QPA2735D

13 – 20 GHz Low Noise Amplifier

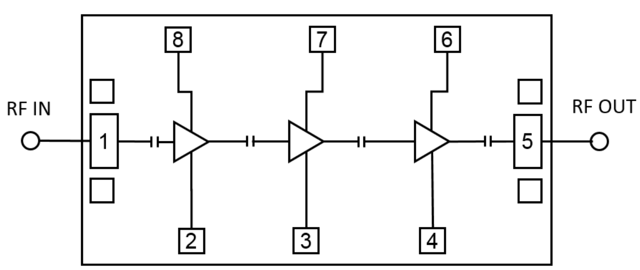
Product Overview

Qorvo's QPA2735D is a high-performance, low noise MMIC amplifier fabricated on Qorvo's production 90 nm pHEMT process (QPHT09). Covering 13 – 20 GHz, the QPA2735D provides 26 dB small signal gain and 1.2 dB noise figure. With a compact size of 2.37 x 0.97 mm, the amplifier can deliver 23 dBm of saturated power with P1dB of 18 dBm. In addition, the device can provide low IMD3 level of −60 dBc at Pout = 0 dBm/tone.

The QPA2735D is matched to 50 ohms with integrated DC blocking caps on both I/O ports for easy handling and simple system integration.

The high performance of the QPA2735D makes it ideal for satellite and point to point communication systems.

Functional Block Diagram



Key Features

- Frequency Range: 13 – 20 GHz
- Noise Figure: 1.2 dB (typical)
- Small Signal Gain: 26 dB (typical)
- P1dB: 18 dBm (typical)
- Psat: 23 dBm (typical)
- IMD3: −60 dBc (typical) (Pout=0 dBm/tone)
- Bias: VD = 3.5 V, IDQ = 105 mA, VG = −0.46 V (typical)
- Die Dimensions: 2.37 x 0.97 x 0.10 mm

Applications

- Satellite Communications
- Point-to-Point Communications

Ordering Information

Part No.	Description
QPA2735D	13 – 20 GHz Low Noise Amplifier
QPA2735DEVB01	QPA2735D Evaluation Board

Absolute Maximum Ratings

Parameter	Rating	Units
Drain Voltage (V_D)	4.5	V
Drain Current ($I_{D1}/I_{D2}/I_{D3}$)	96 / 90 / 192	mA
Gate Voltage Range (V_G)	−1.3 to 0	V
Gate Current ($I_{G1}/I_{G2}/I_{G3}$ at 125 °C)	5.0 / 5.0 / 6.6	mA
RF Input Power (50 Ω, 85 °C)	20	dBm
Channel Temperature, T_{CH}	175	°C
Mounting Temperature (30 seconds)	260	°C
Storage Temperature	−55 to 150	°C

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions

Parameter	Typical Values	Units
Drain Voltage	3.5	V
Drain Current (quiescent, I_{DQ})	105	mA
Drain Current (I_D, Low noise / P_{SAT})	105 / 175	mA
Gate Voltage (typical)	−0.46	V
Operating Temperature Range	−40 to 85	°C

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

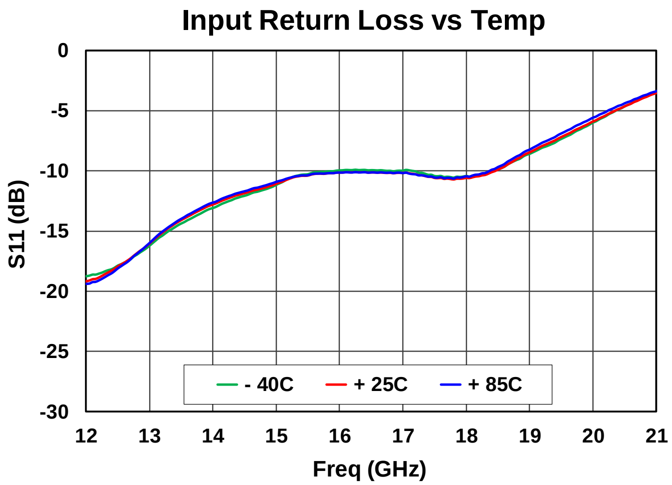
Electrical Specifications

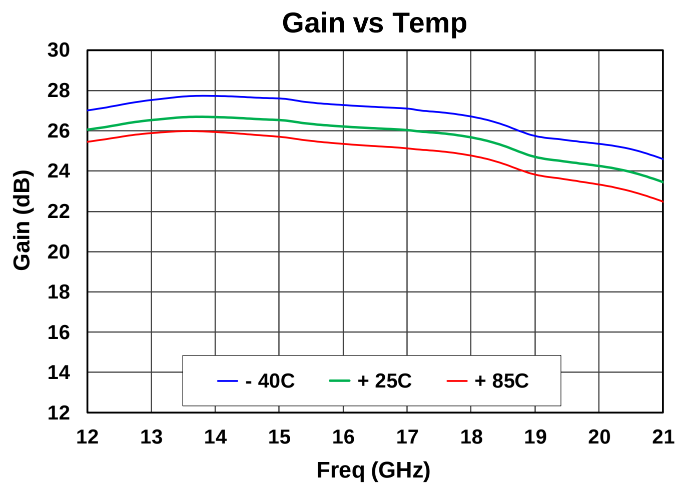
Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C. Data de-embedded to MMIC bond wires.

