TGA2239

13.0 – 15.5 GHz 50 W GaN Power Amplifier

Product Description

Qorvo's TGA2239 is a Ku-band, high power MMIC amplifier fabricated on Qorvo's production 0.15 um GaN on SiC process (QGaN15). The TGA2239 operates from 13.0 – 15.5 GHz and provides a superior combination of power, gain and efficiency by achieving greater than 50 W (47 dBm) of saturated output power with 26.5 dB of large signal gain and greater than 36 % power-added efficiency.

This superior performance provides system designers the flexibility to improve system performance while reducing size and cost.

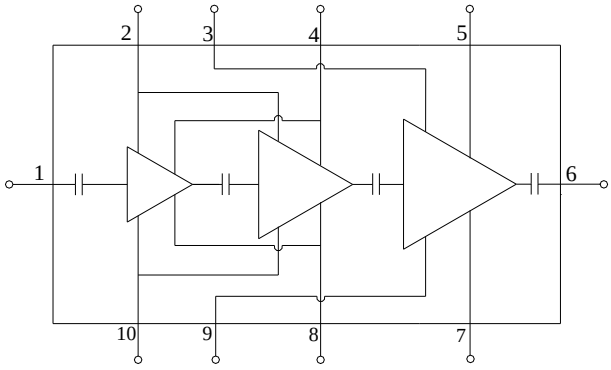
The TGA2239 is fully matched to 50 Ω with integrated DC blocking capacitors on RF ports simplifying system integration. It is ideally suited for military and commercial Ku-band radar and satellite communication systems.

Lead-free and RoHS compliant.

Product Features

- Frequency Range: 13.0 – 15.5 GHz
- P_{SAT} : 47.5 dBm (P_{IN} = 21 dBm)
- PAE: 36.2 % (P_{IN} = 21 dBm)
- Large Signal Gain: 26.5 dB
- Small Signal Gain: 34.4 dB
- Bias: V_D = 28 V, I_{DQ} = 900 mA
- Chip Dimensions: 5.00 x 6.65 x 0.10 mm
- Performance under CW conditions

Functional Block Diagram



Applications

- Satellite Communications
- Data Link
- Radar

Ordering Information

Part No.	Description
TGA2239	13.0 – 15.5 GHz 35 W GaN Power Amplifier
TGA2239EVB1	Evaluation Board

Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V_D)	29.5 V
Gate Voltage Range (V_G)	−5 to 0 V
Drain Current (I_{D1-2})	2.8 A
Drain Current (I_{D3})	4.3 A
Gate Current	See plot page 10
Power Dissipation, 85°C, CW	149 W
Input Power (P_{IN}), CW, 50 Ω, V_D = 28 V, I_{DQ} = 900 mA, 85 °C	33 dBm
Input Power (P_{IN}), CW, VSWR 3:1, V_D = 28 V, I_{DQ} = 900 mA, 85 °C	33 dBm
Mounting Temperature (30 seconds)	320 °C
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
Drain Voltage (V_D)	28 V
Drain Current (I_{DQ})	900 mA
Operating Temperature	−40 to 85 °C

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

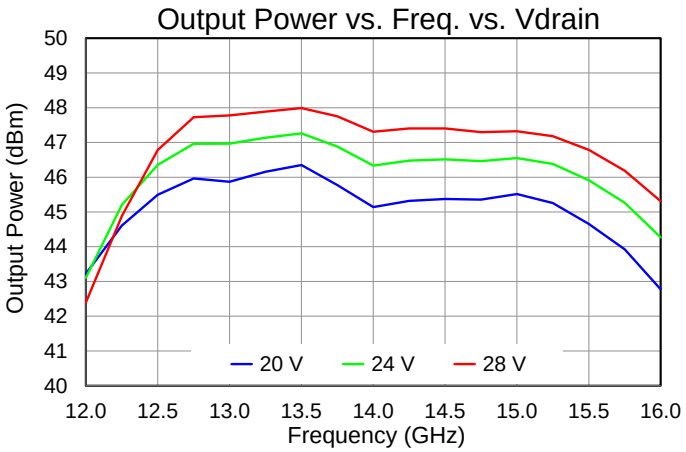
Electrical Specifications

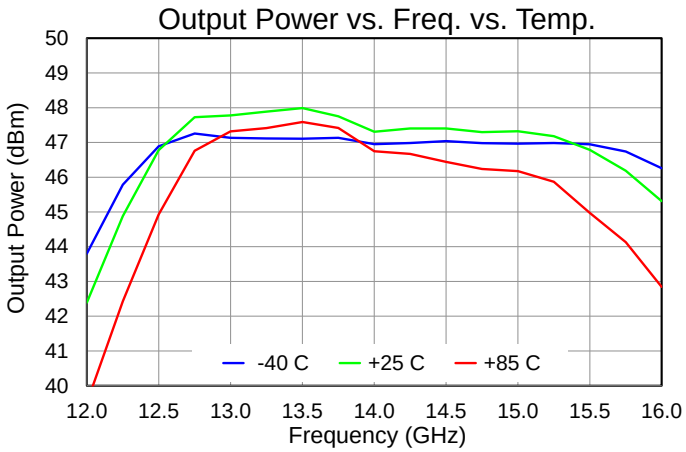
Parameter		Min	Typ	Max	Units
Operational Frequency Range		13	–	15.5	GHz
Output Power (P_{IN} = 21 dBm)	13.0 GHz	46.0	47.8	–	dBm
	13.5 GHz	46.0	48.0	–	dBm
	13.75 GHz	46.0	47.8	–	dBm
	14.5 GHz	46.0	47.4	–	dBm
	15.5 GHz	45.5	46.8	–	dBm
Power Added Efficiency (P_{IN} = 21 dBm)	13.0 GHz	30.0	40.2	–	%
	13.5 GHz	30.0	39.6	–	%
	13.75 GHz	25.0	42.3	–	%
	14.5 GHz	25.0	34.2	–	%
	15.5 GHz	25.0	31.5	–	%
Power Gain (P_{IN} = 21 dBm)		–	26.5	–	dB
Small Signal Gain		–	34.4	–	dB
Input Return Loss		–	19	–	dB
Output Return Loss		–	11	–	dB
Sm. Sig. Gain Temperature Coefficient (85 to −40 °C)		–	−0.100	–	dB/°C
Output Power Temperature Coefficient (85 to 25 °C)		–	−0.014	–	dB/°C

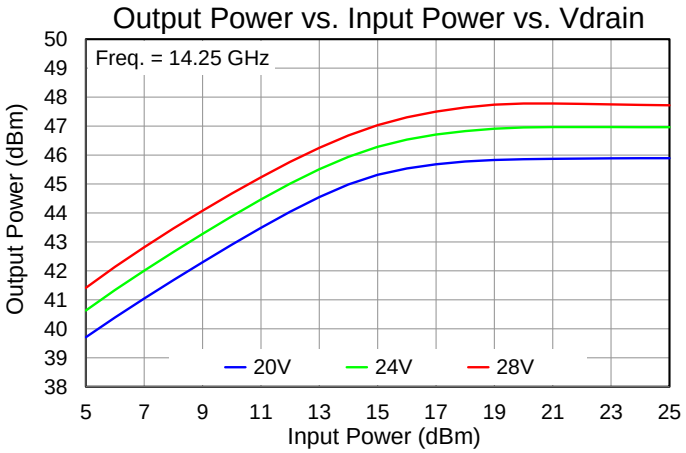
Test conditions unless otherwise noted: 25 °C , V_D = +28 V, I_{DQ} = 900 mA, CW

