MMIC SURFACE MOUNT

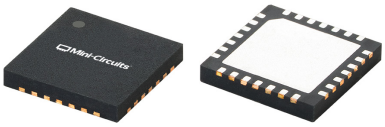
Power Amplifier

PMA6-93-10W+

50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

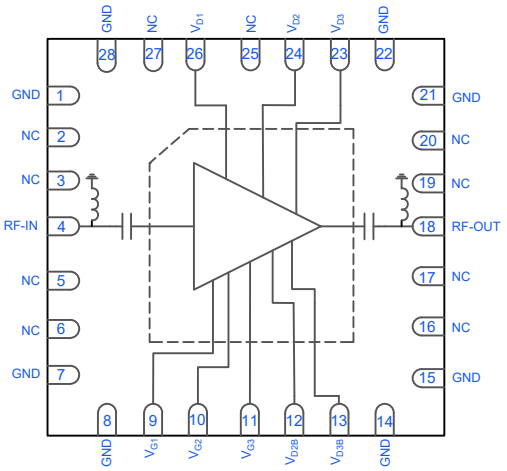
THE BIG DEAL

- High Gain, Typ. 28.9 dB
- High P_{SAT}, Typ. +39.3 dBm
- Excellent PAE, Typ. 32.6%
- 6x6 mm 28-Lead QFN-Style Package
- High Linearity Design Optimized for High PAR Communication Signals



Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM



APPLICATIONS

- Back Haul Radio Systems
- Radar Systems

PRODUCT OVERVIEW

Mini-Circuits' PMA6-93-10W+ is a GaAs MMIC Power Amplifier operating from 7.1 to 8.5 GHz. This internally matched 50Ω amplifier provides 28.9 dB of gain, +39.3 dBm saturated output power, and +47.1 dBm output IP3, while operating from a +8 V power supply and consuming 2 A of bias current. This amplifier is fully matched at the input and output, allowing for seamless implementation, and it is assembled in a 6x6 mm 28-lead QFN-style package. These characteristics make it ideally suited for back haul radio systems and radar systems that require high operating output power, while maintaining very low distortion characteristics.

KEY FEATURES

Feature	Advantages
High P_{SAT} Typ. +39.3 dBm	With a high saturated output power, this device can be used as the power amplifier for Back Haul Radio and/or Radar Systems.
High Gain Typ. 28.9 dB	Reduces the number of amplification stages at the system level.
6x6 mm 28-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.

REV. OR
ECO-026116
PMA6-93-10W+
MCL NY
250707

Power Amplifier

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50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

ELECTRICAL SPECIFICATIONS[1] AT +25°C, V_{DD} = +8 V, UNLESS NOTED OTHERWISE

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range		7.1		8.5	GHz
Gain	7.1	27.1	28.4		dB
	7.4	27.4	28.5		
	7.8	27.7	28.9		
	8.2	28.1	29.3		
	8.5	27.6	28.8		
Output Power at 1 dB Compression (P1dB)	7.1		+38.1		dBm
	7.4		+38.5		
	7.8		+38.4		
	8.2		+38.7		
	8.5		+39.1		
Output Power at Saturation (P_{SAT})[2]	7.1		+39.2		dBm
	7.4		+39.4		
	7.8		+39.3		
	8.2		+39.1		
	8.5		+39.2		
Power Added Efficiency (PAE) at P_{SAT}	7.8		32.6		%
Output Third-Order Intercept (P_{OUT} = +20 dBm/Tone)	7.1		+46.0		dBm
	7.4		+46.8		
	7.8		+47.1		
	8.2		+47.0		
	8.5		+46.7		
Input Return Loss	7.1		19		dB
	7.4		20		
	7.8		13		
	8.2		10		
	8.5		10		
Output Return Loss	7.1		20		dB
	7.4		20		
	7.8		15		
	8.2		13		
	8.5		15		
Isolation	7.1		73		dB
	7.4		73		
	7.8		79		
	8.2		69		
	8.5		67		
Noise Figure	7.1		5.5		dB
	7.4		5.5		
	7.8		5.4		
	8.2		5.5		
	8.5		5.7		
Device Operating Voltage (V_{DD})[3]		+6	+8	+8	V
Device Operating Current (I_{DD})[4, 5]			2		A
Gate Voltage (V_{G1} , V_{G2})			-0.75		V
Gate Voltage (V_{G3})			-0.9		V
Device Gate Current (I_{GG})[6]				28	mA
DC Current Variation vs. Temperature[7]			-0.95		mA/°C
DC Current Variation vs. Voltage[8]			-0.35		µA/mV

1. Tested on Mini-Circuits Characterization Test Board TB-PMA6-9310WC+. See Figure 2. Loss de-embedded to the RF input and output pins of the device.
2. P_{SAT} is defined as when the Output Power changes 0.1 dB per 1 dB change in Input Power.
3. $V_{DD} = V_{D1} = V_{D2} = V_{D3} = V_{D2B} = V_{D3B}$
4. Current at P_{IN} = -15 dBm. Current at saturation reaches 3.7 A.
5. $I_{DD} = I_{DD1} + I_{DD2} + I_{DD3}$. $I_{DD12} = I_{DD1} + I_{DD2}$ = 1000 mA. I_{DD3} = 1000 mA.
6. At saturation.
7. (Current at +95°C – Current at -40°C)/(+135°C).
8. (Current at +8 V – Current at +6 V)/(+2 V)

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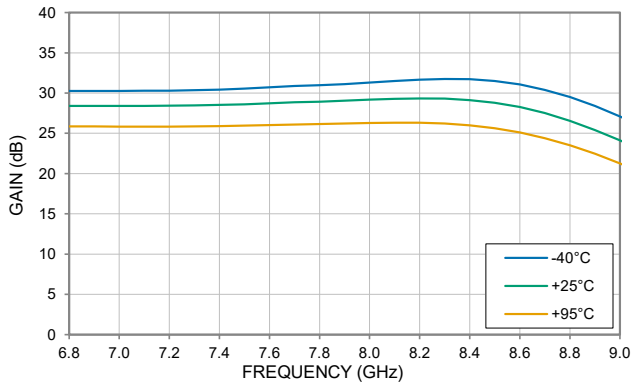
TYPICAL PERFORMANCE GRAPHS

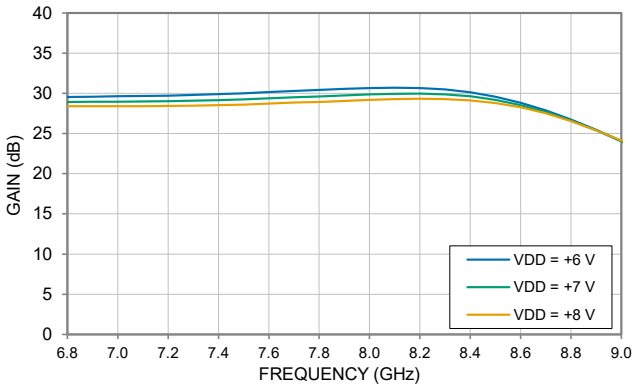
GAIN vs. TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +8 V



