to the same function (i.e., at least two of these parameters have the same setting: H3-02, H3-10, or H3-06).		Change the settings to H3-02, H3-10, and H3-06 so that functions no longer conflict. **Note:** Both 0 (Frequency Reference Bias) and F (Not Used) can be set to H3-02, H3-10, or H3-06 simultaneously.
The following simultaneous contradictory settings: • H3-02, H3-10, or H3-06 = B (PID Feedback) while H6-01 (Pulse Train Input) = 1 (PID Feedback) • H3-02, H3-10, or H3-06 = C (PID Target Value) while H6-01 = 2 (pulse train input sets the PID target value) • H3-02, H3-10, or H3-06 = C (PID Target Value) while b5-18 = 1 (enables b5-19 as the target PID value) • H6-01 = 2 (PID target) while b5-18 = 1 (enables b5-19 as the target PID value)		Disable one of the PID selections.

Digital Operator Display		Error Name
oPE09	oPE09	PID Control Selection Fault
		PID control function selection is incorrect. Requires that PID control is enabled (b5-01 = 1 to 4).
Cause		**Possible Solutions**
The following simultaneous contradictory settings have occurred: • b5-15 is not set to 0.0 (PID Sleep Function Operation Level) • The stopping method is set to either DC Injection Braking or coast to stop with a timer (b1-03 = 2 or 3).		• Set b5-15 to a value other than 0.0. • Set the stopping method to coast to stop or ramp to stop (b1-03 = 0 or 1).
b5-01 is set to 1 or 2, enabling PID control, but the lower limit for the frequency reference (d2-02) is not set to 0 while reverse output is enabled (b5-11 = 1).		Correct the parameter settings.
b5-01 is set to 3 or 4, enabling PID control, but the lower limit for the frequency reference (d2-01) is not 0.		Correct the parameter settings.

Digital Operator Display		Error Name
oPE10	oPE10	V/f Data Setting Error
		One of the following setting errors has occurred: E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04
Cause		**Possible Solutions**
V/f pattern setting error.		Correct the settings for E1-04, E1-06, E1-07, E1-09, and E1-11.

Digital Operator Display		Error Name
oPE11	oPE11	Carrier Frequency Setting Error
		Correct the setting for the carrier frequency.
Cause		**Possible Solutions**
The following simultaneous contradictory settings have occurred: C6-05 > 6 and C6-04 > C6-03 (carrier frequency lower limit is greater than the upper limit). If C6-05 ≤ 6, the drive operates at C6-03.		Correct the parameter settings.
The upper and lower limits between C6-02 and C6-05 are contradictory.		

Digital Operator Display		Error Name
oPE28	oPE28	Sequence Timer Error
		One or more of the sequence timers is not set in the correct order.
Cause		**Possible Solutions**
One of the following contradictory settings is true: • S2-01 > S2-02 • S2-06 > S2-07 • S2-11 > S2-12 • S2-16 > S2-17		Correct the parameter settings.

6.7 Auto-Tuning Fault Detection

When the Auto-Tuning faults shown below are detected, the fault is displayed on the operator and the motor coasts to a stop. Auto-Tuning faults do not trigger a multi-function terminal set for fault or alarm output.

An End□ error indicates that although Auto-Tuning has successfully completed, there is some discrepancy in the calculations. If an End□ error occurs, check for the cause of the error using the table in this section, and perform Auto-Tuning again or manually set the motor parameters after fixing the problem. Start the application if no problem can be diagnosed despite the existence of the End□ error.

◆ Auto-Tuning Codes, Causes, and Possible Solutions

Table 6.12 Auto-Tuning Codes, Causes, and Possible Solutions

Digital Operator Display		Error Name
End1	End1	Excessive V/f Setting (detected only during Rotational Auto-Tuning and displayed after Auto-Tuning is complete)
Cause		**Possible Solutions**
The torque reference exceeded 20% during Auto-Tuning.		• Prior to Auto-Tuning, verify the information on the motor nameplate. • Enter proper values from motor nameplate to parameters T1-02 and T1-04 and repeat Auto-Tuning. • If possible, disconnect the motor from the load and perform Auto-Tuning. If the load cannot be uncoupled, use the current Auto-Tuning results.
The results from Auto-Tuning the no-load current exceeded 80%.		

Digital Operator Display		Error Name
End2	End2	Motor Iron-Core Saturation Coefficient (detected only during Rotational Auto-Tuning and displayed after Auto-Tuning is complete)
Cause		**Possible Solutions**
Motor data entered during Auto-Tuning was incorrect.		• Make sure the data entered to the T1 parameters match the information written on the motor nameplate. • Restart Auto-Tuning and enter the correct information.
Results from Auto-Tuning are outside the parameter setting range, assigning the iron-core saturation coefficients (E2-07 and E2-08) to temporary values.		• Check and correct faulty motor wiring. • Disconnect the motor from machine and perform Rotational Auto-Tuning.

Digital Operator Display		Error Name
End3	End3	Rated Current Setting Alarm (displayed after Auto-Tuning is complete)
Cause		**Possible Solutions**
The correct current rating printed on the motor nameplate was not entered into T1-04.		• Check the setting of parameter T1-04. • Check the motor data and repeat Auto-Tuning.

Digital Operator Display		Error Name
End4	End4	Adjusted Slip Calculation Error
Cause		**Possible Solutions**
The calculated slip is outside the allowable range.		• Make sure the data entered for Auto-Tuning is correct. • If possible, perform Rotational Auto-Tuning. If not possible, perform Stationary Auto-Tuning 2.

Digital Operator Display		Error Name
End5	End5	Resistance Tuning Error
Cause		**Possible Solutions**
The calculated resistance value is outside the allowable range.		• Double-check the data entered for the Auto-Tuning process. • Check the motor and motor cable connection for faults.

Digital Operator Display		Error Name
End6	End6	Leakage Inductance Alarm
Cause		**Possible Solutions**
The calculated leakage inductance value is outside the allowable range.		Double-check the data entered for the Auto-Tuning process.

Digital Operator Display		Error Name
End7	End7	No-Load Current Alarm
Cause		**Possible Solutions**
The entered no-load current value was outside the allowable range.		Check and correct faulty motor wiring.
Auto-Tuning results were less than 5% of the motor rated current.		Double-check the data entered for the Auto-Tuning process.

Digital Operator Display		Error Name
Er-01	Er-01	Motor Data Error
Cause		**Possible Solutions**
Motor data or data entered during Auto-Tuning was incorrect .		• Check that the motor data entered to T1 parameters matches motor nameplate input before Auto-Tuning. • Restart Auto-Tuning and enter the correct information.
Motor output power and motor-rated current settings (T1-02 and T1-04) do not match.		• Check the drive and motor capacities. • Correct the settings of parameters T1-02 and T1-04.
Motor rated current and detected no-load current are inconsistent.		• Check the motor rated current and no-load current. • Correct the settings of parameters T1-04 and E2-03.

Digital Operator Display		Error Name
Er-02	Er-02	Minor Fault
Cause		**Possible Solutions**
An alarm was triggered during Auto-Tuning.		Exit the Auto-Tuning menu, check the alarm code, remove the alarm cause, and repeat Auto-Tuning.

Digital Operator Display		Error Name
Er-03	Er-03	STOP Button Input
Cause		**Possible Solutions**
Auto-Tuning canceled by pressing STOP button.		Auto-Tuning did not complete properly. Restart Auto-Tuning.

Digital Operator Display		Error Name
Er-04	Er-04	Line-to-Line Resistance Error
Cause		**Possible Solutions**
Motor data entered during Auto-Tuning was incorrect.		• Make sure the data entered to the T1 parameters match the information written on the motor nameplate. • Restart Auto-Tuning and enter the correct information.
Results from Auto-Tuning are outside the parameter setting range or the tuning process took too long.		Check and correct faulty motor wiring.
Faulty motor cable or cable connection.		

Digital Operator Display		Error Name
Er-05	Er-05	No-Load Current Error
Cause		**Possible Solutions**
Motor data entered during Auto-Tuning was incorrect.		• Make sure the data entered to the T1 parameters match the information written on the motor nameplate. • Restart Auto-Tuning and enter the correct information.
Results from Auto-Tuning are outside the parameter setting range or the tuning process took too long.		• Check and correct faulty motor wiring. • Perform Rotational Auto-Tuning.
The load was too high during Rotational Auto-tuning.		• Disconnect the motor from machine and restart Auto-Tuning. If motor and load cannot be uncoupled make sure the load is lower than 30%. • If a mechanical brake is installed, make sure it is fully lifted during tuning.

Digital Operator Display		Error Name
Er-08	Er-08	Rated Slip Error
Cause		**Possible Solutions**
Motor data entered during Auto-Tuning was incorrect.		• Make sure the data entered to the T1 parameters match the information written on the motor nameplate. • Restart Auto-Tuning and enter the correct information.
Results from Auto-Tuning are outside the parameter setting range or the tuning process took too long.		• Check and correct faulty motor wiring. • Perform Rotational Auto-Tuning.
The load was too high during rotational Auto-tuning.		• Disconnect the motor from machine and restart Auto-Tuning. If motor and load cannot be uncoupled make sure the load is lower than 30%. • If a mechanical brake is installed, make sure it is fully lifted during tuning.

Digital Operator Display		Error Name
Er-09	Er-09	Acceleration Error
Cause		**Possible Solutions**
The motor did not accelerate for the specified acceleration time.		• Increase the acceleration time (C1-01). • Disconnect the machine from the motor if possible.
The load was too high during Rotational Auto-Tuning.		• Disconnect the motor from machine and restart Auto-Tuning. If motor and load cannot be uncoupled make sure the load is lower than 30%. • If a mechanical brake is installed, make sure it is fully lifted during tuning.

Digital Operator Display		Error Name
Er-11	Er-11	Motor Speed Fault
Cause		**Possible Solutions**
Torque reference is too high.		• Increase the acceleration time (C1-01). • Disconnect the machine from the motor if possible.

Digital Operator Display		Error Name
Er-12	Er-12	Current Detection Error
Cause		**Possible Solutions**
One of the motor phases is missing: (U/T1, V/T2, W/T3).		Check motor wiring and correct any problems.
The current exceeded the current rating of the drive. The current is too low.		• Check motor wiring for a short between motor lines. • Close any magnetic contactors used between motors. • Replace the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.
Attempted Auto-Tuning without motor connected to the drive.		Connect the motor and restart Auto-Tuning.
Current detection signal error.		Replace the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.

Digital Operator Display		Error Name
Er-13	Er-13	Leakage Inductance Error
Cause		**Possible Solutions**
Drive was unable to complete tuning for leakage inductance within 300 seconds.		• Check all wiring and correct any mistakes. • Check the motor rated current value written on the motor nameplate and enter the correct value to T1-04.

Digital Operator Display		Error Name
Er-17	Er-17	Reverse Prohibited Error
Cause		**Possible Solutions**
Drive is prohibited from rotating the motor in reverse while attempting to perform Inertia Tuning.		• Inertia Auto-Tuning cannot be performed if the drive is restricted from rotating in reverse. • Assuming it is acceptable for the application to rotate in reverse, set b1-04 to 0 and then perform Inertia Tuning.

6.8 Copy Function Related Displays

◆ Tasks, Errors, and Troubleshooting

The table below lists the messages and errors that may appear when using the Copy function.

When executing the tasks offered by the Copy function, the operator will indicate the task being performed. When an error occurs, a code appears on the operator to indicate the error. Note that errors related to the Copy function do not trigger a multi-function output terminal that has been set up to close when a fault or alarm occurs. To clear an error, simply press any key on the operator and the error display will disappear.

Table 6.13 lists the corrective action that can be taken when an error occurs.

Note:
1. Whenever using the copy function, the drive should be fully stopped.
2. The drive will not accept a Run command while the Copy function is being executed.
3. Parameters can only be saved to a drive when the voltage class, capacity, control mode, and software version match.

Table 6.13 Copy Function Task and Error Displays

Digital Operator Display		Task
CoPy	CoPy	Writing Parameter Settings (flashing)
Cause		**Possible Solutions**
Parameters are being written to the drive.		This is not an error.

Digital Operator Display		Task
CPyE	CPyE	Error Writing Data
Cause		**Possible Solutions**
Failed writing parameters		Attempt to write parameters again.

Digital Operator Display		Task
CSEr	CSEr	Copy Unit Error
Cause		**Possible Solutions**
Hardware fault		Replace the operator or the USB Copy Unit.

Digital Operator Display		Task
dFPS	dFPS	Drive Model Mismatch
Cause		**Possible Solutions**
The drives used in the copy and write process are not the same model. • The drive from which the parameters were copied is a different model. • The drive to be written to is a different model.		• Verify the model number of the drive from which the parameters were copied and the model of the drive to which those parameters will be written. • Make sure the two drives are the same model and have the same software version.

Digital Operator Display		Task
End	End	Task Complete
Cause		**Possible Solutions**
Finished reading, writing, or verifying parameters.		This is not an error.

Digital Operator Display		Task
iFEr	iFEr	Communication Error
Cause		**Possible Solutions**
A communication error occurred between the drive and the operator or the USB copy unit.		Check the cable connection.
A non-compatible cable is being used to connect the USB Copy Unit and the drive.		Use the cable originally packaged with the USB Copy Unit.

Digital Operator Display		Task
ndAT	ndAT	Model, Voltage Class, Capacity Mismatch
Cause		**Possible Solutions**

The drive from which the parameters were copied and the drive to which the parameters will be written have different electrical specifications, capacities, are set to different control modes, or are different models.	Make sure model numbers and specifications are the same for both drives.
The device being used to write the parameters is blank and does not have any parameters saved on it.	Make sure all connections are correct, and copy the parameter settings onto the USB Copy Unit or the operator.

Digital Operator Display		Task
rdEr	rdEr	Error Reading Data
Cause		**Possible Solutions**
Failed while attempting to read parameter settings from the drive.		Press and hold the READ key on the USB Copy Unit for at least one second to have the unit read parameters from the drive.

Digital Operator Display		Task
rEAd	rEAd	Reading Parameter Settings (flashing)
Cause		**Possible Solutions**
Displayed while the parameter settings are being read onto the USB Copy Unit.		This is not an error.

Digital Operator Display		Task
vAEr	vAEr	Voltage Class, Capacity Mismatch
Cause		**Possible Solutions**
The drive from which the parameters were copied and the drive on which the Verify mode is being performed have different electrical specifications or are a different capacity.		Make sure electrical specifications and capacities are the same for both drives.

Digital Operator Display		Task
vFyE	vFyE	Parameter settings in the drive and those saved to the copy function are not the same
Cause		**Possible Solutions**
Indicates that parameter settings that have been Read and loaded onto the Copy Unit or Digital Operator are different.		To synchronize parameters, either write the parameters saved on the USB Copy Unit or digital operator onto the drive, or Read the parameter settings on the drive onto the USB Copy Unit.

Digital Operator Display		Task
vrFy	vrFy	Comparing Parameter Settings (flashing)
Cause		**Possible Solutions**
The Verify mode has confirmed that parameters settings on the drive and parameters read to the copy device are identical.		This is not an error.

6.9 Diagnosing and Resetting Faults

When a fault occurs and the drive stops, follow the instructions below to remove whatever conditions triggered the fault, then restart the drive.

Note: An oC/SC fault will be displayed in the event of an IGBT failure. It may not be possible to reset this fault until the IGBT problem is corrected.

◆ Fault Occurs Simultaneously with Power Loss

WARNING! *Electrical Shock Hazard. Ensure there are no short circuits between the main circuit terminals (R/L1, S/L2, and T/L3) or between the ground and main circuit terminals before restarting the drive. Failure to comply may result in serious injury or death and will cause damage to equipment.*

1. Turn on the drive input power.
2. Use monitor parameters U2-□□ to display data on the operating status of the drive just before the fault occurred.
3. Remove the cause of the fault and reset.

Note:
1. To find out what faults were triggered, check the fault history in U2-02. Information on drive status when the fault occurred such as the frequency, current, and voltage can be found in U2-03 through U2-20. ***Refer to Viewing Fault Trace Data After Fault on page 310*** for information on how to view fault data.
2. When the fault continues to be displayed after cycling power, remove the cause of the fault and reset.

◆ If the Drive Still has Power After a Fault Occurs

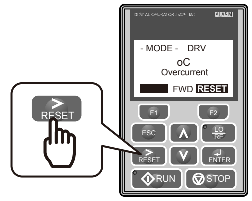
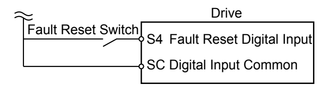
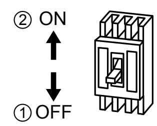
1. Look at the digital operator for information on the fault that occurred.
2. ***Refer to Fault Displays, Causes, and Possible Solutions on page 281***.
3. Reset the fault. ***Refer to Fault Reset Methods on page 311***.

◆ Viewing Fault Trace Data After Fault

	Step		Display/Result
1.	Turn on the drive input power. The first screen displays.	→	- MODE - DRV Rdy FREF (OPR) U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV
2.	Press ∧ or ∨ until the monitor screen is displayed.	→	- MODE - DRV Rdy Monitor Menu U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV
3.	Press ENTER to display the parameter setting screen.	→	-MONITR- DRV Rdy Monitor U1-01= 0.00Hz U1-02= 0.00Hz LSEQ U1-03= 0.00A LREF JOG FWD FWD/REV
4.	Press ∧ and RESET to scroll to monitor U2-02. The fault code shown in U2-02 is the fault that occurred most recently.	→	- MONITR - DRV Rdy Last Fault U2-02= oC U2-03= 0.00Hz LSEQ U2-04= 0.00Hz LREF JOG FWD FWD/REV
5.	Press ∧ to view drive status information when fault occurred. Parameters U2-03 through U2-20 help determine the cause of a fault. Parameters to be monitored differ depending on the control mode.	→	- MONITR - DRV Rdy Frequency Ref U2-03= 0.00Hz U2-04= 0.00Hz LSEQ U2-05= 0.00A LREF JOG FWD FWD/REV ⋮ - MONITR - DRV Rdy Heatsink Temp U2-20= XX °C U2-01= ----- LSEQ U2-02= ----- LREF JOG FWD FWD/REV

◆ Fault Reset Methods

When a fault occurs, the cause of the fault must be removed and the drive must be restarted. The table below lists the different ways to restart the drive.

After the Fault Occurs	Procedure	
Fix the cause of the fault, restart the drive, and reset the fault	Press RESET on the digital operator when the error code is displayed.	
Resetting via Fault Reset Digital Input S4	Close then open the fault signal digital input via terminal S4. S4 is set for “Fault Reset” as default (H1-04 = 14).	
Turn off the main power supply if the above methods do not reset the fault. Reapply power after the digital operator display has turned off.		

Note: If the Run command is present, the drive will disregard any attempts to reset the fault. Remove the Run command before attempting to clear a fault situation.

6.10 Troubleshooting without Fault Display

This section describes troubleshooting problems that do not trip an alarm or fault.

The following symptoms indicate that the drive is not set correctly for proper performance with the motor. ***Refer to Motor Performance Fine-Tuning on page 276*** for guidance on troubleshooting.

- Motor hunting and oscillation
- Poor motor torque
- Poor speed precision
- Poor motor torque and speed response
- Motor noise

◆ Common Problems

Common Problems		Page
Cannot Change Parameter Settings		312
Motor Does Not Rotate Properly after Pressing RUN Button or after Entering External Run Command	Motor Does Not Rotate	313
	Motor Rotates in the Opposite Direction from the Run Command	314
	Motor Rotates in One Direction Only	314
Motor is Too Hot		314
oPE02 Error Occurs When Lowering the Motor Rated Current Setting		315
Motor Stalls During Acceleration or With Large Loads		315
Drive Frequency Reference Differs from the Controller Frequency Reference Command		316
Excessive Motor Oscillation and Erratic Rotation		316
Deceleration Takes Longer Than Expected with Dynamic Braking Enabled		316
Noise From Drive or Motor Cables When the Drive is Powered On		317
Ground Fault Circuit Interrupter (GFCI) Trips During Run		317
Connected Machinery Vibrates When Motor Rotates	Unexpected Noise from Connected Machinery	317
	Oscillation or Hunting	317
PID Output Fault		318
Insufficient Starting Torque		318
Motor Rotates After the Drive Output is Shut Off (Motor Rotates During DC Injection Braking)		318
Output Frequency is not as High as Frequency Reference		318
Buzzing Sound from Motor at 2 kHz		318
Motor Does Not Restart after Power Loss		319

◆ Cannot Change Parameter Settings

Cause	Possible Solutions
The drive is running the motor (i.e., the Run command is present).	• Stop the drive and switch over to the Programming Mode. • Most parameters cannot be edited during run.
The Access Level is set to restrict access to parameter settings.	• Set the Access Level to allow parameters to be edited (A1-01 = 2).
The operator is not in the Parameter Setup Mode (the screen will display “PAr”).	• See what mode the operator is currently set for. • Parameters cannot be edited when in the Setup Mode (“STUP”). Switch modes so that “PAr” appears on the screen. ***Refer to The Drive, Programming, and Clock Adjustment Modes on page 104***.
A multi-function contact input terminal is set to allow or restrict parameter editing (H1-01 through H1-08 = 1B).	• When the terminal is open, parameters cannot be edited. • Turn on the multi-function contact input set to 1B.

Cause	Possible Solutions
The wrong password was entered.	• If the password entered to A1-04 does not match the password saved to A1-05, then drive settings cannot be changed. • Reset the password. If you cannot remember the password: • Scroll to A1-04. Press STOP and ∧ simultaneously. Parameter A1-05 will appear. • Set a new password to parameter A1-05.
Undervoltage was detected.	• Check the drive input power voltage by looking at the DC bus voltage (U1-07). • Check all main circuit wiring.

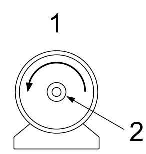
◆ Motor Does Not Rotate Properly after Pressing RUN Button or after Entering External Run Command

■ Motor Does Not Rotate

Cause	Possible Solutions
The drive is not in the Drive Mode.	• Check if the DRV light on the digital operator is lit. • Enter the Drive Mode to begin operating the motor. ***Refer to The Drive, Programming, and Clock Adjustment Modes on page 104***.
LO/RE was pushed.	Stop the drive and check if the correct frequency reference source is selected. If the operator keypad shall be the source, the LO/RE button LED must be on. If the source is REMOTE, it must be off. Take the following steps to solve the problem: • Push LO/RE. • If o2-01 is set to 0, then the LO/RE button will be disabled.
Auto-Tuning has just completed.	• When Auto-Tuning completes, the drive is switched back to the Programming Mode. The Run command will not be accepted unless the drive is in the Drive Mode. • Use the digital operator to enter the Drive Mode. ***Refer to The Drive, Programming, and Clock Adjustment Modes on page 104***.
A Fast Stop was executed and has not yet been reset.	Reset the Fast Stop command.
Settings are incorrect for the source that provides the Run command.	Check parameter b1-02 (Run Command Selection). Set b1-02 so that it corresponds with the correct Run command source. 0: Digital operator 1: Control circuit terminal (default setting) 2: MEMOBUS/Modbus communications 3: Option card
There is faulty wiring in the control circuit terminals.	• Check the wiring for the control terminal. • Correct wiring mistakes. • Check the input terminal status monitor (U1-10).
The drive has been set to accept the frequency reference from the incorrect source.	Check parameter b1-01 (Frequency Reference Selection 1). Set b1-01 to the correct source of the frequency reference. 0: Digital operator 1: Control circuit terminal (default setting) 2: MEMOBUS/Modbus communications 3: Option card 4: Pulse train input (RP)
The terminal set to accept the main speed reference is set to the incorrect voltage and/or current.	***Refer to Terminals A1, A2, and A3 Input Signal Selection on page 92***.
Selection for the sink/source mode and the internal/external power supply is incorrect.	Check jumper S3. ***Refer to Sinking/Sourcing Mode Switch for Digital Inputs on page 92***.
Frequency reference is too low.	• Check the frequency reference monitor (U1-01). • Increase the frequency by changing the maximum output frequency (E1-09).
Multi-function analog input is set up to accept gain for the frequency reference, but no voltage (current) has been provided.	• Check the multi-function analog input settings. • Check if analog input A1, A2, or A3 is set for frequency reference gain (H3-02, H3-10, H3-06 = 1). If so, check if the correct signal is applied to the terminal. The gain and the frequency reference will be 0 if no signal is applied to the gain input. • Check if H3-02, H3-10, and H3-06 have been set to the proper values. • Check if the analog input value has been set properly. (U1-13 to U1-15)

Cause	Possible Solutions
STOP was pressed when the drive was started from a REMOTE source.	• Pressing STOP will decelerate the drive to stop. • Switch off the Run command and then re-enter a new Run command. • Set o2-02 to 0 to disable STOP.
Motor starting torque is too low.	*Refer to Motor Performance Fine-Tuning on page 276.*
Frequency reference value is too low or the drive does not accept the value entered.	Enter a value that is above the minimum output frequency determined by E1-09.
The sequence Start/Stop sequence is set up incorrectly.	• If the drive is supposed to be set up for a 2-wire sequence, then ensure parameters H1-03 through H1-08 are not set to 0. • If the drive is supposed to be set up for a 3-wire sequence, then one of the parameters H1-03 through H1-08 must be set to 0. Terminal S1 will become the Start, terminal S2 will become the Stop input.

■ Motor Rotates in the Opposite Direction from the Run Command

Cause	Possible Solutions
Phase wiring between the drive and motor is incorrect.	• Check the motor wiring. • Switch two motor cables (U, V, and W) to reverse motor direction. • Connect drive output terminals U/T1, V/T2, and W/T3 in the right order to match motor terminals U, V, and W. • Change the setting of parameter b1-14.
The forward direction for the motor is set up incorrectly.	Typically, forward is designated as being counterclockwise when looking from the motor shaft (see figure below).  1. Forward Rotating Motor (looking down the motor shaft) 2. Motor Shaft
The motor is running at almost 0 Hz and the Speed Search estimated the speed to be in the opposite direction.	• Disable bi-directional search (b3-14 = 0) so that Speed Search is performed only in the specified direction.

Note: Check the motor specifications for the forward and reverse directions. The motor specifications will vary depending on the manufacturer of the motor.

■ Motor Rotates in One Direction Only

Cause	Possible Solutions
The drive prohibits reverse rotation.	• Check parameter b1-04. • Set parameter b1-04 to 0 to allow the motor to rotate in reverse.
A Reverse run signal has not been entered, although 3-Wire sequence is selected.	• Make sure that one of the input terminals S3 to S8 used for the 3-Wire sequence has been set for reverse.

◆ Motor is Too Hot

Cause	Possible Solutions
The load is too heavy.	If the load is too heavy for the motor, the motor will overheat as it exceeds its rated torque value for an extended period of time. Keep in mind that the motor also has a short-term overload rating in addition to the possible solutions provided below: • Reduce the load. • Increase the acceleration and deceleration times. • Check the values set for the motor protection (L1-01, L1-02) as well as the motor rated current (E2-01). • Increase motor capacity.
The air around the motor is too hot.	• Check the ambient temperature. • Cool the area until it is within the specified temperature range.
The drive is operating in a vector control mode but Auto-Tuning has not yet been performed.	• Perform Auto-Tuning. • Calculate the motor value and reset the motor parameters.

Cause	Possible Solutions
Insufficient voltage insulation between motor phases.	When the motor cable is long, high voltage surges occur between the motor coils and drive switching. Normally, surges can reach up to three times the drive input power supply voltage. • Use a motor with a voltage tolerance higher than the max voltage surge. • Use an inverter-duty motor rated for use with AC drives when using the motor on drives rated higher than 200 V class. • Install an AC reactor on the output side of the drive. The carrier frequency should be set to 2 kHz when installing an AC reactor.
The motor fan has stopped or is clogged.	Check the motor fan.
The carrier frequency is too low.	Increase the carrier frequency to lower the current harmonic distortion and lower the motor temperature.

◆ oPE02 Error Occurs When Lowering the Motor Rated Current Setting

Cause	Possible Solutions
Motor rated current and the motor no-load current setting in the drive are incorrect.	• The user is trying to set the motor rated current in E2-01 to a value lower than the no-load current set in E2-03. • Make sure that value set in E2-01 is higher than E2-03. • If it is necessary to set E2-01 lower than E2-03, first lower the value set to E2-03, then change the setting in E2-01 as needed.

