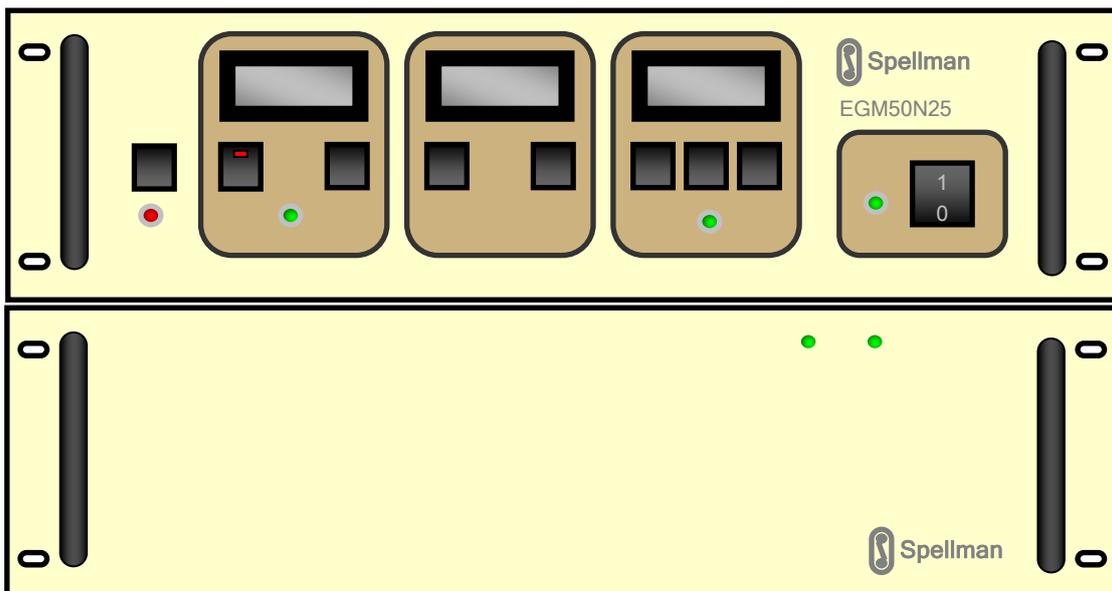




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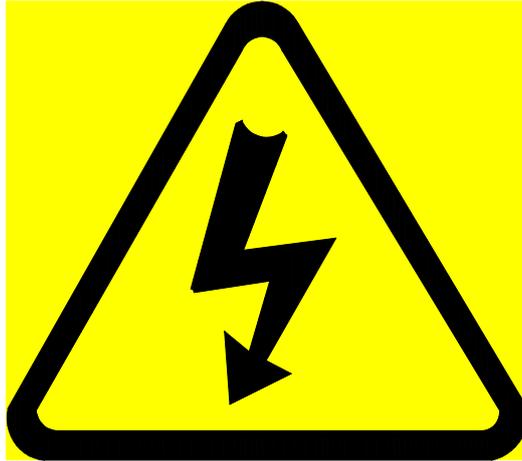
Operating Manual for EGM50N25 High Voltage Power Supply for Electron Gun Machines



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DANGER - HIGH VOLTAGE RISK OF ELECTRIC SHOCK

- **Observe extreme caution when working with this equipment.**
- **High voltage power supplies must always be grounded.**
- **Do not touch connections unless equipment is turned off and the capacitance of both the load and power supply are grounded.**
- **Allow adequate time for discharge of internal capacitance of the power supply.**
- **Do not ground yourself or work under wet or damp conditions.**

Servicing Safety

- **This unit is not user serviceable, return to supplier for repair/service.**

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1 Introduction

The EGM50N25 is a negative polarity, high stability, precision, high voltage power supply. It is designed to achieve and maintain very high output voltage stability <2.5ppm at very low ripple < 2ppm to allow its use in Electron Beam Lithography, Semiconductor inspection, Scanning Electron Microscopes and other exacting electron gun applications. The unit consists of two modules: A Control module to which the all of the low voltage external connections are made and a High Voltage module to which the output cable is connected. There is an umbilical cable which connects the two modules together.

The electrical configuration consists 3 output functions: -50kV accelerator supply with an integral floating filament supply (intended to drive an LaB₆ filament), and bias (grid) supply. The output of the unit is supplied via a 3 pin Standard Federal Connector.

