QPA0023D

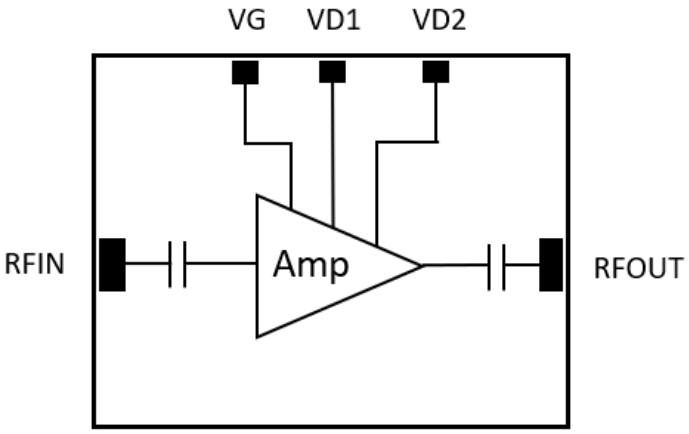
6 – 18 GHz Driver Amplifier

Product Overview

Qorvo's QPA0023D is a high-performance driver amplifier fabricated on Qorvo's production 0.15 um pHEMT process (QPHT15). Covering 6 – 18 GHz, the QPA0023D provides 13.5 dB small signal gain and 30 dBm P1dB with a saturated power of 32 dBm. In addition, the device has low IMD3 level of −40 dBc at Pout = 20 dBm/tone.

QPA0023D is matched to 50 ohms with integrated DC blocking caps on both I/O ports for easy handling and simple system integration. It is an ideal choice for EW and communication systems.

Functional Block Diagram



Key Features

- Frequency Range: 6 – 18 GHz
- Small Signal Gain: 13.5 dB
- P1dB: 30 dBm
- Psat: 32 dBm
- Noise Figure: 5 dB
- IMD3: −40 dBc (typical) (Pout = 20 dBm/tone)
- Bias: VDD = 6 V, IDQ = 400 mA
- Die Dimensions: 2.295 x 2.37 x 0.10 mm

Applications

- Communication Systems
- Radar and Electronic Warfare (EW)
- Instrumentations

Ordering Information

Part No.	Description
QPA0023D	Gel Pack, Qty 50
QPA0023DEVB	Evaluation Board, Qty 1

Absolute Maximum Ratings

Parameter	Min Values	Max Values	Units
Drain Voltage (VDD1, VDD2)	-1.4	6.5	V
Drain Current (VDD1)	-	190	mA
Drain Current (VDD2)	-	760	mA
Gate Control Voltage (VGG)	-2.0	0	V
Gate Current (VGG)	-	10	mA
RF Input Power (85 °C, 50 Ω)	-	27	dBm
RF Input Power (85 °C, Output VSWR 3:1)	-	24	dBm
Channel Temperature, T_{CH}	-	150	°C
Mounting Temperature (30 seconds)	-	320	°C
Storage Temperature	-55	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	Value	Units
Drain Voltage (VDD1, VDD2)	6.0	V
Drain Current (VDD1, VDD2 Total)	400	mA
Gate Voltage (VGG, typical)	−0.5	V
Operating Temperature Range	−55 to 85	°C

