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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 the following Danfoss Series 3000 and 3500 Adjustable Frequency Drives:

VLT 3002-3022, 230V

VLT 3502-3532, 230V

VLT 3002-3052, 380, 460V

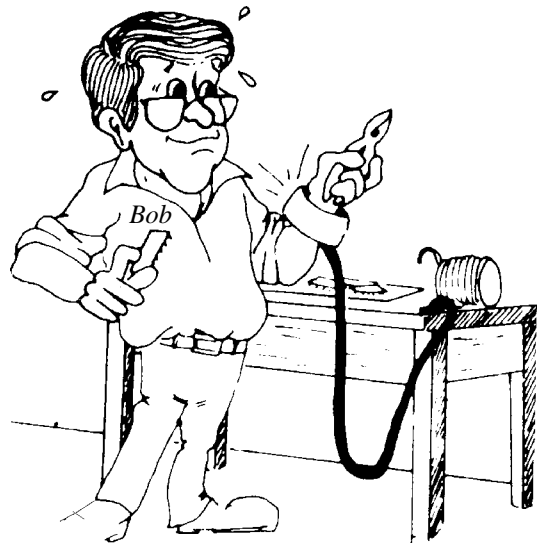
VLT 3502-3562, 380, 460V

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.





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.

TOOLS REQUIRED:

The following tools will be sufficient to troubleshoot and repair all units covered by this manual:

- Digital multi-meter
- Clamp-on ammeter
- Analog voltmeter
- Flat head screw drivers
- Phillips screw drivers
- Torx drivers - T10, T15, T20, T27
- Socket 7mm
- Pliers
- Torque wrench

DESCRIPTION OF OPERATION

Refer to the overall schematic in the Appendix.

This manual is not intended to give a detailed description of the unit's operation. It is intended to provide the reader a general overview of the function of each 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, interface, and power.

LOGIC SECTION

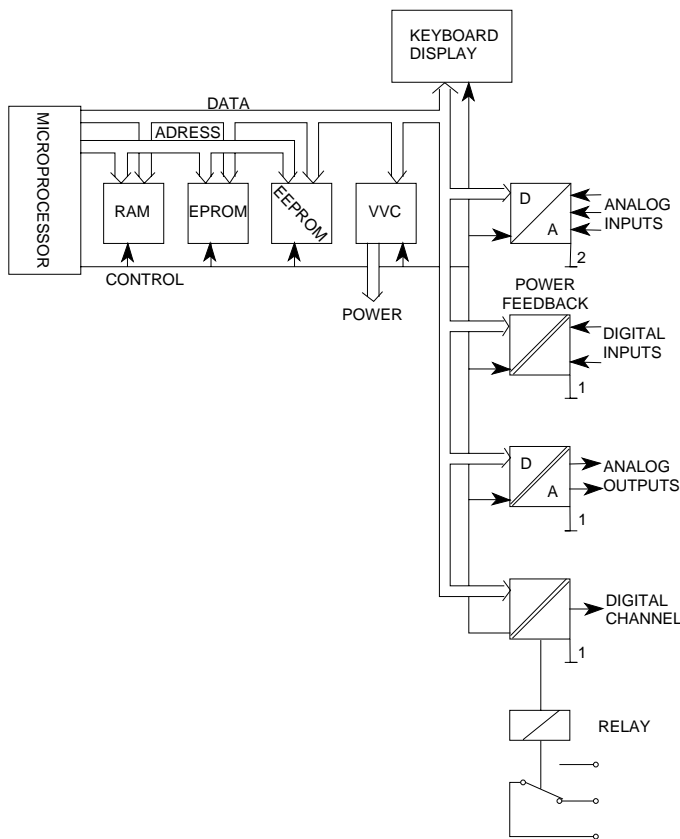
The control card contains the majority of the logic section. The heart of the control card is a microprocessor which controls and supervises all functions of the unit's operation. In addition, a separate PROM contains the parameter sets which characterize the unit and provide the user with the definable 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/ILD Card 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 various local controls, depending on the type of unit.

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/ILD Card via the two conductor ribbon cable.



LOGIC SECTION

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 respond to the commands it receives. It is also possible that due to a failure, the Control Card will not respond to control commands. For this reason it is necessary to isolate the fault to the control commands, control programming, or the drive itself. If, for example, the drive stops unexpectedly, the control commands should first be checked. This would include confirming that contact closures and analog input signals are present at the proper terminals of the drive. Never assume that a signal is present because it is supposed to be. A meter should be used to confirm the presence of signals at the drive terminals.

Secondly, the programming of the drive should be confirmed to insure that the terminals used are set to accept the signals connected. Each digital and analog input terminal can be programmed to respond in very different ways. If there is a concern whether the remote controls are functioning correctly it is possible to take local control of the drive to confirm proper operation. A word of caution here: prior to taking local control, insure that 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.

As there must be a command in order for the Control Card to respond, there may also be situations where the Control Card displays unknown data or that performance may be affected such as in the case of speed instability. In these cases the first thought may be to replace the Control Card. However, this type of erroneous operation is usually due to electrical noise injected onto 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. In these situations it is necessary to investigate the wiring practices used. For example, the control signal wiring should not be run in parallel with higher voltage wiring, including power, motor, and brake resistor leads. The reason being that voltages can be induced from one conductor onto another through capacitive or inductive coupling. This type of problem can be corrected by rerouting the wiring or through the use of shielded cable. When using shielded cable it is important to properly terminate the drain wire. The drain wire should be terminated only at the drive end of the cable. Specific termination points are provided on each unit. The opposite end of the shielded cable drain wire is then cut back and taped off to prevent it from coming in contact with other terminals or acting as an antenna.

LOGIC TO POWER INTERFACE

INPUT LINE DRIVER (ILD) CARD

The logic to power interface isolates the high voltage components of the power section from the low voltage signals of the logic section. This is accomplished by use of the Interface/ILD Card*. All communication between the control logic and the rest of the unit passes through the Interface/ILD Card. This communication includes: DC Bus voltage monitoring, line voltage monitoring, feedback from the current sensors, temperature sensing, and control of the gate drive firing signals. The Interface Card contains a Switch Mode Power Supply (SMPS) which provides the unit with 24VDC, ± 13 VDC, and 5VDC. The switch mode type supply is used due to its efficiency and linearity. Another benefit of the SMPS is that it uses the DC Bus voltage as a power source. In the event of a power loss the power supply remains active for a longer period of time versus conventional power supplies.

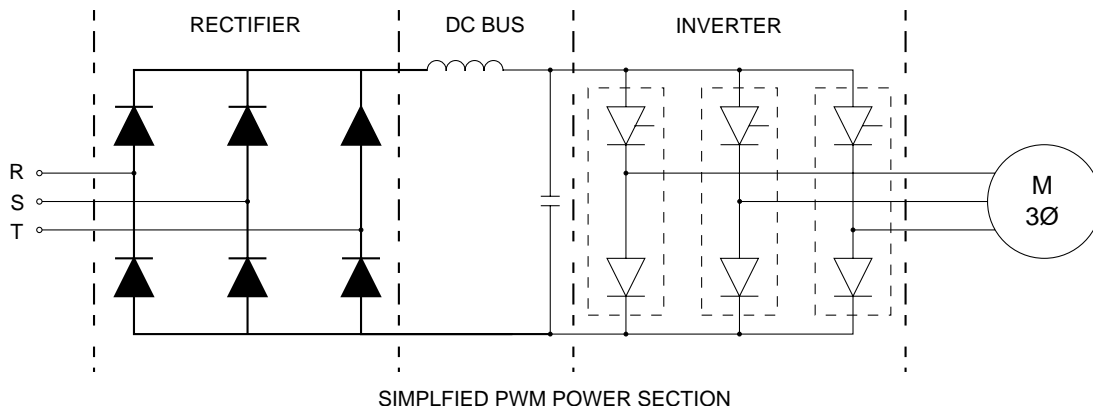
During the troubleshooting process it is important to determine whether the Interface Card is receiving or sending the signal that appears to be at fault. For example, the gate-drive signals are generated by the Interface Card. Conversely an over-temperature fault can result from the Interface Card receiving an "open" from the heatsink thermal switch. If the fault could stem from a signal received by the Interface Card, it is necessary to isolate the fault to either the signal source or the Interface/ILD card. It is critical to check all possibilities to avoid costly errors and long downtime. In any case, the Interface/ILD Card is relatively easy to change, so if it is suspect, a quick exchange will confirm a faulty board.

* The Input Line Driver (ILD) Card is used on VLT 3002-3004, 230V; VLT 3502-3504, 230V; VLT 3002-3008, 380V/460V, and VLT 3502-3511, 380V/460V. All other units covered by this manual use the Interface Card.

POWER SECTION

The power section contains the Rectifier, the DC Capacitor Bank and the IGBT power components. Also included in the power section are the DC Bus Coils and the Motor Coils. During the troubleshooting process, extreme care is required when probing into the power section components. The DC Bus voltage can rise well over 700VDC on 460V units. Although this voltage begins to decrease upon removal of input power, it can take up to fifteen minutes to discharge the DC Capacitor Bank to safe levels.

A fault in the power section will usually result in at least one of the customer provided line fuses being blown. Replacing fuses and re-apply power without further investigation is not recommended. The tests listed under Static Test Procedures in Section Three should be performed to insure that there are no shorted components in the power section. It is recommended that the motor leads be disconnected from the unit prior to re-applying power. This precaution opens the path for short circuit currents through the motor in case a faulty component remains.



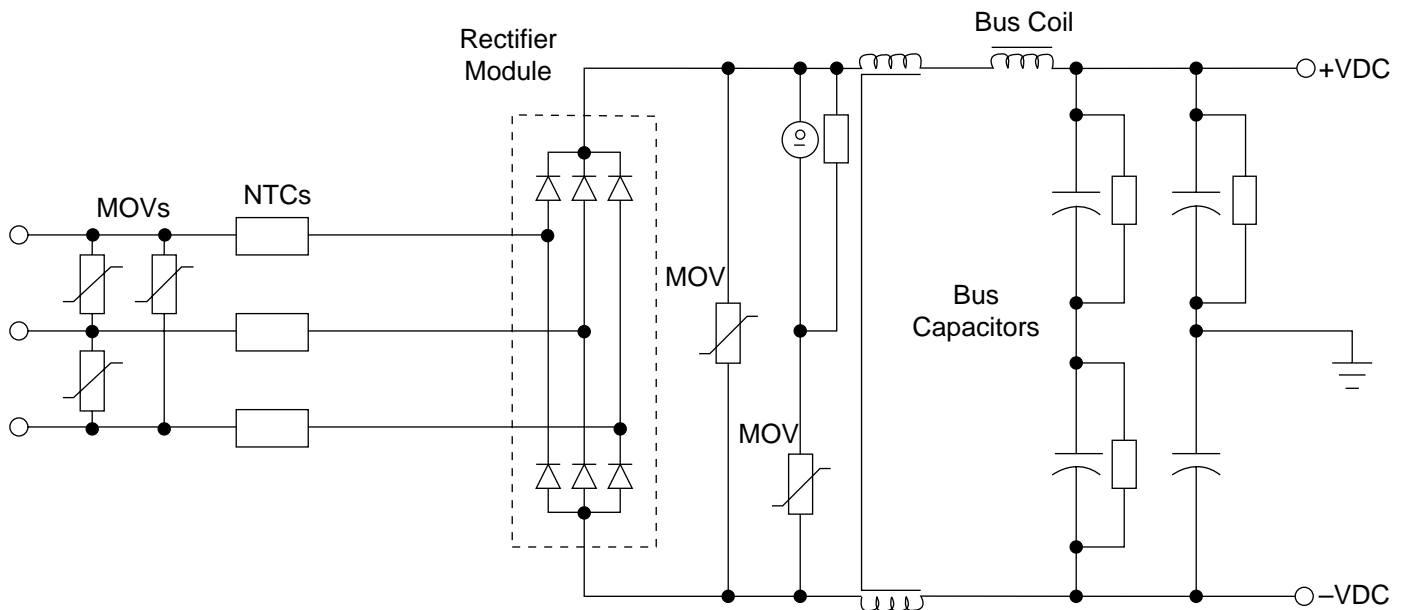
SEQUENCE OF OPERATION

**VLT 3002-3004, 230V,
VLT 3002-3008, 380V/460V**

**VLT 3502-3504, 230V
VLT 3502-3508, 380V/460V**

When input power is first applied, the Rectifier Module converts the line voltage into a DC voltage. The rectified output is then connected to the DC Bus filter establishing a fixed DC Bus voltage. To limit the inrush charge current in the DC Bus capacitors, three Negative Temperature Coefficient (NTC) resistors are added in series with the inputs of the Rectifier Module. NTC resistors decrease in resistance as temperature increases. Providing that the charging process proceeds normally, the power supplies will come up and provide the Control Card with low voltage control power. At this time the Control Card display will indicate that the unit is ready for operation.

Following a run command and a speed reference, the Control Card delivers three Pulse Width Modulation (PWM) signals to the ILD Card. The ILD Card in turn receives these three signals and creates the six individually isolated gate drive signals. These gate pulses are fed directly to the Insulated Gate Bi-polar Transistor (IGBT) output power devices. The IGBTs are switched on and off to develop the PWM waveform which is ultimately delivered to the motor. As the unit operates, the ILD Card monitors the unit's operational status. Currents and voltages out of specified limits or excessive temperatures will result in the ILD Card responding to the fault. The ILD Card sends the appropriate fault message to the Control Card and in virtually all cases causes the unit to trip. Section 2 of this manual describes the fault messages and provides direction in determining the cause and the solution for the fault.



