Schlumberger

Speedstar 2000 Operations Manual

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FOREWORD

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Product Description

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1 PRODUCT DESCRIPTION

The Speedstar 2000 Variable Speed Drive (VSD) provides surface control for electrical submersible pump (ESP) applications, horizontal pumping systems (HPS) applications, and progressing cavity pumping systems (PCP). The enclosure for the VSD is a NEMA-rated cabinet which contains: a human/machine interface (HMI) and the power converter (Toshiba G3, the actual variable-speed drive), as well as other associated power componentry such as control power transformers, circuit breakers, fuses, magnetic contactor, Transient Voltage Surge Supressor (TVSS), etc. Several configurations are available with respect to components mounted on the exterior of the cabinet, such as a heat exchanger, input power junction box, etc. Refer to Chapter 5 Wiring for a simplified block diagram of the Speedstar 2000 and to Figure 1-2 Speedstar 2000–Major Components (interior of typical 66 to 200 kVA shown) for a photo of how its components are interconnected.

Refer to Figure 1-1 Speedstar 2000–Major Components (exterior) for an exterior photo of a typical Speedstar 2000 VSD.

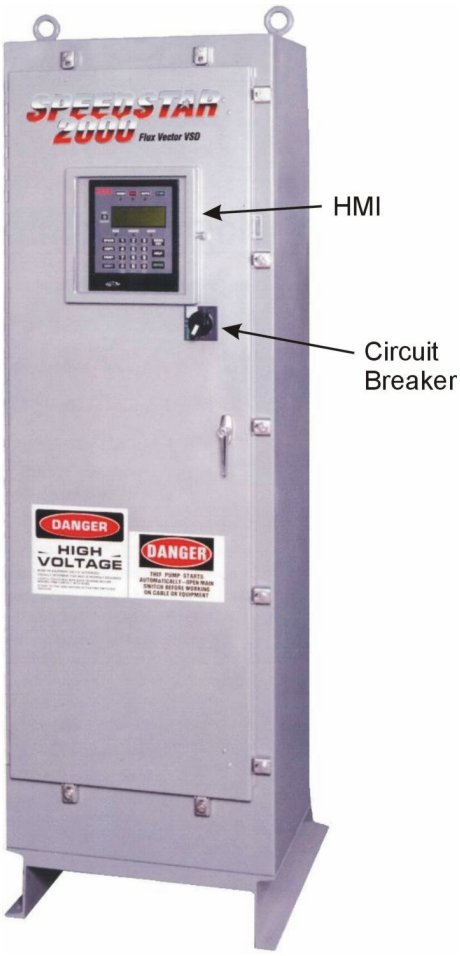

Figure 1-1: Speedstar 2000–Major Components (exterior)

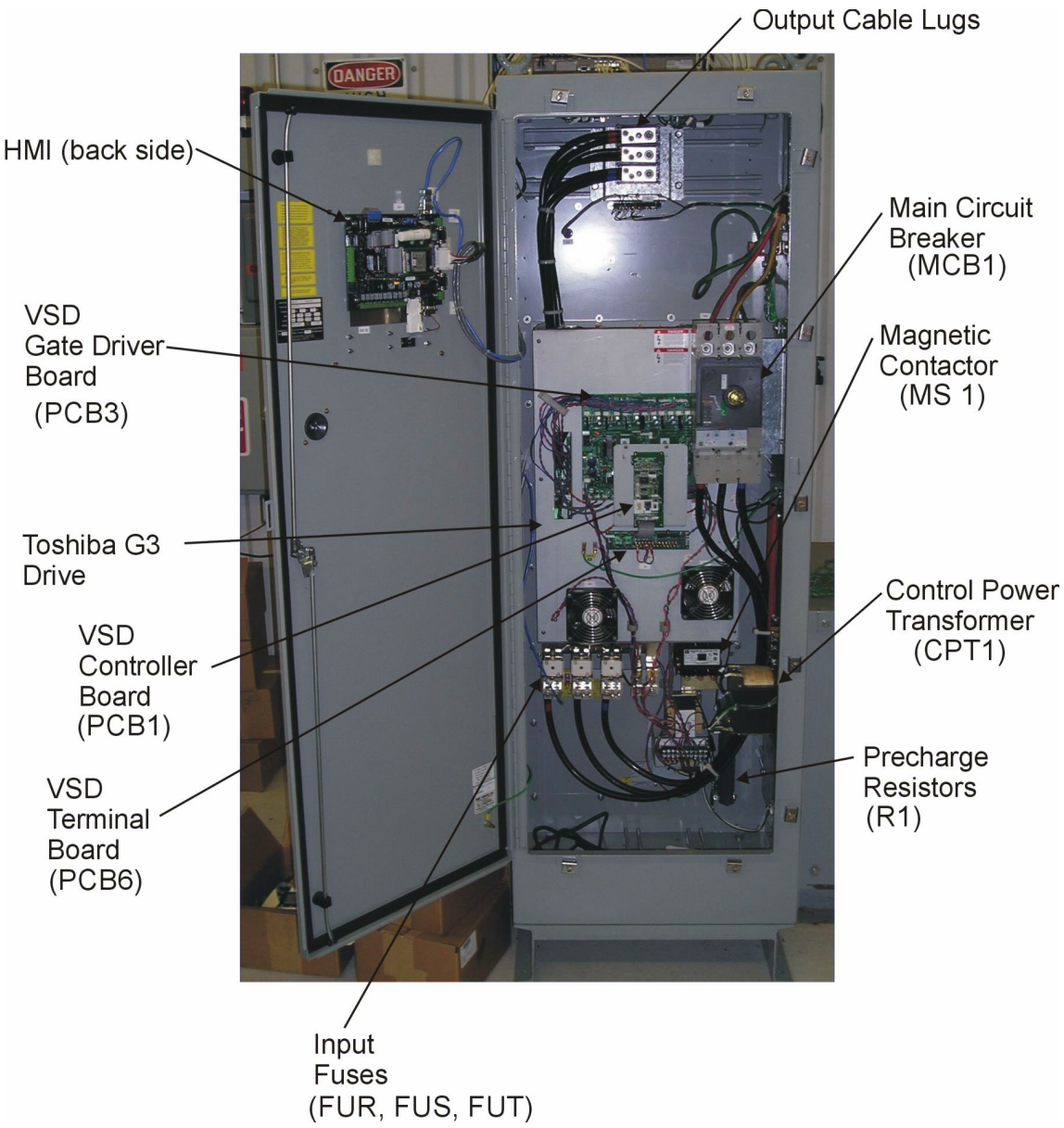

Figure 1-2: Speedstar 2000–Major Components (interior of typical 66 to 200 kVA shown)

External to the Speedstar 2000, various optional and combinable equipment may be installed at the wellsite. Since this equipment is optional and application dependent, it is not within the scope of this manual to discuss function and operation of that equipment, beyond how it connects to the Speedstar 2000 system. Since any communications equipment, such as SCADA systems can be used to communicate with (send commands/acquire data) the VSD, some very basic connection and communication instructions and troubleshooting procedures are included in 9 Optional and Combinable Equipment (p. 9- 1).

1.1 Human/Machine Interface (HMI)

The HMI provides an external (outside the drive enclosure) status and control center to display and edit current drive settings and parameters and/or shut down or start up the drive. The HMI features an integrated LCD screen and multi-function keypad for user input. Refer to Figure 1-3 The HMI (outside the VSD cabinet) for a photo of the external features of the HMI. Detailed function of the display, menus, and keypad is provided in a later chapter of this manual.

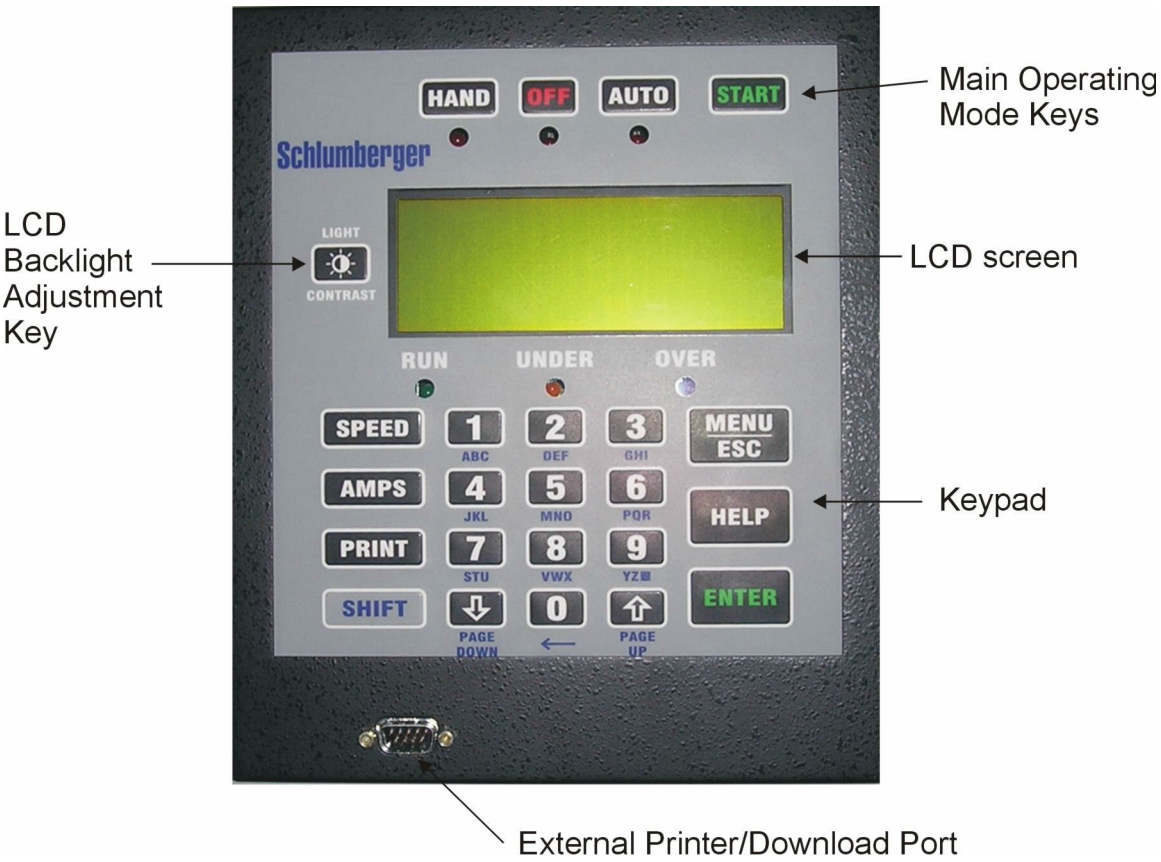

Figure 1-3: The HMI (outside the VSD cabinet)

Interior features (inside the drive enclosure) of the HMI are also very important to communication and control of the VSD. The HMI also offers I/O points for other inputs to the controller such as site (SCADA) communications, analog inputs from external sensors or devices, and digital inputs from external sensors. Refer to Figure 1-4 The HMI (inside the VSD cabinet) for a photo of the internal features of the HMI. Detailed function and connection to the SCADA port(s), analog inputs, and digital inputs are described in a later chapter.

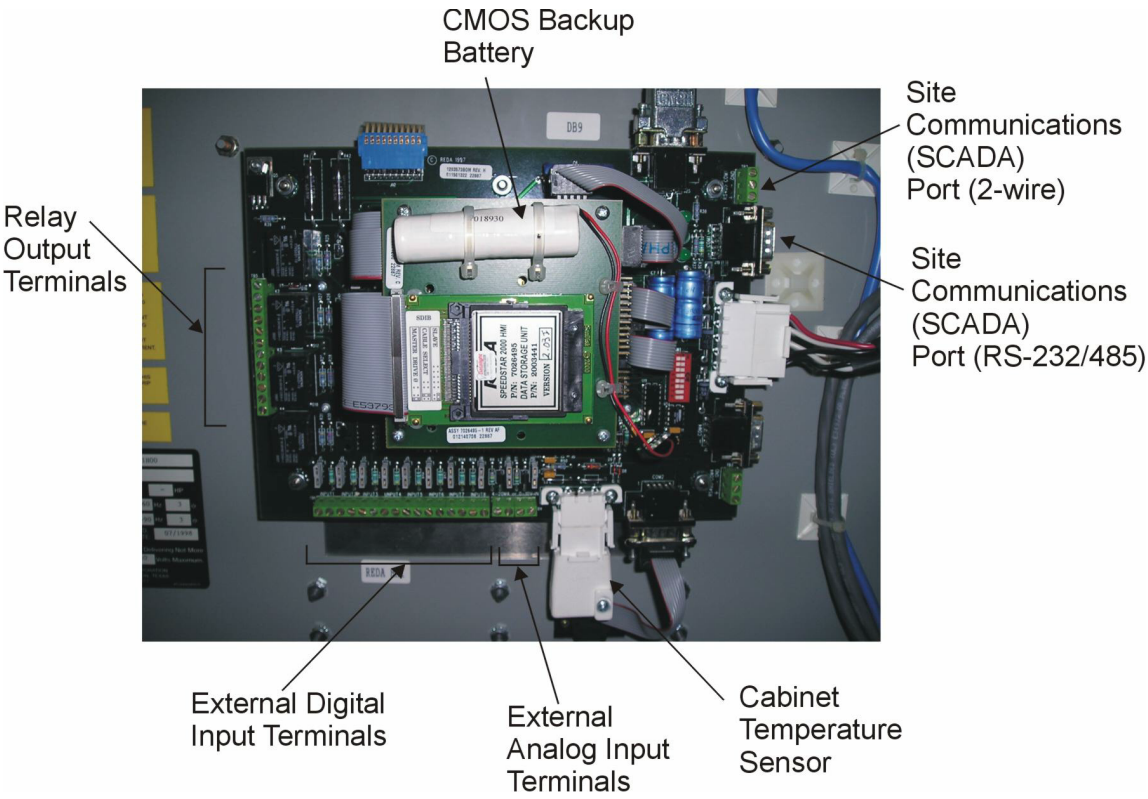

Figure 1-4: The HMI (inside the VSD cabinet)

1.2 The Variable Speed Drive (VSD)

Because of the many functions that the VSD performs (converter, inverter) and the fact that the Speedstar 2000 currently contains a Toshiba G3 Transistor Inverter, many names, such as the G3, the drive, the inverter, etc. have been used to describe the VSD. In this publication, the variable speed drive and all of the terms used for it, will simply be referred to as the VSD. Refer to Figure 1-5 VSD Major Components for a photo of the VSD and its major components.

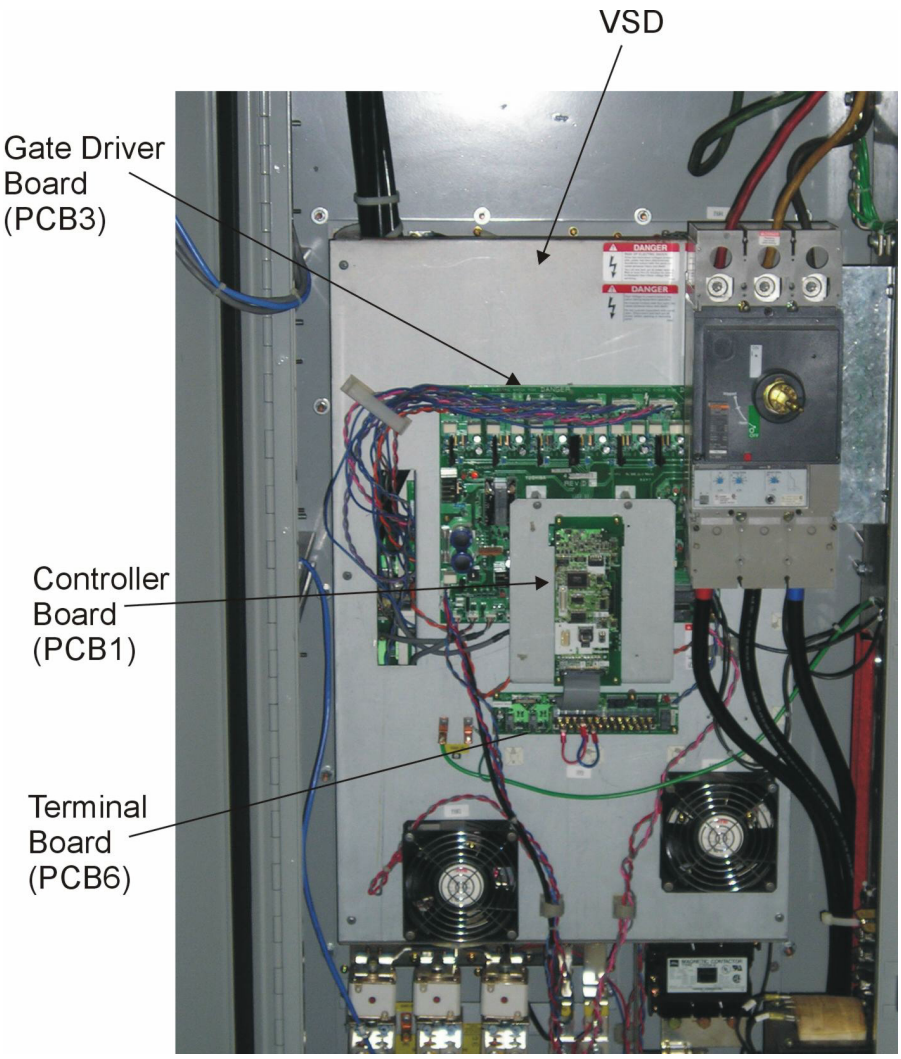

Figure 1-5: VSD Major Components. *Numbers in parentheses denote reference designators on the interconnect diagrams.*

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2 QHSE

The following safety precautions should be followed when installing, operating, or maintaining a Schlumberger variable speed drive.

2.1 Installation safety precautions

1. Install the drive in a secure and upright position in a well ventilated location. NEMA 3R enclosures are used in outdoor applications. If mounted in direct sun, a temperature derating factor may be required. Temperature should range from -4 degF (20 degC) to 122 degF (50 degC).
2. For NEMA 3R units, allow a clearance space of 8 in (20 cm) for the top and 6 in (10 cm) on both sides. Do not obstruct any of the ventilation openings. Rear ventilation requires free air flow for proper cooling. Rear access is required for fan maintenance. NEMA 1 units can be mounted directly to a wall and no side clearance is required.
3. Avoid installation in areas where extreme vibration, extreme heat, or sources of electrical noise are present.
4. Adequate working space should be provided for adjustment, inspection, and maintenance of the drive.
5. Adequate lighting should be available for troubleshooting and maintenance.
6. A noncombustible insulating floor or mat should be provided in the area immediately surrounding the electrical system where maintenance is required.
7. Always ground the unit properly to prevent electrical shock and to help reduce electrical noise.

Warning

Potential Severity: Serious
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives

A separate ground cable should be run inside the conduit with the input, output, and control power cables (Refer to *Grounding* in the Wiring chapter of this manual). **The metal of conduit is not an acceptable ground.**

8. Use lockout/tagout procedures before connecting three phase power of the correct voltage to input terminals (L1, L2, L3 [R, S, T] for a 6–pulse drive; L1, L2, L3 [R, S, T] and L4, L5, L6 [R2, S2, T2] for a 12–pulse drive) and connect three-phase power from output terminals T1, T2, T3 (U, V, W) to a motor of the correct voltage and type for the application. Size the conductors in accordance with *Selection of Main Circuit Wiring Equipment and Standard Cable Sizes* located in the Wiring chapter of this manual.
9. If conductors of a smaller than recommended size are used in parallel to share current, then the conductors should be kept together in sets i.e., U1, V1, W1 in one conduit and U2, V2, W2 in another. National and local electrical codes should be checked for possible cable derating factors if more than three power conductors are run in the same conduit or through the same hole in the cabinet or through a non-metallic flange or bulkhead. Temperatures can become excessive if phase U1, U2, and/or U3 cables are in proximity to each other (eddy current field effect).
10. Use separate metal conduits for routing the input power, output power, and control circuits.
11. Installation of drive systems should conform to the National Electrical Code, regulations of the Occupational Safety and Health Administration, and all national, regional, or industry codes and standards when installed in the United States. Other codes may apply if installed outside of the US.
12. Do not connect control circuit terminal block return connections marked CC to VSD earth ground terminals marked GND(E). See *Standard Connection Diagrams* and *Terminal Connections and Functions* located in the Wiring chapter of this manual.
13.

Potential Severity: Serious
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives

If a secondary Magnetic Contactor (MC) is used between the VSD output and the load, it should be interlocked so that the ST-CC terminals (on the VSD terminal board) are disconnected before the output contactor is opened. If the output contactor is used for bypass operation, it must also be interlocked so that commercial power is never applied to the drive output terminals (U,V,W).

14.


Warning

Potential Severity: Serious
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives

Power factor improvement capacitors or surge absorbers must not be installed on the VSD's output.

15. Never install any type of starter(s) or contactor(s) on the drive output to switch motor loads instantaneously.

16. Only qualified personnel should install this equipment.

2.2 Operating safety precautions

1. Do not power up the VSD until this entire operation manual is reviewed.

2. The input voltage must be within +/-10% of the specified input voltage. Voltages outside of this permissible tolerance range may cause internal protection devices to turn ON or can cause damage to the unit. Also, the input frequency should be within +/-3 Hz of the specified input frequency.

3. Proper coordination of the motor and VSD is required. For submergible and surface motor applications, consult with Schlumberger when utilizing this VSD for a new application.

4. This VSD is designed to operate both standard NEMA B and Schlumberger submersible pump motors. Consult the factory before using the VSD for special applications such as an explosion-proof motor or one with a repetitive type piston load.

5. Do not touch any internal part with power applied to the VSD; first remove the power supply from the drive and wait until charge LED is no longer illuminated. Charged capacitors can present a hazard even if source power is removed.

6.


Danger

Potential Severity: Major
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives

Do not operate this VSD with its cabinet door open.

7. Do not apply commercial power to the output terminals T1 (U), T2 (V), or T3 (W) even if the VSD source power is off. Disconnect the VSD from the motor before using a megger or applying bypass voltage to the motor.

8. Interface problems can occur when this drive is used in conjunction with some types of process controllers. Signal isolation may be required to prevent controller and/or drive malfunction (contact Schlumberger or the process controller manufacturer for additional information about compatibility and signal isolation).
9. Do not open and then reclose a secondary magnetic contactor (MC) between the drive and the load unless the drive is OFF (output frequency has dropped to zero) and the motor is not rotating. Abrupt reapplication of the load while the drive is on or while the motor is rotating can cause drive damage.
10. Use caution when setting output frequency. Overspeeding a motor can decrease its torque-developing capability and can result in damage to the motor and/or driven equipment.
11. Use caution when setting the acceleration and deceleration time. Unnecessarily short time settings can cause tripping of the drive and mechanical stress to loads.
12. Only qualified personnel should have access to the adjustments and operation of this equipment. They should be familiar with the drive operating instructions and with the machinery being driven.
13. Only properly trained and qualified personnel should be allowed to service this equipment.
14. Follow all warnings and precautions. Do not exceed equipment ratings.

Inspection/Storage/Disposal

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3 INSPECTION/STORAGE/DISPOSAL

This chapter describes how to inspect a VSD when it first arrives at the wellsite or jobsite, how to store the unit if it will not be immediately connected and put in service, and how to dispose of any old or previously installed electrical/electronic drive equipment.

3.1 Inspection of the new unit

1. Upon receipt of the drive, a thorough visual inspection for damage should be made after uncrating.
2. Check the unit for loose, broken, bent, or otherwise damaged parts due to shipping.
3. Check to see that the rated capacity and the model number specified on the nameplate conform to the order specifications.

3.2 Storage

1. Store the unit and any optional equipment in a clean, dry, and well-ventilated location; preferably in the original carton if the VSD will not be used immediately after purchase.
2. Avoid storage in locations with high humidity and dust.
3. Storage at temperatures between -20 degC (-4 degF) and 65 degC (145 degF) are permissible.

3.3 Disposal

Please contact your local environmental agency for details on proper disposal of electrical components and packaging in your particular area.

Danger

Potential Severity:	Major
Potential Loss:	Personnel
Hazard Category:	electrical, explosives, fire flammable, toxic corrosive hazardous substances

Never dispose of electrical components by incineration.

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Specifications

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4 SPECIFICATIONS

This chapter contains operating and dimensional specifications for Speedstar 2000 variable speed drives in NEMA 3R and NEMA 1 enclosures. Tabulated dimensional data refers to the dimensions shown on accompanying figures.

4.1 480–volt NEMA Type 3R Standard Enclosure Ratings

Table 4-1: NEMA 3R Enclosure 6–PULSE SPEEDSTAR 2000 VSD

KVA @ 480 Volts	KVA @380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
66	52	79	7026644	78 [1981]	25 [635]	30.3 [770]	800 [363]
83	66	100	7026651	78 [1981]	25 [635]	30.3 [770]	800 [386]
111	88	133	7026669	78 [1981]	25 [635]	30.3 [770]	900 [408]
130	103	156	7026677	78 [1981]	35 [889]	30.3 [770]	1000 [454]
163	129	196	7026685	78 [1981]	35 [889]	30.3 [770]	1100 [499]
200	158	241	7026537	78 [1981]	35 [889]	30.3 [770]	1100 [499]
260	206	313	7026693	78 [1981]	47 [1194]	39 [991]	1300 [590]
325	257	391	7026594	78 [1981]	47 [1194]	39 [991]	1500 [681]
390	309	469	7026545	78 [1981]	47 [1194]	39 [991]	1700 [771]
454	359	546	7026602	78 [1981]	47 [1194]	39 [991]	1900 [862]
518	410	624	7026610	78 [1981]	98 [2489]	44 [1123]	2300 [1044]
600	475	722	7026628	78 [1981]	98 [2489]	44 [1123]	2400 [1089]
700	554	843	7026636	78 [1981]	98 [2489]	44 [1123]	2500 [1134]

KVA @ 480 Volts	KVA @380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
815	645	981	7026552	78 [1981]	98 [2489]	44 [1123]	2600 [1180]
932	738	1122	7026560	78 [1981]	118 [2997]	44 [1123]	2800 [1270]
1000	792	1203	7026578	78 [1981]	118 [2997]	44 [1123]	2900 [1316]
1200	950	1445	7026586	78 [1981]	118 [2997]	44 [1123]	3000 [1361]

Table 4-2: NEMA 3 Enclosure 12–Pulse Speedstar 2000 VSD

KVA @ 480 Volts	KVA @380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
66	52	79	7013907	78 [1981]	25 [635]	30.3 [770]	800 [363]
83	66	100	7013915	78 [1981]	25 [635]	30.3 [770]	850 [386]
111	88	133	7013923	78 [1981]	25 [635]	30.3 [770]	900 [408]
130	103	156	7013931	78 [1981]	35 [889]	30.3 [770]	1000 [454]
163	129	196	7013949	78 [1981]	35 [889]	30.3 [770]	1100 [499]
200	158	241	7013956	78 [1981]	35 [889]	30.3 [770]	1100 [499]
260	206	313	7013964	78 [1981]	47 [1194]	39 [991]	1300 [590]
325	257	391	7013972	78 [1981]	47 [1194]	39 [991]	1500 [681]
390	309	469	7013980	78 [1981]	47 [1194]	39 [991]	1700 [771]
454	359	546	7013998	78 [1981]	47 [1194	39 [991]	1900 [862]
518	410	624	7014004	78 [1981]	98 [2489]	44 [1123]	2300 [1044]
600	475	722	7014012	78 [1981]	98 [2489]	44 [1123]	2400 [1089]
700	554	843	7014020	78 [1981]	98 [2489]	44 [1123]	2500 [1134]
815	645	981	7014038	78 [1981]	98 [2489]	44 [1123]	2600 [1180]
932	738	1122	7014046	78 [1981]	118 [2997]	44 [1123]	2800 [1270]

KVA @ 480 Volts	KVA @380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
1000	792	1203	7014053	78 [1981]	118 [2997]	44 [1123]	2900 [1316]
1200	950	1445	7014061	78 [1981]	118 [2997]	44 [1123]	3000 [1361]

4.2 480–volt NEMA Type 1 Standard Enclosure Ratings

Table 4-3: NEMA 1 Enclosure 6 —PULSE SPEEDSTAR 2000 VSD

KVA @ 480 Volts	KVA @ 380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
66	52	79	7014079	78 [1981]	25 [635]	30.3 [770]	800 [363]
83	66	100	7014087	78 [1981]	25 [635]	30.3 [770]	850 [386]
111	88	133	7014095	78 [1981]	25 [635]	30.3 [770]	900 [408]
130	103	156	7014103	78 [1981]	25 [635]	30.3 [770]	1000 [454]
163	129	196	7014111	78 [1981]	25 [635]	30.3 [770]	1100 [499]
200	158	241	7014129	78 [1981]	25 [635]	30.3 [770]	1100 [499]
260	206	313	7014137	78 [1981]	37 [941]	39 [991]	1300 [590]
325	257	391	7014145	78 [1981]	37 [941]	39 [991]	1500 [681]
390	309	469	7014152	78 [1981]	37 [941]	39 [991]	1700 [771]
454	359	546	7014160	78 [1981]	37 [941]	39 [991]	1900 [862]
518	410	624	7014178	78 [1981]	72 [1829]	44 [1123]	2300 [1044]
600	475	722	7014186	78 [1981]	72 [1829]	44 [1123]	2400 [1089]
700	554	843	7014194	78 [1981]	72 [1829]	44 [1123]	2500 [1134]
815	645	981	7014202	78 [1981]	72 [1829]	44 [1123]	2600 [1180]
932	738	1122	7014210	78 [1981]	84 [2134]	44 [1123]	2800 [1270]

KVA @ 480 Volts	KVA @ 380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
1000	792	1203	7014228	78 [1981]	84 [2134]	44 [1123]	2900 [1316]
1200	950	1445	7014236	78 [1981]	84 [2134]	44 [1123]	3000 [1361]

Table 4-4: NEMA 1 Enclosure 12–Pulse Speedstar 2000 VSD

KVA @ 480 Volts	KVA @ 380 Volts	Cont. Output Amps	Part Number	Height (in [mm])	Width (in [mm])	Depth (in [mm])	Weight (lbm [kg])
66	52	79	7014244	78 [1981]	25 [635]	30.3 [770]	800 [363]
83	66	100	7014251	78 [1981]	25 [635]	30.3 [770]	850 [386]
111	88	133	7014269	78 [1981]	25 [635]	30.3 [770]	900 [408]
130	103	156	7014277	78 [1981]	25 [635]	30.3 [770]	1000 [454]
163	129	196	7014285	78 [1981]	25 [635]	30.3 [770]	1100 [499]
200	158	241	7014293	78 [1981]	25 [635]	30.3 [770]	1100 [499]
260	206	313	7014301	78 [1981]	37 [941]	39 [991]	1300 [590]
325	257	391	7014319	78 [1981]	37 [941]	39 [991]	1500 [681]
390	309	469	7014327	78 [1981]	37 [941]	39 [991]	1700 [771]
454	359	546	7014335	78 [1981]	37 [941]	39 [991]	1900 [862]
518	410	624	7014343	78 [1981]	72 [1829]	44 [1123]	2300 [1044]
600	475	722	7014350	78 [1981]	72 [1829]	44 [1123]	2400 [1089]
700	554	843	7014368	78 [1981]	72 [1829]	44 [1123]	2500 [1134]
815	645	981	7014376	78 [1981]	72 [1829	44 [1123]	2600 [1180]
932	738	1122	7014384	78 [1981]	84 [2134]	44 [1123]	2800 [1270]
1000	792	1203	7014392	78 [1981]	84 [2134]	44 [1123]	2900 [1316]
1200	950	1445	7014400	78 [1981]	84 [2134]	44 [1123]	3000 [1361]

4.3 Enclosure Dimensional Data

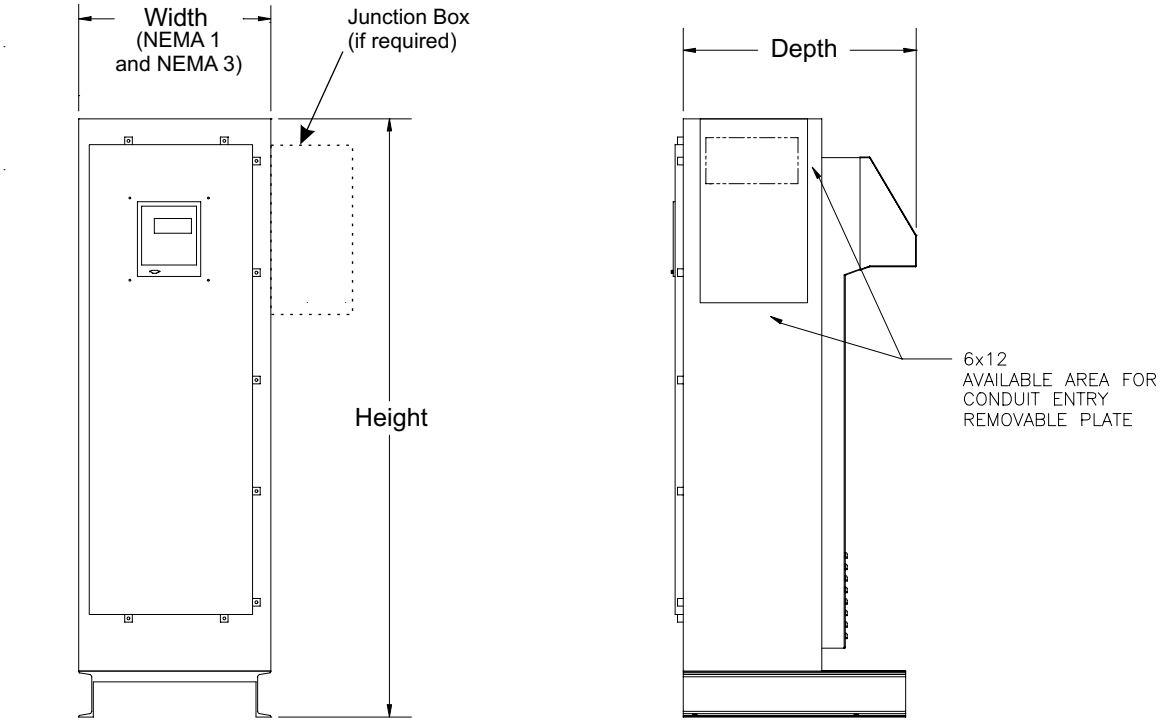

Figure 4-1: 66 kVA to 111 kVA NEMA 1 and 3 and 66 kVA to 200 kVA NEMA 1 Enclosure Dimensions. *The tabulated figure above corresponds to height, width, and depth listed in dimension tables.*

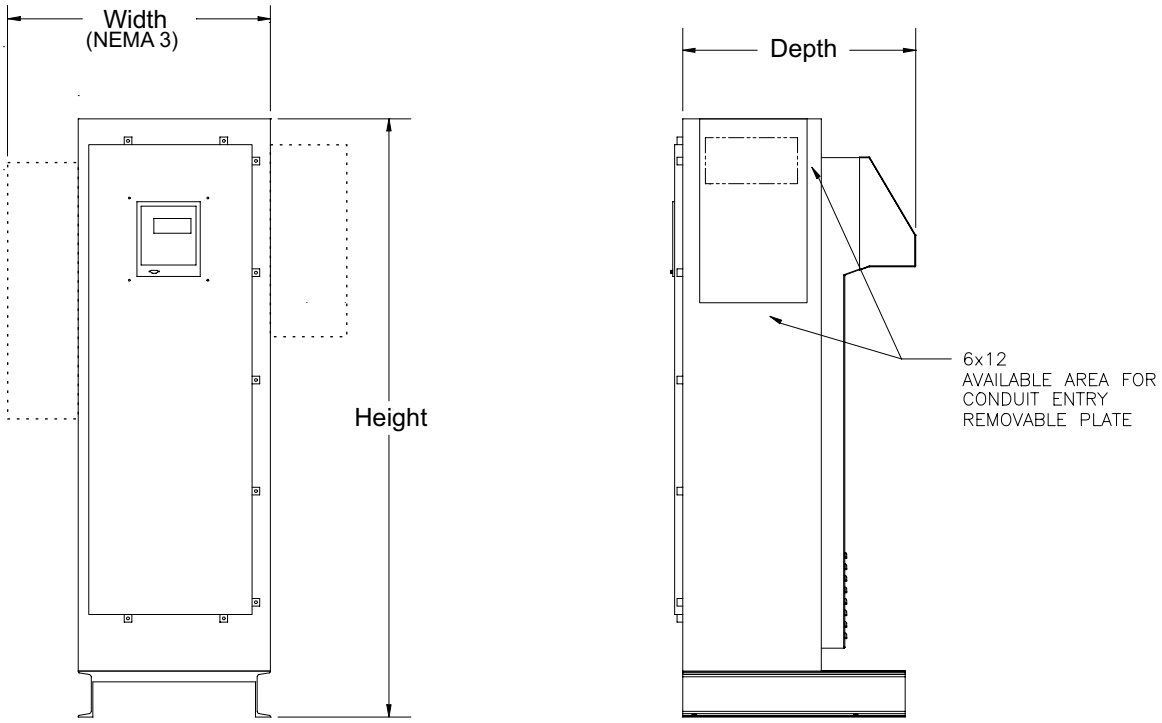

Figure 4-2: 130 kVA to 200 kVA NEMA 3 Enclosure Dimensions. *The tabulated figure above corresponds to height, width, and depth listed in dimension tables.*

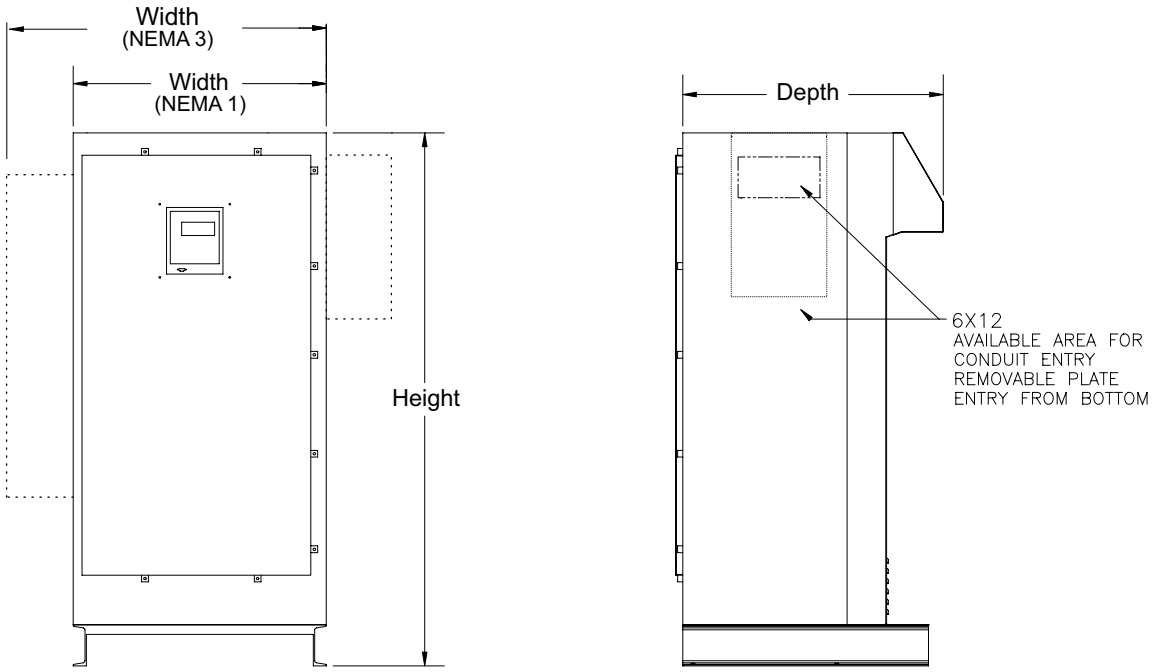

Figure 4-3: 260 kVA to 454 kVA NEMA 3 and 260 kVA to 454 kVA NEMA 1 Enclosure Dimensions.. *The tabulated figure above corresponds to height, width, and depth listed in dimension tables.*

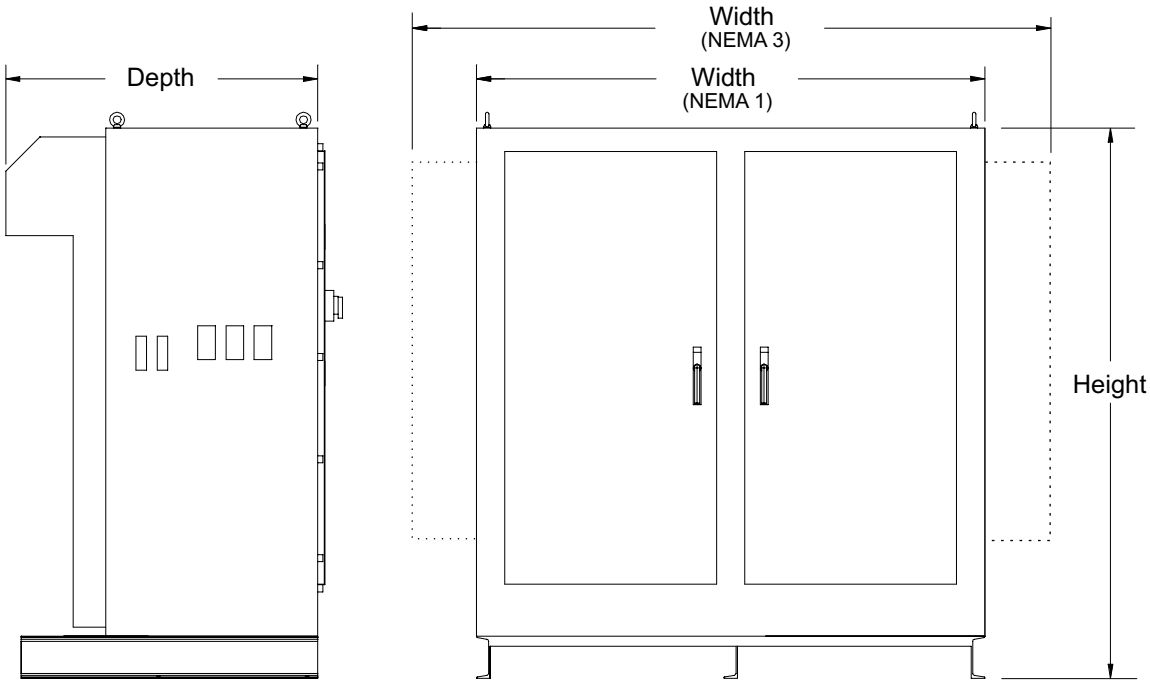

Figure 4-4: 518 kVA to 815 kVA NEMA 3 and NEMA 1 Enclosure Dimensions.. *The tabulated figure above corresponds to height, width, and depth listed in dimension tables.*

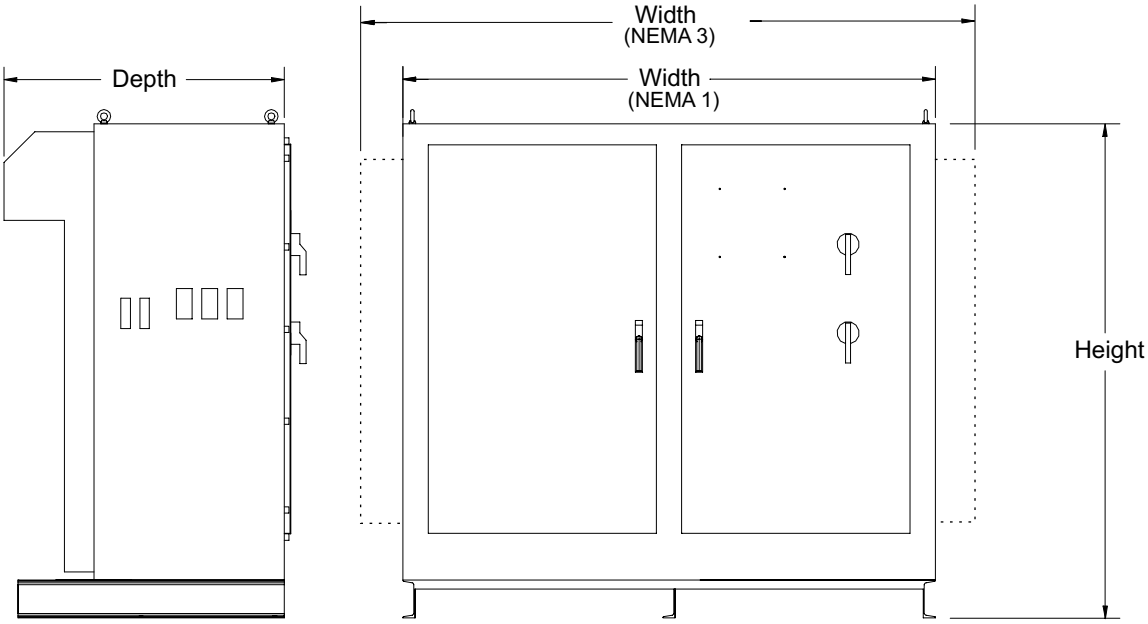

Figure 4-5: 932 kVA to 1200 kVA NEMA 3 and NEMA 1 Enclosure Dimensions.. *The tabulated figure above corresponds to height, width, and depth listed in dimension tables.*

4.4 Operating Specifications

The following table lists operating specifications and ranges for the entire range of Speedstar 2000 variable speed drives.

Table 4-5: Speedstar 2000 Operating Specifications

Item		Standard Specifications
Principal Control Parameters	Control System	Flux vector control PWM
	Input Voltage Supply	380/415/480 volts, 50/60 Hz +/-10% tolerance
	Output Voltage Regulation	Same as power line
	Frequency Setting	0.01 to 120 Hz output (10 to 90 Hz default setting) with 0.01 Hz resolution. Input frequency tolerance +/-5%.
	Carrier frequency	Auto-adjusted between 0.5 and 3 kHz (default is 2.2 kHz. Anything greater than 2.2 kHz is derated 14%).
	Transistor type	Insulated Gate Bipolar (IGBT)
	Inverter Efficiency	98%
	Power Factor	96% at all loads and speeds
	Dynamic braking	Optional
Operating Functions	Accel/Decel time	Frequency range over Time (0.1–20.0 Hz) over (1 to 10000 secs)
	Forward and Reverse	Programmable
	Soft Stall	Automatic load reduction during overload (Default setting is ON)
	Frequency jumps	Three jump frequency settings, set by frequency bandwidth
	HMI	Direct control of VSD
	Automatic Restart (Catch a Spinning Motor)	A coasting motor can be smoothly restarted (Default setting is OFF)
	Upper/Lower Limit	Limits frequency between minimum and maximum values
	Coast stop/Controlled stop/Emergency stop	ST to CC jumper on VSD terminal board is an alternate coast-to-stop. Programmable coast-to-stop and controlled stop available from operator interface. S4 to CC jumper on VSD terminal board sets emergency stop.
	Applications	HMI and software is set up for electrical submergible pumps, horizontal pumping systems, and progressive cavity pumps

Item		Standard Specifications
Operator Interface (HMI)	Interface	Four line, 20 character per line LCD, letters are 5/16–in high, 24 keys, multi-lingual, circuit boards conformal coated, password protection.
	Fault Display	Overcurrent, overvoltage, heatsink overheat, load-side short circuit, load-side ground fault, inverter overload, and load-side overcurrent during startup. EEPROM error, RAM error, ROM error, communication error, emergency stop, undervoltage, low current, and open.
	Monitor functions	Forward/reverse, frequency setting value, output frequency, output current, output voltage, input power, output power, cumulative run time, past faults, excitation current.
	LED charge indicator	Indicates that the main circuit capacitors are charged.
Inverter/Motor	Protective functions	Soft-stall, current limit, overcurrent, overvoltage, short-circuit at load, load-side ground fault, undervoltage, momentary power failure, regeneration power ride-through, electronic thermal overload protection, main-circuit overcurrent at startup, heatsink
	Electronic thermal characteristics	Drive's motor overload protection for motor can be adjusted for motor rated amperage. Motor overload has adjustable speed sensitivity. Soft stall ON/OFF. Motor 120% time programmable.
Input Signals	Digital	Eight auxiliary digital inputs, user-programmable
	Analog	Two analog inputs, 4 to 20 mA or 0 to 10 volts DC, user-programmable
	Serial Ports	One RS-485, one RS-232, and one configurable (allocated for Modbus RTU)
Output	Digital Relays	Four digital relays, user programmable
	Serial Ports	One RS-485, one RS-232, and one configurable (allocated for Modbus RTU)
	Analog	Two analog outputs (AM and FM terminals, 0 to 1 mA or 4 to 20 mA, user-programmable

Item		Standard Specifications
Enclosure	Type	NEMA Type 1 or 3R
	Cooling method	Forced-air cooling. Internal and external fans are automatically stopped when not necessary for extended fan life.
	Color	ANSI gray #61 polyurethane textured finish
	Service environment	Indoor and outdoor ratings. Consult factory for elevations above 4921 ft (1500 m). For example, at 6561 ft (2000 m), derate drive FLA by 11%. Some derating may be required for direct sunlight. Avoid corrosive and/or explosive gases or mists. Consult factory for sunlight deration.
	Ambient temperature	From —30°C to 50°C (-22°F to 122°F).
	Relative humidity	20 to 100% maximum (non-condensing)
	Vibration	5.9 m/s^2 0.5G maximum (10 to 55 Hz)
	Climate class	3K3
	Pollution degree	2
	IP rating	53 for outdoor units
	Disconnect	Circuit breaker disconnect with 100 KAIC current limiting fuses

Wiring

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5 WIRING

This chapter contains interconnection information for variable speed drives and how the VSD is connected to

- incoming (customer-supplied) power
- main power bus through the VSD and other components inside the drive enclosure
- drive major components (between the HMI and VSD) and optional equipment (site communications equipment)
- outgoing power to output transformer (when used) and on to the motor(s).