Control of the unit can be achieved through either the front panel buttons on the Control module or by a remote computer via the RS232 serial link on the rear of the Control module. The simplified system block diagram is shown below :-

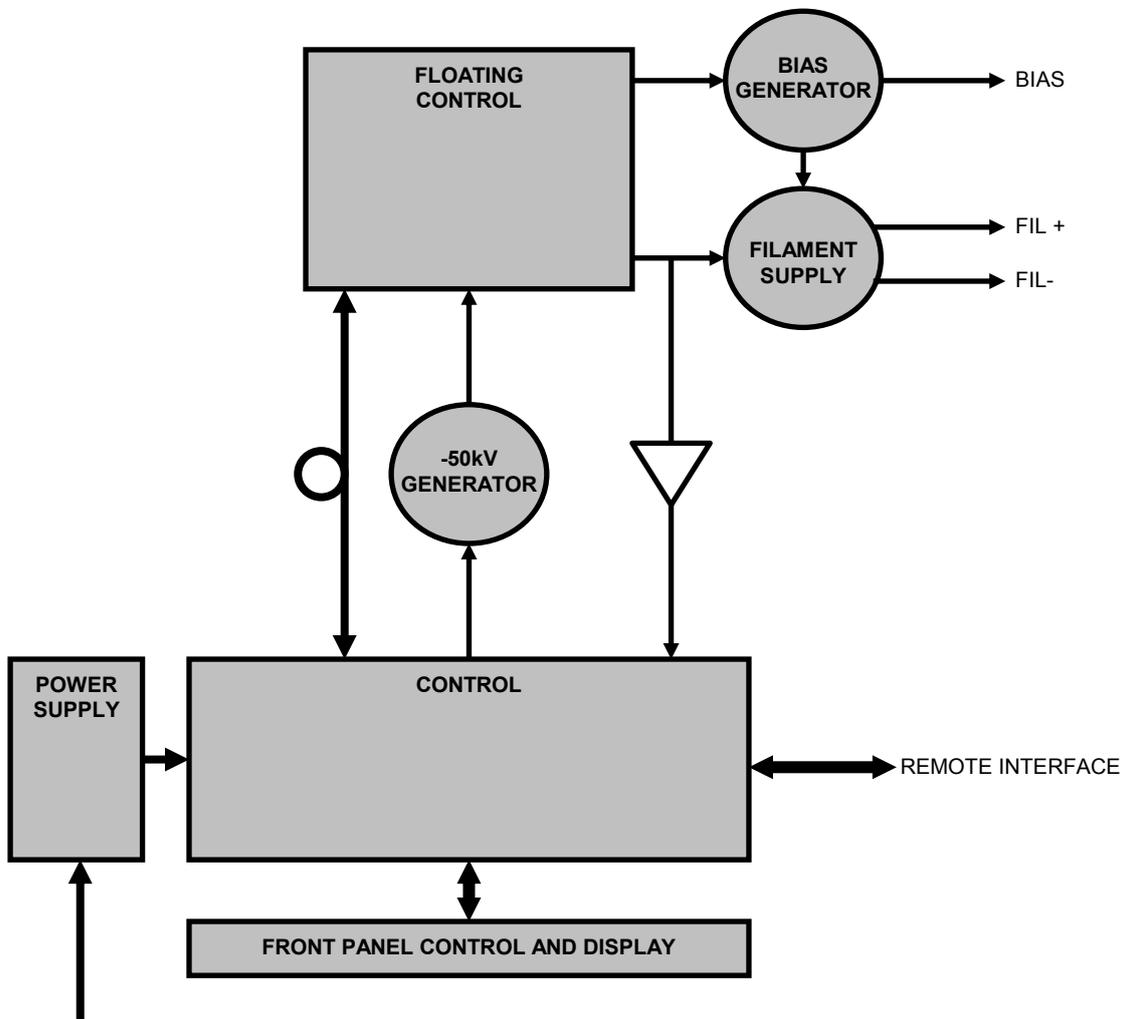


Figure 1 – Unit Block Diagram

2 Basic Specifications

For full specifications, refer to unit specification document 80562-1.

