MMIC SURFACE MOUNT

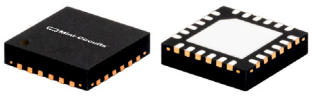
Wideband Amplifier

PMA4-9163+

50Ω 9 to 16 GHz Medium Power Driver Amplifier

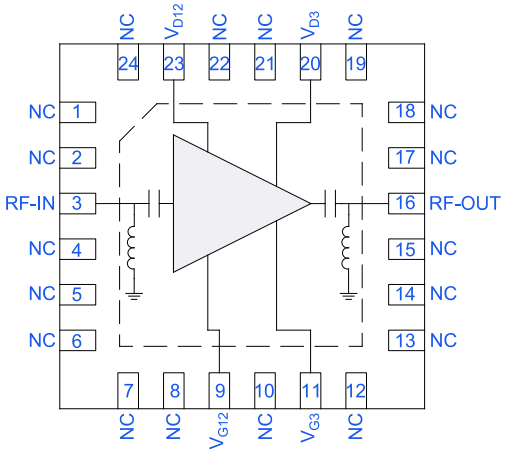
THE BIG DEAL

- P_{SAT}, Typ. +24.6 dBm
- Linear Gain, Typ. 23.5 dB
- Gain Flatness < ± 1.5 dB
- IM3, Typ. -38 dBc @ P_{OUT} = +12 dBm/tone
- Supply Voltage, +5 V at 145 mA
- 4×4 mm 24-Lead QFN-Style Package



Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM (TOP VIEW)



APPLICATIONS

- Backhaul Radio Systems
- Satellite Communication
- Test & Measurement Equipment
- Radar, EW, and ECM Defense Systems

PRODUCT OVERVIEW

The PMA4-9163+ is a GaAs MMIC multi-stage medium power driver amplifier operating from 9 to 16 GHz. The amplifier provides 23.5 dB of linear gain, greater than 0.2 W of saturated output power with 28% power-added efficiency, +52 dBm OIP2, and +30.6 dBm OIP3 at 12 GHz. The device operates on a +5 V supply and consumes 145 mA of quiescent current. The amplifier is 50Ω matched at the input and output, making it easy to implement and comes in an industry standard 4×4 mm 24-lead QFN-Style package for ease of integration into dense circuit board layouts.

KEY FEATURES

Feature	Advantages
Gain, Typ. 23.5 dB P_{SAT}, Typ. +24.6 dBm	Flat, broadband gain and output power make this device excellent for wideband systems from 9 to 16 GHz that require at least 0.2 W of operating output power over the full band.
OIP2, Typ. +52 dBm OIP3, Typ. +30.6 dBm	High operating OIP2 and OIP3 provide low in-band IM distortion products, enabling minimal signal-to-noise degradation in high fidelity measurement systems and communication systems.
4×4 mm 24-Lead QFN-Style Package	Small footprint saves space in dense layouts while providing low inductance, repeatable transitions, and excellent thermal contact to the PCB. Industry standard packaging allows for ease of assembly in high volume manufacturing processes.

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ELECTRICAL SPECIFICATIONS[1] AT +25 °C, V_{DD} = +5 V, AND Z_O = 50Ω UNLESS NOTED OTHERWISE

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range		9		16	GHz
Gain	9	21.8	23.5		dB
	10	21.8	23.5		
	12	21.9	23.5		
	14	21.5	22.9		
	16	20.2	22.2		
Input Return Loss	9		16		dB
	10		29		
	12		14		
	14		22		
	16		16		
Output Return Loss	9		11		dB
	10		18		
	12		15		
	14		34		
	16		16		
Isolation	9–16		56		dB
Output Power at 1 dB Compression (P1dB)	9		+21.5		dBm
	10		+22.0		
	12		+23.2		
	14		+22.6		
	16		+21.5		
Output Power at Saturation (P_{SAT})[2]	9		+22.9		dBm
	10		+23.1		
	12		+24.6		
	14		+23.9		
	16		+22.7		
Output Third-Order Intercept (OIP3) (P_{OUT} = +12 dBm/Tone)	9		+31.0		dBm
	10		+31.4		
	12		+30.6		
	14		+29.5		
	16		+27.5		
Third-Order Intermodulation Distortion (IM3) (P_{OUT} = +12 dBm/Tone)	9		-37.3		dBc
	10		-38.4		
	12		-37.1		
	14		-34.7		
	16		-30.5		
Output Second-Order Intercept (OIP2) (P_{OUT} = +12 dBm/Tone)	9		+34.3		dBm
	10		+40.7		
	12		+51.6		
	14		+68.6		
	16		+55.4		
Noise Figure	9		5.9		dB
	10		5.4		
	12		5.1		
	14		4.9		
	16		4.6		
Device Operating Voltage (V_{DD})[3]		+4	+5	+6	V
Device Operating Current (I_{DD})[4]			145		mA
Gate Voltage (V_{GG})[5]			-0.82		V
Gate Current (I_{GG})[6]			8		µA
Device Current Variation vs. Temperature[7]			0.021		mA/°C

1. Tested on Mini-Circuits Evaluation Test Board TB-PMA4-9163C+. See Figure 2. Board loss de-embedded to the device.
2. Defined as output power at which change is 0.1 per 1 dB change in input power.
3. $V_{DD} = V_{D12} = V_{D3}$
4. Current at P_{IN} = -15 dBm. Increases to 200 mA at P_{SAT}. $I_{DD} = I_{D12} + I_{D3}$.
5. $V_{GG} = V_{G12} = V_{G3}$
6. $I_{GG} = I_{G12} + I_{G3}$
7. (Current at +105 °C - Current at -55 °C)/(160 °C). V_G held constant over temperature.

