COAXIAL SOLID-STATE

High Power Amplifier RFE-24M30M1K7X+

50Ω 1700W 27 MHz SMA to N-Type

THE BIG DEAL

- High output power, 1700W
- 27MHz ISM band
- Power gain of 26 dB with 5W input drive level
- Suitable for CW and pulsed signals
- High gain, 26 dB typical
- 80% efficiency
- Rugged construction
- Built-in monitoring for temperature and current
- Built-in emergency switch-off
- Water cooled



Generic photo used for illustration purposes only

Model No.	RFE-24M30M1K7X+
Case Style	VW3194
Connectors	SMA-Input / N-type-Output

+RoHS Compliant
The +Suffix identifies RoHS Compliance.
See our website for methodologies and qualifications

APPLICATIONS

The RFE-24M30M1K7X+ amplifier module can be used as a building block in any single or multi-channel system for high power RF Energy applications such as:

- Industrial heating and Materials processing
- Food processing (heating, tempering, pasteurization)
- Microwave-assisted chemistry
- Plasma generation and Plasma surface treatment
- Disinfection
- Chemistry
- RF-excited lasers
- Medical (heating, hyperthermia, and ablation)
- Semiconductor RF generators

PRODUCT OVERVIEW

The RFE-24M30M1K7X+ is a new generation light weight solid state connectorized high-power amplifier module which can be used in a wide range of industrial, scientific and medical applications in the 27 MHz ISM band. The RFE-24M30M1K7X+ uses the latest generation semiconductor technology and provides unsurpassed output power, efficiency and ruggedness. The amplifier is capable of amplifying signals (CW & pulsed) in excess of 1700W. A temperature compensated gate bias circuit is provided. Built-in circuitry provides temperature monitoring and current monitoring. An on-board emergency switch can be triggered with an external TTL signal to switch off the power amplifier in the case of too much reflected or dissipated power.

All interfaces to the outside world are accessible through a convenient USB-C connector. The amplifier has a SMA-connector on the input and an N-connector on the output. The mounting base plate has an integrated water channel to provide cooling under difficult operating conditions, such as high mismatch or high dissipated power. Convenient rotatable push-to-connect tube fittings allow for easy and reliable water cooling connections. Integrated transformer cooling ensures a long amplifier lifetime. The amplifier is supplied with a robust shield. M5 screw holes are provided to mount the amplifier to a chassis in larger systems. Easy screw-on power supply connections are provided outside the shield.

KEY FEATURES

Feature	Advantages
High CW Power	Supports high power applications for a wide range of industrial, scientific and medical applications in the 27 MHz ISM band.
High Gain	A typical gain of 26 dB at P3dB allows the RFE-24M30M1K7X+ to be driven to full output power with only 5 Watts of input power.
High Efficiency	The RFE-24M30M1K7X+ uses high efficiency state of the art highly rugged semiconductor technology.
Control and Monitoring Feature	The power amplifier has an integrated temperature compensated gate bias and built-in temperature and current monitoring feature. Monitoring outputs are differential. A TLL level PA enable pin is provided. To avoid any damage, a fast emergency shutoff is provided to shut down the power amplifier in a high dissipation or high reflected power situation.
Small and lightweight	The compact amplifier design (176mm x 96mm x 85mm) is lightweight (1202 grams) which makes it suitable for integration in high power systems that require multiple amplifiers.
Cooling	Convenient rotatable push-to-connect tube fittings allow for easy connection of the water cooling.

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ELECTRICAL SPECIFICATIONS AT 27.12 MHz, T_{WATER}=+25°C, V_{DS}=65V, 50Ω SYSTEM

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Frequency Range	f			27.12		MHz
Operating Voltage	V_{DS}		50	65	66	V
Input Power	P_{IN}		- -	- -	10 40	Watts dBm
Output Power at 1dB compression	P_{1dB}		1200 60.8	1660 62.2	- -	Watts dBm
Output Power at 3dB compression	P_{3dB}		1500 61.8	1891 62.7	- -	Watts dBm
Power Gain	G_P	P3dB	22	25	-	dB
Efficiency	η	P3dB	70	80	-	%
Input VSWR	IRL	P3dB	-	-	1.92	:1
Harmonics (H2)	H2		-	-45	-	dBc
Harmonics (H3)	H3		-	-30	-	dBc
Current Monitor Out	CMO	Connector J1, A2=CDO+, A3=CDO-, P3dB at 27.12 MHz	-	2.5	-	V
Temperature Monitor Out	TMO	Connector J1, A10=TDO-, A11=TDO+, P3dB at 27.12 MHz	-	1.1	-	V
Power Supply Shut-Off	V_{DSSQ}	Enable (TTL low) / Disable (TTL high) on Pin A6 of Connector J1				
PA Enable	PA_{EN}	Enable (TTL high) / Disable (TTL low) on Pin A7 of Connector J1				

1. All power measurements are performed while using a Mini-Circuits NLP-30+ Low Pass Filter in front of the power sensors.
2. +VDS and Ground are connected at the bottom of the amplifier using M5 screws.
3. ⚠This amplifier cannot be run without water cooling. A minimum water flow rate of 4 Gallons/minute (approx. 15 liter/minute) and pressure of 10psi (69 kPa) is recommended.

MAXIMUM RATINGS[1]

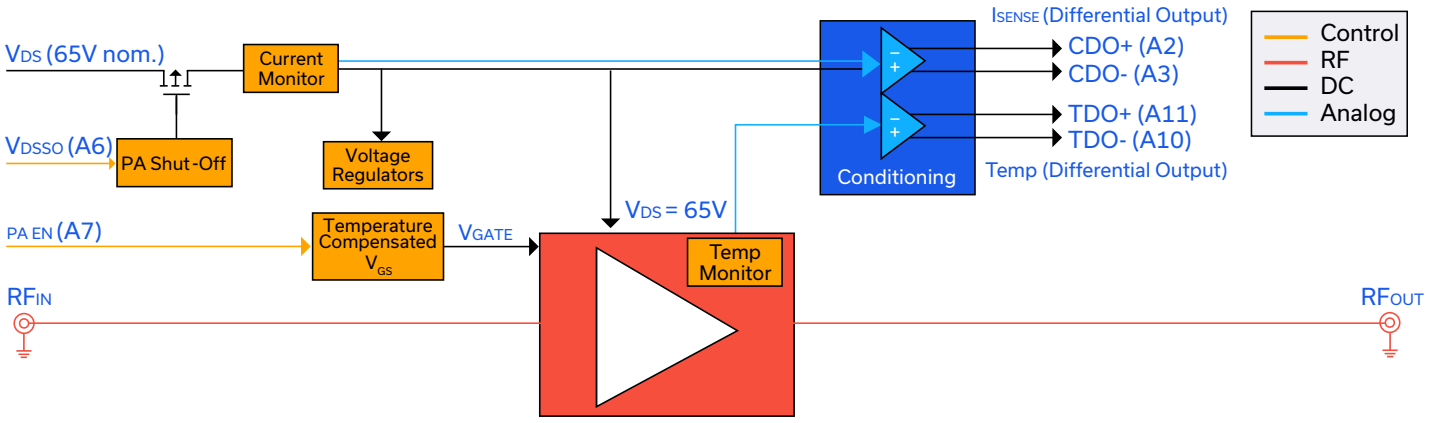
Parameter	Ratings
Operating Water Temperature	0°C to +65°C
Storage Temperature	-20°C to +85°C
DC Voltage (V_{DS})	66V
Input RF Power (no damage)	+40 dBm

1.Specifications apply to CW signals only. Permanent damage may occur if any of these limits are exceeded.

