VS1ST
AC Microdrive

2/08 **Installation & Operating Manual** MN767

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Important:

Be sure to check **www.baldor.com** for the latest software, firmware and drivers for your VS1 product. Also, you can download the latest version of this manual in Adobe Acrobat PDF format.

Table of Contents

Chapter 1
Introduction

This manual is intended for qualified electrical personnel familiar with installing, programming, and maintaining AC Drives. This manual contains information on:

- Installing and wiring the VS1ST drive
- Programming the drive
- Troubleshooting the drive

1.1 Getting Assistance from Baldor

For technical assistance, contact your Baldor District Office. Before calling, please review the troubleshooting section of this manual and you will be asked for the drive model number or catalog number that is located on the Nameplate.

1.2 Safety Notice

This equipment contains voltages that may be as high as 1000 volts! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

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

Precautions: Classifications of cautionary statements

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

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

WARNING: Do not use motor overload relays with an automatic reset feature. These are dangerous since the process may injure someone if a sudden or unexpected automatic restart occurs. If manual reset relays are not available, disable the automatic restart feature using external control wiring.

WARNING: This unit has an automatic restart feature that will start the motor whenever input power is applied and a RUN (FWD or REV) command is issued. If an automatic restart of the motor could cause injury to personnel, the automatic restart feature of the VS1ST should be disabled.

WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury.

WARNING: Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Dangerous voltages are present inside the equipment. Electrical shock can cause serious or fatal injury.

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

Continued on next page

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

WARNING: **Dynamic brake resistors may generate enough heat to ignite combustible materials. Keep all combustible materials and flammable vapors away from brake resistors.**

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

Caution: **Disconnect motor leads (U, V and W) from control before you perform a "Dielectric Withstand" test on the motor. Failure to disconnect motor from the control will result in extensive damage to the control. The control is tested at the factory for high voltage / leakage resistance as part of Underwriter Laboratory requirements.**

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

Horsepower	RMS Symmetrical Amperes
1-30	5,000

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

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

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

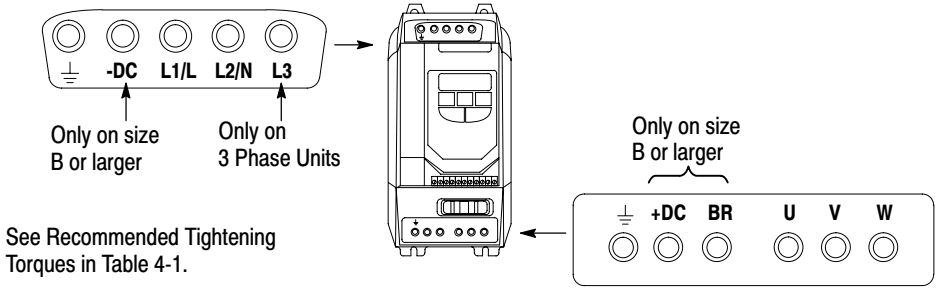
Caution: **Only Baldor cables should be used to connect the keypad and control. These are special twisted pair cables to protect the control and keypad. Damage associated with other cable types are not covered by the Baldor warranty.**

Caution: **If an M-Contactor is installed, the control must be disabled for at least 200msec before the M-Contactor is opened. If the M-Contactor is opened while the control is supplying voltage and current to the motor, the control may be damaged. Before the control is enabled, the M-Contactor must be closed for at least 200msec.**

Caution: **Use of power correction capacitors on the output of the drive can result in erratic operation of the motor, nuisance tripping, and/or permanent damage to the drive. Remove power correction capacitors before proceeding. Failure to observe this precaution could result in damage to, or destruction of, the equipment.**

1.3 Quick Start Quick Start Guide is also available separately, see MS767.

Figure 1-1 Power & Motor Terminal Locations



Powerup Procedure Refer to Chapter 3, 4 and 5 for additional details.

The drive is factory set to run in terminal strip (remote) mode. For this powerup test or to use in keypad (local) mode, perform the following:

1. Remove all power from the control.
2. Connect Power & Motor, See Figure 1-1.
3. Couple the motor to its load.
4. Verify freedom of motion of motor shaft.
5. Verify the motor coupling is tight without backlash.
6. Connect input control wires and output control wires, See Figure 1-2.
7. Jumper pins 1 & 2 of the control terminal strip (+24VDC to Enable). See Figure 1-2 and Table 1-1.
8. Turn power on. Be sure there are no faults.
9. Set the following parameters for the values displayed on the motor nameplate:
   P-01 Motor Rated Voltage
   P-02 Motor Rated Current
   P-03 Motor Rated Frequency
   P-04 Motor Rated Speed
10. Set P-07 = 1 or 2 (Start/Stop Source), P-08=4 (allows keypad ▲ and ▼ for speed control).
11. Verify the holding brakes if any, are properly adjusted to fully release and set to the desired torque.
12. Run the drive from the keypad.
13. Select and program additional parameters to suit your application, see Chapter 8.

The control is now ready for use the in keypad mode. If a different operating mode is desired, refer to Chapter 7 Parameter Descriptions and Chapter 8 Customizing for your Application.

To restore operation to terminal strip (remote) mode, set P-07 to 0 or as deisred, Remove all power from the control, and remove the jumper at 1 & 2 of the control terminal strip

Figure 1-2 Input Connections

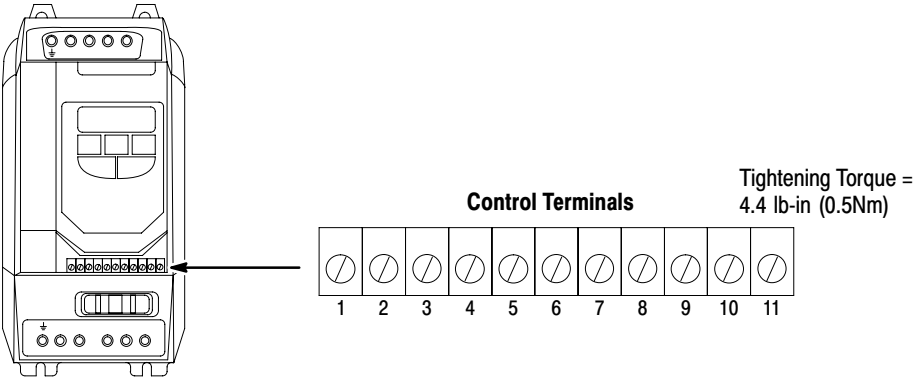


Table 1-1 Control Terminal Descriptions

Terminal	Signal Description
1	+24VDC (@ 100 mA)
2	Digital Input 1
3	Digital Input 2
4	Digital Input 3 / Analog Input 2
5	+10VDC (@ 10mA) Reference for Potentiometer (1k ohm minimum)
6	Analog Input 1 / Digital Input 4
7	Common (terminals 7 & 9 are connected)
8	Analog Output (0-10VDC @ 10mA) / Digital Output
9	Common (terminals 7 & 9 are connected)
10	Relay Common
11	Relay N.O. Contact (rated 250V@6A; 30V@5A)

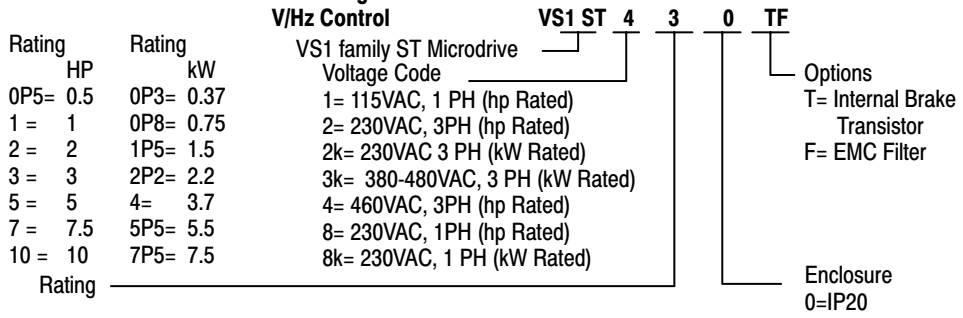
Chapter 2
General Information and Ratings

The VS1ST is a variable frequency PWM drive operating in V/Hz (volts per hertz) mode. This chapter contains information about the VS1ST drive, including how to identify the drive.

2.1 Identify the Drive by Model Number

Each drive can be identified by its model number, as shown in Figure 2-12. The model number is on the shipping label and the drive nameplate. The model number includes the drive and any options.

Figure 2-12 Drive Identification



2.2 Storage Guidelines

If you need to store the drive, follow these recommendations to prolong drive life and performance:

11. Storage ambient temperature is -40°C to 60°C.
12. Storage Humidity range 10% to 90% RH non-condensing.
13. Do not expose to corrosive atmosphere.

2.3 VS1ST Ratings, Model Numbers and Frame Sizes

Table 2-1 Drive Ratings

Catalog No.	Brake Transistor	Input Volt	Frame Size	Output			Watts Loss
				HP	KW	Amps	
VS1ST10P5-0	No	115, 1ph	A	0.5	0.37	2.3	45
VS1ST11-0	No	115, 1ph	A	1.0	0.75	4.3	90
VS1ST11P5-0T	Yes	115, 1ph	B	1.5	1.1	5.8	130
VS1ST80P5-0	No	230, 1ph	A	0.5	0.37	2.3	22
VS1ST81-0	No	230, 1ph	A	1.0	0.75	4.3	45
VS1ST82-0	No	230, 1ph	A	2.0	1.5	7.0	90
VS1ST82-0T	Yes	230, 1ph	B	2.0	1.5	7.0	90
VS1ST83-0T	Yes	230, 1ph	B	3.0	2.2	10.5	130
VS1ST20P5-0	No	230, 3ph	A	0.5	0.37	2.3	22
VS1ST21-0	No	230, 3ph	A	1.0	0.75	4.3	45
VS1ST22-0	No	230, 3ph	A	2.0	1.5	7.0	90
VS1ST22-0T	Yes	230, 3ph	B	2.0	1.5	7.0	90
VS1ST23-0T	Yes	230, 3ph	B	3.0	2.2	10.5	130
VS1ST25-0T	Yes	230, 3ph	C	5.0	3.7	18.0	240
VS1ST41-0	No	460, 3ph	A	1.0	0.75	2.2	50
VS1ST42-0	No	460, 3ph	A	2.0	1.5	4.1	90
VS1ST42-0T	Yes	460, 3ph	B	2.0	1.5	4.1	90
VS1ST43-0T	Yes	460, 3ph	B	3.0	2.2	5.8	130
VS1ST45-0T	Yes	460, 3ph	B	5.0	4.0	9.5	240
VS1ST47-0T	Yes	460, 3ph	C	7.5	5.5	14.0	280
VS1ST410-0T	Yes	460, 3ph	C	10.0	7.5	18.0	380

Chapter 3
Installing the Drive

This chapter provides information that must be considered when planning a VS1ST drive installation and provides drive mounting information and installation site requirements.

3.1 Receiving & Inspection

When you receive your control, there are several things you should do immediately.

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

3.2 General Requirements for the Installation Site

It is important to ensure that the drives environment and operating conditions are satisfactory.

The area behind the drive must be kept clear of all control and power wiring. Power connections may create electromagnetic fields that may interfere with control wiring or components when run in close proximity to the drive.

Read the recommendations in the following sections before continuing with the drive installation.

3.2.1 Operating Conditions

Before deciding on an installation site, consider the following guidelines:

- Protect the cooling fan by avoiding dust or metallic particles. The drive must be protected from debris falling through the drive vents during installation and operation. The drive is designed to operate in IP20 Type installations.
- Do not expose the drive to a corrosive atmosphere.
- Protect the drive from moisture and direct sunlight.
- Verify that the drive location will meet the environmental conditions specified in Table 3-1.

Table 3-1 - Ambient Temperatures and Mounting Clearances

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances (Vertical)
Minimum	Maximum		
32°F (0°C)	122°F (50 °C)	IP20	2 in (50mm)

3.2.2 Minimum Mounting Clearances

Provide proper top, bottom and side clearance.

Frame Size	Recommended Clearance (Minimum)			Recommended Air flow
	Top Clearance	Either Side	Between (side by side drives)	
A	1.97 (50)	1.97 (50)	1.30 (33)	11 CFM
B	2.95 (75)	1.97 (50)	1.81 (46)	11 CFM
C	3.94 (100)	1.97 (50)	2.05 (52)	26 CFM

3.2.3 Watts Loss Data

Refer to Table 2-1 for watts loss data.

3.2.4 Elevation

Maximum elevation is 3300 ft (1000 m) above sea level without derating. Derate output power by 1% per 330 ft (100m) above 3300 ft to 6600 ft (2000 m) maximum elevation.

3.3 Mounting the Drive

Mount the drive upright on a flat, vertical, and level surface. Refer to Figure 3-1 and Table 3-2 for mounting hole locations.

Figure 3-1 Mounting Hole Locations

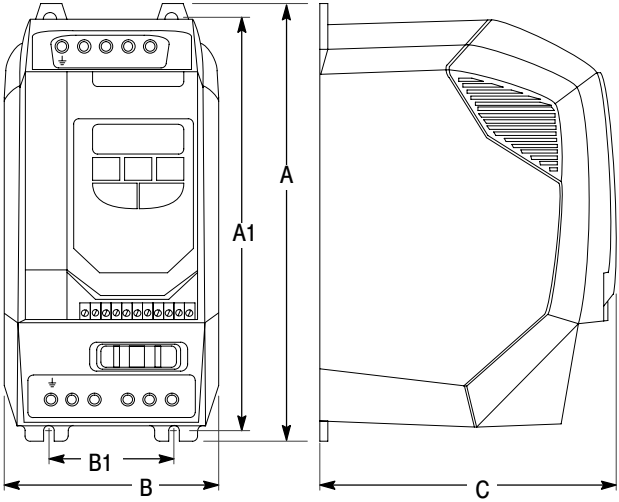


Table 3-2 Mounting Hole & Drive Dimensions

Catalog No.	Output HP	A	A1	B	B1	C	Weight	
							lb	kg
VS1ST10P5-0	0.5	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST11-0	1.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST11P5-0T	1.5	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST80P5-0	0.5	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST81-0	1.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST82-0	2.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST82-0T	2.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST83-0T	3.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST20P5-0	2.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST21-0	2.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST22-0	2.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST22-0T	2.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST23-0T	3.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST25-0T	5.0	10.28(261)	9.72(247)	5.16(131)	3.15(80)	6.89(175)	6.61	3.0
VS1ST41-0	1.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST42-0	2.0	6.81(173)	6.38(162)	3.23(82)	1.97(50)	4.84(123)	2.42	1.1
VS1ST42-0T	2.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST43-0T	3.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST45-0T	5.0	8.70(221)	8.23(209)	4.29(109)	2.48(63)	5.91(150)	5.73	2.6
VS1ST47-0T	7.5	10.28(261)	9.72(247)	5.16(131)	3.15(80)	6.89(175)	6.61	3.0
VS1ST410-0T	10.0	10.28(261)	9.72(247)	5.16(131)	3.15(80)	6.89(175)	6.61	3.0

Refer to Figure 3-1 for dimensions.