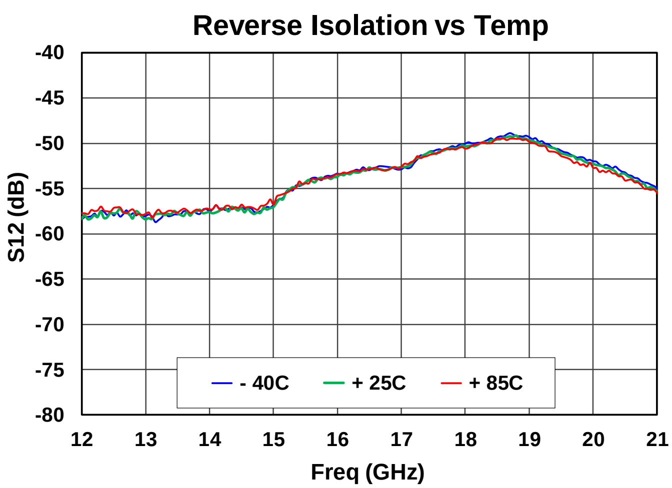
Parameter	Min	Typ	Max	Units
Operating Frequency	13		20	GHz
Small Signal Gain		26		dB
Noise Figure		1.2		dB
Power at 1-dB Compression		18		dBm
Power at Saturation		23		dBm
Input Return Loss		10.0		dB
Output Return Loss		10.0		dB
3RD Order Intermodulation Level (P_{OUT} = 0 dBm / Tone)		−60		dBc
Output TOI (Pout = 0 dBm / tone)		30.0		dBm
Gain (S21) Temperature Coefficient		−0.016		dB/°C

