SERIES 18H
AC Flux Vector Control

Installation & Operating Manual

1/04 **MN718**

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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 and allows 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 “Motor Connections”.
5. Connect the encoder, refer to Section 3 “Encoder Installation”.
6. Install Dynamic brake hardware, if required. Refer to Section 3 “Optional Dynamic Brake Hardware”.
7. Connect the keypad to the control if it is a remote mount. Refer to Section 3 “Keypad Installation” procedure.

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 of motor shaft.
2. Verify that motor coupling is tight without backlash.
3. 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 Control, Motor and Dynamic Brake hardware 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 J1-8 are open.
2. Turn power on. Be sure there are no faults.
3. Set the Level 1 Input block, Operating Mode to “KEYPAD”.
4. Be sure the Level 2 Protection block, Local Enable INP parameter is OFF and the Level 2 Protection block, External Trip parameter is OFF.
5. Set the Level 2 Output Limits block, “OPERATING ZONE” parameter as desired (STD CONST TQ, STD VAR TQ, QUIET CONST TQ or QUIET VAR TQ).
6. 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)
   Encoder Counts
7. If external dynamic braking hardware is used, set the level 2 Brake Adjust block “Resistor Ohms” and “Resistor Watts” parameter values.
8. Go to Level 2 Motor Data block, press ENTER, at CALC PRESETS select YES (using the ▲ key) and let the control calculate preset values for the parameters that are necessary for control operation.
9. 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, 12, 16, 17 and 18.

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

10. Go to Level 2 Autotune block, and do the following tests:
    CMD OFFSET TRIM
    CUR LOOP COMP
    STATOR R1
    FLUX CUR SETTING
    ENCODER TESTS
    SLIP FREQ TEST
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. Remove all power from the control.
14. Couple the motor to its load.
15. Turn power on. Be sure no errors are displayed.
16. Go to Level 2 Autotune block and perform the SPD CNTRLR CALC test.
17. Run the drive from the keypad using one of the following: the arrow keys for direct speed control, a keypad entered speed or the JOG mode.
18. Select and program additional parameters to suit your application.

The control is now ready for use the in 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

CE Compliance

A custom unit may be required, contact Baldor. Compliance to Directive 89/336/EEC is the responsibility of the system integrator. A control, motor and all system components must have proper shielding grounding and filtering as described in MN1383. Please refer to MN1383 for installation techniques for CE compliance.

Overview

The Baldor Series 18H PWM control uses flux vector technology. Flux vector technology (sometimes referred to as Field Oriented Control) is a closed loop control scheme using an algorithm to adjust the frequency and phase of voltage and current applied to a three phase induction motor. The vector control separates the motor current into it's flux and torque producing components. These components are independently adjusted and vectorially added to maintain a 90 degree relationship between them. This produces maximum torque from base speed down to and including zero speed. Above base speed, the flux component is reduced for constant horsepower operation. In addition to the current, the electrical frequency must also be controlled. The frequency of the voltage applied to the motor is calculated from the slip frequency and the mechanical speed of the rotor. This provides instantaneous adjustment of the voltage and current phasing in response to speed and position feedback from an encoder mounted to the motors' shaft.

The control's rated horsepower is based on the use of a NEMA design B four pole motor and 60Hz operation at nominal rated input voltage. If any other type of motor is used, the control should be sized to the motor using the rated current of the motor.

The Baldor Series 18H control may be used in many different applications. It may be programmed by the user to operate in four different operating zones; standard or quiet and constant torque or variable torque. It can also be configured to operate in a number of modes depending upon the application requirements and user preference.

It is the responsibility of the user to determine the optimum operating zone and mode to interface the control to the application. These choices are made with the keypad as explained in Section 4 of this manual.

Limited Warranty

For a period of two (2) years from the date of original purchase, BALDOR will repair or replace without charge controls and accessories 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 voltages that may be as high as 1000 volts! 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: This unit has an automatic restart feature that will start the motor whenever input power is applied and a RUN (FWD or REV) command is issued. If an automatic restart of the motor 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.**

⚠ **WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. 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. Dangerous voltages are present inside the equipment. 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. Certain failure modes of the control can produce peak torque of several times the rated motor torque.**

⚠ **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: Dynamic brake resistors may generate enough heat to ignite combustible materials. 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:** **Disconnect motor leads (T1, T2 and T3) from control before you perform a "Megger" test on the motor. Failure to disconnect motor from the control will result in extensive damage to the control. The control is tested at the factory for high voltage / leakage resistance as part of Underwriter Laboratory requirements.**

⚠ **Caution:** **Suitable for use on a circuit capable of delivering not more than the RMS symmetrical short circuit amperes listed here at rated voltage.**

Horsepower	RMS Symmetrical Amperes
1–50	5,000
51–200	10,000
201–400	18,000
401–600	30,000
601–900	42,000

⚠ **Caution:** **Do not connect AC power to the Motor terminals T1, T2 and T3. Connecting AC power to these terminals may result in damage to the control.**

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

⚠ **Caution:** **Do not supply any power to the External Trip (motor thermostat) leads at J1-16 and 17. Power on these leads can damage the control. Use a dry contact type that requires no external power to operate.**

⚠ **Caution:** **If the DB hardware mounting is in any position other than vertical, the DB hardware must be derated by 35% of its rated capacity.**

⚠ **Caution:** **Do not connect any shields to the encoder case or motor frame. The encoder +5VDC supply at J1-29 is referenced to circuit board common. Do not connect any shields to ground or another power supply or damage to the control may result.**

Section 3
Receiving & Installation

Receiving & Inspection

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. Verify that the part number of the control you received is the same as the part number listed on your purchase order.
3. 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).

Physical Location

The location of the control is important. It should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration.

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

1. For effective cooling and maintenance, the control should be mounted vertically on a flat, smooth, non-flammable vertical surface. Table 3-1 lists the Watts Loss ratings for enclosure sizing.
2. At least two inches clearance must be provided on all sides for air flow.
3. Front access must be provided to allow the control cover to be opened or removed for service and to allow viewing of the Keypad Display.

   A floor mounted enclosure must be positioned with clearance to open the enclosure door. This clearance will also provide sufficient air space for cooling.
4. **Altitude derating**. Up to 3300 feet (1000 meters) no derating required. Above 3300 ft, derate the continuous and peak output current by 2% for each 1000 ft.
5. **Temperature derating**. Up to 40°C no derating required. Above 40°C, derate the continuous and peak output current by 2% per °C. Maximum ambient is 55°C.

Table 3-1 Series 18H Watts Loss Ratings

Enclosure Size	230VAC		460VAC		575VAC	
	2.5kHz PWM	8.0kHz PWM	2.5kHz PWM	8.0kHz PWM	2.5kHz PWM	8.0kHz PWM
A, B and B2	14 Watts/ Amp	17 Watts/ Amp	17 Watts/ Amp	26 Watts/ Amp	18 Watts/ Amp	28 Watts/ Amp
C, C2, D, D2, E and F	12 Watts/ Amp	15 Watts/ Amp	15 Watts/ Amp	23Watts/ Amp	19Watts/ Amp	29 Watts/ Amp
G and G+			15 Watts/ Amp		19Watts/ Amp	
H			15 Watts/ Amp			

Control Installation

The control must be securely fastened to the mounting surface at the mounting holes.

Shock Mounting

If the control will be subjected to levels of shock greater than 1G or vibration greater than 0.5G at 10 to 60Hz, the control should be shock mounted.

Through the Wall Mounting

Control sizes B2, C2 and D2 are designed for panel or through the wall installation. Refer to the installation drawings in Section 7 of this manual.

Keypad Installation

Procedure:

1. Refer to the Optional Remote Keypad Installation procedure and mount the keypad.
2. Connect the keypad cable to the keypad connector of the main circuit board.

Optional Remote Keypad Installation The keypad may be remotely mounted using the optional Baldor keypad extension cable. The keypad assembly (white - DC00005A-01; 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 4X enclosure, it retains the Type 4X 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

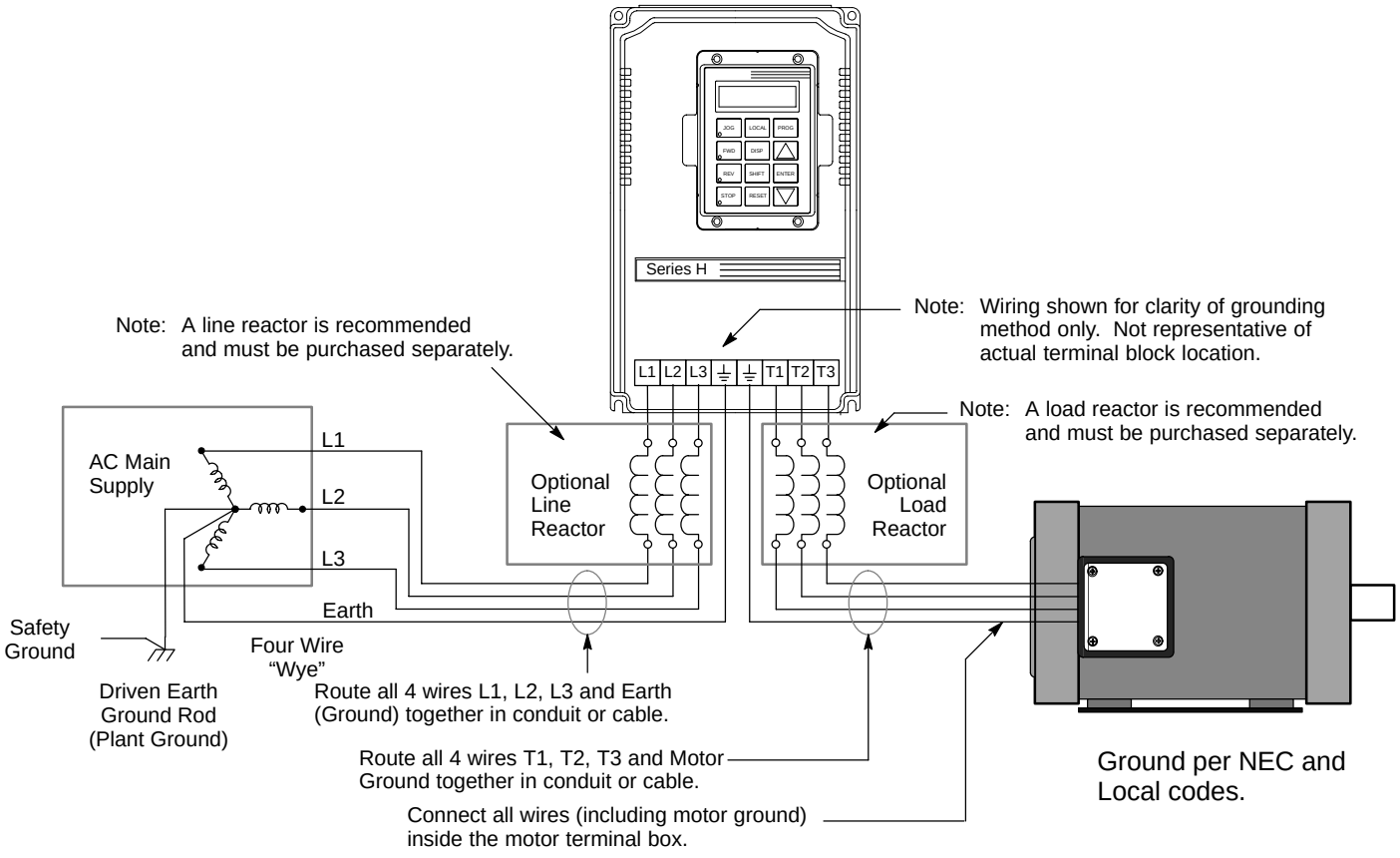
To make electrical connections, use UL listed closed loop connectors that are of appropriate size for wire gauge being used. Connectors are to be installed using crimp tool specified by the manufacturer of the connector. Only Class 1 wiring should be used.

Baldor Series H controls feature UL approved adjustable motor overload protection suitable for motors rated at no less than 50% of the output rating of the control. Other governing agencies such as NEC may require separate over-current protection. The installer of this equipment is responsible for complying with the National Electric Code and any applicable local codes which govern such practices as wiring protection, grounding, disconnects and other current protection.

System Grounding

Baldor recommends not using “Grounded Leg Delta” transformer power leads that may create ground loops. Instead, we recommend using a four wire Wye. Baldor Controls are designed to be powered from standard three phase lines that are electrically symmetrical with respect to ground. System grounding is an important step in the overall installation to prevent problems. The recommended grounding method is shown in Figure 3-1.

Figure 3-1 Recommended System Grounding



System Grounding Continued

Ungrounded Distribution System

With an ungrounded power distribution system it is possible to have a continuous current path to ground through the MOV devices. To avoid equipment damage, an isolation transformer with a grounded secondary is recommended. This provides three phase AC power that is symmetrical with respect to ground.

Input Power Conditioning

Baldor controls are designed for direct connection to standard three phase lines that are electrically symmetrical with respect to ground. Certain power line conditions must be avoided. An AC line reactor or an isolation transformer may be required for some power conditions.

- If the feeder or branch circuit that provides power to the control has permanently connected power factor correction capacitors, an input AC line reactor or an isolation transformer must be connected between the power factor correction capacitors and the control.
- If the feeder or branch circuit that provides power to the control has power factor correction capacitors that are switched on line and off line, the capacitors must not be switched while the control is connected to the AC power line. If the capacitors are switched on line while the control is still connected to the AC power line, additional protection is required. TVSS (Transient Voltage Surge Suppressor) of the proper rating must be installed between the AC line reactor or an isolation transformer and the AC input to the control.

Line Impedance

The Baldor control requires a minimum line impedance. If the impedance of the incoming power does not meet the requirement for the control, 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.

Control Size	A, B, C, D, E	B2, C2, D2, F, G
Line Impedance Required	**3%**	**1%**

The input impedance of the power lines can be determined as follows:

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

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

Line Reactors

Three phase line reactors are available from Baldor. The line reactor to order is based on the full load current of the motor (FLA). If providing your own line reactor, use the following formula to calculate the minimum inductance required.

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

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. Selection should be based on the motor nameplate FLA value.

AC Main Circuit

Power Disconnect

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

Protection Devices

Be sure a suitable input power protection device is installed. Use the recommended circuit breaker or fuses listed in Tables 3-2 through 3-4 (Wire Size and Protection Devices). Refer to ratings in Section 7 of this manual. If the output power from the control will be less than the maximum, the sizes of the wire and protective devices may be adjusted accordingly. Be sure to follow NEC, UL and other applicable codes. Input and output wire size is based on the use of copper conductor wire rated at 75 °C. The ratings are specified for NEMA B motors.

Circuit Breaker:	1 phase, thermal magnetic. Equal to GE type THQ or TEB for 230 VAC 3 phase, thermal magnetic. Equal to GE type THQ or TEB for 230 VAC or GE type TED for 460 VAC and 575 VAC.
Fast Action Fuses:	230 VAC, Buss KTN 460 VAC, Buss KTS to 600A (KTU 601 - 1200A) 575 VAC, Buss KTS
Very Fast Action:	230 VAC, Buss JJN 460 VAC, Buss JJS 575 VAC, Buss JJS
Time Delay Fuses:	230 VAC, Buss FRN 460 VAC, Buss FRS to 600A (KLU 601 - 1200A) 575 VAC, Buss FRS to 600A (KLU 601 - 1200A)

Recommended fuse sizes are based on the following:

115% of maximum continuous current for time delay fuses.

150% of maximum continuous current for fast or very fast acting fuses.

Wire Size and Protection Devices

Table 3-2 230VAC Controls (3 Phase) Wire Size and Protection Devices

Control Rating		Input Breaker	Input Fuse (Amps)		Wire Gauge	
Amps	HP	(Amps)	Fast Acting	Time Delay	AWG	mm^2
3	0.75	7	5	4	14	2.5
4	1	7	6	5	14	2.5
7	2	15	12	9	14	2.5
10	3	15	15	12	14	2.5
16	5	20	25	20	12	3.31
22	7.5	30	35	30	10	5.26
28	10	40	45	35	8	8.37
42	15	60	70	60	6	13.3
54	20	70	80	70	6	13.3
68	25	90	100	90	4	21.2
80	30	100	125	110	3	26.7
104	40	150	175	150	1	42.4
130	50	175	200	175	1/0	53.5
145	60	200	225	200	2/0	67.4
192	75	250	300	250	4/0	107.0

Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 40°C ambient, maximum continuous control output current and no harmonic current.

Table 3-3 460VAC Controls (3 Phase) Wire Size and Protection Devices

Control Rating		Input Breaker (Amps)	Input Fuse (Amps)		Wire Gauge	
Amps	HP		Fast Acting	Time Delay	AWG	mm^2
2	0.75	3	2	2	14	2.5
2	1	3	3	2.5	14	2.5
4	2	7	5	4.5	14	2.5
5	3	7	8	6.3	14	2.5
8	5	15	12	10	14	2.5
11	7.5	15	17.5	15	14	2.5
14	10	20	20	17.5	12	3.31
21	15	30	30	25	10	5.26
27	20	40	40	35	10	5.26
34	25	50	50	45	8	8.37
40	30	50	60	50	8	8.37
52	40	70	80	70	6	13.3
65	50	90	100	90	4	21.2
77	60	100	125	100	3	26.7
96	75	125	150	125	2	33.6
124	100	175	200	175	1/0	53.5
156	125	200	250	200	2/0	67.4
180	150	225	300	250	3/0	85.0
240	200	300	350	300	(2) 2/0	(2) 67.4
302	250	400	450	400	(2) 4/0	(2) 107.0
361	300	450	600	450	(3) 2/0	(3) 67.4
414	350	500	650	500	(3) 3/0	(3) 85.0
477	400	600	750	600	(3) 4/0	(3) 107.0
515	450	650	800	700	(3) 250MCM	(3) 127.0
590	500	750	900	800	(3) 300MCM	(3) 152.0

Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 40°C ambient, maximum continuous control output current and no harmonic current.

Table 3-4 575VAC Controls (3 Phase) Wire Size and Protection Devices

Control Rating		Input Breaker (Amps)	Input Fuse (Amps)		Wire Gauge	
Amps	HP		Fast Acting	Time Delay	AWG	mm^2
1.1	0.75	3	2	1.5	14	2.5
1.4	1	3	2.5	2	14	2.5
2.7	2	7	4	3.5	14	2.5
3.9	3	7	6	5	14	2.5
6.1	5	15	10	8	14	2.5
9.0	7.5	15	15	12	14	2.5
11	10	15	17.5	15	14	2.5
17	15	25	30	25	12	3.31
22	20	30	35	30	10	5.26
27	25	40	40	35	10	5.26
32	30	40	50	40	8	8.37
41	40	60	60	50	8	8.37
52	50	70	80	70	6	13.3
62	60	80	100	80	6	13.3
77	75	100	125	100	4	21.2
99	100	125	150	125	3	26.7
125	125	175	200	175	1/0	53.5
144	150	200	225	200	2/0	67.4
192	200	250	300	250	4/0	107.0
242	250	300	350	300	(2) 2/0	(2) 67.4
289	300	400	450	400	(2) 3/0	(2) 85.0
336	350	450	500	450	(3) 2/0	(3) 67.4
382	400	500	600	500	(3) 3/0	(3) 85.0
412	450	500	650	500	(3) 3/0	(3) 85.0
472	500	600	750	600	(3) 4/0	(3) 107.0

Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 40°C ambient, maximum continuous control output current and no harmonic current.

AC Line Connections

Reduced Input Voltage Derating

All power ratings stated in Section 7 are for the stated nominal AC input voltages (230, 460 or 575VAC). The power rating of the control must be reduced when operating at a reduced input voltage. The amount of reduction is the ratio of the voltage change.

Examples:

A 10HP, 230VAC control operating at 208VAC has a reduced power rating of 9.04HP.

$$10HP \times \frac{208VAC}{230VAC} = 9.04HP$$

Likewise, a 10HP, 460VAC control operating at 380VAC has a reduced power rating of 8.26HP.

$$10HP \times \frac{380VAC}{460VAC} = 8.26HP$$

To obtain the full output rating of 10HP in either case requires a 15HP Control.

380-400VAC Operation

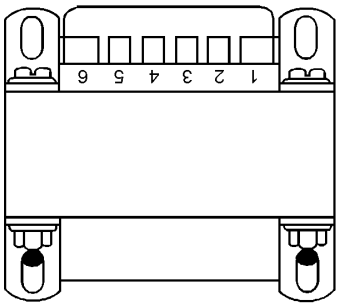
Size A, B, B2, C2 and D2 controls, no modification is necessary.

Be sure all power to the control is disconnected before proceeding.

Tap Change Procedure **(size C, D, E and F controls)**.

1. Be sure drive operation is terminated and control is disabled.
2. Remove all power sources from the control. If power has been applied, wait at least 5 minutes for bus capacitors to discharge.
3. Remove or open the front cover and locate the control transformer (Figure 3-2).
4. Remove the wire from terminal 5.
5. Place the wire that was removed from terminal 5 onto terminal 4.
6. Install or close the front cover.

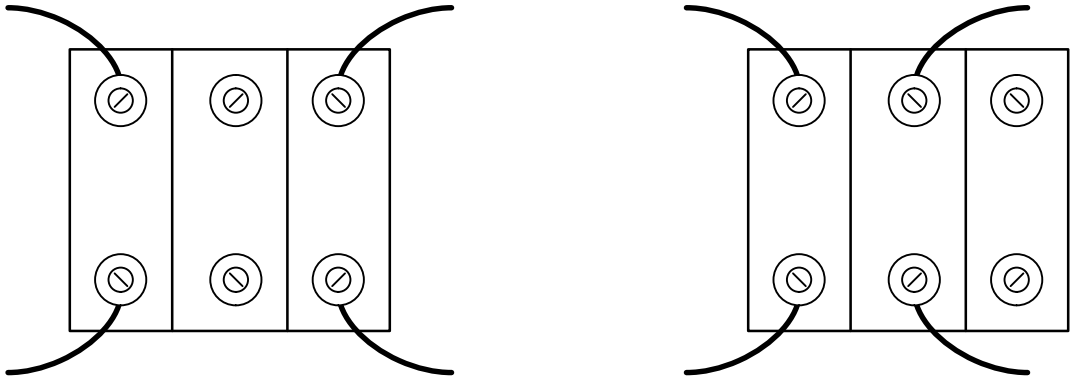
Figure 3-2 Control Transformer Identification



Tap Change Procedure **(size G controls)**. See Figure 3-3.

1. Be sure drive operation is terminated and control is disabled.
2. Remove all power sources from the control. If power has been applied, wait at least 5 minutes for bus capacitors to discharge.
3. Remove or open the front cover and locate the control transformer (Figure 3-3).
4. Remove the wires from the two right side terminals.
5. Place the wires on the center terminals as shown.
6. Install or close the front cover.

Figure 3-3 Size G - Control Transformer Terminal Block



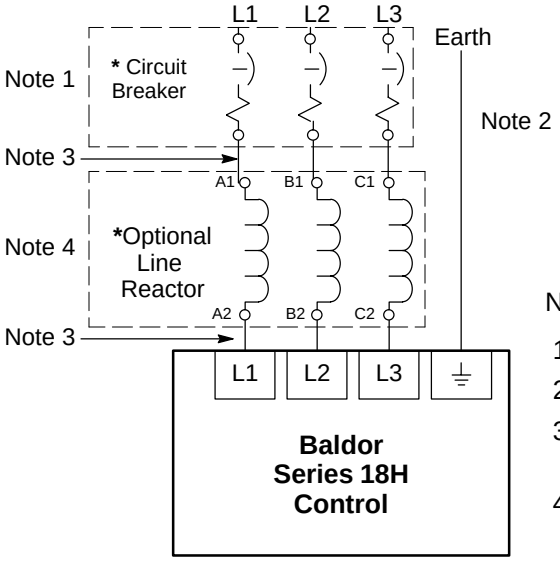
460VAC 380-400VAC

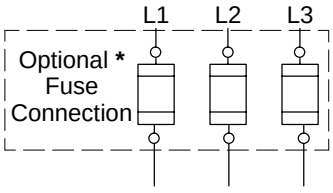
Three Phase Input Power

Three phase AC power connections are shown in Figure 3-4. The 18H control has an electronic I^2t motor overload protection. If motor overloads are desired, they should be sized according to the manufacturers specifications and installed between the motor and the T1, T2 and T3 terminals of the control.

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.

Figure 3-4 Three Phase AC Power Connections





***** Optional components not provided with control.

Notes:

1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Table 3-5 and 3-6 list the wire size for the input AC power wires. Motor leads should be sized from the 3 phase tables.

Table 3-5 Single Phase Rating Wire Size and Protection Devices - 230 VAC Controls*

Control Rating		Input Breaker (Amps)	Input Fuse (Amps)		Wire Gauge	
Amps	HP		Fast Acting	Time Delay	AWG	mm^2
6.9	0.75	10	10	9	14	2.5
8.0	1	10	12	10	14	2.5
12	2	15	20	17.5	14	2.5
17	3	25	25	25	12	3.31
28	5	40	45	35	10	5.26
40	7.5	50	60	50	8	8.37
50	10	70	80	70	6	13.3
68	15	90	110	90	4	21.2
88	20	110	150	125	3	26.7
110	25	150	175	150	2	33.6
136	30	175	200	175	1/0	53.5
176	40	225	250	250	3/0	85.0
216	50	275	350	300	(2) 1/0	(2) 53.5

Table 3-6 Single Phase Rating Wire Size and Protection Devices - 460 VAC Controls*

Control Rating		Input Breaker (Amps)	Input Fuse (Amps)		Wire Gauge	
Amps	HP		Fast Acting	Time Delay	AWG	mm^2
3.5	0.75	5	5	5	14	2.5
4.0	1	5	6	5.6	14	2.5
6.0	2	7.5	10	8	14	2.5
8.5	3	12.5	15	12	14	2.5
14	5	17.5	20	20	12	3.31
20	7.5	25	30	25	10	5.26
25	10	40	40	30	10	5.26
34	15	45	50	45	8	8.37
44	20	60	70	60	8	8.37
55	25	70	80	70	6	13.3
68	30	90	100	90	4	21.2
88	40	110	150	125	3	26.7
108	50	150	175	150	2	33.6

*Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 40°C ambient, maximum continuous control output current and no harmonic current.

Single Phase Input Power Considerations **Single phase operation of G and H size controls is not possible.**

Single phase AC input power can be used to power the control instead of three phase for control sizes A, B, B2, C, C2, D, D2, E and F. The specifications and control sizes are listed in Section 7 of this manual. If single phase power is to be used, the rated Horsepower of the control may have to be reduced (derated). In addition, power wiring and jumper changes are required.

Single phase rating wire size and protection devices are listed in Tables 3-5 and 3-6.

Single Phase Control Derating: Single phase power derating requires that the continuous and peak current ratings of the control be reduced by the following percentages:

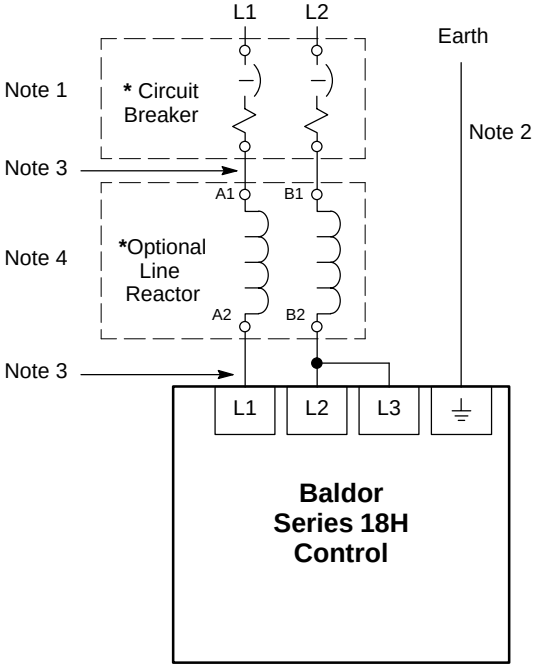
1. **1-2 HP 230 and 460 VAC controls:**
   No derating required.
2. **3-25 HP (Size B and B2) 230 and 460 VAC controls:**
   Derate HP by 40% of the nameplate rating.
3. **15 HP (Size C and D2) and Larger 230 and 460 VAC controls:**
   Derate HP by 50% of the nameplate rating.

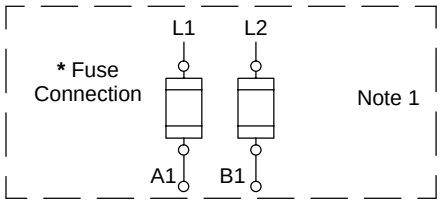
Size A, B and B2 Single Phase Power Installation (See Figure 3-5.)

Jumper Configuration

Size A, B and B2 controls, no jumper changes required.

Figure 3-5 Size A, B and B2 Single Phase 230/460VAC Power Connections





***** Optional components not provided with control.

Notes:

1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Size C2 Single Phase Power Installation (See Figure 3-7.)

Jumper Configuration

Locate the Interface board, and place JP7 on pins 2 & 3 for single phase operation.

Figure 3-6 Jumper Configuration

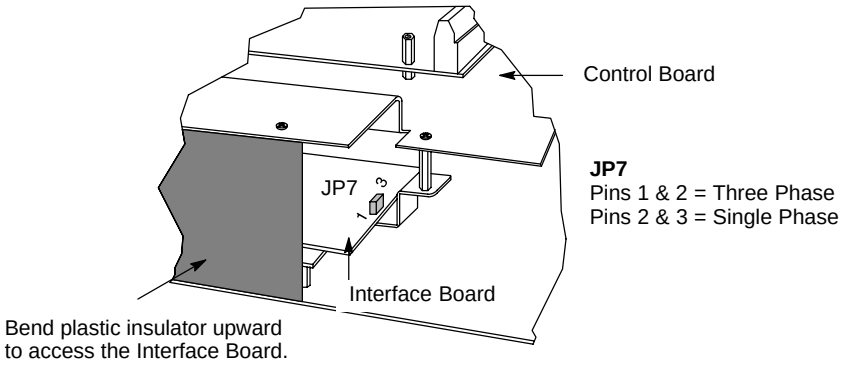
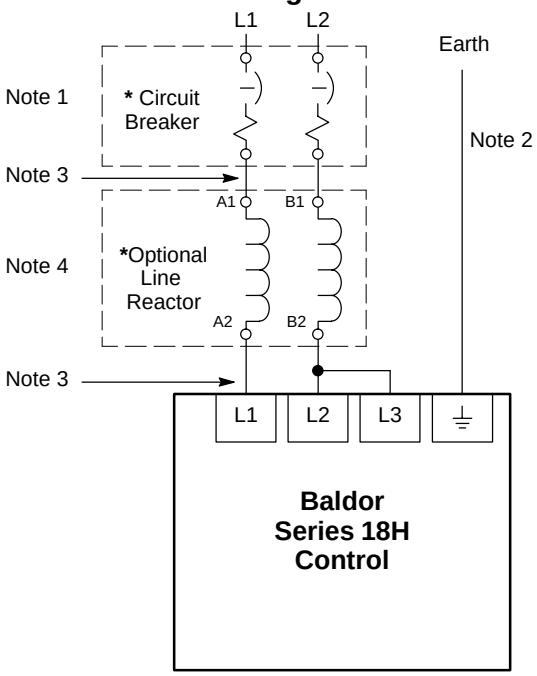
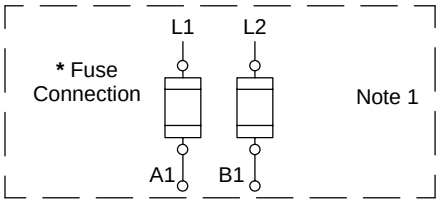


Figure 3-7 Size C2 Single Phase 230/460VAC Power Connections





***** Optional components not provided with control.

Notes:

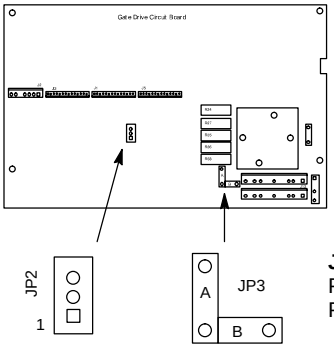
1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Size C and D Single Phase Power Installation (See Figure 3-9.)

Figure 3-8 Jumper Configuration

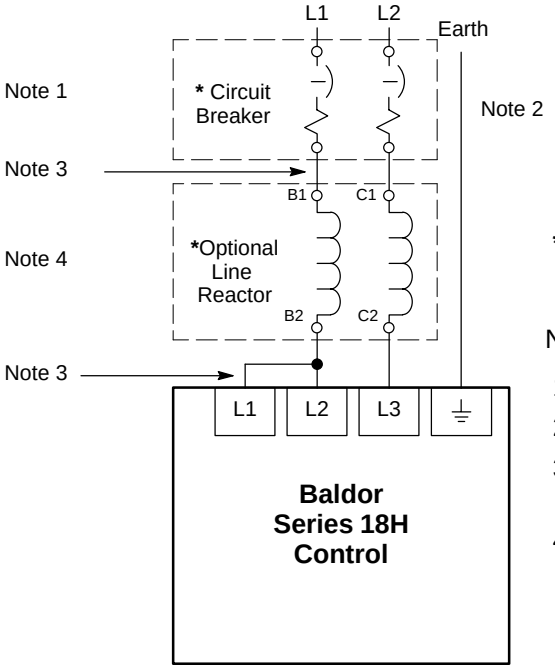
Place JP2 on pins 1 & 2 for control single phase operation.
Place JP3 in position B for fan single phase operation.

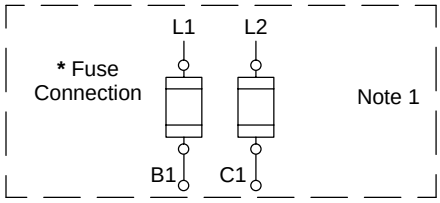


JP2
Pins 1 & 2 = Single Phase
Pins 2 & 3 = Three Phase

JP3
Position A = Three Phase
Position B = Single Phase

Figure 3-9 Size C & D Single Phase 230/460VAC Power Connections





***** Optional components not provided with control.

Notes:

1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Size D2 Single Phase Power Installation

Jumper Configuration

Locate the Interface board, and place J100 on pins 2 & 3 for single phase operation.

