# GaN Amplifier 50 V, 50 W
# DC - 2700 MHz

**MAGX-100027-050C0P**

**Rev. V4**

## Features

- Optimized for a Multitude of Applications
- CW and Pulsed Operation: 50 W Output Power
- Internally Pre-matched
- 260°C Reflow Compatible
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

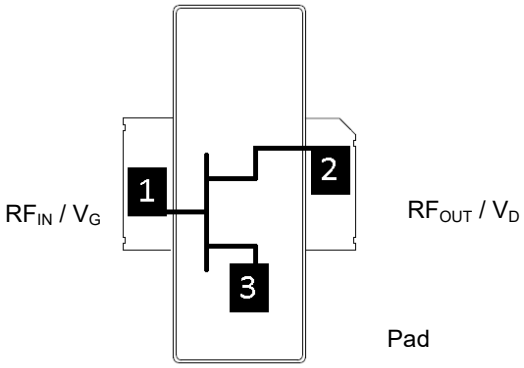

TO-272S-2

## Description

The MAGX-100027-050C0P is a high power GaN on Silicon HEMT D-mode amplifier optimized for DC - 2700 MHz frequency operation. The device supports both CW and pulsed operation with peak output power levels to 50 W (47 dBm) in a plastic package.

The MAGX-100027-050C0P is ideally suited for a multitude of applications including military radio communications, digital cellular infrastructure, RF energy, avionics, test instrumentation and RADAR.

## Functional Schematic




## Typical Performance:

- $V_{DS}$ = 50 V, $I_{DQ}$ = 100mA, $T_C$ = 25°C.
  Measured under pulsed load-pull at optimum efficiency load impedance, 2.0 dB Compression, 100µs pulse width,1ms period, 10% duty cycle

| Frequency (MHz) | Output Power (dBm) | Gain (dB) | $\eta_D$ (%) |
|---|---|---|---|
| 650 | 47.6 | 27.1 | 79.1 |
| 950 | 45.6 | 24.5 | 79.5 |
| 1200 | 47.9 | 22.4 | 79.7 |
| 1600 | 48.3 | 19.8 | 76.3 |
| 2000 | 48.3 | 19.1 | 75.4 |
| 2400 | 47.6 | 18.5 | 76.5 |

## Pin Configuration

| Pin # | Pin Name | Function |
|---|---|---|
| 1 | RF$_{IN}$ / V$_G$ | RF Input / Gate |
| 2 | RF$_{OUT}$ / V$_D$ | RF Output / Drain |
| 3 | Pad[1] | Ground / Source |

1. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

## Ordering Information

| Part Number | Package |
|---|---|
| MAGX-100027-050C0P | Bulk Quantity |
| MAGX-100027-050CTP | Tape and Reel |
| MAGX-1A0027-050C0P | Sample Board |

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

## RF Electrical Characteristics: $T_C$ = 25°C, $V_{DS}$ = 50 V, $I_{DQ}$ = 100 mA
**Note: Performance in MACOM Application Fixture (2400 - 2500 MHz), 50 Ω system**

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Small Signal Gain | CW, 2500 MHz | $G_{SS}$ | - | 18.8 | - | dB |
| Power Gain | CW, 2500 MHz, 2 dB Gain Compression | $G_{SAT}$ | - | 16.8 | - | dB |
| Saturated Drain Efficiency | CW, 2500 MHz, 2 dB Gain Compression | $\eta_{SAT}$ | - | 72 | - | % |
| Saturated Output Power | CW, 2500 MHz, 2 dB Gain Compression | $P_{SAT}$ | - | 48.4 | - | dBm |
| Gain Variation (-25°C to +85°C) | Pulsed[2], 2500 MHz | $\Delta G$ | - | 0.02 | - | dB/°C |
| Power Variation (-25°C to +85°C) | Pulsed[2], 2500 MHz | $\Delta P2dB$ | - | 0.004 | - | dB/°C |
| Gain | CW, 2500 MHz, $P_{IN}$ = 32 dBm | $G_P$ | - | 16.8 | - | dB |
| Drain Efficiency | CW, 2500 MHz, $P_{IN}$ = 32 dBm | $\eta$ | - | 72 | - | % |
| Ruggedness: Output Mismatch | All phase angles | $\Psi$ | VSWR = 10:1, No Device Damage | | | |

## RF Electrical Specifications: $T_A$ = 25°C, $V_{DS}$ = 50 V, $I_{DQ}$ = 100 mA
**Note: Performance in MACOM Production Test Fixture, 50 Ω system**