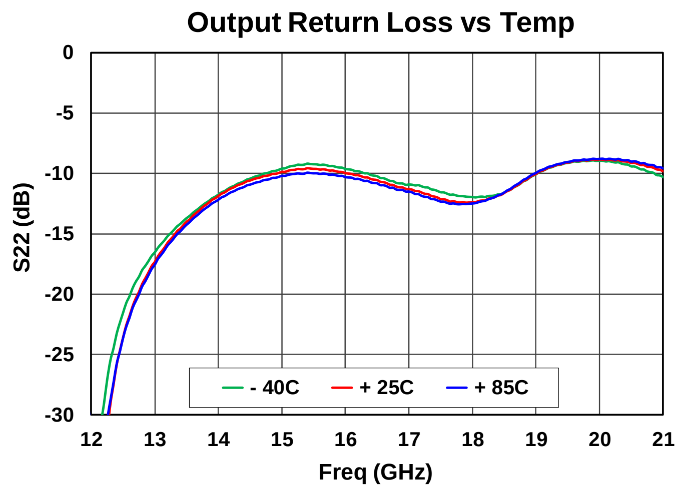
Performance Plots – Small Signal

Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C





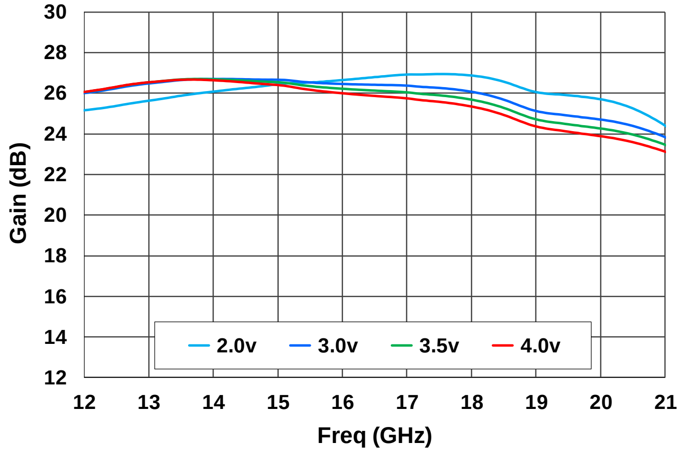




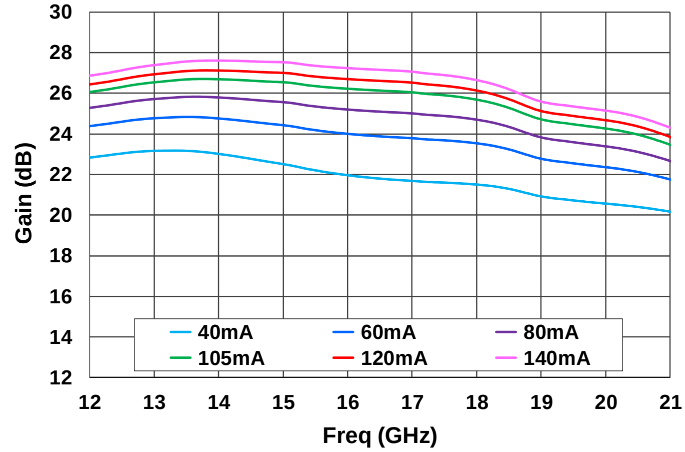
Performance Plots – Small Signal

Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C

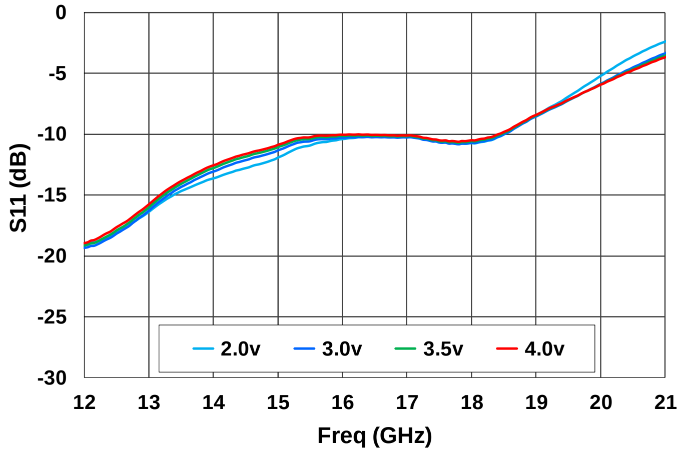
Gain vs Voltage



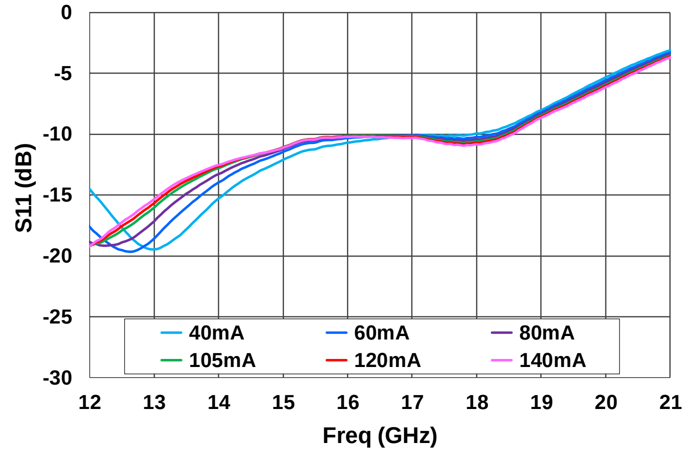
Gain vs Current



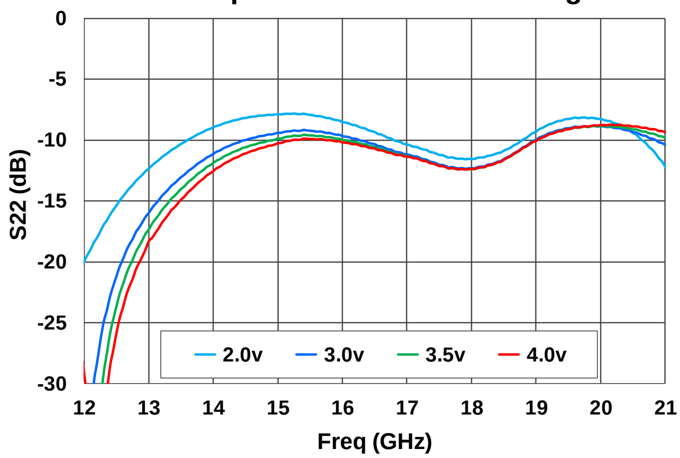
Input Return Loss vs Voltage



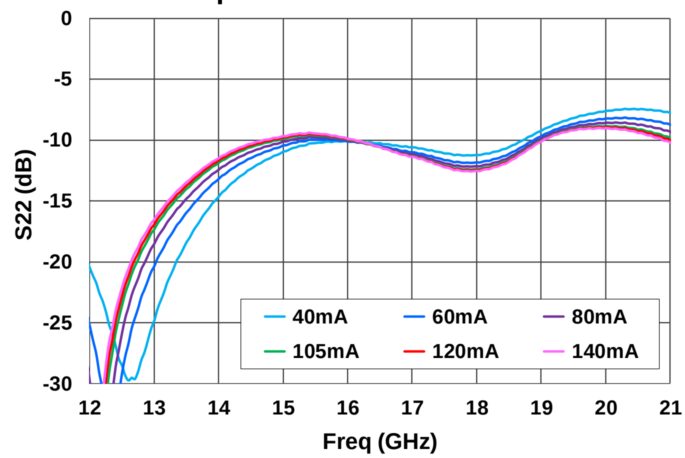
Input Return Loss vs Current



