TROUBLESHOOTING GUIDE

Section 2

CONTENTS PAGE

INTRODUCTION TO SECTION 2

The CSP Units have been designed so that the operator does not need to remove the top cover for any adjustments. The top cover should only be removed by factory trained personnel, and the following points should be noted.

The safety features have been over-engineered for safety, but should not be relied upon:-

- An earth wand - connected to the front panel ground and ship ground should be used to ensure any high voltage inside the unit is dissipated.

- Call the factory for advice if you are unsure about anything!

An earth wand can be supplied if required.

CIRCUITS AND DESCRIPTIONS

The following pages give brief circuit descriptions for major items inside the CSP-S modules themselves.

System Overview

The control board handles operation of the complete system and can be considered to be electrically the '*heart*' of the unit. It controls the operation of the charger with various control lines, as well as switching the storage capacitors in and out of circuit; driving the trigger for the Ignitron and accepting safety information from interlock switches such as the controls on the front panel connector. As a back-up to this board, a separate 'layer' of control electronics - relays from an additional isolated supply - are used to disable the capacitor charger supply.

The CSP-S Control unit is designed for minimal operator intervention. The term, 'No user serviceable parts', does really apply!

Access to the inside of the units is initially through the top covers. To remove the units from the transit case:

- Ensure that the A.C. supply is disconnected and remove the mains plug from the front panel.
- Disconnect HV O/P connector and any other peripherals – remote, trigger.
- Disconnect the two multi-way plugs from the rear of the unit.(Relay and Control)
- Disconnnect the H.V. supplies between the control and energy modules on the rear panel. Located under the metal panel on the rear of Control Unit and the left hand side fan grill can be removed for easier access.
- Disconnect the main earth bond bar on the rear panel.
- Unscrew front panel securing bolts and carefully withdraw the control unit from transit case first.
- Take care when lifting Energy unit as this approx 100Kg!

Energy Unit

Each capacitor bank is switched in and out of circuit by 12 kV rated, spring relays. The relays use a rotating moving contact which is silver plated. The fixed contacts can be rotated in the event of wear. When disconnected, the capacitors are discharged through the relays to ground via 10k Ω resistors, which are mounted on a circuit board on the base tray. Although physically small, these resistors can handle 2000J pulses at well in excess of the rated voltage of the unit. It should be noted that the average power these resistors can tolerate is 6 watts. Repeated discharge of the capacitors into these components will cause them to fail.

A specially designed high current thyristor switch is used in the CSP-S , interfaced to the control board by an interface board. This is held in place with an isolated clamp arrangement manufactured from Nylon 66.

Note: All models operate at approx 4KV.

HV Monitor Board :

The circuitry monitors the HV voltage to detect open circuit load conditions where the energy has not been discharged. Upon detection of the above faults the board flags a general fault to the control board, this fault is automatically reset after 10secs in order to warn the operator of a possible fault with the load thus preventing damage to internal circuitry.

HV Detect Board :

This board using a HV resistor voltage divider via opto isolator provides voltage feedback to the HV Monitor board on the charge status of the capacitors to detect an open circuit fault condition. The board also contains diodes to protect the output bridge of the charger from reverse voltage swing. There is also a set of high current diodes which are used to limit the amount of reverse voltage swing on the output of the unit.

Thyristor Interface Board :

This board provides an interface between the control board and the thyristor by providing an isolated 5V supply and switching the 12V CMOS trigger pulse down to 5V TTL.

Control Unit

The 2 HV Chargers are fitted to the base tray. The chargers are designed as modules, and we would not expect that field servicing could be carried out on this unit.

To gain access to the charger, the rear panels will need to be lowered.

Connections:- L2 - LINE
COM – NEUTRAL
GROUND

The Control Board

The control board forms the management system for both modules. It controls the switching and safety interlock functions.

Energy switching is performed by four solid state relays (FLA, RLB, RLC & RLD), these correspond to Relay banks 1, 2, 3 and 4. Working backwards through the circuit RLA, B, C and D are activated by transistor switches, which in turn enabled by flip flops. The flip flops form the emergency cut off if an interlock or current monitor circuit is activated. They also switch off if the power setting is changed whilst the H.V. is still switched. Each relay has an individual switch on time delay which is pre-set by a monostable timer. The relay switching pattern is determined by the wiring of the front panel power selection switch and the control board power switch.