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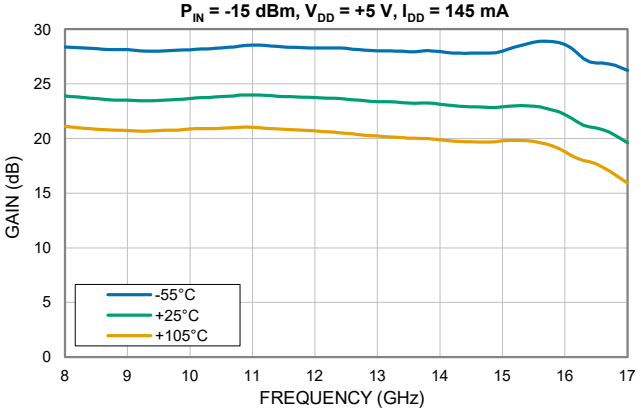
TYPICAL PERFORMANCE GRAPHS

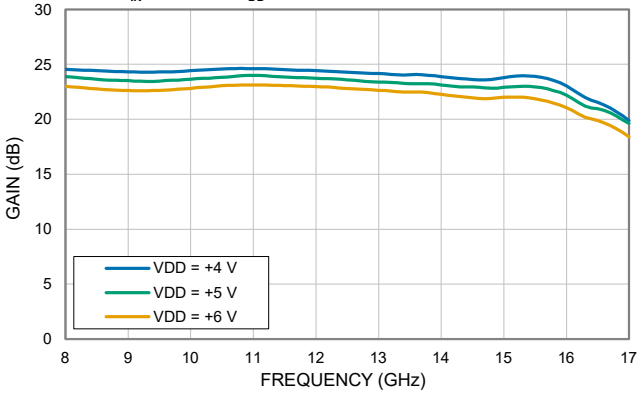
GAIN vs. TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +5 V, I_{DD} = 145 mA



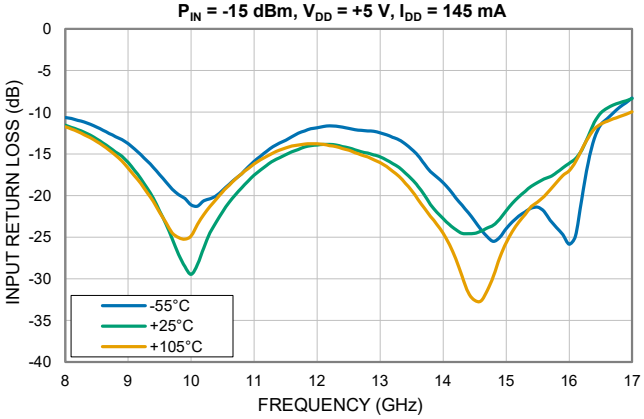
GAIN vs. DEVICE VOLTAGE

P_{IN} = -15 dBm, I_{DD} = 145 mA, TEMPERATURE = +25°C



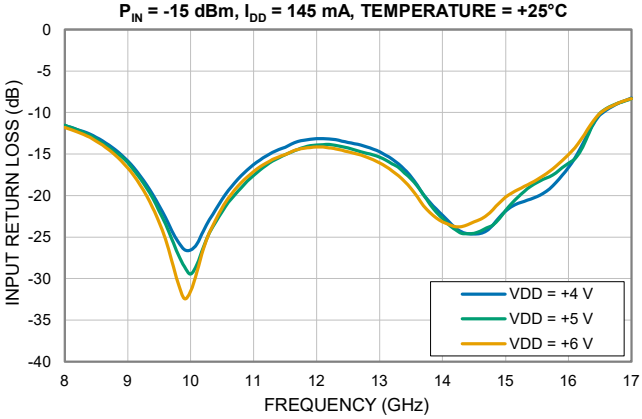
INPUT RETURN LOSS vs.TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +5 V, I_{DD} = 145 mA



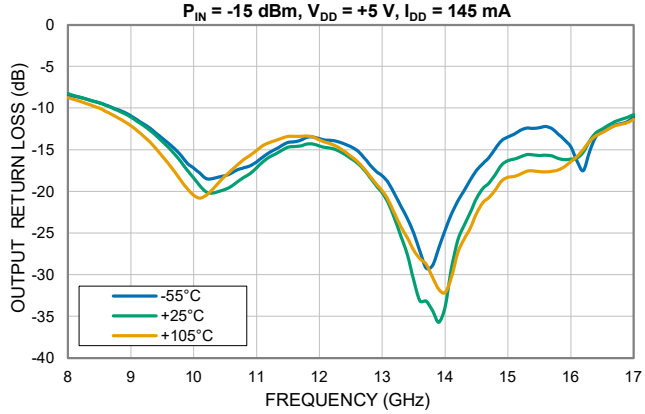
INPUT RETURN LOSS vs. DEVICE VOLTAGE

P_{IN} = -15 dBm, I_{DD} = 145 mA, TEMPERATURE = +25°C



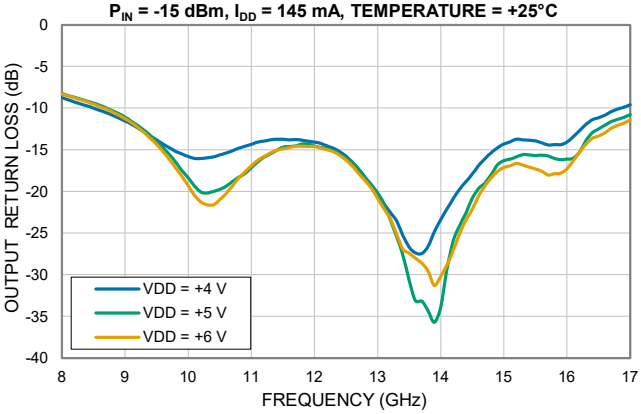
OUTPUT RETURN LOSS vs. TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +5 V, I_{DD} = 145 mA



