Installation and Operation Manual for the SP500 A-C V★S<sup>®</sup> Controller Three-Phase Input and Three-Phase Output 1/4-2 HP @ 200-230 VAC



Instruction Manual D2-3232-1 April, 1993



#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILLAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

V+S\* and Reliance\* are registered trademarks of Reliance Electric Company on its subsidiaries.

<sup>o</sup> Copyright, Reliance Electric Company, 1993.

# **Table of Contents**

1:	Receive and Accept Shipment	1-1
	About this Instruction Manuel	1-1
	Identify the Controller	1-1
	Controller Description	1-2
	Controller Nameplate	1-3
	Heceive and Accept the Shipment	1-3
	File a Relum Requesi	1-3
	Storage until Installation	14
	SP500 Demo Packages	1-4
2:	Specificatione	2-1
	Controller Specifications	2-1
	Service Conditions	22
	Controller Application Data	2-2
	Single Motor Apolications	2-3
	Multi-Motor Applications	2-3
	A Special Note Regarcing Replacement of Partz	2-1
	Optional Kt	2-4
3:	Installation and Wiring	3-1
	Planning and Location	9-1
	Mounting	3-2
	Connect the Mator	3-3
	Motor Lead Lengtha	3-3
	Install an External Input Disconnect	3-4
	Install A C Branch Circuit Protection	3 5
	Install a Transformer (if Needed)	3-6
	Grounding	3.7
	Input/Output Specifications	3-9
	Power Wiring	3-10
	Control and Signal Wiring	3-10
	Hemote Analog input Heference Jumper Setting	3-13
4:	Keyped Operation	4-1
	Keypad Description	1-1
	Indicator Lights	4-1
	Key Descriptions	4-3
	Power Up	4-4
	Modes of Controller Operation	44
	Display Modee	4-4
	Program Mode	4-6
	Fror Log	4-6
5:	Adjusting the Drive Functiona	5-1
	Factory Default Settings	5-1
	FUNCTIONS	52
	F-00 REMOTE ENABLE	5-4
	F-01 - ACCELERATION	ā-ā
	F-02 - DECELERATION	5-6

	F-03 – MINIMUM SPEED	5-7
	F-04 - MAXIMUM SPEED	5-8
	F 05 - CURRENT LIMIT	59
	F-06 - MANUAL TORQUE BOOST	5-10
	F-07 – V/HZ (Base Speec)	5-11
	F-08 - RPM AT BASE SPEED	5-12
	F-08 - IET OUTPUT ENABLE	5-13
	F-10 - CARRIER FREQUENCY	8-14
	F-11 - REMOTE REFERENCE GAIN	5-15
	F-12 - REMOTE REFERENCE OFFSET	5-18
	F 13 - REMOTE REFERENCE DISPLAY ENABLE	5 17
	F-14 - ELECTRONIC THERMAL OVERLOAD	5-18
	F-15 - ELECTRONIC THERMAL OVERLOAD DISABLE	5-19
	F 16 - COAST STOP ENABLE	5 20
	F-17 – REVERSE DISABLE	5-2*
	F-18 - VERSION INFORMATION	5-22
	ERH - ERHOR LOG	5-22
6:	Start the Controller	6-1
	Check the Installation	81
	Start the Controller	8-3
7:	Troubleshooting and Fault Codes	7-1
	System Operation	1-1
	Faul: Codes	7-4
	How to Access and field the Error Log	7-4
	Verify D-C Bus Voltage	75
8:	Index	8-1

# **List of Figures**

Figure 1-1. Nameplate information.	1-2
Figure 3-1. Physical Dimensions.	3-2
Figure 3-2. Motor Wining to Controller.	34
Figure 3-3. Controller Wiring Locations	3-8
Figure 3 4. Example Function Loss/Stop Input	89
Figure 3-5. Terminal Strip Wiring	5-11
Figure 3-6. Speed Reference input Wiring.	3-2
Figure 3-7. Start-Stop Wiring.	\$12
Figure 3-8. Coast-Stop Pushbution Wining.	3-13
Figure 3-9. J6 Jumper Settings.	3 '4
Figure 4-1, SP500 Controller Keybec and Display	41
Figure 5-1. Menual Torque Boost Acjustable Range.	5-6
Figure 5-2. Volts/Heriz Curve.	57
Figure 6-1. location of D-C Bus Terminals.	B-*
Figure 7-1. System Block Diagram.	7-2
Figure 7-2. System Black Diegram (cont d.)	73
Figure 7-3. D-C Bus Terminals.	7-5
. (C. 특히 양 방법 2019년 1977년 1977년 1977년 1977년 2017년 1977년 1	

# List of Tables

2
\$
1
5
5
9
0
1
2
3
8
7

# Settings Table

		Factory	Banna of	User Data	
Function	Description	Setting	Setting	Date	Setting
F-00	Remote Enable	OFF	On. Off		
E-01	Acceleration Rate (sec)	Б.0	0.5-30.0		
F-02	Deceleration Rate (sec)	5.3	1.0-30.0		
F-03	Minimum Speed (Hz)	5.0	3.0-30.0		
F-04	Maximum Speed (Hz)	60.0	30.0-240.0		
F-05	Current Lim ( (%)	150%	10%-150%		
F-06	Manual lorgue Boost (%)	23.	0%-10%		
E-07	Volts/Hertz Base Speed	60	30-240		
F-08	RPM at Base Speed	1750	1-9999		
F-09	IET Output Enable	OFF	On, Off		
F-10	Certier Frequency (kHz)	8	4, 6, 8		
E-11	Remote Reference Gain (%)	100%	60%-100%		
F-12	Remote Reference Offaet (%)	0%	0%-40%		
E-13	Remote Reference Display Enable	OFF	On, Off		
F 14	Electronic Thermal Overload (%)	100%	20%-100%		
F-15	Electronic Thermal Overload Enable	OFF	On, Off		
F-16	Coast Stop Enable	ON	On, Off		
E-17	Reverse Disable	OFF	On, Off		
F-18	Software Version	Read Only	N/A		
ERA	Error Log Iollows F-18		N/A		

# 1: Receive and Accept Shipment

### About this Instruction Manual

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUC-TION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEED-ING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

> The products described in the instruction manual are menufactured by . Reliance Electric incustrial Company.

This instruction manual provides the user with knowledge of the controller and provides the information necessary to start up, operate and troubleshoot the controller.

Specifications necessary to ensure the controller will operate properly in the installed environment, any provided in Section 2.

Section 3 instructs on how to install the drive, necessary wring specifications, and procautions.

Keypad operation is described in Section 4. READ OVER THIS SECTION AND BECOME FAMILIAR WITH THE KEYPAD, DISPLAY, KEYS AND INDICATORS BEFORE ATTEMPTING TO START UP THE CONTROLLER.

Section 5 instructs on how to acjust the drive functions and the defaults as shipped from the factory.

Section 6 gives Controller Startup procedures.

Section 7 provides troubleshooting information and fault code conditions, and illustrates the drive functionality through a system functional block diagram.

Section 8 is an a phabetical index arranged by subject to be used to locate specific information quickly.

### Identify the Controller

Each Relience Electric SP500 A-C V#S\* Controller can be identified by its model number (for standard controllers) or by the sales order number (for dustomenspecified controllers). This number appears on the shipping label and is stamped on the controller nameplate. Refer to Figure 1-1 for nameplate information. Ver ly that the model number shown on the nameplate matches the shipping label. Refer to the model number whenever discussing the equipment with Reliance Electric personnel.



The standard model number describes the controller as follows:

### **Controller Description**

The SP500 controller operates from a three-phase A-C power source at the appropriate reted input voitage (see Section 2: Specifications). The controller provides three-phase and single-phase derated input variable voltage and variable frequency to the motor. All software control functions and any data necessary to drive the inverter are handled by a one chip microcontroller (inicroprocessor). The microcontroller also controls the IGET (insulated-gate bippler transistor) inverter bridge.

The IGBT devices are awtobed using either a 4, 5, or 8 kHz certer frequency. The SP500 also utilizes trip-free characteristics to alleviate nuisance overcurrent trips during acceleration.

## **Controller Nameplate**

The controller nameplate is located on the base in the upper right eide of the controller. The nameplate gives information such as Model Number, Controller rated amps, etc. Refer to Figure 1.1.

EL	ECTR		2000		
1.00.00	221010100200040	8 - 22	H/N		
SER 40	KVA -	1996,8PH / V			
AC IMPUT	YOL15	MAX ANDS	112	8	, Pi
AC OUT	VOLTS	WAX ANDS			
SHORE CIRCL	IT SIN MIS	64 19G			
ENCLOSURE		31036			

Figure 1-1. Nameplate Information.

## **Receive and Accept the Shipment**

Reliance Electric's terms of eale, in all instances, are FO.B. point of origin. The user is responsible for thoroughly inspecting the equipment before accepting shipment from the transportation company.

f all the items called for on the bill of lading or on the express receipt are not included on if any items are obviously damaged, do not accept the shipment until the freight or express egent makes an appropriate notation on your freight bill or express receipt, if any concealed ose or damage is discovered tater, notify your freight or express agent within 18 days of receipt and request that he make an inspection of the shipment. Keep the entire shipment intect if its original shipping container.

The user is responsible for making claim against the Carrier for any shortage or camage occurring in transit. Claims for loss or camage in shipment must not be deducted from the Reliance Electric invoice, nor should payment of the invoice be withheld while awaiting adjustment of such claims since the Carrier guarantees sale delivery.

## File a Return Request

- To return equipment, send a written request to Retarce Electric within ten days of receipt.
- Do not nature equipment without a numbered Equipment Return Authorization (ERA) from Retience Flactne.
- Reliance Electric reserves the right to inspect the equipment on site.

## Storage until Installation

After receipt inspections, repack the controller in its original shioping container until installation. It a period of storage is expected, store in the original shipping container with its internal packing.