For isolation the high voltage charger is enabled by another relay RL1. This relay is driven by a similar circuit as the power control relays and is set at a sufficient delay to allow the control relays to energise before H.V. is switched on. The fault latches automatically turn off H.V. when one of the following scenarios occur:-

1. Interlock switch de-activated (transducer plug interlock or magnetic interlock).

2. Current sense monitor – O/c detect circuit within. (HV turns off but interlock lamp does not illuminate).

3. Time Out (H.V. turns off if a key pulse is not received within 30 to 45 seconds).

4. Power Level Changed.

5. Manual press HV Off.

The control board also sets the H.V. output of the charger in conjunction with the front panel ‘High, Norm, Low’ switch. The connections of the front panel remote are directly interfaced to the control board, as are all other ancillary functions. It is recommended that in event of failure that the control board is returned to AAE for service.

The key signal is applied to the control board via a pair of monostables which set the pulse length for input into the trigger board. Presence of a key pulse is also sensed by the time-out circuitry.

DO NOT INTERCHANGE THE CSP-S CONTROL BOARD WITH A STANDARD CSP CONTROL BOARD. THEY ARE NOT COMPATIBLE.

Control Unit

The Front Panel Board

The front panel board forms the interface between the control board and the front panel controls. It also drives the status and warning lamps. Fault, Time Out and Interlock indicators are all driven directly from the control board via transistors. The energy select lines are also routed across the front panel board and part of the fault detect circuitry is also present. The local/remote switch is directly coupled through the front panel board and is the manual key push button.

The charger status indicators, fault and EOC (end of charge) are also located on the front panel board. These are optically coupled as are all control signals relating to the HV Charger.

The Key In Board

The key in board provides the interface between the applied key pulse and the control board. Four individual key sources are routed via the key board.

a. Manual Key. Derived from the front panel push button which is directly coupled to the control board via a IN914 diode.

b. Key In Positive. The front panel BNC is wired via an opto coupler to the control board.

c. Key In Remote. Via the remote box, through the remote connector to an identical opto coupled circuit as normal key in.

d. Key In (Closure). This is available from the front panel only and utilises a simple transistor switch arrangement.

It is worth noting that when operating with the key in (closure) mode that there is no isolation between the key source and the CSP unit.

The Relay Board (x 2)

The Relay Boards drive the charger(s) supply relays (they do not contain relays!) Within the CSP-S two interlock sensors are provided; transducer socket (to ensure that units are not operated without the sparker load connected) and a magnetic interlock (to ensure that unit cannot be operated outside the main casing). A double fail-safe is also provided to ensure that entire H.V. charger switching is disabled in the event of an internal 12V PSU failure.

The Charger Interface Board

The charger interface board forms a breakout board for the HVC self diagnosis functions (Summary fault and load fault). The interface has indicators for these faults which are paralleled to the front panel.

Repair And Fault Finding on the CSP-S Power Supply

It is not recommended that any internal repairs are undertaken to any CSP by anyone other than a suitably qualified engineer. AAE can take no responsibility for loss or injury caused by repairs that have not been performed either within our own Laboratories or by our own registered service agents.

During diagnosis procedures it is recommended that the power selection switch is placed at 300J and a suitable Transducer or Dummy Load is attached to the output.

It is also imperative that the HV Chargers are disconnected when any adjustments are made within the Control Unit (See Drawing CSP6000-4008/A).

Even with the supply disconnected lethal voltages may be present, so use extreme caution when making any adjustments or measurements within the CSP-S.

Make sure that a responsible assistant is present to prevent people from walking into the service area. They should also be capable of taking the correct actions in the event of an emergency.

IF IN DOUBT / DON'T

CSP SERVICE SAFETY WARNING!

Seismic sound source power supplies such as the CSP produce lethal voltage and current levels which may be present even after the unit is turned off. **The CSP contains no operator serviceable parts** and it is advised that in event of breakdown that repairs should be carried out only by **AAE or AAE trained personnel.** All advice concerning malfunction supplied from AAE is based upon this assumption. Hence **AAE will not be held responsible** for any damages or resultant personal injury caused by intervention within a unit by persons not fitting the aforementioned criteria.

AAE trained personnel are advised that the following guidelines are followed:

1. All measurements should be carried out within a designated test area, which is suitable indicated to prevent entry of unauthorised personnel.

