TROUBLESHOOTING GUIDE

Section 2

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INTRODUCTION TO SECTION 2

The CSPD Units have been designed so that the operator does not need to remove the top cover for any usual 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 Unit itself. The descriptions should be read in conjunction with the diagrams (Schematics).

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 triggering module for the thyristor 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 CSPD Unit is designed for minimal operator intervention. The term, 'No user serviceable parts', does really apply!

Access to the inside of the unit is initially through the top cover. Ensure that the AC supply is disconnected - remove the AC plug from the front panel and then remove the lid securing screws. Note that one of these is longer than the rest. It is this longer screw which controls the lid interlock switch mounted on the left-hand side plate. There are quite a number of screws for the lid. This is a feature recommended by UK HSE (Health and Safety Executive) to deter easy access to the unit! It also is part of the electrical shielding of the system.

Once the lid is removed, access to the high voltage parts is achieved. We remind the reader that we cannot be responsible for any errors or omissions by the manufacturer or any errors by the operator after the top cover has been removed.

High Voltage Section

The right side of the unit contains the high voltage parts. Each capacitor 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 RH panel. 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 CSPD , 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 :

Using a shunt resistor and current sensor the HV monitor circuitry monitors the output current to prevent excessive load currents damaging components. The circuitry also 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 LOAD 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 faut 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.

HV Charger

The HV Charger is fitted under the large storage capacitors and runs from the rear (where air is brought in) to the front of the unit. The charger is designed as a module, 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

AC Section

The AC Section is to the left of the charger. Access to it can be gained by firstly removing the capacitor support clamp and then taking out the screws which hold the LH panel in place. Note that you will also have to disconnect or remove the interlock switch.

Once the LH panel has been removed you will see (from front to back) the AC mains filter, 2 control relays, a separate 12 V power supply for these relays a transformer for the trigger module and a 90-250VAC, 12VDC power supply, as well as 3 fuses which can usually be accessed from the rear panel. These fuses are:-

F1	3A Slow blow 1¼″
F2	3A Slow blow 1¼″

F1 Protects 12v power supply

F2 Protects the relay board and line voltage powering the high voltage relays, also the front panel fans.

Control Board and Front Panel Components

The control board is mounted on an aluminium plate which is mounted vertically 2” behind the Front Panel.

Descriptions of the control board and the front panel items - such as power selector switch and display board are detailed later in this section.

The following *Troubleshooting Guide* can be used to assist the operator in identifying any malfunction.

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.

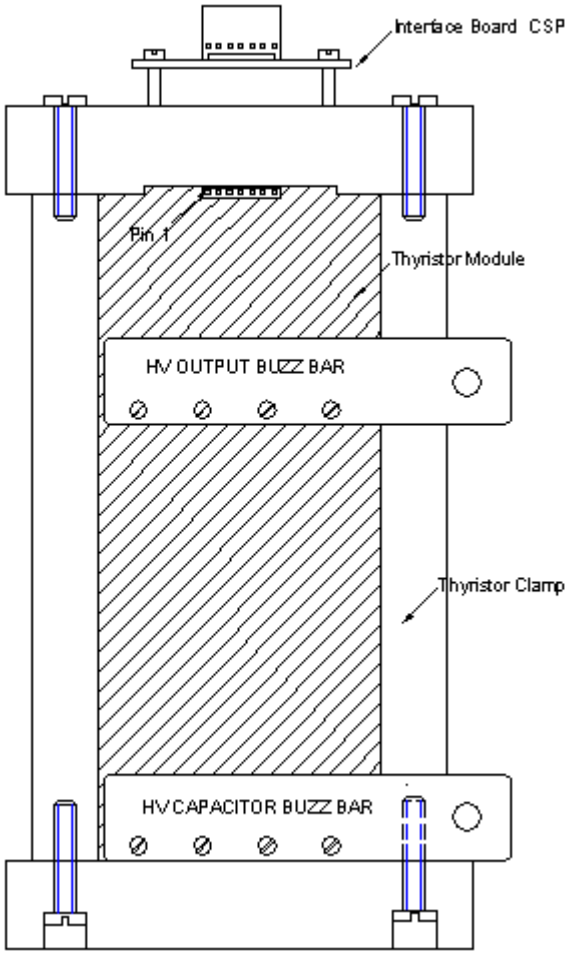
CAUTION: HV capacitors may contain some residual charge.

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.



Repair And Fault Finding on CSP Power Supplies

It is not recommended that any internal repairs are undertaken to any CSPD 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 100J and a suitable Transducer or Dummy Load is attached to the output.

It is also imperative that the HV Charger main supply is disconnected when any adjustments are made within the unit.

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

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.

Try to keep one hand in your pocket at all times and wear non-conductive footwear.

IF IN DOUBT / DONT

1) CSPD Basic Fault Diagnosis.