High Power Amplifier RFE-24M30M1K7X+

50Ω 1700W 27 MHz SMA to N-Type

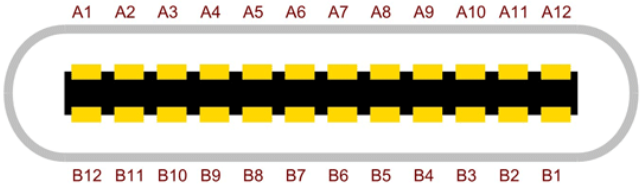
FUNCTIONAL BLOCK DIAGRAM



CONTROL INTERFACE PIN-OUT AND FUNCTIONALITY (J1, MULTI-PIN USB-C CONNECTOR)

Pin Number	Label	Functionality
A1	GND	Ground
A2	CDO+	Current Differential Output+
A3	CDO-	Current Differential Output-
A4	GND	Ground
A5	GND	Ground
A6	V_{DSSO}	Power Supply Shut Off
A7	PA_{EN}	PA Enable
A8	GND	Ground
A9	GND	Ground
A10	TDO-	Temperature Differential Output-
A11	TDO+	Temperature Differential Output+
A12	GND	Ground
B1-B12	Do not connect	Reserved pin for manufacturer

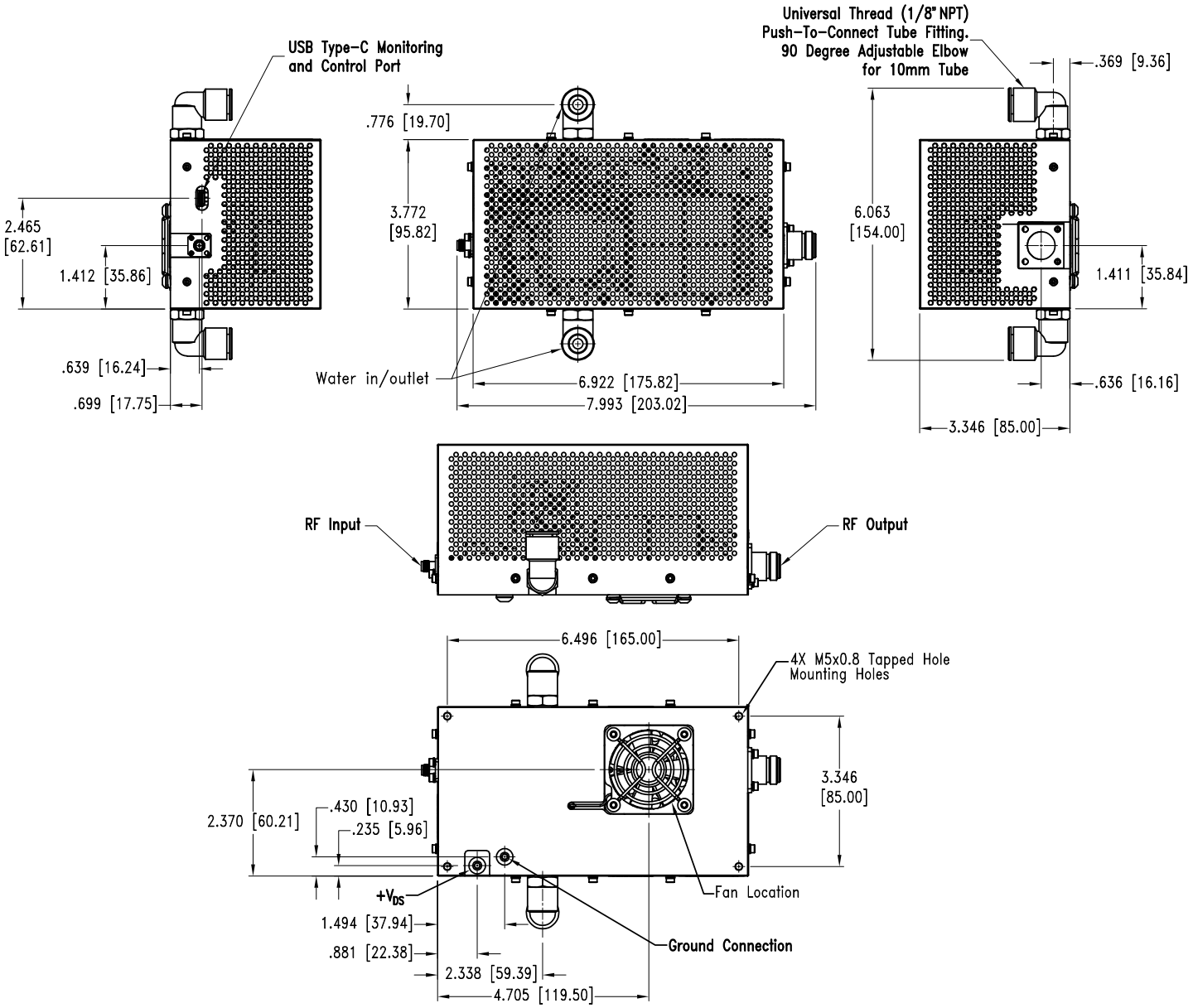
PIN CONFIGURATION USB-C CONNECTOR



