TGA2227

2 – 22 GHz GaN Low Noise Amplifier

Product Description

The Qorvo TGA2227 is a wideband, low noise amplifier fabricated on Qorvo's QGaN15 production GaN-on-SiC process. The TGA2227 operates from 2 – 22 GHz and provides > 15 dB of small signal gain with 2 dB of mid-band noise figure. The TGA2227 can be biased over a wide range of voltage with little impact on noise figure and gain; thus allowing the user to minimize power dissipation depending on power and linearity requirements.

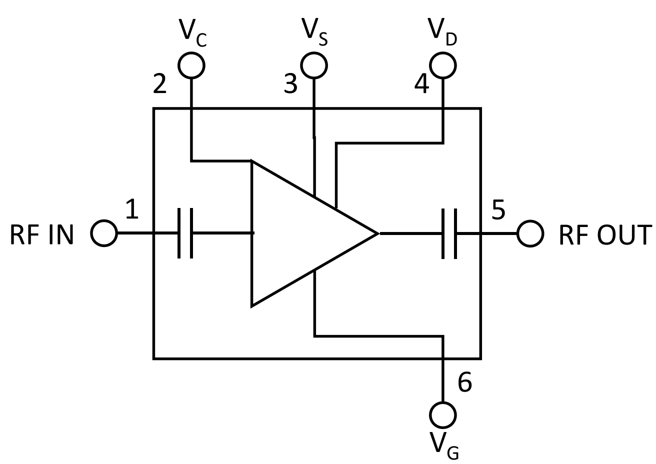
Another key feature is the TGA2227's high robustness to incident power. Able to handle 40 dBm without performance degradation makes the TGA2227 an ideal choice for a front-end LNA. Depending on the application, this level of robustness could easily support the elimination of other receive protect circuitry. This would further support a more simplified board design, reduced BOM costs and lower overall noise figure.

Supported applications span both commercial and military communication and radar systems as well as electronic warfare, instrumentation and any other general RF amplification needs.

Product Features

- Frequency Range: 2 – 22 GHz
- High Input Power Survivability: 40 dBm
- Noise Figure: 2.0 dB (midband)
- Gain > 15 dB
- IM3: −31 dBc (P_{IN} / tone=−4 dBm, Δf = 10 MHz)
- P1dB > 20 dBm
- Bias: : V_D = +8 V, I_{DQ} = 125 mA
- Die Dimensions: 2.040 x 1.490 x 0.1 mm

Functional Block Diagram



Applications

- Commercial & Military Communications
- Commercial & Military Radar
- Electronic Warfare
- Instrumentation
- LNA, driver, gain block, general amplification

Ordering Information

Part No.	Description
TGA2227	2 – 22 GHz GaN LNA
TGA2227EVB02	TGA2227 Evaluation Board

Recommended Operating Conditions

Parameter	Value / Range
Drain Voltage (V_D), Low P_{DISS} Bias	+8.0 V
Drain Voltage (V_D), Power Bias	+15.0 V
Quiescent Drain Current (I_{DQ})	125 mA
Gate Voltage (V_G)	−3.0 V
Cascode Voltage (V_C), Low P_{DISS} Bias	+2.0 V
Cascode Voltage (V_C), Power Bias	+4.0 V
Operating Temperature Range	−40 to +85 °C

Electrical Specifications

Parameter	Min	Typ	Max	Units
Frequency Range	2	–	22	GHz
Small Signal Gain	–	16.0	–	dB
Noise Figure	–	2.5	–	dB
Input Return Loss	–	10	–	dB
Output Return Loss	–	12	–	dB
P_{SAT}	–	23.4	–	dBm
P_{1dB}	–	20.3	–	dBm
IM3 (P_{IN}/tone = −4 dBm, Δf = 10 MHz)	–	−31	–	dBc
S21 Temperature Coefficient	–	−0.022	–	dB / °C
NF Temperature Coefficient	–	0.012	–	dB / °C
Recommended Operating Voltage	5	8	20	V

Test conditions, unless otherwise noted: T_{BASE} = 25 °C, V_D = +8 V, V_C = +2 V

Electrical Specifications

Parameter	Min	Typ	Max	Units
Frequency Range	2	–	22	GHz
Small Signal Gain	–	15.9	–	dB
Noise Figure	–	2.5	–	dB
Input Return Loss	–	10	–	dB
Output Return Loss	–	12	–	dB
P_{SAT}	–	25.8	–	dBm
P_{1dB}	–	22.6	–	dBm
IM3 (P_{IN}/tone = −4 dBm, Δf = 10 MHz)	–	−35	–	dBc
S21 Temperature Coefficient	–	−0.024	–	dB/°C
NF Temperature Coefficient	–	0.011	–	dB/°C
Recommended Operating Voltage	5	15	20	V

Test conditions, unless otherwise noted: TBASE = 25 °C, V_D = +15 V, V_C = +4 V

Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V_D)	+29.5 V
Cascode Voltage (V_C)	V_C<V_D and V_C< +9 V
Drain Current (I_D)	300 mA
Gate Voltage (V_G)	−5 to 0 V
Gate Current (I_G)	See graph on page
RF Input Power (25 °C, 50 Ω)	40 dBm
Channel Temperature (T_{CH})	275 °C
Mounting Temperature (30 seconds maximum)	320 °C
Storage Temperature	−55 to +150 °C

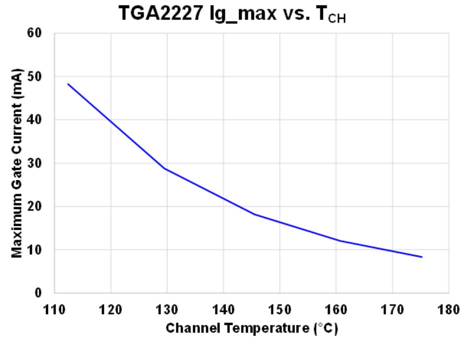
Notes:
1. Maximum VC is dependent on the VD used

Thermal and Reliability Information

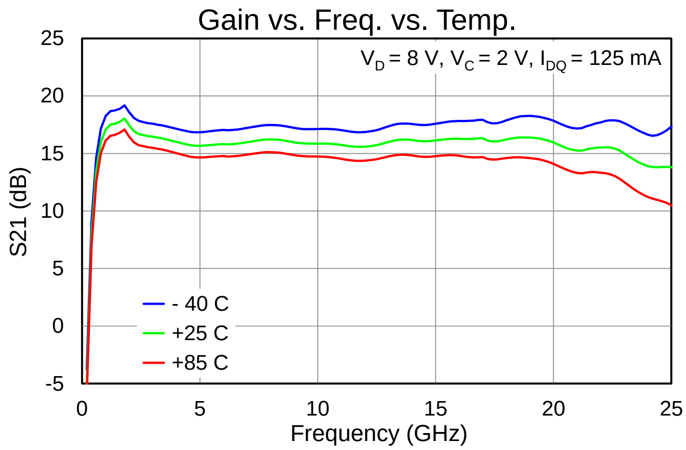
Parameter	Values	Units	Conditions
Small Signal, Thermal Resistance (θ_{JC}) (1,2,3)	3.49	°C/W	T_{BASE} = +85 °C, V_D = +8 V, V_C = +2.0 V V_G = −2.4 V, I_{D_DRIVE} = 125 mA P_{IN} = −10 dBm, P_{OUT} = +6 dBm, P_{DISS} = 1.00 W
Channel Temperature (T_{CH})	88.49	°C	
Small Signal, Thermal Resistance (θ_{JC}) (1,2,3)	4.96	°C/W	T_{BASE} = 85 °C, V_D = +15 V, V_C = +4.0 V V_G = −2.4 V, I_{D_DRIVE} = 125 mA P_{IN} = −10 dBm, P_{OUT} = +6 dBm, P_{DISS} = 1.88 W
Channel Temperature (T_{CH})	94.32	°C	
Under Drive, Thermal Resistance (θ_{JC}) (1,2,3)	5.42	°C/W	T_{BASE} = 85 °C, V_D = +15 V, V_C = +4.0 V V_G = −2.4 V, I_{D_DRIVE} = 231 mA P_{IN} = +16 dBm, P_{OUT} = +28.3 dBm, P_{DISS} = 2.83 W
Channel Temperature (T_{CH})	100.34	°C	