OUTPUT RETURN LOSS vs. DEVICE VOLTAGE

P_{IN} = -15 dBm, I_{DD} = 145 mA, TEMPERATURE = +25°C



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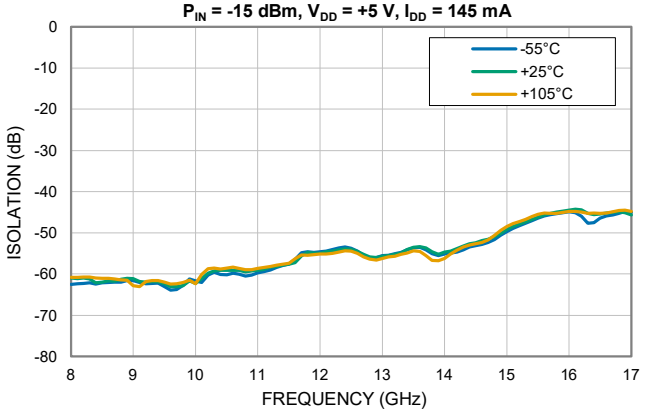
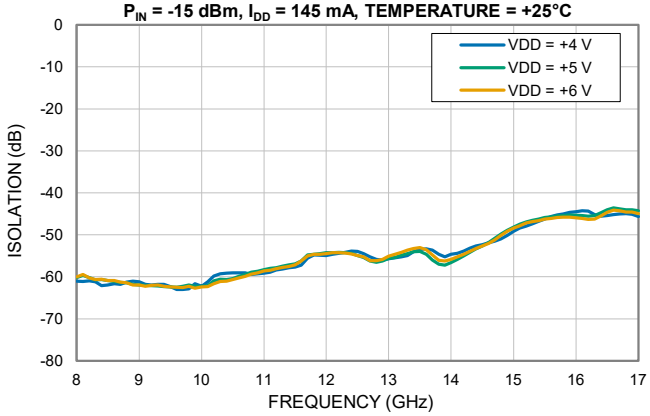
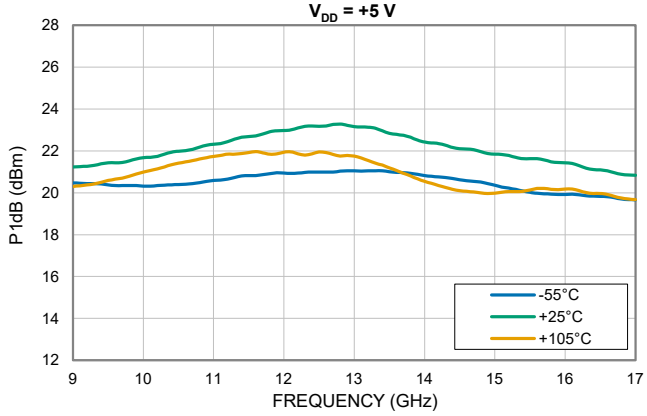
ISOLATION vs.TEMPERATURE
P_{IN} = -15 dBm, V_{DD} = +5 V, I_{DD} = 145 mA



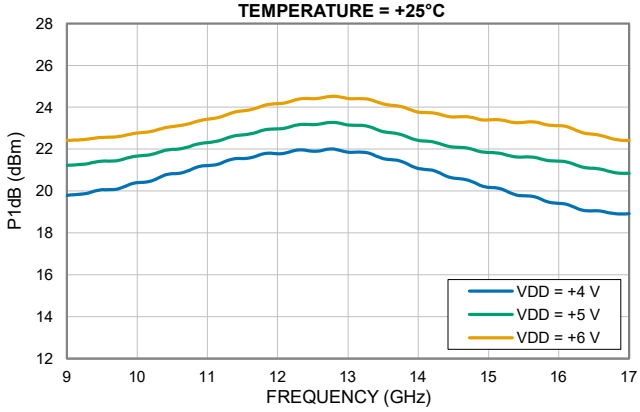
ISOLATION vs. DEVICE VOLTAGE,
P_{IN} = -15 dBm, I_{DD} = 145 mA, TEMPERATURE = +25°C



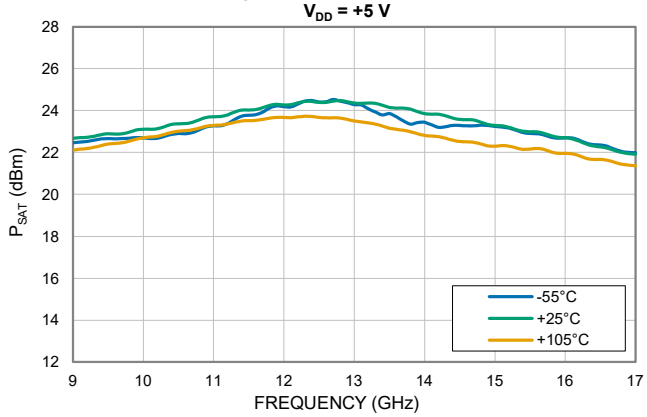
P1dB vs. TEMPERATURE
V_{DD} = +5 V



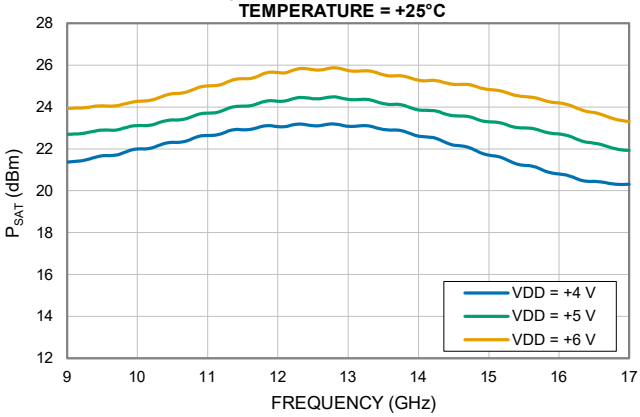
P1dB vs. DEVICE VOLTAGE
TEMPERATURE = +25°C



P_{SAT} vs. TEMPERATURE
V_{DD} = +5 V



P_{SAT} vs. DEVICE VOLTAGE
TEMPERATURE = +25°C



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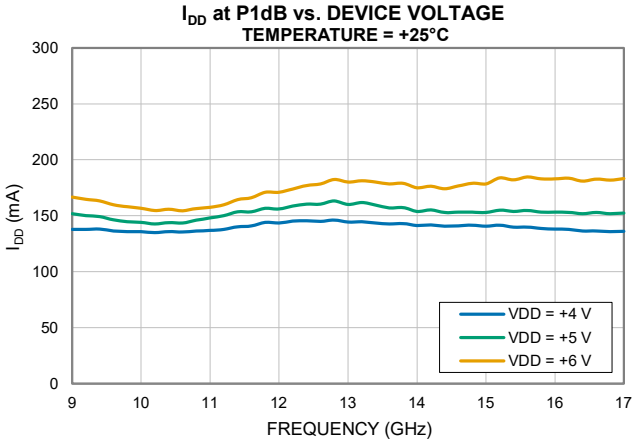