5.1 Connection Block Diagrams

The following block diagrams describe connections from the main power supply input, through the VSD, to the motor being driven. Diagrams are shown for both 6–pulse and 12–pulse input power schemes.

5.1.1 Six-Pulse Input

The figure below shows the standard connections for 6–pulse input to a VSD.

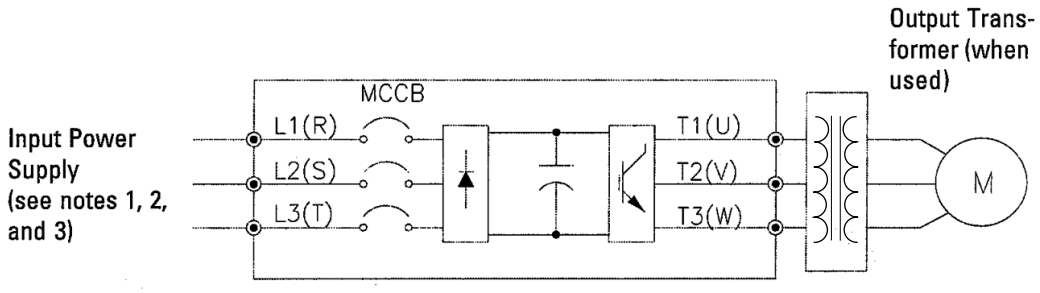

Figure 5-1: Block Diagram for 6–pulse Input

5.1.2 Twelve-Pulse Input

The figure below shows the standard connections for 12–pulse input to a VSD.

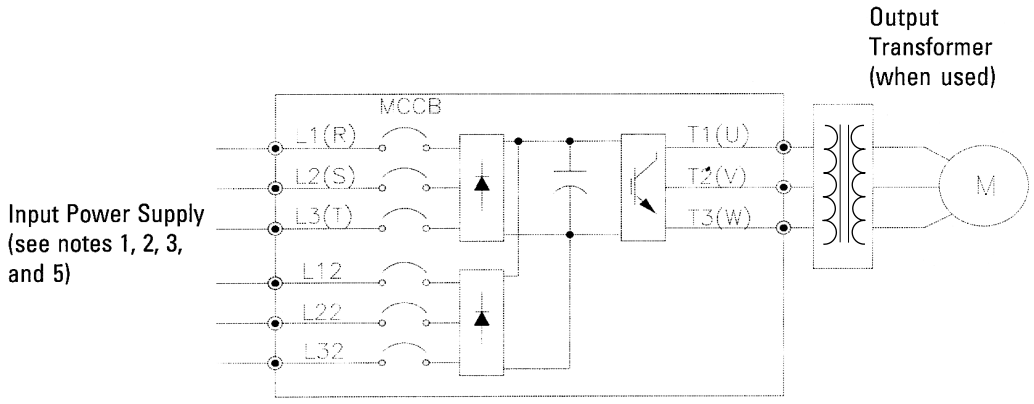

Figure 5-2: Block Diagram for 12–pulse Input

Note

1. Properly ground the drive cabinet with a copper conductor to meet local electrical codes. For VSD applications, metal conduit is *not* an acceptable ground. Cabinet ground connection must also comply with NEC-Article 250 and CEC-Section 10.
2. The motor should be grounded to the same point in the drive cabinet as the copper wire. Do not mix input and output conductors in the same conduit. Ground connection must also comply with NEC-Article 250 and CEC-Section 10.
3. An optional junction box is available to simplify the installation of input and output cables. Terminals are marked identically and accessible from a separate box outside the enclosure.
4. Output transformers have numerous taps for different motors and cable lengths. Contact Schlumberger AL InTouch before starting a new application to ensure correct sizing and wiring.
5. Twelve-pulse input requires an input transformer with a polygon winding secondary. This type of input reduces harmonics reflected to the power line.

5.2 Selection of Wiring Equipment and Standard Cable Sizes

This lists the common sizes of main circuit wiring that are available for Schlumberger SWDs.

Table 5-1: Selection of main circuit wiring equipment (standard cables shown)

	*Molded case circuit breaker (MCCB)	Ampacity (USD FLA x 1.25)	**Typical cable size			
KVA	Amp rating (A)	Amps	Digital Control Inputs	***Input Lug Wire Capacity	***Output Lug Wire Capacity	****Ground Lugs
66	100	99	#14	1(#14 AWG-1/0)	1 (#4 AWG-500 MCM)	2 AWG-4/0
83	150	125	#14	1(#6 AWG-350 MCM)		
111	250	166	#14			
130	250	195	#14			
163	250	245	#14			
200	400	301	#14	1(#2 AWG-500 MCM)		
260	800	391	#14		2(#6 AWG-350 MCM)	
325	800	489	#14	2(#2 AWG-500 MCM)		
390	800	586	#14			
454	800	683	#14	4(4/0–500 MCM)		
518	800	780	#14		4(#2 AWG-600 MCM)	
600	1000	903	#14			
700	1200	1054	#14			
815	1200	1226	#14			
932	800 x 2	1403	#14	4(1/0–750 MCM)	4(1/0–750 MCM)	1/0–350 MCM
1000	800 x 2	1504	#14			
1200	1000 x 2	1806	#14			

*Any customer-supplied Molded Case Circuit Breaker (MCCB) or Magnetic Circuit Protector (MCP) external to the SWD cabinet should be coordinated with the available short circuit current. The drives are rated for output short circuit fault currents of 100,000 amps (in all ratings). The selection of breakers for this table is in accordance with 1987 NEC Article 430.

** Wire sizing is based upon NEC Table 310.16 or CEC Table 2 using 75°C cable, an ambient of 30°C, cable runs for less than 300 ft, and copper wiring for not more than three conductors in raceway or cable or earth (directly buried). The customer should consult the NEC, CEC, or applicable local area codes standard wire tables for their own particular application and wire sizing and ambient de-rating factors.

*** Use parallel conductors instead of a single conductor (this will allow for the proper wire bending radius within the cabinet). Use separate conduits for routing parallel conductors. This prevents the need for conductor derating (see Note 2).

**** Lug sizes are based on using copper/aluminum bonding conductor. Refer to CEC Table 16 for copper wire and NEC Table 250.122, based on copper.

Note

1. Contacts used to connect drive terminals should be capable of switching low-current signals (i.e., 5 mA).
2. When wiring with parallel conductors, the conductors should be kept together in phase sets with U1, V1, W1 in one conduit and parallel conductors U2, V2, W2 in another conduit. The ground conductor should be in one of these conduits.
3. Twisted-pair wiring should be used for pressure feedback signal wiring terminals.
4. Pressure feedback input: 4 to 20 mA or 1 to 5 V signal two–wire twisted pair, #20 AWG; Other signal circuits, use #18 AWG.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: land transport

Turn off power to the drive before making any wiring changes to the analog output circuits.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: land transport

Use separate conduits for routing incoming power, power to motor, and control conductors. Use no more than three power conductors and a ground conductor per conduit.

5.3 Grounding

The VSD should be grounded in accordance with Article 250 of the National Electrical Code or Section 10 of the Canadian Electrical Code, Part I and the grounding conductor should be sized in accordance with NEC Table 250.122 or

CEC, Part I Table 16. See 2.1 Installation safety precautions (p. 2- 1) (notes 7 and 13). Local grounding codes may apply. Ground lug is provided inside the VSD on the Ground bus.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: electrical

Conduit is not a suitable ground for the inverter.

5.4 Motor selection

Exceeding the peak voltage rating or the rise time allowable for a surface motor insulation system will reduce motor life expectancy. To ensure good motor insulation life, consult the motor supplier for specified peak voltage and rise time allowed for the motor used in your application. The National Electrical Manufacturer's Association publishes the following general standards for motor peak voltage and associated rise time.

5.4.1 NEMA MG-1–1993

Section IV, Part 30, Paragraph 30.02.2.9 states that

When operated under usual service conditions for a surface motor (MG-1-14.02 or 20.80.2) the following limit values at the motor terminals should be observed: Voltage (peak) = 1kV or less (where peak voltage is single amplitude) Rise Time = 2 microseconds or greater.

5.4.2 NEMA MG-1-1994

Section IV, Part 31, Paragraph 31.81.2 states that

When operated under usual service conditions (MG-1-31.20) stator winding insulation systems for definite purpose adjustable speed drive-fed motors shall be designed to operate under the following limits at the motor terminals: Voltage (peak) = 1600 volts with a rise time of more than 0.1 microseconds (where peak voltage is single amplitude).

5.5 Wiring Considerations for Mechanical Equipment

The following cautions and warnings are special considerations that should be made for mechanical equipment and components such as motors, shafts, bearings, when this equipment will be driven and controlled by a variable speed drive.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: machinery equipment hand tools, temperature

Surface motors operating from adjustable-speed drive power sources tend to operate at higher temperatures, which may increase the need for more frequent lubrication cycles. Failure to lubricate motors driven by adjustable-speed drives could cause premature failure of the motor.

Warning

Potential Severity: Serious
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives

Operating motors at carrier frequencies higher than 5 kHz may require the motor shaft to be grounded or motor bearings to be insulated to prevent current (by capacitative coupling to ground) from being passed down the shaft.

Warning

Potential Severity: Serious
Potential Loss: Assets
Hazard Category: electrical

Submergible motors powered by VSD output transformers require special application concerns. Contact AL InTouch or AL Engineering before starting a new VSD application.

5.6 Interconnection Wiring

The following subsections describe how the PC boards of the HMI and the VSD are interconnected for power and communication both within the drive and to external or optional equipment. Refer to Figure 5-3 Speedstar 2000 Power/Communications System Overview Block Diagram (p. 5- 9) for a simplified diagram of how the HMI, VSD, Site Communications equipment

(if required), and external devices (if required) are connected. Detailed interconnection diagrams are presented in the respective subsystem sections that follow and circuit diagrams are included in the appendices.

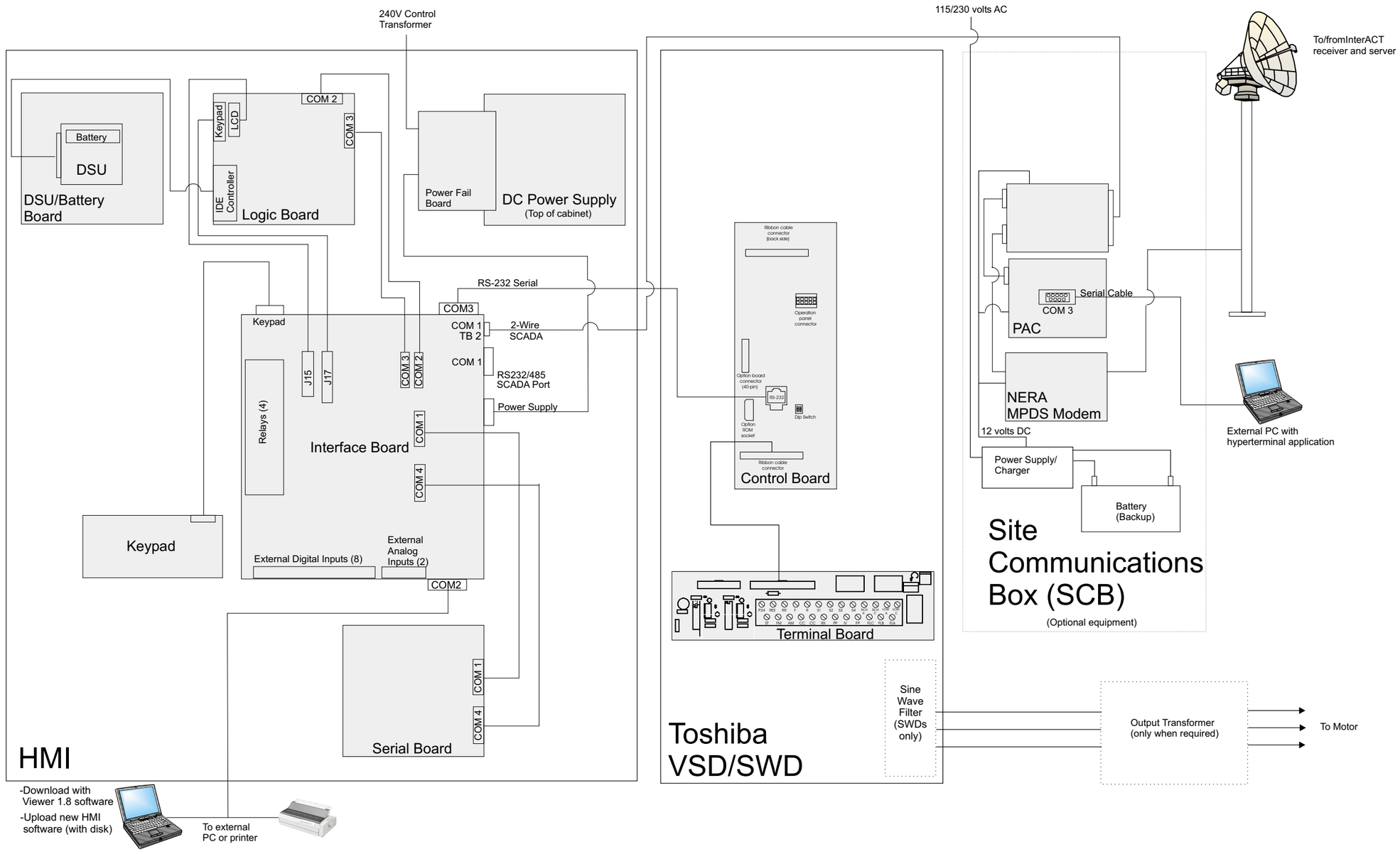

Figure 5-3: Speedstar 2000 Power/Communications System Overview Block Diagram

5.6.1 HMI Wiring

This section contains detailed wiring and connection information about the HMI. Discussions are organized by PC board. For more complex boards with numerous connections, a table follows the detailed block/interconnect diagrams and contains terminal functional descriptions.

5.6.1.1 HMI Terminal Board Connections

The following figure and table describe all control wiring connections to the HMI Terminal Board.

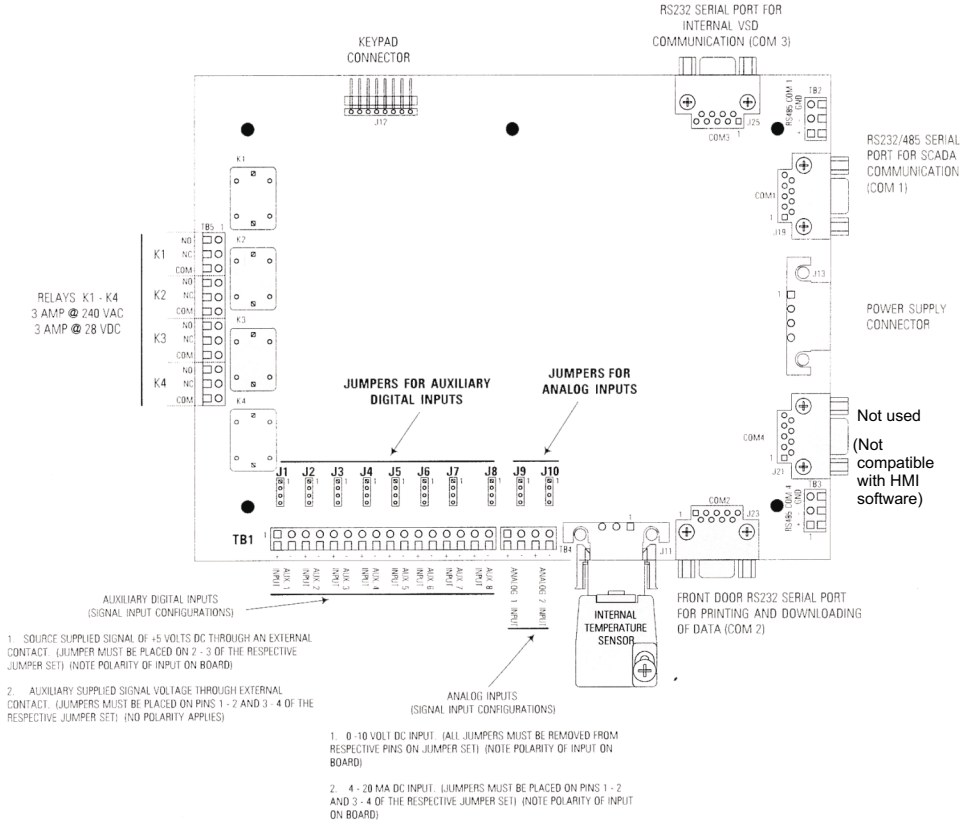

Figure 5-4: HMI Terminal Board Interconnect Diagram

Refer to Table 5-2 HMI Terminal Board Description for HMI board connection descriptions and functions.

Table 5-2: HMI Terminal Board Description

Terminal Name	Terminal Functions	Terminal Location
TB5	Output relays, Contact Ratings: 3A @ 230VAC, 3A@28VDC (Form C — SPDT	HMI Terminal Board
TB1	Digital Auxiliary Inputs	
J1–B	Auxiliary Input Discrete Contacts install jumper 2 to 3 for logic level (+5V) external signal applied to the circuit, install jumpers 1 to 2 and 3 to 4 for external switch with operator interface supplying power	
TB4	Analog Inputs	
J9–10	Install jumper 1 to 2 and 3 to 4 for 4–20mA input. Remove all jumpers for 0–10V input.	
COM2	9–pin D-conn/receptacle standard RS-232 pinout. Printer Default. Download data with Viewer 1.8 software and upload new revs of HMI software (with portable disk).	
TB2	RS-485 two-wire SCADA	
COM4	9–pin D-conn/receptacle RS-485 configurable. Pin1=Data-, Pin2=Data+, Pin5=Ground **Note** Use of this port is not compatible with HMI software.	
COM1	9–pin D-conn/receptacle RS-485 default. RS-232/RS-422/RS-485. SCADA Default Pin1=Data-, Pin2=Data+, Pin5=Ground	
TB3	RS-485 default, two wire only.	
COM3	9–pin D-conn/receptacle standard RS-232 pinout. Connection from Operator Interface to VSD Controller Board (PCB1).	

5.6.1.2 HMI Power Supply and Power Fail Board Connections

The HMI power supply and Power Fail Board are mounted either on the ceiling (top), back wall, or side wall (depending on kVA size of drive) of the drive enclosure. Refer to Figure 5-5 HMI Power Supply and Power Fail Board Interconnect Diagram.

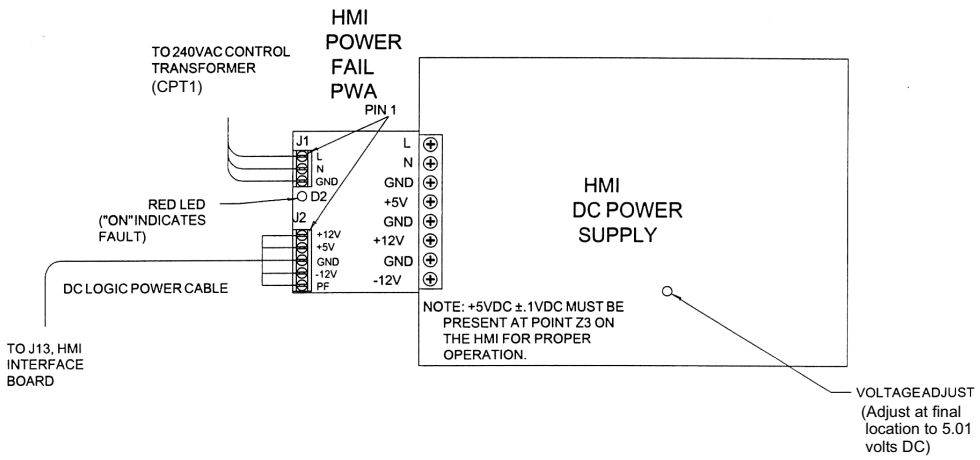

Figure 5-5: HMI Power Supply and Power Fail Board Interconnect Diagram

5.6.1.3 HMI Serial Board Connections

The HMI Serial Board is located/mounted (with standoffs) directly on top of the HMI Terminal Board as you face the inside of the drive enclosure door. Refer to Figure 5-6 HMI Serial Board Interconnect Diagram.

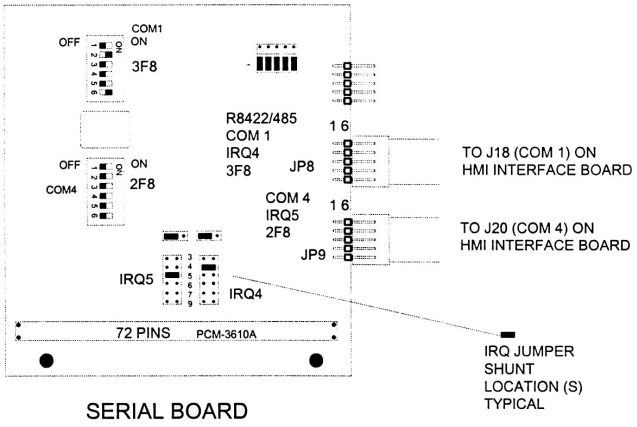

Figure 5-6: HMI Serial Board Interconnect Diagram

5.6.1.4 HMI Logic Board Connections

The HMI Logic Board is located/mounted (with standoffs) directly on top of the HMI Serial Board as you face the inside of the drive enclosure door. Refer to Figure 5-7 HMI Logic Board Interconnect Diagram.

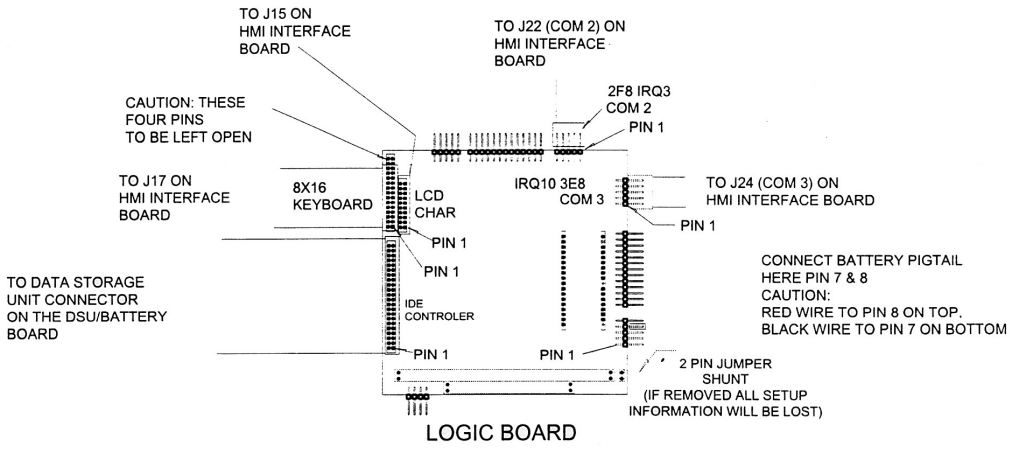

Figure 5-7: HMI Logic Board Interconnect Diagram

5.6.1.5 HMI DSU/Battery Board Connections

The HMI DSU/Battery Board is located/mounted (with standoffs) directly on top of the HMI Logic Board as you face the inside of the drive enclosure door. Refer to Figure 5-8 HMI DSU/Battery Board Interconnect Diagram.

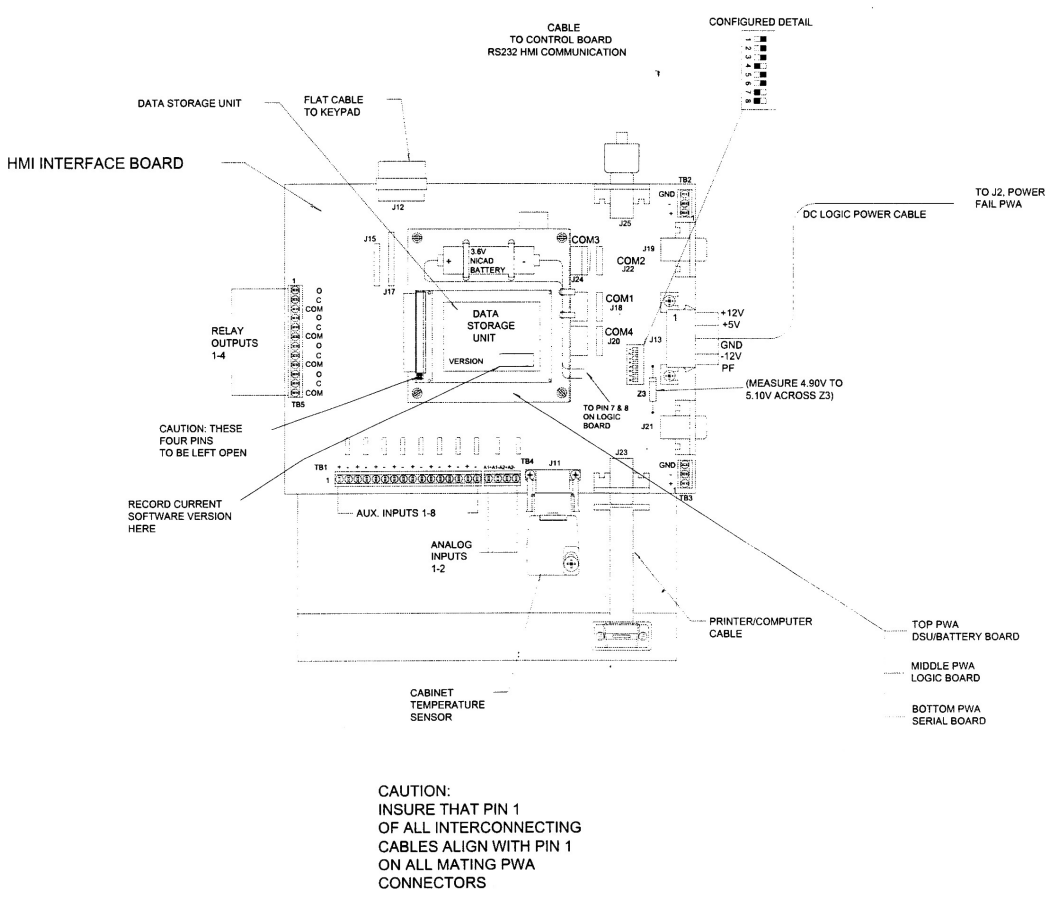

Figure 5-8: HMI DSU/Battery Board Interconnect Diagram

5.6.2 VSD Wiring

For purposes of discussion in this manual, VSD wiring is confined to interconnection or communication wiring to or from the VSD, or to the HMI or other external devices in the Speedstar 2000 system. Wiring internal to the Toshiba G3 is not within the scope of this manual.

5.6.2.1 VSD Terminal Board Connections

The following figure describes all control wiring connections to the VSD Terminal Board. Refer to Figure 5-9 VSD Terminal Board Interconnect Diagram and Table 5-3 VSD Terminal Locations for terminal descriptions.

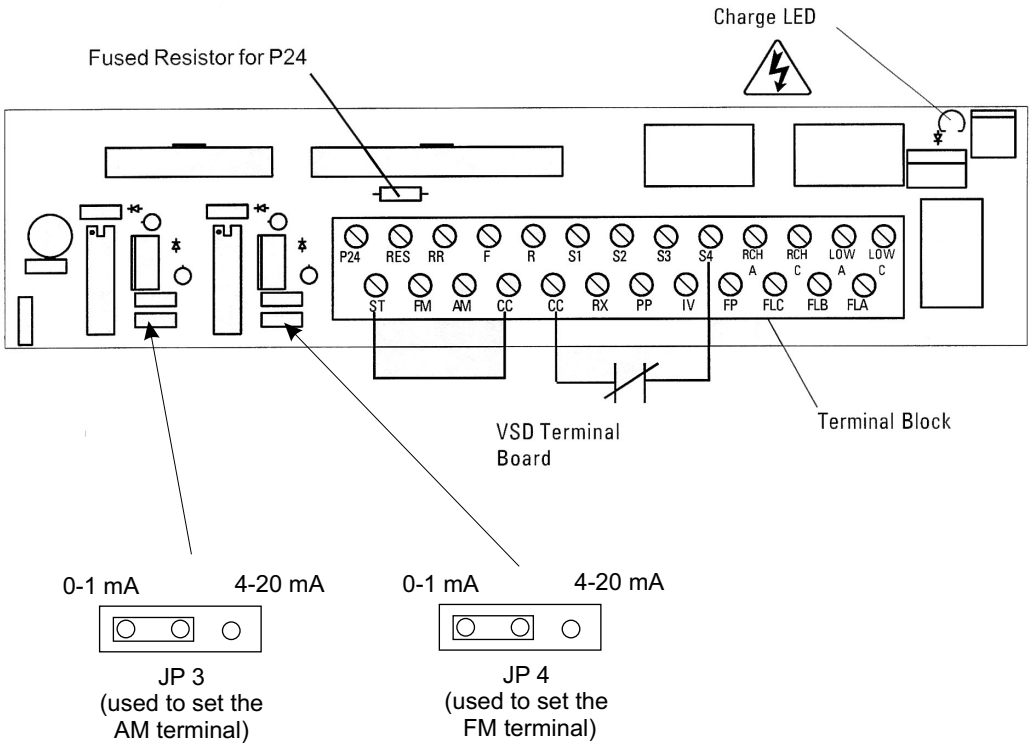

Figure 5-9: VSD Terminal Board Interconnect Diagram

The VSD Terminal Board contains two interlocks which enable and disable certain functions of the drive. See the following list for interlock descriptions.

Term	Definition
ST to CC	Opening this interlock enables the *coast stop* function of the VSD. Reconnecting this interlock restarts the drive if it was running before it stopped. **If connection ST to CC is not made, the drive will not start.** **Note** This interlock should not be used in the field This interlock may cause inverter overload messages when the drive restarts.
S4 to CC	Opening this interlock causes an *E-stop* trip in the VSD. This must be reset before the drive can be restarted.

Table 5-3: VSD Terminal Locations

Terminal Name	Terminal Functions	Terminal Location
L1(R), L2(S), L3(T)	Line input terminals for 6–pulse models: connect to either 3–phase 50–Hz 380 to 400 volts AC or 3–phase 60–Hz 415 to 480 volts AC	VSD terminal block or bus bar
L1(R), L2(S), L3(T), L12(R2), L22(S2), L32(T2)	Line input terminals for 12–pulse models: connect to either 6–phase 50–Hz 380 to 400 volts AC or 6– phase 60–Hz 415 to 480 volts AC	
T1(U), T2(V), T3(W)	Motor output terminals. Connect these terminals to a 3–phase induction motor of the proper voltage, current, and horsepower, or input to a step-up transformer.	

5.6.3 VSD Controller Board Connections

The VSD Controller Board is located directly on top of the VSD Gate Driver Board and is in the direct center of the VSD when viewing the drive with the enclosure door open. Refer to Figure 5-10 VSD Controller Board Interconnect Diagram.

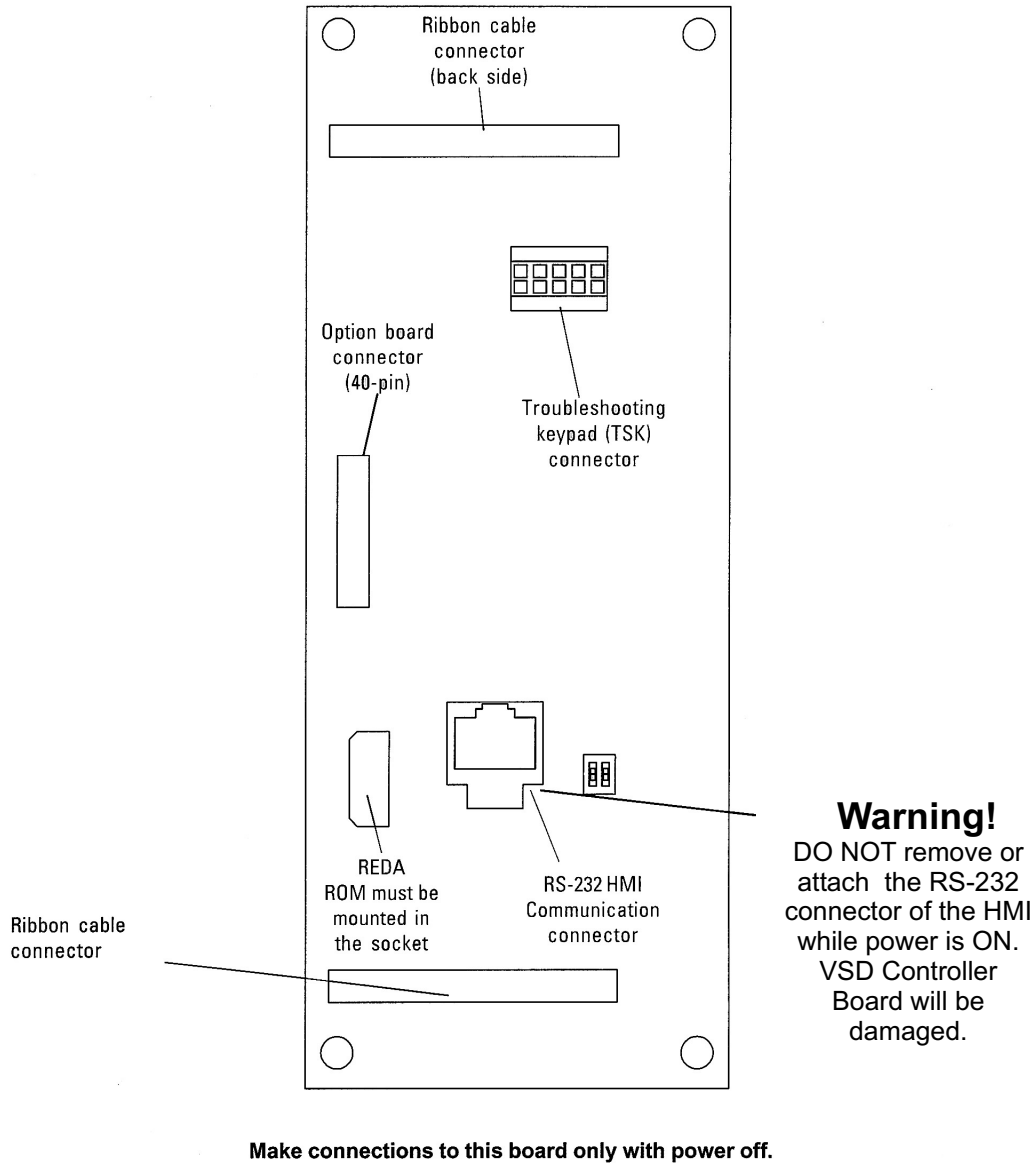

Figure 5-10: VSD Controller Board Interconnect Diagram

5.6.4 Control Power Transformer Wiring

Also located within the VSD enclosure is the Control Power Transformer (one, sometimes two CPTs are included, depending upon application). Refer to Figure 5-11 Control Power Transformer (CPT) Terminal Block and Table 5-4 CPT Connections and Functions for control power transformer (CPT) connections and functions.

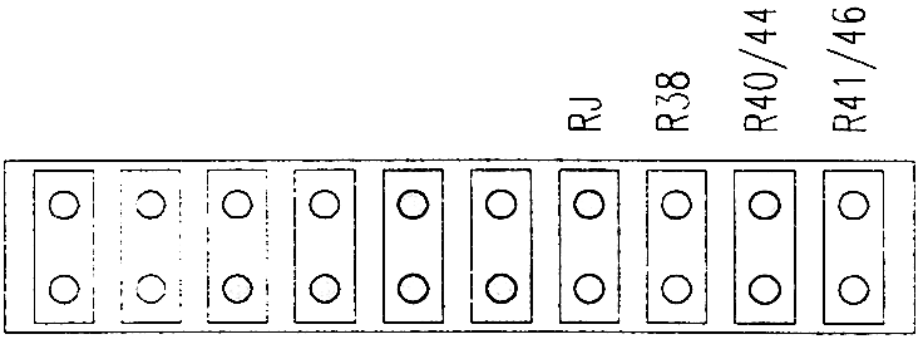

Figure 5-11: Control Power Transformer (CPT) Terminal Block

Note

On VSD ranges of 66 to 454 KVA, a jumper should start at terminal "RJ" and should be terminated on the proper terminal for the appropriate input voltage at which the VSD is to be used. Refer to Table 5-4 CPT Connections and Functions for the proper terminations needed on the Control Power Transformer (CPT).

Table 5-4: CPT Connections and Functions

Terminal Name	Terminal Functions	Terminal Location
R41/46	CPT Connection for 460 V, 60–Hz and 415 V, 50–Hz	CPT terminal block
R40/44	CPT Connection for 440 V, 60–Hz and 400 V, 50–Hz	
R38	CPT Connection for 380 V, 50–Hz	
RJ	CPT Common	

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Operator Interface

6 OPERATOR INTERFACE

This chapter provides detailed descriptions, functions, and operating procedures for the operator interface, more often referred to as the Human/Machine Interface (HMI), used on Schlumberger variable speed drives and sine wave drives. The HMI is a customized interface for Toshiba variable speed drives and therefore replaces the Toshiba keypad and operator interface mentioned in any Toshiba reference material.

6.1 Introduction

The operator interface (HMI) for the Schlumberger variable speed drives and sine wave drives contains several major subsystems: an 8 inch x 8 inch keypad with 24 keys, an expandable embedded controller, extensive I/O points, and flexible, programmable software.

The HMI hardware consists of

- a membrane tactile keypad
- 4 digital output relays
- 8 digital inputs
- 2 analog inputs for either 0 to 10 VDC and/or 4 to 20 mA input
- 3 serial ports.

All information is displayed on a four line, 20–character, liquid crystal display (LCD) mounted on the keypad. All error messages, status, numeric values, etc. are displayed in one of three languages: English, Spanish, or Russian. Programmable software allows additional languages to be added (consult Schlumberger Artificial Lift for additional languages). There are no cryptic numbers or codes to decipher. All inputs to the controller are transmitted via the membrane keypad, SCADA I/O, analog inputs, and digital inputs. The contrast of the liquid crystal display can be adjusted using a single key. The same key toggles the backlight intensity for viewing the HMI in subdued light.

6.1.1 Main Operating Mode Keys and Functions

The main operating keys on the HMI keypad are located across the top of the unit. These may be manipulated manually from the keypad or remotely via SCADA input/commands and are:

Term	Definition
Hand	One of two basic operating modes for the VSD (*Hand* or *Auto*). In *Hand* mode, the restart timer functions are not acknowledged and the VSD may be started or stopped by using either the local keypad (*Off* or *Start* keys) or SCADA mode.
Auto	One of two basic operating modes for the VSD (*Hand* or *Auto*). In the *Auto* mode, the restart timer functions are acknowledged and the VSD may be started or stopped by using either the local keypad or SCADA mode. OFF will always stop the VSD, regardless of the present mode. The present mode is indicated by the lighting of LEDs located just below each key.

Scroll-through menu items are provided for set up of the VSD, and help screens are accessible for each menu item.

Note

An auto-jump function is provided for quicker movement through the parameters by using the SHIFT key. The auto-jump will move to the beginning menu of each menu series. Menu series are organized by major function. Refer to the following table for an overview description of menu series. For detailed menu descriptions, refer to the appendix listing Speedstar 2000 Menus.

Table 6-1: Menu Series Overview

Menu Series	Function
000 thru 099	commissioning,status, and specialized task menus
100	primary input and parameter menus
200	VSD setup menus
300	output menus (for addressing devices external to VSD)
500	special controls
600	auxiliary input menus
700	analog output menus
800	analog input menus
850	equipment menus
900	direct access menus
999	G3 service and test routines (restricted access)

6.1.2 Overview of Additional Functions

- Three main control modes are available for VSD operation: Speed, Current, and Pressure. The Speed control mode contains two sub-modes; speed source and signal-follower. Refer to the *Speed, Current, or Pressure Modes* subsection in this chapter.
- Two logging files are available: History Log and Data Log. An RS232 front-panel port (accessible without opening the drive enclosure) is provided for downloading the history log and data log to a local printer or PC (using Viewer 1.8).
- The HMI offers Modbus RTU protocol as standard for connection to SCADA systems through the RS485 port on the HMI Terminal Board. A 3–pin terminal (TB2) or a 9–pin D connector (COM1) is provided for cable connection.
- Selectable stopping mode (for the motor) is available: Coast-to-stop or controlled stop are the standard choices. Factory default is Coast-to-Stop.

6.2 Display mode

The HMI is in one of three display modes while operating: status, help, or menu.

Note

The *MENU/ESC* key can always be used to access the status screen. Depending upon which screen is presently being displayed, the *MENU/ESC* key may need to be pressed more than once to reach the status screen. Once the status screen is displayed, the *MENU/ESC* key will toggle between the status and menu screens.

6.2.1 Status Mode

The initial status screen display mode is recognizable by the fact the top line of the screen will display the date and time (e.g., 12MAY1998 15:05:21). As expected from its name, the status screen displays various system status parameters. It displays the time and date, the control mode for which the VSD is set up, whether the VSD is running, the speed at which the VSD is running, what current the VSD is supplying, and what voltage the VSD is supplying. Pressing the *UP/DOWN* arrow keys will cause the status screen to page through several other parameters of interest including the drive's amperage rating, the software version number, the analog input values, the internal temperatures, run times, and other information.

6.2.2 Help Mode

Pressing the *HELP* key will cause the help text for the presently displayed screen to appear. Pressing the *HELP* key again will cause the original screen to reappear. Pressing the *UP/DOWN* arrow keys will allow the help text to be scrolled line by line. Pressing the *SHIFT* key allows the arrow keys to be used as *PAGE UP* and *PAGE DOWN* keys and will scroll the help text screen by screen.

6.2.3 Menu Mode

The menu screen is identified by the menu number and a main title located on the first line (e.g., 120 SPEED MENU), the second and third lines contain additional description (e.g., MINIMUM SPEED (HZ)), the fourth line will contain the present value of that menu item (e.g., 20 HZ).

```
120 SPEED MENU
MINIMUM
SPEED (HZ)
20.0
```

6.2.3.1 Data Entry from the Menu Screen

From the menu screen the value of a menu item can be changed by pressing the *ENTER* key. If the value is allowed to be changed, the displayed value will begin flashing. Otherwise, a message such as *PASSWORD REQUIRED* may momentarily appear. Pressing the *ENTER* key will finish the data entry. Pressing the *MENU/ESC* key will abort the data entry.

6.2.3.2 Numeric Entry

If the data entry is numeric, the *UP/DOWN* arrow keys will increment/decrement the displayed value. The numeric (0-9) keys will shift the displayed number one place to the left and place the selected number in the newly vacated position on the right.

6.2.3.3 Text Entry

If the data entry is text, the *UP* arrow key will move the cursor one place to the right, the *DOWN* arrow key will move the cursor one place to the left, the numeric (0-9) keys when pressed repeatedly will cause the character under the cursor to scroll through the characters associated with each numeric key.

6.3 Keypad

The HMI keypad provides input capability to the operator from the exterior of the drive enclosure. Also in the keypad is an integral LCD screen. Refer to Figure 6-1 HMI keypad (Speedstar 2000, Sine Wave Drives) for an example of the keypad.

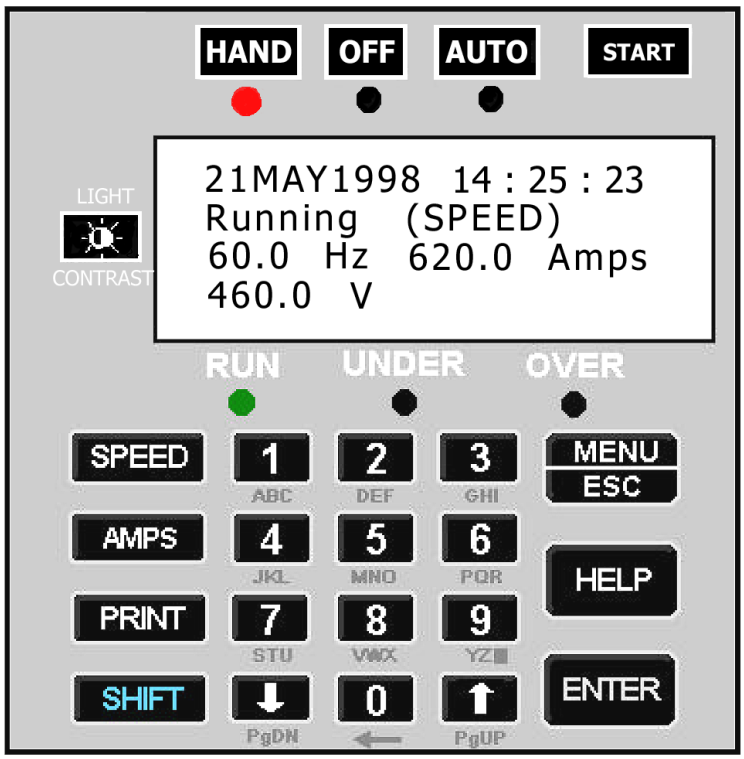
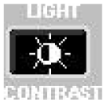


Figure 6-1: HMI keypad (Speedstar 2000, Sine Wave Drives)

Refer to Table 6-2 HMI Keypad Key Descriptions for detailed descriptions for each key.

Table 6-2: HMI Keypad Key Descriptions

Key	Function
	The numeric keys 1 through 9 function as follows in text entry mode: By default each keypress cycles through the number and the letters listed below it (1 - A - B - C) and then repeats the sequence. The *SHIFT* key toggles the sequence so that it begins with the first letter listed and cycles through the remaining letters followed by the number (A - B - C - 1) and then repeats the sequence. The numeric entry mode displays the pressed number only. The 0 (zero) key is used to display zero. *SHIFT* toggles the key so it functions as a backspace.
	Shortcut to the *Maximum Current* Menu
	Puts the drive in *AUTO* mode.
	Pressing *ENTER* while browsing the menus selects the currently displayed item for modification. After modifying, pressing *ENTER* will confirm and retain the change. If no change was made, pressing *ENTER* will return the selected item to its previous setting.
	Puts the drive in *HAND* mode.
	The *HELP* key at any time will display detailed help information for the currently displayed screen.
	Momentarily press the key to toggle the backlight ON or OFF. Press and hold the key down to adjust the contrast until the key is released. If the contrast dims, repeating the procedure will brighten it.
	From the status screen, the *MENU/ESCAPE* key will display the last menu item browsed. If already in the menus, the key functions as follows: If an item is being modified, *MENU/ESCAPE* will discard the change. While browsing the menus, *MENU/ESCAPE* will return the display to the status screen.
	Stops the drive if it is running.

Key	Function
	Performs the *down* function throughout the interface except in text entry mode where it moves the cursor back one character.
	Performs the up function throughout the interface except in text entry mode where it moves the cursor forward one character.
	Shortcut to the *Print Configuration* menu.
	Selects alternate modes for certain keys.
	Shortcut to the *Target Speed* menu.
	Starts the drive if in *HAND* mode, overrides start-up delays and starts drive if in *AUTO* mode.

6.4 Commissioning/Recommissioning

Refer to the Commissioning/Recommissioning section in the Startup and Commissioning chapter of this manual for these procedures.

6.5 Passwords

To be able to operate the HMI in a secure mode, two security levels and their associated passwords must be assigned (or reassigned) and known by users. The two passwords (master password and user password) each must be a number from 0 to 9999. The passwords cannot be alphabetic character strings. Each of the security levels will automatically lock after about 30 minutes of keyboard inactivity and if enabled, will power up locked.

Note

If a password of zero (0) is entered for either the master or user password, then that level will not automatically lock after keyboard inactivity. Essentially, a password of zero disables password protection. For example, the HMI may be left in the user mode without requiring the password to be re-entered every day.

If the HMI is not configured and run in master or user mode, it is locked by limiting the number of menus accessible to the user.

Tip

Menus 102, 105, 610, 800, 111, 100, 240, 241, 242, 246, 247, 248, 250, 251, 252, 253 are always available for the operator, no matter what the current security level of the HMI. Additional menus can be opened to User Password access by setting them to enabled status with Menu 104.

6.5.1 Setting the Master Password

To enable master—level access, the master password must be set and confirmed by the following steps:

1. The master password entered in Menu 102 Figure A-1 Menus 100 to 104 (p. A- 2) must match the master password previously entered in Menu 103 (change master password) Figure A-1 Menus 100 to 104 (p. A- 2). To be able to change the password, you must know the previously active password.
2. If the password entered in menu 102 is correct, the display will change to 0, confirming that the master level is enabled.
3. If the number entered changes to 9999, the master level is locked.

6.5.2 Setting the User Password

To enable user-level access, the user password must be set and confirmed by the following steps:

1. The user password entered in Menu 105 Figure A-2 Menus 105 to 109 (p. A- 3) must match the user password previously entered in Menu 106 Figure A-2 Menus 105 to 109 (p. A- 3).
2. If the password entered in Menu 105 is correct, the display will change to 0, confirming that the user level is enabled.
3. If the password entered causes the display to change to 9999, the user level is locked.

