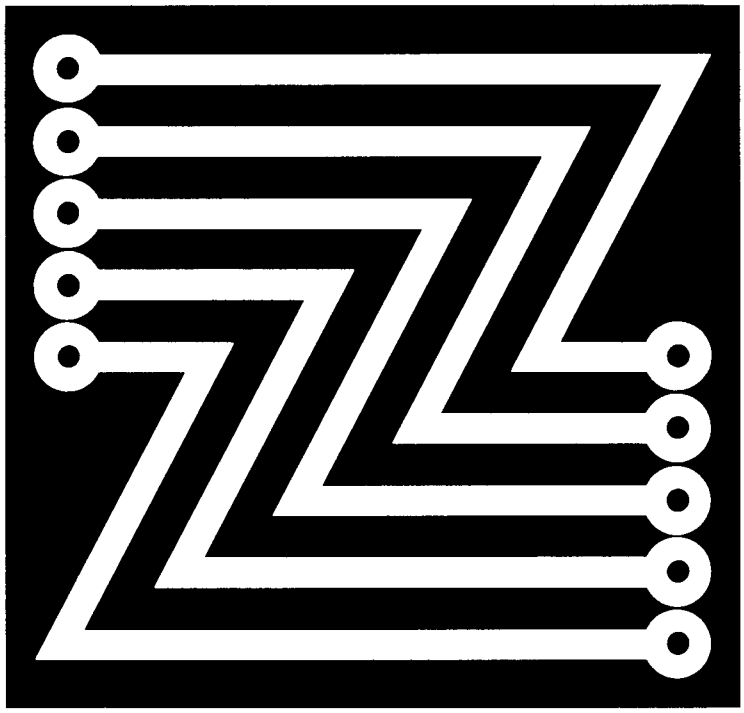


ZENER

VSC Service Manual

ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1978 Zener Electric has supplied many thousands of AC drives to Australian industries. These drives have been installed into numerous applications resulting in a wealth of in house experience.

The Zener VSC AC motor variable speed controller is the culmination of this expertise, modern technology and industrial applications requirements.

The Zener Quality Assurance Programme ensures that every VSC manufactured has proven to operate correctly in the production test bay before despatch.

VSC PRODUCT WARRANTY

Zener Electric warrants the VSC against defective workmanship and materials for a period of 24 months from the date of despatch. Such defects will be rectified free of charge for both labour and material, at Zener Electric's premises subject to:

1. Zener Electric's customer raising an order upon Zener for service and or repairs, subject to a warranty claim. The order is to state particulars of the model and serial number, the date of original purchase and invoice/delivery docket number.
2. All damage resulting from incorrect installation or use other than in accordance with the Instruction Manual issued by Zener Electric is excluded from this warranty.
3. The Warranty being rendered invalid if the product is misused or if any unauthorized alteration, modification or substitution of any part of the product be made or the serial number of the product is defaced or altered.
4. The cost of transportation (both ways) is to be met by the owner if it is necessary to return the product, or any part of it, to Zener Electric's premises.
5. A charge being accepted by the owner for travelling time and expenses incurred in connection with warranty service at the user's site as requested by the owner.
6. If the product was not purchased from Zener Electric directly, then a warranty claim must be lodged with the original supplier in the first instance. Repairs will not be effected by Zener Electric unless approved by the original supplier.
7. Goods not of our own manufacture incorporated in our supply or merchanted by us, carry their maker's warranty only.
8. Goods returned for claim under warranty will be accepted on the condition that should the claim be rejected then all costs, including inspection, will be charged to the customer's account.

SAFETY

Your VSC must be applied, installed and operated in a safe manner. It is the responsibility of the user to ensure compliance with all regulations and practices covering the installation and wiring of your VSC. This Instruction Manual should be completely read and understood before attempting to connect or operate the VSC. Only skilled personnel should install this equipment.

THE CONTENTS OF THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE

TABLE OF CONTENTS

TABLE OF FIGURES

Model Numbers

VSC-H3	VSC-G13	VSC-S3
VSC-H4	VSC-G17	VSC-S4
VSC-H5	VSC-G24	VSC-S5
VSC-H10	VSC-G32	
VSC-H13	VSC-G38	
VSC-H17	VSC-G44	
VSC-H24	VSC-G60	
VSC-H32		
VSC-H38		
VSC-H44		

USE OF THIS MANUAL

This manual is intended as a guide to finding and repairing faults in the Zener VSC. For the experienced service person it provides all the information necessary to isolate a faulty module and replace it.

This manual does not contain information regarding the repair of faulty modules as we recommend that all faulty modules be returned to Zener Electric or an authorized distributor for repair. This is because each module is complex and in order to be sure they function properly, they must conform to comprehensive test specifications, otherwise further damage could result.

It is assumed that the person attempting to service the VSC has some knowledge of electronic components, sufficient at least to identify capacitors, resistors, transistors, etc, and the modules which they make up in the VSC chassis.

The following pages list faults by their symptoms. It is impossible to list every possible symptom individually and so it may be necessary to read the procedures for more than one symptom in order to determine the best course of action.

If you are directed to check a module, refer to the Checking Procedure for that module.

If you need to replace a module, refer to the Replacement Procedure for that module.

Service of the VSC should only be attempted by people with experience working with exposed high voltages.

The Trouble Shooting Guide in the VSC Instruction Manual should be followed carefully before using this manual to ensure that the fault observed is not an external one. Many hours can be wasted looking in the wrong place for the fault.

A Glossary of Terms and a page of Definitions are also included.

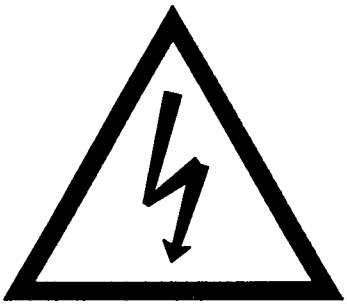
EQUIPMENT REQUIRED FOR SERVICING

A digital or analog multimeter with the following ranges:

- AC Volts up to 500 V range
- DC Volts up to 1 000 V range
- DC Amps 300 mA range
- Resistance 30 to 50 000 ohms ranges
- Diode Test Range

An Electronic Insulation Tester (500 Vdc).
A 1 amp, 100 V rectifier diode
Slotted and Philips head screwdrivers.
M4 (7 mm AF), M5 (8 mm AF) and M6 (10 mm AF) Socket Drivers.

A good working knowledge of these tools is very important.



CAUTION RISK OF ELECTRIC SHOCK

SAFETY WARNINGS

The VSC contains voltage levels in excess of 700 Vdc. These voltages also appear on the control board. Great care must be taken at all times whenever AC power is applied to avoid electric shock or damage to the VSC.

While using a multimeter to measure voltages in the VSC be very careful not to short the probes together or to any point other than the ones being measured.

It is essential that all components in the VSC are installed whenever the AC power supply is connected. DO NOT OPERATE the VSC with any components or modules removed unless directed to do so by the service procedure.

In particular, the DCCT, ELCT and the Capacitor Modules must be properly connected AT ALL TIMES or severe damage may result.

Before doing any work inside the VSC, always be sure that the AC power supply is safely disconnected and that the Capacitor Modules are fully discharged.

Always measure the DC Buss voltage and wait until it falls below 24 Vdc before proceeding with any work inside the VSC.

GLOSSARY OF TERMS

In order to keep this procedure concise, we have used terms which may be unfamiliar.

The following list defines these terms for our service procedure.

Reset Period	When the input power supply is connected and turned on, the Control Board waits 3 seconds while power supplies are established and the DC Buss capacitors are charged. During this period the VSC cannot be started and the output is disabled.
DC Buss	Also known as the DC link, this is simply the AC mains input supply rectified and filtered ready for the transistor inverter to convert back to a variable frequency, variable voltage AC supply.
Buss Voltage	This is the voltage level of the DC Buss. It is nominally 1.41 times the input line-to line voltage. During motor regeneration (over-hauling loads) the DC Buss voltage may rise above this nominal level. The Over Voltage protective circuit disables the VSC if this voltage rises above an internal preset level.
DCCT	Direct Current Current Transformer. This is a current sensing device which is able to sense DC current levels in a conductor, while still maintaining isolation.
ELCT	Earth Leakage Current Transformer. This current transformer senses an imbalance in the current flowing in the +ve and −ve DC Buss wires. Any imbalance indicates a fault current to Earth.
Input Voltage	The input voltage is the line-to-line voltage between terminals LI-L2, L2-L3 and LI-L3.
PCB	Printed Circuit Board.
Insulation Tester	Is a device for measuring insulation resistance. It applies 500 Vdc between its terminals and measures the insulation resistance in megohms (millions of Ohms). We recommend that an electronic insulation tester be used.

Definitions Used Throughout This Manual

Frequently you will be asked to measure a voltage on a particular plug, socket or component network.

The following definitions apply when measuring values in the VSC.

