BALDOR®
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VS1ST
AC Microdrive

11/11 **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 VS1ST product. Also you can download the latest version of this manual in Adobe Acrobat PDF format.

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Appendix E

RS485/MODBUS Protocol

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. You will be asked for the drive model number or catalog number that is located on the Nameplate along with the drive serial number.

1.2 Safety Notices

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: **Indicates a potentially hazardous situation which, if not avoided, could result in injury or death.**

CAUTION: **Indicates a potentially hazardous situation which, if not avoided, could result in damage to property.**

PRECAUTIONS

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

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

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

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

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

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

WARNING: **MEDICAL DEVICE/PACEMAKER DANGER - Magnetic and electromagnetic fields in the vicinity of current carrying conductors and industrial motors can result in a serious health hazard to persons with cardiac pacemakers, internal cardiac defibrillators, neurostimulators, metal implants, cochlear implants, hearing aids, and other medical devices. To avoid risk, stay away from the area surrounding a motor and its current carrying conductors.**

CAUTION: **Disconnect motor leads (U, V and W) from control before you perform a dielectric withstand (insulation) 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 the Underwriters 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
1-15	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 does not recommend using "Grounded Leg Delta" transformer supplies that may create ground loops. Instead, we recommend using a four wire Wye.**

CAUTION: **If the DB hardware mounting is 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 the keypad. Damage associated with other cable types are not covered by the Baldor warranty.**

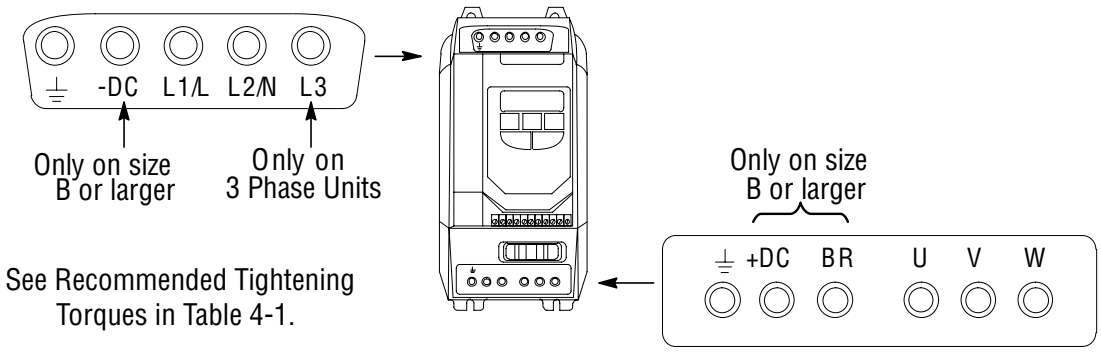
CAUTION: **If an M-Contactor is installed, the control must be disabled for at least 200msec before the M-Contactor is opened. If the M-Contactor is opened while the control is supplying voltage and current to the motor, the control may be damaged. Before the control is enabled, the M-Contactor must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

CAUTION: **Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electric Code and any additional local codes.**

1.3 Quick Start (Quick Start Guide MS767 is also available separately.)

Figure 1-1 Power & Motor Terminal Locations



Power Up Procedure (Refer to Chapter 3, 4 and 5 for additional details.)

1. Remove all power from the control.
2. Couple the motor to its load.
3. Verify freedom of motion of motor shaft.
4. Verify the motor coupling is tight without backlash.
5. Connect input control wires and output control wires, See Figure 1-2.
6. Connect a control switch between terminals 1 and 2 ensuring that the contact is open (drive disabled).
7. Connect Power & Motor wires to the control, See Figure 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 P07 = 1 or 2 (Start/Stop Source).
11. Verify the holding brakes if any, are properly adjusted to fully release and set to the desired torque.
12. Enable the drive by closing the switch between control terminals 1 & 2.
13. Run the drive from the keypad.
14. Select and program additional parameters to suit your application, see Chapter 7.

The control is now ready for use in the 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 desired. Remove all power from the control and then remove the jumper at 1 & 2 of the control terminal strip.

Figure 1-2 Input Connections

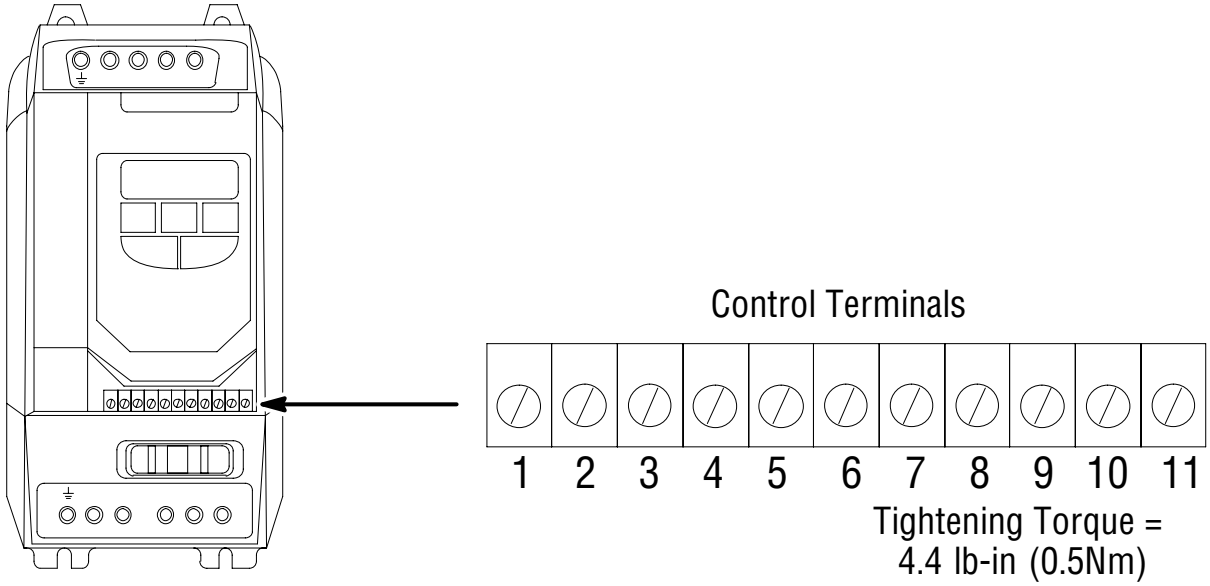


Table 1-1 Control Terminal Descriptions

Terminal	Signal Description
1	+24VDC (@ 100 mA)
2	Digital In1 (8-30 VDC)
3	Digital In2 (8-30 VDC)
4	Digital In3 (8-30 VDC)/ Analog In2 (0-10 VDC, 0-20mA or 4-20mA)
5	+10VDC (@ 10 mA) Reference for Potentiometer (1kohm minimum)
6	Analog In1 (0-10 VDC, 0-20mA or 4-20mA) / Digital In4 (8-30 VDC)
7	Common (terminals 7 & 9 are connected)
8	Analog Output (0-10 VDC @ 20mA max) / Digital Output (0-24 VDC)
9	Common (terminals 7 & 9 are connected)
10	Relay Common
11	Relay N.O. Contact (rated 250VAC@6A; 30VDC@5A)

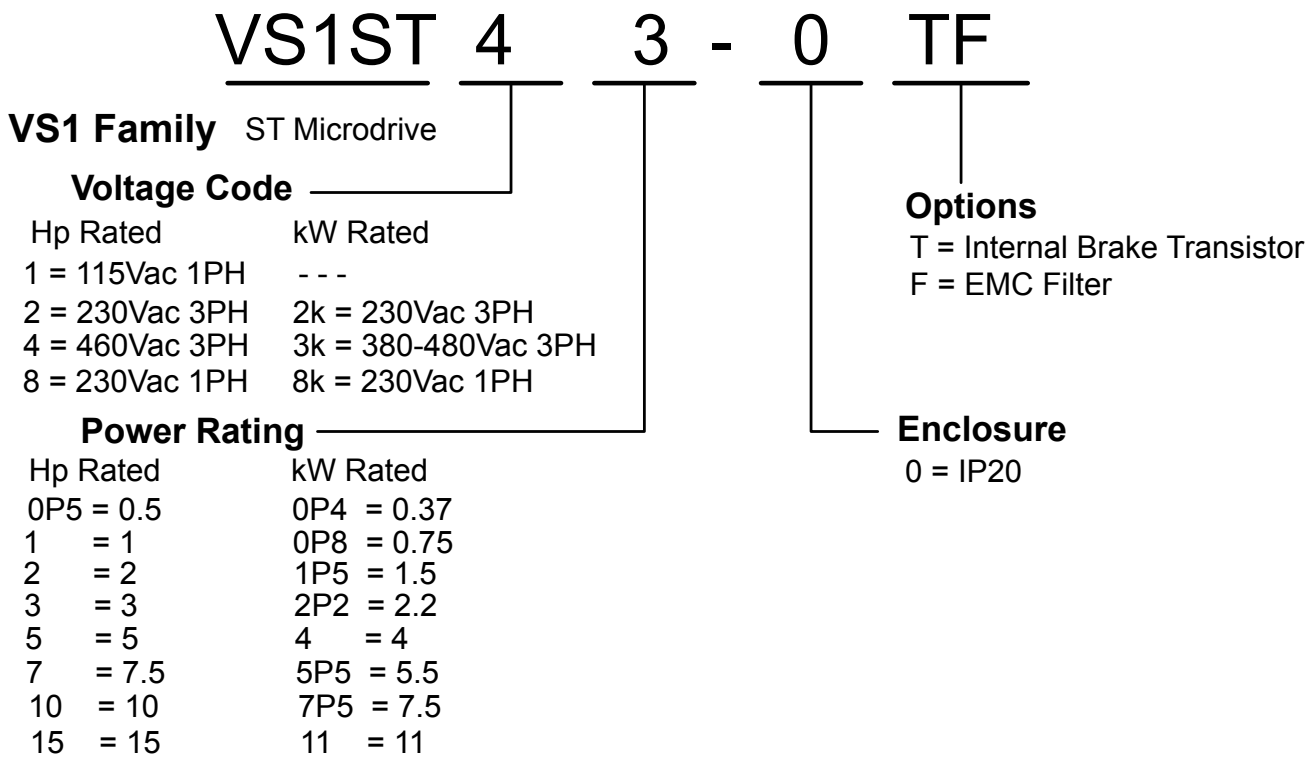
Chapter 2
General Information and Ratings

The VS1ST is an adjustable 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 2-1. The model number is one the shipping label and the drive nameplate. The model number includes the drive and any options.

Figure 2-1 Drive Identification



2.2 Storage Guidelines

Follow these recommendations to prolong drive life and performance if storing the drive:
1. Storage surrounding temperature is -40°C to 60°C.
2. Storage Humidity range 10% to 95% RH non-condensing.
3. Do not expose to corrosive atmosphere.

2.3 VS1ST Ratings, Model Numbers and Frame Sizes

Table 2-1 Drive Ratings

HP Model Number	kW Model Number	HP	kW	Current (Amps)		Frame	Watts Loss
				Input	Output		
110-115V +/-10% 1-Phase Input, 230V 3-Phase Output							
VS1ST10P5-0	---	0.5	---	6.7	2.3	A	45
VS1ST11-0	---	1	---	12.5	4.3	A	90
VS1ST11P5-0T	---	1.5	---	16.8	5.8	B	130
200-240V +/-10% 1-Phase Input, 230V 3-Phase Output							
VS1ST80P5-0	VS1ST8K0P4-0	0.5	0.37	6.7	2.3	A	22
VS1ST81-0	VS1ST8K0P8-0	1	0.75	12.5	4.3	A	45
VS1ST82-0	VS1ST8K1P5-0	2	1.5	14.8	7	A	90
VS1ST82-0T	VS1ST8K1P5-0T	2	1.5	14.8	7	B	90
VS1ST83-0T	VS1ST8K2P2-0T	3	2.2	22.2	10.5	B	130
200-240V +/-10% 3-Phase Input							
VS1ST20P5-0	VS1ST2K0P4-0	0.5	0.37	3	2.3	A	22
VS1ST21-0	VS1ST2K0P8-0	1	0.75	5.8	4.3	A	45
VS1ST22-0	VS1ST2K1P5-0	2	1.5	9.2	7	A	90
VS1ST22-0T	VS1ST2K1P5-0T	2	1.5	9.2	7	B	90
VS1ST23-0T	VS1ST2K2P2-0T	3	2.2	13.7	10.5	B	130
VS1ST25-0T	VS1ST2K4-0T	5	4	20.7	18	C	240
380-480V +/-10% 3-Phase Input							
VS1ST41-0	VS1ST3K0P8-0	1	0.75	2.9	2.2	A	50
VS1ST42-0	VS1ST3K1P5-0	2	1.5	5.4	4.1	A	90
VS1ST42-0T	VS1ST3K1P5-0T	2	1.5	5.4	4.1	B	90
VS1ST43-0T	VS1ST3K2P2-0T	3	2.2	7.6	5.8	B	130
VS1ST45-0T	VS1ST3K4-0T	5	4	12.4	9.5	B	240
VS1ST47-0T	VS1ST3K5P5-0T	7.5	5.5	16.1	14	C	280
VS1ST410-0T	VS1ST3K7P5-0T	10	7.5	20.7	18	C	380
VS1ST415-0T	VS1ST3K11-0T	15	11	27.1	24	C	380

Note: Ratings apply to EMC Filter ratings designated by the –F in the suffix of the model number.

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, make 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 drive's 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:
- Operating surrounding temperature must be within 14°F (-10°C) to 122°F (50°C).
  If temperature exceeds 50°C, de-rate the output by 5% per °C above 50°C up to 55°C maximum surrounding temperature.
- 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.

3.2.2 Elevation

Maximum elevation is 3300 ft (1000m) above sea level without de-rating. De-rate output power by 1% per 330 ft (100m) about 3300 ft to 6600 ft (2000m) maximum elevation.