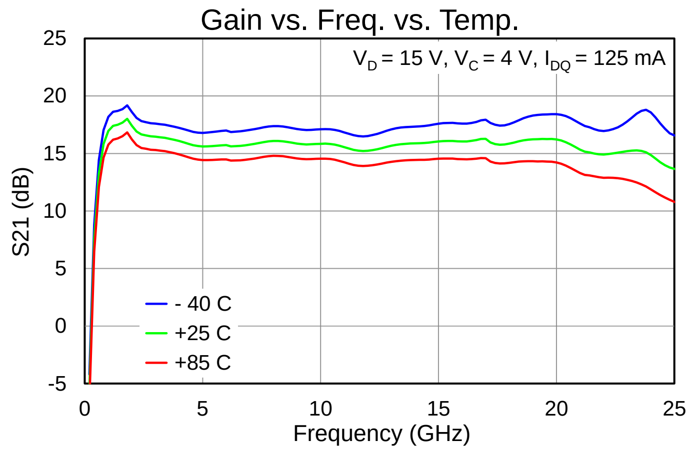
Notes:
1. Thermal resistance is measured to die backside
2. Base or ambient temperature is 85 ˚C
3. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

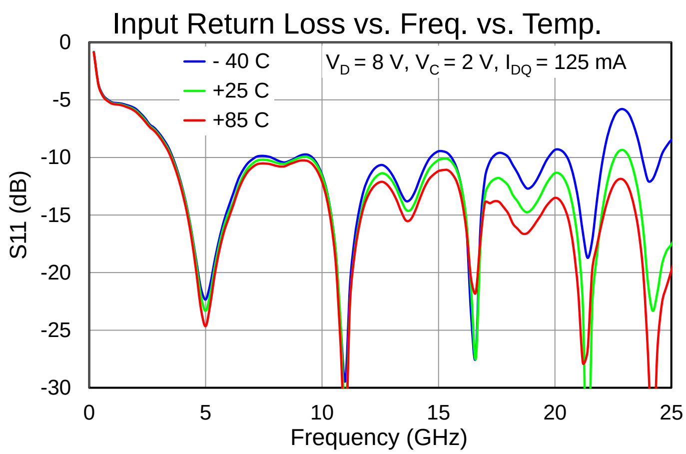
Maximum Gate Current

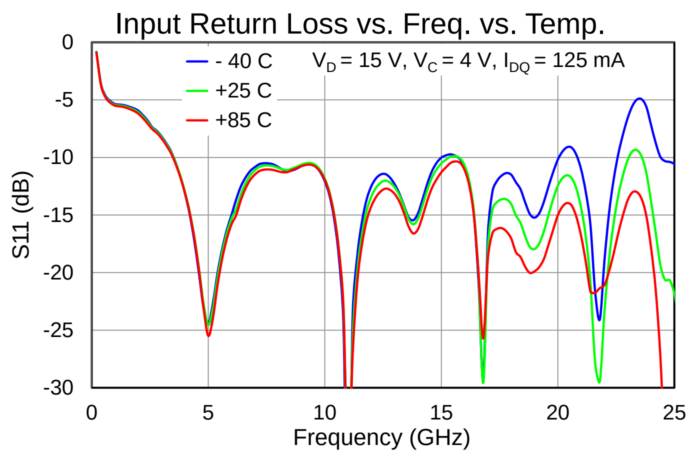


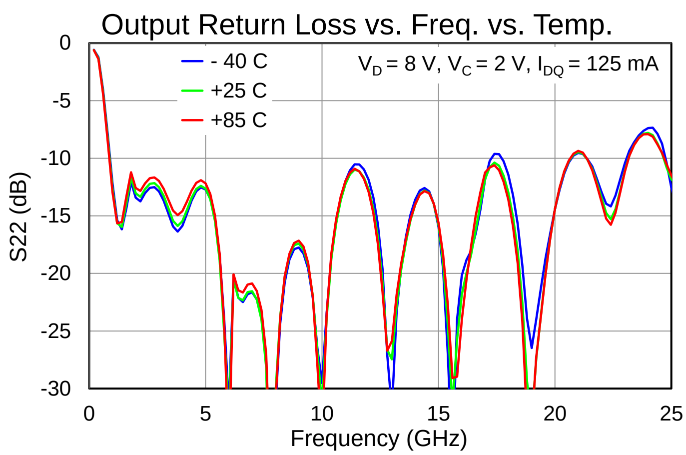
Performance Plots – Small Signal

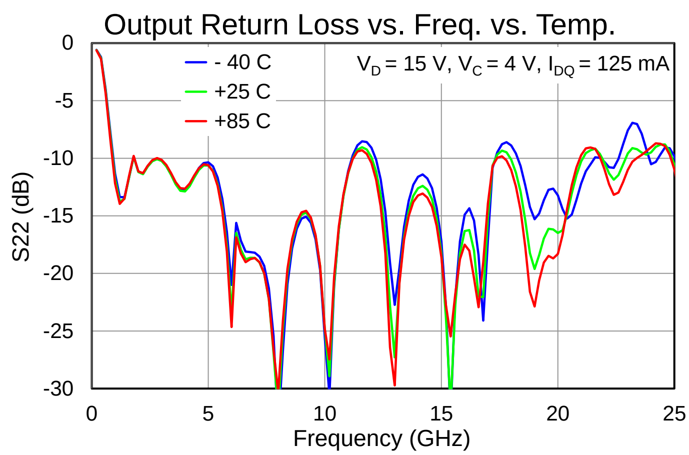




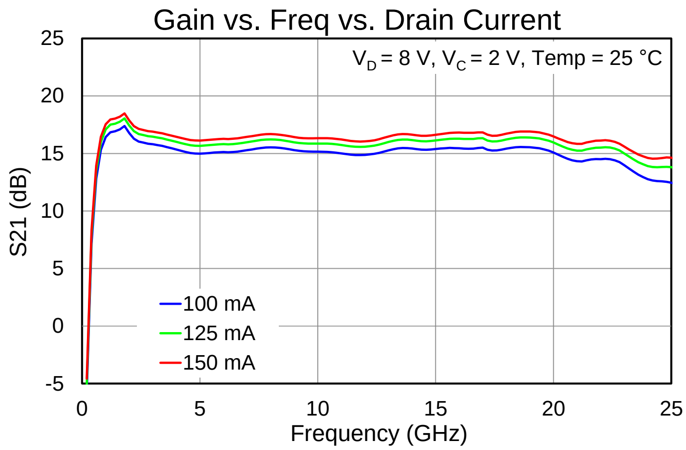


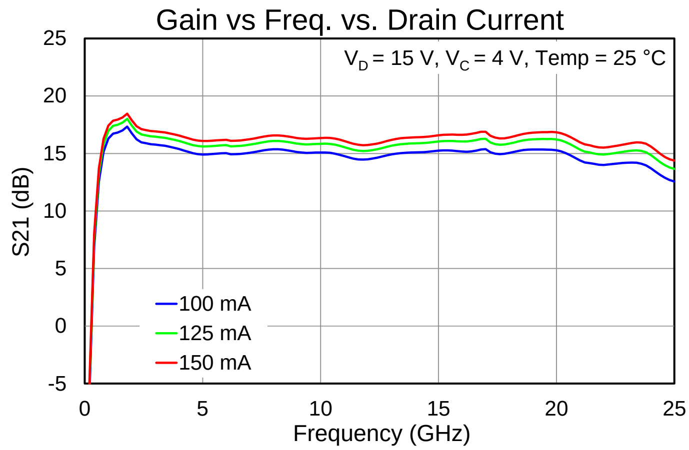


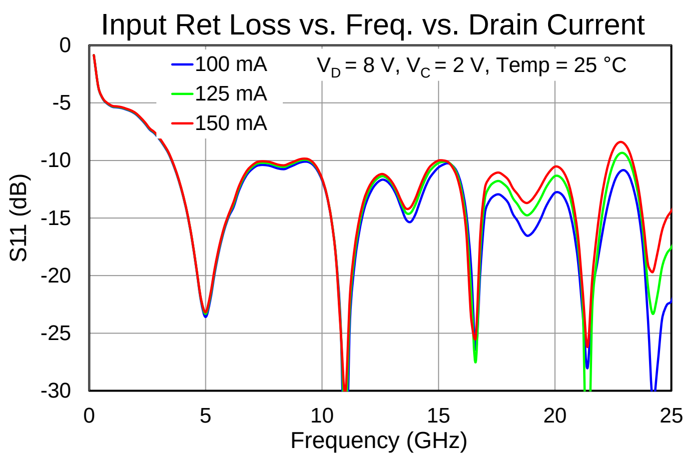


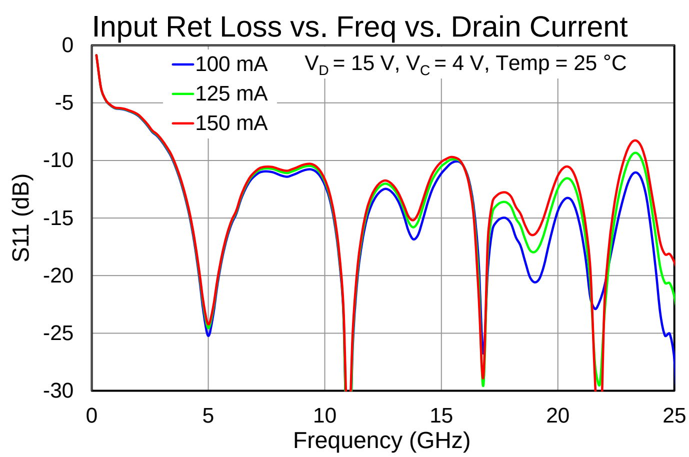