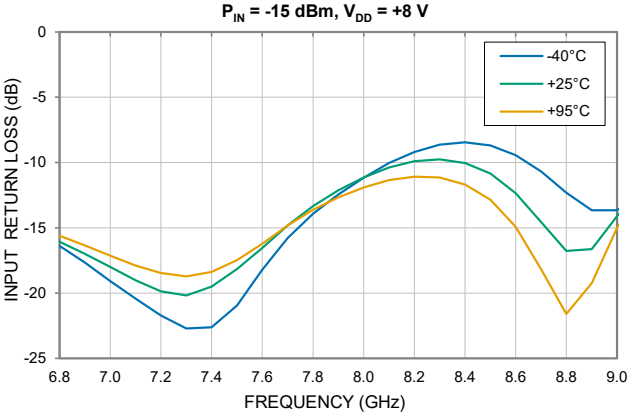
GAIN vs. DEVICE VOLTAGE

P_{IN} = -15 dBm, TEMPERATURE = +25°C



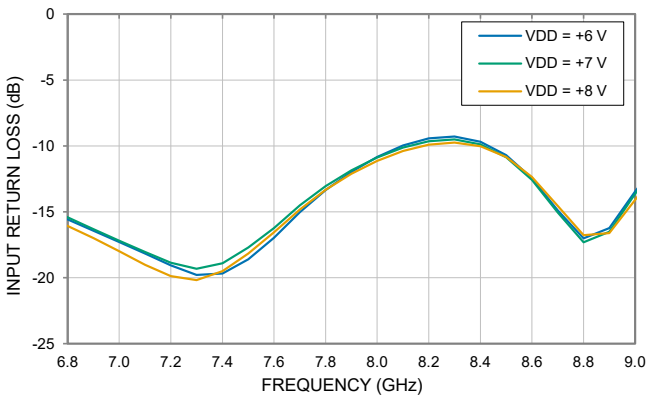
INPUT RETURN LOSS vs. TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +8 V



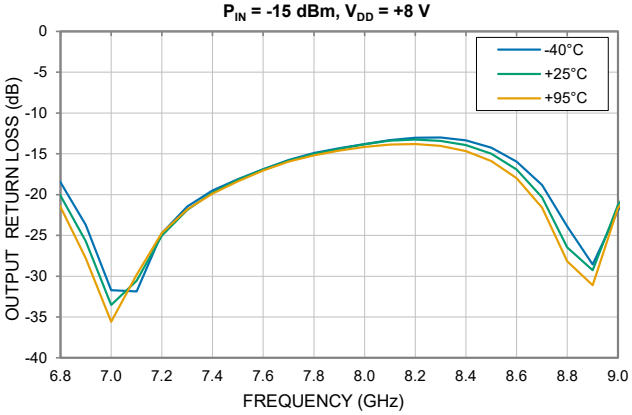
INPUT RETURN LOSS vs. DEVICE VOLTAGE

P_{IN} = -15 dBm, TEMPERATURE = +25°C



OUTPUT RETURN LOSS vs. TEMPERATURE

P_{IN} = -15 dBm, V_{DD} = +8 V



OUTPUT RETURN LOSS vs. DEVICE VOLTAGE

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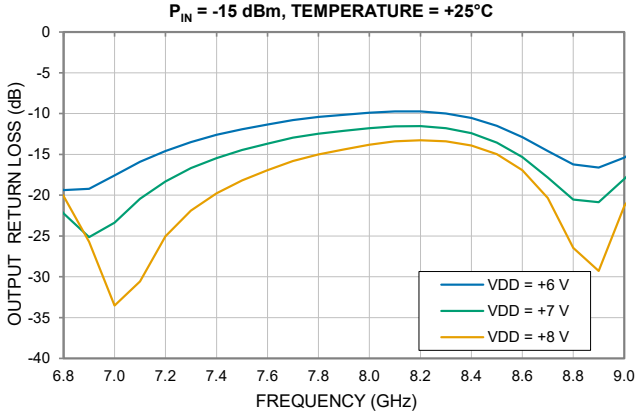

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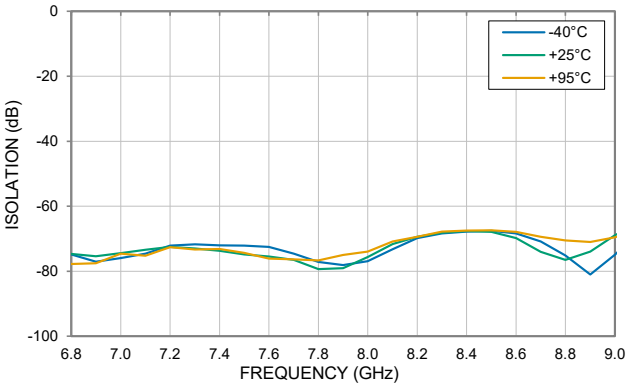
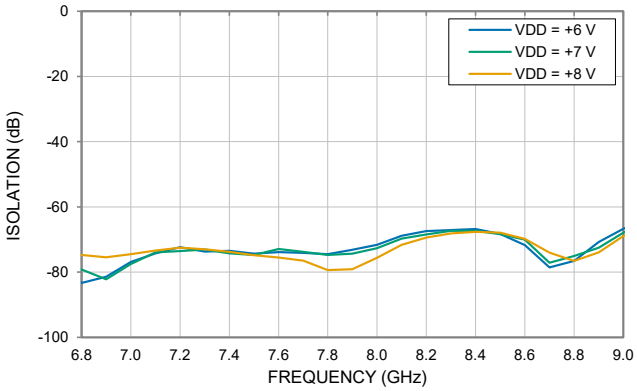
50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

TYPICAL PERFORMANCE GRAPHS

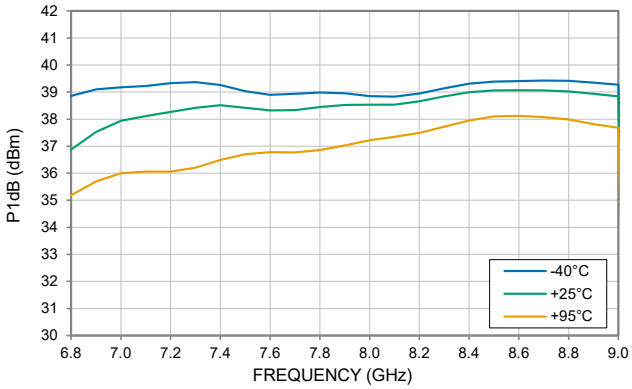
ISOLATION vs.TEMPERATURE
P_{IN} = -15 dBm, V_{DD} = +8 V



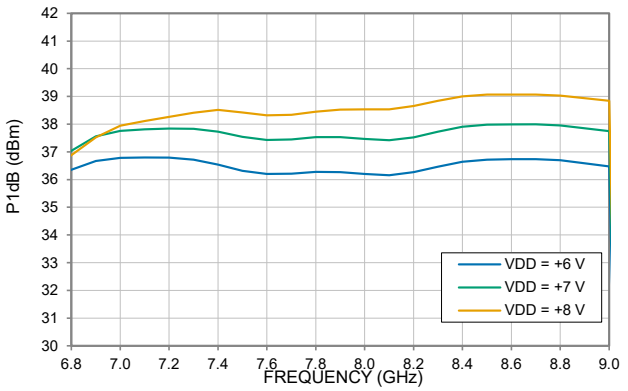
ISOLATION vs. DEVICE VOLTAGE
P_{IN} = -15 dBm, TEMPERATURE = +25°C



