



Allen-Bradley

160Z Variable Speed AC Drive

**0.37–3.7 kW (0.5–5 HP)
FRN 7.xx**

User Manual

**Rockwell
Automation**

Important User Information

Solid-State equipment has operational characteristics differing from those of electromechanical equipment. “*Safety Guidelines for the Application, Installation and Maintenance of Solid-State Controls*” (Publication SGI-1.1 available from your local Rockwell Automation Sales Office or online at <http://www.ab.com/manuals/gi>) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations:



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attentions help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.



Shock Hazard labels may be located on the drive to alert people that dangerous voltage may be present.



ANSI



ISO

Burn Hazard labels may be located on the drive to alert people that surfaces may be at dangerous temperatures.

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Getting Started

Important Precautions

In addition to the precautions listed throughout this manual, you must read and understand the following statements which identify hazards associated with AC drives.



ATTENTION: The drive contains capacitors which take time to discharge from dangerous voltage after removal of mains supply. Before working on drive, ensure isolation of mains supply from line inputs [L1, L2, L3 (R, S, T)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened drive state LEDs is not an indication that capacitors have discharged to safe voltage levels.



ATTENTION: Only personnel familiar with the drive and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.



ATTENTION: The surface temperatures of the drive may become hot, which may cause injury.



ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference Publication 8000-4.5.2, “Guarding Against Electrostatic Damage” or any other applicable ESD protection handbook.



ATTENTION: An incorrectly applied or installed drive can result in component damage or reduction in product life. Wiring or application errors such as undersizing the motor, supplying an incorrect or an inadequate AC supply, or excessive ambient temperatures may result in system malfunction.



ATTENTION: Before applying power to the unit it must be closed. The four cover screws must be inserted by the use of a screwdriver and then tightened with 2.9 Nm (26 lb-in) torque in order to properly ground the cover. Failure to observe this precaution could result in severe bodily injury or loss of life.

Receiving Your New Drive

It is your responsibility to thoroughly inspect the equipment before accepting the shipment from the freight company. Check the item(s) received against your purchase order. If any items are obviously damaged, do not accept delivery until the freight agent notes the damage on the freight bill.

Unpacking

Remove all packing material, wedges, or braces from within and around the drive. If you find any concealed damage during unpacking notify the freight agent. Also, leave the shipping container intact and have the freight agent make a visual inspection of the equipment to verify damage.

Inspecting

After unpacking, check the item(s) nameplate catalog number against your purchase order. An explanation of the catalog numbering system for the 160Z AC Drive follows as an aid for nameplate interpretation. Refer to Figure 1.1, Figure 1.2 and Figure 1.3

Important: Before you install and start up the drive, inspect for mechanical integrity. Look for loose parts, wires, and connections.

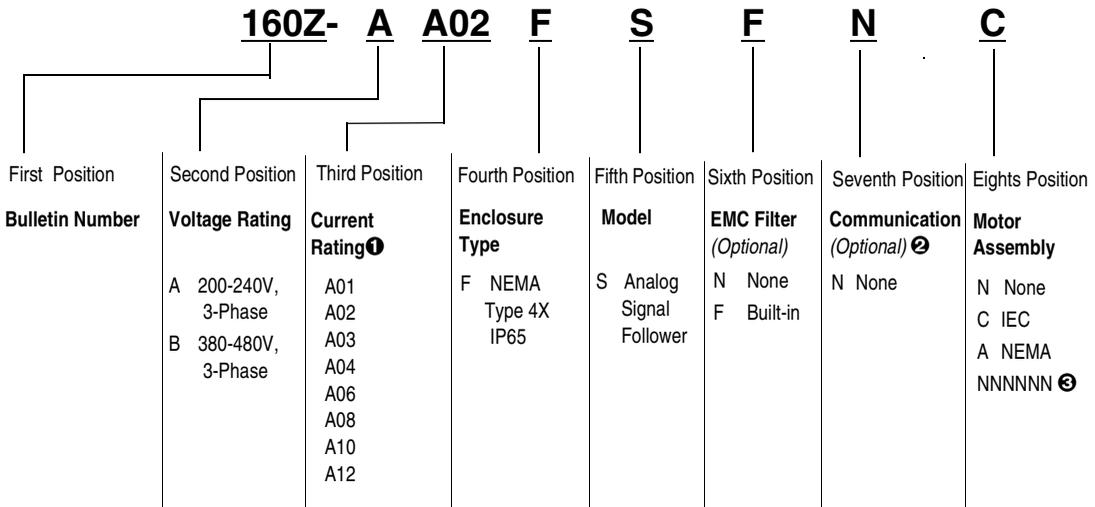
Identifying Your Drive

Catalog Number

The figure below describes the 160Z AC Drive catalog numbering scheme.

Catalog Number Explanation

Figure 1.1



❶ Amperage ratings vary based on voltage.

❷ For available communication boards (to be installed by the customer) refer to Table B.1. A communication board may be added as a factory built-in option. Ask your Rockwell Automation sales office for a custom quotation.

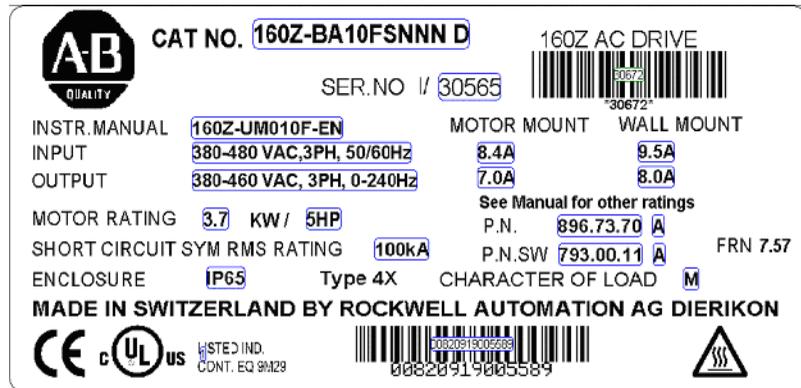
❸ For available motor adapter plates refer to Table B.1.

Nameplate

The drives nameplate is located on the side of the 160Z.

Drive Nameplate Information

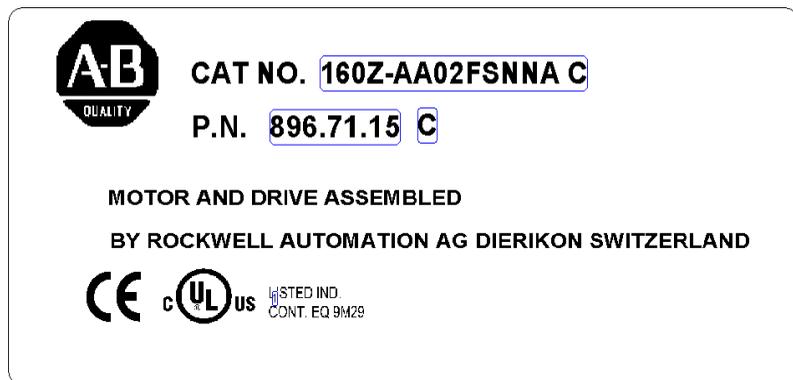
Figure 1.2



On assembled drives with motor the following label is applied to the adapter plate.

Assembled Drive Identification Label

Figure 1.3



Conventions Used In This Manual

Parameter numbers and names are shown in this format: **P01 - [Output Frequency]**. **P01** denotes the parameter number and the parameter name is enclosed in square brackets.

Front view of the 160Z indicates looking at the cover side (open or closed).

Bottom view of the 160Z indicates looking at the adapter plate side (open, without adapter).

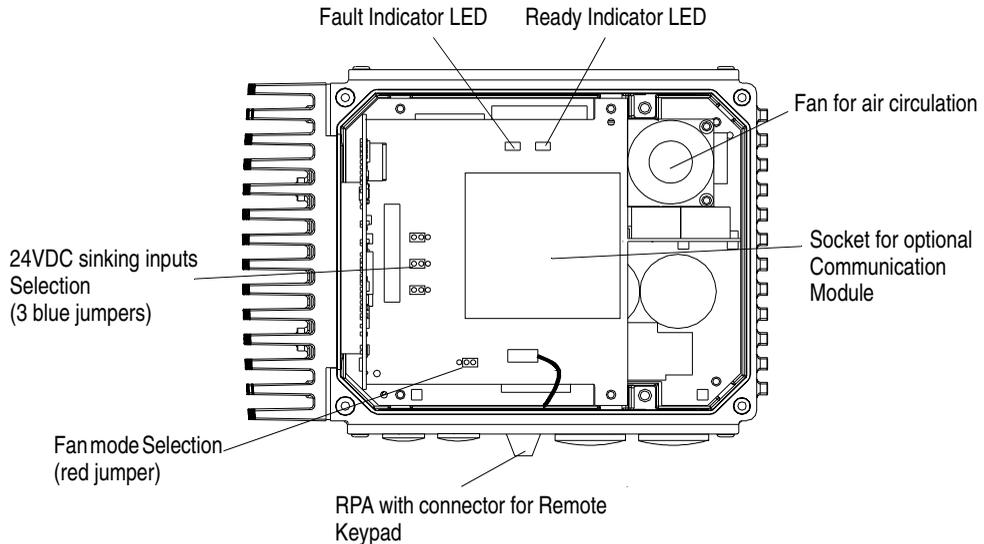
External Keypad is either the Remote Keypad Module 160-P2 or the CopyCat Keypad 160-P3.

Standard Drive Features

The drive features identified in the figure below apply to all models.

Standard Drive Features

Figure 1.4



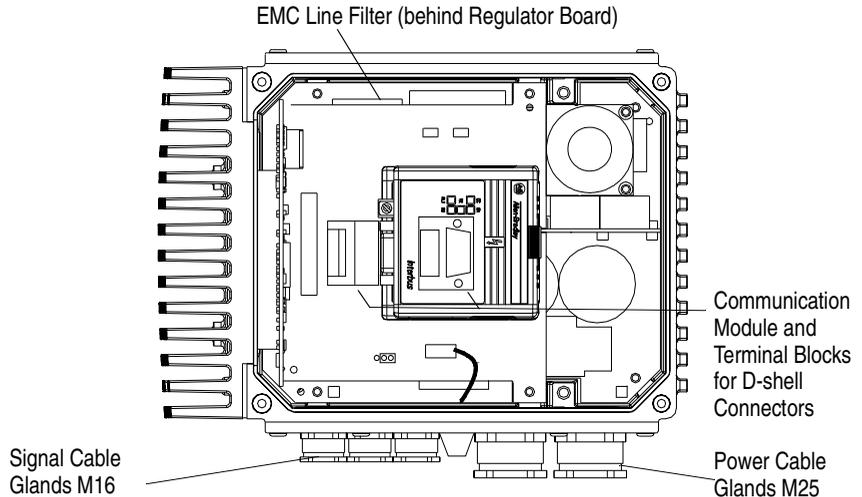
- **Fault Indicator LED** (visible through a window in the cover) illuminates when a drive fault condition exists. Refer to Chapter 6 for details on how to clear a fault and general troubleshooting procedures.
- **Ready Indicator LED** (visible through a window in the cover) illuminates when the DC bus is charged and the drive is ready to run.
- **Remote Programming Adapter RPA** allows connection to Remote Keypad Module or Copycat Keypad Module via plug on Cable Entry Plate.
- **Cooling Fan** provides air circulation inside the enclosure to prevent hot spots.
- **Selection of external 24V DC Source** (via jumpers) allows you to command the drive with 24V logic (sinking inputs).
- **Dynamic Braking Function** allows you to connect dynamic braking resistors to the braking resistor output terminals.
Important: P52 - [DB Enable] must be enabled for proper operation.

Drive Options and Accessories

Some of the drive options and accessories listed below with catalog numbers are identified in Figure 1.5. See also Appendix B for selection and dimensions.

Drive Options

Figure 1.5



- **EMC Line Filter ❶** (built in as an option) to reduce conductive emissions.
- **4 Communication Modules** and **3 Adapter Kits ❷** (loose supplied options) allow control and monitoring of parameters via network.

- DeviceNet Module	160-DN2	- Adapter Kit 160Z-RTB
- RS-232 Module	160-RS1,	- Adapter Kit 160Z-PTB
- Profibus Module	160-PD1,	- Adapter Kit 160Z-ITB
- InterBus Module	160-IB1,	
- **Motor Adapter Plates** for direct mounting of the drive on different NEMA and IEC motors. Refer to Table B.1 for selection.
- **2 Wall Mounting Adapter Plates** 160Z-WMA and 160Z-WMK (with carrier plate) for installations, where the distance drive - motor is up to 10 meters.
- **2 Keypad** options (Remote Keypad 160-P2, CopyCat Keypad 160-P3) can be connected to the round RPA output socket on the cable entry plate. Refer to Chapter 3, *Keypad Module* for a detailed explanation of functionality.
- **3 Keypad Connection Cables** (1, 3 or 5 m) 160Z-C10, 160Z-C30, 160Z-C50.
- **3 Cable Glands:** 160Z-G25, 160Z-G16 (EMC), 160Z-G20 (EMC).
- **5 Dynamic Brake Resistor Kits** 160Z-BMA1/A2, 160Z-BMB1/ B2/ B3.
- **Top Mounting Kit** 160Z-MAX for the DeviceNet MaXum I/O card.
- **2 Quick Disconnect Kits** 160Z-QD (16 pole), 160Z-QDC (32 pole).
- **2 Debris Cover Kits** 160Z-DC / 160Z-DCW for motor / wall mounted drives.

❶ 160Z AC Drives for 380 to 480V with built-in EMC filter meet:

- Overall EMC requirements of EN61800-3 for Second (Industrial) Environments
- High frequency conducted and radiated emissions of EN61800-3 for (second) Industrial Environments (EN55011).

❷ The Adapter Kit contains 1 or 2 printed circuit boards with terminal block, which is linked to the D-shell connector.

End of Chapter

Installation and Wiring

Storage and Operation Conditions

Follow these recommendations to prolong drive life and performance:

- Store within an ambient temperature range of -40° to $+85^{\circ}\text{C}$.
- Store and operate within a relative humidity range of 0% to 95%, non-condensing.
- Avoid storing the drive where it could be exposed to a corrosive atmosphere.
- Operate at an ambient temperature range of 0° to $+40^{\circ}\text{C}$.

CE Compliance

Refer to Appendix C.

Jumper Setting

Jumpers on the Regulator Board

Table 2.A

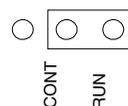
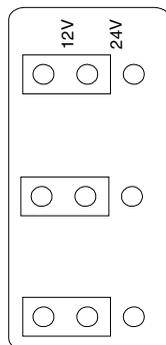
	Function	Mode	Description
3 blue Jumpers	Setting up the control signals	1 (default)	Control inputs are activated if they are connected with dry contacts to common (TB3-7).
		Mode 2	24VDC sinking inputs, 10mA (external 24VDC source, minus at TB3-7).
1 red Jumper	Fan run mode	1	Fan is only running if drive is started. (RUN). DO NOT change this jumper position.

For access to the jumpers remove the cover by loosening the four cover screws.

The default jumper positions (Mode 1) are shown in the following Figure 2-1.

Default Jumper Positions

Figure 2.1



Installation Clearances

Maintain 100 mm (4 in.) clearance on all surfaces of the drive except the adapter side.

Orientation

Depending on the delivered Motor Assembly and Adapter Kit different installation methods are possible:

- Wall mounted
- Motor mounted by use of the Motor Adapter Plate.

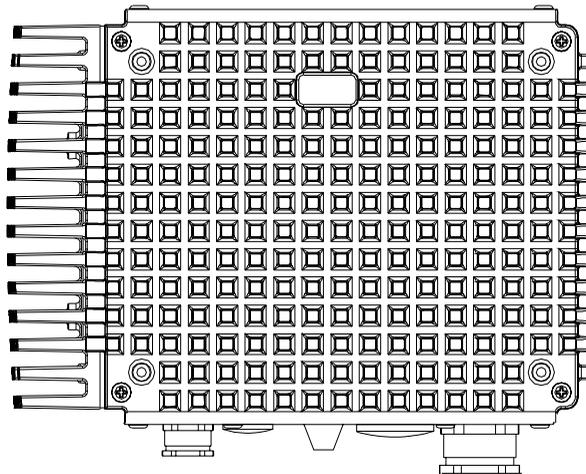
Wall Mounted

Mount the drive by use of the Mounting Kit 160Z-WMA or 160Z-WMK (with carrier plate) on a flat, vertical and level surface. Detailed Mounting Instructions are included in the kit.

Important: When mounting the 160Z AC Drive to a wall, it must be aligned horizontally as shown in Figure 2.2. The drive can also be mounted with the large heat sink on the right side. The cable entry plate must always be on the bottom as shown below.

Orientation of the Wall Mounted Drive

Figure 2.2



Recommended screw size is listed in the table below. See Appendix B for details on drive dimensions and weights.

Fastening the Drive on a Steel Panel

Table 2.B

Description	Metric	English
Minimum Thread Depth in Steel Panel	3 mm	0.12 in.
Mounting Screws	M6 x 1	0.25 in
Mounting Torque	4.8 – 6 Nm	43 – 53 lb.-in.

Motor Mounted

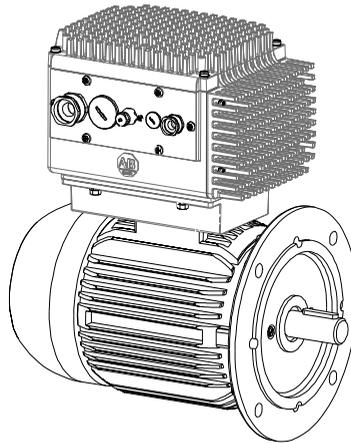
Mount the drive on a specified motor by use of the Adapter Kit (Appendix B). A detailed Mounting Instruction sheet is included in the Adapter Kit.

Important: When mounting the 160Z AC Drive to a motor, it must be aligned horizontally as shown in Figure 2.3. The drive can also be mounted with the large heat sink on the left side.

Do not step on a motor mounted drive!

Orientation of the Motor Mounted Drive

Figure 2.3

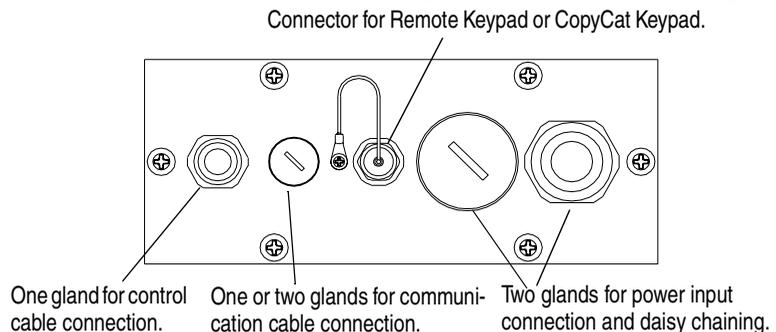


Cable Entry Plate

The 160Z AC Drive is shipped from the factory with two cable entry plates. One plate without holes and the other one equipped with a socket for the external keypad connector cable and four caps, which close the holes for mounting cable glands. The plates can be interchanged, if necessary. For selection of available cable glands (and special cable entry plate for use with the InterBus module) refer to Appendix B, Table B.1.

Cable Entry Plate, equipped with cable glands

Figure 2.4



Power Wiring

Precautions



ATTENTION: The drive contains capacitors which take time to discharge from dangerous voltage after removal of mains supply. Before you open the drives cover for service purposes, or disconnect / reconnect wires, ensure isolation of mains supply from line inputs [L1, L2, L3 (R, S, T)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened drive state LEDs is not an indication that capacitors have discharged to safe voltage levels.



ATTENTION: The drive is intended to be commanded by control input signals that will start and stop the motor. A device that routinely disconnects then reapplies input power to the drive for the purpose of starting and stopping the motor should not be used. If it is necessary to use this method for starting and stopping, or if frequent cycling of power is unavoidable, make sure that it does not occur more than once a minute.



ATTENTION: Do not connect power factor correction capacitors to drive output terminals U, V and W (T1, T2 and T3) or component damage could occur.

ATTENTION: The control common on the regulator board is connected to dangerous voltage level (minus DC-bus). Do not open the drive while it is in operation. Failure to observe this precaution could result in severe bodily injury or loss of life.

Terminal Blocks

Terminal block configuration is depicted in Figure 2.5.

Specifications

Terminal Blocks TB1 and TB2 Wiring Specifications

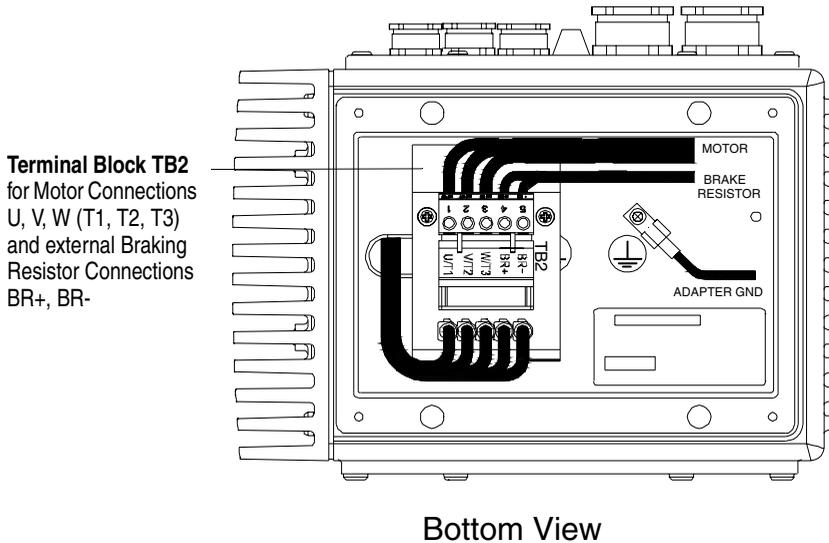
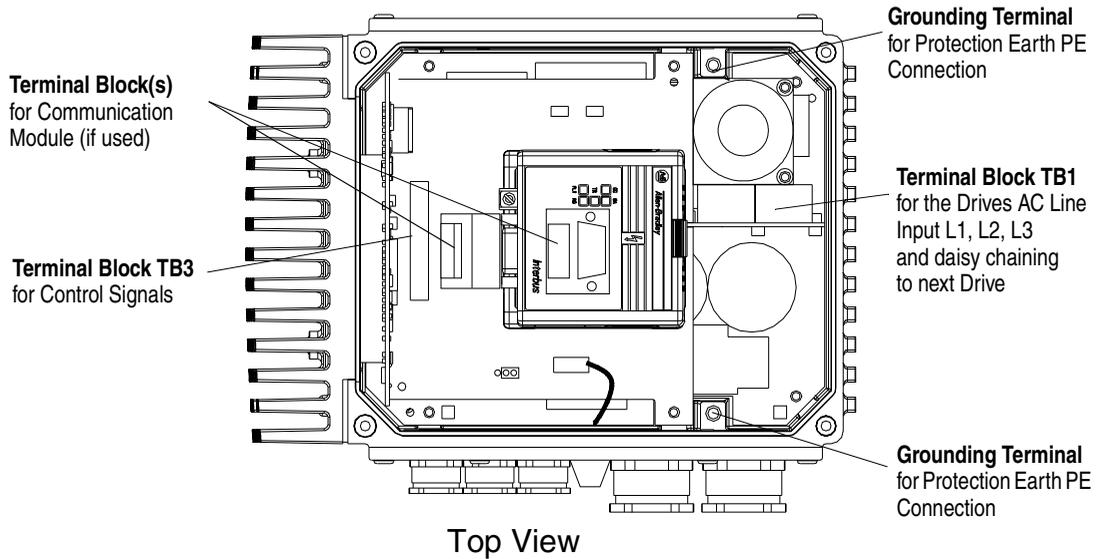
Table 2.C

Terminal Block	Min./Max. Wire Size ^④ <i>mm² (AWG)</i>	Screw Size	Min./Max. Torque <i>Nm (lb.-in.)</i>	Remove Insulation <i>mm (in)</i>
TB1	1 – 4 (18 – 10)	M3	0.5 – 0.6 (4.4 – 5.3)	7 (0.28)
TB2	0.2 – 2.5 (22 – 12)	M3	0.5 – 0.6 (4.4 – 5.3)	7 (0.28)

- ④ Wire sizes given are minimum / maximum sizes that terminal block will accept for 2 wires
- these are not recommendations.