Figure 3-10 Jumper Configuration

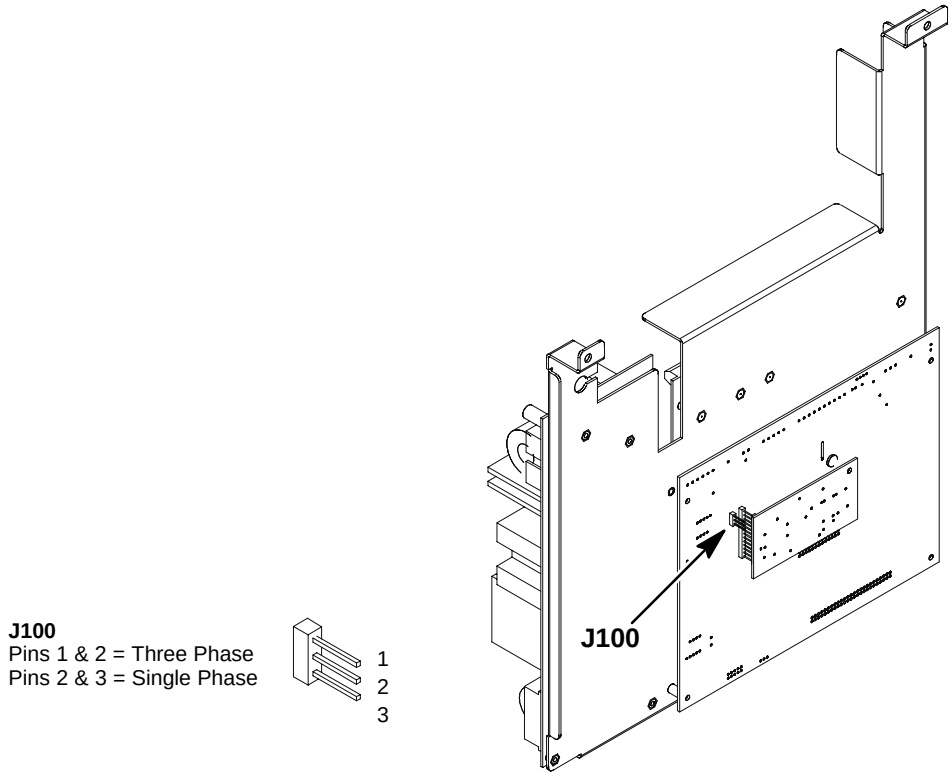
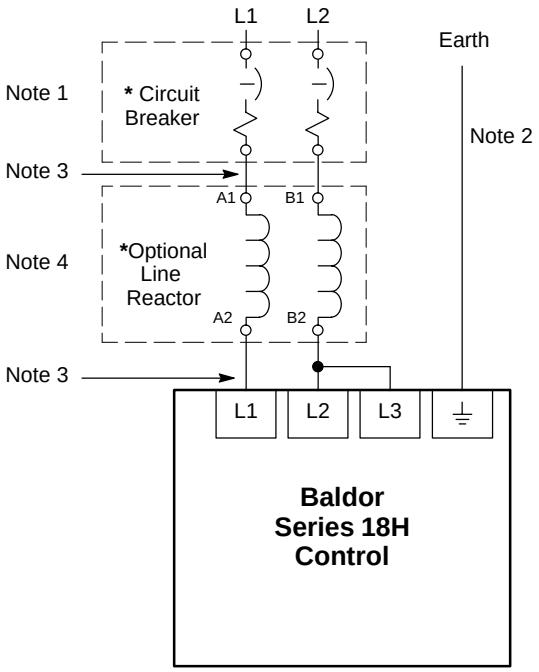
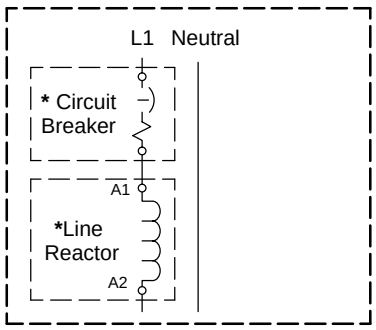


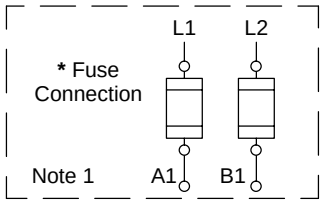
Figure 3-11 Size D2 Single Phase 230/460VAC Power Connections

Single phase 3 wire Connections



Single phase 2 wire Connections





* Optional components not provided with control.

Notes:

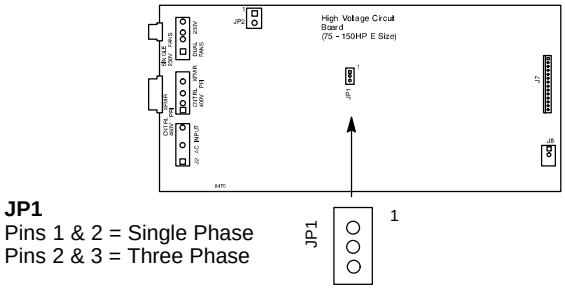
1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Size E Single Phase Power Installation (See Figure 3-13.)

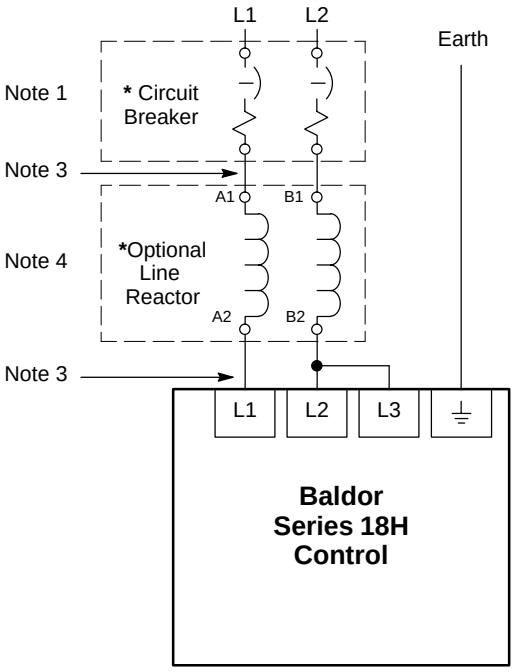
Figure 3-12 Jumper Configuration

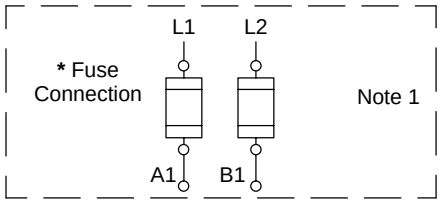
Place JP1 on the High Voltage Circuit Board across pins 1 and 2.



JP1
Pins 1 & 2 = Single Phase
Pins 2 & 3 = Three Phase

Figure 3-13 Size E Single Phase 230/460VAC Power Connections





***** Optional components not provided with control.

Notes:

1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Size F Single Phase Power Installation (See Figure 3-15.)

Figure 3-14 Jumper Configuration

Place JP2 on the High Voltage Circuit Board across pins 1 and 2.

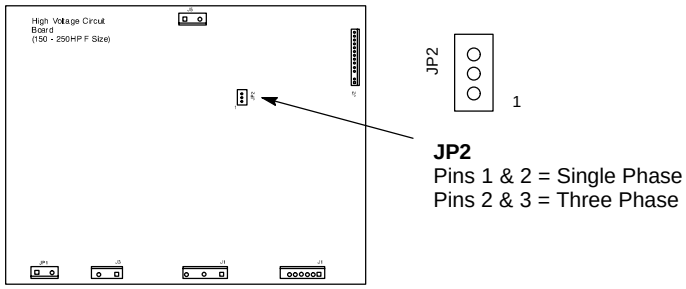
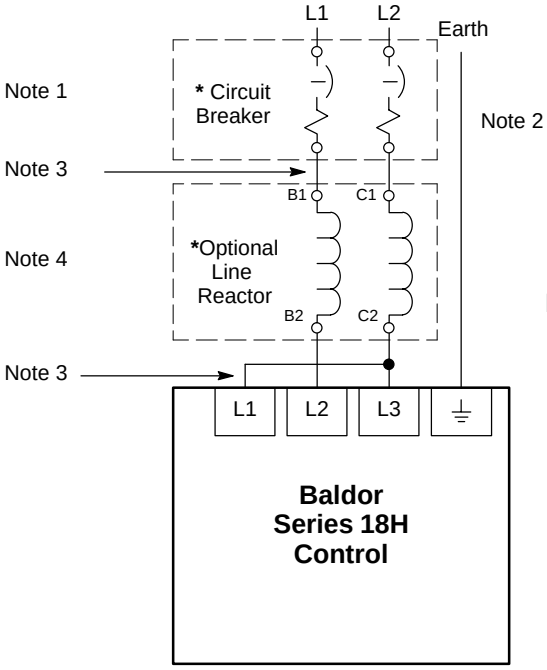
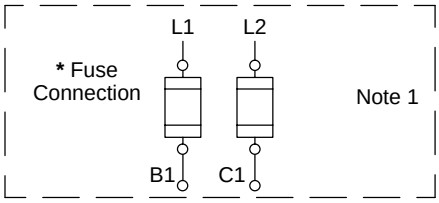


Figure 3-15 Size F Single Phase 230/460VAC Power Connections





***** Optional components not provided with control.

Notes:

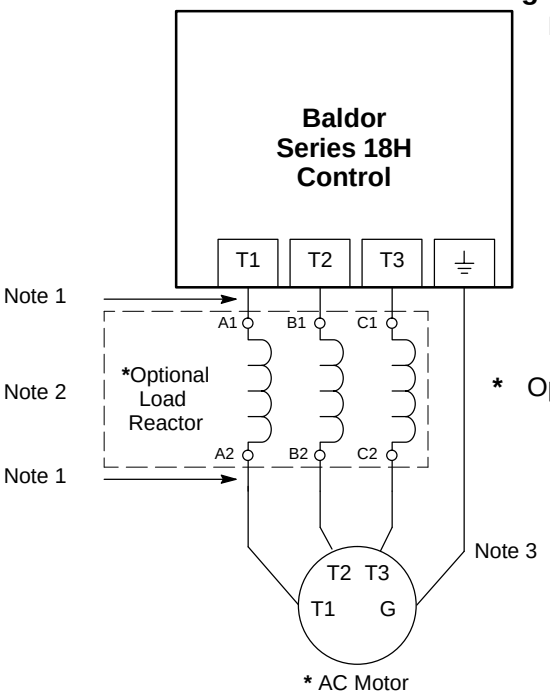
1. See “Protective Devices” described previously in this section.
2. Use same gauge wire for Earth ground as is used for L1, L2 and L3.
3. Metal conduit should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
4. See Line/Load Reactors described previously in this section.

See Recommended Tightening Torques in Section 7.

Motor Connections

Motor connections are shown in Figure 3-16.

Figure 3-16 Motor Connections



Notes:

1. Metal conduit should be used. Connect conduits so the use of Load Reactor or RC Device does not interrupt EMI/RFI shielding.
2. See Line/Load Reactors described previously in this section.
3. Use same gauge wire for Earth ground as for L1, L2 and L3.

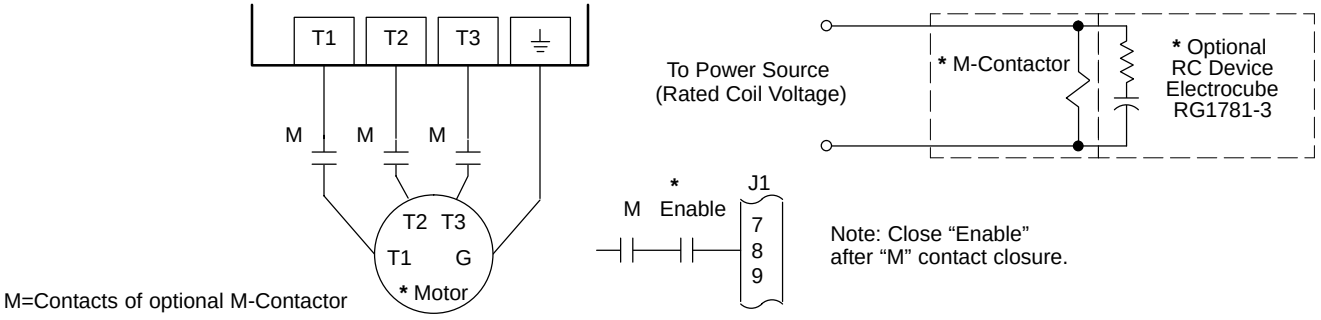
***** Optional components not provided with control.

See Recommended Tightening Torques in Section 7.

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. If an M-Contactor is installed, the control must be disabled for at least 20msec before the M-Contactor is opened or the control may be damaged. M-Contactor connections are shown in Figure 3-17.

Figure 3-17 Optional M-Contactor Connections



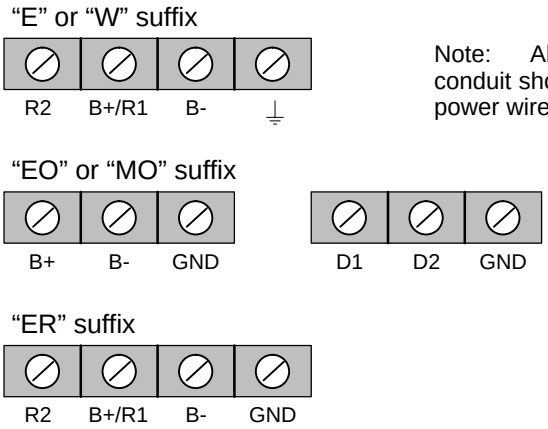
Optional Dynamic Brake Hardware

Dynamic Brake (DB) Hardware must be installed on a flat, non-flammable, vertical surface for effective cooling and operation. Refer to MN701 (for RGA, RBA and RTA assemblies) or MN782 (for RUA assemblies) for additional information.

Electrical Installation

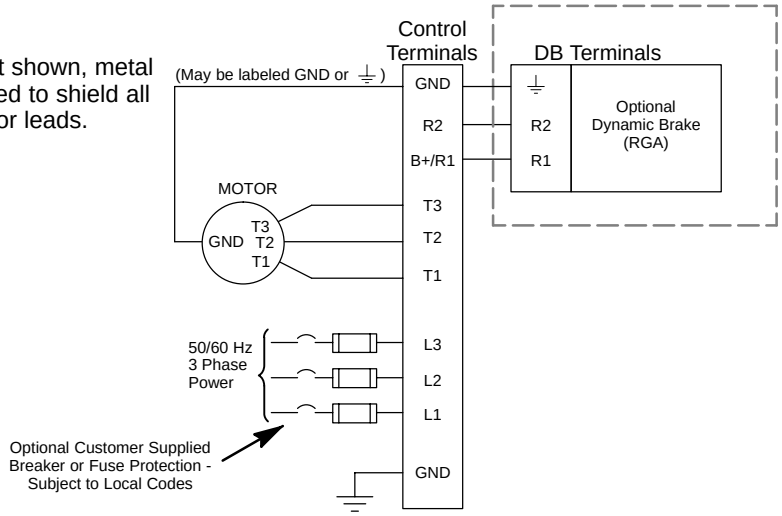
Terminal connections for DB hardware are determined by the Control model number suffix (E, EO, ER or MO). See Figure 3-18 for terminal identification. Refer to Tables 3-7 and 3-8 for wire size information.

Figure 3-18 DB Terminal Identification



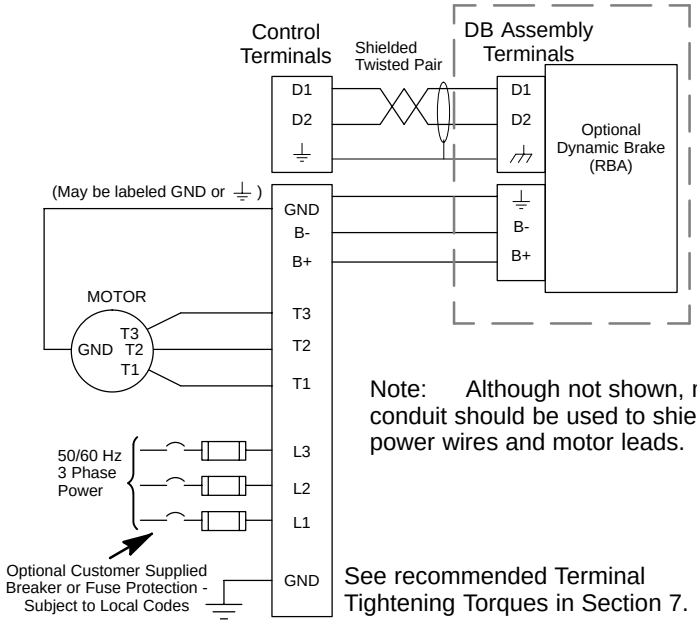
Note: Although not shown, metal conduit should be used to shield all power wires and motor leads.

Figure 3-19 Wiring for RGA Assembly



See recommended Terminal Tightening Torques in Section 7.

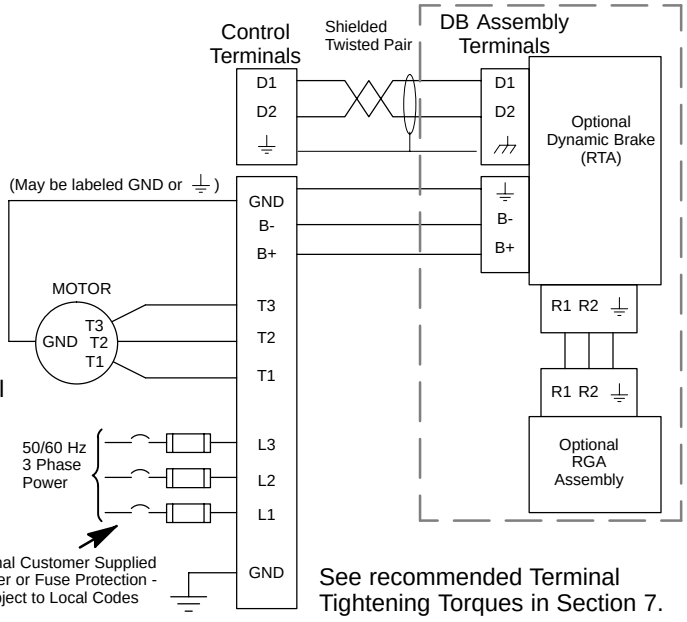
Figure 3-20 Wiring for RBA Assembly



Note: Although not shown, metal conduit should be used to shield all power wires and motor leads.

See recommended Terminal Tightening Torques in Section 7.

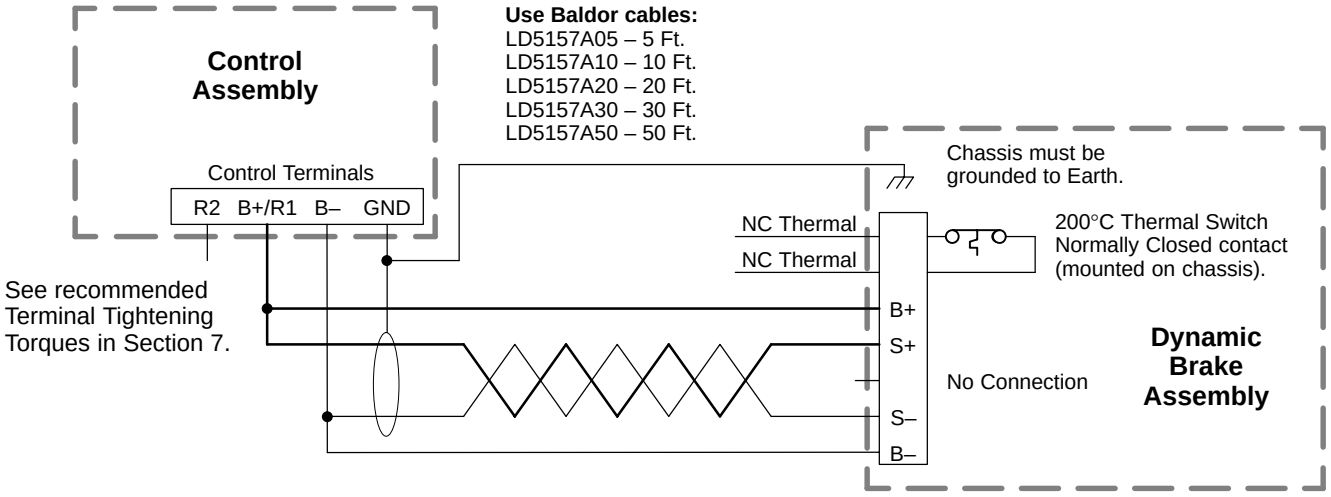
Figure 3-21 Wiring for RTA Assembly



See recommended Terminal Tightening Torques in Section 7.

The RUA Dynamic Brake assembly is designed for controls that have built in dynamic brake hardware. Be sure to disconnect the internal resistor wires from control terminals. These factory installed wires must be removed and the wire ends insulated with electrical tape to prevent contact with other components. The braking capability may also need to be disabled in software. For Baldor Controls, reduce the resistor ohms to the lowest value and increase the resistor watts to greatest value. Be sure to select the proper size kit based on the dissipation rating of the resistor(s) to handle the average watts of the overhauling or cyclic load.

Figure 3-22 Wiring for RUA Assembly



Note: Sense lines S+ and S– must be shielded, twisted pair wire. Terminate shields at control end only.

See recommended Terminal Tightening Torques and wire sizes in Table 3-7.

Table 3-7 Terminal Torques & Wire Size for RUA Assemblies

Control Rating VAC	Braking Option Watts Max.	B+ and B– Terminals					S+ and S– Terminals				
		Shielded Wire Size		AC Volt	Tightening Torque		Shielded Wire Size		AC Volt	Tightening Torque	
		AWG	mm^2		Lb–in	Nm	AWG	mm^2		Lb–in	Nm
230	746	16	1.31	300	9	1	20	0.51	300	9	1
230	1492	16	1.31	300	9	1	20	0.51	300	9	1
230	1865	16	1.31	300	9	1	20	0.51	300	9	1
230	2238	14	2.08	300	9	1	20	0.51	300	9	1
230	3730	14	2.08	300	9	1	20	0.51	300	9	1
230	5600	14	2.08	300	9	1	20	0.51	300	9	1
460	746	16	1.31	600	9	1	20	0.51	600	9	1
460	1492	16	1.31	600	9	1	20	0.51	600	9	1
460	1865	16	1.31	600	9	1	20	0.51	600	9	1
460	2238	16	1.31	600	9	1	20	0.51	600	9	1
460	3730	14	2.08	600	9	1	20	0.51	600	9	1
460	5600	14	2.08	600	9	1	20	0.51	600	9	1
575	746	16	1.31	600	9	1	20	0.51	600	9	1
575	1492	16	1.31	600	9	1	20	0.51	600	9	1
575	1865	16	1.31	600	9	1	20	0.51	600	9	1
575	2238	16	1.31	600	9	1	20	0.51	600	9	1
575	3730	16	1.31	600	9	1	20	0.51	600	9	1
575	5600	16	1.31	600	9	1	20	0.51	600	9	1

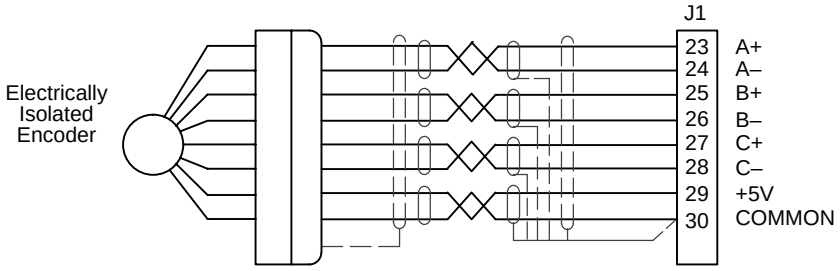
Table 3-8 Dynamic Brake Wire Size for RGA, RBA and RTA Assemblies

Control Voltage Rating VAC	Braking Option Watts Rating	B+ / B- and R1 / R2 / ⏚ Terminals			D1 / D2 / ⏚ Terminals		
		Wire Size			Wire Size		
		AWG	mm^2	Volt	AWG	mm^2	Volt
230	<2,000	16	1.31	600	20-22	0.5	600
230	2,100 – 5,000	14	2.08	600	20-22	0.5	600
230	5,100 – 10,000	10	6	600	20-22	0.5	600
230	>10,000	8	10	600	20-22	0.5	600
460	<4,000	16	1.31	600	20-22	0.5	600
460	4,100 – 10,000	14	2.08	600	20-22	0.5	600
460	10,100 – 20,000	10	6	600	20-22	0.5	600
460	>20,000	8	10	600	20-22	0.5	600
575	<4,000	16	1.31	600	20-22	0.5	600
575	4,100 – 10,000	14	2.08	600	20-22	0.5	600
575	10,100 – 20,000	10	6	600	20-22	0.5	600
575	>20,000	8	10	600	20-22	0.5	600

Encoder Installation

Electrical isolation of the encoder shaft and housing from the motor is required. Electrical isolation prevents capacitive coupling of motor noise that will corrupt the encoder signals. Baldor provides shielded wire for encoder connection. Figure 3-23 shows the electrical connections between the encoder and the encoder connector.

Figure 3-23 Differential Encoder Connections

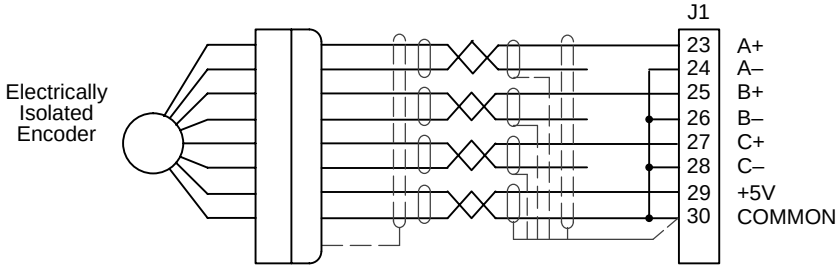


See recommended Terminal Tightening Torques in Section 7.

Single Ended Connections

Differential inputs are recommended for best noise immunity. If only single ended encoder signals are available, connect them to A, B, and INDEX (C) (J1-23, J1-25 and J1-27 respectively). $\overline{A}$, $\overline{B}$, and $\overline{INDEX\ (C)}$ are then connected to common at J1-30 as shown in Figure 3-24.

Figure 3-24 Single Ended Encoder Connections



See recommended Terminal Tightening Torques in Section 7.

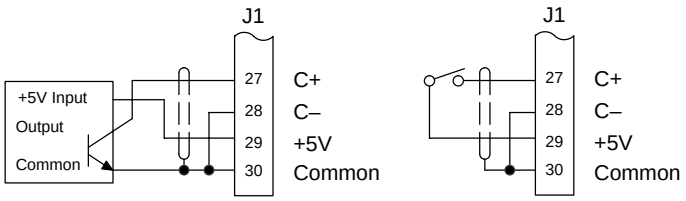
Home (Orient) Switch Input The Home or Orient function causes the motor shaft to rotate to a predefined home position. The homing function allows shaft rotation in the drive forward direction only. The home position is located when a machine mounted switch or the encoder C “Index” pulse is activated (closed). Home is defined by a rising signal edge at terminal J1-27. The shaft will continue to rotate only in a “Drive Forward” direction for a user defined offset value. The offset is programmed in the Level 2 Miscellaneous Homing Offset parameter. The speed at which the motor will “Home” or orient is set with the Level 2 Miscellaneous Homing Speed parameter.

A machine mounted switch may be used to define the Home position in place of the encoder index channel. A differential line driver output from a solid state switch is preferred for best noise immunity. Connect this differential output to terminals J1-27 and J1-28.

A single ended solid-state switch or limit switch should be wired as shown in Figure 3-25. Regardless of the type of switch used, clean rising and falling edges at J1-27 are required for accurate positioning.

Note: A control may require dynamic brake hardware for Orient (Homing) function to work. The control may trip without dynamic brake hardware installed.

Figure 3-25 Typical Home or Orient Switch Connections



5VDC Proximity Switch

Limit Switch (Closed at HOME).

See recommended Terminal Tightening Torques in Section 7.

Buffered Encoder Output The control provides a buffered encoder output on pins J1-31 to J1-38. This output may be used by external hardware to monitor the encoder signals. It is recommended that this output only drive one circuit load (a 26LS31 type device drives this output).

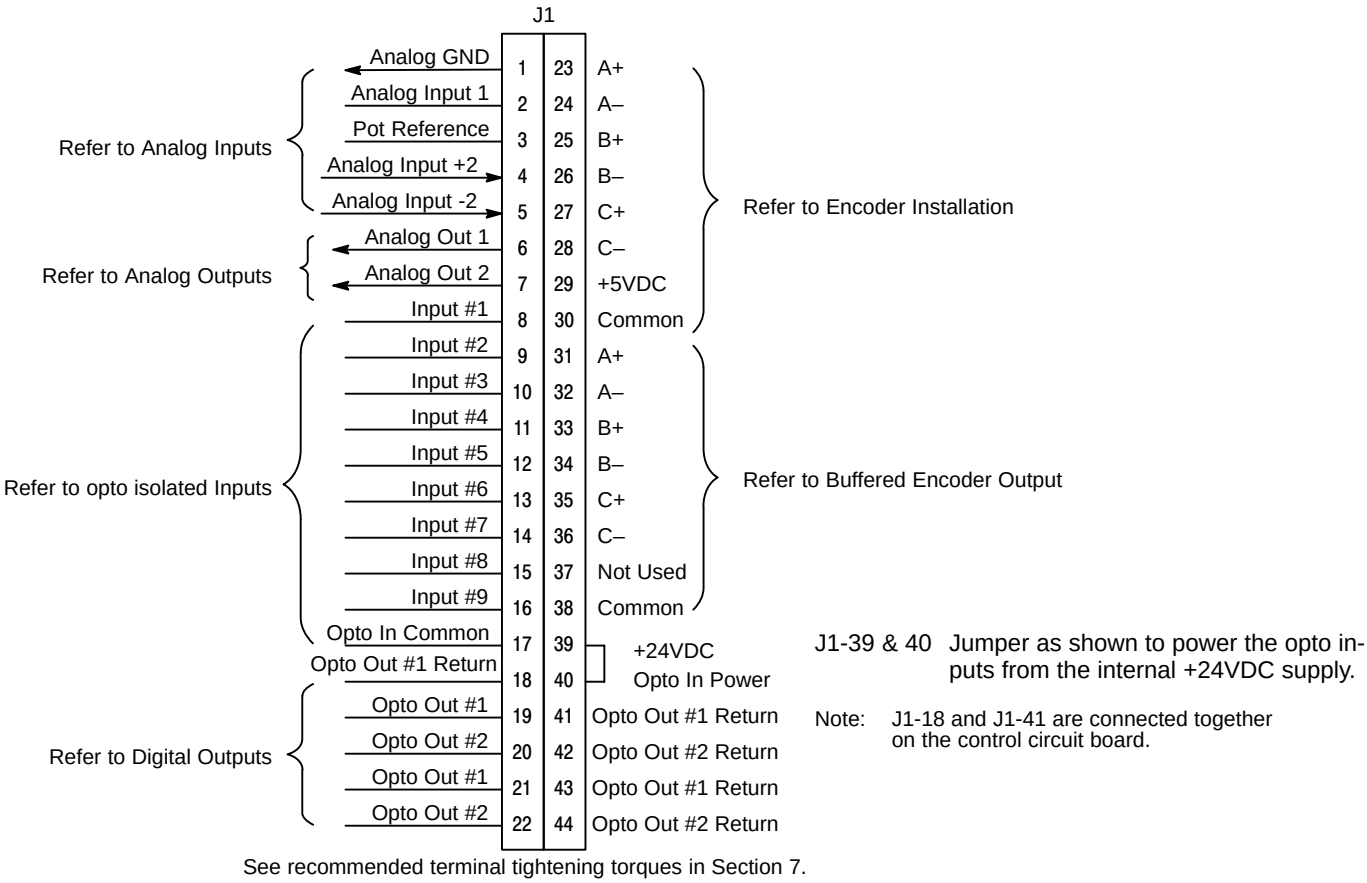
Operating Modes

Ten operating modes are available. These 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 include:

- Keypad
- Standard Run, 3 Wire
- 15 Speed, 2 Wire
- 3 SPD ANA 2 Wire
- 3 SPD ANA 3 Wire
- Bipolar Speed or Torque
- Process Control
- Serial
- Electronic Pot 2 Wire
- Electronic Pot 3 Wire

Each mode requires connections to the J1 terminal strip (except the keypad mode, all connections are optional). The J1 terminal strip is shown in Figure 3-26. The connection of each input or output signal is described in the following pages.

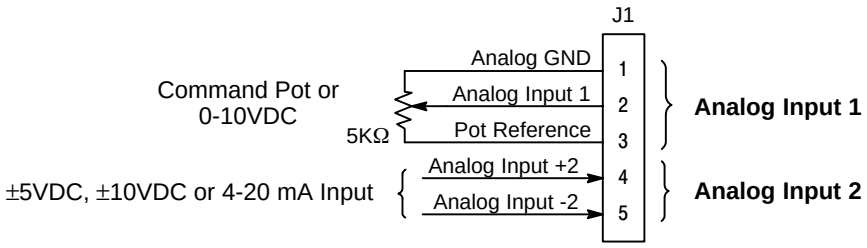
Figure 3-26 Control Signal Connections



Analog Inputs

Two analog inputs are available: analog input #1 (J1-1 and J1-2) and analog input #2 (J1-4 and J1-5) as shown in Figure 3-27. Either analog input may be selected in the Level 1 INPUT block, Command Select parameter value. Analog input #1 is selected if the parameter value is “Potentiometer”. Analog input #2 is selected if the parameter value is “+/-10Volts, +/-5 Volts or 4-20mA”. Figure 3-28 shows the equivalent circuits of the Analog Inputs.

Figure 3-27 Analog Inputs



See recommended terminal tightening torques in Section 7.

Analog Input #1
(Single Ended)

When using a potentiometer as the speed command, process feedback or setpoint source, the Level 1 Input block COMMAND SELECT parameter must be set to “POTENTIOMETER”.

Note: A potentiometer value of 5kΩ to 10kΩ, 0.5 watt may be used.

Parameter Selection

The single ended analog input #1 can be used in one of three ways:

1. Speed or Torque command (Level 1 Input block, Command Select=Potentiometer).
2. Process Feedback (Level 2 Process Control block, Process Feedback=Potentiometer).
3. Setpoint Source (Level 2 Process Control block, Setpoint Source=Potentiometer).

When using Analog Input #1, the respective parameter must be set to “POTENTIOMETER”.

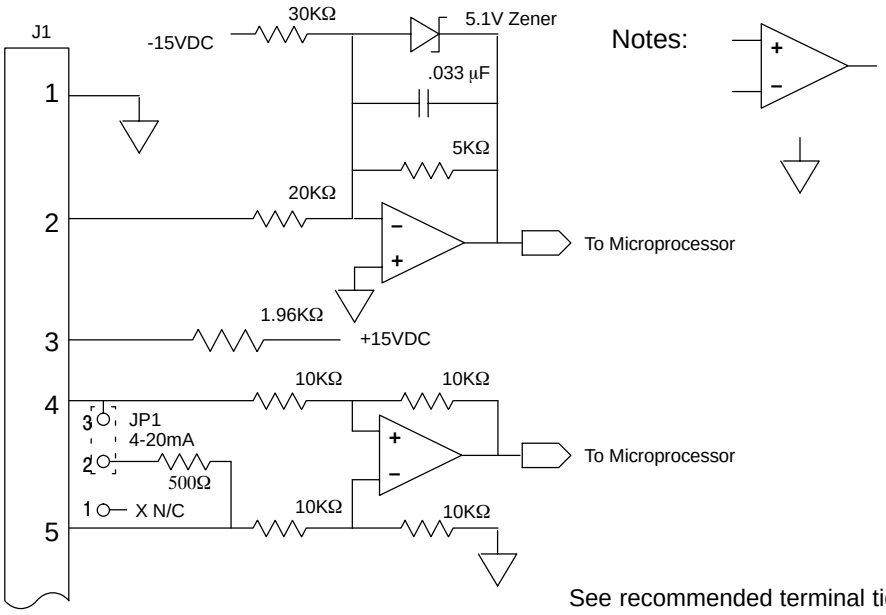
Analog Input #2
(Differential)

Analog input #2 accepts a differential command ±5VDC, ±10VDC or 4-20 mA.
If pin J1-4 is positive with respect to pin 5, the motor will rotate in the forward direction.
If pin J1-4 is negative with respect to pin 5, the motor will rotate in the reverse direction.
JP1 must be set for voltage or current operation as required. 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.