◆ Motor Stalls during Acceleration or Acceleration Time is Too Long

Cause	Possible Solutions
Torque limit has been reached or current suppression keeps the drive from accelerating.	Take the following steps to resolve the problem: • Reduce the load. • Increase motor capacity. **Note:** Although the drive has a Stall Prevention function and a Torque Compensation Limit function, accelerating too quickly or trying to drive an excessively large load can exceed the capabilities of the motor.
Load is too heavy.	
Torque limit is not set properly.	Check the torque limit setting.
Frequency reference is too low.	• Check the maximum output frequency (E1-04). • Increase E1-04 if it is set too low.
	Check U1-01 for proper frequency reference.
	Check if a frequency reference signal switch has been set to one of the multi-function input terminals.
	Check for low gain level set to terminals A1, A2, or A3 (H3-03, H3-11, H3-07).
Load is too heavy.	• Reduce the load so that the output current remains within the motor rated current. • In extruder and mixer applications, the load will sometimes increase as the temperature drops.
	• Increase the acceleration time. • Check if the mechanical brake is fully releasing as it should.
Acceleration time has been set too long.	Check if the acceleration time parameters have been set too long (C1-01, C1-03).
Motor characteristics and drive parameter settings are incompatible with one another.	• Set the correct V/f pattern so that it matches the characteristics of the motor being used. • Check the V/f pattern set to E1-03. • Execute Rotational Auto-Tuning.
Incorrect frequency reference setting.	• Check the multi-function analog input settings. Multi-function analog input terminal A1, A2, or A3 is set for frequency gain (H3-02, H3-10, or H3-06 is set to “1”), but there is no voltage or current input provided. • Make sure H3-02, H3-10, and H3-06 are set to the proper values. • See if the analog input value is set to the right value (U1-13 to U1-15).
The Stall Prevention level during acceleration and deceleration set too low.	• Check the Stall Prevention level during acceleration (L3-02). • If L3-02 is set too low, acceleration may be taking too long. • Increase L3-02.
The Stall Prevention level during run has been set too low.	• Check the Stall Prevention level during run (L3-06). • If L3-06 is set too low, speed will drop as the drive outputs torque. • Increase the setting value.

Cause	Possible Solutions
Drive reached the limitations of the V/f motor control method.	• The motor cable may be long enough (over 50 m) to require Auto-Tuning for line-to-line resistance. • Be aware that V/f Control is comparatively limited when it comes to producing torque at low speeds.

◆ Drive Frequency Reference Differs from the Controller Frequency Reference Command

Cause	Possible Solutions
The analog input gain and bias for the frequency reference input are set to incorrect values.	• Check the gain and bias settings for the analog inputs that are used to set the frequency reference. Check parameters H3-03 and H3-04 for input A1, check parameters H3-11 and H3-12 for input A2, and check parameters H3-07 and H3-08 for input A3. • Set these parameters to the appropriate values.
A frequency bias signal is being entered via analog input terminals A1 to A3.	• If more than one of multi-function analog inputs A1 to A3 is set for frequency reference bias (H3-02, H3-10, or H3-06 is set to “0”), then the sum of all signals builds the frequency reference. • Make sure that H3-02, H3-10, and H3-06 are set appropriately. • Check the input level set for terminals A1 to A3 (U1-13 to U1-15).
PID control is enabled, and the drive is consequently adjusting the output frequency to match the PID setpoint. The drive will only accelerate to the maximum output frequency set in E1-04 while PID control is active.	If PID control is not necessary for the application, disable it by setting b5-01 to 0.

◆ Excessive Motor Oscillation and Erratic Rotation

Cause	Possible Solutions
Poor balance between motor phases.	Check drive input power voltage to ensure that it provides stable power.
Hunting prevention function is disabled.	• Enable Hunting Prevention (n1-01 = 1). • Increase the AFR gain (n2-01) or the AFR time constant (n2-02).

◆ Deceleration Takes Longer Than Expected with Dynamic Braking Enabled

Cause	Possible Solutions
L3-04 is set incorrectly.	• Check the Stall Prevention level during deceleration (L3-04). • If a dynamic braking option has been installed, disable Stall Prevention during deceleration (L3-04 = 0).
The deceleration time is set too long.	Set deceleration to more appropriate time (C1-02, C1-04).
Insufficient motor torque.	• Assuming parameter settings are normal and that no overvoltage occurs when there is insufficient torque, it is likely that the demand on the motor has exceeded the motor capacity. • Use a larger motor.
Reaching the torque limit.	• Check the settings for the torque limit (L7-01 through L7-04). • If the torque limit is enabled, deceleration might take longer than expected because the drive cannot output more torque than the limit setting. Ensure the torque limit is set to a high enough value. • Increase the torque limit setting.
	• If multi-function analog input terminal A1, A2, or A3 is set to torque limit (H3-02, H3-10, or H3-06 equals 10, 11, 12, or 15), ensure that the analog input levels are set to the correct levels. • Ensure H3-02, H3-10, and H3-06 are set to the right levels. • Ensure the analog input is set to the correct value (U1-13 to U1-15).
Load exceeded the internal torque limit determined by the drive rated current.	Switch to a larger capacity drive.

◆ Noise From Drive or Motor Cables When the Drive is Powered On

Cause	Possible Solutions
Relay switching in the drive generates excessive noise.	• Lower the carrier frequency (C6-02). • Install a noise filter on the input side of drive input power. • Install a noise filter on the output side of the drive. • Place the wiring inside a metal conduit to shield it from switching noise. • Ground the drive and motor properly. • Separate the main circuit wiring and the control lines. • Make sure wires and the motor have been properly grounded.

◆ Ground Fault Circuit Interrupter (GFCI) Trips During Run

Cause	Possible Solutions
Excessive leakage current trips GFCI.	• Check the wiring and rating of peripheral devices. • Increase the GFCI sensitivity or use GFCI with a higher threshold. • Lower the carrier frequency (C6-02). • Reduce the length of the cable used between the drive and the motor. • Install a noise filter or reactor on the output side of the drive. Set the carrier frequency to 2 kHz when connecting a reactor. • Disable the internal EMC filter.

◆ Connected Machinery Vibrates When Motor Rotates

■ Unexpected Noise from Connected Machinery

Cause	Possible Solutions
The carrier frequency is at the resonant frequency of the connected machinery.	Adjust the carrier frequency using parameters C6-02 through C6-05.
The drive output frequency is the same as the resonant frequency of the connected machinery.	• Adjust the parameters used for the Jump frequency function (d3-01 through d3-04) to skip the problem-causing bandwidth. • Place the motor on a rubber pad to reduce vibration.

Note: The drive may have trouble assessing the status of the load due to white noise generated from using Swing PWM (C6-02 = 7 to A).

■ Oscillation or Hunting

Cause	Possible Solutions
Insufficient tuning.	Perform Auto-Tuning. *Refer to Motor Performance Fine-Tuning on page 276*.
Gain is too low when using PID control.	*Refer to b5: PID Control on page 149* for details.
The frequency reference is assigned to an external source and the signal is noisy.	• Ensure that noise is not affecting the signal lines. • Separate main circuit wiring and control circuit wiring. • Use twisted-pair cables or shielded wiring for the control circuit. • Increase the analog input time filter constant (H3-13).
The cable between the drive and motor is too long.	• Perform Auto-Tuning. • Reduce the length of the cable.

◆ PID Output Fault

Cause	Possible Solutions
No PID feedback input.	• Check the multi-function analog input terminal settings. • Set multi-function analog input terminal A1, A2, or A3 for PID feedback (H3-02, H3-10, or H3-06 = “B”). • A signal input to the terminal selection for PID feedback is needed. • Check the connection of the feedback signal. • Check the various PID-related parameter settings. • No PID feedback input to the terminal causes the value detected to be 0, causing a PID fault and the drive to operate at max frequency.
The level of detection and the target value do not correspond with each other.	• PID control keeps the difference between target and detection values at 0. Set the input level for the values relative to one another. • Use analog input gains H3-03 and H3-11 to adjust PID target and feedback signal scaling.
Reverse drive output frequency and speed detection. When output frequency rises, the sensor detects a speed decrease.	Set PID output for reverse characteristics (b5-09 = 1).
Adjustment made to PID parameter settings are insufficient.	***Refer to b5: PID Control on page 149*** for details.

◆ Insufficient Starting Torque

Cause	Possible Solutions
Auto-Tuning has not yet been performed.	Perform Auto-Tuning. ***Refer to Motor Performance Fine-Tuning on page 276***.
Only Stationary Auto-Tuning was performed.	Perform Rotational Auto-Tuning.

◆ Motor Rotates After the Drive Output is Shut Off (Motor Rotates During DC Injection Braking)

Cause	Possible Solutions
DC Injection Braking is set too low and the drive cannot decelerate properly.	• Adjust the DC Injection braking settings. • Increase the current level for DC Injection Braking (b2-02). • Increase the DC Injection Braking time at stop (b2-04).
The stopping method is set so that the drive coasts to stop.	Set b1-03 (Stopping Method Selection) to 0 or 2.

◆ Output Frequency is Not as High as Frequency Reference

Cause	Possible Solutions
Frequency reference is set within the range of the Jump frequency.	• Adjust the parameters used for the Jump frequency function (d3-01, d3-02, d3-03). • Enabling the Jump frequency prevents the drive from outputting the frequencies specified in the Jump range.
Upper limit for the frequency reference has been exceeded.	• Set the maximum output frequency and the upper limit for the frequency reference to more appropriate values (E1-04, d2-01). • The following calculation yields the upper value for the output frequency: E1-04 x d2-01 / 100
Large load triggered Stall Prevention function during acceleration.	• Reduce the load. • Adjust the Stall Prevention level during acceleration (L3-02).

◆ Sound from Motor

Cause	Possible Solutions
Exceeded 110% of the rated output current of the drive while operating at low speeds.	• If the output current rises too high at low speeds, the carrier frequency is automatically reduced and causes a whining or buzzing sound. • If the sound is coming from the motor, disable carrier frequency derating (L8-38 = 0). • Disabling the automatic carrier frequency derating increases the chances of an overload fault (oL2). Switch to a larger capacity motor if oL2 faults occur too frequently.

◆ Motor Does Not Restart after Power Loss

Cause	Possible Solutions
The Run command was not issued again when power was restored.	• Check the sequence and wiring that has been set up to enter the Run command. • A relay should be set up to make sure the Run command remains enabled throughout any power loss.
The relay that is supposed to maintain the Run command has been switched off.	Check wiring and circuitry for the relay intended to keep the Run command enabled.

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7

Periodic Inspection & Maintenance

This chapter describes the periodic inspection and maintenance of the drive to ensure that it receives the proper care to maintain overall performance.

7.1 Section Safety

WARNING

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply could result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label; after all indicators are OFF, measure for unsafe voltages to confirm the drive is safe prior to servicing.

Do not operate equipment with covers removed.

Failure to comply could result in death or serious injury.

The diagrams in this section may show drives without covers or safety shields to show details. Be sure to reinstall covers or shields before operating the drives and run the drives according to the instructions described in this manual.

Always ground the motor-side grounding terminal.

Improper equipment grounding could result in death or serious injury by contacting the motor case.

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Do not allow unqualified personnel to perform work on the drive.

Failure to comply could result in death or serious injury.

Installation, maintenance, inspection, and servicing must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of AC drives.

Do not perform work on the drive while wearing loose clothing, jewelry or without eye protection.

Failure to comply could result in death or serious injury.

Remove all metal objects such as watches and rings, secure loose clothing, and wear eye protection before beginning work on the drive.

Do not touch any terminals before the capacitors have fully discharged.

Failure to comply could result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label; after all indicators are OFF, measure the DC bus voltage level to confirm it has reached a safe level.

Fire Hazard

Tighten all terminal screws to the specified tightening torque.

Loose electrical connections could result in death or serious injury by fire due to overheating of electrical connections.

Do not use an improper voltage source.

Failure to comply could result in death or serious injury by fire.

Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.

Do not use improper combustible materials.

Failure to comply could result in death or serious injury by fire.

Attach the drive to metal or other noncombustible material.

NOTICE

Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards.

Failure to comply may result in ESD damage to the drive circuitry.

Follow cooling fan replacement instructions. The cooling fan cannot operate properly when it is installed incorrectly and could seriously damage the drive.

Follow the instructions in this manual to replace the cooling fan, making sure that the label is on top before inserting the cooling fan into the drive. To ensure maximum useful product life, replace both cooling fans when performing maintenance.

Never connect or disconnect the motor from the drive while the drive is outputting voltage.

Improper equipment sequencing could result in damage to the drive.

Do not use unshielded cable for control wiring.

Failure to comply may cause electrical interference resulting in poor system performance. Use shielded, twisted-pair wires and ground the shield to the ground terminal of the drive.

Do not allow unqualified personnel to use the product.

Failure to comply could result in damage to the drive or braking circuit.

Maintenance, inspection, and replacement of parts must be performed only by authorized personnel familiar with installation, adjustment and maintenance of AC drives.

Do not modify the drive circuitry.

Failure to comply could result in damage to the drive and will void warranty.

Yaskawa is not responsible for any modification of the product made by the user. This product must not be modified.

Check all the wiring to ensure that all connections are correct after installing the drive and connecting any other devices.

Failure to comply could result in damage to the drive.

Comply with proper wiring practices.

The motor may run in reverse if the phase order is backward.

Connect motor input terminals U, V and W to drive output terminals U/T1, V/T2, and W/T3. The phase order for the drive and motor should match.

Frequently switching the drive power supply to stop and start the motor can damage the drive.

To get the full performance life out of the electrolytic capacitors and circuit relays, refrain from switching the drive power supply off and on more than once every 30 minutes. Frequent use can damage the drive. Use the drive to stop and start the motor.

Do not operate damaged equipment.

Failure to comply could result in further damage to the equipment.

Do not connect or operate any equipment with visible damage or missing parts.

7.2 Inspection

Power electronics have limited life and may exhibit changes in characteristics or performance deterioration after years of use under normal conditions. To help avoid such problems, it is important to perform preventive maintenance and periodic inspection on the drive.

Drives contain a variety of power electronics such as power transistors, semiconductors, capacitors, resistors, fans, and relays. The electronics in the drive serve a critical role in maintaining proper motor control.

Follow the inspection lists provided in this chapter as a part of a regular maintenance program.

Note: The drive will require more frequent inspection if it is placed in harsh environments, such as:

- High ambient temperatures
- Frequent starting and stopping
- Fluctuations in the AC supply or load
- Excessive vibrations or shock loading
- Dust, metal dust, salt, sulfuric acid, chlorine atmospheres
- Poor storage conditions.

Perform the first equipment inspection one to two years after installation.

◆ Recommended Daily Inspection

Table 7.1 outlines the recommended daily inspection for Yaskawa drives. Check the following items on a daily basis to avoid premature deterioration in performance or product failure. Copy this checklist and mark the “Checked” column after each inspection.

Table 7.1 General Recommended Daily Inspection Checklist

Inspection Category	Inspection Points	Corrective Action	Checked
Motor	Inspect for abnormal oscillation or noise coming from the motor.	• Check the load coupling. • Measure motor vibration. • Tighten all loose components.	
Cooling	Inspect for abnormal heat generated from the drive or motor and visible discoloration.	Check for the following: • Excessive load. • Loose connections. • Dirty heatsink or motor. • Ambient temperature.	
	Inspect drive cooling fan and circulation fan operation.	Check for the following: • Clogged or dirty fan. • Correct Fan operation parameter setting.	
Environment	Verify the drive environment complies with the specifications listed in *Installation Environment* on page *46*.	Eliminate the source of contaminants or correct poor environment.	
Load	The drive output current should not be higher than the motor or drive rating for an extended period of time.	Check for the following: • Excessive load. • Correct motor parameter settings.	
Power Supply Voltage	Check main power supply and control voltages.	• Correct the voltage or power supply to within nameplate specifications. • Verify all main circuit phases.	

◆ Recommended Periodic Inspection

Table 7.2 outlines the recommended periodic inspections for Yaskawa drive installations. Although periodic inspections should generally be performed once a year; the drive may require more frequent inspection in harsh environments or with rigorous use. Operating and environmental conditions, along with experience in each application, will determine the actual inspection frequency for each installation. Periodic inspection will help to avoid premature deterioration in performance or product failure. Copy this checklist and mark the "Checked" column after each inspection.

■ Periodic Inspection

WARNING! *Electrical Shock Hazard. Do not inspect, connect, or disconnect any wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label; after all indicators are OFF, measure for unsafe voltages to confirm the drive is safe prior to servicing.*

Table 7.2 Periodic Inspection Checklist

Inspection Area	Inspection Points	Corrective Action	Checked
Main Circuit Periodic Inspection			
General	• Inspect equipment for discoloration from overheating or deterioration. • Inspect for damaged or deformed parts.	• Replace damaged components as required. • The drive has few serviceable parts and may require complete drive replacement.	
	Inspect for dirt, foreign particles, or dust collection on components.	• Inspect enclosure door seal if used. • Use dry air to clear away foreign matter. Use a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 - 6 kg•cm^2) (57 to 85 psi). • Replace components if cleaning is not possible.	
Conductors and Wiring	• Inspect wiring and connections for discoloration, damage, or heat stress. • Inspect wire insulation and shielding for wear.	Repair or replace damaged wiring.	
Terminals	Inspect terminals for stripped, damaged, or loose connections.	Tighten loose screws and replace damaged screws or terminals.	
Relays and Contactors	• Inspect contactors and relays for excessive noise during operation. • Inspect coils for signs of overheating such as melted or cracked insulation.	• Check coil voltage for overvoltage or undervoltage conditions. • Replace damaged removable relays, contactors, or circuit board.	
Braking Resistors	Inspect for discoloration of heat stress on or around resistors.	• Minor discoloration may be acceptable. • Check for loose connections if discoloration exists.	
Electrolytic Capacitor	• Inspect for leaking, discoloration, or cracks. • Check if the cap has come off, for any swelling, or if the sides have burst open.	The drive has few serviceable parts and may require complete drive replacement.	
Diode, IGBT (Power Transistor)	Inspect for dust or other foreign material collected on the surface.	Use dry air to clear away foreign matter. Use a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 - 6 kg•cm^2) (57 to 85 psi).	
Motor Periodic Inspection			
Operation Check	Check for increased vibration or abnormal noise.	Stop the motor and contact qualified maintenance personnel as required.	
Control Circuit Periodic Inspection			
General	• Inspect terminals for stripped, damaged, or loose connections. • Make sure all terminals have been properly tightened.	• Tighten loose screws and replace damaged screws or terminals. • If terminals are integral to a circuit board, then board or drive replacement may be required.	
Circuit Boards	Check for any odor, discoloration, and rust. Make sure connections are properly fastened and that no dust or oil mist has accumulated on the surface of the board.	• Fix any loose connections. • If an antistatic cloth or vacuum plunger cannot be used, replace the board. • Do not use any solvents to clean the board. • Use dry air to clear away foreign matter. Use a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 - 6 kg•cm^2) (57 to 85 psi). The drive has few serviceable parts and may require complete drive replacement.	

Inspection Area	Inspection Points	Corrective Action	Checked
Cooling System Periodic Inspection			
Cooling Fan, Circulation Fan, Control Board Cooling Fan	• Check for abnormal oscillation or unusual noise. • Check for damaged or missing fan blades.	• Replace as required. • *Refer to Drive Cooling Fans on page 329* for information on cleaning or replacing the fan.	
Heatsink	Inspect for dust or other foreign material collected on the surface.	Use dry air to clear away foreign matter. Use a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 - 6 kg•cm^2) (57 to 85 psi).	
Air Duct	Inspect air intake and exhaust openings. They must be free from obstruction and properly installed.	• Visually inspect the area. • Clear obstructions and clean air duct as required.	
Display Periodic Inspection			
Digital Operator	• Make sure data appears on the display properly. • Inspect for dust or other foreign material that may have collected on surrounding components.	• Contact the nearest sales office if there is any trouble with the display or keypad. • Clean the digital operator.	

7.3 Periodic Maintenance

The drive has Maintenance Monitors that keep track of component wear. This feature provides advance maintenance warning and eliminates the need to shut down the entire system for unexpected problems. The drive allows the user to check predicted maintenance periods for the components listed below.

- Cooling Fan, Circulation Fan, Control Board Cooling Fan
- Electrolytic Capacitors
- Inrush Prevention Circuit
- IGBTs

For replacement parts, contact the distributor where the drive was purchased or contact Yaskawa directly.

◆ Replacement Parts

Table 7.3 contains the estimated performance life of components that require replacement during the life of the drive. Only use Yaskawa replacement parts for the appropriate drive model and revision.

Table 7.3 Estimated Performance Life

Component	Estimated Performance Life
Cooling Fan, Circulation Fan	10 years
Electrolytic Capacitors	10 years <1>

<1> The drive has few serviceable parts and may require complete drive replacement.

NOTICE: *Estimated performance life based on specific usage conditions. These conditions are provided for the purpose of replacing parts to maintain performance. Some parts may require more frequent replacement due to poor environments or rigorous use.*
Usage conditions for estimated performance life:
Ambient temperature: Yearly average of 40 °C (IP00/Open Type enclosure)
Load factor: 80% maximum
Operation time: 24 hours a day

■ Performance Life Monitors Maintenance Monitors

The drive calculates the maintenance period for components that may require replacement during the life of the drive. A percentage of the maintenance period is displayed on the digital operator by viewing the appropriate monitor parameter.

When the maintenance period reaches 100%, there is increased risk that the drive may malfunction. Yaskawa recommends checking the maintenance period regularly to ensure maximum performance life.

Refer to Recommended Periodic Inspection on page 325 for more details.

Table 7.4 Performance Life Monitors Used for Component Replacement

Parameter	Component	Contents
U4-03	Cooling Fan Circulation Fan Control Board Cooling Fan	Displays the accumulated operation time of the fan from 0 to 99999 hours. This value is automatically reset to 0 after it reaches 99999.
U4-04		Displays the accumulated fan operation time as a percentage of the specified maintenance period.
U4-05	DC Bus Capacitors	Displays the accumulated time the capacitors are used as a percentage of the specified maintenance period.
U4-06	Inrush (pre-charge) Relay	Displays the number of times the drive is powered up as a percentage of the performance life of the inrush circuit.
U4-07	IGBT	Displays the percentage of the maintenance period reached by the IGBTs.

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■ Alarm Outputs for Maintenance Monitors

An output can be set up to inform the user when a specific components has neared its expected performance life.

When one of multi-function digital output terminals has been assigned the maintenance monitor function (H2-□□ = 2F), the terminal will close when the cooling fan, DC bus capacitors, or DC bus pre-charge relay reach 90% of the expected performance life, or when the IGBTs have reached 50% of their expected performance life. Additionally the digital operator will display an alarm like shown in ***Table 7.5*** to indicate the specific components that may need maintenance.

Table 7.5 Maintenance Alarms

Digital Operator Alarm Display		Function	Corrective Action
LT-1 <1>	LT-1	The cooling fans have reached 90% of their designated life time.	Replace the cooling fan.
LT-2 <1>	LT-2	The DC bus capacitors have reached 90% of their designated life time.	Contact a Yaskawa representative or the nearest Yaskawa sales office on possible drive replacement.
LT-3 <1>	LT-3	The DC bus charge circuit has reached 90% of its designated life time.	Contact a Yaskawa representative or the nearest Yaskawa sales office on possible drive replacement.
LT-4 <1>	LT-4	The IGBTs have reached 50% of their designated life time.	Check the load, carrier frequency, and output frequency.
TrPC <2>	TrPC	The IGBTs have reached 90% of their designated life time.	Contact a Yaskawa representative or the nearest Yaskawa sales office on possible drive replacement.

<1> This alarm message will be output only if the Maintenance Monitor function is assigned to one of the digital outputs (H2-□□ = 2F). The alarm will also trigger a digital output that is programmed for alarm indication (H2-□□ = 10).

<2> This alarm message will always be output, even if the Maintenance Monitor function is not assigned to any of the digital outputs (H2-□□ = 2F). The alarm will also trigger a digital output that is programmed for alarm indication (H2-□□ = 10).

■ Related Drive Parameters

Use parameters o4-03, o4-05, o4-07, and o4-09 to reset a Maintenance Monitor to zero after replacing a specific component. ***Refer to Parameter List on page 389*** for details on parameter settings.

NOTICE: *If these parameters are not reset after the corresponding parts have been replaced, the Maintenance Monitor function will continue to count down the performance life from the value that was reached with the old part. If the Maintenance Monitor is not reset, the drive will not have the correct value of the performance life for the new component.*

7.4 Drive Cooling Fans

NOTICE: *Follow cooling fan replacement instructions. The cooling fan cannot operate properly when installed incorrectly and could seriously damage the drive. To ensure maximum useful product life, replace all cooling fans when performing maintenance.*

Contact a Yaskawa representative or the nearest Yaskawa sales office to order replacement cooling fans as required.

For drives with multiple cooling fans, replace all the fans when performing maintenance to ensure maximum product performance life.

◆ Number of Cooling Fans

Drive Model	Cooling Fans	Circulation Fans	Control Board Cooling Fans	Page
Three-Phase 200 V Class				
2A0004	–	–	–	–
2A0006	–	–	–	–
2A0008	–	–	–	–
2A0010	–	–	–	–
2A0012	–	–	–	–
2A0018	1	–	–	331
2A0021	1	–	–	
2A0030	2	–	–	
2A0040	2	–	–	
2A0056	2	–	–	
2A0069	2	–	–	
2A0081	2	–	–	
2A0110	2	–	–	334
2A0138	2	–	–	
2A0169	2	–	–	338
2A0211	2	–	–	
2A0250	2	–	–	
2A0312	2	–	–	
2A0360	3	1	–	
2A0415	3	1	–	
Three-Phase 400 V Class				
4A0002	–	–	–	–
4A0004	–	–	–	–
4A0005	–	–	–	–
4A0007	1	–	–	331
4A0009	1	–	–	
4A0011	1	–	–	
4A0018	2	–	–	
4A0023	2	–	–	
4A0031	2	–	–	
4A0038	2	–	–	
4A0044	2	–	–	
4A0058	2	–	–	334
4A0072	2	–	–	
4A0088	2	–	–	336
4A0103	2	–	–	

Drive Model	Cooling Fans	Circulation Fans	Control Board Cooling Fans	Page
4A0139	2	–	–	338
4A0165	2	–	–	
4A0208	2	–	–	
4A0250	3	–	–	
4A0296	3	–	–	
4A0362	3	1	–	
4A0414	3	1	–	342
4A0515	3	2	2	344
4A0675	3	2	2	
Three-Phase 600 V Class				
5A0003	–	–	–	–
5A0004	–	–	–	–
5A0006	1	–	–	331
5A0009	1	–	–	
5A0011	2	–	–	
5A0017	2	–	–	
5A0022	2	–	–	
5A0027	2	–	–	
5A0032	2	–	–	
5A0041	2	–	–	334
5A0052	2	–	–	
5A0062	2	–	–	338
5A0077	2	–	–	
5A0099	2	–	–	
5A0125	2	–	–	
5A0145	2	–	–	
5A0192	3	–	–	
5A0242	3	1	–	

◆ Cooling Fan Component Names

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

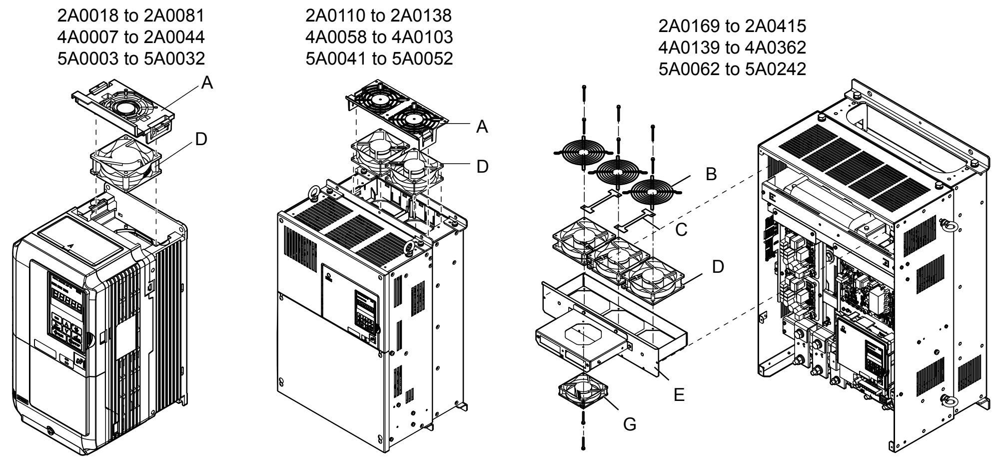
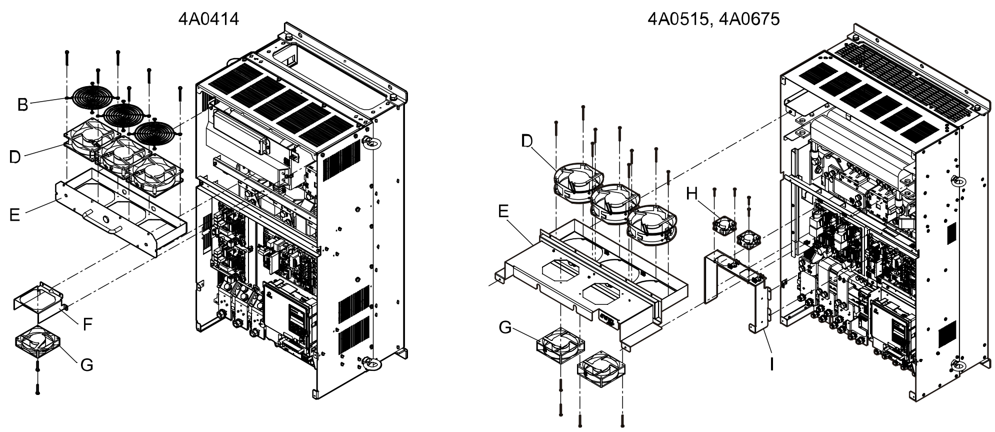


Figure 7.1 Cooling Fan Component Names



A – Fan finger guard
B – Fan guard
C – Cable cover
D – Cooling fan
E – Fan bracket
F – Circulation fan base
G – Circulation fan
H – Circuit board cooling fan
I – Circuit board cooling fan unit case

Figure 7.2 Cooling Fan Component Names (Continued)

◆ Cooling Fan Replacement: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan replacement instructions. Improper fan replacement could cause damage to equipment. Make sure the fan is facing upwards when installing the replacement fan into the drive. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing the Cooling Fan Finger Guard and Cooling Fan

1. Depress the right and left sides of the fan cover tabs and pull upward. Remove the fan cover from the top of the drive. The following figure illustrates a drive with a single cooling fan.