- Input Voltage 90VAC - 260VAC
- Beam Output
 - Voltage: -50kV adjustable to ± 1 kV (Ramp-up time: 60 sec).
 - Current: 0 – 500 μ A.
 - Stability: <2.0ppm/48h/0.5°C (20°C to 25°C)
 - Ripple: 1ppm
 - Load Regulation: 10ppm for 0 – 500 μ A
 - Line Regulation: 10ppm for a 10% line voltage change.
 - Protection: Output is protected against arc down and over current, the unit will perform a controlled shutdown after a specified number of arcs.
 - Impedance: ≥ 100 k Ω .
- Filament Output (centre tapped and floating on beam output)
 - Power: 8W max. adjustable in steps of 0.1W. Constant power controlled.
 - Load: 1-7 Ω
 - Ripple & Noise: <0.1% peak to peak (excitation frequency)
<50ppm (10Hz to 3kHz)
 - Load Regulation: <5% change in power over the range 2 to 7W, 1 ohm to 7 ohm
 - Line Regulation: <10ppm for 10% line change.
 - Protection: Protection against over current is provided in both hardware and software.
- Bias Output (Referenced to centre filament).
 - Range: Selectable between low voltage mode -200 to -1100V and high voltage mode -200 to -2000V. The range will be selected using a key switch located on the rear panel, this will only be enabled when the HV Beam is disabled.

The bias voltage will not exceed 2000V in high voltage mode or 1100V in low voltage mode even under arc conditions.
 - Temperature Coefficient: <100ppm/°C
 - Emission Current Regulation: <0.02% (@100 μ A)
 - Emission Control: 0 to 500 μ A (Adjustable in steps of 0.1 μ A).
 - Control Method: Emission current control can be selected between manual bias and automatic bias. In manual bias control the bias level is manually

adjusted to a fixed point. In automatic mode the system will control the bias to give a fixed emission current.

- Protection: Output is protected against arc down, the unit will perform a controlled shutdown after a specified number of arcs.

3 Installation

The unit has been designed fit into a standard 19 inch rack or freestanding on a bench or other stable surface. The two modules are stackable either way around. Each module can be fixed into a rack using the holes on the front panels.

Installation of the power supply should conform to the drawing below:

