SQUARE D
Instruction Bulletin

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Raleigh, NC, U.S.A.

Omegapak® Class 8803 Type P AC Drive
1.5 to 150 hp
Variable Torque

⚠ DANGER

HAZARDOUS VOLTAGE.

- Read and understand this manual in its entirety before installing or operating Omegapak AC drive controllers. Installation, adjustment, repair and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 2-10 on page 26 and Figure 2-11 on page 27 for drive controller grounding points.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before installing controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the controller disconnect.
- Lock disconnect in open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

PLEASE NOTE:

Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

Table of Contents

Chapter 4: Maintenance

Chapter 5: Options and Special Features

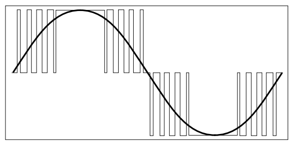
LIST OF FIGURES

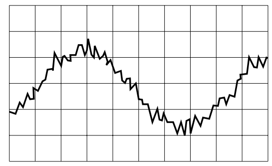
LIST OF TABLES

Chapter 1 – Omegapak® Class 8803 Type P AC Drive

INTRODUCTION

This manual covers the variable torque Omegapak® Class 8803 Type P AC drive, a frequency inverter operating on the principle of synthesizing a sine wave by pulse width modulation (PWM). The resulting current waveform is very close to a sine wave, as shown below. Throughout this manual, the drive is referred to as a drive controller.





When associated with a standard three phase synchronous or asynchronous squirrel cage motor, this controller provides a simple and reliable motor/drive controller combination.

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- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

HANDLING THE DRIVE CONTROLLER

Do not remove the drive controller from the carton until it is at the final installation site. The carton protects the controller and prevents damage to its exterior. Handle the controller carefully to avoid damage to the internal components, frame or exterior. When handling a controller, balance it carefully to keep it from tipping.

Two lifting straps are supplied with 60 to 150 hp controllers for removing them from the carton. Once removed from the carton, the controllers can be handled:

- ❑ With a hoist, attaching a spreader bar to the two lifting rings on top of the drive controller as shown in Figure 1-1, or
- ❑ In a horizontal position, with the back of the controller resting on a pallet.

Place the drive controller in an upright position.

WARNING

HAZARD OF SEVERE PERSONAL INJURY OR DEATH.

Keep area below any equipment being lifted clear of all personnel and property. Use lifting method shown below in Figure 1-1.

Failure to observe these precautions can result in severe personal injury or death!

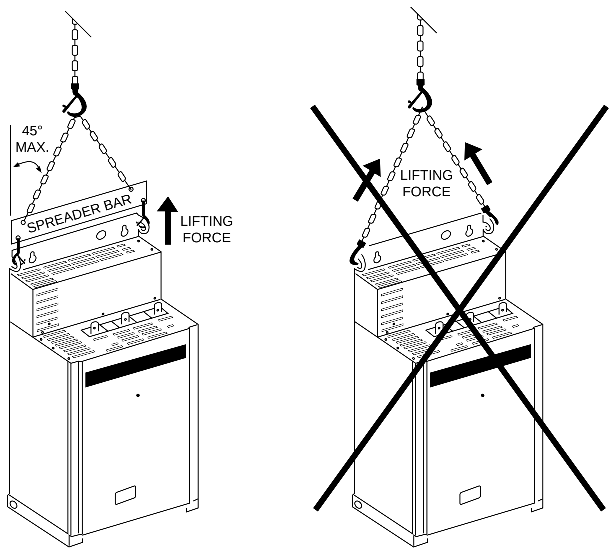

Figure 1-1 Hoisting the 60 to 150 hp Controller

PRELIMINARY INSPECTION

The controller must be thoroughly inspected before storing or installing:

1. Remove the drive controller from its packaging and visually inspect exterior for shipping damage.
2. Make sure controller label conforms to the packing slip and corresponding purchase order.
3. Visually verify that the terminal strip is properly seated, securely fastened and undamaged.
4. Open the drive controller door or remove access covers.
5. Visually verify that the control board is properly seated, securely fastened and undamaged. Verify that internal wiring connections are tight. Inspect all connections for damage.
6. Close and secure the drive controller door or replace access covers.
7. If any shipping damage is found, notify the carrier and your Square D representative.

CAUTION

EQUIPMENT DAMAGE HAZARD.

Do not operate or install any drive controller that appears damaged!

Failure to observe this precaution could result in personal injury, product damage or property damage.

DESIGN AND OPERATION

Omegapak 1.5 to 3 hp Controllers

This section applies to 1.5 to 3 hp drive controllers at 460 V (PØØVO4C to PØØVO4E).

The measurement board components, rectifier, filter capacitors, thermal sensor and the six transistor modules of these drive controllers are all mounted on the power board. The dialog unit and control jumpers are located on the control board.

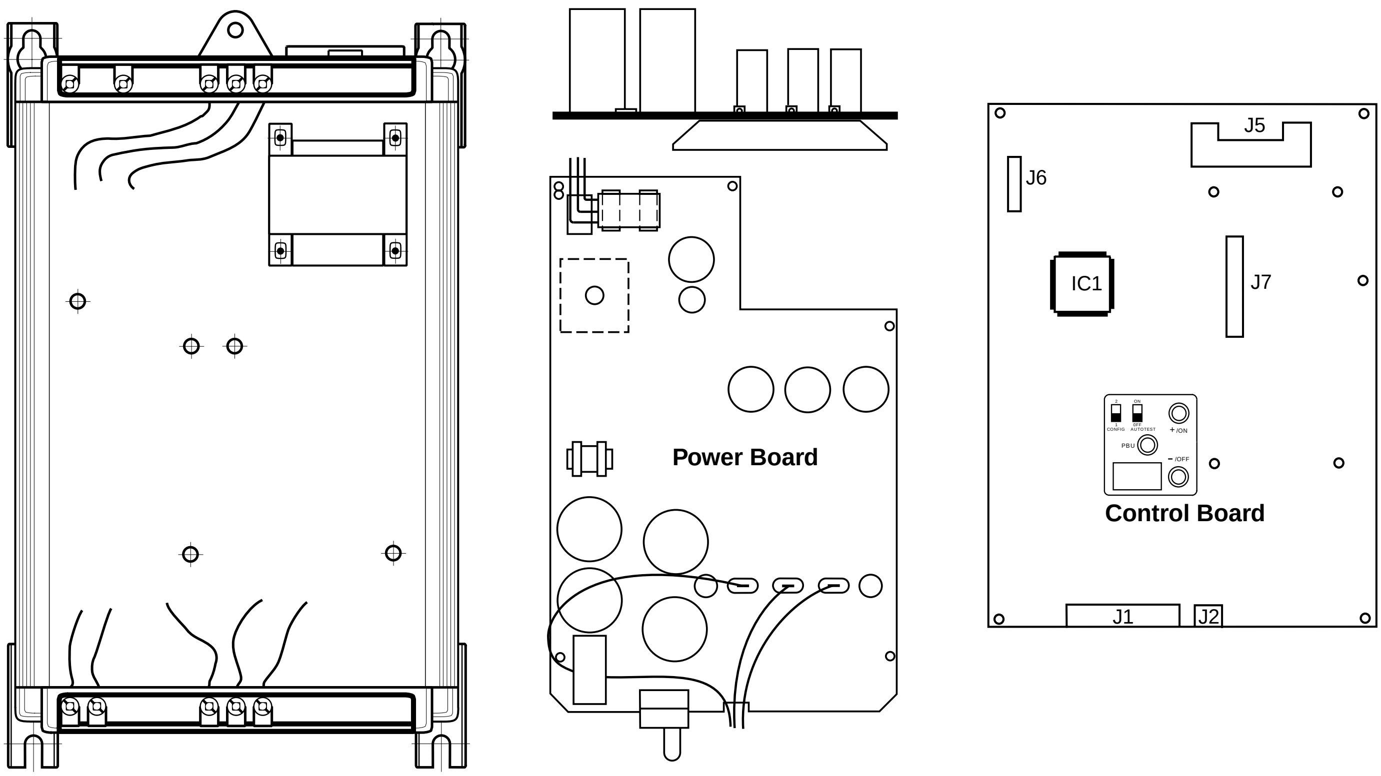

Figure 1-2 Design of 1.5 to 3 hp Controllers

Functional Block Diagram

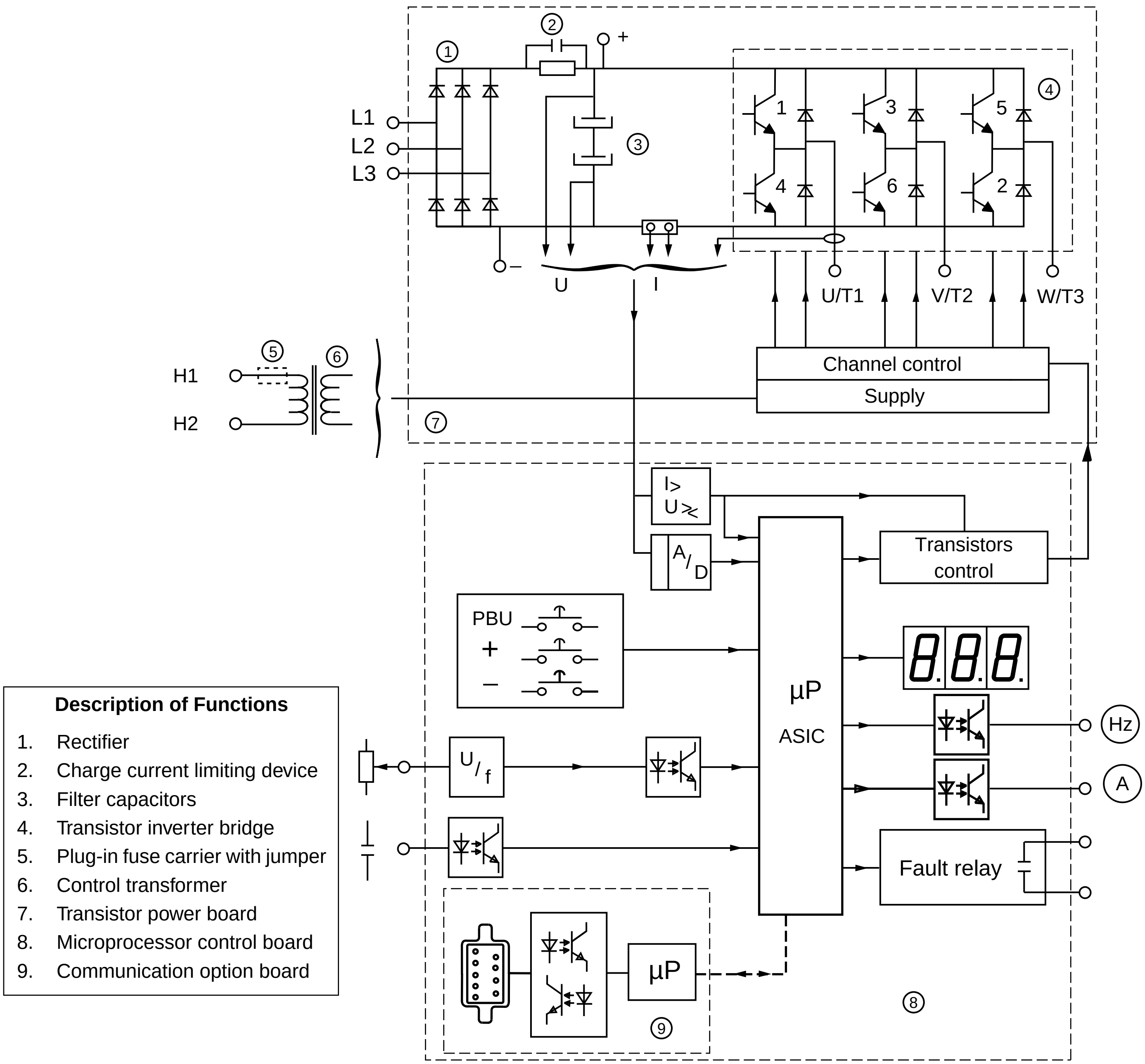

Figure 1-3 Functional Block Diagram for 1.5 to 3 hp Controllers

Omegapak 7.5 to 50 hp Controllers

This section applies to 7.5 to 50 hp drive controllers at 460 V (PØØVO4G to 4P).

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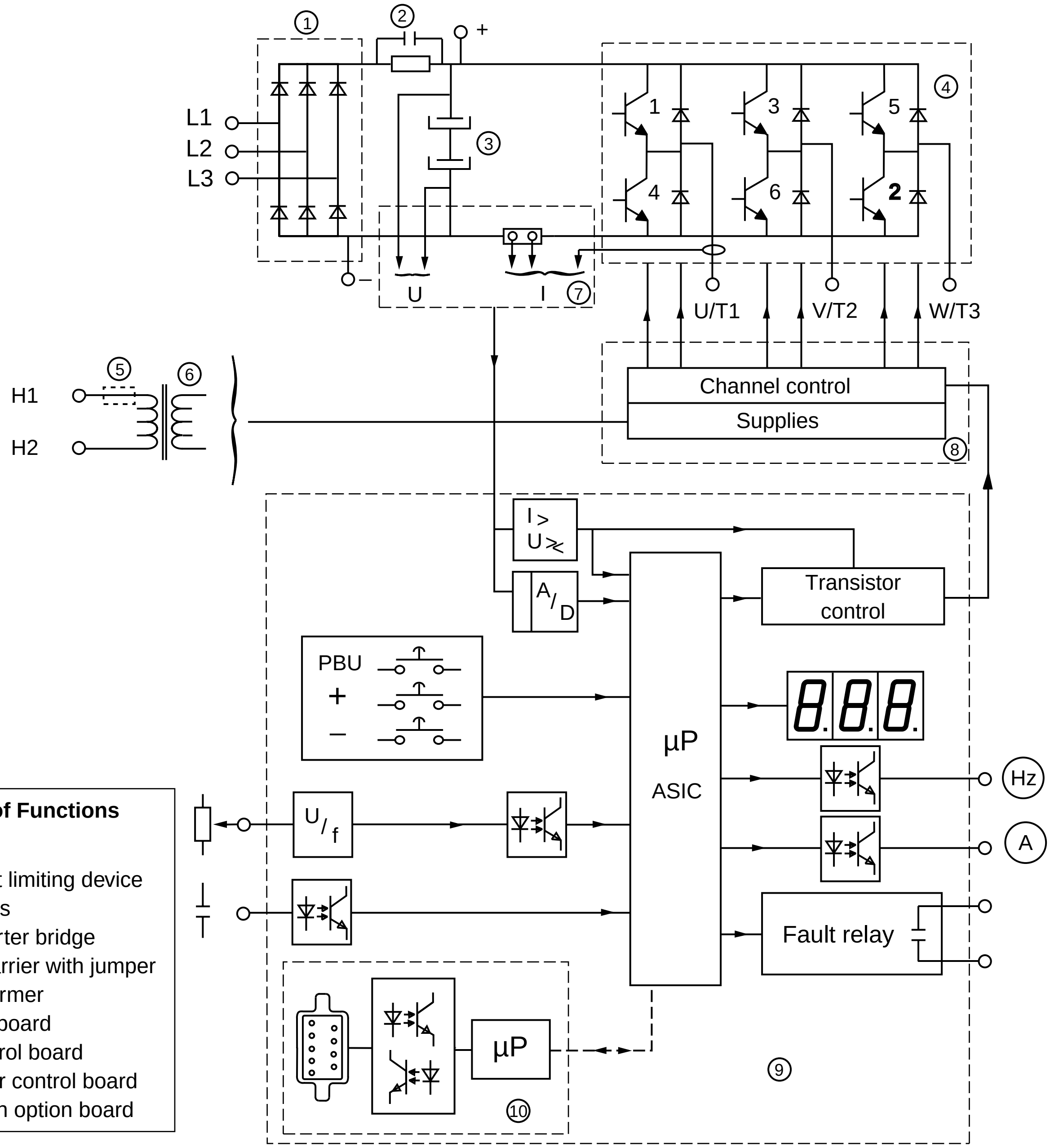
Figure 1-4 Design of 7.5 to 50 hp Controllers

Functional Block Diagram



Description of Functions

1. Rectifier
2. Charge current limiting device
3. Filter capacitors
4. Transistor inverter bridge
5. Plug-in fuse carrier with jumper
6. Control transformer
7. Measurement board
8. Transistor control board
9. Microprocessor control board
10. Communication option board

Figure 1-5 Functional Block Diagram for 7.5 to 50 hp Controllers

Omegapak 60 to 150 hp Controllers

This section applies to the 60 to 150 hp drive controllers at 460 V (PØØVO4Q to 4U).

Figure 1-6 Design of 60 to 150 hp Controllers

Functional Block Diagram

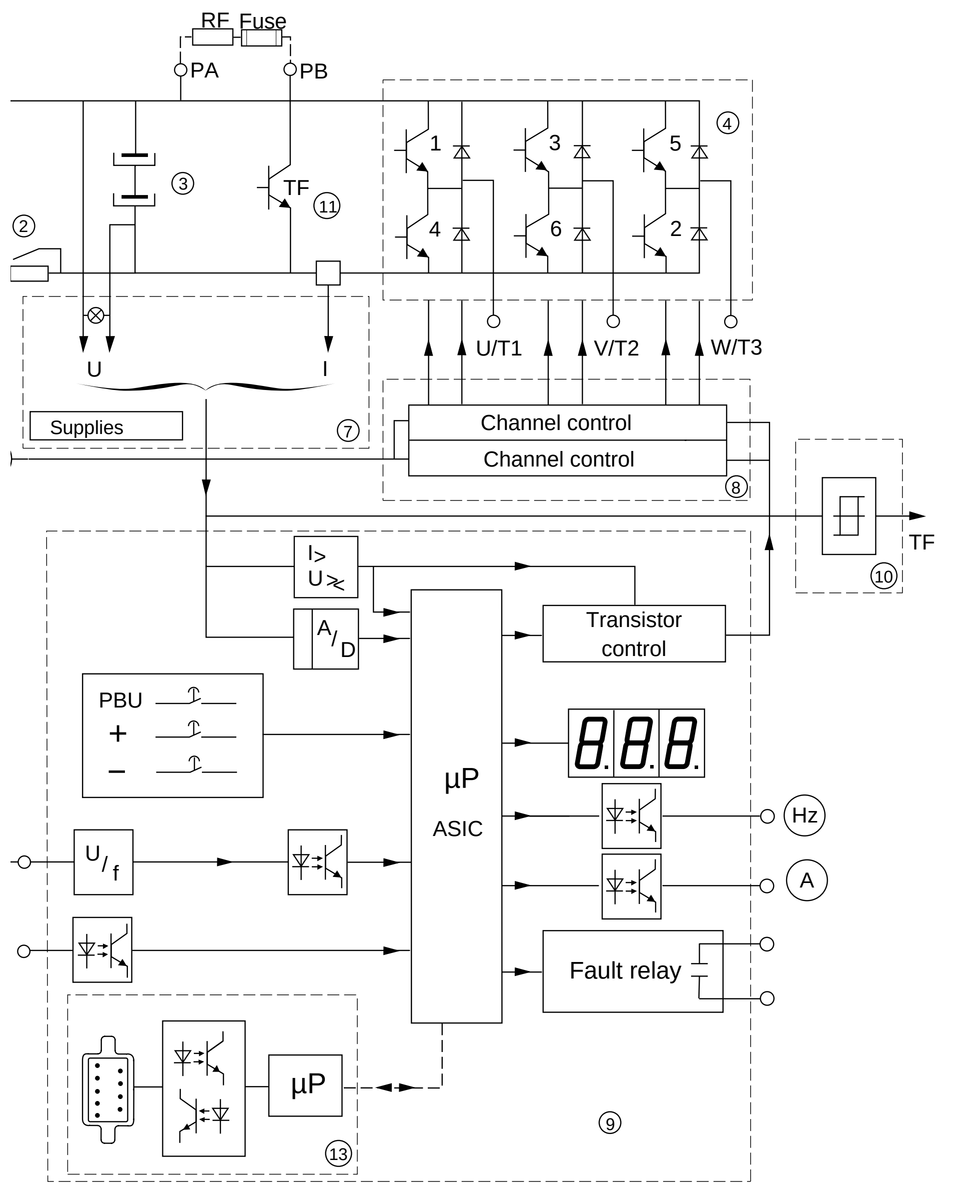


Figure 1-7 Functional Block Diagram for 60 to 150 hp Controllers

TECHNICAL CHARACTERISTICS

Table 1-1 Drive Controller Power and Current

Supply Voltage	Part No.	Motor Power		Line Current[1]	Rated Output Current	Transient Output Current	Total Dissipated Power @ Rated Load[2]	Fault Withstand Current
		kW	hp	A	A	A	W	A rms sym.
460 V	PØØVO4C	1.1	1.5	3.9	2.6	2.9	80	5000
+10%/-15%	PØØVO4E	2.2	3	7	4.8	5.3	110	5000
50/60 Hz	PØØVO4G	5.5	7.5	16	11	12	190	5000
	PØØVO4J	11	15	31	21	23	350	5000
	PØØVO4K	15	20	40	27	30	450	5000
	PØØVO4M	22	30	60	40	44	600	5000
	PØØVO4P	37	50	98	65	72	800	10000
	PØØVO4Q	45	60	115	77	85	1000	10000
	PØØVO4S	75	100	186	124	136	1600	10000
	PØØVO4T	90	125	234	156	170	1800	10000
	PØØVO4U	110	150	270	180	200	2200	10000

[1] The values given correspond to the current absorbed by the drive controller on a low impedance input line supply, with the rated load and speed conditions, for the associated motor. These values can be reduced by adding line inductors (page 44), or when power is supplied via a suitable transformer or autotransformer (page 43).

[2] Multiply by 3.41 to obtain BTU per hour.

Table 1-2 Specifications

Output voltage	Maximum voltage equal to input line voltage
Frequency range	1 to 67/80 Hz
Torque/overtorque	See page 37
Speed reference	0-10 V, 0-20 mA, 4-20 mA, 20-4 mA (page 36)
Frequency resolution	Analog reference: 0.015 Hz Digital reference (by serial link): 0.1 Hz
Reference response time	10 ms < t < 20 ms
Low speed/high speed limits	Adjustable (see page 62)
Ramps	Acceleration: 1 to 990 seconds (page 62) Deceleration: 1 to 990 seconds (page 62)
Reversing	Control inputs (page 33) Optional: adaptation for ± 10 V control (page 75)
Braking to standstill	By DC injection: Automatic for 0.5 s if the frequency drops below 1 Hz Manual by external signal
Dynamic braking	By optional resistor (page 75)
Drive controller protection	Against short circuits: Between output phases[1] Between output phases and ground Against input line supply under/overvoltage Against overheating (thermal sensor)
Motor protection	Incorporated electronic thermal protection (page 39)
Automated system dialog	Optional multidrop serial link (page 94)
Temperature	Operation: + 32° to + 100° F (0° to + 40° C) Storage: - 15° to + 160° F (- 25° to + 70° C)
Humidity	90% maximum without condensation or dripping water (see recommendations on page 33)[2]
Altitude	≤ 3300 ft (1000 m); above this derate by 3% for every 3300 ft
Degree of protection	Open: NEMA Open/IP20 (1.5 to 50 hp) NEMA Open/IP10 (60 to 150 hp)
Pollution	Protect the drive controller against dust, corrosive gases and splashing liquid[2]

[1] PØØVO4T and -4U: protection assured if length of motor-drive controller cables is greater than 75 ft (25 m). Otherwise, install line inductors (page 44).

[2] The controller electrical creepages are designed for use in a Pollution Degree 2 environment per NEMA ICS-111A and IEC 664A.

CATALOG NUMBER IDENTIFICATION

Consult Figure 1-8 below for the interpretation of the catalog numbers that appear throughout this manual.