Table 3-1 Surrounding Temperatures and Mounting Clearances

Surrounding Temperature		Enclosure Rating	Minimum Mounting Clearances (Vertical)
Minimum	Maximum		
14°F (-10°C)	122°F (50°C)	IP20	2 in (50mm)

3.3 Mounting the Drive

For applications that require a higher IP rating than the IP20 offered by the standard drive, mount in an enclosure following the guidelines below.
- Mount the drive upright on a flat, vertical, level surface.
- Use Figure 3-1 for mounting hole locations.
- Any enclosure should be made from a thermally conductive material.
- When vented enclosures are used, there should be venting above the drive and below the drive to ensure good air circulation. Air should be drawn in below the drive and expelled above the drive.
- If the external environment contains contamination particles such as dust, a suitable particle filter should be fitted to the vents and forced ventilation implemented. The filter must be serviced / cleaned appropriately.
- High moisture, salt or chemical content environments should use a suitable sealed (non-ventilated) enclosure.

3.3.1 Watts Loss Data

Refer to Table 2-1 for watts loss data.

3.3.2 Mounting Clearances

Provide proper top, bottom and side clearance using Table 3-2.

Table 3-2 Minimum Mounting Clearances

Frame Size	Recommended Clearance (Minimum)						Recommended Air Flow
	Top Clearance		Either Side		Between		
	in	mm	in	mm	in	mm	
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

Figure 3-1 IP20 Mounting Hole Locations

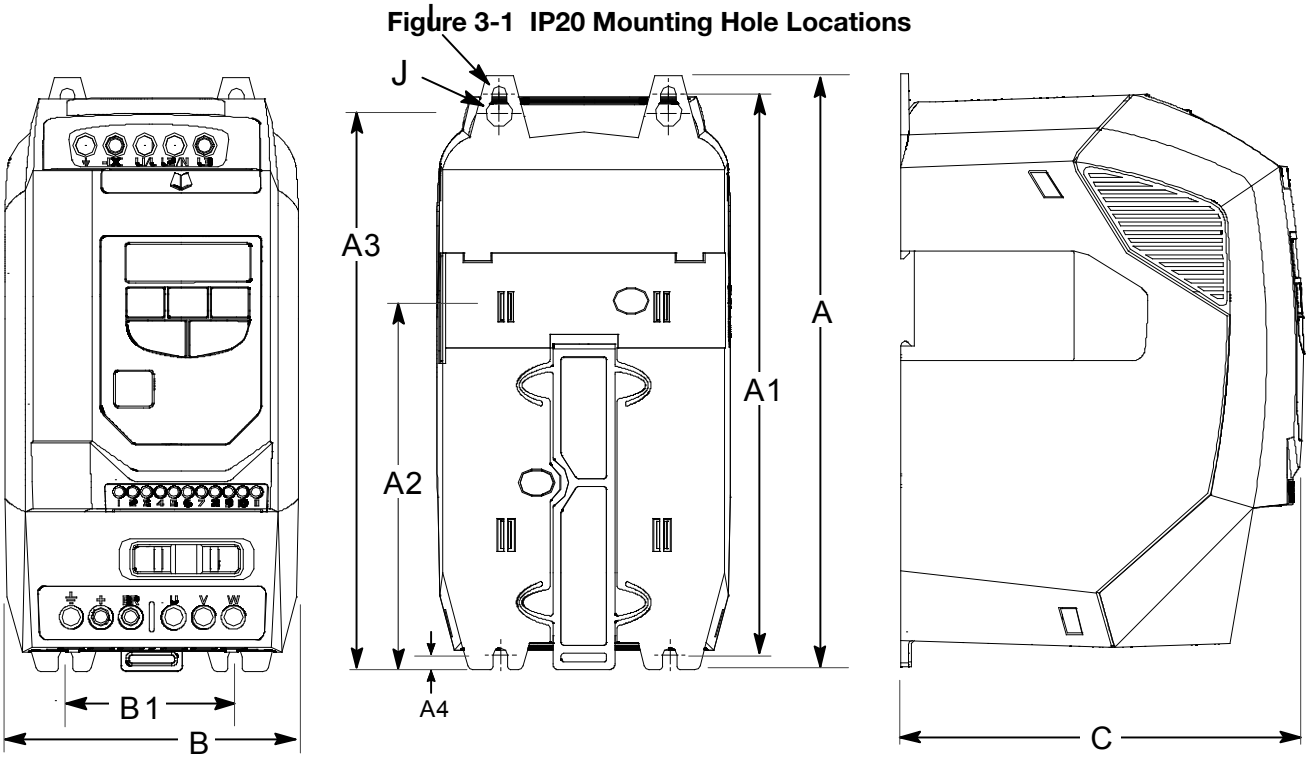


Table 3-3 IP20 Drive Dimensions

Frame	A	A1	A2	A3	A4	B	B1	I Φ	J Φ	C (Depth	Weight	
	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	lb	kg
A	6.81 173	6.38 162	4.29 109	6.30 160	0.20 5	3.23 82	1.97 50	0.22 5.5	0.39 10	4.84 123	2.42	1.1
B	8.70 221	8.23 209	5.39 137	8.15 207	0.21 5.3	4.29 109	2.48 63	0.22 5.5	0.39 10	5.91 150	5.73	2.6
C	10.28 261	9.72 247	---	9.69 246	0.24 6	5.16 131	3.15 80	0.22 5.5	0.39 10	6.89 175	8.82	4.0

Chapter 4
Power Wiring

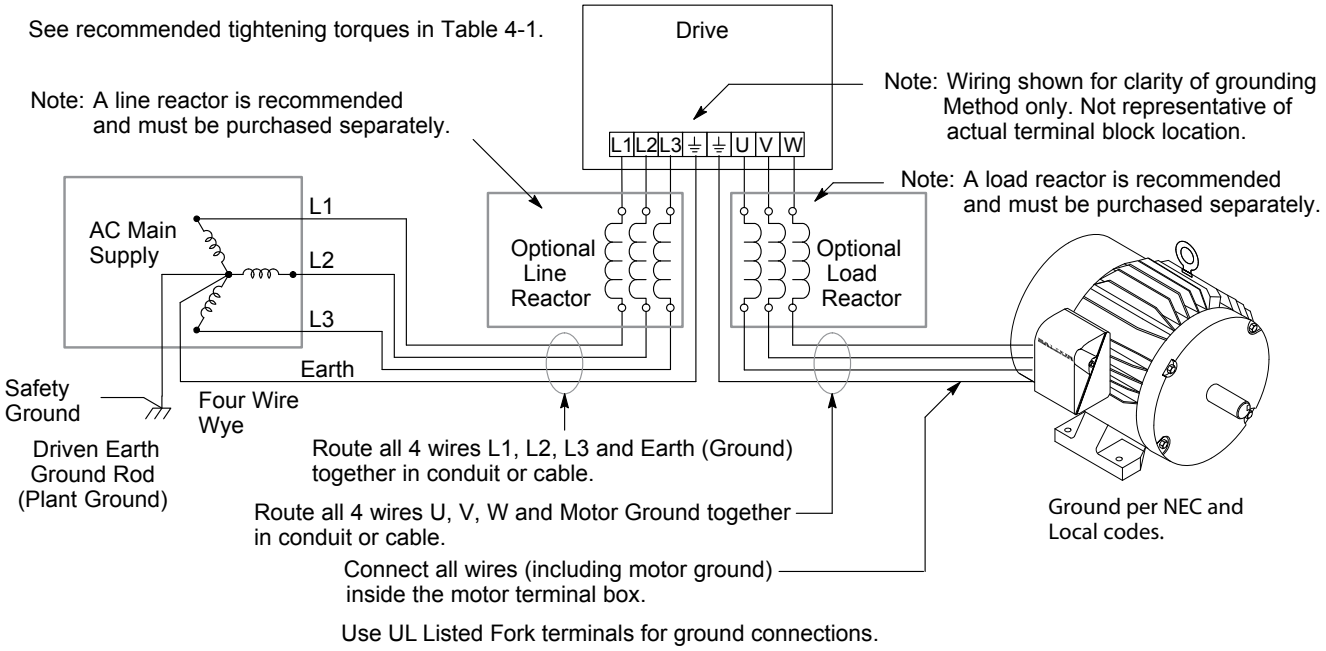
4.1 Overview of Power Connections

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

4.1.1 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



4.1.2 Motor Ground

The motor ground must be connected to one of the ground terminals on the drive. Use UL Listed Fork terminals for ground connections.

4.1.3 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.

4.1.4 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 surrounding 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 M4 Fork 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.

4.4.1 Branch Circuit Protection

These devices require branch circuit protection. Branch circuit protection shall be provided. The size of the Branch Circuit Protection Fuse shall be as shown in the ratings table or equivalent.

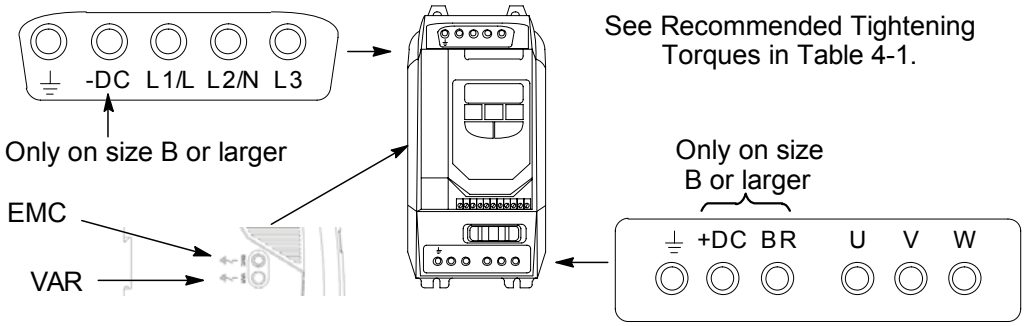
4.4.2 Single Phase Input Power Connections for 1 Phase Control

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.

4.4.3 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).

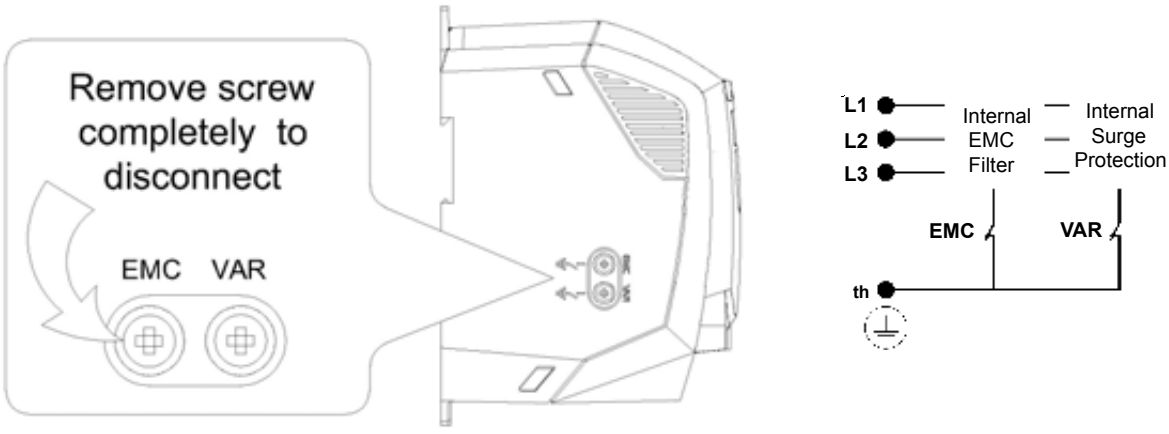
Figure 4-2 Wiring Locations



4.4.4 EMC and VAR Screws

Figure 4-3 shows 2 screws in the side cover, this applies to drive with built in EMC filters only. 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.

Figure 4-3 EMC & VAR Screws



The VS1ST product range has input supply voltage surge suppression components fitted to protect the drive from line voltage transients, typically originating from lightening strikes or switching of high power equipment on the same supply.

When carrying out a HiPot (Flash) test on an installation in which the drive is built, the voltage surge suppression components may cause the test to fail. To accommodate this type of system HiPot test, the voltage surge suppression components can be disconnected by removing the VAR screw. After completing the HiPot test, the screw should be replaced and the HiPot test repeated. The test should then fail, indicating that the voltage surge suppression components are once again in the circuit.

4.4.5 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 Figure 4-2). See Appendix D for more information.

