BALDOR®
MOTORS AND DRIVES

VECTOR DRIVE

Series 24
Multi–Axis
Encoderless Vector Control

Installation & Operating Manual

9/98 **MN724**

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Section 1
Quick Start Guide

Overview

If you are an experienced user of Baldor controls, you are probably already familiar with the keypad programming and keypad operation methods. If so, this quick start guide has been prepared for you. This procedure will help get your system up and running in the keypad mode quickly. This will allow motor and control operation to be verified. This procedure assumes that the Control, Motor and Dynamic Brake hardware are correctly installed (see Section 3 for procedures) and that you have an understanding of the keypad programming & operation procedures. It is not necessary to wire the terminal strip to operate in the Keypad mode (Section 3 describes terminal strip wiring procedures). The quick start procedure is as follows:

1. Read the Safety Notice and Precautions in section 2 of this manual.
2. Mount the control. Refer to Section 3 “Physical Location” procedure.
3. Connect AC power, refer to Section 3 “AC Line Connections”.
4. Connect the motor, refer to Section 3 “Three Phase Input Power”.
5. Install Dynamic brake hardware, if required. Refer to Section 3 “Optional Dynamic Brake Hardware”.

Quick Start Checklist

Check of electrical items.

⚠ **CAUTION: After completing the installation but before you apply power, be sure to check the following items.**

1. Verify AC line voltage at source matches control rating.
2. Inspect all power connections for accuracy, workmanship and torques as well as compliance to codes.
3. Verify control and motor are grounded to each other and the control is connected to earth ground.
4. Check all signal wiring for accuracy.
5. Be certain all brake coils, contactors and relay coils have noise suppression. This should be an R-C filter for AC coils and reverse polarity diodes for DC coils. MOV type transient suppression is not adequate.

⚠ **WARNING: Make sure that unexpected operation of the motor shaft during start up will not cause injury to personnel or damage to equipment.**

Check of Motors and Couplings

1. Verify freedom of motion for all motor shafts and that all motor couplings are tight without backlash.
2. Verify the holding brakes if any, are properly adjusted to fully release and set to the desired torque value.

Quick Start Procedure

Initial Conditions

Be sure the PSM, Dynamic Brake hardware, Control and Motor are wired according to the procedures described in section 3 of this manual. Become familiar with the keypad programming and keypad operation of the control as described in Section 4 of this manual.

1. Verify that any enable inputs to J1B-8 are open.
2. Turn power on. Be sure there are no faults. Verify PSM "Ready" is ON and the "DB ON" and "Monitor" indicators are OFF. Verify the control "Ready" is ON.
3. Set the Level 1 Input block, Operating Mode to "KEYPAD".
4. Enter the following motor data in the Level 2 Motor Data block parameters:
   Motor Voltage (input)
   Motor Rated Amps (FLA)
   Motor Rated Speed (base speed)
   Motor Rated Frequency
   Motor Mag Amps (no load current)
5. At the Level 2 Motor Data block, go to CALC Presets and select YES (using the ▲ key). Press ENTER and let the control calculate the preset values for the parameters that are necessary for control operation.
6. Disconnect the motor from the load (including coupling or inertia wheels). If the load cannot be disconnected, refer to Section 6 and manually tune the control. After manual tuning, perform steps 11 through 14.

⚠ **WARNING: The motor shaft will rotate during the autotune procedure. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment.**

7. Go to Level 2 Autotune block, and do the following tests:
   CMD OFFSET TRIM
   STATOR R1
   FLUX CUR SETTING
8. Remove all power from the control.
9. Couple the motor to its load.
10. Turn power on. Be sure no errors are displayed.
11. Set the Level 2 Output Limits block, "MIN OUTPUT SPEED" parameter.
12. Set the Level 2 Output Limits block, "MAX OUTPUT SPEED" parameter.
13. Run the drive from the keypad using the JOG mode, keypad entered speed commands or speed commands using the arrow keys.
14. Select and program additional parameters to suit your application.

The control is now ready for use in the Keypad mode. If a different operating mode is desired, refer to Section 3 Control Connections and Section 4 Programming and Operation.

Section 2
General Information

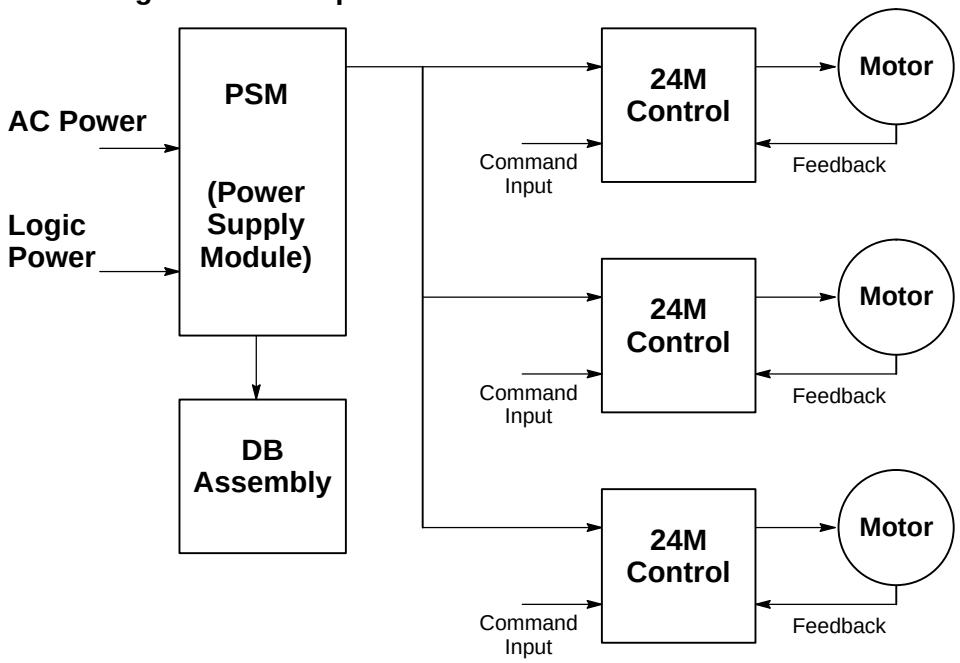
Introduction

The 24M Encoderless Vector Control is one member of a family of multi-axis controls. One or more 24M Encoderless Vector, 25M Flux Vector or 26M AC Servo control may be powered from one Power Supply Module (PSM). The PSM converts the AC line power to DC Bus and logic power. The DC Bus power is converted by the 24M control to a three phase signal for proper motor operation. The 24M control should be sized to the motor based on the rated current found on the motor nameplate.

This series allows one or more controls to be powered from one power supply module (PSM series). See Figure 2-1. The PSM series power supply converts the AC line power to provide rectified DC Bus power and logic operation. DC Bus power is converted to proper voltage levels for motor operation by the control.

A keypad interface is used to program the Series 24M parameters to optimize the control for your application. The keypad is used to program the control parameters, set the mode of operation, monitor the Local mode operation status, perform diagnostics, and examine the fault log.

Figure 2-1 Multiple Controls Powered from One PSM



Limited Warranty

For a period of two (2) year from the date of original purchase, BALDOR will repair or replace without charge controls which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. This warranty is in lieu of any other warranty or guarantee expressed or implied. BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some states do not allow exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. No liability is assumed for expendable items such as fuses.

Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.

Safety Notice:

This equipment contains high voltages. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start–up procedure or troubleshoot this equipment.

This equipment may be connected to other machines that have rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt the start–up procedure or troubleshoot this equipment.

PRECAUTIONS:

⚠ **WARNING: Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start–up procedure or troubleshoot this equipment.**

⚠ **WARNING: Be sure that you are completely familiar with the safe operation of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt the start–up procedure or troubleshoot this equipment.**

⚠ **WARNING: Do not attempt to service this equipment while bus voltage is present within the control. Remove input power and wait at least 5 minutes for the residual voltage in the bus capacitors to dissipate.**

⚠ **WARNING: Be sure all wiring complies with the National Electrical Code and all regional and local codes. Improper wiring may result in unsafe conditions.**

⚠ **WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that grounds are connected. Electrical shock can cause serious or fatal injury.**

⚠ **WARNING: Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Electrical shock can cause serious or fatal injury.**

⚠ **WARNING: Improper operation of control may cause violent motion of the motor shaft and driven equipment. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.**

⚠ **WARNING: Motor circuit may have high voltage present whenever AC power is applied, even when motor is not rotating. Electrical shock can cause serious or fatal injury.**

⚠ **WARNING: A DB Resistor may generate enough heat to ignite combustible materials. To avoid fire hazard, keep all combustible materials and flammable vapors away from brake resistors.**

⚠ **WARNING: The motor shaft will rotate during the autotune procedure. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment.**

Continued on next page

⚠ **Caution:** **To prevent equipment damage, be certain that the electrical service is not capable of delivering more than the maximum line short circuit current amperes listed for 230 VAC or 460 VAC control rating.**

⚠ **Caution:** **To prevent equipment damage, be certain that the input power has correctly sized protective devices installed as well as a power disconnect.**

⚠ **Caution:** **Do not connect AC power to the Motor terminals U, V and W. Connecting AC power to these terminals may result in damage to the control.**

⚠ **Caution:** **Baldor recommends not using “Grounded Leg Delta” transformer power leads that may create ground loops and degrade system performance. Instead, we recommend using a four wire Wye.**

Section 3
Installation

Receiving & Inspection

Baldor controls are thoroughly tested at the factory and carefully packaged for shipment. When you receive your control, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your control.
2. Remove the control from the shipping container and remove all packing materials. The container and packing materials may be retained for future shipment.
3. Verify that the part number of the control you received is the same as the part number listed on your purchase order.
4. Inspect the control for external physical damage that may have been sustained during shipment and report any damage immediately to the commercial carrier that delivered your control.
5. If the control is to be stored for several weeks before use, be sure that it is stored in a location that conforms to published storage specifications. (Refer to Section 7 of this manual).

Location Considerations

The location of the control and Power Supply Module (PSM) is important. Installation should be in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance of the control.

⚠ **CAUTION: Avoid locating control immediately above or beside heat generating equipment, or directly below water or steam pipes.**

⚠ **CAUTION: Avoid locating control in the vicinity of corrosive substances or vapors, metal particles and dust.**

Several other factors should be carefully evaluated when selecting a location for installation:

1. For effective cooling and maintenance, the control and PSM should be mounted on a smooth, non-flammable vertical surface. The amount of heat generated within the control can be calculated based on Table 3-1.
2. At least two inches top and bottom clearance must be provided for air flow.
3. **Altitude derating**. Up to 3300 feet (1000 meters) no derating required. Derate the continuous and peak output current by 2% for each 1000 feet (300 meters) above 3300 feet.
4. **Temperature derating**. From 0°C to 40°C ambient no derating required. Above 40°C, derate the continuous and peak output current by 2% per °C above 40°C. Maximum ambient is 60°C.

Table 3-1 Multi Axis Control Watts Loss Ratings

230 VAC	460 VAC
10 Watts/ Amp	17 Watts/ Amp

Mechanical Installation

Mount the PSM (Power Supply Module) and the control to the mounting surface.

PSM Procedure

The PSM must be securely fastened to the mounting surface. Use the four (4) mounting holes to fasten the PSM to the mounting surface or enclosure. The location of the mounting holes are shown in Section 7 of this manual.

Control Procedure

The control must be securely fastened to the mounting surface. Use the four (4) mounting holes to fasten the control to the mounting surface or enclosure. The location of the mounting holes are shown in Section 7 of this manual.

Through Wall Mounting

The PSM and control module are designed for panel or through wall installation.

Procedure:

1. Refer to Section 7 of this manual for drawings and dimensions for through the wall mounting. Use the information contained in these drawings to layout the appropriate size hole on your enclosure and wall.
2. Cut the holes in your enclosure and wall.
3. Locate and drill holes for mounting hardware as shown in the drawings.
4. Secure the four (4) brackets to the exterior of the customers panel with the hardware provided.
5. Secure the control to the customers panel using the hardware provided.

Remote Keypad Installation The keypad may be remotely mounted using the optional Baldor keypad extension cable. The keypad assembly (grey - DC00005A-02) comes complete with the screws and gasket required to mount it to an enclosure. When the keypad is properly mounted to a NEMA Type 4 indoor enclosure, it retains the Type 4 indoor rating.

Tools Required:

- Center punch, tap handle, screwdrivers (Phillips and straight) and crescent wrench.
- 8-32 tap and #29 drill bit (for tapped mounting holes) or #19 drill (for clearance mounting holes).
- 1-1/4″ standard knockout punch (1-11/16″ nominal diameter).
- RTV sealant.
- (4) 8-32 nuts and lock washers.
- Extended 8-32 screws (socket fillister) are required if the mounting surface is thicker than 12 gauge and is not tapped (clearance mounting holes).
- Remote keypad mounting template. A tear out copy is provided at the end of this manual for your convenience.

Mounting Instructions: For tapped mounting holes

1. Locate a flat 4″ wide x 5.5″ minimum high mounting surface. Material should be sufficient thickness (14 gauge minimum).
2. Place the template on the mounting surface or mark the holes as shown.
3. Accurately center punch the 4 mounting holes (marked A) and the large knockout (marked B).
4. Drill four #29 mounting holes (A). Thread each hole using an 8-32 tap.
5. Locate the 1-1/4″ knockout center (B) and punch using the manufacturers instructions.
6. Debur knockout and mounting holes making sure the panel stays clean and flat.
7. Apply RTV to the 4 holes marked (A).
8. Assemble the keypad to the panel. Use 8–32 screws, nuts and lock washers.
9. From the inside of the panel, apply RTV over each of the four mounting screws and nuts. Cover a 3/4″ area around each screw while making sure to completely encapsulate the nut and washer.

Mounting Instructions: For clearance mounting holes

1. Locate a flat 4″ wide x 5.5″ minimum high mounting surface. Material should be sufficient thickness (14 gauge minimum).
2. Place the template on the mounting surface or mark the holes as shown on the template.
3. Accurately center punch the 4 mounting holes (marked A) and the large knockout (marked B).
4. Drill four #19 clearance holes (A).
5. Locate the 1-1/4″ knockout center (B) and punch using the manufacturers instructions.
6. Debur knockout and mounting holes making sure the panel stays clean and flat.
7. Apply RTV to the 4 holes marked (A).
8. Assemble the keypad to the panel. Use 8–32 screws, nuts and lock washers.
9. From the inside of the panel, apply RTV over each of the four mounting screws and nuts. Cover a 3/4″ area around each screw while making sure to completely encapsulate the nut and washer.

Electrical Installation

When interconnecting wires from power source, control, motor, host controller and other devices it is important to make proper electrical connections. Use only UL (cUL) listed connectors for the wire gauge and type being connected. Connectors are to be installed using the crimp tool specified by the connector manufacturer. Wire with Class 1 wiring.

All signal and encoder wires for the control should be run in conduit that is separate from power wiring. The use of shielded wire is recommended for all signal wiring.

Overload Protection

Baldor Controls feature motor overload protection suitable for motors that consume at least 50% of the output rating of the control. Other governing agencies such as NEC (National Electric Code) may require separate over current protection. The installer of this equipment is responsible for complying with NEC guidelines and applicable local codes that govern wiring protection, grounding, disconnects and other current protection.

Power Disconnect

A power disconnect should be installed between the input power service and the PSM for a fail safe method to disconnect power. The control will remain in a powered-up condition until all input power is removed and the internal bus voltage is depleted.

Protection Devices

The PSM (Power Supply Module) must have a suitable input power protection device installed. Input and output wire size is based on the use of copper conductor wire rated at 75 °C. Use the recommended circuit breaker or fuse types as follows:

Circuit Breaker: 3 phase, thermal magnetic.
Equal to GE type THQ or TEB for 230 VAC or
GE type TED for 460 VAC.

Fast Action Fuses: Buss KTN on 230 VAC or
Buss KTS on 460 VAC, Buss FRS or equivalent.

Time Delay Fuses: Buss FRN on 230 VAC or
Buss FRS on 460 VAC or equivalent.

Table 3-2 describes the wire size to be used for power connections and the ratings of the protection devices.

Table 3-2 Wire Size and Protection Devices

Catalog Number	L1, L2, L3 Incoming Power						X3 Logic Power		
	Maximum Continuous Amps	Input Breaker	Input Fuse		Wire Gauge		Input Fuse	Wire Gauge	
			Fast Acting	Time Delay	AWG	mm^2		AWG	mm^2
PSM2A060-PR1	60	90A	90A	70A	6	13.3	Internal	16	1.0
PSM2A060-PR2	60	90A	90A	70A	6	13.3	Internal	16	1.0
PSM2A100-PR1	100	150A	150A	115A	3	26.7	Internal	16	1.0
PSM2A100-PR2	100	150A	150A	115A	3	26.7	Internal	16	1.0
PSM4A030-PR1	30	50A	50A	40A	8	8.37	Internal	16	1.0
PSM4A030-PR2	30	50A	50A	40A	8	8.37	Internal	16	1.0
PSM4A050-PR1	50	70A	80A	60A	6	13.3	Internal	16	1.0
PSM4A050-PR2	50	70A	80A	60A	6	13.3	Internal	16	1.0
PSM4A100-PR1	100	125A	150A	110A	1	42.4	Internal	16	1.0
PSM4A100-PR2	100	125A	150A	110A	1	42.4	Internal	16	1.0

Note: All wire sizes based on 75°C copper wire, 3% line impedance. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 25°C ambient, maximum continuous control output current and no harmonic current.

Line Impedance

The Baldor Multi-axis Power Supply Module (PSM) requires a minimum line impedance of 3% (voltage drop across the reactor is 3% when the control draws rated input current). If the incoming power line has less than 3% impedance, a 3 phase line reactor can be used to provide the needed impedance in most cases. Line reactors are optional and are available from Baldor.

The input impedance of the power lines can be determined in two ways:

Measure the line to line voltage at no load and at full rated load.
Use these measured values to calculate impedance as follows:

$$\%\text{Impedance} = \frac{(\text{Volts}_{\text{No Load}} - \text{Volts}_{\text{Full Load}})}{(\text{Volts}_{\text{No Load}})} \times 100$$

Line Reactors

Three phase line reactors are available from Baldor. The line reactor to order is based on the continuous current rating of the PSM. If providing your own line reactor, use the following formula to calculate the minimum inductance required. Table 3-4 lists the input current required for this calculation, for each control size.

$$L = \frac{(V_{L-L} \times 0.03)}{(I \times \sqrt{3} \times 377)}$$

Where:

L	Minimum inductance in Henries.
V_{L-L}	Input Volts measured line to line.
0.03	Desired percentage of input impedance.
I	Input current rating of control.
377	Constant used with 60Hz power. Use 314 if input power is 50Hz.

Load Reactors

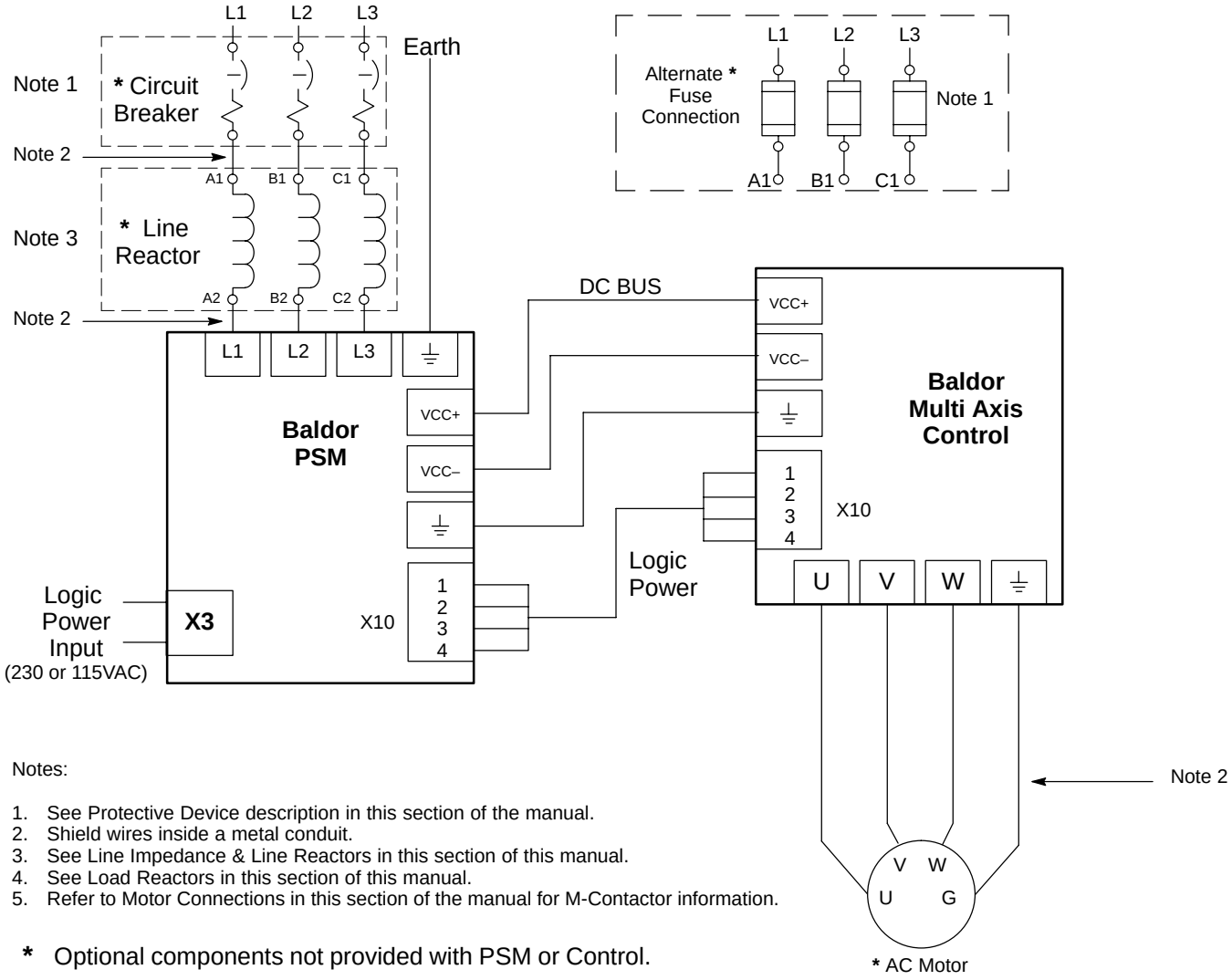
Line reactors may be used at the control output to the motor. When used this way, they are called Load Reactors. Load reactors serve several functions that include:

- Protect the control from a short circuit at the motor.
- Limit the rate of rise of motor surge currents.
- Slowing the rate of change of power the control delivers to the motor.

Load reactors should be installed as close to the control as possible.

Select a Load Reactor that has a current rating equal to the motor FLA on nameplate.

Figure 3-1 3 Phase AC Power and Motor Connections



Notes:

1. See Protective Device description in this section of the manual.
2. Shield wires inside a metal conduit.
3. See Line Impedance & Line Reactors in this section of this manual.
4. See Load Reactors in this section of this manual.
5. Refer to Motor Connections in this section of the manual for M-Contactor information.

***** Optional components not provided with PSM or Control.

See Recommended Tightening Torques in Section 7.

AC and DC Power Connections

⚠ WARNING: Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury.

⚠ Caution: Baldor recommends not using "Grounded Leg Delta" transformer power leads that may create ground loops and degrade system performance. Instead, we recommend using a four wire Wye.

1. Connect the 3 phase incoming power wires from the protection devices to the PSM inputs labeled L1, L2 and L3. (See Figures 3-1 and 3-3). Torque as specified in Section 7.
2. Connect VCC+ bus power from the PSM VCC + to the multi axis control(s) using the copper bus bars provided (see Figure 3-2). Torque as specified in Section 7.
3. Connect VCC– bus power from the PSM VCC – to the multi axis control(s) using the copper bus bars provided (see Figure 3-2). Torque as specified in Section 7.
4. Connect bus power common from the PSM ⏚ to the multi axis control(s) using the copper bus bars provided (see Figure 3-2). Torque as specified in Section 7.

   Note: Use same gauge wire for earth ground as is used for L1, L2 and L3 connections. Refer to the Wire Size and Protection Devices tables shown previously in this section.

5. Connect earth ground (plant ground) to PSM ⏚. Ground terminal should be on top of bus bar and must use a separate washer and nut. Torque as specified in Section 7.
6. Connect the Logic Power source (230VAC or 115VAC depending on the PSM model number) to X3 of the PSM. See Figure 3-3. Torque as specified in Section 7.

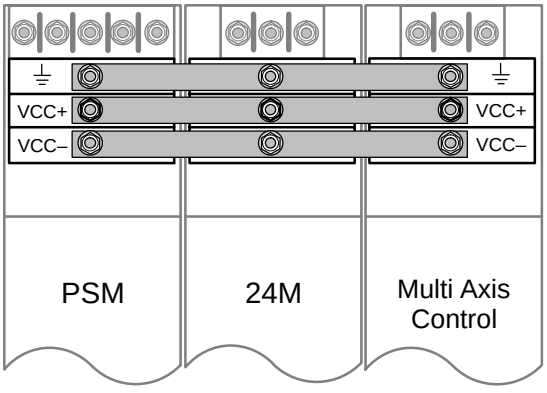
Note: Power to X3 should also have a power disconnect that is separate from the Line Power disconnect and protective devices.

7. Connect the 24 VDC Logic Power (+24VDC & 0VDC) from X10 pins 1 & 2 of the PSM to X10 pins 1 & 2 of the multi axis control(s). See Figure 3-3.

Note: More than one 24 VDC connector is provided at each X10 connector so power to multiple drives can be daisy chained.

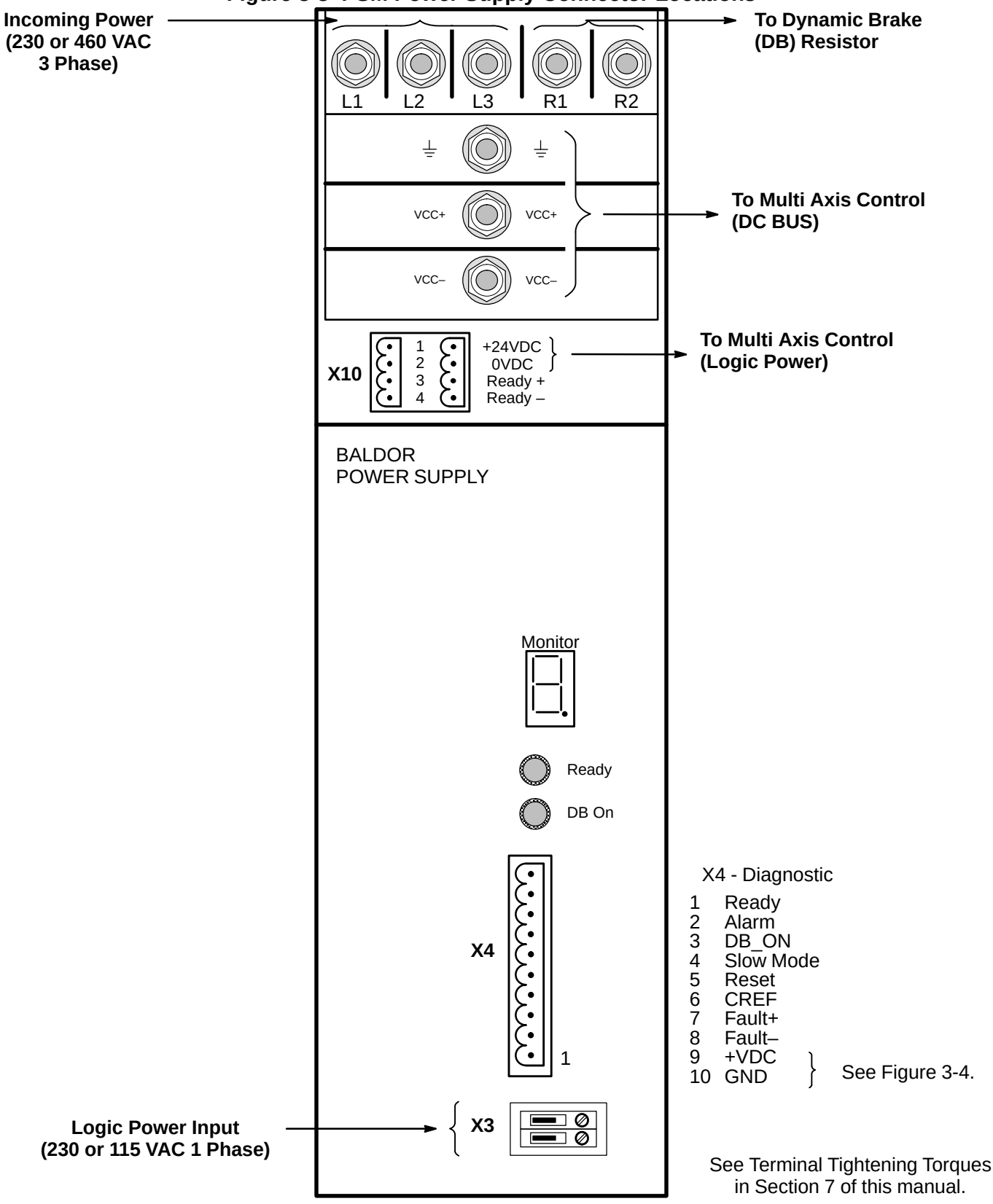
8. Connect "Ready" from X10 pins 3 and 4 of the PSM to X10 pins 3 and 4 of the multi axis control(s).

Figure 3-2 Copper Bus Bar Installation



See Terminal Tightening Torques in Section 7

Figure 3-3 PSM Power Supply Connector Locations

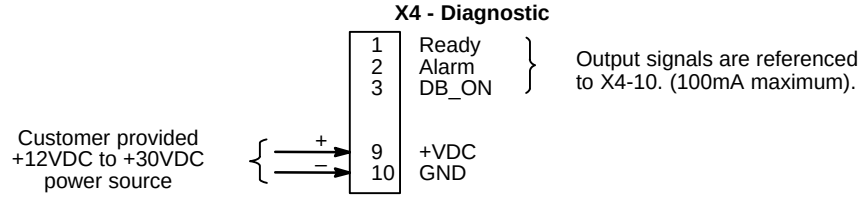


Optional PSM I/O Connections

Connector X4 contains the interface input and output connections for the PSM (Power Supply Module). Connection to the X4 I/O terminal strip is optional. No connections are required for normal operation. However, to monitor PSM status or to "Reset" the PSM you may make some or all of these optional connections.

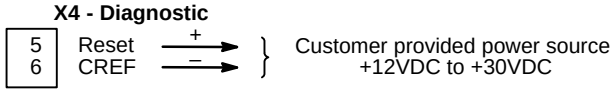
Status monitor connections are shown in Figure 3-4. A separate +24VDC power source must be connected to X4-9 and X4-10. The output signals (X4-1, 2 and 3) can then be connected to an external device (referenced to X4-10). These internal contacts close when active.

Figure 3-4 Status Monitor Output Connections



Reset connection is shown in Figure 3-5. This is useful to reset the control after a fault condition. The reset input voltage is +24VDC (12 to 30VDC @ 10mA) and must be applied for at least 60 μs.

Figure 3-5 Reset Input



Fault Relay connection is shown in Figure 3-6. The fault relay output can be connected to a relay or other device. This internal normally closed contact opens when a fault condition occurs.