To ensure satisfactory operation at alartup and to maintain warranty coverage, store the equipment:

- In its original shipping container in a clean, dry, safe place.
- within an ambient temperature range of 0°C to 40°C (32°F – 104°F)
- within a relative numidity range of 5 to 95% without condensation.
- away from a highly corrosive atmosphere. In harsh environments, cover the shipping/storage container.

### SP500 Demo Packages

CAUTION: The 1SU4100° control or has been modified to operate with a singlephase, 115 VAC input. Do not operate this controller with 230 VAC input. Failure to observe this precaulion could result in camage to, or destruction of the equipment.

> The controller model number, 15U14001, supplied in the SP500 demo packages is specially configured to operate on 1 phase, 116 volt power and is intended for demonstration purposes only. It will operate an unloaded motor, model number PS6X3005. Refer to Table 2-2 for ourrent end voltage deta.

Note: The regulator card used in this demo is part number. 0-56911-3A.

# 2: Specifications

## **Controller Specifications**

The controller is intended to operate from a three-phase, A-C power source at the rated voltage liated on the controller nameplate. (See Figure 1-1.) The controller can operate on a 50 Hz or 60 Hz line frequency. The controller provides three-phase (and single-phase derated input) variable voltage and variable frequency to the motor. Controller current ratings are listed in Tables 2-1 and 2-2.

Model Number	Туре	input Voltage	Output Amps	Inpul Amps	Input KVA
19021001	1 HP NEMA 1 4/6/6 KHz Carrier Frequency <sup>(1)</sup>	239 VAC	5.0A	7.0A	2.78 KVA
19024001	1 HP NEMA 4 70°C 4 KHz Carrier 6/8 KHz Carrier (1)	235 VAC 280 VAC	4.5A 3.5A	8.4A 5.2A	2.1 KVA 2.1 KVA
	1 HP NEMA 4 35%G 4 KHz Cartler 6/8 KHz Cartler (1)	230 VAC 239 VAC	4.5A 4.0A	6.4A 5.8A	2.1 KVA 2.3 KVA
1SU21002	2 HP NEMA 1 40°C 4 KHz Garrier 6 KHz Centler (1) 6 KHz Carrier	230 VAC 250 VAC 230 VAC	7.5A 7.0A 6.5A	9.9A 9.3A 8.7A	4.0 KVA 3.5 KVA 3.5 KVA
	2 HP NEMA 1 35%G 4/6 KHz Carrier 8 KHz Carrier (1)	230 VAC 233 VAC	7.5A 7.0A	A8.8 AC.9	4.0 KVA 3.8 KVA

Table 2-1. Controller Ratings with Three-Phase Input Power.

Model Number	Туре	Input Voltage	Output Amps	Input Amps	Input KVA
1SU21001 1SU24001	1 HP NEMA 1 1 HP NEMA 4 4/6/8 KHz Carrier (2)	230 VAC	1.7A	5.DA	1.3 KVA
15U21002	2 HP NEMA 1 40° C 4 KHz Carrier 6 KHz Carrier 8 KHz Carrier (2)	230 VAC	7.6Å 7.0Å 6.5Å	19.1A 17.2A 15.3A	4.4 KVA 4.0 KVA 3.5 KVA
1\$1121002	2 HP N-MA 1 S5°C 4/8 KHz Carrier <sup>IZ)</sup> 8 KHz Carrier	230 VAC	7.6A 7.0A	19.1A 17.2A	4.4 KVA 4.0 KVA
1SU14001	Demo	115 WAC	2.0A	6.24	9.6 KVA

Table 2-2. Controller Ratings with Single-Phase Input Power.<sup>(1)</sup>

(1) For Single-Phase 2 HP Units. It is not necessary to derate by 50%.

(2) Note: Carrier Frequency Selection of 4, 6 or 8 KHz is made in Function F-10.

## Service Conditions

- Ambient temperature: 0°C to 40°C (32°F to 104°F) for enclosed controllers
- Storage temperature: -40°C to 65°C (-40°F to 149°F).
- Atmosphere: 5 to 95% non-condensing relative humidity
- Elevation: To 3300 feet (1000 meters) above sea level without derating. For every 300 feet (91.4 meters) above 3300 feet, cerate the current rating by 1%. Consult your Reliance Electric Sales office for operation above 10,000 feet
- Line frequency: 50 ±5% Hz, 60 ±5% Hz.
- Line voltage variation: ±10%
- A-C Line distribution system capacity (maximum): 100 KVA for 230 VAC, three-phase with maximum 6,000 symmetrical amps fault current capacity

### **Controller Application Data**

- Displacement Power Factor: 0.96
- Maximum Load: 150% for one minute (based on controller nemeclate rating)
- Overcurrent Trig: 200% rated drive current.
- Linearity of speed reference to output frequency: ±.05%

#### WARNING

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE AP-PLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DIS-CONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDI-TIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES, FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

- Minimum Frequency: 3 to 3D Hz
- Maximum Frequency: 30 to 240 Hz
- Long term frequency stability: 0.01%;
- 500ms Line Dip Ride Through Capability

# Single Motor Applications

The controller and motor must be sized for the load and speed requirements of the specific application.

### Multi-Motor Applications

One controller can run one, two, or more motors. Adhere to the following requirements to assure correct drive operation:

 When all the motors connected to the output of the controller are to star, simultaneously, the sum of the full-load current of all the motors must be equal to or less than the maximum output current, rating of the controller;

For example: With three motors connected to one controller:

FLA	IFLA I	IFLA - B
MOTOD :	MCTOF 2	MOTOR :
그럼 이 가슴을 가 있었다.		0

B < 100% rated current

- When one or more of the motors connected to the output of the controller are to alart independently:
  - Any molor that starts or stops while the controller is running, must have a full-load current rating tess than 10% of the maximum controller putput current rating;

FLA of motor < 10% of maximum centroller rated output current

 The sum of the maximum full load current of all connected motors must be less than the maximum controller output current , rating uncler any conditions.

# A Special Note Regarding Replacement of Parts

The SPSXI controller is constructed as a one-piece design. Replacing individual parts is not recommended. If the controller fails to operate, perform the recommended procedures given in Section 7, Troubleshooting and Fault Codes.

# **Optional Kit**

An optional dynamic braking kit is available as shown in Table 2-3.

#### Table 2-3. Controller Optional Kits.

Description	Model Number	Instruction Sheet
Synamic Braking Kit	2DB2005 (UL) 2DC2005 (CSA)	U2-3178

Note: Pafer to Section 3, for input/output specifications of control wring.

#### Table 2-4. Power Loss (Watts)

HP	Input Voltage	Power Loss (Watts	
1-2HP NEMA 1/4 All Carrier Frequencies	230VAC	100	

# 3:

# Installation and Wiring

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST. OPERATE. AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS EN-TIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

#### DANGER

THE USER IS RESPONSIBLE FOR CONFORMING TO THE NATIONAL ELEC-TRICAL CODE (NEC) AND ALL OTHER APPLICABLE LOCAL CODES. WIR-ING, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAU-TION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

CAUTION: Use of power correction capacitors on the output of the controller can result in ertatic operation of the motor, nuisance in pping, and/or permanent damage to the controller remove power lactor capacitors before proceeding. Failure to observe this precaution could result in damage to, or destruction of the equipment.

## Planning and Location

Planning before installation is necessary to ensure that the controller environment and operating conditions are satis'actory. Read and follow the recommendations advised in this section before proceeding with the installation.

- 1. Verily that the controller can be kept clean and cool.
- Check that the controller will be away from uil, coolants, or other airborne contaminants.
- Check that the temperatures within the vicinity of the controller are between +0°C to 40°C (32°F to 104°F).
- Check the the reletive humicity is between 5 and 95% noncondensing.
- Do not inatall above \$300 feet (1000 meters) without derating. For every 300 feet (91.4 meters) above 3300 feet, derate the current rating by 1%. Consult Refance Electric Sales for operation above 10,000 feet.
- Check that the area chosen will allow the space required for air flow around the controller.

## Mounting

- In the location selected, mount the controller vertically using the (4) mounting holes provided. See Figure 3-1.
- 2. Provide adequate clearances for air ventilation:
  - At least 2" inches from the sides and 2" inches from the top and boltom.

See Figure 3-1 for physical dimensions.



Figure 3-1. Physical Dimensions.

#### WARNING

THE NEC REQUIRES THE INSTALLATION OF AN OVERLOAD PROTECTION DEVICE RESPONSIVE TO MOTOR CURRENT IN EACH POWER LINE OF THE MOTOR (MOTOR OVERLOAD RELAY) OR THAT THE MOTOR CONTAINS A THERMAL PROTECTION DEVICE RESPONSIVE TO MOTOR TEMPERATURE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

- Note: Install the motor according to the motor instruction manual.
- Verify that the motor is the appropriate size to use with the controller.
- Connect the motor leads to the controller output terminate U, V, and W. See Figure 3-5.
- Verily that the motor is properly aligned with the driven machine to minimize unnecessary motor loading from sheft misalignment.
- If the motor is accessible while it is running, instal a protective guare around all exposed rotating parts.
- Note: According to NEC requirements, install an overload protection device responsive to motor current in each power line of the motor (motor overload relay) or verify that a thermal protection device responsive to motor heat is internal to the motor.

### Motor Lead Lengths

For applications using one motor connected to the controller, individual motor lead lengths cannot exceed 250 feet per phase. For applications where multiple motors are used, total lead lengths on each phase cannot exceed 250 feet, and each motor connection cannot exceed 250 leet.

For example, Figure 3-2 Illustrates correct application connections:



Figure 3-2. Motor Wiring to Controller.

If tota 3-phase lead length exceeds 250 feet, nuisance tripping may occur. These trips are caused by capacitive current flow to ground and are not an indication of any problem with the controller. If the lead length must be exceeded, output line reactors or other steps must be taken to correct the problem.

