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INTRODUCTION

The purpose of this manual is to provide technical information and instructions that will enable the user to identify faults and affect repairs on Danfoss series 3000 Adjustable Frequency Drives, VLT 3032 through VLT 3052, 230 Volt models.

The manual has been divided into five sections. The first section covers the description and sequence of operations. Section two covers fault messages and provides troubleshooting charts both in the form of flow and symptom/cause. Section three describes the various tests and methods used to evaluate the drives' condition. Section four covers the removal and replacement of the various components. Section five discusses application-specific information.

ESD SAFETY

Electrostatic discharge. Many electronic components are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

When performing service, proper ESD equipment should be used to prevent possible damage from occurring.

SAFETY

WARNING:

The Adjustable Frequency Drive (AFD) contains dangerous voltages when connected to the line voltage. Only a competent technician should carry out the service.

FOR YOUR SAFETY:

1) DO NOT touch the electrical parts of the AFD when the AC line is connected. After the AC line is disconnected wait at least 15 minutes before touching any of the components.
2) When repairs or inspection is made the AC line must be disconnected.
3) The STOP key on the control panel does not disconnect the AC line.
4) During operation and programming of the parameters the **motor may start without warning**. Activate the STOP key when changing data.

SECTION ONE

DESCRIPTION OF OPERATION

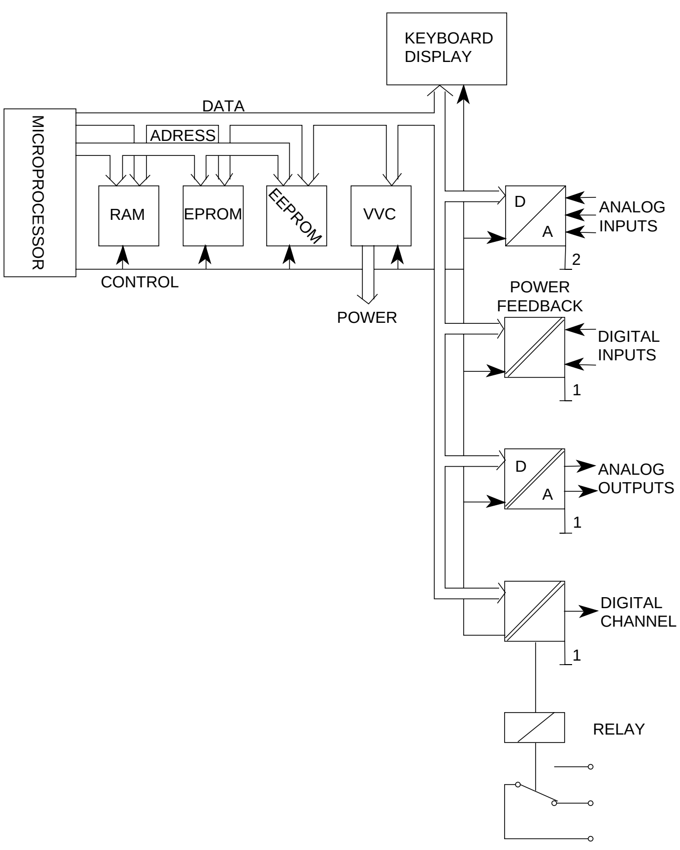
Refer to the overall schematic in the Appendix.

It is not the intention of this manual to enter into a detailed description of the unit's operation. Moreover, it is intended to provide the reader with a general view of the unit's main assemblies. With this information, the repair technician should have a better understanding of the unit's operation and therefore aid in the troubleshooting process.

The VLT is divided primarily into three sections commonly referred to as: logic, power, and interface.

LOGIC SECTION

The control card itself primarily makes up the logic section. The heart of the control card is a microprocessor which controls and supervises all functions of the unit's operation. In addition, a separate PROM contains the parameter sets which characterize the unit and provide the user with the definable data enabling the unit to be adjusted to meet the customer's specific application. This definable data is then stored in an EEPROM which provides security during power-down and also allows flexibility for future changes as needed. A custom integrated circuit generates the PWM waveform which is then sent on to the interface board for distribution to the individual gate drive circuits.



Also, part of the logic section is the keyboard/display mounted on the control card. The keyboard provides the interface between the digital logic and the human programmer. The LCD (Liquid Crystal Display) provides the operator/programmer with menu selection, unit status and fault diagnostic information. Programming is accomplished through the use of four of the eight keys available on the keyboard. The additional four keys provide Local Start, Stop, Forward/ Reverse and Jog.

A series of customer terminals are provided for the input of remote commands such as: Run, Stop and Speed Reference. Terminals are also provided to supply outputs to peripheral devices for the purpose of monitoring and control. Two programmable relay outputs are also available to interface the unit with other devices.

In addition, the control card is capable of communicating via a serial link with outside devices such as a personal computer or a programmable logic controller.

The control card provides two voltages for use from the customer terminal strip. The 24VDC is used primarily to control functions such as: Start, Stop and Forward/Reverse. The 24VDC is provided from a separate section of the unit's power supply and is delivered to the control card from the interface board via the two conductor ribbon cable.

LOGIC SECTION (continued)

A 10VDC supply is also available for use as a speed reference when connected to an appropriate potentiometer. These two voltage references are limited in the amount of available current they can provide (see specifications in Instruction Manual). Attempting to power devices which draw currents in excess of that available may result in an eventual failure of the power supply. In addition, if the supply is loaded too heavily, sufficient voltage will not be available to activate the control inputs.

During the troubleshooting process it is important to remember that the control card can only carry out instructions as it has been commanded. Of course, it is possible that as a result of a failure the control card may fail to respond to commands. For this reason lies the necessity to isolate the fault to the control commands, the control program or the control card itself. If, for example, the unit does not run, but yet an obvious reason is not apparent, check for proper control signals. Has a run command been provided on the correct terminal; and if so, has that terminal been designated as such in the programming of the control card. In addition, be sure to verify that commands are being received by testing for the presence of voltage on the appropriate terminals. Never assume the signal is present because it is suppose to be. If ever in doubt of whether the remote controls are functioning properly, it is possible to take local control of the unit to verify if the control card is operational. A word of caution here: prior to taking local control, insure all other equipment associated with the drive is prepared to operate. In many cases, safety interlocks are installed which can only be activated through the use of a normal remote control start. In the same sense that the control card can only respond to commands, comes the situation that the control card makes a response without the presence of an actual command. By the term response, it is not meant to infer that the control card initiates such actions as Run or Stop, but rather suggests that the control card displays unknown data or its performance is affected as in what might be speed instability. In these cases, the first instinct may be to replace the control card; however, in most instances, this type of erroneous operation is usually due to electrical noise being injected onto the remote control signal wiring. Although the control card has been designed to reject such interference, noise levels of sufficient amplitude can, in fact, affect the performance of the control card.

As mentioned, sufficient levels of electrical noise can cause such things as speed fluctuations as a result of interference with the speed reference or with the operation of the microprocessor. In these situations it is necessary to investigate the wiring practices of the installation. For example, are the control signal wires running in parallel with other higher voltage signals such as the input or output power wiring? As wires are passed in close proximity to one another, voltages are induced through capacitive or inductive coupling. This type of problem can be corrected by rerouting the wiring or through the use of shielded cable. When employing the use of shielded cable, it is important to properly terminate the drain wire. The drain wire is terminated only at the control card end of the wire. Specific terminals are designated for this purpose. The opposite end of the shielded cable drain wire is then cut back and taped off to prevent it from coming in contact with ground or acting as an antenna.

LOGIC TO POWER INTERFACE

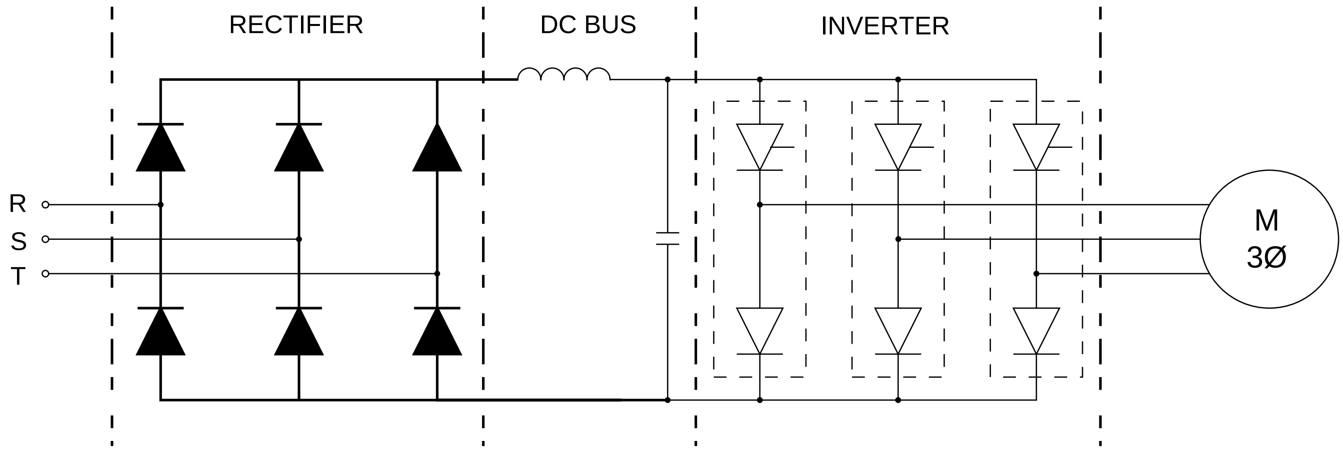
The logic to power interface isolates the high voltage components of the power section from the low voltage signals of the logic. This is accomplished by use of the interface board. All communication between the control logic and the rest of the unit passes through the interface board. This communication includes: feedback from the current sensors, input from the heatsink temperature sensor, line voltage monitoring, DC Bus voltage monitoring, control of the fans , control of the input thyristor rectifiers and control of the gate drive firing signals. Also on the interface board is the power supply which provides the unit with low voltage power such as 24VDC, 16VDC, 13VDC and 5VDC. The power supply is a Switch Mode Power Supply (SMPS). The switch mode type supply is used due to its efficiency and linearity. Another benefit of the switch mode supply is that it obtains its power from the DC Bus; in the event of a power loss the power supply remains active for a longer period of time versus conventional power supplies.