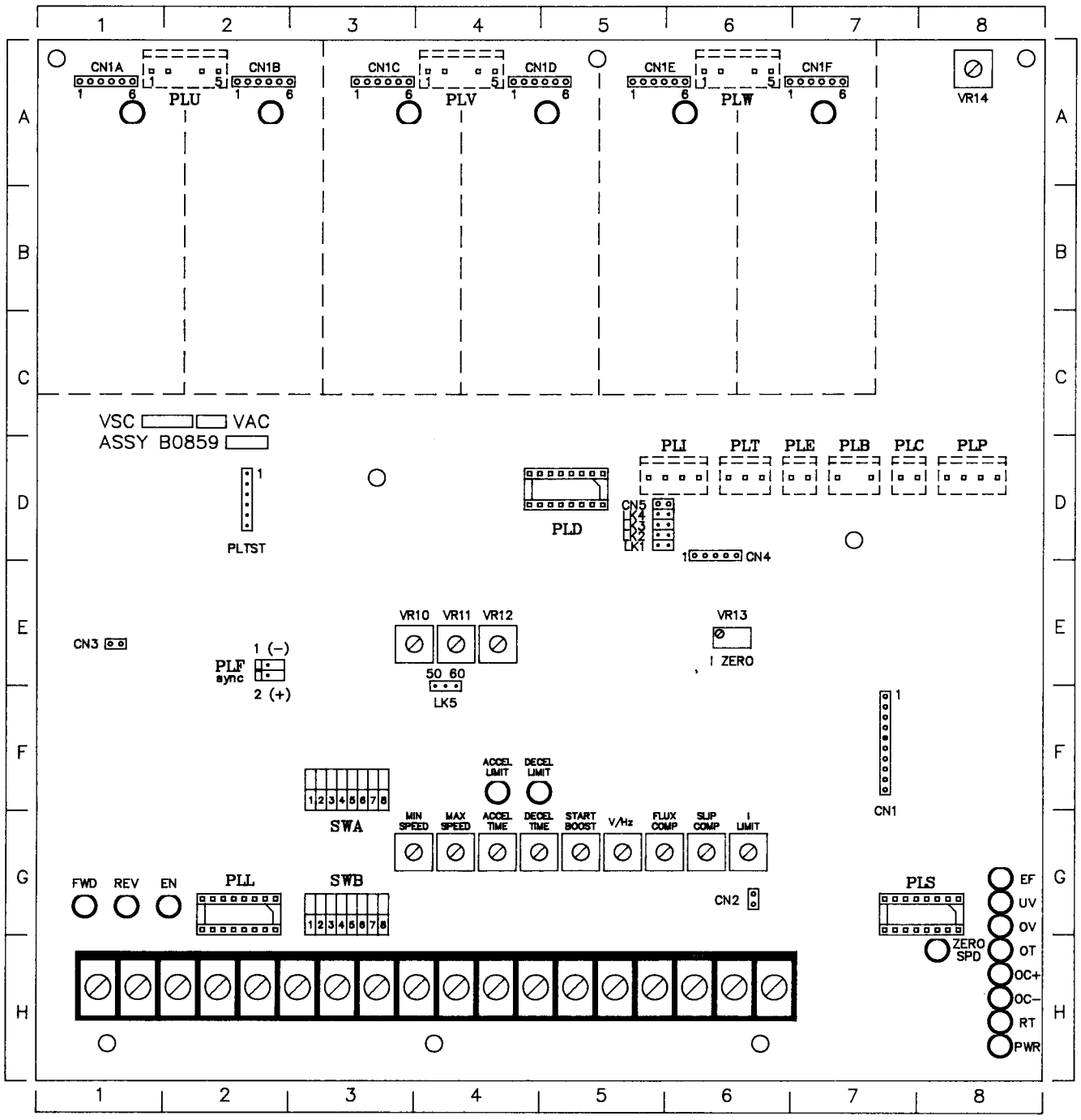
Plug	The part of the connector which is attached to the wires.
Socket	The part of the connector soldered into the PCB.
PLP	Control Board Power Supply Connector.
PLC	Capacitor Module Power Supply Connector.
PLB	DC Buss Voltage Sensing Connector.
PLE	ELCT Connector.
PLT	Temperature Sensor Connector.
PLI	DCCT Current Feedback Connector.
PLU	Base Drive Connector for Phase U.
PLV	Base Drive Connector for Phase V.
PLW	Base Drive Connector for Phase W.
CN4	Component Network Socket (5 pin).
1/PLP	pin 1 of connector PLP etc.
3/CN4	pin 3 of component network CN4, etc.

Refer to the VSC Control Board Layout on page 5 for the location of each of these connectors on the control board.

Where the procedure instructs you to check a module refer to the Checking Procedures at the end of the symptoms section.

When it is necessary to replace a module, refer to the Module Replacement Procedures at the end of this manual.

VSC Control Board Layout

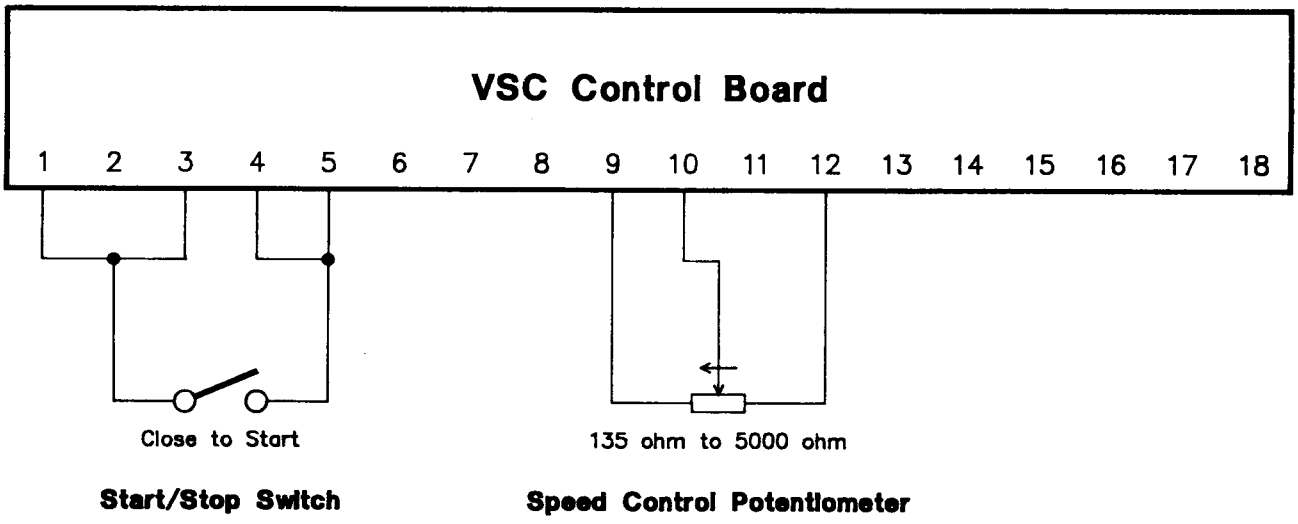


Location Key

Component Networks				Links		Connectors				Switches		Trimpots	
CN1	F7	CN1A	A1	LK1	D5	PLB	D7	PLP	D8	SWA	F3	VR10	E4
CN2	G6	CN1B	A2	LK2	D5	PLC	D7	PLS	G7	SWB	G3	VR11	E4
CN3	E1	CN1C	A3	LK3	D5	PLD	D5	PLT	D6			VR12	E4
CN4	D6	CN1D	A4	LK4	D5	PLE	D7	PLU	A2			VR13	E6
CN5	D5	CN1E	A5	LK5	E4	PLF	E2	PLV	A4			VR14	A8
		CN1F	A7			PLI	D6	PLW	A6				
						PLL	G2	PLTST	D2				

VSC SET UP FOR SERVICING

For ease of servicing we recommend that you reconnect the control circuitry to the minimum required for VSC operation. The following connections are recommended:



In each step of the service procedure will appear a **"Status Line"** as shown below:

Power Supply **Off** VSC **Stopped** Speed=**0%**

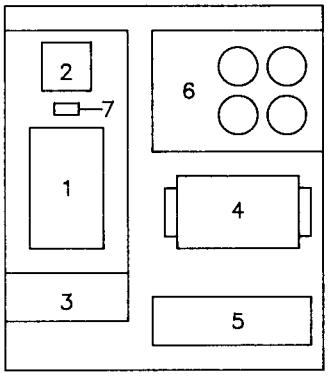
It is important that you observe this line carefully throughout the procedure to obtain the correct result at each step.

Power Supply **Off**	Mains AC supply is NOT connected to L1, L2, L3.
Power Supply **On**	Mains AC supply IS connected to L1, L2, L3.
VSC **Stopped**	Start/Stop switch is OPEN.
VSC **Started**	Start/Stop switch is CLOSED.
Speed=**0% to 100%**	Setting of speed control potentiometer. 0%=zero speed, Pot Counter Clockwise 100%=full speed, Pot Clockwise

If it is not possible to connect the VSC as shown above you must determine how best to use your control circuit to achieve the above conditions.

VSC MODULE LOCATIONS

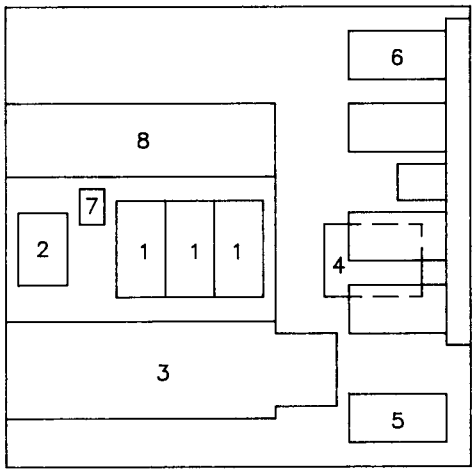
CHASSIS A



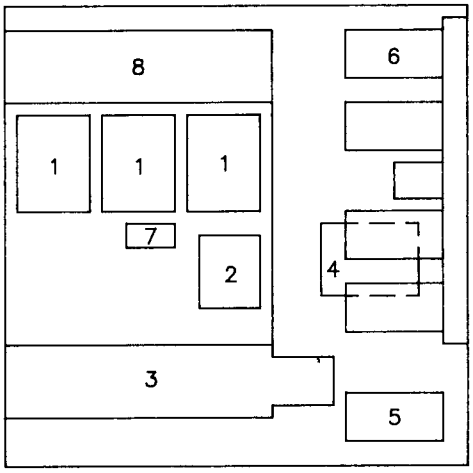
VSC Module Key	
1	TRANSISTOR MODULE
2	BRIDGE RECTIFIER
3	FAN
4	TRANSFORMER
5	TERMINALS
6	CAPACITOR MODULE
7	TEMPERATURE SENSOR
8	SNUBBER BOARD
9	OUTPUT CHOKES

