

Features

- GaN on Si HEMT D-Mode Amplifier
- Suitable for Linear & Saturated Applications
- Tunable from DC - 6 GHz
- 28 V Operation
- 9 dB Gain @ 5.8 GHz
- 45% Drain Efficiency @ 5.8 GHz
- 100% RF Tested
- Thermally-Enhanced 4 mm 24-Lead QFN
- RoHS* Compliant



Description

The MAGX-011086 is a GaN on silicon HEMT amplifier optimized for DC - 6 GHz operation in a user friendly package ideal for high bandwidth applications. The device has been designed for saturated and linear operation with output power levels of 4 W (36 dBm) in an industry standard, low inductance, surface mount QFN package. The pads of the package form a coplanar launch that naturally absorbs lead parasitics and features a small PCB outline for space constrained applications.

The MAGX-011086 is ideally suited for Wireless LAN, High Dynamic Range LNA's, broadband general purpose, land mobile radio, defense communications, wireless infrastructure, and ISM applications.

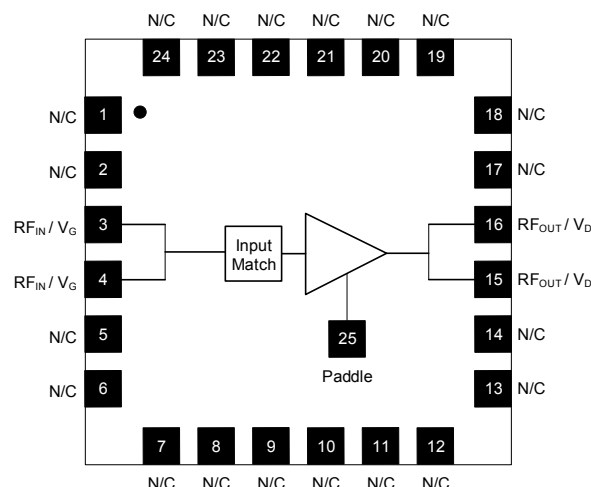
Built using the SIGANTIC® process - a proprietary GaN-on-Silicon technology.

Ordering Information¹

| Part Number | Package |
|--------------------|----------------|
| MAGX-011086 | Bulk Quantity |
| MAGX-011086-TR0500 | 500 piece reel |
| MAGX-011086-SMB2 | Sample Board |

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration²

| Pin # | Pin Name | Function |
|---------|------------------------------------|-------------------|
| 1 - 2 | N/C | No Connection |
| 3 - 4 | RF _{IN} / V _G | RF Input / Gate |
| 5 - 14 | N/C | No Connection |
| 15 - 16 | RF _{OUT} / V _D | RF Output / Drain |
| 17 - 24 | N/C | No Connection |
| 25 | Paddle ³ | Ground / Source |

2. All no connection pins may be left floating or grounded.

3. The exposed pad centered on the package bottom must be connected to RF and DC ground and provide a low thermal resistance heat path.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

GaN on Silicon General Purpose Amplifier DC - 6 GHz, 28 V, 4 W

Rev. V3

RF Electrical Specifications: $T_A = 25^\circ\text{C}$, $V_{DS} = 28\text{ V}$, $I_{DQ} = 50\text{ mA}$

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|--------------------------------|---------------------------------|-----------|-------------------------------|------|------|-------|
| Small Signal Gain | CW, 5.8 GHz | G_{SS} | - | 11 | - | dB |
| Saturated Output Power | CW, 5.8 GHz | P_{SAT} | - | 37 | - | dBm |
| Drain Efficiency at Saturation | CW, 5.8 GHz | h_{SAT} | - | 50 | - | % |
| Power Gain | 5.8 GHz, $P_{OUT} = 4\text{ W}$ | G_P | 8 | 9 | - | dB |
| Drain Efficiency | 5.8 GHz, $P_{OUT} = 4\text{ W}$ | h | 40 | 45 | - | % |
| Ruggedness: Output Mismatch | All phase angles | Y | VSWR = 10:1, No Device Damage | | | |

