

## Features

- GaN on SiC Technology
- Pulsed CW Performance, 2020 MHz, 48 V, 10  $\mu$ s Pulse Width, 10% Duty Cycle, Combined Outputs
- Output Power @  $P_{3dB} = 350$  W
- Efficiency @  $P_{3dB} = 65\%$
- Human Body Model Class 1C (per ANSI/ESDA/JEDEC JS-001)
- Pb-free and RoHS\* Compliant
- Thermally Enhanced Package

## Applications

- Cellular 5G Infrastructure

## Description

The GTRB204402FC/1 is a 350 W (P3dB) GaN on SiC HEMT amplifier designed for use in multi-standard cellular power applications. It features high efficiency, and a thermally-enhanced package with earless flange.

## Typical RF Performance

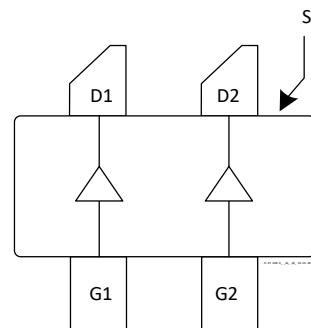
### Single-Carrier WCDMA Specifications<sup>1</sup>:

$V_{DD} = 48$  V,  $I_{DQ} = 150$  mA,  $V_{GS(Peak)} = -5.5$  V,  $T_C = 25^\circ\text{C}$ , Channel Bandwidth = 3.84 MHz, Peak/Average = 10 dB @ 0.01% CCDF

| Parameter    | Frequency (MHz) | Units | Typical |
|--------------|-----------------|-------|---------|
| Output Power | 1930            | dBm   | 47.5    |
|              | 1975            |       | 47.5    |
|              | 2020            |       | 47.5    |
| Gain         | 1930            | dB    | 15.9    |
|              | 1975            |       | 16.0    |
|              | 2020            |       | 16.1    |
| Efficiency   | 1930            | %     | 59.7    |
|              | 1975            |       | 59.7    |
|              | 2020            |       | 61.5    |
| ACPR+        | 1930            | dBc   | -27.2   |
|              | 1975            |       | -27.1   |
|              | 2020            |       | -26.6   |
| ACPR-        | 1930            | dBc   | -27.4   |
|              | 1975            |       | -27.2   |
|              | 2020            |       | -26.6   |
| OPAR         | 1930            | dB    | 8.6     |
|              | 1975            |       | 8.7     |
|              | 2020            |       | 8.1     |

1. Measurements taken on Evaluation Board.

## Functional Schematic



## Pin Configuration

| Pin # | Function              |
|-------|-----------------------|
| D1    | Drain Device 1 (Main) |
| D2    | Drain Device 2 (Peak) |
| G1    | Gate Device 1 (Main)  |
| G2    | Gate Device 2 (Peak)  |
| S     | Source (flange)       |

## Ordering Information

| Part Number        | Package                |
|--------------------|------------------------|
| GTRB204402FC1V1-R0 | Tape and Reel, 50 pcs  |
| GTRB204402FC1V1-R2 | Tape and Reel, 250 pcs |

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

## RF Characteristics

**Single-Carrier WCDMA Specifications<sup>2</sup>:**  $V_{DD} = 48$  V,  $I_{DQ} = 150$  mA,  $P_{OUT} = 56.2$  W avg.,  $V_{GS(PEAK)} = -5.5$  V,  $T_C = 25^\circ\text{C}$ ,  $f = 2020$  MHz, 3GPP Signal, Channel Bandwidth = 3.84 MHz, Peak/Average = 10 dB @ 0.01% CCDF

| Parameter                    | Units | Min. | Typ.  | Max.  |
|------------------------------|-------|------|-------|-------|
| Gain                         | dB    | 14.7 | 16.6  | —     |
| Drain Efficiency             | %     | 53.0 | 59.4  | —     |
| Adjacent Channel Power Ratio | dBc   | —    | -26.8 | -24.5 |
| Output PAR @ 0.01% CCDF      | dB    | 7.3  | 7.8   | —     |