Table 4-1 Fuse & Wire Size / Terminal Torque Specifications

Hp	kW	Nominal Input Current	Fuse or MCB	Supply Cable Size		Torque Lb-in (Nm)	Nominal Output Current	Motor Cable Size		Torque Lb-in (Nm)	Max Motor Cable Length		Min Brake Resistor Value
		amps	amps	AWG	mm2		Amps	AWG	mm2		Feet	Meters	Ohms
110-115V +/-10% 1-Phase Input, 230V 3-Phase Output													
0.5	---	6.7	10	14	1.5	9.0 (1.0)	2.3	14	1.5	9.0 (1.0)	82	25	---
1	---	12.5	16 (15)*	14	1.5	9.0 (1.0)	4.3	14	1.5	9.0 (1.0)	82	25	---
1.5	---	16.8	20	14	2.5	9.0 (1.0)	5.8	14	1.5	9.0 (1.0)	328	100	47
200-240V +/-10% 1-Phase Input, 230V 3-Phase Output													
0.5	0.37	6.7	10	14	1.5	9.0 (1.0)	2.3	14	1.5	9.0 (1.0)	82	25	---
1	0.75	12.5	16	14	1.5	9.0 (1.0)	4.3	14	1.5	9.0 (1.0)	82	25	---
2	1.5	14.8	25	12	4	9.0 (1.0)	7	14	1.5	9.0 (1.0)	82	25	---
2	1.5	14.8	25	12	4	9.0 (1.0)	7	14	1.5	9.0 (1.0)	328	100	47
3	2.2	22.2	32 (35)*	12	4	9.0 (1.0)	10.5	14	1.5	9.0 (1.0)	328	100	47
200-240V +/-10% 3-Phase Input													
0.5	0.37	3	6	14	1.5	9.0 (1.0)	2.3	14	1.5	9.0 (1.0)	82	25	--
1	0.75	5.8	10	14	1.5	9.0 (1.0)	4.3	14	1.5	9.0 (1.0)	82	25	---
2	1.5	9.2	16 (15)*	14	2.5	9.0 (1.0)	7	14	1.5	9.0 (1.0)	82	25	---
2	1.5	9.2	16 (15)*	14	2.5	9.0 (1.0)	7	14	1.5	9.0 (1.0)	328	100	47
3	2.2	13.7	20	12	4	9.0 (1.0)	10.5	14	1.5	9.0 (1.0)	328	100	47
5	4	20.7	32 (35)*	12	4	9.0 (1.0)	18	14	2.5	9.0 (1.0)	328	100	47
380-480V +/-10% 3-Phase Input													
1	0.75	2.9	6	14	1.5	9.0 (1.0)	2.2	14	1.5	9.0 (1.0)	82	25	---
2	1.5	5.4	10	14	1.5	9.0 (1.0)	4.1	14	1.5	9.0 (1.0)	82	25	---
2	1.5	5.4	10	14	1.5	9.0 (1.0)	4.1	14	1.5	9.0 (1.0)	164	50	100
3	2.2	7.6	10	14	2.5	9.0 (1.0)	5.8	14	1.5	9.0 (1.0)	164	50	100
5	4	12.4	16 (15)*	14	2.5	9.0 (1.0)	9.5	14	1.5	9.0 (1.0)	164	50	100
7.5	5.5	16.1	20	12	4	9.0 (1.0)	14	14	2.5	9.0 (1.0)	328	100	47
10	7.5	20.7	25	12	4	9.0 (1.0)	18	14	2.5	9.0 (1.0)	328	100	47
15	11	27.1	32 (35)	10	6	9.0 (1.0)	24	12	4	9.0 (1.0)	328	100	47

For UL compliance Motor Cable to be Copper 75°C and Fuse current rating defined by ratings marked ( )*.
Wire size is based on 40°C surrounding and fuses are based on 45°C surrounding, max continuous output and no harmonic current.

4.4.6 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 4-1 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.

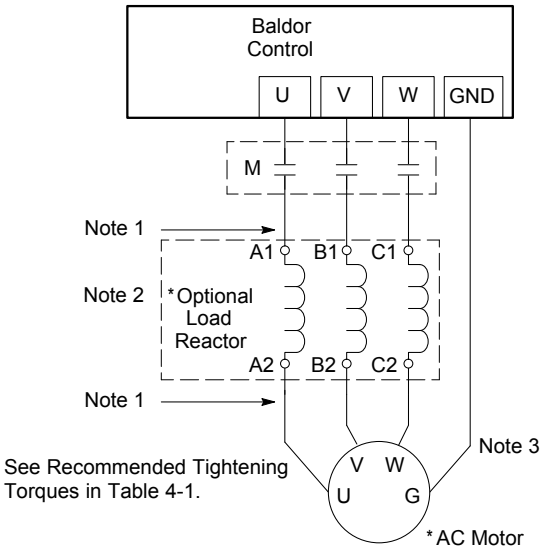
Unexpected faults may occur due to excessive charging current required for motor cable capacitance. If you use long motor leads and experience unexpected trips due to current overload conditions and are not sure how to correctly size and connect the optional load reactors, please contact your Baldor District representative. Baldor is always glad to assist.

4.4.7 M-Contactor Connections

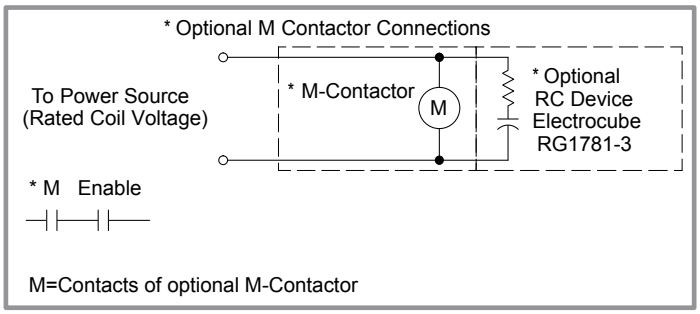
If required by local codes or for safety reasons, an M-Contactor (motor circuit contactor) may be installed. However, incorrect installation or failure of the M-contactor or wiring may damage the control. If an M-Contactor is installed, the control must be disabled for at least 200msec before the M-Contactor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

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 4-4 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.

Chapter 5
Control Wiring

5.1 Control Board Connections

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

Control wire connections can be made using shielded twisted pair #18 AWG (0.8mm2) 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 Terminals

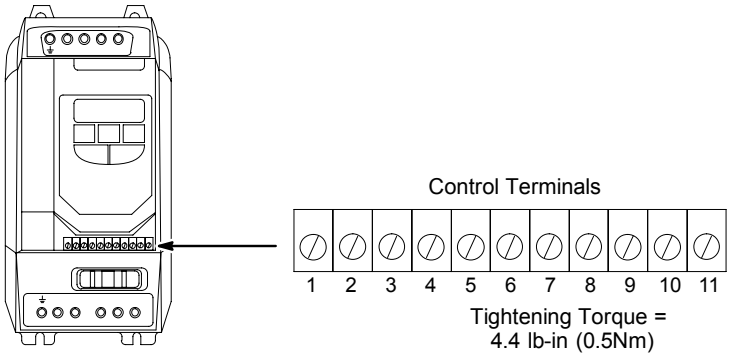


Table 5-1 Control Terminal Descriptions

Terminal	Signal Description
1	+24VDC (@ 100 mA)
2	Digital In1 (8-30VDC)
3	Digital In2 (8-30VDC)
4	Digital In3 (8-30VDC) / Analog In2 (0-10VDC, 0-20mA or 4-20mA)
5	+10VDC (@ 10 mA) Reference for Potentiometer (1kohm minimum)
6	Analog In1 (0-10VDC, 0-20mA or 4-20mA) / Digital In4 (8-30VDC)
7	Common (terminals 7 & 9 are connected)
8	Analog Output (0-10VDC @ 20mA max) / Digital Output (0-24VDC)
9	Common (terminals 7 & 9 are connected)
10	Relay Common
11	Relay N.O. Contact (rated 250VAC@6A; 30VDC@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

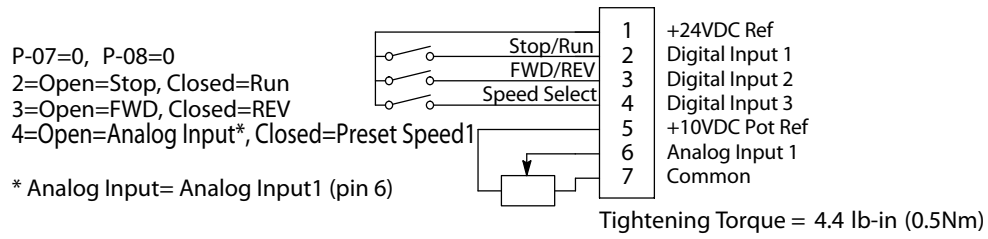
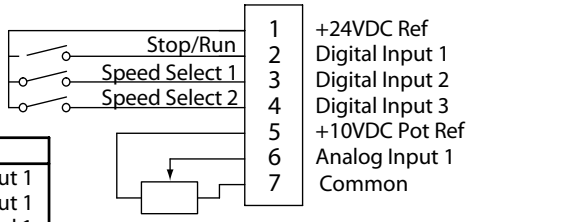


Figure 5-3 2-Wire with Analog Input and 2 Preset Speeds

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

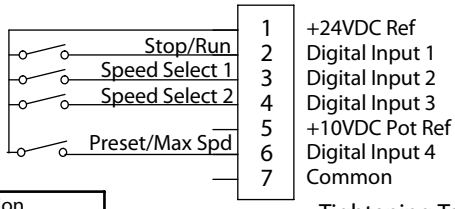


Speed Select 1	Speed Select 2	Action
Open	Open	Analog Input 1
Open	Closed	Analog Input 1
Closed	Open	Preset Speed 1
Closed	Closed	Preset Speed 2

Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-4 2-Wire with 4 Preset Speeds Plus Max. Speed Select Switch

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



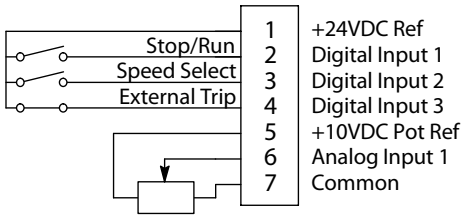
Speed Select 1	Speed Select 2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Tightening Torque = 4.4 lb-in (0.5Nm)

Digital Input 4 Closed = 5V<Vin<30VDC
Digital Input 4 Open = Vin<2VDC

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

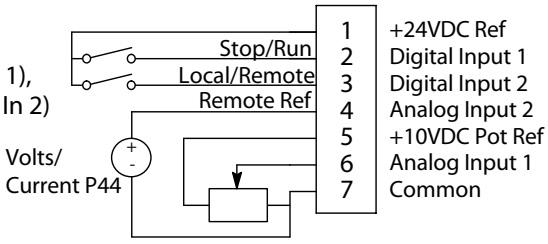
P-07=0, P-08=3
2=Open=Stop, Closed=Run
3=Open=Analog, Closed=Preset Speed1
4=Open=External Trip is generated,
Closed=Reset Fault and run.



Tightening Torque = 4.4 lb-in (0.5Nm)

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

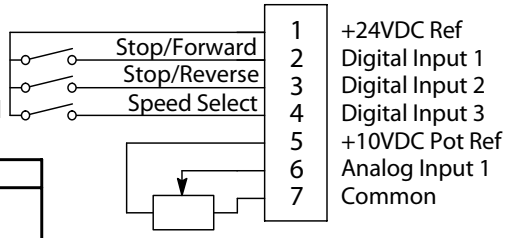
P-07=0, P-08=4
2=Open=Stop, Closed=Run
3=Open=Local Ref (Analog In 1),
Closed=Remote Ref (Analog In 2)



Tightening Torque = 4.4 lb-in (0.5Nm)

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

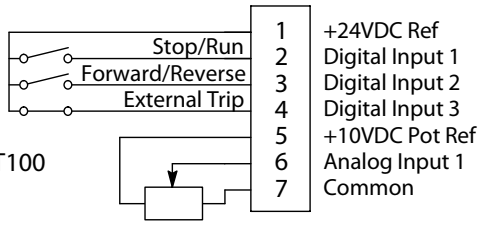


FWD Stop	REV Stop	Action
Open	Open	Drive Stop
Closed	Open	Forward Run
Open	Closed	Reverse Run
Closed	Closed	Fast Stop (see P-33)

Tightening Torque = 4.4 lb-in (0.5Nm)

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

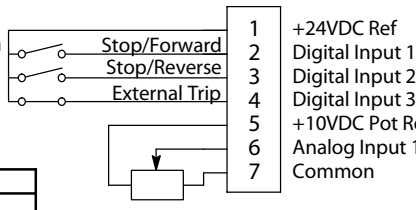
P-07=0, P-08=6
2=Open=Stop, Closed=Run
3=Open=Forward, Closed=Reverse
4=Open=External Trip is generated, Closed=Reset Fault and run.
Connect external thermistor type PT100 or similar to Digital Input 3.



Tightening Torque = 4.4 lb-in (0.5Nm)

Figure 5-9 2-Wire with FWD/REV and 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.



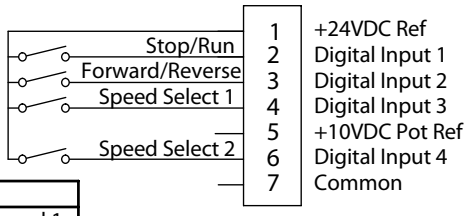
Tightening Torque = 4.4 lb-in (0.5Nm)

FWD Stop	REVStop	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

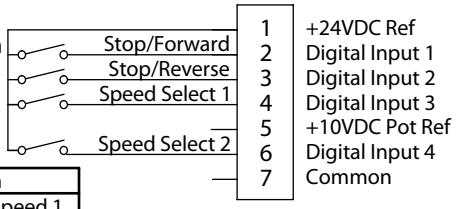


Speed Select 1	Speed Select 2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Tightening Torque = 4.4 lb-in (0.5Nm)

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

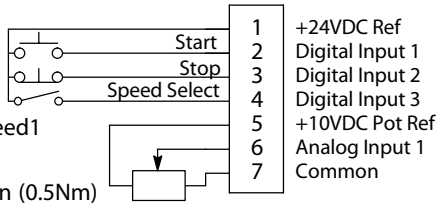


Speed Select 1	Speed Select 2	Action
Open	Open	Preset Speed 1
Closed	Open	Preset Speed 2
Open	Closed	Preset Speed 3
Closed	Closed	Preset Speed 4

Tightening Torque = 4.4 lb-in (0.5Nm)

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

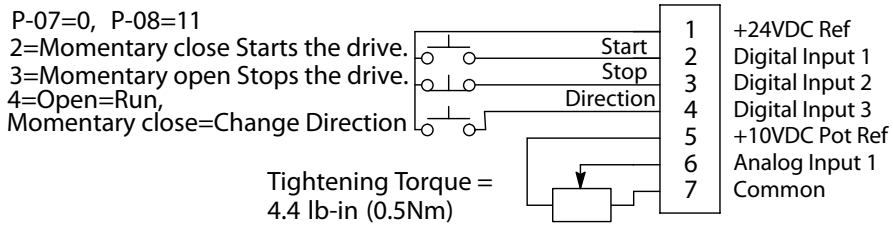
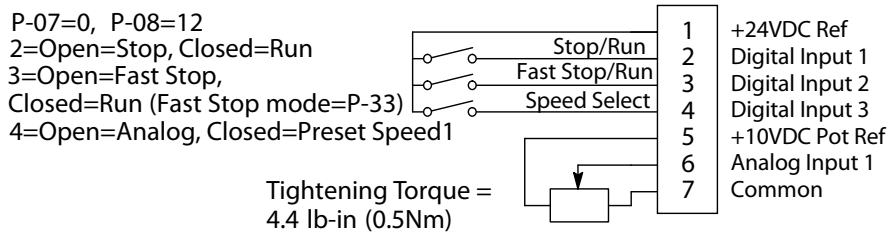


Figure 5-14 2-Wire with 1 Preset Speed and Fast Stop



5.2.2 Other Control Methods

Set parameter P-07 =0 to 6 to use the control method of your choice.

