atg airports ltd

Micro 200 CCR

Microprocessor Controlled PWM Constant Current Regulator

Installation and Operational Manual
HS13-0-00-17

This manual applies to regulators using firmware v3.15 onwards.

CE

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For personnel familiar with AGL Regulators and safe working practises for this type of equipment, refer to Sections 3 and 4 for a quick guide to Connecting and Commissioning the Micro 200 CCR.

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AMENDMENT CONTROL

Issue	Date	Author	Amendment description	Firm-ware	Technical Approval	Approved for issue by
10	11.02.14	I. Crosland P. Craven	Change lowest possible user defined current level to 5% (section 9.3.2.10). Included sections on optional components: 4-20mA monitor units, Output Lightning Arrestors and Cutout Switch. Expanded fault finding table and updated spare parts listings.	V3.06	P. Craven	D. McGuinness
11	26.11.15	I. Crosland	Screen added for AENA Outputs (section 9.4.2.21). SET CCT SEL FLT ACTION description added to Table 9-2. Section on Remote Analogue Input reference removed (obsolete).	V3.15	P. Craven	A. Smart
		P. Craven	Updated Figure 3-3 and Figure 3-4 – ref. for Alternate CSS Back Indication Relay output contacts. Minor changes on Cutout Switch and Earth Leakage Card descriptions	V3.15		
12	13.7.16	P. Craven	Updated 6.6A transformer windings (section 4.3.1), various text changes. Parts list and CCR options list updated	V3.15	P. Craven	D. McGuinness
13	8.2.18	P. Craven	New sections added: 10.1.1 – Location of Main Components of Micro 200 CCR and 10.4 – Replacement of IGBTs and Driver Cards	V3.15	P. Craven	D. McGuinness
14	17.4.18	P. Craven	Updated list of components; the AT1026 Cutout Switch card replaces the AT726.	V3.15	P. Craven	A. Sole
15	30.10.18	P. Craven	Updated Table 10-1 Routine maintenance and Section 10.4 - Testing and replacement of IGBTs, diodes and driver cards	V3.15	P. Craven	D. Watterson
16	15.11.18	P. Craven	AT732 and AT785 Power / IGBT Control Cards now described as fitting to 25A and 55A IGBT stacks respectively.	V3.15	P. Craven	D. Watterson
17	23.9.21	P. Craven	Section 2.3 – text change regarding lifting of CCR cabinet. Table 3-1 added – Minimum recommended supply cable sizes. Figure 3-3 and Figure 3-4 updated terminal labelling, Table 9-3 – CCR Hardware Configuration Screens listing updated. Section 13, contactor part numbers updated in parts list. Figure 13-1 and Figure 13-2 – CCR circuit schematics updated.	V3.15	P. Craven	R. Everett

CCR PART NUMBERING SYSTEM

Example Part Number: M200CCR - 66 15 - 400 - PS - EF/LF/LA/D

Model:
Micro 200 CCR

Output Current:
6.0A = 06
6.6A = 66
12.0A = 12
20.0A (non std) = 20

Output kVA:
1,0 kVA (non std) = 01
2.5 kVA = 02
4.0 kVA = 04
5.0 kVA = 05
7.5 kVA = 07
10.0 kVA= 10
12.5 kVA= 12
15.0 kVA= 15

Note – 12.5-15kVA not available in 220V series

Supply Voltage:
208V = 208
220V = 220
240V = 240

380V = 380
400V = 400
415V = 415

Remote Control:

Hard wired:	24V	= 24
	48V	= 48
Serial Comms:	ProfiBus	= PS
	J-Bus / ModBus RTU	= JS
	ModBus TCP / IP (Ethernet)	= MTS

Optional Accessories (always add to part number in order shown):

	Earth Fault Monitor	= EF
	Load Indicator	= LI
	Lamp Fault Indicator	= LF
	Output Lightning Arrestors	= LA
	Field Circuit Isolator	= FCI
	4-20mA Power Meter	= PM
	4-20mA Current Meter	= CM
	Door Safety Interlocks	= DI
Circuit Selector Switch:	Direction / Alternate	= D
	2 Way Circuit Switch	= 2W
	3 Way Circuit Switch	= 3W
	4 Way Circuit Switch	= 4W
	5 Way Circuit Switch	= 5W
	6 Way Circuit Switch	= 6W

SAFETY NOTICES

DANGER – HIGH VOLTAGE CIRCUITRY

This equipment employs high voltage circuitry within the cubicle – up to 2500V for a 15kVA regulator - that presents a hazard of fatal electric shock should personnel come into contact with or close proximity to the conductors.

Installation and servicing of the CCR should only be undertaken by suitably qualified personnel who are familiar with this type of equipment. Extreme caution should be exercised when working on the CCR.

Whilst every practicable safety precaution has been incorporated in the CCR, the following rules must be strictly observed.

KEEP AWAY FROM LIVE CIRCUITS

Do not perform any service work on the CCR, or remove the covers to the main CCR HT cubicle, HT output terminal and mains supply terminal boxes, work on the series circuit or change AGL circuit lamps, without first turning off and isolating the supply to the CCR.

STATUTORY REGULATIONS AND CODES OF PRACTICE

Regulations, codes of practice and safety precautions applicable in the locality should be strictly adhered to. Reference can also be made to the FAA Advisory Circular AC 150/5340-26 ‘Maintenance of Airport Visual Aid Facilities’ for instructions on safety precautions.

The following are examples of statutory regulations which MUST be complied with in the UK:-

- **Electricity at Work Regulations 1989**
- **Electricity Supply Regulations 1988**
- **Health and Safety at Work Act 1974**
- **Management of Health and Safety at Work Regulations 1992**

RESUSCITATION

Maintenance personnel should familiarise themselves with the technique for resuscitation found in first aid manuals.

1 Introduction

1.1 Description

The **atg airports** Micro 200 Constant Current Regulator provides a controlled level of current to supply airfield ground lighting primary series loop circuits. The Micro 200 uses an advanced IGBT H Bridge which is PWM modulated at high frequency. This is followed by a filter which smooths the output of the bridge back to mains frequency, before applying to the primary of the main CCR output transformer. This provides, for a typical AGL circuit that is largely resistive in characteristic, a sinusoidal output waveform at mains frequency.

The Micro 200 CCR produces significant benefits in terms of the Power Quality drawn from the supply as compared to conventional thyristor regulators. When connected to a rated load, the Power Factor approaches unity at maximum output current, and typically does not drop below 0.85 at minimum current. The level of the supply current total harmonic distortion (THD) is low at all CCR output current steps. To maintain the Power Quality at reduced loads, the CCR output isolation transformer is provided with multiple secondary tappings which can be selected to match the load on the series circuit.

The Micro 200 CCR is available in two supply voltage ranges: the 220V series is available to operate either from a single or two phase supply, and the 400V series operates from a two phase supply. Primary voltage taps are available to provide fine adjustment to suit local conditions; for example, the 400V series can be set to operate at 380, 400 or 415V.

To ensure maximum reliability, the output current control loop, control of the IGBT H Bridge and all critical fault detection circuits are performed in hardware using analogue and digital electronic circuits. The supervising microcontroller provides run and current demand signals as well as status information.

The Micro 200 CCR is pre-programmed with default operating parameters suitable for most applications. If required, programming changes and calibration can be performed by accessing the menu driven system using the four pushbuttons on the front panel display. An external PC is not necessary. Note - the Set-up and Engineering menus are password protected to prevent unauthorised access

1.2 Standard Features and available options

1.2.1 Standard Features

- Accurate control of RMS output current level including into a short circuit load
- Display of output current true RMS value
- 3, 5 or 8 pre-programmed brilliancy levels to IEC, FAA or CAP168 standards
- 8 fully adjustable brilliancy levels, between 0.1 – 100%
- Internal/external brilliancy control; external brilliancy control from 24V, 48V or volt free contact as standard, 8-Wire, 3-Wire encoded or BCD encoded
- Open circuit protection
- Over current protection

- Instantaneous response to overcurrent conditions caused by load impedance changes during block switching operations
- Warning indication of "Tolerance Fault" (output current outside tolerance limits)
- Elapsed time counter records hours run at maximum brilliancy
- Elapsed time counter records total hours run
- Adjustable current ramp for switch on, increases lifetime of lamps
- Black heat - selectable low current output level available for remote "OFF" setting
- Operating parameters configurable from front panel

1.2.2 Optional Features

- Lamp Failure Detection – displayed as a total or as a percentage
- Earth Leakage Resistance Measurement. Continuous measurement of the series circuit resistance to earth at 500V whilst the CCR is operating, or at 1000V during manual testing when the CCR is set to 'Local OFF'. A two-stage alarm / trip output is provided; the resistance value can also be displayed
- Internal Lightning Arrestors on the outgoing circuit
- Series Circuit Cutout Switch with three position plug-in lid. An additional safety device can be fitted that isolates the series circuit from the high voltage output of the CCR and connects the field cables to earth for safe maintenance. It also provides insulation resistance measuring test points
- Serial communication using Profibus, Modbus TCP/IP or J-BUS. Permits remote control of the CCR and / or monitoring of relevant operating parameters

1.3 Specification

The Micro 200 CCR is designed to comply with EN61822:2009 – Electrical installations for lighting and beaconing of aerodromes – Constant current regulators, and all applicable EMC standards.

Mains supply voltage range:	+/-10% of nominal
Mains supply frequency:	46.25 to 64.5 Hz
Control method:	PWM IGBT H Bridge. Hysteresis waveshape inner control loop and output current level outer control loop.
Remote Brilliancy Inputs:	24 / 48V. Internal or external supply, polarity insensitive.
Number of Brilliancy steps:	8
Efficiency (standard models):	90% or better at full load
	80% or better, averaged over all current steps, into a full nominal resistive load tested as per IEC61822
Power factor:	0.95 or better into a full nominal resistive load
Degree of Protection:	IP2X

2 Installation

2.1 Physical Characteristics

The Micro 200 CCR cabinet is constructed from mild steel with an IP2X rating. Figure 2-1 below shows the outline drawing of the CCR. The same cabinet is used for all regulators from 2.5kVA to 15kVA.

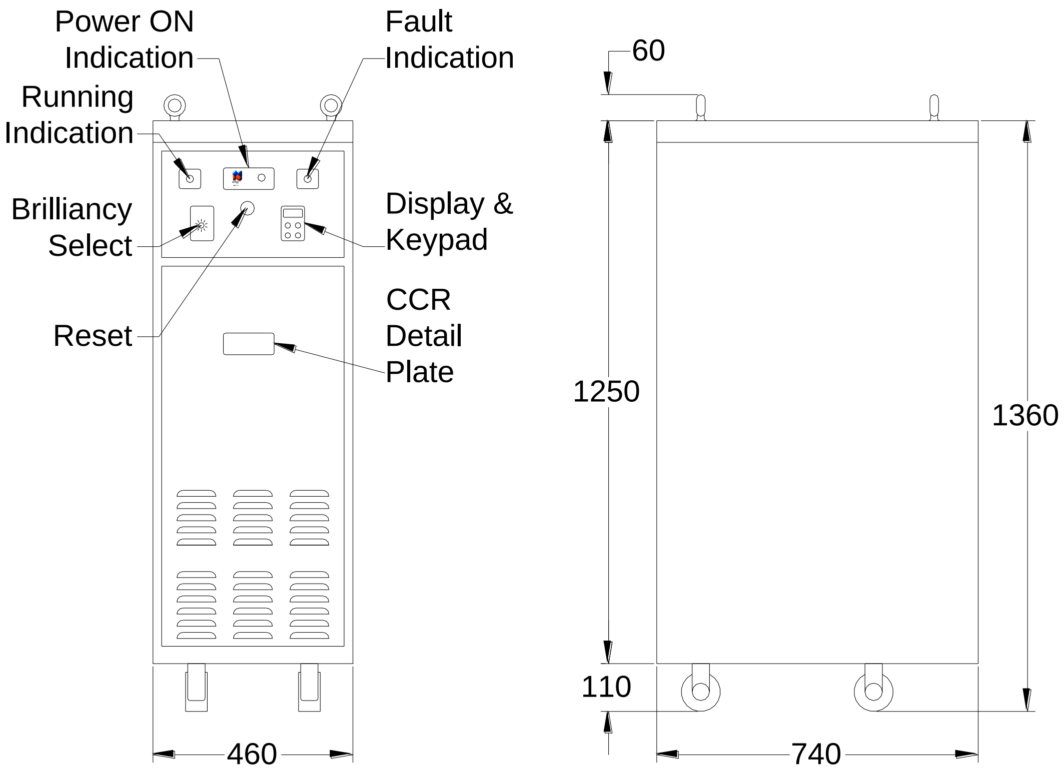


Figure 2-1 CCR Cabinet Outline Dimensions

The cubicle is divided into the following easily accessible compartments, as described below and shown overleaf in the photographs of Figure 2-4:

i) Microcontroller Compartment – accessible from the front

ii) Main Electronics Compartment. Contains the AT733 Main Control Card and all option cards. Accessible via the lower front cover. **Note – there are mains voltages present in this section, up to 415V. These terminals are protected by a shroud.**

iii) Power and HT Compartment. Contains the IGBT H Bridge and AT732 Power Card, filters, main CCR transformer, contactor, RFI filter etc. Accessible via side, rear and top covers. **Note – high voltages are present within this compartment.**

iv) Mains Supply Terminal Box - accessible from the rear

v) Low Voltage Control Terminal Box - accessible from the rear

vi) HT Output Terminal Box - accessible from the rear. **Note – high voltages are present within this compartment.**

Figure 2-2 and Figure 2-3 (below) show the cabinet covers, which can be removed to give access to the individual compartments. Note – locks secure the covers to each of these, except for the Microcontroller Compartment and top cover. Some units include electrical door interlocks, which open the main contactor if a door is opened.

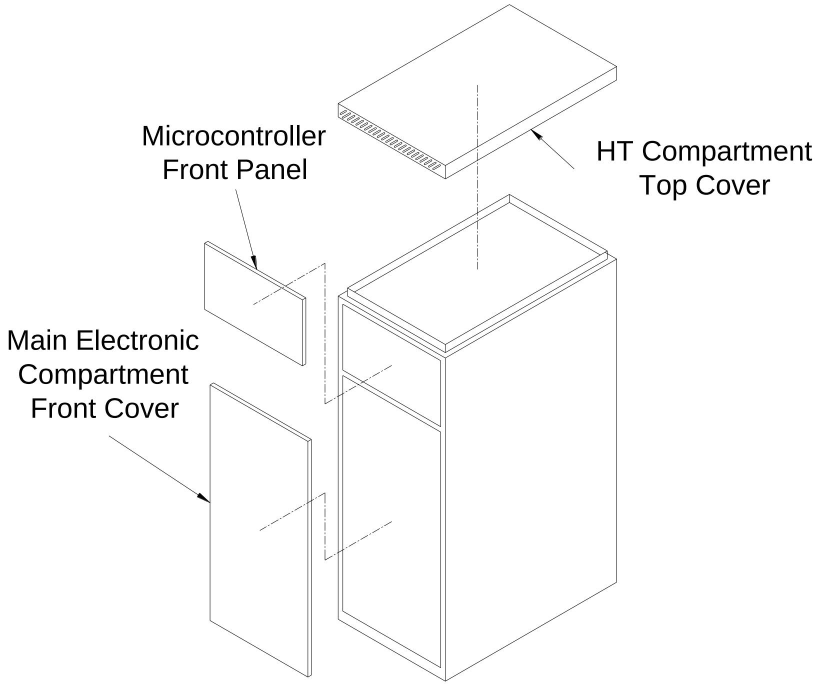


Figure 2-2 CCR Cabinet Covers (Front)

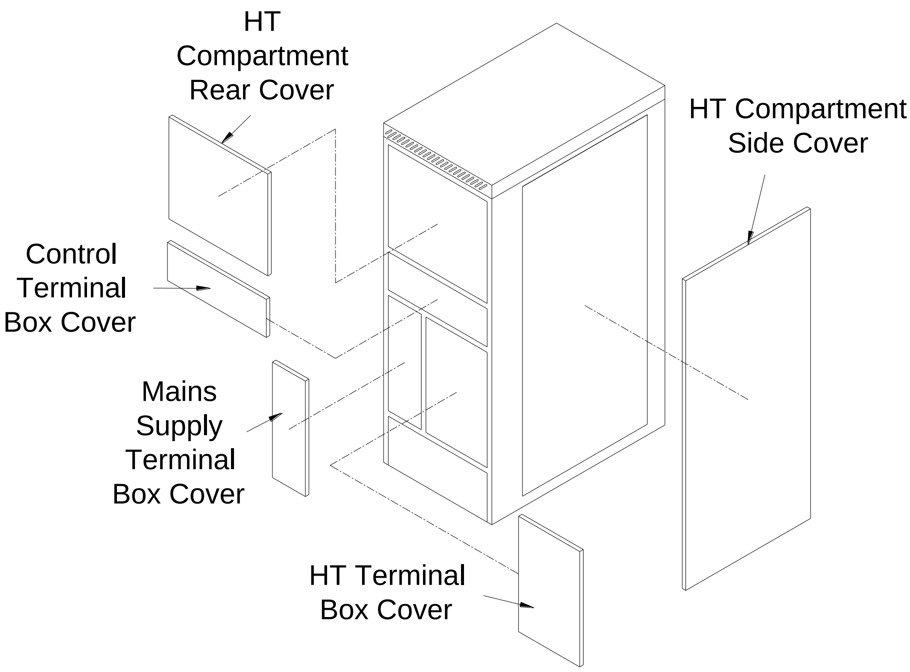


Figure 2-3 CCR Cabinet Covers (Rear)

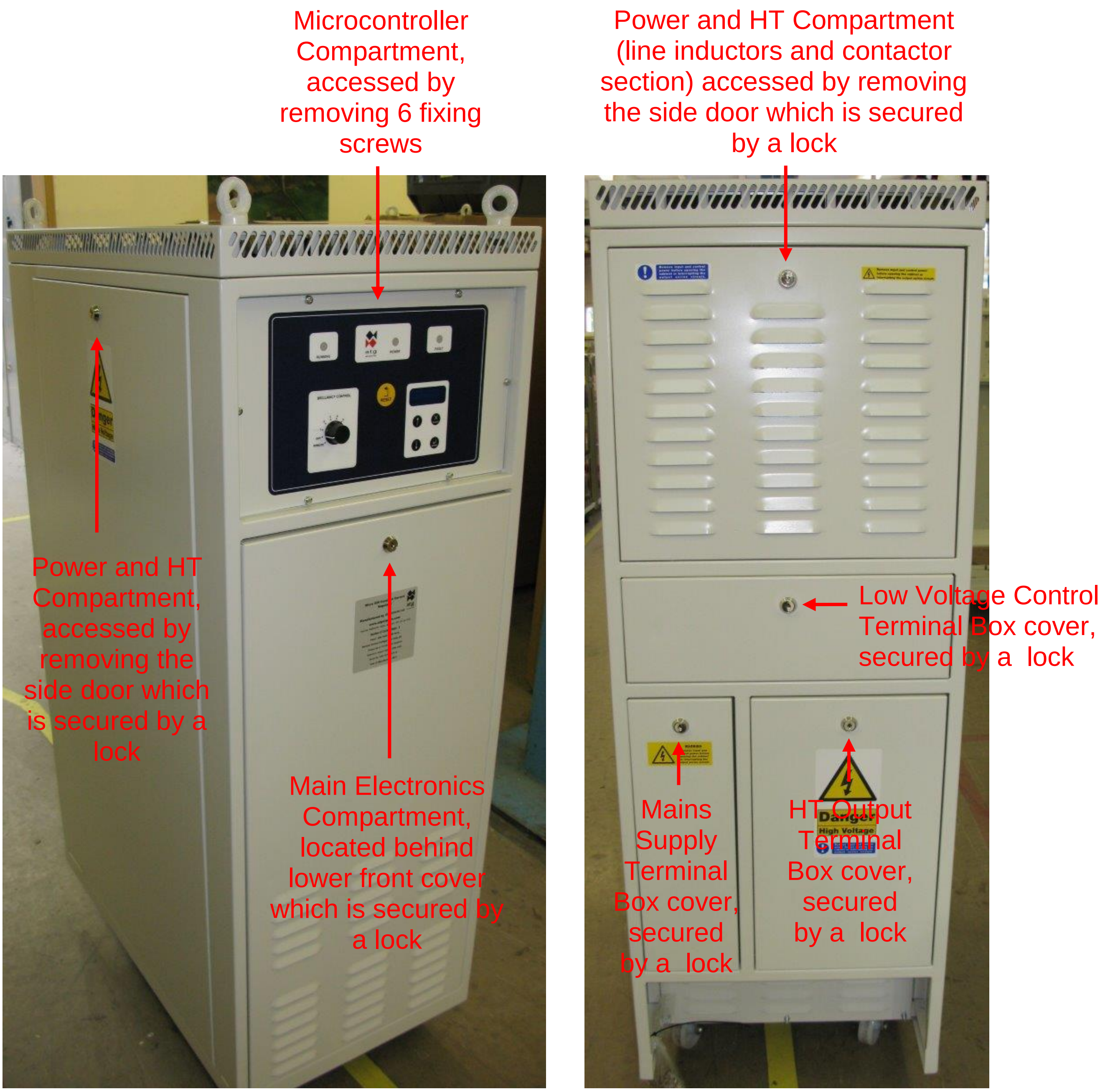


Figure 2-4 CCR front / side view, and rear view showing terminal covers

2.2 Operating environment and clearance around the cabinet

The Micro 200 CCR is designed for indoor installations in an area that should be clean and dry, free of dust, etc. (Pollution Degree 2, as defined by EN 60439-1). There should be adequate ventilation for cooling, with the following environmental conditions:

Temperature range:	-40°C to 50°C
Relative Humidity:	10% to 95%, non-condensing
Altitude:	Sea level to 2000 metres

To facilitate safe working practices for maintenance, a clearance of 1000mm is recommended at the front and back of the regulator.

A clearance of 40mm should be left at the sides of the cabinet for ventilation of the slots in the sides of the cabinet lid.

2.3 Cabinet weights and manoeuvring of the CCR

The approximate weights of the standard sizes of regulator are listed in Table 2-1.

Regulator output size (kVA)	Approximate weight (kg)
2.5	140
4	150
5	170
7.5	190
10	245
12.5	250
15	270

Table 2-1 Approximate Regulator Weights

For general manoeuvring of the CCR cabinet around the substation, the cabinet is fitted with four castors on the underside. These are to be used over short distances, such as within the electrical substation and test facilities. The castors are designed only for smooth surfaces. Prior to manoeuvring a CCR, the person responsible for manoeuvring is to check the route to ensure it is clear of obstructions or other hazards to people or equipment. If it is planned to move the CCR outside of the electrical substation and over uneven ground, it is recommended to use a vehicle with a tail lift to transport the CCR to its final destination.

If it is required to lift the CCR cabinet off the ground then the four lifting eyes should be used, with slings or a lifting shackle inserted through the eyebolts, and a suitable lifting device used to elevate the cabinet. A spreader bar should be used to ensure that the slings or lifting shackles are positioned vertically as the cabinet is raised, so as not to introduce a side load to the lifting eyes. The lift should be performed smoothly without jerking the cabinet as it is raised.

2.4 Supply Current and Input Circuit Breaker Rating

Table 2-2 provides a guide for typical input current requirements for the standard sizes of regulator, with full rated load connected, and the CCR operating at maximum brilliancy.

kVA Rating	**Approximate input current requirement with the CCR running at full rated load.**					
	220V series			**400V series**		
	208V	**220V**	**240V**	**380V**	**400V**	**415V**
2.5	14	13.3	12.2	7.7	7.3	7.1
4	22.5	21.3	19.5	12.3	11.7	11.3
5	28.1	26.6	24.4	15.4	14.7	14.1
7.5	42.2	39.9	36.6	23.1	22	21.2
10	56.2	53.2	48.8	30.8	29.5	28.2
12.5	N/A	N/A	N/A	38.5	36.6	35.3
15	N/A	N/A	N/A	46.2	43.9	42.3

Table 2-2 CCR Input Current Requirements

A guide for calculating the total load of the series circuit, including AGL cable losses and transformer losses, is included in Section 8.1. This can be used to determine the kVA rating of the regulator which should be used on any given circuit.

The regulator output is designed to remain stable with an input voltage variation of up to +/-10% of the nominal supply voltage.

1 provides a list of the minimum recommended supply cable sizes for each rating of CCR.

It is recommended that the external distribution circuit breaker or fuses are rated for 125% of the CCR supply current (or the next size larger), unless local regulations specify a different rating requirement. Ensure that the circuit breakers or fuses used provide adequate protection for the supply cables used, and always install in accordance with the current IEE or local codes of practice.

3 Connecting the CCR

3.1 Terminal Categories

Connections to the CCR are divided into three categories: CCR Mains Supply Input; Control Terminals and HT Series Circuit Output. Each has its own terminal compartment at the rear of the CCR, each with its own lockable cover. These are shown in Figure 3-1:

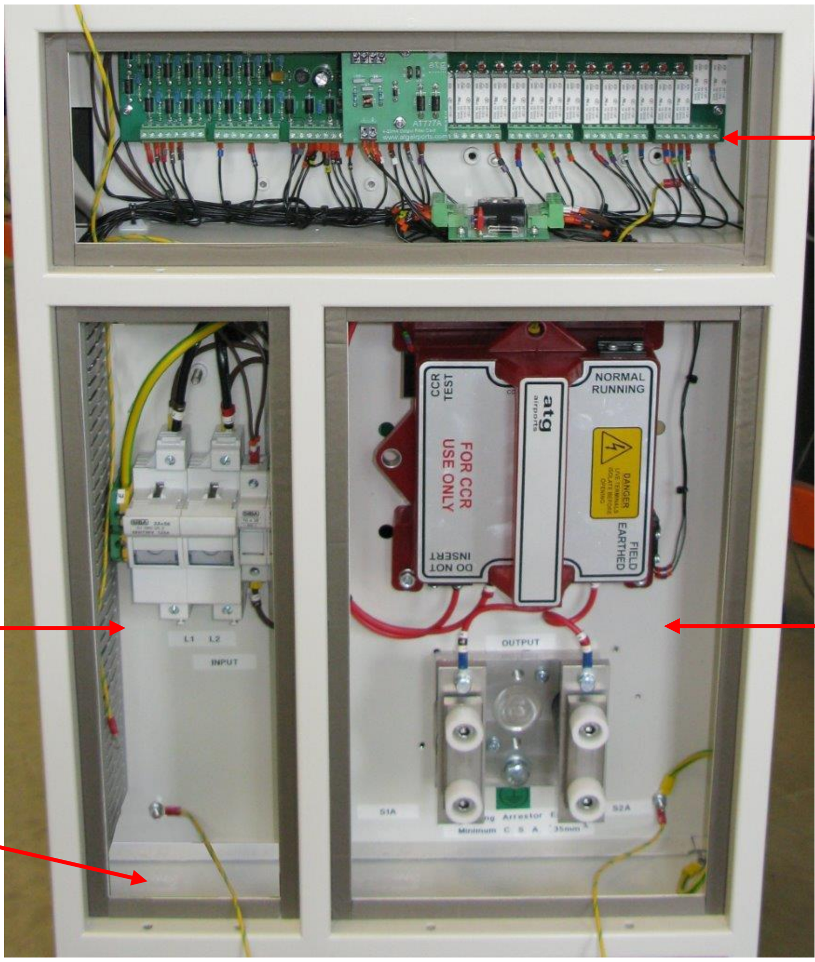


Figure 3-1 Terminal Boxes

The terminal box gland plate – fitted at the bottom – is normally supplied as a blank. Holes will need to be punched at the time of installation. The control cables should enter at the left-hand side of the gland plate, and run through the trunking in the left-hand side of the Mains Supply Terminal Compartment and through the entry hole into the Low Voltage Control Terminal Compartment. For safety, and to maintain the IP rating of the cubicle and the EMC shielding, the gland plate must always be fitted. No extra holes should be made in the plate in addition to those used for the cable glands.

Note – Micro 200 CCRs can be supplied to order fitted with customer specific control connectors, prewired to the internal CCR control terminals; Contact **atg airports** for details.

3.2 CCR Mains Supply Input and Cabinet Earth

This terminal box contains the mains supply fuses or circuit breaker and the control supply fuses. Cable entry is via the gland plate at the bottom of the box; the incoming mains cables connect directly into the fuse carriers (or circuit breaker), to the terminals marked “L1” and “L2”. The typical supply current requirements are listed in Table 2-2 of the previous section, and the minimum recommended CCR supply cable sizes are listed in 1 below.

kVA Rating	Minimum recommended CCR supply cable sizes					
	220V series		400V series			
	CSA mm^2	AWG	CSA mm^2	AWG		
2.5	4 mm^2	AWG 12	2.5 mm^2	AWG 14		
4	6 mm^2	AWG 10	4 mm^2	AWG 12		
5	10 mm^2	AWG 8	4 mm^2	AWG 12		
7.5	16 mm^2	AWG 6	6 mm^2	AWG 10		
10	25 mm^2	AWG 4	10 mm^2	AWG 8		
12.5	25 mm^2	AWG 3	10 mm^2	AWG 8		
15	25 mm^2	AWG 3	16 mm^2	AWG 6		
Note - due to cables specified in mm^2 or AWG not always being available in exactly matching sizes, the recommended CSA in mm^2 may be higher or lower than the nearest AWG cable size depending on the supply current of the particular CCR.						

Table 3-1 Minimum recommended CCR supply cable sizes

The earth cable also connects to a terminal within this box. The minimum size of the earth cable, regardless of the CCR power rating, should be 10 mm^2 (AWG 8), but always with a CSA of at least 50% of that of the mains supply cables. Always ensure compliance with the local electrical codes of practise.

3.3 Control Connections

Except for those regulators with custom control connectors fitted to the gland plate or those using serial communication modules, all control connections are made to screw terminals on PCB(s) fitted within the control terminal box. The field cables enter through the gland plate at the bottom of the mains terminal box and pass through a duct within this box, before entering the low voltage control terminal compartment. The PCB terminal will accommodate cable with a cross sectional area from $0.25mm^2$ to $2.5mm^2$.

In addition to the mains supply input, earth and AGL series loop output connection, no other connections are required to permit the CCR to operate in local control.

For a standard Micro 200 with an AT712 Relay I/O Card fitted, the CCR can operate with the following Remote-Control configurations:

i) 8-Wire Brilliancy Selection, with or without Command On input.
ii) 3-Wire Encoded Brilliancy selection, with or without Command On input (7 Brilliancy Levels)
iii) BCD Encoded Brilliancy Selection, with or without Command On input (8 Brilliancy Levels)

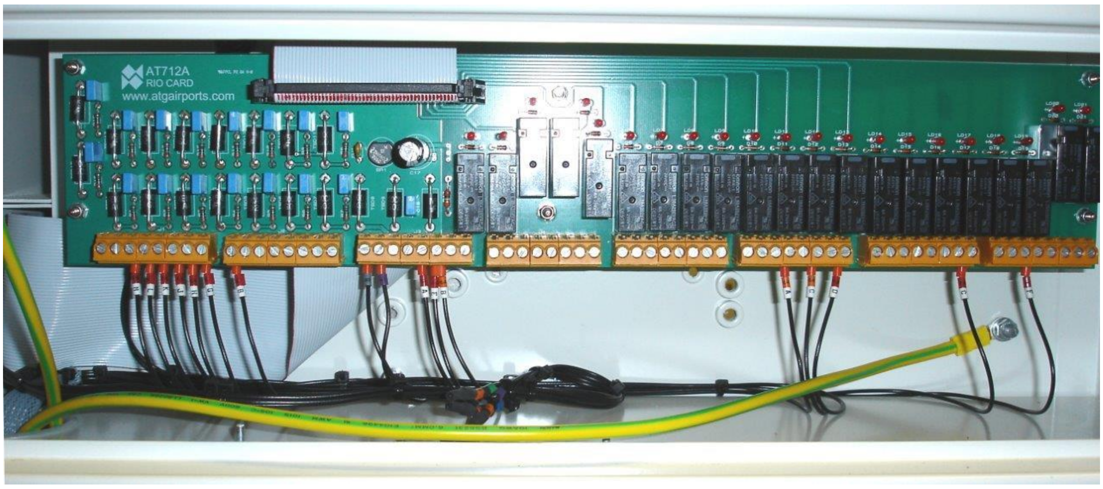


Figure 3-2 AT712 Relay I/O Card fitted in Control Terminal Box

Relay contacts are provided on the AT712 Card for Back Indication of CCR status. The relay contacts are rated at 4A @ 250V AC or 4A @ 30V DC with a resistive load. However, in order to maintain the ELV rating of the control terminal box it is recommended not to apply a voltage greater than 60V DC or 25V AC.

When options such as an integrated Circuit Selector Switch or Power / Current Monitor modules are fitted, additional cards will be mounted over the AT712 Card. Refer to the appropriate supplementary manuals for details.

Optional serial communications modules are available to give Remote Control using Profibus, Modbus TCP/IP or J-BUS. Contact **atg airports** for details. These modules would normally be fitted in place of the AT712 Relay I/O Card, although they can be used in addition to this to give a monitoring function only.

3.3.1 Remote Brilliancy Selection – up to 8 individual inputs

The default Remote Control Configuration for a standard Micro 200 CCR with a Relay I/O Card fitted is 8-Wire Remote Brilliancy Selection without Command On. (In this case, the CCR operates whenever a Brilliancy Input is activated). Other modes of operation can be selected via the keypad menu; for example, 8-Wire control can be used with or without the Command On input. To program the operating mode, refer to Section 9.3.2.2 – Remote Control Configuration.

The CCR can be programmed to operate with a maximum of 8 Brilliancy Steps (using all 8 Brilliancy Inputs - normally UK CAP168 brilliancy levels), but it is also possible to configure for 5 step FAA / IEC Style 2 (using Brilliancy Inputs 1 to 5) or 3 step FAA / IEC Style 1 (using Brilliancy Inputs 1 to 3). Whichever configuration is used, the appropriate pre-programmed current levels assigned to each Brilliancy Input are selected via the keypad menu system. These are normally set during factory testing based on the CCR order specification, but can be changed if necessary – refer to Section 9.3.2.7 - Brilliancy Level Selection. Alternatively, up to a maximum of 8 User Defined Current / Brilliancy Levels may be selected – see Section 9.3.2.10.

Figure 3-3 and Figure 3-4 show the connections to the Relay I/O Card for 8-Wire control. The optional Command On input is also shown; the use of this is selected via the menu system – refer to Section 9.3.2.2 – Remote Control Configuration.

Figure 3-3 shows the connection using the CCR internal power supply, and Figure 3-4 shows the same scheme using an external power source. Note – when using an external supply, it should be free floating and not referenced to earth.

The CCR Remote Brilliancy inputs can be driven from an external 24V or 48/50V DC supply, of either polarity, or an internal 24V DC supply.

If more than one Brilliancy Input is selected the CCR operates using the highest input, but an alarm is flagged on the front panel.

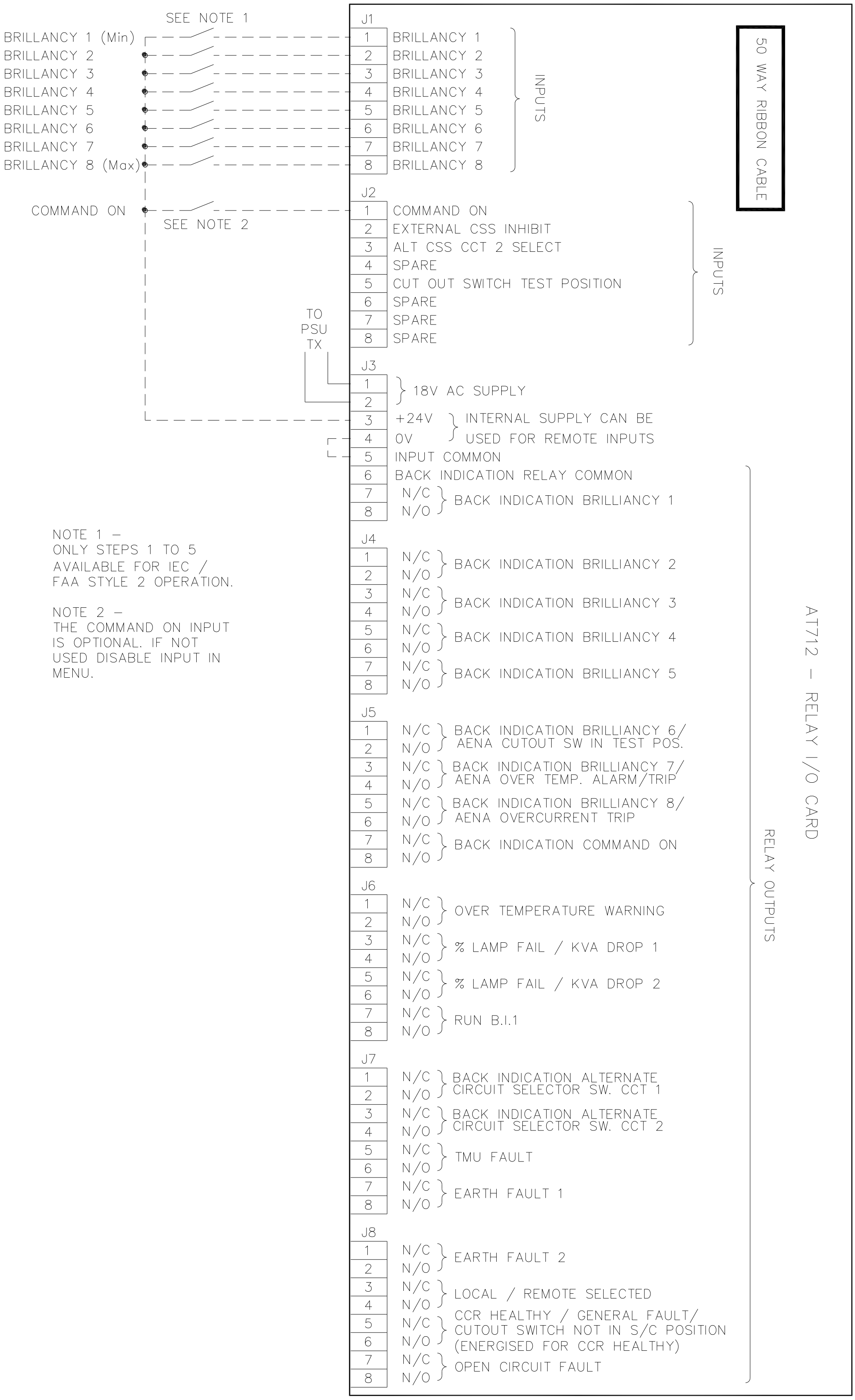


Figure 3-3 Connections for 8-Wire Remote Brilliancy using CCR internal PSU

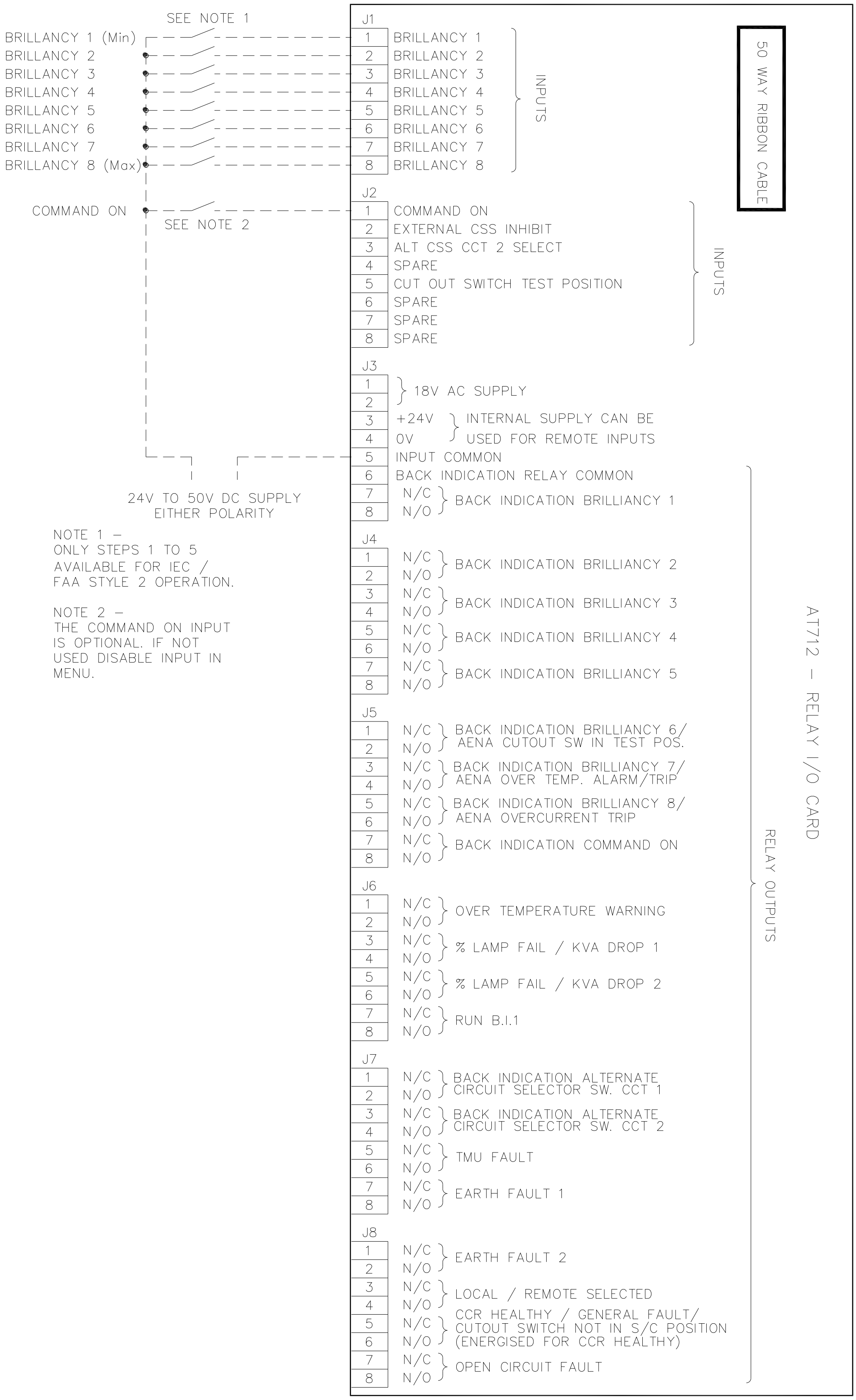


Figure 3-4 Connections for 8-Wire Remote Brilliancy using external PSU

3.3.2 3-Wire Encoded Remote Brilliancy Selection

The circuit of Figure 3-5 below shows the connections for 3-Wire Encoded Remote Brilliancy Selection using the CCR internal power supply. The use of a 'Command On' input is optional; the appropriate configuration should be selected using the keypad menu. All other information in Section 3.3.1 applies. To program the CCR for 3-Wire operation, refer to Section 9.3.2.2.

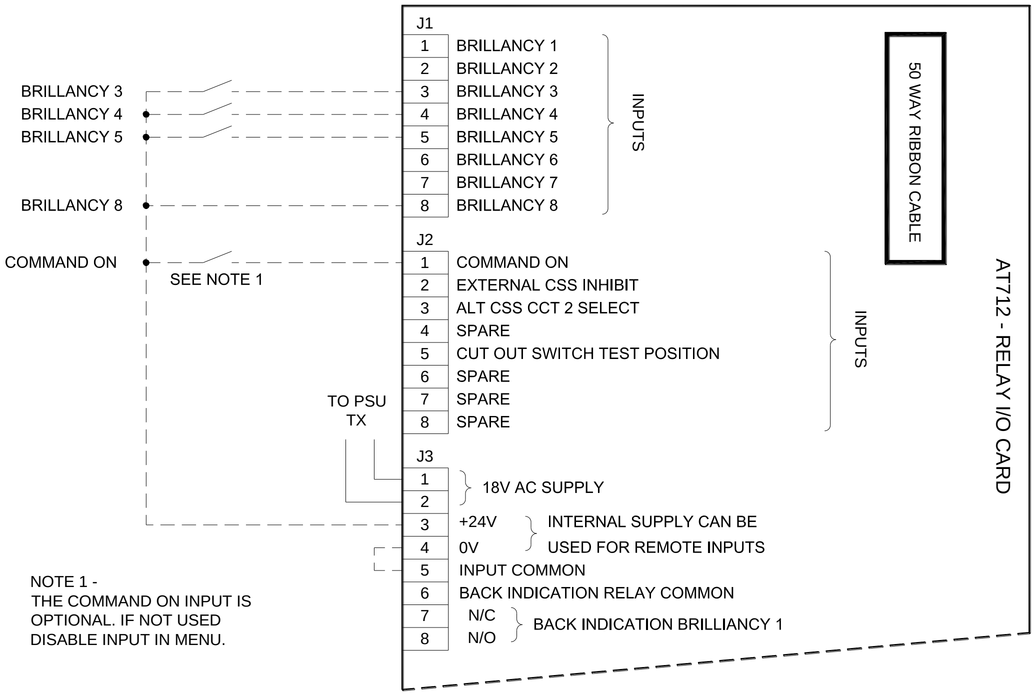


Figure 3-5 Connections for 3-Wire Encoded Remote Brilliancy Selection

Table 3-2 below, describes the encoding. Note – a '1' indicates that the input is selected; 'N/R' indicates not required.

3-Wire Encoded Remote Brilliancy Selection							
Step	Brilliancy (default UK CAP 168 levels)	Remote Input					
		Brilliancy 8	Brilliancy 7	Brilliancy 6	Brilliancy 5	Brilliancy 4	Brilliancy 3
Off	Off	0	N/R	N/R	X	X	X
1	0.1%	1	N/R	N/R	0	0	0
2	0.3%	1	N/R	N/R	0	0	1
3	1%	1	N/R	N/R	0	1	0
4	3%	1	N/R	N/R	0	1	1
5	10%	1	N/R	N/R	1	0	0
6	30%	1	N/R	N/R	1	0	1
7	80%	1	N/R	N/R	1	1	0
8	100%	1	N/R	N/R	1	1	1

Table 3-2 3-Wire Encoded Remote Brilliancy Selection

3.3.3 BCD Encoded Remote Brilliancy Selection

The circuit of Figure 3-6 below shows this configuration. The use of a 'Command On' input is optional. All other information described in Section 3.3.1 applies. To program the CCR for BCD encoded operation, refer to Section 9.3.2.2.

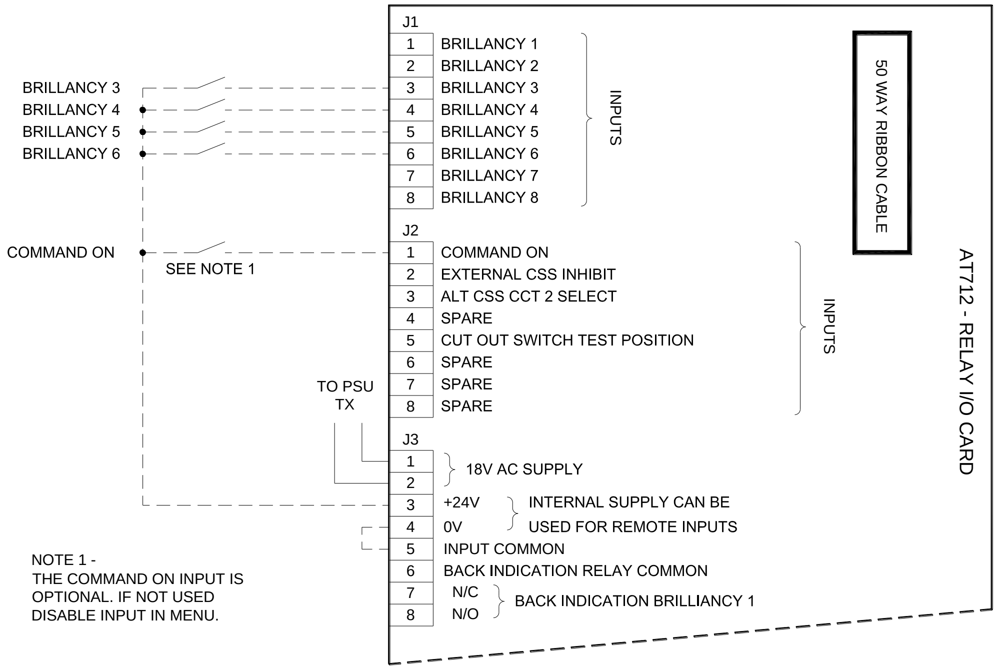


Figure 3-6 Connections for BCD Encoded Remote Brilliancy Selection

Note – it is possible to select from 2 coded tables; BCD (standard) and BCD control Option 2, as shown in Table 3-3 and Table 3-4. Note – a '1' indicates that the input is selected; 'N/R' indicates not required.

BCD (standard) Encoded Remote Brilliancy Selection							
Step	**Brilliancy (default UK CAP 168 levels)**	**Remote Input**					
		Brilliancy 8	**Brilliancy 7**	**Brilliancy 6**	**Brilliancy 5**	**Brilliancy 4**	**Brilliancy 3**
Off	Off	1	N/R	0	0	0	0
1	0.1%	1	N/R	0	0	0	1
2	0.3%	1	N/R	0	0	1	0
3	1%	1	N/R	0	0	1	1
4	3%	1	N/R	0	1	0	0
5	10%	1	N/R	0	1	0	1
6	30%	1	N/R	0	1	1	0
7	80%	1	N/R	0	1	1	1
8	100%	1	N/R	1	0	0	0

Table 3-3 BCD (standard) Encoded Remote Brilliancy Selection

BCD Option 2 Encoded Remote Brilliancy Selection							
Step	Brilliancy (default UK CAP 168 levels)	Remote Input					
		Brilliancy 8	Brilliancy 7	Brilliancy 6	Brilliancy 5	Brilliancy 4	Brilliancy 3
Off	Off	N/R	N/R	N/R	1	1	1
3	1%	N/R	N/R	N/R	1	1	0
4	3%	N/R	N/R	N/R	1	0	1
5	10%	N/R	N/R	N/R	1	0	0
6	30%	N/R	N/R	N/R	0	1	1
7	80%	N/R	N/R	N/R	0	1	0
8	100%	N/R	N/R	N/R	0	0	1
Off	Off	N/R	N/R	N/R	0	0	0

Table 3-4 BCD Option 2 Encoded Remote Brilliancy Selection

3.3.4 External Circuit Selector Switch Connection

The Micro 200 CCR can be supplied with an optional Integral Circuit Selector Switch. However, if an external CSS is to be used a volt-free inhibit contact should be provided on the CSS control unit to momentarily turn off the regulator during switching of the Circuit Selector Switch.

This contact should be connected to the AT712 “EXTERNAL CSS INHIBIT” input (terminal J2/2), as shown in Figure 3-7 below.

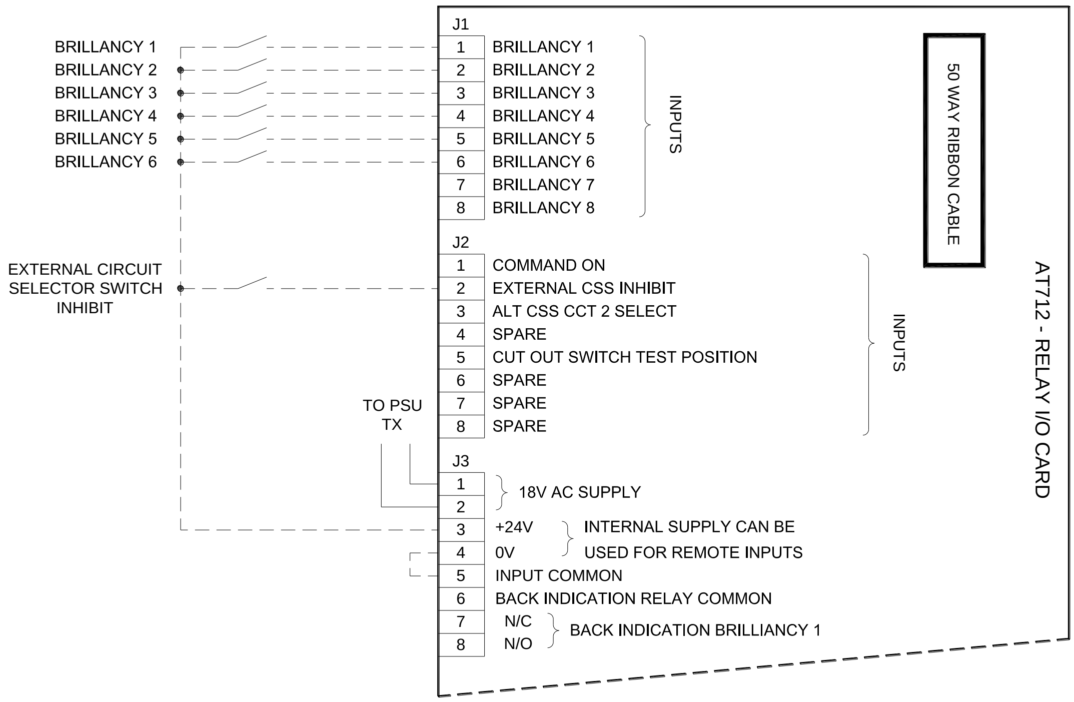


Figure 3-7 Connection for External Circuit Selector Switch inhibit line

When the CSS inhibit contact is CLOSED, the green CCR “RUN” LED on the front panel will flash to indicate that the CCR output is switched off, and the following message will be displayed:

	C	S	S		I	N	H	I	B	I	T				
					I		=		X	X	.	X	X	A	

Note – in this condition, the CCR line contactor remains energised.