DC Electrical Characteristics: $T_A = 25^\circ\text{C}$

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|------------------------------|---|--------------|------|------|------|-------|
| Drain-Source Leakage Current | $V_{GS} = -8\text{ V}$, $V_{DS} = 100\text{ V}$ | I_{DLK} | - | - | 2 | mA |
| Gate-Source Leakage Current | $V_{GS} = -8\text{ V}$, $V_{DS} = 0\text{ V}$ | I_{GLK} | - | - | 1 | mA |
| Gate Threshold Voltage | $V_{DS} = +28\text{ V}$, $I_D = 2\text{ mA}$ | V_T | -2.5 | -1.5 | -0.5 | V |
| Gate Quiescent Voltage | $V_{DS} = +28\text{ V}$, $I_D = 50\text{ mA}$ | V_{GSQ} | -2.1 | -1.2 | -0.3 | V |
| On Resistance | $V_{DS} = +2\text{ V}$, $I_D = 15\text{ mA}$ | R_{ON} | - | 2.0 | - | W |
| Saturated Drain Current | $V_{DS} = 7\text{ V}$, Pulse Width 300 μs | $I_{D(SAT)}$ | - | 1.4 | - | A |

Absolute Maximum Ratings^{4,5,6}

| Parameter | Absolute Max. |
|--------------------------------|-----------------|
| Drain-Source Voltage, V_{DS} | 100 V |
| Gate-Source Voltage, V_{GS} | -10 V to 3 V |
| Gate Current, I_G | 4 mA |
| Junction Temperature, T_J | +200°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -65°C to +150°C |

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with $T_J \leq 200^\circ\text{C}$ will ensure $\text{MTTF} > 1 \times 10^6$ hours.

Thermal Characteristics^{7,8}

| Parameter | Test Conditions | Symbol | Typ. | Units |
|--------------------|--|---------------|------|-------|
| Thermal Resistance | $V_{DS} = 28 \text{ V}, T_J = 200^\circ\text{C}$ | Θ_{JC} | 12.5 | °C/W |

7. Junction temperature (T_J) measured using IR Microscopy. Case temperature measured using thermocouple embedded in heat-sink.
8. The thermal resistance of the mounting configuration must be added to the device Θ_{JC} , for proper T_J calculation during operation. The recommended via pattern, shown on page 6, on a 20 mil thick, 1 oz. plated copper, PCB contributes an additional 6.6°C/W to the typical value.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

Gallium Nitride Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these class 1A devices.

GaN on Silicon General Purpose Amplifier DC - 6 GHz, 28 V, 4 W

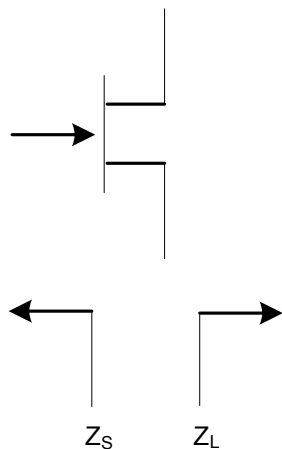
Rev. V3

Load-Pull Performance: $V_{DS} = 28\text{ V}$, $I_{DQ} = 50\text{ mA}$, $T_A = 25^\circ\text{C}$

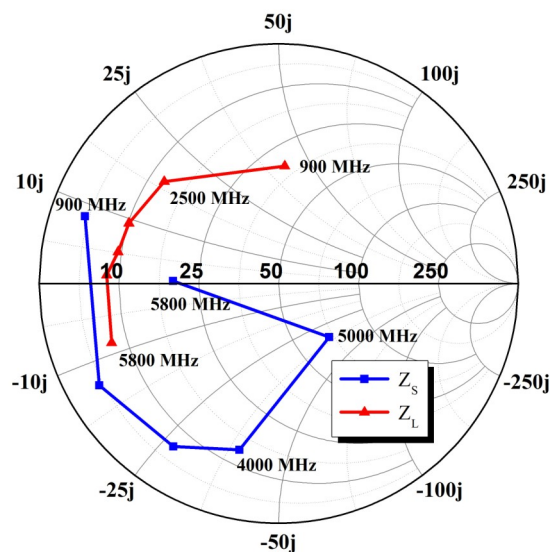
Reference Plane at Device Leads, CW Drain Efficiency and Output Power Tradeoff Impedance