# Install an External Input Disconnect

#### DANGER

THE NEC REQUIRES THAT AN INPUT DISCONNECT BE PROVIDED IN THE INCOMING POWER LINE AND EITHER BE LOCATED WITHIN SIGHT OF THE DRIVE OR BE LOCKABLE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

- Install an input disconnect in the incoming power line according to the NEC guidelines.
- Size the disconnect according to the innush current as well as any additional loade the disconnect may supply.
- Note: Coordinate the disconnect thip rating for the in rush current (10 – 12 times full load current) with that of a transformer (if used). See "Install a Transformer (if Needed)", later in this section.

#### DANGER

THE NEC REQUIRES THAT UPSTREAM BRANCH PROTECTION BE PRO-VIDED TO PROTECT INPUT POWER WIRING. INSTALL THE RATING REC-OMMENDED. DO NOT EXCEED THE MAXIMUM ALLOWABLE RATINGS. FAIL-URE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

**CAUTION:** The input fuse ratings listed in Tables 3-1 and 3-2 are applicable for one crive per branch drout. No other load can be applied to that fused branch drout. Fallure to observe this precaution could result in damage to, or destruction of the equipment.

- Install user-supplied branch circuit protection according to the NEC guidelines.
- 2. Size the branch circuit according to Tables 8-1 and 8-2.

#### Table 3-1. A-C input Line Branch Circuit Protection with Three-Phase Input.

Controller HP	Three- Phase Input Volts	Recommended Fuse Rating		anded Maximum sting Fuse Rating	
		Class	Amps	Class	Amps
Al	230 VAC	N N	20A	J	20A

#### Table 3-2. A-C Line Branch Circuit Protection with Single-Phase Input.

Coniroller HP	Single- Phase Input Volts	Recommended Fuse Rating		Maximum Fuse Rating	
		Class	Amps	Class	Ampş
Al	230 VAC		20A	1	20A

Note: The recommended fuse type is UL Class J, 600% time delay.

## Install a Transformer (If Needed)

input transformers step up or step down the input voltage and can be either autotransformers or isolation transformers, iso ation transformers help to eliminate;

- Damaging A-C line voltage translents from reaching the controller.
- Line noise from the controller back to the incoming power.
- Damaging currente, which could develop if a point inside the controller becomes grounded.

If an input transformer is installed ahead of the controller, a power disconnecting device must be installed between the power line and the primary of the transformer.

If the power disconnecting device is a circuit breaker, the circuit preaker trip rating must be coordinated with the inrush current (10 to 12 times full-load current) of the input transformer.

An input transformer rated at more than 100 KVA for 230VAC, with least than 5% impedance should NOT be used directly ahead of the controller without additional impedance between the controller and the transformet.

**CAUTION:** Distribution system capacity above the maximum recommended system KVA requires using an isolation transformer, a line reactor; or other means of adding similar impedance. Failure to observe these preceditions could result in camage to, or destruction of, the equipment.

**CAUTION:** When the A C line is shared directly with other SCB rectified drives, a line reactor or optional DB kit may be required to alleviate excess D-C bus voltage. Failure to observe these precautions could result in damage to, or cestruction of, the equipment.

#### DANGER

THE USER IS RESPONSIBLE FOR CONFORMING TO THE NEC AND ALL OTHER APPLICABLE CODES. WIRING, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAIL-URE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

- Remove the (4) #10-32 cover screws and remove the cover.
- Pun a suitable equipment grounding conductor unbroken from the controller ground terminal (See Figure 3-3) to an earth ground conductor. See Table 3-3 for recommended wire sizes.
- Connect a suitable equipment grounding conductor to the motor frame, the remote control station (if used), and the transformer. Bun each conductor unbroken to the earth ground.

#### WARNING

THE FACTORY-INSTALLED JUMPER ACROSS TERMINALS 10 AND 11 ON THE CONTROL WIRING TERMINAL STRIP MUST BE REMOVED WHEN FUNCTION LOSS INPUT, COAST-STOP PUSHBUTTON, OR INTERLOCKS ARE USED SO THESE CONTACTS WILL OPEN TO STOP THE CONTROLLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN BODILY INJURY.



Figure 3-3. Controller Wining Locations.

Wiring	Terminal <sup>(2)</sup>	Wire Size
nput Power	R, S. T	11 AWG
Output Power	- U, V, W	14 AWG
3B Power	, +	14 AWG
<b>DB Control</b>	12,13 on Terminal Strip	14-22 AWG
Function Loss	10,11 on Terminal Ship	14-22 AWG
GND terminal	GND stud	14 AWG

Table 3-3. Recommended Wire Sizes.(1)

(1) Table 3-S represents a wide range of acceptable wire sizes. For actual sizes, the user is responsible for following the NEC and all applicable local codes with respect to wire sizes.

For locations, refer to Figure 3-3.

# Input/Output Specifications

(Refer to Figure 3-5.)

- IET Output Relay: 115VAC/24VDC, 1/2 amp; (1) Form A and (1) Form B contact wired with a single common.
- Control Logic Inputs:
  - 1. 24VDC Inputs

Function Loss, and Stop: Both of these inputs must be tied to the 24VDC common to assert the signals. When these signals are not connected, they are field "high" (24VDC is present) at the terminal. See Figure 3-1.



Figure 3-4. Example Function Loss/Stop Input.

Start and IET Reset: These two inputs are edge sensitive and must see a transition from OEE to ON before being asserted.

Forward and Reverse: Signal is high, forward direction; signal is low, reverse direction.

24VDC Common: Logic common for Stop, Start, IET Reset, Forward/Reverse, and Function Loss.

- Dynamic Braking Control Signal: DB control signal referenced to 24VDC common.
- Signal Terminated Points:
  - Speed reference analog voltage supply, referenced to regulator nominon (ouffered 1.875 Kohrt, 15V IC power supply source).
  - 2. Speed reference input (volts or amps)
  - Speed reference OV regulator common

 Metering Analog Output, referenced to 24VDG common; 0–10 vota scaled to represent the currently displayed unit;

Volta=0=258 %Load=0=200% RPM=0=Maximum RPM (or any Engineering unit) External Reference (percentage) = see Function 13, Remote Reference Display Enable

### **Power Wiring**

- Verify that the input power to the controller corresponds to the controller nameplate voltage and frequency and that the plant supply is of sufficient capacity to support the input current requirements of the controller.
- Provide a transformer between the plant power supply and the controller if the correct input line voltage is not available.
- Size upstream branch circuit protection (luses) according to lable 3-1 or 8-2.
- Refer to Table 3-3 and size input and output power wiring to handle the rated maximum controller current as Table 2-1 or 2-2.
- Use only copper wire with a minimum temperature rating of 60/75°C.
- Use the appropriate terminal tightening torque as listed in Table 3-4 for wire connections to input and output terminals.

Table 3-4. Power Terminal Tightening Torques (ib-in).

Terminale	Torque		
Input Terminals B, S, 1	S		
Output Terminals U, V, W	All - 9 min 12 max. in-lbs.		
DB Terminals +, -	18 E		

 Wire the power input leads. Use Figure 3-3 for wring locations. Route A C input leads through the bottom left opening of the controller base to terminals R. S, and T. Only route power wring through the bottom entry openings.

Note: For single-phase units, connect the power input leads to any one combination of R&S, or S&T.

 Route motor teads fit not stready cone so; through the boltom right opening of the controller base to terminals U, V, and W.

## **Control and Signal Wiring**

Size and install all wiring in conformance with the NEC and all other applicable local codes. See Table 3.3 for recommended wire sizes. Refer to Table 3-5 for term nal strip tightening torque.

**CAUTION:** Do not route signal witing with power wiring in the same conduit. This may cause interference with controller operation. Failure to observe this precaution could result in damage to, or destruction of the equipment.

- 1. For all signal wring use twisted pair wire.
- For distances of up to 1000 feet, use a minimum of #22 AWG wire. For distances of more than 1000 feet, contact Rehards.

#### WARNING

THE FACTORY-INSTALLED JUMPER ACROSS TERMINALS 10 AND 11 ON THE CONTROL WIRING TERMINAL STRIP MUST BE REMOVED WHEN FUNCTION LOSS INPUT, COAST-STOP PUSHBUTTON, OR INTERLOCKS ARE USED SO THESE CONTACTS WILL OPEN TO STOP THE CONTROLLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN BODILY INJURY.

Table 3-5. Regulator Terminal Strip Tightening Torque.



Figure 3-5. Terminel Strip Wiring.



Figure 3-5. Speed Reference Input Wiring.



Figure 3-7. Start-Stop Wiring.

#### WARNING

THE CONTROLLER IS NOT EQUIPPED WITH A COAST-STOP PUSHBUTTON. THE USER MUST INSTALL A HARDWIRED, OPERATOR-ACCESSIBLE PUSH-BUTTON THAT PROVIDES A POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE. (USE TERMINALS 10 AND 11. SEE FIGURE 3-8.) FAILURE TO OB-SERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

> Boute all signal wiring through the knockout opening at the too left of the controller. Remove the factory-installed umper at terminal 15 to install a normally closed, maintained emergency stop pushbuitor. Refer to Figure 3-8.



Figure 3-8. Coast-Stop Pushbutton Wiring.

 Route external control wiring (remote station) through the top right opening. Refer to Figures 3-6 through 3-8.

# Remote Analog Input Reference Jumper Setting

Located on the regulator board is a remote speed reference input jumper (J6) that provides a jumper selectable 0-10 VDC or 0-20 mainput with a software programmable gain and offset edjustment (Functions 11 and 12 in Section 5). See Figure 3-3 for the location of the JB jumper.

NOTE: If the position of the reference jumper is changed, the activate does not recognize that the input signal has been changed from 0 – 10 VDC to 0 – 20 mA, or vice versa. Verily that parameters 11 (remote reference gain) and 12 (remote reference offset) calculations are correct before starting the drive.

To change the remote speed reference (umper J6:

#### DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. VERIFY THAT THERE IS NO VOLTAGE PRESENT AT D-C BUS TERMINALS (+) AND (-). FAILURE TO OBSERVE THIS PRECAU-TION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

> Remove power to the crive. Verily at terminals + and - that the D-G bus is zero VDC.

