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Operation and Troubleshooting Manual

HiPAC 10 Controller

Variable Frequency Drive (VFD) for Battery Powered Equipment (Hardwired System)

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2 Your safety

Operation

This chapter contains important information on the operation of the HiPAC 10 variable frequency drive.

Read this chapter carefully and thoroughly. In particular, observe the safety instructions in Chapter 2 “Your safety”.

History

In the early 1970's, solid state peed controls for battery powered underground mining equipment were introduced. Solid state controls increased the range and reliability of the battery powered vehicles along with providing smooth, stepless acceleration. However, even with solid state speed control, direction change was achieved with the use of electromechanical contactors. These contactors provided an endless source of maintenance problems and consumed excessive amounts of valuable controller enclosure space. In addition, most solid state controllers of the past utilized an electromechanical "bypass" contactor to connect the motor directly to the batteries, which resulted in more contactor problems.

In the 1980’s, a contactorless motor controller (X90) was developed. The X90 system used a dual-field motor in combination with SCRs (Silicone Controlled Rectifiers) to achieve solid state direction change.

In the 1990’s, the BUC2000 motor controller was developed. The BUC2000 system used Insulated Gate Bipolar Transistors (IGBTs) to achieve motor control and direction change. Unlike an SCR, an IGBT is turned on and off via a gating electronic signal, eliminating commutating capacitor banks and coils. The microprocessor based BUC2000 logic card provided complete motor control and drove both a diagnostic dashboard display and a handheld calibrator/diagnostic unit.

During the early 2000’s, the successful HiPAC 10 motor controller system was developed. The HiPAC 10 system consists of highly efficient AC 3-phase induction motors and variable frequency drives. The HiPAC 10 system provides increased efficiency, higher torque capabilities, increased machine speeds, and has no motor brushes or brush holders.

Innovative Motor Control

The speed of rotation of AC induction motors is directly dependent upon the frequency of the applied AC voltage. Therefore, In order to control the speed of AC induction motors, the motor must be supplied with a voltage of variable magnitude and frequency. Ideally, this voltage is sinusoidal.