**VLT 3006-3032, 230V,
VLT 3011-3052, 380V/460V**

**VLT 3508-3532, 230V
VLT 3511-3562, 380V/460V**

When power is first applied, the normally open Bus Contactor forces the input line current to flow through the Positive Temperature Coefficient (PTC) resistors. PTC resistors increase in resistance as the temperature increases. The

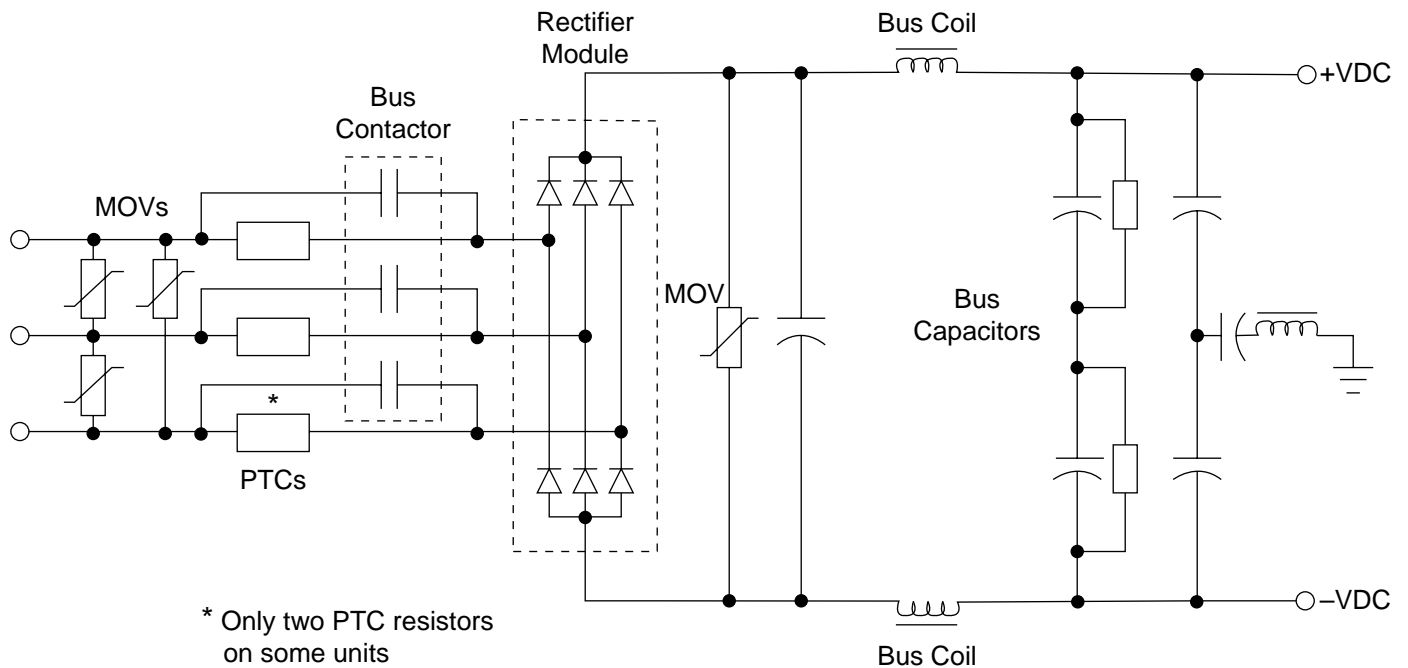
SEQUENCE OF OPERATION

PTC resistors are placed in series with the inputs of the Rectifier Module to limit the initial charge current of the DC Bus capacitors. The rectified line voltage is then applied to the DC Bus filter. As the DC Bus voltage increases, the Interface Card power supplies energize. As the power supplies stabilize, the Interface Card sends a signal to the Relay Card to pull in the Bus Contactor. The Relay Card energizes the contactor coil with a short burst of a high amplitude, full-wave rectified voltage to pull in the Bus Contactor. The Relay Card then switches the Bus Contactor coil voltage to a lower rectified holding voltage. As soon as the DC Bus Contactor closes, the PTC resistors are effectively removed from the circuit and the DC Bus Capacitors quickly finish charging.¹

Providing that the charging process proceeds normally, the Interface Card power supplies will provide the Control Card with low voltage control power and the Control Card display will indicate that the unit is ready for operation.

Following a run command and a speed reference, the Control Card delivers a PWM signal (one per Phase) to the Interface Card. The Interface Card in turn receives these three signals and creates six individual isolated gate drive pulses. From here the gate pulses are fed directly to the Insulated Gate Bi-polar Transistor (IGBT) output power devices. The IGBTs are switched on and off to develop the PWM waveform which is ultimately delivered to the motor.

As the unit operates, the Interface Card monitors the unit's operational status. Currents and voltages out of specified limits or excessive temperatures will result in the Interface Card responding to the fault. The Interface Card sends the appropriate fault message to the Control Card and in virtually all cases causes the unit to trip. Section Two of this manual describes the fault messages and provides direction in determining the cause and the solution for the fault.

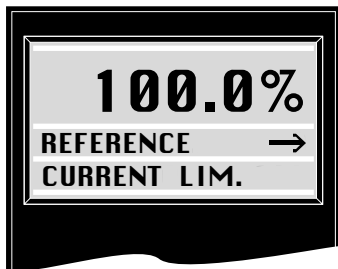


¹ The VLT 3511, 380/460V units have the Bus Contactor relay and PTC resistors mounted on the ILD Card.

FAULT INDICATORS AND MESSAGES

A variety of messages are displayed by the control card. Some messages 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. The particular type of status, warning, or alarm message will be indicated on the bottom line of the display.

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.

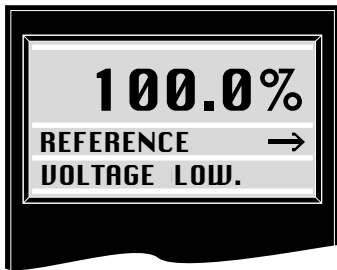
NO 24 VOLT

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".

* Refer to table for specific value.

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".

* Refer to table for specific value.

INVERT TIME

This message will flash when the inverter ETR value has reached 98%. The inverter ETR (Electronic Thermal Relay) 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, "Warning" has been selected as the Data Value, 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

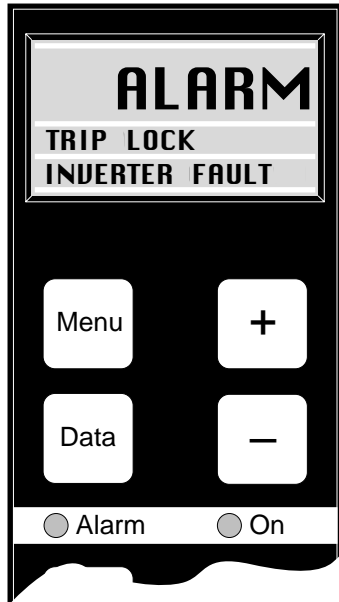
This message indicates at least one of the three output phases has reached the unit's peak current rating. During this time the control card attempts to initiate current limit. If the current rises too fast or the control card cannot control the condition by means of current limit, the unit will trip on "Over Current".

*** DC BUS VOLTAGE LIMITS**

VLT Rating	VLT 3002-3052 VLT 3502-3562		
	230VAC	380VAC	460VAC
SMPS stop	190	360	360
SMPS start	210	410	410
Undervoltage trip, inverter stopped inverter enabled	210	400	460
	230	430	500
Control Card undervoltage warning	235	440	510
Control Card overvoltage warning (brake applied*, parameter 300)	370 (395)	665 (705)	800 (845)
Overvoltage trip, inverter stopped inverter enabled	410	730	880
	380	680	820

* Only on VLT Series 3000 units.

ALARM MESSAGES



Alarm messages will be indicated by the following messages appearing in the display and the red Alarm LED will flash on the unit keypad. 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 Symptom/Cause Section and the Application Section. Also note the numbers in parenthesis by each alarm message. These are the codes which will appear in the Fault memory, parameter 602.

INVERTER FAULT (1)

This message indicates a fault in the power section of the unit. This fault returns a "Trip Locked". Also see Testing The Inverter Section.

OVER VOLTAGE (2)

This message indicates the DC Bus voltage upper limit has been exceeded. 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.

UNDER VOLTAGE (3)

This message indicates the DC bus voltage has fallen below the lower limit. 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.

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 its peak current rating so rapidly that the unit can not respond with current limit. An example may be running the drive at speed and closing an output contactor connecting the drive to a high inertia load. To remedy this fault, check the output wiring and motor for short circuits. This fault returns a "Trip Locked". Also see Over Current Trips.

ALARM MESSAGES



GROUND FAULT (5)

This message indicates a leakage to ground on the output of the inverter. To remedy this fault, check the output wiring and motor for ground faults. It is also necessary to ensure that the VLT has been properly grounded. This fault returns a "Trip Locked". Also see Ground Fault Trips.

OVER TEMP (6)

This message indicates that the unit's heatsink temperature or the unit's internal ambient temperature has exceeded permissible limits. All units covered by this manual use a resetting thermal switch. The thermal switch is located on either the ILD Card or is mounted on the heatsink of units which use the Interface Card. To remedy the fault, correct the over temperature condition. This fault returns a "Trip." Also see Overtemp Trips.

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. 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 value entered in parameter 107 (motor nominal current) for too long (inverse time function). 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. 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".

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.

MOTOR TRIP (15)

This message will be displayed if parameter 400 is set to "Thermistor" and motor thermistor connected between terminals 50 and 16 has increased to a resistance of 3K Ω . To remedy this fault remove the motor over temperature condition. This fault returns a "Trip". The Reset Button can be held to allow access to the parameters.

EXCEPT FAULT

This fault is usually the result of electrical noise caused by a poor earth ground connection to the VLT. This fault may also be seen if Adaptive Motor Tuning is attempted on a motor many times larger than the drive rating (parameter 106). (This fault is accompanied by the PC address where an illegal value was found, also see page 4-1.)

GENERAL TROUBLESHOOTING TIPS

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

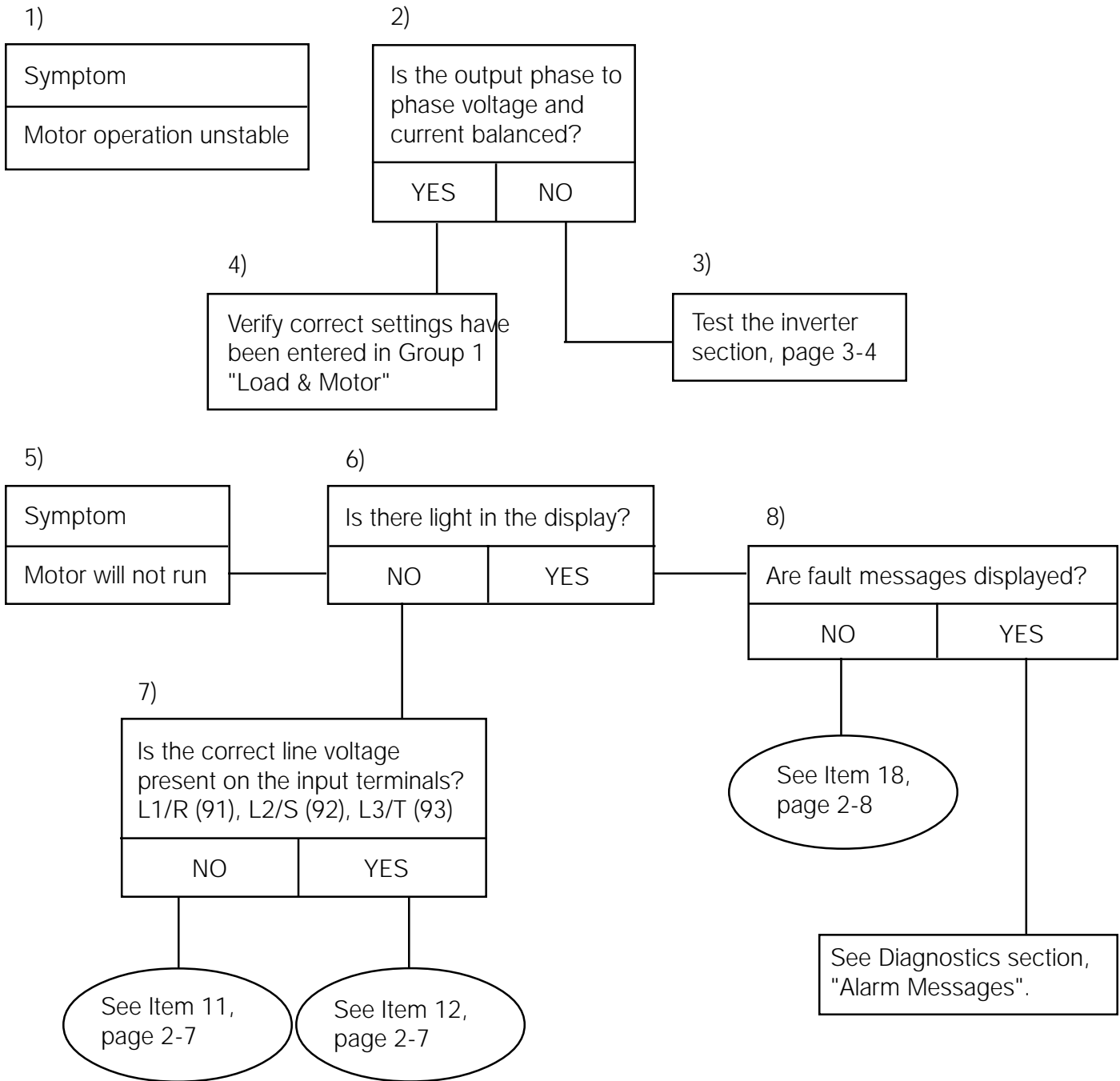
1. First and foremost respect the voltages produced by the drive. Always verify the presence of line voltage and bus voltage before working on the unit. Also remember that some points in the drive are referenced to the negative bus and are at bus potential even though you may not expect it.
2. Never 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. 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 further damage.
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 (an analog voltmeter will work best here). 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 performance 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.

