

Microwave Power Solutions



MICROWAVE POWER SOLUTIONS

Microwave Power Solutions is the complete set of high power microwave products developed and provided by the Leonardo team based in Palermo since 1956, for the production of high power vacuum electronic devices. In the 90s the product range was expanded with the introduction of chip and wire technology for microwave microelectronics hybrid integrated circuits, modules and sub-assemblies.

Today an extensive expertise in the development and production of state-of-the-art TWTs, mini TWTs, Microwave Power Modules (MPM), TWT-A (TWT Amplifiers) and Solid State Power Amplifiers (SSPA) is available for Airborne, Surface, Missile and Space platforms for the Defense and Aerospace Market.

Microwave Power Solutions from Leonardo have been provided in the four continents for Radar, Security, Surveillance, EW & ESM, Instruments and Communication systems.

TECHNOLOGIES AND CAPABILITIES

Key high power vacuum device technology includes:

- > Vacuum technology including brazing, RF induced and resistance welding
- > Etching and plating
- > Manual and automated microwave high power CW and pulsed testing
- > Facilities for inspection, including CNC contactless equipment and SEM electronic microscope.

Key Microelectronic technology includes:

- > Fully automated epoxy (and other adhesive) dispensing automatic eutectic attach
- > Die placement and wire bonding
- > Advanced microwave module assembling
- > Automatic testing.

MAGNETRONS AND COUPLED CAVITY TWT

World class design expertise of Magnetrons and Coupled Cavity TWT. Leonardo Microwave Power Solution is among the few players worldwide that still design, develop and produce such Tubes, among legacy products worth to mention:

- > Magnetron X-Band with 4kW peak output power 1.0 % duty cycle;
- > Coupled Cavity TWT C-Band, X-Band and Ku-Band with peak output power up to 120KW;

These tubes are ideal for several different application such as:

- > Seekers and threat simulators;
- > SAR (synthetic aperture radar) for standoff airborne application or EO (earth observation) space payloads;
- > ATM (Air Traffic Management) systems and weather forecast ground radar.

X-Band Magnetron and C-Band, X-Band, Ku-Band CC TWT for:

- > Seekers and threat simulators
- > Airborne Radar
- > Ground/Shipboard Radar



Type	Frequency Range	Peak Output Power	Heater voltage (preheat & Operate)	Peak Anode Voltage	Peak Anode Current	Duty Cycle	Cooling
ET2127	8900 to 9300 MHz	4 kW	5 V	5 kV	2.5 A	0.8% max	Free convection

Type	Frequency Range	Peak Output Power	Cathode voltage	Cathode current	Duty Cycle	Cooling	Focussing
ET948	5.3 to 5.8 GHz	120 kW	-46 kV	14.5 A	8% max	Liquid	solenoid
ET960	8.5 to 9.5 GHz	12 kW	-22 kV	4 A	2.7% max	Forced air	PPM
ET961	8.6 to 9.5 GHz	20 kW	-26 kV	6.5 A	1.5% max	Forced air	PPM
ET964	10.8 to 11.8 GHz	10 kW	-23.5 kV	3.9A	2.7% max	Forced air	PPM
ET967	9 to 10 GHz	12 kW	-25 kV	3.4 A	10.5% max	Liquid	PPM
ET2980	16.5 to 17 GHz	13.5 kW	-29 kV	2.1 A	2.7% max	Liquid	PPM



HELIX TRAVELLING WAVE TUBE (HX TWT)

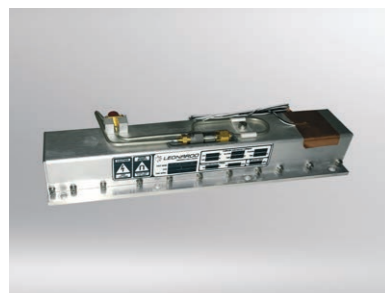
X-Band, K-Band, Ku-Band HELIX TWT for:

- > Surface and Airborne Radar
- > Missile Seeker
- > Electronic Counter Measure



Type	Frequency Range	Power Output	Cathode Voltage	Cathode Current	Duty Cycle
ET3201	1 to 2 GHz	280 W	- 3.6 kV	475 mA	CW
ET3301	2 to 4 GHz	250 W	- 4.2 kV	450 mA	CW
ET3407	4 to 8 GHz	280 W	- 8 kV	320 mA	CW
ET3602	27.5 to 29.5 GHz	100 W	- 12 kV	115 mA	CW
ET6305	3.1 to 3.5 GHz	9 kWpk	-14.6 kV	3.2A	2.5% max
ET6404	5.5 to 9.5 GHz	2 KWpk	-9.2 kV	1.6A	10% max
ET6510	8 to 16 GHz	2 KWpk	- 10.7 kV	1.7A	2 % max
ET6512	8.5 to 10.5 GHz	2 KWpk	- 10.9 kV	1.5A	6 % max
ET6529	9.5 to 10.0 GHz	4 KWpk	-12 kV	1.5A	6 % max
ET6535	8.6 to 9.5 GHz	1.5kW pk	-8 kV	1.3 A	10%