6.6 Date/time

Date and time are recorded with data and events as they occur for analysis of the information at a later date.

Dates are displayed in *ddmmyyyy* format. To change the system date, access Menu 217 Figure A-15 Menus 214 to 219 (p. A-16) and perform the following steps:

1. Enter numbers as text. Press the numeric keys (1 through 9) to increment the month and press 0 to decrement the month.
2. Press the arrow keys to position the cursor to a new location for data entry.

System time is displayed in the *hh:mm:ss* format. To change the system time, access Menu 216 Figure A-15 Menus 214 to 219 (p. A-16). Time is entered as text.

6.7 Speed, Current, or Pressure Control Mode

The VSD can be programmed to operate in one of three basic control modes; speed, current or pressure. This mode is programmed into the VSD by using Menu 107–Control Type Figure A-2 Menus 105 to 109 (p. A- 3).

Note

Speed, Current, or Pressure mode controls how the VSD will change the motor speed while running. These modes are completely independent of the shutdown and restart conditions that are programmed for the most commonly occurring faults that may be experienced while the drive and motor are in service. For example, the VSD may stop due to a sensed underpressure condition, regardless of whether it is running in Speed, Pressure, or Current control mode.

6.7.1 Speed Mode

The speed control mode has two methods of controlling the VSD frequency; speed-source control or signal-follower control (Menu 120 –Speed Source) Figure A-3 Menus 110 to 122 (p. A- 4).

6.7.1.1 Speed-Source Control

In the speed-source control method, the user programs a frequency at which the VSD is to operate. To select this mode, perform the following:

1. Set this method by programming the *speed source* menu to *user*.
2. Once started, the VSD will ramp up the motor speed to the set frequency and maintain the set frequency until the user selects another frequency or the VSD mode is changed.

   Note

   Changes in current or external inputs do not have any effect on the VSD running frequency. The drive will run at the user-selected frequency or will stop due to some other preprogrammed event or fault. Stall Protection is the only exception to this rule (see Menu 451 Figure A-22 Menus 347 to 454 (p. A-23) and Menu 452 Figure A-22 Menus 347 to 454 (p. A-23)).

3. If the user changes the set frequency while the VSD is running, the drive will change to the new frequency by accelerating or decelerating at the programmed ramp rate for speed control (Menus 124 Figure A-4 Menus 123 to 128 (p. A- 5) and 125).

Speed—source control mode is the most common mode and the default mode of VSD operation.

6.7.1.2 Signal-Follower Control

The second speed control method is called signal-follower mode.

1. Set this method by programming the *speed source* menu selection to the correct *analog input* (the analog signal that you wish to control the VSD).

Tip

The analog input to be used for the external speed source is programmed from the HMI (Menu 800–Analog Inputs Selection Figure A-29 Menus 702 to 803 (p. A-30)).

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2. The VSD will adjust the output frequency directly proportional to the analog signal input selected.
3. During signal-follower control method of operation, the HMI will maintain its maximum and minimum limits even if the analog signal should go past these limits.

6.7.2 Current Mode

In current control mode (Menu 140–Target Current Figure A-5 Menus 129 to 141 (p. A- 6)) the VSD continuously changes the output frequency to try to maintain the output (or motor) current to match the user's programmed target current. Current control mode is useful in situations where the motor frequency is not as important as the current, perhaps because the motor is driving a varying load. To program the VSD to run in current control mode, perform the following steps:

1. First, the operator interface needs to be programmed to use the VSD output current or the motor current (Menu 108–Amps Display Value Figure A-2 Menus 105 to 109 (p. A- 3)).
2. If motor current is to be used, calibration of the transducer or current-sensing device will be required. Refer to .
3. Input a target current.
4. Once the VSD is started or changed to current mode if already running, it will continuously monitor the current and compare it to the user's programmed target current.

5. If the current is too high or too low, the VSD output frequency will be adjusted (at the user's programmed current ramp rate) to maintain target current.
6. If the current (or any other parameter) is outside of the programmed range for more than the specified time the VSD may stop and restart, if programmed to do so. Menus 141 Figure A-5 Menus 129 to 141 (p. A- 6) through 147 Figure A-7 Menus 147 to 151 (p. A- 8), and Menu 150 Figure A-7 Menus 147 to 151 (p. A- 8) control drive restart conditions.

6.7.3 Pressure Mode

The pressure control mode operates through an optional Proportional/Integral/Derivative (PID) Control. The PID Control is disabled or enabled with Menu 182 –PID Control Figure A-12 Menus 180 to 185 (p. A-13). When PID control is disabled, the VSD will operate in a similar mode to current control, discussed above. When set to Pressure mode, the HMI continuously monitors the pump output pressure signal set by Menu 163 Figure A-8 Menus 152 to 163 (p. A- 9), compares that signal to the programmed target pressure, then adjusts the VSD output frequency (which ramps up or down at the programmed pressure ramp rate, set by Menus 165 Figure A-9 Menus 164 to 169 (p. A-10) and 166). The rate of VSD frequency change will depend on PID and Pressure Control Ramp Rate settings. The VSD output frequency may be programmed to increase or decrease when the pressure is higher or lower than the target pressure (Menu 164). For more information, refer to the section on PID control in this manual.

6.8 Ramp rates

Ramp rates are defined as the rate of change of VSD output frequency over time. Separate control ramp rates may be programmed by the user for all of the different control modes of the VSD (Speed, Current, Pressure). Also, separate accel ramp rate for initial acceleration from startup frequency (Menu 458 Figure A-23 Menus 455 to 459 (p. A-24)) and minimum speed to target speed may be programmed by using the following menus.

Term	Definition
Menu 124 and 125	Speed Control Ramp
Menu 148 and 149	Current Control Ramp
Menu 165 and 166	Pressure Control Ramp
Menu 470 and 471	Startup Frequency to Minimum Running Frequency

Menu 472 and 473	Minimum Speed to Target Speed Ramp Rate
Menu 474 and 475	Deceleration Ramp Rate (effective only in Controlled Stop Mode)

Note

Excessively fast ramp rates may not have any noticeable effect, since there is a maximum limit at which the VSD may accelerate and decelerate.

To program or change the ramp rates in the VSD, perform the following steps:

1. Enter each of the ramp rates as an amount of frequency change (Hz) versus the time span (seconds) to perform that frequency change. From these entered values, the HMI calculates the actual ramp rate. For example, a 3.0 Hz change every 9 seconds equates to a ramp rate of 1.0 Hz change every 3 seconds. Any frequency adjustments are calculated every second, and the appropriate changes are made by the VSD.
2. When the VSD is started the following frequency changes are performed. The VSD will begin at start frequency and ramp to minimum frequency. Start to minimum ramp rate is defined by Menus 470 Figure A-24 Menus 460 to 471 (p. A-25) and 471.
3. The VSD will then ramp from minimum to target frequency. Minimum to target frequency ramp rate is defined by Menus 472 Figure A-25 Menus 472 to 500 (p. A-26) and 473.
4. Once the VSD is at target speed, it will switch to the corresponding mode control ramp rate (in this case the frequency control ramp rate). If the target frequency is subsequently changed to a new target frequency, the VSD will ramp up or down in frequency at the selected control mode ramp rate.
5. Typically, the ramp rate for frequency control is comparatively fast, whereas the ramp rate for PID Control disabled in the Pressure Mode could be much longer, perhaps as slow as 1.0 Hz per day.

Note

Menus 474 Figure A-25 Menus 472 to 500 (p. A-26) and 475 dictate the stopping ramp rate when the drive is in Controlled Stop Mode (Menu 212 Figure A-14 Menus 207 to 213 (p. A-15)). For more information on stopping see the *Stop Modes* section. Two exceptions exist where the programmed ramp rates will be ignored:

- When the VSD is in the *signal follower* mode (an external source is directly controlling the speed), or
- The VSD is running under PID control in Pressure Control Mode.

6.9 Analog Inputs

The HMI is configured to easily connect analog inputs from external sources (usually transducers) for both monitoring and control. These external signals are typically from a tank level sensor, downhole pressure sensor, or downhole temperature sensor. Each input may be configured for

- a voltage level of 0 to 10V or
- a current level of 4 to 20 mA

by moving jumper blocks on the HMI Terminal Board.

To configure the inputs for 0 to 10 volts, remove any jumper blocks installed on the board by the relevant input terminal.
To set the input for 4 to 20 mA level, perform the following steps:

1. Install one jumper block, shorting pins 1 and 2 together.
2. Install another jumper block shorting pins 3 and 4 together.

   Note

   Note that the low input side of the analog inputs is directly connected to ground.

3. Once the hardware has been configured for the signal level, the operator interface software also needs to be calibrated for the appropriate input signal. Since all types of transducers have different input parameters corresponding to different output levels, they should each be calibrated with the HMI.

   For example, a 0 to 1000 lbf/in^2 pressure transducer may have an output of 4 mA at 0 lbf/in^2 and 20 mA output at 1000 lbf/in^2. Another pressure transducer may have an output of 4 mA at 0 lbf/in^2, and an output of 20 mA at 500 lbf/in^2.

The HMI must be calibrated so that it can operate with correctly scaled units. The ideal way to do this is to

4. Connect the transducer to the HMI.
5. Artificially generate a minimum input parameter (such as a pressure of 0 lbf/in^2).
6. Calibrate the HMI so that it indicates the appropriate minimum value.
7. Repeat the procedure for the maximum transducer value. From these two calibration points the HMI can internally generate a calibration slope that corresponds to the measured parameter.
8. After the calibration, each measurement is internally compensated using the calculated slope before being displayed, stored, or used for control purposes by the HMI.

Note

Many transducers have standard outputs levels and ranges, plus it is often inconvenient to artificially generate external parameters, so the HMI allows transducers to be easily set up without requiring calibration adjustment.

To set up a transducer without calibrating, perform the following steps:

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9. Select the transducer type as 4 to 20 mA or 0 to 10V and enter a high value (Menu 812 Figure A-31 Menus 809 to 812 (p. A-32)) and a low value (Menu 813 Figure A-32 Menus 813 to 852 (p. A-33)).
10. If the transducer is nonstandard or must be calibrated for some reason, select the calibration menu then perform the calibration at low and high points, entering the desired readouts at each input level.

Note

The most accurate readings will be obtained with calibration points that are as far apart as possible from each other (within range at opposite ends of the scale). Each analog input level may be viewed at the bottom of the status screen, if the display is enabled in the analog input menu. The readings are updated approximately once per second.

6.10 Digital Auxiliary Inputs

The operator interface has several digital auxiliary inputs that may be monitored and used for VSD control (Menu 610–Auxiliary Input Selection) Figure A-27 Menus 610 to 615 (p. A-28). These inputs are typically used to monitor external devices such as vibration sensors, tank fluid-level sensors, or ground faults.

Before a digital input may be used, it must be configured on the HMI Terminal Board for the correct signal level. Each digital external device must be configured for one of two types of input; logic-level (+/- 5 V) or Relay Contact.

6.10.1 Logic-Level (DC +/-5 V) Input

The logic-level input method allows the external source to supply a 5-volt logic-level signal. This logic level is then used to drive an opto-isolator on the HMI Terminal Board, which isolates the signal from the external source from the HMI circuitry.

To configure the hardware for logic-level input, perform the following steps:

1. Insert a shorting jumper block between Pin 2 and Pin 3 on the proper jumper pins of the HMI Terminal Board.
2. The externally applied 5-volt signal should be applied with the positive voltage (+) on the input marked *high* and the negative (-) or lower voltage to the terminal input marked *low*.

6.10.2 Relay Contact Input

A second method of configuring a digital input to the HMI does not require the external device to supply any power, but is rather just a standard switch or relay contact, drawing power from the HMI for operation. To configure the HMI for a relay contact input, perform the following steps:

1. Connect one shorting jumper block between Pin 1 and Pin 2 of the proper jumper pins of the HMI Terminal Board.
2. Connect another shorting block between Pin 3 and Pin 4 on the proper jumper pins of the HMI Terminal Board.

Note
Polarity has no effect on the contact input.

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3. Once the hardware has been configured and connected, the digital input device may then be configured for operation from the HMI.

Note

Shutdowns, restarts, and status display all use the term *Active* or *Inactive* to indicate the current state of the device being monitored. *Active* and *Inactive* states may be defined by the user so that *Active* may mean that the external supply is ON or OFF if configured for external logic inputs, or the external contacts may be OPEN or CLOSED. Using this method, the various associated timers and control conditions for each digital auxiliary input do not need to be reprogrammed if the digital input polarity is changed; only the active state must be defined.

6.11 Output Relays

The HMI has four relays that can be configured for several output functions (Output 1, 2, 3, and 4 are configured with Menu 320 Figure A-18 Menus 253 to 320 (p. A-19), 321, 322, and 323, respectively). Each relay has a single-pole common, a normally closed contact, and a normally open contact, which are brought out to a terminal block on the HMI Terminal Board. Each relay may be configured for one of the following operations:

- The relay mimics the state of an external digital input that is being supplied to the operator interface.
- The relay echoes the state of one of the four status-display LEDs on the HMI (*Run*, *Hand*, *Off* and *Auto*) which allows for easy connection of extension status lights on the exterior of the VSD cabinet.
- The relay changes state when the VSD detects a pending shutdown condition. The shutdown could be due to several reasons, such as an undercurrent or a digital input that is programmed to shutdown the VSD; it allows an external indicator or alarm to indicate the pending condition.
- The relay activates when a measured parameter is out of the pre-programmed range. These measured parameters can be
  - overpressure
  - underpressure
  - undercurrent or
  - overcurrent.
- The relay activates at a preset time of day.
- The relay activates for a predetermined period of time.
- The relay can be activated or deactivated by SCADA commands, regardless of VSD state or running condition.

Note

The relay states are internally filtered on the HMI, so that they will not be updated faster than once per second. This filtering is to prevent damage to external devices caused by relay chattering initiated by quickly changing inputs or signals that hover around relay trip points.

6.12 Timers

Most of the warnings and error conditions (faults) that can be detected by the HMI have associated timers. These timers are individually programmed for specific functions and each error or warning condition has its own set of timers that are completely independent from other condition timers. Timers may be classified as

- Ignore-at-Startup
- Activation Delay
- Automatic Restart Delay
- Other Start Delay(s)

For more detailed descriptions of each type of timer, see the following subsections.

6.12.1 Ignore-at-Startup Timer

The main purpose of the Ignore-at-Startup timer is for selected monitored parameters (such as well pressure) that require time to resolve to a normal state after the VSD starts. Once the particular parameter has had time to stabilize, the condition is then monitored for shutdowns; however, until the Ignore-at-Startup timer has expired, the shutdown condition is ignored.

For example, setting an Ignore-at-Startup timer for 60 seconds means that the condition may or may not exist during the first 60 seconds after the drive starts. During the initial 60 second, the HMI will completely ignore it. No errors or warnings related to this condition are displayed on the HMI LCD during this time. After this timer has expired, the HMI will start to monitor for shutdown conditions and responds by taking appropriate action.

6.12.2 Activation Delay Timer

The Activation Delay Timer is used to time a condition that must continuously exist for a specified duration before the HMI will stop the VSD.

For example, the activation delay time for an undercurrent condition may be set to 30 seconds. If the VSD senses an undercurrent condition, the undercurrent must exist continuously for at least 30 seconds before the VSD will stop. The report on the HMI display will read *VSD stopped due to undercurrent*. If the undercurrent condition exists for less than 30 seconds, then goes away, the VSD will not stop. The undercurrent condition may come and go intermittently, but unless it exists for more than 30 seconds continuously, the VSD will keep running. As soon as a condition which can shut down the VSD exists, a warning is displayed on the HMI screen, noting the time remaining before the VSD stops. If the condition disappears, so will the warning. An Activation Delay timer may be set to a minimum time of one (1) second.

6.12.3 Automatic Restart Delay Timer

The Automatic Restart Delay timer is used by the HMI to automatically start the VSD after a particular event, such as power being restored or a digital input closing or clearing a shutdown condition. To allow the VSD to automatically restart, the VSD must first be in *Auto* mode, since the VSD will never start automatically if set to the *Hand* or *Off* mode. Then, three additional parameters must be set for an automatic restart to successfully complete.

- The first parameter enables the automatic start after the relevant condition, and it must be set to *Yes* to allow a start. If set to *No*, the VSD will never automatically restart after the condition clears that caused the shutdown. This *Yes/No* parameter allows automatic starts to be selectively enabled for some conditions and disabled for others. For example, the user may want the system to automatically start after an underpressure shutdown, but remain OFF after an overpressure shutdown.
- The second parameter requires the delay time, called the *Auto Restart Delay* to be set. The *Auto Restart Delay* is the time span (seconds/minutes/hours/days) that the HMI will wait before an automatic restart is attempted. For typical operation, this time may be set from 30 minutes to up to a day or more.
- The last parameter required to successfully initiate an automatic restart is the number of automatic restarts that are allowed before the VSD will stop and remain OFF, changing the control mode of the VSD from *Auto* to *Off*.

  For example, an operator may only want a remote VSD (controlled remotely by SCADA input) to attempt to start twice after an undercurrent condition (detrimental to the drive and motor), but may want the VSD to restart 100 times if the shutdowns were caused by low-pressure readings (a more common occurance in well production, not overly detrimental to the VSD and motor). The maximum number of automatic restarts is set as the *Number of Auto Restarts*.

There is one extra setting that may be used for automatic starts. The underpressure setting may be used to initiate an automatic start, but rather than waiting for the underpressure restart timer to expire, it may be programmed to wait for a measured pressure to reach a user-input value. To set a pressure-triggered automatic start rather than a time-triggered one, set the *underpressure restart type* to *pressure* rather than time, and enter a pressure value that when exceeded, will cause the restart.

Note
An underpressure is the only condition that may be used for signal-amplitude-based auto restarts.

6.12.4 Other Start Delay Timers

Finally, there are two start delays which are similar to the *Automatic Restart Delays* described in the previous subsection. The first is called the *Auto Start* timer and it is invoked when the operator changes the control mode of the VSD from the *Off* or *Hand* mode to the *Auto* mode. The HMI waits for this auto delay time to expire, then automatically attempts to start the VSD. This timer allows the operator to start the VSD within a predetermined amount of time, for example, allowing the operator time to travel and reach a remote location before the VSD starts.

Note
The HMI can also be set to wait for the pressure to reach a predetermined level, if the pressure restart type is set to *pressure* rather than time.

The last timer is called the *Power Fail* timer. This timer allows the VSD to automatically restart at a specified time after power to the system is restored. When several VSDs are operating from a common power source, each power fail restart timer may be set to a different time. Then, when power is restored, the power source is not overloaded from all the drives starting at the same time. The VSD must be in the *Auto* control mode when the power was lost for the power fail timer to operate; however, it does not matter whether the VSD was running when power was removed. Power fail restarts must be enabled for them to operate. To enable this type of timer, set the *Power Fail* restarts to *Yes* (Menus 205 Figure A-13 Menus 200 to 206 (p. A-14) and 206).

6.13 Jump Frequencies

A jump frequency is a frequency range that the VSD is programmed to avoid (Menu 126 Figure A-4 Menus 123 to 128 (p. A- 5) to 131 Figure A-5 Menus 129 to 141 (p. A- 6)). This programmable control parameter prevents VSD operation at a frequency that could cause damage to certain equipment combinations, perhaps due to resonance.

For example, a jump frequency of 67.0 Hz with a bandwidth of 2.0 Hz may be entered. By entering this jump frequency, a jump band from 66.0 Hz to 68.0 Hz is created. If the VSD is slowly changing frequency from 60 to 70 Hz, it will slowly speed up until it reaches 65.9 Hz. There, it will pause, depending on the ramp rate and mode selected. Then, the drive will jump to 66.0 Hz, where it will pause before accelerating up to 70 Hz and will avoid running within the jump frequency bandwidth. The user may enter up to three separate jump frequencies and bandwidths. If the jump bands overlap each other, they will have the effect of a larger, single band. If the jump frequencies are not needed, set them to zero (0), which disables them.

6.14 Proportional/Integral/Derivative (PID) Control

The VSD HMI has built-in software routines for PID speed control (Menu 182 Figure A-12 Menus 180 to 185 (p. A-13) to Menu 185). PID is used for special applications or speed control that includes some kind of feedback signal from an external source. PID control has three parameters which allow the user to set speed control for their particular application: proportional speed control, integral speed control, and derivative speed control. A typical application is using a VSD to control a pump that fills a tank, and automatically adjusts the VSD frequency to maintain a constant volume of fluid in the tank. PID control may only be used while in the *pressure* speed control mode, although any type of input sensor may be used. A target set point must be established before PID control may be used. The target set point must correspond to the external parameter that the VSD attempts to maintain at a constant level. After setting the target point of the external parameter, the VSD also must be programmed to speed up or slow down if the parameter rises or falls.

For example, if the VSD is driving a pump that is filling a tank, the drive must be configured to function in reverse as compared to a VSD that is being used to empty the tank. When the VSD is started in PID mode, it will initially ramp up to the users normal speed control setting. If the VSD is already running when the speed control mode is changed to PID, it will begin PID control at the present speed. Then, PID control will make the following speed adjustments.

1. The VSD will constantly sample the pressure input, and compare this input to the target set point.
2. From the measured pressure input and the pressure set point it will calculate an error signal (the difference between pressure input and pressure set point).
3. If the signal input is equal to the set point there will be no error, and the VSD will continue to run at the present frequency.
4. Since this does not normally shift the speed point enough to reduce the error signal to zero, another user-programmable parameter called integral speed control is used. Refer to the Integral Speed Control subsection. Otherwise, see Proportional Speed Control.

Note
The VSD will internally compensate for unit scale and range differences on the input, calculating the error based on the full-scale range of the input.

6.14.1 Proportional Speed Control

Proportional speed control operates on the following principles. If there is an error signal (it cannot be zero), the VSD will calculate and change the speed depending on the following:

- The amplitude of the error will be multiplied by the user's programmed setting for *proportional*, and this signal will be applied as an offset to the present frequency.
- The result is that the frequency will change from the present setting in proportion to the size of the error signal.
- As the error signal reduces in amplitude, the speed changes proportionally.
- If the error falls to zero, the speed will return to the previous speed (target set point).

6.14.2 Integral Speed Control

Integral speed control (sometimes called resets per minute) essentially calculates and resets the running speed point to the present speed by calculating the integral between the two speed differences and smoothly adjusting the speed with respect to time. Rather than resetting the running speed every minute, the HMI continually resets it by adjusting the speed in repeated, diminishing amounts

for smoother control. The net effect of integral control is to slowly change the speed incrementally over time, to ensure that the user's selected parameter is maintained at a constant level.

6.14.3 Derivative Speed Control

The last parameter is called derivative speed control, and is used to quickly change the VSD frequency to compensate for rapidly changing input signals, such as step changes. For most normal applications, derivative speed control will probably never need to be used.

None of the three PID parameters have units associated with them (they are unitless values). The smallest value that may be programmed for each parameter is zero. Zero has no effect and does not cause any speed control corrections to start.

Tip

When setting up a VSD to use PID control, start with small values (for example, less than 5) for the control settings, as it is easy to create an unstable system if large values are used.

Many transducers that may be externally connected to the VSD will only update outputs periodically, so response to changing conditions may be slow. For a more complete description of setting up PID control routines, please consult one of the many books available on the subject. Complete theory and example applications are beyond the scope of this manual.

6.15 Data Log/History Log/Configuration

The data log, when enabled (Menu 244 Figure A-16 Menus 240 to 245 (p. A-17)), will check data (frequency, current, and voltage) at 10– second read intervals and output data at user-specified write intervals (1 minute minimum interval, refer to Menu 245). Output data consists of the minimum, maximum, and average values of the data since the last write, as well as when (time/date stamp) the data was written. The only way to view data output is to print it (Menu 248 Figure A-17 Menus 246 to 252 (p. A-18)).

The history log keeps track of all system events, including when the user changes parameters, as well as starts, stops, faults, and a time/date stamp of when each occurred. The history log can be viewed (Menu 111 Figure A-3 Menus 110 to

122 (p. A- 4)) as well as printed (Menu 243 Figure A-16 Menus 240 to 245 (p. A-17)). When viewing the history, the UP/DOWN arrow keys are used to scroll UP/DOWN through the recorded events.

The configuration lists all important system settings in a single place for easy reference. The only way to view the configuration is to print it (Menu 240 Figure A-16 Menus 240 to 245 (p. A-17)).

6.16 Printing

Printing is usually performed to save desired information for later review and is done by connecting a serial printer to the front port of the VSD. Then, select the desired information (data log, history log, configuration) for hard copy.

Printing the configuration (Menu 240 Figure A-16 Menus 240 to 245 (p. A-17)) is the easiest since there are no menu items that affect the configuration printout. Before printing the history log (Menu 243), the amount of history to print must be selected. The number of DAYS or EVENTS must be selected (Menu 241) followed by the number of copies (Menu 242) to print. The most recent history events are printed first. For example, if two (2) EVENTS are printed, the most recent history event will be printed first, followed by the next most recent history event.

Before printing the data log (Menu 248 Figure A-17 Menus 246 to 252 (p. A-18)), the amount of data to print must be selected. The number of DAYS or EVENTS must be selected (Menu 246), followed by the number of copies (Menu 247) to print. The most recent data is printed first. For example, if two (2) EVENTS are printed, the most recent data event will be printed first followed by the next most recent data event.

6.17 Stop Mode

The HMI may be programmed to stop the VSD in two different modes: *Controlled* and *Coasting* stop (Menu 212 Figure A-14 Menus 207 to 213 (p. A-15)). When the VSD is set for controlled stop, the VSD output frequency and voltage decelerate towards zero until the motor is stopped (Stopping Ramp Rate is set by Menus 474 Figure A-25 Menus 472 to 500 (p. A-26) and 475). Most applications will typically be set to use the controlled stop method. When the VSD is set for coasting stop, the VSD output frequency and voltage are effectively disconnected from the motor and the motor coasts to a stop. The coast stop method is typically used for motors that develop a lot of inertia (flywheel effect), such as surface

horizontal pumps where the motor is unable to slow down quickly. In abnormal VSD shutdowns such as emergency stops or power failures, the stop method will usually default to coasting, regardless of the programmed setting.

6.18 Internal Temperature

The HMI has a transducer that continuously monitors the internal temperature of the VSD cabinet (Menu 213 Figure A-14 Menus 207 to 213 (p. A-15) and Menu 214 Figure A-15 Menus 214 to 219 (p. A-16)). High and low trip points may be set to prevent the VSD from operating outside a certain range.

Note
The VSD has additional temperature shutdowns to protect the drive in case of abnormal conditions. These additional shutdowns are not user programmable.

6.19 Direct access

Direct access is a method used to adjust preset operating points in the VSD. These operating points are normally not required for standard applications, therefore, direct access to them is not required. For further information, contact Artificial Lift-InTouch for direct access assistance.

6.20 Motor/VSD Current Measurement Calibration

The VSD is equipped with current sensing devices for drive output and these devices are factory-calibrated to measure the current in two output phases (this effectively estimates current in the third phase) and calculate an average value for its three-phase output. This computed average is then used by algorithms for all HMI message displays, data logging, and control purposes.

The HMI may also be programmed to use a scaled value of the motor current (measured after the output transformer) rather than the direct VSD output current (Menu 108 Figure A-2 Menus 105 to 109 (p. A- 3)) described in the previous paragraph. Periodically, the VSD current-sensing device must be calibrated to ensure that it is performing to specification. This is especially important when using a scaled value of the motor current. To calibrate the motor current use the following procedure:

1. Start the VSD and ensure it is running with a suitable load.

2. While it is running at a constant current, use a clamp-on type current meter (ammeter) to measure the current in each of the three outgoing phases from the drive to the motor, after the output transformer.
3. These three current measurements may differ somewhat, especially if flat cable is being used, which can cause some imbalance between the phases.
4. Calculate the average of these three measured currents.
5. At the *Motor Current Calibration menu* (Menu 109 Figure A-2 Menus 105 to 109 (p. A- 3)) enter the average motor current just measured.
6. Select current type as *motor* rather than *actual amps* in Menu 108–Amps Display Type Figure A-2 Menus 105 to 109 (p. A- 3).

All measurements, displays, and control actions now use the scaled motor current rather than the VSD output current. The selection of actual amps or scaled motor current may be changed without losing the *scale factor* values stored in the HMI.

Note
The HMI performs more accurate calculations if the calibration is performed at a reasonable current level such as the normal running current. Calibrations made with very small currents may introduce scaling errors as the current is increased.

6.21 Tracking Underload

The HMI has a *Tracking Underload* feature. Once tracking underload is enabled (Menu 151 Figure A-7 Menus 147 to 151 (p. A- 8)), the HMI keeps a running average of the last few minutes of operation. If the current falls below the preset *percentage of running current* (Menu 152 Figure A-8 Menus 152 to 163 (p. A- 9)), an underload condition is triggered and the corresponding undercurrent activation timer will start to count down. If the undercurrent condition lasts longer than it takes for the undercurrent activation shutdown timer to expire, the drive will stop. If in the drive is in the *Auto* control mode, the drive may automatically restart at a later time, depending on the standard restart timers and counters.

The purpose of the tracking underload shutdown is to protect motors when the normal underload current is required to be set low enough so that slowly changing currents will not cause nuisance undercurrent trips, but relatively fast current drops (such as those caused by gas locks and broken shafts) may occur. If tracking underload is enabled, the undercurrent activation delay should not be set for longer than a few minutes. The delay should only be for a few

minutes because the average tracking underload level will start to fall during this time and the shutdown condition that triggers the *activation delay* may be cancelled or cleared.

The tracking threshold current level (amps) may be monitored in the main status screen. If the VSD speed changes rapidly, the tracking threshold current level used for tracking underload will be automatically reset and will start to build up from zero again. This prevents nuisance tracking underload shutdowns if, for example, the user changes the target speed while the VSD is running.

Note
Setting the tracking underload to a high setting (such as 98%) will result in an almost constant underload ON/OFF condition as the drive current fluctuates above and below the tracking undercurrent level.

6.22 Graph Printing

The HMI can directly print graphs to hard copy using the standard thermal printer. To configure the HMI for printing and to print a graph, perform the following steps:

1. Plug the printer into the HMI front panel connector (9–pin serial port) then use Menus 250 Figure A-17 Menus 246 to 252 (p. A-18) through 253 Figure A-18 Menus 253 to 320 (p. A-19) to access the graph printing functions. Menu 250 is used to select the item (speed, current or pressure) to be printed.

   Note
   Only one item may be printed at a time.

2. Select the number of previous days to print in Menu 251 Figure A-17 Menus 246 to 252 (p. A-18). These are actual calendar days previous to the present date and include any days when the drive was not running. The graph may be printed for up to the last 100 days, but see the note below.

   Note
   Printing data for an excessive number of days can take considerable time. Be careful to identify a reasonable amount of data (days) that you require before you begin printing.

3. Enter the graph scale size in Menu 253 Figure A-18 Menus 253 to 320 (p. A-19). Graph scale is the height (length) of the axes. If graphing speed, a typical graph scale size may be 75 or 100. If graphing pressure, it may be 5000. The graph's lower axis origin is fixed at zero.

4. Once these items have been entered, start printing by using Menu 253.

Unlike printing data or history, the HMI keyboard and display may be used for other functions during graph printing, so even though graph printing is slow, the operator may perform other functions as the HMI prints.

Another selection in Menu 253 allows the operator to stop the HMI from printing a graph while in process.

Note

Most printers have an internal data buffer that may take quite a while to empty once the Stop command has been issued from the HMI. Even after the HMI has stopped sending data to the printer, the printer may still be printing. If this occurs, turn the printer OFF then ON again to empty the printer's internal data buffer.

The graphs display the time and date on the X axis. The parameter (speed, current, or pressure) selected by Menu 250 is displayed on the Y axis. The parameter is printed as a solid vertical line between the minimum and maximum values recorded during each 15 minute interval of the day. Somewhere in the line, you will notice a small gap. This gap is the average value recorded during the 15 minute time interval. If a single dot or line is visible for any 15–minute period, the difference between the minimum, maximum, and average value was too small to be printed on the graph.

6.23 Catch a Spinning Motor

Menu 454 Figure A-22 Menus 347 to 454 (p. A-23) allows the user to enable or disable the *Catch a Spinning Motor* function of the VSD. Once enabled, this function analyzes any voltage present at the output of the VSD before starting to determine if a connected motor is still spinning. If it appears that a connected motor is still spinning, the VSD attempts to match the motor speed with an active drive signal to gain control of the motor, then continue to control the motor in whatever mode is programmed by the operator. If the motor is spinning opposite to the required direction, the VSD will slow down the motor, change direction, and accelerate up to the required speed.

The primary use for the *Catch a Spinning Motor* function is to safely start a motor that is being turned backwards by falling fluid in a pump string that has stopped pumping. If this function is enabled, a check valve may no longer be required in some downhole systems or the HMI-programmed time delay required for back-spinning systems to stop before attempting a restart may not be necessary.

6.24 Base Frequency Voltage Select

Menu 455 Figure A-23 Menus 455 to 459 (p. A-24) allows the user to select different references for the base frequency output voltage settings. Three settings are available: input, auto, and fixed.

Selecting *input* causes the output voltage to fluctuate with any changes on the power input to the VSD, so if the input voltage dropped by 20%, so would the output voltage (if running at the base frequency).

Selecting *auto* causes the VSD to output a fixed base voltage that is determined by the input power voltage to the VSD. The input power voltage is measured when power is first applied to the VSD. The VSD will try to compensate for any changes in the input voltage to maintain a constant base output voltage.

If the base frequency output voltage is set to *fixed*, the operator can manually set a base output voltage using Menu 456 Figure A-23 Menus 455 to 459 (p. A-24), which is independent of both the input voltage and changes to the input voltage.

Note
If the base frequency output voltage is set to *auto* or *input* Menu 456 has no effect.

6.25 Start Hertz

Menu 458–Startup Frequency (Hz) Figure A-23 Menus 455 to 459 (p. A-24) allows the user to set the starting frequency of the VSD. The starting frequency is the initial frequency output by the drive when it starts, and may be used to prevent the drive from starting at frequencies below those specified by the output transformer manufacturer. Once started, the drive immediately ramps up from the *Start Hertz* speed to the minimum speed at the rate set by the user in Menus 470–Starting Accel Rate Figure A-24 Menus 460 to 471 (p. A-25) and Menu 471–Minimum to Target Hz.

If a downhole monitoring tool is included in the string to be controlled by the VSD, set the Startup Frequency to 7 Hz.

6.26 Start-Up Voltage Boost

With this function, the user may enter a value (up to 30%) that will calculate and apply a voltage boost percentage (%) over the normal output voltage during start-up. This boost is only active up to a frequency of 12 Hz. A voltage boost

may help some motors start by supplying additional torque; however, it may it may also cause overcurrent trips while starting if the boost percentage is set too high. Start-Up Voltage Boost is normally not used for most installations.

6.27 Volts-per-Hertz Patterns and Vector Control

Volts per Hertz Patterns and Vector Control allow the user to change the method used by the VSD to generate the volts-per-hertz slope during acceleration and speed changes. The standard mode for this function is *constant torque*; however, also available are other modes such as *vector control*, *auto boost*, and *variable* modes, several of which have energy-saving options. Refer to the Toshiba G3 manual for further details of all the possible settings of these modes.

The VSD must be stopped before any of the selections mentioned previously can be changed. The number of motor poles (Menu 462 Figure A-24 Menus 460 to 471 (p. A-25)), the moment of inertia (Menu 461) and the motor horsepower (Menu 850 Figure A-32 Menus 813 to 852 (p. A-33)) must be entered before the vector control modes will operate correctly. Most standard Schlumberger downhole motors are two-pole, some are surface inertia, and some surface systems, such as horizontal pumps may have a large moment of inertia. The VSD uses this information during vector control computations.

6.28 Acceleration Rate

Menu 470 Figure A-24 Menus 460 to 471 (p. A-25) and Menu 471 can be used to enter the acceleration ramp rate that the VSD will use to accelerate the motor from the starting hertz (Menu 458 Figure A-23 Menus 455 to 459 (p. A-24)) to the minimum drive speed (Menu 122 Figure A-3 Menus 110 to 122 (p. A- 4)). This rate is entered in a similar manner to the other ramp rates, with separate menu entries for the time and frequency change. Once the minimum speed (Menu 122) has been reached, the VSD changes acceleration rates and uses the minimum to target the hertz rate (set by Menu 472 Figure A-25 Menus 472 to 500 (p. A-26) and Menu 473) until one of the control modes (such as *frequency* or *current*) takes control of the speed. These acceleration rates overwrite any settings that may have been previously entered into the VSD using the (Toshiba) handheld keypad.

6.29 Deceleration Rate

Menu 474 Figure A-25 Menus 472 to 500 (p. A-26) and Menu 475 can be used to enter the deceleration ramp rate that the VSD uses when stopping, if the stop mode (Menu 212 Figure A-14 Menus 207 to 213 (p. A-15)) is set to *controlled*.

The deceleration ramp rate is entered in a similar manner to the other ramp rates with separate menu entries for the time and frequency change. This deceleration rate is ignored if the drive is set to stop in *coast-to-stop* mode.

Note
Fast deceleration rates may cause drive overvoltage trips.

6.30 Rocking Starts

The VSD may be able to jog or break free a pump and motor that has become seized downhole by using the *Rocking Start* function. The drive performs a rocking start by rapidly rocking (rotating) the motor backward and forward, and will then try to bring the motor up to full operating speed. Menu 500 Figure A-25 Menus 472 to 500 (p. A-26) enables or disables rocking starts, Menu 501 sets the number of *rocks* (forward/backward jogs) and Menu 502 selects the rocking start method.

There are three methods that change the time (duration) the VSD is ON in each direction and the way the VSD changes directions during these rocking attempts. Each method should be tried until one is successful, since the size and type of equipment affects how well rocking starts work. It is possible that the VSD reports overcurrents during rocking start attempts. Rocking starts are only used as a last resort (when downhole equipment may have seized).

In version 2.06 of the HMI software, rocking starts are a one-shot operation (the setting must be enabled before each start). Several InTouch tickets have been published that support the effectiveness of this one-shot software feature.

Warning

Potential Severity:	Serious
Potential Loss:	Assets
Hazard Category:	machinery equipment hand tools

It is possible to overstress and damage equipment by attempting to start it with a rocking start or with extremely fast acceleration rates.

6.31 Forced Frequencies

The VSD has the capability of *forced frequency* control. Menu 510 Figure A-26 Menus 501 to 512 (p. A-27) enables or disables this function. Forcing the frequency allows the VSD to change to an operator-preset speed when a predefined digital input becomes active, effectively (temporarily) overwriting any

controlled speed mode that is currently in effect. Once the selected digital input becomes inactive, the speed control reverts to the former setting. This function can be useful in special circumstances, for example, to remotely change the drive speed to fill or empty a tank. Menu 511 sets the force frequency and Menu 512 enables the user to select the digital input that will be used for forced speed control. The normal drive protection such as underloads and overloads are not disabled during forced frequency speed control.

6.32 VSD Service Routines

Danger

Potential Severity: Major
Potential Loss: Assets
Hazard Category: electrical

Only properly trained, qualified (successfully completed the Toshiba 4–day Technical Training for VSDs) personnel should attempt to service the variable speed drives. Failure to comply with this recommendation can cause severe damage to equipment and endanger the person working on the drive and surrounding personnel.

Standard Toshiba G3 software routines, such as *Type 3*, *Type 7*, and *Type 255* (with HMI software version 2.06) resets that may be required when servicing a drive can be directly invoked from Menu 999 Figure A-35 Menus 901 to 999 (p. A-36). The Toshiba *SuperUser* mode may also be turned on to operate the VSD without any bus voltage. The drive will drop out of *SuperUser* mode if a trip or fault occurs. The HMI cannot report this fault, since it cannot query the VSD as to the present *SuperUser* state.

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

A trip will be forced if current greater than 50% of the VSD's full load output is detected while in *SuperUser* mode. This mode is strictly for testing and should never be used with bus voltage and a load other than the transformer.

The power to the system (both the VSD and the HMI) must be cycled to exit *SuperUser* mode. The VSD must be in OFF mode before any of the service routines can be selected.

Note

Since these service routines and several drive tuning routines (such as acceleration and deceleration ramp rates) have been added, the need to use Menu 900 through Menu 904 for writing G3 parameters has diminished. Hence, the write capability of Menu 904–Direct Access has been restricted and now requires a factory code to be entered in Menu 905 to enable writes using the 900–series menus. It is expected that the 900 through 905 menus will be removed entirely in future product releases.

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Installation

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7 INSTALLATION

This chapter describes how to install a Speedstar 2000 VSD on location. Installation procedures for optional and combinable equipment for the Speedstar 2000 (site communications, external inputs or output devices such as transducers) are discussed in the Optional and Combinable Equipment chapter of this manual.

Danger

Potential Severity:	Major
Potential Loss:	Assets, Personnel, Reputation
Hazard Category:	electrical, explosives, machinery equipment hand tools

Troubleshooting or servicing a Schlumberger VSD must be performed by qualified personnel. Qualified personnel is defined as those who have attended and successfully completed the Toshiba technical course for industrial drives or Schlumberger equivalent training and have their course reference material on hand. Only then should qualified personnel contact AL InTouch for additional support and troubleshooting/repair instructions.

7.1 Confirmation of Wiring

Make the following final checks before applying power to the unit:

1. Confirm that source power is connected to terminals L1(R), L2(S), and L3(T) for a 6–pulse sine wave drive; L1(R), L2(S), L3(T) and L12(R2), L22(S2), L32(T2) for a 12–pulse sine wave drive. Connection of incoming source power to any other terminals will damage the drive.
2. The 3-phase source power should be within the correct voltage and frequency tolerances.
3. The output leads must be connected to terminals T1(U), T2(V), and T3(W).
4. Make sure there are no short circuits or inadvertent grounds and tighten any loose connector terminal screws.

7.2 HMI Battery

Any time a VSD or an HMI is shipped, the HMI battery should be disconnected. Otherwise, the keyboard encoder may have corrupt data in the battery-backed CMOS.

Warning

Potential Severity: Serious
Potential Loss: Assets, Reputation
Hazard Category: electrical, machinery equipment hand tools

Connecting the battery, without power applied to the HMI, may discharge the battery. A discharged battery can prevent the HMI from powering up.

Check to make sure the HMI battery is disconnected before powering on the drive. If the HMI battery is disconnected, connect the battery on the HMI (only *after* power is applied. If the battery was connected during shipment, perform the following:

1. Disconnect the battery on the HMI.
2. Wait 10–15 minutes (allows capacitors on the CPU card to discharge and clear the CMOS).
3. Power on the VSD and reconnect the battery.
4. Reset the time and date.

Note

The HMI battery location and properly connected configuration is shown in the *HMI p/n 7026495 Interconnect Layout* section of the Wiring chapter in this manual. Align the red dots on the connectors to ensure correct battery connection.

Note

Time and date are the only settings or information lost when the battery is disconnected on the HMI.

7.3 Start-Up Test

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: electrical

Prior to releasing an electrical drive system for regular operation after installation, the system should be given a start-up test by qualified personnel. This start-up test assures correct operation of the equipment for reasons of reliable and safe performance. It is important to schedule time for a startup test, to conduct it, and document it. Perform start-up testing as described in the *Start-Up and Commisssioning* chapter of this manual.
When power is applied for the first time, the drive's parameters are set to default values that may or may not be appropriate for your application. If these settings are not optimal for the application, the desired settings must be programmed before initiating a run. The drive can be operated with no motor connected.

Note

Operation with no motor connected or use with a small trial motor is recommended for initial adjustment or for learning to adjust and operate the drive.

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Startup and Commissioning

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8 STARTUP AND COMMISSIONING

This chapter describes step-by-step procedures for starting up and commissioning new Speedstar 2000 installations. Some steps are included for equipment that is optional and combinable with Speedstar 2000, where practical. If this manual does not include information for the optional equipment attached to your drive application, refer to the appendices of this manual (specifically reference material and third-party information) for additional information.

8.1 Pre-Powerup Checks for Initial Startup of Single Inverter Units (66 to 454 kVA)

The procedures in this section should be performed before applying any power to the drive.

8.1.1 Required Startup Equipment and Tools

Before attempting any startup procedures, ensure that the personnel assigned to the job have the required equipment and tools listed in the VSD Tools Kit (Schlumberger part number 100072064) located in the Schlumberger Global Engineering Management System (GeMS).

The list may also be found and items ordered from OneCAT (WCP Product Catalog).

8.1.2 Pre-Powerup Checks for Initial Startup of Single Inverter Units (66 to 454 kVA)

Perform the following pre-powerup checks:

Danger

Potential Severity: Major
Potential Loss: Personnel, Reputation
Hazard Category: electrical, explosives

Use appropriate lockout/tagout procedures (refer to InTouch ID# 3827719) to ensure that VSD power is OFF before proceeding with the following checks and procedures.
Use a VOM to verify that ALL power is OFF on the VSD, including

- Incoming lines (if unit is a 12–pulse, check two sets of incoming lines) at the bottom of the circuit breaker
- Motor terminals
- The DC bus

1. Verify board numbers, switch settings, and jumper settings are correct for the application and that connections to the proper taps of the CPT(s) are made.
2. Verify all connectors are properly plugged in.
3. Verify that the installation is properly grounded.
4. Verify that the input and output cables for the installation have been properly sized and properly terminated.
5. Verify that the customer interface wiring is properly installed and ready to be connected to the application.
6. Verify that the wiring is properly installed and connected in the motor terminal box.
7. Disconnect the motor leads at the drive output terminals and meg (connect and test with a megohmmeter) the motor and cables.
8. Check the tightness on all cable and bus connections.
9. Check all fuses before power-up. A blown fuse indicates that power has been applied to the drive prior to your arrival.
10. Use a VOM to check the Softstart resistor (refer to the appropriate schematic for resistor value specified on the drawing).
11. Ensure that RTV has been applied to the HMI keypad flexible cable to prevent shorts.
12. Ensure that a Category-5 (CAT5) communication cable has been installed from the HMI to the VSD.
13. Ensure that the HMI contains a lithium battery.

8.2 Main Power Circuit Checks for Initial Startup of Single Inverter Units (66 to 454 kVA)

Perform the following procedures to check all components in the main power circuit for proper function:

Danger

Potential Severity:	Major
Potential Loss:	Assets, Personnel, Reputation
Hazard Category:	electrical, explosives, machinery equipment hand tools

Turn all power OFF before making changes to transformer taps or connecting wires to components.

---

1. Use a VOM to ensure that the DC bus capacitors have been **completely** discharged.

Danger

Potential Severity:	Major
Potential Loss:	Personnel
Hazard Category:	electrical, explosives

DO NOT trust the LED inside the VSD cabinet to indicate discharge state of the DC bus capacitors.

---

2. Use a VOM to test the following main circuit components:

   - DC bus capacitors-Check the charge and discharge rate of the capacitors and ensure that the charge rate is faster than discharge. Use the diode mode of the VOM to charge the capacitors and DC volts to discharge.
   - discharge resistor R2-Manually push in MS2 to take reading (if applicable).

8.2.1 Checking Input Diodes (Diodes in the Circuit)

This section describes how to test the input diodes (rectifiers) with the diodes installed in their operating circuit. If VOM readings do not display as shown, refer to the Speedstar 2000 Test Procedure (testing the diodes isolated from the circuit). Refer to the table below for values that should be read on the VOM with the diodes in circuit. Use the diode tester function of the VOM.

Note

A charging indication on the VOM is caused by the charging action of the DC bus filter capacitors through the forward-biased diode.

Table 8-1: Input diode test reading (diode in circuit)

Meter (+)	Meter (-)	Reading
DC Bus +	Input R	Charging
DC Bus +	Input S	Charging
DC Bus +	Input T	Charging
Input R	DC Bus +	0 .2 to 0 .6 Vdc
Input S	DC Bus +	0 .2 to 0 .6 Vdc
Input T	DC Bus +	0 .2 to 0 .6 Vdc
DC Bus -	Input R	0 .2 to 0 .6 Vdc
DC Bus -	Input S	0 .2 to 0 .6 Vdc
DC Bus -	Input T	0 .2 to 0 .6 Vdc
Input R	DC Bus -	Charging
Input S	DC Bus -	Charging
Input T	DC Bus -	Charging

8.2.2 Checking Single—Transistor IGBTs for Single Inverter Units (66 to 454 kVA)

This section gives step-by-step procedures on how to test a single-transistor type IGBT.