2. Measurements taken in Doherty Production Test Fixture.

## DC Characteristics

| Parameter                      | Test Conditions  | Units | Min. | Typ. | Max.       |
|--------------------------------|--|-------|------|------|------------|
| Drain-Source Breakdown Voltage | $V_{GS} = -8$ V, $I_D = 10$ mA<br>Main, Peak                                 | V     | 150  | —    | —          |
| Drain-Source Leakage Current   | $V_{GS} = -8$ V, $V_{DS} = 10$ V<br>Main<br>Peak                             | mA    | —    | —    | 3.1<br>6.3 |
| Gate-Source Leakage Current    | $V_{GS} = -8$ V, $V_{DD} = 50$ V<br>Main<br>Peak                             | mA    | —    | —    | -5<br>-10  |
| Gate Threshold Voltage         | $V_{DS} = 10$ V, $I_D = 18$ mA, Main<br>$V_{DS} = 10$ V, $I_D = 36$ mA, Peak | V     | -3.8 | -3.1 | -2.3       |

## Recommended Operating Voltages

| Parameter               | Test Conditions                 | Units | Min. | Typ. | Max. |
|-------------------------|---------------------------------|-------|------|------|------|
| Drain Operating Voltage | —                               | V     | 0    | —    | 50   |
| Gate Quiescent Voltage  | $V_{DS} = 48$ V, $I_D = 150$ mA | V     | -3.6 | -2.9 | -2.1 |

**Absolute Maximum Ratings<sup>3,4,5</sup>**

| Parameter                     | Absolute Maximum  |
|-------------------------------|-------------------|
| Drain Source Voltage          | 125 V             |
| Gate Source Voltage           | -10 V to +2 V     |
| Operating Voltage             | 55 V              |
| Gate Current<br>Main<br>Peak  | 18 mA<br>36 mA    |
| Drain Current<br>Main<br>Peak | 6.75 A<br>13.50 A |
| Junction Temperature          | +275°C            |
| Storage Temperature           | -65°C to +150°C   |

3. Exceeding any one or combination of these limits may cause permanent damage to this device.

4. MACOM does not recommend sustained operation near these survivability limits.

5. Product's qualification were performed @ +225°C. Operation @  $T_J$  (+275°C) reduces median time to failure.

**Thermal Characteristics**

| Parameter  | Test Conditions   | Units | Min. | Typ.       | Max. |
|--|---|-------|------|------------|------|
| Thermal Resistance ( $R_{\theta JC}$ )<br>Main<br>Peak | $T_C = +85^\circ\text{C}$ , 48 V<br>76 W DC<br>136 W DC | °C/W  | —    | 1.8<br>1.0 | —    |

**Bias Sequencing**

**Bias ON**

1. Ensure RF is turned off
2. Apply pinch-off voltage of -5 V to the gate
3. Apply nominal drain voltage
4. Bias gate to desired quiescent drain current
5. Apply RF

**Bias OFF**

1. Turn RF off
2. Apply pinch-off voltage to the gate
3. Turn-off drain voltage
4. Turn-off gate voltage

**Handling Procedures**

Please observe the following precautions to avoid damage:

**Static Sensitivity**

These electronic devices 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 1C devices.

# Thermally Enhanced GaN Amplifier

## 350 W, 48 V, 1930 - 2020 MHz

**MACOM**®

**GTRB204402FC/1**

Rev. V2

### Load Pull Performance: Pulsed CW Signal: 10 $\mu$ s, 10% Duty Cycle

#### Main Side:

| Frequency<br>(MHz) | $Z_{\text{SOURCE}}$<br>( $\Omega$ ) | Maximum Output Power  |              |                           |                         |                 |
|--------------------|-------------------------------------|---|--------------|---------------------------|-------------------------|-----------------|
|                    |                                     | $V_{\text{DS}} = 48 \text{ V}$ , $I_{\text{DQ}} = 150 \text{ mA}$ , $T_c = 25^\circ\text{C}$ , P3dB, Class AB |              |                           |                         |                 |
|                    |                                     | $Z_{\text{LOAD}}$<br>( $\Omega$ )   | Gain<br>(dB) | $P_{\text{3dB}}$<br>(dBm) | $P_{\text{3dB}}$<br>(W) | $\eta_D$<br>(%) |
| 1930               | 5.31 - j12.2                        | 7.44 - j9.43  | 17.43        | 52.66                     | 184.5                   | 74.1            |
| 2025               | 8.49 - j13.1                        | 6.54 - j10.39   | 17.50        | 52.70                     | 186.2                   | 71.0            |