Fig. 11: Voltage cutbacks for a 240-Volt system

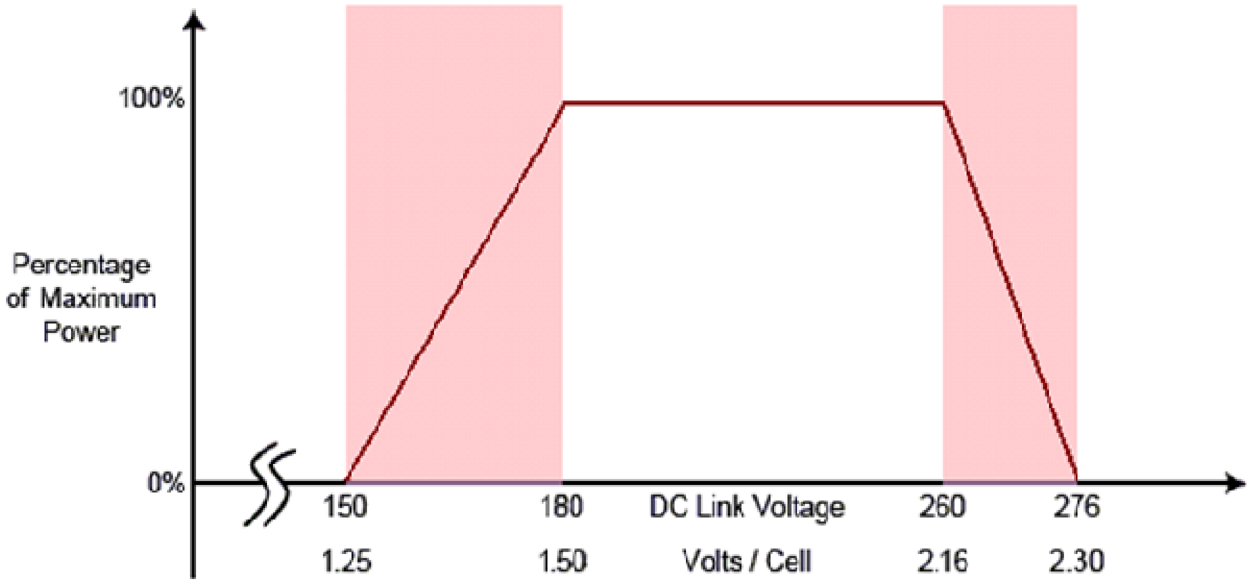

Fig. 12: Voltage cutbacks for a 128-Volt system

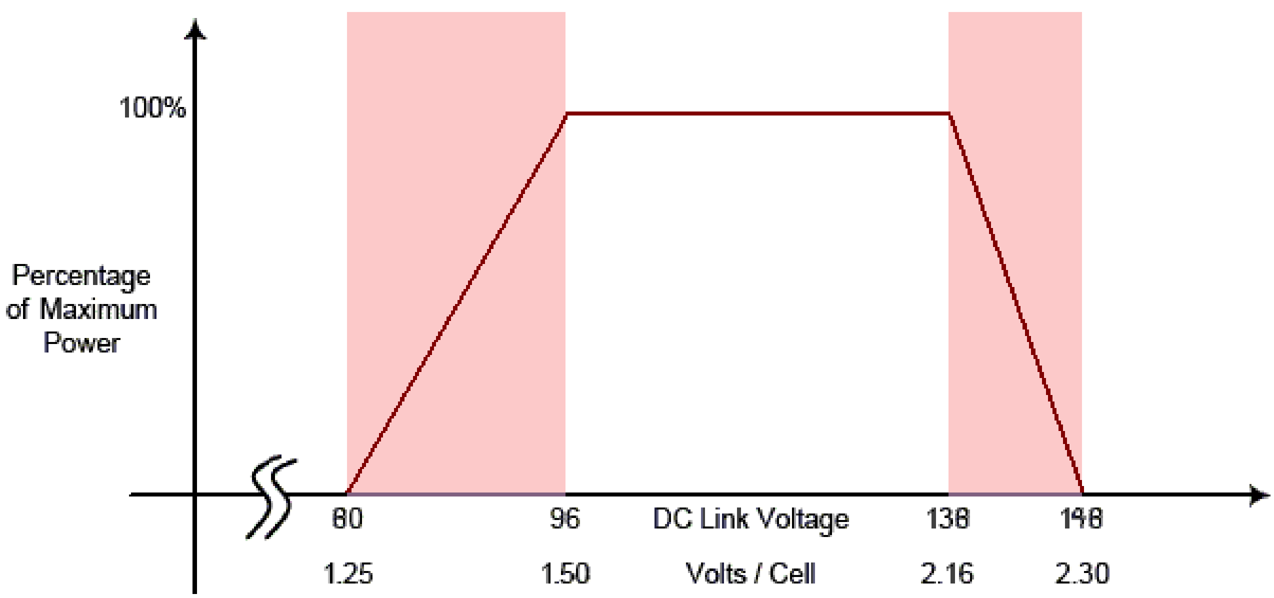

Table 13: Supervisor - Front Traction VFD (Node 1), connector "C" (VT680)

Input Description	Connector/Pin
+24VDC Supply input	C1
(reserved for service brake)	C2
UVR driver (24VDC common)	C3
Park brake solenoid driver (24VDC common)	C4
Breaker "ON" for headlight relay driver (24VDC common)	C5
Not Used	C6
Not Used	C7
Not Used	C8

Table 14: Supervisor - Front Traction VFD (Node 1), connector "D" (VT680)

Input Description	Connector/Pin
Not Used	D1
Pre-Charge Feed from B+	D2
Not Used	D3
Not Used	D4
Not Used	D5
Not Used	D6
Not Used	D7
Not Used	D8

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Control System Operation

Controller Start-up

The VFDs are supplied control power from a 24V DC-DC converter and power up when the operator manually closes the battery circuit breaker on the battery assembly (if equipped) and releases the emergency stop push button in the operator's compartment.