VSC Chassis Type					
High Performance		General Purpose		Single Phase	
VSC-H3	A	VSC-G13	A	VSC-S3	A
VSC-H4	A	VSC-G17	B	VSC-S4	A
VSC-H5	A	VSC-G24	B	VSC-S5	A
VSC-H10	A	VSC-G32	B		
VSC-H13	A	VSC-G38	C		
VSC-H17	B	VSC-G44	D		
VSC-H24	B	VSC-G60	D		
VSC-H32	C				
VSC-H38	D				
VSC-H44	D				

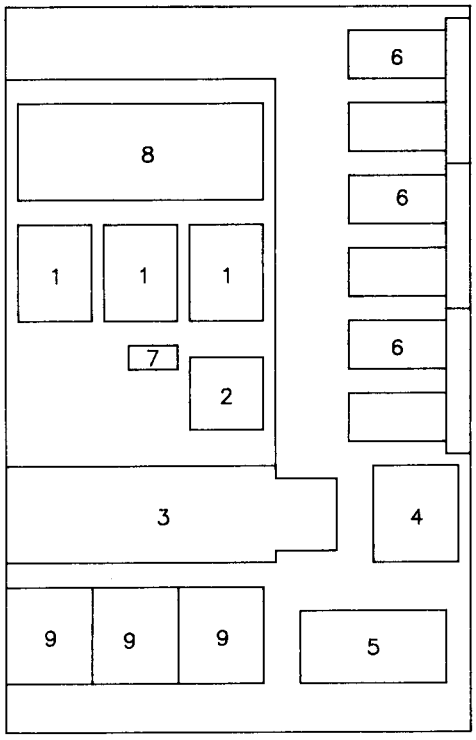
CHASSIS B



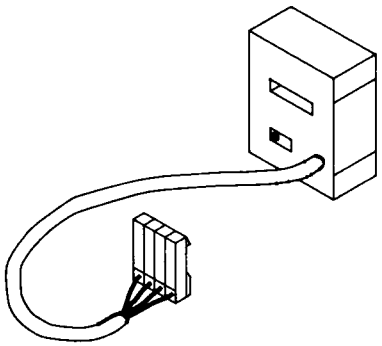
CHASSIS C



CHASSIS D

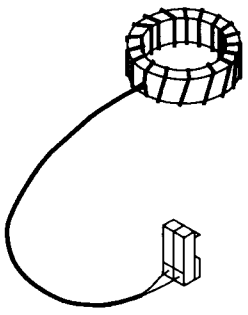


DIRECT CURRENT CURRENT TRANSFORMER



NOTE: There are a number of different types of DCCT. They are not interchangeable.

EARTH LEAKAGE CURRENT TRANSFORMER



NOTE: There are a number of different types of ELCT. They are not interchangeable.

Over Voltage Trip at End of Reset Period

Power Supply **On** VSC **Stopped** Speed=**0%**

Measure the Input Voltage and check that it is within +10% to −15% of the nameplate voltage.

Measure the DC Buss voltage between 1/PLB (−) and 3/PLB (+). It should be 1.4×Input voltage. If it is higher than this then electrical noise may be present on the AC mains. See the section below regarding electrical noise.

If the DC Buss voltage is correct, measure between 1/PLP and 3/PLP. You should get 30 Vac±3 Vac. If not, check the control transformer and it's wiring for damage and replace it if necessary.

If the voltage at PLP is correct, replace the Control Board. Refer to the Control Board Replacement Procedure.

Over Voltage Trip When ZSP LED Goes Out

Power Supply **Off** VSC **Stopped** Speed=**0%**

Locate the Capacitor Module(s) and the relay(s) on them. Turn the AC Power Supply on and check that ALL the relays energize approximately 1 second after power is applied. If any of the relays do not energize replace the Capacitor module immediately or further damage may result.

Check each capacitor module. Replace as necessary.

Intermittent Over Voltage Tripping

Power Supply **On** VSC **Stopped** Speed=**0%**

Intermittent OV tripping could be caused by one of two things. Either there is an intermittent fault in the Control Board or there is electrical noise on the main power supply. The latter is most common and can usually be verified by observing the Decel Limit LED on the control board with the VSC powered up but not operating.

If the Decel Limit LED flashes occasionally, and these flashes correspond to OV trips, then there is probably electrical noise on the AC mains power supply.

Electrical Noise

There is no simple solution for electrical noise problems. The best approach is to analyse the noise for typical amplitude and duration characteristics, then design an appropriate filter to remove the noise. If you think you have a noise problem please contact our sales personnel to discuss the best solution for your particular problem.

Over Current Plus or Over Current Minus at End of Reset Period

Power Supply **On** VSC **Stopped** Speed=**0%**

Whenever the transistor drivers are disabled, no current can flow, therefore the fault lies in the control board or the DCCT. Remove the plug from connector PLI. Measure between 1/PLI (+) and 3/PLI (−) on the control board, it should be 12 Vdc±0.1 Vdc. If not replace the control board. If OK, insert the plug back into connector PLI. Measure the voltage between 2/PLI (+) and 3/PLI (−) it should be 6 Vdc±0.5 Vdc. If not, replace the DCCT.

Measure between 2/CN4 (+) and 3/CN4 (−) on the dc millivolts range. It should be 0.0 Vdc±300 mV. If it is outside this range, adjust VRI3 on the control board until the meter reads 0.0 Vdc±30 mV. If you cannot achieve this, replace the DCCT.

If the VSC still trips on OC+ or OC− at the end of the reset period, replace the Control Board.

Over Current Plus or Over Current Minus when ZSP LED Goes Out

Power Supply **Off** VSC **Stopped** Speed=**0%**

Check the Power Transistors. If one or more is faulty, replace the transistor module(s) as necessary.

Check the Base Drive Circuits. If any of the six circuits do not operate properly, replace the control board BEFORE proceeding any further or transistor damage may result.

Power Supply **On** VSC **Stopped** Speed=**0%**

Remove the plug from connector PLI. Measure between 1/PLI (+) and 3/PLI (−) on the control board, it should be 12 Vdc±0.1 Vdc. If not replace the control board. If OK, insert the plug back into connector PLI. Measure the voltage between 2/PLI (+) and 3/PLI (−) it should be 6 Vdc±0.5 Vdc. If not, replace the DCCT.

Measure between 2/CN4 (+) and 3/CN4 (−) on the dc millivolts range. It should be 0.0 Vdc±300 mV. If it is outside this range, adjust VRI3 on the control board until the meter reads 0.0 Vdc±30 mV. If you cannot achieve this, replace the DCCT.

If the VSC still trips on OC+ or OC− when the ZSP led goes out, replace the Control Board.

Earth Fault Trip

Power Supply **Off** VSC **Stopped** Speed=**0%**

Inspect the ELCT for physical damage. Remove the plug from PLE and measure between 1/PLE and 2/PLE on the plug with a multimeter on ohms range. It should be a short circuit. If not, replace the Sensor Wiring. If the ELCT is OK, plug it back into PLE.

If your model VSC has output chokes (refer to the Internal Wiring diagrams) remove the choke wires from the Transistor Modules. Use an Insulation Tester (500 V) to check between each of the output terminals (MI, M2, M3) and the Earth terminal. Replace any choke connected to an output terminal which is less than 50 kohms to Earth.

If the VSC still trips on Earth Fault, replace the Control Board.

Under Voltage Trip

Power Supply **On** VSC **Stopped** Speed=**0%**

Measure between 1/PLP and 2/PLP on the control board. You should read 15 Vac±2 Vac. Measure between 3PLP and 2PLP. Again you should get 15 Vac±2 Vac. If not, check the control transformer for damage and replace as necessary.

Measure between 1/CN4 and 3/CN4 for a voltage between 4.18 Vdc and 6.88 Vdc. If this voltage is less than 4.18 Vdc, check the wiring between the DC Buss and connector PLB, also check the Bridge Rectifier Module.

If the voltage at CN4 is correct, replace the Control Board.

Check the Bridge Rectifier Module. Refer to the Checking Bridge Rectifier section.

Check the Capacitor Module(s) as described in the Checking Capacitor Module section.

Over Temperature Trip

Check that the fan (if installed) is operating properly and that the heatsink is not blocked with any foreign matter. If the VSC is in an enclosure, check all filters and grills for blockages and check that the enclosure fan(s) (if fitted) are operating.

Power Supply **Off** VSC **Stopped** Speed=**0%**

Measure the temperature of the heatsink (by touch if you do not have a thermometer).

Power Supply **On** VSC **Stopped** Speed=**0%**

Measure between 1/PLT (+) and 2/PLT (−). The voltage should be:

$$V = (273 + \text{Heatsink Temp } °C) \times 10 \text{ mV} \pm 5\%$$

If you do not obtain this, replace the Sensor Wiring.

The temperature trip point is 3.52 Vdc which corresponds to 80°C. If the voltage at PLT is less than 3.52 Vdc and the OT LED illuminates replace the control board.

Power LED Does Not Illuminate

Power Supply **On** VSC **Stopped** Speed=**0%**

Measure between 1/PLP and 2/PLP on the control board for 15 Vac±2 Vac. Measure between 3/PLP and 2/PLP for 15 Vac±2 Vac. If not replace the control transformer.

Power Supply **Off** VSC **Stopped** Speed=**0%**

If the voltage at PLP is OK then remove the plug from connector PLI.

If the Power On LED illuminates, replace the DCCT. If the Power On LED still fails to illuminate, replace the Control Board.

Fuses Blow On Application of Input Power

Check the Bridge Rectifier and replace if necessary.

Check the Transistor Module(s) and replace if necessary.

If there is any damage to the transistor module(s) then check the control board base drive circuits.

Check the Capacitor Module(s) and replace if necessary.

Power Supply **Off** VSC **Stopped** Speed=**0%**

Remove the plug from connector PLP. Use an Insulation Tester to check between the control transformer primary winding and Earth. Replace the control transformer if the winding is less than 500 k ohms to Earth. Repeat the test between the secondary winding and Earth. If the transformer is OK, plug it back into connector PLP.