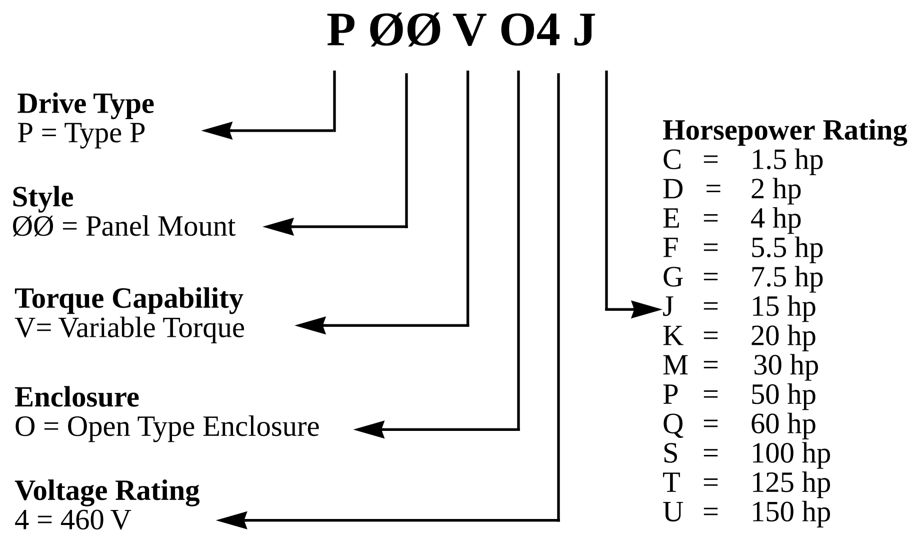


Figure 1-8 Catalog Number Identification

Chapter 2 – Installation and Wiring

INSTALLATION PRECAUTIONS

⚠ DANGER

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- Disconnect all power before servicing drive controller. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 2-10 on page 26 and Figure 2-11 on page 27 for drive controller grounding points.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before installing controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the controller disconnect.
- Lock disconnect in open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

Follow these precautions when installing the drive controller:

- ❏ When installation surface is not even, put a spacer behind the controller mounting pads to eliminate gaps. The controller exterior may be damaged if fastened to an uneven surface.
- ❏ Controllers are open devices and must be installed in suitable enclosures or controlled access areas. The environment around the controller must meet Pollution Degree 2 requirements as defined in NEMA ICS 1-111A or IEC 664A.

⚠ WARNING

HAZARDOUS VOLTAGE.

Omegapak Class 8803 Type P drive controllers are open style devices and must be mounted in a NEMA Type 12 enclosure or equipment room with a controlled environment relatively free of contaminants.

Failure to observe this precaution may cause shock or burn, resulting in severe personal injury or death!

- ❏ The controller generates heat. It must be properly ventilated when installed inside a control panel. Refer to Table 1-1 on page 11 for power dissipated.
- ❏ When several drive controllers are installed in a control panel, arrange them in a row. Stacking controllers is not recommended because the heat generated from the bottom controller may cause the ambient temperature of the top controller to rise, causing an overtemperature trip.
- ❏ Voltage and frequency specifications of the input line must match the drive controller configuration.
- ❏ A disconnect switch must be installed between the input line and controller.

Turn off all power before installing the drive controller. Place a “DO NOT TURN ON” label on the controller disconnect. Before proceeding with the installation, lock the disconnect in the open position. Depending on the model, the controller may operate on numerous voltages, frequencies and phases. Verify that the AC line being connected to the controller matches the nameplate rating on the controller.

Measuring Bus Capacitor Voltage

DC bus capacitor voltage is measured between the + and **-** terminals of the drive controller. The DC bus capacitors are discharged slowly when input power is removed from the controller. To ensure that the capacitors are fully discharged, always disconnect all power, wait 10 minutes, then test with a DC voltmeter (1000 VDC scale) before wiring, troubleshooting or working inside the drive controller. If no reading is shown on the voltmeter, reduce scale and test again.

Measuring Bus Capacitor Voltage on 1.5 to 50 hp Controllers

The + and **-** terminals are located near the bottom of 1.5 to 50 hp controllers (see Figure 2-1). To measure the bus capacitor voltage:

1. Disconnect all power from controller.
2. Wait 10 minutes to allow the DC bus to discharge.
3. Set the voltmeter to the 1000 VDC scale. Measure the bus capacitor voltage between the + and **-** terminals to verify that the DC voltage is zero. **Do not short across capacitor terminals with voltage present!**
4. If the bus capacitors are not fully discharged, contact your local Square D representative – **do not operate the controller**.

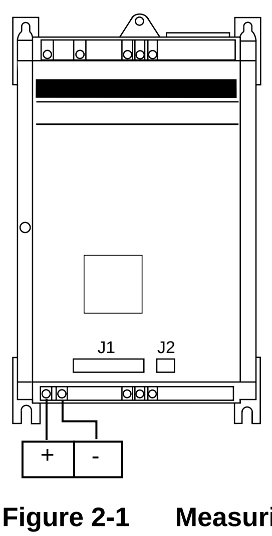


Figure 2-1 Measuring DC Bus Voltage on 1.5 to 50 hp Controllers

Measuring Bus Capacitor Voltage on 60 to 150 hp Controllers

The + and - terminals are located behind the top panel of 60 to 150 hp controllers (see Figure 2-2). To measure the bus capacitor voltage:

1. Disconnect all power from controller.
2. Wait 10 minutes to allow the DC bus to discharge.
3. Carefully remove the front cover from the controller. **Hazardous voltage may still be present! Do not touch any components!**
4. Set the voltmeter to the 1000 VDC scale. Measure the bus capacitor voltage between the + and - terminals to verify that the DC voltage is zero. **Do not short across capacitor terminals with voltage present!**
5. If the bus capacitors are not fully discharged, contact your local Square D representative – **do not operate the controller**.

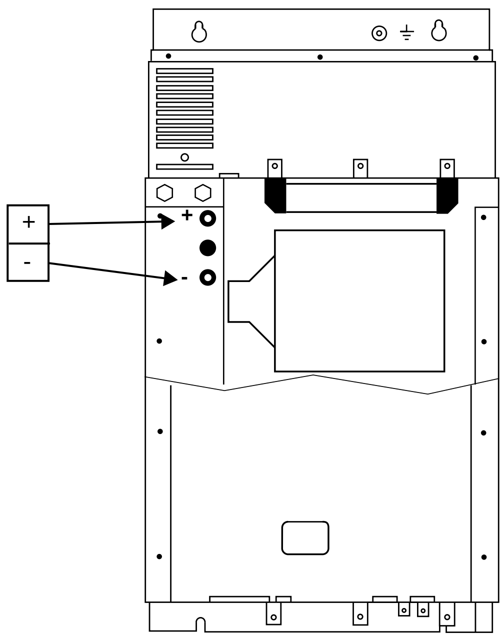


Figure 2-2 Measuring DC Bus Voltage on 60 to 150 hp Controllers

GENERAL WIRING PRACTICES

Good wiring practice requires the separation of control circuit wiring from all power (line) wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive or other drives; **do not run in the same conduit**. This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits.

> ⚠ **CAUTION**
>
> EQUIPMENT DAMAGE HAZARD.
>
> Follow wiring practices described in this document in addition to those already required by the National Electrical Code and local electrical codes.
>
> Failure to observe this precaution could result in personal injury, product damage or property damage.

Follow the practices below when wiring Omegapak Type P drive controllers:

- ❏ Use metallic conduit for all controller wiring. Do not run control and power wiring in the same conduit.
- ❏ Metallic conduits carrying power wiring or low-level control wiring must be separated by at least 4 in (10 cm).
- ❏ Non-metallic conduits or cable trays used to carry power wiring must be separated from metallic conduit carrying low-level control wiring by at least 12 in (30.5 cm).
- ❏ Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.

Branch Circuit Connections

All branch circuit components and equipment (such as transformers, feeder cables, disconnect devices and protective devices) must be rated for the maximum input current of the Omegapak Type P drive controller, not the motor full load current. The drive controller input current is stamped on the nameplate.

⚠ WARNING

EQUIPMENT DAMAGE HAZARD.

- Branch circuit components and equipment must be rated for the maximum drive controller rated current.
- If the system short circuit capacity (current) available at the input line terminals is larger than the nameplate rating, higher-than-rated line currents will be drawn from the input line and equipment misoperation may occur.

Failure to observe this precaution can result in severe personal injury, product damage or property damage.

In some installations, conducted emissions to the line from the controller must be attenuated to prevent interference with telecommunication, radio and sensitive electronic equipment. In these instances, attenuating filters may be required. Consult factory for selection and application of these filters.

Control Wiring Precautions

Certain control wiring precautions must be followed:

- ❏ All external devices and conductors connected to the terminals of the optional dynamic brake must be insulated for line voltage with respect to ground. All other control inputs and outputs of the controller are isolated from the input lines.
- ❏ Control wiring conductor runs must be kept short and direct. Follow the conduit and circuit separation requirements listed at the top of this page.
- ❏ Control contacts used with the controller inputs must be rated for operation at open circuit voltages and closed circuit currents of 24 VDC and 14 mADC respectively when used with the internal power supply. (Also refer to "CONTROL INPUT FUNCTIONS" on page 33.)

- ❑ Twisted cable with a pitch of 1 to 2 inches is required for analog inputs and outputs. Use of a cable shield is recommended. The shield must be terminated to ground at one end only. It is generally recommended that the shield be terminated at the controller.
- ❑ The coils of all relays and solenoids connected to the output contacts of the controller must be equipped with appropriate transient suppressors.

Output Wiring Precautions

The drive controller is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the controller may trip on overcurrent. Follow the guidelines below when selecting output cable:

- ❑ Cable type: the cable selected must have a low capacitance phase-to-phase and to ground. Do not use mineral impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- ❑ Cable length: the longer the cable, the greater the capacitance. Cable lengths greater than 320 ft (100 m) may cause problems.
- ❑ Proximity to other output cables: because of the high frequency switching and increased capacitance, the drive may fault under some conditions.
- ❑ Do not use lightning arrestors on output of drive controller.

For installation where cable capacitances may be a problem, an inductor installed between the controller and the motor can be utilized. See page 44 for additional information.

⚠ CAUTION

CONTROLLER SWITCH FAILURE.

For proper controller electronic short circuit protection, certain values of inductance may be required in the output power wiring (see page 44 for values). Inductance can be supplied by the power wiring or auxiliary inductors.

Failure to observe this precaution could result in controller damage.

Grounding

For safe, dependable operation, drive controllers must be grounded according to National Electrical Code and all local codes. To ground the drive controller:

- ❑ Connect a copper wire from the grounding terminal to the power system ground conductor. Wire size is determined by the drive size, the National Electrical Code and local electrical codes.
- ❑ Verify that resistance to ground is one ohm or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

HAZARDOUS VOLTAGE.

- Ground equipment using screw provided. Drive panel must be properly grounded before applying power.
- Do not use metallic conduits as a ground conductor.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

Multiple drives must be grounded as shown in Figure 2-3. Do not loop or series the ground cables.

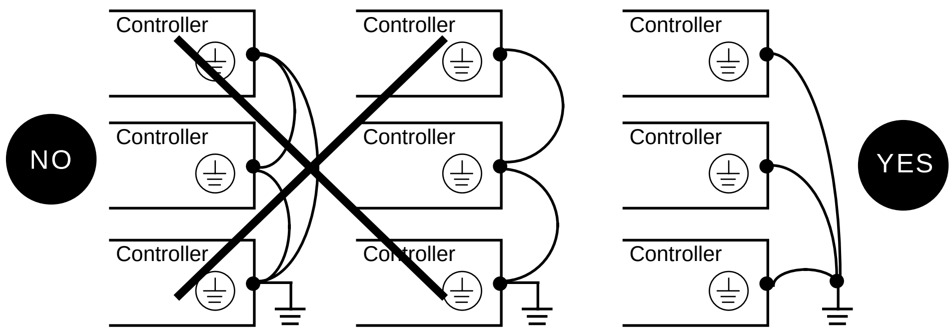


Figure 2-3 Grounding Multiple Controllers

1.5 to 50 hp CONTROLLERS

Dimensions and Weights

Table 2-1 Dimensions and Weights for 1.5 to 50 hp Controllers

Drive Part No.	**A** in (mm)	**B** in (mm)	**C** in (mm)	**G** in (mm)	**H** in (mm)	**Weight** lb (kg)
PØØVO4C	9.41 (239)	15.04 (382)	6.69 (170)	8.35 (212)	14.17 (360)	17.6 (8)
PØØVO4E PØØVO4G	9.41 (239)	15.83 (402)	7.56 (192)	8.35 (212)	14.96 (380)	24.2 (11) 25.3 (11.5)
PØØVO4J	9.21 (234)	15.94 (405)	10.55 (268)	8.19 (208)	14.17 (360)	33 (15)
PØØVO4K	9.21 (234)	21.85 (555)	10.55 (268)	8.19 (208)	20.08 (510)	46.2 (21)
PØØVO4M	9.21 (234)	23.43 (595)	10.55 (268)	8.19 (208)	21.65 (550)	51.7 (23.5)
PØØVO4P	9.21 (234)	32.28 (820)	10.55 (268)	8.19 (208)	29.53 (750)	66 (30)

PØØVO4C
PØØVO4D

PØØVO4E
PØØVO4G

PØØVO4J
PØØVO4K
PØØVO4M
PØØVO4P

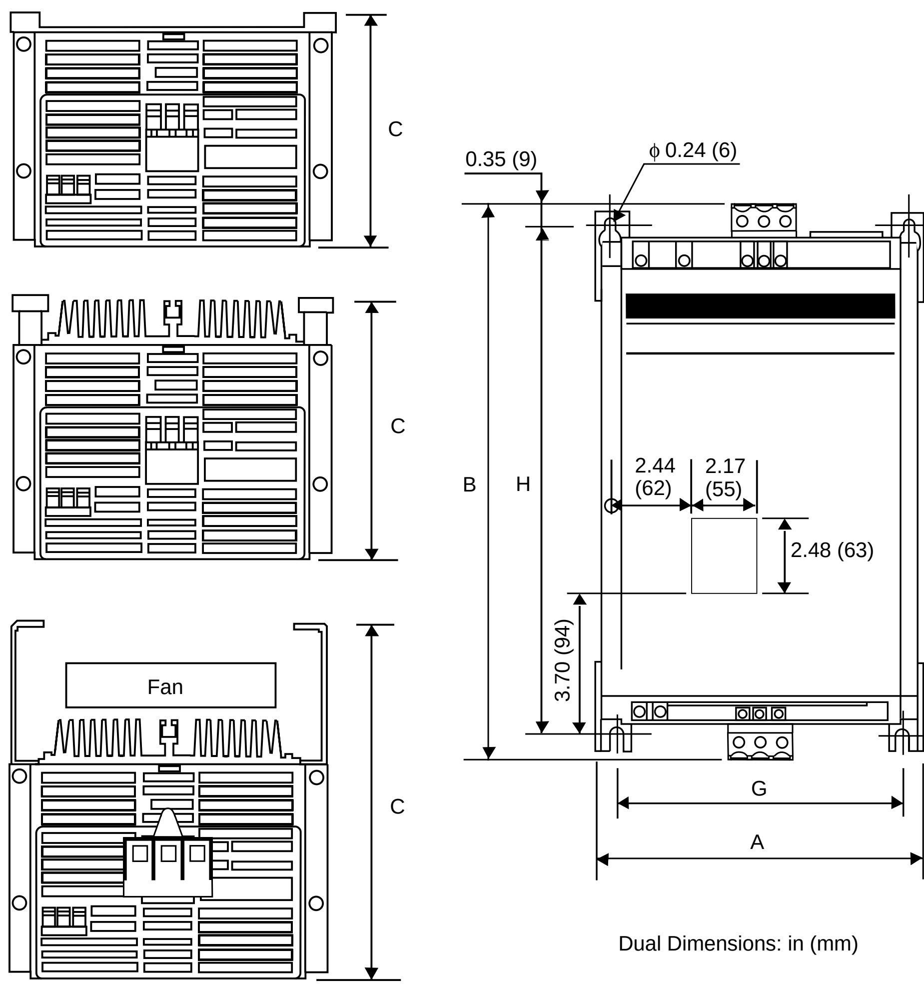


Figure 2-4 Dimension Drawing for 1.5 to 50 hp Controllers

Mounting Precautions

⚠ WARNING

HAZARDOUS VOLTAGE.

Omegapak Class 8803 Type P drive controllers are open style devices and must be mounted in a NEMA Type 12 enclosure or equipment room with a controlled environment relatively free of contaminants.

Failure to observe this precaution may cause shock or burn, resulting in severe personal injury or death!

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD.

• Mount the controller vertically.

• Do not locate controller near heat radiating elements.

Failure to observe this precaution could result in product damage or property damage.

Mounting in General Purpose Metal Enclosure

Degree of protection: NEMA Type 1 (IP23). When mounted in this type of enclosure, the controller must be installed in an equipment room with a controlled environment relatively free of contaminants.

To ensure adequate air flow inside the drive controller:

- ❏ Leave sufficient space around the controller: A ≥ 2 in (50 mm), B ≥ 4 in (100 mm), see Figure 2-5.
- ❏ Provide ventilation.
- ❏ Check that ventilation is sufficient. If not, install a cooling fan with filters.

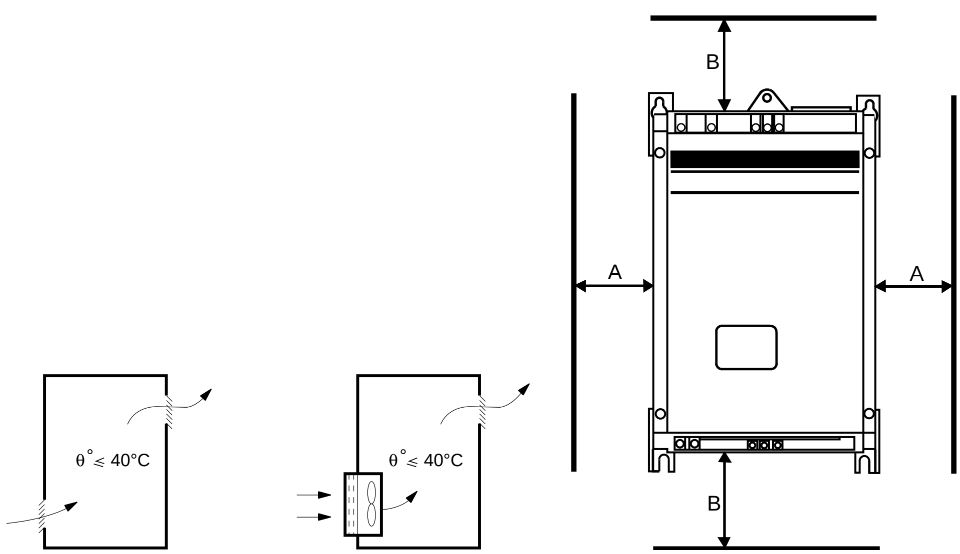


Figure 2-5 Ventilation and Clearances for 1.5 to 50 hp Controllers

Mounting in Dust and Damp Proof Metal Enclosure

Degree of protection: NEMA Type 12 (IP54).

Provide a stirring fan to circulate the air inside the enclosure and prevent hot spots in the drive controller. This allows operation of the controller in an enclosure with a maximum internal temperature of 140° F (60° C). Ventilation kit VY1-A05107 may be used for this purpose (page 93).

Locate the fan to ensure:

- ❑ Air movement over the control and power boards.
- ❑ Air flow inside enclosure = 200 CFM (100 dm^3/s), fan mounted beneath the controller at a maximum distance of 2 in (50 mm); see Figure 2-6.

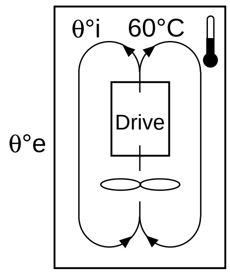


Figure 2-6 Ventilation for Dust and Damp Proof Enclosure

Calculating Enclosure Size for Non-Ventilated Enclosures

Below is the equation for calculating Rth (°C/W), the maximum allowable thermal resistance of the enclosure:

$$Rth = \frac{60 - \theta°e}{P}$$

θ°e = Maximum external temperature (°C)

P = Total power dissipated in enclosure (W)

For the power dissipated by the controllers at rated load, see Table 1-1 on page 11.

Useful heat exchange surface area of a wall mounted enclosure S (in^2) consists of the sides, top and front. The minimum surface area required for a controller enclosure is calculated as follows:

$$S = \frac{K}{Rth}$$

Rth = Thermal resistance of the enclosure (calculated previously)

K = 300 for a painted metal enclosure

Do not use polymetric enclosures, since they have poor thermal conduction. Do not install enclosures where external heat sources can add to enclosure heat load.

Below is an example of how to calculate the enclosure size for a PØØVO4E (3 hp) mounted in a NEMA 12 enclosure with internal stirring fan.

- ❑ Maximum external temperature: 30°C
- ❑ Power dissipated inside the enclosure: 110 W
- ❑ Maximum allowable thermal resistance:

$$Rth = \frac{60 - 30}{110} = 0.27 \text{ °C/W}$$

- ❑ Minimum useful heat exchange surface area:

$$S = \frac{300}{0.27} = 1099 \text{ in}^2$$

Useful heat exchange surface area of the proposed wall mounted enclosure:

- ❑ Height:24 in (600 mm)
- ❑ Width: 20 in (500 mm)
- ❑ Depth: 10 in (250 mm)

$$S = \underbrace{(24 \times 20)}_{\text{front area}} + \underbrace{(10 \times 20)}_{\text{top area}} + \underbrace{2(24 \times 10)}_{\text{side area}} = 1160 \text{ in}^2$$

Recess Mounting

To reduce power dissipated in the enclosure, the drive controller can be recess mounted in the back of the enclosure, with the heat sink on the outside. This arrangement necessitates a cut-out and a gasket kit. To obtain a temperature that does not exceed 140° F (60° C), the air inside the enclosure must be stirred by the addition of a fan with a flow rate of 100 CFM (44 dm^3/s).

The minimum metal enclosure dimensions enabling the mounting of one drive controller with an internal fan in an external ambient air temperature less than 86° F (30° C) are given in Table 2-2 below:

Table 2-2 Minimum Metal Enclosure Dimensions

Gasket Kit Part No.	**Drive Part No.**	**H** in (mm)	**W** in (mm)	**D** in (mm)	**Pi**[1] W
VY1-A451U1501	PØØVO4C	19.69 (500)	15.75 (400)	9.84 (250)	70
VY1-A451U4001	PØØVO4E PØØVO4G	19.69 (500) 27.56 (700)	15.75 (400) 15.75 (400)	9.84 (250) 9.84 (250)	85 105
VY1-A451U7501	PØØVO4J	23.62 (600)	15.75 (400)	9.84 (250)	80
VY1-A451D1101	PØØVO4K	27.56 (700)	19.69 (500)	9.84 (250)	95
VY1-A451D1501	PØØVO4M	27.56 (700)	19.69 (500)	9.84 (250)	110
VY1-A451D3001	PØØVO4P[2]	35.43 (900)	27.56 (700)	11.81 (300)	150

[1]Pi = power dissipated in the enclosure by a recess mounted drive controller.

[2]Gasket kit does not maintain dust- and damp-proof integrity of interior of 50 hp drive controller enclosures (bus capacitors protrude through heat sink).

60 to 150 hp CONTROLLERS

Dimensions And Weights

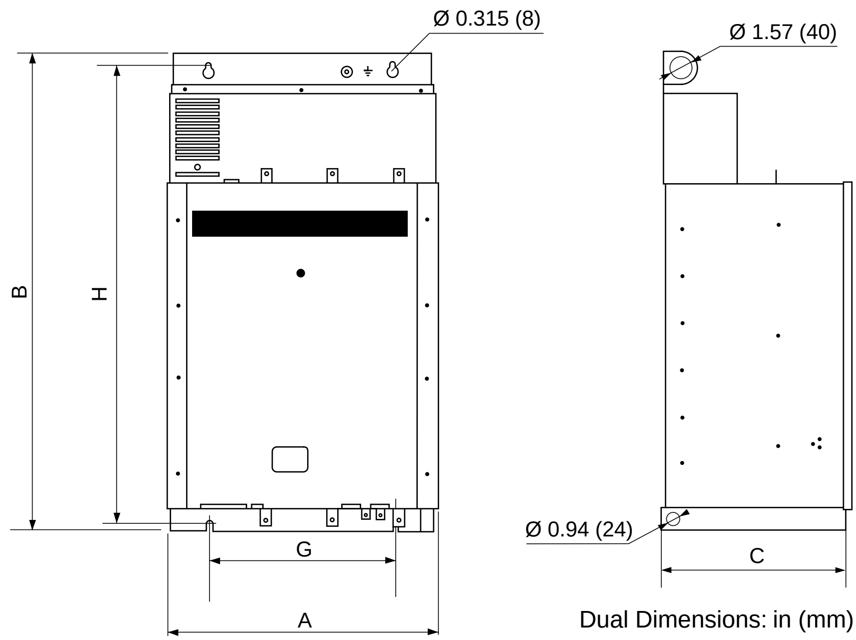


Figure 2-7 Dimension Drawing for 60 to 150 hp Controllers

Table 2-3 Dimensions and Weights for 60 to 150 hp Controllers

Drive Part No.	**A** in (mm)	**B** in (mm)	**C** in (mm)	**G** in (mm)	**H** in (mm)	**Weight** lb (kg)
PØØVO4Q	19.06 (484)	33.86 (860)	13.78 (350)	13.19 (335)	32.28 (820)	189 (86)
PØØVO4S	19.06 (484)	40.94 (1040)	13.78 (350)	13.19 (335)	39.37 (1000)	231 (105)
PØØVO4T	23.42 (595)	46.77 (1188)	14.37 (365)	17.52 (445)	45.67 (1160)	308 (140)
PØØVO4U	23.42 (595)	46.77 (1188)	14.37 (365)	17.52 (445)	45.67 (1160)	308 (140)

Drive Controller Ventilation

The Omegapak Type P drive controller is forced air cooled. A tangential fan is placed in the upper part of the controller (see Figure 2-8) and is protected by a perforated cover. The fan draws in the ambient air and expels it vertically from top to bottom over the heat sink fins, which hold the power components. When mounting the controller, be sure the air inlets and outlets are not obstructed.