A valid start-up sequence is described as follows:

1. Turn the battery circuit breaker and/or disconnect switch (if equipped) to the "ON" position.
2. Press and hold the diagnostics momentary switch. The VFDs energize the pre-charge circuit and the controller start-up device checks are performed (checks are done within a matter of seconds). If all checks are okay, the supervisor traction VFD will energize the main circuit breaker UVR Coil (Pin C3) and the display will signal the operator that it is OK to close the main machine circuit breaker.
3. Release the diagnostics momentary switch.
4. Close the main machine circuit breaker supplying full battery power to the VFDs.

Once the main machine circuit breaker is determined closed by the supervisor VFD through the use of the circuit breaker auxiliary switch (Pin A12 on supervisor VFD), the system is ready for pump motor operation.

Note: Once the main machine circuit breaker is closed, the Diagnostics momentary switch becomes the button to change screens on the display.

See the machine operation manual for machine operation.

NOTICE!
MSHA requirements limit the maximum machine tram speed to 6 mph. This occurs automatically through the VFD software and correct hardwired configuration inputs.

IMPORTANT!
If the operator selects FS1 before selecting a direction, a SRO fault will be produced and direction selection inhibited.

individual inputs monitor screen

Individual inputs can be monitored from the Vehicle Inputs Monitor screen (Fig. 19), which can be very helpful for troubleshooting.

Note: The payload speed limit, oil level, hydraulic filter, and payload counter switches and inputs are not available on single motor systems.