3.4 HT Series Circuit Output Terminals.

WARNING – HIGH VOLTAGES – UP TO 2500V FOR A 15KVA REGULATOR – ARE PRESENT WITHIN THE HT TERMINAL BOX. THE COVER TO THIS COMPARTMENT SHOULD NEVER BE OPENED WITHOUT FIRST ISOLATING THE REGULATOR MAINS SUPPLY INPUT

FURTHERMORE, BEFORE THE AGL FIELD CABLES AND CCR OUTPUT TERMINALS ARE SAFE TO TOUCH, THEY SHOULD BE SHORTED TOGETHER AND CONNECTED TO EARTH, PREFERABLY USING A SUITABLE SWITCHING DEVICE. RESIDUAL CHARGE OR INDUCED EMF FROM OTHER AGL CIRCUITS MAY OTHERWISE PRESENT A HAZARD TO PERSONNEL.

CCRS CONTAINING INTEGRAL LIGHTNING ARRESTORS MAY BE SUPPLIED WITH TWO INSULATING COVERS FITTED OVER THE LIGHTNING ARRESTOR TERMINALS. IN THIS CASE, ENSURE THAT THE INSULATING COVERS ARE REFITTED AFTER THE AGL SERIES CIRCUIT CABLES HAVE BEEN CONNECTED.

This terminal box contains 2 HT output terminals for a standard regulator, 4 for an Integral Alternate Circuit Selector Switch, and up to 7 for a Multi-way Circuit Selector. Refer to the manual supplements for connection details for these options.

Figure 3-8 (overleaf) shows photographs of standard output terminals, and a 4-terminal lightning arrestor assembly as used for an integral alternate circuit selector switch or a 3-way simultaneous circuit selector switch. This 4-terminal assembly is fitted with insulating sheets at the sides of the terminals; these are necessary since clearance is limited between the end terminals and the sides of the compartment.

Note – the voltage rating of the AGL cable should be chosen according to the rated output voltage of the regulator used, on the output current setting used; be it 6.0 / 6.6A or 12A. Refer to Table 4-6 and Table 4-7 for the Main CCR Transformer output voltages.

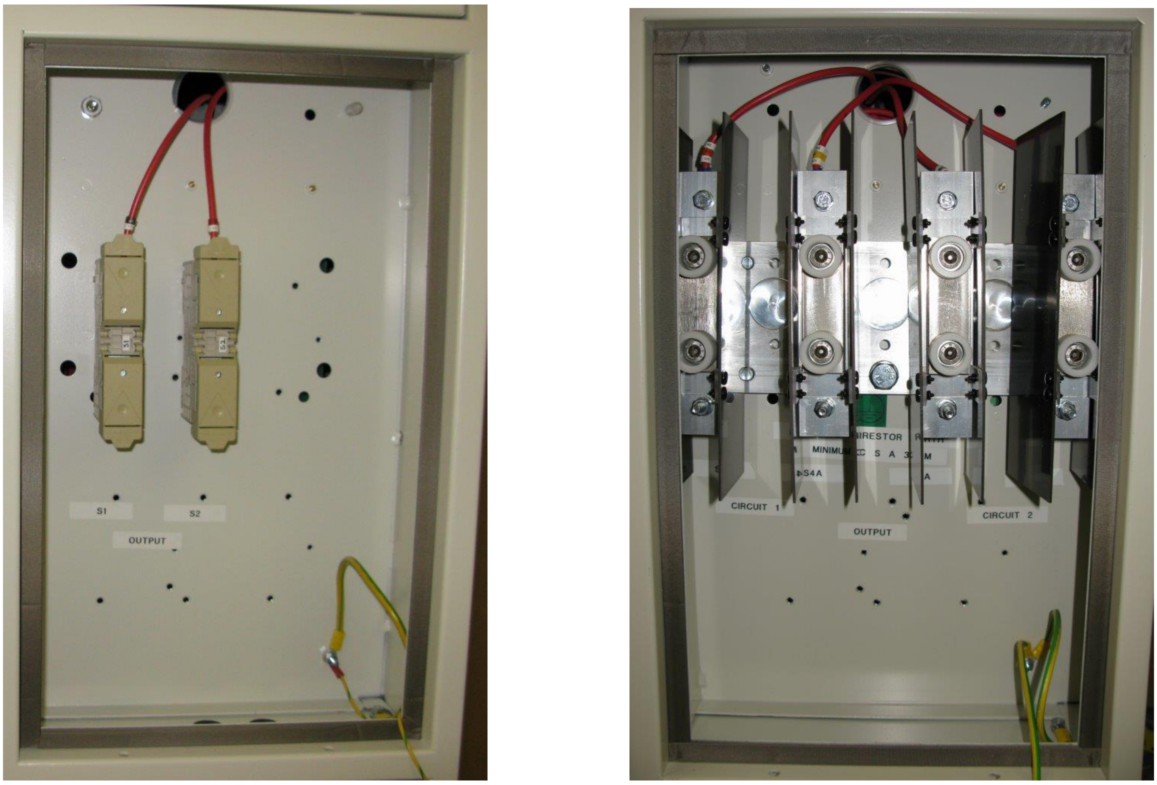


Figure 3-8 Standard Output Terminals and 4 Terminal Lightning Arrestor

For those regulators fitted with Integral Lightning Arrestors, a separate earth connection must be made. This should connect to the aluminium lightning arrestor assembly base plate, using the bolt near the bottom of the plate. The earth cable used should have a cross sectional area of at least 35 mm^2. Refer to Section 6 - Output Lightning Arrestors, for more information.

4 Commissioning

4.1 Introduction

The factory test of the Micro 200 CCRs includes accurate calibration of the CCR output current level to that specified by the customer. This is performed using a specialised, calibrated, power analyser. Re-calibration of the regulator should not therefore, be undertaken as part of the commissioning process.

If verification of the set current is required this can be done by connecting either a short circuit, or better still, a resistive load bank to the output terminals and running the regulator at maximum brilliancy.

Note – **atg airports** do not consider ‘clamp’ type RMS ammeters as being sufficiently accurate for the calibration of CCRs, due to the variation in measured current with clamp pressure. If a regulator is to be re-calibrated, this should be done using a suitable in-line ‘true RMS’ ammeter as described in Section 10.2.

For a standard Micro 200 CCR with no Option Modules fitted, and providing that the AGL circuit is matched to the CCR rated output current (see rating label), then commissioning of the regulator requires only to:

i) Verify that the default CCR operating parameters are correct for the application, eg. 8-Wire Remote Brilliancy Selection, UK CAP168 Brilliancy / Current Levels. (Note - if any special requirements were notified to **atg airports** at the time of ordering, these will have been programmed during factory testing). See Section 4.2

ii) Verify the correct operation of the external control connections.

iii) Set the CCR Main Transformer (T101) input voltage connection to be one tap lower than the local supply, for example connect the 380V tap for a 400V supply. (This is to ensure that the Micro 200 can cope with a 10% dip in mains supply voltage, and still maintain the output current within the specified limits at full load). Set the Transformer output voltage taps to correctly match the series circuit load - see Section 4.3. For CCR output voltage and load kVA monitoring, program in the output voltage used on the CCR Main Transformer – see Section 9.4.2.18

If any Option Cards or Modules are fitted, then these may require hardware set-up and / or programming of operating parameters. The set-up of the most commonly used Option Cards are included in this manual; the Earth Leakage Resistance Measurement Module is described in Section 4.5, and the Percentage Lamp Failure System is described in Section 4.6.

Refer to the supplementary manuals for any other optional components fitted, for example, a serial communications module.

After the regulator has been correctly configured, as described in the following sections, it will be ready for initial power up of the AGL circuit.

First, turn the Front Panel Brilliancy Selection rotary switch to “OFF” and energise the mains supply. On power up, the microprocessor reads the CCR configuration and hours run data from the EEPROM. During this operation the following screen will be briefly displayed.

						C	C	R							
		I	N	I	T	I	A	L	I	S	I	N	G		

Following a successful initialisation; the screen will change to indicate the regulator’s operational state, which in this case will be ‘OFF’.

4.2 Default CCR Operating Parameters

Table 4-5, overleaf, lists the most important CCR Operating Parameters, along with a brief description and the default setting. A box is provided to record any non-standard settings used. Table 4-1 through to Table 4-4 list the pre-programmed current settings available and their associated tolerance limits.

Section 9 describes navigating around the Menu System and programming the CCR using the Front Panel Keypad. Sections 9.3 and 9.4 contain comprehensive listings of all Operating Parameters, along with the default settings. The majority of the parameters can be left on the default setting for most applications.

Brilliancy Step		UK CAP 168 Brilliancy level	Default / UK CAP 168			FAA / IEC Style 1			FAA / IEC Style 2		
			Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps	
FAA / IEC	DOE			Lower Limit	Upper Limit		Lower Limit	Upper Limit		Lower Limit	Upper Limit
8	MAX		6.00	5.82	6.09						
7	2		5.73	5.64	5.78						
6	3		4.86	4.78	5.23						
5	4		4.14	3.82	4.36						
4	5	N/A	3.54	3.36	3.68	N/A	N/A	N/A	N/A	N/A	N/A
3	MIN		3.06	2.96	3.25						
2	N/A		2.64	2.51	2.89						
1	N/A		2.34	2.17	2.41						
0	OFF		0	0	0						

Table 4-1 6.00A pre-programmed current levels.

Brilliancy Step		UK CAP 168 Brilliancy level	Default / UK CAP 168			FAA / IEC Style 1			FAA / IEC Style 2		
			Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps	
FAA / IEC	DOE			Lower Limit	Upper Limit		Lower Limit	Upper Limit		Lower Limit	Upper Limit
8	MAX	100 %	6.60	6.40	6.70	6.60	6.50	6.70	6.60	6.50	6.70
7	2	80 %	6.30	6.20	6.36	6.60	6.50	6.70	6.60	6.50	6.70
6	3	30 %	5.35	5.26	5.76	6.60	6.50	6.70	6.60	6.50	6.70
5	4	10 %	4.55	4.20	4.80	6.60	6.50	6.70	6.60	6.50	6.70
4	5	3 %	3.89	3.70	4.05	6.60	6.50	6.70	5.20	5.10	5.30
3	MIN	1 %	3.37	3.26	3.58	6.60	6.50	6.70	4.10	4.00	4.20
2	N/A	0.3 %	2.90	2.76	3.18	5.50	5.40	5.60	3.40	3.30	3.50
1	N/A	0.1 %	2.57	2.39	2.65	4.80	4.70	4.90	2.80	2.70	2.90
0	OFF	0 %	0	0	0	0	0	0	0	0	0

Table 4-2 6.60A pre-programmed current levels.

Brilliancy Step		UK CAP 168 Brilliancy level	Default / UK CAP 168			FAA / IEC Style 1			FAA / IEC Style 2		
			Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps	
FAA / IEC	DOE			Lower Limit	Upper Limit		Lower Limit	Upper Limit		Lower Limit	Upper Limit
8	MAX	100 %	12.00	11.64	12.18	N/A	N/A	N/A	N/A	N/A	N/A
7	2	80 %	11.45	11.27	11.56						
6	3	30 %	9.72	9.56	10.47						
5	4	10 %	8.28	7.64	8.73						
4	5	3 %	7.08	6.72	7.36						
3	MIN	1 %	6.12	5.92	6.51						
2	N/A	0.3 %	5.28	5.01	5.78						
1	N/A	0.1 %	4.68	4.34	4.82						
0	OFF	0 %	0	0	0						

Table 4-3 12.00A pre-programmed current levels.

Brilliancy Step		UK CAP 168 Brilliancy level	Default / UK CAP 168			FAA / IEC Style 1			FAA / IEC Style 2		
			Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps		Current Level, Amps	Range, Amps	
FAA / IEC	DOE			Lower Limit	Upper Limit		Lower Limit	Upper Limit		Lower Limit	Upper Limit
8	MAX	100 %	20.00	19.62	20.40	N/A	N/A	N/A	20.00	19.70	20.30
7	2	80 %	19.21	18.78	19.28				20.00	19.70	20.30
6	3	30 %	16.21	15.90	17.45				20.00	19.70	20.30
5	4	10 %	13.79	12.72	14.54				20.00	19.70	20.30
4	5	3 %	11.79	11.21	12.27				15.80	15.50	16.10
3	MIN	1 %	10.20	9.87	10.85				12.40	12.10	12.70
2	N/A	0.3 %	8.79	8.36	9.64				10.30	10.00	10.60
1	N/A	0.1 %	7.79	7.24	8.03				8.50	8.20	8.80
0	OFF	0 %	0	0	0				0	0	0

Table 4-4 20.00A pre-programmed current levels.

Parameter	Description	Location of parameter	Firmware default setting	CCR Serial Number: User Settings
CCR FULL LOAD CURRENT	Maximum CCR output current, 6.0A, 6.6A, 12.0A or 20.0A (note - the output currents available are also dependent on the power transformer fitted)	CCR Hardware Configuration Menu. Section 9.4.2.1	6.60A; non-standard requirements programmed at time of factory testing.	
REMOTE CONTROL CONFIG.	Remote Control Brilliancy Selection: 8 Wire, 3 Wire Encoded, BCD Encoded, (all with or without Command On), Serial Communication	Set-up Menu. Section 9.3.2.2	8 WIRE	
BRILL. LEVELS	Current setting for each Brilliancy step; Pre-programmed table to UK Cap 168 levels, FAA / IEC Style 1, FAA / IEC Style 2 or User Defined	Set-up Menu. Sections 9.3.2.7 and 9.3.2.10	UK CAP168 (note - FAA / IEC Style 2 programmed during factory testing for units exported outside UK)	
BLACK HEAT	CCR produces a low current output when in 'OFF' state under remote control. Prevents condensation in AGL lamps	Set-up and Hardware Config. Menus. Sections 9.3.2.8 and 9.4.2.3	DISABLED	
TOLERANCE MON.	Tolerance Monitoring Unit (TMU), checks that measured CCR output current falls within specified limits	Set-up Menu. Sections 9.3.2.9 and 9.4.2.6	ENABLED (Limits set according to Brilliancy Levels table selected)	
EARTH FAULT: TRIP ON EARTH 2	Two threshold levels can be set for the resistance to earth of the series loop circuit. This parameter selects whether the CCR should trip or alarm only once the second threshold is reached (Stage 2). (Note – the Earth Leakage Card is optional)	CCR Hardware Configuration Menu. Section 9.4.2.11	ENABLED (for reasons of safety, it is recommended to leave ENABLED, to trip the CCR on Stage 2 earth leakage threshold)	
PERCENTAGE LAMP FAIL	Monitors the inductance of the series loop circuit to detect lamp failures. (Note – PLF detection requires fitting of the optional AT923 PLF Card)	CCR Hardware Configuration Menu Section 9.4.1 The PLF detection set-up procedure is described in Section 4.6	2 STAGE ALARM (note – if optional card not fitted, leave setting as default)	

Table 4-5 Main CCR Operating Parameters

4.3 Setting the Main Transformer Output Voltage

WARNING – HIGH VOLTAGES – UP TO 2500V FOR A 15KVA REGULATOR – ARE PRESENT ON THE CCR MAIN TRANSFORMER OUTPUT TERMINALS. THE TRANSFORMER IS MOUNTED WITHIN THE HT CUBICLE, THE COVER OF WHICH SHOULD NEVER BE OPENED WITHOUT FIRST ISOLATING THE REGULATOR MAINS SUPPLY INPUT

FURTHERMORE, THE AGL FIELD CABLES SHOULD BE SHORTED TOGETHER AND CONNECTED TO EARTH BEFORE THE HT CIRCUITRY – INCLUDING THE TRANSFORMER OUTPUT TERMINALS - IS SAFE TO TOUCH. RESIDUAL CHARGE OR INDUCED EMF FROM ADJACENT AGL CIRCUITS MAY OTHERWISE PRESENT A HAZARD TO PERSONNEL.

Figure 11-1 of Section 11.1 shows the block diagram of the CCR with a primary series field loop connected. The CCR uses a PWM IGBT H bridge to control the voltage applied to the primary of the main CCR transformer. The transformer secondary has multiple tappings such that the output voltage can be adjusted to give the correct operating range according to the load connected to the AGL circuit. The conduction period of the H Bridge is then controlled so as to give the correct RMS current on the output side of the transformer.

It is important that the main transformer output voltage is correctly adjusted to match the load of the series loop circuit. Too low an output voltage will mean that the CCR will not be able to drive the rated current into the load, causing an 'Open Circuit' trip or an 'Under Current' tolerance alarm. (Depending on the output voltage set, this may only become a problem during conditions of supply voltage dips or when lamps have failed).

If the transformer output voltage is set higher than required for a particular load, then the CCR compensates for this mismatch by reducing the conduction period of the IGBT H Bridge to maintain the correct RMS output current. However, the CCR supply current and supply kVA will be higher than necessary. For a badly mismatched transformer output voltage, the power factor of the supply to the CCR will also be slightly worse, as will the level of harmonic current on the supply.

(Note – for correct operation of the Micro 200 control loop and to prevent instability, the transformer secondary tapping voltages should be set no lower than 20% of maximum, even for short circuit load tests).

atg airports have developed two standard ranges of transformers for use in the Constant Current Regulators; one range is designed for operation at a maximum current of 6.6A, whilst the other range can be configured for operation at 12.0A or 6.0 / 6.6A. These two ranges are described below.

4.3.1 6.6A Transformer Winding Arrangement

For CCRs designed to operate at a maximum current of 6.6A, the transformers have 3 (or more) isolated secondary windings. The type with 3 is shown in Figure 4-1; the label on the transformer itself will also show the arrangement and voltage of each section. Each section of the secondary winding produces twice the voltage of the preceding section; for example, the voltage of winding section 5 is twice that of section 4. By connecting the appropriate winding sections in series, the CCR output voltage can be set to suit the load on the AGL series circuit. Table 4-6 lists the secondary winding voltages for the most common of the 6.6A range of transformers for each size of regulator.

The primary tapping voltages shown are for the 400V series CCR.

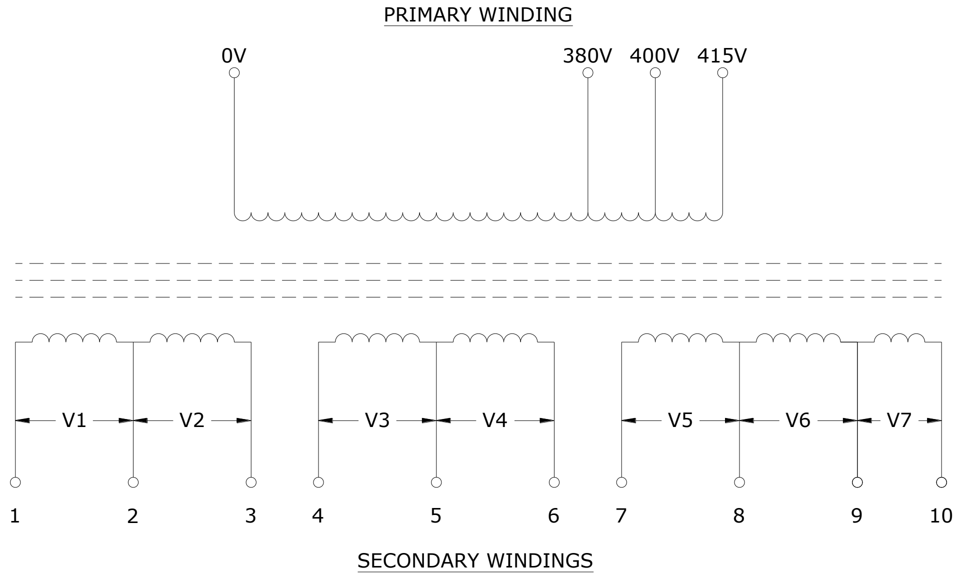


Figure 4-1 6.6A CCR Main Transformer winding arrangement

RATED OUTPUT kVA	RATED OUTPUT VOLTAGE AT 6.6A	WINDING V1 OP VOLTAGE	WINDING V2 OP VOLTAGE	WINDING V3 OP VOLTAGE	WINDING V4 OP VOLTAGE	WINDING V5 OP VOLTAGE	WINDING V6 OP VOLTAGE	WINDING V7 OP VOLTAGE. SEE NOTE
1.0	153	2.4	4.8	9.7	19.5	39	78	N/A
2.5	382	6.06	12.13	24.25	48.5	97	194	N/A
4	610	9.7	19.4	38.8	77.5	155	310	N/A
5	764	12.1	24.2	48.5	97	194	388	N/A
7.5	1146	18.2	36.4	72.8	145.5	291	582	N/A
10	1528	24.25	48.5	97	194	388	776	N/A
12.5	1909	30.3	60.6	121.3	242.5	485	869	100
15	2287	36.4	72.75	145.5	291	582	1044	120

Table 4-6 6.6A CCR Main Transformer Output Voltages

Note - winding V7 is only included on transformers rated at 12.5kVA or above. It should be connected for IEC applications to give the ability to cope with supply voltage dips of up to 10%, and disconnected for FAA applications to give the ability to cope with supply voltage dips of up to 5%, with full rated load connected.

For transformers where the secondary and/or primary tapping voltages differ from those shown above, the winding arrangement and tapping voltages are indicated on the transformer label.

A third connection is made to the transformer output windings, which goes to the Earth Leakage Detector. This should connect as closely as possible to the mid – voltage point of whichever windings are utilised – see Figure 4-2.

There is also a 20V low current secondary winding provided on the transformer, for load monitoring purposes. This is not shown on these drawings.

To set the maximum output voltage on a 6.6A regulator, all the windings will be connected in series as shown in Figure 4-2 and below.

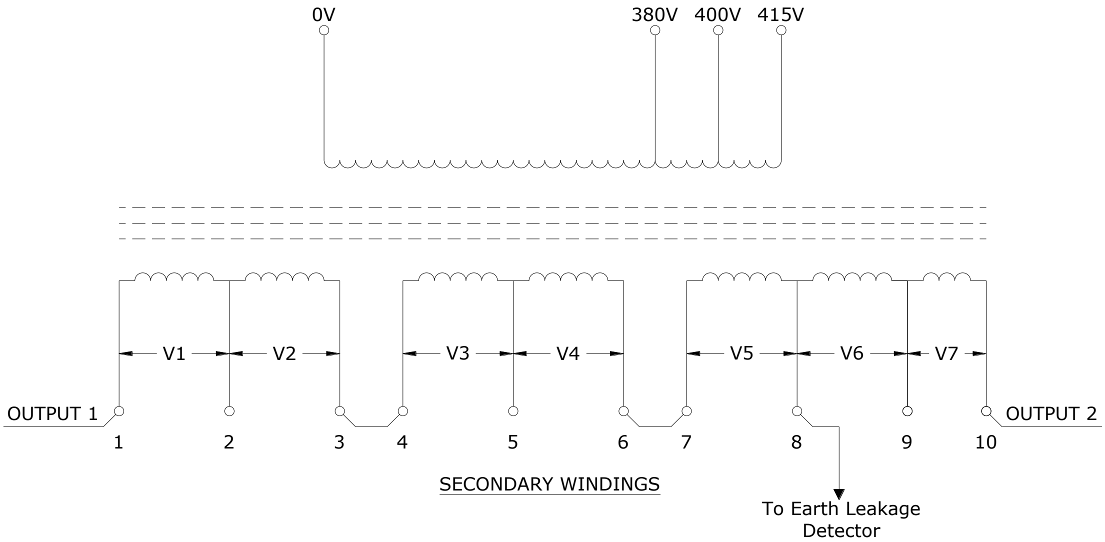


Figure 4-2 6.6A Transformer configured for full voltage

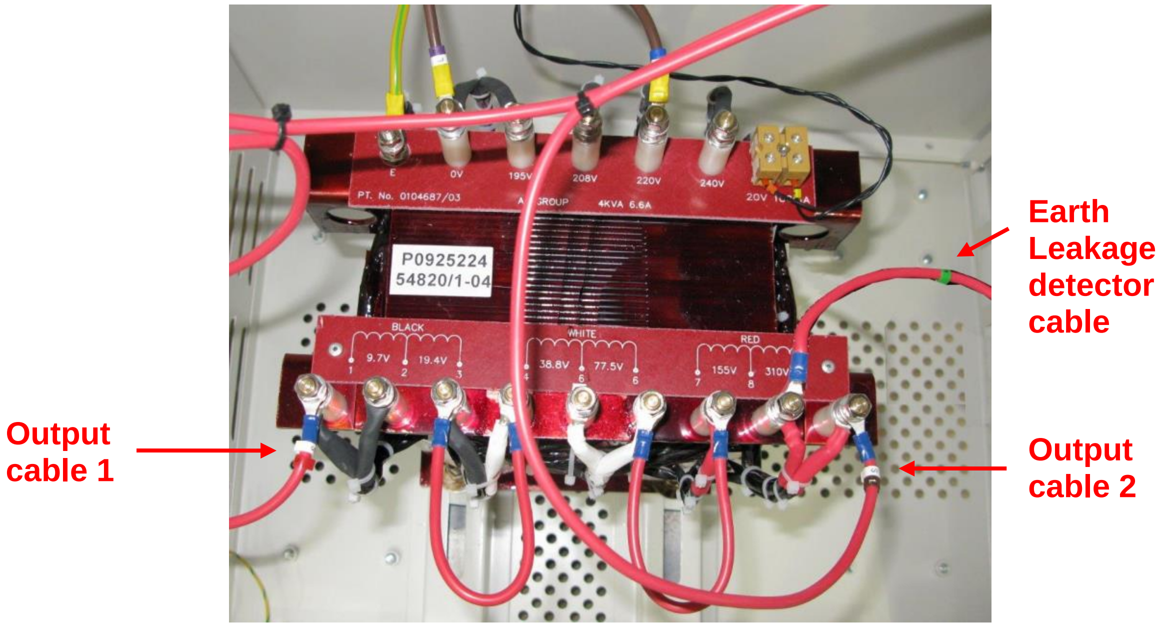


Figure 4-3 Photograph of 6.6A Transformer configured for full voltage

To calculate the required CCR output voltage according to the AGL circuit load, refer to Section 8.1

An example of an intermediate output voltage (based on a 6.6A circuit) is shown below. In this case the output voltage is:

$$V3 + V4 + V6 + V7$$

This for a 15KVA regulator is:

$$145.5 + 291 + 1044 + 120 = 1600.5V$$

The connections to give this voltage are shown in Figure 4-4.

Note – when connecting together sections of the secondary windings, ensure that the windings are connected with the correct orientation (phasing), as shown in Figure 4-2 or Figure 4-4. In this way, the voltages from each section will add and not subtract.

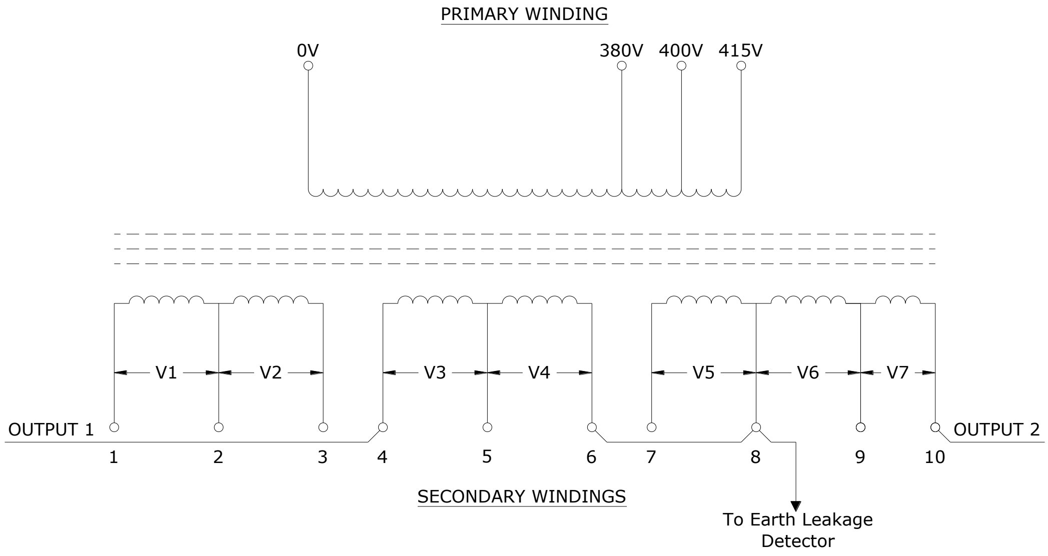


Figure 4-4 6.6A Transformer configured for intermediate voltage

It is important to verify that the transformer output voltage tappings are set to correctly match the load, as described in Section 4.3.3.

4.3.2 6.6A / 12.0A Transformer Winding Arrangement

The range of transformers fitted to CCRs which can operate at 6.6A or 12.0A either have 6 isolated secondary windings, arranged as 2 sets of 3 windings, or 4 isolated secondary windings, arranged as 2 sets of 2 windings. Each winding is rated at 6.6A; these can be connected in parallel to give a 12.0A rating, or in series for 6.0A or 6.6A operation, but at twice the output voltage. A different coloured sleeve identifies the cables from each winding. Each section of the secondary winding produces twice the voltage of the preceding section; for example, the voltage of winding section 5 is twice that of section 4.

Figure 4-5 shows the winding arrangement for the 6.6A / 12.0A range of CCR Main Transformers which have 2 sets of 3 secondary windings, whilst Table 4-7 lists the secondary winding voltages for the most common sizes of transformer of this style.

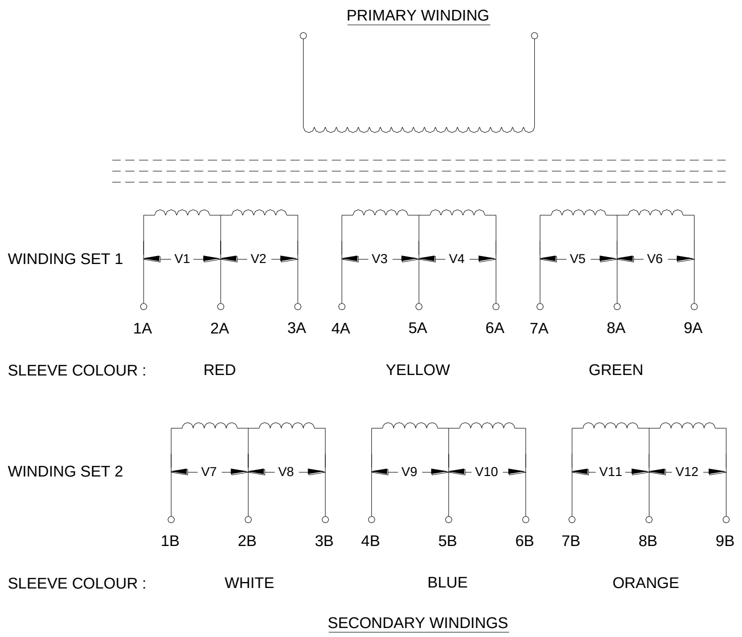


Figure 4-5 6.6A / 12.0A CCR Main Transformer, 2 sets of 3 secondary windings

RATED OUTPUT KVA	RATED OUTPUT VOLTAGE AT 12A	RATED OUTPUT VOLTAGE AT 6.6A	OUTPUT VOLTAGE WINDINGS V1 AND V7	OUTPUT VOLTAGE WINDINGS V2 AND V8	OUTPUT VOLTAGE WINDINGS V3 AND V9	OUTPUT VOLTAGE WINDINGS V4 AND V10	OUTPUT VOLTAGE WINDINGS V5 AND V11	OUTPUT VOLTAGE WINDINGS V6 AND V12
4	315	630	5	10	20	40	80	160
7.5	630	1260	10	20	40	80	160	320
15	1260	2520	20	40	80	160	320	640

Table 4-7 6.6A / 12.0A Main Transformer Output Voltages, 2 sets of 3 windings

Figure 4-6 shows the winding arrangement for those transformers which have 2 sets of 2 secondary windings.

Note – For those transformers whose winding voltages are not listed in Table 4-7, refer to the tapping voltages marked on the transformer itself.

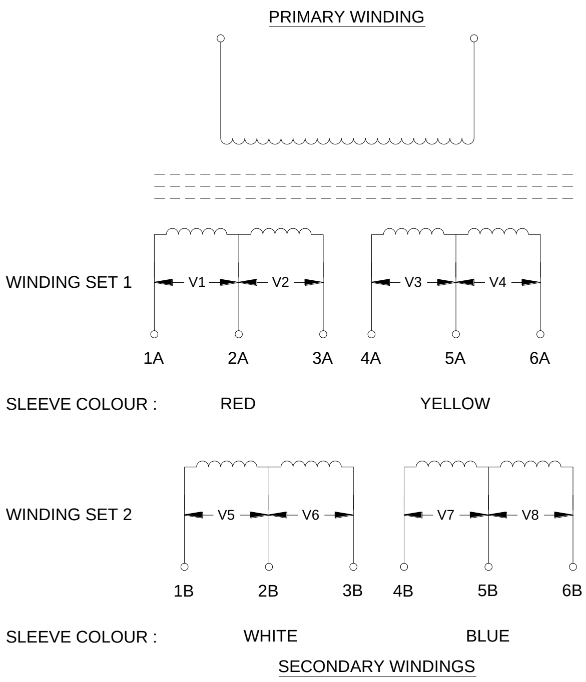


Figure 4-6 6.6A / 12.0A CCR Main Transformer, 2 sets of 2 secondary windings

By connecting the appropriate winding sections in series and / or parallel the required CCR output voltage and current can be obtained. To set the maximum output voltage on a 6.0A or 6.6A regulator, all the windings will be connected in series as shown in Figure 4-7. To set the maximum output voltage for a 12A regulator, winding set 1 will be connected in parallel with winding set 2, using the links provided. This is shown in Figure 4-8.

Note – a third connection is made to the transformer output windings, which goes to the Earth Leakage Detector. This should connect as closely as possible to the mid – voltage point of whichever windings are utilised.

There is also a low current secondary (monitoring) winding provided on the transformer, for use by the AT733 Control Card and the (optional) AT923 Percentage Lamp Failure Card. This is not shown on these drawings.

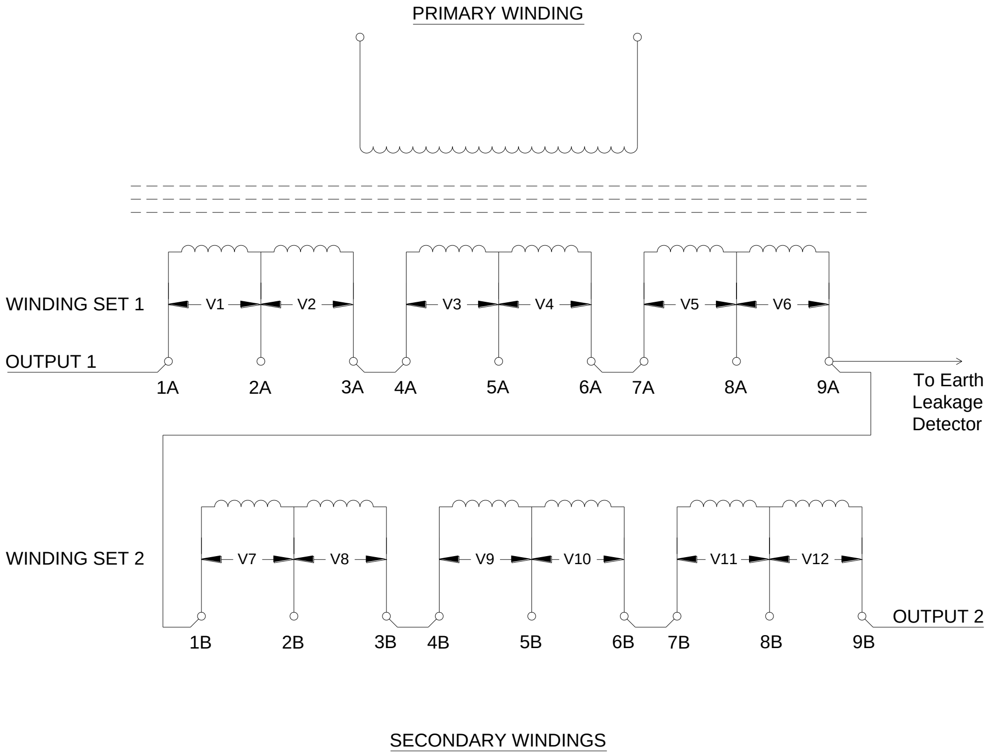


Figure 4-7 6.6A / 12.0A Transformer configured for 6.6A at full voltage

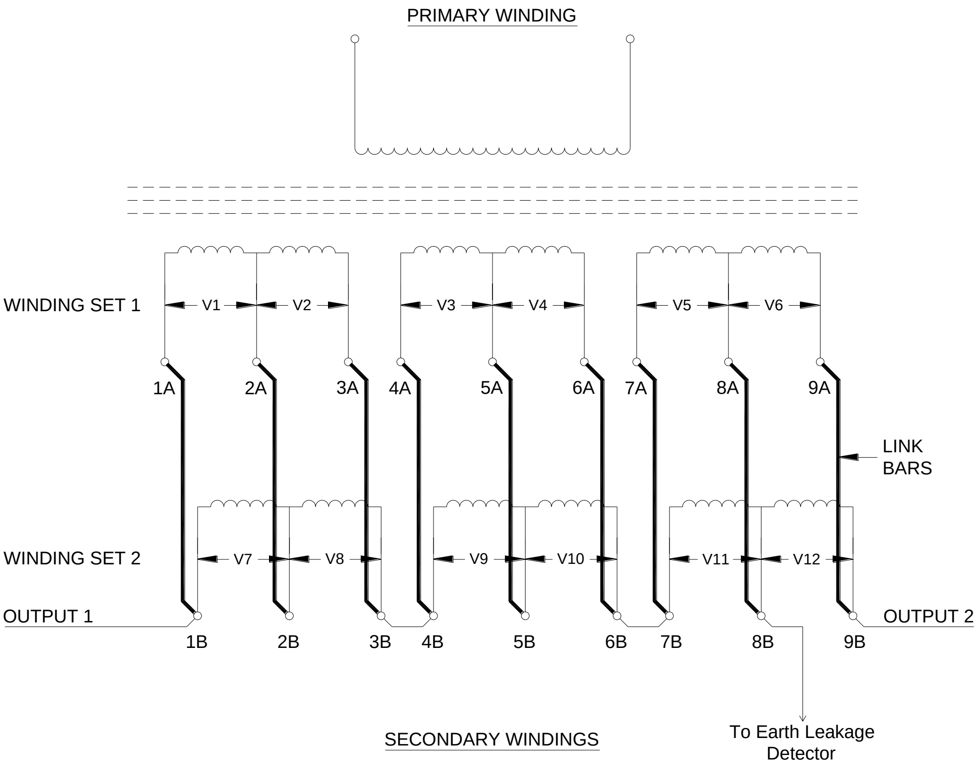


Figure 4-8 6.6A / 12.0A Transformer configured for 12.0A at full voltage

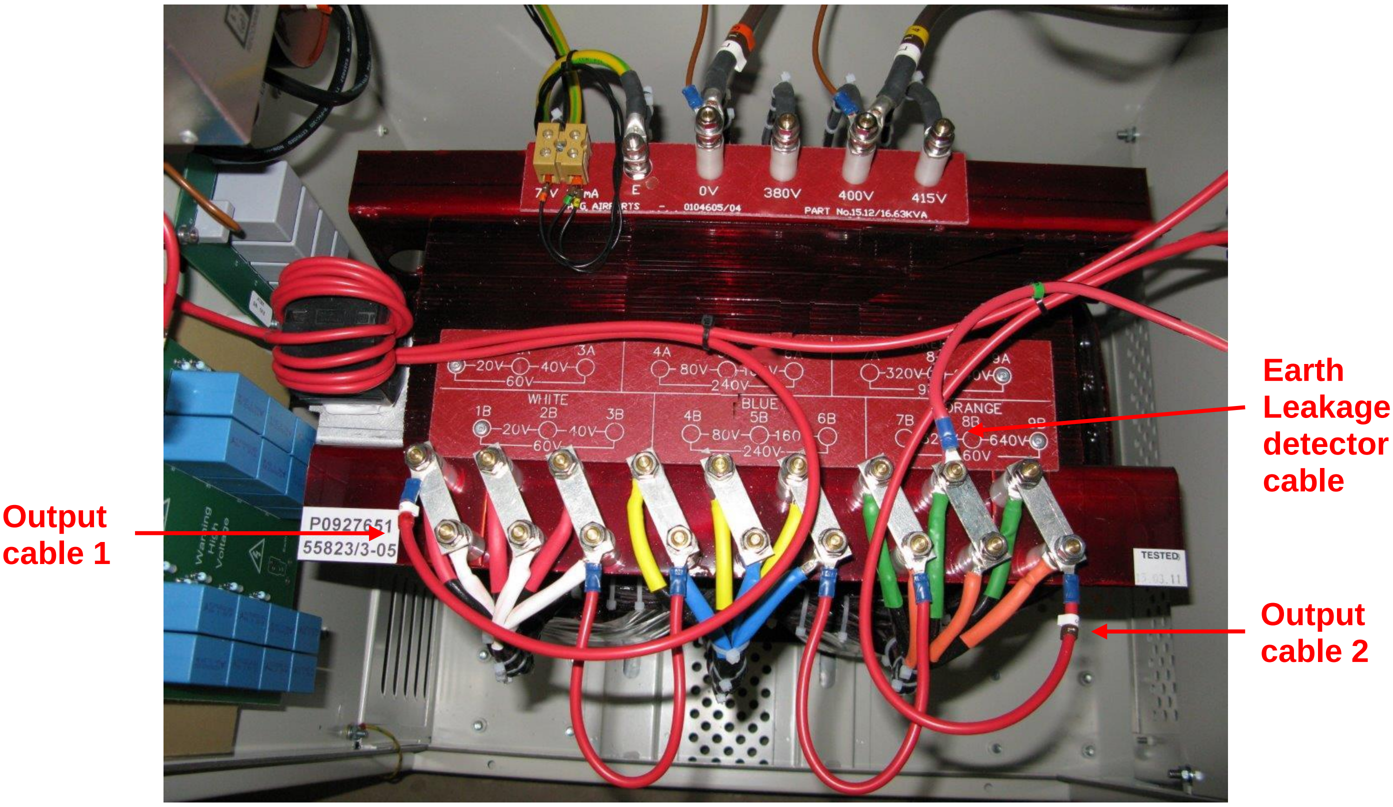


Figure 4-9 Photograph of 6.6A/12.0A Transformer configured for 12.0A, full voltage

To calculate the required CCR output voltage according to the AGL circuit load, refer to Section 8.1

An example of an intermediate output voltage (based on a 6.6A circuit) is shown below. In this case the output voltage is:

$$V4 + V5 + V6 + V10 + V11 + V12$$

Which for a 15kVA regulator is:

$$160 + 320 + 640 + 160 + 320 + 640 = 2240V$$

The transformer connections to give this voltage are shown in Figure 4-10.

Note – when connecting together sections of the secondary windings, ensure that the windings are connected with the correct orientation (phasing), as shown in Figure 4-7 or Figure 4-10. In this way, the voltages from each section will add and not subtract.

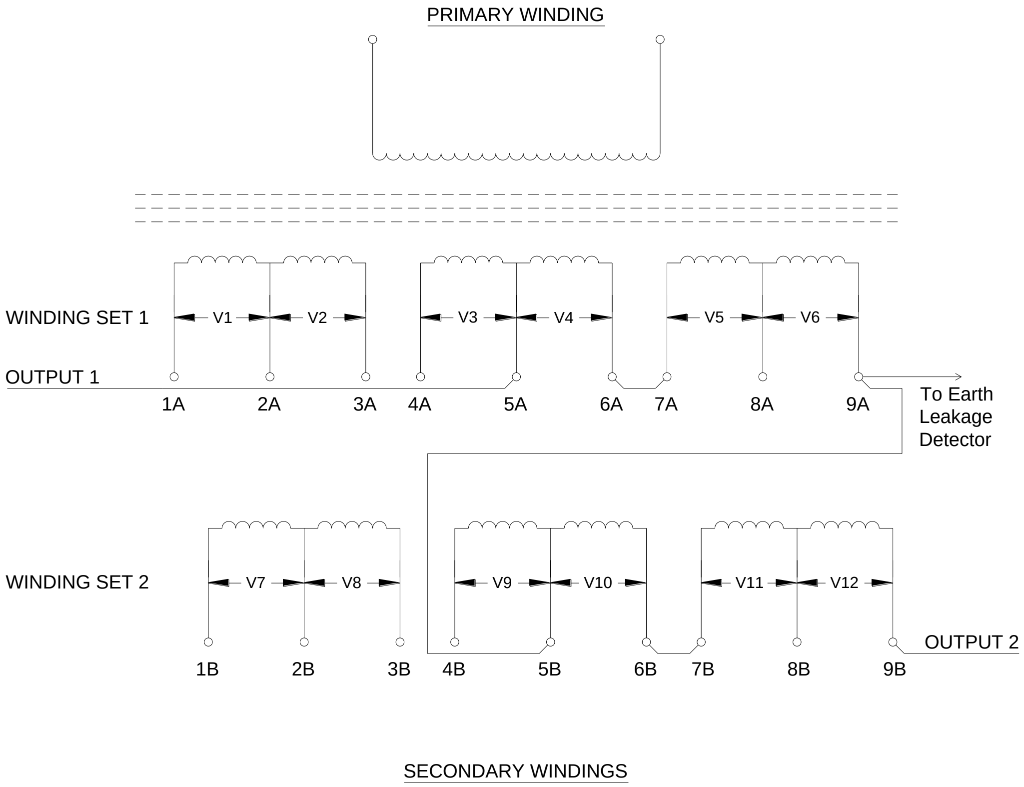


Figure 4-10 6.6A / 12.0A Transformer configured for 6.6A, intermediate voltage

It is important to verify that the transformer output voltage tappings are set to correctly match the load, as described in Section 4.3.3.

4.3.3 Verifying the Transformer Setting

The CCR output voltage should be adjusted to suit the load on the series circuit in order to optimise the supply Power Factor and supply current harmonics.

To verify that the transformer tapping is set correctly, the CCR should be operated at maximum current into the maximum load impedance which will normally be connected.

Before applying mains voltage to the CCR input terminals, open the HT cubicle door and check the main transformer output tapping voltage setting. The output tapping voltage is the sum of all the secondary windings which are connected. (This is normally set to maximum, that is, the rated CCR output voltage, during factory testing of the CCR). The output tapping voltage, as connected, should be programmed in via the keypad in order to obtain an accurate indication on the display of the actual CCR output voltage. Again, this will have been done during factory testing of the CCR. If necessary, this can be checked – refer to Section 4.4.1

Close all the doors and covers, apply power to the CCR, and switch it on at maximum current. Make a note of the displayed CCR output voltage; if it is between 90% and 100% of the selected tapping voltage, then no adjustment to the main transformer secondary tappings will be necessary. If the displayed output voltage is less than 90% of the selected tapping voltage, then the transformer tapping voltage should be reduced.

If, on the other hand, the displayed output voltage is greater than the selected tapping voltage, then the transformer output is too low. In this case the CCR may not be able to deliver maximum current, particularly in conditions of supply voltage dips. The CCR may trip on 'open circuit' or give a 'low current' tolerance alarm.

Isolate the supply to the CCR, and then open the HT cubicle door. Reconfigure the main transformer secondary connections (as described in the previous sections) in order that the total voltage of the winding sections connected in series are at, or just above, the voltage displayed on the front panel during operation at maximum current.

Apply power to the CCR, and whilst in the 'Off' state, program in the connected transformer secondary tapping voltage as described in Section 4.4.1

Switch the CCR on at maximum current, and re-check that the displayed output voltage is at, or lower (by no more than 10%) of, the selected tapping voltage.

4.4 Output Voltage and Output Load Monitoring

The CCR can display output voltage and output load (kVA and kW) by scrolling up from the Running Screen, and can also be programmed to give an alarm signal if the output load kVA drops by 10% or more at any particular brilliancy.

In order that the CCR output voltage and output load can be correctly displayed, the output voltage of the CCR Main Transformer tappings, as connected, should be programmed in via the keypad menu system. This is also important for the correct functioning of the load compensation capacitors. During factory testing, this will have been set to be the maximum output tapping voltage. If the transformer secondary taps have not been changed during commissioning, then no change is required to the programmed value. If adjustment is required, then refer to Section 4.4.1 below.

Refer to Section 4.4.2 to enable the load kVA Alarm.

4.4.1 Programming the Output Transformer Tapping Voltage

To correctly monitor the output voltage and output load of the CCR, the actual tapping voltage used on the Main CCR Output Transformer must be entered. The actual transformer output voltage is the sum of all sections of the transformer secondary windings that are connected in series. Using the example of Figure 4-4, this would be 2065V.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	E	N	T		T	X		O	P		V	O	L	T	S
Y	=	↵		U	S	E	↑	↓		0	0	0	1	V	

It is now possible to load the Output Transformer Tapping Voltage, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The Output Transformer Tapping Voltage can be set between 1 and 5000 Volts. Press the (↵ Enter) button to confirm the setting.

Note - Potentiometer VR5 ‘VOLT CAL’ on the AT733 card is used to calibrate the voltage feedback; this is set during factory testing and should not require further adjustment. Do not adjust VR5 to correct the displayed value if the tapping voltage used has not been correctly programmed in.

4.4.2 KVA Alarm Enable

If ‘Voltage Feedback’ is activated, then ‘KVA Alarm’ can also be enabled. This generates an alarm if the CCR output load kVA drops below 90% of the peak measured load value for the brilliancy step in operation, for a period of 5 seconds.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	K	V	A		A	L	A	R	M					↑	↓
					E	N	A	B	L	E	D				

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED & DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

4.5 Commissioning the Earth Leakage Measurement System

Each AGL lamp module is isolated from the high voltage primary series loop circuit by an AGL transformer. The joints connecting the primary windings of these AGL transformers to the series loop cables tend to leak and allow water to penetrate into the transformer. This causes earth faults on the primary loop internally within the transformer, or from the cable joint itself to earth.

This causes two problems:

i) If more than one earth fault develops, then sections of the AGL circuit between the faults can be shorted out. This results in reduced brilliancy levels, or sections of the lamp circuit may switch off altogether.

ii) More importantly, having an earth leakage path presents a safety hazard. The CCR output circuit is isolated from the mains power supply and from earth by the CCR main power transformer. However, if there is leakage to earth at one or more points in the primary series field circuit there will now be a potential difference between other sections of the circuit and earth, and this could be up to several thousand volts for a high power regulator. If personnel come into contact with the high voltage cables under these conditions, this could, depending on the earth leakage resistance and hence the level of current flow through the contactee, result in a lethal electric shock.

For these reasons, it is necessary to detect earth faults before they become a problem.

This section describes commissioning of the **atg airports** Analogue Earth Leakage Resistance Measurement system which is available as an option on the Micro 200. This system, based on the AT699 card, provides a measurement of the resistance to earth of the Primary Series Loop Circuit using two test modes:

i) Continuously when the CCR is operating (and optionally in standby), using a test voltage of 500V DC.

ii) Manual test using a voltage of 1000V DC. Note - this test is only available when the CCR is set to “OFF”. (Performance of this test is described in Section 9.2.2).

The Micro 200 CCR can be configured to carry out 500V DC testing both while operating and in standby by selecting the ‘CONT ANALOGUE’ type of testing (see section 9.4.2.11 Earth Leakage Detection Type).

Two resistance alarm thresholds are provided, the levels of which can be individually set. The Stage 1 Alarm and Stage 2 Alarm / Trip Threshold levels should be set according to the CCR kVA rating and the Primary Series Loop Circuit characteristics. For reasons of safety, it is recommended that the Stage 2 threshold is programmed to trip the CCR.

The actual resistance measurement circuit is calibrated during factory testing and does not require adjustment during commissioning of the CCR. Note – the continuous 500V DC test is for indication only; for accurate measurements the 1000V DC manual test should be used.

4.5.1 Calculation of Earth Leakage Resistance Alarm and Trip points

The first part of the commissioning procedure involves the calculation of the desired (Stage 1) Alarm and (Stage 2) Trip thresholds. These should be set according to the CCR rating, and to match the particular AGL Primary Series Loop Circuit.

For an AGL Primary Series Loop Circuit WITHOUT a breakdown of the insulation to earth, the leakage resistance is dependent on the total number of AGL transformers fitted, and the total length of the AGL cable.

4.5.1.1 Calculation of Stage 1 Alarm Threshold

Calculate the Stage 1 Alarm Threshold Resistance as follows:

Stage 1 Alarm Threshold Resistance (Ω) = (1.5 x Maximum CCR output voltage) / ((0.4µA x number of AGL transformers) + (0.01µA x total cable length in km))

The resulting resistance value should be programmed in as described in Section 4.5.2.2.

An example calculation is shown below:

An 8km long series loop circuit is fitted with 200 AGL transformers, and powered from a 7.5kVA regulator. The circuit is rated at 6.6A.

The maximum CCR output voltage is 1147V (when operating at 6.6A).