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 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 Fuse2 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

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

Ensure Interlock screw is present in top panel and is correctly operating the Interlock switch. A distinct audible CLICK may be heard when switch is activated/de-activated. Also check the interlock switch within the Transducer connector.
Wait 10sec for load fault to self reset depending upon logic state upon power up fault nay be reported.
Also:

Check Interlock switch within power cable junction box
Replace Interlock Relay
Replace Relay Board
Replace Control Board
Check ancillary wiring

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

HV Relays Operate but no EOC Lamp

Suspect HV Charger or HV BNC charger cable. Also:

Charger Power Switching Relay
Control Board
Output Thyristor
Storage Capacitors
HV Diodes
Auto Power Control Board

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

If LED2 on Control Board is Illuminating In Conjunction with Input Key, but unit still not discharging no load fault reported.

Check Thyristor Interface board and thyristor.
Check cabling to Thyristor interface board and thyristor.

Upon discharge Load fault reported and unit shuts down.

Check load for continuity.
Check load for short circuit, unit will shut down if current greater than 4500A.

EOC And HV Fault Lamp Illuminated

Open circuit on HV Charger output. Also:

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

HV Fault Illuminated, No EOC

HV Charger Faulty, Also:

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

No Warning Lamps Illuminated, No EOC and No Output

Press Charge Rate switch, if Unit now operates then Auto Charge Control board is faulty.

Unit Fires On Alternative Key Pulses.

Input Key Rate too high.

2) TROUBLESHOOTING GUIDE

POWER SELECT SWITCH SHOULD BE LEFT ON 100 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.

TROUBLESHOOTING GUIDE

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 & LED 2 on control brd is flashing.	Check connection to / from thyristor int brd.Check for presence of TTL trigger pulse with oscilloscope on ZD1 on Thyristor Int Brd.	Repair cabling if required.
	If all LEDs are correct and load is properly connected, there may be a problem with the thyristor.	Check 5Vdc on Thyristor Int Brd.	Replace thyristor.
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 100J setting.	Capacitor / Relay problem.	Listen for 100J relay to click in when HV ON button is pressed. Check HV is OK by trying on a different power setting. (200J). 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 100 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.
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.	Top cover microswitch not closed.	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.

PROBLEM	POSSIBLE FAULT CONDITION	TEST	ACTION
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.
	High voltage relay faulty.	Switch power select SW on front panel to 200J.	If this relay operates, 100J relay may be faulty. Check wiring from control board. If wiring OK a new relay may be required.

CIRCUIT DESCRIPTION
CONTROL BOARD

Key Circuit Drawing No CSP1000-5000 Section 3.

Key Board Drawing No CSP1000-5003 Section 3.

The power supply can be triggered using any of the following:-

1. *Key in* is via the BNC connector on the front panel. The key source is opto-isolated, and this can be either a pulse (3-24VDC) or a contact closure, selectable using the key polarity switch on the front panel.
2. *Remote key in* is via the remote box and cable (3-24VDC positive key only). Key source is opto-isolated from the power supply.
3. *Manual key* - each time the switch is depressed.

The Key In / Remote Key signal is applied to the key board optically coupled via OP1 and OP2 to IC1A on the control board. IC1A generates a 150mS delay preventing repetition rates in excess of 6 times per second. The output of IC1A triggers IC1B which produces a 1mS pulse to key the trigger board via the driver IC4.

IC2 is configured as a *time out* alarm. If there is no key input after 20.25 seconds, the Fault / Time Out LEDs on the front panel will illuminate and the high voltage will be disabled.

A 10mS pulse is generated via IC8A inhibiting the high voltage charger during and after the firing of the ignitron. IC4 is also used to drive the HV ON / OFF and Key LEDs on the remote box.

High Voltage / Relay Switching Drawing No CSP1000-5000 Section 3.

The high voltage capacitors are switched in / out of circuit using the Output Power Switch located on the front panel. The power select switch is connected via the front panel board to IC3 on the control board. When the high voltage button is pressed , (providing no fault conditions occur), an 0 on any of the switch inputs will allow that capacitor to be placed in circuit.

For Capacitor 1 in the diagram; with no fault latches activated, IC11D O/P is high allowing 11A O/P to be high. IC9A generates a ½ second delay before allowing relay RLA to close via IC10A. RLA closing connects 115VAC to the high voltage relay, switching the HV capacitor in circuit.

IC7B produces a 3 second delay after the high voltage button is pressed, before the HV is activated. Relay RL1 controls the HV ON / OFF in the charging unit. ICs 9A, 9B, 8B and 7A all provide a small time delay, (less than 3 seconds), allowing the HV capacitors to be in circuit before the charger high voltage is connected. The sequential delays for switching these relays is to ensure large current pulses are not drawn from the torroidal transformer.

Fault Latches / HV on Circuit

Drawing No CSP1000-5000 Section 3.

A reset / fault condition can occur due to any of the following:-

1. High voltage connector to transducer not being connected while power supply is switched ON.
2. The top cover has been opened or left OFF with power supply switched ON.
3. The power supply has not received a key for approximately 20 - 25 seconds.
4. The output power switch has been changed.
5. A failure on the 12V logic supply.
6. A fault has occurred with the high voltage diodes.
7. There is a short circuit on the output cable or load.