| Frequency (MHz) | Z_S (W) | Z_L (W) | P_{SAT} (W) | G_{SS} (dB) | Drain Efficiency @ P_{SAT} (%) |
|-----------------|----------------|----------------|---------------|---------------|----------------------------------|
| 900 | $4.0 + j8.4$ | $31.9 + j41.2$ | 5.8 | 24.6 | 65 |
| 2500 | $4.0 - j13.1$ | $12.5 + j18.0$ | 5.1 | 19.5 | 63 |
| 3500 | $6.8 - j26.8$ | $10.1 + j9.3$ | 5.0 | 57 | |
| 4000 | $13.4 - j37.8$ | $9.5 + j4.7$ | 5.0 | 15.3 | 56 |
| 5000 | $67.4 - j33.2$ | $8.2 + j1.2$ | 5.0 | 13.8 | 55 |
| 5800 | $19.4 + j0.5$ | $7.7 - j8.4$ | 5.0 | 12.0 | 55 |

Impedance Reference



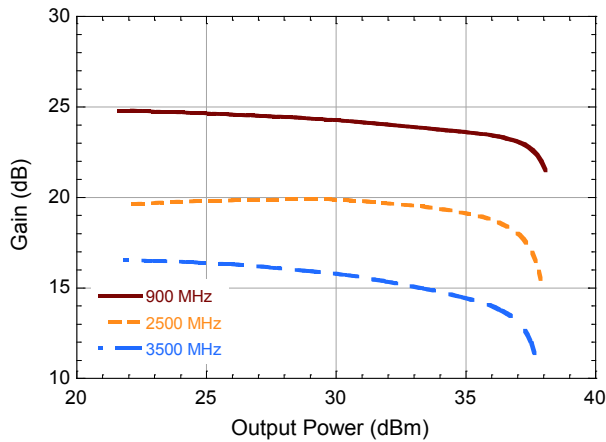
Z_S and Z_L vs. Frequency



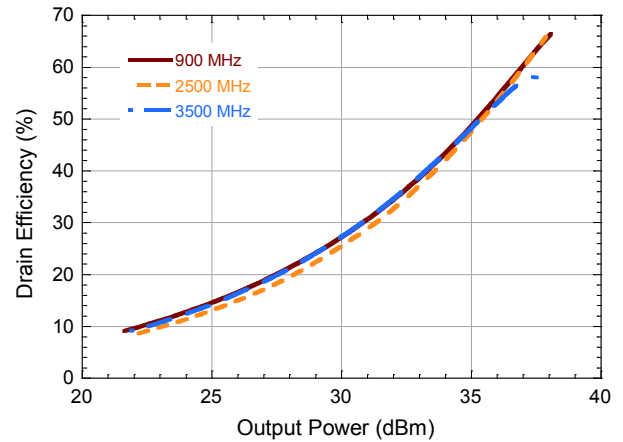
Load-Pull Performance: $V_{DS} = 28\text{ V}$, $I_{DQ} = 50\text{ mA}$, $T_A = 25^\circ\text{C}$

Reference Plane at Device Leads, CW Drain Efficiency and Output Power Tradeoff Impedance