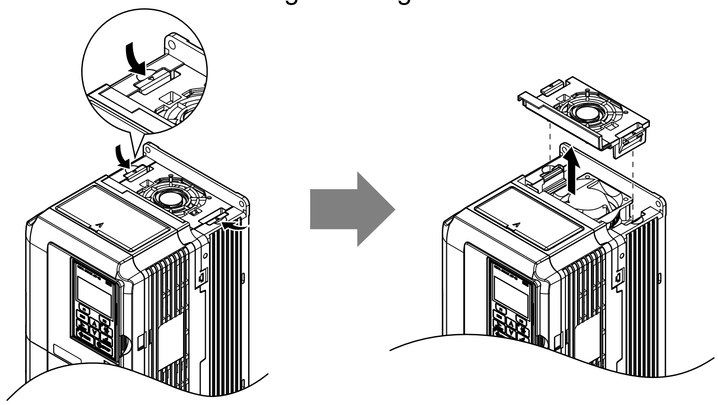


Figure 7.3 Remove the Cooling Fan Finger Guard: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

2. Remove the cooling fan cartridge. Disconnect the pluggable connector and remove the fan.

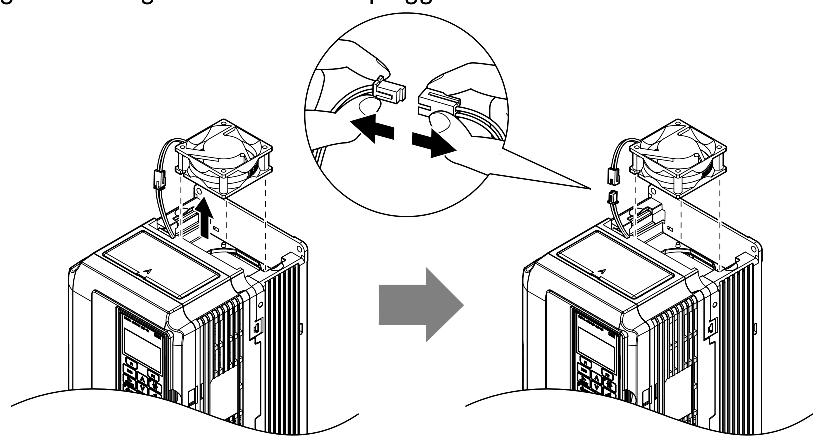


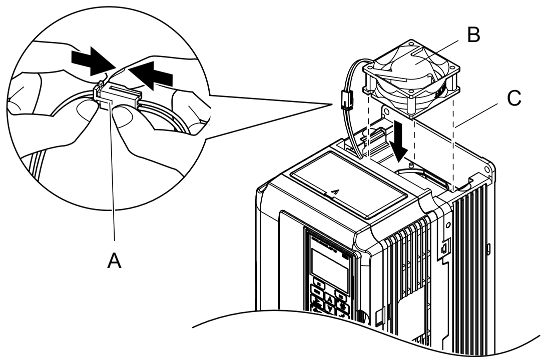
Figure 7.4 Remove the Cooling Fan: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

■ Installing the Cooling Fan

NOTICE: *Prevent Equipment Damage. Follow cooling fan replacement instructions. Improper cooling fan replacement could result in damage to equipment. When installing the replacement cooling fan into the drive, make sure the fan is facing upwards. To ensure maximum useful product life, replace all cooling fans when performing maintenance.*

Reverse the procedure described above to reinstall the cooling fan.

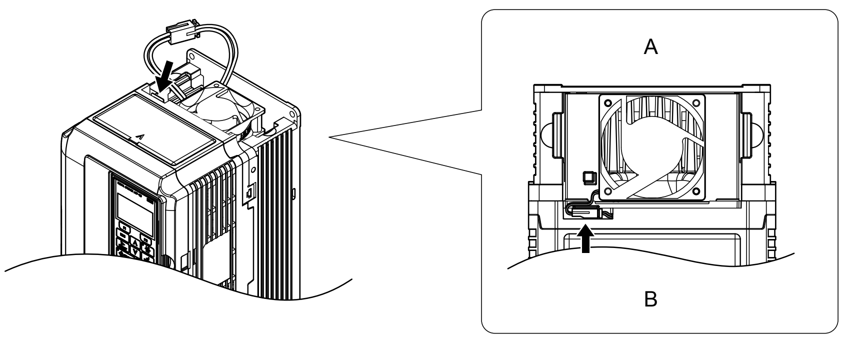
1. Install the replacement cooling fan into the drive, ensuring the alignment pins line up as shown in the figure below.



A – Push the connectors together so no space remains between them
B – Label facing up
C – Make sure the alignment pins line up properly

Figure 7.5 Install the Cooling Fan: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

2. Properly connect the fan power lines, then place the cable back into the recess of the drive.



A – Back **B – Front**

Figure 7.6 Connect the Cooling Fan Power Supply Connectors: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

3. While pressing in on the hooks on the left and right sides of the fan finger guard, guide the fan finger guard until it clicks back into place.

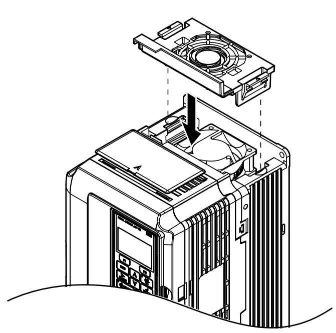


Figure 7.7 Reattach the Fan Finger Guard: 2A0018 to 2A0081, 4A0007 to 4A0044, and 5A0006 to 5A0032

4. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

◆ Cooling Fan Replacement: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan and circulation fan replacement instructions. Improper fan replacement may cause damage to equipment. When installing the replacement fan into the drive, make sure the fan is facing upwards. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing the Cooling Fan Finger Guard and Cooling Fan

1. While pressing in on the hooks located on the left and right sides of the fan finger guard, free the fan finger guard leading by lifting the back end first.

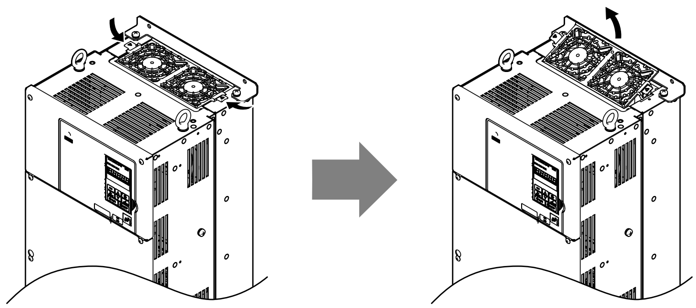


Figure 7.8 Remove the Cooling Fan Finger Guard: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

2. Lift out the back end of the fan finger guard first. Unplug the replay connector and free the fan finger guard from the drive.

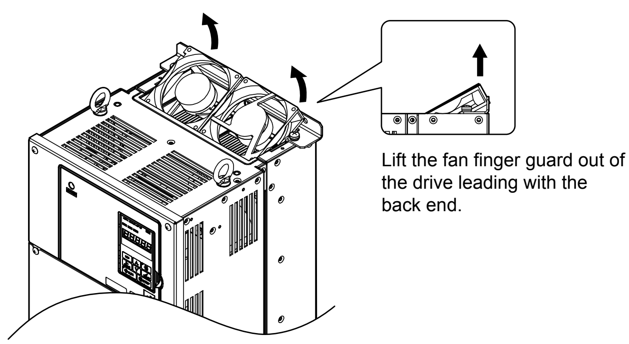


Figure 7.9 Remove the Cooling Fan: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

■ Installing the Cooling Fan

Reverse the procedure described above to reinstall the cooling fan.

1. Properly connect the fan power lines.
2. Place the power supply connectors and cable back into the recess of the drive.

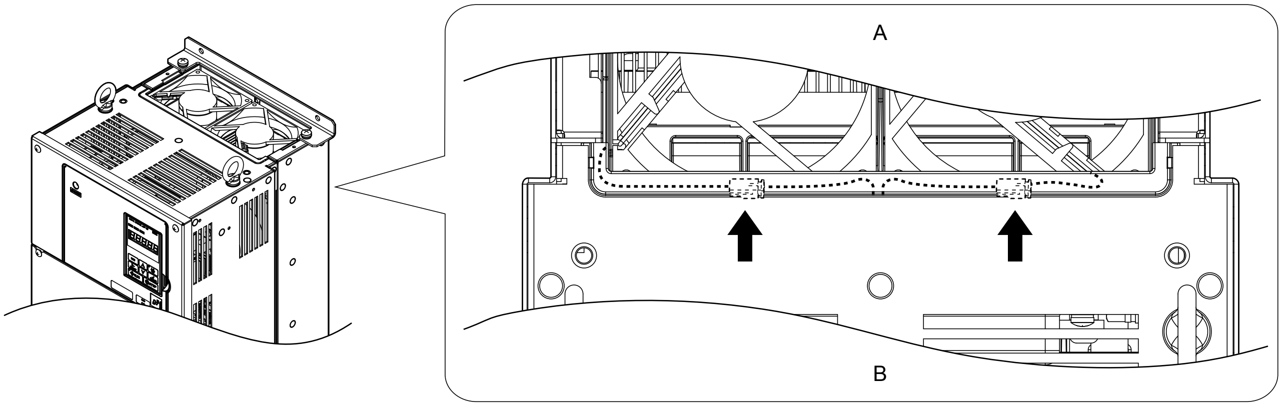


Figure 7.10 Cooling Fan Power Supply Connectors: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

3. Install the replacement fan into the drive.

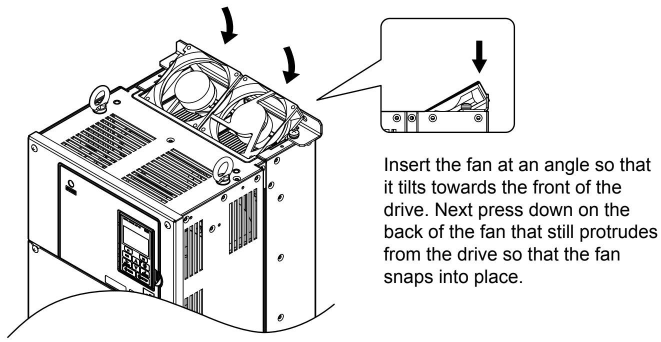


Figure 7.11 Install the Cooling Fan: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

4. Tilt up the back end of the fan finger guard and slide the fan finger guard into the opening near the front of the drive, then guide the fan finger guard into place.

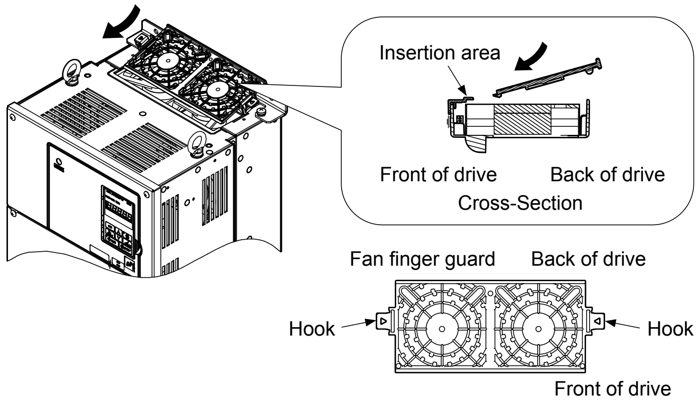


Figure 7.12 Reattach the Fan Cover: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

5. Press in on the hooks of the left and right sides of the fan cover and guide the fan finger guard until it clicks into place.

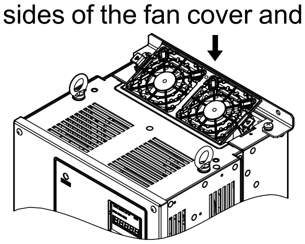


Figure 7.13 Reattach the Fan Finger Guard: 2A0110, 2A0138, 4A0058, 4A0072, 5A0041, and 5A0052

6. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

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◆ Cooling Fan Replacement: 4A0088 and 4A0103

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan and circulation fan replacement instructions. Improper fan replacement may cause damage to equipment. When installing the replacement fan into the drive, make sure the fan is facing upwards. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing the Cooling Fan Finger Guard and Cooling Fan

1. While pressing in on the hooks located on the left and right sides of the fan finger guard, free the fan finger guard by lifting the back end first.

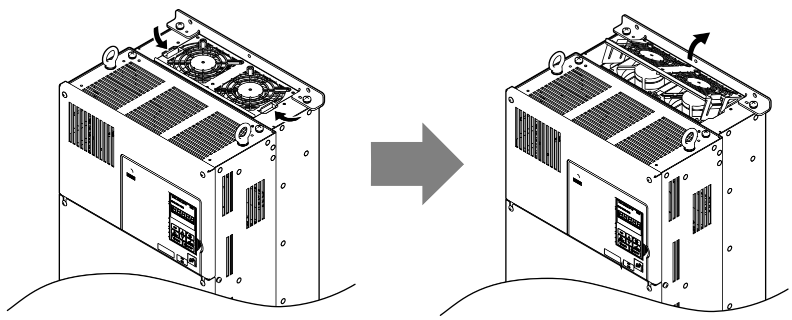


Figure 7.14 Remove the Cooling Fan Finger Guard: 4A0088 and 4A0103

2. Lift up directly on the cooling fan as shown in ***Figure 7.15***. Unplug the relay connector and release the fan from the drive.

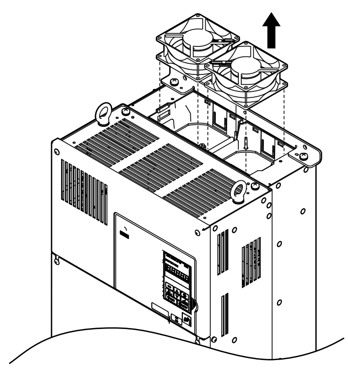


Figure 7.15 Remove the Cooling Fan: 4A0088 and 4A0103

■ Installing the Cooling Fan

Reverse the procedure describe above to reinstall the cooling fan.

1. Install the replacement fan into the drive. Align the pins as shown in *Figure 7.16*.

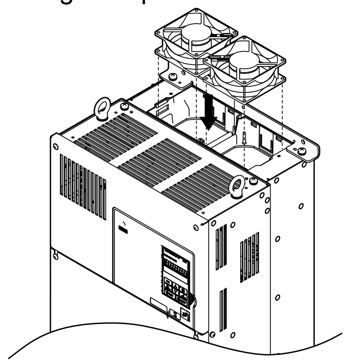
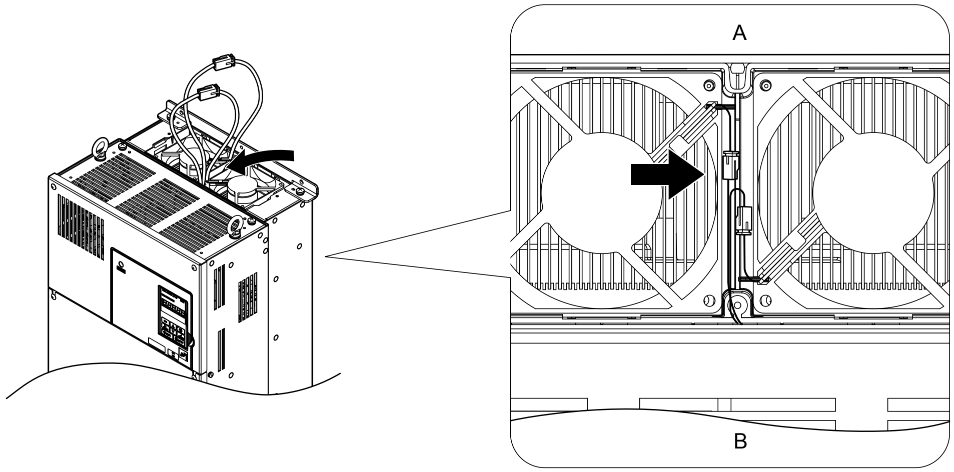


Figure 7.16 Install the Cooling Fan: 4A0088 and 4A0103

2. Properly connect the fan power lines then replace the power supply connectors and cables into the recess of the drive.



A – Back **B – Front**

Figure 7.17 Cooling Fan Power Supply Connectors: 4A0088 and 4A0103

3. Angle the fan finger guard as shown in *Figure 7.18* and insert the connector tabs into the corresponding holes on the drive.

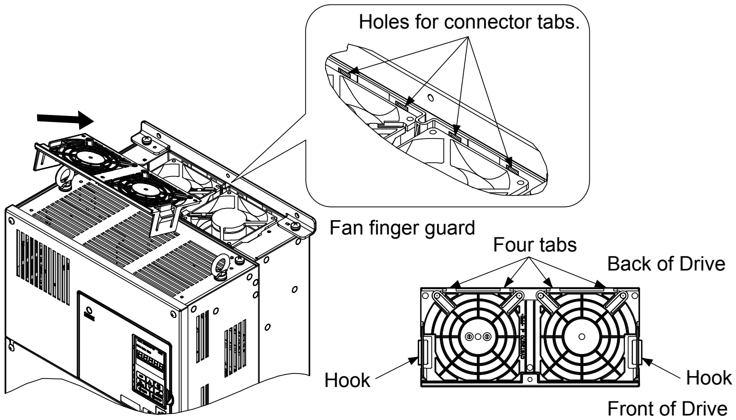


Figure 7.18 Reattach the Fan Finger Guard: 4A0088 and 4A0103

4. While pressing in on the hooks of the left and right sides of the fan finger guard, guide the fan finger guard until it clicks back into place.

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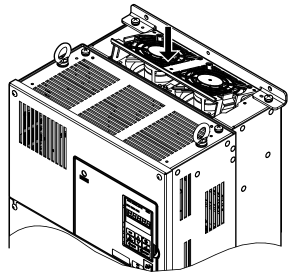


Figure 7.19 Reattach the Fan Finger Guard: 4A0088 and 4A0103

5. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

◆ Cooling Fan Replacement: 2A0169 to 2A0415, 4A0139 to 4A0362, and 5A0062 to 5A0242

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

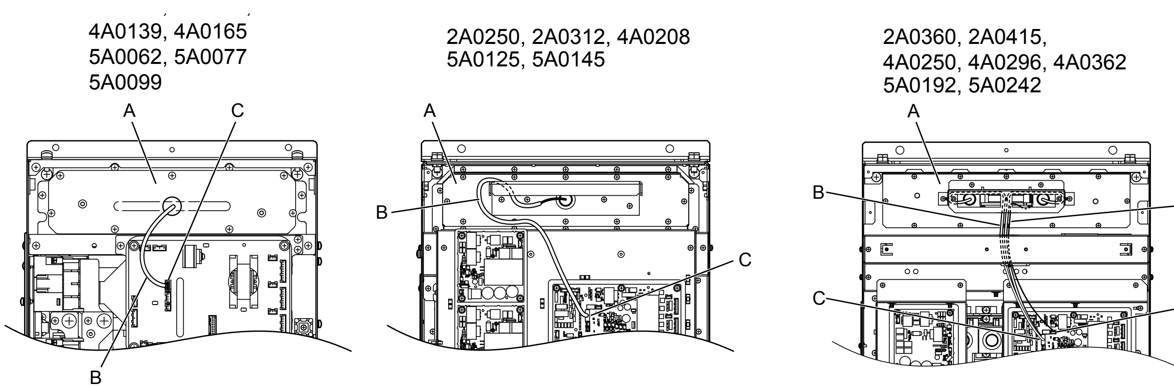
CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan and circulation fan replacement instructions. Improper fan replacement may cause damage to equipment. When installing the replacement fan into the drive, make sure the fan is facing upwards. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing and Disassembling the Cooling Fan Unit

1. Remove the terminal cover and front cover.
2. Remove the fan connector (CN6).

   Remove the fan connectors (CN6, CN7) in models 2A0360, 2A0415, 4A0362, and 5A0242.



A – Fan unit
B – Fan relay cable
C – Fan connector (CN6)
D – Circulation fan relay cable
E – Fan connector (CN7)

Figure 7.20 Cooling Fan Replacement: Fan Unit and Connectors

3. Remove the screws holding the fan unit in place and slide the fan unit out of the drive.

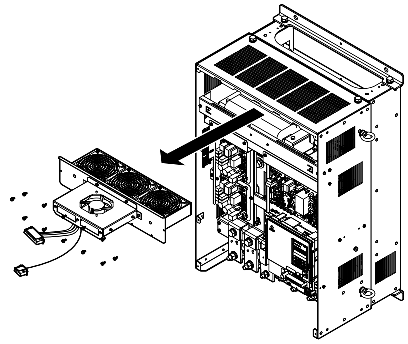
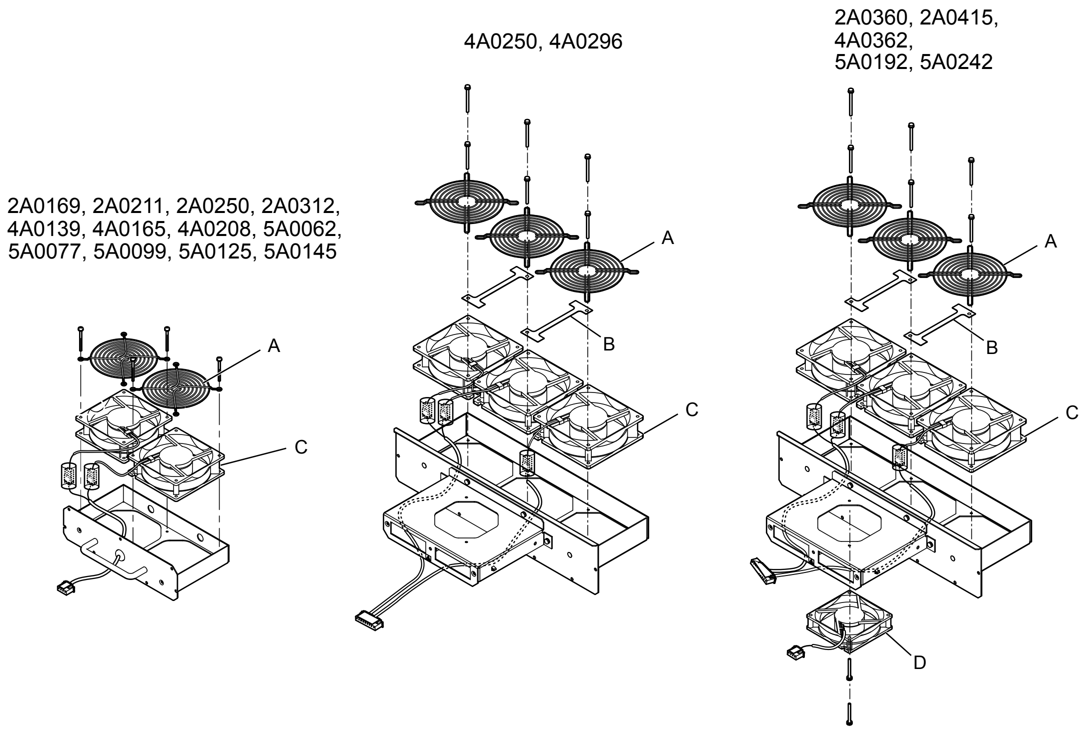


Figure 7.21 Remove the Fan Unit: 2A0169 to 2A0415, 4A0139 to 4A0362, and 5A0062 to 5A0242

4. Remove the fan guard and replace the cooling fans.

Note: Do not pinch the fan cable between parts when reassembling the fan unit.

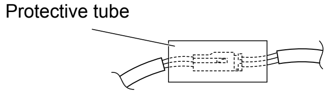


A – Fan guard
B – Cable cover
C – Cooling fan
D – Circulation fan

Figure 7.22 Fan Unit Disassembly: 2A0169 to 2A0415, 4A0139 to 4A0362, and 5A0062 to 5A0242

■ Cooling Fan Wiring: 2A0169, 2A0211, 4A0139, 4A0165, and 5A0062 to 5A0099

1. Position the protective tube so the fan connector sits in the center of the protective tube.



2. Place the fan connector covered by the tube as shown in *Figure 7.23*.

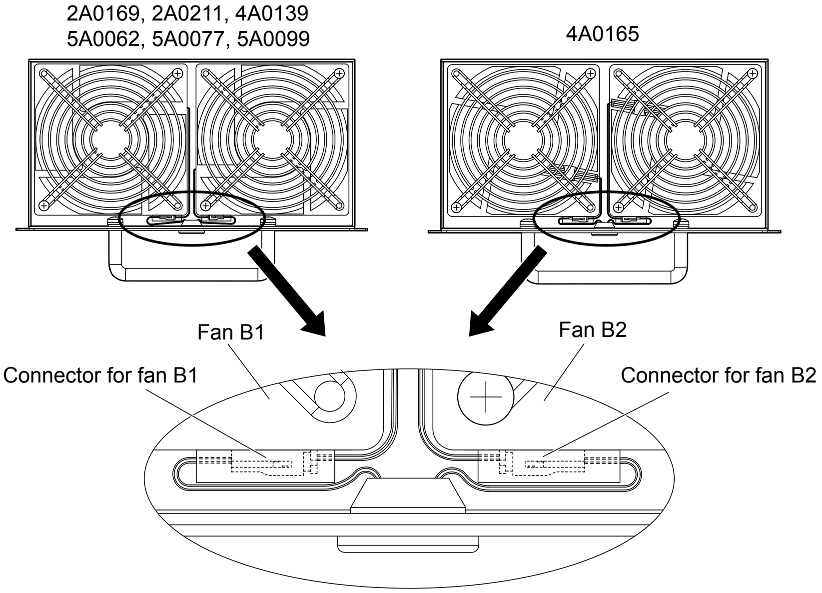
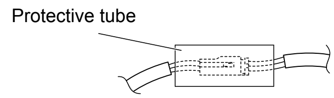


Figure 7.23 Cooling Fan Wiring: 2A0169, 2A0211, 4A0139, 4A0165, and 5A0062 to 5A0099

3. Make sure that the protective tube does not stick out beyond the fan guard.

■ Cooling Fan Wiring: 2A0250, 2A0312, 4A0208, 5A0125, and 5A0145

1. Position the protective tube so the fan connector sits in the center of the protective tube.



2. Insert the connector for fan B2 and guide the lead wire for fan B2 so the cable hook holds it in place.
   Insert the connector for fan B1.

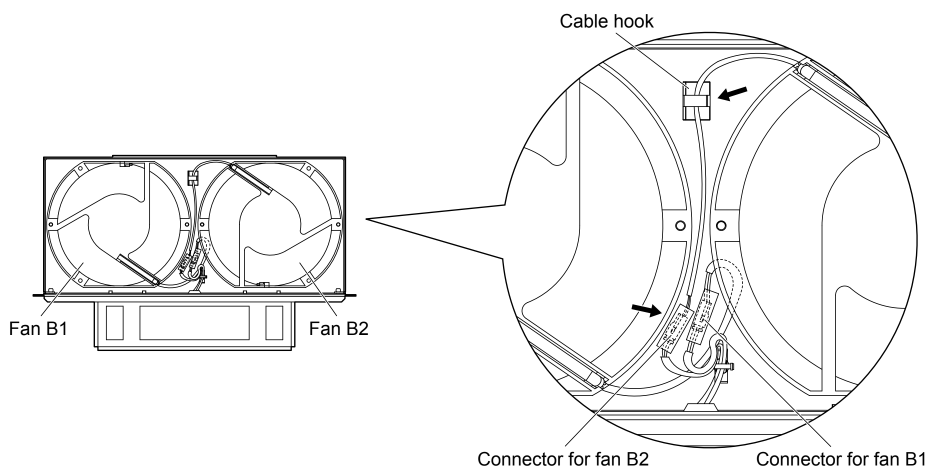
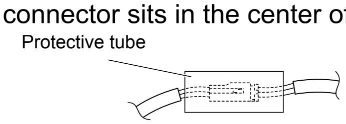


Figure 7.24 Cooling Fan Wiring: 2A0250, 2A0312, 4A0208, 5A0125, and 5A0145

3. Make sure that the protective tube does not stick out beyond the fan guard.

■ Cooling Fan Wiring: 2A0360, 2A0415, 4A0250 to 4A0362, 5A0192, and 5A0242

1. Position the protective tube so the fan connector sits in the center of the protective tube.



2. In the space between fans 1 and 2, place the fan connector for fan B2 in front of the fan connector for fan B1.
3. Place the connector for fan B3 between fans B2 and B3.