During the troubleshooting process it is important to determine whether the interface board is receiving or sending the signal that appears to be at fault. For example, the loss of a gate-drive signal is a waveform generated by the interface board and conversely a heatsink over-temperature fault is a result of the interface board receiving an input from the heatsink temperature sensor. If the signal is of the later type (received), it is then necessary to isolate the fault to either the sending device or the interface board. It is generally assumed that a component within the unit is usually at fault; and although this may in fact be the case, it is critical to check all possibilities to avoid costly errors and lengthy downtime. In any case, the interface board is a relatively quick and easy assembly to exchange; and so if it is suspect, a quick exchange will prove the assumption.

POWER SECTION

The power section is made up of the SCR/Diode modules (input rectifiers), the soft charge circuit, the DC capacitor bank, the gate drive and snubber cards and the IGBT power devices. Also located in the power section are the DC Bus coil, the motor coils and, although not typically considered part of the power section, the output phase current sensors.

During the troubleshooting process, extreme care is required when probing into the power section components. The DC Bus, when fully charged, can be as high as 350VDC. Although this voltage begins to decrease upon the removal of input power, it takes up to approximately fifteen minutes to fully discharge the DC capacitor bank. Located on the interface board is the Bus Charged Indicator. The red LED is visible through the shield covering the lower portion of the interface board; and as long as it is lit it indicates the DC Bus voltage is greater than 50VDC. A fault in the power section will usually result in at least one of the incoming line fuses being blown. If one or more line fuses have blown, it is not recommended to replace them and reapply power without further investigation. In a case such as this, it would be suggested to conduct the tests listed under Static Test Procedures in Section Three. These tests will result in a thorough check of all the components operating in the power section. In addition, following the identification and replacement of power section components, it is recommended to disconnect the motor wires prior to reapplying power. This precaution opens the path for short circuit currents through the motor in the case that all faulty components have not been replaced.



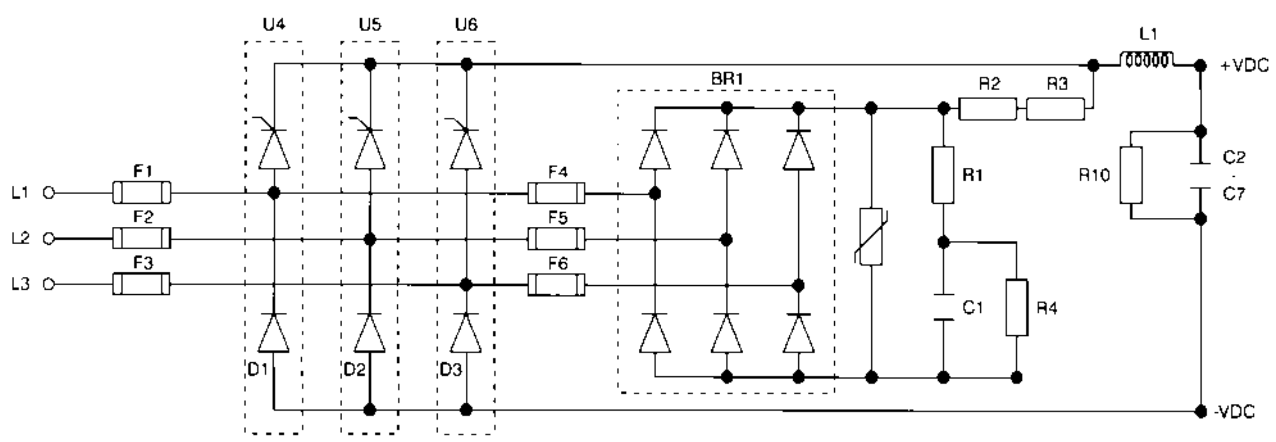
SIMPLFIED PWM POWER SECTION

SEQUENCE OF OPERATION

When input power is first applied, the SCR/Diode modules (input rectifiers) are not gated so the incoming line voltage is rectified by the soft charge rectifier (BR1). As the DC Bus capacitors charge, the inrush current is limited by the series soft charge resistors (R2 and R3). Following a time delay of approximately one second, the interface board monitors the DC Bus voltage and, providing it has reached an acceptable level, begins sending gate pulses to the SCR/Diode Modules. Once the SCR's have been gated on, they remain in this state and the SCR/ Diode modules act as a normal rectifier. This scenario will only be interrupted if the DC Bus fails to charge. This can be caused by insufficient line voltage, a fault in the Power Section, a fault in the soft charge circuit, and also by an open connection at PINS 1 and 2 of MK15. The SCR Disable input at MK15 is provided as a means to disable the SCR/Diode modules in the case of an external failure such as in the Dynamic Brake option. Note that although the SCR/Diode modules may be disabled, line voltage is still applied to the unit through the soft charge circuit.

Providing the charging process proceeds normally, the power supplies will come up and provide the control card and all other sections of the unit with low voltage control power. At this time the display in the control card will indicate the unit is ready for operation.

Following a run command and a speed reference, the control card delivers the PWM signals (one for each phase) to the interface board. The interface board in turn receives these three signals and creates the six individual gate drive pulses. The gate drive pulses are sent to the respective gate drive circuits located on the gate drive card. From here the output power devices (IGBTS) are switched on and off to develop the PWM waveform which is ultimately delivered to the motor.



As the unit operates, the interface board monitors the status of the units operating condition. Currents in excess of limits, temperatures being exceeded, and voltages out of specification will result in the interface board responding with a fault and sending the appropriate fault message to the control card. When a fault occurs, the interface board will indicate the condition via a series of LED's. The control card will also display a fault message, and in virtually all cases trip the unit off line. Section 2 of this manual describes the fault LED's and messages and provides direction in determining the cause and the solution for the fault condition.

SECTION TWO

FAULT INDICATORS AND MESSAGES

A variety of messages are displayed by the control card. Some of these indicate the operational status of the unit while others provide warnings of an impending fault. In addition, there are the alarm messages which indicate that the unit's operation has stopped due to a fault condition. In this section we will deal with only those messages which interrupt the unit's operation. A complete list of status messages can be found in the Instruction Manual. Along with the control card message, the interface board contains several Light Emitting Diodes (LED's) which aid in the identification of the fault condition.

STATUS MESSAGES

CURRENT LIMIT
This message will flash in the display when the unit is operating above the current limit setting as recorded in parameter 209. Parameter 310 may be set to provide a fixed time delay after which the unit will trip.

REF FAULT
This message will flash in the display should any live zero signal be operating outside of its range. For example, 4-20ma has been selected as the speed reference. Should the current loop be broken, the display will flash "REF FAULT". Parameters 414 and 415 may be used to select the unit's response to this condition.

NO 24 VOLT
This message will flash if the 24 volt power supply is missing or out of tolerance. The 24 volt supply is used only for the customer's remote connections.

NO MOTOR
This message will flash if Motor Check has been activated in parameter 313, terminal 27 is enabled and no motor is detected.

WARNING MESSAGES

VOLTAGE LOW

This message will flash when the DC Bus voltage has fallen below the lower limit. This is an indication of low line voltage. This is only a warning message, however. If the condition persists, it will result in a unit trip on "Under Voltage".

VOLTAGE HIGH

This message will flash when the DC Bus voltage has exceeded the upper limit. This is an indication of high line voltage or regenerative energy being returned to the bus. This is only a warning message, however. If the condition persists, it will result in a unit trip on "Over Voltage".

INVERT TIME

This message will flash when the inverter ETR value has reached 98%. The inverter ETR begins counting up as soon as the output current exceeds 105% of the unit's continuous current rating. At an inverter ETR value of 100%, the unit trips on "Invert Time".

MOTOR TIME

This message will flash if Motor Thermal Protection has been activated in parameter 315 and the motor ETR value has reached 98%. The motor ETR value begins counting up if the motor is run at slow speed or if the motor is consuming more than 116% of the motor's nominal rated current as entered in parameter 107. At a motor ETR value of 100%, the unit will respond based on the setting in parameter 315. If Trip has been selected, the unit will trip on "Motor Time".

OVERCURRENT

This message indicates at least one of the three output phases has reached the peak current rating. In addition, the "Overcurrent" LED (D8) on the interface board will flicker. During this time the control card is attempting to initiate current limit. If the current rises to fast or the control card cannot control the condition by means of current limit, the unit will trip on "Over Current".

ALARM MESSAGES

Alarm messages will be indicated by the following messages appearing in the display and the red alarm LED being lit on the control panel. All alarm messages result in the unit's operation being interrupted and require a Manual or Automatic reset. Automatic reset can be selected in parameters 309 and 312. In addition, the message "Trip" or "Trip Locked" will be displayed. If "Trip Locked" is displayed, the only possible reset is to cycle power and then perform a manual reset. Manual reset is accomplished by means of the front panel push button or by a remote contact closure on the appropriate control terminal. Remedies listed with each alarm message give a basic description of the corrective action which can be taken to correct the fault condition. For a more detailed explanation, see the Sympton/Cause section beginning on page 21 and the application section on page 35. Also note the numbers in parenthesis by each alarm message. These are the codes which will appear in the Fault memory, Parameter 602. See APPENDIX I for more on the Fault memory.

INVERTER FAULT (1)
This message indicates a fault in the power section of the unit. This message may also be displayed if the unit has detected a phase loss on the input. If a phase loss has been detected, the "Loss of Phase" LED (D9) on the interface board will be illuminated and the "Inverter OK" LED (D4) on the interface board will be out. This fault returns a "Trip Locked". Also see Testing The Inverter Section, page 26.

OVER VOLTAGE (2)
This message indicates the DC Bus voltage upper limit has been exceeded. In addition, the "High Bus Voltage" LED (D5) on the interface board will be illuminated and the "Inverter OK" LED (D4) on the interface board will be out. This fault can be caused by high line voltage or regenerative energy being returned from the motor. To remedy this fault condition, reduce the line voltage or extend the Decel Ramp. This fault returns a "Trip". Also see Over Voltage Trips, page 38.

UNDER VOLTAGE (3)
This message indicates the DC bus voltage has fallen below the lower limit. In addition, the "Low Bus Voltage" LED (D6) on the interface board will be illuminated and the "Inverter OK" LED (D4) on the interface board will be out. To remedy this fault, increase the line voltage to the correct value for the unit rating. This fault returns a "Trip". Also see Testing The Soft Charge Circuit, page 23.

OVER CURRENT (4)
This message indicates a short circuit on the output of the inverter. This fault may also be caused by the unit reaching the peak current rating too rapidly for the unit to respond with current limit. An example may be closing an output contactor with the unit at speed and a high inertia load. The "Overcurrent Trip" LED (D7) on the interface board will be illuminated and the "Inverter OK" LED (D4) on the interface board will be out. To remedy this fault, check the output wiring and motor for short circuits. This fault returns a "Trip Locked". Also see Over Current Trips, page 37.