Motor Phase Voltage or Current Imbalance

Check the Transistor Module(s) for an open circuit transistor and replace if necessary.

Check the Control Board Base Drive Circuits and replace if necessary

If no fault is found in either the transistor module(s) or the base drive circuits, replace the control board.

Motor Instability

Check the Capacitor Module(s). In particular, if there is more than one Capacitor module, check that the wiring to all the modules is intact and that one or more capacitors are not damaged.

Accel Limit (Current Limit) Circuit Activates Too Early

Power Supply **Off** VSC **Stopped** Speed=**0%**

Inspect the DCCT for physical damage.

Power Supply **On** VSC **Stopped** Speed=**0%**

Remove the plug from connector PLI. Measure between 1/PLI (+) and 3/PLI (−) on the control board, it should be 12 Vdc±0.1 Vdc. If not, replace the control board. If OK, insert the plug back into connector PLI. Measure the voltage between 2/PLI (+) and 3/PLI (−), it should be 6 Vdc±0.5 Vdc. If not, replace the DCCT.

Measure between 2/CN4 (+) and 3/CN4 (−) on the dc millivolts range. It should be 0.0 Vdc±300 mV. If it is outside this range, adjust VRI3 on the control board until the meter reads . Vdc±30 mV. If you cannot achieve this, replace the DCCT.

Check the Capacitor Module(s). If there is more than one module check the wiring to all modules.

If the DCCT and the Capacitor Module(s) are OK then replace the Control Board.

The following list of symptoms indicate a Control Board Failure

Enabled LED does not illuminate when the VSC is enabled.

Direction LED does not illuminate when a direction is selected.

Enabled/Direction leds illuminate but VSC will not start.

Speed Reference selector does not function.

Remote Trip led stays illuminated when terminals 5 and 6 are bridged.

Speed Reference inputs do not work.

Speed Output does not work.

Load Output does not work.

Control Board relay does not function properly.

CHECKING THE TRANSISTOR MODULES

The Transistor Modules come in two different packages, "Six-Pack" Modules and "Two-Pack" Modules. "Six-Pack" Modules contain six power transistors, and so only one is required to make up the three phase inverter bridge. "Two-Pack" Modules contain two power transistors, and so three are required to make up the three phase inverter bridge.

To check transistor modules you will require a multimeter with a "diode test" range. This range measures the forward biased voltage drop of a semiconductor junction. You will also need to be able to measure resistance on the 100 to 1 000 Ohms range.

For the diode tests on the transistor modules, we have defined the "Red" and "Black" leads of the multimeter as described below.

"Red Lead"	Source of conventional current or positive lead
"Black Lead"	Sink of conventional current or negative lead

Testing Six-Pack Modules

Power Supply **Off** VSC **Stopped** Speed=**0%**

Carefully note the connections to the transistor module and then remove all the wiring from it. Set the multimeter to the appropriate range, and measure between each of the terminals shown in the table below. If the result of each test is not as shown, then the transistor module must be replaced.

Set the multimeter to Diode Test Range.

Red Lead	Black Lead	Required Result	
P	N	Open Circuit	
N	P	0.4 to 1.0 Vdc	(2 diode drops)
P	U,V,W	Open Circuit	
N	U,V,W	0.20 to 0.50 Vdc	(1 diode drop)
U,V,W	P	0.20 to 0.50 Vdc	(1 diode drop)
U,V,W	N	Open Circuit	
P	BuP, BvP, BwP	Open Circuit	
U	BuN	Open Circuit	
V	BvN	Open Circuit	
W	BwN	Open Circuit	

Set the multimeter to Ohms Range (100 to 1 000 Ohms)

BuP	EuP	300 to 800 ohms
BvP	EvP	300 to 800 ohms
BwP	EwP	300 to 800 ohms
BuN	EuN	300 to 800 ohms
BvN	EvN	300 to 800 ohms
BwN	EwN	300 to 800 ohms

If the module passes this test, replace all the wiring. Refer to the VSC Base Wiring diagram for details of the base connections.

Testing Two-Pack Modules

Power Supply **Off** VSC **Stopped** Speed=**0%**

Carefully note the connections to the three transistor modules and then remove all wiring from each one. For each transistor module, set the multimeter to the appropriate range, and measure between each of the terminals shown in the table below. If the result of each test is not as shown, then the transistor module must be replaced.

Set the multimeter to the Diode Test Range.

Red Lead	Black Lead	Result	
C1	E2	Open Circuit	
E2	C1	0.80 to 1.00 Vdc	(2 diode drops)
C1	C2E1	Open Circuit	
C2E1	C1	0.20 to 0.50 Vdc	(1 diode drop)
E2	C2E1	0.20 to 0.50 Vdc	(1 diode drop)
C2E1	E2	Open Circuit	
C1	B1	Open Circuit	
C2E1	B2	Open Circuit	

Set the multimeter to the Ohms range (100 to 1 000 Ohms).

B1	E1	50 to 800 ohms
B2	E2	50 to 800 ohms

If the module passes this test, replace all the wiring. Refer to the VSC Base Wiring diagram for details of the base connections.

Checking the Bridge Rectifier Module

For the diode tests on the bridge rectifier modules, we have defined the "Red" and "Black" leads of the multimeter as described below.

"Red Lead"	Source of conventional current or positive lead
"Black Lead"	Sink of conventional current or negative lead

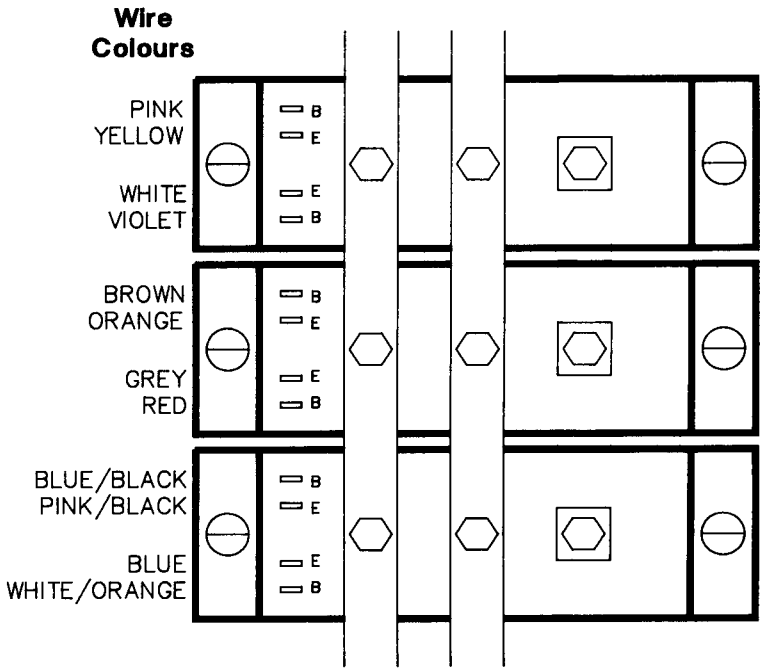
Power Supply **Off** VSC **Stopped** Speed=**0%**

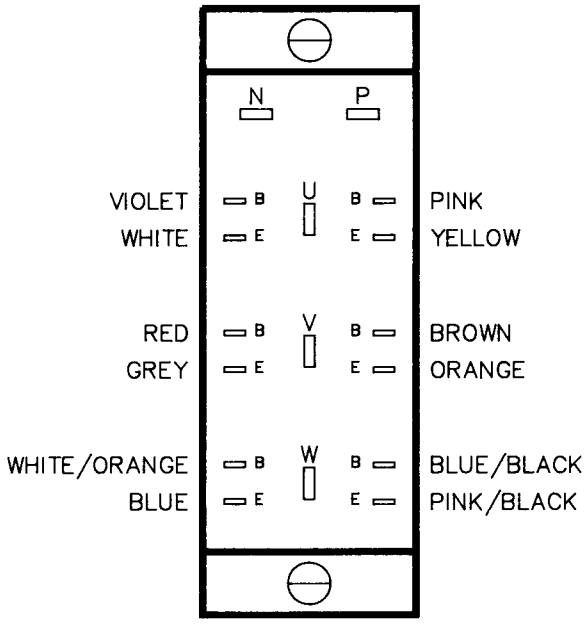
Note the connections to bridge rectifier module, then remove all wiring from it. Set the multimeter to the diode test range and measure between each of the terminals shown in the table below. If the result of each test is not as shown, then the bridge rectifier module must be replaced. If the module passes the test, replace all the wiring.

Red Lead	Black Lead	Result	
+ (KM+)	− (−AM)	Open Circuit	
− (−AM)	+ (KM+)	0.60 to 1.2 Vdc	(2 diode drops)
+ (KM+)	AC1, AC2, AC3	Open Circuit	
AC1, AC2, AC3	+ (KM+)	0.30 to 0.60 Vdc	(1 diode drop)
− (−AM)	AC1, AC2, AC3	0.30 to 0.60 Vdc	(1 diode drop)
AC1, AC2, AC3	− (−AM)	Open Circuit	

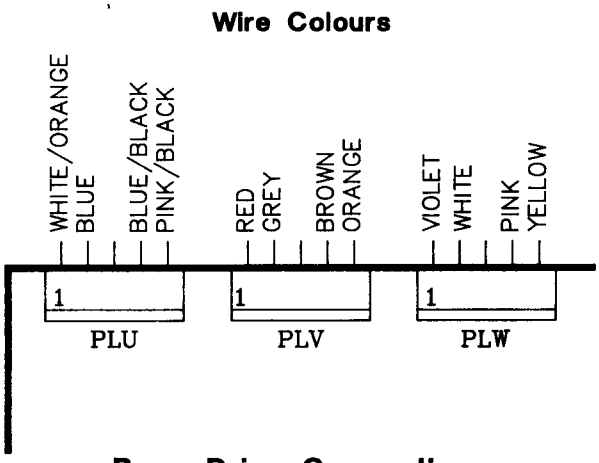
VSC BASE DRIVE WIRING

Base Drive Connections to ALL 2-PACK Transistor Modules





Base Drive Connections to ALL 6-PACK Transistor Modules



Base Drive Connections to VSC Control Board

Checking the Base Drive Circuits

To check the base drive circuits on the control board, you will require an ammeter capable of measuring 300 mA DC, and a 1 amp, 100 V rectifier diode. (1N4001 or equivalent.)