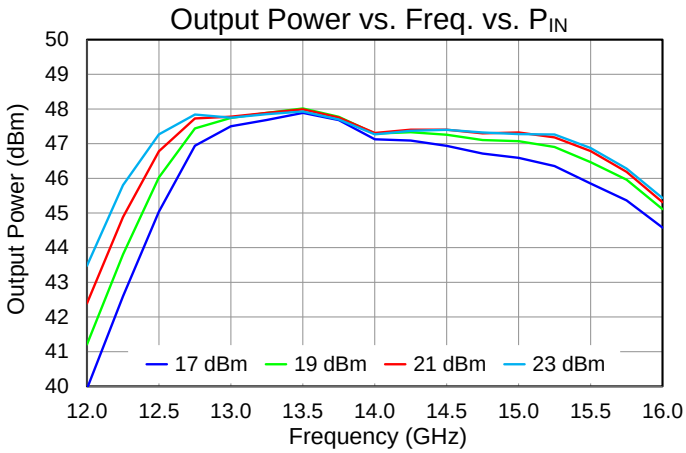
Typical Performance – CW Operation

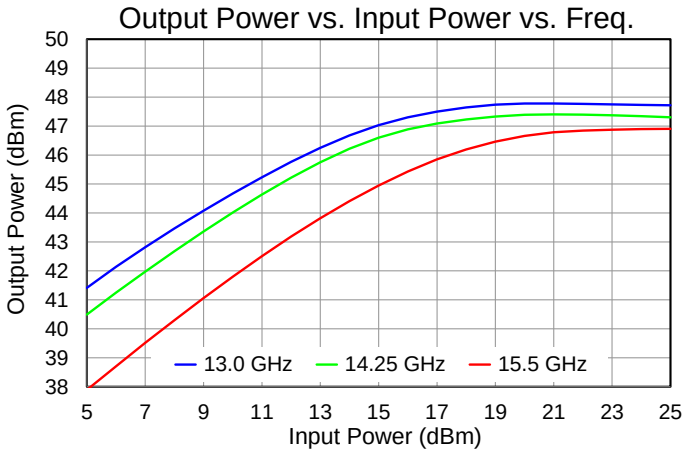
Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, P_{IN} = 21 dBm, T=+25 °C





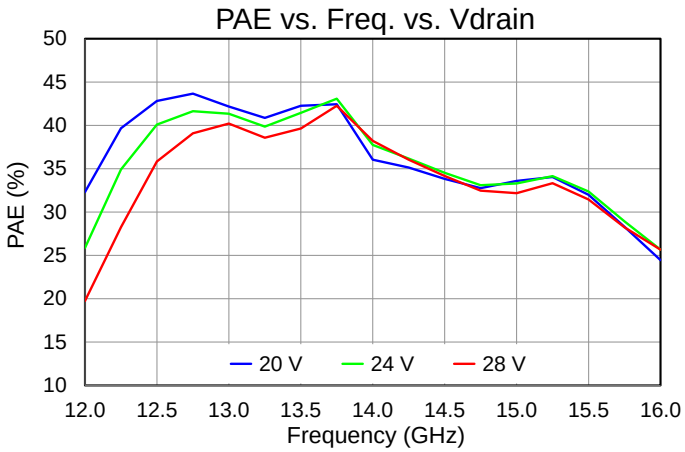


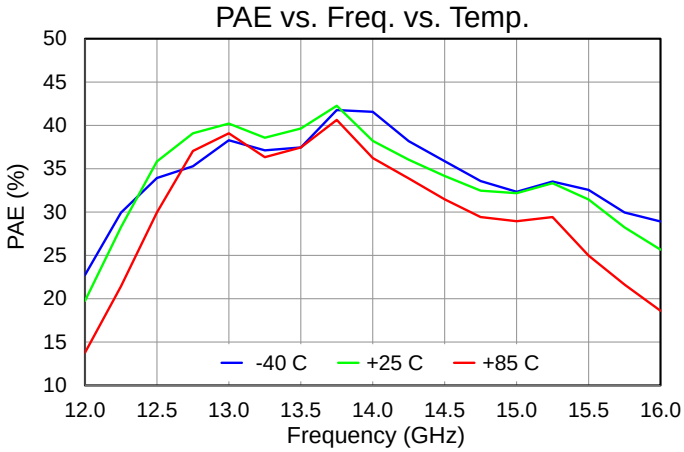


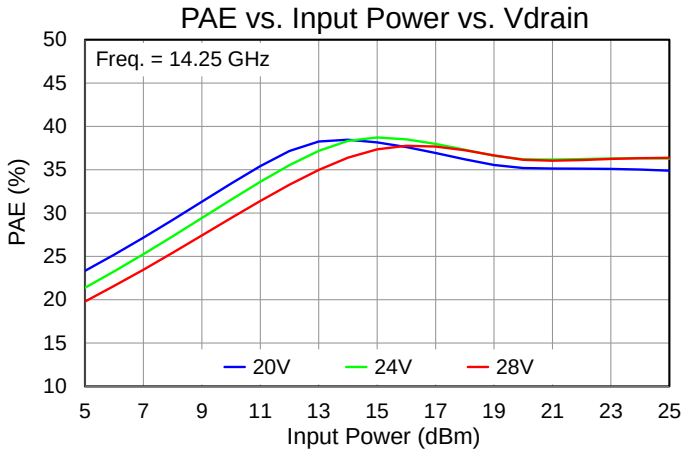


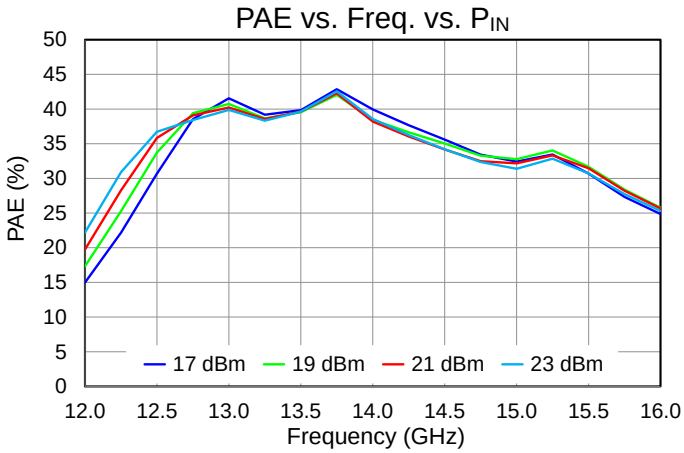
Typical Performance – CW Operation

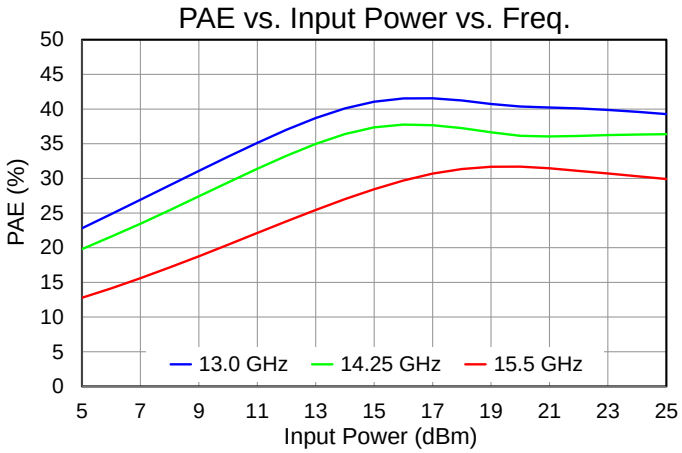
Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, P_{IN} = 21 dBm, T=+25 °C