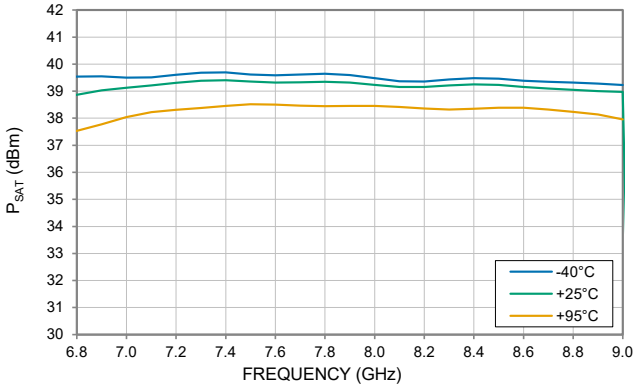
P1dB vs. TEMPERATURE
V_{DD} = +8 V



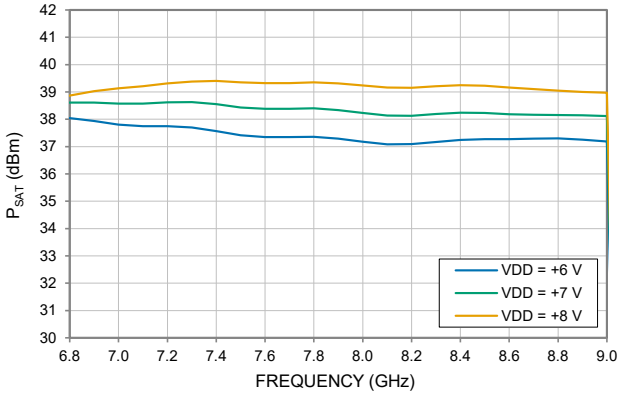
P1dB vs. DEVICE VOLTAGE
TEMPERATURE = +25°C