Fan characteristics:

- ❑ Flow rate: 450 CFM (210 dm^3/s)
- ❑ Supply: from the control voltage
- ❑ Controlled by a thermal sensor attached to the heat sink. Thermal sensor closes when the temperature reaches 122° F (50° C) and opens when the temperature falls to 86° F (30° C).

Thermal protection of the drive controller is ensured by another thermal sensor attached to the heat sink, which opens when the temperature reaches 167° F (75° C). When this contact opens:

- ❑ Drive controller locks and fault code OhF appears on dialog unit display.
- ❑ Ventilation system continues operating if control supply is maintained, enabling controller to be rapidly cooled down.

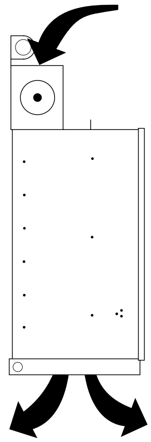


Figure 2-8 Ventilation for 60 to 150 hp Controllers

Mounting Precautions

⚠ WARNING

HAZARDOUS VOLTAGE.

Omegapak Class 8803 Type P drive controllers are open style devices and must be mounted in a NEMA Type 12 enclosure or equipment room with a controlled environment relatively free of contaminants.

Failure to observe this precaution may cause shock or burn, resulting in severe personal injury or death!

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD.

- Mount the controller vertically.
- Do not locate controller near heat radiating elements.

Failure to observe this precaution could result in personal injury or equipment damage.

Mounting in General Purpose Metal Enclosure

Degree of protection: NEMA Type 1 (IP23) When mounted in this type of enclosure, the controller must be installed in an equipment room with a controlled environment relatively free of contaminants.

To ensure adequate air flow inside the drive controller:

- ❑ Leave sufficient space around the controller: A ≥ 2 in (50 mm), B ≥ 8 in (200 mm), see Figure 2-5.
- ❑ Provide ventilation.
- ❑ Check that ventilation is sufficient. If not, install a cooling fan with filters.

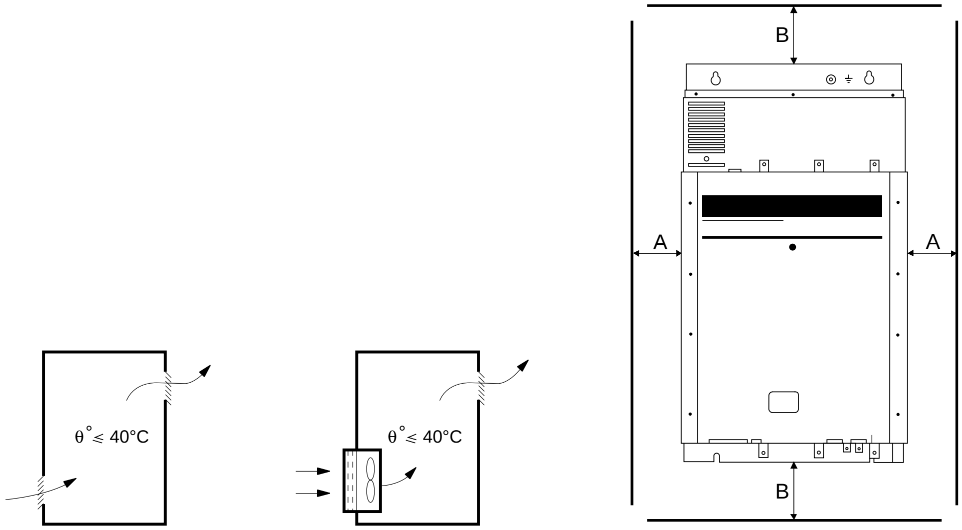


Figure 2-9 Ventilation and Clearances for 60 to 150 hp Controllers

Mounting in Dust and Damp Proof Metal Enclosure

Degree of protection: NEMA Type 12 (IP54).

Provide a stirring fan to circulate the air inside the enclosure and prevent hot spots on the drive controller.

- ❑ See power dissipated by drive controllers, listed in Table 1-1 on page 11.
- ❑ Refer to "Calculating Enclosure Size for Non-Ventilated Enclosures" on page 22.

TERMINAL STRIP CONNECTIONS

1.5 to 50 hp

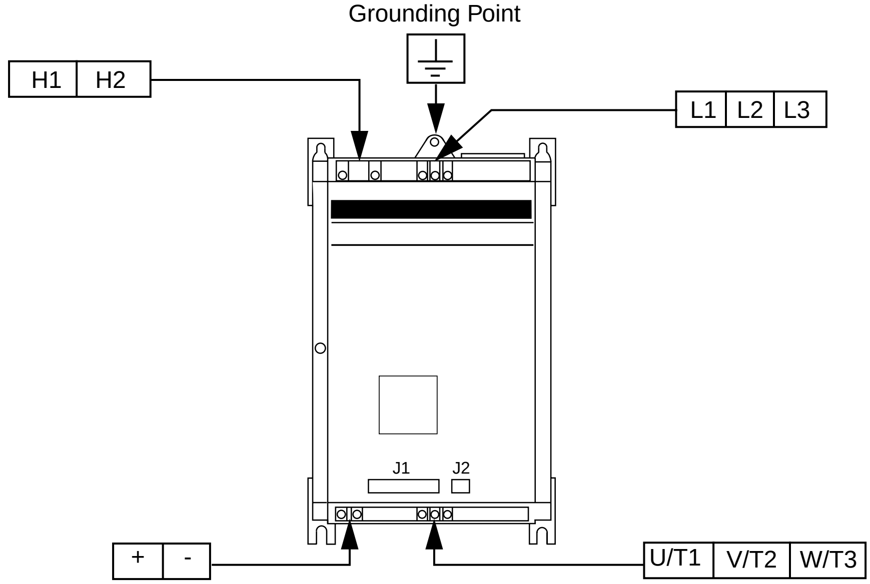


Figure 2-10 Terminal Strip Connections for 1.5 to 50 hp Controllers

60 to 150 hp

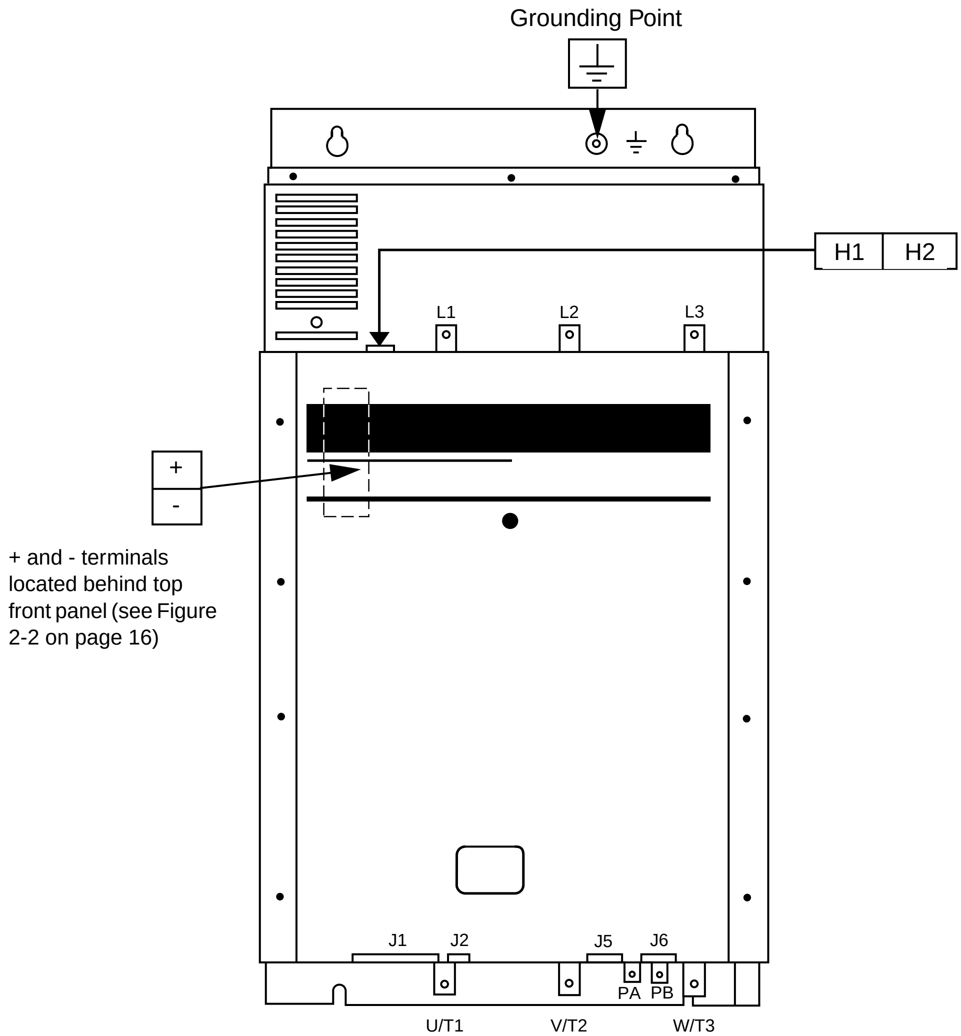


Figure 2-11 Terminal Strip Connections for 60 to 150 hp Controllers

Table 2-4 Terminal Strip Characteristics for 1.5 to 150 hp Controllers

Jumper	Item	Function	Characteristics PØØVO4_
	L1 L2 L3	3-phase power supply	460 V +10%/-15% @ 50/60 Hz
	H1 H2	Single phase control supply	460 V @ 50/60 Hz
	U/T1 V/T2 W/T3	Output connections to the motor	460 V @ 50/60 Hz
1.5 to 50 hp	+ -	Filtered DC voltage	550 to 800 V
60 to 150 hp	PA PB	Braking Resistance	Refer to page 80
J1	OE1 E1 P10 E2 EC	Speed reference Input 1 - Speed reference voltage Output voltage Input 2 - Speed reference voltage Input 3 - Speed reference current	0V 0 - 10 V, Impedance = 28 kΩ 10 V, Is = 10 mA 0 - 10 V, Impedance = 28 kΩ 0 - 20 mA, 4 - 20 mA, 20-4 mA, Impedance = 100 Ω
J1	A01 A02	Analog output 1 Analog output 2	0 - 20 mA, 10 V maximum 0 - 20 mA, 10 V maximum
J1	PL NL FW RV DCB	Control inputs supply Negative supply Forward control input Reverse control input DC injection braking control input	24 V, Is = 60 mA maximum -15 V, Is = -10 mA maximum 24 V (minimum 19 V, maximum 30 V), Impedance = 1.5 kΩ 24 V (minimum 19 V, maximum 30 V), Impedance = 1.5 kΩ 24 V (minimum 19 V, maximum 30 V), Impedance = 1.5 kΩ
J2	SA SB	Fault relay output	Closes when power is applied, opens on fault Voltage free contact (220/240 V, 50/60 Hz, 2 A maximum) V min 10 V, I min 16 mA
60 to 150 hp **J5**	SN+ SGN PN	Do Not Connect — Braking Option	
60 to 150 hp **J6**	300 V 145 V 70 V 10 V 0 V	Do Not Connect	
J6	PZ PY	Braking Resistance Thermocontact	
J6	LA LB	Mechanical Brake Control Relay	Voltage free contact (220/240 V, 50/60 Hz, 2 A max) V min 10 V,I min 16 mA

⚠ DANGER

NON-ISOLATED CIRCUIT.

- **All terminals on J5 and J6 connectors are at line voltage potential except LA and LB terminals on J6.**
- **External devices connected to Pz and Py terminals must be insulated for line voltage with respect to ground.**

Failure to observe these precautions will cause shock or burn resulting in severe personal injury or death!

RECOMMENDED CIRCUIT DIAGRAM

The circuit diagram in Figure 2-12 shows how to connect a branch circuit disconnect device, protective fusing and optional line isolation contactor (KM1). The sequencing of contactor KM1 is designed for energizing and deenergizing the drive controller power circuit. Use of S1 and S2 for starting and stopping the controller may not be appropriate for all control situations. Additional sequencing logic may be required.

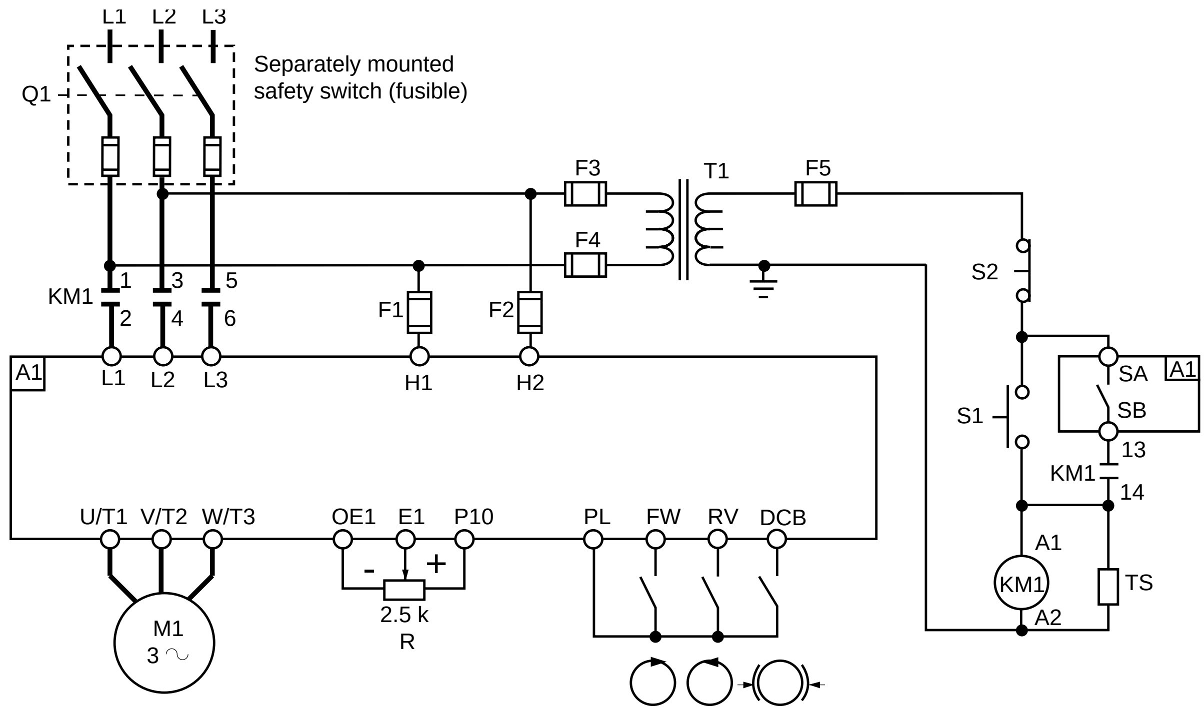


Figure 2-12 Recommended Circuit Diagram

EQUIPMENT REQUIREMENTS

The equipment lists in the following tables are valid for both versions of the circuit diagram (see Figure 2-12 above and Figure 2-13 on page 32).

Table 2-5 Equipment Required for all Controllers, Ratings and Models

F1- F5	Fuse carriers	Class 9080 FB1611CC
R1	Potentiometer	Class 9001 K2106
S1-S2	Push buttons	Class 9001 KR1UH13
	Control station enclosure[1]	Class 9001 KYAF3

[1] Accepts R1, S1 and S2.

Table 2-6 Equipment Required for 1.5 to 15 hp 460 V Controllers

M1	Motor hp	1.5	3	7.5	15
A1	Drive	PØØVO4C	PØØVO4E	PØØVO4G	PØØVO4J
Q1	Safety Switch (Fusible)	Class 3110 H361	Class 3110 H361	Class 3110 H361	Class 3110 H362

Table 2-6 Equipment Required for 1.5 to 15 hp 460 V Controllers (Cont'd)

M1	Motor hp	1.5	3	7.5	15
	+ 3 Fuses [1]	KTS-R-6	KTS-R-10	KTS-R-20	KTS-R-40
KM1	Contactor	Class 8502 PC3.10EV02	Class 8502 PC3.10EV02	Class 8502 PD3.10EV02	Class 8502 PF1.11V02
TS	Suppressor	Class 9999 PZV250	Class 9999 PZV250	Class 9999 PRV250	Class 9999 PSF220
T1	Transformer	Class 9070 K50D1	Class 9070 K50D1	Class 9070 K50D1	Class 9070 K75D1
F1, F2	Control Fuses [1]	FNQ-R-1.0	FNQ-R-1.0	FNQ-R-1.0	FNQ-R-1.0
F3, F4	Control Fuses [1]	FNQ-R-1/4	FNQ-R-1/4	FNQ-R-1/4	FNQ-R-1/4
F5	Control Fuse [1]	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-3/4

[1] Bussman or equivalent

Table 2-7 Equipment Required for 20 to 60 hp 460 V Controllers

M1	Motor hp	20	30	50	60
A1	Drive	PØØVO4K	PØØVO4M	PØØVO4P	PØØVO4Q
Q1	Safety Switch (Fusible)	Class 3110 H362	Class 3110 H363	Class 3110 H364	Class 3110 H364
	+ 3 Fuses [1]	KTS-R-50	KTS-R-80	KTS-R-125	KTS-R-150
KM1	Contactor	Class 8502 PF3.11V02	Class 8502 PG1.11V02	Class 8502 PJ1.11V02	Class 8502 PJ1.11V02
TS	Suppressor	Class 9999 PSF220	Class 9999 PSF220	Class 9999 PSJ220	Class 9999 PSJ220
T1	Transformer	Class 9070 K75D1	Class 9070 K150D1	Class 9070 K200D1	Class 9070 K200D1
F1, F2	Control Fuses [1]	FNQ-R-1.0	FNQ-R-1.0	FNQ-R-3.0	FNQ-R-3.0
F3, F4	Control Fuses [1]	FNQ-R-1/4	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
F5	Control Fuse [1]	FNQ-R-3/4	FNQ-R-1.5	FNQ-R-2.0	FNQ-R-2.0

[1] Bussman or equivalent

Table 2-8 Equipment Required for 100 to150 hp 460 V Controllers

M1	Motor hp	100	125	150
A1	Drive	PØØVO4S	PØØVO4T	PØØVO4U
Q1	Safety Switch (Fusible)	Class 3110 H365	Class 3110 H365	Class 3110 H365
	+ 3 Fuses [1]	KTS-R-225	KTS-R-250	KTS-R-300
KM1	Contactor	Class 8502 PK1.11V02	Class 8502 PK1.11V02	Class 8502 PK5.11V02
TS	Suppressor	Class 9999 PSJ220	Class 9999 PSJ220	Class 9999 PSJ220

Table 2-8 Equipment Required for 100 to150 hp 460 V Controllers (Cont'd)

M1	Motor hp	100	125	150
T1	Transformer	Class 9070 K250D1	Class 9070 K250D1	Class 9070 K250D1
F1, F2	Control Fuses [1]	FNQ-R-3.0	FNQ-R-3.0	FNQ-R-3.0
F3, F4	Control Fuses [1]	FNQ-R-3/4	FNQ-R-3/4	FNQ-R-3/4
F5	Control Fuse [1]	FNQ-R-2.5	FNQ-R-2.5	FNQ-R-2.5

[1] Bussman or equivalent

Table 2-9 Terminal Wire Range for 1.5 to 15 hp Controllers

Terminals	Drive Part No.	Max. Wire Size [1]		Mounting Screw	Required Terminal Torque
		AWG	mm^2	mm	lb-in
H1, H2	All ratings	14	2.5		
PL, FW, RV, DCB, SA, SB, NL, OE1, E1, P10, E2, EC	All ratings	18	1	N/A	
L1,L2,L3,U/T1,V/T2,W/T3, +, -	PØØVO4C	8	10	N/A	15
	PØØVO4E	8	10	N/A	15
	PØØVO4G	8	10	N/A	15
	PØØVO4J[2]	8	10	N/A	15

[1] 60/75° C copper only.
[2] Controller shipped with terminal adapter that accepts AWG 4 wire max (part no. LA9Z960).

Table 2-10 Terminal Wire Range for 20 to 150 hp Controllers

Terminals	Drive Part No.	Max. Wire Size [1]		Mounting Screw [3]	Required Terminal Torque
		AWG	mm^2	mm	lb-in
H1, H2	All ratings	14	2.5		
PL, FW, RV, DCB, SA, SB, NL, OE1, E1, P10, E2, EC	All ratings	18	1	N/A	
L1,L2,L3,U/T1,V/T2,W/T3, +, -	PØØVO4K [2]	8	10	N/A	15
	PØØV O4M [2]	8	10	N/A	15
	PØØVO4PFS	2	30	N/A	30
	PØØVO4Q	N/A	N/A	20x3 M6 screw	
	PØØVO4S	N/A	N/A	25x3 M8 screw	
	PØØVO4T	N/A	N/A	25x3 M10 screw	
	PØØVO4U	N/A	N/A	25x3 M10 screw	
PA-PB	PØØVO4Q	N/A	N/A	15x3 M6 screw	
	PØØVO4S	N/A	N/A	15x3 M6 screw	
	PØØVO4T	N/A	N/A	15x3 M6 screw	
	PØØVO4U	N/A	N/A	15x3 M6 screw	

[1] 60/75° C copper only.
[2] Controller shipped with terminal adapter that accepts AWG 4 wire max (part no. LA9Z960).
[3] Requires user supplied lug.

ALTERNATE CIRCUIT DIAGRAM

The alternate circuit diagram shown in Figure 2-13 may be used when the drive controller is connected to the load-side of an existing starter circuit. The alternate circuit minimizes modifications required to the existing circuits. The circuit does have the characteristic that fault and thermal protection memory is lost if contactor KM1 de-energizes. In addition, self-diagnostics cannot be performed. Use of the fault relay (terminals SA-SB) is recommended for signalling if the drive controller locks out.