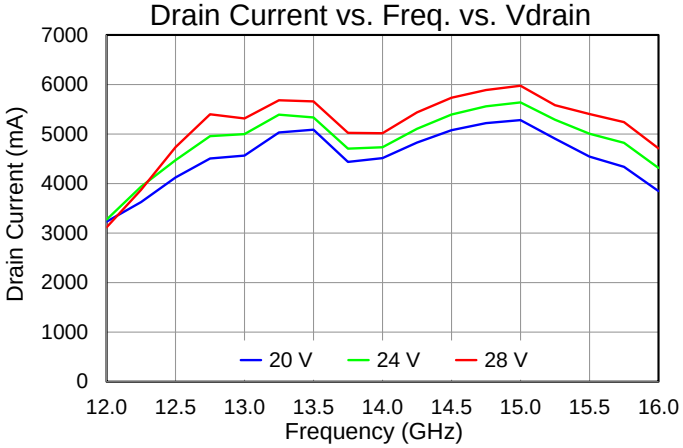




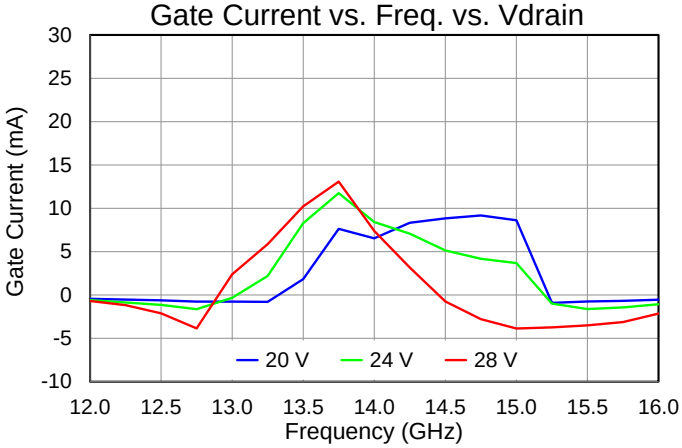
Typical Performance – CW Operation

Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, P_{IN} = 21 dBm, T=+25 °C

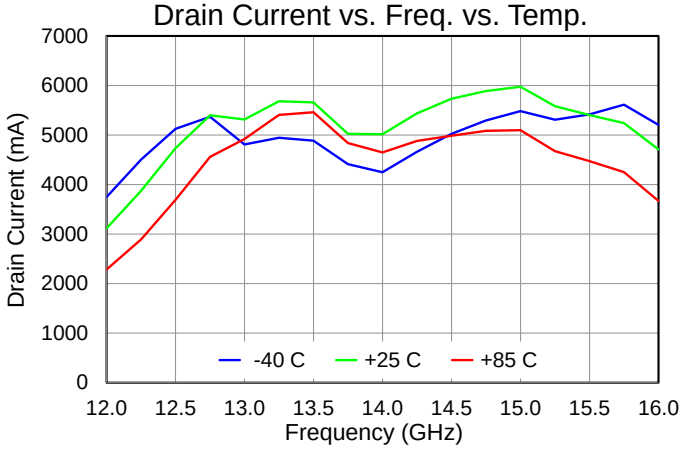
Drain Current vs. Freq. vs. Vdrain



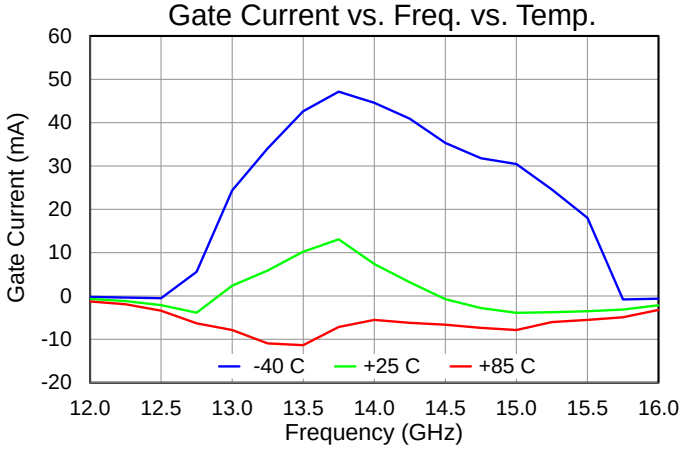
Gate Current vs. Freq. vs. Vdrain



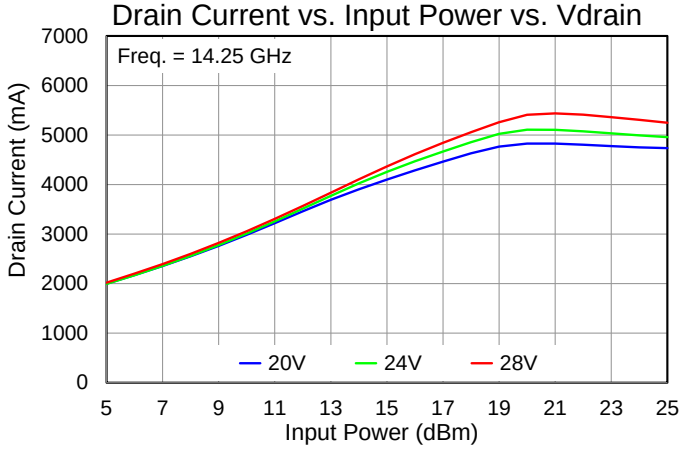
Drain Current vs. Freq. vs. Temp.



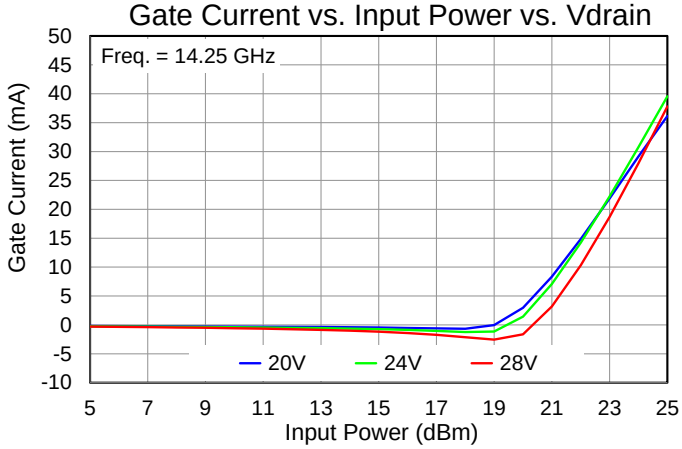
Gate Current vs. Freq. vs. Temp.