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Power Gain | CW, 2500 MHz, 2 dB Gain Compression | $G_{SAT}$ | 14 | 15.3 | - | dB |
| Saturated Drain Efficiency | CW, 2500 MHz, 2 dB Gain Compression | $\eta_{SAT}$ | 60 | 67.5 | - | % |
| Saturated Output Power | CW, 2500 MHz, 2 dB Gain Compression | $P_{SAT}$ | 48 | 49.4 | - | dBm |
| Gain | CW, 2500 MHz, $P_{IN}$ = 33 dBm | $G_P$ | 15 | 16 | - | dB |
| Drain Efficiency | CW, 2500 MHz, $P_{IN}$ = 33 dBm | $\eta$ | 58 | 65 | - | % |

2. Pulse details: 100 µs pulse width, 1 ms period, 10% Duty Cycle

## DC Electrical Characteristics $T_A$ = 25°C

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Drain-Source Leakage Current | $V_{GS}$ = -8 V, $V_{DS}$ = 130 V | $I_{DLK}$ | - | - | 10.8 | mA |
| Gate-Source Leakage Current | $V_{GS}$ = -8 V, $V_{DS}$ = 0 V | $I_{GLK}$ | - | - | 10.8 | mA |
| Gate Threshold Voltage | $V_{DS}$ = 50 V, $I_D$ = 10.8 mA | $V_T$ | -2.6 | -2.0 | -1.6 | V |
| Gate Quiescent Voltage | $V_{DS}$ = 50 V, $I_D$ = 250 mA | $V_{GSQ}$ | -2.4 | -1.8 | -1.4 | V |
| Maximum Drain Current | $V_{DS}$ = 7 V pulsed, pulse width 300 µs | $I_{D, MAX}$ | - | 9.2 | - | A |

## Absolute Maximum Ratings[3,4,5,6,7]

| Parameter | Absolute Maximum |
|---|---|
| Drain Source Voltage, $V_{DS}$ | 130 V |
| Gate Source Voltage, $V_{GS}$ | -10 to 3 V |
| Gate Current, $I_G$ | 10 mA |
| Storage Temperature Range | -65°C to +150°C |
| Case Operating Temperature Range | -40°C to +120°C |
| Channel Operating Temperature Range, $T_{CH}$ | -40°C to +225°C |
| Absolute Maximum Channel Temperature | +250°C |

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. MACOM does not recommend sustained operation above maximum operating conditions.
5. Operating at drain source voltage $V_{DS}$ < 55 V will ensure MTTF > 1 x $10^7$ hours.
6. Operating at nominal conditions with $T_{CH}$ ≤ 225°C will ensure MTTF > 1 x $10^7$ hours.
7. MTTF may be estimated by the expression MTTF (hours) = A $e^{[B + C/(T+273)]}$ where *T* is the channel temperature in degrees Celsius, *A* = 3.686, *B* = -35.00, and *C* = 25,416.

## Thermal Characteristics[8]

| Parameter | Test Conditions | Symbol | Typical | Units |
|---|---|---|---|---|
| Thermal Resistance using Finite Element Analysis | $V_{DS}$ = 50 V, $P_D$ = 30 W, $T_C$ = 85°C, $T_{CH}$ = 225°C | $R_{\theta}$(FEA) | 3.3 | °C/W |
| Thermal Resistance using Infrared Measurement of Die Surface Temperature | $V_{DS}$ = 50 V, $P_D$ = 30 W, $T_C$ = 85°C, $T_{CH}$ = 225°C | $R_{\theta}$(IR) | 2.76 | °C/W |

8. Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on this measurement.