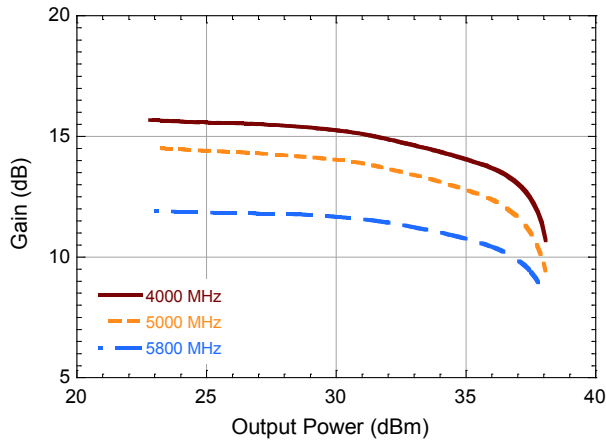
Gain vs. Output Power



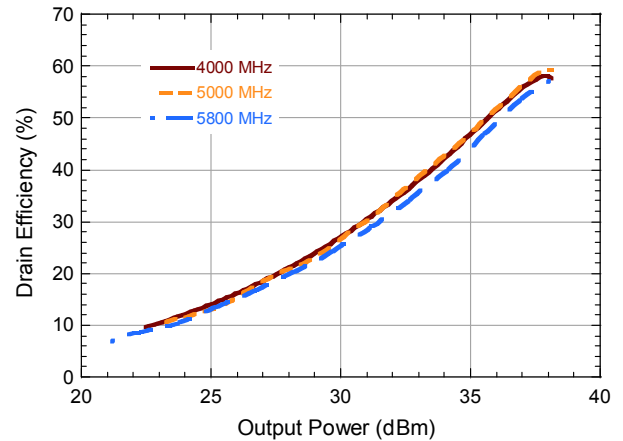
Drain Efficiency vs. Output Power



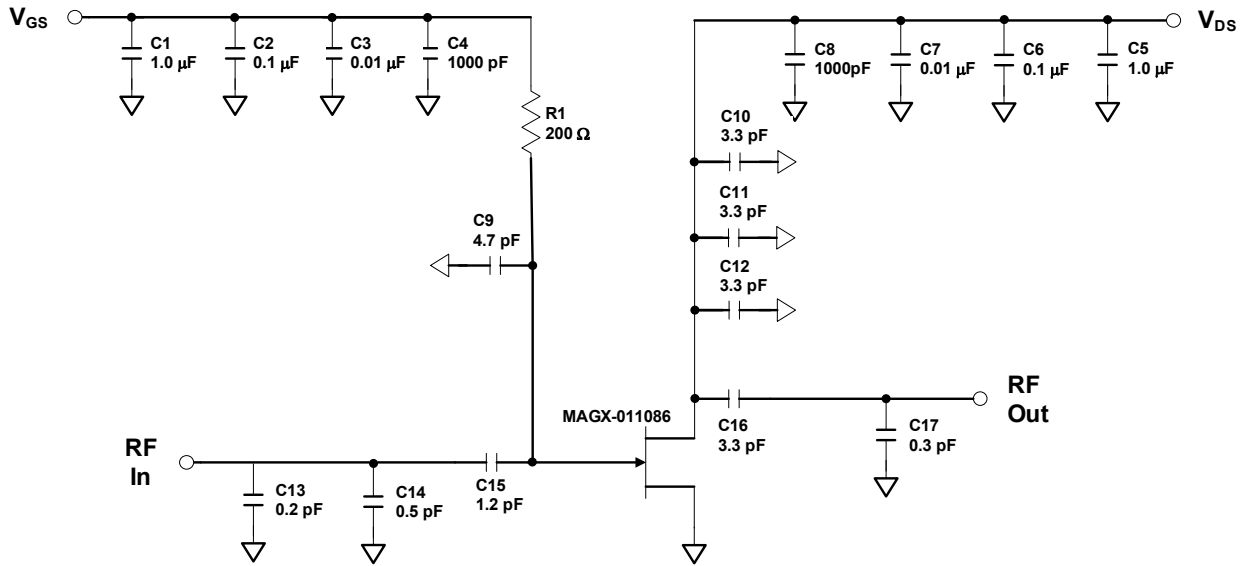
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Board and Recommended Tuning Solution
5.8 GHz Narrowband Circuit



Description

Parts measured on evaluation board (20-mil thick RO4350). The PCB's electrical and thermal ground is provided using a standard-plated densely packed via hole array (see recommended via pattern).