ALARM MESSAGES (continued)

GROUND FAULT (5)

This message indicates a leakage to ground on the output of the inverter. The "Ground Fault Trip" LED (D2) on the interface board will be illuminated and the "Inverter OK" LED on the interface board will be out. This fault will also be present if the programming card on the interface board is not installed. To remedy this fault, check the output wiring and motor for ground faults. This fault returns a "Trip Locked". Also see Ground Fault Trips, page 37.

OVER TEMP (6)

This message indicates that the unit's heatsink temperature or the unit's internal ambient temperature has exceeded permissible limits. This fault may also be caused by a trip received from the optional external temperature sensor if a sensor has been connected to terminal MK15 on the interface board. The interface board LED's indicate the nature of the specific trip. In all cases below the "Inverter OK" LED will be out. "Over Temperature Trip" LED (D3) only indicates the unit's heatsink sensor has caused the trip. "Over Temperature Trip" LED (D3) and Internal Over Temperature" LED (D109) illuminated indicates the thermal sensor located on the interface board has detected high ambient temperature within the unit and caused the trip. "Over Temperature Trip" LED (D3) and "External Over Temperature" LED (D108) illuminated indicates the external temperature sensor has caused the trip. To remedy this fault, correct the over-temperature condition. This fault returns a "Trip". Also see Overtemp Trips, page 39.

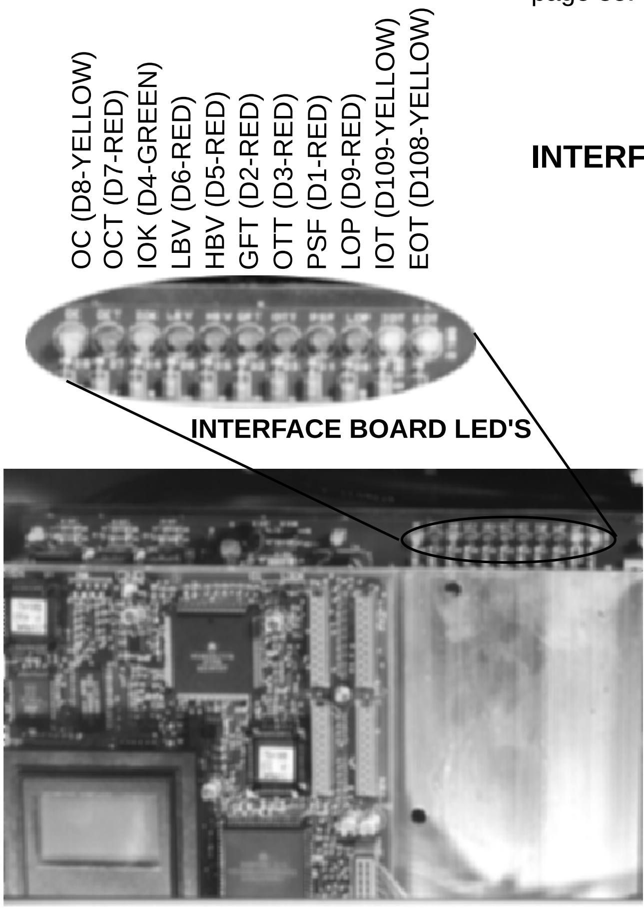
INVERT TIME (7)

This message indicates the unit has delivered greater than 105% of the unit's continuous current rating for too long (inverse time function). Prior to this fault condition the "Invert Time" warning will be displayed. An indication from the interface board status LED's does not apply. To remedy this fault, reduce the motor load to at or below the unit's continuous current rating. This fault returns a "Trip Locked". During the trip the counter will count down. Upon reaching 90%, the "Trip Locked" will change to "Trip".

MOTOR TIME (8)

This message indicates the motor has consumed greater than 116% of the motor's nominal current rating for too long as entered in parameter 107. This fault may also be caused from running the motor at a low speed and high current for too long a period of time. This trip will only occur if the "Motor Thermal Protection" has been activated in parameter 315. Prior to the trip the "Motor Time" warning will be displayed. In addition, this fault may be displayed if an external thermistor has been connected to input 16 and is defective, disconnected or indicating an over-temperature condition. Also note that by selecting "Thermistor" in parameter 400 in error will result in a "Motor Time" fault. An indication from the interface board status LED's does not apply. To remedy this fault, reduce the load on the motor or raise the motor's speed. This fault returns a "Trip Locked". During the trip the counter will count down. Upon reaching 0% the "Trip Locked" will change to "Trip".

ALARM MESSAGES (continued)



CURRENT LIMIT (9)
This message will be displayed if the unit has run in current limit for a time which exceeds the setting in parameter 310. To remedy this fault, reduce the motor's load or verify that the correct settings have been entered in parameter 209 (Current Limit) and parameter 310 (Current Limit Trip Delay). This fault returns a "Trip". See Current Limit Trips, page 35.

INTERFACE BOARD LED'S

HIGH BUS VOLTAGE
HBV (D5-RED)
Indicates the DC Bus voltage upper limit has been exceeded.
The I0K LED will be off and the control card indicates "Over Voltage".

LOW BUS VOLTAGE
LBV (D6-RED)
Indicates the DC Bus voltage has fallen below the lower limit.
The I0K LED will be off and the control card will indicate "Under Voltage".

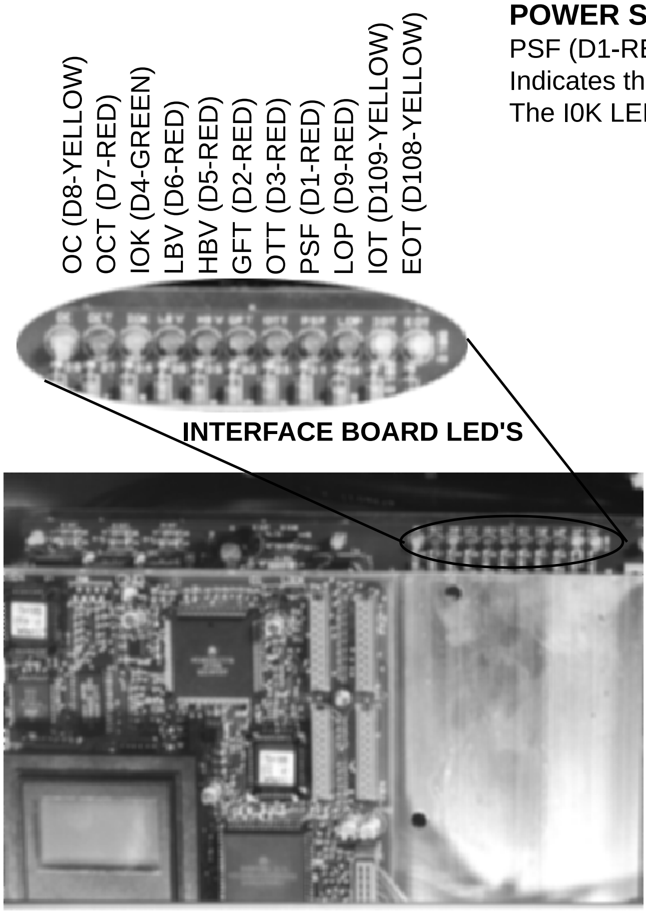
OVER CURRENT TRIP
OCT (D7-RED)
Indicates a short circuit on the inverter output.
The I0K LED will be off and the control card will indicate "Over Current".

GROUND FAULT TRIP
GFT (D2-RED)
Indicates a Ground Fault on the Inverter Output.
The I0K LED will be off and the control card will indicate "Ground Fault".

OVER TEMP TRIP
OTT (D3-RED)
Indicates the heatsink temperature is outside of the specified operating range.
The I0K LED will be off and the control card will indicate "Over Temp".

INTERNAL OVER TEMP
IOT (D109-YELLOW)
Indicates the internal ambient temperature has been exceeded.
The I0K LED will be off and the control card will indicate "Over Temp".

ALARM MESSAGES (continued)



INTERFACE BOARD LED'S

EXTERNAL OVER TEMP
EOT (D108-YELLOW)
Indicates the external temperature sensor has detected an over temp condition. If used, the sensor is connected to MK15 on the interface board.
The I0K LED will be off and the control card will indicate "Over Temp".

POWER SUPPLY FAULT
PSF (D1-RED)
Indicates the low voltage power supplies are out of tolerance.
The I0K LED will be off.

LOSS OF PHASE FAULT
LOP (D9-RED)
Indicates one of the input phases is missing or extremely low.
The I0K LED will be off and the control card will indicate "Inverter Fault".

OVERCURRENT
OC (D8)-YELLOW
Indicates the peak current of the inverter has been exceeded.

INVERTER OK
IOK (D4) GREEN
Indicates the inverter is free of faults.

GENERAL TROUBLESHOOTING TIPS

Prior to diving into a repair here a few tips if followed will make the job easier and may prevent unnecessary damage to good components.

1. First and foremost respect the voltages produced by the drive. Always verify the presence of line voltage and bus voltage before working on the unit. Also remember that some points in the drive are referenced to the negative bus and are at bus potential even though you may not expect it.

2. Never power up a unit which has had power removed and is suspected of being faulty. If a short circuit exists within the unit applying power is likely to result in further damage. The safe approach is to conduct the Static Test Procedures starting on page 23. The static tests check all high voltage components for short circuits. The tests are relatively simple to make and can save money and downtime in the long run.