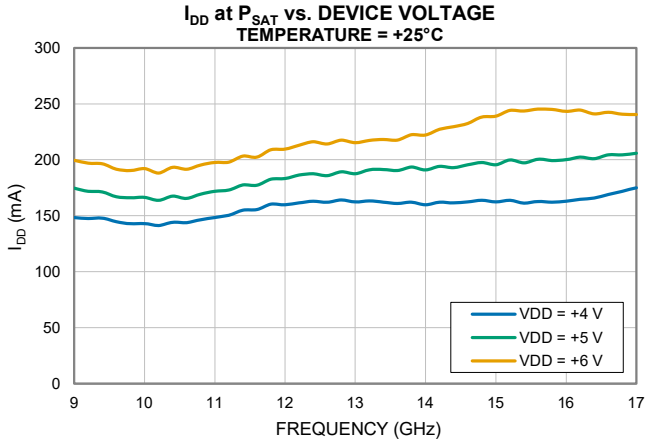

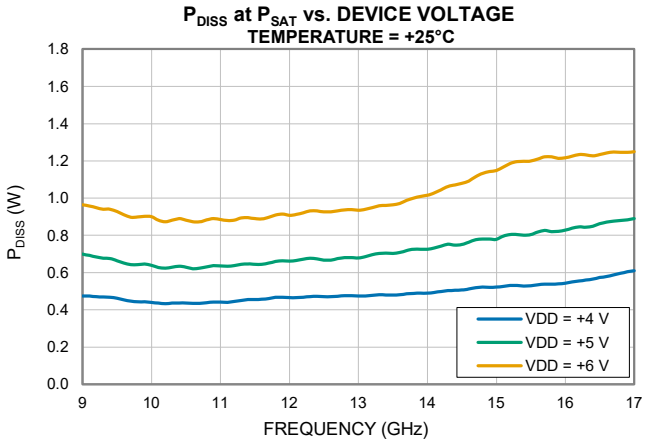

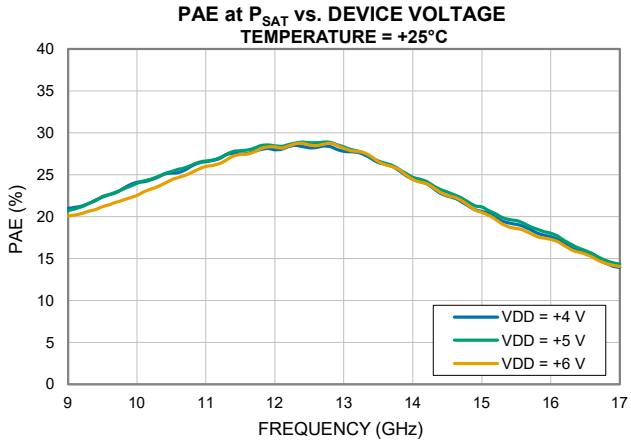

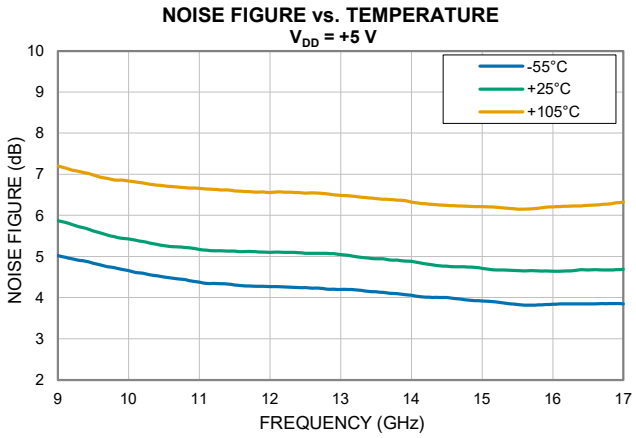

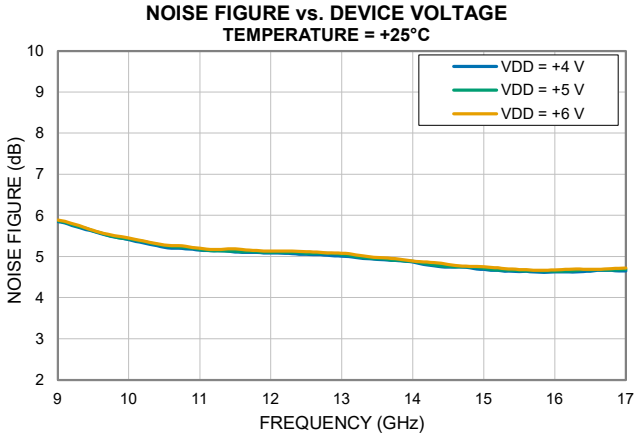

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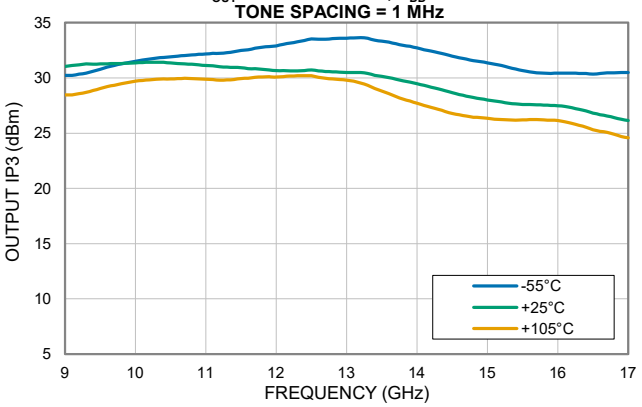
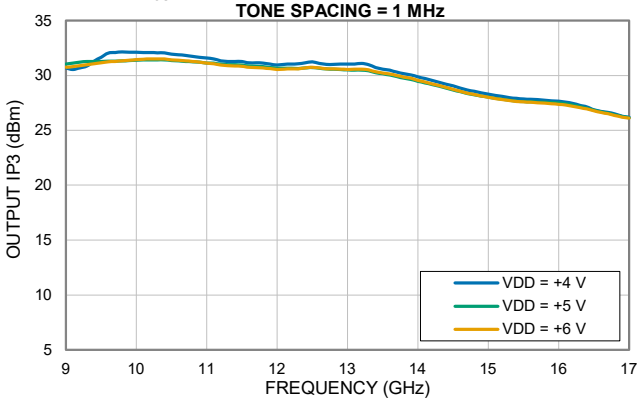
TYPICAL PERFORMANCE GRAPHS