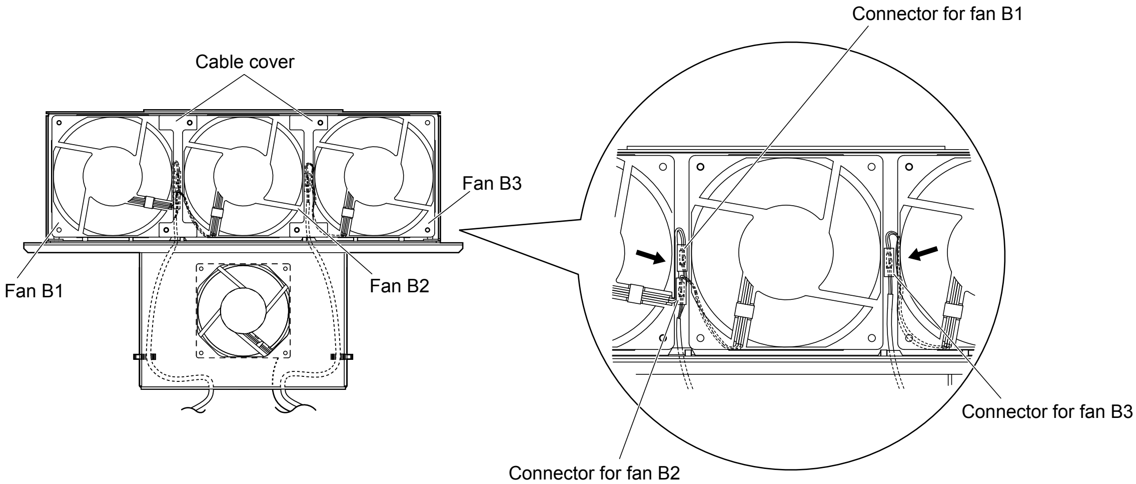


Figure 7.25 Cooling Fan Wiring: 2A0360, 2A0415, 4A0250 to 4A0362, 5A0192, and 5A0242

4. Double-check the relay connector to ensure it is properly connected.
5. Reattach the cable cover to its original position and tighten the screws so the fan guard holds the cable cover in place.

Note: Do not pinch the fan cable between parts when reassembling the fan unit.

■ Installing the Cooling Fan Unit

1. Reverse the procedure described above to reinstall the cooling fan unit.

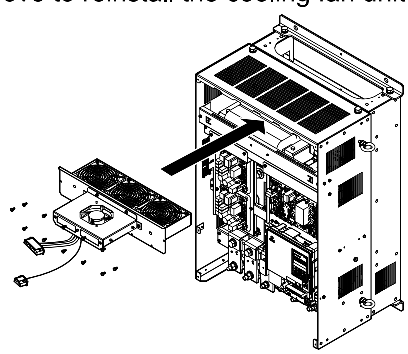


Figure 7.26 Install the Cooling Fan Unit: 2A0169 to 2A0415 and 4A0139 to 4A0362, and 5A0062 to 5A0242

2. Reattach the covers and digital operator.
3. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

◆ Cooling Fan Replacement: 4A0414

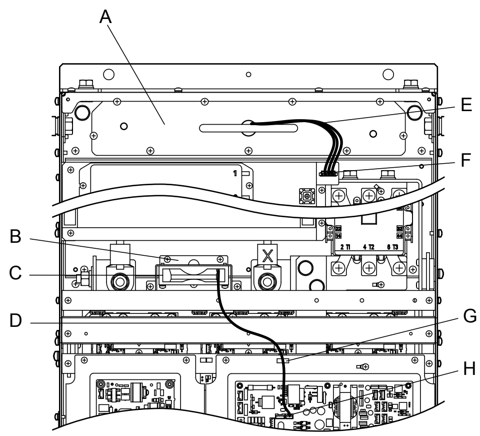
WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan and circulation fan replacement instructions. Improper fan replacement may cause damage to equipment. When installing the replacement fan into the drive, make sure the fan is facing upwards. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing and Disassembling the Cooling Fan Unit

1. Remove the terminal cover and front covers 1 and 2.
2. Remove the fan connector (CN6).



A – Fan unit
B – Circulation fan unit
C – Circulation fan
D – Circulation fan relay cable
E – Fan relay cable
F – Fan connector (CN6)
G – Hook
H – Fan connector (CN7)

Figure 7.27 Component Names: 4A0414

3. Remove the circulation fan relay cable from the hook. Remove the fan connector (CN7).
4. Remove the screws holding the fan units in place and slide the fan units out of the drive.

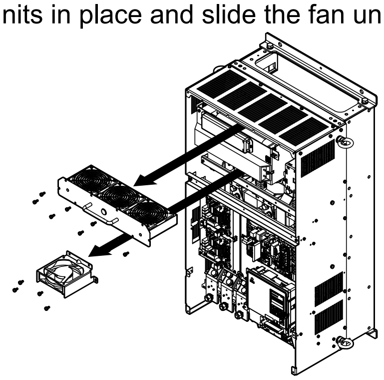
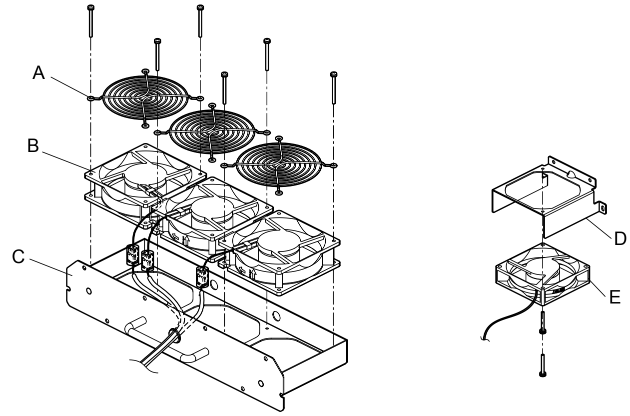


Figure 7.28 Remove the Fan Unit: 4A0414

5. Remove the fan guard and circulation fan casing. Replace the cooling fans.

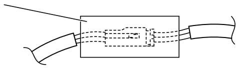


A – Fan guard
B – Cooling fan
C – Fan unit case
D – Circulation fan base
E – Circulation fan

Figure 7.29 Fan Unit Disassembly: 4A0414

■ Cooling Fan Wiring

1. Position the protective tube so the fan connector sits in the center of the protective tube.



2. Place the fan connector covered by the tube as shown in ***Figure 7.30***.

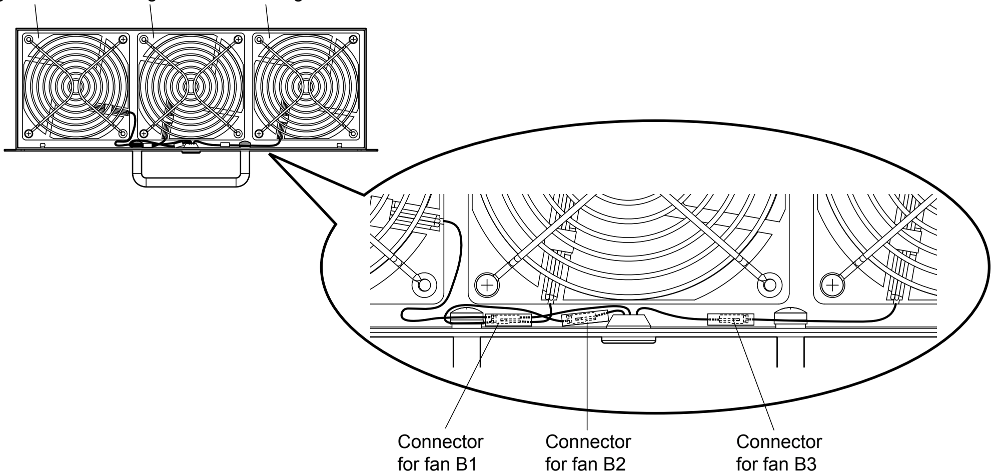


Figure 7.30 Cooling Fan Wiring: 4A0414

3. Double-check the relay connector to ensure that it is properly connected.

■ Installing the Cooling Fan Unit

1. Reverse the procedure described above to reinstall the cooling fan unit.

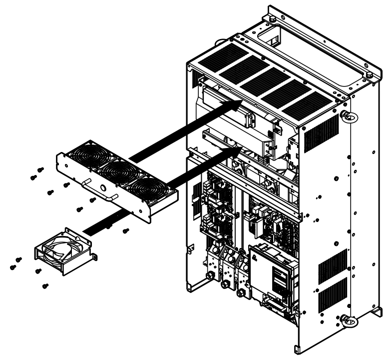


Figure 7.31 Install the Cooling Fan Unit: 4A0414

2. Reattach the covers and digital operator.
3. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

◆ Cooling Fan Replacement: 4A0515 and 4A0675

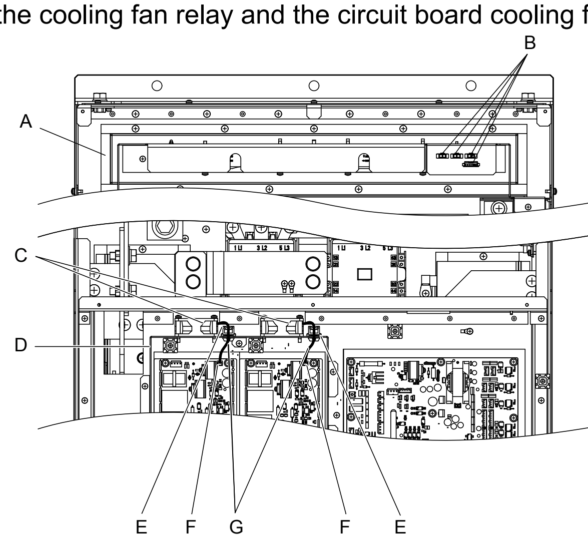
WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

CAUTION! *Burn Hazard. Do not touch a hot drive heatsink. Failure to comply could result in minor or moderate injury. Shut off the power to the drive when replacing the cooling fan. To prevent burns, wait at least 15 minutes and ensure the heatsink has cooled down.*

NOTICE: *Follow cooling fan and circulation fan replacement instructions. Improper fan replacement may cause damage to equipment. When installing the replacement fan into the drive, make sure the fan is facing upwards. Replace all fans when performing maintenance to help ensure maximum useful product life.*

■ Removing and Disassembling the Cooling Fan Unit

1. Remove the terminal cover and front covers 1 and 2.
2. Remove the connectors for the cooling fan relay and the circuit board cooling fan.



A – Fan unit
B – Fan relay connector
C – Circuit board cooling fan
D – Circuit board cooling fan case
E – Hook
F – Circuit board cooling fan connector
G – Circuit board cooling fan cable

Figure 7.32 Component Names: 4A0515 and 4A0675

3. Loosen all nine screws and slide the panel to the right.

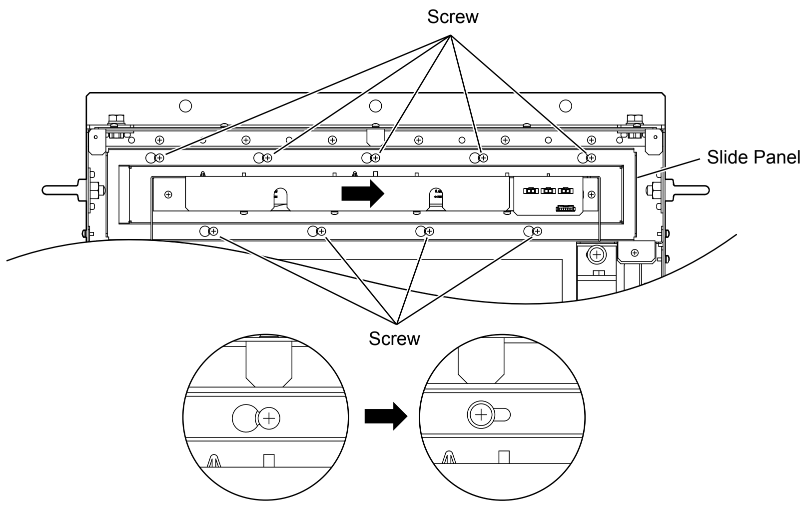


Figure 7.33 Remove the Fan Unit: 4A0515 and 4A0675

4. Remove the slide panel, fan unit, and circuit board cooling fan unit.

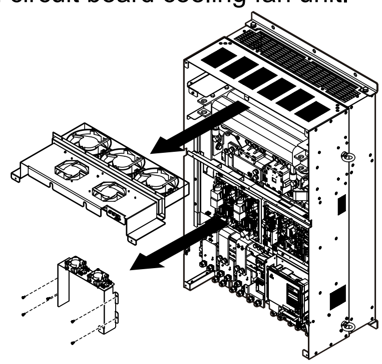
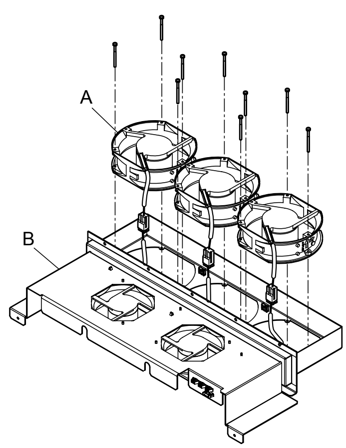


Figure 7.34 Remove the Fan Unit: 4A0515 and 4A0675

5. Replace the cooling fans.

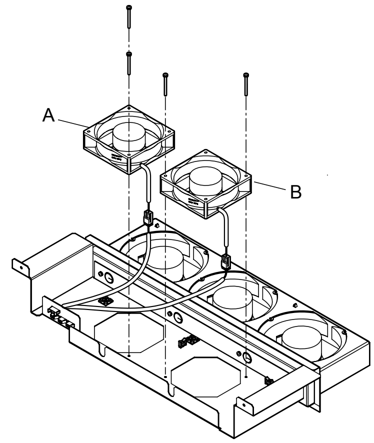
Note: Do not pinch the fan cable between parts when reassembling the fan unit.



A – Cooling fan **B – Fan unit case**

Figure 7.35 Fan Unit Disassembly: 4A0515 and 4A0675

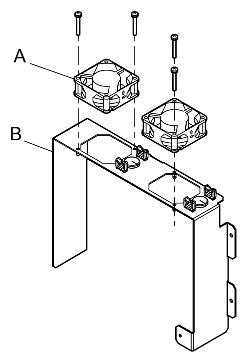
6. Turn the fan unit over and replace the circulation fans.



A – Circulation fan 1 **B – Circulation fan 2**

Figure 7.36 Fan Unit Disassembly: 4A0515 and 4A0675

7. Replace the cooling fans.



A – Circuit board cooling fan **B – Circuit board cooling fan case**

Figure 7.37 Fan Unit Disassembly: 4A0515 and 4A0675

■ Cooling Fan Wiring

1. Place the cooling fan connectors and guide the lead wires so they are held in place by the cable hooks.

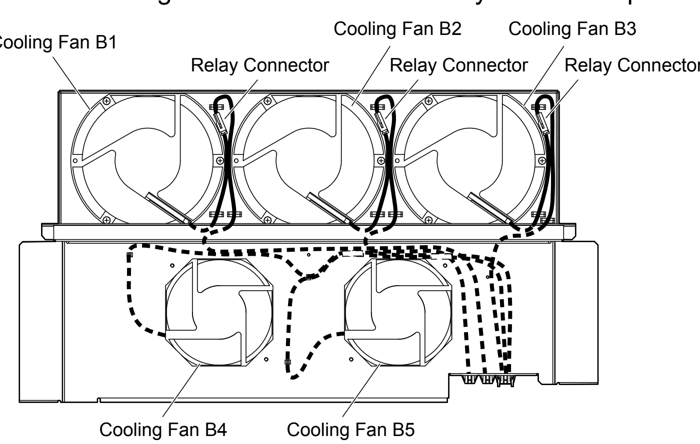


Figure 7.38 Cooling Fan Wiring: 4A0515 and 4A0675

2. Guide the lead wires so that they are held in place by the cable hooks and place the circulation fan connectors between the fan and the fan unit.

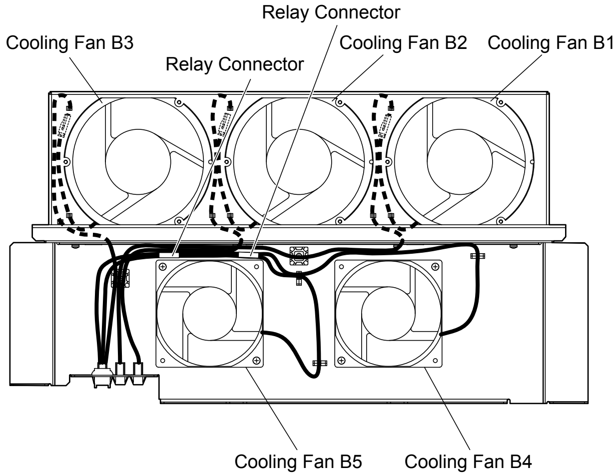
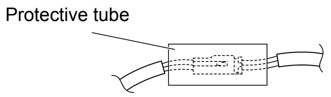


Figure 7.39 Cooling Fan Wiring: 4A0515 and 4A0675

3. Position the protective tube so the fan connector sits in the center of the protective tube. (Circuit board cooling fans only)



4. Guide the lead wires through the provided hooks so the wires are held in place.

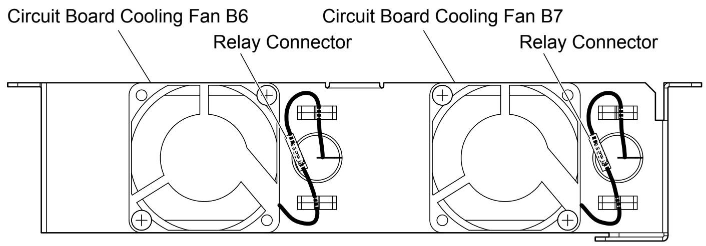


Figure 7.40 Cooling Fan Wiring: 4A0515 and 4A0675

5. Double-check the relay connector to ensure that it is properly connected.

■ Installing the Cooling Fan Unit

1. Reverse the procedure described above to reinstall the cooling fan unit.

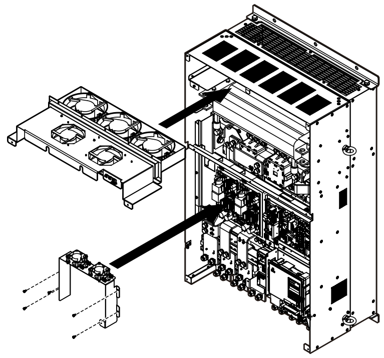


Figure 7.41 Install the Cooling Fan Unit: 4A0515 and 4A0675

2. Reattach the covers and digital operator.
3. Turn on the power supply and set o4-03 to 0 to reset the Maintenance Monitor cooling fan operation time.

7.5 Drive Replacement

◆ Serviceable Parts

The drive contains some serviceable parts. The following parts can be replaced over the life span of the drive:

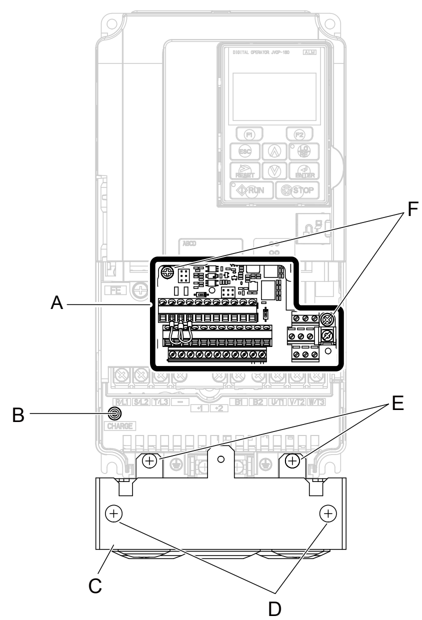
- Terminal board I/O PCBs
- Cooling fan(s)
- Front cover

Replace the drive if the main power circuitry is damaged. Contact your local Yaskawa representative before replacing parts if the drive is still under warranty. Yaskawa reserves the right to replace or repair the drive according to Yaskawa warranty policy.

◆ Terminal Board

The drive has a modular I/O terminal block that facilitates quick drive replacement. The terminal board contains on-board memory that stores all drive parameter settings and allows the parameters to be saved and transferred to the replacement drive. To transfer the terminal board, disconnect the terminal board from the damaged drive and reconnect it to the replacement drive. There is no need to manually reprogram the replacement drive after transferring the terminal board.

Note: If the damaged drive and the new replacement drive are have different capacities, the data stored in the terminal board cannot be transferred to the new drive and an oPE01 error will appear on the display. The terminal board can still be used, but parameter setting from the old drive cannot be transferred. The replacement drive must be initialized and manually programmed.



A – Removable terminal board
B – Charge LED
C – Conduit bracket
D – Conduit bracket cover screws
E – Conduit bracket mounting screws
F – Terminal board locking screws

Figure 7.42 Terminal Board

◆ Replacing the Drive

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply can result in serious personal injury. Before servicing the drive, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.*

WARNING! *Electrical Shock Hazard. Do not allow unqualified personnel to perform work on the drive. Failure to comply could result in serious injury. Installation, maintenance, inspection and servicing must be performed only by authorized personnel familiar with installation, adjustment and maintenance of AC drives.*

NOTICE: *Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards. Failure to comply may result in ESD damage to the drive circuitry.*

The following procedure explains how to replace a drive.

This section provides instructions for drive replacement only.

To install option boards or other types of options, refer to the specific manuals for those options.

NOTICE: *When transferring a braking transistor, braking resistor, or other type of option from a damaged drive to a new replacement drive, make sure it is working properly before reconnecting it to the new drive. Replace broken options to prevent immediate breakdown of the replacement drive.*

1. Remove the terminal cover.

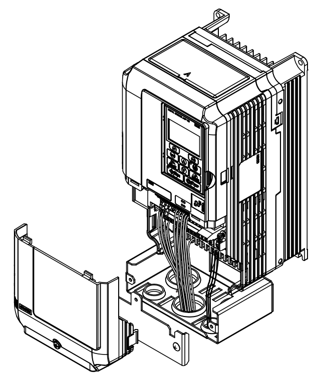


Figure 7.43 Remove the Terminal Cover

2. Loosen the screws holding the terminal board in place. Remove the screw securing the bottom cover and remove the bottom cover from the drive.

Note: IP00/Open Type enclosure drives do not have a bottom cover or conduit.

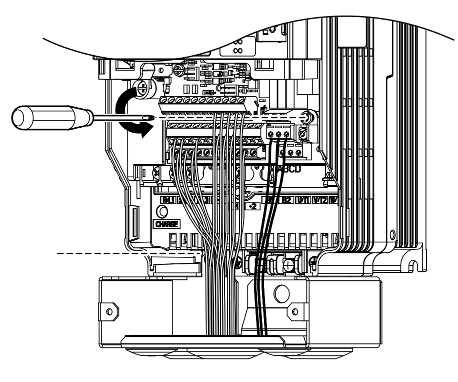


Figure 7.44 Unscrew the Terminal Board and Remove the Bottom Cover

3. Slide the terminal board as illustrated by the arrows to remove it from the drive along with the bottom cover.

Periodic Inspection & Maintenance

7

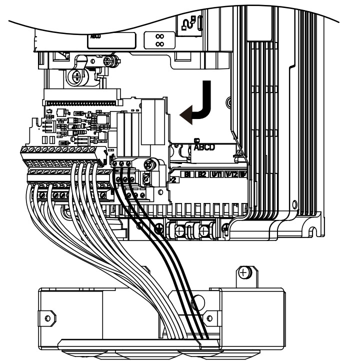


Figure 7.45 Remove the Terminal Board

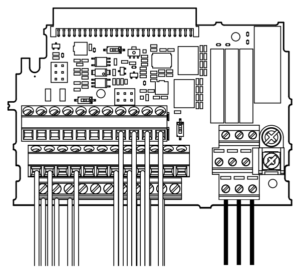


Figure 7.46 Disconnected Removable Terminal Board

4. Disconnect all option cards and options, making sure they are intact before reusing.
5. Replace the drive and wire the main circuit.

■ Installing the Drive

1. After wiring the main circuit, connect the terminal block to the drive as shown in *Figure 7.47*. Use the installation screw to fasten the terminal block into place.

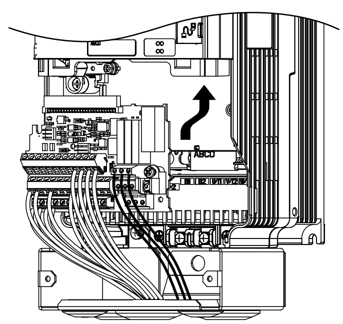


Figure 7.47 Install the Terminal Board

2. Reconnect options for the new drive the same way the options were connected in the old drive. Connect option boards to the same option ports in the new drive that were used in the old drive.
3. Replace the terminal cover.
4. After powering on the drive, all parameter settings are transferred from the terminal board to the drive memory. If an oPE04 error occurs, load the parameter settings saved on the terminal board to the new drive by setting parameter A1-03 to 5550. Reset the Maintenance Monitor function timers by setting parameters o4-01 through o4-12 to 0, and parameter o4-13 to 1.

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Revision History

The revision dates and the numbers of the revised manuals appear on the bottom of the back cover.

Date of Publication	Revision Number	Section	Revised Content
August 2012	1	Chapter 1	Revision: Corrected drive front view.
		Chapter 3	Revision: Removed Pulse train output information.
		Chapter 5	Revision: Parameter descriptions corrected.
		Appendix B	Revision: Parameter descriptions corrected.
June 2012	–	–	First Edition. This manual supports drive software version PRG: 8500.

YASKAWA AC Drive P1000

Industrial Fan and Pump Drive

Technical Manual

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YASKAWA

YASKAWA AMERICA, INC.

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OPERATION AND MAINTENANCE MANUAL

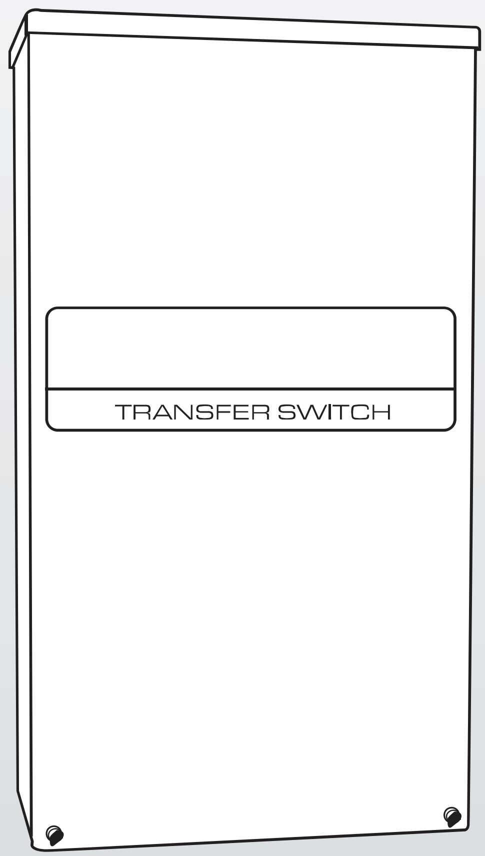
VOLUME III

TAB 12

GENERAC AUTOMATIC TRANSFER SWITCH
GENERAC EMERGENCY GENERATOR
MANUAL

Owner's Manual

Automatic Transfer Switch



DANGER!

NOT INTENDED FOR USE IN CRITICAL LIFE SUPPORT APPLICATIONS.

THIS PRODUCT CAN BE INSTALLED BY THE HOMEOWNER. HOWEVER, IF YOU ARE UNCOMFORTABLE WITH THE SKILLS OR TOOLS REQUIRED, HAVE A QUALIFIED ELECTRICIAN OR CONTRACTOR PERFORM THE INSTALLATION.

DEADLY EXHAUST FUMES! OUTDOOR INSTALLATION ONLY!

REFERENCE THE OWNER'S MANUAL SUPPLIED WITH THE GENERATOR WHEN USING THIS DOCUMENTATION.

This manual should remain with the unit.

Table of Contents

SAVE THESE INSTRUCTIONS! Read the following information carefully before attempting to install, operate or service this equipment. Also read the instructions and information on tags, decals, and labels that may be affixed to the transfer switch. Replace any decal or label that is no longer legible.