MINI HELIX TWT & FOLDED TWT



Type	Frequency Range	Power Output	Cathode voltage	Cathode Current	Duty Cycle	Control Electrode
ET3554	6 to 18 GHz	100W	-4.5 kV	200 mA	up to CW	Grid
ET3556	6 to 18 GHz	100W	-4.5 kV	200 mA	up to CW	FOCUS
ET3580	4.5 to 18 GHz	150W	-4.5 kV	230 mA	up to CW	Focus
ET5515	13.5 to 14.0 GHz	370 Wpk	-8.9 kV	250 mA	25% max	Grid
ET5530	9 to 9.8 GHz	300W	-8.5 kV	270 mA	20% max	Grid
ET5710	34 to 36 GHz	500W	17÷20	250	30%	Grid
ET9900	34 to 36 GHz	900W	18 ÷ 21	650	10%	Grid

(*) Preliminary data

MICROWAVE POWER MODULE (MPM)

The Microwave Power Module is a microwave amplifier which includes: the mini TWT, the solid state amplifier and gain equalizer, the RF input and output network and the Electronic Power Conditioner.

All the parts are packaged into a single compact, lightweight housing. With respect to traditional TWT-Amplifiers, the MPM is much smaller, lighter, more efficient, with significant noise reduction.

Based on proprietary novel potting-free concept the HVPS (High Voltage Power Supply) results in high reliable module and very light weight and an easy concept for life cycle support and maintenance.

APPLICATIONS FOR SURFACE, MISSILE OR AIRBORNE PLATFORMS

- > EW equipment
- > Test and measurement equipment
- > Commercial and military radars

KEY FEATURES

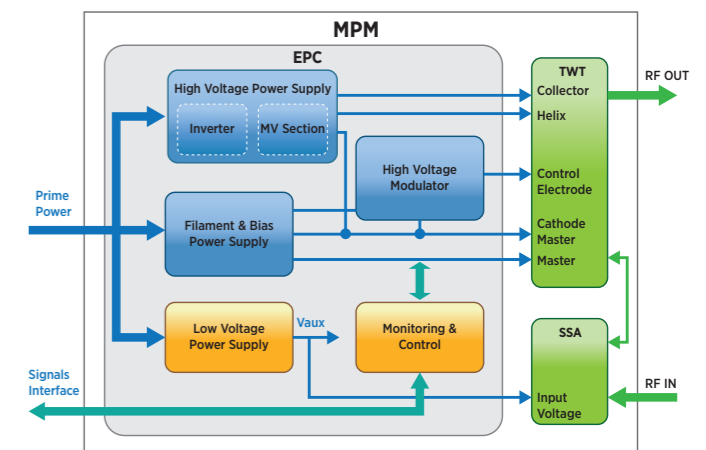
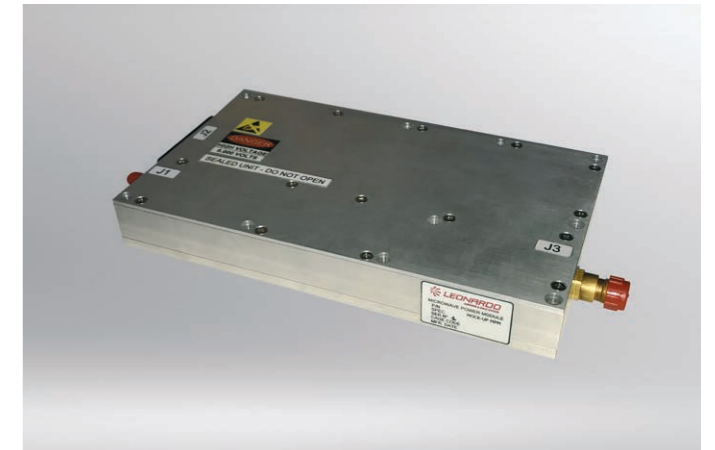
The amplifiers are designed for:

- > 70 dB typical small signal gain
- > -40°C to +90°C operating baseplate temperature (TBP)
- > Output power flatness 1dB (typ.)
- > -35dBm/MHz noise power density (typ.)

Unit is conductively cooled through baseplate and HVPS is hermetically sealed.

All the amplifiers are very compact, light weight 270 V DC Nominal input (other can be arranged) rack mount available.

Type	Frequency Range	Power Output	Dimensions/Weight	Duty/PRF	Input Voltage
MPM3502	6 to 18 GHz	100W	280x200x38mm / 3.5kg	Up to CW / 250kHz	270VDC
MPM3503	6 to 18 GHz	120W	210x120x27 mm / 1.85kg	Up to CW / 10kHz	270VDC



SOLID STATE POWER AMPLIFIER (SSPA)

Leonardo solid state power amplifiers are based on gallium nitride (GaN) monolithic microwave integrated circuit (MMIC) provided in an environmentally sealed compact light weight mechanical housing. Output power is saturated, in the same enclosure several different output power levels are available, the efficiency of these SSPAs is outstanding because the amplifiers are based on a proprietary novel power combining network that enable the compact outline and light weight.