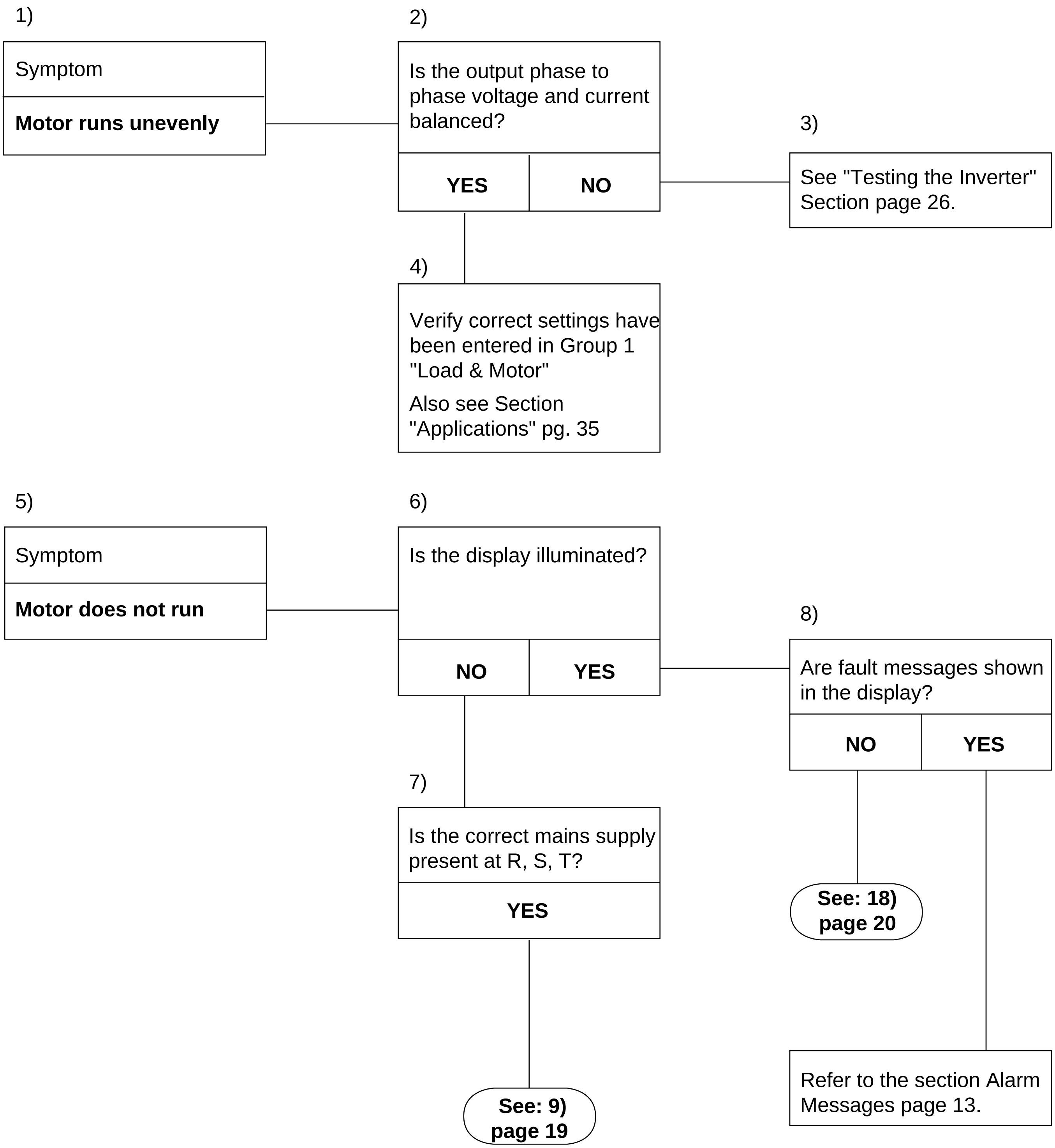
3. The safest method of conducting tests on the drive is with the motor disconnected. In this way a faulty component that was overlooked or the unfortunate slip of a test probe will generally result in a unit trip instead of a component failure.

4. Following the replacement of parts test run the unit with the motor disconnected. Start the unit at zero speed and slowly ramp the speed up until the speed is at least above 40 Hz. Monitor the phase to phase output voltage on all three motor terminals to check for balance. If balanced the unit is ready to be tested on a motor. If not, further investigation is necessary.

5. Never attempt to defeat fault protection devices within the drive. This will only result in unwanted component damage and may result in personal injury as well.

6. Always use factory approved replacement parts. The unit has been designed to operate within certain specifications. Incorrect parts may effect the tolerence and result in further damage to the unit.

7. Read the instruction and service manuals. A thorough understanding of the unit is the best approach. If ever in doubt consult the factory or an authorized repair center for assistance.


1)
Symptom
Motor runs unevenly
2)
Is the output phase to phase voltage and current balanced?
YES
NO
3)
See "Testing the Inverter" Section page 26.
4)
Verify correct settings have been entered in Group 1 "Load & Motor"
Also see Section "Applications" pg. 35
5)
Symptom
Motor does not run
6)
Is the display illuminated?
NO
YES
8)
Are fault messages shown in the display?
NO
YES
7)
Is the correct mains supply present at R, S, T?
YES
See: 18) page 20
See: 9) page 19
Refer to the section Alarm Messages page 13.

9)

Symptom

No fault report or light in display.

10)

Have prefuses for the VLT adjustable frequency drive blown, F1, F2, F3 or F4, F5, 56?

NO → 12) | **YES** → 11)

11)

If one or more of the fuses F1, F2 or F3 have blown, test the input rectifiers and the inverter section, pages 25 and 26. If one or more of the fuses F4, F5 or F6 have blown test the soft charge circuit, page 23.

12)

Disconnect all control signal wires on the control card.

Does that remove the fault?

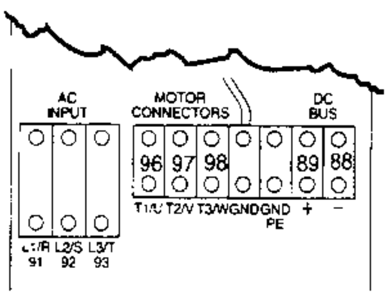
NO → 14) | **YES** → 13)

13)

The fault may be caused by a short circuit in the control signals.

Check control wiring for proper connection.

14)



Is the DC Bus voltage OK? Measure the DC Bus voltage between terminals (89) +VDC and (88) –VDC.

YES → 16) | **NO** → 15)

15)

Test the Soft Charge Circuit and input rectifier, pages 23-25.

16)

Replace the Control Card, see page 31. Does the problem disappear?

YES → Resume operation | **NO** → 17)

17)

Replace the Interface/ILD card, see page 30. Does the fault disappear?

YES → Resume operation | **NO** → Consult factory

18)

Symptom
Motor stopped. Light in display, but no fault report.

19)

Start the VLT adjustable frequency drive by pressing "Start" on the control panel.

20)

Has the display locked, i.e. it cannot be changed or is illegible?

NO → 22) | **YES** → 21)

21)

Replace the Control Card, see page 31. If this does not help, the fault might be electrical noise. Check whether the following precautions have been taken:

- Have shielded cables been used?
- Are the shields correctly terminated?
- Is the unit properly grounded to earth?

22)

Has the motor been correctly connected and are all motor phases in order?

YES → 23) | **NO** → Correct the motor wiring

Correct the motor wiring

Insure motor overloads are seset and output contactor closed.

CAUTION:
Prior to running in Local, insure all other equipment associated with the VLT is ready to function or has been isolated

23)

Attempt to run the VLT in local.
SEE CAUTION at LEFT
Make the following parameter settings:
Parameter 003 = Local
Parameter 004 = Fref.
Change by means of
+ and – keys.
Does the motor run?

YES → 24) | **NO** → 25)

24)

Verify that the control signals are connected to the correct terminals and the appropriate parameter settings have been entered.

25)

Replace the Control card, see page 31.

Does the motor run?

NO → 26)

26)

Replace the Interface/ILD card, see page 31.

Does the motor run?

NO → Consult factory

Consult factory

SYMPTOM/CAUSE CHARTS

SYMPTOM/CAUSE charts are generally directed towards the more experienced technician. The intent of these charts is to provide a range of possible causes for a specific symptom. In doing so, these charts provide a direction, but with limited instruction.

SYMPTOM	POSSIBLE CAUSES
1. Control Card Display Is Not Lit.	Incorrect or missing input voltage
	Incorrect or missing DC bus voltage
	Remote control wiring loading the power supply
	Defective Control Card
	Defective Interface Board
	Defective or disconnected ribbon cables
2. Blown Input Line Fuses	Shorted SCR/Diode module
	Shorted IGBT
3. Blown Soft Charge Fuses	Shorted soft charge rectifier
	Shorted DC bus
	Shorted brake IGBT
	Mis-wired Dynamic Brake option
4. Motor Operation Unstable (Speed Fluctuating)	Start compensation set too high
	Slip Compensation set too high
	Improper current feedback
	PID Regulator or Auxilary Reference misadjusted
5. Motor Draws High Current But Cannot Start. (May appear to rock back and forth.)	Open winding in motor
	Open connection to motor
	One inverter phase missing. Test output phase balance, page 27.
6. Motor Runs Unloaded But Stalls When Loaded. (Motor may run rough and VLT may trip.)	One half of one inverter phase missing. Test output phase balance, page 27.

SYMPTOM/CAUSE CHARTS

SYMPTOM/CAUSE charts are generally directed towards the more experienced technician. The intent of these charts is to provide a range of possible causes for a specific symptom. In doing so, these charts provide a direction, but with limited instruction.

SYMPTOM	POSSIBLE CAUSES
7. Unbalanced Input Phase Currents	Input line voltage unbalanced
Note: Slight variations in phase currents is normal. Variations greater than 5% require investigation.	Faulty connection on input wiring
	Fault in plant power transformer
	Input SCR/Diode module faulty or not being gated.
8. Unbalanced Motor Phase Currents	Open motor winding
Note: Slight variations in phase currents is normal. Variations greater than 5% require investigation.	Faulty motor connection
	Fault in inverter section (see Symptom No. 6.)

SECTION THREE

STATIC TEST PROCEDURES

All tests will be made with an ohmmeter capable of testing diodes. Use a digital VOM set on diode scale or an analog ohm meter set on RX100 scale. Before making any checks disconnect all input power, motor and brake option connections.

<u>CAUTION</u>: Allow sufficient time for the DC Bus to fully discharge before beginning testing. The presence of bus voltage can be tested by setting your voltmeter for 500VDC and reading the terminals labeled 88 (–) and 89 (+).

