MPT5839 Series
Direct Switching Solid-State Modulator

DESCRIPTION

The MPT5839 Series is a range of fully integrated, compact, direct switching, high voltage solid-state modulator systems.

They are specifically designed to drive any of the e2v technologies range of linac magnetrons, and utilise e2v technologies' patented AMM solid-state modular technology.

The modulator, when combined with an e2v technologies linac magnetron, provides a reliable, high energy, pulsed microwave source from a prime power input.

The system is constructed in two sub-assemblies: the Modulator Assembly, housing the high voltage switch, energy store and magnetron filament isolation transformer, and the High Voltage Power Supply and Control System.

The assemblies are designed to operate during rotation through most orientations. For fixed operation the recommended orientations are shown in Figure 1. For further information, contact e2v.

MAXIMUM RATINGS

Electrical (see note 1)

Output power (peak)	13.75	MW
Output power (mean)	10	kW
Peak output voltage	55	kV
Peak output current	240	A
Heater current (see note 2)	15	A dc
Heater voltage (see note 2)	20	V dc
Heater power (see note 2)	270	W
Pulse width (user controlled)	1.5 to 5.0	µs
Pulse repetition frequency	6 to 1000	Hz
Prime power (3-phase and neutral), 50/60 Hz	440	V

Environmental

	Min	Max	
Temperature range:			
operating	+10	+50	ºC
storage	-25	+70	ºC
Relative humidity (non-condensing):			
for ambient up to 31 ºC	-	80	% max
for ambient up to 45 ºC	-	20	% max
Vibration (20 to 200 Hz)	-	4	g
Shock (11 ms, half-sine)	-	25	g

The unit is capable of operating in a low pressure environment, down to 700 mbar.

Cooling Requirements

Ambient free flow of air to the high voltage power supply.

Cooling liquid (water) in the temperature range 10 ºC to 30 ºC for full power operation or operation for extended periods.

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ELECTRICAL INPUT CHARACTERISTICS

	Min	Typ	Max	
Input 3-phase supply	360	400	440	V rms
Supply frequency	47	50	63	Hz
Supply current per phase	-	-	30	A rms
Inrush current per phase	-	-	30	A rms
Power factor	0.9	-	-	
Single-phase supply	220	-	250	V rms
Single-phase current	-	-	3.5	A rms
Earth leakage current	-	-	3	mA

TYPICAL OPERATING CONDITIONS

Anode voltage	52	kV
Anode current	220	A
Pulse length	3.5	µs
Pulse repetition frequency	200	Hz
Rate of rise of voltage	180	kV/ms
Heater current (see note 2)	13	A dc
Heater voltage (see note 2)	13	V dc
Heater power (see note 2)	170	W

PULSE PERFORMANCE PARAMETERS

	Min	Typ	Max	
Pulse current ripple/droop (see note 3)	-	2.0	-	%
Pulse current overshoot	-	-	5.0	%
Peak current rise time (10 - 0%)	-	0.2	-	µs
Peak current fall time (90 -10%)	-	-	1.0	µs
Voltage fall time (90 - 50%)	-	-	3.0	µs
Voltage fall time (to 10%)	-	-	15	µs
Back-swing voltage	-	0	10	kV
Amplitude jitter (pulse to pulse)	-	-	0.1	%
Warm-up variation (0 – 2 s)	-	-	3.0	%
Long-term stability	-	0.1	-	%

NOTES

1. Ratings do not all apply simultaneously.
2. The heater supply is current controlled, with automatic turn-down determined by the magnetron type and mean power.
3. Droop at 120 A. This is a function of operating level and pulse width.

MECHANICAL

Overall dimensions (maximum) W x H x L:		
modulator	340 x 530 x 985	mm
power and control unit (19" rack)	311 x 483 x 541	mm
Net weights:		
modulator	106	kg
power and control unit	70	kg

MODULATOR INTERFACE

Electrical Output Interface

The modulator-magnetron interface connections mounted on an insulated output plate shall be mounted within an RF-tight enclosure with the magnetron side arm, for maximum RFI screening.

Monitoring of the magnetron peak voltage and current is built in to the system and provided to the user on BNC available on the rear of the control unit.

	Scale	Connector
Peak voltage monitor	10 kV/1 V	BNC
Peak current monitor	100 A/1 V	BNC
Filament voltage via	RS485 (opt)	D-type
Filament current via	RS485 (opt)	

The MPT5839 manual contains further details of the control system interface including status information, trips and options.

Guidance on specific mounting and interface arrangements is available on request.

Electrical Input Interface

Termination of the three-phase mains supply is via terminals on the high voltage power supply.

The control interface provides the following functions:

a) Standby power on/off.

b) Heaters on/off.
Current control pre-set with filament turn-down requirements.

c) HV pulse on/off.
Control of peak anode current amplitude via analogue voltage as default.

d) Provision for external input of pulse width and pulse repetition frequency.

e) Interlock/fault status.

f) Provision for remote/local control (RS485).

Interlocks and Fault Indication

a) Separate external interlocks to prevent HV operation for both local and remote operation unless safe to do so.

b) Heater interlock to prevent HV pulse operation during a pre-set interval following application of the heater power. The heater interlock interval is started on detection of heater current.

c) The magnetron arc detector inhibits HV pulse operation after a pre-set number of arcs for a short period of time.

The modulator is self-protecting under normal operating and fault conditions, including magnetron arcing, excessive duty and component overheating.

Provision is made for both local and remote indication of all interlocks.

HEALTH AND SAFETY HAZARDS

e2v technologies devices are safe to handle and operate, provided that the relevant precautions stated herein are observed. e2v technologies does not accept responsibility for damage or injury resulting from the use of electronic devices it produces. Equipment manufacturers and users must ensure that adequate precautions are taken. Appropriate warning labels and notices must be provided on equipments incorporating e2v technologies devices and in operating manuals.

High Voltage

Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored charges before allowing access. Interlock switches must not be bypassed to allow operation with access doors open.

RF Radiation

Personnel must not be exposed to excessive RF radiation. All RF connectors must be correctly fitted before operation so that no leakage of RF energy can occur and the RF output must be coupled efficiently to the load. It is particularly dangerous to look into open waveguide or coaxial feeders while the device is energised. Screening of the cathode sidearm of high power magnetrons may be necessary.

X-Ray Radiation

High voltage magnetrons emit a significant intensity of X-rays not only from the cathode sidearm but also from the output waveguide. These rays can constitute a health hazard unless adequate shielding for X-ray radiation is provided. This is a characteristic of all magnetrons and the X-rays emitted correspond to a voltage much higher than that of the anode.

ADDITIONAL HV SAFETY

The following access interlocks shall be provided if required:

a) All capacitors shall be fitted with a means of removing the stored energy to below 50 V after one minute from removal of the energising source. This may be accomplished by a bleed resistor or active dump.

b) All HV parts shall be mounted within a grounded enclosure and all connections to HV components shall be made with HV shielded cable.

c) Non-current carrying metal parts shall be grounded.

d) Access to voltages of 50 V dc or 25 V ac shall be controlled by a physical barrier.

Figure 1

When operating the modulator in a fixed position, see recommended orientations below.
For further information, contact e2v.