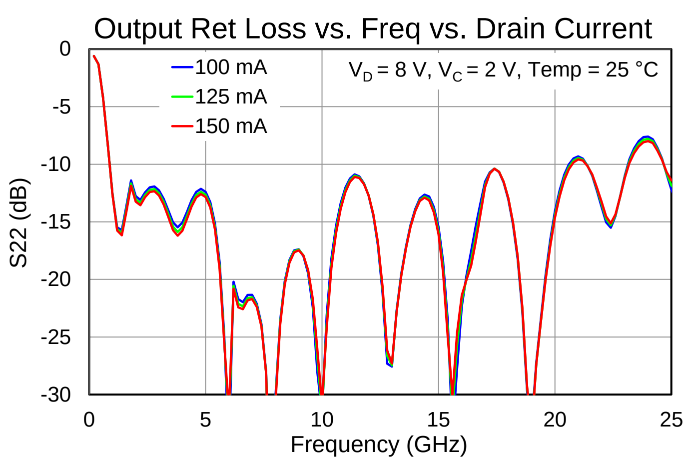
Performance Plots – Small Signal

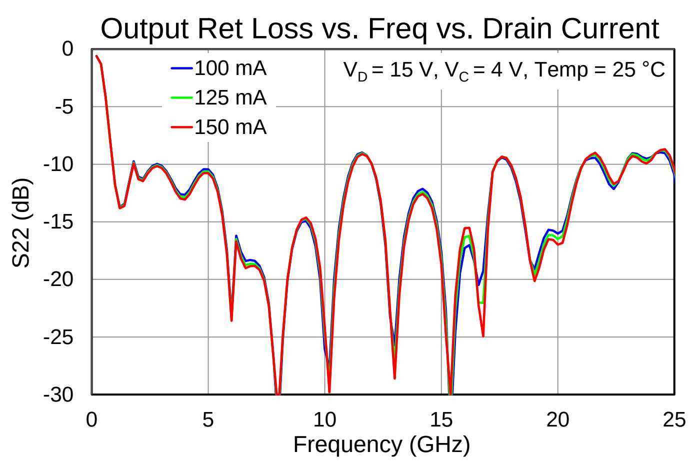




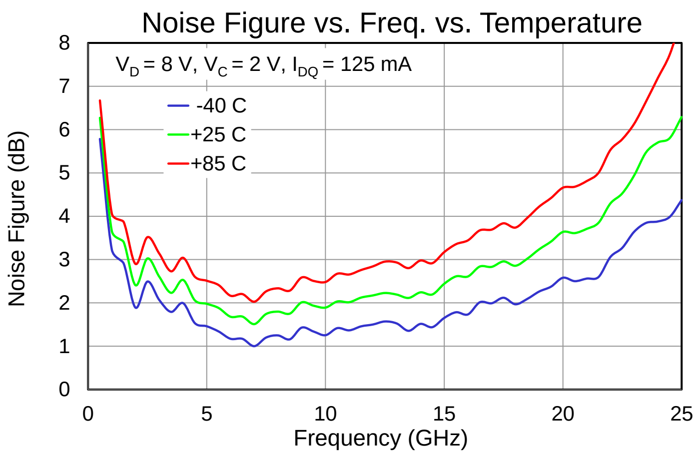


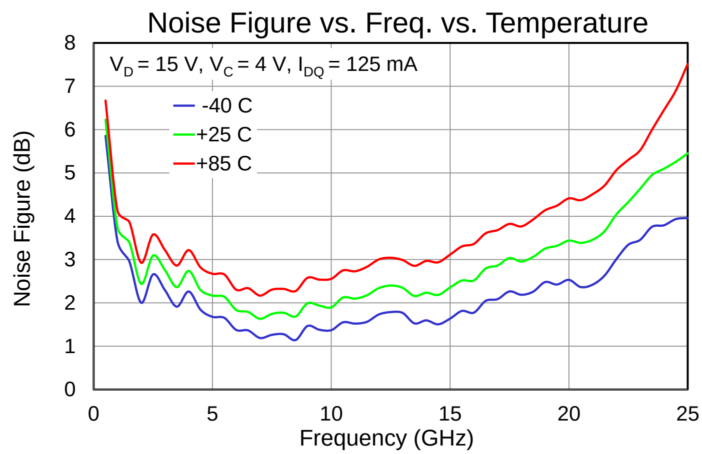


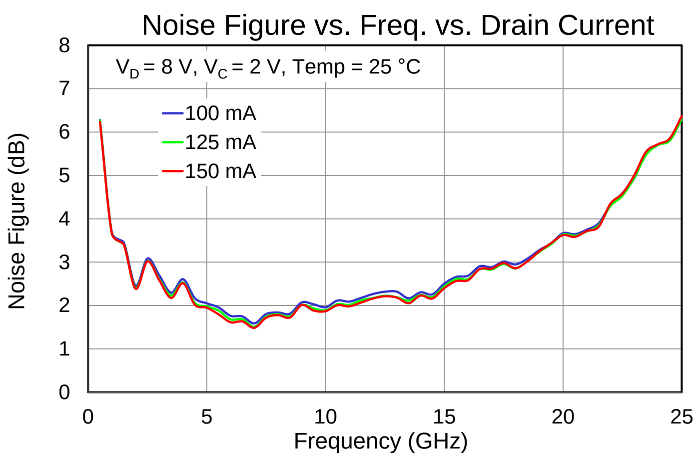


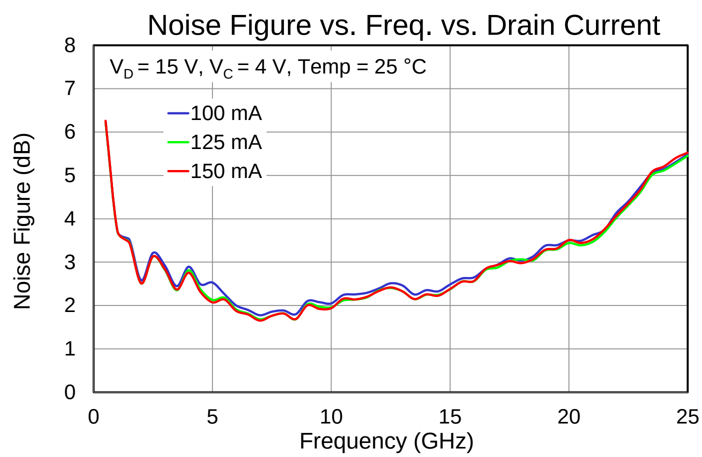


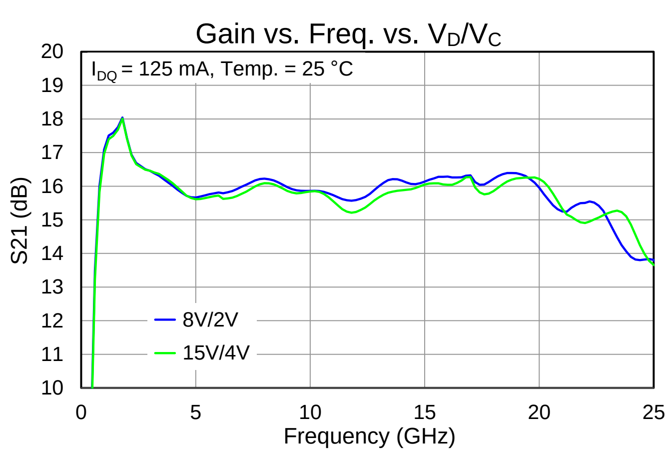
Performance Plots – Noise Figure

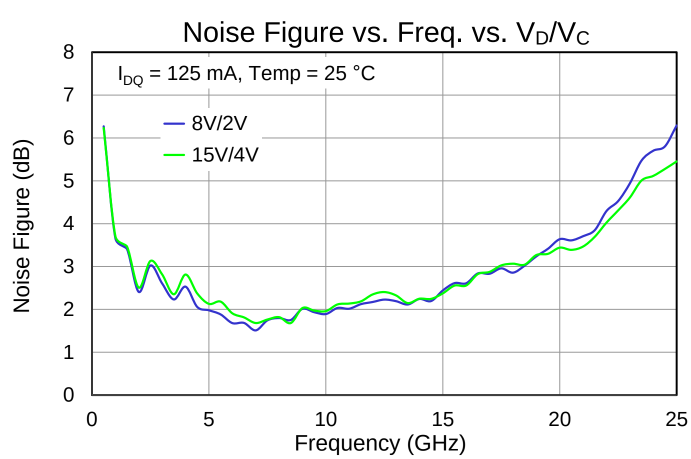




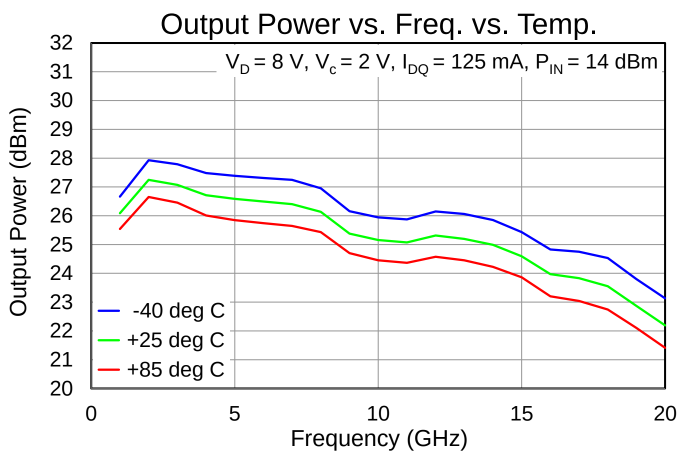


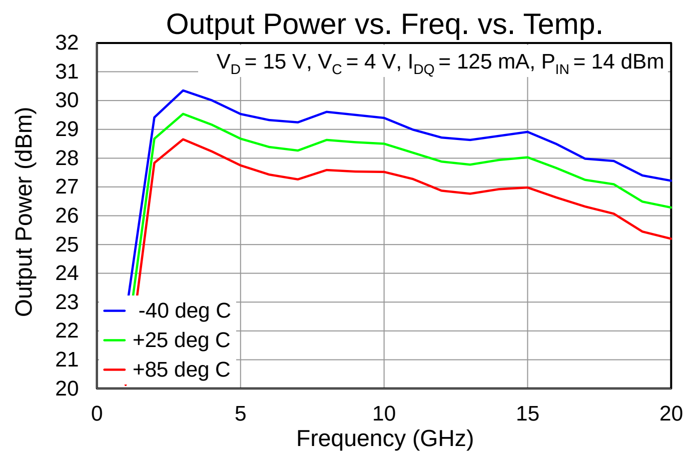


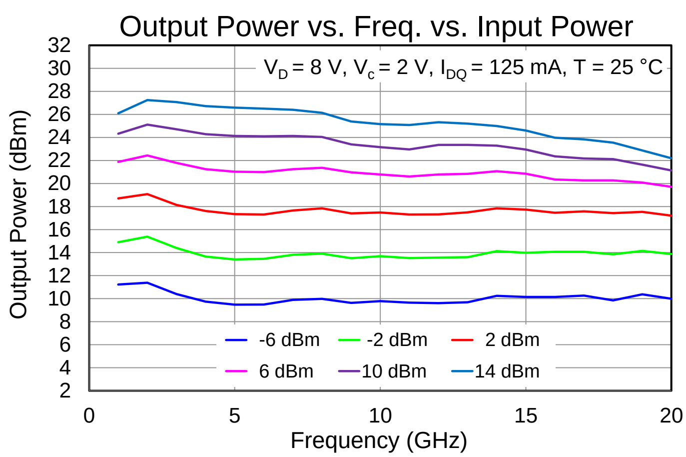


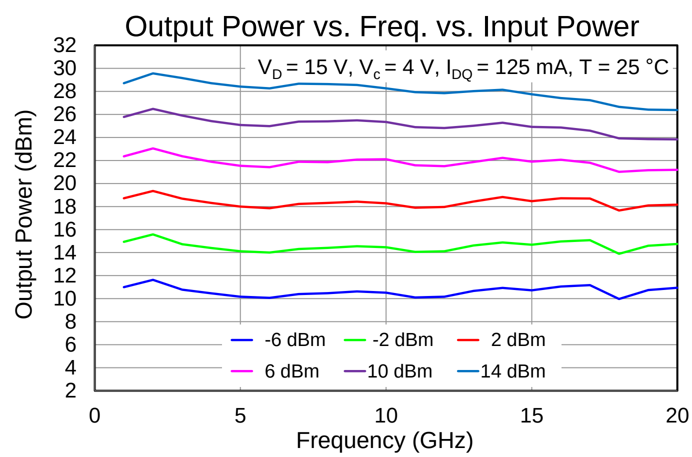