Output Return Loss vs Voltage

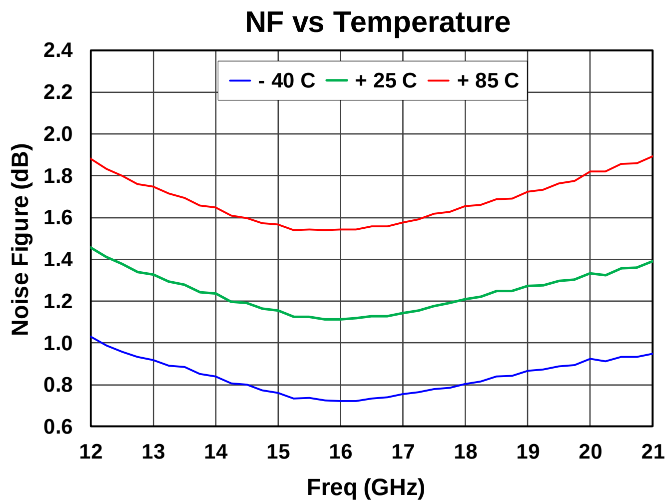


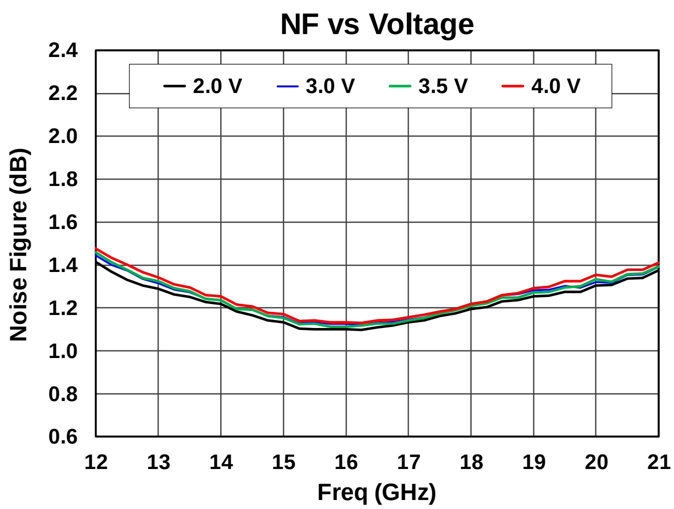
Output Return Loss vs Current

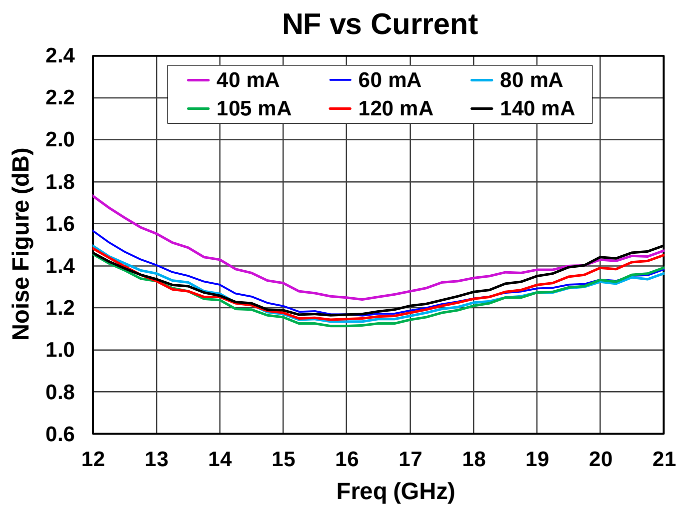


Performance Plots – Noise Figure

Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C

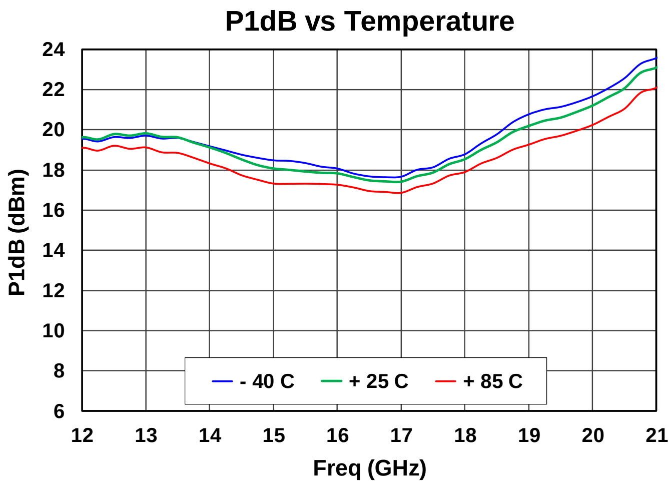


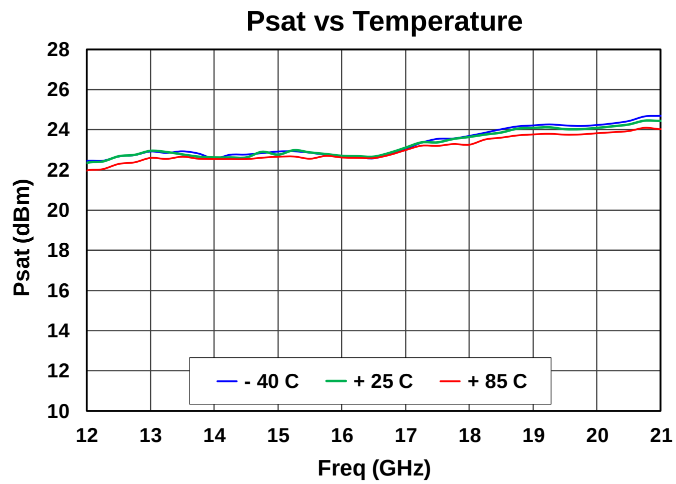


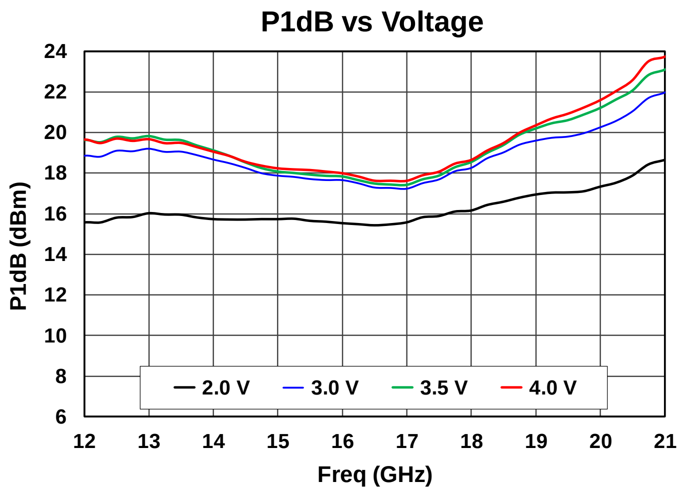


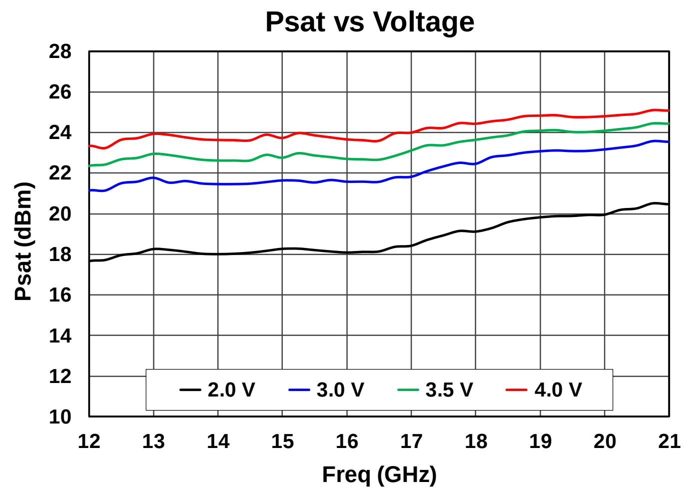
Performance Plots – Large Signal

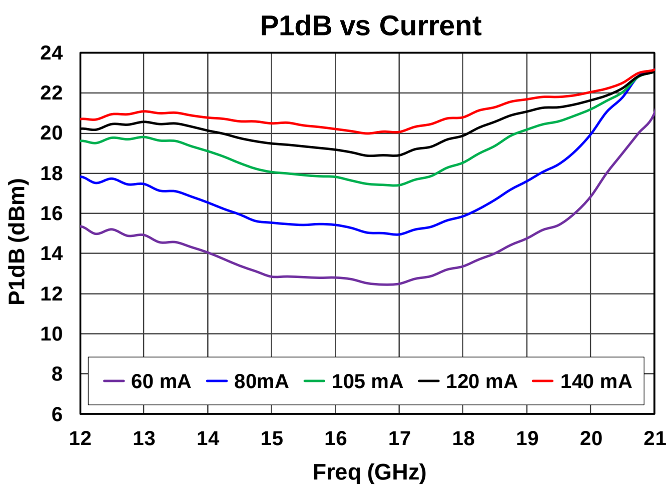
Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C