Drive Terminal Blocks Location

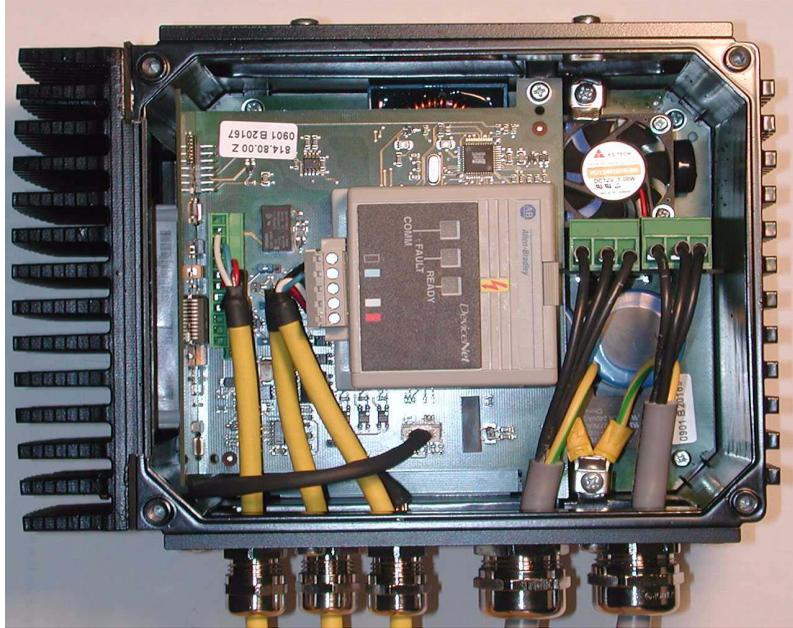
Figure 2.5



Terminal Block Wiring

Terminal Block Wiring Example

Figure 2.6



Line Input

Connect the 3 incoming AC power wires to one of the two unit's TB1 terminal blocks. For Daisy Chaining the second TB1 block can be used as shown in the Figure above on the right side.

Connect the ground wire brought in with the incoming AC power to one (or two for Daisy Chaining) of the unit's grounding screws (Figure 2.5, Figure 2.6). This grounding conductor must run unbroken from the unit to earth ground.

Control Signals

Pass the shielded cable through the gland and connect it to the terminal block TB3 on the regulator board. For details refer to "Control Wiring" on page 2-14.

DeviceNet

If a DeviceNet Module (160-DN2) is inserted, pass the two cables through the glands and connect them to the terminal block on the module. For details refer to "Signal Cable for Control and Communication Module Wiring" on page 2-12.

Profibus, InterBus or RS-232

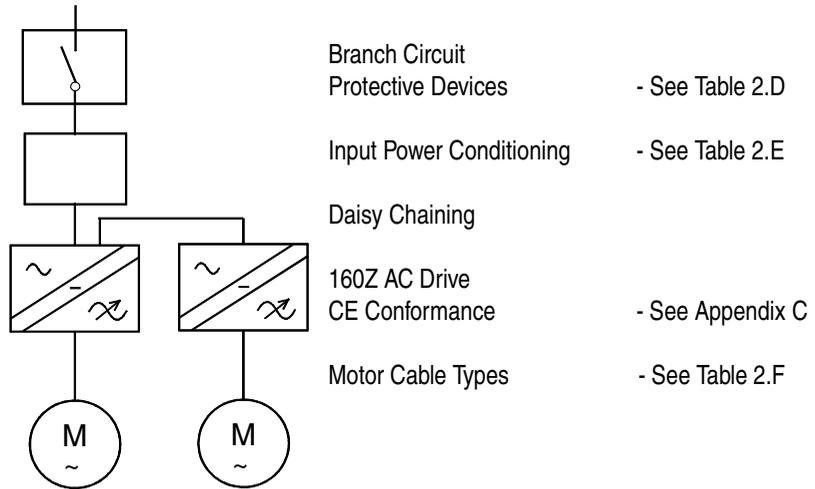
If a Profibus Module (Cat. No. 160-PD1), InterBus Module (Cat. No. 160-IB1) or RS-232 Module (Cat. No. 160-RS1) is inserted, pass the cable(s) through the glands and connect it (them) to the terminal block(s) on the modules D-shell adapter. For details refer to "Signal Cable for Control and Communication Module Wiring" on page 2-12.

Motor Branch Circuit Analysis

Short circuit and overload protection are requirements of any motor branch circuit. Input power conditioning, CE conformance and motor cable type are important considerations of drive applications.

Branch Circuit Configuration

Figure 2.7



- **Branch Circuit Protective Devices**

A motor branch circuit requires protection against excessive current.

This protection can be provided by a fuse, circuit breaker, or manual motor starter. See Table 2.D for a detailed list of these options.

- **Input Power Conditioning**

Certain conditions may exist that could damage a drive in the branch circuit. See Table 2.E for an explanation of problems and solutions.

- **Daisy Chaining**

The number of drives that can be connected in this manner is limited by the maximum ratings of the line input terminal block TB1, which are 20 Amps, 4mm² (10 AWG).

Local codes may require individual protection devices in each branch circuit.

- **CE Conformance**

See Appendix C for information on CE Conformance.

- **Motor Cable Types**

See Table 2.F for recommended cable types.

- **Overload Protection**

All motor branch circuits require overload protection. An external overload relay is not required for single motor applications as long as the Drive kW (HP) rating is less than three times larger than the motor kW (HP) rating.

Branch Circuit Protective Devices

Fusing

The 160Z AC Drive has been UL tested and approved for use with input fuses. The ratings in the table below are the minimum recommended values for use with each drive rating. The devices listed in this table are provided to serve as a guide. Other devices which meet the requirements of UL508C and UL489 with similar trip characteristics may be used in order to meet local or national electrical codes.

Bulletin 140 Manual Motor Starters/UL489 Circuit Breakers

When using Bulletin 140 manual motor starters or UL489 rated circuit breakers, the guidelines listed below must be followed in order to meet the NEC requirements for branch circuit protection.

- Bulletin 140 manual motor starters can be used in single and group motor applications.
- In single motor applications, a fuse or UL489 rated circuit breaker is required ahead of the Bulletin 140 manual motor starter.
- In group motor installations, the Bulletin 140 can be used for protection of an individual motor within the group and “one set” of fuses or a UL489 rated circuit breaker serves as the Branch Circuit Protective Device for the entire “Group Installation”.
- Bulletin 140M manual motor starters can be used in single and group motor applications without additional short circuit protection. Refer to the technical support literature for the 140M for more details.

Minimum Recommended Branch Circuit Protective Devices ❶ Table 2.D

Voltage Rating	Drive Rating <i>kW (HP)</i>	Fuse Rating ❷	UL489 Rated Circuit Breaker <i>Amps</i>	Bulletin 140/140M Manual Motor Starter <i>Amps</i>
Three Phase 240V	0.37 (0.5)	6	16	16
	0.55 (0.75)	6	16	16
	0.75 (1)	10	16	16
	1.5 (2)	15	16	16
	2.2 (3)	20	20	20
Three Phase 460V	0.37 (0.5)	4	6	6
	0.55 (0.75)	4	6	6
	0.75 (1)	4	6	6
	1.5 (2)	8	16	16
	2.2 (3)	15	16	16
	3.7 (5)	20	20	20

❶ The maximum branch circuit protection rating is limited to 20A.

❷ Fuse class CC, J, BS88, VDE 06366/gG, IEC 269-1/gG, EN60269 part 1 and 2 type gG

Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see Appendix A). Listed in Table 2.E are certain input power conditions which may cause component damage or reduction in product life.

If any of the conditions exist, as described in Table 2.E, install a line reactor (see Appendix B) or an isolation transformer on the line side of the drive.

Important: Only one device per branch circuit is required. It should be mounted closest to the branch and sized to handle the total branch current.

When using a *Daisy Chain* power wiring arrangement, check for individual branch circuit protection requirements.

Input Power Conditions

Table 2.E

Low Line Impedance (less than 1% line reactance)
Available short circuit currents (fault currents) greater than 100,000 Amps. (Check Supply Transformer)
Greater than 120 kVA supply transformer
Line has power factor correction capacitors
Line has frequent power interruptions
Line has intermittent noise spikes in excess of 6000V (lightning)

Motor Cable Types (for wall mounted drives)

A variety of cable types are acceptable for variable speed drive installations. For many installations, *unshielded* cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 1 meter (3.3 feet) for every 10 meters (33 feet) of unshielded length. If you cannot separate motor cables from sensitive circuits, or if you must run motor cables from multiple drives (more than three) in a common conduit or cable tray, *shielded* motor cable is recommended to reduce system noise.

Motor cables should be four-conductor with the ground lead connected to the ground terminal inside the flange and the motor frame ground terminals.

The shield (if using shielded cable) must be connected to the flange cable entry plate via EMC tested cable gland.

Table 2.F provides the recommended wire type for both wet and dry installations as defined by NEC 1996 (70-31). These recommendations are based upon a variety of factors such as insulation thickness, susceptibility to moisture and susceptibility to nicks and cuts during installation.

Recommended Cable Type

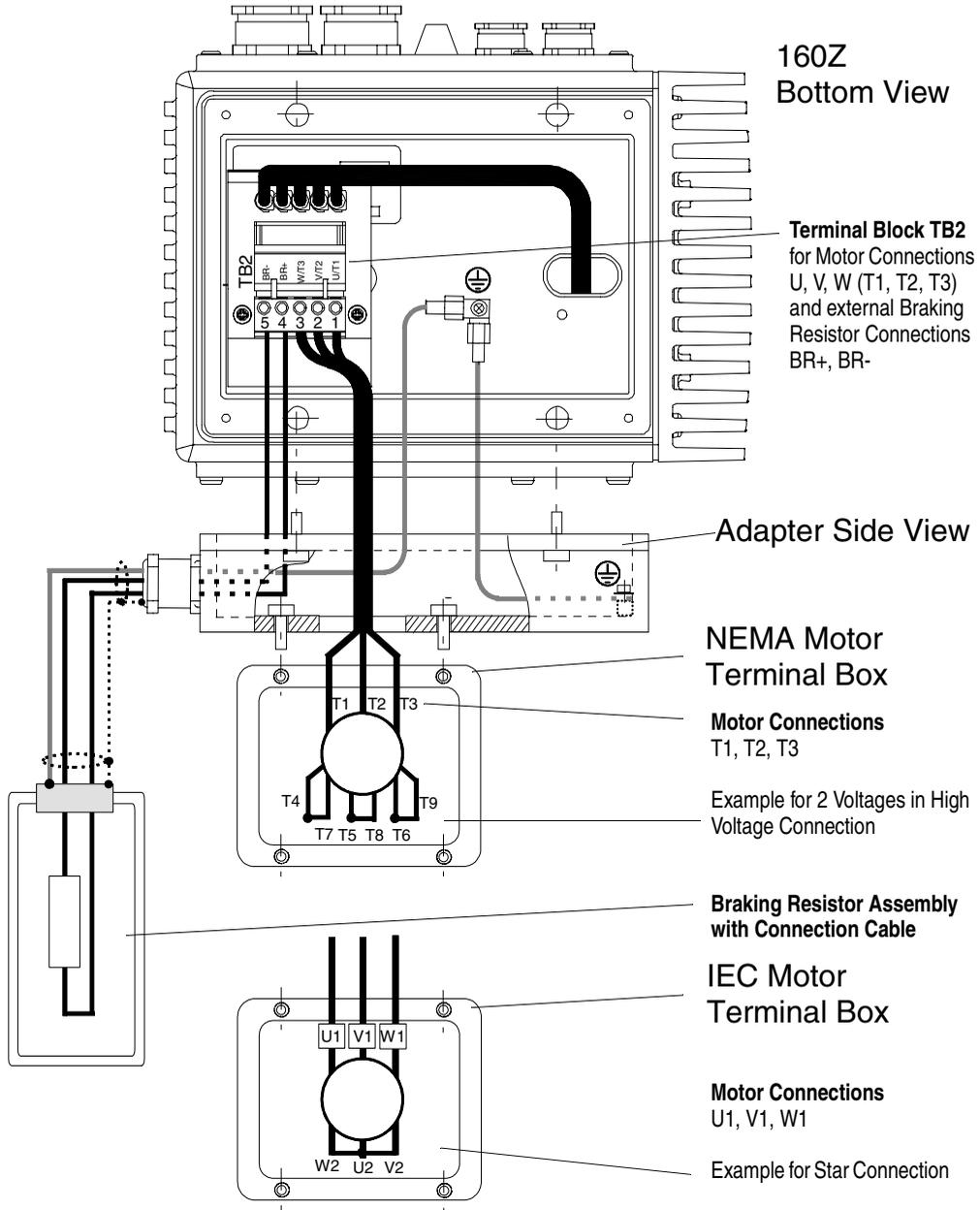
Table 2.F

Condition	Insulation Type	Example
Dry	PVC ❶	THHN
Wet	XLPE	XHHW-2

❶ For input power voltages in excess of 264VAC wire with XLPE insulation is recommended.

Motor and Braking Resistor Connection Examples

Figure 2.8

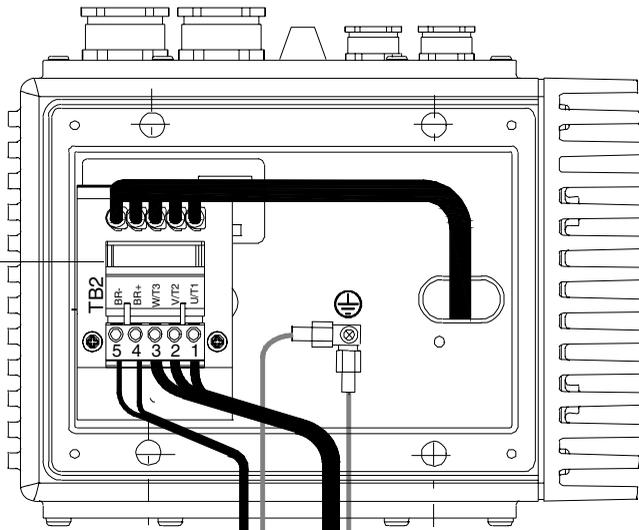


Motor and Braking Resistor Connection Example, Wall Mounted Drive

Figure 2.9

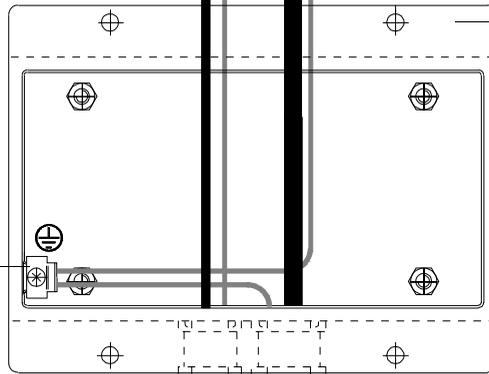
160Z Bottom View

Terminal Block TB2
for Motor Connections
U, V, W (T1, T2, T3)
and external Braking
Resistor Connections
BR+, BR-

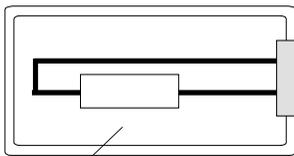


Adapter
Top View

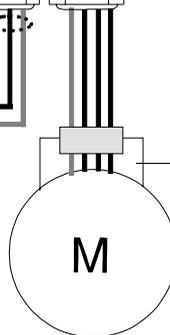
Ground Terminal for
Motor Protection Earth
Connection



**Braking Resistor Assembly
with Connection Cable**



Motor Terminal Box
for Motor Connections
U, V, W (T1, T2, T3)

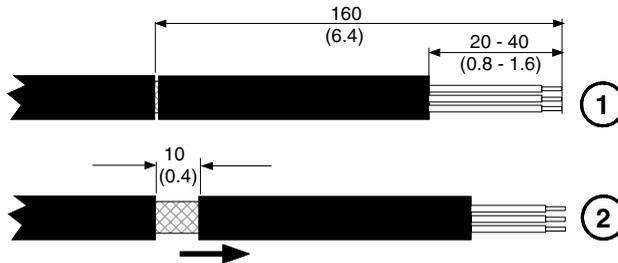


Signal Cable for Control and Communication Module Wiring

- Control wiring and Communication Module wiring must use shielded cable.
- The shield must be connected to ground through EMC tested (spring type) cable glands and reach as close as possible to the terminals inside the drive.
- Before fixing the cable to the gland prepare the cable as shown in Figure 2.10.
 - (1) Cut the cables outer plastic jacket 360 degrees at 160mm (6.4in) from the end and remove insulation and braid at the end over a length of 20 - 40mm (0.8 - 1.6in), depending on number of conductors.
 - (2) Pull the plastic jacket 10mm (0.4in) towards the end.
- For Communication Module cable types and wire numbering refer to the individual manual of the Module (DeviceNet, InterBus, Profibus, RS232)
- For Communication Module adapter terminal block specifications refer to Table 2.G and Figure 2.12 on the next page.

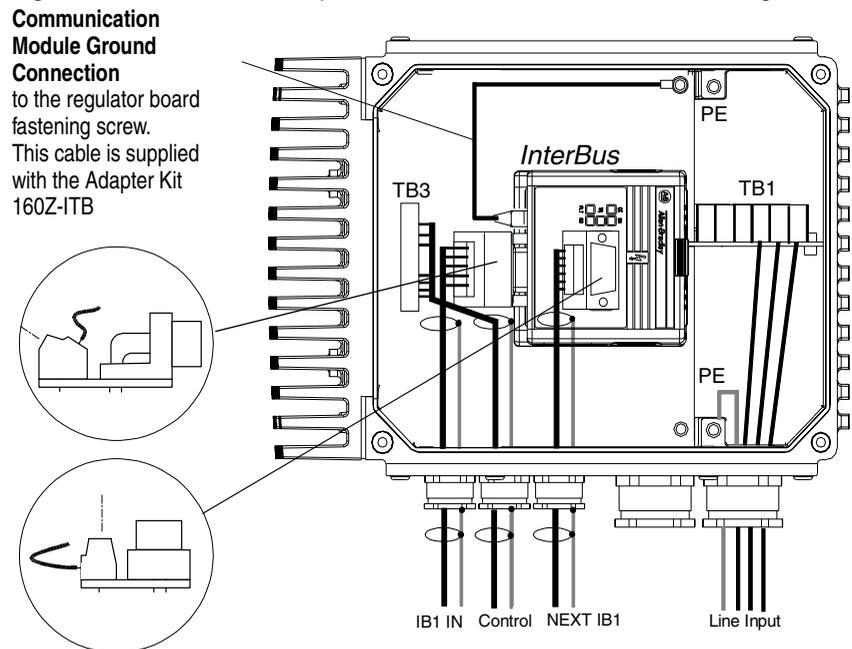
Shielded Signal Cable

Figure 2.10



Signal Connections, Example with InterBus Module

Figure 2.11



Communication Module

Terminal Blocks

As the space inside the 160Z is limited, standard D-shell communication cable connectors cannot be used for direct connection to the communication modules 160-IB1, 160-PD1 and RS-232. Therefore the modules - if used on a 160Z Drive - need to be equipped with individual adapter kits. These contain a terminal block, which is linked to the standard D-shell connector as described in the instruction manual of the communication module.

Requirements

- Insert the Communication Module into the socket on the regulator board and plug in the D-shell connector adapter kit(s) containing the terminal block.
- Remove the standard D-shell connector on the communication module side of the cable.
- Connect the cable to the terminal block(s) of the module, following the procedures as shown in Figure 2.10.
- On 160-DN2 Comm. modules connect the blank wire to terminal 3 only and not to ground potential.
- On 160-IB1 and 160-PD1 Comm. modules connect the ground terminal with the attached cable to the regulator boards fastening screw (see Figure 2.11).

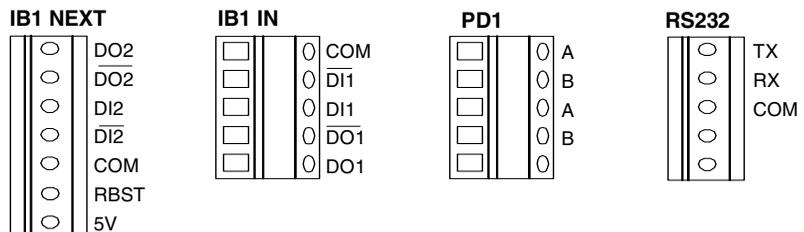
Important: The Adapter Kit 160Z-PTB on the Profibus Communication Module also contains the termination resistors, which are required at both ends of the Profibus network. The termination can be made active by setting the dip switch to position ON. Refer to chapter 3 of the 160-PD1 manual.

Specifications

Communication Module Terminal Block Wiring Specifications Table 2.G

Terminal Block on Module	Min./Max. Wire Size <i>mm² (AWG)</i>	Screw Size	Max./Min. Torque <i>Nm (lb.-in.)</i>	Remove Insulation <i>mm (in)</i>
RS232, PD1, IB1 IN	0.14 – 1.0 (24 – 16)	M3	0.5 – 0.6 (4.4 – 5.3)	9 (0.35)
IB1 NEXT	0.14 – 1.0 (24 – 16)	M2	0.22 – 0.25 (1.9 – 2.2)	9 (0.35)

Communication Module Adapter Terminal Designations Figure 2.12



Terminals RBST and 5V are internally linked

Control Wiring

Requirements

- Run all signal wiring in a shielded cable.
- Connect the shielded cable for control wiring to the terminal block TB3, following the procedures as shown in Figure 2.10.
- Connect the shield to the cable entry plate via the EMC tested cable glands.
- Do not exceed control wiring length of 15 meters (50 feet). Control signal cable length is highly dependent on electrical environment and installation practices.
- Use Belden 8760 (or equivalent) — 18 AWG (0.750 mm²), twisted pair, shielded conductor.