Note: The common mode voltage can be measured with a voltmeter. Apply the maximum command voltage to analog input 2 (J1-4, 5). Measure the AC and DC voltage across J1-1 to J1-4. Add the AC and DC readings together. Measure the AC and DC voltage from J1-1 to J1-5. Add the AC and DC readings together.

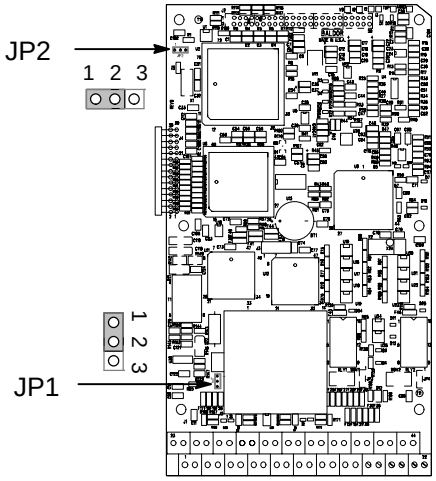
If either of these measurement totals exceeds a total of ±15 volts, then the common mode voltage range has been exceeded. To correct this condition, either change the command source or isolate the command signal with a signal isolator.

Figure 3-28 Analog Inputs Equivalent Circuits



See recommended terminal tightening torques in Section 7.

Figure 3-29 Control Board Jumper Locations



Refer to Table 3-9
for jumper placement information.

See recommended terminal tightening torques in Section 7.

Table 3-9 Control Board Jumper

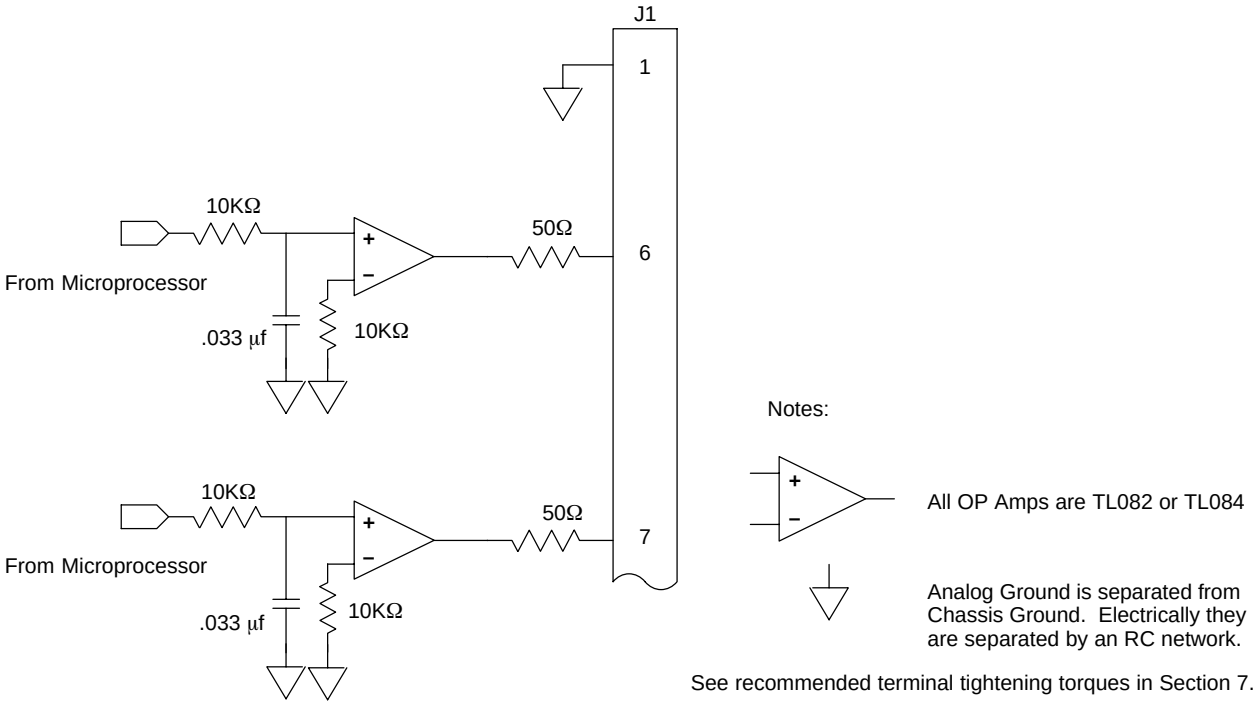
Jumper	Jumper Position	Description of Jumper Position Setting
JP1	1-2	Voltage Speed Command Signal. (Factory Setting)
	2-3	4-20mA input at Analog #2
JP2	1-2	Factory Setting
	2-3	Not used.

Analog Outputs

Two programmable analog outputs are provided on J1-6 and J1-7. See Figure 3-30. These outputs are scaled 0 - 5 VDC (1mA maximum output current) and can be used to 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 J1-1 analog ground. Each output is programmed in the Level 1 Output block.

Figure 3-30 Analog Outputs Equivalent Circuits



See recommended terminal tightening torques in Section 7.

Serial Operating Mode

The Serial operating mode requires one of the optional Serial Interface expansion boards (RS232, RS422 or RS485). Installation and operation information for these serial expansion boards is provided in Serial Communications expansion board manual MN1310. This manual is shipped with the serial expansion boards.

Keypad Operating Mode

The Keypad operating mode allows the control to be operated from the keypad. This mode requires no connections to J1. However, the Enable, Stop and External Trip inputs may optionally be used. All other opto inputs remain inactive. The analog outputs and opto-outputs remain active at all times.

Parameter Selection

For operation in Keypad mode, set the Level 1 Input block, Operating Mode parameter to Keypad. 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.

To use the Enable input, J1-8 must be connected and the Local Enable INP parameter in the Level 2 Protection block must be set to ON. The Enable line is normally closed. When opened, the motor will COAST to a stop. When the enable line is again closed, the motor will not start until a new direction command is received from the keypad.

To use the Stop input, J1-11 must be connected and the Level 1 Keypad Setup block, LOC. Hot Start parameter must be set to ON. The Stop line is normally closed. When opened, the motor will COAST or REGEN to a stop depending upon the setting of Level 1 Keypad Setup block Keypad Stop Mode parameter value. Closing the input will immediately start the motor.

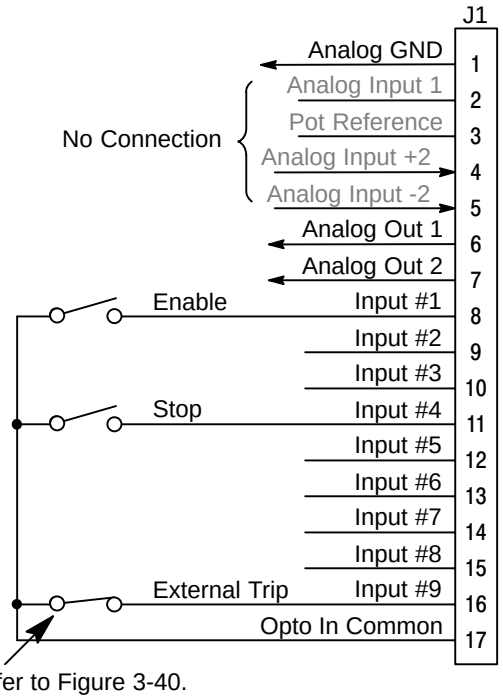
The External Trip input causes a fault condition during a motor over temperature condition (when normally closed input opens). The External Trip input (J1-16) must be connected and the External Trip parameter in the Level 2 Protection block must be set to "ON". When J1-16 is opened, an external trip fault occurs. The control will disable and the motor coasts to a stop. An external trip fault is displayed on the keypad display (also logged into the fault log).

Figure 3-31 Keypad Control Connection Diagram

J1-8 If J1-8 is connected, you must set Level 2 Protection block, Local Enable INP parameter to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN disables the control and motor coasts to a stop.

J1-11 If J1-11 is connected, you must set Level 1 Keypad Setup block, Loc. Hot Start parameter to to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN motor decels to stop (depending on Keypad Stop mode). The motor will restart when J1-11 closes after open (if the keypad FWD or REV key is still pressed).

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



See recommended terminal tightening torques in Section 7.

Standard Run 3 Wire Operating Mode

In Standard Run mode, the control is operated by the opto isolated inputs at J1-8 through J1-16 and the analog command input. The opto inputs can be switches as shown in Figure 3-32 or logic signals from another device.

For 4–20mA operation, refer to Figure 3-29. Analog input 2 can then be used for 4–20mA operation.

Figure 3-32 Standard Run 3-Wire Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and motor coasts to a stop.

J1-9 MOMENTARY CLOSED starts motor operation in the Forward direction. In JOG mode (J1-12 CLOSED), continuous CLOSED jogs motor in the Forward direction.

J1-10 MOMENTARY CLOSED starts motor operation in the Reverse direction. In JOG mode (J1-12 CLOSED), CONTINUOUS closed JOGS motor in the Reverse direction.

J1-11 MOMENTARY OPEN motor decels to stop (depending on Decel time).

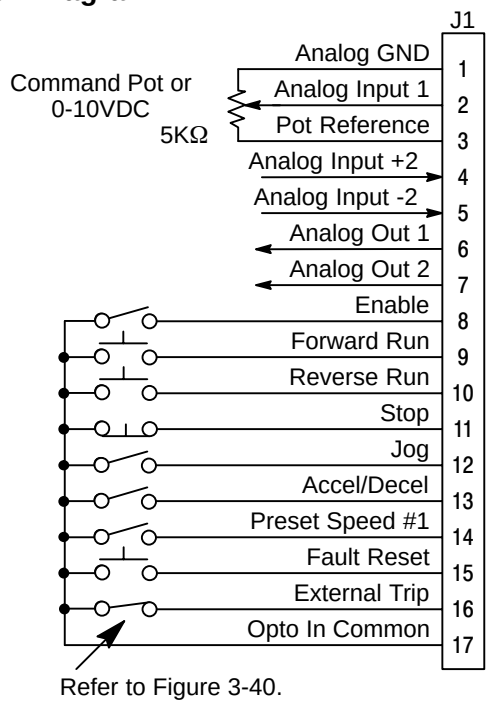
J1-12 CLOSED places control in JOG mode, Forward and Reverse run are used to jog the motor.

J1-13 CLOSED selects ACC / DEC / S-CURVE group 2.
OPEN selects ACC / DEC / S-CURVE group 1.

J1-14 CLOSED selects preset speed #1, (J1-12, will override this preset speed).
OPEN allows speed command from Analog input #1 or #2.

J1-15 CLOSED to reset fault condition.
OPEN to run.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



Refer to Figure 3-40.

See recommended terminal tightening torques in Section 7.

15 Speed 2-Wire Operating Mode

Operation in the 15 Speed 2-Wire mode is controlled by the opto isolated inputs at J1-8 through J1-16. The opto inputs can be switches as shown in Figure 3-33 or logic signals from another device.

Switched inputs at J1-11 through J1-14 allow selection of 15 preset speeds and provide Fault Reset as defined in Table 3-10.

Figure 3-33 15 Speed 2-Wire Control Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and motor coasts to a stop.

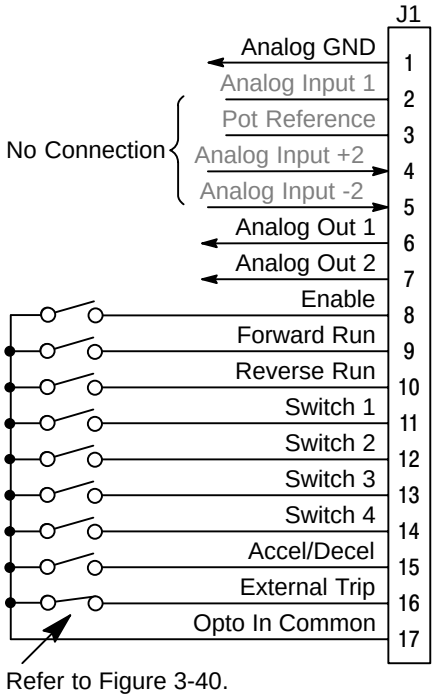
J1-9 CLOSED operates the motor in the Forward direction (with J1-10 open).
OPEN motor decels to stop (depending on Decel time).

J1-10 CLOSED operates motor in the Reverse direction (with J1-9 open).
OPEN motor decels to stop (depending on Decel time).

J1-11-14 Selects programmed preset speeds as defined in Table 3-10.

J1-15 CLOSED selects ACC / DEC / S-CURVE group 2.
OPEN selects ACC / DEC / S-CURVE group 1.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



Refer to Figure 3-40.

See recommended terminal tightening torques in Section 7.

Table 3-10 Switch Truth Table for 15 Speed, 2 Wire Control Mode

Function	J1-11	J1-12	J1-13	J1-14
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

3 Speed Analog 2 Wire Operating Mode

Allows selection of 3 preset speeds with 2 wire inputs. The opto inputs can be switches as shown in Figure 3-34 or logic signals from another device.

The values of the preset speeds are set in the Level 1 Preset Speeds block, Preset Speed #1, Preset Speed #2 and Preset Speed #3.

Figure 3-34 3 SPD ANA 2 Wire Control Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and the motor coasts to a stop.

J1-9 CLOSED operates the motor in the Forward direction (with J1-10 open).
OPEN motor decels to stop (depending on Decel time).

J1-10 CLOSED operates the motor in the Reverse direction (with J1-9 open).
OPEN motor decels to stop (depending on Decel time).

Note: Closing both J1-9 and J1-10 at the same time will reset a fault condition.

J1-11 CLOSED selects Analog Input #1.
OPEN selects Level 1 Input block, Command Select parameter.

Note: If Command Select (Level 1 Input block) is set to Potentiometer, then Analog Input #1 is always selected regardless of this switch position.

J1-12 CLOSED selects STOP/START and Reset commands from terminal strip.
OPEN selects STOP/START and Reset commands from Keypad.

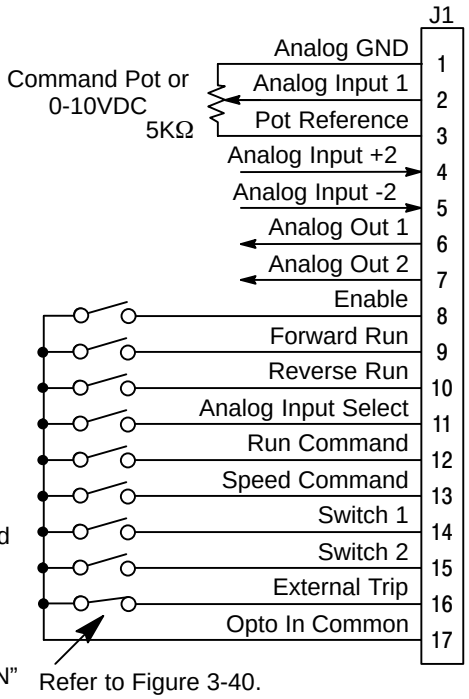
J1-13 CLOSED selects Level 1 Input block, Command Select parameter.
OPEN selects speed commanded from Keypad.

Note: When changing from Terminal Strip to Keypad (J1-12 or J1-13) the motor speed and direction will remain the same after the change.

J1-14 Selects preset speeds as defined in the Speed Select Table (Table 3-11).

J1-15 Selects preset speeds as defined in the Speed Select Table (Table 3-11).

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



See recommended terminal tightening torques in Section 7.

Table 3-11 Speed Select Table

J1-14	J1-15	Command
OPEN	OPEN	Analog Input (Command Select)
CLOSED	OPEN	Preset #1
OPEN	CLOSED	Preset #2
CLOSED	CLOSED	Preset #3

3 Speed Analog 3 Wire Operating Mode

Allows selection of 3 preset speeds with 3 wire inputs. The opto inputs can be switches as shown in Figure 3-35 or logic signals from another device.

The values of the preset speeds are set in the Level 1 Preset Speeds block, Preset Speed #1, Preset Speed #2 and Preset Speed #3.

Figure 3-35 3 SPD ANA 3 Wire Control Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and the motor coasts to a stop.

J1-9 MOMENTARY CLOSED starts motor operation in the Forward direction.

J1-10 MOMENTARY CLOSED starts motor operation in the Reverse direction.

Note: Closing both J1-9 and J1-10 at the same time will reset a fault condition.

J1-11 Momentary OPEN motor decels to stop (depending on Decel time).

J1-12 CLOSED selects STOP/START and Reset commands from terminal strip.
OPEN selects STOP/START and Reset commands from Keypad.

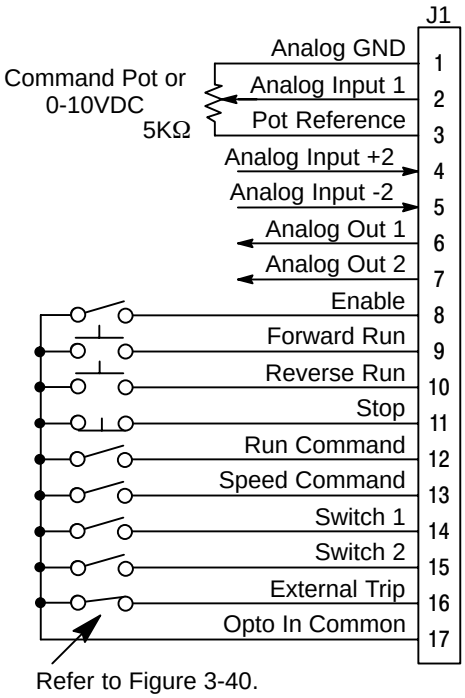
J1-13 CLOSED selects Level 1 Input block, Command Select parameter.
OPEN selects speed commanded from Keypad.

Note: When changing from Terminal Strip to Keypad (J1-12 or J1-13) the motor speed and direction will remain the same after the change.

J1-14 Selects preset speeds as defined in the Speed Select Table (Table 3-12).

J1-15 Selects preset speeds as defined in the Speed Select Table (Table 3-12).

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



See recommended terminal tightening torques in Section 7.

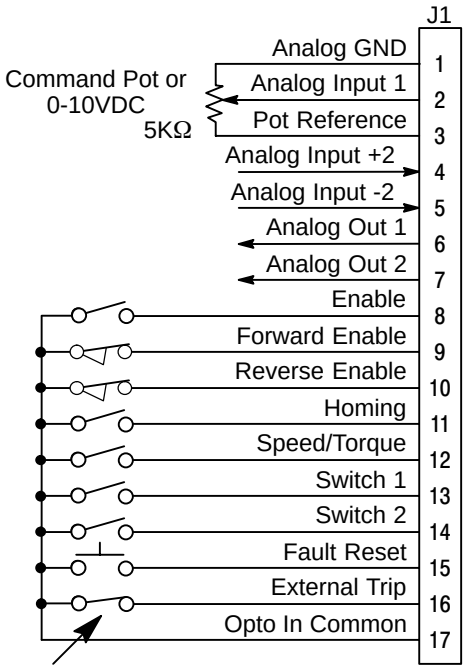
Table 3-12 Speed Select Table

J1-14	J1-15	Command
OPEN	OPEN	Analog Input (Command Select)
CLOSED	OPEN	Preset #1
OPEN	CLOSED	Preset #2
CLOSED	CLOSED	Preset #3

Bipolar Speed or Torque Operating Mode

Provides bipolar speed or torque control. Also, you may store up to four (4) complete sets of operating parameters. This is important if you wish to store and use different acceleration rates, speed commands, jog speeds or to store tuning parameter values for different motors etc. The opto inputs can be switches as shown in Figure 3-36 or logic signals from another device.

Figure 3-36 Bipolar Speed or Torque Connection Diagram



See recommended terminal tightening torques in Section 7.

J1-8 CLOSED allows normal operation.
OPEN disables the control & motor coasts to a stop.

J1-9 CLOSED to enable operation in the Forward direction.
OPEN TO DISABLE Forward operation (drive will brake to a stop if a Forward command is still present).
Reverse operation is still possible if J1-10 is closed.

J1-10 CLOSED to enable operation in the Reverse direction.
OPEN to disable Reverse operation (drive will brake to a stop if a Reverse command is still present).
Forward operation is still possible if J1-9 is closed.

Note: If J1-9 and J1-10 are both opened, the drive will brake to a stop.

J1-11 CLOSED causes the motor to rotate in the forward direction until the load reaches a marker or external switch location.
OPEN allows normal operation.

J1-12 CLOSED puts the control in torque command mode.
OPEN puts the control in speed (velocity) command mode.

Note: If a stop command is issued while in the torque (current) mode, the control will stop but will not maintain position (zero current). This is different than zero speed operation for the velocity mode.

J1-13 & 14 Select from four parameter tables as defined in Table 3-13.

J1-15 Momentary CLOSED to reset fault condition.
OPEN allows normal operation.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).

Table 3-13 Bipolar Mode Table Select Truth Table

Function	J1-13	J1-14
Parameter Table #0	Open	Open
Parameter Table #1	Closed	Open
Parameter Table #2	Open	Closed
Parameter Table #3	Closed	Closed

Note: See multiple parameter sets.

Multiple Parameter Sets

The following procedure allows you to program up to four complete sets of parameter values and to use these multiple parameter sets. When programming each parameter set, use the ENTER key to accept and automatically save parameter values.

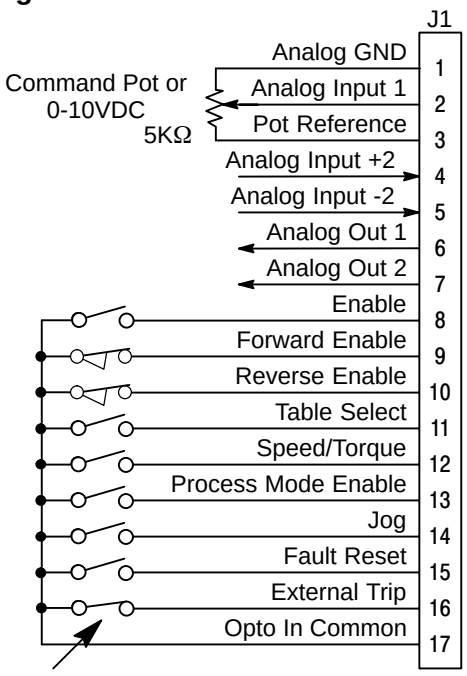
Note: The control can be programmed in the REMOTE mode with the drive enabled. The control must be disabled to change the operating mode parameter and the operating mode can not be stored in a parameter table.

Note: Preset speed does not apply to table select.

1. If this is a new installation, do this procedure after the Pre-Operation Checklist and Power-Up Procedures at the end of this section.
2. Set the Level 1 INPUT block, Operating Mode parameter value to BIPOLAR in each of the parameter sets.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.

Process Operating Mode

Figure 3-37 Process Mode Connection Diagram



J1-8 CLOSED allows normal operation.
OPEN disables the control & motor coasts to a stop.

J1-9 CLOSED to enable operation in the Forward direction.
OPEN TO DISABLE Forward operation (drive will brake to a stop if a Forward command is still present). Reverse operation is still possible if J1-10 is closed.

J1-10 CLOSED to enable operation in the Reverse direction.
OPEN to disable Reverse operation (drive will brake to a stop if a Reverse command is still present). Forward operation is still possible if J1-9 is closed.

Note: If J1-9 and J1-10 are both opened, the drive will brake to a stop.

J1-11 CLOSED = TABLE 1, OPEN = TABLE 0. (See multiple parameter sets.)

J1-12 CLOSED, the control is in torque command mode.
OPEN, the control is in speed (velocity) command mode.

Note: If a stop command is issued while in the torque (current) mode, the control will stop but will not maintain position (zero current). This is different than zero speed operation for the velocity mode.

J1-13 CLOSED to enable the Process Mode.

J1-14 CLOSED places control in JOG mode. The control will only JOG in the forward direction.

J1-15 CLOSED to reset a fault condition.
OPEN to run.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).

See recommended terminal tightening torques in Section 7.

Table 3-14 Process Mode Input Signal Compatibility

Setpoint or Feedforward	Feedback						
	J1-1 & 2	**J1-4 & 5**	**5V EXB [1]**	**10V EXB [1]**	**4-20mA EXB [1]**	**3-15 PSI EXB [2]**	**DC Tach EXB [3]**
J1-1 & 2	■						
J1-4 & 5		■					
5V EXB [1]			■	■	■	▨	
10V EXB [1]			■	■	■	▨	
4-20mA EXB [1]			■	■	■	▨	
3-15 PSI EXB [2]			▨	▨	▨	■	
DC Tach EXB [3]							■
EXB PULSE FOL [4] [5]							▨
Serial [5] [6]			▨	▨	▨	▨	

[1] Requires expansion board EXB007A01 (High Resolution Analog I/O EXB).

[2] Requires expansion board EXB004A01 (4 Output Relays/3-15 PSI Pneumatic Interface EXB).

[3] Requires expansion board EXB006A01 (DC Tachometer Interface EXB).

[4] Requires expansion board EXB005A01 (Master Pulse Reference/Isolated Pulse Follower EXB).

[5] Used for Feedforward only. Must not be used for Setpoint Source or Feedback.

[6] Requires expansion board EXB001A01 (RS232 Serial Communication EXB). or
Requires expansion board EXB002A01 (RS422/RS485 High Speed Serial Communication EXB).

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

▨ Conflicting level 1 or 2 expansion boards. Do not use!

Electronic Pot 2 Wire Operating Mode

Provides speed Increase and Decrease inputs to allow EPOT operation with 2 wire inputs. The opto inputs can be switches as shown in Figure 3-38 or logic signals from another device. The values of the preset speeds are set in the Level 1 Preset Speeds block, Preset Speed #1 or Preset Speed #2.

Figure 3-38 EPOT, 2 Wire Control Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and motor coasts to a stop.

J1-9 CLOSED starts motor operation in the Forward direction.
OPEN motor decels to stop (depending on Decel time).

J1-10 CLOSED starts motor operation in the Reverse direction.
OPEN motor decels to stop (depending on Decel time).

Note: Closing both J1-9 and J1-10 at the same time will reset a fault condition.

J1-11 Selects preset speeds as defined in the Speed Select Table (Table 3-15).

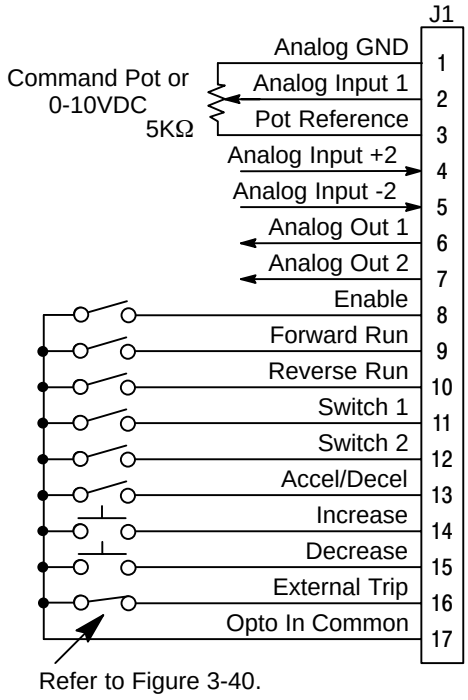
J1-12 Selects preset speeds as defined in the Speed Select Table (Table 3-15).

J1-13 CLOSED selects ACC / DEC / S-CURVE group 2.
OPEN selects ACC / DEC / S-CURVE group 1.

J1-14 Momentary CLOSED increases motor speed while contact is closed.

J1-15 Momentary CLOSED decreases motor speed while contact is closed.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



See recommended terminal tightening torques in Section 7.

Table 3-15 Speed Select Table

J1-11	J1-12	Function
OPEN	OPEN	Electronic Pot Command Select *
CLOSED	OPEN	
OPEN	CLOSED	Preset #1
CLOSED	CLOSED	Preset #2

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

Electronic Pot 3 Wire Control Mode

Provides speed Increase and Decrease inputs to allow EPOT operation with 3 wire inputs. The opto inputs can be switches as shown in Figure 3-39 or logic signals from another device.

Figure 3-39 EPOT, 3 Wire Control Connection Diagram

J1-8 CLOSED allows normal operation.
OPEN disables the control and motor coasts to a stop.

J1-9 Momentary CLOSED starts motor operation in the Forward direction.

J1-10 Momentary CLOSED starts motor operation in the Reverse direction.

Note: Closing both J1-9 and J1-10 at the same time will reset a fault condition.

J1-11 Momentary OPEN motor decels to stop (depending on Decel time).

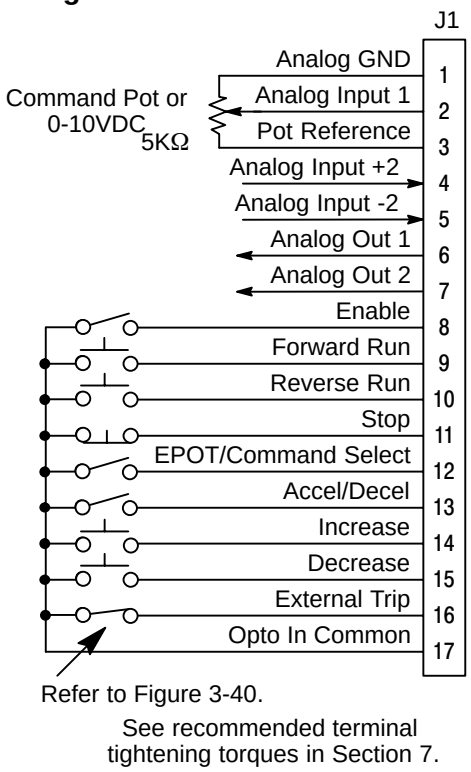
J1-12 CLOSED selects Level 1 Command Select parameter value.
OPEN selects EPOT.

J1-13 CLOSED selects ACC / DEC / S-CURVE group 2.
OPEN selects ACC / DEC / S-CURVE group 1.

J1-14 Momentary CLOSED increases motor speed while contact is closed.

J1-15 Momentary CLOSED decreases motor speed while contact is closed.

J1-16 If J1-16 is connected, you must set Level 2 Protection block, External Trip to "ON" to activate the opto input.
CLOSED allows normal operation.
OPEN causes an external trip fault. The control will disable and the motor coasts to a stop. An external trip fault is displayed (also logged in the fault log).



Refer to Figure 3-40.

See recommended terminal tightening torques in Section 7.

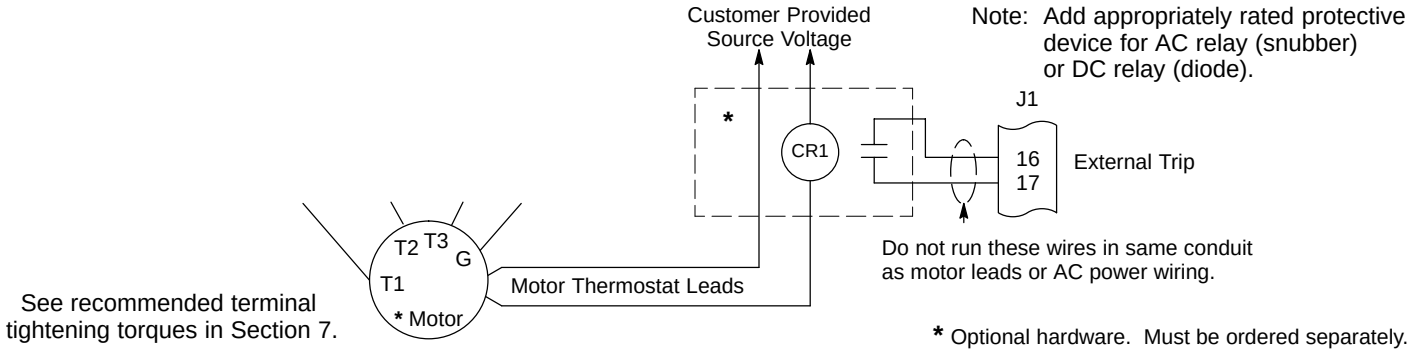
External Trip Input

Terminal J1-16 is available for connection to a normally closed thermostat or overload relay in all operating modes as shown in Figure 3-40. 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, the control will automatically shut down and give an External Trip fault. The optional relay (CR1) shown provides the isolation required and the N.O. contact is open when power is applied to the relay and the motor is cold. If the motor thermostat is tripped, CR1 is de-energized and the N.O. contact closes.

Connect the External Trip Input wires (N.O. relay contact) to J1-16 and J1-17. Do not place these wires in the same conduit as the motor power leads.

To activate the External Trip input, the External Trip parameter in the Level 2 Protection Block must be set to “ON”.

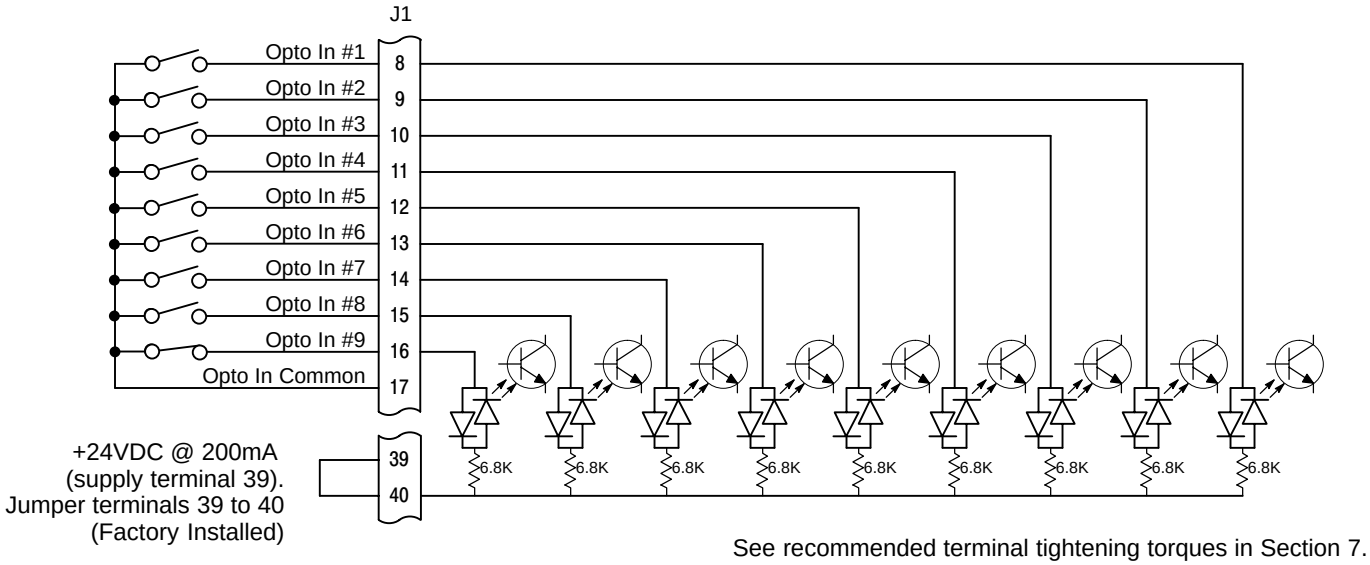
Figure 3-40 Motor Temperature Relay



Opto-Isolated Inputs

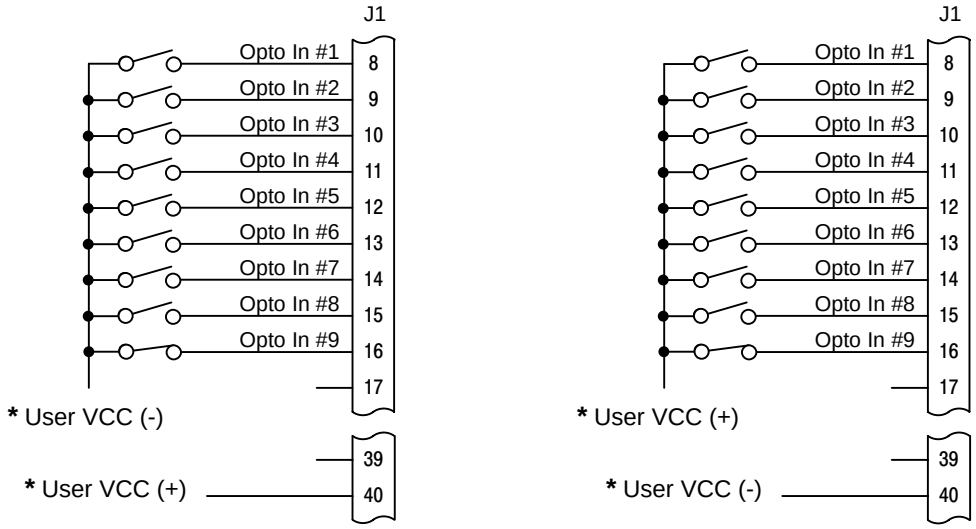
The equivalent circuit of the nine opto inputs is shown in Figure 3-41. The function of each input depends on the operating mode selected and are described previously in this section. This Figure also shows the connections using the internal opto input Supply.