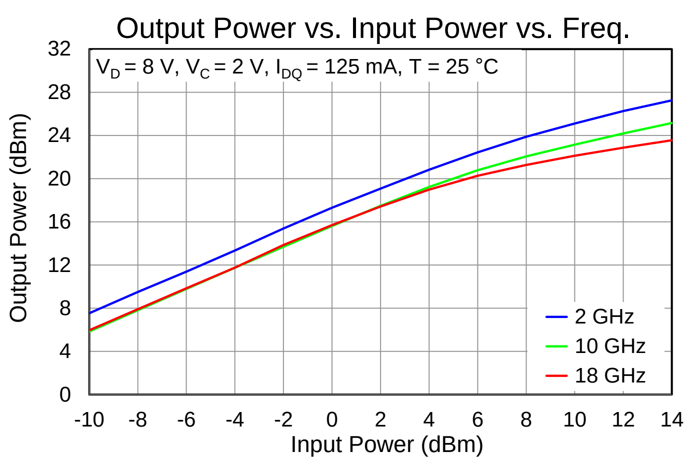
Performance Plots – Large Signal

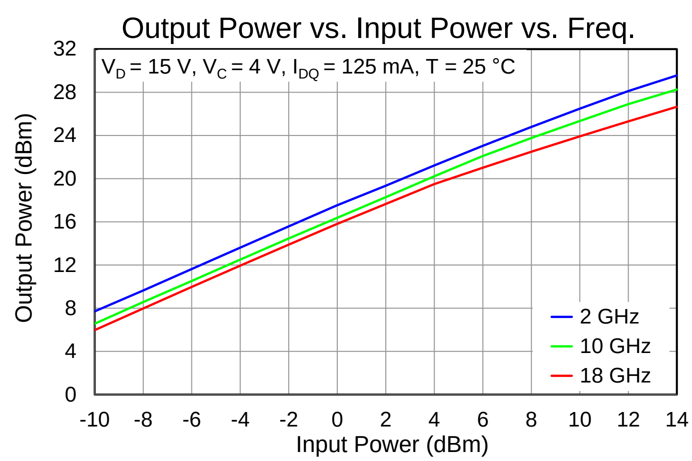




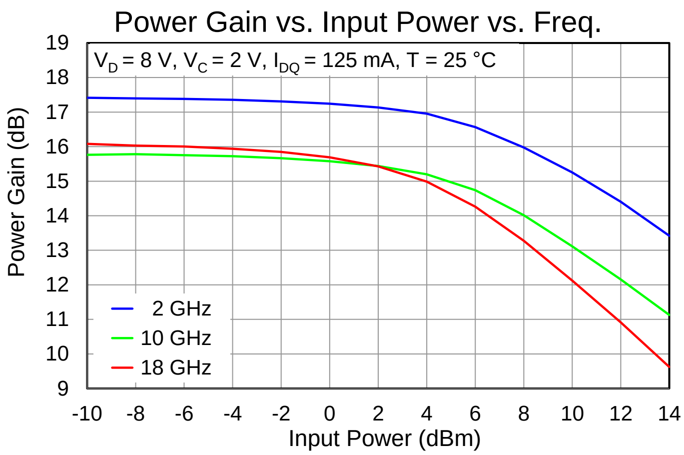


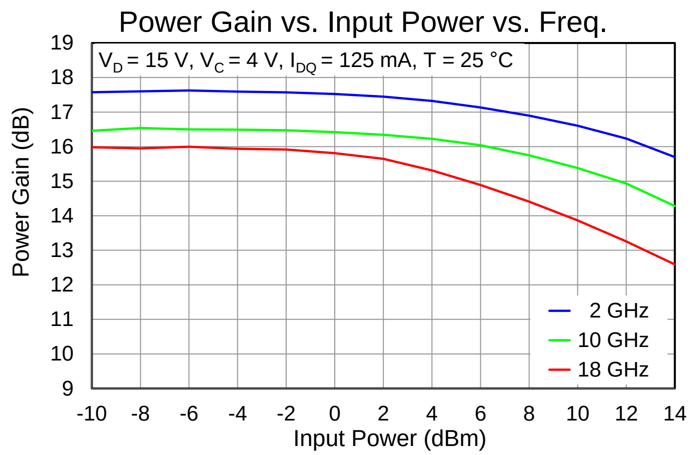


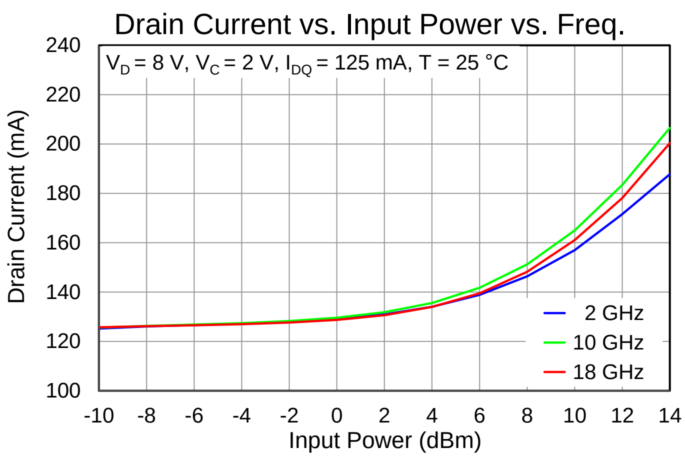


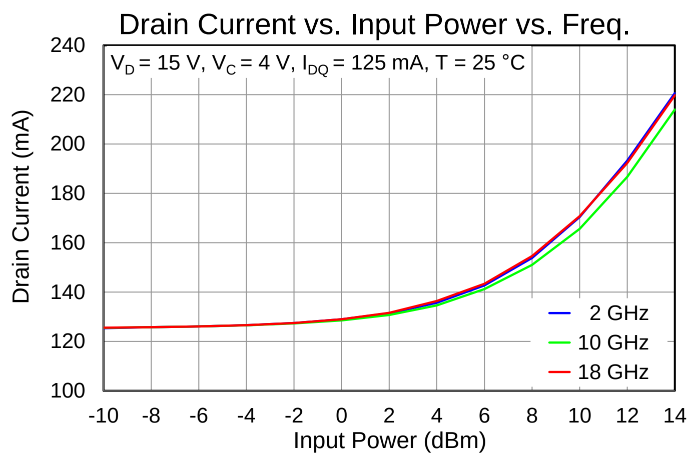


Performance Plots – Large Signal

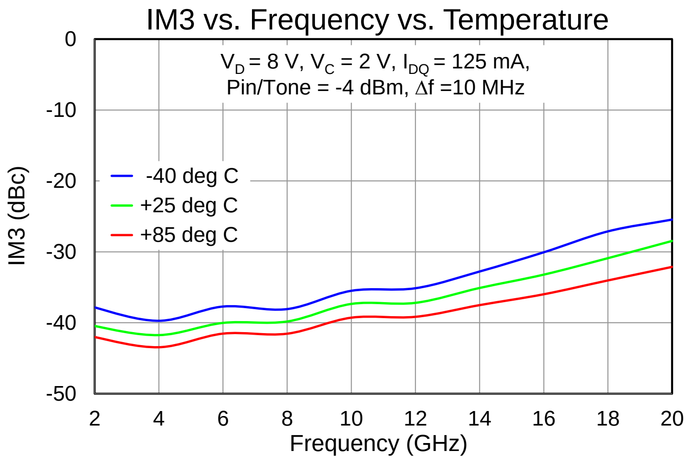


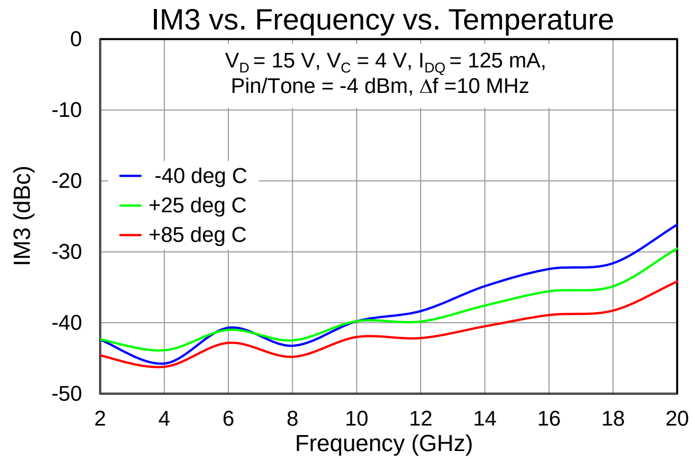


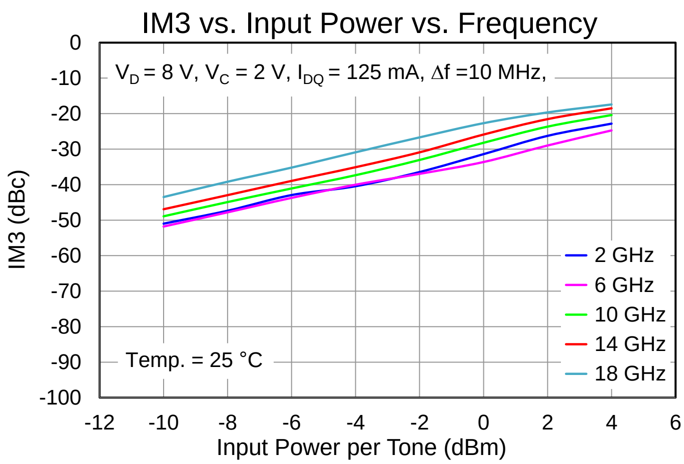


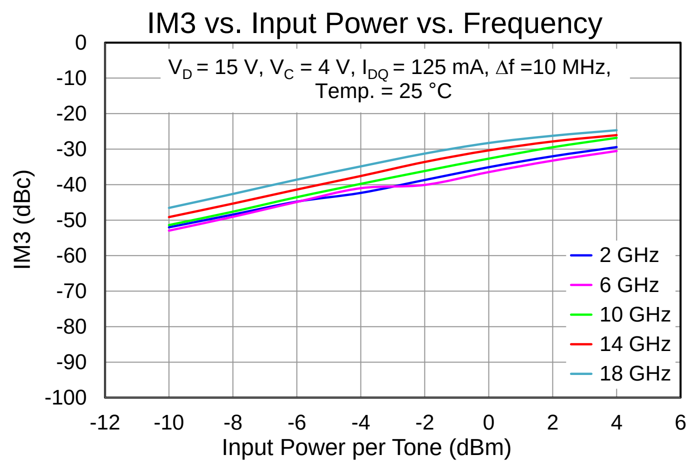


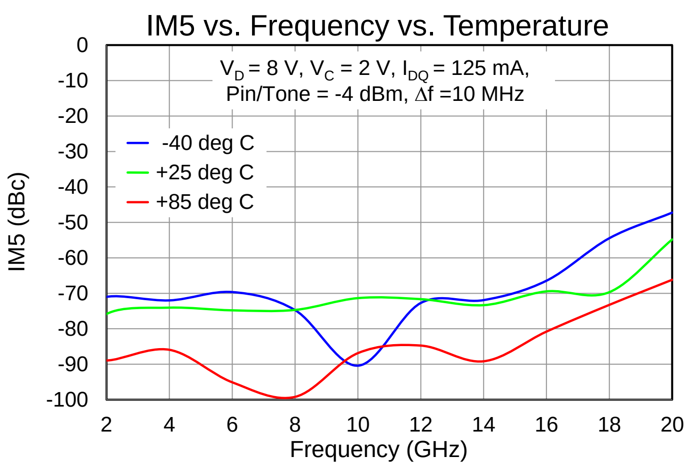
Performance Plots – Linearity

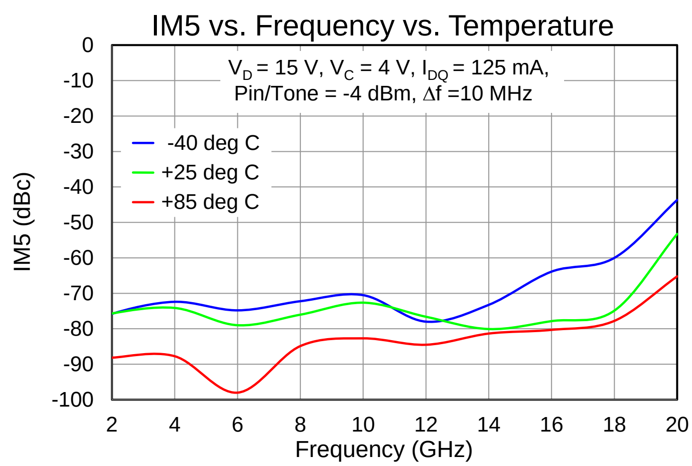