Specifications

Control Terminal Block TB3 Wiring Specifications

Table 2.H

Terminal Block	Min./Max. Wire Size <i>mm² (AWG)</i>	Screw Size	Max./Min. Torque <i>Nm (lb.-in.)</i>	Remove Insulation <i>mm (in)</i>
TB3	0.14 – 1.5 (24 – 16)	M2	0.22 – 0.25 (1.9 – 2.2)	9 (0.35)

Important Precautions



ATTENTION: The drive is supplied with an internal 12V supply. Dry contact or open collector inputs are required for discrete control inputs. If an external voltage is applied and the 3 blue jumpers are set to position 12V (Mode 1), component damage could occur.



Control Wiring Considerations

Wiring Diagram Key



Stop Control Circuit



ATTENTION: The drive start and stop control circuitry includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit is required to remove AC input power to the drive. When AC input power is removed, there will be a loss of inherent regenerative braking effect and the motor will coast to a stop. An auxiliary braking method may be required.



ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. The input device must not exceed one operation per minute or drive damage will occur.

Control Terminal Functions Overview

Control Terminals

TB3 Number	Terminal Function
1	+10V DC-Supply
2	Frequency Control/Speed Control (Wiper Potentiometer)
3	Common
4	4 to 20mA Frequency Control/Speed Control
5	Reverse
6	Start or Run forward
7	Common
8	Stop / Enable / Accel - Decel / Terminal-NW / Clear Faults
	Not connected
9	Relay Output, Normally Closed
10	Relay Output, Common
11	Relay Output, Normally Open

Drive Control at Start-up

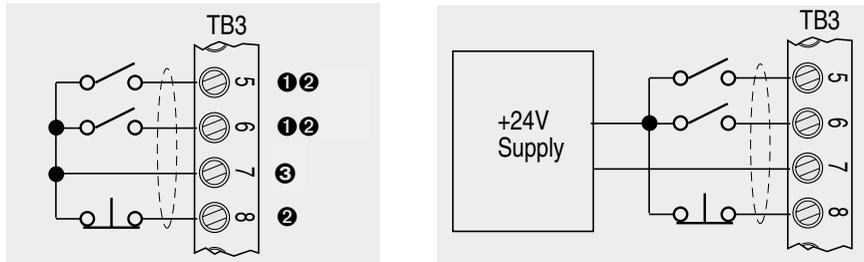
If the 160Z should run on a communication network, which is not ready, the drive can be operated in mode 10 via TB3 terminal inputs or in mode 11 with the external keypad.

General Control Wiring Advisories

The left figure below lists the control wiring requirements for all two wire control input modes (P46 - [Input Mode] settings 1 and 4 – 9) supplied by internal 12V (The 3 blue jumpers on the Regulator Board are in position 12V).

The requirements specific to each input mode are shown separately for that mode.

The right figure below shows the same two wire control input modes, but supplied by external 24V sinking input. The 3 blue jumpers are in position 24V.



- ❶ Run input must be maintained. After a stop command, either a Run Forward or Run Reverse input must be toggled to start the drive.
- ❷ Internal 12V supply. Contact closure or open collector input required. Refer to Appendix A for solid state control input specifications.
- ❸ Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, TB3 Common must be connected to ground terminal/protective earth. For control wiring installations greater than 15 meters (50 feet) in length, the use of 24V DC sinking inputs with external power supply (with the blue jumpers in position 24V) is recommended.

Control Methods and Selection Guide

You can use P46 - [Input Mode] to select the control method for start, stop, and direction control. Control can be performed from the Control Terminal Block TB3, Network, or via cable from the optional Remote Keypad Module (160-P2) or CopyCat Keypad (160-P3) depending on the P46 - [Input Mode] setting being used. The default setting is 0 which means that only the Control Terminal Block will be active for control. If any other input mode is needed (1-11) you must have a device for changing the input mode such as a Remote Keypad, Copycat Keypad or communication module (Except input modes 10 and 11, which cannot be set via DeviceNet or RS1). Table 2.I is a guide to wiring diagrams associated with each P46 - [Input Mode] setting.

Important: After a Stop input, a Run command (either Run Forward, Run Reverse or Start) must be toggled to run again. This is true for all P46 - [Input Mode] settings *except* setting 3. See the **Attention** statement on following page.



ATTENTION: If P46 [Input Mode] is set to 11, the external keypad gets the control of the drive. The network speed reference will be ignored in this mode. If a network option has the control, the external keypad is not allowed to change the speed of the drive by setting a speed value in P58 [Internal Frequency].



ATTENTION: Hazard of injury exists due to unintended operation. When P46 - [Input Mode] is set to 3, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).



ATTENTION: Hazard of injury exists due to uncontrolled operation. The following modules of the Bulletin 160 SSC Drive **must not be used** on the 160Z drive:

- RPA Module 160-RPA to connect an external keypad,
- Programming Keypad 160-P1 to program parameters.

Control Selection by Input Mode

Table 2.I

P46 Setting	Description	Reference
0	Three-Wire control/F (factory default)	Figure 2.13
1	Two-Wire Run Forward/Run Reverse control	Figure 2.14
2	Program, Communication Module control	Figure 2.15
3	Momentary Run Forward/Run Reverse control	Figure 2.16
4	Two-Wire Accel/Decel control	Figure 2.17
5	Two-Wire Enable control	Figure 2.18
6	Two-Wire TB3 or Communication control	Figure 2.19
7	Two-Wire Frequency Select control	Figure 2.20
8	Two-Wire Preset control	Figure 2.21
9	Two-Wire PI control	Figure 2.22
10	Three-Wire control	Figure 2.23
11	External Keypad control	Figure 2.24

Summary of Drive Control depending on selected Input Mode Table 2.J

Input Mode P46	0	1	2	3	4	5	6	7	8	9	10	11
Start, Reverse	TB3	NW	TB3	TB3	TB3	TB3	NW, TB3	TB3	TB3	TB3	TB3	EKP
Stop	TB3, EKP	All	TB3, EKP	TB3, EKP	TB3, EKP	TB3, EKP	All	TB3, EKP	TB3, EKP	TB3, EKP	TB3, EKP	
External Keypad						MON						CS
Keypad Removal	FLT					RUN						FLT
DeviceNet / RS1	MON	CS	MON	MON	MON	MON	TB3 CS	MON	MON	NS	NS	NS
DeviceNet Fault						FLT					RUN	
Profibus, InterBus	MON	CS	MON	MON	MON	MON	TB3 CS	MON	MON	MON		
PD1, IB1 Fault	RUN	FLT	RUN	RUN	RUN	RUN	FLT	RUN	RUN	RUN		

TB3 = Control Terminal Block Input
 NW = Network Communication Option
 FLT = Drive Fault at Communication Fault
 RUN = Drive continues running at Communication Fault
 MON = Monitor: Read/Write Parameter Access (P58 may be overwritten by active control source)

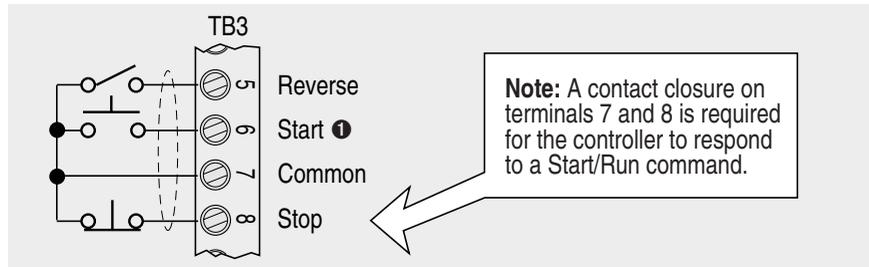
CS = Control Source
 EKP = External Keypad
 NS = Not supported
 All = TB3, EKP, NW

P46 Setting 0 - Three-Wire Control/F (Factory Default)

This input mode provides a typical three wire control function where a momentary start input will command the drive to start. With no keypad connected before power up, the drive will be ready. If a keypad is connected during power up or run, the drive will generate an error after disconnecting the keypad. The fault can be reset through input TB3-8 (see Figure 2.25).

Three-Wire control/F – Factory Default

Figure 2.13



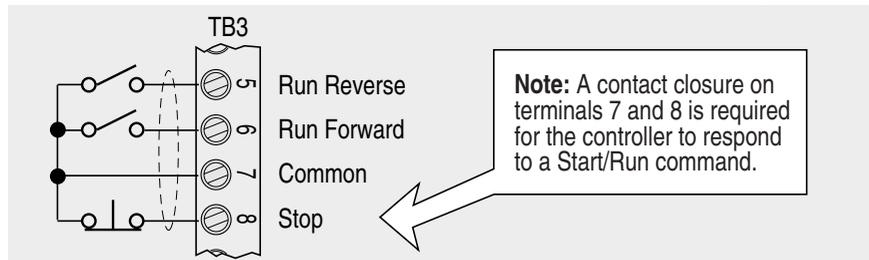
1 Start input can be a momentary input.

P46 Setting 1 - Two-Wire Run Forward/Run Reverse Control

This input mode provides a typical two wire control function where a maintained Run Forward or Run Reverse input will provide both a directional and start command to the drive. Opening the Run Forward or Run Reverse input will command the drive to stop in accordance with the P34 - [Stop Mode] setting. The stop switch (TB3-7 and 8) is not required but can be wired as an Auxiliary Stop if desired.

Two-Wire Run Forward/Run Reverse control

Figure 2.14



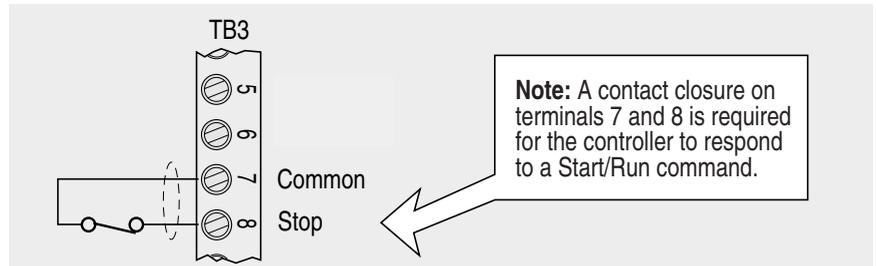
P46 Setting 2 - Communication Module Control

This input mode activates the Start and Reverse functions from a plug in communication module and deactivates the Start and Reverse inputs on the control terminal block (TB3). Monitoring (Read/Write Parameter Access) via External Keypad or Network Communication Option is possible in almost all input modes (refer to Table 2.J).

Note: the frequency reference can be controlled from the communication modules by setting P59 - [Frequency Select] to a setting of “1”. The frequency will then be controlled by the value programmed into P58 - [Internal Frequency].

Communication Module control

Figure 2.15

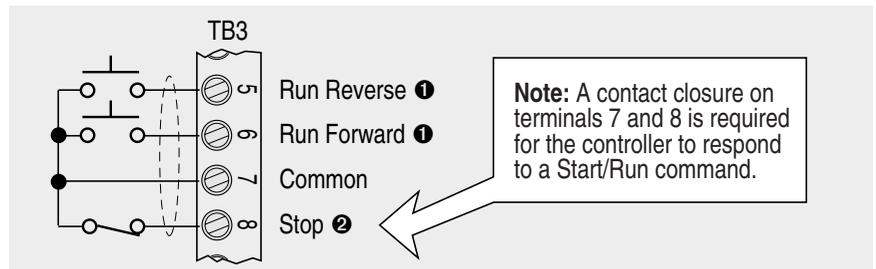


P46 Setting 3 - Momentary Run Forward/Run Reverse Control

This input mode allows the drive to respond to either a momentary or maintained Run Forward or Run Reverse input, but requires a stop input to TB3 terminals 7 and 8 to command the drive to stop. In addition, this is the only input mode that uses “level triggered” control logic, therefore once the stop command is removed or if power is lost and restored, the drive will immediately restart if a maintained Run command is present.

Momentary Run Fwd/Run Rev control

Figure 2.16



ATTENTION: Hazard of injury exists due to unintended operation. When P46 - [Input Mode] is set to 3, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).

- ❶ A momentary or maintained input can be used. If using maintained inputs, please read the **Attention** statement above.
- ❷ A normally closed maintained input is recommended. See **Attention** statement above.

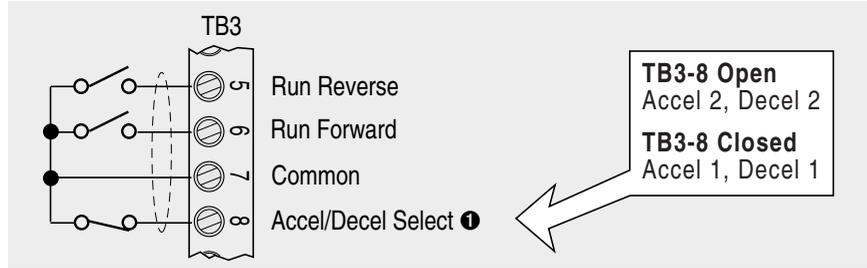
Important: Settings 4 through 9 provide additional flexibility of TB3 control input terminal 8.

P46 Setting 4 - Two-Wire Accel/Decel Control

This input mode is similar to Setting 1 except TB3 terminal 8 provides the function of switching from P30 - [Accel Time 1] and P31 - [Decel Time 1] to P69 - [Accel Time 2] and P70 - [Decel Time 2] for any commanded frequency reference.

Two-Wire Accel/Decel control

Figure 2.17



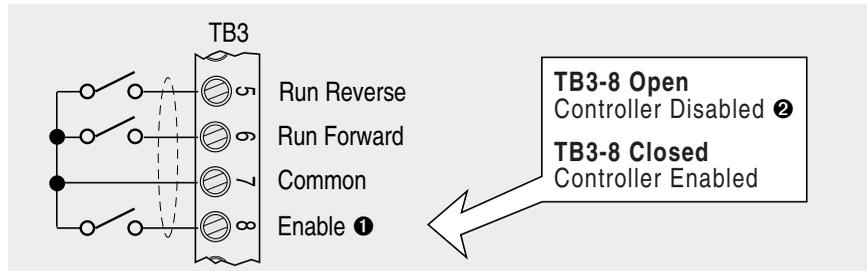
❶ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details.

P46 Setting 5 - Two-Wire Enable Control

This input mode is similar to Setting 1 except TB3 terminal 8 provides the function of “enable” command. The “enable” input is required for the drive to operate and if opened during operation the programmed P34 - [Stop Mode] will be overridden and the motor will coast to rest.

Two-Wire Enable control

Figure 2.18



❶ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details.

❷ When this input is in an open state, the motor will coast to rest.

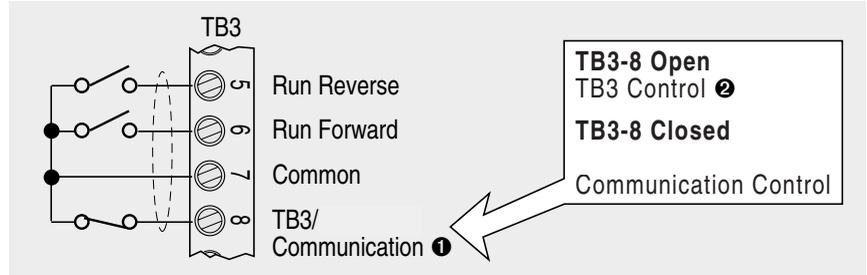
P46 Setting 6 - Two-Wire TB3 Control or Communication Control

This input mode is similar to Setting 1 except TB3 terminal 8 provides the function of switching the start, reverse and speed reference from the Communication Module to the control terminal block (TB3).

Monitoring (Read/Write Parameter Access) via External Keypad or Network Communication Option is possible in almost all input modes (refer to Table 2.J).

Two-Wire TB3 control or Communication control

Figure 2.19



❶ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details.

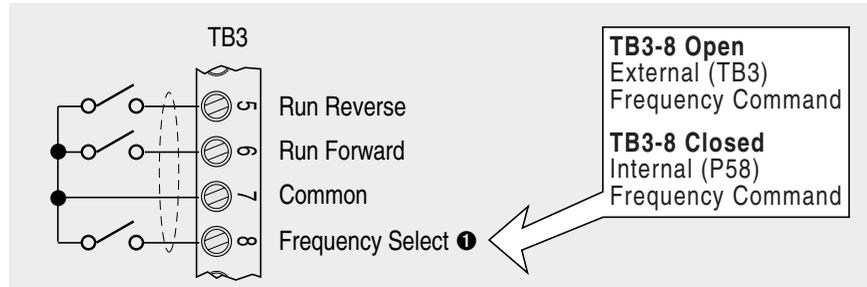
❷ When this input is in an open state the Frequency source is always from the terminal block regardless of the setting of P59 - [Frequency Select].

P46 Setting 7 - Two-Wire Frequency Select Control

This input mode is similar to Setting 1 except TB3 terminal 8 provides the function of switching the frequency reference from the control terminal block (TB3) to the frequency commanded by P58 - [Internal Frequency]. This provides the ability to switch from analog control to one preset speed.

Two-Wire Frequency Select control

Figure 2.20



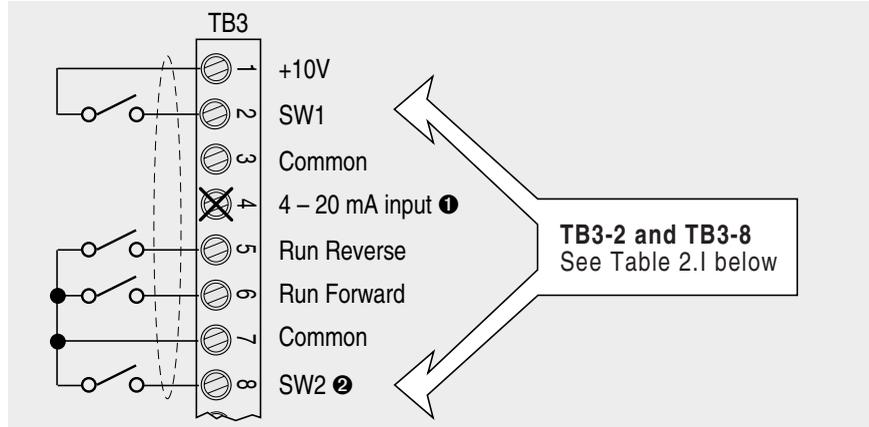
❶ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details.

P46 Setting 8 - Two Wire Preset Speed Control

This input mode is similar to Setting 1 except TB3 terminals 1, 2 and 8 provide the function of preset speeds. Note: All analog functionality is disabled when using this input mode setting.

Two-Wire Preset control

Figure 2.21



TB3 Terminal 2 and 8 Switch Definitions

Table 2.K

SW2 Position TB3-8	SW1 Position TB3-2	Speed Reference	Accel Rate	Decel Rate
Open (0)	Open (0)	Parameter 61 (Preset 0)	Parameter 30	Parameter 31
Open (0)	Closed (1)	Parameter 62 (Preset 1)	Parameter 30	Parameter 31
Closed (1)	Open (0)	Parameter 65 (Preset 4)	Parameter 69	Parameter 70
Closed (1)	Closed (1)	Parameter 66 (Preset 5)	Parameter 69	Parameter 70

❶ Do not connect to TB3-4 in this mode.

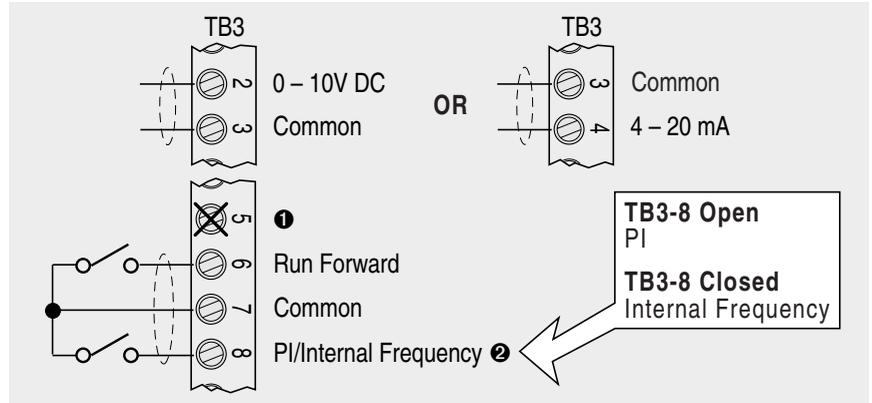
❷ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details.

P46 Setting 9 - Two-Wire PI Control

This input mode is similar to Setting 1 except TB3 terminal 8 provides the function of PI Control.

Two-Wire PI control

Figure 2.22



Refer to Chapter 5, *160 PI Control Setup* for a detailed PI Control Setup description.

- ❶ Do not connect to TB3-5 in this mode.
- ❷ TB3 terminal 8 can be used to clear faults. See Figure 2.25 for details

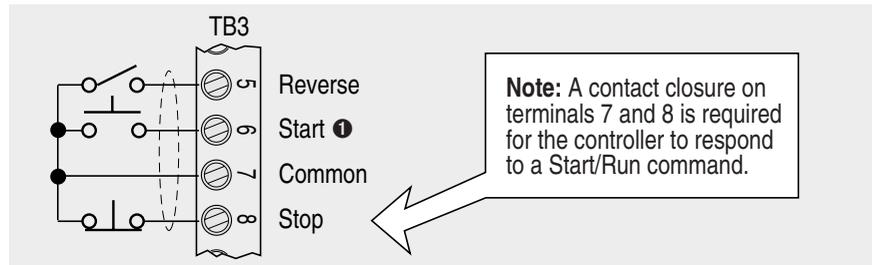
P46 Setting 10 - Three-Wire Control

This input mode provides a typical three wire control function where a momentary start input will command the drive to start. It is similar to *Setting 0* with the exception that the drive will not be faulted, if the connection to the external keypad is lost.

Note: DeviceNet and RS1 are not supported in this input mode.

Three-Wire control

Figure 2.23



- ❶ Start input can be a momentary input.

P46 Setting 11- External Keypad Control

This input mode activates the Start and Reverse functions if either the Remote Keypad Module or CopyCat Keypad is connected to the drive and deactivates the Start and Reverse inputs on the control terminal block (TB3) and control from any communication module.

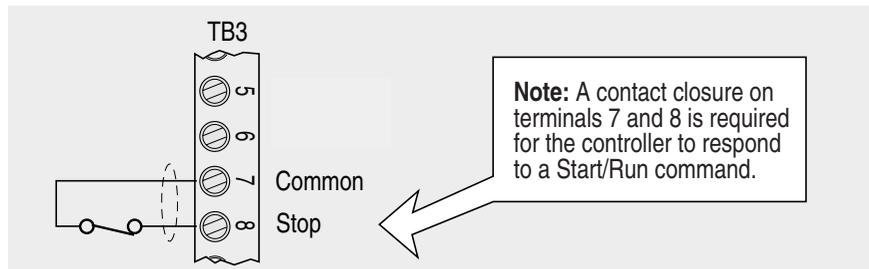
The drive will be faulted if the communication to the external keypad is interrupted. The fault reset is only possible with a keypad connected.