1. Attach the VOM leads as shown in the corresponding schematic and table.

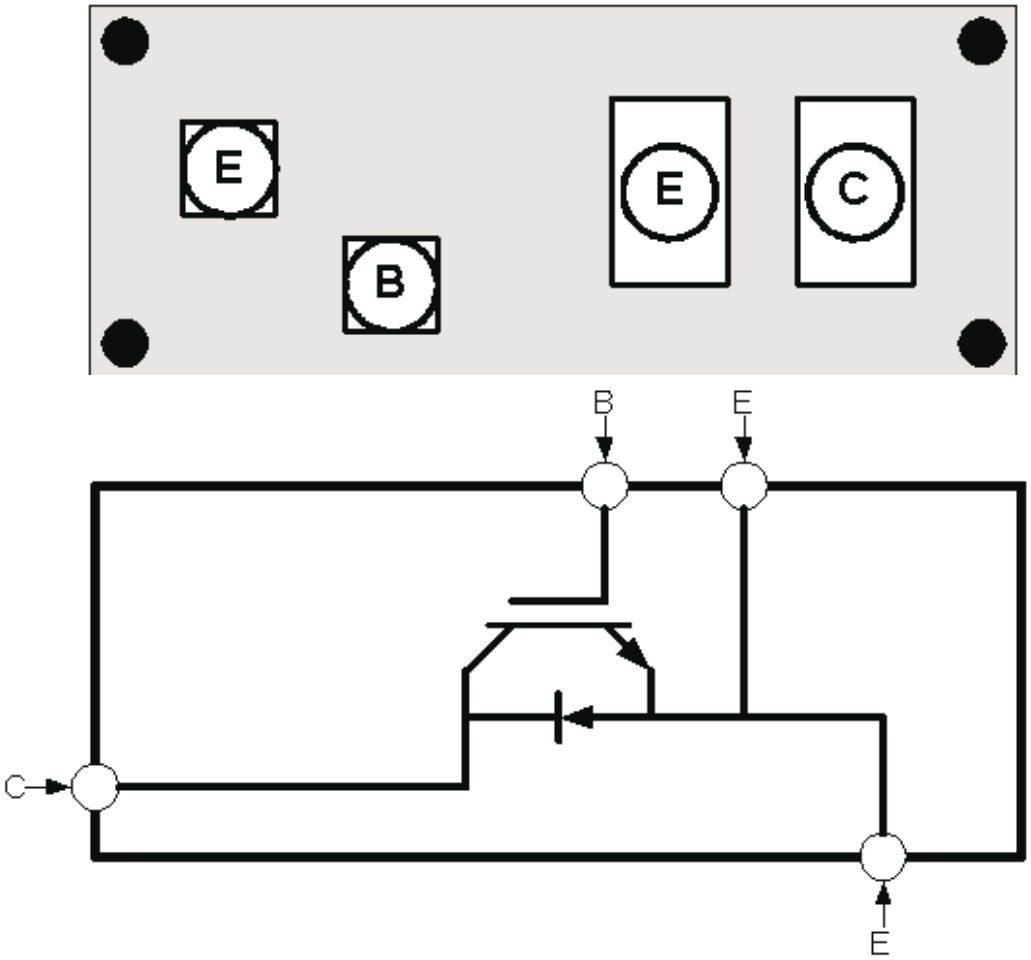

Figure 8-1: Single-Transistor IGBT Block Diagram and Schematic (module MG500Q1US11 shown)

Meter Lead Connection Points		**Meter Display**
NEG	POS	reading
C	E	0.2 to 0.6
E	C	OL (charging)
B	C	OL (charging)
C	B	OL (charging)
B	E	OL (charging)
E	B	OL (charging)

2. Ensure that the VOM readings match or approximate those shown in the Single-Transistor Test Connection Points and Values table.

8.2.3 Main Power Test

Perform the following test to make sure the drive's power supplies are functioning properly.

1. Completely reassemble the drive.
2. Turn main power ON.
3. Refer to the following block diagram of the VSD Terminal Board and table of Control Power Supplies Test Points and Readings. Check and ensure that all power supplies are working properly.

Warning

Potential Severity: Serious
Potential Loss: Assets, Reputation
Hazard Category: electrical, machinery equipment hand tools

DO NOT touch pins on the VSD Terminal Board together. Use a test adapter plug (refer to the Required Startup Equipment and Tools list) to ensure pins and test leads do not contact each other.

Use a VOM to check the power supplies (+5 V, +15 V, —15 V, +24 V).

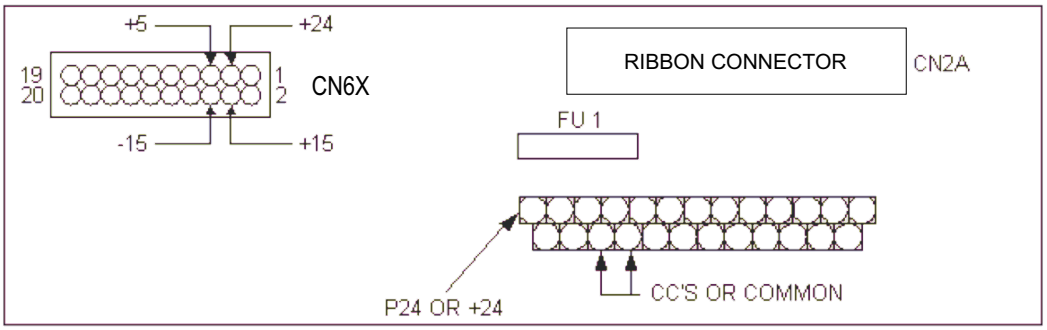

Figure 8-2: VSD Terminal Board (control power test points)

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+15	14.4 to 15.6	CN6X-4	Terminal CC
-15	–14.4 to –15.6	CN6X-6	Terminal CC
+5	4.8 to 5.2	CN6X-5	Terminal CC
+24	21 to 27	TERM P24	Terminal CC
+24	21 to 27	CN6X-3	Terminal CC

8.2.4 HMI Power Supply Checks for Single Inverter Units (66 to 454 kVA)

Perform the following checks while referring to the HMI Power Supply Block Diagram and HMI Power Supply Voltages table. Ensure that the power supplies are providing the proper voltages to ground (COM) within the permissible range as shown in Figure 8-3 HMI Power Supply Block Diagram and the accompanying table.

Note

The HMI Power Supply/Power Fail Board are usually located either in the left panel of the drive enclosure or the top (ceiling) of the enclosure.

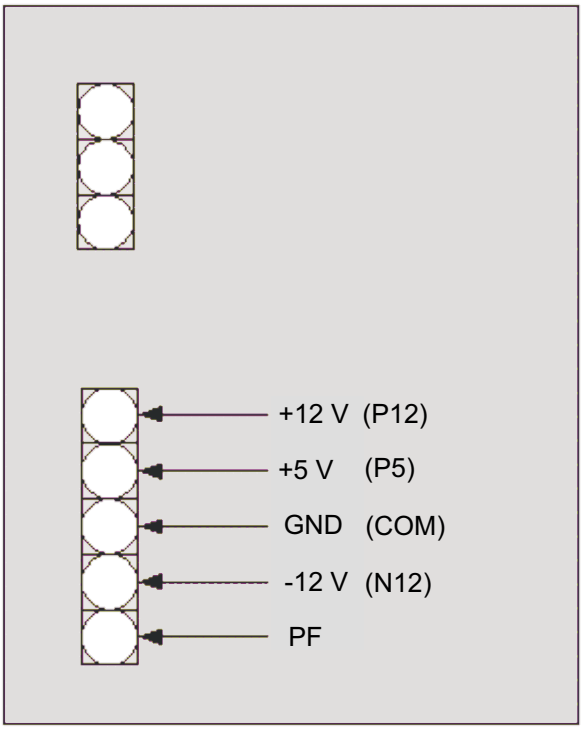

Figure 8-3: HMI Power Supply Block Diagram

Table 8-2: HMI Power Supply Voltages

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+12	approx. +12	P12	COM
+5	approx. +5	P5	COM
-12	approx. —12	N12	COM

8.2.5 Sequence Tests

The following tests are performed to ensure that the drive's timed and monitored sequences occur according to specification.

1. Test all applicable sequences for the VSD you are starting up (MST, MS2, MS1, blown-fuse indicator, door-switch interlock, fan circuit, etc).
2. Program the operating, alarm, and trip parameters into the drive.

8.2.6 Full Output Voltage Test (without motor)

This test checks the VSD for proper operation without a load (motor) attached. Perform the following steps:

1. Run the drive at 10 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
2. Run the drive up to 60 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
3. Turn power OFF.

8.2.7 Full Voltage Output (with motor)

This test checks the VSD for proper operation with a load (motor) attached. Perform the following steps:

1. Ensure all power is OFF. Connect the motor leads to the drive output lugs.

2. Apply power and run the drive at 10 Hz. Monitor load current on the front (HMI) display.
3. Run the drive up to 60 Hz.
4. Use clamp-on ammeters to check for balanced current between U, V, and W outputs to the motor windings. Monitor the drive performance for a reasonable period of time to ensure proper operation.

8.3 Pre-Powerup Checks for Initial Startup of Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following checks before applying any power to the drive.

Danger

Potential Severity:	Major
Potential Loss:	Personnel, Reputation
Hazard Category:	electrical, explosives

Use appropriate lockout/tagout procedures (refer to InTouch ID# 3827719) to ensure that VSD power is OFF before proceeding with the following checks and procedures.
Use a VOM to verify that ALL power is OFF on the VSD, including

- Incoming lines (if unit is a 12–pulse, check two sets of incoming lines) at the bottom of the circuit breaker
- Motor terminals
- The DC bus

---

1. Verify board numbers, switch settings, and jumper settings are correct for the application and that connections to the proper taps of the CPT(s) are made.
2. Verify all connectors are properly plugged in.
3. Verify that the installation is properly grounded.
4. Verify that the input and output cables for the installation have been properly sized and properly terminated.
5. Verify that the customer interface wiring is properly installed and ready to be connected to the application.
6. Verify that the wiring is properly installed and connected in the motor terminal box.
7. Disconnect the motor leads at the drive output terminals and meg (connect and test with a megohmmeter) the motor and cables.

8. Check the tightness on all cable and bus connections.
9. Check all fuses before power-up. A blown fuse indicates that power has been applied to the drive prior to your arrival.
10. Use a VOM to check the Softstart resistor (refer to the appropriate schematic for resistor value specified on the drawing).
11. Ensure that RTV has been applied to the HMI keypad flexible cable to prevent shorts.
12. Ensure that a Category-5 (CAT5) communication cable has been installed from the HMI to the VSD.
13. Ensure that the HMI contains a lithium battery.

8.4 Main Power Circuit Checks for Initial Startup of Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following procedures to check all components in the main power circuit for proper function:

Potential Severity: Major
Potential Loss: Assets, Personnel, Reputation
Hazard Category: electrical, explosives, machinery equipment hand tools

Turn all power OFF before making changes to transformer taps or connecting wires to components.

1. Use a VOM to ensure that the DC bus capacitors have been **completely** discharged.

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical, explosives

DO NOT trust the LED inside the VSD cabinet to indicate discharge state of the DC bus capacitors.

2. Use a VOM to test the following main circuit components:

   - DC bus capacitors-Check the charge and discharge rate of the capacitors and ensure that the charge rate is faster than discharge. Use the diode mode of the VOM to charge the capacitors and DC volts to discharge.

- discharge resistor R2-Manually push in MS2 to take reading (if applicable).

8.4.1 Checking Input Diodes

This section describes how to test the input diodes (rectifiers) with the diodes installed in their operating circuit. If VOM readings do not display as shown, refer to the Speedstar 2000 Test Procedure (testing the diodes isolated from the circuit). Refer to the table below for values that should be read on the VOM with the diodes in circuit. Use the diode tester function of the VOM.

Note
A charging indication on the VOM is caused by the charging action of the DC bus filter capacitors through the forward-biased diode.

Table 8-3: Input diode test reading (diode in circuit)

Meter (+)	Meter (-)	Reading
DC Bus +	Input R	Charging
DC Bus +	Input S	Charging
DC Bus +	Input T	Charging
Input R	DC Bus +	0 .2 to 0 .6 Vdc
Input S	DC Bus +	0 .2 to 0 .6 Vdc
Input T	DC Bus +	0 .2 to 0 .6 Vdc
DC Bus -	Input R	0 .2 to 0 .6 Vdc
DC Bus -	Input S	0 .2 to 0 .6 Vdc
DC Bus -	Input T	0 .2 to 0 .6 Vdc
Input R	DC Bus -	Charging
Input S	DC Bus -	Charging
Input T	DC Bus -	Charging

8.4.2 Checking Single—Transistor IGBTs for Double/Triple Inverter Units (518 to 1200 kVA)

This section gives step-by-step procedures on how to test a single-transistor type IGBT.

1. Attach the VOM leads as shown in the corresponding schematic and table.

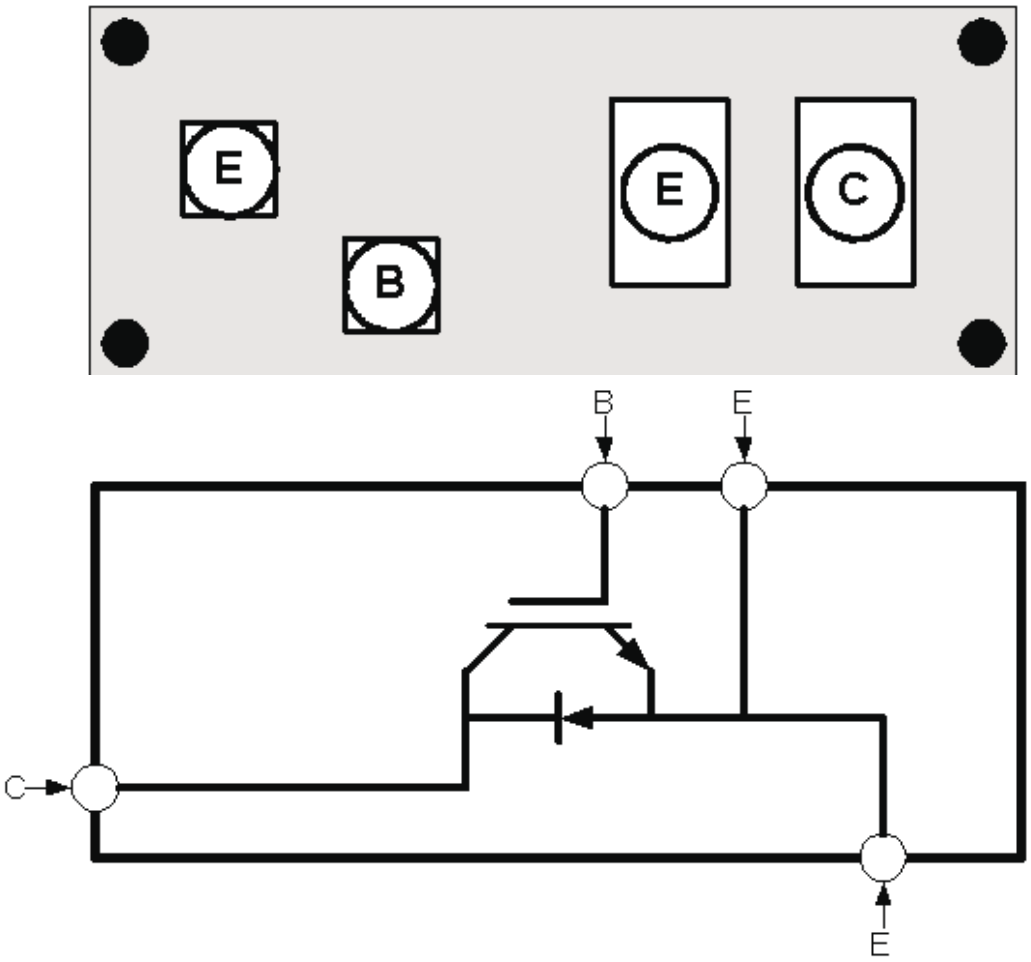

Figure 8-4: Single-Transistor IGBT Block Diagram and Schematic (module MG500Q1US11 shown)

Meter Lead Connection Points		**Meter Display**
NEG	POS	reading
C	E	0.2 to 0.6
E	C	OL (charging)
B	C	OL (charging)
C	B	OL (charging)
B	E	OL (charging)
E	B	OL (charging)

2. Ensure that the VOM readings match or approximate those shown in the Single-Transistor Test Connection Points and Values table.

8.4.3 Main Power Test

Perform the following test to make sure the drive's power supplies are functioning properly.

1. Completely reassemble the drive.
2. Turn main power ON.
3. Refer to the following block diagram of the VSD Terminal Board and table of Control Power Supplies Test Points and Readings. Check and ensure that all power supplies are working properly.

Warning

Potential Severity: Serious
Potential Loss: Assets, Reputation
Hazard Category: electrical, machinery equipment hand tools

DO NOT touch pins on the VSD Terminal Board together. Use a test adapter plug (refer to the Required Startup Equipment and Tools list) to ensure pins and test leads do not contact each other.

Use a VOM to check the power supplies (+5 V, +15 V, —15 V, +24 V).

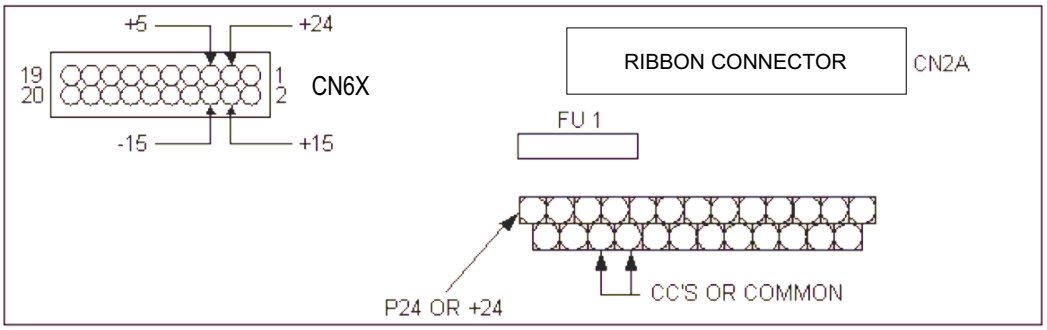

Figure 8-5: VSD Terminal Board (control power test points)

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+15	14.4 to 15.6	CN6X-4	Terminal CC
-15	–14.4 to –15.6	CN6X-6	Terminal CC
+5	4.8 to 5.2	CN6X-5	Terminal CC
+24	21 to 27	TERM P24	Terminal CC
+24	21 to 27	CN6X-3	Terminal CC

4. Also check the voltages in the VSD Interface Board voltage readings table and Interface Board test points diagram that follows.

Table 8-4: VSD Interface Board voltage readings

Positve (+) Meter Lead	Negative Meter Lead (-)	Reading
P24	LG	21 ~ 27 Vdc
P15	LG	14.5 ~15.5 Vdc
N15	LG	-14.5 ~ -15.5 Vdc
P8	LG	6 ~ 10 Vdc
P5	LG	4.8 ~ 5.2 Vdc
P15A	N1A	14.5 ~ 15.5 Vdc
N15A	N1A	-14.5 ~ -15.5 Vdc
P15B	N1	14.5 ~ 15.5 Vdc
N15B	N1	-14.5 ~ -15.5 Vdc

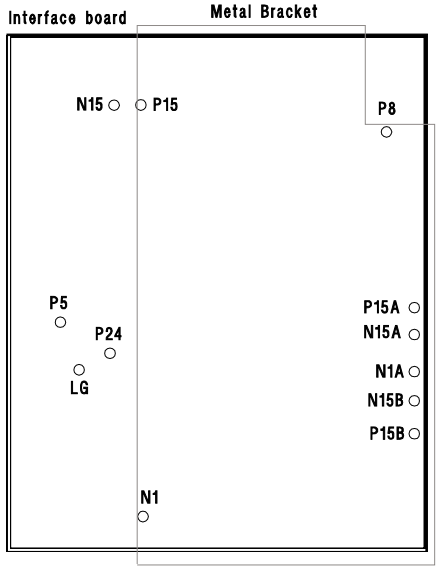

Figure 8-6: Interface Board test points

8.4.4 HMI Power Supply Checks for Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following checks while referring to the HMI Power Supply Block Diagram and HMI Power Supply Voltages table. Ensure that the power supplies are providing the proper voltages to ground (COM) within the permissible range as shown in Figure 8-7 HMI Power Supply Block Diagram and the accompanying table.

Note

The HMI Power Supply/Power Fail Board are usually located either in the left panel of the drive enclosure or the top (ceiling) of the enclosure.

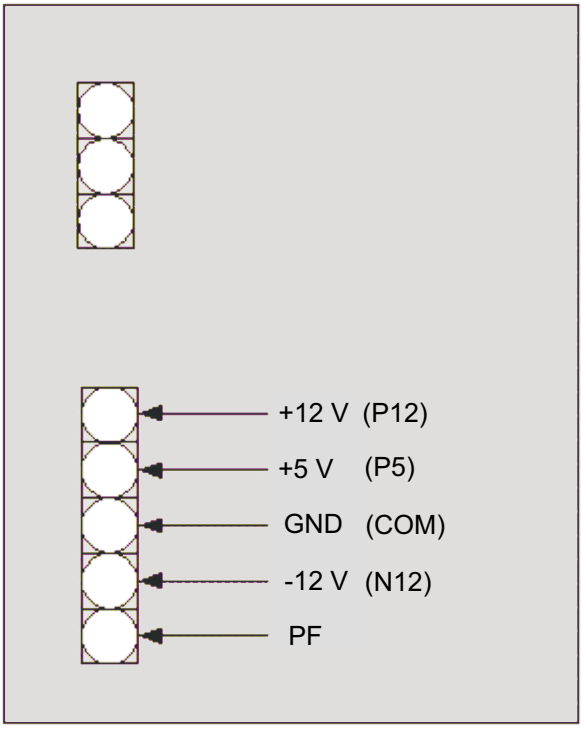

Figure 8-7: HMI Power Supply Block Diagram

Table 8-5: HMI Power Supply Voltages

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+12	approx. +12	P12	COM
+5	approx. +5	P5	COM
-12	approx. —12	N12	COM

8.4.5 Sequence Tests

The following tests are performed to ensure that the drive's timed and monitored sequences occur according to specification.

1. Test all applicable sequences for the VSD you are starting up (MST, MS2, MS1, blown-fuse indicator, door-switch interlock, fan circuit, etc).

2. Program the operating, alarm, and trip parameters into the drive.

8.4.6 Full Output Voltage Test (without motor)

This test checks the VSD for proper operation without a load (motor) attached. Perform the following steps:

1. Run the drive at 10 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
2. Run the drive up to 60 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
3. Turn power OFF.

8.4.7 Full Voltage Output (with motor)

This test checks the VSD for proper operation with a load (motor) attached. Perform the following steps:

1. Ensure all power is OFF. Connect the motor leads to the drive output lugs.
2. Apply power and run the drive at 10 Hz. Monitor load current on the front (HMI) display.
3. Run the drive up to 60 Hz.
4. Use clamp-on ammeters to check for balanced current between U, V, and W outputs to the motor windings. Monitor the drive performance for a reasonable period of time to ensure proper operation.

8.5 Commissioning Procedures

8.5.1 Detailed Commissioning/recommissioning Procedure

To load the default operating parameters for a pumping application (whether ESP, HPS, or PCP) the VSD must be commissioned. Although the overall process is the same in both sections, this section offers a more detailed description of how to commission or recommission a VSD than the previous Quick Operating Procedures.

Commissioning the VSD is accomplished by performing the following:

1. Access the *COMMISSION VSD* (Menu 101) and entering *YES*.
2. You are then prompted to confirm that you want to commission the drive. Entering *YES* at the confirmation screen will enable the commissioning mode.

Note
In some cases, Master Password level maybe required to enter the *recommissioning* (if the drive is being recommissioned after a previous application) mode.

Note
Recommissioning will change all drive settings to default settings. Print or download configuration files. These files will be needed later.

Note
Once the commissioning mode is enabled, the only way to exit is to finish the commissioning and accept the entries. Even cycling power to the unit cannot exit the commissioning mode. If commissioning was in progress when a power loss occurs, when power is restored, the VSD will automatically return to the first commissioning menu.

3. When in commissioning mode, two menus are available. The first menu allows the user to choose the appropriate language (English, Spanish, Russian) and the second menu is to choose the pump application (ESP, PCP, HPS).

4. Choose the pump application for which the VSD will be used.
5. Once the pump application has been entered, the defaults for that application will be loaded and additional commissioning menus for that application are available.

Note

Note that the defaults (loaded at the factory) for the VSD are only meant to provide a safe mode so the drive can be run without a load to ensure that it is functioning properly. Many of the VSD settings must be set for each application.

The commissioning menus function in almost the same manner as the normal operating menus. The menu navigation, help, and data entry functions all operate the same as the normal menus, but menu shortcuts are disabled.

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6. When the desired values have been entered for each commissioning item, selecting *ACCEPT ENTRIES* on the *EXIT SCREEN CHOICE* menu will exit the commissioning menu and automatically display the status screen.
7. The VSD is now commissioned and in normal operating mode.

8.5.2 Output Transformer Startup and Check

Perform the following steps to verify that the output transformer is functioning properly:

1. Set the output transformer for the correct output voltage for your application.
2. Connect the transformer to the VSD.
3. Turn ON the main circuit breaker (MCB1).
4. Start the VSD and check for proper operation of the VSD and transformer.
   a. The output voltages measured at the transformer should be balanced at +/- 2%.

Note
Incorrect voltages may appear if the VSD is in any mode other than *Constant* (Menu 460).

Note
Remember, a voltage filter (p/n 1229053) must be used to register accurate readings from the transformer, if there is no filter connected. Sine wave drives and VSDs with a filter connected do not require the voltage filter.

b. If no voltage filter is used, the voltages will read high and will be non-linear.

5. Stop the VSD after confirming correct output voltages at the output transformer.
6. Turn OFF the main circuit breaker (CB1).

8.5.3 Connecting the VSD to Downhole Equipment

Once the HMI, the VSD, and the output transformer are verified, perform the following steps to connect the drive to downhole equipment, start it up, and check for proper operation.

1. Verify that all downhole equipment has been checked out before and after being run in the hole. Verify motor resistances (phase-to-phase and phase-to-ground) are correct.
2. Connect the VSD output cables to the downhole equipment at the wellhead.
3. Turn ON the main circuit breaker.
4. Start the VSD.
5. Perform a calibration on the amperage monitoring components of the VSD (Menu 109, or refer to Motor/VSD Current Calibration section of the Operator Interface chapter of this manual).
6. Reset the underload, target, and overload current settings of the VSD.
7. If the artificial lift system is equipped with pressure monitoring equipment, the VSD must be calibrated to the pressure transducers providing the output signal.
8. Once all external signals and subsystems have been connected to the drive, run the drive for a reasonable period of time to confirm proper operation and that no faults or shut downs occur.

9. Download configuration/history/data for future reference.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: electrical, machinery equipment hand tools

Depending upon the type of external devices connected to the VSD and their function, it may be best to test drive shutdowns and other conditions with only the transformer connected to minimize wear and tear on the downhole equipment.

Optional and Combinable Equipment

Intentionally Blank

9 OPTIONAL AND COMBINABLE EQUIPMENT

This chapter discusses basic connection as well as how to start up and troubleshoot equipment that is external to the VSD or SWD. Data acquisition and remote access equipment, such as SCADA systems, are optional for VSDs and must be specified and ordered for the individual application. Every attempt to include complete information about available (Schlumberger-recommended) options for the VSD has been made. However, very detailed theory and complex troubleshooting techniques for optional equipment are beyond the scope of this manual. Where applicable, a reference or link to additional reference material for optional equipment is included in this manual.

9.1 SCADA Equipment

If the VSD you are installing or servicing is configured for remote data acquistion or control, SCADA (supervisory control and data acquisition) equipment is connected to the drive. This section describes how the equipment is physically and logically connected to the VSD.

9.1.1 Physical connection

The VSD HMI has been equipped with an input/output port for the purposes of Supervisory Control and Data Acquisition (SCADA) functions. The port connectors are located in the top right hand corner of the HMI Interface board, as you face the back of the unit (COM 1). Two connectors are provided to facilitate two interface options. The signals on both connectors conform to the RS485 standard. Both connectors are wired to the same driver circuit. Independent use of both connectors is not possible.

The upper communications connector (TB2) is a three-position screw terminal block designed for direct connection to shielded, twisted-pair copper wire. This type of cabling is commonly used for multi-drop communications. The RS485 standard recommends a linear bus topology, which is best implemented by daisy-chaining cable to each connected device. Each loop of cable should have the outer insulation removed over a 4 to 6 in length of the cable.

The shielding and conductor should be severed to produce a complete electrical break in the shielding.

Note

Only ground the shield at one end.

Following this grounding procedure from the beginning to the end of the cable will eliminate the possibility of ground currents flowing between devices.

Warning

Potential Severity: Serious
Potential Loss: Assets
Hazard Category: electrical

High potentials exist within variable speed drives and sine wave drives and other equipment of its type. Unexpected ground currents can be high enough to damage connected devices.

Note

Some cable connections may require termination resistor(s), depending upon your application. Be sure to consult current RS485 and Modbus literature to confirm proper installation and use of termination resistors.

9.1.1.1 Preparing Cable for Connection to TB2 (3–Terminal Block)

Once the outer insulation and shielding has been removed and/or prepared, the data transmission pair should be separated from one another and their polarity determined. The individual conductors of the data transmission pair are known as positive (+) and negative (-). All devices on the same wire must have their positive connector connected to the positive conductor. The same is true for the negative conductor and negative connector. To prepare the data transmission conductors for connection to the three-terminal screw block, perform the following steps:

1. Remove the insulation from the middle of the exposed conductor. It is recommended that the conductor remain intact to preserve the integrity of the data transmission bus. Remove approximately 3/4 of an inch of insulation.
2. Bend (or fold) the conductor 180 deg, with the bend occurring at the midpoint of the exposed conductor.
3. Align the insulated portions of the conductor to maximize the available exposed conductor.
4. Twist the folded conductor to form a single conductor and connect to the proper terminal (+ or -) of the three terminal screw block.

9.1.1.2 Temporary SCADA Connection

For installations that require temporary connection, or are point-to-point in nature, a DB-9F connector can be used to mate with the DB9-M connector provided. Additional handshaking signals are available on the DB-9M connector. These signals include CTS/RTS and DSR/DTR. At the present time, the Modbus Driver software does not support or require the use of these signals. Should your application require the use of one or more of these handshake signaling lines, please contact Artificial Lift InTouch. The port can be configured for RS485 4–wire or RS232. Please contact InTouch for instructions detailed instructions.

9.1.2 Logical Connection

The VSD and SWD HMI SCADA port (COM 1) conforms to the Modbus-RTU Protocol Standard, as defined by the *Modicon Modbus Protocol Reference Guide*, publication PI-MBUS-300 Rev. C (January 1991) published by Modicon Inc. This information may also be located at the following web site:http://www.modicon.com/techpubs/TechPubNew/PI_MBUS_300.pdf.

The information contained in the *Modbus Protocol Reference Guide* is sufficient in detail for the task of implementing the software drivers that send and receive Modbus Packets. Many off-the-shelf products exist to provide a software interface to be able to communicate with the VSD at the packet level of Modbus-RTU. These software packages run on a standard IBM-compatible computer under a variety of operating systems.

The remainder of this document describes the features of the protocol that have been implemented for Schlumberger VSDs and SWDs, and the semantics of what is sent to and from the drive by way of the Data Highway provided by the physical and logical layers of the Modbus-RTU protocol.

9.1.3 Modbus Protocol Features

The Modbus protocol (rules) requires that each device on a physical network be assigned a unique address. This unique address is assigned using Menu 341. The Modbus Device Address of the variable speed drive or sine wave drive can be changed to any valid value using the HMI keypad on the front of the drive. Once configured, the drive will respond to that address until

- the address is changed
- SCADA access is suspended by a user at the keypad interface, or

- SCADA communications are disabled from the SCADA communication port.

9.1.3.1 Exception Response

The VSD or SWD HMI Modbus Protocol implementation provides full exception response support. In the event that the drive receives a request containing an invalid command or an invalid register address, an exception response is generated by the drive and returned to the requesting Modbus Master. In the event that a valid command is received, containing a valid register address but contains an invalid or out-of-range value, no exception response is generated. The control software in the VSD performs data validation on any requested parameter change, whether from the front-panel keypad or from the SCADA interface. In the event that a requested parameter change is invalid, it is rejected and the original value is retained. On a subsequent request to read the same register that the invalid value was previously sent, the original, unchanged value is reported.

Since the drive automatically rejects attempts to change register values outside of its default or user-programmed acceptance limits, it is not necessary to range-limit or restrict data values that are requested or manipulated through the use of various Graphic User Interface (GUI) builders such as Wonderware's InTouch™ product. This user-programmed method of setting an individual drive's acceptance limits speeds the software development of the master side of a SCADA system, since customization of individual slave devices is not needed.

9.1.3.2 Request Packet Processing

Modbus request packet processing begins upon receipt of a properly framed data packet that is addressed either to the individual SCADA device (such as a VSD) via its Modbus Device Address, or a packet that is addressed to Device Zero (0x00). Packets that are addressed to Device Zero are broadcast packets, which are processed by all devices on the physical network. Responses to broadcast packets are not returned to the master via the physical network. Commands received by a specified device always return a response to the master.

If an exception response is generated from a packet arriving at an individual drive's SCADA port, the response is generated by an exception condition, and processing of the received request packet is terminated. For this reason *Invalid Value* responses are not generated by the drive, since one bad value in the middle of a multiple-register write command would result in a partial update being performed. Instead, all writes are attempted, and the HMI control software handles the job of data validation.

9.1.4 Broadcast Acceptance Control

The drive's HMI allows operator control of Modbus broadcast acceptance using the HMI keypad. The receiving of modbus broadcast messages can only be *enabled* through the drive's HMI keypad. (Broadcast acceptance control may become available through SCADA in a future version.) There are three modes of operation of broadcast acceptance: enabled, date/time, and disabled.

9.1.4.1 Enabled

In the *enabled* mode, the VSD will accept and process *all* commands that are transmitted as a broadcast. In the case that the same parameter on multiple drives must be simultaneously changed to the same value (i.e., Master Shutdown Command or Date/Time Settings) then a packet containing the proper address and data value(s) should be sent with the device address set to zero (0x00). There will be no response by individual VSDs to a broadcast.

9.1.4.2 Date/Time

In the *date/time* mode, only the ACA compatible Date/Time set command will be accepted if it is sent as a broadcast write command. All other broadcast commands will be rejected and not processed. For the drive to process an ACA compatible Date/Time set command, it must be a broadcast. If an ACA compatible Date/Time set, or check command is sent to a specific drive, it will be rejected as an invalid register address. This rule holds true at all times.

9.1.4.3 Disabled

The *disabled* mode is provided for mixed networks (where VSDs are not the only kind of device on the same network). In this situation, a broadcast intended for a device other than a VSD can possibly corrupt information, or change the operating state of the drive. To protect against this undesirable effect, the ability to ignore commands sent as broadcasts is provided.

9.1.5 Modbus Register Addressing

The Modbus protocol was designed to accommodate various Processes Controllers, specifically Modicon developed devices. Within the Modicon memory model, there are four distinct address spaces:

(0xxxx) Coils	(1xxxx) Inputs
(3xxxx) Input Registers	(4xxxx) Holding Registers

Four command groups are associated with the four address spaces.

Example

Within the context of this manual, the sequences of the letter x can be three (xxx) or four (xxxx) digits long, and is noted as (xxx(x)). This notation allows for the ambiguous notation of 40001 and 4001 resulting in the same holding register, which is the first holding register and is at address 0x0000.

Commands 01, 05 and 15 refer to coils, and map as follows:

0x0000 -> 00001, 0x0001 -> 00002, ... , 0x270E -> 09999

Command 02 refers to inputs, and maps as follows:

0x0000 -> 10001, 0x0001 -> 10002, ... , 0x270E -> 19999

Command 04 refers to input registers, and maps as follows:

0x0000 -> 30001, 0x0001 -> 30002, ... , 0x270E -> 39999

Commands 03, 06 and 16 refer to holding registers, and map as follows:

0x0000 -> 40001, 0x0001 -> 40002, ... , 0x270E -> 49999

With this arrangement, the command implies the Most Significant Nibble of a 19– or 20–bit address, and the remaining sixteen bits are specified in the command's data field. This bit arrangement allows a total of 262,140 addresses to be specified in the Modbus address space versus the 39,996 addresses possible with their *paged decimal* notation.

The side effect of this arrangement is that the address 0x0010 is ambiguous since it specifies any of: coil #17, input #17, and input register #17 or holding register #17.

Address ambiguity does not exist in the VSD's and SWD's memory because of designers limiting the addressed address space to 65,536 possible values and assigning unique address ranges to groups of functions, such that the intersection of each set of addresses with the others is the null set.

addresses 101..114 (0x065..0x072) correspond to Modicon aliases 00102..00115

addresses 121..139 (0x079..0x08B) correspond to Modicon aliases 10122..10140

addresses 201..225 (0x0C9..0x0E1) correspond to Modicon aliases 30202..30226

addresses 251..289 (0x0FB..0x121) correspond to Modicon aliases 40252..40290

This address-limitation scheme seems to allow for any of the *read* commands to be used to access the data contained in the sine wave drive addresses; however, there is specific type information associated with each address range. Therefore, any Modbus implementation must restrict the allowed address range for a given function.

If properly constructed, it is possible to allow the addresses in the coil segment of memory to overlap into the input segment, since they are distinct commands. That is, if coil addresses need space beyond address 00121, this does not pose a problem from the protocol standpoint.

It does, however, pose a significant issue with regard to internal address or data item assignment. Logic must be employed to either resolve the supplied addresses into the Modicon aliases, thus regenerating the leading 0, 1, 3, or 4, or defining distinct translation tables.

The latter case from above has been implemented in the Modbus protocol handler constructed for the VSD and SWD HMI. In version 1.00 and beyond of the HMI software, each command implies a unique address space. Although the current version of Modbus register mapping contains no duplicate addresses, future versions of the VSD and SWD HMI software may contain duplicate address values for separate commands. It is strongly suggested that applications, which can utilize five-character aliases, be configured to do so.

9.1.6 Modbus Address Map

The following table lists the memory addresses on the HMI that are used for SCADA Modbus communications.

Table 9-1: Modbus Addresses in HMI Memory.

Note

The following terms are used in the Modbus Address table:
1. mom indicates a momentary contact.
2. Items with a minimum value of 99 are unused in this implementation. This value will be returned if the item is queried.
3. Auxiliary analog and digital input queries listed may not correspond to available hardware connected to the drive. Digital output sets/queries listed may not correspond to available hardware connected to the drive.
4. Addresses for which the write command and broadcast write command are listed as n/a indicate a read-only value.
5. Addresses for which the read command and write command are listed as n/a indicate a broadcast-update-only variable.

** Denotes commands/addresses only available with HMI software version 2.06.*

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
00102	101	0065	bit value	1	5	15	0	1	Aux Digital 1 Trip Level (1 open, 0 closed)
00103	102	0066	bit value	1	5	15	0	1	Aux Digital 2 Trip Level (1 open, 0 closed)
00104	103	0067	bit value	1	5	15	0	1	Aux Digital 3 Trip Level (1 open, 0 closed)
00105	104	0068	bit value	1	5	15	0	1	Aux Digital 4 Trip Level (1 open, 0 closed)
00106	105	0069	bit value	1	5	15	0	1	Aux Digital 5 Trip Level (1 open, 0 closed)
00107	106	006A	bit value	1	5	15	0	1	Aux Digital 6 Trip Level (1 open, 0 closed)
00108	107	006B	bit value	1	5	15	0	1	Aux Digital 7 Trip Level (1 open, 0 closed)
00109	108	006C	bit value	1	5	15	0	1	Aux Digital 8 Trip Level (1 open, 0 closed)
00110	109	006D	bit value	1	5	15	0	1	(mom) Start Drive (0 no action, 1 start)
00111	110	006E	bit value	1	5	15	0	1	(mom) Stop Drive (0 no action, 1 stop)

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
00112	111	006F	bit value	1	5	15	0	1	(mom) Put Drive in Automode (0 no action, 1 automode)
00113	112	0070	bit value	1	5	15	0	1	(mom) Put Drive in Handmode (0 no action, 1 handmode)
00114	113	0071	bit value	1	5	15	0	1	Spare — No Action
00115	114	0072	bit value	1	5	15	0	1	(mom) Disable SCADA Communications
00116	115	0073	bit value	1	5	15	0	1	(mom) Relay 1 Control/Status (1 closed, 0 open)
00117	116	0074	bit value	1	5	15	0	1	(mom) Relay 2 Control/Status (1 closed, 0 open)
00118	117	0075	bit value	1	5	15	0	1	(mom) Relay 3 Control/Status (1 closed, 0 open)
00119	118	0076	bit value	1	5	15	0	1	(mom) Relay 4 Control/Status (1 closed, 0 open)
10122	121	0079	bit value	2	n/a	n/a	0	1	Auxiliary Input 1 (0 open, 1 closed)
10123	122	007A	bit value	2	n/a	n/a	0	1	Auxiliary Input 2 (0 open, 1 closed)
10124	123	007B	bit value	2	n/a	n/a	0	1	Auxiliary Input 3 (0 open, 1 closed)
10125	124	007C	bit value	2	n/a	n/a	0	1	Auxiliary Input 4 (0 open, 1 closed)
10126	125	007D	bit value	2	n/a	n/a	0	1	Auxiliary Input 5 (0 open, 1 closed)
10127	126	007E	bit value	2	n/a	n/a	0	1	Auxiliary Input 6 (0 open, 1 closed)
10128	127	007F	bit value	2	n/a	n/a	0	1	Auxiliary Input 7 (0 open, 1 closed)
10129	128	0080	bit value	2	n/a	n/a	0	1	Auxiliary Input 8 (0 open, 1 closed)
10130	129	0081	bit value	2	n/a	n/a	0	1	Auxiliary Input 9 (0 open, 1 closed)

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
10131	130	0082	bit value	2	n/a	n/a	0	1	Auxiliary Input 10 (0 open, 1 closed)
10132	131	0083	bit value	2	n/a	n/a	0	1	Auxiliary Input 11 (0 open, 1 closed)
10133	132	0084	bit value	2	n/a	n/a	0	1	Auxiliary Input 12 (0 open, 1 closed) (spare)
10134	133	0085	bit value	2	n/a	n/a	0	1	Auxiliary Input 13 (0 open, 1 closed) (spare)
10135	134	0086	bit value	2	n/a	n/a	0	1	Auxiliary Input 14 (0 open, 1 closed) (spare)
10136	135	0087	bit value	2	n/a	n/a	0	1	Auxiliary Input 15 (0 open, 1 closed) (spare)
10137	136	0088	bit value	2	n/a	n/a	0	1	Auxiliary Input 16 (0 open, 1 closed) (spare)
10138	137	0089	bit value	2	n/a	n/a	0	1	Auxiliary Input 17 (0 open, 1 closed) (spare)
10139	138	008A	bit value	2	n/a	n/a	0	1	Auxiliary Input 18 (0 open, 1 closed) (spare)
10140	139	008B	bit value	2	n/a	n/a	0	1	Auxiliary Input 19 (0 open, 1 closed) (spare)
*10141	140	008C	bit value	2	n/a	n/a	0	1	Amps Displayed and Used Menu # 108 0 = VSD Amps; 1 = Motor Amps
30202	201	00C9	Amps	4	n/a	n/a	0	3000	Drive Current 3–Phase Average RMS
30203	202	00CA	Hz/10	4	n/a	n/a	0	2000	Drive Frequency
30204	203	00CB		4	n/a	n/a	99		Spare
30205	204	00CC		4	n/a	n/a	99		Spare
30206	205	00CD		4	n/a	n/a	0	65535	4–20ma or 0–10 volts ANA-IN-5 (scaled) (spare)
30207	206	00CE		4	n/a	n/a	0	65535	4–20ma or 0–10 volts ANA-IN-4 (scaled) (spare)

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
30208	207	00CF		4	n/a	n/a	0	65535	4–20ma or 0–10 volts ANA-IN-3 (scaled) (spare)
30209	208	00D0		4	n/a	n/a	0	65535	4–20ma or 0–10 volts ANA-IN-2 (scaled) (spare)
30210	209	00D1		4	n/a	n/a	0	65535	4–20ma or 0–10 volts ANA-IN-1 (scaled) (pres./temp/other)
30211	210	00D2		4	n/a	n/a	99		Spare
30212	211	00D3		4	n/a	n/a	0	65535	Reason Stopped [*m*]
30213	212	00D4		4	n/a	n/a	0	65535	Reason Cannot Start [*m*]
30214	213	00D5		4	n/a	n/a	0	65535	Drive Mode [*m*]‘
30216	215	00D7	Amps *10	4	n/a	n/a	0	65535	Drive Capacity in Amps
30217	216	00D8	hours	4	n/a	n/a	0	65535	Drive Run Hours
30218	217	00D9	minutes	4	n/a	n/a	0	59	Drive Run Minutes
30219	218	00DA	hours	4	n/a	n/a	0	65535	Power on Hours
30220	219	00DB	minutes	4	n/a	n/a	0	59	Power on Minutes
30221	220	00DC		4	n/a	n/a	0	65535	Starts on Drive
*30222	221	00DD		4	n/a	n/a	99		VSD Output Voltage
*30223	222	00DE		4	n/a	n/a	99		VSD Output Power
*30224	223	00DF		4	n/a	n/a	99		HMI Temperature
30225	224	00E0		4	n/a	n/a	99		Spare
30226	225	00E1		4	n/a	n/a	99		Spare
40252	251	00FB	Hz	3	6	16	0	400	Drive Base Speed
40253	252	00FC	Hz/10	3	6	16	0	900	Target Frequency Set Point
40254	253	00FD	Hz	3	6	16	0	90	Maximum Frequency Set Point
40255	254	00FE	Hz	3	6	16	0	89	Minimum Frequency Set Point
40256	255	00FF	Amps	3	6	16	0	999	Target Current Set Point

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
40257	256	0100	Amps	3	6	16	0	999	Maximum Current Set Point
40258	257	0101	Amps	3	6	16	0	999	Minimum Current Set Point
40259	258	0102	psia	3	6	16	0	5000	Target Pressure Set Point
40260	259	0103	psia	3	6	16	0	5000	Maximum Pressure Set Point
40261	260	0104	psia	3	6	16	0	5000	Minimum Pressure Set Point
40262	261	0105	sec	3	6	16	99		Spare
40263	262	0106	1 10Hz amp	3	6	16	99		Spare
40264	263	0107	sec	3	6	16	99		Spare
40265	264	0108	sec	3	6	16	99		Spare
40266	265	0109		3	6	16	0	1	Ramp Direction (0 raise, 1 lower)
40267	266	010A		3	6	16	1	3	Pump Control (1 pressure, 2 current, 3 frequency)
40268	267	010B		3	6	16	99		Spare
40269	268	010C	Hz psia 10	3	6	16	99		Spare
40270	269	010D	sec	3	6	16	0	9999	Soft Start Time Delay
40271	270	010E	Hz/10	3	6	16	0	10	Soft Start Frequency Increment
*40272	271	010F		3	6	16	99		Broadcast acceptance
*40273	272	0110		3	6	16	99		Under Current Ignore Delay
*40274	273	0111		3	6	16	99		Under Current Activation Delay
*40275	274	0112		3	6	16	99		Under Current Restart Delay
*40276	275	0113		3	6	16	99		OverCurrent Activation Delay
40277	276	0114		3	6	16	99		Spare
40278	277	0115		3	6	16	99		Spare
40279	278	0116		3	6	16	99		Spare

Alias	Addr.	Addr. In Hex	Units	Read	Write	Broadcast Write	Min	Max	Description
40280	279	0117	c0,c1	3	6	16	0	65535	Well ID Characters (null terminated)
40281	280	0118	c2,c3	3	6	16	0	65535	Well ID Characters (null terminated)
40282	281	0119	c4,c5	3	6	16	0	65535	Well ID Characters (null terminated)
40283	282	011A	c6,c7	3	6	16	0	65535	Well ID Characters (null terminated)
40284	283	011B	c8,c9	3	6	16	0	65535	Well ID Characters (null terminated)
40285	284	011C	c10,c11	3	6	16	0	65535	Well ID Characters (null terminated)
40286	285	011D	c12,c13	3	6	16	0	65535	Well ID Characters (null terminated)
40287	286	011E	c14,c15	3	6	16	0	65535	Well ID Characters (null terminated)
40288	287	011F	c16,c17	3	6	16	0	65535	Well ID Characters (null terminated)
40289	288	0120	c18,c19	3	6	16	0	65535	Well ID Characters (null terminated)
40290	289	0121	0x00 0x00	3	6	16	0	65535	Well ID Characters (null terminated)
40538	538	021A	sec	n/a	na/	16	0	65535	Low-Order portion of above (addr. 537)(see text)
42001	2000	07D0	year	3	6	16	1980	2235	Read/Set current Year of internal calendar
42002	2001	07D1	month	3	6	16	1	12	Read/Set current Month of Year
42003	2002	07D2	day	3	6	16	1	31	Read/Set current Day of Month
42004	2003	07D3	hour	3	6	16	0	23	Read/Set current Time of Day (24hour check)
42005	2004	07D4	minute	3	6	16	0	59	Read/Set current Time of Day (minutes)
42006	2005	07D5	second	3	6	16	0	59	Read/Set current Time of Day (seconds)

Tip

- Physical media for communication to the VSD (from the SCADA transmitter/receiver equipment) is two-wire cable, as specified by the RS485 standard. Electrical line coding standards are specified by the RS485 standard. Also refer to the Physical Connection section in this chapter for addition information about properly terminating and connecting SCADA communication cable.
- Data rates for the SCADA function of the VSD are user selectable (Menu 342) and can be 300, 1200, 2400, 4800, 9600 and 19,200 bits per second (baud).
- Transport protocol is Modbus RTU, as defined by the Modicon *Modbus Protocol Reference Guide* PI-MBUS-300 Rev. C (Jan 1991).

9.1.7 SCADA Messages

Table 9-2 SCADA Messages shows explanations of the SCADA messages available from addresses 211, 212 and 213. These messages are returned to the Modbus Master when a drive fault/shutdown occurs.