There are six base drive circuits on the control board, two connected to each of the three sockets, PLU, PLV and PLW as shown below.

To check each base drive circuit, the positive base current and the negative base current are measured seperately. This is achieved by placing the diode in series with the ammeter.

Base Current Measurement Procedure

Power Supply Off, VSC Stopped, Speed = 0%

Check that the capacitor module(s) are fully discharged by carefully measuring between the plus and minus terminals on each module. DO NOT do any work inside the VSC until this voltage is below 24 Vdc.

Remove the three connectors, PLU, PLV and PLW from their sockets and place them where they cannot touch any live wires, the control board or the chassis.

Positive Base Current Check

Connect the Positive Base Current Measuring circuit to 1/PLU and 2/PLU as shown below.

Power Supply On, VSC Started, Speed = 100%

Check that the measured current corresponds to the value shown in the table for your VSC model.

Power Supply Off, VSC Stopped, Speed = 0%

Repeat this procedure for the other five base drive circuits as shown below.

Negative Base Current Check

Power Supply Off, VSC Stopped, Speed = 0%

Connect the Negative Base Current Measuring circuit to 1/PLU and 2/PLU as shown below.

Power Supply On, VSC Started, Speed = 100%

Check that the measured current corresponds to the value shown in the table for your VSC model.

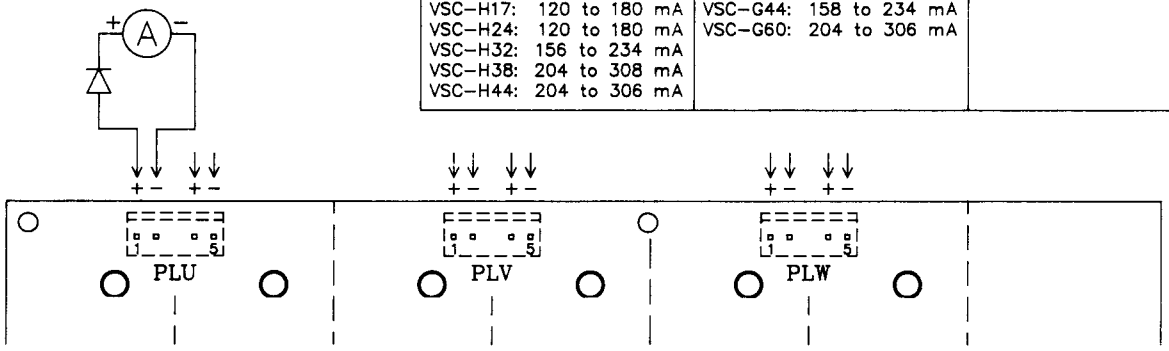
Power Supply Off, VSC Stopped, Speed = 0%

Repeat this procedure for the other five base drive circuits as shown below.

If any one of the six base drive circuits fails to meet either the Positive OR negative currents required, then the Control Board MUST be replaced or further damage may result.

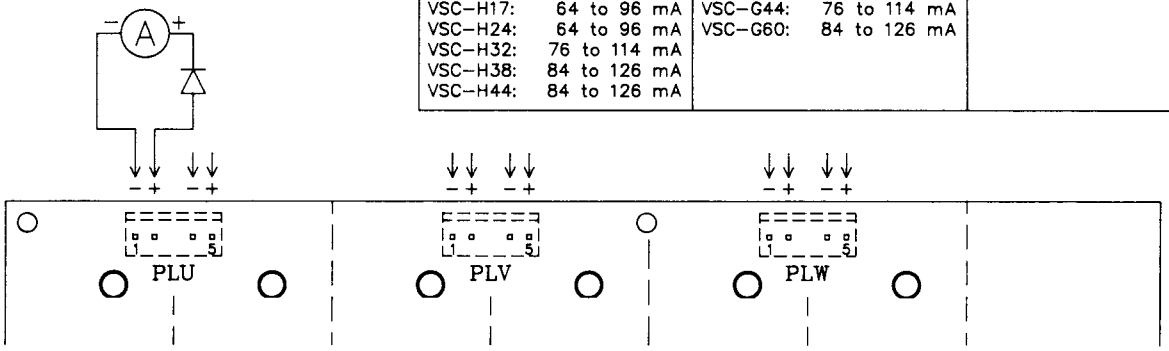
Positive Base Current Measurement

VSC-H3:	44 to 66 mA	VSC-G13:	84 to 126 mA	VSC-S3:	61 to 93 mA
VSC-H4:	44 to 66 mA	VSC-G17:	120 to 180 mA	VSC-S4:	61 to 93 mA
VSC-H5:	44 to 66 mA	VSC-G24:	120 to 180 mA	VSC-S5:	61 to 93 mA
VSC-H10:	84 to 126 mA	VSC-G32:	120 to 180 mA		
VSC-H13:	120 to 180 mA	VSC-G38:	156 to 234 mA		
VSC-H17:	120 to 180 mA	VSC-G44:	158 to 234 mA		
VSC-H24:	120 to 180 mA	VSC-G60:	204 to 306 mA		
VSC-H32:	156 to 234 mA				
VSC-H38:	204 to 308 mA				
VSC-H44:	204 to 306 mA				



Negative Base Current Measurement

VSC-H3:	31 to 47 mA	VSC-G13:	52 to 78 mA	VSC-S3:	31 to 47 mA
VSC-H4:	31 to 47 mA	VSC-G17:	64 to 96 mA	VSC-S4:	31 to 47 mA
VSC-H5:	31 to 47 mA	VSC-G24:	64 to 96 mA	VSC-S5:	31 to 47 mA
VSC-H10:	52 to 78 mA	VSC-G32:	64 to 96 mA		
VSC-H13:	64 to 96 mA	VSC-G38:	76 to 114 mA		
VSC-H17:	64 to 96 mA	VSC-G44:	76 to 114 mA		
VSC-H24:	64 to 96 mA	VSC-G60:	84 to 126 mA		
VSC-H32:	76 to 114 mA				
VSC-H38:	84 to 126 mA				
VSC-H44:	84 to 126 mA				



CHECKING THE CAPACITOR MODULES

Before removing the capacitor module(s) from the chassis, check that the relay driver circuit is functioning properly by following the procedure below.

Power Supply **Off** VSC **Stopped** Speed=**0%**

Make sure the small plug-in connector is secured in its socket on each of the modules. Check that all wiring to each module is properly connected.

Observe the large relay(s) on the module as you apply input power to the VSC. Approximately 1 second after application of input power the relay(s) should energize and stay energized until input power is removed. If the relay(s) do not energize or if they take longer than 2 seconds to energize, then the module is not functioning properly and must be replaced before proceeding any further.

Warning — If the capacitor module's discharge circuit has failed, it may take several minutes for the voltage to discharge to a safe level.

If the relays energize properly, remove power from the VSC and observe the neon indicator on the capacitor module. Time the period between turning the power off and the neon going out. If it is longer than 60 seconds then the discharge circuit has failed and the module must be replaced.

Carefully measure between the plus (+) and minus (−) terminals on the capacitor module with a multimeter on 1 000 Vdc range. Wait until this voltage is below 24 Vdc before doing any work inside the VSC.

Warning — If there is more than one capacitor module in the VSC, measure the voltage on each one to be sure that they have all discharged before doing any work inside the VSC.

Disconnect the power supply from the VSC input terminals.

Locate the wires connecting the capacitor module to the transistor module(s). Make a note of where each wire connects to the transistor module so that you can replace it properly. Disconnect the wires at the transistor module end, **leaving them connected to the capacitor module.**

If the Capacitor module is mounted to the bottom of the chassis remove the four flange nuts and carefully lift the module from the studs. If the module is mounted on the side of the chassis, remove the four screws from the outside of the chassis while supporting the module on the inside.

Remove the capacitor module from the chassis, complete with wiring, and check the following:

Inspect the body of each capacitor for physical damage such as dents, small holes, bubbles in the aluminium case (particularly the top) or any sign of excessive heat (melted plastic etc.).

Check the underside of the PCB for damage such as broken tracks, scorching, excessive heating, dry (cold) solder joints or arcing.

Check the relay contacts for signs of arcing pitting or excessive heating.

Check that the "push-on" connectors on each wire are firmly connected to the module.

If any physical damage is observed, the entire capacitor module, including wiring, should be replaced.

Capacitor Module Multimeter Check

There are three different PCB's. Check the underside of the capacitor module, and locate the part number. This is a three-letter code and a seven-character code. Choose the appropriate procedure below to perform the multimeter tests on your module.

AFY (B083190, B083112, B083160)

This is a two or four-capacitor module used in VSC-G and VSC-H models.

Locate the two black tubular power resistors (120 ohm ASW5 or 150 ohm ASW5). Measure across each one on ohms range for 110 to 160 ohms.

Set the multimeter to the 30 kohm or 50 kohm range.

Arrange the wires so that they cannot touch each other or the PCB.

Measure between the + (plus) push-on terminal and the – (minus) push-on terminal on the capacitor module. The meter should start from zero ohms and slowly increase to full scale in approximately 20 seconds. Reverse the meter leads. The meter should go from minus full scale to zero and then increase to full scale again in approximately 30 seconds.

The charging times and resistances given above may vary depending upon the meter used. The important thing is that the capacitors should "charge up" (the resistance increases) and, when the leads are reversed, they should "discharge and then re-charge" (the resistance appears to go negative, drop to zero and increase again).

If the module fails either of these two tests it must be replaced.