Note: The frequency reference can be controlled from the external keypad by setting P59 - [Frequency Select] to "1". The frequency will then be controlled by the value programmed into P58 - [Internal Frequency].

Note: DeviceNet and RS1 are not supported in this input mode.

External Keypad control

Figure 2.24

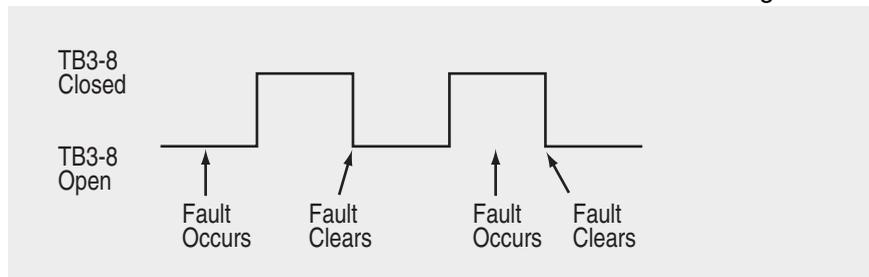


Clear Faults

Important: For P46 - [Input Mode] settings 4 through 11, Terminal TB3-8 is also used to clear faults. See figure below for details.

TB3-8 – Clear Faults

Figure 2.25

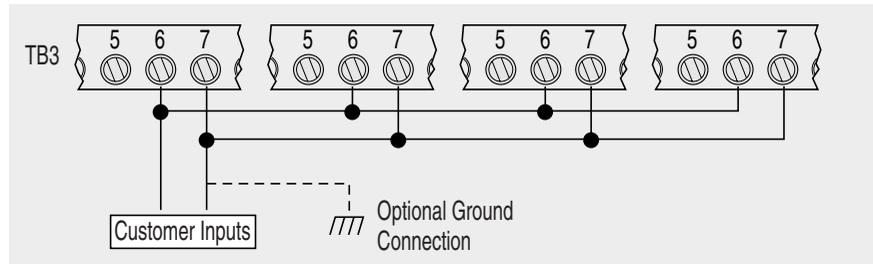


Important: The system programmer is responsible for returning terminal TB3-8 to its original state if necessary.

When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect the commons (TB3-7) together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of TB3-7 should be connected. Predicting actual performance given the variety of installation possibilities is difficult, however, up to five drives with two meters of cable between have been tested without problems.

Typical Multiple Drive Input Connections

Figure 2.26

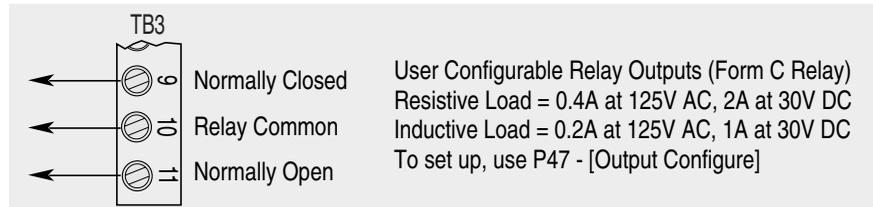


Configurable Relay Output Contacts (P47 Settings)

You can configure the drive's dry contact Form C output relay to change state based on P47 - [Output Configure] setting and P48 - [Output Threshold] limits. See Chapter 5 for details.

Configurable Relay Output Contacts

Figure 2.27



Frequency Source Wiring

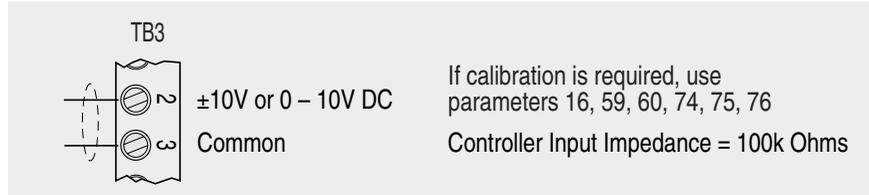
You can control the output frequency of the drive via the Control Terminal Block (TB3) using the following methods.

Analog Frequency Sources

Important: Only one frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

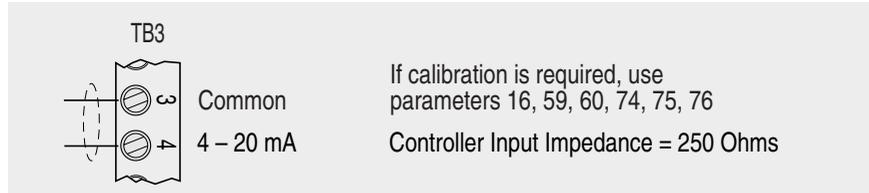
±10V or 0 – 10V DC Frequency Control/Speed Control

Figure 2.28



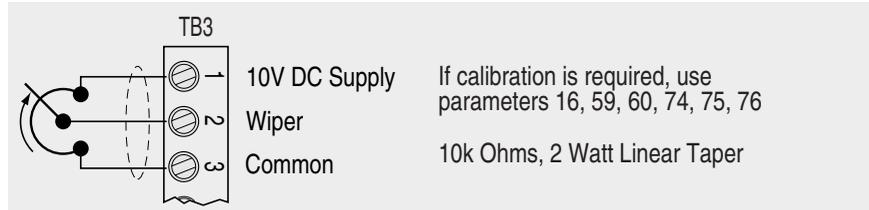
4 – 20 mA Frequency Control/Speed Control

Figure 2.29



Potentiometer Frequency Control/Speed Control

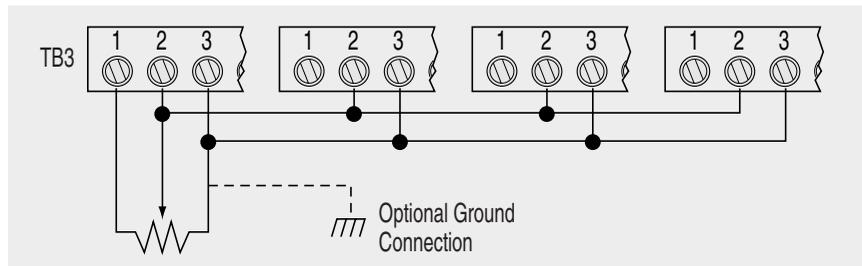
Figure 2.30



When connecting a single potentiometer to multiple drives it is important to connect commons (TB3-3) together for all drives. TB3-3 (common) and TB3-2 (potentiometer wiper) should be daisy-chained to each drive. All drives must be powered up for the analog signal to be read correctly. Predicting actual performance given the variety of installation possibilities is difficult, however, up to five drives with two meters of cable between have been tested without problems.

Typical Multiple Drive Analog Connection

Figure 2.31



Preset Frequency Sources

The drive has a special input mode, P46 setting 8 that allows the drive to be operated via preset speed inputs. See Figure 2.21 and Table 2.K for details.

Internal Frequency Source

The drive has the provision for frequency control via P58 - [Internal Frequency]. This is accomplished by setting P59 - [Frequency Select] to a value of 1. See Chapter 5 for a description of these parameters.

What To Do Next

You should become familiar with the Keypad Module operation in Chapter 3 if you need to change any factory default parameter settings for your application. Then proceed to Chapter 4, *Start-Up* and follow the flow diagram. After applying power, you can program parameters if necessary. Refer to Table 5.A for a list of commonly changed parameters.

Review all setup instructions thoroughly before making any adjustments or applying power to the unit.

Before making any adjustments to the unit, be sure to take the following precautions:



ATTENTION: Before applying power to the unit it must be closed. The four cover screws must be inserted by the use of a screwdriver and then tightened with 2.9 Nm (26 lb-in) torque in order to properly ground the cover. Failure to observe this precaution could result in severe bodily injury or loss of life.

End of Chapter

Using A Keypad Module

One of the two options Remote Keypad Module or CopyCat Keypad can be connected via cable to a socket on the drives cable entry plate.

The Program Keypad Module (used on the 160 SSC drive) **must not** be used.

Also the CopyCat Keypad **must not** be used to copy program data from the 160Z to the Bulletin 160 SSC.

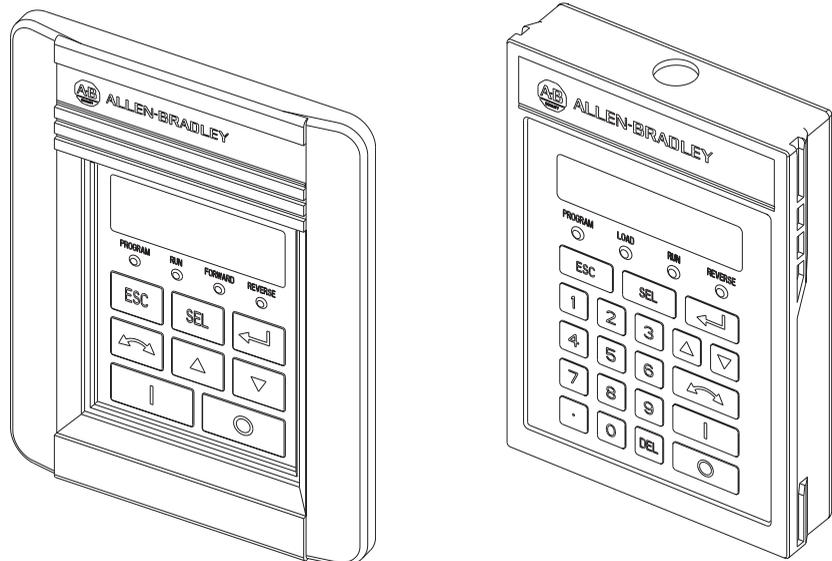
Features

The 2 Keypads provide the following features:

- 4-digit, 7-segment LED display (Remote Keypad) or 2-row by 16-column liquid crystal display (LCD) (CopyCat Keypad)
- Program Mode Indicator
- Five keys for programming and displaying drive parameters
Additional twelve numeric keys on CopyCat Keypad
- Three keys for control inputs to the drive
- Two directional LED indicators

Remote Keypad Module (left) and CopyCat Keypad

Figure 3.1



Display Mode

The drive always powers up in the Display mode. While in this mode you may view all *read only* drive parameters, but not modify them.

Program Mode

Refer to the Bulletin 160 Remote Keypad Manual or Bulletin 160 CopyCat Keypad Manual for programming steps.

Keypad Control

To get the control over the drive:

- Connect one of the external keypads to the drive.
- Wait until communication is established.
- If the drive is running, stop it.
- Change P46 [Input Mode] to 11 and set P56 [Reset Function] to 2. The keypad now has control of the drive.
- Make sure input TB3-8 has been closed to start the drive. Disconnecting the keypad in this mode will fault the drive.
- If the keypad is not used anymore change P46 [Input Mode] back to the previous mode and set P56 [Reset Function] to 2.

The drive is controllable as before. (The drive is not running immediately after changing back. It must be started again).

Important: With the stop input TB3-8 closed, the drive can be stopped via keypad in each mode. If P46 [Input Mode] is not set to 2, 6 or 11 and a stop command is released on the keypad, the run command must be opened and closed to again enable drive start by input TB3. Faults cannot be reset via keypad if the stop input TB3-8 is open.

Display or Modify Parameters

To only display or modify parameter values:

- Connect one of the external keypads to the drive.
- Wait until communication is established.
- Use the external keypad to change parameter values as described in the individual Keypad User Manual.
- Note that some parameters cannot be programmed while the drive is running.
- Disconnect the keypad.

DeviceNet and External Keypad

If Instance 21 Data Format (P.107) is selected and it is intended to change P46 [Input Mode] with the keypad, Bit 5 (Net Control) must be set to zero. Otherwise the DeviceNet latches Input Mode 2. If the Net Control Bit is zero, it is not feasible to set the Input Mode to 2. Every other mode can be set.

To change the Input Mode with the keypad the following steps are necessary:

Setup the DeviceNet Master:

Output Assemblies:

Instance 21 Data Format (Reversing Speed Control Output Assembly).

Input Assemblies:

Instance 71 Data Format (Extended Speed Control Input Assembly).

(see User Manual DeviceNet Communication Module, Cat. No. 160-DN2, page B-21 and B-26)

Procedure:

- Set Net Control and start the drive.
- Reset the Net Control bit.
- Connect the keypad to the drive and release a stop command.
- Change P46 [Input Mode] to 11 and P56 [Reset Function] to 2.
The keypad now has control of the drive.

Important: If P46 [Input Mode] is set to 10 or 11, the drive does not support any parallel communication options such as DeviceNet or RS1. The option modules do not communicate to the drive and the values of the displayed parameters keep the last state before mode change.

- If the keypad is not used anymore, set P46 [Input Mode] to 2 and P56 [Reset Function] to 2. Unplug the keypad and start the drive again via DeviceNet (set Net Control and reset after start).

If you do not want to allow the keypad to have the control of the drive, set the Net Control bit.

Key Functions



Escape

The ESCape key allows you to toggle between the Display and Program modes. When the Program mode is active, this key will disable the editing of a parameter value.



Select

The SELect key enables editing of a parameter value when the Program mode is active. When you press this key, the Program Mode Indicator flashes.



Up/Down Arrow Keys

Use the Up/Down Arrow keys to scroll through a list of parameters, or increase and decrease parameter values. Press and hold either key to increase scrolling speed. Real time frequency adjustment can be achieved when using P58 - [Internal Frequency] and P59 - [Frequency Select]. Refer to Chapter 5 for further information.



Enter

Pressing this key causes the current value displayed to be entered into memory (only while in the Program mode). When you press this key, the Program Mode Indicator remains on, but stops flashing.



Direction LEDs (Indicators)

The appropriate LED will illuminate continuously to indicate the commanded direction of rotation. If the second LED is flashing, the drive has been commanded to change direction, but is still decelerating.

Important: Actual motor rotation could be different if motor leads are not connected properly. Refer to Chapter 4 for details on how to verify correct motor rotation.



Reverse (Change Direction)

This function is only active when P46 - [Input Mode] is set to 2. When active, pressing this key causes the motor to ramp down to 0 Hz and then ramp up to its set speed in the opposite direction. When the motor is running, pressing this key causes the (currently illuminated) LED to flash, indicating motor rotation while decelerating to zero. The other LED will illuminate indicating the commanded direction.



Start

This function is only active when P46 - [Input Mode] is set to 2. When active, pressing this key initiates a start command.



Stop

Pressing the Stop key will cause the motor to stop, using the selected stop mode. Refer to the P34 - [Stop Mode] parameter. If the drive has stopped due to a fault, pressing this key will clear the fault.

Important: The Stop key is always active in all control modes.

Keypad Connection

Insert the connection cable of the external keypad into the plug on the cable entry plate of the drive.

For catalog numbers of available cables refer to Appendix B.



ATTENTION: Hazard of injury exists due to uncontrolled operation. The following modules of the Bulletin 160 SSC Drive **must not be used** on the 160Z drive:

- RPA Module 160-RPA to connect an external keypad,
 - Programming Keypad 160-P1 to program parameters
-

Remote Keypad (shown) or CopyCat Keypad Connection

Figure 3.2



End of Chapter

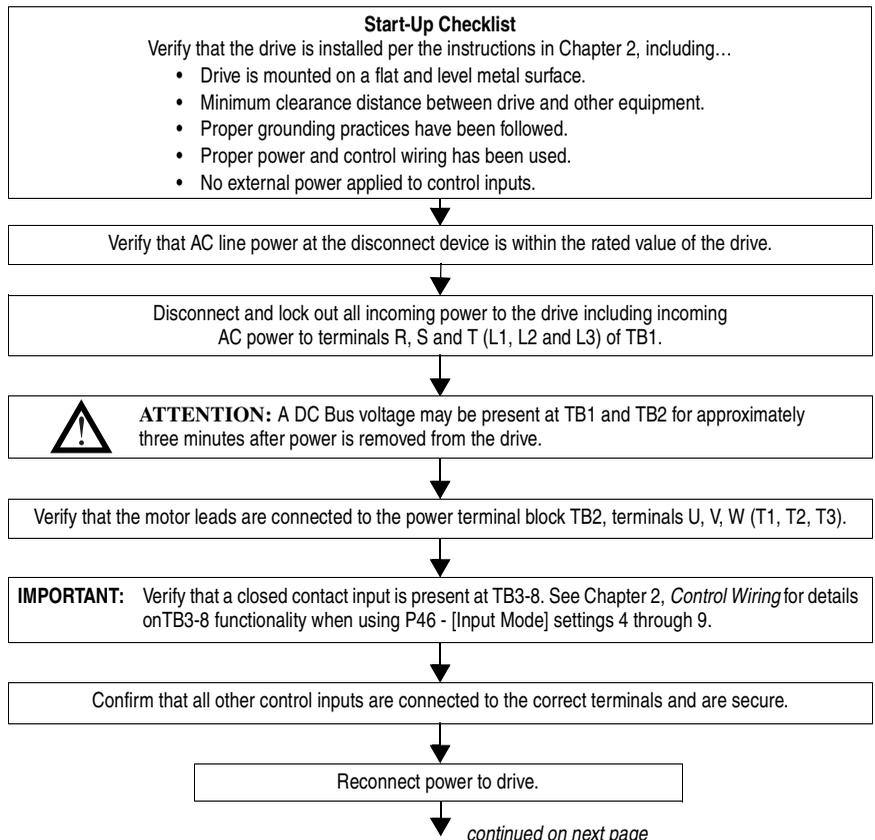
Start-Up

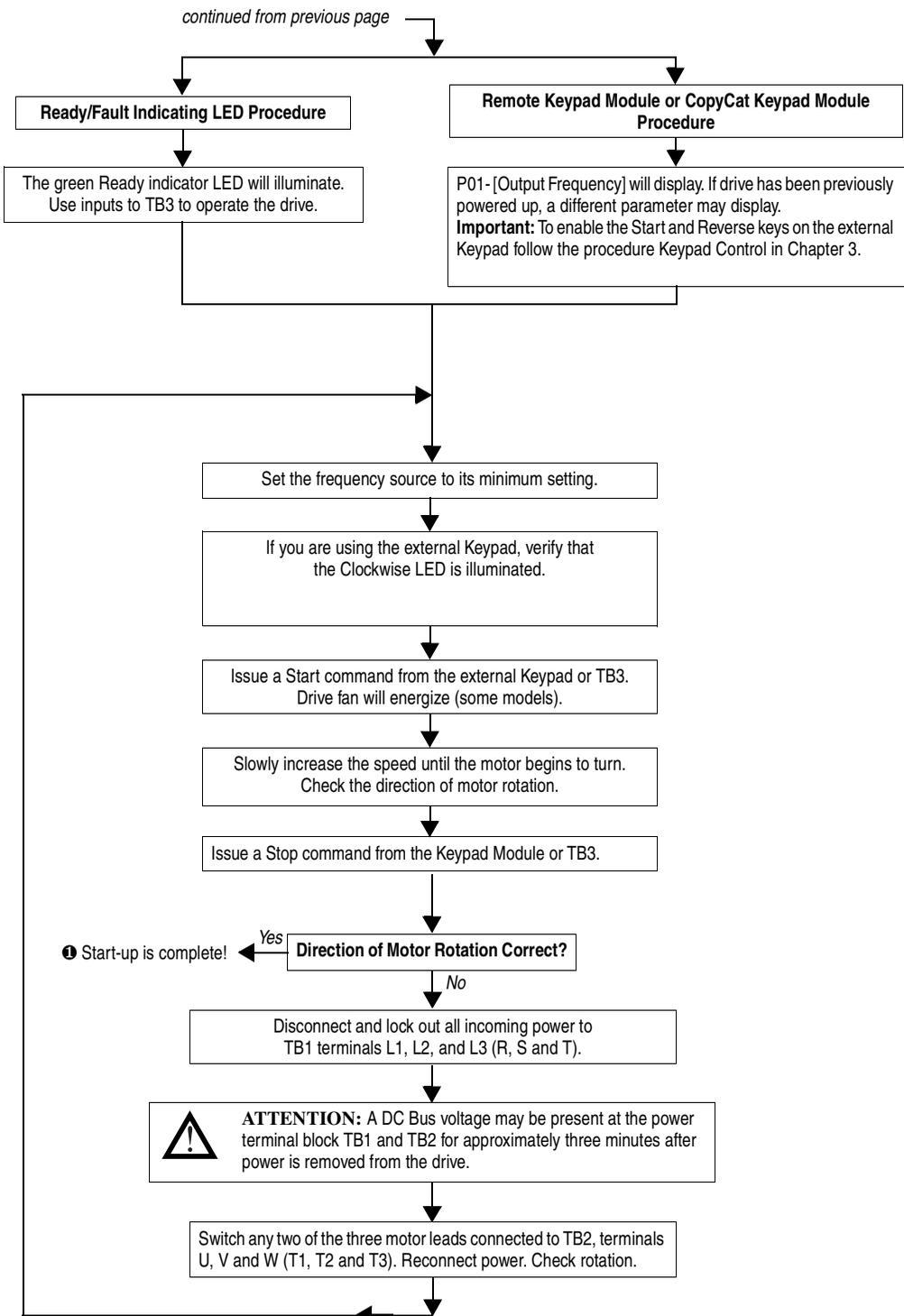
Start-Up Procedures

This chapter guides you through a basic start-up of the drive using factory default parameter settings. The objective is to verify power and control wiring, set motor direction, control motor speed and prepare you for programming parameters (tuning) if necessary. Refer to Chapter 5 for a complete listing and description of parameters and programming information.



ATTENTION: Power must be applied to the drive to perform the following start-up procedure. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove Power** by opening the branch circuit disconnect device and correct the malfunction before continuing.





❗ After successfully completing start-up, proceed to Chapter 5. If you need to change any factory defaults, you will need an external Keypad or other type of Communication Module.

Parameters and Programming

Overview of Parameters

This chapter describes both Display and Program parameters. Display parameters are *read only* (they cannot be programmed), while Program parameters *can* be changed to fit your motor control requirements.

A Remote Keypad Module or CopyCat Keypad allows you to view or change parameters. The Communication Modules 160-DN2, 160-RS1, 160-PD1 or 160-IB1 allow you to view or change parameters.

A Ready/Fault Indicating Panel or the Programming Keypad Module 160-P1 **cannot be used** to view or change parameters.

Review the factory default settings. These parameters can be changed to meet your specific application requirements with any of the following:

Remote Keypad Module or CopyCat Keypad.

The table below provides a list of parameters that are frequently changed.