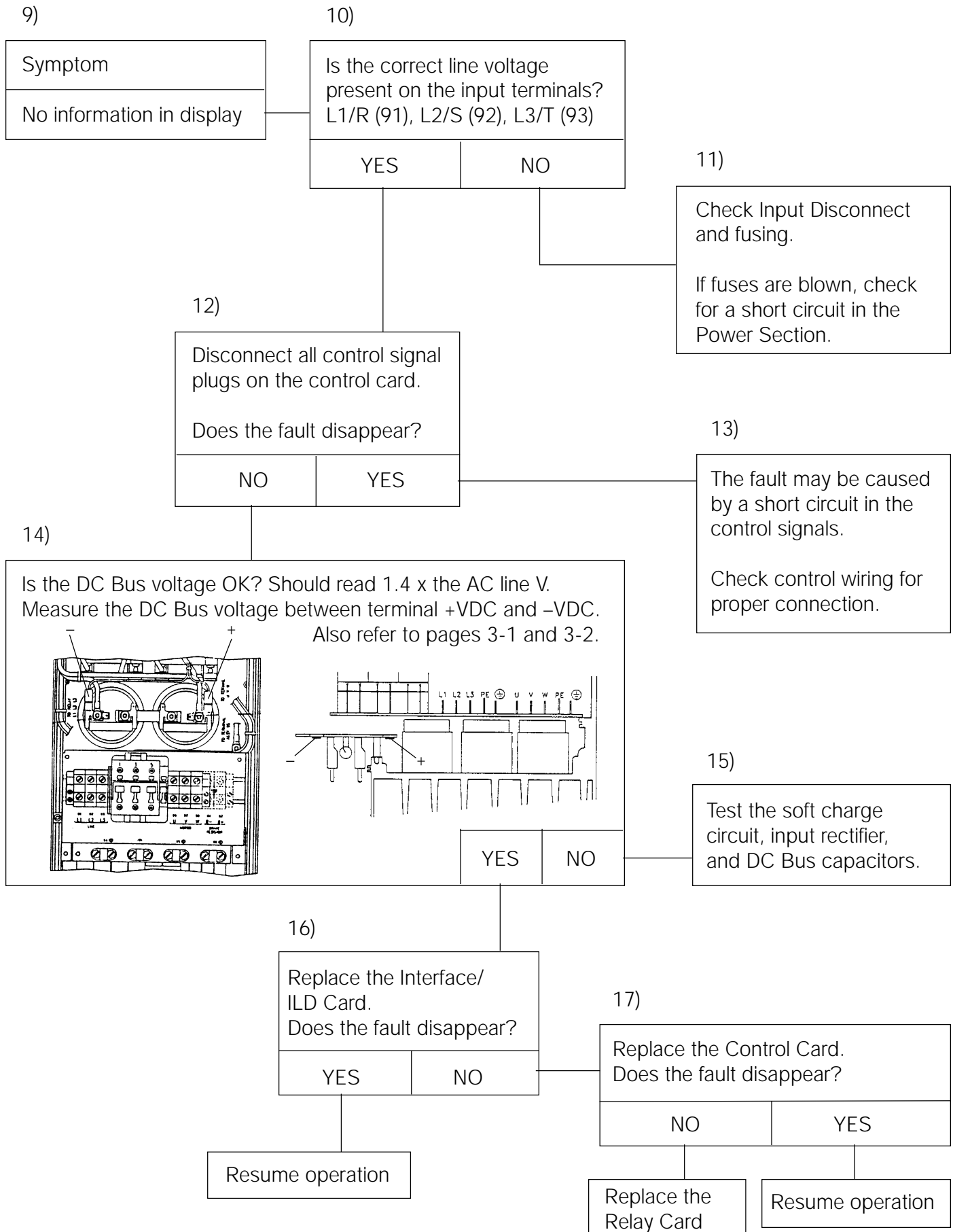
Section Two



VLT 3002-3022, 230V
VLT 3002-3052, 400/500V

VLT 3502-3532, 230V
VLT 3502-3562, 400/500V





18)

Motor stationary, info in display but no fault message displayed

19)

Start VLT by pressing Start on the keypad.

20)

Is the display frozen, i.e., the display cannot be changed or is undefinable?

NO	YES
----	-----

22)

Is the motor connected correctly/

YES	NO
-----	----

23)

Try to run the VLT in local.
Refer to CAUTION at left.

Local control parameters.
On VLT Series 3000:
003 = Local
004 = Frequency reference change by means of + and -
On VLT Series 3500:
003 = keypad HOA
Press the Local/Hand key change speed by the + and -

Does the motor run?

YES	NO
-----	----

24)

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

21)

Replace the Control Card, 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?

Correct the motor wiring.
Insure motor overloads are reset and output contactor closed.

25)

Replace Control Card.
Does the motor run?

NO

26)

Replace Interface/ILD Card.
Does the motor run?

NO

27)

Consult factory.

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

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/ILD Card

Defective Relay Card

Defective or disconnected ribbon cables

2. Blown Input Line Fuses

Shorted Rectifier module

Shorted IGBT

Shorted DC Bus

Shorted brake IGBT

Mis-wired Dynamic Brake option

3. Motor Operation Unstable
(Speed Fluctuating)

Start compensation set too high

Slip Compensation set too high

Improper current feedback

PID Regulator or Auxiliary Reference mis-adjusted

Control signal noise

4. Motor Draws High Current But
Cannot Start. (May appear to rock
back and forth.)

Start voltage set too high

Open winding in motor

Open connection to motor

One inverter phase missing. Test output phase balance.

SYMPTOM/CAUSE CHARTS

SYMPTOM

POSSIBLE CAUSES

5. Motor Runs Unloaded But Stalls When Loaded. (Motor may run rough and VLT may trip.)

Current Limit set too low
One half of one inverter phase missing. Test output phase balance.

6. Unbalanced Input Phase Currents

Note: Slight variations in phase currents are normal. Variations greater than 5% require investigation.

Input line voltage unbalanced
Faulty connection on input wiring
Fault in plant power transformer
Input Rectifier module faulty (open diode).

7. Unbalanced Motor Phase Currents

Note: Slight variations in phase currents are normal. Variations greater than 5% require investigation.

Open motor winding
Faulty motor connection
Fault in inverter section (see Symptom No. 6.)

STATIC TEST PROCEDURES

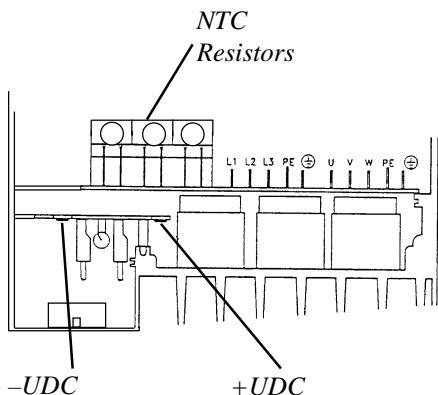
All tests will be made with a meter capable of testing diodes. Use a digital VOM set on diode scale or an analog ohmmeter set on R x 100 scale. Before making any checks disconnect all input power, motor and brake option connections.

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 1000VDC and reading the voltage at the labeled terminals shown in the drawings.

TESTING THE INPUT RECTIFIER

The purpose of making static tests on the input rectifier is to rule out failures in this device, either shorted or open diodes. Failure of the rectifier module will usually result in blown line fuses. It should be noted that blown input line fuses can also be the result of shorts in the IGBT module(s) or a damaged bus capacitor. See Testing the Inverter Section and Testing the Bus Capacitors. For measurements where an open-circuit is expected the meter may show some initial continuity as the DC Bus capacitors charge up. This is normal and to be expected.



VLT 3002-3004, 230V
VLT 3002-3008, 380V/460V

VLT 3502-3504, 230V
VLT 3502-3511, 380V/460V

1. Remove the Control Card to expose the ILD Card. Locate the UDC connector on the ILD Card (MK102). The red lead at the top side of the connector will be used for the (+UDC) test point and the black lead at the bottom of the connector will be the (-UDC) test point. The +UDC and -UDC fast-on terminals on the DC Card (as shown) can also be used.
2. Connect the positive (+) meter lead to (+UDC). Connect the negative (-) meter lead to terminals 91 (L1), 92 (L2), and 93 (L3) in turn. Each reading should be open.
3. Reverse the meter leads connecting the negative (-) meter lead to (+UDC) and the positive (+) meter lead to power terminals 91 (L1), 92 (L2), and 93 (L3) in turn. Each reading should show a diode drop.
4. Connect the positive (+) meter lead to the red lead (-UDC). Connect the negative (-) meter lead to power terminals 91 (L1), 92 (L2), and 93 (L3) in turn. Each reading should show a diode drop.
5. Reverse the meter leads connecting the negative (-) meter lead to the (-UDC) and the (+) meter lead to power terminals 91 (L1), 92 (L2), and 93 (L3) in turn. Each reading should show open. Test is complete.

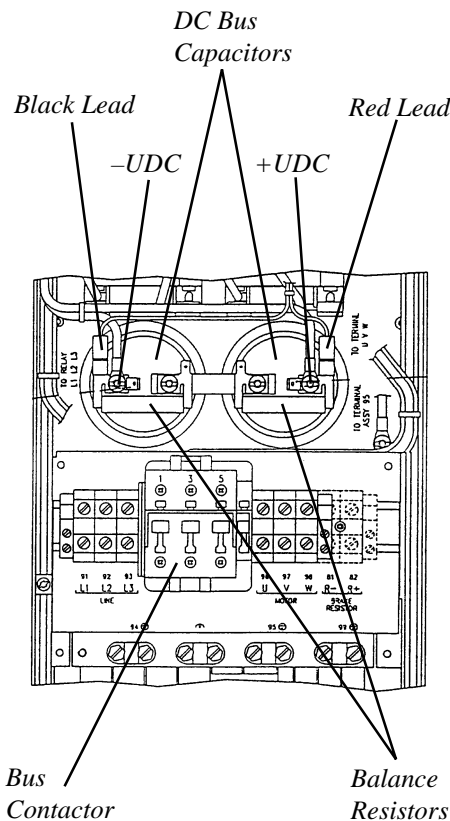
Incorrect readings could indicate a faulty Rectifier Module. See Removal and Replacement Instructions. If there is an open circuit reading when a diode drop reading is expected, see Testing the Soft Charge Circuit.

STATIC TEST PROCEDURES

TESTING THE INPUT RECTIFIER

VLT 3006-3022, 230V
VLT 3011-3052, 380V/460V

VLT 3508-3532, 230V
VLT 3516-3562, 380V/460V

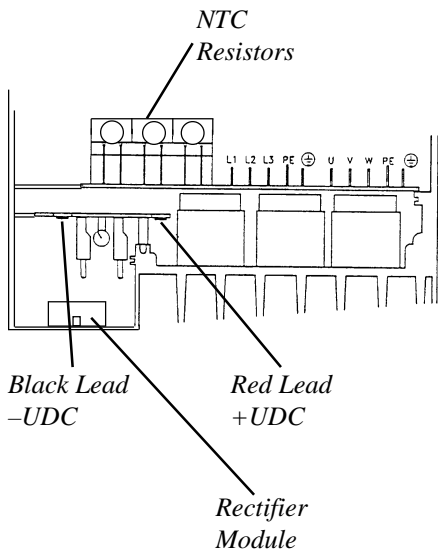


1. Remove any plastic shields covering the DC Bus Capacitors and locate the 18 gauge red and black leads connected to the Bus Capacitor bus bars as shown. These leads indicate the positive (+UDC) and negative (- UDC) DC Bus test points. The number and location of the bus capacitors will vary between units.
2. Connect the positive (+) meter lead to (+UDC). Connect the negative (-) meter lead in turn to the terminals (1/L1), (3/L2), and (5/L3) as labeled on the top side of the Bus Contactor. Each reading should be open.
3. Reverse the meter leads connecting the negative (-) meter lead to (+UDC) and the positive (+) meter lead in turn to the terminals (1/L1), (3/L2), and (5/L3) on the top side of the Bus Contactor. Each reading should read a diode drop.
4. Connect the positive (+) meter lead to (-UDC). Connect the negative (-) meter lead in turn to the terminals (1/L1), (3/L2), and (5/L3) on the top side of the Bus Contactor. Each reading should show a diode drop.
5. Reverse the meter leads connecting the negative (-) meter lead to (-UDC) and the positive (+) meter lead in turn to the terminals (1/L1), (3/L2), and (5/L3) on the top side of the Bus Contactor. Each reading should show open. Test completed.

Incorrect readings indicate a faulty rectifier module. See Removal and Replacement Instructions on page 4-4. If the rectifier module is shorted, it is important to inspect the Bus Charge Contactor. See page 3-3 for testing the soft-charge circuit.

STATIC TEST PROCEDURES

TESTING THE SOFT-CHARGE CIRCUIT



The purpose of the soft-charge circuit is to provide an initial high impedance current path for building up a charge on the Bus Capacitors. The size of the unit determines whether NTC resistors or PTC/Contactor combination are used.

VLT 3002-3004, 230V

VLT 3502-3504, 230V

VLT 3002-3008, 380V/460V

VLT 3502-3511, 380V/460V

Measure the three NTC resistors (R303, R304, R305) located on the ILD Card. The resistance should read about 10Ω - 20Ω at room temperature.

VLT 3006-3022, 230V

VLT 3508-3532, 230V

VLT 3011-3052, 380V/460V

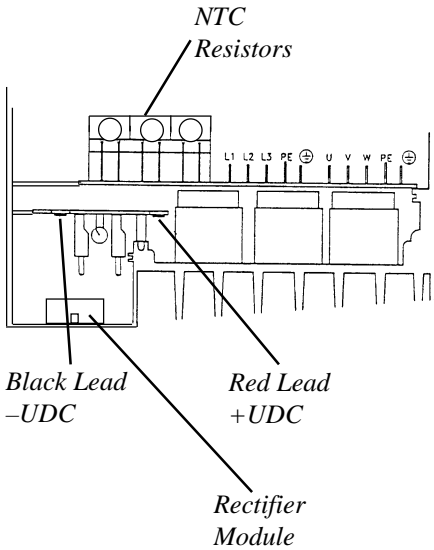
VLT 3516-3562, 380V/460V

1. Inspect the Bus Charge Contactor. Remove the MK6 harness from the Relay Card (see Appendix for component location) and check that the contacts measure open and the spring mechanism is functional. The armature resistance should be approximately 500Ω .
2. Check the resistance of the PTC resistors located on the Relay Card. At room temperature the resistance value should be about 30Ω .
3. Remove the Balance Resistors from the DC Bus capacitors. Use an ohmmeter to insure that the resistance values are correct, ($18K\Omega$).
4. If all measurements are correct, re-install all components and proceed with dynamic tests.