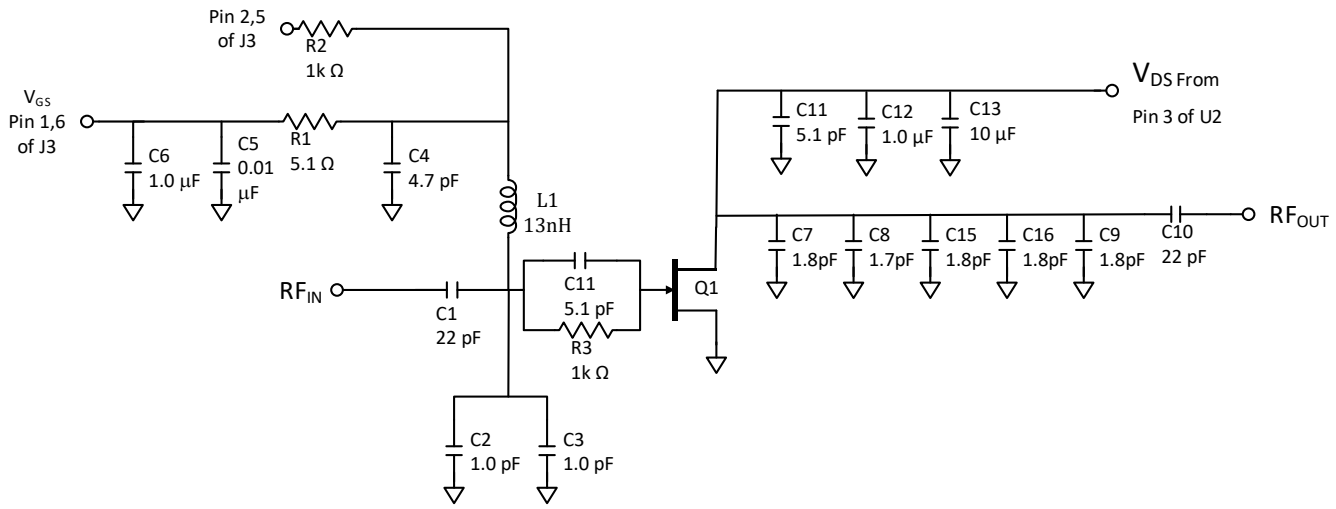
## Handling Procedures

Please observe the following precautions to avoid damage:

## Static Sensitivity

Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B, CDM Class C3 devices.

## Application Fixture 2400 - 2500 MHz




## Description

Parts measured on application board (20-mil thick RF35A2). 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

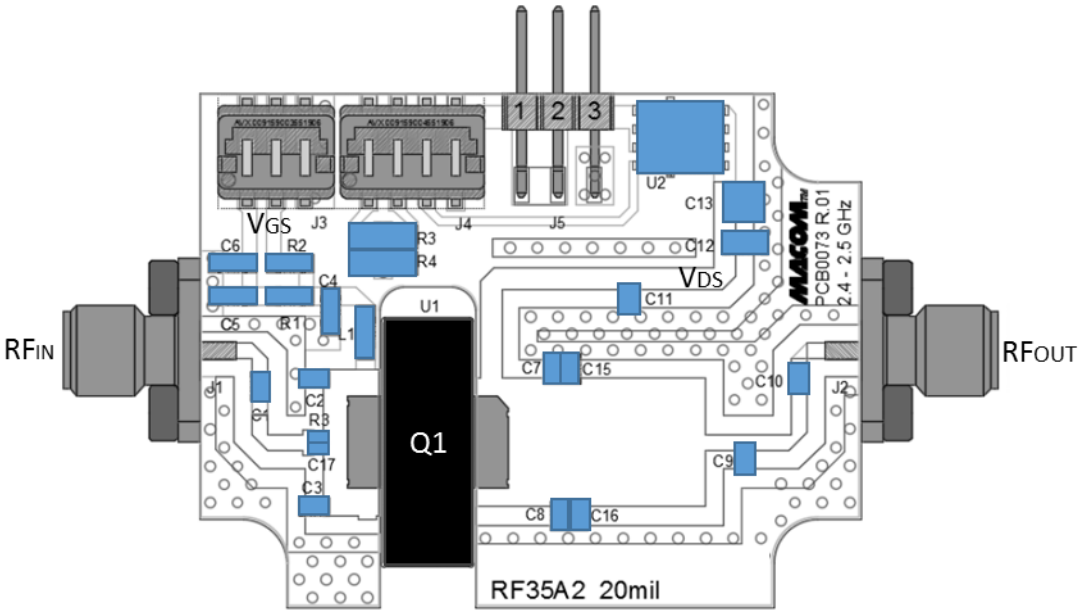
### Turning the device ON

1. Set $V_{GS}$ to pinch-off ($V_P$).
2. Turn on $V_{DS}$ to nominal voltage (50 V).
3. Increase $V_{GS}$ until $I_{DS}$ 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 $V_P$ pinch-off.
3. Decrease $V_{DS}$ down to 0 V.
4. Turn off $V_{GS}$.