Drain Current vs. Input Power vs. Vdrain

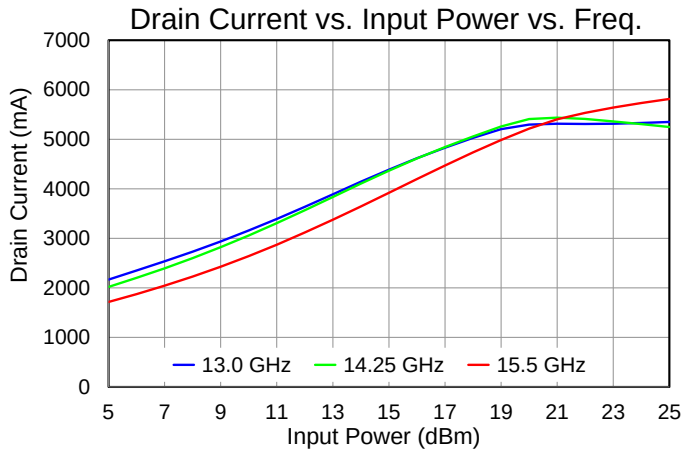


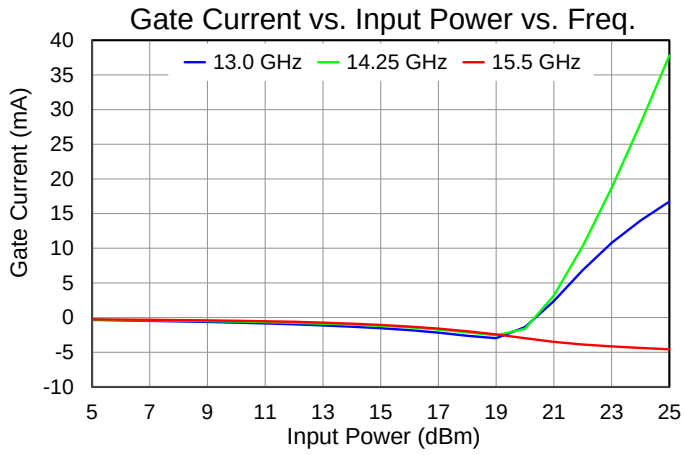
Gate Current vs. Input Power vs. Vdrain

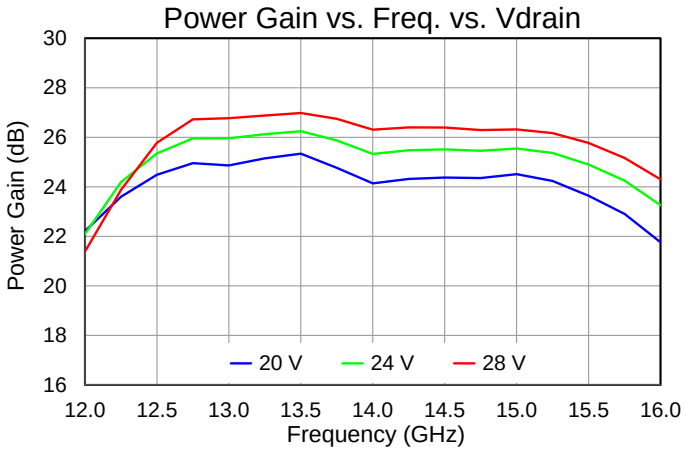


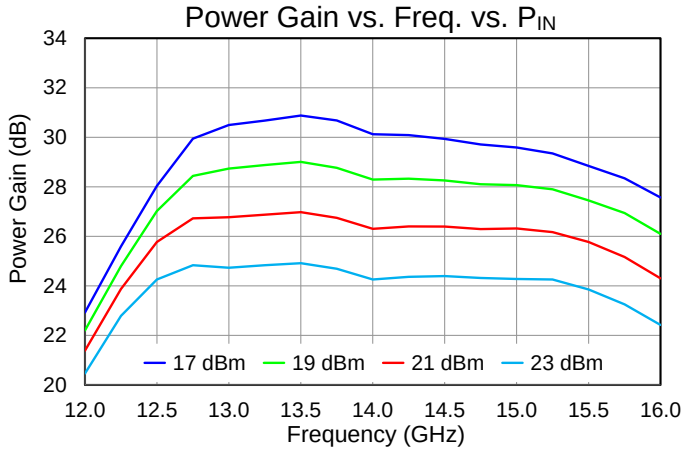
Typical Performance – (CW Operation)

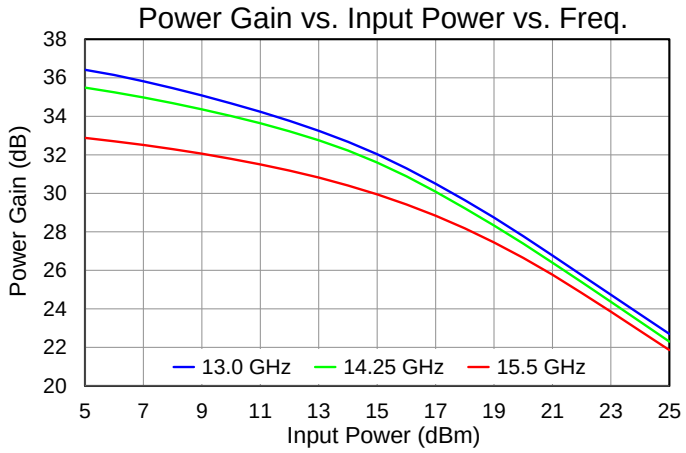
Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, P_{IN} = 21 dBm, T=+25 °C

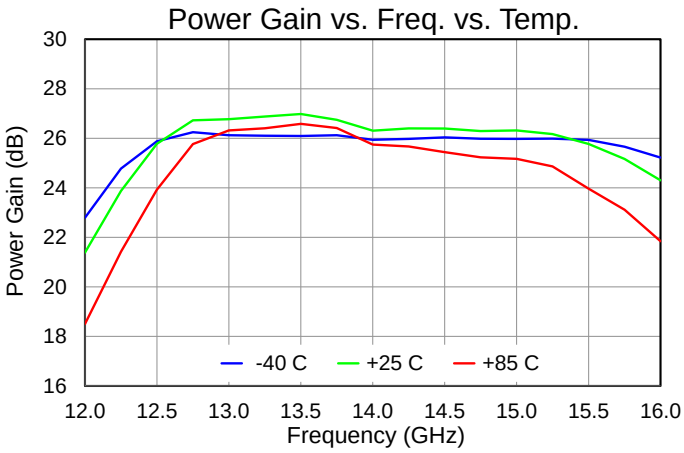








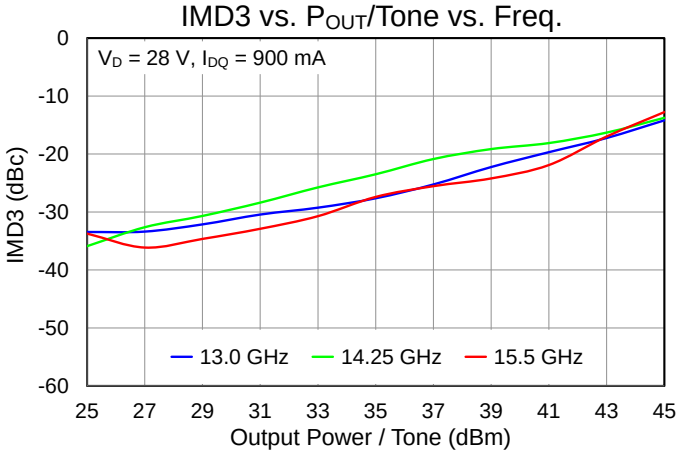




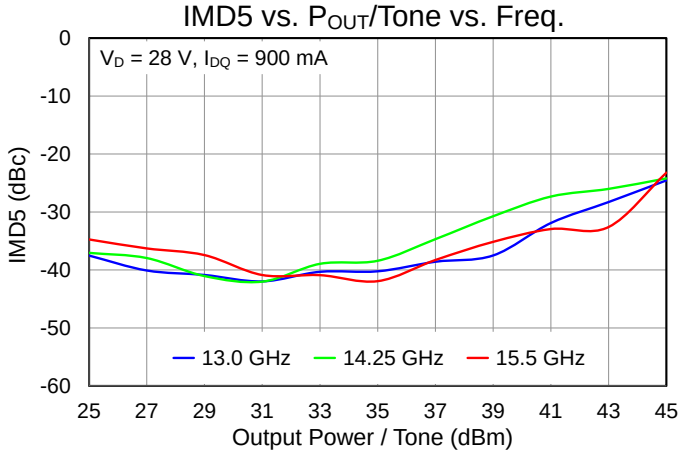
Typical Performance – Linearity

Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, T = +25 °C, Tone Spacing = 10 MHz

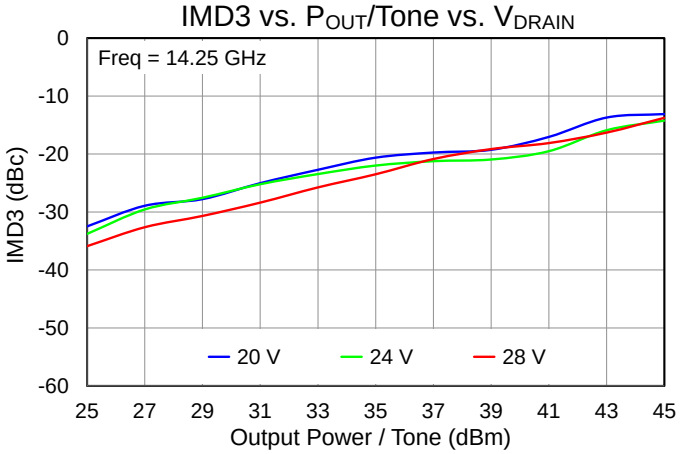
IMD3 vs. P_{OUT}/Tone vs. Freq.