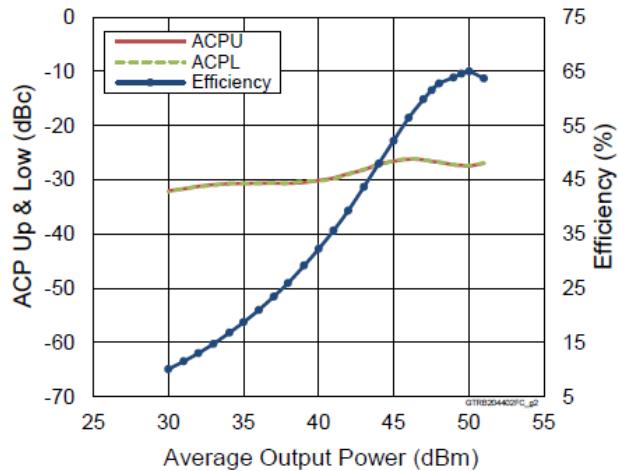
| Frequency<br>(MHz) | $Z_{\text{SOURCE}}$<br>( $\Omega$ ) | Maximum Drain Efficiency  |              |                           |                         |                 |
|--------------------|-------------------------------------|---|--------------|---------------------------|-------------------------|-----------------|
|                    |                                     | $V_{\text{DS}} = 48 \text{ V}$ , $I_{\text{DQ}} = 360 \text{ mA}$ , $T_c = 25^\circ\text{C}$ , P3dB, Class AB |              |                           |                         |                 |
|                    |                                     | $Z_{\text{LOAD}}$<br>( $\Omega$ )   | Gain<br>(dB) | $P_{\text{3dB}}$<br>(dBm) | $P_{\text{3dB}}$<br>(W) | $\eta_D$<br>(%) |
| 1930               | 5.31 - j12.2                        | 9.59 - j1.86  | 18.90        | 50.30                     | 107.4                   | 81.9            |
| 2025               | 7.77 - j3.09                        | 7.77 - j3.09  | 19.50        | 50.40                     | 109.7                   | 83.1            |

#### Peak Side:

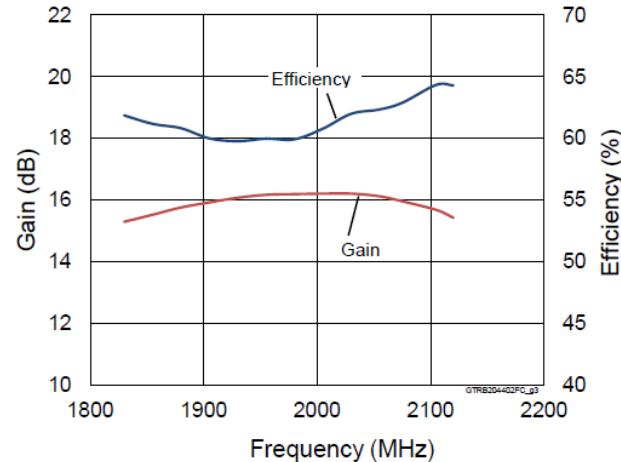
| Frequency<br>(MHz) | $Z_{\text{SOURCE}}$<br>( $\Omega$ ) | Maximum Output Power   |              |                           |                         |                 |
|--------------------|-------------------------------------|--|--------------|---------------------------|-------------------------|-----------------|
|                    |                                     | $V_{\text{DS}} = 48 \text{ V}$ , $V_{\text{GS(PEAK)}} = -5.5 \text{ V}$ , $T_c = 25^\circ\text{C}$ , P1dB, Class C |              |                           |                         |                 |
|                    |                                     | $Z_{\text{LOAD}}$<br>( $\Omega$ )  | Gain<br>(dB) | $P_{\text{1dB}}$<br>(dBm) | $P_{\text{1dB}}$<br>(W) | $\eta_D$<br>(%) |
| 1930               | 2.97 - j7.14                        | 2.43 - j3.67   | 15.85        | 55.42                     | 348.3                   | 65.0            |
| 2025               | 3.10 - j8.80                        | 1.92 - j3.69   | 16.50        | 55.50                     | 354.8                   | 65.1            |