Chapter 4
Power Wiring

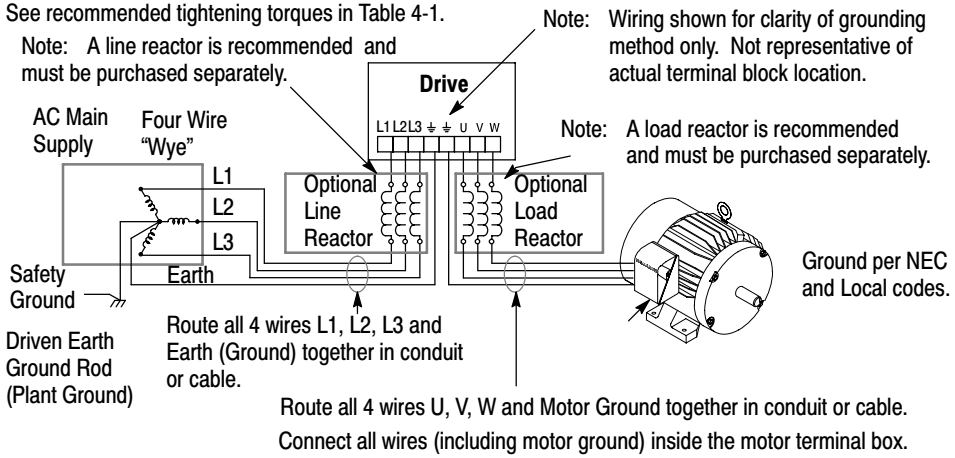
4.1 Overview of Power Connections

The recommended grounding method is shown in Figure 4-1.

Safety Ground - (G) ⏚

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod, or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

Figure 4-1 Recommended System Grounding



Motor Ground

The motor ground must be connected to one of the ground terminals on the drive.

Shield Termination

Either of the safety ground terminals located on the power terminal block provides a grounding point for the motor cable shield. The motor cable shield connected to one of these terminals (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal.

When shielded cable is used for control and signal wiring, the shield should be grounded at the drive end only, never at both ends.

RFI Filter Grounding

Using single-phase drives with integral filter, or an external filter with any drive rating, may result in relatively high ground leakage currents. Therefore, the filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded (bonded) to the building power distribution ground.

Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections. The integrity of all connections should be checked periodically.

4.2 Power Disconnect

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

4.3 Protective Devices

Recommended fuse sizes are based on the following:
115% of maximum continuous current for time delay.
150% of maximum continuous current for Fast or Very Fast action.

Note: These recommendations do not consider harmonic currents or ambient temperatures greater than 45°C.

Be sure a suitable input power protection device is installed. Use the recommended fuses and wire sizes shown in Table 4-1 is based on the use of copper conductor wire rated at 75 °C. The table is specified for NEMA B motors.

Fast Action Fuses:	240VAC, Buss® KTN; 460VAC, Buss® KTS
Very Fast Action:	240VAC, Buss® JJN; 460VAC, Buss® JJS
Semiconductor	240VAC, Ferraz Shawmut A50QS

Buss® is a trademark of Cooper Industries, Inc.

4.4 Electrical Installation

All interconnection wires between the drive, AC power source, motor, host control and any operator interface stations should be in metal conduits or shielded cable must be used. Use listed closed loop connectors that are of appropriate size for wire gauge being used. Connectors are to be installed using crimp tool specified by the manufacturer of the connector. Only class 1 wiring should be used.

Figure 4-2 shows 2 screws in the side cover. EMC filters inherently have a high leakage current. Removing the EMC screw reduces trips caused by this condition. Removing the VAR screw disconnects voltage suppression circuits for certain tests. Both screws should be left in and securely tightened.

4.4.1 Single Phase Input Power Connections for 1 Phase Control

All cables must be shielded and the shields must be grounded at the enclosure cable entrance.

1. Connect the single phase input power wires to an appropriate interrupter and protection.
2. Connect the single phase AC input power leads to terminals L1/L and L2/N of the control (see Figure 4-2 for location).
3. Connect the power ground wire to the ground terminal ⏚ (see Figure 4-2).

4.4.2 Three Phase Input Power Connections for 3 Phase Control

All cables must be shielded and the shields must be grounded at the enclosure cable entrance.

1. Connect the three phase input power wires to an appropriate interrupter and protection.
2. Connect the three phase AC input power leads to terminals L1/L. L2/N and L3 of the control (see Figure 4-2 for location).
3. Connect the power ground wire to the ground terminal ⏚ (see Figure 4-2).

Figure 4-2 Power Terminal Locations

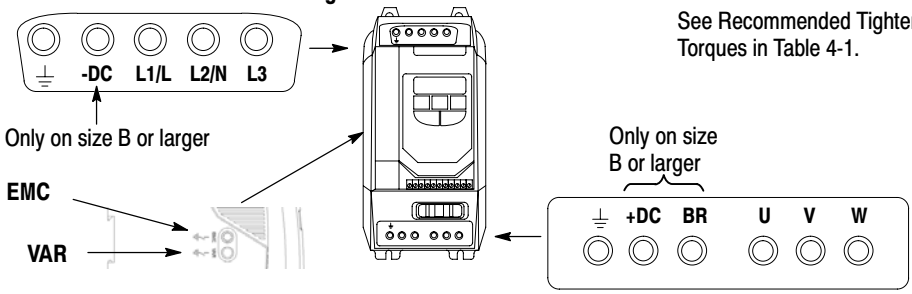


Table 4-1 Fuse & Wire Size and Terminal Tightening Torque Specifications

Catalog Number	Input Fuse (Amps)	Wire Gauge		Tightening Torque	
	Fast Acting (UL)	AWG	mm^2	lb-in	Nm
VS1ST10P5-0	15	14	2.5	8.84	1
VS1ST11-0	25	12	4.0	8.84	1
VS1ST11P5-0T	30	12	4.0	8.84	1
VS1ST80P5-0	8	14	2.5	8.84	1
VS1ST81-0	12	14	2.5	8.84	1
VS1ST82-0	20	14	2.5	8.84	1
VS1ST82-0T	20	14	2.5	8.84	1
VS1ST83-0T	25	12	4.0	8.84	1
VS1ST20P5-0	4	14	2.5	8.84	1
VS1ST21-0	6	14	2.5	8.84	1
VS1ST22-0	12	14	2.5	8.84	1
VS1ST22-0T	12	14	2.5	8.84	1
VS1ST23-0T	15	14	2.5	8.84	1
VS1ST25-0T	25	12	4.0	8.84	1
VS1ST41-0	3	14	2.5	8.84	1
VS1ST42-0	5	14	2.5	8.84	1
VS1ST42-0T	5	14	2.5	8.84	1
VS1ST43-0T	8	14	2.5	8.84	1
VS1ST45-0T	12	14	2.5	8.84	1
VS1ST47-0T	17.5	14	2.5	8.84	1
VS1ST410-0T	20	12	4.0	8.84	1

Note: Wire sizes based on 75°C copper wire, 40°C ambient. Fuses based on 45°C ambient, max continuous output and no harmonic current.

4.4.3 Optional Dynamic Brake Hardware Size B & C Controls.

If optional DB resistor is to be used, connect it to the +DC and BR terminals. **See Appendix D for more information**.

4.4.4 Motor Connections

All cables must be shielded and the shields must be grounded at the enclosure cable entrance.

1. Connect the Motor leads to terminals U, V and W (see Figure 4-2 for location).
2. Connect the motor ground wire to the ground terminal (see Figure 4-2).

Long Motor Leads

The wire leads that connect the motor to the control are critical in terms of sizing, shielding and the cable characteristics. Short cable runs are usually trouble free but fault-monitoring circuitry can produce numerous faults when long cables are used. Refer to Table 4-2 for maximum cable lengths.

Baldor recommends adding an optional load reactor to the output of the control.

The load reactor and/or common mode choke should be placed in close physical proximity to the control. Unexpected faults may occur due to excessive charging current required for motor cable capacitance.

If you use long motor leads and experience unexpected trips due to current overload conditions and are not sure how to correctly size and connect the optional load reactors, please contact your Baldor representative. Baldor is always glad to assist.

Table 4-2 Motor Cable Length

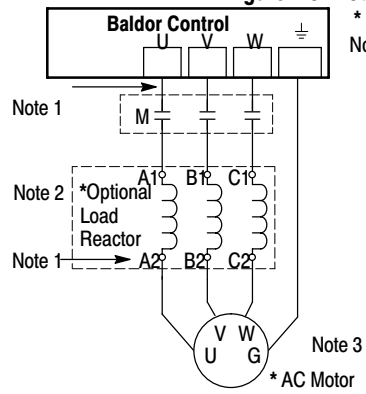
Drive Size	Maximum Motor Cable Length
A	82' (25m)
B	328' (100m)
C	328' (100m)

4.4.5 M-Contactor Connections

If required by local codes or for safety reasons, an M-Contactor (motor circuit contactor) may be installed. However, incorrect installation or failure of the M-contactor or wiring may damage the control. If an M-Contactor is installed, the control must be disabled for at least 200msec before the M-Contactor is opened or the control may be damaged. M-Contactor connections are shown in Figure 4-3.

Caution: If an M-Contactor is installed, the control must be disabled for at least 200msec before the M-Contactor is opened. If the M-Contactor is opened while the control is supplying voltage and current to the motor, the control may be damaged. Before the control is enabled, the M-Contactor must be closed for at least 200msec.

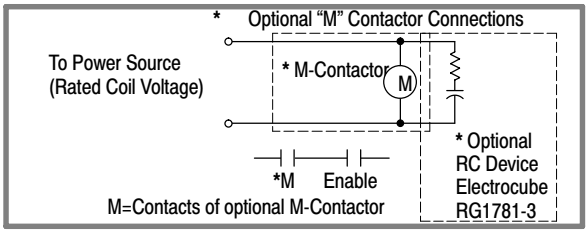
Figure 4-3 Motor Connections and Optional Connections



* Optional components not provided with control.

Notes: 1. Metal conduit should be used. Connect conduits so the use of Load Reactor or RC Device does not interrupt EMI/RFI shielding.

2. See Line/Load Reactors described previously in this section.
3. Use same gauge wire for ground as for U, V and W.



See Recommended Tightening Torques in Table 4-1.

Chapter 5
Control Wiring

5.1 Control Wiring Overview

Analog and Digital input and output connections are made at the Control wiring terminals shown in Figure 5-1.

Control wire connections an be made using shielded twisted pair #18 AWG (0.8mm^2) wire minimum. The cable must also have an overall shield and not exceed 100 feet (30m) in length. Control wire cables must be separated from power wiring. Separate parallel runs of control cables and power cables by at least 3″. Cross power wires at right angles only. Insulate or tape ungrounded end of shields to prevent contact with other conductors or ground.

Figure 5-1 Control Terminal Identification

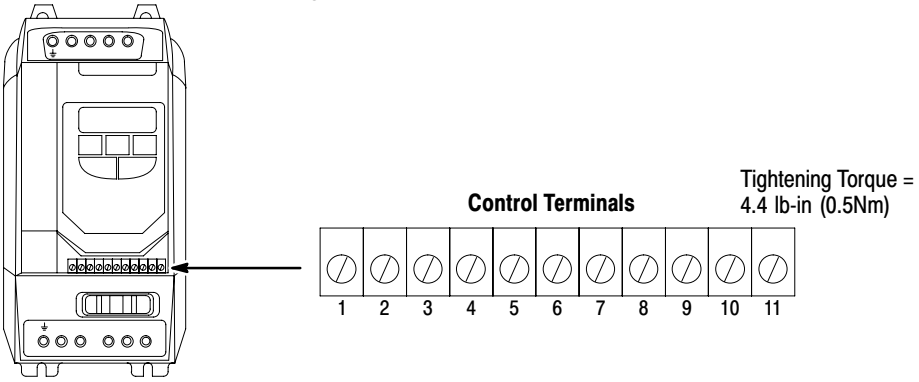


Table 5-1 Control Terminal Descriptions

Terminal	Signal Description
1	+24VDC (@ 100 mA)
2	Digital Input 1
3	Digital Input 2
4	Digital Input 3 / Analog Input 2
5	+10VDC (@ 10mA) Reference for Potentiometer (1k ohm minimum)
6	Analog Input 1 / Digital Input 4
7	Common (terminals 7 & 9 are connected)
8	Analog Output (0-10VDC @ 10mA) / Digital Output
9	Common (terminals 7 & 9 are connected)
10	Relay Common
11	Relay N.O. Contact (rated 250V@6A; 30V@5A)

5.2 Connection Examples

The connections used are determined by the setting of Parameter P-08. 2-Wire or 3-Wire connections for Digital In1, Digital In2 and Digital In3 are defined by this parameter. Preset Speed selections are also made by setting parameters P-12 to P-15. These selections are defined in Table 7-1.

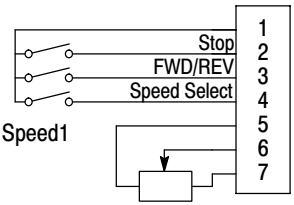
Analog Input 1 (terminal 6) can also be set as an additional digital input (Digital Input 4).
Digital Input 3 (terminal 4) can also be set as an additional analog input (Analog Input 2).
Analog Output (terminal 8) can also be set as a Digital Output.

5.2.1 Terminal Strip Control Set parameter P-07 =0 to use the control terminal strip connections.

Figure 5-2 2 Wire with 1 Preset & FWD/REV

P-07=0, P-08=0
2=Open=Stop, Closed=Run
3=Open=FWD, Closed=REV
4=Open=Analog Input*, Closed=Preset Speed1

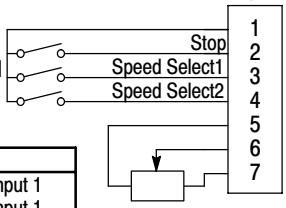
* Analog Input= Analog Input1 (pin 6)



Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-3 2 Wire with 2 Preset Speeds

P-07=0, P-08=1
2=Open=Stop, Closed=Run
3=Open=Analog, Closed=Preset Speed1
4=Preset Speed1/Preset Speed2

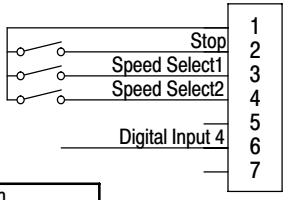


Speed Select1	Speed Select2	Action
Open	Open	Analog Input 1
Open	Closed	Analog Input 1
Closed	Open	Preset Speed 1
Closed	Closed	Preset Speed 2

Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-4 2 Wire with 4 Preset Speeds

P-07=0, P-08=2
2=Run/Stop
3=Speed Select1
4=Speed Select2
6=Open=Preset Speed 1-4
Closed= Max Speed (P-06)



Speed Select1	Speed Select2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Tightening Torque = 4.4 lb-in (0.5Nm)

Digital Input 4 Closed = 5V<Vin<30VDC
Digital Input 4 Open = Vin>12VDC

Figure 5-5 2 Wire with 1 Preset Speed and External Trip Input

P-07=0, P-08=3
2=Run/Stop
3=Open=Analog, Closed=Preset Speed1
4=Open=External Trip is generated,
Closed=Reset Fault and run.

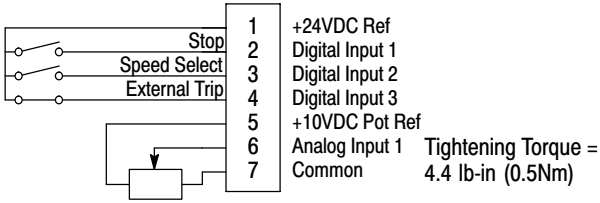


Figure 5-6 2 Wire with Local or Remote Analog Speeds and 2 Analog Inputs

P-07=0, P-08=4
2=Run/Stop
3=Open=Local Ref (Analog In 1),
Closed=Remote Ref

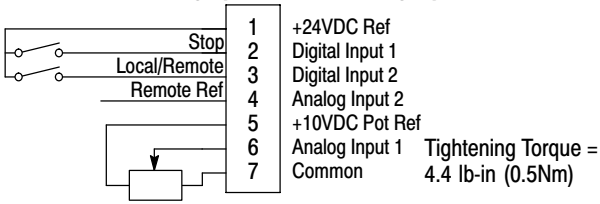
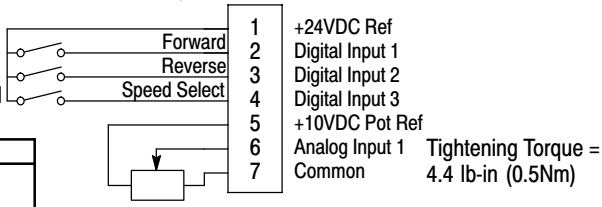


Figure 5-7 2 Wire with 1 Preset Speed, and FWD/REV

P-07=0, P-08=5
2=Open=Stop, Closed=Forward Run
3=Open=Stop, Closed=Reverse Run
4=Open=Analog, Closed=Preset Speed1



FWD Stop	REV Stop	Action
Open	Open	Drive Stop
Closed	Open	Forward Run
Open	Closed	Reverse Run
Closed	Closed	Fast Stop (see P-33)

Figure 5-8 2 Wire with FWD/REV and External Trip Input

P-07=0, P-08=6
2=Open=Stop, Closed=Run
3=Open=Forward, Closed=Reverse
4=Open=External Trip is generated,
Closed=Reset Fault and run.
Connect external thermistor type PT100 or similar to Digital Input 3.