Incorrect readings could indicate a damaged Bus Contactor, Relay Card, or problems with the DC Bus capacitors. If a balance resistor is damaged, replace the bus capacitors the resistor mounted across as well as any series connected Bus Capacitors. See Replacing the Bus Contactor, replacing the Relay Card, and replacing the Bus Capacitors, page 4-4.

STATIC TEST PROCEDURES

TESTING THE INVERTER SECTION



The purpose of static testing the inverter section is to rule out failures in the IGBT power devices. If a short circuit is discovered during the testing, the particular module can be pinpointed by noting the output terminal indicating the short circuit. When looking in units with multiple IGBT modules, the "U" phase is on the left, "V" phase in the middle and the "W" phase is on the right.

VLT 3002-3004, 230V
VLT 3002-3008, 380V/460V

VLT 3502-3504, 230V
VLT 3502-3511, 380V/460V

1. Disconnect the motor leads from the unit. The low winding resistance within the motor will affect test measurements in the inverter section.
2. Remove the Control Card to expose the ILD Card. Locate the UDC connector on the ILD Card (MK102). The red lead at the top side of the connector will be used for the (+UDC) test point and the black lead at the bottom of the connector will be the (-UDC) test point. The +UDC and -UDC fast-on terminals on the DC Card (as shown) can also be used.
3. Connect the positive (+) meter lead to terminal (+UDC). Connect the negative (-) meter lead to motor terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should be open.
4. Reverse the meter leads connecting the negative (-) meter lead to (+UDC) and the positive (+) meter lead to motor terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show a diode drop.
5. Connect the positive (+) meter lead to (-UDC). Connect the negative (-) meter lead to motor terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show a diode drop.
6. Reverse the meter leads connecting the negative (-) meter lead to (-UDC) and the positive (+) meter lead to motor terminals 96 (U), 97 (V), and 98 (W) in turn. Each reading should show open. Test is complete.

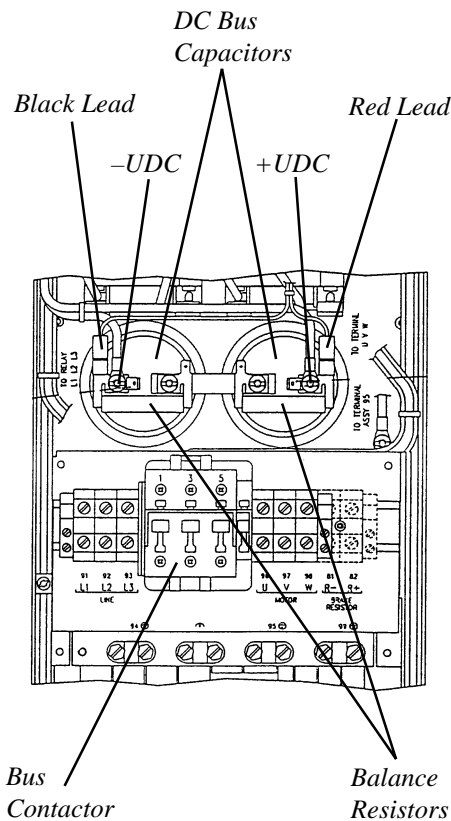
Incorrect readings indicate a damaged IGBT module. See Removal and Replacement Instructions on page 4-3.

STATIC TEST PROCEDURES

TESTING THE INVERTER SECTION

VLТ 3006-3022, 230V
VLТ 3011-3052, 380V/460V

VLТ 3508-3532, 230V
VLТ 3516-3562, 380V/460V



1. Prior to making any measurements it is necessary to disconnect the motor leads from the unit. The low winding resistance within the motor will make it appear that there is a short circuit in the inverter section.
2. Remove any plastic shields covering the DC Bus capacitors and locate the 18 gauge red and black leads connected to the capacitor bus bars. These leads indicate the positive (+UDC) and negative (-UDC) DC Bus test points as shown.
3. Connect the positive (+) meter lead to the red lead to (+UDC). Connect the negative (-) meter lead in turn to motor terminals (T1/U), (T2/V) and (T3/W). Each reading should be open.
4. Reverse the meter leads connecting the negative (-) meter lead to (+UDC) and the positive (+) meter lead in turn to motor terminals (T1/U), (T2/V), and (T3/W). Each reading should show a diode drop.
5. Connect the positive (+) meter lead to (-UDC). Connect the negative (-) meter lead in turn to motor terminals (T1/U), (T2/V), and (T3/W). Each reading should show a diode drop.
6. Reverse the meter leads connecting the negative (-) meter lead to (-UDC) and the positive (+) meter lead in turn to motor terminals (T1/U), (T2/V), and (T3/W). Each reading should show open. Test completed.

Incorrect readings indicate a damaged IGBT module. See Removal and Replacement Instructions on page 4-4.

STATIC TEST PROCEDURES

TESTING THE HEATSINK THERMAL SWITCH

There are thermal switches included on all units covered by this manual. The smaller drives monitor the ambient temperature within the unit. The thermal switch is mounted on the ILD Card. All units with Interface Cards have a stand alone thermal switch mounted on the heatsink.

VLT 3006-3022, 230V **VLT 3508-3532, 230V**
VLT 3011-3052, 380V/460V **VLT 3516-3562, 380V/460V**

The heatsink temperature is sensed by a thermal switch. The thermal switch harness is connected to the top of the Interface Card at connector MK401. The switch will open when the heatsink temperature exceeds 100°C/212°F and will close when the heatsink temperature falls below 50°C/122°F. By unplugging the connector from the Interface Card, the thermal switch continuity can be checked.

DYNAMIC TEST PROCEDURES

TESTING FOR OUTPUT PHASE VOLTAGE IMBALANCE

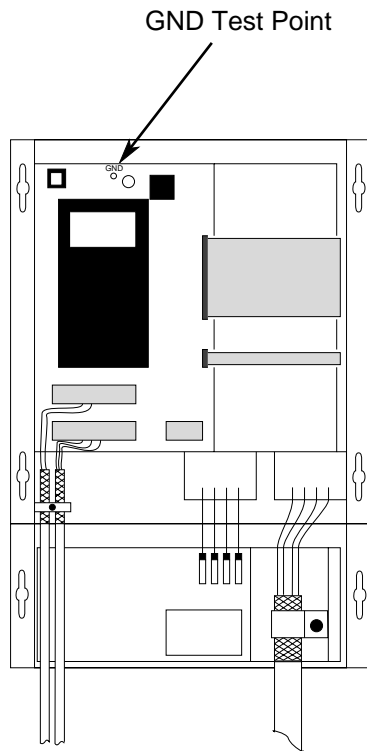
When testing phase imbalances, it is practical to measure both voltage and current. A balanced voltage reading, but unbalanced current, indicates the motor is drawing uneven current. This could be caused by a fault in the motor windings or in the wiring connections between the drive and motor. When both 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. A faulty IGBT or loose wire connection between the IGBT and the output terminals may also be the cause.

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.
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.
6. If the phase-to-phase output voltage is balanced, recheck motor and connections for faults. Consult the factory for additional assistance.

DYNAMIC TEST PROCEDURES

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 motor phase. The VLT relies on this feedback for proper output waveform control and for providing fault protection. Problems with the current sensors can cause unstable operation, over current trips, and ground fault trips.

A simple test of these signals can be made with a voltmeter. The measured voltage will be proportional to the current signal produced by each current sensor. At very light loads the AC voltage signal may be no more than 100mV to 300mV. The purpose of this test is to verify that all three sensors are functioning and that the signals are approximately equal when compared to each other.

1. Apply power to the unit. Leave the unit in stop mode.
2. Using a DC voltmeter, connect the negative (-) meter lead to the Control Card test point labeled GND. Connect the positive (+) meter lead in turn to pins 4, 5, and 6 of the Control Card MK200 connector, (pin 1 of MK200 is on the lower side, closest to the MK201 connector). All three readings should be within 20 millivolts of zero.
3. Start the drive and bring the motor up to stable speed. Change the voltmeter to read AC voltage and measure the Same signals at pins 4, 5, and 6 of MK201. All readings should be approximately equal.

Severe imbalances in the readings indicate a faulty current sensor or an uneven current draw by the motor. See "Testing for Output Phase Voltage Imbalance" on page 3-6. (The current sensors will vary with unit size. Consult Appendix drawings for assistance in finding component locations.)

Control Card Ribbon Cables

MK200	20	+5V	
	19	+5V	
	18	+5V	
	17	+5V	
	16	INVOK	FAULT LOGIC
	15	WP	PWM SIGNALS
	14	VP	
	13	UP	
	12	SYNC	SERIAL COMMUNICATION SIGNAL
	11	DISAB	RUN MODE LOGIC
	10	COM	COMMON FOR +13V, -13V, +5V SAME AS "GND" TEST POINT
	9	COM	
	8	COM	
	7	SIN	NOT USED
6	CR BW	MOTOR CURRENT SIGNALS	
5	CR BV		
4	CR BU		
3	VF B	DC BUS SIGNAL	
2	+13V		
1	-13V		
MK201	2	+24V	SEPERATE CONTROL LOGIC POWER SUPPLY
	1	COM1	

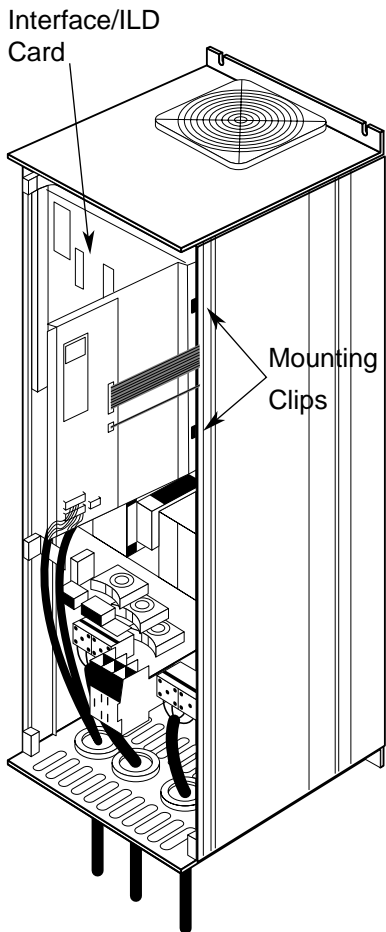
TESTING GATE DRIVE FIRING CIRCUITS

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/ILD Card. These signals are then distributed to the individual IGBT's. 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 the gate pulse voltage readings between phases. A missing gate pulse or an incorrect gate pulse have a different average voltage when compared with the other pulse outputs. At very low frequencies (below 10Hz) the voltmeter reading will tend to bounce around as the pulses rise and fall. Above 10Hz the reading will stabilize. When using an oscilloscope, the test points remain the same, as shown. These tests must be made with the motor disconnected. The internal impedance of a meter or scope can induce problems to the IGBTs.

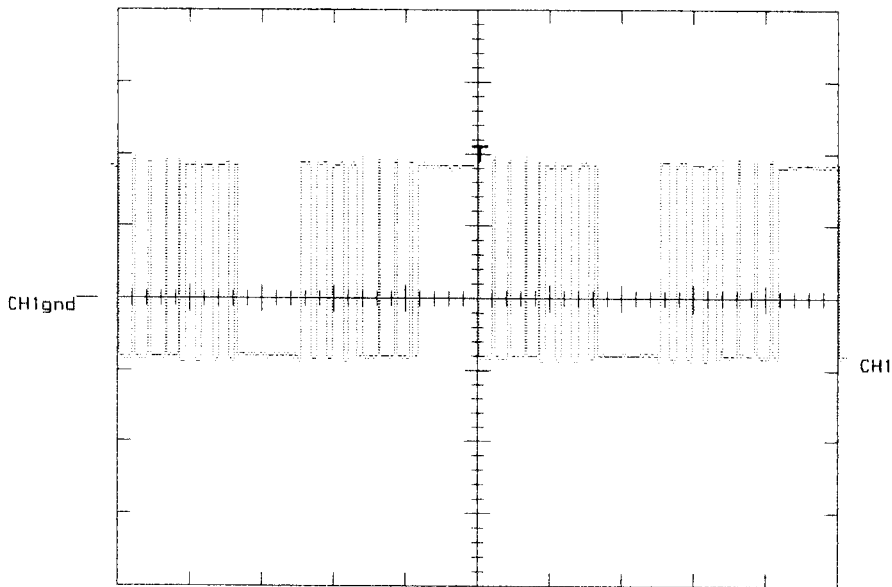
1. With power off, remove and re-install the Control Card as shown to allow easy access to the Interface/ILD Card.*
2. Measure the resistance at each of the six test points. Each test point should read approximately 2.2k Ω .
3. Apply power and run the unit up to 20Hz. Measure each of the six IGBT gate pulse signals.
4. If gate pulses are missing or the readings are inconsistent, remove power, remove the three IGBT gate wire harnesses from the Interface/ILD Card and measure the gate pulse signals directly at the Interface/ILD Card Connectors.

There may be a slight DC shift in voltage readings between the positive and negative half IGBT gate signals.