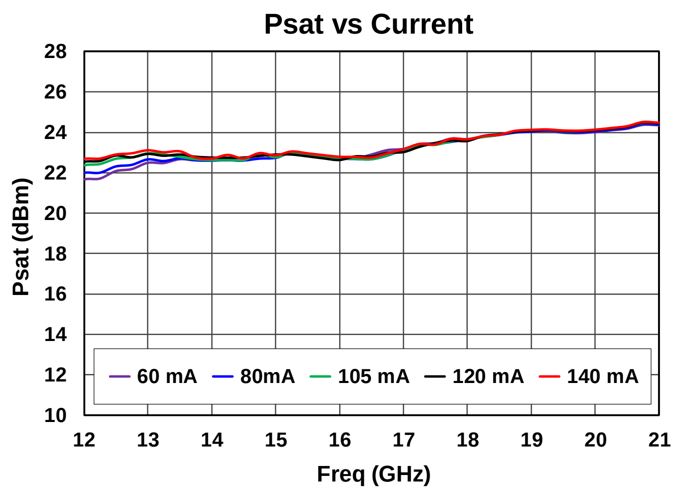






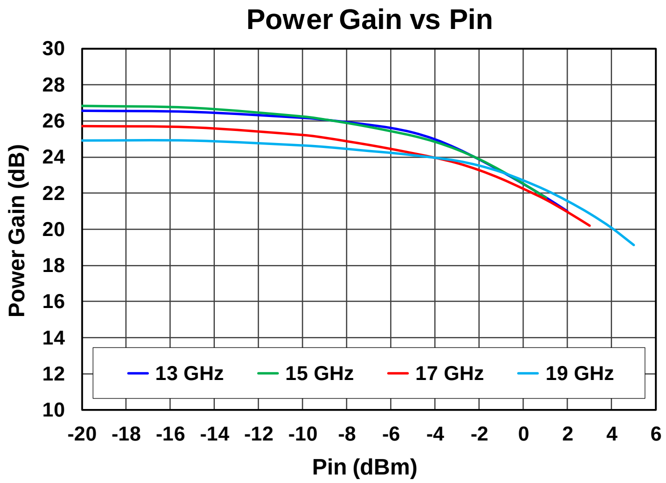


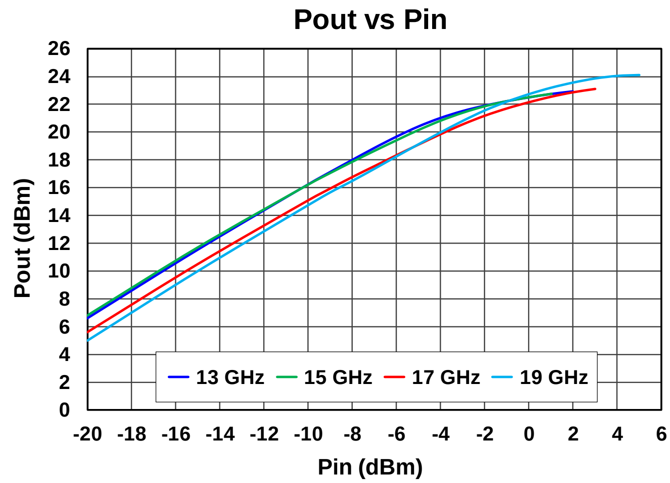


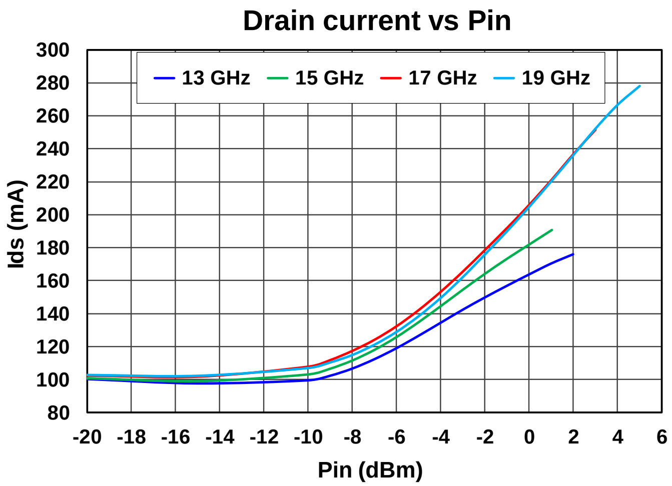


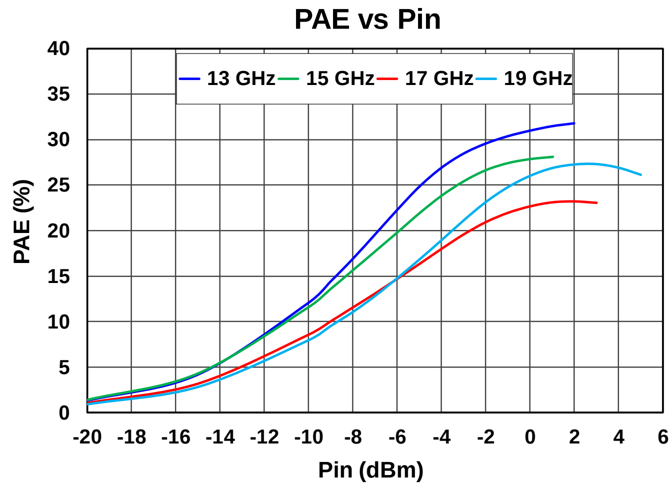
Performance Plots – Large Signal

Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Temp. = + 25 °C