Stage 1 Alarm Threshold Resistance (Ω) = (1.5 x 1147V) / ((0.4µA x 200) + (0.01µA x 8))

Stage 1 Alarm Threshold Resistance (Ω) = 1720.5V / ((80 x 10^{-6}) + (0.08 x 10^{-6}))A

Stage 1 Alarm Threshold Resistance (Ω) = 21.5MΩ

Owing to the programming steps, the threshold should be set to 20MΩ

4.5.1.2 Calculation of Stage 2 Trip Threshold

The Stage 2 Trip Threshold should be set so as to limit the maximum current that could be conducted to anybody who may come into contact with the AGL Series Loop cables to a level below 10mA. This is the threshold of let go, and therefore the contactee should be able to disengage before a fatal electric shock is received. It is recommended, therefore, that the Stage 2 Threshold should be programmed to trip out the CCR, rather than just triggering an alarm. See Section 4.5.2.2

NOTE – THE OPERATION OF THE EARTH LEAKAGE RESISTANCE MEASUREMENT CIRCUITRY DOES NOT GUARANTEE THAT THE HIGH VOLTAGE OUTPUT FROM THE CONSTANT CURRENT REGULATOR WOULD BE CUT BEFORE A LETHAL ELECTRIC SHOCK COULD BE RECEIVED BY PERSONNEL COMING INTO CONTACT WITH THE PRIMARY SERIES LOOP CONDUCTORS. THE EARTH LEAKAGE MODULE IS DESIGNED ONLY AS AN AID TO SAFETY.

NORMAL SAFE WORKING PROCEDURES SHOULD ALWAYS BE STRICTLY ADHERED TO. BEFORE WORKING ON THE PRIMARY SERIES LOOP CABLING, OR ANY AGL TRANSFORMERS CONNECTED TO THE PRIMARY SERIES LOOP, ENSURE THAT THE CCR FEEDING THE CIRCUIT IS SWITCHED OFF, AND THAT THE MAINS POWER TO THE CCR IS ISOLATED AND LOCKED OFF. IT IS ALSO RECOMMENDED TO CONNECT THE AGL FIELD CABLES TO EARTH TO DISSIPATE ANY STORED CHARGE OR INDUCED EMF.

The Stage 2 Trip Threshold should be calculated as follows:

Stage 2 Trip Threshold Resistance (Ω) = Maximum CCR output voltage / I_B

Where I_B = maximum body current, 10mA

The resulting resistance value should be programmed in as described in Section 4.5.2.2.

An example based on a 7.5kVA regulator operating on a 6.6A circuit would give:

Stage 2 Trip Threshold Resistance (Ω) = 1147V / 10mA

Stage 2 Trip Threshold Resistance (Ω) = 115kΩ

Owing to the programming steps, the threshold should be set to 120kΩ

4.5.2 Programming the Earth Leakage System

4.5.2.1 Stage 2 Earth Leakage Trip Selection

The Stage 2 Earth Leakage Resistance Threshold can be programmed either to activate an alarm or to trip out the CCR. For reasons of safety, **atg airports** recommend that the Stage 2 Earth Leakage Threshold should be set to trip out the CCR. This functionality is programmed as follows:

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	T	R	I	P		O	N		E	A	R	T	H		2
				E	N	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line:

	T	R	I	P		O	N		E	A	R	T	H		2
→				E	N	A	B	L	E	D					

The setting can now be selected between ENABLED and DISABLED using the (↑) and (↓) buttons. Setting to 'ENABLED' will cause the CCR to trip on Stage 2 Earth Fault.

Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

4.5.2.2 Programming the Earth Leakage Resistance Alarm and Trip Points

The following screens are only available if the optional Analogue Earth Leakage Resistance Measurement Module is fitted and the CCR is programmed for 'ANALOGUE' or 'CONT. ANALOGUE' Earth Leakage type. If for any reason the screens are not available, refer to Section 9.4.2.11.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) or (↓) buttons to scroll to the following screen:

→	E	A	R	T	H		L	E	A	K	A	G	E	↑	↓
	S	T	A	G	E		1				2	0		M	Ω

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. Use the (↑) or (↓) buttons to set the Stage 1 Alarm threshold resistance anywhere between 4kΩ and 50 MΩ, or to DISABLE the alarm.

Press the (↵ Enter) button to accept the setting. The arrow will return to the top left-hand corner of the screen.

To set the Stage 2 Trip Threshold, press the (↓) buttons to scroll to the following screen:

→	E	A	R	T	H		L	E	A	K	A	G	E	↑	↓
	S	T	A	G	E		2			1	2	0		k	Ω

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. Use the (↑) or (↓) buttons to set the Stage 2 Trip threshold resistance anywhere between 4kΩ and 50 MΩ, or to DISABLE the alarm.

Press the (↵ Enter) button to accept the setting. The arrow will return to the top left-hand corner of the screen.

4.6 Commissioning the Percentage Lamp Failure System

The Percentage Lamp Failure System is available as an option on the Micro 200 CCR. This system is based on the AT923 PLF Card, which if this option is selected, will be mounted behind the CCR lower front door. The card generates an error voltage that is a function of the number of failed lamps on the AGL circuit.

The system is designed to be used with AGL transformers feeding tungsten lamps. LED fittings may not behave in the same way if the fitting develops a fault unless they specifically include a facility to open circuit the input of the light fitting in the event of a fault. Only in the latter case would the PLF system operate correctly with a circuit composed of LED fittings.

An AGL circuit with all the lamps working is largely resistive; however, when lamps fail the load becomes more inductive due to the open circuited ground transformer now presenting an inductive load. This change in the total AGL primary series loop circuit characteristic can be detected by the PLF card, which produces an error voltage that can be used to give an indication of the number of failed lamps on the circuit.

The PLF card is also used for capacitive current detection.

The following sections describe how to commission the PLF system.

Note – the characteristic of the series loop circuit (as regards the behaviour of the PLF system) changes dependant on the condition of the ground, particularly whether the ground is wet or dry. It is therefore recommended to recalibrate the PLF system every 6 months, especially after a change in weather conditions.

4.6.1 AT923 Card Settings

The AT923 PLF card monitors the CCR output voltage and output current waveforms for distortion caused by the load becoming inductive when lamps fail open circuit. Threshold levels on the card are set to monitor the part of the waveform most likely to be affected by this distortion in order to maximise the discrimination in error voltage between operating with all lamps intact and that with a proportion of lamps open circuited. Note – depending on the exact characteristics of the AGL circuit, some ‘tuning’ of the threshold levels may be required for best performance; see Section 4.6.3.

PLK2 on the AT923 should be fitted in position B for high sensitivity (standard setting), which detects up to a maximum of around 10% lamp outage, or position A, for a range up to around 30%.

The initial threshold settings listed in Table 4-8 should be checked before attempting to commission the PLF system. This should be done with the regulator powered up, but in the ‘OFF’ state. A digital voltmeter will be required to check these; set it to read DC volts (up to 20 volts) and measure the voltage on the specified test point, using TP11 on the AT923 card (next to VREG2) as the 0v connection.

Description	Test Point	Adjusting Potentiometer	Threshold setting
Voltage waveform rising edge comparator threshold (VTH)	TP5	VR4 (VTH)	–7.5v DC +/- 0.1v
Current waveform rising edge comparator threshold (ITH)	TP6	VR5 (ITH)	–7.0v DC +/- 0.1v

Table 4-8 AT923 Percentage Lamp Failure Card initial settings

With all lamps intact on the AGL circuit, use the CCR front panel rotary switch to operate the CCR at maximum current. Using the DVM, measure the (DC) error voltage produced at TP3. Make a record of this voltage level; it will later be compared with the error voltage levels produced with a number of lamps open circuited to match the desired alarm points – see Section 4.6.2.1. If the error discrimination between all lamps intact and the desired number of lamps open circuited is not greater than around 0.8V (normally it will be several volts), then adjustment of the comparator threshold levels will be necessary, as described in Section 4.6.3. This will require the use of an oscilloscope, preferably 4 channel, but with a minimum of 2 channels.

4.6.2 Programming for Analogue Input PLF Operation

First, it will be necessary to program the PLF Monitoring Configuration for ‘ANALOGUE IP’ operation.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen (note – the second line may already read ‘ANALOGUE IP’ if the settings have been changed from the default setting):

→	%		L	A	M	P		F	A	I	L			↑	↓
			D	I	S	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. Using the (↑) (↓) buttons, scroll through until ‘ANALOGUE IP’ is displayed on the bottom line. Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

→	%		L	A	M	P		F	A	I	L			↑	↓
			A	N	A	L	O	G	U	E		I	P		

Next, program in the total number of lamps fitted to the AGL series loop circuit.

Use the (↓) button to scroll down to the following screen:

→	N	U	M		O	F		L	A	M	P	S		↑	↓
				x	x	x									

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. Enter the total number of lamps on the circuit, one digit at a time, by using the (↑) (↓) buttons and confirm by pressing the (↵ Enter) button. The permissible setting is between 1 and 400. The arrow will return to the top left-hand corner of the screen after all 3 digits have been set.

Next, set the Stage 1 PLF Alarm threshold level.

Use the (↓) button to scroll down to the following screen:

→	P	L	F		L	I	M	I	T		1			↑	↓
		x	x	x		(	x	x	x	%	)				

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The number of failed lamps required to trigger a Stage 1 PLF alarm can now be set by counting up or down using the (↑) (↓) buttons. Note - the corresponding figure for the Percentage of Lamps Failed on the circuit will be calculated and displayed at the same time.

Confirm the setting by pressing the (↵ Enter) button twice, or alternatively, press the (↵ Enter) button once to move to the percentage display. The alarm threshold can now be set as a Percentage of Lamps Failed by counting up or down using the (↑) (↓) buttons. The corresponding figure for the number of lamps failed will be calculated and displayed at the same time. Confirm the setting by pressing the (↵ Enter) button once.

Next, set the Stage 2 PLF Alarm threshold level.

Use the (↓) button to scroll down to the following screen:

→	P	L	F		L	I	M	I	T		2			↑	↓
		x	x	x		(	x	x	x	%	)				

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The number of failed lamps required to trigger a Stage 2 PLF alarm can now be set by counting up or down using the (↑) (↓) buttons. Note - the corresponding figure for the Percentage of Lamps Failed on the circuit will be calculated and displayed at the same time.

Confirm the setting by pressing the (↵ Enter) button twice, or alternatively, press the (↵ Enter) button once to move to the percentage display. The alarm threshold can now be set as a Percentage of Lamps Failed by counting up or down using the (↑) (↓) buttons. The corresponding figure for the number of lamps failed will be calculated and displayed at the same time. Confirm the setting by pressing the (↵ Enter) button once.

If the setting selected for either of the thresholds above is different to the calibration levels used (see next section), then the following screen is displayed:

C	A	L	.		A	T		T	R	I	P		P	T	.
		F	O	R		A	C	C	U	R	A	C	Y		

Press the (↵ Enter) button once more to return to the previous screen.

4.6.2.1 Calibrating the PLF System

The PLF system requires calibrating by sampling the error signal at two levels of open circuit lamps; the error voltage can then be calculated for all levels in between. It is recommended, however, that for the most accurate operation, the calibration be done with the number of lamps removed / AGL transformers open circuited that correspond to the two alarm points (2 Stages) that will be used.

WARNING – always turn the CCR off and isolate the power supply, and it is recommended to earth down the AGL cables at the CCR output before connecting or disconnecting AGL transformers and / or AGL lamps. The open circuited secondary connections from an AGL transformer can generate high voltages. Ensure that these connections are well insulated during this test, and that personnel do not come into contact with them.

i/ Switch off the CCR and isolate the power supply. Remove a number of lamps from the field circuit or connect additional AGL transformers in series with the CCR output (same VA rating as those in the field circuit, with the secondary connections open circuited). The number of lamps removed (or open circuit transformers connected) should preferably correspond to the lower of the required alarm points (Stage 1 PLF), programmed as described in Section 4.6.2, above.

Turn the power to the CCR back on, but leave the rotary switch in the ‘Off’ position. Connect the DVM, set to read DC volts (up to 20 volts) to TP3 on the AT923 PLF Card (use TP11 - next to VREG2 - as the 0v connection). Set the CCR front panel rotary switch to operate the CCR at maximum current, and record the error voltage measured. Providing that the difference in the error signal between all lamps intact (as measured in Section 4.6.1) and that with the number of lamp(s) open circuited corresponding to the first alarm point is greater than around 0.8V, then continue with the set-up described below. Otherwise, the AT923 PLF Card threshold levels will have to be ‘tuned’ to match the AGL circuit characteristics, as described in Section 4.6.3

Return the CCR front panel rotary switch to ‘OFF’. Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		P	L	F		↑	↓
	I	N	P	U	T	?							Y	=	↵

Press the (↵ Enter) button; the screen will change to:

A	L	A	R	M		S	T	A	G	E		T	O		
C	A	P	T	U	R	E	:		S	1		↑	↓		↵

If necessary, use the (↑) or (↓) buttons to select level ONE; Confirm by pressing the (↵ Enter) button; the screen will change to:

E	N	T		N	U	M		O	C		L	A	M	P	S
S	1		Y	=	↵		U	S	E	↑	↓				5

Use the (↑) or (↓) buttons to set the number of lamps removed / AGL transformers open circuited for this calibration point, and confirm by pressing the (↵ Enter) button. If the setting used is different to that programmed for the PLF Limit 1 alarm threshold set in Section 4.6.2 above, then the following screen will be displayed:

C	A	L	.		A	T		T	R	I	P		P	T	.
		F	O	R		A	C	C	U	R	A	C	Y		

Press the (↵ Enter) button; the screen will change to:

	C	C	R		W	I	L	L		S	T	A	R	T	
	C	O	N	T	I	N	U	E	?			Y	=	↵	

Press the (↵ Enter) button again. The CCR will switch on and the screen will change to:

	P	R	E	S	S		↵		T	O					
	C	A	P	T	U	R	E		I	/	P				

Press the (↵ Enter) button again, and the auto-calibration routine will record the PLF Card error voltages for level one calibration. After running and automatically recording the error voltage at all Brilliancy levels above half maximum current, the CCR will switch off, and the screen will revert back to the 'Calibrate PLF' screen.

ii/ Repeat the procedure for the second calibration point, as follows.

Switch off the CCR and isolate the power supply. Remove a number of lamps from the field circuit or connect additional AGL transformers in series with the CCR output (with the secondary connections open circuited). The number of lamps removed (or open circuit transformers connected) should preferably correspond to the higher of the required alarm points (Stage 2 PLF), programmed as described in Section 4.6.2 above.

Turn the power to the CCR back on, but leave the rotary switch in the 'Off' position. Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		P	L	F		↑	↓
	I	N	P	U	T	?							Y	=	↵

Press the (↵ Enter) button; the screen will change to:

A	L	A	R	M		S	T	A	G	E		T	O		
C	A	P	T	U	R	E	:		S	1		↑	↓		↵

Use the (↑) or (↓) buttons to select level TWO; Confirm by pressing the (↵ Enter) button; the screen will change to:

E	N	T		N	U	M		O	C		L	A	M	P	S
S	2		Y	=	↵		U	S	E	↑	↓			1	0

Use the (↑) or (↓) buttons to set the number of lamps removed / AGL transformers open circuited for this calibration point, and confirm by pressing the (↵ Enter) button. If the setting used is different to that programmed for the PLF Limit 2 alarm threshold set in Section 4.6.2 above, then the following screen will be displayed:

C	A	L	.		A	T		T	R	I	P		P	T	.
		F	O	R		A	C	C	U	R	A	C	Y		

Press the (↵ Enter) button; the screen will change to:

	C	C	R		W	I	L	L		S	T	A	R	T	
	C	O	N	T	I	N	U	E	?			Y	=	↵	

Press the (↵ Enter) button again. The CCR will start and the screen will change to:

	P	R	E	S	S		↵		T	O					
	C	A	P	T	U	R	E		I	/	P				

Press the (↵ Enter) button again, and the auto-calibration routine will record the PLF Card error voltages for level two calibration. After running and automatically recording the error voltage at all Brilliancy levels above half maximum current, the CCR will switch off, and the screen will revert back to the ‘Calibrate PLF’ screen.

To exit from the screen, press the (X Clear) button.

Turn the CCR off and isolate the supply. Remove the test AGL transformers from the circuit, if used, and replace any AGL lamps that were removed.

4.6.3 Optimising the AT923 Card Threshold Levels to match the AGL circuit

This section describes how to adjust the comparator threshold levels on the AT923 Card to maximise the discrimination of the error signal between all lamps intact and that with lamps open circuited. It requires the use of an oscilloscope, preferably with 4 channels, but as a minimum 2 channels.

The following oscilloscope traces illustrate how to optimise these AT923 card settings. They were captured on a 12A Micro 200 CCR at 2 different current levels, with either all lamps intact or with 1 lamp open circuit. The traces on each waveform are as follows:

Channel 1 (yellow): AT923 TP10 – CCR output voltage waveform after rectification and automatic gain control (AGC) applied. (Leading waveform).

Channel 2 (blue): AT923 TP8 – CCR output current waveform after rectification and automatic gain control (AGC) applied. (Lagging waveform).

Channel 3 (violet): AT923 TP12 – Error signal produced at comparator output (held low if no error; goes high for period dependant on number of failed lamps).

Channel 4 (green): AT923 TP3 – Error voltage (average, after smoothing).

The 0V level for all traces is in the centre of the screen.

Referring to the oscilloscope traces below, Figure 4-11 has no error signal (held low), since all lamps are intact, whereas in Figure 4-12 the signal at TP12 goes high for a period of around 1mS, thus raising the error voltage at TP3 (to 6.9V). TP12 goes high after the (rising) voltage waveform at TP10 crosses its' comparator threshold, which is set at -6.0V (measured at TP5, adjusted by VR4 / VTH). TP12 remains high until the (rising) current waveform at TP8 crosses its' comparator threshold, which is set at -8.0V (measured at TP6, adjusted by VR5 / ITH).

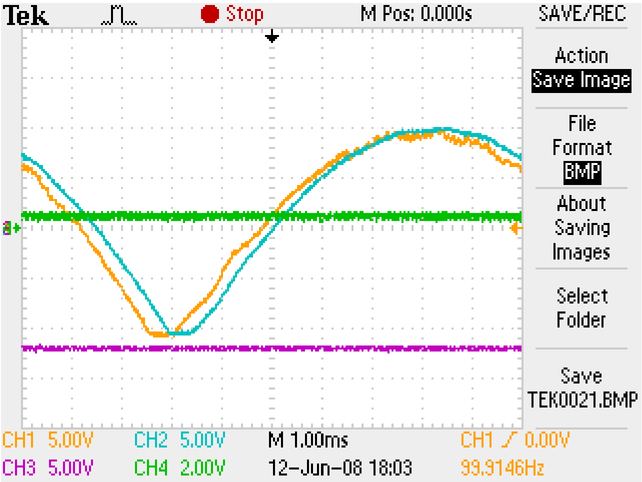


Figure 4-11 12A CCR running at 12A, all lamps intact

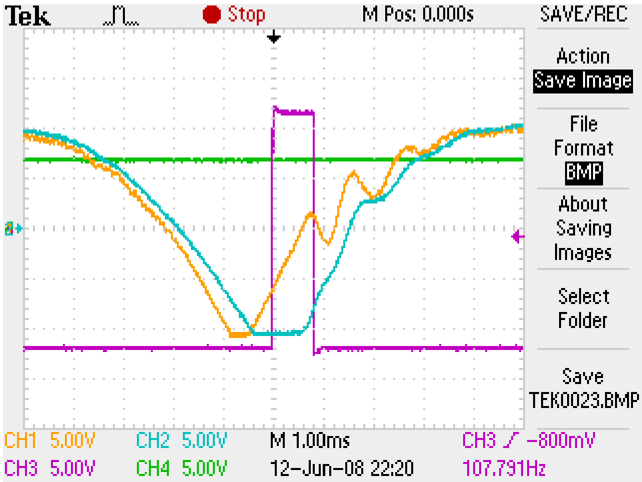


Figure 4-12 12A CCR running at 12A, 1 lamp open circuit

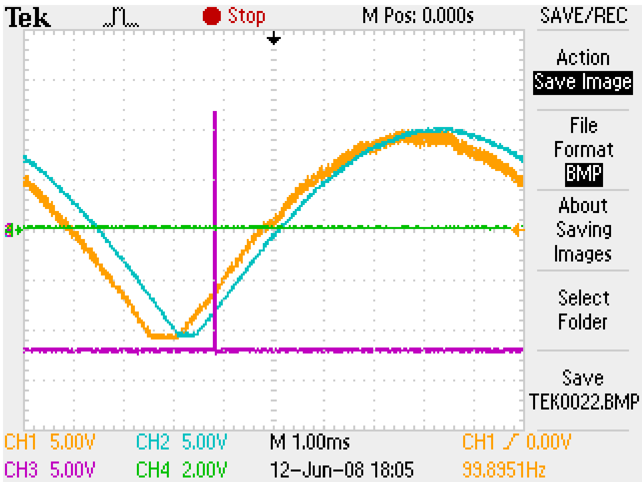


Figure 4-13 12A CCR running at 6.54A, all lamps intact

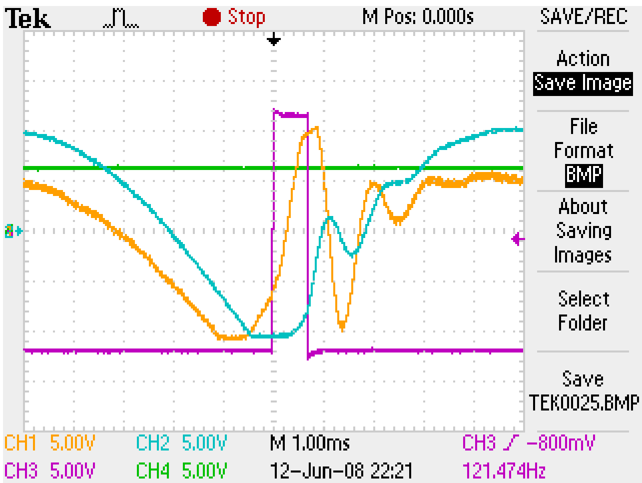


Figure 4-14 12A CCR running at 6.54A, 1 lamp open circuit

Note – all of the above traces were taken with the factory threshold levels set, as per Table 4-9 below. As can be seen, the error signal varies slightly with the CCR operating current.

Optimising the PLF system involves varying the comparator threshold levels for the waveforms of voltage and current in order to maximise the time period when TP12 goes high when the circuit becomes more inductive due to lamps failing. The system measures the period that the voltage waveform is leading that of the current waveform; TP12 goes high when the voltage waveform crosses its comparator threshold, and goes low when the current waveform crosses its comparator threshold. On the other hand, when all lamps are intact the threshold settings should be such that TP12 should either be held low, or better still, go momentarily high at certain output current levels (as per Figure 4-13). Setting the threshold levels just to the point of producing a small error signal with all lamps intact - possibly just at certain levels of current - is recommended, since any small change in circuit inductance due to lamps failing would produce a reasonable error signal.

Optimising the error signal requires adjusting the threshold levels to focus in on the area of the (rectified) waveforms for voltage and current where there is maximum distortion and divergence (the rising edge of the voltage waveform starts to lead the current waveform) as the load becomes more inductive due to failed lamps. The system should be optimised at maximum current, and at the next current step above half maximum output current. (The latter is the minimum step at which the auto-calibration routine samples the error voltage - see Section 4.6.2.1).

Depending on the AGL circuit, there may be some resonant effects, particularly when lamps have failed open circuit – this can be seen in Figure 4-14. In some cases (although not with this example circuit), this may mean that the factory threshold settings may not produce the best results, and makes tuning the system more difficult.

Table 4-9 lists the threshold level monitoring test points and adjustment potentiometers. Use TP11 on the AT923 card (next to VREG2) as the 0v connection.

Description	Test Point	Adjusting Potentiometer	Factory Threshold setting
Voltage waveform rising edge comparator threshold (VTH)	TP5	VR4 (VTH)	–7.5v DC +/- 0.1v
Current waveform rising edge comparator threshold (ITH)	TP6	VR5 (ITH)	–7.0v DC +/- 0.1v

Table 4-9 AT923 Percentage Lamp Failure Card adjustments

4.6.4 Capacitive current detection threshold setting

The capacitive current detection threshold level is factory preset and should not require adjustment. The threshold voltage level can be measured on TP14 on the AT923 PLF card; the default setting is 7.4V. If it is necessary to change the level, then turn the rotary switch SW2; turning clockwise will increase the voltage threshold level, and therefore the level of capacitive current before the CCR will trip. (Fine adjustment can be made by adjusting VR2).

5 4-20mA Current Loop Meter - Current or Power Measurement

Fitting of a 4-20mA current loop meter is optional on the Micro 200. This can be configured to give CCR output current (true rms) or output power measurement. For CCRs built to the AENA specification, this unit is fitted and configured for power measurement.

The output connections are taken from the AT777 4-20mA Output Filter Card mounted in the control terminal box at the back of the CCR. The 4 –20mA output can be loop powered or powered from the transducer modules internal 24V supply. For a loop powered system, links LK1 and LK2 on the AT777 Card are fitted in position ‘A’, this configuration is shown in Figure 5-1 below. (Note – this configuration is used on BAA specification regulators).

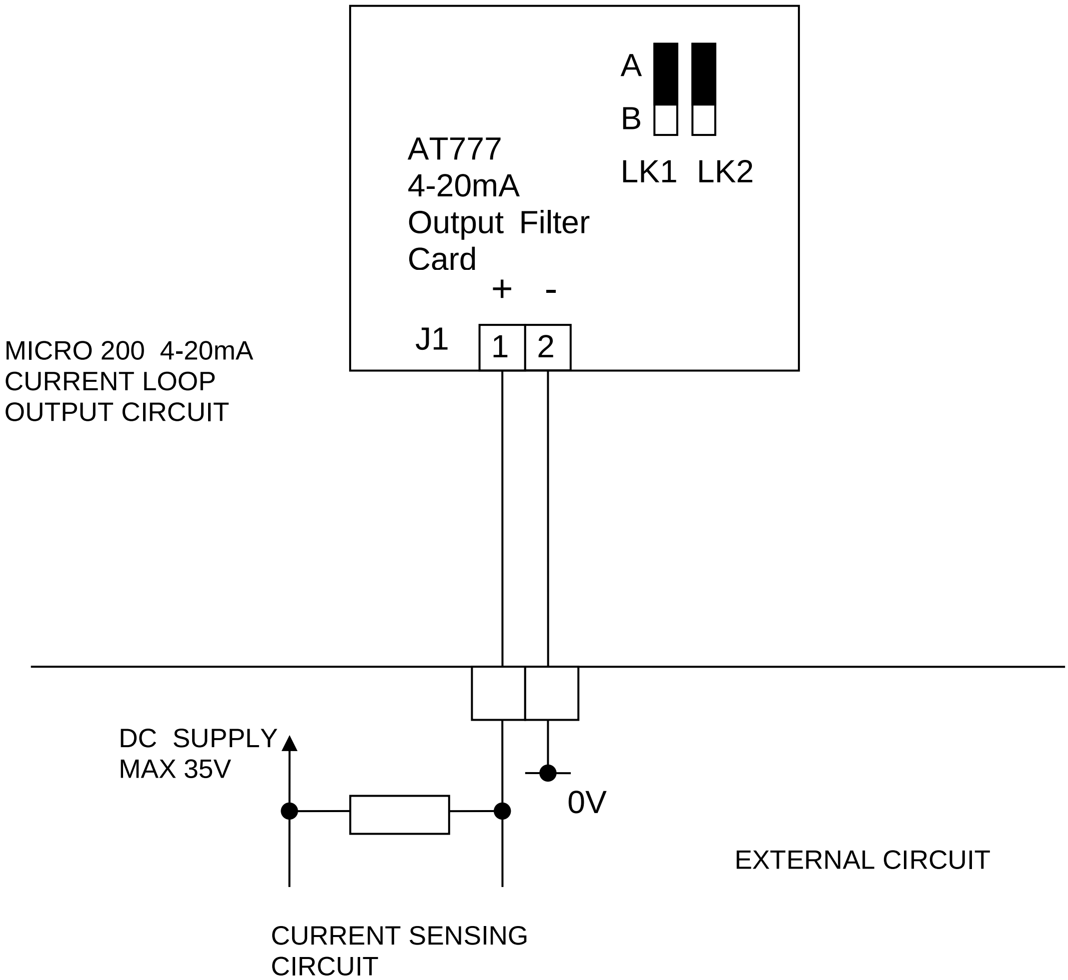


Figure 5-1 Loop powered 4 – 20mA output configuration

To use the AT777 Card's internal 24V supply, links LK1 and LK2 on the AT777 Card are fitted in position 'B', this configuration is shown in Figure 5-2 below. (Note – this configuration is used on AENA specification regulators).

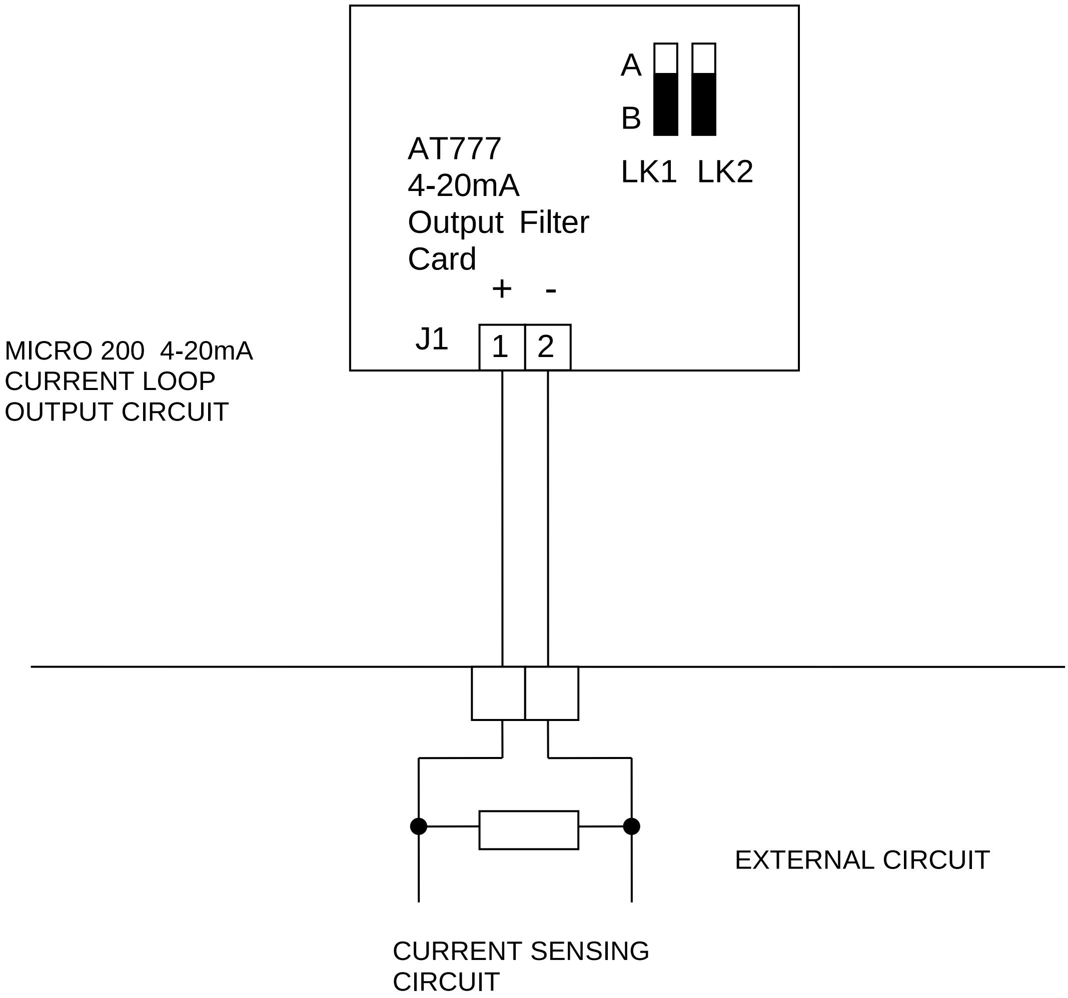


Figure 5-2 4 – 20mA output configuration using the AT777 internal supply

6 Output Lightning Arrestors

Output Lightning Arrestors are available as an option on the Micro 200. These are fitted in place of the standard CCR HT output terminals, and function both as the CCR output terminal and the Output Surge Protective Device (SPD). Each Lightning Arrestor terminal consists of a high power MOV and a terminal bar clamp. The assembly meets the impulse surge requirements of IEC 61822 and FAA Advisory Circular 150/5345-10F.

Figure 6-1 below shows a 2-pole Output Lightning Arrestor Terminal; more poles can be fitted for CCRs which include integral Circuit Selector Switches. The Lightning Arrestor base plate should be earthed with a cable having a cross sectional area of at least 35 mm^2.

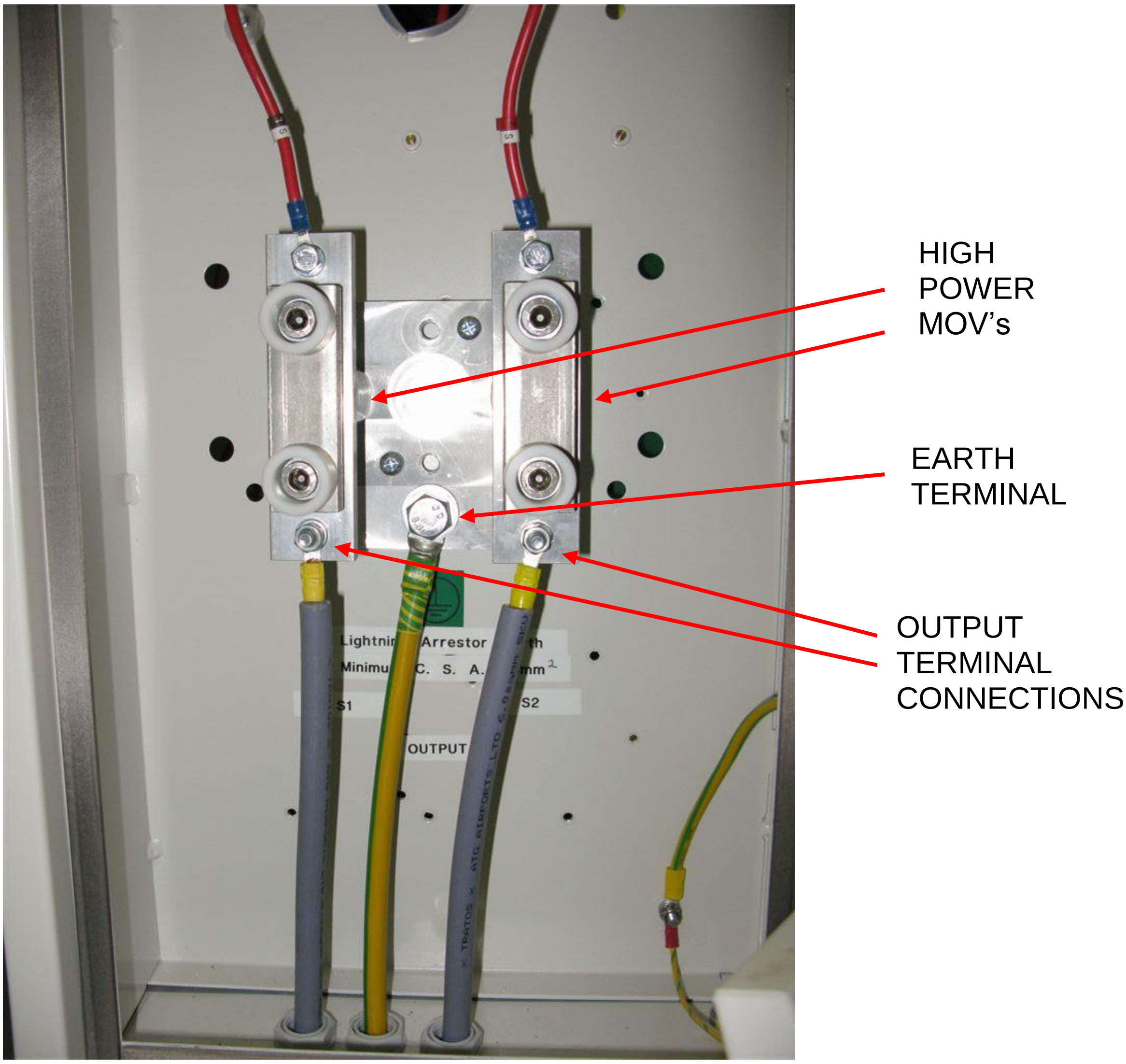


Figure 6-1 Output Lightning Arrestor Terminal

7 Cutout Switch

The Cutout Switch, which is available as an option on the Micro 200, is a three position plug-in switch / connector which is designed to facilitate safe working on the CCR and the AGL field circuit for maintenance purposes. By using the Cutout Switch to short together and earth down the field circuit (after first isolating the supply to the regulator), any induced voltages on the field circuit cables will be dissipated and so the conductors made safe to work on. The MKV Cutout Switch complies with IEC 61822:2009 and AENA DIN/DSEYN/PPT/002-05/13.

The Cutout Switch is usually mounted in the HT terminal box at the rear of the regulator, although on Micro 200 CCRs fitted with Alternate or 2 Way Simultaneous Circuit Selector Switches, two Cutout Switches may be mounted in a lockable enclosure fitted on top of the CCR.

WARNING – HIGH VOLTAGES – UP TO 2500V FOR A 15kVA REGULATOR – ARE PRESENT WITHIN THE HT TERMINAL BOX AND HT COMPARTMENT. THE COVERS TO THESE COMPARTMENTS SHOULD NEVER BE OPENED WITHOUT FIRST ISOLATING THE REGULATOR MAINS SUPPLY INPUT

Figure 7-1 below shows a Cutout Switch mounted above the CCR lightning arrestor / output terminals in the HT Terminal box of a Micro 200 CCR.

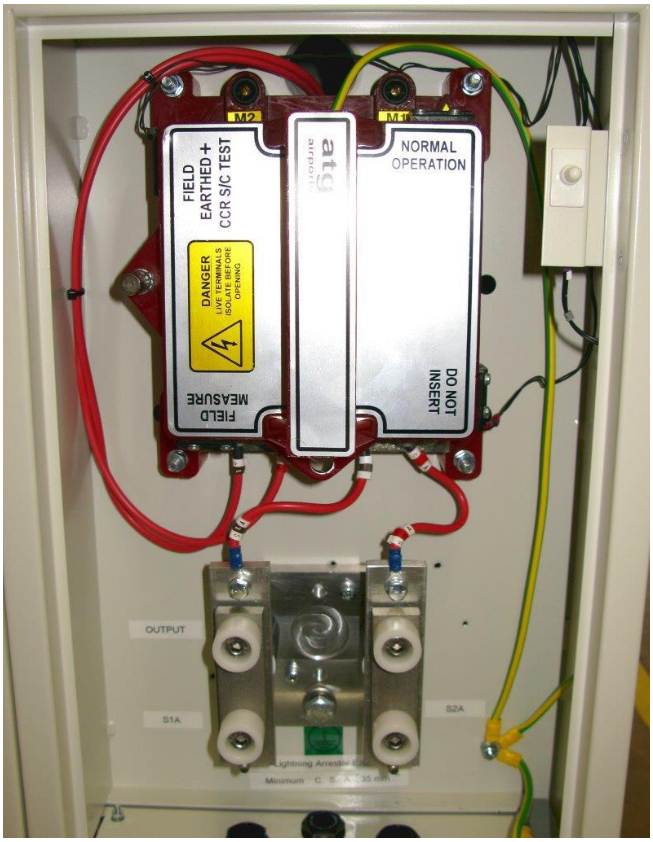


Figure 7-1 Cutout Switch mounted in CCR HT Output Terminal box

The Cutout Switch can be fitted with magnetic reed switches to give positional feedback; the reed switches work in conjunction with the optional AT726 Cutout Switch Relay Card. When these are fitted, removal of the Cutout Switch lid will prevent the CCR contactor from energising. Additionally, for units built to the AENA specification (Spanish market), Back Indication is given via the control connector that the Cutout Switch is in the test position.

Figure 7-2 below shows the outline of the Cutout Switch, and identifies the cable connections. M2 and M1 are 4mm test terminals – see Section 7.1.3

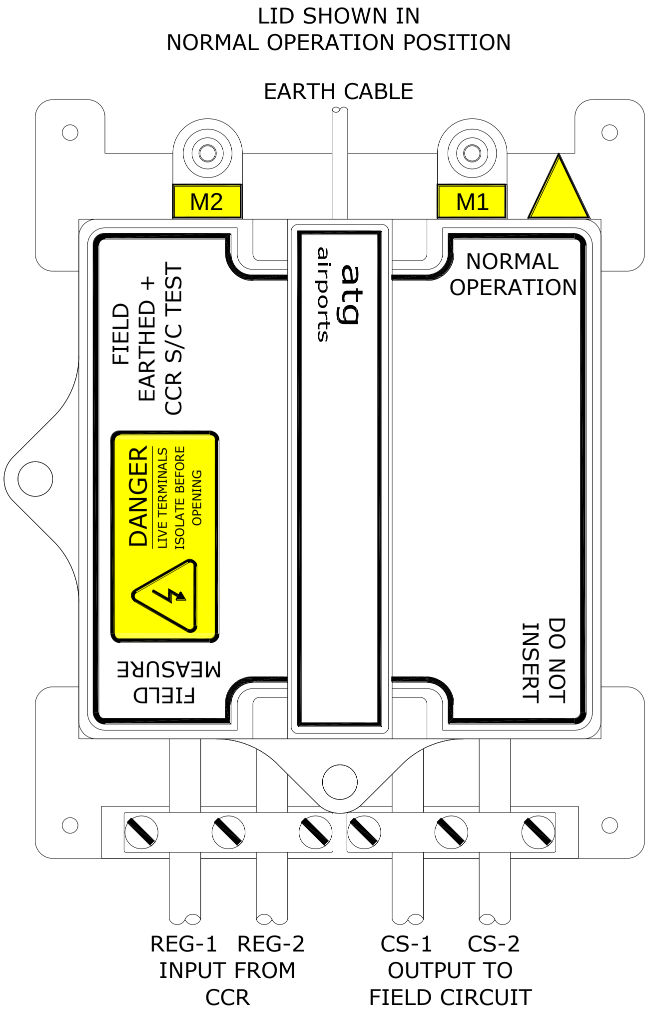


Figure 7-2 Cutout Switch outline drawing

7.1 Use of the Cutout Switch

The lid of the Cutout Switch can be removed and fitted in any of three different orientations in order to give the required connectivity. The three switch positions are described in the following sections. Note – the yellow arrow in the top right-hand corner of the base indicates the active position, alongside the text in this corner of the lid. In the case of Figure 7-2, this is Normal Operation.

WARNING: HIGH VOLTAGES – UP TO 2500V FOR A 15kVA REGULATOR – ARE PRESENT WITHIN THE HT TERMINAL BOX AND HT CUBICLES, AND ON THE TERMINALS OF THE CUTOUT SWITCH. THE COVERS TO THESE COMPARTMENTS SHOULD NEVER BE OPENED, NOR THE CUTOUT SWITCH LID REMOVED, WITHOUT FIRST ISOLATING THE REGULATOR MAINS SUPPLY INPUT.

7.1.1 Cutout Switch in 'Normal Operation' position

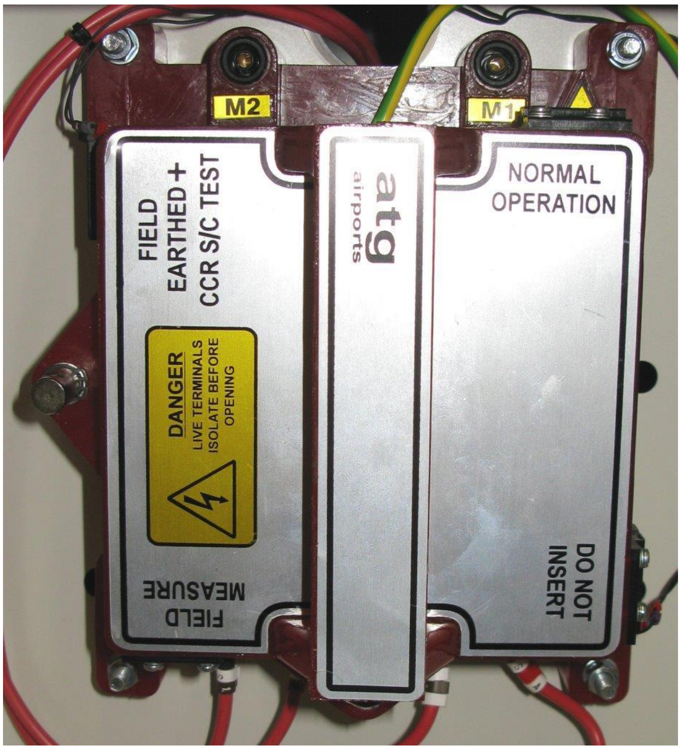


Figure 7-3 Cutout Switch in 'Normal Operation' position

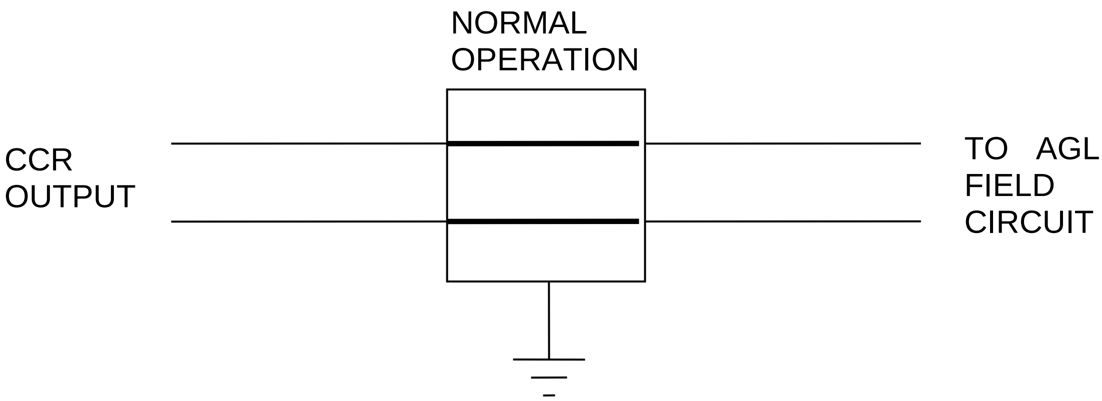


Figure 7-4 Electrical connections of Cutout Switch in 'Normal Operation' position

In the 'Normal Operation' position, the output of the CCR is connected directly to the AGL primary series loop.

7.1.2 Cutout Switch in 'Field Earthed and CCR Short Circuit Test' maintenance position

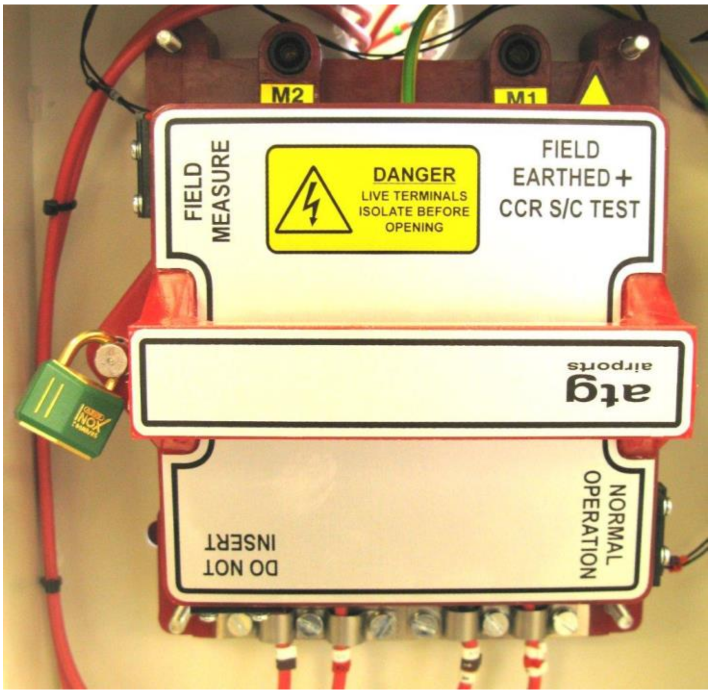


Figure 7-5 Cutout Switch in 'Field Earthed and CCR Short Circuit Test' maintenance position

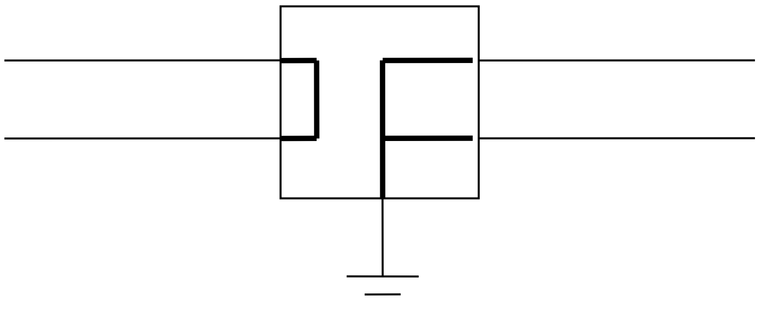


Figure 7-6 Electrical connections of Cutout in 'Field Earthed + CCR S/C Test' maintenance position

In the 'Field Earthed and CCR Short Circuit Test' position, the output of the CCR is shorted together, isolated from the AGL field circuit, and the field circuit is shorted and connected to earth.

The Cutout Switch is fitted in this position so that maintenance work can be safely carried out on the field circuit. Note – a padlock may be attached to lock the Cutout Switch in this position for additional security.

7.1.3 Cutout Switch in 'Field Measure' position

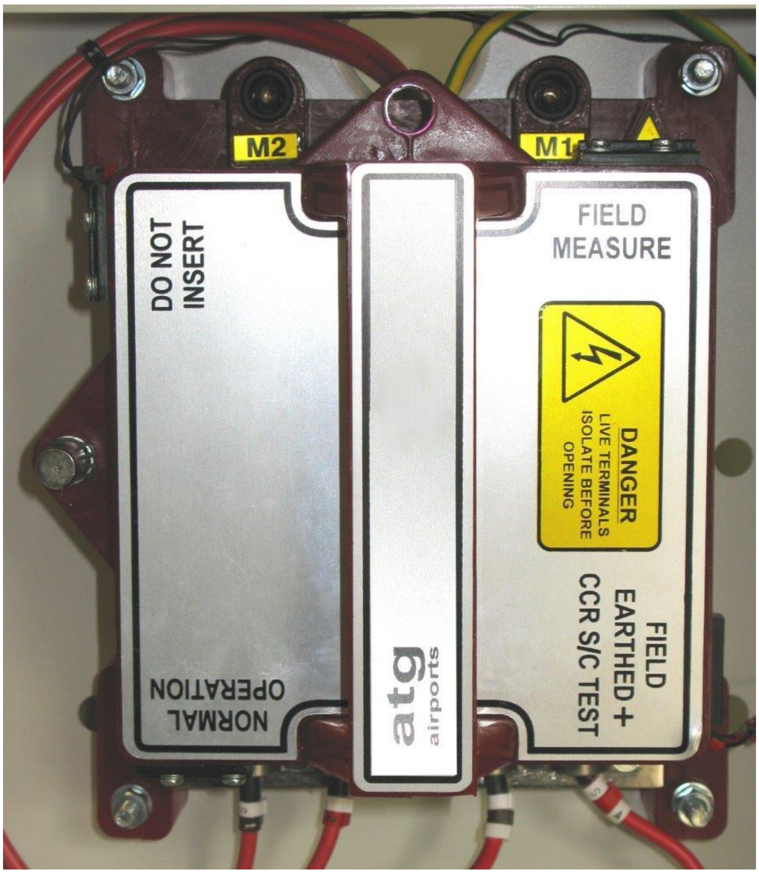


Figure 7-7 Cutout Switch in 'Field Measure' position

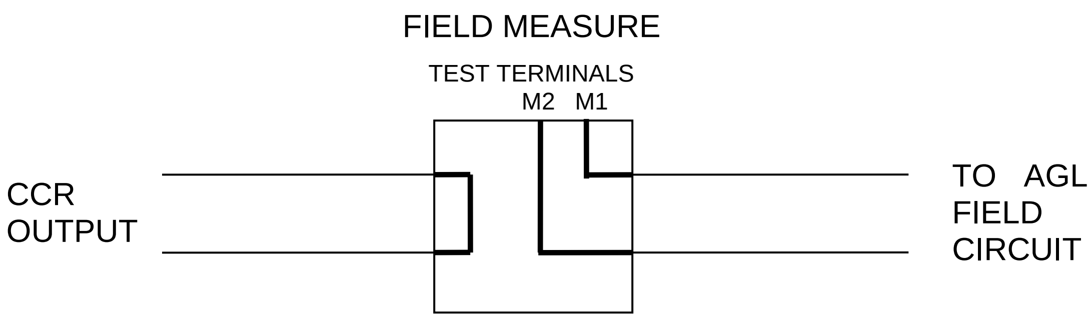


Figure 7-8 Electrical connections of Cutout Switch in 'Field Measure' position

In the 'Field Measure' position, the output of the CCR is shorted together. Access for instrument connection to both of the load side terminals is provided via 4mm test sockets M1 and M2.

The test terminals allow for insulation or 'Megger testing' to measure the resistance of the AGL field circuit to ground, and to measure continuity of the field circuit.

8 General CCR Application Information

8.1 Calculation of the AGL Circuit Load: Regulator Sizing and Required Output Voltage

The CCR kVA rating must be chosen to match the field circuit load requirements. If the CCR is too small, the maximum output voltage will be too low to drive the required current into the load circuit. If it is too big, it will work but at a cost of reduced efficiency.

This section describes how to calculate the total AGL circuit load. The CCR used should be the next size up from this calculated load.