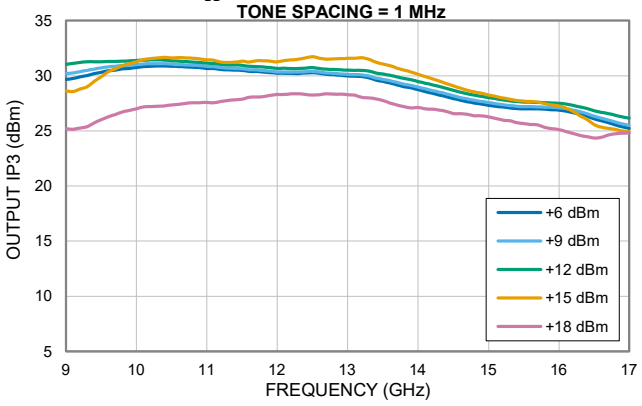
OUTPUT IP3 vs. TEMPERATURE
P_{OUT} = +12 dBm/TONE, V_{DD} = +5 V
TONE SPACING = 1 MHz



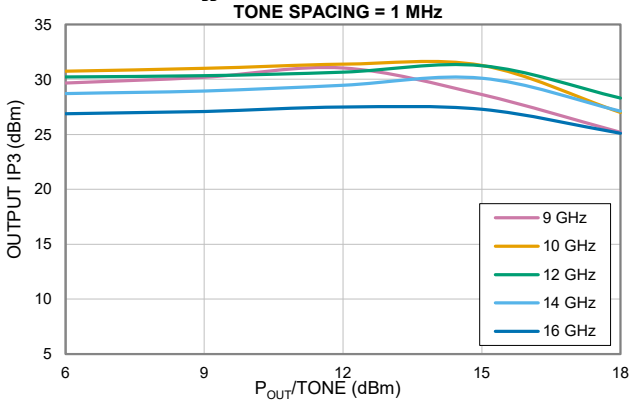
OUTPUT IP3 vs. DEVICE VOLTAGE,
P_{OUT} = +12 dBm/TONE, TEMPERATURE = +25°C
TONE SPACING = 1 MHz



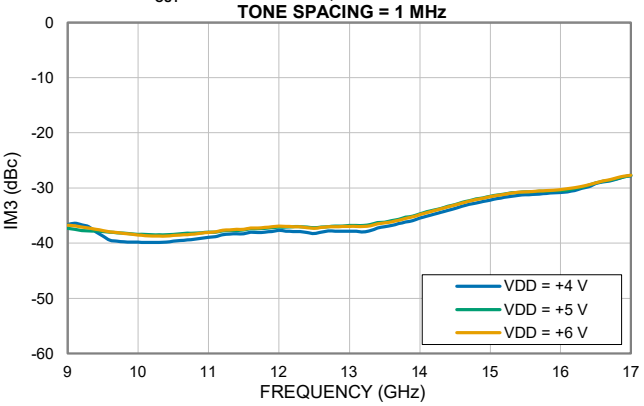
OUTPUT IP3 vs. OUTPUT POWER
V_{DD} = +5 V, TEMPERATURE = +25°C
TONE SPACING = 1 MHz



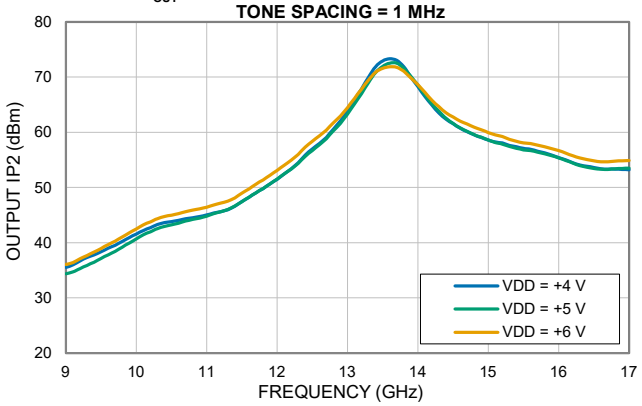
OUTPUT IP3 vs. FREQUENCY
V_{DD} = +5 V, TEMPERATURE = +25°C
TONE SPACING = 1 MHz



IM3 vs. DEVICE VOLTAGE,
P_{OUT} = +12 dBm/TONE, TEMPERATURE = +25°C
TONE SPACING = 1 MHz



OUTPUT IP2 vs. DEVICE VOLTAGE,
P_{OUT} = +12 dBm/TONE, TEMPERATURE = +25°C
TONE SPACING = 1 MHz



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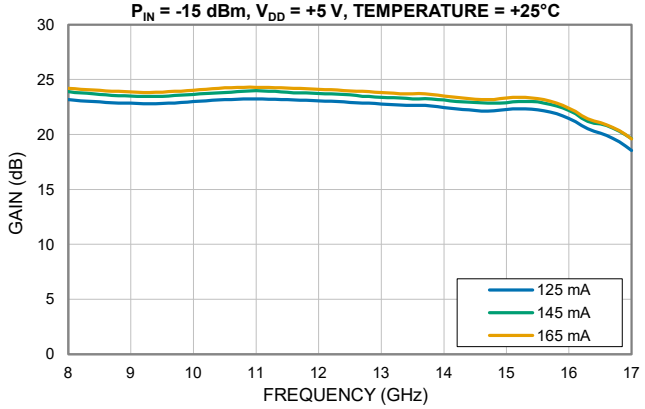
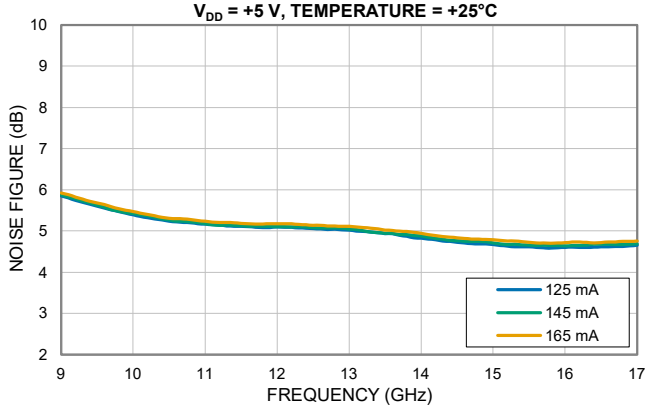
TYPICAL PERFORMANCE GRAPHS