| Frequency<br>(MHz) | $Z_{\text{SOURCE}}$<br>( $\Omega$ ) | Maximum Drain Efficiency   |              |                           |                         |                 |
|--------------------|-------------------------------------|--|--------------|---------------------------|-------------------------|-----------------|
|                    |                                     | $V_{\text{DS}} = 48 \text{ V}$ , $V_{\text{GS(PEAK)}} = -5.5 \text{ V}$ , $T_c = 25^\circ\text{C}$ , P1dB, Class C |              |                           |                         |                 |
|                    |                                     | $Z_{\text{LOAD}}$<br>( $\Omega$ )  | Gain<br>(dB) | $P_{\text{1dB}}$<br>(dBm) | $P_{\text{1dB}}$<br>(W) | $\eta_D$<br>(%) |
| 1930               | 2.97 - j7.14                        | 2.14 - j1.18   | 15.70        | 52.53                     | 179.1                   | 78.1            |
| 2025               | 3.10 - j8.80                        | 2.29 - j1.96   | 16.40        | 53.41                     | 219.3                   | 76.7            |

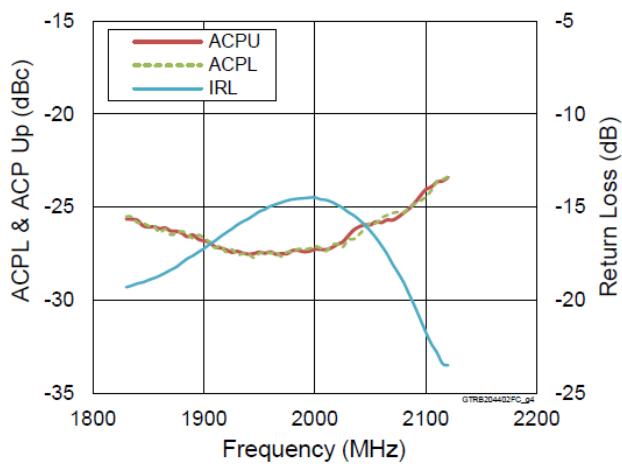
Typical Performance Curves: Data taken in production test fixture



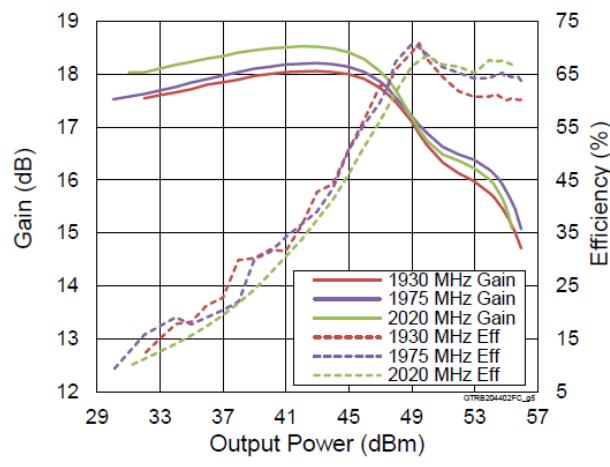
**Figure 1.** Single-carrier WCDMA drive-up  
 $V_{DD} = 48$  V,  $I_{DQ(\text{Main})} = 150$  mA,  $V_{GS(\text{Peak})} = -5.5$  V,  
 $f = 2020$  MHz, 3GPP WCDMA signal,  
PAR = 10 dB



**Figure 2.** Single-carrier WCDMA broadband  
 $V_{DD} = 48$  V,  $I_{DQ(\text{Main})} = 150$  mA,  $V_{GS(\text{Peak})} = -5.5$  V,  
 $P_{OUT} = 47.5$  dBm, 3GPP WCDMA signal,  
PAR = 10 dB