Figure 3-6 Fault Relay

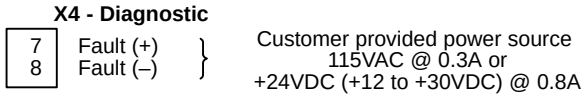
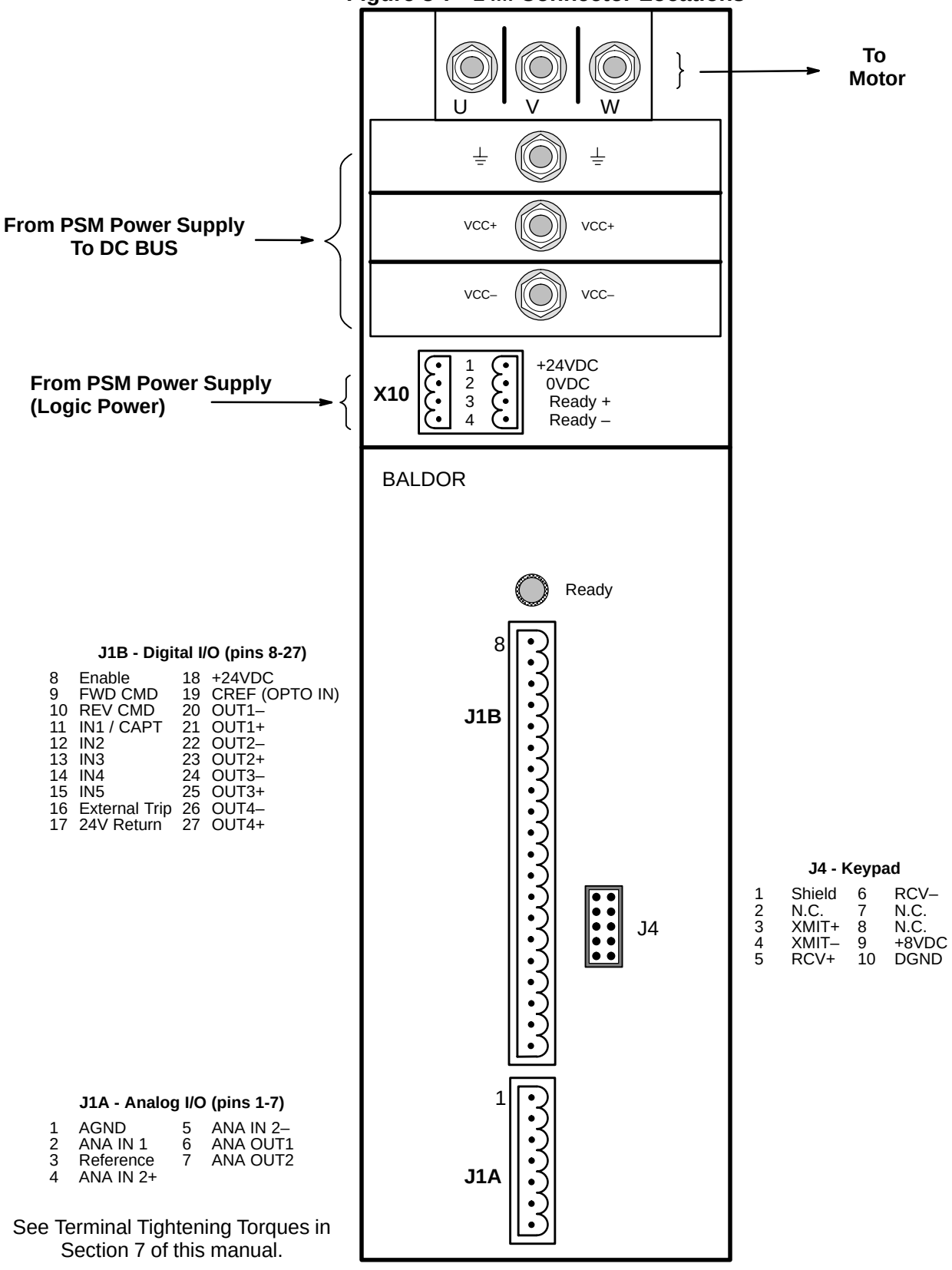


Figure 3-7 24M Connector Locations



J1B - Digital I/O (pins 8-27)

8	Enable	18	+24VDC
9	FWD CMD	19	CREF (OPTO IN)
10	REV CMD	20	OUT1–
11	IN1 / CAPT	21	OUT1+
12	IN2	22	OUT2–
13	IN3	23	OUT2+
14	IN4	24	OUT3–
15	IN5	25	OUT3+
16	External Trip	26	OUT4–
17	24V Return	27	OUT4+

J4 - Keypad

1	Shield	6	RCV–
2	N.C.	7	N.C.
3	XMIT+	8	N.C.
4	XMIT–	9	+8VDC
5	RCV+	10	DGND

J1A - Analog I/O (pins 1-7)

1	AGND	5	ANA IN 2–
2	ANA IN 1	6	ANA OUT1
3	Reference	7	ANA OUT2
4	ANA IN 2+		

See Terminal Tightening Torques in Section 7 of this manual.

Motor Connections

Load Reactors should be installed to protect the motor (install as close as possible to the control). A motor circuit contactor (M-Contactor shown in Figure 3-1) is recommended and should be installed to provide a positive disconnect of the motor from the control. This ensures that the motor shaft will not rotate and cause damage or injury. The M-contactor should open the Enable line (J1B pin 8) 20 msec before the main M-Contacts open. This will prevent contact arcing and allows use of IEC rated contactors.

⚠ **Caution: Do not connect AC power to the Motor terminals U, V and W. Connecting AC power to these terminals may result in damage to the control.**

1. Connect the “U” terminal of the 24M to the U motor lead.
2. Connect the “V” terminal of the 24M to the V motor lead.
3. Connect the “W” terminal of the 24M to the W motor lead.
4. Connect the “⏚” terminal of the 24M to motor ground (G).

M-Contactor

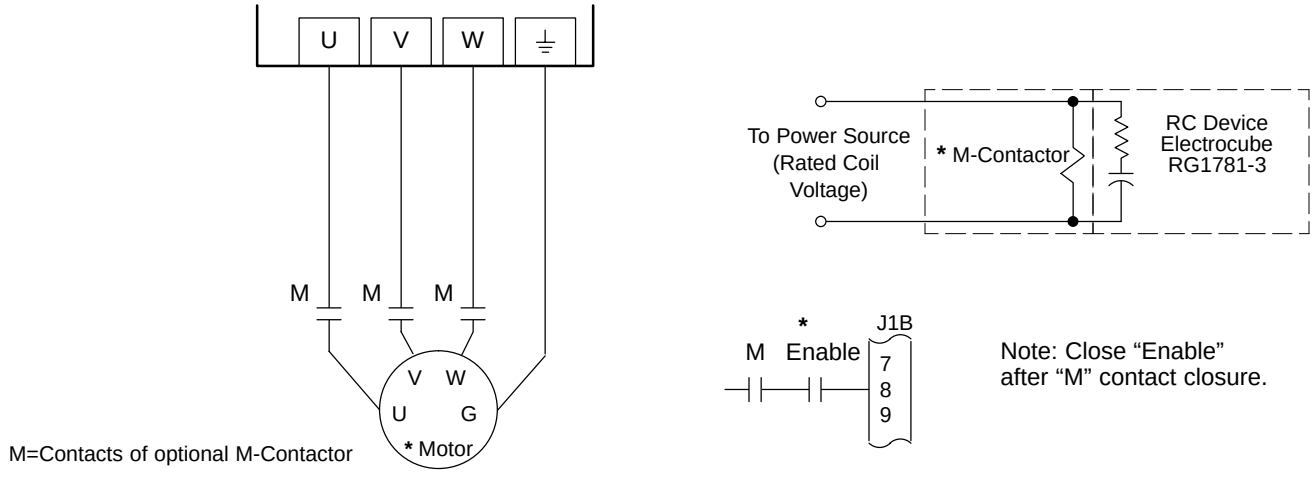
If required by local codes or for safety reasons, an M-Contactor (motor circuit contactor) may be installed. However, incorrect installation or failure of the M-Contactor or wiring may damage the control.

⚠ **Caution: If an M-Contactor is installed, the control must be disabled at least 20msec before the M-Contactor is opened. If the M-Contactor is opened while the control is supplying voltage and current to the motor, the control may me damaged.**

A motor circuit contactor provides a positive disconnect of the motor windings from the control. Opening the M-Contactor ensures that the control cannot drive the motor. This may be required during certain manual operations with the load (like equipment maintenance etc.). Figure 3-8 shows how an M-Contactor is connected to the control.

⚠ **Caution: Do not connect AC power to the control terminals U, V and W. Connecting AC power to these terminals may result in damage to the control.**

Figure 3-8 M-Contactor Diagram



See Recommended Tightening Torques in Section 7.

⚠ **WARNING: A DB Resistor may generate enough heat to ignite combustible materials. To avoid fire hazard, keep all combustible materials and flammable vapors away from brake resistors.**

Dynamic Brake Resistor

An external DB (Dynamic Brake) resistor must be installed to dissipate excess power from the DC bus during motor deceleration operations.

1. Mount the DB resistor near the top of the enclosure (to dissipate the heat). Mounting dimensions are provided in Section 7 of this manual.
2. Connect one wire from the DB resistor to terminal R1 of the PSM.
3. Connect the other wire from the DB resistor to terminal R2 of the PSM.

Note: For selection of the DB resistor, refer to the Specifications located in Section 7 of this manual.

Control Circuit Connections Twelve operating modes are available. These operating modes define the basic motor control setup and the operation of the input and output terminals. After the circuit connections are completed, the operating mode is selected by programming the Operating Mode parameter in the Level 1 Input programming block.

Operating modes are:

- Keypad Mode
- Standard Run 3 Wire Mode
- 15 Speed 2 Wire Mode
- 3SPD ANA 2 Wire
- 3SPD ANA 3 Wire
- Serial
- Bipolar Speed Mode
- Process Control
- Fan Pump, 2 Wire Control
- Fan Pump, 3 Wire Control
- EPOT – 2 Wire
- EPOT – 3 Wire

Opto Isolated Inputs Logic input connections are made at terminal strip J1B pins 8, 9, 10, 11, 12, 13, 14, 15, and 16. Input connections at J1B can be wired as active High or active Low as shown in Figure 3-9. J1B pin 19 is the Control Reference point (CREF) for the Opto Isolated Input signals.

Active High (Sourcing) - If pin 19 is grounded, an input is active when it is at +24VDC (+10VDC to +30VDC).

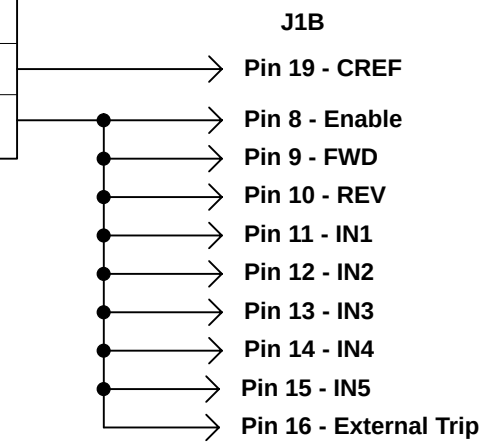
Active Low (Sinking) - If pin 19 is at +24VDC (+10VDC to +30VDC), an input is active when it is grounded.

Note: The internal 24VDC power supply can be used to power the the Opto Input circuits by connecting a jumper between J1B pin 18 to J1B pin 19. This provides 24VDC at CREF and an Active Low input condition. Opto Input signals can then be grounded to make the input active (use the 24V Return at J1B pin 17 for input switching or external circuit connections).

1. Connect the Keypad to J4 on the 24M panel.
2. Select the operating mode for your application. Connect the remaining control connections as shown in the diagram for that operating mode. (Refer to Figures 3-10, 3-11, 3-12, 3-15 and 3-17.)

Figure 3-9 Active HIGH (Sourcing)/LOW (Sinking) Relationship

Active Low	Active High
GND_{ext} (Sink)	V_{ext} (Source)
+24VDC	GND
GND	+24VDC



Note: These pins are shown wired together. Although this can be done, each input is usually connected to a switch for individual control of each input condition.

Keypad Mode

To operate in the Keypad mode, set the Level 1 Input block, OPERATING MODE parameter to KEYPAD. In this mode, only two Opto inputs can be active. Both analog outputs (at J1A) remain active.

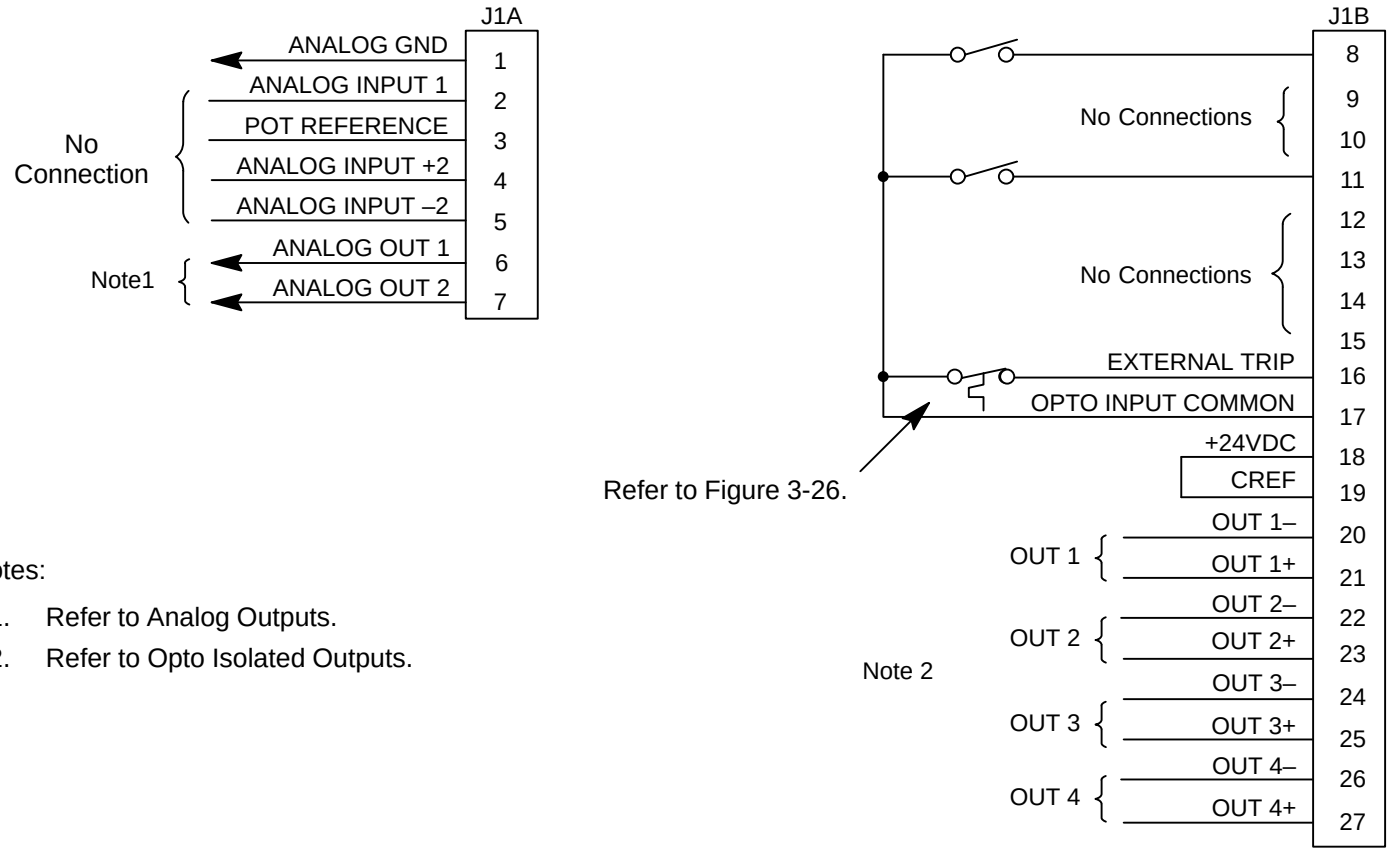
If the Level 2 PROTECTION block, EXTERNAL TRIP and LOCAL ENABLE INPUT parameters remain OFF (factory setting), no terminal strip wiring is required.

1. The External Trip Opto Input at J1B-16 is active if the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON. If “ON”, make connections as shown in Figure 3-10.
2. The Local Enable Opto Input at J1B-8 is active if the Level 2 PROTECTION block, LOCAL INP ENABLE parameter is set to ON. If “ON”, make connections as shown in Figure 3-10.

The STOP key can operate in two ways:

- Press STOP key one time to brake or coast to stop.
- Press STOP key two times to disable control.

Figure 3-10 Keypad Mode Connection Diagram



Notes:

1. Refer to Analog Outputs.
2. Refer to Opto Isolated Outputs.

J1B-8 Optional Enable input (not required).
OPEN disables the control and motor coasts to a stop if Level 1 KEYPAD block, Local Enable INP parameter is set to “ON”.
CLOSED allows current to flow in the motor.

J1B-11 Optional STOP input (not required).
OPEN disables the control and motor coasts or brakes to a stop if Level 1 KEYPAD block, LOCAL HOT START parameter is set to “ON”. Motor will restart when switch closes after open.
CLOSED allows current to flow in the motor.

J1B-16 Optional External Trip input (not required).
OPEN causes an External Trip to be received by the control (when programmed to “ON”). When this occurs, the drive disables, drive “Ready” LED goes out and an external trip fault is displayed on the keypad display (also logged into the fault log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to “ON” to recognize the J1B-16 input.

J1B-18 & 19 Jumper shown for using the internal +24VDC source for the CREF input. (Active Low).

Standard Run 3 Wire Mode

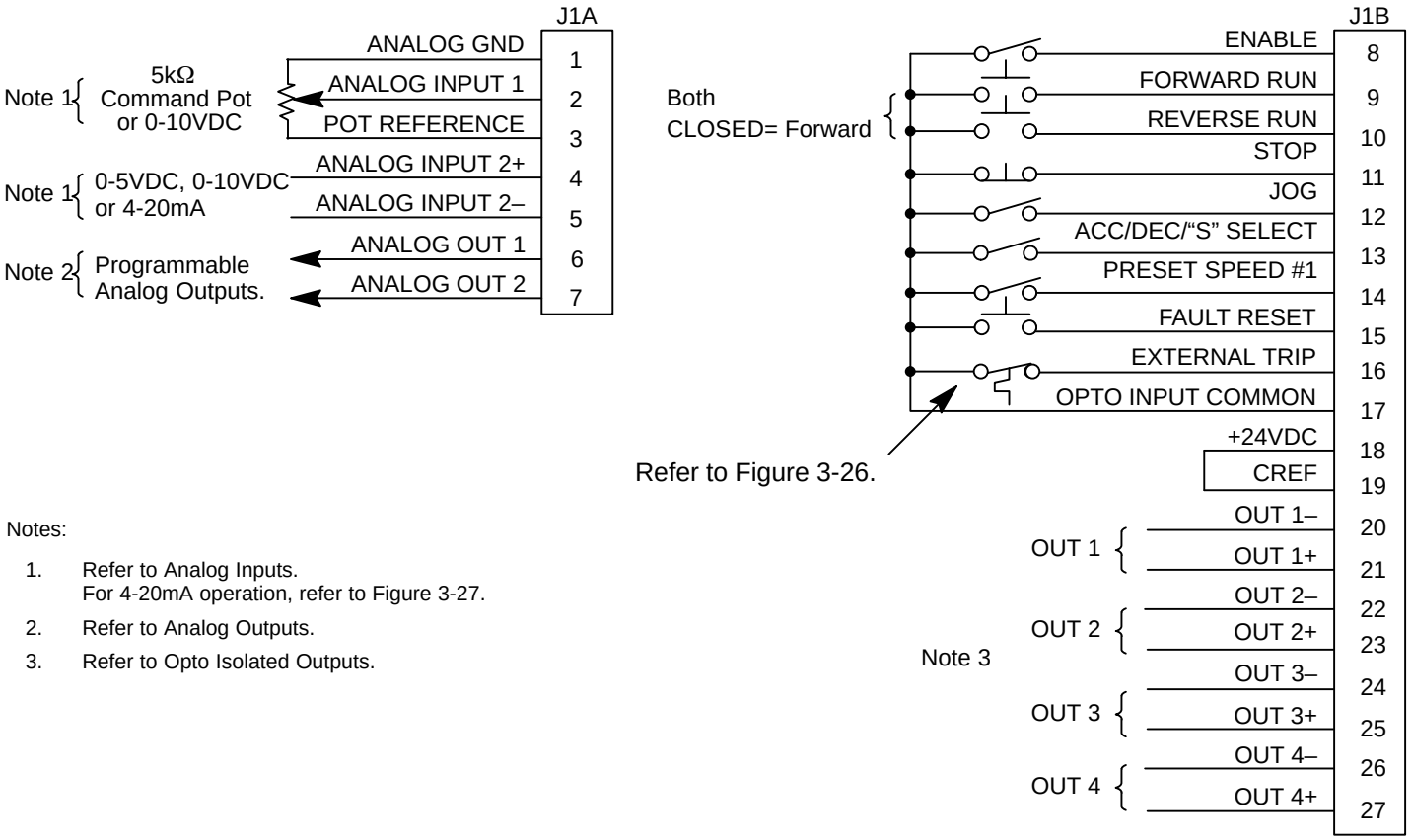
In Standard Run mode, the control is operated by the Opto Isolated inputs at J1B-8 through J1B-16 and the analog command input J1A pins 1, 2 and 3 (5KΩ pot, 0-5VDC or 0-10VDC). J1A-4 and J1A-5 can be used as the input (0-5VDC, 0-10VDC or 4-20mA). The Opto inputs can be switches as shown in Figure 3-11 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

The motor speed command may be one of the following:

Preset Speed (J1B-14)
Command Input (Potentiometer, 0-5VDC or 0-10VDC)
±5VDC, ±10VDC, or 4-20mA

Connect the control as shown in Figure 3-11.

Figure 3-11 Standard Run 3-Wire Mode Connection Diagram



Notes:

1. Refer to Analog Inputs.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control and motor coasts to a stop.

J1B-9 Momentary CLOSED starts motor operation in the Forward direction. In JOG mode (J1B-12 CLOSED), continuous CLOSED jogs motor in the Forward direction.

J1B-10 Momentary CLOSED starts motor operation in the Reverse direction. In JOG mode (J1B-12 CLOSED), CONTINUOUS closed JOGS motor in the Reverse direction.

J1B-11 Momentary OPEN causes the control to REGEN to stop and disable. (Coasts to stop if Level 1 Keypad Setup block, Keypad Stop Mode parameter is set to coast.)

J1B-12 CLOSED places control in JOG mode, Forward and Reverse run are used to jog the motor.

J1B-13 CLOSED selects ACC / DEC / S-CURVE group 2.
OPEN selects ACC / DEC / S-CURVE group 1.

J1B-14 CLOSED selects Preset Speed #1 (J1B-12 "JOG" will override this preset speed).
OPEN allows speed command as selected in the command select parameter.

J1B-15 CLOSED to reset fault condition.
OPEN to run.

J1B-16 OPEN causes an external trip to be received by control. The control will disable and display External Trip when programmed "ON".
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

15 Speed 2-Wire Mode Switch Truth Table is defined in Table 3-3.

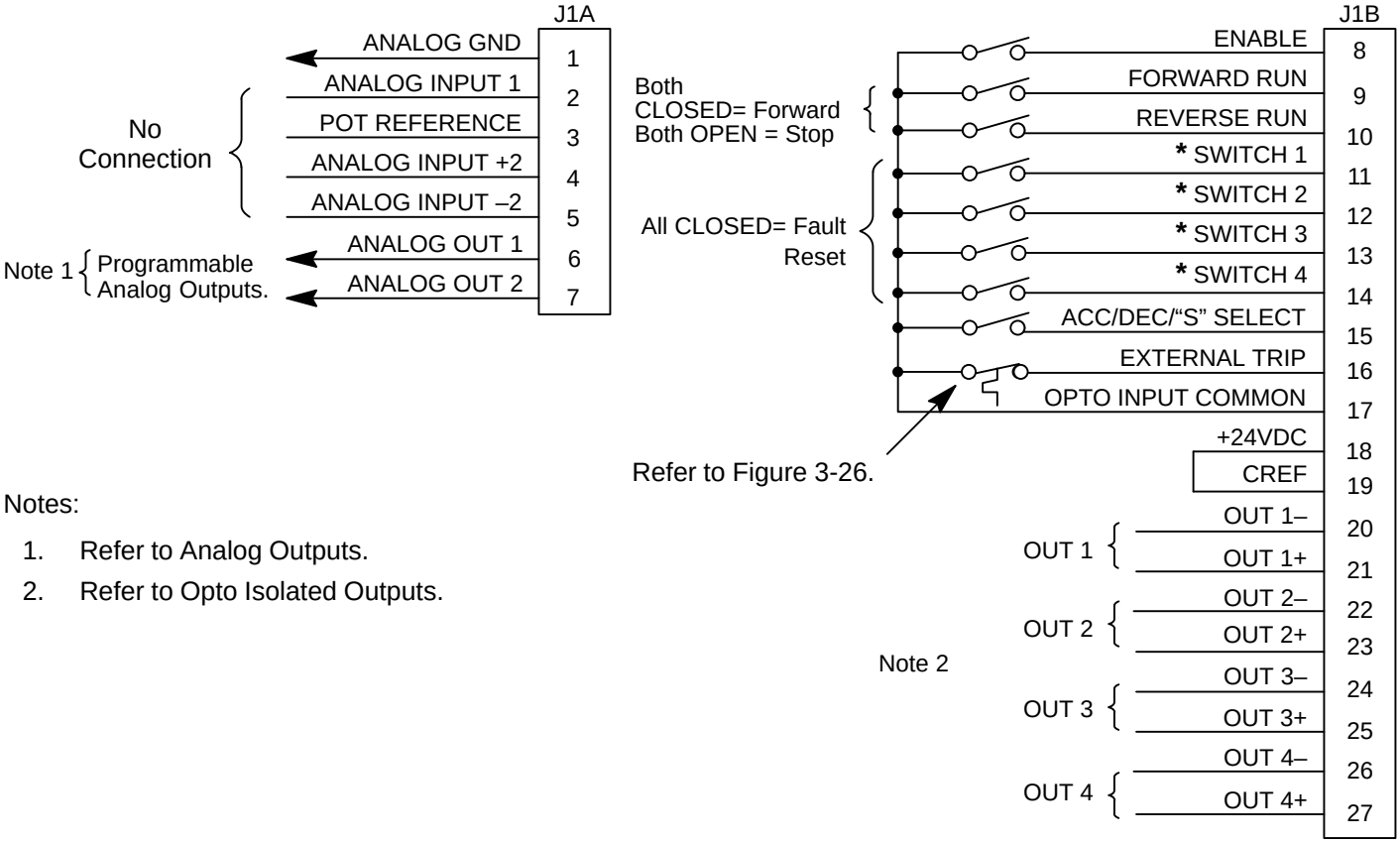
Operating speed in the 15 Speed 2-Wire mode is controlled by the Opto Isolated inputs at J1B-11 through J1B-14. The Opto inputs can be switches as shown in Figure 3-12 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

Switched inputs at J1B-11 through J1B-14 allow selection of 15 preset speeds and provide Fault Reset as defined in Table 3-3.

Table 3-3 Switch Truth Table for 15 Speed, 2 Wire Control Mode

Function	J1B-11	J1B-12	J1B-13	J1B-14
Preset 1	Open	Open	Open	Open
Preset 2	Closed	Open	Open	Open
Preset 3	Open	Closed	Open	Open
Preset 4	Closed	Closed	Open	Open
Preset 5	Open	Open	Closed	Open
Preset 6	Closed	Open	Closed	Open
Preset 7	Open	Closed	Closed	Open
Preset 8	Closed	Closed	Closed	Open
Preset 9	Open	Open	Open	Closed
Preset 10	Closed	Open	Open	Closed
Preset 11	Open	Closed	Open	Closed
Preset 12	Closed	Closed	Open	Closed
Preset 13	Open	Open	Closed	Closed
Preset 14	Closed	Open	Closed	Closed
Preset 15	Open	Closed	Closed	Closed
Fault Reset	Closed	Closed	Closed	Closed

Figure 3-12 15 Speed 2-Wire Mode Connection Diagram



Notes:

1. Refer to Analog Outputs.
2. Refer to Opto Isolated Outputs.

J1B-8	CLOSED allows current to flow in the motor and produce torque. OPEN disables the control & motor coasts to a stop.
J1B-9	CLOSED operates the motor in the Forward direction. OPEN coasts or REGEN to stop depending on value of Level 1 Keypad Setup block, Keypad Stop Mode parameter.
J1B-10	CLOSED operates motor in the Reverse direction. OPEN coasts or REGEN to stop depending on value of Level 1 Keypad Setup block, Keypad Stop Mode parameter.
J1B-11 to J1B-14	Selects programmed preset speeds as defined in Table 3-3.
J1B-15	Selects ACC/DEC group. CLOSED selects group 2. OPEN selects group 1.
J1B-16	OPEN causes an External Trip to be received by the control (when programmed to "ON"). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log). If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.
J1B-19	Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

3SPD ANA 2 Wire Control Mode

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED to start motor operation in the Forward direction.
OPEN to initiate a stop command.

J1B-10 CLOSED to start motor operation in the Reverse direction.
OPEN to initiate a stop command.

J1B-11 CLOSED selects Analog Input #1.
OPEN selects the value of the Level 1 Input block, Command Select parameter.

Note: If Level 1 Input block, Command Select parameter is set to “Potentiometer”, then Analog Input #1 is always selected.

J1B-12 CLOSED selects Start/Stop and Reset commands from the terminal strip.
OPEN selects Start/Stop and Reset commands from keypad.

J1B-13 CLOSED selects terminal strip speed source (Level 1 Input block, Command Select).
OPEN selects speed command from Keypad.

Note: When changing from terminal strip to keypad (J1B-12 or 13) the motor speed and direction will remain the same after the change.

J1B-14 OPEN selects Preset Speed #1 regardless of the Speed Command input (J1B-13). (FIRESTAT).

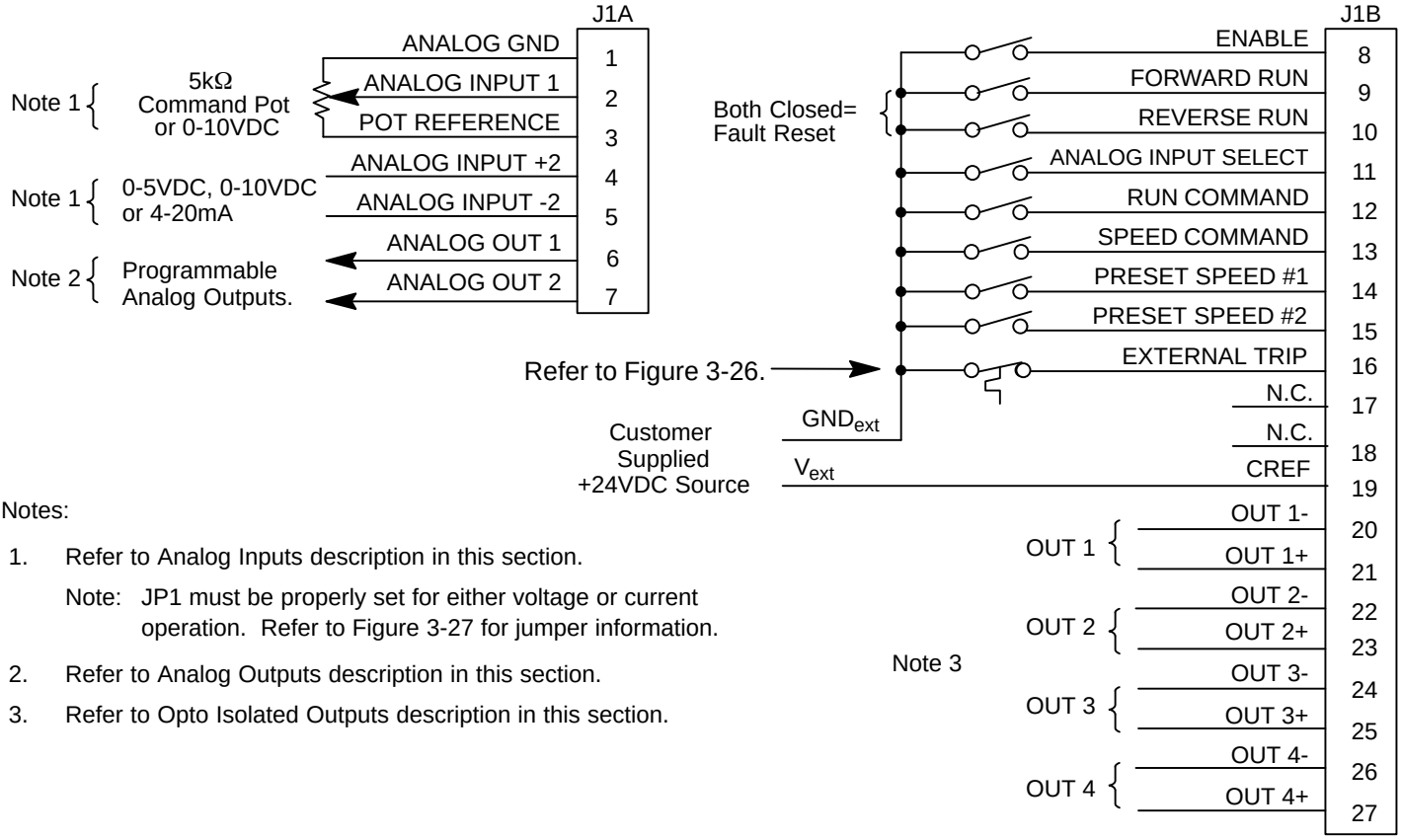
J1B-15 OPEN selects Preset Speed #2 regardless of the Speed Command input (J1B-13). (FREEZESTAT).