2. A second person should be present at all times to ensure that supplies etc. are turned off in event of an emergency. It is essential that they have training in first aid and resuscitation and are conversant with the hazards of working with this type of equipment.

3. All high voltage measurements should be carried out with one hand only to prevent the possibility of inadvertent discharge.

4. If possible it is best to set up for each test or measurement before power is applied to the unit, thus eliminating the need for physical contact with the unit whilst it is turned on.

5. Close monitors should be made of humidity and related environmental factors. Condensation is conductive and may cause upredictable discharge.

6. The wearing of non-conductive footwear is highly recommended.

7. Extreme caution is required if servicing the unit on a metal topped work bench.

Always ensure that any internal CSP intervention is carried out with safe working practice as the key factor and that prioritisation is made on safety and not equipment down time. Remember at all times the energy levels that you are working with. A 100J discharge equates to approximately 7 Megawatts so there are no second chances. It is suicidal to attempt a repair on a CSP unit without suitable training, any attempt to do so is entirely at your own risk.

CSP-S Basic Fault Diagnosis

Within this section we have listed common fault scenarios that could be experienced with the CSP-S unit. We have also included expanded board function explanations and circuit diagrams should it be desired to fault find to board component level.

The quick fault diagnosis tables should only be used in conjunction with their respective start-up guides. This is to ensure that the CSP-S may be re-commissioned safely after a breakdown.

CSP Start Up Guide And Fault Diagnosis For Control Circuitry

Seismic Power Supplies such as the CSP-S produce lethal voltage and current levels. Only trained (preferably by AAE), qualified Electronics Engineers should attempt to make internal adjustments, measurements and/or repairs. All measurements should be carried out within a designated test area which is suitable indicated to prevent entry by unauthorised personnel. A second person should be present at all times to ensure that in the event of a disaster supplies etc. may be turned off and first aid administered. All high voltage measurements should be carried out using one hand only to prevent the possibility of inadvertent discharge. If possible it is best to set up for each measurement before power is applied, so that no physical contact is made with the unit whilst it is turned on. Close monitors should be made of humidity and other environmental factors, condensation etc. is conductive and may cause un-predictable discharge. The use of non-conductive footwear is highly recommended and extreme caution is required when working on metal topped work benches. Always ensure that internal CSP work is carried out with safe working practice as the key factor and that prioritisation is made on safety as opposed to equipment down time. Remember at all times the energy levels that you are working with. A 300J discharge equates to approximately 21 megawatts so there are no second chances. It is suicidal to attempt such a repair without suitable training. Inappropriate internal intervention of any kind may lead to serious injury or death and possibly both. Applied Acoustic Engineering Ltd cannot be held responsible for any personal injury which may occur as a result of inappropriate intervention by non-AAE Technicians.

Overview

The purpose of this guide is to ensure the safe re-commissioning of CSP-S units after failure. By following this procedure stage by stage, the risk of further damage by incorrect fault diagnosis will be minimised. This procedure should only be performed by technicians conversant with the safety procedures required for working with high voltage circuitry. For maximum protection complete every section of the procedure and if failures are encountered investigate possible fault causes in the sections 1 & 3 `fault look up tables'. Section 2 is a mandatory procedure for verification of trigger and output circuitry. **DO NOT OPERATE CSP-S UNTIL ALL SECTIONS (1 to 3) HAVE BEEN COMPLETED.**

Basic Fault Look-Up Table

Step 1

Damage to cable and/or load (short circuit)
Internal damage to front panel transducer connector

Step 2

Failure of Dump resistor(s)
Failure of wiring to the dump board.
Worn out HV relay(s)
Ageing of energy storage capacitors

Step 3

Failure of control board
Failure of front panel board
Failure of control wiring
HV charger(s) faulty
Faulty charger power relay

Step 4

HV charger faulty
Failure of Energy storage capacitor

Step 5

Failure of energy storage capacitor

Step 6

Failure of respective energy storage capacitor(s)

Step 7

If unit does not function return to section 1 and repeat procedure!

CSP-S Basic Fault Diagnosis

Apparatus Required

Digital Volt Meter
Key Pulse Source

Section 1

Disconnect HV charger mains leads from terminal block at the front of the Control Unit, this is to disable the High Voltage supply.