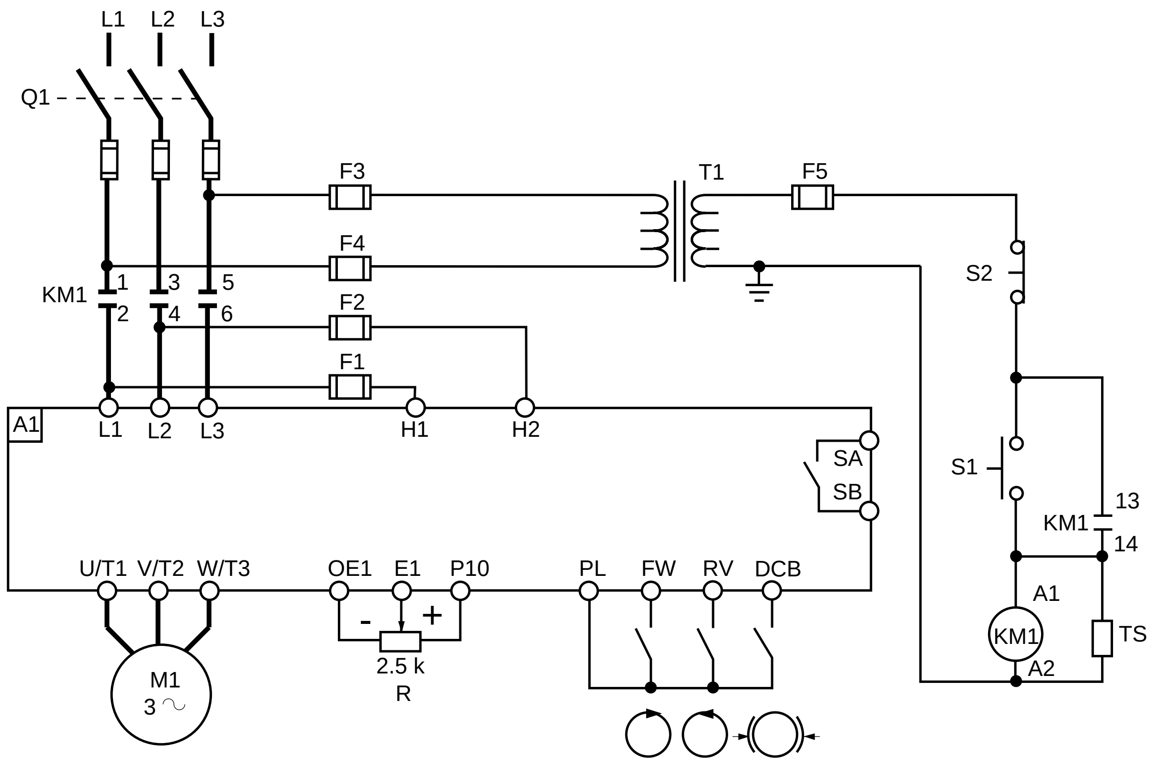


Figure 2-13 Alternate Circuit Diagram

PRECAUTIONS

⚠ WARNING

EQUIPMENT DAMAGE HAZARD.

Check power connections before energizing controller. Controller will be damaged if input line voltage is applied to output terminals (U/T1, V/T2, W/T3).

Failure to observe this precaution can result in severe personal injury, product damage or property damage.

NOTE

- Avoid switching output while controller is running.
- If an output contactor is required for switching between the controller and motor, use a special timing sequence (see page 42).

Humidity

If there is a possibility of condensation, leave control power applied during periods when the motor is not running or, alternatively, install anti-condensation heaters.

CONTROL INPUT FUNCTIONS

Direction of Rotation

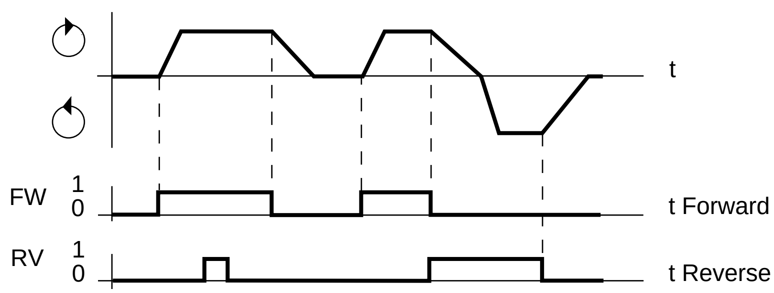


Figure 2-14 Direction of Rotation

- ❑ Direction control input selected first takes priority over the other.
- ❑ When the automatic DC injection function is selected, automatic DC injection braking will begin within 0.5 s after the drive controller output frequency drops below 1 Hz.

DC Injection Braking

⚠ WARNING

NO HOLDING TORQUE.

- DC injection braking does not provide holding torque at zero speed.
- DC injection braking does not function during loss of power or controller fault.
- When required, use separate brake function for holding torque.

Failure to observe this precaution can result in severe personal injury or equipment damage.

⚠ CAUTION

MOTOR OVERHEATING AND DAMAGE.

Application of DC injection braking for long periods of time can cause motor overheating and damage. Protect motor from extended periods of DC injection braking.

Failure to observe this precaution could result in personal injury, product damage or property damage.

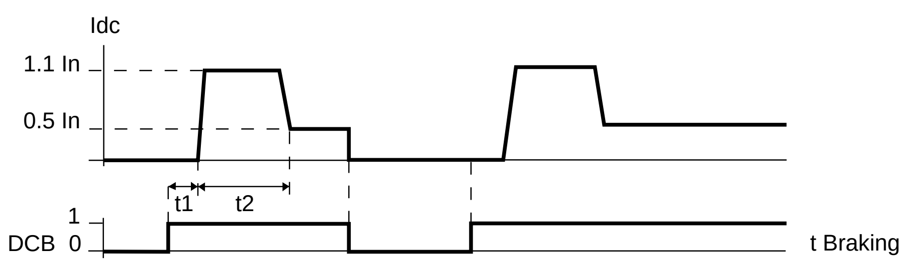


Figure 2-15 DC Injection Braking

- ❑ t1 = time delay from 0 to 4 seconds (period determined by drive controller)
- ❑ t2 = 3 seconds

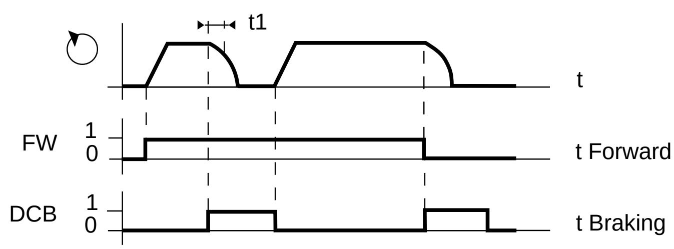


Figure 2-16 Control Circuit Priority for DC Injection Braking

- ❑ Braking control has priority over direction control signals.

Typical Braking Curves

The braking torque curves are linked to the motor characteristics.

Braking torque is zero at standstill.

Tn: rated torque, ωn: rated speed, In: rated current

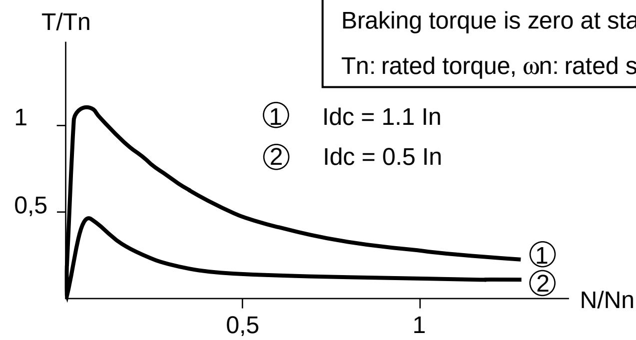


Figure 2-17 Typical Braking Curves

The DC current can be adjusted to a lower value.

USING THE CONTROL INPUTS

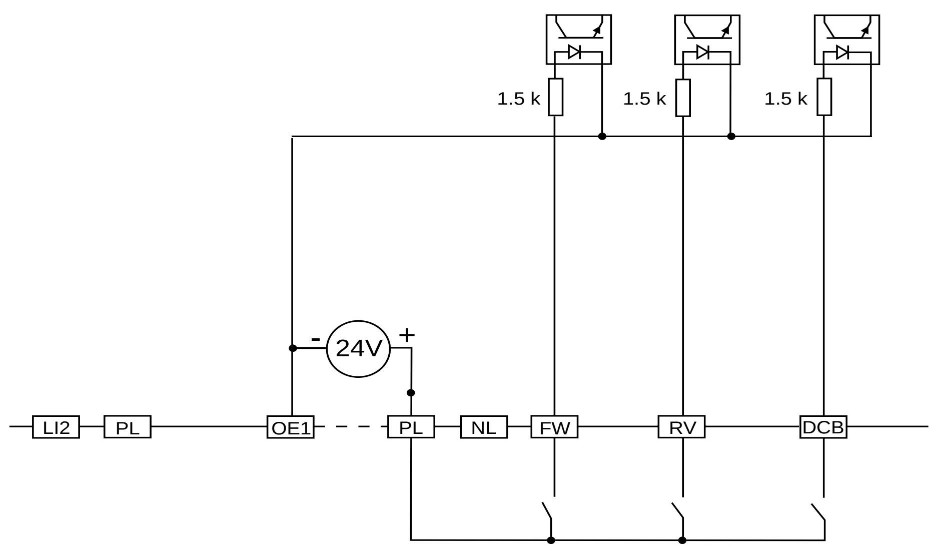


Figure 2-18 Operating from Internal Power Supply

SPEED REFERENCE INPUT FUNCTIONS

The reference sets the speed of the rotating field in the motor. The actual speed remains dependent on the acceleration and deceleration ramps as well as the torque capabilities of the motor/drive controller combination.

- ❏ The resulting reference value is the algebraic sum of the different speed references applied simultaneously, within the limits of the frequency range selected.
- ❏ Speed range is limited by low and high speed threshold settings (page 62).
- ❏ Speed reference inputs are isolated from the input line.
- ❏ 10 V internal supply (terminals OE1-P10) is protected against short circuits.

USING THE SPEED REFERENCE INPUTS

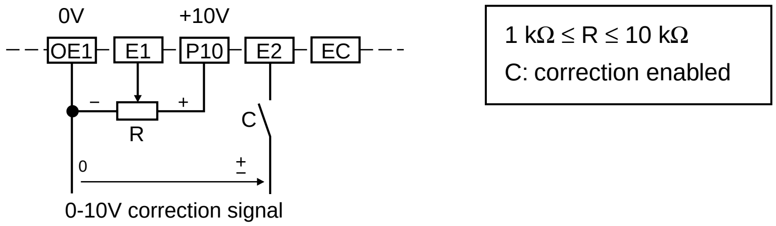


Figure 2-19 Example 1: Manual Reference with Correction Signal

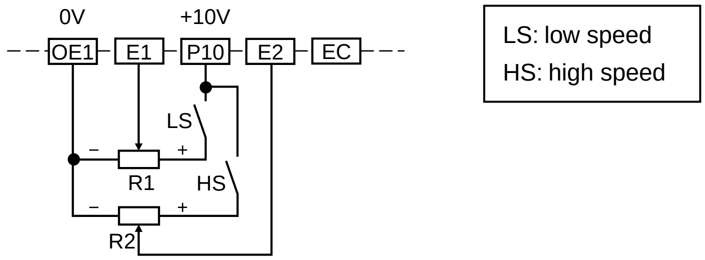


Figure 2-20 Example 2: Selection of Two Manual References

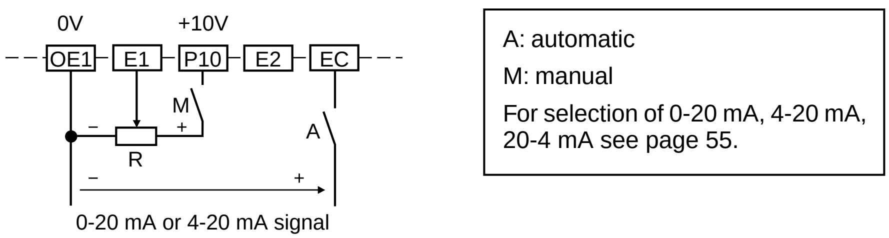


Figure 2-21 Example 3: Automatic Reference from 0-20 mA , 4-20 mA or 20-4 mA Sensor

The drive controller can also be controlled by a +/- 10 V signal via an interface module. This module transforms the +/- 10 V command into a 0-10 V speed reference and a rotation direction signal (forward or reverse).

ANALOG OUTPUTS

The drive controller has two 0-20 mA analog outputs: A01 and A02. The current supplied by these two outputs is proportional to:

- ❏ A01: motor frequency
- ❏ A02: motor current

Maximum output voltage: +10 V for a maximum impedance of 500 Ω. Scale factor:

- ❏ A01: 20 mA corresponds to high speed (see page 62)
- ❏ A02: 20 mA corresponds to the maximum transient current of the drive (see Table 1-1 on page 11).

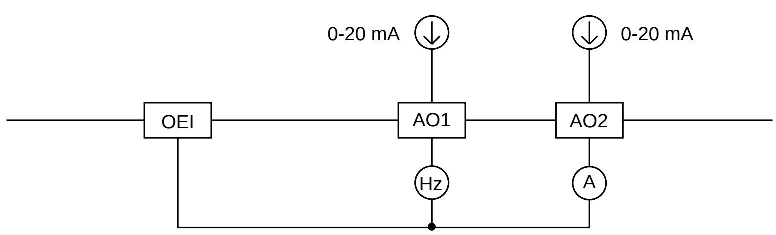


Figure 2-22 Analog Outputs

AVAILABLE MOTORING TORQUE

Continuous Duty

For continuous duty reduced speed applications, motor torque derating may be necessary. This derating is linked to two causes:

- Although the current waveform is very close to a sine wave, motor heating is slightly greater than that obtained by direct supply from the input line. The resulting torque derating is approximately 5%.
- For self-ventilating motors, the ventilation produced by the internal shaft fan decreases as the speed is reduced. This necessitates derating of the maximum continuous torque capability of the motor. Generally, the required derating occurs at approximately 50% of nameplate motor speed. Since motor designs vary, the motor manufacturer should be consulted for the required derating for a specific motor.

Overtorque Capability

The driving overtorque capabilities of a given motor are determined by: the motor NEMA design category (Design B, Design D, etc.), no-load (magnetizing) current of the motor at nameplate speed, maximum transient output current of the controller and the applied V/f at reduced speed.

- For NEMA design B motors whose no-load currents are less than 58% of the motor nameplate current, the maximum overtorque capability is approximately 110% of motor rated torque with 110% of motor rated current.
- With constant V/f excitation, the motor overtorque capability begins to decrease below 50% of motor nameplate speed. To improve low speed overtorque performance, adjust UFr.

Overspeed Operation (f ≥ 50/60 Hz)

With an adjustable frequency controller, operation at speeds greater than motor nameplate speed may be possible. The following issues must be considered:

> ⚠ **CAUTION**
>
> MACHINERY OVERSPEED.
>
> Some motors and/or loads may not be suited for operation above nameplate motor speed and frequency. Consult the motor manufacturer before operating the motor above rated speed.
>
> Failure to observe this precaution could result in personal injury, product damage or property damage.

- Above some output frequency, the controller is incapable of producing additional output voltage. Generally, this frequency is 50/60 Hz. When operated in this region, the available continuous motor torque will begin to decrease along with the motor maximum overtorque capability. The motor manufacturer should be consulted concerning the continuous and overtorque torque capabilities of the particular motor.

Reduced V/f Operation

Many centrifugal fans and pumps require driving torque which increases in proportion to the square of the speed. Such load types are sometimes called quadratic loads. Since the torque production ability of an induction motor decreases in proportion to the square of the applied motor V/f, it is possible, when driving quadratic loads, to linearly reduce the motor V/f as motor speed decreases and still have sufficient torque for satisfactory operation. When operated in this manner, constant motor slip is maintained throughout the operating speed range of the load.

Reduced V/f motor operation with quadratic loads can be advantageous.

- ❑ Audible motor noise resulting from the controller PWM output voltage waveform at reduced speeds is significantly reduced.
- ❑ Motor excitation losses should decrease resulting in more efficient motor operation at reduced speed.

Reduced V/f operation is selected by the UFr setting. Refer to Chapter 3, page 64 for UFr adjustment procedure.

Driving Torque Production Envelope

Figure 2-23 and Figure 2-24 illustrate typical continuous torque and overtorque driving capability for a typical self-ventilated NEMA Design B, 1.0 service factor motor whose no-load current is less than 58% of the motor rated current. In Figure 2-23, the motor is operated with reduced V/f excitation while in Figure 2-24 the motor is operated with constant V/f excitation. In addition, the controller rated output current is greater than or equal to the motor nameplate current and the controller transient output current capability is no less than 110% of controller rated output current.

For 1.15 service factor motors, the continuous torque rating is 1.0 times the motor rated torque from 50 to 100% of motor nameplate rated speed.

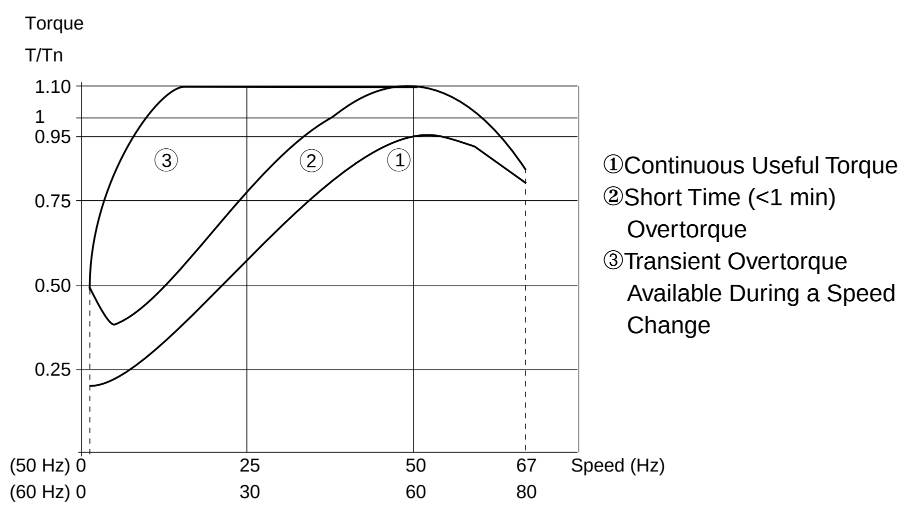


Figure 2-23 Operation with Quadratic Torque Load

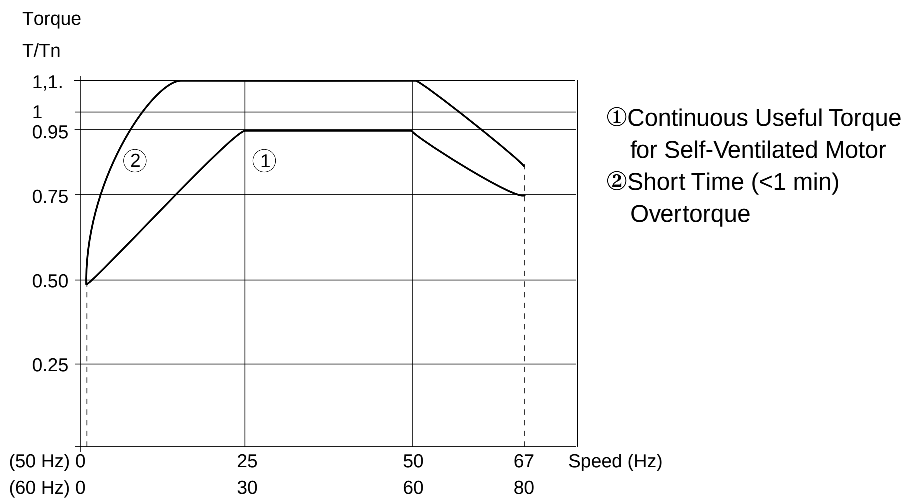


Figure 2-24 Operation with Constant Torque Load

THERMAL (OVERLOAD) PROTECTION OF THE MOTOR

Indirect thermal (overload) protection of the motor is incorporated in the drive controller, taking into account:

- ❏ Current absorbed by the motor
- ❏ Motor speed (ventilation)
- ❏ Ambient air temperature of 104° F (40° C)

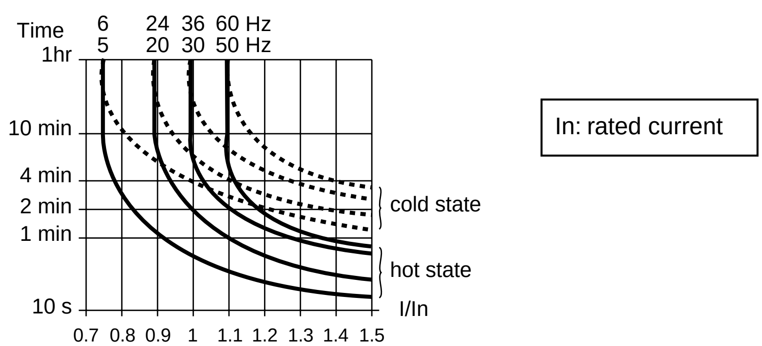


Figure 2-25 Thermal Trip Curves

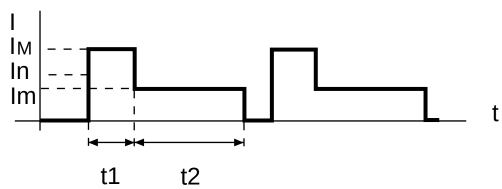
To adjust the motor thermal (overload) protection, see page 65.

> ⚠ **CAUTION**
>
> MOTOR OVERHEATING AND DAMAGE.
>
> This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds or loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.
>
> Failure to observe this precaution could result in product or property damage.

INTERMITTENT DUTY

The controller can supply output current in excess of its rating for a finite duration of time. The allowable magnitude and duration of a non-periodic overload for a controller is defined by the transient output current and the thermal trip curves shown in Figure 2-25 on page 39. For this case, In equals the controller rated output current.

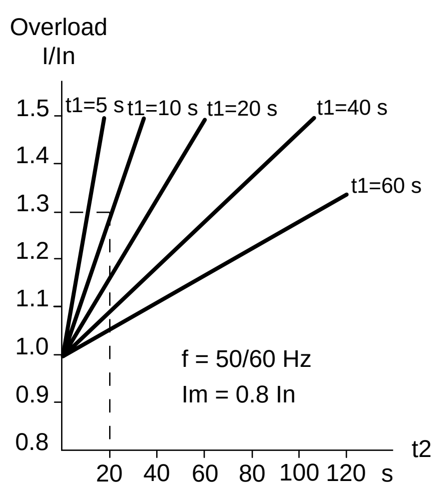
For intermittent (periodic) overloads, the controller overload period must be followed by a cool-down period as illustrated in Figure 2-26. The relationship between the magnitude and period of overload versus cool-down is given by the formula in Figure 2-27. The formula assumes operation at output frequencies of 50/60 Hz. For frequencies below 50/60 Hz, the rated current, In, must be decreased by the amount shown in Figure 2-25 to prevent tripping the thermal (overload) protection. If the thermal (overload) protection is set for a force-cooled motor, no reduction is required.



IM: overload current
In: rated current
Im: normal running current
t1: duration of overload
t2: recovery time

Figure 2-26 Intermittent Duty

The curves in Figure 2-27 can be used to determine the ratio between the overload duration and the operating time at 80% of the rated current at 50/60 Hz. For example, following an overload of 1.1 In for 40 seconds, it would require 20 seconds at 0.8 In to return to the previous thermal state.



IM: overload current
In: rated current
Im: normal running current

Formula for controller:

$$t2 = 1.25[(IM - In)/(In - Im)]t1$$

Figure 2-27 Overload Curves for Controller

ASSOCIATION WITH DIFFERENT MOTORS

Omegapak Type P drive controllers are designed to drive motors with a corresponding power rating. However, they can be used with motors having different power ratings as long as certain precautions are observed. Depending on the motor characteristics and performance necessary for the application, special configuration may be necessary.

Omegapak Type P drive controllers are selected on the basis of required output current and power over the expected frequency range. Under no circumstances should the motor continuous power or current requirements for a given load situation exceed the drive controller's continuous output current and power rating.

When Motor Power is Less Than or Equal to Controller Rated Power

It is permissible for motor power to be less than or equal to the drive rated power. However, since compensation is not at the optimum level, this can lead to a reduction in continuous torque at low speed. Adjust the V/f ratio if necessary (page 64).

If the motor rated current is less than 50% of drive rated output current, correct adjustment of motor thermal protection is impossible (page 65) and nuisance tripping of the controller on OLF. fault may result. In this case, disable the internal protection and use standard external protection (overload relay or thermal sensor).

When Motor Power is Greater Than Controller Rated Power

Magnetizing current peaks generally limit this combination to the motor power immediately above the drive rating. Compensation is not at the optimum level, and the V/f ratio should be adjusted if necessary (page 64). The motor current must remain less than or equal to the drive controller's rated current. In addition, the power required by the load should not exceed the power rating of the controller. If necessary, install a three-phase inductor between the drive controller and the motor (page 44).

Motors in Parallel

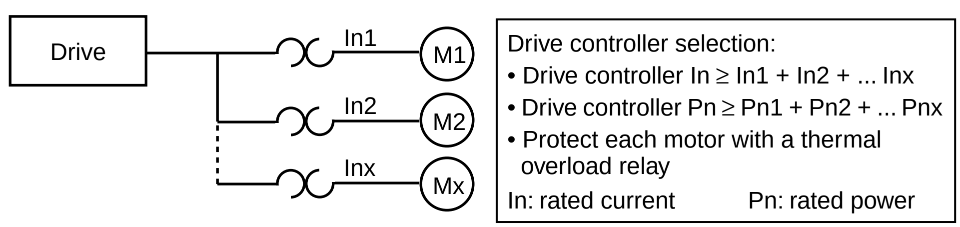


Figure 2-28 Motors in Parallel

When motors are in parallel, compensation is not at the optimum level. Adjust the V/f ratio if necessary (page 64). If the motors have different power ratings, the ratio adjustment can only be a compromise. If the load is to be shared between the motors, override the slip compensation (page 56).