Note: If J1B-14 and 15 are both Closed, the 5kΩ pot provides the speed command input. If J1B-14 and 15 are both OPEN, Preset Speed #1 is selected.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to “ON”). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to “ON” to recognize the J1B-16 input.

J1B-19 CREF connection. Connect to +VCC for active Low or to GND for active High.

Figure 3-13 3SPD ANA 2 Wire Connection Diagram



Notes:

1. Refer to Analog Inputs description in this section.

   Note: JP1 must be properly set for either voltage or current operation. Refer to Figure 3-27 for jumper information.

2. Refer to Analog Outputs description in this section.
3. Refer to Opto Isolated Outputs description in this section.

3SPD ANA 3 Wire Control Mode

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 Momentary CLOSED to start motor operation in the Forward direction.
OPEN to initiate a stop command.

J1B-10 Momentary CLOSED to start motor operation in the Reverse direction.
OPEN to initiate a stop command.

J1B-11 OPEN causes motor to decel to stop.

J1B-12 CLOSED selects Start/Stop and Reset commands from the terminal strip.
OPEN selects Start/Stop and Reset commands from keypad.

J1B-13 CLOSED selects terminal strip speed source (Level 1 Input block, Command Select).
OPEN selects speed command from Keypad.

Note: When changing from terminal strip to keypad (J1B-12 or 13) the motor speed and direction will remain the same after the change.

J1B-14 OPEN selects Preset Speed #1 regardless of the Speed Command input (J1B-13). (FIRESTAT).

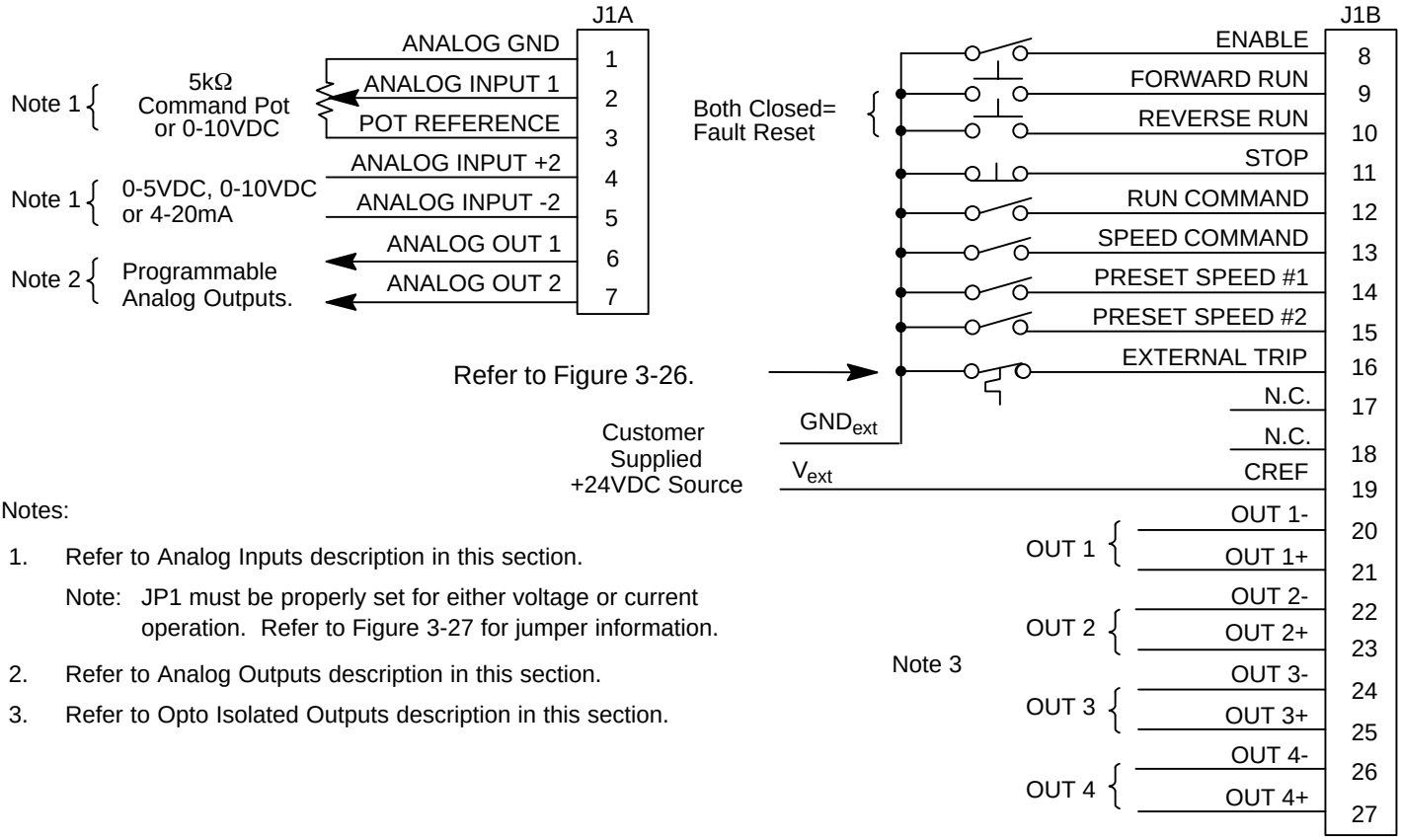
J1B-15 OPEN selects Preset Speed #2 regardless of the Speed Command input (J1B-13). (FREEZESTAT).

Note: If J1B-14 and 15 are both Closed, the 5kΩ pot provides the speed command input. If J1B-14 and 15 are both OPEN, Preset Speed #1 is selected.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to “ON”). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to “ON” to recognize the J1B-16 input.

J1B-19 CREF connection. Connect to +VCC for active Low or to GND for active High.

Figure 3-14 3SPD ANA 3 Wire Mode Connection Diagram



Notes:

1. Refer to Analog Inputs description in this section.

   Note: JP1 must be properly set for either voltage or current operation. Refer to Figure 3-27 for jumper information.

2. Refer to Analog Outputs description in this section.
3. Refer to Opto Isolated Outputs description in this section.

Bipolar Speed Control Mode with Multiple Parameter Sets

This mode allows the user to store up to four (4) different complete sets of operating parameters. This is important if you wish to store and use different acceleration rates, different jog speeds or to store tuning parameter values for different motors etc.

To program and use multiple parameter sets: (refer to Figure 3-15 and Table 3-4) the control must be in Remote mode (not Local mode):

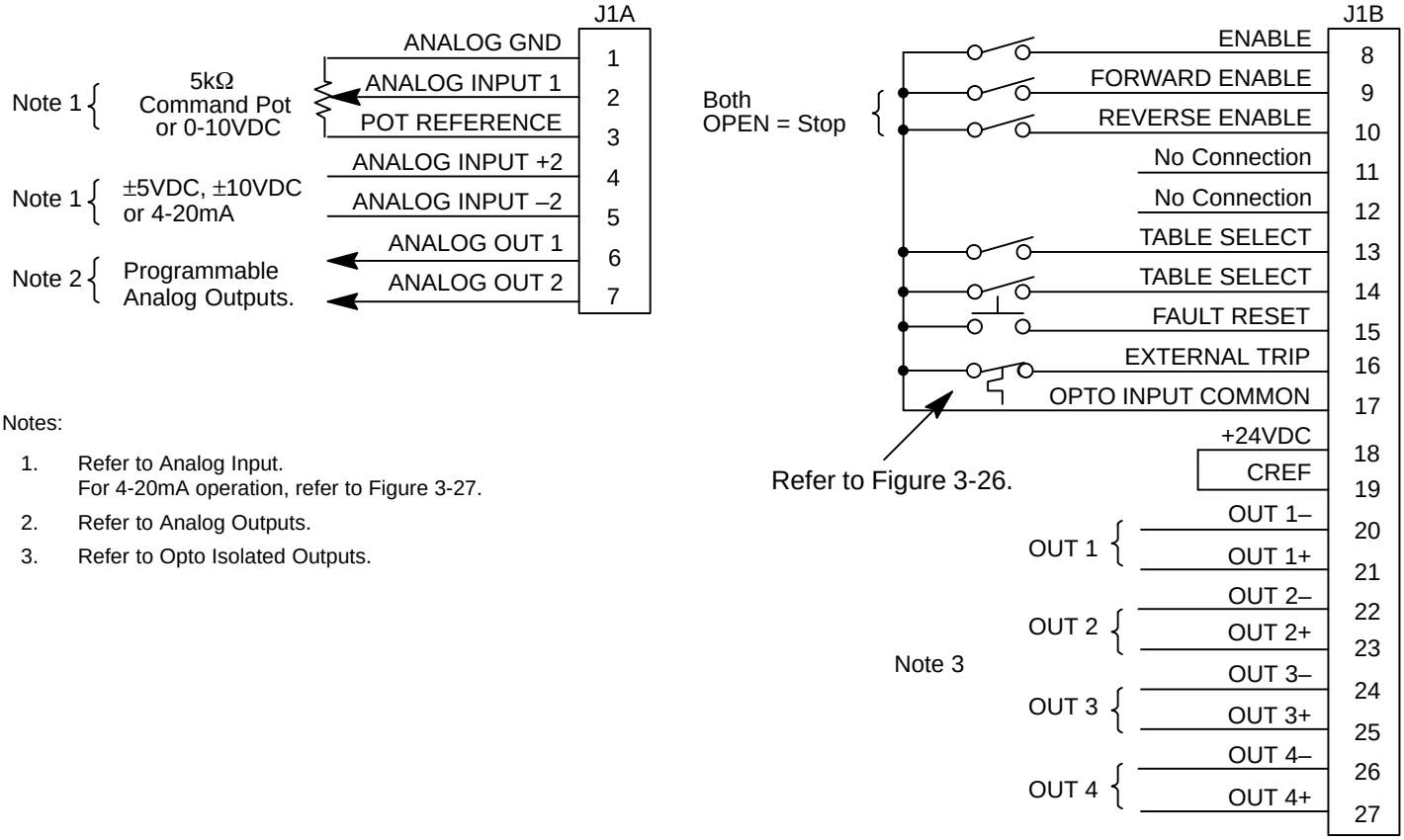
Note: When programming each parameter set, use the ENTER key to accept and automatically save parameter values.

1. Set the Level 1 INPUT block, Operating Mode parameter value to BIPOLAR in each of the parameter sets.
2. Set switches J1-13 and J1-14 to Parameter Table #0 (both switches open). Be sure switches J1-9 and J1-10 are OPEN, J1-8 is CLOSED. Enter all parameter values, and autotune as instructed in Section 3 of this manual. This creates and saves the first parameter set which is numbered Table#0.
3. Set switches J1-13 and J1-14 to Parameter Table #1. Be sure switches J1-9 and J1-10 are OPEN, J1-8 is CLOSED. Enter all parameter values, and autotune as instructed in Section 3 of this manual. This creates and saves the second parameter set which is numbered Table#1.
4. Set switches J1-13 and J1-14 to Parameter Table #2. Be sure switches J1-9 and J1-10 are OPEN, J1-8 is CLOSED. Enter all parameter values, and autotune as instructed in Section 3 of this manual. This creates and saves the third parameter set which is numbered Table#2.
5. Set switches J1-13 and J1-14 to Parameter Table #3. Be sure switches J1-9 and J1-10 are OPEN, J1-8 is CLOSED. Enter all parameter values, and autotune as instructed in Section 3 of this manual. This creates and saves the final parameter set which is numbered Table#3.
6. Remember that to change the value of a parameter in one of the parameter tables, you must first select the table using the switches. You cannot change a value in a table until you have first selected that table.

Table 3-4 Bipolar Mode Table Select Truth Table

Function	**J1B-13**	**J1B-14**
Parameter Table #0	Open	Open
Parameter Table #1	Closed	Open
Parameter Table #2	Open	Closed
Parameter Table #3	Closed	Closed

Figure 3-15 Bipolar Speed Mode Connection Diagram



Notes:

1. Refer to Analog Input.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED to enable operation in the Forward direction.
OPEN to stop Forward operation (drive will brake to a stop if Forward command is still present). Reverse operation is still possible if J1B-10 is closed.
J1B-9 & 10 both OPEN = brake to stop.

J1B-10 CLOSED to enable operation in the Reverse direction.
OPEN to stop Reverse operation (drive will brake to a stop if Reverse command is still present). Forward operation is still possible if J1B-9 is closed.
J1B-9 & 10 both OPEN = brake to stop.

J1B-13 & J1B-14 Select from four parameter tables as defined in Table 3-4.

J1B-15 Momentary CLOSED to reset fault condition.
OPEN to run.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to "ON"). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16.
J1B-17 is then used as switch common.

Process Mode Connections The process control mode provides an auxiliary closed loop general purpose PID set point control that is shown in Figure 3-16. The process control loop may be configured in either of two ways.

1. Using two (2) inputs; a set point and a process feedback input. The error signal (between the setpoint and the feedback signals) adjusts the speed or torque of the motor to eliminate error.
2. Using three (3) inputs; a setpoint, process feedback and feedforward inputs. Instead of waiting for an error signal to develop between the setpoint and the process feedback signals, the feedforward signal adjusts the speed or torque of the motor to reduce the amount of error that will develop between the feedback and setpoint inputs.

The objective of either method is to force the process feedback to be as close to the setpoint as possible and eliminate process error.

Two Input Configuration

For 2 input operation, several parameters must be set as follows:

1. Level 2 Process Control block, “Process Feedback” parameter must be set to the type of feedback signal used. The process feedback signal can be any Analog input available at the J1A terminal strip or expansion board. Selections are shown in Figure 3-16. A signal compatibility matrix is shown in Table 3-5.
2. Level 2 Process Control block, “Setpoint Source” parameter must be set to the type of set point being used.
   A. A fixed value setpoint is a keypad programmed parameter value. To program a fixed setpoint, do the following:
      i. Set the Level 2 Process Control block, “Setpoint Source” parameter to Setpoint CMD.
      ii. Set the Level 2 Process Control block, “Setpoint CMD” parameter to a value between –100% to +100% of the process feedback input.
   B. If a variable value setpoint is used, the Setpoint Source must be set to any available terminal strip or expansion board input not being used for the process feedback input. Selections are shown in Figure 3-16. A signal compatibility matrix is shown in Table 3-5.
3. Level 1 Input block “Command Select” parameter must be set to “None”.

Three Input Configuration

For 3 input operation, several parameters must be set as follows:

1. Level 2 Process Control block “Process Feedback” parameter must be set to the type of feedback signal used. The process feedback signal can be any Analog input available at the J1A terminal strip or expansion board. Selections are shown in Figure 3-16. A signal compatibility matrix is shown in Table 3-5.
2. Level 2 Process Control block “Setpoint Source” parameter must be set to the type of set point being used.
   A. If a fixed value setpoint is used, set the Level 2 Process Control block, Setpoint Source parameter to “Setpoint CMD”. Set the Level 2 Process Control block “Setpoint Command” parameter to a value between –100% to +100% of the process feedback.
   B. If a variable value setpoint is used, set the Level 2 Process Control block, Setpoint Source parameter to any Analog1, Analog2 or expansion board input not being used for the process feedback input. Selections are shown in Figure 3-16. A signal compatibility matrix is shown in Table 3-5.

3. Level 1 Input block “Command Select” parameter must be set to the feedforward signal type. This signal may be any Analog1, Analog2 or expansion board input not being used for the process feedback or setpoint source inputs. Selections are shown in Figure 3-16.

Note: An input can only be used one time for Process Feedback, **OR** Setpoint Source, **OR** Feedforward.

Figure 3-16 Simplified Process Control Block Diagram

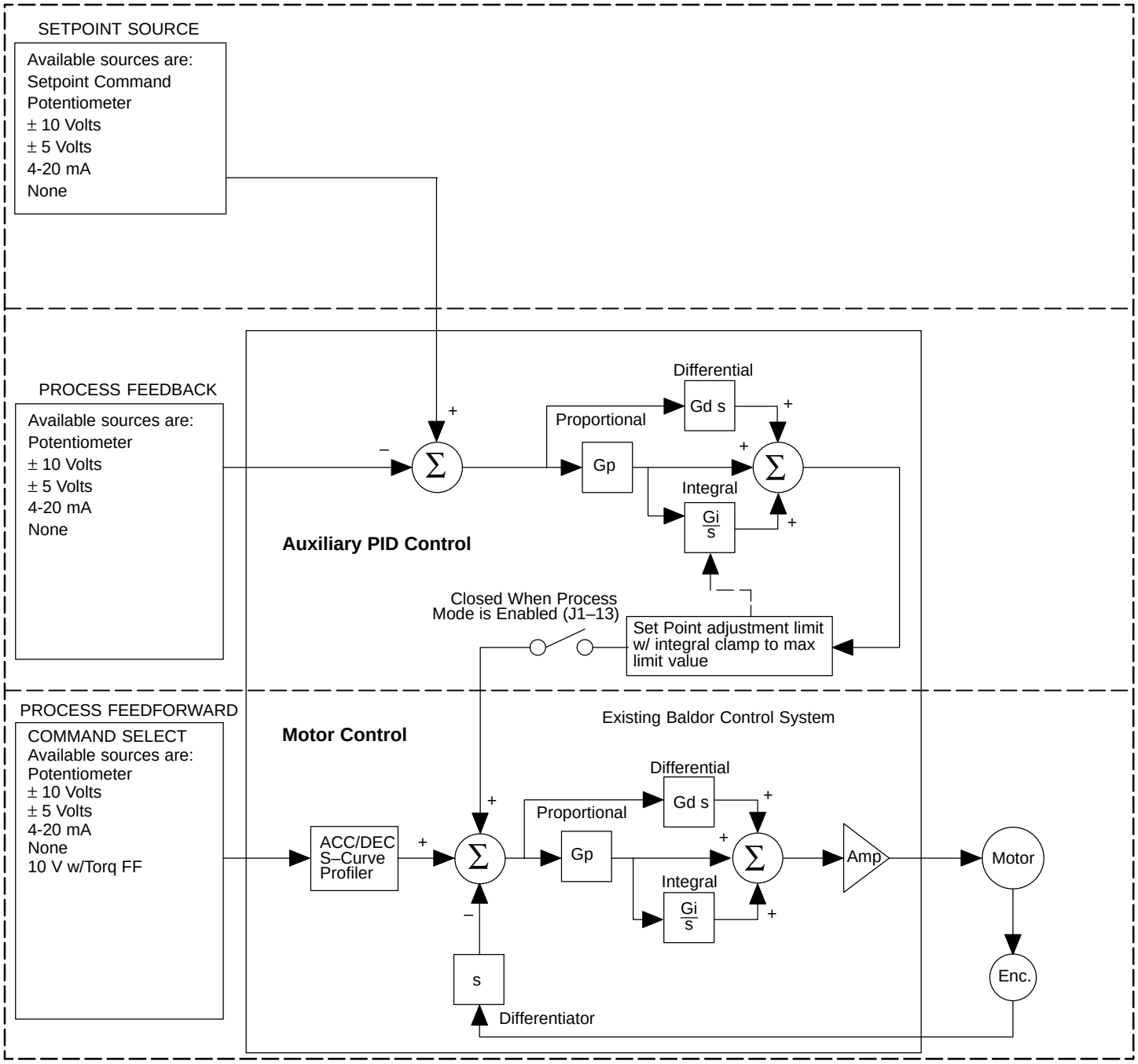


Table 3-5 Process Mode Input Signal Compatibility

Process Feedback	Set Point or Feedforward	
	J1A-1 & 2	J1A-4 & 5
J1A-1 & 2		
J1A-4 & 5		

Conflicting inputs. Do not use same input signal multiple times.

Specific Process Mode Outputs

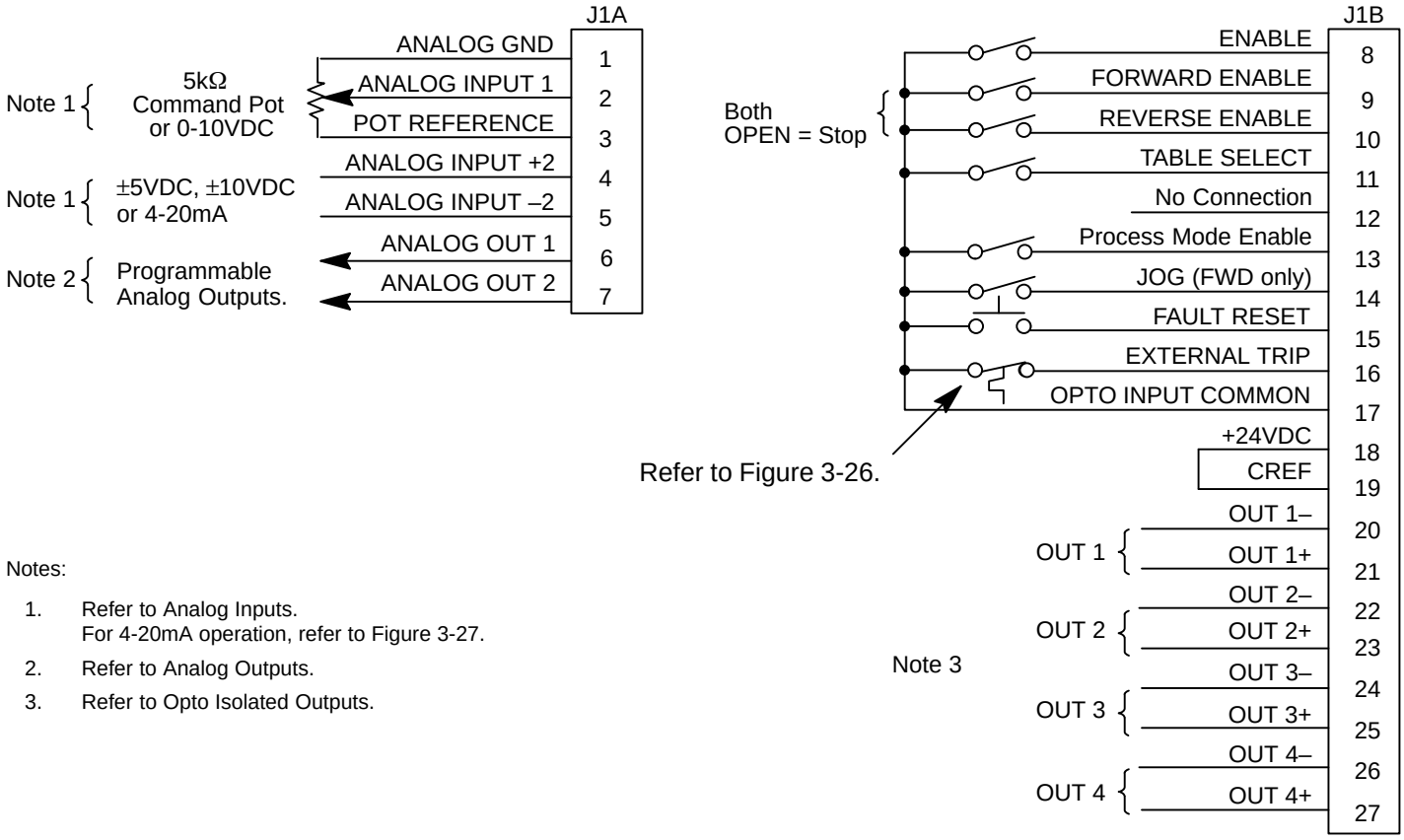
Process Mode Only, Analog Monitoring Outputs

Name	Description
Process FDBK	Process Feedback scaled input. Useful for observing or tuning the process control loop.
Setpoint CMD	Setpoint Command scaled input. Useful for observing or tuning the process control loop.
Speed Command	Commanded Motor Speed. Useful for observing or tuning the output of the control loop.

Process Mode Only, Opto Isolated Outputs

Name	Description
Process Error	CLOSED when the Process Feedback is within the specified tolerance band. OPEN when the Process Feedback is greater than the specified tolerance band. The width of the tolerance band is adjusted by the Level 2 Process Control block PROCESS ERR TOL parameter value.

Figure 3-17 Process Mode Connection Diagram



Notes:

1. Refer to Analog Inputs.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED to enable operation in the Forward direction.
OPEN TO DISABLE Forward operation.

J1B-10 CLOSED to enable operation in the Reverse direction.
OPEN to disable Reverse operation.

J1B-11 OPEN=Table 0, CLOSED=Table 1.

J1B-13 CLOSED to enable the Process Mode.

J1B-14 CLOSED puts the control in JOG Mode. Control will only JOG in the forward direction.
OPEN allows PID & Feedforward Speed or Torque control.

J1B-15 Momentary CLOSED to reset fault condition.
OPEN to run.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to "ON"). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16.
J1B-17 is then used as switch common.

Fan Pump 2 Wire Control Mode

The Opto inputs can be switches as shown in Figure 3-18 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED to start motor operation in the Forward direction.
OPEN to initiate a stop command.

J1B-10 CLOSED to start motor operation in the Reverse direction.
OPEN to initiate a stop command.

J1B-11 CLOSED selects Analog Input #1.
OPEN selects the value of the Level 1 Input block, Command Select parameter.

Note: If Level 1 Input block, Command Select parameter is set to “Potentiometer”, then Analog Input #1 is always selected.

J1B-12 CLOSED selects Start/Stop and Reset commands from the terminal strip.
OPEN selects Start/Stop and Reset commands from keypad.

J1B-13 CLOSED selects terminal strip speed source (Level 1 Input block, Command Select).
OPEN selects speed command from Keypad.

Note: When changing from keypad to terminal strip (J1B-12 or 13) the motor speed and direction will remain the same after the change.

J1B-14 OPEN selects Preset Speed #1 regardless of the Speed Command input (J1B-13). (FIRESTAT).

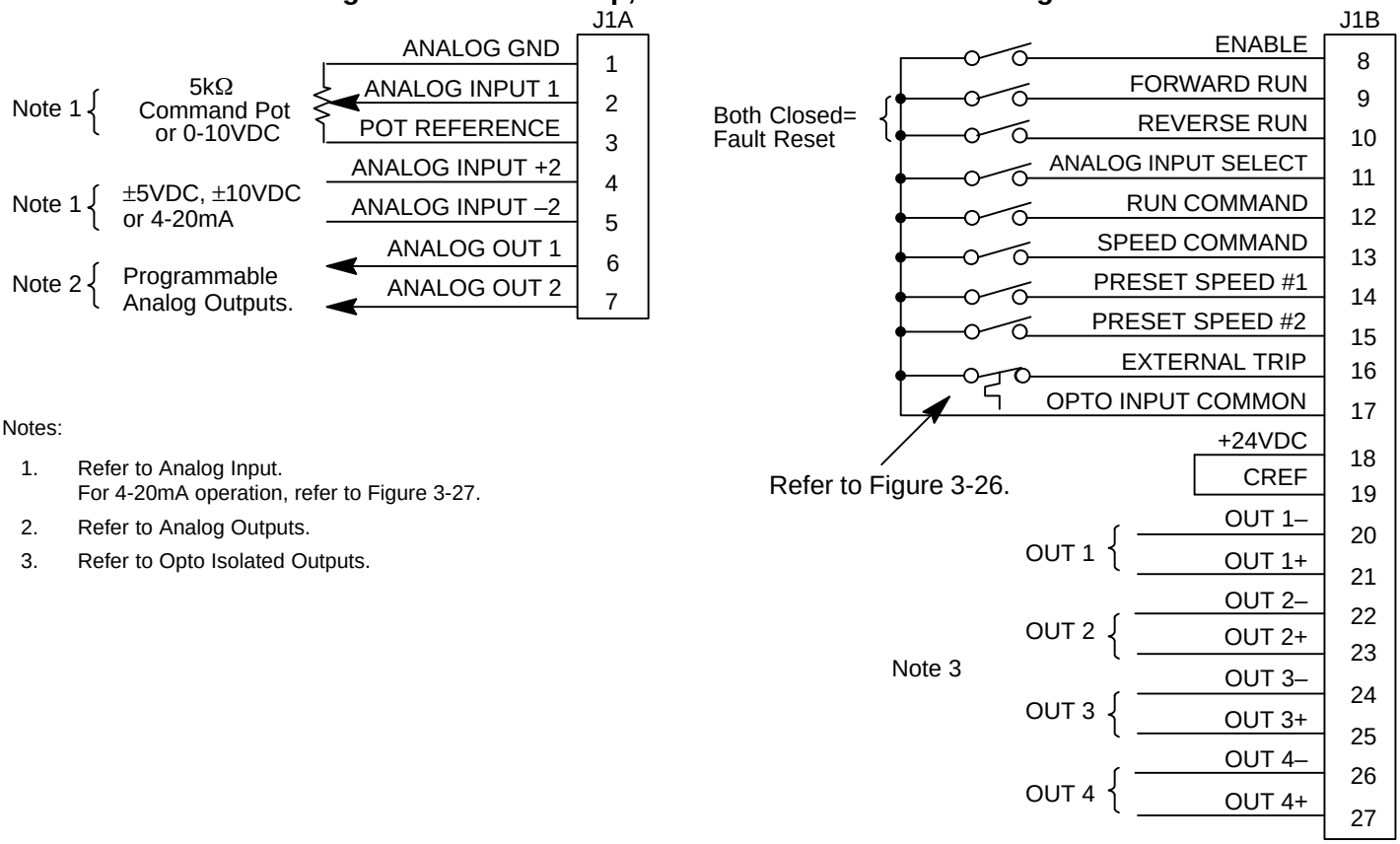
J1B-15 OPEN selects Preset Speed #2 regardless of the Speed Command input (J1B-13). (FREEZESTAT).

Note: If J1B-14 and 15 are both OPEN, Preset Speed #1 is selected.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to “ON”). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to “ON” to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for “Active Low” operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

Figure 3-18 Fan Pump, 2 Wire Mode Connection Diagram



Notes:

1. Refer to Analog Input.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

Fan Pump 3 Wire Control Mode

The Opto inputs can be switches as shown in Figure 3-19 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 Momentary CLOSED to start motor operation in the Forward direction.
OPEN to initiate a stop command.

J1B-10 Momentary CLOSED to start motor operation in the Reverse direction.
OPEN to initiate a stop command.

J1B-11 OPEN causes motor to decel to stop.

J1B-12 CLOSED selects Start/Stop and Reset commands from the terminal strip.
OPEN selects Start/Stop and Reset commands from keypad.

J1B-13 CLOSED selects terminal strip speed source (Level 1 Input block, Command Select).
OPEN selects speed command from Keypad.

Note: When changing from keypad to terminal strip (J1B-12 or 13) the motor speed and direction will remain the same after the change.

J1B-14 OPEN selects Preset Speed #1 regardless of the Speed Command input (J1B-13). (FIRESTAT).

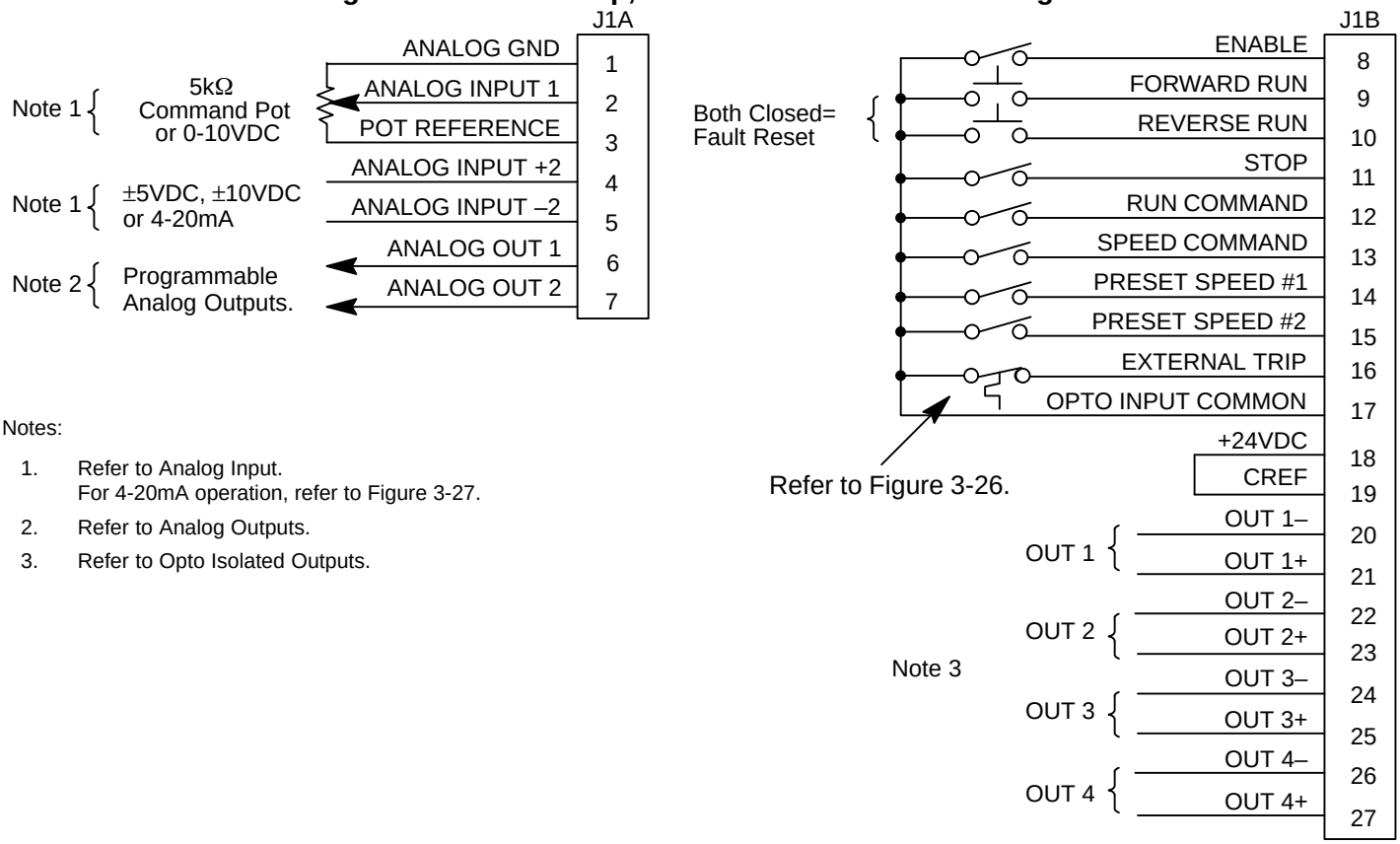
J1B-15 OPEN selects Preset Speed #2 regardless of the Speed Command input (J1B-13). (FREEZESTAT).