Commonly Changed Parameters Table 5.A

Parameter	Setting	Default Setting
P30 - [Accel Time 1]	Desired accel time.	10.0 sec
P31 - [Decel Time 1]	Desired decel time.	10.0 sec
P33 - [Maximum Frequency]	Maximum frequency required.	60 Hz
P34 - [Stop Mode Select]	Desired stopping mode.	0
P35 - [Base Frequency]	Motor rated nameplate frequency.	60 Hz
P36 - [Base Voltage]	Motor rated nameplate voltage.	460V or 230V
P38 - [Boost Select]	Desired V/F boost setting.	2
P42 - [Motor Overload Current]	Motor nameplate Full Load Amps (FLA).	115%
P43 - [Current Limit]	Desired maximum output current.	150%
P46 - [Input Mode]	Desired control method.	0
P47 - [Output Configure]	Desired output relay function.	0
P56 - [Reset Functions]	Desired drive reset description.	0
P58 - [Internal Frequency]	Desired internal frequency.	60.0 Hz
P59 - [Frequency Select]	Desired frequency source.	0
P61 – P66 - [Preset Frequency 0-5]	Desired preset frequencies.	0-5
P74 – P76 - [Analog Input]	Desired analog input functionality.	0, 0.0, 100.0%

Refer to the *Programming Example* on the next page for instructions.

Important Reset Actions

You must set P56 - [Reset Functions] to 2 after changing the setting of P46 - [Input Mode] for the change to take effect.

If you reset to factory defaults, you cannot use the Remote Keypad Module or Copycat Keypad for start or reverse control until it is selected using P46 setting 11.

An F48 - Reprogram Fault can be cleared using the Remote Keypad Module or CopyCat Keypad stop button, if the stop input TB3-8 closed.

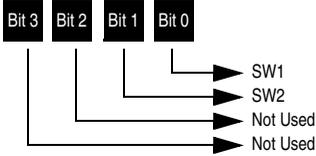
Display Group Parameters (Read Only)

This group of parameters consists of commonly viewed drive operating conditions such as output frequency, output voltage, output current and frequency command. All parameters in this group are *read only*.

Important: The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.

Display Group (Read Only)			
No.	Parameter Name/Description	Min./Max. Range	Units
01	[Output Frequency] Displays the drives output frequency	0.0/240.0	0.1 Hz
02	[Output Voltage] Displays the drives output voltage.	0/Max Voltage	1 Volt
03	[Output Current] Displays the drives output current.	0/2 x Drive Rated Output Current	0.01A
04	[Output Power] Displays the drives output power.	0/2 x Rated Drive Output Power	0.01 kW
05	[Bus Voltage] Displays the DC Bus Voltage level.	0/400 - 230V 0/800 - 460V	1 Volt
06	[Frequency Command] Displays the frequency that the drive is commanded to output. This command may come from any of the frequency sources selected by P59 - [Frequency Select] or from a currently selected preset frequency.	0.0/240.0	0.1 Hz
07	[Active Fault] Displays the coded active fault number. If a fault is currently active (has not been cleared) the display will flash. After fault condition is cleared, display will read zero. Refer to P17, P18, and P19 for fault history. See Chapter 6 for fault code descriptions.	0/48	Numeric Value
08	[Heatsink Temperature] Displays the temperature of the drive heatsink. Note: A display value of 69 indicates a temperature of less than 70°C.	69/150	1 Degree C
09	[Drive Status] Displays the status of the drive in a binary coded format. Important: 0 = Inactive, 1 = Active.	0000/1011	Binary Number
<pre> graph TD B3[Bit 3] --> R[Running] B2[Bit 2] --> F[Forward] B1[Bit 1] --> A[Accel] B0[Bit 0] --> D[Decel] </pre>			
10	[Drive Type] Used by Rockwell Automation field service personnel.	Numeric Value	Numeric Value
11	[Firmware Version] Displays version of drive firmware. Used by Rockwell Automation field service personnel.	Fixed Value	Numeric Value

Display Group (Read Only)

No.	Parameter Name/Description	Min./Max. Range	Units																																																							
12	<p>[Input Status]</p> <p>Displays the open (0) and closed (1) state of the inputs to TB3 in binary coded format as follows:</p> <table border="1"> <thead> <tr> <th></th> <th>Bit 3 Polarity</th> <th>Bit 2 TB3-6</th> <th>Bit 1 TB3-8</th> <th>Bit 0 TB3-5</th> </tr> </thead> <tbody> <tr> <td>Input Mode 0 (3-Wire Control/F)</td> <td rowspan="2">0 = Positive Analog Input</td> <td>Start</td> <td>Stop</td> <td>Reverse</td> </tr> <tr> <td>Input Mode 1 (2-Wire Control)</td> <td>Run Forward</td> <td>Stop</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 2 (Communic. Module)</td> <td rowspan="10">1 = Negative Analog Input</td> <td>N/A</td> <td>Stop</td> <td>N/A</td> </tr> <tr> <td>Input Mode 3 (Mom. Run Fwd./Rev.)</td> <td>Run Forward</td> <td>Stop</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 4 (Accel/Decel)</td> <td>Run Forward</td> <td>0 = Accel 2/Decel 2 1 = Accel 1/Decel 1</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 5 (Coast to Rest)</td> <td>Run Forward</td> <td>Coast to Rest Stop</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 6 (TB3 or Comm.)</td> <td>Run Forward</td> <td>0 = TB3 Control 1 = Communication</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 7 (Frequency Select)</td> <td>Run Forward</td> <td>0 = Analog Frequency Select 1 = Internal Frequency Select</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 8  (SF1 Preset Speed)</td> <td>Run Forward</td> <td>0 = Open 1 = Closed</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 9 (2-Wire PI control)</td> <td>Run Forward</td> <td>0 = PI 1 = Internal Frequency Select</td> <td>Run Reverse</td> </tr> <tr> <td>Input Mode 10 (3-Wire control)</td> <td>Start</td> <td>Stop</td> <td>Reverse</td> </tr> <tr> <td>Input Mode 11 (Keypad control)</td> <td>N/A</td> <td>Stop</td> <td>N/A</td> </tr> </tbody> </table> <p> Status of Bit 3 for Input Mode 8 is TB3-2 is: 0 = Open, 1 = Closed.</p>		Bit 3 Polarity	Bit 2 TB3-6	Bit 1 TB3-8	Bit 0 TB3-5	Input Mode 0 (3-Wire Control/F)	0 = Positive Analog Input	Start	Stop	Reverse	Input Mode 1 (2-Wire Control)	Run Forward	Stop	Run Reverse	Input Mode 2 (Communic. Module)	1 = Negative Analog Input	N/A	Stop	N/A	Input Mode 3 (Mom. Run Fwd./Rev.)	Run Forward	Stop	Run Reverse	Input Mode 4 (Accel/Decel)	Run Forward	0 = Accel 2/Decel 2 1 = Accel 1/Decel 1	Run Reverse	Input Mode 5 (Coast to Rest)	Run Forward	Coast to Rest Stop	Run Reverse	Input Mode 6 (TB3 or Comm.)	Run Forward	0 = TB3 Control 1 = Communication	Run Reverse	Input Mode 7 (Frequency Select)	Run Forward	0 = Analog Frequency Select 1 = Internal Frequency Select	Run Reverse	Input Mode 8  (SF1 Preset Speed)	Run Forward	0 = Open 1 = Closed	Run Reverse	Input Mode 9 (2-Wire PI control)	Run Forward	0 = PI 1 = Internal Frequency Select	Run Reverse	Input Mode 10 (3-Wire control)	Start	Stop	Reverse	Input Mode 11 (Keypad control)	N/A	Stop	N/A	0000/1111	Binary Number
	Bit 3 Polarity	Bit 2 TB3-6	Bit 1 TB3-8	Bit 0 TB3-5																																																						
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Input Mode 10 (3-Wire control)		Start	Stop	Reverse																																																						
Input Mode 11 (Keypad control)		N/A	Stop	N/A																																																						
13	<p>[Power Factor Angle]</p> <p>Displays the angle in electrical degrees between motor voltage and motor current.</p>	0.0/180.0	0.1 degrees																																																							
14	<p>[Memory Probe Display]</p> <p>Used by Rockwell Automation field service personnel.</p>	Numeric Value	Numeric Value																																																							
15	<p>[Preset Status]</p> <p>Displays the open (0) and closed (1) state of TB3 inputs SW1 and SW2 in binary coded format.</p> 	Preset – 0000/0111 Analog – 0000/0011	Binary Number																																																							
16	<p>[Analog Input]</p> <p>Displays the analog input as a percent of full scale. Used in setting P60 - [Zero Offset], P75 - [Analog Input Minimum], and P76 - [Analog Input Maximum].</p> <p>Important: On initial set up of the drive, apply a 0V or 4 mA analog command to the drive. Once applied, if the value of this parameter displays something other than zero, program that value into P60 - [Zero Offset]. Please note that the value of [Zero Offset] will be subtracted from the value of this parameter.</p>	-150.0/+150.0	0.1%																																																							

Display Group (Read Only)

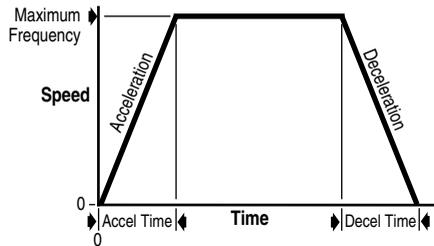
No.	Parameter Name/Description	Min./Max. Range	Units
17	[Fault Buffer 0] This parameter stores the last fault that occurred. If the same fault occurs multiple times in a row, it will be stored once. After a "reset defaults" (P56) this will set this parameter to F48 - Reprogram Fault. As faults occur, the previous value of this parameter is moved to P18 - [Fault Buffer 1].	0/48	Numeric Value
18	[Fault Buffer 1] This parameter stores the second most recent fault that occurred. After a "reset defaults" (P56) this will set this parameter to 0 (No active fault). As faults occur, the value of this parameter will be overwritten by P17 - [Fault Buffer 0]. The previous value of this parameter is moved to P19 - [Fault Buffer 2].	0/48	Numeric Value
19	[Fault Buffer 2] This parameter stores the third most recent fault that occurred. After a "reset defaults" (P56) this will set this parameter to 0 (No active fault). As faults occur, the value of this parameter will be overwritten by P18 - [Fault Buffer 1].	0/48	Numeric Value

Program Group Parameters

This group contains parameters whose values *can* be programmed. Refer to *Programming Example* earlier in this chapter. Unless otherwise stated, parameters that are programmed while the drive is running take immediate effect.

Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
30	[Accel Time 1] Time for the drive to ramp from 0.0 Hz. to P33 - [Maximum Frequency]. The rate is linear for any increase in command frequency unless P53 - [S-Curve] is set to a value other than "0". Setting this to 0.0 sec. gives 0.1 sec acceleration with the initial current limit turned off. This allows quicker acceleration times for low inertia systems. For medium to high inertia systems, the minimum value should be 0.1 sec.	0.0/600.0	0.1 Seconds	10.0 Seconds

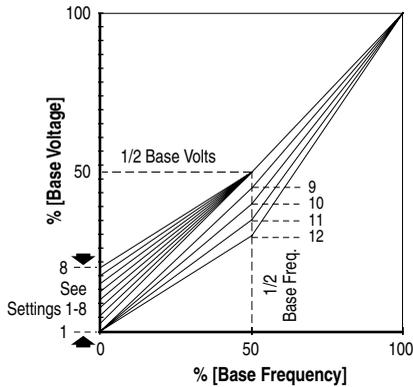


Program Group																		
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default														
31	<p>[Decel Time 1]</p> <p>Time for the drive to ramp from P33 - [Maximum Frequency] to 0.0 Hz. The rate is linear for any decrease in command frequency unless P53 - [S-Curve] is set to a value other than 0.</p> <p>● Minimum deceleration time must be set based on the applied motor size. To guard against premature drive failure, do not set P31 - [Decel Time 1] or P70 - [Decel Time 2] below the minimum value listed in the table below.</p> <table border="1"> <thead> <tr> <th>230 and 460V Motor Sizes</th> <th>Minimum Deceleration Settings</th> </tr> </thead> <tbody> <tr> <td>4.0 kW (5 HP)</td> <td>0.7 seconds</td> </tr> <tr> <td>2.2 kW (3 HP)</td> <td>0.6 seconds</td> </tr> <tr> <td>1.5 kW (2 HP)</td> <td>0.2 seconds</td> </tr> <tr> <td>0.75 kW (1 HP)</td> <td>0.1 seconds</td> </tr> <tr> <td>0.55 kW (0.75 HP)</td> <td>0.1 seconds</td> </tr> <tr> <td>0.37 kW (0.5 HP)</td> <td>0.1 seconds</td> </tr> </tbody> </table>	230 and 460V Motor Sizes	Minimum Deceleration Settings	4.0 kW (5 HP)	0.7 seconds	2.2 kW (3 HP)	0.6 seconds	1.5 kW (2 HP)	0.2 seconds	0.75 kW (1 HP)	0.1 seconds	0.55 kW (0.75 HP)	0.1 seconds	0.37 kW (0.5 HP)	0.1 seconds	●/600.0	0.1 Seconds	10.0 Seconds
230 and 460V Motor Sizes	Minimum Deceleration Settings																	
4.0 kW (5 HP)	0.7 seconds																	
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0.75 kW (1 HP)	0.1 seconds																	
0.55 kW (0.75 HP)	0.1 seconds																	
0.37 kW (0.5 HP)	0.1 seconds																	
32	<p>[Minimum Frequency]</p> <p>Lowest frequency that drive will output continuously.</p>	0/240	1 Hz	0 Hz														
33	<p>[Maximum Frequency]</p> <p>Highest frequency the drive will output.</p> <p>This parameter cannot be changed while running. The value of this parameter setting must be greater than the value set in P32 - [Minimum Frequency].</p> <p>Important: This parameter must not exceed the value on the motor nameplate.</p>	0/240	1 Hz	60 Hz														
34	<p>[Stop Mode Select]</p> <p>Determines stopping mode used by the drive when a stop is initiated. Refer to the P44 - [DC Hold Time] and P45 - [DC Hold Voltage] diagrams.</p> <p>Settings:</p> <ul style="list-style-type: none"> 0 Ramp to Stop 1 Coast to Stop 2 DC Injection Braking 3 DC Injection Braking (w/Auto Shutoff) – works the same as standard DC injection braking except that it may shut off before the P44 - [DC Hold Time]. This occurs if the drive is out of current limit before the P44 - [DC Hold Time] expires. 	0/3	Numeric Value	0														
35	<p>[Base Frequency]</p> <p>Set value to rated nameplate frequency of motor. A Remote Keypad Module or CopyCat Keypad is required if P35 must be changed to 50 Hz.</p>	10/240	1 Hz	60 Hz														
36	<p>[Base Voltage]</p> <p>Set value to rated nameplate voltage of motor.</p>	20/460 for 460V units & 20/230 for 230V units	1 Volt	460 for 460V units & 230 for 230V units														
37	<p>[Maximum Voltage]</p> <p>Sets the highest voltage that the drive will output. P37 - [Maximum Voltage] must be greater than or equal to P36 - [Base Voltage].</p>	20/510 for 460V units & 20/255 for 230V units	1 Volt	460 for 460V units & 230 for 230V units														

● The analog inputs to the drive (i.e. 4-20mA, 0 to +10 V, or remote potentiometer) can be scaled to P32 - [Minimum Frequency] and P33 - [Maximum Frequency] by programming P75 - [Analog Input Minimum] and P76 - [Analog Input Maximum].

Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
38	[Boost Select] Sets the boost voltage and redefines the Volts per Hz curve. Settings 0 – 8 can provide increased torque at low frequency. Settings 9 – 12 are used to reduce energy consumption.	0/12	Numeric Value	2

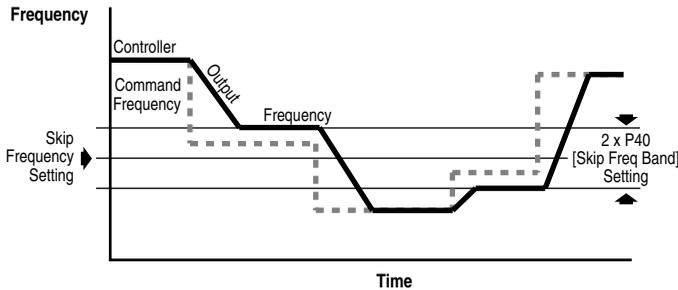


Setting	Boost Voltage (% of [Base Voltage])
0	0
1	2.5
2	5.0
3	7.5
4	10.0
5	12.5
6	15.0
7	17.5
8	20.0

Setting	Fan/Pump Curves ❶
9	45.0
10	40.0
11	35.0
12	30.0

❶ Break Point Voltages in percent of [Base Voltage]

39	[Skip Frequency] Works in conjunction with P40 - [Skip Frequency Band] creating a range of frequencies at which the drive will not operate continuously.	0/240	1 Hz	240 Hz
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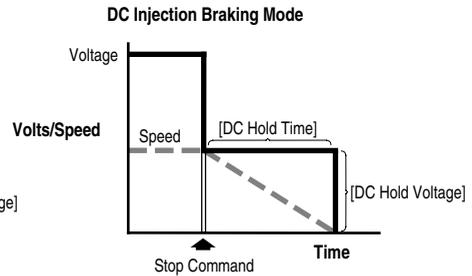
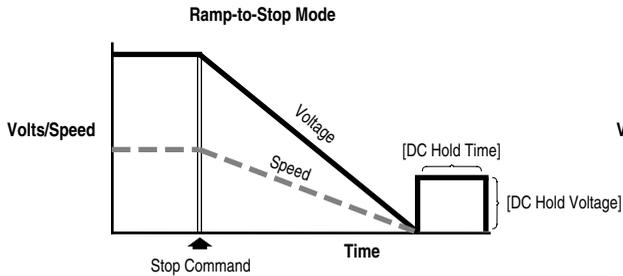
40	[Skip Frequency Band] Determines the band around the P39 - [Skip Frequency] parameter. The actual band width will be 2 times P40 - [Skip Frequency Band] - 1/2 the band above and 1/2 the band below. A value of zero will disable the skip frequency.	0/30	1 Hz	0 Hz
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Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default								
41	[Motor Overload Select] Bulletin 160 provides Class 10 overload protection. Settings 0 – 2 select the derating factor for the I ² t overload function.	0/2	Numeric Value	0								
	<table border="1"> <thead> <tr> <th>Setting</th> <th>Derate Level</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No Derate 10:1 speed range</td> </tr> <tr> <td>1</td> <td>Min. Derate 4:1 speed range, derate below 25% of base speed</td> </tr> <tr> <td>2</td> <td>Max. Derate 2:1 speed range, derate below 50% of base speed</td> </tr> </tbody> </table>	Setting	Derate Level	0	No Derate 10:1 speed range	1	Min. Derate 4:1 speed range, derate below 25% of base speed	2	Max. Derate 2:1 speed range, derate below 50% of base speed			
Setting	Derate Level											
0	No Derate 10:1 speed range											
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	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>No Derate</p> </div> <div style="text-align: center;"> <p>Min Derate</p> </div> </div> <div style="text-align: center; margin-top: 20px;"> <p>Max Derate</p> </div> <div style="margin-top: 20px;"> <p>Settings 0 = No Derating 1 = Minimum Derating 2 = Maximum Derating</p> </div>											
42	[Motor Overload Current] Set to motor nameplate Full Load Amps (FLA).	0.1/200% of Drive Rating	0.01A	115% of Drive Rating								
43	[Current Limit] Maximum output current allowed before current limiting occurs. Value set in percent of drive rated output current.	1/180% of Drive Rating	1%	150%								
44	[DC Hold Time] The time that P45 - [DC Hold Voltage] will be applied to the motor when P34 - [Stop Mode Select] is set to either "DC Injection Braking" or "Ramp to Stop."	0.0/25.0	0.1 Seconds	0.0 Seconds								
45	[DC Hold Voltage] DC Voltage level applied to the motor during braking when P34 - [Stop Mode Select] is set to either DC Injection Braking or Ramp to Stop mode. If the current exceeds P43 - [Current Limit] the voltage applied to the motor will be less than this setting.	0/115	1 Volt	0 Volts								

Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
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46	[Input Mode]	0/9	Numeric Value	0
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Configures the TB3 control inputs for various 3-wire or 2-wire control schemes. Also enables/disables the External Keypad input control. See Chapter 2 for wiring diagrams and descriptions of settings.

Important: The method used to activate PI control is dependent upon Firmware Version. Refer to 5-17 for PI Control Setup and Activation instructions.

Important: This parameter cannot be programmed while the drive is running. In addition, P56 - [Reset Function] must be set to 2 for the change to take effect.

- Settings:
- 0 = 3-wire control/F ❶
 - 1 = 2-wire control ❶
 - 2 = Communication Module control ❶
 - 3 = Momentary Run Forward/ Run Reverse control ❶
 - 4 = 2-wire Accel/Decel control
 - 5 = 2-wire Coast to Rest control ❶
 - 6 = 2-wire TB3 or Communication control
 - 7 = 2-wire Frequency Select control
 - 8 = 2-wire Preset control
 - 9 = 2-wire PI control
 - 10 = 3-wire control ❶
 - 11 = External Keypad control ❶

❶ A contact closure on TB3 Terminal 7 and 8 is required for the drive to respond to a Run command.