#### Remove the (4) corner screws and the controller cover it not already removed.

0-10 VDC	0-20 mA
O PIN 8	O PIN3
O PIN 2	O PIN2
O PIN 1	O PIN1

#### Figure 3-9. Jd Jumper Settings.

- 3. Locate jumper J6 on the regulator board. See Figure 3-3.
- 4. Locate Pin 1 on JG as shown in Figure 3-9.
- Move the jumper to the desired setting as shown in Figure 3-9.
- Verify that Functions 11 (reference gain) and 12 (reference offset) are set correctly each time the jumper is moved.
- Make a written note of the jumper settings in the table labeled "Settings liable" on the back cover of this manual.

# 4: Keypad Operation

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE AND/OR SERVICE IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PRO-CEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

## **Keypad Description**

The SP500 keypad consists of a four-character display that indicates one of four display modes, a function number, the value of the function, or fault codes when a fault occurs. Refer to Figure 4-1 for an illustrated view of the keypad and display.



Figure 4-1. SPS00 Controller Keypad and Display.

## Indicator Lights

The keypad has eight indicators (LEDa). The (3) LEDs on the left top of the Kaypad indicate the current diaplay mode of either RPM, %Load, or Volts. A fourth display mode is activated when Function 13, "Remote Reference Display Enable" is set to ON. If the remote reference display function is turned "ON", and selected using the MODE/ENTER key, all 3 display mode LEDs will be it (RPM, %-OAD, VOLTS) to indicate that the external reference is currently being displayed. If all lines display mode LEDs are fit, this indicates that the alphanumeric display will be displaying percentage of (external) speed reference. See Section 5, "Adjusting the Controllar Functions", for more information on Function 5. The fourth LED on the left side (REMOTE) indicates that the orive is following a remote speed reference from the remote digital inputs (1 Function 00—"ON").

The group of four LEDs on the right side under the display, indicate that the crive is running (RUN LED), whether the Program Mode (PROGRAM LED) is active, or indicates the speed direction (either FORWARD or REVERSE).

- RPM LED: The "RPM" LED is automatically illuminated upon drive power-up and is the default display mode. Once the display mode is changed, the drive will power up in the display mode that was active when power was removed. This LED inclustes that the values being displayed, while the drive is running, are in units of RPM. When the drive is stopped, the value displayed will be zero.
- %LQAD LFD: The "%LQAD" LFD indicates, while the drive is running, that the values being displayed are in a percentage of full load ampa. When the drive is stopped, the value displayed will be zero.
- VOLTS LED: The "VOLTS" LED indicates, while the drive is numing, that the value being displayed is that of the drive output voltage to the motor. When the drive is stopped, the value displayed will be zero.
- Note: If all three claplay mode LEDs are iff, this indicates that the alphanumeric display will be displaying percentage of (external) speec reference.
- REMOTE LED: The "REMOTE" LED indicates, when illuminated, that the drive is in remute operation and is following signals from the terminal strip. When the REMOTE LED is not lit, the crive is in LOCAL mode. Enabling Function 00 (-ON) will illuminate the LED.

The fast display mode chosen when the drive is powered down will then be the same one active when the drive is powered up again. Example: The display mode RPM is changed to %LOAD. The drive is powered down, and powered back up egain. The display mode will remain as %LOAD.

#### DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. THE RUN LED MUST NOT BE USED AS AN INDICA-TION THAT THERE IS NO LINE VOLTAGE PRESENT IN THE CONTROLLER. VERIFY THERE IS NO VOLTAGE PRESENT AT THE D-C BUS TERMINALS (+) AND (-) BEFORE SERVICING THE CONTROLLER. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

•	RUN LED:	This LED is illuminated when the drive is running (the controller is generating an output voltage and frequency).
•	PROGRAM LHD:	This LHD is duminated when the control or s in Program Mode. Program Mode is entered by pressing the MODE/ENTER key when the prive is slopped.
•	FORWARD/ REVERSE LED:	One of these LEDs are illuminated to indicate the requested rotational direction of the motor while the crive is running.

## **Key Descriptions**

Onive operation is controlled by etx keys. These keys are described below.

START key: The START key will start the drive if no faults are active and the drive is in LOCAL control mode (F-00 = OFF). The last display mode used will be illuminated by one of the display mode LFDs. When this key is pressed, the drive will accelerate to the last frequency setpoint.

#### WARNING

THE CONTROLLER IS NOT EQUIPPED WITH A COAST-STOP PUSHBUTTON. THE USER MUST INSTALL & HARDWIRED. OPERATOR-ACCESSIBLE PUSH-BUTTON THAT PROVIDES & POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE (USE TERMINALS 10 AND 11). FAILURE TO OBSERVE THIS PRECAU-TION COULD RESULT IN BODILY INJURY.

- STOP/RESET key: The STOP/RESET key will stop the crive or reaet any fault indications (1 the cause of the fault has been cleared). If the drive is already stopped, the STOP/RESET key will terminate the PROGRAM mode if it is currently active.
- Note: The drive will perform a ramp to a rest stop (ramp down based on the set deceleration rate) or coast-to-rest stop, depending on the value of Function F-16, when stooped under normal conditions. If an IET fault occurs, the prive will coast to a stop.
- · MODE/

ENTER key: This key will select what display mode (RPM, SJIOAD, VOLTS, or REMOTE REFERENCE D SPLAY) is active while the drive is running. If the drive is alopped, the MODE/ENTER key will place the drive in PROGRAM mode. Once in the PROGRAM mode, the MODE/ENTER key will anter function information into the drive.  FORWARD/ REVERSE KEY: The FORWARD/REVERSE key is used to select the speed cirection of the motor. The FORWARD or REVERSE LED will be illuminated indicating the requested rotational direction. (Note: The LED may illuminate before the drive turns in the new direction.)
 UP/DOWN ARROW KEYS: The UP/DOWN arrow keys are used to increase or decrease the speed reterance to the drive, or to change individual function information. Holding the up or cown arrow key for more than

a few seconds will increase the scroll speed.

### Power Up

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE AND/OR SERVICE IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PRO-CEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

> When the controller has power applied, the display will show "SELF" and during this display period, the microprocessor will perform a diagnostic routine. This is normal and the display should "click" to the RPM display mode, or whatever mode the controller was in when it was powered down last.

### Modes of Controller Operation

#### **Display Modes**

There are three display modes (or four, if Remote Relerance Display mode is active) available when the crive is powered up. These are: RPM, %Load, and Volts. The current display mode (while the drive is surroung) is indicated by an illuminated LED. The factory default cisplay mode is RPM.

To select a display mode (RPM, %LOAD. or VOLTS):

While this drive is mining, press the MODE/ENTER key. This explay will show SEOAD; and the SEOAD; LED will be indered the SEOAD; and the SEOAD; LED will be note indered the boot mode.
 Is displayed and the appropriate LED will light; The value cisplayed is in the units of the display mode chosen.
 To change the display mode again, press the MODE/ENTER.

A fourth display mode, "HEMOTE REFERENCE DISPLAY", can be activated by Function 13. The value disclayed in this mode is the value of the external reference signal as 0–100% of the total scaled reference range. (Functions 11 and 12 are functions that "ecale" the reference.)

If Function 13 is enabled (or turned "ON") a fourth display mode choice can be activated by pressing the MODE/ENTER key once after the "VOLTS" display mode. All three I FD's (RPM, %I OAD, and VOLTS) will be illuminated at the same time, indicating the fourth display mode is active. Refer to Function 13 for more information and examples for II're REMOTE REFERENCE DISPLAY ENABLE Function.

#### To select the REMOTE REFERENCE DISPLAY mode:

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Prover un the crow	ł
	2
2Prees INS.MODE/ENTER.key ID.Select Ins.H-ILIGH/M.Rudde.	÷
(The PROGRAM LCD will be illuminated and the bisplay will	ż
show (H-ODC)	÷
3. Move the up arrow key until /6-13*. s displayed. The down	:
: ; ; ;etubix key dan alao be (ubvec to declement decivitatids; ; ; ;	•
· · · · · Darough-bae lest l· · · · · · · · · · · · · · · · · · ·	ŧ
. 4. Press the MODE/ENTER key.	:
5. Move the up arrow key until the display shows "ON".	2
. S. Prees the MODE/ENTER key to "lock in" the value,	:
7. Press the STOP RESET vevice axit the PROGRAM Mode.	1
	÷
• 8. Stars the drive by pressing-the START key.	•
4 Prace the MODE/ENTER key (3) strate a still all targe sizeday.	t
· · · · · · · · · · · · · · · · · · ·	2
,	÷
10. The display should how be in the REMOTE REFERENCE	t
	1
dsb@wed	÷,

### Program Mode

The Program Mode allows function values to be viewed or adjusted. All functions (00–18), including the entir log ("CRR") are accessible in the Program Mode.

- Note: The PROGRAM mode can only be entered if the drive is stopped.
- To enter the Program Mode and access the functions:
- 1.0

: (Stop the drive (it running) by pressing the STOP/RESET	bey,
2 Protecting MODE/ENTER Key The PROGRAM LED show	ð::
<ul> <li>S -lise the Lindown serve kays to move through the functions</li> </ul>	an -
lisC	
4. Préas tria MODE/ENTER kay foldablev the value of trial	:::
current function displayed	:::
*b. Use the Opydown arrow keys to change the value of a to thos. (No.e. Holdrin down the up of down arrow key for	10-
more than one second will increase the scrol speed.)	888
B Press the MODE/ENTER key again to "lock in" the news	ak :
ue. (Libe display will return to a splaying the function our der	2::

To exit the Program mode:

Pressible STOP/RESET key, Sole that (the entry logits being) rexamined, the STOP/RESET key will reset the entry (and dear 1 of endrs). Note that the entry will only clear (the external cause of the problem has been eliminated. The entry log function can be as ted by pressing the STOP/RESET key while the 'ESR' display teractive:

# Error Log

Located after Function 18, is an error log ("Err" is displayed) that slores the first three faults that have occurred. The Program mode must first be entered to access the error log. Refer to Section 7, Troubleshooting and Fault Codes, for more information on the Error Log and clearing the faults.