Matching is provided using a combination of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution component placement, transmission lines, and details are shown on the next page.

Bias Sequencing

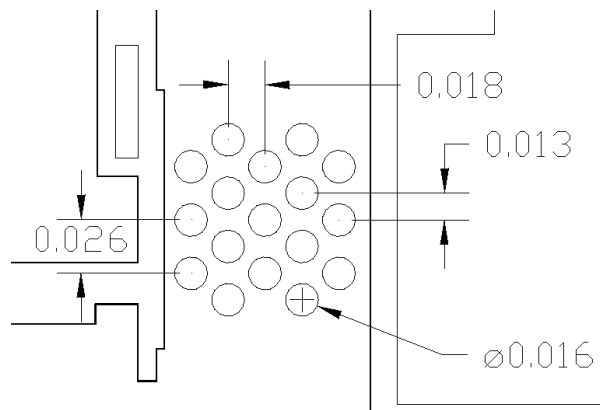
Turning the device ON

1. Set V_{GS} beyond pinch-off (V_P), typically -5 V.
2. Turn on V_{DS} to nominal voltage (28 V).
3. Increase V_{GS} until the I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

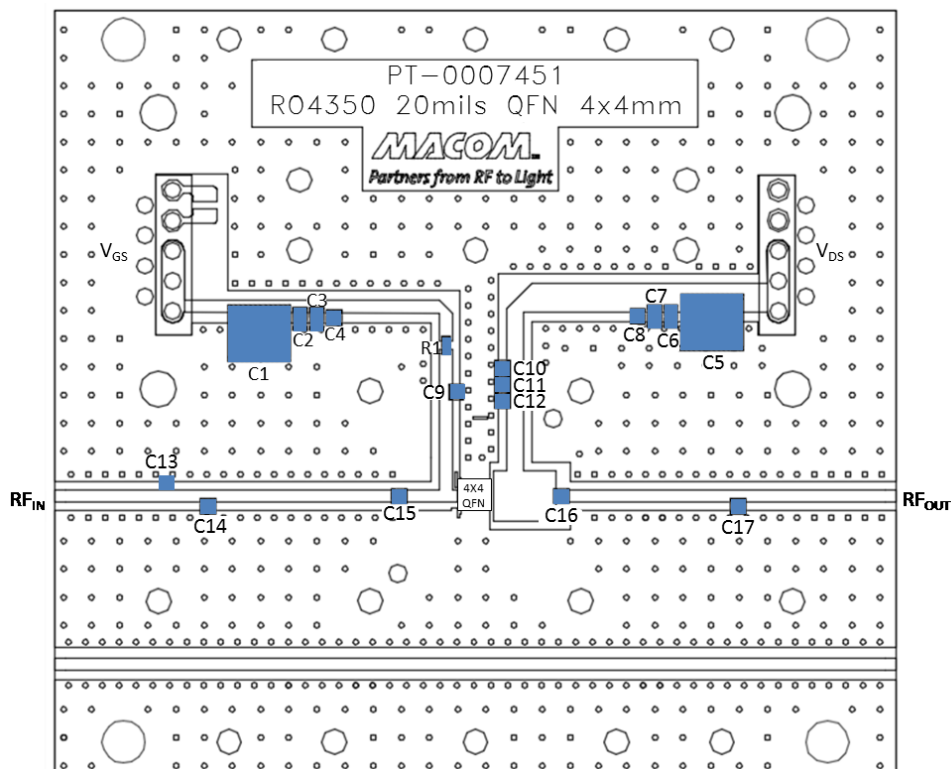
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P .
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS} .