APPLICATIONS FOR SURFACE, MISSILE OR AIRBORNE PLATFORMS

- › Commercial and military radars
- › Test and measurement equipment

KEY FEATURES

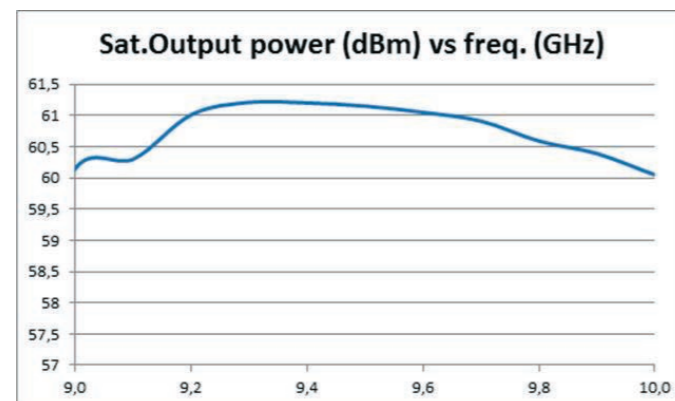
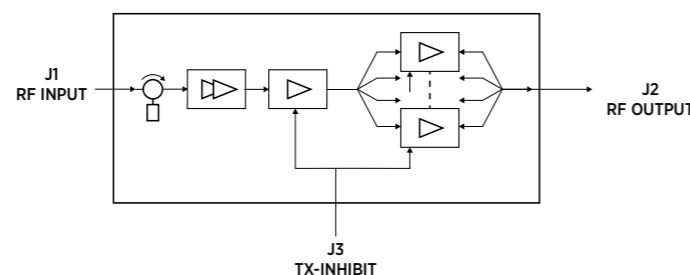
- The amplifiers are designed for:
- › 70 dB typical small signal gain
 - › -40°C to +70°C operating baseplate temperature (TBP)
 - › Output power flatness 1dB (typ.)
 - › -30dBm/MHz noise power density (typ.)
 - › Very long pulse width

- Several control bits are available.
- › Status and control interface 5V TTL compatible
 - › Internal thermal regulation
 - › Over-temperature protection
 - › Alarm status communicated via Control connector

Unit is conductively cooled through baseplate and hermetically sealed

All the amplifiers are very compact 177,8mm x 228,6mm x 40,2mm, weight, less than 4kg
28 V DC Nominal input (22-33 V)
rack mount available.

Type	Frequency Range	Power Output	Dimensions/Weight	Duty	Input voltage
MHXA017	X-Band (9 to 10 GHz)	700W	228,6mm x 177,8mm x 40,2mm / 5kg	25%	28VDC
MHXA019	X-Band (9 to 9,55 GHz)	600W	228,6mm x 177,8mm x 40,2mm / 3kg	1%	28VDC
MHXA020	X-Band (9 to 10 GHz)	500 W	228,6mm x 177,8mm x 40,2mm / 3,5 kg	20%	28VDC
MHXA022	X-Band (8,5 to 11 GHz)	120 W	228,6mm x 177,8mm x 30,5mm / 1,5 kg	25%	28VDC
MHXA024	X-Band (9 to 10 GHz)	1000 W	228,6mm x 177,8mm x 40,2mm / 4kg	15%	28VDC
MHXA026	X-Band (9 to 10 GHz)	2000 W	350mm x 250mm x 150mm / 8kg	10%	28VDC
MHXA027	X-Band (8,5 to 11 GHz)	700 W	228,6mm x 177,8mm x 40,2mm / 4 kg	15%	28VDC

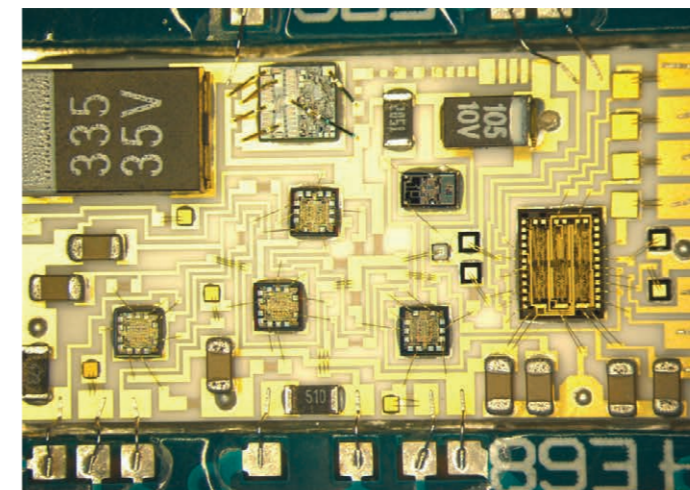


MICROELECTRONICS

- › State-of-the-art design expertise in μ W solid-state hybrids: multi-assemblies and front-ends
- › Up-to-date facilities for hybrids manufacturing including fully automated manufacturing line and RF testing capabilities for modules up to 40GHz.
- › Cutting edge expertise for Active Electronically Scanning Antenna Components.