If there are three or more motors in parallel, installation of a three phase inductor between the drive controller and the motor is recommended (page 44).

Using a Brake Motor

Electric Brake Solenoid

Make sure that the brake winding is brought out to terminals, without a common point to the stator. The brake should be supplied separately at its rated voltage and switched on simultaneously with the motor.

Tapered Rotor Motor

The brake on a tapered rotor motor is released by the magnetic field of the motor. This kind of motor can be used with a frequency inverter, but requires special adjustments.

Using a Synchronous Permanent Magnet or Wound-Field Motor

It is possible to operate a synchronous motor as long as the following conditions are met:

- ❏ Slip compensation is overridden (see page 56).
- ❏ Internal overload protection (see page 65) is disabled and external protection (overload relay or thermal sensor) is used.
- ❏ Operation only at constant V/f.
- ❏ Appropriate field excitation and protection is provided for externally-excited motors.

Using a Synchronous Reluctance Motor

It is possible to operate a synchronous reluctance motor as long as the slip compensation is overridden (see page 56).

Additional Motor Connected Downstream of the Drive Controller

When connecting an additional motor, comply with the timing sequence shown in Figure 2-29:

- ❏ t1 = 20 ms
- ❏ t2 = time required for motor residual voltage to reach 10% of motor nameplate voltage.

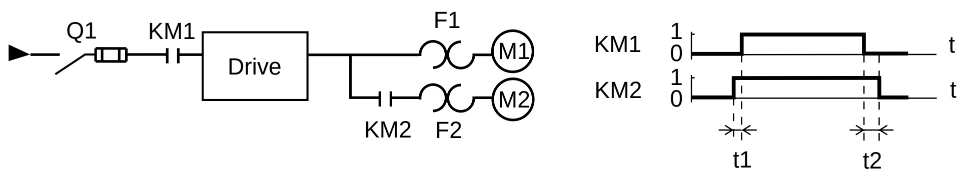


Figure 2-29 Connecting an Additional Motor

If the motor is to be connected to the controller while the controller is running, the sum of the running motor current(s) plus the expected starting current of the switched motor must not exceed 90% of the controller's transient output current rating.

Bypassing the Drive Controller

When bypassing the drive controller or inserting an isolation contactor between the controller and motor, comply with the timing sequence shown in Figure 2-30:

- ❏ t1 = 20 ms
- ❏ t2 = time required for motor residual voltage to reach 10% of motor nameplate voltage.

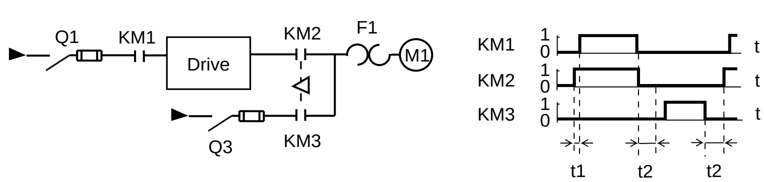


Figure 2-30 Bypassing the Drive (Direct Coupling)

INSTALLING THE MOTOR

Mount and connect the motor carefully, so as to eliminate any possible problems with vibrations and resonance.

Adaptation to the Motor Load

The motor/drive controller combination must be adequately rated to:

- ❑ Overcome the load torque of the motor load over the entire speed range used
- ❑ Supply the transient overtorque needed for the required accelerations (see Figure 2-23 on page 38 and Figure 2-24 on page 39.)

If braking is required for rapid deceleration, refer to:

- ❑ DC injection braking (page 34)
- ❑ Dynamic braking (page 75).

Depending on the type of machine load, some precautions must be taken:

- ❑ Constant torque load (conveyors): ensure that the starting torque is compatible with the available overtorque.
- ❑ Quadratic torque load (fans and centrifugal pumps): adjust the V/f ratio (page 64) and override the slip compensation (page 56). Torque increases rapidly with speed and it may be necessary to limit the maximum speed to avoid exceeding the capabilities of the motor-controller combination.
- ❑ Constant power load (winders): check the speed range. If torque is highest at low speed, check torque capability at lowest speed and provide forced ventilation if necessary.
- ❑ Overhauling load/high inertia: examine the braking methods (page 75), and adjust if necessary.

ADAPTATION TO THE INPUT LINE

If a suitable input line is not available, the drive controller can be supplied via a three-phase transformer or autotransformer, rated as shown in Table 2-11.

Table 2-11 Suitable Transformers

Drive	Transformer Rating
PØØVO4C	2 kVA
PØØVO4E	4 kVA
PØØVO4G	9 kVA
PØØVO4J	16 kVA
PØØVO4K	22 kVA
PØØVO4M	32 kVA
PØØVO4P	52 kVA
PØØVO4Q	75 kVA
PØØVO4S	100 kVA
PØØVO4T	125 kVA
PØØVO4U	155 kVA

LINE INDUCTORS

Use line inductors in the following circumstances:

- ❏ Input lines subject to interference from other loads (interference, overvoltage).
- ❏ Drive controller supplied by a line with very low impedance (fed from power transformers with more than 10 times the drive power).
- ❏ Large number of adjustable frequency drives installed on the same line.

In the cases above, using line inductors provides the following advantages:

- ❏ Increased protection of input rectifier bridge against overvoltage and spikes.
- ❏ Reduction of the current absorbed by the drive controller at full load.
- ❏ Reduction of the harmonic current load on the power factor correction capacitors, when used.

Inductors Between the Drive Controller and the Motor

The addition of inductors between the drive controller and the motor is recommended in the following circumstances:

- ❏ Wire connecting drive controller and motor is longer than 320 ft (100 m).
- ❏ For PØØVO4T and PØØVO4U, if the drive-motor connection wires are less than 82 ft (25 m) (to ensure protection against short circuits between output phases).
- ❏ More than three motors being controlled in parallel.
- ❏ Motor has more than six poles, with a high power factor and low stator inductance.
- ❏ Motor with a higher power rating than the controller power rating.

In the cases above, using line inductors enables reduction of:

- ❏ Values of the current peaks absorbed by the motor.
- ❏ Ground leakage interference currents.
- ❏ Radio interference created by the motor connection wiring.
- ❏ Vibrations and motor noise.

Recommended Three-Phase Inductors

The inductors listed in Table 2-12 can be used between the input line and drive controller and/or between the drive controller and the motor.

Table 2-12 Suitable Inductors

Inductor Characteristics		Drive	Drive Ratings	
Inductance	Amperes (continuous)[1]		Horsepower	Voltage
5 mH	5 A	PØØVO4C PØØVO4E	1.5 hp 3 hp	460 V 460 V
1.7 mH	15 A	PØØVO4G	7.5 hp	460 V
0.80 mH	30 A	PØØVO4J PØØVO4K	15 hp 20 hp	460 V 460 V
0.6 mH	40 A	PØØVO4M	30 hp	460 V
0.35 mH	70 A	PØØVO4P	50 hp	460 V
0.17 mH	150 A	PØØVO4Q PØØVO4S	60 hp 100 hp	460 V 460 V
0.150 mH	250 A	PØØVO4T PØØVO4U	125 hp 150 hp	460 V 460 V

[1] Continuous rms current rating. To prevent inductor saturation, inductor peak current rating must be 3 to 4 times the continuous current rating.

Notes:

Chapter 3 – Setting Up the Drive Controller

INTRODUCTION

DANGER

HAZARDOUS VOLTAGE.

- Read and understand this manual in its entirety before installing or operating Omegapak AC drive controllers. Installation, adjustment, repair and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 2-10 on page 26 and Figure 2-11 on page 27 for drive controller grounding points.
- Many parts, including printed wiring boards, in this drive controller operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before servicing controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the controller disconnect.
- Lock disconnect in open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

The Omegapak Type P drive controller is factory preset to meet the most common application requirements.

DRIVE CONTROLLER SETTINGS

NOTE

Throughout this chapter, preset values are marked with an asterisk (*).

Make sure the preset values are compatible with your requirements. If they are:

1. Check the drive controller connections (see Figure 2-12 on page 29).
2. Close and secure all enclosures.
3. Be sure the dialog unit CONFIG switch is set to 1 and AUTOEST switch is off.
4. Apply power to the controller.

If the preset values are not compatible with your requirements, readjust the settings as described in this chapter. The setting controls are grouped on front of the control board and are accessible without removing the front cover by lifting the protective flap.

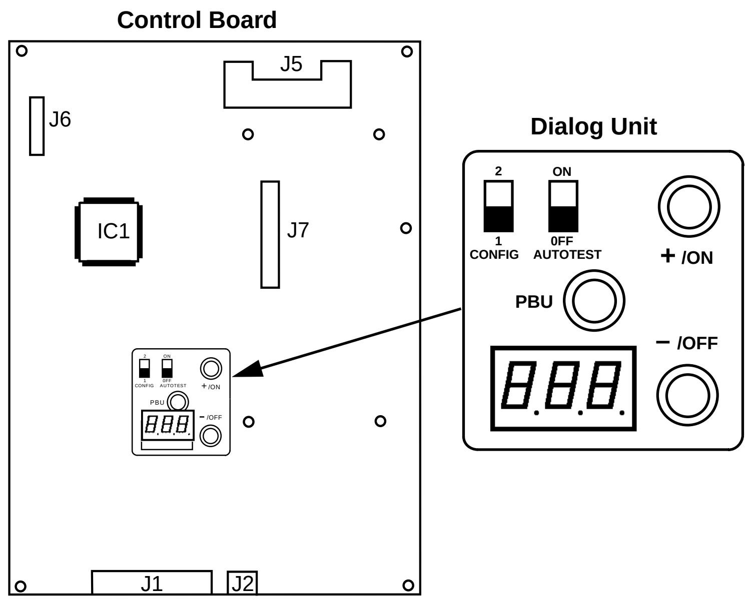


Figure 3-1 Drive Controller Settings

Dialog Unit Switches

The dialog unit has two switches, shown in Figure 3-2. The CONFIG switch enables access to the configuration parameters. The AUTOTEST switch selects the test sequence.

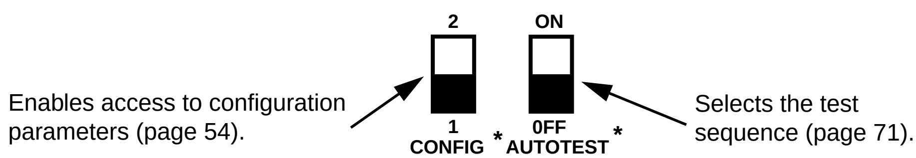


Figure 3-2 Switches on Dialog Unit

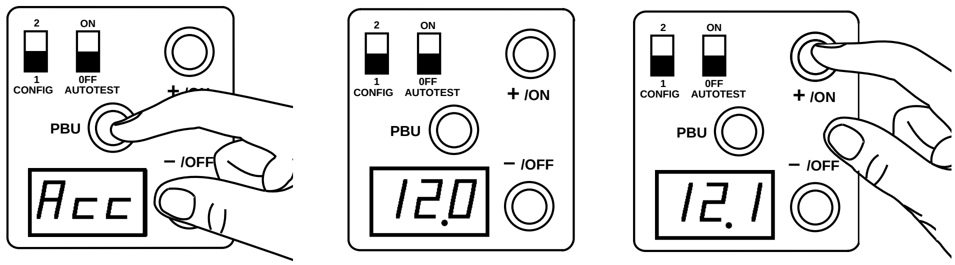
Dialog Unit Push Buttons

> ⚠ **WARNING**
>
> UNINTENDED EQUIPMENT ACTION.
> - Parameter changes affect controller operation.
> - Read and understand this manual before using internal keypad (dialog unit).
>
> Failure to observe these precautions may cause severe personal injury or equipment damage.

- ❑ PBU: When this push button is pressed and released, the parameter name and then its value is displayed (see Figure 3-3). If the parameter value is already displayed, pressing and releasing this push button causes the parameter name to be displayed (see Figure 3-4). Pressing and holding this push button causes the parameter names to scroll on the display.

- ❏ +/ON: Pressing this push button allows a user to increase a parameter value or enable a function.
- ❏ -/OFF: Pressing this push button allows a user to decrease a parameter value or disable a function.

Figure 3-3 shows how to change a parameter value.

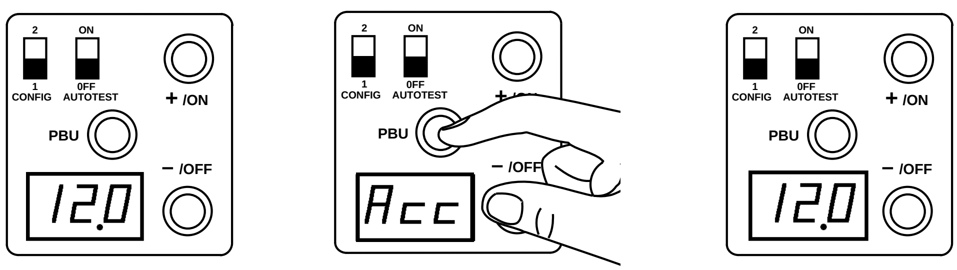


Calling up parameter | Parameter value | Changing parameter value

Figure 3-3 Changing a Parameter Value

Simultaneous pressing of PBU and +/ON enables scrolling of the parameters in the reverse order shown on page 51 and page 52.

When a parameter value is displayed, the name of the parameter can be called up again by briefly pressing PBU (see Figure 3-4).



Parameter not known | Calling up parameter name | Parameter value

Figure 3-4 Calling up a Parameter Name

DISPLAYING SETTINGS AND ELECTRICAL VALUES

With the CONFIG selector switch in position 1, and without a push button being pressed, the displays shown below are possible.

Operation Parameters

Drive Controller Stopped

rdY	Drive controller ready.
--F	Possible fault, see Table 4-1 on page 70.
SLc	Controller ready with serial communication option board.

Drive Controller Running

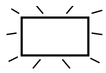
FrH ➨ 45.0 Value of the frequency reference, or another parameter selected during the previous operating period. For example:

Lcr ➨ 23.7 Motor Current

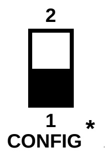
Other Displays Possible During Operation

dcb — DC braking: braking by DC injection enabled. This code shows that the braking command has been accepted.

Obr — Overbraking: excessive braking causes capacitor overvoltage. Increase deceleration time or install optional dynamic brake.


Display flashing: controller is operating in current limit.

Simplified Input Display



When the CONFIG selector switch is in position 1, press and hold the PBU push button to display the main operating parameters in the order shown in Figure 3-5.

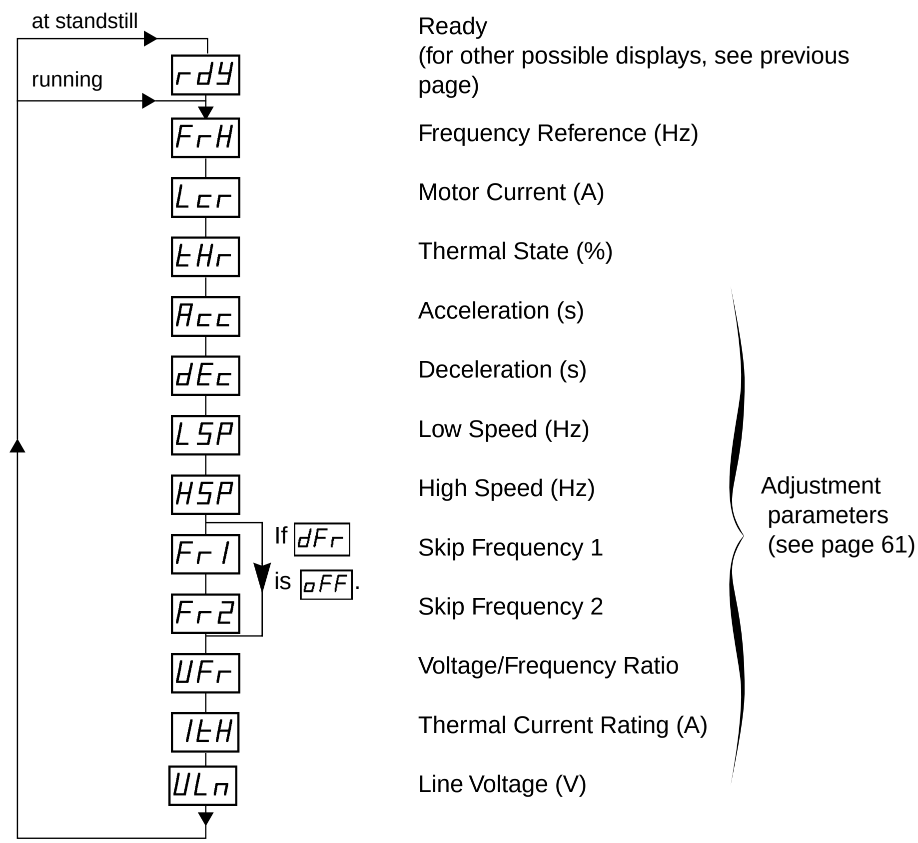
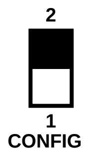


Figure 3-5 Simplified Input Display

> **NOTE**
>
> The value of the input line voltage ULn is valid only when the drive controller is in the standby mode(rdy). In addition, the value displayed may be incorrect if the input line is subject to waveform distortion.

Complete Display

To view all operating parameters, apply power to the drive controller's control circuit and move the CONFIG selector switch to position 2. Press and hold PBU to display all operating parameters in the order shown in Figure 3-6.



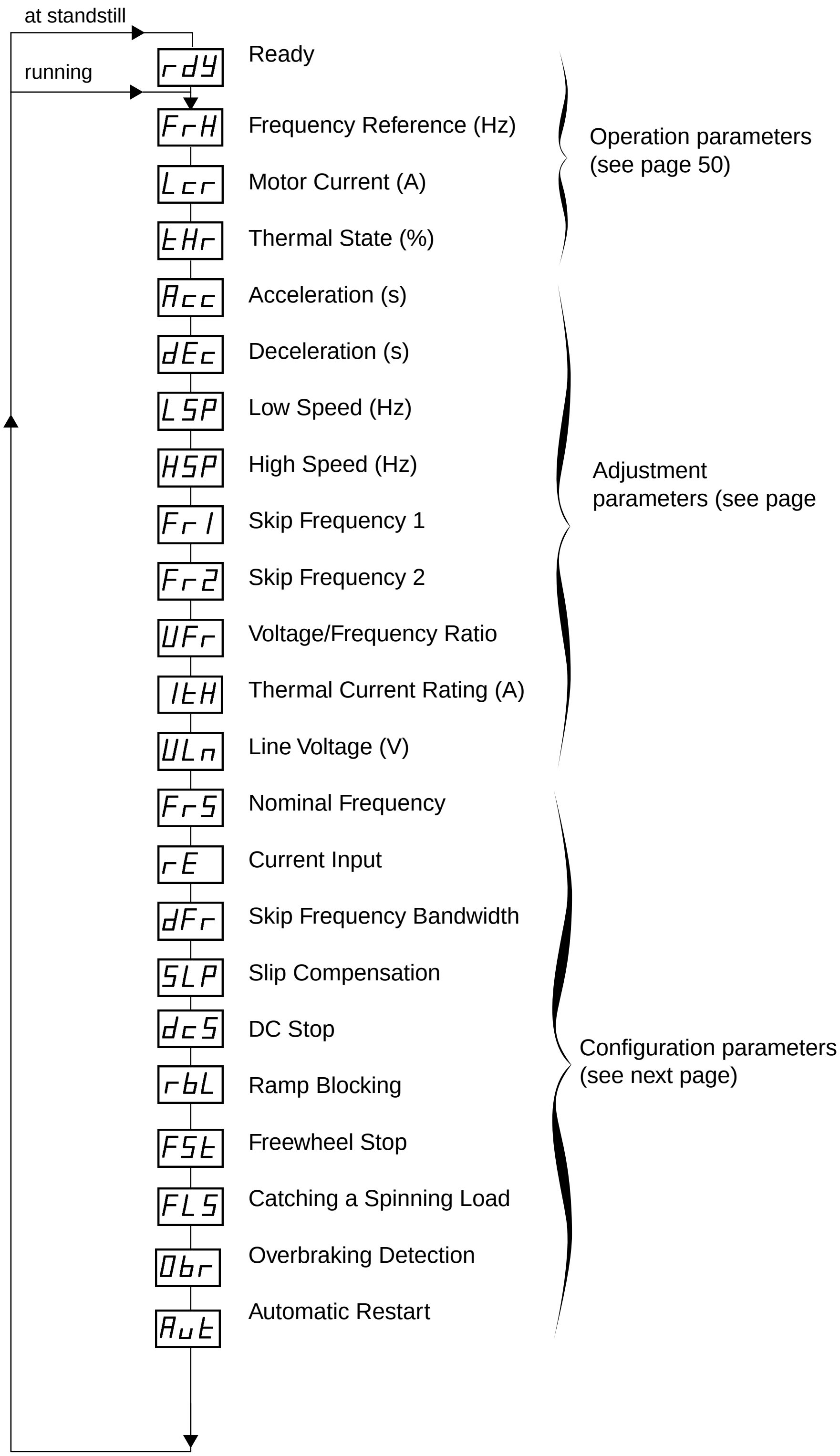


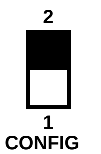
Figure 3-6 Complete Display

CONFIGURATION PARAMETERS

Displaying Configuration Parameters

Configuration parameters can be displayed at any time by putting the CONFIG selector switch in position 2. These parameters can be modified as long as the CONFIG selector switch is in position 2 when power is applied to the drive controller's control circuit. When in this mode, the controller will not start while the switch is in position 2. The serial communications option (if installed) is inactive in this mode.

Press and hold PBU to display the configuration parameters in the order shown in Figure 3-7.



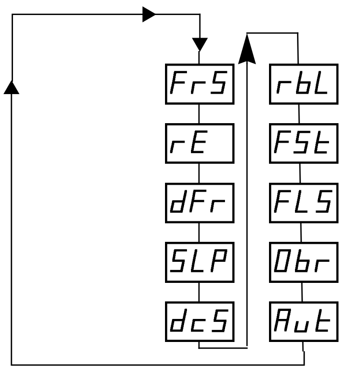


Figure 3-7 Display of Configuration Parameters

Changing Configuration Parameter Values

NOTE

All configuration parameter changes are STORED in the controller's permanent memory (EEPROM) when the CONFIG switch is moved from position 2 to position 1.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION.

- Depending on the state of controller's external inputs, drive may start when configuration switch is moved from position 2 to position 1.
- ALL external inputs to controller must be set to prevent drive operation when configuration switch is moved to position 1.

Failure to observe this precaution can result in severe personal injury or death!

Figure 3-8 shows how to change a configuration parameter value.

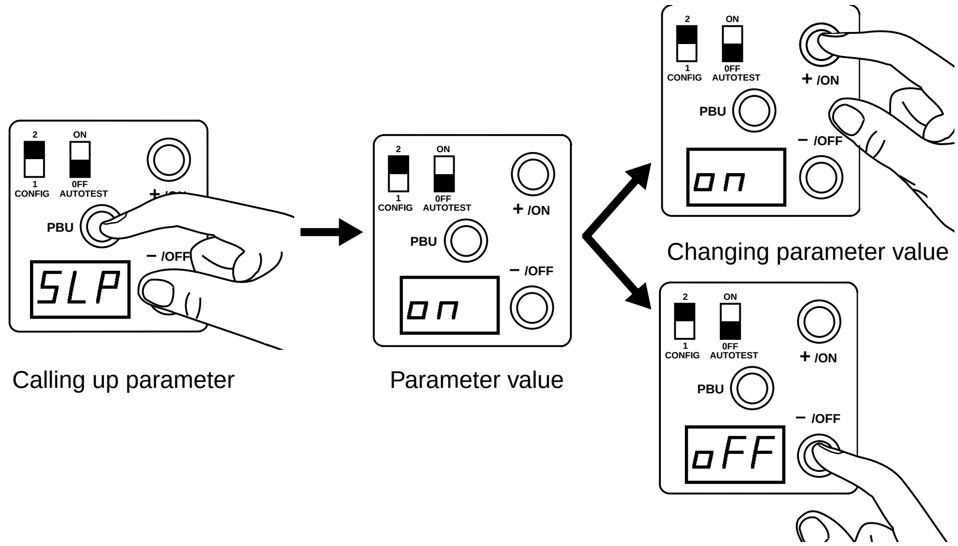


Figure 3-8 Changing Configuration Parameter Values

After changing the value of any parameter, turn the CONFIG switch to position 1 to return to the list of parameters on page 51.