Table 9-2: SCADA Messages

Message Number	Description
4802	Manual start
4803	Automatic start
4804	Overcurrent
4805	Undercurrent
4806	Manual stop
4807	Pressure too high
4808	Pressure too low
4809	VSD HMI too hot
4810	VSD HMI too cold
4811	INP1 active
4812	INP2 active
4813	INP3 active
4814	INP4 active
4815	INP5 active
4816	INP6 active
4817	INP7 active
4818	INP8 active
4819	INP9 active

Message Number	Description
4820	INP10 active
4821	INP11 active
4822	INP12 active
4823	INP13 active
4824	INP14 active
4825	INP15 active
4826	INP16 active
4827	INP17 active
4828	Power failed
4829	ANA 1 out of range
4830	Not Used
4831	ANA 2 out of range
4832	Not Used
4833	ANA 3 out of range
4834	Not Used
4835	ANA 4 out of range
4836	Not Used
4837	ANA 5 out of range
4838	Not Used
4839	ANA 6 out of range
4840	Not Used
4841	ANA 7 out of range
4842	Not Used
4843	ANA8 out of range
4844	Not Used
4845	VSD tripped
4846	Unknown reason
4847	VSD Communication Error — No Packets
4848	VSD Communication Short Packet Came
4849	VSD Communication Bank Packet Error
4850	VSD Communication Address Packet Error
4851	VSD Communication Mask Packet Error
4852	VSD Communication Data Packet Error
4853	Drive tripped; waiting to read error code from drive
4854	Drive tripped; reason in VSD_TRIP_CODE
4855	VSD Trip

Message Number	Description
4856	Overcurrent during acceleration
4857	Overcurrent during deceleration
4858	Overcurrent during constant speed run
4859	Load End Overcurrent
4860	U Phase Armature Short Circuit
4861	V Phase Armature Short Circuit
4862	W Phase Armature Short Circuit
4863	Lost Input Phase
4864	Lost Output Phase
4865	Overvoltage during Accel.
4866	Overvoltage during Decel.
4867	Overvoltage during Constant speed.
4868	Inverter Overload
4869	Motor Overload
4870	Dynamic Braking resistor overload
4871	Inverter Overheat
4872	Emergency Off
4873	EEProm Failure during write
4874	EEProm Failure during read
4875	Unused
4876	RAM Error
4877	ROM Error
4878	CPU Error
4879	RS232 Timeout
4880	Gate Array Error
4881	Output Current Detection Circuit Fail
4882	Option PCB Error
4883	Option ROM Error
4884	Low Current
4885	Main current undervoltage
4886	Unused
4887	Over Torque
4888	Earth Fault (Software)
4889	Earth Fault (Software)
4890	Open Fuse
4891	Dynamic Braking Resistor overcurrent

Message Number	Description
4892	Overcurr in DC Sect. while Accel.
4893	Overcurr in DC Sect. while Decel.
4894	Overcurr in DC Sect. while Const. speed
4895	Autotuning Error
4896	Inverter Typeform Error
4897	Power Failed
4898	Power was restored
4899	Exited program
4900	VSD Inverter off Due to Interlock
4901	VSD control voltage low.
4902	VSD bus voltage low.
4903	Drive cannot start because ....
4904	Drive will start on ....
4905	Running (string) XX.X Hz XX.X Amps
4906	XX seconds
4907	Message
4908	SHIFT
4909	END OF HELP
4910	HELP BUFFER FULL
4911	XXX <EMPTY MENU>
4912	Ready to start
4913	Initializing VSD
4914	Too many auto-starts

9.2 SCADA Equipment Installation

SCADA equipment or site communication equipment is optional for Schlumberger VSD and SWD systems. The standard site communication solution for Schlumberger VSDs and SWDs is the Site Communication Box (SCB). Equipment other than the SCB may be specified, but is beyond the scope of this manual. Anyone installing site communication equipment other than the SCB will have to refer to manufacturer's recommendations and documentation.

Training is required before installing, commissioning, and operating Schlumberger site communication equipment. Training level and skill set are defined by the following note (a reprint from the Site Communication Box B Installation and Commissioning Manual for espWatcher Services).

Note

Only qualified personnel should perform SCB installations. Installation requires knowledge of the PAC, satellite modem, satellite network, end devices, and industrial electrical and communication wiring. The installer is responsible for installing the equipment according to local electrical and hazardous location regulations. The Schlumberger-France Training Center and Edmonton Product Center offer a training course on the installation of SCB.

For detailed installation instructions for the SCB, refer to InTouch Content ID 3833966 (WCP - AL Site Communications Box (SCB) Installation and Operation Manuals) . Installation topics include SCB mounting location, antenna installation, antenna aiming, satellite modem installation, PAC setup, power and communication cabling, and appendices which contain field wiring instructions for external devices to the SCB.

9.3 SCADA Equipment Operation

After the SCB is completely installed and the site is powered up, the PAC must be configured to connect to the end device(s). Configuring the PAC may be performed locally, by qualified personnel, or remotely by the Schlumberger InterACT Production Support Team. For detailed instructions for configuring and operating the SCB, refer to InTouch Content ID 3833966 (WCP - AL Site Communications Box (SCB) Installation and Operation Manuals). Operation topics include establishing communications with the PAC/MPDS/MSAT, connecting supporting end devices, and end device addresses and I/Os.

9.4 SCADA Equipment Commissioning

Commissioning of an SCB actually begins before the unit is installed on site. Formal commissioning procedures are completed in the field in communication with the Schlumberger InterACT Production Support Team.

For detailed instructions on commissioning the site (VSD and SCB), refer to InTouch Content ID 3833966 (WCP - AL Site Communications Box (SCB) Installation and Operation Manuals). Commissioning topics include how to fill out and submit an Application Data Sheet to InterACT, precommissioning procedures, and setting a formal post-installation appointment for site commissioning.

The following contact information is a reprint from the SCB manual, and is included in the event that the SCB installation and commissioning manual is not available.

Potential Severity: Serious
Potential Loss: Reputation
Hazard Category: electrical

Please contact the InterACT Production support team to make an appointment with your installer to complete the commissioning process at least 24 hours before the site installation visit is planned. This allows the support team to plan and allocate resources to ensure the site commissioning process is smooth and efficient.
Commissioning appointments can be made by calling the support team during business hours from 08:00 – 17:00 (the time zone is North American Mountain Standard Time which is -7:00 GMT) at 1-303-791-2400 ext. 4, or by sending an email to ipro@slb.com.
Commissioning appointments can be accommodated based on your time zone, however, you must make the appointment during the office hours shown above. Due to the amount of time involved in the creating and commissioning a site, InterACT will give priority to customers who have made commissioning appointments. In the event that no appointment is made, the InterACT Production support team will do its best to accommodate the commissioning needs. However, should no member of the support team be available due to previous appointments, we will not be able to perform the commissioning of the site.

9.5 SCADA Equipment Maintenance

Site communication equipment does require periodic on-site maintenance.

For detailed steps to be performed for maintenance of the SCB, refer to InTouch Content ID 3833966 (WCP - AL Site Communications Box (SCB) Installation and Operation Manuals). Topics include power-down safety procedures, how to inform the InterACT production team that a power outage is for maintenance (and not faulty equipment), on-site visual inspection checklist, and preparations for site emergencies (high winds, water penetration, etc).

9.6 SCADA Equipment Troubleshooting

When a site is not responding to remote communication or does not start up smoothly, troubleshooting procedures are required to identify the problem and solve it.

For detailed troubleshooting procedures for the SCB, refer to InTouch Content ID 3833966 (WCP - AL Site Communications Box (SCB) Installation and Operation Manuals). Topics include basic connection to a PAC with a PC, satellite modem troubleshooting, a comprehensive troubleshooting checklist, and how to capture background information to contact customer support at ipro@slb.com.

Maintenance

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10 MAINTENANCE

This chapter discusses preventive maintenance that is required for Speedstar 2000 VSDs. Recommended service intervals for maintenance procedures (especially life-limited parts and components) are included.

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel, Reputation
Hazard Category: electrical, machinery equipment hand tools

Troubleshooting or servicing a Schlumberger VSD must be performed by qualified personnel. Qualified personnel is defined as those who have attended and successfully completed the relevant Schlumberger training at a recognized Training Center. The Toshiba variable speed drive course is also highly recommended for personnel that (will) start up and service drives on a regular basis. Completion of these courses is NOT a substitute for field experience. Course-trained personnel should be accompanied and mentored by experienced personnel until deemed competent to work unsupervised. Qualified personnel should have their course reference material on hand. Only then should they contact AL InTouch for additional support and troubleshooting/repair instructions.

10.1 Periodic Inspection

Maintenance for variable speed drives includes periodic inspections for drives that seemingly are functioning properly, but have been in service for a reasonable amount of time. Often, visual inspection can identify a problem or malfunction before it gets serious enough to require the drive to be shutdown for maintenance or repair, or the drive registers a fault and shuts down by itself. The following table lists the major visual inspection objectives that should be checked on a periodic basis:

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel, Reputation
Hazard Category: electrical

Use lockout/tagout procedures in accordance with local electrical codes before performing any drive maintenance.
Do not use liquid cleaning agents.

Table 10-1: Periodic Visual Inspection Checklist

Inspection Item	Recommended Inspection Interval	RecommendedAction	Condition Observed (write in)
Check the operating drive for cleanliness.	Every time drive is checked	Enclosure should be free of dust, moisture, or grease. Check also for bird and insect penetration to the enclosure (exterior applications).	
Keep the exposed heatsinks free of dust and debris.	Every time drive is checked	With power to the drive OFF, blow dust and debris from heatsinks and away from enclosure.	
Check electrical connections for tightness (with power off, locked out, and with charge LED out).	As needed	Tighten with proper wrenches.	
Check heat exchanger filters.	Dependent upon prevailing conditions in the area (some areas have excess dust, sand, or leaves).	Clean or replace as needed.	
Check for proper air flow through enclosure.	Every time drive is checked.	Physically feel for air flow outside the top heat exchanger on the exterior of the enclosure. Open doors and check lower heat exchanger air flow from inside the enclosure. Listen for noisy bearings and feel for excessive vibration.	
Check rear blower assemblies	Every time drive is checked.	Physically feel for air flow from the bottom of the assembly. If not adequate flow, remove housing and clean between fins of heat sink.	
Check muffin fans for proper operation.	Every time drive is checked.	Check for air flow with a piece of paper. Depending on size of drive, there may be up to three or more fans. Don't forget fans on top of capacitors.	

Inspection Item	Recommended Inspection Interval	RecommendedAction	Condition Observed (write in)
Check all around drive enclosure for unused holes or knockouts.	Every time drive is checked.	Plug holes with appropriate covers. At minimum, or as temporary remedy, cover with duct tape.	
Visually inspect the capacitors.	Every time drive is opened for inspection.	Look for discoloration or swelling of the capacitor. Be sure to look over the explosion barrier in the drive enclosure with a flashlight, or remove the barrier for closer inspection. Replace in pairs (at minimum).	

10.2 Requesting Maintenance Support

Refer to for an example of an Application Data/Problem Information Sheet. This sheet is also included in Appendix C of this manual so that extra copies may be produced for additional usage.

The Application Data/Problem Information Sheet is created to correspond to information flow on InTouchSupport.com so that the field user can complete a hardcopy version on site and enter the information on the InTouchsupport.com database upon returning to the Schlumberger service center or shop.

10.3 Component Service Life

Some VSD components have a known optimum service life and must be replaced when their service life expires. The service lives of life-limited VSD components are shown in Table 10-2 Service Life Replacement Chart.

Table 10-2: Service Life Replacement Chart

Part Name	Service Life	Remarks
large-capacity electrolytic capacitor	5 years	Apply power semiannually during long periods of inactivity.
internal cooling fan	26,000 hours	
external cooling fan	26,000 hours	

Part Name	Service Life	Remarks
contact relays	500,000 operations	
connectors	100 operations	Replace pin in case of failure.

10.4 Explanation of VSD Resets

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel, Reputation
Hazard Category: electrical, machinery equipment hand tools

Troubleshooting or servicing a Schlumberger VSD must be performed by qualified personnel. Qualified personnel is defined as those who have attended and successfully completed the Toshiba technical course for industrial drives and have their course reference material on hand. Only then should qualified personnel contact AL InTouch for additional support and troubleshooting/repair instructions.

Note

The following reset definitions are valid for HMI software version 2.06 only.

Term	Definition
TYPE 3 RESET	This resets all of the normal parameters in the VSD to the factory default settings. After this type of reset, the power to the VSD should be cycled once to complete the process.
TYPE 7 RESET	This resets the typeform of the VSD. The CPU will monitor the gate drive board on smaller VSDs and the coordination board on 518-1200 KVA units, and will reset the output amperage of the VSD to match the board. After this type of reset, the power to the VSD should be cycled once to complete the process.
TYPE 255 RESET	This will reset all of the parameters in the VSD to factory settings and will include any settings that have been changed using the Superuser mode. **Note** After this type of reset, a Type 7 reset must also be performed and power must be cycled to complete the process.

Note
The TYPE 255 RESET can only be performed using the diagnostic (Toshiba) keypad.

10.5 Superuser Resets

Note
Superuser Reset may only be performed using the Toshiba keypad. This function is not possible using the HMI keypad. This type of reset is usually performed only when troubleshooting a VSD and should only be performed in the following events.

The superuser reset should be used in the event one or more of the following is true for the application:

- The inverter control board is changed
- The gate drive board is changed
- The option ROM is changed
- The VSD is not operating as expected in reference to the proper output amperage
- The coordination board is changed or the DIP switches are changed on the coordination board (518-1200 KVA drives only).

The superuser reset is used to return the VSD to the factory settings. This reset will reset all of the programmed parameters in the VSD that are associated with the inverter controls. These include but are not limited to:

- maximum output amperage
- volts-per-hertz settings (base speed)
- minimum frequency
- maximum frequency
- start frequency
- acceleration rate (ramp frequency)
- deceleration rate.

Warning

Potential Severity: Serious
Potential Loss: Assets
Hazard Category: machinery equipment hand tools

The superuser reset should only be performed by qualified personnel; serious equipment damage may result if not done properly.

Refer toTable 10-3 Superuser Reset-Required Parts for a list of the parts or tools that are required to perform the superuser reset.

Table 10-3: Superuser Reset-Required Parts

Part Number	Description
1303148	Five (5)–meter cable for connecting the diagnostic Toshiba G3 keypad to the SWD or VSD
1303130	Diagnostic G3 keypad for the SWD or VSD
1303080	Metal case for the diagnostic G3 keypad for the SWD or VSD

10.5.1 Performing a Reset Using the Diagnostic Keypad

There is a special function within *GROUP: SUPERUSER* that will perform a factory reset similar to the standard reset; however, this factory reset will also return all *superuser* parameters to their default values.

To access the superuser mode, perform the following steps after cycling power to the drive.

1. Press and release the *LOCAL/REMOTE* key.
2. Press and hold the *READ/WRITE* key.
3. While holding the *READ/WRITE* key, press the *LOCAL/REMOTE* key.

   On the display, you should now see *GROUP: SUPERUSER* followed by *RAMF*. If you do not see this, cycle the power to the drive and repeat Step 1, 2, and 3 above.

10.5.2 Performing a Type 255 Reset

The Type 255 reset is the superuser reset that will return all parameters (*normal and superuser*) their original factory settings.

1. With *RAMF* displayed on the screen, press up the *ARROW* key until *TYP* is displayed.

2. Press *READ/WRITE* again to enter *TYP* mode.
3. Use the ARROW keys to change the current value to 255.
4. Press *READ/WRITE* to write the new value, the drive should display the word *INITIALIZING*. The display is followed by an audible relay click. The drive should then default to *OUTPUT FREQUENCY=0.0 Hz.*

Note

Occasionally the G3 will display an *INVERTER TYPEFORM ERROR* following a superuser reset. Clear the fault normally as instructed on the screen and proceed with the next step of this procedure.

10.5.3 Performing a Type Form (Type 7) Reset

After resetting the VSD in superuser mode, it is necessary to perform an inverter typeform reset (in standard programming mode) to ensure the software recognizes the inverter type.

1. Go into the *UTILITY PARAMETERS* program group and scroll to the *STANDARD SETTING MODE SELECTION* parameter.
2. Enter the numeral 7 into this parameter. This will initialize a typeform reset. After the inverter displays *INITIALIZING*, it will default back to *OUTPUT FREQUENCY=0.0 Hz*. The entire drive memory is now reset back to factory settings.

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Troubleshooting

11 TROUBLESHOOTING

This chapter provides troubleshooting procedures for Speedstar 2000 VSDs that are in service and must be tested or are malfunctioning. These procedures are intended to help the field user identify which part of the VSD is malfunctioning. Any attempted repairs to a VSD should be performed in conjunction with AL InTouch support and should be performed by qualified personnel as defined in the note that follows.

Danger

Potential Severity:	Major
Potential Loss:	Assets, Personnel, Reputation
Hazard Category:	electrical, explosives, machinery equipment hand tools

Troubleshooting or servicing a Schlumberger VSD must be performed by qualified personnel. Qualified personnel is defined as those who have attended and successfully completed the relevant Schlumberger training at a recognized Training Center. The Toshiba variable speed drive course is also highly recommended for personnel that (will) start up and service drives on a regular basis. Completion of these courses is NOT a substitute for field experience. Course-trained personnel should be accompanied and mentored by experienced personnel until deemed competent to work unsupervised. Qualified personnel should have their course reference material on hand. Only then should they contact AL InTouch for additional support and troubleshooting/repair instructions.

11.1 Required Troubleshooting Equipment and Tools

Before attempting any troubleshooting procedures, ensure that the personnel assigned to the job have the required troubleshooting equipment and tools listed in the VSD Tools Kit (Schlumberger part number 100072064) located in GeMS (Schlumberger Global Engineering Management System).

The list may also be found and items ordered from OneCat (Schlumberger WCP Products Catalog.

11.2 Capturing Drive Data

The first step in starting up or troubleshooting a VSD system is to capture all equipment and personnel contact data for the drive system. Refer to the following table that may be used as a checklist to ensure complete drive data has been captured. Refer to this data when contacting AL InTouch for further assistance.

Table 11-1: Drive Data. *Record drive data in this table.*

Data Item	Description (write in)	Comments/Check Mark
Drive Rating (kVA)		
Drive Location		
Date		
Service Engineer Name		
Customer		
Output Filter Type		
Motor Type		
Pump Type		
Number of Stages		
Cable Type and Length		
Output Transformer Type and Mfr.		
Transformer Impedance		
Schlumberger Office		
Customer Contact Name		
Customer Phone Number		

Note

If the drive you are troubleshooting fails or does not perform as expected, complete the Drive Data capture as shown above or the VSD Application Data/Problem Information Sheet in Appendix C and contact Artificial Lift InTouch for assistance.

11.3 Pre-Powerup Checks for Single Inverter Units (66 to 454 kVA)

Perform the following checks before applying any power to the drive.

Danger

Potential Severity: Major
Potential Loss: Personnel, Reputation
Hazard Category: electrical, explosives

Use appropriate lockout/tagout procedures (refer to InTouch ID# 3827719) to ensure that VSD power is OFF before proceeding with the following checks and procedures.
Use a VOM to verify that ALL power is OFF on the VSD, including

- Incoming lines (if unit is a 12–pulse, check two sets of incoming lines) at the bottom of the circuit breaker
- Motor terminals
- The DC bus

1. Verify board numbers, switch settings, and jumper settings are correct for the application and that CPT(s) have connections made to the proper taps for the application.
2. Verify that the MST (initial charge timer) is set to 0.3 to 1.0 seconds (if applicable).
3. Verify all connectors are properly plugged in.
4. Inspect the DC bus capacitors. Make sure they are not leaking oil, show bulges, or that the vent plug is opened.
5. Inspect MS1 (initial charge contactor) contacts (if possible).
6. Check the tightness on all cable and bus connections.
7. Perform a thorough visual check of all drive components. Ensure that the installer did not bend resistors or break any components on the circuit boards.
8. Ensure that the drive is clean and free of debris, dust, cobwebs, etc.
9. Check all fuses before power-up. A blown fuse indicates that power has been applied to the drive prior to your arrival. Check fuses and main wiring connections for loose components and connections. Tighten if necessary.
10. Confirm proper grounding of all appropriate items.
11. Ensure that RTV has been applied to the HMI keypad flexible cable to prevent shorts.
12. Ensure that a Category-5 (CAT5) communication cable has been installed from the HMI to the VSD.
13. Ensure that the HMI contains a lithium battery.
14. If analog signals are used in the application, ensure that there are no grounds present to interrupt the signals. No resistance to ground should be detected.

15. Confirm that step-up transformer taps are consistent with motor data and cable data. Record data if necessary.

Table 11-2: Step-Up Transformer/Motor/Cable Data Confirmation

Item	Data (write in)	Comments
Tap Setting		
Output Voltage		
Cable Size (AWG)		

16. Confirm that no grounds exist on the step-up transformer primary and secondary. Also ensure that no cable resistance to ground exists. Record data in the table provided.

Table 11-3: Step-Up Transformer and Cable Resistances

Item	Data (write in)	Comments
Resistance at primary (ohms)		
Resistance at secondary (ohms)		
Cable Resistance (ohms)		

17. Check the resistance of the motor with the cable for balance. To do this, the cable must be disconnected from the transformer.

Tip

Do not reconnect the step-up transformer to the cable at this time. The drive will be run without the motor in upcoming startup procedures.

11.4 Main Power Circuit Component Checks for Single Inverter Units (66 to 454 kVA)

Perform the following checks to ensure proper function of the main power circuit components.

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel, Reputation
Hazard Category: electrical

Turn all power OFF before making changes to transformer taps or connecting wires to components.

11.4.1 Main Power Circuit Checks

1. Use a VOM to ensure that the DC bus capacitors have been completely discharged.

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel
Hazard Category: electrical

DO NOT trust the LED inside the VSD cabinet to indicate discharge state of the DC bus capacitors.

---

2. Remove the input power fuses and test them.
3. Carefully disassemble the drive, only to the level to expose the main power circuit components.
4. Give all drive components a thorough visual inspection and ensure that no parts are broken or damaged.
5. Use a VOM to test the following main circuit components:

   - control power fuses
   - DC bus fuse(s)
   - soft-start resistor-Refer to the appropriate drawing for Softstart resistor value.
   - DC bus capacitors-Check the charge and discharge rate of the capacitors and ensure that the charge rate is faster than discharge. Use the diode mode of the VOM to charge the capacitors and DC volts to discharge.
   - discharge resistor R2-Manually push in MS2 to take reading (if applicable).
   - thermistor (should read 18 to 24 kohms@room temperature)

11.4.1.1 Checking Input Diodes

This section describes how to test the input diodes while they are still included in the drive's circuits.

Note

The charging indication displayed on the VOM is caused by the charging action of the DC bus filter capacitors through the forward-biased diode.

Refer to the following table for VOM connection points and readings while the diode is still in the circuit.

Table 11-4: Input diode test reading (diode in circuit)

Meter (+)	Meter (-)	Reading
DC Bus +	Input R	Charging
DC Bus +	Input S	Charging
DC Bus +	Input T	Charging
Input R	DC Bus +	0 .2 to 0 .6 Vdc
Input S	DC Bus +	0 .2 to 0 .6 Vdc
Input T	DC Bus +	0 .2 to 0 .6 Vdc
DC Bus -	Input R	0 .2 to 0 .6 Vdc
DC Bus -	Input S	0 .2 to 0 .6 Vdc
DC Bus -	Input T	0 .2 to 0 .6 Vdc
Input R	DC Bus -	Charging
Input S	DC Bus -	Charging
Input T	DC Bus -	Charging

11.4.1.2 Checking Input Diodes (isolated from circuit)

This section describes how to test the input diodes (rectifiers) if some problem was discovered while testing them in the circuit. Refer to the following figure for test point location and to the table for values that should be read on the VOM. Use the diode tester function of the VOM.

Note

Testing the diodes isolated from the circuit helps avoid any interference from other connected components such as the DC link capacitors. Any charging display on the VOM is the result of the DC link capacitors trying to charge from the voltage applied to them from the meter.

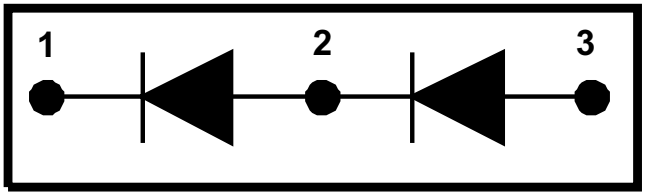

Figure 11-1: Diode test points

Meter (+) Lead	Meter (-) Lead	Meter Reading (diode removed from circuit)	Meter Reading (diode in circuit)
2	1	0.2 to 0.6 volts DC	0.2 to 0.6 volts DC
2	3	OL	charging
3	2	0.2 to 0.6 volts DC	0.2 to 0.6 volts DC
1	2	OL	charging

11.4.1.3 Checking Single—Transistor IGBTs for Single Inverter Units (66 to 454 kVA)

This section gives step-by-step procedures on how to test a single-transistor type IGBT.

1. Attach the VOM leads as shown in the corresponding schematic and table.

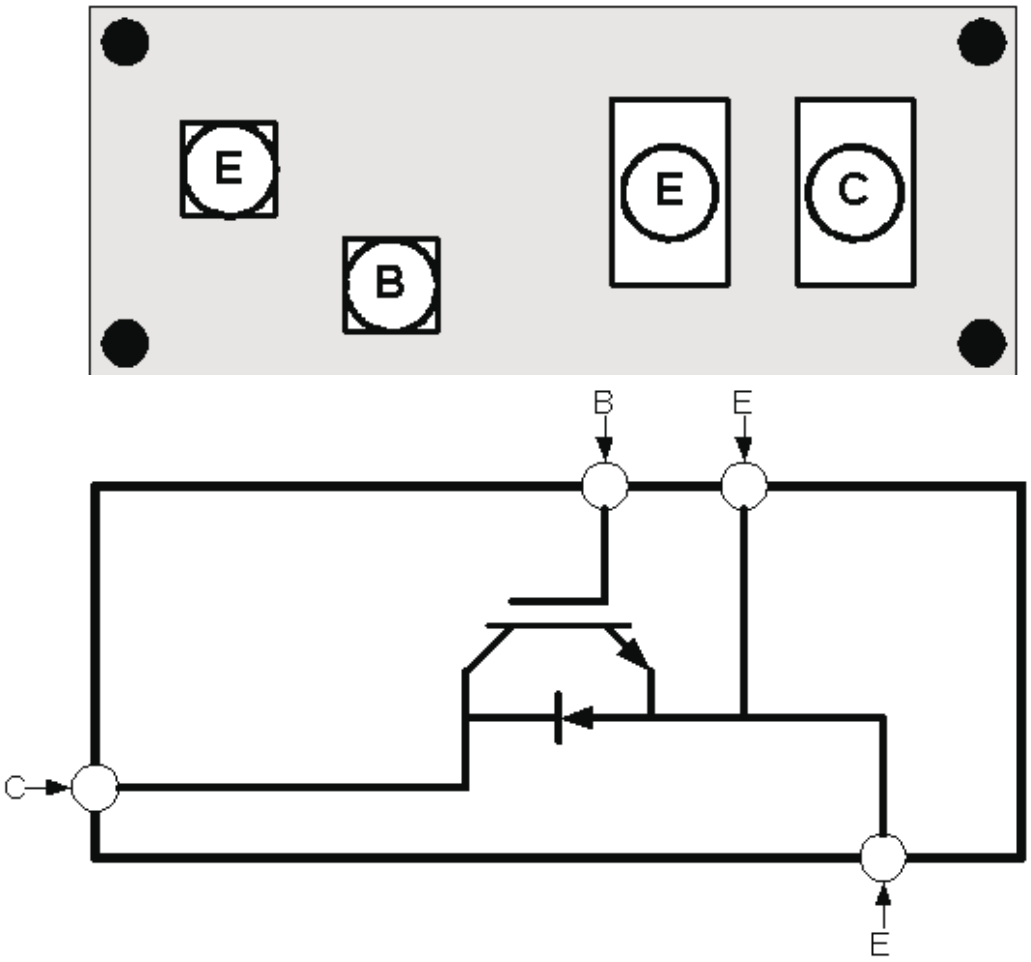

Figure 11-2: Single-Transistor IGBT Block Diagram and Schematic (module MG500Q1US11 shown)

Table 11-5: Single-transistor test connection points and values

Meter Lead Connection Points		**Meter Display**
NEG	POS	Reading
C	E	0.2 to 0.6
E	C	OL (charging)
B	C	OL (charging)
C	B	OL (charging)
B	E	OL (charging)
E	B	OL (charging)

2. Ensure that the VOM readings match or approximate those shown in the Single-Transistor Test Connection Points and Values table.

11.4.1.4 Control Power Supply Checks

Perform the following checks to ensure that the drive's control circuits and power supplies are operating properly.

Control Power Supply Check Procedure

1. Remove the input fuses (if they are not already removed).
2. Make sure the control-power leads are attached to the bus bars on the *load* side of the input circuit breaker, ahead of the input fuses.
3. Jumper the fuse indicator circuit to complete the circuit (if applicable).
4. Remove the MST timer (if applicable).
5. Disconnect the fan circuit (CN11) to reduce noise while testing.
6. Temporarily defeat the door interlock switches (if applicable).

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

High voltage (480 volts) will be turned ON for the next phase of testing. Keep hands, tools, and personnel in the area away from high voltage risk areas.

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7. When all connections are safely completed from Steps 1 through 6 above, close the Main Circuit Breaker (MCB1).
8. Make sure any power LEDs on the base drive board are illuminated.
9. Make sure the charge LED (indicating DC bus voltage) is NOT illuminated.
10. Use the VOM to make sure the control power transformer(s) (CPT1 and possibly an additional CPT) are functioning properly.
11. The display on the Toshiba keypad should be flashing `DC bus undervoltage`.

Warning

Potential Severity: Serious
Potential Loss: Assets, Reputation
Hazard Category: electrical, machinery equipment hand tools

DO NOT touch pins on the VSD Terminal Board together. Use a test adapter plug (refer to the Troubleshooting Required Equipment and Tools list) to ensure pins and test leads do not contact each other.
Use a VOM to check the power supplies (+5 V, +15 V, —15 V, +24 V).

12. Refer to the following block diagram of the VSD Terminal Board and table of Control Power Supplies Test Points and Readings. Check and ensure that all power supplies are working properly.

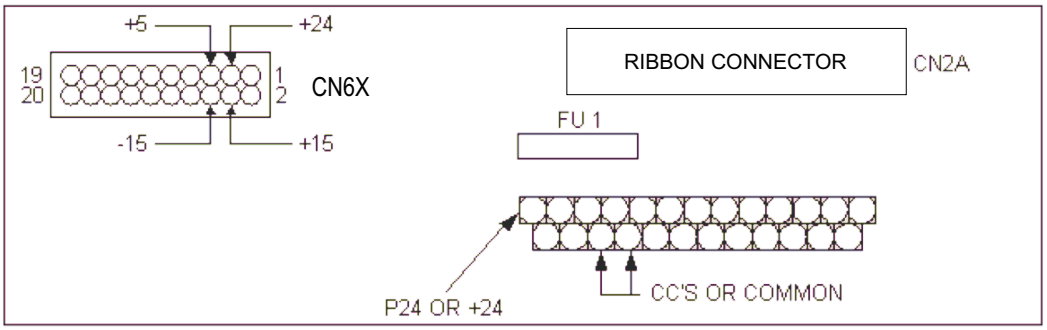

Figure 11-3: VSD Terminal Board (control power test points)

Table 11-6: Control power supplies test points and readings

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+15	14.4 to 15.6	CN6X-4	Terminal CC
-15	–14.4 to –15.6	CN6X-6	Terminal CC
+5	4.8 to 5.2	CN6X-5	Terminal CC
+24	21 to 27	TERM P24	Terminal CC
+24	21 to 27	CN6X-3	Terminal CC

11.4.1.5 HMI Power Supply Checks for Single Inverter Units (66 to 454 kVA)

Perform the following checks while referring to the HMI Power Supply Block Diagram and HMI Power Supply Voltages table. Ensure that the power supplies are providing the proper voltages to ground (COM) within the permissible range as shown in Figure 11-4 HMI Power Supply Block Diagram and the accompanying table.

Note

The HMI Power Supply/Power Fail Board are usually located either in the left panel of the drive enclosure or the top (ceiling) of the enclosure.

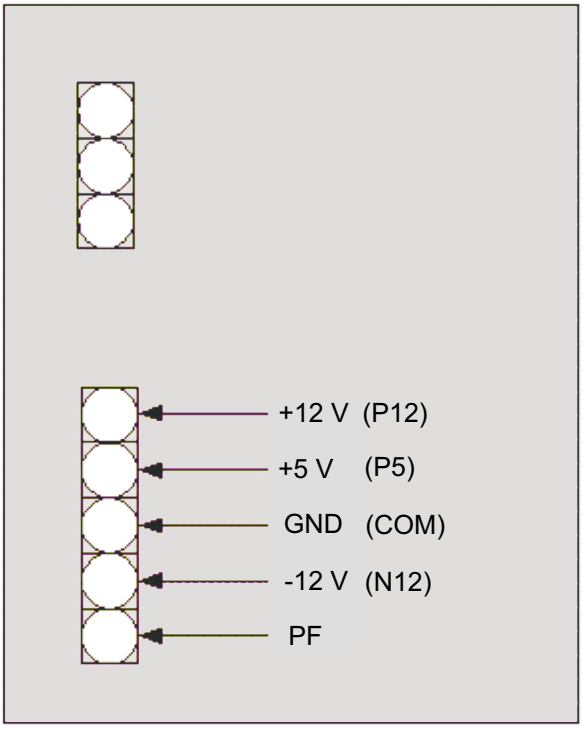

Figure 11-4: HMI Power Supply Block Diagram

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+12	approx. +12	P12	COM
+5	approx. +5	P5	COM
-12	approx. —12	N12	COM

11.4.2 VSD Output Tests for Single Inverter Units (66 to 454 kVA)

Note

To perform the output tests desribed in this section, the VSD must be placed in SuperUser mode. The drive you are troubleshooting already has an HMI display, but you may choose to invoke SuperUser mode using the Toshiba keypad included in the Troubleshooting Required Equipment and Tools list. Be sure to refer to the correct procedure for the user interface (keypad and display) you are using.

11.4.2.1 Placing the VSD in SuperUser Mode (with Toshiba keypad)

The procedures in this subsection check the VSD output pulses to make sure the drive is operating per specification. The VSD must be placed in SuperUser mode to defeat the `DC Undervoltage` warning and subsequent drive shutdown to perform this test.

Danger

Potential Severity: Major
Potential Loss: Assets, Reputation
Hazard Category: electrical

Do not use any feature of SuperUser programming to do anything with the VSD other than temporarily placing the drive in TEST MODE as described in this procedure without specific authorization from Toshiba Corporation. Unauthorized modification of SuperUser parameters can lead to equipment damage.

Place the VSD in SuperUser mode by performing the following steps:

1. Program the VSD with the steps listed in the SuperUser mode programming steps figure that follows.

	DISPLAY	DESCRIPTION
	DC BU S UND E R VOLTAGE	When Power is applied
LOCAL / REMOTE	DC BU S UND E R VOLTAGE	Panel Control LED will change state when key is pressed unless locked out
READ / WRITE	DC BU S UND E R VOLTAGE	Press this key the display will not change
READ / WRITE & LOCAL / REMOTE	GRO UP : SUPE RU SER	Press and hold the read/write key then press local/re mote
READ / WRITE	RAMF	1st para meter of S uper User is displayed
△	TEST	Test mode setting address shown
READ / WRITE	0	Displays value in test mode
△	1	Change value to a 1 to activate test mode
READ / WRITE	TEST ◄—► 1	Test and 1 flash to show test mode is activated
PRG	OUTPUT FREQUENCY 0.0HZ	Returns to normal display
To reactivate DC U V turn off power and then re-energize		

Figure 11-5: SuperUser mode programming steps

2. Once the drive is in SuperUser mode, proceed to Base Drive Pulse Test and Output Waveform Test.

11.4.2.2 Placing the VSD in SuperUser Mode (with HMI)

The HMI has SuperUser routines included in the software (version 2.06).

Note

If the HMI you are using does not have version 2.06 software loaded, use the Toshiba keypad to invoke SuperUser mode. Do not attempt to place the drive in SuperUser mode with older software revisions of the HMI.

To place the VSD in SuperUser mode using the HMI, perform the following steps:

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

Make sure the main input fuses (that provide power to the auxiliary transformer [PT]) are removed.

1. Press the MENU/ESC key on the HMI keypad.
2. Press 999 on the numerals keypad. A non-flashing NONE displays at the bottom of the LCD.
3. Press the ENTER key. NONE display at bottom of the LCD should begin to flash.
4. Press the UP or DOWN arrows to toggle through the menu selections until TURN ON SUPERUSER appears.
5. Press ENTER. At the top of the LCD, SUPERUSER should be scrolling across horizontally. The VSD is now in SuperUser mode.
6. To exit SuperUser mode, you must cycle the power to the VSD.

11.4.2.3 Base Drive Pulse Test

Hint

The terms base and gate are used interchangeably to describe the Base Drive Board or Gate Drive Board in this manual.

After the VSD is in SuperUser mode, perform the following steps to check and verify proper waveform of the pulses at the output of the Base Drive Board.

1. Run the VSD at 60 Hz.

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

Some test points on the Base Drive Board are very close to the input breaker terminals which have power on them. Keep hands and tools clear of possible high-voltage hazards.

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2. Use an oscilloscope to check the waveform. Refer to the appropriate schematic for your particular drive's Base Drive Board output points. Make sure the scope is in DC input mode. The waveform should read 30 volts peak to peak (+15 to -15 volts) PWM square wave as shown in the Base Drive Board waveform figure.

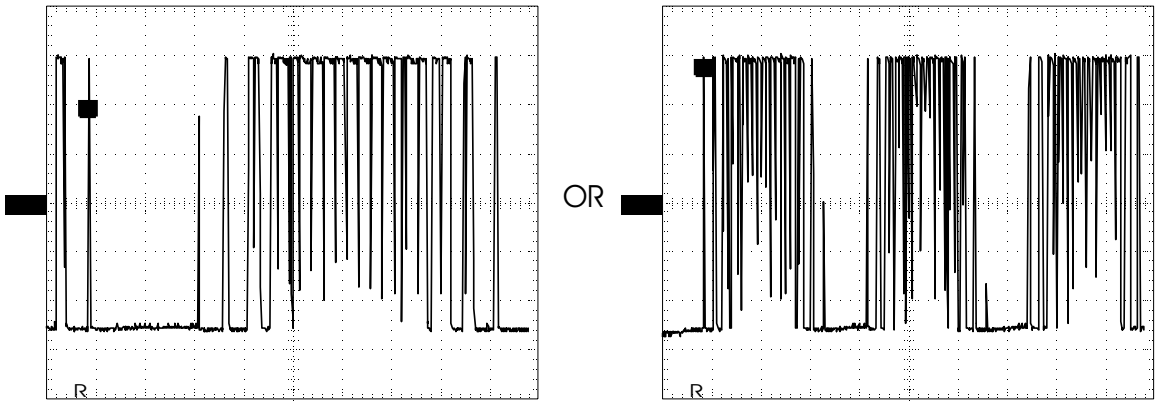

Figure 11-6: Base (Gate) Drive Board waveform. *left figure vertical scale = 5 volts per division, horizontal scale = 2 ms per division; right figure vertical scale = 5 volts per division, horizontal scale 5 ms per division*

Refer to Figure 11-7 Base (Gate) Drive Board connections for a diagram showing phase points and lead connections for the oscilloscope.

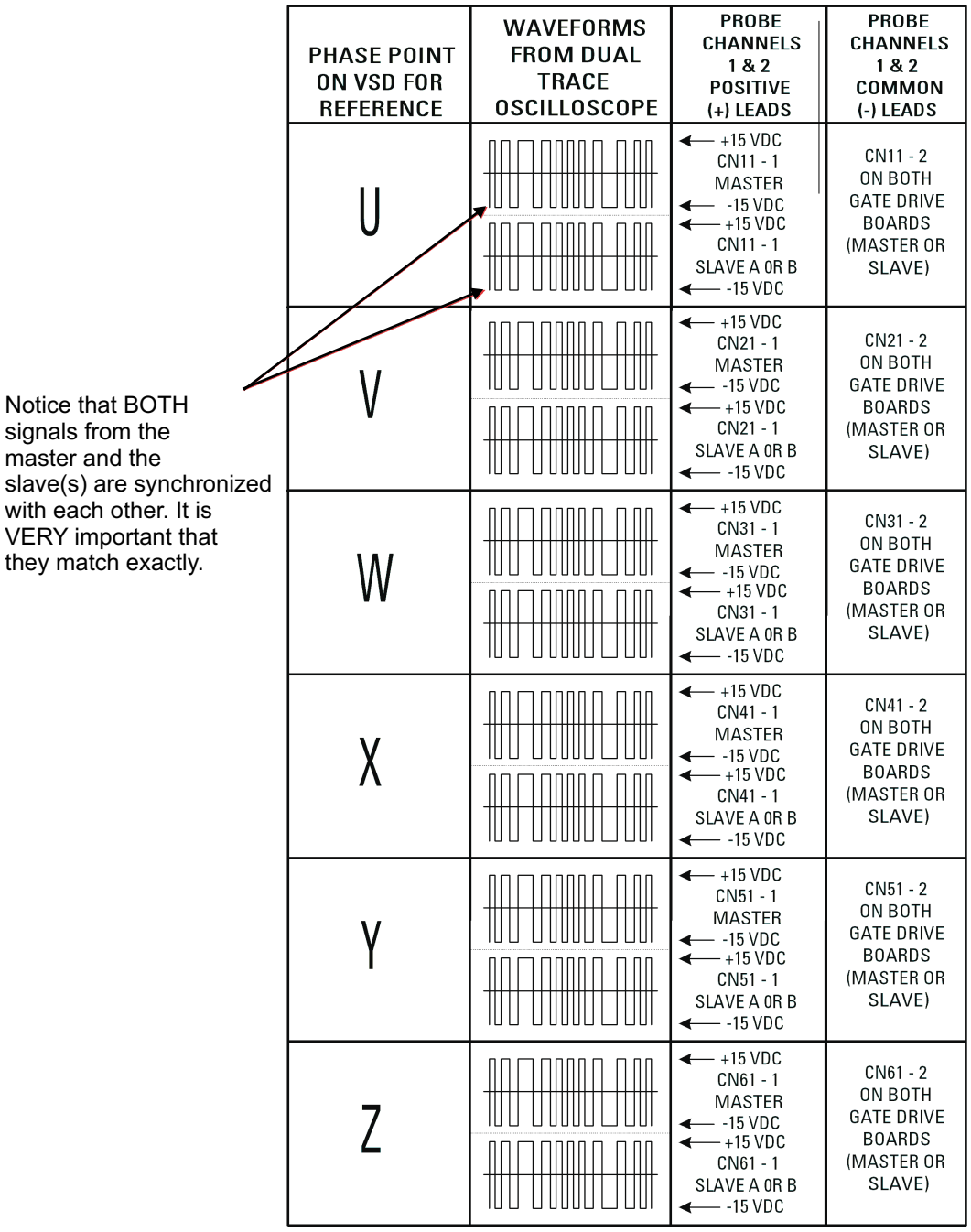

Figure 11-7: Base (Gate) Drive Board connections

11.4.2.4 Output Waveform Test

Perform the following test to observe the waveforms on the output points indicated.

1. Run the drive at 60 Hz.
2. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, and U-W. The waveform should be 8 volts peak to peak (+4 volts peak to -4 volts peak) as shown in Figure 11-8 Drive output waveform.

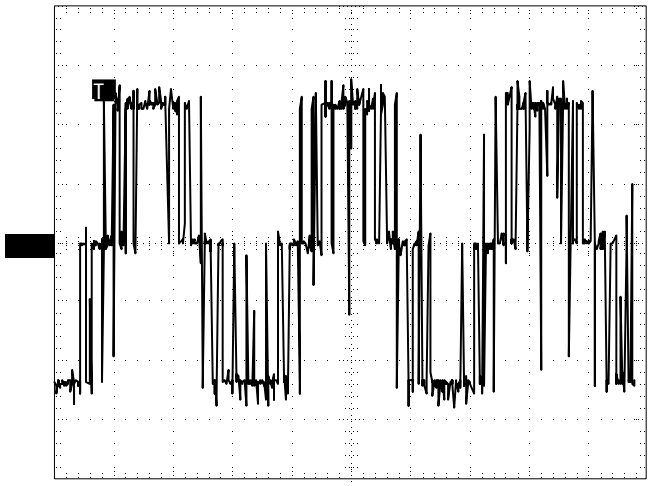

Figure 11-8: Drive output waveform. *vertical scale = 2 volts per division, horizontal scale = 5 ms per division*

3. Turn power OFF.

11.4.2.5 Reduced Output Voltage Test

This procedure tests the VSD at reduced voltage on the DC bus. Perform the following steps to test the drive:

1. Main power should still be OFF.
2. Connect a 120 volt-AC-capable jumper (cheater cord) to two of the bus bars on the input of the rectifier.
3. Connect the cheater cord to a Variac. The Variac should be set to zero (0) volts output.
4. Turn Main Power ON.
5. Run the drive at 60 Hz.
6. Slowly increase the Variac until the DC bus reads approximately 30 volts DC.
7. Use an oscilloscope to observe waveform on the outputs U-V, V-W, U-W.
8. Waveform should be 60 V peak to peak (+30V peak to –30 volts peak) as shown in Figure 11-9 Reduced output voltage waveform.

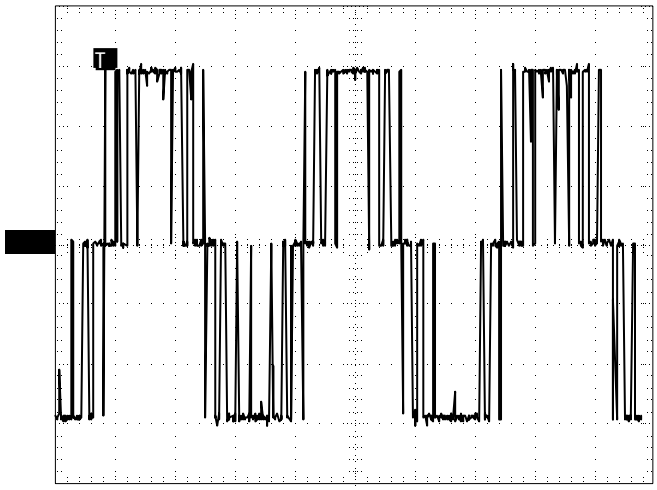

Figure 11-9: Reduced output voltage waveform. *vertical scale = 10 volts per division, horizontal scale = 5 ms per division*

9. Decrease Variac setting back to zero volts output.
10. Turn power OFF.

11.4.2.6 Sequence Checks

The following checks test for proper operation of drive shunt trip, timed contactor sequences, door interlock, fuse indicator, fan circuits, and other timed and monitored sequences. All sequences may not be applicable to every drive application.

Perform the following checks:

1. Remove the Variac and cheater cord from the drive.
2. Reinstall the input fuses.
3. Reinstall the MST timer.
4. Set the MST timer to minimum and apply power. The Input circuit breaker should shunt trip. Reset the circuit breaker and set the MST to 0.3 to 1.0 seconds.
5. Turn the main power ON and ensure that MS2 picks up. Approximately one (1) second later, MS1 closes.
6. Test the blown fuse indicator circuit by pulling the tab on one of the indicators. The input circuit breaker should shunt trip.
7. Reset the input circuit breaker and main power ON.
8. Test the door switch interlock circuit by opening the drive enclosure door. The input circuit breaker should trip.

9. Reset the input circuit breaker. Reconnect CN11, apply power, and test the fan circuit by running the drive.
10. Test all remaining sequences (differs by application/jobsite).
11. With power ON, program the correct parameters for the appliction into the VSD.

11.4.2.7 Full Output Voltage Test (without Motor)

This test checks the VSD for proper operation without a load (motor) attached. Perform the following steps:

1. Run the drive at 10 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
2. Run the drive up to 60 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
3. Verify the output waveform (at U-V, V-W, and U-W) with an oscilloscope. The waveform should look similar to one of the full voltage test waveforms (no motor load) in the following figure.

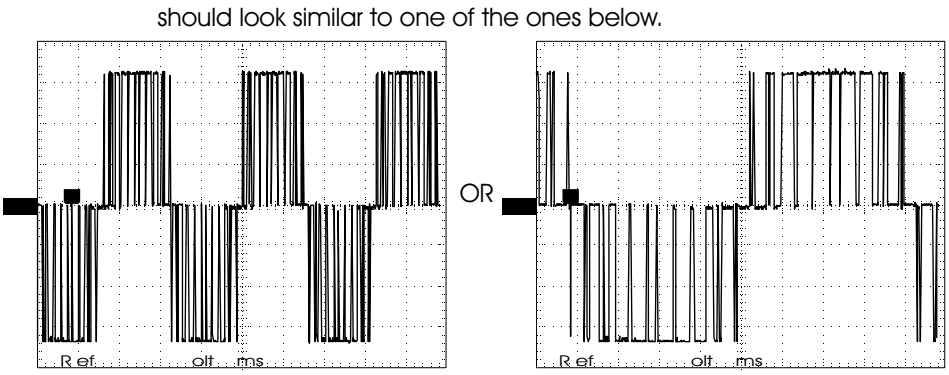

Figure 11-10: Full voltage test waveform (no motor load). *left figure vertical scale = 200 volts per division, horizontal scale = 5 ms per division; right figure vertical scale = 200 volts per division, horizontal scale = 2 ms per division*

4. Turn power OFF.

11.4.2.8 Full Output Voltage Test (with Motor)

This test checks the VSD for proper operation with a load (motor) attached. Perform the following steps:

1. Ensure all power is OFF. Reconnect the motor leads to the drive output lugs.
2. Apply power and run the drive at 10 Hz. Monitor load current on the front (HMI) display.
3. Run the drive up to 60 Hz.
4. Use clamp-on ammeters to check for balanced current between U, V, and W outputs to the motor windings. Monitor the drive performance for a reasonable period of time to ensure proper operation.