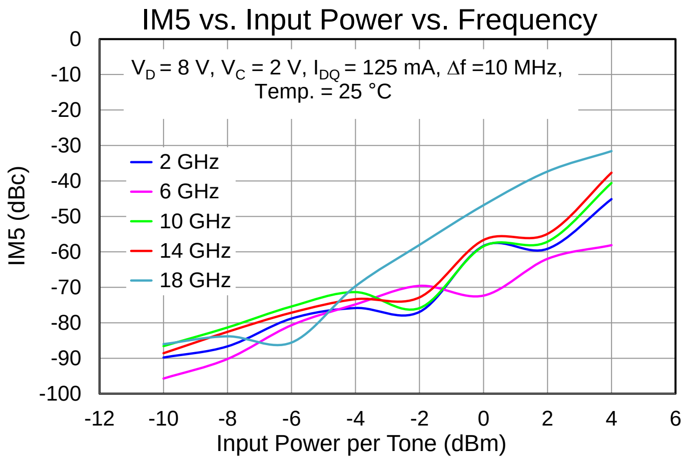


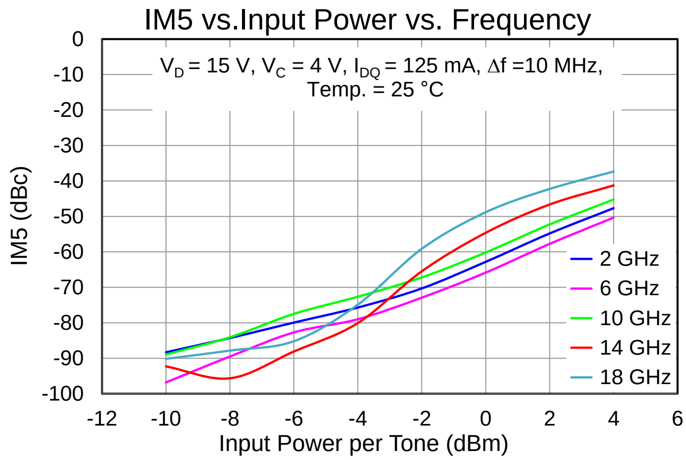




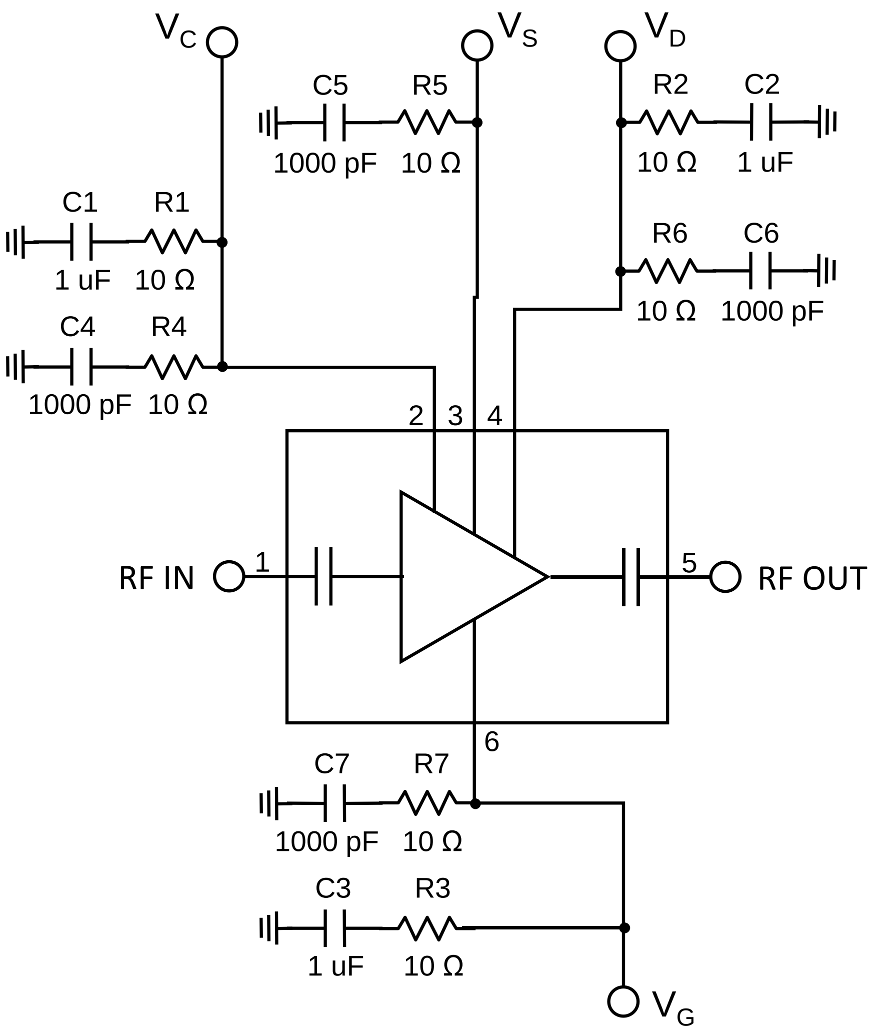


Performance Plots – Linearity





Application Circuit



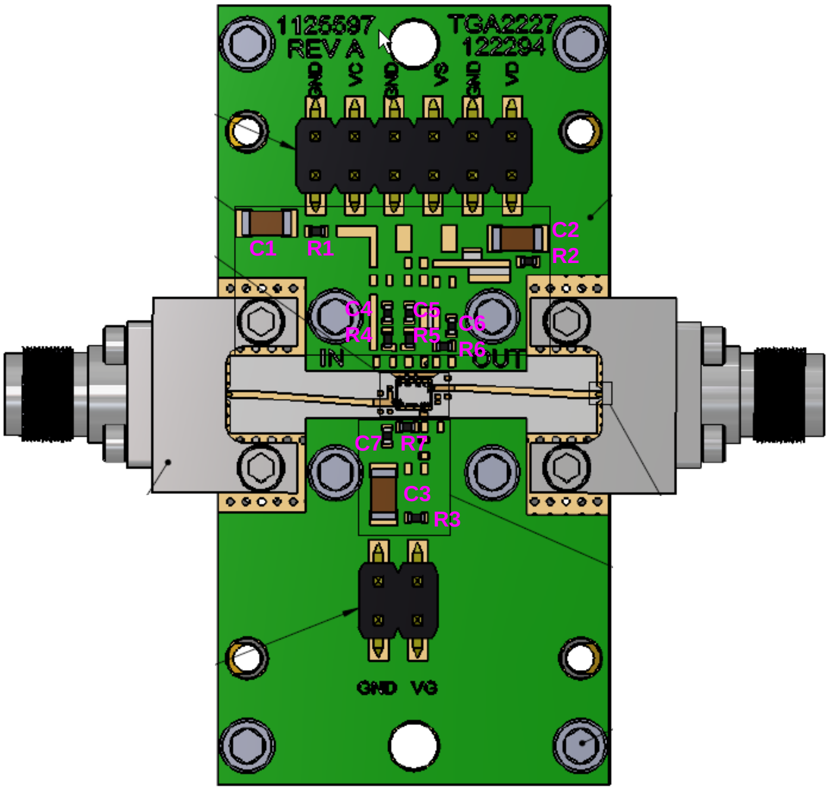
Bias Up Procedure

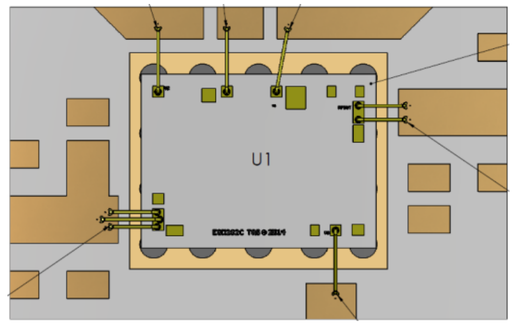
1. Set V_G = −5.0 V, V_C = 0.0 V, V_D = 0.0 V
2. Adjust V_D to desired drain voltage
3. Adjust V_C to desired voltage
4. Adjust V_G until I_{DS} = 125 mA
5. Turn on RF signal

Bias Down Procedure

1. Turn off RF signal
2. Adjust V_G to −5.0 V
3. Adjust V_C to 0.0 V
4. Adjust V_D to 0.0 V