Fig. 19: Vehicle Inputs Monitor screen

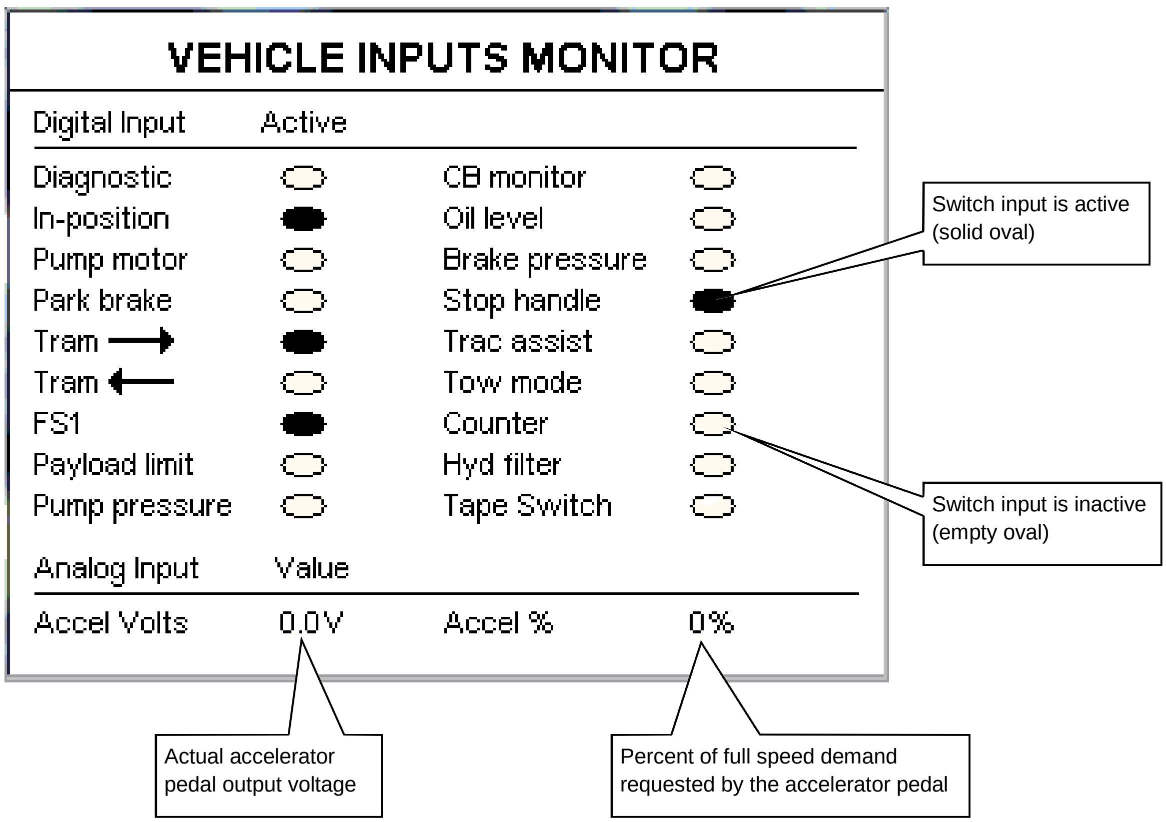


Table 27: Fault information codes, continued

Fault ID	Severity	Fault Description	Fault Help
4f01	3	CANbus configuration fault	Node has difficulty communicating via CAN. Confirm all drives have unique node ID. Check that all other drives are connected and powered up. Check configuration wiring.
4f02	3	CAN hardware fault	Node has difficulty communicating via CAN. Confirm all drives have unique node ID. Check toroids on CAN bus wires. Look for noise or breaks in CAN wiring. Check configuration wiring.
4f41	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f42	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f43	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f44	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f45	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f46	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f47	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f48	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f49	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f4a	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f4b	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f4c	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f4d	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.
4f4e	5	Internal software fault	Potential configuration error on drive. Recycle power. If fault does not clear, check firmware and configuration.

Test Measurements

If the cause of a fault remains unknown, simple meter checks can provide useful information to find it. While external measurements will not tell you exactly what is wrong “in the box”, they will often confirm if it is the VFD that has failed. Conversely, such test’s can “clear” a good VFD, saving both time and expense.

Tables 29, 30, 31, and 32 outline a series of tests that should prove useful in the troubleshooting process. All drives can be measured in the same way, regardless of node.

Table 29: Meter checks, “A” connector

Pin	Electrical Description	Expected measurements
A1	15 Volt Encoder Supply -	Zero Volt reference for A2.
A2	15 Volt Encoder Supply +	With 24V supply on, 13V to 15V, reference A1 or A3.
A3	15 Volt Encoder Supply -	Zero Volt reference for A2.
A4	Speed Encoder Input	With 24V supply on, should pulse between 0V and 12V when encoder spins. Reference to A1 or A3.
A5	Speed Encoder Input	With 24V supply on, should pulse between 0V and 12V when encoder spins. Reference to A1 or A3.
A6	Digital Input 1	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A7	Digital Input 2	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A8	Digital Input 3	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A9	Digital Input 4	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A10	Digital Input 5	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A11	Digital Input 6	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A12	Digital Input 7	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A13	Digital Input 8	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A14	Digital Input 9	With 24V supply on, 13V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A15	Digital Input 10	With 24V supply on, 13V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A16	Digital common	Zero Volt reference for Digital Inputs.
A17	Digital output	Zero Volts
A18	12 Volt supply +	With 24V supply on, 12V output. Reference “A” pins 16, 25, 28, or 31.
A19	5 Volt supply -	With 24V supply on, 5V output. Reference “A” pins 16, 25, 28, or 31.
A20	Motor thermal sensor input	With 24V supply on, 5V open circuit, drops to 2.5V when connected to PTC. Reference “A” pins 16, 25, 28, or 31.
A21	Motor temperature switch	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.
A22	Towing Mode	With 24V supply on, 10V with open switch, 0V when switch is closed. Reference “A” pins 16, 25, 28, or 31.

The password may be entered by use of the control station diagnostics, screen select, and stop buttons.