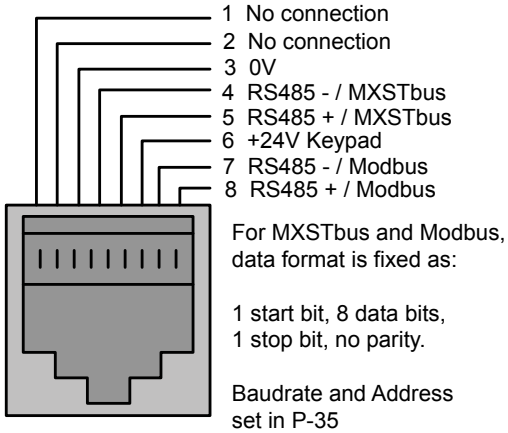
P-07 =0 is described in this section. For P-07 = 1-6 refer to Chapter 8.
0- Terminal Strip, Speed and other commands are from the terminal strip.
1- Keypad control - forward only, uni-directional control from the keypad
Up and Down arrows are used to change the speed reference).
2- Keypad control - forward and reverse, bi-directional control from the keypad.
START changes between forward and reverse, Up and Down arrows 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 RJ45 Communication Connection

The RJ45 Data Port can be used as either a RS485 Serial Modbus interface or to connect the optional remote keypad (VS1ST-RKEY3) and/or copycat loader (VS1ST-CCL).

Serial Modbus networks use the RS485 PIN connection; see Appendix E for the communication protocols. Remote keypad kits and copycat programmers use the dedicated MXSTbus connection.

Figure 5-2 RJ45 Data Connection



5.4 Changing Parameters

To change a parameter value press and hold the ENT/PROG key for > 1 second while the drive displays StoP. The display changes to P-01 indicating parameter 01. Press and release the ENT/PROG key to display the value of this parameter.

Use the UP and DOWN arrow keys to change to the required value. Press and release the ENT/PROG key once more to store the change. Press and hold the ENT/PROG key for > 1 second to return to operational mode. The display shows StoP if the drive is stopped or the real-time information (for example speed) if the drive is running.

5.5 Reset Factory Default Settings

To reset factory default parameters, press the UP, DOWN, and STOP keys simultaneously for > 2 seconds. The display shows P-dEF indicating the drive has reset itself to factory default parameters. Press the STOP button to acknowledge and reset the drive.

5.6 Terminal Control

When delivered, the VS1ST is set to operate in terminal control mode and all parameters (P-xx) have the default values as indicated in Chapter 7 Parameters. Connect the motor to the drive, checking star/delta connection for the voltage rating.

1. Remove all power from the control.
2. Connect a control switch between the control terminals 1 and 2 ensuring that the contact is open (drive disabled).
3. Connect a potentiometer (1 kΩ min to 10 kΩ max) between terminals 5 and 7, and the wiper to terminal 6.
4. With the potentiometer set to zero, switch on the power supply to the drive. The display will show StoP.
5. Enter motor data from motor nameplate:
   P-01 = motor rated voltage
   P-02 = motor rated current
   P-03 = motor rated frequency
   P-04 = motor rated speed
6. Close the control switch, terminals 1-2. The drive is now 'enabled' and the output frequency/speed are controlled by the potentiometer. The display shows zero speed in Hertz [H 0.00] with the potentiometer turned to minimum.
7. Turn the potentiometer to maximum. The motor will accelerate to 60Hz (the default value of P-06) under the control of the accelerating ramp time P-10. The display shows 60Hz [H 60.00] at max speed.
8. To display motor current (A), briefly press the ENT/PROG key.
9. Press ENT/PROG again to return to speed display.
10. To stop the motor, either turn the potentiometer back to zero or disable the drive by opening the control switch (terminals 1-2).
11. If the enable/disable switch is opened the drive will decelerate to stop at which time the display will show StoP. If the potentiometer is turned to zero with the enable / disable closed the display will show H 0.0. (0.0Hz), if left like this for 20 seconds the drive will go into standby mode, display shows StndbY, waiting for a speed reference signal.

5.7 Keypad Control

To allow the VS1ST to be controlled from the keypad in a forward direction only, set P-07 =1:

1. Connect Motor as for terminal control above.
2. Enable the drive by closing the switch between control terminals 1 & 2. The display will show StoP.
3. Press the START key. The display shows H 0.0.
4. Press the UP arrow to increase speed.
5. The drive will run forward, increasing speed until the UP arrow is released. The rate of acceleration is controlled by the setting of P-10, check this before starting.
6. Press the DOWN arrow to decrease speed. The drive will decrease speed until DOWN is released. The rate of deceleration is limited by the setting in P-11.
7. Press the STOP key. The drive will decelerate to rest at the rate set in P-11.
8. The display will finally show StoP at which point the drive is disabled.
9. To preset a target speed prior to enable, press the DOWN arrow key while the drive is stopped. The display will show the target speed, use the UP & DOWN arrow keys to adjust as required then press the STOP key to return the display to StoP.
10. Pressing the START key will start the drive accelerating to the target speed. Setting P-07=2 allows the VS1ST to be controlled in a forward and reverse direction from the keypad.
11. Operation is the same as when P-07=1 for start, stop and changing speed.
12. Press the START key. The display changes to H 0.0.
13. Press the UP arrow to increase speed the drive will run forward, increasing speed until the UP arrow is released. Acceleration is limited by the setting in P-10. The maximum speed is the speed set in P-06.
14. To reverse the direction of rotation of the motor, press the START key again.

Note: Keypad Speed Control and Terminal Start/Stop Inputs:
To use the drive keypad to control speed with a remote start/stop from the terminal strip (2-wire only), set parameter P-28 = 2 or 3. The status of digital input 1 controls the start/stop and the speed reference is from the keypad in this case. The drive Stop button is disabled in this case.

Chapter 6
Using the Keypad

6.1 Keypad Components

This chapter provides an overview of the integrated keypad and how to use it to program the VS1ST drive. The controls are shown in Table 6-1.

Table 6-1 Operator Interface Description

Key	Name	Description
	Display	6 Digit seven segment display. Display of parameter numbers, values, error messages and other information.
	Start	Starts motor if Direction command and Speed reference are set. Only active if P-07 is set to allow keypad control and when P-28 is not set to 2 or 3. Programmable to change the motor direction if pressed while running.
	Stop / Reset	Stops the drive when in Keypad mode only. Active when P-07 = 1 or 2 and when P-28 is not set to 2 or 3. Resets any active faults, if fault condition has been cleared.
	Enter / Program	Momentarily press to view available displays. Pressing and holding the ENT Key for approximately 2 Seconds or more will enter the programming mode or escape back out of the programming mode.
	Increase	During operation increases the speed reference. (Active in keypad mode). Pressing for a period of time will increase the reference value rate of change. In edit mode, navigates between parameters and increments parameter values.
	Decrease	During operation decreases the speed reference. (Active in keypad mode). Pressing for a period of time will increase the reference value rate of change. In edit mode, navigates between parameters and decrements parameter values.

6.2 Keypad Display Parameters

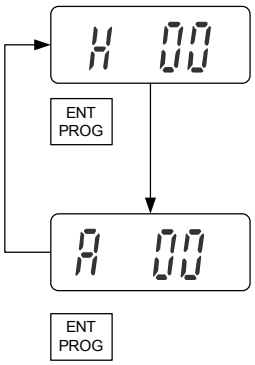
The following display values can be viewed from the keypad while operating the drive.

6.2.1 Default Configuration

Speed and Amps can be displayed by the drive in its default configuration.
Press the ENT/PROG key momentarily to toggle between Hertz and Amps on the display.

Figure 6-1 Standard Display Screen

P-04 = 0, P-23 = 0

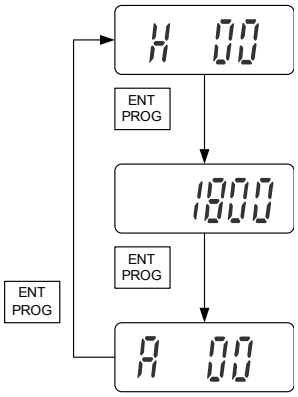


6.2.2 RPM Display

Setting P-04 to a value other than zero will set units for the VS1ST in RPM. This will enable a third display screen in operational mode to show the RPM units set in parameter P-04.

Figure 6-2 RPM Display

P-04 = 1800, P-23 = 0



6.2.3 Custom Display Unit

Parameter P-23 is used to configure the display and show custom units based on the scale factor assigned. When a value other than zero is assigned to P-23, a new display is enabled in operational mode. If P-04=0, P-23 will scale units in Hertz, and if P-04 is not zero, P-23 will scale the RPM units set by P-04 (see display examples set below):

Figure 6-3 Custom Display

P-04 = 0, P-23=2.0

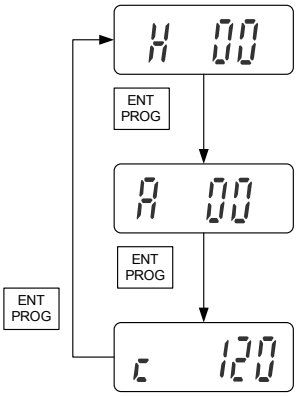
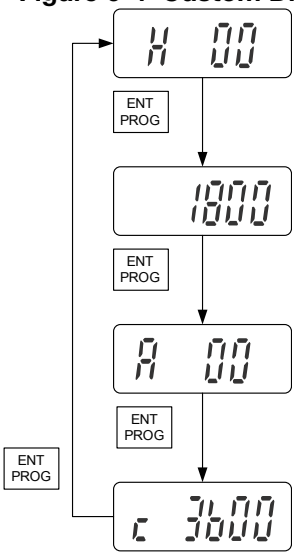


Figure 6-4 Custom Display with RPM

P-04 = 1800, P-23 = 2.0



Chapter 7
Parameter Descriptions

7.1 Overview

Parameters P00 through P-45 are presented in this Chapter and each setting is explained. Selecting P00 and pressing ENT/PROG accesses a read-only menu to monitor internal drive values. Once in the display view, the UP and DOWN arrows will scroll between the read only variables shown below.

Table 7-1 Parameter Descriptions

Number	Name (Display Level)	Value Range, Description and Preset Value
P00-01	**Read Only**	Analog Input 1 Value (100%=Max Vin).
P00-02	**Parameters**	Analog Input 2 Value (100%=Max Vin).
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 500 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).
		1=Analog Input 1 Value  Display Number Value Value (0.0% of Max Vin)
P-01	**Motor Rated Volts**	**Range:** 0, 20V to 250V= 230VAC 0, 20V to 500V= 460VAC (400VAC) **Preset:** 0 Rated (nameplate) voltage of the motor (Volts). Value limited to 250V for low voltage drives. Setting to zero disables voltage compensation.
P-02	**Motor Rated Current**	**Range:** 25% to 100% rated drive current (A) **Preset:** 4.3 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.

Table 7-1 Parameter Descriptions Continued

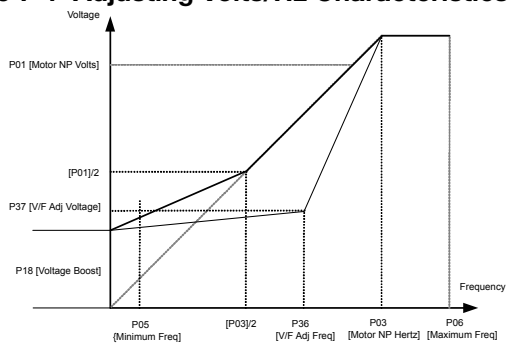
Number	Name (Display Level)	Value Range, Description and Preset Value
P-03	**Motor Rated Frequency**	**Range:** 25 to 500 Hz **Preset:** 60 Hz (Display shows H 60) Rated frequency of the motor (listed on the nameplate). Adjusting the Voltage / Frequency (V/F) If motor instability is experienced, increase or decrease the voltage (P-37) at the speed of instability (P-36). **Figure 7-1 Adjusting Volts/Hz Characteristics** 
P-04	**Motor Rated Speed**	**Range:** 0, 360 to 30000 RPM **Preset:** 0 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.
P-05	**Minimum Output Speed**	**Range:** 0 to P-06 (max 500 Hz) **Preset:** 0 Limits the speed reference to the drive regardless of the speed reference supplied to the drive. Note: When P-04 is set to a value other than “0”, the value displayed will be in RPM.
P-06	**Maximum Output Speed**	**Range:** P-05 to 5 times P-03 (max 500Hz) **Preset:** 60.0 User specified maximum motor speed, speeds greater than this are not allowed. Note: When P-04 is set to a value other than “0”, the value displayed will be in RPM.
P-07	**Start/Stop Source**	**Range:** 0 to 6 **Preset:** 0 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 & 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 using internal accel / decel ramps. 4: MODBUS Network control with accel / decel ramp adjustment via modbus. 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.