Figure 3-41 Opto-Input Connections (Using Internal Supply)



See recommended terminal tightening torques in Section 7.

Figure 3-42 Opto-Input Connections (Using External Supply)



Opto Inputs Closing to Ground **Opto Inputs Closing to +VCC**

***** User VCC = 10 - 30VDC External Power Source

See recommended terminal tightening torques in Section 7.

Digital Outputs

Four programmable outputs are available at terminals J1-19 through J1-22. Each output may be programmed to represent one output condition. The output conditions are defined in Table 4-2 of Section 4 of this manual.

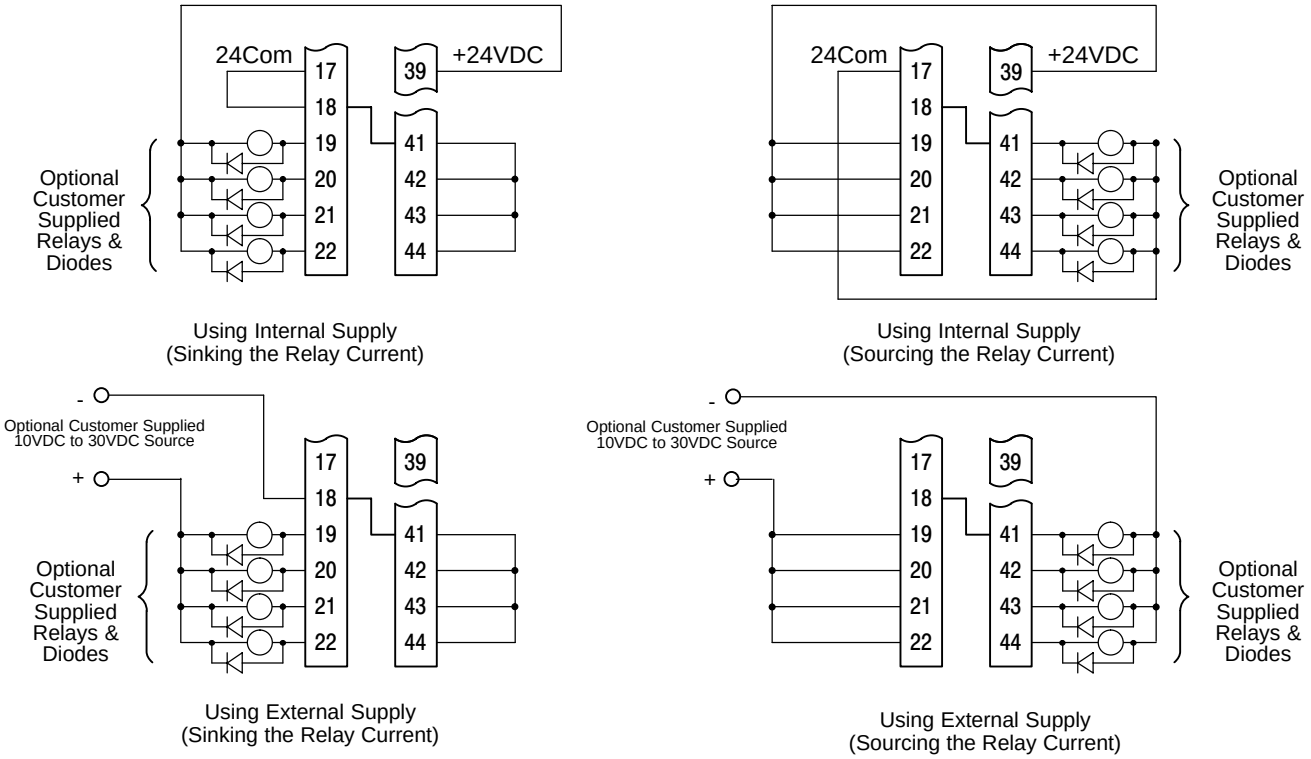
Opto Isolated Outputs

The outputs are opto isolated and may be configured for sinking or sourcing 60 mA each, as shown in Figure 3-43. However, all must be configured the same. The maximum voltage from opto output to common when active is 1.0 VDC (TTL compatible). The equivalent circuit for the opto isolated outputs is shown in Figure 3-44.

If the opto outputs are used to directly drive a relay, a flyback diode rated at 1A, 100 V (IN4002 or equivalent) minimum should be connected across the relay coil.

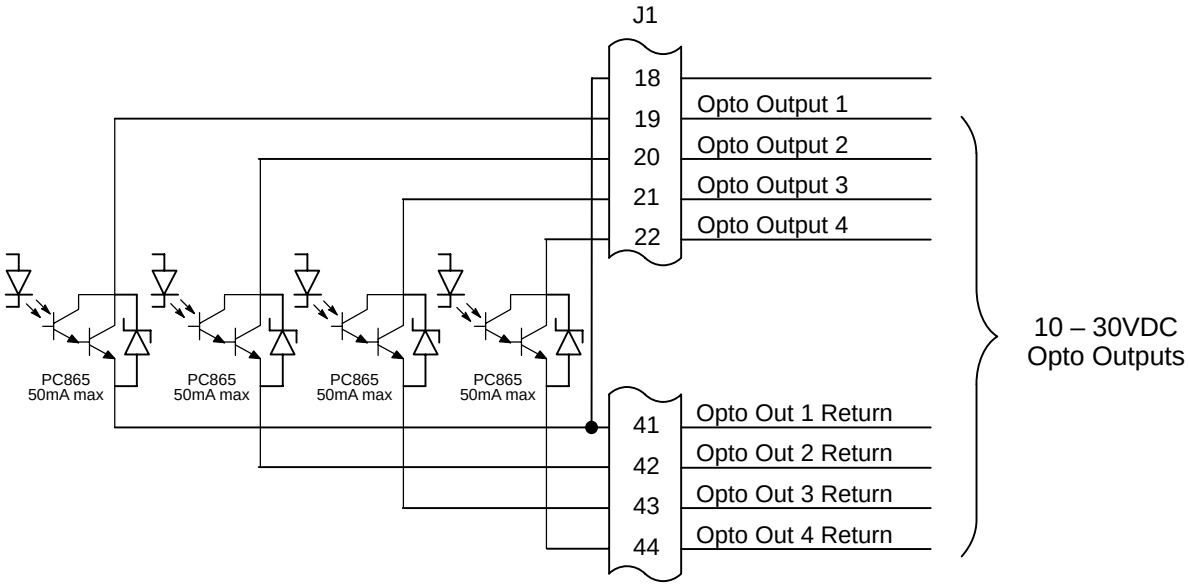
Each opto output is programmed in the Output programming block.

Figure 3-43 Opto-isolated Output Configurations



See recommended terminal tightening torques in Section 7.

Figure 3-44 Opto-Output Equivalent Circuit



See recommended Terminal Tightening Torques in Section 7.

Pre-Operation Checklist

Check of Electrical Items

1. Verify AC line voltage at source matches 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 polarity diodes for DC coils. MOV type transient suppression is not adequate.

Check of Motor and Coupling

1. Verify freedom of motion of motor shaft.
2. Verify the motor coupling is tight without backlash.
3. 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 system up and running in the keypad mode quickly. This will allow you to prove the motor and control operation. This procedure assumes that the Control, Motor and Dynamic Brake hardware are correctly installed and that you have an understanding of the keypad programming & operation procedures (Section 4 of this manual).

1. Verify that any enable inputs to J1-8 are open.
2. Turn power on. Be sure there are no faults.
3. Set the Level 1 Input block, Operating Mode to “KEYPAD”.
4. Be sure the Level 2 Protection block, Local Enable INP parameter is OFF and the Level 2 Protection block, External Trip parameter is OFF.
5. Set the Level 2 Output Limits block, “OPERATING ZONE” parameter as desired (STD CONST TQ, STD VAR TQ, QUIET CONST TQ or QUIET VAR TQ).
6. 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)
   Encoder Counts
7. If external dynamic brake hardware is used, set the Level 2 Brake Adjust block “Resistor Ohms” and “Resistor Watts” parameters.
8. Go to Level 2 Motor Data block, press ENTER, at CALC PRESETS select YES (using the ▲ key) and let the control calculate preset values for the parameters that are necessary for control operation.
9. 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, 12, 16, 17 and 18.

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

10. Go to Level 2 Autotune block, and do the following tests:
    CMD OFFSET TRIM
    CUR LOOP COMP
    STATOR R1
    FLUX CUR SETTING
    ENCODER TESTS
    SLIP FREQ TEST
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. Remove all power from the control.
14. Couple the motor to its load.
15. Turn power on. Be sure no errors are displayed.
16. Go to Level 2 Autotune block and perform the SPD CNTRLR CALC test.
17. Run the drive from the keypad using one of the following: the arrow keys for direct speed control, a keypad entered speed or the JOG mode.
18. Select and program additional parameters to suit your application.

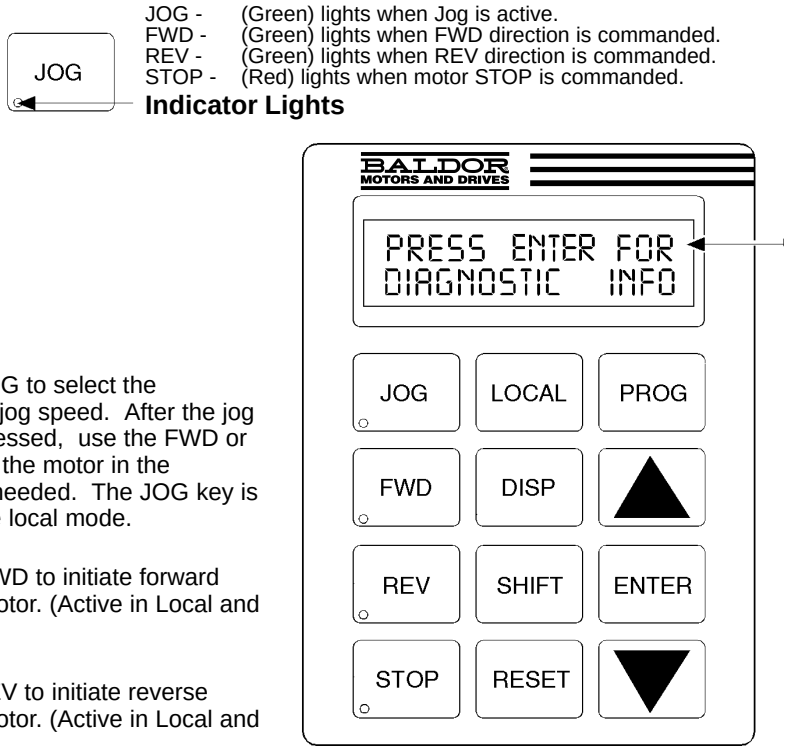
The control is now ready for use the in keypad mode. If a different operating mode is desired, refer to Section 3 Control Connections and Section 4 Programming and Operation.

Section 4
Programming and Operation

Overview

The keypad is used to program the control parameters, to operate the motor and to monitor the status and outputs of the control by accessing the display options, the diagnostic menus and the fault log.

Figure 4-1 Keypad



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. (Active in Local and Jog modes).

REV - Press REV to initiate reverse rotation of the motor. (Active in Local and Jog modes).

STOP - Press STOP one time 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. Press STOP twice to disable control (coast to stop).

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 J1 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 including the diagnostic screens.

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 ENTER 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

The control is in the display mode at all times except when parameter values are changed (Programming mode). The Keypad Display shows the status of the control as in the following example.

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		
Press DISP Key	Places control in display mode		
Press SHIFT SHIFT	Allows display contrast adjustment		
Press ▲ or ▼ Key	Adjusts display intensity	ADJUST CONTRAST ▲▼[ENTER] TO SAVE	
Press ENTER	Saves level of contrast and exits to display mode	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Typical display

Display Mode Screens

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing motor speed.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	No faults present. Local keypad mode. If in remote/serial mode, press local for this display.
Press DISP key	Screen to enter Fault Log	PRESS ENTER FOR FAULT LOG	
Press DISP key	Screen to enter Diagnostic Menu	PRESS ENTER FOR DIAGNOSTIC INFO	
Press DISP key	Display motor speed and direction	STOP MOTOR SPEED LOCAL 0 RPM	
Press DISP key	Display mode custom unit output rate (only if Level 2 Custom Units block parameters are set).	STOP OUTPUT RATE LOCAL 00000 XXXX	
Press DISP key	Display Frequency	STOP FREQUENCY LOCAL 0.00 HZ	
Press DISP key	Display Current	STOP CURRENT OUT LOCAL 0.00 A	
Press DISP key	Display Voltage	STOP VOLTAGE OUT LOCAL 0 V	

Program Mode

The Program Mode is used to:

1. Enter motor data.
2. Autotune the motor.
3. Customize the drive (Control and Motor) parameters to your application.

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 change 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 the motor is operating. 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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode.
	If no faults and programmed for REMOTE operation.	STP 0V 0 RPM REM 0.0A 0.0 HZ	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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	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.	PRESS ENTER FOR INPUT	Press ENTER to access INPUT block parameter.
Press ENTER key	Access Input Block.	OPERATING MODE P: KEYPAD	Keypad mode shown is the factory setting.
Press ENTER key	Access Operating Mode parameter.	OPERATING MODE ⇳□ KEYPAD	Keypad mode shown is the factory setting.
Press ▲ key	Scroll to change selection.	OPERATING MODE ⇳□ BIPOLAR	At flashing cursor, select desired mode, BIPOLAR in this case.
Press ENTER	Save selection to memory.	OPERATING MODE P: BIPOLAR	Press ENTER to save selection.
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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	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. Be sure to change the Level 2 Motor Data block "Motor Rated Amps" to the correct value after this procedure (restored factory setting is 999).

Note: All parameter values already programmed will be changed when resetting the control to factory settings.

Note: After factory settings are restored, the drive must be autotuned.

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	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	Exit Level 2 blocks.
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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.

Operation Examples

Operating the Control from the Keypad

If the control is configured for remote or serial control, the LOCAL Mode must be activated before the control may be operated from the keypad. To activate the LOCAL Mode, first the motor must be stopped using the keypad STOP key (if enabled), remote commands or serial commands.

Note: Pressing the keypad STOP key (if enabled) will automatically issue a motor stop command and change to LOCAL mode.

When the motor has stopped, the LOCAL Mode is activated by pressing the “LOCAL” key. Selection of the LOCAL Mode overrides any remote or serial control inputs except for the External Trip input, Local Enable Input or STOP input.

The control can operate the motor in three (3) different ways from the keypad.

1. JOG Command.
2. Speed adjustment with Keypad entered values.
3. Speed adjustment using the Keypad arrow keys.

Note: If the level 1, input block operating mode parameter is set to Keypad, then no other means of operation is permitted other than from the keypad.

Accessing the Keypad JOG Command

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.
Press JOG key	Access programmed JOG speed.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	JOG key LED on.
Press and hold FWD or REV key	Move control forward or reverse at JOG speed.	FWD 30V 200 RPM LOC 6.3A 6.5HZ	Control runs while FWD or REV key is pressed. JOG & FWD (or REV) LED’s on.
Press JOG key	Disables JOG mode.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	JOG LED off. Stop key LED on.

Speed Adjustment using Local Speed Reference

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.
Press ENTER key	Select the local speed reference.	LOCAL SPEED REF ▲▼ 0000 0 RPM	
Press SHIFT key	Move blinking cursor right one digit.	LOCAL SPEED REF ▲▼ 0000 0 RPM	☐ represents blinking cursor.
Press ▲ key	Increase hundreds value by one digit.	LOCAL SPEED REF ▲▼ 0100 0 RPM	
Press ENTER key	Save new value and return to display mode.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	
Press FWD or REV key	Motor runs FWD or REV at commanded speed.	FWD 16V 100 RPM LOC 6.3A 3.2HZ	FWD (REV) LED on.
Press STOP key	Motor stop command issued.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.

Speed Adjustment Using Arrow Keys

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.
Press FWD or REV key	Motor runs FWD or REV at selected speed.	FWD 16V 100 RPM LOC 6.3A 3.2HZ	FWD key LED on.
Press ▲ key	Increase motor speed.	FWD 78V 500 RPM LOC 6.3A 16.6HZ	Display mode.
Press ▼ key	Decrease motor speed.	FWD 30V 200 RPM LOC 6.3A 6.5HZ	Display mode.
Press STOP key	Motor stop command issued.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.
Press FWD or REV key	Motor runs FWD or REV at commanded speed.	FWD 30V 200 RPM LOC 6.3A 6.5HZ	Motor runs at previously set speed.
Press STOP key	Motor stop command issued.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.

Security System Changes

Access to programmed parameters can be protected from change by the security code feature. The Security Code is defined by setting the Level 2 Security Control block. To implement the security feature, use the following procedure:

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	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	Access Level 2 Blocks.	PRESS ENTER FOR OUTPUT LIMITS	
Press ▲ or ▼ key	Scroll to the Security Control block.	PRESS ENTER FOR SECURITY CONTROL	
Press ENTER key	Access the Security Control block.	SECURITY STATE P: OFF	
Press ENTER key		SECURITY STATE ▲▼ □ OFF	□ represents blinking cursor.
Press ▲ key	Scroll to local security	SECURITY STATE ▲▼ LOCAL SECURITY	
Press ENTER key	Save value	SECURITY STATE ▲▼ LOCAL SECURITY	
Press ENTER key	Set the Access Code	ACCESS CODE? P: 9999	
Press ENTER key	The Access Code parameter can be changed.	ACCESS CODE? P: 9999 9999	□ represents blinking cursor.
Press ▼ key	Use ▼ key to change value. Example: 8999.	ACCESS CODE? P: 8999 9999	□ represents blinking cursor.
Press ENTER key	Save Access Code parameter	ACCESS CODE? P: 9999	Keypad Display will not show user access code. Record its' value for future reference.
Press DISP key	Return to Display mode.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	

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 Baldor. Be prepared to give the 5 digit code located on the lower right side of the Keypad Display at the Enter Code parameter prompt.

Changing Parameter Values with a Security Code in Use

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Display mode. Stop LED on.
Press PROG key	Enter program mode.	PRESS ENTER FOR PRESET SPEEDS	
Press ▲ or ▼ key	Scroll to Input block.	PRESS ENTER FOR INPUT	
Press ENTER key	Access Input block to change Operating Mode setting.	OPERATING MODE L: KEYPAD	L: shows parameter is Locked.
Press ENTER key	When security on, parameter values cannot be changed.	ACCESS CODE? ▲▼ 9999 23956	
Press ▼ key	Enter the Access Code . Example: 8999.	ACCESS CODE? ▲▼ 8999 23956	☐ represents blinking cursor.
Press ENTER key		OPERATING MODE P: KEYPAD	
Press ENTER key		OPERATING MODE ▲▼ KEYPAD	
Press ▲ or ▼ key	Scroll to make your selection.	OPERATING MODE ▲▼ STANDARD RUN	
Press ENTER	Save selected parameter	OPERATING MODE P: STANDARD RUN	P: will change to L: after you return to Display mode for longer than the time specified in the Access Timeout parameter.
Press ▲ or ▼ key	Scroll to Menu Exit.	PRESS ENTER FOR MENU EXIT	
Press ENTER key	Returns to Input block.	PRESS ENTER FOR INPUT	
Press DISP key	Return to Display mode.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Typical display mode.

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 Baldor. Be prepared to give the 5 digit code located on the lower right side of the keypad display at the enter code prompt.

Security System Access Timeout Parameter Change

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.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	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	Access Level 2 Blocks.	PRESS ENTER FOR OUTPUT LIMITS	
Press ▲ or ▼ key	Scroll to the Security Control block.	PRESS ENTER FOR SECURITY CONTROL	
Press ENTER key	Access the Local Security block.	SECURITY STATE L:LOCAL SECURITY	
Press ▲ key	Scroll to the Access Timeout parameter.	ACCESS TIMEOUT L: 0 SEC	
Press ENTER key	Attempt to access the Access Timeout parameter.	ACCESS CODE? ▲▼ 9999 23956	☐ represents blinking cursor.
Press ▼ key	Use ▼ key to change value. Example: 8999.	ACCESS CODE? ▲▼ 8999 23956	Note: Ignore the 5 digit number to the right (example: 23956).
Press ENTER key	Save Access Code parameter	ACCESS TIMEOUT ▲▼ 000 0 S	Security code entered is correct. All parameters may be changed.
Press SHIFT key.	Move cursor right on digit.	ACCESS TIMEOUT ▲▼ 0 0 0 0 S	Access Timeout can be any value between 0 and 600 seconds.
Press ▲ key 3 times	Change the 0 to 3.	ACCESS TIMEOUT ▲▼ 0 3 0 0 SEC	Example: 30 seconds.
Press ENTER key	Save value.	ACCESS TIMEOUT P: 30 S	P: will change to L: after you return to Display mode for longer than the time specified in the Access Time parameter.
Press DISP key	Return to Display mode.	STP 0V 0 RPM LOC 0.0A 0.0 HZ	Typical display mode.

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 Baldor. Be prepared to give the 5 digit code located on the lower right side of the Keypad Display at the Enter Code prompt.

Parameter Definitions

To make programming easier, parameters have been arranged as shown in Table 4-1. Press the PROG key to enter the programming mode and the "Preset Speeds" programming block will be displayed. Use the Up (▲) and Down (▼) arrows to scroll through the parameter blocks. Press ENTER to access parameters within a programming 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 preset value for each parameter and has space to record your settings for future reference.

Table 4-1 List of Parameters (Version 3.20)

LEVEL 1 BLOCKS		LEVEL 2 BLOCKS	
Preset Speeds	**Input**	**Output Limits**	**Brake Adjust**
Preset Speed #1	Operating Mode	Operating Zone	Resistor Ohms
Preset Speed #2	Command Select	Min Output Speed	Resistor Watts
Preset Speed #3	ANA CMD Inverse	Max Output Speed	DC Brake Current
Preset Speed #4	ANA CMD Offset	PK Current Limit	
Preset Speed #5	ANA 2 Deadband	PWM Frequency	**Process Control**
Preset Speed #6	ANA1 CUR Limit	Current Rate Limit	Process Feedback
Preset Speed #7			Process Inverse
Preset Speed #8	**Output**	**Custom Units**	Setpoint Source
Preset Speed #9	Opto Output #1	Decimal Places	Setpoint Command
Preset Speed #10	Opto Output #2	Value at Speed	Set PT ADJ Limit
Preset Speed #11	Opto Output #3	Units of Measure	Process ERR TOL
Preset Speed #12	Opto Output #4		Process PROP Gain
Preset Speed #13	Zero SPD Set PT	**Protection**	Process INT Gain
Preset Speed #14	At Speed Band	Overload	Process DIFF Gain
Preset Speed #15	Set Speed	External Trip	Follow I:O Ratio
	Analog Out #1	Local Enable INP	Follow I:O Out
Accel / Decel Rate	Analog Out #2	Following Error	Master Encoder
Accel Time #1	Analog #1 Scale	Torque Proving	
Decel Time #1	Analog #2 Scale		**Communications**
S-Curve #1	Position Band	**Miscellaneous**	Protocol
Accel Time #2		Restart Auto/Man	Baud Rate
Decel Time #2	**Vector Control**	Restart Fault/Hr	Drive Address
S-Curve #2	Ctrl Base Speed	Restart Delay	
	Feedback Filter	Factory Settings	**Auto-Tuning**
Jog Settings	Feedback Align	Homing Speed	CALC Presets
Jog Speed	Current PROP Gain	Homing Offset	CMD Offset Trim
Jog Accel Time	Current INT Gain		CUR Loop Comp
Jog Decel Time	Speed PROP Gain	**Security Control**	Stator R1
Jog S-Curve Time	Speed INT Gain	Security State	Flux CUR Setting
	Speed DIFF Gain	Access Timeout	Feedback Test
Keypad Setup	Position Gain	Access Code	Slip Freq Test
Keypad Stop Key	Slip Frequency		SPD CNTRLR CALC
Keypad Stop Mode	Stator R1	**Motor Data**	
Keypad Run Fwd	Stator X1	Motor Voltage	
Keypad Run Rev	Prop Gain #1	Motor Rated Amps	
Keypad Jog Fwd	Int Gain #1	Motor Rated SPD	
Keypad Jog Rev		Motor Rated Freq	
Loc. Hot Start		Motor Mag Amps	
		Encoder Counts	
		Resolver Speeds	
		CALC Presets	

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 terminals at J1. 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.
	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 and Decel time and provides smooth starts and stops. Half of programmed S-Curve % applies to Accel and half to Decel ramps. 0% represents no "S" and 100% represents full "S" with no linear segment. 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. Note: If drive faults occur during rapid Accel or Decel, selecting an S-curve may eliminate the faults.
JOG SETTINGS	Jog Speed	Jog Speed is the programmed speed used during jog. Jog can be initiated from the keypad or terminal strip. At the Keypad, press the JOG key then press and hold the direction (FWD or REV). For Standard Run mode, close the JOG input (J1-12) at the terminal strip then close and maintain the direction input (J1-9 or J1-10). Process Control mode operation is different. If the terminal strip Process Mode Enable input (J1-13) is closed, pressing the Keypad JOG key (or closing J1-14) will cause the drive to move in the direction of the error (without pressing FWD or REV).
	Jog Accel Time	Jog Accel Time changes the Accel Time to a new preset value for jog mode.
	Jog Decel Time	Jog Decel Time changes the Decel Time to a new preset value for jog mode.
	Jog S-Curve	Jog S-Curve changes the S-Curve to a new preset value for jog mode.

Figure 4-2 40% S-Curve Example

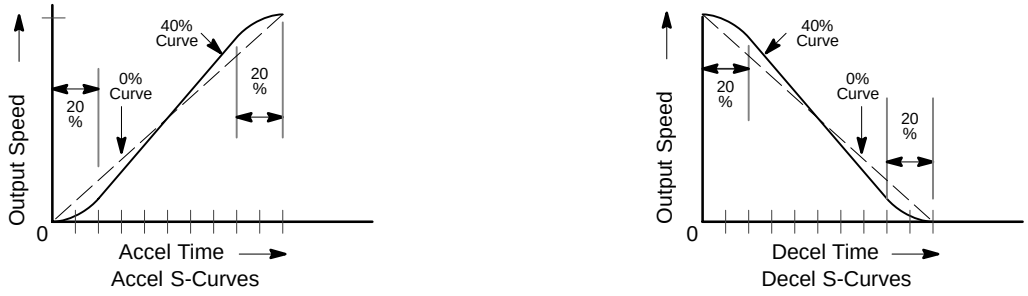


Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
KEYPAD SETUP	Keypad Stop Key	Remote OFF Keypad STOP key is not active. Remote ON Allows keypad STOP key to initiate motor stop during remote or serial operation. If active, pressing STOP selects Local mode and initiates the stop command.
	Keypad Stop Mode	Stop Mode - Selects if the Stop command 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.
	Keypad Run FWD	Run FWD - OFF disables FWD key in Local mode. ON makes the keypad FWD key active in Local mode.
	Keypad Run REV	Run REV - OFF disables REV key in Local mode. ON makes the keypad REV key active in Local mode.
	Keypad Jog FWD	Jog FWD - OFF disables FWD key in Local Jog mode. ON makes the keypad FWD key active in Local Jog mode.
	Keypad Jog REV	Jog REV - OFF disables REV key in Local Jog mode. ON makes the keypad REV key active in Local Jog mode.
	Loc. Hot Start	Loc. Hot Start OFF disables the Stop input at J1-11 in the keypad operating mode. ON enables the Stop input at J1-11 in the keypad operating mode.
INPUT	Operating Mode	Ten “Operating Modes” are available. Choices are: Keypad, Standard Run, 15SPD, 3 SPD ANA 2 Wire, 3 SPD ANA 3 Wire, Serial, Bipolar, Process, EPOT 2 Wire and EPOT 3 Wire. External connections to the control are made at the J1 terminal strip (wiring diagrams are shown in Section 3 “Operating Modes”).
	Command Select	Selects the external speed reference to be used. Potentiometer is the most simple method of speed control. Select POTENTIOMETER and connect a 5KΩ pot at J1-1, J1-2, and J1-3. ±5 or ±10VDC selection is used when a voltage input signal is applied to J1-4 and J1-5. 4-20mA selection is used when a voltage input signal is applied to J1-4 and J1-5. 4-20mA should be considered when a long distance (up to 50 ft) between the external device and J1-4 and J1-5 of the control is necessary. Note: When using the 4-20mA input, the JP1 jumper on the main control board must be moved to pins 2 and 3 (see Figure 3-29). 10 VOLT W/TORQ FF - when a differential command is present at J1-4 and 5, allows additional 5V torque feedforward input at J1-1, 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. 5V EXB - selects optional High Resolution I/O expansion board if installed. 10V EXB - selects optional High Resolution I/O expansion board if installed. 4-20mA EXB - selects the 4-20mA input of the 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.

Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
INPUT Continued	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 the control as 0VDC. The value of this parameter is automatically adjusted during the autotune CMD 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	"OFF" Allows normal control operation. "ON" Allows the 5V input at J1-2 (referenced to J1-1) to be used for reduction of the programmed current limit parameter for torque trimming during operation.
OUTPUT	OPTO OUTPUT #1 – #4	Four optically isolated digital outputs are available. 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 frequency to motor is less than the value of the Level 1 Output "Zero SPD Set Pt" parameter. At Speed - Active when output speed is within the speed range defined by the Level 1 Output "At Speed Band" parameter. In the torque command mode, this opto output will always be in the "OFF" state. Overload - A normally closed contact that is active (opens) during an Overload fault caused by a time-out when the output current is greater than Rated Current. Keypad Control - Active when control is in Local keypad control. At Set Speed - Active when output speed is at or greater than the Level 1 Output "Set Speed" parameter. 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. Motor Direction - Active High when REV direction command received. Active Low when FWD direction command received. Drive On - Active when control is "Ready" (has reached excitation level and capable of producing torque). CMD Direction - Active at all times. Logical output state indicates Forward (high or low) or Reverse (high or low) direction. AT Position - Active during a positioning command when control is within the position band parameter tolerance. Over Temp Warn - A normally closed contact that is active (opens) when control heat sink temperature is within 3°C of Int Overtemp. Process Error - Active when process feedback signal is outside the range specified by the Level 2 Process Control block, AT Setpoint Band parameter. Turns off when process feedback error is eliminated. Drive Run - Active when drive is Ready, Enabled, Speed or Torque command received with FWD/REV direction issued. Serial - Active when drive is in Serial mode.
	Zero SPD Set PT	Sets the speed 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.
	Set Speed	Sets the speed that the AT Set Speed opto output becomes active (turns on). When the speed is greater than the Level 1 Output SET SPEED parameter, the opto output becomes active. This is useful when another machine must not start or stop until the motor exceeds a predetermined speed.

Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
OUTPUT Continued	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 the no fault operating speed range 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 is outside of this band, the Level 2 Protection block, Following Error parameter will shut down the drive (if it is set to ON).
	Analog Output #1 and #2	Two 0-5VDC linear outputs can be configured to represent any of these conditions: **Condition** **Description** ABS Speed - Represents the absolute motor speed where 0VDC = 0 RPM and +5VDC = MAX RPM. ABS Torque - Represents the absolute value of torque where +5VDC = Torque at CURRENT LIMIT. Speed Command - Represents the absolute value of commanded speed where +5VDC = MAX RPM. PWM Voltage - Represents the amplitude of PWM voltage where +5VDC = MAX AC Voltage. Flux Current - Represents the actual portion of total current used for excitation. 5VDC= MAX flux current. CMD Flux CUR - Represents the calculated value for flux current. 5VDC= MAX commanded flux current. Load Current - Represents the actual portion of total current used to produce torque (CW and CCW torque). 5V = Max. CW torque, 0V = Max. CCW torque. CMD Load Current - Represents the calculated value of load current. 5V = Max. commanded load current. Motor Current - Amplitude of continuous current including motor excitation current. 5VDC = Rated Current. Load Component - Amplitude of load current not including the motor excitation current. 5VDC = Rated Current. Quad Voltage - Load controller output. Used to diagnose control problems. Direct Voltage - Flux controller output. Used to diagnose control problems. AC Voltage - A scaled AC waveform that represents the AC line to line motor terminal voltage. 0V = Neg Peak PWM voltage. 2.5V centered. 5V = Pos Peak PWM voltage. At rated motor voltage, a full 0 to 5V sinusoidal waveform should be present. This waveform should be at or greater than the motor base frequency. (At half the motor base frequency, a 1.25V to 3.75 sine wave is present.) Bus Voltage - Bus voltage scaled to 0-5VDC. 5V = 1000VDC. Torque - Bipolar torque output. 2.5V centered, 5V = Max Positive Torque, 0V = Max negative torque. Power - Bipolar power output. 2.5V = Zero Power, 0V = negative rated peak power, +5V = Positive rated peak power. Velocity - Represents motor speed scaled to 0V = negative max RPM, +2.5V = Zero Speed, +5V = positive max RPM. Overload - (Accumulated current)^2 x (time), Overload occurs at +5V. PH 2 Current - Sampled AC phase 2 motor current. 2.5V = zero amps, 0V = negative rated peak amps, +5V = positive rated peak amps. PH 1 Current - Sampled AC phase 1 motor current. 2.5V = zero amps, 0V = negative rated peak amps, +5V = positive rated peak amps. Process Feedback - Represents the selected Process Feedback signal. 2.5V centered, 5V = 100%, 0V = –100%. Position - Position within a single revolution. +5V = 1 complete revolution. The counter will reset to 0 every revolution. Setpoint Command - Represents the selected Setpoint Command signal. 2.5V centered, 5V = 100%, 0V = –100%.. Serial - 0-5VDC level that represents a value programmed by a serial command.