Remove 12 volt input connector (PL1) on control board
Remove 12 way Molex connector (PL5) on control board
Remove HV patch lead from Control to Energy Unit.
Remove 9 way Molex connector on the relay boards[i]
Remove the three fuses from the fuse holders on the Control Unit rear panel
Remove the t fuse from the Energy Unit rear panel
Ensure that the control interconnect lead between units are installed.

Step 1 Mains Filter Test
Connect mains supply to CSP front panel socket and switch on, with DVM set to AC volts check for presence of 230V +/- 10 volts on the output of mains filter. Turn unit off.

Step 2 12V PSU Test
Place a 3 Amp Anti-surge fuse in F1 fuse holder (TOP FUSE), with DVM set to DC volts, place black probe on pin 2 of PL1 and red probe on pin 1 of PL1 (PL1 is the two way Molex plug that goes to the control board). DVM should read 12V+/- 0.2 volts. Switch off unit and reconnect PL1 to control board.

Step 3 Fan Test
Place a 3 Amp Anti-surge fuse in F2 fuse holder (MIDDLE FUSE) and switch on, PCU fans should operate. Switch off.
Place a 3 amp anti-surge fuse in F3 (TCB). TCH fans should operated.
Replace connectors on the PCU control board and relay boards.

Step 4
Switch unit on. With DVM set to AC volts check for presence of 230V+/-10V on pin 1 (black probe) and pin 2 (red probe) of PL5 (Control board). Switch off unit and replace PL5 on control board also replace the 9 way Molex connector to the Relay board.

Step 5
Switch unit on. LED 3 on the Control board should light, indicating presence of 12V supply. On the unit Front panel the Fault, Timeout, Interlock and HV OFF/RESET should illuminate.

[i] **Note** that the **RELAY BOARD** does not have any relays on it. It is the power supply for the unit main relays

CSP-S Basic Fault Diagnosis

Step 6
Make sure that all connectors (except mains supply to HV charger) are replaced in their respective positions. Connect HV junction box to front panel Transducer socket and activate magnetic switch to the rear of the Energy Unit. Check also that key type switch is in the pulse position and the Local/Remote switch is set to Local. Switch unit on and verify that:

Fault LED	**ON**
Timeout LED	**ON**
Interlock LED	**ON**
Local	**ON**
HV/RESET	**ON**

All other LED's should be off except for Control board LED 3

Press HV OFF/RESET

Fault LED	**OFF**
Timeout LED	**OFF**
Interlock LED	**OFF**
HV OFF/RESET	**OFF**
Local LED	**ON**

Step 7
Remove the front panel transducer connector, Fault, Interlock and HV OFF/RESET LED's should illuminate. Replace connector in socket and press HV OFF/RESET, all LED's should extinguish. Unscrew the interlock bolt on the left hand side panel. Fault, Interlock and HV OFF/RESET should illuminate again. Replace screw and press reset, all LED's should extinguish.

Step 8
Set power selection switch to 300J position. Press HV OFF/RESET, then HV ON, relay A should engage. Next press HV OFF/RESET again, relay should disengage (reset button should illuminate whilst being pressed). Verify relay operation for all marked energy settings.

Step 9
Reset unit and select 300J, turn power switch to next position. 300J relay should drop out and HV OFF/RESET lamp should illuminate. Reset and re-select 300J, press HV ON and wait, relay should remain engaged for 20 – 45 seconds. Relay then automatically disengages, Fault and Timeout LED's illuminate and also the HV OFF/Reset switch.

Step 10
Apply a 1PPS key source to the unit via the front panel BNC. Switch on unit, MANUAL KEY lamp and LED 2 (located on the control board) illuminate in unison with the applied key source. Disconnect key source and press manual key button, MANUAL KEY lamp should flash once.

CSP-S Troubleshooting Guide

Unit Dead

First check the integrity of the mains supply fuse and the mains supply itself, if the fuse itself has blown try the following components:

Mains Circuit Breaker?
Input Mains Filter?
Damage to the input power wiring?

Unit Fans Operate, But no front Panel indicators.

Check fuse 1 on the rear panel, (this is the supply fuse to the internal 12V PSU), if O.K try the following:

Internal wiring to the 12V PSU
Replace the 12V PSU

12V PSU O.K., But still no front panel indicators.

Ensure that LED 3 on Control Board (PCU) is illuminated, if not, suspect the following:

Wiring between 12V PSU and the control board

If LED 3 is illuminated:

Replace Control Board
Replace Front Panel Board
Check interconnect wiring between these sub-assemblies

Fans Do Not Operate.