DANGER! Connection of a generator to an electrical system normally supplied by an electric utility shall be by means of suitable transfer equipment so as to isolate the electric system from utility distribution system when the generator is operating (Article 701 Legally Required Standby Systems or Article 702 Optional Standby Systems, as applicable). Failure to isolate electric system by these means may result in damage to generator and may result in injury or death to utility workers due to backfeed of electrical energy.

The manufacturer cannot anticipate every possible circumstance that might involve a hazard. The warnings in this manual, and on tags and decals affixed to the unit are, therefore, not all-inclusive. If using a procedure, work method or operating technique the manufacturer does not specifically recommend, ensure that it is safe for others. Also make sure the procedure, work method or operating technique chosen does not render the transfer switch unsafe.

Throughout this publication, and on tags and decals affixed to the generator, DANGER, WARNING, CAUTION and NOTE blocks are used to alert personnel to special instructions about a particular operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully. Their definitions are as follows:

DANGER!

After this heading, read instructions that, if not strictly complied with, will result in serious personal injury, including death.

WARNING!

California Proposition 65

Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

WARNING!

California Proposition 65

This product contains or emits chemicals known to the state of California to cause cancer, birth defects, and other reproductive harm.

⚠ WARNING!

After this heading, read instructions that, if not strictly complied with, could result in serious personal injury, including death.

⚠ CAUTION!

After this heading, read instructions that, if not strictly complied with, might result in minor or moderate injury.

NOTE:

After this heading, read instructions that, if not strictly complied with, may result in damage to equipment and/or property.

These safety warnings cannot eliminate the hazards that they indicate. Common sense and strict compliance with the special instructions while performing the service are essential to preventing accidents.

Four commonly used safety symbols accompany the DANGER, WARNING and CAUTION blocks. The type of information each indicates follows:

This symbol points out important safety information that, if not followed, could endanger personal safety and/or property.

This symbol points out potential explosion hazard.

This symbol points out potential fire hazard.

This symbol points out potential electrical shock hazard.

GENERAL HAZARDS

- Any AC generator that is used for backup power if a NORMAL (UTILITY) power source failure occurs, must be isolated from the NORMAL (UTILITY) power source by means of an approved transfer switch. Failure to properly isolate the NORMAL and STANDBY power sources from each other may result in injury or death to electric utility workers, due to backfeed of electrical energy.
- Improper or unauthorized installation, operation, service or repair of the equipment is extremely dangerous and may result in death, serious personal injury, or damage to equipment and/or personal property.
- Extremely high and dangerous power voltages are present inside an installed transfer switch. Any contact with high voltage terminals, contacts or wires will result in extremely hazardous, and possibly LETHAL, electric shock. DO NOT WORK ON THE TRANSFER SWITCH UNTIL ALL POWER VOLTAGE SUPPLIES TO THE SWITCH HAVE BEEN POSITIVELY TURNED OFF.
- Competent, qualified personnel should install, operate and service this equipment. Adhere strictly to local, state and national electrical and building codes. When using this equipment, comply with regulations the National Electrical Code (NEC), CSA Standard; C22.1 Canadian Electric Code and Occupational Safety and Health Administration (OSHA) have established.
- Never handle any kind of electrical device while standing in water, while barefoot, or while hands or feet are wet. DANGEROUS ELECTRICAL SHOCK MAY RESULT.
- Remove all jewelry (such as rings, watches, bracelets, etc.) before working on this equipment.
- If work must be done on this equipment while standing on metal or concrete, place insulative mats over a dry wood platform. Work on this equipment only while standing on such insulative mats.
- Never work on this equipment while physically or mentally fatigued.
- Keep the transfer switch enclosure door closed and bolted at all times. Only qualified personnel should be permitted access to the switch interior.
- In case of an accident caused by electric shock, immediately shut down the source of electrical power. If this is not possible, attempt to free the victim from the live conductor but AVOID DIRECT CONTACT WITH THE VICTIM. Use a nonconducting implement, such as a dry rope or board, to free the victim from the live conductor. If the victim is unconscious, apply first aid and get immediate medical help.
- When an automatic transfer switch is installed for a standby generator set, the generator engine may crank and start at any time without warning. To avoid possible injury that might be caused by such sudden start-ups, the system's automatic start circuit must be disabled before working on or around the generator or transfer switch. Then place a "DO NOT OPERATE" tag on the transfer switch and on the generator. Remove the Negative (Neg) or (–) battery cable.

For authorized service, reference the dealer locator number found inside the generator owner's manual.

1.1 INTRODUCTION

This manual has been prepared especially for the purpose of familiarizing personnel with the design, application, installation, operation and servicing of the applicable equipment. Read the manual carefully and comply with all instructions. This will help to prevent accidents or damage to equipment that might otherwise be caused by carelessness, incorrect application, or improper procedures.

Every effort has been expended to make sure that the contents of this manual are both accurate and current. The manufacturer, however, reserves the right to change, alter or otherwise improve the product or manual at any time without prior notice.

1.2 UNPACKING

Carefully unpack the transfer switch. Inspect closely for any damage that might have occurred during shipment. The purchaser must file with the carrier any claims for loss or damage incurred while in transit.

Check that all packing material is completely removed from the switch prior to installation.

1.3 EQUIPMENT DESCRIPTION

The automatic transfer switch is used for transferring electrical load from a UTILITY (NORMAL) power source to an GENERATOR (STANDBY) power source. Such a transfer of electrical loads occurs automatically when the UTILITY power source has failed or is substantially reduced and the GENERATOR source voltage and frequency have reached an acceptable level. The transfer switch prevents electrical feedback between two different power sources (such as the UTILITY and GENERATOR sources) and, for that reason, codes require it in all standby electric system installations.

The transfer switch consists of a transfer mechanism, UTILITY SERVICE DISCONNECT circuit breaker, a control relay, fuses, terminal strip, and fuse holder for connection of sensing wires.

This transfer switch is suitable for use as service equipment.

1.3.1 TRANSFER SWITCH MECHANISM

These switches (Figure 1.1) are used with a single-phase system, when the single-phase NEUTRAL line is to be connected to a Neutral Lug and is not to be switched.

Solderless, screw-type terminal lugs are standard.

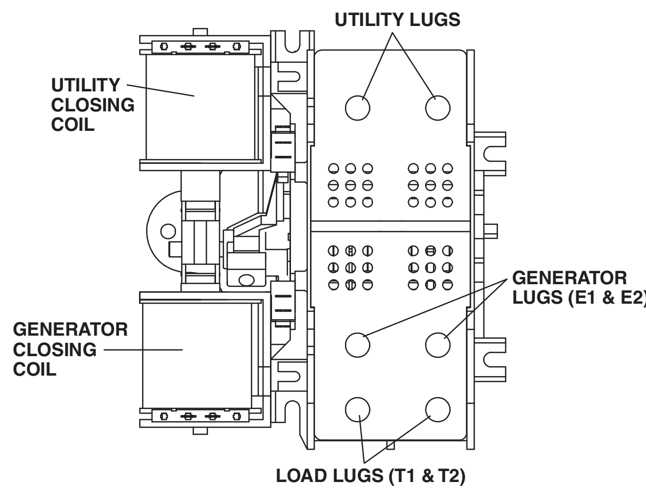
Switch	Wire	Conductor Tightening
Rating	Range	Torque
100A	#14-1/0 AWG	50 in-lbs.
200A	#6-250 MCM	275 in-lbs.

This transfer switch is suitable for control of motors, electric discharge lamps, tungsten filament and electric heating equipment where the sum of motor full load ampere ratings and the ampere ratings of other loads do not exceed the ampere rating of the switch and the tungsten load does not exceed 30 percent of the switch rating.

This UL listed transfer switch is for use in optional standby systems only (NEC article 702).

This transfer switch is suitable for use on a circuit capable of 22,000 rms (200A) and 10,000 (100A) symmetrical amperes, 240 VAC maximum.

Figure 1.1 — Typical ATS Transfer Mechanism



1.3.2 UTILITY SERVICE DISCONNECT CIRCUIT BREAKER

The utility service and generator disconnect circuit breakers for the 100 amp models are:

- Type BQ, 2-pole
- 120/240VAC, 100A
- 50/60 Hertz
- Heating, Air Conditioning and Refrigeration (HACR) rated
- Wire range: #1 - #8 AWG.
- The conductor tightening torque is 50 in-lbs.

The utility service circuit breaker for the 150/200 amp models are:

- Type 225AF, 2-pole
- 120/240VAC, 150A/200A
- 50/60 Hertz
- Wire range: 300 MCM - 6 STR (Line), 250 MCM - 6 STR (Load - ATS)
- The conductor tightening torque is 375 in-lbs. (Line), 275 in-lbs. (Load - ATS)

1.3.3 OVERLOAD PREVENTION CONTROL BOARD (OPCB)

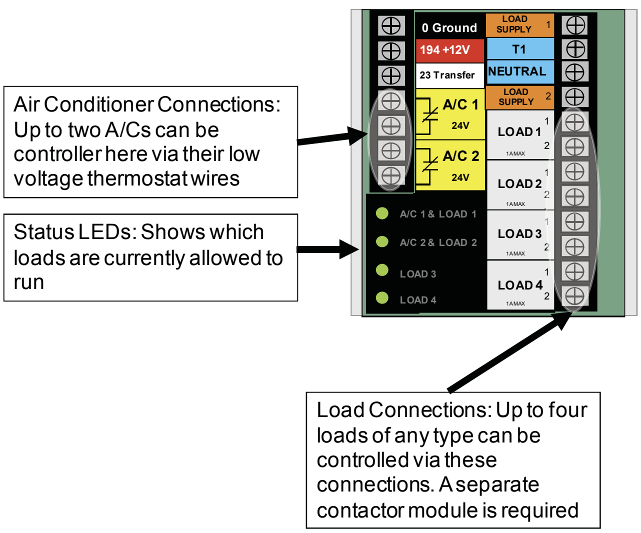
The Overload Prevention Control Board is designed to prevent an overload on the generator when it is supplying the customer loads (see Figure 1.2). Up to six loads can be managed by the OPCB; 2 air conditioner loads and 4 other loads. The OPCB manages the loads by “shedding” the connected loads in the event of a drop in generator frequency (overload). Loads to be “shed” are grouped in 4 priority levels on the OPCB.

- Priority 1 and 2 has connections for both one air conditioner and one contactor. Both an air conditioner and a contactor can be used at the same time if desired. To control an air conditioner, no additional equipment is required. Internal relays interrupt the thermostat 24VAC control signal to disable the air conditioner load.

- Priority 3 and 4 have connections for one contactor only.
- Four LEDs, located on the Overload Prevention Control Board, will indicate when a load priority level is enabled. When loads are connected, the LEDs will be illuminated.
- Any loads, including central air conditioners, can be controlled via a contactor that must be purchased separately. Up to four contactors can be controlled by the Overload Prevention Control Board (24 Vac or 120 Vac is supplied through the OPCB to energize each contactor coil).
- Generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58Hz for 3 seconds or <50Hz for ½ Second (For 60Hz).

The OPCB has a Test button which forces the unit to act as if an overload has occurred. This button operates even when the transfer signal is inactive.

Figure 1.2 — Overload Prevention Control Board



1.4 TRANSFER SWITCH DATA DECAL

A DATA DECAL is permanently affixed to the transfer switch enclosure. Use this transfer switch only with the specific limits shown on the DATA DECAL and on other decals and labels that may be affixed to the switch. This will prevent damage to equipment and property.

When requesting information or ordering parts for this equipment, make sure to include all information from the DATA DECAL.

Record the Model and Serial numbers in the space provided below for future reference.

MODEL #	
SERIAL #	

1.5 TRANSFER SWITCH ENCLOSURE

The standard switch enclosure is a National Electrical Manufacturer's Association (NEMA) and UL 3R type. UL and NEMA 3R (indoor/outdoor rated) type enclosures primarily provide a degree of protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.

1.6 SAFE USE OF TRANSFER SWITCH

Before installing, operating or servicing this equipment, read the SAFETY RULES (inside front cover) carefully. Comply strictly with all SAFETY RULES to prevent accidents and/or damage to the equipment. The manufacturer recommends that a copy of the SAFETY RULES are posted near the transfer switch. Also, be sure to read all instructions and information found on tags, labels and decals affixed to the equipment.

Three publications that outline the safe use of transfer switches are the following:

- NFPA 70; National Electrical Code
- NFPA 70E; Standard for Electrical Safety in the Workplace
- UL 1008, STANDARD FOR SAFETY-AUTOMATIC TRANSFER SWITCHES

NOTE:

It is essential to use the latest version of any standard to ensure correct and current information.

2.1 INTRODUCTION TO INSTALLATION

This equipment has been wired and tested at the factory. Installing the switch includes the following procedures:

- Mounting the enclosure.
- Connecting power source leads and load leads.
- Connecting the generator sensing and transfer relay circuits.
- Connecting any auxiliary contact (if needed)
- Connect Overload Prevention Control Board loads (as required)
- Testing functions.

2.2 MOUNTING

Mounting dimensions for the transfer switch enclosure are in this manual. Enclosures are typically wall-mounted. See the "Installation Diagram".

⚠ CAUTION!

Handle transfer switches carefully when installing. Do not drop the switch. Protect the switch against impact at all times, and against construction grit and metal chips. Never install a transfer switch that has been damaged.

This transfer switch is mounted in a UL type 3R enclosure. It can be mounted outside or inside and should be based on the layout of installation, convenience and proximity to the utility supply and load center.

Install the transfer switch as close as possible to the electrical loads that are to be connected to it. Mount the switch vertically to a rigid supporting structure. To prevent switch distortion, level all mounting points. If necessary, use washers behind mounting holes to level the unit.

2.3 CONNECTING POWER SOURCE AND LOAD LINES

DANGER!

Make sure to turn OFF both the UTILITY (NORMAL) and GENERATOR (STANDBY) power supplies before trying to connect power source and load lines to the transfer switch. Supply voltages are extremely high and dangerous. Contact with such high voltage power supply lines causes extremely hazardous, possibly lethal, electrical shock.

Wiring diagrams and electrical schematics are provided in this manual.

NOTE:

All installations must comply with national, state and local codes. It is the responsibility of the installer to perform an installation that will pass the final electrical inspection.

The utility supply connection is made at the UTILITY SERVICE DISCONNECT circuit breaker terminals. The generator and customer load connections are made at the transfer switch mechanism, inside the switch enclosure.

Conductor sizes must be adequate to handle the maximum current to which they will be subjected, based on the 75°C column of tables, charts, etc. used to size conductors. The installation must comply fully with all applicable codes, standards and regulations.

All power cables must enter the enclosure through the knockouts provided. If not using the knockouts, conduit entry into the enclosure must be at or below knockouts to maintain the Type 3R rating. Conduits should be arranged to provide separation between the Utility and Generator supply conductors inside the enclosure.

Before connecting wiring cables to terminals, remove any surface oxides from the cable ends with a wire brush. If ALUMINUM conductors are used, apply corrosion inhibitor to conductors. Tighten terminal lugs to the torque values on "Utility Service Disconnect Circuit Breaker", and on the decal located on the inside of the door. After tightening terminal lugs, carefully wipe away any excess corrosion inhibitor.

CAUTION!

Use a torque wrench to tighten the conductors, being sure not to overtighten, or damage to the switch base could occur. If not tightened enough, a loose connection would result, causing excess heat which could damage the switch base.

Connect power source load conductors to clearly marked transfer mechanism terminal lugs as follows

1. Connect UTILITY (NORMAL) power source cables to UTILITY SERVICE DISCONNECT circuit breaker.
2. Connect the GENERATOR (STANDBY) source power cables to switch terminals E1, E2.
3. Connect customer LOAD leads to switch terminals T1, T2.

Conductors must be properly supported, of approved insulative qualities, protected by approved conduit, and of the correct wire gauge size in accordance with applicable codes.

Be sure to maintain proper electrical clearance between live metal parts and grounded metal. Allow at least 1/2 inch for 100-400 amp circuits.

2.4 CONNECTING START CIRCUIT WIRES

Control system interconnections (Electrical Data section) consist of UTILITY 1 (N1), UTILITY 2 (N2) and LOAD (T1), and leads 23, 0 and 194. Recommended wire gauge sizes for this wiring depends on the length of the wire, as recommended in the following chart:

MAXIMUM WIRE LENGTH	RECOMMENDED WIRE SIZE
1-115 ft (1-35m)	No. 18 AWG.
116-185 ft (36-56m)	No. 16 AWG.
186-295 ft (57-89m)	No. 14 AWG.
296-460 ft (90-140m)	No. 12 AWG.

2.5 OVERLOAD PREVENTION CONTROL BOARD (OPCB)

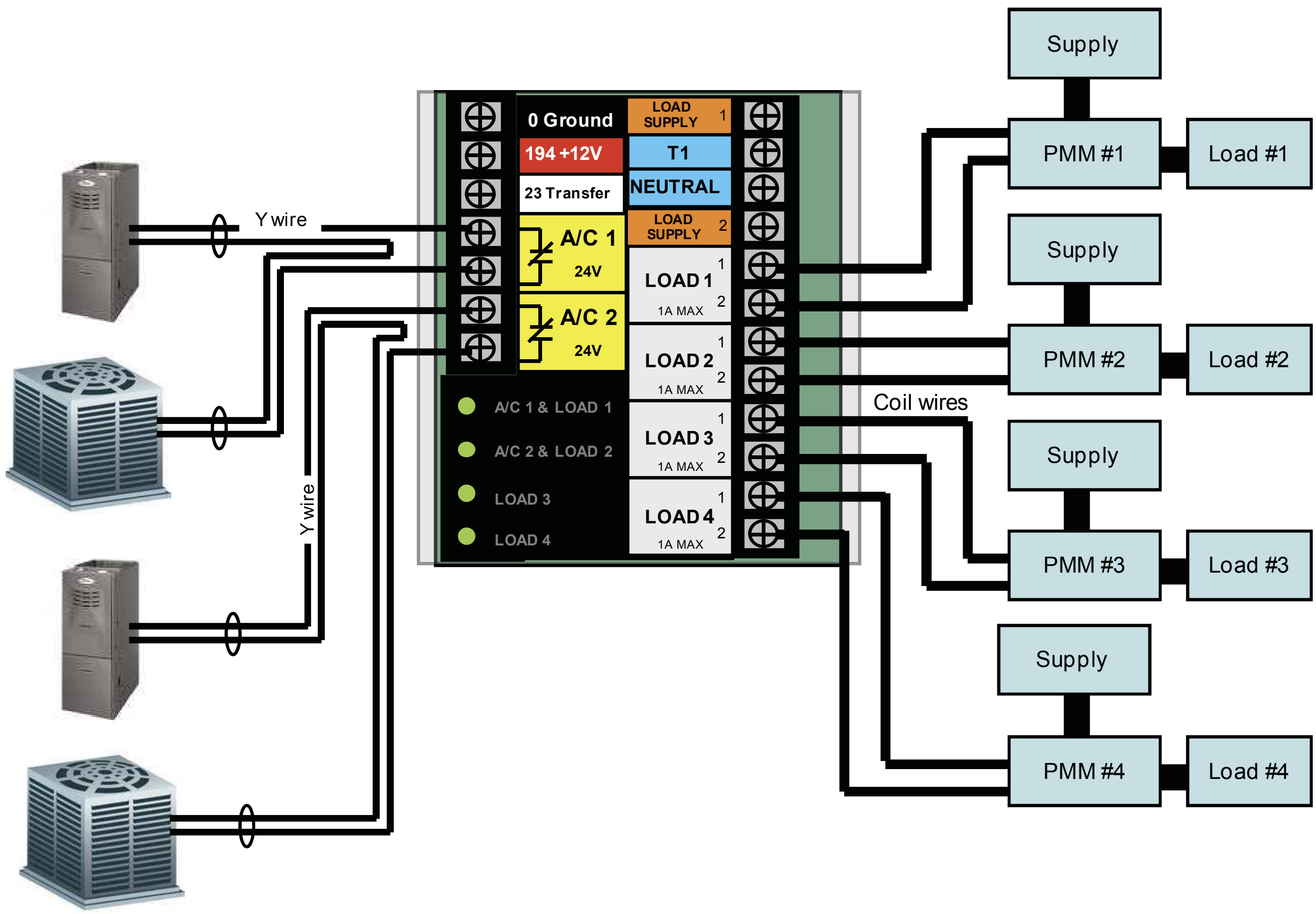
The OPCB can control an air conditioner (24 Vac) directly or a separate contactor (24 Vac or 120 Vac operating coil) which can control any load connected to it. See Figure 2.2.

The Power Management Module (PMM) is not supplied with the transfer switch. It can be purchased separately from the manufacturer. The PMM is for use with the Overload Prevention Control Board (OPCB) mounted in the transfer switch. The OPCB is designed and connected to power the PMM contactor operating coil. The OPCB is supplied by a 24 Vac supply, class 2 power supply transformer, connected to the LOAD supply in the RTS. (Each output is limited to 1 amp) The PMM contactor coil connections are made at the OPCB terminal strip.

Connect the PMM contactor coil to OPCB contactor terminals (1, 2, 3 or 4). The selection of contactor terminal used will depend on the priority of the load being controlled. This is a 24 Vac circuit and wiring methods for class 2 should be used. Use ¼" quick connect terminals to make the contactor coil connections on the PMM. See Figure 2.3.

A grommet is provided to route Class 2 wiring through. The grommet can be used in any knockout for NEMA 1 installations. The grommet can only be used in the bottom knockouts for NEMA 3R installations.

Figure 2.1 — Overload Prevention Control



Control of Air Conditioner Load

1. Route the thermostat cable (from the furnace to the outdoor air conditioner unit) to the transfer switch.
2. Connect the wire to the terminal strip terminals (Air 1) on the OPCB as shown in Figure 2.2. These are normally closed contacts which open upon load shed conditions. Route thermostat wire away from High voltage wires.
3. If required, connect the second air conditioner to the terminal strip terminals (Air 2).

Contact Ratings	
Air 1 & 2	24 VAC, 5.0 Amps Max

NOTE:

These instructions are for a typical air conditioner installation. Control of heat pump and 2-stage air conditioners will require special connections or the use of Power Management Modules to control the loads.

Control of a Separate Contactor

A separate contactor relay module can be purchased from the manufacturer. This model is supplied in a 24 Vac or 120 Vac coil version.

1. Mount the contactor module and connect the load to the main contacts.
2. Connect the contactor coil to the desired OPCB L1-L4 terminals on the terminal strip.
3. Connect additional Power Management Module contactors in a similar fashion.

NOTE:

It will be necessary to determine the order of "shedding" the connected loads and connect the loads to the OPCB in that order. One is the highest priority and four is the lowest priority.

2.6 CONNECTION OF POWER SUPPLY FOR CONTACTORS

The Overload Prevention Control Board (OPCB) can be powered from either a 24 Vac or 120 Vac power supply. The 24 Vac supply is from a class 2 transformer that can be purchased from the manufacturer. Mounting holes are provided in the enclosure sub-plate for mounting of the transformer. The 120 Vac supply is fused at 5 amps and is factory connected to OPCB terminals labeled "T1 and "Neutral".

2.6.1 24 VAC SUPPLY

Transformer connection are made as shown in Figure 2.3

- Blue wire - OPCB "LOAD SUPPLY 1" terminal
- Black wire - OPCB "T1" terminal
- White wire - OPCB "NEUTRAL" terminal
- Yellow wire - OPCB "LOAD SUPPLY 2" terminal

2.6.2 120 VAC SUPPLY

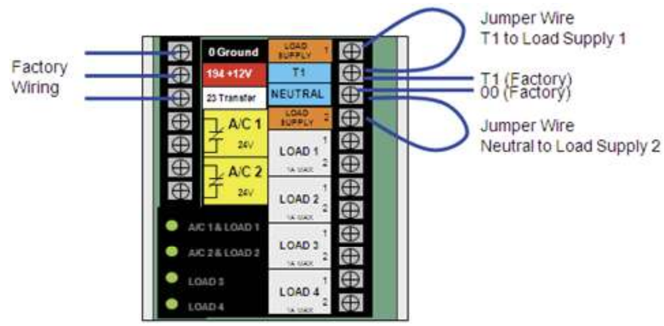
Install the following jumpers on the OPCB (Figure 2.4).

- Load Supply 1 to T1
- Load Supply 2 to Neutral

⚠ CAUTION!

Load supply voltage on the OPCB terminals must match the PMM contactor coil voltage, or the equipment will be damaged.

Figure 2.4 — 120 Vac Supply Connections



3.1 FUNCTIONAL TESTS AND ADJUSTMENTS

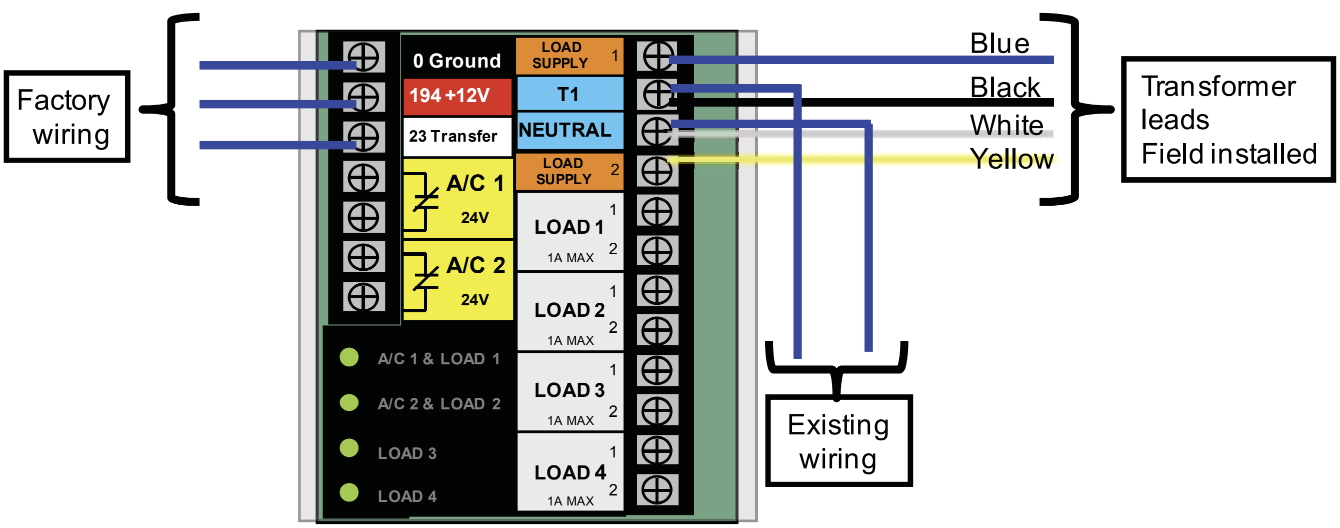
Following transfer switch installation and interconnection, inspect the entire installation carefully. A competent, qualified electrician should inspect it. The installation should comply strictly with all applicable codes, standards, and regulations. When absolutely certain the installation is proper and correct, complete a functional test of the system.

⚠ CAUTION!

Perform functional tests in the exact order presented in this manual, or damage could be done to the switch.

IMPORTANT: Before proceeding with functional tests, read and make sure all instructions and information in this section are understood. Also read the information and instructions of labels and decals affixed to the switch. Note any options or accessories that might be installed and review their operation.

Figure 2.3 — 24 Vac Supply Connections



3.2 MANUAL OPERATION

⚠ DANGER!

Do NOT manually transfer under load. Disconnect transfer switch from all power sources by approved means, such as the main circuit breaker(s).

A manual HANDLE is shipped with the transfer switch. Manual operation must be checked BEFORE the transfer switch is operated electrically. To check manual operation, proceed as follows:

1. Put the generator into the OFF mode.
2. Turn OFF both UTILITY (service disconnect circuit breaker) and GENERATOR (generator main line circuit breaker) power supplies to the transfer switch.
3. Note position of transfer mechanism main contacts by observing the moveable contact carrier arm. This can be viewed through the long narrow slot in the inside cover of the ATS. The top of the moveable contact carrier arm is yellow to be easily identified.
   - Manual operation handle in the UP position - LOAD terminals (T1, T2) are connected to UTILITY terminals (N1, N2).
   - Manual operation handle in the DOWN position - LOAD terminals (T1, T2) are connected to EMERGENCY terminals (E1, E2).

⚠ CAUTION!

Do not use excessive force when operating the transfer switch manually or damage could be done to the manual handle.

3.2.1 CLOSE TO UTILITY SOURCE SIDE

Before proceeding, verify the position of the switch by observing the position of manual operation handle in Figure 3.1. If the handle is UP, the contacts are closed in the NORMAL (UTILITY) position, no further action is required. If the handle is DOWN, proceed with Step 1.

Step 1: With the handle inserted into the moveable contact carrier arm, move handle UP. Be sure to hold on to the handle as it will move quickly after the center of travel.

Step 2: Remove manual operating handle from moveable contact carrier arm. Return handle to storage bracket.