Program Group

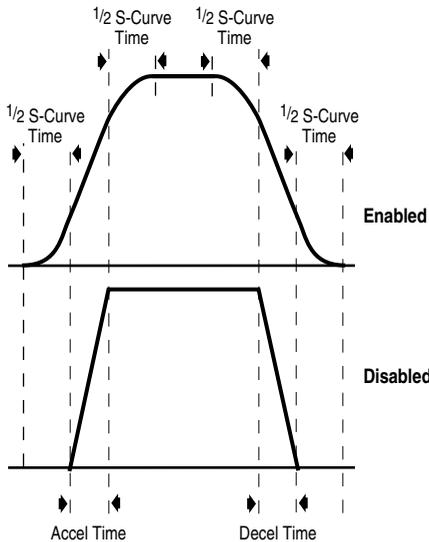
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default																								
47	[Output Configure] Configures the TB3 relay output functionality.	0/10	Numeric Value	0																								
	<table border="1"> <thead> <tr> <th>Setting</th> <th>Output Changes State When . . .</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Drive Ready/Faulted Energized and returns to shelf state when power is removed or a fault occurs.</td> </tr> <tr> <td>1</td> <td>At Frequency Drive reaches commanded frequency.</td> </tr> <tr> <td>2</td> <td>Motor Running The motor is receiving power from drive.</td> </tr> <tr> <td>3</td> <td>Reverse Drive is commanded to run in the reverse direction.</td> </tr> <tr> <td>4</td> <td>Motor Overload A motor overload condition exists.</td> </tr> <tr> <td>5</td> <td>Ramp Regulated The ramp regulator is modifying the programmed accel/ decel times to avoid an overcurrent or overvoltage fault from occurring.</td> </tr> <tr> <td>6</td> <td>Above Frequency The drive exceeds the frequency value set in P48 - [Output Threshold].</td> </tr> <tr> <td>7</td> <td>Above Current Drive exceeds the value set in P48 - [Output Threshold]. Important: Value for P48 - [Output Threshold] must be entered in percent of drive rated output current.</td> </tr> <tr> <td>8</td> <td>Above DC Bus Voltage Drive exceeds the DC bus voltage value set in P48 - [Output Threshold].</td> </tr> <tr> <td>9</td> <td>Retries Exhausted Number of retries for P50 - [Restart Tries] is exceeded.</td> </tr> <tr> <td>10</td> <td>Above Power Factor Angle Power Factor angle exceeds the value set in P48 - [Output Threshold].</td> </tr> </tbody> </table>	Setting	Output Changes State When . . .	0	Drive Ready/Faulted Energized and returns to shelf state when power is removed or a fault occurs.	1	At Frequency Drive reaches commanded frequency.	2	Motor Running The motor is receiving power from drive.	3	Reverse Drive is commanded to run in the reverse direction.	4	Motor Overload A motor overload condition exists.	5	Ramp Regulated The ramp regulator is modifying the programmed accel/ decel times to avoid an overcurrent or overvoltage fault from occurring.	6	Above Frequency The drive exceeds the frequency value set in P48 - [Output Threshold].	7	Above Current Drive exceeds the value set in P48 - [Output Threshold]. Important: Value for P48 - [Output Threshold] must be entered in percent of drive rated output current.	8	Above DC Bus Voltage Drive exceeds the DC bus voltage value set in P48 - [Output Threshold].	9	Retries Exhausted Number of retries for P50 - [Restart Tries] is exceeded.	10	Above Power Factor Angle Power Factor angle exceeds the value set in P48 - [Output Threshold].			
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48	[Output Threshold] Determines the on/off point for the TB3 output relay when P47 - [Output Configure] is set to 6, 7, 8, and 10. <table border="1"> <thead> <tr> <th>Setting</th> <th>Ranges</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>0 to 240 Hz</td> </tr> <tr> <td>7</td> <td>0 to 180%</td> </tr> <tr> <td>8</td> <td>0 to 815 Volts</td> </tr> <tr> <td>10</td> <td>0 to 180°</td> </tr> </tbody> </table>	Setting	Ranges	6	0 to 240 Hz	7	0 to 180%	8	0 to 815 Volts	10	0 to 180°	0/815	Numeric Value	0														
Setting	Ranges																											
6	0 to 240 Hz																											
7	0 to 180%																											
8	0 to 815 Volts																											
10	0 to 180°																											
49	[PWM Frequency] Carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting. NOTE: If a 160-RS1 module is installed to program, monitor and control the drive via PC set with drive running [PWM frequency] at 4.1 to 4.6 kHz. Ask your Rockwell Automation office if you need further assistance	2.0/8.0	0.1 kHz	4.0 kHz																								
	<table border="1"> <caption>Derating Guidelines Data</caption> <thead> <tr> <th>Carrier Frequency (kHz)</th> <th>% Output Current (A)</th> </tr> </thead> <tbody> <tr><td>2</td><td>100</td></tr> <tr><td>3</td><td>100</td></tr> <tr><td>4</td><td>100</td></tr> <tr><td>5</td><td>96</td></tr> <tr><td>6</td><td>92</td></tr> <tr><td>7</td><td>88</td></tr> <tr><td>8</td><td>84</td></tr> </tbody> </table>	Carrier Frequency (kHz)	% Output Current (A)	2	100	3	100	4	100	5	96	6	92	7	88	8	84											
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5	96																											
6	92																											
7	88																											
8	84																											
	Important: Ignoring derating guidelines can cause reduced drive performance.																											
50	[Restart Tries] Maximum number of times the drive will attempt to reset a fault. Faults 04 – 10, 12– 20 will automatically reset according to this parameter setting.	0/9	Numeric Value	0																								

Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
51	<p>[Restart Time] Time between restart attempts. If this parameter and P50 - [Restart Tries] are both set to zero, and P46 - [Input Mode] is not set to 3, the auto fault clear feature is enabled. This feature automatically clears overvoltage, undervoltage, and overtemperature faults 1 second after the fault condition is removed. If this parameter is set to zero and P50 - [Restart Tries] is not zero, then the time between restart attempts is 1 second.</p>	0.0/300.0	0.1 Seconds	10.0 Seconds

52	<p>[DB Enable] Enables/disables external dynamic braking. Setting "0" = Disable. Settings 1 through 100 = % duty cycle braking.</p> <p>⚠ ATTENTION: The 160 Dynamic Brake Module is rated for 5% duty cycle. Use of this package above 5% should not be used and voids the UL rating of this device. When setting this parameter to a value above 5% duty cycle, the resistor must be sized to avoid overheating of the resistor package.</p> <p>This parameter cannot be programmed while the drive is running.</p>	0/100	Numeric Value	0
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53	<p>[S-Curve] Enables a fixed shape S-Curve. See formula below: Formula: S-Curve Time = Accel or Decel Time x S-Curve Setting (in percent) ① ① See values below. Example: Accel Time = 10 Seconds S-Curve Setting = 3 S-Curve Time = 10 x 0.3 = 3 Seconds Important: Maximum S-Curve time is 60 seconds.</p>	0/10	Numeric Value	0
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S-Curve Setting	
0	= 0%
1	= 10%
2	= 20%
3	= 30%
4	= 40%
5	= 50%
6	= 60%
7	= 70%
8	= 80%
9	= 90%
10	= 100%

Program Group				
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
54	<p>[Clear Fault]</p> <p>Setting this parameter to a 1 performs a fault reset. When the fault reset function is complete, the value is automatically set back to 0.</p> <p>This parameter cannot be programmed while the drive is running.</p>	0/1	Numeric Value	0
55	<p>[Memory Probe Address]</p> <p>Used by Rockwell Automation field service personnel.</p>	Numeric Value	Numeric Value	Numeric Value
56	<p>[Reset Functions]</p> <p>Drive parameters and their associated defaults are reset according to the following descriptions:</p> <p>Settings:</p> <p>0 Idle State</p> <p>1 Reset defaults (restores all parameter settings to factory defaults).</p> <p>2 Update Input Mode (restores the drive to most recent programmed P46 - [Input Mode] setting).</p> <p>After the reset/update function is complete, this parameter will set itself back to a "0." This parameter cannot be programmed while the drive is running.</p> <p>Important: For setting 1 only, an F48 - Reprogram Fault will occur and must be cleared by cycling the Stop input to the drive. P46 - [Input Mode] factory defaults to 3-wire control. If using keypad control, change parameter setting back to a 11 to regain External Keypad control, use P56 Setting 2 again.</p>	0/2	Numeric Value	0
57	<p>[Program Lock]</p> <p>When set to 1, all parameters will be protected against change by unauthorized personnel.</p>	0/1	Numeric Value	0
58	<p>[Internal Frequency]</p> <p>When P59 - [Frequency Select] is set to a 1, this parameter will provide the drive frequency command. This parameter will change the frequency command in "Real time" using the up/down arrow keys. Maximum value is set in P33 - [Maximum Frequency].</p> <p>Important: Follow normal programming procedures. Once the desired command frequency is reached, the Enter key must be pressed to store this value to EEPROM memory. If the ESC key is used before the Enter key, the frequency will return to the original value following the normal accel/decel curve.</p>	0.0/240.0	0.1 Hz	60.0 Hz
59	<p>[Frequency Select]</p> <p>Selects the source of the frequency command for the drive.</p> <p>Settings: 0 = External frequency command from the Control Terminal Block (TB3)</p> <p>1 = Internal frequency command from P58 - [Internal Frequency].</p>	0/1	Numeric Value	0
60	<p>[Zero Offset]</p> <p>Used to add or subtract any system offset to the analog input. See P16 - [Analog Input] for additional information.</p> <p>Important: This parameter cannot be programmed while the drive is running.</p>	-50.0/+ 50.0	Numeric Value	0%

Program Group

No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
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[Preset Frequency 0, 1, 4 & 5] 0.0/240.0 0.1 Hz See Table
 The programmed value sets the frequency that the drive outputs when selected.

		(Input Mode 8)			
Preset Freq.	Default	TB3-8 (SW2)	TB3-2 (SW1)	Accel ⓐ	Decel ⓐ
61	Preset 0	3.0 Hz	0	0	P30 [Accel Time 1] P31 [Decel Time 1]
62	Preset 1	20.0 Hz	0	1	
65	Preset 4	45.0 Hz	1	0	P69 [Accel Time 2] P70 [Decel Time 2]
66	Preset 5	50.0 Hz	1	1	

ⓐ When using P46 - [Input Mode] setting 4, the Accel and Decel times are selected by providing an input to TB3-8..

69 [Accel Time 2] 0.0/600.0 0.1 Sec. 20.0 Seconds
 Time for the drive to ramp from 0.0 Hz to P33 - [Maximum Frequency]. The rate is linear for any increase in command frequency unless P53 - [S-Curve] is set to a value other than 0. Setting this to 0.0 gives 0.1 seconds acceleration with the initial current limit turned off. This allows quicker acceleration times for low inertia systems. For medium to high inertia systems, the minimum value should be 0.1.

70 [Decel Time 2] ⓐ/600.0 0.1 Sec. 20.0 Seconds
 Time for the drive to ramp from P33 - [Maximum Frequency] to 0.0 Hz. The rate is linear for any decrease in command frequency unless P53 - [S-Curve] is set to a value other than 0.
 ⓐ Minimum deceleration time must be set based on the applied motor size. To guard against premature drive failure, do not set P31 - [Decel Time 1] or P70 - [Decel Time 2] below the minimum value listed in the table below.

230 and 460V Motor Sizes	Minimum Deceleration Settings
4.0 kW (5 HP)	0.7 seconds
2.2 kW (3 HP)	0.6 seconds
1.5 kW (2 HP)	0.2 seconds
0.75 kW (1 HP)	0.1 seconds
0.55 kW (0.75 HP)	0.1 seconds
0.37 kW (0.5 HP)	0.1 seconds

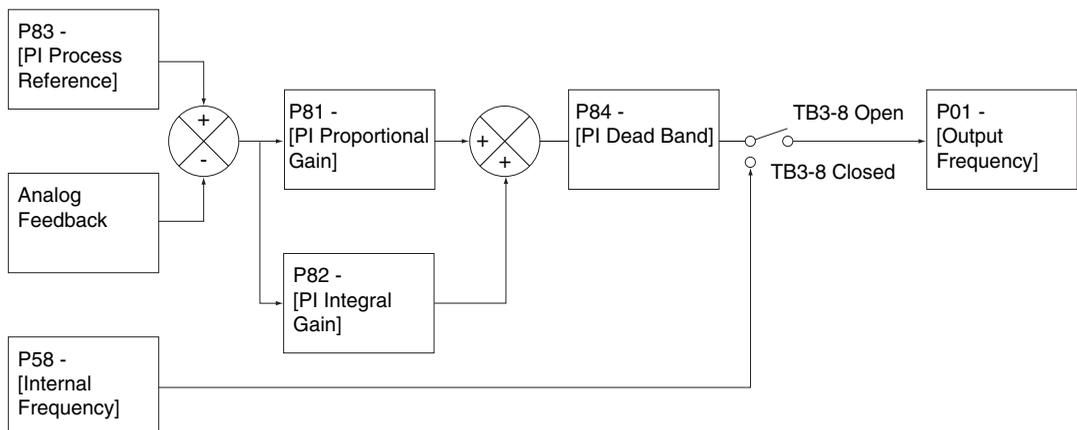
Program Group				
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
71	<p>[IR Compensation]</p> <p>The programmed value adds a voltage to the output based on the torque current. An additional 31 volts (150%) is added to 460 volt units to compensate for stator resistance. 15.5 volts (150%) is added for 230 volt units. If the drive trips on an F07 - Motor Overload fault, or has trouble accelerating to commanded speed, this value should be reduced. A setting of 0% disables this function.</p>	0/150	1%	50%
72	<p>[Slip Compensation]</p> <p>This parameter compensates for the inherent slip in an induction motor. A frequency is added to the commanded output frequency based on torque current. If motor shaft speed decreases significantly under heavy loads then this value should be increased. A setting of 0.0 Hz disables the function. This parameter along with P83 - [PI Process Reference] also activates PI control in drives using Firmware Version FRN 7.06. See page 5-17 for PI Control Setup and Activation instructions.</p> <p> ATTENTION: Hazard of personal injury or equipment damage exists due to unpredictable changes in motor speed. Do not use P72 - [Slip Compensation] and P83 - [Process Reference] to disable PI control while the drive is running. Disable PI control only when the drive is stopped.</p>	0.0/5.0	0.1 Hz	2.0 Hz
73	<p>[Reverse Disable]</p> <p>When this parameter is set to a 1, reverse is disabled. The reverse command may come from the analog input, TB3-5, the keypad or a serial command. With a negative analog input and reverse disabled, the frequency command will be zero in bipolar mode and minimum frequency in unipolar mode. All digital reverse inputs including two-wire Run Reverse will be ignored with reverse disabled.</p> <p>Important: This parameter cannot be programmed while the drive is running.</p>	0/1	Numeric value	0
74	<p>[Analog Select]</p> <p>Settings: 0 = unipolar analog input 0 to +10V 1 = bipolar analog input -10 to +10V</p> <p>Important: With this parameter set to bipolar (setting 1), the parameter settings for P75 - [Analog Input Minimum] and P32 - [Minimum Frequency] are ignored. In addition, all other reverse inputs (External keypad, TB3-5 control terminal block, or serial communication module) are ignored with the exception of when P46 - [Input Mode] is programmed to setting 7. (This applies to drives with firmware version FRN 7.03 and later.) When P46 - [Input Mode] setting 7 is active, and TB3-8 is closed, the frequency source is P58 - [Internal Frequency] and the direction will be commanded from the control terminal block (either terminal TB3-5 or TB3-6).</p> <p>Important: This parameter cannot be programmed while the drive is running.</p>	0/1	Numeric value	0

Program Group				
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
75	<p>[Analog Input Minimum]</p> <p>Important: Do not adjust this parameter until setting P60 - [Zero Offset]. Sets the percent of analog input used to represent P32 - [Minimum Frequency]. If the minimum analog input equals minimum frequency, no action is needed. If it is desired to adjust the analog input to equal P32 - [Minimum Frequency], use P16 - [Analog Input] to adjust the analog input to the desired level using P60 and then enter this value into P75. Analog inversion can be accomplished by setting this value larger than P76. Important: This parameter cannot be programmed while the drive is running.</p>	0.0/150.0	0.1%	0.0%
76	<p>[Analog Input Maximum]</p> <p>Important: Do not adjust this parameter until setting P60 - [Zero Offset]. Sets the percent of analog input used to represent P33 - [Maximum Frequency]. If the maximum analog input equals maximum frequency, no action is needed. If it is desired to adjust the analog input to equal P33 - [Maximum Frequency], use P16 - [Analog Input] to adjust the analog input to the desired level using P60 and then enter this value into P76. Analog inversion can be accomplished by setting this value smaller than P75. Important: This parameter cannot be programmed while the drive is running.</p>	0.0/150.0	0.1%	100.0%
78	<p>[Compensation]</p> <p>Settings:</p> <p>0 No compensation.</p> <p>1 Some drive/motor combinations have inherent instabilities which are exhibited as non-sinusoidal motor currents. This setting attempts to correct this condition.</p> <p>2 Some motor/load combinations have mechanical resonances which can be excited by the drive current regulator. This setting slows down the current regulator response and attempts to correct this condition.</p>	0 to 2	Numeric value	0
79	<p>[Software Current Trip]</p> <p>This provides a software instantaneous current trip similar to the 300% hardware current trip. This value is the percent above the P43 - [Current Limit] at which the drive trips immediately. A setting of zero disables the Software Current Trip.</p>	0/50%	1%	0%
80	<p>[Stall Fault Time]</p> <p>This selects the amount of time the drive must be in a stall condition before it causes a stall fault.</p> <p>0 = Normal stall time, approximately 60 seconds 1 = 2 times normal stall time 2 = 4 times normal stall time 3 = 6 times normal stall time 4 = 8 times normal stall time 5 = Stall fault disabled</p> <p> ATTENTION: Continuous operation at high currents caused by a stall can cause motor damage.</p>	0/5	Numeric Value	0

Program Group				
No.	Parameter Name/Description	Min./Max. Range	Units	Factory Default
81	<p>[PI Proportional Gain]</p> <p>Proportional gain used by the PI regulator. This parameter is scaled so that when it is set to 1.0, the process response is 1 Hz when the process error is 1%. The correct value for this parameter depends on the dynamics of the process being controlled, as well as the desired response. This parameter is active when P46 - [Input Mode] setting 9 is used.</p>	0/10.00	Numeric Value	0.01
82	<p>[PI Integral Gain]</p> <p>Integral Gain used by the PI regulator. This parameter is scaled so that when it is set to 1.0, the process response is 10 Hz/sec when the process error is 1%. The correct value for this parameter depends on the dynamics of the process being controlled, as well as the desired response. This parameter is active when P46 - [Input Mode] setting 9 is used.</p>	0/10.00	Numeric Value	0.01
83	<p>[PI Process Reference]</p> <p>The PI control will regulate to this set point value. It represents a percentage of the analog input. This parameter is active when P46 - [Input Mode] setting 9 is used. This parameter along with P72 - [Slip Compensation] also activates PI control in drives using Firmware Version FRN 7.06. See page 5-17 for PI Control Setup and Activation instructions.</p> <p>⚠ ATTENTION: Hazard of personal injury or equipment damage exists due to unpredictable changes in motor speed. Do not use P72 - [Slip Compensation] and P83 - [Process Reference] to disable PI control while the drive is running. Disable PI control only when the drive is stopped.</p>	0/100.0%	0.1%	0.0%
84	<p>[PI Dead Band]</p> <p>The PI control will ignore errors less than this value. This parameter is active when P46 - [Input Mode] setting 9 is used.</p>	0/10.0%	0.1%	0.0%

PI Control Block Diagram

Figure 5.1



PI Control Setup and Activation

This drive provides for closed loop process control (PI control) where PI regulator output is used to drive the process to a desired set point.

Wire For PI Control

1. Connect input and output power to the drive.
Follow the instructions provided in Section 2, *Installation and Wiring*.
2. Connect control wiring (see Chapter 2, Figure 2.17). A contact closure on terminals 6 and 7 is required for the drive to respond to a Start/Run command.
3. Select an external frequency command source. See Table 5.B.
4. Connect feedback device to TB3-2 and TB3-3 for 0 – 10V feedback or to TB3-3 and TB3-4 for 4 – 20 mA feedback.
5. Verify polarity of feedback. That is, increasing feedback signal requires increasing output frequency.

Program for PI Control

1. Set P56 - [Reset Functions] to 1 to reset the drive to defaults.
An F48 - Reprogram Fault will occur which must be cleared by cycling the Stop input to the drive.
2. Set P46 - [Input Mode] to the desired setting.
Table 5.B describes how to reference the external frequency command source for each P46 - [Input Mode] setting.

Parameter 46 Settings and Frequency Source Selection

Table 5.B

P46 Setting	Reference External Frequency Command Source
0	Set P59 - [Frequency Select] to 0 (Factory Default)
1	Set P59 - [Frequency Select] to 0 (Factory Default)
2	Set P59 - [Frequency Select] to 0 (Factory Default)
3	Set P59 - [Frequency Select] to 0 (Factory Default)
4	Set P59 - [Frequency Select] to 0 (Factory Default)
5	Set P59 - [Frequency Select] to 0 (Factory Default)
6	Set P59 - [Frequency Select] to 0 (Factory Default)
7	Open the contact at TB3-8
8	This setting is not used with PI control.
9	Open the contact at TB3-8
10	Set P59 - [Frequency Select] to 0 (Factory Default)
11	Set P59 - [Frequency Select] to 0 (Factory Default)

3. Set P56 - [Reset Functions] to 2 for the change made at Step 2 to take effect.
4. Set P72 - [Slip Compensation] to 0.

5. Use P75 - [Analog Input Minimum] and P76 - [Analog Input Maximum] to scale feedback to the process operating range. This may also be used to invert the feedback so that increasing feedback signal produces decreasing output frequency.
6. Set P83 - [PI Process Reference] to 20 as an initial setting.
This establishes the set point as 20% of the maximum analog input.
(This setting must be greater than zero to activate PI control in Firmware Version FRN 7.06 except when using input mode 9.)
7. Connect TB3-8 with TB3-7. This will disable PI control and force the output frequency to the P58 - [Internal Frequency] setting.
8. Connect TB3-6 with TB3-7 to start the drive. Verify motor operation and direction.
9. Remove the connection between TB3-8 from TB3-7. This will place the drive into PI control mode when using input modes 7 and 9.



ATTENTION: Hazard of personal injury or equipment damage exists due to unpredictable changes in motor speed. Do not use P72 - [Slip Compensation] and P83 - [Process Reference] to disable PI control while the drive is running. Disable PI control only when the drive is stopped.

Tune the PI Loop

Parameters P81 - [PI Proportional Gain] and P82 - [PI Integral Gain] are used to set how the drive will respond to errors (fluctuations) in feedback.

- P81 - [PI Proportional Gain] corrects output frequency based on the magnitude of the error.
 - P82 - [PI Integral Gain] corrects output frequency based on the length of time an error has been present.
1. Set P82 - [PI Integral Gain] to zero and P81 - [PI Proportional Gain] to some low value.
 2. Apply a step function command via P83 - [PI Process Reference] and monitor the output response.
 3. Increase P81 - [PI Proportional Gain] until the response of the output is acceptably fast or the output becomes too noisy.
 4. Reduce P81 - [PI Proportional Gain] back to the highest value at which the response is still clean.
 5. Set P82 - [PI Integral Gain] to a low value.
 6. Apply a step function command and monitor the output response.
 7. Increase P82 - [PI Integral Gain] until the response is acceptably fast without overshoot.

Important: If either the value of P81 or P82 is set too high, drive output will oscillate around the set point entered in P83 - [PI Process Reference] due to continually changing loads in the application. Use P84 - [Dead Band] to limit the effects of this oscillation by blocking a frequency count to either side of the set point frequency.

Common Problems with PI Control

1. Drive direction is incorrectly set for PI control.
Ensure that the drive is operating with the clockwise direction indicator illuminated.
2. Drive oscillates between 0 and 3 Hz.
 - Check direction and polarity of analog input signal.
 - Ensure that the drive is operating with the clockwise direction indicator illuminated.
 - Ensure the +10V DC wire is connected to TB3-2 and that the common is connected to TB3-3.
 - Check that parameters P81 - [PI Proportional Gain] and P82 - [PI Integral Gain] are set to a value other than 0.00.
3. Drive accelerates too quickly resulting in an F05 - Over Voltage Fault.
 - Lower P81 - [PI Proportional Gain] below its current value.
 - Lower P82 - [PI Integral Gain] below its current value.
 - Raise P31 - [Decel Time 1] above its current value.
 - Raise P30 - [Accel Time 1] above its current value.
 - Evaluate the need for a dynamic brake for the application.
4. Drive will only run off the internal frequency or does not control with the PI process loop.
 - Check that P46 - [Input Mode] is set to 9.
 - Ensure that power was cycled for one minute after changing the P46 setting.
 - Ensure that there is not a connection between TB3-7 and 8.
5. Nothing works properly.
 - Set P56 - [Reset Functions] to 1 and press the Enter key.
 - Press the Stop button to clear the F48 - Reprogram Fault.
 - Cycle power to the drive.
 - Confirm that wiring is correct.
 - Reapply power and program according to this procedure.
6. PI does not function with DeviceNet.