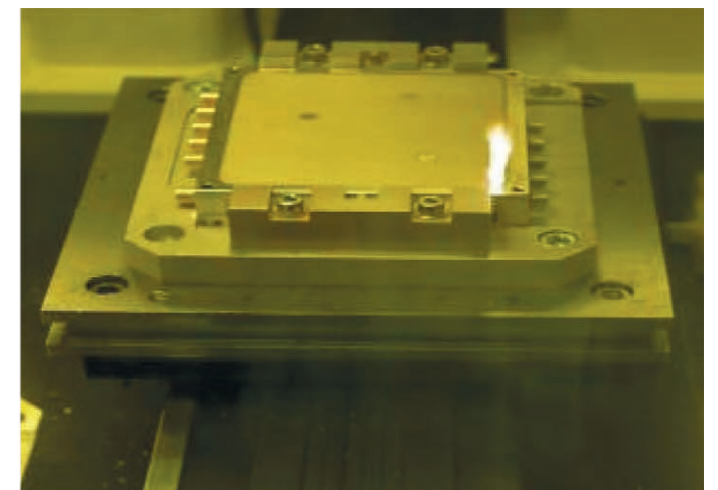
ACTIVE PHASED ARRAY ANTENNA TECHNOLOGY

- › Active Components
- › Compact Receivers
- › Multifunction Hybrids (HPA, TTD, Switch matrix, etc...)
- › Antenna Subsystem (Planks, Panels & Manifolds)



RADAR AND EW COMPONENT AND SUBSYSTEM

- › Front end and pedestal components
- › Receiver, Exciter, Processor components
 - › Down converter (up to 2 conversion)
 - › Up converter (up to 2 conversion)
 - › Stretch module for de-ramp-on-receive SAR mode
 - › Synthesiser: Very low phase noise, fast switching
 - › Exciter and LO distributor
 - › Compact Receiver/Exciter
- › Seeker, AOA/RW Receiver
 - › Multifunction Hybrids
 - › Broadband front end and receiver
 - › Very wide band assembly
 - › Front end amplifier and receiver
 - › Fast switching synthesiser
 - › Transceiver.



MHXA024

9 GHZ TO 10 GHZ, 1KW POWER AMPLIFIER

FEATURES

- > 9 GHz to 10 GHz
- > 60.5 dBm typical saturated RF output power (POUT)
- > 15% duty cycle max
- > 70 dB typical small signal gain
- > -40°C to +70°C operating baseplate temperature (TBP)
- > Power consumption 550W typical @10%
- > Output power flatness 1dB (typ.)
- > -30dBm/MHz noise power density (typ.)
- > Status and control interface 5V TTL compatible
- > Internal thermal regulation
- > Over-temperature protection
- > Alarm status communicated via Control connector
- > Conductively cooled through baseplate
- > Hermetically sealed
- > Very compact 177,8mm x 228,6mm x 40,2mm
- > light weight, less than 4kg
- > 28 V DC Nominal input (22-33 V)
- > rack mount available.



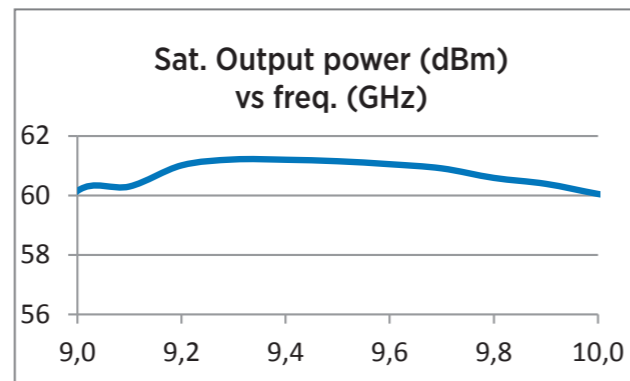
APPLICATIONS

- > Commercial and military radars
- > Test and measurement equipment

GENERAL DESCRIPTION

The MHXA024 is a **1kW peak** solid state power amplifier based on gallium nitride (GaN) monolithic microwave integrated circuit (MMIC) that operates between 9 GHz and 10 GHz, provided in an environmentally sealed chassis.

Other DC Supply configuration can be arranged.



SPECIFICATIONS

POWER = 28 VDC, overt operating temperature (baseplate -40°C to +70°C).

Min values refer to item performance in worst case condition (over temperature/frequency/duty/pulse width).

PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS/COMMENTS
Frequency Range	9.0		10	GHz	
GAIN					
Small Signal Gain	65	70	75	dB	Pin=-25dBm
Power gain		58.5		dB	Pin=0dBm
RF OUTPUT					
Saturated Output Power (PSAT) over					Pin=0dBm see figure 1 for typical Saturated output power over frequency
Droop@128usec			1	dB	
Droop@256usec			1.5	dB	
Noise Figure		7	10	dB	
Spurious		-90	-50	dB	
Harmonics		-30	-20	dBc	
Over pulse protection		350		usec	
TX INHIBIT					
High (VINH)		3.4 to 5.0		V	
Low (VINL)		0 to 0.8		V	
ON/OFF TIME		0.2	0.3	µsec	From rising/fall edge of EN/DISABLE to RF
Propagation delay			10	nsec	
Pulse width			256	usec	
Duty Cycle			15	%	
Cold Start		0.5		msec	From dc applied to PS_OK high. Standby
Supply Voltage					
Input Voltage	+22	28	33	VDC	MIL-STD-704D
Output VSWR			1.4:1		
Load VSWR (without damage)			2.0:1		
Weight			4	Kg	
Size					228,6mm x 177.8mm x 40.2mm, see figure 3.