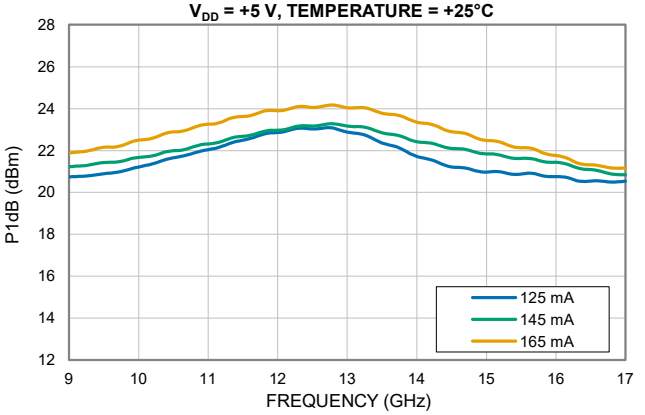
GAIN vs. CURRENT
P_{IN} = -15 dBm, V_{DD} = +5 V, TEMPERATURE = +25°C



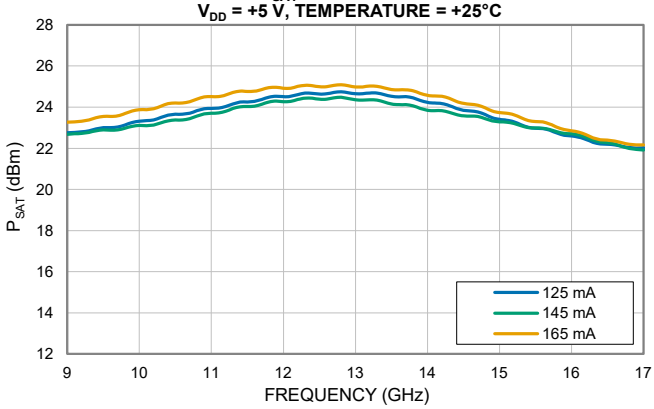
NOISE FIGURE vs. CURRENT,
V_{DD} = +5 V, TEMPERATURE = +25°C



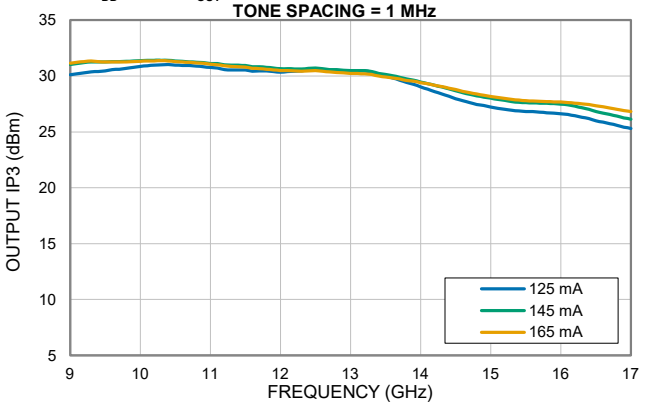
P1dB vs. CURRENT
V_{DD} = +5 V, TEMPERATURE = +25°C



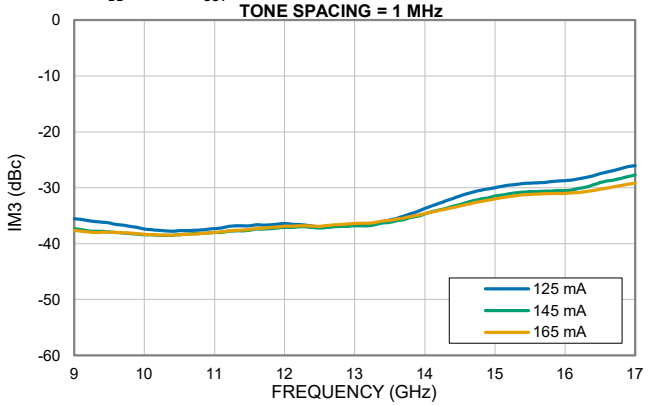
P_{SAT} vs. CURRENT,
V_{DD} = +5 V, TEMPERATURE = +25°C



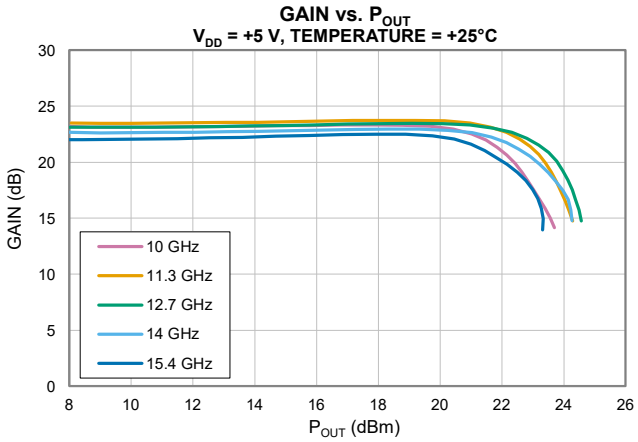
OUTPUT IP3 vs. CURRENT,
V_{DD} = +5 V, P_{OUT} = +12 dBm/TONE, TEMPERATURE = +25°C
TONE SPACING = 1 MHz

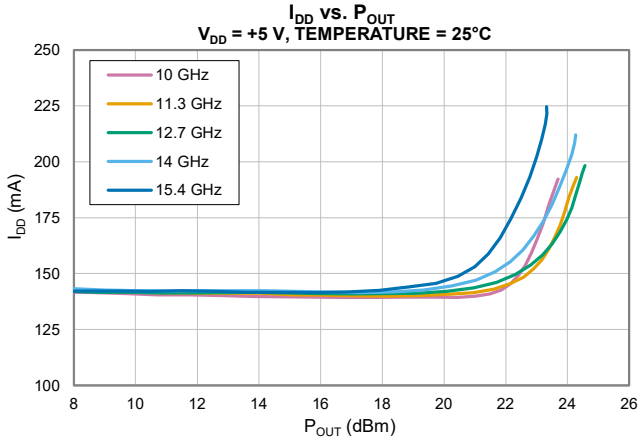


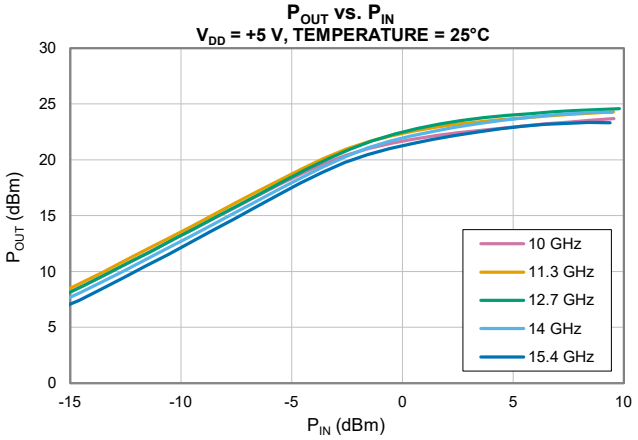
IM3 vs. CURRENT,
V_{DD} = +5 V, P_{OUT} = +12 dBm/TONE, TEMPERATURE = +25°C
TONE SPACING = 1 MHz