11.5 Pre-Powerup Checks for Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following checks before applying any power to the drive.

Danger

Potential Severity: Major
Potential Loss: Personnel, Reputation
Hazard Category: electrical, explosives

Use appropriate lockout/tagout procedures (refer to InTouch ID# 3827719) to ensure that VSD power is OFF before proceeding with the following checks and procedures.
Use a VOM to verify that ALL power is OFF on the VSD, including

- Incoming lines (if unit is a 12–pulse, check two sets of incoming lines) at the bottom of the circuit breaker
- Motor terminals
- The DC bus

---

1. Verify board numbers, switch settings, and jumper settings are correct for the application and that CPT(s) have connections made to the proper taps for the application.
2. Verify that the MST (initial charge timer) is set to 0.3 to 1.0 seconds (if applicable).
3. Verify all connectors are properly plugged in.

4. Inspect the DC bus capacitors. Make sure they are not leaking oil, show bulges, or that the vent plug is opened.
5. Inspect MS1 (initial charge contactor) contacts (if possible).
6. Check the tightness on all cable and bus connections.
7. Check all fuses before power-up. A blown fuse indicates that power has been applied to the drive prior to your arrival. Check fuses and main wiring connections for loose components and connections. Tighten if necessary.
8. Confirm proper grounding of all appropriate items.
9. Ensure that RTV has been applied to the HMI keypad flexible cable to prevent shorts.
10. Ensure that a Category-5 (CAT5) communication cable has been installed from the HMI to the VSD.
11. Ensure that the HMI contains a lithium battery.
12. If analog signals are used in the application, ensure that there are no grounds present to interrupt the signals. No resistance to ground should be detected.
13. Confirm that step-up transformer taps are consistent with motor data and cable data. Record data if necessary.

Table 11-7: Step-Up Transformer/Motor/Cable Data Confirmation

Item	Data (write in)	Comments
Tap Setting		
Output Voltage		
Cable Size (AWG)		

14. Confirm that no grounds exist on the step-up transformer primary and secondary. Also ensure that no cable resistance to ground exists. Record data in the table provided.

Table 11-8: Step-Up Transformer and Cable Resistances

Item	Data (write in)	Comments
Resistance at primary (ohms)		
Resistance at secondary (ohms)		
Cable Resistance (ohms)		

15. Check the resistance of the motor with the cable for balance. To do this, the cable must be disconnected from the step-up transformer.

Tip

Do not reconnect the step-up transformer to the cable at this time. The drive will be run without the motor in upcoming startup procedures.

11.6 Main Power Circuit Component Checks for Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following checks to ensure that the main power circuit components are functioning properly.

11.6.1 Main Power Circuit Checks

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel
Hazard Category: electrical, explosives, machinery equipment hand tools

Make sure the main circuit breaker (MCB1) is OFF. Use proper lockout and tagout procedures while performing main power circuit checks.

1. Use a VOM to ensure that the DC bus capacitors have been completely discharged.

Danger

Potential Severity: Major
Potential Loss: Assets, Personnel
Hazard Category: electrical

DO NOT trust the LED inside the VSD cabinet to indicate discharge state of the DC bus capacitors.

2. Remove the input power fuses and test them.
3. Carefully disassemble the drive, only to the level to expose the main power circuit components.
4. Give all drive components a thorough visual inspection and ensure that no parts are broken or damaged.
5. Use a VOM to test the following main circuit components:
   - control power fuses
   - DC bus fuse(s)

- soft-start resistor-Refer to the appropriate drawing for Softstart resistor value.
- DC bus capacitors-Check the charge and discharge rate of the capacitors and ensure that the charge rate is faster than discharge. Use the diode mode of the VOM to charge the capacitors and DC volts to discharge.
- discharge resistor R2-Manually push in MS2 to take reading (if applicable).
- thermistor (should read 18 to 24 kohms@room temperature).

11.6.1.1 Checking Input Diodes

This section describes how to test the input diodes while they are still included in the drive's circuits.

Note

The charging indication displayed on the VOM is caused by the charging action of the DC bus filter capacitors through the forward-biased diode.

Refer to the following table for VOM connection points and readings while the diode is still in the circuit.

Table 11-9: Input diode test reading (diode in circuit)

Meter (+)	Meter (-)	Reading
DC Bus +	Input R	Charging
DC Bus +	Input S	Charging
DC Bus +	Input T	Charging
Input R	DC Bus +	0 .2 to 0 .6 Vdc
Input S	DC Bus +	0 .2 to 0 .6 Vdc
Input T	DC Bus +	0 .2 to 0 .6 Vdc
DC Bus -	Input R	0 .2 to 0 .6 Vdc
DC Bus -	Input S	0 .2 to 0 .6 Vdc
DC Bus -	Input T	0 .2 to 0 .6 Vdc
Input R	DC Bus -	Charging
Input S	DC Bus -	Charging
Input T	DC Bus -	Charging

11.6.1.2 Checking Input Diodes (isolated from circuit)

This section describes how to test the input diodes (rectifiers) if some problem was discovered while testing them in the circuit. Refer to the following figure for test point location and to the table for values that should be read on the VOM. Use the diode tester function of the VOM.

Note

Testing the diodes isolated from the circuit helps avoid any interference from other connected components such as the DC link capacitors. Any charging display on the VOM is the result of the DC link capacitors trying to charge from the voltage applied to them from the meter.

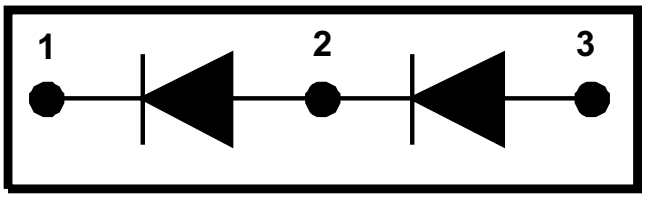

Figure 11-11: Diode test points

Meter (+) Lead	Meter (-) Lead	Meter Reading (diode removed from circuit)	Meter Reading (diode in circuit)
2	1	0.2 to 0.6 volts DC	0.2 to 0.6 volts DC
2	3	OL	charging
3	2	0.2 to 0.6 volts DC	0.2 to 0.6 volts DC
1	2	OL	charging

11.6.1.3 Checking Single—Transistor IGBTs for Double/Triple Inverter Units (518 to 1200 kVA)

This section gives step-by-step procedures on how to test a single-transistor type IGBT.

1. Attach the VOM leads as shown in the corresponding schematic and table.

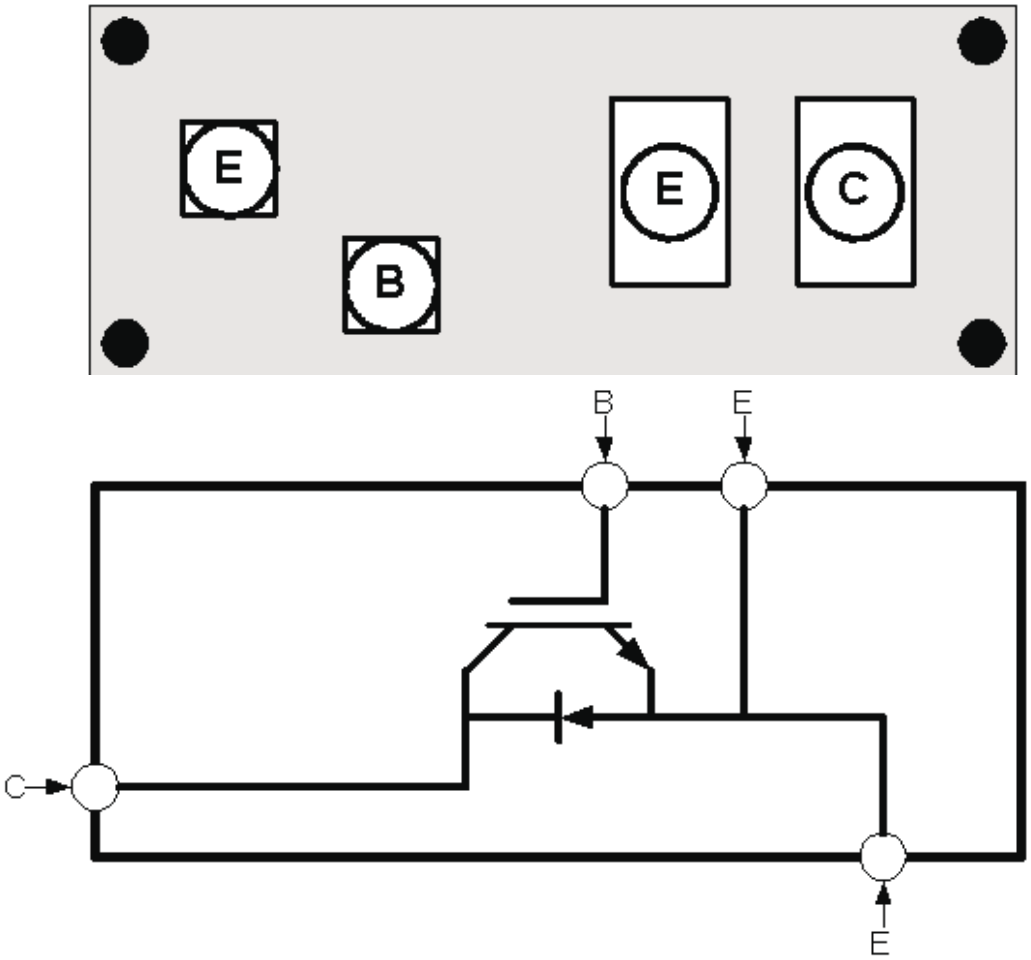

Figure 11-12: Single-transistor IGBT block diagram and schematic (MG500Q1US11)

Meter Lead Connection Points		Meter Display
NEG	POS	Reading
C	E	0.2 to 0.6
E	C	OL (charging)
B	C	OL (charging)
C	B	OL (charging)
B	E	OL (charging)
E	B	OL (charging)

2. Ensure that the VOM readings match or approximate those shown in the Single-Transistor Test Connection Points and Values table.

11.6.1.4 Control Power Supply Checks

Perform the following checks to ensure that the drive's control circuits and power supplies are operating properly.

Control Power Supply Check Procedure

1. Remove the input fuses (if they are not already removed).
2. Make sure the control power leads are attached to the bus bars on the *load* side of the input circuit breaker, ahead of the input fuses.
3. Jumper the fuse indicator circuit to complete the circuit (if applicable).
4. Remove the MST timer (if applicable).
5. Disconnect the fan circuit (CN11) to reduce noise while testing.
6. Temporarily defeat the door interlock switches (if applicable).

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

High voltage (480 volts) will be turned ON for the next phase of testing. Keep hands, tools, and personnel in the area away from high voltage risk areas.

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7. When all connections are safely completed from Steps 1 through 6 above, close the Main Circuit Breaker (MCB1).
8. Make sure any power LEDs on the base drive board are illuminated.
9. Make sure the charge LED (indicating DC bus voltage) is NOT illuminated.
10. Use the VOM to make sure the control power transformer(s) (CPT1 and possibly an additional CPT) are functioning properly.
11. The display on the Toshiba keypad should be flashing `DC bus undervoltage`.

Warning

Potential Severity: Serious
Potential Loss: Assets, Reputation
Hazard Category: electrical, machinery equipment hand tools

DO NOT touch pins on the VSD Terminal Board together. Use a test adapter plug (refer to the Troubleshooting Required Equipment and Tools list) to ensure pins and test leads do not contact each other.
Use a VOM to check the power supplies (+5 V, +15 V, —15 V, +24 V).

12. Refer to the following block diagram of the VSD Terminal Board and table of Control Power Supplies Test Points and Readings. Check and ensure that all power supplies are working properly.

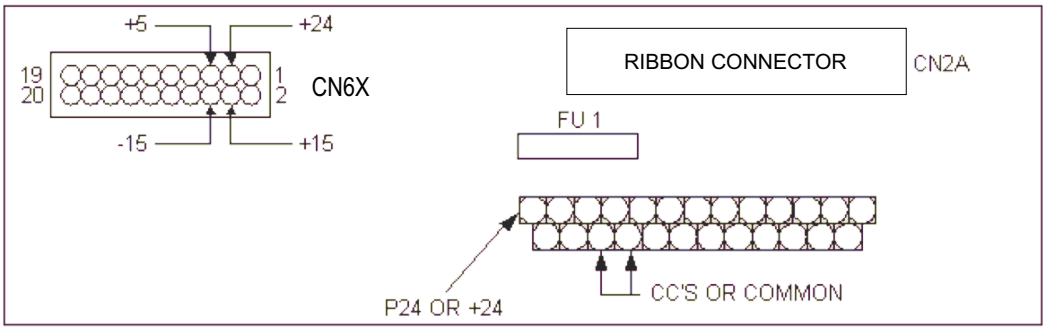


Figure 11-13: VSD Terminal Board (control power test points)

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+15	14.4 to 15.6	CN6X-4	Terminal CC
-15	–14.4 to –15.6	CN6X-6	Terminal CC
+5	4.8 to 5.2	CN6X-5	Terminal CC
+24	21 to 27	TERM P24	Terminal CC
+24	21 to 27	CN6X-3	Terminal CC

13. Also check the voltages in the VSD Interface Board voltage readings table and Interface Board test points diagram that follows.

Table 11-10: VSD Interface Board voltage readings

Positve (+) Meter Lead	Negative Meter Lead (-)	Reading
P24	LG	21 ~ 27 Vdc
P15	LG	14.5 ~15.5 Vdc
N15	LG	-14.5 ~ -15.5 Vdc
P8	LG	6 ~ 10 Vdc
P5	LG	4.8 ~ 5.2 Vdc

Positve (+) Meter Lead	Negative Meter Lead (-)	Reading
P15A	N1A	14.5 ~ 15.5 Vdc
N15A	N1A	-14.5 ~ -15.5 Vdc
P15B	N1	14.5 ~ 15.5 Vdc
N15B	N1	-14.5 ~ -15.5 Vdc

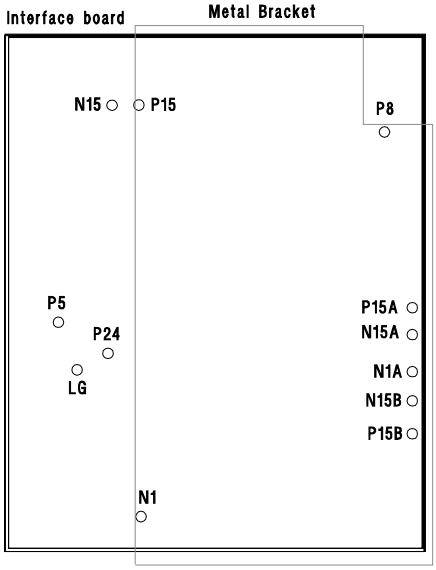


Figure 11-14: Interface Board test points

11.6.1.5 HMI Power Supply Checks for Double/Triple Inverter Units (518 to 1200 kVA)

Perform the following checks while referring to the HMI Power Supply Block Diagram and HMI Power Supply Voltages table. Ensure that the power supplies are providing the proper voltages to ground (COM) within the permissible range as shown in Figure 11-15 HMI Power Supply Block Diagram and the accompanying table.

Note

The HMI Power Supply/Power Fail Board are usually located either in the left panel of the drive enclosure or the top (ceiling) of the enclosure.

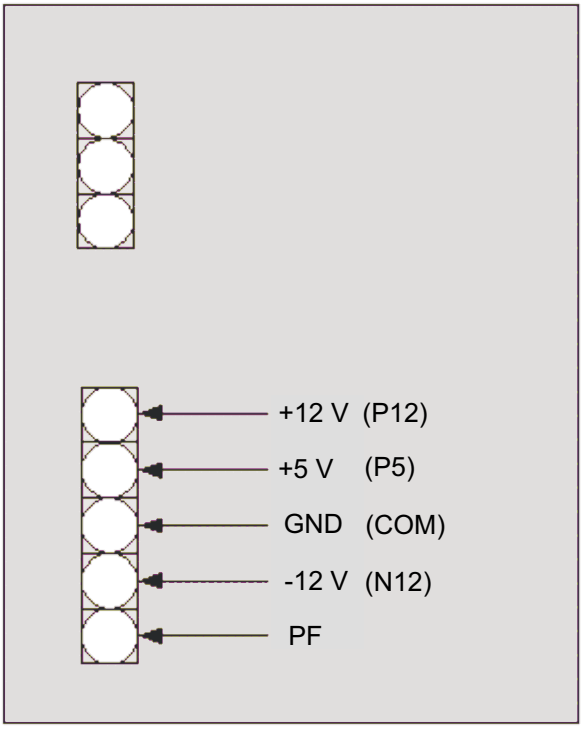


Figure 11-15: HMI Power Supply Block Diagram

Power Supply (nominal volts)	Permissible Voltage Range (volts DC)	Test Point Probe	Test Point Common
+12	approx. +12	P12	COM
+5	approx. +5	P5	COM
-12	approx. —12	N12	COM

11.6.2 VSD Output Tests for Double/Triple Inverter Units (518 to 1200 kVA)

Note

To perform the output tests desribed in this section, the VSD must be placed in SuperUser mode. The drive you are troubleshooting already has an HMI display, but you may choose to invoke SuperUser mode using the Toshiba keypad included in the Troubleshooting Required Equipment and Tools list. Be sure to refer to the correct procedure for the user interface (keypad and display) you are using.

11.6.2.1 Placing the VSD in SuperUser Mode (with Toshiba keypad)

The procedures in this subsection check the VSD output pulses to make sure the drive is operating per specification. The VSD must be placed in SuperUser mode to defeat the `DC Undervoltage` warning and subsequent drive shutdown to perform this test.

Danger

Potential Severity: Major
Potential Loss: Assets, Reputation
Hazard Category: electrical

Do not use any feature of SuperUser programming to do anything with the VSD other than temporarily placing the drive in TEST MODE as described in this procedure without specific authorization from Toshiba Corporation. Unauthorized modification of SuperUser parameters can lead to equipment damage.

Place the VSD in SuperUser mode by performing the following steps:

1. Program the VSD with the steps listed in the SuperUser mode programming steps figure that follows.

	DISPLAY	DESCRIPTION
	DC BU S UND E R VOLTAGE	When Power is applied
LOCAL / REMOTE	DC BU S UND E R VOLTAGE	Panel Control LED will change state when key is pressed unless locked out
READ / WRITE	DC BU S UND E R VOLTAGE	Press this key the display will not change
READ / WRITE & LOCAL / REMOTE	GRO UP : SUPE RU SER	Press and hold the read/write key then press local/re mote
READ / WRITE	RAMF	1st para meter of S uper User is displayed
△	TEST	Test mode setting address shown
READ / WRITE	0	Displays value in test mode
△	1	Change value to a 1 to activate test mode
READ / WRITE	TEST ◄—► 1	Test and 1 flash to show test mode is activated
PRG	OUTPUT FREQUENCY 0.0HZ	Returns to normal display
To reactivate DC U V turn off power and then re-energize		

Figure 11-16: SuperUser mode programming steps

2. Once the drive is in SuperUser mode, proceed to Base Drive Pulse Test and Output Waveform Test.

11.6.2.2 Placing the VSD in SuperUser Mode (with HMI)

The HMI has SuperUser routines included in the software (version 2.06).

Note

If the HMI you are using does not have version 2.06 software loaded, use the Toshiba keypad to invoke SuperUser mode. Do not attempt to place the drive in SuperUser mode with older software revisions of the HMI.

To place the VSD in SuperUser mode using the HMI, perform the following steps:

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

Make sure the main input fuses (that provide power to the auxiliary transformer [PT]) are removed.

1. Press the MENU/ESC key on the HMI keypad.
2. Press 999 on the numerals keypad. A non-flashing NONE displays at the bottom of the LCD.
3. Press the ENTER key. NONE display at bottom of the LCD should begin to flash.
4. Press the UP or DOWN arrows to toggle through the menu selections until TURN ON SUPERUSER appears.
5. Press ENTER. At the top of the LCD, SUPERUSER should be scrolling across horizontally. The VSD is now in SuperUser mode.
6. To exit SuperUser mode, you must cycle the power to the VSD.

11.6.2.3 Base Drive Pulse Test

After the VSD is in SuperUser mode, perform the following steps to check and verify proper waveform of the pulses at the output of the Base Drive Board.

Hint

The terms base and gate are used interchangeably to describe the Base Drive Board or Gate Drive Board in this manual.

1. Run the VSD at 60 Hz.

Danger

Potential Severity: Major
Potential Loss: Personnel
Hazard Category: electrical

Some test points on the Base Drive Board are very close to the input breaker terminals which have power on them. Keep hands and tools clear of possible high-voltage hazards.

2. Use an oscilloscope to check the waveform. Refer to the appropriate schematic for your particular drive's Base Drive Board output points. Make sure the scope is in DC input mode. The waveform should read 30 volts peak to peak (+15 volts peak to —15 volts peak) PWM square wave as shown in the Base Drive Board waveform figure.

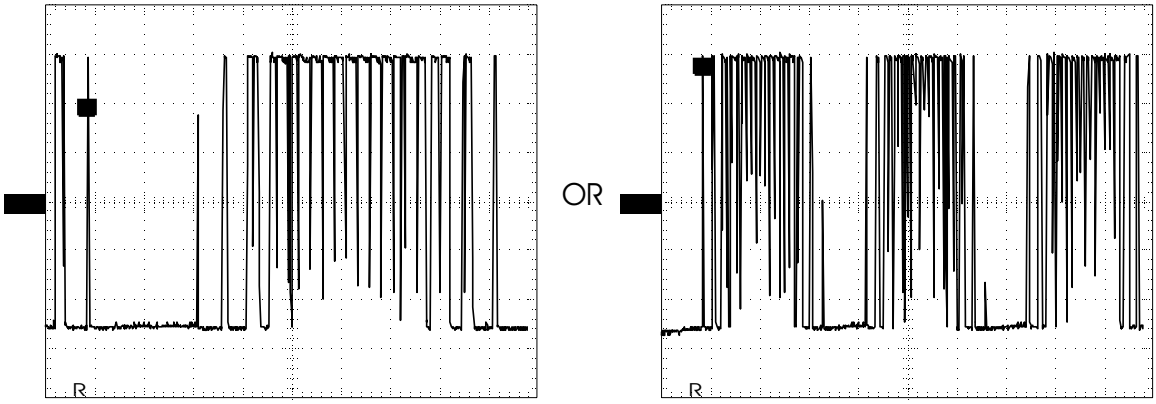


Figure 11-17: Base (Gate) Drive Board waveform. *left figure vertical scale = 5 volts per division, horizontal scale = 2 ms per division; right figure vertical scale = 5 volts per division, horizontal scale 5 ms per division*

Refer to Figure 11-18 Base (Gate) Drive Board connections for a diagram showing phase points and lead connections for the oscilloscope.

Notice that BOTH signals from the master and the slave(s) are synchronized with each other. It is VERY important that they match exactly.

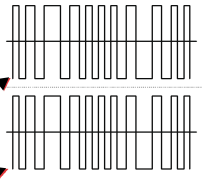
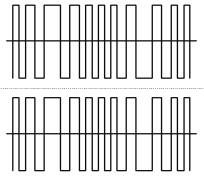
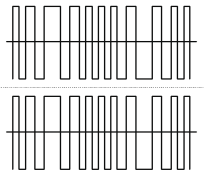
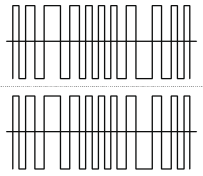
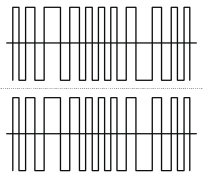
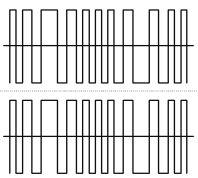
PHASE POINT ON VSD FOR REFERENCE	WAVEFORMS FROM DUAL TRACE OSCILLOSCOPE	PROBE CHANNELS 1 & 2 POSITIVE (+) LEADS	PROBE CHANNELS 1 & 2 COMMON (-) LEADS
U		← +15 VDC CN11 - 1 MASTER ← -15 VDC ← +15 VDC CN11 - 1 SLAVE A 0R B ← -15 VDC	CN11 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)
V		← +15 VDC CN21 - 1 MASTER ← -15 VDC ← +15 VDC CN21 - 1 SLAVE A 0R B ← -15 VDC	CN21 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)
W		← +15 VDC CN31 - 1 MASTER ← -15 VDC ← +15 VDC CN31 - 1 SLAVE A 0R B ← -15 VDC	CN31 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)
X		← +15 VDC CN41 - 1 MASTER ← -15 VDC ← +15 VDC CN41 - 1 SLAVE A 0R B ← -15 VDC	CN41 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)
Y		← +15 VDC CN51 - 1 MASTER ← -15 VDC ← +15 VDC CN51 - 1 SLAVE A 0R B ← -15 VDC	CN51 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)
Z		← +15 VDC CN61 - 1 MASTER ← -15 VDC ← +15 VDC CN61 - 1 SLAVE A 0R B ← -15 VDC	CN61 - 2 ON BOTH GATE DRIVE BOARDS (MASTER OR SLAVE)

Figure 11-18: Base (Gate) Drive Board connections

3. If signal looks identical to the previous waveform example, proceed directly to the Output Waveform Test section. Otherwise, proceed to the Base Drive Pulse Troubleshooting Procedures section.

11.6.2.4 Base Drive Pulse Troubleshooting Procedures

1. Check to see if the signal is leaving the Interface board by checking signals at CN20 and CN20A (If unit has three modules, also check CN20B) Pins 1 through 6 with reference to CC (or LG). Refer to Figure 11-18 Base (Gate) Drive Board connections The signal should look similar to one shown in the Waveform-signals leaving Interface board figure that follows.

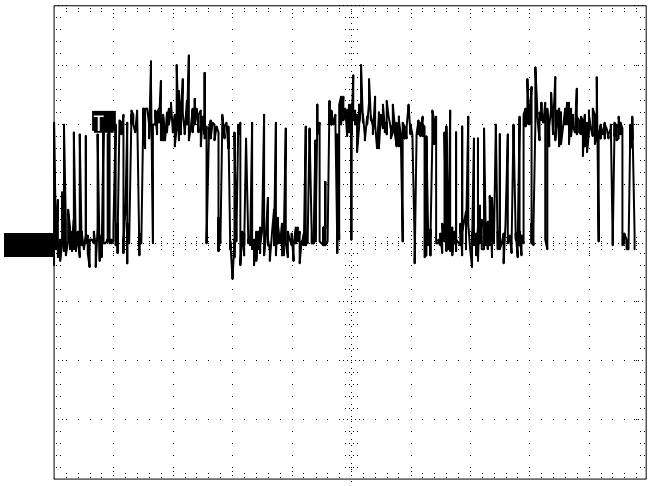


Figure 11-19: Waveform-signals leaving Interface board. *vertical scale = 2 volts per division, horizontal scale = 5 ms per division*

2. If the signal is missing, the problem is either the Control Board or Interface Board. See the appropriate schematics to trace the signal further.
3. If the proper signal is present, check to see if the signal is present at entrance to Base Drive Board, CN2A. Results should be similar to the waveform shown previously (signal leaving the Interface Board).
4. If the signal is missing at CN2A, the problem is a cable. If the signal is present, but not at output of Base Drive Board, problem is the Base Drive Board.

11.6.2.5 Output Waveform Test

Perform the following test to observe the waveforms on the output points indicated.

1. Unplug CN20A on the Interface board. (If your application has three power units, unplug CN20B also).
2. Turn the Main Power ON and reinitialize SuperUser Mode on the VSD.

3. Run the drive at 60 Hz.
4. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, and U-W. The waveform should be 8 volts peak to peak (+4 volts peak to –4 volts peak) as shown in the following example.

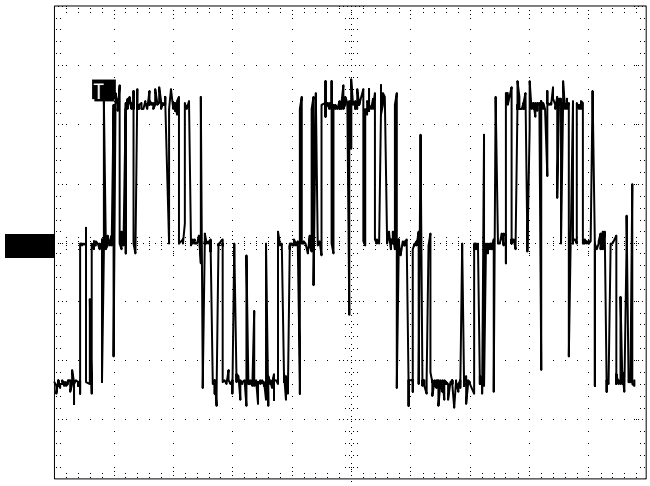


Figure 11-20: Drive output waveform. *vertical scale = 2 volts per division, horizontal scale = 5 ms per division*

5. Turn power OFF.
6. Reconnect CN20A, and disconnect CN20. (If the application has three power units, CN20B remains disconnected as well).
7. Turn Main Power ON and reinitialize Superuser Test Mode on the drive.
8. Run the drive at 60 Hz.
9. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, U-W. The waveform should be 8 volts peak to peak (+4 volts to -4 volts) as shown in Step 4.
10. Turn power OFF.
11. *If the application has only two power units*, reconnect CN20 again and skip the remaining portion of this section (Steps 12 to 17). Then proceed directly to the Reduced Voltage Output Test.
12. *If the application has three power units*, disconnect CN20A again (with CN20 still disconnected) and reconnect CN20B.
13. Turn Main Power ON and reinitialize the drive in Superuser Test Mode.
14. Run the drive at 60 Hz.
15. Use an oscilloscope to observe waveform on the outputs U-V, V-W, U-W.
16. Waveform should be 8 volts peak to peak (+4 volts to -4 volts) as shown previously.

17. Turn power OFF and reconnect CN20 and CN20A.

11.6.2.6 Reduced Output Voltage Test

This procedure tests the VSD at reduced voltage on the DC bus. Perform the following steps to test the drive:

1. Main power should still be OFF.
2. Leave CN20 connected and disconnect CN20A (and CN20B if applicable).
3. Connect a 120 volt-AC-capable jumper (cheater cord) to two of the bus bars on the input of the rectifier.
4. Connect the cheater cord to a Variac. The Variac should be set to zero (0) volts output.
5. Turn Main Power ON and reinitialize the drive in Superuser Test Mode.
6. Run the drive at 60 Hz.
7. Slowly increase the Variac until the DC bus reads approximately 30 volts DC.
8. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, U-W.
9. The waveform should be approximately 60 V peak to peak (+30V peak to –30 volts peak) as shown in Figure 11-21 Reduced output voltage waveform.

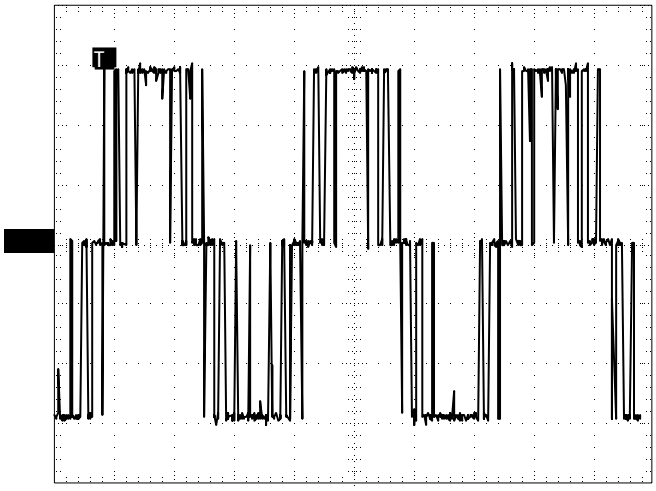


Figure 11-21: Reduced output voltage waveform. *vertical scale = 10 volts per division, horizontal scale = 5 ms per division*

10. Decrease Variac setting back to zero volts output.
11. Turn power OFF.
12. Reconnect CN20A, and disconnect CN20 (leaving CN20B disconnected, if applicable).

13. Turn Main Power ON and reinitialize the drive in Superuser Test Mode.
14. Run the drive at 60 Hz.
15. Slowly increase the Variac until the DC Bus reads approximately 30 volts DC.
16. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, U-W.
17. The waveform should appear as shown in Step 9.
18. Decrease the Variac setting back to zero (0) volts out.
19. Turn power OFF.
20. If the application you are servicing has only two power units, reconnect CN20 again and skip Step 21. Then, proceed directly to the Reduced Voltage Output Signal Timing Test subsection.
21. If your application has three power units, disconnect CN20A again (with CN20 still disconnected) and reconnect CN20B.
22. Turn Main Power ON and reinitialize Superuser Test Mode on the drive.
23. Run the drive at 60 Hz.
24. Slowly increase the Variac until the DC Bus reads approximately 30 volts DC.
25. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, and U-W.
26. The waveform should resemble the approximate 30 V (peak) (refer to Figure 11-21 Reduced output voltage waveform) as shown in previous steps.
27. Decrease Variac setting back to zero (0) volts output and turn power OFF.
28. Reconnect CN20 and CN20A (CN20, CN20A, and CN20B should all be connected).

11.6.2.7 Reduced Voltage Output Signal Timing Test

The following test sequence is used to test the timing of reduced voltage output to multiple VSD (or SWD) units. To test timing, perform the following steps:

1. Turn Main Power ON and reinitialize Superuser Test Mode on the drive.
2. Run the drive at 60 Hz.
3. Slowly increase the Variac until the DC Bus reads approximately 30 volts DC.
4. Use an oscilloscope to observe the waveform on the outputs U-V, V-W, and U-W.

5. The waveform should be 60 V peak to peak (+30V peak to –30 volts peak) (refer Figure 11-21 Reduced output voltage waveform). At this point in the procedure, the outputs of both (or all three) power units are combined at the U, V, and W outputs.

Note

Note the appearance of the PWM signal with respect to the waveform, just as you did earlier observing the output of a single power unit. The signal should be stable, with little indication that the waveform now displayed is actually the output of multiple power units overlaying one another on the screen. The Gate Interface Board is responsible for creating multiple reproductions the single gate pulse signal originating on the Control Board. The Gate Interface Board then routes these signals in phase with one another to their respective Gate Driver Boards. Significant differences in timing between these multiple signals at the U, V, and W outputs may indicate a bad Gate Interface Board (its multiple Gating Pulse outputs are out of phase) or a bad Gate Driver Board (one board has a propagation delay time which is significantly different than the other(s).

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6. Decrease the Variac setting back to zero (0) volts output.
7. Turn power OFF and remove the cheater cord to the DC bus and the Variac from the drive.

11.6.2.8 Sequence Checks

The following checks test for proper operation of drive shunt trip, timed contactor sequences, door interlock, fuse indicator, fan circuits, and other timed and monitored sequences. All sequences may not be applicable to every drive application.

Perform the following checks:

1. Verify that the power is turned OFF.
2. Reinstall the input fuses.
3. Reinstall the MST timer.
4. Set the MST timer to minimum and apply power. The input circuit breaker should shunt trip. Reset the MST to 0.3 to 1.0 seconds.
5. Reset the input circuit breaker.
6. Turn the main power ON and ensure that MS2 picks up. Approximately 1 second later, MS1 should close.

7. Test the blown fuse indicator circuit by pulling the tab on one of the indicators. The input circuit breaker should shunt trip.
8. Reset the input circuit breaker and turn the main power ON.
9. Test the door switch interlock circuit by opening the drive enclosure door. The input circuit breaker should trip.
10. Reset the input circuit breaker. Reconnect CN11, apply power, and test the fan circuit by running the drive.
11. Test all remaining sequences (differs by application/jobsite).
12. With the power ON, program the correct parameters for the appliction into the VSD.

11.6.2.9 Full Output Voltage Test (without Motor)

This test checks the VSD for proper operation without a load (motor) attached. Perform the following steps:

1. Run the drive at 10 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
2. Run the drive up to 60 Hz. With a VOM (set to AC voltage mode) check to see that the voltages between the three outputs (U-V, V-W, and U-W) are balanced. Because the drive signal is PWM instead of sinusoidal, a VOM set to AC volts may not read accurately, but all three outputs should give the same reading.
3. Verify the output waveform (at U-V, V-W, and U-W) with an oscilloscope. The waveform should look similar to one of the full voltage test waveforms (no motor load) in the following figure.

should look similar to one of the ones below.

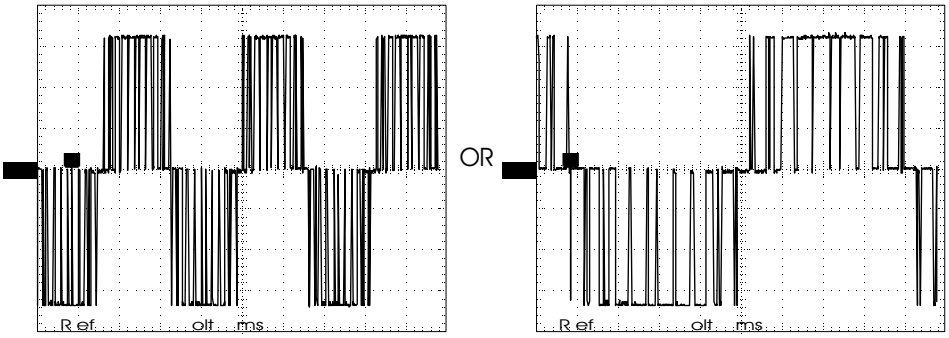

Figure 11-22: Full voltage test waveform (no motor load). *left figure vertical scale = 200 volts per division, horizontal scale = 5 ms per division; right figure vertical scale = 200 volts per division, horizontal scale = 2 ms per division*

4. Turn power OFF.

11.6.2.10 Full Output Voltage Test (with Motor)

This test checks the VSD for proper operation with a load (motor) attached. Perform the following steps:

1. Ensure all power is OFF. Reconnect the motor leads to the drive output lugs.
2. Apply power and run the drive at 10 Hz. Monitor load current on the front (HMI) display.
3. Run the drive up to 60 Hz.
4. Use clamp-on ammeters to check for balanced current between U, V, and W outputs to the motor windings. Monitor the drive performance for a reasonable period of time to ensure proper operation.

11.7 Common Fault Displays

This section describes common faults or errors as displayed on the HMI or Toshiba keypad LCD.

Code or Message	Cause	Remedial Action
OVERCURRENT (ACCEL) or DC OVERCURRENT (ACC)	Drive current exceeded 215% of its rated FLA (190% above 100 hp).	Check for phase-phase short. ACCELERATION TIME may be too small. VOLTAGE BOOST may be too high. Is motor/machine jammed? Is mechanical brake engaged while drive is running? If there is a contactor between motor and drive, wire so that contactor changes state only when drive is outputting 0.0 Hz.
OVERCURRENT (DECEL) or DC OVERCURRENT (DEC)	Drive current exceeded 215% of its rated FLA (190% above 100 hp).	Check for phase-phase short. DECELERATION TIME may be too small. Is motor/machine jammed? Is mechanical brake engaged while drive is running? Adding appropriate braking resistor across OPTIONAL "PA" and "PB" terminals may solve problem.
OVERCURRENT (RUN) or DC OVERCURRENT (RUN)	Drive current exceeded 215% of its rated FLA (190% above 100 hp).	Check for phase-phase short. Is motor/machine jammed? Is mechanical brake engaged while drive is running? If there are severe load fluctuations, adding mechanical dampening or an output line reactor may help.
U-PHASE SHORT-CIRCUIT or V PHASE SHORT-CIRCUIT or W PHASE SHORT-CIRCUIT	Drive detected short-circuit in transistor.	Replace transistor. Contact Schlumberger for authorized repair.
LOAD-END OVERCURRENT	Drive detected short-circuit on output.	Check for phase-phase short. Meg motor/leads with leads disconnected from drive. Remove any power factor correction caps on motor.
OVERVOLTAGE (ACCEL) or OVERVOLTAGE (RUN)	Bus exceeded 787 VDC.	Incoming AC may have gone high or spiked; a line reactor or a lower tap on transformer may help. Motor may be mechanically forced to run faster than drive is commanding; install appropriate OPTIONAL dynamic braking resistor. On eccentric cyclic loads like presses or pump jacks, contact REDA for special programming instructions that may make a DBR (Dynamic Braking Resistor) unnecessary.

Code or Message	Cause	Remedial Action
OVERVOLTAGE (DEC)	Bus exceeded 787 VDC.	Incoming AC may have gone high or spike; a line reactor or a lower tap on transformer may help. DECELERATION TIME #1 may be too short. Motor may be mechanically forced to run faster than drive is commanding (due to large load inertias mechanical couplings); install appropriate OPTIONAL dynamic braking resistor. On eccentric cyclic loads like presses or pump jacks, contact REDA for special programming instructions that may make a DBR unnecessary.
INVERTER OVERLOAD	Drive exceeded 100% of its rated current for too long of a time.	This trip indicates that the drive output exceeded its rated current for specific amounts of time. Make sure that drive is seeing voltage on all three of its input phases. Drive may be undersized.
MOTOR OVERLOAD	Motor is in danger of overheating because it required too much current for an excessive period as determined by the drive.	Check HMI programming manual to ensure overload is set properly.
INVERTER OVERHEAT	Drive's heatsink exceeded 90 C.	Check drive's fans (if any). Clear heatsinks of anything blocking airflow. Drive may not have been properly sized for operating altitude. Thermistor on heatsink may be bad.
EMERGENCY OFF	Drive received one of the following E-STOP commands. Drive was receiving STOP/START command via terminal strip when STOP button on optional TSK keypad was pressed. Input terminal "S4" is being opened/closed to command E-STOP.	
EEPROM WRITE FAILURE or EEPROM READ FAILURE	EEPROM was unable to read/write to peripherals.	Check for mis-wiring that may be causing noise (such as "CC" connected to ground, an external 10 volt source connected to "PP" etc.) Control board may need to be replaced (see spare parts list). See picture of board.

Code or Message	Cause	Remedial Action
RAM ERROR or ROM ERROR		Check for mis-wiring that may be causing noise (such as "CC" connected to ground, an external 10 volt source connected to "PP" etc.). Replace control board (see spare parts list). See picture of board.
OPTION ROM ERROR		Check for mis-wiring that may be causing noise (such as "CC" connected to ground, an external 10 volt source connected to "PP" etc.). If drive is energized with REDA ROM installed and is later energized without REDA ROM installed, this fault will appear. Install REDA ROM and try again. Also check for contamination in the connector and try to read ROM version with the TSK.
CPU ERROR		If REDA ROM or an option board is installed or removed when drive is powered, this fault will appear. Reset like any fault. Check for mis-wiring that may be causing noise (such as "CC" connected to ground, an external 10 volt source connected to "PP" etc.). If the CPU is truly damaged, the fault will not reset and replacement of the control board is necessary. Spare parts list. See picture of control board.
COMMUNICATION ERROR (RS-232 Time-out)	RS232 timer exceeded time limit	Check wiring to RS232 HMI port. Cable may be broken.
OPTION PCB ERROR		If drive is energized with an option board installed and is later energized without the board installed, this fault will appear. Check connectors between control board and option board. Use standoffs to secure board.

Code or Message	Cause	Remedial Action
LOW CURRENT TRIP	The drive's output current went below the current value entered in HMI for LOW CURRENT DETECT LEVEL.	Drive detected some current to ground. Depending on rating, drive senses ground fault via ZCT (hard fault) or HCT (soft fault). Comments: With leads disconnected from drive, Meg transformer or motor and leads. Look for any moisture that may provide current path to ground. Make sure that control wiring is separated from power wiring. Adding noise suppressors on coils of starters on same line as drive may snub noise picked up by ZCT. RF/EMI filter may help remove noise generated by SCR rectifiers in the vicinity. Make sure drive chassis and motor are grounded.
GATE ARRAY ERROR		Replace control board.
OUTPUT CURRENT DETECTION CIRCUIT FAIL		Occurs when drive is stopped but CPU detects current flowing. This fault could be caused by plugging in HMI cable with drive powered (resulting in damage to control board). Adding a RF/EMI filter may remove noise spikes from nearby SCR rectifiers. If the control board is damaged, the drive must be serviced.
INV TYPEFORM ERROR	Control board is not configured to drive's rating.	HMI must be reset to factory settings

11.8 Known Troubleshooting Topics

This section is included in the Troubleshooting chapter because it provides a link to resolved (known) and historic troubleshooting problems and topics. Refer to the InTouch VSD reference page for details of how the problem or issue was resolved.

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HMI Menus

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A HMI MENUS

This appendix contains examples and descriptions of all available Speedstar 2000 HMI menus (version 2.06 HMI software release).

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
100 PRIMARY MENU	ALL:__1-3	ESP:__1 HPS:__1 PCP:__1
A NUMERICAL VALUE ENTERED HERE WILL CHANGE THE MENUS TO THE LANGUAGE INDICATED. 1=ENGLISH 2=ESPANOL		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
101 PRIMARY MENU	ALL:__YES, NO	ESP:__YES HPS:__YES PCP:__YES
BY USING THE UP AND DOWN KEYS YOU CAN SELECT YES OR NO TO COMMISSION THE VSD. AFTER YES IS ENTERED THERE WILL BE A WARNING THAT ALL HISTORICAL INFORMATION AND ALL USER SET PARAMETERS WILL BE RESET TO DEFAULT VALUES. YOU MUST SELECT YES AGAIN FOR CONFIRMATION.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
102 PRIMARY MENU	ESP:__0 -9999 HPS:__0-9999 PCP:__0-9999	ESP:__0 HPS:__0 PCP:__0
THE MASTER PASSWORD WILL GIVE YOU ACCESS TO ALL OF THE PARAMETER SETTINGS. THIS PASSWORD SHOULD NOT BE AVAILABLE TO ALL OPERATORS. TO DISABLE ALL ACCESS, ENTER AN INVALID PASSWORD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
103 PRIMARY MENU	ESP:__0 -9999 HPS:__0 -9999 PCP:__0-9999	ESP:__0 HPS:__0 PCP:__0
THE MASTER PASSWORD MAY BE CHANGED IF THE EXISTING MASTER PASSWORD HAS ALREADY BEEN ENTERED. CHANGE THE PASSWORD TO A SPACE IF NO PASSWORD IS DESIRED FOR MASTER ACCESS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
104 PRIMARY MENU	ALL:__0 characters = no password-10 characters	ESP:__ HPS:__ PCP:__
THIS MENU CONTROLS THE USER'S ACCESS TO THE MENUS AND CAN ONLY BE ACCESSED AFTER THE PROPER MASTER PASSWORD HAS BEEN ENTERED. PRESS ENTER TO BEGIN CHANGING THE USER ACCESSES. TO CHANGE THE USER ACCESS, USE THE UP AND DOWN ARROW KEYS TO SCROLL THROUGH THE MENUS AND PRESS THE ENTER KEY TO TOGGLE THE ACCESS LEVEL. PRESS MENU KEY WHEN DONE.		

Figure A-1: Menus 100 to 104

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
105 PRIMARY MENU	ESP:__0 -9999 HPS:__0-9999 PCP:__0-9999	ESP:__0 HPS:__0 PCP:__0
THE USER PASSWORD ALLOWS ACCESS TO SELECTED PARAMETER SETTINGS. THE DEFAULT PARAMETERS ARE TARGET SPEED, TARGET CURRENT, TARGET PRESSURE, AND PRINTER CONTROL. USER ACCESS PARAMETERS MAY BE CHANGED USING THE MASTER PASSWORD. TO DISABLE ALL ACCESS, ENTER AN INVALID PASSWORD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
106 PRIMARY MENU	ESP:__0 -9999 HPS:__0 -9999 PCP:__0-9999	ESP:__0 HPS:__0 PCP:__0
ONCE THE USER OR MASTER PASSWORD HAS BEEN ENTERED, THE USER PASSWORD MAY BE CHANGED. CHANGE THE PASSWORD TO A SPACE IF NO PASSWORD IS DESIRED FOR USER ACCESS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
107 PRIMARY MENU	ALL:__SPEED, CURRENT, PRESSURE	ESP:__SPEED HPS:__SPEED PCP:__SPEED
USE THE UP AND DOWN ARROW KEYS TO SCROLL THROUGH THE CONTROL MODES. THE CHOICES ARE: SPEED, CURRENT, OR PRESSURE CONTROL. IN THE SPEED CONTROL MODE, THE VSD WILL ADJUST ITS SPEED TO MAINTAIN THE TARGET SPEED. IN THE CURRENT CONTROL MODE, THE VSD WILL ADJUST ITS SPEED TO MAINTAIN THE TARGET CURRENT. IN THE PRESSURE CONTROL MODE, THE VSD WILL ADJUST ITS SPEED TO MAINTAIN THE TARGET PRESSURE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
108 PRIMARY MENU	ALL:__MOTOR AMPS, ACTUAL AMPS	ESP:__ACTUAL AMPS HPS:__ACTUAL AMPS PCP:__ACTUAL AMPS
PRESS THE UP OR DOWN KEYS TO SELECT HOW THE CURRENT (AMPS) IS DISPLAYED. THE CHOICES ARE ACTUAL AMPS OR MOTOR AMPS. THE ACTUAL AMPS IS THE ACTUAL AMPERAGE OF THE VSD ON THE OUTPUT TERMINALS. THE MOTOR AMPERAGE IS A SCALED MEASUREMENT ENTERED IN THE FOLLOWING PARAMETER TYPICALLY USED TO COMPENSATE FOR VARIOUS LOSSES SO THE DISPLAYED AMPERAGE REFLECTS THE AMPERAGE REACHING THE MOTOR.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
109 PRIMARY MENU	ESP:__0-10000 HPS:__0-4000 PCP:__0-10000	ESP:__0 HPS:__0 PCP:__0
ENTER THE ACTUAL MOTOR CURRENT (AMPS). WHEN MOTOR AMPS IS SELECTED IN THE PREVIOUS PARAMETER, THE MEASURED AMPERAGE WILL BE SCALED TO THE ACTUAL MOTOR AMPERAGE. FOR BEST ACCURACY, ENTER THE VALUE WHILE THE DRIVE IS RUNNING AT 50% OR MORE OF RATED LOAD.		