P_{SAT} vs. TEMPERATURE
V_{DD} = +8 V



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



Power Amplifier

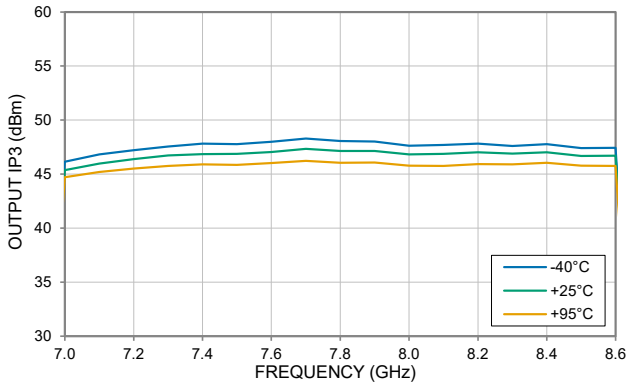
PMA6-93-10W+

50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

TYPICAL PERFORMANCE GRAPHS

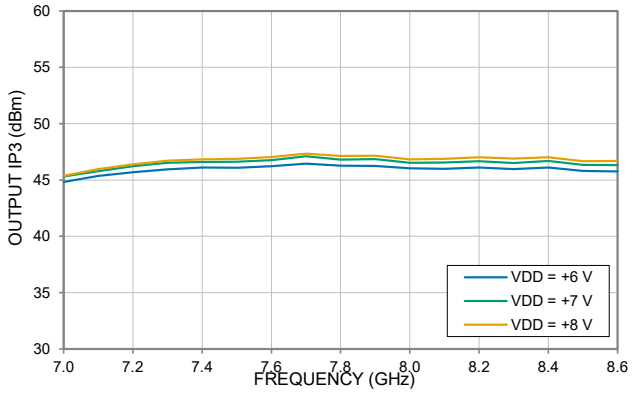
OUTPUT IP3 vs. TEMPERATURE

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5 MHz, V_{DD} = +8 V



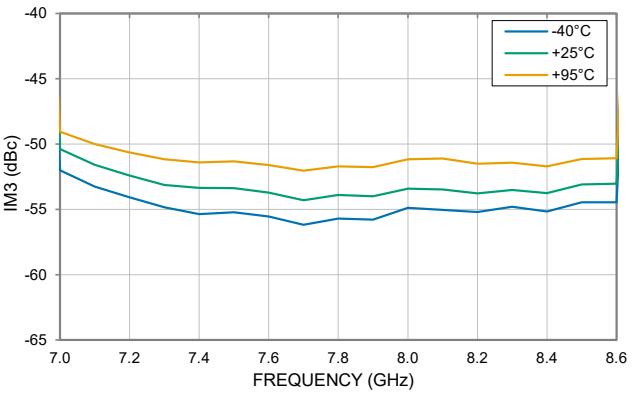
OUTPUT IP3 vs. DEVICE VOLTAGE

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5 MHz
TEMPERATURE = +25°C



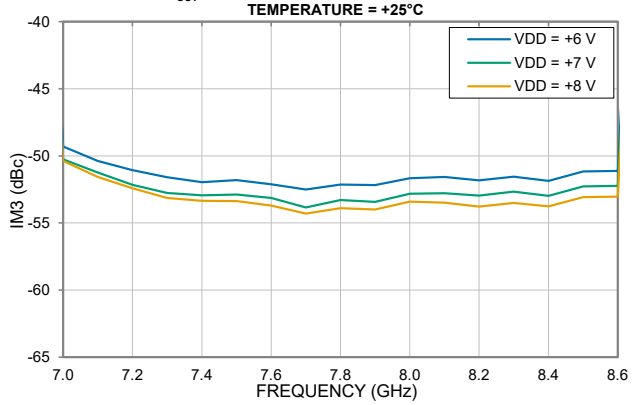
IM3 vs. TEMPERATURE

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5 MHz, V_{DD} = +8 V



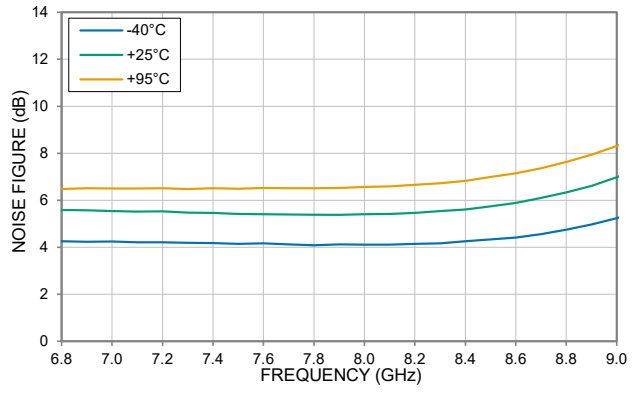
IM3 vs. DEVICE VOLTAGE

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5 MHz
TEMPERATURE = +25°C



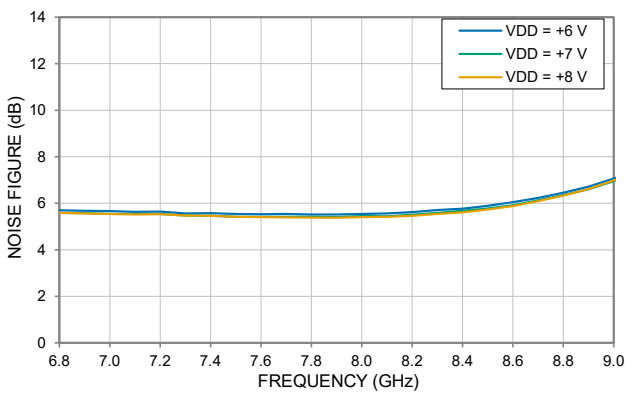
NOISE FIGURE vs. TEMPERATURE

V_{DD} = +8 V



NOISE FIGURE vs. DEVICE VOLTAGE

TEMPERATURE = +25°C



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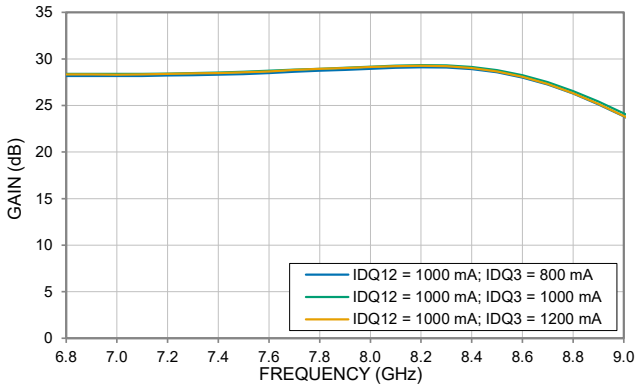
TYPICAL PERFORMANCE GRAPHS

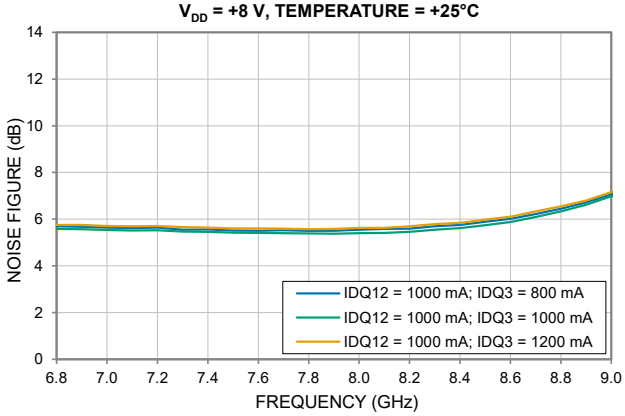
GAIN vs. CURRENT

P_{IN} = -15 dBm, V_{DD} = +8 V, TEMPERATURE = +25°C



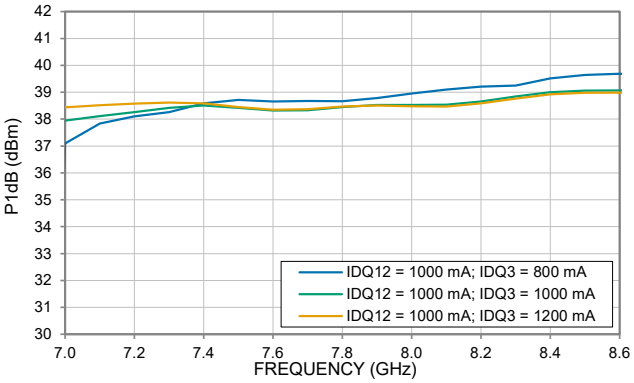
NOISE FIGURE vs. CURRENT

V_{DD} = +8 V, TEMPERATURE = +25°C



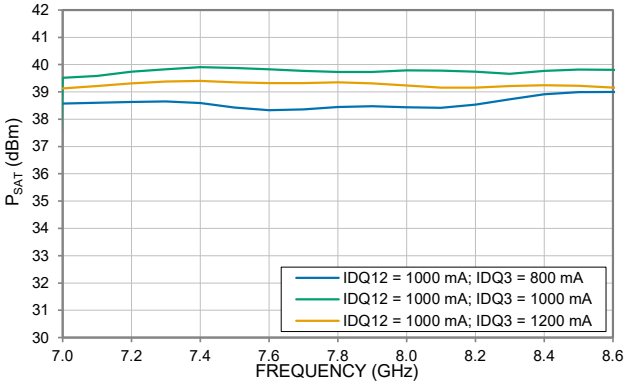
P1dB vs. CURRENT

V_{DD} = +8 V, TEMPERATURE = +25°C



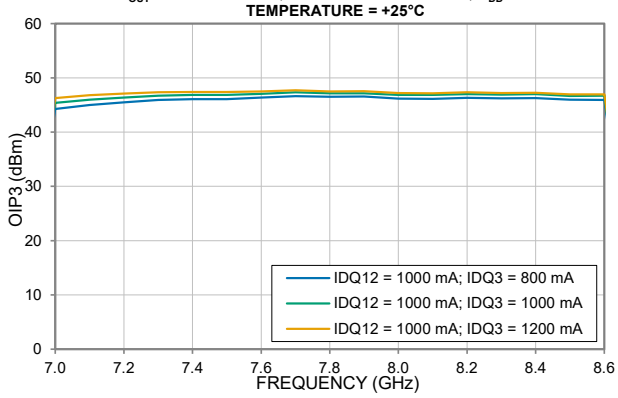
P_{SAT} vs. CURRENT

V_{DD} = +8 V, TEMPERATURE = +25°C



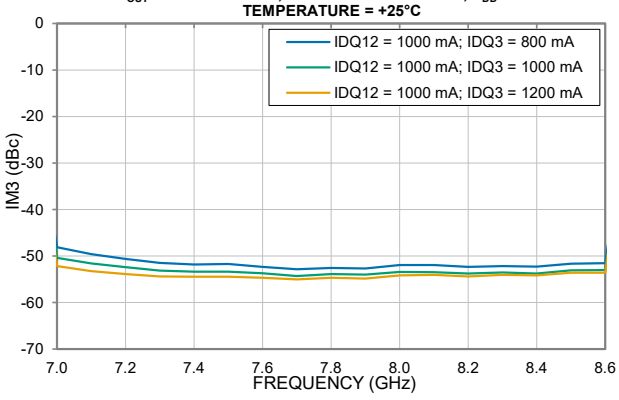
OIP3 vs. CURRENT

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5 MHz, V_{DD} = +8 V
TEMPERATURE = +25°C