To access the Error Log:

2.

 Enter the Program Vacks.
 Enter the Program Vacks.
 Enter the Program Vacks.
 Enter the display shows "F 00", use the down arrow key to move cureftly in "Fer". Entred the up or down arrow key can be used to move through the function fils: "Entrolows "P-18".
 Press the MODE/ENTER key.
 Press the Up arrow key to move through the error codes.
 Press the STOP/RESET key to clear the fault. (Refer to Seclion 7, Troubleshooling and Fault Codes for more information on error codes.)

# 5: Adjusting the Drive Functions

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS EN-TIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

> The drive offers 19 functions that can be either accessed, monitored, or changed using the keyped. The first fifteen functions are shipped from the factory with default settings. These settings must be adjusted for the application.

## Factory Default Settings

Table 5-1 lists the fectory initial settings for each function number.

Tunction		Factory Initial Setting	Range of Setting
F-00	Hemote Fnable	OFF	Qn, Qff
F-01	Acceleration Rate (sec)	5.0	0.5-30.0
F-02	Deceleration Rate (sec)	5.0	1.0-30.0
F-03	Minimum Speed (Hz)	5.0	3.0 30.0
F 04	Maximum Speec (Hz)	60.0	30.0-240.0
Γ-06	Current Limit (%)	160%	10%-160%
F-06	Manual Torque Boost (%)	2%	0%-10%
H-07	Volts/Hertz Base Speed	60	30-240
F-be(f)	RPM a: Base Speed	1760	1-9999
F-09	IET Oulput Enable	OFF	On, Off
F-10	Carter Frequency (kHz)	8	4, 6, 8
F11	Remote Reference Gain (%)	100%	60%-100%
F-12	Remote Reierence Oilset (%)	0%	0%-40%
F-13	Remote Reference Display Enable (?)	OFF	On, Off
F-14	Electronic Thermal Overload (%)	100%	20% 100%
E-1	Electronic Thermal Overload Enable	OFF	On, Off
F-16	Coast Stop Enable	ON.	On, Off
F-17	Reverse Disable	OFF	On, Off
F-'8	Software Version	Head Only	N A
ERR	Error Log follows F 18		N/A

Table 5-1. Factory Delault Settings.

(1) Note: This function can be used to scale the display to any engineering units in addition to RPM.

(2) F-13 activates the 4th Display Mode.
#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST. OPERATE. AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS EN-TIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

To change the value of a function:

1.1. Proving und this drive.	
2. Pressing MODE/ENTER key b	a selection RROGRAM model 1
::::(The PHOGRAM (ED will be f)	urtinated and the display will; ;
· · · SUDAL ISAO / CIE NISCIDINGUIN	
<ul> <li>3. Move the up/down errow keys intribution is displayed.</li> </ul>	until the desired function
: 4. Press II's MODC/ENTER key s	ជំនាំរៀង ដែនស្នែក ដែនស្នែក ដែនស្នែក ដែនស្នែក
; \$.; Press II'd up/dat/h atrovi bays	(o)change(the(value)) ) ) ) ) ) )
: 6.: Press III & MODE/ENTER My II	o("lock in" the believed values ( )
7. Prodube to the next function to down entry keys.	(b): Soshped ወይ መርሆንር up? [ [ ] [
8. Press the STOP/HESET key to	exit-the PROGRAM made

## FUNCTIONS

## F-00 - REMOTE ENABLE

#### Settinge

OFF - Local Operation ON = Remote Operation

#### Description

This function selects the control mode for the drive. In LOCAL control the drive takes input from the keyped, while in REMOTE control the crive takes commands from signals from the terminal strip. If the controller is in REMOTE mode, the REMOTE LED will be It.

Under LOCAL control the following keys can be used:

- START
- STOP/RESET
- FORWARD/REVERSE
- MODE/ENTER (when prive is stopped)
- Up and Down Arrow (when drive is in PROGRAM mode) In addition to these keys, the following signals are processed:
  - Remote IET/Controller Running (see Figure 3.6)
  - Remote Function Loss (see Figure 3.5).
  - Remote Display (BPM, %LOAD, VOLTS).

Under HEMOTE control the following keys can be used:

- MODE/ENTER (when orive is stopped)
- Up and Down Arrow (when drive is in PBOGBAM mode).
- · STOP/RESET

All remote signals (e.g., remote stop, start, etc.) wired to the terminal sing are processed. (See Figure 3-5.)

## F-01 - ACCELERATION

#### Settings

Parge of 0.5 - 30 seconds

Step Size

0.10 seconds

#### Description

The acceleration rate is the amount of time to ramo from stop to the programmed maximum speed setting (Function 4).

If the setcoint frequency (fast requested local speed from the up/down arrow key) is less than the maximum speed setting, the time to ramp to that setpoint will be proportionally less than the actual acceleration rate setting. If maximum speed aquals 60 Hz and accel time equals 4 seconds, it will take 2 seconds to ramp to a frequency setpoint of 30 Hz (and 1 second to ramp to 15 Hz).

If the acceleration rate is set too fast, the crive may trip out on an overcurrent IET condition. (See Section 7 if this condition exists.)

#### F-02 - DECELERATION

#### Settings

Range of 1.0 to 30 seconds

Step Size

0.10 seconda

Description

The deceleration rate is the amount of time to ramp from the programmed maximum speed setting (Function 7) to a stop.

The deceleration time is also proportional to the last set frequency. (See Function 1, Acceleration.)

If the deceleration rate is set foo fast, the drive may big out on a high bus fault. (See Section 7 if this condition exists.)

## F-03 - MINIMUM SPEED

#### WARNING

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE AP-PLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DIS-CONNECTION. THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDI-TIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

#### Settings

Range of 3 - 30 Hz

#### Step Size

0.10 Hz if maximum apaed is less than 100 Hz 0.25 Hz if maximum apaed is greater than or equal to 100 Hz.

#### Description

Minimum speed is the minimum output frequency value.

## F-04 - MAXIMUM SPEED

#### WARNING

THE USER IS RESPONSIBLE FOR ENSURING THAT DRIVEN MACHINERY, ALL DRIVE-TRAIN MECHANISMS, AND PROCESS LINE MATERIAL ARE CA-PABLE OF SAFE OPERATION AT AN APPLIED FREQUENCY OF 100% OF THE MAXIMUM FREQUENCY (UP TO THE FREQUENCY OF F-04). FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

#### **Sctlings**

Range of 30 - 240 Hz

Step Size

0.10 Hz if max speed is less than 100 Hz 0.25 Hz if max speed is greater than or equal to 100 Hz -

Description

The maximum speed is the maximum output frequency value.

## F-05 - CURRENT LIMIT

#### Settings

Pange of 10% to 150% of rated controller current

#### Step Size

1.3%

#### Description

This function provides the means to limit motor output torque during run or acceleration. When output current attempts to exceed the preset current limit, motor speed is maintained or reduced, or deceleration time is extended. If current limit is set too low, an "OC" (Overcurrent) feult may occur.

## F-06 - MANUAL TORQUE BOOST

#### Settings

Range of 0 - 10%

1 = 1%2 = 2%10 - 10%

#### Step Size

1.0%

#### Description

Torque boost is required to offeel the voltage drop of the A-C motor at low speeds. For friction loads, or high inertia loads, a high starting torque level may be needed. Manual torque boost is only effective at speeds lower than helf of base frequency. See Figure 5-1.

When adjusting this function, start with the default setting of 2%, and gradually increase the adjustment until satisfactory motor operation is resoned.



Figure 5-1. Manual Torque Boost Adjustable Range.

## F-07 - V/HZ (Base Speed)

#### Settings

Range of 30 - 240 Hz

#### Step Size

1.0 Hz

#### Description

The volts/hertz feeture allows the drive to maintain a constant volts/hz ratio, thus providing constant torque at any frequency. The frequency value entered to establish the volts/hertz curve is the base speed at maximum output voltage (200V). See Figure 5-2.



Figure 5-2. Volts/Hertz Curve.

## F-08 - RPM AT BASE SPEED

Settings

Range of 1 - 9999

51ep Size

1.0 unit

Description

This feature provides the user the ability to scale the display by using the RPM display mode, to any desired engineering unit to match an application. For example, if the application requires claplaying frequency (nates) of RPM), enter the value for the frequency into Function 6. The following example equation is used to calculate the value needed to enter into Function 8. (The scaling is based on the maximum output frequency of the drive.)

+	+			-+	+	٠		-+	+	٠		-+	+		-	-+	+	٠		-+	+	٠	4	+	+	٠		+	+	٠	-	-+	+	٠		-+	+	14	-4
٠	٠	٠	٠	٠	٠	٠	÷	÷	÷	3	٠	٠	4	D	85	ir.	æ	1.1	D:	at	2 le	11	ex	41	VE	JI.	JIE	2	e i	P-	07	ē.	٠	٠	٠	٠	٠	٠	А
	. 4						٠		£	в						-	+	-		-	-	-		-					+		÷	••					٠		- 4
•	٠		٠	•	٠	÷	٠	٠	ř	÷	٠	•			٠	٠			٠	м	80	eł	Hz	-	F	0	4)	÷	•	÷	٠	÷	٠		٠	•	٠		
+	+	٠		+	٠		4	+	+	٠		+			-4	+	+	٠			*	٠	4	γ.		х.	*	۰.	٠		4	+	+	٠	-	+	٠		14

Note: This function can be used to scale the display to sny engineering units desired, including RPM.

## F-09 - IET OUTPUT ENABLE

#### Settings

ON - IET fault indication OFF = Controller is running indication

#### Description

This function selects whether the remote output signal (at terminals 14–16) represents the state of an active IET fault or that the controller is currently running. If the signal represente an active IET fault (F 09–ON), then it will remain asserted until the fault is cleared by pressing the "STOP/PESET" key (in LOCAL operation) or by using the remote IET reset signal (for REMOTE operation).

