

# GaN Amplifier

## 400 W, 48 V, 2110 - 2200 MHz



**MACOM PURE CARBIDE™**

**GTRB224402FC**

Rev. V1

### Features

- GaN on SiC Technology
- Pulsed CW Performance, 2200 MHz, 48 V, 10  $\mu$ s Pulse Width, 10% Duty Cycle, Combined Outputs
- Output Power @  $P_{3dB}$  = 400 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 GTRB224402FC is a 400 W ( $P_{3dB}$ ) 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

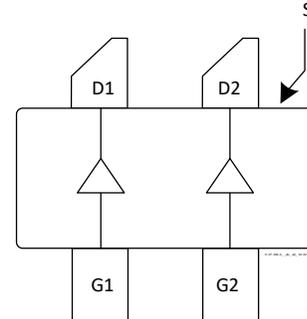
#### Single-Carrier WCDMA Specifications<sup>1</sup>:

$V_{DD}$  = 48 V,  $I_{DQ}$  = 750 mA,  $V_{GS(PEAK)}$  = -5.15 V,  
 $T_C$  = 25°C, Channel Bandwidth = 3.84 MHz,  
 Peak/Average = 10 dB @ 0.01% CCDF

Parameter	Frequency (MHz)	Units	Typical
Output Power	2100	dBm	47.6
	2155		47.6
	2200		47.6
Gain	2100	dB	16.6
	2155		16.8
	2200		16.9
Efficiency	2100	%	58.8
	2155		57.3
	2200		57.7
ACPR+	2100	dBc	-28.6
	2155		-30.3
	2200		-31.2
ACPR-	2100	dBc	-28.7
	2155		-29.9
	2200		-30.8
OPAR	2100	dB	8.4
	2155		8.8
	2200		8.8

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
GTRB224402FC-V1-R0	Bulk Quantity
GTRB224402FC-V1-R2	Tape and Reel
LTAGTRB224402FC-E1	Sample Board

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

## RF Characteristics

**Single-Carrier WCDMA Specifications<sup>2</sup>:**  $V_{DD} = 48\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $P_{OUT} = 47.6\text{ dBm}$ ,  
 $V_{GS(PEAK)} = V_{GS} @ I_{DQ(PEAK)} = 300\text{ mA}$ ,  $-2.4\text{ V}$ ,  $T_C = 25^\circ\text{C}$ ,  $f = 2200\text{ MHz}$ , 3GPP Signal,  
 Channel Bandwidth = 3.84 MHz, Peak/Average = 10 dB @ 0.01% CCDF

Parameter	Units	Min.	Typ.	Max.
Gain	dB	14.0	15.5	—
Drain Efficiency	%	52	55	—
Adjacent Channel Power Ratio	dBc	—	-28.8	-26.0
Output PAR @ 0.01% CCDF	dB	7.8	8.3	—

2. Measurements taken in Doherty Production Test Fixture.

## DC Characteristics

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Drain-Source Breakdown Voltage	$V_{GS} = -8\text{ V}$ , $I_D = 10\text{ mA}$ Main, Peak	V	150	—	—
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DS} = 10\text{ V}$ Main Peak	mA	—	—	3.1 6.3
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}$ , $V_{DD} = 50\text{ V}$ Main Peak	mA	—	—	-5 -10
Gate Threshold Voltage	$V_{DS} = 10\text{ V}$ , $I_D = 18\text{ mA}$ , Main $V_{DS} = 10\text{ V}$ , $I_D = 36\text{ mA}$ , Peak	V	-3.8	-3.05	-2.3

## Recommended Operating Voltages

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Drain Operating Voltage	—	V	0	—	50
Gate Quiescent Voltage	$V_{DS} = 48\text{ V}$ , $I_D = 750\text{ mA}$	V	-3.5	-2.75	-2.0

**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 Main Peak	18 mA 36 mA
Drain Current Main Peak	6.75 A 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<sub>J</sub> (+275°C) reduces median time to failure.

**Thermal Characteristics**

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Thermal Resistance (R <sub>θJC</sub> ) Main Peak	T <sub>C</sub> = +85°C, 48 V 76 W DC 136 W DC	°C/W	—	1.8 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.