TESTING THE SOFT CHARGE CIRCUIT

The purpose of statically testing the soft charge circuit is to rule out failures of the Soft Charge Rectifier and Soft Charge Resistors. If the soft charge fuses have blown, it indicates the possibility of a short circuit of the DC Bus. A DC Bus short can be caused by:

- Two shorted IGBT's--one negative and one positive in the same phase
- A shorted Brake Module IGBT or having connected the Brake Module incorrectly
- Shorted DC Bus capacitors

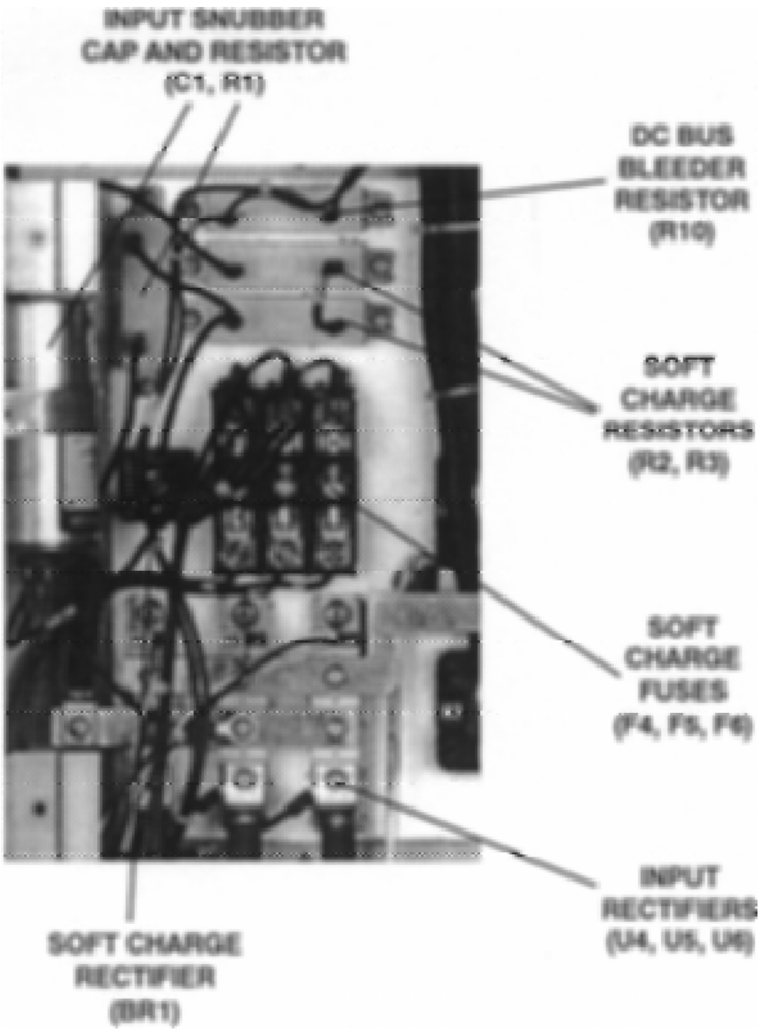
These are the primary causes; however, any component which is connected across the positive and negative bus if shorted can result in a DC Bus short. Conducting the remaining Static Test Procedures should rule out the remaining possibilities.

TESTING THE SOFT CHARGE CIRCUIT

1. Prior to making the test, it is necessary to verify that the three soft charge fuses (F4, F5, and F6) are good. If they are not, they must be replaced before proceeding.

2. Remove the plug on spade connectors from the plus and minus terminals of the rectifier bridge (BR1).

3. Connect the positive (+) meter lead to the positive terminal of the rectifier. Connect the negative (–) meter lead to the soft charge fuses (F4, F5, and F6) in turn. Each reading should show open.



(SHOWN WITH CONTROL/INTERFACE CARD CARRIER REMOVED)

4. Reverse the meter leads connecting the (–) lead to the positive terminal of the rectifier and the (+) lead to the soft charge fuses (F4, F5, and F6) in turn. Each reading should show a diode drop.

5. Connect the positive (+) meter lead to the negative terminal of the rectifier. Connect the negative (–) meter lead to the soft charge fuses (F4, F5, F6) in turn. Each reading should show a diode drop.

6. Reverse the meter leads connecting the (–) lead to the negative terminal of the rectifier and the (+) lead to the soft charge fuses (F4, F5, and F6) in turn. Each reading should show open.

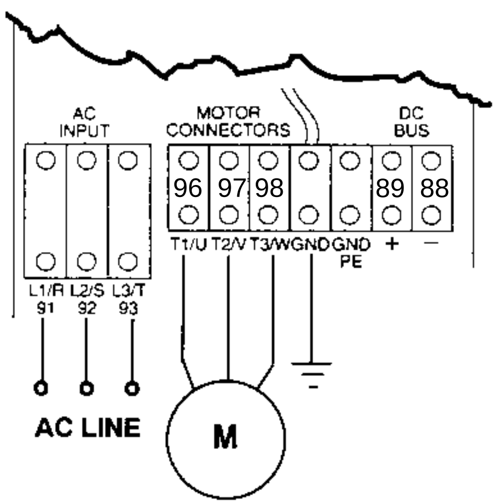
7. Set the meter on the lowest resistance scale. Connect the positive (+) meter lead to the wire previously removed from the positive terminal of the rectifier. Connect the negative (–) meter lead to the positive bus rail on the input rectifiers. The positive bus rail is the lower bus bar. The series soft charge resistors (R2 and R3) should read twenty (20) ohms plus or minus two (2) ohms.

8. Reconnect the wires to the plus and minus terminals of the bridge rectifier (BR1). Test is complete.

NOTE: Finding a shorted Soft Charge Rectifier and/or open Soft Charge Resistor may indicate a short circuit on the DC bus. Continue with the remaining static test procedures prior to applying power.

TESTING THE INPUT RECTIFIERS

The purpose of statically testing the input rectifiers is to rule out failures in these devices. Typically a failure of an input rectifier will have caused the input line fuses to blow. It should also be noted that blown input line fuses can also be a result of a shorted IGBT. Testing the inverter section as described on page 26 will rule out short circuits in the IGBT's.



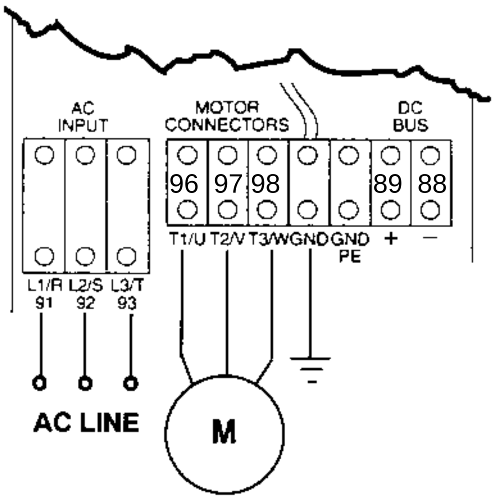
AC LINE AND MOTOR WIRING

1. Prior to making the test, it is necessary to verify that the three input fuses (F1, F2, and F3) are good. If they are not, they must be replaced before proceeding.
2. Connect the positive (+) meter lead to terminal 89 (+VDC). Connect the negative (–) meter lead to terminals 91 (R), 92 (S), and 93 (T) in turn. Each reading should show open.
3. Reverse the meter leads connecting the (–) lead to terminal 89 (+VDC) and the (+) lead to terminals 91 (R), 92 (S), and 93 (T) in turn. Each reading should show a diode drop.
4. Connect the positive (+) meter lead to terminal 88 (–VDC). Connect the negative (–) meter lead to terminals 91 (R), 92 (S), and 93 (T) in turn. Each reading should show a diode drop.
5. Reverse the meter leads connecting the (–) lead to terminal 88 (–VDC) and the (+) lead to terminals 91 (R), 92 (S), and 93 (T) in turn. Each reading should show open. Test is complete.

Incorrect readings indicate a faulty Input Rectifier. The rectifier at fault can be identified by noting which terminal read incorrectly. Terminal 91 corresponds to U4, Terminal 92 to U5 and Terminal 93 to U6. The modules are arranged in the unit from left to right, U4, U5, U6. See Removal and Replacement Instructions on page 33.

TESTING THE INVERTER SECTION

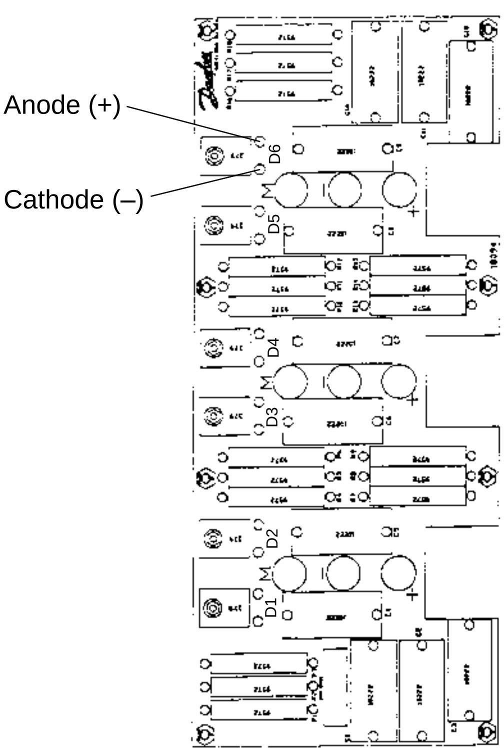
The purpose of statically testing the inverter section is to rule out failures of the IGBT power devices and the snubber diodes. If a short circuit is discovered during the testing, the particular devices can be pinpointed by noting the output terminal indicating the short circuit. The output terminals are designated with a letter corresponding to the phase that feeds that terminal. When looking in the unit, the "U" phase is on the top, "V" phase in the middle and the "W" phase on the bottom. In each phase the negative half of the phase in on the right and the positive half is on the left.



AC LINE AND MOTOR WIRING

1. Prior to making the test, it is necessary to disconnect the motor leads from the unit. By not doing so, the low resistance windings of the motor will make a short circuit on one terminal also appear on the other terminals.
2. Connect the positive (+) meter lead to terminal 89 (+VDC). Connect the negative (–) meter lead to terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show open.
3. Reverse the meter leads connecting the (–) lead to terminal 89 (+VDC) and the (+) meter lead to terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show a diode drop.
4. Connect the positive (+) meter lead to terminal 88 (–VDC). Connect the negative (–) meter lead to terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show a diode drop.
5. Reverse the meter leads connecting the (–) lead to terminal 88 (–VDC) and the (+) meter lead to terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show open. Test is complete.

SNUBBER DIODES D1 - D6



Incorrect readings indicate a faulty IGBT and/or Snubber Diode. To further identify the faulty component the IGBT Snubber Board must be removed. The Snubber Diodes on the IGBT Snubber Board and the IGBT's can then be tested individually. See Removing and Replacing Gate Card and IGBT on page 32.

Once the IGBT Snubber Board is removed the Inverter Section can be retested, using the same tests as above, to verify the condition of the IGBT's.

Testing Snubber Diodes

To test the Snubber Diodes connect the positive (+) meter lead to the Anode (+) and the negative (–) meter lead to the Cathode (–) of each diode. Each reading should show a diode drop.

Reverse the meter leads connecting, the (–) lead to the Anode (+) and the (+) meter lead to the Cathode (–) of each diode. Each reading should show open.

Incorrect readings indicate a faulty Snubber Diode. Replace the Snubber Board.

TESTING THE HEATSINK TEMPERATURE SENSOR

The heatsink temperature sensor is a NTC (negative temperature coefficient) resistor rated for 10K ohm at 25°C. As the temperature rises, the resistance decreases. Conversely, as the temperature falls, the resistance increases. The interface board monitors this resistance and initiates a fault when the resistance is less than 787 ohms. This corresponds to a heatsink temperature of approximately 95°C. By unplugging connector MK16 on the interface board, the resistance of the sensor may be read.