When the CONFIG switch is moved from position 2 to position 1, the value of the configuration parameters is STORED in permanent memory (EEPROM). If the value of one of the parameters is changed, the new value is recorded in memory the moment the CONFIG switch is moved to position 1. If power is removed before the value is recorded, the parameter remains unchanged.

Configuration Parameter Values

The configuration parameters and their possible values are listed below. The preset values are marked with an asterisk (*).

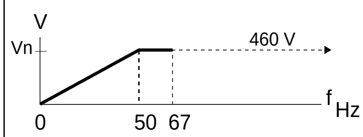
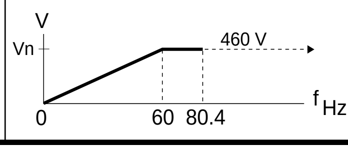
FrS

❑ Rated frequency of the motor:

	50	50 Hz
*	60	60 Hz

The various voltage/frequency ratio possibilities, depending on the FrS parameter and supply voltage, are given in the table below.

Table 3-1 Voltage/Frequency Curves

FrS	**Drive Controller V/F Curve PØØVO4_ (460 V)**
50	
60	

rE

❑ Current reference:

* 0.20 0-20 mA

4.20 4-20 mA

20.4 20-4 mA

In the special case when current input is 20-4 mA, the E1 and E2 inputs thus become 10-0 V inputs (high speed HSP obtained for 4 mA or 0 V reference.)

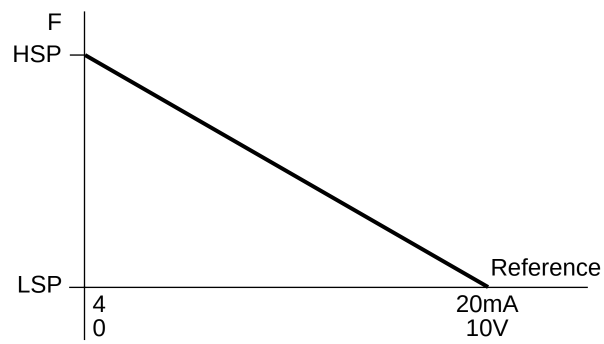


Figure 3-9 Current Input 20-4 mA

dFr

❑ Skip frequency bandwidth:

* oFF Suppression of skip frequencies

2 Suppression band 2 Hz

5 Suppression band 5 Hz

See page 63 for skip frequency settings.

SLP

❑ Slip compensation:

	on	Slip compensation On
*	oFF	Slip compensation Off

When On, slip compensation enables motor speed to be maintained almost constant, regardless of the load. Slip compensation must be switched off for operation with quadratic torque loads (such as fans and centrifugal pumps) and machines with high inertia.

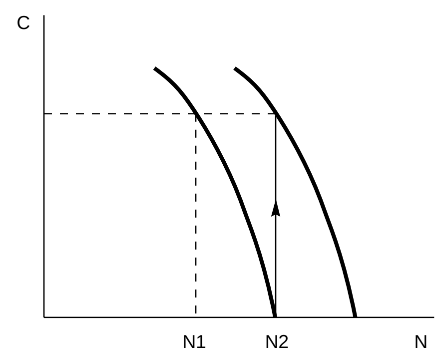


Figure 3-10 Slip Compensation Curves

dcS

❑ DC stop:

	on	DC stop on
*	oFF	DC stop off

⚠ WARNING

NO HOLDING TORQUE.

- DC injection braking does not provide holding torque at zero speed.
- DC injection braking does not function during loss of power or controller fault.
- When required, use separate brake function for holding torque.

Failure to observe this precaution can result in severe personal injury or death!

When On, this function enables braking by automatic DC injection during 0.5 seconds if the frequency becomes less than 1 Hz.

rbL

- Ramp blocking:

	on	Ramp blocking on
*	oFF	Ramp blocking off

When On, the ramp blocking function enables faster/slower operation in one direction only. The control inputs are reassigned as follows:

- FW: "faster" by increasing the frequency according to the acceleration ramp, maximum frequency being fixed by the reference.
- RV: "slower" by decreasing the frequency according to the deceleration ramp.
- FW+RV: ramp blocking; the frequency no longer varies.

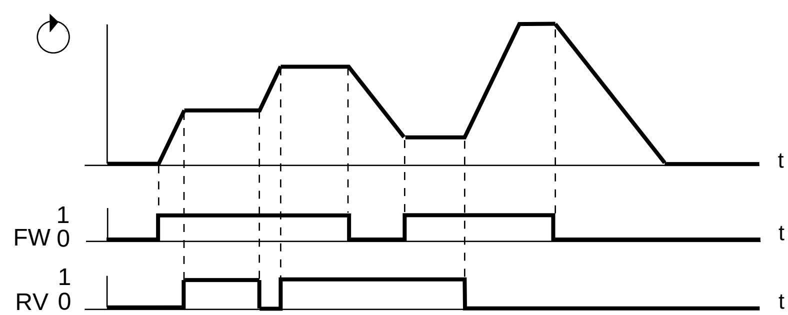


Figure 3-11 Ramp Blocking Curves

FSt

- Freewheel stop:

	on	Freewheel stop on
*	oFF	Freewheel stop off

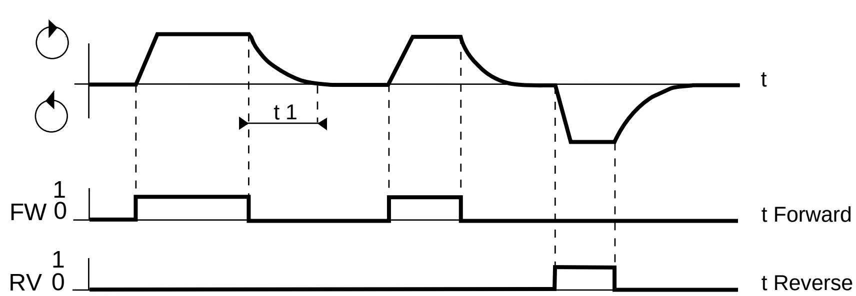


Figure 3-12 Freewheel Stop

When the Freewheel stop (FST) function is On:

- ❏ The drive controller output will be disabled when the run input (FW or RV) is disabled.
- ❏ The drive controller will decelerate with no power applied to the motor.
- ❏ The deceleration time (t1) depends on motor speed, machine inertia and resistive torque.

NOTE

- Restarting a coasting motor may cause the controller to trip on overcurrent.
- Restarting a coasting motor may subject the motor and driven load to acceleration and deceleration rates that exceed the controller ramp settings.

FLS

❏ Catching a spinning load:

	on	On
*	oFF	Off

⚠ WARNING

UNINTENDED EQUIPMENT ACTION.

- Automatic restart and catching a spinning load can only be used for machines or installations that present no danger in the event of automatic restarting, either for personnel or equipment.
- Equipment operation must conform to national and local safety regulations.

Failure to observe this precaution can result in severe personal injury or death!

The use of this function requires a special control sequence. Maintain the power and control supply via a 2 wire control of the line contactor (by selector switch or latching push buttons). Maintain the speed reference and the direction signal.

This function permits smooth pick-up of motor speed in the event of a short input line failure (>20 ms). It is intended for machines (such as fans and machines with high inertia) for which a loss of speed is slight during short power line failures. This function is not intended for use with overhauling loads and should be set to Off when used with such loads.

If this function is set to Off, when power is reapplied frequency ramping starts from zero and progresses to the reference value. If set to On, when power is reapplied the output frequency is immediately equal to the speed reference value, and the voltage develops gradually so as not to cause an overcurrent condition.

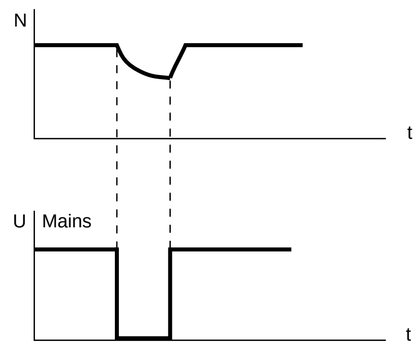


Figure 3-13 Catching a Spinning Load

Obr

❏ Overbraking detection:

*	on	On
	oFF	Off

When On, the overbraking detection function enables deceleration time to be increased automatically if the ramp time setting is too low, taking into account load inertia.

This function can be switched off if the dynamic braking option is used in order to obtain maximum braking performance.

Aut

❏ Automatic restarting:

	on	On
*	oFF	Off

⚠ WARNING

UNINTENDED EQUIPMENT ACTION.

- Automatic restart and catching a spinning load can only be used for machines or installations that present no danger in the event of automatic restarting, either for personnel or equipment.
- Equipment operation must conform to national and local safety regulations.

Failure to observe this precaution can result in severe personal injury or death!

The use of this function requires a special control sequence. Maintain the power and control supply via a 2 wire control of the line contactor (by selector switch or latching push buttons). Maintain the speed reference and the direction signal.

Activation of this function enables automatic restarting of the drive controller following an overbraking fault or a motor overload fault.

If the drive controller faults following filter capacitor overvoltage, the controller remains disabled for 1 minute with ObF displayed (overbraking) and automatically restarts if the fault has disappeared and if the other operating conditions allow. The fault relay (terminals SA-SB) remains closed.

If overvoltage occurs again, the sequence above is repeated 4 times (that is, a maximum of 5 sequences) before the drive controller faults and has to be reset.

If the drive controller faults following motor overvoltage, the drive controller remains disabled for as long as the thermal state stays above 100% (about 7 minutes). The fault relay (terminals SA-SB) remains closed. Restarting is possible if the other operating conditions allow.

This function is intended for HVAC systems or high inertia applications.

NOTE

If controller is fitted with optional serial communication board (page 94), the Adr parameter (address) appears after the parameters above.

Refer to Instruction Bulletin 50006-378-05, supplied with the serial communication board.

ADJUSTMENT PARAMETERS

Adjustment parameters can be displayed and modified at any moment, whether the drive is running or not. The parameter values are stored in permanent memory (EEPROM).

Changing Adjustment Parameter Values

> **⚠ WARNING**
>
> UNINTENDED EQUIPMENT ACTION.
> - Parameter changes affect controller operation.
> - Read and understand this manual before using internal keypad (dialog unit).
>
> Failure to observe these precautions may cause severe personal injury or equipment damage.

If a parameter is changed from the dialog unit, the new value immediately affects drive operation. The parameter is acted upon even while the display is scrolling through the adjustment range. For example, if acceleration time is modified while the controller is accelerating, a nonlinear acceleration time will result.

The new value is recorded in memory (EEPROM) in one of two ways:

1. Changes are saved if another adjustment parameter is called up (by pressing PBU).
2. There is a 10 second window that starts when the user stops making changes to adjustment parameters. If 10 seconds expires and no additional changes are made, the new values are stored in memory (EEPROM). If additional changes are made before the 10 second window elapses, the window is reset and starts again when the user stops making changes.

If power is removed from the controller before 10 seconds has elapsed, the parameter remains unchanged. Figure 3-14 shows how to change an adjustment parameter value.

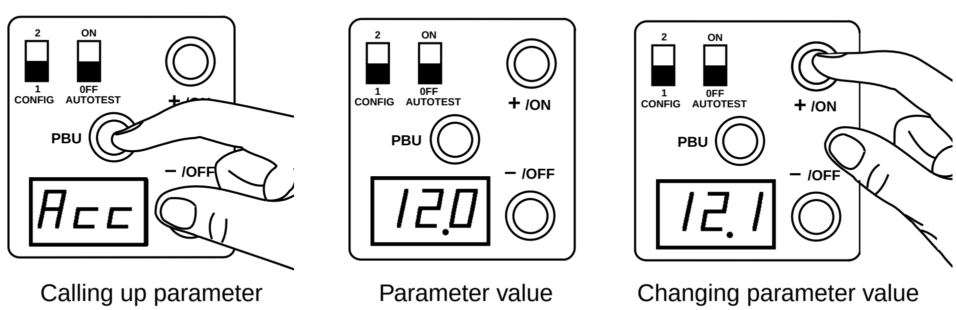


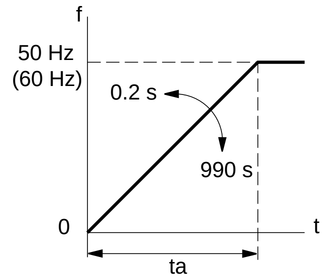
Figure 3-14 Changing an Adjustment Parameter Value

List of Adjustment Parameters

Acc

❑ Acceleration (1 to 990 s)

Acceleration time is increased automatically if overtorque occurs.



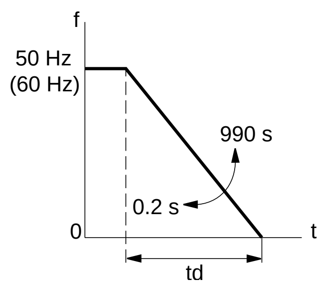
* Preset value 5 s

Figure 3-15 Acceleration Curve

dEc

❑ Deceleration (0.2 to 990 s)

Deceleration time is increased automatically if excessive braking occurs (display of code Obr).



* Preset value 10 s

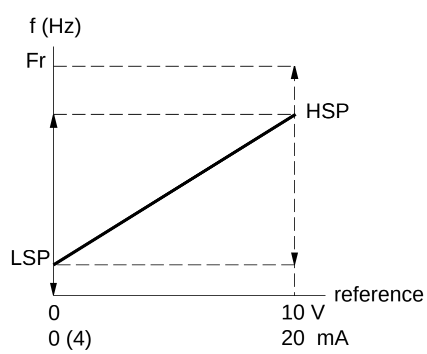
Figure 3-16 Deceleration Curve

LSP

HSP

❑ Low speed

❑ High speed



See page 54.

Figure 3-17 Frequency Curve

LSP and HSP scale the input range for speed references on the drive controller. LSP sets the minimum frequency at which a reference input can command the drive controller to run. HSP sets the maximum frequency at which a reference input can command the controller to run. For example, with a 0 to 10 V input, if the reference is 0 V and LSP = 10, the drive is commanded to run at 10 Hz. If the reference is 10 V and HSP = 52, the drive is commanded to run at 52 Hz.

LSP and HSP are not the minimum and maximum frequency clamps of the drive controller. They are the minimum and maximum output frequencies of the controller during normal, steady state operation. During transients or loss of speed feedback, the controller's output frequency is limited to ± 6 Hz of the input reference value.

With LSP set to minimum, the absolute minimum controller speed is 1 Hz. The controller will not run with references less than 1 Hz.

The preset values are:

- ❏ LSP minimum
- ❏ HSP *60 Hz for PØØVO4_ (460 V)

Fr1
Fr2

- ❏ Skip frequencies 1 and 2

Skip frequencies are selected in such a manner as to prevent the motor from operating steady state at machine or installation resonant frequencies. The Fr1 and Fr2 parameters allow the user to specify up to two skip frequencies with a bandwidth of 2 or 5 Hz according to the dFr parameter value (i.e., if dFr is set to oFF there are no skip frequencies).

To adjust the skip frequencies:

- ❏ Adjust the speed reference to determine the critical frequency or frequencies (noise and mechanical resonance).
- ❏ Set the dFr parameter to 2. This selects a 2 Hz bandwidth.
- ❏ Adjust one or both of the Fr1 and Fr2 parameters to the 1 or 2 determined values.
- ❏ If the resonance phenomena persists, extend the frequency band from 2 to 5 Hz using the dFr parameter.

Preset values Fr1 and Fr2 to 50 or 60.

If there is only one critical frequency value, adjust Fr2 to the same value as Fr1. Example: for a motor 1500 rpm at 50 Hz, with critical frequency given at 30 Hz and dFr parameter set to 2, set Fr1 to 30.0. For a frequency reference of 30 Hz, rotation frequency will be 29 Hz on acceleration and 31 Hz on deceleration.

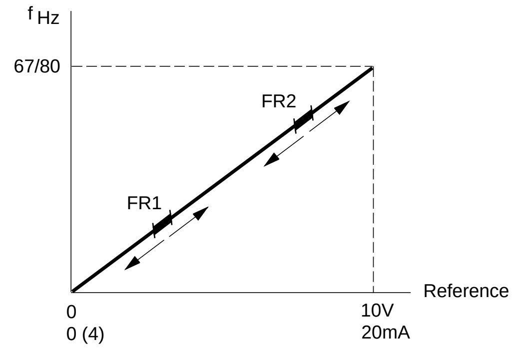


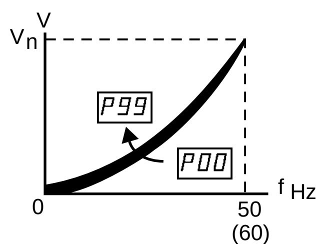
Figure 3-18 Critical Operating Frequency Curves

UFr

❑ Voltage/frequency ratio

* Preset value P00: setting for operation with quadratic torque load.

Figure 3-19 shows the V/f curve for applications with quadratic load torque, such as fans and centrifugal pumps.

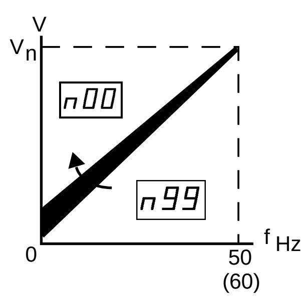


To improve motor performance, adjust between P00 and P99 in such a way as to obtain correct and silent operation with minimum current. This adjustment range is obtained via the - /OFF push button.

Vn: rated voltage

Figure 3-19 Quadratic Torque Curve

Figure 3-20 shows the V/f curve for applications needing high torque at low speed:



If torque is inadequate, increase gradually from n00 to n99 until correct operation is obtained. This adjustment range is obtained via the +/On pushbutton.

Vn: rated voltage

Figure 3-20 High Torque Curve

ItH

❏ Thermal (overload) motor protection (page 39)

* Preset, in units of amps, to 0.9 of the drive controller's rated current. Setting range: from 0.45 to 1.05 of controller's rated current (see Table 1-1 on page 11).

Set ItH to the rated motor current value listed on the motor nameplate.

To disable thermal protection, press and hold the +/ON push button (increasing the value of ItH) until the code nTH appears.

Special case: UFr setting in the P00 to P99 range (quadratic torque load). With some ventilation applications, it may be necessary to increase flow in continuous operation when operating conditions permit (for example, reduction of air density by increasing temperature). The motor is thus operating at overspeed. In order to avoid the thermal overload relay tripping if the load curve changes (cooling down of the air for example), the current taken by the motor must be limited to a permissible value in continuous operation.

The current limitation is reduced to 1.05 times the ItH preset value from the current taken by the motor reaches this value in continuous operation whatever the speed reference. During the transient acceleration and deceleration phases, the current remains fixed at its initial value, that is 1.1 times the speed controller's rated value. The drive controller will not trip on OLF motor overload due to the reduced current limit.

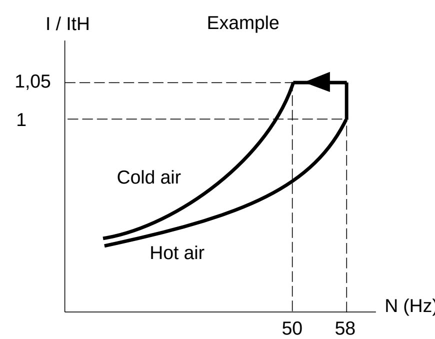


Figure 3-21 Motor Thermal Protection Curve

Notes:

Chapter 4 – Maintenance

SAFETY PRECAUTIONS

Read the safety statements below before proceeding with any maintenance or troubleshooting procedures.

⚠ DANGER

HAZARDOUS VOLTAGE.

- Read and understand this manual in its entirety before installing or operating Omegapak AC drive controllers. Installation, adjustment, repair and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 2-10 on page 26 and Figure 2-11 on page 27 for drive controller grounding points.
- Many parts, including printed wiring boards, in this drive controller operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before servicing controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the controller disconnect.
- Lock disconnect in open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

PREVENTIVE MAINTENANCE

The following preventive maintenance procedures are recommended at regular intervals:

- ❏ Check the condition and tightness of the connections.
- ❏ Make sure that the ventilation is effective and that the temperature around the drive controller remains at an acceptable level.
- ❏ Remove dust and debris from the drive controller, if necessary.

If anything unusual occurs when putting the controller into service or during operation, be sure that all the recommendations relating to the environment, mounting and connecting the drive controller have been followed.

FAULT CODES

The Omegapak Type P drive controller can detect a certain number of faults and display them in the form of codes. These fault codes are listed in Table 4-1 on page 70.

Fault Storage

The first fault detected is displayed and stored if the control circuit voltage stays on. The fault relay drops out except when automatic restarting is configured. Use of the circuit diagram shown on page 29 is recommended.

Erasing Faults

To erase a fault from memory (the fault code may be steady or flashing), remove all power from the drive controller.

If the fault code is steady, switch the power supply back on; this erases the fault storage and resets the drive controller.

If the fault code is flashing, this indicates that the fault is still present. Find and correct the cause and wait for the code to be steady before switching the power supply back on to reset the drive controller.

Overcurrent due to Short Circuit

The fault code OcF requires special attention. With this type of fault, it is essential to switch off the drive controller's power and control circuits and to check the connection cables and motor insulation. Carry out the self-diagnostics before resetting (page 71).

Table 4-1 Fault Codes

Code	Probable Cause	Troubleshooting Procedure
[ ] Display off or partial display	1. No control supply. 2. Control voltage too low.	1. Check the control voltage, supply fuses, internal fuses and connections.[1] 2. Check the H1-H2 control terminal connections.
PhF Phase fault	1. No supply to terminals L1-L2-L3. 2. Power fuses blown. 3. Brief input line failure (t ≥ 200 ms). 4. Internal connections.	1. Check the power supply, supply fuses. 2. Reset the drive. 3. Check the connections.[1]
USF Undervoltage	1. Supply too low: PØØVO4_: V ≤ 380 V 2. Temporary voltage drop (t ≥ 200 ms). 3. Internal connections.	1. Check the supply voltage. 2. Reset the drive. 3. Check the connections.[1]
OSF Overvoltage	1. Supply too high: PØØVO4_: V ≥ 550 V (50 Hz) PØØVO4_: V ≥ 510 V (60 Hz)	1. Check the supply voltage. 2. Check parameter Fr5 (50 or 60).
OhF Overtemperature	1. Heat sink temperature too high (≥ 167° F / 75° C). 2. ≤ 37 kW models: J8 on power board disconnected. 3. ≥45 kW models: switch on measurement board in wrong position. 4. Braking resistor thermal contact tripped (see page 87).	1. Check the motor load, the fan and the ambient temperature around the drive controller. Wait for controller to cool down before resetting. 2. Check connector J8. 3. Check the switch position (page 91). 4. Check the dynamic brake connections. Change the resistor if necessary.
OLF (overload) OLF. (loss of current sensor) Motor overload	1. If tHr ≥ 118%, thermal trip due to prolonged overload or phase failure. 2. If tHr < 118%, phase U failure (≤ 37 kW models) or phase V failure (≥ 45 kW models). 3. Motor power rating too low for application.	1. Check the ItH setting and compare with motor In. Check the load and compare with the operating speed. Check the braking conditions (Possibility of single phase operation). Wait approximately 7 minutes before resetting. 2. Check the motor connections for open phase. 3. For motors whose continuous current rating is less than 50% of the controller current rating, see page 41.
ObF (overvoltage) ObF. (overcurrent) Excessive braking	1. Overvoltage or overcurrent due to excessive braking or an overhauling load (even with braking option).	1. Increase the deceleration time. Add the braking option if necessary. Reset is possible if ULn: ≤ 550 V: PØØVO4_
OcF (anti-sat) OcF. (bus sensor) Overcurrent	1. Short circuit or grounding on the drive controller output. 2. Internal drive fault. 3. Excessive transient operation.	1. Remove all power and control. Check the connecting cables and motor insulation, with the drive controller disconnected. 2. Use the drive self-diagnostics. 3. Increase the acceleration or deceleration time then reset drive.