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

**Main Side:**

Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Output Power				
		$V_{DS} = 48\text{ V}, I_{DQ} = 100\text{ mA}, T_C = 25^\circ\text{C}, P_{3dB}, \text{Class AB}$				
		$Z_{LOAD}$ ( $\Omega$ )	Gain (dB)	$P_{3dB}$ (dBm)	$P_{3dB}$ (W)	$\eta_D$ (%)
2110	7.2 - j16.2	8.1 - j9.0	16.88	52.83	191.9	67.2
2200	11.9 - j14.3	8.1 - j9.2	17.91	52.79	190.1	68.6

Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Drain Efficiency				
		$V_{DS} = 48\text{ V}, I_{DQ} = 360\text{ mA}, T_C = 25^\circ\text{C}, P_{3dB}, \text{Class AB}$				
		$Z_{LOAD}$ ( $\Omega$ )	Gain (dB)	$P_{3dB}$ (dBm)	$P_{3dB}$ (W)	$\eta_D$ (%)
2110	7.2 - j16.2	11.3 + j1.3	19.61	50.39	109.4	82.0
2200	11.9 - j14.3	9.2 - j2.5	19.76	51.37	137.1	81.0

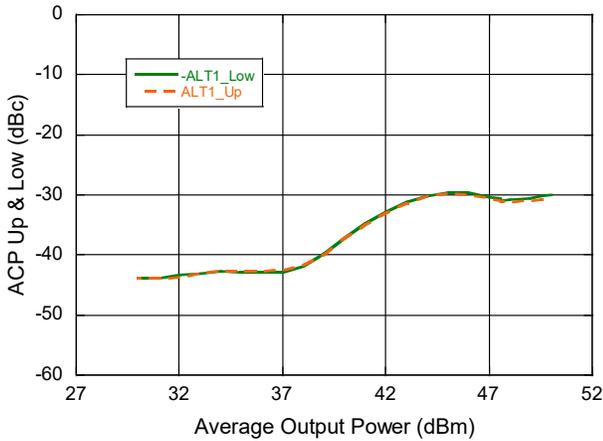
**Peak Side:**

Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Output Power				
		$V_{DS} = 48\text{ V}, V_{GS(PEAK)} = -3.3\text{ V}, T_C = 25^\circ\text{C}, P_{3dB}, \text{Class B}$				
		$Z_{LOAD}$ ( $\Omega$ )	Gain (dB)	$P_{3dB}$ (dBm)	$P_{3dB}$ (W)	$\eta_D$ (%)
2110	2.0 - j8.8	2.5 - j2.9	17.52	56.45	441.6	70.2
2200	3.0 - j11.2	2.6 - j2.9	17.24	56.33	429.5	68.7

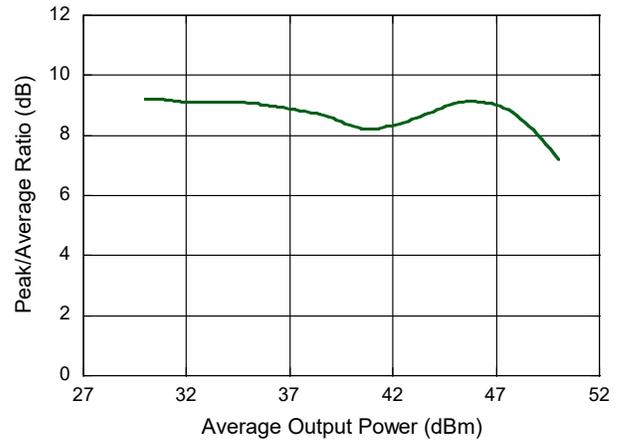
Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Drain Efficiency				
		$V_{DS} = 48\text{ V}, V_{GS(PEAK)} = -5\text{ V}, T_C = 25^\circ\text{C}, P_{3dB}, \text{Class C}$				
		$Z_{LOAD}$ ( $\Omega$ )	Gain (dB)	$P_{3dB}$ (dBm)	$P_{3dB}$ (W)	$\eta_D$ (%)
2110	2.0 - j8.8	2.2 - j1.2	18.68	54.91	309.7	78.2
2200	3.0 - j11.2	2.2 - j1.6	18.56	55.26	335.7	75.9