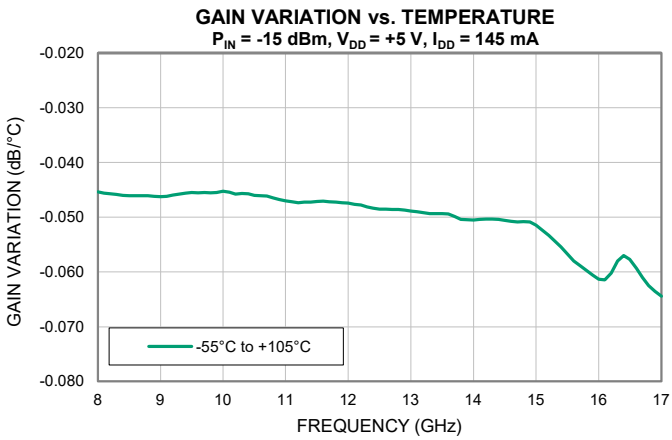


TYPICAL PERFORMANCE GRAPHS









ABSOLUTE MAXIMUM RATINGS[8]

Parameter	Ratings
Operating Temperature (ground lead)	-55 °C to +105 °C
Storage Temperature	-65 °C to +150 °C
Junction Temperature[9]	+175 °C
Total Power Dissipation	1.81 W
Input Power (CW), V_{DD} = +5 V	+27 dBm
DC Drain Voltage on V_{DD}[10]	+8 V
DC Drain Current I_{DD}[11]	300 mA
DC Gate Voltage at $V_{GG} = V_{G12} = V_{G3}$	-3 V < V_{GG} < -0.4 V
DC Gate Current I_{GG}	1.6 mA

8. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
9. Peak Temperature on top of Die.
10. $V_{DD} = V_{D12} = V_{D3}$.
11. $I_{DD} = I_{D12} + I_{D3}$.

THERMAL RESISTANCE

Parameter	Ratings
Thermal Resistance (Θ_{JC})[12]	38.7 °C/W

12. Θ_{JC} = (Hot Spot Temperature on Die - Temperature at Ground Lead) / Dissipated Power

ESD RATING

	Class	Voltage Range	Reference Standard
HBM	1C	1000 V to < 2000 V	ANSI/ESDA/JEDEC JS-001-2023
CDM	C1	250 V to < 500 V	ANSI/ESDA/JEDEC JS-002-2022

ESD HANDLING PRECAUTION: This device is designed to be Class 1C for HBM. Static charges may easily produce potentials higher than this with improper handling and can discharge into DUT and damage it. As a preventive measure Industry standard ESD handling precautions should be used at all times to protect the device from ESD damage.

MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020E/JEDEC J-STD-033C

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FUNCTIONAL DIAGRAM (TOP VIEW)

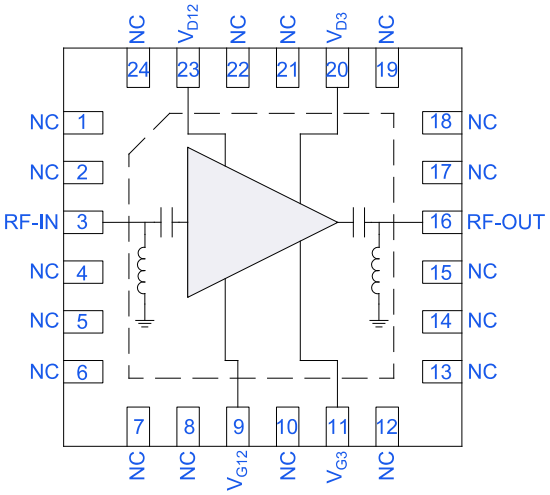


Figure 1. PMA4-9163+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Description (Refer to Figure 2)
RF-IN	3	RF-IN Pad connects to RF Input port.
RF-OUT	16	RF-OUT Pad connects to RF Output port.
V_{D12}	23	DC Input pad connects to First/Second Stage Drain Voltage port.
V_{G12}	9	DC Input pad connects to First/Second Stage Gate Voltage port.
V_{D3}	20	DC Input pad connects to Third Stage Drain Voltage port.
V_{G3}	11	DC Input pad connects to Third Stage Gate Voltage port.
NC	1-2, 4-8, 10, 12-15, 17-19, 21-22, 24	Not used internally. Connected to ground on test board.
GND	Paddle	Connects to ground.

EVALUATION TEST BOARD

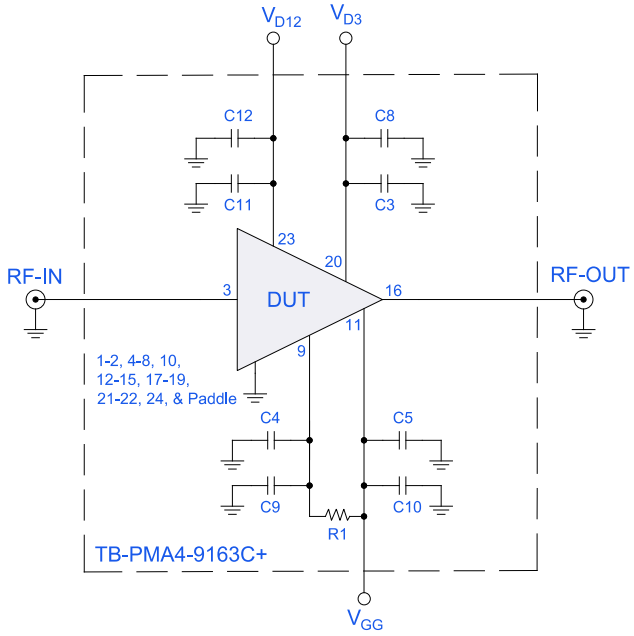


Figure 2. PMA4-9163+ Evaluation and Application Circuit

Electrical Parameters and Conditions
Gain, Return Loss, Output Power at 1 dB Compression (P1dB), Output IP3 (OIP3), and Noise Figure measured using N5245B PNA-X Microwave Network Analyzer.