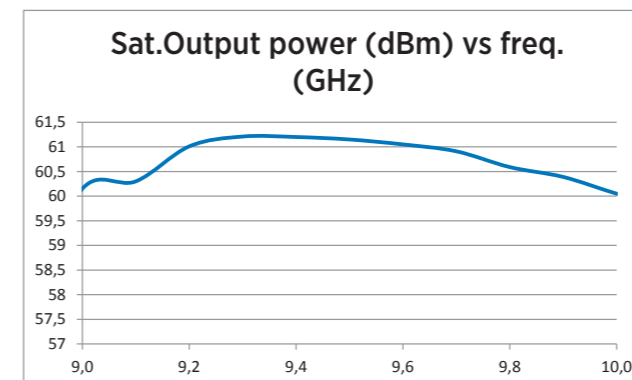



Figure 1. Typical saturated output power @ +25°C !0% duty 256µsec pulse width.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING
> RF Input (RF IN) Power	5 dBm
> Operating Temperature	-40°C to +70°C
> Storage Temperature	-40°C to +85°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

ESD CAUTION



ESD (electrostatic discharge) sensitive device.
Charged devices and circuit boards can discharge without detection. Although this product feature patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

CONNECTORS CONFIGURATION AND FUNCTION DESCRIPTIONS

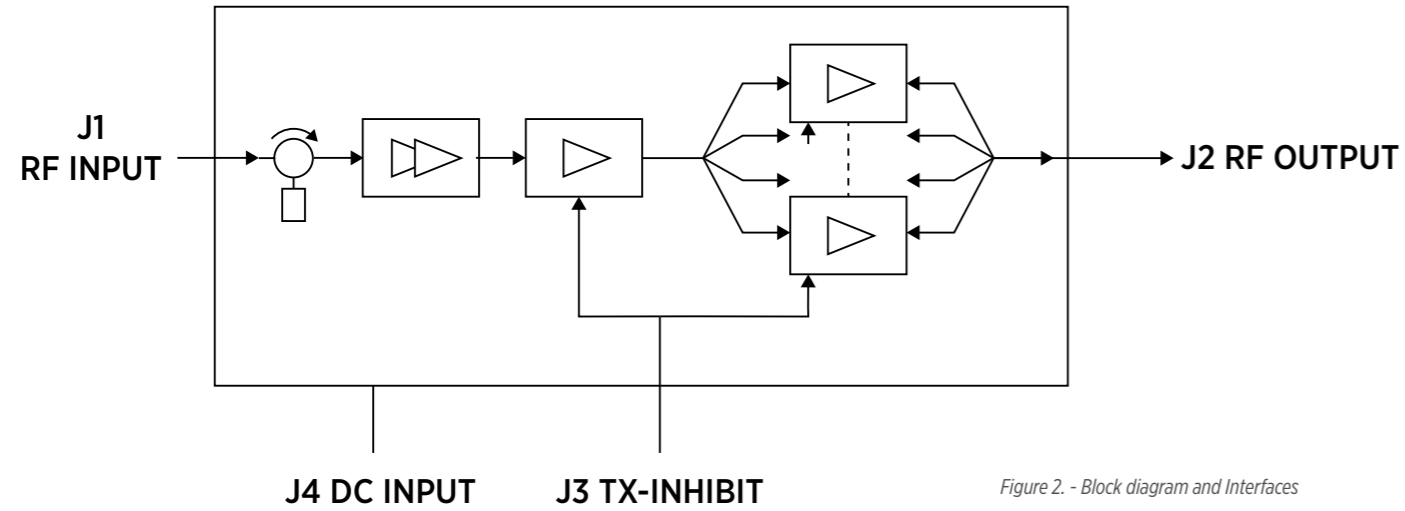


Figure 2. - Block diagram and Interfaces

CONNECTORS FUNCTION

CONNECTOR CONFIGURATIONS

CONNECTOR NO.	MNEMONIC	DESCRIPTION
> J1	RF IN	RF Input. This connector is ac-coupled and matched to 50 Ω.
> J2	RF OUT	RF Output. This connector is ac-coupled and matched to 50 Ω.
> J3	CONTROL	Alarm and Command Interfaces. See Table 4 for pinout.
> J4	+28 VDC	Supply Voltage Connector. See Table 5
> Chassis		GND

CONNECTOR 4 PIN DEFINITION

PIN	NAME	HPA INPUT OR OUTPUT	DESCRIPTION
> 1	TX INHIBIT	TTL INPUT	LOW = STANDBY (RF AMP OFF) HIGH = ENABLED (RF AMP ON)
> 9	ground	NA	GROUND
> 2 to 7 & 10 to 15	Reserved for manufacturer service pin	Reserved for manufacturer, service pin	Reserved for manufacturer, service pin

CONNECTOR 1 PIN DEFINITION

PIN	DESCRIPTION
> A1	28 Vdc Ret (-)
> A2	28 VDC FWD (+)
> 1, 2, 3, 4, 5	N.C.