Upon installation, the Main CCR transformer output voltage will have to be set to match the calculated circuit load. The calculated load power (kW) should be divided by the maximum series circuit current to give a value for the desired CCR output voltage:

$$V = P / I$$

The CCR output transformer voltage taps can be configured as described in Section 4.3 to give a total maximum output voltage equal to this value.

8.1.1 AGL Circuit Load

Figure 8-1 below, shows a typical AGL circuit.

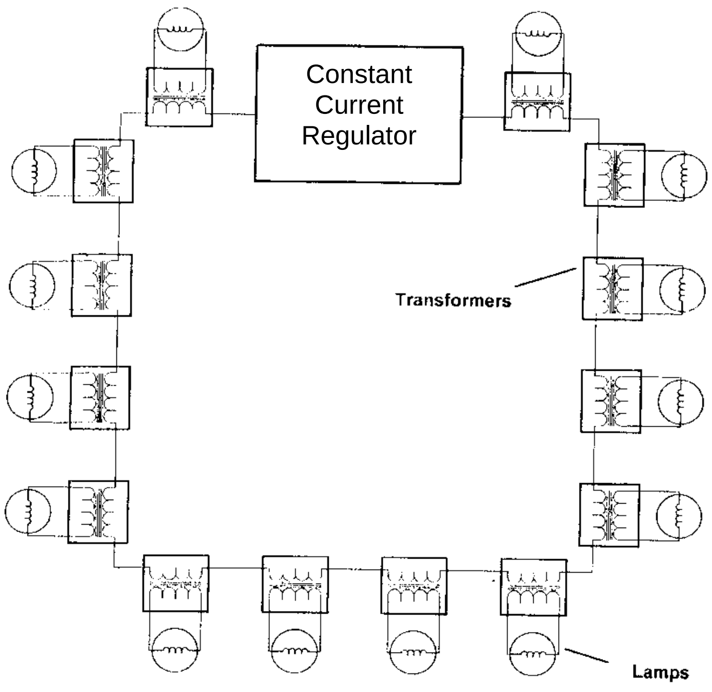


Figure 8-1 Typical Airfield Lighting Circuit

The AGL circuit load therefore consists of the following components:

- The total wattage of all the lamps on the circuit

- An allowance, if necessary, for the losses in long AGL transformer secondary extension leads. AGL transformers are supplied as standard with a secondary lead of 2 metres in length, of $4mm^2$ cross sectional area. In this case, the power dissipation in the secondary lead is negligible and can be ignored. If, however, long extension leads of a small CSA were to be used, this would produce an appreciable volt-drop. In this case, the additional I^2R power loss should be calculated and taken into account. (Note – the AGL transformer secondary current can be different from the primary loop current. This should be verified before any calculations are done).

- An allowance of 10% for the inefficiency of the AGL lamp transformers, based on the transformer load being the addition of the above 2 items. Note - If only a small proportion of transformers have long extensions, then as a rough rule of thumb, simply increase the allowance for transformer losses to 15%

- Power losses in the AGL primary series loop cable. This is simply an I^2R power loss. A typical circuit would use $6mm^2$ AGL cable, which has a resistance of 3 ohms per kilometre.

- An allowance for lamp failures, conditions of reduced supply voltage and other supply losses - oversize by 10%

In summary, the total CCR load will be:

((Total lamp wattage x 1.1) + (I^2R power loss in the AGL primary series loop cable)) x 1.1

Or, if long AGL transformer secondary extension leads are used:

(((Total lamp wattage + AGL tx secondary extension lead I^2R losses) x 1.1)

+ (I^2R power loss in the AGL primary series loop cable))) x 1.1

Note – the load calculations give a value in kilowatts, whilst the CCR is rated in kVA. These figures can be considered to be equivalent for the purposes of rating the CCR.

8.1.2 Example AGL Circuit Load Calculation

Consider the following worked example.

i/ Circuit 1 has 160 lamps each rated at 45w, with 6.6A filaments. The lamps are mounted adjacent to the AGL transformers; such that the secondary leads have negligible losses.

The primary series circuit is also rated at 6.6A, and the total length of the series circuit loop is 5.5 kilometres. 6mm^2 AGL cable has been used, with a resistance of 3 ohms per kilometre

Lamp load	160 x 45w = 7200 watts
Total transformer load (Lamp load plus transformer losses)	7200w x 1.1 = 7920 watts
Primary series circuit cable I^2R power losses	6.6 x 6.6 x 3 x 5.5 = 718.74 watts
Total circuit load	7920w + 718.74w = 8638.74 watts
Overrate by 10% to allow for lamp failures, conditions of reduced supply voltage and other supply losses	8638.74 x 1.1 = 9.5 kilowatts (approx.)

In this case, a 10KVA CCR should be used

The transformer output voltage taps should be configured to give a maximum output voltage of:

$$V = P/I = 9500/6.6 = 1440 \text{ volts}$$

Refer to Section 4.3 to set the transformer output voltage selector taps.

8.2 Load Changing / Block Switching

During ‘Block Switching’ operations, for example, when using electronic switching of the secondary side of the airfield ground lighting transformers to short out and switch off (‘Suppress’) sections of the AGL circuit, many types of regulator produce a momentary overloading of the remainder of the circuit. This is because there is a finite time before the CCR control loop can reduce the CCR output voltage to match the reduced load impedance, and bring the current back to its set point. It can cause failures of lamps and of fuses in the CCR; it is particularly a problem with conventional thyristor regulators, where the best that can be achieved is to limit the overload to half a mains cycle.

The Micro 200 overcomes this problem due to the fast-acting control of the IGBT H-bridge, which responds almost instantaneously to the current overload.

However, it is recommended that during block switching operations, the control system should momentarily reduce the CCR Brilliancy, or switch off the CCR altogether, during block switching operations.

8.3 Black Heat

In certain circumstances (usually on PAPIs), a "black heat" output is required. Black heat means that a small output current flows all the time even if the regulator is commanded "off" by air traffic control, in order to prevent condensation in tungsten halogen light fittings. See Section 9.3.2.8 for details of enabling Black Heat, and Section 9.4.2.3 for setting the current level.

9 Programming Menus

9.1 Overview

This section describes the Microcontroller Menu system, how to load the CCR operating parameters via the Front Panel Keypad and how to set up some of the more specialised functions.

The Micro 200 CCR is pre-programmed with default operating parameters suitable for most applications. Parameters such as the CCR Full Load Current will normally be programmed to customer specifications during factory testing, along with any other non-standard requirements if these were notified to **atg airports** at the time the equipment was ordered.

The screens are divided into three menus, as listed below

1. Main menu – displays information about the status of the regulator
2. Set-Up menu – allows programming of CCR operating parameters
3. CCR Hardware Configuration menu – gives access to calibration and engineering screens

Access to the Set-up menu is password protected with a further password to access the CCR Hardware Configuration menu.

Additionally, there are a number of fault screens that can be activated. CCR faults are divided between those that give a 'soft' alarm but allow continued operation, and those that trip the regulator.

9.1.1 How to Navigate Around the Screens

There are four buttons on the Front Panel Keypad that are used to navigate through the menus and select screens as required. These are the (↑), (↓), (↵ Enter) and (X Clear) buttons, as shown in Figure 9-1 below:

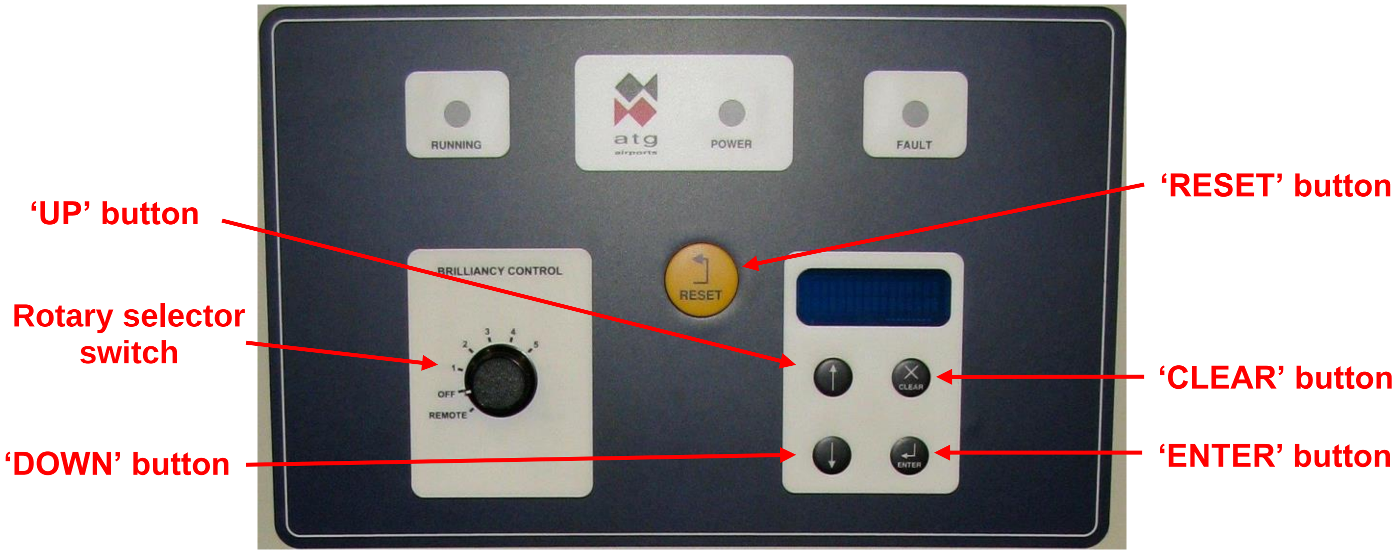


Figure 9-1 Front Panel Keypad

The (↑) and (↓) buttons are used to scroll up and down through the menu or to increment or decrement any parameters being changed, whilst the (↵ Enter) is pressed to input and accept any changes. The (X Clear) button is used to cancel selections and leave screens. The other button on the Front Panel is the Reset button, which is used to reset any faults that may occur with the operation of the CCR.

9.2 Main Menu and CCR Status Screens

If the CCR is powered up and set to 'Local Off' (that is, by turning the brilliancy control selector switch SW1 to 'OFF') the display will show 'LOCAL OFF'. The operator can then scroll up or down using the (↑) (↓) buttons to display the Hours Run screen and the Set-up Menu Password Entry screen. If the optional Earth Leakage Resistance Measurement module is fitted, the Earth Leakage screen can also be displayed.

When the CCR output is energised, the display shows the regulator's Running Mode and Output Current. The operator can scroll up or down using the (↑) (↓) buttons to display the following screens: Output kVA, Output kW, Hours Run, PLF Display (if available), Earth Leakage Display (if available), and the screens for any faults which may be present. If no buttons are pressed, after a predetermined time the display will revert to show the Running Mode and Output Current.

The Main Menu Flowchart is shown in Figure 9-2 below whilst Table 9-1 lists the Main Menu screens and gives a brief description of them.

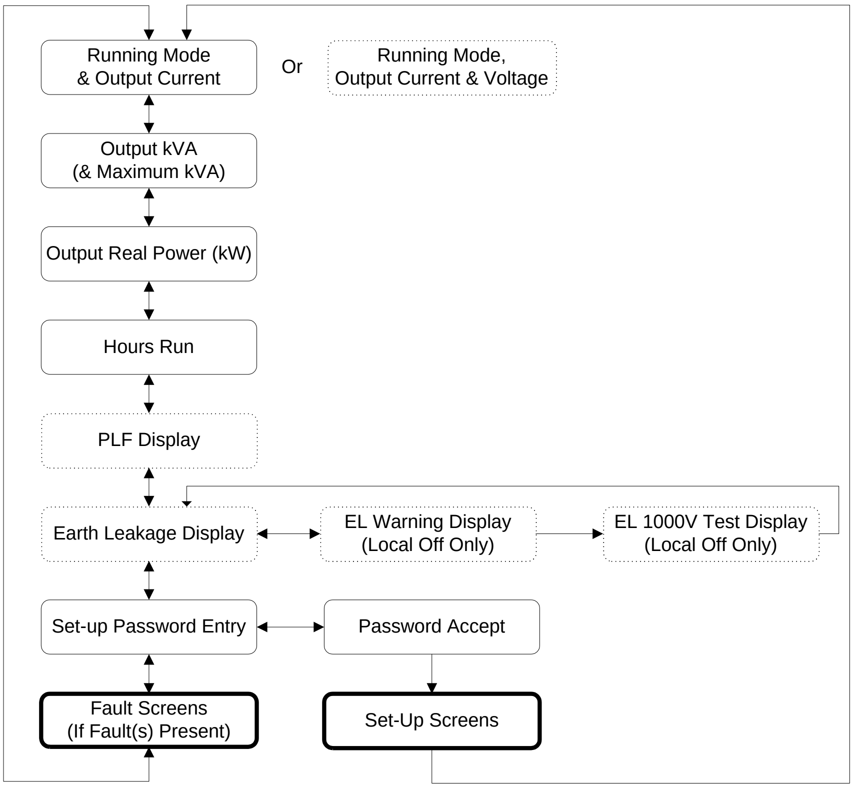


Figure 9-2 Main Menu Flowchart.

Parameter	Description
Running Mode & Output Current (& Voltage) Display	Indicates whether the CCR is operating under Local or Remote control, and displays the Brilliancy Level selected and the CCR output current. If 'Voltage Feedback' is enabled, also displays CCR output voltage
Hours Run	Displays overall Hours Run and the Hours Run at Maximum Brilliancy
kVA (& Brilliancy Step Maximum kVA)	Displays output kVA. If 'kVA Alarm' is enabled, displays Maximum recorded kVA for the selected brilliancy level
Real Power Output (kW)	Displays the Output Real Power in kW
Number of Lamps Failed	Displays the number of lamps failed (screen only available if 'Analogue IP' PLF mode selected)
Earth Leakage	Displays the last measured value of the Resistance to Earth of the Primary Series Loop Circuit. The measurement is made continuously at 500V DC whilst the CCR is operating. It can also be selected to measure continuously at 500V DC in the 'Off' state, or, when the CCR is set to 'Local Off', a manual test can be made at 1000V DC. (Note – this screen is only available if 'Analogue' type Earth Leakage Detection is selected, applicable when the optional Earth Leakage Measurement module is fitted)
Press to Test Circuit at 1000V	Confirm 1000V Earth Leakage test to be carried out.
Testing Circuit at 1000 Volts	1000V Earth Leakage test in progress.
Set-up Password Entry	Allows entry of password to access Set-up menu
Fault screens (shown during fault conditions only)	See Section 9.5

Table 9-1 Main Menu screens

If a fault occurs, then the display alternates between the fault(s) and the Running Mode and Output Current display. The fault screens are described in Section 9.5, and listed in Table 9-4. Any faults must be reset before the display returns to normal, even if the fault is no longer present. To reset a fault, then the reset button must be pressed during the time when the fault is displayed on the screen.

9.2.1 Screens Displayed During Normal CCR Operation

Examples of screens displayed during normal operation are shown below:

The 'Running Mode' screen appears like this when the CCR has been programmed for UK CAP 168 current levels, 6.60A, with Voltage Feedback (CCR output voltage display) enabled, is set to 'Remote' and has been commanded on at 100% Brilliancy:

	R	E	M	O	T	E			1	0	0	%			
I	=		6	.	6	0	A		V	=	1	9	0	0	V

The screen appears like this when the CCR has been set to 'Remote' but has not been commanded on. In this example, 'Black Heat' has been enabled:

	R	E	M	O	T	E		B	L		H	E	A	T	
					I		=			1	.	5	0	A	

If the CCR has been configured to perform continuous Earth Leakage resistance measurements ('Continuous Analogue' under the 'Earth Leakage Detection Type' menu), and if the CCR is in the 'Off' state, then the display will show a warning to that effect. A warning may also be displayed if a Cutout switch is fitted (optional), and it has been set to the test position.

The 'Output kVA' screen (available if Voltage Feedback is enabled) is reached by scrolling down from the 'Running Mode' screen. If the kVA alarm is also enabled, the second line will show the measured peak kVA value for the selected brilliancy step. (If the output kVA drops by more than 10% from the peak recorded value for that Brilliancy step, for example, due to an earth fault on the AGL series circuit, then an alarm is raised).

			k	V	A				=		1	2	.	5	
S	T	E	P		P	E	A	K	=		1	2	.	5	

The 'Earth Leakage Display' screen is available if the optional Earth Leakage Measurement module is fitted and correctly programmed. Scroll down from the 'Running Mode' screen; the Earth Leakage Resistance measurement is displayed. When the CCR is running, the display will show the value as currently measured using a test voltage of 500V DC. When the CCR is in the 'Off' state, the display shows the last measured value and the test voltage used.

E	A	R	T	H		L	E	A	K	A	G	E	:		
@		5	0	0	V			>		5	0		M	Ω	

The 'PLF Display' screen is available if the optional Power Analyser module is fitted and correctly programmed for PLF operation. With the CCR running, scroll down from the 'Running Mode' screen. The (approximate) number of lamps failed is displayed; this is also expressed as a percentage of the total number of lamps on the field circuit:

N	U	M		L	A	M	P	S		F	A	I	L	E	D
			5			(		1	0	%	)				

If the Stage 1 Percentage lamp failure threshold has been exceeded, then the following fault screen will be shown. The display will alternate between the 'Running Mode' screen and the fault screen every 2 seconds:

1	F	A	U	L	T		-		S	T	A	G	E		1
		%		L	A	M	P		F	A	I	L	U	R	E

9.2.2 Earth Leakage Resistance – Manual Test at 1000V DC

This test is only available if the optional Earth Leakage Measurement module is fitted and correctly programmed.

The measurement of the Primary Series Loop Earth Leakage Resistance using a test voltage of 1000V DC can only be made when the CCR is set to 'LOCAL OFF'. Turn the CCR brilliancy control selector switch SW1 to 'OFF'; the display will show 'LOCAL OFF'. Scroll up or down using the (↑) (↓) buttons to display the Earth Leakage screen:

E	A	R	T	H		L	E	A	K	A	G	E	:		
@		5	0	0	V			>		5	0		M	Ω	

The screen will display the last measured value of the leakage resistance. Normally, this will have been measured at 500V when the CCR was last running, however if the CCR has not been run since the last 1000V manual test, it will display the results of this test. Press the (↵ Enter) button, the screen will change to:

P	R	E	S	S		↵		T	O		T	E	S	T	
C	I	R	C	U	I	T		A	T		1	0	0	0	V

Pressing the (↵ Enter) button will initiate the leakage resistance test at 1000V DC. The screen will change to:

T	E	S	T	I	N	G		C	I	R	C	U	I	T	
	A	T		1	0	0	0		V	O	L	T	S		

The screen will flash to indicate that the test is in progress. After the test is finished, the screen will display the measured resistance:

E	A	R	T	H		L	E	A	K	A	G	E	:		
@		1	0	0	0	V		>		5	0		M	Ω	

To exit from any of the above screens, press the (X Clear) button.

If the CCR is set to running, or the Earth Leakage test type is set to continuous analogue, the display will revert to show the result of the 500V Earth Leakage resistance testing.

9.3 Set-up Menu Screens

The Set-up Menu allows access to many of the Set-up and Operating Parameters to allow configuration of the CCR. The Set-up Menu flowchart is shown in Figure 9-3 below, whilst Table 9-2 gives a listing of the screens and the default settings for the operating parameters.

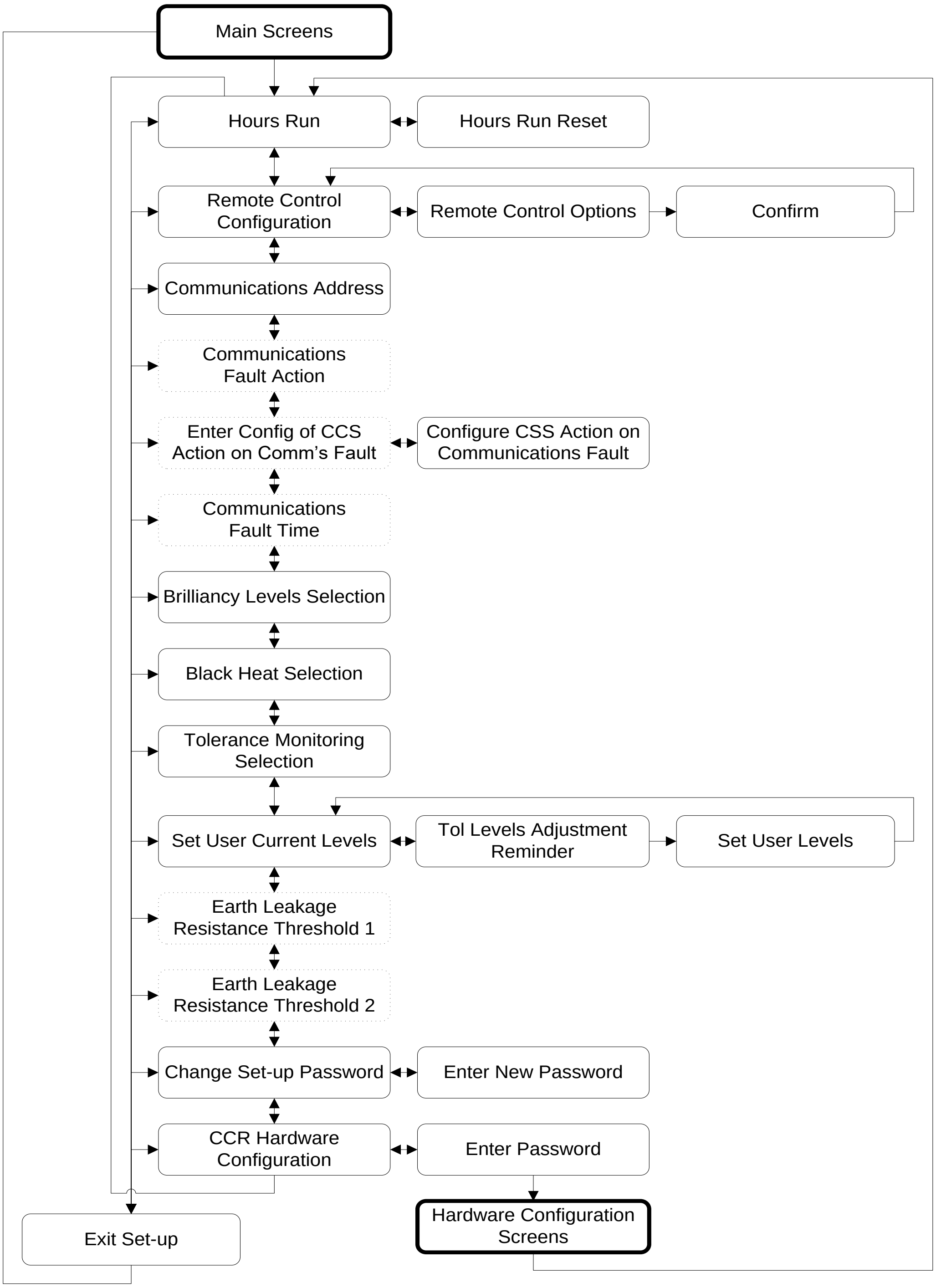


Figure 9-3 Set-up Menu Flowchart

Parameter	Description	Default Setting
HOURS RUN RESET?	Reset the hours run data	
Confirm Reset	Confirm hours run reset	
REMOTE CONTROL CONFIG	Configure the remote-control method	
Remote Control Options	Select method of remote control (3 Wire, 3 Wire & Command, BCD, BCD & Command, BCD (Option 2), BCD (Option 2) & Command, 8 Wire, 8 Wire & Command, Serial Communications.)	8 WIRE
Confirm Remote	Confirm choice of remote-control method	
COMMS ADDRESS	Select Address of unit for serial communications (If 'Communication' is not selected as method for remote control, setting an address allows read only access for monitoring purposes)	255 (not selected)
COMMS FAULT ACTION	Select the action to be taken in the case of a communications fault. (Only available if 'Communication' selected as method for remote control)	CCR OFF
SET CCT SEL FLT ACTION?	Configure CCS action on communications fault	
Circuit Selector action on Communications Fault Options	Select the action to be taken by the circuit selector in the case of a communications fault. (Only available if 'Communication' selected as method for remote control and the CCR is configured to use an internal circuit selector.)	Individual circuits revert to fail-safe condition; alternate CSS circuits revert to CCT1
COMMS FAULT TIME	Select the delay time (in seconds) before the Communications fault is raised	2 S
BRILL LEVELS	Select (UK) CAP168, FAA / IEC Style 1, FAA / IEC Style 2 User Defined or User Def. DOE. brilliancy levels	(UK) CAP 168
BLACK HEAT	Enable/ Disable Black Heat operation	DISABLED
TOLERANCE MON	Enable/ Disable internal Tolerance Monitoring Unit	ENABLED
SET USER CURRENT LEVELS?	When User Defined Brilliancy Levels are selected, allows adjustment of the current levels. (Note - the default levels are those of UK CAP 168).	(UK) CAP 168
User Levels reminder	Reminds the user that the Tolerance Monitoring levels may need to be changed if current levels are changed	
Set User Levels	Allows selection of User Defined current levels	(UK) CAP 168
EARTH LEAKAGE STAGE 1	Select the threshold of resistance for the 1st stage Earth Leakage Alarm.	10 MΩ
EARTH LEAKAGE STAGE 2	Select the threshold of resistance for the 2nd stage Earth Leakage Alarm / Trip.	200 kΩ
CHANGE SET-UP PASSWORD?	Go to Change the Set-up password Screen	
Enter Set-up Password	Enter new Set-up password	atg
CCR HARDWARE CONFIG?	Access CCR Hardware Configuration menu	
CCR Hardware Configuration Password	To access the CCR Hardware Configuration menu, enter the password one letter at a time.	eng
Press Clear to display:		
EXIT SETUP?	Confirmation of exiting setup menu	

Table 9-2 Set-up Menu screens

9.3.1 Accessing the Set-up Menu

The Set-up Menu is accessed from the Main Menu by the use of a password. The CCR must first be set to ‘Local Off’, by turning the brilliancy control selector switch SW1 to 'OFF'. Press the (↑) button to display the password entry screen:

E	N	T		S	E	T	-	U	P		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		*	*	*			

Press (↵ Enter), the screen will change to:

E	N	T		S	E	T	-	U	P		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		a	a	a			

Enter the correct password one letter at a time using the (↑) (↓) buttons to scroll up and down the alphabet, and then pressing the (↵ Enter) button. **The default password is 'atg'.** If you enter the password incorrectly the screen will display:

E	N	T		S	E	T	-	U	P		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		N	N	N			

You can re-try the password by first pressing (↵ Enter) and then loading the correct password. There is no limit to the number of retries. If you enter the correct password the screen will display:

E	N	T		S	E	T	-	U	P		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		Y	Y	Y			

Press (↵ Enter) and the screen will change to the first of the set-up screens.
It is now possible to scroll through the Menu using the (↑) (↓) buttons.

Pressing the (↵ Enter) button will permit modifications to the parameters for the selected screen. The left-hand arrow will move to the second line, and then pressing the (↑) or (↓) buttons will scroll through the available parameter settings.

For example, if you have entered the Brilliancy Levels screen and changed the selection from UK CAP 168 to User Defined using the (↑) (↓) buttons

		B	R	I	L	L		L	E	V	E	L	S	↑	↓
→		U	S	E	R		D	E	F	I	N	E	D		

Pressing (↵ Enter) will load the new parameter, or pressing the (X Clear) button will quit without loading the changes, maintaining the CAP 168 setting as shown below:

→		B	R	I	L	L		L	E	V	E	L	S	↑	↓
				C	A	P		1	6	8					

To exit from the Set-up Menu and return to the Main Menu, press the (X Clear) button. The screen will change to:

		E	X	I	T		S	E	T	U	P		?		
		Y	=	↵		C	A	N	C	E	L	=	X		

Press the (↵ Enter) button to confirm exit from the Menu.

9.3.2 Set-up Menu Screens

9.3.2.1 Hours Run Reset

The CCR records the total number of Hours Run and the number of Hours Run at Maximum Brilliancy. It is possible to reset the Hours Run Counter values to zero from this menu.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 above. The first screen displayed will be:

H	O	U	R	S		R	U	N						↑	↓
R	E	S	E	T	?								Y	=	↵

To reset the ‘Hours Run’ press the (↵ Enter) button and the screen will change to:

H	O	U	R	S		R	U	N		R	E	S	E	T	
S	U	R	E	?			Y	=	↵		N	=	X		

Press the (↵ Enter) button again, the Hours Run Counters will be reset to zero. Note – if the (X Clear) button is pressed instead, the screen will be exited without resetting the hours Run Counter. In both cases, the screen will change back to:

H	O	U	R	S		R	U	N						↑	↓
R	E	S	E	T	?								Y	=	↵

To return to the Main Menu, press the (X Clear) button followed by the (↵ Enter) button to confirm exit from the Set-up Menu.

9.3.2.2 Remote Control Configuration

The Remote Control of the CCR may be performed using 8-Wire Brilliancy Selection (this is normally used for 3 step, 5 step as well as 8 step applications), 3-Wire Encoded, BCD Encoded or BCD Option 2 all with or without Command On. This section describes how to program the CCR for the required configuration.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

R	E	M	O	T	E		C	O	N	T	R	O	L	↑	↓
			C	O	N	F	I	G	?				Y	=	↵

Press the (↵ Enter) button and the screen will change to show the following control option:

			3		W	I	R	E						↑	↓
	L	I	N	E		C	O	N	T	R	O	L		↵	X

Pressing the (↑) or (↓) button will allow scrolling through the other possible control options as detailed below:

	3	W	I	R	E		&		C	M	M	D		↑	↓
	L	I	N	E		C	O	N	T	R	O	L		↵	X

					B	C	D							↑	↓
	L	I	N	E		C	O	N	T	R	O	L		↵	X

		B	C	D		&		C	M	M	D			↑	↓
	L	I	N	E		C	O	N	T	R	O	L		↵	X

		B	C	D		C	O	N	T	R	O	L		↑	↓
			O	P	T	I	O	N		2				↵	X

		B	C	D		&		C	M	M	D			↑	↓
			O	P	T	I	O	N		2				↵	X

*				8		W	I	R	E					↑	↓
			C	O	N	T	R	O	L					↵	X

	8	W	I	R	E		&		C	M	M	D		↑	↓
			C	O	N	T	R	O	L					↵	X

	C	O	M	M	S		M	O	D	U	L	E		↑	↓
				C	O	N	T	R	O	L				↵	X

Press the (↵ Enter) button when the required option is displayed and the screen will change to:

	C	H	A	N	G	E		R	E	M	O	T	E		
	C	O	N	T	R	O	L	?			Y	=	↵		

Press the (↵ Enter) button to accept the new setting. The screen will return to the selected setting and a star in the top left-hand corner of the screen will indicate the selection:

*		3	W	I	R	E		B	R	I	L	L		↑	↓
		&		C	M	M	D		L	I	N	E		↵	X

9.3.2.3 Communications Address

If the CCR is configured to use 'Communication' for remote control, the serial communications address must be set. (This must also be set if 'read only' communications are to be used for monitoring purposes).

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

→	C	O	M	M	S		A	D	D	R	E	S	S	↑	↓
		0	0	5											

Pressing the (↵ Enter) button will cause the arrow in the top left-hand corner of the screen to move to the bottom line. The required address can now be set; the valid range is between 001 and 254. Use the (↑) (↓) buttons to increment or decrement the value; press the (↵ Enter) button to load the value for each digit in turn.

When all 3 digits are programmed, press the (↵ Enter) button again to accept the new address. The arrow will return to the top left-hand corner of the screen.

Note: The communications protocol used is dependent upon which communications module is fitted to the CCR. These are described in the corresponding supplementary documentation: Micro 100/200 CCR Communications Card (Profibus), document number HS12-0-03-0*, or Micro 100/200 CCR Communications Card (J-Bus), document number HS12-0-04-0*. (Note – the last digit indicates the document issue number).

9.3.2.4 Communications Fault Action

If the CCR is configured to use 'Communication' for remote control, the action to be taken in the event of a serial communications fault can be set using this screen.

The three possible fault actions are: 'CCR OFF', 'LATCH', and 'CCR ON'. Selecting the first option will cause the CCR, if set for remote control, to turn off in the event of a communications fault. Selecting the second means the CCR will continue operating with the last instruction received. Selecting the third option will, if the CCR was commanded to ‘OFF’ by the last instruction received, but with a brilliancy level selected, turn the CCR on at the brilliancy level of the last instruction. If the CCR was commanded to ‘ON’ by the last instruction received, it will continue operating with the previously selected brilliancy.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

→	C	O	M	M	S		F	A	U	L	T			↑	↓
	A	C	T	I	O	N	-		C	C	R		O	F	F

Pressing the (↵ Enter) button will cause the arrow in the top left-hand corner of the screen to move to the bottom line. The required fault action can be selected using the (↑) (↓) buttons.

Press the (↵ Enter) button to accept the selection. The arrow will return to the top left-hand corner of the screen.

Note: The fault actions described above apply only when the CCR Brilliancy Selector Switch is set to ‘REM’.

9.3.2.5 Circuit Selector action on Communications Fault.

If the CCR is fitted with an Internal Circuit Selector Switch and it is configured to use ‘Communication’ for the remote-control method, then reference should be made to the Internal Circuit Selector Manual for details on how to program the action for each individual circuit in the event of a serial communications fault.

9.3.2.6 Communications Fault Time

This screen allows adjustment of the time delay between a communications fault being detected and the alarm being activated. Note – this alarm can only be activated if the CCR is configured to use ‘Communication’ for remote control.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

→	C	O	M	M	S		F	A	U	L	T			↑	↓
	T	I	M	E			2		S						

Pressing the (↵ Enter) button will cause the arrow in the top left-hand corner of the screen to move to the bottom line. The required time can now be set; the valid range is between 2 and 15 seconds. Use the (↑) (↓) buttons to increment or decrement the value.

Press the (↵ Enter) button to accept the fault time selected. The arrow will return to the top left-hand corner of the screen.

9.3.2.7 Brilliancy Level Selection

The CCR may operate using output current levels specified by UK CAP 168, FAA or IEC standards (see Table 4-1 through to Table 4-4 of Section 4.2), or levels defined by the user.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

→		B	R	I	L	L		L	E	V	E	L	S	↑	↓
					C	A	P	1	6	8					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The required brilliancies can now be selected between CAP 168, FAA / IEC STYLE 1, FAA / IEC STYLE 2, USER DEFINED and USER DEF. DOE. using the (↑) (↓) buttons.

Press the (↵ Enter) button to accept the setting. The arrow will return to the top left-hand corner of the screen.

Refer to Section 9.3.2.10 to set the User Current levels

9.3.2.8 Black Heat Selection

The CCR may be configured to give a 'Black Heat' low level output current when the CCR is set to ‘Remote Off’. This section describes how to select the Black Heat mode of operation.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↓) button to scroll down to the following screen:

→		B	L	A	C	K		H	E	A	T			↑	↓
			D	I	S	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED and DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to accept the setting. The arrow will return to the top left-hand corner of the screen.

Refer to Section 9.4.2.3 to set the Black Heat current level.

9.3.2.9 Tolerance Monitoring Selection

This section describes how to enable or disable the operation of the Tolerance Monitoring function.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) or (↓) buttons to scroll to the following screen:

→	T	O	L	E	R	A	N	C	E		M	O	N	↑	↓
				E	N	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED and DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to accept the setting. The arrow will return to the top left-hand corner of the screen.

9.3.2.10 User Current Levels (including DOE)

For each of the eight Brilliancy Levels, the CCR output current can be programmed – in amps, to 2 decimal places - to any value between 5% and 100% of Full Load Current. However, the default settings are exactly the same as the UK CAP 168 levels.

The CCR can also be programmed to turn off on when a particular Brilliancy Level is selected. This is particularly useful when a number of CCRs are controlled in parallel by the same remote Brilliancy control lines, and it is required to turn off one or more CCRs on certain Brilliancy Levels. This is done by setting the User Current Level to ‘0.00A’. When this Brilliancy Level is selected in operation, the CCR will switch off and display one of the following, depending if the CCR is operating in Local or Remote:

	L	O	C	A	L			B	R	I	L	L		X	
	U	S	E	R		B	R	I	L	L		O	F	F	

	R	E	M	O	T	E		B	R	I	L	L		X	
	U	S	E	R		B	R	I	L	L		O	F	F	

This section describes how to set the User Current Levels.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) or (↓) buttons to scroll to the following screen:

S	E	T		U	S	E	R		C	U	R	R		↑	↓
L	E	V	E	L	S	?								↵	X

Press the (↵ Enter) button and the screen will change to:

T	O	L		L	E	V	S		M	A	Y		R	Q	R
A	D	J	U	S	T	I	N	G						↵	X

The screen warns the user that following a change of User Current Levels, the Tolerance Monitoring threshold levels may require adjustment. If this is not done, Tolerance Monitoring Alarms may occur.

Press the (↵ Enter) button and the screen will change to:

→		B	R	I	L	L		L	E	V	E	L		8	
						6	.	2	0		A				

Note: If the USER DEF. DOE. setting is used, the screen shown will change to:

→	B	R	I	L	L		L	E	V	E	L		M	A	X
						6	.	2	0		A				

Use the (↑) and (↓) buttons to scroll to whichever Brilliancy Level requires adjustment.

Press the (↵ Enter) button and the arrow in the top left-hand corner of the screen will move to the bottom line. The current setting can now be adjusted one digit at a time by using the (↑) (↓) and (↵ Enter) buttons.

After setting each digit, the arrow at the left of the screen will move to the top line.

9.3.2.11 Earth Leakage Resistance – Alarm and Trip Thresholds

These screens are only available if the CCR is programmed for ‘ANALOGUE’ Earth Leakage type. If for any reason the screens are not available, refer to Section 9.4.2.11.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) or (↓) buttons to scroll to the following screen:

→	E	A	R	T	H		L	E	A	K	A	G	E	↑	↓
	S	T	A	G	E		1				2	0		M	Ω

Refer to Section 4.5 for a complete description of how to commission the Analogue Earth Leakage Measurement system.

9.3.2.12 Changing the Set-up Menu Password

This section describes how to change the Set-up Menu entry password. Ensure that a record is kept of the new password.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) button to scroll to the following screen:

C	H	A	N	G	E		S	E	T	-	U	P		↑	↓
P	A	S	S	W	O	R	D	?					Y	=	↵

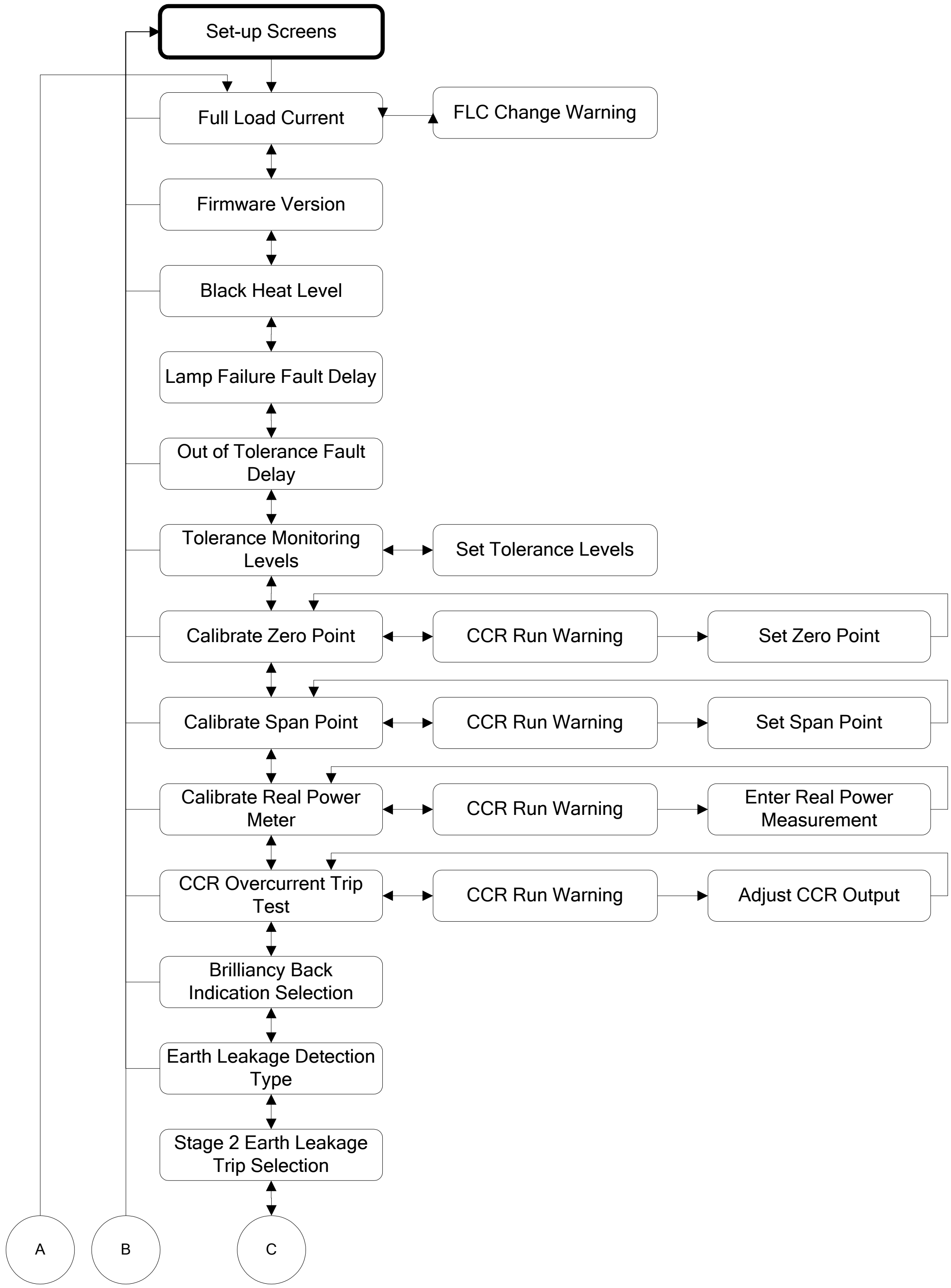
Press the (↵ Enter) button and the screen will change to:

S	E	T		S	E	T	-	U	P		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		a	t	g			

Enter the new password one letter at a time using the (↑) (↓) buttons to scroll up and down the alphabet, and then pressing the (↵ Enter) button.

9.4 CCR Hardware Configuration Menu

The Hardware Configuration Menu allows access to the engineering parameters of the CCR. The flowchart of the Menu is shown in Figure 9-4 below, whilst Table 9-3 gives a listing of the screens and the default settings for the parameters.



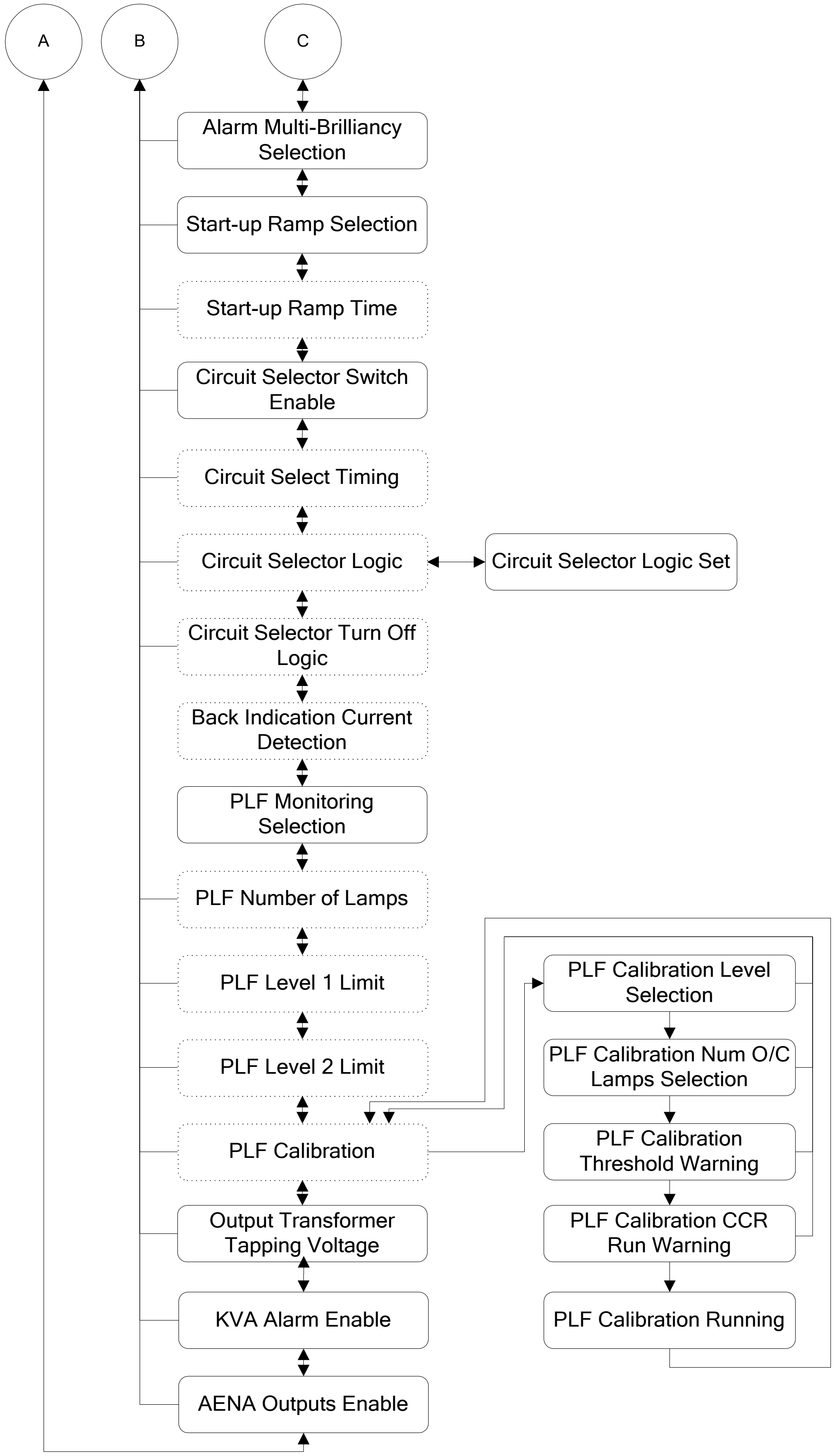


Figure 9-4 Hardware Configuration Menu Flowchart

Parameter	Description	Default Settings
FULL LOAD I	Select CCR nominal output current. Available settings are 6.00, 6.60, 12.0 and 20.0A.	6.60A
FLC Change Warning	Displays a warning that changing the FLC setting will require re-calibration of the CCR	
FIRMWARE VERSION	Displays the version of the CPU firmware	
BLACK HEAT	Set the Black Heat current level	6.0A FLC = 1.5A 6.6A FLC = 1.5A 12A FLC = 2.5A 20A FLC= 5.75A
% LAMP FAIL TIME	Set the delay time before the Percentage Lamp Failure alarm is raised	15 S
TOL MON FAIL TIME	Set the delay time before an out of tolerance alarm is raised	15 S
SET USER TOL LEVELS	Program the Tolerance Monitoring alarm levels	(UK) CAP 168
Enter out of tolerance levels	Set the under and over current Tolerance Monitoring alarm threshold levels	
CALIBRATE ZERO POINT	Calibrate the zero point for the control loop	
CCR run warning	Warning that the CCR will start during this operation	
Set Zero Point	Sets the zero point control reference and other analogue input zero calibration points.	
CALIBRATE SPAN POINT	Calibrate the span point for the control loop	
CCR run warning	Warning that the CCR will start during this operation	
Set Span Point	Sets the span point control reference, calibrates the CCR ammeter and CCR maximum output current	
CAL REAL POWER METER	Calibrate the Real Power Meter. (Note – only used with obsolete type power analyser).	
CCR run warning	Warning that the CCR will start during this operation	
Set Real Power input	Sets the Real Power Meter span calibration parameters	
TEST OVERCURRENT TRIP POINT	Test use only - not to be used on live circuit. Allows manual control of output current in order to test the Over-current Trip Point	
CCR run warning	User warning that the CCR will start during this operation	
Set current output	Allows direct control of current output. Displays current demand level and peak measured current for over-current test	
BRILL BI ON FLT ENABLED	Configure the brilliancy back indication to be active or inactive when a fatal alarm is present (only applicable if non-standard I^2C Back Indication option card fitted)	DISABLED
EARTH LEAK DET	Configure the earth leakage detection type to be Digital, Analogue, Continuous Analogue or Disabled. Note - optional AT699 Earth Leakage Detection card rqd for this function to operate	DISABLED
TRIP ON EARTH 2	Configure the stage 2 Earth Leakage detector to give an alarm and continue to run, or to shutdown (trip) the CCR	ENABLED
ALARM MULT BRIL	Enable/ Disable the alarm which alerts if an illegal combination of remote-control inputs is detected	ENABLED

Parameter	Description	Default Settings
OP START RAMP	The CCR can be programmed to gradually ramp up the O/P current to selected level on start-up, in a set time period, rather than switch on directly at the selected level. Enable/ Disable Start Ramp.	DISABLED
ST RAMP TIME	Set the Current Ramp time for CCR start-up. (Only available if Start Up Ramp is enabled)	600ms
CCT SELECTOR	Disables (internal) CSS operation or allows selection of Alternate or Multiway (2 - 6 way) CSS	DISABLED
CCT SEL TIME	Set the changeover switching time before re-energisation of the internal circuit selector. Allows selection of Slow Contactor (500ms), 300ms, 250ms, 200ms, 150ms, 100ms or Vacuum Relay (15ms). (Screen only available when circuit selector is enabled)	SLOW CONTACTOR
SET CCT SEL LOGIC?	Select normally open or normally closed logic for correct fail-safe modes for Multiway Circuit Selector	N/O
Circuit Selector Logic	Program Multiway Circuit Selector operating logic	
C/S TURN OFF CCR	Allows the Circuit Selector control logic to turn off the CCR when all circuits are selected to off. (Available when Multiway (2 to 6 way) Circuit Selector is enabled)	ENABLED
C/S PCB TYPE	Allows selection of the Multi-Way Circuit Selector Back Indication Current Detection philosophy, depending on the PCB type fitted.	AT661C ONWARD
% LAMP FAIL	Enable Percentage Lamp Failure monitoring; Analogue (with auto calibration) is recommended. Note - requires the optional AT923 PLF card to be fitted for this function to operate.	DISABLED
NUM OF LAMPS	Enter the total number of lamps on the AGL circuit (Only available if 'Analogue IP' PLF monitoring is enabled)	100
PLF LIMIT 1	Enter the number of lamps failed to trigger a Stage-1 alarm. (Only available if 'Analogue IP' PLF monitoring is enabled)	5 (5%)
PLF Threshold warning	Warning that the PLF alarm threshold does not match the calibration level used.	
PLF Level 2 limit	Enter the number of lamps failed to trigger a Stage-2 alarm. (Only available if 'Analogue IP' PLF monitoring is enabled)	10 (10%)
PLF Threshold warning	Warning that the PLF alarm threshold does not match the calibration level used.	
CALIBRATE PLF INPUT	Calibration screens for PLF. (Only available if 'Analogue IP' PLF monitoring is enabled)	
SELECT LEVEL	Allows selection of which PLF alarm threshold points are to be calibrated - high or low level	
NUM OF OPEN CCT LAMPS	Enter the number of open circuit lamp fittings in the test circuit used for calibration of this level.	
PLF Threshold warning	Warning that the PLF alarm threshold does not match the calibration level used.	
CCR run warning	Warning that the CCR will start during this operation	
PLF threshold	Record the PLF error voltage for the lamps out threshold being calibrated, at each brilliancy level	

Parameter	Description	Default Settings
ENT TX OP VOLTS	Enter the value for the main transformer output voltage as connected (sum of each winding section connected).	0001V
ENTER KVA	Enter the value for the CCR kVA rating	15kVA
kVA ALARM	Alarm screen displayed if there is a 10% or greater drop in the volt-amperes being delivered to the series loop circuit.	Disabled
AENA OUTPUTS	Two of the Back Indication relay outputs on the AT662A Card are re-allocated for AENA requirements: Over Temperature Shutdown on terminals J5/3 and J5/4 (normally gives BI Brilliancy 7) and Over Current Shutdown on J5/5 and J5/6 (normally gives BI Brilliancy 8)	Disabled

Table 9-3 CCR Hardware Configuration Screens

9.4.1 Accessing the CCR Hardware Configuration Menu

The CCR Hardware Configuration Menu is accessed from the Set-up Menu by the use of a password, as described below.

Turn the Brilliancy Control Selector switch SW1 to 'OFF'. Enter the Set-up Menu as described in Section 9.3.1 and use the (↑) button to scroll to the following screen:

	C	C	R		H	A	R	D	W	A	R	E		↑	↓
			C	O	N	F	I	G	?				Y	=	↵

Press (↵ Enter) and the screen will change to the CCR Hardware Configuration Password screen:

E	N	T		C	O	N	F	I	G		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		a	a	a			

Enter the password 'e n g' using the (↑), (↓) and (↵ Enter) buttons. (Note – this password cannot be changed).

If you enter the password incorrectly the screen will display:

E	N	T		C	O	N	F	I	G		P	W	O	R	D
Y	=	↵		U	S	E	↑	↓		N	N	N			

You can re-try the password by first pressing (↵ Enter) and then loading the correct password. There is no limit to the number of retries.