If the signal represents controller running (F-09 – OFF), then the signal is only asserted when the RUN LED is lit.

## F-10 - CARRIER FREQUENCY

#### Settings

Range of 4 - 8 KHz

4 = 4 KHz 6 = 6 KHz 8 = 6 KHz

Description

The carrier frequency can compensate for acoustic noise, heating, and other current problems by adjusting the switching frequency of the transistors in the inverter section.

The carrier frequency controls the width of the pulse and keeps the current smooth to the motor.

Keeping the corner frequency at 4kHz will maximize the continuous power racing of the drive and generally still have an acceptable accustic noise from the motor, increasing the carrier frequency will alleviate the accustic noise, but in some applications can result in derating of the controller.

## F-11 - REMOTE REFERENCE GAIN

#### Settings

Range of 60% - 100% of full scale maximum reference.

Step Size

0.10%

Description

The remote reference gain scaling is used to scale the **maximum** remote sceed reference to match external equipment. Normally, the maximum speed reference (amount of reference at maximum apeed, F-04) is either 10 VDC or 20 ma. The reference gain is used to scale the sceed reference to another value (for example 9.5 VDC or 19 ma). Enter this function in percent (%) of full scale reference. To calculate the scaled reference, use the following equations:

If using a 0-20 ma remote reference:

Quisings Was	iriuiri B	diárária	<u>\$: (69)</u> :	× 150	) — % çah (ma refe	rence;
Horard	irod Har	.dé (%)	ξ			
Example 1.	If the r maxim	emote um refe	speed n atanca ra	eleren: squirec	a is 0—20 ma and t is 19.2 ma, scale a	he s follows:
	19,2 20	X	100	-	95% gan	

If using a 3-10 VDC remote reference,

10

	b	ie	á	re	đ	Ň	ia	ź.	ŕ	Ĵ,	ŵ	ł	è	ŧe	fe	ń	3	ė	ŵ	ġ	ċ	ġ,	5	è	in	'n	2	3	ŝ	i.	-	ñ	ñ	'n	'n	÷.,	÷	i.	å	ñ	å	ŝ	ŝ
t:	2	1	2		7	2	ŝ.	í.	÷.	Ň	5	k	÷,	å	ä	č	ŵ	S.			2	2	2	2	2		5	•	Y	2	2	Y	5	1		1	2	7	1	~	2	.,	5
Ε.	5	3	2	2	5	1.64		20		-		-		ş		5	1	0	2	2	5	C	2	ē.	5	3	2	ĉ	5	C	2	5	5	0	2	2	5	C	2	ð	5	3	1

Example 2.	If the n maxim follows	emote i ium refe s:	spaec re stence n	derence equired	e is 010 VDC and the J is 9.5 VDC, scale as
	9.ő	x	100	=	95% gain

## F-12 - REMOTE REFERENCE OFFSET

#### Settings

Range of 0% - 40% of full scale minimum reference.

#### Step Size

0.10%

#### Description

The remote reference offset scaling is used to acate the minimum remote speed reference to match external equipment. Normally, the initiation speed reference (amount of reference at minimum speed, F-03) is either 0 VDC or 0 mA. The reference gain offset is used to scale the minimum zero speed reference to another value (for example 0.4 VDC or 4 mA). Enter this function in percent (%) of full acate reference to be offset from minimum speed. To calculate the scaled minimum reference, use the following equations:

If using a 0-20 ma remote reference;

٠	•	•••	•••	•	•	• •				•		•		•		•	. •	•	•	•	•	•			•	•	•	•	•	•		•	•	٠	•	•	•	•		ा	L
٠	*	Cer	01/10	æ,	$\mathbf{z}_i$	án'	ς.	Rn	14	οŃ	19	DH:	the	a	65	iπ.	14	i÷.											×	٠		٠	٠	٠		.+	٠	٠		-	l
٠	1	55	1.1	Υ.	÷	253	-	25	19	22	٠.	5		Ŷ	2.0	23	2			- 4	ς.	10	ю	-	÷	34	- 22	eĿ,	26	t-	-		÷	+		14		۰.		4	L
÷	٠	4.4	• 5	-	(B)	e1	ic	H'	Пź	an	a	ė	12	6	ţ.							4	4			•		.+	÷	4	٠	÷	÷		٠		٠	4	٠	A	l
٠	+		+ +		÷	+ +		G+	+		4	۰.	57	÷	٠.		- 4	+		14		+		-	- 4	+		14	+	+	٠		+	+	٠		4	+		-	ŀ

Example 1. If the remote speed reference is 0-20ms and the offset from minimum speed required is 4 ms, scale as follows:

4	8	100	ù <del>≜</del> ⊘,	20% offset
20				

If using a 0 - 10 V JG remote reference:

;	Desired Zero Speed Offset (VDC)	i.	:	-		in	à	1	2	-	à	ń.	-	÷	:	:	ţ	:	:	1	÷	:	:	:
÷	**************************************		÷	£	٠.	12	¥			9	÷	1	~	×.	٠	÷	÷				٠	*	۰.	A.
٠	Selenence.Hengle (NV)	• .	٠		٠		٠	+	٠				٠	۰.			÷						۰.	-
	******************		4	12	-	- 20	12	1.00			14	2		Ξ.	21				14	12	-	ω.	100	-1

Example 2. If the remote speed reference is 0-10 VDC and the offset from minimum speed required is 0.4 VDC, scale as tollows:

<u>6.4</u> x 100 - 4% cliset

## F-13 - REMOTE REFERENCE DISPLAY ENABLE (4TH DISPLAY MODE)

#### Settings

Disclays the external speed reference as 0 - 100% of the ecaled reference range.

ON=41h cieplay mode is enabled and will display the external speed reference when the REMOTE display mode is chosen. (Function 20  $\pm$  ON)

OFF - 4th display mode is disabled. The external speed reference will not be displayed.

#### Description

This function enables a 4th display mode which allows the display of the current value of the external speed reference as a value in percent. (%).

When enabled (Function 13 - ON), the 4th display mode is activated by hitting the MODE/ENTER key (while the drive is running) and all three display LEDs are illuminated at the same time.

When the REMOTE REFERENCE Display Mode is chosen, the display will show the external reference as 0 – 100% of the speed reference range as specified by Function 11 (remote gain) and Function 12 (remote offset). Refer to Section 4, on "To select the REMOTE REFERENCE Display Mode."

#### Example

•		٠	٠	,		٠		٠		٠	٠	,		٠	۰.	٠		٠	٠	,		٠	۰.	٠		٠	٠	,	,	٠	۰.	٠		٠	•	,		٠	
•		H.		٠		٠				٠	٠			٠	٠		٠	+	٠		٠	٠				٠	٠			٠				٠	٠		٠	٠	
•		ħ.	÷			×			٠	÷	÷			×	÷	+	٠	÷	÷		٠	×		+	٠	÷	÷		*	×		٠		÷			٠	×	
	κ.		Υ.	*			+					*		+		*					÷	*					•		÷	*			*	+		*		*	
•		F	-1	1	(fr	Ľ	ГH	ы	e	쁥	ai	N	ĥ	U)	E.	H.	14	xi	NI	H	171	£.	eſ	ET.	н	TH.	æ	F.	Ŧ	9	5	×.	2	M	d,	æ		٠	Э.
•	٠	E	1	6	ř.	÷,	-	÷	in.	ĩ,	e.	.54	11	-		λ.	÷	1	2.	×.	-	έ.	-		÷	÷.	-	t.	2	÷	A.,	Ā.			10	e.	٠	٠	+
		F	v	۴	v	w	ų	.,	w	w	12			v,	49	£.	5		φ,	э-	w	53	4	ų,	-	20	×.	90	9	÷	4	×.			Ŷ	٩,		۰.	
•	÷	t	¥8	÷c	ie,	3	la,	٧	w	QI.	(b)	d,	in	αí	e	arlı.	Ð	2	0	a.	B	÷i	f I	t T	Ð,	Ø3	ch	er:	n;	el,	N	ife	20	eir	IC:	8	is,	×	
•	*		26	Υ.	٠.		11	ч.	12	2.	7.	2	а.	1	4	40	2.	4	2	de la	16		Λ.	44	1		24	1	1	÷.	12.	24		-	2.	1		۰.	۰.
-	2	-	22		a,	ч.	a,	4,	υ	τ.	e,	α.	цĶ	4	u	q,	œ	-UP	н,	J.	-24	ч.	4	u	÷		w		ų,	ιų.	1	e,	빈	4	UX.	28			
•	×	18		-	θ.	5	٧	з	C	×	÷		•	×	÷			÷	÷	+		÷	÷			÷			*	×	÷	+		÷	÷	÷		×	
		*		+				÷	-							+				٠																			

## F-14 - ELECTRONIC THERMAL OVERLOAD

#### Settings

20% - 100% rated current

#### Step Size

19

#### Description

This function should be adjusted if the motor amperage rating is less than the controller amparage rating. Using the formula below, calculate the setting level as a percentage of maximum continuous current:

																					1					ι.		÷					4			÷			-
÷	٠	٠	٠	٠	+	۰,	÷	×.	4	٠	+	٠	+		Мβ	200	i l	F,	IH	10	Đ,	11	ы	ЯT	÷	π	÷	÷	٠	•	4	÷.	12	÷	٠	÷	٠	٠	-
۰.	÷	٠	٠	٠	٠	9		4	-	•	÷	2		11	5.	â.	1	R.	5	1.1			1.5.	đ	÷.	1.	1.	4	÷.	٠	~2	¢.	ю	ĸ,	٠	٠	٠	٠	4
٠	٠	٠	٠	٠	٠	٠	٠	٠	•	٠	٠	4	10	and it	34	NIE.	11.	ų	-	n l		11	uas		ω	ш	ve	11	٩.	٠		٠	٠	٠	٠	٠	٠	٠	-
			÷	1	4										Υ.		1.1	- 6											4				Υ.	έ.	4		÷		

The motor full load current can be taken from the motor nameplate, and the controller rated output current can be taken from Table 2-1 or 2.2 (or the controller nameplate).