## Application Fixture 2400 - 2500 MHz

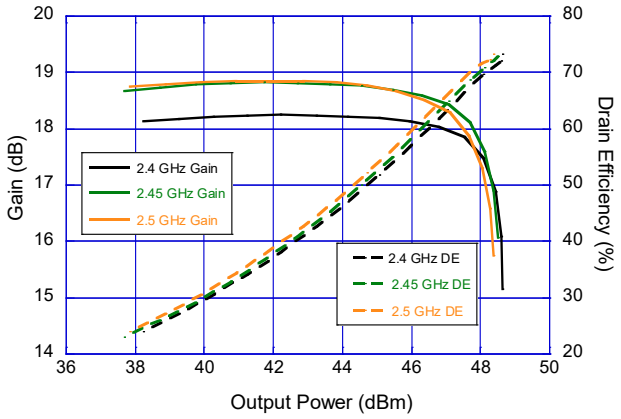



## Parts List

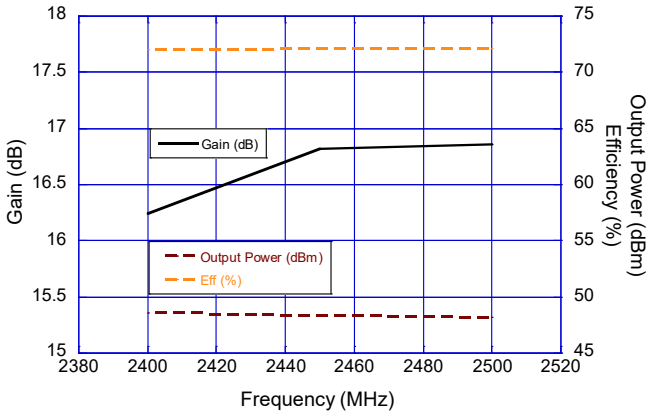
| Reference Designator | Value | Tolerance | Manufacturer | Part Number |
|---|---|---|---|---|
| C1, C10 | 22 pF | +/-5% | Passive Plus | 0805N220JW251T |
| C2, C3 | 1.0 pF | +/-0.1 pF | Passive Plus | 0805N1R0BW251T |
| C4 | 4.7 pF | +/-0.1 pF | Passive Plus | 0805N4R7BW251T |
| C5 | 0.01 µF | 10% | Murata | GRM219R7YA103KA12D |
| C6 | 1 µF | 10% | Murata | GRM219R7YA105KA12D |
| C7, C15, C16 | 1.8 pF | +/-0.1 pF | Passive Plus | 0805N1R8BW251T |
| C8 | 1.7 pF | +/-0.1 pF | Passive Plus | 0805N1R7BW251T |
| C9 | 1.8 pF | +/-0.1 pF | Passive Plus | 0805N1R8BW251T |
| C11 | 5.1 pF | +/-0.1 pF | Passive Plus | 0805N5R1BW251T |
| C12 | 1 µF | 10% | Murata | GRM31CR72A105K |
| C13 | 10 µF | 20% | Murata | GRM32ER71J106MA12 |
| C17 | 6.8 pF | +/-0.1 pF | Passive Plus | 0603N6R8BW251T |
| L1 | 12 nH | 5% | Coilcraft | 0805HQ-12NXGLB |
| R1 | 5.1 Ω | +/-1% | VIKING | CR-05FLF---5R1 |
| R2 | 1 kΩ | 5% | VIKING | CR-05FLF----1K |
| R3 | 5.1 Ω | +/-1% | VIKING | CR-03FLF---5R1 |
| U2 | 80-V | - | MACOM | Si7469DP |
| Q1 | 50 W | - | MACOM | MAGX-100027-050C0P |
| PCB | Taconic RF35A2, 20 mil, 1 oz. Cu, Au Finish | | | |

## Typical Performance Curves as Measured in the 2400 - 2500 MHz Application Fixture:
## CW, 2.45 GHz, $V_{DS}$ = 50 V, $I_{DQ}$ = 100 mA, $T_C$ = 25°C
## Unless Otherwise Noted

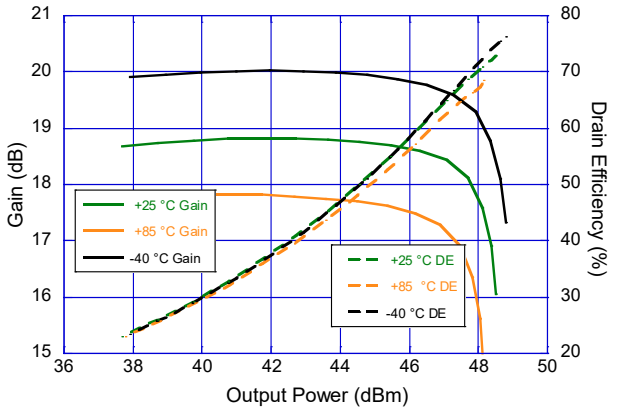
***Gain and Drain Efficiency vs. Output Power and Frequency***