If you enter the correct password the screen will display:

E	N	T		C	O	N	F	I	G		P	W	O	R	D
Y	=	↲		U	S	E	↑	↓		Y	Y	Y			

Press (↲ Enter) and the screen will change to the first of the CCR Hardware Configuration screens. It is now possible to scroll through the Menu using the (↑) (↓) buttons.

Pressing the (↲ Enter) button will permit modifications to the parameters for the selected screen. The left-hand arrow will move to the second line, and then pressing the (↑) or (↓) buttons will scroll through the available parameter settings. Pressing the (↲ Enter) button will load the new parameter.

To exit from the CCR Hardware Configuration Menu and return to the Set-up Menu, press the (X Clear) button. (Note – if you are within one of the Hardware Configuration screens, you will need to press the (X Clear) button twice).
The screen will change to:

	C	C	R		H	A	R	D	W	A	R	E		↑	↓
			C	O	N	F	I	G	?				Y	=	↲

To exit from the Set-up Menu and return to the Main Menu, press the (X Clear) button. The screen will change to:

		E	X	I	T		S	E	T	U	P		?		
		Y	=	↲		C	A	N	C	E	L	=	X		

Press the (↲ Enter) button to confirm the exit.

9.4.2 Hardware Configuration Screens

9.4.2.1 Setting the Full Load Current

This screen allows the Full Load Current (nominal output current) of the regulator to be programmed. The value would normally be set to customer specifications during factory testing – as indicated on the regulator identification plate - and would only need to be reset if the conditions described Section 10.2.2 occurred.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

→		F	U	L	L		L	O	A	D		I		↑	↓
					6	.	6	0		A					

Press the (↲ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. (NOTE - IF THE SCREEN IS ACCESSED BY MISTAKE, PRESS THE X (CLEAR) BUTTON TO EXIT). The required Full Load Current can now be selected between 6.00, 6.60; 12.0 using the (↑) (↓) buttons.

If the (↲ Enter) button is pressed the screen will change to

	W	I	L	L		R	Q	R		S	E	T	U	P	
	A	C	C	E	P	T	?					Y	=	↲	

The screen warns the user that following a change of the FLC setting, the CCR will require recalibration. Changing the FLC resets the Microcontroller 'Span' Current Demand register output value to the default value of 50 from a normal calibrated level of between 182 and 198. The 'Zero' register is also put back to the default value, and the User Current Levels revert to the default UK CAP 168 values for the selected FLC rating.

Pressing the (↲ Enter) button will load the new Full Load Current. The CCR should now be recalibrated as described in Section 10.2.

9.4.2.2 Firmware Version

This screen displays the version number of the Microprocessor Firmware; no changes can be made to the screen. Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to display:

F	I	R	M	W	A	R	E							↑	↓
V	E	R	S	I	O	N			X	.	X				↲

9.4.2.3 Black Heat Current Level

The Black Heat current may be set as required to any value between 12% of the Full Load Current, and Full Load Current. This section describes how to set the Black Heat current level.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

→			B	L	A	C	K		H	E	A	T		↑	↓
					2	.	5	0		A					

Press the (↲ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be adjusted a digit at a time by using the (↑) (↓) and (↲ Enter) buttons.

9.4.2.4 Percentage Lamp Fail Alarm Delay

This screen allows adjustment of the time delay between the Percentage Lamp Failure threshold being crossed, and the alarm being activated.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

→	%		L	A	M	P			F	A	I	L		↑	↓
	T	I	M	E			5	.	0	0	S				

Press (↵ Enter) button and the arrow in the top left-hand corner of the screen will move to the bottom line.

	%		L	A	M	P			F	A	I	L		↑	↓
→	T	I	M	E		1	0	.	0	0		S			

Set the Lamp Fail Alarm Delay time, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The delay time can be set between 5 and 60 seconds, with a resolution of 1 second.

9.4.2.5 Tolerance Monitoring Alarm Delay

This screen allows adjustment of the time delay between the Tolerance Monitoring threshold being crossed, and the alarm being activated.

Enter the Hardware Configuration Menu as described in Section 9.4.1, and use the (↑) or (↓) buttons to scroll to the following screen

→	T	O	L		M	O	N		F	A	I	L		↑	↓
	T	I	M	E		1	5	.	0	0		S			

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line.

	T	O	L		M	O	N		F	A	I	L		↑	↓
→	T	I	M	E		1	5	.	0	0		S			

Set the Tolerance Monitoring Alarm delay time, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The delay time can be set between 5 and 60 seconds, with a resolution of 1 second.

9.4.2.6 Setting of User Defined Tolerance Levels

When the Brilliancy Level selection is set to operate from UK CAP 168, FAA / IEC Style 1 or FAA / IEC Style 2 levels, the relevant tolerance Levels will automatically be used (see Section 4.2 above). When the Brilliancy Level selection is set to User Defined, then Tolerance Monitoring Levels set by the user will be applied. By default, these are set to UK CAP168 Levels, but they should be adjusted to values appropriate to the User Defined Current Levels.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↑) or (↓) buttons to scroll to the following screen:

S	E	T		U	S	E	R			T	O	L		↑	↓
L	E	V	E	L	S	?								↵	X

Press the (↵ Enter) button and the screen will change to:

→		O	V	E	R			T	O	L		8			
						6	.	7	0		A				

This is the screen for the Upper Tolerance Limit on Brilliancy Level 8.

Press the (↓) button and the screen will change to:

→		U	N	D	E	R		T	O	L		8			
						6	.	4	0		A				

This is the screen for the Lower Tolerance Limit on Brilliancy Level 8

Note: If the USER DEF. DOE. setting is used, the screen shown will change to:

→		U	N	D	E	R		T	O	L		M	A	X	
						6	.	4	0		A				

Use the (↑) (↓) buttons to scroll to whichever Tolerance Limit is to be adjusted.

To modify the Tolerance Limit, press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. Change the Tolerance Limit, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The digit flashing on and off indicates the digit being set. The 'tens' digit is only displayed if it has been set to a value other than zero. Press the (↵ Enter) button to accept the new setting.

		O	V	E	R			T	O	L		8			
→						6	.	7	0		A				

When all four digits have been entered, the arrow returns to the top line and the operator can now select another Tolerance Limit to define.

The lower limits, the ‘UNDER TOL’ values, cannot be set to a value greater than the operating current level for that particular User Defined Brilliancy, or to a value less than the operating current level minus 10%.

Over tolerance values cannot be set to a value greater than the operating current level for that particular User Defined Brilliancy plus 10%, or to a value less than the operating current level.

9.4.2.7 Zero Point Calibration

This screen allows entry to the CCR Zero Point Calibration routine.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		Z	E	R	O	↑	↓
P	O	I	N	T									Y	=	↵

Refer to Section 10.2.2.2 for a full description of the calibration method.

9.4.2.8 Span Point Calibration

This screen allows entry to the CCR Span Point Calibration routine.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		S	P	A	N	↑	↓
P	O	I	N	T									Y	=	↵

Refer to Section 10.2.2.3 for a full description of the calibration method.

9.4.2.9 Real Power Meter Calibration

Note – this screen is not for general use, since it is only applicable where the optional (and rarely used) AT755A Power Analyser Card is fitted. The Power Analyser Card provides more features than just power measurement; standard Micro 200 CCRs already include a Real Power Meter, of which the measurement can be displayed on the CCR front panel. Calibration of the standard Real Power Meter is done using a potentiometer on the AT733 card – refer to Section 10.2.3

To access the screen, enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L		R	E	A	L		P	O	W	E	R	↑	↓
M	E	T	E	R									Y	=	↵

9.4.2.10 Test Over-current Trip Point

This screen allows the operator to directly control the CCR output current level. The current can be increased above the normal Full Load Current value in order to test the Over-current Trip Point and Trip Time.

The testing of the Over-current Detection Circuit is, however, part of the factory tests, and would not normally be performed by the user.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

T	E	S	T		O	V	E	R	C	U	R	R	E	N	T
T	R	I	P		P	O	I	N	T				Y	=	↵

9.4.2.11 Earth Leakage Detection Type

There are 2 types of Earth Leakage Modules which can be fitted to the CCR; the Analogue Module (based on the AT699 pcb) gives an actual measurement of the earth leakage resistance, whilst an earlier design – the 2 Stage Earth Leakage system (based on the B101981 rev3 card) - gives 2 fixed alarm threshold levels.

This screen allows programming the CCR to match the type of Earth Leakage Module fitted.

Note – this setting will be made during factory testing of the CCR, and will not normally require any modification.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	E	A	R	T	H		L	E	A	K		D	E	T	
			A	N	A	L	O	G	U	E					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line:

	E	A	R	T	H		L	E	A	K		D	E	T	
→			A	N	A	L	O	G	U	E					

The setting can now be selected between ANALOGUE, CONT. ANALOGUE, DIGITAL and DISABLED, using the (↑) and (↓) buttons. If the AT699 Earth Leakage Measurement Module is fitted, select ‘ANALOGUE’, or if continuous testing at 500V DC is also required in the ‘Off’ state, select ‘CONT. ANALOGUE’.

The setting should be set to ‘DISABLED’ if the AT699 Earth Leakage Measurement Module is not fitted.

Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

9.4.2.12 Stage 2 Earth Leakage Trip Selection

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	T	R	I	P		O	N		E	A	R	T	H		2
				E	N	A	B	L	E	D					

Refer to Section 4.5.2.1 to program this menu.

9.4.2.13 Alarm on Multiple Remote Brilliancy Selection

The CCR will give an alarm if more than one Remote Brilliancy Input is selected when using 8-Wire control. This screen allows the alarm to be disabled.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	A	L	A	R	M		M	U	L	T		B	R	I	L
				E	N	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line:

	A	L	A	R	M		M	U	L	T		B	R	I	L
→				E	N	A	B	L	E	D					

Select between ENABLED and DISABLED using the (↑) and (↓) buttons, and press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

9.4.2.14 Start Up Ramp Selection

This screen allows the selection of a CCR Output Current Start-up Ramp.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	O	P		S	T	A	R	T		R	A	M	P	↑	↓
				E	N	A	B	L	E	D					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED & DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to load the new setting; the arrow will return to the top left-hand corner of the screen.

When enabled, the default Start-up Ramp Time is 600ms. The time can be adjusted as described below.

9.4.2.15 Start Up Ramp Time

This screen, only available if the CCR Output Current Start-up Ramp is enabled, allows the Ramp Time to be set.

Note – the Ramp Time relates to the approximate time taken to go from zero to 100% current on start-up. If a lower Brilliancy is selected at Start-up, then the Ramp Time will be proportionally smaller.

After enabling the Start-up Ramp as described in Section 9.4.2.14 above, use the (↓) button to change the screen to

→	S	T		R	A	M	P		T	I	M	E		↑	↓
				X	X	X	X		m	S					

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line.

	S	T		R	A	M	P		T	I	M	E		↑	↓
→				X	X	X	X		m	S					

It is now possible to set the Ramp Time, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The Ramp Time can be set between 10 and 1600 milliseconds.

Press the (↵ Enter) button to confirm the setting.

9.4.2.16 Internal Circuit Selector Configuration

This screen allows configuration of the Internal Circuit Selector Switch type, and allows entry to the other CSS set-up screens.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	C	C	T		S	E	L	E	C	T	O	R		↑	↓
				D	I	S	A	B	L	E	D				

Refer to the supplementary manual for the Internal Circuit Selector Switch for instructions on CSS configuration.

9.4.2.17 Percentage Lamp Failure Monitoring Selection

The PLF Monitoring inputs are configured via this screen.

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

→	%		L	A	M	P		F	A	I	L			↑	↓
					E	N	A	B	L	E	D				

Refer to Section 4.6, for a complete description of the calibration method.

9.4.2.18 Programming the Output Transformer Tapping Voltage

To correctly monitor the output voltage and output load kVA of the CCR, the actual tapping voltage used on the Main CCR Output Transformer must be entered. The actual transformer output voltage is the sum of all sections of the transformer secondary windings that are connected in series. Using the example of Figure 4-4, this would be 1600V.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	E	N	T		T	X		O	P		V	O	L	T	S
Y	=	↵		U	S	E	↑	↓		0	0	0	1	V	

It is now possible to load the Output Transformer Tapping Voltage, one digit at a time, by using the (↑) (↓) and (↵ Enter) buttons. The Output Transformer Tapping Voltage can be set between 1 and 5000 Volts. Press the (↵ Enter) button to confirm the setting.

9.4.2.19 Programming the CCR kVA Rating

To correctly measure the output load kVA of the CCR whilst it is running, and for correct switching of the load compensation capacitors, the kVA rating of the CCR must first be programmed.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	E	N	T	E	R		K	V	A						
Y	=	↵		U	S	E	↑	↓			1	5	K	V	A

It is now possible to scroll up and down the pre-programmed kVA values using the (↑) (↓) buttons. When the correct value is reached, press (↵ Enter).

9.4.2.20 KVA Alarm Enable

If 'Voltage Feedback' is activated, then 'KVA Alarm' can also be enabled. This generates an alarm if the CCR output load kVA drops below 90% of the peak measured load value for whichever brilliancy step is in operation, for a period of 5 seconds.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	K	V	A		A	L	A	R	M					↑	↓
					E	N	A	B	L	E	D				

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED & DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

9.4.2.21 AENA Outputs Enable

If enabled, two of the Back Indication relay outputs on the AT712 Card are re-allocated for AENA requirements: Over Temperature Shutdown on terminals J5/3 and J5/4 (normally indicates BI Brilliancy 7) and Over Current Shutdown on J5/5 and J5/6 (normally indicates BI Brilliancy 8) – refer to Figure 3-3.

Enter the Hardware Configuration Menu as described in Section 9.4.1 and use the (↓) button to scroll down to the following screen:

	A	E	N	A		O	U	T	P	U	T	S		↑	↓
				D	I	S	A	B	L	E	D				

Press the (↵ Enter) button; the arrow in the top left-hand corner of the screen will move to the bottom line. The setting can now be selected between ENABLED & DISABLED using the (↑) (↓) buttons.

Press the (↵ Enter) button to load the new setting. The arrow will return to the top left-hand corner of the screen.

9.5 Fault Screens

All faults are logged by the Microcontroller and will result in an appropriate fault screen being displayed. The display will alternate between the Running Display and the fault screen every 2 seconds. Example screens are shown below:

1	F	A	U	L	T		-		%		L	A	M	P	
									F	A	I	L	U	R	E

If more than one fault has been registered, the fault screen with the highest priority only will be the one normally shown. However, it is possible to scroll down through the fault screens, starting from the priority fault screen, by using the (↓) button. The total number of faults logged is also indicated.

4	F	A	U	L	T	S	-		O	P	E	N			
									C	I	R	C	U	I	T

The fault screen will continue to be displayed even if the fault is no longer present. (Except for external communications fault, which is self re-setting.) To clear a fault screen, press the Reset button at the moment that the fault screen is being displayed. The screen will not reset if the button is pressed while the Running Display is present, nor if the fault is still present on the system.

Figure 9-5 overleaf shows the Fault Screen hierarchy, whilst
Table 9-4 gives a listing of the Fault Screens and a description of each.

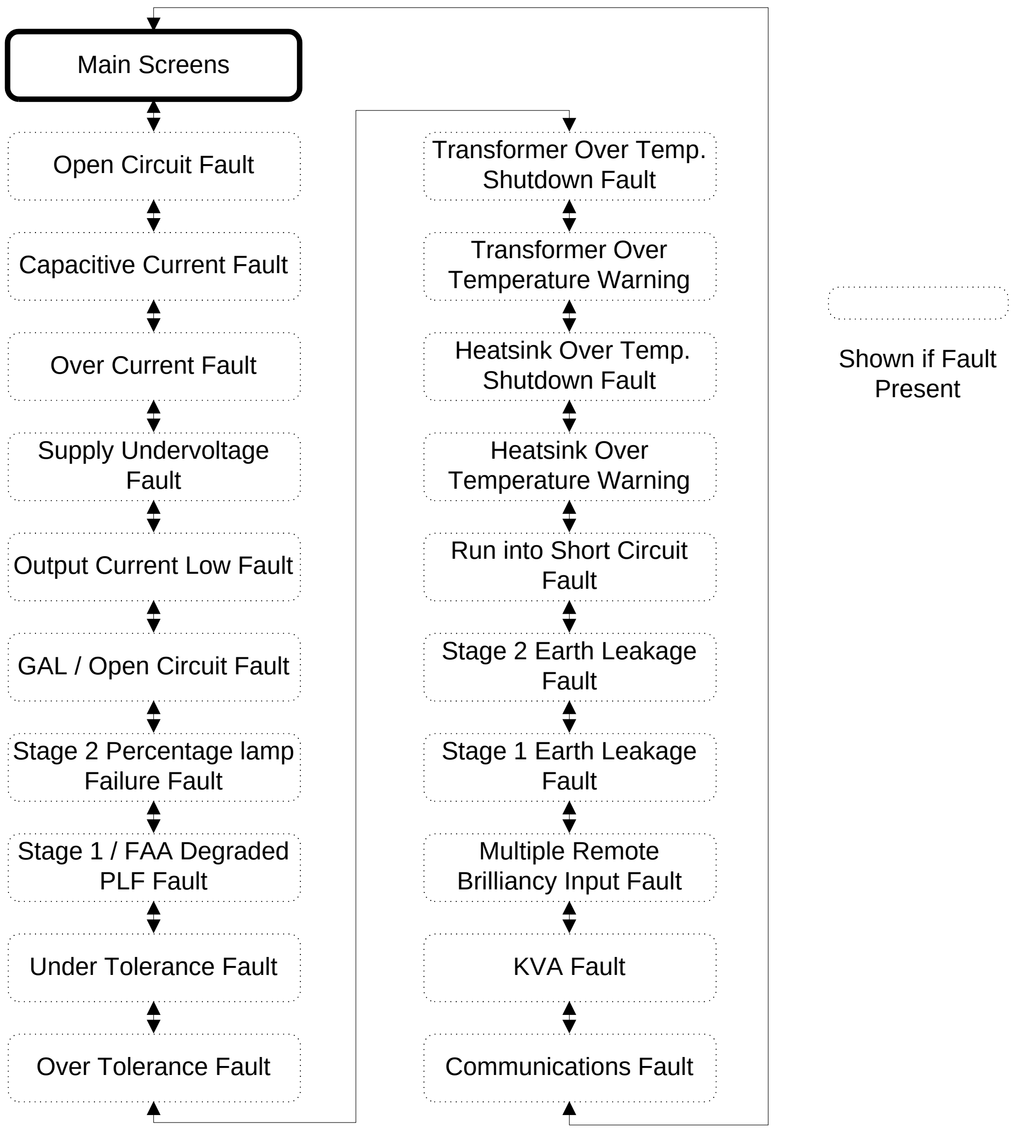


Figure 9-5 Fault Screen Hierarchy

Fault Screen	**Description**
Open Circuit	Series loop open circuit, main CCR transformer output voltage taps set too low, or CCR reverted to default operating parameters after 'Verify Failure' on power up, and recalibration required
Capacitive Current	Open circuit fault with capacitance current flow
Over Current	CCR output current overload fault
Supply Under Voltage	CCR supply voltage drops below 75% of nominal for more than 1 second
Output Current Low	Lamp Loop Live fault. Little or no CCR output current; likely to occur if CCR reverted to default operating parameters after 'Verify Failure' on power up, and recalibration required
GAL / Open Circuit Fault	IGBT Control fault or series loop open circuit.
Stage 2 Percentage Lamp Failure	The number of failed lamps on the field circuit exceeds the Stage 2 Percentage Lamp Failure threshold
Stage 1 / FAA Degraded Mode Percentage Lamp Failure	The number of failed lamps on the field circuit exceeds the Stage 1 Percentage Lamp Failure threshold. (FAA Type Selected: Running in Degraded Mode)
Tolerance Monitoring Under Current	CCR output current less than lower tolerance limit for the selected brilliancy
Tolerance Monitoring Over Current	CCR output current greater than upper tolerance limit for the selected brilliancy
Transformer Over Temperature Shutdown	CCR Shutdown due to Main Transformer over temperature
Transformer Over Temperature Warning	Main Transformer Over Temperature warning
Heatsink Over Temperature Shutdown	CCR Shutdown due to IGBT heatsink over temperature
Heatsink Over Temperature Warning	IGBT heatsink Over Temperature warning
Run into Short Circuit	The CCR has been running with the output load in a short circuit condition for 30 seconds
Stage 2 Earth Leakage	The resistance to earth of the series loop circuit is less than the threshold level for the Stage 2 Earth Leakage Fault Detector. (Note Stage 2 Earth Leakage indicates a higher leakage current flow than Stage 1)
Stage 1 Earth Leakage	The resistance to earth of the series loop circuit is less than the threshold level for the Stage 1 Earth Leakage Fault Detector.
Multiple Remote Brilliancy Inputs	More than one Remote Brilliancy Input activated. Only applicable for 8-Wire Remote Brilliancy Control
KVA	CCR output kVA drops below 90% of the peak measured load value for whichever brilliancy step is in operation, for a period of 5 seconds.
Communications	The Internal and/or External Communications have failed. Notes: • The fault reported will be internal if the communications between the microprocessor board and the communications adaptor have failed, or external if the failure is with the external bus (eg. Profibus, J-Bus). • Priority is given to reporting internal communications faults. • External faults are automatically reset.

Table 9-4 Fault Screens

10 Maintenance, Hardware Configuration and Calibration

10.1 Introduction

Routine maintenance is generally confined to those items listed in the table below, however the period between maintenance work may need to be reduced according to the installation conditions.

Maintenance	Period
• Visual examination for damage, discolouration / heating of cable connections • Check all connections for tightness, including cabinet earth connection • Check continuity of CCR cabinet earth studs to substation earth	6 Monthly
• Visual examination for damage, discolouration / heating of cable connections • Check all connections for tightness, including cabinet earth connection • Check continuity of CCR cabinet earth studs to substation earth • Clean out any dust which may have built up • Verify CCR output current level using high quality in-line true RMS ammeter	Annually

Table 10-1 Routine maintenance

If a fault should develop it will first be necessary to determine if a fault lies in the regulator or with its associated field circuit. See Section 12 of this manual for a fault-finding guide.

10.1.1 Location of main components of the Micro 200

The following photographs show the main components of the Micro 200 CCR:

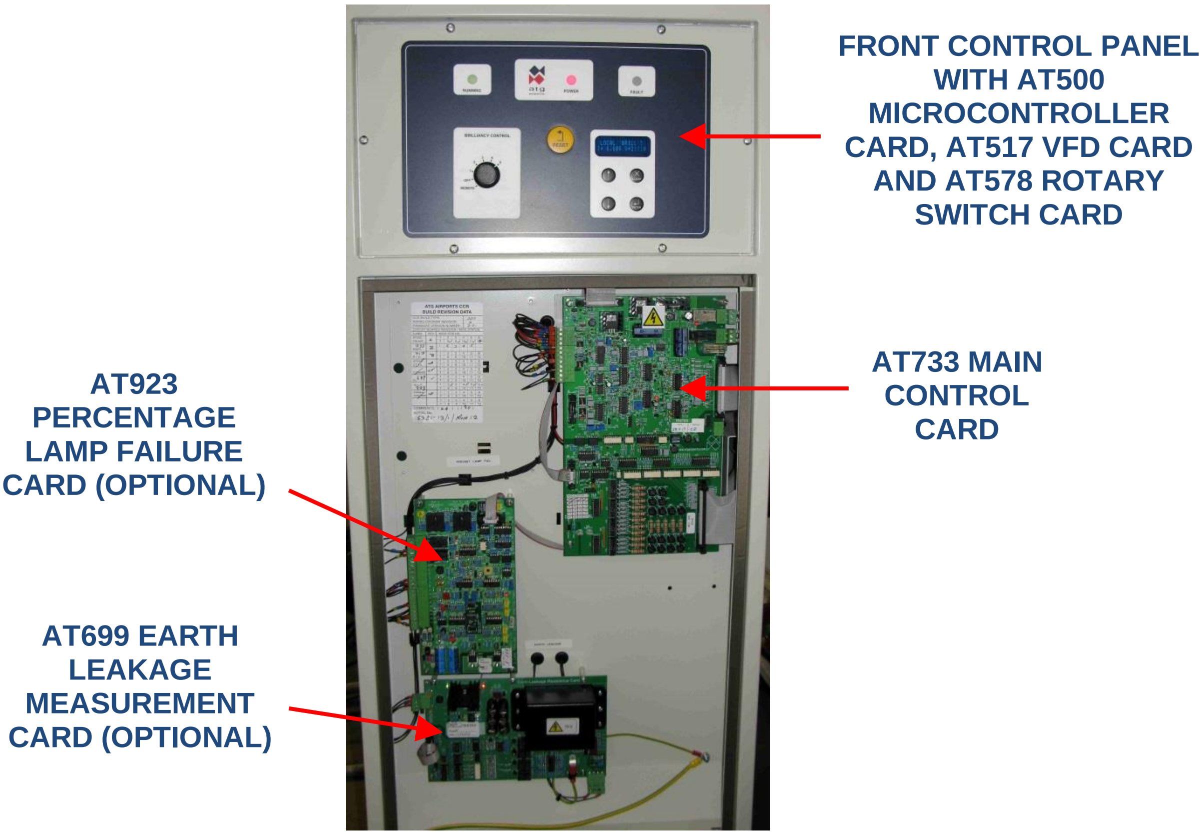


Figure 10-1 Control cards behind front door

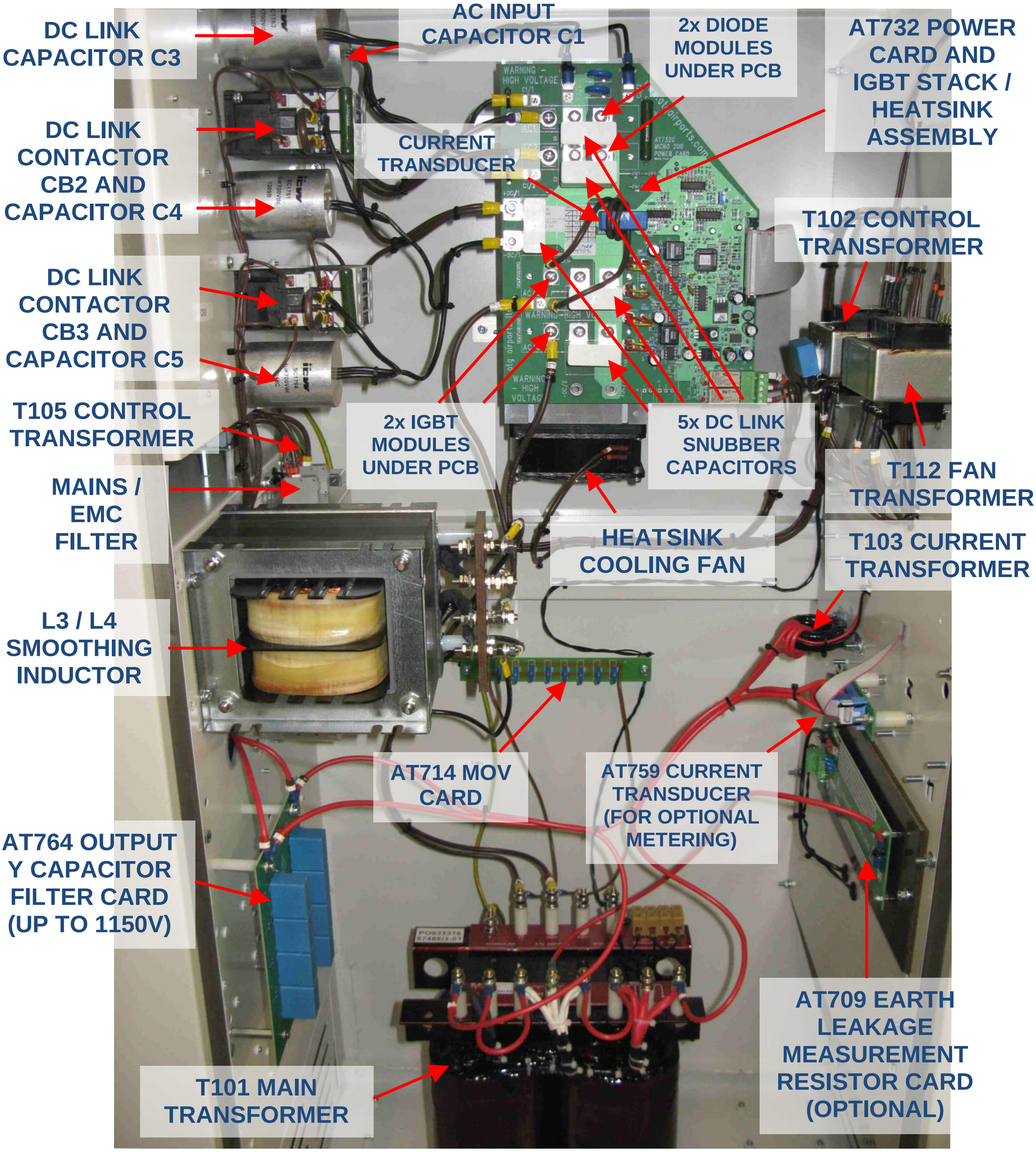


Figure 10-2 Components fitted in HT cubicle – CCRs up to 25A supply current

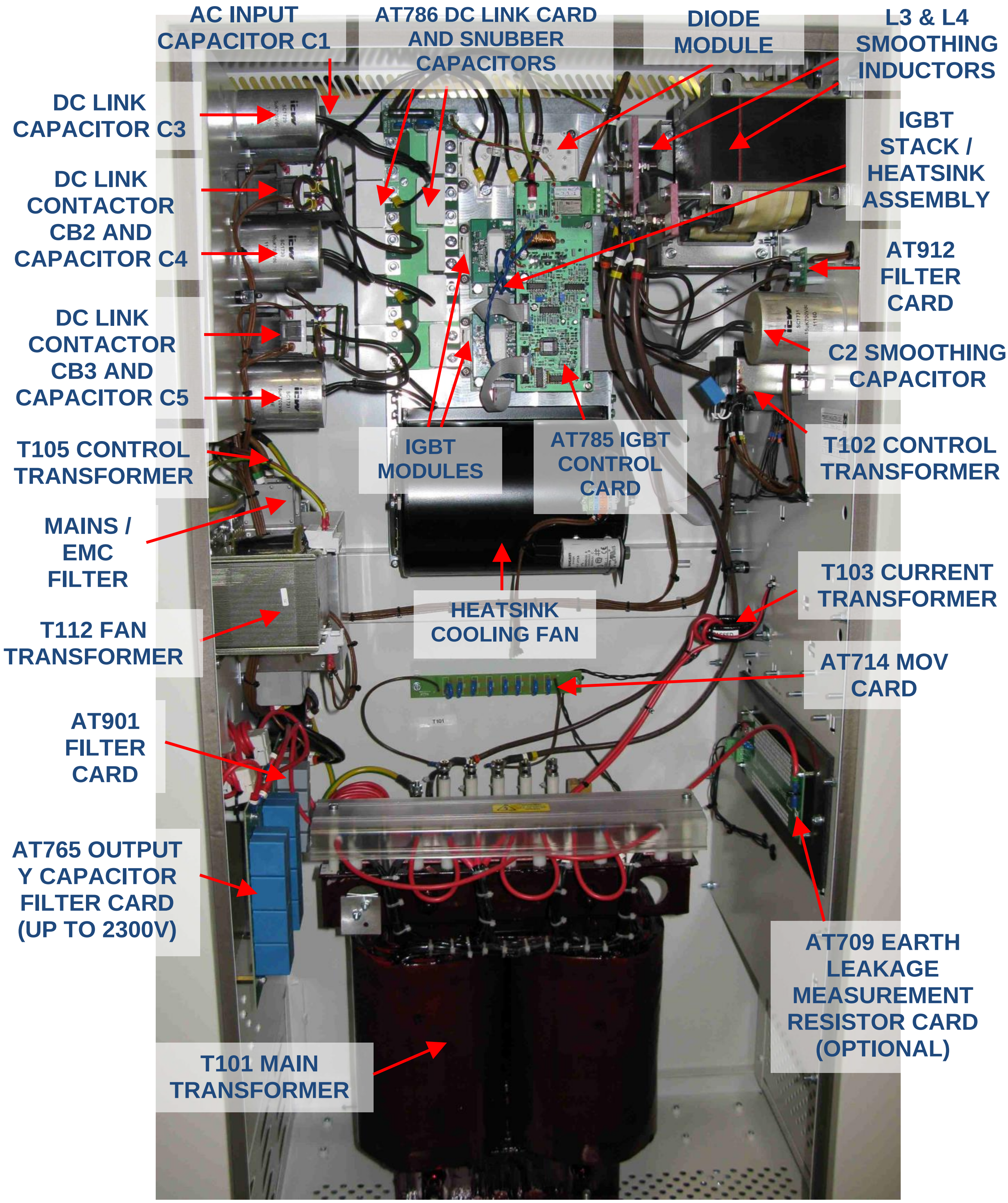


Figure 10-3 Components fitted in HT cubicle – CCRs up to 55A supply current

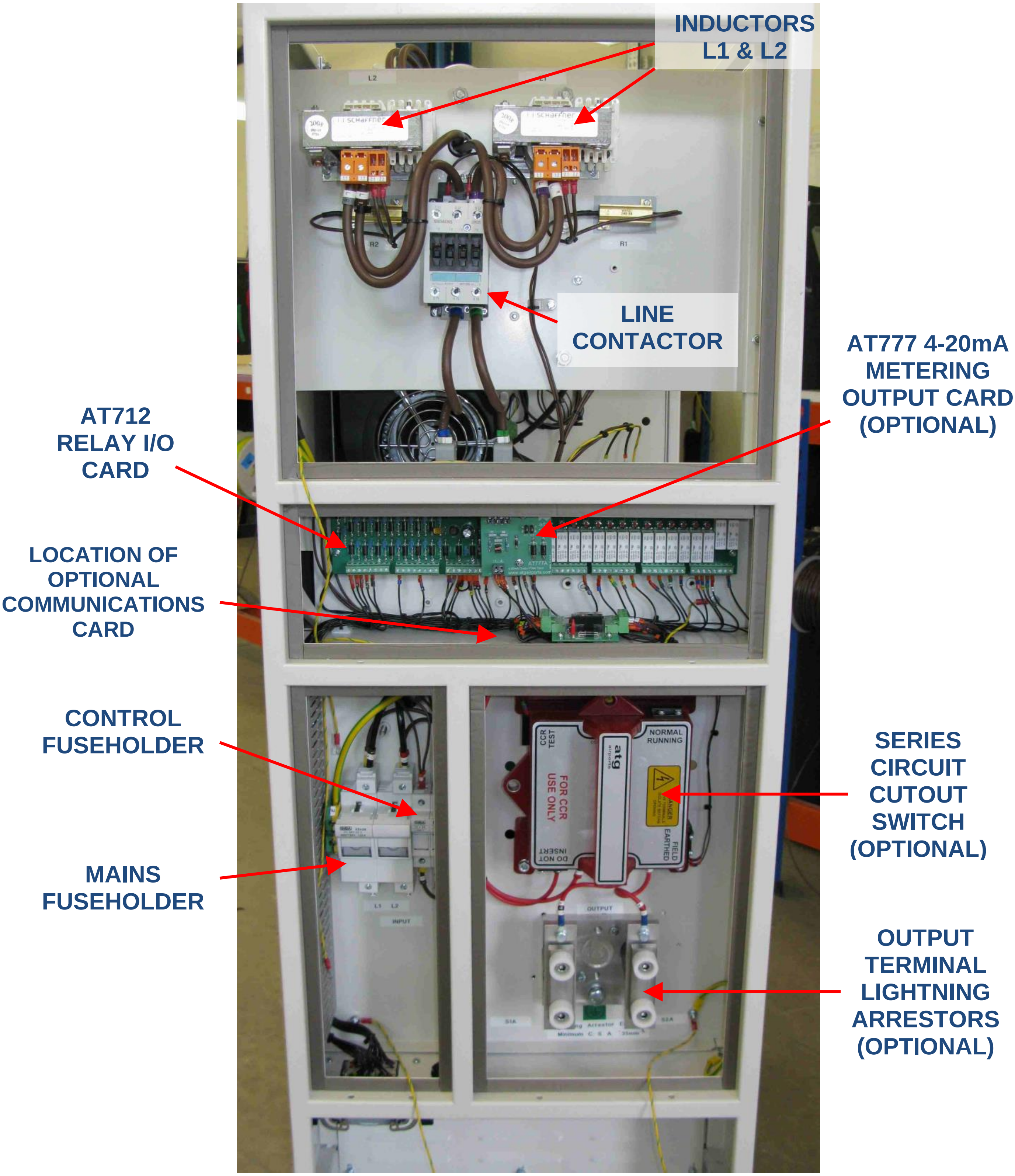


Figure 10-4 Components at rear of CCR

10.2 Calibrating the CCR

10.2.1 Overview

Calibration of the regulator output current may be required for the following reasons:

i/ After measuring the maximum output current level of the CCR using a high quality in-line 'true RMS' ammeter (recommended annual test), the current is found to be outside the tolerance limits specified in Table 4-1 to Table 4-4.

ii/ If the Microcontroller Front Display Panel (containing the AT500 Card) has been replaced.

iii/ If the AT733 Control Card has been replaced (note – a partial recalibration may be sufficient in this case – see Section 10.2.3)

It is recommended that calibration should not be performed with the regulator connected to the AGL circuit to avoid any possible damage to the AGL lamps. Ideally, a resistive load bank should be connected in place of the AGL circuit, or, if a load bank is not available, then the CCR output terminals can be short circuited. The functionality of the regulator can be tested in this way without the risk of damaging the AGL lamps should the output current go too high, or should the CCR control loop become unstable for any reason.

The transformer output voltage selector taps should be set according to the load used; see Section 4.3. However, for correct operation of the Micro 200 control loop the transformer secondary tapping voltages should be set no lower than 20% of maximum. (This also applies if testing the CCR into a short circuit load; setting the output voltage too low will cause the control loop to become unstable and the CCR to trip).

atg airports do not recommend the use of 'clamp' type RMS ammeters for calibrating the CCR since the measurement can change substantially with clamping pressure. A high quality, 'true RMS' in-line meter should instead be used, and the meter itself should have a valid certificate of calibration. It should be connected in the CCR output loop in order to measure the actual regulator output current during re-calibration.

Configuration and setting up of the regulator is largely achieved via menu selections using the keypad. However, calibration of the regulator also requires that certain voltage measurements are made on the main control board (AT733) whilst in the 'Calibrate Span' menu, and adjustment of the 'CCR CAL' pot VR3.

Warning – the main contactor coil connections are at mains potential – this could be as high as 415V. These connect to terminal block J1, located at the top right-hand corner of the AT733 card. Due to the voltages present, a cover is fitted over these terminals.

10.2.2 Calibrating the CCR Output Current

Calibration of the regulator requires setting the Zero and Span points, as described in the following sections. The Full Load Current setting of the regulator is programmed during factory testing, and should not require adjustment unless:

i/ The CCR output current rating is to be changed, for example, if the regulator is to be used on a different AGL circuit.

ii/ The Microcontroller Front Panel (containing the AT500 Card) has been replaced.

iii/ The Microcontroller has displayed the following message on power up:

	V	E	R	I	F	Y		F	A	I	L	U	R	E	
↵	=	A	P	P	L	Y		D	E	F	A	U	L	T	S

If this occurs and default operating parameters are applied without next recalibrating the regulator, then the output current will be extremely low and the unit will trip on 'Open Circuit' fault. The Full Load Current will also return to its default setting, (6.60A), and so may require changing. If a record has been kept of all CCR operating and calibration parameters, then these can be reloaded as described in Section 12.3.

If any of the above three conditions apply, then the Full Load Current should be programmed first, since any changes to the Full Load Current always require that the Zero and Span points are then recalibrated.

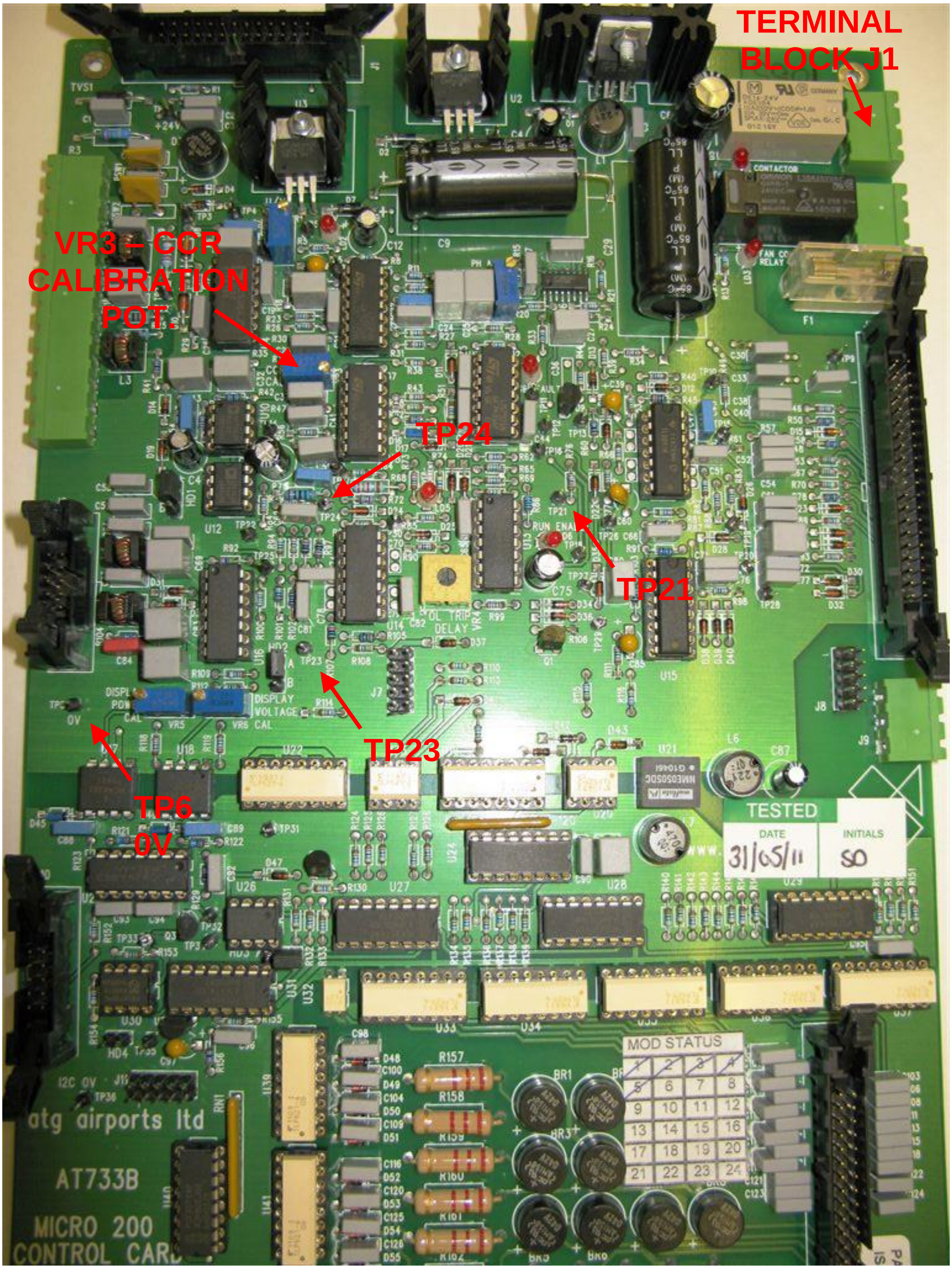


Figure 10-5 AT733 Control Card Test Points and CCR calibration pot

10.2.2.1 Setting the Full Load Current

If it is necessary to change the CCR Full Load Current from the Firmware default value of 6.60A, then this should be done before calibrating the Zero and Span points.

Turn the Brilliancy Control Selector Switch SW1 to ‘OFF’, then programme the Full Load Current by entering the Hardware Configuration Menu. This is described in Sections 9.4.1 and 9.4.2.1.

The CCR may be programmed to operate at 6.00, 6.60 or 12.0 Amps. However, the transformers fitted in the majority of the CCRs are limited to 6.6A maximum output. Transformers wound with dual sets of secondary windings can operate at 6.6A or 12A. If it is required to change the nominal output current of the CCR from 6.00 / 6.60 to 12.0 Amps or vice-versa, then the number of turns through the control loop CT and the configuration of the Main CCR Transformer output connections will have to be changed, (see Sections 4.3 and 10.3.1), followed by reprogramming the Full Load Current and recalibration of the regulator to the new output current level.

10.2.2.2 Setting the Zero Point

Ensure there are no alarms present; turn the Brilliancy Control Selector Switch SW1 to ‘OFF’. Connect a DVM, set on the 200mV DC range, between TP6 (0 volts) and TP21 on the AT733 Main Control Board. This card is located behind the front cover of the regulator, below the keypad. The location of the test pins are shown in Figure 10-5.

Enter the Hardware Configuration Menu as described in Section 9.4.1; use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		Z	E	R	O	↑	↓
P	O	I	N	T									Y	=	↵

Press the (↵ Enter) button and the screen will change to

→	C	C	R		W	I	L	L		S	T	A	R	T	
	C	O	N	T	I	N	U	E	?			Y	=	↵	

Press (↵ Enter) button again, the CCR will start and the screen will change to

	P	R	E	S	S		↑	↓		U	N	T	I	L	
T	P	2	1	=	0	.	0	0	V		(		2	0	)

The figure in brackets on the second line is the Microcontroller Zero Point output register value. This will change during calibration; the default value is 20.

Press the (↑) (↓) buttons to adjust the voltage measured at TP21 as close as possible to 0 volts; the residual voltage can be of either polarity. It should be possible to reduce the voltage to a magnitude of less than 50mV. When this has been correctly adjusted, press the (↵ Enter) button.

Note – if accessing this menu just in order to make a record of the calibration factor, pressing the (X Clear) button will exit without altering the calibration.

10.2.2.3 Setting the Span Point

Do not calibrate the regulator 'Span' point with an AGL circuit connected in case an excess current is produced which could damage the AGL lamps. Ideally, a resistive load bank should be connected in place of the AGL circuit, or, if a load bank is not available, then the CCR output terminals can be short circuited. The functionality of the regulator can be tested in this way without the risk of damaging the AGL lamps should the output current go too high, or should the CCR control loop become unstable for any reason.

The transformer output voltage selector taps should be set according to the load used; see Section 4.3. However, for correct operation of the Micro 200 control loop the transformer secondary tapping voltages should be set no lower than 20% of maximum. (This also applies if testing the CCR into a short circuit load; setting the output voltage too low will cause the control loop to become unstable and the CCR to trip).

Connect a calibrated in-line 'true RMS' ammeter in the regulator output circuit.

Ensure there are no alarms present; turn the Brilliancy Control Selector Switch SW1 to 'OFF'.

Connect a DVM, set on 2V DC range, between TP6 (0 volts) and TP24 on the AT733 Main Control Board (The location of the test pins and potentiometers are shown in Figure 10-5). Measure the voltage at TP24 with the CCR in the off state – it should be close to 1.50v. Make a record of the exact voltage.

Reconnect the DVM between TP6 (0 volts) and TP23 on the AT733 Main Control Board. Turn the 'CCR CAL' pot VR3 on the AT733 fully anticlockwise (this gives minimum current).

Enter the Hardware Configuration Menu as described in Section 9.4.1, then use the (↑) or (↓) buttons to scroll to the following screen:

C	A	L	I	B	R	A	T	E		S	P	A	N	↑	↓
P	O	I	N	T									Y	=	↵

Press (↵ Enter) button and screen will change to

	C	C	R		W	I	L	L		S	T	A	R	T	
	C	O	N	T	I	N	U	E	?			Y	=	↵	

Press (↵ Enter) button again, the CCR will start and the screen will change to

	P	R	E	S	S		↑	↓		U	N	T	I	L	
T	P	2	3	=	T	P	2	4		(	1	9	8	)	

The internal demand voltage can now be adjusted using the (↑) (↓) buttons until the voltage measured on the DVM at TP23 is exactly equal to that previously measured at TP24 in the off state - approximately 1.50v. This sets the correct operating voltage level for the Current Control Loop and for the Over-current Protection.

The second line of the display should read somewhere between 182 and 198 when correctly adjusted.

Note – if a shorting link has been connected to the CCR output terminals in place of the load, then the CCR will trip out after 30 seconds. Press the Reset button to continue the calibration process.

Once this is achieved the ‘CCR CAL’ pot VR3 on the main control board can be adjusted until exactly the required CCR Full Load Current – be it 6.00, 6.60 or 12.00A - is measured on the true RMS ammeter. When, and only when the current is correct, press the (↵ Enter) button.

Pressing (↵ Enter) loads the Microcontroller’s internal scaling factor, such that the actual measured current is set to the selected CCR Full Load Current.

Note – if accessing this menu just in order to make a record of the calibration factor, pressing the (X Clear) button will exit without altering the calibration.

10.2.3 AT733 Control Card replacement – partial recalibration

This procedure can be used to put the CCR back into service after replacing ONLY the AT733 Control Card; it assumes that the CCR output current display meter calibration is correct. An independent ‘True RMS’ ammeter – not necessarily of the accuracy normally used for calibration purposes - can be used as a backup if necessary, but it will be the CCR current display that will be used to calibrate the AT733 Card.

The procedure is as follows:

i/ Prior to switching on the CCR, turn VR3 - the 'CCR CALIBRATION' potentiometer - fully anticlockwise. Refer to Figure 10-5 for the location of the potentiometer.

ii/ Connect a resistive load bank or a shorting link to the output of the regulator in place of the AGL field circuit. (Follow the normal safety procedures for working on high voltage airfield lighting circuitry - refer to Section 3.4 – HT Series Circuit Output Terminals). Initial calibration of the AT733 Card should not be undertaken with a live AGL circuit, in case there is a problem with the card which could result in an excessive CCR output current.

iii/ Switch the CCR on at maximum brilliancy using the front panel rotary switch. Turn the 'CCR CALIBRATION' potentiometer on the AT733 Card slowly clockwise until the CCR front panel displays a current of exactly 6.60A, 12.0A, or whichever is the rated output current.

Note – if a shorting link has been connected to the CCR output terminals in place of the load, then the CCR will trip out after 30 seconds. Press the Reset button to continue the calibration process.

iv/ Switch the CCR off and isolate the mains supply. Remove the resistive load bank or output shorting link and reconnect the AGL field circuit.

v/ Switch the CCR on at minimum current using the front panel rotary switch, and slowly increase the brilliancy level one step at a time. Verify that the current displayed on the CCR front panel is at the correct level for each brilliancy step.

vi/ Increase to maximum brilliancy and verify that the output current shown on the CCR display is at precisely the correct value when operating into the field circuit. Adjust the 'CCR CALIBRATION' potentiometer if necessary, taking care not to go above the rated output current.

10.2.4 Calibrating the front panel Real Power Meter

The Real Power Meter is calibrated during factory testing of the CCR, and does not require adjustment when the regulator is commissioned.

If it is required to recalibrate the meter, then this can be performed with the AGL circuit connected, or with a resistive load bank. It is recommended that the CCR Main Transformer output tapping voltage should already have been adjusted to match the load used (see Section 4.3), and the tapping voltage that has been set is programmed in as described in Section 4.4.1. (The latter is very important to achieve the correct output power measurement).

For a reference measurement, connect an independent, calibrated, Real Power meter to the regulator output circuit. (Note – ensure that the input of the meter is rated for the output voltage of the CCR. If it is not, it will be necessary to use an interposing step-down voltage transformer of instrumentation class).

Run the regulator at maximum output. Press the (↑) or (↓) buttons until the output kW screen is displayed. Check that the value displayed on the CCR front panel matches that of the independent Power Meter. If it does not, then adjust potentiometer VR5 (‘DISPLAY POWER CAL’) on the AT733 Card.

10.2.5 Calibrating the front panel Output Voltage, kVA and kW Meters

The Output Voltage, kVA and kW metering is calibrated during factory testing of the CCR, and does not require adjustment when the regulator is commissioned.

If it is required to recalibrate (both meters are calibrated from the same potentiometer), then this can be performed with the AGL circuit connected, or with a resistive load bank. It is recommended that the CCR Main Transformer output tapping voltage should already have been adjusted to match the load used (see Section 4.3), and the sum total voltage of the secondary windings connected is programmed in as described in Section 4.4.1. (The latter is very important to achieve the correct meter readings).

For a reference measurement, connect an independent, calibrated, voltmeter, kVA and kW meter to the regulator output circuit. (Note – ensure that the meter input voltage measurement circuit is rated for the output voltage of the CCR. If it is not, an interposing voltage instrumentation transformer will be necessary).

Run the regulator at maximum output. Check that the value of the Output Voltage displayed on the CCR front panel matches that of the independent Voltmeter. If it does not, then adjust VR6 (‘DISPLAY VOLTAGE CAL’) on the AT733 Card.

Now press the (↑) or (↓) buttons until the output kVA screen is displayed. Check that the value displayed on the CCR front panel matches that of the independent kVA Meter. If there is a large discrepancy, even though the voltage metering was correct, then check the calibration of the CCR output current as described in section 10.2.2.

Now press the (↑) or (↓) buttons until the output kW screen is displayed. Check that the value displayed on the CCR front panel matches that of the independent kW Meter. If it does not, then adjust VR5 (‘DISPLAY POWER CAL’) on the AT733 Card.

10.3 Additional CCR Hardware configuration

10.3.1 Control Loop Current Transformer Primary Turns

The main CT, reference T103, which is used to measure the CCR output current, is set as follows: for 6.00A or 6.60A operation, there should be 4 primary turns through the CT, and for 12.00A operation there should be 2 primary turns.