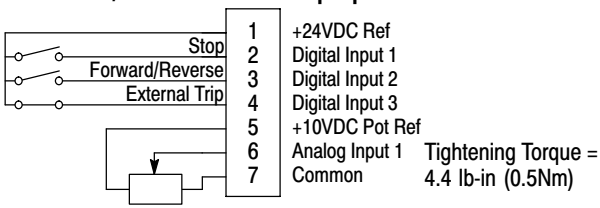
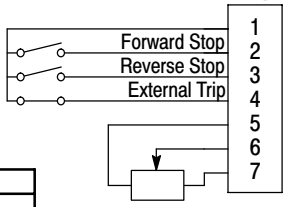


Figure 5-9 2 Wire with FWD/REV, External Trip and Fast Stop

P-07=0, P-08=7
2=Open=Stop, Closed=Forward Run
3=Open=Stop, Closed=Reverse Run
4=Open=External Trip is generated,
Closed=Reset Fault and run.



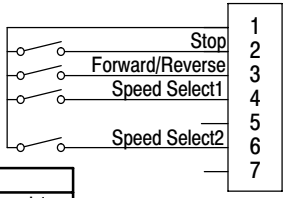
Tightening Torque = 4.4 lb-in (0.5Nm)

FWD Stop	REV Stop	Action
Open	Open	Drive Stop
Closed	Open	Forward Run
Open	Closed	Reverse Run
Closed	Closed	Fast Stop (see P-33)

Connect external thermistor type PT100 or similar to Digital Input 3.

Figure 5-10 2 Wire with FWD/REV and 4 Preset Speeds

P-07=0, P-08=8
2=Open=Stop, Closed=Run
3=Open=Forward, Closed=Reverse

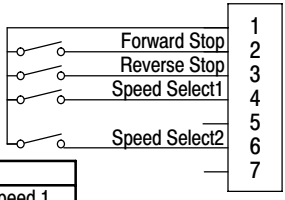


Tightening Torque = 4.4 lb-in (0.5Nm)

Speed Select1	Speed Select2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Figure 5-11 2 Wire with FWD/REV and 4 Preset Speeds

P-07=0, P-08=9
2=Open=FWD Stop, Closed=FWD Run
3=Open=REV Stop, Closed=REV Run

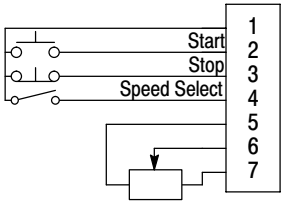


Tightening Torque = 4.4 lb-in (0.5Nm)

Speed Select1	Speed Select2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Figure 5-12 3 Wire Start and Stop with 1 Preset Speed

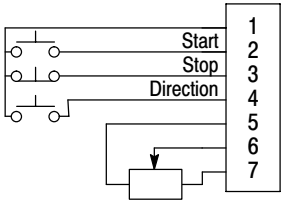
P-07=0, P-08=10
2=Momentary close Starts the drive.
3=Momentary open Stops the drive.
4=Open=Analog, Closed=Preset Speed1



Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-13 3 Wire Start and Stop with 1 Preset Speed and Change Direction

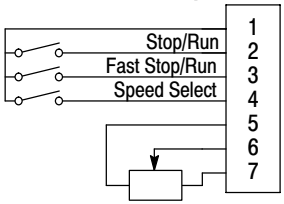
P-07=0, P-08=11
2=Momentary close Starts the drive.
3=Momentary open Stops the drive.
4=Open=Run,
Momentary close=Change Direction



Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-14 2 Wire with 1 Preset Speed and Fast Stop

P-07=0, P-08=12
2=Open=Stop, Closed=Run
3=Open=Fast Stop,
Closed=Run (Fast Stop mode=P-33)
4=Open=Analog, Closed=Preset Speed1



Tightening Torque = 4.4 lb-in (0.5Nm)

5.2.2 Other Control Methods Set parameter P-07 =0 to 6 to use the control method of your choice. P-07 =0 is described in this section. For P-07 =1-2 see Chapter 6. For P-07 =3-6 refer to Chapter 8.

0- Terminal Strip, Speed and other commands are from the terminal strip.

1- Keypad control - forward only, uni-directional control from the keypad (▼ and ▲ arrows are used to change the speed reference).

2- Keypad control - forward and reverse, bi-directional control from the keypad. START changes between forward and reverse, ▼ and ▲ change speed.)

3. MODBUS network control with internal accel / decel ramps.

4. MODBUS network control with accel / decel ramp adjustment.

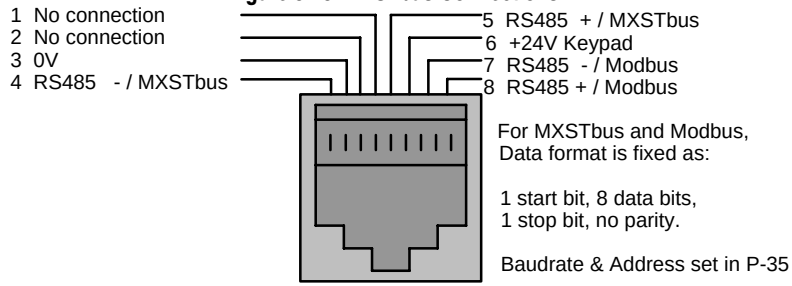
5. User PI control with external feedback signal.

6. User PI control with analog input 1 summation.

5.3 Communications Connection

The MXSTbus is used to connect an external device like a remote keypad or RS485 device. The connections are shown in Figure 5-15.

Figure 5-15 MXSTbus Connections



Powerup Procedure Refer to Chapter 3, 4 and 5 for additional details.

The drive is factory set to run in terminal strip (remote) mode.

1. Remove all power from the control.
2. Connect Power & Motor, See Chapter 4.
3. Couple the motor to its load.
4. Verify freedom of motion of motor shaft.
5. Verify the motor coupling is tight without backlash.
6. Connect input control wires and output control wires, See Figure 5-1.
7. Turn power on. Be sure there are no faults.
8. Set the following parameters for the values displayed on the motor nameplate:
   P-01 Motor Rated Voltage
   P-02 Motor Rated Current
   P-03 Motor Rated Frequency
   P-04 Motor Rated Speed
9. Set P-07 = 1 or 2 (Start/Stop Source).
10. Verify the holding brakes if any, are properly adjusted to fully release and set to the desired torque.
11. If optional external brake resistor is used, set P-34 for protection.
12. Run the drive from the keypad.
13. Select and program additional parameters to suit your application, see Chapter 8.

The control is now ready for use the in keypad mode. If a different operating mode is desired, refer to Chapter 7 Parameter Descriptions and Chapter 8 Customizing for your Application.

To restore operation to terminal strip (remote) mode, set P-07 and P-08 as desired, remove all power from the control, and remove the jumper at 1 & 2 of the control terminal strip.

Chapter 6
Using the Keypad

6.1 Keypad Overview

This chapter provides an overview of the integrated keypad and how to use it to program the VS1ST drive. Factory settings of parameter values allow the drive to be controlled from the integral keypad. The controls are shown in Figure 6-1.

Figure 6-1 Keypad Components

Display- 6 character 7 segment LED.

Start - Run the drive in keypad operation mode. Changes the motor direction if pressed while running (if P-07=2).

Stop/Reset - Stop the drive.
Active in all P-07 modes.
Resets drive after fault is cleared.

ENT/PROG - Momentarily press to view available displays.
Press & hold for 2 second to access parameters.
During programming press ENT/PROG to accept changed value.
Press and hold again to exit Programming mode.

▲ (increase) - During operation increases the speed reference. In edit mode, navigates between parameters and increases values.

▼ (decrease) - During operation decreases the speed reference. In edit mode, navigates between parameters and decreases values.

Display Example: Press ENT/PROG (P-04=0 and P-23=0).

1. Press ENT/PROG. The display will show H X.X which is the speed in hertz.
2. Press ENT/PROG again. The display will show A X.X which is the motor current in amps.
3. Press ENT/PROG again. The display returns to the H X.X which is the speed in hertz.

Display Example: Press ENT/PROG (P-04=0 and P-23≠0).

1. Press ENT/PROG. The display will show H X.X which is the speed in hertz.
2. Press ENT/PROG again. The display will show A X.X which is the motor current in amps.
3. Press ENT/PROG again. The display will show C X.X which is the scaled value.
4. Press ENT/PROG again. The display returns to the H X.X which is the speed in hertz.

Display Example: Press ENT/PROG (P-04≠0 and P-23=0).

1. Press ENT/PROG. The display will show H X.X which is the speed in hertz.
2. Press ENT/PROG again. The display will show X.X which is motor speed in RPM.
3. Press ENT/PROG again. The display will show A X.X which is the motor current in amps.
4. Press ENT/PROG again. The display returns to the H X.X which is the speed in hertz.

Display Example: Press ENT/PROG (P-04≠0 and P-23≠0).

1. Press ENT/PROG. The display will show H X.X which is the speed in hertz.
2. Press ENT/PROG again. The display will show X.X which is motor speed in RPM.
3. Press ENT/PROG again. The display will show A X.X which is the motor current in amps.
4. Press ENT/PROG again. The display will show C X.X which is the scaled value.
5. Press ENT/PROG again. The display returns to the H X.X which is the speed in hertz.

6.2 Keypad Operation Examples As configured from factory.

The drive is factory set to run in terminal strip (remote) mode. Terminal strip operating modes are described in Chapter 5.

For this powerup test or to use in keypad (local) mode, perform the following:

1. Remove all power from the control.
2. Jumper pins 1 & 2 of the control terminal strip (+24VDC to Enable).
3. Set P-07 = 1 or 2 (Start/Stop Source).
4. Turn power on. Be sure there are no faults.
6. The display will display StoP 
7. Press Start. The display will show "H 0.0". (Motor speed in Hertz).
8. Press ▲ to increase the motor speed.
9. Press ▼ to decrease the motor speed.
10. Increase the motor speed then press stop.
    After decel to zero speed, the display will show StoP. The drive is disabled.

Note: To restore terminal strip operation, turn off power, remove the jumper (installed in step 2), turn on power and change P-07 and P-08 as desired.

6.2.1 Example: Change Parameter P07 from 0 to 1 (Keypad Control-Forward only).

1. Press and hold ENT/PROG. The display will show P-00.
2. Press ▲ until P-07 is displayed. The display will show P-07.
3. Press ENT/PROG to select and change the parameter value. The display will show 0.
4. Press ▲ to change the value to 1. The display will show 1.
5. Press ENT/PROG to save the change and exit. The display will show P-07.
6. Wait several seconds and StoP is displayed.

This procedure can be used to change any parameter.

6.2.2 Example: Restore Parameters to Factory Settings.

1. Press Stop. The display will show StoP.
2. Press "▲" "▼" and "STOP" simultaneously for 2 seconds.
   The display will shoe P-dEF.
3. Press STOP to clear the fault. The display will show StoP.
   All parameter values have been changed to factory settings.
   Any motor parameters etc. that were set will have to be programmed again.

6.2.3 Example: Setting multiple parameters within P-35.

1. Press and hold ENT/PROG. The display will show P-00 (or the last parameter displayed).
2. Press ▲to scroll to P-35.
3. Press ENT/PROG to view the present setting. Adr 1 is displayed. The Comms Address is set to 1.
4. To change the address, press "▲" or "▼" to increase or decrease the value.
5. Press ENT/PROG to advance to OP-buS/Modbus Baud Rate. OP-buS is displayed.
   Press "▲" or "▼" to increase or decrease to the desired setting.
6. Press ENT/PROG to advance to Trip Enable /Delay setting. t 3000 is displayed.
   Press "▲" or "▼" to increase or decrease to the desired setting.
7. Press ENT/PROG to exit and save the settings. P-35 is now displayed.
   Press and hold ENT/PROG to exit programming mode StoP is displayed.

6.2.4 Example: View Read Only parameters (P-00 to P-47)

1. Press and hold ENT/PROG. The display will show P-00 (or the last parameter displayed).
2. Press ENT/PROG to view the first read only parameter, P00-01.
3. Press ENT/PROG to view the parameter value, 0.0 is displayed.
4. Press ENT/PROG return to parameter selection. P00-01 is displayed.
5. Press "▲" or "▼" to view the next or previous parameter. Press ENT/PROG to view the value, press ENT/PROG to choose another parameter using "▲" or "▼" or press and hold ENT/PROG to exit parameter viewing and StoP is displayed.

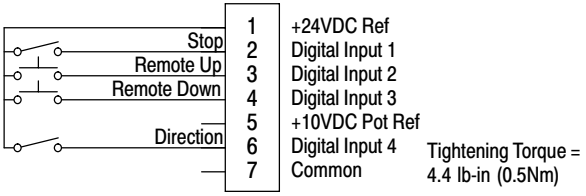
6.2.5 Example: Save all parameter values.

To save changes in parameter settings, switch the power supply off and wait for the drive to power down. The drive display will be blank when the unit is completely off. All settings are saved in memory.