Recommended Via Pattern (All dimensions shown as inches)



Evaluation Board and Recommended Tuning Solution

5.8 GHz Narrowband Circuit

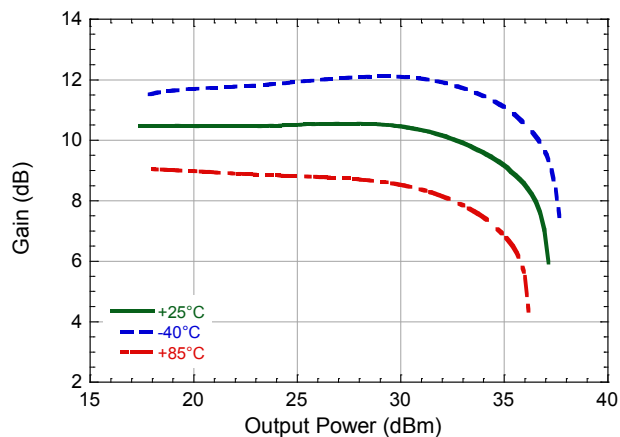


Parts list

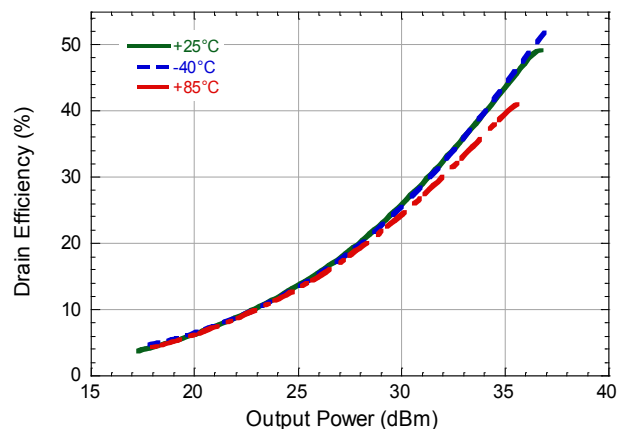
| Reference | Value | Tolerance | Manufacturer | Part Number |
|--------------------|----------------|-----------|-----------------|------------------|
| C1, C5 | 1.0 μ F | 10% | AVX | 12101C105KAT2A |
| C2, C6 | 0.1 μ F | 10% | Kemet | C1206C104K1RACTU |
| C3, C7 | 0.01 μ F | 10% | AVX | 12061C103KAT2A |
| C4, C8 | 1000 pF | 10% | Kemet | C0805C102K1RACTU |
| C9 | 4.7 pF | 0.1 pF | ATC | ATC800A4R7B250 |
| C10, C11, C12, C16 | 3.3 pF | 0.1 pF | ATC | ATC800A3R3B250 |
| C13 | 0.2 pF | 0.1 pF | ATC | ATC800A0R2B250 |
| C14 | 0.5 pF | 0.1 pF | ATC | ATC800A0R5B250 |
| C15 | 1.2 pF | 0.1 pF | ATC | ATC800A1R2B250 |
| C17 | 0.3 pF | 0.1 pF | ATC | ATC800A0R3B250 |
| R1 | 200 Ω | 1% | Panasonic | ERJ-6ENF2000V |
| RF Connector | SMA | — | Amphenol-Connex | 132150 |
| DC Connector | D-Subminiature | — | ERNI | 284525 |
| PCB | RO4350 | — | Rogers Corp | — |

Typical Performance as measured in the 5.8 GHz evaluation board:
CW, $V_{DS} = 28\text{ V}$, $I_{DQ} = 50\text{ mA}$ (unless noted)