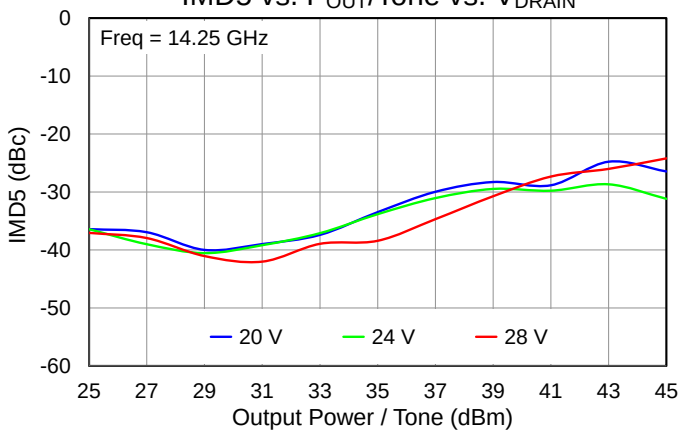
IMD5 vs. P_{OUT}/Tone vs. Freq.



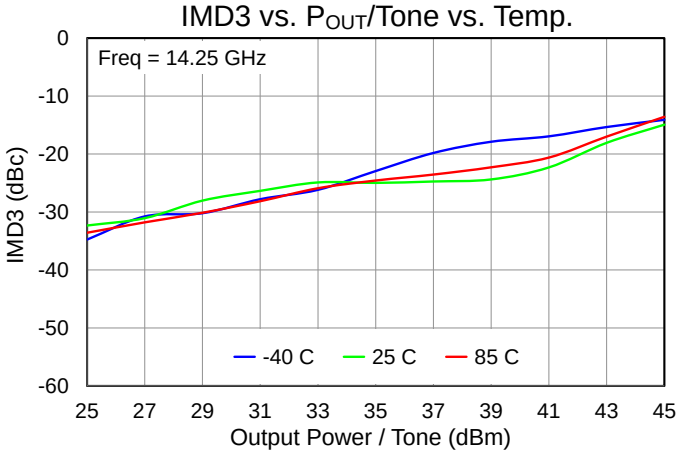
IMD3 vs. P_{OUT}/Tone vs. V_{DRAIN}



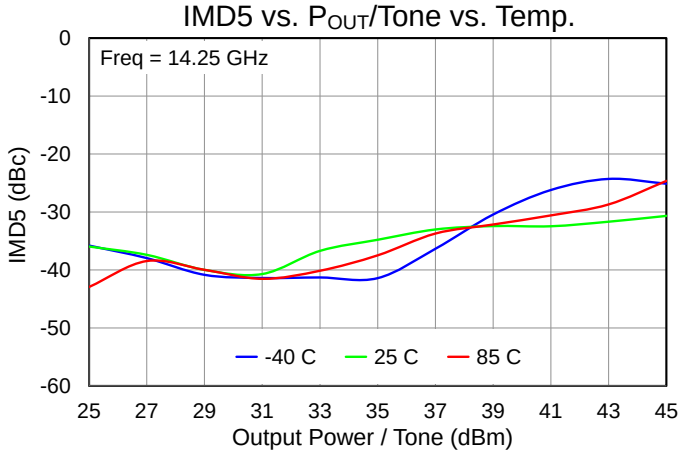
IMD5 vs. P_{OUT}/Tone vs. V_{DRAIN}



IMD3 vs. P_{OUT}/Tone vs. Temp.



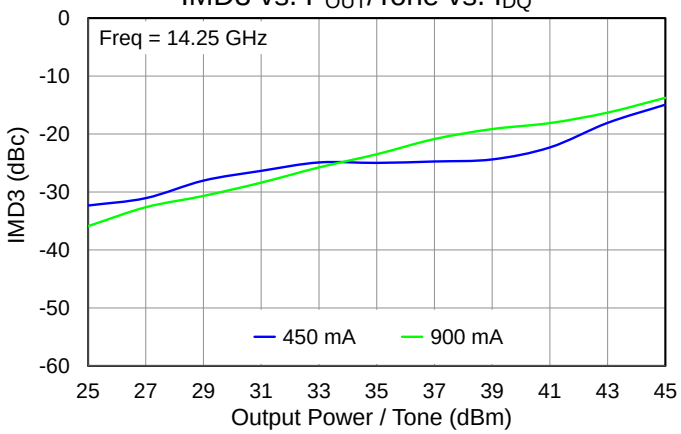
IMD5 vs. P_{OUT}/Tone vs. Temp.



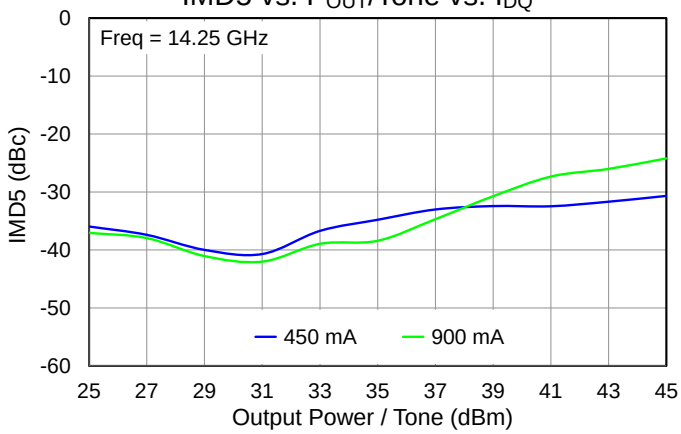
Typical Performance – Linearity

Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, T = +25 °C, Tone Spacing = 10 MHz

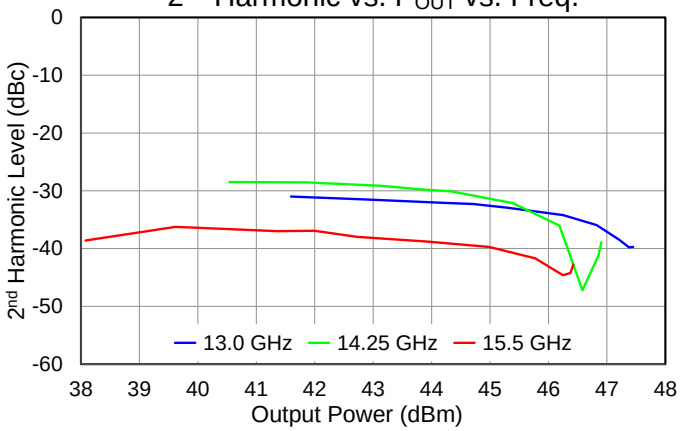
IMD3 vs. P_{OUT}/Tone vs. I_{DQ}



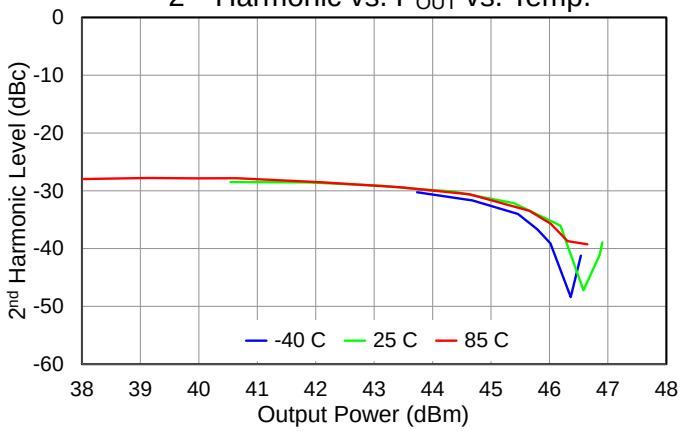
IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



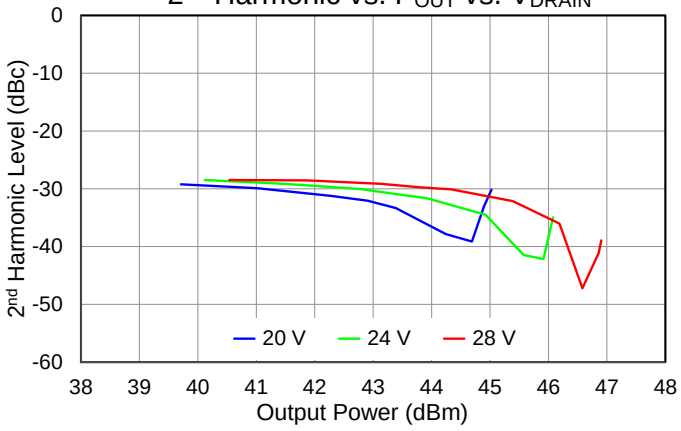
2nd Harmonic vs. P_{OUT} vs. Freq.