High Power Amplifier RFE-24M30M1K7X+

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OUTLINE DRAWING

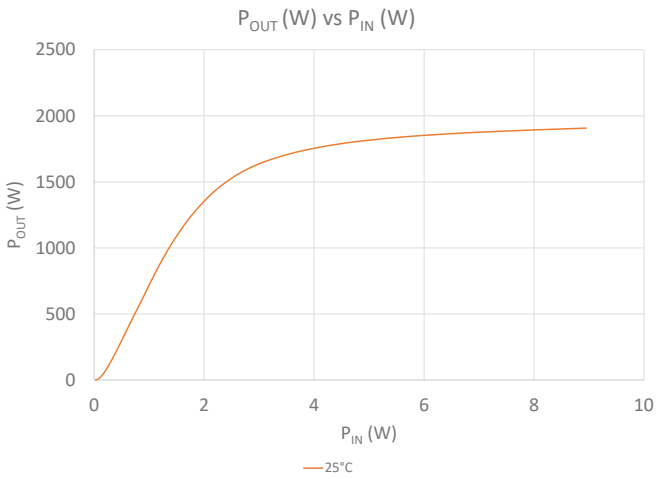


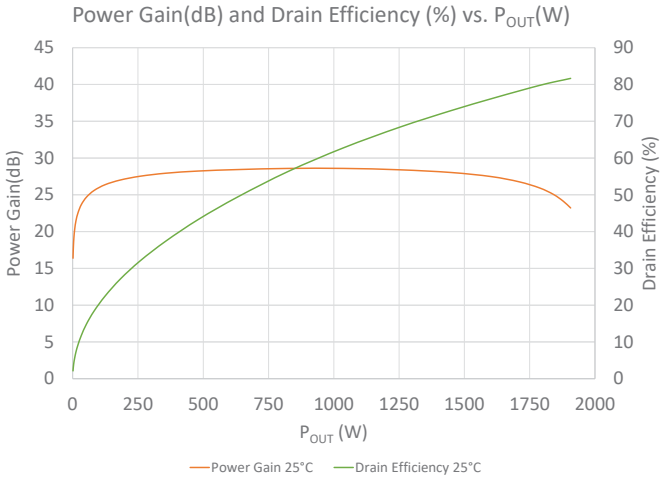
Weight: 1202 grams;
Dimensions are in inches (mm). Tolerances: 2 Pl.± ; 3 Pl. ±

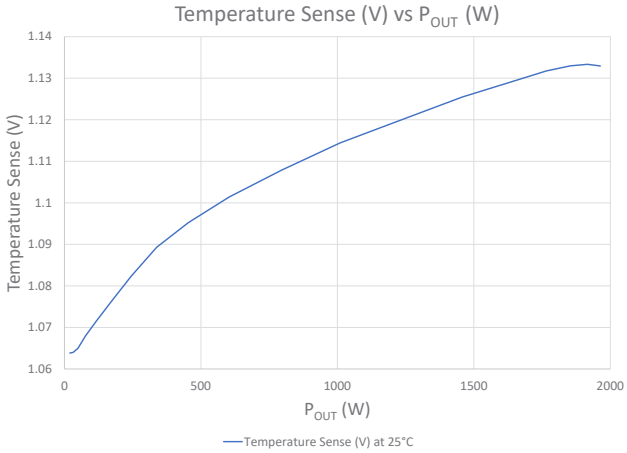
High Power Amplifier RFE-24M30M1K7X+

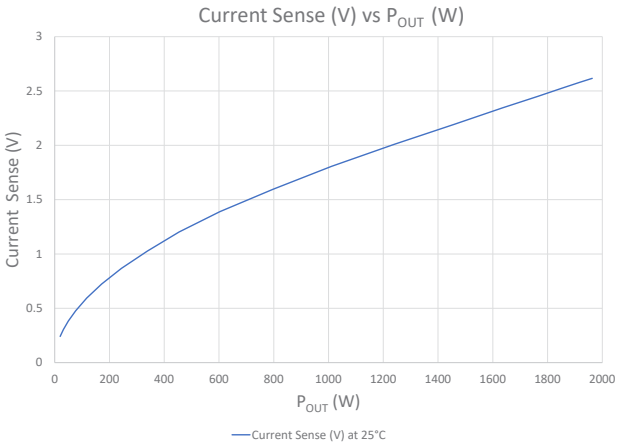
50Ω 1700W 27 MHz SMA to N-Type

TYPICAL PERFORMANCE DATA AT 27 MHz (T_{WATER} = +25°C, V_{DS} = 65V, 50Ω SYSTEM)

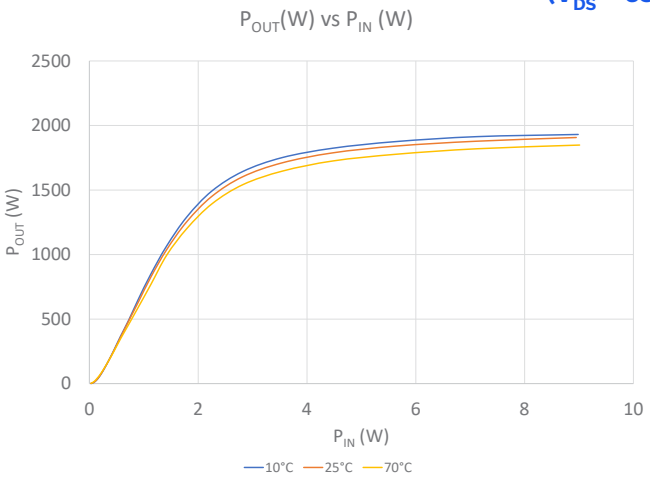


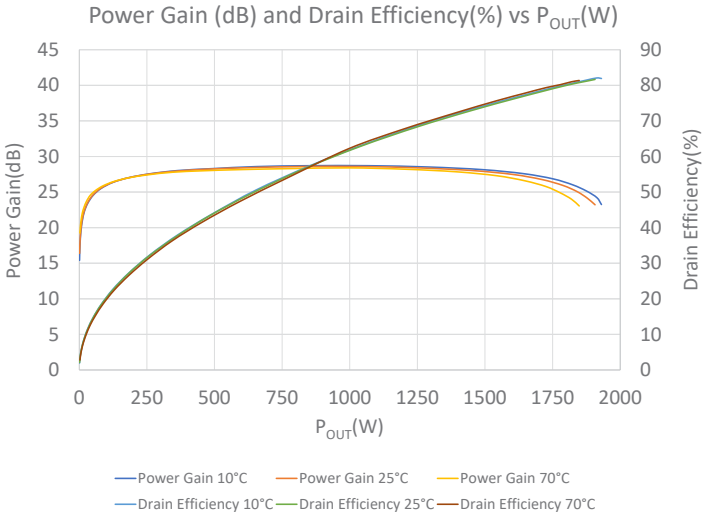






TYPICAL PERFORMANCE DATA AT 27 MHz ACROSS DIFFERENT OPERATING WATER TEMPERATURE (V_{DS} = 65V, 50Ω SYSTEM)