AFZ (B083290, B083212, B083260)

This is a six or eight-capacitor module used in VSC-G and VSC-H models.

Locate the four black tubular power resistors (120 ohm ASW5 or 150 ohm ASW5). Measure across each one on ohms range for 65 to 80 ohms.

Set the multimeter to the 30 kohm or 50 kohm range.

Arrange the wires so that they cannot touch each other or the PCB.

Measure between the + (plus) push-on terminal and the – (minus) push-on terminal on the capacitor module. The meter should start from zero ohms and slowly increase to about 20 kohms in approximately 60 seconds. Reverse the meter leads. The meter should go from minus 20 kohms to zero and then increase to 20 kohms again in approximately 60 seconds.

The charging times and resistances given above may vary depending upon the meter used. The important thing is that the capacitors should "charge up" (the resistance increases) and, when the leads are reversed, they should "discharge and then re-charge" (the resistance appears to go negative, drop to zero and increase again).

If the module fails either of these two tests it must be replaced.

AGH (B084090, B084012,B084060, B084061)

This is a two, three or four-capacitor module used in the VSC-S model.

Locate the black tubular power resistor (120 ohm ASW5 or 150 ohm ASW5). Measure across it on ohms range for 110 to 160 ohms.

Set the multimeter to the 30 kohm or 50 kohm range.

Arrange the wires so that they cannot touch each other or the PCB.

Measure between the + (plus) push-on terminal and the – (minus) push-on terminal on the capacitor module. The meter should start from zero ohms and slowly increase to about 20 kohms in approximately 90 seconds. Reverse the meter leads. The meter should go from minus 20 kohms to zero and then increase to 20 kohms again in approximately 90 seconds.

The charging times and resistances given above may vary depending upon the meter used. The important thing is that the capacitors should "charge up" (the resistance increases) and, when the leads are reversed, they should "discharge and then re-charge" (the resistance appears to go negative, drop to zero and increase again).

If the module fails either of these two tests it must be replaced.

CAPACITOR MODULE REPLACEMENT PROCEDURE

A capacitor module consists of the PCB **AND** the wires which connect to it. **Do not swap the wires between modules.** If you have obtained a new module, be sure to use the wires supplied with this module.

To replace the Capacitor Module in the chassis, fit it back on its mounting hardware and re-connect the wiring to the transistor module(s). Replace all the wires EXACTLY as they were originally connected. Check that the relay is firmly plugged into its socket.

CHECK ALL WIRING CAREFULLY BEFORE APPLYING INPUT POWER OR TRANSISTOR MODULE DAMAGE MAY RESULT.

VSC CONTROL BOARD REPLACEMENT PROCEDURE

Power Supply **Off** VSC **Stopped** Speed=**0%**

Remove all the plugs from the old control board. Remove all the wiring from the terminal strip. (Make sure you can put it all back.) With a SMALL pair of pliers, carefully squeeze each of the plastic stand-offs, gently lifting under each one at the same time. When all the stand-offs have been released, remove the old control board.

Locate the Model Number and Voltage Rating of the new control board on the left hand side about 150 mm from the front edge of the board (just above the large IC). Make sure it is the same as the board you are replacing.

If the model number and voltage rating are blank, you will have to set up the board for your particular VSC model. There will be an instruction sheet and a packet of plug-in component networks supplied with the new board. Follow the instructions carefully to set the board up for your VSC model.

Place the new control board on the stand-offs, making sure they are all poking through the mounting holes. Gently push down around each of the stand-offs so that they all push through and lock down over the board. Be careful not to bend any components.

Replace all the plugs into their sockets.

Re-connect all the wiring to the terminals on the control board.

CHECK THAT ALL THE PLUGS HAVE BEEN INSERTED PROPERLY. MAKE SURE NONE OF THEM ARE DISPLACED BY ONE PIN.

Power Supply **On** VSC **Stopped** Speed=**0%**

Locate VR13, "I zero", a ten-turn trimpot. Refer to the VSC Control Board Layout for its location.

Measure between 2/CN4 and 3/CN4 on DC millivolts range. Adjust VRI3 until the meter reads 0.00 Vdc±30 mVdc. (Note: If measured at another time this voltage may be ±300 mVdc due to temperature drift. This is not a problem, and there is no need to re-adjust it.)

Power Supply **Off** VSC **Stopped** Speed=**0%**

This completes the installation of the new control board.

DCCT REPLACEMENT PROCEDURE

Power Supply **Off** VSC **Stopped** Speed=**0%**

Locate the small 10-turn adjustment trim-pot on the DCCT and note which end of the wire or Buss bar is adjacent to it. Remove the wire or Buss bar which goes through the DCCT. Remove the DCCT and replace it with the new one so that the adjustment trim-pot is on the same side of the conductor as with the old DCCT.

Power Supply **On** VSC **Stopped** Speed=**0%**

Locate VRI3, a 10-turn trimpot, "I zero". Refer to page 5 for its location.

Measure between 2/CN4 and 3/CN4 on DC millivolts range. Adjust VR13 until the meter reads 0.00 Vdc±300 mVdc. (Note: If measured at another time this voltage may be ±300 mVdc due to temperature drift. This is not a problem, and there is no need to re-adjust it.)

Power Supply **Off** VSC **Stopped** Speed=**0%**

This completes the installation of the new DCCT.

INPUT RECTIFIER REPLACEMENT PROCEDURE

Power Supply **Off** VSC **Stopped** Speed=**0%**

Note carefully the orientation of the rectifier module on the heatsink. Also note the connections to the module. Remove the mounting screw(s) from the module and lift it from the heatsink.

Apply a light smear of heatsink grease to the base of the new module and place it on the heatsink in the same position as the old module.

Replace the mounting screw(s) and re-connect the wires carefully. If the wires connect to push-on terminals, make sure they all make a tight connection.

TRANSISTOR MODULE REPLACEMENT PROCEDURE

Power Supply **Off** VSC **Stopped** Speed=**0%**

Before removing the old transistor module, make a note of all the connections to it. Pay careful attention to the connection of the Base Drive wires.

Remove the wires from the transistor module. If there are three modules remove the Buss bars from the transistors WITHOUT removing the wires connecting the Buss bars to the capacitor modules.

Remove the mounting screws from the module(s), and then remove the old module(s).

Apply a thin smear of heatsink grease to the base of the new module(s).

Place the new transistor on the heatsink and insert the mounting screws. Turn all the screws up finger tight, and then turn them up a little at a time. DO NOT over tighten the screws or the transistor module may crack.

Replace the wiring and check it carefully.

SENSOR WIRING REPLACEMENT PROCEDURE

Power Supply **Off** VSC **Stopped** Speed=**0%**

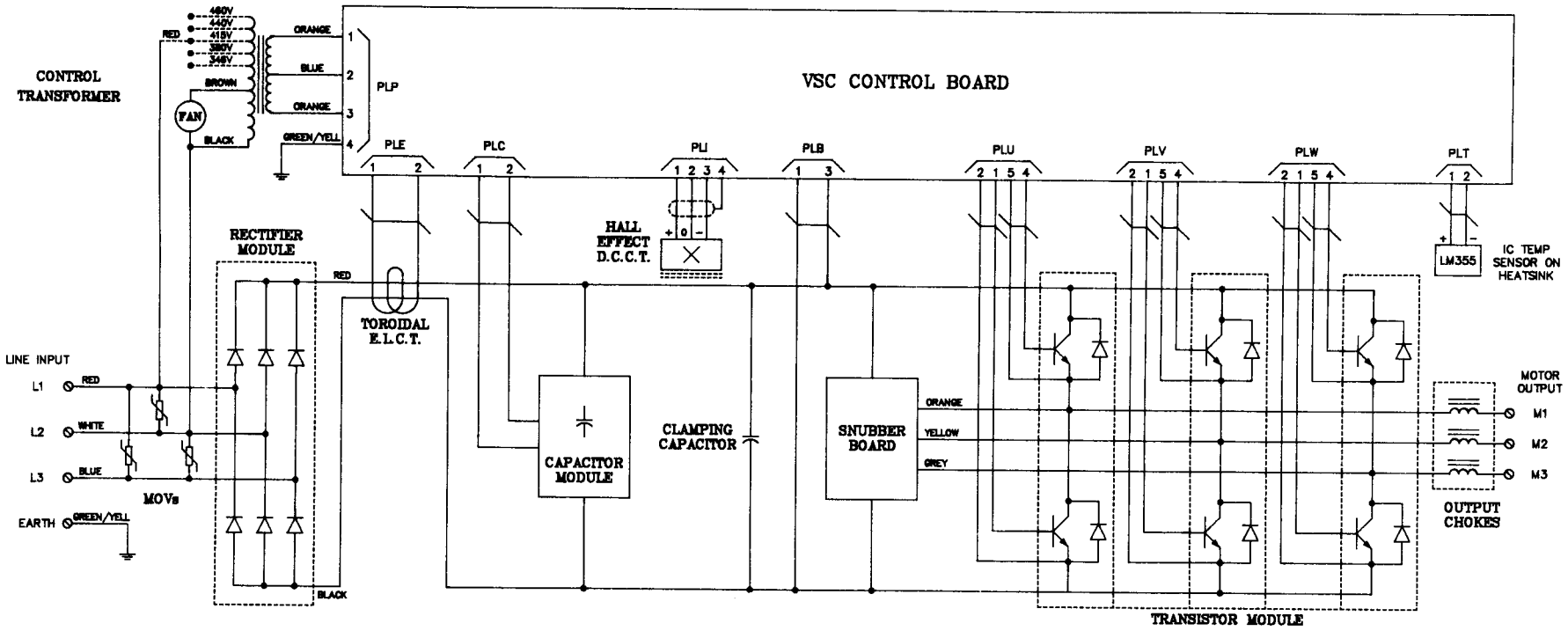
The Sensor Wiring consists of:

the Buss voltage sensing wires — connector PLB
the temperature sensor (LM355) — connector PLT
the ELCT — connector PLE

If any one of these items needs replacing, the Sensor Wiring should be replaced. Carefully observe the location, mounting and connection of the ELCT, Temperature Sensor and Buss Sensing Wires. Remove the ELCT by removing the wires which pass through it and sliding it over the end of them. Remove the Temperature Sensor by removing the screw from the clamp holding it to the heatsink. Remove the Buss sensing wires, noting carefully where they connect. Unplug the connectors PLE, PLT and PLB from the control board. Now the old Sensor Wiring may be removed.