The sensors' resistance must be between 787 ohms - 105 K ohms to be free of a fault condition.

In the case of an open reading or very high resistance, the connections between the plug and the sensor should also be checked.

DYNAMIC TEST PROCEDURES

TESTING FOR OUTPUT PHASE IMBALANCE

When testing phase imbalances, it is practical to measure both voltage and current. A balanced voltage reading, but unbalanced current, indicates the motor is drawing uneven current. This could be caused by a fault in the motor windings or in the wiring connections between the drive and motor. When both voltage and current are unbalanced, it indicates a switching problem or a faulty connection within the unit itself. This can be caused by improper gate drive signals as a result of a faulty interface board or gate drive board. A faulty IGBT or loose wire connection between the IGBT and the output terminals may also be the cause.

CAUTION: Allow sufficient time for the DC Bus to fully discharge before beginning testing. The presence of bus voltage can be tested by setting your voltmeter for 500VDC and reading the terminals labeled 88 (–) and 89 (+).

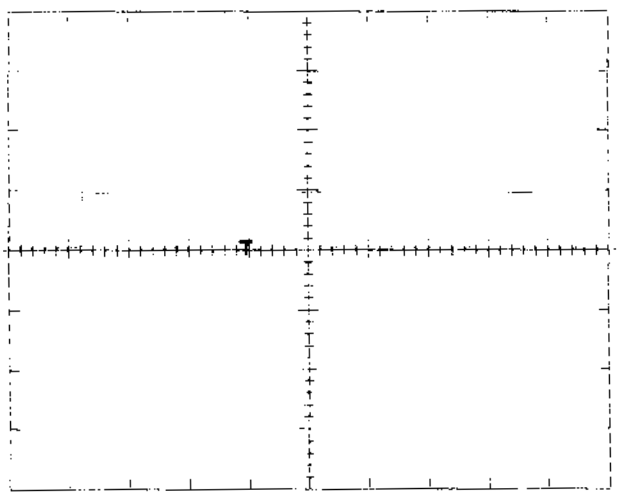
NOTE: When monitoring output voltage an analog voltmeter should be used. Digital meters are sensitive to the switching frequency and usually read erroneously.

1. Remove the motor leads from the output terminals of the unit.
2. Conduct the Inverter Test Procedure in Section Three on page 26.
3. If the Inverter Test Procedure proves good, power the unit back up. Initiate a Run command with a speed reference greater than 40Hz.
4. Read the phase-to-phase output voltage. The actual value of the readings is of less importance than the phase-to-phase balance. This balance should be within 8 volts per phase.
5. If a greater-than-8-volt imbalance exists, measure the gate drive firing signals. See page 28.
6. If the phase-to-phase output voltage is balanced, recheck motor and connections for faults. Consult the factory for additional assistance.

TESTING GATE DRIVE FIRING CIRCUITS

CAUTION: The gate firing signals are referenced to the negative DC Bus and are therefore at Bus potential. Extreme care must be taken to prevent personal injury or damage to equipment. Oscilloscopes, when used, should be equipped with isolation devices.

The individual gate drive firing pulses originate on the interface board. These pulses leave from connector MK1 and are distributed to each phase via the Gate Drive Board. An oscilloscope is the instrument of choice when observing waveforms; however, when a scope is not available, a simple test can be made with a DC voltmeter. When using a voltmeter, compare all the gate pulses to one another. A missing gate pulse will show no reading and an incorrect gate pulse will generally read more or less than the others. At very low frequencies (below 10Hz) the voltmeter will tend to bounce around as the pulse rises and falls. Above 10Hz the voltmeter will remain stable. When testing with an oscilloscope, the test points are the same. This test can be made at the interface board or at each gate card output to its respective IGBT. These tests can be made with or without a motor. However, it is generally safer to have the motor disconnected.



GATE DRIVE SIGNAL AT INTERFACE BOARD MK1 5V/DIV DRIVE IN RUN AT 10HZ 100uSEC/DIV

TESTING AT THE INTERFACE BOARD

Use an oscilloscope or an analog or digital DC voltmeter set for 10VDC. Connect the negative (-) meter lead or scope ground to pin 1 of connector MK1 of the interface board. With the positive (+) meter lead or scope probe compare the readings of pins 13, 14, 17, 18, 21 and 22 of connector MK1. Remember, with the voltmeter the running speed of the VLT must be above 10Hz. A voltmeter will read an average voltage of 2.3VDC and the scope will exhibit a waveform similar to that shown to the left. If any of the readings appear incorrect, replace the interface board. Test again since the gate card may be loading the source and pulling down the signal. If replacement of the interface board does not correct the problem, replace the respective gate card.

Pins 21 and 22 feed the "U" phase.

Pins 17 and 18 feed the "V" phase.

Pins 13 and 14 feed the "W" phase.

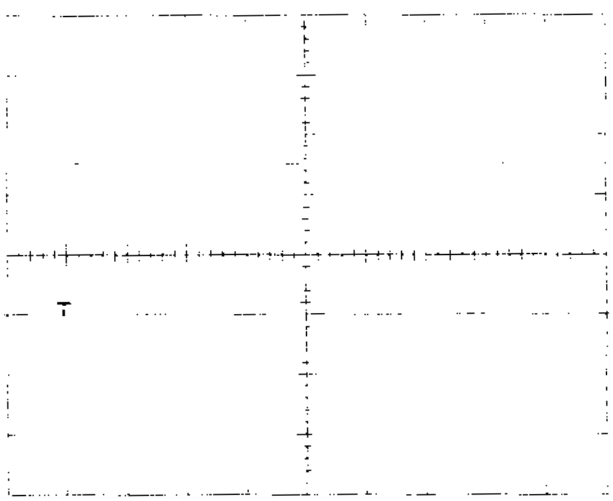
TESTING AT THE GATE CARD OUTPUT

<u>CAUTION</u>: Allow sufficient time for the DC Bus to fully discharge before beginning testing. The presence of bus voltage can be tested by setting your voltmeter for 500VDC and reading the terminals labeled 88 (–) and 89 (+).

Never power up the unit with any of the IGBT gate leads disconnected from the Gate Drive Card. A disconnected gate lead will cause the IGBT to switch on and result in its failure.

Testing the gate drive firing pulses at the output of the gate card insures the signal has successfully made it to that point removing suspicion from the interface board and the gate card. Testing in this area also requires a greater deal of caution since the working space is tighter and high voltages are in close proximity.

Unlike similar models of the VLT, the control card/interface board carrier does not tilt down. It must be completely removed in order to gain access to the Gate Drive Card. As this is the case, testing at the gate driver requires that the test leads are connected and then the unit is reassembled to conduct the tests. Extreme care must be taken to insure test leads can not come in contact with other points of the card when reinstalling the control card/interface board carrier.



IGBT GATE DRIVER SIGNAL AT GATE CARD OUTPUT 10V/DIV 100uSEC/DIV

If any of the readings as observed below appear incorrect, replace the gate card. Prior to doing so, insure the signals have also been tested at the interface board to verify they are correct. If replacement of the gate card does not correct the problem, the IGBT(s) in that phase may be the cause.

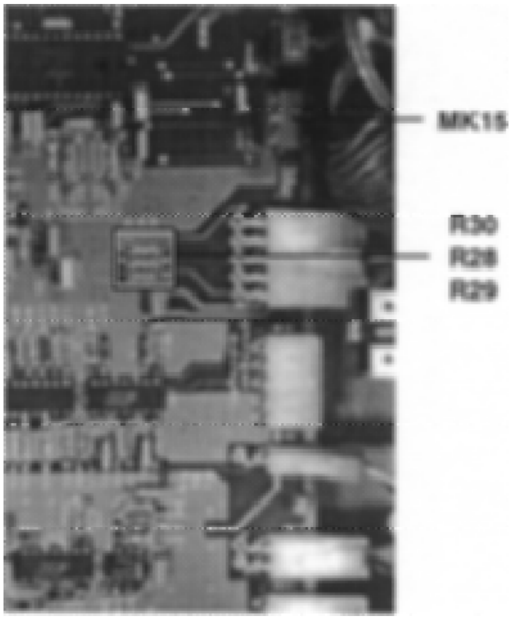
Use an oscilloscope or an analog or digital DC voltmeter set for 10VDC. Connect the negative (–) meter lead or scope ground to pin 2 of connector MK2 of the gate card. Connect the positive (+) meter lead or scope probe to pin 1 of connector MK2. Remember, with the voltmeter the running speed of the VLT must be above 10Hz. A voltmeter will read an average voltage of approximately 2.2VDC and the scope will exhibit a waveform similar to that shown on the left. Repeat the test on the remaining connectors MK3, MK5, MK6, MK8 and MK9.

TESTING INPUT RECTIFIERS

Theoretically, the input current drawn on each of the three input phases should be equal. These currents will vary, however, due to variations in phase-to-phase input voltage and due to some single phase loads within the drive.

Given that the input phase voltages are equal, the input currents phase-to-phase should not vary more than 5%. Current imbalances in excess of 5% may indicate one of the SCR/diode modules is not conducting properly. When the VLT is lightly loaded, it may not be possible to detect a current imbalance. If suspect, the modules should be statically tested. Refer to the Static Test procedures beginning on page 23.

TESTING FOR CURRENT FEEDBACK



A current sensor is in line with each phase of the output. These hall effect devices generate a current that is proportional to the current being drawn in each respective phase. The VLT relies on this feedback for proper waveform control and for providing fault protection.

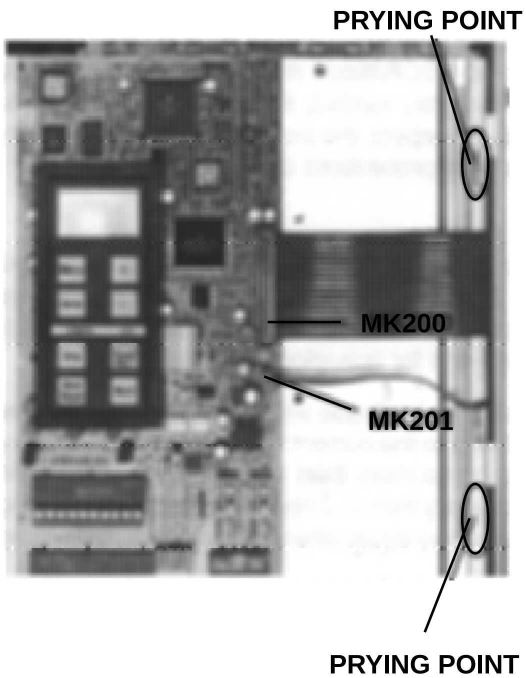
A simple test of the signals can be made with an AC voltmeter. The voltage level present is relative to the current signal generated. At very light loads the voltage may be no more than 100 to 300 millivolts. The importance of this test is to verify that all three sensors are functioning and the signals are approximately equal when compared to each other.