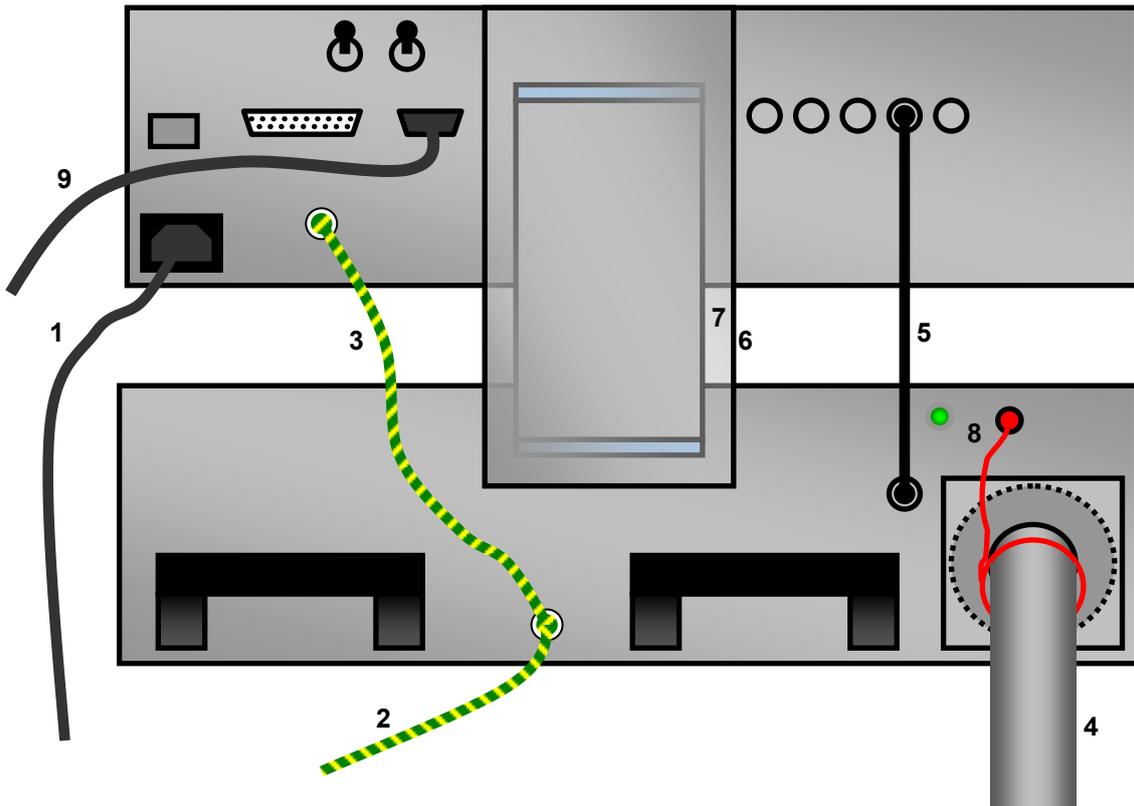


Figure 2 – Rear view showing cable connections.

1. IEC Main input cable.
2. Safety Earth. Size 4mm² or greater recommended. To be bonded to the system safety Earth or chassis.
3. Safety Earth connection between HV and Control modules.
4. HV output cable (Standard Federal Connector).
5. Micro-discharge interconnect cable.
6. Umbilical cable shield.
7. Umbilical cable.
8. Cable interlock.
9. System connector (contains an interlock connection).

4 Unit Functions

4.1 Front Panel Operation

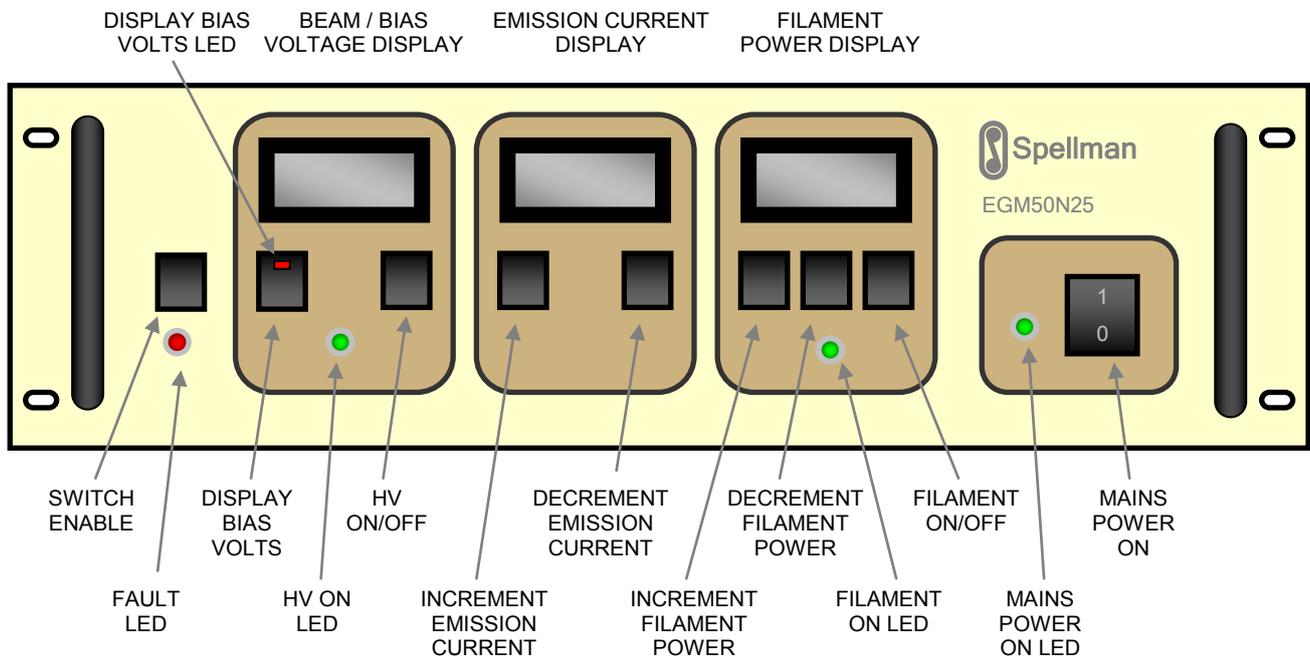


Figure 3 – Front Panel Features

4.1.1 LCD Displays

BEAM/BIAS VOLTAGE

Displays beam voltage in kV to a resolution of 0.01kV, displays bias voltage in kV to a resolution of 0.001kV when the 'DISPLAY BIAS VOLTS' LED is illuminated.