3.2.2 CLOSE TO GENERATOR SOURCE SIDE

Before proceeding, verify the position of the switch by observing the position of the manual operation handle in Figure 3.1. If the handle is DOWN, the contacts are closed in the GENERATOR (STANDBY) position. No further action is required. If the handle is UP, proceed with Step 1.

Step 1: With the handle inserted into the moveable contact carrier arm, move the handle DOWN. Be sure to hold on to the handle as it will move quickly after the center of travel.

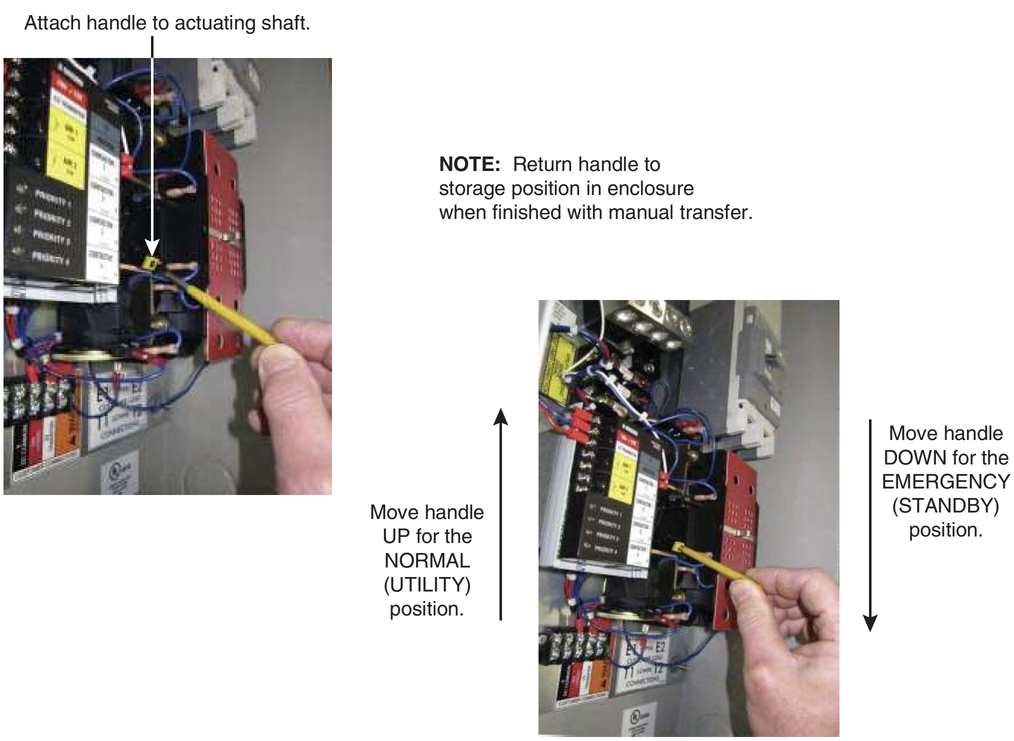
Step 2: Remove manual operating handle from moveable contact carrier arm. Return handle to storage bracket.

3.2.3 RETURN TO UTILITY SOURCE SIDE

Step 1: Manually actuate switch to return manual operating handle to the UP position.

Step 2: Remove manual operating handle from moveable contact carrier arm. Return handle to storage bracket.

Figure 3.1 — Actuating Transfer Switch



3.3 VOLTAGE CHECKS

1. Turn ON the UTILITY power supply to the transfer switch using the UTILITY SERVICE DISCONNECT circuit breaker.

⚠ DANGER!

PROCEED WITH CAUTION. THE TRANSFER SWITCH IS NOW ELECTRICALLY HOT. CONTACT WITH LIVE TERMINALS RESULTS IN EXTREMELY HAZARDOUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

2. With an accurate AC voltmeter, check for correct voltage. Measure across ATS terminal lugs N1 and N2. Also check N1 to NEUTRAL and N2 to NEUTRAL.
3. When certain that UTILITY supply voltage is correct and compatible with transfer switch ratings, turn OFF the UTILITY supply to the transfer switch.
4. Set the generator to the MANUAL mode. The generator should crank and start.
5. Let the generator stabilize and warm up at no-load for at least five minutes.
6. Set the generator's main circuit breaker (CB1) to its ON or CLOSED position.

⚠ DANGER!

PROCEED WITH CAUTION. GENERATOR OUTPUT VOLTAGE IS NOW BEING DELIVERED TO TRANSFER SWITCH TERMINALS. CONTACT WITH LIVE TERMINALS RESULTS IN EXTREMELY DANGEROUS AND POSSIBLY FATAL ELECTRICAL SHOCK.

7. With an accurate AC voltmeter and frequency meter, check the no-load, voltage and frequency.
   Measure across ATS terminal lugs E1 to E2. Also check E1 to NEUTRAL and E2 to NEUTRAL.
   a. Frequency..60-62 Hertz
   b. Terminals E1 to E2.............................240-246 VAC
   c. Terminals E1 to NEUTRAL..................120-123 VAC
   d. Terminals E2 to NEUTRAL..................120-123 VAC
8. Set the generator’s main circuit breaker (CB1) to its OFF or OPEN position.
9. Set the generator to the OFF mode to shut down the generator.

NOTE:

Do NOT proceed until generator AC output voltage and frequency are correct and within stated limits. If the no-load voltage is correct but no-load frequency is incorrect, the engine governed speed may require adjustment. If no-load frequency is correct but voltage is not, the voltage regulator may require adjustment.

3.4 GENERATOR TESTS UNDER LOAD

1. Set the generator's main circuit breaker to its OFF or OPEN position.
2. Set the UTILITY SERVICE DISCONNECT circuit breaker to the OFF or OPEN position.
3. Manually actuate the transfer switch main contacts to their GENERATOR (STANDBY) position. Refer to "Manual Operation".
4. To start the generator, put it into the MANUAL mode. When engine starts, let it stabilize for a few minutes.
5. Turn the generator's main circuit breaker to its ON or CLOSED position. The generator now powers all LOAD circuits. Check generator operation under load as follows:
   - Turn ON electrical loads to the full rated wattage/amperage capacity of the generator. DO NOT OVERLOAD.
   - With maximum rated load applied, check voltage and frequency across transfer switch terminals E1 and E2. Voltage should be greater than 230VAC and frequency should be greater than 59 Hertz. Also, verify that the gas pressure remains within acceptable parameters (see the generator Installation Guidelines manual).
   - Let the generator run under rated load for at least 30 minutes. With unit running, listen for unusual noises, vibration, overheating, etc., that might indicate a problem.
6. When checkout under load is complete, turn the generator's main circuit breaker to its OFF or OPEN position.
7. Let the generator run at no-load for several minutes. Then, shut down by putting it into the OFF mode.

3.5 CHECKING AUTOMATIC OPERATION

To check the system for proper automatic operation, proceed as follows:

1. Ensure that the generator is in it’s OFF mode.
2. Install front cover of the transfer switch.
3. Turn ON the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).

NOTE:

Transfer Switch will transfer back to utility position.

4. Set the generator’s main circuit breaker to its ON (or CLOSED) position.
5. Push the generator’s AUTO mode button. The system is now ready for automatic operation.
6. Turn OFF the utility power supply to the transfer switch.

With the generator ready for automatic operation, the engine should crank and start when the utility source power is turned OFF after a 10 second delay (factory default setting). After starting, the transfer switch should connect load circuits to the standby side after a five (5) second delay. Let the system operate through its entire automatic sequence of operation.

With the generator running and loads powered by generator AC output, turn ON the utility power supply to the transfer switch. The following should occur:

- After approximately 15 seconds, the switch should transfer loads back to the utility power source.
- Approximately one minute after re-transfer, the engine should shut down.

With the generator in the AUTOMATIC mode, the system is now set for fully automatic operation.

3.6 TESTING OVERLOAD PREVENTION CONTROL BOARD (OPCB)

A Test pushbutton is provided on the bottom of the OPCB to test the operation of the tested functions. The Test button will work when the ATS is in the Utility or the Generator position.

1. Turn the Utility supply on to the ATS.
2. Press the TEST pushbutton on the OPCB.
3. Verify that all of the connected loads to be “shed” become disabled. The method of verification will depend on the type of load.
4. After five (5) minutes verify AC 1 and Load 1 are energized Status LED AC 1 and Load 1 is ON.
5. After another 15 seconds, verify AC 2 and Load 2 are energized Status LED AC 2 and Load 2 are ON.
6. After another 15 seconds, verify Load 3 is energized Status Load 3 is ON.
7. After another 15 seconds, verify Load 4 is energized Status Load 4 is ON.

3.7 INSTALLATION SUMMARY

1. Ensure that the installation has been properly performed as outlined by the manufacturer and that it meets all applicable laws and codes.
2. Test and confirm proper operation of the system as outlined in the appropriate installation and owner’s manuals.
3. Educate the end-user on the proper operation, maintenance and service call procedures.

Important! If the end user ever finds it necessary to turn the generator off during prolonged utility outages to conserve on fuel, educate them on these simple, but important steps:

To turn the generator OFF (while running in AUTO and online):

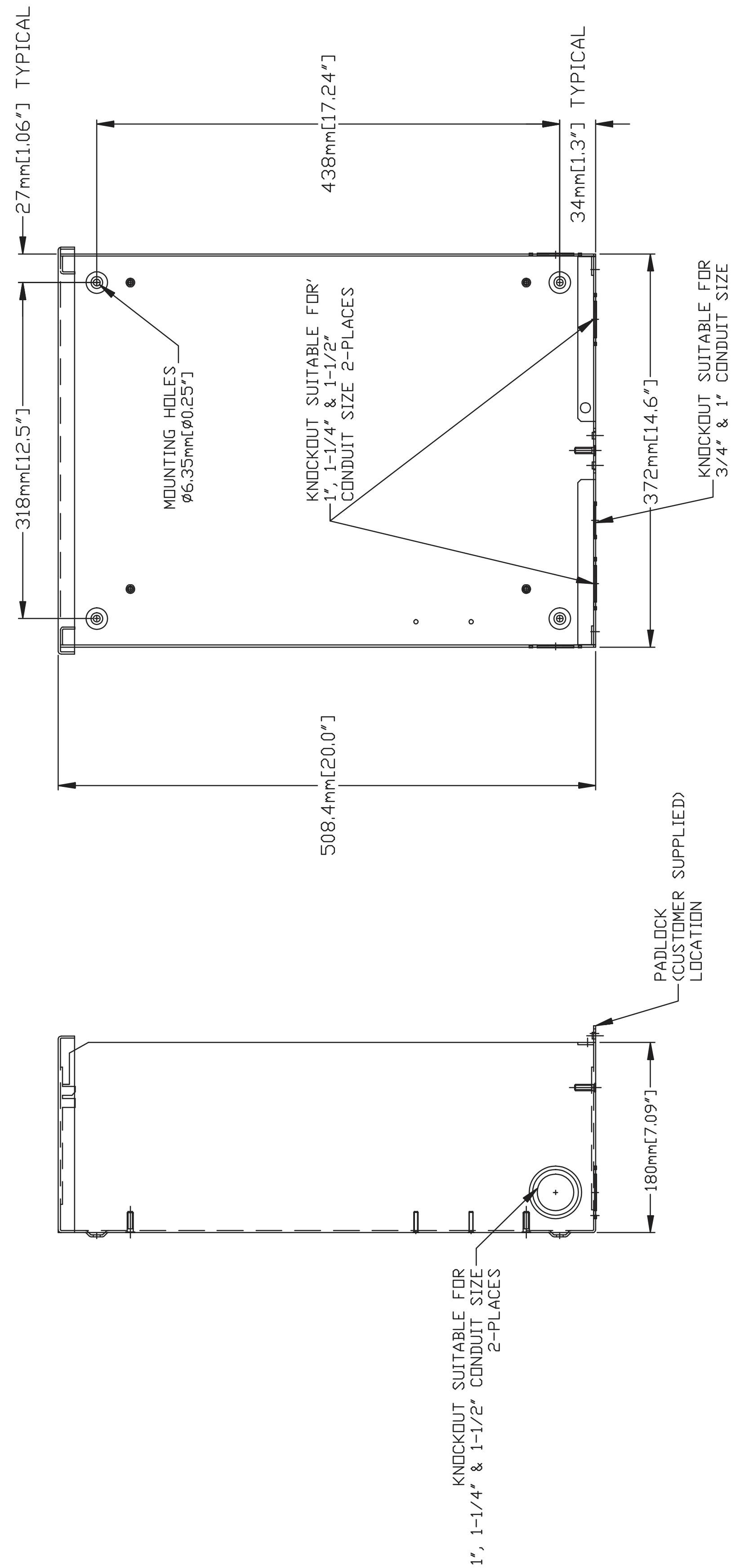
1. Turn OFF (or OPEN) the main Utility disconnect.
2. Turn OFF (or OPEN) the Main Line Circuit Breaker (MLCB) on the generator.
3. Turn the generator OFF.

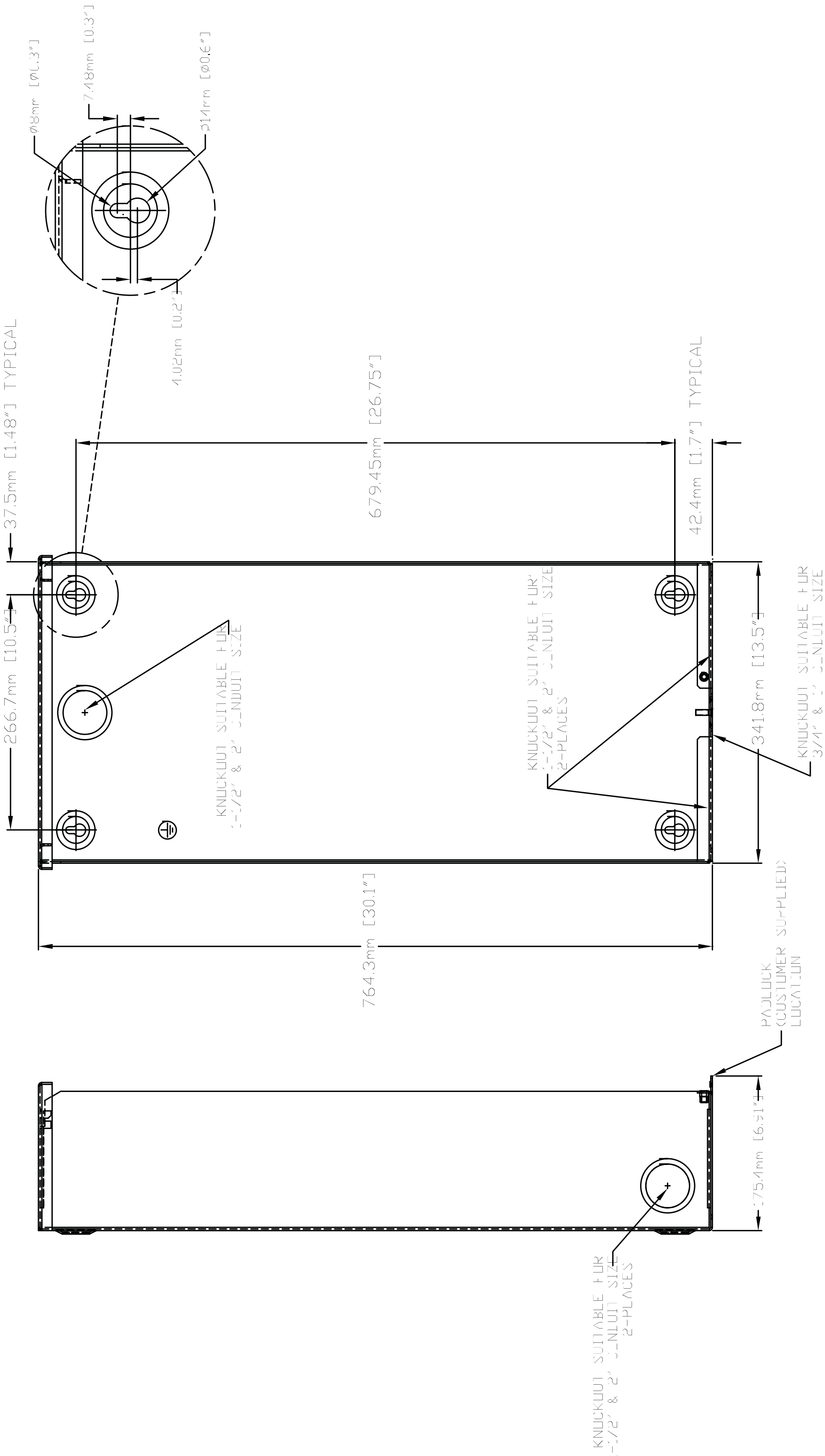
To turn the generator back ON:

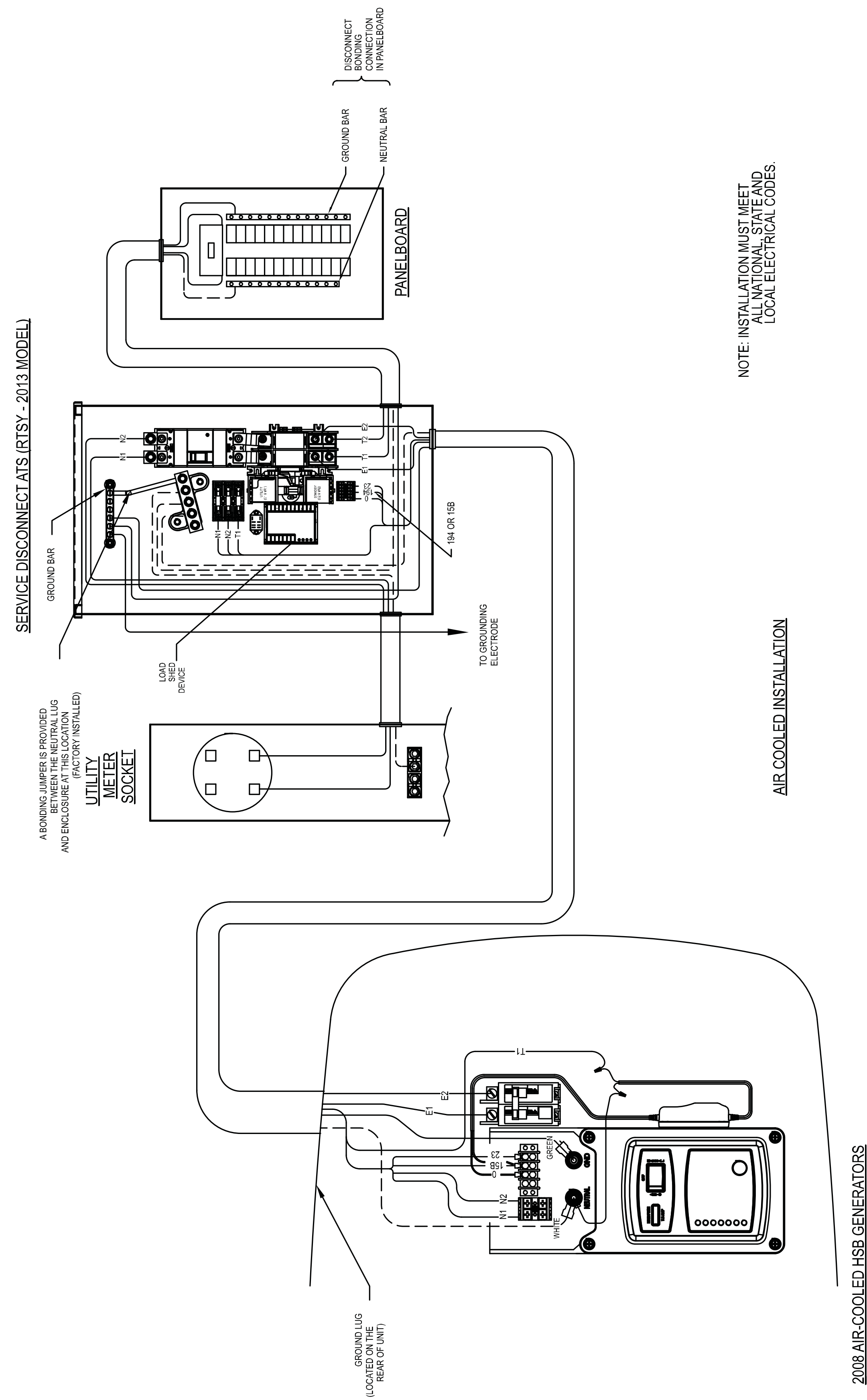
1. Put the generator back into AUTO and allow to start and warm-up for a few minutes.
2. Turn ON (or CLOSE) the MLCB on the generator.

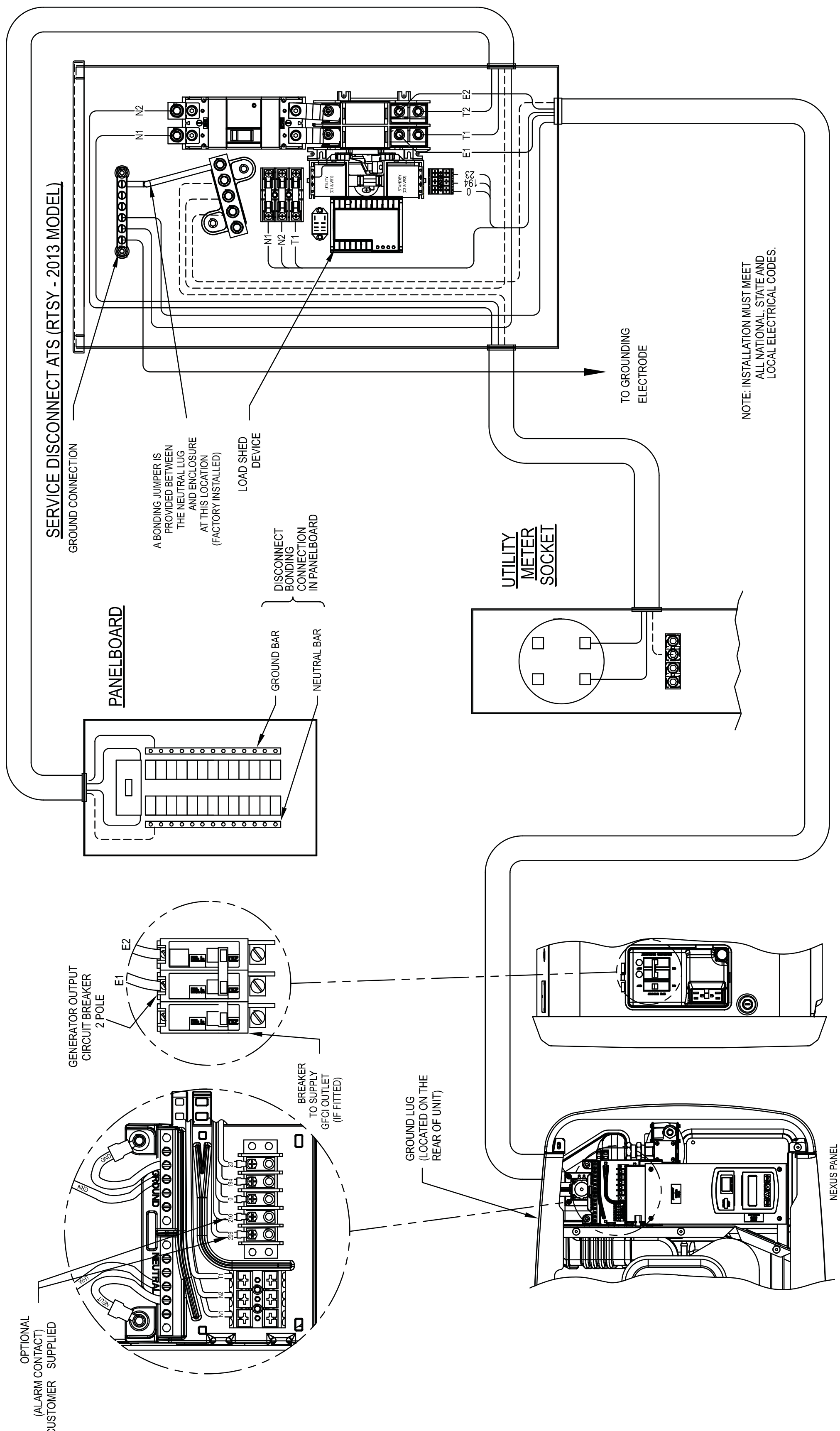
The system will now be operating in its automatic mode. The main utility disconnect can be turned ON (or CLOSED), but to shut the unit off, this complete process must be repeated.

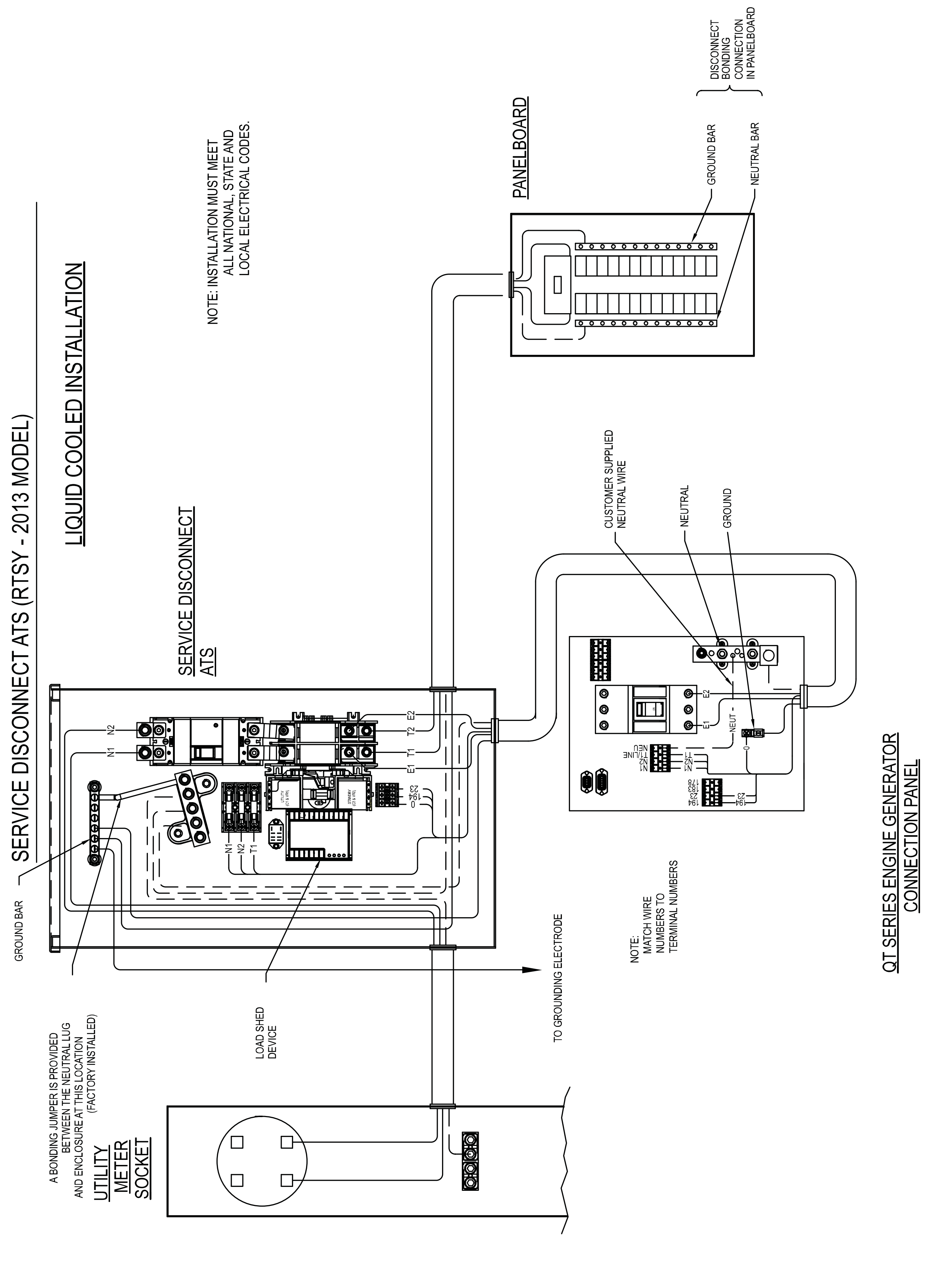
Notes

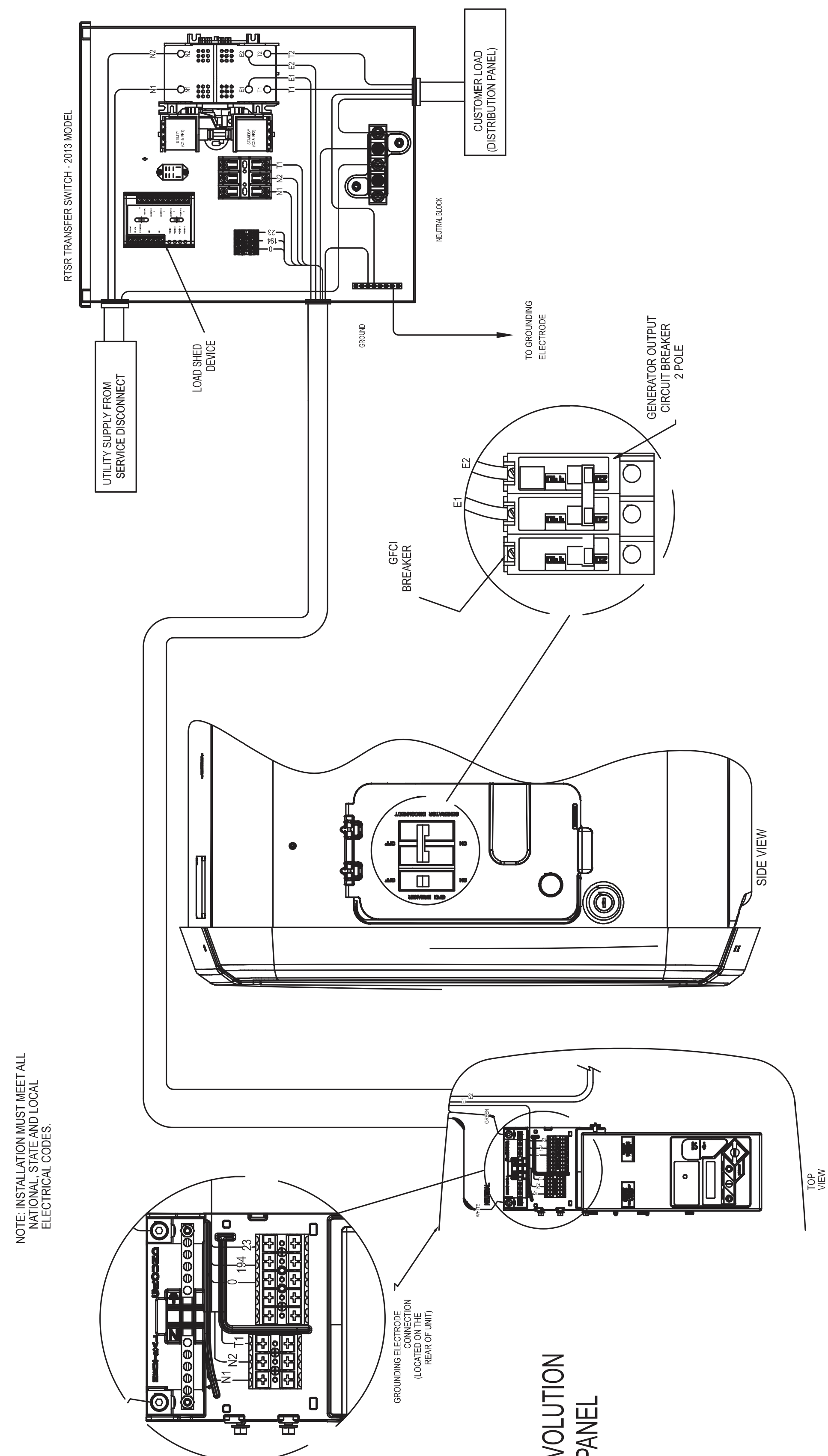

27mm[1.06"] TYPICAL
438mm[17.24"]
34mm[1.3"] TYPICAL
318mm[12.5"]
MOUNTING HOLES
Ø6.35mm[Ø0.25"]
KNOCKOUT SUITABLE FOR'
1", 1-1/4" & 1-1/2"
CONDUIT SIZE 2-PLACES
372mm[14.6"]
KNOCKOUT SUITABLE FOR
3/4" & 1" CONDUIT SIZE
508.4mm[20.0"]
PADLOCK
(CUSTOMER SUPPLIED)
LOCATION
180mm[7.09"]
KNOCKOUT SUITABLE FOR
1", 1-1/4" & 1-1/2" CONDUIT SIZE
2-PLACES