Check integrity of Fuse 2 on rear panel, if O.K. :

Check Mains Wiring To Fans
Check Wiring to Relay Board

Fans Operate, But Pronounced Delay Between Power Up and Front Panel Illumination

Replace 12V PSU

CSP-S Troubleshooting Guide

Unit Powers Up Normally, Interlock Lamps do not go out on pressing Reset

Ensure magnetic switch (on Energy Unit) is correctly operating. Also check the interlock switch within the Transducer connector. Also:

Check Interlock switch within power cable junction box
Replace Interlock Relay
Replace Relay Board(s)
Replace Control Board
Check ancilary wiring - unit interconnects

Unit Resets As Normal, HV Will Not Select

Check position of Remote/Local switch. Also:

Replace Control Board
Replace Front Panel Board
Replace Front Panel Power Selection Switch
Monitor Circuitry (Diode Board)

HV Relays Operate but no EOC Lamp

Suspect HV Charger or HV interlink cable. Alternately disconnect each HV charger (I/P and O/P) to define which charger is faulty.

Charger Power Switching Relay
Control Board
Storage Capacitors

EOC Lamp Illuminates, but unit Will Not Discharge

Check for presence of Input Key Pulse and position of Key Polarity switch. Is key Lamp Illuminating in unison with Input Key pulse?, if not suspect Input Key Board. Also:

Control Board
SCR Failure
Output Load Problem
Output Cabling Fault

CSP-S Troubleshooting Guide

If LED2 on Control Board is Illuminating In Conjunction with Input Key, but unit still not discharging

Thyristor Interface Board
Thyristor
Check The Output Load

EOC And Summary Fault Lamp Illuminated

Open circuit on HV Charger(s) output. Also:

Open Circuit Energy Storage Capacitor
(Verify by trying alternative power setting)

Summary Fault Illuminated, No EOC

Either HV Charger Faulty, Also:

Short Circuit Energy Storage Capacitor
(Verify by trying an alternative power setting)

Unit Fires On Alternative Key Pulses.

Input Key Rate too high.
Incorrect Load (Sparker) or Load Fault.

System Resets after Discharge into Load

Fault with Diode/Reverse voltage protection board. Replace board

Load fault

COMMON FAULT DIAGNOSTICS

POWER SELECT SWITCH SHOULD BE LEFT ON 300 JOULES

This section is to be carried out by trained personnel only and undertaken in a safe environment. A transducer or dummy load should be connected to the unit, prior to these tests.

COMMON FAULTS

PROBLEM	POSSIBLE FAULT CONDITION	TEST	ACTION
Unit fails to discharge with High Voltage and EOC LEDs on.	No Key Input to CSP Unit.	Check connection from key source.	
	Key LED flashing but no discharge into load.	Check connection to source from CSP PSU.	
	If all LEDs are correct and load is properly connected, there may be a problem with the O/P SCR	Check Key Pulse arriving at Interface.	Replace SCR.
High Voltage LED will not light after pressing '*HV ON'*.	Remote / local Switch switched to remote, not allowing operator to turn HV on from the unit.	Check Local / Remote Switch.	Change if required.
End Of Charge LED fails to light when unit is firing.	CSP is being fired too quickly.	Slow firing rate and observe EOC LED.	Slow the firing rate until EOC LED is flashing allowing capacitors to reach full charge.
Unit fails to discharge at 300J setting.	Capacitor / Relay problem.	Listen for 300J relay to click in when HV ON button is pressed. Check HV is OK by trying on a different power setting. (1200J). If relay clicks in, and unit operates at different power setting, a faulty capacitor could be the problem.	Substitute capacitor.

Before carrying out the following checks, remove AC power to High Voltage Charger by disconnecting the yellow crimp connectors on the large relay located below and to the left side of the Control Board. This will disable the 4kV supply.