Table 4-2 Level 1 Parameter Block Definitions - Continued

Block Title	Parameter	Description
OUTPUT (Continued)	Analog Scale #1 & #2	Scale factor for the Analog Output voltage. Useful to set the zero value or full scale range for external meters.
	Position Band	Sets the acceptable range in digital counts (pulses) at which the AT Position Opto becomes active (turns on).
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.
	Feedback Filter	A larger value provides a more filtered signal but at the cost of reduced bandwidth.
	Feedback Align	Sets the encoder's electrical direction of rotation to match that of the motor.
	Current PROP Gain	Sets the current loop proportional gain.
	Current INT Gain	Sets the current loop integral gain.
	Speed PROP Gain	Sets the speed (velocity) loop proportional gain.
	Speed INT Gain	Sets the speed (velocity) loop integral gain.
	Speed DIFF Gain	Sets the speed (velocity) loop differential gain.
	Position Gain	Sets the position loop proportional 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 may 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 decel time will tend to increase.
	Prop Gain #1	The anti–saturation controller's proportional gain. Leave the gain at the factory setting. Do not change this gain unless authorized by Baldor.
	INT Gain #1	The anti–saturation controller's integral gain. Leave the gain at the factory setting. Do not change this gain unless authorized by Baldor.
LEVEL 2 BLOCK		ENTERS LEVEL 2 MENU

Table 4-3 Level 2 Parameter Block Definitions

Block Title	Parameter	Description
OUTPUT LIMITS	Operating Zone	Sets the PWM operating zone to Standard 2.5kHz or Quiet 8.0kHz output carrier frequency. Two operating modes are available: Constant Torque and Variable Torque. Constant Torque allows 170 - 200% for 3 seconds and 150% for 60 seconds of peak overload capacity. Variable Torque allows 115% peak overload for 60 seconds.
	MIN Output Speed	Sets the minimum motor speed in RPM. During operation, the motor speed will not decrease below this value except for motor starts or during dynamic braking to 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 may be available depending upon the operating zone selected.
	PWM Frequency	The frequency that the output transistors are switched. PWM (pulse width modulation) 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. Note: Derate output current by 30% for operation between 8.5KHz and 16KHz.
	Current Rate Limit	Limits the rate of torque change in response to a torque command.

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
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 value 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 numbers by placing the flashing cursor over the up/down arrow.
	Value DEC Places	Serial Only. *
	Value Speed REF	Serial Only. *
	Units of Measure	Allows user specified units of measure to be displayed on the Output Rate 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.
	Units of MEAS 2	Serial Only. *

* Note: Serial Commands. When using the serial command option, the "Value AT Speed", "Value DEC Places", and "Value Speed REF" parameters must be set. The Value AT Speed parameter sets the desired output rate per increment of motor speed. The Value DEC Places sets the desired number of decimal places of the Value AT Speed number. The Value Speed REF sets the increment of motor speed for the desired output rate.

The Units of Measure parameter sets the two left-most characters of the custom units display while the Units of MEAS 2 parameter sets the two right most characters. For example, if "ABCD" is the custom units, "AB" is set in the Level 2 Custom Units block, Units of Measure parameter and "CD" is set in the Level 2 Custom Units block, Units of MEAS 2 parameter.

Note: Custom Display Units. The output rate display is only available if the Value AT Speed parameter has been changed from a value of 0 (zero). To access the Output Rate display, use the DISP key to scroll to the Output Rate display.

Block Title	Parameter	Description
PROTECTION	Overload	Fault causes the control to trip off during overload condition. Fault requires the control be "Reset" after an overload condition. Foldback causes the control to automatically reduce the output current below the continuous output level during an overload. Choose Foldback if continuous operation is desired. The output current will automatically be reduced to less than the continuous output level until the overload condition is eliminated.
	External Trip	OFF - External Trip is Disabled. ON - External Trip is enabled. If a normally closed contact at J1-16 is opened, an External Trip fault will occur and cause the drive to shut down.
	Local Enable INP	OFF - Ignores J1-8 input when in the "LOCAL" mode. ON - Requires J1-8 input to be closed to enable the control when in the "LOCAL" mode.
	Following Error	OFF - Control ignores "At Speed Error" from the process. ON - Control monitors the following error from the process. If the process speed is outside the range set in the Level 1 Output block, AT Speed Band parameter the drive will fault and will disable.
	Torque Proving	OFF - Control ignores unbalanced motor phases. ON - Control looks for balanced output current in all three phases to the motor. If output current is unbalanced, the control will trip off generating a torque proving fault.

Table 4-3 Level 2 Parameter Block Definitions Continued

Block Title	Parameter	Description
MISCELLANEOUS	Restart Auto/Man	**Manual** Power Up Start – If set to MAN and a run command (enable line & FWD or REV command) is present at power up, the motor will not run. The run command must be removed then reapplied to start operation. The run command refers to the enable plus direction (FWD or REV) lines. Restart after Fault – If a fault occurs during operation, the control must be reset[1] and the run command must be removed then reapplied to start operation. [1] Note: If Restart Fault/Hr. is zero, the control must be manually reset. If Restart Fault/Hr. is non–zero, the control will automatically attempt to reset the fault but will not restart until the run command is removed then reapplied to start operation. **Automatic** Power Up Start – If set to AUTO and a run command (enable line & FWD or REV command) is present at power up, the control will automatically start. Restart after Fault – If a fault occurs during operation, the control will automatically reset (after the restart delay time) to resume operation if the Fault/Hr is set to a non zero value. 3 Wire modes, AUTO start after a fault or loss of power will not occur because the momentary contacts are open and the run command must again be applied. The run command refers to the enable plus direction (FWD or REV) lines.
	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 condition before restart is attempted.
	Factory Settings	NO - Does not change parameter values. YES - 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. All programmed parameter values are changed to the factory settings. The drive must be autotuned. 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.
	Homing Speed	This parameter sets the speed that the motor shaft will rotate to a “Home” position when the orient input switch is closed (J1-11). Available only in modes that have a homing (orient) input.
	Homing Offset	This parameter sets the number of quadrature encoder counts past home at which the motor will stop. Quadrature encoder pulses are 4 times the number of encoder lines per revolution. The recommended minimum number is 100 encoder counts to allow for deceleration distance to allow the motor to stop smoothly. Example: Encoder resolution is 1024 lines per revolution. The motor must stop one complete revolution past the home marker position. Therefore, the homing offset is: Homing Offset = (1 Revolution) X (4 X 1024 lines per Rev.) = 4096 quadrature counts. Note: Homing direction is always in the drive forward direction.

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 before changes can be made using the keypad. Serial - Requires security access code to be entered before changes can be made using the serial link. Total - Requires security access code to be entered before changes can be made using the keypad or serial link. Note: If security is set to Local, Serial or Total you can press PROG and scroll through the parameter values that are programmed but you are not allowed to change them 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).
	Access Code	A 4 digit number code. Only persons that know the code can change secured Level 1 and Level 2 parameter values. 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 Baldor. 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 rated 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 (see Level 2 Output Limits).
	Motor Rated SPD	The rated speed of the motor (listed on the motor nameplate). If Motor Rated SPD = 1750 RPM and Motor Rated Freq = 60 Hz, the Keypad Display will show 1750 RPM at 60 Hz and 875 RPM at 30Hz.
	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.
	Encoder Counts	The number of encoder feedback counts in lines per revolution. Note: Reducing the encoder counts parameter value to zero will cause the vector control to operate as a sensorless control.
	Resolver Speed	The speed of the resolver, if a resolver is used for feedback.
	CALC Presets	NO - No presets are calculated. YES - This procedure loads preset values into memory that are required to perform autotune. Always run CALC Presets as the first step of autotune.
BRAKE ADJUST	Resistor Ohms	The dynamic braking resistor value in ohms. Refer to dynamic braking manual or call Baldor for additional information.
	Resistor Watts	The dynamic braking resistor watts rating. Refer to dynamic braking manual or call Baldor for additional information.
	DC Brake Current	The amount of DC injection brake current. 0% = Flux current, 100% = Motor rated current. (Used during encoderless operation).

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	OFF - The process feedback signal is not inverted. ON - 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 type 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, as a percentage of the process feedback signal, 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. If at the process setpoint, the motor speed is 1500 RPM, the maximum speed adj limits is then 1325 to 1675 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 (within the Set PT ADJ Limit) is made to move the analog input to the setpoint.
	Process INT Gain	Sets the PID loop Integral gain. This determines how quickly the motor speed is adjusted to correct long term error.
	Process DIFF Gain	Sets the PID loop differential gain. This determines how much adjustment to motor speed (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. Master:Follower 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. Note: When using Serial Communications to operate the control, this value is the MASTER portion of the ratio. The FOLLOWER portion of the ratio is set in the Follow I:O Out 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. Defines the number of pulses per revolution of the master encoder. Only used for follower drives.
COMMUNICATIONS	Protocol	Sets the type of communication the control is to use, RS-232 ASCII, RS-485 ASCII, RS-232 BBP or RS-485 BBP 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
AUTOTUNING		The autotune procedure is used to automatically measure and calculate certain parameter values. Dynamic Brake Hardware is required to perform “Slip Freq Test” and “Spd Cntrlr Calc” autotuning test. Occasionally, the autotune 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 section 6 of this manual.
	CALC Presets	This procedure loads into memory the preset values that are required to perform autotune. Always run CALC Presets as the first step of autotune.
	CMD Offset Trim	This procedure trims out voltage offsets for the differential analog input at J1-4 and J1-5.
	CUR Loop COMP	Measures current response to pulses of one half the rated motor current.
	Stator R1	Measures motor stator resistance.
	Flux CUR Setting	Sets motor magnetizing current by running motor at near rated speed.
	Feedback Tests	Checks the values for Encoder Lines per revolution and encoder alignment parameters while the motor is running at near full rated speed. Test will automatically switch encoder phasing to match motor rotational direction.
	Slip FREQ Test	Calculates motor Slip Frequency during repeated motor accelerations.
	SPD CNTRLR CALC	Should be performed with the load coupled to the motor shaft. Sets the motor current to acceleration ratio, Speed INT gain and Speed PROP gain values. If done under no load, the Integral gain will be too large for high inertia loads if the PK Current Limit is set too low. If the control is too responsive when the drive is loaded, adjust the PK Current Limit parameter to a greater value and repeat this test.
LEVEL 1 BLOCK		ENTERS LEVEL 1 MENU

Section 5
Troubleshooting

The Baldor Series 18H Control requires very little maintenance and should provide years of trouble free operation when installed and applied correctly. Occasional visual inspection and cleaning should be considered to ensure tight wiring connections and to remove dust, dirt, or foreign debris which can reduce heat dissipation.

Operational failures called “Faults” will be displayed on the keypad display as they occur. A comprehensive list of these faults, their meaning and how to access the fault log and diagnostic information is provided later in this section. Troubleshooting information is provided in table format with corrective actions later in this section.

Before attempting to service this equipment, all input power must 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 at least 1 meg Ohm input impedance. In some cases, an oscilloscope with 5 MHZ minimum bandwidth may be useful. Before contacting Baldor, check that all power and control wiring is correct and installed according to the recommendations in this manual.

No Keypad Display - Display Contrast Adjustment

At power up, the display may be blank if the contrast is improperly set. Use the following procedure to adjust the display contrast.

Action	Description	Display	Comments
Apply Power	No visible display.		
Press DISP key	Ensures control in Display mode.		Display mode.
Press SHIFT key 2 times	Allows display contrast adjustment.		
Press ▲ or ▼ key	Adjusts display contrast (intensity).		
Press ENTER key	Saves display contrast adjustment level and exits to display mode.		

How to Access Diagnostic Information

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 6 times	Scroll to Diagnostic Information screen	PRESS ENTER FOR DIAGNOSTIC INFO	Diagnostic Access screen.
Press ENTER key	Access diagnostic information.	STOP SPEED REF LOCAL 0 RPM	First Diagnostic Information screen.
Press DISP key	Display showing control temperature.	STOP CONTROL TEMP LOCAL 0.0° C	
Press DISP key	Display showing bus voltage.	STOP BUS VOLTAGE LOCAL XXXV	
Press DISP key	Display showing % overload current remaining.	STOP OVRLD LEFT LOCAL 100.00%	
Press DISP key	Display showing real time 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 showing actual drive running time.	TIME FROM PWR UP 0000000.01.43	HR.MIN.SEC format.
Press DISP key	Display showing operating zone, voltage and control type.	QUIET VAR TQ XXXV FLUX VECTOR	
Press DISP key	Display 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	ID is displayed as a hexadecimal value.
Press DISP key	Display showing which Group1 or 2 expansion boards are installed.	G1 NOT INSTALLED G2 NOT INSTALLED	
Press DISP key	Display showing motor shaft revolutions from the REV home set point.	POSITION COUNTER + 000.00000 REV	
Press DISP key	Display mode showing parameter table selected.	STOP TABLE LOCAL 0	
Press DISP key	Display showing software version and revision installed in the control.	SOFTWARE VERSION SXX-X.XX	
Press DISP key	Displays exit choice.	PRESS ENTER FOR DIAGNOSTIC EXIT	Press ENTER to exit diagnostic information.

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 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 frequency	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	Typical display.
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.

How to Clear the Fault Log Use the following procedure to clear the fault log.

Action	Description	Display	Comments
Apply Power		BALDOR MOTORS & DRIVES	Logo display for 5 seconds.
	Display mode showing output frequency.	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 message.	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.
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	

Initialize New Software

After new software is installed, the control must be initialized to the new software version and memory locations. Use the following procedure to initialize the software.

Note: All parameter values already programmed will be changed when resetting the control to factory settings.

Note: After factory settings are restored, the drive must be autotuned.

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 DISP key several times	Scroll to diagnostic information screen.	PRESS ENTER FOR DIAGNOSTIC INFO	If you wish to verify the software version, enter 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 SXX-X.XX	Verify new software version.
Press DISP key	Displays exit choice.	PRESS ENTER FOR DIAGNOSTIC EXIT	Press ENTER to exit diagnostic information.

Table 5-1 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.
Encoder Loss	Noise on encoder lines, encoder power supply loss, encoder coupling slipping or broken, defective encoder or defective wiring.
External Trip	An external over temperature condition occurred or open circuit on J1-16.
Following Error	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 does not recognize power base ID.
Inverter Base ID	Control board installed on power base without current feedback.
Line Regen FLT	Only applies to Series 21H and 22H Line Regen controls.
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 will reset to factory preset values.
Low INIT Bus V	Insufficient bus voltage on start-up.
Memory Error	EEPROM error occurred. Contact Baldor.
New Base ID	Control board was changed since last operation.
No Faults	Fault log is empty.
No EXB Installed	Programmed operating mode requires an expansion board.
Over Current FLT	Instantaneous over current condition detected by bus current sensor.
Overload - 1 min	Output current exceeded 1 minute rating.
Overload - 3 sec	Output current exceeded 3 second rating.
Over speed	Motor RPM exceeded 110% of programmed MAX Motor Speed.
μP Reset	Power applied before the Bus voltage reached 0VDC.
PWR Base FLT	Desaturation of power device occurred or bus current threshold was exceeded. (On B2 size controls, a desat error can indicate any of the following: low line impedance, brake transistor failure or excessive internal output transistor temperature.)
Regen R PWR FLT	Regen power exceeded Dynamic Brake value (Level 2 Brake Adjust resistor rating).
Resolver Loss	Resolver feedback problem is indicated (if resolver used). Check for defective resolver, power supply loss, or defective wiring.
Torque Prove FLT	Unbalanced current between all 3 motor phases.
User Fault Text	Custom software operating fault occurred.

Table 5-2 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).
	Loose connections.	Check input power termination. Verify connection of operator keypad.
	Adjust display contrast.	See Adjust Display Contrast.
Auto Tune Encoder Test failed	Encoder miswired.	Correct wiring problems.
	Encoder coupling slipping, broken or misaligned.	Correct encoder to motor coupling.
	Excessive noise on encoder lines.	Check the position counter in the Diagnostic Information for jittering, which will confirm an encoder problem. Use recommended encoder cable. Check encoder connections including shields. Separate encoder leads from power wiring. Cross encoder wires and power leads at 90°. Electrically isolate encoder from motor. Install optional Isolated Encoder Feedback expansion board.
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 power.	Increase the DECEL time. Check dynamic brake watt and resistance parameter values. Add optional dynamic braking hardware.
	Dynamic brake mis-wiring.	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.
DC Bus Low	Input voltage too low.	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. Disconnect dynamic brake hardware and repeat operation.
Encoder Loss	Encoder power supply failure.	Check 5VDC at J1-29 and J1-30. Also, check at encoder end pins +5VDC and Ground.
	Encoder coupling slipping, broken or misaligned	Correct or replace encoder to motor coupling.
	Excessive noise on encoder lines.	Check the position counter in the diagnostic information display for jittering, which will confirm an encoder problem. Check encoder connections. Separate encoder leads from power wiring. Cross encoder wires and power leads at 90°. Electrically isolate encoder from motor. Install optional Isolated Encoder Feedback expansion board.
Following ERR	Speed proportional gain set too low.	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 5-2 Troubleshooting Continued

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
External Trip	Motor ventilation insufficient.	Clean motor air intake and exhaust. Check external blower for operation. Verify motor's internal fan is coupled securely.
	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 J1-16 (External Trip Input).
	Poor thermostat connections.	Check thermostat connections.
	External trip parameter incorrect.	Verify connection of external trip circuit at J1-16. Set external trip parameter to "OFF" if no connection made at J1-16.
INT Over-Temp	Motor Overloaded.	Correct motor loading. Verify proper sizing of control and motor.
	Ambient temperature too high.	Relocate control to cooler operating area. Add cooling fans or air conditioner to control cabinet.
Invalid Base ID	Control does not recognize HP and Voltage configuration.	Press "RESET" key on keypad. If fault remains, call Baldor.
Inverter Base ID	Power base with no output phase current sensors being used.	Replace power base with one that has output leg current feedback. Contact Baldor.
Logic Supply FLT	Power supply malfunctioned.	Replace logic power supply.
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.
Low INIT Bus V	Improper AC line voltage.	Disconnect Dynamic Brake hardware and retry test. Check input AC voltage level.
Memory Error	EEPROM memory 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. Maximum common mode voltage at terminals J1-4 and J1-5 is ±15VDC referenced to chassis common.
Motor Shaft Oscillates back and forth	Incorrect encoder alignment direction.	Change the Feedback Align parameter in the Level 1 Vector Control block. If it is Reverse, change it to Forward. If it is Forward, change it to Reverse.
Motor Shaft rotates at low speed regardless of commanded speed	Incorrect encoder alignment direction.	Check encoder connections. Change the Feedback Align parameter in the Level 1 Vector Control block. If it is Reverse, change it to Forward. If it is Forward, change it to Reverse.
Motor Shaft rotates in wrong direction	Incorrect encoder wiring.	Reverse the A and $\overline{A}$ or B and $\overline{B}$ encoder wires at the J1 input to control and change encoder direction in the Feedback Align parameter in the Level 1 Vector Control block.
Motor Will Not Reach Maximum Speed	Max Output Speed set too low.	Adjust 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.

Table 5-2 Troubleshooting Continued

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
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 frequency setting.	Increase speed command or lower minimum frequency setting.
	Incorrect Command Select parameter.	Change Command Select parameter to match wiring at J1.
	Incorrect speed command.	Verify control is receiving proper command signal at J1.
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.
New Base ID	Software parameters are not initialized on newly installed control board.	Press “RESET” key on keypad to clear the fault condition. Cycle power (turn power OFF then ON). Reset parameter values to factory settings. Access diagnostics and compare power base ID number to list in Table 5-3 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.
	ACCEL/DECEL time too short.	Increase ACCEL/DEC parameters in the Level 1 ACCEL/DECEL Rate block.
	Excessive load.	Reduce the motor load. Verify proper sizing of control and motor.
	Encoder coupling slipping, broken or misaligned.	Correct or replace encoder to motor coupling.
	Encoder bearing failure.	Replace encoder.
	Excessive noise on encoder lines.	Check the position counter in the Diagnostic Information for jittering, which will confirm an encoder problem. Check encoder connections. Separate encoder leads from power wiring. Cross encoder wires and power leads at 90°. Electrically isolate encoder from motor. Install optional Isolated Encoder Feedback expansion board.
	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.
Overload - 3 Sec FLT	Peak output current exceeded 3 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. Check motor for overloading. Increase ACCEL time. Reduce motor load. Verify proper sizing of control and motor.
	Encoder coupling slipping, broken or misaligned.	Correct or replace encoder to motor coupling.
	Encoder bearing failure.	Replace encoder.

Table 5-2 Troubleshooting Continued

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
Overload - 1 Min FLT	Peak output current exceeded 1 minute 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. Check motor for overloading. Increase ACCEL/DECEL times. Reduce motor load. Verify proper sizing of control and motor.
	Encoder coupling slipping, broken or misaligned.	Correct or replace encoder to motor coupling.
	Encoder bearing failure.	Replace encoder.
Over Speed	Motor exceeded 110% of MAX Speed parameter value.	Check Max Output Speed in the Level 2 Output Limits block. Increase Speed PROP Gain in the Level 1 Vector Control block.
Power Module	Power supply failure.	Press “RESET” key on keypad. If fault remains, call Baldor.
PWR Base FLT	Improper ground Excessive current.	Be sure control has separate ground wire to earth ground. Panel grounding or conduit connections is not sufficient. Disconnect motor leads from control and retry test. If fault remains, call Baldor.
	Excessive load.	Correct motor load. Verify proper sizing of control and motor.
	Excessive power in dynamic brake circuit.	Verify proper Ohm and Watt parameters of DC Injection Braking. Increase decel time. Add optional dynamic braking hardware.
	Encoder coupling slipping, broken or misaligned.	Correct or replace encoder to motor coupling.
	Encoder bearing failure.	Replace encoder.
	Excessive noise on encoder lines.	Check encoder connections. Separate encoder leads from power wiring. Cross encoder wires and power leads at 90°. Electrically isolate encoder from motor. Install optional Isolated Encoder Feedback expansion board.
	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.
Regen R PWR FLT	Incorrect dynamic brake parameter.	Check Resistor Ohms and Resistor Watts parameters in the Level 2 Brake Adjust block.
	Regen power exceeded dynamic brake resistor rating.	Add optional dynamic braking hardware.
	Input voltage too high.	Verify proper AC line voltage. Use step down transformer if needed. Use line reactor to minimize spikes.
Resolver Loss	Resolver defect.	Check resolver to motor coupling (align or replace if needed). Verify correct wiring. Refer to the Resolver to Digital expansion board manual. Electrically isolate resolver from motor.
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.
User Fault Text	Fault detected by custom software.	Refer to custom software fault list.

Table 5-3 Power Base ID - Series 18H

230VAC Catalog No.	Power Base ID	460VAC Catalog No.	Power Base ID	575VAC Catalog No.	Power Base ID
201-E	823	401-E	A3B	501-E	E1A
201-W	823	401-W	A3B	501-W	E1A
202-E	824	402-E	A3C	502-E	E1B
202-W	824	402-W	A3C	502-W	E1B
203-E	825	403-E	A3D	503-E	E1C
203-W	825	403-W	A3D	503-W	E1C
205-E	826	405-E	A41	505-E	E1D
205-W	82A	405-W	A41	505-W	E1D
207-E	82D	407-E	A3E	507-E	E1E
207-W	82D	407-W	A3E	507-W	E1E
207L-E	801	407L-E	A01	510-E	E29
210-E	82E	410-E	A4A	510-W	E29
210-W	82E	410-W	A4A	515-E	E2A
210L-E	82B	410L-E	A3F	515-W	E2A
215-E	82F	415-E	A4B	515L	E0A
215-W	82F	415-W	A4B	520-E	E2B
210L-ER	80C	410L-ER	A08	520L	EOB
215V	808	415V	A0E	525-E	E2C
215L	80D	415L	A0F	525L	E0C
220-E	830	420-E	A4C	530	E13
220L	80E	420L	A20	530L	E0D
225	81D	425-E	A4D	540	E14
225V	809	425V	A0B	540L	E0E
225L	80F	425L	A21	550	E15
230	813 82C	430	A13	550L	E0F
230V	816	430V	A0C	560	E16
230L	817	430L	A22	575	E17
240	814	440	A14 A48	5100	E18
240L	818	440L	A23	5150	E1A
250	815	450	A15	5150V	E19
250V	80A	450L	A1C	5200	E2A
250L	81C	460	A16	5250	E3A
275		460V	A0A	5300	EA4
		460L	A24	5350	EA5
		475	A17	5400	EA6
		475L	A1D		
		4100	A18		
		4100L	A2F		
		4125L	A30		
		4150	A9A		
		4150V	A19		
		4200	A9B		
		4250	AA5		
		4300	AAE		
		4350	AA6		
		4400	AA7		
		4450	AA9		
		4500	AC4		
		4600	AC5		
		4700	AC6		
		4800	AC7		

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

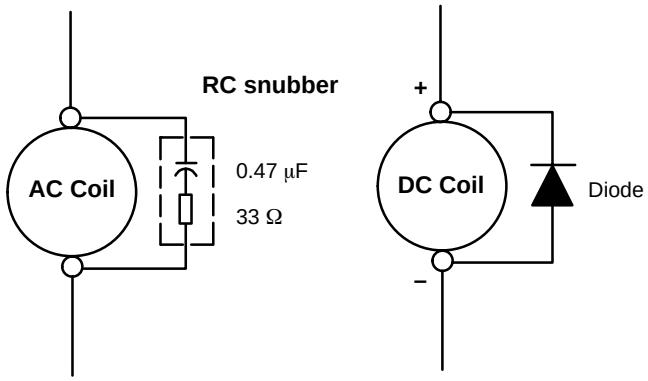
Electrical Noise Considerations All electronic devices are vulnerable to significant electronic interference signals (commonly called “Electrical Noise”). At the lowest level, noise can cause intermittent operating errors or faults. From a circuit standpoint, 5 or 10 millivolts of noise may cause abnormal operation.

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.

Relay and Contactor Coils Among the most common sources of noise is the coil of a contactor or a relay. 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.

Figure 5-1 illustrates noise suppression for AC and DC operated coils.

Figure 5-1 AC & DC Coil Noise Suppression



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. If shielded pair cable is used, the coupling is reduced by nearly 90% compared to unshielded cable.

Even input AC power lines contain noise and can induce noise in adjacent wires. In some cases, line reactors may be required.

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. Do not place line conductors and load conductors in same conduit. Use one conduit for 3 phase input wires and another conduit for the motor leads. The conduits 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.

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.

Reactors are typically 3% reactance and are designed for the frequencies encountered in PWM drives. For maximum benefit, the reactors should be mounted in the drive enclosure with short leads between the control and the reactors.

Control Enclosures

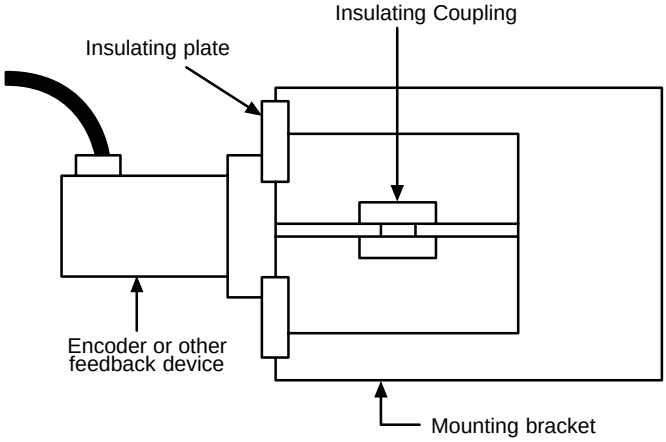
Motor controls mounted in a grounded enclosure should also be connected to earth ground with a separate conductor to ensure best ground connection. Often grounding the control to the grounded metallic enclosure is not sufficient. Usually painted surfaces and seals prevent solid metallic contact between the control and the panel enclosure. Likewise, conduit should never be used as a ground conductor for motor power wires or signal conductors.

Special Motor Considerations

Motor frames must also be grounded. As with control enclosures, motors must be grounded directly to the control and plant ground with as short a ground wire as possible. 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.

Sometimes motor frame transient voltages are capacitively coupled to feedback devices mounted on the motor shaft. To prevent this problem, add electrical isolation between the motor and the feedback device. The most simple isolation method, shown in Figure 5-2, has two parts: 1) A plate of electrical insulating material placed between the motor mounting surface and the feedback device. 2) An insulating coupling between motor shaft and the shaft of the feedback device.

Figure 5-2 Isolated Mounting Method



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.

Section 6
Manual Tuning the Series 18H Control

Manually Tuning the Control In some applications the drive cannot be accurately autotuned in an application. 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 autotuned. 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 with the motor coupled to the load:

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. By reducing 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 autotuned.

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

Current Prop Gain Parameter This parameter is located in the Level 1, Vector Control Block. The Current Prop Gain parameter is normally autotuned when motor inductance is not known. Where autotuning 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 for a WYE connected motor.

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 20 will yield adequate performance.

Current Int Gain Parameter

The Current Int Gain parameter located in the Level 1 Vector Control Block is factory set at 150 Hz. This setting is suitable for most applications.

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.

Speed Int Gain Parameter

The Speed Int Gain parameter located in the Level 1 Vector Control Block is set to 1 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 for systems where overshoot must be avoided and stiffness (ability of the controller to maintain commanded speed with varying torque loads) isn't required.

Increasing values of the Speed Int Gain parameter increases the stiffness of the controller. Typical setting is 4 Hz. If the Speed Prop Gain parameter and the Speed Int Gain parameter are set too high, an overshoot condition can 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.

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 Series 18H 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 = $K_p (s + 2\pi K_I) / s$.

The integral gain is a frequency (in Hz) and should be set to 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 electrical noise is excessive, the most likely cause is that the proportional gain is set too high.

Section 7
Specifications, Ratings & Dimensions

Specifications:

Horsepower	1-50 HP @ 230VAC 1-800 HP @ 460VAC 1-600 HP @ 575VAC	
Input Frequency	50/60 HZ ± 5%	
Output Voltage	0 to Maximum Input VAC	
Output Current	See Ratings Table	
Service Factor	1.0	
Duty	Continuous	
Overload Capacity	Constant Torque Mode:	170-200% for 3 seconds 150% for 60 seconds
	Variable Torque Mode:	115% for 60 seconds
Speed Command Potentiometer	5k or 10k ohm, 0.5 watt	

Operating Conditions:

Voltage Range:	230 VAC Models	180-264 VAC 3ϕ 60 Hz / 180-230 VAC 3ϕ 50 Hz
	460 VAC Models	340-528 VAC 3ϕ 60 Hz / 380-415 VAC 3ϕ 50 Hz
	575 VAC Models	495-660 VAC 3ϕ 60 Hz
Input Line Impedance:		3% Minimum Required (A, B, C, D, E Sizes) 1% (B2, C2, D2, F, G, G2, G+, H Sizes)
Ambient Operating Temperature:		-10 to +40 °C Derate Output 2% per °C over 40 °C to 55 °C Max
Rated Storage Temperature:		– 30 °C to +65 °C
Enclosure:	NEMA 1:	E, ER and EO (suffix) Models
	NEMA 4X:	W (suffix) Models
Humidity:	NEMA 1:	10 to 90% RH Non-Condensing
	NEMA 4X:	To 100% RH Condensing
Altitude:		Sea level to 3300 Feet (1000 Meters) Derate 2% per 1000 Feet (303 Meters) above 3300 Feet
Shock:		1G
Vibration:		0.5G at 10Hz to 60Hz

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 and 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 (30.3m) max from control

Control Specifications:

Control Method	PWM
Velocity Loop Bandwidth	Adjustable to 180 Hz
Current Loop Bandwidth	Adjustable to 1200 Hz
Maximum Output Frequency	500 Hz
Quiet PWM Frequency Version	Full rating 1-8 kHz PWM frequency, Adjustable to 16 kHz with linear derating (between 8 - 16kHz) of 30% at 16 kHz
Standard PWM Frequency Version	Full rating 1-2.5 kHz PWM frequency, Adjustable to 5 kHz with linear derating (between 2.5 - 5kHz) of 10% at 5 kHz
Selectable Operating Modes	Keypad Standard Run, 3 Wire 15 Speed Analog 2 Wire 3 Speed Analog 2 Wire 3 Speed Analog 3 Wire Bipolar Speed or Torque Serial Process Electronic Pot 2 Wire Electronic Pot 3 Wire

Differential Analog Input:

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

Single Ended Analog Input:

Full Scale Range	0 - 10 VDC (0 to –10VDC and 0 to +10VDC are valid inputs)
Resolution	9 bits + sign
Update Rate	500 μs

Analog Outputs:

Analog Outputs	2 Assignable
Full Scale Range	0 - 5 VDC
Source Current	1 mA maximum
Resolution	8 bits
Update Rate	2.0 msec

Digital Inputs:

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

Digital Outputs: (4 Opto Isolated Outputs)

Rated Voltage	5 to 30VDC
Maximum Current	60 mA Maximum
ON Voltage Drop	2 VDC Maximum
OFF Leakage Current	0.1 μA Maximum

Diagnostic Indications:

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

Note: All specifications are subject to change without notice.