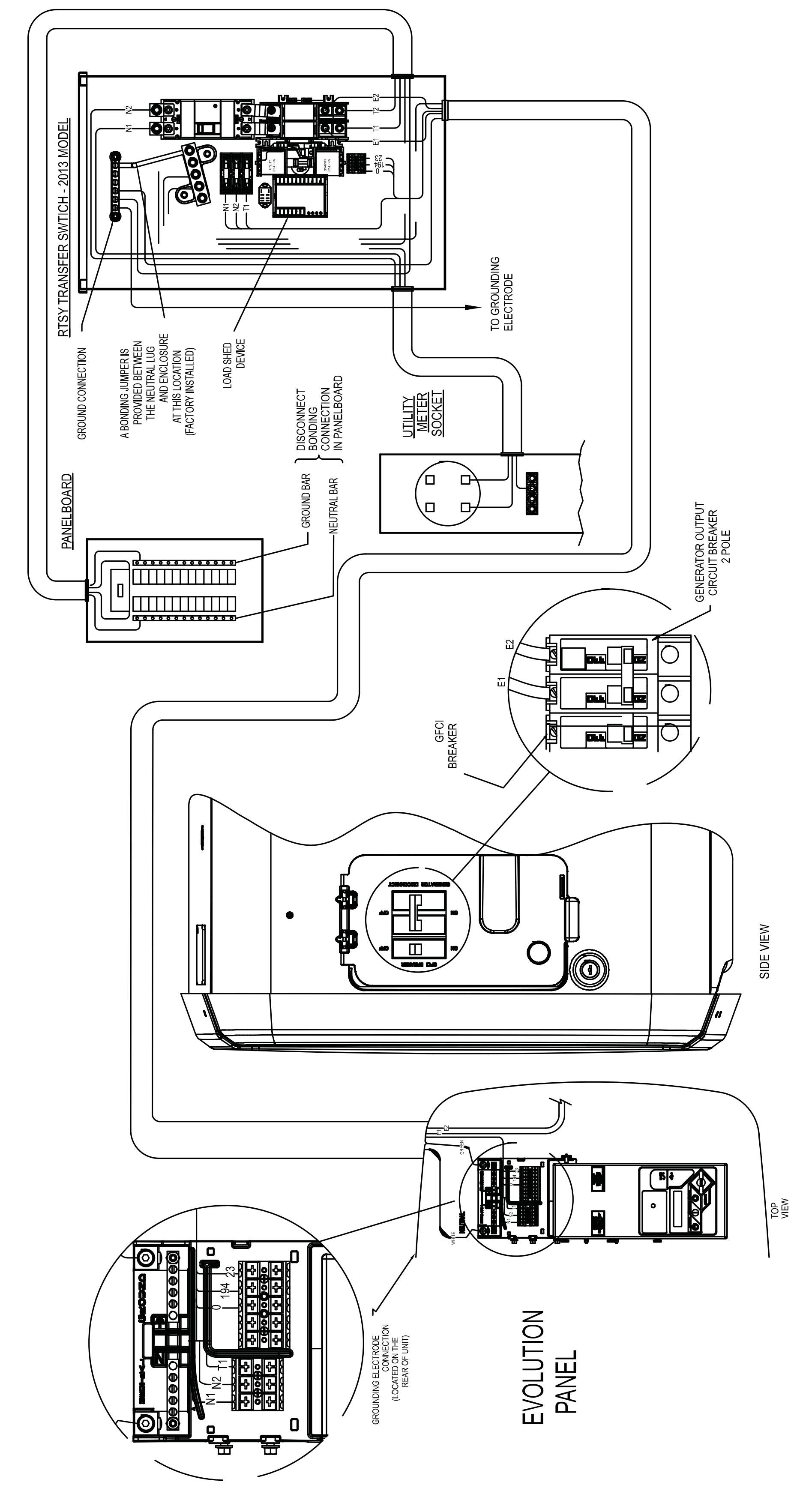

37.5mm [1.48"] TYPICAL
679.45mm [26.75"]
42.4mm [1.7"] TYPICAL
266.7mm [10.5"]
341.8mm [13.5"]
764.3mm [30.1"]
PADLOCK (CUSTOMER SUPPLIED) LOCATION
2-PLACES


DISCONNECT BONDING CONNECTION IN PANELBOARD
GROUND BAR
NEUTRAL BAR
PANELBOARD
NOTE: INSTALLATION MUST MEET ALL NATIONAL, STATE AND LOCAL ELECTRICAL CODES.
SERVICE DISCONNECT ATS (RTSY - 2013 MODEL)
GROUND BAR
N1 N2
E2 T2 E1 T1
N1 N2 T1
194 OR 15B
TO GROUNDING ELECTRODE
LOAD SHED DEVICE
A BONDING JUMPER IS PROVIDED BETWEEN THE NEUTRAL LUG AND ENCLOSURE AT THIS LOCATION (FACTORY INSTALLED)
UTILITY METER SOCKET
AIR COOLED INSTALLATION
T1
E2
E1
GREEN
23
15B
0
N1 N2
WHITE
GROUND LUG (LOCATED ON THE REAR OF UNIT)
2008 AIR-COOLED HSB GENERATORS


SERVICE DISCONNECT ATS (RTSY - 2013 MODEL)
GROUND CONNECTION
A BONDING JUMPER IS PROVIDED BETWEEN THE NEUTRAL LUG AND ENCLOSURE AT THIS LOCATION (FACTORY INSTALLED)
LOAD SHED DEVICE
N1
N2
T1
T2
E1
E2
TO GROUNDING ELECTRODE
NOTE: INSTALLATION MUST MEET ALL NATIONAL, STATE AND LOCAL ELECTRICAL CODES.
PANELBOARD
DISCONNECT BONDING CONNECTION IN PANELBOARD
GROUND BAR
NEUTRAL BAR
UTILITY METER SOCKET
GENERATOR OUTPUT CIRCUIT BREAKER 2 POLE
BREAKER TO SUPPLY GFCI OUTLET (IF FITTED)
GROUND LUG (LOCATED ON THE REAR OF UNIT)
NEXUS PANEL
OPTIONAL (ALARM CONTACT) CUSTOMER SUPPLIED
GROUND
NEUTRAL


SERVICE DISCONNECT ATS (RTSY - 2013 MODEL)
LIQUID COOLED INSTALLATION
NOTE: INSTALLATION MUST MEET ALL NATIONAL, STATE AND LOCAL ELECTRICAL CODES.
PANELBOARD
GROUND BAR
NEUTRAL BAR
DISCONNECT BONDING CONNECTION IN PANELBOARD
SERVICE DISCONNECT ATS
CUSTOMER SUPPLIED NEUTRAL WIRE
NEUTRAL
GROUND
GROUND BAR
LOAD SHED DEVICE
TO GROUNDING ELECTRODE
NOTE: MATCH WIRE NUMBERS TO TERMINAL NUMBERS
QT SERIES ENGINE GENERATOR CONNECTION PANEL
A BONDING JUMPER IS PROVIDED BETWEEN THE NEUTRAL LUG AND ENCLOSURE AT THIS LOCATION (FACTORY INSTALLED)
UTILITY METER SOCKET


RTSR TRANSFER SWITCH - 2013 MODEL
CUSTOMER LOAD (DISTRIBUTION PANEL)
UTILITY SUPPLY FROM SERVICE DISCONNECT
LOAD SHED DEVICE
NEUTRAL BLOCK
GROUND
TO GROUNDING ELECTRODE
GENERATOR OUTPUT CIRCUIT BREAKER 2 POLE
GFCI BREAKER
E1
E2
SIDE VIEW
TOP VIEW
NOTE: INSTALLATION MUST MEET ALL NATIONAL, STATE AND LOCAL ELECTRICAL CODES.
GROUNDING ELECTRODE CONNECTION (LOCATED ON THE REAR OF UNIT)
N1
N2
T1
0
194
23
EVOLUTION PANEL



NOTE: INSTALLATION MUST MEET ALL NATIONAL, STATE AND LOCAL ELECTRICAL CODES.

PLACE HOLDER FOR
GENERATOR OPERATION AND
MAINTENANCE MANUAL

OPERATION AND MAINTENANCE MANUAL

VOLUME III

TAB 13

GREENHECK WET WELL VENTILATOR

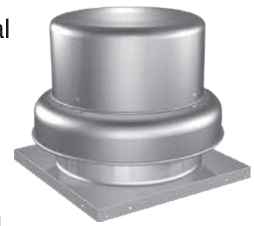
GREENHECK
Building Value in Air.

Document 471558
Model G Direct Drive
Model GB Belt Drive
Downblast Centrifugal Roof Exhaust

Installation, Operation and Maintenance Manual

Please read and save these instructions for future reference. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage!

Model G Direct Drive



Model G is a direct drive downblast centrifugal exhaust fan. These fans are specifically designed for roof mounted applications exhausting relatively clean air. Performance capabilities range up to 6,300 cfm *(10,703 m^3/hr)* and up to 1.75 in. wg *(435 Pa)* of static pressure. The maximum continuous operating temperature is 180°F *(82ºC)*. G models are available in 20 sizes with nominal wheel diameter ranging from 8 to 22 inches *(203 to 558 mm)* (060 - 203 unit sizes). Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number. All fans are UL/cUL Listed Standard 705.

Model GB Belt Drive

GB model fans are belt drive downblast centrifugal exhaust fans. These fans are specifically designed for roof mounted applications exhausting relatively clean air. Performance capabilities range up to 44,700 cfm *(75,950 m^3/hr)* and up to 3.25 in. wg *(809 Pa)* of static pressure. The maximum continuous operating temperature is 180°F *(82ºC)*. GB models are available in 29 sizes with nominal wheel diameters ranging from 11 to 54 inches *(279 to 1372 mm)* (071-540 unit sizes). Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number. All fans are UL/cUL Listed Standard 705.

General Safety Information

Only qualified personnel should install this fan. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if high winds or seismic activity is present. If more information is needed, contact a licensed professional engineer before moving forward.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electric Code (CEC) in Canada.
2. The rotation of the wheel is critical. It must be free to rotate without striking or rubbing any stationary objects.
3. Motor must be securely and adequately grounded.
4. Do not spin fan wheel faster than max cataloged fan RPM. Adjustments to fan speed significantly affects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to a duct while the fan is running.

DANGER
Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.

CAUTION
When servicing the fan, motor may be hot enough to cause pain or injury. Allow motor to cool before servicing.

CAUTION
Precaution should be taken in explosive atmospheres.

DANGER
Pour écarter les risques d'incendie, de choc électrique ou de blessure grave, veiller à toujours débrancher, verrouiller et étiqueter la source de courant avant l'installation ou l'entretien.

ATTENTION
Lors de toute intervention sur la soufflante, le moteur peut être suffisamment chaud pour provoquer une douleur voire une blessure. Laisser le moteur refroidir avant toute maintenance.

ATTENTION
Faire preuve de précaution dans les atmosphères explosives.

Receiving

Upon receiving the product, check to ensure all items are accounted for by referencing the delivery receipt or packing list. Inspect each crate or carton for shipping damage before accepting delivery. Alert the carrier of any damage detected. The customer will make notification of damage (or shortage of items) on the delivery receipt and all copies of the bill of lading which is countersigned by the delivering carrier. If damaged, immediately contact your Greenheck Representative. Any physical damage to the unit after acceptance is not the responsibility of Greenheck Fan Corporation.

Unpacking

Verify that all required parts and the correct quantity of each item have been received. If any items are missing, report shortages to your local representative to arrange for obtaining missing parts. Sometimes it is not possible that all items for the unit be shipped together due to availability of transportation and truck space. Confirmation of shipment(s) must be limited to only items on the bill of lading.

Handling

G Direct Drive

Lift unit on to the roof utilizing hooks under the lip of the shroud. Evenly space the hooks around the shroud using a minimum of four lifting straps. Use a spreader bar to ensure the straps do not come in contact with the unit (see Figure 1).

Figure 1

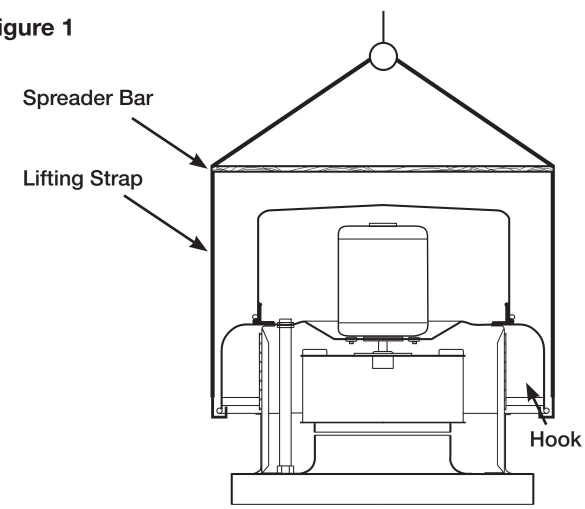


Figure 2

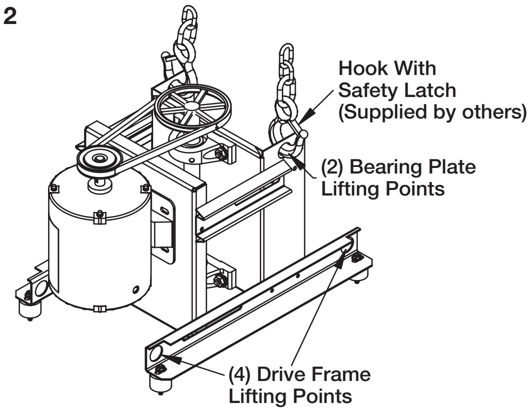
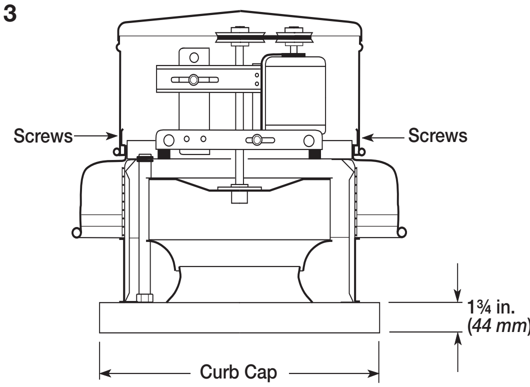


Figure 3



GB Belt Drive

When lifting the unit on to the roof, use either the four lifting points on the drive frame or the two lifting points on the bearing plate if present (see Figure 2 for lifting points). Access to the drive frame is accomplished by removing the screws pointed out in Figure 3. The cover can then be removed and placed on a flat surface in an area protected from strong winds.

When G/GB unit is on the roof, move fan to desired location using lifting points and fasten securely through mounting holes in base. Shims may be necessary depending upon roofing material thickness.

The motor amperage and voltage ratings must be checked for compatibility to supply voltage prior to final electrical connection. For G/GB installations, the electrical supply should be routed through the conduit chase located between the curb cap and the bottom of the motor compartment. Wiring must conform to local and national codes.

Storage

Fans are protected against damage during shipment. If the unit cannot be installed and operated immediately, precautions need to be taken to prevent deterioration of the unit during storage. The user assumes responsibility of the fan and accessories while in storage. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user.

Indoor

The ideal environment for the storage of fans and accessories is indoors, above grade, in a low humidity atmosphere which is sealed to prevent the entry of blowing dust, rain or snow. Temperatures should be evenly maintained between 30° to 110°F *(-1° to 43°C)* (wide temperature swings may cause condensation and "sweating" of metal parts). All accessories must be stored indoors in a clean, dry atmosphere.

Remove any accumulations of dirt, water, ice or snow and wipe dry before moving to indoor storage. To avoid "sweating" of metal parts, allow cold parts to reach room temperature. To dry parts and packages, use a portable electric heater to get rid of any moisture buildup. Leave coverings loose to permit air circulation and to allow for periodic inspection.

The unit should be stored at least 3½ inches *(89 mm)* off the floor on wooden blocks covered with moisture proof paper or polyethylene sheathing. Aisles between parts and along all walls should be provided to permit air circulation and space for inspection.

Outdoor

Fans designed for outdoor applications may be stored outdoors, if absolutely necessary. Roads or aisles for portable cranes and hauling equipment are needed.

The fan should be placed on a level surface to prevent water from leaking into the fan. The fan should be elevated on an adequate number of wooden blocks so that it is above water and snow levels and has enough blocking to prevent it from settling into soft ground. Locate parts far enough apart to permit air circulation, sunlight and space for periodic inspection. To minimize water accumulation, place all fan parts on blocking supports so that rain water will run off.

Do not cover parts with plastic film or tarps as these cause condensation of moisture from the air passing through heating and cooling cycles.

Fan wheels should be blocked to prevent spinning caused by strong winds.

Inspection and Maintenance during Storage

While in storage, inspect fans once per month. Keep a record of inspection and maintenance performed.

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. At each inspection, rotate the wheel by hand ten to fifteen revolutions to distribute lubricant on motor. If paint deterioration begins, consideration should be given to touch-up or repainting. Fans with special coatings may require special techniques for touch-up or repair.

Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. Immediately remove the original rust preventive coating with petroleum solvent and clean with lint-free cloths. Polish any remaining rust from surface with crocus cloth or fine emery paper and oil. Do not destroy the continuity of the surfaces. Thoroughly wipe clean with Tectyl® 506 (Ashland Inc.) or the equivalent. For hard to reach internal surfaces or for occasional use, consider using Tectyl® 511M Rust Preventive, WD-40® or the equivalent.

Removing From Storage

As fans are removed from storage to be installed in their final location, they should be protected and maintained in a similar fashion until the fan equipment goes into operation.

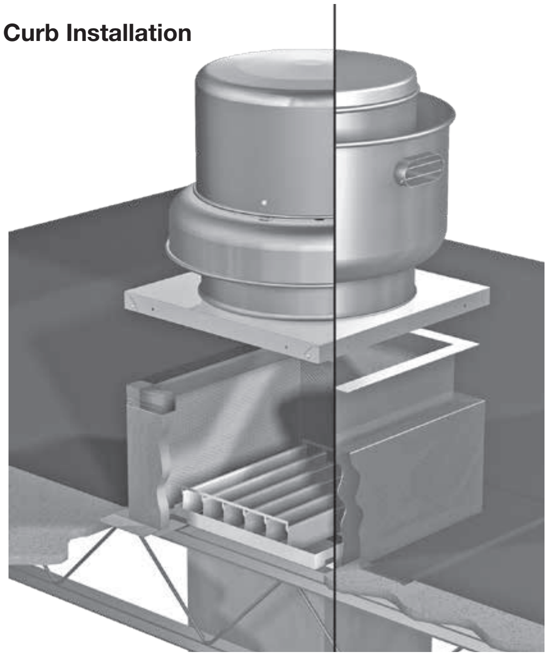
Table of Contents

Installation

Typical Roof Mounting Installation

1. On the roof surface, cut an appropriate sized hole and follow manufacturer's instructions on curb installation. Caulk and flash the curb to ensure a water tight seal.

Roof Curb Installation



2. If unit is equipped with a backdraft damper, it should be installed now.
3. Remove motor cover. Access to the motor compartment is accomplished by removing the screws as shown in Figure 3, page 2.
4. On GB Belt Drive fans, use the lifting lugs on the drive frame or bearing plate to lift and place the unit on top of roof curb. Refer to Figure 2, page 2.
5. On G Direct Drive fans, lift and place the unit on top of roof curb using hooks under the lip of the shroud. Refer to Figure 1, page 2.
6. Secure fan to curb using a minimum of eight lag screws, metal screws or the suitable fasteners. Shims may be required depending upon curb installation and roofing material.

   Note: *Severe duty applications may require additional fasteners. See page 6.*
7. Verify power line wiring is de-energized before connecting fan motor to power source.
8. Connect power supply wiring to the motor as indicated on the motor nameplate or terminal box cover. Check the power source for compatibility with the requirements of your equipment.
9. Check fan wheel for free rotation, recenter if necessary.
10. Check all fasteners for tightness.
11. Mount and wire safety disconnect switch under motor cover. Wire control switches at ground level, refer to Figure 4.
12. Replace motor cover.

Typical Wiring Diagram

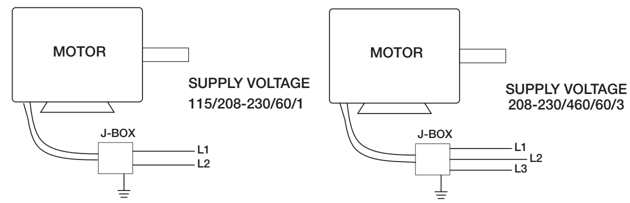


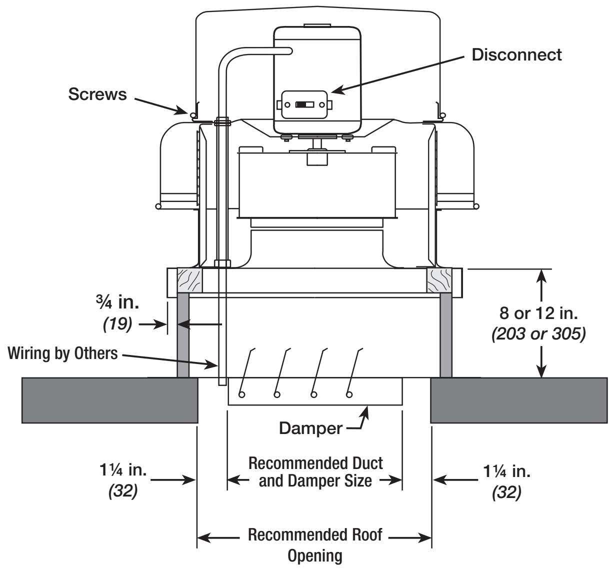
Figure 4

Vari-Green Wiring

For Vari-Green wiring, refer to the Vari-Green Motor and Controls Installation, Operation and Maintenance Manual for complete wiring and operation instructions.

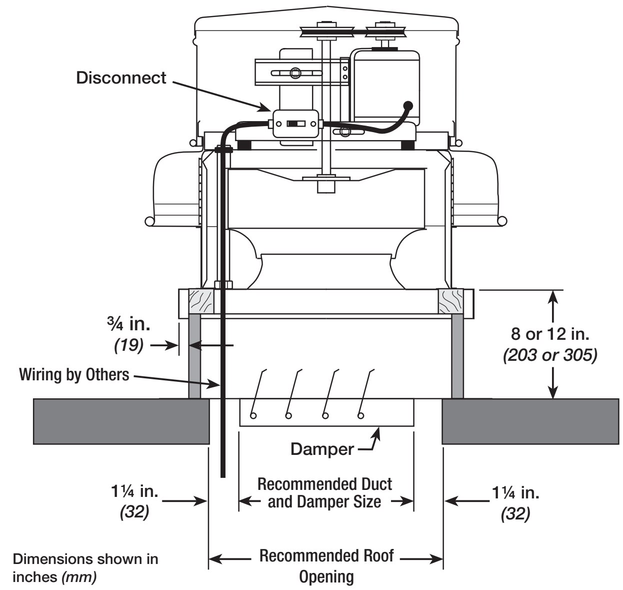
G Direct Drive

Figure 5 - Typical Roof Mounting Installation



GB Belt Drive

Figure 6 - Typical Roof Mounting Installation



Model	Curb Cap	Damper	Roof Opening	*Approx. Weight
G 060, 065, 070, 075	17 *(432)*	8 *(203)*	10½ *(267)*	18 *(8)*
G 080, 085, 090, 095	17 *(432)*	10 *(254)*	12½ *(318)*	26 *(12)*
G 097, 098, 099	19 *(483)*	12 *(305)*	14½ *(368)*	57 *(26)*
G 103, 103 HP	19 *(483)*	12 *(305)*	14½ *(368)*	62 *(28)*
G 123	19 *(483)*	12 *(305)*	14½ *(368)*	65 *(30)*
G 133	19 *(483)*	12 *(305)*	14½ *(368)*	66 *(30)*
G 143, 143 HP	22 *(559)*	16 *(406)*	18½ *(470)*	76 *(35)*
G 163	22 *(559)*	16 *(406)*	18½ *(470)*	80 *(36)*
G 183	30 *(762)*	18 *(457)*	20½ *(521)*	119 *(54)*
G 203	30 *(762)*	18 *(457)*	20½ *(521)*	130 *(59)*

- All dimensions are in inches (millimeters).

* Approximate weight shown in pounds (kilograms) is the largest cataloged Open Drip Proof motor.

- The roof curb should be 1½ in. (38 mm) less than the curb cap to allow for roofing and flashing.