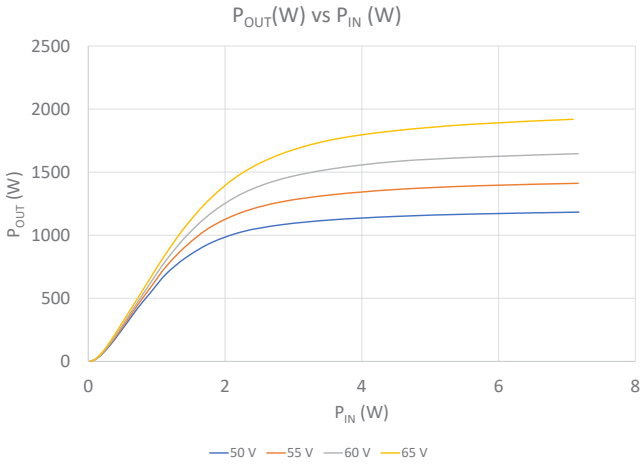


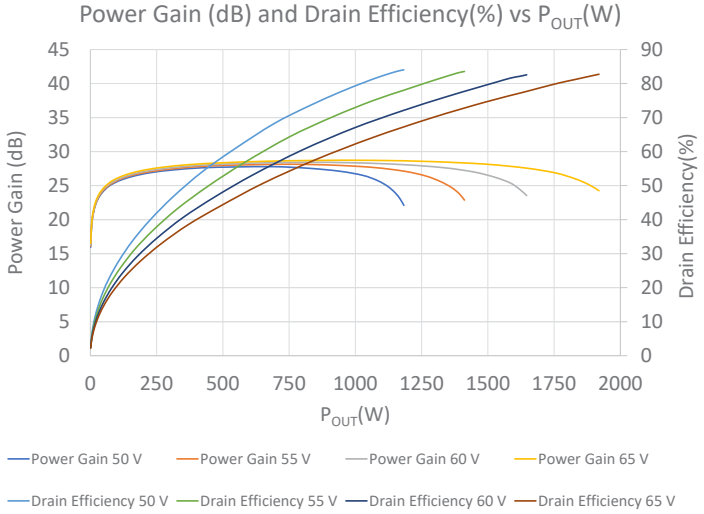


High Power Amplifier RFE-24M30M1K7X+

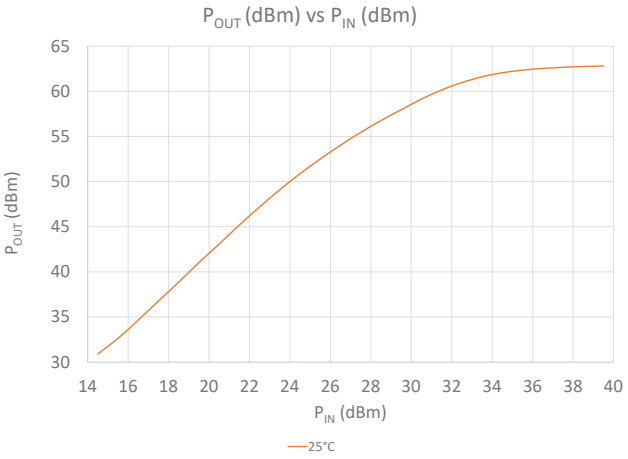
50Ω 1700W 27 MHz SMA to N-Type

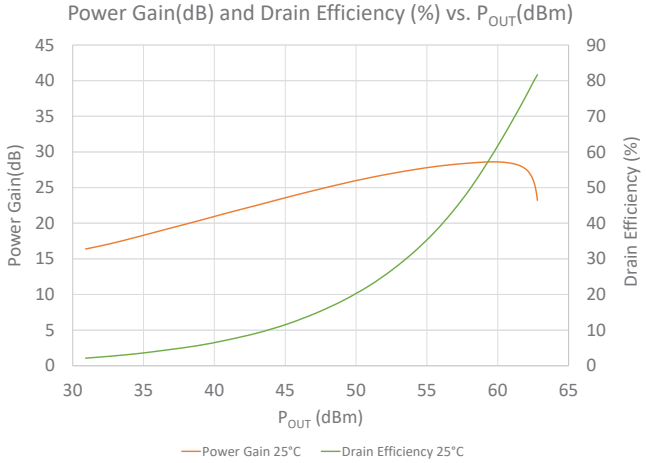
TYPICAL PERFORMANCE DATA AT 27 MHz ACROSS DIFFERENT VOLTAGES (T_{WATER}= +25°C, 50Ω SYSTEM)

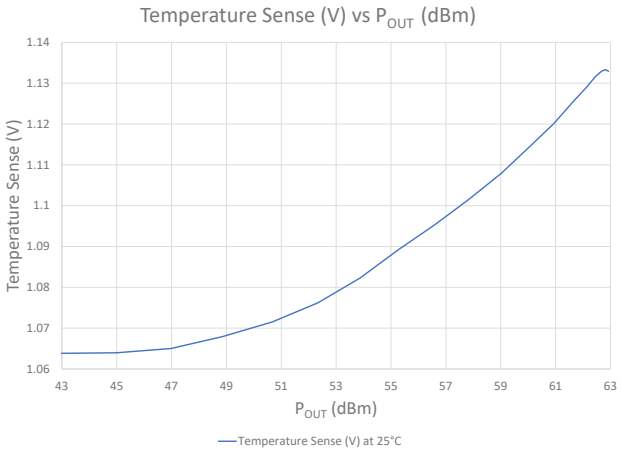


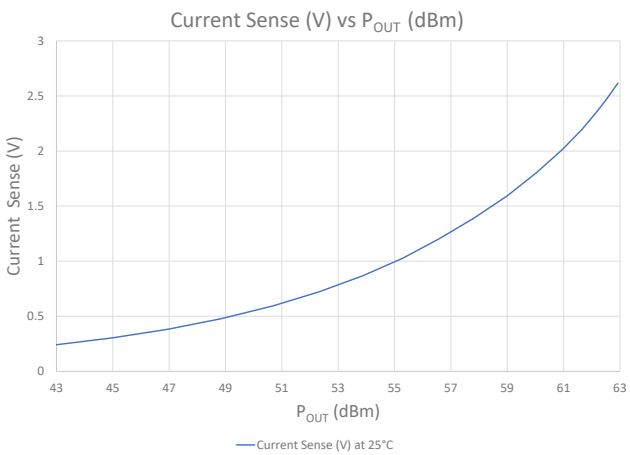


TYPICAL PERFORMANCE DATA AT 27 MHz (T_{WATER} = +25°C, V_{DS} = 65V, 50Ω SYSTEM)