Ratings Series 18H Stock Products

CATALOG NO.	INPUT VOLT	SIZE	STANDARD 2.5 kHz PWM									
			CONSTANT TORQUE					VARIABLE TORQUE				
			Input Amp	Output				Input Amp	Output			
				HP	KW	IC	IP		HP	KW	IC	IP
ZD18H201–E, –W	230	A	4.1	1	0.75	4.0	8.0	7.2	2	1.5	7	8
ZD18H202–E, –W	230	A	7.2	2	1.5	7.0	14	10.3	3	2.2	10	12
ZD18H203–E, –W	230	A	10.3	3	2.2	10	20	16.5	5	3.7	16	19
ZD18H205–E, –W	230	A	16.5	5	3.7	16	32	22.7	7.5	5.5	22	25
ZD18H207–E, –W	230	B2	22.7	7.5	5.5	22	44	28.8	10	7.4	28	32
ZD18H210–E –W	230	B2	28.8	10	7.4	28	56	43.2	15	11.1	42	48
ZD18H215–E –W	230	B2	43.3	15	11.1	42	84	57	20	11.1	54	62
ZD18H220–E	230	B2	57	20	14.9	54	108	57	20	18.6	54	62
ZD18H225–EO	230	C2	70	25	18.6	68	116	82	30	22.3	80	92
ZD18H230–EO	230	C2	82	30	22.3	80	140	82	30	22.4	80	92
ZD18H240–EO	230	D2	108	40	30	105	200	134	50	37	130	150
ZD18H250–EO	230	D2	134	50	37	130	225	134	50	37	130	150
ZD18H250V–MO	230	D	134	50	37	130	260	134	50	37	130	150
ZD18H401–E, –W	460	A	2.1	1	0.75	2.0	4.0	4.1	2	1.5	4.0	5.0
ZD18H402–E, –W	460	A	4.1	2	1.5	4.0	8.0	5.2	3	2.2	5.0	6.0
ZD18H403–E, –W	460	A	5.2	3	2.2	5.0	10	8.2	5	3.7	8.0	10
ZD18H405–E, –W	460	A	8.2	5	3.7	8.0	16	11.3	7.5	5.6	11	13
ZD18H407–E, –W	460	A	11.3	7.5	5.6	11	22	14.4	10	7.5	14	17
ZD18H410–E, –W	460	B2	14.4	10	7.4	14	28	21.6	15	11.2	21	24
ZD18H415–E, –W	460	B2	21.6	15	11.2	21	42	27.8	20	14.9	27	31
ZD18H420–E, –W	460	B2	28	20	14.9	27	54	35	25	18.7	34	39
ZD18H425–E	460	B2	35	25	18.7	34	68	35	25	22.4	34	39
ZD18H430–EO	460	C2	41	30	22.4	40	70	54	40	29.9	52	60
ZD18H440–EO	460	C2	57	40	29.9	55	100	54	40	29.9	52	60
ZD18H450–EO	460	D	67	50	37	65	115	82	60	45	80	92
ZD18H460–EO	460	D	82	60	45	80	140	103	75	56	100	115
ZD18H475–EO	460	E	103	75	56	100	200	129	100	75	125	144
ZD18H4100–EO	460	E	129	100	75	125	220	165	125	93	160	184
ZD18H4150V–EO	460	E	185	150	112	180	300	185	150	112	180	207
ZD18H4150–EO	460	F	196	150	112	190	380	247	200	149	240	276
ZD18H4200–EO	460	F	258	200	149	250	500	319	250	187	310	360
ZD18H4250–EO	460	F	319	250	187	310	620	381	300	224	370	430
ZD18H4300–EO	460	G2	381	300	224	370	630	432	350	261	420	490
ZD18H4350–EO	460	G2	432	350	261	420	720	494	400	298	480	560
ZD18H4400–EO	460	G2	494	400	298	480	820	556	450	336	540	620
ZD18H4450–EO	460	G	556	450	336	540	920	607	500	373	590	680
ZD18H4500–EO	460	G+	607	500	373	590	1180	731	600	447	710	820
ZD18H4600–EO	460	G+	731	600	447	710	1210	855	700	522	830	960
ZD18H4700–EO	460	G+	855	700	522	830	1660	979	800	597	950	1100
ZD18H4800–EO	460	G+	979	800	597	950	1710	1102	900	671	1070	1230
ZD18H501–E, –W	575	A	1.6	1	0.75	1.5	3.0	3.1	2.0	1.5	3.0	4.0
ZD18H502–E, –W	575	A	3.1	2	1.5	3.0	6.0	4.1	3	2.2	4.0	5.0
ZD18H503–E, –W	575	A	4.1	3	2.2	4.0	8.0	7.2	5	3.7	7.0	8.0
ZD18H505–E, –W	575	A	7.2	5	3.7	7.0	14	9.3	7.5	5.6	9.0	11
ZD18H507–E, –W	575	A	9.3	7.5	5.6	9.0	18	11.3	10	7.5	11	13
ZD18H510–E, –W	575	B2	11.3	10	7.5	11	22	17.5	15	11.2	17	20
ZD18H515–E, –W	575	B2	17.5	15	11.2	17	34	22.7	20	14.9	22	25
ZD18H520–E, –W	575	B2	23	20	15	22	44	28	20	14.9	22	25
ZD18H525–E	575	B2	28	25	19	27	54	28	25	18.7	27	31
ZD18H530–EO	575	C2	33	30	22	32	56	44	40	30	41	47
ZD18H540–EO	575	C2	44	40	29.8	41	75	56	50	37.2	52	60
ZD18H550–EO	575	D2	56	50	37	52	92	67	60	45	62	71
ZD18H560–EO	575	D2	67	60	45	62	109	67	60	45	62	71
ZD18H575–EO	575	E	79	75	56	77	155	102	100	75	100	115
ZD18H5100–EO	575	E	102	100	75	100	200	129	125	93	125	145
ZD18H5150–EO	575	F	155	150	112	150	300	206	200	149	200	230
ZD18H5150V–EO	575	E	148	150	112	145	260	148	150	112	145	166
ZD18H5200–EO	575	F	206	200	149	200	400	258	250	186	250	290
ZD18H5300–EO	575	G	300	300	224	290	580	350	350	261	340	400
ZD18H5350–EO	575	G	350	350	261	340	680	402	400	298	390	450
ZD18H5400–EO	575	G	402	400	298	390	780	453	450	336	440	510

Ratings Series 18H Stock Products Continued

CATALOG NO.	INPUT VOLT	SIZE	QUIET 8.0 kHz PWM									
			CONSTANT TORQUE					VARIABLE TORQUE				
			Input Amp	Output				Input Amp	Output			
				HP	KW	IC	IP		HP	KW	IC	IP
ZD18H201–E, –W	230	A	3.1	0.75	0.56	3.0	6.0	4.1	1	0.75	4	5
ZD18H202–E, –W	230	A	4.1	1	0.75	4.0	8.0	7.2	2	1.5	7	8
ZD18H203–E, –W	230	A	7.2	2	1.5	7.0	14	10.3	3	2.2	10	12
ZD18H205–E, –W	230	A	10.3	3	2.2	10	20	16.5	5	3.7	16	19
ZD18H207–E, –W	230	B2	16.5	5	3.7	16	32	22.7	7.5	5.5	22	25
ZD18H210–E –W	230	B2	22.7	7.5	5.5	22	44	28.8	10	7.4	28	32
ZD18H215–E –W	230	B2	28.8	10	7.4	28	56	43.3	15	11.1	42	48
ZD18H220–E	230	B2	43	15	11.1	42	84	56	20	14.9	54	62
ZD18H225–EO	230	C2	56	20	14.9	54	92	70	25	18.6	68	78
ZD18H230–EO	230	C2	72	25	18.6	70	122	70	25	18.6	68	78
ZD18H240–EO	230	D2	82	30	22	80	160	107	40	30	104	120
ZD18H250–EO	230	D2	108	40	30	105	183	134	50	37	130	150
ZD18H250V–MO	230	D	134	50	37	130	244	134	50	37	130	150
ZD18H401–E, –W	460	A	1.6	0.75	0.56	1.5	3.0	2.1	1	0.75	2.0	3.0
ZD18H402–E, –W	460	A	2.1	1	0.75	2.0	4.0	4.1	2	1.5	4.0	5.0
ZD18H403–E, –W	460	A	4.1	2	1.5	4.0	8.0	5.2	3	2.2	5.0	6.0
ZD18H405–E, –W	460	A	5.2	3	2.2	5.0	10	8.2	5	3.7	8.0	10
ZD18H407–E, –W	460	A	8.2	5	3.7	8.0	16	11.3	7.5	5.6	11	13
ZD18H410–E, –W	460	B2	11.3	7.5	5.6	11	22	14.4	10	7.5	14	16
ZD18H415–E, –W	460	B2	15.5	10	7.5	15	28	21.6	15	11.2	21	24
ZD18H420–E, –W	460	B2	22	15	11.2	21	42	28	20	14.9	27	31
ZD18H425–E	460	B2	22	15	11.2	21	42	28	20	14.9	27	31
ZD18H430–EO	460	C2	36	25	18.7	35	61	41	30	22.4	40	46
ZD18H440–EO	460	C2	41	30	22.4	40	80	41	30	22.4	40	46
ZD18H450–EO	460	D	57	40	30	55	92	67	50	37	65	75
ZD18H460–EO	460	D	67	50	37	65	122	82	60	45	80	92
ZD18H475–EO	460	E	82	60	45	80	160	103	75	56	100	115
ZD18H4100–EO	460	E	103	75	56	100	183	129	100	75	125	144
ZD18H4150V–EO	460	E	128	100	75	125	240	165	125	93	160	184
ZD18H4150–EO	460	F	155	125	93	150	260	175	150	112	170	200
ZD18H4200–EO	460	F	196	150	112	190	380	216	175	130	210	240
ZD18H4250–EO	460	F	258	200	149	250	500	319	250	186	310	360
ZD18H4300–EO	460	G2										
ZD18H4350–EO	460	G2										
ZD18H4400–EO	460	G2										
ZD18H4450–EO	460	G										
ZD18H501–E, –W	575	A	1.2	0.75	0.56	1.1	2.2	1.6	1	0.75	1.5	1.7
ZD18H502–E, –W	575	A	1.5	1	0.75	1.5	3.0	3.1	2	1.5	3.0	4.0
ZD18H503–E, –W	575	A	3.1	2	1.5	3.0	6.0	4.1	3	2.2	4.0	5.0
ZD18H505–E, –W	575	A	4.1	3	2.2	4.0	8.0	7.2	5	3.7	7.0	8.0
ZD18H507–E, –W	575	A	7.2	5	3.7	7.0	14	9.3	7.5	5.6	9	11
ZD18H510–E, –W	575	B2	9.3	7.5	5.6	9	18	11.3	10	7.5	11	13
ZD18H515–E, –W	575	B2	11.3	10	7.5	11	22	17.5	10	7.5	11	13
ZD18H520–E, –W	575	B2	18	10	7.5	11	22	17.5	10	7.5	11	13
ZD18H525–E	575	B2	23	20	15.5	22	44	28	25	19	27	31
ZD18H530–EO	575	C2	28	25	19	27	47	33	30	22	32	37
ZD18H540–EO	575	C2	33	30	22.3	32	58	44	40	29.8	41	47
ZD18H550–EO	575	D2	44	40	30	41	73	56	50	37	52	60
ZD18H560–EO	575	D2	56	50	37	52	91	67	60	45	62	71
ZD18H575–EO	575	E										
ZD18H5100–EO	575	E										
ZD18H5150–EO	575	F										
ZD18H5150V–EO	575	E										
ZD18H5200–EO	575	F										
ZD18H5300–EO	575	G										
ZD18H5350–EO	575	G										
ZD18H5400–EO	575	G										

Ratings Series 18H Custom High Peak Current Control

CATALOG NO.	INPUT VOLT	SIZE	STANDARD 2.5 kHz PWM								QUIET 8.0 kHz PWM							
			CONSTANT TORQUE				VARIABLE TORQUE				CONSTANT TORQUE				VARIABLE TORQUE			
			HP	KW	IC	IP	HP	KW	IC	IP	HP	KW	IC	IP	HP	KW	IC	IP
ZD18H210L–ER	230	C	10	7.4	32	72	15	11.1	42	48	7.5	5.5	24	61	15	11.1	42	48
ZD18H215L–ER	230	C	15	11.1	46	108	20	14.9	54	62	10	7.4	32	92	20	14.9	54	62
ZD18H220L–ER	230	C	20	14.9	60	140	20	14.9	54	62	15	11.1	48	122	20	14.9	54	62
ZD18H225L–ER	230	C	25	18.6	75	190	25	18.6	68	78	20	14.9	60	170	20	14.9	54	62
ZD18H230L–ER	230	C	30	22.3	90	210	40	29.8	104	120	25	18.6	75	190	30	22.3	80	92
ZD18H240L–MR	230	D	40	29.8	115	270	40	29.8	115	133	30	22.3	90	240	40	29.8	104	120
ZD18H410L–ER	460	C	10	7.4	16	36	15	11.1	21	24	7.5	5.5	12	30	15	11.1	21	24
ZD18H415L–ER	460	C	15	11.1	24	54	20	14.9	27	31	10	7.4	16	46	20	14.9	27	31
ZD18H420L–ER	460	C	20	14.9	30	70	20	14.9	27	31	15	11.1	24	61	20	14.9	27	31
ZD18H425L–ER	460	C	25	18.6	38	90	25	18.6	34	38	20	14.9	30	90	20	14.9	27	31
ZD18H430L–ER	460	C	30	22.3	45	108	40	29.8	52	60	25	18.6	37	95	30	22.3	40	46
ZD18H440L–ER	460	C	40	29.8	60	140	40	29.8	60	69	30	22.3	45	122	30	22.3	40	46
ZD18H450L–ER	460	D	50	37.2	75	190	60	44.7	80	92	40	29.8	60	170	50	37.2	65	75
ZD18H460L–ER	460	D	60	44.7	90	215	75	56	100	115	50	37.2	75	190	60	44.7	80	92
ZD18H475L–EO	460	E	75	56	110	270	100	74.6	125	144	60	44.7	90	240	75	56	100	115

Ratings Series 18H Custom Vector Control w/Internal DB Transistor

CATALOG NO.	INPUT VOLT	SIZE	STANDARD 2.5 kHz PWM								QUIET 8.0 kHz PWM							
			CONSTANT TORQUE				VARIABLE TORQUE				CONSTANT TORQUE				VARIABLE TORQUE			
			HP	KW	IC	IP	HP	KW	IC	IP	HP	KW	IC	IP	HP	KW	IC	IP
ZD18H215–E	230	B	15	11.1	42	84	15	11.1	42	48	10	7.4	30	61	15	11.1	42	48
ZD18H215–ER	230	C	15	11.1	42	72	20	14.9	54	62	10	7.4	30	61	15	11.1	42	48
ZD18H220–ER	230	C	20	14.9	55	100	25	18.7	68	78	15	11.1	42	92	20	14.9	54	62
ZD18H225–ER	230	C	25	18.6	68	116	30	22.3	80	92	20	14.9	54	92	25	18.6	68	78
ZD18H230–ER	230	C	30	22.3	80	140	40	29.8	104	120	25	18.6	70	122	30	22.3	80	92
ZD18H230V–ER	230	C	30	22.3	80	200	40	29.8	104	120	30	22.3	80	183	40	29.8	104	120
ZD18H240–MR	230	D	40	29.8	105	200	50	37.2	130	150	40	29.8	105	183	50	37.2	130	150
ZD18H250V–MR	230	D	50	37.2	130	260	50	37.2	130	150	50	37.2	130	244	50	37.2	130	150
ZD18H250–MR	230	D	50	37.2	130	225	50	37.2	130	150	40	29.8	105	183	50	37.2	130	150
ZD18H415–ER	460	C	15	11.1	21	36	20	14.9	27	31	10	7.4	15	30	15	11.1	21	24
ZD18H420–ER	460	C	20	14.9	27	54	25	18.7	34	39	15	11.1	21	46	20	14.9	27	31
ZD18H425–ER	460	C	25	18.6	34	58	30	22.3	40	46	20	14.9	27	46	25	18.6	34	39
ZD18H430–ER	460	C	30	22.3	40	70	40	29.8	52	60	25	18.6	35	61	30	22.3	40	46
ZD18H430V–ER	460	C	30	22.3	40	100	40	29.8	52	60	30	22.3	40	92	30	22.3	40	46
ZD18H440–ER	460	D	40	29.8	55	100	50	37.2	65	75	30	22.3	40	80	40	29.8	52	60
ZD18H450–ER	460	D	50	37.2	65	115	60	44.8	80	92	40	29.8	55	92	50	37.2	65	75
ZD18H460–ER	460	D	60	44.7	80	140	75	56	100	115	50	37.2	65	122	60	44.7	80	92
ZD18H460V–ER	460	D	60	44.7	80	200	75	56	100	115	60	44.7	80	183	60	44.7	80	92
ZD18H515–ER	575	B	15	11.1	17	29	20	14.9	22	26	10	7.5	11	19	15	11.1	17	20
ZD18H520–ER	575	C	20	14.9	22	44	25	18.7	27	31	15	11.1	17	34	20	14.9	22	25
ZD18H525–ER	575	C	25	18.7	27	46	30	22.3	32	37	20	14.9	22	38	25	18.6	27	31
ZD18H530–ER	575	C	30	22.3	32	56	40	29.8	41	47	25	18.6	27	47	30	22.3	32	37
ZD18H540–ER	575	D	40	29.8	41	75	50	37.2	52	60	30	22.3	32	58	40	29.8	41	47
ZD18H550–ER	575	D	50	37.2	52	92	60	44.7	62	71	40	29.8	41	73	50	37.2	52	60
ZD18H560–ER	575	D	60	44.7	62	109	60	44.7	62	71	50	37.2	52	91	60	44.7	62	71

Terminal Tightening Torque Specifications

Table 7-4 Tightening Torque Specifications

230 VAC Catalog No.	Tightening Torque									
	Power TB1		Ground		Control J1		B+/R1; B+; B–; or R2		D1/D2	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
ZD18H201–E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H202–E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H203–E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H205–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H205–W	20	2.5	15	1.7	4.5	0.5	20	2.5	–	–
ZD18H207–E or W	20	2.5	15	1.7	4.5	0.5	20	2.5	–	–
ZD18H210–E	20	2.5	15	1.7	4.5	0.5	20	2.5	–	–
ZD18H210–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H210L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H215–E	20	2.5	15	1.7	4.5	0.5	20	2.5	–	–
ZD18H215V–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H215V–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H215–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H215–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H215L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H220–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H220–ER	35	4	22–26	2.5–3	4.5	0.5	35	4	–	–
ZD18H220L–ER	35	4	22–26	2.5–3	4.5	0.5	35	4	–	–
ZD18H225V–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H225V–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H225–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H225–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H225L–ER	35	4	22–26	2.5–3	4.5	0.5	35	4	–	–
ZD18H230–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H230V–EO	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	3.5	0.4
ZD18H230V–ER	35	4	22–26	2.5–3	4.5	0.5	35	4	–	–
ZD18H230L–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H240–MO	140	15.8	50	5.6	4.5	0.5	140	15.8	3.5	0.4
ZD18H240–MR	140	15.8	50	5.6	4.5	0.5	140	15.8	–	–
ZD18H240L–MR	140	15.8	50	5.6	4.5	0.5	140	15.8	–	–
ZD18H250V–MO	140	15.8	50	5.6	4.5	0.5	140	15.8	3.5	0.4
ZD18H250V–MR	140	15.8	50	5.6	4.5	0.5	140	15.8	–	–
ZD18H250–MO	140	15.8	22–26	2.5–3	4.5	0.5	140	15.8	3.5	0.4
ZD18H250–MR	140	15.8	22–26	2.5–3	4.5	0.5	140	15.8	–	–

Table 7-4 Tightening Torque Specifications Continued

460 VAC Catalog No.	Tightening Torque									
	Power TB1		Ground		Control J1		B+/R1; B+; B–; or R2		D1/D2	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
ZD18H401–E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H402–E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H403 –E or W	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H405–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H405–W	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H407–E or W	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H410–E	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H410–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H415–E	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H415V–EO	35	4	20	2.5	4.5	0.5	35	4	3.5	0.4
ZD18H415–EO	35	4	20	2.5	4.5	0.5	35	4	3.5	0.4
ZD18H415–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H415L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H420–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H420–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H420L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H425V–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H425V–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H425–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H425–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H425L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H430V–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H430V–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H430–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H430L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H440–EO	50	5.6	50	5.6	4.5	0.5	50	5.6	32	3.6
ZD18H440–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H440L–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H450–EO	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	3.5	0.4
ZD18H450–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H450L–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H460V–EO	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	3.5	0.4
ZD18H460V–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H460–EO	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	3.5	0.4
ZD18H460–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H460L–ER	22–26	2.5–3	22–26	2.5–3	4.5	0.5	22–26	2.5–3	–	–
ZD18H475–EO	140	15.8	50	5.6	4.5	0.5	140	15.8	3.5	0.4
ZD18H475L–EO	75	8.5	50	5.6	4.5	0.5	75	8.5	3.5	0.4

Table 7-4 Tightening Torque Specifications Continued

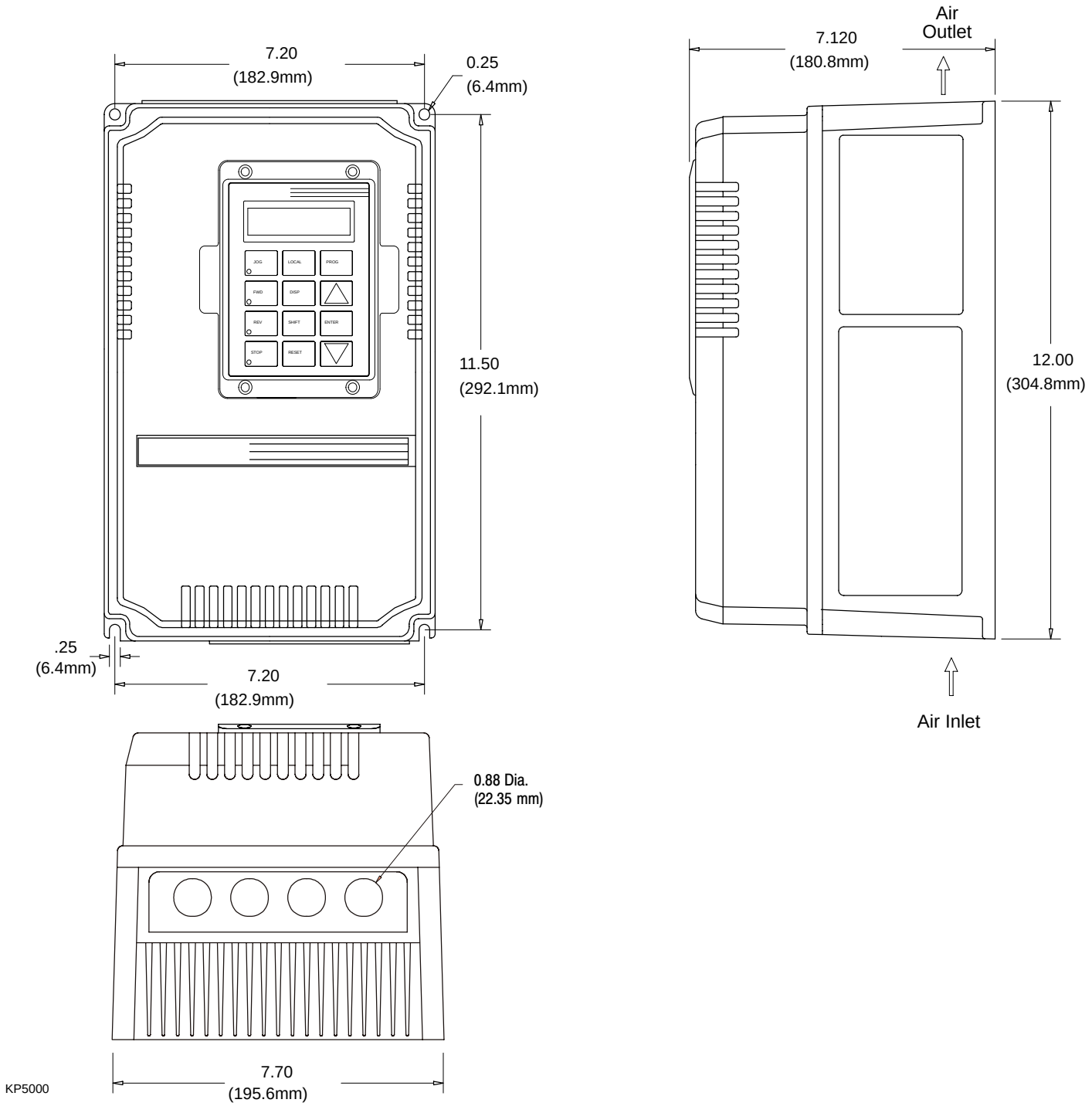
460 VAC Catalog No. Continued	Tightening Torque									
	Power TB1		Ground		Control J1		B+/R1; B+; B–; or R2		D1/D2	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
ZD18H4100–EO	75	8.5	50	5.6	4.5	0.5	75	8.5	3.5	0.4
ZD18H4150V–EO	75	8.5	50	5.6	4.5	0.5	75	8.5	3.5	0.4
ZD18H4150–EO	275	31	50	5.6	4.5	0.5	275	31	3.5	0.4
ZD18H4200–EO	275	31	50	5.6	4.5	0.5	275	31	3.5	0.4
ZD18H4250–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4
ZD18H4300–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4
ZD18H4350–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4
ZD18H4400–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4
ZD18H4400–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4
ZD18H4450–EO	375	42	375	42	4.5	0.5	375	42	3.5	0.4

Table 7-4 Tightening Torque Specifications Continued

575 VAC Catalog No.	Tightening Torque									
	Power TB1		Ground		Control J1		B+/R1; B+; B–; or R2		D1/D2	
	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm	Lb-in	Nm
ZD18H501–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H502–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H503–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H505–E	8	0.9	15	1.7	4.5	0.5	8	0.9	–	–
ZD18H507–E	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H510–E	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H515–E	20	2.5	20	2.5	4.5	0.5	20	2.5	–	–
ZD18H515–EO	35	4	20	2.5	4.5	0.5	35	4	3.5	0.4
ZD18H515–ER	35	4	20	2.5	4.5	0.5	35	4	–	–
ZD18H520–EO	35	4	20	2.5	4.5	0.5	35	4	3.5	0.4
ZD18H520–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H525–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H525–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H530–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H530–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H540–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H540–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H550–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H550–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H560–EO	35	4	50	5.6	4.5	0.5	35	4	3.5	0.4
ZD18H560–ER	35	4	50	5.6	4.5	0.5	35	4	–	–
ZD18H575–EO	20 - 30	2.5 - 3.5	50	5.6	4.5	0.5	20 - 30	2.5 - 3.5	3.5	0.4
ZD18H5100–EO	20 - 30	2.5 - 3.5	50	5.6	4.5	0.5	20 - 30	2.5 - 3.5	3.5	0.4
ZD18H5150V–EO	35 - 50	4 - 5.7	50	5.6	4.5	0.5	35 - 50	4 - 5.7	3.5	0.4