Conditions:
1. Gain and Return Loss: P_{IN} = -15 dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, +12 dBm/Tone at output.

Power ON/Power OFF Sequence:
Caution: Permanent damage to the device will occur if the Power ON and Power OFF sequences are not followed.

POWER ON:
1. Set V_{GG} = -2 V and Turn ON.
2. Set V_{D12} = +5 V and Turn ON.
3. Set V_{D3} = +5 V and Turn ON.
4. Increase V_{GG} to desired nominal current I_{DD} = 145 mA. $I_{DD} = I_{D12} + I_{D3}$.
5. Turn ON RF signal.

POWER OFF:
1. Turn OFF RF signal.
2. Decrease V_{GG} to -2 V.
3. Turn OFF V_{D12}, V_{D3}.
4. Turn OFF V_{GG}.

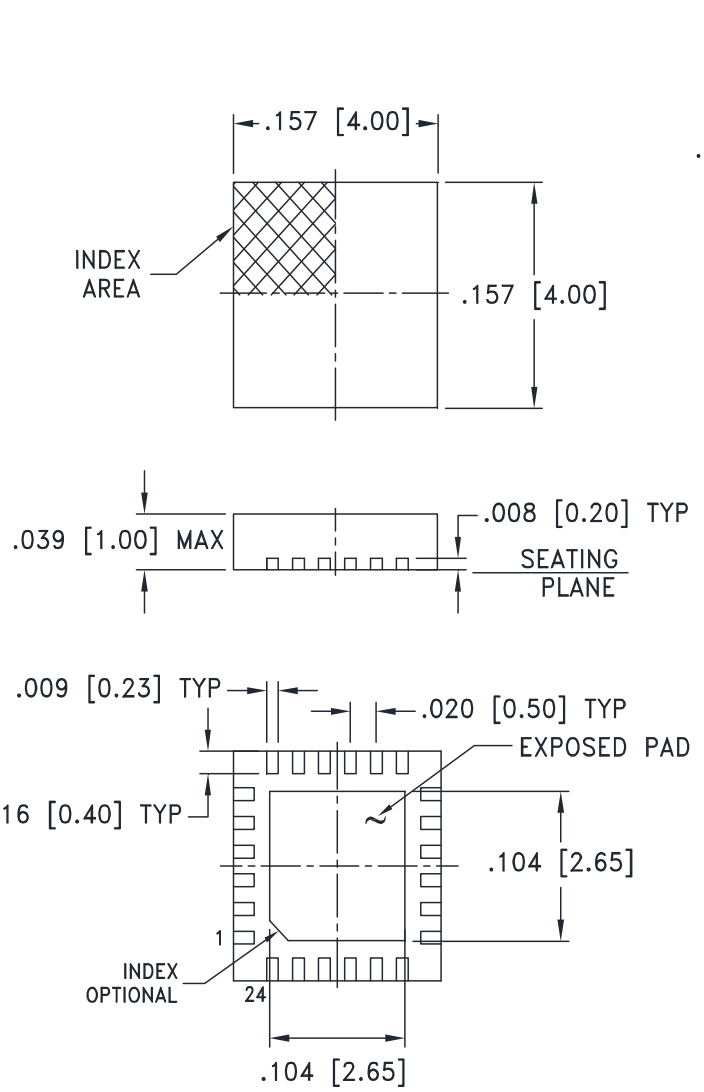
Component	Value	Size	Part Number	Manufacturer
C3, C4, C5, C11	1 nF	0402	GRM1555C1H102JA01D	Murata
C8, C9, C10, C12	0.1 uF	0402	GRM155R71E104KE14D	Murata
R1	100 Ω	0402	RK73H1ETTP1000F	KOA

Wideband Amplifier

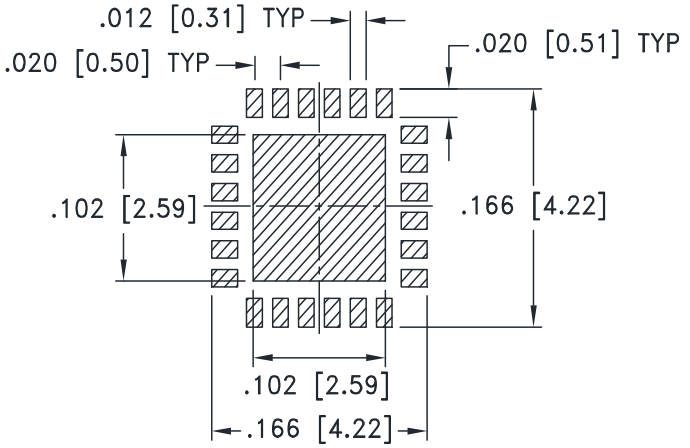
PMA4-9163+

50Ω 9 to 16 GHz Medium Power Driver Amplifier

CASE STYLE DRAWING



PCB Land Pattern

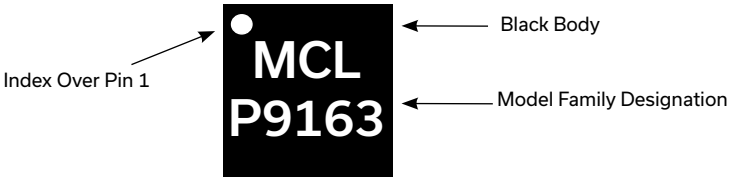


SUGGESTED LAYOUT,
TOLERANCE TO BE WITHIN ±.002

Weight: .04 Grams

Dimensions are in inches [mm]. Tolerances in inches: 2 Pl. ± .01; 3 Pl. ± .005 inches

PRODUCT MARKING



Marking may contain other features or characters for internal lot control.

Wideband Amplifier

PMA4-9163+

50Ω 9 to 16 GHz Medium Power Driver Amplifier

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD CLICK HERE

Performance Data & Graphs	Data Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	DG1847 Plastic package, exposed paddle, Lead Finish: Matte-Tin
RoHS Status	Compliant
Tape & Reel **Standard Quantities Available on Reel**	F68 7" Reels with 20, 50, 100, 200, 500, or 1000 devices 13" Reels with 2000, 3000, or 4000 devices
Suggested Layout for PCB Design	PL-871
Evaluation Board	TB-PMA4-9163C+ Gerber File
Environmental Ratings	ENV08T1

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-Circuits' 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