Model	Curb Cap	Damper	Roof Opening	*Approx. Weight
GB 071, 081, 091	19 *(483)*	12 *(305)*	14½ *(368)*	58 *(26)*
GB 101, 101HP	19 *(483)*	12 *(305)*	14½ *(368)*	63 *(29)*
GB 121	19 *(483)*	12 *(305)*	14½ *(368)*	66 *(30)*
GB 131	19 *(483)*	12 *(305)*	14½ *(368)*	67 *(30)*
GB 141, 141HP	22 *(559)*	16 *(406)*	18½ *(470)*	83 *(38)*
GB 161, 161HP	22 *(559)*	16 *(406)*	18½ *(470)*	89 *(40)*
GB 180, 180HP	30 *(762)*	18 *(457)*	20½ *(521)*	125 *(57)*
GB 200, 200HP	30 *(762)*	18 *(457)*	20½ *(521)*	138 *(63)*
GB 220, 220HP, 240, 240HP	34 *(864)*	24 *(610)*	26½ *(673)*	158 *(72)*
GB 260	40 *(1016)*	30 *(762)*	32½ *(826)*	305 *(138)*
GB 300, 300HP	40 *(1016)*	30 *(762)*	32½ *(826)*	320 *(145)*
GB 330	46 *(1168)*	36 *(914)*	38½ *(978)*	385 *(175)*
GB 360, 360HP	46 *(1168)*	36 *(914)*	38½ *(978)*	403 *(183)*
GB 420	52 *(1321)*	42 *(1067)*	44½ *(1130)*	495 *(225)*
GB 480	52 *(1321)*	48 *(1219)*	50½ *(1283)*	623 *(283)*
GB 500	64 *(1626)*	54 *(1372)*	56½ *(1435)*	687 *(312)*
GB 540	64 *(1626)*	54 *(1372)*	56½ *(1435)*	748 *(339)*

- All dimensions are in inches (millimeters).

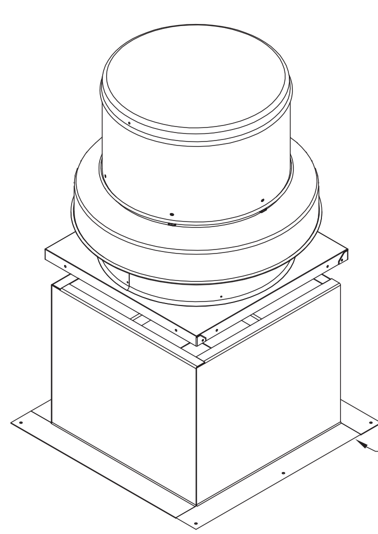
* Approximate weight shown in pounds (kilograms) is the largest cataloged Open Drip Proof motor.

- The roof curb should be 1½ in. (38 mm) less than the curb cap to allow for roofing and flashing.

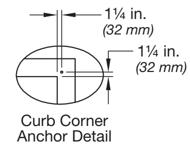
Mounting for Severe Duty Installations

Fan to Curb Mounting

5/16-inch self-drilling fasteners are to be installed on each side of fan with one fastener 4 inches from each edge and one fastener in the center. Fasteners are to be equally spaced.

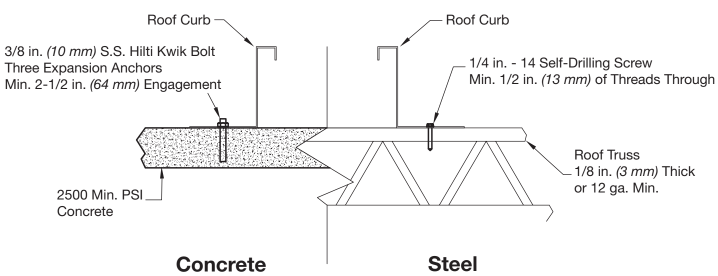


Fan Size	Fasteners Per Side
≤ 163	3
180 to 240	5
≥ 260	9



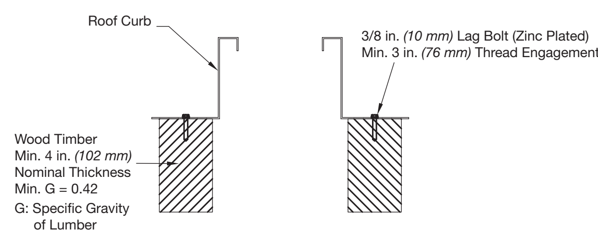
Curb to Deck Mounting

Fasteners need to be located on all four sides of the curb.



Concrete Deck Anchoring

Steel Deck Anchoring



Timber Anchoring

High Wind Ratings

	Fan Size	Curb Cap Size	Self-Drilling Screw Size	Fasteners Per Side	Total Fasteners
Concrete	≤ 141	17x17 to 22x22 *(432x432 to 559x559 mm)*	3/8”	3	12
	> 141	26x26 to 40x40 *(660x660 to 1016x1016 mm)*		3	12
Steel	≤ 141	17x17 to 22x22 *(432x432 to 559x559 mm)*	1/4” - 14	3	12
	> 141	26x26 to 40x40 *(660x660 to 1016x1016 mm)*		4	16
Timber	≤ 141	17x17 to 22x22 *(432x432 to 559x559 mm)*	3/8”	3	12
	> 141	26x26 to 40x40 *(660x660 to 1016x1016 mm)*		4	16

All dimensions are in inches *(millimeters)*.

Seismic Ratings

Fan Size	Fasteners Per Side	Total
060-300	2	8
330-540	3	12
060-300	2	8
330-540	3	12
060-300	2	8
330-540	3	12

NOTE: Installation instructions for seismic ratings are only recommendations.

Final design must be determined by Structural Engineer of Record (SEOR) including requirements for curb construction, mounting of unit to curb and mounting of curb to structure.

Pre-Starting Checks

1. Check all fasteners and setscrews for tightness. The wheel should rotate freely and be aligned as shown in Figure 7.

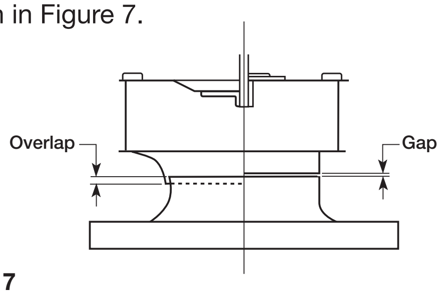


Figure 7

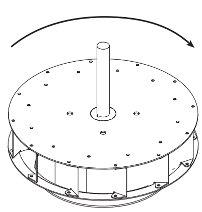
Model		Size	Overlap in. *(mm)*	Gap in. *(mm)*
G		060-095	–	3/32 *(2)*
G		097-163	1/4 *(6)*	–
	GB	071-161	1/4 *(6)*	–
G		183-243	3/8 *(10)*	–
	GB	180-240	3/8 *(10)*	–
	GB	260-540	1/2 *(13)*	–

2. Wheel position is preset and the unit is test run at the factory. Movement may occur during shipment and realignment may be necessary.
3. **Only G model** - Centering height alignment can be accomplished by loosening the set screws in the wheel and moving the wheel to the desired position.
4. **Only GB model** - Centering can be accomplished by loosening the bolts holding the drive frame to the shock mounts and repositioning the drive frame.

   Wheel and inlet cone overlap can be adjusted by loosening the set screws in the wheel and moving the wheel to the desired position.

   Fan RPM should be checked and verified with a tachometer.
5. Check wheel rotation (viewing from the shaft side) by momentarily energizing the unit. Rotation should be clockwise as shown in Figure 8 and correspond to rotation decal on the unit.

   If wheel rotation is incorrect, reverse two of the wiring leads or check motor wiring for single phase.



Clockwise Rotation

Figure 8

WARNING

Correct direction of wheel rotation is critical. Reversed rotation will result in poor air performance, motor overloading and possible motor burnout.

AVERTISSEMENT

La turbine doit impérativement tourner dans le bon sens. Une rotation en sens inverse entraînerait de mauvaises performances de soufflage, une surcharge du moteur voire un grillage du moteur.

IMPORTANT

The fan has been checked for mechanical noises at the factory prior to shipment. If mechanical noise should develop, suggested corrective actions are offered in the Troubleshooting section.

IMPORTANT

Over tightening will cause excessive bearing wear and noise. Too little tension will cause slippage at startup and uneven wear.

Model GB Pre-Starting Belt Tension Checks

6. Always loosen tension enough to install belts without stretching, see Figure 9.

   Do not force belt(s). Forcing the belts will break the cords and cause belt failure.

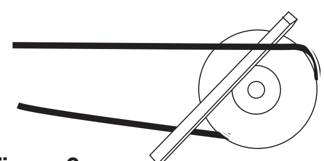


Figure 9

7. For units with two groove pulleys, adjust so the tension is equal in both belts.
8. If adjustments are made, it is very important to check the pulleys for proper alignment. Misaligned pulleys lead to excessive belt wear vibration, noise and power loss, see Figure 10.

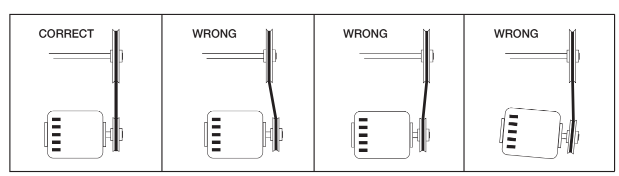


Figure 10

9. **For GB units:** Belt tension can be adjusted by loosening four fasteners on the drive frame, see Figure 11. The motor plate slides on the slotted adjusting arms and drive frame angles in the same manner.

   Four (4) fasteners in total.

   Identical fasteners on opposing side must also be loosened.

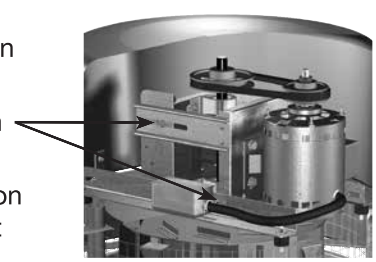


Figure 11

10. Belt tension can be adjusted by loosening four fasteners on the drive frame, see Figure 11. The motor plate slides on the slotted adjusting arms and drive frame angles in the same manner.
11. **Sizes 071-161:** Belts should be tensioned just enough to prevent slippage at full load.

    Note: Belts should have a slight bow on the slack side while running at full load, see Figure 12a.

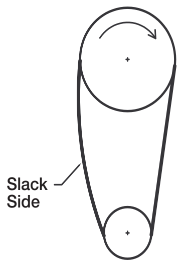


Figure 12a

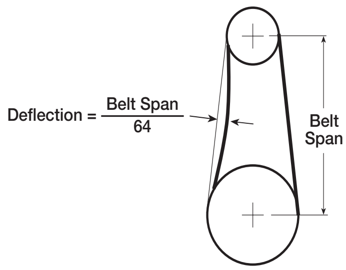


Figure 12b

    Sizes 180-540: Belt tension should be adjusted to allow 1/64 in. *(0.397 mm)* of deflection per inch of belt span. For example, a 15 in. *(381 mm)* belt span should have 15/64 in. *(0.234 mm)* (or about 1/4 in. *(6 mm)*) of deflection with moderate thumb pressure at mid-point between pulleys, see Figure 12b.
12. The adjustable motor pulley is factory set for the RPM specified. Speed can be increased by closing or decreased by opening the adjustable motor pulley.
13. Any increase in speed represents a substantial increase in the horsepower required by the unit.
14. Motor amperage should always be checked to avoid serious damage to the motor when speed is varied.

Operation

1. Before starting up or operating fan, check all fasteners for tightness. In particular, check the setscrews in wheel hub.
2. While in the OFF position or before connecting the fan to power, turn the fan wheel by hand to be sure it is not striking the venturi or any obstacle.
3. Start the fan and shut it off immediately to check rotation of the wheel with directional arrow in the motor compartment.
4. When the fan is started, observe the operation and check for any unusual noises.
5. With the system in full operation and all ductwork attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.
6. Keep inlets and approaches to fan clean and free from obstruction.

IMPORTANT
Adjust (tighten) belt tension after the first 24-48 hours of operation.

Inspection

Inspection of the fan should be conducted at the first 30 minute and 24 hour intervals of satisfactory operation.

30 Minute Interval

Inspect bolts, setscrews and motor mounting bolts. Adjust and tighten as necessary.

24 Hour Interval

Check all internal components. On GB unit only, inspect belt alignment and tension. Adjust and tighten as necessary.

Routine Maintenance

DANGER
Disconnect and secure to the “off” position all electrical power to the fan prior to inspection or servicing. Failure to comply with this safety precaution could result in serious injury or death.
DANGER
Pour écarter les risques de blessure grave ou de mort, débrancher et verrouiller l’alimentation électrique en position « Arrêt » avant tout contrôle ou entretien.
IMPORTANT
Uneven cleaning of the wheel will produce an out of balance condition that will cause vibration in the fan.
WARNING
This unit should be made non-functional when cleaning the wheel or housing (fuses removed, disconnect locked off).
AVERTISSEMENT
L’appareil doit être rendu non opérationnel lors du nettoyage de la turbine ou du caisson (fusibles retirés, sectionneur verrouillé).

Greasing of motors is only intended when fittings are provided. Many fractional horsepower motors are permanently lubricated and should not be lubricated after installation. Motors supplied with grease fittings should be greased in accordance with manufacturers’ recommendations. Where motor temperatures do not exceed 104ºF *(40ºC)*, the grease should be replaced after 2,000 hours of running time as a general rule.

Wheels require very little attention when moving clean air. Occasionally, oil and dust may accumulate causing imbalance. When this occurs, the wheel and housing should be cleaned to ensure smooth and safe operation.

All fasteners should be checked for tightness each time maintenance checks are performed prior to restarting unit.

A proper maintenance program will help these units deliver years of dependable service.

Belt and Bearing Maintenance for GB Model

1. Belts tend to stretch after a period of time. They should be checked periodically for wear and tightness. When replacing belts, use the same type as supplied with the unit.
2. Matched belts should always be used on units with multi-groove pulleys.
3. For belt replacement, loosen the tensioning device enough to allow removal of the belt by hand.
4. Once installed, adjust belts as shown in “Pre-Starting Checks.”
5. To ensure tightness, check pulley setscrews. Proper keys must be in keyways.
6. Fan RPM should not be readjusted. Only use pulleys of identical size and type when replacing pulleys.
7. Shaft bearings can be classified in two groups: relubricating and non-relubricating. All non-relubricating bearings on model GB fans are factory lubricated and require no further lubrication under normal use (between -20º to 180ºF *(-29º to 82ºC)* in a relatively clean environment).
8. On GB belt driven fans, the standard cast pillow block bearings are factory lubricated and are provided with external grease fittings. Annual lubrication is recommended, or more frequently if needed (See Table 2). Do not over-grease. Use only one or two shots of lubricant with a hand gun. Maximum hand gun rating is 40 psi. Rotate bearings during lubrication where good safety practice permits. Caution should be employed to prevent over packing or contamination.
9. Grease fittings should be wiped clean. The unit should be in operation while lubricating. Extreme care should be used around moving parts.
10. Grease should be pumped in very slowly until a slight bead forms around the seal. A high grade lithium base grease should be used. (See Table 3)
11. During the first few months of operation, check bearing setscrews periodically to ensure tightness.
12. If unit is to be left idle for an extended period, remove belts and store in a cool, dry place to avoid premature belt failure.

Recommended Bearings Lubrication Frequency in Months

NOTE: If unusual environment conditions exist (extreme temperature, moisture or contaminants) more frequent lubrication is required.

A good quality lithium base grease, conforming to NLGI Grade 2 consistency, such as those listed in Table 3 may be used.

Table 2: Suggested Fan Bearing Lubrication Intervals

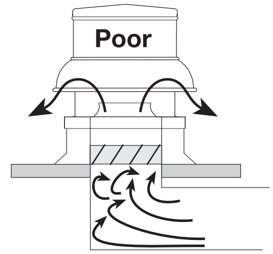
Interval (months)	Type of Service
1 to 3	Heavy duty in dirty, dusty locations; high ambient temperatures; moisture laden atmosphere; vibration.
3 to 6	12 to 24 hours per day, heavy duty, or if moisture is present
6 to 12	8 to 16 hours per day in clean, relatively dry atmosphere
12 to 18	Infrequent operation or light duty in clean atmosphere

Table 3: Grease Manufacturers

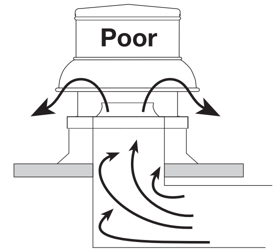
Manufacturer	Grease (NLGI #2)
U.S. Electric Motors	Grease No. 83343
Chevron U.S.A. Inc	Chevron SRI Grease #2
Mobil Oil Corporation	Mobilith
	Mobil 532
Texaco, Inc.	Premium BRB #2
	Texaco Multifak #2
Amoco Oil Co.	Rykon Premium #2
Exxon	Unirex N2
Shell	B Shell Alvania #2

Fan Inlet Connections

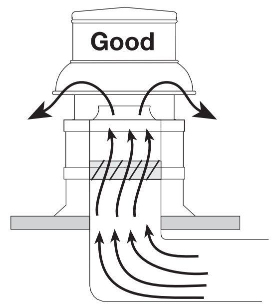
In order to assure proper fan performance, caution must be exercised in fan placement and connection to the ventilation system. Obstructions, transitions, poorly designed elbows, improperly selected dampers, etc., can cause reduced performance, excessive noise and increased mechanical stress. For performance to be as published, the system must provide uniform and stable airflow into the fan.



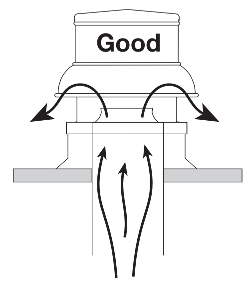
Dampers must open fully. Use motorized dampers in low airflow applications to reduce losses.



Avoid sharp turns or entrance conditions which cause uneven flow. Use turning vanes in elbows to reduce adverse effects.



Provide uniform airflow at fan inlet and through the damper to assure optimum performance. The curb cap should be three wheel diameters from the radius. Use turning vanes in duct when possible.



Provide uniform airflow at fan inlet to assure optimum performance.

Troubleshooting

WARNING
Before taking any corrective action, make certain unit is not capable of operation during repairs.

AVERTISSEMENT
Avant d’entreprendre toute action corrective, s’assurer que l’appareil ne pourra pas fonctionner durant les réparations.

PROBLEM	CAUSE	CORRECTIVE ACTION
Excessive noise or vibration	Wheel rubbing inlet	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	V-belt drive	Tighten pulleys on motor/fan shaft. Adjust belt tension. Align pulleys properly, see page 7, Figure 9-10. Replace worn belts or pulleys.
	Bearings	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel unbalance	Clean all dirt off wheel. Check wheel balance, rebalance in place if necessary.
	Belts too tight or too loose	Adjust tension, see page 8, Figure 12a-b.
	Wheel improperly aligned and rubbing	Center wheel on inlet, see page 7, Figure 7.
	Loose drive or motor pulleys	Align and tighten. See “Pre-Starting Checks”, see page 7.
	Foreign objects in wheel or housing	Remove objects, check for damage or unbalance.
	Fan base not securely anchored	Secure properly.
	Motor hood loose and rattling	Tighten screws securing motor hood.
	Defective or loose motor bearings	Replace motor with same frame size, RPM-HP.
High horsepower	Fan	Check rotation of wheel, see page 7, Figure 8. Reduce fan speed.
	Duct system	Resize ductwork. Check proper operation of face and bypass dampers. Check filters and access doors.
Fan does not operate	Electrical supply	Check fuses/circuit breakers. Check for switches off. Check for correct supply voltage.
	Drive	Check for broken belts. Tighten loose pulleys.
	Motor	Assure motor is correct horsepower and not tripping overload protector.
Motor overloads or overheats	Lubrication	Check for excessive or insufficient grease in the bearing.
	Mechanical	Replace damaged bearing. Relieve excessive belt tension. Align bearings. Check for bent shaft.
	Belt slippage	Adjust tension or replace bad belts, see page 7-8.
	Over/Under line voltage	Contact power company.
	Incorrect wheel rotation	Check motor wiring (page 4) verify motor is wired for correct rotation.
	Wheel RPM too high	Check drives or slow down fan by opening variable pitch pulley on motor shaft.
	Undersized motor	Check motor ratings with catalog speed and air capacity chart.
	Motor wired incorrectly	Check motor wiring to wiring diagram located on fan motor.
Reduced airflow	System resistance too high	Check system: Proper operation of backdraft or control dampers, obstruction in ductwork, clean dirty filters.
	Unit running backwards	Correct as shown on page 7, Figure 8.
	Excessive dirt buildup on wheels	Clean wheel.
	Improper wheel alignment	Center wheel on inlets, see Pre-Starting checks on page 7, Figure 7.
	Dampers closed	Inspect and repair.
	Blocked duct/clogged filter	Clean or replace.
	Belt slippage	Replace and adjust tension.
	Speed too slow	Check for correct drives.

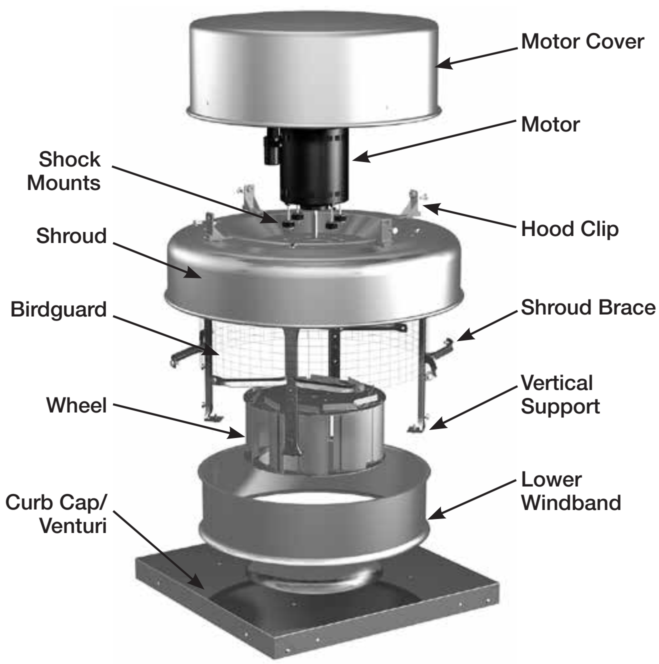
Parts List

Each fan bears a manufacturer's nameplate with model number and serial number embossed. This information will assist the local Greenheck representative and the factory in providing service and replacement parts. Before taking any corrective action, make certain unit is not capable of operation during repairs.

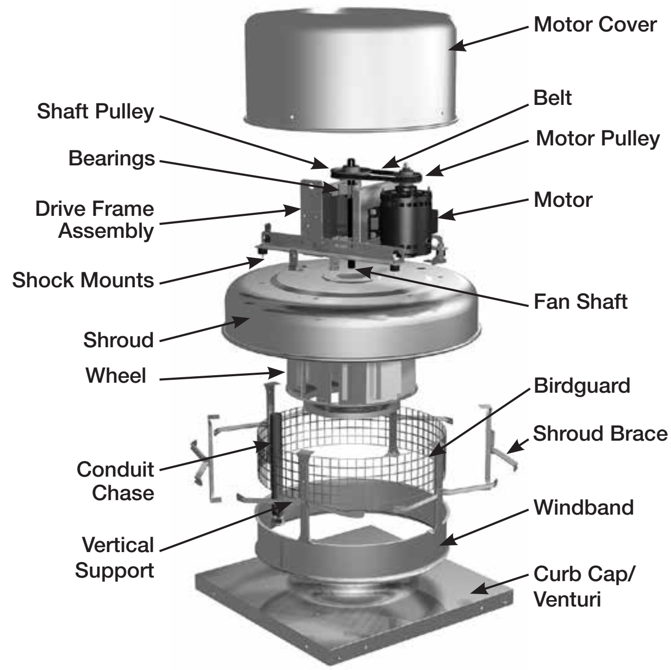
CAUTION
A fan manufactured with an explosion resistant motor does not certify the entire unit to be explosion proof. Refer to UL Listing Mark for the fans approved usage.

CAUTION
La présence d'un moteur antidéflagrant sur un ventilateur ne garantit pas que tout l'appareil est antidéflagrant. Pour connaître les emplois autorisés de l'appareil, voir son marquage de conformité UL.

G Direct Drive



GB Belt Drive



Our Commitment

As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.

Specific Greenheck product warranties are located on greenheck.com within the product area tabs and in the Library under Warranties.

Greenheck's Centrifugal Upblast and Sidewall Exhaust catalog provides additional information describing the equipment, fan performance, available accessories, and specification data.

AMCA Publication 410-96, Safety Practices for Users and Installers of Industrial and Commercial Fans, provides additional safety information. This publication can be obtained from AMCA International, Inc. at www.amca.org.

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OPERATION AND MAINTENANCE MANUAL

VOLUME III

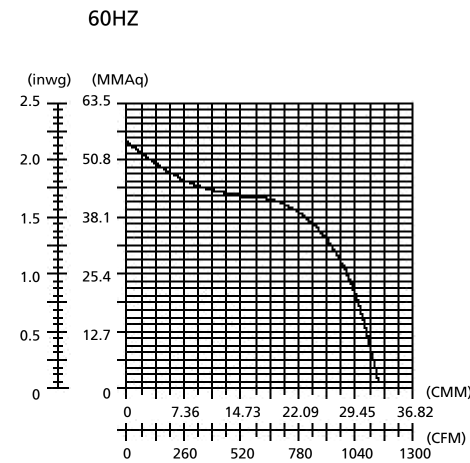
TAB 14

DAYTON VALBE VAULT BLOWER

Dayton® PSC and Shaded Pole Blowers

Description

Dayton PSC and Shaded Pole blowers provide economical air delivery for general heating, cooling, ventilating, or component cooling. Typical applications include cooling greenhouses, blowers for wood and corn stoves, ventilating small buildings, cooling electrical enclosures and removing heat from machinery. The blowers are exact replacements for many OEM blowers with the same physical footprint. Forward curve wheels driven by Dayton motors are rated for continuous duty with all-position mount. These units incorporate balanced ball or sleeve-bearing motors with cast aluminum end shields. This provides greater heat dissipation and protection, reducing down time due to component failure and accidental damage. Direct drive blower wheels are dynamically balanced to reduce noise and vibration and to maintain CFM at higher static pressures.



Specifications

Reference Number	CFM @0″	0.1″	0.2″	0.3″	0.4″	0.5″	0.6″	0.7″	0.8″	VOLTS	AMPS	HZ
1TDU2*	1162	1150	1130	1140	1120	1100	1080	1075	1040	115/230	7.3 @115V 3.7 @230V	60

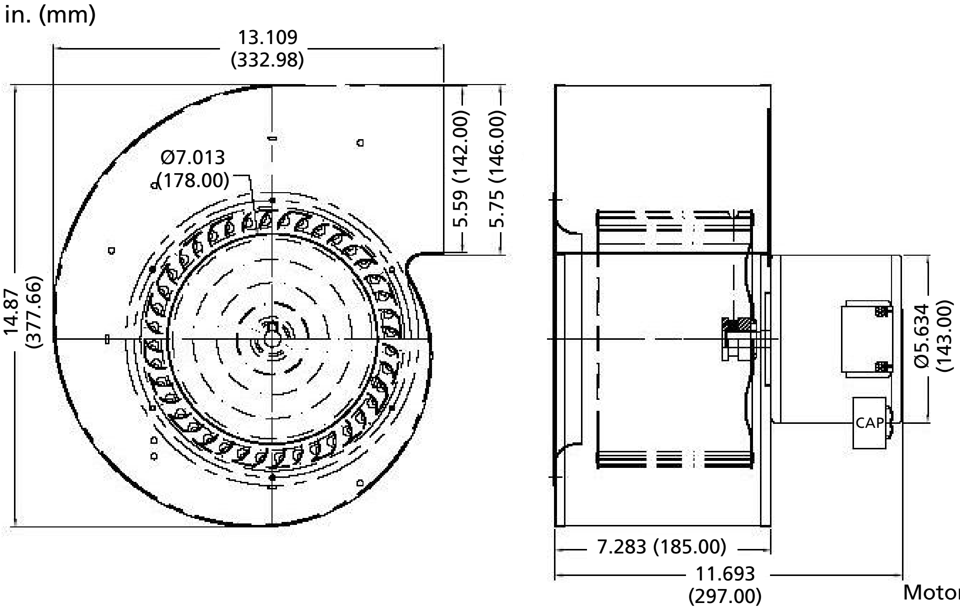
* Replaces 4C831

NOTE: Includes Conduit Box with 8″ Lead Length.

NOTE: Not suitable for use with speed-controlled devices.

Dimensions

in. (mm)



Features

- PSC motor
- Baked enamel Gray finish
- Heavy gauge steel housing
- All position Mounting
- Maximum Ambient Temperature 104°F
- Suitable for 50Hz operation

Additional Benefits

- Permanently Lubricated Ball-Bearings
- Extruded Aluminum Blower Frame for Increased Rigidity
- Auto-Thermal Protection

Motor Component Recognition c RU us E47479

Dayton®

Dayton® PSC and Shaded Pole Blowers

DISCLAIMER. *Dayton has made a diligent effort to provide product information and illustrate the products in this literature accurately; however, such information and illustrations are for the sole purpose of identification, and do not express or imply a warranty that the products are MERCHANTABLE, or FIT FOR A PARTICULAR PURPOSE, or that the products will necessarily conform to the illustrations or descriptions.*

PRODUCT SUITABILITY. *Many jurisdictions and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, review the product applications, and all applicable national and local codes and regulations, and be sure that the product, installation, and use will comply with them.*

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Project:	Date:
Location:	

Notes