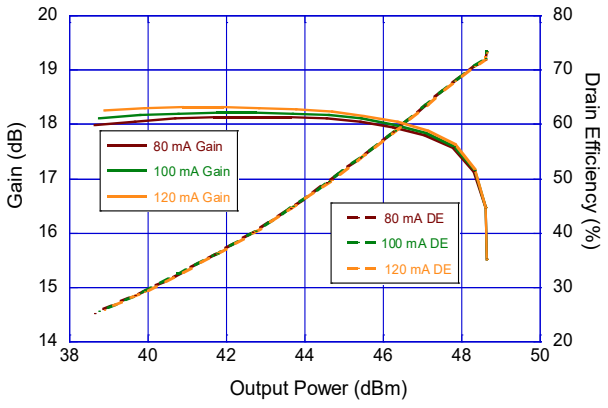

***Performance vs. Frequency at Fixed $P_{IN}$ = 32 dBm***



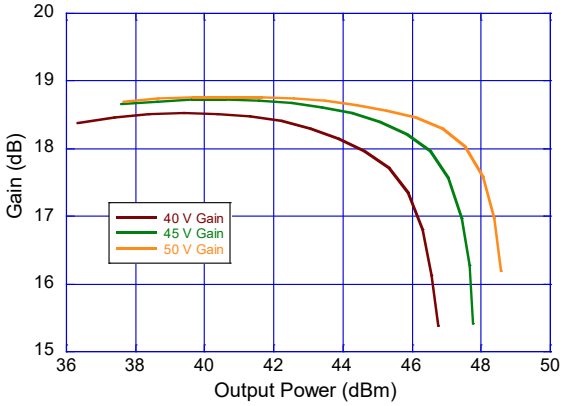

***Gain and Drain Efficiency vs Output Power and $T_C$***



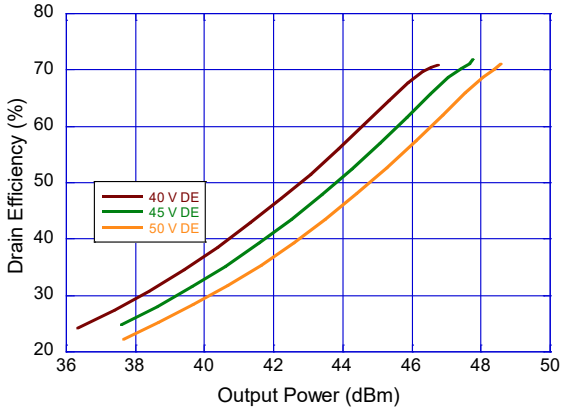

***Gain and Drain Efficiency vs. Output Power and $I_{DQ}$***



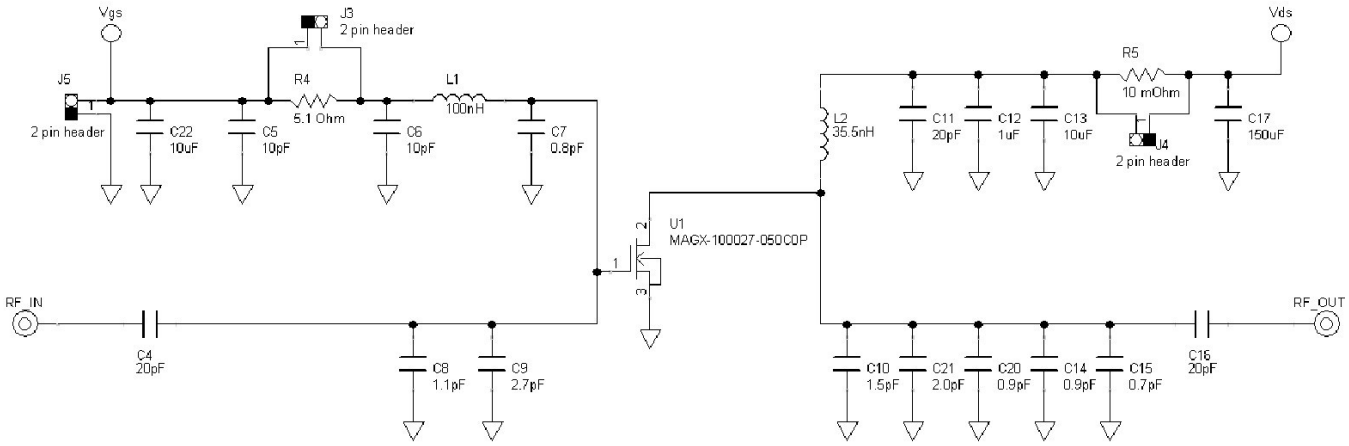

***Gain vs. Output Power and $V_{DS}$***




***Drain Efficiency vs. Output Power and $V_{DS}$***



## MAGX-1A0027-050C0P Sample Board 500 - 2500 MHz




## Description

Parts measured on sample board (RO4350, 20-mil thick input, 30-mil thick output). 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