CONNECTOR TYPE

CONNECTOR NO.	MNEMONIC	DESCRIPTION OR PART NUMBER
> 1	+28 VDC	DAMM7W2P
> 2	RF IN	SMA-F
> 3	RF OUT	WR-90 low profile
> 4	CONTROL	MIL-C-83513/04B

MECHANICAL DATA

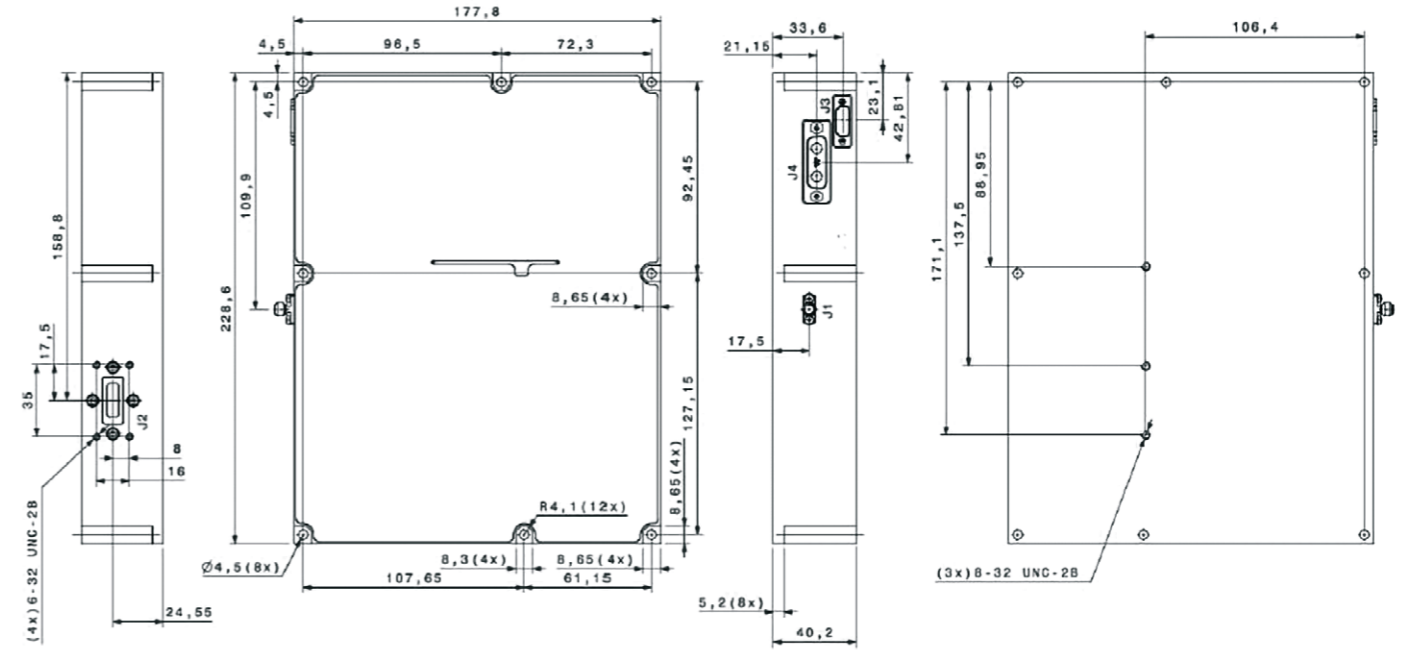
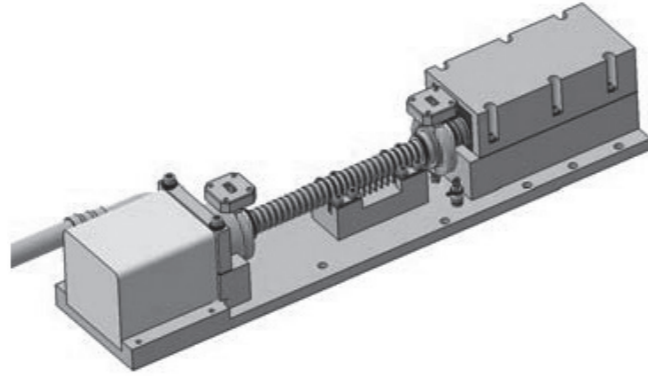


Figure 3 - Dimnesions

ET3702A HIGH POWER 34 ÷ 36 GHz TWT

FEATURES

- > 34 to 36 GHz Band
- > 150 W Output Power
- > 30 dB Gain
- > High duty pulsed
- > Helix type tube
- > PPM focused



ELECTRICAL DATA

RF PERFORMANCE (TYPICAL)

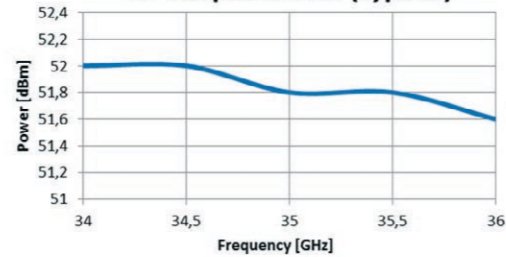
> Frequency range	34 to 36 GHz
> Output power	51.2 dBm min, see graph
> Input drive power	23 dBm max
> RF Gain	28 dB min, see graph
> Input VSWR (cold)	2.5 :1 max
> Output VSWR (cold)	2.5:1 max
> Duty Cycle	40% max

TYPICAL POWER SUPPLY REQUIREMENTS

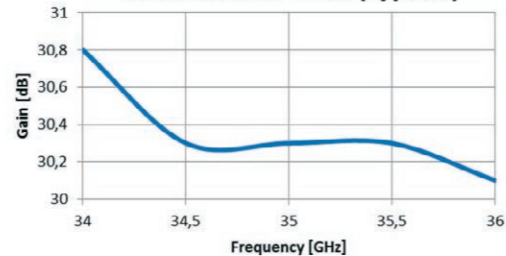
> Cathode voltage	-13kV
> Cathode current	170 mA max
> Anode voltage	1000 V
> Anode current	1 mA max
> Helix current	20 mA max
> BFE voltage:	-400 V (beam OFF) 0V (beam ON)
> BFE current	1 mA max
> Collector Voltage	50% of Cathode voltage
> Collector Current	170 mA
> Heater voltage	5 ÷ 6 Volt
> Heater current	1.3 A
> Power Consumption	1000 W max

Note: all voltages are referenced to cathode, except the cathode and anode which are referenced to ground.