6.2.6 Example: Motor Operation with P-07=1 or 2 and P-08=0.

Keypad Operation with pushbutton Speed Control and FWD/REV Switch

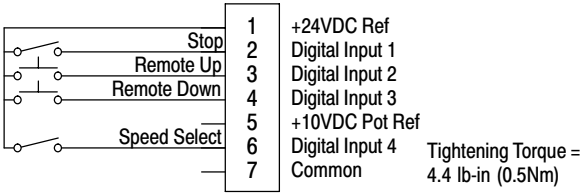
P-07=1 or 2, P-08=0
2=Open=Stop, Closed=Run
3=Open=, Closed=Remote Up
4=Open=, Closed=Remote Down
6=Open=FWD, Closed=REV



6.2.7 Example: Motor Operation with P-07=1 or 2 and P-08=2.

Keypad Operation with 1 preset speed

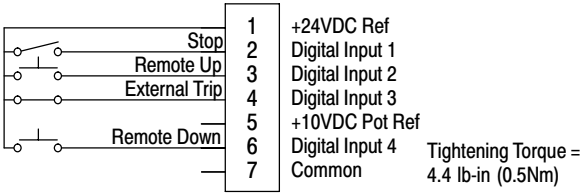
P-07=1 or 2, P-08=2
2=Open=Stop, Closed=Run
3=Open=, Closed=Remote Up
4=Open=, Closed=Remote Down
6=Open=Keypad Speed Ref,
Closed=Preset Speed 1



6.2.8 Example: Motor Operation with P-07=1 or 2 and P-08=3.

Keypad Operation with Motor Thermistor Trip

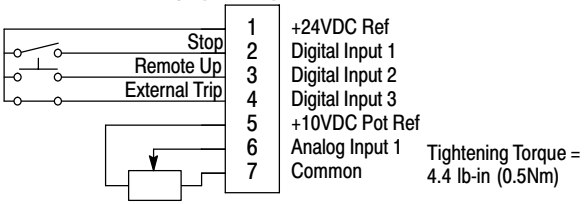
P-07=1 or 2, P-08=3
2=Open=Stop, Closed=Run
3=Open=, Closed=Remote UP
4=Open=Trip, Closed=Run
Connect external thermistor type PT100 or similar to Digital Input 3.
6=Open=, Closed=Remote Down



6.2.9 Example: Motor Operation with P-07=1 or 2 and P-08=4.

Keypad Operation with Analog speed input

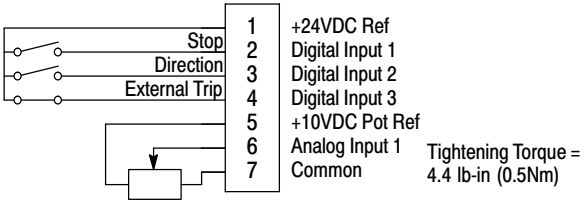
P-07=1 or 2, P-08=4
2=Open=Stop, Closed=Run
3=Open=, Closed=Remote UP
4=Open=Keypad Speed Ref,
Closed=Analog Input 1



6.2.10 Example: Motor Operation with P-07=1 or 2 and P-08=6.

Keypad Operation with Analog speed input, FWD/REV Switch and Motor Thermistor Trip

P-07=1 or 2, P-08=6
2=Open=Stop, Closed=Run
3=Open=FWD Run, Closed=REV Run
4=Open=Trip, Closed=Run
Connect external thermistor type PT100 or similar to Digital Input 3.
6=Open=Keypad Speed Ref,
Closed=Analog Input 1

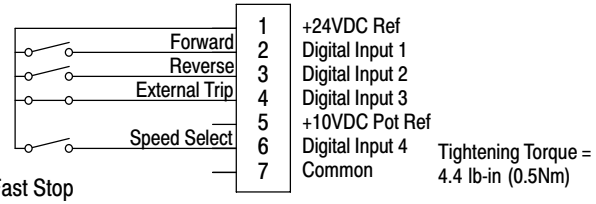


6.2.11 Example: Motor Operation with P-07=1 or 2 and P-08=7.

Keypad Operation FWD/REV Switches, 1 Preset Speed and Motor Thermistor Trip

P-07=1 or 2, P-08=7
2=Open=FWD Stop, Closed=FWD Run
3=Open=REV Stop, Closed=REV Run
4=Open=Trip, Closed=Run
6=Open=Keypad Speed Ref,
Closed=Preset Speed 1

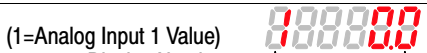
Close Digital Inputs 1 & 2 at same time=Fast Stop

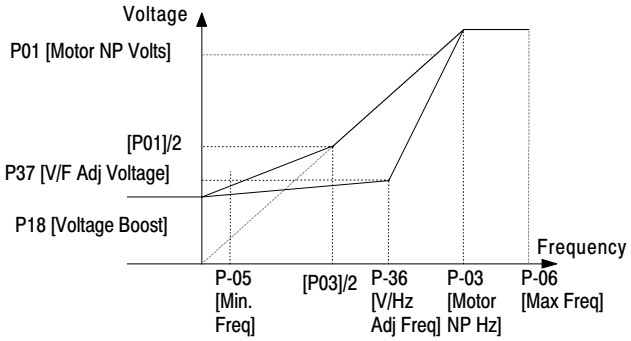


Chapter 7
Parameter Descriptions

7.1 Overview

Parameters P00 through P-45 are presented in this Chapter and each setting is explained.

Number	Name (Display Level)	Value Range, Description and Preset Value
P00-01	**Read Only Parameters**	Analog Input 1 Value (100%=Max V_{in}).
P00-02		Analog Input 2 Value (100%=Max V_{in}).
P00-03		Speed Reference Input -P-06 to P-06 (Hz if P-04=0, RPM if P-04≥1)
P00-04		Digital Input Status
P00-05		Reserved
P00-06		Reserved
P00-07		Motor Voltage
P00-08		DC Bus Voltage
P00-09		Internal Heatsink Temperature (in °C)
P00-10		Total Hours Run Time (Power applied)
P00-11		Run time since last trip. Reset on next enable after trip or power down.
P00-12		Run time since last trip. Reset on next enable after trip. Not by Undervolt trip or power down (unless after a trip condition).
P00-13		Run time since drive enabled. Reset on next enable after disable.
P00-14		PWM Frequency. May be less than selected by P-21 if drive is hot.
P00-15		DC Bus Volts Log. Last 8 sample values (every 250 msec).
P00-16		Thermistor temperature log. Last 8 sample values (every 250 msec).
P00-17		Motor Current. Last 8 sample values (every 250 msec).
P00-18		Software ID, I/O Processor & Motor Control versions.
P00-19		Drive Serial Number.
P00-20		Drive Identifier. (Drive Rating & Type).
		

Number	Name (Display Level)	Value Range, Description and Preset Value
P-01	**Motor Rated Volts**	(Range: 0, 20V to 250V= 230VAC 0, 20V to 500V= 460VAC (400VAC) Rated (nameplate) voltage of the motor (Volts). Value limited to 250V for low voltage drives. Setting to zero disables voltage compensation Preset Value: 230 See also, P-03.
P-02	**Motor Rated Current**	(Range: 25% to 100% rated drive current A) The (FLA) Full Load Amps of the motor (listed on the motor nameplate). The drive will fault on a motor overload if the value set in this parameter is exceeded. Preset Value: 4.3
P-03	**Motor Rated Frequency**	(Range: 25 to 500 Hz) The rated frequency of the motor (listed on the motor nameplate). Adjusting the Voltage / Frequency (V/f) characteristics. The V/f characteristic is defined by several parameters as shown. Reducing the voltage at a particular frequency reduces the current in the motor and hence the torque and power. The V/f curve can be further modified by using P-36 and P-37, where P-36 determines the percentage increase or decrease of the voltage applied to the motor at the frequency specified in P-37. This can be useful if motor instability is experienced at certain frequencies, if this is the case increase or decrease the voltage (P-36) at the speed of instability (P-37). For applications requiring energy saving, typically HVAC and pumping, the energy savings (P-19) parameter can be enabled. This automatically reduces the applied motor voltage on light load. Preset Value: 60Hz (Display shows “H 60” where H=Hz) 

Number	Name (Display Level)	Value Range, Description and Preset Value
P-04	**Motor Rated Speed**	(Range: 0, 360 to 30000 RPM) The RPM rated speed of the motor (listed on the motor nameplate). When set to a value other than 0, all speed related parameters are displayed in RPM. Preset Value: 0
P-05	**Minimum Output Speed**	(Range: 0.0 to P-06 (max 500.0Hz)) User specified minimum motor speed for application. Except for stop, speed less than this value are not allowed. Preset Value: 0.0
P-06	**Maximum Output Speed**	(Range: P-05 to 5 times P-03 (max 500Hz)) User specified maximum motor speed, speeds greater than this are not allowed. Preset Value: 60.0
P-07	**Start/Stop Source**	(Range: 0- Terminal Strip, Speed and other commands are from the terminal strip. 1- Keypad control - forward only, uni-directional control from the keypad (up down arrows are used to change the speed reference). The drive must be enabled (control terminals 1 and 2 connected). 2- Keypad control - forward and reverse, bi-directional control from the keypad. START changes between forward and reverse, ▼ and ▲ change speed) The drive must be enabled (control terminals 1 and 2 connected). 3. MODBUS network control with internal accel / decel ramps. 4. MODBUS network control with accel / decel ramp adjustment. 5. User PI control with external feedback signal. 6. User PI control with analog input 1 summation. Sets the input source for Speed, Start/Stop and other commands. Note: The drive will respond to the keypad stop key regardless of the value in this parameter. Preset Value: 0

Number	Name (Display Level)	Value Range, Description and Preset Value
P-08	**Speed Reference Source**	(Range: 0-12) Sets the digital inputs configuration. The operation of P-08 changes depending on the value of P-07. Refer to Tables 7-1, 7-2, 7-3 and 7-4. Preset Value: 0

Table 7-1 Parameter P-08 Control of Digital Inputs when P-07=0

P-08	Digital In 1		Digital In 2		Digital In 3		Analog Input1*	
0	Open	Stop	Open	FWD Run	Open	Analog Input 1	SPD Ref	
	Closed	Run	Closed	REV Run	Closed	Preset Speed1		
1	Open	Stop	Open	Analog SPD Ref	Open	Preset Speed1	SPD Ref	
	Closed	Run	Closed	Preset Speed1/2	Closed	Preset Speed2		
2	Open	Stop	DigIn2	DigIn3	Speed Select		Open	Preset Speed 1-4
			0	0	Preset Speed 1			
			1	0	Preset Speed 2			
	Closed	Run	0	1	Preset Speed 3		Closed	Max Speed (P-06)
			1	1	Preset Speed 4			
3	Open	Stop	Open	Analog SPD Ref	Open	Trip (Ext Trip)	SPD Ref	
	Closed	Run	Closed	Preset Speed1	Closed	Run		
4	Open	Stop	Open	Analog Input 1	Analog Input 2		SPD Ref	
	Closed	Run	Closed	Analog Input 2				
5	Open	FWD Stop	Open	REV Stop	Open	Analog SPD Ref	SPD Ref	
	Closed	FWD Run	Closed	REV Run	Closed	Preset Speed1		
6	Open	Stop	Open	FWD Run	Open	Trip (Ext Trip)	SPD Ref	
	Closed	Run	Closed	REV Run	Closed	Run		
7*	Open	FWD Stop	Open	REV Stop	Open	Trip (Ext Trip)	SPD Ref	
	Closed	FWD Run	Closed	REV Run	Closed	Run		
8	Open	Stop	Open	FWD Run	DigIn3	AnalogIn1	Speed Select	
	Closed	Run	Closed	REV Run	0	0	Preset Speed 1	
9*	Open	FWD Stop	Open	REV Stop	1	0	Preset Speed 2	
	Closed	FWD Run	Closed	REV Run	0	1	Preset Speed 3	
					1	1	Preset Speed 4	
10	3Wire Close=Run		3Wire Close=Stop		Open	Analog SPD Ref	SPD Ref	
					Closed	Preset Speed1		
11	3Wire Close=Run		3Wire Close=Stop		3Wire Close=REV		SPD Ref	
12	Open	Stop	Open	Fast Stop	Open	Analog SPD Ref	SPD Ref	
	Closed	Run	Closed	Run	Closed	Preset Speed1		

* Table 7-1 notes:

Analog Input 1 Note: Closed: 8V< Analog Input1 < 30V
Open: Analog Input1 > 12V

P-08=7 or 9 Note: Closing both Digital Input 1and 2 = Fast Stop.

Table 7-2 Parameter P-08 Control of Digital Inputs when P-07=1 or 2

P-08	Digital In 1		Digital In 2		Digital In 3		Analog Input1*	
0, 1, 5, 8-12	Open	Stop	Open		Open		Open	Forward
	Closed	Run	Closed	Remote UP	Closed	Remote Down	Closed	Reverse
2	Open	Stop	Open		Open		Open	Keypad Speed Ref
	Closed	Run	Closed	Remote UP	Closed	Remote Down	Closed	Preset Speed 1
3	Open	Stop	Open		Open	Trip (Ext Trip)	Open	
	Closed	Run	Closed	Remote UP	Closed	Run	Closed	Remote Down
4	Open	Stop	Open		Open	Keypad Speed Ref	Analog Input 1	
	Closed	Run	Closed	Remote UP	Closed	Analog Input 1		
6	Open	Stop	Open	FWD Run	Open	Trip (Ext Trip)	Open	Keypad Speed Ref
	Closed	Run	Closed	REV Run	Closed	Run	Closed	Preset Speed 1
7	Open	FWD Stop	Open	REV Stop	Open	Trip (Ext Trip)	Open	Keypad Speed Ref
	Closed	FWD Run	Closed	REV Run	Closed	Run	Closed	Preset Speed 1

Remote Up and Remote Down are MOP (E-Pot) controls. These provide Speed Increase and Decrease inputs to allow MOP operation. (Keypad controls remain active).

Table 7-3 Parameter P-08 Control of Digital Inputs when P-07=3 or 4

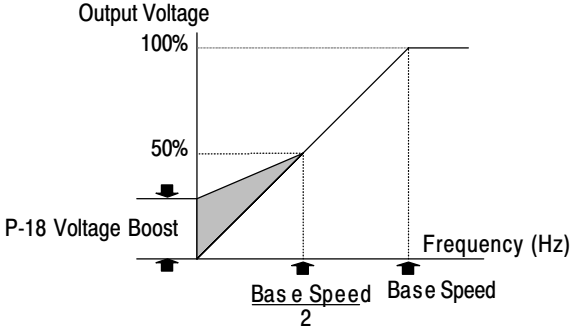
P-08	Digital In 1		Digital In 2		Digital In 3		Analog Input1*
0, 2, 4-5, 8-12	Open	Stop	Open		Open		
	Closed	Run	Closed		Closed		
3	Open	Stop	Open		Open	Trip (Ext Trip)	
	Closed	Run	Closed	Preset Speed 1	Closed	Run	
6	Open	Stop	Open		Open	Trip (Ext Trip)	
	Closed	Run	Closed	Analog Input 1	Closed	Run	
7	Open	Stop	Open		Open	Trip (Ext Trip)	
	Closed	Run	Closed	Keypad Speed Ref	Closed	Run	

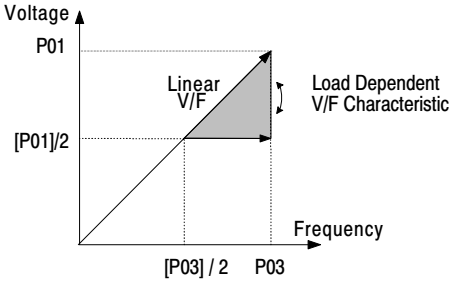
For drive to run, Digital In 1 must be closed and run and stop commands must be received on the RS485 link.
Master Speed Ref - start and stop controlled by RS485.
Keypad Speed Ref - drive auto runs if digital input 1 closed, depending on P-31 setting.
For information on MODBUS RTU see Appendix E.