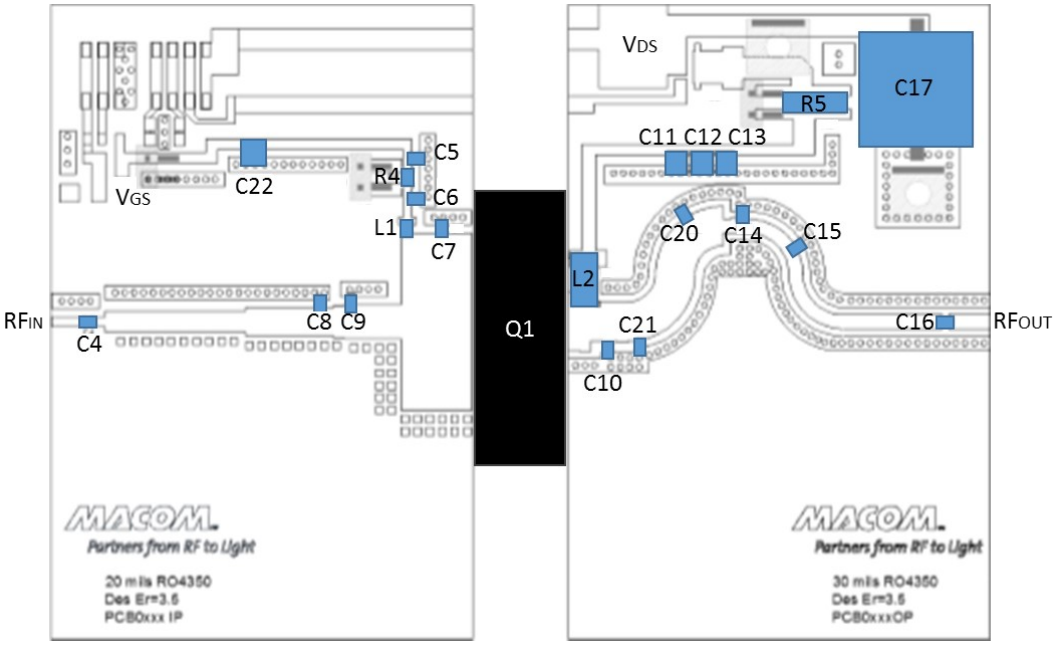
### Turning the device ON

1. Set $V_{GS}$ to pinch-off ($V_P$).
2. Turn on $V_{DS}$ to nominal voltage (50 V).
3. Increase $V_{GS}$ until $I_{DS}$ 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 $V_P$ pinch-off.
3. Decrease $V_{DS}$ down to 0 V.
4. Turn off $V_{GS}$.