To Expose the Interface/ILD Card:

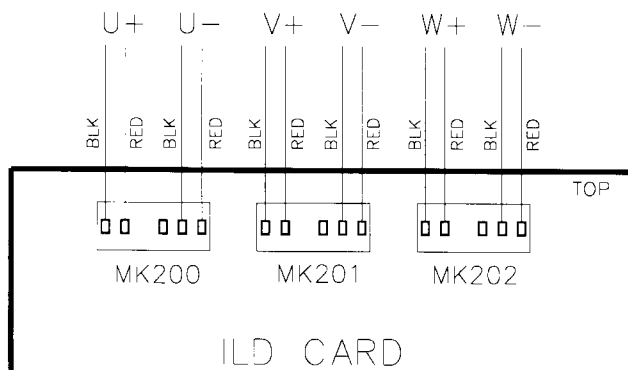
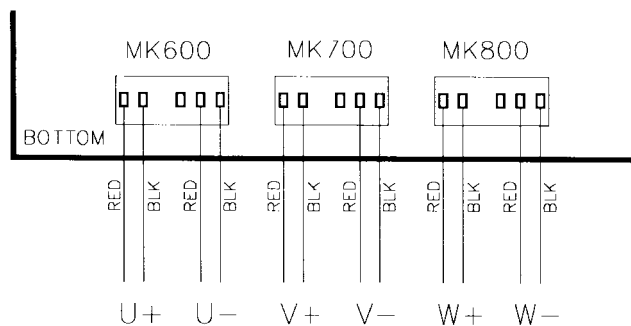
- Leaving the Ribbon Cables attached, remove the Control Card
- Mount the card by snapping the right side (edge) of the Control Card into the two (2) mounting clips.



Gate pulses @ 20Hz, 10V/Div, 10mS/Div

GATE PULSE PIN-OUTS

INTERFACE CARD



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 diodes 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 3-1.

COMPONENT REPLACEMENT PROCEDURES

REMOVING & REPLACING THE CONTROL CARD

NOTE: The Control Card comes mounted to a metal plate. When installed this plate sits in a slot provided on the left-hand side of the unit enclosure and is secured by two press-fit mounting clips attached to the right-hand side of the enclosure.

These mounting clips provide the earth ground connection for the Control Card. If loose or damaged, the Control Card may experience electrical noise problems resulting in an "Except Fault" (see page 2-4).

REMOVAL

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

REPLACEMENT

- Inspect Control Card mounting clips to ensure they are not loose or damaged.
- Insert the left side of the control card plate into the slot on the left side of the enclosure and slide the card down against the metal stop to ensure proper alignment with front cover.
- Reconnect the two ribbon cables to plugs MK200 and MK201.
- Firmly press down on the right side of the control card plate until it snaps into place.

REMOVING & REPLACING THE ILD CARD, DC CARD, RECTIFIER CARD AND IGBT

VLT 3002-3004, 230V
VLT 3002-3008, 380V/460V

VLT 3502-3504, 230V
VLT 3502-3511, 380V/460V

ILD Card:

1. Remove the ground screw(s) on the ILD Card. The screws are located at the bottom and possibly at the top right on the board.
2. Remove all wire harnesses from the ILD Card. The three leads connecting the ILD Card to the motor coils may need to be removed from the Motor Coil side. The replacement ILD Card will show if these leads should be disconnected from the ILD Card or from the Motor Coils. Pay close attention to the orientation and routing of these wire leads.
3. Use the tip of a flat-head screw driver to release the ILD Card from the plastic mounting clips and lift the card upward.
4. To install, make sure that the Insulation Foil is in place.
5. Connect the ILD Card to Motor Coil wire leads.
6. Reverse the rest of the installation steps.

DC Card:

1. Remove the wires connecting the DC Card to the Bus Coil and the IGBTs.
2. Remove the mounting screws and the green/yellow ground lead.
3. Use the tip of a flat-head screw driver to release the DC Card from the plastic mounting clips and lift the card upward. This may require a little flexing of the side of the enclosure to accomplish.
4. Remove the wires connecting the DC Card to the rectifier module and remove the DC Card.
5. Reverse the steps above to replace.

Rectifier Module:

1. Remove the wire harness from the module terminals. Note the wire orientations.
2. Remove the two mounting screws and remove the module.
3. Clean the thermal grease from the enclosure heatsink and from underneath the Rectifier Module.
4. Install the wire harness to the module.
5. Apply silicon grease 3 mils thick to the entire base of the Rectifier Module.
6. Secure the Rectifier with the two screws. Torque to 12-14 LB-IN (1.5Nm).

Six-Pack IGBT Module:

1. Remove all wire leads connected to the Six-Pack module.
2. Remove the mounting hardware and remove from the unit.
3. Clean the remaining heatsink compound from the enclosure heatsink and the Six-Pack module.
4. Apply silicon grease 3 mils thick to the entire base of the Six-Pack module.
5. Install the module and alternately tighten the mounting hardware to 21-23 LB-IN (2.5Nm).
6. Re-connect all wire leads to the Six-Pack Module.

IGBT Modules (VLT 3008, 380V/460V; VLT 3508-3511, 380/460V):

1. Remove all wire leads connected to the IGBT modules.
2. Remove the hardware holding the DC Link PCB to the IGBT Modules.
3. Remove the hardware which connects the Motor Coil to the IGBT lead on the module to be replaced.
4. Remove the two mounting screws and remove from the unit.
5. Clean the heatsink grease from the enclosure heatsink and underneath the IGBT Module.
6. Apply silicon grease 3 mils thick to the entire base of the IGBT Module.
7. Install the module and tighten the mounting hardware to 21-23 LB-IN (2.5Nm).
8. Reverse the steps above to replace.

REMOVING & REPLACING THE INTERFACE CARD, RELAY CARD, RECTIFIER, AND IGBT

VLT 3006-3022, 230V
VLT 3011-3052, 380V/460V

VLT 3508-3532, 230V
VLT 3516-3562, 380V/460V

To gain access to some assemblies remove the Control Card (page 4-2). It may also be necessary to remove one of the enclosure cross support braces to gain access to components on some units.

Interface Card:

1. Remove all wire harnesses from the Interface Card.
2. Remove the ground screw from the top right-hand corner, (on units without Interface Card ground wire).
3. Note in which enclosure slot the left side of the interface card was mounted. Use the tip of a flat-head screw driver to release the right side of the Interface Card from the plastic board supports and lift the board out of the unit.
4. Remove and inspect the Interface Card Insulation Foil, (not on 230V units).
5. Replace the Insulation Foil.
6. Slide the left-hand side of the Interface Card in the appropriate enclosure slot and snap the right-hand side of the plastic board supports. Make sure that all wire harnesses are accessible prior to seating the Interface Card.
7. Re-connect all wire harnesses and the ground screw.

Relay Card:

1. Remove all wire harnesses from the Relay Card.
2. Release the Relay Card from all plastic mounting clips and remove. Use the tip of a flat-head screw driver for the black plastic clips and needle nose pliers if white plastic stand-offs are used.
3. For units with the current sensors mounted on the Relay Card, note the wire labeling and orientation prior to moving the board. Remove the three leads connected to the drive side of the motor terminal strip and feed the leads back through the current sensors.
4. Reverse the steps above to replace.

Rectifier Module:

1. Remove the five terminal screws from the module. Note the wire orientation and disconnect all wire leads.
2. Remove the two mounting screws securing the rectifier module to the heatsink and remove the module.
3. Clean the thermal grease from the enclosure heatsink and from underneath the Rectifier Module.
4. Apply silicon grease 3 mils thick to the entire base of the Rectifier Module.
5. Install the module and alternately torque the screws to 19-21 LB-IN (2.2Nm).
6. Replace all wire leads to the Rectifier Module terminals and torque the terminal hardware to 19-21 LB-IN (2.2 Nm).

IGBT Module:

1. Remove the HF Card (does not apply to 230V units).
2. Remove all hardware mounting the IGBT bus bars and the Clamp Capacitors.
3. Remove the remaining wire connecting the IGBT to the Motor Coil.
4. Remove the mounting screws on the IGBT and remove from the unit.
5. Clean the thermal grease from the enclosure heatsink and from underneath the IGBT Module.
6. Prior to installing the IGBT module, apply silicon grease 3 mils thick to the entire base of the module.
7. Install the module and lightly tighten the mounting screws. Tighten the mounting screws to a final torque of 19-21 LB-IN (2.2Nm).
8. Re-install the IGBT bus bars, clamp capacitors and Motor Coil lead. The IGBT terminal hardware (including the 7mm HF Card standoffs) should be torqued to 27-29 LB-IN, (3.2 Nm).
9. Replace the HF Card and HF Card foil. The HF Card mounting screws should be tighten down to 12-14 LB-IN, (1.5Nm)

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 (VLT 3000 only)
- 209 - Current Limit

PARAMETER 100

Load type is selected based on application demands. VLT Series 3000 drive can be set for both constant and variable torque applications. The VLT Series 3500 drive is specifically designed for variable torque applications. The available selections vary between these different series. An incorrect setting may provide an improper voltage to frequency (V/F) ratio to the motor with respect to 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 for a CT load, sufficient starting torque will not be available.

When a VLT Series 3000 unit is set for one of the variable torque modes, adjustments to parameters 109-113 will have no effect. The various VT modes have direct control over these parameters. When one of the CT Start/VT modes is selected on a VLT Series 3000 unit, the above mentioned parameters will have effect only until the reference has been reached. At this point the unit reverts to VT operation. It should be noted that parameters 110-113 do not exist in the VLT Series 3500.

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 (VLT SERIES 3000 ONLY)

Start compensation 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 compensation may be necessary with loads requiring high starting torques and loads with changing demands as speed increases.

If multiple motors are connected to a single unit, the start compensation must be set to zero.

It is also possible to have start compensation set too high, resulting in excessive current drawn at start up and motor instability.

PARAMETER 209

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.

Current limit will automatically reset to 160% of the value entered into parameter 107 unless this would exceed the maximum allowable value.

"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 using a megger, it is necessary to disconnect the motor leads from the output of the VLT. The measurements should then be taken so that 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 3-7. 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's current limit 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 mis-interpreting the readings observed.

"OVERCURRENT" TRIPS

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 down 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**

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 severe 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. Another solution is to release the motor using the "Motor Coast" function. The "Flying Start" function is usually employed when using this method.

In very high inertia applications where a short decel time is required, the only solution may be that of adding a Dynamic Brake Option (only VLT Series 3000 units only).

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 and dynamic brake resistors for your application.

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 2-3.

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
**VLT 3002-3004, 230V
VLT 3502-3504, 230V**

	VLT 3002 VLT 3502	VLT 3003	VLT 3004 VLT 3504
Control Card (VLT 3000)	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	N/A	175H4539
ILD Card	175H7064	175H7065	175H7066
DC Bus Card	175H7018	175H7018	175H7019
Six Pack IGBT	175H7017	175H7017	175H7017
Recifier Module	612L2026	612L2026	612L2026
Brake Control Card *	175H7030	175H7030	175H7030
Brake IGBT *	175H7029	175H7029	175H7029
Top Fan IP54	175H0327	175H0327	175H0327
Insulator Foil	175H1415	175H1415	175H1415

* Only on VLT 3000

Section Six



SPARE PARTS

VLT 3006-3022, 230V
VLT 3508-3532, 230V

	VLT 3006 VLT 3508	VLT 3008 VLT 3511	VLT 3011 VLT 3516	VLT 3016 VLT 3522	VLT 3022 VLT 3532
Control Card (VLT 3000)	175H7086	175H7086	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539	175H4539	175H4539	175H4539
Interface Card	175H5375	175H5376	175H5377	175H5379	175H5382
IGBT Module	175H5340	175H5340	175H5341	175H5341	175H4510
IGBT Snubber Cap	175H0810	175H0810	175H0810	175H0831	175H0831
Recifier	612L9471	612L9471	612L9472	612L9473	612L9264
Relay Card	175H4481	175H4481	175H4481	175H4483	175H4485
Current Sensor	N/A	N/A	N/A	N/A	175H1789
Bus Charge Contactor	175H1761	175H1761	175H1761	175H1762	175H1762
Bus Contactor Coil Cap	175H2852	175H2852	175H2852	175H2852	175H2852
Time Delay Relay Module	047H0173	047H0173	047H0173	047H0173	047H0173
DC Cap Resistor	175H2324	175H2324	175H2324	175H2324	175H2324
DC Bus Capacitor	612B6762	612B6598	612B6708	612B6864	612B6864
Brake Control Card *	175H5398	175H5398	175H5398	175H5398	175H5398
Brake IGBT *	175H5370	175H5370	175H5370	175H5371	175H4508
MOV	175H7305	175H7305	175H7305	175H7305	175H7305
24V Internal Fan (IP54)	N/A	175H0827	175H0827	175H0827	175H0827
Top Fan (IP20)	24VDC 175H0827	24VDC 175H0827	24VDC 175H0827	230VAC 175H0761	230VAC 175H0761
Top Fan AC (IP54)	175H0753	175H0753	175H0761	175H0761	175H1807

* Only on VLT 3000

SPARE PARTS
**VLT 3002-3008, 380V
VLT 3502-3511, 380V**

	VLT 3002 VLT 3502	VLT 3003	VLT 3004 VLT 3504 VLT 3505	VLT 3006 VLT 3508	VLT 3008 VLT 3511
Control Card (VLT 3000)	175H7086	175H7086	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539	175H4539	175H4539	175H4539
ILD Card	175H7067	175H7068	175H7069	175H7088	175H7087
ILD Card (VLT 3504)			175H7077		
DC Card	175H7020	175H7020	175H7021	175H7022	175H7023
Six Pack IGBT	175H7017	175H7017	175H7017	175H7017	N/A
IGBT Module	N/A	N/A	N/A	N/A	175H7016
DC Link	N/A	N/A	N/A	N/A	175H1162
Recifier Module	612L2026	612L2026	612L2026	612L2026	612L2026
Brake Control Card *	175H7031	175H7031	175H7031	175H7031	175H7031
Brake IGBT *	175H7029	175H7029	175H7029	175H7029	175H7029
Top Fan IP54	175H0327	175H0327	175H0327	175H0327	175H0327