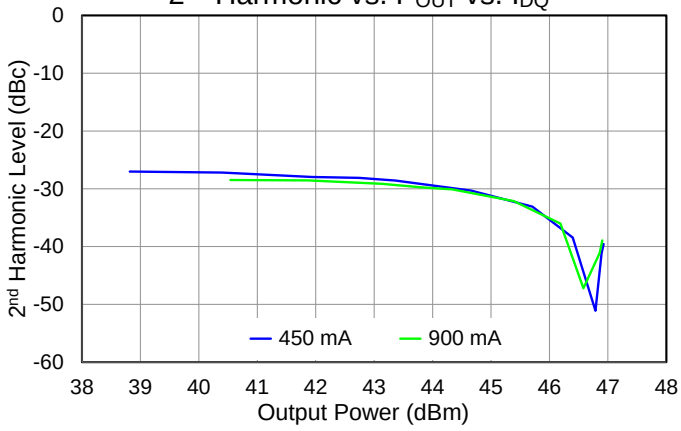
2nd Harmonic vs. P_{OUT} vs. Temp.



2nd Harmonic vs. P_{OUT} vs. V_{DRAIN}



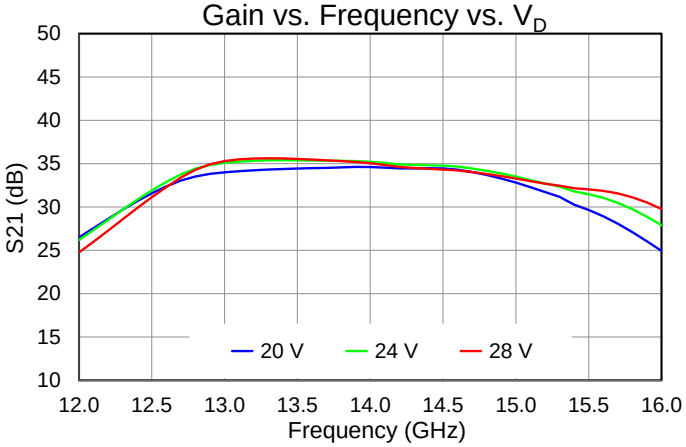
2nd Harmonic vs. P_{OUT} vs. I_{DQ}



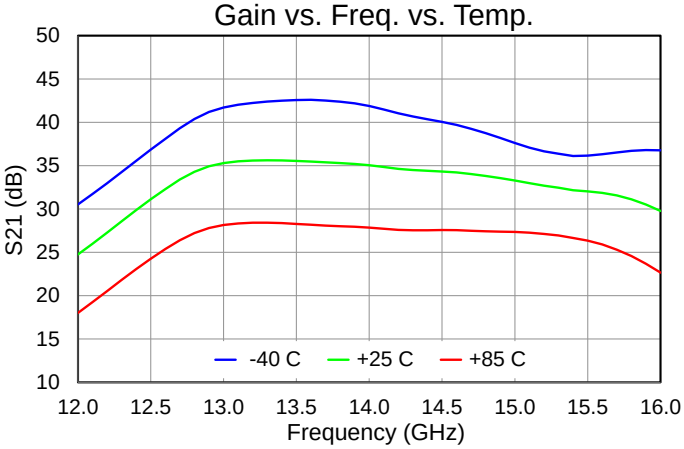
Typical Performance – Small Signal

Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, T = +25 °C

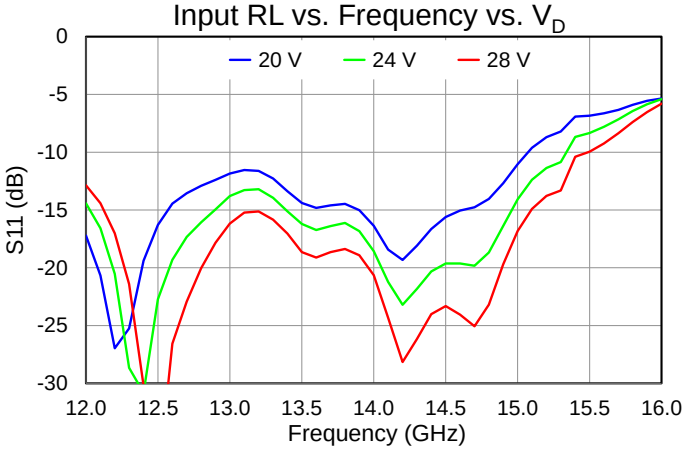
Gain vs. Frequency vs. V_D



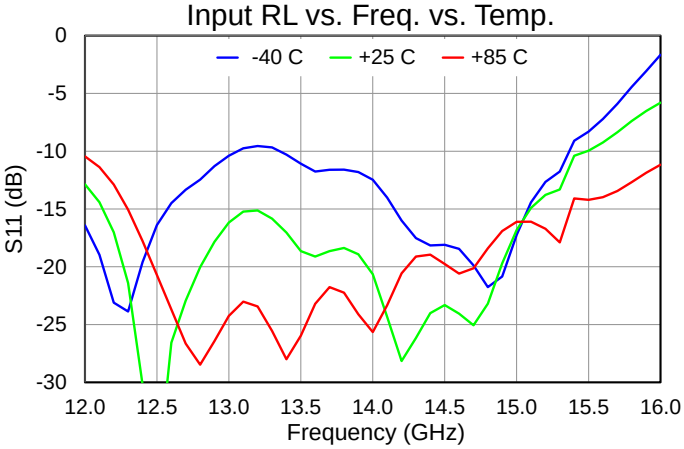
Gain vs. Freq. vs. Temp.



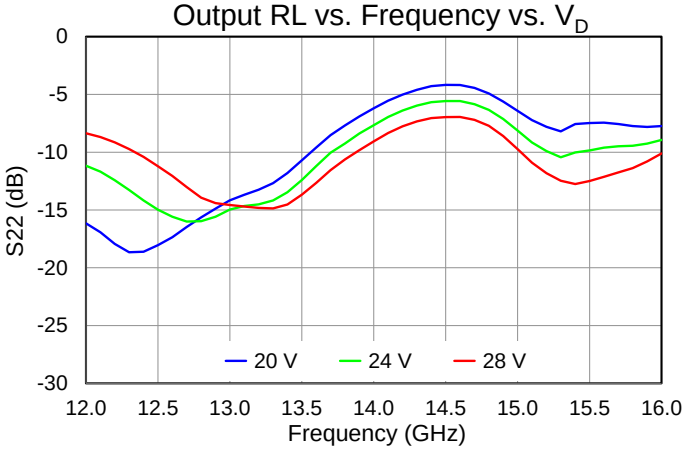
Input RL vs. Frequency vs. V_D



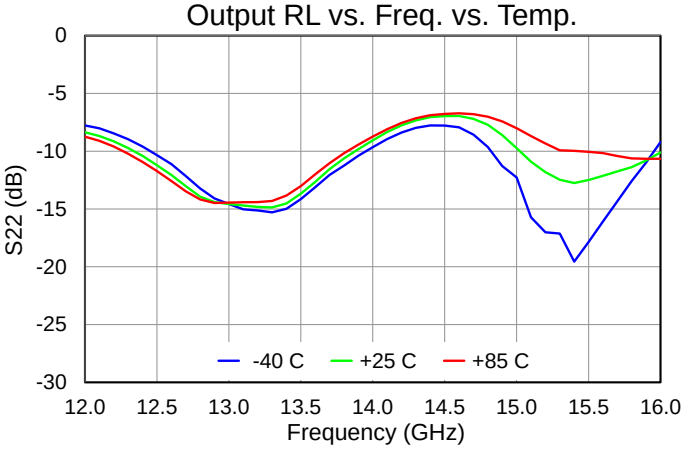
Input RL vs. Freq. vs. Temp.