RF Output Power (typical)



Saturated RF Gain (typical)



PHYSICAL DATA

MECHANICAL

> Dimensions:	260 (L); 70 (W); 50 (H) (mm, including connectors)
> Weight	1.5 kg max
> Cooling	Conduction
> RF input interface	WR-28 flat flange
> RF output interface	WR-28 flat flange

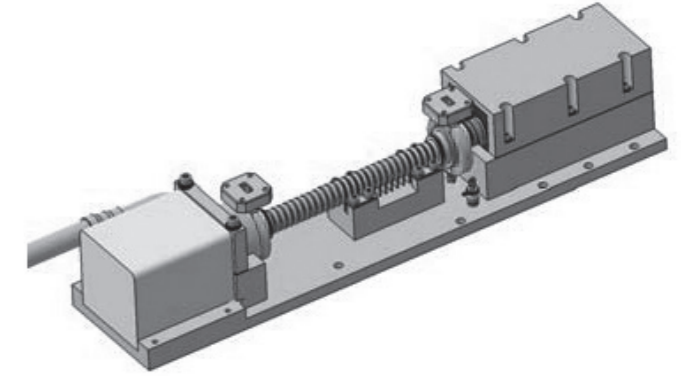
ENVIRONMENTAL

- > Constructional features allow tube operation in severe environmental conditions for defence and commercial applications

ET3702B HIGH POWER 28 ÷ 38 GHz TWT

FEATURES

- > 28 to 38 GHz Band
- > 150 W Output Power
- > 30 dB Gain
- > High duty pulsed
- > Helix type tube
- > PPM focused



ELECTRICAL DATA

RF PERFORMANCE (TYPICAL)

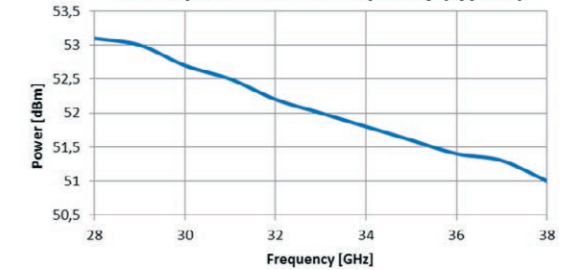
> Frequency range	28 to 38 GHz
> Output power	50.5 dBm min, see graph
> Input drive power	25 dBm max
> RF Gain	25 dB min, see graph
> Input VSWR (cold)	2.5 :1 max
> Output VSWR (cold)	2.5:1 max
> Duty Cycle	40% max

TYPICAL POWER SUPPLY REQUIREMENTS

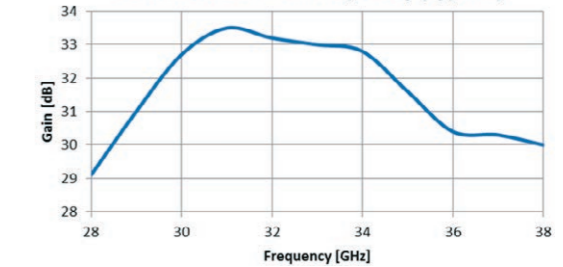
> Cathode voltage	-13kV
> Cathode current	170 mA max
> Anode voltage	1000 V
> Anode current	1 mA max
> Helix current	20 mA max
> BFE voltage:	-400 V (beam OFF) 0V (beam ON)
> BFE current	1 mA max
> Collector Voltage	50% of Cathode voltage
> Collector Current	170 mA
> Heater voltage	5 ÷ 6 Volt
> Heater current	1.5 A
> Power Consumption	1000 W max

Note: all voltages are referenced to cathode, except the cathode and anode which are referenced to ground.

RF Output Power Vs Frequency (typical)



Saturated Gain Vs Frequency (typical)



PHYSICAL DATA

MECHANICAL

> Dimensions:	260 (L); 70 (W); 50 (H) (mm, including connectors)
> Weight	1.5 kg max
> Cooling	Conduction
> RF input interface	WR-28 flat flange
> RF output interface	WR-28 flat flange

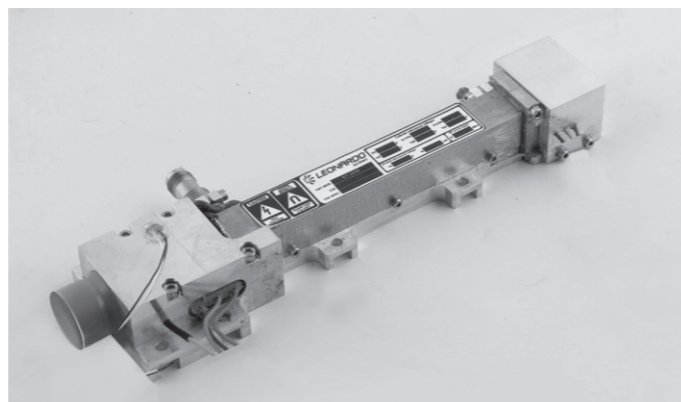
ENVIRONMENTAL

- > Constructional features allow tube operation in severe environmental conditions for defence and commercial applications