* Only on VLT 3000

Section Six



SPARE PARTS

VLT 3011-3032, 380
VLT 3516-3542, 380

	VLT 3011 VLT 3516	VLT 3016 VLT 3522	VLT 3022 VLT 3532	VLT 3032 VLT 3542
Control Card (VLT 3000)	175H7086	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539	175H4539	175H4539
Interface Card (VLT 3000)	175H5386	175H5387	175H5388	175H5389
Interface Card (VLT 3500)	175H5392	175H5393	175H5394	175H5395
IGBT (VLT 3500)	175H0266	175H0266	175H7005	175H7005
VLT 3000 IGBT	175H0266	175H0266	175H7005	175H0268
IGBT Snubber Cap	175H0810	175H0810	175H0810	175H0810
Recifier	612L9261	612L9261	612L9262	612L9263
Relay Card Pre-Series 7**	175H4712 175H1099	175H4712 175H1099	175H4712 175H1099	175H4713 175H1143
Bus Charge Contactor Pre-Series 7**	175H1761 175H0841	175H1761 175H0841	175H1761 175H0841	175H1762 175H0842
Bus Contactor Coil Cap	175H2852	175H2852	175H2852	175H2852
DC Capacitor	612B6762	612B6598	612B6708	612B6864
Brake Control Card *	175H1572	175H1572	175H1572	175H1572
Brake IGBT *	175H7059	175H7059	175H7059	175H7060
MOV	175H4204	175H4204	175H4204	175H4204
24V Internal Fan (IP54)	N/A	175H0827	175H0827	175H0827
Top Fan (IP20)	24VDC 175H0827	24VDC 175H0827	24VDC 175H0827	230VAC 175H0765
Top Fan (IP54) 400VAC	175H0668	175H0668	175H0668	175H0765
Fan Cap (IP20)				175H4487
Fan Cap (IP54)			175H4487	175H4487
HF Card (IP20)	175H7303	175H7303	175H7303	175H7303
HF Card (IP54)	175H7304	175H7304	175H7304	175H7304
DC Balance Resistor	175H2324	175H2324	175H2324	175H2324
Interface Insulator Foil	175H1786	175H1786	175H1786	175H1784

* Only on VLT 3000

** Series included in unit serial number
Example: 0000_07_G000, Series 7

SPARE PARTS

VLT 3042-3052, 380V
VLT 3552-3562, 380V

	VLT 3042 VLT 3552	VLT 3052 VLT 3562
Control Card (VLT 3000)	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539
Interface Card (VLT 3000)	175H5390	175H5391
Interface Card (VLT 3500)	175H5396	175H5397
IGBT Module	175H0268	175H4100
Snubber Cap	175H0831	175H0831
Recifier	612L9264	612L9264
Relay Card Pre-Series 7**	175H4714 175H1143	175H4714 175H1143
Current Transducer	175H1789	175H1789
Bus Charge Contactor Pre-Series 7**	175H1762 175H0842	175H1762 175H0842
Bus Contactor Coil Cap	175H2852	175H2852
DC Capacitor	612B6598	612B6708
Brake Control Card*	175H1572	175H1572
Brake IGBT*	175H7061	175H7061
MOV	175H4204	175H4204
24V Internal Fan (IP54)	175H0827	175H0827
Top Fan (IP20) 400VAC	175H0765	175H0765
Top Fan (IP54) 400VAC	175H0765	175H1808
Fan Cap (IP20)	175H4487	175H4487
Fan Cap (IP54)	175H4487	175H4487
HF Card (IP20)	175H7303	175H7303
HF Card (IP54)	175H7304	175H7304
DC Balance Resistor	175H2324	175H2324
Interface Insulator Foil	175H1784	175H1784

* Only on VLT 3000

** Series included in unit serial number
Example: 0000_07_G000, Series 7

SPARE PARTS

VLT 3002-3008, 460V
VLT 3502-3511, 460V

	VLT 3002 VLT 3502	VLT 3003	VLT 3004 VLT 3504	VLT 3006 VLT 3506	VLT 3008 VLT 3508 VLT 3511
Control Card (VLT 3000)	175H7086	175H7086	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539	175H4539	175H4539	175H4539
ILD Card	175H7072	175H7073	175H7074	175H7075	175H7076
ILD Card (VLT 3511)					175H7054
DC Card	175H7024	175H7024	175H7025	175H7026	175H7026
Six Pack IGBT	175H7017	175H7017	175H7017	175H7017	N/A
IGBT Module	N/A	N/A	N/A	N/A	175H7016
DC Link	N/A	N/A	N/A	N/A	175H1162
Recifier Module	612L9351	612L9351	612L9351	612L9351	612L9351
Brake Control Card*	175H7031	175H7031	175H7031	175H7031	175H7031
Brake IGBT*	175H7029	175H7029	175H7029	175H7029	175H7029
Top Fan IP54	175H0327	175H0327	175H0327	175H0327	175H0327
Insulator Foil	175H1415	175H1415	175H1415	175H1415	175H1415

* Only on VLT 3000

SPARE PARTS

VLT 3011-3032, 460V
VLT 3516-3542, 460V

	VLT 3011 VLT 3516	VLT 3016 VLT 3522	VLT 3022 VLT 3532	VLT 3032 VLT 3542
Control Card (VLT 3000)	175H7086	175H7086	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539	175H4539	175H4539
Interface Card	175H5378	175H5380	175H5381	175H5383
IGBT Module	175H5342	175H5342	175H5343	175H6251
IGBT Snubber Cap	175H0810	175H0810	175H0810	175H0831
Recifier	612L9474	612L9474	612L9475	612L9476
Relay Card	175H4482	175H4482	175H4482	175H4484
Bus Charge Contactor	175H1761	175H1761	175H1761	175H1762
Bus Contactor Coil Cap	175H2852	175H2852	175H2852	175H2852
DC Capacitor	612B7095	612B7096	612B7098	612B7096
Brake Control Card *	175H5399	175H5399	175H5399	175H5399
Brake IGBT *	175H5372	175H5372	175H5372	175H5373
MOV	175H7306	175H7306	175H7306	175H7306
24V Internal Fan (IP54)	N/A	175H0827	175H0827	175H0827
Top Fan (IP20)	24VDC 175H0827	24VDC 175H0827	24VDC 175H0827	230VAC 175H0761
Top Fan (IP54)	460VAC 175H0754	460VAC 175H0754	230VAC 175H0761	230VAC 175H0761
Fan Start Cap (IP20)	N/A	N/A	N/A	175H7327
Fan Start Cap (IP54)	N/A	N/A	175H7327	175H7327
Fan Series Cap (IP20)	N/A	N/A	N/A	175H7328
Fan Series Cap (IP54)	N/A	N/A	175H7328	175H7328
HF Card (IP20)	175H7303	175H7303	175H7303	175H7303
HF Card (IP54)	175H7304	175H7304	175H7304	175H7304
DC Balance Resistor	175H2324	175H2324	175H2324	175H2324
Interface Insulator Foil	175H1785	175H1785	175H1785	175H1783

* Only on VLT 3000

Section Six



SPARE PARTS

VLT 3042-3052, 460V
VLT 3552-3562, 460V

	VLT 3042 VLT 3552	VLT 3052 VLT 3562
Control Card (VLT 3000)	175H7086	175H7086
Control Card (VLT 3500)	175H4539	175H4539
Interface Card	175H5384	175H5385
IGBT Module	175H6251	175H1371
IGBT Snubber Cap	175H0831	175H0831
Recifier	612L9476	612L9477
Relay Card	175H4486	175H4486
Bus Charge Contactor	175H1762	175H1762
Bus Contactor Coil Cap	175H2852	175H2852
DC Capacitor	612B7097	612B7097
Brake Control Card*	175H5399	175H5399
Brake IGBT*	175H4509	175H4509
MOV	175H7306	175H7306
24V Internal Fan (IP54)	175H0827	175H0827
Top Fan (IP20) 230VAC	175H0761	175H0761
Top Fan (IP54) 230VAC	175H1807	175H1807
Fan Cap (IP20)	175H4487	175H4487
Fan Cap (IP54)	175H4487	175H4487
Fan Start Cap (IP20)	175H7327	175H7327
Fan Start Cap (IP54)	175H7328	175H7328
Fan Series Cap (IP20)	175H7328	175H7328
Fan Series Cap (IP54)	175H1855	175H1855
HF Card (IP20)	175H7303	175H7303
HF Card (IP54)	175H7304	175H7304
DC Balance Resistor	175H2324	175H2324
Current Transducer	175H1789	175H1789
Interface Insulator Foil	175H1783	175H1783

* Only on VLT 3000

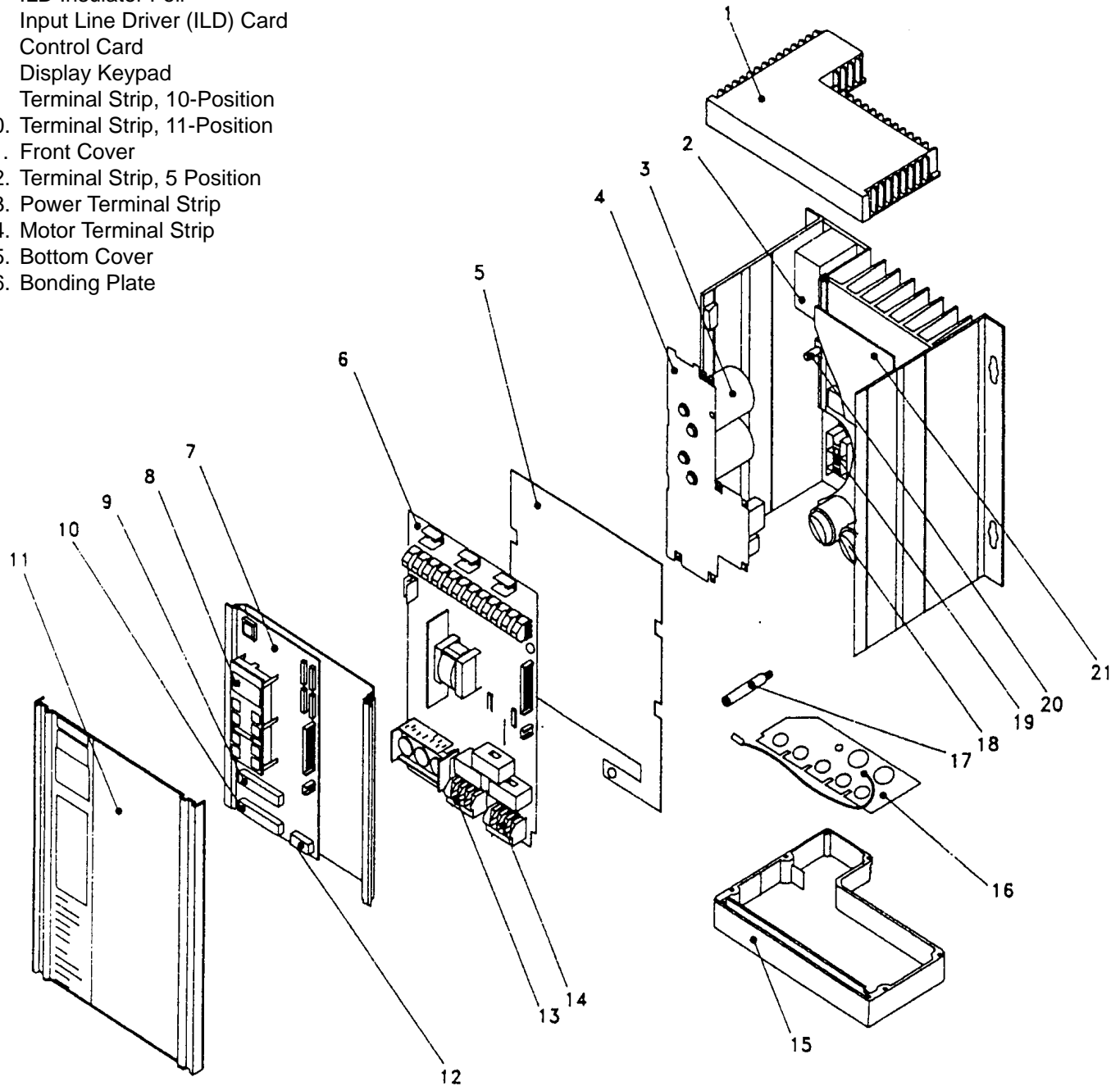
COMPONENT LOCATION

VLT 3002-3004, 230V
VLT 3002-3008, 380/460V

VLT 3502-3504, 230V
VLT 3502-3511, 380/460V

Appendix

1. Top Cover
2. DC Coil
3. DC Bus Capacitor
4. DC Card
5. ILD Insulator Foil
6. Input Line Driver (ILD) Card
7. Control Card
8. Display Keypad
9. Terminal Strip, 10-Position
10. Terminal Strip, 11-Position
11. Front Cover
12. Terminal Strip, 5 Position
13. Power Terminal Strip
14. Motor Terminal Strip
15. Bottom Cover
16. Bonding Plate