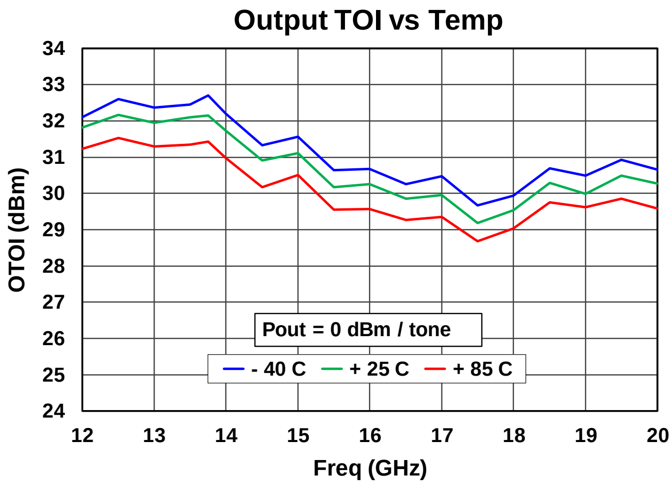


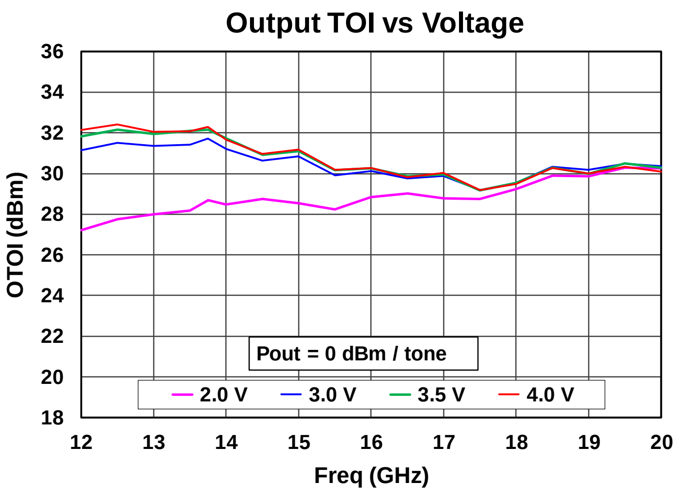


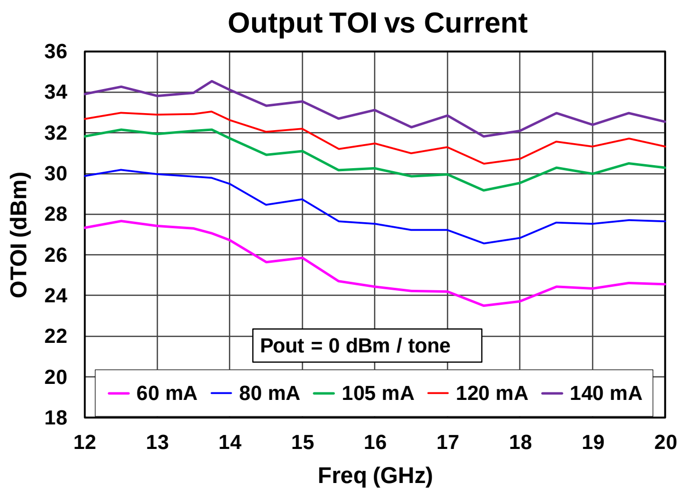


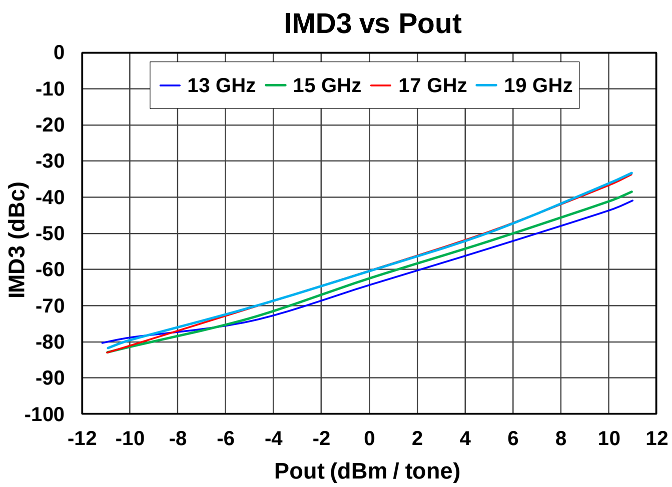
Performance Plots – Linearity

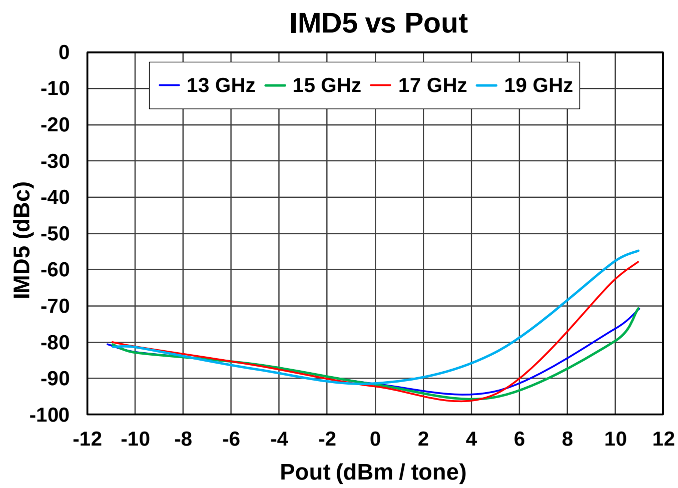
Test conditions unless otherwise noted: V_D = + 3.5 V, I_{DQ} = 105 mA, Δf = 11 MHz, Temp. = + 25 °C