EMISSION CURRENT

Displays emission current to a resolution of 0.1 μ A.

FILAMENT POWER

Displays filament power to a resolution of 0.01W

4.1.2 Switches

SWITCH ENABLE:

This switch must be held on to operate 'HV ON/OFF' and 'FILAMENTON/OFF' switches. This is to prevent spurious operation of these functions.

DISPLAY BIAS VOLTS:

Toggles 'BEAM/BIAS DISPLAY' between beam voltage and bias voltage. The integral red led illuminates when the display shows bias voltage.

HV ON/OFF:

Enables/disables the beam supply.

INCREMENT EMISSION CURRENT:

Increases emission demand by 0.1 μ A. If the switch is held on, the emission demand will increase at faster rate.

DECREMENT EMISSION CURRENT: Decreases emission demand by 0.1 μ A. If the switch is held on, the emission demand will increase at faster rate.

FILAMENT ON/OFF: Enables/disables the filament supply.

MAINS POWER ON: Enables/disables mains power to the unit.

4.1.3 LED Indicators

DISPLAY BIAS VOLTS: Illuminates when the BEAM/BIAS display is indicating bias voltage.

FAULT: Illuminates when a fault has occurred.

HV ON: Illuminates when beam voltage is enables. This LED also flashes when the beam is ramping from 0 to 50kV.

FILAMENT ON: Illuminates when the filament is enabled.

MAINS POWER ON: Illuminates when the unit mains is switched on.

4.2 Rear Panel

There are a number of functions and ports on the rear panel of the control module.

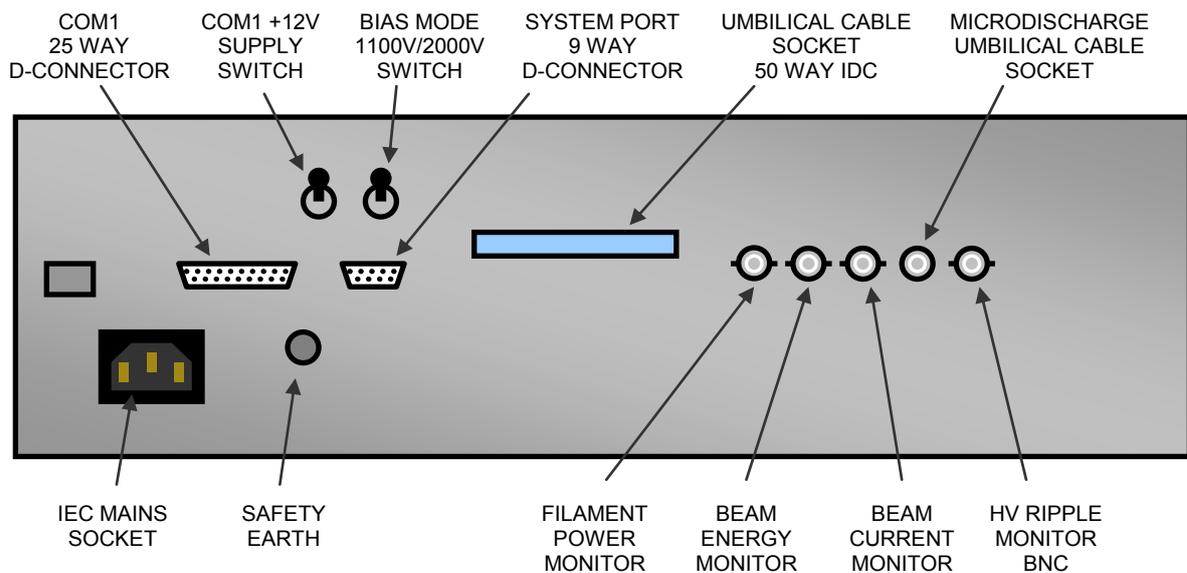


Figure 4 – Control Module Rear Panel Connections

4.2.1 Connectors

IEC MAINS SOCKET AC mains input.

SAFETY EARTH Primary Earth stud for Control module.

COM1 (25 WAY D) RS232 serial port, see Appendix 2 for protocol and commands.