If the high voltage connector is disconnected or top cover left off, the mains relay located under the left side panel will open, disconnecting mains to the charger. (See Relay Board, Section 3)

Any high voltage within the charger is then dumped via an internal resistor network. The input to IC5A via opto-isolator OP4 will go high, setting the RS latch. IC5 output is fed to IC6 (8 input OR gate). A logic 1 on any of the inputs will activate the OR O/P, Pin 1. This resets IC5D, which holds the O/P of IC11D low.

With IC11D O/P low, all the capacitor switching relays RLA-D (see HV / Relay Switching Circuit) are deactivated. Any high voltage relays in circuit will open, discharging the high voltage capacitors to ground via 10K dump resistors situated on the right side panel.

IC11D O/P at logic 0 also stops the key to the trigger board via IC4 Pin 8 and disables the charger ON / OFF relay RL1 by resetting IC7B.

The O/P from the time out alarm IC2 is fed to IC6 via RS latch IC5B. An input to IC6 is also provided from the front panel board resetting the system if the power select switch is operated independent of high voltage status. (Reset circuit shown on front panel board.)

The HV OFF / RESET switch on the front panel connects to IC6 via IC3C. The fault LED situated on the remote box is controlled by D3/D7 acting as a diode OR gate, with Q2 as driver transistor.

If there is an open circuit in the high voltage diodes situated on the RHS panel, the high voltage will switch off and keep resetting until the diodes have been replaced. The same fault condition may occur if there is a short circuit on the output cable or in the sound source itself. A current monitor circuit disables the high voltage charger and resets IC6 via Pin 11.

HIGH VOLTAGE ON CIRCUIT

The high voltage can be activated from the power supply front panel, or remotely from the instrument room using the remote box and cable. Both switches are controlled using the Remote / Local (R/L) switch on the front panel.

With the switch in local the high voltage can only be operated from the power supply front panel, disabling the remote HV ON button.

If the R/L switch is in remote, the power supply can only be operated from the instrument room, also disabling the front panel HV ON button. The high voltage OFF button will still operate regardless either from the front panel or on the remote box if pressed.

The HV ON switch is connected to IC5D on the control board. Providing there is no fault condition, RS latch IC5 is set, sending its O/P high. The 8 input OR gate IC6 also has a NOR function Pin 13. With no faults or resets (logic 1s) on the I/P, the NOR O/P on Pin 13 will be high sending the O/P of AND gate 11D high. This will then allow any high voltage capacitors to be switched in circuit via the HV relay control circuit.

IC7B is also triggered, generating a 3 second delay before the high voltage from the charger is activated.

Front Panel Board

Drawing No CSP-CSPD-5100 Section 3.

The front panel (FP) board contains driver circuits for LEDs on the CSP front panel. Most of the panel switches are connected to the control board via the FP board.

The HIGH VOLTAGE ON and EOC (End Of Charge) LED inputs, are controlled directly from the Charger. OP1/2 provide isolation between the FP board and the charger.

The output power switch is monitored by a reset circuit comprising IC1 (4 I/P OR gate) and IC2 (RS latch). Whenever the O/P power switch is operated, one of the inputs to IC4 will go high, sending the output high and setting the RS latch. The output is connected to the HV OFF / RESET circuit on the control board, which will then reset the CSP power supply.

Interlocks / Relay Board

Drawing No CSP1000-5002 Section 3

The mains input for the high voltage charger is routed via a contactor controlled from the relay board located under the left side panel. A small mains transformer and rectifier provide 12VDC to operate the contactor relay.

Mains to the transformer is connected via a microswitch situated on the left side panel. The microswitch disconnects power to the transformer when the top cover is removed. With the cover off, the charger has no mains power connected.

TO ENSURE CORRECT OPERATION OF THE POWER SUPPLY, THE TOP COVER MUST BE SECURED IN PLACE. A special 20mm hex screw is provided to operate the microswitch, THE 20MM SCREW NEEDS TO BE PLACED IN THE FRONT POSITION ON THE TOP LEFT HAND SIDE OF THE UNIT.

FAILURE TO SECURE THE COVER USING THE 20MM SCREW WILL RESULT IN A FAULT CONDITION ON THE FRONT PANEL OF THE POWER SUPPLY!

The 12VDC output from the rectifier is connected to the relay via an interlock on the high voltage socket. With the high voltage connector removed or disconnected, the relay is de-energised, disconnecting mains power to the charger.

FOR CORRECT OPERATION OF THE POWER SUPPLY, THE HIGH VOLTAGE CONNECTOR MUST BE FITTED AND TOP COVER SCREWED DOWN.

If the top cover or high voltage connector is left off, the FAULT and INTERLOCK LEDs will illuminate on the CSP front panel, resetting the system.

A second contactor relay will disconnect mains power to the high voltage charger, if a problem occurs in the 12VDC logic supply to the control and front panel boards.