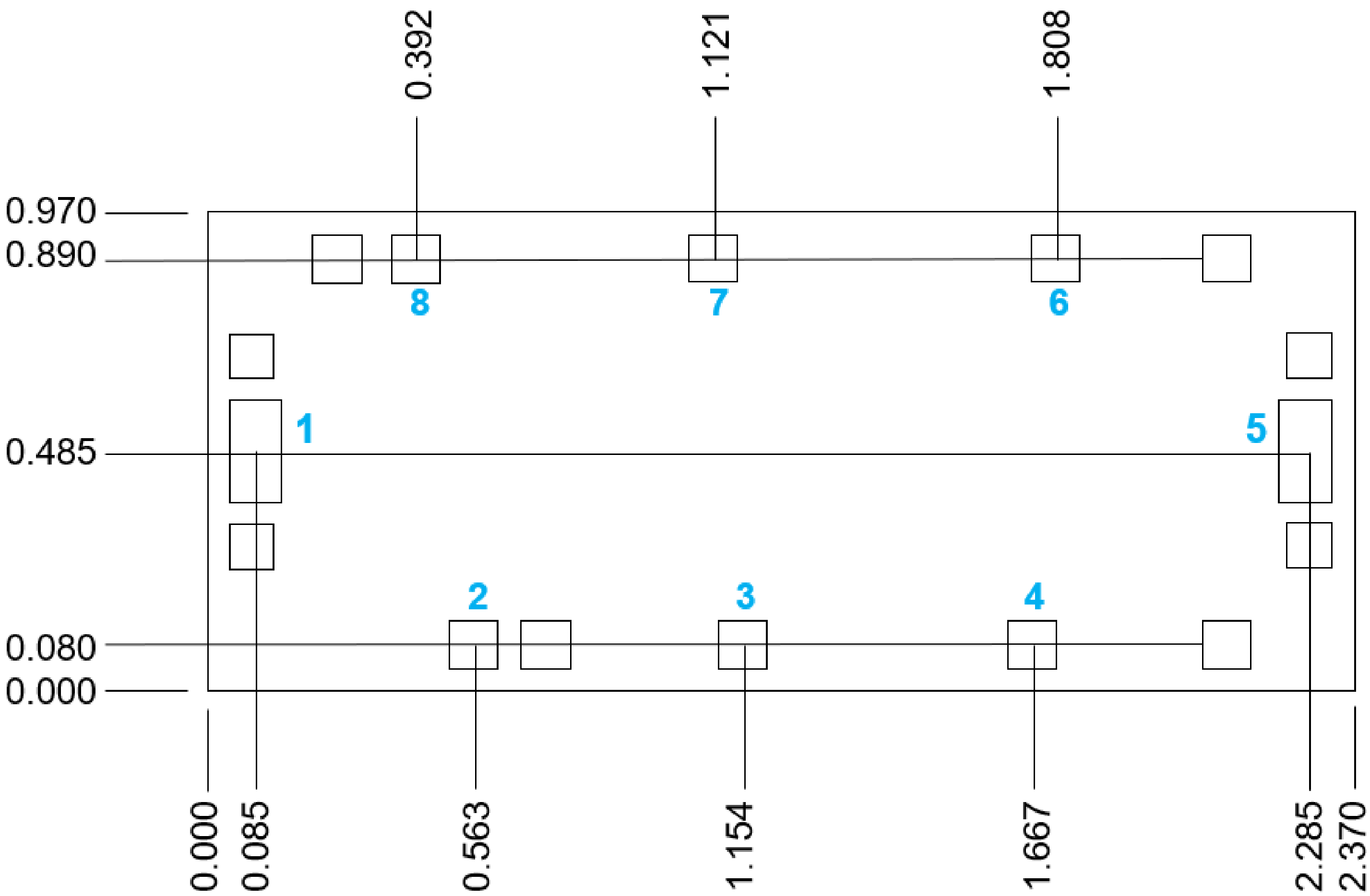








Mechanical Drawing and Bond Pad Description



Unit: millimeters. Die thickness: 0.10, Die x, y size tolerance: +/- 0.010
Chip edge to bond pad dimensions are shown to center of pad. Ground is backside of die

Pad No.	Label	Pad Size (um)	Description
1	RF Input	91 x 197	Matched to 50 ohms, DC blocked
2	VG1	82 x 82	Gate Voltage; bias network is required (VG can be tied together at PCB)
3	VG2	82 x 82	Gate Voltage; bias network is required (VG can be tied together at PCB)
4	VG3	82 x 82	Gate Voltage; bias network is required (VG can be tied together at PCB)
5	RF Output	91 x 197	Matched to 50 ohms, DC blocked
6	VD3	82 x 82	Drain Voltage; bias network is required
7	VD2	82 x 82	Drain Voltage; bias network is required (VD1 and VD2 can be tied together at PCB)
8	VD1	82 x 82	Drain Voltage; bias network is required (VD1 and VD2 can be tied together at PCB)

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., conductive epoxy) can be used in low-power applications.
- Curing should be done in a convection oven; proper exhaust is a safety concern.

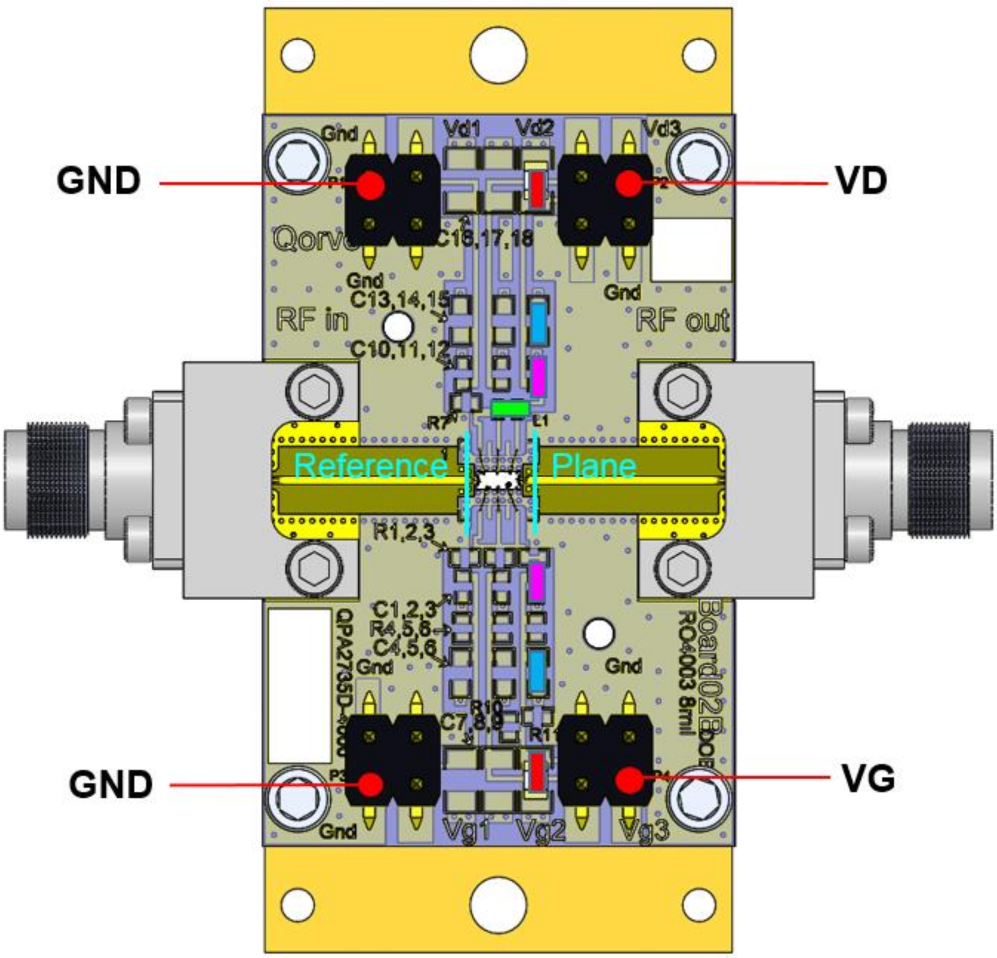
Reflow process assembly notes:

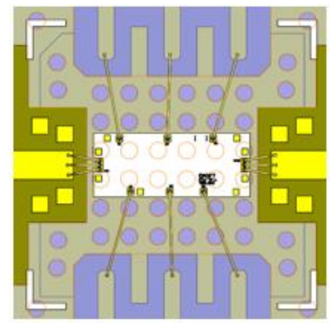
- Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3-4 minutes, maximum.
- Conductive epoxy die attach is recommended for PCB mounting.
- Bonding pads plating: Au.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- 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.