- The Diagnostics switch acts as an “enter key” or acknowledgment key.
- The Screen Select button increments the display value up.
- The Stop button increments the display value down.

Once the password has been accepted, the display falls into the Initial Configuration screen (Fig. 30) From here, different menus and functions may be navigated and changed using the same three control box buttons - Diagnostics, Screen Select, and Stop. An example of a Parameter Change screen is on Fig. 31.

Fig. 30: Initial Configuration screen

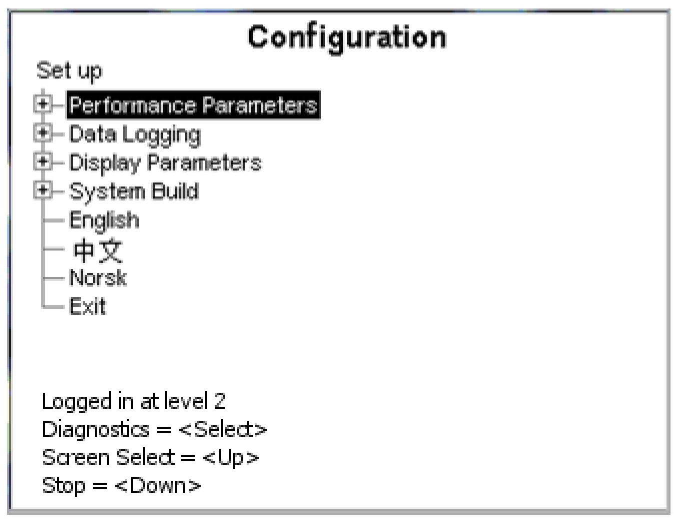
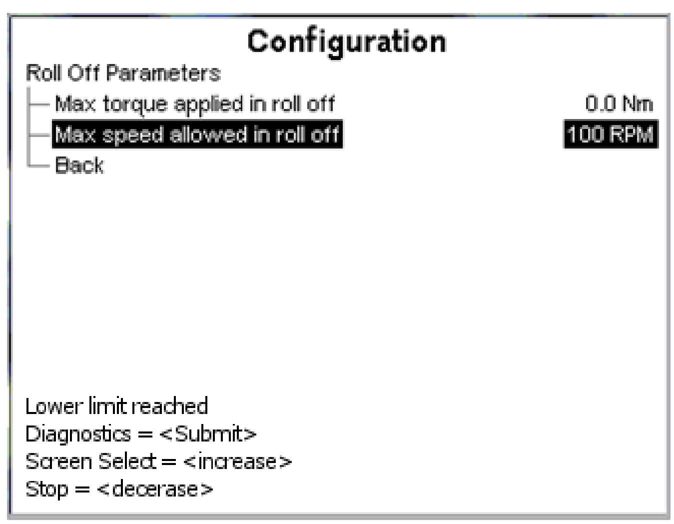


Fig. 31: Typical parameter change screen



Parts replacement

Removal and installation of VFDs

The following section outlines the removal and installation of VFDs.

CAUTION!
Before removing or installing a VFD, verify that the battery has been disconnected from the machine, that the circuit breakers are in the "OFF" position, and that the battery plug has been disconnected and locked/tagged out. Failure to do so may result in machine damage or injury to you or other personnel.

Connectors

Locking type connectors are used on the VFDs (Fig. 35).

To remove a connector:

1. Verify that the battery has been disconnected from the machine, that the circuit breakers are in the "OFF" position, and that the battery plug is disconnected and locked/tagged out.
2. Remove the cover from the machine.
3. Locate the VFD and identify the connectors, labeled "A", "B", "C", and "D".
4. The connectors are equipped with a screwdriver slot to release the latch (Fig. 36). Insert the screwdriver into the latch and lift up.
5. Pull up firmly to remove the connector.

To install a connector:

1. Verify that the correct connector, labeled "A", "B", "C", and "D", is selected.
2. Press connector down firmly to lock in place. Locking latch (Fig. 36) must be firmly fastened for mating.

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