Figure A-2: Menus 105 to 109

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
110 PRIMARY MENU	ALL:__0	ESP:__0 HPS:__0 PCP:__0
USE THE KEYPAD TO ENTER AN ALPHANUMERIC NAME. THIS IS A USER DEFINED ENTRY FOR IDENTIFICATION OF THE EQUIPMENT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
111 PRIMARY MENU	ALL:__	ESP:__ HPS:__ PCP:__
AFTER PRESSING ENTER, YOU MAY USE THE UP AND DOWN ARROW KEYS TO SCROLL THROUGH THE HISTORY. PRESSING ENTER WILL EXIT THE VIEW MODE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
112 PRIMARY MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
RECORDS ARE KEPT OF THE POWER ON TIME, THE VSD RUNNING TIME AND THE NUMBER OF VSD STARTS. THERE ARE TWO SETS OF THESE RECORDS, ONE WHICH THE USER MAY RESET, TYPICALLY WHEN A NEW PUMP OR MOTOR IS INSTALLED. TO RESET THE RECORDS SELECT 'YES'. THE RECORDS MAY BE SEEN IN THE STATUS SCREEN AND BY PRINTING OUT THE CONFIGURATION.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
120 SPEED MENU	ALL:__USER INPUT, ANALOG 1, ANALOG 2	ESP:__USER INPUT HPS:__USER INPUT PCP:__USER INPUT
THIS IS WHERE THE VSD WILL REFERENCE ITS TARGET SPEED WHEN IN THE SPEED CONTROL MODE. PRESS THE UP OR DOWN KEYS TO SCROLL THROUGH THE CHOICES. WHEN AN ANALOG INPUT IS SELECTED THE SPEED IS REFERENCED TO THE SCALED VALUE OF THAT ANALOG INPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
121 SPEED MENU	ESP:__20-90 HPS:__10-70 PCP:__6-70	ESP:__50 HPS:__60 PCP:__45
THE TARGET SPEED IS USED WHEN IN THE SPEED CONTROL MODE. THIS VALUE MUST BE WITHIN THE MINIMUM AND MAXIMUM LIMITS SET IN FOLLOWING PARAMETERS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
122 SPEED MENU	ESP:__20-90 HPS:__10-70 PCP:__6-70	ESP:__20 HPS:__30 PCP:__10
THIS VALUE IS NOT A TRIP POINT. IT IS THE MINIMUM FREQUENCY AT WHICH THE VSD WILL RUN.		

Figure A-3: Menus 110 to 122

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
123 SPEED MENU	ESP:__20-90 HPS:__31-70 PCP:__10-70	ESP:__60 HPS:__70 PCP:__60
THIS VALUE IS NOT A TRIP POINT. IT IS THE MAXIMUM FREQUENCY AT WHICH THE VSD WILL RUN.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
124 SPEED MENU	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__4 HPS:__2 PCP:__4
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE THE SPEED CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
125 SPEED MENU	ALL:__1-10000	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE THE SPEED CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
126 SPEED MENU	ALL:__0-120	ESP:__0 HPS:__0 PCP:__0
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE CENTER FREQUENCY. SETTING THIS PARAMETER TO ZERO WILL DISABLE THIS FEATURE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
127 SPEED MENU	ALL:__1-5	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE BANDWIDTH FREQUENCY. IF THE PREVIOUS PARAMETER IS SET TO 30 AND THIS PARAMETER IS SET TO 4, THE VSD WILL AVOID THE FREQUENCY RANGE OF 28 TO 32 HZ.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
128 SPEED MENU	ALL:__0-120	ESP:__0 HPS:__0 PCP:__0
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE CENTER FREQUENCY. SETTING THIS PARAMETER TO ZERO WILL DISABLE THIS FEATURE.		

Figure A-4: Menus 123 to 128

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
129 SPEED MENU	ALL:__1-5	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE BANDWIDTH FREQUENCY. IF THE PREVIOUS PARAMETER IS SET TO 30 AND THIS PARAMETER IS SET TO 4, THE VSD WILL AVOID THE FREQUENCY RANGE OF 28 TO 32 HZ.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
130 SPEED MENU	ALL:__0-120	ESP:__0 HPS:__0 PCP:__0
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE CENTER FREQUENCY. SETTING THIS PARAMETER TO ZERO WILL DISABLE THIS FEATURE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
131 SPEED MENU	ALL:__1-5	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE A FREQUENCY RANGE THAT MAY CAUSE PROBLEMS. THE VSD WILL AVOID THIS FREQUENCY RANGE IN ALL CONTROL MODES. THIS VALUE SETS THE BANDWIDTH FREQUENCY. IF THE PREVIOUS PARAMETER IS SET TO 30 AND THIS PARAMETER IS SET TO 4, THE VSD WILL AVOID THE FREQUENCY RANGE OF 28 TO 32 HZ.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
140 CURRENT MENU	ESP:__0-5000 HPS:__0-4000 PCP:__0-5000	ESP:__50 HPS:__50 PCP:__50
THE TARGET CURRENT IS USED WHEN IN THE CURRENT CONTROL MODE. THIS VALUE MUST BE WITHIN THE MINIMUM AND MAXIMUM LIMITS SET IN FOLLOWING PARAMETERS. IT IS VERY IMPORTANT TO REMEMBER THAT WHETHER THE AMPERAGE DISPLAY PARAMETER IS THE REAL AMPERAGE OR THE SCALED AMPERAGE, THE NUMBER ENTERED HERE IS BASED AND DISPLAYED ON THAT VALUE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
141 CURRENT MENU	ESP:__0-5000 HPS:__0-4000 PCP:__0-5000	ESP:__0 HPS:__0 PCP:__0
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MINIMUM CURRENT ALLOWED DURING OPERATION. IT IS VERY IMPORTANT TO REMEMBER THAT WHETHER THE AMPERAGE DISPLAY PARAMETER IS THE REAL AMPERAGE OR THE SCALED AMPERAGE, THE NUMBER ENTERED HERE IS BASED AND DISPLAYED ON THAT VALUE.		

Figure A-5: Menus 129 to 141

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
142 CURRENT MENU	ESP:__0-5000 HPS:__0-4000 PCP:__0-5000	ESP:__100 HPS:__100 PCP:__100
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MAXIMUM CURRENT ALLOWED DURING OPERATION (SHOULD NOT EXCEED MAXIMUM OUTPUT CURRENT). IT IS VERY IMPORTANT TO REMEMBER THAT WHETHER THE AMPERAGE DISPLAY PARAMETER IS THE REAL AMPERAGE OR THE SCALED AMPERAGE, THE NUMBER ENTERED HERE IS BASED AND DISPLAYED ON THAT VALUE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
143 CURRENT MENU	ESP:__0-864000 HPS:__0-3600 PCP:__0-864000	ESP:__60 HPS:__60 PCP:__60
ENTER THE ALLOWABLE TIME FOR OPERATION IN AN UNDER CURRENT CONDITION DURING STARTUP. THIS IS HOW LONG AN UNDER CURRENT CONDITION WILL BE IGNORED DURING THE STARTUP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
144 CURRENT MENU	ESP:__1-3600 HPS:__1-600 PCP:__1-3600	ESP:__60 HPS:__60 PCP:__60
THIS DELAY ALLOWS OPERATION IN AN UNDER CURRENT CONDITION FOR THE TIME SET. THE ACTIVATION DELAY TIMER WILL CAUSE AN UNDER CURRENT CONDITION TO BE IGNORED FOR THE TIME ENTERED. WHEN THIS TIME IS EXCEEDED A SHUTDOWN WILL OCCUR.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
145 CURRENT MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USE THE UP OR DOWN KEYS TO TOGGLE THIS ENTRY. IF AUTO RESTART IS "YES", WHEN AN UNDER CURRENT SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THE FOLLOWING PARAMETER. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
146 CURRENT MENU	ALL:__1-864000	ESP:__1800 HPS:__1800 PCP:__1800
AFTER AN UNDER CURRENT SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THIS PARAMETER. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

Figure A-6: Menus 142 to 146

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
147 CURRENT MENU	ALL:__1-9999	ESP:__6 HPS:__6 PCP:__6
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER UNDER CURRENT SHUTDOWNS. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS ON UNDER CURRENT SHUTDOWNS. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
148 CURRENT MENU	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE THE CURRENT CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
149 CURRENT MENU	ESP:__1-10000 HPS:__1-7200 PCP:__1-10000	ESP:__10 HPS:__10 PCP:__10
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE THE CURRENT CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
150 CURRENT MENU	ALL:__0-5	ESP:__0 HPS:__0 PCP:__0
THIS DELAY ALLOWS OPERATION IN AN OVER CURRENT CONDITION FOR THE TIME SET. THE ACTIVATION DELAY TIMER WILL CAUSE AN OVER CURRENT CONDITION TO BE IGNORED FOR THE TIME ENTERED. WHEN THIS TIME IS EXCEEDED A SHUTDOWN WILL OCCUR.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
151 CURRENT MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
THIS MENU IS USED TO ENABLE OR DISABLE THE TRACKING UNDERLOAD FUNCTION, WHICH IS TYPICALLY USED TO PREVENT DAMAGE CAUSED BY CONDITIONS SUCH AS GAS LOCKS. MENU 152 SETS THE TRACKING UNDERLOAD LEVEL AS A PERCENTAGE OF THE RUNNING CURRENT. THE TRACKING UNDERLOAD SHUTDOWN SHARES THE SAME SHUTDOWN AND RESTART TIMERS AS THE NORMAL UNDERLOAD SHUTDOWNS.		

Figure A-7: Menus 147 to 151

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
152 CURRENT MENU	ALL:__0.0-98.9	ESP:__85.0 HPS:__85.0 PCP:__85.0
IF TRACKING UNDERLOAD IS ENABLED (MENU 151) THIS MENU SETS THE PERCENTAGE OF THE AVERAGE RUNNING CURRENT THAT WILL START THE UNDERLOAD SHUTDOWN TIMERS TO COUNT DOWN THIS TRACKING UNDERLOAD CURRENT IS BASED ON A RUNNING AVERAGE OF THE LAST FEW MINUTES OF CURRENT. IF THERE ARE ANY SUDDEN SPEED CHANGES THE TRACKING UNDERLOAD CURRENT IS AUTOMATICALLY RESET TO ZERO, AND WILL START TO BUILD BACK UP AGAIN TOWARDS THE SET PERCENTAGE OF NORMAL RUNNING CURRENT AS THE DRIVE RUNS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
160 PRESSURE MENU	ALL:__1-10000	ESP:__2500 HPS:__5000 PCP:__2500
THE TARGET PRESSURE IS USED WHEN IN THE PRESSURE CONTROL MODE. THIS VALUE MUST BE WITHIN THE MINIMUM AND MAXIMUM LIMITS SET IN FOLLOWING PARAMETERS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
161 PRESSURE MENU	ALL:__0-9999	ESP:__0 HPS:__0 PCP:__0
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MINIMUM PRESSURE ALLOWED DURING OPERATION.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
162 PRESSURE MENU	ESP:__1-20000 HPS:__1-15000 PCP:__1-20000	ESP:__5000 HPS:__10000 PCP:__5000
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MAXIMUM PRESSURE ALLOWED DURING OPERATION.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
163 PRESSURE MENU	ALL:__ANALOG 1,ANALOG 2,NONE	ESP:__NONE HPS:__NONE PCP:__NONE
ENTER THE ANALOG INPUT NUMBER CONNECTED TO PRESSURE SENSING DEVICE. THIS SETTING INDICATES THE ANALOG INPUT TO BE USED IN PRESSURE CONTROL MODE.		

Figure A-8: Menus 152 to 163

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
164 PRESSURE MENU	ALL:__SPEED UP, SLOW DOWN	ESP:__SPEED UP HPS:__SPEED UP PCP:__SPEED UP
USE THE UP OR DOWN ARROW KEYS TO TOGGLE ENTRIES. THIS SETTING DEFINES THE ACTION ON A PRESSURE INCREASE. "SPEED UP" WILL CAUSE THE MOTOR SPEED TO INCREASE. "SLOW DOWN" WILL CAUSE THE MOTOR SPEED TO DECREASE. THE AMOUNT OF CHANGE IS SET IN THE FOLLOWING PARAMETERS. THIS PARAMETER IS USED ONLY IN PRESSURE CONTROL MODE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
165 PRESSURE MENU	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__0.5 HPS:__0.5 PCP:__0.5
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE THE PRESSURE CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
166 PRESSURE MENU	ESP:__1-10000 HPS:__1-7200 PCP:__1-10000	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE THE PRESSURE CONTROL RAMP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
167 PRESSURE MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USE THE UP OR DOWN ARROW KEYS TO ENABLE OR DISABLE THE UNDER PRESSURE SHUTDOWN OPTION. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
168 PRESSURE MENU	ALL:__0-86400	ESP:__0 HPS:__0 PCP:__0
ENTER THE ALLOWABLE TIME FOR OPERATION IN AN UNDER PRESSURE CONDITION DURING STARTUP. THIS IS HOW LONG AN UNDER PRESSURE CONDITION WILL BE IGNORED DURING THE STARTUP. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
169 PRESSURE MENU	ALL:__0-86400	ESP:__0 HPS:__0 PCP:__0
ENTER THE UNDER PRESSURE ACTIVATION DELAY TIME. THIS DELAY ALLOWS OPERATION IN AN UNDER PRESSURE CONDITION FOR THE TIME SET. THE ACTIVATION DELAY TIMER WILL CAUSE AN UNDER PRESSURE CONDITION TO BE IGNORED FOR THE TIME ENTERED. WHEN THIS TIME IS EXCEEDED A SHUTDOWN WILL OCCUR. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

Figure A-9: Menus 164 to 169

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
170 PRESSURE MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USE THE UP OR DOWN KEYS TO TOGGLE THIS ENTRY. IF AUTO RESTART IS "YES", WHEN AN UNDER PRESSURE SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THE FOLLOWING PARAMETER. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
171 PRESSURE MENU	ALL:__1-9999	ESP:__1 HPS:__3 PCP:__1
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER UNDER PRESSURE SHUTDOWNS. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS ON UNDER PRESSURE SHUTDOWNS. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
172 PRESSURE MENU	ALL:__TIME, PRESSURE-TIME, PRESSURE	ESP:__TIME HPS:__TIME PCP:__TIME
USE THE UP OR DOWN KEYS TO SELECT TIME OR PRESSURE AUTO RESTART. IF TIME IS SELECTED, THE VSD WILL WAIT FOR THE AMOUNT OF TIME IN THE FOLLOWING PARAMETER BEFORE AN AUTO RESTART IS ATTEMPTED. IF PRESSURE IS SELECTED, THE VSD WILL WAIT FOR THE PRESSURE INPUT TO RISE ABOVE THE SETTING IN THE FOLLOWING PARAMETER BEFORE AN AUTO RESTART IS ATTEMPTED. PRESSURE CONTROL MODE AND AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
173 PRESSURE MENU	ALL:__1-20000	ESP:__1 HPS:__1 PCP:__1
AFTER AN UNDER PRESSURE SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE PRESSURE RECOVERS TO THE LEVEL ENTERED IN THIS PARAMETER. (THE LEVEL ENTERED MUST BE ABOVE THE MINIMUM PRESSURE TRIP POINT). AUTO MODE, AUTO RESTART, AND PRESSURE CONTROL MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. UNDER PRESSURE RESTART TYPE MUST ALSO BE SELECTED TO "PRESSURE" FOR THE FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
174 PRESSURE MENU	ALL:__1-864000	ESP:__1800 HPS:__1800 PCP:__1800
AFTER AN UNDER PRESSURE SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THIS PARAMETER. AUTO MODE, AUTO RESTART, AND PRESSURE CONTROL MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. UNDER PRESSURE RESTART TYPE MUST ALSO BE SELECTED TO "TIME" FOR THE FUNCTION TO TAKE EFFECT.		

Figure A-10: Menus 170 to 174

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
175 PRESSURE MENU	ALL:__0-864000	ESP:__0 HPS:__0 PCP:__0
THIS VALUE IS ADDED TO THE AUTO RESTART DELAY TIMER EACH TIME A RESTART OCCURS. THIS FUNCTIONALITY IS USEFUL IN PRESSURE PUMP OFF TESTING. AUTO MODE, AUTO RESTART, AND PRESSURE CONTROL MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. UNDER PRESSURE RESTART TYPE MUST ALSO BE SELECTED TO "TIME" FOR THE FUNCTION TO TAKE EFFECT. FOR EXAMPLE, WITH THE AUTO RESTART SET AT 60 MINUTES AND THE NUMBER OF ALLOWED RESTARTS SET TO 5 AND THE INCREMENT VALUE WAS SET TO 0 MINUTES, THEN THE TIME BETWEEN RESTARTS WOULD BE 60, 60, 60, 60, AND 60. IF THE INCREMENT VALUE WAS SET TO 30 MINUTES INSTEAD OF 0, THEN THE TIME BETWEEN RESTARTS WOULD BE 90, 120, 150, 180, AND 210.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
176 PRESSURE MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USE THE UP OR DOWN ARROW KEYS TO ENABLE OR DISABLE THE OVER PRESSURE SHUTDOWN OPTION. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
177 PRESSURE MENU	ALL:__1-864000	ESP:__30 HPS:__30 PCP:__30
ENTER THE ALLOWABLE TIME FOR OPERATION IN AN OVER PRESSURE CONDITION DURING STARTUP. THIS IS HOW LONG AN OVER PRESSURE CONDITION WILL BE IGNORED DURING THE STARTUP. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
178 PRESSURE MENU	ALL:__1-864000	ESP:__1 HPS:__1 PCP:__1
ENTER THE OVER PRESSURE ACTIVATION DELAY TIME. THIS DELAY ALLOWS OPERATION IN AN OVER PRESSURE CONDITION FOR THE TIME SET. THE ACTIVATION DELAY TIMER WILL CAUSE AN OVER PRESSURE CONDITION TO BE IGNORED FOR THE TIME ENTERED. WHEN THIS TIME IS EXCEEDED A SHUTDOWN WILL OCCUR. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
179 PRESSURE MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USE THE UP OR DOWN KEYS TO TOGGLE THIS ENTRY. IF AUTO RESTART IS "YES", WHEN AN OVER PRESSURE SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THE FOLLOWING PARAMETER. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

Figure A-11: Menus 175 to 179

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
180 PRESSURE MENU	ALL:__1-9999	ESP:__1 HPS:__3 PCP:__1
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER OVER PRESSURE SHUTDOWNS. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS ON OVER PRESSURE SHUTDOWNS. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
181 PRESSURE MENU	ALL:__1-864000	ESP:__1800 HPS:__1800 PCP:__1800
AFTER AN OVER PRESSURE SHUTDOWN OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THIS PARAMETER. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
182 PRESSURE MENU	ALL:__PID, NORMAL	ESP:__NORMAL HPS:__NORMAL PCP:__NORMAL
WHEN THIS PARAMETER IS SELECTED TO YES IT WILL ENABLE THE PID CONTROL FOR THE VSD. THE TARGET PRESSURE WILL BECOME THE SET POINT, THE INPUT SELECTION WILL BECOME THE PROCESS VARIABLE INPUT, THE SPEED UP OR SLOW DOWN WITH PRESSURE RISE WILL BECOME THE CONTROL ACTION, THE CONTROL RAMP HZ AND SECONDS WILL BE DISABLED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
183 PRESSURE MENU	ALL:__0-10	ESP:__1 HPS:__1 PCP:__1
THIS IS THE PROPORTIONAL SETTING FOR THE PID CONTROL LOOP.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
184 PRESSURE MENU	ALL:__0-100.0	ESP:__0.1 HPS:__0.1 PCP:__0.1
THIS IS THE INTEGRAL SETTING OF THE PID CONTROL LOOP. THE VALUE ENTERED HERE IS IN REPEATS / MINUTE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
185 PRESSURE MENU	ALL:__0.0-100.0	ESP:__0 HPS:__0 PCP:__0
THIS IS THE DERIVATIVE SETTING OF THE PID CONTROL LOOP. THE VALUE ENTERED HERE IS IN MINUTES.		

Figure A-12: Menus 180 to 185

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
200 VSD SETUP MENU	ALL:__ESP, HPS, PCP	ESP:__ESP HPS:__HPS PCP:__PCP
USE THE UP OR DOWN KEYS TO SCROLL THROUGH THE SELECTIONS. PRESS ENTER TO ACCEPT THE SELECTED PUMPING SYSTEM. THIS PARAMETER ALLOWS THE VSD TO PRESET CERTAIN PARAMETERS DEPENDING ON THE TYPE OF APPLICATION. THIS SHOULD ONLY BE CHANGED WHEN RECOMMISSIONING.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
203 VSD SETUP MENU	ALL:__50-60	ESP:__60 HPS:__60 PCP:__60
USING THE KEYPAD YOU MAY ENTER THE LINE FREQUENCY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
204 VSD SETUP MENU	ESP:__30-120 HPS:__30-70 PCP:__30-120	ESP:__60 HPS:__60 PCP:__60
BY USING THE KEYPAD YOU MAY ENTER THE BASE SPEED OF THE VSD. THE BASE SPEED IS THE POINT AT WHICH THE VSD WILL REACH ITS MAXIMUM OUTPUT VOLTAGE AT THE FREQUENCY ENTERED. IF 70 IS ENTERED AND THE INPUT VOLTAGE OF THE VSD IS 460 VOLTS, THEN THE VSD WILL OUTPUT 460 VOLTS AT 70 HZ.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
205 VSD SETUP MENU	ALL:__YES, NO	ESP:__NO HPS:__YES PCP:__NO
USING THE UP OR DOWN KEYS THE OPERATOR WILL SELECT "YES" TO HAVE THE VSD AUTO RESTART AFTER A POWER LOSS OR "NO" TO HAVE THE VSD DO NOTHING AFTER A POWER LOSS HAS SHUTDOWN THE VSD. THE VSD MUST BE IN THE AUTO MODE FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
206 VSD SETUP MENU	ALL:__1-864000	ESP:__1800 HPS:__1800 PCP:__1800
AFTER A POWER LOSS OCCURS, AN AUTOMATIC RESTART WILL BE ATTEMPTED AFTER THE TIME ENTERED IN THIS PARAMETER. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

Figure A-13: Menus 200 to 206

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
207 VSD SETUP MENU	ALL:__1-9999	ESP:__1 HPS:__3 PCP:__1
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER POWER LOSSES. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS AFTER POWER LOSSES. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
208 VSD SETUP MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
THIS ENABLES OR DISABLES THE DRIVE FROM AUTOMATICALLY STARTING AFTER A PRESET TIME (SET BY MENU 209) WHEN THE DRIVE IS SWITCHED FROM THE OFF TO THE AUTO MODE. THIS MENU AND MENU 209 ONLY AFFECT THE AUTO START TIME AS THE DRIVE IS SWITCHED FROM OFF TO AUTO AND THESE TWO MENUS HAVE NO EFFECT ON ANY OF THE OTHER AUTO RESTART ENABLES OR TIMES.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
209 VSD SETUP MENU	ALL:__1-864000	ESP:__1800 HPS:__1800 PCP:__1800
THIS IS THE TIME THAT THE DRIVE WILL WAIT BEFORE MAKING AN AUTOSTART ATTEMPT AFTER THE DRIVE IS SWITCHED FROM OFF TO AUTO, PROVIDED THAT MENU 208, THE 'TIMED AUTOSTART' IS ENABLED. THIS TIME AND MENU 208 ONLY AFFECT THE AUTO START AS THE DRIVE IS SWITCHED FROM OFF TO AUTO. THESE TWO MENUS HAVE NO EFFECT ON ANY OF THE OTHER AUTO RESTART ENABLES OR TIMES.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
212 VSD SETUP MENU	ALL:__CONTROLLED, COASTING	ESP:__COASTING HPS:__CONTROLLED PCP:__COASTING
THIS PARAMETER SETS THE VSD TO COAST TO A STOP OR RAMP TO A STOP. (WARNING SETTING THIS PARAMETER INCORRECTLY CAN CAUSE SERIOUS EQUIPMENT DAMAGE IN SOME APPLICATIONS)		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
213 VSD SETUP MENU	ALL:__104-170	ESP:__160 HPS:__160 PCP:__160
THIS PARAMETER SETS THE HIGHEST TEMPERATURE AT WHICH THE VSD WILL RUN.		

Figure A-14: Menus 207 to 213

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
214 VSD SETUP MENU	ALL:__-40-50	ESP:__-40 HPS:__-40 PCP:__-40
THIS PARAMETER SETS THE LOWEST TEMPERATURE AT WHICH THE VSD WILL RUN.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
215 VSD SETUP MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
SELECTING YES WILL RESET THE MINIMUM/MAXIMUM INTERNAL TEMPERATURES THAT HAVE BEEN RECORDED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
216 VSD SETUP MENU	ALL:__	ESP:__ HPS:__ PCP:__
THIS PARAMETER SETS THE TIME OF THE INTERNAL CLOCK.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
217 VSD SETUP MENU	ALL:__	ESP:__ HPS:__ PCP:__
THIS PARAMETER SETS THE DATE OF THE INTERNAL CLOCK.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
218 VSD SETUP MENU	ALL:__1-2	ESP:__1 HPS:__1 PCP:__2
BY USING THE UP AND DOWN KEYS YOU MAY REVERSE THE DIRECTION OF THE MOTOR BY SCROLLING THROUGH THE CHOICES. DIRECTION IS RELATIVE, DEPENDING ON HOW THE MOTOR IS HOOKED UP THEREFORE THE CHOICES ARE 1 AND 2 INSTEAD OF FORWARD AND REVERSE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
219 VSD SETUP MENU	ALL:__1-9999	ESP:__24 HPS:__24 PCP:__24
THIS IS THE NUMBER OF HOURS THAT THE UNIT MUST RUN BEFORE THE NUMBER OF RESTARTS WILL BE AUTOMATICALLY CLEARED. THIS IS USED SO FAILURES THAT OCCUR INTERMITTENTLY WILL NOT CAUSE A SHUTDOWN THAT REQUIRES USER INTERVENTION TO RESTART.		

Figure A-15: Menus 214 to 219

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
240 PRINT MENU	ALL:__	ESP:__ HPS:__ PCP:__
BY PRESSING ENTER KEY WHILE IN THIS PARAMETER THE CONFIGURATION WILL BE PRINTED TO THE SERIAL PORT ON THE FRONT OF THE OPERATOR INTERFACE. THE DRIVE WILL SHOW "PRINTING CONFIGURATION" TO CANCEL THIS OPERATION THE MENU/ESC KEY MAY BE PRESSED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
241 PRINT MENU	ALL:__EVENTS, DAYS	ESP:__EVENTS HPS:__EVENTS PCP:__EVENTS
BY USING THE UP OR DOWN KEYS YOU MAY SELECT THE EVENTS OR DAYS BACK THAT IS TO BE PRINTED. THE NUMBER OF EVENTS OR DAYS TO BE PRINTED IS ENTERED IN THE NEXT PARAMETER.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
242 PRINT MENU	ALL:__1-1000	ESP:__20 HPS:__20 PCP:__20
BY USING THE KEYPAD YOU MAY ENTER HERE HOW MANY EVENTS OR DAYS OF HISTORY ARE TO BE PRINTED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
243 PRINT MENU	ALL:__	ESP:__ HPS:__ PCP:__
BY PRESSING ENTER KEY WHILE IN THIS PARAMETER THE HISTORY FILE BE PRINTED TO THE SERIAL PORT ON THE FRONT OF THE OPERATOR INTERFACE. THE DRIVE WILL SHOW "PRINTING HISTORY" TO CANCEL THIS OPERATION THE MENU/ESC KEY MAY BE PRESSED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
244 PRINT MENU	ALL:__YES, NO	ESP:__YES HPS:__YES PCP:__YES
BY USING THE UP AND DOWN KEYS YOU MAY ENABLE OR DISABLE THE DATA LOGGING FUNCTIONS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
245 PRINT MENU	ALL:__1-480	ESP:__15 HPS:__15 PCP:__15
BY USING THE KEYPAD YOU MAY ENTER THE AMOUNT OF TIME (IN MINUTES) BETWEEN EACH LOG CYCLE. BY ENTERING A SMALL NUMBER THE DATA IS LOGGED MORE OFTEN AND CAN GIVE MORE INFORMATION WHEN ANALYZED, THIS MAY BE USEFUL FOR TROUBLE SHOOTING WELL PROBLEMS.		

Figure A-16: Menus 240 to 245

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
246 PRINT MENU	ALL:__EVENTS, DAYS	ESP:__EVENTS HPS:__EVENTS PCP:__EVENTS
BY USING THE UP OR DOWN KEYS YOU MAY SELECT THE EVENTS OR DAYS BACK THAT IS TO BE PRINTED. THE NUMBER OF EVENTS OR DAYS TO BE PRINTED IS ENTERED IN THE NEXT PARAMETER.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
247 PRINT MENU	ALL:__1-1000	ESP:__20 HPS:__20 PCP:__20
BY USING THE KEYPAD YOU MAY ENTER HOW MANY EVENTS OR DAYS OF LOGGED DATA ARE TO BE PRINTED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
248 PRINT MENU	ALL:__	ESP:__ HPS:__ PCP:__
BY PRESSING ENTER KEY WHILE IN THIS PARAMETER THE LOGGED DATA FILE BE PRINTED TO THE SERIAL PORT ON THE FRONT OF THE OPERATOR INTERFACE. THE DRIVE WILL SHOW "PRINTING LOG DATA" TO CANCEL THIS OPERATION THE MENU/ESC KEY MAY BE PRESSED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
250 PRINT MENU	ALL:__	ESP:__ HPS:__ PCP:__
SELECT THE ITEM THAT WILL BE PRINTED AS A GRAPH AGAINST TIME. MENU 251 SETS THE NUMBER OF DAYS TO GRAPH, MENU 252 THE GRAPH SCALE AND MENU 252 STARTS THE GRAPH PRINTING.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
251 PRINT MENU	ALL:__1-100	ESP:__2 HPS:__2 PCP:__2
SELECT THE NUMBER OF DAYS TO GRAPH. MENU 250 SELECTS THE ITEM TO GRAPH, MENU 252 THE GRAPH SCALE HEIGHT AND MENU 253 STARTS THE GRAPH PRINTING.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
252 PRINT MENU	ALL:__1.0-9999	ESP:__90.0 HPS:__90.0 PCP:__90.0
THE MAXIMUM HEIGHT OF THE GRAPH SCALE MAY BE SET HERE. THIS ALLOWS THE GRAPH TO BE SCALED IN OR OUT TO SHOW AREAS OF INTEREST.		

Figure A-17: Menus 246 to 252

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
253 PRINT MENU	ALL:__	ESP:__ HPS:__ PCP:__
ONCE THE GRAPH PRINT SETTINGS HAVE BEEN ENTERED USING MENUS 250,251 AND 252 THIS MENU LETS THE USER START OR STOP THE GRAPH PRINTING.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
261 PRINT MENU	ALL:__	ESP:__VSD OUTPUT CURRENT HPS:__VSD OUTPUT CURRENT PCP:__VSD OUTPUT CURRENT
THIS MENU SELECTS THE PARAMETERS TO BE LOGGED TO THE DATALOG FILE. THIS SELECTION CAN BE CHANGED AT ANY TIME. AN ENTRY WITH VALUES EQUAL TO 999.9 INDICATE A CHANGE WAS MADE, HOWEVER THE PARAMETER NAME IS NOT STORED INSIDE THE LOG FILE. AS A RESULT, THE VALUES INSIDE THE LOG FILE MAY NOT MATCH THE HEADER AT THE TIME LOGDATA IS DOWN-LOADED. REFER TO THE HISTORY FILE FOR THE CORRECT SELECTION HEADER IF CHANGE IS INDICATED BY A 999.9 STAMP. VALUES WILL ALWAYS MATCH THE HEADER WHEN MOVING BACK IN TIME FROM THE HEADER TO THE POINT A 999.9 STAMP IS REACHED. MEASURED CURRENT WILL BE EITHER VSD OR MOTOR AMPS SHOWN IN MENU # 108 . VSD OUTPUT CURRENT WILL ALWAYS REFLECT VSD OUTPUT. FREQUENCY OUTPUT WILL REFLECT THE ACTUAL RUNNING FREQ OF VSD INCLUDING STALL CONDITIONS. PRESSURE INPUT WILL REFLECT THE ANALOG INPUT SELECTED IN MENU # 163. POWER OUTPUT IS IN KW UNITS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
262 PRINT MENU	ALL:__	ESP:__FREQUENCY OUTPUT HPS:__FREQUENCY OUTPUT PCP:__FREQUENCY OUTPUT
SEE MENU # 261 HELP TEXT		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
263 PRINT MENU	ALL:__	ESP:__PRESSURE INPUT HPS:__PRESSURE INPUT PCP:__PRESSURE INPUT
SEE MENU # 261 HELP TEXT		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
320 OUTPUT MENU	ALL:__	ESP:__HAND HPS:__NONE PCP:__HAND
BY USING THE UP AND DOWN KEYS YOU MAY SCROLL THROUGH THE CHOICES THAT WILL CAUSE A CONTACT CLOSURE ON THIS SPECIFIC RELAY OUTPUT.		

Figure A-18: Menus 253 to 320

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
321 OUTPUT MENU	ALL:__	ESP:__OFF HPS:__OFF PCP:__OFF
BY USING THE UP AND DOWN KEYS YOU MAY SCROLL THROUGH THE CHOICES THAT WILL CAUSE A CONTACT CLOSURE ON THIS SPECIFIC RELAY OUTPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
322 OUTPUT MENU	ALL:__	ESP:__AUTO HPS:__AUTO PCP:__AUTO
BY USING THE UP AND DOWN KEYS YOU MAY SCROLL THROUGH THE CHOICES THAT WILL CAUSE A CONTACT CLOSURE ON THIS SPECIFIC RELAY OUTPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
323 OUTPUT MENU	ALL:__	ESP:__RUNNING HPS:__RUNNING PCP:__RUNNING
BY USING THE UP AND DOWN KEYS YOU MAY SCROLL THROUGH THE CHOICES THAT WILL CAUSE A CONTACT CLOSURE ON THIS SPECIFIC RELAY OUTPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
330 OUTPUT MENU	ALL:__0-86399	ESP:__60 HPS:__60 PCP:__60
THIS PARAMETER SETS THE ENERGIZED TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD TURN ON IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY ON.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
331 OUTPUT MENU	ALL:__0-86399	ESP:__120 HPS:__120 PCP:__120
THIS PARAMETER SETS THE DE-ENERGIZE TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD GO OFF IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY OFF.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
332 OUTPUT MENU	ALL:__0-86399	ESP:__60 HPS:__60 PCP:__60
THIS PARAMETER SETS THE ENERGIZED TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD TURN ON IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY ON.		

Figure A-19: Menus 321 to 332

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
333 OUTPUT MENU	ALL:__0-86399	ESP:__120 HPS:__120 PCP:__120
THIS PARAMETER SETS THE DE-ENERGIZE TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD GO OFF IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY OFF.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
334 OUTPUT MENU	ALL:__0-86399	ESP:__60 HPS:__60 PCP:__60
THIS PARAMETER SETS THE ENERGIZED TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD TURN ON IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY ON.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
335 OUTPUT MENU	ALL:__0-86399	ESP:__120 HPS:__120 PCP:__120
THIS PARAMETER SETS THE DE-ENERGIZE TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD GO OFF IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY OFF.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
336 OUTPUT MENU	ALL:__0-86399	ESP:__60 HPS:__60 PCP:__60
THIS PARAMETER SETS THE ENERGIZED TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD TURN ON IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY ON.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
337 OUTPUT MENU	ALL:__0-86399	ESP:__120 HPS:__120 PCP:__120
THIS PARAMETER SETS THE DE-ENERGIZE TIME FOR THE RELAY. IF THE RELAY ASSIGNMENT IS SET TO "TIME OF DAY" ENTER THE TIME OF DAY THE RELAY SHOULD GO OFF IF ASSIGNMENT IS SET TO "ABSOLUTE TIME" SET TO THE DURATION THAT THE RELAY SHOULD STAY OFF.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
340 COMM MENU	ALL:__FULL, READ ONLY, NONE	ESP:__FULL HPS:__FULL PCP:__FULL
USE THE UP AND DOWN KEYS TO SELECT THE ACCESS ALLOWED FOR THE SCADA SYSTEM.		

Figure A-20: Menus 333 to 340

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
341 COMM MENU	ALL:__1-247	ESP:__1 HPS:__100 PCP:__1
ENTER THE SCADA ADDRESS THAT HAS BEEN ASSIGNED TO THE VSD FOR COMMUNICATIONS. PRESS ENTER TO ACCEPT THE NEW VALUE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
342 COMM MENU	ALL:__300, 1200, 2400, 4800, 9600, 19200, 33600-300, 1200, 2400, 4800, 9600, 19200, 33600	ESP:__9600 HPS:__9600 PCP:__9600
USE THE UP OR DOWN ARROW KEYS TO SCROLL THROUGH THE BAUD RATE SELECTIONS. PRESS ENTER TO ACCEPT THE DISPLAYED SETTING.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
343 COMM MENU	ALL:__7N1, 7E1, 7O1, 7N2, 7E2, 7O2, 8N1, 8E1, 8O1, 8N2, 8E2, 8O2-7N1, 7E1, 7O1, 7N2, 7E2, 7O2, 8N1, 8E1, 8O1, 8N2, 8E2, 8O2	ESP:__8N1 HPS:__8N1 PCP:__8N1
USE THE UP OR DOWN ARROW KEYS TO SCROLL THROUGH THE DATA MODE CHOICES TO SET THE DATA BITS, PARITY, AND STOP BITS. FOR EXAMPLE, 8N1 IS 8 DATA BITS WITH NO PARITY AND 1 STOP BIT. PRESS ENTER TO ACCEPT THE DISPLAYED SETTING. 7 DATA BITS CAN ONLY BE SELECTED IF THE PROTOCOL IS SELECTED AS ASCII.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
344 COMM MENU	ALL:__ASCII, RTU	ESP:__RTU HPS:__RTU PCP:__RTU
USE THE UP OR DOWN ARROW KEYS TO SCROLL THROUGH THE PROTOCOL SELECTIONS. PRESS ENTER TO ACCEPT THE DISPLAYED SETTING. RTU CAN ONLY BE SELECTED IF THE DATA MODE IS SELECTED TO 8 DATA BITS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
345 COMM MENU	ALL:__ENABLED, TIME & DATE, DISABLED	ESP:__TIME & DATE HPS:__TIME & DATE PCP:__TIME & DATE
USE THE UP OR DOWN ARROW KEYS TO SCROLL THROUGH THE SELECTIONS. PRESS ENTER TO ACCEPT THE DISPLAYED SETTING. THIS CONTROLS WHAT SCADA BROADCAST MESSAGES WILL BE ACCEPTED. ENABLED WILL ACCEPT ALL BROADCAST MESSAGES, DISABLED WILL ACCEPT NO BROADCAST MESSAGES. TIME & DATE WILL ONLY ACCEPT MESSAGES TO SET THE TIME AND DATE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
346 COMM MENU	ALL:__	ESP:__ HPS:__ PCP:__
THIS PARAMTER IS USED TO ENVOKE THE TRANSFER MODE TO INSTALL A NEW CONFIGURATION INTO THE HMI. ATTACHING A PC WITH THE APPROPRIATE SOFTWARE AND PRESSING ENTER WILL TRANSFER INFORMATION. ONLY QUALIFIED PERSONEL SHOULD USE THIS PARMETER.		

Figure A-21: Menus 341 to 346

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
347 COMM MENU	ALL:__	ESP:__ HPS:__ PCP:__
CAUTION ACTIVATES HYPERTERMINAL FILE TRANSFER COMPATABLE ONLY !!!! FOLLOW UPGRADE INSTRUCTIONS WITH UPGRADE FILESET.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
450 DRIVE TUNING	ALL:__0.5-3.0	ESP:__2.2 HPS:__2.2 PCP:__2.2
THIS IS THE INTERNAL MODULATION FREQUENCY OF THE PWM WAVE FORM PRODUCED BY THE VSD. ** WARNING ** FREQUENCIES ABOVE 2.2 KHZ WILL RESULT IN REDUCED DRIVE CAPACITY. CONTACT REDA ELECTRONICS FOR MORE INFORMATION REGARDING THIS ADJUSTMENT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
451 DRIVE TUNING	ALL:__YES, NO	ESP:__YES HPS:__YES PCP:__YES
THE DEFAULT VALUE OF "YES" WILL ENABLE STALL PROTECTION ON THE VSD. THE STALL THRESHOLD LEVEL IS SET VIA MENU 452.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
452 DRIVE TUNING	ALL:__10-215	ESP:__120 HPS:__120 PCP:__120
THE DEFAULT VALUE OF 120% IS THE STANDARD THRESHOLD WHERE SOFT STALL AUTO FREQUENCY REDUCTION WILL OCCUR AFTER 1 MINUTE OF OPERATING IN THE OVERLOAD CONDITION, PROVIDED THAT MENU 451 IS SET TO ENABLE SOFT STALL.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
454 DRIVE TUNING	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
THE DEFAULT SETTING OF "ENABLED" ALLOWS THE DRIVE TO LOOK FOR A SPINNING MOTOR AND IF FOUND, CATCH THE MOTOR IN THE DIRECTION THAT IS IS SPINNING, AND APPLY DECELERATION AND/OR ACCELERATION AS NEEDED TO RUN THE MOTOR IN THE DESIRED DIRECTION AND AT THE DESIRED FREQUENCY IN THE MINIMUM TIME ALLOWED BY THE CONFIGURATION OF THE DRIVE.		

Figure A-22: Menus 347 to 454

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
455 DRIVE TUNING	ALL:__INPUT, AUTO, FIXED	ESP:__INPUT HPS:__INPUT PCP:__INPUT
SELECT THE BASE FREQUENCY VOLTAGE REFERENCE USING THIS MENU, WHEN THE DRIVE IS NOT OPERATING. IF THE DRIVE IS RUNNING THEN CHANGES WILL NOT BE ACCEPTED, AND THE ORIGINAL SETTING WILL REMAIN INTACT THIS MENU ALLOWS THE OPERATOR TO SELECT THE REFERENCE VALUE THAT DETERMINES THE VOLTAGE OUTPUT OF THE DRIVE WHEN THE DRIVE IS OPERATING AT THE DESIRED BASE FREQUENCY. THE "INPUT" SETTING REQUIRES THAT THE OUTPUT VOLTAGE FLUCTUATE WITH THE INPUT VOLTAGE CONTINUOUSLY. "AUTO" MODE FIXES THE BASE FREQUENCY OUTPUT VOLTAGE TO THE LEVEL OF THE INPUT VOLTAGE AT THE TIME THAT THE DRIVE IS FIRST POWERED. THE "FIXED" SETTING REQUIRES THAT THE DRIVE USE THE VALUE SET VIA THE NEXT MENU ITEM AS THE DESIRED VOLTAGE WHEN THE DRIVE IS RUNNING AT BASE SPEED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
456 DRIVE TUNING	ALL:__0-500	ESP:__460 HPS:__460 PCP:__460
THIS IS THE MAXIMUM RMS VOLTAGE THAT IS OUTPUT WHEN THE DRIVE IS RUNNING AT OR ABOVE THE BASE FREQUENCY. IT IS ONLY USED IF MENU 455 IS SET TO FIXED, OTHERWISE IT IS IGNORED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
458 DRIVE TUNING	ALL:__0.0-10.0	ESP:__7.0 HPS:__1.0 PCP:__7.0
THIS WILL BE THE INITIAL FREQUENCY OUTPUT BY THE DRIVE WHEN FIRST STARTED. THIS MAY BE USED TO PREVENT THE DRIVE STARTING AT FREQUENCIES BELOW THOSE SPECIFIED BY THE TRANSFORMER MANUFACTURER. ONCE STARTED THE DRIVE WILL RAMP UP FROM THIS SPEED TO THE MINIMUM SPEED AT THE RATE SET BY MENUS 470 AND 471.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
459 DRIVE TUNING	ALL:__0.0-30.0	ESP:__1.0 HPS:__1.0 PCP:__1.0
THIS AJDUSTS THE PERCENT INCREASE IN OUTPUT VOLTAGE WHEN THE DRIVE STARTS. VOLTAGE BOOST CEASES AT A FREQUENCY OF 12.0HZ, AFTER WHICH, THE SELECTED VOLTS PER HERTZ (MENU 460) DETERMINES THE RMS OUTPUT VOLTAGE OF THE DRIVE.		

Figure A-23: Menus 455 to 459

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
460 DRIVE TUNING	ALL:__CONSTANT, VARIABLE, AUTO BOOST, AUTO BOOST ES, VECTOR CONTROL, VECTOR CONTROL ES	ESP:__CONSTANT HPS:__CONSTANT PCP:__CONSTANT
THIS PARAMETER MAY BE CHANGED ONLY WHEN THE DRIVE IS IN THE OFF MODE. USE THIS PARAMETER TO SELECT THE VOLTS PER HERTZ PATTERN USED TO START AND CHANGE THE SPEED OF THE MOTOR. DIFFERENT LEVELS AND PATTERNS OF TORQUE, PERFORMANCE AND ENERGY SAVINGS ARE POSSIBLE. "CONSTANT" TORQUE MODE IS THE DEFAULT SETTING FOR THE SPEEDSTAR 2000 VSD. USE OF THE VECTOR CONTROL MODES WILL REQUIRE THAT THE MOTOR HORSEPOWER BE ENTERED IN THE MENU #850. VERIFY THAT THE NUMBER OF MOTOR POLES MATCHES THE VALUE ENTERED IN MENU #462		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
461 DRIVE TUNING	ALL:__SMALL, MEDIUM, LARGE, VERY LARGE	ESP:__SMALL HPS:__SMALL PCP:__SMALL
THIS SPECIFIES THE RELATIVE MOMENT OF INERTIA FOR THE PUMP / MOTOR COMBINATION. ALL NORMAL REDA ESP EQUIPMENT HAS A SMALL MOMENT OF INERTIA. THIS PARAMETER IS ONLY EFFECTIVE IF MENU 460 IS SET TO 'VECTOR' CONTROL.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
462 DRIVE TUNING	ALL:__2-6	ESP:__2 HPS:__2 PCP:__4
ENTER THE NUMBER OF MOTOR POLES 2,4 OR 6 THIS NUMBER IS USED BY VECTOR CONTROL COMPUTATIONS WHEN MENU 460 IS SET FOR VECTOR MODE AND MENUS #461 AND #850 HAVE ALSO BEEN CONFIGURED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
470 DRIVE TUNING	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__10 HPS:__2 PCP:__6
THIS AND MENU 471 DEFINE THE RAMP RATE AS THE DRIVE ACCELERATES FROM THE STARTING FREQUENCY (MENU 458) TO THE MINIMUM RUNNING FREQUENCY (MENU 122). THIS IS THE NUMBER OF HZ THAT THE DRIVE WILL CHANGE BY IN THE TIME DEFINED BY MENU 471.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
471 DRIVE TUNING	ALL:__1-10000	ESP:__1 HPS:__1 PCP:__1
THIS AND MENU 470 DEFINE THE RAMP RATE AS THE DRIVE ACCELERATES FROM THE STARTING FREQUENCY (MENU 458) TO THE MINIMUM RUNNING FREQUENCY (MENU 122). THIS IS THE NUMBER OF SECONDS THAT THE DRIVE WILL TAKE TO CHANGE BY THE NUMBER OF HZ DEFINED IN MENU 470.		