Note – this is always set during factory testing to match the nominal CCR Full Load Current. It will therefore not require changing unless the regulator operating current range is to be changed from 6.00 / 6.60A to 12.00A or vice-versa. (Note – only transformers with dual sets of secondary windings can operate at 6.00 / 6.60A or 12.00A). In this case, it will be necessary to change the Main Transformer secondary connections (see Section 4.3) and the programmed CCR Full Load Current (see section 9.4.2.1) to suit the new operating current, followed by recalibrating the CCR (see section 10.2.2).

10.3.2 4-20mA Power / Current Meter

The 4-20mA Power / Current Meter is optional. The unit is factory set for either power OR current measurement, and is factory calibrated and should not normally require adjustment. The 4-20mA output signal is derived from either the AT904 or AT958 cards, which are plugged into the AT733 Main Control Board (fitted behind the CCR front door), and contain ‘Zero’ and ‘Span’ adjustment potentiometers. The output signal is fed via the AT777A card mounted in the control cubicle at the back of the regulator; refer to the circuit drawings supplied with the regulator for more details.

10.3.3 Other Control Board Potentiometers

The remaining potentiometers on the AT733 Main Control Board, and those on the Power Boards (AT732 – 25A IGBT stack, or AT785 – 55A IGBT stack), are factory set and should not require adjustment. The following sections give a description of their functions, and how the settings are made.

The AT732 card is fitted to the 25A IGBT stack assembly in the HT cubicle, and is used on regulators up to 4kVA from a 220V supply, or up to 7.5kVA from a 400V supply.

The AT785 card is fitted to the 55A IGBT stack assembly in the HT cubicle, and is used on regulators up to 10kVA from a 220V supply, or up to 15kVA from a 400V supply.

The AT733 Main Control Board is mounted behind the CCR front door; refer to Figure 10-5 for the location of the potentiometers and test points on this card.

10.3.3.1 AT733 VR1 – 'U/V' - Supply Under-Voltage Trip Level

This potentiometer sets the undervoltage level at which the CCR will switch off.

However, the procedure for adjusting this involves reducing the supply voltage to the CCR to 85.5% of nominal. The CCR should switch off; increasing the voltage to 87% of nominal should allow the CCR to be reset by pressing the front panel 'Reset' pushbutton. (Note – resetting a fault screen is only possible if the reset button is pressed at the moment when the fault message is actually displayed. If the reset button is pressed when it toggles to the normal run screen, the fault will not be reset).

10.3.3.2 AT733 VR2 – 'PH ANGLE' - Phase Angle Compensation

This potentiometer sets the phase angle between the CCR output current and the supply voltage. Adjustment of this potentiometer affects the supply Power Factor and supply current harmonic content, and can also affect the output waveshape. It is set during factory testing of the CCR to obtain the best input current waveshape and lowest harmonic level; it should NOT be adjusted as part of the commissioning process.

10.3.3.3 AT732 / AT785 Hysteresis Setting

Warning – the AT732 and AT785 cards are fitted over the IGBT stack in the high voltage cubicle, and it is not recommended to gain access to these cards whilst the CCR is powered.

25A IGBT stack - AT732 – VR1 'HYSTERESIS'
55A IGBT stack – AT785 – VR1 'HYST'

These potentiometers set the hysteresis level, or upper and lower threshold levels, which control the switching of the IGBT H-Bridge to maintain the waveshape of the output current. Raising the threshold levels reduces the switching frequency of the IGBTs, but increases the amplitude of the error from the idealised sinewave output. Reducing the threshold levels reduces the error amplitude, and raises the operating frequency, which also reduces the audible noise level.

The potentiometer is set during factory testing and should not be adjusted.

However, if a replacement IGBT stack and power card assembly is fitted, the hysteresis level can be checked with reference to Table 13-10

10.3.3.4 AT785 – DC Offset

55A IGBT stack – AT785 – VR2 'DC OFFSET'

This potentiometer can used to remove any DC offset on the CCR output current.

Again, this potentiometer is set during factory testing and should not be adjusted.

10.4 Testing and replacement of IGBTs, diodes and driver cards

The IGBT stack assemblies are mounted inside the high-tension cubicle above the power transformer, and are accessed by opening the large side door of the CCR.

WARNING - HIGH VOLTAGES – UP TO 2500V FOR A 15KVA REGULATOR – ARE PRESENT ON THE CCR MAIN TRANSFORMER OUTPUT TERMINALS. THE TRANSFORMER IS MOUNTED WITHIN THE HT CUBICLE, THE DOOR TO WHICH SHOULD NEVER BE OPENED WITHOUT FIRST ISOLATING THE REGULATOR MAINS SUPPLY INPUT.

MAINS VOLTAGES OF UP TO 415V AC AND 590V DC ARE PRESENT ON THE IGBT STACK AND DC LINK CAPACITOR CONNECTIONS DURING NORMAL OPERATION.

10.4.1 25A IGBT stack assembly

The 25A IGBT heatsink / stack assembly (stock code 7500-1800K) is used in CCRs up to 7.5kVA in the 400V series, and up to 4kVA in the 220V series. This assembly includes two SKM75GB IGBT modules (each containing two IGBTs), two SKKD 81/14 diode modules (each containing two power diodes), heatsink, fan and the AT732 Power Card. It is shown in the photograph of Figure 10-8.

Whilst individual components can be replaced, in the case of faults it is recommended to replace the complete 25A IGBT heatsink and AT732 Card assembly, since a fault on the card can be one cause of IGBT failures, and conversely, an IGBT failure can damage the driver Card.

10.4.1.1 Testing of 25A stack IGBT and diode modules

Before gaining access to the high voltage cubicle, isolate and lock off the mains supply.

The usual mode of failure for an IGBT is to fail short circuit; this can be verified by measuring the resistance across the IGBT power terminals as described below and as indicated in Figure 10-6 and Figure 10-7 overleaf. Note - the IGBTs are mounted underneath the AT732 Card, near the bottom of the stack assembly.

Since the IGBT modules are effectively connected in parallel – the input connections for both modules are connected together via the DC Link (on the AT732 Card), and the output connections are connected together via the smoothing inductors and the power transformer primary windings - in order to determine which of the two IGBT modules may have a fault, cable L10 should be temporarily disconnected from the AC/OP2 screw terminal before performing the following tests. Refit the screw after disconnecting the cable, and ensure that the cable end does not touch any other conductors.

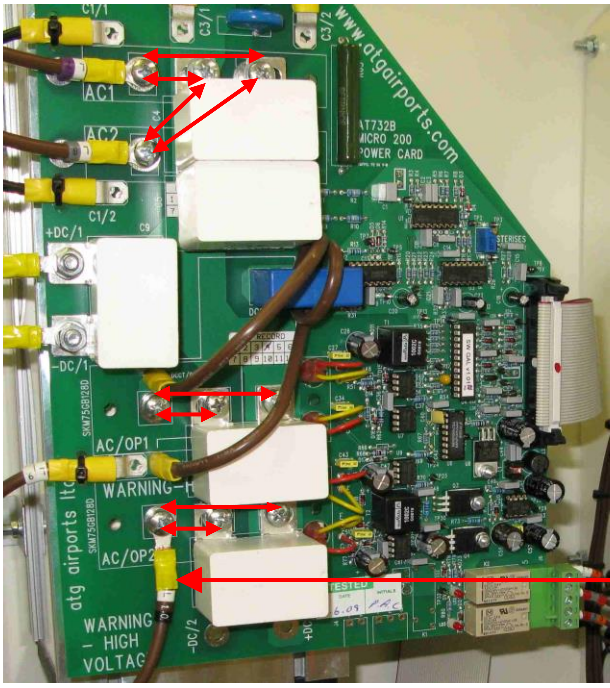
1/ Measure between the AC/OP1 left-hand IGBT screw connections and the adjacent centre and right-hand IGBT screw connections, each in turn. Note – the AC/OP1 connection has a cable looped through the current transducer, so measure from the left-hand IGBT screw power connection to the centre and right-hand screws. Healthy readings should be over 100k ohms; a faulty IGBT usually goes short circuit.

2/ Measure between the AC/OP2 left-hand IGBT screw connection and the adjacent centre and right-hand IGBT screw connections (if there is access, depending on the type of capacitors fitted), or upper centre and right-hand IGBT screw connections, each in turn.

(Note - the upper and lower IGBT module centre and right-hand terminals are connected together on the DC link). Measurements should be as above.

DIODE MODULES – USE DVM IN DIODE TEST MODE TO MEASURE BETWEEN POINTS INDICATED BY ARROWS; A SHORT CIRCUIT INDICATES A FAULTY DIODE.

IGBTS - MEASURE RESISTANCE BETWEEN POINTS INDICATED BY ARROWS; A SHORT CIRCUIT INDICATES A FAULTY IGBT.

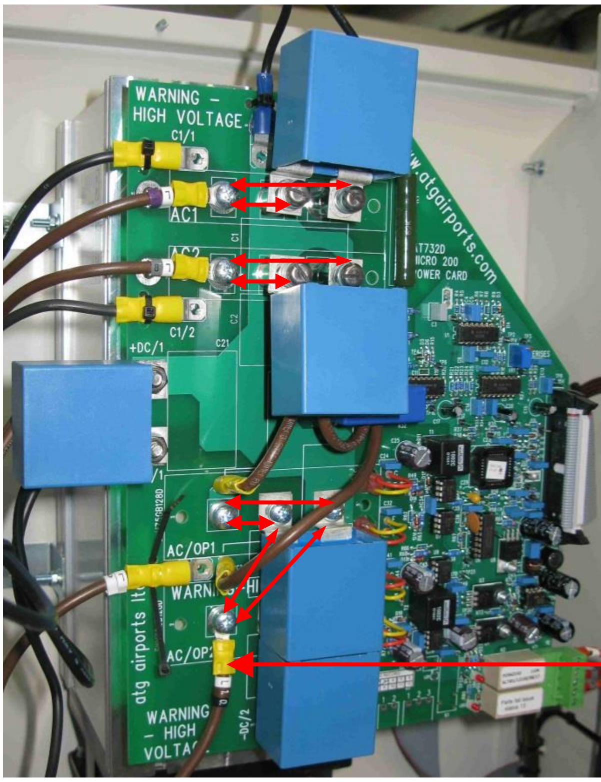


TEMPORARILY DISCONNECT CABLE L10 BEFORE MAKING IGBT RESISTANCE MEASURMENTS

Figure 10-6   25A IGBT stack test measurement points – early type snubber capacitor

DIODE MODULES – USE DVM IN DIODE TEST MODE TO MEASURE BETWEEN POINTS INDICATED BY ARROWS; A SHORT CIRCUIT INDICATES A FAULTY DIODE.

IGBTS - MEASURE RESISTANCE BETWEEN POINTS INDICATED BY ARROWS; A SHORT CIRCUIT INDICATES A FAULTY IGBT.



TEMPORARILY DISCONNECT CABLE L10 BEFORE MAKING IGBT RESISTANCE MEASURMENTS

Figure 10-7   25A IGBT stack test measurement points – Epcos snubber capacitor

It is also possible to check the condition of the diode modules using a DVM, but this time set to ‘diode test’, which measures the diode volt drop. Measure between each of the stack AC input cable connections (near the top of the stack assembly) and the adjacent centre and right-hand screws of the diode module power connections each in turn, as follows and as shown in Figure 10-6 and Figure 10-7:

1/ Measure from the AC1 left-hand diode screw connection to the centre and right-hand diode screw connections, each in turn. Two measurements will be required each time, with the meter leads reversed in order to measure in both polarities. In one direction, the forward volt drop of the diode should be measured – around 0.42V, and in the other direction an 'OL' reading should be obtained. A faulty diode is usually short circuit – measuring 0V.

2/ Measure from the AC2 left-hand diode screw connection to the adjacent centre and right-hand diode screw connections (if there is access – depending on the type of capacitors fitted) or upper centre and right-hand diode screw connections, each in turn. (Note - the centre and right-hand connections for the upper and lower diode modules are connected together on the DC link). Again, two measurements will be required, with the meter leads reversed in order to measure in both polarities. Measurements should be as above.

10.4.1.2 Replacement of complete 25A IGBT stack assembly

Before gaining access to the high voltage cubicle, isolate and lock off the mains supply. Referring to the photograph of Figure 10-8, make a note of the position of the power and capacitor cables before disconnecting them from the AT732 Card. Next, disconnect the ribbon control cable, the plug next to the relays (J6 at the bottom right-hand side of the AT732), and the fan cables.

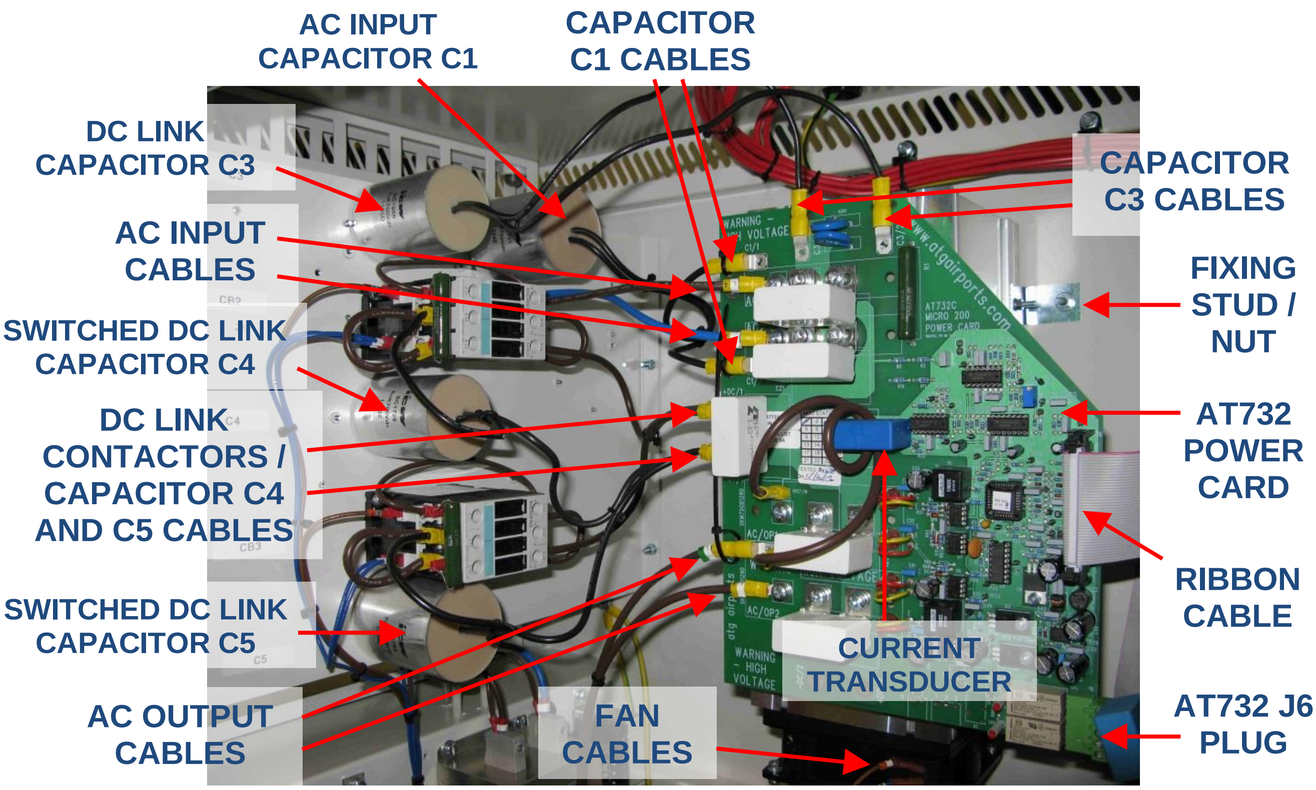


Figure 10-8 25A IGBT stack assembly with connections marked

The assembly is held in place by a total of four mounting brackets, two on either side of the heatsink. Remove the nuts which go over the studs fixed to the side of the cubicle (undo the bottom ones first), so that the assembly can be withdrawn with the fixing brackets still attached.

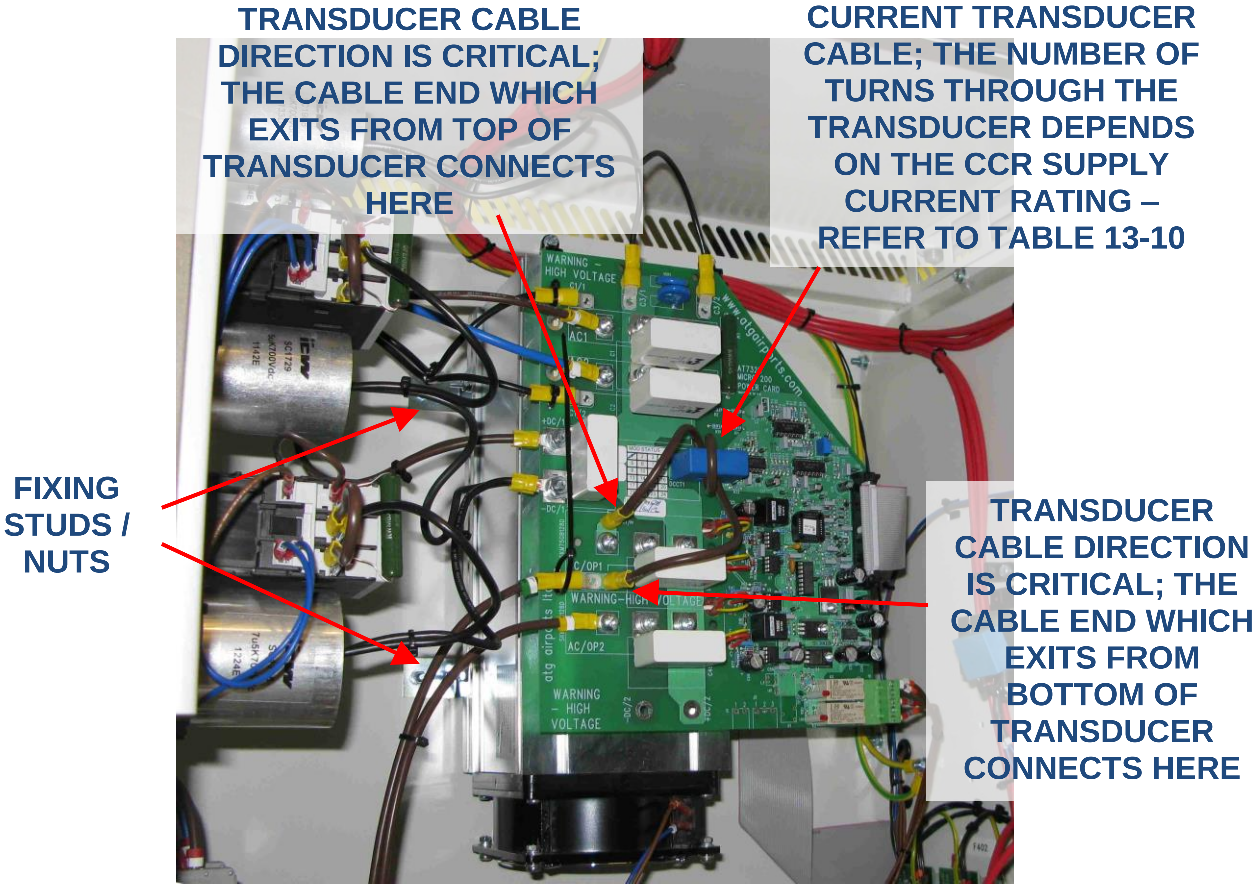


Figure 10-9   25A IGBT stack assembly - fixings and current transducer cable marked

It will be necessary to swop the mounting brackets from the old to the new stack assembly; carefully fit them in the same position so that they line up with the fixing studs in the cabinet. The new stack assembly is then be fitted over the studs in the cabinet, the washers and nuts fitted (top ones first), then all cables reconnected as before. Tighten the M5 screws connecting the cables to the diodes (terminals AC1 and AC2) and IGBT (terminal AC/OP2) to a torque of 3 Nm. Some power cables use push-on connectors; in this case use a small tie-wrap to secure the cable in place. The two fan cables use small push on connectors.

It is very important that the cable through the current transducer has the correct number of turns and is of the correct cable CSA to suit the CCR primary current. This is specified in Table 13-10, but it is easier just to copy the original assembly or re-use the cable from the original. To remove the cable from the old stack assembly it will be necessary to cut off one of the crimp connectors in order to pull the cable out from the transducer. The cables are connected using 6.3mm push on crimps, so after passing the cable through the transducer on the replacement unit, the new cable crimp can then be fitted.

Note – the orientation of the cable through the current transducer / direction of current flow is critical. If it is reversed, it will destroy the IGBTs – refer to the photographs above and the markings on the AT732 pcb for the correct connection of the cable.

10.4.1.3 Replacement of 25A stack IGBT and diode modules

The SKM75GB IGBTs (stock code 2323-0207) and SKKD 81/14 diodes (stock code 2270-0005) used on the 25A stack can be replaced individually if necessary, as described below.

Caution - IGBTs are extremely sensitive to damage from static electricity, as are parts of the driver boards, so a wrist earthing strap should be worn when working with these devices. Avoid touching the gate and emitter connections if the driver boards are not fitted to the IGBT modules, and if the boards are fitted, avoid touching the sensitive electronic circuitry on the board. Always handle these components by the edges.

1. Although this procedure can be undertaken with the stack fitted inside the CCR, for ease of work it is recommended that the complete stack assembly should be removed from the CCR as described in section 10.4.1.2 above.
2. Disconnect the gate and emitter drive cables from the IGBTs as shown below, using a pair of long nosed pliers.

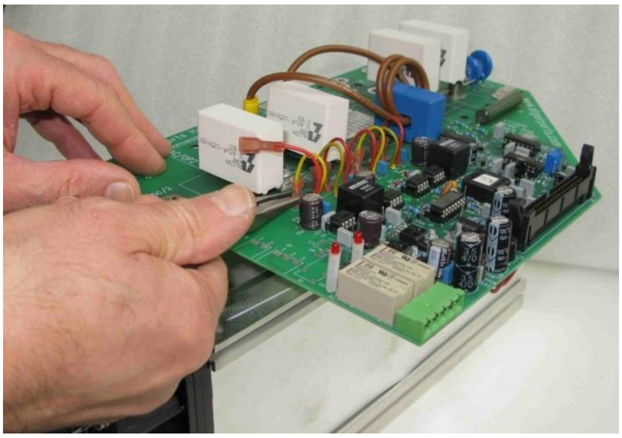


Figure 10-10 25A IGBT stack – disconnection of gate drive cables

3. Remove all of the snubber capacitor mounting screws and other screws fixing the AT732 board to the IGBT and diode modules as shown in the photographs below. Note – once the screws are removed, hold the board in position so as not to strain the thermistor cable underneath the board.

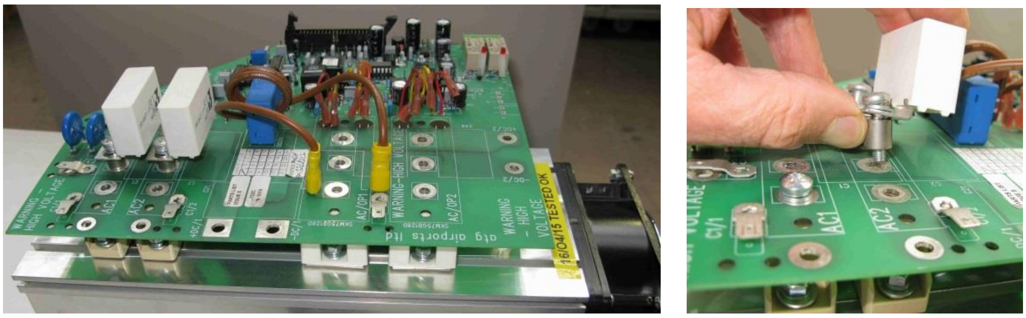


Figure 10-11 25A IGBT stack removal of snubber capacitors and AT732 fixing screws

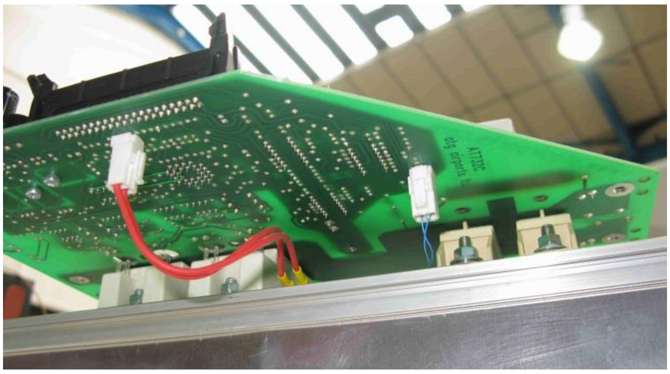


Figure 10-12 25A IGBT stack – thermal switch and thermistor cables

4. Carefully tilt the board to reveal the thermistor and thermal switch connections on the underside of the AT732 card, and unplug the connectors as shown in the photographs below. Note – it will be necessary to squeeze the tag on the cable end to release the connector.

Caution – avoid touching the IGBT gate and emitter connections - these are extremely sensitive to damage from static electricity. A wrist earthing strap should be worn during this procedure.

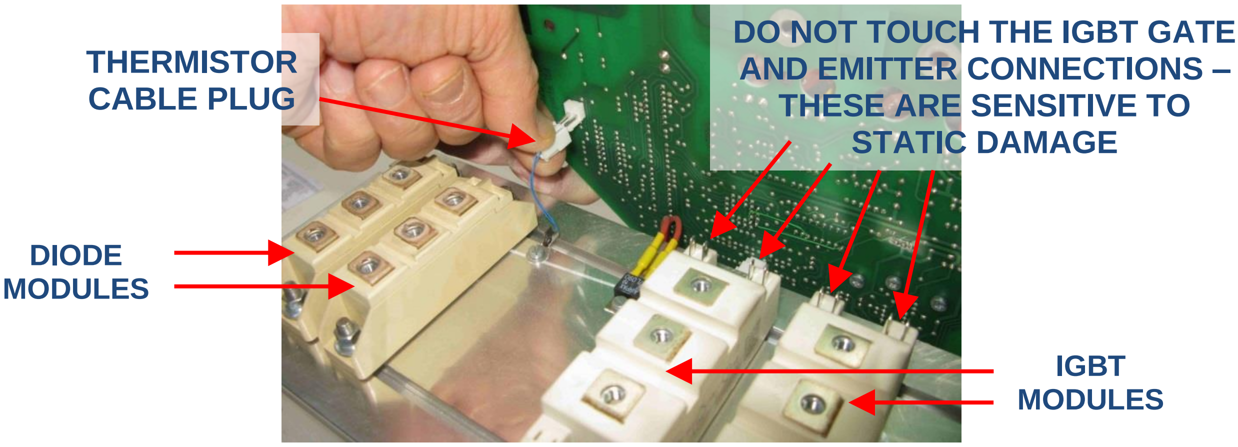


Figure 10-13 25A IGBT stack – disconnection of thermistor cable plug

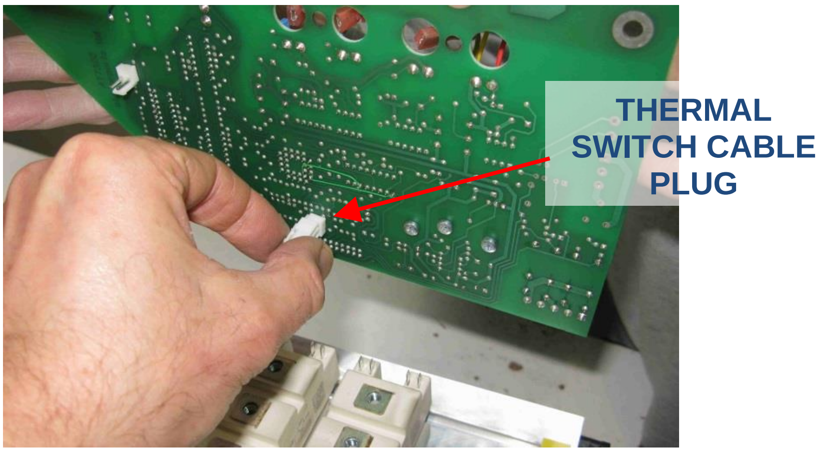


Figure 10-14 25A IGBT stack – disconnection of thermal switch cable plug

5. Using a fine marker pen, mark the position of the edge of the IGBT (or diode module) that is to be removed on the heatsink in order to correctly position the new module.

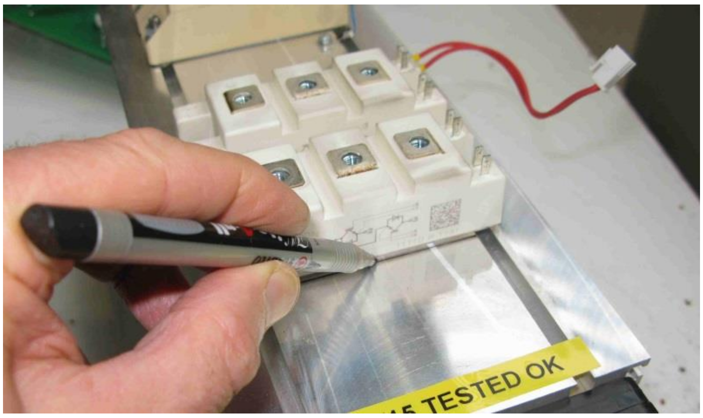


Figure 10-15 25A IGBT stack – mark position of module that is to be removed

6. Using an 8mm ‘Nut Driver’ type spanner unbolt and remove the faulty IGBT or diode module:

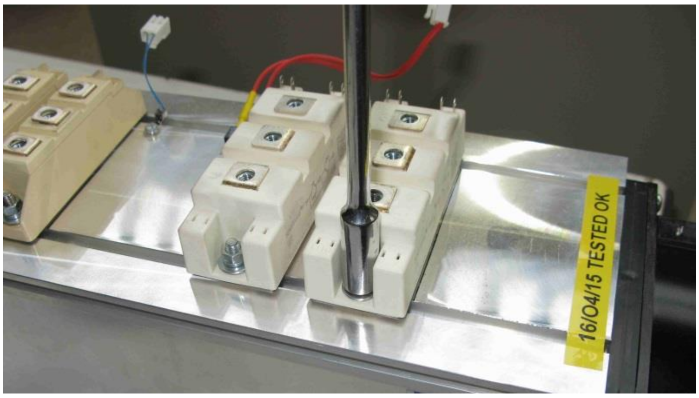


Figure 10-16 25A IGBT stack – unbolt the faulty IGBT or diode module

7. Smear a thin coating of heatsink compound onto the back surface of the new IGBT or diode module. Use Dow Corning 340 heatsink compound or similar; spread uniformly to a thickness of around 50 µm. Ensure no dust or dirt contaminates this surface before it is fitted to the heatsink. Note – the IGBT gate / emitter connections are sensitive to static damage; handle by the device body and at this stage leave the protective gate / emitter shorting rings in place.

Figure 10-17 25A IGBT stack – smear the back of the module with heatsink compound

8. Position the new device over the fixing bolts on the heatsink, fit the plain washer, spring washer then nut and tighten evenly on each side to a torque of 3 Nm.
9. For a replacement IGBT module, and whilst wearing the wrist earthing strap, remove the gate / emitter shorting rings with a pair of long nosed pliers.

Figure 10-18 25A IGBT stack – remove the gate / emitter shorting rings from new IGBT

10. Reconnect the thermal switch cable plug to the underside of the AT732 card, followed by the thermistor cable plug.

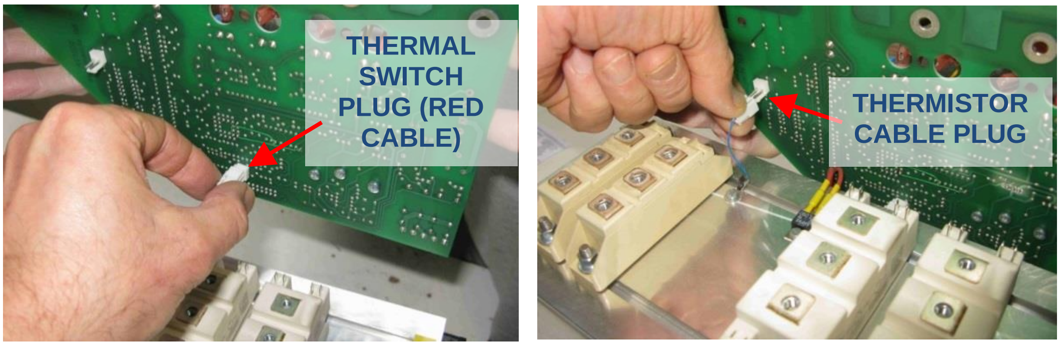


Figure 10-19 25A IGBT stack – re-connection of thermal switch and thermistor plugs

11. Position the AT732 card over the diode and IGBT modules, and loosely fit two screws in the AC1 and AC/OP2 terminals to hold in place, as shown below:

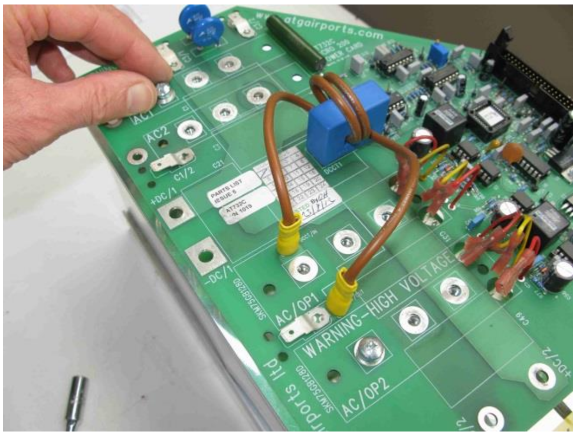


Figure 10-20 25A IGBT stack – re-fit AT732 card, loosely fitting two screws to hold

12. Refit the snubber capacitors in the same sequence as they were removed, using the metal spacers for the capacitors fitted over the diode modules. Tighten the M5 fixing screws to a torque of 3 Nm.

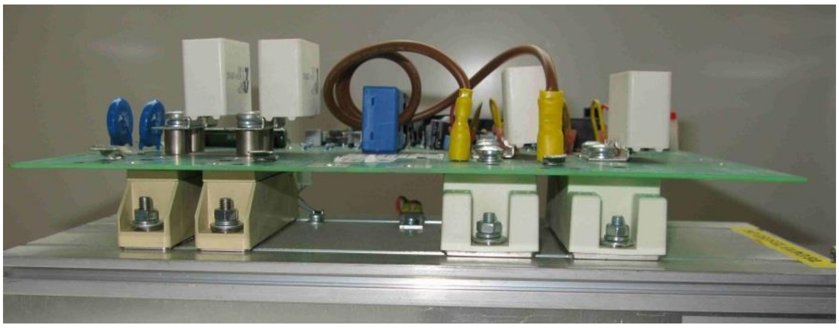


Figure 10-21 25A IGBT stack – re-fit the snubber capacitors

Note – for CCRs manufactured from 2018 onwards using the Epcos snubber capacitors (blue), ensure that three plain washers (plus the spring washer) are fitted under the heads of the screws securing the snubber capacitors above the diode modules, since otherwise these screws are too long. Note also that two spacers are used for each of these screws. See Figure 10-22 below.

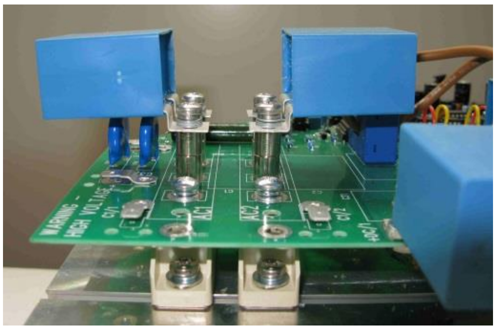


Figure 10-22 25A IGBT stack – Epcos capacitors fitted over diodes

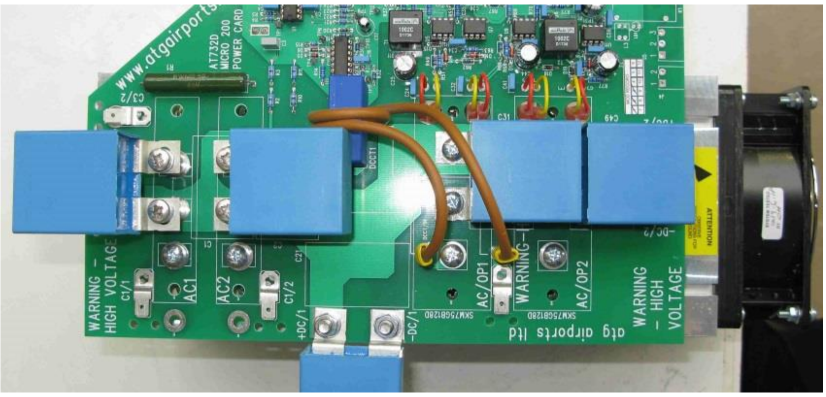


Figure 10-23 25A IGBT stack – Epcos snubber capacitors

Note – the fifth snubber capacitor, fitted at the side of the AT732 card (at the bottom in the above photograph - terminals marked +DC/1 and –DC/1), only needs to be fitted when the stack is installed into the CCR since there are two cables which connect under the capacitor fixing bolts.

13. Using a pair of long nosed pliers, re-connect all the gate and emitter driver cables from the AT732 Card to the IGBTs. Ensure that the crimp is correctly pushed down over the IGBT connector blade pin, and that the connector pin of the IGBT does not go between the cable crimp and the plastic outer insulator, resulting in an unreliable connection.

Caution – avoid touching the IGBT gate and emitter connections - these are extremely sensitive to damage from static electricity. A wrist earthing strap should be worn during this procedure.

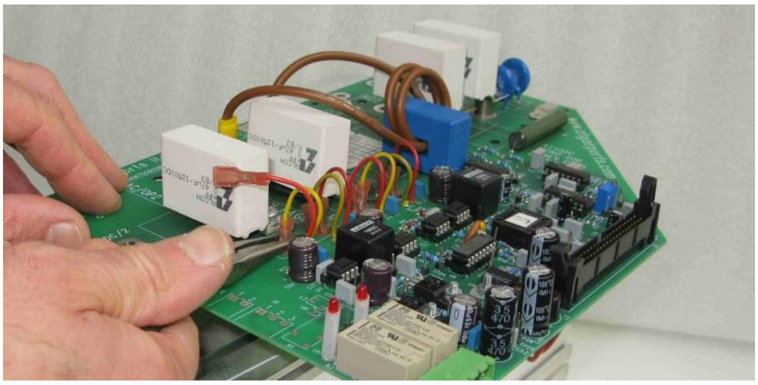


Figure 10-24 25A IGBT stack – re-connection of IGBT gate and emitter driver cables

14. Refit the stack assembly to the CCR, referring to Figure 10-8 and Figure 10-9 from section 10.4.1.2. Ensure that all cables are reconnected exactly as before. Some power cables use push-on connectors; in this case use a small tie-wrap to secure the cable in place. The two fan cables use small push on connectors.

10.4.2 55A IGBT stack assembly

The 55A IGBT heatsink / stack assembly (stock code 7500-1761A) is used in CCRs up to 15kVA in the 400V series, and up to 10kVA in the 220V series. This assembly includes two Semix 202 IGBT modules (each containing two IGBTs), two sets of 2S Adapter Boards and Skyper 32 Driver Cards, one Semix 341 diode module (containing six power diodes), heatsink, fan, AT785 IGBT Control Card and AT786 DC Link Card. The stack assembly is shown in the photograph below:

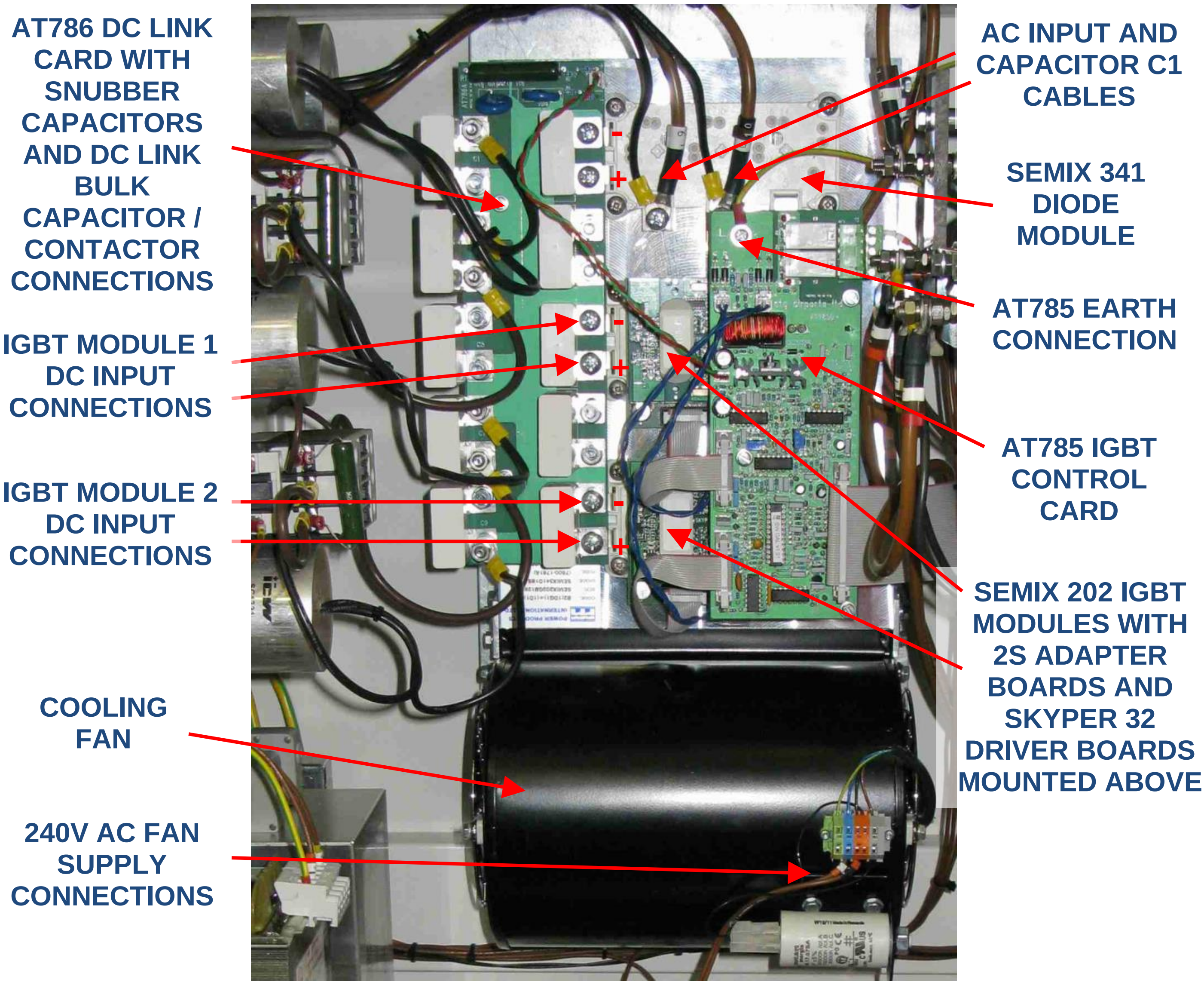


Figure 10-25 55A IGBT stack assembly components

In case of faults, it is usually simpler to replace individual components or sub-assemblies, as described overleaf.

10.4.2.1 Testing of 55A stack IGBT and diode modules

The usual mode of failure for an IGBT is to fail short circuit; this can be verified by measuring the resistance between each of the DC input connections (on the left-hand side of the IGBT modules) to the output connection to the smoothing inductors. Test as follows:

1/ To determine if one of the modules is faulty without disconnecting any cables, measure the resistance (using a DVM) from the IGBT module 2 '+' and '-' terminals, each in turn, to wire L12 at the connection to inductor L4 – refer to Figure 10-26 below. The resistance measured should be at least 100k ohms; a short circuit indicates a faulty device.

2/ Since the IGBT modules are effectively connected in parallel – the input connections for both modules are connected together via the AT786 DC Link Card and the output connections are connected together via the smoothing inductors and the power transformer primary windings - if there is a fault, in order to determine which device is faulty, disconnect wire L11 from inductor L3 and test again. Measure between each of the IGBT module 1 input connections in turn to the disconnected end of wire L11; repeat for each of the IGBT module 2 input connections in turn to wire L12 at the connection to inductor L4, whilst wire L11 is still disconnected from inductor L3.

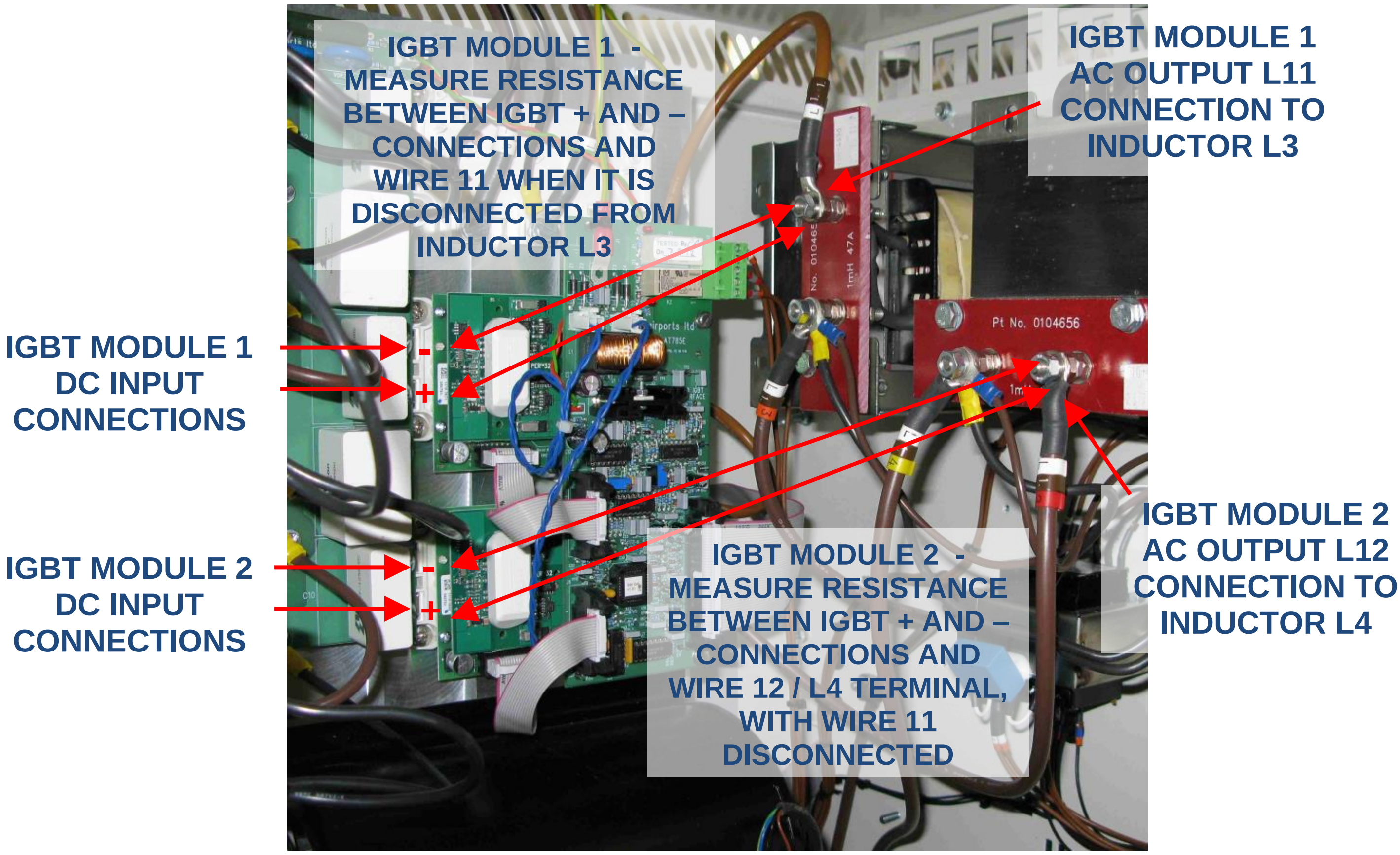


Figure 10-26 55A IGBT stack assembly IGBT test measurement points

The resistance measurement test points are shown in Figure 10-27 with the AT785 Card moved out of the way. If one or both of the IGBT modules is faulty, or if it is suspected that one of the Skyper 32 driver boards or 2S Adapter Cards are faulty ('Output Current Low' fault trip, with all other possible causes ruled out) then they should be replaced as described in the next section.

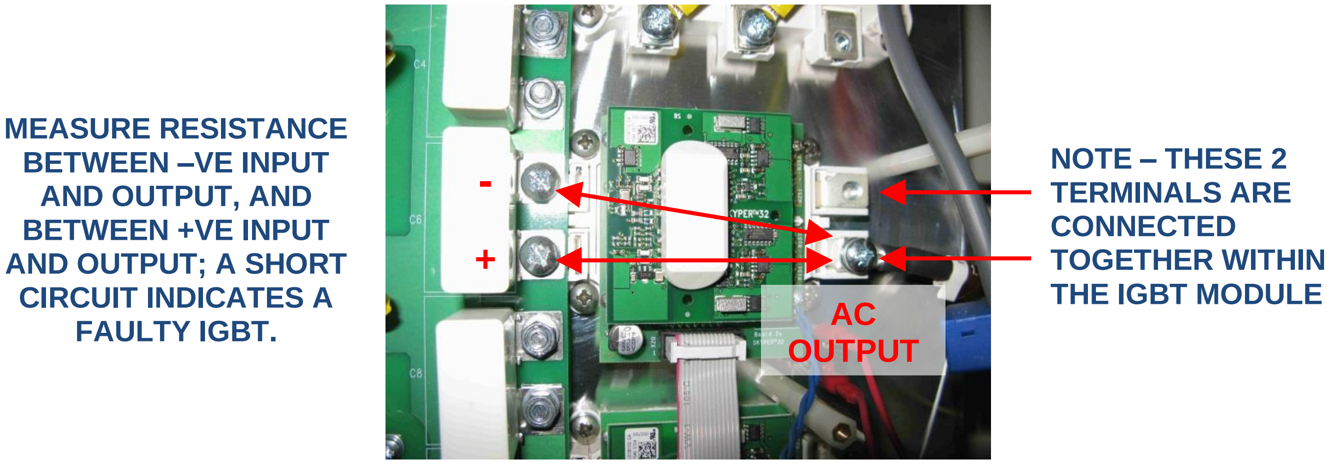


Figure 10-27 55A IGBT stack assembly IGBT terminal test measurement points

It is also possible to check the condition of the diode modules using a DVM, but this time set to ‘diode test’, which measures the diode volt drop. Measure between each of the stack AC input cable connections to the diode bridge (near the top of the stack assembly) and the DC power output connecting screws on the left-hand side of the diode module each, in turn, as follows and as shown in Figure 10-28 below.

1/ Measure between the L9 cable screw connection (bottom left diode terminal) and the DC output screw connections (on the left), each in turn. Two measurements will be required each time, with the meter leads reversed in order to measure in both polarities. In one direction, the forward volt drop of the diode should be measured – around 0.45V, and in the other direction an ‘OL’ reading should be obtained. A faulty diode will be short circuit – ie 0V.

2/ Measure between the L10 cable screw connection (bottom centre diode terminal) and the DC output screw connections (on the left), each in turn. Again, two measurements will be required, with the meter leads reversed in order to measure in both polarities. Measurements should be as above.