Table 7-4 Parameter P-08 Control of Digital Inputs when P-07=5 or 6

P-08	Digital In 1		Digital In 2		Digital In 3		Analog Input1*
0, 2, 4-5, 8-12	Open	Stop	Open	PI Control	Analog In2 (PI Feedback)		
	Closed	Run	Closed	Preset Speed1			
1	Open	Stop	Open	PI Control	Analog In2 (PI Feedback)		Analog Input 1
	Closed	Run	Closed	Analog Input 1			
3, 6, 7	Open	Stop	Open	PI Control	Open	Trip (Ext Trip)	Analog In1 (PI Feedback)
	Closed	Run	Closed	Preset Speed1	Closed	Run	

Number	Name (Display Level)	Value Range, Description and Preset Value
P-09	**Stop Mode**	(Range: 0: Ramp to stop (power dip ride-through. If input power is lost the drive will use regen power to reduce the motor speed. 1: Coast to stop. The transistor power device drivers are turned off and motor coasts to stop (no braking). 2: Ramp to stop (fast stop). Also uses deceleration ramp when input power is lost or to use constant power braking mode for normal braking. If the supply is lost and P-09=0 the drive will try to continue running by reducing the speed of the load using the load as a generator. If the supply is lost and P-09=2, the drive will ramp to stop using the P-33 decel ramp. Also activates constant power braking mode for normal braking. Preset Value: 0
P-10	**Accel Time**	(Range: 0 to 600.0 seconds) Sets the time for the motor to accelerate from 0 to motor rated speed (P-03). Short times may cause overcurrent trips. Preset Value: 5.0
P-11	**Decel Time**	(Range: 0 to 600.0 seconds) Sets the time for the motor to decelerate from motor rated speed (P-03) to 0. Short times may cause overvoltage trips. When set to 0, drive will decel as fast as possible without tripping. Preset Value: 5.0
P-12	**Preset Speed 1**	(Range: -P-06 to P-06) Sets the value of Preset Speed 1. Range is -P-06 (reverse) to + P-06. Preset Value: 0.0
P-13	**Preset Speed 2**	(Range: -P-06 to P-06) Sets the value of Preset Speed 2. Range is -P-06 (reverse) to + P-06. Preset Value: 0.0
P-14	**Preset Speed 3**	(Range: -P-06 to P-06) Sets the value of Preset Speed 3. Range is -P-06 (reverse) to + P-06. Preset Value: 0.0
P-15	**Preset Speed 4**	(Range: -P-06 to P-06) Sets the value of Preset Speed 4. Range is -P-06 (reverse) to + P-06. Preset Value: 0
P-16	**Speed Reference Scaling**	(Range: 0 to 500.0%) Sets the parameter value in percent of full scale. Normally, the maximum speed reference (P-06) is 10 VDC or 20mA. This value adjusts the speed reference to another value (for example, 9.5 VDC or 19mA). In keypad mode, this parameter adjusts the keypad reference and an Analog Reference if P-07 =1 or 2. Preset Value: 100.0

Number	Name (Display Level)	Value Range, Description and Preset Value
P-17	**Analog Input Format**	(Range: U 0 - 10 b 0 - 10 A 0 - 20 t 4 - 20 r 4 - 20 t 20 - 4 r 20 - 4 Sets the analog input for voltage or current operation and the range of expected input signal. 0-10V can be used for bipolar input signals. A 50% offset by P-30 and 200% scaling by P-16 gives ± P-06. t indicates the drive will trip if signal removed when drive is enabled. r indicates the drive will ramp to Preset Speed 1 if signal is removed when drive is enabled Preset Value: U 0 - 10
P-18	**Voltage Boost**	(Range: 0.0 to 20.0% for size A, 0.0 to 15.0% for size B, 0.0 to 10.0% for size C controls; % of max. output voltage) Sets the percentage of output voltage boost at zero frequency. Torque boost offsets the voltage drop of the AC motor at low speeds. For high friction loads or high inertia loads, a high starting torque level may be needed. Voltage boost is only effective at speeds less than one-half of the motor's base frequency. Preset Value: CALC 

Number	Name (Display Level)	Value Range, Description and Preset Value
P-19	**Energy Savings**	(Range: 0=Disabled, 1=Enabled) When enabled, automatically reduces applied motor voltage on light load. Minimum value is 50% of nominal. Preset Value: 0 
P-20	**Trip Log**	(Range: Last four trips stored) Displays the last four trips as a code to represent a drive fault. The codes are displayed most recent first to oldest. Use the up or down arrow keys to scroll the fault list. Preset Value: N/A (Read Only)
P-21	**PWM Frequency**	(Range: 4-32kHz) Sets the effective switching frequency of the drive. Preset Value: 16
P-22	**Relay Output Select**	(Range: 0: Drive enabled 1: Drive healthy 2: Motor at target speed 3: Drive tripped 4: Motor speed >= limit 5: Motor current >= limit 6: Motor speed < limit 7: Motor current < limit Defines the function of the user relay, when the operating conditions are met. Disabled: Contacts open, Enabled: Contacts closed. Options 4 to 7: the Relay output is enabled using the level set in P-25. Preset Value: 1
P-23	**Display Speed Scale Factor**	Custom scaling factor if P-04 = 0, speed in Hz are scaled by this value. If P-04>0 RPM units are scaled by this value. Scaled display values are preceded with “C” for custom units on the display. Preset Value: 0.000

Number	Name (Display Level)	Value Range, Description and Preset Value
P-24	**Analog output function select**	(Range: **Digital output mode** 0: Drive enabled 1: Drive healthy 2: Motor at target speed 3: Drive tripped 4: Motor speed >= limit 5: Motor current >= limit 6: Motor speed < limit 7: Motor current < limit **Analog output mode** 8: Motor speed 9: Motor current) **Digital Output Mode:** Options 0 to 7 select a digital voltage output signal Disabled: 0V; Enabled: +24V, (25mA limit). Options 4 to 7: the Digital output is enabled using the level set in P-25 **Analog Output Mode**: Option 8: Motor Speed signal range 0-10V = 0-100% of P-06 Option 9: Motor Current signal range 0-10V = 0-200% of P-02 Preset Value: 8
P-25	**Relay output limit**	(Range: 0.0 to 100.0%) Sets the limit for P-22 and P-24 (when using Digital Output Mode). Preset Value: 100.0
P-26	**Skip Frequency**	(Range: P-05 to P-06) Sets the midpoint of the avoidance band selected in P-27 - Skip Frequency Band. The avoidance band can help alleviate problems with vibration harmonics at a specific operating frequency of the driven motor or machinery. See also P-27. Preset Value: 0.0
P-27	**Skip Frequency Band**	(Range: 0 to P-06) Sets the width of the skip frequency band. Setting P-27 to 0 disables the avoidance frequency. See also P-26. Preset Value: 0.0
P-28	**Restart Mode**	(Range: 0: Minimum Speed 1: Previous speed 2: Minimum speed (Auto-run) 3: Previous speed (Auto-run)) If set to 0 or 2, drive will always start from minimum speed. If set to 1 or 3, drive ramps up to the operating speed prior to the last STOP command. If set to 2 or 3, the status of digital input 1 controls drive to start or stop. The start and stop button on the drive will not operate in this case. See also P-29. Preset Value: 1

<table>
<tr><th>Number</th><th>Name
(Display Level)</th><th>Value Range, Description and Preset Value</th></tr>
<tr><td>P-29</td><td>Auto Restart Attempts</td><td>(Range:
Edge-r: if drive is powered up with Digital Input 1 closed (enabled), drive will not run. The switch must be opened & closed after power up or after clearing a trip for the drive to run.
Auto-0: drive will run whenever digital input 1 is closed (if not tripped).
Auto-1-5: drive will make 1-5 attempts to automatically restart after a trip (25s between attempts). If fault has cleared drive will restart. To reset the counter the Drive must be powered down, reset on the keypad or by re-enabling the drive.)
Preset Value: Auto-0</td></tr>
<tr><td>P-30</td><td>Analog Input Offset</td><td>(Range: -500.0 to 500.0%)
Amount of offset for analog input level. Resolution of 0.1%.
Preset Value: 0.0</td></tr>
<tr><td>P-31</td><td>Brake After Stop</td><td>(Range: 0 to 60.0 seconds)
Sets the amount of time DC injection braking is applied during stop when zero speed is reached. (P-31=0, no DC Brake is applied). The amount of braking is set in P-18 - Voltage Boost.)
Preset Value: 0.0 See also P-18, P-32.</td></tr>
<tr><td>P-32</td><td>Brake Before Start</td><td>(Range:
0 - The drive accelerates to speed without delay.
1 - Applies DC braking when run command is issued. The amount of time is set in P-31 and the amount of braking in P-18. The drive will then accelerate.)
DC braking may be applied after run command is issued.
Preset Value: 0 See also P-18, P-31.</td></tr>
<tr><td>P-33</td><td>Decel2 Fast Stop</td><td>(Range: 0 to 25 seconds)
Sets a second Decel time. P-33 is used if the drive input power is lost or fast stop mode is selected; P-09=0 or 2. Fast stop may also be enabled by setting P-08 =12 and Open Digital Input 2.
When P-09 = 2 and P-33 = 0, activating the fast stop disables the drive without braking, effectively coasting to a stop.
Preset Value: 0.00 See also P-08, P-09.</td></tr>
<tr><td>P-34</td><td>Brake Chopper Enable</td><td>(Range:
0: Disabled.
1: Enabled with Software protection for standard brake resistors (200W).
2: Enabled without s/w protection.
When enabled, the VS1ST software monitors bus voltage and turns On/Off braking as shown here.
Preset Value: 0
<table><tr><th>Drive Voltage Rating</th><th>Brake Turn Off Level</th><th>Brake Turn On Level</th></tr><tr><td>240VAC</td><td>378VDC</td><td>390VDC</td></tr><tr><td>460VAC</td><td>756VDC</td><td>780VDC</td></tr></table></td></tr>
</table>

Number	Name (Display Level)	Value Range, Description and Preset Value
P-35	**Serial Comms address**	(Range: Addr: 0 (disable) to 63. Unique drive address for communication network
	Modbus enable / baudrate select	OP-buS, 9.6, 19.2, 38.4, 57.6, 115.2 kBPS. When set to OP-buS, MODBUS disabled. Setting a baudrate enables MODBUS at that baudrate and disables OP-buS (Also called MXSTBus).
	Trip enable / delay	0 (no trip), t 30, 100, 1000, 3000 (ms) r 30, 100, 1000, 3000 (ms)) The time before a trip in the event of a communication loss can be set in milliseconds. Setting 0 disables the communications trip. t indicates the drive will trip if time exceeded. r indicates the drive will ramp to stop if time exceeded. Preset Value: Adr 1 OP-BuS t3000
P-36	**V/F Frequency Adjustment**	(Range: 0 to P-03Hz) Sets the frequency at which the adjustment voltage set in P-37 is applied. Preset Value: 0.0
P-37	**V/F Voltage Adjustment**	(Range: 0 to P-01V) Sets the applied motor voltage at the frequency set in P-36. Preset Value: 0
P-38	**User PI Proportional Gain**	(Range: 0.1 - 30.0) Increase the value for high inertia. Too large a value gives instability. Preset Value: 1.0
P-39	**User PI Integral time constant**	(Range: 0.0s - 30.0seconds) Preset Value: 1.0
P-40	**User PI feedback mode**	(Range: 0: Direct 1: Inverse. When set to 1, the bipolar analog input is used.) Sets the source for the PI control reference signal. Preset Value: 0
P-41	**User PI reference select**	(Range: 0: Digital 1: Analog. The bipolar analog input is used.) Sets the source for the PI control reference signal. Preset Value: 0
P-42	**User PI digital reference**	(Range: 0 to 100.0%) Sets the preset reference used when P-10, P-11 & P-09 = 0. Preset Value: 0.0

Number	Name (Display Level)	Value Range, Description and Preset Value
P-43	**User PI feedback select**	(Range: 0: 2nd analog input 1: 1st analog input 2: motor load current This parameter selects the feedback signal source. Preset Value: 0
P-44	**2nd analog input format**	(Range: 0-10V, 0-20mA, t 4-20mA, r 4-20mA, t 20-4mA r 20-4mA) Selects the format of the 2nd analog input . Preset Value: 0-10V
P-45	**Parameter access lock**	(Range: 0: Parameters can be changed, auto-saved on power down 1: Read-only. No changes allowed. Controls access to parameters. Preset Value: 0

Chapter 8
Customizing for Your Application

8.1 Simple Parameter Adjustments

Factory settings may give satisfactory performance, however certain adjustments may be beneficial.

Adjustment	Parameter	Parameter Name
Motor Rated Volts	P-01	The factory default setting P01 = 0 should be used unless voltage compensation is required.
Motor Rated Current	P-02	Must be set to the value on the motor nameplate. P04 is optional. If this parameter is set to zero (default state), speed is displayed in Hz (otherwise, RPM).
Motor Rated Frequency	P-03	
Motor Rated Speed	P-04	
Minimum Speed	P-05	Set P06 to the maximum speed and P05 to the minimum speed. These limits can also be negative for reverse speeds. If a non-zero minimum speed is set in P05, the motor will ramp to this minimum speed at the rate set in P10 as soon as the drive is enabled.
Maximum Speed	P-06	
Start/Stop Source	P-07	Set as required by the application.
Speed Ref Source	P-08	Set as required by the application.
Stop Mode	P-09	Select method of stopping required when drive is disabled.
Accel	P-10	Adjust as need for your application. Short Accel or decel time may cause excess motor current an may result in it tripping or the motor stalling.
Decel	P-11	
Analog Input Format	P-17	Set as required by the application (0-10V, 10-0V, 4-20mA etc.)
Voltage Boost	P-18	Any sticky to start load will benefit from a voltage boost on starting. P18 permits a boost of up to 25% of full motor voltage to be applied.

8.2 Additional Connection Examples

Parameter P-08 can be set to allow various operating modes. Chapter 5 described the Terminal Strip connections for Remote operation, P-07 =0. Keypad Operation (Local operation) P-07 =1 was described in Chapter 6.

Other modes allowed by the setting of P-07 are described here.

P-07=3 or 4 MODBUS

Figure 7-1 2 Wire

Run and stop commands are by RS485 link and Digital input 1 must be closed for the drive to run.

P07=3 or 4, P-08=0-2,4-5,8-12
2= Open=Stop, Closed=Run

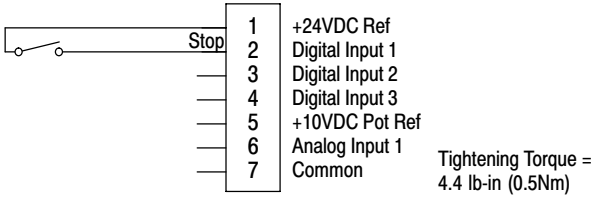


Figure 7-2 2 Wire with Analog Input, Preset Speed and External Trip Input

Run and stop commands are by RS485 link and Digital input 1 must be closed for the drive to run.

Connect external motor thermal overload device (thermistor type PT100 or similar) to digital input 3.

P07=3 or 4, P-08=3
2= Run/Stop
3= Open=Master Speed Ref.,
Closed=Preset Speed1
4= Open=External Trip is generated,
Closed=Run.

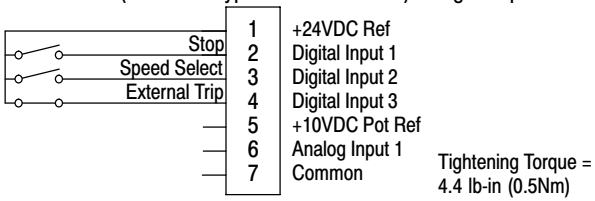
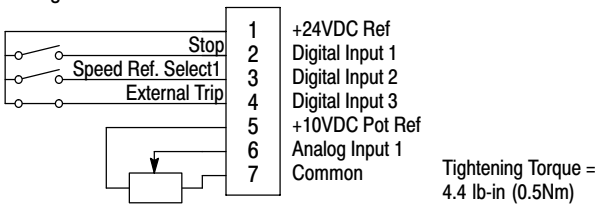


Figure 7-3 2 Wire with Analog Input and External Trip Input

Run and stop commands are by RS485 link and Digital input 1 must be closed for the drive to run.

Master Speed Ref - start and stop controlled via RS485. Keypad Speed Ref - drive auto runs if digital input 1 closed, depending on P-28 setting

P07=3 or 4, P-08=6
2= Open=Stop, Closed=Run
3= Open=Master Speed Ref.,
Closed=Analog Input (T6)
4= Open=External Trip is generated,
Closed=Run.



P-07=3 or 4 MODBUS Continued

Figure 7-4 2 Wire with 2 Speed References and External Trip Input

Run and stop commands are by RS485 link and Digital input 1 must be closed for the drive to run.

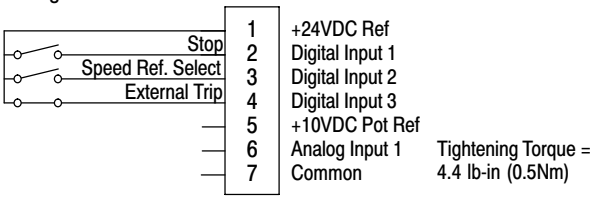
Master Speed Ref - start and stop controlled via RS485. Keypad Speed Ref - drive auto runs if digital input 1 closed, depending on P-28 setting

P07=3 or 4, P-08=7

2= Open=Stop, Closed=Run

3= Open=Master Speed Ref., Closed=Keypad Speed Ref.

4= Open=External Trip is generated, Closed=Run.