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

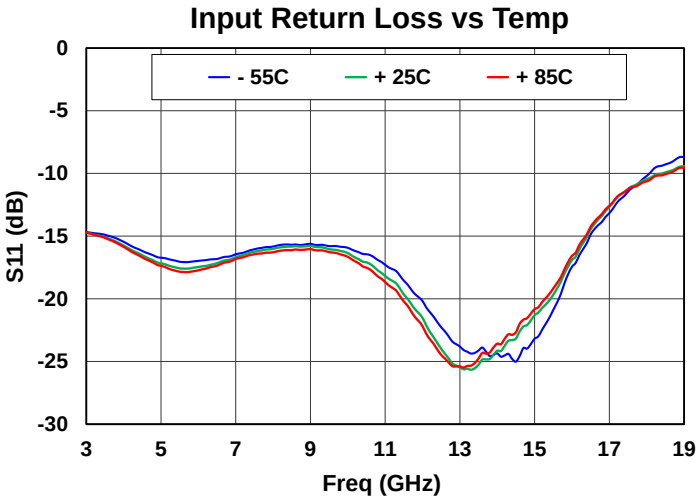
Electrical Specifications

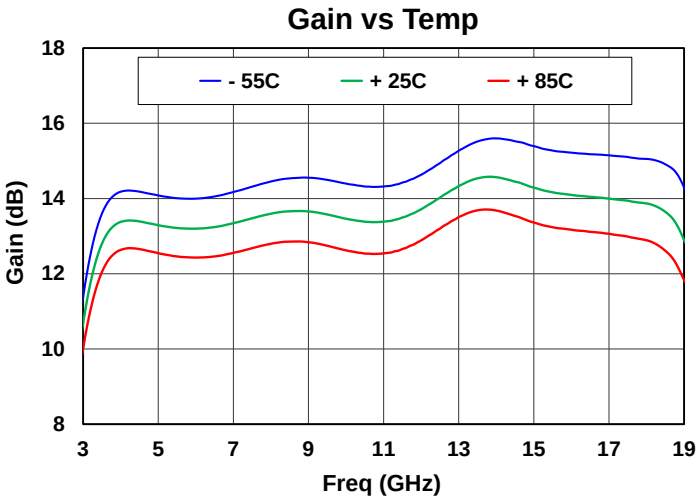
Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, Temp. = +25 °C.
Data de-embedded of fixture losses, data included bond wire effects.

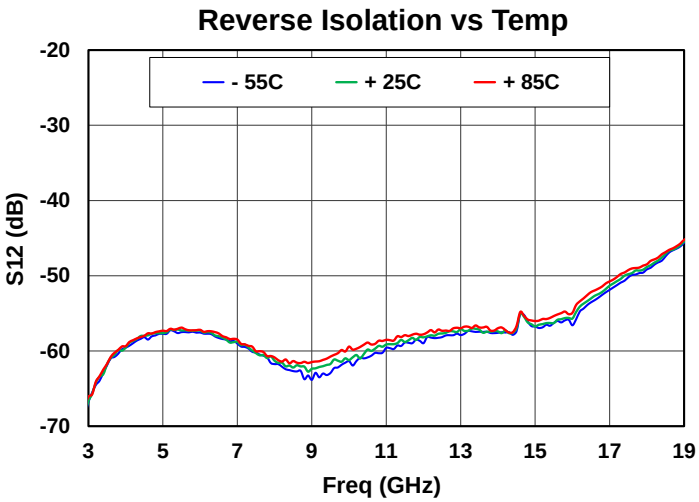
Parameter	Min	Typ	Max	Units
Operating Frequency	6		18	GHz
Small Signal Gain		13.5		dB
Input Return Loss		14.0		dB
Output Return Loss		13.0		dB
1-dB Compression Point		30		dBm
Psat (@ 22 dBm Pin)		32		dBm
3RD Order Intermodulation Level (Pout = 20 dBm / Tone)		−40		dBc
Noise Figure		5		dB
Gain (S21) Temperature Coefficient		−0.0127		dB/°C

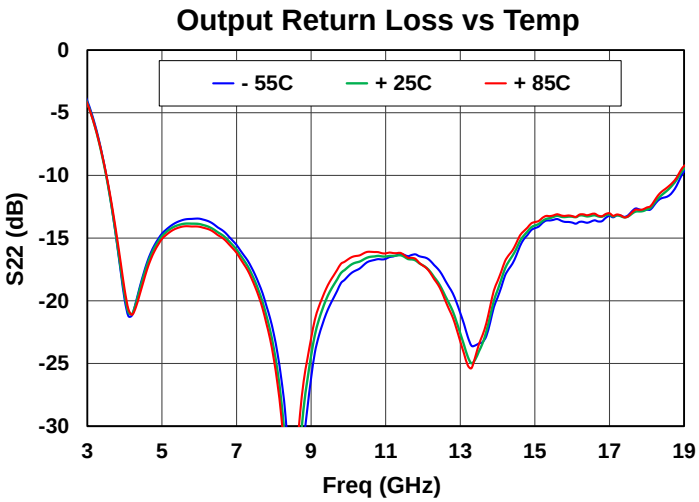
Performance Plots – Small Signal

Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, Temp. = +25 °C.