## MAGX-1A0027-050C0P Sample Board 500 - 2500 MHz

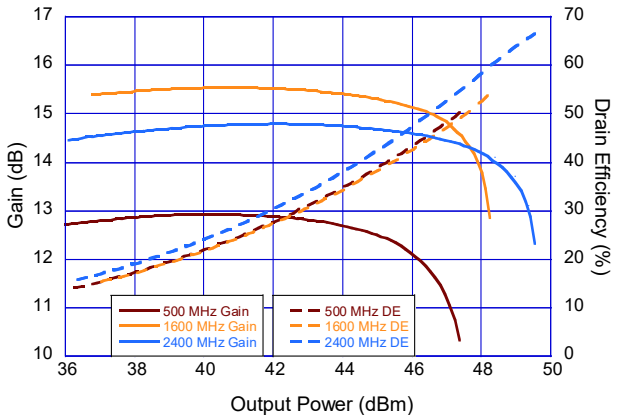



## Parts List

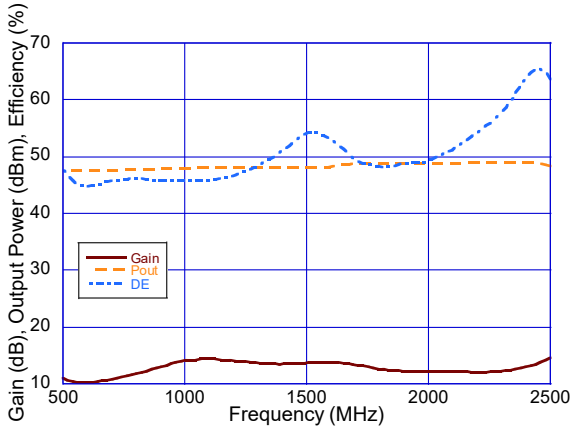
| Reference Designator | Value | Tolerance | Manufacturer | Part Number |
|---|---|---|---|---|
| C4, C16 | 20 pF | +/-0.1pF | Passive Plus | 0805N200JW251T |
| C5, C6 | 10 pF | +5% | Passive Plus | 0805N100JW251T |
| C7 | 0.8 pF | +/-0.1pF | Passive Plus | 0805N0R8BW251T |
| C8 | 1.1 pF | +/-0.1pF | Passive Plus | 0805N1R1BW251T |
| C9 | 2.7 pF | +/-0.1pF | Passive Plus | 0805N2R7BW251T |
| C10 | 1.5 pF | +/-0.1pF | Passive Plus | 0805N1R5BW251T |
| C11 | 20 pF | 5% | Passive Plus | 1111N200JW251T |
| C12 | 1 µF | 10% | Murata | GRM32ER72A105K |
| C13, C22 | 10 µF | 10% | Murata | GRM32DF51H106ZA01L |
| C14, C20 | 0.9 pF | +/-0.1pF | Passive Plus | 0805N0R9BW251T |
| C15 | 0.7 pF | +/-0.1pF | Passive Plus | 0805N0R7BW251T |
| C17 | 150 µF | 20% | Panasonic | EEV-FK1K151Q |
| C21 | 2 pF | +/-0.1pF | Passive Plus | 0805N2R0BW251T |
| L1 | 100 nH | 5% | Coilcraft | 0805CS-101 |
| L2 | 35.5 nH | 5% | Coilcraft | B09T |
| R4 | 5.1 Ω | +/-1% | VIKING | CR-05FL7---5R1 |
| R5 | 10 mΩ | +/-1% | VIKING | CS75FTFR010 |
| Q1 | MACOM GaN Power Amplifier | | | MAGX-100027-050C0P |
| PCB | RO4350, 20mil, 1oz Cu, Au Finish (input) RO4350, 30mil, 1oz Cu Au Finish (output) | | | |

## Typical Performance Curves as Measured in the 500 - 2500 MHz Application Fixture: Pulsed[2], 2.4 GHz, $V_{DS}$ = 50 V, $I_{DQ}$ = 100 mA, $T_C$ = 25°C Unless Otherwise Noted

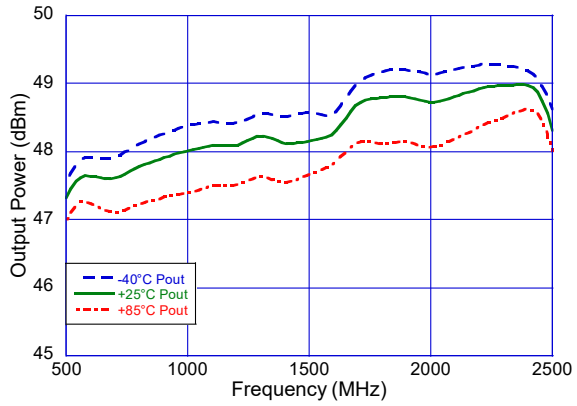
***Gain and Drain Efficiency vs. Output Power and Frequency***