**Typical Performance Curves: Data taken in Evaluation Board**  
**Single-Carrier WCDMA Drive-up @ 2200 MHz**

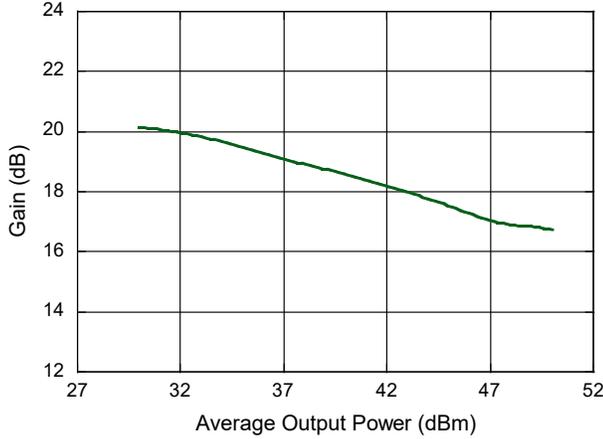
*ACP Up & Low Vs. Output Power*



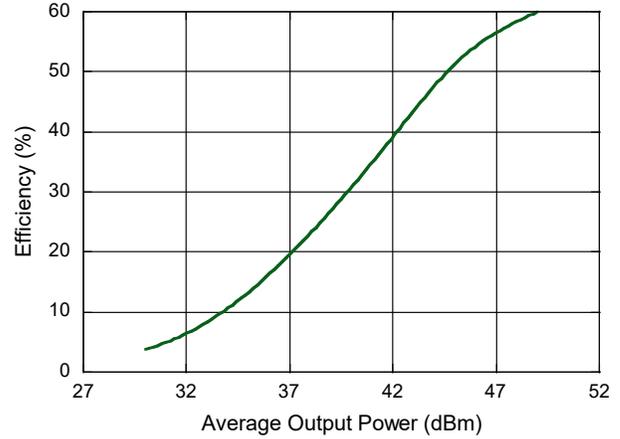
*PAR @ 0.01% CCDF Vs. Output Power*



*Gain Vs. Output Power*

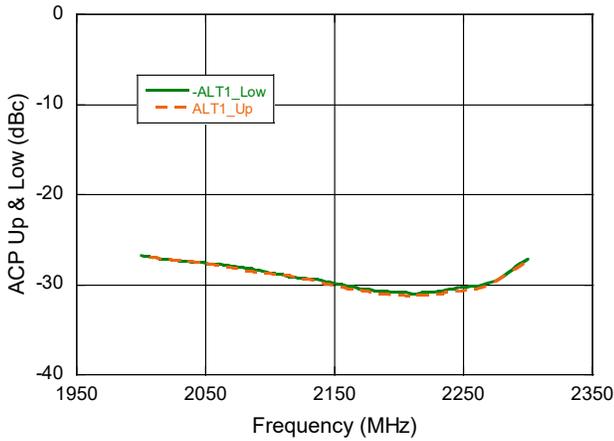


*Efficiency Vs. Output Power*

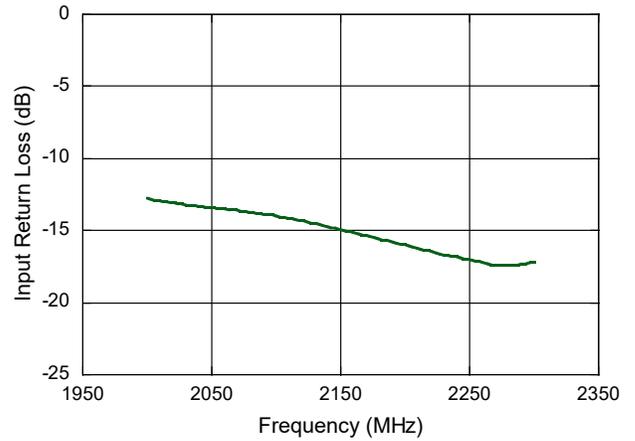


**Typical Performance Curves: Data taken in Evaluation Board**  
**Single-Carrier WCDMA Broadband Performance**

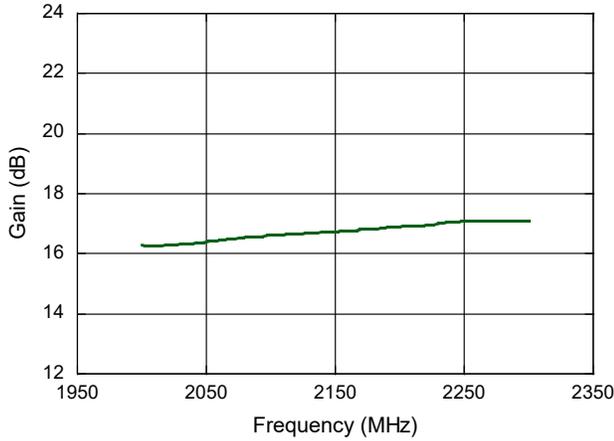
*ACP Up & Low Vs. Frequency*



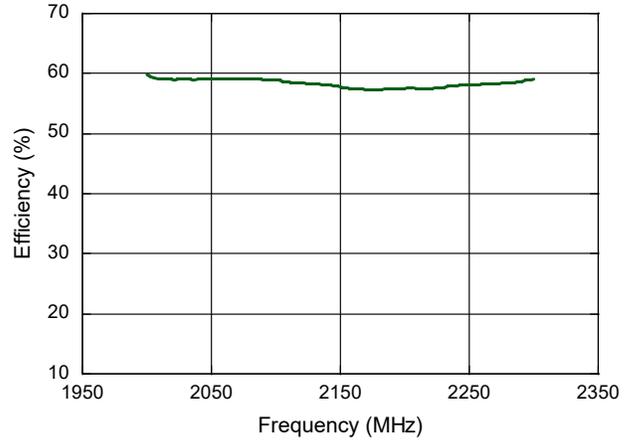
*Input Return Loss Vs. Frequency*



*Gain Vs. Frequency*

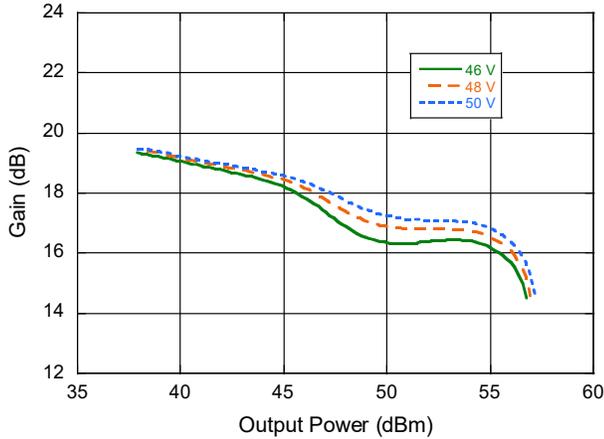


*Efficiency Vs. Frequency*

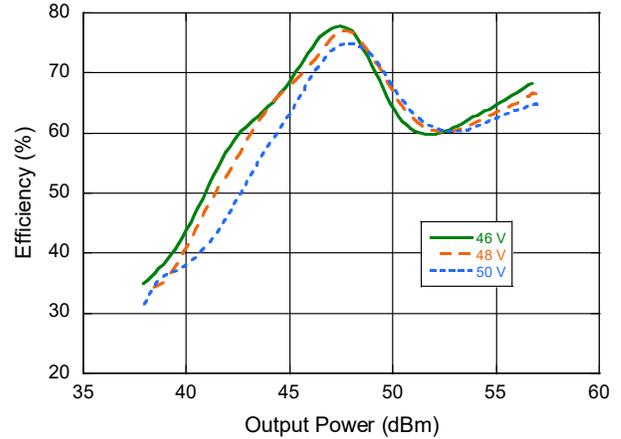


**Typical Performance Curves: Data taken in Evaluation Board**  
**Pulsed CW Performance**

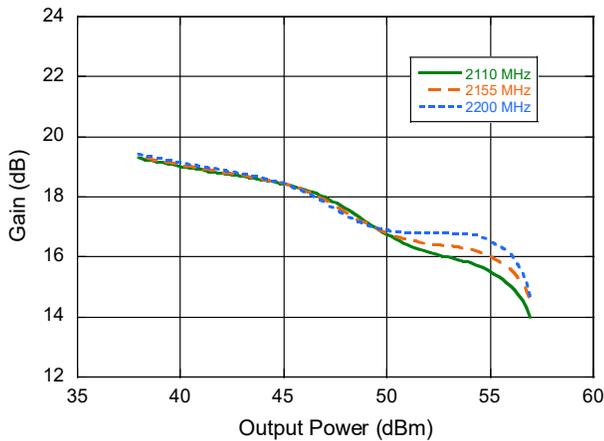
*Gain Vs. Output Power over Voltage @ 2200 MHz*



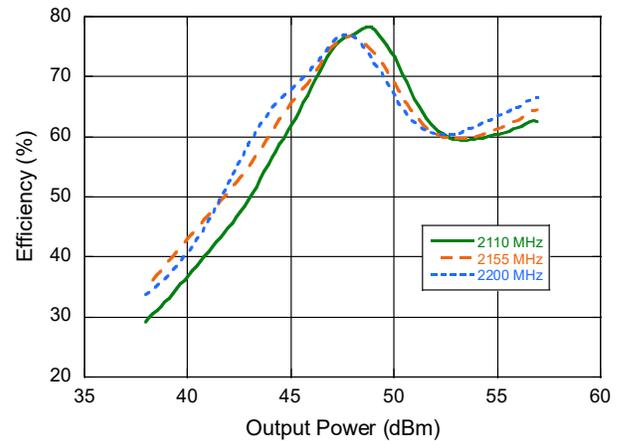
*Efficiency Vs. Output Power over Voltage @ 2200 MHz*



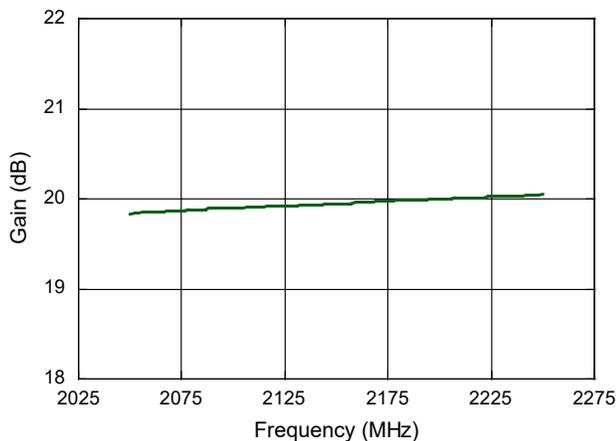
*Gain Vs. Output Power over Frequency @ 2200 MHz*



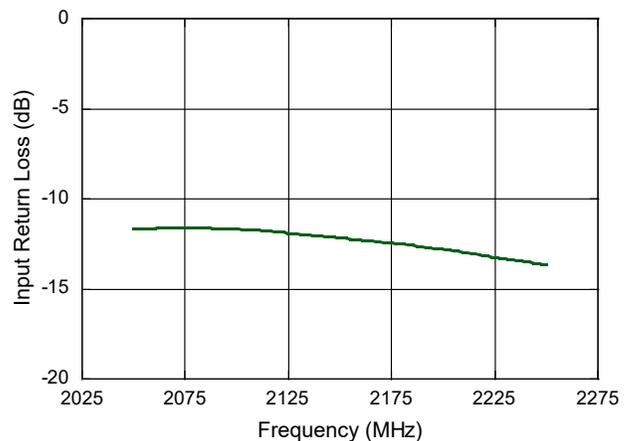
*Efficiency Vs. Output Power over Frequency @ 2200 MHz*



*Gain Vs. Frequency*



*Input Return Loss Vs. Frequency*



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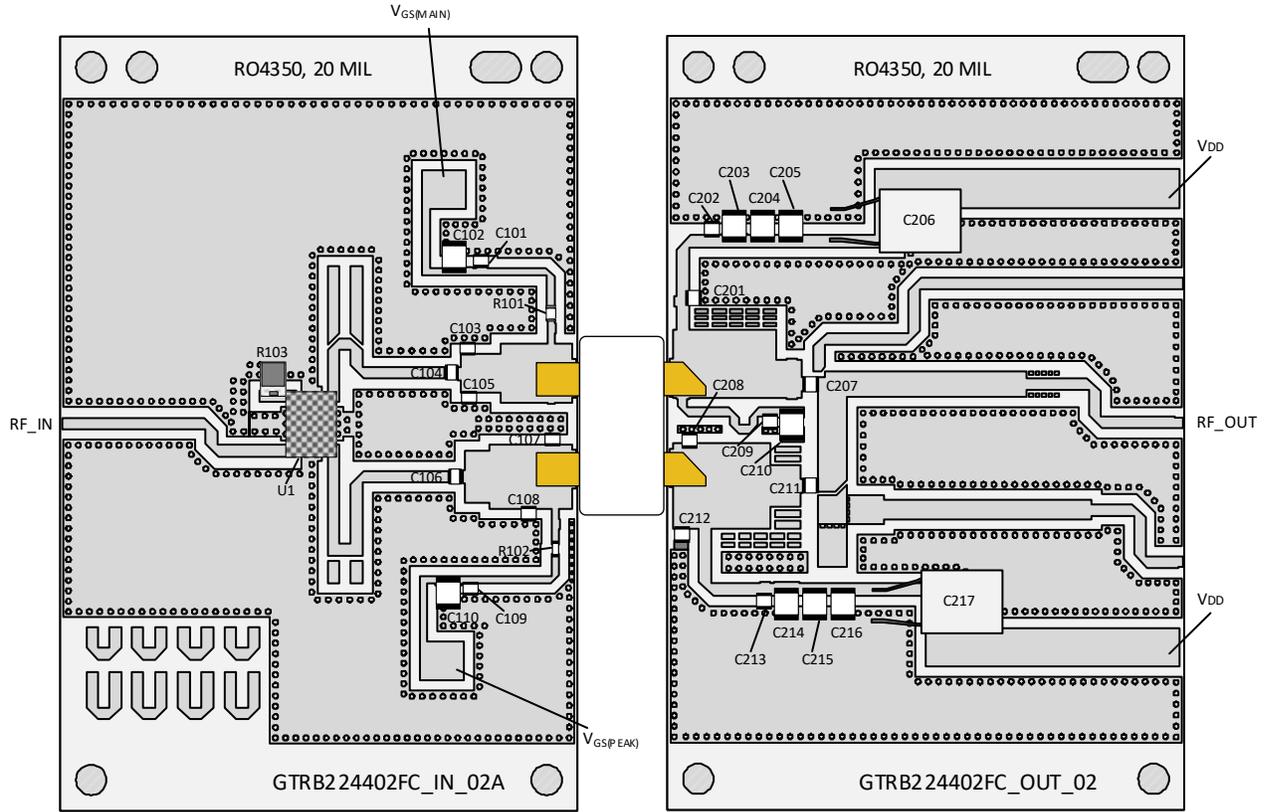


**MACOM PURE CARBIDE™**

**GTRB224402FC**

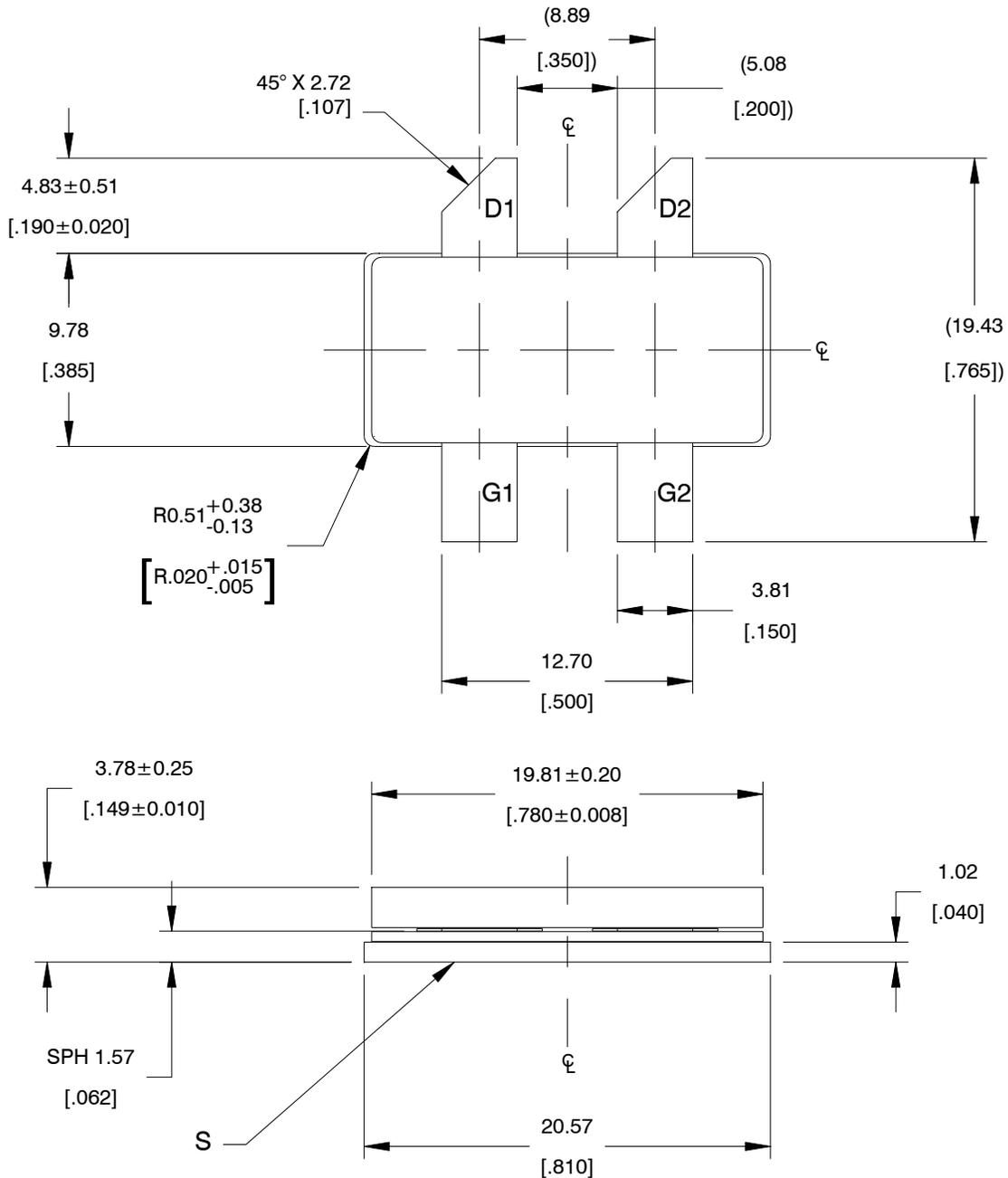
Rev. V1

### Evaluation Board: 2110 - 2200 MHz



Component	Description	Manufacturer	Manufacturer P/N
<b>Input</b>			
C101, C104, C106, C109	Capacitor, 10 pF	ATC	ATC600F100JT250XT
C102, C110	Capacitor, 100 V, 10 μF	Murata Electronics	GRM32EC72A106KE05L
C103	Capacitor, 1.2 pF	ATC	ATC600F1R2BT250XT
C105	Capacitor, 1.0 pF	ATC	ATC600F1R0BT250XT
C107, C108	Capacitor, 0.9 pF	ATC	ATC600F0R9BT250XT
R101, R102	Resistor, 5.6 Ω	Panasonic Electronics	ERJ-8RQJ5R6V
R103	Resistor, 50 Ω	Richardson	C8A50Z4B
U1	Hybrid Coupler	Anaren	X3C21P1-03S
<b>Output</b>			
C201	Capacitor, 0.7 pF	ATC	ATC600F0R7BT250XT
C202, C209, C213	Capacitor, 10 pF	ATC	ATC600R100JT250XT
C203, C204, C205, C210, C214, C215, C216	Capacitor, 100 V, 10 μF	Murata Electronics	GRM32EC72A106KE05L
C206, C217	Capacitor, 220 μF	Panasonic Electronics	ECA-2AHG221
C207	Capacitor, 6.8 pF	ATC	ATC600F6R8BT250XT
C208	Capacitor, 2.0 pF	ATC	ATC600F2R0BT250XT
C211	Capacitor, 18 pF	ATC	ATC600F180JT250XT
C212	Capacitor, 2.4 pF	ATC	ATC600F2R4BT250XT

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 ± 0.127 [0.005]  
 Lead thickness: 0.13 ± 0.05 mm [0.005 ± 0.002 inch]  
 Gold plating thickness: 1.14 ± 0.38 micron [45 ± 15 microinch]

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