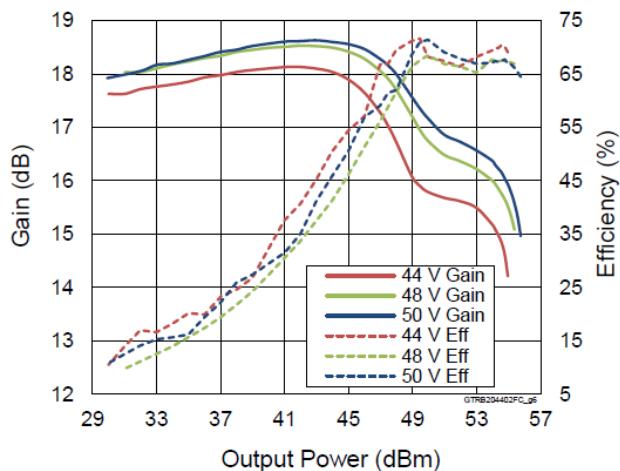


**Figure 3.** Single-carrier WCDMA broadband  
 $V_{DD} = 48$  V,  $I_{DQ(\text{Main})} = 150$  mA,  $V_{GS(\text{Peak})} = -5.5$  V,  
 $P_{OUT} = 47.5$  dBm, 3GPP WCDMA signal,  
PAR = 10 dB

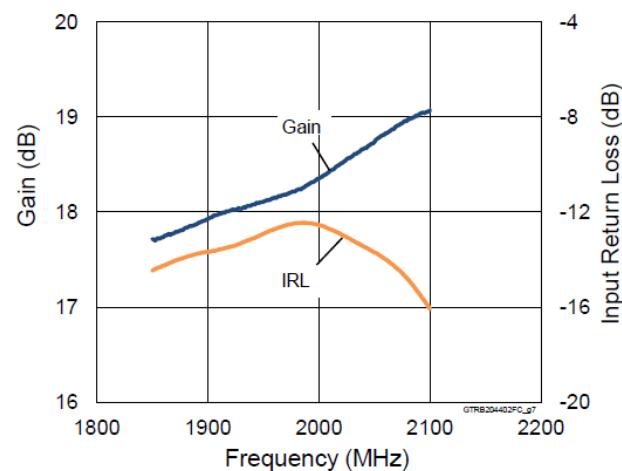


**Figure 4.** Pulsed CW performance  
 $V_{DD} = 48$  V,  $I_{DQ(\text{Main})} = 150$  mA,  $V_{GS(\text{Peak})} = -5.5$  V

Typical Performance Curves: Data taken in production test fixture



**Figure 5.** Pulsed CW performance at various  $V_{DD}$   
 $I_{DQ(\text{Main})} = 150 \text{ mA}$ ,  $V_{GS(\text{Peak})} = -5.5 \text{ V}$ ,  
 $f = 2020 \text{ MHz}$



**Figure 6.** Small signal CW gain & input return loss  
 $V_{DD} = 48 \text{ V}$ ,  $I_{DQ(\text{Main})} = 150 \text{ mA}$ ,  $V_{GS(\text{Peak})} = -5.5 \text{ V}$