SYSTEM PORT (9 WAY D)	Interface for remote interlock and HV ON output.
UMBILICAL CABLE SOCKET	Connection for Control to HV module umbilical cable.
MICRODISCHARGE SOCKET	Connection for Control to HV module micro-discharge umbilical cable.

4.2.2 Monitors (BNC Sockets)

FILAMENT POWER	Filament Power monitor Scale: 0.1V/W
BEAM ENERGY	Beam Voltage monitor. Scale: 1V/10kV
BEAM CURRENT	Emission Current Monitor. Scale: 1V/100 μ A
HV RIPPLE	Beam AC monitor. Gain: 1 (Unity)

4.2.3 Switches

COM1 +12V SUPPLY	Enables/Disables +12V supply on pin 9 of COM 1.
BIAS MODE 1100V/2000V	Maximum bias voltage selection 1100V/2000V. Bias mode changes are only possible when the beam energy is disabled.

5 Unit Operation

5.1 Interlocks

ALL INTERLOCKS MUST BE CLOSED BEFORE THE UNIT WILL ALLOW THE HIGH VOLTAGE AND FILAMENT POWER SUPPLIES TO BE ENABLED.

The unit interlock system consists of 3 interlocks which must be closed by the operator before the high voltage or filament functions will be unlocked for use.

5.1.1 Umbilical Cable

The 50 way IDC umbilical cable must be connected. If the cable is not fitted 'HV ERR' will be indicated on the front panel displays.

5.1.2 HV Cable Interlock

The red 4mm socket on the rear of the HV module must have a plug fitted to close the interlock chain. The red cable loop and plug assembly provided with the unit, should be fitted around the HV connector and plugged into the red INTERLOCK HV CONNECTOR socket. If this interlock is not made, the unit will be disabled and 'ILOC CAB' will be indicated on the front panel displays.

5.1.3 System Interlock

The system connector on the rear panel of the Control module has an interlock connection on pin 6. This pin must be linked to 0V to close this interlock, this can be done locally using a link on a mating connector or remotely by making the link through a host system interlock circuit or relay. If this interlock is not made, the unit will be disabled and 'ILOC SYS' will be indicated on the front panel displays.

5.2 Filament

The filament supply is constant power controlled, power will be supplied according to the demand power set on either the front panel or RS232 interface. The voltage and current supplied will be a function of the demand power and the load (filament) resistance up to the specified limits.

The filament may be enabled by the ON/OFF button and then controlled by the 'UP' and 'DOWN' buttons on the filament section of the front panel. The display will show the power demand for 3 seconds after each button press, before reverting to the actual level. The Filament can also be operated via RS232 serial commands as listed in Appendix 2.

5.3 Beam Energy

To enable the -50kV output, press the Beam ON/OFF button simultaneously with the SWITCH ENABLE switch. The output will ramp up to full output voltage in 60 seconds. The Beam On LED will flash whilst the output is ramping. The output may be adjusted by $\pm 1\text{kV}$ and enabled/disabled by means of the RS232 commands, see Appendix 2.

5.4 Emission Current

Set the emission current demand as required with the Emission Current UP/DOWN buttons, or by RS232 commands. Whilst the beam energy is off, the display will show '----'. Once the beam is enabled, the Emission Current display becomes active and the required current demand can be set. The emission current display will show the demand setting for 3 seconds after each button press, before reverting to the actual current display. The Emission Current can also be operated via RS232 commands as listed in Appendix 2.

5.5 Bias Voltage

The Bias voltage is regulated by the Emission Current control loop. The bias voltage is regulated such a stable emission current at the demand value is maintained. Monitoring is facilitated on the beam

energy display by pressing the DISPLAY BIAS VOLTS button. The LED indicator shows that this mode has been selected. The Bias Voltage can also be monitored via RS232 commands as listed in Appendix 2.

APPENDIX 1 - Interface Definitions

A1.1 SYSTEM '9-Way D' Male Connector Pin Connections

The 9Way System 'D' connector requires pins 5 and 6 to be connected before the unit can be operated. This allows for remote interlock features to be incorporated in the equipment.

Pins 1 and 9 of this connector are connected to the contacts of a relay which is enabled by the +24V control voltage rail. This may be used as a remote indication of whether the EGM is powered. The contacts will be closed whilst the EGM is powered.