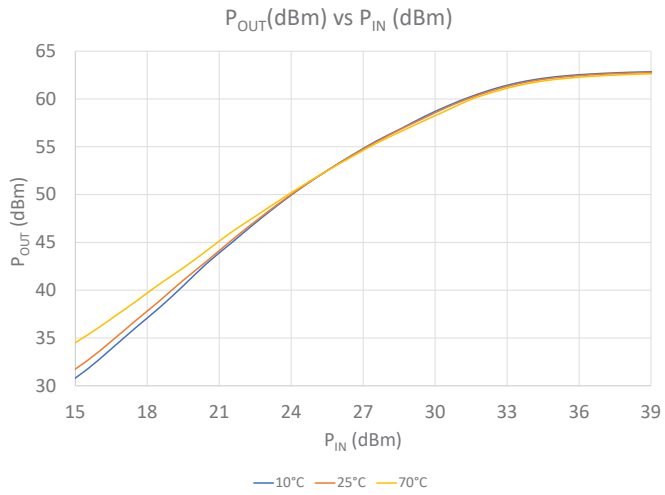


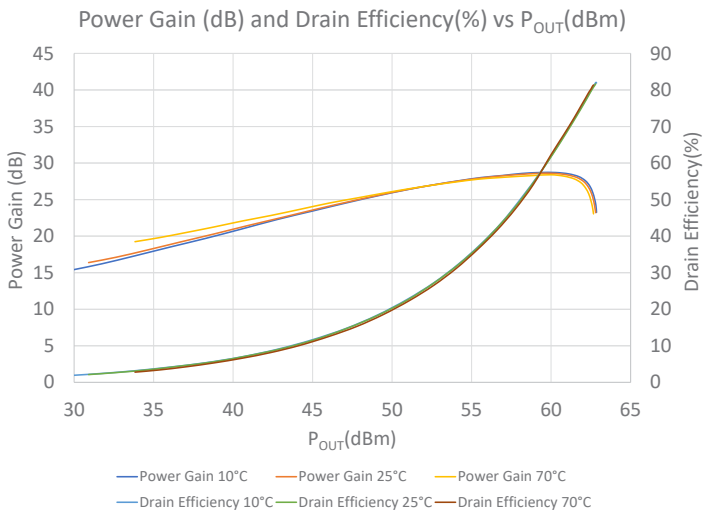


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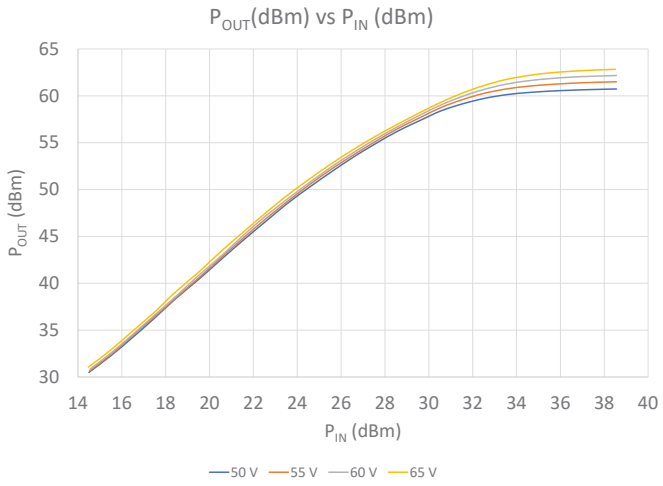
50Ω 1700W 27 MHz SMA to N-Type

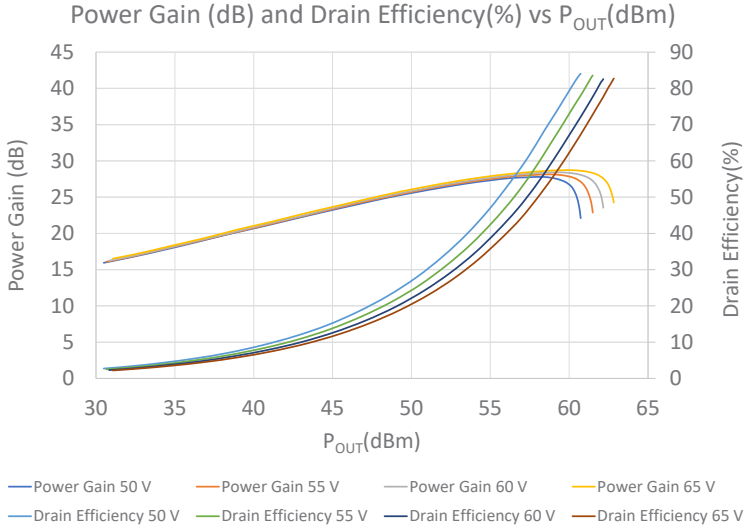
TYPICAL PERFORMANCE DATA AT 27 MHz ACROSS DIFFERENT OPERATING WATER TEMPERATURE (V_{DS} = 65V, 50Ω SYSTEM)





TYPICAL PERFORMANCE DATA AT 27 MHz ACROSS DIFFERENT VOLTAGES (T_{WATER}= +25°C, 50Ω SYSTEM)



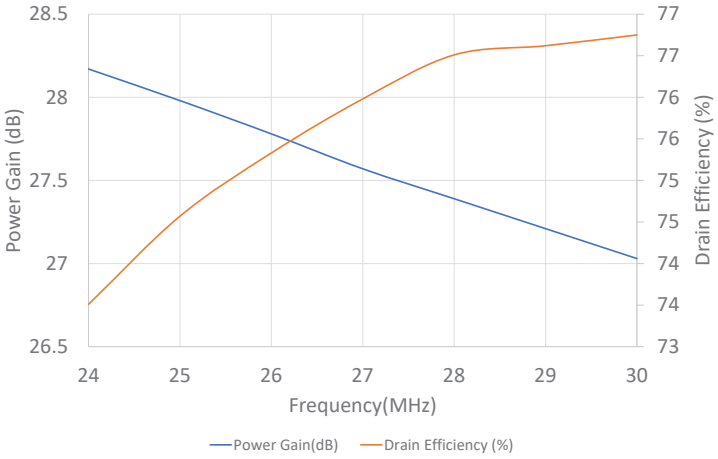


High Power Amplifier RFE-24M30M1K7X+

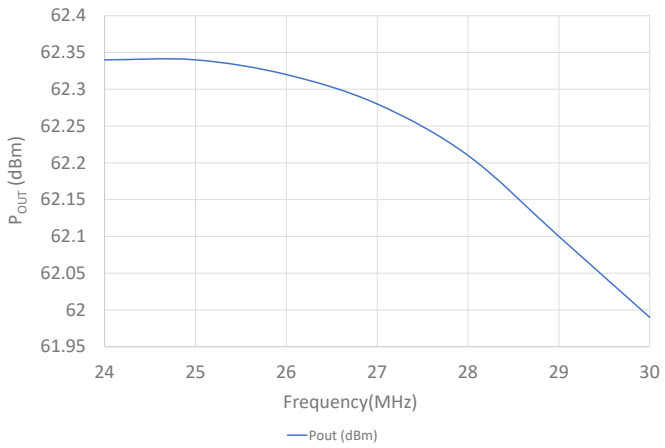
50Ω 1700W 27 MHz SMA to N-Type

TYPICAL PERFORMANCE DATA ACROSS FREQUENCY (T_{WATER}= +25°C, V_{DS} = 65V, 50Ω SYSTEM)

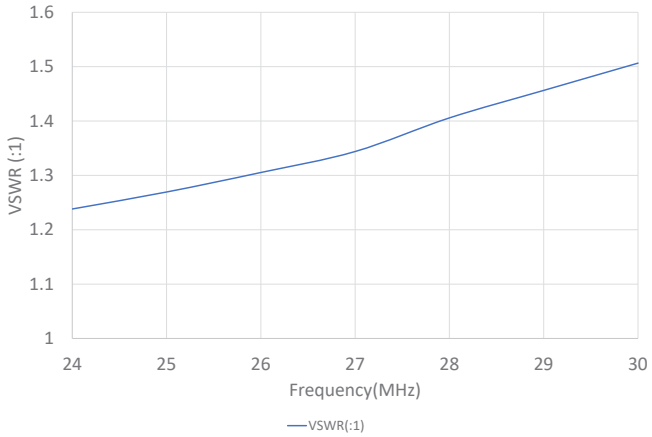
Power Gain (dB) and Drain Efficiency(%) at P_{1dB} Compression