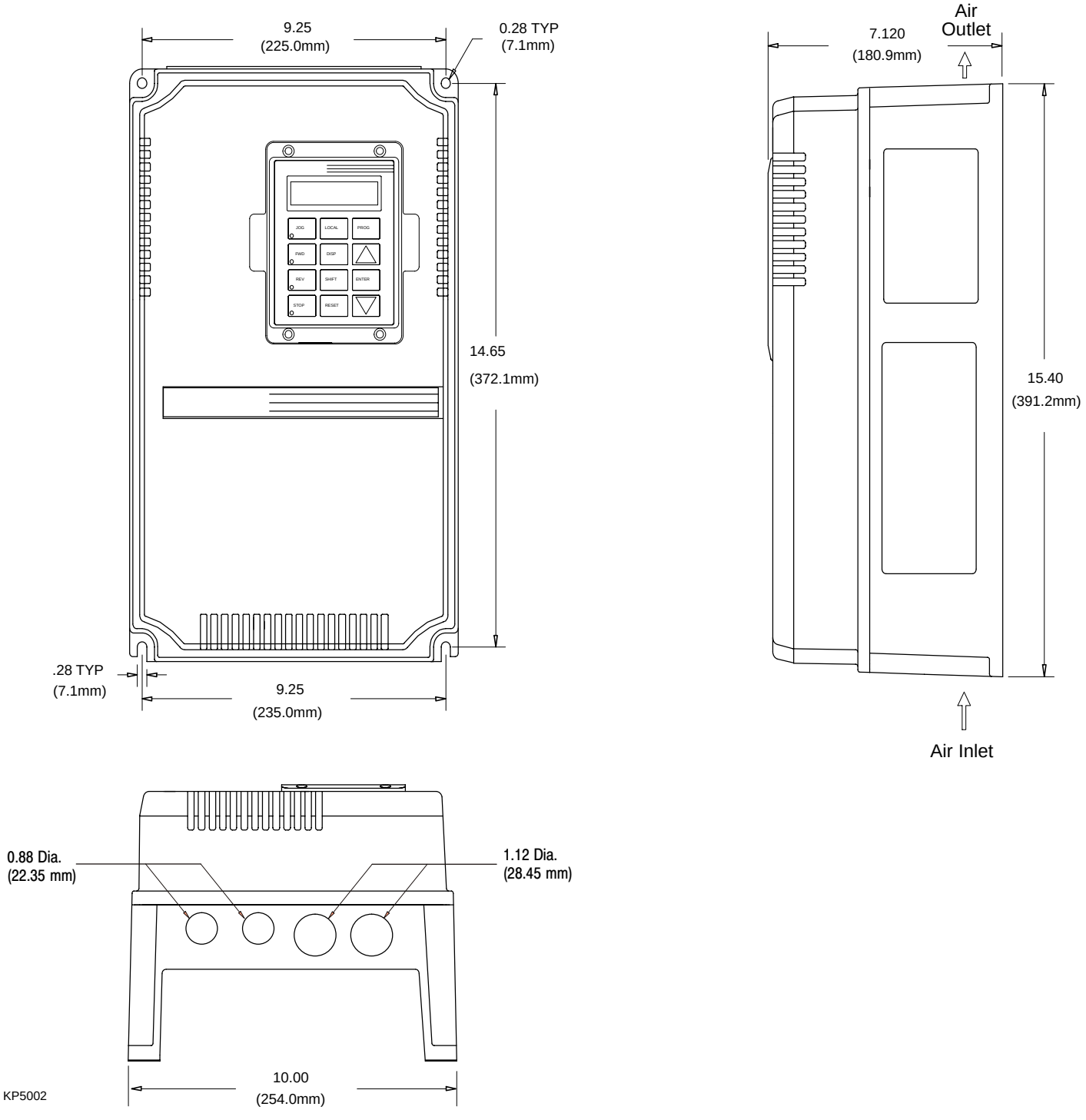
Mounting Dimensions

Size A Control



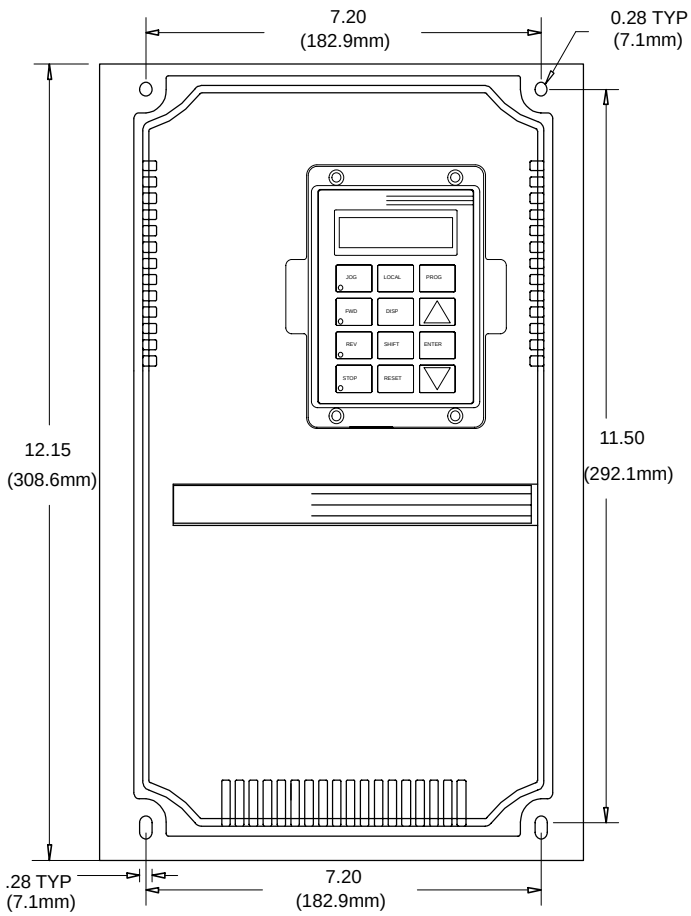
Dimensions Continued

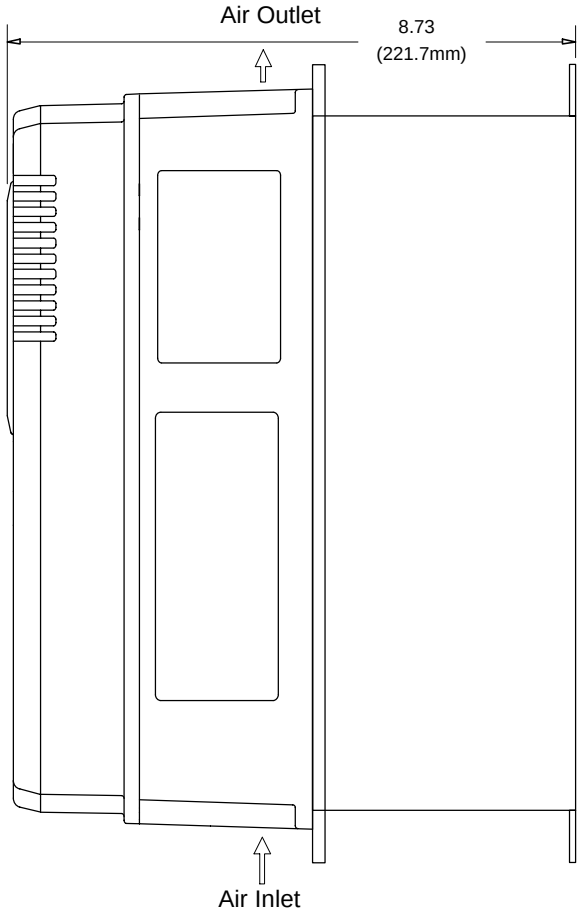
Size B Control

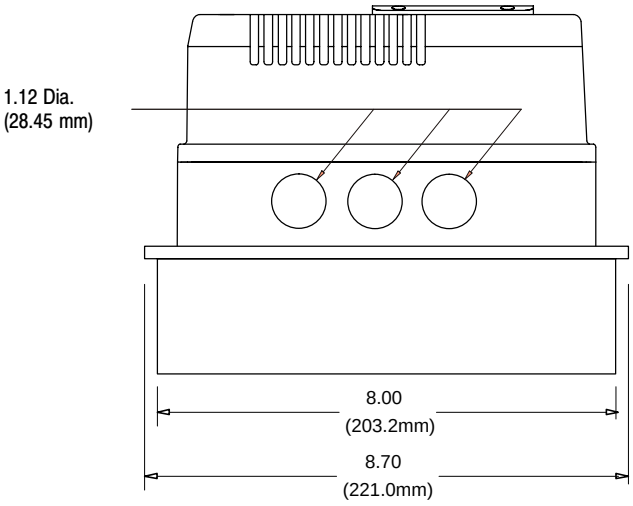


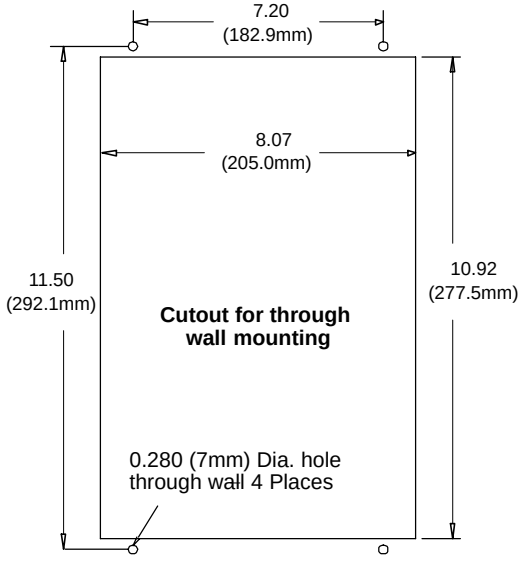
Dimensions Continued

Size B2 Control





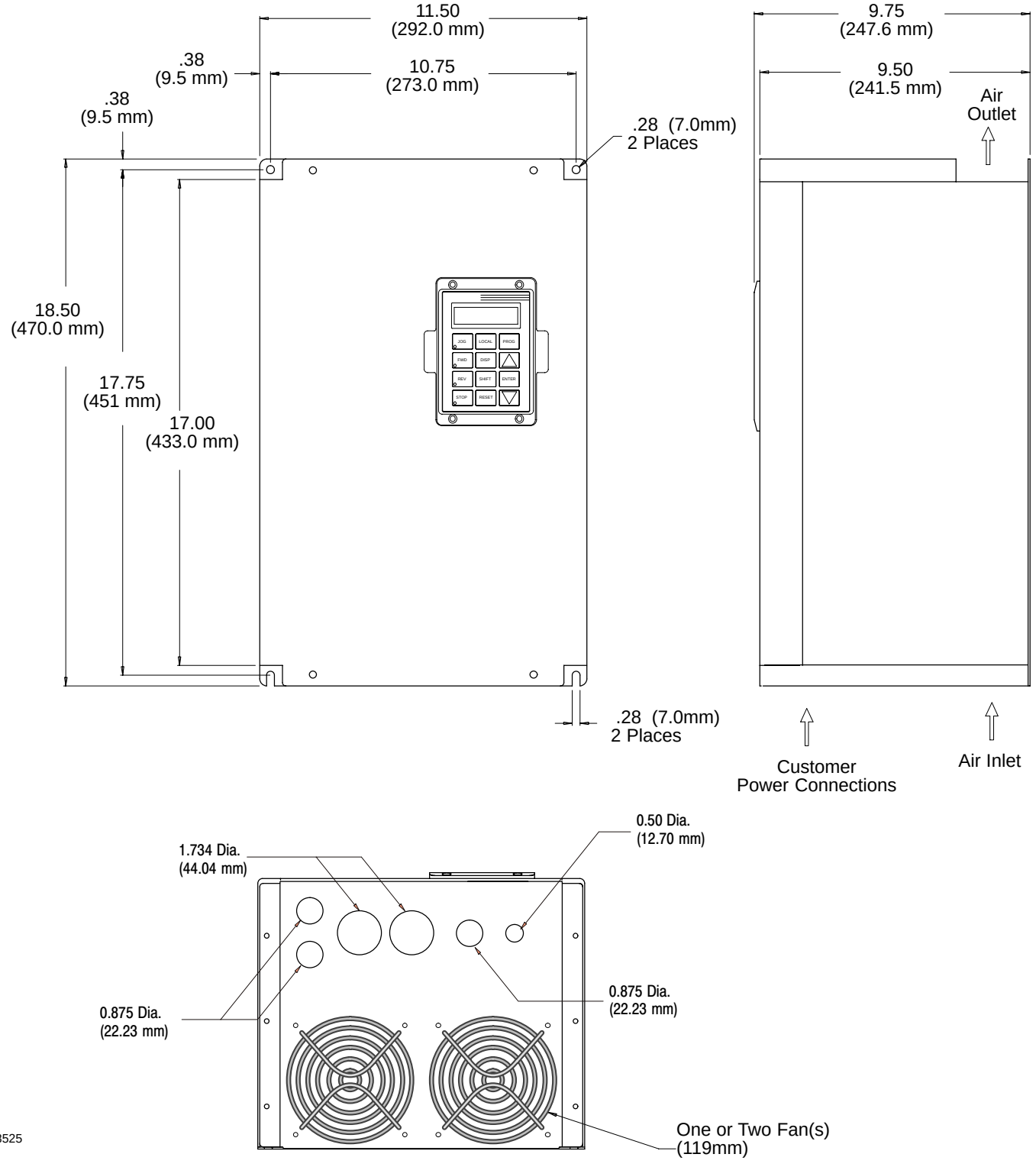




OM0001A15

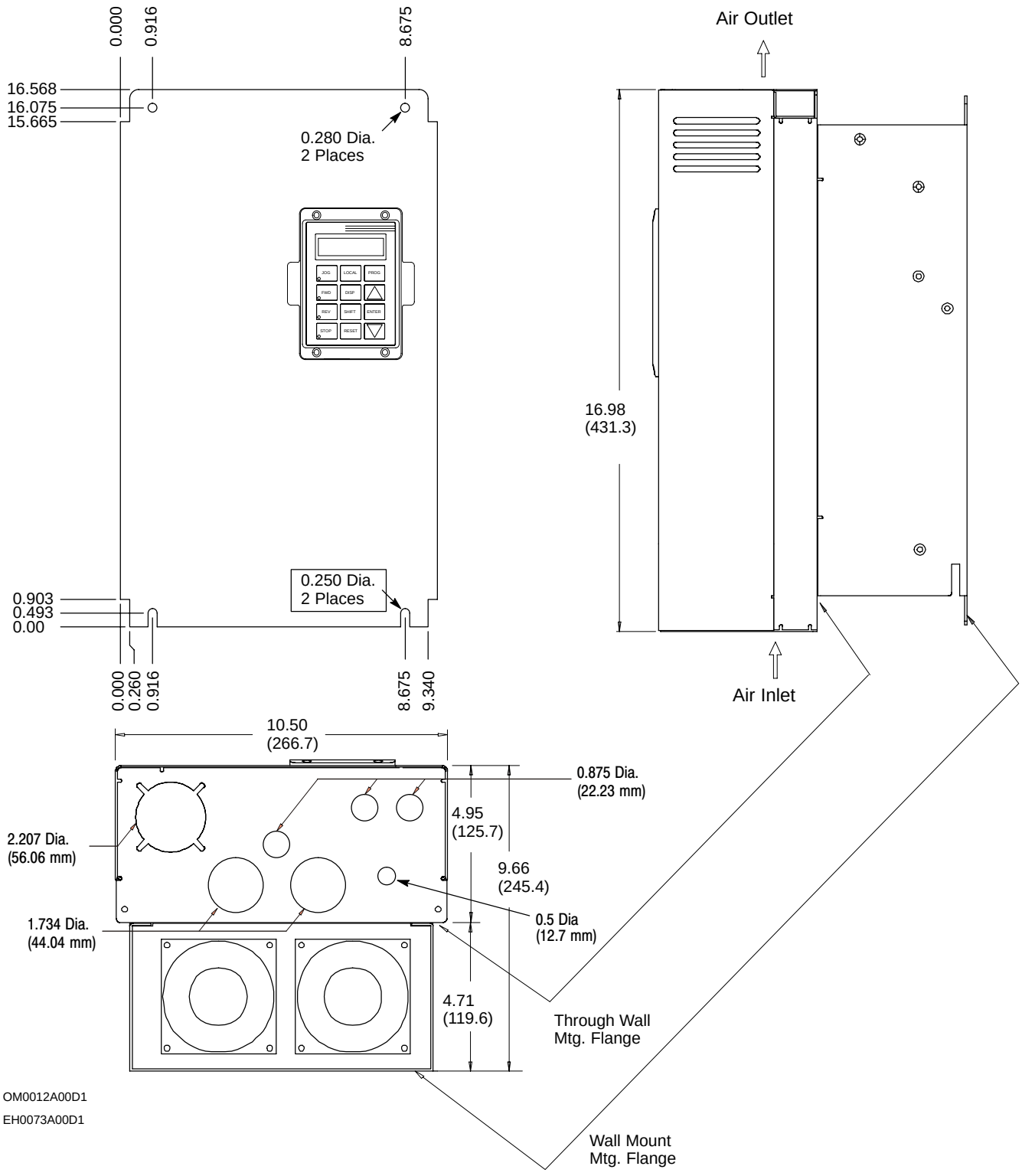
Dimensions Continued

Size C Control



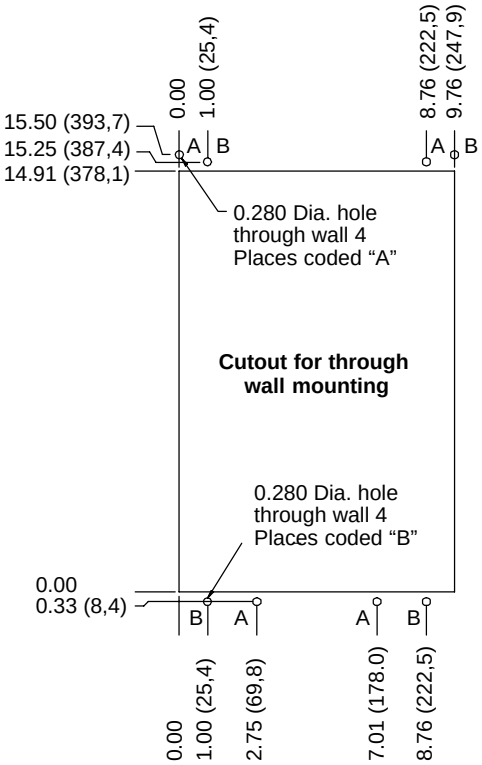
Dimensions Continued

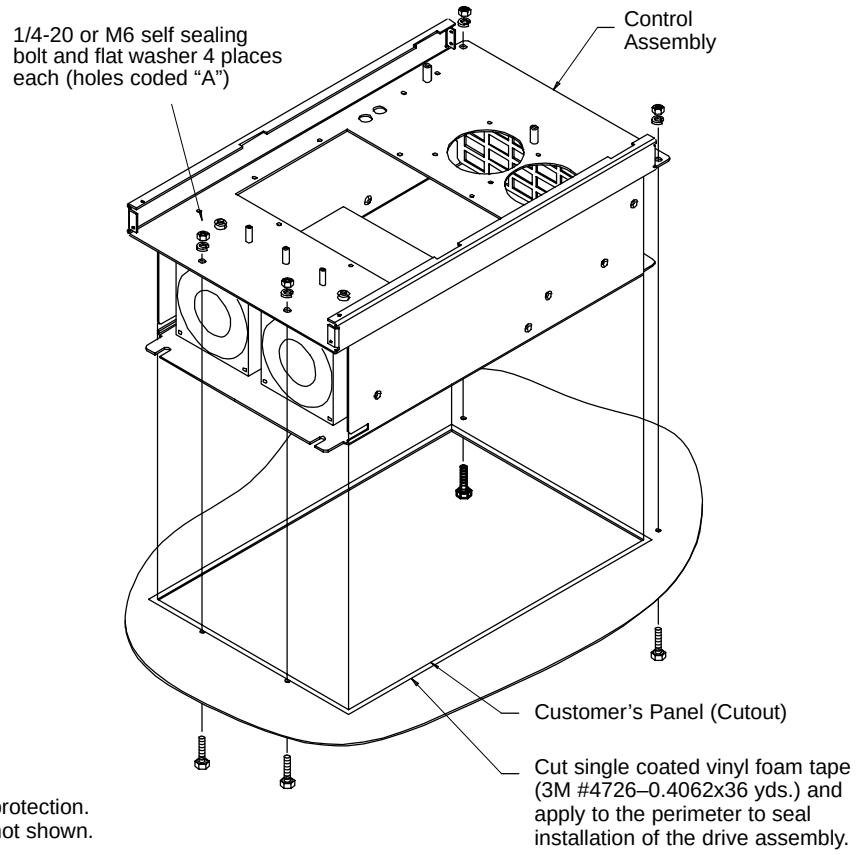
Size C2 Control



Dimensions Continued

Size C2 Control – Through–Wall Mounting

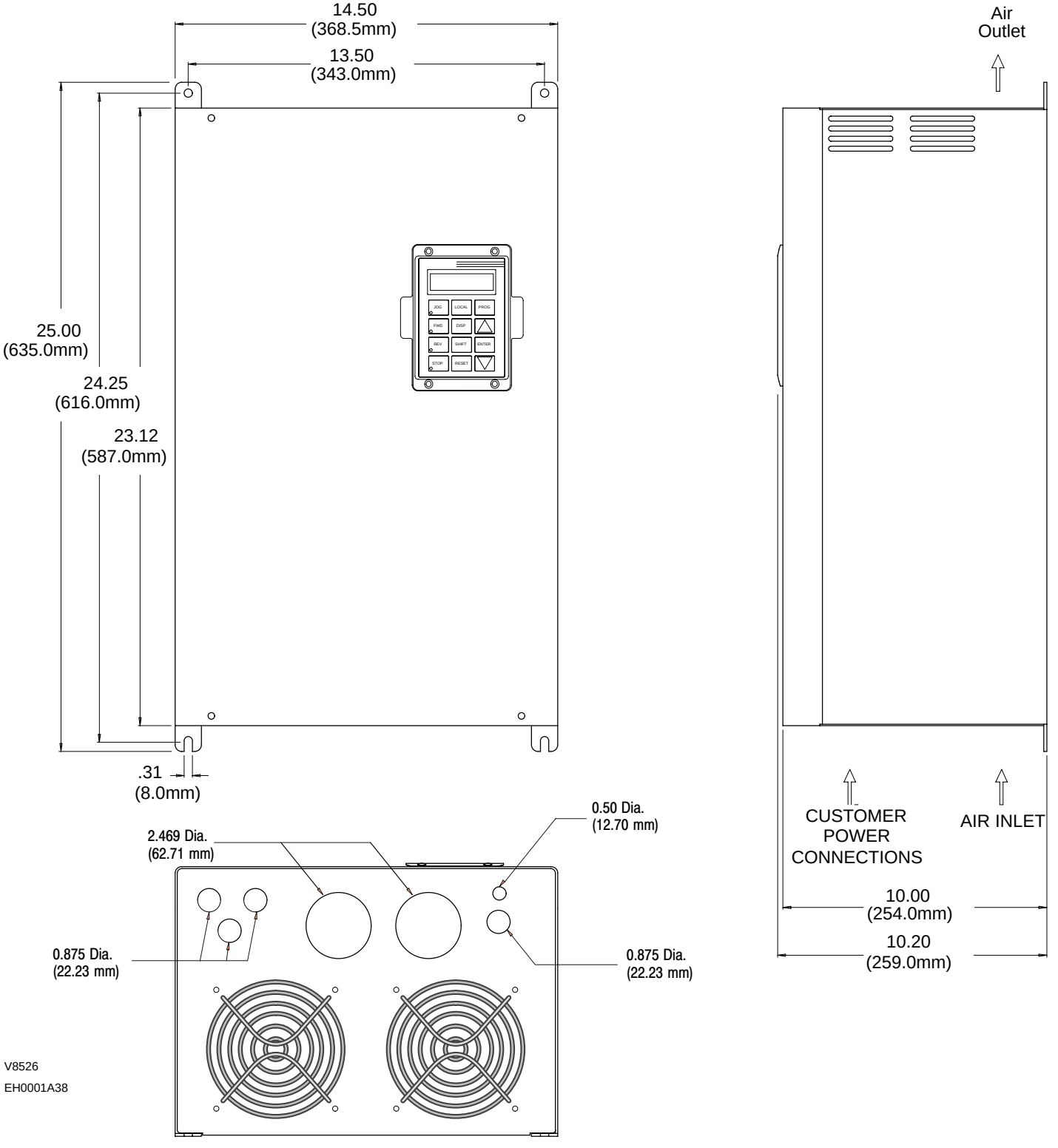




Note: Throughwall mounting provides NEMA 4 protection.
For clarity, cover and inside components not shown.