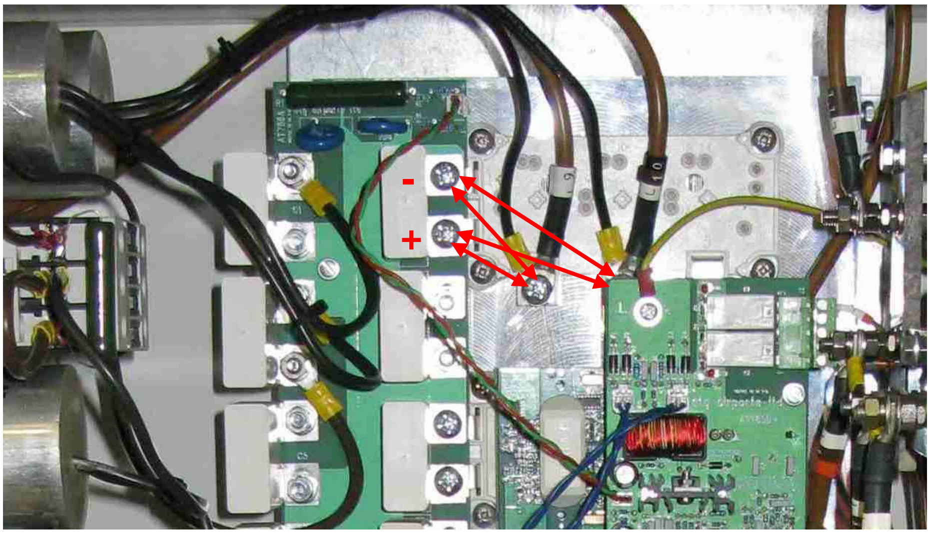


Figure 10-28 55A IGBT stack assembly diode test measurement points

10.4.2.2 Replacement of 55A stack IGBT and driver boards

The Semix 202 IGBT module, 2S Adapter Board and Skyper 32 Driver Card are supplied as a complete sub-assembly (stock code 2323-0216), and are replaced as described below. First it will be necessary to move the AT785 card to one side to gain access to the IGBT sub-assembly:

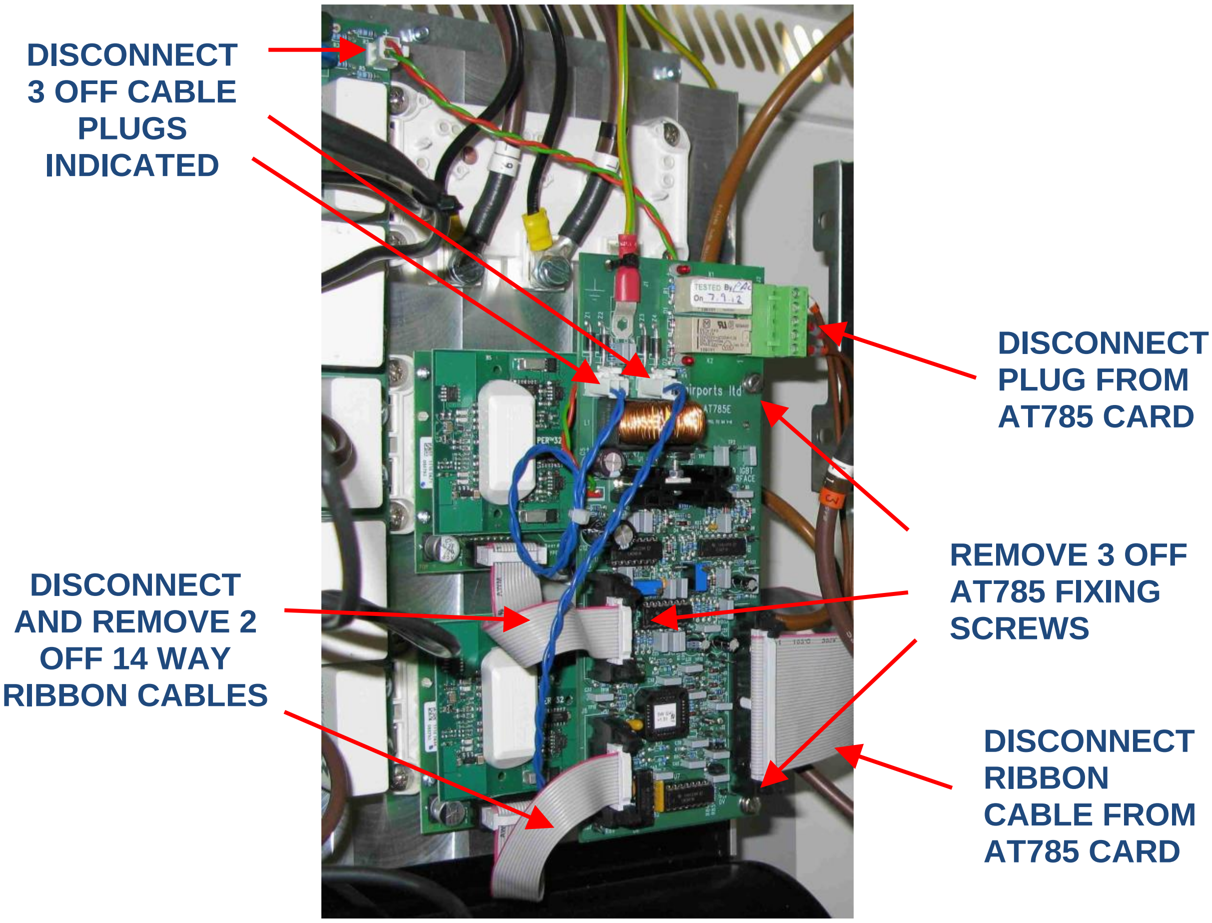
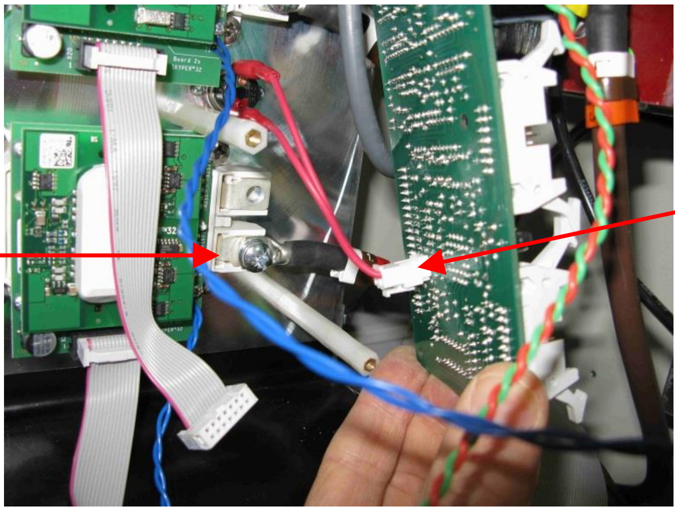


Figure 10-29 Disconnecting and moving the AT785 IGBT Control Card

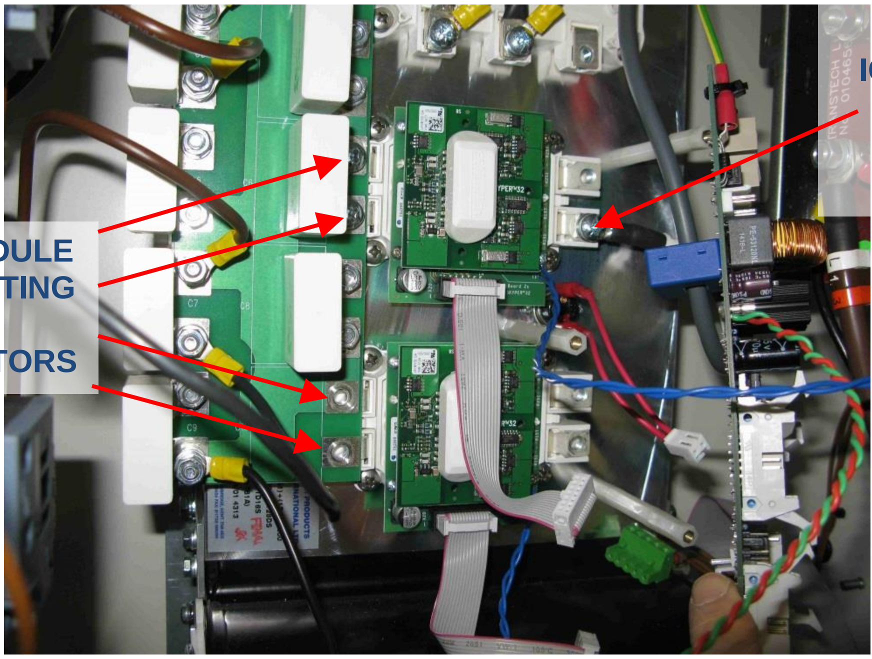
Undo the thermal switch plug and power connections indicated below; the following photographs show the disconnection and removal of both IGBT modules; in some cases it will only be necessary to remove and replace one module depending on the faults found.

DISCONNECT IGBT MODULE 2 AC OUTPUT CONNECTION (WIRE L12)



DISCONNECT THERMAL SWITCH PLUG FROM UNDERSIDE OF AT785

Figure 10-30 Disconnecting thermal switch



DISCONNECT IGBT MODULE 1 AC OUTPUT CONNECTION (WIRE L11)

REMOVE IGBT MODULE DC INPUT CONNECTING SCREWS AND SNUBBER CAPACITORS

Figure 10-31 Disconnection of 55A stack IGBT module power connections

Caution - IGBTs are extremely sensitive to damage from static electricity, as are parts of the driver boards, so a wrist earthing strap should be worn when working with these devices. Avoid touching the gate connections if the driver boards are not fitted to the IGBT modules, and if the boards are fitted, avoid touching the sensitive electronic circuitry. Always handle these components by the edges.

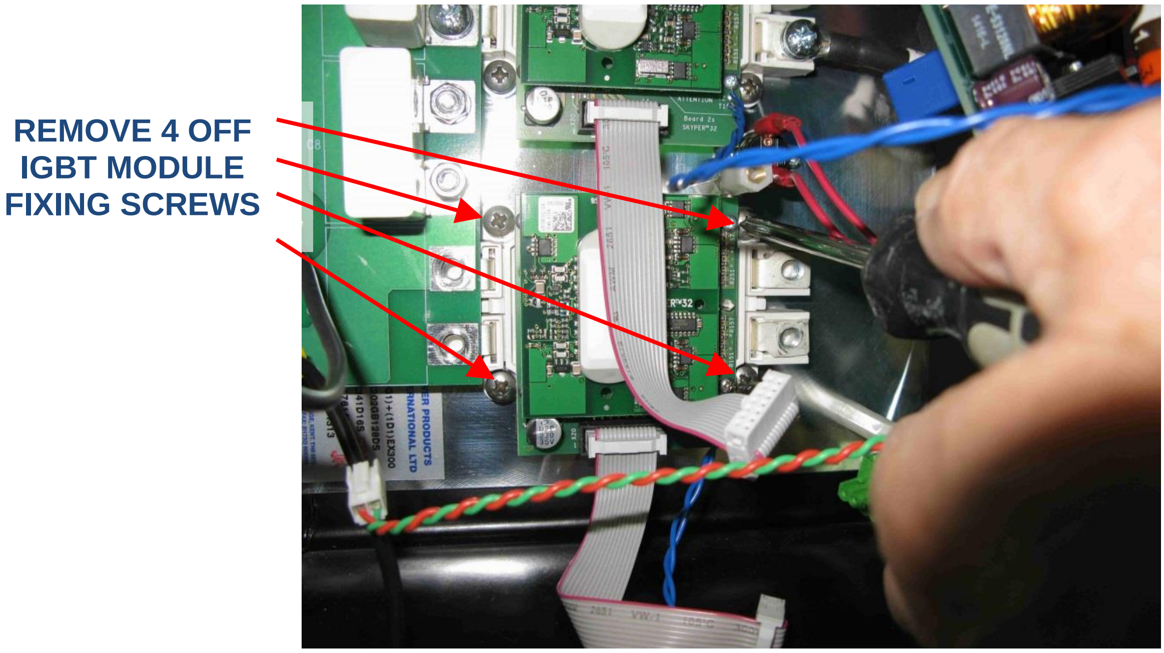


Figure 10-32 Removal of Semix 202 IGBT module fixing screws

Slide the module to the right slightly and withdraw it from the heatsink assembly with the driver card and Adapter Card still attached. Remove the other module in the same manner if it is also faulty.

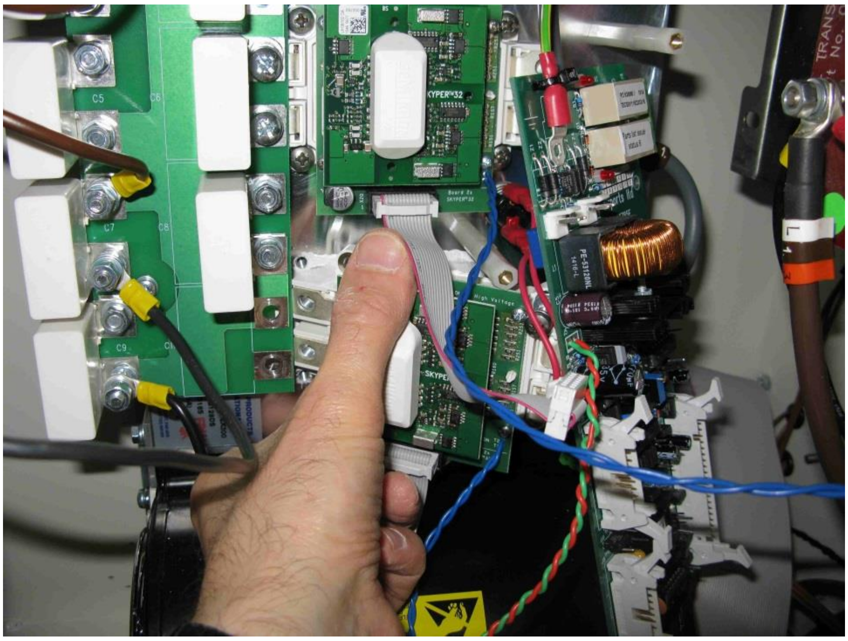


Figure 10-33 Removal of Semix 202 IGBT module

Ensure that the mounting face on the heatsink, which will have a covering of heatsink compound, does not become contaminated with dust or grit. If any dirt sticks to this surface, then the new IGBT module will not fit flush onto the surface and the flow of heat to the heatsink will be impeded.

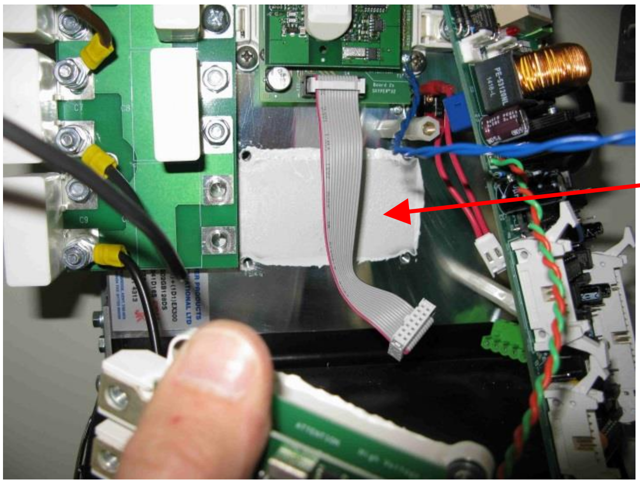


Figure 10-34 IGBT / heatsink contact area

Fitting of the new Semix 202 IGBT and Driver Card assembly is a reversal of the process described above, but before fitting it will be necessary to smear a thin coating of heatsink compound onto the back surface of the IGBT. Use Dow Corning 340 heatsink compound or similar; spread to a thickness of around 100 µm, uniformly applied with a maximum unevenness of 50 µm. Ensure no dust or dirt contaminates this surface before it is fitted to the heatsink.

Tighten the M5 fixing screws and the M6 connecting screws to a torque of 4 Nm.

It is very important to re-connect the output cables to the correct IGBT module, so that the direction of current flow through the transducer on the back of the AT785 Card goes in the right direction; refer to Figure 10-35 below:

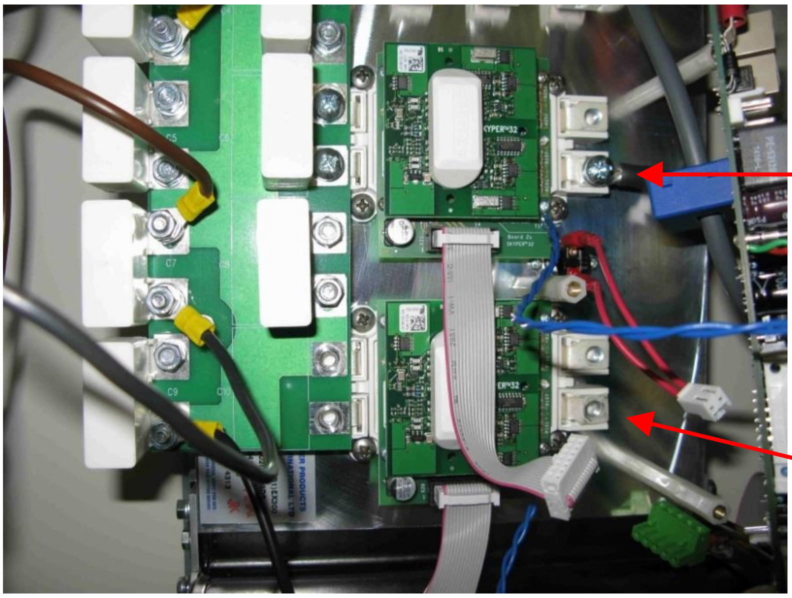


Figure 10-35 55A stack output connections

10.4.2.3 Replacement of 55A stack diode module

The diode module fitted is a Semix 341D16S, stock code 2270-0007. Referring to Figure 10-36 below, replacement of the diode module follows a similar procedure to that for the Semix 202 IGBT module described above. Disconnect the supply cables L9 and L10 and the capacitor cables from the input to the module, remove the DC output terminal screws and snubber capacitor from the left-hand side of the module, then unscrew the four fixing screws and slide the module to the right and withdraw it from the assembly.

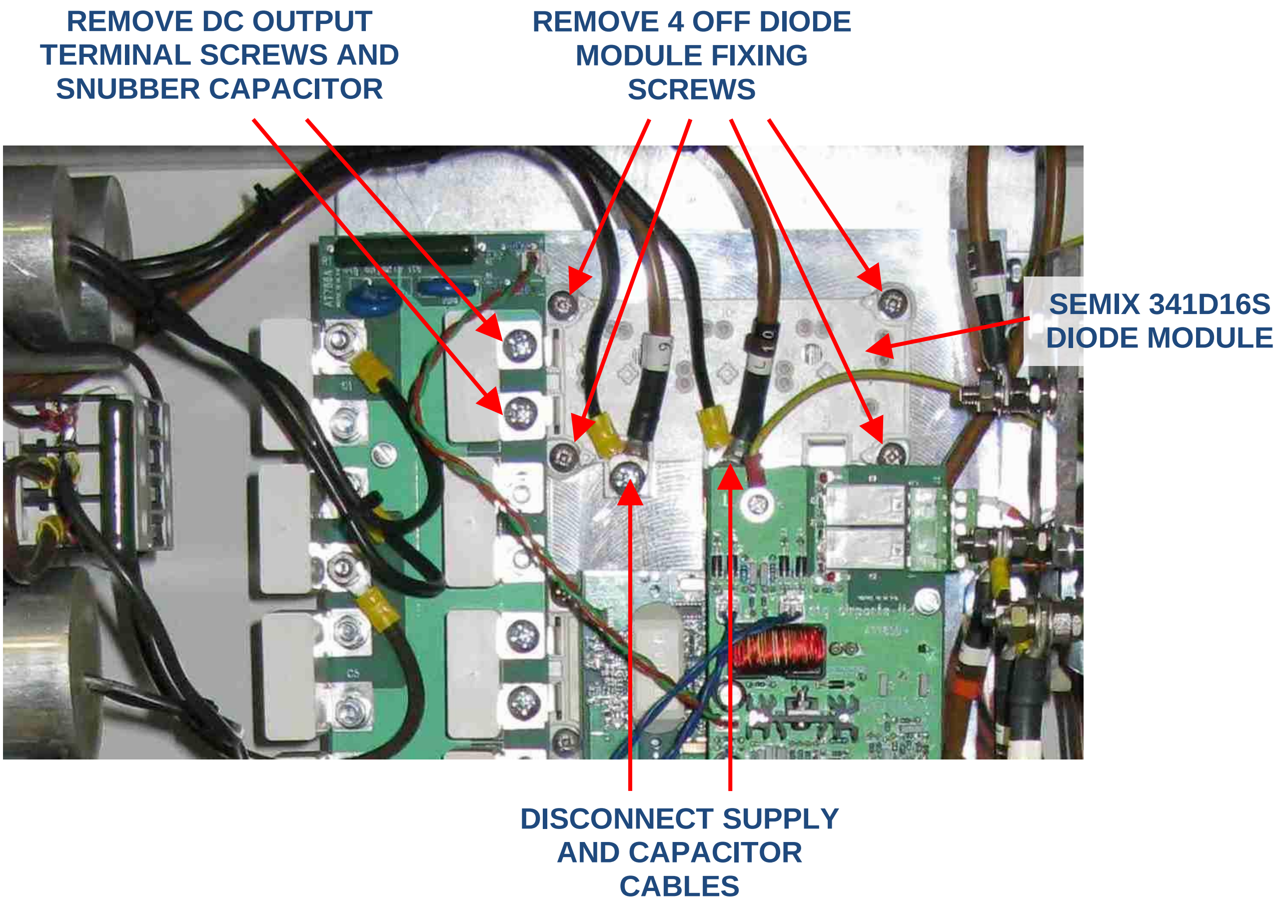


Figure 10-36 55A stack - removal of Semix 341D16S diode module

Fitting of the new Semix 341D16S diode module is a reversal of the process described above, but before fitting it will be necessary to smear a thin coating of heatsink compound onto the back surface of the diode module. Use Dow Corning 340 heatsink compound or similar; spread to a thickness of around 100 µm, uniformly applied with a maximum unevenness of 50 µm. Ensure no dust or dirt contaminates this surface before it is fitted to the heatsink.

Tighten the M5 fixing screws and the M6 connecting screws to a torque of 4 Nm.

11 CCR Theory of Operation

11.1 Introduction

A constant current regulator provides a controlled source of power for an airfield ground lighting circuit. An AGL circuit consists of a number of lights, each of which is connected to the secondary side of an AGL transformer, the primaries of which are connected together in series. Refer to Figure 8-1. The number of lamps on a circuit can range from just a few to a hundred or more, depending on the application.

The regulator supplies a constant level of current to the primary series loop, and thus to each lamp via the AGL transformer secondary connection. This means that all the lamps operate at the same brilliancy.

The AGL transformer is basically a primary wound current transformer which matches the primary series loop current, be it 6.0, 6.6 or 12.0 amps, to that required by the AGL lamp, which is typically 6.6 amps for a modern lamp. Since the AGL series loop current passes through all of these transformers connected in series, then if a lamp filament fails open circuit, the series loop current is not interrupted. In this case, the AGL transformer merely adds inductance to the series circuit load. Note – high voltages can be present on the secondary connections of AGL transformers in open circuit conditions.

Figure 11-1 (overleaf) shows the block diagram of the Micro 200 CCR with a primary series field loop connected. The AC supply to the CCR is first passed through an EMC filter then through inductors L1 and L2 to the bridge rectifier, which provides a DC supply to the IGBT (Insulated-Gate Bipolar Transistor) H-bridge. To generate an AC output from the H-bridge, the transistors which are diametrically opposed to each other are switched on and off together at high frequency; one pair conducts current in one direction, and the other pair in the other direction. The H-bridge output current is then fed to a low pass filter consisting of the output chokes L3 / L4 and capacitor C2.

The conduction times of the transistors are Pulse Width Modulated such that the current flowing through the low pass filter (and fed to the primary of the CCR main transformer) is smoothed back to a sinewave at mains frequency. The transistor switching is also modulated so as to give the correct RMS current at the output side of the transformer, ie, at the CCR output. (The brilliancy of the AGL lamps is a function of the RMS current level flowing through them).

The CCR main transformer secondary has multiple tappings such that the output voltage can be adjusted to give the correct range according to the load connected to the AGL circuit.

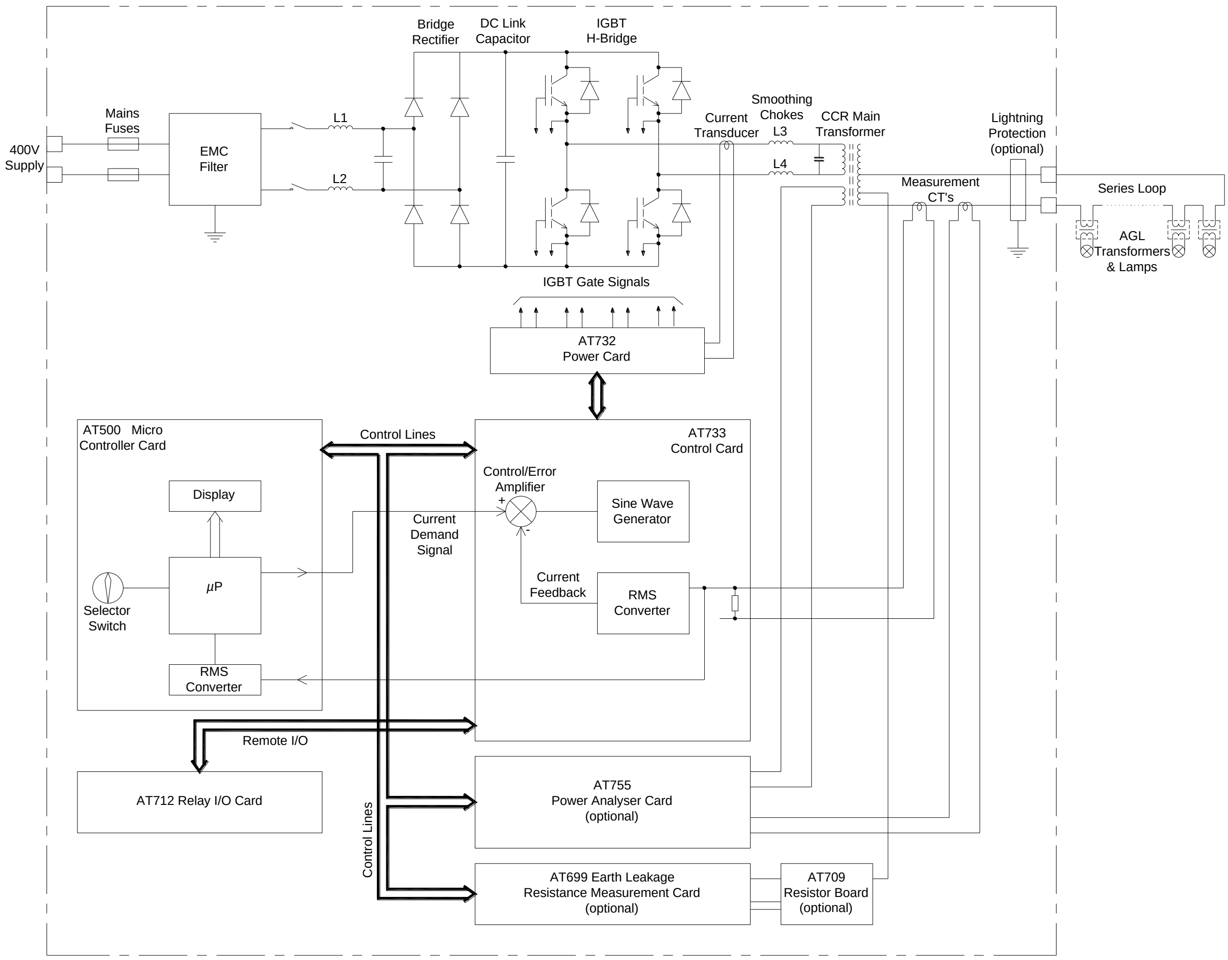


Figure 11-1 Block diagram of Micro 200 CCR

Two control loops are employed. The outer control loop maintains the desired CCR output current level by comparing the current demand reference signal with the measured CCR RMS output current level, and varying the output of the control amplifier accordingly. The control amplifier output is then fed to a gain control circuit which varies the magnitude of an internally generated sinusoidal signal. This signal, which is synchronized to the mains supply, is the instantaneous current demand (I_{ref}) for the inner control loop, which sets the CCR output current waveshape.

11.2 Control Cards

11.2.1 AT500 Microcontroller Card

The AT500 card, which is mounted behind the Front Display Panel, contains a Microcontroller IC which provides run control and supervisory functions, along with the brilliancy / current demand signal. It also has an independent RMS current measurement circuit that provides a running value to the display module. Additionally, this signal is used for Tolerance Monitoring, to ensure that the CCR output current is within acceptable limits.

All input signals are routed to the Microcontroller and the majority of output relays are also controlled by it. Additionally, all fault conditions are logged by the Microcontroller.

11.2.2 AT733 Main Control Card

Note – the main contactor coil connections are at mains potential – this could be 415V. These connect to terminal block J1, located at the top right-hand corner of the board. Due to the voltages present, a cover is fitted over these terminals.

This card, mounted behind the CCR lower front cover (see Figure 10-5), contains the control / error amplifier, sinewave generator, phase angle control circuitry, current feedback, RMS to DC converter and the remote I/O circuitry. It provides a sinusoidal output signal to the AT732 Power Card, the amplitude of which is controlled to maintain the RMS level of CCR output current demanded by the AT500 Microcontroller card.

The AT733 Card also contains circuitry for the detection of Open Circuit and Over-Current fault conditions.

11.2.3 2 Stage Percentage Lamp Failure Card AT923

This card is also mounted behind the CCR lower front cover. The function of the AT923 PLF Card is to give an indication of the Percentage of Lamps Failed on an AGL circuit. The Microcontroller interprets the AT923 error voltage to give a display of the actual number of failed lamps.

The principle of operation of the AT923 PLF Card is that the time delay between the CCR output voltage and current waveforms is measured and used to generate an error voltage.

When all lamps are intact, the time delay, or phase lag, can be very small – dependent on the particular AGL circuit characteristics. When lamp filaments on the AGL circuit fail open circuit, the load seen by the CCR becomes more inductive, meaning that the rising edge of the current waveform lags that of the voltage waveform. This lag increases as the load becomes more inductive. The error voltage generated is proportional to this phase lag, and hence is a function of the percentage of failed lamps.

A more detailed description of this card is given in Section 4.6.

Note - some versions of the regulator use a 70v output from the auxiliary PLF winding on the main CCR transformer (connecting to terminals 2 and 3 on the PLF card). For this reason, a cover is fitted over these terminals.

11.2.4 Earth Leakage Resistance Measurement - AT699 and AT709

Each AGL lamp module is isolated from the high voltage primary series loop circuit by an AGL transformer. The joints connecting the primary windings of these AGL transformers to the series loop cables tend to leak and allow water to penetrate into the transformer. This causes earth faults on the primary loop internally within the transformer, or from the cable joint itself to earth.

This causes two problems:

i) If more than one earth fault develops, then sections of the AGL circuit between the faults can be shorted out. This results in reduced brilliancy levels, or sections of the lamp circuit may switch off altogether.

ii) More importantly, having an earth leakage path presents a safety hazard. If there is leakage to earth at one or more points in the primary series field circuit there will now be a potential difference between other sections of the circuit and earth. If personnel come into contact with the high voltage cables under these conditions, this could, depending on the earth leakage resistance and hence the level of current flow through the contactee, result in a lethal electric shock.

For these reasons, it is necessary to detect earth faults before they become a problem.

The Analogue Earth Leakage Resistance Measurement Module, which is optional, is based on the AT699 pcb, which mounts behind the CCR front door, and the AT709 sub Card, which mounts in the HT cubicle. The module operates by superimposing a DC test voltage onto the CCR Main Transformer output; the test voltage is 500V while the CCR is operating, or 1000V for a manual test when the CCR is in the 'OFF' state. If there is an earth fault, this causes a DC leakage current which can be measured, and a calculation is performed to give a leakage resistance value. This value can then be displayed on the CCR front panel.

The Earth Leakage Resistance Measurement Module is calibrated using specialised test equipment, and should not require adjustment. However, the alarm and trip thresholds can be programmed via the keypad.

11.2.5 Power Cards for 25A IGBT stack

11.2.5.1 AT732 Power Card

Note – the AT732 card is fitted over the IGBT stack in the HT cubicle, and it is not recommended to gain access to this card whilst the CCR is powered up except under special circumstances.

The AT732 card is fitted to the 25A IGBT stack assembly, for regulators up to 4kVA from a 220V supply, or up to 7.5kVA from a 400V supply. This card contains control circuitry for the inner control loop, over temperature monitoring, DC link monitoring, and drive circuitry for the IGBT H-bridge.

Two connectors are provided on the rear of the card to plug in cables from the heat sink thermistor (J1) and thermal switch (J3).

11.2.6 Power Cards for 55A IGBT stack

The following cards are fitted to the 55A IGBT stack assembly, for regulators up to 10kVA from a 220V supply, or up to 15kVA from a 400V supply.

Warning – the AT785 and the other power cards listed below are fitted over the IGBT stack in the high voltage cubicle, and it is not recommended to gain access to these cards whilst the CCR is powered up except under special circumstances.

11.2.6.1 AT785 IGBT Control Card

The AT785 contains control circuitry for the inner control loop, over temperature monitoring, DC link monitoring, and the interface circuitry for the Skyper 32 IGBT H-bridge driver cards.

A flying lead from the AT785 IGBT Control Card connects to the AT786 DC Link Card to provide supply voltage monitoring.

11.2.6.2 Adapter Cards 2S

Two of these cards are fitted – one for each of the Semix 202 IGBT modules. They are mounted directly on top of the IGBT module (on the IGBT stack heat sink assembly in the high voltage cubicle) and provide contact points for the electrical connections on the IGBT. The Skyper 32R Driver Cards are then plugged into the Adapter Cards. Ribbon cables connect the Adapter Cards to the AT785 IGBT Control Card to provide the drive signals.

These cards also provide connections to the thermistors built into the IGBT modules. Flying leads from the Adapter Cards plug into the AT785 IGBT Control Card to provide over-temperature protection.

11.2.6.3 Skyper 32R IGBT Driver Cards

Two of these cards are fitted – one for each of the Semix 202 IGBT modules - on the IGBT stack heat sink assembly in the high voltage cubicle. They provide the IGBT gate drive signals and also some fault monitoring.

They plug into the Adapter Cards (described above) which mount on top of the IGBT's on the heat sink assembly in the high voltage cubicle.

11.2.6.4 AT786 DC Link Card

This card is fitted on the IGBT stack heat sink in the high voltage cubicle, and connects between the bridge rectifier output terminals and the IGBT DC input terminals. It is fitted with ten 470nF, 1250V DC rated snubber capacitors. It also provides terminals to connect the large DC link capacitors (C3, C4 and C5) with the load compensation contactors.

12 Fault Finding

PROBLEM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
Regulator does not operate and Power light is not illuminated	Main power source 'OFF'.	Check main power supply.
	Incorrect supply voltage.	Check supply voltage against regulator rating plate.
	Blown mains fuses F1, F2. (Note - gRL fuses are fitted, which have a combined characteristic for general line and ultra-rapid to give improved protection to the power electronics)	Check for AGL circuit earth faults. Check IGBT stack DC link snubber capacitors visually for signs of failure. (Warning – isolate the power before opening the HT cubicle). Check IGBTs and power rectifier diodes for short circuit faults - refer to Section 10.4. (Warning – isolate the power before opening the HT cubicle).
	Blown control fuses F3, F4.	Check control transformers T102 and T105 for faults before replacing.
	Blown fuse AT500 Microcontroller Board (AT500 F1).	Check for transformer or other fault on AT500 board before replacing.
	Faulty transformer T102.	Check that 230V AC appears between terminals L & N on the AT500 Micro Controller Board
Regulator does not operate, Power and Fault lights are illuminated but Vacuum Fluorescent display is blank	Incorrect supply voltage.	Check supply voltage against regulator rating plate.
	Faulty transformer T102.	Check that 40V AC appears between J3 terminals 1 and 3 on the AT733 Main Control Board.
	Supply to Control Board AT733 disconnected	Re-connect supply to Control Board AT733 J2.
Regulator does not operate, Power and Fault lights are illuminated and Supply Under-voltage fault is displayed	Incorrect supply voltage.	Check supply voltage against regulator rating plate.
	Faulty or disconnected 10 way ribbon cable between AT500 and AT733 Cards	Replace or re-connect ribbon cable.
	Incorrectly adjusted supply undervoltage detector on AT733 Control Board	Adjust as described in Section 10.3.3.1
	Faulty control board AT733	Replace Control Board AT733 and re-calibrate the regulator.
Regulator does not operate; Power and Fault lights are illuminated and Output Current Low fault is displayed	Incorrect Zero and Span calibration ('Verify Failure' message may be observed after power up)	Check and if necessary, re-calibrate the regulator. See Sections 12.3 and 10.2
	Incorrect voltage selector tappings on Main CCR Output Transformer T101	Adjust as described in Section 4.3 .

PROBLEM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
Regulator does not operate, Power and Fault lights are illuminated, GAL fault is displayed	H-Bridge instantaneous over current fault, or IGBT trigger error	Press reset button when the fault message is displayed, or disconnect the mains supply momentarily then turn back on again
Regulator does not operate; Power and Fault lights are illuminated.	Ascertain if fault lies within the regulator or the AGL series circuit	Switch off the power to the regulator. Connect a shorting link between the regulator output terminals S1 and S2, in place of the AGL circuit. If possible, measure the regulator supply current using a true RMS ammeter. Switch back on; the regulator should run at the rated output current without taking excessive input current. If the regulator operates correctly, the problem is with AGL series circuit.
Regulator does not operate; Power and Fault lights are illuminated	Faulty or disconnected 34-way ribbon cable between the AT500 and AT733	Replace or re-connect ribbon cable.
	Faulty control board AT733	Replace Control Board AT733 and re-calibrate the regulator.
Regulator does not operate; Power and Fault lights are illuminated and Main Contactor CB1 does not energise. Output Current Low fault is displayed	Door open (if door interlocks fitted)	Close door
	Faulty Contactor CB1	Check the coil voltage of CB1. If supply voltage is present, but the contactor fails to operate, CB1 is defective. Replace contactor.
	Faulty RL1 relay contact on AT733 control pcb, or faulty pcb	Check that the AT733 LED LD1 lights up when the CCR is switched on. If it does, then the relay contact is faulty, or there is a break in the wiring to the contactor
Regulator does not respond to the remote brilliancy signals	Keypad rotary switch SW1 not in Remote position	Turn switch to Remote position
	Faulty or disconnected 50-way ribbon cable between the AT733 and AT712	Replace or re-connect ribbon cable
Regulator switches to fewer than expected brilliancy levels in response to remote brilliancy signals	Incorrect Remote-Control configuration	Check operating mode selected for Remote Control, see Section 9.3.2.2
	Fault on external brilliancy control signals	Check switching of all appropriate remote brilliancy control signals. Refer to Section 3.3
	Faulty or disconnected 50-way ribbon cable between the AT733 and AT712	Replace or re-connect ribbon cable

PROBLEM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
When a brilliancy level is selected the regulator operates briefly before tripping and then displays 'Open Circuit' or 'Output Current Low' fault.	Open Circuit / discontinuity on AGL series loop circuit.	This can be proven in 2 ways: i/ Connect a DVM (set to read AC voltage), or better still an oscilloscope, between wires 13 and 14 which connect to terminal block J3 of the AT733 control card. (This is the output from the auxiliary winding of the power transformer T101, normally rated at 20V AC, or 70V AC for some 12A CCRs). When the CCR is energised, the AC voltage should ramp up, indicating that the main transformer is energised, before the CCR trips due to an open circuit load fault. ii/ Switch off the power to the regulator. Connect a shorting link between the regulator output terminals S1 and S2, in place of the AGL circuit. Switch back on; if the regulator operates correctly with the output shorted, the problem is with the AGL series circuit.
	Incorrect output voltage selector tappings on Main CCR Output Transformer T101	There may be insufficient voltage produced by transformer T101 to deliver rated current into the load impedance, or the transformer tapping voltage is below 20% of maximum and the control loop is unstable. Adjust as described in Section 4.3
	Loose or broken connections.	Shut off power to regulator and check all wiring connections for tightness.
	Faulty IGBT H bridge (other than short circuit fault), or faulty IGBT driver card or power control card.	Connect a DVM (set to read AC voltage, up to 20V), or better still an oscilloscope, to TP19 on the AT733 control card (use TP6 as the 0V return). When the CCR is energised, the AC voltage should ramp up, indicating that the current demand signal is present on the control card. If this signal is present, but the AC voltage is not present on wires 13 and 14 (output from the auxiliary winding of the main transformer - see open circuit test above), then this is likely to be caused by a faulty IGBT H bridge or faulty driver / power control card.
	Faulty IGBT Stack Adapter Board 2S (10 to 15kVA 400V series, or 5 to 10kVA 220V series – not used on smaller sizes)	Test as above. The Adapter Board 2S is the most common cause of failure on the larger IGBT stack assemblies; if the exact cause of failure cannot be ascertained, replace both adapter boards or the complete IGBT stack assembly
Distorted input and output current waveforms, which may become worse at higher output current levels. 'Clicking' sound heard from stack output smoothing inductor L3 / L4.	Insulation breakdown within inductor L3 / L4	Replace faulty inductor.
When a brilliancy level is selected the regulator operates briefly then displays 'Over Current' fault.	Incorrect Zero and Span calibration	Switch off the power to the regulator. Connect an in-line true RMS ammeter in place of the AGL circuit between the regulator output terminals S1 and S2. Check the regulator output current. If necessary, recalibrate the regulator as described in Section 10.2
CCR output voltage (if enabled) and output load KVA incorrectly displayed	Actual CCR Main Transformer output tapping voltage used not correctly loaded via set-up screens	Program this as described in Section 4.4.1

Table 12-1 CCR Fault Finding

12.1 Cooling Fan and Heatsink Temperature Monitor

The Micro 200 utilises a cooling fan which switches on once the IGBT stack heatsink reaches a temperature of approximately 70 ^{o}C. Should the heatsink temperature continue to rise and reach a temperature of 90 ^{o}C, a 'Heatsink Over Temperature Warning' message will be displayed. If the heatsink remains above 90 ^{o}C for a period of time then the CCR will shut down.

12.2 Transformer Over Temperature Monitor

Some versions of the Micro 200 have thermal switches fitted within both bobbins of the T101 power transformer in order to protect the transformer against over temperature conditions. In the event of the transformer running too hot, a warning message will first be displayed and the 'Transformer Over Temperature Warning' back indication relay will energise. Should the over temperature condition persist, then after 1 minute the CCR will shut down.

In the event of a T101 power transformer over temperature condition first check that the circuit load is not greater than the CCR power rating.

12.3 Reloading Operating Parameters

In the event that the Microcontroller has displayed the following message on power up:

	V	E	R	I	F	Y		F	A	I	L	U	R	E	
↵	=	A	P	P	L	Y		D	E	F	A	U	L	T	S

This indicates that there has been corruption of data stored in the eeprom on the AT500 Microcontroller Card. Pressing the (↵ Enter) button – which is the only means to go past this screen - will load default operating parameters, thus requiring a full reprogramming and recalibration of the regulator. (Note – if default operating parameters are applied without recalibrating the regulator, the CCR will operate but with an extremely low output current, causing an 'Open Circuit' fault trip).

Providing that a record has been kept of the operating parameters and calibration factors for the regulator in question, it is a straightforward process of reloading these into the two menus. (Note - a Micro CCR Parameter Record sheet is included in the following section for the purposes of recording this data). However, if the original Zero and Span calibration values for the particular regulator were not recorded, then a full recalibration will be required using a high quality true RMS ammeter, preferably of the in-line type. Refer to Section 10.2.2

Note – if the Microcontroller front panel assembly (including the AT500 Card) has been replaced, a full calibration will also be required. This is because of tolerances in the AT500 circuitry, which means that the calibration factors are matched to the particular circuit board.

Providing that the original circuit boards remain in place – the AT500 Microcontroller Card, and the AT733 Main Control Card - and that the ‘CCR CAL’ potentiometer on the AT733 has not been adjusted, then reloading the original Span Calibration factor should bring the CCR output current precisely back to the correct value without the need to perform a full recalibration.

Since the following process involves a partial recalibration of the regulator, then to prevent the possibility of damaging the AGL lamps in case of a current overload, it is advisable to disconnect the CCR from the AGL circuit. It is recommended either to connect a shorting link, or for a more accurate calibration, a resistive load bank to the output of the regulator, in place of the AGL circuit. (Follow the normal safety procedures for working on high voltage airfield lighting circuitry - refer to Section 3.4 – HT Series Circuit Output Terminals).

However, if reprogramming has to be carried out with the AGL circuit connected (for example, if an Approved Person is not available to issue HT permits), then extreme caution must be exercised when calibrating the Span Point not to overshoot the original calibration factor value and cause a current overload. It is advisable to monitor the CCR output current on a true RMS ammeter to ensure that it does not exceed the rated level.

The following is a list of the main CCR operating parameters, which should be reprogrammed in the sequence described below.

Hardware Configuration Menu:
FULL LOAD I - (Note – the default value is 6.6A)
CALIBRATE ZERO POINT - (Press the (↵ Enter) button after loading the correct value)
CALIBRATE SPAN POINT - (Load the correct value and wait for a few seconds for the current to stabilise then press the (↵ Enter) button. Note – if a shorting link has been connected in place of the load across the output terminals, the CCR may trip out after 30 seconds. If this occurs, press the keypad Reset button to continue the calibration process)
EARTH LEAK DET - (Requires optional earth leakage measurement card set to be fitted)
DISPLAY OP V
ENT TX OP VOLTS
ENTER KVA

Set-up Menu:
REMOTE CONTROL CONFIG?
BRILL LEVELS
BLACK HEAT - (If required)
SET USER CURRENT LEVELS? - (If User Defined ‘BRILL LEVELS’ selected)
EARTH LEAKAGE STAGE 1 - (If ‘EARTH LEAK DET’ used, and default threshold level not suitable)
EARTH LEAKAGE STAGE 2 - (If ‘EARTH LEAK DET’ used, and default threshold level not suitable)

If the following functions are used, it will be necessary to return to the Hardware Configuration Menu.

Hardware Configuration Menu:
BLACK HEAT - (If ‘BLACK HEAT’ selected, and the default current setting is not suitable, set the current level)
SET USER TOL LEVELS - (If User Defined ‘BRILL LEVELS’ selected)
% LAMP FAIL - (Requires optional AT923 PLF card to be fitted. Note - if ‘ANALOGUE’ type selected, the sub-menus will also require programming, and PLF calibration will be necessary)

After completing this procedure, ensure that the CCR power transformer secondary taps – if they were altered - are put back to the original settings.

12.4 Micro CCR Parameter Record Sheet

CIRCUIT:		**SUBSTATION:**	
CCR SERIAL NUMBER:		**FIRMWARE VERS:**	
CCR KVA RATING:		**OP CURRENT:**	
DATE COMMISSIONED:			

NOTE - IF A CCR IS BEING PROGRAMMED FOR THE FIRST TIME OR IF IT IS BEING REPROGRAMMED AFTER A LOSS OF PARAMETERS, IT IS NECESSARY FIRST OF ALL TO PROGRAMME THE FOLLOWING PARAMETERS FROM THE HARDWARE CONFIGURATION MENU:

1. FULL LOAD I - PROGRAMME THE NOMINAL CCR OUTPUT CURRENT, IF DIFFERENT FROM THE DEFAULT VALUE OF 6.60A
2. CALIBRATE ZERO POINT
3. CALIBRATE SPAN POINT
4. ENT TX OP VOLTS - PROGRAMME THE TRANSFORMER TAPPING VOLTAGE USED
5. ENTER KVA - ENTER THE KVA RATING OF THE CCR

SET-UP MENU

The Set-up menu is accessed from the Running / Main Menu by the use of a password. The CCR must first be set to ‘Local Off’, by turning the brilliancy control selector switch SW1 to 'OFF'. Press the (↑) button to display the password entry screen '* * *', press (Enter) to show 'a a a'.

Enter the correct password one letter at a time using the (↑) (↓) buttons to scroll up and down the alphabet, and then press the (Enter) button. The default password is 'atg'. If the password is loaded correctly, the display will show 'YYY'.

Press (Enter) and the screen will change to the first of the set-up screens. It is now possible to scroll through the menu using the (↑) (↓) buttons; scroll down (↓) to reach the following screens.

Pressing the (Enter) button will permit modifications to the parameters for the selected screen. The left-hand arrow will move to the second line, and then pressing the (↑) or (↓) buttons will scroll through the available parameter settings.

Pressing (Enter) will load the new parameter, or pressing the (X Clear) button will quit without loading the changes.

To exit the Set-up menu press the (X Clear) button, and at the exit confirmation screen, press the (Enter) button.

Refer to Section 9.3 for more detailed information on the menu structure.

NOTE - THE PARAMETERS / ROWS WITH THE SHADED BACKGROUND ARE THOSE MOST COMMONLY CHANGED FROM DEFAULT. THOSE SCREENS MARKED * ARE ONLY AVAILABLE WHEN THAT FUNCTION IS SELECTED IN THE HARDWARE CONFIGURATION MENU.

PARAMETER	DESCRIPTION	DEFAULT SETTING	SETTING USED (IF CHANGED FROM DEFAULT)
HOURS RUN RESET?	Reset the hours run data	N/A	
REMOTE CONTROL CONFIG?	Select method of remote control (3 Wire, 3 Wire & Command, BCD, BCD & Command, BCD (Option 2), BCD (Option 2) & Command, 8 Wire, 8 Wire & Command, Serial Communications)	8 WIRE	
COMMS ADDRESS	Select Address of unit for serial communications (Only required if ‘Communication’ selected for remote control)	255 (not selected)	

COMMS FAULT ACTION	Select the action to be taken in the case of a communications fault. (Only available if 'Communication' selected for remote control)	CCR OFF			
SET CCT SEL FLT ACTION? *	Select the action to be taken by the circuit selector in the case of a communications fault. (Only available if 'Communication' selected as method for remote control and the CCR is configured to use an internal circuit selector)	Each individual circuit reverts to fail-safe condition; alternate CSS reverts to CCT1			
COMMS FAULT TIME	Select the delay time (in seconds) before the Communications fault is raised. (Only available if 'Communication' selected for remote control)	5 S			
BRILL LEVELS	Select (UK) CAP168, FAA / IEC Style 1, FAA / IEC Style 2 User Defined or User Def. DOE. brilliancy levels	(UK) CAP 168			
BLACK HEAT	Enable/ Disable Black Heat operation	DISABLED			
TOLERANCE MON	Enable/ Disable internal Tolerance Monitoring Unit	ENABLED			
SET USER CURRENT LEVELS?	When User Defined Brilliancy Levels are selected, allows adjustment of the current levels. (Note - the default levels are those of UK CAP 168).	N/A			N/A
Set User Levels	CCR OUTPUT CURRENT RATING	6.0A	6.6A	12A	
	MAX	6.00	6.60	12.00	
	STEP 7 / DOE STEP 2	5.73	6.30	11.45	
	STEP 6 / DOE STEP 3	4.86	5.35	9.72	
	STEP 5 / DOE STEP 4	4.14	4.55	8.28	
	STEP 4 / DOE STEP 5	3.54	3.89	7.08	
	STEP 3 / DOE MIN	3.06	3.37	6.12	
	STEP 2 / DOE N/A	2.64	2.90	5.28	
	MIN / DOE N/A	2.34	2.57	4.68	
EARTH LEAKAGE STAGE 1 *	Select the threshold of resistance for the 1st stage Earth Leakage Alarm.	10 MΩ			
EARTH LEAKAGE STAGE 2 *	Select the threshold of resistance for the 2nd stage Earth Leakage Alarm / Trip.	200 kΩ			
CHANGE SET-UP PASSWORD?	Enter new Set-up password	atg			
CCR HARDWARE CONFIG?	To access the CCR Hardware Configuration menu, enter the password one letter at a time	eng			

HARDWARE CONFIGURATION MENU

The CCR Hardware Configuration Menu is accessed from the Set-up Menu by the use of a password, as described below.

From the Set-up menu, scroll through the menu using the (↑) (↓) buttons to reach the CCR Hardware Config password entry screen (it is in fact the first screen up after entering the Hardware Config menu).

Enter the password 'eng' one letter at a time using the (↑) (↓) buttons to scroll up and down the alphabet, and then press the (Enter) button.
If the password is loaded correctly, the display will show 'YYY'. Press (Enter) and the screen will change to the first of the Hardware Configuration screens. It is now possible to scroll through the menu using the (↑) (↓) buttons.

Pressing the (Enter) button will permit modifications to the parameters for the selected screen. The left-hand arrow will move to the second line, and then pressing the (↑) or (↓) buttons will scroll through the available parameter settings.

Pressing (Enter) will load the new parameter, or pressing the (X Clear) button will quit without loading the changes.

To exit the Hardware Config menu and go back to the Set-up menu press the (X Clear) button. To exit the Set-up menu press the (X Clear) button again, and at the exit confirmation screen, press the (Enter) button.

Refer to Section 9.4 for more detailed information on the menu structure.