## F-15 - ELECTRONIC THERMAL OVERLOAD DISABLE

#### Settings

OFF - No electronic thermal overload protection

ON - Electronic thermal over oad protection is active. The factory default for this function is OFF (or cleabled).

If this function is ON, the controller will trip on an IET if the thermal overload time is exceeded (80 seconds at 152% of F-14). When an external thermal switch (an alarm, or warning light, etc.) is wired into the Function Loss circuit (terminals 10 and 11), this function should be set equal to "OFF". Hefer to Figure 3-5, Terminal Strip Wring.

## F-16 - COAST STOP ENABLE

#### WARNING

THE FACTORY INSTALLED JUMPER ACROSS TERMINALS 10 AND 11 ON THE CONTROL WIRING TERMINAL STRIP MUST BE IN PLACE TO ALLOW THE COAST-STOP FUNCTION TO BE ENABLED. THIS JUMPER SHOULD ONLY BE REMOVED IF A FUNCTION LOSS INPUT, A COAST-STOP PUSHBUT-TON, OR INTERLOCKS ARE INSTALLED, SO THAT THE CONTACTS WILL OPEN TO STOP THE CONTROLLER. FAILURE TO OBSERVE THIS PRECAU-TION COULD RESULT IN BODILY INJURY.

#### Settings

ON - Enable Goast-Stop (Goast-to-rest)

OFF - Disable Coast Stop (Ramp to rest)

#### Description

This function, when enabled, will permit a coast-to-rest stop. Instead of the defaulted ramp to rest stop.

## F-17 - REVERSE DISABLE

#### Settings

ON - Disable Reverse (from LOCAL and REMOTE control)

OFF = Frable Reverse (This is the default setting)

#### Description

When this function is ON, the drive will not be able to turn in the reverse direction. Also, when the drive is in LOCAL mode, pressing the Forward or Paverse keys, will have no effect on crive operation. The Forward LED will always display ON, and the Reverse LED will always display ON.

Regardless of what is entered or changed, when this function is ON (reverse is disabled), the drive will be forced in the forward direction.

## F-18 - VERSION INFORMATION

Settings

X.XX = Version Number

#### Description

When the diap ey shows "F-18", press the MODE/ENTER key to show the current revision. This function cannot be changed.

## ERR - ERROR LOG

Hefer to Section 7, Troubleshooting and Hault Codes for information on the Error Log that follows Function 18.

# 6: Start the Controller

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS EN-TIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

## Check the installation

#### DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. VERIFY THAT NO VOLTAGE EXISTS ON THE DC BUS [TERMINALS (+) AND (-)] BEFORE SERVICING THE CONTROLLER. FAIL-URE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

- If an input disconnect is installed, make sure it is in the OFF position.
- 2. Verify that D-C bus volts is zero. (see Figure 8-1.)
- Make sure the controller interlecks installed around the driven machine are operational.



Figure 6-1. Location of D-C Bus Terminals.

#### WARNING

#### THE SP50D CONTROLLER IS NOT EQUIPPED WITH A COAST-STOP PUSH-BUTTON. THE USER MUST INSTALL A HARDWIRED, OPERATOR-ACCESSI-BLE PUSHBUTTON THAT PROVIDES A POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE. FAILURE TO OBSERVE THIS PRECAUTION COULD RE-SULT IN BODILY INJURY.

 Verify that the user-installed stop pushbutton is operational. When pushed, it should shut down the controller. The factory-installed jumper should not be connected to terminate 10 and 11 for the stop pushbuttor to work. Remove this jumper.

CAUTION: Make sure electrical commons are not intermixed in the controller. Failure to observe this precaution could result in damage to, or destruction of the equipment.

- Remove any debris from the controller, using clean, dry, low pressure sir (at less than 25psi).
- Check that there is adequate clearance around the controller.
- Check and verify that the wiring to the regulator terminal strip and power terminals is correct (Figures 3-3 and 3-5).
- Check that the terminals are tightened property to the appropriate torque specifications given in Tables 3-4 and 3-5.
- Check that user-supplied branch circuit protection is installed and correctly rated.
- 10. Check that the incoming A-C power is rated correctly.
- 11. Check the motor installation and length of motor leeds.
- Disconnect any power correction capacitors connected to the motor.
- Uncouple the motor from any driven machinery to initially alart the controller.
- Check that any motor thermal switch or overload device is wredto the control or correctly.
- Check that the rating of the transformer (if used) matches the controller requirements, and is connected for the proper voltage.
- 16. Verify that a property sized ground wire is installed and that a suitable earth ground is used. Check for and eliminate any grounde between the motor frame and the motor power leads. Verify that all ground leade are run unbroken.

#### DANGER

SUBSEQUENT STEPS REQUIRE ROTATING PARTS AND/OR ELECTRICAL CIRCUITS TO BE EXPOSED. STAY CLEAR IF UNIT MUST BE RUNNING OR DISCONNECT AND LOCKOUT OR TAG POWER SOURCE IF CONTACT MUST BE MADE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

#### DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. VERIFY THAT NO VOLTAGE EXISTS BETWEEN THE D-C BUS TERMINALS [(+) AND (-)] BEFORE SERVICING THE CONTROL-LER. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

- Make sure all power is "OFF" to the controller.
- Connect a voltmeter to terminals (+) and (-), and verify that the controller bus voltage is 0 VOC. See Figure 6-1.
- 3. Uncouple the driven equipment from the motor, if possible.
- Turn the power ON. With a voltmeter at terminals (+) and (-) observe that the voltmeter reading is the no load D-C bus voltage value as listed in Table 5-1.

#### Table 6-1. D-C Bus Voltage Value.

A-C Input Line Voltage	No Load in Stop Mode	Full Load in Run Mode
280 VAC	828 V	SIDV

- Check all function settings (Section 6) and verify that they are set correctly.
- Press the START key. The controller should ramp to the preset maximum speed (F-04). The motor should ramp up at the deceleration rate (F-02) until it reaches the preset Hz.
- While the controller is in the RUN mode, check the display modes and verify that Volts and %Load are reading correctly.

For Remote: If using a remote speed reference check that the speed reference (= 13 must be "ON") is correct (0 – 10VDC, or 0 – 20mA). All three display mode I H2s should be lift to incloate that the remote reference is currently being displayed. The fourth display LED (REMOTE LED) should also be lift.

Take into account any values set into F-11 (Remote Reference Gain) and F-12 (Remote Reference Offset) that have scaled the speed reference.

- RPM can also be monitored by using the RPM display mode.
- Verify the error on of the motor shaft rotation. Press the STOP key to also the controller.

- 10. If the direction of ehaft rotation is incorrect, change as followe:
  - a. Wait until motor has completely stopped.
  - b. Turn the Power OFF.
  - c. Verify that the D-C Bus voltage (at terminals + and -) is 0 VBC. See Figure 6 1.
  - Reverse any of two of the three motor power leads (U.V. or W).
- 11. Turn the Power ON.
- 12. Press the START key.
- 13. Using the up or cown arrow keys, change the maximum speed setting (F-O') and run the motor without any load acrose the speed range. If the motor is unloaded and does not operate satisfactory, check the function settings in Section 6. If it does operate satisfactory, go to Step 14.
- Tum Power OFR Verify that the D-C bus has discharged to 0 VDC at terminals (1) and (1).
- 15. Couple the drive equipment to the motor.
- 16. Turn Power ON.
- 17. Press the controller START key.
- Run the controller across the recuired apeed range under load. If the motor does not rotate at minimum apeed, increase manual torque boost (F-96).
- 19. If the controller operates the motor property:
  - Turn Power OFF Verify that the D C bus has discharged to 0 VBC at terminals (+) and (-).
  - b. Heplace the controller oover and secure.
  - c. Make note of final function settings in the "Softings liable" in the back of this manual.
  - If the controller does not operate the motor properly:
  - Refer to Section 7. Troubleshooting, if any fault indications occurred during startup.
  - b. Verify junction settings again.

7:

## Troubleshooting and Fault Codes

#### DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZ-ARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS EN-TIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

## System Operation

Refer to Figures 7-1 and 7-2, System Block Diagrams.

The SP500 uses the conventional inverter bridge to transfer energy from the A-C input line to the A-C motor. The A-C line voltage is rec.if ed through the input diode module which in turn generates the constant D-C bus voltage.

A large ous capacitor across the D-C bus smooths the D-C bus voltage and buffers the current flow to the motor. The six IGBTs and the associated diodes convert the constant D-C voltage into PVM (pulse width modulated) waveforms.

The SP500 uses the Volts/Hz constant control scheme which generates constant primary flux over the variable speec range of the motor so that lorgue is linearly produced in proportion to the slip of the motor.

DIGDE ICST MODULE DC C1 IMPL/T FUSE NOV u AC INSUCTOR ъ. 2 LINE SPOT 2364WC U. Figure 7-1. System Block Disgram. À ..... ÷. 12.000 "0 сРПаня. 08 кт A VIC H ÷---+ FN 426 RES VOLACE POADS SUPPLY To Figure 7-2 78 VIC REPLACED OPERATION ONE SIGHLS OFACELEDARD.

7-2



## Fault Codes

The SP500 controller requiree only minor troubleehooting if a fault should occur. If a fault condition occurs while the drive is running, the drive will coast to rest and the fault type is flashed on the display as a 2-digit alphabet cal code.

The fault is then entered into the error log. The error log is accessible after Function 18, and is designated as "ERR" on the disclay.

## How to Access and Read the Error Log

IFT fault codes are entered into the error log in sequential order \* more than 1 fault should occur. The first error to occur will be flashed on the display, and two more errors will then be logged into the error log. (The error log must be accessed to see them). After three faults have occurred, no more subsequent faults will be entered into the error log.

Fault codes are indicative of what faults they represent. For example, "OC "indicates an overcurrent condition. The faults entered into the error log are numbered sequentially. If first an overcurrent fault were to occur, if would be in the error log as "1=OC". If next a thermal over oad fault were to occur (and the first error was not yet cleared), it would be in the error log as "2=OC", and so on.