17. Standoff, ILD Card to Ground
18. Motor Coil
19. Rectifier Module
20. Standoff, DC Card
21. IGBT Six-Pack Module

Appendix

BLOCK DIAGRAM

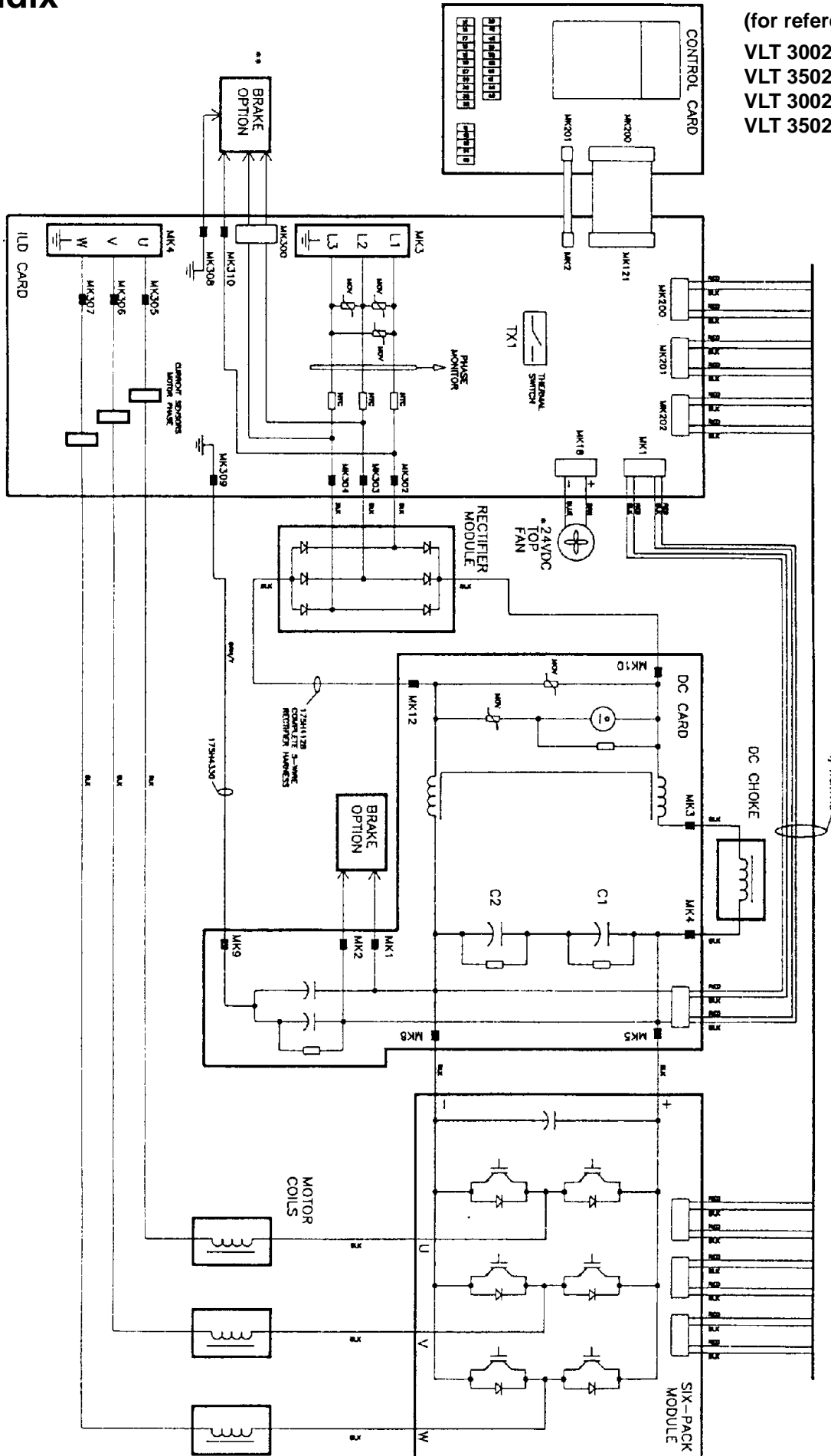
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VLT 3002-3004, 230V

VLT 3502-3504, 230V

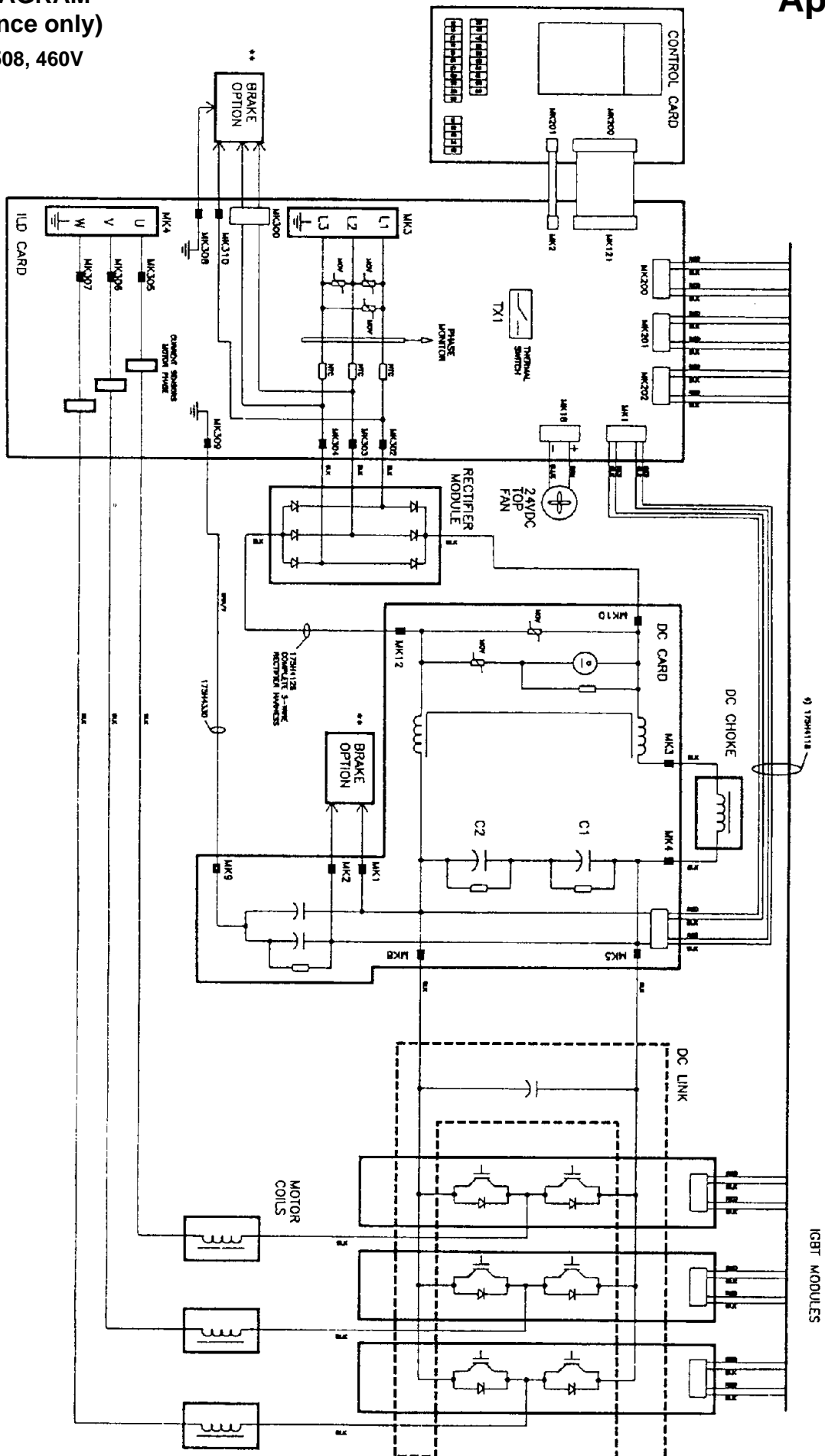
VLT 3002-3006, 460V

VLT 3502-3506, 460V

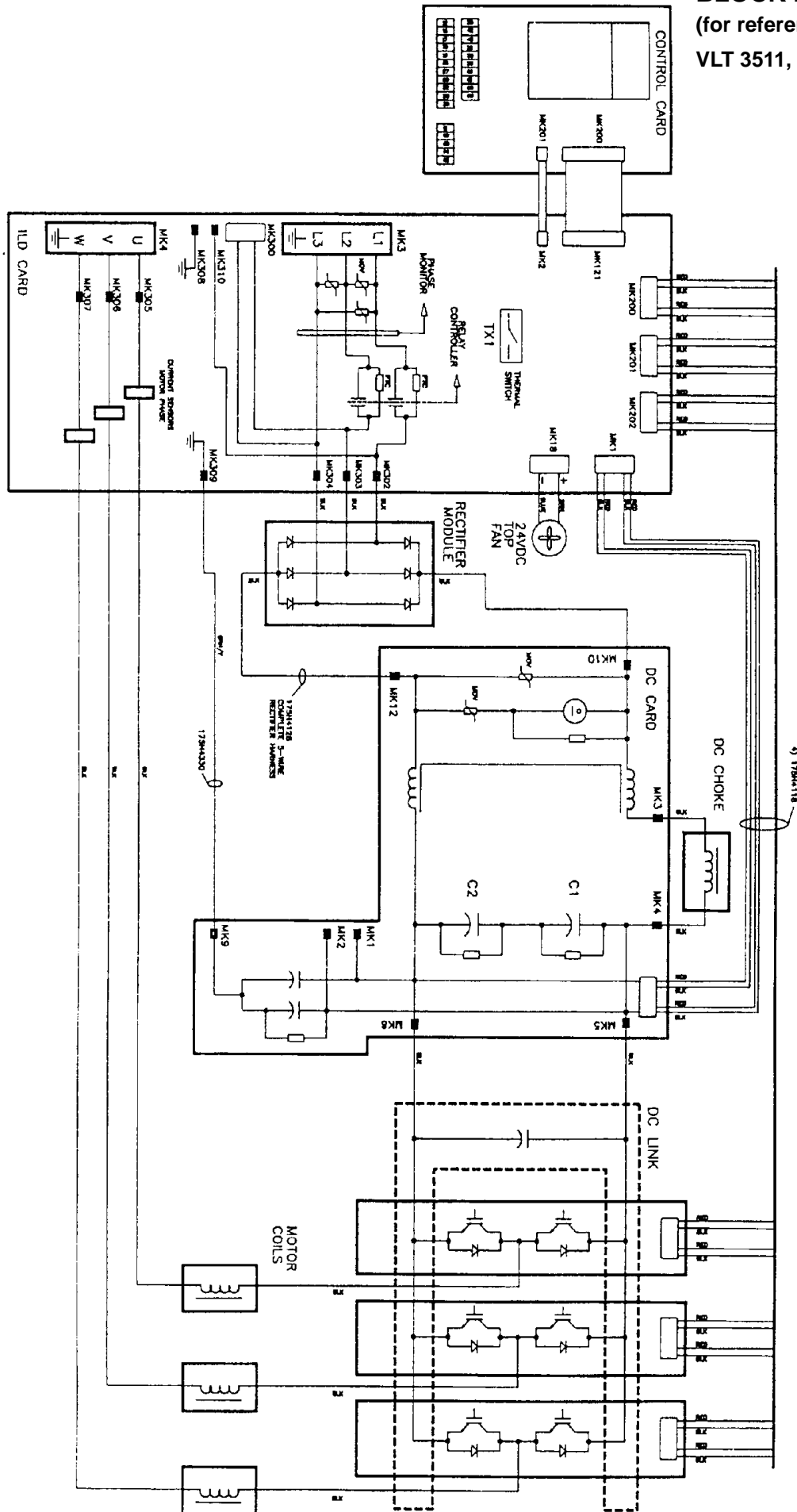


BLOCK DIAGRAM (for reference only)

VLT 3008, 3508, 460V



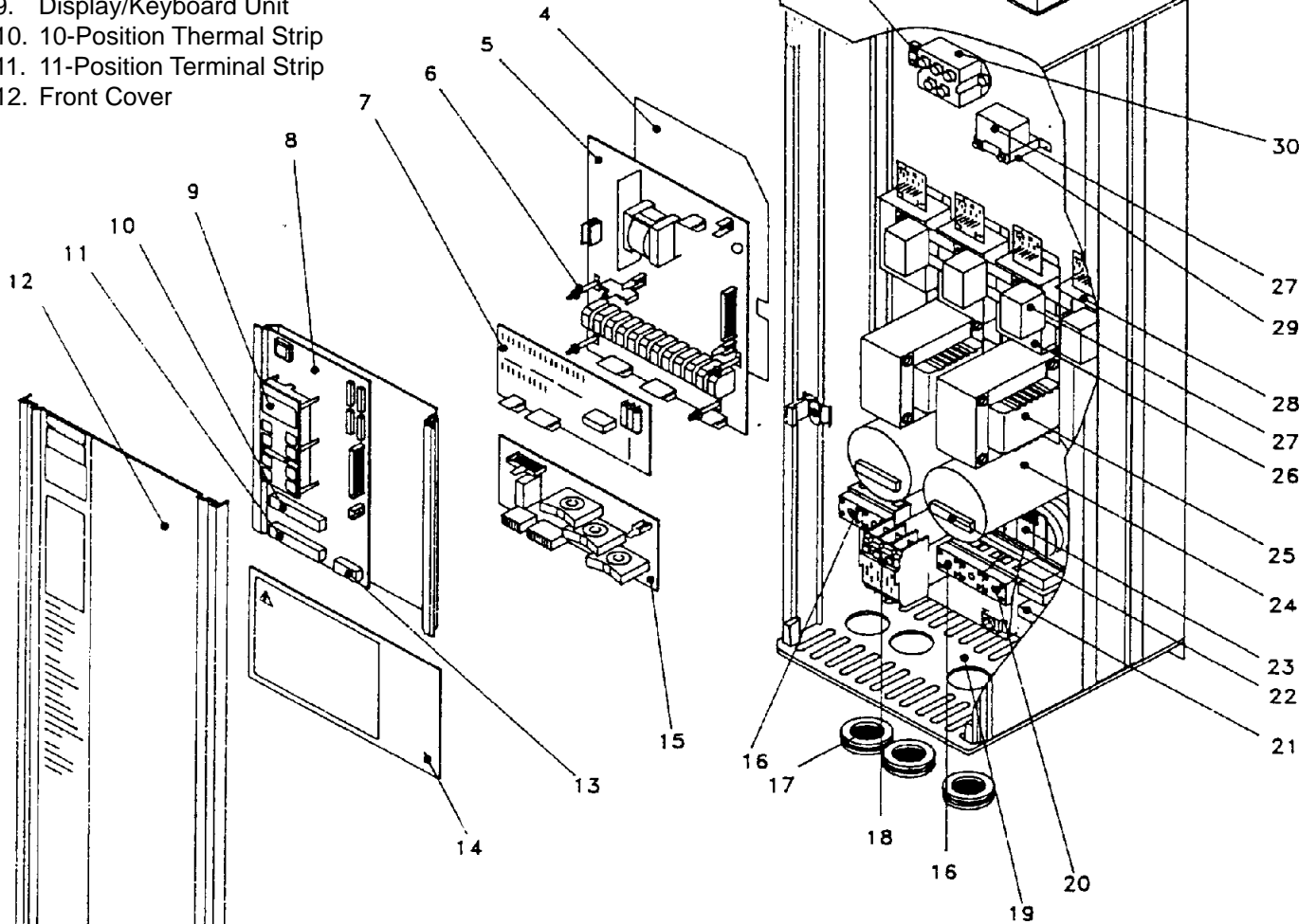
BLOCK DIAGRAM (for reference only) VLT 3511, 460V