Fit the new Sensor Wiring by sliding the ELCT over the wires which passed through the old ELCT and re-connecting those wires. Place the Temperature Sensor on to the heatsink, with the flat side face down. Replace the clamp and screw it into place. Connect the Buss sensing wires to the DC buss. Plug connectors PLE, PLT and PLB into their sockets on the control board.

This completes the replacement of the Sensor Wiring.



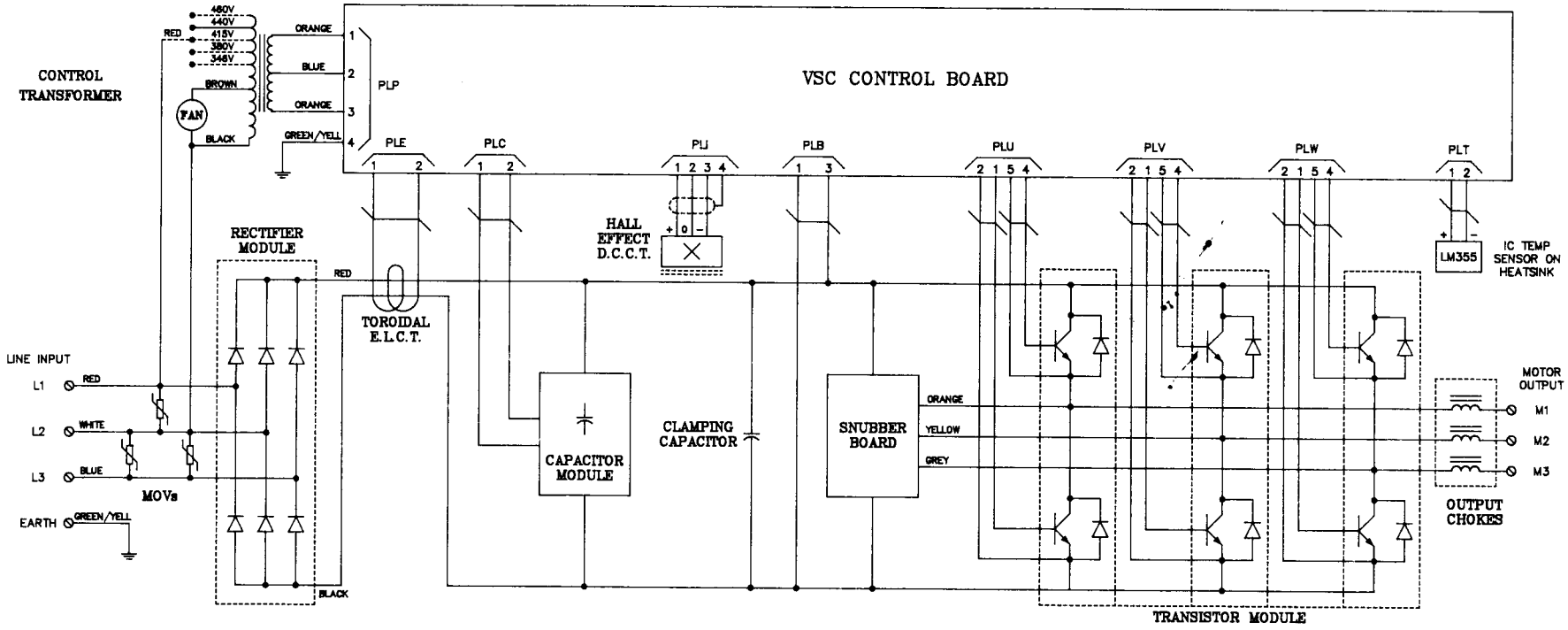
HIGH PERFORMANCE VSC SPARE PARTS

MODEL NUMBER	kW RATING AT 415V	INPUT RECTIFIER	TRANSISTOR MODULE	CAPACITOR MODULE	FAN	D.C.C.T.	SENSOR LOOM	SNUBBER BOARD	CHOKES	CHASSIS	CLAMPING CAPACITOR	CONTROL BOARD	CONTROL TRANSFORMER			MOVs	
													415 Vac	460 Vac	MULTI-TAP	346 to 440V	460 Vac
VSC-H3	0.75	AP20003	AP20004	1 x AP20013		AP20005	AP20023			AP20024		AP20037	AP99001	AP99002	AP99003	AP20038	AP20039
VSC-H4	1.5	AP21003	AP21004	1 x AP21013	AP21006	AP21005	AP21023			AP21024		AP21037	AP99001	AP99002	AP99003	AP21038	AP21039
VSC-H5	2.2	AP22003	AP22004	1 x AP22013	AP22006	AP22005	AP22023			AP22024		AP22037	AP99001	AP99002	AP99003	AP22038	AP22039
VSC-H10	4.0	AP23003	AP23004	1 x AP23014	AP23006	AP23005	AP23023			AP23024		AP23037	AP99001	AP99002	AP99003	AP23038	AP23039
VSC-H13	5.5	AP24003	3 x AP24004	1 x AP24014	AP24006	AP24005	AP24023			AP24024		AP24037	AP99001	AP99002	AP99003	AP24038	AP24039
VSC-H17	7.5	AP25003	3 x AP25004	1 x AP25015	AP25006	AP25005	AP25023			AP25024		AP25037	AP99001	AP99006	AP99003	AP25038	AP25039
VSC-H24	11	AP26003	3 x AP26004	1 x AP26016	AP26006	AP26005	AP26023	AP26008		AP26024		AP26037	AP99001	AP99006	AP99003	AP26038	AP26039
VSC-H32	15	AP27003	3 x AP27004	1 x AP27014 1 x AP27016	AP27006	AP27005	AP27023	AP27008		AP27024	AP27022	AP27037	AP99001	AP99006	AP99003	AP27038	AP27039
VSC-H38	18.5	AP28003	3 x AP28004	1 x AP28015 1 x AP28016	AP28006	AP28005	AP28023	AP28008	AP28021	AP28024		AP28037	AP99001	AP99006	AP99003	AP28038	AP28039
VSC-H44	22	AP29003	3 x AP29004	1 x AP29016 1 x AP29017	AP29006	AP29005	AP29023	AP29008	AP29021	AP29024		AP29037	AP99001	AP99006	AP99003	AP29038	AP29039

NOTES

1. When ordering Spare Parts, please specify the Part Number, Serial Number and Input Voltage rating of your VSC.
2. The "Sensor Loom" includes the ELCT, the Temperature Sensor and the Buss Voltage Sensing Wires.
3. The Multi-Tap Control Transformer has windings for 346, 380, 400 and 440 Vac Input Voltages.

VSC-G Internal Wiring Diagram



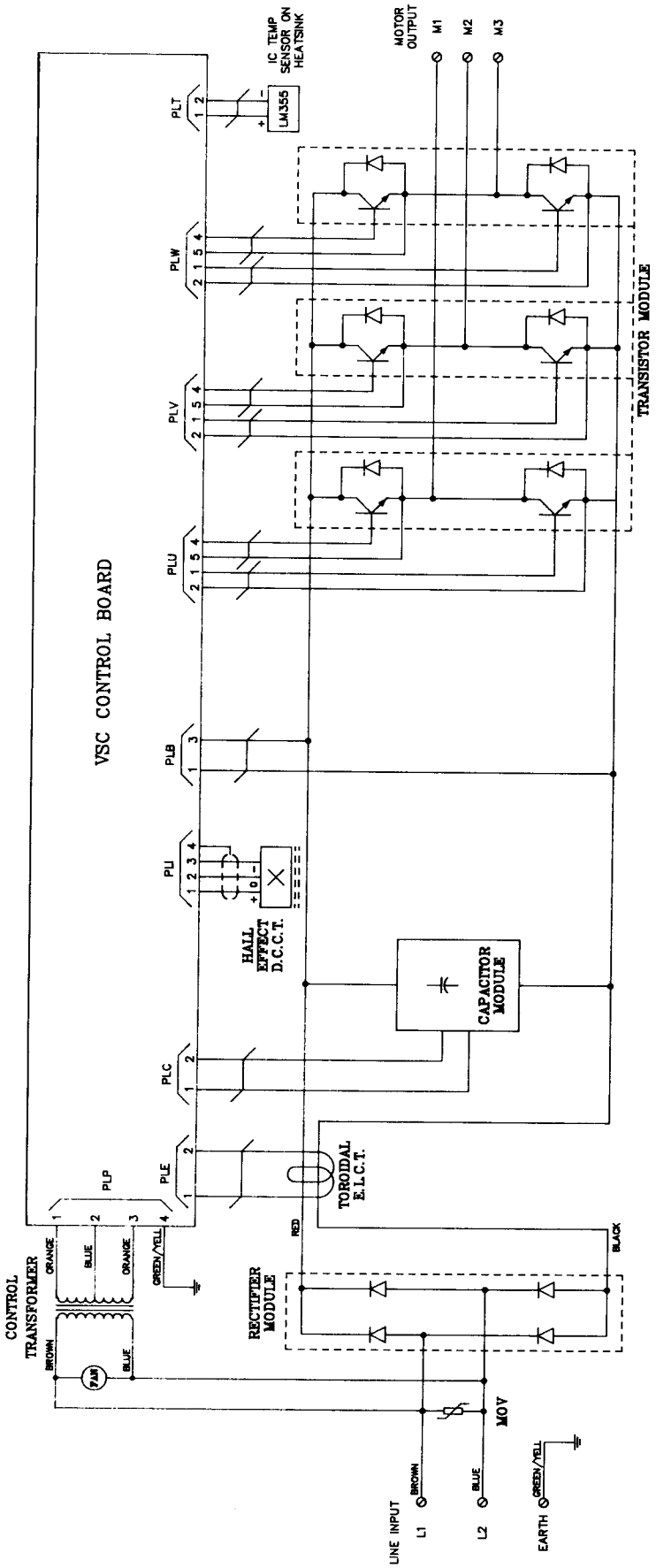
NOTES

1. When ordering Spare Parts, please specify the Part Number, Serial Number and Input Voltage rating of your VSC.
2. The "Sensor Loom" includes the ELCT, the Temperature Sensor and the Buss Voltage Sensing Wires.
3. The Multi-Tap Control Transformer has windings for 346, 380, 400 and 440 Vac Input Voltages.