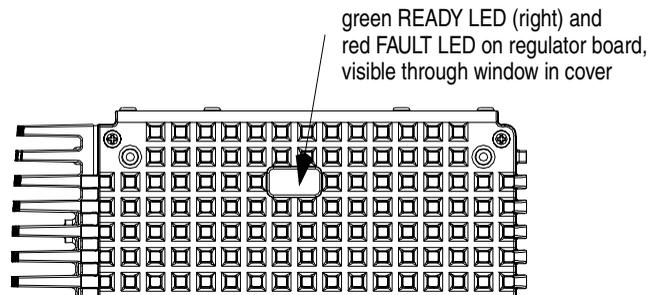
Troubleshooting

Fault Information

This chapter provides information to guide you in troubleshooting the drive. Included is a list and description of drive faults and problems that may occur.

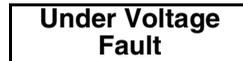
160Z Ready/Fault Indicating LEDs

Figure 6.1



Remote Keypad Module and CopyCat Keypad Fault Display

Figure 6.2



The Remote Keypad Module has a four character LED display which shows the fault codes and other messages.

The CopyCat Keypad has a 2-row by 16-column liquid crystal display (LCD) which shows the fault codes and other messages.

How to Clear a Fault

When a fault occurs, the cause must be corrected before the fault can be cleared. After corrective action has been taken, any of the following actions will clear the fault.

- Press the Remote Keypad or CopyCat Keypad Stop button, if input TB3-8 is closed.
- Disconnect power to the drive, wait one minute, reapply power.
- Cycle the input signal at TB3-8 to the drive.
- Set P54 - [Clear Fault] to 1.

Bulletin 160 Fault Descriptions

Table 6.A

Fault No.	Fault Name	Fault Description	Corrective Action
03	Power Loss Fault	The DC Bus voltage remains below 85% nominal on power up for longer than 5 seconds.	Monitor the incoming AC line for low voltage or line power interruptions.
04❶	UnderVoltage Fault	The DC Bus voltage fell below the minimum rated voltage. For 200-240VAC input drives, the undervoltage trip occurs at a bus voltage of 210VDC (equivalent to a 150VAC incoming line voltage). For 380-480VAC rated drives, the undervoltage trip occurs at a bus voltage of 390VDC (equivalent to 275VAC)	Monitor the incoming AC line for low voltage or line power interruptions.
05❶	OverVoltage Fault	The max. DC Bus voltage has been exceeded. For 240VAC input drives, the overvoltage trip occurs at a bus voltage of 400VDC (equivalent to a 290VAC). For 380-480VAC input drives, the overvoltage trip occurs at a bus voltage of 800VDC (equivalent to a 575VAC).	Motor regeneration has caused a bus overvoltage. Monitor the incoming AC line for excessive voltage. Extend the decel time or install a dynamic brake module (See Appendix A).
06❶	Motor Stall Fault	The motor has stalled due to an excessive motor load.	A longer acceleration time or a reduced load is required.
07❶	Motor Overload Fault	An internal electronic overload trip has occurred. An excessive motor load exists.	Reduce the motor load until the drive output current does not exceed the current set by P42 - [Motor Overload Current]. Reduce P38 - [Boost Select].
08❶	Over Temperature Fault	Excessive heat has been detected.	Clear blocked or dirty heat sink fins. Check ambient temperature. Check for a blocked or non-operating fan.
11	Operator Fault	- P46 was set to 0 or 11 and the external keypad has been disconnected while the drive is powered. - Netw. communication PD1,IB1 is interrupted. - Program Keypad 160-P1 is connected.	Connect the external keypad and clear the fault. Make connection. Remove the Program Keypad 160-P1.
12❶	Overcurrent Fault	An overcurrent has been detected in the hardware trip circuit.	Check for a short circuit at the drive output or for excessive load conditions at the motor.
13❶	Software Over Current Fault	Motor current exceeded value set in parameter 79.	A longer acceleration time, reduced load, or removal of motor shaft blockage is required.
20❶	Drive Overload Fault	An internal electronic overload trip has occurred. The drive is over heating.	Clear blocked or dirty heat sink fins. Check ambient temperature. Check for blocked or non-operating fan. Reduce motor load current.
32	EEPROM Fault	The EEPROM has invalid data.	Reset EEPROM using P56 - [Reset Functions] — Set to 1 and cycle power.
33	Max Retries Fault	The drive failed to reset within the number of retries set in P50 - [Restart Tries].	Repair the system fault.
36	Incompatible Fault	Incompatible communication module installed.	Verify compatibility of communication module.
38	Phase U Fault	A phase to ground fault has been detected between the drive and the motor in phase U.	Check the wiring between the drive and the motor. Check the motor for a grounded phase. Check that ground is not connected to U.
39	Phase V Fault	A phase to ground fault has been detected between the drive and the motor in phase V.	Check the wiring between the drive and the motor. Check the motor for a grounded phase.
40	Phase W Fault	A phase to ground fault has been detected between the drive and the motor in phase W.	Check the wiring between the drive and the motor. Check the motor for a grounded phase.
41	UV Short Fault	Excessive current has been detected between these two drive output terminals.	Check the motor and wiring to the drive output terminals for a shorted condition.
42	UW Short Fault	Excessive current has been detected between these two drive output terminals.	Check the motor and wiring to the drive output terminals for a shorted condition.
43	VW Short Fault	Excessive current has been detected between these two drive output terminals.	Check the motor and wiring to the drive output terminals for a shorted condition.
46	Intermittent Phase Fault	A short occurred while running diagnostics.	Check wiring between the drive and the motor. Check for more than one shorted output.
48	Reprogram Fault	Occurs when the drive parameters are reset to default.	Clear the fault.

❶ These faults have an auto reset feature. This feature automatically clears overvoltage, undervoltage, and overtemperature faults 1 second after the fault condition is removed. Refer to P51 - [Restart Time].

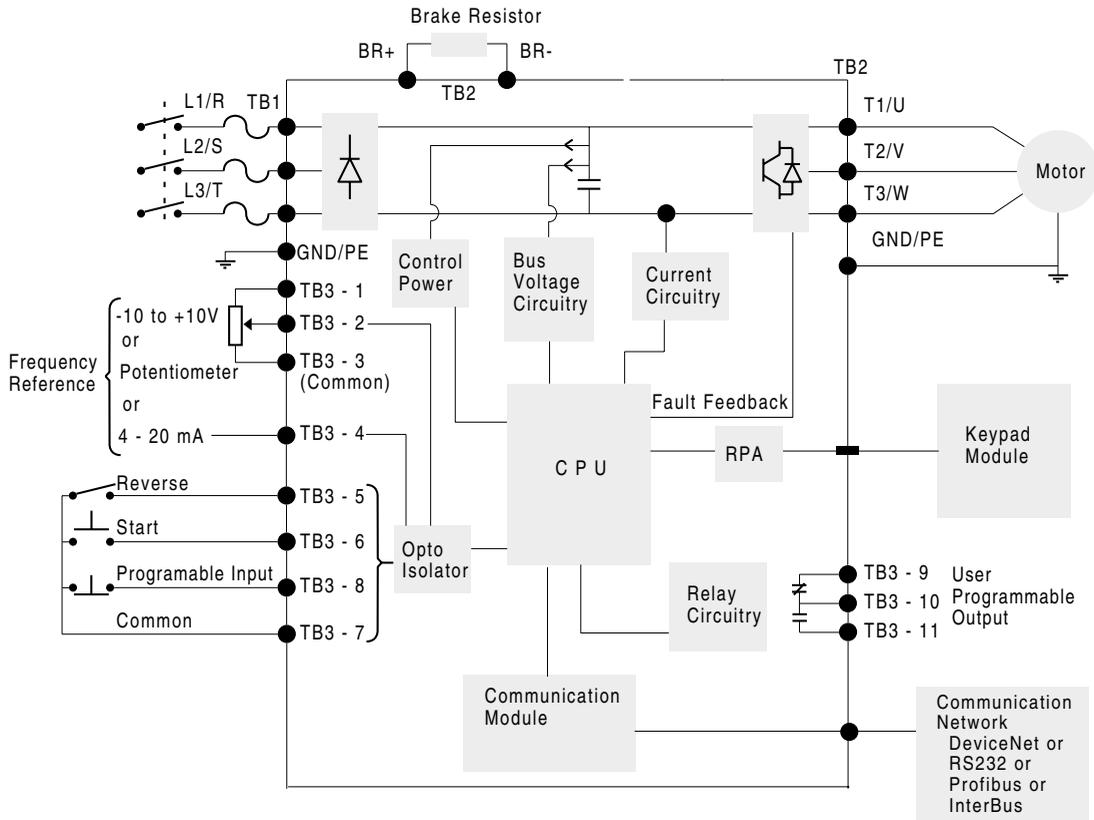
Possible Problems and Corrective Actions

Table 6.B

Problem	Corrective Action
The motor does not start — No output voltage to the motor.	<ol style="list-style-type: none"> 1. Check the power circuit. <ul style="list-style-type: none"> • Check the supply voltage. • Check all fuses and disconnects. 2. Check the motor. <ul style="list-style-type: none"> • Verify that the motor is connected properly. 3. Check the control input signals. <ul style="list-style-type: none"> • Verify that the Start signal is present. • Verify that the contact closure signal is present at TB3-8. • Verify that either the Run Forward or Run Reverse signal is active, but not both. 4. Check P46 - [Input Mode]. <ul style="list-style-type: none"> • If P46 - [Input Mode] is set to 2, only the Remote or Copycat Keypad module Start button will start the motor. 5. Use P56 - [Reset Functions] if you changed P46 - [Input Mode].
The drive is started but the motor is not rotating. P01 - [Output Frequency] displays 0.0.	<ol style="list-style-type: none"> 1. Check the motor. <ul style="list-style-type: none"> • Verify that the motor is connected properly. 2. Check the frequency source P06 - [Frequency Command]. <ul style="list-style-type: none"> • Verify that a frequency signal is present at terminal block TB3 — Either a -10 to +10V signal or a 4-20 mA signal. • Verify that the Preset Frequencies are set properly. 3. Check the control input signals. <ul style="list-style-type: none"> • Verify that SW1, SW2 and SW3 are correct. (Refer to the chart in Chapter 5.) 4. Check the following parameter settings. <ul style="list-style-type: none"> • Verify that P59 - [Frequency Select] is showing the desired frequency source. • Verify that P58 - [Internal Frequency] is set to the desired frequency. 5. Use P56 - [Reset Functions] if you changed P46 - [Input Mode].
The motor is not accelerating properly.	<ol style="list-style-type: none"> 1. Check the motor. <ul style="list-style-type: none"> • Verify that the motor is connected properly. • Verify that no mechanical problems exist. 2. Check the following parameter settings. <ul style="list-style-type: none"> • Verify that P30 - [Accel Time 1] or P69 - [Accel Time 2] — whichever is currently used — is set properly. • Verify that P43 - [Current Limit] is set properly. • Verify that P38 - [Boost Volts] is set properly.
Drive will not operate in the run/forward or run reverse modes.	<ol style="list-style-type: none"> 1. Verify that P46 - [Input Mode] is set to 1. 2. Verify that neither P73 - [Reverse Disable] nor P74 - [Analog Select] is set to 1. 3. Verify that the power has been cycled for 1 and 2 to take effect. 4. Verify that both the Run Forward and Run Reverse switches are not closed simultaneously. 5. Use P56 - [Reset Functions] if you changed P46 - [Input Mode].
Display is dark.	<ol style="list-style-type: none"> 1. Verify that the external keypad is firmly connected. 2. Remove external keypad and inspect connector pins. If pins are not damaged, reconnect the keypad.

Block Diagram of the 160Z Drive

Figure 6.3



Specifications

Tables A.1 and A.2 contain information that is unique to each 160Z Drive rating. Table A.3 contains information that applies to all drive ratings.

200-240VAC – 3-Phase Input Drive Ratings

Table A.1

Drive Catalog Number (first 9 digits)						
3-Phase Input	160Z-AA02	160Z-AA03	160Z-AA04	160Z-AA08	160Z-AA12	
Output Ratings						
Drive mounted on:	Motor or Wall				Motor	Wall
3-Phase Motor Rating — kW (HP)	0.37 (1/2)	0.55 (3/4)	0.75 (1)	1.5 (2)	2.2 (3)	2.2 (3)
Maximum Output Amps	2.3	3.0	4.5	7.3	9.0	7.8
Power Dissipation — Watts	20	25	35	74	107	107
Input Ratings						
Input Voltage, Frequency	200/240VAC, 3-Phase, 50/60 Hz					
Operational Input Voltage Range	180-265VAC					
Input kVA	1.1	1.4	2.2	3.5	4.3	3.7
3-Phase Input Current ^①	2.8	3.6	5.4	8.8	10.8	9.4
Dynamic Braking Torque ^②						
With External Dynamic Brake Module	200%	200%	200%	150%	115%	115%
Without External Dynamic Brake Module	100%	100%	100%	50%	50%	50%

380-480VAC – 3-Phase Input Drive Ratings

Table A.2

Drive Catalog Number (first 9 digits)								
3-Phase Input	160Z-BA01	160Z-BA02	160Z-BA03	160Z-BA04	160Z-BA06	160Z-BA10		
Series	C	C	C	C	C	C and D	D	
Output Ratings								
Drive mounted on:	Motor or Wall					Motor		Wall
						IEC 400V	NEMA 460V	
3-Phase Motor Rating — kW (HP)	0.37 (1/2)	0.55 (3/4)	0.75 (1)	1.5 (2)	2.2 (3)	3.7 kW	5 HP	3.7 (5)
Maximum Output Amps	1.2	1.7	2.3	4.0	5.1	8.0	7.0	8.0
Power Dissipation — Watts	25	30	37	50	77	120	120	120
Input Ratings								
Input Voltage, Frequency	380/480VAC, 3-Phase, 50/60 Hz							
Operational Input Voltage Range	340-528VAC							
Input kVA	1.1	1.6	2.2	3.7	4.9	7.6	6.7	7.6
Input Current ^①	1.4	2.0	2.8	4.6	6.1	9.5	8.4	9.5
Dynamic Braking Torque ^②								
With External Dynamic Brake Module	200%	200%	200%	150%	115%	100%	100%	100%
Without External Dynamic Brake Module	100%	100%	100%	50%	50%	20%	20%	20%

^① Input current ratings are calculated based on a nominal input voltage of 230V and 460V respectively.

^② Estimated – Actual value depends upon motor characteristics.

All Drive Ratings

Table A.3

Input/Output Ratings	
Output Voltage	Adjustable from 0 to Input Voltage
Output Frequency	Programmable from 0 to 240 Hz
Efficiency	97.5% Typical
Transient Protection	Standard 6 kV
Environmental Specifications	
Enclosure	IP65, NEMA Type 4X
Ambient Temperature	0°C to 40°C
Storage Temperature	-40°C to 85°C
Relative Humidity	0% to 95%, Non-Condensing
Vibration	1.0 G Operational — 2.5 G Non-Operational
Shock	15 G Operational — 30 G Non-Operational
Altitude	1,000 m (3,300 ft) without Derating for the Output Current. (Above 1000 m the Derating is 1% per 100 m.)
Approvals and Standards Compliance	
Approvals	UL and cUL Listed to UL508C and CAN/CSA-C2.2
	
	LV Directive 73/23/EEC: EN50178, EN60204-1 EMC Directive 89/336/EEC: EN61800-3: 1996
Designed to Meet These Standards	IEC 146-1-1, EN61000-6-2, EN61000-6-4
Control Inputs	
Control Input Type	Dry Contact Inputs — Drive has an internal 12V power supply that provides 10 mA typical current flow. 24V Inputs — 24V DC interface on Regulator Board (selectable through Jumpers) allows use of 24VDC sinking inputs.
Start, Stop, Fwd/Rev	Configurable Inputs for Two- or Three-Wire Control
Programmable Input	TB3-8 Can Be Configured to Select: <ul style="list-style-type: none"> • Accel/Decel Times • External Coast to Rest • TB3 Control/Keypad or Communication Control • Frequency Select • Preset Speed
SW1, SW2	Configurable Inputs for Control of 4 Preset Speeds and 2 Accel/Decel Times
External Speed Potentiometer	1k to 10k Ohms, 2 Watts Minimum
4 – 20mA Analog Input	250 Ohms Input Impedance
-10 to +10VDC Analog Input	100k Ohms Input Impedance
Control Output	
Programmable Output (Form C Relay Contact)	Resistive Rating: 0.4A at 125VAC — 0.2A at 230VAC — 2A at 30VDC Inductive Rating: 0.2A at 125VAC — 0.1A at 230VAC — 1A at 30VDC

Control Features	
PWM Algorithm	Sine Weighted PWM with Harmonic Compensation
Switching Device	IGBT
V/Hz Ratio	Programmable
Carrier Frequency	Adjustable from 2 to 8kHz in 100 Hz Increments (Factory Default is 4kHz)
DC Boost	Adjustable — Select from a Family of Boost Curves
Current Limiting	Software Controlled, Coordinated for Drive and Motor Protection — Programmable from 1 to 180% of Drive Output Current
Motor Protection	I^2t Overload Protection — 150% for 60 Seconds, 200% for 30 Seconds
Overload Pattern #0	Flat Response Over Speed Range (No Speed Compensation)
Overload Pattern #1	Speed Compensation Below 25% of Base Speed
Overload Pattern #2	Speed Compensation Below 100% of Base Speed
Accel/Decel Time(s)	0.1 to 600 Seconds
S-Curve Accel/Decel Time(s)	0 to 100% of Accel/Decel Time — Not to Exceed 60 Seconds
Stopping Modes	4 Programmable Modes: Ramp to Stop — 0.1 to 600 Seconds Coast to Stop — Stops All PWM Output DC Injection Braking — Applies DC Voltage to the Motor for 0 to 25 Seconds DC Injection Braking with Auto Stop

Protective Features	
Overcurrent	Programmable limit, 200% of Hardware Limit, 300% of Instantaneous Fault
Excessive Temperature	Embedded Temperature Sensor Trips if Heatsink Temperature Exceeds 95°C
Over/Under Voltage	DC bus voltage is monitored for safe operation. <ul style="list-style-type: none"> • For 200-240VAC input drives, the overvoltage trip occurs at a bus voltage of 400VDC (equivalent to a 290VAC incoming line voltage). • For 380-480VAC input drives, the overvoltage trip occurs at a bus voltage of 800VDC (equivalent to a 575VAC incoming line voltage). • For 200-240VAC input drives, the undervoltage trip occurs at a bus voltage of 210VDC (equivalent to a 150VAC incoming line voltage). • For 380-480VAC input drives, the undervoltage trip occurs at a bus voltage of 390VDC (equivalent to a 275VAC incoming line voltage).
Control Ride Through	Minimum Ride Through is 0.5 Seconds — Typical Value is 2 Seconds
Ground Short	Any Output Phase to Ground Short
Faultless Ride Through	100 Milliseconds
Output Short Circuit	Any Output Phase to Phase Short

Programming	
Programmer	Optional — External Keypad Module
Display Type	4-digit, 7-segment LED display (Remote Keypad) or 2-row by 16-column liquid crystal display (LCD) (CopyCat Keypad)
Keypad Controls	Speed, Run, Stop and Direction

End of Chapter

Accessories and Dimensions

Accessories for All Drive Ratings

Table B.1

Drive Ratings			Dynamic Braking Resistor Kit		3% Line Reactor Open Style	Fan Replacement Kit ❶
Input Voltage	KW	HP	Catalog No. / (ohm)		Catalog No. ❷	Catalog No.
200-240VAC 50/60 Hz 3-Phase	0.37	1/2	160Z-BMA1	188	1321-3R4-B	160Z-FRK
	0.55 / 0.75	3/4, 1	160Z-BMA1	188	1321-3R4-A	160Z-FRK
	1.5	2	160Z-BMA2	94	1321-3R8-A	160Z-FRK
	2.2	3	160Z-BMA2	94	1321-3R12-A	160Z-FRK
380-480VAC 50/60 Hz 3-Phase	0.37	1/2	160Z-BMB1	755	1321-3R2-B	160Z-FRK
	0.5 / 0.75	3/4, 1	160Z-BMB1	755	1321-3R2-A	160Z-FRK
	1.5	2	160Z-BMB2	377	1321-3R4-B	160Z-FRK
	2.2	3	160Z-BMB2	377	1321-3R8-B	160Z-FRK
	3.7	5	160Z-BMB3	180	1321-3R18-B	160Z-FRK
Communication			Module Catalog No.	Adapter Kit ❸ Catalog No.	Gland Plate, 5 holes Catalog No.	
DeviceNet			160-DN2	—	—	
RS-232			160-RS1	160Z-RTB	—	
Profibus ❹			160-PD1	160Z-PTB	—	
InterBus ❹			160-IB1	160Z-ITB (3 pieces)		160Z-ISM
Motor Adapter Plate for			Range 1	Catalog No.	Range 2	Catalog No.
A-B	1329RS	NEMA motor	1 - 2 HP	160Z-ABN1	3 - 5 HP	160Z-ABN2
Reliance	XEX	NEMA motor	0.5 - 2 HP	160Z-REX1	3 - 5 HP	160Z-REX2
SEW	D-Type	IEC motor	0.37 - 1.5 kW	160Z-SEW1	2.2 kW	160Z-SEW2
					3.7 kW ❺	160Z-SEW3
WEG	Multivoltage	IEC motor	0.37 - 2.2 kW	160Z-WEG1	3.7 kW	160Z-WEG2
SICME	AM-Type	IEC motor	0.75 - 2.2 kW	160Z-SIC3		
ABB	AM4-Type	IEC motor	0.75 - 2.2 kW	160Z-ABB3		
Other motors (no holes) ❺				160Z-BLK		
Quick Disconnect Kit			16-pole	160Z-QD	32-pole for IB1	160Z-QDC
Wall Mounting Adapter			0.37 - 3.7 kW	160Z-WMA or 160Z-WMK (with plate)		
Programming			Catalog No.			
Remote Keypad Module			160-P2			
CopyCat Keypad			160-P3			
Keypad Cable locking each end			160Z-C10 (1 m),	160Z-C30 (3 m),	160Z-C50 (5 m)	
Mechanical Accessories						
Gland M25			160Z-G25	for AC Input cable		
Gland M16 (EMC type)			160Z-G16	for signal and DB-resistor cables		
Gland M20 (EMC type)			160Z-G20	for motor cable on wall mounted drives		
Top Mounting Set			160Z-MAX	for DeviceNet MaXum Card		
Debris Cover			160Z-DC/-DCW	for motor / wall mounted drives		
Gasket Set			160Z-GSK	Set of spare gaskets		

- ❶ The MTBF for the fan is 50,000 hours at 40°C drive ambient.
- ❷ Catalog numbers listed are for 3% impedance open style units. NEMA Type 1 and 5% impedance reactor types are also available. Refer to publication 1321-2.0 for detailed information.
- ❸ The Adapter Kit contains 1 or 2 printed circuit boards with terminal block, which is linked to the D-shell connector.
- ❹ Only use modules with software version 1.3 or higher with the 160Z Drive.
- ❺ The customer is responsible for insuring mechanical and thermal compatibility when using the 160Z-BLK. It is recommended that you contact Rockwell Automation for qualifying motors not on the list.
- ❻ Maximum continuous output for 3.7 kW only at 2kHz carrier frequency (parameter 49). Max. contin. output at 4kHz is 3.0 kW.