With an AC voltmeter, connect the negative (-) meter lead to pin 3 of connector MK15 on the interface board. With the positive (+) meter lead compare the voltage readings at the right side of resistors R28, R29, R30.

Severe imbalances in the readings indicates an uneven current draw by the motor. See "Testing for Output Phase Imbalance" on page 27 if a large imbalance exists.

SECTION FOUR

REMOVING AND REPLACING THE CONTROL CARD



REMOVAL
1. Remove the two ribbon cables from plugs MK200 and MK201.
2. Insert a screwdriver at the points indicated on the right side of the control card cassette and pry upward.
3. Lift the control card out and set aside.

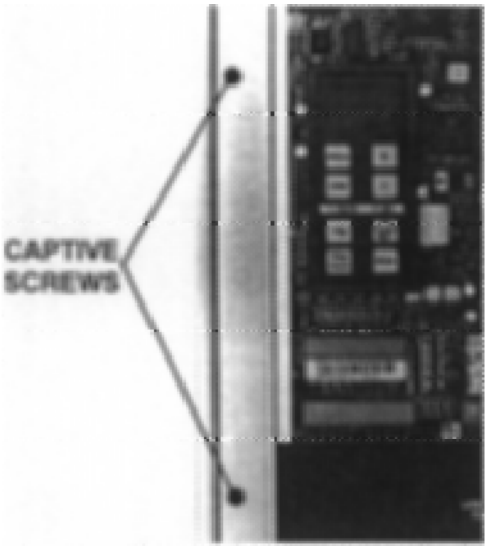
REPLACEMENT
1. Insert the left side of the control card into the guide slot of the control card/interface board carrier.
2. Firmly press down on the right side of the control card cassette until it snaps into place.
3. Reconnect the two ribbon cables to plugs MK200 and MK201.

REMOVING AND REPLACING THE INTERFACE BOARD

REMOVAL
1. Remove the control card to gain access to the interface board.
2. Remove all plugs from the interface board. *Note: All plugs are coded to insure they can be returned to the correct location.*
3. Working around the board, release the 11 swag clips with the use of needle-nose pliers. Gently lift the board clear of the swags as you go.
4. If the interface board is being exchanged with another, remove the Programming Module installed in socket MK4 from the existing board and install it in the replacement board.

REPLACEMENT
1. To install, align the interface board over the swag clips and gently but firmly press down on the board in the area of each swag clip insuring the board snaps securely in place.
2. Reconnect all plugs.
3. Insure the programming module is installed in socket MK4 of the interface board.
4. Reinstall the control card.

REMOVING AND REPLACING GATE CARD, SNUBBER BOARD AND IGBT



ESD Caution IGBT
Electro Static Discharge (ESD) can have damaging effects on sensitive components. The IGBT gate connection is sensitive to static electricity. Whenever the gate leads are disconnected from the gate card or IGBT, the gate lead terminals must be shorted together. This can be accomplished with test leads or by inserting small jumper wires in the ends of the gate lead wire connectors.

1. To gain access to these assemblies remove the Control Card/ Interface Board Carrier. This is done by loosening the two captive screws on the left side of the Carrier. Slide the carrier towards the top of the unit and lift out. There is ample cable length to allow the Carrier to rest in the bottom of the unit.

GATE DRIVE CARD

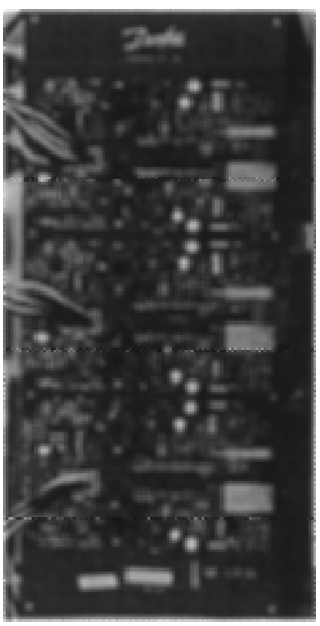
2. Remove plugs MK1 through MK9 from the gate drive card. Note: Coded plugs and the wire harness arrangement insure all plugs can be returned to the correct location.
3. Working around the board, release the eight swag clips with the use of needle-nose pliers. Lift the board free of the swags as you go.
   Reverse the procedure to replace.

IGBT SNUBBER BOARD

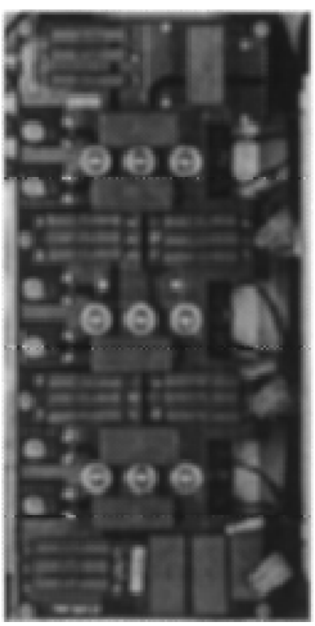
4. Remove the nine Phillips screws securing the IGBT Snubber Board. NOTE: This is a good time to statically test the Snubber Diodes. See testing the Snubber Diodes on page 26.
   Reverse the procedure to replace. Torque to 15-19 LB-IN (1.7-2.15 NM).

IGBT

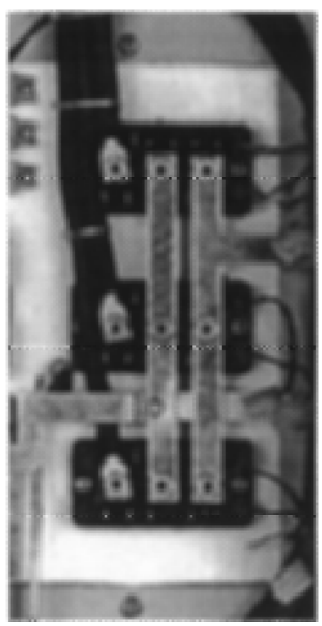
5. Remove the three (3) Standoffs (13mm) securing the Bus Bar and the Motor Coil Wire to the IGBT to be replaced.
6. Loosen the remaining Standoffs, but do not remove, on the remaining two IGBT's. This should allow sufficient clearance to slide the IGBT from beneath the Bus Bar.
7. Remove the two Phillips screws securing the IGBT to the heatsink. Reverse the procedure to replace. Prior to installing the IGBT, apply silicon grease 3 mils thick to the entire base of the module. Transfer the gate wires from the replaced IGBT to the new IGBT insuring correct polarity. Upper set (E2-NEG, G2-POS), lower set (E1-NEG, G1-POS). Alternately torque the IGBT mounting screws initially to 8-10 LB-IN (.90-1.13 NM), final torque to 22-26 LB-IN (2.49-2.93 NM).
   Replace the standoffs and insure all standoffs are torqued initially to 8-10 LB-IN and finally torqued to 15-19 LB-IN (1.70-2.15 NM).



GATE DRIVE CARD



IGBT SNUBBER BOARD



IGBT'S

REMOVING AND REPLACING INPUT RECTIFIERS

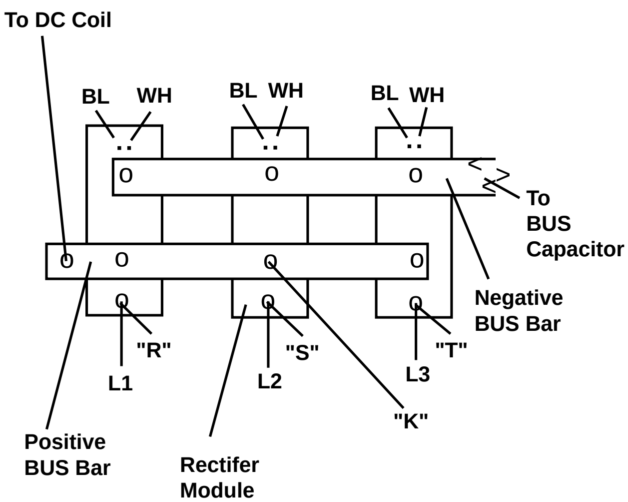
REMOVAL

1. Remove the line side Phillips screw from the rectifier to be replaced.

2. Remove the two Phillips screws from the bus bar connections of the rectifier being replaced. Loosen but do not remove the remaining bus bar screws on the other rectifiers.

3. Remove the two gate wire leads from the rectifier.

4. Remove the two Phillips screws securing the rectifier module to the heatsink and slide the module from beneath the bus bars.



REPLACING

5. Prior to installing apply silicon grease 3 mils thick to the entire base of the module.

6. Install the two Phillips screws securing the module to the heatsink and torque initially to 22-26 LB-IN (2.49-2.93 NM) then final torque to 44 LB-IN (5.00 NM).

7. Plug the gate wires into the gate lead connectors.

8. Install the Phillips screws securing the bus bars to the rectifier. Torque these and the remaining bus bar screws to 18-22 LB-IN (2.03-2.49 NM). Insure the bus sensing wire marked "K" is secured to the lower bus bar.

9. Install the Phillips screw securing the line connection to the module. Torque to 18-22 LB-IN (2.03-2.49 NM). Insure the soft charge jumper wires have been included. The three soft charge jumper wires are labeled "R", "S" and "T" and are connected in that order from left to right.

SECTION FIVE

APPLICATIONS

CURRENT LIMIT TRIPS

UNSTABLE MOTOR OPERATION

Excessive loading of the VLT may result in "CURRENT LIMIT" trips. This is not a concern if the unit has been properly sized and intermittent load conditions cause anticipated operation in current limit. Nuisance current limiting and unstable motor operation can, however, be caused by improperly setting specific parameters. The following parameters are those which are most critical to the VLT/Motor relationship.

- 100 - Load Type
- 103 - Motor Power
- 104 - Motor Voltage
- 105 - Motor Frequency
- 107 - Motor Current
- 108 - Motor Magnetizing Current
- 109 - Start Voltage
- 110 - Start Compensation
- 209 - Current Limit

Parameter 100

An incorrect setting may provide an improper voltage to frequency ratio to the motor with respect to the load demand. For example, a constant torque (CT) load requires a higher V/F ratio at start-up than a variable torque (VT) load. If a VT mode of operation has been selected when operating a CT load, improper starting torque will be available.