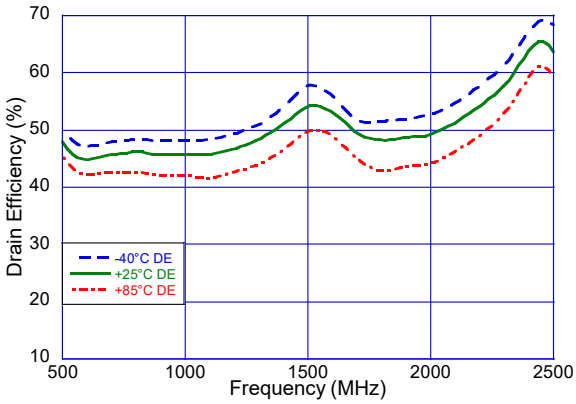

***Performance vs. Frequency at $T_C$ = 25°C***



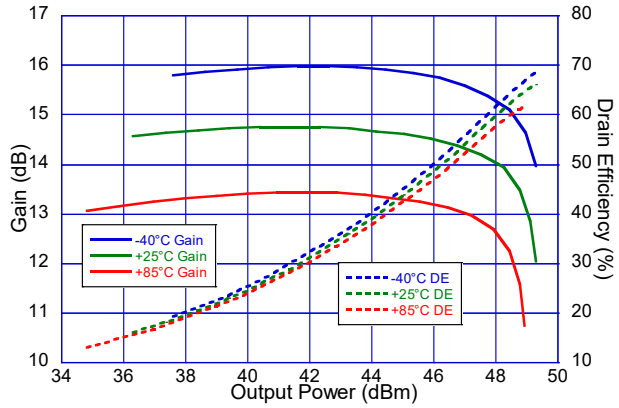

***Output Power vs. Frequency and $T_C$***



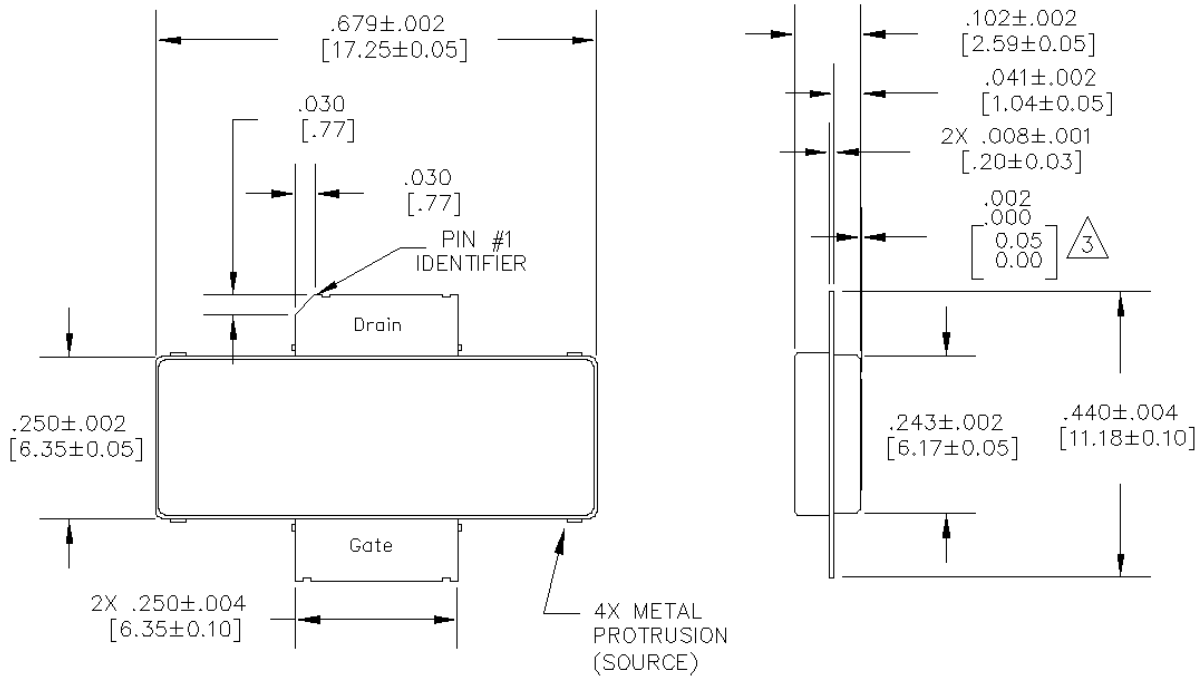

***Drain Efficiency vs. Frequency and $T_C$***




***Gain and Drain Efficiency vs. Output Power and $T_C$***



## Lead-Free TO-272S-2 Package Dimensions†




NOTES:

1. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN in AND CONVERTED mm DIMENSIONS ARE NOT NECESSARILY EXACT.
2. LEAD FINISH: 100% MATTE Sn PLATE.
3. INDICATED DIMENSIONS/TOLERANCES APPLY TO EXPOSED PAD.
4. PACKAGE BODY DIMENSIONS DO NOT INCLUDE MOLD AND METAL PROTRUSIONS. ALLOWABLE PROTRUSION IS .010[0.25] PER SIDE.
5. LEAD DIMENSIONS DO NOT INCLUDE DAMBAR PROTRUSIONS. ALLOWABLE PROTRUSION IS .010[0.25 PER SIDE.

† Reference Application Note AN0004125 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Matte Sn.