Table 7-1 Parameter Descriptions Continued

Number	Name (Display Level)	Value Range, Description and Preset Value
P-08	**Speed Reference Source**	**Range:** 0-12 **Preset:** 0 Sets the digital inputs configuration. The operation of P-08 changes depending on the value of P-07. Refer to Table 8-1, Table 8-2, Table 8-3, and Table 8-4.
P-09	**Stop Mode**	**Range:** 0 to 2 **Preset:** 0 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). Uses deceleration ramp when input power is lost or uses 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.
P-10	**Accel Time**	**Range:** 0 to 600.0 seconds **Preset:** 5.0 Sets the time for the motor to accelerate from 0 to motor rated speed (P-03). Short times may cause over current trips.
P-11	**Decel Time**	**Range:** 0 to 600.0 seconds **Preset:** 5.0 Sets the time for the motor to decelerate from motor rated speed (P-03) to 0. Short times may cause over voltage trips. When set to 0, drive will decel as fast as possible without tripping.
P-12	**Preset Speed 1**	**Range:** -P-06 to P-06 **Preset:** 0.0 Sets the value of Preset Speed 1. Range is -P-06 (reverse) to + P-06.
P-13	**Preset Speed 2**	**Range:** -P-06 to P-06 **Preset:** 0.0 Sets the value of Preset Speed 2. Range is -P-06 (reverse) to + P-06.
P-14	**Preset Speed 3**	**Range:** -P-06 to P-06 **Preset:** 0.0 Sets the value of Preset Speed 3. Range is -P-06 (reverse) to + P-06.
P-15	**Preset Speed 4**	**Range:** -P-06 to P-06 **Preset:** 0 Sets the value of Preset Speed 4. Range is -P-06 (reverse) to + P-06.
P-16	**Speed Reference Scaling**	**Range:** 0 to 500.0% **Preset:** 100.0 Sets the parameter value in % of full scale. Normally, the max speed reference (P-06) is 10 VDC or 20mA. P-16 adjusts the speed reference to another value (for example, 9.5 VDC or 19mA). If P-07 = 1 or 2, this parameter adjusts the keypad reference and an Analog Reference.

Table 7-1 Parameter Descriptions Continued

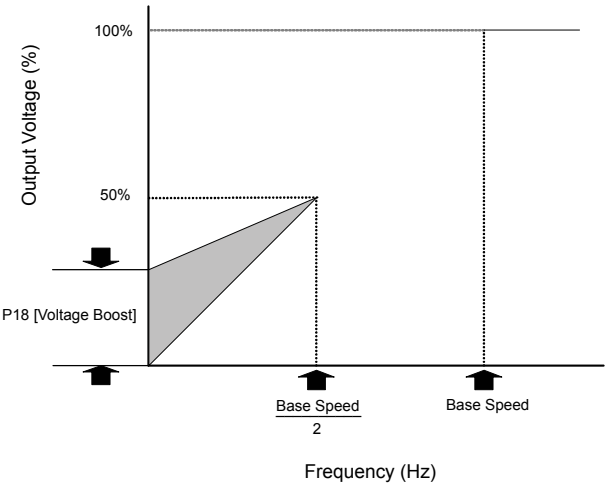
Number	Name (Display Level)	Value Range, Description and Preset Value
P-17	**Analog Input Format (Analog Input 1)**	**Range:** U 0 - 10 b 0 - 10 A 0 - 20 t 4 - 20 r 4 - 20 t 20 - 4 r 20 - 4 **Preset:** U 0 - 10 Sets the analog input for voltage or current operation and the range of expected input signal. A 50% offset by P-30 and 200% scaling by P-16 gives ± P-06. See parameter P-44 for Analog Input 2. "b" can be used for bipolar input signals. "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.
P-18	**Voltage Boost**	**Range:** 0.0 to 20.0% for frame A 0.0 to 15.0% for frame B 0.0 to 10.0% for frame C (% of max. output voltage) **Preset:** CALC 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. **Figure 7-2 Boost Voltage** 

Table 7-1 Parameter Descriptions Continued

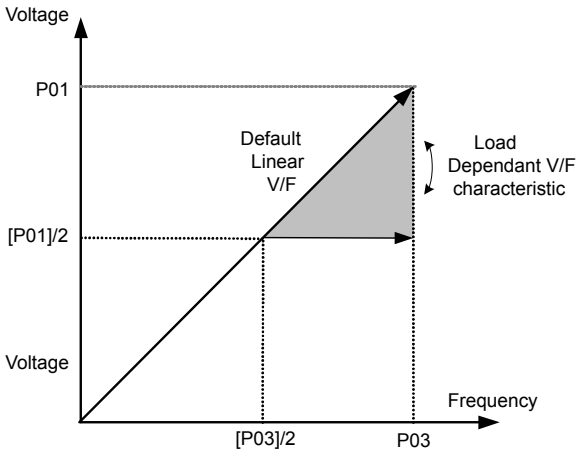
Number	Name (Display Level)	Value Range, Description and Preset Value
P-19	**Energy Savings**	**Range:** 0=Disabled 1=Enabled **Preset:** 0 When enabled, automatically reduces applied motor voltage on light load. Minimum value is 50% of nominal. **Figure 7-3 Energy Saving Adjustment** 
P-20	**Trip Log**	**Range:** Last four trips stored **Preset:** N/A (Read Only) Displays the last four trips as a coded fault. The codes are displayed most recent first to oldest. Use the up or down arrow keys to scroll the fault list.
P-21	**PWM Frequency**	**Range:** 4-32kHz **Preset:** 16 Sets the effective switching frequency of the drive. If “rEd” is displayed, the switching frequency has been reduced to the level in P00-14 due to excessive drive heatsink temperature.
P-22	**Relay Output Select**	**Range:** 0 to 7 **Preset:** 1 Defines the function of the user relay (when operating conditions are met). 0: Drive enabled — 4: Motor speed >= limit 1: Drive healthy — 5: Motor current >= limit 2: Motor at target speed — 6: Motor speed < limit 3: Drive tripped — 7: Motor current < limit Disabled: Contacts open — Enabled: Contacts closed Options 4 to 7: the Relay output is enabled using the level set in P-25.
P-23	**Display Speed Scale Factor**	Custom scaling factor **Preset:** 0.000 P-04 = 0, speed in Hz are scaled by this value. P-04 > 0 RPM units are scaled by this value. Scaled display values are preceded with “c” for custom units.

Table 7-1 Parameter Descriptions Continued

Number	Name (Display Level)	Value Range, Description and Preset Value
P-24	**Analog/Digital output function select**	**Range:** 0 to 9 **Preset:** 8 **Digital output mode** 0: Drive enabled — 4: Motor speed >= limit 1: Drive healthy — 5: Motor current >= limit 2: Motor at target speed — 6: Motor speed < limit 3: Drive tripped — 7: Motor current < limit **Digital 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, (20mA 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
P-25	**Relay output limit**	**Range:** 0.0 to 100.0% for speed 0.0 to 200.0% for current **Preset:** 100.0 Sets the limit for P-22 and P-24 (when using Digital Output Mode).
P-26	**Skip frequency**	**Range:** P-05 to P-06 **Preset:** 0.0 Sets the midpoint of the avoidance band selected in P-27. 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
P-27	**Skip Frequency Band**	**Range:** 0 to P-06 **Preset:** 0.0 Sets the width of the skip frequency band. Setting P-27 to 0 disables the avoidance frequency.
P-28	**Restart Mode**	**Range:** 0 to 3 **Preset:** 1 0: Minimum Speed — 2: Minimum Speed (Auto-run) 1: Previous Speed — 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 (overrides Parameter P-07). The start and stop button on the drive will not operate in this case. See also P-29.
P-29	**Auto Restart Attempts**	**Range:** See below **Preset:** Auto-0 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.

Table 7-1 Parameter Descriptions Continued

Number	Name (Display Level)	Value Range, Description and Preset Value
P-30	**Analog Input Offset**	**Range:** -500.0 to 500.0% **Preset:** 0.0 Amount of offset for analog input level. Resolution of 0.1%.
P-31	**Brake After Stop**	**Range:** 0 to 60.0 seconds **Preset:** 0.0 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. See also P-18, P-32.
P-32	**Brake Before Start**	**Range:** 0 or 1 **Preset:** 0 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. See also P-18, P-31.
P-33	**Decel2** **Fast Stop**	**Range:** 0 to 25 **Preset:** 0.00 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 opening 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. See also P-08, P-09.
P-34	**Brake Chopper Enable**	**Range:** 0 to 2 **Preset:** 0 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. Drive Voltage Rating / Brake Turn Off Level / Brake Turn On Level 240VAC / 378VDC / 390VDC 460VAC / 756VDC / 780VDC

Table 7-1 Parameter Descriptions Continued

Number	Name (Display Level)	Value Range, Description and Preset Value
P-35	**Serial Comms address**	**Range:** Adr: 0 (disable) to 63 **Preset:** Adr: 1 Sets a unique drive address for communication network
	Modbus enable / baudrate select	**Range:** OP-buS, 9.6, 19.2, 38.4, 57.6, 115.2 kBPS **Preset:** OP-buS 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	**Range:** 0 (no trip) t 30, 100, 1000, 3000 (ms) r 30, 100, 1000, 3000 (ms) **Preset:** t3000 (3 second trip) 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.
P-36	**V/F Frequency Adjustment**	**Range:** 0 to P-03Hz **Preset:** 0.0 Sets the frequency at which the adjustment voltage set in P-37 is applied.
P-37	**V/F Voltage Adjustment**	**Range:** 0 to P-01V **Preset:** 0 Sets the applied motor voltage at the frequency set in P-36.
P-38	**User PI Proportional Gain**	**Range:** 0.1 - 30.0 **Preset:** 1.0 Increase the value for high inertia. Too large a value gives instability.
P-39	**User PI Integral Time Constant**	**Range:** 0.0s - 30.0seconds **Preset:** 1.0 Higher values gives slower, more damped response.
P-40	**User PI Feedback Mode**	**Range:** 0 or 1 **Preset:** 0 0: Direct 1: Inverse (When set to 1, the bipolar analog input is used) Sets the source for the PI control reference signal.
P-41	**User PI Reference Select**	**Range:** 0 or 1 **Preset:** 0 0: Digital 1: Analog (The bipolar analog input is used) Sets the source for the PI control reference signal. Note: Parameter setting is ignored (irrelevant) when P-07 is set to 5 and P-08 is set to 9.
P-42	**User PI Digital Reference**	**Range:** 0 to 100.0% **Preset:** 0.0 Sets the preset reference used when P-41 = 0.

Table 7-1 Parameter Descriptions Continued

Number	Name (Display Level)	Value Range, Description and Preset Value
P-43	**User PI Feedback Select**	**Range:** 0 to 2 **Preset:** 0 0: 2nd analog input 1: 1st analog input 2: Motor load current This parameter selects the feedback signal source. Note: Parameter setting is ignored (irrelevant) when P-07 is set to 5 and P-08 is set to 9.
P-44	**2nd Analog Input format**	**Range:** U 0 - 10 A 0 - 20 t 4 - 20 r 4 - 20 t 20 - 4 r 20 - 4 **Preset:** U 0 – 10 Selects the format of the 2nd analog input. “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.
P-45	**Parameter access lock**	**Range:** 0 or 1 **Preset:** 0 0: Parameters can be changed, auto-saved on power down 1: Read-only. No changes allowed. Controls access to parameters.

Chapter 8
Customizing 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. Note: When P-04 is set to a value other than “0”, the value displayed will be in RPM.
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 needed for your application. Short Acceleration or Deceleration times may cause excessive motor current and 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, 0-20V, 4-20mA)
Voltage Boost	P-18	Any hard to start load will benefit from voltage boost. Permits a boost of up to 20% of full motor voltage to be applied.

8.2 Analog and Digital Input Configurations

Parameters P-07 and P-08 can be set to allow various operating modes. Following are settings for these parameters.

8.2.1 Terminal Strip Mode (P-07 = 0)

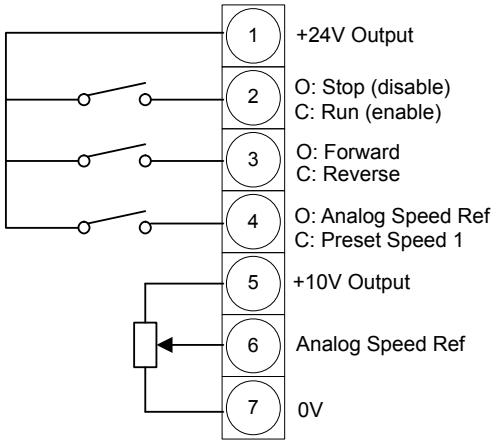
Table 8-1 Parameter P-08 Control of Digital Inputs when P-07=0

P-08	Digital In 1 (Term. 2)		Digital In 2 (Term. 3)		Digital In 3 (Term. 4)		Analog Input 1 (Term. 6)	
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 Speed 1/2	Closed	Preset Speed2		
2*	Open	Stop	Digital In 2 (Term 3)	Digital In 3 (Term 4)	Speed Select		Digital In 4* (Term 6) 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	Digital In 3 (Term 4)	Digital In 4* (Term 6)	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 Control Momentary Close = RUN		3Wire Control Open = STOP		Open	Analog SPD Ref	SPD Ref	
					Closed	Preset Speed 1		
11*	3Wire Control Momentary Close = RUN		3Wire Control Open = STOP		3Wire Control Momentary Closed = REV		SPD Ref	
12	Open	Stop	Open	Fast Stop (P33)	Open	Analog SPD Ref	SPD Ref	
	Closed	RUN (ENABLE)	Closed	RUN (ENABLE)	Closed	Preset Speed1		

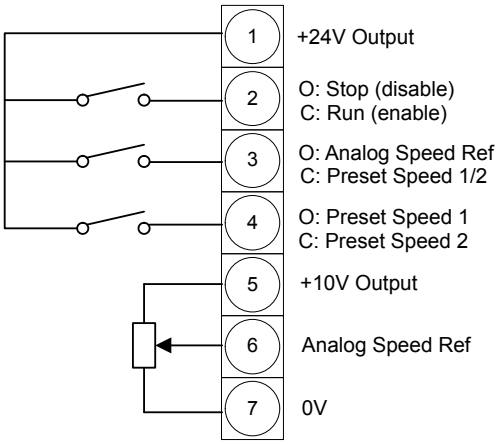
*Table 8-1 notes:
P-08 = 2, 8 or 9 Note: Analog Input 1 becomes Digital Input 4
Closed: 8V< Analog Input1 < 30V
Open: Analog Input1 < 2V
P-08 = 5, 7 or 9 Note: Closing both Digital Input 1 and 2 = Fast Stop (P33).
P-08 = 3 or 6 Note: Connect external PTC Motor Thermistor or similar user contact to Digital Input 3.
P-08 = 11 Note: Closing both Digital Input 1 and Digital Input 3 = Fast Stop (P33).