PARAMETER	DESCRIPTION	DEFAULT SETTINGS	SETTING USED
FULL LOAD I	Select nominal CCR output current. Available settings are 6.0, 6.6, 12 and 20A. NOTE - IF THE (ENTER) BUTTON IS PRESSED BY MISTAKE TO ACCESS THE SCREEN (MOVING THE CURSOR TO THE BOTTOM LINE) PRESS THE X (CLEAR) BUTTON TO EXIT. PRESSING (ENTER) AGAIN, EVEN WITHOUT CHANGING THE CURRENT SETTING, WOULD DELETE THE CALIBRATION FACTORS THUS REQUIRING RECALIBRATION OF THE CCR	6.6A	
FIRMWARE VERSION	Displays the version of the CPU firmware	N/A	
BLACK HEAT	Set the Black Heat current level	6.0A FLC = 1.5A 6.6A FLC = 1.5A 12A FLC = 2.5A 20A FLC = 5.75A	
% LAMP FAIL TIME	Set the delay time (seconds) before the Percentage Lamp Failure alarm is raised	15 S	
TOL MON FAIL TIME	Set the delay time (seconds) before an Out Of Tolerance alarm is raised	15 S	

SET USER TOL LEVELS	When User Defined Brilliancy Levels are selected, allows adjustment of the Tolerance Monitoring alarm threshold levels	N/A			N/A
	CCR OUTPUT CURRENT RATING	6.0A	6.6A	12A	
	OVER TOL 8 / DOE - OVER TOL MAX	6.09	6.70	12.18	
	UNDER TOL 8 / DOE - UNDER TOL MAX	5.82	6.40	11.64	
	OVER TOL 7 / DOE - OVER TOL 2	5.78	6.36	11.56	
	UNDER TOL 7 / DOE - UNDER TOL 2	5.64	6.20	11.27	
	OVER TOL 6 / DOE - OVER TOL 3	5.23	5.76	10.47	
	UNDER TOL 6 / DOE - UNDER TOL 3	4.78	5.26	9.56	
	OVER TOL 5 / DOE - OVER TOL 4	4.36	4.80	8.73	
	UNDER TOL 5 / DOE - UNDER TOL 4	3.82	4.20	7.64	
	OVER TOL 4 / DOE - OVER TOL 5	3.68	4.05	7.36	
	UNDER TOL 4 / DOE - UNDER TOL 5	3.36	3.70	6.72	
	OVER TOL 3 / DOE - OVER TOL MIN	3.25	3.58	6.51	
	UNDER TOL 3 / DOE - UNDER TOL MIN	2.96	3.26	5.92	
	OVER TOL 2 / DOE - N/A	2.89	3.18	5.78	
	UNDER TOL 2 / DOE - N/A	2.51	2.76	5.01	
	OVER TOL 1 / DOE - N/A	2.41	2.65	4.82	
	UNDER TOL 1 / DOE - N/A	2.17	2.39	4.34	
CALIBRATE ZERO POINT	Calibrate the zero point for the control loop. IMPORTANT - IF ACCESSING THIS MENU JUST IN ORDER TO MAKE A RECORD OF THE CALIBRATION FACTOR, EXIT BY PRESSING THE 'X CLEAR' BUTTON. THIS WILL EXIT WITHOUT ALTERING THE CALIBRATION.				
CALIBRATE SPAN POINT	Calibrate the span point for the current control loop. (Note - the CCR will run at full output current during this procedure). IMPORTANT - IF ACCESSING THIS MENU JUST IN ORDER TO MAKE A RECORD OF THE CALIBRATION FACTOR, EXIT BY PRESSING THE 'X CLEAR' BUTTON. THIS WILL EXIT WITHOUT ALTERING THE CALIBRATION.				
CAL REAL POWER METER	Calibrate the Real Power Meter. (Note - this screen is only used with the obsolete power analyser card)	N/A			N/A
TEST OVERCURRENT TRIP POINT	Test use only - not to be used on live circuit	N/A			N/A
EARTH LEAK DET	Configure the earth leakage detection type to be Digital, Analogue, Continuous Analogue or Disabled. Note - requires the optional AT699 Earth Leakage Detection card to be fitted for this function to operate	DISABLED			
TRIP ON EARTH 2	Configure the stage 2 Earth Leakage detector to give an alarm and continue to run (disabled), or to shutdown (trip) the CCR (enabled)	ENABLED			

ALARM MULT BRIL	Enable/ Disable the alarm which alerts if an illegal combination of remote control inputs is detected	ENABLED	
OP START RAMP	The CCR can be programmed to gradually ramp up the O/P current to selected level on start-up, in a set time period, rather than switch on directly at the selected level. Enable/ Disable Start Ramp.	DISABLED	
ST RAMP TIME	Set the Start Up Current Ramp time. (Only available if Start Up Ramp is enabled)	600ms	
CCT SELECTOR	Disables (internal) CSS operation or allows selection of Alternate or Multiway (2 to 6 way) CSS	DISABLED	
CCT SEL TIME	Set the changeover switching time before re-energisation of the internal circuit selector. Allows selection of Slow Contactor (500ms), 300ms, 250ms, 200ms, 150ms, 100ms or Vacuum Relay (15ms). (Screen only available when circuit selector is enabled)	SLOW CONTACTOR	
SET CCT SEL LOGIC?	Select normally open or normally closed logic for correct fail safe modes for each circuit of Multiway Circuit Selector	N/Op: 1, 2, 3, 4, 5, 6 N/Cl:	
C/S TURN OFF CCR	Allows the Circuit Selector control logic to turn off the CCR when all circuits are selected to off. (Available when Multiway (2 to 6 way) Circuit Selector is enabled)	ENABLED	
C/S PCB TYPE	Allows selection of the Multi-Way Circuit Selector Back Indication Current Detection philosophy, depending on the PCB type fitted.	AT661C ONWARD	
% LAMP FAIL	Enable Percentage Lamp Failure monitoring; Analogue (with auto calibration) is recommended, Note - requires the optional AT923 PLF card to be fitted for this function to operate	DISABLED	
NUM OF LAMPS	If ‘Analogue IP’ PLF monitoring is selected, this screen becomes available and is used to enter the total number of lamps on the AGL circuit	100	
PLF LIMIT 1	Enter the threshold for the number of failed lamps to trigger a Stage-1 alarm. (Only available if ‘Analogue IP’ PLF monitoring is selected). There will be a warning screen regarding calibration	5 (5%)	
PLF LIMIT 2	Enter the threshold for the number of failed lamps to trigger a Stage-2 alarm. (Only available if ‘Analogue IP’ PLF monitoring is selected). There will be a warning screen regarding calibration	10 (10%)	

CALIBRATE PLF INPUT	Calibration screens for PLF. (Only available if 'Analogue IP' PLF monitoring is enabled)	N/A	N/A
SELECT LEVEL	Select which PLF alarm threshold points are to be calibrated - level ONE (low) or TWO (high)	ONE	
NUM OPEN CCT LAMPS	Enter the number of lamp fittings which will be open circuited for calibration of this threshold level. After pressing enter, a 'CCR will start' warning will be displayed, followed by 'Press (enter) to capture' ie, calibrate	5	
SELECT LEVEL	Select which PLF alarm threshold points are to be calibrated - level ONE (low) or TWO (high)	TWO	
NUM OPEN CCT LAMPS	Enter the number of lamp fittings which will be open circuited for calibration of this threshold level. After pressing enter, a 'CCR will start' warning will be displayed, followed by 'Press (enter) to capture' ie, calibrate	10	
ENT TX OP VOLTS	Enter the total main transformer output voltage as connected (sum of each winding section connected).	0001V	V
KVA ALARM	If enabled, an alarm screen is displayed if there is a 10% or greater drop in the volt-amperes being delivered to the series loop circuit. (Only available if 'Voltage Feedback' is enabled)	DISABLED	
AENA OUTPUTS	Enables AENA I/O configuration (for Spanish market)	DISABLED	

Table 12-2 CCR Parameter Record Sheet

13 Parts Listings and Circuit Schematics

Table 13-1 to Table 13-10 provide a list of all major components fitted to a standard CCR, with the exception of the cabinet, covers and fixings. The list includes the parts for all voltage and power ratings, plus the optional components available for the Micro 200 series. When choosing spare parts, check carefully the specification of the regulator for which the parts are to be purchased.

The recommended spares quantity varies depending on the quantity of CCRs for the project, and on how many of these CCRs use any given part.

Items which are recommended to purchase as spares include a letter in the listing denoting the spare parts category; a typical spares kit would include those parts denoted category ‘A’ and ‘B’.

The categories are defined as follows:

Category A – fuses only in this category. Refer to Table 13-6 for the quantities of each fitted; normally keep 2 spares of each type (2A control and power fuse) for every CCR on site which would use these components.

Category B – keep 1 spare part from this category where there are 5 or more CCRs on site which would use these components. Eg, 7400-1733A Control Card

Category C – keep 1 spare part from this category where there are 15 or more CCRs on site which would use these components.

For example, all Micro 200 CCRs use the AT733 Control Card (stock number 7400-1733A), and so a mixture of different CCRs, which could be in terms of voltage or kVA rating, or optional parts fitted, will make up the total quantity of CCRs using this part to determine whether it should be included in the list of recommended spares.

On the other hand, the Micro 200 CCRs with built-in Circuit Selector Switches use a different Microcontroller Front Panel than that for a standard CCR, and the Front Panel is specific to the exact type of Circuit Selector fitted. In this case, the quantities of each particular variant of Circuit Selector Switch are used to determine the type and quantity of recommended spare Microcontroller Front panels.

T101 CCR POWER TRANSFORMERS						
220V SERIES, 6.6A OUTPUT				400V SERIES, DUAL 6.6 / 12A OUTPUT		
CCR RATING, kVA	MANUFACTURER	ATG AIRPORTS STOCK CODE		CCR RATING, kVA	MANUFACTURER	ATG AIRPORTS STOCK CODE
1	ATG AIRPORTS	2690-0689		3.78	ATG AIRPORTS	2690-0610
2.5	ATG AIRPORTS	2690-0690		7.5	ATG AIRPORTS	2690-0611
4	ATG AIRPORTS	2690-0691		11.34	ATG AIRPORTS	2690-0615
5	ATG AIRPORTS	2690-0692		15	ATG AIRPORTS	2690-0612
7.5	ATG AIRPORTS	2690-0693		18.9	ATG AIRPORTS	2690-0616
10	ATG AIRPORTS	2690-0694		22.68	ATG AIRPORTS	2690-0613
12.5	ATG AIRPORTS	2690-0695		26.46	ATG AIRPORTS	2690-0614
15	ATG AIRPORTS	2690-0696				
400V SERIES, 6.6A OUTPUT						
CCR RATING, kVA	MANUFACTURER	ATG AIRPORTS STOCK CODE				
1	ATG AIRPORTS	2690-0674				
2.5	ATG AIRPORTS	2690-0675				
4	ATG AIRPORTS	2690-0676				
5	ATG AIRPORTS	2690-0677				
7.5	ATG AIRPORTS	2690-0678				
10	ATG AIRPORTS	2690-0679				
12.5	ATG AIRPORTS	2690-0680				
15	ATG AIRPORTS	2690-0681				
20	ATG AIRPORTS	2690-0682				
25	ATG AIRPORTS	2690-0683				
30	ATG AIRPORTS	2690-0684				

Table 13-1 Parts List: T101 Power Transformers

Note – other transformer types from those listed above may be fitted depending on the exact specification of the CCR. Check the part number for the transformer actually fitted if a replacement is to be ordered.

REF	OPTION CODES WHERE FITTED	QTY	COMPONENT TYPE	DESCRIPTION	MANUFACTURER	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY / COMMENT
FP		1	FRONT PANEL	STANDARD MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2010K	7500-2010K	B
FP	D	1	FRONT PANEL	ALTERNATE CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2011K	7500-2011K	B
FP	2W	1	FRONT PANEL	2W SIMULTANEOUS CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2012K	7500-2012K	B
FP	3W	1	FRONT PANEL	3W SIMULTANEOUS CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2013K	7500-2013K	B
FP	4W	1	FRONT PANEL	4W SIMULTANEOUS CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2014K	7500-2014K	B
FP	5W	1	FRONT PANEL	5W SIMULTANEOUS CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2015K	7500-2015K	B
FP	6W	1	FRONT PANEL	6W SIMULTANEOUS CIRCUIT SELECTOR MICRO 200 MICROCONTROLLER FRONT PANEL	ATG AIRPORTS	7500-2016K	7500-2016K	B
AT637	2W/3W/4W/5W/6W	1	PCB	SIMULTANEOUS / MULTIWAY CIRCUIT SELECTOR SWITCH CARD	ATG AIRPORTS	AT637	7400-1637A	
AT657	D	1	PCB	DIRECTION / ALTERNATE CIRCUIT SELECTOR CARD	ATG AIRPORTS	AT657A	7400-1657A	PART OF 7500-2021K
AT661C	2W/3W/4W/5W/6W	1	PCB	SIMULTANEOUS / MULTIWAY CIRCUIT SELECTOR CONTROL CARD	ATG AIRPORTS	AT661C	7400-1661A	B
AT663A	2W/3W/4W/5W/6W	1	PCB	SIMULTANEOUS / MULTIWAY CIRCUIT SELECTOR RELAY I/O CARD	ATG AIRPORTS	AT663A	7400-1663A	B
AT683	JS	1	PCB	J-BUS / MODBUS COMMUNICATION ADAPTOR CARD	ATG AIRPORTS	AT683	7400-1683A	B
AT699	EF	1	PCB	EARTH LEAKAGE DETECTION CARD	ATG AIRPORTS	AT699	7400-1699A	C
AT709	EF	1	PCB	EARTH LEAKAGE SUB - CARD	ATG AIRPORTS	AT709	7400-1709A	C
AT712A	24/48	1	PCB	RELAY I/O CARD	ATG AIRPORTS	AT712A	7400-1712A	B
AT714		1	PCB	MOV TRANSIENT SUPPRESSION CARD	ATG AIRPORTS	AT714	7400-1714	B
AT728	PS	1	PCB	DUAL PROFIBUS COMMUNICATION ADAPTOR CARD	ATG AIRPORTS	AT728	7400-1728A	B
AT733B		1	PCB	MAIN CONTROL CARD	ATG AIRPORTS	AT733B	7400-1733A	B

REF	OPTION CODES WHERE FITTED		COMPONENT TYPE	DESCRIPTION	MANUFACTURER	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY
AT742		1	PCB	INPUT Y CAPACITOR FILTER CARD (UP TO 25A INPUT CURRENT)	ATG AIRPORTS	AT742	7400-1742A	
AT759A	CM, PM	1	PCB	CURRENT TRANSDUCER PCB	ATG AIRPORTS	AT759A	7400-1759A	
AT764		1	PCB	OUTPUT Y CAPACITOR FILTER CARD (UP TO 1150V)	ATG AIRPORTS	AT764	7400-1764A	
AT765		1	PCB	OUTPUT Y CAPACITOR FILTER CARD (UP TO 2300V)	ATG AIRPORTS	AT765	7400-1765A	
AT901		1	PCB	INPUT X AND Y CAPACITOR FILTER CARD (UP TO 55A INPUT CURRENT)	ATG AIRPORTS	AT901	7400-1901A	
AT904A	CM, PM	1	PCB	4-20mA CURRENT / POWER OUTPUT MONITOR CARD	ATG AIRPORTS	AT904A	7400-1904A	
AT912A		1	PCB	STACK OUTPUT Y CAPACITOR FILTER CARD (UP TO 55A INPUT CURRENT)	ATG AIRPORTS	AT912A	7400-1912A	
AT923	LF	1	PCB	PERCENTAGE LAMP FAILURE CARD	ATG AIRPORTS	AT923D	7400-1923A	C
AT958	CM, PM	1	PCB	4-20mA POWER OUTPUT MONITOR CARD (SOFTWARE CONTROLLED)	ATG AIRPORTS	AT958	7400-1958A	
AT1026	FCI	1	PCB	CUTOUT SWITCH RELAY CARD	ATG AIRPORTS	AT1026	7410-1026	B
AT1056	MTS	1	PCB	MODBUS TCP / IP COMMUNICATION CARD	ATG AIRPORTS	AT1056	7400-1056	B
BOARDS WHICH ARE A PART OF THE STACK ASSEMBLIES (ALREADY INCLUDED WITH THOSE PARTS KITS):								
AT732D		1	PCB	POWER CARD	ATG AIRPORTS	AT732D	7400-1732A	B
AT785F		1	PCB	IGBT CONTROL CARD	ATG AIRPORTS	AT785F	7400-1785A	B
AT786A		1	PCB	DC LINK CARD	ATG AIRPORTS	AT786A	7400-1786A	

Table 13-2 Parts List: Circuit Boards, including optional

CONTROL TRANSFORMERS - ALL BUILD STANDARDS							220V SERIES - QUANTITY						400V SERIES - QUANTITY							
REF	PRI. VOLTS	SEC VOLTS AND VA	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
T102	0-208-220-240V	18/0/18v (22VA) TO AT533, 0-220v (22VA) TO AT500, 15/0/15v (12VA) TO AT699 E/F CARD, 0-20v (3VA) SPARE	DOUGLAS TRANSFORMERS	M5978	2690-0020	C	1	1	1	1	1	1								
T105	0-208-220-240V	18/0/18 (22VA) TO AT712A RIO CARD, 0-9v (6VA) TO PROFIBUS / MODBUS / J-BUS CARD	DOUGLAS TRANSFORMERS	M5979	2690-0021	C	1	1	1	1	1	1								
T102	0-380-415-440V	18/0/18v (22VA) TO AT533, 0-220v (22VA) TO AT500, 15/0/15v (12VA) TO AT699 E/F CARD, 0-20v (3VA) SPARE	DOUGLAS TRANSFORMERS	M5866	2690-0013	C							1	1	1	1	1	1	1	1
T105	0-380-415-440V	18/0/18 (22VA) TO AT712A RIO CARD, 0-9v (6VA) TO PROFIBUS / MODBUS / J-BUS CARD	DOUGLAS TRANSFORMERS	M5700	2690-0014	C							1	1	1	1	1	1	1	1
T112	0-380-415-440V	18/0/18v (22VA) TO AT533, 0-220v (22VA) TO AT500, 15/0/15v (12VA) TO AT699 E/F CARD, 0-20v (3VA) SPARE	DOUGLAS TRANSFORMERS	M5866	2690-0013	C							1	1	1	1	1			
T112	15-0-230-400V	0-230v, 200VA, 1A	RS	504-139 (ST53334)	2690-0024	C												1	1	1

Table 13-3 Parts List: standard Control Transformers

CONTROL TRANSFORMERS FOR CCR OPTIONS									
REF	OPTION CODES WHERE FITTED	QTY	DESCRIPTION	PRIMARY VOLTAGE	SECONDARY VOLTAGE(S) AND RATINGS	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY
220V SERIES									
T106	2W/3W/4W/ 5W/6W	1	CONTROL SUPPLY FOR AT661 MULTIWAY CIRCUIT SELECTOR CARD	0-208-220-240V	0-18v (24VA), 0-18v (12VA), 0-9v (6VA)	DOUGLAS TRANSFORMERS	M6293	2690-0012A	C
T107	D	1	CONTROL SUPPLY FOR AT657 DIRECTION / ALTERNATE CIRCUIT SELECTOR CARD	0-208-220-240V	0-18v (12VA)	DOUGLAS TRANSFORMERS	M6292	2690-0017A	C
400V SERIES									
T106	2W/3W/4W/ 5W/6W	1	CONTROL SUPPLY FOR AT661 MULTIWAY CIRCUIT SELECTOR CARD	0-380-400-415V	0-18v (24VA), 0-18v (12VA), 0-9v (6VA)	DOUGLAS TRANSFORMERS	M5586	2690-0012	C
T107	D	1	CONTROL SUPPLY FOR AT657 DIRECTION / ALTERNATE CIRCUIT SELECTOR CARD	0-380-400-415V	0-18v (12VA)	DOUGLAS TRANSFORMERS	M5536	2690-0017	C
CURRENT TRANSFORMERS					RATING				
T103	STD CCR AND 2W/3W/4W/ 5W/6W	1 - 7	CURRENT TRANSFORMER	N/A	150:0.5 AMPS, 1VA CL0.5	NORATEL	TI-077554 ISS 3	2690-0009	

Table 13-4 Parts List: Control Transformers for optional circuitry and CT's

REF	CCR OPTION CODES	QTY	COMPONENT TYPE	DESCRIPTION	RATING	MANUFACTURER	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY
OUTPUT TERMINALS AND LIGHTNING ARRESTORS									
OUTPUT TERMINAL	ALL EXCEPT LA	2 - 7	TERMINAL	STANDARD CCR OUTPUT TERMINAL	125A	WEIDMULLER	WFF 35	2720-0071	
COVER	ALL EXCEPT LA	4 - 14		OUTPUT TERMINAL COVER		WEIDMULLER	WAH 35	2720-0075	
LIGHTNING ARRESTOR	LA	1	MOV / TERMINAL	2 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0210	7200-0210	C
LIGHTNING ARRESTOR	LA - 2W	1	MOV / TERMINAL	3 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0212	7200-0212	C
LIGHTNING ARRESTOR	LA - 3W	1	MOV / TERMINAL	4 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0213	7200-0213	C
LIGHTNING ARRESTOR	LA - 4W	1	MOV / TERMINAL	5 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0214	7200-0214	C
LIGHTNING ARRESTOR	LA - 5W	1	MOV / TERMINAL	6 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0215	7200-0215	C
LIGHTNING ARRESTOR	LA - 6W	1	MOV / TERMINAL	7 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0216	7200-0216	C
LIGHTNING ARRESTOR	LA - D	1	MOV / TERMINAL	4 OUTPUTS - METAL OXIDE VARISTOR AND TERMINAL ASSEMBLY	MOV IMPULSE RATING - 15kA, 10 x 20µS	ATG AIRPORTS	7200-0211	7200-0211	C
CUTOUT SWITCH ASSEMBLIES									
CUTOUT SWITCH	FCI	1 OR 2	ISOLATING SWITCH	SAFETY ISOLATING SWITCH	12A	ATG AIRPORTS	2610-0022A	2610-0022A	
CUTOUT SWITCH + INTERLOCK	FCI (EG, AIR. NZ)	1 OR 2	ISOLATING SWITCH	SAFETY ISOLATING SWITCH WITH REED RELAY INTERLOCK TO DISCONNECT CCR OUTPUT	12A	ATG AIRPORTS	2610-0024A	2610-0024A	
CUTOUT SW + INTLK + BACK IND	FCI (EG, AENA SPEC, SP)	1	ISOLATING SWITCH	SAFETY ISOLATING SWITCH WITH REED RELAY INTERLOCK TO DISCONNECT CCR OUTPUT, AND POSITION BACK INDICATION	12A	ATG AIRPORTS	2610-0023A	2610-0023A	
CIRCUIT SELECTOR RELAYS, MAX. 6.6A, UP TO 10kVA									
C1 - C6	2W/3W/4W /5W/6W/D	1 - 6	CONTROL RELAY	24V LOW CONSUMPTION DC COIL, INC. SUPPRESSOR. 3 NO AND 2 NC CONTACTS	CONTACT RATING: 10A	TELEMECANIQUE	CAD-32BL	2610-0140	B
CIRCUIT SELECTOR RELAYS, 12.5kVA TO 30kVA AT 6.6A, ALL KVA RATINGS AT 12A									
C1 - C6	2W/3W/4W /5W/6W/D	1 - 6	VACUUM RELAY	CIRCUIT SELECTOR RELAY, 6.6A, 12.5kVA TO 30kVA, AND 12A AT ALL KVA RATINGS	CONTACT RATING: 50A @ 12kV AC	JENNINGS	RJ2B-26S	2515-0055	B

Table 13-5 Parts List: Output Terminals, Cutout, Lightning Arrestors and CSS Relays

FUSES FOR IEC BUILD STANDARD								220V SERIES - QUANTITY. F2/F4=NUETRAL LINK ON SINGLE PHASE (L-N) MODELS. 2 PHASE MODEL QTY IN (-)						400V SERIES - QUANTITY							
REF	COMPONENT TYPE	VOLT. RAT.	CURR. RAT.	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARES CATEGORY	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
F1, F2	FUSEHOLDER (DUAL), 10 x 38mm	N/A	N/A	SIBA	5106304.2	2720-0090		1	1	1				1	1	1	1	1			
F1, F2	gRL FUSE, 10 x 38mm	500V	10A	SIBA	6003434.10A	2550-0311	A	1 (2)						2	2						
F1, F2	gRL FUSE, 10 x 38mm	500V	20A	SIBA	6003434.20A	2550-0320	A		1 (2)							2	2				
F1, F2	gRL FUSE, 10 x 38mm	500V	30A	SIBA	6003434.30A	2550-0330	A			1 (2)								2			
F1, F2	FUSEHOLDER (DUAL), 22 x 58mm	N/A	N/A	SIBA	5106004.2	2720-0092					1	1	1						1	1	1
F1, F2	gRL FUSE, 22 x 58mm	690V	40A	SIBA	5014034.40A	2550-0440	A				1 (2)								2		
F1, F2	gRL FUSE, 22 x 58mm	690V	50A	SIBA	5014034.50A	2550-0350	A													2	
F1, F2	gRL FUSE, 22 x 58mm	690V	63A	SIBA	5014034.63A	2550-0363	A					1 (2)									2
F1, F2	gRL FUSE, 22 x 58mm	690V	80A	SIBA	5014034.80A	2550-0380	A						1 (2)								
F3, F4	FUSEHOLDER (DUAL), 10 x 38mm	N/A	N/A	SIBA	5106304.2	2720-0090		1	1	1	1	1	1	1	1	1	1	1	1	1	1
F3, F4	gG FUSE, 10 x 38mm	500V	2A	SIBA	5006308.2A	2550-0302	A	1 (2)	1 (2)	1 (2)				2	2	2	2	2			
F3, F4	gG FUSE, 10 x 38mm	500V	4A	SIBA	5006308.4A	2550-0304	A				1 (2)	1 (2)	1 (2)						2	2	2
F2, F4	NUETRAL LINK, 10 x 38mm	N/A			5006308.N	2550-0402		2 (0)	2 (0)	2 (0)	1 (0)	1 (0)	1 (0)								
F2	NUETRAL LINK, 22 x 58mm	N/A			5006008.N	2550-0404		0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)								
NOTE - 220V SERIES SINGLE PHASE (L-N) MODELS USE 1 OF EACH FUSE, WITH F2 AND F4 REPLACED BY A NUETRAL LINK. 220V 2 PHASE MODELS USE 2 OF EACH FUSE																					
FUSE TYPES:																					
gG - GENERAL LINE FUSE																					
gRL - COMBINED LINE AND SEMICONDUCTOR PROTECTION FUSE																					

Table 13-6 Parts List: Fuses

CIRCUIT BREAKERS / MCB'S - OPTIONAL, IN PLACE OF LINE FUSES.							SPARES CATEGORY	220V SERIES - QUANTITY. F2/F4=NEUTRAL LINK ON SINGLE PHASE (L-N) MODELS. 2 PHASE MODEL QTY IN (-)						400V SERIES - QUANTITY							
REF	COMP. TYPE	VOLT. RAT.	CURR. RAT.	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE		1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
F1	MCB, SINGLE POLE 10A TYPE C	440V	10A	ABB	S201MC10	2550-1810	C	1													
F1	MCB, SINGLE POLE 20A TYPE C	440V	20A	ABB	S201MC20	2550-1820	C		1												
F1	MCB, SINGLE POLE 32A TYPE C	440V	32A	ABB	S201MC32	2550-1832	C			1											
F1	MCB, SINGLE POLE 40A TYPE C	440V	40A	ABB	S201MC40	2550-1840	C				1										
F1	MCB, SINGLE POLE 63A TYPE C	440V	63A	ABB	S201MC63	2550-1863	C					1									
F1	MCB, SINGLE POLE 80A TYPE C	440V	80A	ABB	S801N-C80	2550-1880	C						1								
F2	HOLDER, SINGLE 10x38mm	N/A	N/A	SIBA	5106304	2720-0097		1	1												
F2	HOLDER, SINGLE 22x58mm	N/A	N/A	SIBA	5106005.1	2720-0098				1	1	1									
F1, F2	MCB, 2 POLE 6A TYPE C	440V	6A	ABB	S202MC6	2550-2006	C							1							
F1, F2	MCB, 2 POLE 10A TYPE C	440V	10A	ABB	S202MC10	2550-2010	C	(1)							1						
F1, F2	MCB, 2 POLE 20A TYPE C	440V	20A	ABB	S202MC20	2550-2020	C		(1)							1	1				
F1, F2	MCB, 2 POLE 32A TYPE C	440V	32A	ABB	S202MC32	2550-2032	C			(1)								1			
F1, F2	MCB, 2 POLE 40A TYPE C	440V	40A	ABB	S202MC40	2550-2040	C				(1)								1		

CIRCUIT BREAKERS / MCB'S - OPTIONAL, IN PLACE OF LINE FUSES.							SPARES CATEGORY	220V SERIES - QUANTITY. F2/F4=NEUTRAL LINK ON SINGLE PHASE (L-N) MODELS. 2 PHASE MODEL QTY IN (-)						400V SERIES - QUANTITY							
REF	COMP. TYPE	VOLT. RAT.	CURR. RAT.	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE		1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
F1, F2	MCB, 2 POLE 50A TYPE C	440V	50A	ABB	S202MC50	2550-2050	C													1	
F1, F2	MCB, 2 POLE 63A TYPE C	440V	63A	ABB	S202MC63	2550-2063	C					(1)									1
F1, F2	MCB, 2 POLE 80A TYPE C	440V	80A	ABB	S802N-C80	2550-2080	C						(1)								
F3, F4	HOLDER, 10x38mm	N/A	N/A	SIBA	5106304.2	2720-0090		1	1	1	1	1	1	1	1	1	1	1	1	1	1
F3, F4	gG FUSE, 10x38mm	500V	2A	SIBA	5006308.2A	2550-0302	A	1 (2)	1 (2)	1 (2)				2	2	2	2	2			
F3, F4	gG FUSE, 10x38mm	500V	4A	SIBA	5006308.4A	2550-0304	A				1 (2)	1 (2)	1 (2)						2	2	2
F2, F4	NEUTRAL LINK, 10x38mm	N/A	N/A	SIBA	5006308.N	2550-0402		2 (0)	2 (0)	1 (0)	1 (0)	1 (0)	1 (0)								
F2	NEUTRAL LINK, 22x58mm	N/A	N/A	SIBA	5006008.N	2550-0404		0 (0)	0 (0)	1 (0)	1 (0)	1 (0)	1 (0)								
NOTE - 220V SERIES SINGLE PHASE (L-N) MODELS USE SINGLE POLE MCB'S FOR F1 AND F3, WITH F2 AND F4 REPLACED BY A NEUTRAL LINK. 220V 2 PHASE MODELS USE 2 POLE MCB.							SPARES CATEGORY	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
FUSE TYPES:								220V SERIES - QUANTITY. F2/F4=NEUTRAL LINK ON SINGLE PHASE (L-N) MODELS. 2 PHASE MODEL QTY IN (-)						400V SERIES - QUANTITY							
gG - GENERAL LINE FUSE																					

Table 13-7 Parts List: Circuit Breakers (optional, in place of line fuses)

POWER CAPACITORS							220V SERIES - REF / QUANTITY						400V SERIES - REF / QUANTITY							
COMP. TYPE	VOLT. RAT. (AC)	CAPACI TANCE	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARES CATEGORY	1kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
NOT FITTED													C3							
CAPACITOR	700V DC	1uF	ICW	SC1988	2190-0019	C	C3	C3					C4, 5							
CAPACITOR	700V DC	2uF	ICW	SC1763	2190-0020	C								C3	C3	C3				
CAPACITOR	700V DC	3uF	ICW	SC1751	2190-0021	C			C3	C3			C1, 2	C4	C4	C4	C3			
CAPACITOR	700V DC	4uF	ICW	SC1764	2190-0022	C								C2, 5	C2, 5	C2, 5				
CAPACITOR	700V DC	5uF	ICW	SC1729	2190-0023	C	C4	C4	C2		C3						C2, 4	C3	C3	C3
CAPACITOR	700V DC	7.5uF	ICW	SC1765	2190-0024	C	C5	C5	C4			C3					C1, 5	C4		
CAPACITOR	700V DC	10uF	ICW	SC1730	2190-0025	C			C1A, 1B,5	C4	C2A,2B, 5A,5B	C4A, 4B		C1	C1	C1		C1, 5	C4	C4
CAPACITOR	700V DC	15uF	ICW	SC1731	2190-0026	C	C1, 2	C1, 2		C1A, 1B,2, 5	C1A,1B, 1C,2C,4	C2A,2B, 2C, 5A, 5B						C2	C1,2, 5	C1,2, 5
CAPACITOR	700V DC	20uF	ICW	SC2348	2190-0031	C						C1A,1B, 1C								

INDUCTORS							220V SERIES - QUANTITY						400V SERIES - QUANTITY							
COMP. TYPE	INDUCTANCE / DESCRIPTION	CURR. RAT.	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE		1kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
INDUCTOR	0.2mH DAMPER	16A	IST POWER PRODUCTS	0104637	2630-0037		2	2					2	2	2					
INDUCTOR	0.2mH DAMPER	25A	SCHAFFNER	RU2300 4-25-99	2630-0066											2	2			
INDUCTOR	0.15mH DAMPER	34A	IST POWER PRODUCTS	0104655	2630-0068				2	2								2		
INDUCTOR	0.125mH DAMPER	47A	SCHAFFNER	RU2300 4-47-99	2630-0067														2	2
INDUCTOR	0.05mH DAMPER	60A	IST POWER PRODUCTS	0104682	2630-0064						2	2								

INDUCTORS							SPARES CATEGORY	220V SERIES - QUANTITY						400V SERIES - QUANTITY							
	COMP. TYPE	INDUCTANCE / DESCRIPTION	CURR. RAT.	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE		1kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
	INDUCTOR	1.7 + 1.7mH DIFFERENTIAL	16A	IST POWER PRODUCTS	0104636	2630-0072								1	1	1					
	INDUCTOR	1.7 + 1.7mH DIFFERENTIAL	25A	IST POWER PRODUCTS	0104599	2630-0073											1	1			
	INDUCTOR	1.5mH	34A	IST POWER PRODUCTS	0104654	2630-0038													2		
	INDUCTOR	0.8mH	43A	IST POWER PRODUCTS	0104222	2630-0043		2	2												
	INDUCTOR	1.0mH	47A	IST POWER PRODUCTS	0104656	2630-0039														2	2
	INDUCTOR	0.8mH	50A	IST POWER PRODUCTS	0104250	2630-0042				2	2	2									
	INDUCTOR	0.71mH	60A	IST POWER PRODUCTS	0104665	2630-0051							2								
	INDUCTOR	1.0mH COMMON MODE	50A	SCHAFFNER	RD8127-50-1M0	2630-0040					1	1							1	1	1
	INDUCTOR	0.8mH COMMON MODE	64A	SCHAFFNER	RD8127-64-0M8	2630-0044							1								
	INDUCTOR	FERRITE BEAD		WURTH ELECTRONICS	74270115	2680-0020		2	2	2				2	2	2	2	2			
	INDUCTOR	FERRITE BEAD (CLAMP ON)		WURTH ELECTRONICS	74271622	2680-0021					2	2	2						2	2	2
	INDUCTOR	FERRITE BEAD (CLAMP ON)		FAIR-RITE VO	431177081	2680-0022					1	1	1						1	1	1

Table 13-8 Parts List: Capacitors and Inductors

EMC FILTERS								220V SERIES - QUANTITY						400V SERIES - QUANTITY							
REF	COMPONENT TYPE	VOLT. RATING (AC)	CURR. RATING	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
F101	EMC FILTER	520V	25A	SCHAFFNER	FN2410H-25-33	2620-0011		1	1					1	1	1	1				
F101	EMC FILTER	520V	32A	SCHAFFNER	FN2410H-32-33	2620-0013				1								1			
F101	EMC FILTER	520V	60A	SCHAFFNER	FN2410H-60-34	2620-0021					1	1							1	1	1
F101	EMC FILTER	520V	100A	SCHAFFNER	FN2410H-100-34	2620-0026							1								
CONTACTORS AND COIL SUPPRESSORS								220V SERIES - QUANTITY						400V SERIES - QUANTITY							
REF	COMPONENT TYPE	VOLT. RATING (AC)	CURR. RATING	MFTR	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
CB1	CONTACTOR, 230V AC COIL, SIZE S0	690V	35A	SIEMENS	3RT2025-1AL20	2610-0220K	C	1	1	1											
CB1	CONTACTOR, 230V AC COIL, SIZE S2	690V	55A	SIEMENS	3RT2035-1AL20	2610-0221K	C				1	1									
CB1	CONTACTOR, 230V AC COIL, SIZE S2	690V	90A	SIEMENS	3RT2038-1AL20	2610-0222K	C						1								
CB1	CONTACTOR, 400V AC COIL, SIZE S0	690V	35A	SIEMENS	3RT2025-1AR60	2610-0091K	C							1	1	1	1				
CB1	CONTACTOR, 400V AC COIL, SIZE S2	690V	55A	SIEMENS	3RT2035-1AR60	2610-0102K	C											1	1	1	1
CB1	COIL SUPPRESSOR, SIZE S0	240 TO 400V	N/A	SIEMENS	3RT29 26-1CE00	2610-0109	C	1	1	1				1	1	1	1				
CB1	COIL SUPPRESSOR, SIZE S2	240 TO 400V	N/A	SIEMENS	3RT29 36-1CE00	2610-0103	C				1	1	1					1	1	1	1
CB2, 3	CONTACTOR, 230V AC COIL, SIZE S0	690V	35A	SIEMENS	3RT2025-1AL20	2610-0220K	C	2	2	2	2	2	2								
CB2, 3	CONTACTOR, 400V AC COIL, SIZE S0	690V	35A	SIEMENS	3RT2025-1AR60	2610-0091K	C							2	2	2	2	2	2	2	2
CB2, 3	COIL SUPPRESSOR, SIZE S0	240 TO 400V	N/A	SIEMENS	3RT29 26-1CE00	2610-0109	C	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 13-9 Parts List: EMC Filters and Contactors

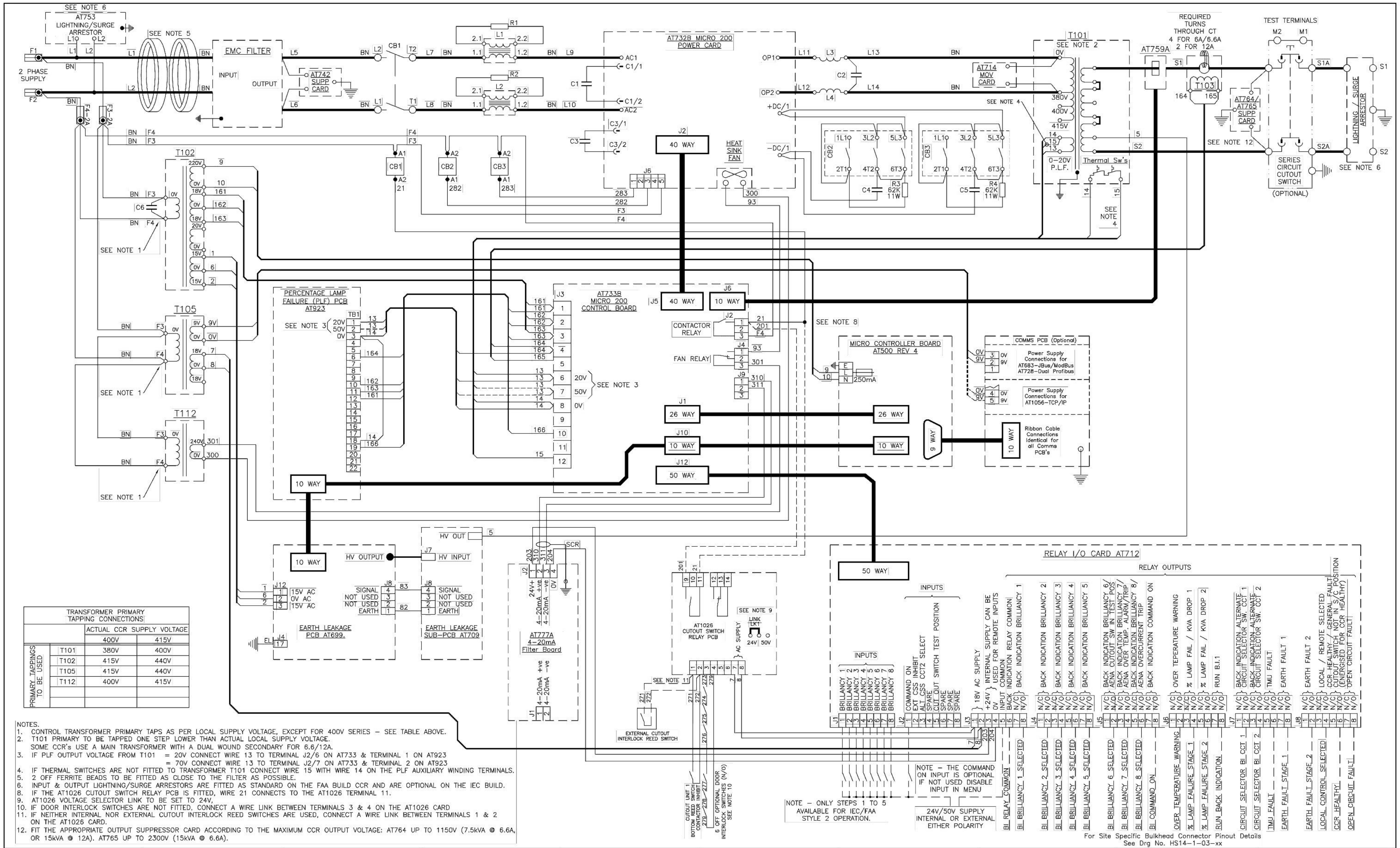
IGBT STACK ASSEMBLIES							SPARES CATEGORY	220V SERIES - QUANTITY						400V SERIES - QUANTITY							
	COMPONENT TYPE	VOLTAGE AND CURRENT RATINGS (AC)	NUMBER OF TURNS AND CABLE CSA THROUGH AT732 / AT785 CURRENT TRANSDUCER FOR THE CORRECT RANGE OF PRIMARY CURRENT	AT732 OR AT785 HYSTERESIS POTENTIOMETER SETTING	MFTR	ATG AIRPORTS STOCK CODE		1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
	SKM75GB12T4 IGBT STACK ASSEMBLY AND AT732 CARD	415V / 25A	7 TURNS OF 1 MM	AT732 TP5 = 3.5V (ADJUST VR1; TP32 IS 0V RETURN)	ATG AIRPORTS	7500-1800K	B							1							
	SKM75GB12T4 IGBT STACK ASSEMBLY AND AT732 CARD	415V / 25A	3 TURNS OF 4 MM	AT732 TP5 = 3.5V (ADJUST VR1; TP32 IS 0V RETURN)	ATG AIRPORTS	7500-1800K	B	1							1	1					
	SKM75GB12T4 IGBT STACK ASSEMBLY AND AT732 CARD	415V / 25A	2 TURNS OF 6 MM	AT732 TP5 = 3.5V (ADJUST VR1; TP32 IS 0V RETURN)	ATG AIRPORTS	7500-1800K	B		1								1				
	SKM75GB12T4 IGBT STACK ASSEMBLY AND AT732 POWER CARD	415V / 25A	2 TURNS OF 6 MM	AT732 TP5 = 2.5V (ADJUST VR1; TP32 IS 0V RETURN)	ATG AIRPORTS	7500-1800K	B			1								1			
	SEMiX 202GB12E4S IGBT STACK ASSEMBLY	415V / 55A	1 TURN (USE 10 MM HIGH TEMP POLYRAD FXT IF MAINS CABLE IS 16MM OR 25MM)	AT785 TP6 = 7mV (ADJUST VR2; TP2 IS 0V RETURN. TP6 IS LOCATED NEXT TO VR1, 'HYST')	ATG AIRPORTS	7500-1761A					1								1		
	SEMiX 202GB12E4S IGBT STACK ASSEMBLY	415V / 55A	1 TURN (USE 10 MM HIGH TEMP POLYRAD FXT IF MAINS CABLE IS 16MM OR 25MM)	AT785 TP6 = 10mV (ADJUST VR2; TP2 IS 0V RETURN. TP6 IS LOCATED NEXT TO VR1, 'HYST')	ATG AIRPORTS	7500-1761A						1									
	SEMiX 202GB12E4S IGBT STACK ASSEMBLY	415V / 55A	1 TURN (USE 10 MM HIGH TEMP POLYRAD FXT (HIGH TEMP CABLE) WHERE MAINS CABLE IS 16MM OR 25MM)	AT785 TP6 = 20mV (ADJUST VR2; TP2 IS 0V RETURN. TP6 IS LOCATED NEXT TO VR1, 'HYST')	ATG AIRPORTS	7500-1761A							1							1	1

REPLACEMENT IGBTS, DIODE MODULES, SNUBBER CAPACITORS AND FANS (NOTE - THESE ARE SUPPLIED AS PART OF THE COMPLETE STACK ASSEMBLIES LISTED ABOVE)							SPARES CATEGORY	220V SERIES - QUANTITY						400V SERIES - QUANTITY							
	COMPONENT TYPE	MFTR	MFTR P/N	VOLTAGE RATING	CURRENT RATING	ATG AIRPORTS STOCK CODE		1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	1.0kVA	2.5kVA	4.0kVA	5.0kVA	7.5kVA	10kVA	12.5kVA	15kVA
	IGBT	SEMIKRON	SKM75GB12T4	1200V	75A	2323-0207		2	2	2				2	2	2	2	2			
	IGBT	SEMIKRON	SEMiX 202GB12E4S	1200V	200A	2323-0215					2	2	2						2	2	2
	IGBT, DRIVER AND ADAPTER BOARD 2S COMPLETE SET	SEMIKRON	SEMiX 202GB12E4S, L6100102, L6100141	1200V	200A	2323-0216	B				2	2	2						2	2	2
	RECTIFIER DIODE MODULE	SEMIKRON	SKKD 81/14	1400V	80A	2270-0005		2	2	2				2	2	2	2	2			
	RECTIFIER DIODE MODULE	SEMIKRON	SEMIX 341D16S	1600V	340A	2270-0007	B				1	1	1						1	1	1
	CAPACITOR	ALCON	KPF 0.47uF/1250VDC	1250V DC		2195-0150		5	5	5	10	10	10	5	5	5	5	5	10	10	10
	COOLING FAN, 25A STACK	PPI	69-0036	220V AC		2570-0016	C	1	1	1				1	1	1	1	1			
	COOLING FAN, 60A STACK	PPI	69-0045	220V AC		2570-0017	C				1	1	1						1	1	1

Table 13-10 Parts List: IGBT stack and power card assemblies

DOOR SAFETY INTERLOCKS (OPTIONAL)									
REF	CCR OPTION CODES	QTY	COMPONENT TYPE	DESCRIPTION	RATING	MANUFACTURER	MFTR P/N	ATG AIRPORTS STOCK CODE	SPARE PART CATEGORY
ISOLATING SWITCH	DI (EG, AENA SPEC, SP)	6	ISOLATING SWITCH	LIMIT SWITCH	1A / 125V AC	OMRON	D3D-131	021020	
ISOLATING SWITCH	DI (EG, AENA SPEC, SP)	6	ISOLATING SWITCH	CONNECTOR HOUSING		JST	HLP-03V	021021	
ISOLATING SWITCH	DI (EG, AENA SPEC, SP)	12	ISOLATING SWITCH	CONNECTOR INSERT	18-22AWG	JST	SSF-21T-P1.4	021023	

Table 13-11 Parts List: Door interlocks



TRANSFORMER PRIMARY TAPPING CONNECTIONS		ACTUAL CCR SUPPLY VOLTAGE 400V	ACTUAL CCR SUPPLY VOLTAGE 415V
PRIMARY TAPPINGS TO BE USED	T101	380V	400V
	T102	415V	440V
	T105	415V	440V
	T112	400V	415V

NOTES.
1. CONTROL TRANSFORMER PRIMARY TAPS AS PER LOCAL SUPPLY VOLTAGE, EXCEPT FOR 400V SERIES – SEE TABLE ABOVE.
2. T101 PRIMARY TO BE TAPPED ONE STEP LOWER THAN ACTUAL LOCAL SUPPLY VOLTAGE.
   SOME CCR's USE A MAIN TRANSFORMER WITH A DUAL WOUND SECONDARY FOR 6.6/12A.
3. IF PLF OUTPUT VOLTAGE FROM T101 = 20V CONNECT WIRE 13 TO TERMINAL J2/6 ON AT733 & TERMINAL 1 ON AT923
   = 70V CONNECT WIRE 13 TO TERMINAL J2/7 ON AT733 & TERMINAL 2 ON AT923
4. IF THERMAL SWITCHES ARE NOT FITTED TO TRANSFORMER T101 CONNECT WIRE 15 WITH WIRE 14 ON THE PLF AUXILIARY WINDING TERMINALS.
5. 2 OFF FERRITE BEADS TO BE FITTED AS CLOSE TO THE FILTER AS POSSIBLE.
6. INPUT & OUTPUT LIGHTNING/SURGE ARRESTORS ARE FITTED AS STANDARD ON THE FAA BUILD CCR AND ARE OPTIONAL ON THE IEC BUILD.
8. IF THE AT1026 CUTOUT SWITCH RELAY PCB IS FITTED, WIRE 21 CONNECTS TO THE AT1026 TERMINAL 11.
9. AT1026 VOLTAGE SELECTOR LINK TO BE SET TO 24V,
10. IF DOOR INTERLOCK SWITCHES ARE NOT FITTED, CONNECT A WIRE LINK BETWEEN TERMINALS 3 & 4 ON THE AT1026 CARD
11. IF NEITHER INTERNAL NOR EXTERNAL CUTOUT INTERLOCK REED SWITCHES ARE USED, CONNECT A WIRE LINK BETWEEN TERMINALS 1 & 2 ON THE AT1026 CARD.
12. FIT THE APPROPRIATE OUTPUT SUPPRESSOR CARD ACCORDING TO THE MAXIMUM CCR OUTPUT VOLTAGE: AT764 UP TO 1150V (7.5kVA @ 6.6A, OR 15kVA @ 12A). AT765 UP TO 2300V (15kVA @ 6.6A).

REV	DATE	DESCRIPTION	DRN	CHK	APP
G	9-9-11	F3 & F4 Wiring Modified, 1 to 4 kVA 220V CCR Ref Removed	AJT	PAC	GC
H	9-12-11	RIO Card J2 Descriptions Modified - Wires 14 & 166 Added to PLF AT642	AJT	PAC	GC
J	27-5-14	ECN091 - AT712 J5-3,4,5,6 and J7-1,2,3,4, Function Modified	AJT	PAC	DM
K	15-9-15	Cutout Switch & Comms Board Modified, AT753 Surge Arrestor Added	AJT	PAC	APS
L	24-01-20	AT1026 CUTOUT SWITCH RELAY PCB ADDED.	AB	PAC	DJ
F	1-3-11	AT759A added - AT757A replaced by AT777A	AJT	PAC	AM

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CLIENT

TITLE
MICRO 200 CCR, 2.5 TO 7.5kVA 400V SERIES WITH 2 PHASE SUPPLY
- STANDARD WIRING DIAGRAM

PROJECT No.

SCALE N/A

DRG No. HS14-1-01-01 L

atg - A3

Figure 13-1 Micro 200 standard circuit schematic 2.5kVA to 7.5kVA, 400V series

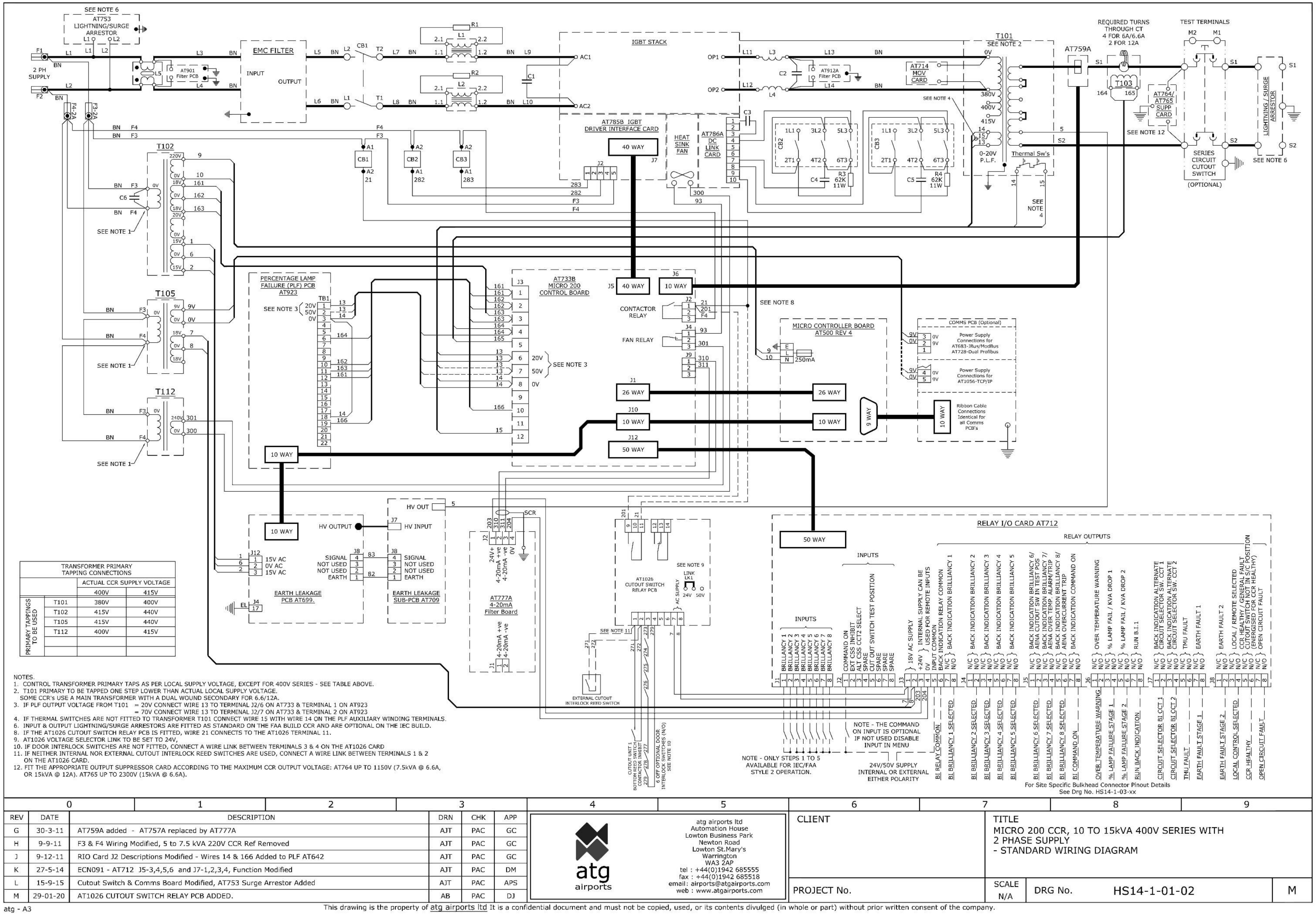

Figure 13-2 Micro 200 standard circuit schematic 10kVA to 15kVA, 400V series