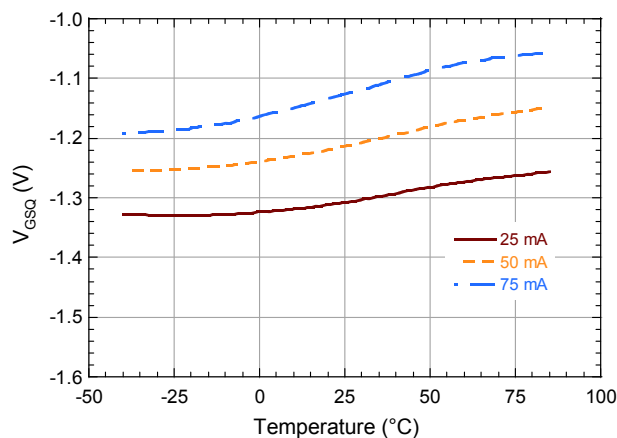
Gain vs. Output Power over Temperature



Drain Efficiency vs. Output Power over Temperature

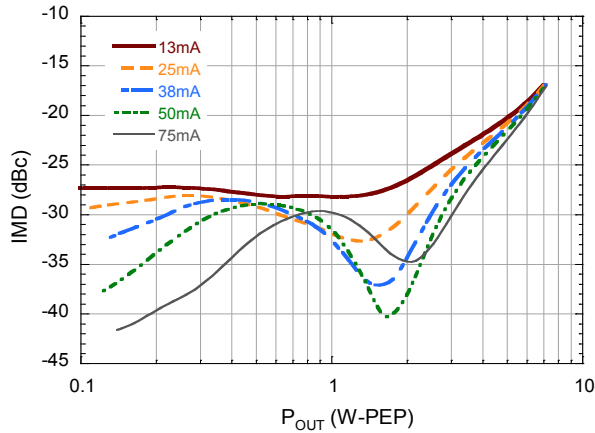


Quiescent V_{GS} vs. Temperature

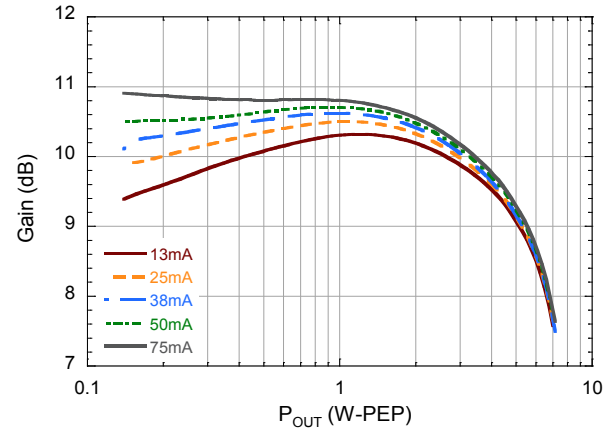


Typical 2-Tone Performance as measured in the 5.8 GHz evaluation board:
1 MHz Tone Spacing, $V_{DS} = 28\text{ V}$, $I_{DQ} = 50\text{ mA}$, $T_A = 25^\circ\text{C}$ (unless noted)

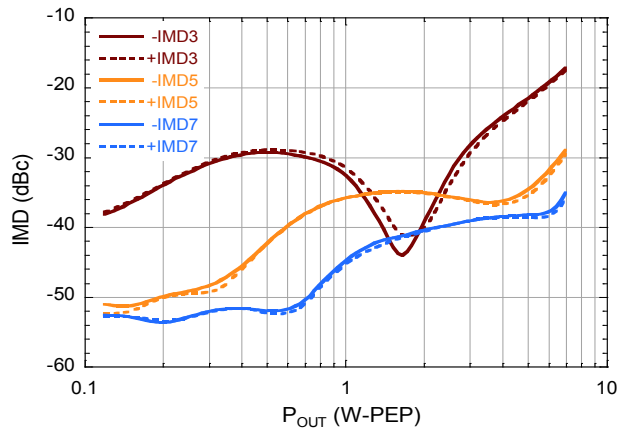
2-Tone IMD3 vs. Output Power vs. Quiescent Current