Dimensions Continued

Size D Control

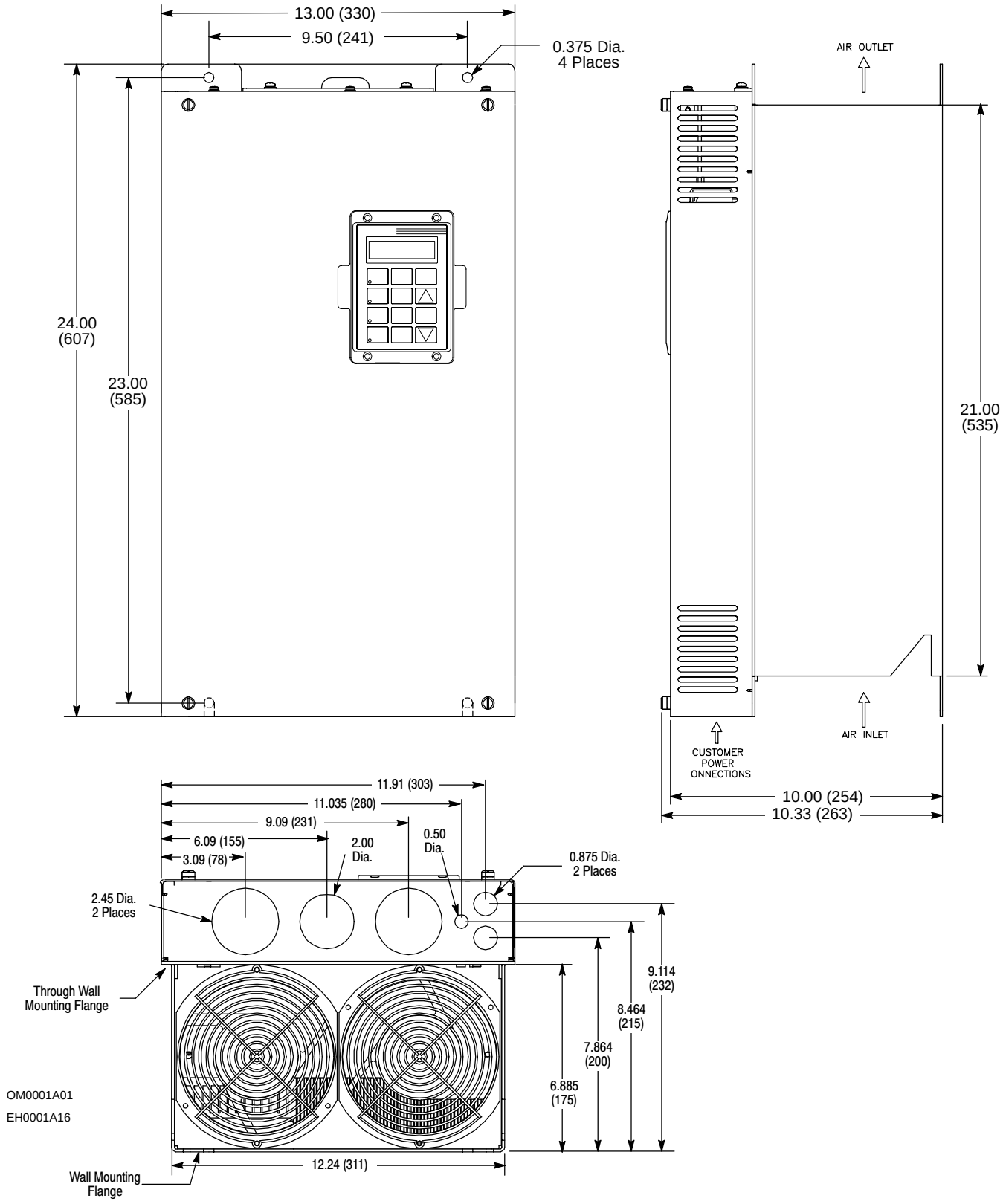


V8526

EH0001A38

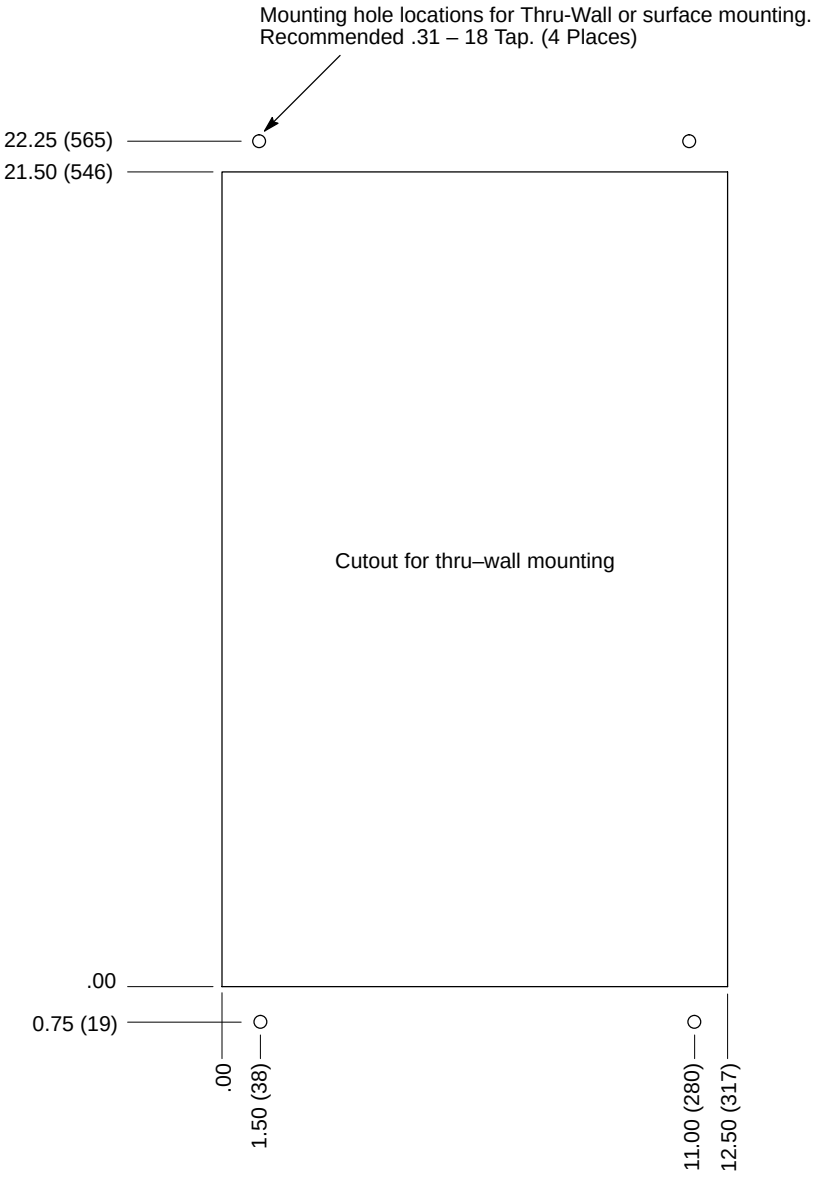
Dimensions Continued

Size D2 Control



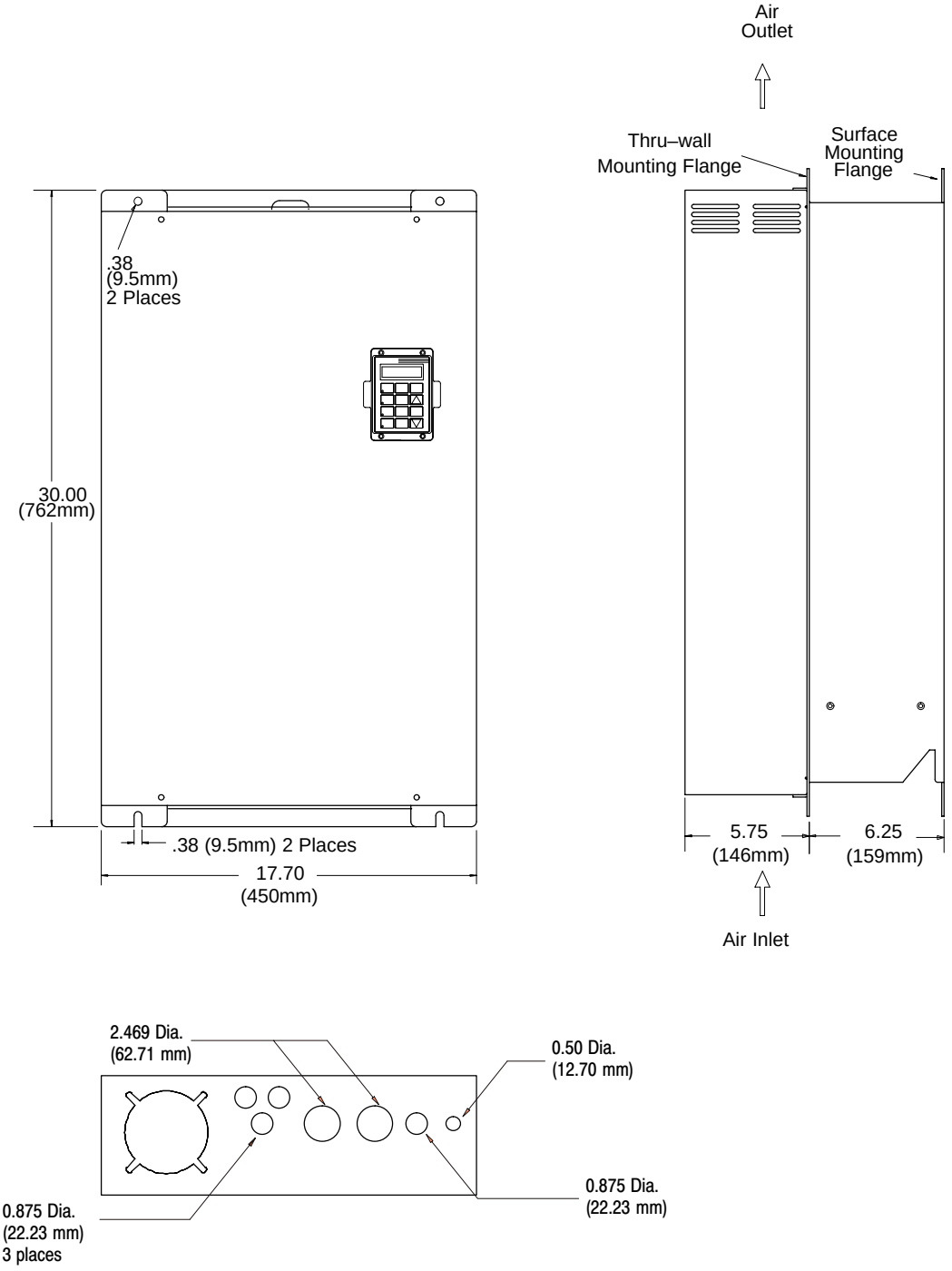
Dimensions Continued

Size D2 Control – Through–Wall Mounting



Dimensions Continued

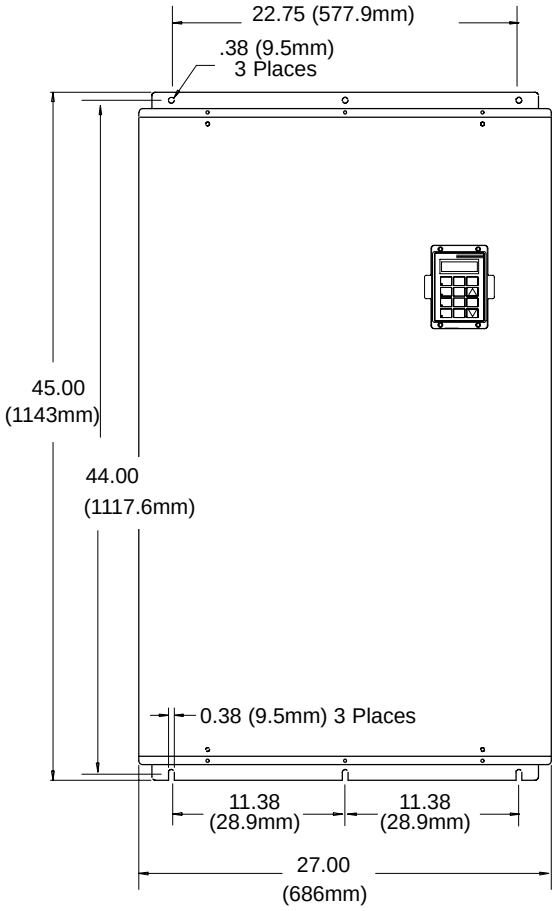
Size E Control

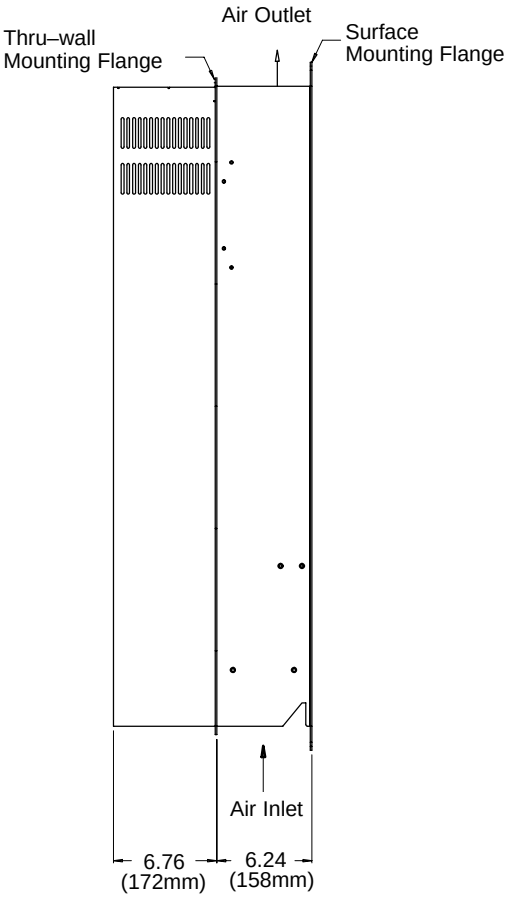


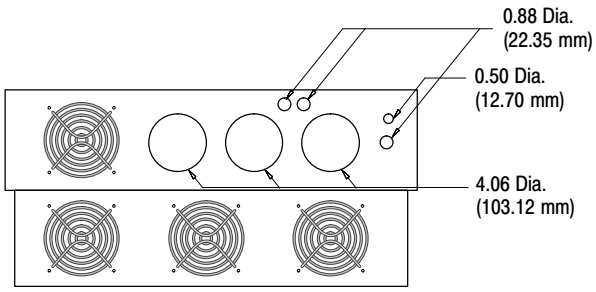
V8316

EH0001A43

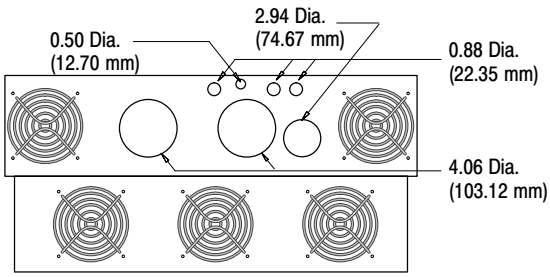
Size F Control







Standard Regen & Non–Regen

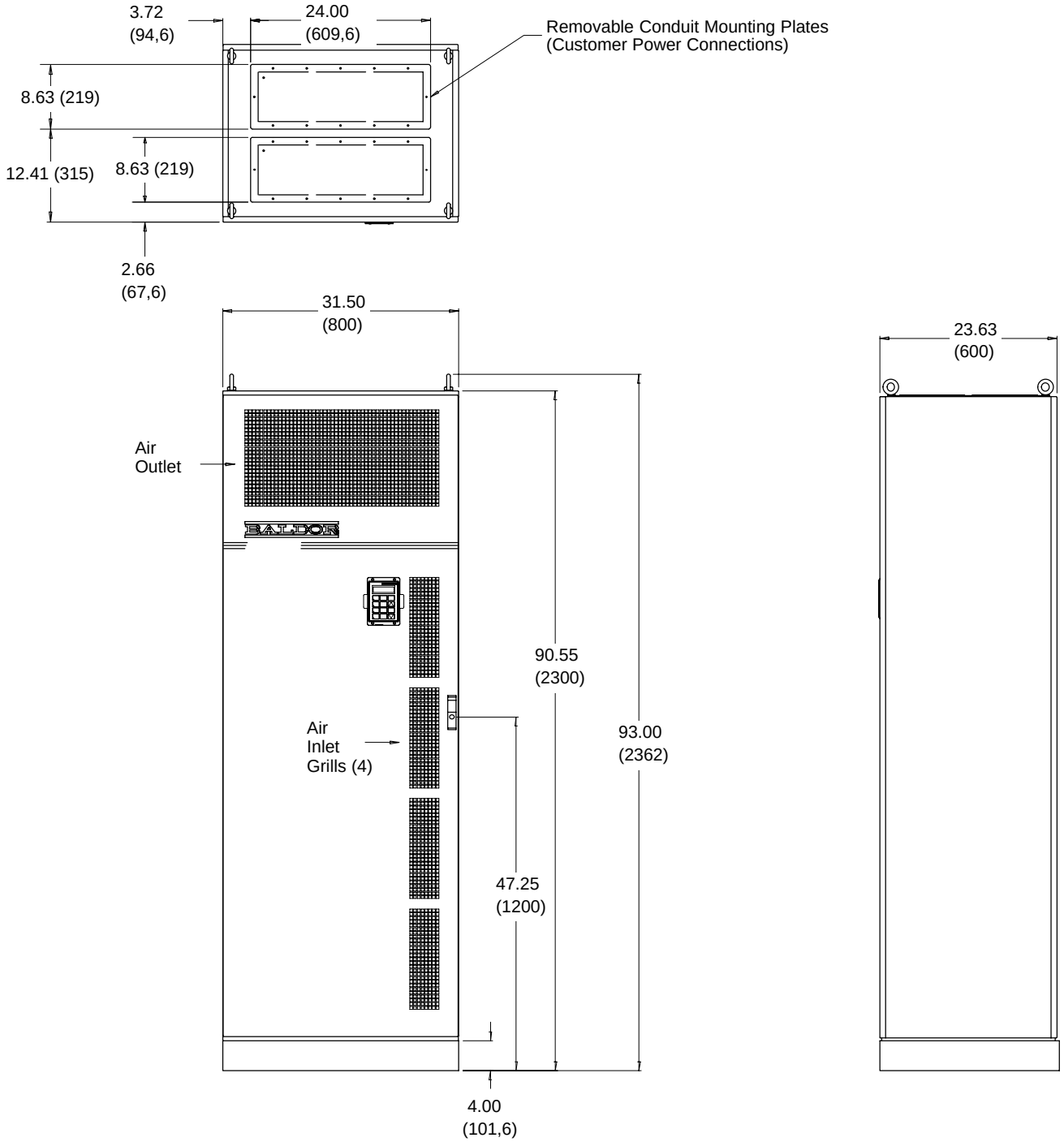


Non–Regen with DC Link Inductor

OM0031A00D1

Dimensions Continued

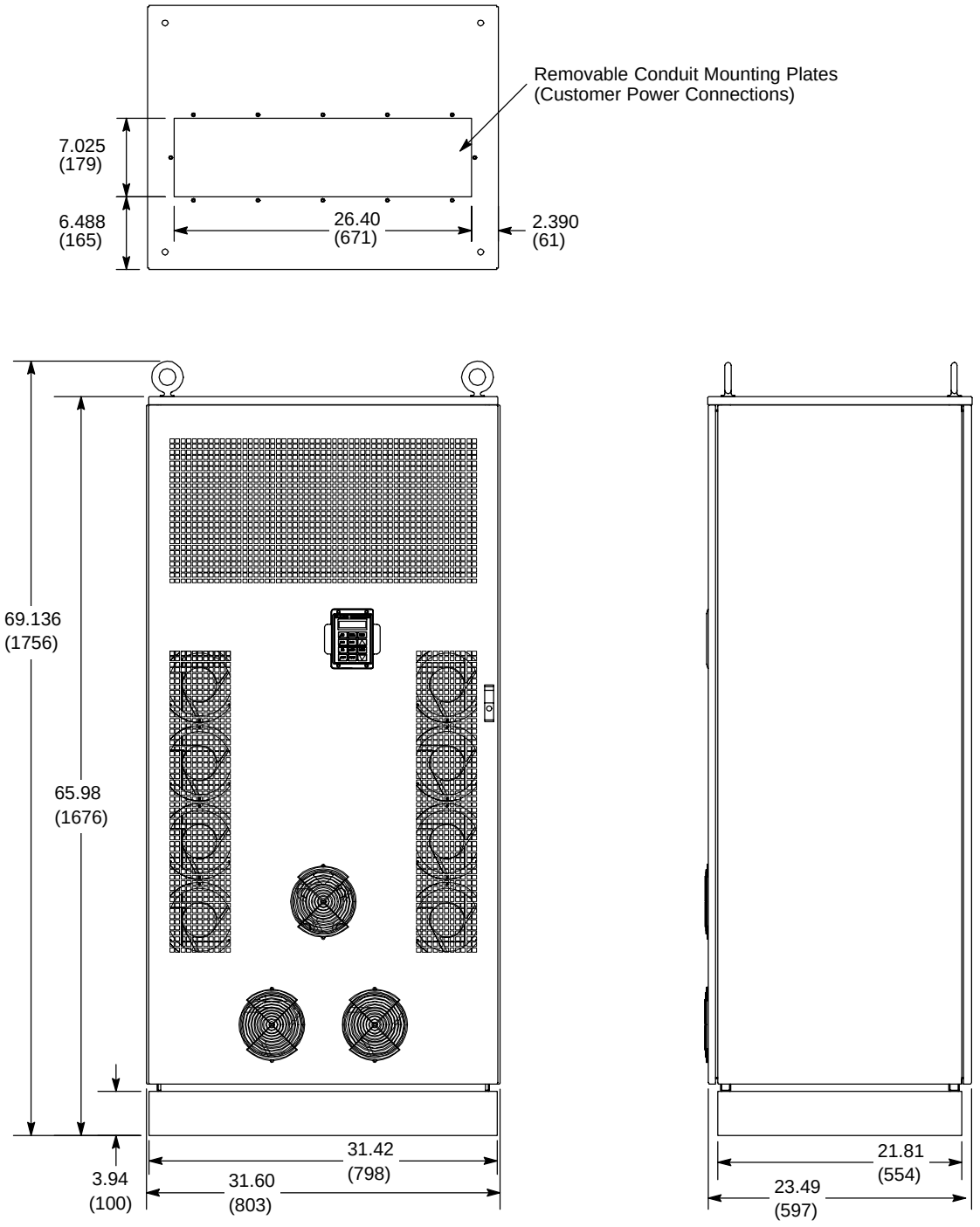
Size G Control



V1373

Dimensions Continued

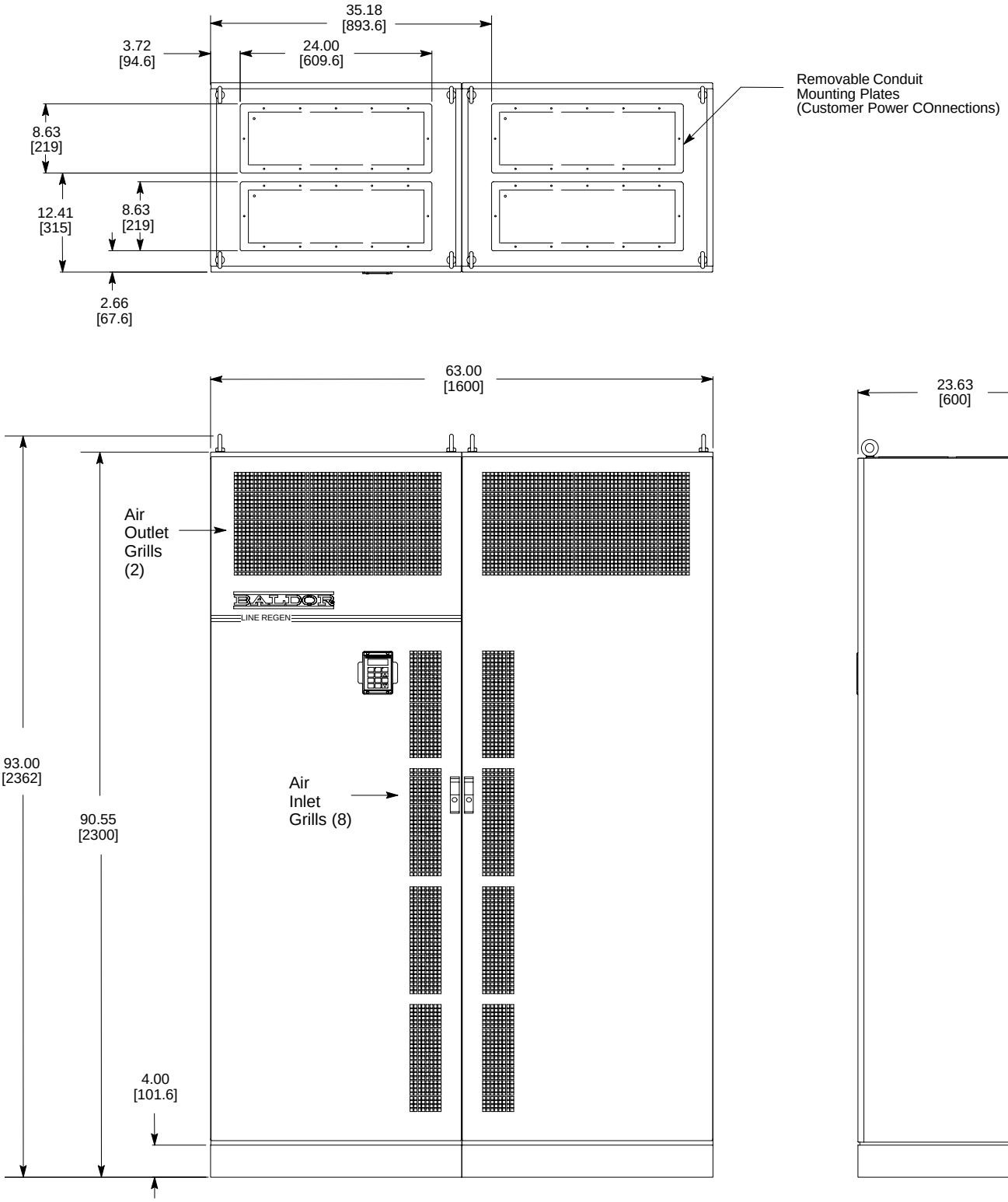
Size G2 Control



OM0001A04

Dimensions Continued

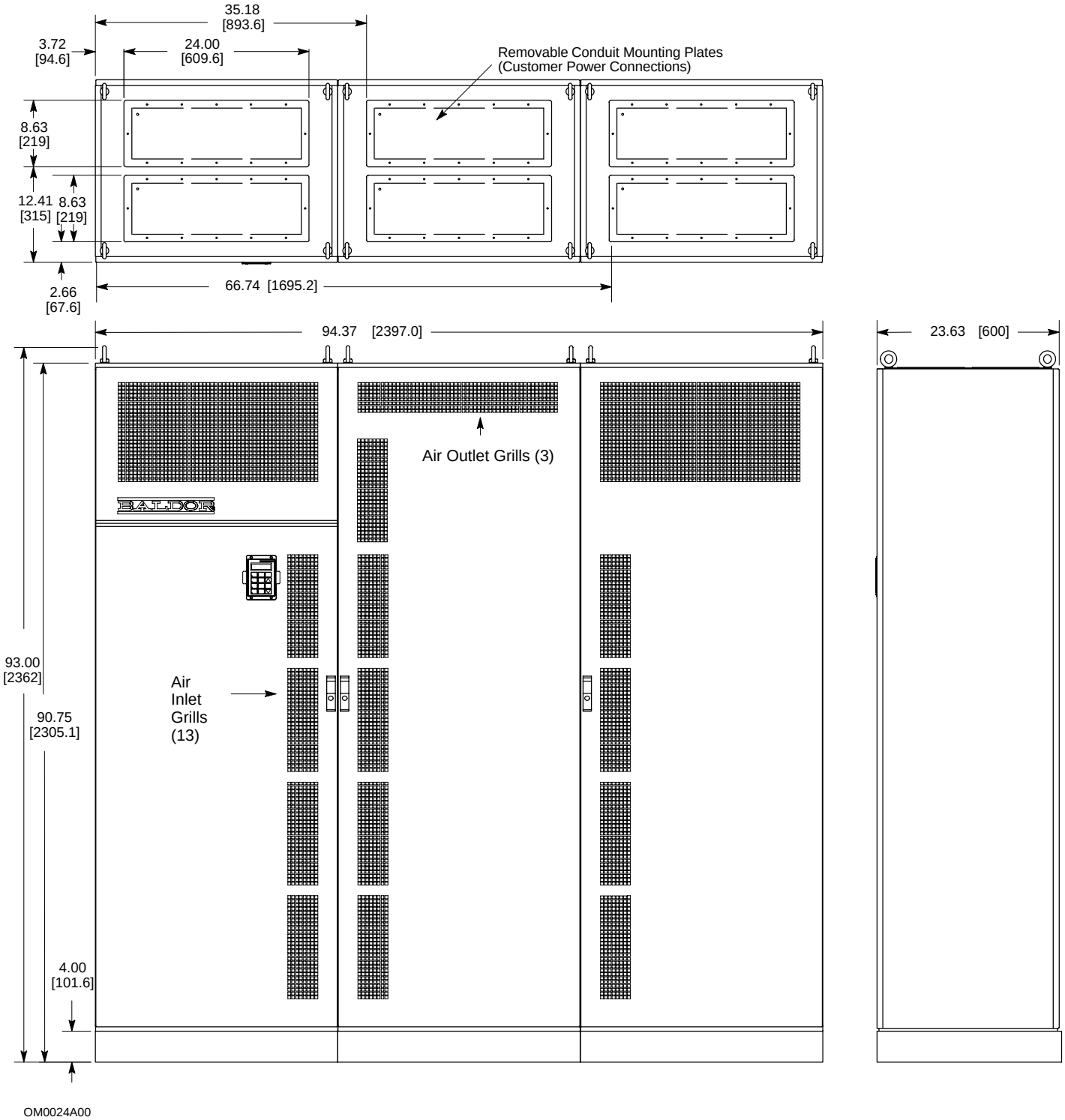
Size G+ Control



OM0001A00
OM0010A00D1

Dimensions Continued

Size H Control



OM0024A00

Appendix A

Dynamic Braking (DB) Hardware Whenever a motor is abruptly stopped or forced to slow down quicker than if allowed to coast to a stop, the motor becomes a generator. This energy appears on the DC Bus of the control and must be dissipated using dynamic braking hardware. Table A-1 provides a matrix of DB turn ON and turn OFF voltages.

Table A-1

Parameter Description	Control Input Voltage		
Nominal Voltage	230VAC	460VAC	575VAC
Overvoltage Fault (Voltage exceeded)	400VDC	800VDC	992VDC
DB ON Voltage	381VDC	762VDC	952VDC
DB upper tolerance peak	388VDC	776VDC	970VDC
DB OFF Voltage	375VDC	750VDC	940VDC

Braking torque and time should not exceed the available drive braking torque and time rating. The drive braking torque is limited to the available peak current and peak current time rating of the control. If the peak current or peak current time limit is exceeded during braking, the control may trip on an over voltage or a regen power fault. Selecting an oversized control or a line regenerative control should be considered in these cases.

Selection Procedure

1. Calculate the Watts to be dissipated using the following formulas for the appropriate load type.
2. Identify the control model number and determine which braking hardware is required based on the model number suffix: E, EO, ER, MO or MR.
3. Select appropriate braking hardware from Baldor 501 Catalog or Tables A-2, A-3 and A-4.

Hoisting Load Calculations

1. Calculate braking duty cycle:

$$\text{Duty Cycle} = \frac{\text{Lowering Time}}{\text{Total Cycle Time}}$$

2. Calculate braking Watts to be dissipated in dynamic braking resistors:

$$\text{Watts} = \frac{\text{duty cycle} \times \text{lbs} \times \text{FPM} \times \text{efficiency}}{44}$$

where: lbs = weight of load
FPM = Feet Per Minute
efficiency = mechanical efficiency
i.e., 95% = 0.95

Continued on next page

Dynamic Braking (DB) Hardware Continued

General Machinery Load Calculations:

1. Calculate braking duty cycle:

$$\text{Duty Cycle} = \frac{\text{Braking Time}}{\text{Total Cycle Time}}$$

2. Calculate deceleration torque:

$$T_{Decel} = \frac{\text{RPM change} \times Wk^2}{308 \times \text{time}} - \text{Friction}_{(Lb.Ft.)}$$

where: T_{Decel} = Deceleration torque in lb.-ft.
Wk^2 = Inertia in lb. ft.^{2}
time = In seconds

3. Calculate Watts to be dissipated in dynamic braking resistor:

$$\text{Watts} = T_{Decel} \times (S_{max} - S_{min}) \times \text{Duty Cycle} \times (0.0712)$$

where: S_{max} = Speed at braking start
S_{min} = Speed after braking

4. Multiply Watts calculated in step 3 by 1.25 to allow for unanticipated loads (safety factor).

Dynamic Braking (DB) Hardware Continued

18H Catalog Numbers with an “E” Suffix

These controls are equipped with a factory installed dynamic brake transistor and brake resistor(s). Should additional braking capacity be required an optional externally mounted RGA brake resistor can be used in lieu of the internal resistors. See RGA assemblies.

18H Catalog Numbers with an “ER” or “MR” Suffix

These controls include a factory installed dynamic braking transistor. If dynamic braking is required, use an optional external RGA brake resistor. See RGA assemblies.

18H Catalog Numbers with an “EO” or “MO” Suffix

No dynamic braking hardware is installed in these controls. If dynamic braking is required, an optional RBA assembly or a combination of RTA and RGA assemblies should be added. The RBA assembly provides up to 4,000 Watts dynamic braking capacity. Should more capacity be required, a combination of an RTA (DB transistor) and RGA (DB resistor) should be used. Refer to RBA, RTA and RGA Assemblies description.

Dynamic Braking (DB) Hardware Continued

RGA Assemblies

RGA Assemblies include braking resistors completely assembled and mounted in a NEMA 1 enclosure. A listing of available RGA assemblies is provided in Table A-2. The minimum resistance “Minimum Ohms” shown in the table is the minimum resistor value that can be connected to the control without causing damage to the internal dynamic brake transistor for E, ER and MR controls.

RGA assemblies can also be used with EO and MO controls in combination with an RTA assembly when more than 4000 Watts of brake capacity is needed. In this case, the minimum resistance of the RGA assembly must be equal to or greater than the minimum resistance specified for the RTA assembly. Refer to Section 3 “Optional Dynamic Brake Hardware” for wiring diagram.

Table A-2 Dynamic Braking Resistor Assemblies (RGA)

Input Volts	HP	Minimum Ohms	Continuous Rated Watts						
			600	1200	2400	4800	6400	9600	14200
230	1 - 2	30	RGA630	RGA1230	RGA2430				
	3 - 5	20	RGA620	RGA1220	RGA2420	RGA4820			
	7.5 - 10	10		RGA1210	RGA2410	RGA4810			
	15 - 20	6		RGA1206	RGA2406	RGA4806			
	25 - 40	4		RGA1204	RGA2404	RGA4804			
	50	2			RGA2402	RGA4802	RGA6402	RGA9602	RGA14202
460	1 - 3	120	RGA6120	RGA12120	RGA24120				
	5 - 7.5	60	RGA660	RGA1260	RGA2460	RGA4860			
	10	30	RGA630	RGA1230	RGA2430	RGA4830			
	15 - 25	20	RGA620	RGA1220	RGA2420	RGA4820			
	30 - 60	10		RGA1210	RGA2410	RGA4810			
	75 - 250	4		RGA1204	RGA2404	RGA4804	RGA6404	RGA9604	RGA14204
	300 - 450	2			RGA2402	RGA4802	RGA6402	RGA9602	RGA14202
575	1 - 2	200	RGA6200	RGA12200	RGA24200				
	3 - 5	120	RGA6120	RGA12120	RGA24120				
	7.5 - 10	60	RGA660	RGA1260	RGA2460	RGA4860			
	15	30	RGA630	RGA1230	RGA2430	RGA4830			
	20 - 30	24		RGA1224	RGA2424	RGA4824			
	40 - 150	14			RGA2414	RGA4814	RGA6414	RGA9614	RGA14214

Dynamic Braking (DB) Hardware Continued

RBA Assemblies

An RBA Assembly includes a dynamic brake transistor and resistors completely assembled and mounted in a NEMA 1 enclosure. They are designed for use with EO and MO controls. Select the RBA based on the voltage rating of the control and the dynamic brake watt capacity required. Use Table A-3 to select the RBA assembly. If more than 4,000 Watts of brake capacity is required, use a combination of RTA (DB transistor) and RGA (DB resistor) assemblies. Refer to Section 3 “Optional Dynamic Brake Hardware” for wiring diagram.

Table A-3 Dynamic Braking Assemblies (RBA)

	MAXIMUM BRAKING TORQUE IN % OF MOTOR RATING													Cont. Watts	Catalog No.
INPUT VOLTAGE	HP	20	25	30	40	50	60	75	100	150V	150	200	250		
	200 to 240	90%	75%	60%	45%	36%								600	RBA2-610
		150%	125 %	100%	75%	62%								1800	RBA2-1806
		150%	150 %	150%	115 %	92%								4000	RBA2-4004
	380 to 480	150%	150 %	120%	90%	72%	60%	48%	36%	28%				600	RBA4-620
		150%	150 %	120%	90%	72%	60%	48%	36%	28%				1800	RBA4-1820
		150%	150 %	150%	150 %	150 %	120 %	96%	72%	56%	48%	36%	29%	4000	RBA4-4010
	550 to 600	150%	150 %	120%	90%	72%	60%	48%	36%	28%				600	RBA5-624
		150%	150 %	120%	90%	72%	60%	48%	36%	28%				1800	RBA5-1824
		150%	150 %	150%	150 %	150 %	120 %	96%	72%	56%				4000	RBA5-4014

Dynamic Braking (DB) Hardware Continued

RTA Assemblies

RTA assemblies include a dynamic brake transistor and gate driver circuit board completely assembled and mounted in a NEMA 1 enclosure. Brake resistors are not included in the RTA assembly. Each RTA assembly is designed to be used with an RGA dynamic brake resistor assembly. The minimum resistance of the RGA assembly must be equal to or greater than the minimum resistance specified for the RTA assembly. Select the RTA based on the voltage rating of the control and HP which provides the dynamic brake watt capacity required. Use Table A-4 to select the RTA assembly. Refer to Section 3 “Optional Dynamic Brake Hardware” for wiring diagram.

Table A-4 Dynamic Braking Transistor Assemblies (RTA)

HP	MAXIMUM BRAKING TORQUE IN % OF MOTOR RATING									
	208 - 230 VAC			380 - 480 VAC				550 - 600 VAC		
20	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%
25	125%	150%	150%	150%	150%	150%	150%	150%	150%	150%
30	100%	150%	150%	120%	150%	150%	150%	150%	150%	150%
40	75%	115%	150%	90%	150%	150%	150%	127%	150%	150%
50	62%	92%	150%	72%	150%	150%	150%	100%	150%	150%
60				60%	150%	150%	150%	85%	145%	150%
75				48%	96%	150%	150%	68%	116%	150%
100				36%	72%	150%	150%	50%	87%	150%
150V				28%	56%	150%	150%	40%	70%	150%
150					48%	126%	150%	34%	58%	150%
200					36%	95%	150%	25%	44%	150%
250					29%	76%	150%		35%	122%
300						62%	125%		29%	100%
350						54%	108%			87%
400						47%	94%			76%
450						41%	84%			68%
CAT. NO.	**RTA2-6**	**RTA2-4**	**RTA2-2**	**RTA4-20**	**RTA4-10**	**RTA4-4**	**RTA4-2**	**RTA5-24**	**RTA5-14**	**RTA5-4**
Minimum Ohms	6	4	2	20	10	4	2	24	14	4

Appendix B

Parameter Values (Version 3.20)

Table B-1 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	0.0 to 3600.0 Seconds	3.0 SEC	
	DECEL TIME #1	1102	0.0 to 3600.0 Seconds	3.0 SEC	
	S-CURVE #1	1103	0-100%	0 %	
	ACCEL TIME #2	1104	0.0 to 3600.0 Seconds	3.0 SEC	
	DECEL TIME #2	1105	0.0 to 3600.0 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	0.0 to 3600.0 Seconds	3.0 SEC	
	JOG DECEL TIME	1203	0.0 to 3600.0 Seconds	3.0 SEC	
	JOG S-CURVE TIME	1204	0-100%	0 %	
KEYPAD SETUP	KEYPAD STOP KEY	1301	0–REMOTE OFF (Stop key inactive during remote operation). 1–REMOTE ON (Stop key active during remote operation).	REMOTE ON	
	KEYPAD STOP MODE	1302	0–COAST, 1–REGEN	REGEN	
	KEYPAD RUN FWD	1303	0–OFF, 1–ON	ON	
	KEYPAD RUN REV	1304	0–OFF, 1–ON	ON	
	KEYPAD JOG FWD	1305	0–OFF, 1–ON	ON	
	KEYPAD JOG REV	1306	0–OFF, 1–ON	ON	
	LOC. HOT START	1307	0–OFF, 1–ON	OFF	

Table B-1 Parameter Block Values Level 1 Continued

Level 1 Blocks - Continued					
Block Title	**Parameter**	P#	**Adjustable Range**	**Factory**	**User Setting**
INPUT	OPERATING MODE	1401	1–KEYPAD 2–STANDARD RUN 3–15SPD 4–3SPD ANA 2 WIRE 5–3SPD ANA 3 WIRE 6–SERIAL 7–BIPOLAR 8–PROCESS MODE 9–EPOT –2WIRE 10–EPOT –3WIRE	KEYPAD	
	COMMAND SELECT	1402	0–POTENTIOMETER 1–+/-10 VOLTS 2–+/-5 VOLTS 3–4 TO 20 mA 4–10V W/ TORQ FF 5–EXB PULSE FOL 6–5V EXB 7–10 V EXB 8–4-20mA EXB 9–3-15 PSI EXB 10–TACHOMETER EXB 11–SERIAL 12–NONE	+/-10 VOLTS	
	ANA CMD INVERSE	1403	0–OFF, 1–ON	OFF	
	ANA CMD OFFSET	1404	-20.00 TO +20.00% (where ±0.5V=±20%)	0.00 %	
	ANA 2 DEADBAND	1405	0.00-10.00 V	0.00 V	
	ANA 1 CUR LIMIT	1406	0–OFF, 1–ON	OFF	
OUTPUT	OPTO OUTPUT #1	1501	0–READY 1–ZERO SPEED 2–AT SPEED 3–OVERLOAD 4–KEYPAD CONTROL 5–AT SET SPEED 6–FAULT 7–FOLLOWING ERR 8–MOTR DIRECTION 9–DRIVE ON 10–CMD DIRECTION 11–AT POSITION 12–OVER TEMP WARN 13–PROCESS ERROR 14–DRIVE RUN 15–SERIAL	READY	
	OPTO OUTPUT #2	1502		ZERO SPEED	
	OPTO OUTPUT #3	1503		AT SPEED	
	OPTO OUTPUT #4	1504		FAULT	
	ZERO SPD SET PT	1505	1-MAX Speed	10 RPM	
	AT SPEED BAND	1506	1-1000 RPM	100 RPM	
	SET SPEED	1507	0-MAX Speed	Rated Motor Speed	

Table B-1 Parameter Block Values Level 1 Continued

Level 1 Blocks - Continued					
Block Title	**Parameter**	P#	**Adjustable Range**	**Factory**	**User Setting**
OUTPUT (Continued)	ANALOG OUT #1	1508	0–ABS SPEED 1–ABS TORQUE 2–SPEED COMMAND 3–PWM VOLTAGE 4–FLUX CURRENT 5–CMD FLUX CUR 6–LOAD CURRENT 7–CMD LOAD CUR 8–MOTOR CURRENT 9–LOAD COMPONENT 10–QUAD VOLTAGE 11–DIRECT VOLTAGE 12–AC VOLTAGE 13–BUS VOLTAGE 14–TORQUE 15–POWER 16–VELOCITY 17–OVERLOAD 18–PH2 CURRENT 19–PH3 CURRENT 20–PROCESS FDBK 21–SETPOINT CMD 22–POSITION 23–SERIAL	ABS SPEED	
	ANALOG OUT #2	1509		MOTOR CURRENT	
	ANALOG #1 SCALE	1510	10 - 100%	100%	
	ANALOG #2 SCALE	1511	10 - 100%	100%	
	POSITION BAND	1512	1-32767 CNTS	CALC	
	ZERO SPEED BAND	1513	1-1000 RPM	100 RPM	
VECTOR CONTROL	CTRL BASE SPEED	1601	0-MAX Speed	CALC	
	FEEDBACK FILTER	1602	0-7	CALC	
	FEEDBACK ALIGN	1603	0–REVERSE, 1–FORWARD	FORWARD	
	CURRENT PROP GAIN	1604	0-1000	CALC	
	CURRENT INT GAIN	1605	0-400 Hz	150 Hz	
	SPEED PROP GAIN	1606	0-1000	10	
	SPEED INT GAIN	1607	0.00-9.99 Hz	1.00 HZ	
	SPEED DIFF GAIN	1608	0-100	0	
	POSITION GAIN	1609	0-9999	31	
	SLIP FREQUENCY	1610	0.00-20.00 Hz	CALC	
	STATOR R1	1611	0.000-65.535	CALC	
	STATOR X1	1612	0.000-65.535	CALC	
	PROP GAIN #1	1613	0-65535	15000	
	INT GAIN #1	1614	0-65535	5000	
LEVEL 2 BLOCK	ENTERS LEVEL 2 MENU - See Table B-2.				
PRESS ENTER FOR PROGRAMMING EXIT	Exit programming mode and return to display mode.				

Table B-2 Parameter Block Values Level 2

Level 2 Blocks					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory**	**User Setting**
OUTPUT LIMITS	OPERATING ZONE	2001	1–STD CONST TQ 2–STD VAR TQ 3–QUIET CONST TQ 4–QUIET VAR TQ	STD CONST TQ	
	MIN OUTPUT SPEED	2002	0-MAX Speed	0 RPM	
	MAX OUTPUT SPEED	2003	0-30000 RPM	Rated Motor Speed	
	PK CURRENT LIMIT	2004	0-PEAK RATED CURRENT	PK Control Rating	
	PWM FREQUENCY	2005	1.0-5.0 KHZ (Standard) 1.0-16.0 KHZ (Quiet)	2.5 KHZ	
	CUR RATE LIMIT	2006	0.000-10.000 SEC	0.004 SEC	
CUSTOM UNITS	DECIMAL PLACES	2101	0-5	5	
	VALUE AT SPEED	2102	1-65535/1-65535	0./ 01000	
	VALUE DEC PLACES	2103	0-5 (Serial Only)	0	
	VALUE SPEED REF	2104	1 to 65535 (Serial Only)	00000/ 01000	
	UNITS OF MEASURE	2105	See Table 4-3.	-	
	UNITS OF MEASURE 2	2106	See Table 4-3. (Serial Only)	-	
PROTECTION	OVERLOAD	2201	0–FOLDBACK, 1–FAULT,	FOLDBACK	
	EXTERNAL TRIP	2202	0–OFF, 1–ON	OFF	
	LOCAL ENABLE INP	2203	0–OFF, 1–ON	OFF	
	FOLLOWING ERROR	2204	0–OFF, 1–ON	OFF	
	TORQUE PROVING	2205	0–OFF, 1–ON	OFF	
	FEEDBACK FAULT	2206	0–OFF, 1–ON	OFF	
MISCELLANEOUS	RESTART AUTO/MAN	2301	0–MANUAL, 1–AUTOMATIC	MANUAL	
	RESTART FAULT/HR	2302	0-10	0	
	RESTART DELAY	2303	0-120 SECONDS	0 SEC	
	FACTORY SETTINGS	2304	0–NO, 1–YES	NO	
	HOMING SPEED	2305	0-MAX Speed	100 RPM	
	HOMING OFFSET	2306	0-65535 CNTS	1024	
	STAB.LOW LIMIT	2307	0-30000 RPM	1920 RPM	
SECURITY CONTROL	SECURITY STATE	2401	0–OFF 1–LOCAL SECURITY 2–SERIAL SECURITY 3–TOTAL SECURITY	OFF	
	ACCESS TIMEOUT	2402	0-600 SEC	0 SEC	
	ACCESS CODE	2403	0-9999	9999	

Table B-2 Parameter Block Values Level 2 Continued

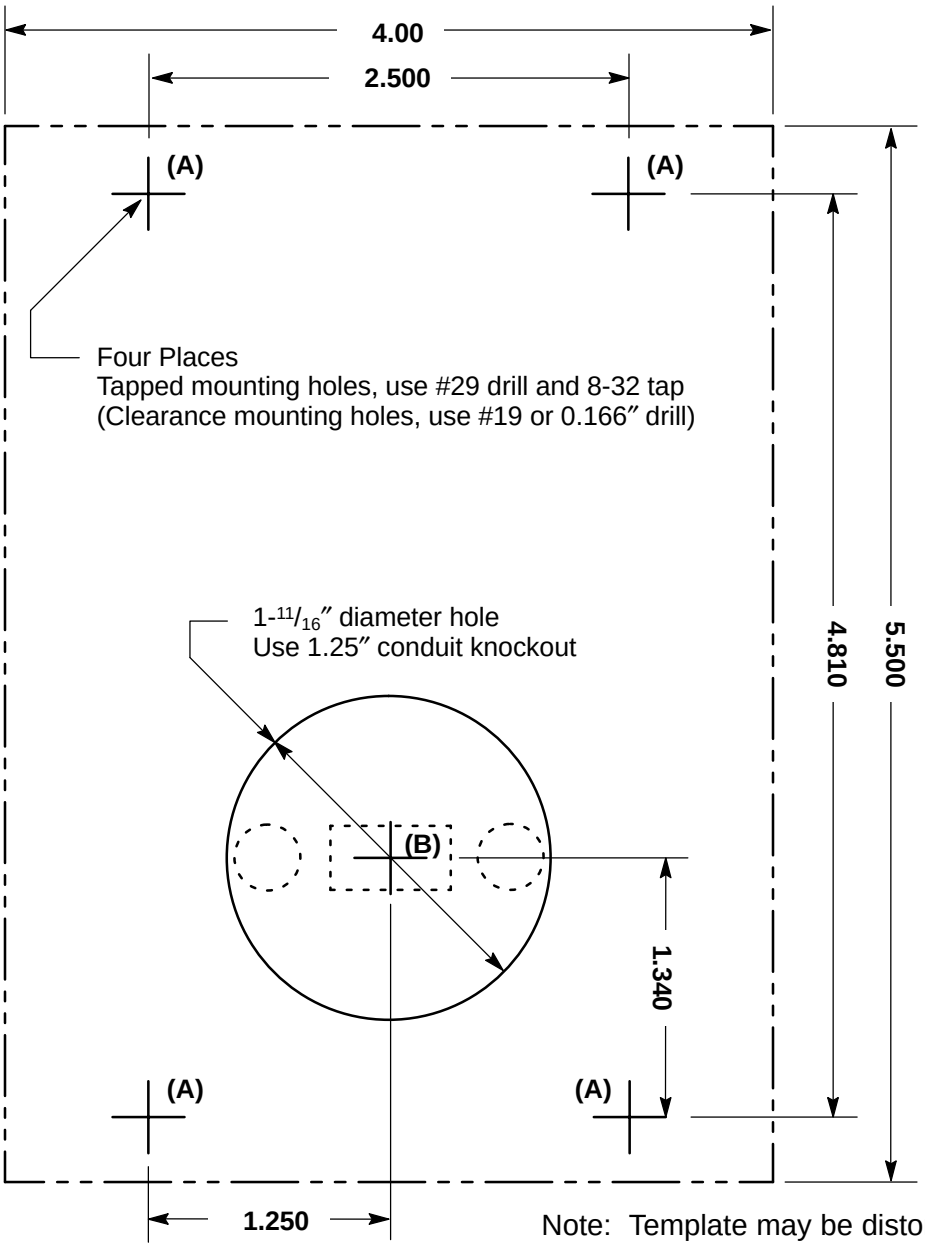
Level 2 Blocks - Continued					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory**	**User Setting**
MOTOR DATA	MOTOR VOLTAGE	2501	150-999 VOLTS	Factory Set	
	MOTOR RATED AMPS	2502	0.0-999.9	Factory Set	
	MOTOR RATED SPD	2503	0-32767 RPM	1750 RPM	
	MOTOR RATED FREQ	2504	0.0-500.0 Hz	60.0 Hz	
	MOTOR MAG AMPS	2505	0-85% Rated Current	CALC	
	ENCODER COUNTS	2506	0-65535 CNTS	1024 PPR	
	RESOLVER SPEEDS	2507	0 to 10	0 SPEED	
	CALC PRESETS	2508	0–NO, 1–YES	NO	
BRAKE ADJUST	RESISTOR OHMS	2601	0-250.0 Ohms	Factory Set	
	RESISTOR WATTS	2602	0-360.00 KW	Factory Set	
	DC BRAKE CURRENT	2603	0-100%	0%	
PROCESS CONTROL	PROCESS FEEDBACK	2701	0–POTENTIOMETER 1–+/-10VOLTS 2–+/-5 VOLTS 3–4 TO 20mA 4–5V EXB 5–10V EXB 6–4-20mA EXB 7–3-15 PSI EXB 8–TACHOMETER EXB 9–NONE	NONE	
	PROCESS INVERSE	2702	0–OFF, 1–ON	OFF	
	SETPOINT SOURCE	2703	0–POTENTIOMETER 1–+/-10VOLTS 2–+/-5 VOLTS 3–4 TO 20mA 4–5V EXB 5–10V EXB 6–4-20mA EXB 7–3-15 PSI EXB 8–TACHOMETER EXB 9–NONE 10–SETPOINT CMD	SETPOINT CMD	
	SETPOINT COMMAND	2704	–100% to +100%	0.0 %	
	SET PT ADJ LIMIT	2705	0.0-100.0%	10.0 %	
	PROCESS ERR TOL	2706	1-100%	10 %	
	PROCESS PROP GAIN	2707	0-2000	0	
	PROCESS INT GAIN	2708	0.00-9.99 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	50-65535	1024 PPR	

Table B-2 Parameter Block Values Level 2 Continued

Level 2 Blocks - Continued					
Block Title	**Parameter**	**P#**	**Adjustable Range**	**Factory**	**User Setting**
COMMUNICATIONS	PROTOCOL	2801	0-RS-232 ASCII, 1-RS-485 ASCII, 2-RS-232 BBP, 3-RS-485 BBP	RS–232 BBP	
	BAUD RATE	2802	0-9600, 1-19.2KB, 2-38.4KB, 3-57.6KB, 4-115.2KB, 5-230.4KB, 6-460.8KB, 7-921.6KB	9600	
	DRIVE ADDRESS	2803	0 - 31	0	
AUTO-TUNING	**CALC PRESETS**		0–NO, 1–YES	NO	
	CMD OFFSET TRM Measures and trims out offset voltage at Analog Input #2 (J1-4 & J1-5).		-	-	
	CUR LOOP COMP Measures current response while running motor at one half the rated motor current.		-	-	
	STATOR R1 Measures stator resistance		-	-	
	FLUX CUR SETTING Sets the Motor Mag Amps.		-	-	
	FEEDBACK TESTS Checks the Master Encoder and Feedback Align values.		-	-	
	SLIP FREQ TEST Measures motor Slip Frequency during motor acceleration/deceleration at repeated intervals.		-	-	
	SPD CNTRLR CALC Measures the motor current to acceleration ratio during motor rotation. This procedure adjusts the Speed INT Gain and Speed PROP Gain parameters.			-	
LEVEL 1 BLOCK	Enters Level 1 Menu - See Table B-1.				
PRESS ENTER FOR PROGRAMMING EXIT	Exit programming mode and return to display mode.				

Appendix C

Remote Keypad Mounting Template



Note: Template may be distorted due to reproduction.

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