IM3 vs. CURRENT

P_{OUT} = +20 dBm/TONE, TONE SPACING = 5MHz, V_{DD} = +8 V
TEMPERATURE = +25°C



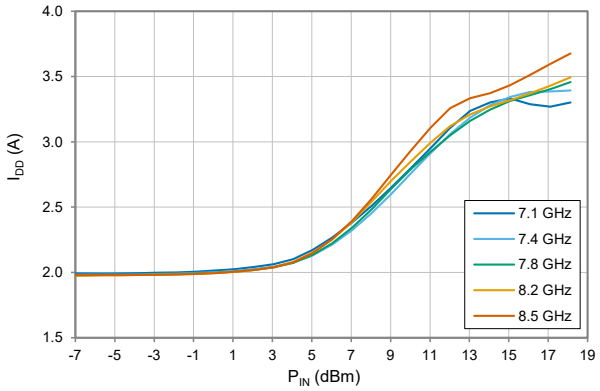
Power Amplifier

PMA6-93-10W+

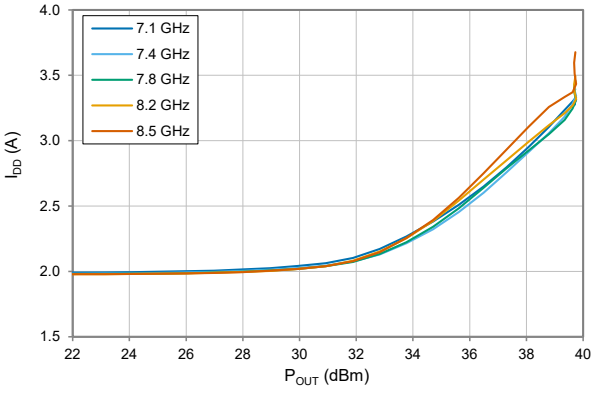
50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

TYPICAL PERFORMANCE GRAPHS

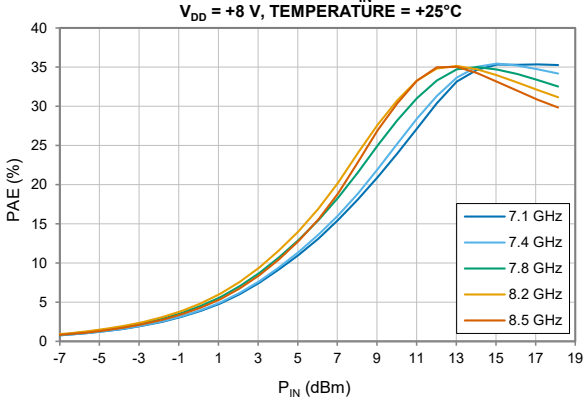
I_{DD} vs. P_{IN}
V_{DD} = +8 V, TEMPERATURE = +25°C



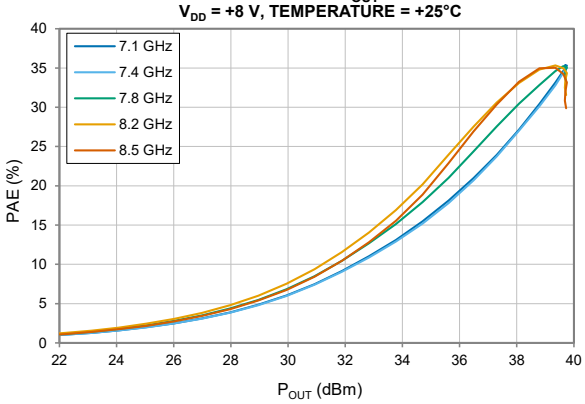
I_{DD} vs. P_{OUT}
V_{DD} = +8 V, TEMPERATURE = +25°C



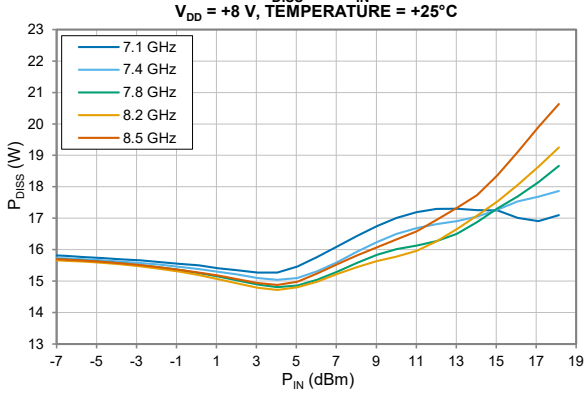
PAE vs. P_{IN}
V_{DD} = +8 V, TEMPERATURE = +25°C



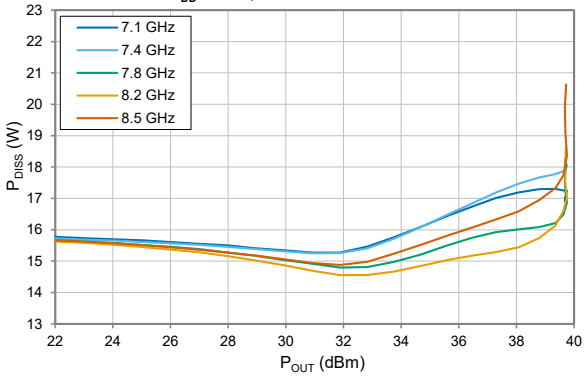
PAE vs. P_{OUT}
V_{DD} = +8 V, TEMPERATURE = +25°C



P_{DISS} vs. P_{IN}
V_{DD} = +8 V, TEMPERATURE = +25°C



P_{DISS} vs. P_{OUT}
V_{DD} = +8 V, TEMPERATURE = +25°C



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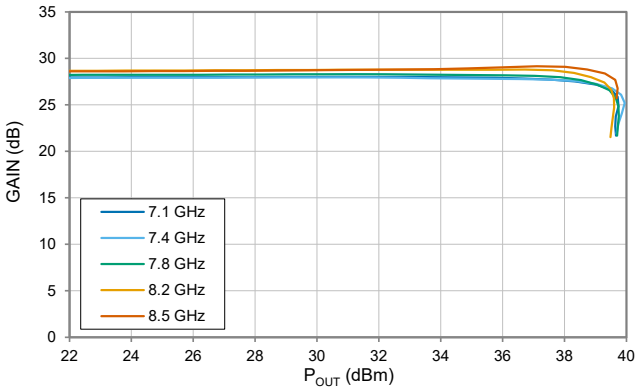
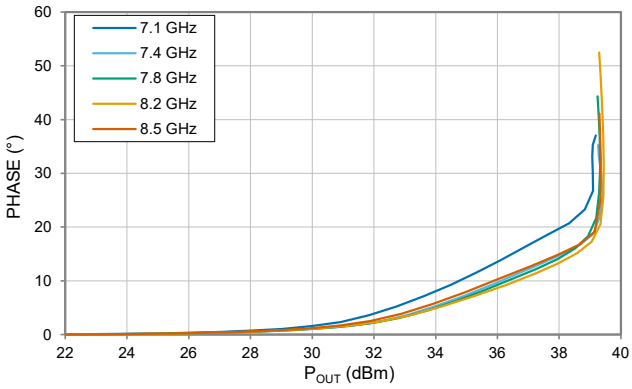
TYPICAL PERFORMANCE GRAPHS