POWER SELECT SWITCH SHOULD BE LEFT ON 300 JOULES

This section is to be carried out by trained personnel only and undertaken in a safe environment

PROBLEM	POSSIBLE FAULT CONDITION	TEST	ACTION
OFF / ON circuit breaker snaps open on power up.	Mains filter defective.	Check for S/C between live / neutral and ground.	Replace mains filter if required.
	Mains wiring problem.	Check with ohm meter mains wiring to unit.	Correct if necessary.
	HV Charger problem.	Dis-connect HV Chargers in turn.	Replace if necessary.
Circuit breaker OK, no LEDs on front panel.	Fuse F1 open circuit (O/C).	Check with ohm meter.	Replace.
	No O/P from 12V PSU.	Remove LHS panel and measure O/P from PSU located to the rear of unit.	Check internal fuse. If faulty, replace. If OK replace board.
	Problem with control board.	Remove PL1 (12V I/P to board) and measure12VDC on plug.	If 12VDC is present replace control board.
	Problem with front panel board.	Check for 12VDC on board.	Replace board.
	Broken connection(s) between control and front panel boards.	Using DVM set to ohms range, check for continuity of wiring.	Correct if required.

PROBLEM	POSSIBLE FAULT CONDITION	TEST	ACTION
Fault and Interlock LEDs stay lit after reset button pressed.	Energy Unit magnetic switch Inoperative.	Replace lid and screw in place.	Re-check after lid is replaced.
	High voltage connector not fully mated.		Check.
	Lid of junction box (if being used) not in place.	Close lid.	Re-check.
	Also no front panel fans operating.	Check fuses F1 and F2 with ohm meter.	
	Relay PSU board U/S.	Remove LHS panel. Measure 240VAC with meter on Pins 1 & 2 of PL1. Measure 12VDC on PL1 Pins 8 (+ve) and 9 (-ve).	Replace if DC voltage is not present.
When HV ON button is pressed HV LED comes on (after approximately 3 seconds) but HV relay(s) do not operate.	Fuse F2 blown.	Check with ohm meter.	Replace.
	Control board faulty.		Replace.

CSP-S Start Up High Voltage Circuitry Post Repair Test Procedure

Within this section the correct operation of the CSP discharge circuit is verified

Apparatus Required.

HV Probe (X1000)[ii]
Digital Volt Meter
Capacitance Meter

Step 1

Ensure that **mains supply** cable is **disconnected** and all other cables have been correctly re-connected within the CSP unit including H.V. charger mains leads. Make sure that a suitable load is connected to the front panel TRANSDUCER socket and that the unit is isolated from the electricity supply. Next locate the output protection diodes mounted on the right hand side panel. Check All diodes for possible short or open circuit.

Step 2

Inspect HV relays for electrode damage and/or loose connections. Using a capacitance meter measure the values of the energy storage capacitors, the 10M bleed resistors do not significantly affect this measurement. If any capacitor has deviated more than 15% of marked value **REPLACE.**

Step 3

Re-connect and switch on unit, activate magnetic switch on left-hand side panel, select 300J output power and switch on unit. Press HV OFF/RESET, followed by HV ON switch should illuminate followed by yellow EOC LED. Switch off unit

Step 4

Attach HV probe to Charger output lead, ground to CSP front panel boss. Set to a suitable range and repeat step 3.3, meter should read 3600V +/- 50V at normal voltage setting.

Step 5

Switch off unit and verify that voltage quickly discharges to zero. Select 1200J, verify again that output voltage is 3600V +/- 50V.

Step 6

Repeat step 3.5 for all other marked power settings. Watch for excess sparking around relay electrodes. **Allow sufficient time between tests for the dump resistors to cool down.**

Step 7

Switch off unit and remove all meter probes. Ensure that no foreign bodies or other detritus are present within the unit. Replace unit top lid. Unit is now ready for operation.

[ii] If a HV probe is not available Step 3.4, to 3.6 will have to be omitted. It is recommended that an HV probe be made available for the eventuality of CSP servicing

Changing a Thyristor ‘Module’ in the field

SAFETY

Ensure all mains voltages are switched off and disconnected from the unit before attempting any maintenance or upgrades.

Only trained engineers or qualified technicians should attempt any maintenance or upgrades.

CAUTION: HV capacitors may contain some residual charge.

TOOLS

Flat Blade Screw Driver.
10mm Ring Spanner x 2.

PROCEDURE

(A) Remove the connections to the HV Buzz Bars using the 10mm ring spanners. Noting the wiring configuration.
(B) Remove the interface control cabling.
(C) Remove the upper clamp plate by removing the two M5 securing screws.
(D) The Thyristor Module can now be removed from the clamp.
(E) The Buzz Bars are intercahangable between modules.
(F) Fitting is the reverse of this procedure.