ET3580 HIGH POWER 4.5 ÷ 18 GHz TWT

FEATURES

- > 4.5 to 18 GHz band
- > 150 W Output Power
- > 30 dB Gain
- > 100% Duty Cycle
- > Helix type tube



ELECTRICAL DATA

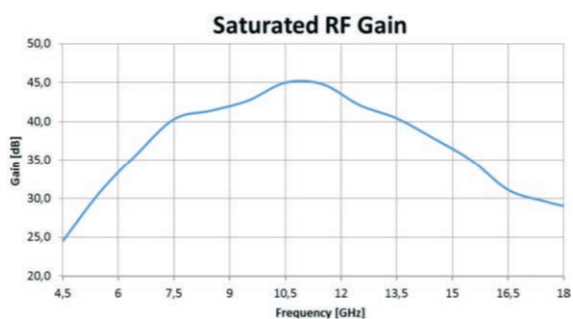
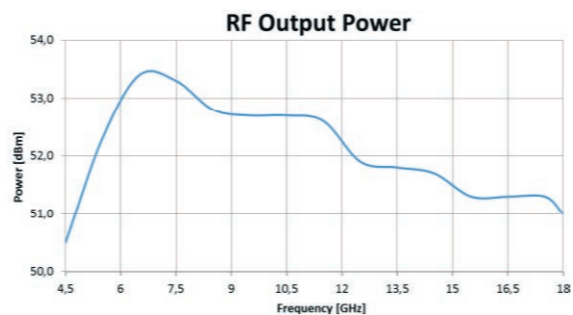
RF PERFORMANCE

> Frequency range	4.5 to 18 GHz
> Output power	see graph
> Input drive power	26 dBm max
> Noise Power density	-25 dBm/MHz max
> Harmonic output ratio	-4 dBc at 4.5 GHz -7 dBc at 6 GHz -9 dBc at 9 GHz
> Spurious	-50 dBc
> Duty Cycle	100%

TYPICAL POWER SUPPLY REQUIREMENTS

> Cathode voltage	-4.65 kV
> Cathode current	230 mA max
> Helix current	15 mA max
> BFE voltage:	-1200 V (beam OFF) 0V (beam ON)
> BFE current	0 mA max
> Collector Voltages:	2.85 kV 1st stage 2 kV 2nd stage 1 kV 3rd stage
> Collector Currents:	150 mA 1st stage (with RF) 90 mA 2nd stage (with RF) 230 mA 3rd stage (NO RF)
> Heater voltage	5.5V
> Heater current	1.3 A
> Power Consumption	630 W max

Note: all voltages are referenced to cathode, except the cathode and anode which are referenced to ground.



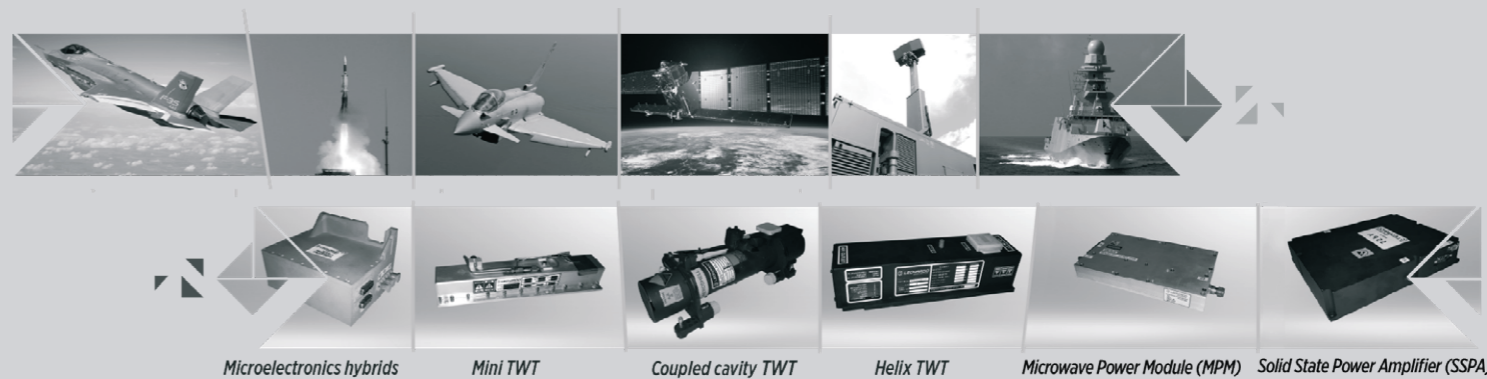
PHYSICAL DATA

MECHANICAL

> Dimensions:	220 (L); 50 (W); 70 (H) (mm, including connectors)
> Weight	0.6 kg max
> Cooling	Conduction
> RF input connector	SMA female
> RF output connector	TNC female

ENVIRONMENTAL

- > Constructional features allow tube operation in severe environmental conditions for defence and commercial applications



Microelectronics hybrids

Mini TWT

Coupled cavity TWT

Helix TWT

Microwave Power Module (MPM)

Solid State Power Amplifier (SSPA)

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MM08956 03-22

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