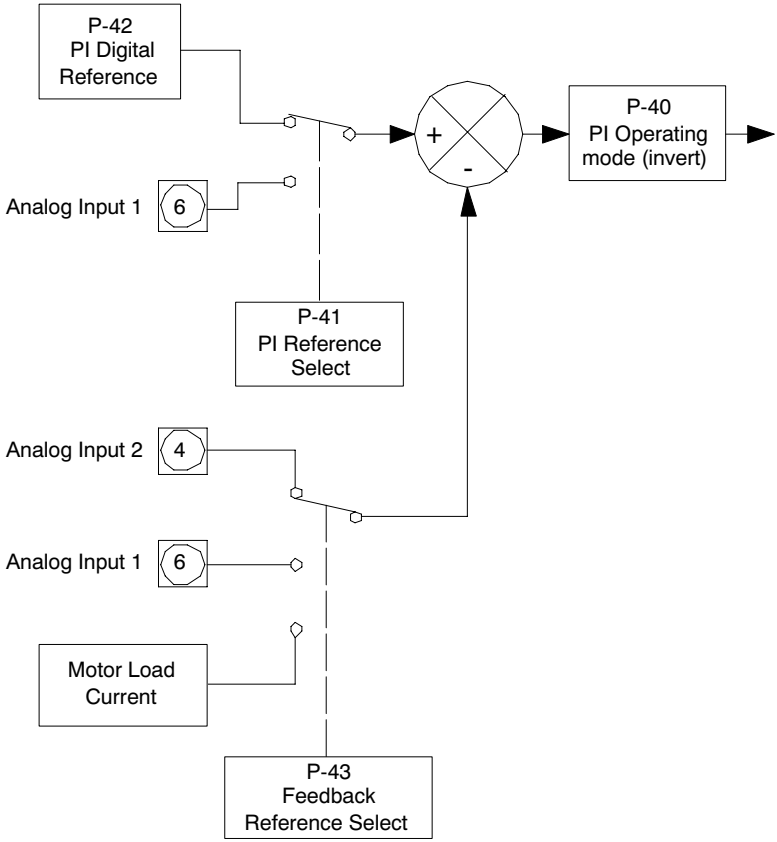
P-07=5 or 6 PI Control

Factory Settings for Proportional Gain (P-38), Integral Time Constant (P-39) and Feedback mode (P-43) are suitable for many HVAC and Pump applications. Adjustment of these parameter values may be necessary for your application.

Figure 7-5 is the block diagram of the closed loop PI Control system.

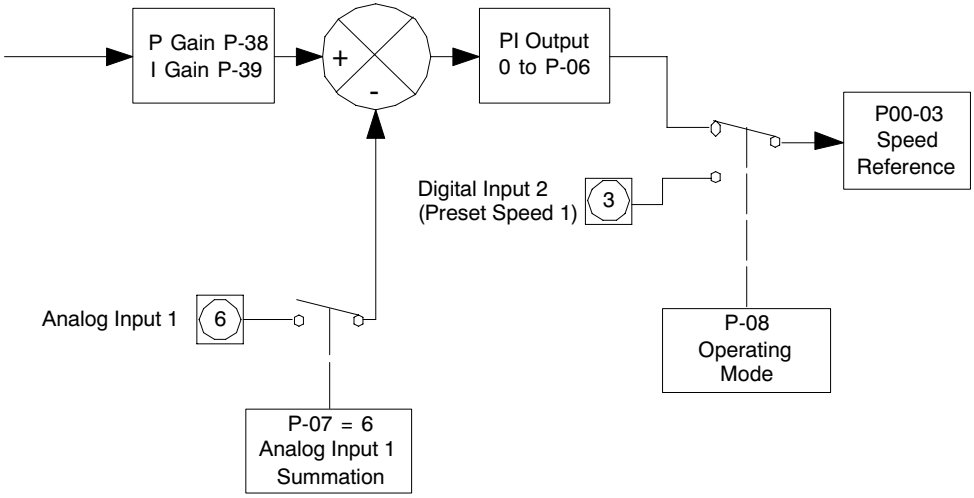
P-07=5 or 6 PI Control Continued

Figure 7-5 PI Block Diagram



P-07=5 or 6 PI Control Continued

Figure 7-5 PI Block Diagram Continued

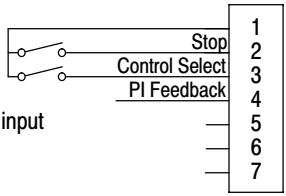


P-07=5 or 6 PI Control Continued

Figure 7-6 2 Wire with PI and Preset Speed

Closed loop PI control with analog PI feedback signal.
PI reference is set by the P-42 digital reference level.
Factory settings for PI Gain P-41

P07=5 or 6, P-08=0,2,4,5,8,12
2= Open=Stop, Closed=Run
3= Open=PI Control,
Closed=Preset Speed 1
4= Analog Input 2 = PI Feedback signal input
(Format is set in P-44)

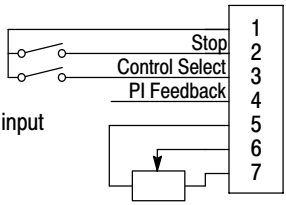


Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 7-7 2 Wire with PI and Analog Input

Closed loop PI control with analog PI feedback signal and Local Speed Reference (Analog Input 1).
PI reference is set by the P-42 digital reference level.

P07=5 or 6, P-08=1
2= Open=Stop, Closed=Run
3= Open=PI Control,
Closed=Analog Input (T6)
4= Analog Input 2 = PI Feedback signal input
(Format is set in P-44)

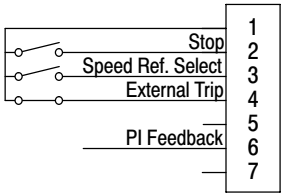


Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 7-8 2 Wire with PI, Preset Speed and External Trip Input

Closed loop PI control with analog PI feedback signal.
Use Analog reference P-41 = 1 (analog) and connect reference signal to Analog Input 1 (T6).
PI reference is set by the P-42 digital reference level.

P07=5 or 6, P-08=3, 6, 7
2= Open=Stop, Closed=Run
3= Open=PI Control
Closed=Preset Speed 1
4= Open=External Trip is generated,
Closed=Run.
6= PI Feedback signal input
(Format is set in P-44)



Tightening Torque = 4.4 lb-in (0.5Nm)

Chapter 9
Troubleshooting

The VS1ST constantly monitors its status and provides the following ways to determine the status of the drive and to troubleshoot problems that may occur:

- LEDs on the drive
- Fault Codes displayed on seven segment display
- Drive monitor and status parameters
- Entries in the fault queue

9.1 Fault Codes

Fault codes indicate conditions within the drive that require immediate attention. The drive responds to a fault by initiating a coast-to-stop sequence and turning off motor power.

1. Note the fault code on the display. See Table 9-1 for a description of the fault and corrective actions. The cause must be corrected before the fault can be cleared.
2. Remove the condition which caused the trip and press the STOP key or re-enable the drive.
3. The drive will restart according to the mode selected by P29.
4. If the motor is stopped and the display shows STOP, there is no fault; the drive output is disabled and the drive is ready to run.

Read fault log as follows:

1. Press and hold the Navigate to enter program mode.
2. Use the Up / Down arrow keys to select P20 - Trip Log.
3. Press Navigate to access the fault log. The last four faults can be monitored using the Up / Down arrow keys to view.
4. The codes appear in the order they occurred with the first fault displayed being the most recent.

9.2 Periodic Inspection

A periodic inspection schedule for the drive and driven equipment promotes proper operation and reduces down time. The frequency of inspections depends on operating environment. Inspections should be conducted more frequently in hostile conditions where there might be high vibration, dust, dirt, high humidity, or corrosive atmosphere.

- Check for any loose mounting hardware and tighten to specified torque value as required.
- Check electrical connections are tight and secure.
- Check the cooling fan and heatsink for debris. Remove obstructions as necessary.

Table 9-1 Fault Descriptions and Corrective Actions

Fault	Description	Remedy
P-deF	Default parameters loaded	Press STOP key, drive is ready to configure for particular application
O-I	Output over current condition. Excess load on the motor. Over temperature on the heatsink.	• Motor at constant speed: investigate overload or malfunction. • Motor starting: load stalled or jammed. Check for motor wiring error. • Motor accelerating / decelerating: the accel / decel time too short requiring too much power. If P-03 or P-04 cannot be increased, a larger drive motor is needed.
Ol-b	Brake channel over current	Over current in the brake resistor circuit. Check the cabling to the brake resistor. Check the brake resistor value. Ensure minimum resistance values form the rating tables are observed.
OL-br	Brake resistor overload	Brake resistor overload. Increase deceleration time, reduce load inertia or add further brake resistors in parallel. Ensure minimum resistance values form the rating tables are observed.
PS-T rp	Internal power stage fault	Check motor wires for phase-to-phase or phase-to-ground short circuit. Check drive ambient temperature, or if additional space or cooling is needed. Check drive is not forced into overload.
O-Uolt	Over voltage on DC bus	Supply problem, or increase decel time P04.
U-Uolt	Under voltage on DC bus	Check power supply voltage.
O-t	Heatsink over temperature	Check drive ambient temperature, or if additional space or cooling needed.
U-t	Under temperature	Trip occurs when ambient temperature is less than 0°C. Temperature must increase over 0°C to start the drive.
I.t-.trP	The drive has tripped on overload after delivering greater than 100% load for a period of time.	Verify display decimal points are flashing (drive in overload) and either increase acceleration rate or decrease load. Check cable length is within specification.
th-Fit	Faulty thermistor on heatsink.	Contract your Baldor District Office.
E-triP	External trip (on Digital input 2 or 3)	External trip on digital input. See P08 (digital input configuration).
EE-F	EEPROM fault. Parameters not saved, defaults reloaded.	Try again. If problem recurs, contact your Baldor District Office.
SC-trp	Comms loss trip	Check communication link between drive and external devices. Make sure each drive in the network has its unique address.
P-LOSS	Input phase loss trip	Drive intended for use with a 3 phase supply has lost one input phase.
SPIn-F	Spin start failed	Spin start function failed to detect the motor speed.
dAtA-F	Internal memory fault.	Parameters not saved, defaults reloaded. Try again. If problem recurs, contact your Baldor District Office.
4-20F	Analog input current out of range	Check input current in range defined by P-16.

Appendix A
Technical Specifications

All specifications are subject to change without notice.

Input Ratings	Voltage	115	230	460
	Voltage range	99-126	198-264	342-528
	Phase	Single Phase	Single Phase and Three Phase	Three Phase (single phase with derating)
	Frequency	50/60Hz ±5%		
	Impedance	1% minimum from mains connection		

Output Ratings	Horsepower	0.5-1.5 HP @ 115VAC, 1 PH 0.5-3 HP @ 230VAC, 1PH 0.5-5 HP @ 230VAC, 3PH 1-10 HP @ 460VAC, 3PH
	Overload Capacity	150% for 1 minute; 175% for 2 seconds.
	Frequency	0-500Hz
	Voltage	0 to maximum input voltage (RMS)

Protective Features	Trip	Over current, under voltage, Drive Overload, over temperature (control), output shorted or grounded, motor overload, DC Bus overvoltage, output phase loss, loss of speed command, comms error.
	Stall Prevention	Over voltage suppression, over current suppression
	External Output	LED trip condition indicators, 4 assignable logic outputs, 2 assignable analog outputs
	Short Circuit	Phase to phase, phase to ground
	Electronic Motor Overload	Meets UL508C (I^2T)

Environmental Conditions	Temperature	0 to 50 °C Derate 3% per degree C above 50 to 55 °C maximum ambient temperature
	Cooling	0.5hp Natural; 1-10hp Forced air
	Enclosure	IP20
	Altitude	Sea level to 3300 Feet (1000 Meters) Derate 2% per 1000 Feet (303 Meters) above 3300 Feet to 6600 Feet (2000m) maximum
	Humidity	10 to 95% RH Non-Condensing
	Shock	1G
	Vibration	0.5G at 10Hz to 60Hz
	Storage Temperature	-20 to +60 °C
	Duty Cycle	1.0

Control Specifications	Control Method	V/Hz inverter, Sensorless vector
	PWM Frequency	Adjustable 8, 16 or 32kHz
	Speed Setting	0-10 VDC, 0-20 mA; digital (keypad)
	Accel/Decel	0-600 seconds
	Analog Output	0-10VDC, 10mA (1k ohm)
	Relay Output	30VDC@5A, 250VAC@5A

Operation at increased PWM frequency selection causes more heat build up within the drive. Therefore, derate the maximum operating temperature as shown here.

Drive Derating by PWM Carrier Frequency Selection

Catalog No.	Input Volt	Frame Size	Output			Maximum Ambient Temperature °C			
			HP	KW	Amps	8kHz	15kHz	24kHz	32kHz
VS1ST10P5-0	115, 1ph	A	0.5	0.37	2.3	50	50	50	45
VS1ST11-0	115, 1ph	A	1.0	0.75	4.3	50	50	45	40
VS1ST11P5-0T	115, 1ph	B	1.5	1.1	5.8	50	50	45	40
VS1ST80P5-0	230, 1ph	A	0.5	0.37	2.3	50	50	50	45
VS1ST81-0	230, 1ph	A	1.0	0.75	4.3	50	50	45	40
VS1ST82-0	230, 1ph	A	2.0	1.5	7.0	50	45	40	35
VS1ST82-0T	230, 1ph	B	2.0	1.5	7.0	50	50	45	40
VS1ST83-0T	230, 1ph	B	3.0	2.2	10.5	50	45	40	35
VS1ST20P5-0	230, 3ph	A	0.5	0.37	2.3	50	50	50	45
VS1ST21-0	230, 3ph	A	1.0	0.75	4.3	50	50	45	40
VS1ST22-0	230, 3ph	A	2.0	1.5	7.0	50	45	40	35
VS1ST22-0T	230, 3ph	B	2.0	1.5	7.0	50	50	45	40
VS1ST23-0T	230, 3ph	B	3.0	2.2	10.5	50	45	40	35
VS1ST25-0T	230, 3ph	C	5.0	3.7	18.0	50	45	40	35
VS1ST41-0	460, 3ph	A	1.0	0.75	2.2	50	50	45	40
VS1ST42-0	460, 3ph	A	2.0	1.5	4.1	50	45	40	35
VS1ST42-0T	460, 3ph	B	2.0	1.5	4.1	50	50	50	45
VS1ST43-0T	460, 3ph	B	3.0	2.2	5.8	50	50	45	40
VS1ST45-0T	460, 3ph	B	5.0	4.0	9.5	50	45	40	35
VS1ST47-0T	460, 3ph	C	7.5	5.5	14.0	50	50	45	40
VS1ST410-0T	460, 3ph	C	10.0	7.5	18.0	50	45	40	35

Appendix B
Parameter Tables

B.1 Parameters Sorted by Parameter Number

Param #	Access	Parameter Name	**Description** (Range)	Factory Setting	User Setting
P00	RO	Read Only Parameters	1-20		
P01	RW	Motor Rated Volts	0, 20-250VAC; or 0, 20-500VAC	0	
P02	RW	Motor Rated Current	25-100%	CALC	
P03	RW	Motor Rated Frequency	25 to 500 Hz	60	
P04	RW	Motor Rated Speed	0 to 30000 RPM	0	
P05	RW	Minimum Output Speed	0.0 to P06 (max 500.0Hz)	0.0	
P06	RW	Maximum Output Speed	P05 to 5*P03 (max 500Hz)	60.0	
P07	RW	Start/Stop Source	0- Terminal Strip, 1- Keypad FWD 2- Keypad bi-directional 3- MODBUS with accel / decel ramps. 4- MODBUS with accel / decel ramp adjustment. 5- User PI with external FDBK 6- User PI control Analog Input	0	
P08	RW	Operating Mode	0-12	0	
P09	RW	Stop Mode	0: Ramp to stop 1: Coast to stop. 2: Ramp to stop (fast stop)	0	
P10	RW	Accel Time	0 to 600 seconds	5.0	
P11	RW	Decel Time	0 to 600 seconds	5.0	
P12	RW	Preset Speed 1	-P06 to P06	0.0	
P13	RW	Preset Speed 2	-P06 to P06	0.0	
P14	RW	Preset Speed 3	-P06 to P06	0.0	
P15	RW	Preset Speed 4	-P06 to P06	0.0	
P16	RW	Speed Reference Scaling	0 to 500%	100.0	
P17	RW	Analog Input Format	0-10V, 0-20mA, 4-20mA, 20-4mA	V 0-10	
P18	RW	Voltage Boost	0.0 to 25.0%	CALC	