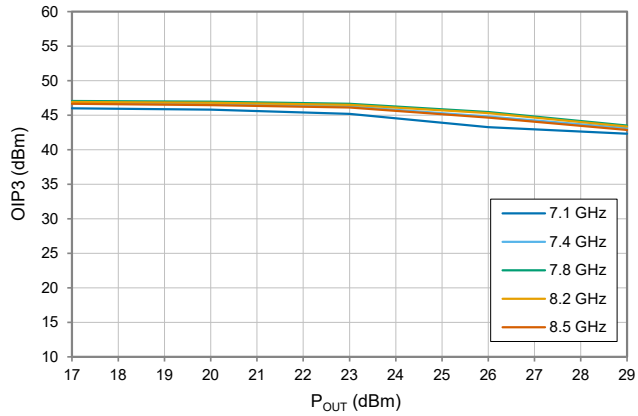
AM - AM
V_{DD} = +8 V, TEMPERATURE = +25°C



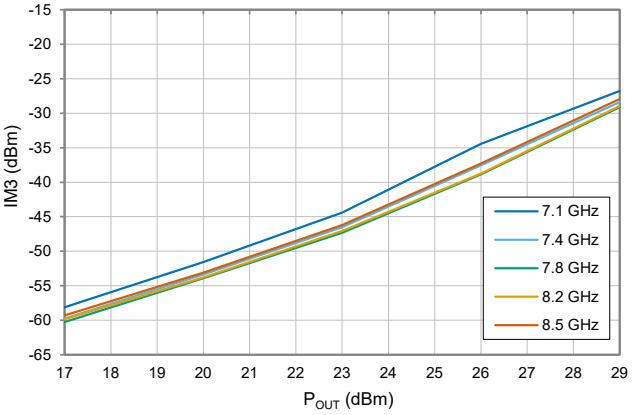
AM - PM
V_{DD} = +8 V, TEMPERATURE = +25°C



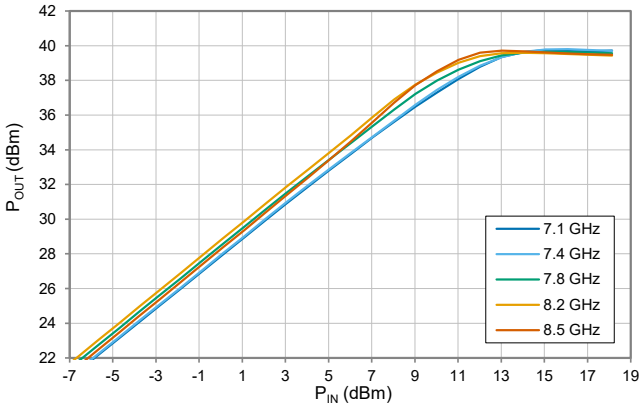
OIP3 vs. P_{OUT}/TONE
V_{DD} = +8 V, TONE SPACING = 5 MHz, TEMPERATURE = +25°C



IM3 vs. P_{OUT}/TONE
V_{DD} = +8 V, TONE SPACING = 5 MHz, TEMPERATURE = +25°C



P_{OUT} vs. P_{IN}
V_{DD} = +8 V, TEMPERATURE = +25°C



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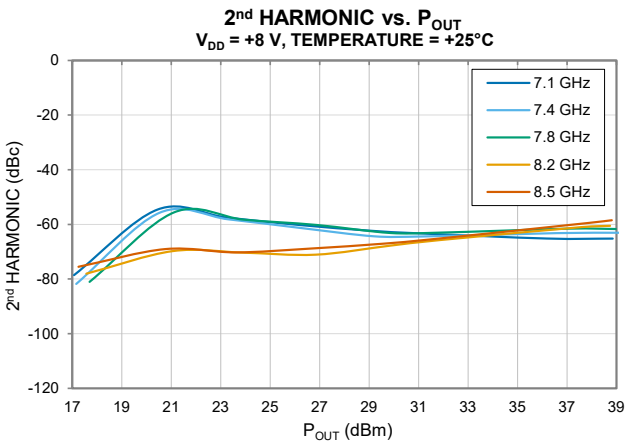
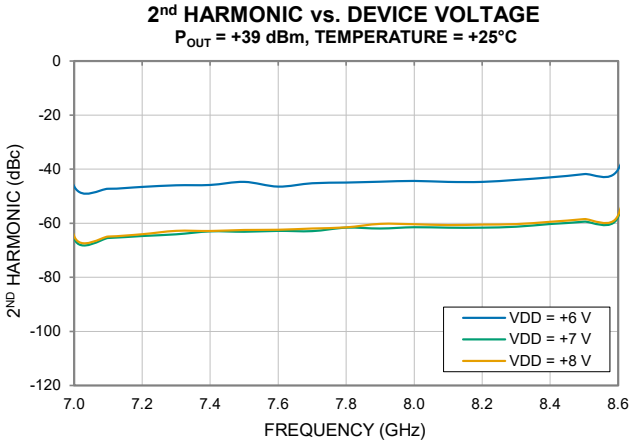
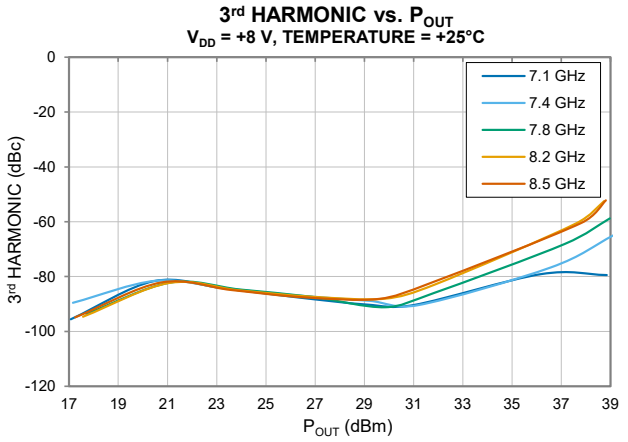
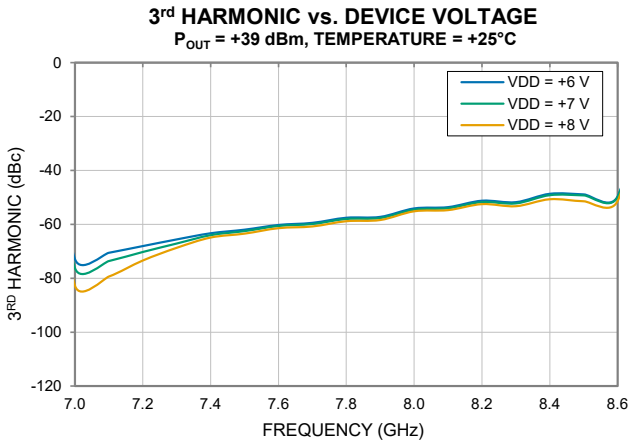