[1] See Instruction Bulletin 50006-378-04 (Troubleshooting Manual).

Table 4-1 Fault Codes (Cont'd)

Code	Probable Cause	Troubleshooting Procedure
CrF Charge relay fault	1. Capacitor charge relay closure control fault.	1. Check the connections.[1]
SLF Serial link fault	1. Serial link communication fault (with communication option board).	1. Check the connections between the drive controller and programmable controller (or computer).
InF (item not found) InF. (AUTOTEST switch position) Internal fault	1. Internal connection fault. 2. AUTOTEST selector switch moved to the ON position during operation	1. Check the internal connectors, with the supply switched off and capacitors discharged (at least 10 minutes, see page 15). 2. Move the selector switch to OFF. Reset the drive controller.

[1] See Instruction Bulletin 50006-378-04 (Troubleshooting Manual).

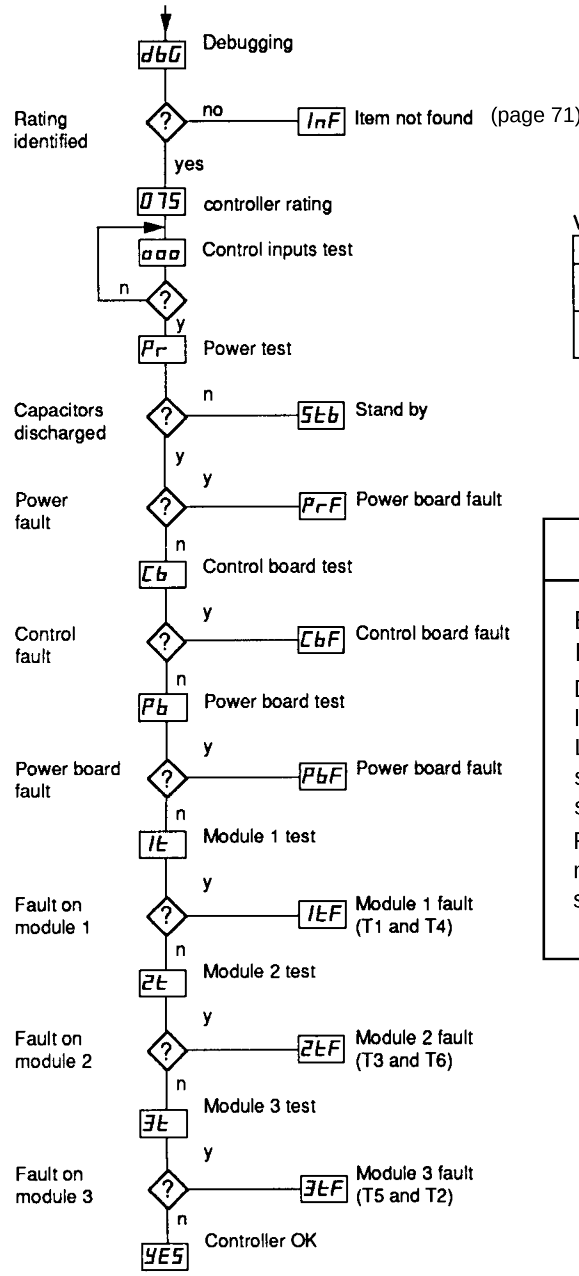
SELF-DIAGNOSTICS

The drive controller has incorporated a self-diagnostic system. It allows a user to check the main functions. To perform the self-diagnostics (autotest):

1. **Remove all power and refer to Danger statement on page 68.**
2. Disconnect U/T1, V/T2 and W/T3 leads at the controller.
3. Select the test sequence by moving the AUTOTEST selector switch on the dialog unit to ON.
4. Do not apply line power to L1, L2 or L3. Connect control power only to H1 and H2 terminals of drive controller.
5. Switch the control supply back on.

> ⚠ **WARNING**
>
> EQUIPMENT DAMAGE HAZARD.
>
> Do NOT energize the input line connected to L1, L2 and L3 or move the AUTOTEST switch during the autotest sequence.
>
> Failure to observe this precaution may result in equipment damage, severe personal injury or death.

Figure 4-1 is the flowchart for the self-diagnostics.



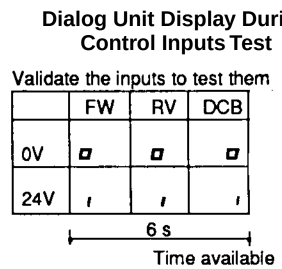


Figure 4-1 Flowchart for Self-Diagnostics

> ⚠ **WARNING**
>
> EQUIPMENT DAMAGE HAZARD.
>
> Do NOT energize the input line connected to L1, L2 and L3 or move the AUTOTEST switch during the autotest sequence.
>
> Failure to observe this precaution may result in equipment damage, severe personal injury or death.

When the autotest is complete:

- ❑ Switch off the control supply to reset the test sequence to zero.
- ❑ After rectifying the fault, run a second test to check the controller condition.
- ❑ **Before operating the drive, move the AUTOTEST switch back to the OFF position before applying line power.**

Chapter 5 – Options and Special Features

SAFETY PRECAUTIONS

Read the safety statements below before installing any drive option.

⚠ DANGER

HAZARDOUS VOLTAGE.

- Read and understand this manual in its entirety before installing or operating Omegapak AC drive controllers. Installation, adjustment, repair and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 2-10 on page 26 and Figure 2-11 on page 27 for drive controller grounding points.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before installing controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the controller disconnect.
- Lock disconnect in open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

ADAPTATION FOR ±10 V CONTROL

The ±10 V control module, part no. VW3-A45108, is an interface that changes the ±10 V input into a 0 to 10 V speed reference and a rotation direction (forward or reverse) control. It has the following characteristics:

- ❑ Dimensions (H x W x D):
  3.78 in (96 mm) x 1.89 in (48 mm) x 1.65 in (42 mm)
- ❑ Clip-on fastener onto ⌐_⌐ 1.38 in (35 mm) omega rail
- ❑ Two summing analog input terminals, 22 and 23 (Ze = 28 kΩ). The resulting speed reference is equal to the absolute value of the sum of references AE1 and AE2.
- ❑ The sign (+ or -) of the sum of the references determines the rotation direction.

The module may be enabled by a balanced 30 VDC external supply between terminals 25 (+) and 26 (-).

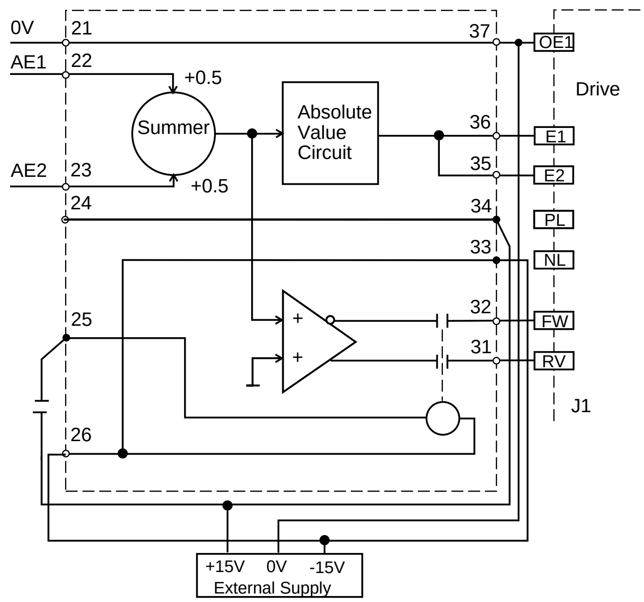


Figure 5-1 Block Diagram of ±10 V Control Module

DYNAMIC BRAKING AND SPEED REGULATION

This section describes the dynamic braking and speed regulation options for the Class 8803 Type P AC drive. These two functions, grouped together as one option, are available in three versions according to the drive power:

- ❑ Dynamic braking module (8803 PB01) for 1.5 to 30 hp Omegapak Type P AC drives
- ❑ Dynamic braking module (8803 PB02) for 50 hp Omegapak Type P AC drives
- ❑ Dynamic braking board (8803 PB03) for 60 to 150 hp Omegapak Type P AC drives

The braking resistor is not supplied with the dynamic braking option and must be ordered separately. Four resistor kits are available for use with the three dynamic braking options. The resistor kits are intended to be mounted separately from the drive controller. For installation and connection of the resistor kits, see page 86.

Dynamic Braking Module

⚠ DANGER

HAZARDOUS VOLTAGE.

- DB module power and control terminals are at line potential.
- Ground equipment using screw provided.
- Disconnect all power before servicing DB module.
- High voltage remains after power is removed.
- Bus capacitors do not discharge immediately.

Before servicing:

- WAIT TEN MINUTES.
- Measure bus capacitor voltage between + and - terminals of controller to verify DC voltage is zero (see page 15).
- DO NOT short across capacitor terminals with voltage present.
- Install all covers before applying power to DB module.
- Use insulating tool when adjusting ASP potentiometer.
- External devices connected to DB module must be insulated for line voltage with respect to ground.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

This module is mounted on the left side of the drive controller by a clip-on fastener. It is supplied with:

- ❏ 2 multi-conductor cables with connectors for termination to the controller:
  - •Dynamic braking option: connector J8 of the power board
  - •Speed regulation option: not available on the Variable Torque drive controllers. Tacho-generator cable may be discarded.
- ❏ Connection and mounting instructions
- ❏ 2 conductors, pre-wired to the module, for connection to terminals + and - of the drive controller
- ❏ 2 conductors, pre-wired to the module, for connections to terminals H1 and H2 (PB02 only)

The module has the following features:

- ❏ Environmental conditions: identical to the drive controller
- ❏ Degree of protection: NEMA Open / IP20 (open)
- ❏ Dimensions (H x W): 10.04 in (255 mm) x 2.17 in (55 mm)
- ❏ Weight: 2.64 lb (1.2 kg)

Dynamic Braking Board

⚠ DANGER

HAZARDOUS VOLTAGE.

- DB board components and control terminals are at line potential.
- Disconnect all power before servicing DB board.
- High voltage remains after power is removed.
- Bus capacitors do not discharge immediately.

Before servicing:

- WAIT TEN MINUTES.
- Measure bus capacitor voltage between + and - terminals of controller to verify DC voltage is zero (see page 15).
- DO NOT short across capacitor terminals with voltage present.
- Use insulating tool when adjusting ASP potentiometer.
- External devices connected to DB board must be insulated for line voltage with respect to ground.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

The dynamic braking board is supplied with a connection cable to the control board for use with a speed regulation option. This option is not available on the Variable Torque drive controllers. Please discard the special tachogenerator cable. To mount and connect the board, see page 90.

Dynamic Braking Principles

When the frequency produced by the controller decreases rapidly, the motor behaves like an asynchronous generator and produces a braking torque. The motor feeds energy back to the drive controller. The amount of energy depends on the rate of deceleration, the inertia of the moving mass and the resistive torque.

Since the controller cannot feed the energy back into the supply, this causes an increase in the voltage of the filter capacitors, which limits the braking effect, potentially causing the controller to fault on overvoltage (code OBF). Part of the braking energy is dissipated as losses in the motor, the corresponding braking torque varying from 10 to 35% of the rated motor torque.

Dynamic braking allows a higher braking torque to be obtained and ensures dissipation of part of the braking energy in an external resistor. Dynamic braking consists of the following major components:

- ❑ Power transistor that switches the braking resistor across the filter capacitor terminals
- ❑ Control electronics
- ❑ Separately mounted braking resistor and fuse
- ❑ Low speed relay, which will control a brake if necessary: pick up at $f > 0$ Hz and motor $I \geq 0.7$ rated drive controller current, drop out at $f \leq 0$ Hz.

For Omegapak 1.5 to 50 hp drives, the dynamic braking modules contain all the control electronics, power transistor and low speed relay.

For Omegapak 60 to 150 hp drives, the power transistor is incorporated directly into the drive controller. The control electronics and low speed relay are located on the dynamic braking board.

Resistor kits containing resistor(s) and fuses are available for all drive controllers.

Characteristics

Maximum permissible braking current is limited by:

- ❑ Braking resistor value
- ❑ Associated drive controller's transient current capability
- ❑ Maximum power transistor current:
  - 50 A for 8803 PB01 modules
  - 75 A for 8803 PB02 modules
  - 100 A for PØØVO4Q and PØØVO4R drive controllers
  - 200 A for PØØVO4T and PØØVO4U drive controllers

Protection

NOTE

The power transistor is protected against short circuits at the braking resistor terminals.

AVAILABLE BRAKING TORQUE

⚠ WARNING

OVERSPEED HAZARD.

- Generation of braking torque throughout the operating speed range of the controller requires dynamic braking be present and operating.
- Dynamic braking resistor must be selected to generate required torque. Refer to page 80 for resistor selection procedure.

Failure to observe these precautions can result in severe personal injury, product damage or property damage.

⚠ WARNING

NO HOLDING TORQUE.

- Dynamic braking does not provide holding torque at zero speed.
- Dynamic braking does not function during loss of power or controller fault.
- When required, use separate braking function for holding torque.

Failure to observe these precautions can result in severe personal injury, product damage or property damage.

Continuous Duty

Motor torque derating may be necessary for continuous duty reduced speed applications. When supplying braking torque, less derating is required than when the motor is supplying continuous driving torque at reduced speed (see page 38). For applications requiring both driving and braking torque, motor derating based on the continuous driving torque requirements is sufficient.

For applications requiring only braking torque, derating of the maximum continuous torque capability of the motor must generally be done for operation at speeds below 25% of motor nameplate speed. However, since motor designs vary, the motor manufacturer must be consulted for the required derating for a specific motor.

For continuous braking, the dynamic braking resistor must be sized to continuously absorb the nameplate power rating of the motor. To allow the motor power to flow into the resistor, the resistor ohmic value must be selected according to the following formula:

$$R_{db} = \frac{(\sqrt{2}Vc + 40)^2}{P_N}$$

Where Vc=Controller nameplate voltage rating and P_N= Motor nameplate power rating. In no instance should the ohmic value of the resistor chosen be less than the values listed in Table 5-1 on page 81.

Braking Torque Production Envelope

Figure 5-2 illustrates typical continuous torque braking capabilities for a typical NEMA design B motor. Curve 1 represents the motor capability when operated with reduced V/f (i.e., UFr set for P00 through P99) while Curve 2 represents the motor capability when operated with constant V/f (i.e., UFr set for n00 through n99). For both curves, the controller rated output current is greater than or equal to the motor nameplate current and the controller transient ouput current capability is no less than 110% of the controller rated output current. In addition, the dynamic brake resistor ohmic value is 100% of the value calculated for continuous operation.

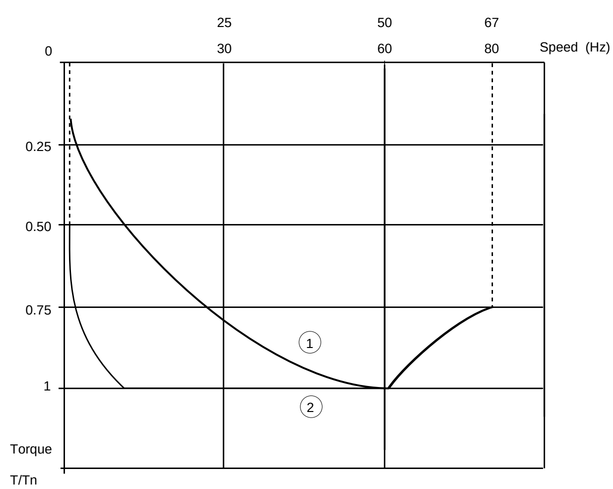


Figure 5-2 Typical Braking Torque Curves

Calculating Braking Power

To calculate braking power for a high inertia machine, non-overhauling load:

- ❑ Braking torque (Tb) on deceleration: $Tb = \frac{Wk^2 \times \Delta rpm}{308 \times \Delta t}$ in lb-ft, where

  Wk^2 = total moment of inertia referred to the motor shaft in lb-ft^2

  Δrpm = speed difference in rpm

  Δt = deceleration time in seconds

- ❑ Instantaneous braking power: $Pb = \frac{Tb \times rpm}{7.04}$ in W.

- ❑ Average braking power during deceleration: $Pbd = \frac{0.5Tb \times \Delta rpm}{7.04}$ in W.

- ❑ Average braking power during one cycle: $Pbm = Pbd\,\frac{t}{\tau}$ in W, where
  t = braking time in s, τ = time of one cycle in s

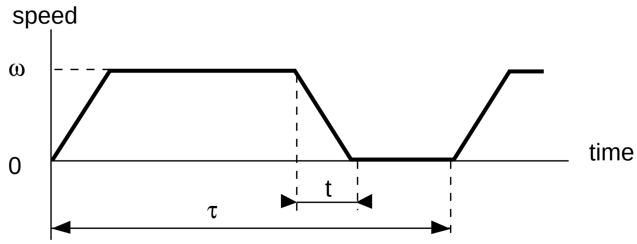


Figure 5-3 Average Braking Power

To calculate braking power for continuous operation of unspecified duration:

- ❑ Braking is treated as continuous braking: $Pb = Pbm = \frac{Tb \times rpm}{7.04}$ in W, where

  Tb = braking torque in ft-lb

  rpm = speed in revolutions per minute

Selecting a Braking Resistor

The braking resistor is defined by its ohmic value and power dissipation capacity. Use the following formula to determine the ohmic value of resistance needed to supply the proper braking torque:

$$R_{db} = \frac{(\sqrt{2}Vc + 40)^2}{P_b}$$

Where:
Vc = Controller nameplate voltage rating
P_b = Instantaneous braking power (watts)

The ohmic value of the resistor can be less than the calculation, but should never be less than the values listed in Table 5-1.

Table 5-1 Ohmic Value of the Braking Resistor

Drive Controller	Minimum Resistor Value (Ω)
PØØVO4C, PØØVO4E, PØØVO4G	47
PØØVO4J, PØØVO4K	27
PØØVO4M, PØØVO4P	15
PØØVO4Q	10
PØØVO4S	8
PØØVO4T, PØØVO4U	5

To determine the power of the resistor, evaluate:

- ❏ Rated power (Pn): power that can be dissipated continuously. Must be greater than the average braking power, Pbm.
- ❏ Maximum power (Pmax): power that can be dissipated over a short period on intermittent duty. Must be greater than braking power, Pb.

BRAKING RESISTOR KITS

Kits containing standard values of braking resistors and associated fuses are available. Table 5-2 lists the electrical and thermal characteristics of the resistor kits as well as the recommended kits for various drive controllers.

Table 5-2 Standard Braking Resistors

Resistor Kit No.		8803 PR01	8803 PR02	8803 PR02 (2 ea)	8803 PR04	8803 PR04 (2 ea)
Drive	**PØØVO-4** 460 V	**C** (1.5 hp) **E** (3 hp) **G** (7.5 hp)	**J** (15 hp) **K** (20 hp)	**M** (30 hp) **P** (50 hp)	**Q** (60 hp) **S** (100 hp)	**T** (125 hp) **U** (150 hp)
Standard Resistor Configuration [1]	**PØØVO-4** 460 V	50 Ω (2 ea.) in series	6.4 Ω (5 ea.) in series	2 PR02 kits in parallel [2]	10 Ω	2 PR04 kits in parallel [2]
Power Rating per Resistor [3]		50 W	57.6 W	57.6 W	1440 W	1440 W
Std. Resistor Value [4]		100 Ω	32 Ω	16 Ω	10 Ω	5 Ω
Fuse Value		1 A	3 A	3 A	12 A	12 A
Gould Shawmut Part No. [5]		TRS1R	TRS3R	TRS3R	TRS12R	TRS12R

[1] Resistors supplied with kits are type PX1 for kits PR01 and PR02, and type TW27D for kit PR04.
[2] When more than one kit is required to obtain the correct power and resistance values, connect the fuse and resistor supplied with each kit in series to form a group, then connect the groups in parallel. The ohmic value of the combined resistor kits must be greater than or equal to the values listed in Table 5-1 on page 81.
[3] Power ratings per resistor are calculated based on fuse current. Actual resistor power rating is 135 W for kits PR01 and PR02 and 7290 W for kit PR04.
[4] Standard resistor value represents the total series resistance of the recommended resistor string.
[5] Do not substitute for these fuses, since they can operate correctly at the DC voltages in this application.

Standardized resistances may not be suitable for every application. See calculation example on page 84.

Figure 5-4 shows the overload capability of the various resistors supplied as part of the dynamic braking resistor kits.

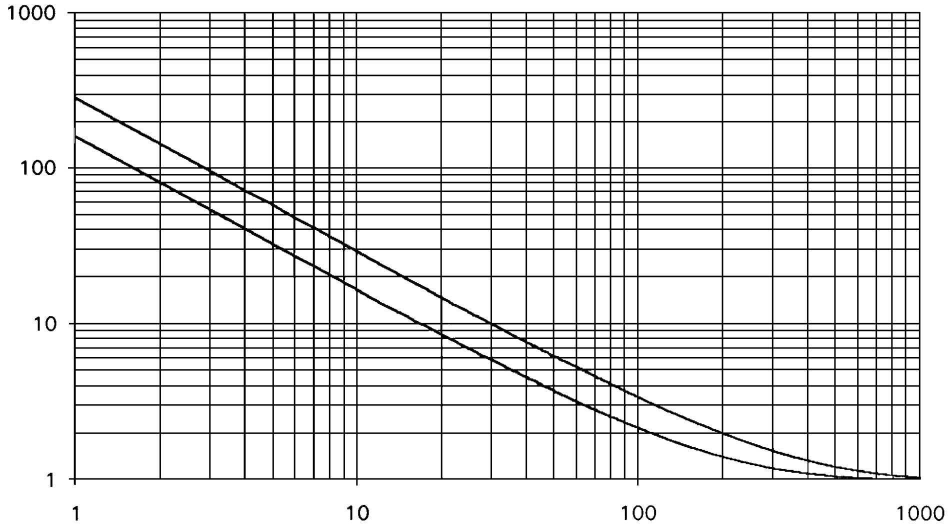


Figure 5-4 Typical Braking Resistor Overload Curve

Figure 5-5 shows the melting time vs. current for the fuses in the dynamic braking resistor kits (8803 PR01, PR02, PR03 and PR04).

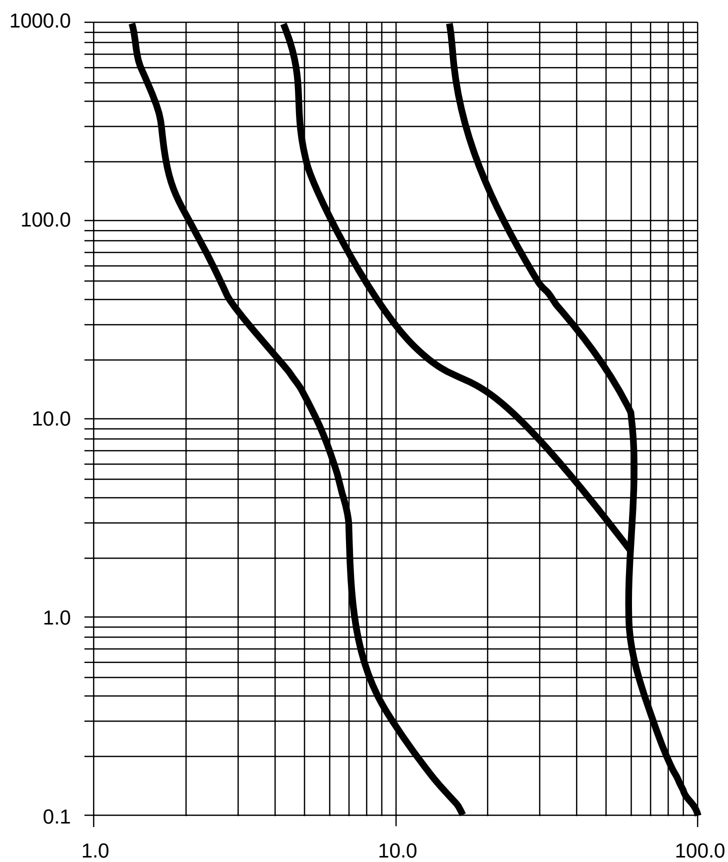


Figure 5-5 Fuse Current vs. Melting Time

Figure 5-6 shows the braking resistor kits.