GENERAL PURPOSE VSC SPARE PARTS

MODEL NUMBER	kW RATING AT 415V	INPUT RECTIFIER	TRANSISTOR MODULE	CAPACITOR MODULE	FAN	D.C.C.T.	SENSOR LOOM	SNUBBER BOARD	CHOKES	CHASSIS	CLAMPING CAPACITOR	CONTROL BOARD	CONTROL TRANSFORMER			MOVs	
													415 Vac	460 Vac	MULTI-TAP	380 to 440V	460V
VSC-G13	5.5	AP44003	AP44004	1 x AP44014	AP44006	AP44005	AP44023			AP44024		AP44037	AP99001	AP99002	AP99003	AP44038	AP44039
VSC-G17	7.5	AP45003	3 x AP45004	1 x AP45015	AP45006	AP45005	AP45023			AP45024		AP45037	AP99001	AP99006	AP99003	AP45038	AP45039
VSC-G24	11	AP46003	3 x AP46004	1 x AP46016	AP46006	AP46005	AP46023			AP46024		AP46037	AP99001	AP99006	AP99003	AP46038	AP46039
VSC-G32	15	AP47003	3 x AP47004	1 x AP47014 1 x AP47016	AP47006	AP47005	AP47023	AP47008		AP47024		AP47037	AP99001	AP99006	AP99003	AP47038	AP47039
VSC-G38	18.5	AP48003	3 x AP48004	1 x AP48014 1 x AP48016	AP48006	AP48005	AP48023	AP48008		AP48024	AP48022	AP48037	AP99001	AP99006	AP99003	AP48038	AP48039
VSC-G44	22	AP49003	3 x AP49004	1 x AP49016 1 x AP49017	AP49006	AP49005	AP49023	AP49008		AP49024	AP49022	AP49037	AP99001	AP99006	AP99003	AP49038	AP49039
VSC-G60	30	AP50003	3 x AP50004	1 x AP50014 1 x AP50016 1 x AP50017	2 x AP50006	AP50005	AP50023	AP50008	AP50021	AP50024		AP50037	AP99004	AP99007	AP99008	AP50038	AP50039

VSC-S Internal Wiring Diagram



SINGLE PHASE VSC SPARE PARTS

MODEL NUMBER	kW RATING AT 240V	INPUT RECTIFIER	TRANSISTOR MODULE	CAPACITOR MODULE	FAN	D.C.C.T.	SENSOR LOOM	CHASSIS	CONTROL BOARD	CONTROL TRANSFORMER	MOV
VSC-S3	0.55	AP00003	AP00004	AP00025		AP00005	AP00023	AP00024	AP00037	AP99005	AP00041
VSC-S4	0.75	AP01003	AP01004	AP01028	AP01006	AP01005	AP01023	AP01024	AP01037	AP99005	AP01041
VSC-S5	1.1	AP02003	AP02004	AP02027	AP02008	AP02005	AP02023	AP02024	AP02037	AP99005	AP02041

NOTES

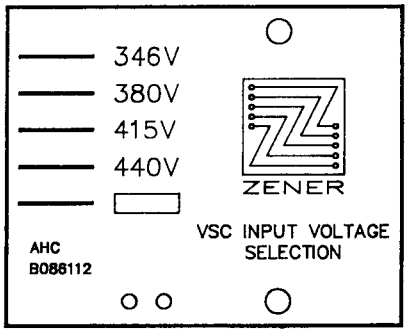
1. When ordering Spare Parts, please specify the Part Number, Serial Number and Input Voltage rating of your VSC.
2. The "Sensor Loom" includes the ELCT, the Temperature Sensor and the Buss Voltage Sensing Wires.

VSC Voltage Selection Procedure

This procedure is only applicable to "MULTI VOLTAGE" VSC's. These VSC's have a Part Number "ACXXXX3", where the "XXXX" stands for any combination of digits. Any VSC with a Part Number that does not end with 3 can not have it's input voltage changed. You should have been supplied with a packet containing 4 small plug in links and a sheet of self adhesive labels. Follow the three steps below to select the input voltage you require.

1. Transformer Tapping Selection

Remove the AC Power Supply from the VSC. Ensure the filter capacitors are fully discharged. Loosen the screw in the lid of the VSC and open the lid. Locate the control transformer just above the Power Input/Motor Output terminals. On the top of the transformer is a printed circuit board with the voltage selection tappings. A drawing of this board is shown opposite. Remove the tapping carefully and replace it on the pin adjacent to the voltage you require. Close the lid and tighten the lid screw.

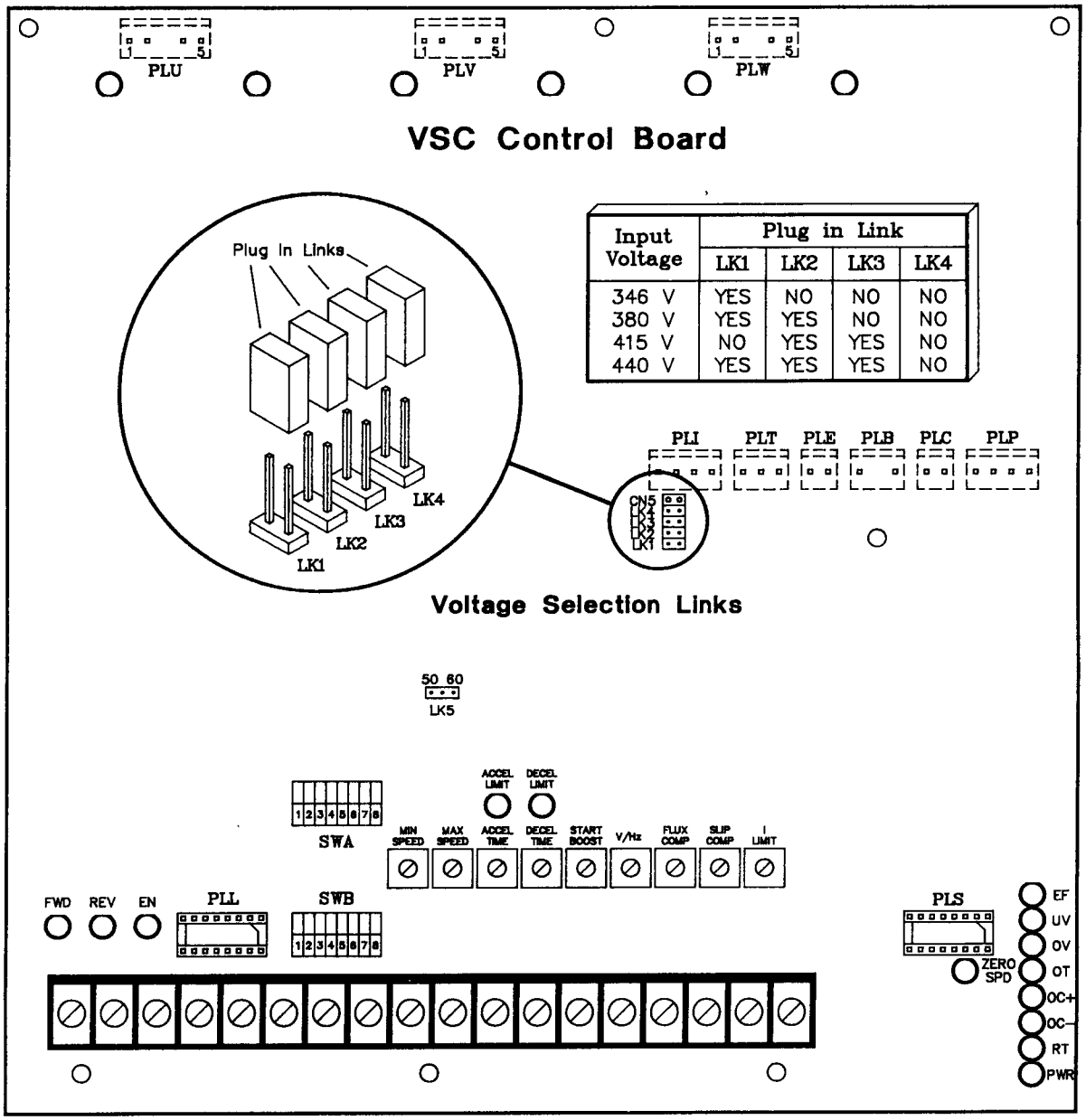


2. Voltage Selection Links

Locate the Voltage Selection Links on the VSC control board. Refer to the drawing below for their location. From the table below, select the input voltage required and plug in the links as shown.

3. Input Voltage Label Change

Locate the Input Voltage Label below the Input/Output terminals on the VSC chassis. Remove the Input Voltage Labels from the packet supplied. Select the label with the NEW Input Voltage marked on it and remove it from the backing paper. Stick it down on top of the OLD Input Voltage Label.



Input Voltage	Plug in Link			
	LK1	LK2	LK3	LK4
346 V	YES	NO	NO	NO
380 V	YES	YES	NO	NO
415 V	NO	YES	YES	NO
440 V	YES	YES	YES	NO