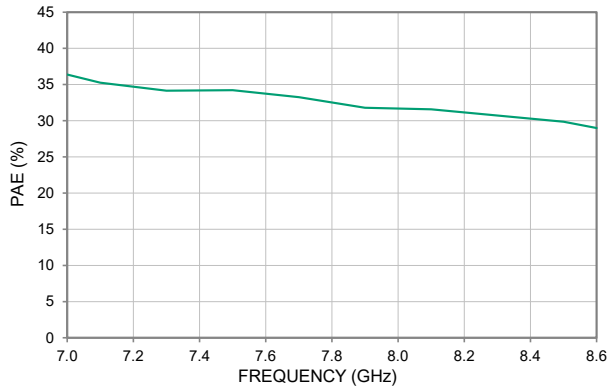
Power Amplifier

PMA6-93-10W+

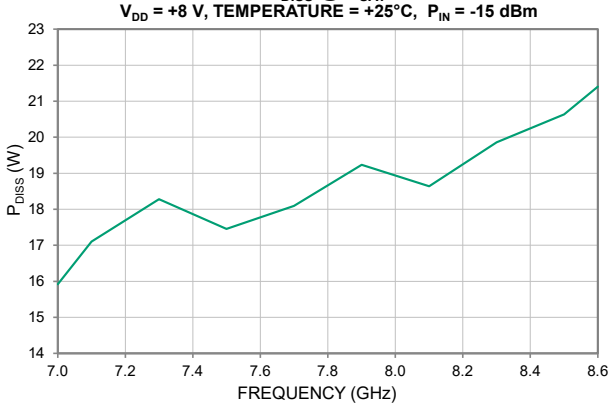
50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

TYPICAL PERFORMANCE GRAPHS

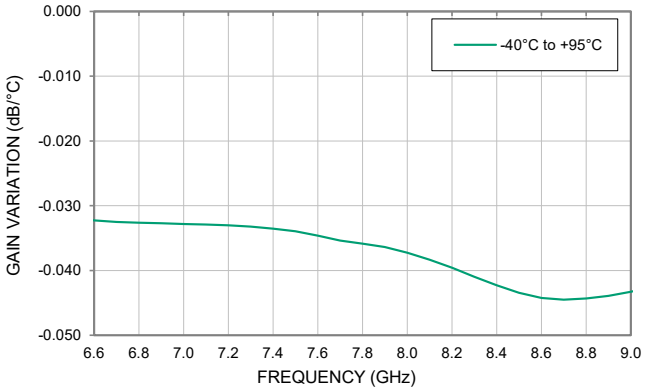
PAE @ P_{SAT}
V_{DD} = +8 V, TEMPERATURE = +25°C, P_{IN} = -15 dBm



P_{DISS} @ P_{SAT}
V_{DD} = +8 V, TEMPERATURE = +25°C, P_{IN} = -15 dBm



GAIN VARIATION vs. TEMPERATURE
P_{IN} = -15 dBm, V_{DD} = +8 V



ABSOLUTE MAXIMUM RATINGS[9]

Parameter	Ratings
Operating Temperature[10]	-40°C to +95°C
Storage Temperature	-65°C to +150°C
Junction Temperature[11]	+175°C
Total Power Dissipation	22 W
Input Power (CW), V_{DD} = +8 V	+33 dBm
DC Drain Voltage at V_{DD}[12]	+9 V
DC Gate Voltage at V_{G1}, V_{G2}, V_{G3}	-3 V ≤ V_{G1}, V_{G2}, V_{G3} ≤ -0.4 V
DC Drain Current I_{DD}	5 A
DC Gate Current I_{GG}	28 mA

9. Permanent damage may occur if these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
10. Bottom of Die.
11. Peak temperature on top of Die.
12. V_{DD} = V_{D1} = V_{D2} = V_{D3} = V_{D2B} = V_{D3B}

THERMAL RESISTANCE

Parameter	Ratings
Thermal Resistance (Θ_{JC})[13]	4.9°C/W

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

ESD RATING

	Class	Voltage Range	Reference Standard
HBM	1C	1000 to < 2000	ANSI/ESDA/JEDEC JS-001-2023
CDM	C2A	500 to < 750	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

Power Amplifier

PMA6-93-10W+

50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

FUNCTIONAL DIAGRAM

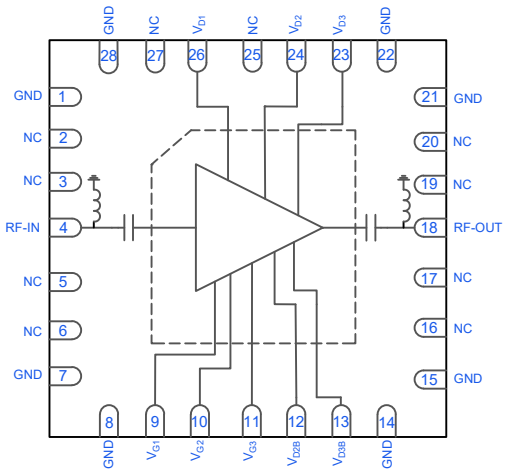


Figure 1. PMA6-93-10W+ Functional Diagram

PIN DESCRIPTION

Function	Pin Number	Description (Refer to Figure 1)
RF-IN	4	RF-IN pin connects to RF Input port.
RF-OUT	18	RF-OUT pin connects to RF Output port.
V_{D1}	26	DC Input pin connects to First Stage Drain Voltage port.
V_{D2}	24	DC Input pin connects to Drain Voltage port of 2nd stage top half.
V_{D3}	23	DC Input pin connects to 3rd stage Gate Voltage port.
V_{D2B}	12	DC Input pin connects to Drain Voltage of 2nd stage bottom half.
V_{D3B} [15]	13	DC Input pin connects to Drain Voltage port of 3rd stage bottom half.
V_{G1} [14]	9	DC Input pin connects to First Stage Gate Voltage port.
V_{G2} [14]	10	DC Input pin connects to 2nd Stage Gate Voltage port.
V_{G3}	11	DC Input pin connects to 3rd Stage Gate Voltage port.
NC	3, 5, 17, 19, 27	Not connected on test board. May be connected to ground or left open.
NC	2, 6, 16, 20, 25	Connected to ground on test board. May be connected to ground or left open.
GND	1, 7, 8, 14, 15, 21, 22, 28, PADDLE	Connect to ground.

14. V_{G1} and V_{G2} are connected on TB-PMA6-9310WC+.
15. For optimal performance voltage should be applied to V_{D3} and V_{D3B} ports. During characterization, both ports were connected via a jumper on TB-PMA6-9310WC+.