COMPONENT LOCATION

VLT 3006-3022, 230V VLT 3508-3532, 230V
 VLT 3011-3052, 380/460V VLT 3516-3562, 380/460V

1. Top fan
2. Top Cover
3. Heat Sink Thermal Switch
4. Interface Insulator Foil (not on 230V)
5. Interface Card
6. Brake Control Card Support (not on VLT 3500)
7. Brake Control Card (not on VLT 3500)
8. Control Card
9. Display/Keyboard Unit
10. 10-Position Thermal Strip
11. 11-Position Terminal Strip
12. Front Cover



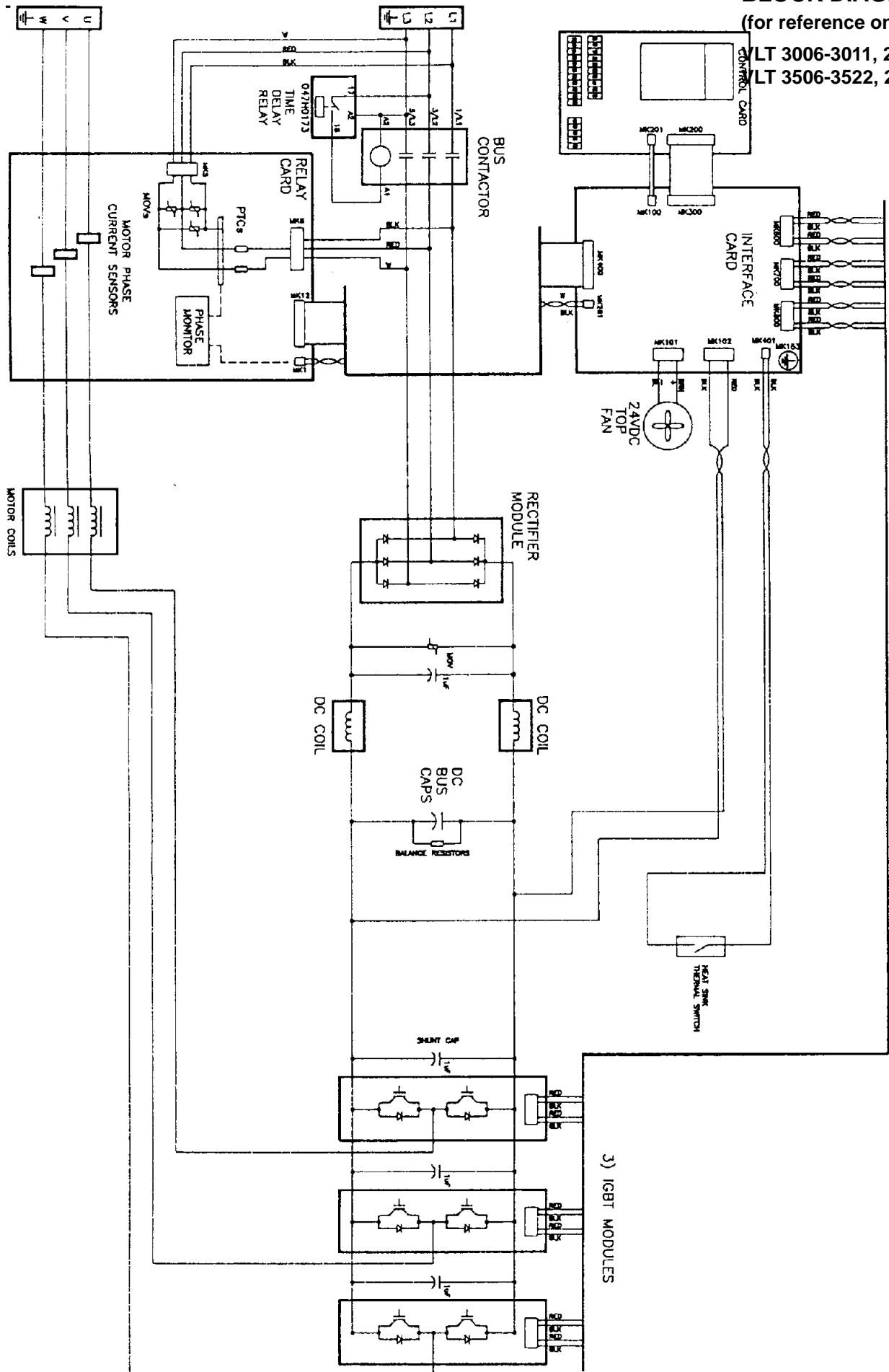
- | | |
|--|----------------------------------|
| 13. 5-Position Terminal Strip | 22. Balance Resistor |
| 14. Safety Shield | 23. Motor Coil |
| 15. Relay Card | 24. DC Bus Capacitor |
| 16. LINE/MOTOR Terminal Strip | 25. DC Coil |
| 17. Rubber Grommet | 26. Brake IGBT (not on VLT 3500) |
| 18. Bus Contactor | 27. Clamp Capacitor |
| 19. Bottom Cover | 28. IGBT Module |
| 20. BRAKE Terminal Strip (not on VLT 3500) | 29. MOV |
| 21. RFI Option | 30. Rectifier Module |

Appendix

BLOCK DIAGRAM

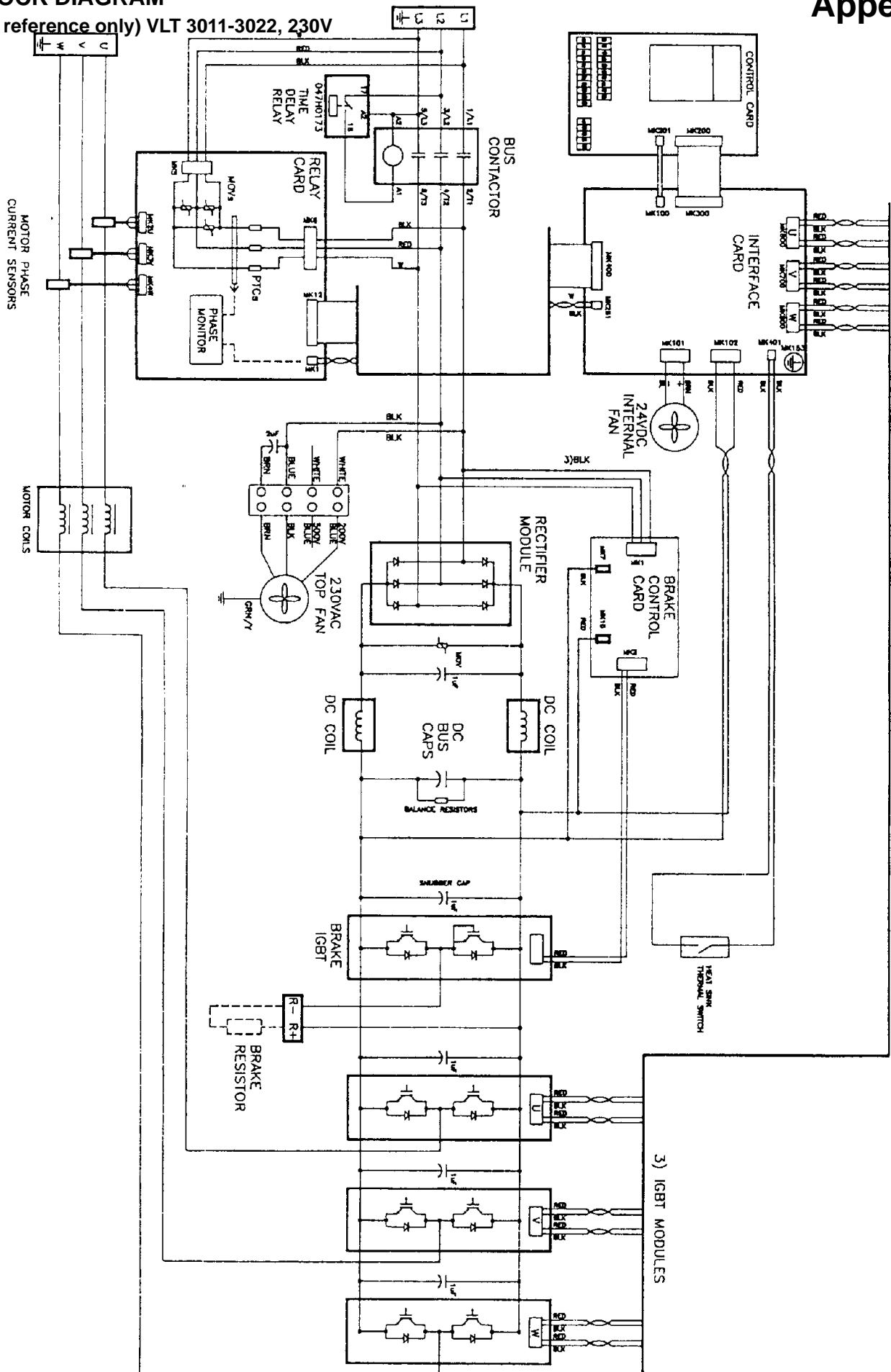
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LT 3006-3011, 230V
LT 3506-3522, 230V



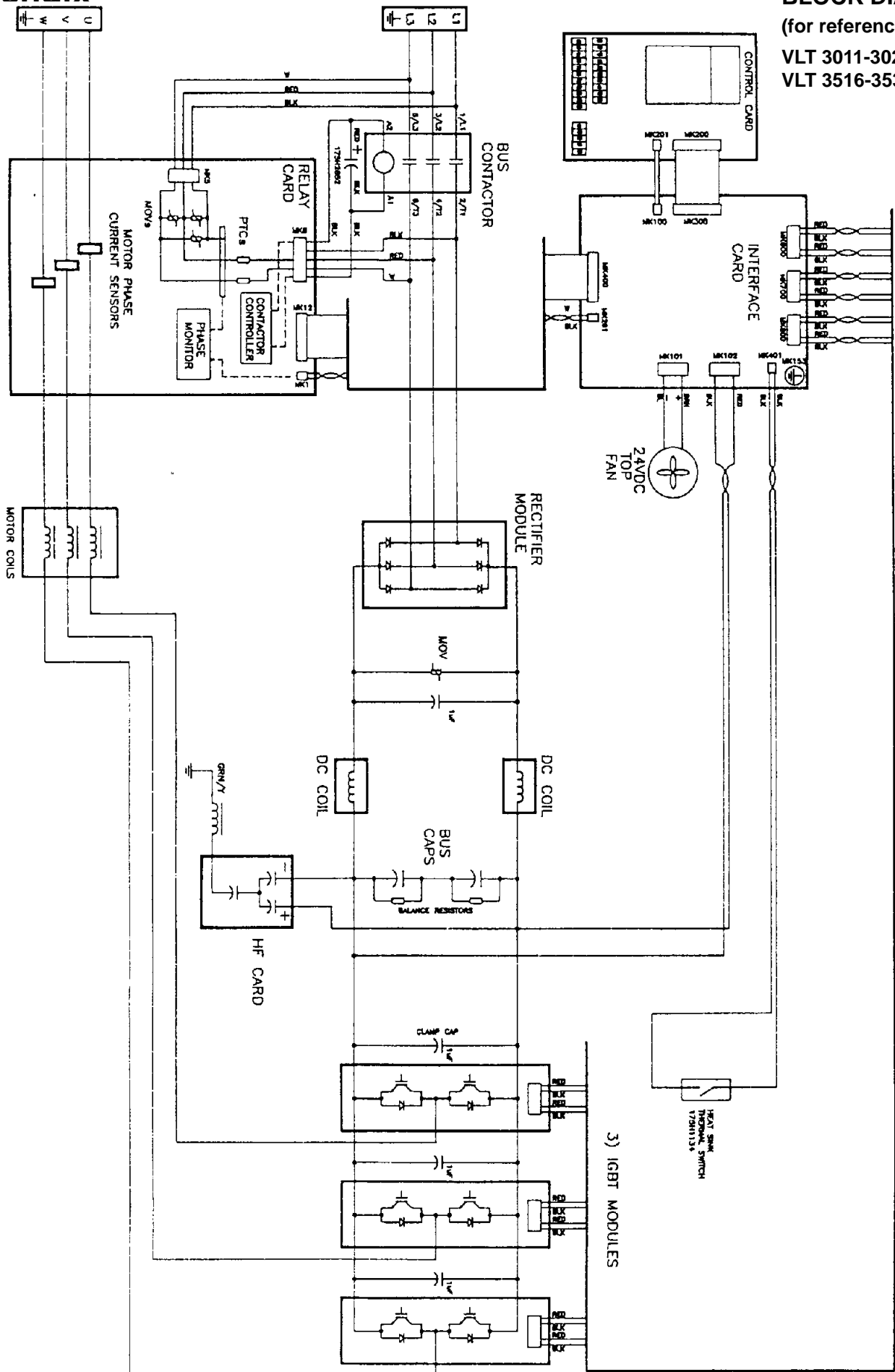
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(for reference only) VLT 3011-3022, 230V



Appendix

BLOCK DIAGRAM (for reference only) VLT 3011-3022, 460V VLT 3516-3532, 460V



BLOCK DIAGRAM
(for reference only) VLT 3032-3052, 460V