Drive Dimensions

Wall Mounted Drive

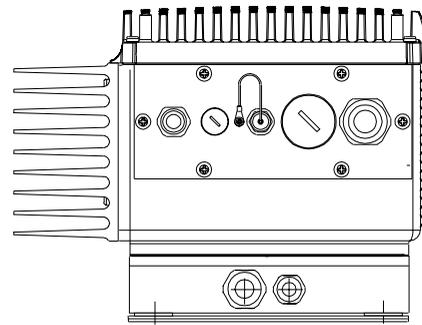
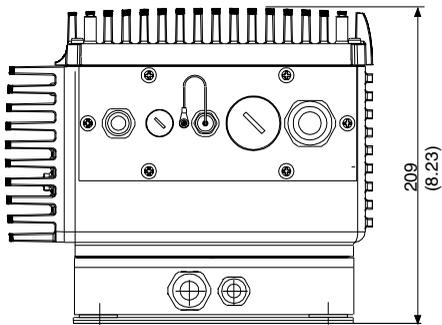
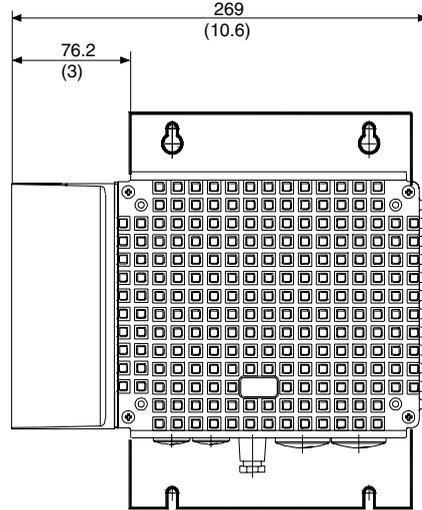
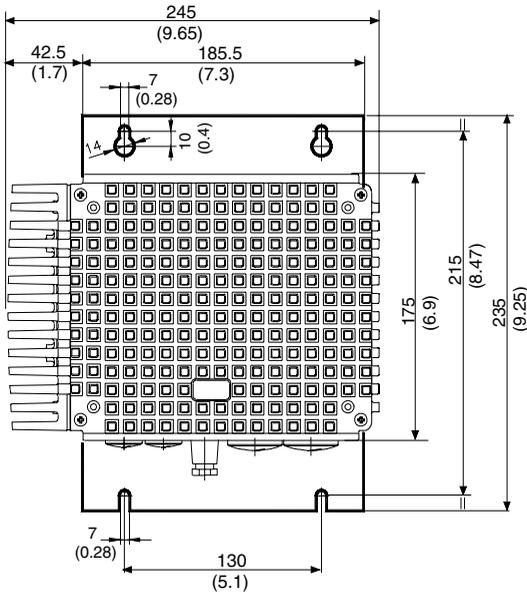
All dimensions are millimeters and (inches).

Wall Mounted Drive Dimensions

Figure B.1

Series C

Series D



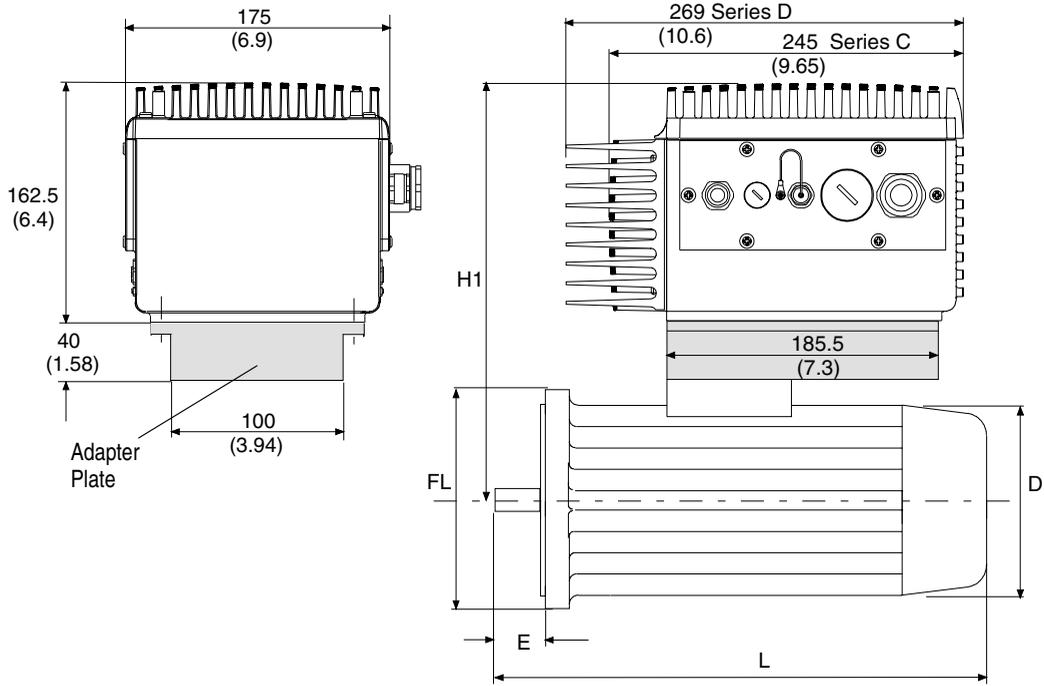
Weight including adapter: 5.2 kg (10.5 pounds)

Motor Mounted Drive

All dimensions are in millimeters and (inches), all weights are in kilograms and (pounds).

Motor Mounted Drive Dimensions

Figure B.2



Drive Dimensions

Table B.2

Motor Mounted Drive with Adapter								
	Catalog No.	Motor Type	Motor Power	H1	L	FL	D	E
Assembly	160Z-.....A	1329RS	0.5 - 1 HP	300 (11.8)	297 (11.7)	167 (6.57)	207 (8.14)	54 (2.12)
	Adapter 160Z-ABN1		1.5 / 2 HP	300 (11.8)	356 (14.0)	167 (6.57)	207 (8.14)	54 (2.12)
	Adapter 160Z-REX1	XEX						
Assembly	160Z-.....A	1329RS	3 / 5 HP	334 (13.2)	435 (17.1)	225 (8.86)	238 (9.4)	66 (2.6)
	Adapter 160Z-ABN2							
	Adapter 160Z-REX2	XEX						
	Adapter 160Z-SEW1	DFT/DT/DT..F 90	0.37-1.5 kW	277 (10.9)	323 (12.7)	200 (7.87)	< FL	50 (1.97)
	Adapter 160Z-SEW2	DFV/DV..F 100M	2.2 kW	324 (12.75)	371 (14.6)	250 (9.84)	< FL	60 (2.36)
	Adapter 160Z-SEW3	DFV/DV..F 112M	4.0 kW	324 (12.75)	409 (16.1)	250 (9.84)	< FL	60 (2.36)
Assembly	160Z-.....C	Multivoltage 71	0.37 kW	272 (10.7)	248 (9.8)	160 (6.3)	< FL	30 (1.18)
	Adapter 160Z-WEG1	Multivoltage 80	0.55/ 0.75 kW	281 (11.1)	276 (10.9)	200 (7.87)	< FL	40 (1.57)
		Multivoltage 90L	1.5 kW	301 (11.85)	329 (12.95)	200 (7.87)	< FL	50 (1.97)
		Multivoltage 100L	2.2 kW	303 (11.9)	376 (14.8)	250 (9.84)	< FL	60 (2.36)
Assembly	160Z-.....C	Multivoltage 112M	4.0 kW	315 (12.4)	393 (15.5)	250 (9.84)	< FL	60 (2.36)
	Adapter 160Z-WEG2							
	Adapter 160Z-SIC3 and 160Z-ABB3	AM 80	0.75 kW	280 (11)	265 (10.4)	200 (7.87)	< FL	40 (1.57)
		AM 90L	1.1 kW	292 (11.5)	328 (13)	200 (7.87)	< FL	50 (1.97)
		AM 100L	2.2 kW	306 (12)	358 (14)	250 (9.84)	< FL	60 (2.36)

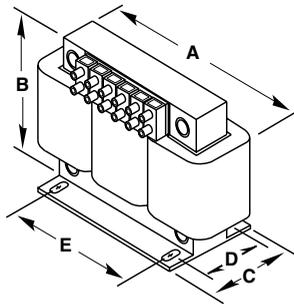
Weight 160Z Drive with Adapter Plate: 5.2 kg (10.5 pounds)

Accessory Dimension

All dimensions are in millimeters and (inches). Dimensions are not used for manufacturing purposes.

Bulletin 1321 Line Reactors

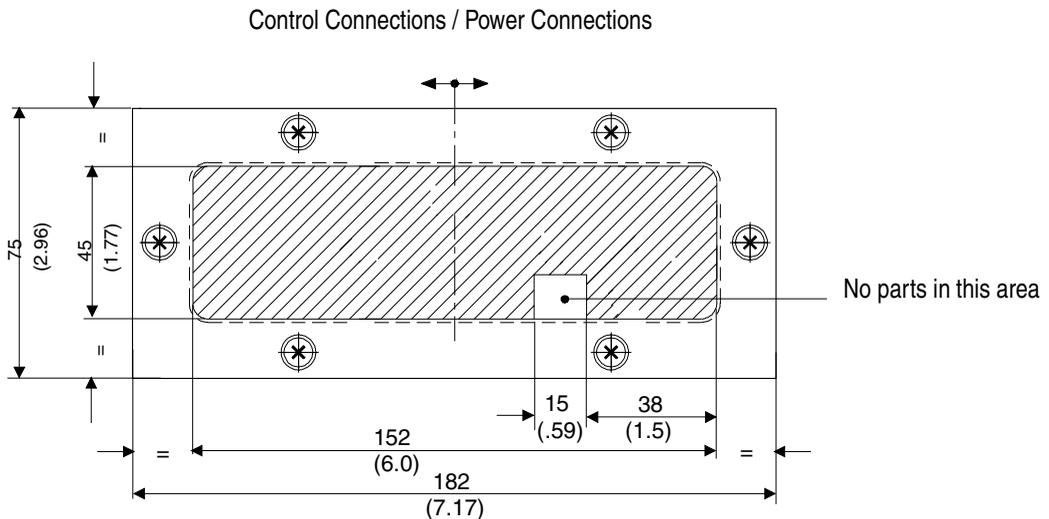
Figure B.3



Catalog No.	A	B	C	D	E
1321-3R2-A	112 (4.4)	104 (4.1)	74 (2.9)	50 (2.0)	37 (1.44)
1321-3R2-B	112 (4.4)	104 (4.1)	74 (2.9)	50 (2.0)	37 (1.44)
1321-3R4-A	112 (4.4)	104 (4.1)	76 (3.0)	50 (2.0)	37 (1.44)
1321-3R4-B	112 (4.4)	104 (4.1)	76 (3.0)	50 (2.0)	37 (1.44)
1321-3R8-A	152 (6.0)	127 (5.0)	76 (3.0)	53 (2.1)	51 (2.0)
1321-3R8-B	152 (6.0)	127 (5.0)	76 (3.0)	53 (2.1)	51 (2.0)
1321-3R12-A	152 (6.0)	127 (5.0)	76 (3.0)	53 (2.1)	51 (2.0)
1321-3R18-A	152 (6.0)	133 (5.3)	79 (3.1)	51 (2.0)	51 (2.0)

Cable Entry Plate Dimensions in mm (inch)

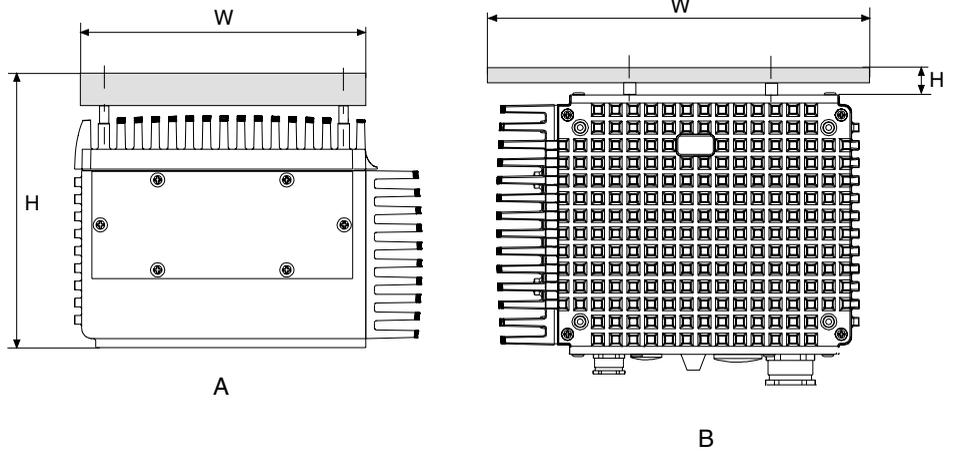
Figure B.4



Dashed area is available for customer specific mounting of cable glands or connectors. The depth of these parts from outside must not exceed 20mm.

Accessories Mounted on the Inverter

Figure B.5



Catalog No.	Accessory	H	W	View
160Z-BMxx	Dynamic Braking Resistor Kit	206.5 (8.1)	200 (7.9)	A
160Z-MAX	Top Mounting Set for DeviceNet MaXum Card	228 (9.0)	200 (7.9)	A
160Z-DC	Debris Cover for motor mounted drives	182 (7.2)	255 (10.5)	A
160Z-DCW	Debris Cover for wall mounted drives	25 (1.0)	255 (10.0)	B

End of Chapter

CE Conformity

CE Compliance

This drive is a component intended for implementation in machines or systems for the industrial environment. It is CE marked and conforms to both the Low Voltage (LV) Directive 73/23/EEC and the Electromagnetic Compatibility (EMC) Directive 89/336/EEC. Compliance with the LV Directive has been demonstrated using the standards EN50178 and applicable clauses of EN60204-1. Compliance with the EMC Directive has been demonstrated using the standard EN61800-3 and the associated A11 Amendment. All EMC emissions tests were conducted with a PWM frequency (Parameter 49) of 4.0 kHz.

The 160Z drive satisfies EMC emission limits for the Second Environment and is not intended to be used on a public network which supplies domestic premises because it may cause radio frequency interference if used on such a network.

Important: The conformity of the drive and filter to any standard does not guarantee that the entire installation will conform. Many other factors can influence the total installation and only direct measurements can verify total conformity. It is therefore the responsibility of the machine manufacturer, to ensure, that the conformity is met.

A copy of the Declaration of Conformity (DOC) is available from your local Rockwell Automation Sales Office.

Harmonic Emissions

Electronic converters such as the 160Z Drive can cause conducted low frequency disturbances (harmonic emissions) to the supply network. The magnitude of harmonic emissions produced by the 160Z depend upon the network impedance at the point where the drive is connected to the network, and may be mitigated if necessary using a line inductor in series with the power input to the drive. Currently, there are no mandatory harmonic emission limits related to CE compliance for equipment connected to private power networks. Upon request, Rockwell Automation can provide information regarding harmonic emissions from the 160Z.

Essential Requirements for a Conforming EMC Installation

The following items are required for CE Conformance:

1. A 160Z Drive version for 400-480V with built-in EMC line input filter must be selected to reduce conducted high frequency emissions. (See Table A.2). These units have been tested with a maximum motor cable length of 10m (33ft).
2. As the 160Z drive is mounted in a shielded enclosure radiated emissions are reduced to permitted levels. This also applies to brake resistor assemblies (NEMA Type 4X, IP65) mounted on top of the drive.
3. Grounding of equipment and cable shields must be solid, with low impedance connections and all wiring, except input power leads, must be shielded cable.
4. All cables, except input power leads, entering the enclosure must have suitable shielded EMC cable glands (spring type contact for signal cables).
5. Input power, communication and control wiring inside the enclosure must be physically separated and wires do not touch the heatsink.

General Instructions for an EMC Compliant Installation

Shielded Enclosure

- The metal enclosure of the 160Z Drive is electromagnetically shielded, because the protection degree is NEMA Type 4X / IP65 and its removable parts (cover, adapter, motor terminal box) are connected with good conductivity.

Grounding

The following ground wires must be solidly connected:

1. AC line input ground conductor(s) to the PE terminal(s) of the drive.
 2. Ground connection between the 160Z enclosure and the adapter plates ground terminal. A yellow/green cable is provided (at the bottom, next to TB2).
 3. Motor cable ground conductor to the adapter plates ground terminal (on wall mounted drives only).
- Good conductivity must be assured – grounding must provide a low impedance path for high frequency signals.

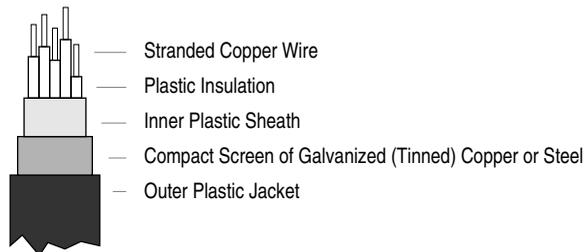
Cable Glands

- Use suitable EMC cable glands only (spring type contact for signal cables).
- The connection area must be 360 degrees around the shielded cable.
- The cable glands also provide strain-relief for the cable.

Shielded Cable

Shielded Cable Example

Figure C.1



Motor Cable (for Wall Mounted Drives)

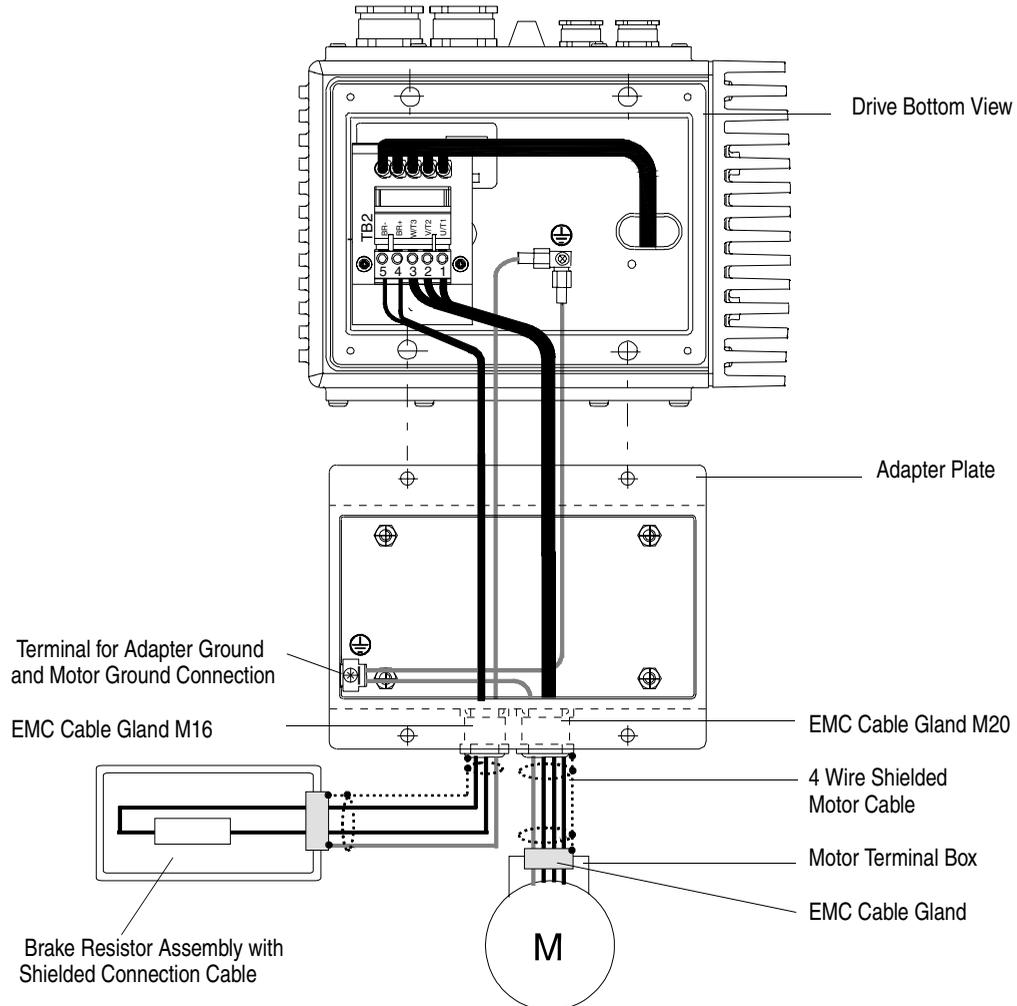
- The cable between the drive and motor must be a 4-wire shielded cable (three phases and ground).
- Do not exceed the maximum motor cable length of 10 meters.
- The motor cable ground conductor must be solidly connected to the ground terminal of the adapter plate.
- An EMC-tested cable gland must be used to solidly connect the cable shield to the enclosure.
- The shield on the motor side must be solidly connected to the motor housing with an EMC cable gland, providing good conductivity from the cable shield to the motor housing.

Brake Resistor Cable

- The 3-wire shielded and heat resistant cable is included in the brake resistor assembly.
- An EMC-tested cable gland is also included to solidly connect the cable shield to the adapter plate.
- The resistor cable ground conductor must be connected to the Fast-on ground terminal on the drive bottom.

Motor and Brake Resistor Connections

Figure C.2



Signal Cables

Control and communication module wiring complies with the EMC directive if the installation requirements for signal cables as described on pages 2-12 to 2-14 are fulfilled.

Low Voltage Directive 73/23/EEC Compliance

This product complies with Low Voltage Directive 73/23/EEC when conforming with the following installation requirements:

- Review Chapter 1, *Important Precautions* and other **ATTENTION** statements throughout this manual prior to installation of the drive.
- The drive is intended to be installed with a fixed connection to the earth. The use of residual-current-operated protective devices (RCDs) or ground fault indicators is not recommended. If unavoidable, the 160Z is compatible with type B RCDs only.
- The drives ac line input devices (circuit breaker, contactor, line reactor) should be installed in an appropriate or suitable enclosure (i.e. 190Z-ESE).

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