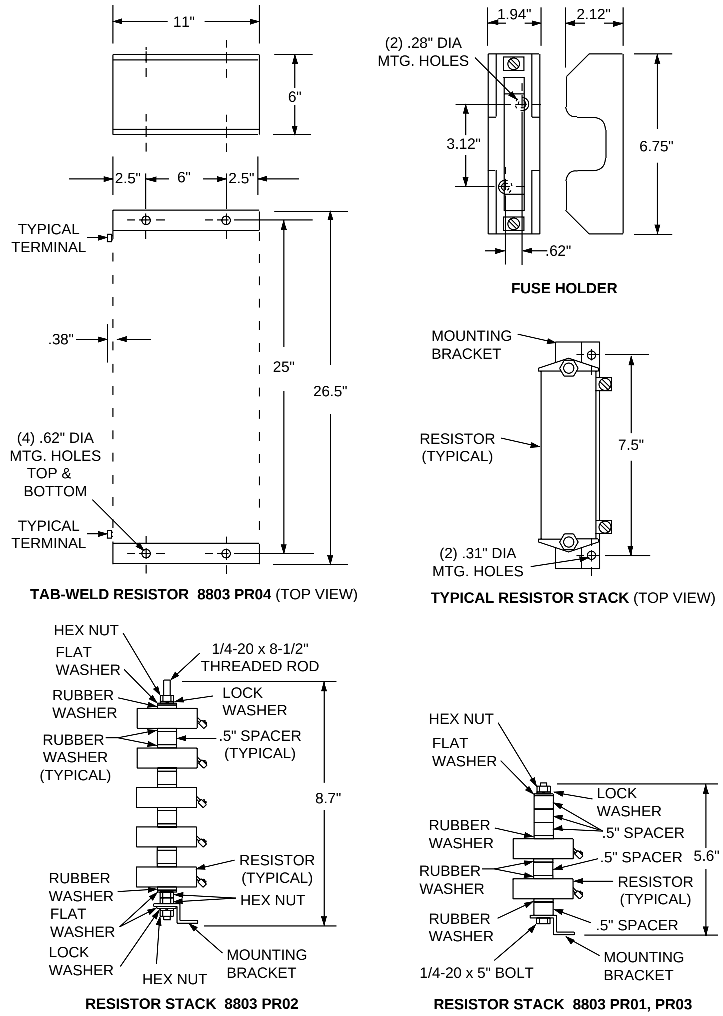


Figure 5-6 Braking Resistor Kits

Resistor Calculation Example

Calculate the resistor needed for a motor with the following characteristics:

- ❑ Power: 5 hp
- ❑ Rated speed: 1740 rpm
- ❑ Moment of inertia: 0.28 lb-ft^2

The motor is driving a machine with:

- ❑ Inertia 10 times that of the motor with no interposing speed changer
- ❑ Resistive torque one tenth of the rated motor torque

The requirement is to stop in 5 seconds from rated speed at a rate of 2 cycles per minute.

Rated motor torque: $$Tn = \frac{hp \times 5250}{rpm_{rated}} = \frac{5 \times 5250}{1740} = 15.1 \text{ lb-ft}$$

Resistive torque: $$Tr = \frac{15.1}{10} = 1.51 \text{ lb-ft}$$

Total inertia:	$Wk^2 = 0.28 + (10 \times 0.28) = 3.08$ lb-ft^2
Braking torque:	$T = \frac{Wk^2 \times \Delta rpm}{308 \times \Delta t} = \frac{3.08 \times 1740}{308 \times 5} = 3.48$ lb-ft
Motor braking torque:	$Tb = T - Tr = 3.48 - 1.51 = 1.97$ lb-ft
Instantaneous braking power:	$Pb = \frac{Tb \times rpm}{7.04} = \frac{1.97 \times 1740}{7.04} = 487$ W
Average braking power during deceleration:	$Pbd = \frac{0.5Tb \times \Delta rpm}{7.04} = 243$ W
Cycle time:	$\tau = \frac{60}{2} = 30$ s
Average braking power during one cycle:	$Pbm = Pbd \frac{t}{\tau} = 243 \times \frac{5}{30} = 40.5$ W

For a 460 V drive controller, R_{db}, the ohmic value of resistance required, is:

$$R_{db} = \frac{(\sqrt{2}Vc + 40)^2}{P_b} = \frac{(\sqrt{2}\ 460 + 40)^2}{487} = 979\ \Omega$$

For this application, the 100 ohm resistor kit (8803 PR01) is sufficient. The operation of the dynamic braking module causes the 100 ohm resistor to appear to have an effective resistance of 979 ohms.

The instantaneous and rated power of the resistor kit exceeds the instantaneous (Pb) and rated (Pbm) power calculated.

- For the 100 Ω resistor kit (8803 PR01), the rated power is 100 W (2 resistors times 50 W).
- As shown in Figure 5-4 on page 83, the instantaneous power of the resistors is 60 times (6000 W) the rated power for 5 seconds.
- As shown in Figure 5-5 on page 83, the fuse will pass approximately 6.2 A for 5 seconds before tripping. This limits the resistors to 3844 W for 5 seconds instead of 6000 W calculated in the previous step.

⚠ CAUTION

INSUFFICIENT BRAKING POWER.

Precise calculation of the resistor, as shown above, is essential for severe applications requiring high braking power such as machines with high inertia and overhauling loads.

Failure to observe this precaution could result in personal injury, product damage or property damage.

If the required braking torque is high, choose a resistor with an ohmic value equal to or slightly greater than the minimum value given in Table 5-1 on page 81.

INSTALLING A BRAKING RESISTOR

⚠ WARNING

HAZARDOUS VOLTAGE AND HOT COMPONENTS.

Avoid accidental contact with braking resistor. Resistor operating voltage may reach 1000 VDC between terminals and its temperature may reach 752° F (400° C).

- Install resistors in appropriate enclosure or restricted area.
- Provide sufficient cooling air and clearance.
- Do not mount on or enclose with combustible materials.
- Use conductors rated for expected voltage and temperature.

Failure to observe these precautions may cause shock or burn, resulting in severe personal injury or death!

Each resistor kit contains the following:

- ❏ Fuse, rated to protect the resistors against overload
- ❏ Fuse holder
- ❏ Resistor(s)
- ❏ Mounting plate as required

When mounting the resistor and associated fusing, observe the following precautions:

- ❏ Resistor and fuse holder must be mounted in an appropriate enclosure or restricted access area to prevent accidental contact with energized parts.
- ❏ Sufficient space and air flow must be provided to allow for dissipation of heat produced by braking action. Maintain at least 2 inches between the resistor element and any surface. Do not mount the resistor to combustible surfaces or house the resistor in a combustible enclosure.
- ❏ Fuse and fuse holder must be mounted away from the resistor. If mounted too close to the resistor, premature operation of the fuse may result due to temperature effects.
- ❏ Resistors supplied within a kit should be connected in series to obtain the recommended resistance values listed in Table 5-2 on page 82. The fuse is then connected in series with the resistor string.

  Where more than one resistor kit is recommended to obtain the correct power and resistance values, the fuse and resistor supplied with each kit must be connected in series to form a group. Then connect the groups in parallel. All group resistance values should be equal and set so the resistance of the paralleled groups equals the values recommended in Table 5-2.
- ❏ Do not use any fuses with the resistor kits other than those recommended in Table 5-2. Do not substitute fuses with other ratings or manufacturers.
- ❏ When connecting the braking resistor to the drive controller, use conductors whose temperature and voltage ratings are suitable for the application. The conductor insulation voltage rating must meet or exceed the input line voltage rating. The conductor insulation temperature rating must be 194° F (90° C) or greater.

- ❏ For applications where the resistor continuous power rating may exceed the cooling capability of the surrounding environment, a thermal switch can be used to protect the resistor and its surroundings against overtemperature. All dynamic braking modules and boards are equipped to accept a normally closed thermal switch contact that opens on rising temperature. The switch is connected to the PY-PZ terminals of the braking module or board. When connected, opening the thermal switch causes the drive controller to trip and fault code OhF to be displayed on the dialog unit. When not used, thermal switch inputs (PY-PZ) must be jumpered on the braking module. For controllers using the dynamic braking board, the PY-PZ input may be disabled by a jumper select. For more details, refer to the dynamic braking module or board installation procedure.
- ❏ Thermal switch contacts must be capable of operation on circuits whose open circuit voltage is 10 V and closed circuit current is 5 mADC.

INSTALLING THE DYNAMIC BRAKING MODULE

(1.5 to 50 hp Drives)

To install the dynamic braking module, follow the procedure below.

1. **Remove all power and refer to Danger statement on page 74**.
2. Remove plastic access cover on the side of the dynamic braking module. Removing this cover exposes the resistor connection terminals of the module (see Figure 5-7).

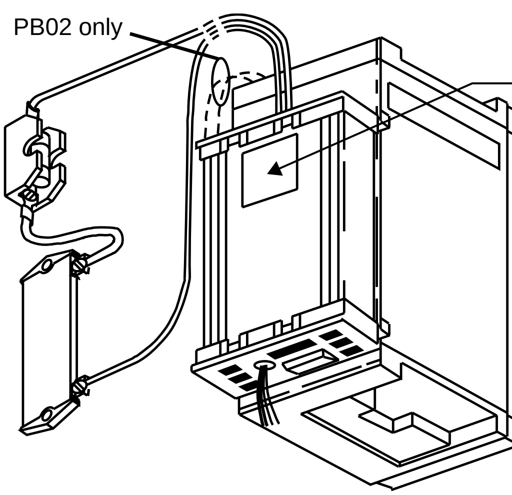


Figure 5-7 Installing the Dynamic Braking Module

3. The dynamic braking module attaches to the left side of the drive controller. To attach the module, place the module rear mounting clips into the rear channel of the side plate of the controller. Push the module against the side of the controller while depressing the spring-loaded mounting tabs on front of the module. The front mounting tabs should engage the front channel of the controller side plate with a “clicking” sound.
4. Connect the green/yellow wire supplied on the dynamic braking module. Ground the connection to the ground terminal of the drive controller.

5. Connect the red and black flying power leads of the module to + and - terminals at the bottom of the drive controller. Connect the red wire to + terminal. Connect the black wire to - terminal.
6. For kit PB02 only, connect the flying leads at the top of the dynamic braking module to H1 and H2 terminals.
7. Remove the shorting plug from connector J8 of the drive controller.
8. Install the short cable provided with the module between module connector J8 and drive controller connector J8.
9. Connect the resistor-fuse power wires to the module resistor power terminal connections, located under the access cover. Replace the access cover (see Figure 5-8).
10. If a thermal switch is used, connect the thermal switch to PY-PZ terminals of the dynamic braking module. If a thermal switch is not used, jumper PY-PZ terminals (see Figure 5-8).

DANGER

NON-ISOLATED CIRCUIT.

- Thermal switch circuit is at line voltage potential.
- Thermal switch and associated wiring must be insulated for line voltage with respect to ground.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

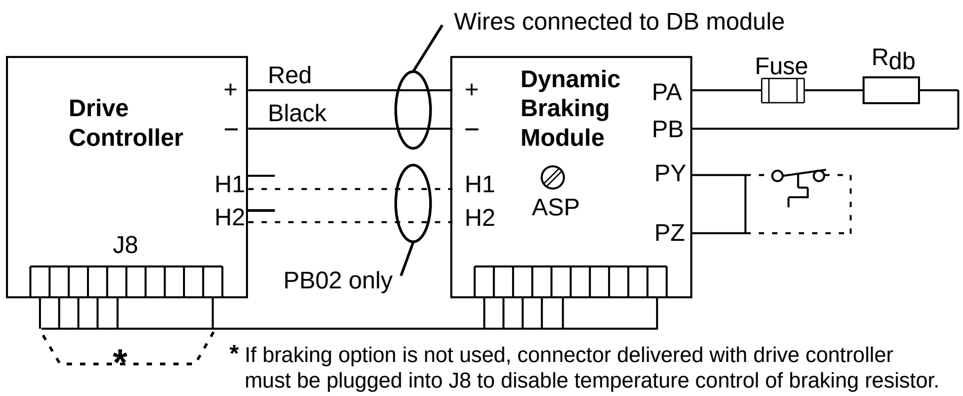


Figure 5-8 Connecting the Dynamic Braking Module

11. If the motor is fitted with a brake with windings accessible via terminals, connect the contact of the low speed relay available at terminals LA-LB into the control sequence. The contact ratings of the relay are: 230 V, 50/60 Hz, 2 A.

Initial Set Up

DANGER

HAZARDOUS VOLTAGE.

- Disconnect all power before servicing drive controller or adding any option. WAIT TEN MINUTES until bus capacitors discharge, then measure bus capacitor voltage between + and - terminals to verify DC voltage is zero (see page 15).
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the controller.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

No adjustments are necessary for the initial set up of the braking option. After checking the connections and possibly adjusting the drive controller settings (see Chapter 3, Setting Up the Controller), the drive can be switched on.

If there is any doubt as to the braking power, proceed in the following manner:

1. Set a deceleration ramp time longer than the required braking time.
2. Start up the machine and carry out successive braking operations, gradually reducing the ramp time until the final adjustment is reached, making sure that the braking cycles are identical to those for actual use.

Troubleshooting

In case of problems, refer to the following procedures.

1. If the resistor power rating is exceeded, the series fuse will operate and the controller will trip on ObF. If this occurs, check that the controller, motor and resistor combination are properly selected for the application.
2. If insufficient braking capability is produced, an Obr or ObF fault may result. The series fuse will not operate. If this occurs, check that the controller, motor and resistor combination are properly selected for the application. It may be necessary to reduce the ohmic value of the braking resistor to increase the braking capability.
3. If the resistor ohmic value is set too low or the resistor is short-circuited, a ObF. fault will result. If this occurs, check that the resistor wiring is correct and that the ohmic value of the resistor is not less than that recommended in Table 5-1 on page 81.

INSTALLING THE DYNAMIC BRAKING BOARD
(60 to 150 hp Drives)

To install the dynamic braking board, follow the procedure below.

1. **Remove all power and refer to Danger statement on page 74**.
2. Remove the drive controller protective covers.
3. The DB board must be installed to the right of the control board. Four internal jumpers labeled J1, J2, J3 and J8 are attached to the support plate. Release these jumpers before mounting the DB board.
4. Unplug removable connectors J5 and J6 from the DB board.
5. Take the DB board, holding it so the components face up and the connectors face down. Via the lower part, slide it onto the two positioning blocks situated at the bottom of the enclosure, and then click the top of the board into position (see Figure 5-9).

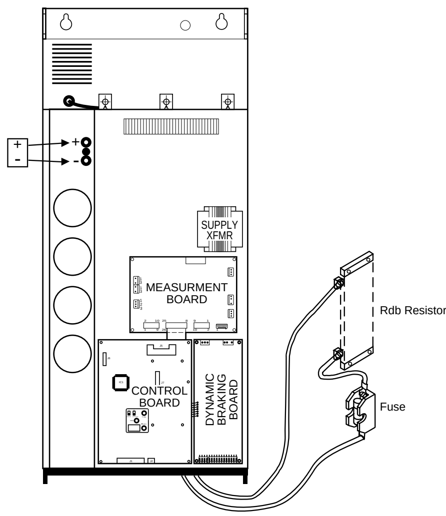


Figure 5-9 Dynamic Braking Board

6. Connect the four jumpers (J1, J2, J3 and J8) to the corresponding connectors on the DB board. There is another jumper on the DB board that must be connected to J13 on the measurement board

.

> **⚠ CAUTION**
>
> IMPROPER CONNECTIONS MAY DAMAGE EQUIPMENT.
> Attach connectors without forcing them, making sure they are correctly oriented, then verify they are correctly seated.
> Failure to observe this precaution could result in equipment damage.

7. Reinstall the plug-in terminal block onto connector J6.
8. Connect the resistor-fuse power wires to PA-PB connectors on the drive controller.
9. If a thermal switch is used, connect it to PY-PZ terminals of the DB board and set jumper CV1 on the measurement board as shown in Figure 5-10.

⚠ DANGER

NON-ISOLATED CIRCUIT.

- Thermal switch circuit is at line voltage potential.
- Thermal switch and associated wiring must be insulated for line voltage with respect to ground.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death!

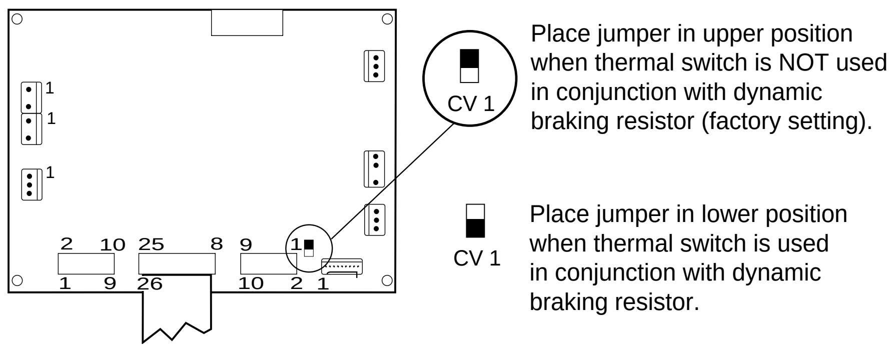


Figure 5-10 Measurement Board

10. If speed regulation is used, install the short cable supplied with the DB board between J5 on the DB board and J3 of the control board.
11. If the motor is fitted with a brake with windings accessible via terminals, connect the contact of the low speed relay available at terminals LA-LB into the control sequence.

Initial Set Up

See initial set up procedures on page 89.

Troubleshooting

See troubleshooting procedures on page 89.

MOUNTING IN DUST AND DAMP PROOF METAL ENCLOSURE
(1.5 to 50 hp Drives)

To reduce power dissipated in the enclosure, the drive controller can be recess mounted in the back of the enclosure, with the heat sink on the outside. Follow the mounting instructions given in "Mounting in Dust and Damp Proof Metal Enclosure" on page 22.

Figure 5-11 shows the dimensions of the cut out to be made in the enclosure and the spacing of the mounting holes.

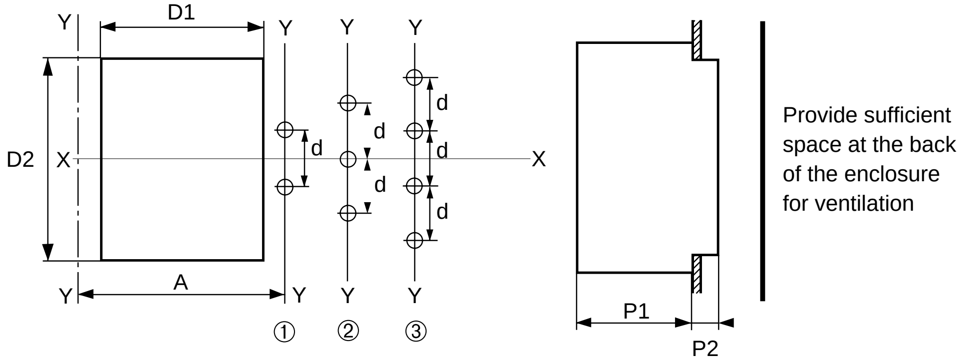


Figure 5-11 Cut Out for Recess Mounting

> **NOTE**
>
> - For PØØVO4J, 4K, 4M and 4P, the fan is located outside the enclosure.
> - Gasket kit does not maintain dust- and damp-proof integrity of interior of 30-40 hp controller enclosures (bus capacitors protrude through heat sink).

Table 5-3 Dimensions for Recess Mounting Cutout

Drive	**D1** in (mm)	**D2** in (mm)	**A** in (mm)	**P1** in (mm)	**P2** in (mm)	**Drilling**			**Gasket Kit Part No.**
						Dwg	**d** in (mm)	**Ø** in (mm)	
PØØVO4C	7.6 (194)	10.9 (278)	8.35 (212)	6.3 (160)	0	①	6.3 (160)	0.276 (7)	VY1-A451U1501
PØØVO4E, 4G	6.7 (172)	13.5 (342)	8.35 (212)	6.5 (165)	0.98 (25)	②	5.91 (150)	0.276 (7)	VY1-A451U4001
PØØVO4J	6.7 (172)	15.0 (382)	8.35 (212)	6.5 (165)	4.09 (104)	②	5.91 (150)	0.276 (7)	VY1-A451U7501
PØØVO4K	6.7 (172)	20.9 (532)	8.35 (212)	6.5 (165)	4.09 (104)	③	5.91 (150)	0.276 (7)	VY1-A451D1101
PØØVO4M	6.7 (172)	22.5 (572)	8.35 (212)	6.5 (165)	4.09 (104)	③	5.91 (150)	0.276 (7)	VY1-A451D1501
PØØVO4P	6.7 (172)	30.4 (772)	8.35 (212)	6.5 (165)	4.09 (104)	④	5.91 (150)	0.276 (7)	VY1-A451D3001

Hardware supplied with the dust and damp proof kits:

- ❑ Self-adhesive flat gasket and mounting instructions (all kits)
- ❑ Dust and damp proof plates, screws and accessories (② and ③ only)

VENTILATION KIT
(1.5 to 50 hp drives)

The ventilation kit, part no. VY1-A05107, is comprised of a single phase stirring fan and mounting accessories. It is attached to the upper part of the drive controller. This arrangement reduces hot spots, allowing the controller to be used in an enclosure with a maximum internal temperature of 140° F (60° C).

The ventilation kit, shown in Figure 5-12, has the following characteristics:

- Attached to upper part of drive controller with 0.79 in (20 mm) standoffs, leaving an area free for wiring
- Overall height: 2.95 in (75 mm) + 0.79 in (20 mm) = 3.74 in (95 mm)

At least 2 in (50 mm) clearance must be provided above the fan for air flow.

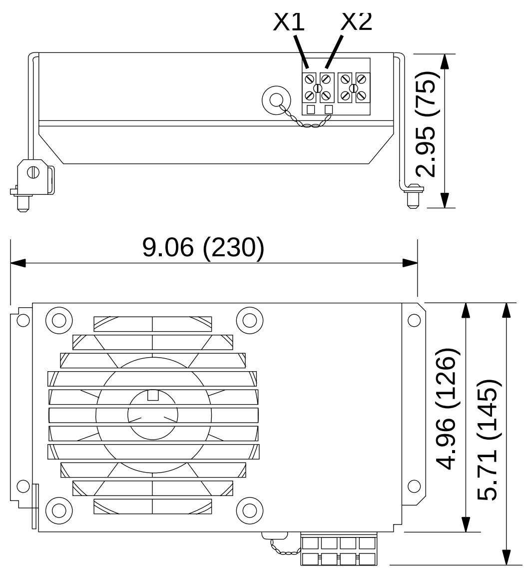


Figure 5-12 Ventilation Kit

The fan has the following characteristics:

- Flow: 100 CFM (44 dm^3/s)
- Power supply (terminals X1-X2): 208 to 240 V, 50/60 Hz
- Current consumption: 125/105 mA

To access the top of the drive controller once the fan is installed, remove the two screws on the right hand side of the kit and pivot the kit away from the controller.

SERIAL COMMUNICATION BOARD

⚠ CAUTION

LOSS OF CONTROL.

- The designer of any control scheme must consider the potential failure modes of the control paths and, for certain critical control functions (such as emergency stop and over-travel stop), provide a means of achieving a safe state during and after a path failure. Separate or redundant control paths must be provided for critical control functions.
- The control paths of a system may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.

Failure to observe these precautions could result in personal injury, product damage or property damage.[1]

1.For additional information, refer to NEMA ICS 1.1-1984, "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and NEMA ICS 3.1-1983 (R1988), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems."

Designed for incorporation in modern automated system architectures, the Omegapak Type P AC drives can be connected to an RS-485 standard multidrop bus. This option board (part no. 8803 PS01) is required for each drive on the bus.

The serial communication board is supplied complete with accessories for mounting it onto the control board of the drive controller and an instruction bulletin.

This option enables data exchange via the following protocols:

- ❏ UNI-TELWAY®
- ❏ MODBUS®/JBUS®
- ❏ SY/MAX® PNIM

Via a single asynchronous serial link, a programmable controller or computer can control and monitor up to 28 Omegapak Type P drive controllers equipped with the communication option board.

The following data may be transmitted over the serial link:

- ❏ Operating mode (read and write): LOCAL or LINE
- ❏ Drive controller configurations and settings (read and write): ramp times, speed limits, voltage/frequency ratio, thermal (overload) protection, etc.
- ❏ Commands (read and write): run, frequency reference, braking, et.
- ❏ Signalling (read only): state and fault recording, motor current, thermal state, etc.

For further information, refer to the Serial Communication Board Instruction Bulletin part no. 50006-378-05.

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Notes: