



# TGA2238-CP

## 8 – 11 GHz 50 W GaN Power Amplifier

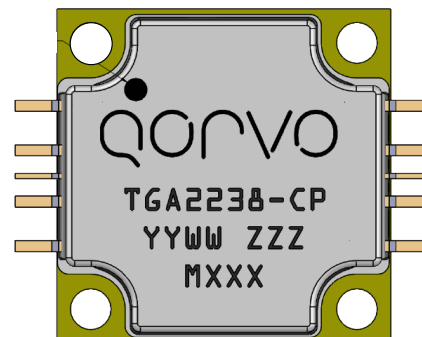
### Product Description

Qorvo's TGA2238-CP is a packaged, high power X-band amplifier fabricated on Qorvo's QGaN25 0.25  $\mu\text{m}$  GaN on SiC production process. Operating from 8 – 11 GHz, the TGA2238-CP achieves 50 W saturated output power with 24 dB power gain and 34 % power-added efficiency.

The TGA2238-CP is packaged in a 10-lead 15 x 15 mm bolt-down package with a Cu base for superior thermal management. Both RF ports (RF input internally DC blocked) are matched to 50 ohms allowing for simple system integration.

The TGA2238-CP is ideally suited for both military and commercial X-band radar systems and data links.

Lead-free and RoHS compliant.

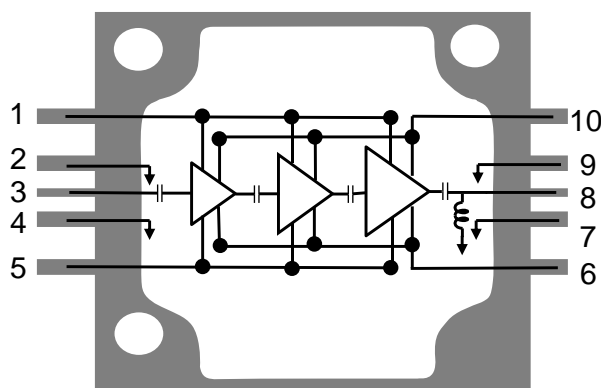


### Product Features

- Frequency Range: 8 – 11 GHz
- $P_{\text{SAT}}$ : 47 dBm @  $P_{\text{IN}} = 23$  dBm
- PAE: 34% @  $P_{\text{IN}} = 23$  dBm
- Power Gain: 24 dB @  $P_{\text{IN}} = 23$  dBm
- Small Signal Gain: > 28 dB
- Return Loss: > 9 dB
- Bias:  $V_D = +28$  V,  $I_{\text{DQ}} = 650$  mA  
(Pulsed  $V_D$ :  $PW = 100$   $\mu\text{s}$  and  $DC = 10$  %)
- Package Dimensions: 15.2 x 15.2 x 3.5 mm
- Package base is pure Cu offering superior thermal management

*Performance is typical across frequency. Please reference electrical specification table and data plots for more details*

### Functional Block Diagram



### Applications

- X-band Radar
- Datalinks

### Ordering Information

Part No.	Description
TGA2238-CP	8 – 11 GHz 50 W GaN Power Amplifier
TGA2238-CP EVB	Evaluation Board



# TGA2238-CP

## 8 – 11 GHz 50 W GaN Power Amplifier

### Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage ( $V_D$ )	40 V
Gate Voltage Range ( $V_G$ )	-8 to 0 V
Drain Current ( $I_D$ )	8 A
Gate Current ( $I_G$ )	See plot page 9
Power Dissipation ( $P_{DISS}$ ), 85°C Pulsed: PW = 100 $\mu$ s, DC = 10%	158 W
Input Power ( $P_{IN}$ ), 50 $\Omega$ , 85°C, $V_D$ = 28V, Pulsed: PW = 100 $\mu$ s, DC = 10%	30 dBm
Input Power ( $P_{IN}$ ), 85°C, VSWR 3:1, $V_D$ = 28V, Pulsed: PW = 100 $\mu$ s, DC = 10%	30 dBm
Mounting Temperature	Refer to Assembly Notes, page 13
Storage Temperature	-55 to 150 °C

Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied.

### Recommended Operating Conditions

Parameter	Value / Range
Input Power ( $P_{IN}$ )	Pulsed: 23 dBm
	CW: 20 dBm <sup>1/</sup>
Drain Voltage ( $V_D$ )	28 V
Drain Current ( $I_{DQ}$ )	650 mA
Temperature Range	-40 to +85 °C

<sup>1/</sup> CW operating requires thermal consideration; CW applications are up to 2 dBm back off from saturated output power  $P_{SAT}$ .

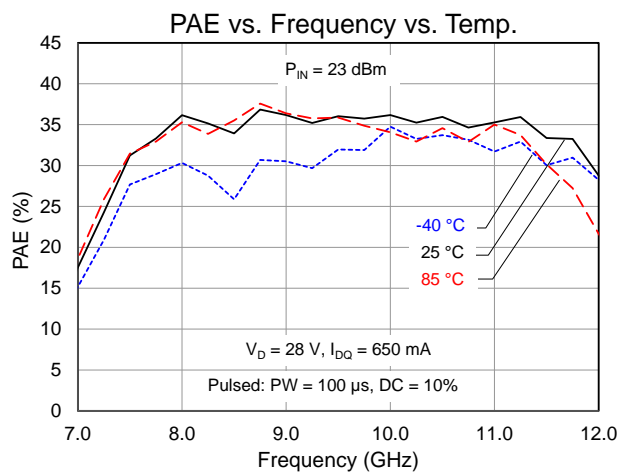
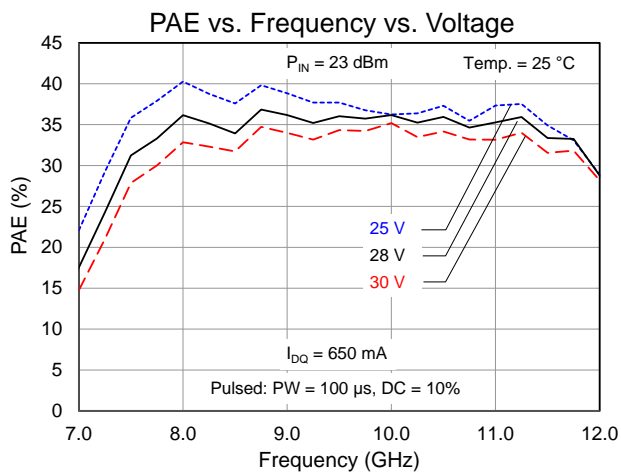
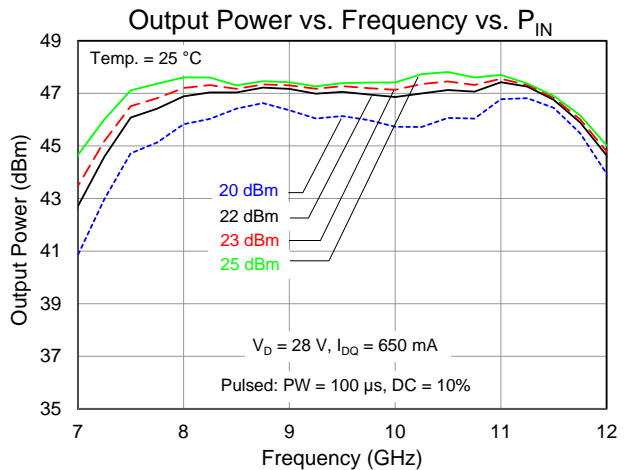
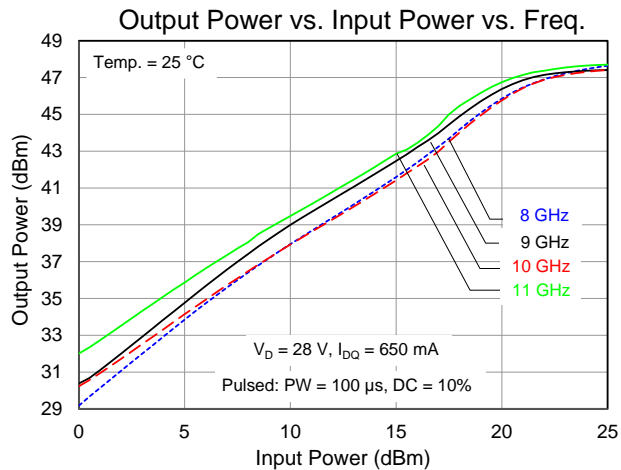
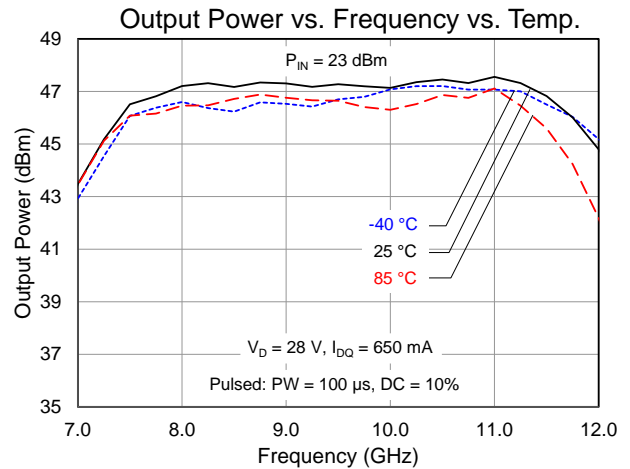
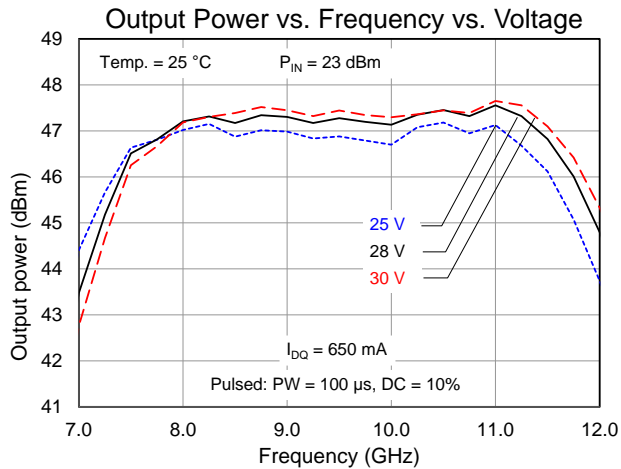
Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

### Electrical Specifications

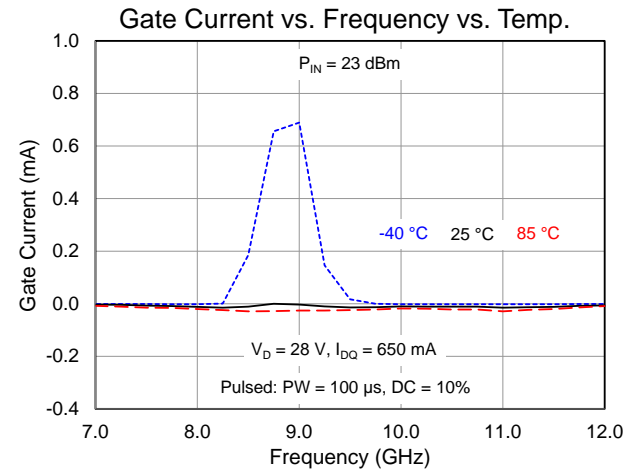
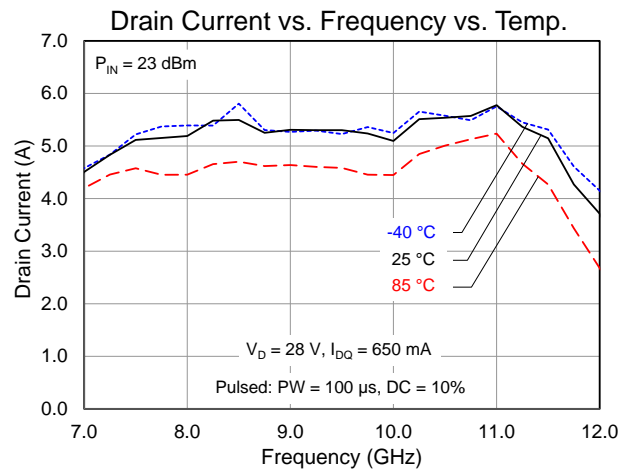
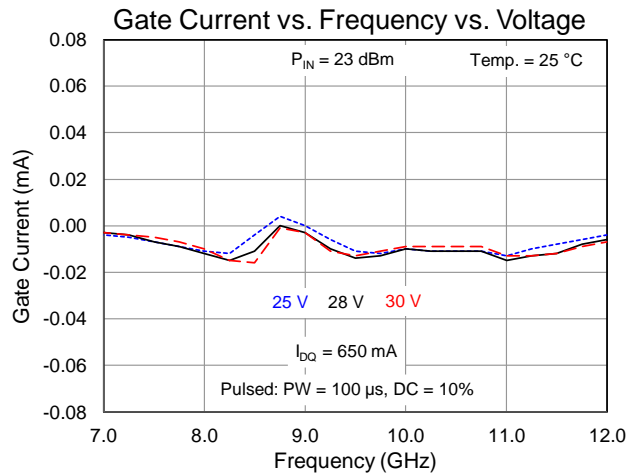
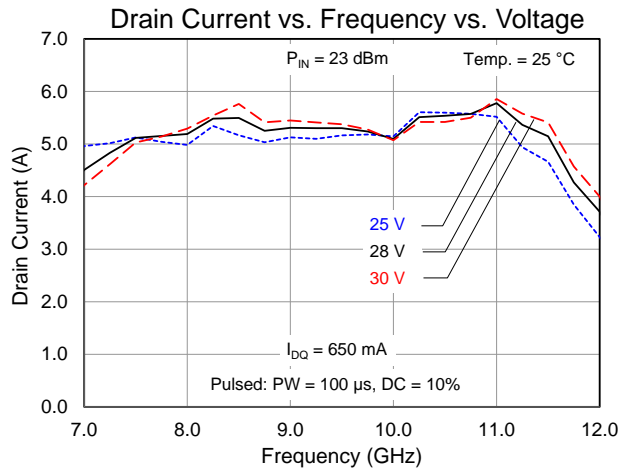
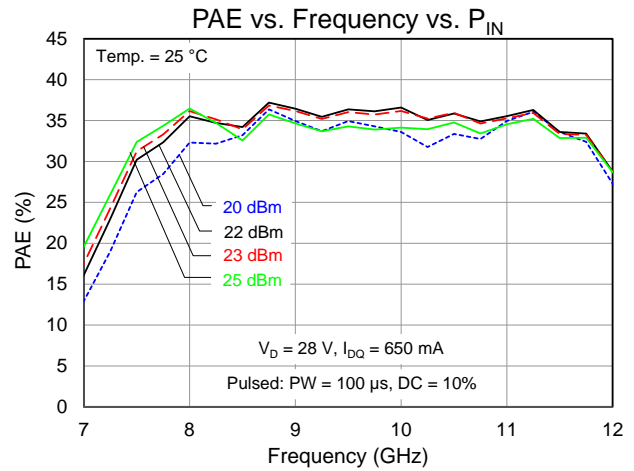
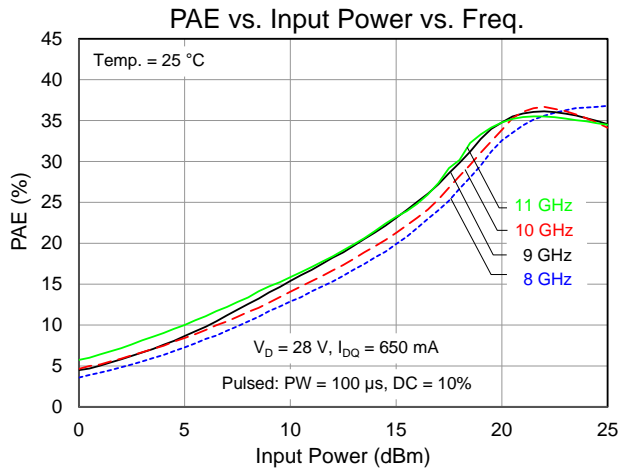
Parameter	Min	Typ	Max	Units
Operational Frequency Range	8		11	GHz
Small Signal Gain		>28		dB
Input Return Loss		>9		dB
Output Return Loss		>10		dB
Output Power ( $P_{IN}$ = 23 dBm)		47		dBm
Power Added Efficiency ( $P_{IN}$ = 23 dBm)		34		%
Power Gain ( $P_{IN}$ = 23 dBm)		24		dB
Gate Leakage ( $V_D$ = +10 V, $V_G$ = -3.7V)	-29			mA
Small Signal Gain Temperature Coefficient		-0.056		dBm/°C
Power Temperature Coefficient ( $P_{IN}$ =23 dBm)		-0.001		dBm/°C

Test conditions unless otherwise noted: 25 °C,  $V_D$  = +28 V,  $I_{DQ}$  = 650 mA, Pulsed  $V_D$ : PW = 100  $\mu$ s, DC = 10 %

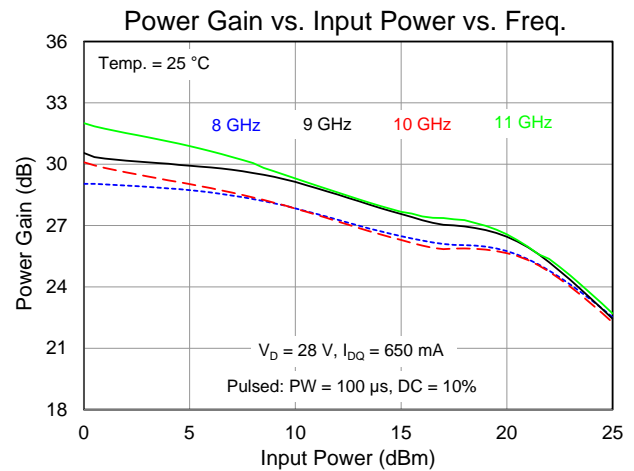
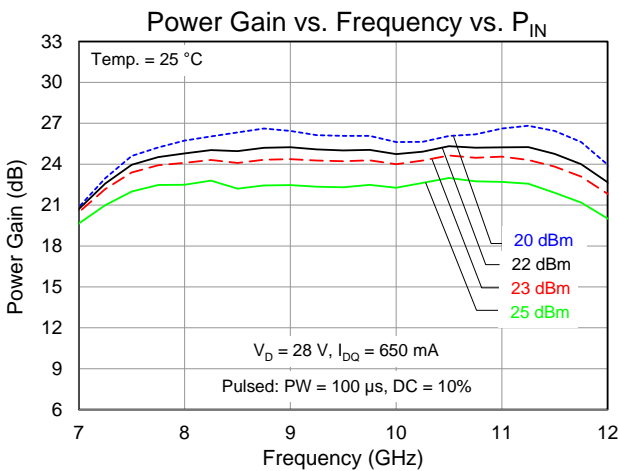
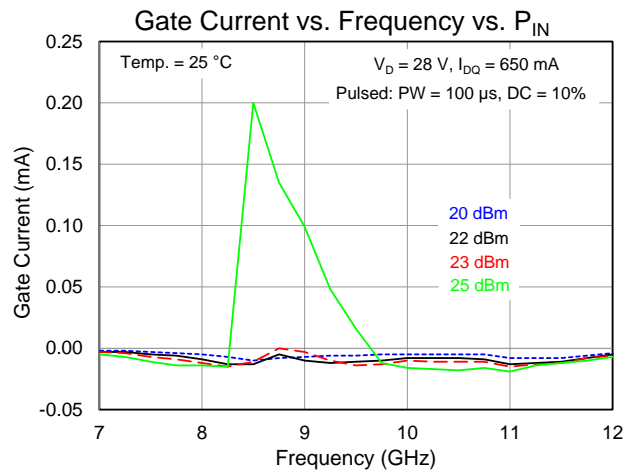
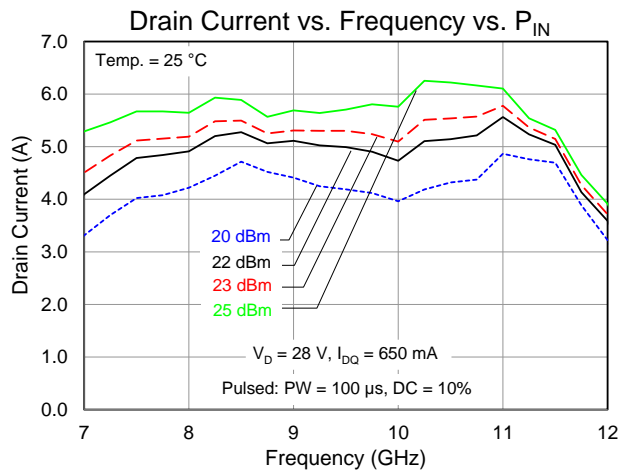
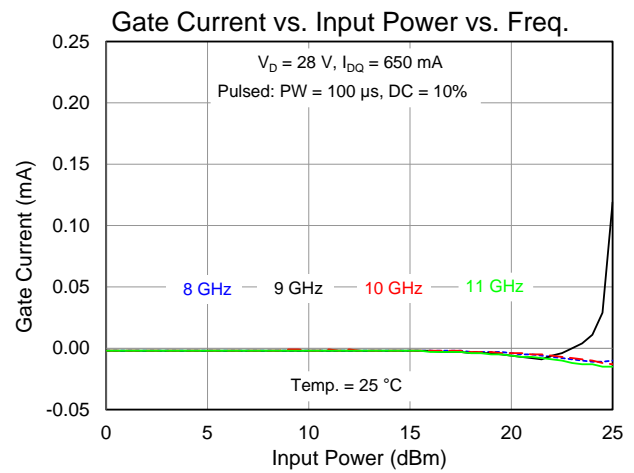
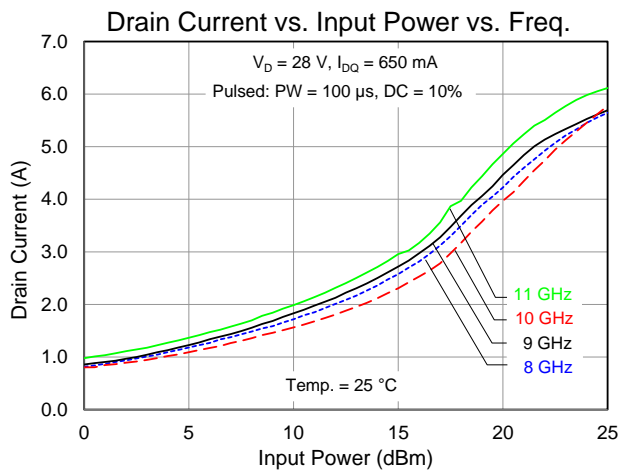
### Typical Performance – Large Signal (Pulsed)



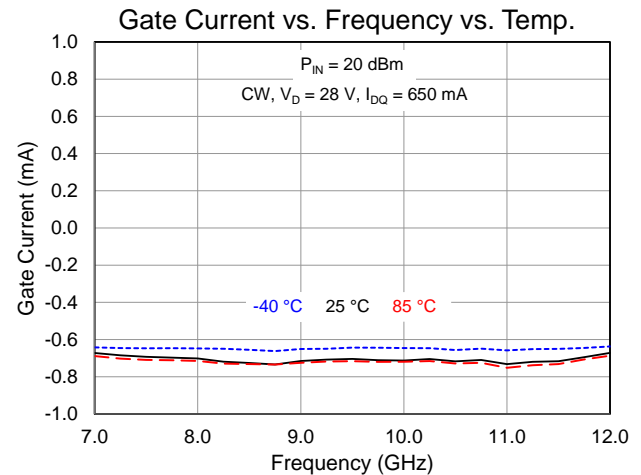
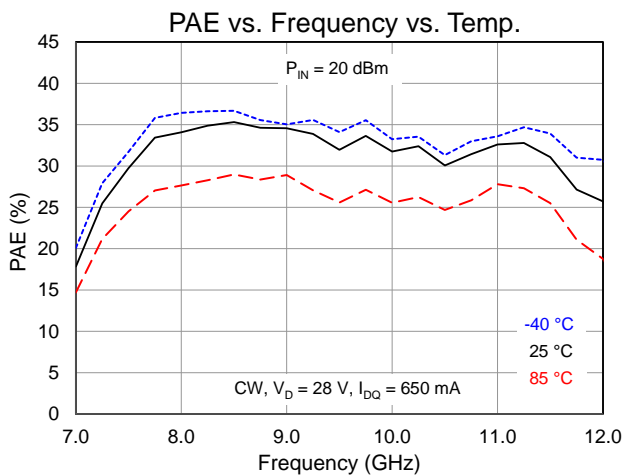
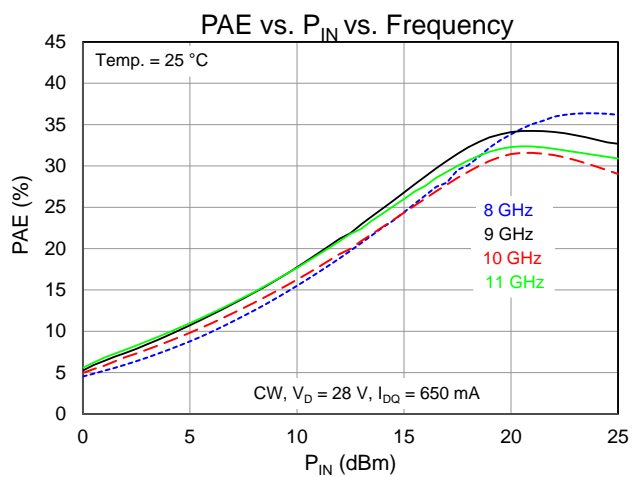
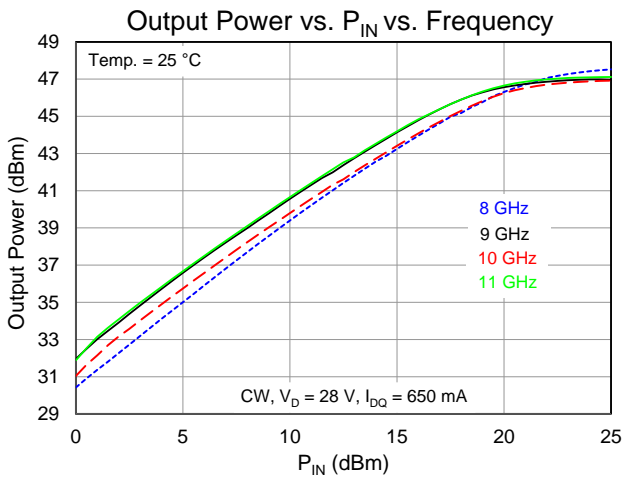
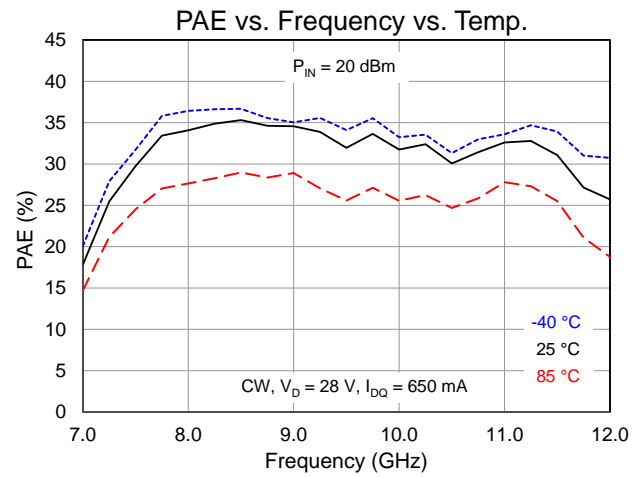
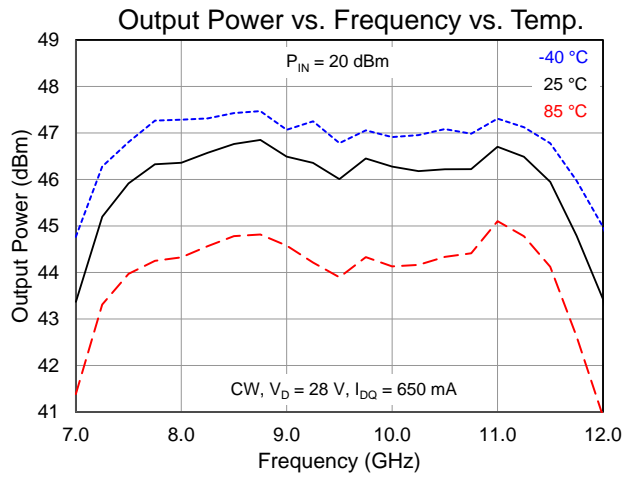
### Typical Performance – Large Signal (Pulsed)



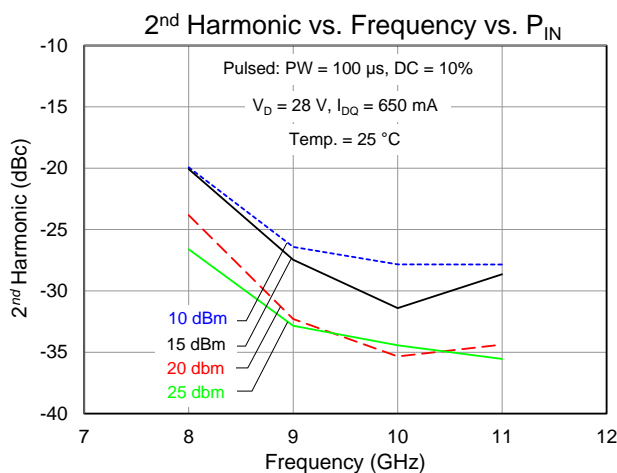
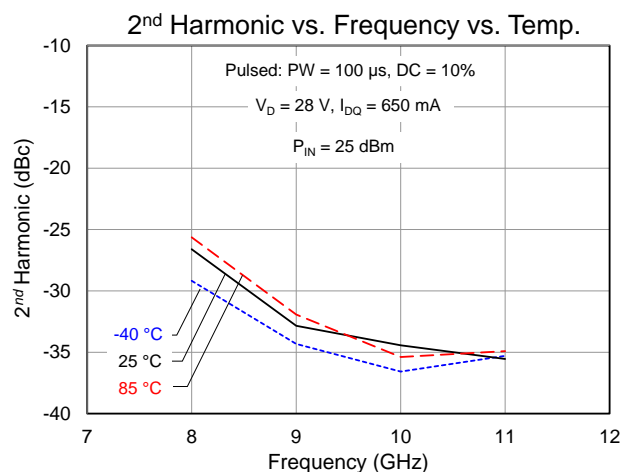
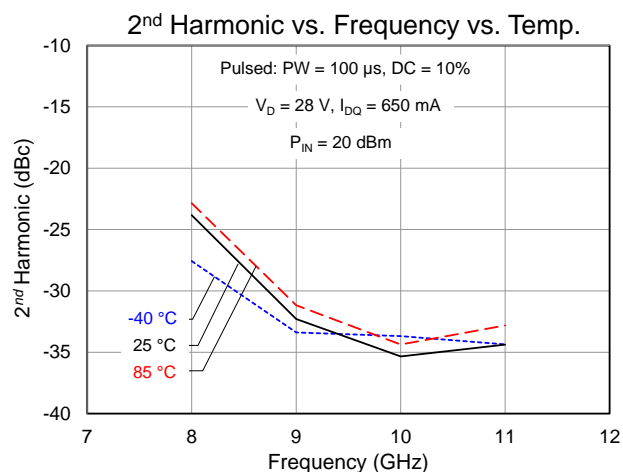
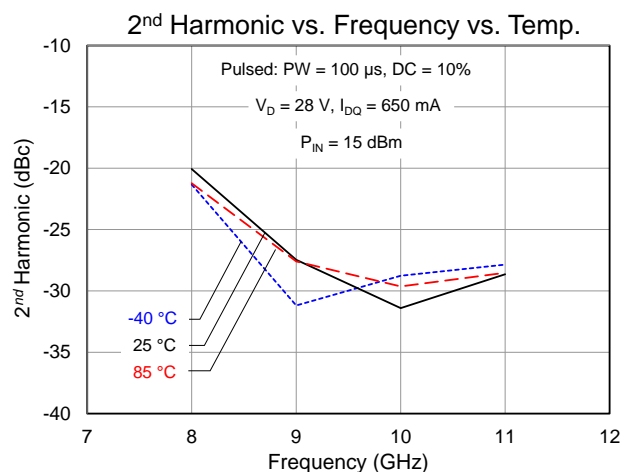
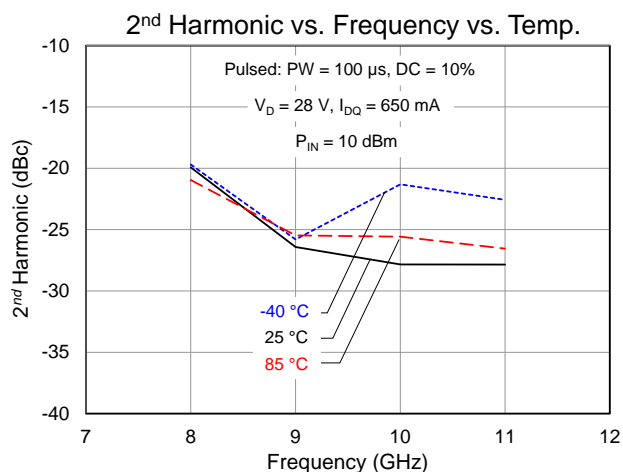
### Typical Performance – Large Signal (Pulsed)



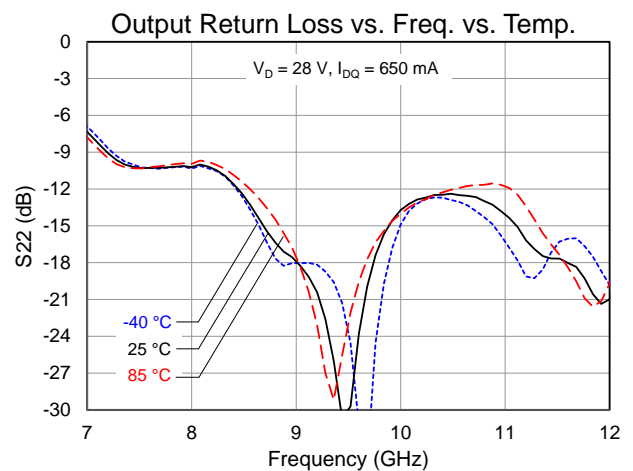
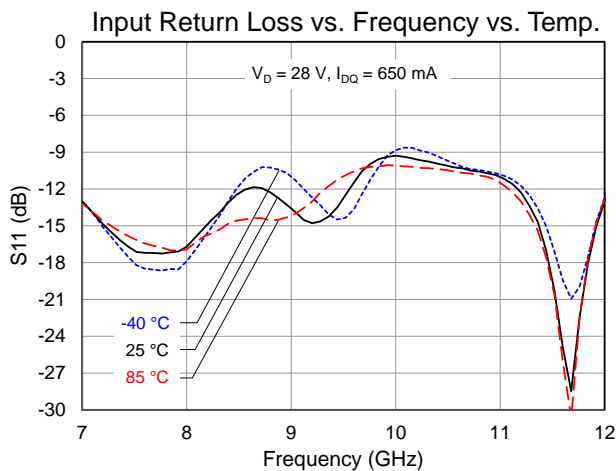
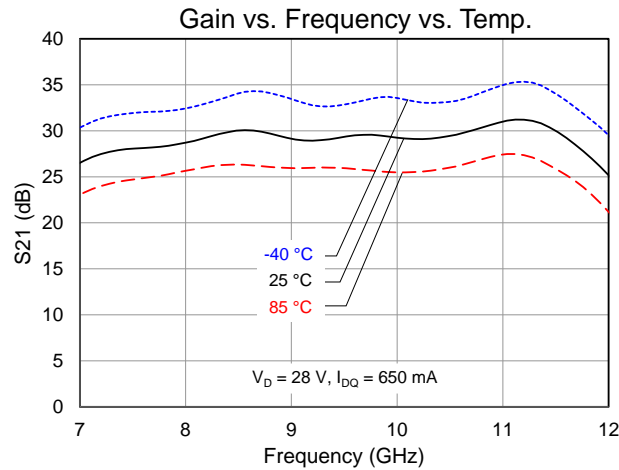
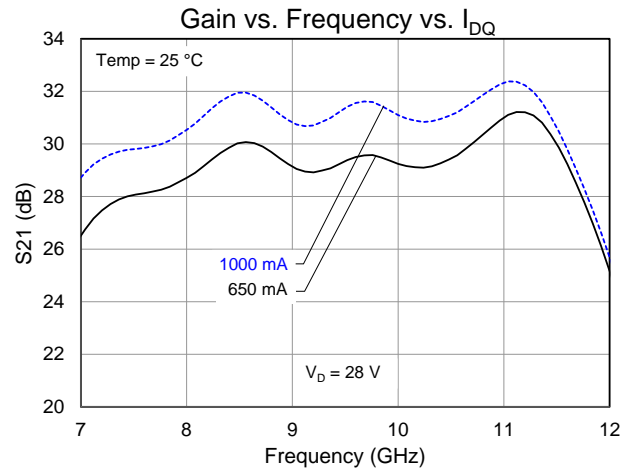
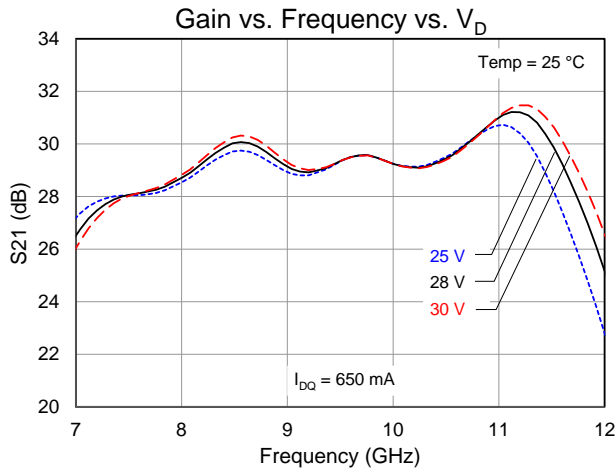
### Typical Performance – Large Signal (CW)



### Performance Plots – Large Signal (Pulsed)

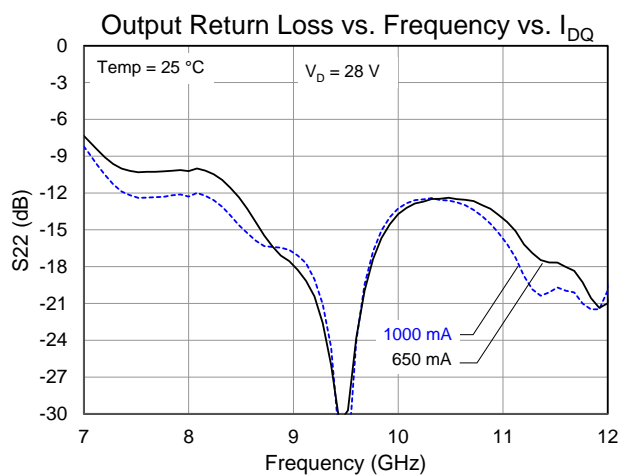
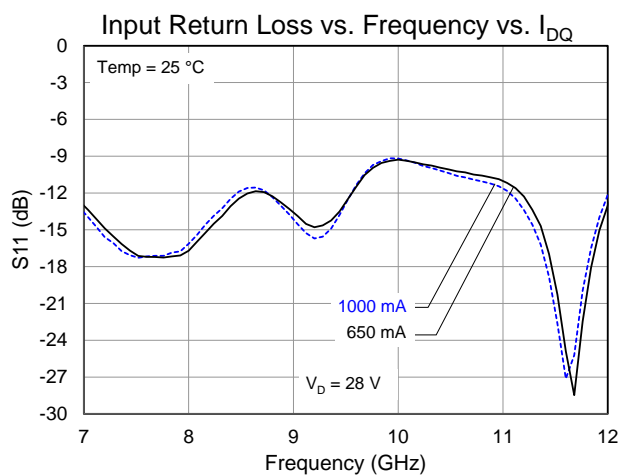
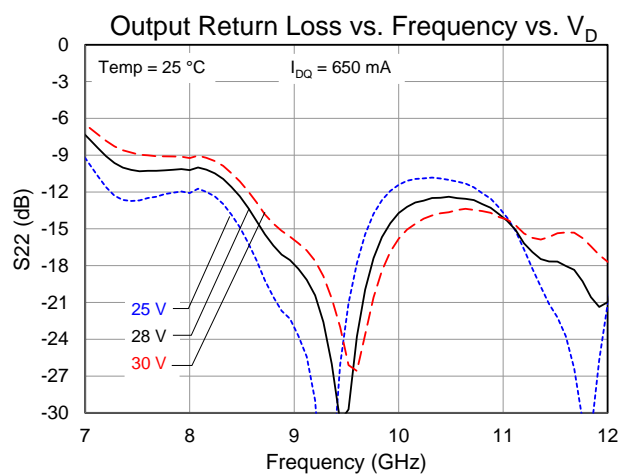
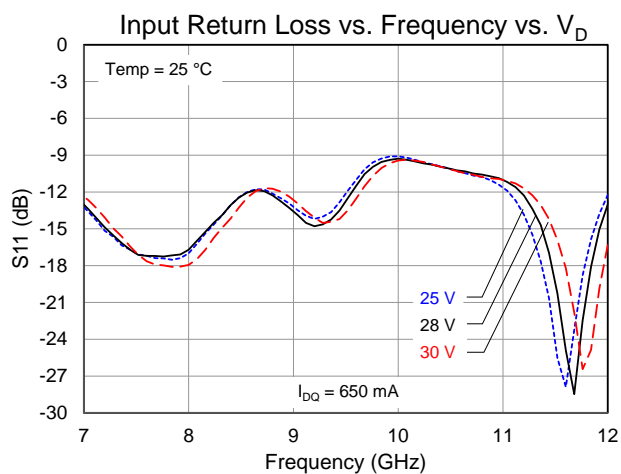


### Performance Plots – Small Signal (CW)





### Performance Plots – Small Signal (CW)



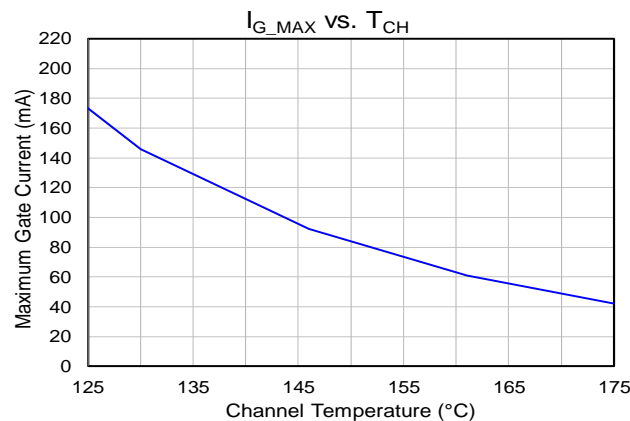
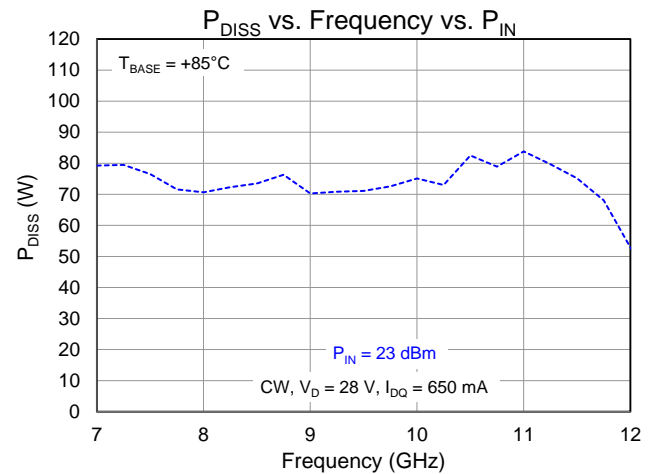
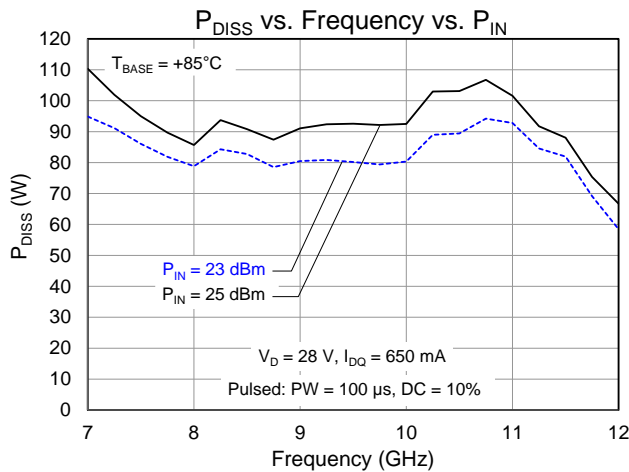
### Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance ( $\theta_{JC}$ ) <sup>(1)</sup>	$V_D = 28\text{ V}$ , $I_{DQ} = 650\text{ mA}$ ,	0.33	$^{\circ}\text{C/W}$
Channel Temperature, $T_{CH}$ (No RF) <sup>(2)</sup>	$T_{base} = 85\text{ }^{\circ}\text{C}$ , $P_{DISS} = 18.2\text{ W}$ (Quiescent)	91	$^{\circ}\text{C}$
Thermal Resistance ( $\theta_{JC}$ ) <sup>(1)</sup>	Pulsed $V_D$ : $T_{BASE} = 85\text{ }^{\circ}\text{C}$ , $V_D = 28\text{ V}$ , $I_{DQ} = 650\text{ mA}$ ,	0.52	$^{\circ}\text{C/W}$
Channel Temperature, $T_{CH}$ (Under RF) <sup>(2)</sup>	$I_{D\_Drive} = 5.9\text{ A}$ , $PW = 100\text{ }\mu\text{s}$ , $DC = 10\%$ , $P_{IN} = 25\text{ dBm}$ , $P_{OUT} = 47.5\text{ dBm}$ , $P_{DISS} = 108\text{ W}$	141	$^{\circ}\text{C}$
Thermal Resistance ( $\theta_{JC}$ ) <sup>(1)</sup>	CW: $T_{BASE} = 85\text{ }^{\circ}\text{C}$ , $V_D = 28\text{ V}$ , $I_{DQ} = 650\text{ mA}$ , $I_{D\_Drive}$	0.74	$^{\circ}\text{C/W}$
Channel Temperature, $T_{CH}$ (Under RF) <sup>(2)</sup>	$= 4.15\text{ A}$ , Frequency = $11\text{ GHz}$ , $P_{IN} = 20\text{ dBm}$ , $P_{OUT} = 45\text{ dBm}$ , $P_{DISS} = 83.8\text{ W}$	147	$^{\circ}\text{C}$

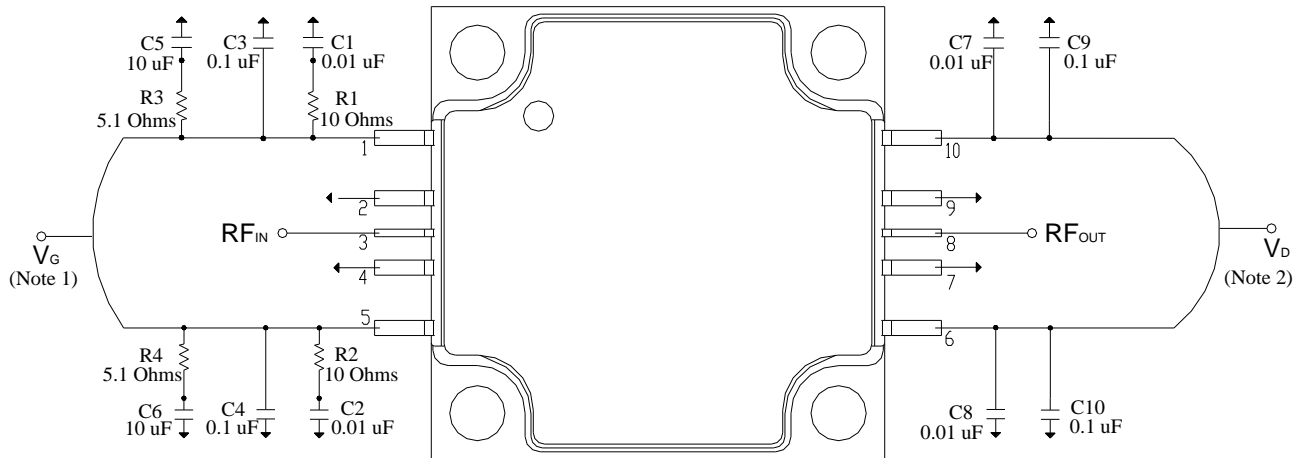
#### Notes:

- Thermal resistance is referenced to the back of package ( $85\text{ }^{\circ}\text{C}$ )
- Refer to the following document: [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

### Dissipated Power and Maximum Gate Current



### Applications Information and Pin Layout



#### Notes:

1.  $V_G$  must be biased from both sides (Pins 1 and 5)
2.  $V_D$  must be biased from both sides (Pins 6 and 10)

### Bias Up Procedure

1. Set  $I_D$  limit to 7 A,  $I_G$  limit to 20 mA
2. Apply  $-5$  V to  $V_G$
3. Apply 28 V to  $V_D$ ; ensure  $I_{DQ}$  is approx. 0 mA
4. Adjust  $V_G$  until  $I_{DQ} = 650$  mA
5. Turn on RF supply

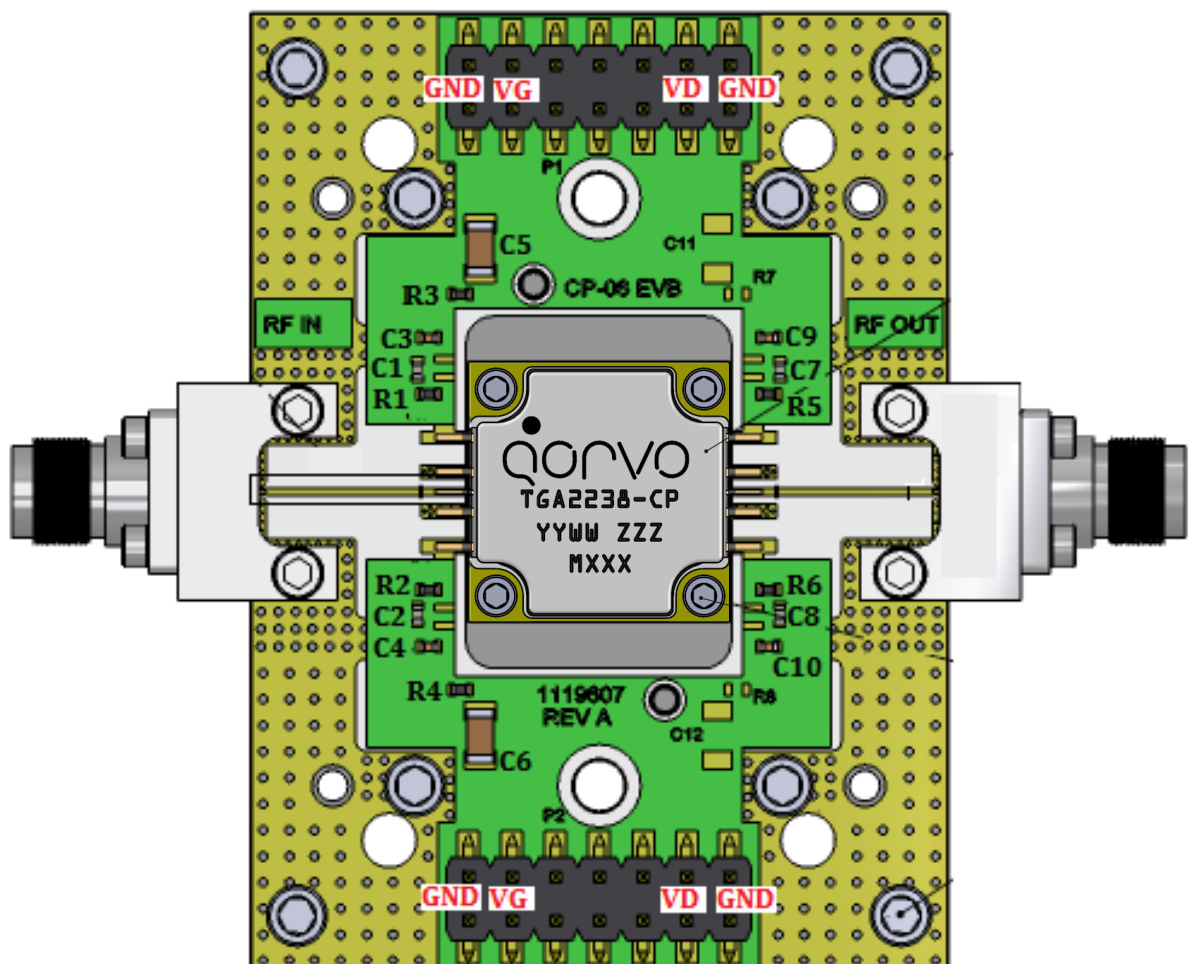
### Bias Down Procedure

1. Turn off RF supply
2. Reduce  $V_G$  to  $-5$  V; ensure  $I_{DQ}$  is approx. 0 mA
3. Set  $V_D$  to 0 V
4. Turn off  $V_D$  supply
5. Turn off  $V_G$  supply

### Pin Description

Pad No.	Symbol	Description
1,5	$V_G$	Gate Voltage; Bias network is required; must be biased from both sides; see recommended Application Information above.
2,4,7,9	GND	Must be grounded on the PCB.
3	$RF_{IN}$	Input; matched to 50 $\Omega$ ; DC blocked
6,10	$V_D$	Drain voltage; Bias network is required; must be biased from both sides; see recommended Application Information above.
8	$RF_{OUT}$	Output; matched to 50 $\Omega$ ; DC shorted to ground.

## Evaluation Board (EVB) Assembly Drawing



### PCB NOTES:

1. PCB is made from Rogers 4003C dielectric, 0.008 inch thick, 0.5 oz. copper both sides.
2. Both Top and Bottom  $V_D$  and  $V_G$  must be biased.

## Bill of Materials

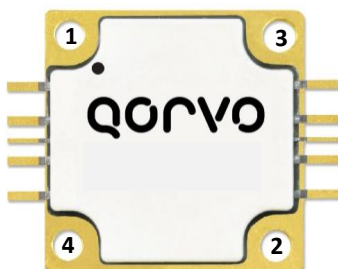
Reference Des.	Value	Description	Manuf.	Part Number
C1, C2, C7, C8	0.01 $\mu$ F	Cap, 0402, 50 V, 10%, X7R	Various	–
C3, C4, C9, C10	0.1 $\mu$ F	Cap, 0402, 50 V, 10%, X7R	Various	–
C5, C6	10 $\mu$ F	Cap, 1206, 50 V, 20%, X5R	Various	–
R1, R2	10 $\Omega$	Res, 0402, 5%, SMD	Various	–
R3, R4	5.1 $\Omega$	Res, 0402, 5%, ROHS	Various	–
R5, R6	0 $\Omega$	Res, 0402, SMD, jumpers required for the above EVB	Various	–

### Assembly Notes

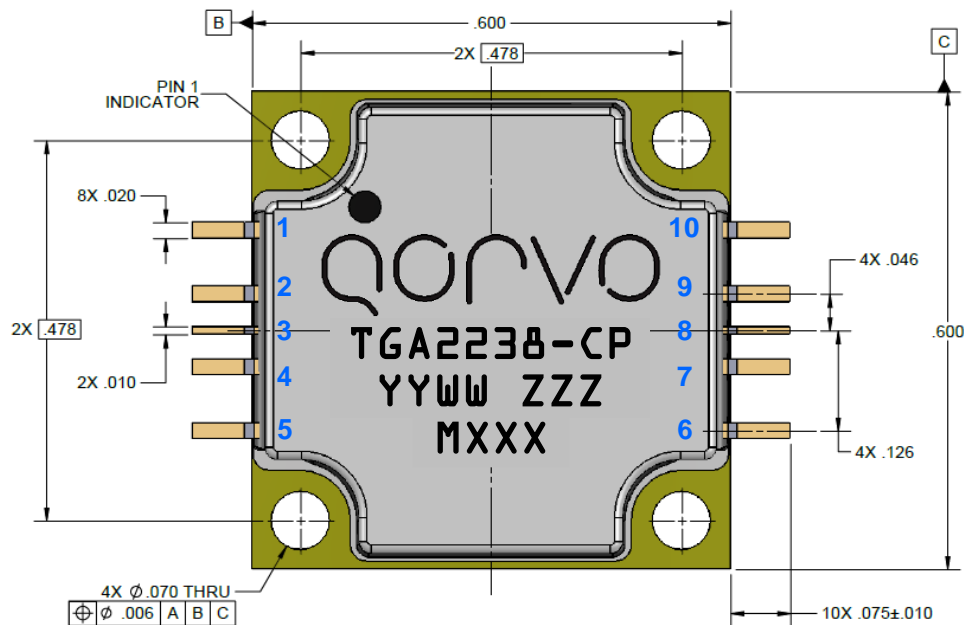
1. Carefully clean the PC board, base plate, and package leads with alcohol. Allow it to dry fully.
2. To improve the thermal and RF performance, Qorvo recommends attaching a heat sink to the bottom of the package and apply either a thermal compound (Arctic Silver 5 recommended) or a .004 inch (maximum thickness) Indium shim between the heat sink and the package. Refer to the applications note [Application of Arctic Silver 5 Thermal Compound and Indium Shims for Qorvo CP-style Packaged Components](#) for more information.
3. The component leads should be manually soldered. Apply a low residue solder alloy meeting J-STD-001 (ROL0, ROL1 or equivalent) with a liquidus temperature below 220 °C to each pin of the TGA2238-CP. The use of low residue/no-clean flux (ROL0, ROL1) is recommended. The package lead temperature should not exceed 260 deg C. Each solder connection should be completed within 2 to 5 seconds. Adding flux during hand soldering of the component leads with localized spot cleaning is acceptable. Soldering irons meeting the requirements of J-STD-001, Appendix A are acceptable.
4. The leads should be soldered in a staggered or star pattern from side to side, and never solder two adjacent leads. This allows the heat to dissipate on each lead, and not cause the adjacent leads to become de-soldered and damaged or displaced.



5. The packaged part should not be subjected to conventional SMT automated solder reflow processes.
6. (The following is for information only. There are many variables in a second level assembly that Qorvo does not control, so Qorvo does not recommend an absolute torque value.) Use screws to attach the component to the heat sink. A suggested final torque value is 16 in-oz. for a 0-80 screw. Start with screws finger tight, then torque to 8 in-oz., then torque to final value. Use the following tightening pattern:



## Mechanical Information



### NOTES:

#### 1. MATERIALS

PACKAGE BASE: COPPER  
LEADS: ALLOY 194  
LID: PLASTIC  
FINISH: GOLD

#### 2. PART IS EPOXY SEALED

#### 3. UNITS: INCHES

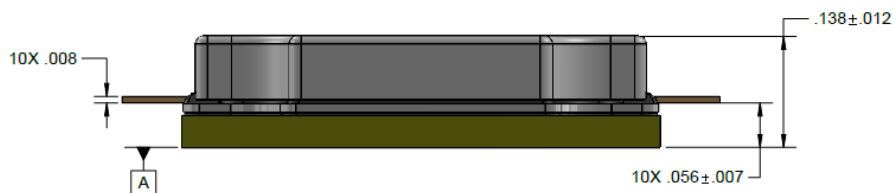
#### 4. TOLERANCES (UNLESS NOTED):

.XX = ± .01

.XXX = ± .005

#### 5. MARKINGS

PART NUMBER: TGA2238-CP  
WORK YEAR: YY  
WORK WEEK: WW  
SERIAL NUMBER: ZZ  
BATCH ID: MXXX



### Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B	JEDEC Standard JESD22 A114
ESD – Charge Device Model (CDM)	Class C2	JEDEC Standard JESD22-C101F
MSL – Moisture Sensitivity Level	N/A	



Caution!  
ESD-Sensitive Device

### Solderability

The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. The use of no-clean solder to avoid washing after soldering is recommended.

### RoHS Compliance

This product is compliant with the 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), as amended by Directive 2015/863/EU. This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free

### Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: [www.qorvo.com](http://www.qorvo.com)

Tel: 1-844-890-8163

Email: [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

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