Note: If J1B-14 and 15 are both OPEN, Preset Speed #1 is selected.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to “ON”). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to “ON” to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for “Active Low” operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

Figure 3-19 Fan Pump, 3 Wire Mode Connection Diagram



Notes:

1. Refer to Analog Input.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

EPOT 2 Wire Control Mode

The Opto inputs can be switches as shown in Figure 3-20 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED starts motor operation in the Forward direction.
OPEN initiates a stop command.

J1B-10 CLOSED starts motor operation in the Reverse direction.
OPEN initiates a stop command.

J1B-11 Selects programmed preset speeds as defined in the Speed Select Table in Figure 3-20.

J1B-12 Selects programmed preset speeds as defined in the Speed Select Table in Figure 3-20.

J1B-13 Selects ACC/DEC/S-Curve group. OPEN selects group 1. CLOSED selects group 2.

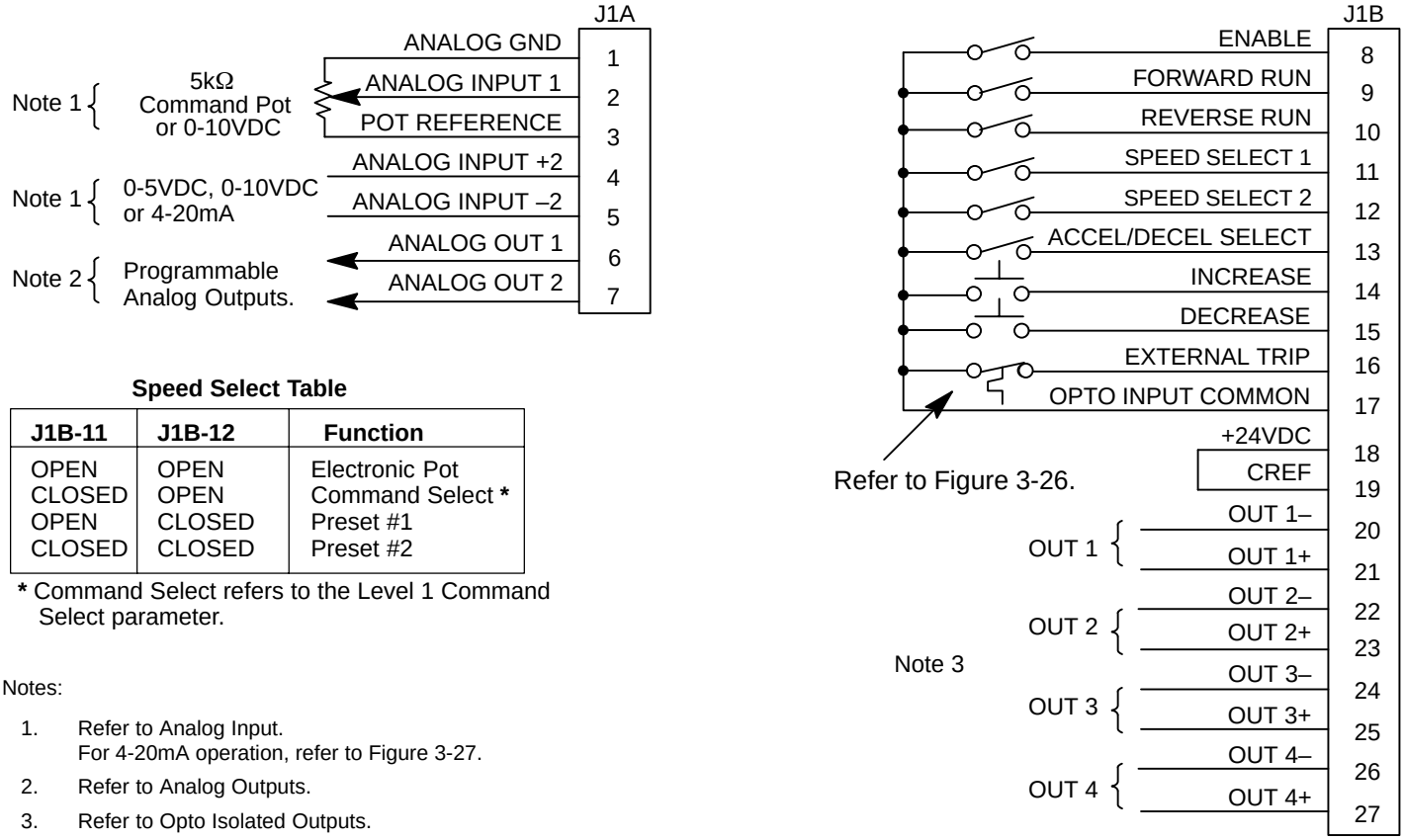
J1B-14 Momentary CLOSED increases motor speed while contact is closed.

J1B-15 Momentary CLOSED decreases motor speed while contact is closed.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to "ON"). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

Figure 3-20 EPOT – 2 Wire Mode Connection Diagram



Speed Select Table

J1B-11	J1B-12	Function
OPEN	OPEN	Electronic Pot
CLOSED	OPEN	Command Select *
OPEN	CLOSED	Preset #1
CLOSED	CLOSED	Preset #2

***** Command Select refers to the Level 1 Command Select parameter.

Notes:

1. Refer to Analog Input.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

EPOT 3 Wire Control Mode

The Opto inputs can be switches as shown in Figure 3-21 or logic signals from another device. The External Trip Opto Input at J1B-16 is active if connected as shown and the Level 2 PROTECTION block, EXTERNAL TRIP parameter is set to ON.

J1B-8 CLOSED allows current to flow in the motor and produce torque.
OPEN disables the control & motor coasts to a stop.

J1B-9 CLOSED starts motor operation in the Forward direction.
OPEN initiates a stop command.

J1B-10 CLOSED starts motor operation in the Reverse direction.
OPEN initiates a stop command.

J1B-11 Momentary OPEN initiates Stop command.

J1B-12 OPEN selects EPOT.
CLOSED selects Level 1 Command Select parameter value.

J1B-13 Selects ACC/DEC/S-Curve group. OPEN selects group 1. CLOSED selects group 2.

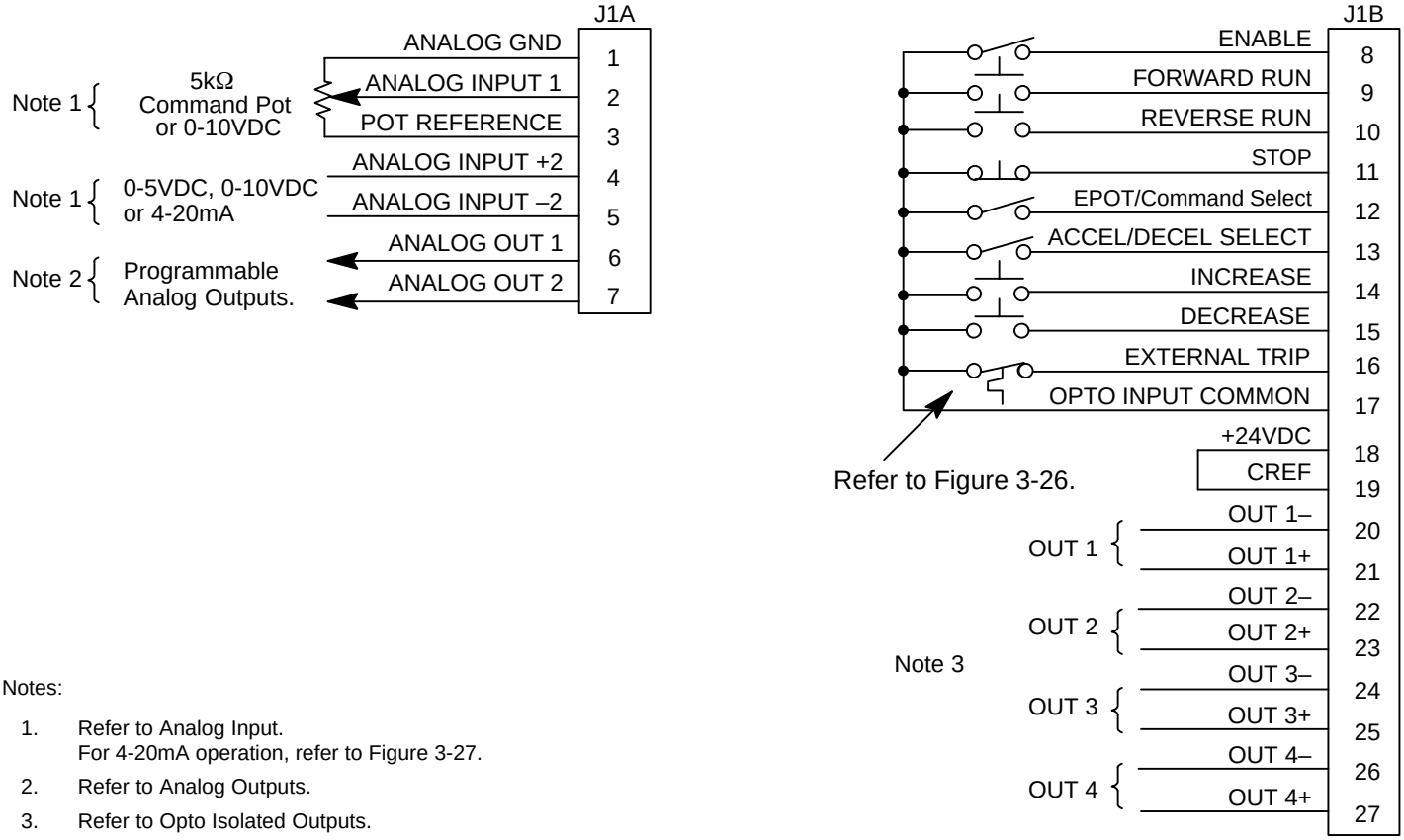
J1B-14 Momentary CLOSED increases motor speed while contact is closed.

J1B-15 Momentary CLOSED decreases motor speed while contact is closed.

J1B-16 OPEN causes an External Trip to be received by the control (when programmed to "ON"). When this occurs, the control disables and an external trip error is displayed on the keypad display (also logged into the error log).
If J1B-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to recognize the J1B-16 input.

J1B-19 Jumper to J1B-18 (+24VDC) for "Active Low" operation of input signals at J1B-8 to 16. J1B-17 is then used as switch common.

Figure 3-21 EPOT – 3 Wire Mode Connection Diagram



Notes:

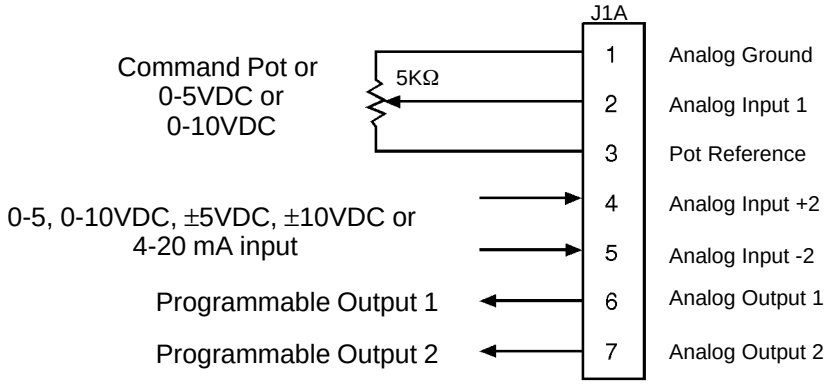
1. Refer to Analog Input.
   For 4-20mA operation, refer to Figure 3-27.
2. Refer to Analog Outputs.
3. Refer to Opto Isolated Outputs.

Analog Inputs and Outputs

Analog Inputs

Two analog inputs are available: Analog Input #1 (J1A-1 and J1A-2) and Analog Input #2 (J1A-4 and J1A-5) as shown in Figure 3-22. Either analog input #1 or #2 may be grounded provided the common mode range is not exceeded. Either analog input may be selected in the Level 1 INPUT block, Command Select parameter value. Analog input #1 is selected if parameter value "Potentiometer" is selected. Analog input #2 is selected if parameter value "+/–10Volts, +/–5 Volts or 4-20mA" is selected.

Figure 3-22 Analog Inputs and Outputs



Analog Input #1

Analog input #1 (J1A-2) can be used when the control is set to Standard 3 Wire, Fan Pump 2 or 3 Wire, Bipolar or Process modes (not Keypad or 15 Speed 2 Wire modes). When using a potentiometer as the command input, the Level 1 Input block COMMAND SELECT parameter must be set to "POTENTIOMETER".

1. Connect the wires from the 5KΩ pot as shown in Figure 3-22. One end of the pot is connected to J1A-1 (analog ground) and the other end is connected to J1A-3 (reference voltage).
2. Connect the wiper of the pot to J1A-2. The voltage across terminals J1A-1 and J1A-2 is the speed command input.
3. A 0-10VDC speed command signal may be connected across J1A-1 and J1A-2 instead of a 5KΩ pot.

Analog Input #2

Analog input #2 accepts 0-5VDC, 0-10VDC, ±5VDC, ±10VDC or 4-20 mA command input. The operating mode is defined in the Level 1 Input block OPERATING MODE parameter.

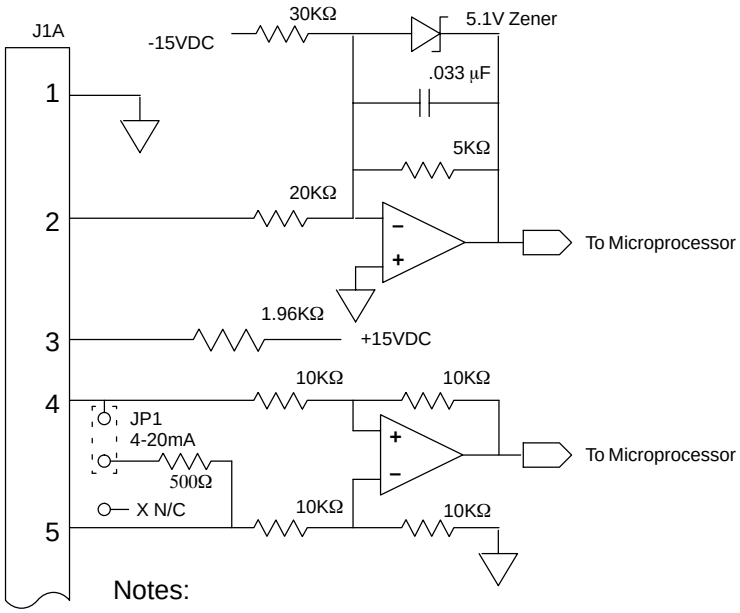
Note: Analog Input #2 is available with Standard Run 3-Wire, Fan Pump 2 Wire, Fan Pump 3 Wire, Bipolar or Process Control modes and not available for the Keypad or 15 Speed 2 Wire modes.

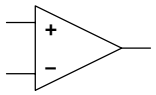
1. Connect the Analog Input 2+ wire to J1A-4 and the 2– wire to J1A-5.
2. If using 4-20mA as the command signal, JP1 must be across pins 2 and 3. For voltage inputs, JP1 must be on pins 1 and 2. See Figure 3-27 for jumper information.

Note: Analog Input #2 can be connected for single ended operation by grounding either of the inputs, provided the common mode voltage range is not exceeded. The common mode voltage can be measured with a voltmeter. Apply the maximum command voltage to analog input 2 (J1A-4, 5). Measure the AC and DC voltage across J1A-1 to J1A-4. Add the AC and DC readings together. Measure the AC and DC voltage from J1A-1 to J1A-5. Add the AC and DC readings together.

If either of these measurement totals exceeds a total of ±15 volts, then the common mode voltage range has been exceeded. If the common mode voltage range has been exceeded, the solution is either to change the command voltage source or isolate the command voltage with a commercially available signal isolator.

Figure 3-23 Analog Inputs Equivalent Circuits





All OP Amps are TL082 or TL084

Analog Ground is separated from Chassis Ground. Electrically they are separated by an RC network.

Terminal Tightening Torque = 7 Lb-in (0.8 Nm).

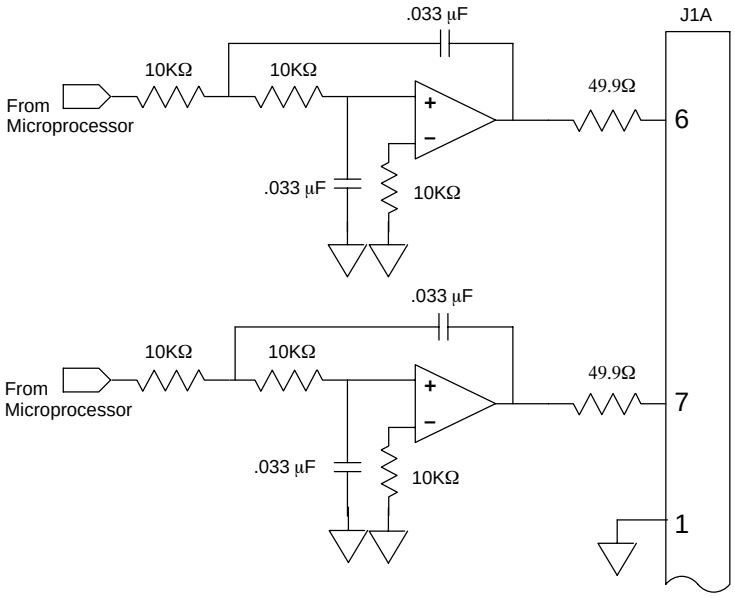
Analog Outputs

Two programmable analog outputs are provided on J1A-6 and J1A-7. The output conditions are defined in Section 4 of this manual. The actual output voltage for each analog output condition can be 0-10VDC or ±10VDC depending upon the output condition selected (1mA maximum output current) and can provide real-time status of various control conditions. The output conditions are defined in Section 4 of this manual.

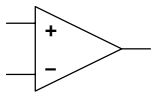
The return for these outputs is J1A-1 analog ground. Each output is programmed in the Level 1 Output block.

1. Connect the Output #1 wires to J1A-6 and J1A-1.
2. Connect the Output #2 wires to J1A-7 and J1A-1.

Figure 3-24 Analog Outputs Equivalent Circuits



Notes:

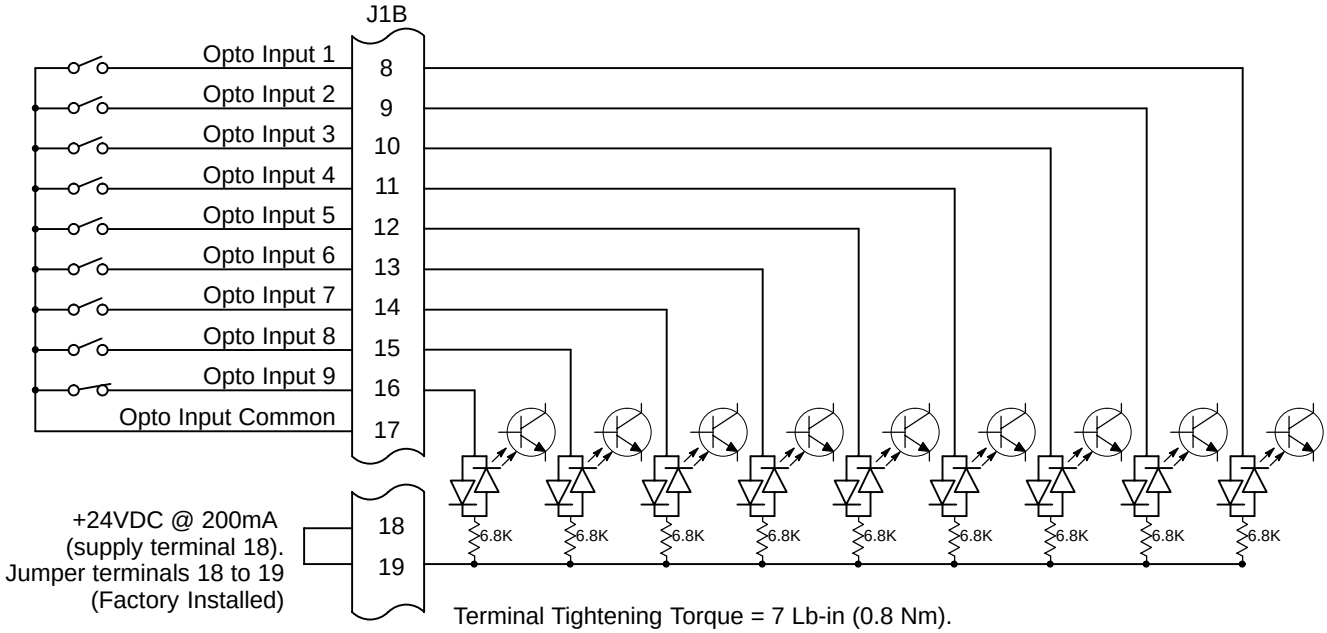


All OP Amps are TL082 or TL084

Analog Ground is separated from Chassis Ground. Electrically they are separated by an RC network.

Terminal Tightening Torque = 7 Lb-in (0.8 Nm).

Figure 3-25 Opto-Input Equivalent Circuit



Terminal Tightening Torque = 7 Lb-in (0.8 Nm).

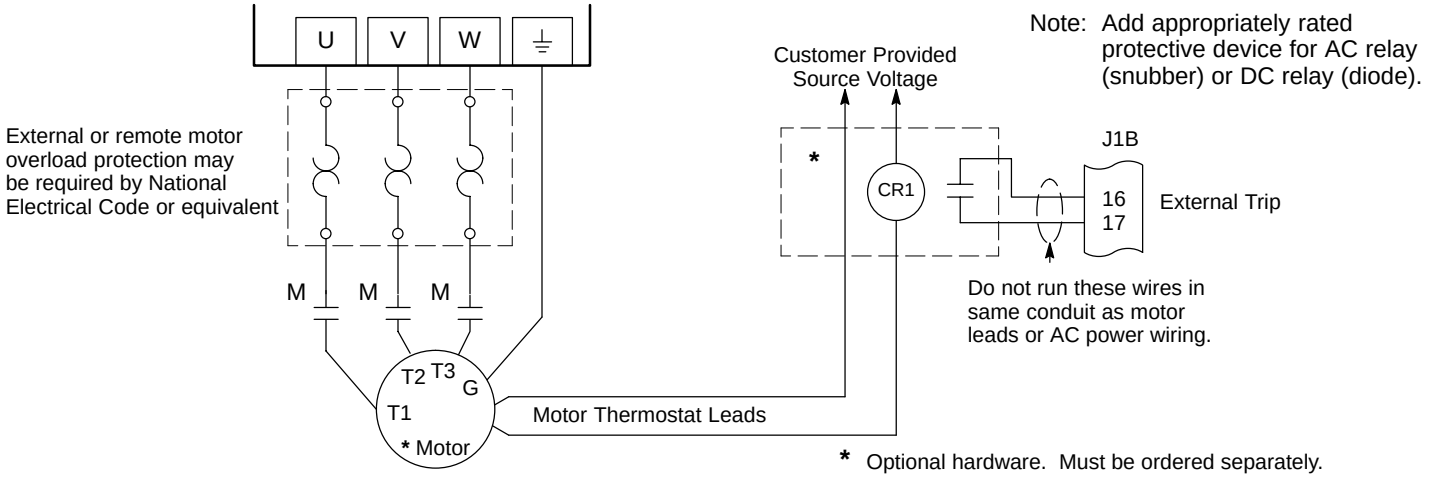
External Trip Input

To activate the External Trip input, the External Trip parameter in the programming Protection Block must be set to “ON”.

Terminal J1B-16 is available for connection to a normally closed thermostat or overload relay contact in all operating modes as shown in Figure 3-26. The thermostat or overload relay should be a dry contact type with no power available from the contact. If the motor thermostat or overload relay activates (opens the J1B-16 to J1B-17 connection) the control will automatically shut down and give an External Trip fault.

Connect the External Trip Input wires to J1B-16 and J1B-17. Do not place these wires in the same conduit as the motor power leads.

Figure 3-26 Motor Temperature Relay



* Optional hardware. Must be ordered separately.

Figure 3-27 Jumper Locations

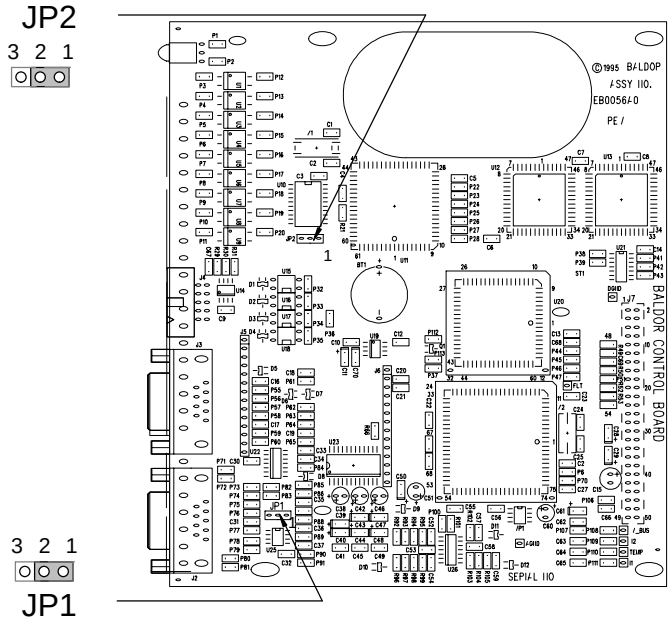


Table 3-6 Jumper Positions

Jumper	Jumper Position	Description of Jumper Position Setting
JP1	1–2	Voltage Command Signal. (Factory Setting)
	2–3	4–20mA Command Signal.
JP2	1–2	Do Not Move (Factory Setting)
	2–3	Not used.

Opto-Isolated Outputs

Four programmable Opto-isolated outputs are available at terminals J1B-20 through J1B-27. See Figure 3-28.

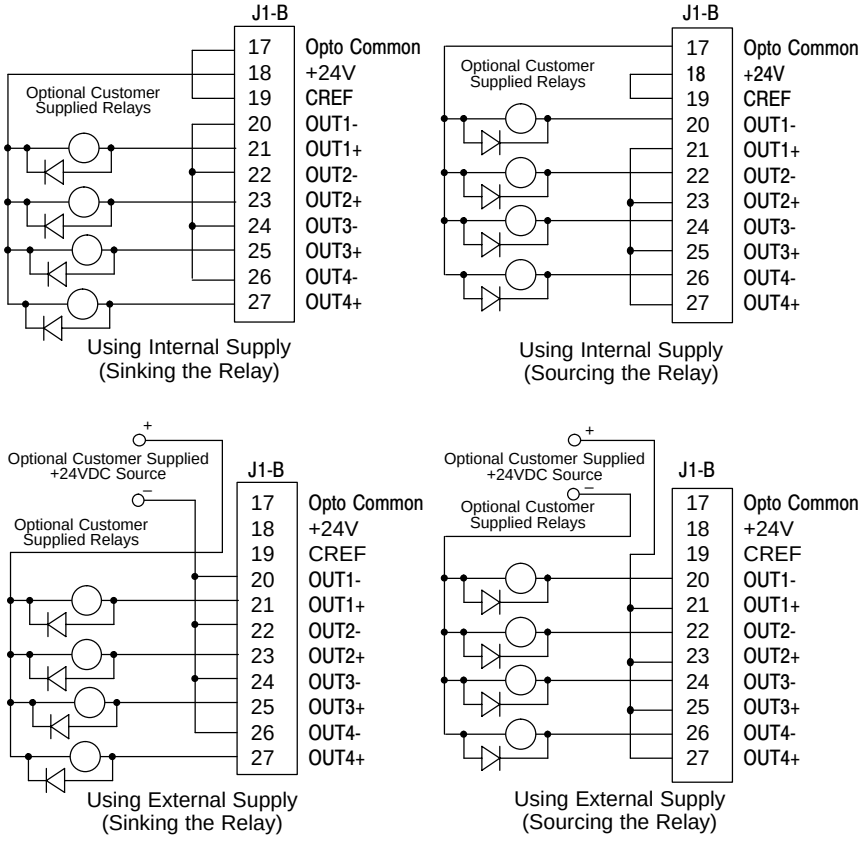
The Opto-isolated outputs may be configured for sinking or sourcing 50 mA each. However, all must be configured the same. The maximum voltage from opto output to common when active is 1.0 VDC (TTL compatible). The Opto-isolated outputs may be connected in different ways as shown in Figure 3-28.

If the opto outputs are used to directly drive a relay, a flyback diode rated at 1A, 100 V (1N4002) minimum should be connected across the relay coil. See Electrical Noise Considerations in Section 5 of this manual.

1. Connect OPTO OUT #1 wires to J1B-20 and J1B-21.
2. Connect OPTO OUT #2 wires to J1B-22 and J1B-23.
3. Connect OPTO OUT #3 wires to J1B-24 and J1B-25.
4. Connect OPTO OUT #4 wires to J1B-26 and J1B-27.

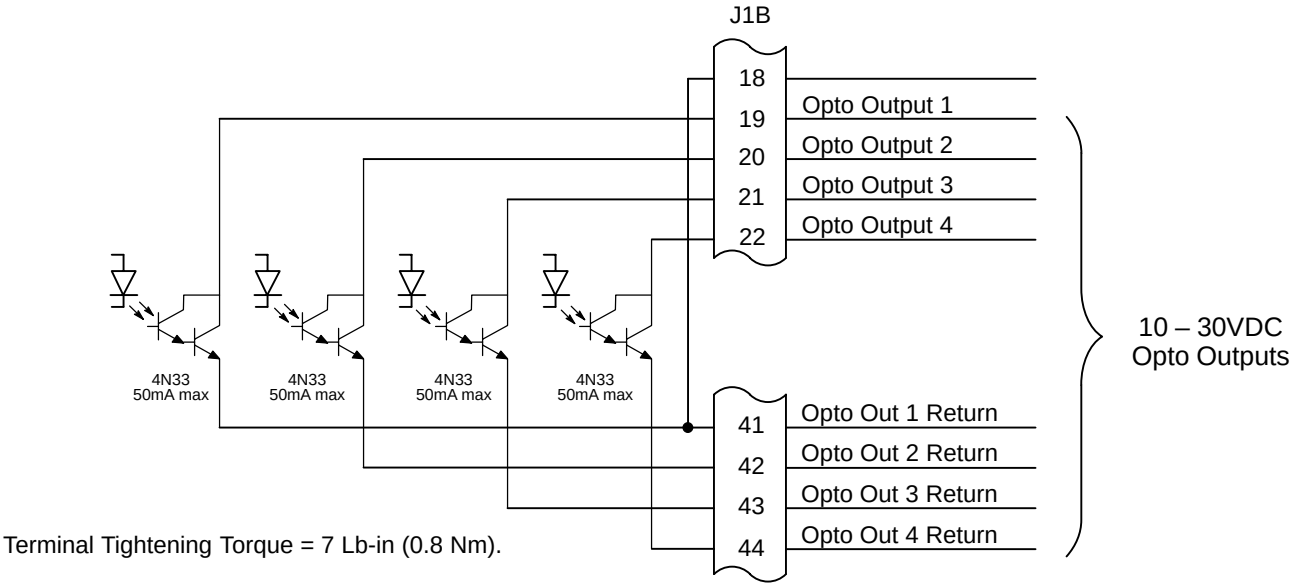
Each Opto Output is programmed in the Level 1 Output programming block.