# Thermally Enhanced GaN Amplifier

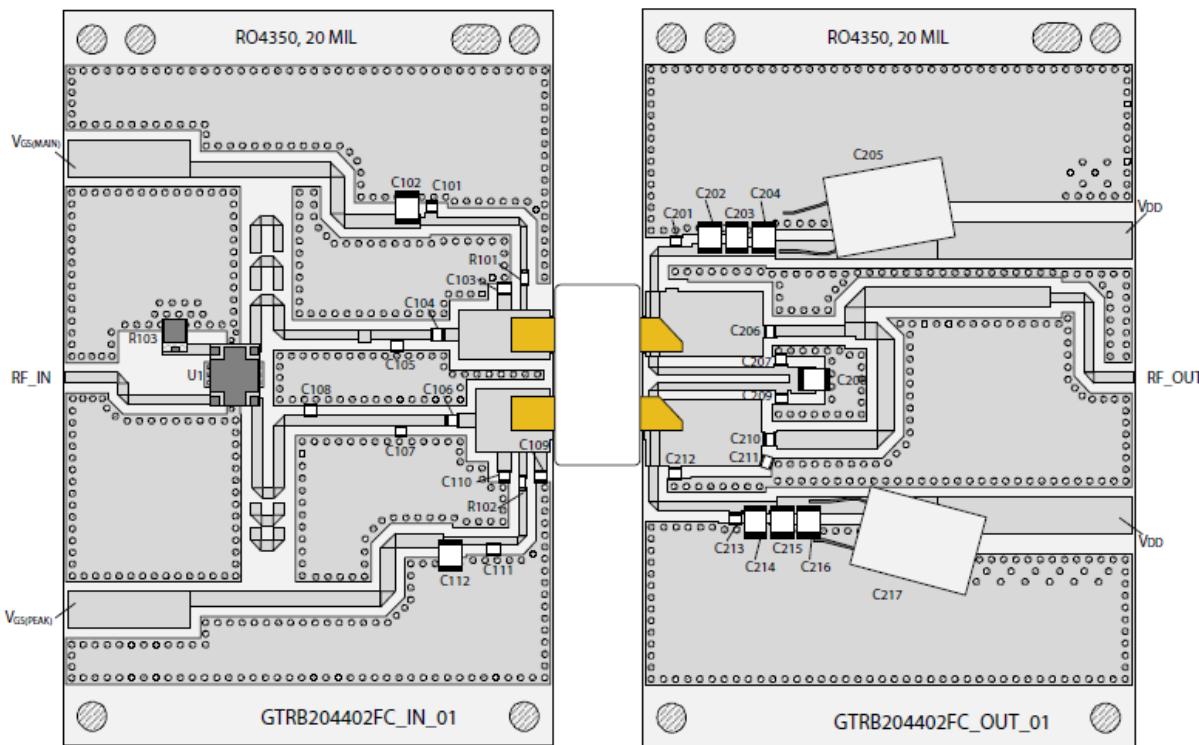
## 350 W, 48 V, 1930 - 2020 MHz

**MACOM**®

**GTRB204402FC/1**

Rev. V2

### Evaluation Board: 1930 - 2020 MHz



| Component                                | Description                  | Manufacturer          | Manufacturer P/N   |
|--|------------------------------|-----------------------|--------------------|
| <b>Input</b>                             |                              |                       |                    |
| C101, C104, C106, C111                   | Capacitor, 18 pF             | ATC                   | ATC600F180JT250XT  |
| C102, C112                               | Capacitor, 100 V, 10 $\mu$ F | Murata Electronics    | GRM32EC72A106KE05L |
| C103                                     | Capacitor, 1.6 pF            | ATC                   | ATC600F1R6CT250XT  |
| C105                                     | Capacitor, 1.2 pF            | ATC                   | ATC600F1R2CT250XT  |
| C107                                     | Capacitor, 0.8 pF            | ATC                   | ATC600F0R8CT250XT  |
| C108                                     | Capacitor, 0.6 pF            | ATC                   | ATC600F0R6CT250XT  |
| C109                                     | Capacitor, 1.8 pF            | ATC                   | ATC600F1R8CT250XT  |
| C110                                     | Capacitor, 1.5 pF            | ATC                   | ATC600F1R5CT250XT  |
| R101, R102                               | Resistor, 9.1 $\Omega$       | Panasonic Electronics | ERJ-3GEYJ9R1V      |
| R103                                     | Resistor, 50 $\Omega$        | Richardson            | C8A50Z4B           |
| U1                                       | Hybrid Coupler               | Anaren                | X3C21P1-03S        |
| <b>Output</b>                            |                              |                       |                    |
| C201, C207, C209, C213                   | Capacitor, 18 pF             | ATC                   | ATC600F180JT250XT  |
| C202, C203, C204, C208, C214, C215, C216 | Capacitor, 100 V, 10 $\mu$ F | Murata Electronics    | GRM32EC72A106KE05L |
| C205, C217                               | Capacitor, 220 $\mu$ F       | Panasonic Electronics | EEE-FP1V221AP      |
| C206                                     | Capacitor, 2.7 pF            | ATC                   | ATC600F2R7CT250XT  |
| C210                                     | Capacitor, 3.0 pF            | ATC                   | ATC600F3R0CT250XT  |
| C211                                     | Capacitor, 0.8 pF            | ATC                   | ATC600F0R8CT250XT  |
| C212                                     | Capacitor, 2.2 pF            | ATC                   | ATC600F2R2CT250XT  |