Output RL vs. Frequency vs. V_D



Output RL vs. Freq. vs. Temp.



Thermal and Reliability Information

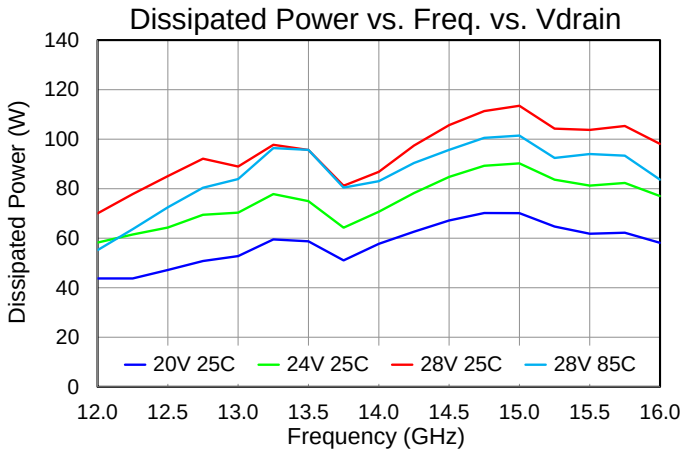
Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 °C, V_D = 28 V, I_{DQ} = 900 mA, P_{DISS} = 25.2 W	0.798	ºC/W
Channel Temperature (T_{CH}) (No RF drive) (2)		105.1	°C
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 °C, CW, V_D = 28 V, I_{DQ} = 900 mA Freq = 15.0 GHz, I_{D_Drive} = 5.10 A, P_{IN} = 21 dBm, P_{OUT} = 46.2 dBm, P_{DISS} = 101.4 W	0.804	ºC/W
Channel Temperature (T_{CH}) (Under RF drive) (2)		166.5	°C

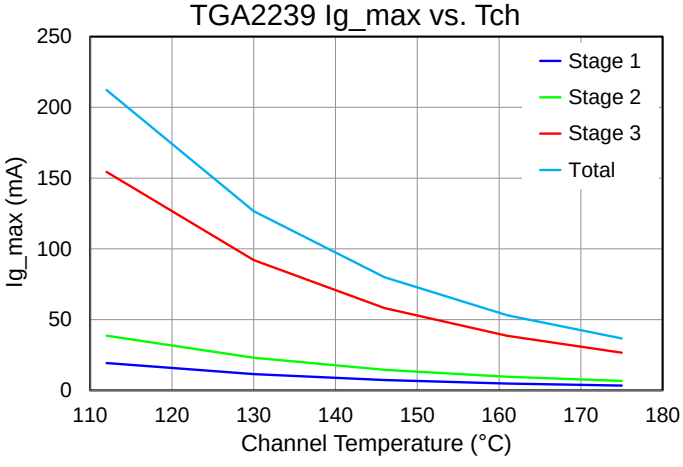
Notes:

1. Thermal resistance measured to back of 20 mil CM15 carrier plate.
2. IR Scan equivalent temperature. Refer to the following document for more details: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

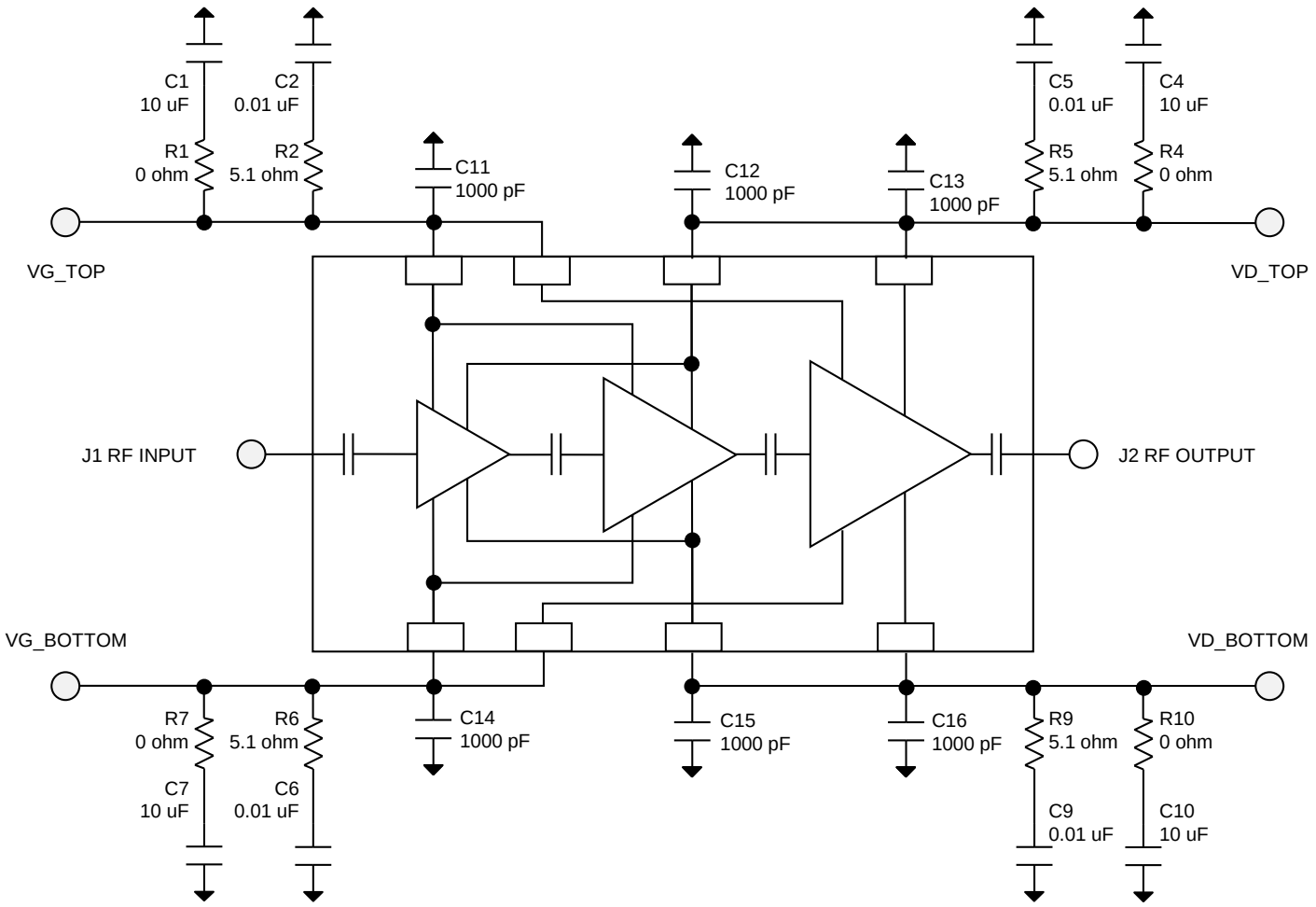
Power Dissipation and Gate Current

Test conditions, unless otherwise noted: V_D = 28 V, I_{DQ} = 900 mA, P_{IN} = 21 dBm





Application Circuit



Notes: VG & VD must be biased from both sides, top and bottom.