B.1 Parameters Sorted by Parameter Number Continued

Param #	Access	Parameter Name	Description (Range)	Factory Setting	User Setting
P19	RW	Energy Savings	0- Disabled, 1-Enabled	0	
P20	RW	Trip Log	N/A		
P21	RW	PWM Frequency	4 to 32 kHz	16	
P22	RW	Relay Output	0: Drive enabled 1: Drive healthy 2: Motor at target speed 3: Drive tripped 4: Motor speed >= limit 5: Motor current >= limit 6: Motor speed < limit 7: Motor current < limit	1	
P23	RW	Display Speed Scale Factor	Custom scaling factor used only if P-04 = 0, speed in Hz	0.000	
P24	RW	Analog Output	**Digital output mode** 0: Drive enabled 1: Drive healthy 2: Motor at target speed 3: Drive tripped 4: Motor speed >= limit 5: Motor current >= limit 6: Motor speed < limit 7: Motor current < limit **Analog output mode** 8: Motor speed 9: Motor current)	8	
P25	RW	Relay output limit	0.0 to 100.0%	100.0	
P26	RW	Skip Frequency	P-05 to P-06	0.0	
P27	RW	Skip Frequency Band	0 to P-06	0.0	
P28	RW	Restart Mode	0: Minimum Speed 1: Previous speed 2: Minimum speed (Auto-run) 3: Previous speed (Auto-run)	1	
P29	RW	Auto Restart Attempts	Edge-r; Auto-0; Auto-1-5	Auto-0	
P30	RW	Analog Input Offset	-500.0 to 500.0%	0.0	

B.1 Parameters Sorted by Parameter Number Continued

Param #	Access	Parameter Name	Description (Range)	Factory Setting	User Setting
P31	RW	Brake After Stop	0 to 60.0 seconds	0.0	
P32	RW	Brake Before Start	0 - The drive accelerates to speed without delay. 1 - Applies DC braking when run command is issued. The amount of time is set in P31 and the amount of braking in P18. The drive will then accelerate.)	0	
P33	RW	Decel2 Fast Stop	0 to 25 seconds	0.00	
P34	RW	Brake Chopper Enable	0: Disabled. 1: Enabled. 2: Enabled without s/w protection	0	
P35	RW	Serial Comms address Modbus enable / baudrate select Trip enable / delay	Addr: 0 (disable) to 63. OP-buS, 9.6, 19.2, 38.4, 57.6, 115.2 kBPS. 0 (no trip), t 30, 100, 1000, 3000 (ms) r 30, 100, 1000, 3000 (ms)	Adr 1 OP-BuS t3000	
P36	RW	V/F Frequency Adjustment	0 to P-03	0.0	
P37	RW	V/F Voltage Adjustment	0 - P-01	0	
P38	RW	User PI Proportional Gain	0.1 - 30.0	1.0	
P39	RW	User PI Integral time constant	0.0s - 30.0seconds	1.0	
P40	RW	User PI feedback mode	0: Direct 1: Inverse.	0	
P41	RW	User PI reference select	0: Digital 1: Analog.	0	
P42	RW	User PI digital reference	0 - 100.0%	0.0	
P43	RW	User PI feedback select	0: 2nd analog input 1: 1st analog input 2: motor load current	0	
P44	RW	2nd analog input format	0-10V, 0-20mA, t 4-20mA, r 4-20mA, t 20-4mA r 20-4mA	0-10V	
P45	RW	Parameter access lock	0: Parameters can be changed, 1: Read-only.	0	

Appendix C
CE Guidelines

C.1 CE Declaration of Conformity

Baldor indicates that the products are only components and not ready for immediate or instant use within the meaning of “Safety law of appliance”, “EMC Law” or “Machine directive”.

The final mode of operation is defined only after installation into the user’s equipment. It is the responsibility of the user to verify compliance.

C.2 EMC - Conformity and CE - Marking

The information contained herein is for your guidance only and does not guarantee that the installation will meet the requirements of the council directive 89/336/EEC.

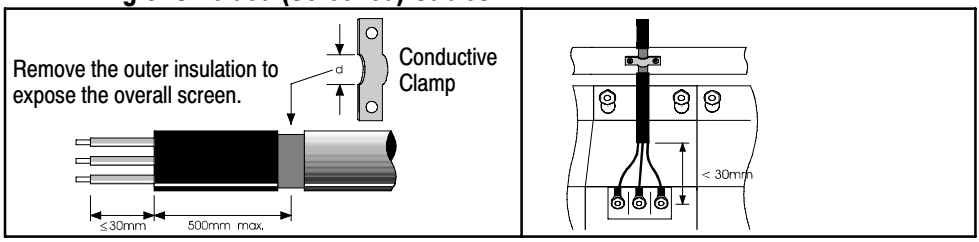
The purpose of the EEC directives is to state a minimum technical requirement common to all the member states within the European Union. In turn, these minimum technical requirements are intended to enhance the levels of safety both directly and indirectly.

Council directive 89/336/EEC relating to Electro Magnetic Compliance (EMC) indicates that it is the responsibility of the system integrator to ensure that the entire system complies with all relative directives at the time of installing into service.

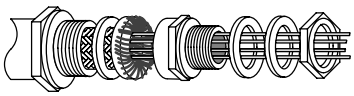
Motors and controls are used as components of a system, per the EMC directive. Hence all components, installation of the components, interconnection between components, and shielding and grounding of the system as a whole determines EMC compliance.

The CE mark does not inform the purchaser which directive the product complies with. It rests upon the manufacturer or his authorized representative to ensure the item in question complies fully with all the relative directives in force at the time of installing into service, in the same way as the system integrator previously mentioned. Remember, it is the instructions of installation and use, coupled with the product, that comply with the directive.

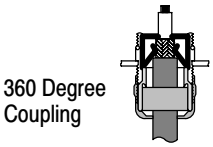
Wiring of Shielded (Screened) Cables



Shielded Couplings



360 Degree Coupling



360 Degree Coupling

Conductive 360 degree Clamp

EMC Installation Options

When installed for Class A or Class B operation, the control is compliant with EN55011 (1991)/ EN55022 (1994) for radiated emissions as described.

Grounding for Wall Mounting (Class A) also see Chapters 4 and 5.

Top cover must be installed.

- A single-star point (earth) is required.
- The protective earth connection (PE) to the motor must be run inside the screened cable or conduit between the motor and control and be connected to the protective earth terminal at the control.
- The internal/external AC supply filter must be permanently earthed.
- The signal/control cables must be screened.

Grounding for Enclosure Mounting (Class B) also see Chapters 4 and 5.

- The unit is installed for Class B operation when mounted inside an enclosure that has 10dB attenuation from 30 to 100MHz (typically the attenuation provided by a metal cabinet with no opening greater than 0.15m), using the recommended AC supply filter and having met all cable requirements.

Note: Radiated magnetic and electric fields inside the cubicle will be high and components installed inside must be sufficiently immune.

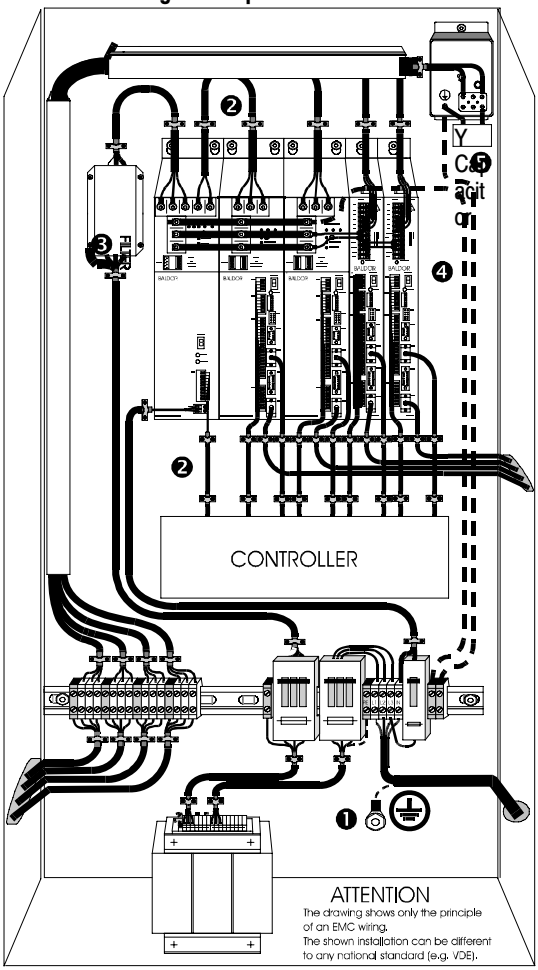
- The control, external filter and associated equipment are mounted onto a conducting, metal panel. Do not use enclosures that use insulating mounting panels or undefined mounting structures. Cables between the control and motor must be screened or in conduit and terminated at the control.

Using CE approved components will not guarantee a CE compliant system!

1. The components used in the drive, installation methods used, materials selected for interconnection of components are important.
2. The installation methods, interconnection materials, shielding, filtering and grounding of the system as a whole will determine CE compliance.
3. The responsibility of CE mark compliance rests entirely with the party who offers the end system for sale (such as an OEM or system integrator).

Baldor products which meet the EMC directive requirements are indicated with a “CE” mark. A signed CE declaration of conformity is provided in this section.

EMC Wiring Technique



1 **CABINET**
The drawing shows an electroplated zinc coated enclosure, which is connected to ground.
This enclosure has the following advantages:
- All parts mounted on the back plane are connected to ground.
- All shield (screen) connections are connected to ground.
Within the cabinet there should be a spatial separation between power wiring (motor and AC power cables) and control wiring.

2 **SCREEN CONNECTIONS**
All connections between components must use shielded cables. The cable shields must be connected to the enclosure. Use conductive clamps to ensure good ground connection. With this technique, a good ground shield can be achieved.

3 **EMC - FILTER**
The EMI or main filter should be mounted next to the power supply (here BPS). For the connection to and from the main filter screened cables should be used. The cable screens should be connected to screen clamps on both sides. (Exception: Analog Command Signal).

4 **Grounding (Earth)**
For safety reasons (VDE0160), all BALDOR components must be connected to ground with a separate wire. The diameter of the wire must be at minimum AWG#6 (10mm^2). Ground connections (dashed lines) must be made from the central ground to the regen resistor enclosure and from the central ground to the Shared Power Supply.

5 **Y-CAPACITOR**
The connection of the regeneration resistor can cause RFI (radio frequency interference) to be very high. To minimize RFI, a Y-capacitor is used. The capacitor should only be connected between the dynamic brake resistor housing and terminal pin R1 (lead from Lin).

C.3 EMC Installation Instructions

To ensure electromagnetic compatibility (EMC), the following installation instructions should be completed. These steps help to reduce interference.
Consider the following:

- Grounding of all system elements to a central ground point
- Shielding of all cables and signal wires
- Filtering of power lines

A proper enclosure should have the following characteristics:

A) All metal conducting parts of the enclosure must be electrically connected to the back plane. These connections should be made with a grounding strap from each element to a central grounding point. [1]

B) Keep the power wiring (motor and power cable) and control wiring separated. If these wires must cross, be sure they cross at 90 degrees to minimize noise due to induction.

C) The shield connections of the signal and power cables should be connected to the screen rails or clamps. The screen rails or clamps should be conductive clamps fastened to the cabinet. [2]

D) The cable to the regeneration resistor must be shielded. The shield must be connected to ground at both ends.

E) The location of the AC mains filter has to be situated close to the drive so the AC power wires are as short as possible.

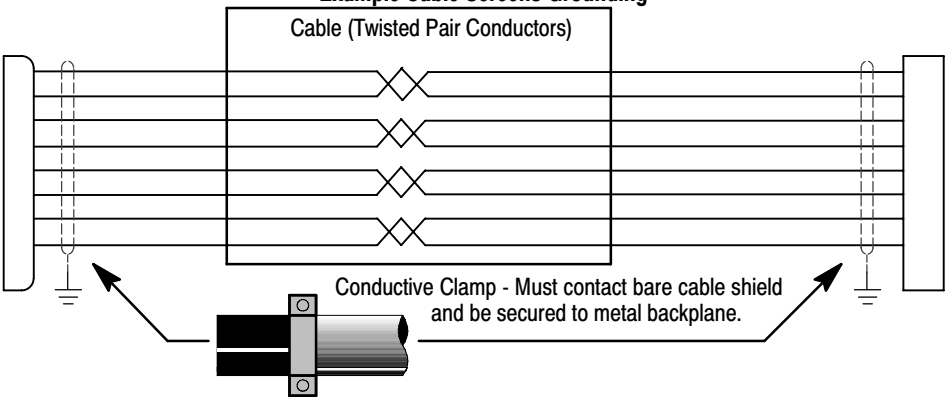
F) Wires inside the enclosure should be placed as close as possible to conducting metal, cabinet walls and plates. It is advised to terminate unused wires to chassis ground. [1]

G) To reduce ground current, use at least a 10mm^2 (6 AWG) solid wire for ground connections.

[1] Grounding in general describes all metal parts which can be connected to a protective conductor, e.g. housing of cabinet, motor housing, etc. to a central ground point. This central ground point is then connected to the main plant (or building) ground.

[2] Or run as twisted pair at minimum.

Example Cable Screens Grounding

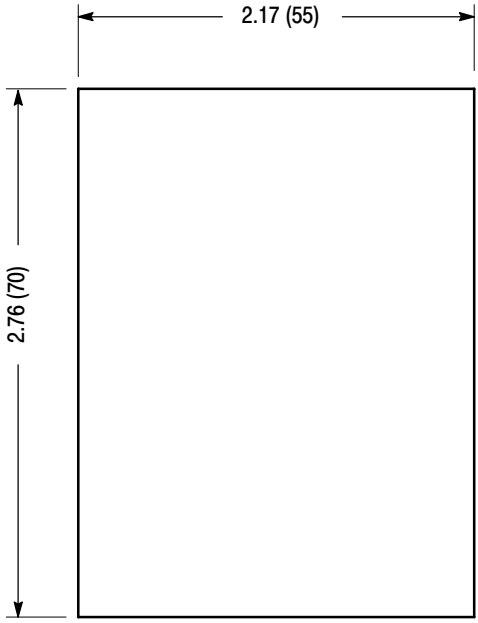


Appendix D
Options & Kits

D.1 Remote Keypad Option

Catalog Number	Description
VS1ST-RKEY3	VS1ST Remote Keypad and 9 ft (3m) cable

Figure 7-1 Remote Keypad Mounting
Note: Template may be distorted due to reproduction.



1. Cut a rectangular opening at the enclosure mounting location using the Figure 7-1 as a template.
2. Remove the covering from the adhesive backing on the rear of the keypad.
3. The Remote keypad snaps into place. Simply press into the mounting location to seal.
4. Attach one end of the remote cable in the keypad connector of the control.
5. Attach the other end of the remote cable to the remote keypad.

D.2 Accessories

Remote Keypad for VS1ST

The VS1ST Remote Keypad can be panel mounted for remote control or display of the drive.
The remote keypad comes with a standard 3.0 meter cable.

Catalog Number	Description
VS1ST-RKEY3	VS1ST Remote Keypad with 3m cable

Optional Cables for VS1ST

Option cable assemblies for setting up and connecting a simple serial network

Catalog Number	Description
VS1ST-J45SP	RJ45 Cable Splitter
VS1ST-CBL0P5	0.5m RJ45 Cable
VS1ST-CBL1	1m RJ45 Cable
VS1ST-CBL3	3m RJ45 Cable

VS1ST Dynamic Braking Resistors

VS1ST Frame B and C drives include built-in braking transistors to aid in applications requiring the ability to stop rapidly. The resistor kits are designed specifically for the VS1ST and mount internally to the drive, Figure 7-2. The brake resistor fits into the drive as shown and is secured in place using 2 * M4 screws into the rear of the drive. The two wires connect to the +DC and BR terminals on the power strip of the size B or larger enclosure. Refer to Table 7-2 for minimum brake resistor values.