P_{OUT} (dBm) at P_{1dB} Compression



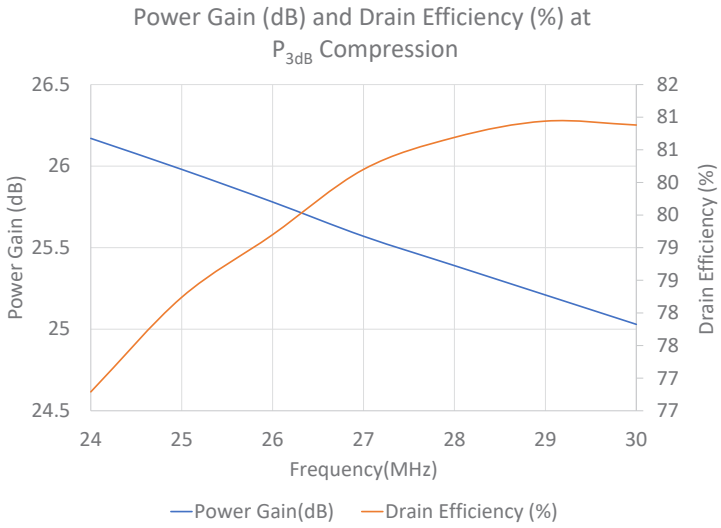
Input VSWR (:1) at P_{1dB} Compression

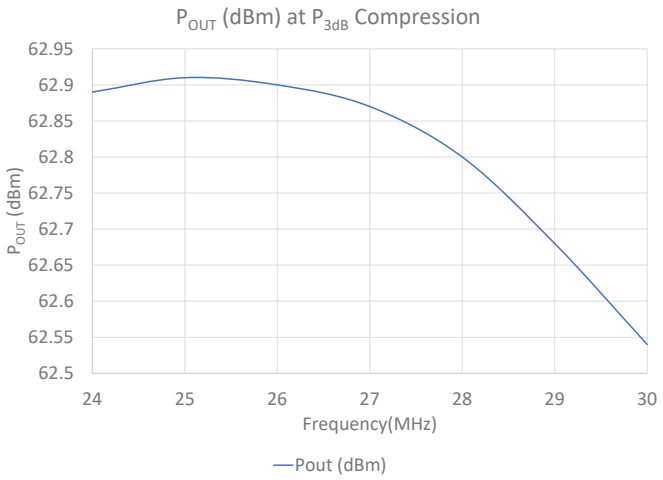


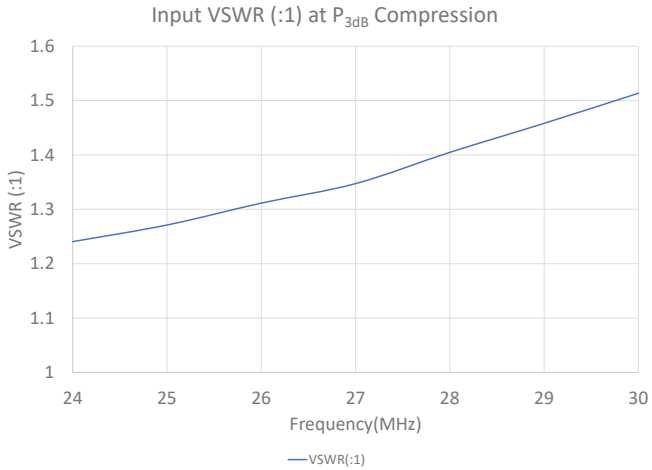
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TYPICAL PERFORMANCE DATA ACROSS FREQUENCY (T_{WATER}= +25°C, V_{DS} = 65V, 50Ω SYSTEM)







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AMPLIFIER INTERFACES AND SUGGESTED MATING HARDWARE*

	J1 - CONN RCP USB3.1 TYPEC 24P SMD RA equivalent to Molex P/N 1054500101
	+65V Supply Voltage Connector, M5 Ground Connection,M5 Tightening Torque 1.7 N-m (15 in-lbs) Mating Hardware*: M5 screw equivalent to McMaster P/N 92095A308 Belville washer equivalent to McMaster P/N 90895A027 Ring Terminal equivalent to McMaster P/N 7113K29
	J3: SMA Connector Receptacle, Female Socket 50Ohm equivalent toTE Connectivity AMP Connectors, P/N 1052566-1
	J4 - N Type Connector Receptacle, Female Socket 50Ohm equivalent to Amphenol P/N 172195

*Mating hardware not included with amplifier. Similar mating hardware available from other manufactures.

SAFETY INSTRUCTIONS.

WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN BODILY INJURY, DEATH, OR PROPERTY DAMAGE.
For your own safety, this section provides instructions for avoiding potential dangers when using this product.

QUALIFIED PERSONNEL

This product should be operated by qualified personnel only. Qualified personnel are individuals who are familiar with the operation of the product and the hazards involved with such operation.

DAMAGED OR MISSING HARDWARE

Do not operate the product if there is physical damage or hardware is missing.

MAXIMUM RATINGS

The maximum ratings in this data sheet should never be exceeded. Stress above one or more maximum ratings may cause permanent damage to the product and may permanently and irreversibly affect the quality and reliability of the product, which may increase the risk of bodily injury, death, or property damage.

HAZARDOUS RF VOLTAGES

The RF voltages inside the product and on the center pin of the RF output connector can be hazardous. Contact with the internal components of the product or the center pin of the RF output connector may lead to burns or electrical shock. Disconnect power before removing the protective cover from the product. Note that removing the protective cover from the product will void the express warranty specified in Mini-Circuits Standard Terms.

To reduce the risks presented by these hazards:
1. never operate the product without its protective cover,
2. always connect the RF output connector to a load before the power source is applied to the product, and
3. always place the product in a non-operating condition before disconnecting or connecting the load to the RF output connector.

COOLING

RF Power amplifiers always need proper cooling. Failure to properly cool the product may increase the risk of bodily injury, death, or damage to property or the product.

Some products contain water cooling systems to help cool down the product. If this data sheet indicates that the product contains a water cooling system, proper waterflow as specified in this data sheet is required to keep the temperature of the product within the temperature range that is specified in this data sheet.

Some products also contain built-in protection circuitry designed to shut-off the amplifier at excessive high temperatures or at other excessive operating conditions. Even if this data sheet indicates that the product contains protective circuitry, such protective circuitry is not a substitute for proper handling in accordance with these instructions. Accordingly, do not rely on the protective circuitry to prevent injury or damage to property or the product.