Figure 8-1 Terminal Mode Example Wiring

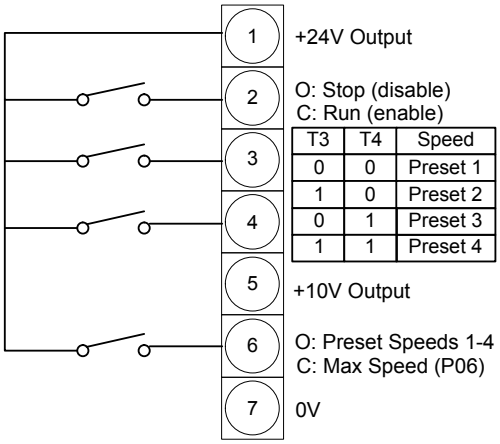
Terminal mode P07 = 0, P08 = 0



Terminal mode P07 = 0, P08 = 1

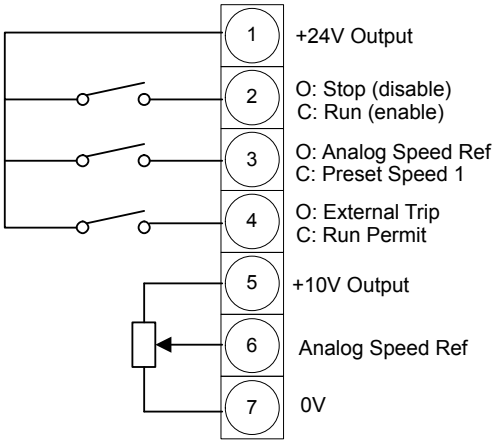


Terminal mode P07 = 0, P08 = 2

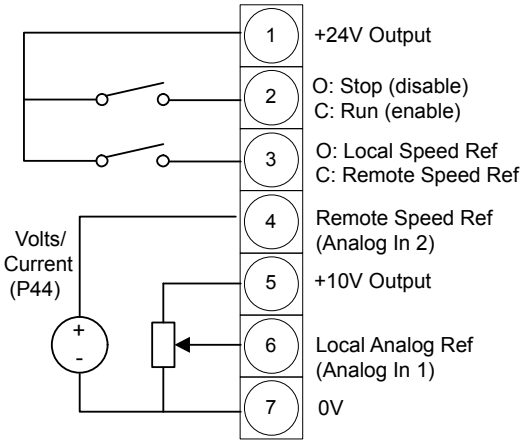


T3	T4	Speed
0	0	Preset 1
1	0	Preset 2
0	1	Preset 3
1	1	Preset 4

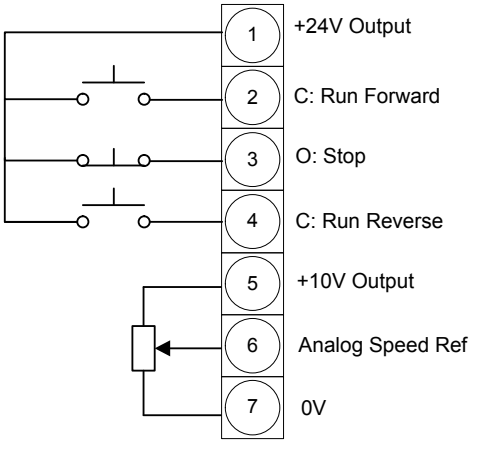
Terminal mode P07 = 0, P08 = 3



Terminal mode P07 = 0, P08 = 4



Terminal mode P07 = 0, P08 = 11



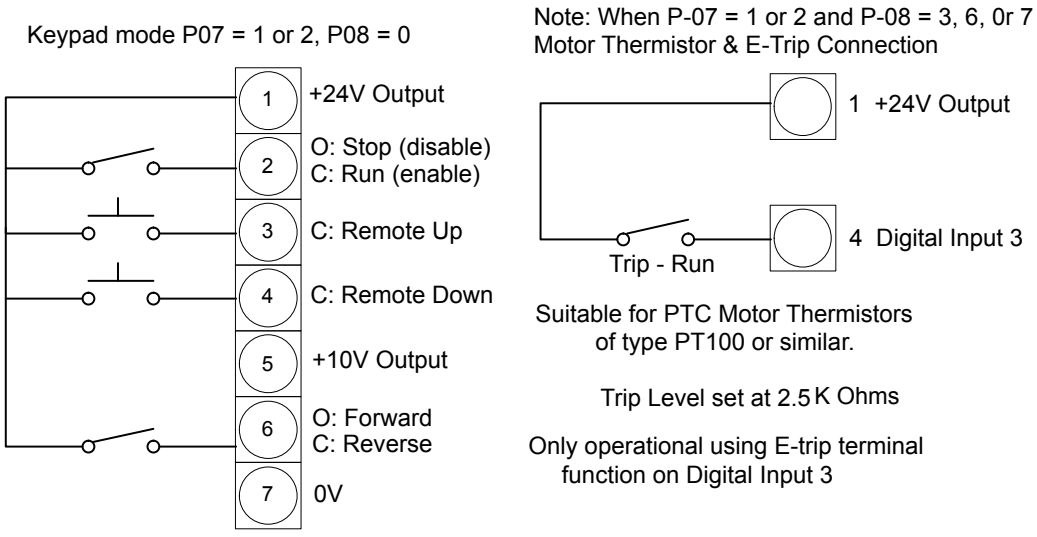
8.2.2 Keypad Mode (P-07 = 1 or 2)

Table 8-2 Parameter P-08 Control of Digital Inputs when P-07=1 or 2

P-08	Digital In 1 (Term. 2)		Digital In 2 (Term. 3)		Digital In 3 (Term. 4)		Analog Input 1 (Term. 6)	
0, 1, 5, 8-12	Open	Stop	Open	KeypadSpeedRef	Open	KeypadSpeedRef	Open	Forward
	Closed	Run	Closed	Remote Up*	Closed	Remote Down*	Closed	Reverse
2	Open	Stop	Open	KeypadSpeedRef	Open	KeypadSpeedRef	Open	KeypadSpeedRef
	Closed	Run	Closed	Remote Up*	Closed	Remote Down*	Closed	Preset Speed 1
3*	Open	Stop	Open	KeypadSpeedRef	Open	Trip (Ext Trip)	Open	KeypadSpeedRef
	Closed	Run	Closed	Remote Up*	Closed	Run	Closed	Remote Down
4	Open	Stop	Open	KeypadSpeedRef	Open	KeypadSpeedRef	Analog Input 1	
	Closed	Run	Closed	Remote Up*	Closed	Analog Input 1		
6*	Open	Stop	Open	FWD Run	Open	Trip (Ext Trip)	Open	KeypadSpeedRef
	Closed	Run	Closed	REV Run	Closed	Run	Closed	Preset Speed 1
7*	Open	FWD Stop	Open	REV Stop	Open	Trip (Ext Trip)	Open	KeypadSpeedRef
	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)
P-08 = 3, 6 or 7 Note: Connect external PTC Motor Thermistor or similar user contact to Digital Input 3.
P-08 = 7 Note: Closing both Digital Input 1 and 2 = Fast Stop (P33).

Figure 8-2 Keypad Mode Example Wiring



8.2.3 Modbus Control Mode (P-07 = 3 or 4)

Table 8-3 Parameter P-08 Control of Digital Inputs when P-07=3 or 4

P-08	Digital In 1 (Term. 2)		Digital In 2 (Term. 3)		Digital In 3 (Term. 4)		Analog Input 1 (Term. 6)
0, 2, 4-5, 8-12	Open	Stop	Open	No Effect	Open	No Effect	No Effect
	Closed	Run	Closed		Closed		
3	Open	Stop	Open	Master Speed Ref	Open	Trip (Ext Trip)	No Effect
	Closed	Run	Closed	Preset Speed 1	Closed	Run	
6	Open	Stop	Open	Master Speed Ref	Open	Trip (Ext Trip)	Analog Input Reference
	Closed	Run	Closed	Analog Input 1	Closed	Run	
7	Open	Stop	Open	Master Speed Ref	Open	Trip (Ext Trip)	No Effect
	Closed	Run	Closed	Keypad Speed Ref	Closed	Run	

For the 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-28 setting. For information on MODBUS RTU see Appendix E.
Connect an external PTC Motor Thermistor or similar user contact to Digital Input 3.

8.2.4 User PI Control Mode (P-07 = 5 or 6)

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.

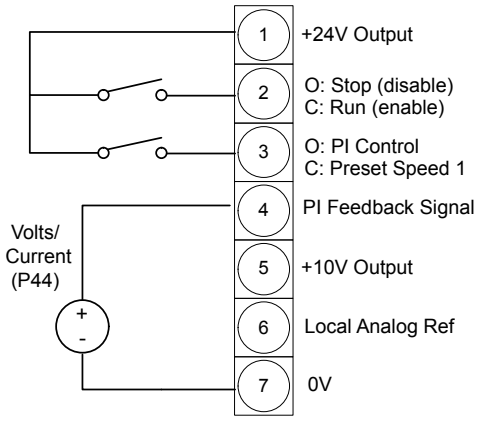
Table 8-4 Parameter P-08 Control of Digital Inputs when P-07=5 or 6

P-08	Digital In 1 (Term. 2)		Digital In 2 (Term. 3)		Digital In 3 (Term. 4)		Analog Input 1 (Term. 6)
0, 2, 4-5, 8-12	Open	Stop	Open	PI Control	Analog In2 (PI feedback)		No effect
	Closed	Run	Closed	Preset Speed 1			
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 Speed 1	Closed	Run	
9*	Open	Stop	Open	PI Control	Analog In2 (PI Feedback)		Analog In1 (PI Feedback)
	Closed	Run	Closed	Preset Speed 1			

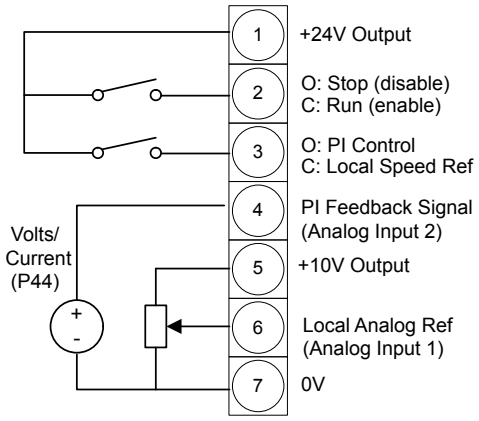
*Table 8-4
P-08 = 3, 6 or 7 Note: Connect external PTC Motor Thermistor or similar user contact to Digital Input 3.
P-08 = 9 Note: Analog In1 or 2 selected on highest value. There will be a 5% selection bandwidth to stop continual switching when analog inputs are approximately equal.

Figure 8-3 PI Control Mode Example Wiring

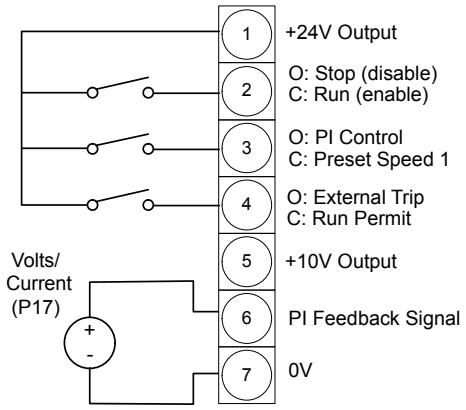
Terminal mode P07 = 5, P08 = 0



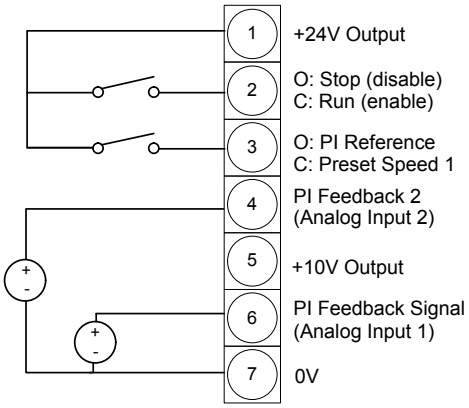
Terminal mode P07 = 5, P08 = 1



Terminal mode P07 = 5, P08 = 3



Terminal mode P07 = 5, P08 = 9



Note: 2 Analog Feedback signals are provided to Analog In1 and Analog In2. Feedback loop is prioritized based on highest value of Analog In1 and Analog In2.