Figure 7-2 Dynamic Brake Resistor Installation

When internal brake resistor is used, set P-34= 1. This provides software thermal protection for internal brake resistors 200W.

When external brake resistor is used, set P-34= 2. No software thermal protection is provided in this setting so external thermal device is required.

Catalog Number	Ohms	Wattage	Frame
VS1ST-R100W200	100	200	B & C

Table 7-2 Minimum Resistor Values

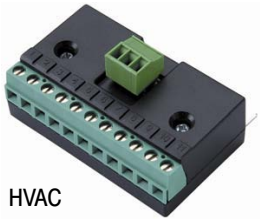
Drive Voltage Rating			Minimum Resistor Value (ohms)
Volts	HP	kW	
115VAC	2	-	47
230VAC	2 to 5	1.5 to 4	47
460VAC	2 to 3	1.5 to 2.2	47
	5	4	33
	7.5 to 10	5.5 to 7.8	22

CopyCat Loader
Connects to the RJ45 Port on the front of the VS1ST and allows the upload or download of software parameters.

Catalog Number	Description
VS1ST-CCL	VS1ST RJ45 CopyCat Loader

Relay Output Cards for VS1ST
Provides additional relay outputs for signal and control


2ROUT


HVAC

Catalog Number	Description
VS1ST-2ROUT	Provides one additional relay output for the drive
VS1ST-HVAC	Provides 2 relays for drive running & drive tripped indicators
VS1ST-LOGHV-1 1	Provides the ability to accept 100-120VAC control inputs
VS1ST-LOGHV-23	Provides the ability to accept 200-240VAC control inputs

VS1ST Field Bus Gateways
Connects the VS1ST Modbus RTU RS485 communication interface to the field bus gateway

VS1ST-PBUS	Profibus Gateway
VS1ST-DNET	DeviceNet Gateway
VS1ST-ENET	Ethernet Gateway

Appendix E
RS485/MODBUS Protocol

E.1 Introduction

The VS1ST AC Drive is supplied with imbedded RS-485 communications that supports the Modbus-RTU protocol. This allows the user to set up a multi-drop communications network between multiple VS1ST drives and a PLC or host computer without the requirement of option boards for the drives. This is a master-slave architecture where the master (e.g. PLC) can monitor and control multiple VS1ST drives on the same network with other Modbus-RTU slaves.

This appendix defines the specifics needed to set up a VS1ST on an RS-485 network running the Modbus-RTU protocol and documents the function codes and exception codes supported by the VS1ST. For a complete definition of the Modbus-RTU protocol and the content of specific messages see www.modbus.org.

E.2 Installation

1. Connect the RS485 communication line to RJ45 connector, (see Chapter 5) .
2. Check the connections and turn ON the inverter.
3. This table documents the parameters within the VS1ST that are related to communications:

Number	Name	Comments
P07	Start/Stop Source	Set to 3 or 4 for applications that require network control to start and stop the over the network
P35	Drive Address	Set to the desired Modbus-RTU address (note that each device on the network must have a unique address)
P35	Baud Rate	Select the baud rate utilized by the master device on the network. All devices on the network must utilize the same baud rate
P35	Trip Enable Delay	Set to desired trip response to a loss of communications

4. Make connection to the master and other slave devices.
   The maximum number of drives that can be connected is 31.
   Maximum length of communication line is 2300 ft (700m).

E.3 Operation

1. Remove all power from the VS1ST control.
2. Disconnect the motor load from the control (terminals U, V and W). (Do not connect the motor load until stable communication between the master controller and the inverter is verified.)
3. Verify master controller and the inverter connections.
4. Turn ON the inverter.
5. Start the communications program on the master controller.
6. Verify proper communications and that the VS1ST is controlled as desired.
7. Remove all power from the VS1ST control.
8. Connect the motor load to the control (terminals U, V and W).
9. Turn ON the inverter.
10. Verify proper operation. See Troubleshooting at the end of this section to aid in resolving any remaining problems.

E.4 Performance Specifications

Communication Method	RS485 Hardware specification, MODBUS protocol
Transmission Form	Bus method, Multi drop Master/Slave architecture
Applicable inverter	VS1ST series
Connectable drives	Max 31
Transmission distance	Max. 2,300 ft (Repeater may be required for high noise environments)

E.5 Hardware Specifications

Installation	Use RJ45 connector on control (see Chapter 5)
Power supply	Provided by isolated power from the inverter power supply

E.6 Communications Specifications

Communication speed	19200, 9600, 4800, 2400, 1200 bps selectable
Control procedure	Asynchronous communication system
Communication	Half Duplex
Characters (Data bits)	ASCII (8 bit)
Start bits	1 bits
Stop bits	1 bits
Check Sum	2 byte CRC
Parity	None

E.7 Communications Protocol (MODBUS-RTU)

Use Modbus-RTU protocol (Open Protocol)

Requires computer or other host to be network Master and inverters to be Slaves. Inverters respond to Read/Write commands from the Master.

Table 7-3 Supported Function Calls

Register	Upper byte	Lower Byte	Command	Type
1*	Command		03,06	R/W
2*	Speed reference		03,06	R/W
3*	Reserved		03,06	R/W
4*	Modbus ramp control time		03,06	R/W
5	Reserved		03	R
6*	Error code	Drive status	03	R
7*	Motor speed		03	R
8*	Motor current		03	R
9*	Reserved		03	R
10	Reserved		03	R
11	Digital input status		03	R
12	Rating ID		03	R
13	Power rating		03	R
14	Voltage rating		03	R
15	IO processor software version		03	R
16	Motor control processor software version		03	R
17	Drive type		03	R
18	Reserved		03	R
19	Reserved		03	R
20	Analog 1 input result		03	R
21	Analog 2 input result		03	R
22	Speed reference value		03	R
23	DC bus voltages		03	R
24	Drive temperature		03	R
25 to 30	Reserved		03	R

* Registers are available in standard field bus gateway configuration

E.7.1 Register Descriptions

Read and write register

Register 1: Drive command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High byte								Low byte							

Bit 0: Run/Stop command: Set to 1 to enable the drive. Set to 0 to stop the drive.

Bit 1: Fast stop request. Set to 1 to enable drive to stop with 2nd deceleration ramp.

Bit 2: Reset request. Set to 1 in order to reset the drive if drive is under trip condition.
User must clear this bit when drive is under normal condition to prevent unexpected reset.

Bit 3: Coast stop request. Set to 1 to issue a coast stop command.

For normal operation, Bit 3 has the highest priority, Bit 0 has the lowest priority (bit 3>bit 1>bit 0).

Example: If user set command as 0x0009, drive will do a coast stop rather than run. For normal run/start, set register to 1.

Note that start/stop (bit 0), fast stop (bit 1) and coast stop (bit 3) only works if P-28 [Restart Mode] = 0 or 1. Otherwise, start/stop function is controlled by drive control terminals.
Reset function (bit 2) works all the time as long as drive is operated under Modbus control mode (P-07 [Control Source Select] = 3 or 4).

Register 2: speed reference setup

This register holds the speed reference value. The input data is 16bits integer and includes one decimal place. For example, value 500 represents 50.0Hz, value 123 gives 12.3Hz. To get negative speed reference, user needs put negative value into this register. For example, -1(0xFFFF) gives -0.1Hz. -234(0xFF16) gives -23.4Hz. The input value range from -5000 (0 for single phase output drive) to +5000, however the drive output speed will be limited by the maximum speed set by P-06.

Register 4: Modbus ramp control time

This register specifies the drive acceleration and deceleration ramp time. User can only write to this register when P-07 is set to 4. The input data range is from 0 to 60000 (0.00s to 600.00s)

Read only register

Register 6: Drive status and error code

High byte gives drive error code. (Valid when drive tripped, see appendix for details)
Low byte gives drive status (0: drive stopped, 1: drive running, 2: drive tipped)

Register 7: Motor speed information

This register gives motor speed information. The data is 16bits integer with one decimal place.
For example, value 123 gives 12.3Hz. Value -234 (0xFF16) gives -23.4Hz.

Register 8: Motor current

This register gives motor current information. The data is 16bits integer with one decimal place.
For example, 156 = 15.6A, 12 = 1.2A.

Register 11: Digital input status

The value in this register represents the drive terminal digital input status (Digital input 1 to 4).
Lowest bit indicates digital input 1 status.

Register 12: Rating ID

The value in this parameter includes specific drive ID information, and is not recommended to be used in general application by the customer.

Register 13: Power rating

This gives the drive power rating information, value includes two decimal places.
The unit of this register depends on the drive type (KW/HP)

Register 14: Voltage level. This register gives the rated input voltage for the drive.
230: 230V 400: 400V 460: 460V

Register 15: IO software version

This register contains the drive IO software version info. Value includes two decimal places. For example, 100 means version 1.00

Register 16: Motor control processor software version

This register contains the software version information of the motor control processor.

Value includes two decimal places. For example, 100 means version 1.00

Register 17: Drive type

This register gives drive internal type code.

Register 20: Analog input 1 value

This register gives drive analog input 1 value after scaling and offset control. Value 4096 = 100%.

Register 21: Analog input 2 value

This register gives drive analog input 2 value after scaling and offset control. Value 4096 = 100%.

Register 22: Speed reference value. This register contains the reference speed information that being used by the drive for motor speed control.

The data is in Hz and with one decimal place (for example, 234 = 23.4Hz)

Register 23: DC bus voltage

This register contains drive internal DC bus voltage information. Data unit is Volt.

Register 24: Drive temperature

This register contains drive temperature information. Data is in Celsius with no decimal place.

Parameter Registers (Support command 03 and 06)

Adr	Description	Data range	Data format
129	Motor Rated Voltage	0, 20 to 250 V 0, 20 to 500 V	
130	Motor Rated Current	Drive dependent	One decimal place 300=30.0A
131	Motor Rated Frequency	25 to 500	Data unit is in Hz
132	Motor Rated Speed	0 to Sync speed	Maximum value equals to the sync speed of a typical 2-pole motor
133	Min Speed Limit	0 to P-01	Internal value (3000 = 50.0Hz)
134	Max Speed Limit	0 to 50 * P-09	Internal value (3000 = 50.0Hz)
135	Start/Stop Source	0 to 6	0: Terminal 1: Keypad forward only 2: Keypad forward and reverse 3: Modbus control mode 4: Modbus control with ramp control 5 : PID control 6 : PID control with analog speed sum
136	Operating Mode	0 to 12	See Chapter 7 for details
137	Stop Mode	0 to 2	0: Ramp to stop 1: Coast to stop 2: Ramp to stop
138	Accel Time	0 to 6000	One decimal place 300=3.00s
139	Decel Time	0 to 6000	One decimal place 300=3.00s

Adr	Description	Data range	Data format
140	Preset Speed 1	-P06 to P06	Internal value (3000 = 50.0Hz)
141	Preset Speed 2	-P06 to P06	Internal value (3000 = 50.0Hz)
142	Preset Speed 3	-P06 to P06	Internal value (3000 = 50.0Hz)
143	Preset Speed 4	-P06 to P06	Internal value (3000 = 50.0Hz)
144	Speed Reference Scaling	0-5000	100 = 10%
145	Analog Input Format	0-6	0: 0-10V 1: b 0-10V 2: 0-20mA 3: t 4-20mA 4: r 4-20mA 5: t 20-4mA 6: r 20-4mA
146	Voltage Boost	0-200	100 = 10.0%
147	Energy Savings	0, 1	0: Disable 1: Enable
148	Trip Log		Last four trips (See E.7.2 Drive Error Codes)
149	PWM Frequency	0-5	0 = 4kHz, 1 = 8kHz, 2 = 12kHz 3 =16kHz, 4 = 24kHz, 5 = 32kHz
150	Relay Output	0-7	See user guide for function details
151	Display Speed Scale Factor	0-6000	100 = 0.100
152	Analog Output	0-9	See user guide for function details
153	Relay output limit	0-1000	100 = 10.0%
154	Skip Frequency	0 to P01	Internal value (3000 = 50.0Hz)
155	Skip Frequency Band	0 to P01	Internal value (3000 = 50.0Hz)
156	Restart Mode	0-3	See user guide for details
157	Auto Restart Attempts	0-6	0: Edgr-r 1: Auto_0 2-6: Auto_1 to Auto_5
158	Analog Input Offset	-5000 to 5000	One decimal place 300=30.0%
159	Brake After Stop	0-600 seconds	One decimal place 100=10.0 sec
160	Brake Before Start	0-1	0 - No brake. 1 - DC braking when run command is issued.
161	Decel2 Fast Stop	0-2500	Two decimal places 1000=10.00 sec
162	Brake Chopper Enable	0-2	0 : Disabled. 1 : Enabled. 2 : Enabled without s/w protection
163	Serial Comms address	0-63	Drive comms address
	Modbus enable / baudrate select	1-6	1 = Optibus (or MXSTBus) fixed baudrate 2 = 9K6 3 = 19K2 4 = 38K4 5 = 57K6 6 = 115K2
	Trip enable / delay	0-8	0 (no trip), t 30, 100, 1000, 3000 (ms) r 30, 100, 1000, 3000 (ms)

Adr	Description	Data range	Data format
164	V/F Frequency Adjustment	0 to P09	60 = 60Hz
165	V/F Voltage Adjustment	0 to P07	100 = 100V
166	User PI Proportional Gain	1-300	10 = 1.0
167	User PI Integral time constant	0-300	10 = 1.0s
168	User PI feedback mode	0-1	0: Direct, 1: Inverse
169	User PI reference select	0-1	0: Digital, 1: Analog.
170	User PI digital reference		100 =10.0%
171	User PI feedback select	0-3	0 : 2nd analog input 1 : 1st analog input 2 : motor load current
172	2nd analog input format	0-5	0: 0-10V 1: 0-20mA 2: t 4-20mA 3: r 4-20mA 4: t 20-4mA 5: r 20-4mA
173	Parameter access lock	0 or 1	0: Unlock 1: Locked

E.7.2 Drive Error Codes

0x00 No trip
0x01 Brake circuit over current (short circuit)
0x02 Brake circuit overload
0x03 Drive output over current
0x04 Motor overload
0x05 Power stage trip
0x06 DC bus over voltage trip
0x07 DC bus under voltage trip
0x08 Over temperature trip
0x09 Under temperature trip
0x0A Parameter default
0x0B External trip
0x0C Communication data link loss trip
0x0D Phase imbalance trip
0x0E Phase loss trip
0x0F Spin start failure
0x10 Thermistor fault
0x11 Flash data error fault
0x12 4..20mA /20..4mA input signal error

E.7.3 Data Flow Examples

1 Read Data from Register 6.

Request:	[01]	[03]	[00] [05]	[00] [01]	[94] [0B]
	(Drive Addr)	(Command)	(Reg start addr)	(No. of Registers)	(Checksum)
Reply:	[01]	[03]	[02]	[00] [00]	[B8] [44]
	(Drive Addr)	(Command)	(No of data bytes)	(Data)	(Checksum)

Note: The actual start address of register 6 is 5. All data in [ ] is in 8bits Hex format.

2 Write start command to the register 1 (assumes P-07=3, P-08=0 and Digital Input1=Closed)

Request:	[01]	[06]	[00] [00]	[00] [01]	[48] [0A]
	(Drive Addr)	(Command)	(Reg addr)	(Data value)	(Checksum)
Reply:	[01]	[06]	[00] [00]	[00] [01]	[48] [0A]
	(Drive Addr)	(Command)	(Reg addr)	(Data value)	(Checksum)

Note: The actual address of register 1 on the data link is 0. All data in [ ] is in 8bits Hex format.
Reply can be error message depending on drive parameter settings and digital input status.

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MN767 2/08