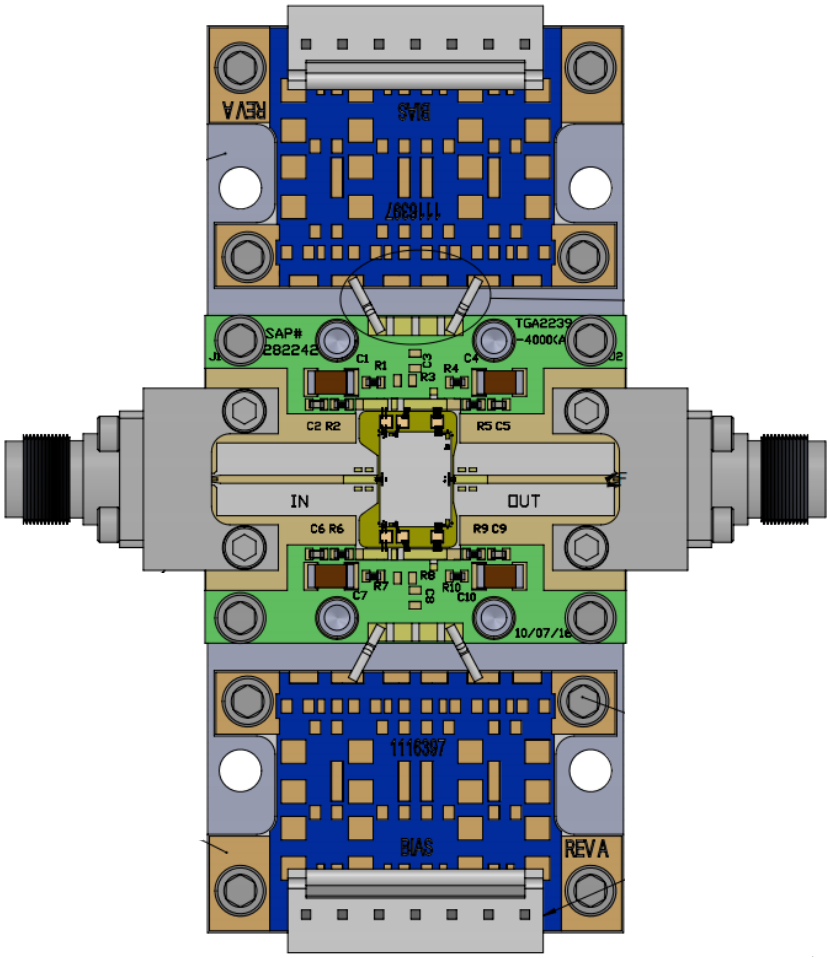
Bias Up Procedure

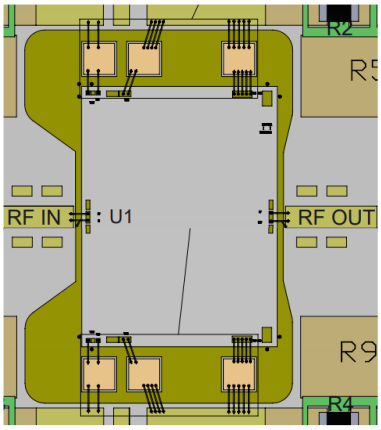
1. Set I_D limit to 6 A, I_G limit to 50 mA
2. Set V_G to −5 V
3. Set V_D = 28 V
4. Adjust V_G until I_{DQ} = 900 mA
5. Apply RF signal

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

Evaluation Board (EVB) Layout Assembly



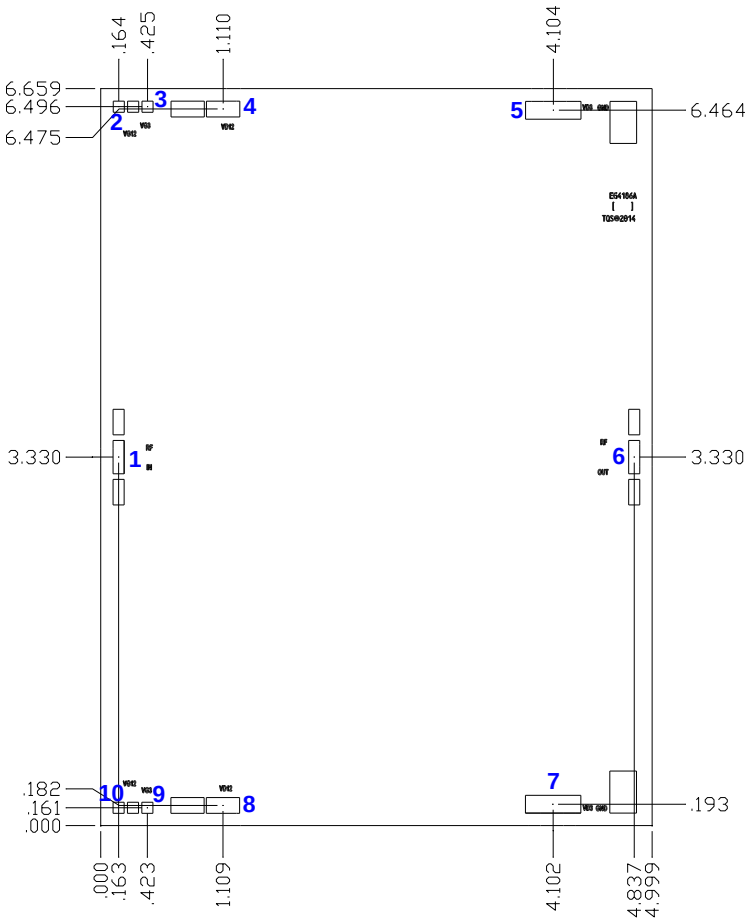


Notes: VG & VD must be biased from both sides, top and bottom.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part No.
C1,C4,C7,C10	10 uF	CAP, 10uF, 20%, 50V, 20%, X5R, 1206	Various	–
C2,C5,C6,C9	0.01 uF	CAP, 0.01uF, 10%, 50V, X7R, 0402	Various	–
C11,C12,C13,C14,C15,C16	1000 pF	CAP, 1000pF, ±10% 50V, BORDER, SL	Various	–
R1,R4,R7,R10	0 Ohm	RES, 0 OHM, JMPR, 0402	Various	–
R2,R5,R6,R9	5.1 Ohm	RES, 5.1 OHM, 5%, 50V, 0402	Various	–
J1,J2	2.92 mm	CONN, 2.92, END, F, PIN .005, DIEL .029	SW Microwave	1092-01A-5

Mechanical Drawing



Unit: millimeters
Thickness: 0.10
Die x, y size tolerance: +/- 0.050
Chip edge to bond pad dimensions are shown to center of pad
Ground is backside of die

Bond Pad Description

Pad No.	Symbol	Pad Size	Description
1	RF In	0.101 x 0.302	RF Input; matched to 50 Ω, DC blocked
2, 10	VG1-2	0.101 x 0.101	Gate voltage 1, bias network is required; see Application Circuit on page 11 as an example.
3, 9	VG3	0.101 x 0.101	Gate voltage 3, bias network is required; see Application Circuit on page 11 as an example.
4, 8	VD1-2	0.302 x 0.143	Drain voltage 1, bias network is required; see Application Circuit on page 11 as an example.
5, 7	VD3	0.503 x 0.161	Drain voltage 3, bias network is required; see Application Circuit on page 11 as an example.
6	RF Out	0.101 x 0.302	RF Output; matched to 50 Ω, DC blocked

Assembly Notes

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.

Reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300 °C to 3 – 4 minutes, maximum.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Interconnect process assembly notes:

- Thermosonic ball bonding is the preferred interconnect technique.
- Force, time, and ultrasonic are critical parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	0B	JEDEC Standard JS-001-2017

Caution!
ESD-Sensitive Device

Solderability

Use only AuSn (80/20) solder, and limit exposure to temperatures above 300 °C to 3 – 4 minutes, maximum.

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 ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

Contact Information

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

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Email: customer.support@qorvo.com

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