Parameters 103, 104, 105, 107

These parameters, when incorrectly set, have an effect on other parameters as well as the unit's interpretation of the load. In setting these parameters enter the name plate data from the motor into the appropriate parameter. Use the conversion chart to change from HP to KW.

HP	1	2	3	5	7	10	15	20	30	40	50	60	75
kW	0.75	1.5	2.2	4.0	5.5	7.5	11	15	22	30	37	45	55
HP	100	125	150	200	250	300							
kW	75	90	110	160	185	200							

Parameter 108

Motor Magnetization Current is the current required to maintain the magnetic field in the motor. Magnetization Current is factory set based on the motor power entered in parameter 103. This current value can also be found by running the motor without anything connected to the shaft and recording the current. Data charts in motor catalogs also contain this information.

Parameter 109

Start voltage is factory set based on the motor power entered in parameter 103. In most cases the factory setting is sufficient; however, a slight increase in start voltage may be required for high inertia loads. High current at low speeds results in an increased voltage drop in the motor and hence the need for additional start voltage.

If multiple motors are connected to a single unit, it is usually necessary to increase the start voltage. Smaller motors have greater voltage drops at low frequencies so additional start voltage is usually required.

It is also possible to have start voltage set too high and result in start-up trouble. The best rule of thumb is to start at the factory setting and make changes in small increments. Start and stop the unit to test the results.

Parameter 110

Start compensation; In higher horsepower ranges the need for start compensation is usually unnecessary. The factory setting is (0) zero. Changes can be made, however, if the load/motor combination does not require it, Instability or start-up difficulty will be the result.

Parameter 209

Current limit; Current limit is factory set based on the motor size and voltage selected. Current limit settings which are too low may result in difficulty starting or premature trips.

"GROUND FAULT" TRIPS

Trips occurring from ground faults are usually the result of short circuits to earth ground either in the motor or the wiring to the motor. The VLT detects ground faults by monitoring all three phases of output current and looking for severe imbalances in those currents. When a "Ground Fault" trip occurs it is necessary to measure the resistance of the motor windings and wiring with respect to earth ground. The instrument normally used for this purpose is a Megohmmeter or commonly referred to as a "Megger". Many times these resistance readings are taken with a common Ohmmeter, which is actually incapable of detecting any shorts other than those that are virtually direct. A Megger has the capability of supplying higher voltages, typically 500 volts or more, which enables the Megger to detect breakdowns in insulation or higher resistance shorts which cannot be picked up through the use of an Ohmmeter. When making resistance measurements to ground, it is necessary to disconnect the motor leads from the output of the VLT. The measurements should then be taken at the point of connection to the VLT so the motor and all associated wiring and connections are captured in the test. When reading the results of the Megger test, the rule of thumb is any reading less than 500 Megohms should be suspect. Solid, dry wiring connections normally result in a reading of infinity.

Since the VLT monitors output current to detect ground faults, there is also the possibility that the current sensors and/or the detection circuitry in the VLT could also be the cause of a ground fault. Tests can be made on this circuitry to isolate the possibilities. Refer to the Dynamic Test procedures on "Testing for Current Feedback" page 30. Consult the factory for additional assistance.

"OVERCURRENT" TRIPS

Trips due to "OVERCURRENT" can be caused by short circuits on the output of the unit or by instantaneous high currents occurring so rapidly that the unit cannot respond.

Short circuit trips are generally a result of a phase-to-phase short in the motor windings or in the wiring between the unit and the motor. Short circuit trips are easily diagnosed by removing the motor leads from the unit and performing a phase-to-phase resistance test on the motor leads. This resistance read in ohms will normally be quite low so it is important to have the ohmmeter set on its lowest resistance scale to avoid misinterpreting the readings observed.

"OVERCURRENT" TRIPS (CONTINUED)

Instantaneous overcurrent trips are caused by the current rising so fast on the output that the unit cannot respond. One example of this situation is in applications where the unit is running at speed and an output contactor is closed between the unit and the motor. At the point the contactor is closed, the motor is effectively seen as a short circuit to the unit. During this time the unit will attempt to gain control of the motor by employing current limit. If the current limit function is unable to limit the current to acceptable levels, the result will be an "OVERCURRENT" trip. This example is not to imply that output contactors should not be used. In fact, that is quite the contrary as the VLT has been designed to withstand this type of operation without failure. The important consideration in applications such as this is that the unit is properly sized to handle the inrush currents.

A second example of instantaneous overcurrent is that experienced in applications with windmilling loads. A large fan has not yet been commanded to run; however, air movement is causing the fan to rotate. When the unit is started it must first drive the fan to zero speed and then begin the acceleration process from there. The amount of current required may be so great and rise so rapidly that the current limit function cannot control the process. The result is an "OVERCURRENT" trip. However, this situation can also be solved by a VLT feature "Flying Start". With the flying start feature employed the VLT will interrogate the motor to determine its effective frequency and match the VLT output to that same frequency. Flying start results in a smooth start and full control of the load current.

"OVERVOLTAGE" TRIPS DUE TO REGENERATIVE APPLICATIONS

Regenerative energy is created when the load overhauls the motor. This means that the motor is being forced by the inertia of the load to rotate at a speed greater than the command speed. When overhauling occurs, the motor acts as a generator and the voltage generated is returned to the DC capacitor bank in the unit.

Regeneration is most commonly found in applications with high inertia loads and medium to fast decel ramps. However, even an unloaded motor ramped fast enough can cause regeneration to occur.

It is most common that regeneration is experienced during ramping, although loads such as flywheels will generate regenerative energy to some degree on every cycle.

Since the unit can absorb approximately 15 percent of the motor's rated power in regenerated energy, this phenomena will go unnoticed in most applications.

"OVERVOLTAGE" TRIPS DUE TO REGENERATIVE APPLICATIONS (CONTINUED)

When the energy returned, combined with the DC Bus voltage, exceeds the upper voltage limit, the unit responds in different ways to limit the voltage rise. If the returned energy is occurring during ramp down (to stop or to a lower speed), the unit will automatically adjust the decel ramp in an attempt to limit the voltage. In more sever instances, the ramp may even stop for periods of time to allow the voltage to dissipate. During these periods while regeneration is occurring, the words "HIGH VOLTAGE" can be observed flashing in the control card display. If the returned energy is returned at a high enough level and/or so fast that the unit cannot respond, the unit will trip on "OVERVOLTAGE".

To prevent a trip from occurring, one solution is to lengthen the decel ramp. In applications with very high inertia loads, or in the case of such loads as flywheels, the only solution may be that of adding a Dynamic Brake option.

The Dynamic Brake option combines a power IGBT, the electronics for controlling it and a resistor bank of sufficient wattage to dissipate the unwanted energy. The Dynamic Brake option monitors the level of the DC Bus voltage. When the voltage level exceeds permissible limits, the IGBT is switched on and the excess DC Bus voltage is dissipated in the resistor bank.

Particular attention must be paid to the proper sizing of the resistor bank. Consult your local representative or the factory for assistance in selecting the appropriate Dynamic Brake option for your application.

"OVERTEMP" TRIPS

Trips due to "OVERTEMP" can be due to internal or external over temperature conditions. Two temperature sensors are located inside of the drive. One located on the Interface Board monitors the ambient temperature within the drive itself. This normally open switch closes at a temperature of 73 to 87 degrees centigrade. The switch will reset at a temperature between 53 to 67 degrees centigrade allowing a fault reset to be possible. A fault occuring as a result of the ambient temperature switch results in both the "IOT" and the "OTT" LED being illuminated on the Interface Board and the Control card will display "OVERTEMP". The second sensor located on the heatsink monitors the surface temperature of the heatsink. This sensor is a NTC device which changes in resistance value based on temperature. As the temperature rises the resistance decreases, and conversely as the temperature decreases the resistance increases. The sensors resistance must be between 787 ohms and 105 K ohms to be free of a fault condition. Testing this sensor is explained on page 27. A fault occuring as a result of the NTC sensor results in the "OTT" LED on the Interface Board being illuminated and the Control Card will display "OVERTEMP". These temperature faults can be caused by high ambient temperatures, clogged fan filters or inoperative cooling fans. The heatsink and the door fans operate on 24VDC supplied by the Interface Board.

"OVERTEMP" TRIPS (CONTINUED)

A terminal connection MK15 is supplied on the Interface Board to provide for the connection of an external temperature sensor. The sensor is customer supplied and may be used for such things as monitoring the temperature of external brake resistors. By selecting the terminal connections the MK15 input can accept a normally open or closed input. If not used a jumper must be installed between terminals 1 and 2 of MK15. When MK15 is activated the result is a fault trip with the "OTT" and "EOT" LED's on the Interface Board being illuminated. The Control Card will display "OVERTEMP". An "EOT" fault also disables the input rectifiers so the main power to the unit is interupted and supplied only through the soft charge circuit. It is important to note that full bus voltage is still supplied to the unit through the soft charge circuit. If the fault occured as a result of shorted brake resistors or a faulty brake module the soft charge fuses will blow shortly after the trip.

Fault Memory

The VLT stores faults which have occurred in its fault memory register. The register stores the last 8 occurrences on a first in first out basis. You can access the fault memory by calling up parameter 602. In doing so you can then scroll through the register using the Data key to view each fault code stored. The codes that are displayed correspond to the numbers in parenthesis printed next to the Alarm Messages described on page 13.

In addition there are six more codes which may appear in parameter 602.

10) Trip Locked
    Indicates a trip lock fault has occurred.

11) CT/OP Card Fault
    Indicates a software fault has occurred in either the Control Card or an installed option card.

12) Ref Fit Timeout
    Indicates the Reference Fault Timeout has occurred as controlled by Parameters 414 and 415.

13) Adaptive Tune Fail
    Indicates the Adaptive Tuning Process failed, initiated by parameter 106.

14) DC Supply Fault
    Indicates one or more of the low voltage DC power supplies have fallen out of tolerance.

15) Motor Thermistor
    Indicates the motor thermistor as selected in parameter 400 has caused the trip.

Spare Parts List

Control Card	175H7086
Interface Board	175L3821
Gate Drive Board	175L3822
IGBT Snubber Board	175L3823
Input Fuse	175L3830
Soft Charge Fuse	175L3829
Soft Charge Rectifier	175L3832
Input Rectifier	175L3831
Soft Charge Resistor Assembly	175L3833
IGBT Module 3032	175L3836
IGBT Module 3042/52	175L3837
Power Supply Fuse	175L3497
Fan 24VDC	175L3497
DC Bus Capacitor	175L3434
Current Sensor Module	175L3593