Figure 3-28 Opto-isolated Output Configurations



Note: Shows typical flyback diode rated at least 1Amp/100V (1N4002) across each relay coil (if coil does not have built in flyback).

Figure 3-29 Opto-Output Equivalent Circuit



Terminal Tightening Torque = 7 Lb-in (0.8 Nm).

Pre-Operation Checklist

Check of electrical items.

⚠ **CAUTION: After completing the installation but before you apply power, be sure to check the following items.**

1. Measure the AC line voltage and verify it matches the PSM and control rating.
2. Inspect all power connections for accuracy, workmanship and tightness and compliance to codes.
3. Verify control and motor are grounded to each other and the control is connected to earth ground.
4. Check all signal wiring for accuracy.
5. Be certain all brake coils, contactors and relay coils have noise suppression. This should be an R-C filter for AC coils and reverse biased diodes for DC coils. MOV type transient suppression is not adequate.

⚠ **WARNING: Make sure that unexpected operation of the motor shaft during start up will not cause injury to personnel or damage to equipment.**

Check of Motors and Couplings

1. Verify freedom of motion for all motor shafts and that all motor couplings are tight without backlash.
2. Verify the holding brakes if any, are properly adjusted to fully release and set to the desired torque value.

Power-Up Procedure

This procedure will help get your drive up and running in the Keypad mode quickly. This will allow you to prove the motor and control operation. You should have an understanding of the keypad programming & operation procedures described in Section 4 of this manual.

Note: The control terminal strip does not require any connections to operate in the Keypad mode (if Level 2 Protection block, External Trip parameter is set to OFF and Level 2 Protection block, Local INP Enable is set to “OFF”).

Initial Conditions

Be sure the PSM, DB resistor, Control, and Motor are wired according to the procedures described in this section.

1. Verify that any enable inputs to J1B-8 are open.
2. Turn power on. Be sure there are no faults. Verify PSM “Ready” is ON and the “DB ON” and “Monitor” indicators are OFF. Verify the control “Ready” is ON.
3. Set the Level 1 Input block, Operating Mode to “KEYPAD”.
4. Enter the following motor data in the Level 2 Motor Data block parameters:
   Motor Voltage (input)
   Motor Rated Amps (FLA)
   Motor Rated Speed (base speed)
   Motor Rated Frequency
   Motor Mag Amps (no load current)
5. At the Level 2 Motor Data block, go to CALC Presets and select YES (using the ▲ key). Press ENTER and let the control calculate the preset values for the parameters that are necessary for control operation.
6. Disconnect the motor from the load (including coupling or inertia wheels). If the load cannot be disconnected, refer to Section 6 and manually tune the control. After manual tuning, perform steps 11 through 14.

⚠ **WARNING: The motor shaft will rotate during the autotune procedure. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment.**

7. Go to Level 2 Autotune block, and do the following tests:
   CMD OFFSET TRIM
   STATOR R1
   FLUX CUR SETTING
8. Remove all power from the control.
9. Couple the motor to its load.
10. Turn power on. Be sure no errors are displayed.
11. Set the Level 2 Output Limits block, “MIN OUTPUT SPEED” parameter.
12. Set the Level 2 Output Limits block, “MAX OUTPUT SPEED” parameter.
13. Run the drive from the keypad using the JOG mode, keypad entered speed commands or speed commands using the arrow keys.
14. Select and program additional parameters to suit your application.

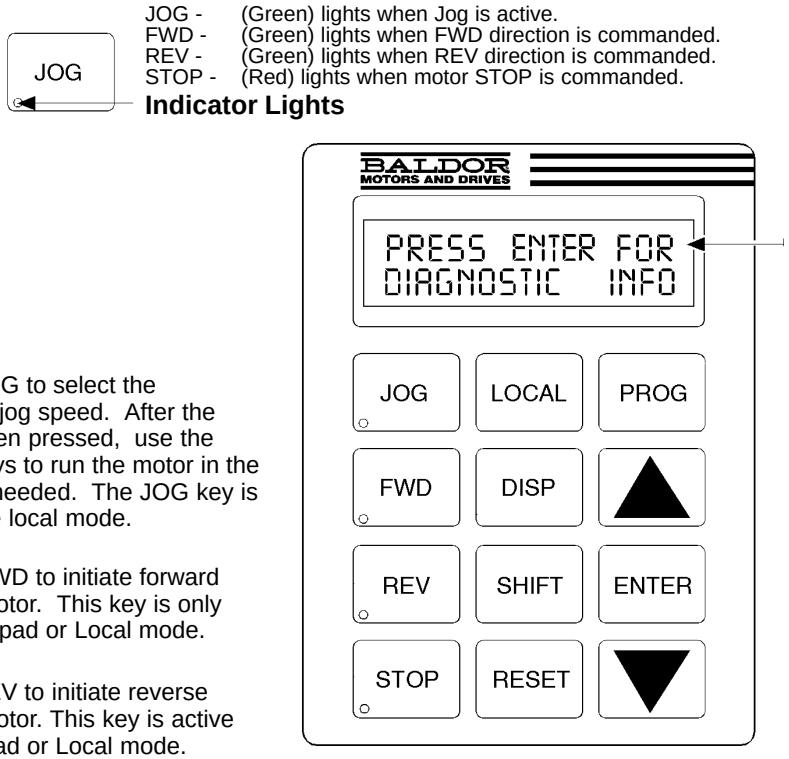
The control is now ready for use in the Keypad mode. If a different operating mode is desired, refer to Section 3 Control Connections and Section 4 Programming and Operation.

Section 4
Programming and Operation

Overview

The keypad is used to program the control parameters; operate the motor when programmed for the Keypad operating mode; and to monitor the status and outputs of the control by accessing the display options, diagnostic menus and the fault log.

Figure 4-1 Keypad



Keypad Display - Displays status information during Local or Remote operation. It also displays information during parameter setup and fault or Diagnostic Information.

JOG - Press JOG to select the preprogrammed jog speed. After the JOG key has been pressed, use the FWD or REV keys to run the motor in the direction that is needed. The JOG key is only active in the local mode.

FWD - Press FWD to initiate forward rotation of the motor. This key is only active in the Keypad or Local mode.

REV - Press REV to initiate reverse rotation of the motor. This key is active only in the Keypad or Local mode.

STOP - Press STOP to initiate a stop sequence. Depending on the setup of the control, the motor will either ramp or coast to a stop. This key is operational in all modes of operation unless it has been disabled by the Keypad Stop parameter in the Keypad (programming) Setup Block.

Note: If the control is operating in remote mode and the stop key is pressed the control will change to the local mode when the stop command is initiated. To resume operation in the remote mode, press the LOCAL key.

LOCAL - Press LOCAL to change between the Local (keypad) and Remote operation. When the control is in the Local mode all other external commands to the J1B terminal strip will be ignored with the exception of the external trip input.

DISP - Press DISP to return to Display mode from Programming mode. Provides operational status and advances to the next display menu item.

SHIFT - Press SHIFT in the program mode to control cursor movement. Pressing the SHIFT key once moves the blinking cursor one character position to the right. While in Program mode, a parameter value may be reset to the factory preset value by pressing the SHIFT key until the arrow symbols at the far left of the keypad display are flashing, then press an arrow key. In the Display mode the SHIFT key is used to adjust the keypad contrast.

RESET - Press RESET to clear all fault messages (in local mode). Can also be used to return to the top of the block programming menu without saving any parameter value changes.

PROG - Press PROG to enter the program mode. While in the Program mode the PROG key is used to edit a parameter setting.

▲ - (UP Arrow)
Press ▲ to change the value of the parameter being displayed. Pressing ▲ increments the value to the next greater value. Also, when the fault log or parameter list is displayed, the ▲ key will scroll upward through the list. In the local mode pressing the ▲ key will increase motor speed to the next greater value.

ENTER - Press ENTER to save parameter value changes and move back to the previous level in the programming menu. In the Display mode the ENTER key is used to directly set the local speed reference. It is also used to select other operations when prompted by the keypad display.

▼ - (Down Arrow)
Press ▼ to change the value of the parameter being displayed. Pressing ▼ decrements the value to the next lesser value. Also, when the fault log or parameter list is displayed, the ▼ key will scroll downward through the list. In the local mode pressing the ▼ key will decrease motor speed to the next lower value.

Display Mode

During normal operation, the control is in the DISPLAY MODE. In this mode, the Keypad Display shows the status of the control as in the following example.

The DISPLAY MODE is used to view operating conditions, DIAGNOSTIC INFO and the FAULT LOG and to adjust the Display Contrast. The description of how to do these tasks are described on the following pages.

Adjusting Display Contrast When AC power is applied to the control the keypad should display the status of the control. If there is no visible display, use the following procedure to adjust the contrast of the display.

(Contrast may be adjusted in display mode when motor is stopped or running)

Action	Description	Display	Comments
Apply Power	No visible display	BLANK	
Press DISP Key	Places control in display mode	BLANK	Display mode with nothing visible (blank) or too dim to be read.
Press SHIFT SHIFT	Allows display contrast adjustment	ADJUST CONTRAST ▲▼[ENTER] TO SAVE	
Press ▲ or ▼ Key	Adjusts display intensity	ADJUST CONTRAST ▲▼[ENTER] TO SAVE	
Press ENTER	Saves level of contrast and exits to display mode	STOP MOTOR SPEED LOCAL 0 RPM	Typical display

Display Mode Continued

Display Screens & Diagnostic Information Access

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing motor speed.	STOP MOTOR SPEED LOCAL 0 RPM	No faults present. Local keypad mode. If in remote/serial mode, press local for this display.
Press DISP key	Display showing motor frequency.	STOP FREQUENCY LOCAL 0.00 HZ	
Press ▲ key	Scroll to diagnostic info block.	PRESS ENTER FOR DIAGNOSTIC INFO	
Press ENTER key	Access diagnostic information.	STOP SPEED REF LOCAL 0 RPM	Displays commanded speed, direction of rotation, Local/ Remote.
Press DISP key	Display mode showing control temperature.	STOP CONTROL TEMP LOCAL 0.0° C	Displays operating temperature in degrees C.
Press DISP key	Display mode showing bus voltage.	STOP BUS VOLTAGE LOCAL 321V	
Press DISP key	Display mode showing % overload current remaining.	STOP OVRLD LEFT LOCAL 100.00%	
Press DISP key	Display mode showing opto inputs & outputs state. 0=Open, 1=Closed.	DIGITAL I/O 000000000 0000	Opto Inputs states (Left); Opto Outputs states (Right).
Press DISP key	Display mode showing time the drive has been powered up.	TIME FROM PWR UP 0000000.01.43	HR.MIN.SEC format.
Press DISP key	Display mode showing continuous amps; PK amps rating; amps/volt scale of feedback, power base ID.	X.XA X.X APK X.XX A/V ID:XXX	
Press DISP key	Display mode showing which Group1 or 2 expansion boards are installed.	G1 NOT INSTALLED G2 NOT INSTALLED	
Press DISP key	Display mode showing parameter table selected.	STOP TABLE LOCAL 0	
Press DISP key	Display mode showing software version and revision installed in the control.	SOFTWARE VERSION XXX-X.XX	
Press DISP key	Displays exit choice.	PRESS ENTER FOR DIAGNOSTIC EXIT	Press ENTER to exit diagnostic information.

Display Mode Continued

Fault Log Access

When a fault condition occurs, motor operation stops and a fault code is displayed on the Keypad display. The control keeps a log of up to the last 31 faults. If more than 31 faults have occurred the oldest fault will be deleted from the fault log to make room for the newest fault. To access the fault log perform the following procedure:

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing motor speed.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode.
Press DISP key	Press DISP to scroll to the Fault Log entry point.	PRESS ENTER FOR FAULT LOG	Fault Log access screen.
Press ENTER key	Display first fault type and time fault occurred.	EXTERNAL TRIP 1: 0:00:30	1 = Most recent Fault. 2 = Next most recent fault. Etc.
Press ▲ key	Scroll through fault messages.	PRESS ENTER FOR FAULT LOG EXIT	If no messages, the fault log exit choice is displayed.
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode stop key LED is on.

Program Mode

The Program Mode is used to enter or change parameter values, enter or change motor data, and autotune the drive.

From the Display Mode press the PROG key to access the Program Mode.

Note: When a parameter is selected, alternately pressing the Disp and Prog keys will toggle between the Display Mode and the selected parameter. When a parameter is selected for programming, the keypad display provides the following information:

Parameter Status. All programmable parameters are displayed with a “P:” in the lower left corner of the keypad display. If a parameter is displayed with a “V:”, the parameter value may be viewed but not changed while control is enabled. If the parameter is displayed with an “L:”, the value is locked and the security access code must be entered before its’ value can be changed.

Parameter Blocks Access for Programming

Use the following procedure to access parameter blocks to program the control.

Action	Description	Display	Comments
Apply Power	Keypad Display shows this opening message.	BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	If no faults and programmed for LOCAL operation.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode.
	If no faults and programmed for REMOTE operation.	STOP MOTOR SPEED REMOTE 0 RPM	
	If fault is displayed, refer to the Troubleshooting section of this manual.		
Press PROG key		PRESS ENTER FOR PRESET SPEEDS	Press ENTER to access Preset Speed parameters.
Press ▲ or ▼ key	Scroll to the ACCEL/DECEL block.	PRESS ENTER FOR ACCEL/DECEL RATE	Press ENTER to access Accel and Decel rate parameters.
Press ▲ or ▼ key	Scroll to the Level 2 Block.	PRESS ENTER FOR LEVEL 2 BLOCKS	Press ENTER to access Level 2 Blocks.
Press ENTER key	First Level 2 block display.	PRESS ENTER FOR OUTPUT LIMITS	
Press ▲ or ▼ key	Scroll to Programming Exit menu.	PRESS ENTER FOR PROGRAMMING EXIT	Press ENTER to return to Display mode.
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	

Program Mode Continued

Changing Parameter Values when Security Code Not Used

Use the following procedure to program or change a parameter already programmed into the control when a security code is not being used.

The example shown changes the operating mode from Keypad to Bipolar.

Action	Description	Display	Comments
Apply Power	Keypad Display shows this opening message.	BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	If no faults and programmed for LOCAL operation.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode. Stop LED on.
Press PROG key	Access programming mode.	PRESS ENTER FOR PRESET SPEEDS	
Press ▲ or ▼ key	Scroll to Level 1 Input Block. Then press ENTER to access Input Block.	PRESS ENTER FOR INPUT	Press ENTER to access INPUT block parameter.
Press PROG key	Access Operating Mode.	OPERATING MODE P: KEYPAD	Keypad mode shown is the factory setting.
Press ▲ key	Scroll to make your selection.	OPERATING MODE ▲▽ BIPOLAR	At flashing cursor, select desired mode. Bipolar is shown.
Press ENTER or PROG	Save selection to memory.	OPERATING MODE P: BIPOLAR	
Press ▲ key	Scroll to menu exit.	PRESS ENTER FOR MENU EXIT	
Press ENTER key	Return to Input Block.	PRESS ENTER FOR INPUT	
Press DISP key	Return to Display Mode.	STOP MOTOR SPEED LOCAL 0 RPM	Typical display mode.

Program Mode Continued

Reset Parameters to Factory Settings

Sometimes it is necessary to restore the parameter values to the factory settings. Follow this procedure to do so.

Note: All specific application parameters already programmed will be lost when resetting the control to factory settings.

Action	Description	Display	Comments
Apply Power	Keypad Display shows this opening message.	BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	If no faults and programmed for LOCAL operation.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode. Stop LED on.
Press PROG key	Enter program mode.	PRESS ENTER FOR PRESET SPEEDS	
Press ▲ or ▼ key	Scroll to Level 2 Blocks.	PRESS ENTER FOR LEVEL 2 BLOCKS	
Press ENTER key	Select Level 2 Blocks.	PRESS ENTER FOR OUTPUT LIMITS	
Press ▲ or ▼ key	Scroll to the Miscellaneous block.	PRESS ENTER FOR MISCELLANEOUS	
Press ENTER key	Select Miscellaneous block.	RESTART AUTO/MAN P: MANUAL	
Press ▲ key	Scroll to Factory Settings parameter.	FACTORY SETTINGS P: NO	
Press ENTER key	Access Factory Settings parameter.	FACTORY SETTINGS ▲▼ □ NO	□ represents blinking cursor.
Press ▲ key	Scroll to YES, to choose original factory settings.	FACTORY SETTINGS ▲▼ □ YES	
Press ENTER key	Restores factory settings.	FACTORY SETTINGS P:LOADING PRESETS	"Loading Presets" is first message "Operation Done" is next "No" is displayed last.
Press ▲ key	Scroll to menu exit.	PRESS ENTER FOR MENU EXIT	
Press ▲ or ▼ key	Scroll to Programming exit.	PRESS ENTER FOR PROGRAMMING EXIT	Exit programming mode and return to display mode.
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode. Stop LED on.

Note: After factory settings are restored, the drive must be re-tuned.

Program Mode Continued

Initialize New Firmware

When new firmware is installed, the control must be initialized to the new firmware version and memory locations. Use the following procedure to Initialize the firmware.

Action	Description	Display	Comments
Apply Power	Keypad Display shows this opening message.	BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	If no faults and programmed for LOCAL operation.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode. Stop LED on.
Press PROG key	Enter program mode.	PRESS ENTER FOR PRESET SPEEDS	
Press ▲ or ▼ key	Scroll to Level 2 Blocks.	PRESS ENTER FOR LEVEL 2 BLOCKS	
Press ENTER key	Select Level 2 Blocks.	PRESS ENTER FOR OUTPUT LIMITS	
Press ▲ or ▼ key	Scroll to the Miscellaneous block.	PRESS ENTER FOR MISCELLANEOUS	
Press ENTER key	Select Miscellaneous block.	RESTART AUTO/MAN P: MANUAL	
Press ▲ key	Scroll to Factory Settings parameter.	FACTORY SETTINGS P: NO	
Press ENTER key	Access Factory Settings parameter.	FACTORY SETTINGS ▲▼ □ NO	□ represents blinking cursor.
Press ▲ key	Scroll to YES, to choose original factory settings.	FACTORY SETTINGS ▲▼ □ YES	
Press ENTER key	Restores factory settings.	FACTORY SETTINGS P:LOADING PRESETS	"Loading Presets" is first message "Operation Done" is next "No" is displayed last.
Press ▲ key	Scroll to menu exit.	PRESS ENTER FOR MENU EXIT	
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode. Stop LED on.
Press ▲ key	Scroll to diagnostic info block.	PRESS ENTER FOR DIAGNOSTIC INFO	
Press ENTER key	Access diagnostic information.	STOP SPEED REF LOCAL 0 RPM	Displays commanded speed, direction of rotation, Local/ Remote and motor speed.
Press DISP key	Display mode showing software version and revision installed in the control.	SOFTWARE VERSION XXX-X.XX	Verify new software version.
Press DISP key	Displays exit choice.	PRESS ENTER FOR DIAGNOSTIC EXIT	Press ENTER to exit diagnostic information.

Parameter Adjustments

To make programming easier, parameters have been arranged into the two level structure shown in Table 4-1. Press the PROG key to enter the programming mode. The first programming block to be displayed is “Preset Speeds”. Use the Up (▲) and Down (▼) arrows to scroll through the parameter blocks. Press ENTER to access parameters within a programing block.

Tables 4-2 and 4-3 provide an explanation of each parameter. A complete Parameter Block Values list is located at the end of this manual. This list defines the programmable range and factory preset value for each parameter. The list has a space to record your settings for future reference.

Table 4-1 List of Parameters

LEVEL 1 BLOCKS		LEVEL 2 BLOCKS	
Preset Speeds	**Input**	**Output Limits**	**Brake Adjust**
Preset Speed #1	Operating Mode	Min Output Speed	DC Brake Current
Preset Speed #2	Command Select	Max Output Speed	
Preset Speed #3	ANA CMD Inverse	PK Current Limit	
Preset Speed #4	ANA CMD Offset	PWM Frequency	**Process Control**
Preset Speed #5	ANA 2 Deadband	CUR Rate Limit	Process Feedback
Preset Speed #6	ANA 1 CUR Limit		Process Inverse
Preset Speed #7		**Custom Units**	Setpoint Source
Preset Speed #8	**Output**	Decimal Places	Setpoint Command
Preset Speed #9	Opto Output #1	Value at Speed	Set PT ADJ Limit
Preset Speed #10	Opto Output #2	Units of Measure	Process ERR TOL
Preset Speed #11	Opto Output #3		Process PROP Gain
Preset Speed #12	Opto Output #4	**Protection**	Process INT Gain
Preset Speed #13	Zero SPD Set PT	Overload	Process DIFF Gain
Preset Speed #14	At Speed Band	External Trip	Follow I:O Ratio
Preset Speed #15	Set Speed Point	Local Enable INP	Master Encoder
	Analog Out #1	Following Error	
Accel / Decel Rate	Analog Out #2	Torque Proving	**Communications**
Accel Time #1	Analog #1 Scale		Protocol
Decel Time #1	Analog #2 Scale	**Miscellaneous**	Baud Rate
S-Curve #1		Restart Auto/Man	Drive Address
Accel Time #2	**Vector Control**	Restart Fault/Hr	
Decel Time #2	Ctrl Base Speed	Restart Delay	**Synchro Start**
S-Curve #2	Current PROP Gain	Factory Settings	Sync Starts
	Speed PROP Gain		Sync Start Speed
Jog Settings	Speed INT Gain	**Security Control**	Sync Scan Time
Jog Speed	Slip Frequency	Security State	Sync Direction
Jog Accel Time	Stator R1	Access Timeout	
Jog Decel Time	Stator X1 @ 60Hz	Access Code	**Auto-Tuning**
Jog S-Curve Time			CALC Presets
		Motor Data	CMD Offset Trim
Keypad Setup		Motor Voltage	STATOR R1
Keypad Stop Key		Motor Rated Amps	CUR Loop Comp
Keypad Stop Mode		Motor Rated SPD	Flux CUR Setting
Keypad Run Fwd		Motor Rated Freq	
Keypad Run Rev		Motor Mag Amps	
Keypad Jog Fwd		CALC Presets	
Keypad Jog Rev			
Loc Hot Start			

Table 4-2 Level 1 Parameter Block Definitions

Block Title	Parameter	Description
PRESET SPEEDS	Preset Speeds #1 – #15	Allows selection of 15 predefined motor operating speeds. Each speed may be selected using external switches connected to J1B-11, J1B-12, J1B-13 and J1B-14. For motor operation, a motor direction command must be given along with a preset speed command.
ACCEL/DECEL RATE	Accel Time #1,2	Accel time is the number of seconds required for the motor to increase at a linear rate from 0 RPM to the RPM specified in the "Max Output Speed" parameter in the Level 2 Output Limits block. Example: Maximum Output Speed =1000 RPM; Preset Speed = 500 RPM, Accel Time=10 Sec. In this example, motor will be at 500 RPM 5 seconds after commanded because preset is half the max speed.
	Decel Time #1,2	Decel time is the number of seconds required for the motor to decrease at a linear rate from the speed specified in the "Max Output Speed" parameter to 0 RPM.
	S-Curve #1,2	S-Curve is a percentage of the total Accel or Decel time and provides smooth starts and stops. 0% represents no "S" and 100% represents full "S" with no linear segment. Figure 4-2 illustrates how motor acceleration is changed using a 40% S-Curve. Note: Accel #1, Decel #1 and S-Curve #1 are associated together. Likewise, Accel #2, Decel #2 and S-Curve #2 are associated together. These associations can be used to control any Preset Speed or external speed command (pot). Note: If faults (motor trips) occur during rapid Accel or Decel, selecting an S-curve may eliminate the faults without affecting the overall ramp time.
JOG SETTINGS	Jog Speed	Jog Speed is the programmed speed used during for jog. Jog can be initiated from the keypad or terminal strip. At the Keypad, press the JOG key then press and hold the FWD or REV key. At the terminal strip,close the JOG input then close the FWD or REV input (J1B-9 or J1B-10). The motor will run at jog speed until FWD or REV key is released or external command signal is removed. Jog speed can be less than the minimum speed parameter setting. Process Control mode operation is different. If the terminal strip Process Mode Enable input (J1B-13) is closed, pressing the Keypad JOG key (or closing J1B-14) will cause the drive to move in the Drive "Forward" direction (without pressing FWD or REV).
	Jog Accel Time	Jog Accel Time changes the slope of the Jog Accel ramp. It is the time in seconds, from zero speed to maximum speed.
	Jog Decel Time	Jog Decel Time changes the slope of the Jog Decel ramp. It is the time in seconds, from maximum speed to zero speed.
	Jog S-Curve	Jog S-Curve changes the S-Curve to a preset value for jog mode.

Figure 4-2 S-Curve Example

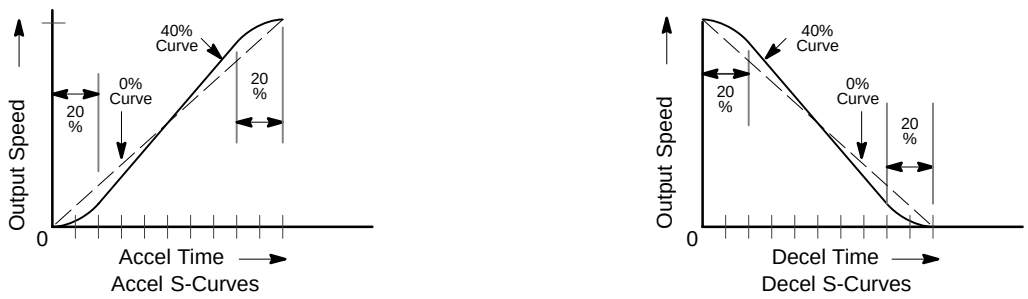


Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
KEYPAD SETUP	Keypad Stop Key	Selects keypad "STOP" key to initiate motor stop during remote operation (if Stop key is programmed to Remote ON). If active, pressing "STOP" automatically selects Local mode and initiates the stop command.
	Keypad Stop Mode	Causes the motor to "COAST" to a stop or "REGEN" to a stop. In COAST, the motor is turned off and allowed to coast to a stop. In REGEN, the voltage and frequency to the motor is reduced at a rate set by "Decel Time". Note: In REGEN mode, it is possible to cause an Overvoltage Trip if "REGEN" to stop decelerates the motor too quickly. If a fault occurs, increase the DECEL time.
	Keypad Run FWD	Makes the keypad "FWD" key active (ON) or inactive (OFF) in Local mode.
	Keypad Run REV	Makes the keypad "REV" key active (ON) or inactive (OFF) in Local mode.
	Keypad Jog FWD	Makes the keypad "FWD" key active (ON) or inactive (OFF) in Local Jog mode.
	Keypad Jog REV	Makes the keypad "REV" key active (ON) or inactive (OFF) in Local Jog mode.
INPUT	Operating Mode	Twelve "Operating Modes" are available. Choices are: Keypad, Standard Run, 15 Speed, 3SPD ANA 2 Wire, 3SPD ANA 3 Wire, Serial, Process Control, Bipolar, Fan Pump 2 Wire, Fan Pump 3 Wire, EPOT 2 Wire and EPOT 3 Wire. External connections to the control are made at the J1B terminal strip (wiring diagrams are shown in Section 3).
	Command Select	Selects the external speed reference to be used. The easiest method of speed control is to select POTENTIOMETER and connect a 5KΩ pot to J1A-1, J1A-2, and J1A-3. ±5 or ±10VDC input command can be applied to J1A-4 and J1A-5. 4 TO 20mA, if long distance is required between the external speed control and the control, the 4-20mA selections at J1A-4 and J1A-5 should be considered. Current loop allows long cable lengths without attenuation of the command signal. 10 VOLT W/TORQ FF - when a differential command is present at J1A-4 and 5, allows additional torque feedforward input at J1A-1, 2 and 3 to set a predetermined amount of torque inside the rate loop with high gain settings. EXB PULSE FOL - selects optional Master Pulse Reference/Isolated Pulse Follower expansion board if installed. 5VOLT EXB - selects optional High Resolution I/O expansion board if installed. 10VOLT EXB - selects optional High Resolution I/O expansion board if installed. 3-15 PSI EXB selects optional 3-15 PSI expansion board if installed. Tachometer EXB- selects optional DC Tachometer expansion board if installed. Serial -selects optional Serial Communications expansion board if installed. Note: When using the 4-20mA input, the JP1 jumper on the main control board must be moved to pins 2 and 3. NONE - Used in the process control two input configuration with no feedforward input.
	ANA CMD Inverse	"OFF" will cause a low input voltage (e.g. 0VDC) to be a low motor speed command and a maximum input voltage (e.g. 10VDC) to be a maximum motor speed command. "ON" will cause a low input voltage (e.g. 0VDC) to be a maximum motor speed command and a maximum input voltage (e.g. 10VDC) to be a low motor speed command.
	ANA CMD Offset	Provides an offset to the Analog Input to minimize signal drift. For example, if the minimum speed signal is 1VDC (instead of 0VDC) the ANA CMD Offset can be set to -10% so the minimum voltage input is seen by control as 0VDC. May be adjusted by Level 2 Autotune block, Command Offset Trim test.
	ANA 2 Deadband	Allows a defined range of voltage to be a deadband. A command signal within this range will not affect the control output. The deadband value is the voltage above and below the zero command signal level.
	ANA 1 CUR Limit	Allows the 5V input at J1A-2 (referenced to J1A-1) to be used for reduction of the programmed current limit parameter for torque trimming during operation.

Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
OUTPUT	OPTO OUTPUT #1 – #4	Four optically isolated digital outputs that have two operating states, logical High or Low. Each output may be configured to any of the following conditions: **Condition** — **Description** Ready - Active when power is applied and no faults are present. Zero Speed - Active when output speed is below the programmed value of the "Zero SPD Set Pt" Level 1 Output parameter. At Speed - Active when output speed is within the speed range defined by the "At Speed Band" Level 1 Output parameter. At Set Speed - Active when output speed is at or above the "Set Speed Point" Level 1 Output parameter. Overload - A normally closed contact that is active (opens) during an Overload fault caused by a time out when output current is greater than Rated Current. Keypad Control - Active when control is in Local keypad control. Fault - Active when a fault condition is present. Following ERR - Active when the motor speed is outside the user specified tolerance band defined by the AT Speed Band parameter. Drive On - Active when control is "Ready" (has reached excitation level and capable of producing torque). CMD Direction - Active when Forward or Reverse is enabled. Logical output state indicates Forward or Reverse direction. Over Temp Warn - Active when control heatsink temperature is within 3°C of the INT. Overtemp value. Process Error - Active when the process feedback signal is outside the process error tolerance (PROC ERR TOL) parameter value. Turns off when process feedback error is within tolerance. Drive Run - Active when drive is Ready, Enabled, Speed or Torque command is received and FWD or REV command is issued. Serial - Active when drive is in Serial mode.
	Zero SPD Set PT	Sets the RPM at which the Zero Speed opto output becomes active (turns on). When the speed is less than the ZERO SPD SET PT, the Opto Output becomes active. This is useful when a motor brake is to interlock operation with a motor.
	At Speed Band	The At Speed Band serves two Opto Output Conditions and the Level 2 Protection block Following Error: Sets the speed range in RPM at which the At Speed opto output turns on and remains active within the range. Sets the Following Error Tolerance Band for the Level 1 OUTPUT, Opto Output condition Following ERR. The opto output is active if the motor speed is outside this band. Sets allowable following error speed band of the drive. This value is used by the Level 2 Protection block, Following Error parameter (if it is set to ON). If the drive speed falls out of this band, the Level 2 Protection block, Following Error parameter will shut down the drive (if it is set to ON).
	Set Speed Point	Sets the RPM at which the AT Set Speed opto output becomes active (turns on). When the speed is greater than the SET SPEED POINT, the Opto Output becomes active. This is useful when another machine must not start until the motor exceeds a predetermined speed.

Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
OUTPUT (Continued)	Analog Output #1 and #2	Two Linear Analog outputs may be configured to represent any of the following conditions: (note 0-10VDC or ±10VDC operation per condition) **Condition** — **Description** ABS Speed - Represents the absolute motor speed where 0VDC = 0 RPM and 10VDC = MAX RPM. ABS Torque - Represents the absolute value of torque where 10VDC = Torque at CURRENT LIMIT. Speed Command - Represents the absolute value of commanded speed where 0VDC=0 RPM and +10VDC = MAX RPM. PWM Voltage - Represents the amplitude of PWM voltage where 10VDC = MAX AC Voltage. Flux Current - 0-10VDC represents actual portion of total current used for excitation. 10VDC = Maximum flux current. CMD Flux CUR - 0-10VDC represents calculated portion of total current used for excitation. 10VDC = Maximum commanded flux current. Load Current - Represents actual portion of total current used to produce torque (CW and CCW torque). +10VDC=Maximum CW Torque, –10VDC= Maximum CCW Torque. CMD Load Current - 0-10VDC represents calculated portion of total current used to produce torque. 10VDC=Maximum commanded load current. Motor Current - Amplitude of continuous current including motor excitation current. 10V = rated Current. Load Component - Amplitude of load current not including the motor excitation current. 10V = rated current. Quad Voltage - 0-10VDC represents load controller output (quadrature voltage). Useful when diagnosing control problems. Direct Voltage - 0-10VDC represents flux controller output. Useful to troubleshoot control problems. AC Voltage - PWM control voltage which is proportional to AC line to line motor terminal voltage. 0VDC = Neg. Peak PWM voltage, 5V centered, 10VDC = Pos. Peak PWM voltage. At rated motor voltage, a full 0 to 10V sinusoidal waveform at or greater than the motor base frequency would be present. At half the motor base frequency, a 2.5V to 7.5V sinusoidal waveform would be present. The waveform is centered around 5V. Bus Voltage - Amplitude of control bus voltage, 10V = 1000VDC. Torque - Bipolar torque output. 0V = Max negative torque, 5V centered, 10V = Max Positive Torque. Power - Bipolar power output. 0V = negative rated peak power, 5V = Zero Power, 10V = Positive rated peak power. Velocity - Represents motor speed scaled to 0V = negative max RPM, 5V = Zero Speed, 10V = positive max RPM. Overload - $(\text{Accumulated current})^2 \times (\text{time})$, Overload indication occurs at 10V. PH 2 Current - Sampled AC phase 2 motor current. 0V = negative rated peak amps, 5V = zero amps, 10V = positive rated peak amps. PH 1 Current - Sampled AC phase 1 motor current. 0V = negative rated peak amps, 5V = zero amps, 10V = positive rated peak amps. Process FB. - ± 10VDC represents ±100% of Process Feedback signal. Setpoint CMD - ± 10VDC represents ±100% of Setpoint signal.
	Analog Scale #1 and #2	Scale factor for the Analog Output voltage. Useful to set the zero value or full scale range for external meters.

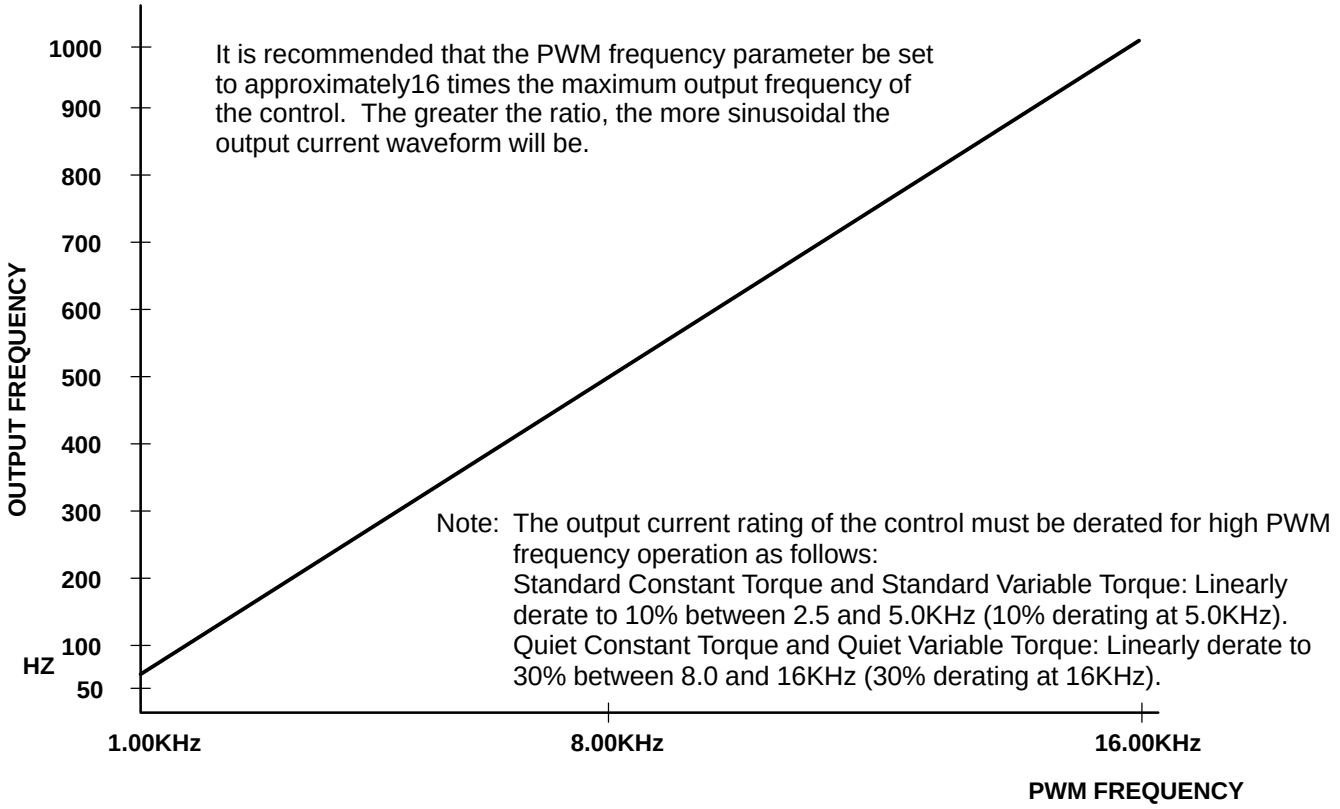
Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
Vector Control	CTRL BASE Speed	Sets the speed in RPM at which the saturation voltage of the control is reached. Above this RPM value the control will output constant voltage and variable frequency.
	Current PROP Gain	Sets the current loop proportional gain.
	Speed PROP Gain	Sets the speed (velocity) loop proportional gain.
	Speed INT Gain	Sets the speed (velocity) loop integral gain.
	Slip Frequency	Sets the rated slip frequency of the motor.
	Stator R1	Stator resistance in ohms. If set too high, the motor will tend to stall at zero speed when reversing or accelerating from low speed. Reducing this value will eliminate the problem. When too low, speed regulation may suffer.
	Stator X1	Stator leakage reactance, in ohms at 60Hz. This parameter has most impact when reversing motor rotation at full current limit. If set too low, the true decel time will tend to increase.
LEVEL 2 BLOCK		ENTERS LEVEL 2 MENU

Table 4-3 Level 2 Parameter Block Definitions

Block Title	Parameter	Description
OUTPUT LIMITS	MIN Output Speed	Sets the minimum motor speed in RPM. During operation, the motor speed will not be allowed to go below this value except for motor starts from 0 RPM or during a stop.
	MAX Output Speed	Sets the maximum motor speed in RPM.
	PK Current Limit	The maximum output peak current to the motor. Values above 100% of the rated current are available depending upon the operating zone selected.
	PWM Frequency	The frequency that the output transistors are switched. PWM frequency is also referred to as “Carrier” frequency. PWM should be as low as possible to minimize stress on the output transistors and motor windings. It is recommended that the PWM frequency be set to approximately 15 times the maximum output frequency of the control. Ratios less than 15 will result in non-Sinusoidal current waveforms. See Figure 4-3.
	Current Rate Limit	Limits the rate of torque change in response to a torque command.
CUSTOM UNITS	Decimal Places	The number of decimal places of the output rate display on the Keypad display. This value will be automatically reduced for large values. The output rate display is only available if the Value At Speed parameter is non zero.
	Value At Speed	Sets the desired output rate per RPM of motor speed. Two numbers are displayed on the keypad display (separated by a slash “/”). The first number (left most) is the value you want the keypad to display at a specific motor speed. The second number (right most) is the motor RPM corresponding to the units in the first number. A decimal may be inserted into the left numbers by placing the flashing cursor over the up/down arrow and using the arrow keys.
	Units of Measure	Allows user specified units of measure to be displayed on the Keypad display. Use the shift and arrow keys to scroll to the first and successive characters. If the character you want is not displayed, move the flashing cursor over the special up/down character arrow on the left side of the display. Use the up/down arrows and the shift key to scroll through all 9 character sets. Use the ENTER key to save your selection.
PROTECTION	Overload	Sets the protection mode to Fault (trip off during overload condition) or to Foldback (automatically reduce the output current below the continuous output level) during an overload. Foldback is the choice if continuous operation is desired. Fault will require the control be “Reset” manually or automatically after an overload.
	External Trip	OFF - External Trip is Disabled. ON - When a normally closed contact at J1B-16 is opened will cause an External Trip fault and will cause the drive to shut down.
	Local INP Enable	OFF - Local enable input is Disabled. (Control is enabled without J1B-8 connection). ON - When a contact at J1B-8 is closed (to J1B-17 common), the control is enabled.
	Following Error	This parameter determines if the control is to monitor the amount of following error that occurs in an application. Following Error is the programmable tolerance for the AT Speed Opto output. Operation outside the tolerance range will cause a fault and the drive will shut down.
	Torque Proving	When this parameter is set to ON the control measures output current in all three phases to the motor. If output current is unbalanced, the control will trip off generating a torque proving fault. In a hoist application, for example, this is useful to ensure that motor torque exists before the fail safe brake is released. “Drive On” output, if programmed, will not occur if torque proving fails.

Figure 4-3 Maximum Output Frequency vs PWM Frequency



⚠ **Caution: If an automatic restart of the motor control could cause injury to personnel, the automatic restart feature should be disabled by changing the Level 2 Miscellaneous block, Restart Auto/Man parameter to manual.**

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
MISCELLANEOUS	Restart Auto/Man	Manual - If a fault occurs, the control must be manually reset to resume operation. Automatic - If a fault occurs, the control will automatically reset to resume operation.
	Restart Fault/Hr	The maximum number of automatic restart attempts before requiring a manual restart. After one hour without reaching the maximum number of faults or if power is turned off and on again, the fault count is reset to zero.
	Restart Delay	The amount of time allowed after a fault condition for an automatic restart to occur. Useful to allow sufficient time to clear a fault before restart is attempted.
	Factory Settings	Restores factory settings for all parameter values. Select YES and press “ENTER” key to restore factory parameter values. The keypad Display will show “Operation Done” then return to “NO” when completed. Note: When factory settings are reset, the Motor Rated Amps value is reset to 999.9 amps. This Level 2 Motor Data block parameter value must be changed to the correct value (located on the motor rating plate) before attempting to start the drive.

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
SECURITY CONTROL	Security State	Off - No security Access Code required to change parameter values. Local - Requires security Access Code to be entered (using the keypad) before parameter changes can be made using the Keypad. Total - Requires security Access Code to be entered (using Keypad) before parameter changes can be made using the Keypad. Note: If security is set to Local, Serial or Total you can press PROG and scroll through the parameter values and view their values but you are not allowed to change their values unless you enter the correct access code.
	Access Timeout	The time in seconds the security access remains enabled after leaving the programming mode. If you exit and go back into the program mode within this time limit, the security Access Code does not have to be re-entered. This timer starts when leaving the program mode (by pressing DISP). Only active with Local Security. Note: This feature is not available if power is cycled or when using the Serial Operating mode.
	Access Code	A 4 digit number code. Only persons that know the code can change secured parameter values. When changing the code, the new number will not be displayed. Note: Please record your access code and store it in a safe place. If you cannot gain entry into parameter values to change a protected parameter, please contact your local Baldor office. Be prepared to give the 5 digit code shown on the lower right side of the Keypad Display at the Security Control Access Code parameter prompt.
MOTOR DATA	Motor Voltage	The rated voltage of the motor (listed on the motor nameplate).
	Motor Rated Amps	The full load current of the motor (listed on the motor nameplate). If the motor current exceeds this value for a period of time, an Overload fault will occur.
	Motor Rated SPD	The rated speed of the motor (listed on the motor nameplate).
	Motor Rated Freq	The rated frequency of the motor (listed on the motor nameplate).
	Motor Mag Amps	The motor magnetizing current value (listed on the motor nameplate). Also called no load current. Measure using a clamp on amp meter at the AC power line while the motor is running at line frequency with no load connected to the motor shaft.
	CALC Presets	Loads operating values into memory. These values are based on information programmed into the Level 2 Output Limits and Motor Data parameter values. CALC Presets must be run before Autotuning or manually tuning the drive.
BRAKE ADJUST	DC Brake Current	The amount of DC injection brake current. 0% = Flux current, 100% = Motor rated current.

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
PROCESS CONTROL	Process Feedback	Sets the type of signal used for the process feedback signal.
	Process Inverse	Causes the process feedback signal to be inverted. Used with reverse acting processes that use a unipolar signal such as 4-20mA. If “ON”, 20mA will decrease motor speed and 4mA will increase motor speed.
	Setpoint Source	Sets the source input signal to which the process feedback will be compared. If “Setpoint CMD” is selected, the fixed value of the set point is entered in the Setpoint Command parameter value.
	Setpoint Command	Sets the value of the setpoint the control will try to maintain by adjusting motor speed. This is only used when the Setpoint Source is a fixed value “Setpoint CMD” under Setpoint Source.
	Set PT ADJ Limit	Sets the maximum speed correction value to be applied to the motor (in response to the maximum feedback setpoint error). For example, if the max motor speed is 1750 RPM, the setpoint feedback error is 100% and the setpoint adjustment limit is 10%, the maximum speed the motor will run in response to the setpoint feedback error is ±175 RPM.
	Process ERR TOL	Sets the width of the comparison band (% of setpoint) with which the process input is compared. The result is that if the process input is within the comparison band the corresponding Opto Output will become active.
	Process PROP Gain	Sets the PID loop proportional gain. This determines how much adjustment to motor speed or torque (within the Set PT ADJ Limit) is made to reduce process error.
	Process INT Gain	Sets the PID loop Integral gain. This determines how quickly the motor speed or torque is adjusted to correct long term error.
	Process DIFF Gain	Sets the PID loop differential gain. This determines how much adjustment to motor speed or torque (within the Set PT ADJ Limit) is made for transient error.
	Follow I:O Ratio	Sets the ratio of the Master to the Follower in Master/Follower configurations. Requires the Master Pulse Reference/ Isolated Pulse Follower expansion board. For example, the master encoder you want to follow is a 1024 count encoder. The follower motor you wish to control also has a 1024 count encoder on it. If you wish the follower to run twice the speed of the master, a 1:2 ratio is entered. Fractional ratios such as 0.5:1 are entered as 1:2. Ratio limits are (1-65,535) : (1-20). Note: The Master Encoder parameter must be defined if a value is entered in the Follow I:O Ratio parameter.
	Follow I:O Out	This parameter is used only when Serial Communications is used to operate the control. A Master Pulse Reference/ Isolated Pulse Follower expansion board is required. This parameter represents the FOLLOWER portion of the ratio. The MASTER portion of the ratio is set in the Follow I:O Ratio parameter.
	Master Encoder	Only used if an optional Master Pulse Reference/Isolated Pulse Follower expansion board is installed and the Level 1 Input block, Command Select parameter is set to MPR/F EXB. Defines the number of pulses per revolution of the master encoder. Programmed into follower drives only.
COMMUNICATIONS	Protocol	Sets the type of communication the control is to use, RS-232 or RS-485 ASCII (text) protocol.
	Baud Rate	Sets the speed at which communication is to occur.
	Drive Address	Sets the address of the control for communication.

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
SYNCHRO STARTS	Synchro Starts	Used when the motor shaft is rotating at the time the inverter applies power to the motor. If set to Restarts Only, allows Synchro Starts after a fault condition is reset. If set to All Starts, allows Synchro Starts at all fault resets as well as restarts after power failure or after a run command.
	Sync Start Speed	Allows the Synchro Start feature to begin scanning motor RPM at the selected motor RPM.
	Sync Scan Time	The time allowed for Synchro Start to scan and detect motor speed. Scanning begins at the Sync Start speed and decreases to 0 RPM. Generally, the shorter the Sync Scan Time the more likely a false Synchro Start will be detected. This value should be set high enough to eliminate false Synchro Starts.
	Sync Direction	Allows Synchro Starts in either or both motor rotational directions. If the application requires motor shaft rotation in one direction only, scanning in that direction only will minimize Sync Scan Time.
AUTO TUNING		The Auto Tune procedure is used to automatically measure and calculate certain parameter values. Occasionally, the Auto Tune procedure cannot be run due to various circumstances such as the load cannot be uncoupled from the motor. The control can be manually tuned by entering the parameter values based on calculations you have made. Refer to “Manually Tuning the Control” in the Troubleshooting section of this manual.
	CALC Presets	Loads operating values into memory. These values are based on information programmed into the Level 2 Output Limits and Motor Data parameter values. CALC Presets must be run before Autotuning or manually tuning the drive.
	CMD Offset Trim	This procedure trims out voltage offsets for the differential analog input at J1A-4 and J1A-5.
	Stator R Test	Measures motor stator resistance.
	Flux CUR Setting	Sets motor magnetizing current by running motor at near rated speed.
LEVEL 1 BLOCK		ENTERS LEVEL 1 MENU

Section 5
Troubleshooting

Overview

The Baldor Series 24M Control requires very little maintenance and should provide years of trouble free operation when installed and applied correctly. Occasional visual inspection should be considered to insure tight wiring connections and to avoid the build up of any dust, dirt, or foreign debris which can reduce heat dissipation.

Before attempting to service this equipment, all input power should be removed from the control to avoid the possibility of electrical shock. The servicing of this equipment should be handled by a qualified electrical service technician experienced in the area of high power electronics.

It is important to familiarize yourself with the following information before attempting any troubleshooting or service of the control. Most troubleshooting can be performed using only a digital voltmeter having an input impedance exceeding 1 megohm. In some cases, an oscilloscope with 5 MHZ minimum bandwidth may be useful. Before consulting the factory, check that all power and control wiring is correct and installed per the recommendations given in this manual.

PSM Troubleshooting Procedure

Troubleshooting the Power Supply Module (PSM) involves observing the status of the "Ready" LED, the "DB On" LED and the "Monitor" 7 segment display. Table 5-1 defines the indications provided by these devices.

The DB LED is on whenever Dynamic Brake power is dissipated into the the DB (Dynamic Brake) resistor.

Display Identification

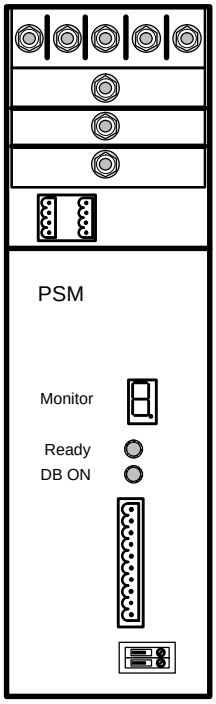


Table 5-1 Operating Mode Indications

Ready	Monitor	Status
OFF	OFF	Control disabled or powered off
Green	Decimal Point	Control enabled, normal operation, no faults
OFF	0	Phase loss
OFF	1	Source undervoltage
OFF	2	Bus undervoltage
OFF	3	Loss of source phase
OFF	4	Overtemperature
OFF	5	Dynamic brake fault
OFF	6	Source or bus overvoltage
Green	L	Softstart active

Ready LED

The 24M control has a "Ready" LED on the panel. If a PSM fault occurs, the Ready LED will be OFF for all controls connected to that PSM and those controls are disabled. Additional troubleshooting procedures are described on the following pages "Control Module Troubleshooting Procedure".

Control Module Troubleshooting Procedure

No Keypad Display - Display Contrast Adjustment

Control module faults are displayed on the keypad display (if plugged into the control module). If the keypad is plugged in, the control has AC power applied and characters are not displayed on the keypad display, adjust the display contrast using the procedure that follows.

Action	Description	Display	Comments
Apply Power	No visible display.	BLANK	
Press DISP key	Puts control in Display mode.	BLANK	Display mode with nothing visible (blank) or too dim to be read.
Press SHIFT key 2 times	Accesses display contrast adjustment.	ADJUST CONTRAST ▲▼[ENTER] TO SAVE	
Press ▲ or ▼ key	Adjusts display contrast (intensity).	ADJUST CONTRAST ▲▼[ENTER] TO SAVE	
Press ENTER key	Saves display contrast adjustment level and exits to display mode.	STOP FREQUENCY LOCAL 0.00 HZ	

Table 5-2 24M Fault Messages

FAULT MESSAGE	DESCRIPTION
Current Sens FLT	Defective phase current sensor or open circuit detected between control board and current sensor.
DC Bus High	Bus over voltage condition occurred.
DC Bus Low	Bus under voltage condition occurred.
External Trip	An external over temperature condition occurred or open circuit on J1B-16.
Following ERR	Excessive following error detected between command and feedback signals.
GND FLT	Low impedance path detected between an output phase and ground.
INT Over-Temp	Temperature of control heatsink exceeded safe level.
Invalid Base ID	Control board sensed a different power base since last power up.
Logic Supply FLT	Logic power supply not working properly.
Lost User Data	Battery backed RAM parameters have been lost or corrupted. When fault cleared (Reset), the control should reset to factory preset values.
Memory Error	Memory error occurred. Contact Baldor.
New Base ID	Control board sensed a different power base since last power up.
No Faults	Fault log is empty.
No EXB Installed	Programmed parameter requires an expansion board.
Over Current FLT	Instantaneous over current condition detected by bus current sensor.
Overload - 7 sec	Output current exceeded 7 second rating.
Overload - 1.5 sec	Output current exceeded 1.5 second rating.
Over speed	Motor RPM exceeded 110% of programmed MAX Motor Speed.
μP Reset	Power cycled before the residual Bus voltage reached 0VDC.
Power Module	Affects shared bus multi axis systems only. Indicates power supply failure.
PWR Base FLT	Desaturation of power device occurred or bus current threshold exceeded.
Torque Prove FLT	Unbalanced current between all 3 motor phases.
User Fault Text	Custom software operating fault occurred.
Co Processor FLT	Fault detected in the Co Processor function.

How to Access the Fault Log

When a fault condition occurs, motor operation stops and a fault code is displayed on the keypad display. The control keeps a log of up to the last 31 faults. If more than 31 faults have occurred the oldest fault will be deleted from the fault log to make room for the newest fault. To access the fault log use the following procedure:

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing output speed	STOP MOTOR SPEED LOCAL 0 RPM	Display mode.
Press DISP key 5 times	Use DISP key to scroll to the Fault Log entry point.	PRESS ENTER FOR FAULT LOG	
Press ENTER key	Display first fault type and time fault occurred.	EXTERNAL TRIP 1: 0:00:30	1 = Most recent fault. 2 = Next recent fault. Etc.
Press ▲ key	Scroll through fault messages.	PRESS ENTER FOR FAULT LOG EXIT	If no messages, the fault log exit choice is displayed.
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	

How to Clear the Fault Log Use the following procedure to clear the fault log and reset the internal clock.

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing output speed.	STOP MOTOR SPEED LOCAL 0 RPM	Display mode.
Press DISP key	Press DISP to scroll to the Fault Log entry point.	PRESS ENTER FOR FAULT LOG	
Press ENTER key	Displays most recent fault.	EXTERNAL TRIP 1: 00000:00:30	
Press SHIFT key		EXTERNAL TRIP 1: 00000:00:30	
Press RESET key		EXTERNAL TRIP 1: 00000:00:30	
Press SHIFT key		EXTERNAL TRIP 1: 00000:00:30	
Press ENTER key	Fault log is cleared.	FAULT LOG NO FAULTS	No faults in fault log and internal clock reset.
Press ▲ or ▼ key	Scroll Fault Log Exit.	PRESS ENTER FOR FAULT LOG EXIT	
Press ENTER key	Return to display mode.	STOP MOTOR SPEED LOCAL 0 RPM	

How to Access Diagnostic Information

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing speed in RPM.	STOP MOTOR SPEED LOCAL 0 RPM	No faults present. LOCAL keypad mode. If in remote/serial mode, disable drive and press local for this display.
Press DISP key	Display showing motor frequency.	STOP FREQUENCY LOCAL 0.00 HZ	
Press DISP key	Scroll to diagnostic info block.	PRESS ENTER FOR DIAGNOSTIC INFO	
Press ENTER key	Access diagnostic information.	STOP SPEED REF LOCAL 0 RPM	Displays commanded speed, direction of rotation, Local/ Remote.
Press DISP key	Display mode showing control temperature.	STOP CONTROL TEMP LOCAL 0.0° C	Displays operating temperature in degrees C.
Press DISP key	Display mode showing bus voltage.	STOP BUS VOLTAGE LOCAL 321V	
Press DISP key	Display mode showing % overload current remaining.	STOP OVRLD LEFT LOCAL 100.00%	
Press DISP key	Display mode showing opto inputs & outputs states. 0=Open, 1=Closed.	DIGITAL I/O 000000000 0000	Opto Inputs states (Left); Opto Outputs states (Right).
Press DISP key	Display mode showing actual drive running time.	TIME FROM PWR UP 0000000.01.43	HR.MIN.SEC format.
Press DISP key	Display mode showing continuous amps; PK amps rating; amps/volt scale of feedback, power base ID.	X.XA X.X APK X.XX A/V ID:XXX	
Press DISP key	Display mode showing which Group1 or 2 expansion boards are installed.	G1 NOT INSTALLED G2 NOT INSTALLED	
Press DISP key	Display mode showing parameter table selected.	STOP TABLE LOCAL 0	
Press DISP key	Display mode showing software version and revision installed in the control.	SOFTWARE VERSION XXX-X.XX	
Press DISP key	Displays exit choice.	PRESS ENTER FOR DIAGNOSTIC EXIT	Press ENTER to exit diagnostic information.

Table 5-3 Troubleshooting

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
No Display	Lack of input voltage.	Check input power for proper voltage. Verify fuses are good (or breaker is not tripped). Verify Bus voltage is correct.
	Loose connections.	Check input power termination. Verify connection of operator keypad.
	Adjust display contrast.	See Adjust Display Contrast.
Current Sense FLT	Open circuit between control board and current sensor.	Check connections between control board and current sensor.
	Defective current sensor.	Replace current sensor.
DC Bus High	Excessive dynamic braking DB power.	Increase the DECEL time. Add optional dynamic braking hardware.
	Dynamic brake wiring problem.	Check dynamic brake hardware wiring.
	Input voltage too high.	Verify proper AC line voltage. Use step down isolation transformer if needed. Use line reactor to minimize spikes.
	Too fast decel time	Increase Level 1 Accel/Decel Rate block, Decel time parameter value.
DC Bus Low	Input voltage too low.	Disconnect dynamic brake hardware and repeat operation. Verify proper AC line voltage. Use step up isolation transformer if needed. Check power line disturbances (sags caused by start up of other equipment). Monitor power line fluctuations with date and time imprint to isolate power problem.
External Trip	Motor ventilation insufficient.	Clean motor air intake and exhaust. Verify motor's internal fan is coupled securely. Check external blower for operation. Verify correct line power to external blower.
	Motor draws excessive current.	Check motor for overloading. Verify proper sizing of control and motor.
	No thermostat connected.	Connect thermostat. Verify connection of all external trip circuits used with thermostat. Disable thermostat input at J1B-16 (External Trip Input).
	Poor thermostat connections.	Check thermostat connections.
	External trip parameter incorrect.	Verify connection of external trip circuit at J1B-16. Set external trip parameter to "OFF" if no connection made at J1B-16.
Following ERR	Speed proportional gain set too low.	Following error tolerance band set too narrow. Increase Speed PROP Gain parameter value.
	Current limit set too low.	Increase Current Limit parameter value.
	ACCEL/DECEL time too short.	Increase ACCEL/DECEL parameter time
	Excessive load.	Verify proper sizing of control and motor.
GND FLT	Improper wiring. Wiring shorted in conduit. Motor winding shorted.	Disconnect wiring between control and motor. Retry test. If GND FLT is cleared, reconnect motor leads and retry the test. Rewire as necessary. Repair motor. If GND FLT remains, contact Baldor.

Table 5-3 Troubleshooting Continued

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
INT Over-Temp	Ambient temperature too high.	Check air flow path is clean and free of debris. Relocate control to cooler operating area. Add cooling fans or air conditioner to control cabinet.
	Drive Overloaded.	Correct motor loading. Verify proper sizing of control and motor.
Invalid Base ID	Control board does not recognize power base.	Press “RESET” key on keypad. If fault remains, access Diagnostic Info and compare the reported ID# with Table 5-4. If different, call Baldor.
Logic Supply FLT	PSM malfunctioned.	Check PSM for defect. Check input power to PSM.
Lost User Data	Battery backed memory failure.	Parameter data was erased. Disconnect power to control and apply power (cycle power). Enter all parameters. Cycle power. If problem persists, contact Baldor.
Memory Error	Firmware fault occurred.	Press “RESET” key on keypad. If fault remains, call Baldor.
µP Reset	Power was cycled before Bus voltage reached 0VDC.	Press “RESET” key on keypad. Disconnect power and allow at least 5 minutes for Bus capacitors to discharge before applying power. If fault remains, call Baldor.
Motor has wrong response to Speed Command	Analog input common mode voltage may be excessive.	Connect control input source common to control common to minimize common mode voltage. Maximum common mode voltage at terminals J1A-4 and J1A-5 is ±15VDC referenced to chassis common.
	Incorrect MIN or MAX speed settings.	Check Level 2 Output Limits block, MIN Output Speed and MAX Output Speed parameter values and adjust as needed.
	Analog offset trim is incorrectly set.	Re-run “Offset Trim” autotune test.
	Speed gain value is too large.	Reduce the Level 1 Vector Control block, Speed PROP Gain and Speed INT Gain parameter values.
Motor Will Not Start	Not enough starting torque.	Increase Current Limit setting.
	Motor overloaded.	Check for proper motor loading. Check couplings for binding. Verify proper sizing of control and motor.
	Motor may be commanded to run below minimum speed setting.	Increase speed command or reduce minimum speed setting.
	Incorrect Command Select parameter.	Change Command Select parameter to match wiring at J1A.
	Incorrect speed command.	Verify control is receiving proper command signal at J1A.
Motor Will Not Reach Maximum Speed	Max Output Speed set too low.	Adjust Level 2 Output Limits block, MAX Output Speed parameter value.
	Motor overloaded.	Check for mechanical overload. If unloaded motor shaft does not rotate freely, check motor bearings.
	Improper speed command.	Verify control is set to proper operating mode to receive speed command. Verify control is receiving proper command signal at input terminals. Check velocity loop gains.
	Speed potentiometer failure.	Replace potentiometer.
Motor Will Not Stop Rotation	MIN Output Speed parameter set too high.	Adjust MIN Output Speed parameter value.
	Improper speed command.	Verify control is receiving proper command signal at input terminals. Verify control is set to receive speed command.
	Speed potentiometer failure.	Replace potentiometer.
	Analog input common mode voltage may be excessive.	Connect control input source common to control common to minimize common mode voltage. Maximum common mode voltage at terminals J1A-4 and J1A-5 is ±15VDC referenced to chassis common.
	Analog offset trim set incorrectly.	Re-run “Offset Trim” autotune test. Adjust the Level 1 Input block, ANA CMD Offset parameter to obtain zero speed.