MAINTENANCE CAUTION

Maintenance or repair of the product must only be performed by qualified personnel when the product is in a non-operating condition and disconnected from its power source. Note that performance of maintenance or repairs to the product will void the express warranty specified in Mini-Circuits Standard Terms.

ENVIRONMENTAL CONDITIONS

Unless otherwise stated in this data sheet, this product is designed to be operated under the environmental conditions set forth in this data sheet, as well as the following conditions:

- Indoor use only
- Temperature of 5°C to 40°C (non-condensing)

WARNING SIGNS

In addition to being qualified before operating the product, pay attention to all warning signs and danger symbols. Failure to heed warnings signs and danger symbols, or to follow their associated instructions, may result in bodily injury, death, or property damage.

NOTES

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/terms/viewterm.html

Coaxial Amplifier RFE-24M30M1K7X+

Typical Performance Data

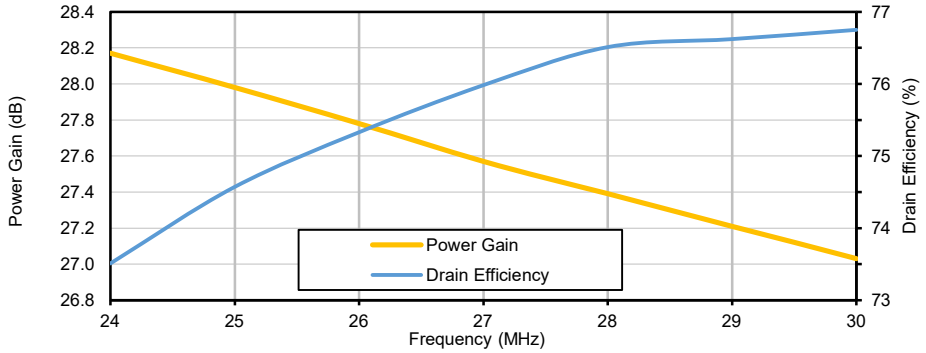
Test Condition: $T_{MOUNTING\ BASE}$ = +25°C, V_{DS} = 65V, 50Ω SYSTEM

FREQUENCY (MHz)	Power Gain at P_{1dB} Compression (dB)	VSWR (:1) at P_{1dB} Compression IN	P_{OUT} at P_{1dB} Compression (dBm)	Drain Efficiency at P_{1dB} Compression (%)
24	28.17	1.24	62.34	73.51
25	27.98	1.27	62.34	74.57
26	27.78	1.31	62.32	75.33
27	27.57	1.34	62.28	75.98
28	27.39	1.41	62.21	76.51
29	27.21	1.46	62.1	76.62
30	27.03	1.51	61.99	76.75
FREQUENCY (MHz)	**Power Gain at P_{3dB} Compression (dB)**	**VSWR (:1) at P_{3dB} Compression IN**	**P_{OUT} at P_{3dB} Compression (dBm)**	**Drain Efficiency at P_{3dB} Compression (%)**
24	26.17	1.24	62.89	76.79
25	25.98	1.27	62.91	78.24
26	25.78	1.31	62.9	79.2
27	25.57	1.35	62.87	80.2
28	25.39	1.40	62.8	80.69
29	25.21	1.46	62.68	80.94
30	25.03	1.51	62.54	80.88

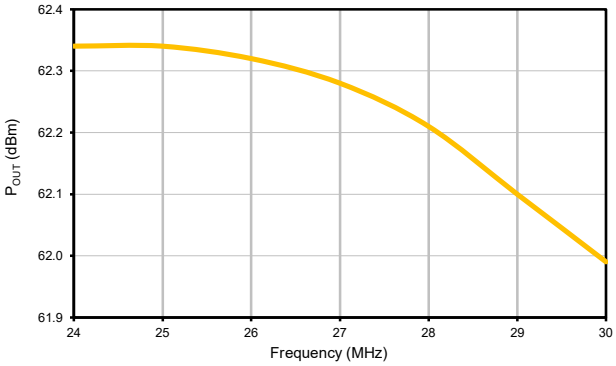
Typical Performance Curves

Test Condition: $T_{MOUNTING\ BASE}$ = +25°C, V_{DS} = 65V, 50Ω SYSTEM

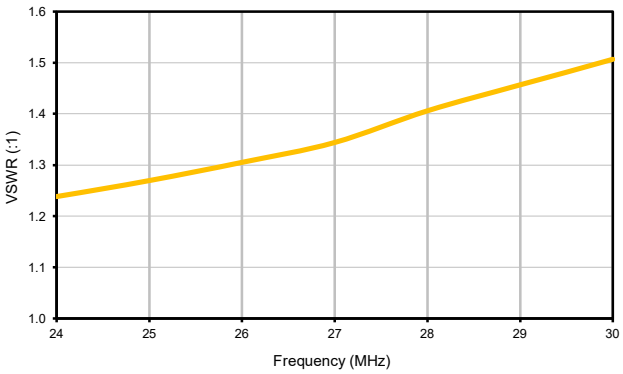
Power Gain (dB) and Drain Efficiency (%) at P_{1dB} Compression



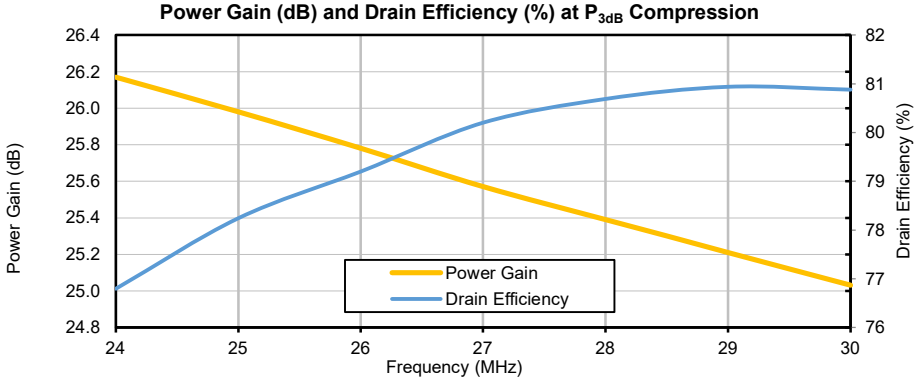
P_{OUT} (dBm) at P_{1dB} Compression



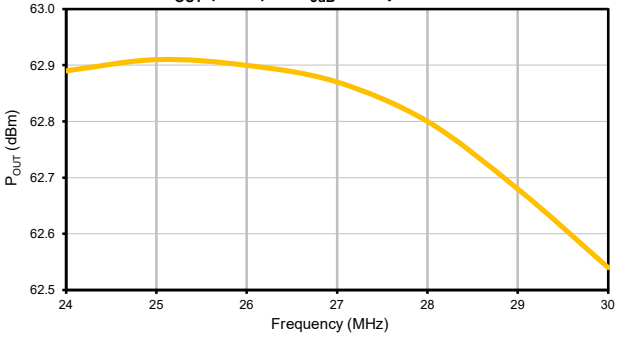
VSWR (:1) at P_{1dB} Compression



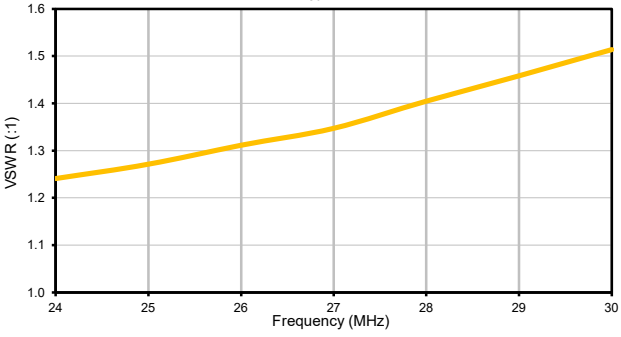
Power Gain (dB) and Drain Efficiency (%) at P_{3dB} Compression