Figure 8-4 PI Control Block Diagram (When P-08 ≠ 9)

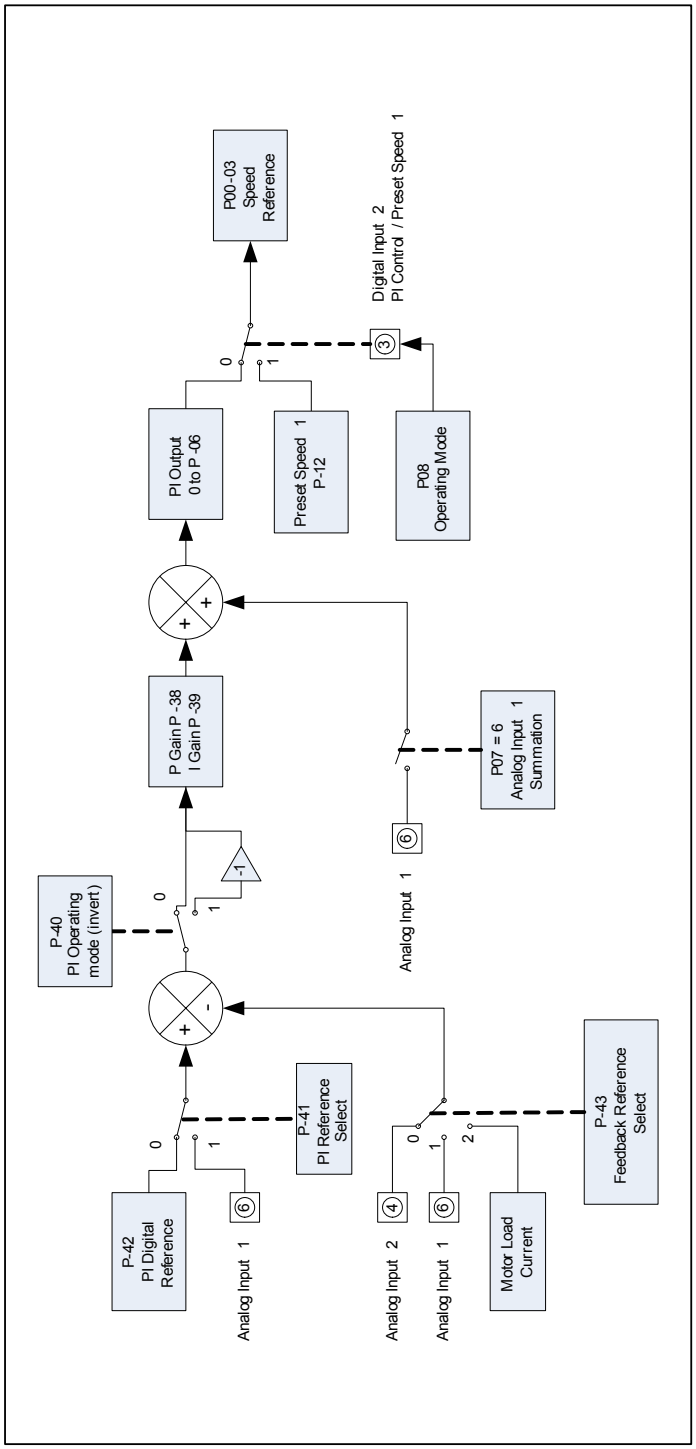
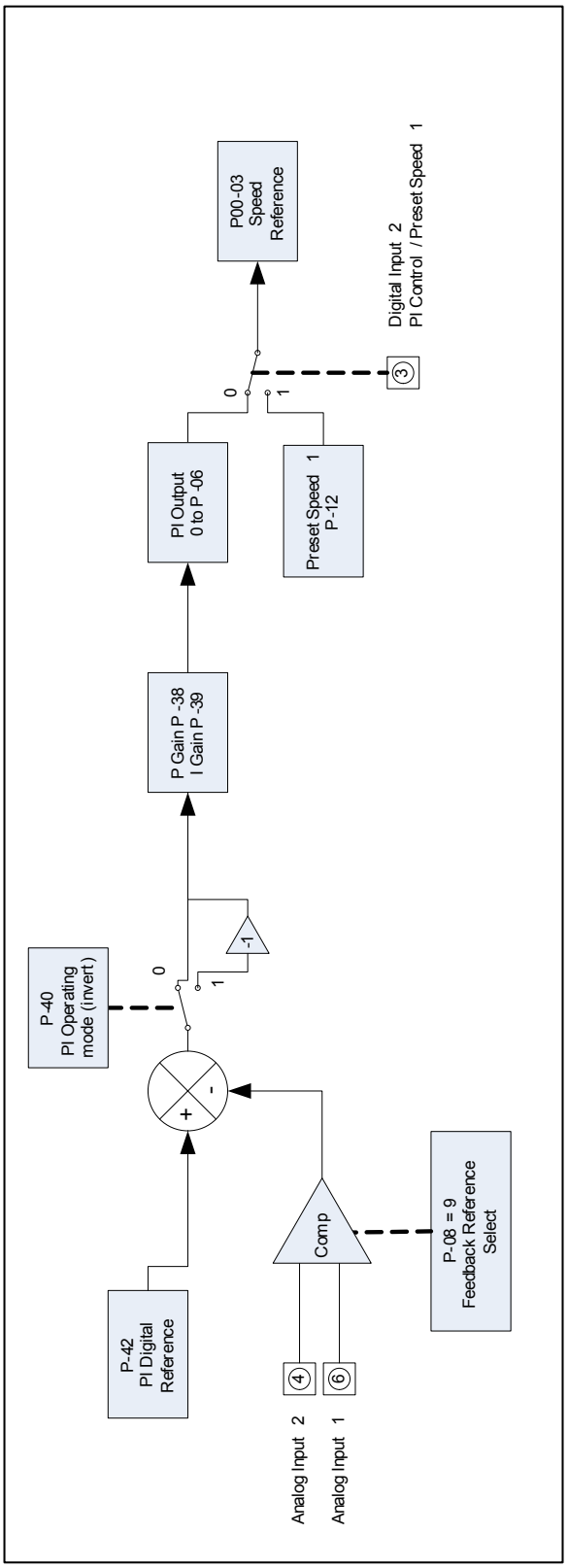


Figure 8-5 PI Control Block Diagram (When P-08 = 9)



Chapter 9
Troubleshooting

The VS1ST continuously monitors its status and operation. When a fault occurs, the event and drive status is captured to help you troubleshoot problems. The following are designed to help in troubleshooting:
- LEDs on the keypad indicate status (Stop, FWD, REV, Jog)
- Fault Codes displayed on the keypad display as they occur
- A log of these faults and the time each occurred is kept in the Event Log
- A trace log for each event stored in the Event log

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.
- 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 Code	Description	Corrective Action
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 star-delta motor wiring error. Motor accelerating/decelerating: The accel/decel time is too short requiring too much power. If P-10 or P-11 cannot be increased, a bigger drive is required. Cable fault between drive and motor.
I_t-trP	Drive has tripped on overload after delivering >100% of value in P02 for a period of time.	Check to see when the decimal points are flashing (drive in overload) and either increase acceleration ramp (P-10) or decrease motor load. Check cable length is within drive specification. Check the load mechanically to ensure it is free, and no jams, blockages or other mechanical faults exist.
OI-b	Brake circuit over current	Check the cabling to the brake resistor. Check the brake resistor value. Ensure minimum resistance values from the rating tables are observed.
OL-br	Brake resistor overload	Increase deceleration time, reduce load inertia or add further brake resistors in parallel. Ensure minimum resistance values from the rating tables are observed.
PS-trP	Internal power stage fault	Check wiring to motor, look for phase-phase or phase-Earth short circuit. Check drive surrounding temp, additional space or cooling is needed. Check drive is not forced into overload.
O_Volt	Over voltage on DC bus	Check to see if the Input Supply Voltage exceeds the rating, or increase deceleration ramp time P-11.
U_Volt	Under voltage on DC bus	This occurs routinely when power is switched off. If it occurs during running, check power supply voltage.
O-t	Heatsink over temperature	Check drive surrounding temp. Additional space or cooling required.
U-t	Under temperature	Trip occurs when surrounding temperature is less than -10°C. Temperature must be raised over -10°C in order to start the drive.
th-FLt	Faulty thermistor on heatsink.	Refer to 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, refer to your Baldor District Office.
4-20 F	Analog input current out of range	Check input current in range defined by P-17.
SC-FLt	Internal drive Fault	Refer to your Baldor District Office.
FAULtY	Internal drive Fault	Refer to your Baldor District Office.
E-tr iP	External trip (on digital Input 3)	E-trip requested on digital input 3. Normally closed contact has opened for some reason. If motor thermistor is connected, check to see if the motor is too hot.
Prog__	Internal drive Fault	Refer to your Baldor District Office.

Appendix A
Technical Specifications

Table A-1 VS1ST Specifications

Input Ratings	Voltage	115	230	460
	Voltage Range	99-126	198-264	342-528
	Phase	Single Phase	Single Phase and Three Phase	Three Phase
	Frequency	50/60Hz ±5%		
	Impedance	1% minimum from main connection		

Output Ratings	Horsepower	1/2-1.5HP 115VAC, 1PH 1/2-3HP 230VAC, 1PH 1/2-5HP 230VAC, 3PH 1-15HP 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	Missing control power, over current, over voltage, under voltage, over temperature (motor or control), output shorted or grounded, motor overload
	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 (I2T)

Environmental Conditions	Temperature	-10 to 50°C De-rate 3% per degree C above 50 to 55°C maximum surrounding temperature
	Cooling	0.5hp Natural; 1-15hp Forced air
	Enclosure	IP20
	Altitude	Sea level to 3300 Feet (1000 Meters) De-rate 3% per 1000 Feet (303 Meters) above 3300 Feet
	Humidity	10 to 95% RH Non-Condensing
	Shock	1G
	Vibration	0.5G at 10Hz to 60Hz
	Storage Temperature	-40 to +60°C
	Duty Cycle	1.0

Control Specifications	Control Method	V/Hz inverter
	PWM Frequency	Adjustable 4-32kHz
	Speed Setting	0-10VDC, 0-20mA; digital (keypad)
	Accel/Decel	0-600 seconds
	Analog Output	0-10VDC, 20mA (1k ohm)
	Relay Output	30VDC@5A, 250VAC@6A

Appendix B
Parameter Tables

B.1 Parameters Sorted by Parameter Number

Table 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 (Analog In 1)	0-10V, 0-20mA, 4-20mA, 20-4mA	u 0-10	
P18	RW	Voltage Boost	0.0 to 20.0%	CALC	
P19	RW	Energy Savings	0: Disabled 1: Enabled	0	
P20	RO	Trip Log	Last Four Trips Stored		
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	0.000	

Table B-1 Parameters Sorted by Parameter Number (Cont.)

Param #	Access	Parameter Name	Description (Range)	Factory Setting	User Setting
P24	RW	Analog/Digital 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% for Speed; 0-200% for Current	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	
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 - 30.0 seconds	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 (Analog In 2)	0-10V, 0-20mA, t 4-20mA, r 4-20mA, t 20-4mA r 20-4mA	u0-10	
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.

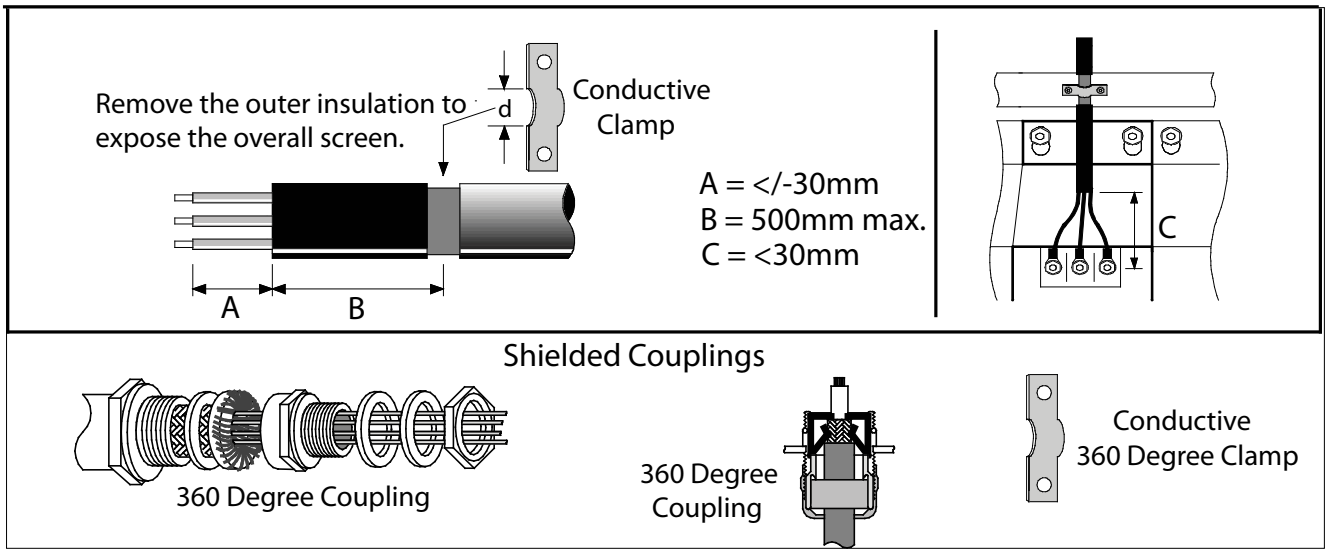
C.2 EMC - Conformity and CE Marking

The information contained herein is for your guidance only and does not guarantee that the installation will meet the requirements of the council directive 2004/108/EC.
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 2004/108/EC 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.

Note that this drive is commercial in design; not for residential environments.

Wiring of Shielded (Screened) Cables

Figure C-1



C.3 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.

C.4 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.

C.5 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.

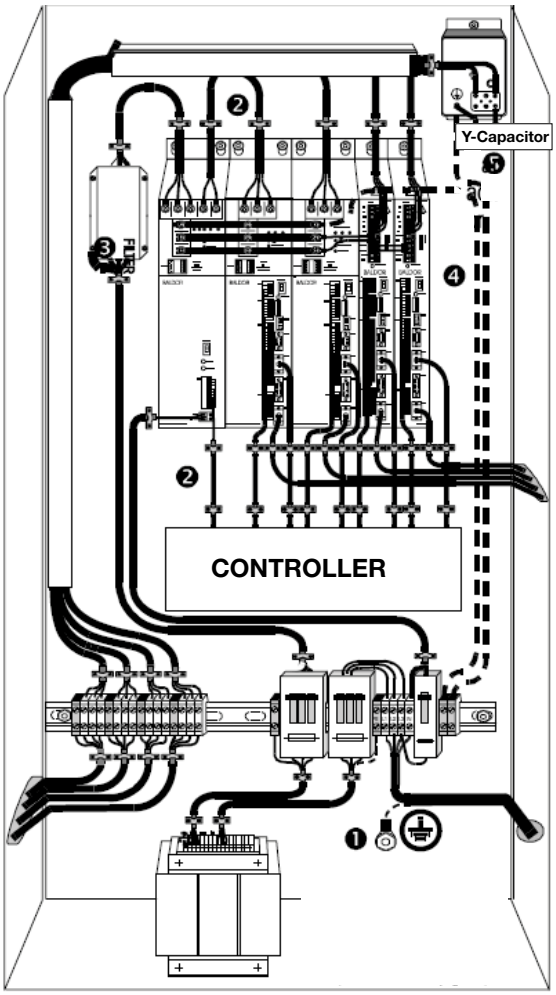
C.6 Using CE approved components will not guarantee a CE compliant system!

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.