5. Adjust V_G to 0.0 V

EVB Part Number or Ref. Design Name





MMIC mounting/wire bonding detail

RF Layer is 0.008" thick Rogers Corp. RO4003C, ε_r = 3.38. Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-5.

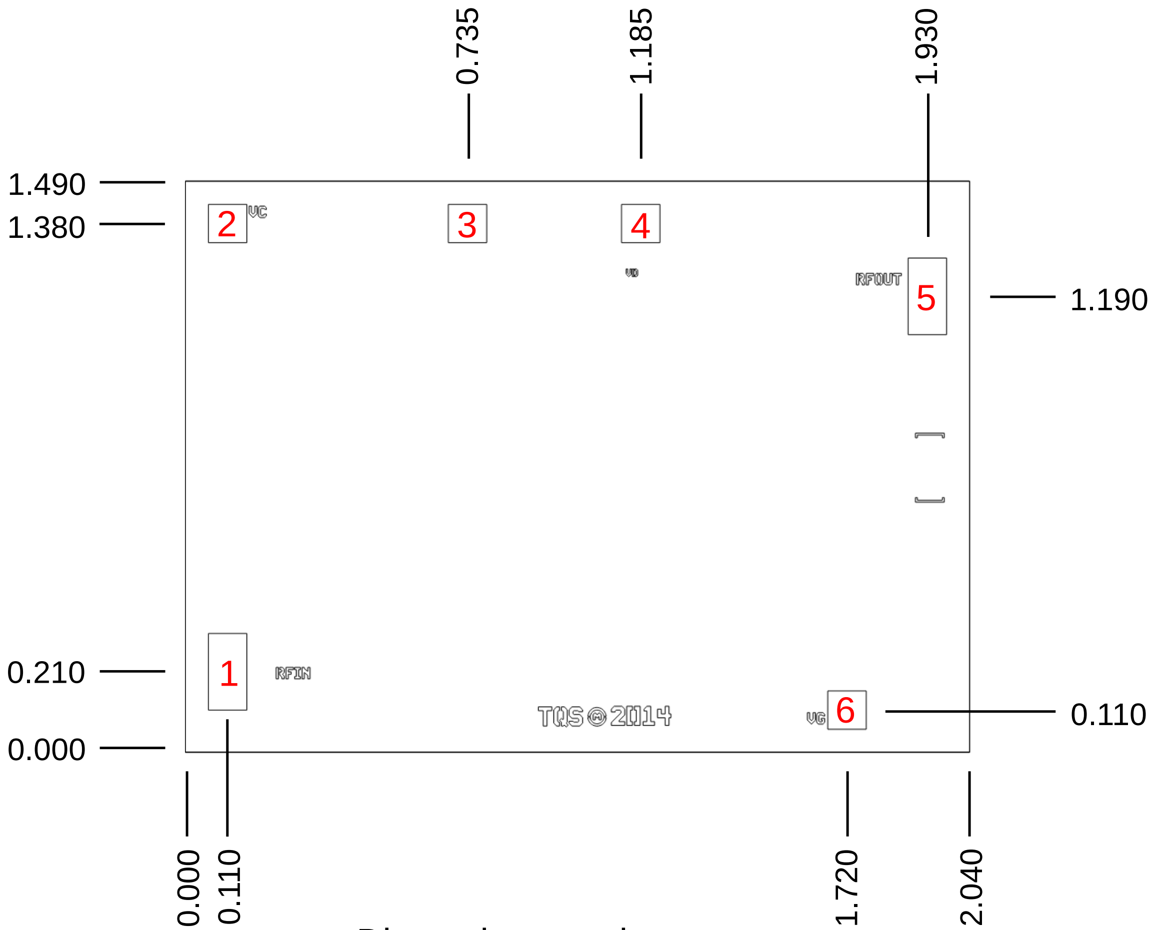
The trace pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead tolerances. Since processes vary from company to company, careful process development is recommended.

Note: Conductive epoxy is used for attaching the die to the EVB PCB.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1 – C3	1 uF, +50 V, 5 %	CAP X5R 1206	Various	–
C4 – C7	1000 pF, +50 V, 10 %	CAP X7R 0402	Various	–
R1 – R2, R4 – R7	10 Ohm, 5 %	RES 0402, SMD	Various	–
R3	Not used	–	–	–

Mechanical Drawing and Bond Pad Description



Dimensions are in mm

Pad Number	Symbol	Description	Pad Size (um x um)
1	RF Input	RF input pad, DC blocked	100 x 200
2	V_C	Cascode voltage	100 x 100
3	V_S	Drain voltage monitor	100 x 100
4	V_D	Drain voltage	100 x 100
5	RF Output	RF output pad, DC blocked	100 x 200
6	V_G	Gate voltage	100 x 100

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.
- Organic attachment (i.e. epoxy) can be used in low-power applications and for die attach to soft substrates.
- Curing should be done in a convection oven; proper exhaust is a safety concern.

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 ultrasonics 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)	TBD	JEDEC Standard JESD22 A114

Caution!
ESD-Sensitive Device

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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Web: www.qorvo.com

Email: customer.support@qorvo.com

For technical questions and application information: **Email: appsupport@qorvo.com**

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