Table 5-3 Troubleshooting Continued

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
New Base ID	Software parameters are not initialized on newly installed control board.	Press “RESET” key on keypad to clear the fault condition. Reset parameter values to factory settings. Access diagnostics and compare power base ID number to list in Table 5-4 to ensure a match. Re-enter the Parameter Block Values you recorded in the User Settings at the end of this manual. Autotune the control.
No EXB Installed	Incorrect operating mode programmed.	Change Operating Mode in the Level 1 Input block to one that does not require the expansion board.
	Need expansion board.	Install the correct expansion board for selected operating mode.
Over Current FLT	Current Limit parameter set lower than drive rating.	Increase PK Current Limit parameter in the Level 2 Output Limits block, not to exceed drive rating.
	ACCEL/DECEL time too short.	Increase ACCEL/DEC parameters in the Level 1 ACCEL/DECEL Rate block.
	Electrical noise from external DC coils.	Install reverse biased diodes across all external DC relay coils as shown in the Opto Output circuit examples of this manual. See Electrical Noise Considerations in Section 5 of this manual.
	Electrical noise from external AC coils.	Install RC snubbers on all external AC coils. See Electrical Noise Considerations in Section 5 of this manual.
	Excessive load.	Reduce the motor load. Verify proper sizing of control and motor.
Overload - 1.5 Sec FLT	Peak output current exceeded 1.5 second rating.	Check PK Current Limit parameter in the Level 2 Output Limits block. Change Overload parameter In the Level 2 Protection block from Trip to Foldback. Increase ACCEL time. Reduce motor load. Verify proper sizing of control and motor.
Overload - 7 Sec FLT	Peak output current exceeded 7 second rating.	Verify proper motor data parameter values. Check PK Current Limit parameter in the Level 2 Output Limits block. Change Overload parameter In the Level 2 Protection block from Trip to Foldback. Increase ACCEL/DECEL times. Reduce motor load. Verify proper sizing of control and motor.
Over Speed	Motor exceeded 110% of MAX Speed parameter value.	Check the Level 2 Output Limits block, Max Output Speed. Increase the Level 1 Vector Control block, Speed PROP Gain.
Power Module	Power supply failure.	Press “RESET” key on keypad. If fault remains, call Baldor.
PWR Base FLT	Improper ground	Be sure the PSM has separate ground wire to earth ground. Panel grounding or conduit connections is not sufficient.
	Excessive current usage.	Disconnect motor leads from control and retry test. If fault remains, call Baldor.
	Electrical noise from external DC coils.	Install reverse biased diodes across all external DC relay coils as shown in the Opto Output circuit examples of this manual. See Electrical Noise Considerations in Section 5 of this manual.
	Electrical noise from external AC coils.	Install RC snubbers on all external AC coils. See Electrical Noise Considerations in Section 5 of this manual.
	Excessive load.	Correct motor load. Verify proper sizing of control and motor.
	Excessive power in dynamic brake circuit.	Increase decel time. Increase optional dynamic braking hardware capacity.
Torque Prove FLT	Unbalanced current in 3 motor phases.	Check continuity from control to motor windings and verify motor connections.
Unknown Fault	Fault occurred but cleared before its source could be identified.	Check AC line for high frequency noise. Check input switch connections and switching noise.
User Fault Text	Fault detected by custom software.	Refer to custom software fault list.

Table 5-4 Power Base ID

230 VAC Control Catalog Numbers	Power Base ID No.	460 VAC Control Catalog Numbers	Power Base ID No.
ZD24M2A05-P0	16	ZD24M4A02-P0	1E
ZD24M2A10-P0	17	ZD24M4A07-P0	20
ZD24M2A15-P0	18	ZD24M4A15-P0	21
ZD24M2A25-P0	19	ZD24M4A25-P0	26
ZD24M2A35-P0	1A	ZD24M4A35-P0	22
ZD24M2A45-P0	1B	ZD24M4A45-P0	23
ZD24M2A60-P0	1C	ZD24M4A60-P0	24
ZD24M2A90-P0	1D	ZD24M4A90-P0	25

Note: The Power Base ID number of a control is displayed in a Diagnostic Information screen.

Electrical Noise Considerations All electronic devices including the Series 24M control is vulnerable to significant electronic interference signals (commonly called “Electrical Noise”). At the lowest level, noise can cause intermittent operating errors or faults. From a circuit standpoint, 5 or 10 millivolts of noise may cause detrimental operation. For example, analog speed and torque inputs are often scaled at 5 to 10 VDC maximum with a typical resolution of one part in 1,000. Thus noise of only 5 mV represents a substantial error.

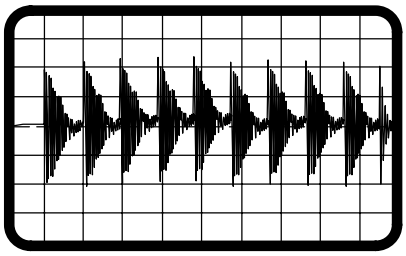
At the extreme level, significant noise can cause damage to the drive. Therefore, it is advisable to prevent noise generation and to follow wiring practices that prevent noise generated by other devices from reaching sensitive circuits. In a control, such circuits include inputs for speed, torque, control logic, and speed and position feedback, plus outputs to some indicators and computers.

Causes and Cures

Unwanted electrical noise can be produced by many sources. Depending upon the source, various methods can be used to reduce the effects of this noise and to reduce the coupling to sensitive circuits. All methods are less costly when designed into a system initially than if added after installation.

Figure 5-1 shows an oscilloscope trace of noise induced (as the coil circuit is opened) in a 1 ft. wire located next to a lead for a size 2 contactor coil. Scope input impedance is 10KΩ for all scope traces. Maximum peak voltage is over 40V. Unless well filtered this is often enough noise to ruin the output of a productive machine.

Figure 5-1 Electrical Noise Display

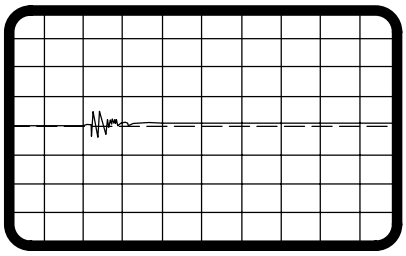


Relay and Contactor Coils

Among the most common sources of noise are the ever–present coils of contactors and relays. When these highly inductive coil circuits are opened, transient conditions often generate spikes of several hundred volts in the control circuit. These spikes can induce several volts of noise in an adjacent wire that runs parallel to a control–circuit wire.

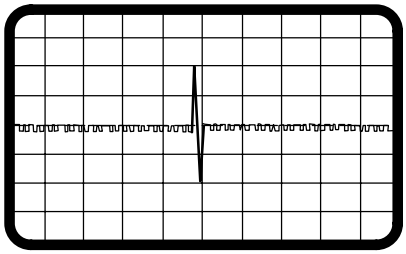
To suppress these noise generators, add an R–C snubber across each relay and contactor coil. A snubber consisting of a 33KΩ resistor in series with a 0.47μF capacitor usually works well. The snubber reduces the rate of rise and peak voltage in the coil when current flow is interrupted. This eliminates arcing and reduces the noise voltage induced in adjacent wires. In our example, the noise was reduced from over 40 V zero–to–peak (V0P) to about 16 V0P as shown in Figure 5-2.

Figure 5-2 R-C Snubber Circuit



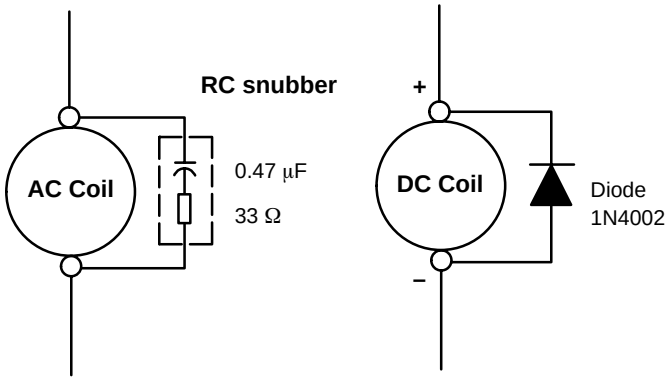
Combining an R-C snubber and twisted-pair shielded cable keeps the voltage in a circuit to less than 2 V for a fraction of a millisecond. The waveform shown in Figure 5-3 in addition to the snubber across the coil, the adjacent wire is grounded in a twisted–pair, shielded cable. Note that the vertical scale is 1 V/div., rather than the 20 V/div. in figures 5-1 and 5-2. This shows that snubbers and twisted-pair shielded wire should be used for sensitive circuits located adjacent to coil wires.

Figure 5-3 R-C Snubber Circuit & twisted-pair



A reverse biased diode across a DC coil achieves the same result as adding an R–C snubber across an AC coil, Figure 5-4.

Figure 5-4 AC and DC Coil Noise Suppression

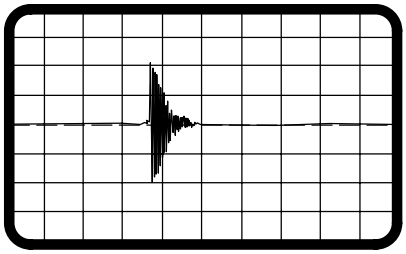


Electrical Noise Considerations Continued

Wires between Controls and Motors

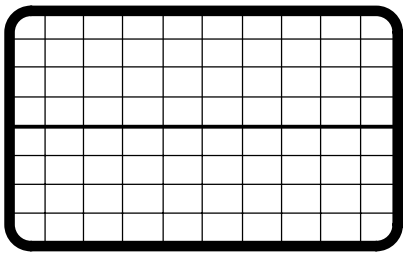
Output leads from a typical 460 VAC drive controller contain rapid voltage rises created by power semiconductors switching 650V in less than a microsecond, 1,000 to 10,000 times a second. These noise signals can couple into sensitive drive circuits as shown in Figure 5-5. For this waveform, a transient induced in 1 ft. of wire adjacent to motor lead of a 10 hp, 460 VAC drive. Scope is set at 5 V/div. and 2 µsec/div.

Figure 5-5 10HP, 460VAC Drive



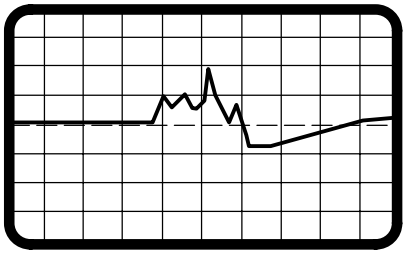
If the shielded pair cable is used, the coupling is reduced by nearly 90%, Figure 5-6.

Figure 5-6 10HP, 460VAC Drive, Shielded



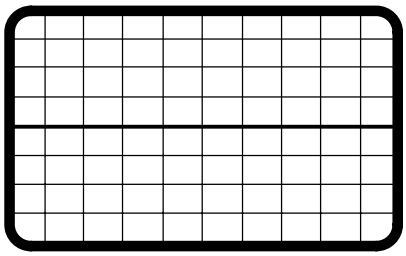
The motor leads of DC motors contain similar voltage transients. The switching rate is about 360 times a second. These noise transients can produce about 2V of noise induced in a wire adjacent to the motor lead. A 30HP, 500VDC Drive, as shown in Figure 5-7. Scope is set at 1 V/div. and 5 µsec/div.

Figure 5-7 30HP, 500VDC Drive



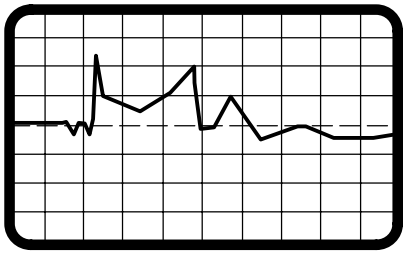
Again, Replacing a single wire with a shielded pair cable reduces the induced noise to less than 0.3 V, Figure 5-8.

Figure 5-8 30HP, 500VDC Drive, Shielded



Even input AC power lines contain noise and can induce noise in adjacent wires. This is especially severe with SCR controlled DC drives, current–source and six–step inverters. Figure 5-9 shows a transient induced in 1 ft. wire adjacent to AC input power wire to 20 hp, DC drive. Scope is set at 500 mV/div. and 2µsec/div.

Figure 5-9 30HP, 500VDC Drive, Shielded



To prevent induced transient noise in signal wires, all motor leads and AC power lines should be contained in rigid metal conduit, or flexible conduit. The conduit should be grounded to form a shield to contain the electrical noise within the conduit path. Signal wires - even ones in shielded cable should never be placed in the conduit with motor power wires.

If flexible conduit is required, the wires should be shielded twisted-pair. Although this practice gives better protection than unshielded wires, it lacks the protection offered by rigid metal conduit.

Special Drive Situations

For severe noise situations, it may be necessary to reduce transient voltages in the wires to the motor by adding load reactors. Load reactors are installed between the control and motor. These are often required where a motor housing lacks the necessary shielding (typically linear motors mounted directly to machine frames) or where the power wires to motors are contained in flexible cables.

Reactors are typically 3% reactance and are designed for the frequencies encountered in PWM drives. Manufactured by such companies as TCI (Milwaukee, WI) and MTE (Menomonee Falls, WI) these reactors also reduce ripple current in the motor windings and often improve motor life. For maximum benefit, the reactors should be mounted in the drive enclosure with short leads between the control and the reactors.

Drive Power Lines

The same type of reactor as installed on the load side of the control can also suppress transients on incoming power lines. Connected on the line side of the drive, the reactor protects the adjustable–speed drive from some transients generated by other equipment and suppresses some of the transients produced by the drive itself.

Radio Transmitters

Not a common cause of noise. Radio frequency transmitters, such as commercial broadcast stations, fixed short–wave stations, and mobile communications equipment (including walkie talkies) create electrical noise. The probability of this noise affecting an adjustable–speed drive increases with the use of open control enclosures, open wiring, and poor grounding.

Electrical Noise Considerations Continued

Control Enclosures The cure for some electrical noise may be a grounded metallic control enclosure. The enclosure should be grounded to the building ground with a short, heavy gauge wire. Also, the power conduit, motor lead conduit and signal wire conduit must be grounded to the enclosure. Sometimes paint and seals prevent electrical contact between conduit and the cabinet. Sometimes wire or straps are used to ensure good electrical grounding.

Special Motor Considerations Motor frames are also on the required grounding list. As with control enclosures, motors should be grounded directly to plant ground with as short a ground wire as possible. Here's why. Capacitive coupling within the motor windings produces transient voltages between the motor frame and ground. The severity of these voltages increases with the length of the ground wire. Installations with the motor and control mounted on a common frame, and with heavy ground wires less than 10 ft. long, rarely have a problem caused by these motor–generated transient voltages.

Wiring Practices

The type of wire used and how it is installed for specific applications makes the difference between obtaining reliable operation and creating additional problems.

Power Wiring Conductors carrying power to anything (motor, heater, brake coil, or lighting units, for example) should be contained in conductive conduit that is grounded at both ends. These power wires must be routed in conduit separately from signal and control wiring.

Control–logic Conductors Typically, operator's controls (push buttons and switches), relay contacts, limit switches, PLC I/O's, operator displays, and relay and contactor coils operate at 115VAC or 24VDC. Although these devices usually operate at low current levels, they contain switching noise caused by contact open/closure and solid–state switch operations. Therefore, these wires should be routed away from sensitive signal wires and contained within conduits or bundled away from open power and signal wires.

DC Tachometer Circuits Among the most sensitive circuits is the DC Tachometer. Reliability of a DC tachometer circuit is often improved by the following noise reduction techniques:

- Connect a 0.1 μF capacitor across the tachometer terminals to suppress AC noise.
- Use twisted-pair shielded wires with the shield grounded at the control end only. You should avoid grounding the shield to the tachometer case or conduit.
- Follow the practices for analog signal wiring.

Analog Signal Wires Analog signals generally originate from speed and torque controls, plus DC tachometers and process controllers. Reliability is often improved by the following noise reduction techniques:

- Use twisted-pair shielded wires with the shield grounded at the drive end only.
- Route analog signal wires away from power or control wires (all other wiring types).
- Cross power and control wires at right angles (90°) to minimize inductive noise coupling.

Optical Isolation

Isolating electrical circuits with some form of light transmission reduces the electrical noise that is transmitted from one part of a circuit to another. That is, an electrical signal is converted to a light signal that is transmitted to a light receiver. This converts the light back to an electrical signal that has less noise than the input. Two methods are commonly used; optical couplers and fiber optics.

Optical Couplers

The common term for optical couplers, opto couplers use a light transmitter and light receiver in the same unit to transmit data while electrically isolating two circuits. This isolation rejects some noise. The magnitude of noise rejection is usually specified by the "common mode rejection, dv/dt rating". Typically, low cost opto couplers have a common mode rejection of 100 to 500 V/μ sec, which is adequate for most control logic signals. High performance opto couplers with common mode ratings up to 5,000 V/μ sec are installed for the most severe noise environments.

Fiber Optics

Special plastic fiber stands transmit light over long as well as short distances. Because the fibers are immune to electromagnetic energy, the use of fiber optic bundles eliminate the problem of coupling noise into such circuits. These noise–free fiber optic cables can be run with power or motor conductors because noise cannot be inductively or capacitively coupled into the fiber optic stands.

Plant Ground

Connecting electrical equipment to a good ground is essential for safety and reliable operation. In many cases, what is perceived as a ground isn't. Result: equipment malfunctions or electrical shock hazard exists.

It may be necessary to retain the services of an electrical consultant, who is also a licensed professional engineer experienced in grounding practices to make the necessary measurements to establish if the plant ground is really grounded.

Section 6
Manually Tuning the Series 24M Control

Manually Tuning the Control In some applications the drive cannot be accurately auto-tuned. In these cases it is necessary to calculate the values needed to tune the drive and manually enter these calculated parameter values.

Motor Mag Amps Parameter This parameter is located in the Level 2, Motor Data Block. This parameter is normally entered using the nameplate data (motor no load amps) or auto–tuned. If no other data is available, set Motor Mag Amps parameter to about 40% of the motor rated current stated on the nameplate.

The following procedure should be used for setting the Motor Mag Amps parameter when the load cannot be uncoupled from the motor shaft:

1. Adjust the Motor Mag Amps Parameter to 40% of the motor nameplate full load current rating.
2. Give the controller a speed command input of 80% of the Base Speed on motor nameplate.
3. Select motor voltage on keypad display by pressing the DISP key until the motor voltage value is displayed.
4. Observe the motor voltage. Ideally, it should read 80% of motor nameplate voltage. By raising the Motor Mag Amps parameter value, the motor voltage will raise proportionally. Continuing to raise the Motor Mag Amps parameter value will eventually saturate the motor voltage. By lowering the Motor Mag Amps parameter value, the motor voltage will lower proportionally.
5. While the motor is running adjust the Motor Mag Amps parameter until the display indicates the proper voltage (80% of motor rated).

Slip Frequency Parameter This parameter is located in the Level 1, Vector Control Block. The slip frequency may be calculated from nameplate data or auto tuned.

$$F_{slip} = \text{Rated Freq} - \left[\frac{(\text{Rated RPM x Number of Motor Poles})}{120}\right] \text{ OR}$$

$$F_{slip} = \text{Rated Freq} - \left[\left(\frac{\text{Base Speed}}{\text{Sync Speed}}\right)(\text{Rated Freq})\right]$$

Current Prop Gain Parameter This parameter is located in the Level 1, Vector Control Block. The Current Prop Gain parameter is normally auto–tuned when motor inductance is not known. Where auto–tuning can't be used, the proper manual setting for the proportional gain can be calculated by:

$$\text{Current PROP Gain} = \frac{\left[740 \text{ x L x } (A/V)\right]}{\text{VAC}}$$

Where:

L = Line to neutral leakage inductance of the motor in mH
VAC = Nominal line Volts
A/V = The Amps/Volt scaling of the current feedback

Motor line to neutral leakage inductance can be obtained either from the motor manufacturer or by measuring the line–to–line inductance and dividing by two.

The A/V scaling for the controller can be found in the diagnostic information located in the DISPLAY MODE.

For most applications setting the Current Prop Gain parameter to a value of 60 will yield adequate performance.

Speed Prop Gain Parameter

The Speed Prop Gain parameter located in the Level 1 Vector Control Block is factory set to 10. This gain may be increased or decreased to suit the application. Increasing the Speed Prop Gain parameter will result in faster response, excessive proportional gain will cause overshoot and ringing. Decreasing the Speed Prop Gain parameter will cause slower response and decrease overshoot and ringing caused by excessive proportional gain.

Speed Int Gain Parameter

The Speed Int Gain parameter located in the Level 1 Vector Control Block is set to 3 Hz and may be set at any value from zero to 9.99 Hz. See also, PI Controller later in this section.

Setting the Speed Int Gain parameter to 0Hz removes integral compensation that results in a proportional rate loop. This selection is ideal for systems where overshoot must be avoided and substantial stiffness (ability of the controller to maintain commanded speed despite varying torque loads) isn't required.

Increasing values of the Speed Int Gain parameter increases the low frequency gain and stiffness of the controller, an excessive integral gain setting will cause overshoot for transient speed commands and may lead to oscillation. If the Speed Prop Gain parameter and the Speed Int Gain parameter are set too high, an overshoot condition can also occur.

To manually tune the control, the following procedure is used:

1. Set the speed Int Gain parameter = 0 (remove integral gain).
2. Increase the Speed Prop Gain parameter setting until adequate response to step speed commands is attained.
3. Increase the Speed Int Gain parameter setting to increase the stiffness of the drive, or ability to maintain speed with dynamic load changes.

Note: It is convenient to monitor speed step response with a strip chart recorder or storage oscilloscope connected to J1–6 or –7 with Level 1, Output Block Analog Out #1 or #2 set to ABS SPEED, 0 VDC = zero speed. See Section 3 for a discussion of analog outputs.

PI Controller

Both the current and rate control loops are of the Proportional plus Integral type. If “E” is defined to be the error signal,

E = Command – Feedback

then the PI controller operated on “E” as

Output = $(K_p * E) + (K_i \int E\, dt)$

where K_p is the proportional gain of the system and K_i is the integral gain of the system.

The transfer function (output /E) of the controller using 1/s (Laplace Operator) to denote the integral,

Output/E = $K_p + K_i / s = K_p (s + K_i/K_p) /s$.

The second equation shows that the ratio of K_i/K_p is a frequency in radians/sec. In the Baldor AC Vector Control, the integral gain has been redefined to be,

$K_I = (K_i / K_p) / (2\pi)$ Hz,

and the transfer function is,

Output/E = $K_p (s + 2\pi K_I) / s$.

This sets the integral gain as a frequency in Hz. As a rule of thumb, set this frequency about 1/10 of the bandwidth of the control loop.

The proportional gain sets the open loop gain of the system, the bandwidth (speed of response) of the system. If the system is excessively noisy, it is most likely due to the proportional gain being set too high.

Section 7
Specifications and Product Data

Identification

Vector Control ZD **24 M X A X X –P O**

Vector Drive

Series No.

Multi-Axis
(Separate Power Supply)

Input DC Power
(2=DC Rectified from 230VAC)
(4=DC Rectified from 460VAC)

A=Amps

Control Current Rating

Panel Mounting

No Internal DB Capability

Identification

Power Supply PS **M X A XXX – P R X**

Power Supply

Multi-Axis

Input AC Power
(2=230VAC)
(4=460VAC)

A=Amps

Power Supply Current Rating

Panel Mounting

External DB Resistor

Logic Input Power
1=115VAC
2=230VAC

Control Specifications and Ratings: (230VAC)

Description	Unit	05–P	10–P	15–P	25–P	35–P	45–P	60–P	90–P
Nominal Input Bus Voltage	VDC	320							
Input Logic & Fan Power	VDC	+24 (+20% –15%)							
	ADC	1.6							
Nominal Output Bus Voltage	VDC	320							
Nominal Bus Current **	A_{RMS}	5	10	15	25	35	45	60	90
Peak Output Bus Current (±10%); 1.5s ±.5s	A_{RMS}	10	20	30	50	70	90	120	180
Nominal Output Power	KW	1.1	2.2	3.4	5.7	7.9	10.2	13.7	20.5
Efficiency	%	>97							
Minimum Load Inductance	µH	200							
Nominal Switching Frequency **	KHz	8.0							
Mounting *	–	Panel or through wall							
Package Size		B	B	B	B	B	C	D	D
Weight	lb(Kg)	21(9.5)	21(9.5)	21(9.5)	21(9.5)	21(9.5)	26(11.8)	51(23.1)	51(23.1)
Operating Altitude	Ft(M)	To 3300ft (1000M). Above 3300 ft, derate 2% per 1000ft (300M).							
Operating Shock	G	1G							
Operating Vibration	G	0.5G (10-60Hz)							
Operating Temperature Range	°C	0 to 40°C. Derate output by 2% per °C above 45°C. (60°C Max.)							
Maximum Operating Temperature	°C	60°C Maximum with derating.							
Storage Temperature Range	°C	–25 to +70°C							

Control Specifications and Ratings: (460VAC)

Description	Unit	ZD24M 4AXX–X							
		02–P	07–P	15–P	25–P	35–P	45–P	60–P	90–P
Nominal Input Bus Voltage	VDC	650							
Input Logic & Fan Power	VDC	+24 (+20% –15%)							
	Size	B	B	B	B	B	C	D	D
	ADC	1.7	1.7	1.7	1.7	1.7	1.7	2.9	2.9
Nominal Output Bus Voltage	VDC	650							
Nominal Output Bus Current **	A_{RMS}	2	7	15	25	35	45	60	90
Peak Output Bus Current (±10%); 1.5s ±.5s	A_{RMS}	4	14	30	50	70	90	120	180
Nominal Output Power	KW	0.9	3.2	6.9	11.6	16.2	20.8	27.8	41.7
Efficiency	%	>97							
Minimum Load Inductance	µH	200							
Nominal Switching Frequency **	KHz	2.5							
Mounting *	–	Panel or through wall							
Package Size		B	B	B	B	C	D	D	D
Weight	lb(Kg)	21(9.5)	21(9.5)	21(9.5)	21(9.5)	26(11.8)	51(23.1)	51(23.1)	51(23.1)
Operating Altitude	Ft(M)	To 3300ft (1000M). Above 3300 ft, derate 2% per 1000ft (300M).							
Operating Shock	G	1G							
Operating Vibration	G	0.5G (10-60Hz)							
Operating Temperature Range	°C	0 to 40°C. Derate output by 2% per °C above 45°C. (60°C Max.)							
Maximum Operating Temperature	°C	60°C Maximum with derating.							
Storage Temperature Range	°C	–25 to +70°C							

All values at ambient temperature of 25°C unless otherwise stated.

***** Thru wall mounting is possible. Refer to mounting dimensions.

****** Nominal Bus Output Current rating from the 1–8KHz PWM switching frequency.
PWM switching frequency is adjustable to 16KHz. Above 8KHz, derate Bus Current at a linear rate to 30% reduction at 16KHz.

Power Supply Specifications:

Description	Unit	PSM2AXXX-X		PSM4AXXX-X		
		060-PR1	100-PR1	030-PR1	050-PR1	100-PR1
Input Bus Voltage – Nominal (Range)	VAC	230 (180-264; 60Hz 180-230; 50Hz)		460 (400-528; 60Hz 340-457; 50Hz)		
Input Frequency	Hz	50 / 60 ±5%				
Nominal Output Bus Voltage	VDC	320		650		
Nominal Output Bus Current	A_{RMS}	60	100	30	50	100
Peak Output Bus Current	A_{RMS}	120	200	60	100	200
Input Logic Voltage – Nominal (Range)	VAC	115 (+6% –10%; 60Hz only 1 phase)				
Input Logic Current – Nominal (Range) *	AMP	2.4A (@115)				
Output Logic	VDC	+24 (+20% – 15%)				
Output Logic	ADC	8.0				
Mounting	–	Panel or Thru Wall				
Package Size		B	B	B	B	D
Weight	lb(Kg)	33(15)	33(15)	33(15)	33(15)	63(28.6)

All values at 25°C unless otherwise stated.
***** Maximum surge current <100msec = 6A (230V); 12A (115V)

Description	Unit	PSM2AXXX-X		PSM4AXXX-X		
		060-PR2	100-PR2	030-PR2	050-PR2	100-PR2
Input Bus Voltage – Nominal (Range)	VAC	230 (180-264; 60Hz 180-230; 50Hz)		460 (400-528; 60Hz 340-457; 50Hz)		
Input Frequency	Hz	50 / 60 ±5%				
Nominal Output Bus Voltage	VDC	320		650		
Nominal Output Bus Current	A_{RMS}	60	100	30	50	100
Peak Output Bus Current	A_{RMS}	120	200	60	100	200
Input Logic Voltage – Nominal (Range)	VAC	230 (+6% –10%; 50/60Hz 1 phase)				
Input Logic Current – Nominal (Range) *	AMP	1.2A (@230)				
Maximum Input Surge Current (for 100ms)	A_{RMS}	6				
Output Logic	VDC	+24 (+20% – 15%)				
Output Logic	ADC	8.0				
Mounting	–	Panel or Through Wall				
Package Size		B	B	B	B	D
Weight	lb(Kg)	33(15)	33(15)	33(15)	33(15)	63(28.6)

All values at 25°C unless otherwise stated.
***** Maximum surge current<100msec = 6A (230V); 12A (115V)

Keypad Display:

Display	Backlit LCD Alphanumeric 2 Lines x 16 Characters
Keys	12 key membrane with tactile response
Functions	Output status monitoring Digital speed control Parameter setting and display Diagnostic display Fault log display Motor run and jog Local/Remote toggle
LED Indicators	Forward run command Reverse run command Stop command Jog active
Remote Mount	100 feet max from control

Control Signal Levels:

Description	Unit	ZD24M
Command Input	VDC	±10
Command Signal Resolution	bits	9 + sign
A/D Conversion Rate	μsec	476
Feedback System	–	Encoder
Feedback Resolution	ppr	1024 (Standard)
Buffered Encoder Output	ppr	1024

Differential Analog Input:

Description	Unit	ZD24M
Common Mode Rejection	db	40 db
Full Scale Range	VDC	±5VDC, ±10VDC, 4-20 mA
Resolution	bits	9 + sign
Update rate	sec	500μsec

Other Analog Input:

Description	Unit	ZD24M
Full Scale Range	VDC	0 - 10 VDC
Resolution	bits	9 + sign
Update Rate	msec	500μsec

Analog Outputs:

Description	Unit	ZD24M
Analog Outputs		2 Assignable
Full Scale Range	VDC	0-10 VDC or ±10VDC (depends on output condition selected)
Source Current	mA	1 mA maximum
Resolution	bits	8 bits
Update Rate	msec	2 msec

Digital Inputs:

Description	Unit	ZD24M
Opto-isolated Logic Inputs		9 Assignable
Rated Voltage	VDC	10 - 30 VDC (closed contacts std)
Input Impedance	KΩ	6.8 K Ohms
Leakage Current	μA	10 μA maximum
Update Rate	msec	16 msec

Digital Outputs:

Description	Unit	ZD24M
Opto-isolated Logic Outputs		4 Assignable
ON Current Sink	mA	60 mA Max
ON Voltage Drop	VDC	2 VDC Max
Update Rate	msec	31 msec

Diagnostic Indications:

Current Sense Fault	Regeneration (db) Overload
Ground Fault	Soft Start Fault
Instantaneous Over Current	Under Voltage
Invalid Power Base ID	Ready
Line Power Loss	Parameter Loss
Microprocessor Failure	Overload
Over temperature (Motor or Control)	Overvoltage
Over speed	Torque Proving
Following Error	Co-Processor

Note: All specifications are subject to change without notice.

Terminal Tightening Torque Specifications

Table 7-1 Tightening Torque Specifications – Controls

Control	Tightening Torque					
	U, V and W		GND		+VCC, –VCC, GND	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
Size B	20-27	2.3-3.0	35-46	4.0-5.0	35-46	4.0-5.0
Size C	20-27	2.3-3.0	35-46	4.0-5.0	35-46	4.0-5.0
Size D	22-27	2.5-3.0	22-27	2.5-3.0	52	6.0

Table 7-2 Tightening Torque Specifications – Power Supply Modules

PSM	Tightening Torque							
	GND		L1, L2, L3		R1, R2		+VCC, –VCC, GND	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
Size B	35-46	4.0-5.0	20-27	2.3-3.0	20-27	2.3-3.0	35-46	4.0-5.0
Size D	22-27	2.5-3.0	22-27	2.5-3.0	10.6-12.3	1.2-1.4	52	6.0

DB Resistor Selection

Mounting Information

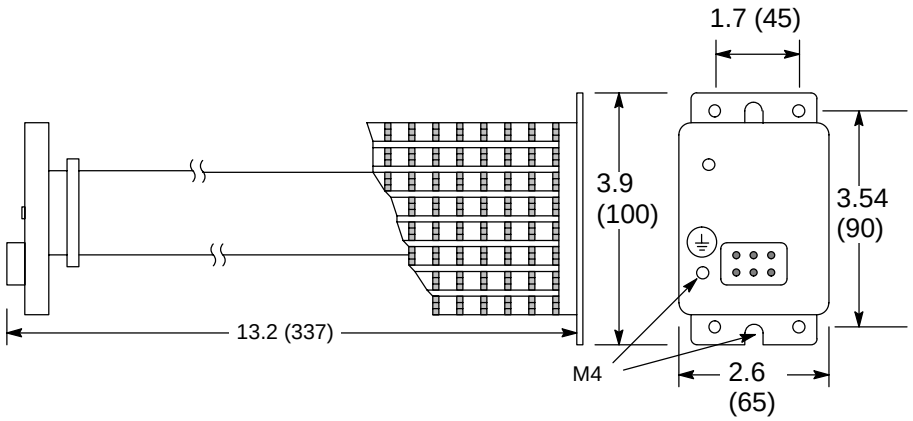


Table 7-3 DB Resistor

Power Supply Catalog No.	320 Continuous Watts			640 Continuous Watts			1200 Continuous Watts		
	Part No.	Max. Peak Watts	Peak Watts Max. Duty%	Part No.	Max. Peak Watts	Peak Watts Max. Duty%	Part No.	Max. Peak Watts	Peak Watts Max. Duty%
PSM2A060-PR2	RG6.8	15,050	2	RGA606*	17,000	3.5	RGA1210	10,240	11.7
PSM2A100-PR2	RG3.9	26,250	1.2	RG4.1	25,000	2.5	RGA1204	25,600	5.0
PSM2A060-PR1	RG6.8	15,050	2	RGA606*	17,000	3.5	RGA1210	10,240	11.7
PSM2A100-PR1	RG3.9	26,250	1.2	RG4.1	25,000	2.5	RGA1204	25,600	5.0
PSM4A030-PR2				RG23	18,000	3.5	RGA1224	17,600	6.8
PSM4A050-PR2				RG16	26,400	2.5	RGA1220	21,000	5.7
PSM4A100-PR2				RGA610*	42,250	1.4	RGA1210	42,250	2.8
PSM4A030-PR1				RG23	18,000	3.5	RGA1224	17,600	6.8
PSM4A050-PR1				RG16	26,400	2.5	RGA1220	21,000	5.7
PSM4A100-PR1				RGA610*	42,250	1.4	RGA1210	42,250	2.8

* 600 watt resistors.