C.7 EMC Wiring Technique

Figure C-2



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 betwee power wiring (motor and AC power cables) and control wiring.

2 SCREEN CONNECTIONS
All connections between components must use shielded cable 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.

Attention: The drawing shows only the principle of an EMC wiring. The installation shown can be different to any national standard (e.g. VDE).

C.8 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]

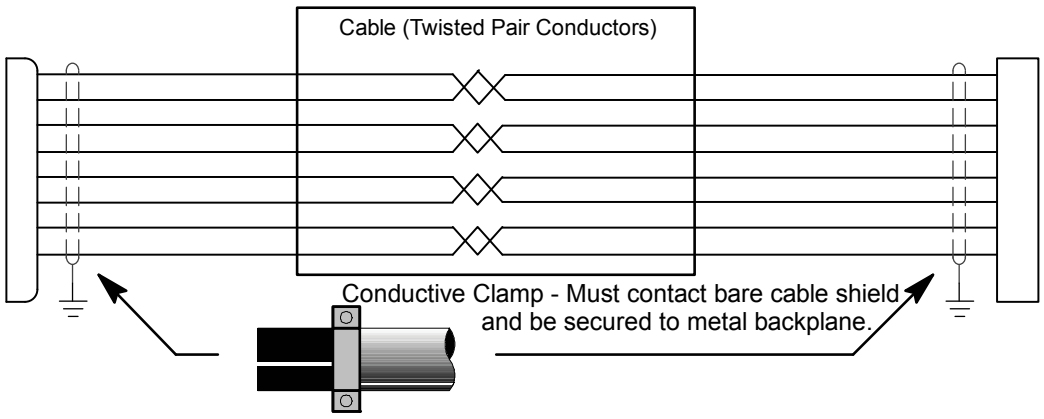
G) To reduce ground current, use at least a 10mm^2 (6 AWG) solid wire for ground connections.

[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

Figure C-3



Appendix D
Options and Kits

D.1 Remote Keypad Option

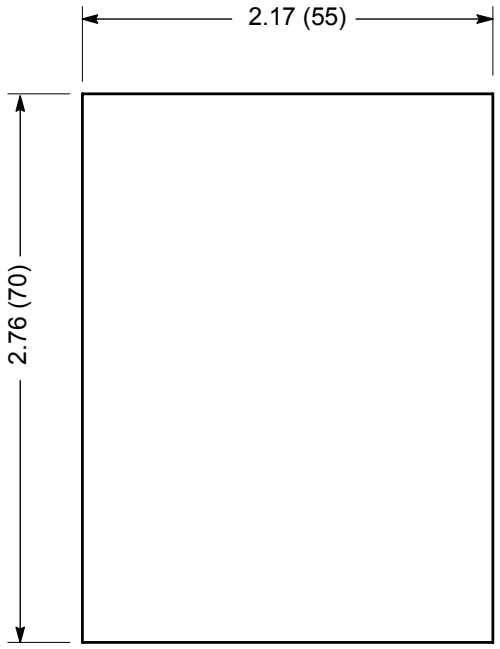
The VS1ST Remote Keypad can be panel mounted for remote control or display of the drive. The remote keypad comes with a standard 3.0 meter cable.

Table D-1 Remote Keypad

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

Note: Template may be distorted due to reproduction

Figure D-1



1. Cut a rectangular opening at the enclosure mounting locating using Figure D-1 as a template.
2. Remove the covering from 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

Optional Cables for VS1ST
Option cable assemblies for setting up and connecting a simple serial network.

Table D-2 Option Cables

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 brake resistor must be mounted and secured in place. Two wires connect to the +DC and BR terminals on the power strip of the size B or the larger enclosure. Refer to Table 4-1 for minimum brake resistor values if a value that is larger than the stock resistor kit is required.

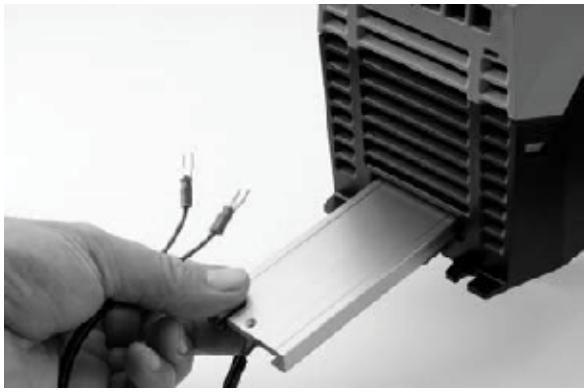
Table D-3 Dynamic Braking Resistor

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

Table D-4 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	100
	5	4	100
	7.5 to 15	5.5 to 11	47

Figure D-2 Dynamic Braking Resistor Installation



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

When external brake resistors are used, set P-34=2.
No software thermal protection is provided in this setting and an external thermal device is required to protect the resistor.

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

Figure D-3 CopyCat Loader

Table D-5 CopyCat Loader

Catalog Number	Description
VS1ST-CCL	VS1ST and VS1MX RJ45 CopyCat Loader

Option Cards for VS1ST
Provides additional relay outputs for signal and control.

Figure D-4

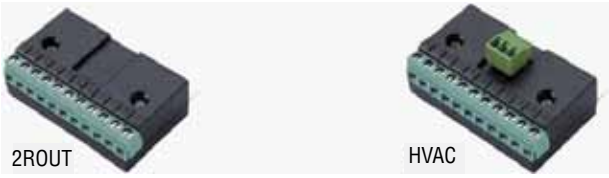


Table D-6 Option Cards

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-11	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.

Table D-7 Field Bus Gateways

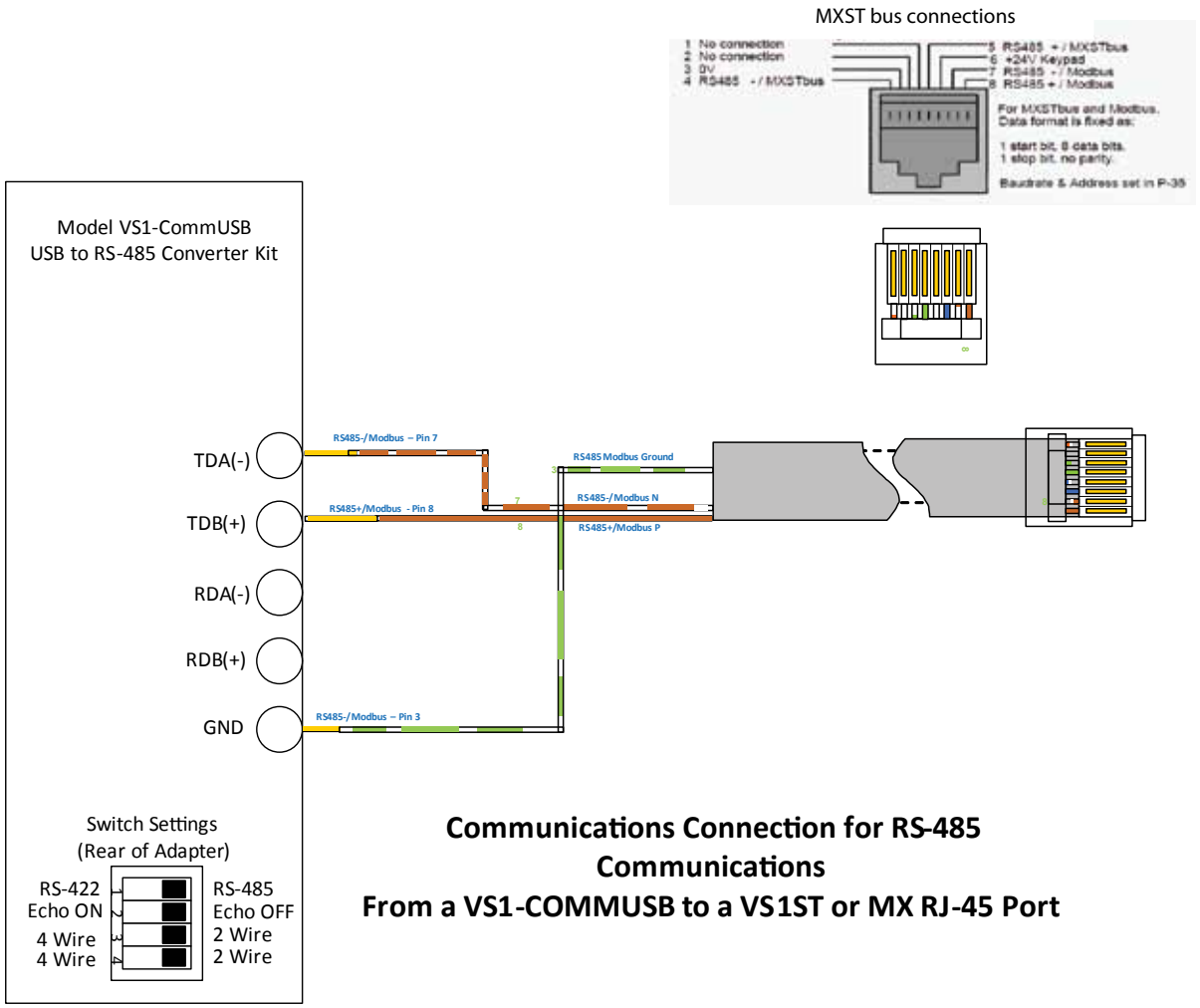
Catalog Number	Description
VS1ST-PBUS	Profibus Gateway
VS1ST-DNET	DeviceNet Gateway
VS1ST-ENET	Ethernet Gateway

Appendix E
RS485/MODBUS Protocol

E.1 Introduction

The VS1ST AC Drive is supplied with imbedded RS-485 communications that supports the Modbus-R TU 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-R TU 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.

Figure E-1 Communication Connection for RS-485



Communications Connection for RS-485 Communications From a VS1-COMMUSB to a VS1ST or MX RJ-45 Port

E.2 Installation

1. Connect the RS485 communication line to RJ45 connector, (see Figure E-1).
2. Check the connections and turn ON the inverter.
3. Table E-1 documents the parameters within the VS1ST that are related to communications:

Table E-1 Communication Parameters

Number	Name	Comments
P07	Start/Stop Source	Set to 3 or 4 for applications that require network control to start and stop the drive 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 are 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

Table E-2 Communication Performance

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

Table E-3 Communication Hardware

Installation	Use RJ45 connector on control (see Figure E-1)
Power Supply	Provided by isolated power from the inverter power supply

E.6 Communication Specifications

Table E-4 Communication Specifications

Communication Speed	9600,19200, 38400, 57600, 115200 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 E-5 Modbus-RTU Protocol

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 registers

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 times 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 registers

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)

Table E-6 Parameter Registers

Adr	Description	Data range	Data format
129	Motor Rated Voltage	0, 20 to 250 V = 230 VAC 0, 20 to 500 V = 460 VAC	
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-06	Internal value (3000 = 50.0Hz)
134	Max Speed Limit	0 to 50 * P-03	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 w/ 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 (Fast 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
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%

Table E-6 Parameter Registers (Continued)

Adr	Description	Data range	Data format
145	Analog Input Format (Analog In 1)	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 P-06	Internal value (3000 = 50.0Hz)
155	Skip Frequency Band	0 to P-06	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

Table E-6 Parameter Registers (Continued)

Adr	Description	Data range	Data format
163	Serial Comms address [Parsing - Lower Byte]	0-63	Drive comms address
	Modbus enable / baudrate select [Parsing - Lower Nibble; Upper Byte]	1-6	1 = Optibus (or MXSTBus) fixed baudrate 2 = 9.6K 3 = 19.2K 4 = 38.4K 5 = 57.6K 6 = 115.2K
	Trip enable / delay [Parsing - Upper Nibble; Upper Byte]	0-8	0 = No Stop 1 = t30 2 = t100 3 = t1000 4 = t3000 (ms) 5 = r30 6 = r100 7 = r1000 8 = r3000 (ms) t = Trip Time; r = Ramp to Stop Time
	Table E-6 Note: Address 163 Example 0100 0010 0000 0001 Fault Ramp Time 4 = Fault 3000ms Baud Rate 2 = 9.6K Address Node 1		
164	V/F Frequency Adjustment	0 to P03	60 = 60Hz
165	V/F Voltage Adjustment	0 to P01	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	0-1000	100 =10.0%
171	User PI feedback select	0-2	0 : 2nd analog input 1 : 1st analog input 2 : motor load current
172	2nd analog input format (Analog In 2)	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

Table E-7 Read Data Example

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)

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

Table E-8 Write Data Example

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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WINNIPEG, MANITOBA R3B 1K2
PHONE: 204-942-5205
FAX: 204-956-4251

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SEVEN HILLS, NSW 2147, AUSTRALIA
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FAX: (61) (2) 9674 2495

UNIT 8, 5 KELLETTS ROAD
ROWVILLE, VICTORIA, 3178 AUSTRALIA
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FAX: (61) (3) 9753 4366

EL SALVADOR
RESIDENCIAL PINARES DE SUIZA
POL. 15 #44,
NVA. SAN SALVADOR, EL SALVADOR
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FAX: +503 2288-1518

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LUIS THAYER OJEDA 166,
OF 402 - PROVIDENCIA
SANTIAGO, CHILE
PHONE: +56 2 964-3210

CHINA
160 SONG SHENG ROAD
SONGJIANG INDUSTRY ZONE
SHANGHAI 201613, CHINA
PHONE: +86 21 5760 5335
FAX : +86 21 5760 5336

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KÖLN, D-50858 GERMANY
PHONE: +49 2234 37941-0
FAX: +49 2234 3794164

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SUITE 100W
ARLINGTON HEIGHTS, IL 60004 USA
PHONE: 847 590 5547
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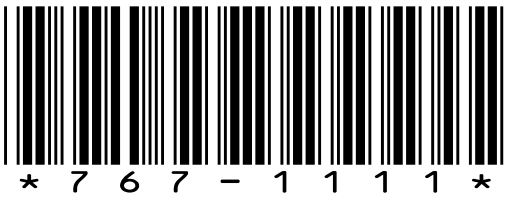

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