Figure A-24: Menus 460 to 471

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
472 DRIVE TUNING	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__6 HPS:__2 PCP:__6
THIS PARAMETER AND THE FOLLOWING PARAMETER DEFINE THE ACCELERATION RAMP FROM MIN SPEED TO TARGET SPEED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
473 DRIVE TUNING	ALL:__1-9999	ESP:__1 HPS:__1 PCP:__1
THIS PARAMETER AND THE PREVIOUS PARAMETER DEFINE THE ACCELERATION RAMP FROM MIN SPEED TO TARGET SPEED. TARGET SPEED MUST BE REACHED BEFORE THE SELECTED CONTROL MODE IS ENTERED. THIS IS TRUE FOR SPEED, CURRENT AND PRESSURE MODES.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
474 DRIVE TUNING	ESP:__0.1-20 HPS:__0.1-30 PCP:__0.1-20	ESP:__3 HPS:__3 PCP:__3
THIS AND MENU 475 DEFINE THE RAMP RATE DURING A CONTROLLED STOP. THIS IS THE NUMBER OF HZ THAT THE DRIVE WILL CHANGE BY IN THE TIME DEFINED BY MENU 475. THIS SETS THE DECELERATION RAMP RATE AS THE DRIVE CHANGES FROM RUNNING TO STOP. IT IS ONLY USED WHEN THE STOP MODE (MENU 212) IS SET TO 'CONTROLLED', OTHERWISE IT IS IGNORED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
475 DRIVE TUNING	ALL:__1-10000	ESP:__1 HPS:__1 PCP:__1
THIS AND MENU 474 DEFINE THE RAMP RATE DURING A CONTROLLED STOP. THIS IS THE NUMBER OF SECONDS THAT THE DRIVE WILL TAKE TO CHANGE BY THE NUMBER OF HZ DEFINED IN MENU 474. THIS SETS THE DECELERATION RAMP RATE AS THE DRIVE CHANGES FROM RUNNING TO STOP. IT IS ONLY USED WHEN THE STOP MODE (MENU 212) IS SET TO 'CONTROLLED', OTHERWISE IT IS IGNORED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
500 SPECIAL CONTROLS	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
THIS ALLOWS 'ROCKING STARTS' TO BE TURNED ON OR OFF. A 'ROCKING START' MAY BE ATTEMPTED TO FREE A STUCK MOTOR OR PUMP. IT WILL CAUSE THE VSD TO RAPIDLY JERK THE MOTOR BACKWARDS AND FORWARDS BEFORE TRYING TO BRING THE VSD UP TO NORMAL SPEED. THE NUMBER OF JERK ATTEMPTS AND THE SPEED OF THEM MAY ALSO BE SET. FOR NORMAL OPERATION THIS SETTING WOULD BE DISABLED BY BEING SET TO 'NO'		

Figure A-25: Menus 472 to 500

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
501 SPECIAL CONTROLS	ALL:__1-20	ESP:__4 HPS:__4 PCP:__4
THIS IS THE NUMBER OF TIMES THE MOTOR WILL 'ROCK' BACKWARDS AND FORWARDS WHEN 'ROCKING START' IS ENABLED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
502 SPECIAL CONTROLS	ESP:__10.0-20.0 HPS:__10.0-20 PCP:__10.0-20.0	ESP:__5.0 HPS:__5.0 PCP:__5.0
THIS WILL BE THE VSD FREQUENCY THAT ROCKING STARTS WILL BE RUN AT. THE VSD WILL RAPIDLY CHANGE BETWEEN FORWARD AND BACKWARDS, 'JOGGING' AT THIS FREQUENCY. AFTER THE 'NUMBER OF ROCKS' HAVE BEEN EXCEEDED THE VSD WILL ATTEMPT TO RAMP UP AND RUN AT THE NORMAL RUNNING SETTINGS. THIS VALUE MAY BE BETWEEN 10.0 AND 20.0 HZ. A SMALLER SETTING MAY BE MORE EFFECTIVE ON HIGH INERTIA SYSTEMS		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
503 SPECIAL CONTROLS	ALL:__1-3	ESP:__1 HPS:__1 PCP:__1
THERE ARE THREE ROCKING START METHODS THAT MAY BE ATTEMPTED. SOME OPERATE MORE AGGRESSIVELY THAN OTHERS, AND MAY RESULT IN REDUCTION OF ROCKING TORQUE DUE TO DIFFERENT MOTOR AND LOAD CHARACTERISTICS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
510 SPECIAL CONTROLS	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
THIS ALLOWS THE USER TO ENABLE OR DISABLE SPEED FORCE CAPABILITY. ONCE ENABLED THE DRIVE WILL RUN AT THE SPEED SPECIFIED IN MENU 511 WHENEVER THE AUXILARY INPUT SPECIFIED IN MENU 512 IS ACTIVE. THIS IS ONLY USED FOR SPECIAL APPLICATIONS AND IS NORMALLY DISABLED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
511 SPECIAL CONTROLS	ESP:__20.0-90.0 HPS:__20.0-90.0 PCP:__8.0-70.0	ESP:__55.0 HPS:__60.0 PCP:__20.0
THIS WILL BE THE VSD FREQUENCY THAT THE DRIVE WILL RUN AT IF MENU 510 IS ENABLED AND THE AUX. INPUT SPECIFIED IN MENU 512 IS ACTIVE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
512 SPECIAL CONTROLS	ALL:__1-8	ESP:__8 HPS:__8 PCP:__8
THIS IS THE DIGITAL AUX INPUT NUMBER THAT WILL BE USED FOR SPEED FORCE IF MENU 510 IS ENABLED.		

Figure A-26: Menus 501 to 512

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
610 AUX. INPUT MENU	ALL:__1-8	ESP:__1 HPS:__1 PCP:__1
BY USING THE KEYPAD YOU MAY SELECT AN INPUT ON WHICH ALL OF THE FOLLOWING AUXILIARY MENUS WILL BE BASED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
611 AUX. INPUT MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
BY USING THE UP AND DOWN KEYS YOU MAY CHOOSE TO DISPLAY THIS AUXILIARY INPUT ON THE STATUS SCREEN AT THE BOTTOM. IF ANY INPUTS ARE SELECTED TO BE DISPLAYED, THE UP AND DOWN KEYS CAN BE USED ON THE STATUS SCREEN TO PAGE THROUGH THE DIFFERENT INPUTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
612 AUX. INPUT MENU	ALL:__	ESP:__AUXILIARY # HPS:__AUXILIARY # PCP:__AUXILIARY #
BY USING THE KEYPAD YOU MAY ASSIGN AN ALPHANUMERIC NAME TO THIS SPECIFIC INPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
613 AUX. INPUT MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
BY USING THE UP OR DOWN KEYS YOU CAN CHOOSE EITHER YES OR NO TO HAVE THE EQUIPMENT SHUTDOWN OR STAY RUNNING IN THE EVENT OF THIS AUXILIARY INPUT BECOMING ACTIVE. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
614 AUX. INPUT MENU	ALL:__OPEN, CLOSED	ESP:__CLOSED HPS:__CLOSED PCP:__CLOSED
BY USING THE UP OR DOWN ARROW KEYS YOU CAN CHOOSE WHAT INPUT STATE WILL BE CONSIDERED ACTIVE. (THE PREVIOUS MENU MUST BE SET TO YES FOR THIS PARAMETER TO WORK)		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
615 AUX. INPUT MENU	ALL:__0-864000	ESP:__1 HPS:__1 PCP:__1
ENTER THE ALLOWABLE TIME FOR OPERATION WHILE THIS AUXILIARY INPUT IS ACTIVE DURING STARTUP. THIS IS HOW LONG THIS AUXILIARY INPUT WILL BE IGNORED DURING STARTUP.		

Figure A-27: Menus 610 to 615

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
616 AUX. INPUT MENU	ALL:__0-864000	ESP:__1 HPS:__1 PCP:__1
THIS AUXILIARY INPUT MUST BE ACTIVE FOR THE TIME ENTERED BEFORE A SHUTDOWN WILL OCCUR.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
617 AUX. INPUT MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USING THE UP OR DOWN KEYS YOU WILL SELECT "YES" TO HAVE AN AUTO RESTART AFTER THIS INPUT CAUSES A SHUTDOWN OR "NO" TO DO NOTHING AFTER THIS INPUT CAUSES A SHUTDOWN. AUTO MODE MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
618 AUX. INPUT MENU	ALL:__1-9999	ESP:__1 HPS:__1 PCP:__1
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER THIS INPUT HAS CAUSED A SHUTDOWN. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS AFTER A SHUTDOWN. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
619 AUX. INPUT MENU	ALL:__0-864000	ESP:__1800 HPS:__1800 PCP:__1800
THE RESTART DELAY TIMER VALUE IS HOW LONG TO WAIT BEFORE ATTEMPTING TO RESTART AFTER THIS INPUT CAUSES A SHUTDOWN. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
700 ANALOG OUT MENU	ALL:__	ESP:__OUTPUT FREQUENCY HPS:__OUTPUT FREQUENCY PCP:__OUTPUT FREQUENCY
SELECTS THE FUNCTION OF THE FM TERMINAL. REFER TO TOSVERT MANUAL FOR DETAILS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
701 ANALOG OUT MENU	ALL:__0-65535	ESP:__5000 HPS:__5000 PCP:__5000
SETS CALIBRATION VALUE TO ANALOG OUPUT. REFER TO TOSVERT MANUAL FOR DETAILS.		

Figure A-28: Menus 616 to 701

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
702 ANALOG OUT MENU	ALL:__	ESP:__OUTPUT CURRENT HPS:__OUTPUT CURRENT PCP:__OUTPUT CURRENT
SELECTS THE FUNCTION OF THE AM TERMINAL. REFER TO TOSVERT MANUAL FOR DETAILS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
703 ANALOG OUT MENU	ALL:__0-65535	ESP:__5000 HPS:__5000 PCP:__5000
SETS CALIBRATION VALUE TO ANALOG OUPUT. REFER TO TOSVERT MANUAL FOR DETAILS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
800 ANALOG IN MENU	ALL:__1-10	ESP:__1 HPS:__1 PCP:__1
BY USING THE KEYPAD YOU MAY SELECT AN INPUT ON WHICH ALL OF THE FOLLOWING ANALOG MENUS WILL BE BASED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
801 ANALOG IN MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
BY USING THE UP AND DOWN KEYS THE OPERATOR MAY CHOSE TO DISPLAY THIS ANALOG INPUT ON THE STATUS SCREEN AT THE BOTTOM. IF OTHER INPUTS ARE SELECTED TO BE DISPLAYED THE UP AND DOWN KEYS CAN BE USED TO SCROLL THE BOTTOM LINE OF THE STATUS SCREEN FOR VIEWING OF THE DIFFERENT INPUTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
802 ANALOG IN MENU	ALL:__	ESP:__ANALOG INPUT # HPS:__ANALOG INPUT # PCP:__ANALOG INPUT #
BY USING THE KEYPAD YOU MAY ASSIGN AN ALPHANUMERIC NAME TO THIS SPECIFIC INPUT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
803 ANALOG IN MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
BY USING THE UP OR DOWN KEYS YOU MAY CHOOSE EITHER YES OR NO TO HAVE THE EQUIPMENT SHUTDOWN OR STAY RUNNING IN THE EVENT OF THIS ANALOG INPUT EXCEEDING A TRIP POINT.		

Figure A-29: Menus 702 to 803

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
804 ANALOG IN MENU	ALL:__0-864000	ESP:__1 HPS:__1 PCP:__1
USING THE KEYBOARD THE OPERATOR MAY SELECT HOW LONG THE VSD WILL IGNORE THE CHANGE OF THIS AUXILIARY ALARM DURING THE STARTUP OF THE VSD. THE VSD MUST BE IN THE AUTO MODE FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
805 ANALOG IN MENU	ALL:__0-864000	ESP:__1 HPS:__1 PCP:__1
THE ACTIVATION DELAY TIMER WILL CAUSE THE VSD TO IGNORE THIS ANALOG INPUT FOR THE AMOUNT OF TIME ENTERED. THE ANALOG INPUT MUST BE OUT OF BOUNDS FOR THE NUMBER SECONDS ENTERED BEFORE THE VSD WILL TAKE SOME SORT OF ACTION TO CURE THE PROBLEM OR SHUTDOWN THE VSD MUST BE IN THE AUTO MODE FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
806 ANALOG IN MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
USING THE UP OR DOWN KEYS THE OPERATOR WILL SELECT "YES" TO HAVE THE VSD AUTO RESTART AFTER A SHUTDOWN OR "NO" TO HAVE THE VSD DO NOTHING AFTER THIS ANALOG INPUT HAS SHUTDOWN THE VSD. THE VSD MUST BE IN THE AUTO MODE FOR THIS FUNCTION TO TAKE EFFECT.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
807 ANALOG IN MENU	ALL:__1-9999	ESP:__1 HPS:__1 PCP:__1
ENTER THE NUMBER OF AUTO RESTART ATTEMPTS ALLOWED AFTER THIS INPUT HAS CAUSED A SHUTDOWN. THIS VALUE SETS THE NUMBER OF RESTART ATTEMPTS AFTER A SHUTDOWN. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT. TOGGLING FROM HAND MODE TO AUTO MODE WILL RESET THE INTERNAL COUNT OF ATTEMPTED STARTS.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
808 ANALOG IN MENU	ALL:__0-864000	ESP:__1800 HPS:__1800 PCP:__1800
THE RESTART DELAY TIMER VALUE IS HOW LONG TO WAIT BEFORE ATTEMPTING TO RESTART AFTER THIS INPUT CAUSES A SHUTDOWN. AUTO MODE AND AUTO RESTART MUST BE SELECTED FOR THIS FUNCTION TO TAKE EFFECT.		

Figure A-30: Menus 804 to 808

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
809 ANALOG IN MENU	ALL:__0-9999	ESP:__5000 HPS:__5000 PCP:__5000
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MAXIMUM ANALOG INPUT ALLOWED DURING OPERATION. IT IS VERY IMPORTANT TO REMEMBER THAT THE NUMBER ENTERED WILL APPLY TO THE CALIBRATED VALUE FOR THIS INPUT (NOT THE RAW VALUE).		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
810 ANALOG IN MENU	ALL:__-9999-9999	ESP:__0 HPS:__0 PCP:__0
THIS IS A TRIP POINT IN ALL MODES OF OPERATION TO PROTECT ANY ATTACHED EQUIPMENT. ENTER THE MINIMUM ANALOG INPUT ALLOWED DURING OPERATION. IT IS VERY IMPORTANT TO REMEMBER THAT THE NUMBER ENTERED WILL APPLY TO THE CALIBRATED VALUE FOR THIS INPUT (NOT THE RAW VALUE).		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
811 ANALOG IN MENU	ALL:__AUTO 4-20 MA, AUTO 0-10 V, MANUAL, DISABLED-AUTO 4-20 MA, AUTO 0-10 V, MANUAL, DISABLED	ESP:__DISABLED HPS:__DISABLED PCP:__DISABLED
BY USING THE UP / DOWN KEYS YOU MAY SCROLL THROUGH THE CHOICES FOR THE DIFFERENT CALIBRATION METHODS. THE AUTO METHODS WILL CALIBRATE TO THE SELECTED INPUT RANGE WITHOUT THE NEED TO APPLY A CALIBRATION SIGNAL. THE MANUAL METHOD REQUIRES THE APPLICATION OF A CALIBRATION SIGNAL TO THIS ANALOG INPUT. PROPERLY DONE, THE MANUAL CALIBRATION IS MORE ACCURATE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
812 ANALOG IN MENU	ALL:__0-9999	ESP:__100 HPS:__100 PCP:__100
THIS IS USED TO CALIBRATE THE HIGH END VALUE OF THIS ANALOG INPUT. FIRST FIND OUT WHAT THE INPUT IS SETUP FOR (4-20 MA, 1-10V). WHEN THIS IS DETERMINED, USING A CALIBRATION DEVICE PLACE THE MAXIMUM SIGNAL ON THE PROPER INPUT TERMINALS. WHILE THE MAXIMUM SIGNAL IS APPLIED, ENTER THE VALUE THAT IS TO BE DISPLAYED ON THE STATUS SCREEN AS THE MAXIMUM INPUT. FOR EXAMPLE, IF YOU WANT 20 MA TO BE DISPLAYED ON THE STATUS SCREEN AS 1000 THEN 20 MA WOULD BE APPLIED TO THE INPUT TERMINALS FOR THIS ANALOG SIGNAL AND 1000 ENTERED IN THE HIGH VALUE. AFTER DOING THIS WHENEVER A 20 MA SIGNAL IS APPLIED TO THE INPUTS OF THIS ANALOG CHANNEL THE VSD WILL DISPLAY 1000.		

Figure A-31: Menus 809 to 812

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
813 ANALOG IN MENU	ALL:__-9999-9999	ESP:__0 HPS:__0 PCP:__0
THIS IS USED TO CALIBRATE THE LOW END VALUE OF THIS ANALOG INPUT. FIRST FIND OUT WHAT THE INPUT IS SETUP FOR (4-20 MA, 0-10V). WHEN THIS IS DETERMINED, USING A CALIBRATION DEVICE PLACE THE MINIMUM SIGNAL ON THE PROPER INPUT TERMINALS. WHILE THE MINIMUM SIGNAL IS APPLIED, ENTER THE VALUE THAT IS TO BE DISPLAYED ON THE STATUS SCREEN AS THE MINIMUM INPUT. FOR EXAMPLE, IF YOU WANT 4 MA TO BE DISPLAYED ON THE STATUS SCREEN AS 10 THEN 4 MA WOULD BE APPLIED TO THE INPUT TERMINALS FOR THIS ANALOG SIGNAL AND 10 ENTERED IN THE LOW VALUE. AFTER DOING THIS WHENEVER A 4 MA SIGNAL IS APPLIED TO THE INPUTS OF THIS ANALOG CHANNEL THE VSD WILL DISPLAY 10.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
820 ANALOG IN MENU	ALL:__YES, NO	ESP:__NO HPS:__NO PCP:__NO
SET TO YES IF A PCM3718 EXTENDED ANALOG INPUT BOARD HAS BEEN INSTALLED. THIS ALLOWS ACCESS TO THE EXTRA CHANNELS. USE MENUS 800 TO 813 FOR ALL SETTINGS OF INPUTS. DO NOT CHANGE IF BOARD IS NOT INSTALLED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
850 EQUIPMENT MENU	ALL:__1-1500	ESP:__100 HPS:__1 PCP:__1
THE NAMEPLATE HORSEPOWER OF THE MOTOR IS ENTERED HERE FOR USE DURING VECTOR CONTROL MODE IT IS ALSO RECORDED FOR DISPLAY WITH THE SITE INFORMATION INCLUDED ON THE PRINTOUT WHEN THE CONFIGURATION IS PRINTED.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
851 EQUIPMENT MENU	ALL:__100-5000	ESP:__1500 HPS:__460 PCP:__1500
THE NAMEPLATE VOLTAGE OF THE VSD IS ENTERED HERE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
852 EQUIPMENT MENU	ALL:__1-1500	ESP:__30 HPS:__100 PCP:__30
THE NAMEPLATE AMPERAGE OF THE MOTOR IS ENTERED HERE FOR INFORMATION ONLY.		

Figure A-32: Menus 813 to 852

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
853 EQUIPMENT MENU	ALL:__1000-5000	ESP:__3500 HPS:__3570 PCP:__3500
THE NAMEPLATE MOTOR RPM IS ENTERED HERE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
854 EQUIPMENT MENU	ALL:__0-9999	ESP:__0 HPS:__100 PCP:__0
THE NAMEPLATE MOTOR SERIES IS ENTERED HERE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
855 EQUIPMENT MENU	ESP:__20-120 HPS:__30-60 PCP:__20-120	ESP:__60 HPS:__60 PCP:__60
THE NAMEPLATE FREQUENCY OF THE MOTOR IS ENTERED HERE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
856 EQUIPMENT MENU	ALL:__1-2000	ESP:__1 HPS:__100 PCP:__1
THE PUMP HORSEPOWER IS ENTERED HERE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
857 EQUIPMENT MENU	ALL:__0-999	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAY ENTER THE PRIMARY INPUT VOLTAGE OF THE OUTPUT TRANSFORMER FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
858 EQUIPMENT MENU	ESP:__0-5000 HPS:__0-7000 PCP:__0-5000	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAY ENTER THE SECONDARY VOLTAGE OF THE OUTPUT TRANSFORMER FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
859 EQUIPMENT MENU	ALL:__0-10	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAY ENTER THE INPUT IMPEDANCE OF THE OUTPUT TRANSFORMER IN PERCENT FOR INFORMATION ONLY.		

Figure A-33: Menus 853 to 859

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
860 EQUIPMENT MENU	ESP:__0-10 HPS:__0-0 PCP:__0-10	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAY ENTER THE TRANSFORMER LOSSES IN PERCENT FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
861 EQUIPMENT MENU	ALL:__0-20000	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAN ENTER THE TRANSFORMER TO MOTOR CABLE LENGTH FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
862 EQUIPMENT MENU	ESP:__0-10 HPS:__0-9999 PCP:__0-10	ESP:__0 HPS:__0 PCP:__0
BY USING THE KEYPAD YOU MAY ENTER THE SIZE OF THE CABLE THAT IS RUNNING TO THE MOTOR FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
863 EQUIPMENT MENU	ALL:__1-10	ESP:__4 HPS:__4 PCP:__4
BY USING THE KEYPAD YOU MAY ENTER THE KILOVOLT RATING OF THE CABLE TO THE MOTOR FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
864 EQUIPMENT MENU	ALL:__0-500	ESP:__100 HPS:__100 PCP:__100
BY USING THE KEYPAD YOU MAY ENTER THE DOWN HOLE TEMPERATURE OF THE WELL IF APPLICABLE FOR INFORMATION ONLY.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
900 DIRECT ACCESS	ALL:__0-9	ESP:__0 HPS:__0 PCP:__0
FOR TRAINED PERSONNEL ONLY, DIRECT ACCESS TO THE VSD IS POSSIBLE. THIS IS DANGEROUS TO DO SINCE AN INCORRECT PARAMETER CAN DAMAGE THE VSD.		

Figure A-34: Menus 860 to 900

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
901 DIRECT ACCESS	ALL:__	ESP:__0 HPS:__0 PCP:__0
FOR TRAINED PERSONNEL ONLY, DIRECT ACCESS TO THE VSD IS POSSIBLE. THIS IS DANGEROUS TO DO SINCE AN INCORRECT PARAMETER CAN DAMAGE THE VSD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
902 DIRECT ACCESS	ALL:__	ESP:__0 HPS:__0 PCP:__0
FOR TRAINED PERSONNEL ONLY, DIRECT ACCESS TO THE VSD IS POSSIBLE. THIS IS DANGEROUS TO DO SINCE AN INCORRECT PARAMETER CAN DAMAGE THE VSD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
903 DIRECT ACCESS	ALL:__	ESP:__0 HPS:__0 PCP:__0
FOR TRAINED PERSONNEL ONLY, DIRECT ACCESS TO THE VSD IS POSSIBLE. THIS IS DANGEROUS TO DO SINCE AN INCORRECT PARAMETER CAN DAMAGE THE VSD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
904 DIRECT ACCESS	ALL:__READ, WRITE	ESP:__INVALID HPS:__INVALID PCP:__INVALID
FOR TRAINED PERSONNEL ONLY, DIRECT ACCESS TO THE VSD IS POSSIBLE. THIS IS DANGEROUS TO DO SINCE AN INCORRECT PARAMETER CAN DAMAGE THE VSD.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
905 DIRECT ACCESS	ALL:__0-9999	ESP:__0 HPS:__0 PCP:__0
FOR EXTENDED DIAGNOSTICS A CODE SUPPLIED BY REDA MAY BE ENTERED HERE WHICH ALLOWS THE 904 MENU TO PERFORM MEMORY WRITES TO THE G3 DRIVE. THIS IS ONLY NORMALLY USED DURING FACTORY SERVICE.		

MENU # AND DESCRIPTION	MENU ITEM RANGE	MENU ITEM DEFAULT
999 G3 SERVICE AND	ALL:__	ESP:__ HPS:__ PCP:__
FOR TRAINED PERSONNEL ONLY. THE DRIVE MUST BE STOPPED BEFORE OPERATING ANY OF THESE TEST ROUTINES. THE DRIVE FUSES, BUS VOLTAGE AND LOAD MUST BE REMOVED BEFORE TURNING ON 'SUPERUSER' MODE. THE DRIVE POWER MUST BE CYCLED TO TAKE THE DRIVE OUT OF 'SUPERUSER' MODE. NOTE THAT THE DRIVE MAY DROP OUT OF 'SUPERUSER' MODE IF A TRIP OCCURS.		

Figure A-35: Menus 901 to 999

A.1 HMI Menus Index

The following figure provides a quick index to HMI menus numbers and gives a brief description of the menu function.

2.06 MENU NUMBERS

100	LANGUAGE	200	PUMP TYPE (ESP / PCP /HPS)	500	ROCKING STARTS ENABLE
101	COMMISSION DRIVE	203	AC INPUT LINE FREQUENCY	501	NUMBER OR ROCKS
102	MASTER PASSWORD	204	BASE SPEED	502	ROCKING STARTS FREQUENCY
103	CHANGE MASTER PASSWORD	205	POWER FAIL AUTO START	503	ROCKING STARTS METHOD
104	ACCESS SELECTION	206	POWER FAIL START DELAY	510	INPUT SPEED FORCE ENABLE
105	USER PASSWORD	207	POWER LOSS AUTO START NUM.	511	INPUT SPEED FORCE FREQUENCY
106	CHANGE USER PASSWORD	208	TIMED AUTO START IN AUTO	512	INPUT FORCE AUX. INPUT NUMBER
107	CONTROL TYPE	209	TIMED AUTO START DELAY	610	AUX. INPUT SELECTION
108	AMPS DISPLAYED AND USED	212	STOP MODE	611	DISPLAY ON SCREEN
109	MEASURED AMPS	213	INTERNAL MAX TEMP	612	AUX. LABEL
110	WELL I.D.	214	INTERNAL MIN TEMP	613	AUX. SHUTDOWN ENABLE
111	VIEW HISTORY	215	RESET INTERNAL TEMPS	614	AUX. ACTIVE WHEN
112	RESET USER RUN POWER ON TIMERS	216	SET TIME	615	AUX. IGNORE AT START
120	SPEED SOURCE	217	SET DATE	616	AUX. ACTIVATION DELAY
121	TARGET SPEED	218	MOTOR / PUMP ROTATION	617	AUX. AUTO RESTART
122	MINIMUM SPEED	219	TIME TO CLEAR RESTARTS HRS.	618	AUX. NUMBER OF AUTO RESTARTS
123	MAXIMUM SPEED	240	PRINT CONFIGURATION	619	AUX. AUTO RESTART DELAY
124	SPEED RAMP HZ	241	HISTORY EVENTS OR DAYS	700	FM TERMINAL SELECTION
125	SPEED RAMP TIME	242	NUMBER OF EVENTS OR DAYS	701	FM CALIBRATION SETTING
126	JUMP FREQUENCY 1	243	PRINT HISTORY	702	AM TERMINAL SELECTION
127	JUMP BANDWIDTH 1	244	DATA LOGGING YES OR NO	703	AM CALIBRATION SETTING
128	JUMP FREQUENCY 2	245	DATA LOGGING INTERVAL	800	ANALOG INPUT SELECTION
129	JUMP BANDWIDTH 2	246	DATA LOG EVENTS OR DAYS	801	ANALOG DISPLAY ON SCREEN
130	JUMP FREQUENCY 3	247	NUMBER OF EVENTS OR DAYS	802	ANALOG LABEL
131	JUMP BANDWIDTH 3	248	PRINT DATA LOG	803	ANALOG SHUTDOWN ENABLE
140	TARGET CURRENT	250	GRAPH ITEM	804	ANALOG IGNORE AT START
141	MINIMUM CURRENT	251	GRAPH NUMBER OF DAYS BACK	805	ANALOG ACTIVATION DELAY
142	MAXIMUM CURRENT	252	GRAPH FULL SCALE HEIGHT	806	ANALOG AUTO RESTART
143	UC IGNORE AT START UP	253	START STOP GRAPH PRINTING	807	ANALOG AUTO RESTART NUMBER
144	UC ACTIVATION DLY	261	DATA LOG PAR. # 1 SELECTION	808	ANALOG AUTO RESTART DELAY
145	UC AUTO START	262	DATA LOG PAR. # 2 SELECTION	809	ANALOG HIGH LIMIT TRIP
146	UC AUTO START DLY	263	DATA LOG PAR. # 3 SELECTION	810	ANALOG LOW LIMIT TRIP
147	UC AUTO START NUMBERS	320	RELAY # 1 ASSIGNMENT	811	ANALOG CALIBRATION METHOD
148	CURRENT RAMP HZ	321	RELAY # 2 ASSIGNMENT	812	ANALOG INPUT HIGH VALUE
149	CURRENT RAMP SECONDS	322	RELAY # 3 ASSIGNMENT	813	ANALOG INPUT LOW VALUE
150	OC ACTIVATION DELAY	323	RELAY # 4 ASSIGNMENT	820	EXTENDED ANALOG INPUT CARD
151	TRACKING UL ENABLE	330	RELAY O/P # 1 ON TIME & DURATION	850	MOTOR NAMEPLATE HORSEPOWER
152	TRACKING UL DEVIATION %	331	RELAY O/P # 1 OFF TIME & DURATION	851	MOTOR NAMEPLATE VOLTAGE
160	TARGET PRESSURE	332	RELAY O/P # 2 ON TIME & DURATION	852	MOTOR NAMEPLATE CURRENT
161	MINIMUM PRESSURE	333	RELAY O/P # 2 OFF TIME & DURATION	853	MOTOR NAMEPLATE RPM
162	MAXIMUM PRESSURE	334	RELAY O/P # 3 ON TIME & DURATION	854	MOTOR NAMEPLATE SERIES
163	PRESSURE INPUT	335	RELAY O/P # 3 OFF TIME & DURATION	855	MOTOR NAMEPLATE FREQUENCY
164	SPEED UP OR DOWN WITH PSI INC.	336	RELAY O/P # 4 ON TIME & DURATION	856	PUMP HORSEPOWER
165	PRESSURE RAMP HZ	337	RELAY O/P # 4 OFF TIME & DURATION	857	TRANSFORMER PRIMARY VOLTAGE
166	PRESSURE RAMP SECONDS	340	SCADA ACCESS	858	TRANSFORMER SECONDARY VOLTAGE
167	UNDER PRESS SHUTDOWN ENABLE	341	SCADA ADDRESS	859	TRANSFORMER IMPEDANCE
168	UNDER PRESS IGNORE AT START	342	SCADA BAUD RATE	860	TRANSFORMER LOSSES %
169	UNDER PRESS ACTIVE DELAY	343	SCADA DATA MODE	861	CABLE LENGTH IN FEET
170	UNDER PRESS AUTO RESTART	344	SCADA PROTOCOL	862	CABLE SIZE WIRE GAUGE
171	UNDER PRESS AUTO START NUM.	345	SCADA BROADCAST	863	CABLE RATING KV
172	UNDER PRESS START TYPE	346	DATA TRANSFER	864	DOWNHOLE TEMP
173	UNDER PRESS AUTO START PRESS.	347	WIN 2000 HYPERTERM UPGRADE ONLY	900	DIRECT BANK
174	UNDER PRESS START DELAY	450	PWM CARRIER FREQUENCY	901	DIRECT ADDRESS
175	PRESS DELAY INCREMENT	451	STALL PROTECTION ENABLE	902	DIRECT MASK
176	OVER PRESS SHUTDOWN ENABLE	452	STALL THRESHOLD % OF VFD	903	DIRECT DATA
177	OVER PRESS IGNORE DELAY	454	CATCH A SPINNING MOTOR ENABLE	904	DIRECT COMMAND
178	OVER PRESS ACTIVE DELAY	455	BASE FREQ. VOLTAGE SELECT	905	DIRECT WRITE CODE
179	OVER PRESS AUTO START	456	MAX BASE FREQ. VOLTS	999	G3 SERVICE ROUTINES
180	OVER PRESS START NUM.	458	START UP FREQ. HZ		
181	OVER PRESS START TYPE	459	START UP VOLTAGE BOOST %		
182	PID CONTROL	460	WHZ PATTERN		
183	PID PROPORTIONAL	461	VECTOR CONTROL MOMENT OF INERTIA		
184	PID INTEGRAL	462	NUMBER OF MOTOR POLES		
185	PID DERIVATIVE	470	STARTING ACCELL RATE HZ		
		471	STARTING ACCELL SECONDS		
		472	MIN TO TARGET ACCELL RATE HZ		
		473	MIN TO TARGET ACCELL SECONDS		
		474	STOP DECELL RATE		
		475	STOP DECELL SECONDS		

Figure A-36: HMI Menus Index

Electrical Drawings

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B ELECTRICAL DRAWINGS

This appendix contains circuit diagrams, schematics, and other electrical engineering file documents required to install and maintain VSDs or SWDs.

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Reference Material

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C REFERENCE MATERIAL

This appendix contains documents that do not readily belong in the main chapters of the manual. Often, newly released information will be included in reference material before being incorporated to the main manual chapters.

C.1 Harmonics Concerns with VSDs

This section contains a worksheet (questionnaire) for the installer or troubleshooter to use should a problem arise or be suspected due to harmonics problems being created by VSD loads. Please answer each question as completely as possible and then contact Artificial Lift InTouch for support.

C.1.1 Harmonics Worksheet

Please answer the following questions as completely as possible. This information will be used to run a computer simulation of your drive application to generate an estimate of the harmonic levels produced by any VSD loads. If some of the questions cannot be answered, some assumptions will be made about the system. Refer to the drawing(s) included in this manual and the drive cabinet for complete system details. When the questions below are completed, contact Artificial Lift InTouch for assistance.

Note

In the questions below, PCC refers to common point(s) of coupling on the following figure.

---

1. What is the utility input voltage and frequency to the main transformer (PCC) ? _____Volts
2. What is the utility system short circuit duty amperage (I_{sc}) immediately before the main transformer for the facility (PCC1)? _____Amps (*this is optional - provided by the utility - required only if PCC1 is the PCC of concern*)
3. What is the main transformer (T1) _____kVA? and the percent impedance? _____%
4. What is the impedance ratio of the main transformer (T1) _____ to _____? (*Inductance : Resistance - Typically 10:1 for large transformer, ratios higher than 10:1 will have negligible impact on results*)

5. What is the bus fault current (I_{sc}) after the main transformer (at PCC2)? _____Amps
6. What is the main bus voltage of the (secondary of the main transformer T1)? _____Volts
7. What is the inductance or distance of the power line from the main transformer (PCC2) to the main plant power bus (PCC3) _____?
8. What is the inductance or distance of the power line from the main plant bus (PCC3) to the VSD isolation transformer_____?
9. What is the VSD isolation transformer (T2) kVA and % impedance? _____kVA_____ % (*transformer directly before the VSD*)
10. What is the impedance ratio of the input transformer (T2) _____? (*Inductance : Resistance - Typically 10:1 for large transformer, ratios higher than 10:1 will have negligible impact on results*)
11. Is an AC line reactor going to be used? _____(YES / NO) If so, what is the impedance or reactance in microHenries? _____uH
12. What is the system's nominal fundamental (other non— harmonic) load current on the main power bus? _____Amps
13. Are there other VSDs in the system? If so, how many? All information on the transformer associated with these VSDs must be supplied.
14. Are there any other harmonic on the system that need to be considered in this calculation? If so, please give the values of these harmonics.
15. What is the point of common coupling for the harmonics measurements (PCC 1-7)? Refer to Figure C-1 VSD Points of Common Coupling.

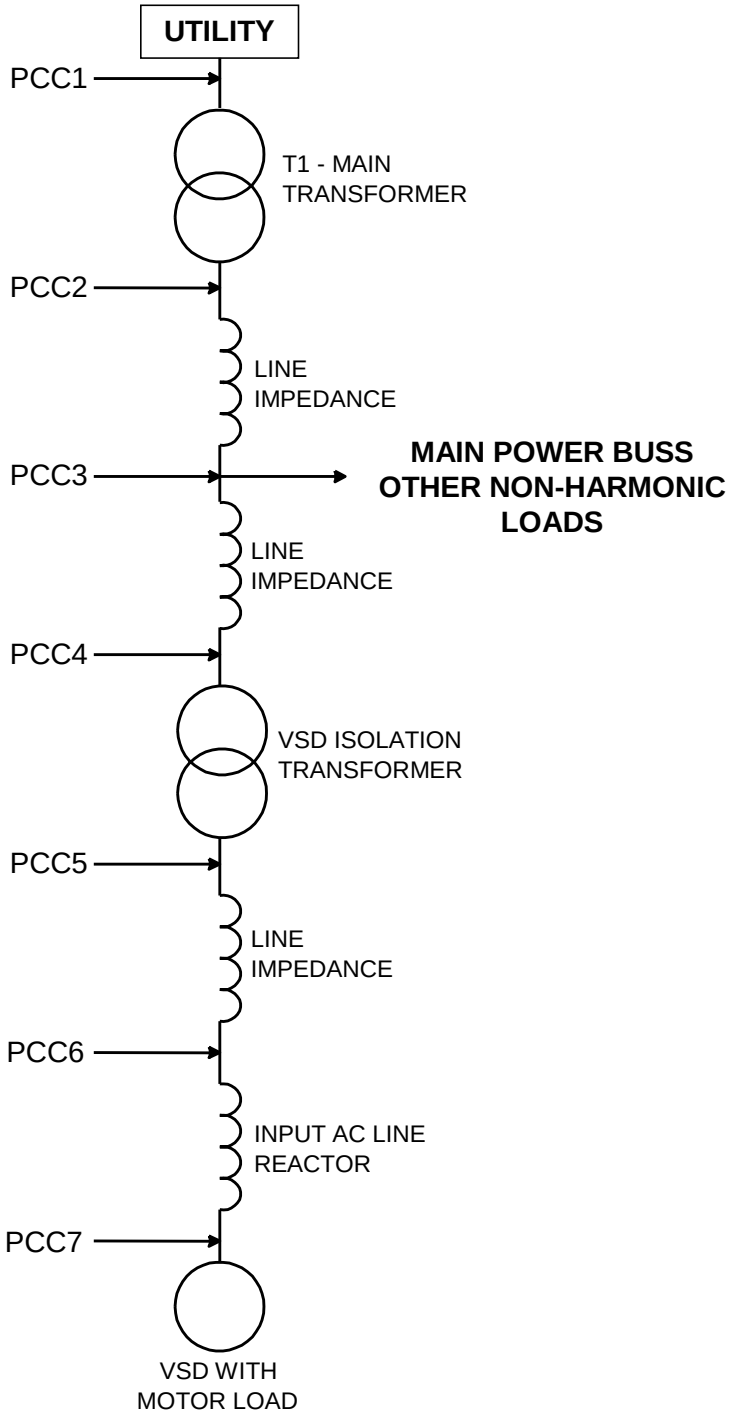

Figure C-1: VSD Points of Common Coupling. *In this diagram, PCCs listed on the left identify common points of coupling.*

C.2 HMI Software Version 2.06 Release Notes

This section describes the additions, enhancements, and revisions included in the version 2.06 release of the HMI software. Please ensure that your HMI contains the latest software update. Refer to InTouch for the latest HMI software revision.

C.2.1 Additions

- Russian language and Russian language support has been added. Selection is available in Menu 100.
- Type 255 Reset option was added to Menu 999. This reset is required when changing the VSD ROM and also should be performed when replacing the G3 Controller Board.
- Short Circuit check is turned OFF in the G3 during HMI initialization. This should prevent starting problems on VSDs equipped with an output filter.
- Added Control of the FM and AM terminals on the G3 Terminal Board in Menus 700 through 704. These terminals provide analog outputs. The default selections are Output Frequency and Output Amps. Other selections are available as outlined in the Help text and the G3 Tosvert Manual (InTouch Content ID#).
- Relay Timer Modification
  - Added Time of Day and Absolute Time selections for Relay Output control. The extra selections are available in Menus 320-323. The Time Settings are available in Menus 330-337.
  - Time of Day: Relay will activate at the time entered in the Relay ON Time, which is entered in Menus 330, 332, 334 or 336. The Relay will de-activate at the time entered in Relay OFF Time, Menus 331, 333, 335 or 337.
  - Absolute Time: In this mode the Relay continuously alternates from activated to de-activated base on the ON and OFF Duration time settings in Menus 330-337. Menus 330, 332, 334 or 336 establish the time duration that the relay will remain activated. Menus 331, 333, 335 or 337 establish the time duration that the relay will remain de-activated. The timers are absolute and are not synchronized with the time of day or other drive activity.

- Win 2000 Upgrade Mod added for Win 2000 file transfer. Future upgrades will use the Hyperterminal application in the standard Schlumberger OPS Pack-equipped PCs.

C.2.2 Enhancements

- Current Update Mod-The amps value is updated more frequently and will have a resolution of 0.2% of VSD rated amps. Previously, the amps value had a resolution of 1%, which resulted in large step changes, especially in larger drives. There will still be a step change but it has been reduced to 0.2 %.
- DataLog Mod-Changed DataLog to allow the user to select the parameters to be logged. The selections are made in Menus 261, 262, and 263. Previously, the parameters logged were set to Frequency, Amps, and Pressure input only. This version allows the user to select: *MEASURED CURRENT , FREQUENCY OUTPUT, PRESSURE INPUT, HMI TEMPERATURE, VSD OUTPUT CURRENT, OUTPUT VOLTAGE, POWER OUTPUT, SCALED ANALOG INPUTS.*
- Configuration Printout Mod-Added *Catch a Spinning Motor* setting to the *Configuration* printout. Added the VSD/Motor Amps selection from Menu 108 and the conversion factor used to calculate the Motor Amps Value. Added Menu numbers to most settings on the *Configuration* printout to help simplify accessing the settings.
- Modbus Mod-SCADA settings can be changed while being polled and changes will take effect immediately. Previously, there were occasional delays or lock-ups when changing the SCADA Access Level (Menu 340) and SCADA ID (Menu 341). Now they can be changed regardless of poll rates. Also corrected Address 109 to reflect Run/Stop status of the drive. When read, it will return a 1 if drive is running and a 0 if the drive is stopped. Added parameters are accessible via the SCADA link. Additions are: VSD/Motor Amps Selection, VSD Output Voltage, VSD Output Power, HMI Temperature, Broadcast acceptance, Underload Ignore Delay, Underload Activation Delay and Overcurrent Activation Delay.
- Default Changes: Underload Ignore and Activation timers default settings were changed to 1 minute. Previously defaulted to 1 second. Track Underload Enable (Menu 151) and Catch a Spinning Motor (Menu 454) are now defaulted to NO. Be sure to reset these features to YES if they are being used. Start Frequency (Menu 458) default has been corrected to 7.0 Hz when VSD is commissioned. Previously recommissioning the drive would set the start frequency to 1.0 Hz.
- Overcurrent Mod —The amps value is now saved in the *History* when an HMI-initiated overcurrent trip occurs.

- AI Scan Mod-Scan rate for the analog inputs has been increased to improve update time. Software filtering has been added to reduce spurious readings on noisy signals.
- Earth Fault and ROM Mod-Earth Fault trip level has been increased to prevent nuisance trips. This setting is not a user-settable parameter. Corrected the VSD ROM display to show the ROM revision level currently installed on the G3 Controller Board. Previously showed 5121 regardless of the ROM installed.

C.2.3 Corrections

- Overload Setting-The G3 Overload mode setting is set during initialization at power-up. This negates the need for Field Service Bulletin 136, which outlines a manual method of setting the Motor Overload Mode.
- VSD Communications-Multiple changes were made to vastly improve VSD Communications stability. Changed communications to allow for occasional No Response error from G3 with shutting down the drive. This should reduce nuisance trips on VSD communications errors. Added error checking to the HMI/G3 communication link to verify transfer of data. This stabilizes communication and will eliminate the possibility of accepting spurious data. Corrected the error which caused VSD communication errors to be logged as “VSD Stopped due… Communication Error” when the drive did not actually stop. The HMI verifies each exchange with the G3 Controller Board. If an error is detected, it will be logged to the History file to document the occurrence and assist in troubleshooting.
- ST-CC Open Mod-Corrected the error that caused the drive to stop without the HMI interpreting this as a stop. Now the drive correctly trips with the message *VSD stopped due to ST-CC Open*. This contact, located on the G3 Termination Board may be used as an Emergency stop.
- Save Settings Mod-Hand/Off/Auto mode is saved immediately upon any change. Configuration data is saved 30 seconds after any change. Previously the user was required to press Menu/Esc twice to ensure the Hand/Off/Auto state and configuration changes were saved. While this action will still force a save of data, it is not required.
- Type 3 Reset Mod —Corrected a timing error that resulted in the maximum frequency in the G3 to be left at default setting when a Type 3 Reset was activated.
- Rocking Start Mod-Rocking Start Enable, Menu 500, was changed to a one-shot operation. The enable flag is forced back to NO after each start. This prevents accidentally leaving the Rocking Start feature activated.

- AI Test Mod-This change is transparent to the user. It corrects a condition that could cause the HMI to fail to boot if the analog input circuitry has a problem.
- Password Boot Lock Mod-If a Password lock has been enabled, the HMI will power up in the locked condition. Previously, the HMI would boot unlocked for 30 minutes.
- Restart Display Mod-Corrected error in display of the Restart timer countdown when in excess of 9 hours.
- Underload Help Mod-Corrected help text for the *Underload Ignore* and *Activation* timers. Previously, the text incorrectly stated that the VSD must be in Auto mode in order for timers to function. Only the Restart parameters require an Auto mode setting.

C.3 ROM Versions and History

This section contains a table that lists all available ROM versions and describes the VSD and SWD versions with which they are compatible.

Version	Description/History	Effective Date
V7000	Probably not applicable to any active drives.	12/5/97
V7001	Changed to facilitate a communication match for compatibility with the HMI.	12/24/97
V7002	Added typeforms for 518 kVA drives and larger. If an older ROM was installed in such a drive, a typeform error would display, but there were no problems with the drive.	5/22/98
V7003	Changed software to implement DC Bus voltage detection. In very rare cases (high harmonic content) the MS1 contactor would open and reset. This problem was reported by a distributor of VSDs.	unknown
V7004	Never implemented. This rev would have enabled 1400 kVA capability.	unknown
V7005	Never implemented. Was to add new defaults that HMI usually makes for use with W992.	unknown

Version	Description/History	Effective Date
V7006	Added 1400 kVA capability plus ground fault alarm function.	unknown
V7007	Implemented recently to add 230 V functionality for Carrier Corp. No shipments of this ROM have been made to Schlumberger to date. As of 2/12/2003 existing ROM stock still being shipped. New p/n is 53909 (v7007). Part number 52796 (v7006) is now obsolete.	2/12/2003

Note

Any newer ROM versions are backward compatible with previous ROM versions. To obtain the latest ROM version, order SLB part number 7012529.

C.4 Problem Information Sheet

The Problem Information Sheet provided here is a reprint from the Troubleshooting chapter of this manual. It is provided for the field user to have photocopying capability for additional sheets to provide to field service personnel.

VSD Application Data/Problem Information Sheet (p. 1 of 2)

	Item						
Application Data	Application Data	Customer and Well ID Information					
		Installation Info	New?	Running?	Restart after outage?	Other	
		VSD S/N	VSD Size (kVA)		NEMA 1 or NEMA 3?		
			6 or 12-pulse?		Base Frequency:	Software version:	
		Input Transformer	Mfr:		KVA:	Impedance (%)	
			Primary volts:		Secondary volts:		
		Output Transformer	Mfr:		KVA:	Impedance (%)	
			Primary volts:		Secondary volts:		
		Filter	Mfr:		Schlumberger P/N or detailed info:		
		Downhole Cable	Type and Size:		Total Length (cable to motor)		
		Motor Nameplate Data:	Motor 1:	Series:	Hp:	Volts:	Amps: Hz:
			Motor 2:				
			Motor 3:				
			Motor Running:	Max Volts:	Max Amps:	Max Hz:	
	Pump Data Refer to Person in Charge	Type:	# of stages:		Series:	Intake Type:	

Figure C-2: Application Data/Problem Info Sheet (p. 1 of 2)

VSD Application Data/Problem Information Sheet (p. 2 of 2)

Problem Info

Contact(s)	Person in Charge	
	Address	Telephone No.
Inverter Specification	Test Number	
Optional or combinable equipment (SCADA, analog, digital):		
Delivery date Time in service Date when problem arose		
Status of Use	Motor Rating	Poles: Horsepower: Voltage: Hz: Made by Schlumberger? Made by another company? New? Number of units? Alternate? Continuous?
	Ambient Conditions	Indoor? Outdoor? Temperature Range? Humidity: Dust composition and size: Presence of salt and extent of corrosion from it: Vibrations (in micrometers): Presence of corrosive gas: Availability of air conditioning: Number of phases:
Phenomenon	Power Source	Voltage between L1 phase and L2 phase: L11 and L21: Voltage between L2 phase and L3 phase: L21 and L31: Voltage between L3 phase and L1 phase: L31 and L11: Number of Hz:
	State of motor when problem was found	Problem occurred hours after motor had been started. Motor has been stopped for hours. Did problem occur during periodic inspection? Did problem occur when motor was started? Did problem occur during acceleration? Did problem occur during deceleration? Did problem occur while motor was not running?
	Frequency of problem	First time? Problem has occurred how many times? Does problem occur every time the motor is operated? When did problem first occur?
	Trouble indicator	What was the LCD Screen Message:
Detailed description of problem:		
Temporary diagnosis and corrective action:		
Date defective product shipped:		Shipped to:
Deadline for repairs:		

Figure C-3: Application Data/Problem Info Sheet (p. 2 of 2)