2-Tone Gain vs. Output Power vs. Quiescent Current



2-Tone IMD vs. Output Power



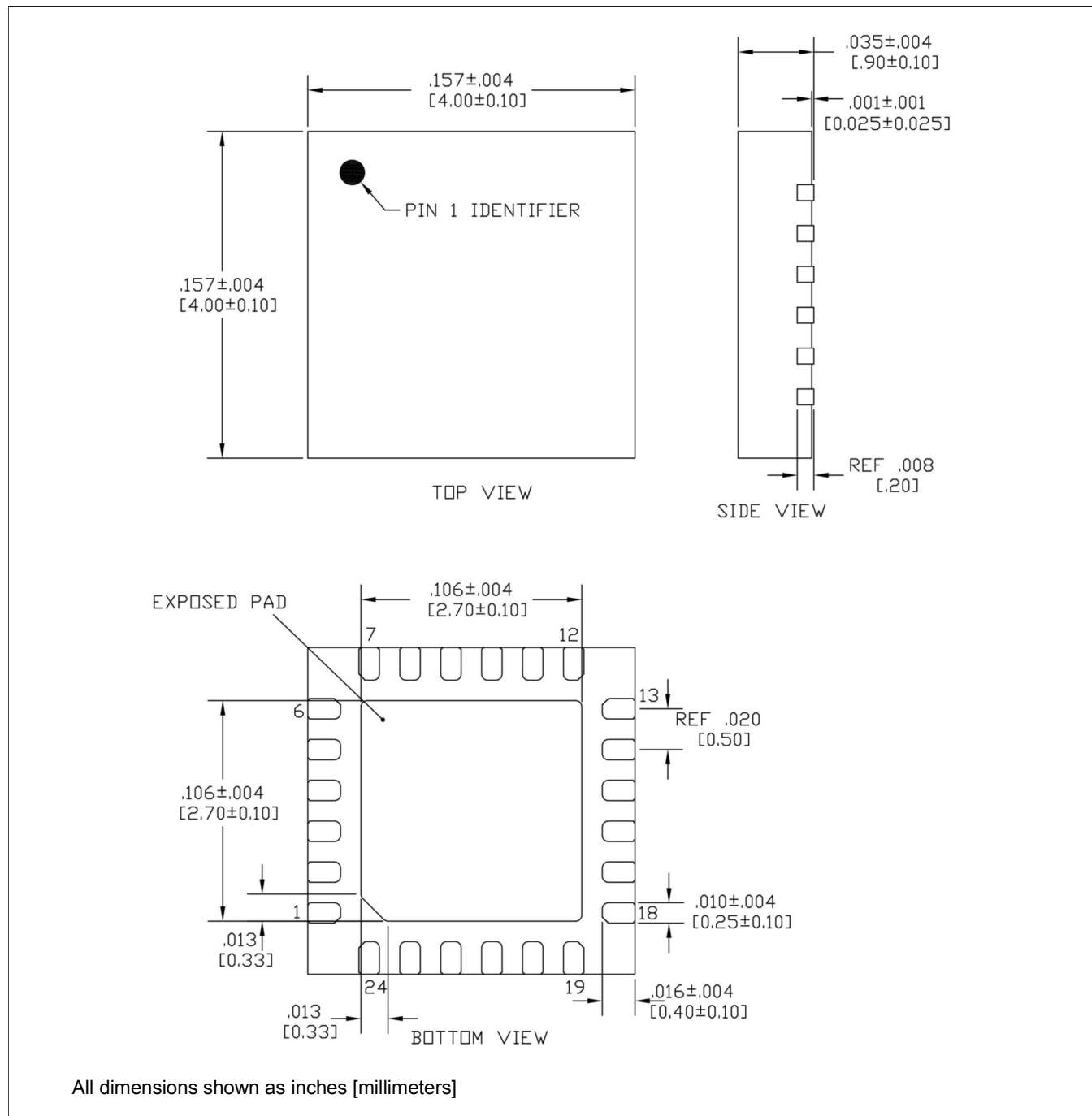
MAGX-011086



GaN on Silicon General Purpose Amplifier
DC - 6 GHz, 28 V, 4 W

Rev. V3

Lead Free 4 mm 24 Lead QFN Plastic Package[†]



[†] Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Matte Sn.

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