P_{OUT} (dBm) at P_{3dB} Compression

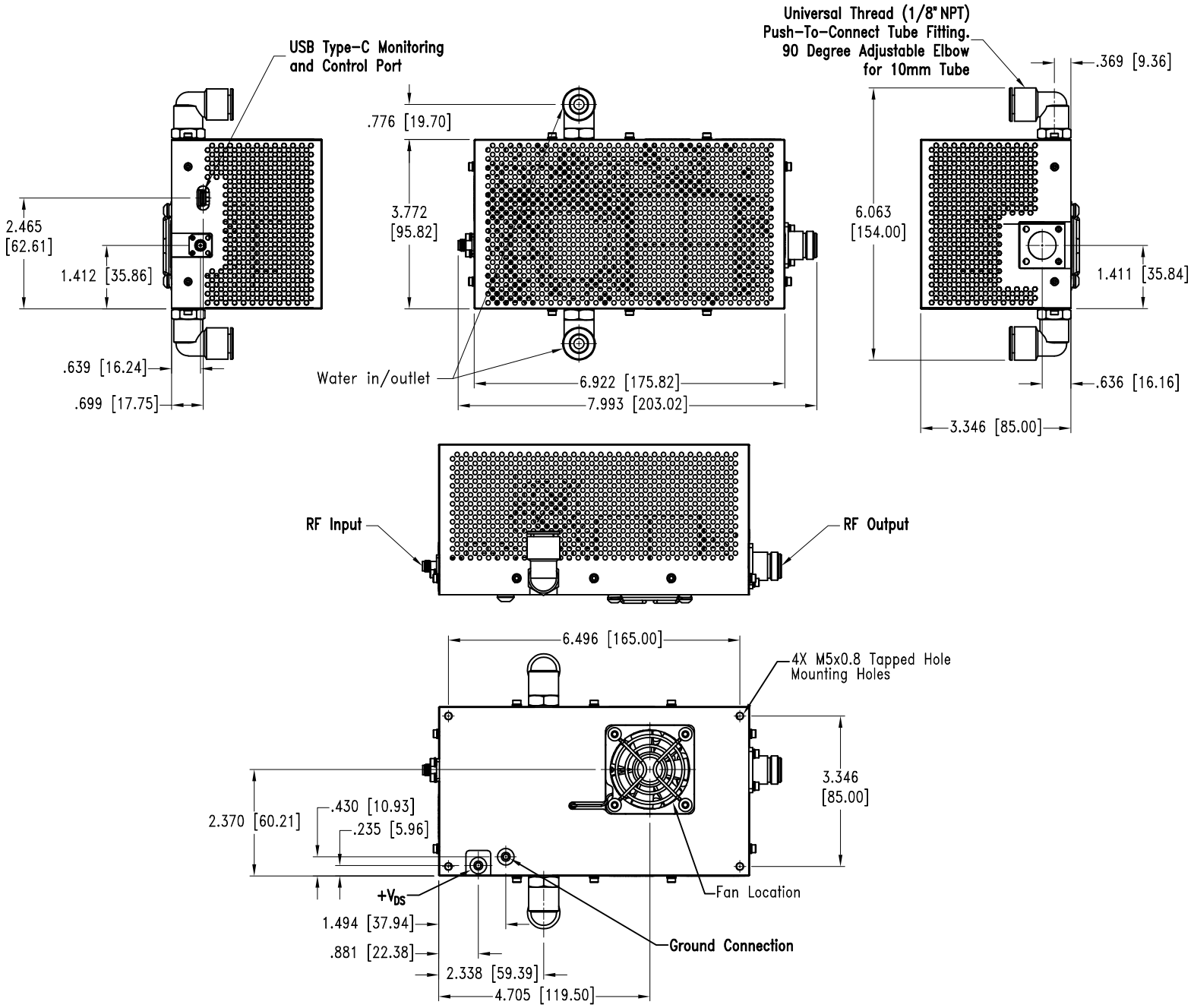


VSWR (:1) at P_{3dB} Compression



Case Style VW

Outline Dimensions VW3194



Weight: 1202 grams;

Dimensions are in inches (mm). Tolerances: 2 Pl.±.01 (0.254); 3 Pl. ± .005 (0.127)

Notes:

1. Case material: Bottom base plate: 6063-T5 Aluminum; Shield: 0.016" Tin plated steel.
2. Case Finish: Top Shield: Tin (Sn); Bottom base plate: 200-400 uin EN per MIL-C-26074E
3. Refer to the individual model data sheet for the type of connectors available.
4. Recommended screw for mounting model without heatsink M5 x 10-20mm Length (depending on mounting plate thickness)

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Environmental Specifications ENV23T30

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	0°C to +65°C	----
Storage Temperature	-20°C to +85°C	----
Stabilization Bake	125°C, 24 hours (Non-operating)	----
Thermal Shock	-40°C to +150°C 15 min dwell at extreme temperatures, 1 min transfer 250 cycles	MIL-STD-202, Method 107
Humidity Storage	Temp: 85°C, Humidity: 85% RH, Non-operating for 1000 Hrs.	----
DC Burn In	Ambient Conditions with Bias. Bias Conditions: +65V ~203mA 500 Hrs	----
Thermal Imaging	27 MHz 1k6W @P3 dB 30 min soak	----
ESD Gun	Air Discharge: ±2.0 kV, ±4.0 kV, ±8.0 kV. Contact Discharge: ±2.0 kV, ±4.0 kV, ± 6.0 kV, ±8.0Kv Non-operating Condition. 10 positive & 10 negative charges at each location	IEC 61000-4-2
ESD HBM Test	Tested up to ± 1000V	JS-001
FedEx Transit Test (Packaging)	Test performed on packaged unit. Pre-conditioning + Shock (20 drops, 30 inches) + Compression (210 lb, 0.11" deflection) + Vibration (90 min random Vibration)	ISTA 6-FEDEX-A TEST

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