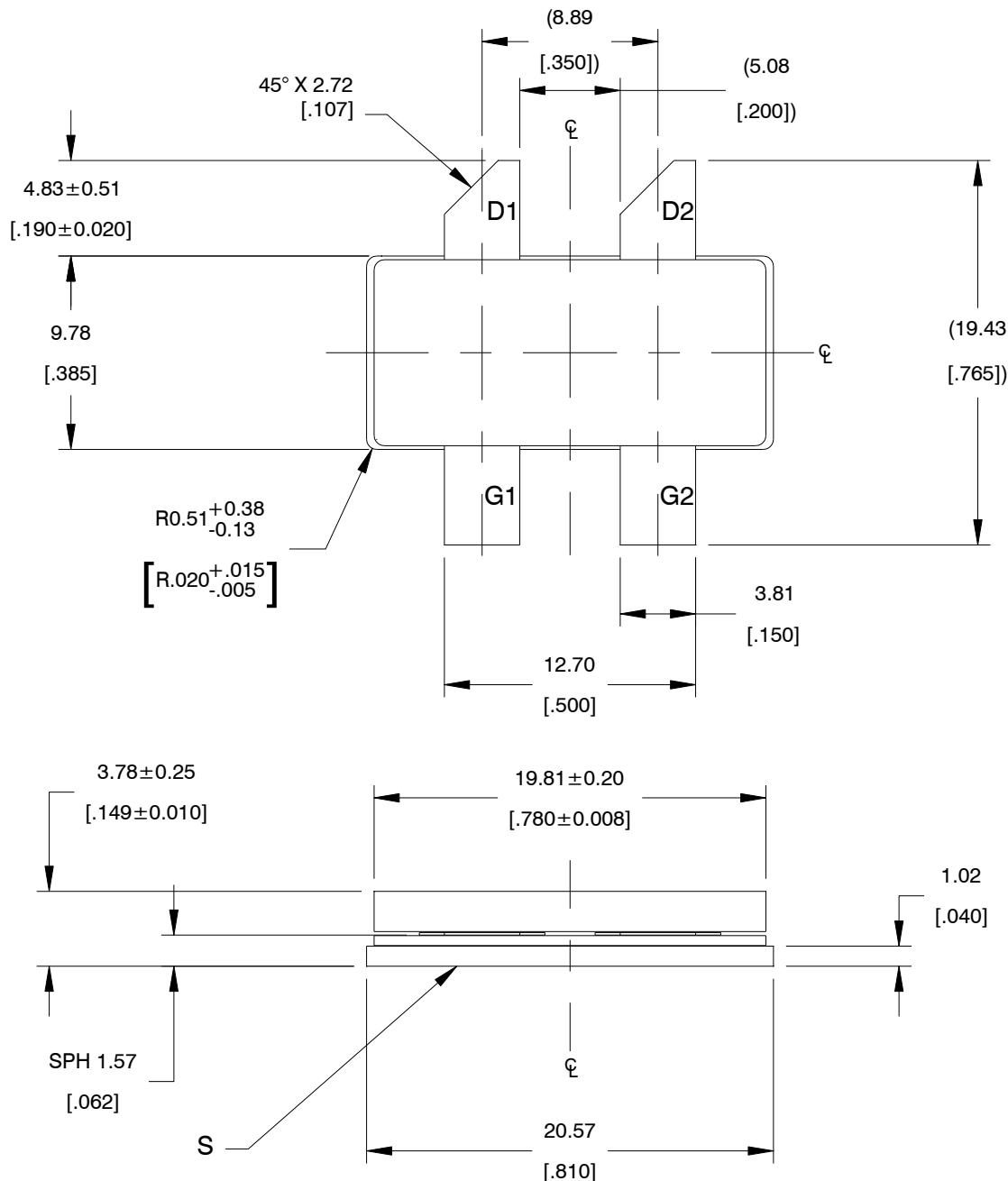
# Thermally Enhanced GaN Amplifier 350 W, 48 V, 1930 - 2020 MHz

**MACOM**<sup>®</sup>

GTRB204402FC/1

Rev. V2

Lead-Free Outline Drawing H-37248C-4



Interpret dimensions and tolerances per ASME Y14.5M-1994  
Primary dimensions are mm; alternate dimensions are inches  
All tolerances  $\pm 0.127$  [0.005]  
Lead thickness:  $0.13 \pm 0.05$  mm [ $0.005 \pm 0.002$  inch]  
Gold plating thickness:  $1.14 \pm 0.38$  micron [ $45 \pm 15$  microinch]

# Thermally Enhanced GaN Amplifier

## 350 W, 48 V, 1930 - 2020 MHz



GTRB204402FC/1

Rev. V2

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