The last fault to occur will appear first when accessing the error log. For example, if the last fault was a low bus fault, and the error log has 3 entries, then the error log would display "3+L0" when the error log la first accessed.

Each fault in the error log can be cleared by cressing the STOP/RESET button until "En" is displayed again.

Faults are retentive to the error log II a power loss occura.

Table 7-1 lists fault codes, descriptions, causes, and actions if a fault occurs.

To access the Error Log:

1. Enter the Program Model (Press the MQCE/ENTER XeV.); 111
(2. Iff the display ishows) "F-D0", use the down alrow key to move i directly to 'Ent': Either the up or down arrow key can be used to initial through the lunguip fiel. "Ent' follows: "F(18"
14. (Présis MédiMOQE/CNTER)kirý, 11.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1
14. (Press the up arrow key)to move through the error podes. ( )
(u) (Préss trie:STOP/RESET key) di diéar bách (táuh) Refer tai (1111)
••••Tabla 7-4.••••••••••••••••••••••••••••••••••••

Table 7.1 shows the possible causes and actions to take to clear a tauti.

#### DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. VERIFY AT THE A-C INCOMING POWER TERMINALS (R, S, T) AND AT THE D-C BUS TERMINALS(+) AND (-) THAT THERE IS NO VOLTAGE PRESENT BEFORE SERVICING THE CONTROLLER. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Before servicing the controller:

- 1. Turn power off to the controller.
- Verify that there is no voltage entering the controller at terminals R, S, and L.
- Venfy at 0-C Bus terminels (-) and (-) that the D-C Bus has failen to zero VDC. This will take a few minutes to drop to a safe level. See Figure 7-3 for location of D-C Bus.



Figure 7-3. D-C Bus Terminals.

## Table 7-1. Faull Code Action List.

HU:	High bus voltage condition.		
Cau The atio eve	iBe D-C bus charged we the IET threshold Fof 430 volts.	Ac Pro Lor Frie bu	tion iss the STOP/RESET iton (or a REMOTE IET reset remote operation), a error will not clear until bus fails below the high s lovel.
1.	Decel rate too fast (Function 2).	1x. 1h	Lower the decel rate (Function 2), Refer to Section 5. Install the optional DB kit.
2.	Starling the crive Into a forward running load that has a high incrita.	2.1	natali the optional DB Kit.
	Low bue voltage condition.	2	
Çau	<b>50</b>	Ac	tion
The the of 1	D-C bus has fallen pelow IET low threshold level 80 volts.	Pre bur for Th the the tak	ess the STOP/RESET from (or a REMOTE IET reset remote operation), elector will not clear until imput line voltage is within proper range. This may e a few seconds.
١	Loss of input power.	Т.	Check incoming power.
2.	Low line voltage.	2.	Check incoming power.
Not	<ul> <li>If a line dip or momentary keyel is able to use back to the drive will automatically running when the fault occ perform above steps, or pr</li> </ul>	powe the test arres rees l	or loss occurs, and the bus proper range within 500 ms, art (if the onive was already d). If the drive does not restart, the STOP/RESET kay.
OL:	Electronic thermal overload		
Cau	80	Ac	tion
The over prot mot a sp	electronic therms ficad trip level has been reded. This fault ects the crive and or from overheating due to assive current with n accilied period.	Pre built in the lev	as the STOP/RESET ton (or a REMOTE IET reset remote operation), a error will not clear it the drive has sgrated to the proper age. This may take a viseounds.
1.	The Current Limit Setting (Function 5) is not set correctly.	1.	If current limit level is too low relative to load, increase the current limit level.
			Charles and the second s

## Table 7-1 Fault Code Action List (Continued)

OH: Thermostal/Drive Overload		
Cause	Ac	tion
The Internal thermostat has caused a trip that indicates excessive temperatures in the controller.	Pre (or ren not orb ran sec	ese the STOP/RESET button a REMOTE IET reset for note operation). The error will to car until the internal vetemperature is back within ign. This may take a few conde.
<ol> <li>The drive densiting specifications are ex- ceeded. See Tables 2-1 and 2-2.</li> </ol>	1.	Re check the application and change the carrier frequency of Function 10. Refer to Section 5.
<ol> <li>The ambient temperature of the controller is exceeded.</li> </ol>	2.	Check the location site and move the controller to a cooler area.
OC: Overcurrent		
Cause	Ac	tion
The current rating of the controller (>200% rated drive current) has been exceeded.	Pre (cir ren	ese the STOP/RESET button REMOTE/ICT reset for note operation).
This fault can be caused by any of t	thet	o lowing conditions:
<ul> <li>Shor, in drive outputs</li> </ul>	1.	Verify that the input and output wiring to the drive are properly connected.
<ol> <li>Ground fault condition</li> </ol>	26	Verify that the input and output witing to the drive is properly connected. See Figures 4-2 and 4-2.
	26.	Verify that the output wiring to the motor is not connected to Ground or any other voltage acurce. See Figures 4 2 and 4 3.
nstantaneous overcurrent resulting in greater than 250% rated drive current.	3a. 3b.	Increase acceleration or deceleration time (F 01 or F 02). Increase current limit level, if too low relative to the load.
EL : Condian Lar-		(Change in 5% increments.)
re, rangoon Loss Course		ton
The second (external three	P-	
tion loss signal has been asserted. (Terminals 10 and 11.)	the una	es de STOMMESET ten (or RHMOTE/LH et for remote operation), is fault will not dear until function loss signal is asserted.
<ol> <li>The external equipment connected to the function loss terminals has failed, or is giving repeated stop requests.</li> </ol>	1a. 1b.	Check the external equipment wired to the remote function loss terminals (10 and 11), Check function loss connections.

# 8: Index

## Page

%LCAO	42.44.45
Acceleration function (F-01)	5-5
altitude	2-2, 3-1
ambient temperature	2-2
analog output	3-10
arrow keys	44
atmosphere	1.4.2.2

## в

base speed	5-11
block diagram	7-2, 7-3
branch circuit protection	3-5

## С

Carrier Frequency function (F-10)	2-1, 5-14
dearances	3-2
Coast Stop Enable function	5-20
nade. lauit	71.74
control logic	5-9
controller running, IET,	3-11, 5-4
Current Limit function (F-05)	5-B

## D

Deceleration function	5-6
default settings	5-2
diagram, terminal strip	8-1
dlagram, system	7-2, 7-3
dimensions, physical	3-2
diaconnect	3-4
disolay mode	4-2 through 4-6, 5-17
dynamic braking kit	24.36

## E

Electronic Thermal Overload function (F-14)	5-1B
Electronic Thermal Overload Enable	
function (F-15)	5-19
elevation	2-2, 3-1
emergency stop	3-12
ети-Тад	46.522.74

## F

## Page

factory settings	5-2
fault oode	4-6.7-4
fault code action list	1-6,1-1
forward direction	4-3
tourth display mode	5-17
frequency, carter	2-1, 5-14
frequency in nimum, maximum	2-3
function kiss	38,39,310,311
fuses, branch circuit protection	8-5

## G

gain, remote reference	 3-18, 5-15
grounding	 3-7

#### 1

IET Output Enable function (F-09)	5-13
IET relay	3-9
indicators	4-1.4-2
input Amps	2-1
input KVA	2-1
Inputs, specifications	2-3, 3-9

## J

(umper (JB)		. 3-13
-------------	--	--------

## κ

	keypec. operation								•			•	•	•	•			•		•				2	ş	1	-1	į
--	-------------------	--	--	--	--	--	--	--	---	--	--	---	---	---	---	--	--	---	--	---	--	--	--	---	---	---	----	---

## L

line frequency	2-2
line voltage variation	2-2
local control	5-4
location, mounting	31,32
log, arror	4-6, 5-22, 7-4

## M

Manuel Torque Boost function (F-36)	5-10
Minimum Speed function (F-03)	5-7
maximum load	2-2
Maximum Speed lunction (F-04)	5-8
MODE/ENTER key	43.45
mode numbers	12,21
modes, disclay	44
monilor, RPM	4-2
motor	3-3
mounting, controller	2-2
1997 E C. 1	

## N

nameplate .					è				è					è			è	è		-			÷		1	3	1. 2	2	1	
nominal HP		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•	÷	÷	۶	1				

## Page

offset, remote reference	\$-18, 5-16
outout emps	2-1
outout, specifications	3-8
overgument	5-8
over dad, electronic thermal	5-18

## P

Ó

parts	24
planning. insta lation	8-1
power factor, displacement	2-2
powerup	4-4, 8-3
PROGRAM	4-2, 4-8

## R

ratings. controller	2-1.2-2	
Remote Enable function (F 00)	54	
Remote Reference Display Enable function		
(F-13)	5-15.5-17	
Remote Reference Gain function (F-11)	5-16, 5-17	
Remote Reference Offset function (F-12)	5-16	
Reverse Disable function (F-17)	5-21	
REVERSE key	44	
PPM at Base Speed function (+ 08)	5.12	
RPM monitor	4-2	
RUN	4-5	

## S

ecaling, olfaet, gain	3-13, 5-5, 5-8
shipment	1-1
specifications, controller	2-1
speed, maximum	58
speed, minimum	5-7
speed reference local remote	3-12
START	4-3
stop pushbutton	3-12, 3-13
STOP/RESET key	4 3. 4.6
storaga	2-2
system clearant	7-2.7-3

## т

terminal strip	S-8, 3-11
thermal overload	5-6
tarque baost	5-10
torque ratings	3-10, 3-11
transformer	. S-6

## ۷

version, software	5.22
Volts/hz Base Speed function (F-07)	5-11
VOLTS	4-5

## Page

			۱.	٠	
1	ш		Ц		
		1			
	-				

walls, power loss								•									2-4
witing, power	• •			•		þ	•	•						•	•	-	2-10
witing, terminal strip	1	•	•	•	• •	•	•	•	•	•	•	• •	•	•	•	-	3-10



Printed in U.S.A.

12-3232.\*

April, 1993