PIN NO.	FUNCTION
1	PSU ON (Volts Free Contact)
2	unused
3	unused
4	unused
5	0V
6	Interlock (Link to 0V to Enable HV)
7	unused
8	Unused
9	PSU ON (Volts Free Contact)

A1.2 RS232 '25-Way D' Female Connector Pin Connections For Remote Control

PIN NO.	FUNCTION
1	Unused
2	Tx DATA
3	Rx DATA
4	RTS
5	CTS
6	Unused
7	0V
8	Unused
9	+12V Supply (Switch enabled from rear panel)
10 - 25	Unused

A1.3 High Voltage Output Connections

Orientation as viewed into the HV output socket.

CABLE	COLOUR	FUNCTION
LEFT	WHITE	Filament -ve
RIGHT	RED	Filament +ve
TOP	BLACK	Bias Voltage

APPENDIX 2 – Serial Interface

The RS232 commands below relate to communication to and from Tx DATA and Rx DATA on COM 1 (25-Way D).

A2.1 Rationale

Communications are implemented on a RS-232C serial link with the following configuration:

PROPERTY	PARAMETER
Baud Rate	9600bps
Data length	8 bit ASCII
Parity	No parity
Stop Bits	2 (two) stop bits

The interface circuits are not isolated from the chassis ground.

Messages all begin with a two character identifier followed by a single character operator.

The operators and their function:

OPERATOR	FUNCTION
=	Set the value of a variable. Followed by a value string.
+	Increment a value
-	Decrement a value
0	Set the Boolean 'FALSE' condition
1	Set the Boolean 'TRUE' condition
?	Query the value of a variable

- All strings are terminated with a carriage return (CR/ENTER) character.
- Any messages from the Remote Control Input will produce a response from the CPU.
- Queries will produce a message reporting the appropriate value.
- Increment and decrement commands will produce messages reporting the value of the associated variable.
- Boolean messages produce a response which echoes the received message i.e. the response will not contain any character (e.g. FLO<CR> gets the response FLO<CR>).

A2.2 Commands

A2.2.1 Incremental commands

COMMAND	FUNCTION
BE+	Increment Beam Energy (EHT) trim value
BE-	Decrement Beam Energy (EHT) trim value
EC+	Increase Emission Current Demand by 0.1uA
EC-	Decrease Emission Current Demand by 0.1uA
FL+	Increments Filament Power Demand by 0.1W
FL-	Decrements filament Power Demand by 0.1W

A2.2.2 Enabling commands

COMMAND	FUNCTION
BE0	Disable Beam Energy
BE1	Enable Beam Energy
EC0	Set Emission Current Demand to Zero
FL0	Disable Filament Supply
FL1	Enable Filament Supply
CO1	Set Coarse Control ON (applies to Beam Energy trim only)
CO0	Set Coarse Control OFF
FP0	Lock Front Panel Controls
FP1	Unlock Front Panel Controls
DV1	Display Bias Voltage
DV0	Display Beam Energy
MB1	Selects Manual Bias Control
MB0	Selects Automatic Bias Control

A2.2.3 Query Commands

COMMAND	FUNCTION
BE?	Report Beam Energy
EC?	Report Emission Current
ED?	Report Emission Current Demand Level
FI?	Report Filament Voltage and Current
FL?	Report Filament Power
FO?	Report Filament Enable Status (10N, OOFF)
FV?	Report Filament Demand Level
BV?	Report Bias Voltage
IR?	Report Interlock Status (IOPEN, OCLOSED)
TP?	Report Feedback Assembly Temperature
ID?	Report Software Version
SP?	Request Temperature Set-Point Value
FI?	Report Filament voltage and current values.
SN?	Request unit's serial number
SD?	Request date and time (format YYYY:MM:DD:HH:MM:SS)

A2.2.4 Assign Commands

COMMAND	FUNCTION
EC=xxxx	Set Emission Current demand to xxxx, where xxxx is 4-digit hexadecimal. 0000h to FFFFh corresponds to 0 to 500uA,
SN=Cxxxxx-xxx	Set unit serial number
SD=YYYY:MM:DD:HH:MM:SS	Set date and time.
TP=xxxx	Set Feedback Target Temperature in Deg C, where 0014<xxxx<0046 is 4 digit Hexadecimal. (20 – 70 deg C)