CHARACTERIZATION BOARD

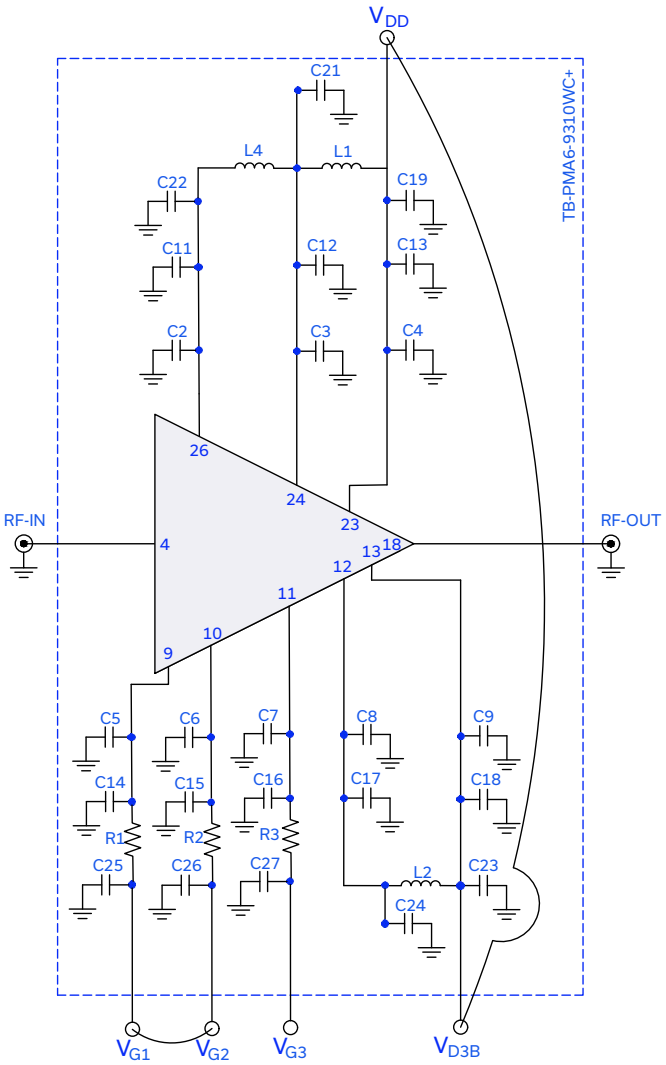


Figure 2. PMA6-93-10W+ Characterization Circuit

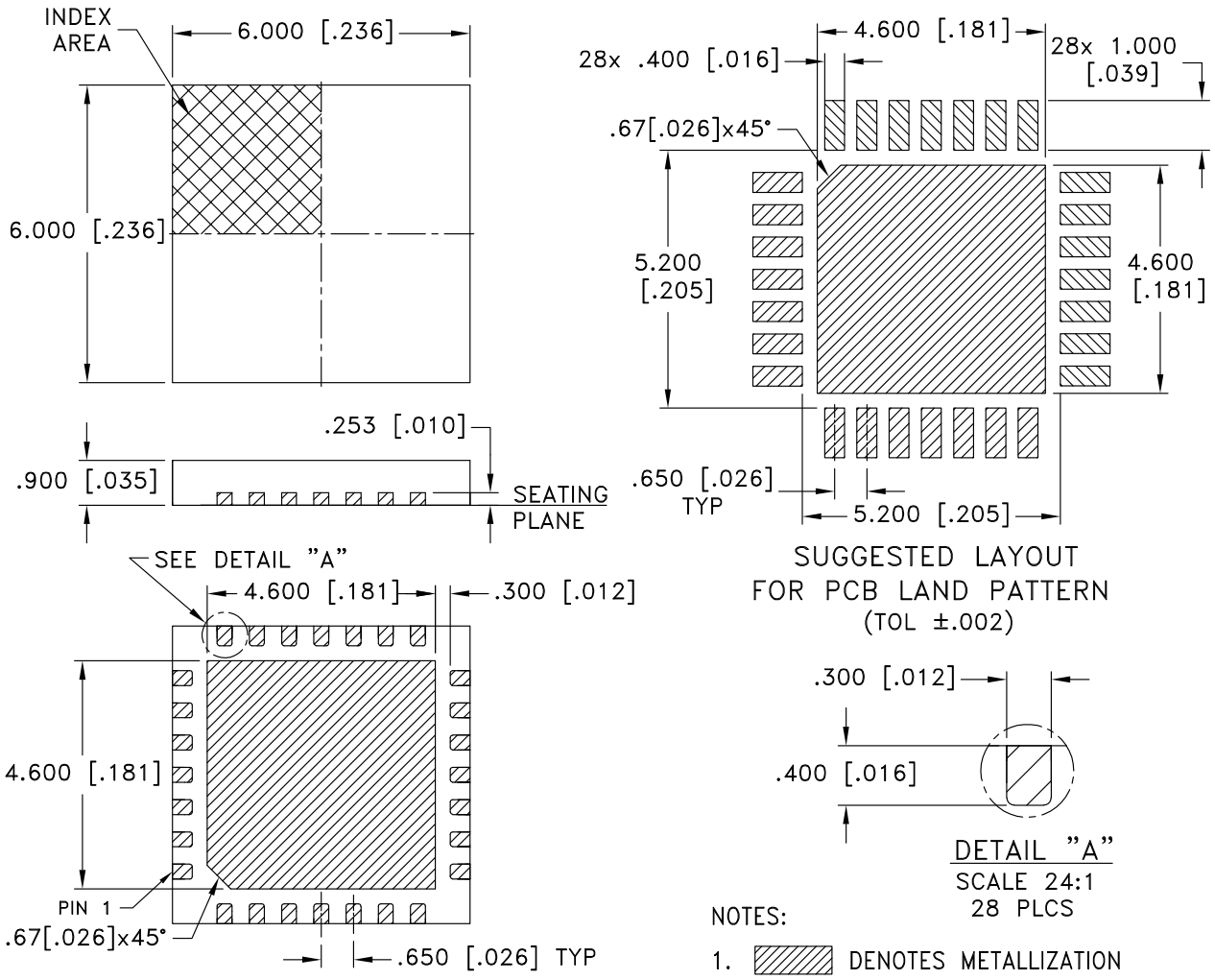
Component	Value	Size	Part Number	Manufacturer
C2 – C9	0.001 µF	0402	GRM1555C1H102JA01D	MURATA
C11 – C18	0.1 µF	0402	GRM155R71E104KE14D	MURATA
C19, C21-C27	1 µF	0603	06035C105KAT2A	KYOCERA AVX
L1, L2	33 nH	0603	0603AF-33NXJRW	COILCRAFT
L4	56 nH	0402	0402DF-560XJRW	COILCRAFT
R1	24Ω	0402	RK73H1ETTP24R0F	KOA SPEER
R2	12Ω	0402	RK73H1ETTP12R0F	KOA SPEER
R3	0Ω	0402	RK73Z1ETTP	KOA SPEER

Power Amplifier

PMA6-93-10W+

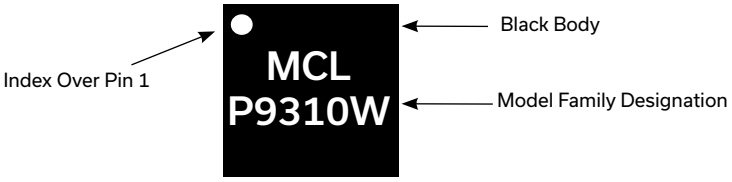
50Ω 7.1 to 8.5 GHz +39 dBm P_{SAT}

CASE STYLE DRAWING



Weight: 0.11 grams
Dimensions are in mm [inches]. Tolerances: 3 Pl.±.050 [.002] mm [Inches]

PRODUCT MARKING



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

Power Amplifier

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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	WQ3359 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 1K 13" reels with 2K, 3K, or 4K
Suggested Layout for PCB Design	PL-826
Evaluation Board	TB-PMA6-9310WC+ 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-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