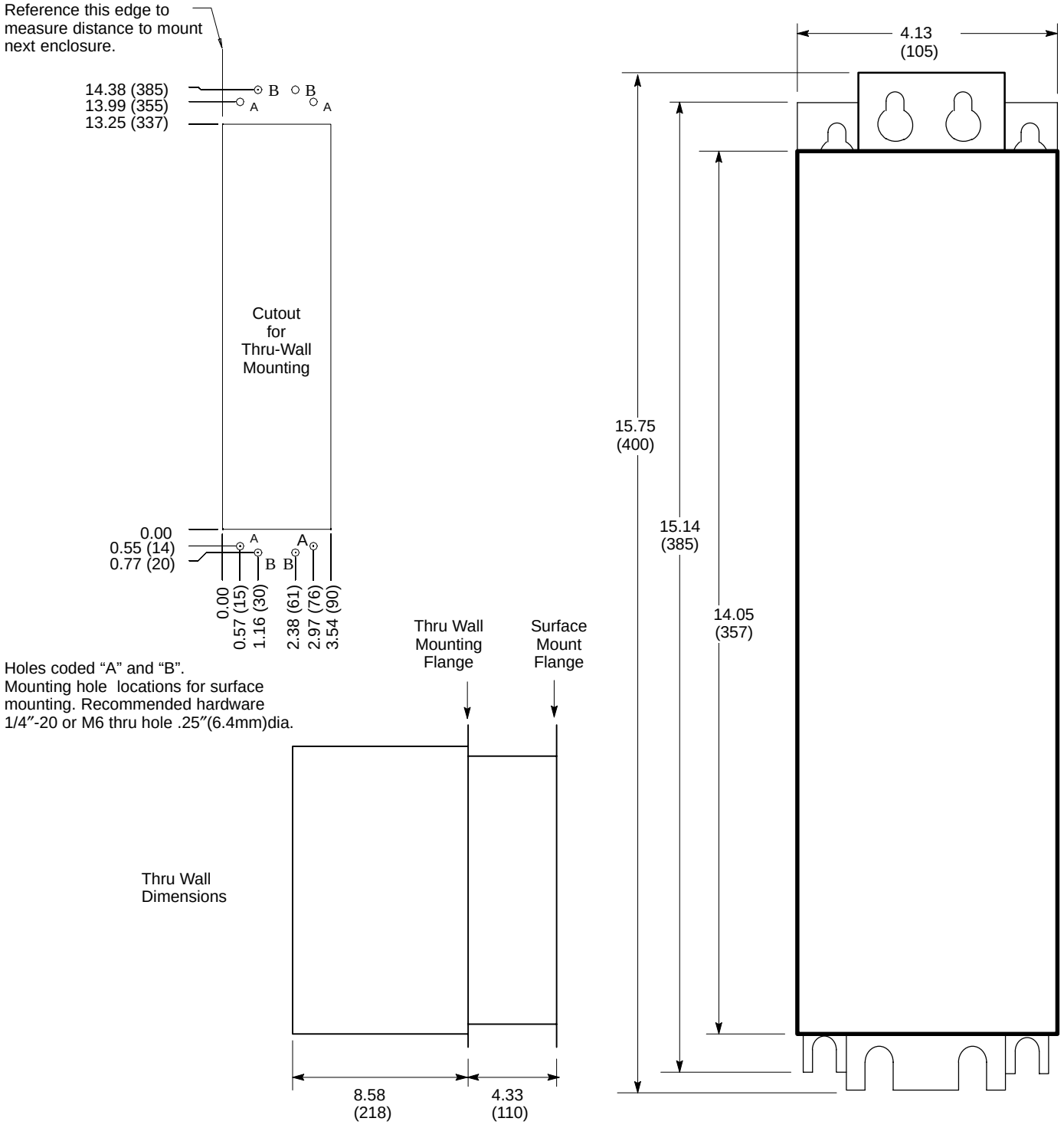
Not available.

Table 7-3 DB Resistor – Continued

Power Supply Catalog No.	2400 Continuous Watts			4800 Continuous Watts		
	Part No.	Max. Peak Watts	Peak Watts Max. Duty%	Part No.	Max. Peak Watts	Peak Watts Max. Duty%
PSM2A060-PR2	RGA2410	10,240	23.0	RGA4810	10,240	46.8
PSM2A100-PR2	RGA2404	25,600	9.3	RGA4804	25,600	18.7
PSM2A060-PR1	RGA2410	10,240	23.0	RGA4810	10,240	23.4
PSM2A100-PR1	RGA2404	25,600	9.3	RGA4804	25,600	18.7
PSM4A030-PR2	RGA2424	17,600	13.6	RGA4824	17,600	27.2
PSM4A050-PR2	RGA2420	21,000	11.4	RGA4820	21,000	22.8
PSM4A100-PR2	RGA2410	42,250	5.7	RGA4810	42,250	11.3
PSM4A030-PR1	RGA2424	17,600	13.6	RGA4824	17,600	27.2
PSM4A050-PR1	RGA2420	21,000	11.4	RGA4820	21,000	22.8
PSM4A100-PR1	RGA2410	42,250	5.7	RGA4810	42,250	11.3

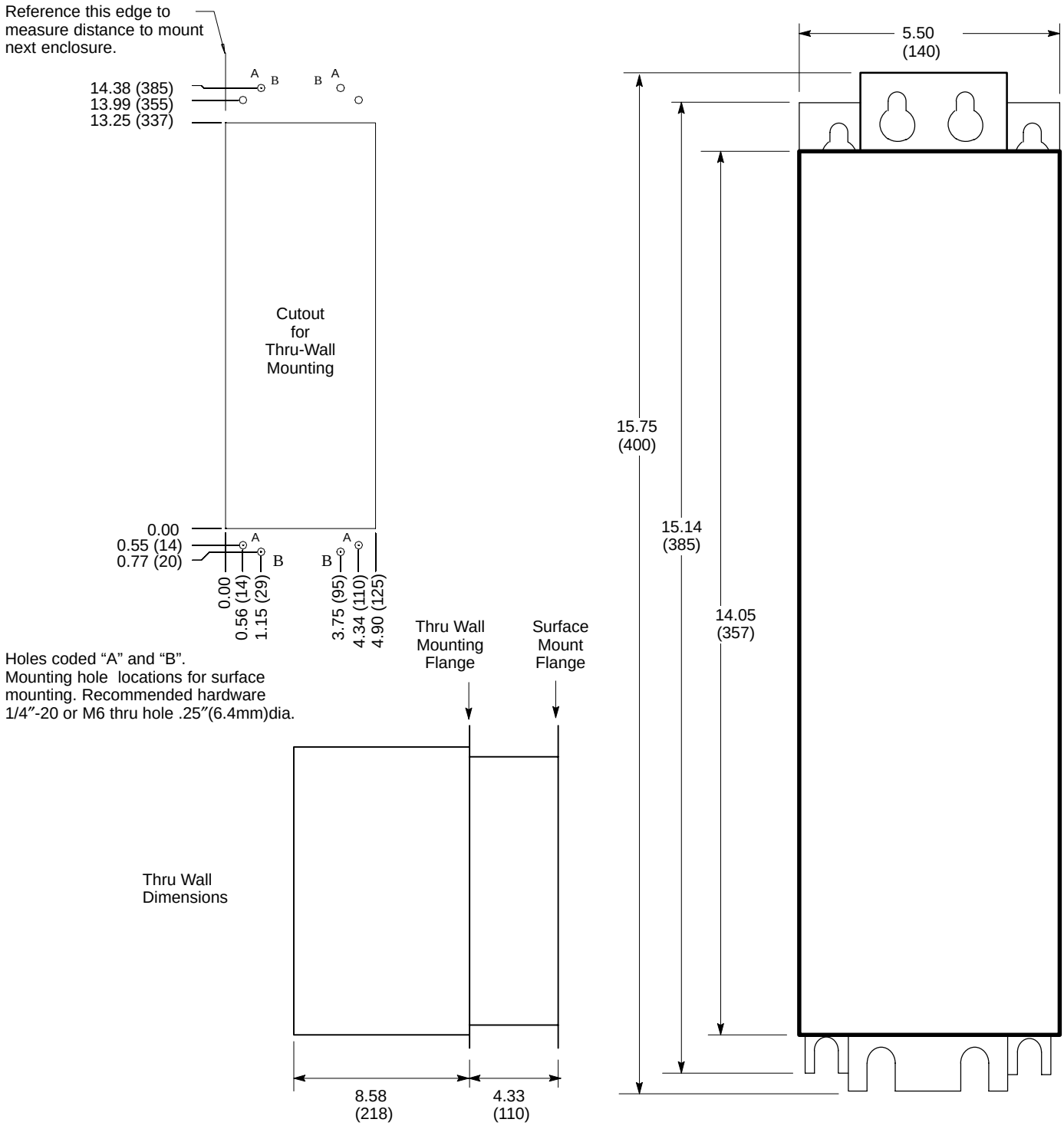
Dimensions

Size B Mounting



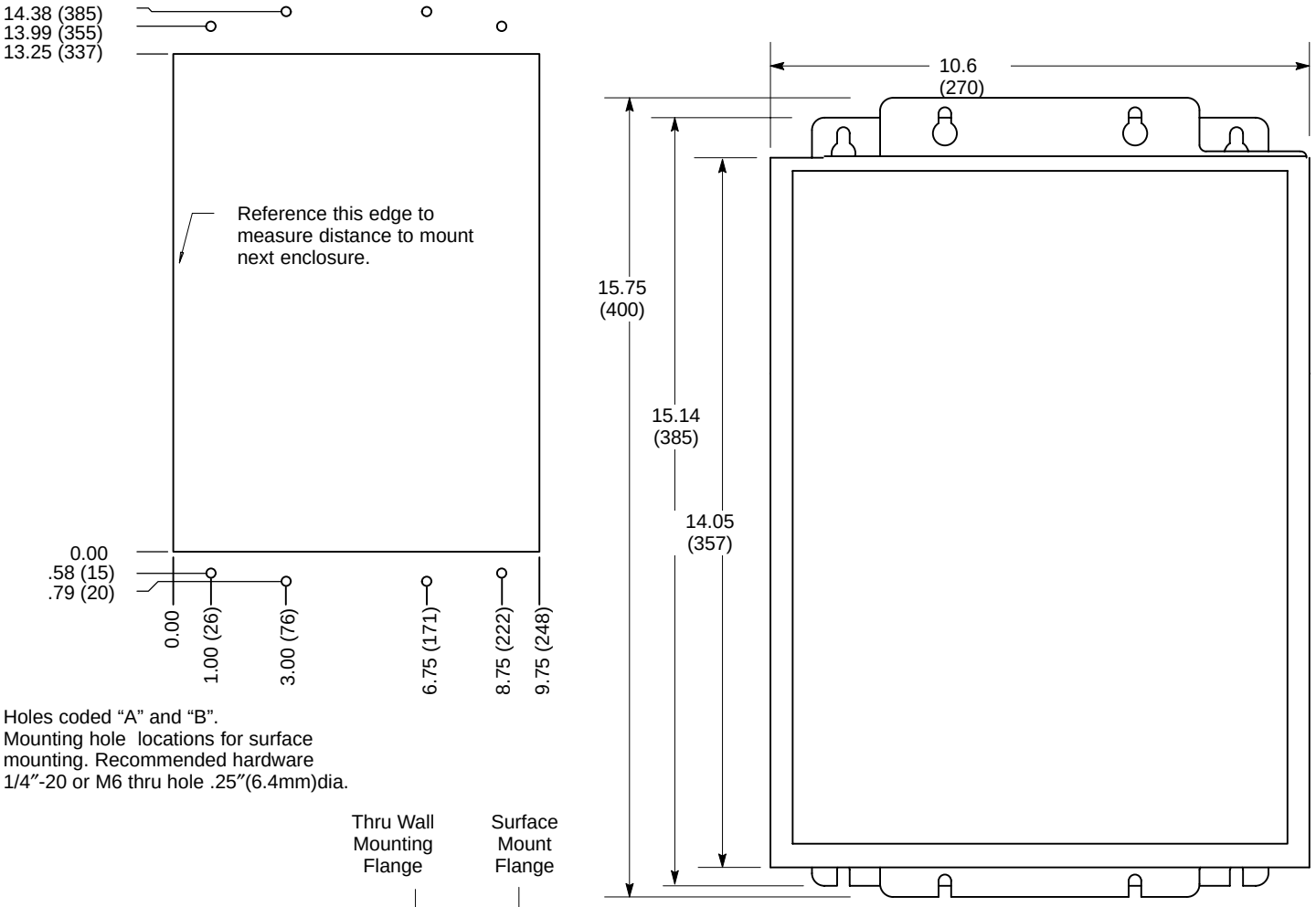
Dimensions Continued

Size C Mounting



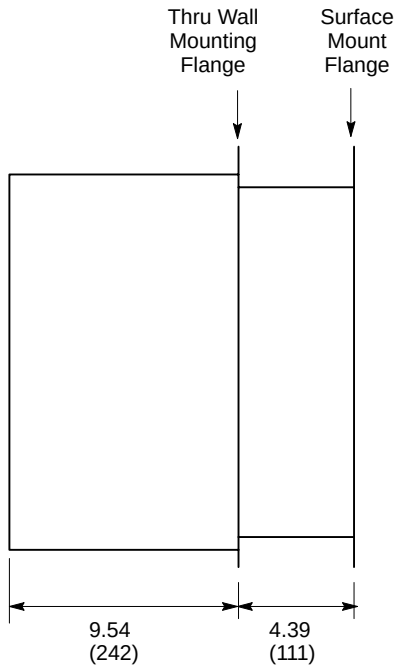
Dimensions Continued

Size D Mounting



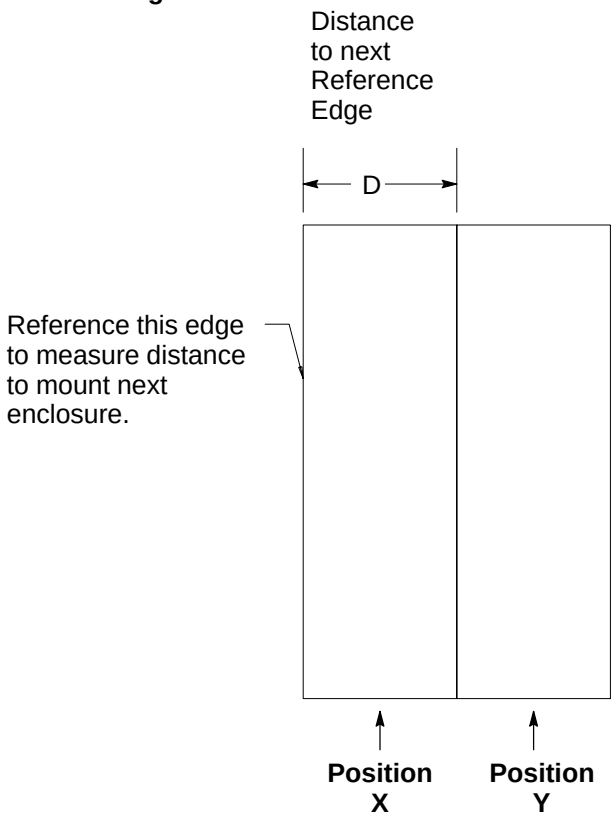
Holes coded “A” and “B”.
Mounting hole locations for surface mounting. Recommended hardware 1/4″-20 or M6 thru hole .25″(6.4mm)dia.

Thru Wall Dimensions



Dimensions Continued

Mounting Considerations



Note:
Always mount the PSM in the first position from left to right. This allows proper installation of the power bus bars.

Mounting and Bus Bar Information

Position X Size	Position Y Size	Distance to next reference edge "D"	Power Bus Bar Part Number
D	D	10.6 (270)	V1093641
D	C	10.5 (267)	V1093651
D	B	10.5 (267)	V1093651
C	C	5.5 (140)	V1093661
C	B	5.5 (140)	V1093661
B	D	4.3 (109)	V1093681
B	B	4.2 (106)	V1093671
B	C	4.2 (106)	V1093671

Appendix A

Parameter Values

Parameter Block Values Level 1

Level 1 Blocks					
Block Title	**Parameter**	P#	**Adjustable Range**	**Factory Setting**	**User Setting**
PRESET SPEEDS	PRESET SPEED #1	1001	0-MAX Speed	0 RPM	
	PRESET SPEED #2	1002	0-MAX Speed	0 RPM	
	PRESET SPEED #3	1003	0-MAX Speed	0 RPM	
	PRESET SPEED #4	1004	0-MAX Speed	0 RPM	
	PRESET SPEED #5	1005	0-MAX Speed	0 RPM	
	PRESET SPEED #6	1006	0-MAX Speed	0 RPM	
	PRESET SPEED #7	1007	0-MAX Speed	0 RPM	
	PRESET SPEED #8	1008	0-MAX Speed	0 RPM	
	PRESET SPEED #9	1009	0-MAX Speed	0 RPM	
	PRESET SPEED #10	1010	0-MAX Speed	0 RPM	
	PRESET SPEED #11	1011	0-MAX Speed	0 RPM	
	PRESET SPEED #12	1012	0-MAX Speed	0 RPM	
	PRESET SPEED #13	1013	0-MAX Speed	0 RPM	
	PRESET SPEED #14	1014	0-MAX Speed	0 RPM	
	PRESET SPEED #15	1015	0-MAX Speed	0 RPM	
ACCEL/DECEL RATE	ACCEL TIME #1	1101	0 to 3600 Seconds	3.0 SEC	
	DECEL TIME #1	1102	0 to 3600 Seconds	3.0 SEC	
	S-CURVE #1	1103	0-100%	0 %	
	ACCEL TIME #2	1104	0 to 3600 Seconds	3.0 SEC	
	DECEL TIME #2	1105	0 to 3600 Seconds	3.0 SEC	
	S-CURVE #2	1106	0-100%	0 %	
JOG SETTINGS	JOG SPEED	1201	0-MAX Speed	200 RPM	
	JOG ACCEL TIME	1202	0 to 3600 Seconds	3.0 SEC	
	JOG DECEL TIME	1203	0 to 3600 Seconds	3.0 SEC	
	JOG S-CURVE	1204	0-100%	0 %	
KEYPAD SETUP	KEYPAD STOP KEY	1301	REMOTE ON (Stop key active during remote operation). REMOTE OFF (Stop key inactive during remote operation).	REMOTE ON	
	KEYPAD STOP MODE	1302	COAST, REGEN	REGEN	
	KEYPAD RUN FWD	1303	ON, OFF	ON	
	KEYPAD RUN REV	1304	ON, OFF	ON	
	KEYPAD JOG FWD	1305	ON, OFF	ON	
	KEYPAD JOG REV	1306	ON, OFF	ON	
	LOC. HOT START	1307	ON, OFF	OFF	

Parameter Block Values Level 1 Continued

Level 1 Blocks - Continued					
Block Title	**Parameter**	P#	**Adjustable Range**	**Factory Setting**	**User Setting**
INPUT	OPERATING MODE	1401	KEYPAD STANDARD RUN 15SPD 3SPD ANA 2 WIRE 3SPD ANA 3 WIRE SERIAL BIPOLAR PROCESS MODE FAN PUMP 2 WIRE FAN PUMP 3 WIRE EPOT 2 WIRE EPOT 3 WIRE	KEYPAD	
	COMMAND SELECT	1402	POTENTIOMETER +/-10 VOLTS +/-5 VOLTS 4 TO 20 mA 10V W/TORQ FF EXB PULSE FOL 5V EXB 10V EXB 4-20 mA EXB 3-15PSI EXB TACHOMETER EXB SERIAL NONE	+/-10 VOLTS	
	ANA CMD INVERSE	1403	ON, OFF	OFF	
	ANA CMD OFFSET	1404	-20.0 To +20.0%	0.0 %	
	ANA 2 DEADBAND	1405	0-10.00 V	0.20 V	
	ANA1 CUR LIMIT	1406	ON, OFF	OFF	
OUTPUT	OPTO OUTPUT #1	1501	READY ZERO SPEED AT SPEED OVERLOAD KEYPAD CONTROL AT SET SPEED FAULT FOLLOWING ERR MOTR DIRECTION DRIVE ON CMD DIRECTION AT POSITION OVER TEMP WARN PROCESS ERROR DRIVE RUN SERIAL	READY	
	OPTO OUTPUT #2	1502		ZERO SPEED	
	OPTO OUTPUT #3	1503		AT SPEED	
	OPTO OUTPUT #4	1504		FAULT	
	ZERO SPD SET PT	1505	0-MAX Speed	200 RPM	
	AT SPEED BAND	1506	0-1000 RPM	100 RPM	
	SET SPEED	1507	0-MAX Speed	Rated Motor Speed	

Parameter Block Values Level 1 Continued

Level 1 Blocks - Continued					
Block Title	**Parameter**	P#	**Adjustable Range**	**Factory Setting**	**User Setting**
OUTPUT (Continued)	ANALOG OUT #1	1508	ABS SPEED ABS TORQUE SPEED COMMAND PWM VOLTAGE FLUX CURRENT CMD FLUX CUR LOAD CURRENT CMD LOAD CUR MOTOR CURRENT LOAD COMPONENT QUAD VOLTAGE DIRECT VOLTAGE AC VOLTAGE BUS VOLTAGE TORQUE POWER VELOCITY OVERLOAD PH2 CURRENT PH1 CURRENT PROCESS FDBK SETPOINT CMD	ABS SPEED	
	ANALOG OUT #2	1509		MOTOR CURRENT	
	ANALOG #1 SCALE	1510	10-100%	100%	
	ANALOG #2 SCALE	1511	10-100%	100%	
VECTOR CONTROL	CTRL BASE SPEED	1601	0-MAX Speed	CALC	
	CURRENT PROP GAIN	1602	0-1000	80	
	SPEED PROP GAIN	1603	0-1000	10	
	SPEED INT GAIN	1604	0-9.99 HZ	0.50 HZ	
	SLIP FREQUENCY	1605	0-20.00 HZ	CALC	
	STATOR R1	1606	0-65.535	CALC	
	STATOR X1	1607	0-65.535	CALC	
LEVEL 2 BLOCK	ENTERS LEVEL 2 MENU				
PRESS ENTER FOR PROGRAMMING EXIT	Exit programming mode and return to display mode.				

Parameter Block Values Level 2

Level 2 Blocks					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory Setting**	**User Setting**
OUTPUT LIMITS	MIN OUTPUT SPEED	2002	0-MAX Speed	0 RPM	
	MAX OUTPUT SPEED	2003	0-32767 RPM	Rated Motor Speed	
	PK CURRENT LIMIT	2004	0-PEAK RATED CURRENT	PK Control Rating	
	PWM FREQUENCY	2005	1-16KHZ	8.5kHz	
	CUR RATE LIMIT	2006	0-10.00SEC	0.04SEC	
CUSTOM UNITS	DECIMAL PLACES	2101	0-5	5	
	VALUE AT SPEED	2102	0-65535 / 0-65535	00000/ 01000 RPM	
	UNITS OF MEASURE	2103	Selection of 9 Character Sets	-	
PROTECTION	OVERLOAD	2201	FAULT, FOLDBACK	FOLDBACK	
	EXTERNAL TRIP	2202	ON, OFF	OFF	
	LOCAL ENABLE INP	2203	ON, OFF	OFF	
	FOLLOWING ERROR	2204	ON, OFF	OFF	
	TORQUE PROVING	2205	ON, OFF	OFF	
MISCELLANEOUS	RESTART AUTO/MAN	2301	AUTOMATIC, MANUAL	MANUAL	
	RESTART FAULT/HR	2302	0-10	0	
	RESTART DELAY	2303	0-120 SECONDS	0 SEC	
	FACTORY SETTINGS	2304	YES, NO	NO	
SECURITY CONTROL	SECURITY STATE	2401	OFF LOCAL SECURITY SERIAL SECURITY TOTAL SECURITY	OFF	
	ACCESS TIMEOUT	2402	0-600 SEC	0 SEC	
	ACCESS CODE	2403	0-9999	9999	
MOTOR DATA	MOTOR VOLTAGE	2501	0-999 VOLTS	Factory Set	
	MOTOR RATED AMPS	2502	0-999.9	Factory Set	
	MOTOR RATED SPD	2503	0-32767 RPM	1750 RPM	
	MOTOR RATED FREQ	2504	0-1000 Hz	60.0 Hz	
	MOTOR MAG AMPS	2505	0-85% Rated Current	CALC	
	CALC PRESETS	2506	YES, NO	NO	

Parameter Block Values Level 2 Continued

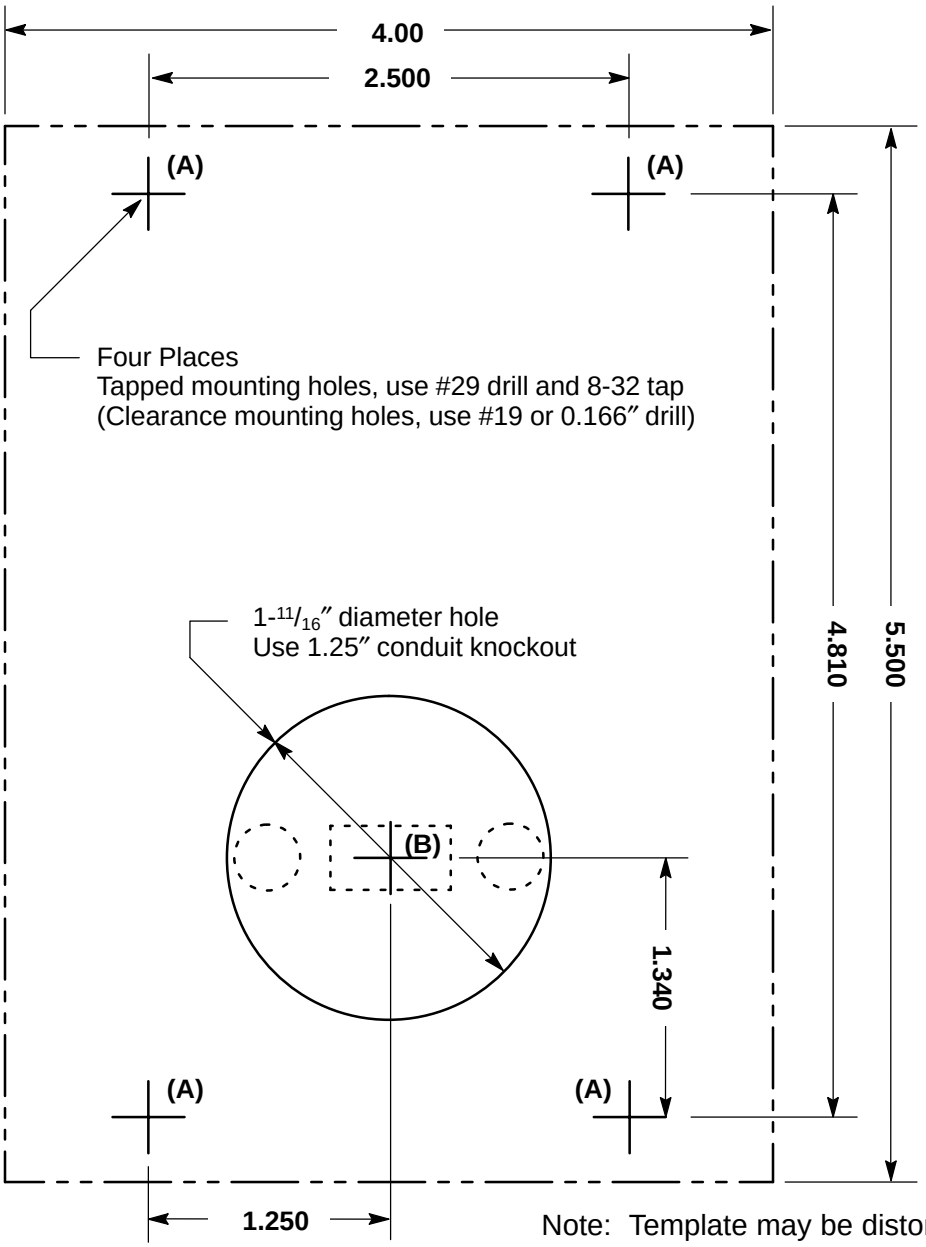
Level 2 Blocks - Continued					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory Setting**	**User Setting**
BRAKE ADJUST	DC BRAKE CURRENT	2601	0 - 100%	0%	
PROCESS CONTROL PROCESS CONTROL PROCESS CONTROL	PROCESS FEEDBACK	2701	POTENTIOMETER +/-10 VOLTS +/-5 VOLTS 4 TO 20 mA 10V W/TORQ FF EXB PULSE FOL 5V EXB 10V EXB 4-20 mA EXB 3-15PSI EXB TACHOMETER EXB SERIAL NONE	NONE	
	PROCESS INVERSE	2702	ON, OFF	OFF	
	SETPOINT SOURCE	2703	SETPOINT CMD POTENTIOMETER +/-10 VOLTS +/-5 VOLTS 4 TO 20 mA 10V W/TORQ FF EXB PULSE FOL 5V EXB 10V EXB 4-20 mA EXB 3-15PSI EXB TACHOMETER EXB SERIAL NONE	SETPOINT CMD	
	SETPOINT COMMAND	2704	–100% to +100%	0.0 %	
	SET PT ADJ LIMIT	2705	0-100%	10.0 %	
	PROCESS ERR TOL	2706	1-100%	10 %	
	PROCESS PROP GAIN	2707	0-2000	0	
	PROCESS INT GAIN	2708	0-9.99 HZ	0.00 HZ	
	PROCESS DIFF GAIN	2709	0-1000	0	
	FOLLOW I:O RATIO	2710	(1:65535) : (1:20)	1:1	
	FOLLOW I:O OUT	2711	(1:65535) : (1:65535)	1:1	
	MASTER ENCODER	2712	0- 65535 PPR	1024PPR	
COMMUNICATIONS	PROTOCOL	2801	RS–232 ASCII, RS-485 ASCII	RS–232 ASCII	
	BAUD RATE	2802	9600, 19.2KB, 38.4KB, 57.6KB, 115.2KB, 230.4KB, 460.8kB, and 921.6kB	9600	
	DRIVE ADDRESS	2803	0 - 31	0	

Parameter Block Values Level 2 Continued

Level 2 Blocks - Continued					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory Setting**	**User Setting**
SYNCHRO STARTS	SYNC STARTS	2901	OFF, RESTARTS ONLY, ALL STARTS	OFF	
	SYNC START SPEED	2902	0-MAX Speed	1750 RPM	
	SYNC SCAN TIME	2903	0-60.0 SEC	10.0 SEC	
	SYNC DIRECTION	2904	SYNC FWD & REV SYNC FORWARD SYNC REVERSE	SYNC FWD & REV	
AUTO-TUNING	**CALC PRESETS**	2508	YES, NO	NO	
	CMD OFFSET TRM Measures and trims out offset voltage at Analog Input #2 (J1A-4 & J1A-5).	AU1	-	-	
	STATOR R1 Measures stator resistance	AU2	-	-	
	CUR LOOP COMP Measures current response while running motor at one half the rated motor current.	AU3	-	-	
	FLUX CUR SETTING Sets the Motor Mag Amps.	AU4	-	-	
LEVEL 1 BLOCK	Enters Level 1 Menu				
PRESS ENTER FOR PROGRAMMING EXIT	Exit programming mode and return to display mode.				

Appendix B

Remote Keypad Mounting Template



Note: Template may be distorted due to reproduction.

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