Evaluation Board and BOM





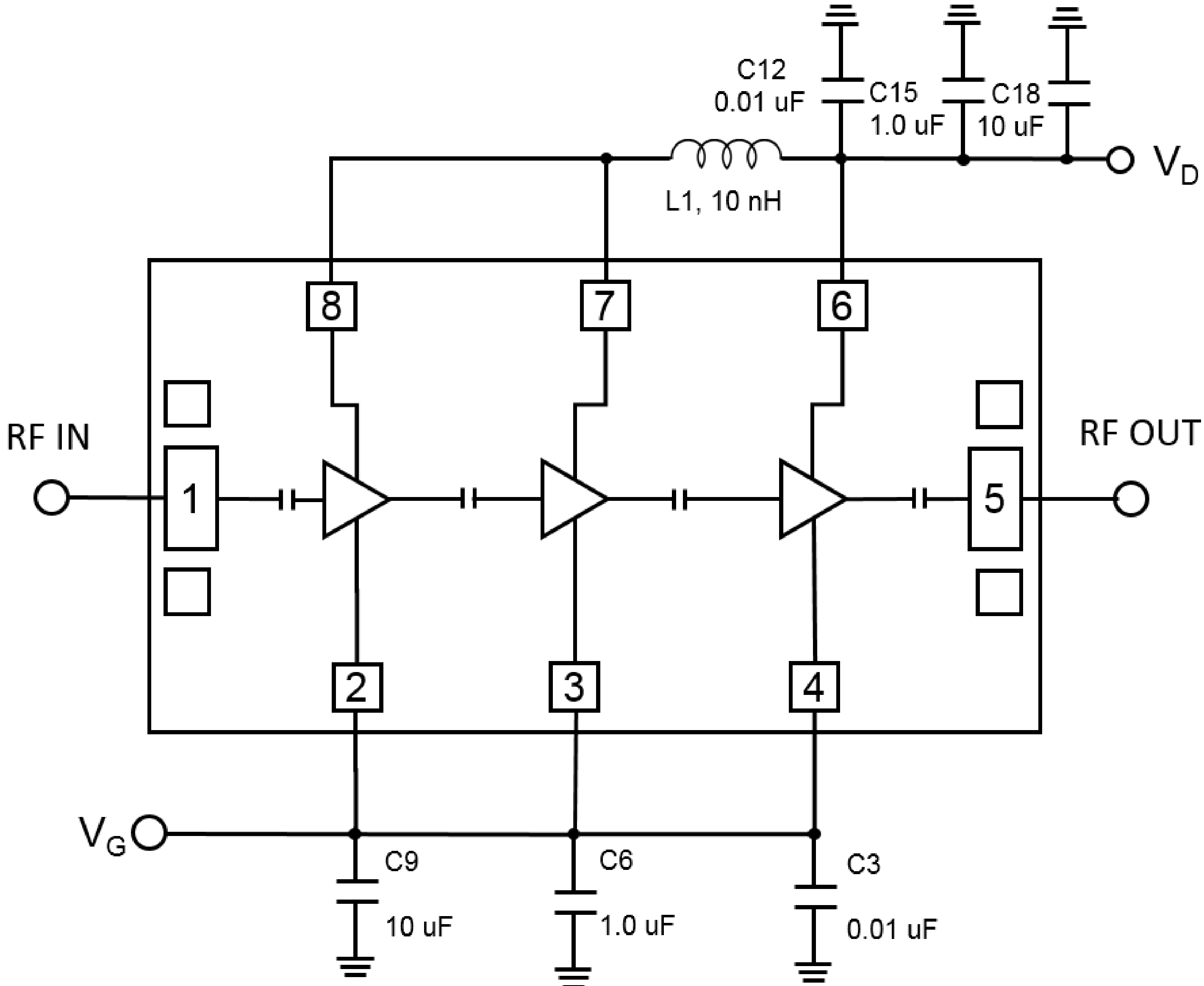
Mounting pad detail

RF Layer is 0.008” thick Rogers Corp. RO4003C (ε_r = 3.35). 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.

Bill of Material – Evaluation Board

Ref. Des.	Value	Description	Manuf.	Part Number
C3, C12	0.01 uF	CAP 0.01UF +/-10% 50V 0402 X7R ROHS	Various	
C6, C15	1.0 uF	CAP 1.0UF +/-10% 16V 0603 X7R ROHS	Various	
C9, C18	10 uF	CAP CER 10UF 10V X7R 10% 0805 TDK ROHS	Various	
L1	10 nH	IND 10 nH 500mA, 0402, 5.5 GHz, + / - 2%	Various	
RF IN, RF OUT	2.92 mm	2.92 MM END LAUNCH CONNECTOR	Southwest Microwave	1092-01A-5

Application Circuit and Biasing Sequence



Notes:
1. Can use separate gate and drain for individual stage controls.

Bias-up Procedure
1. Set I_D limit to 220 mA, I_G limit to 10 mA
2. Set V_G to −1.3 V
3. Set V_D +3.5 V
4. Adjust V_G more positive until I_{DQ} = 105 mA ($V_G \approx$ −0.46 V Typical)
5. Apply RF signal

Bias-down Procedure
1. Turn off RF signal
2. Reduce V_G to −1.3 V. Ensure $I_{DQ} \approx$ 0mA
3. Set V_D to 0V
4. Turn off V_D supply
5. Turn off V_G supply

Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) [1]	T_{base} = 85°C, V_D = 3.5 V, I_{DQ} = 105 mA Quiescent/Small Signal operation, P_{DISS} = 0.37 W	65.0	ºC/W
Channel Temperature, T_{CH} (Under RF)		108.9	°C
Median Lifetime (T_M)		6.7E07	Hrs

Notes:
1. Die mounted to 40 mil CuMo carrier plate with AuSn eutectic. Thermal resistance measured at back of carrier plate.

Median Lifetime

Test Conditions: V_D = +4 V
Failure Criteria is 10% reduction in I_{D_MAX}