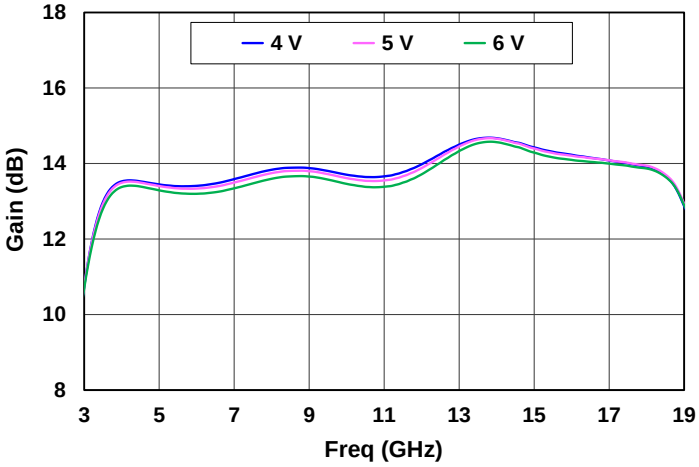




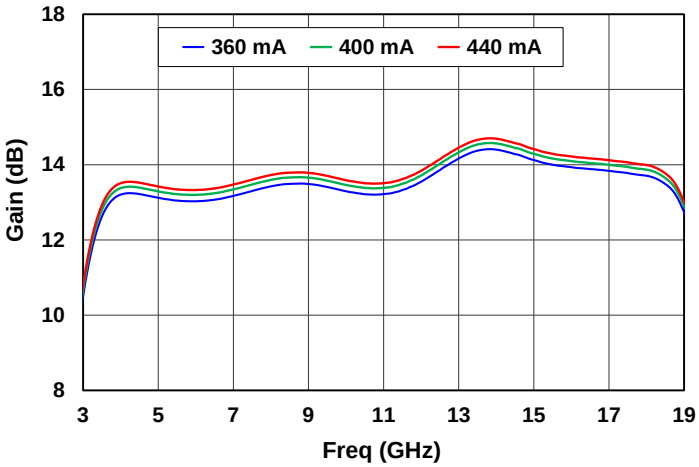
Performance Plots – Small Signal

Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, Temp. = +25 °C.

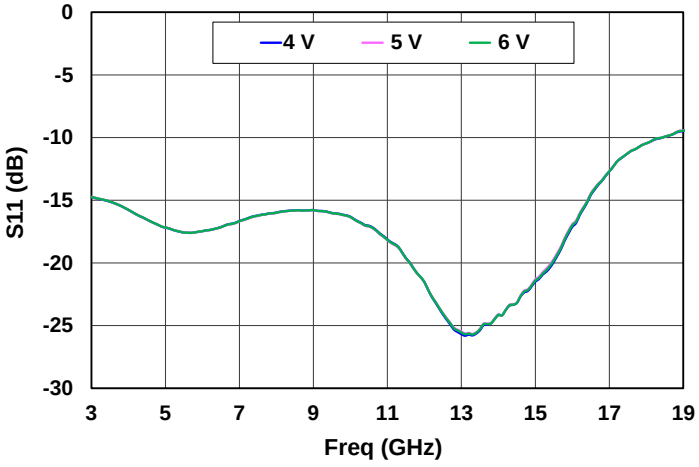
Gain vs Voltage



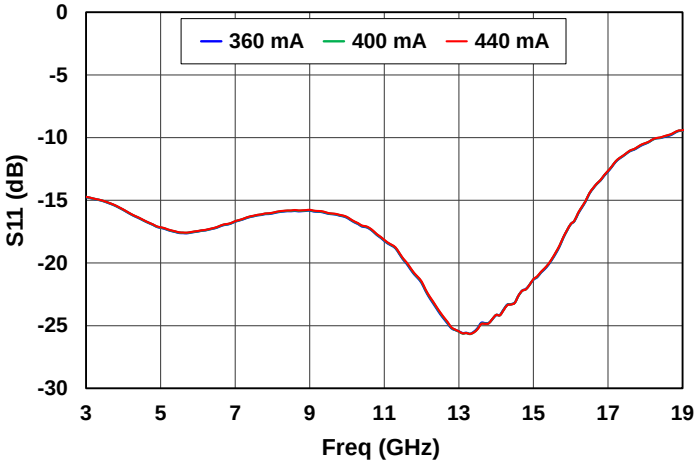
Gain vs Current



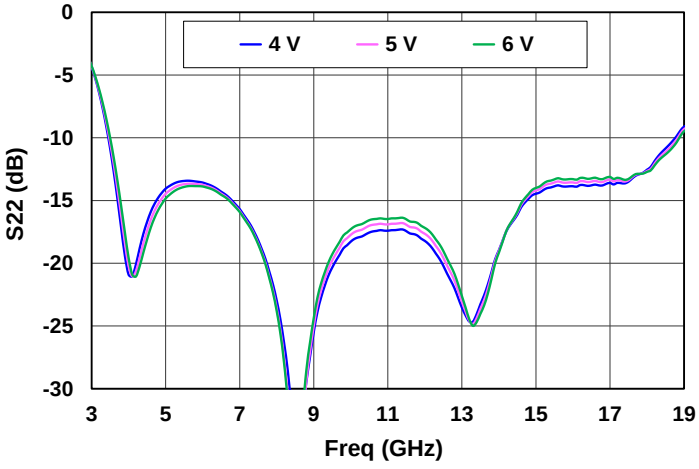
Input Return Loss vs Voltage



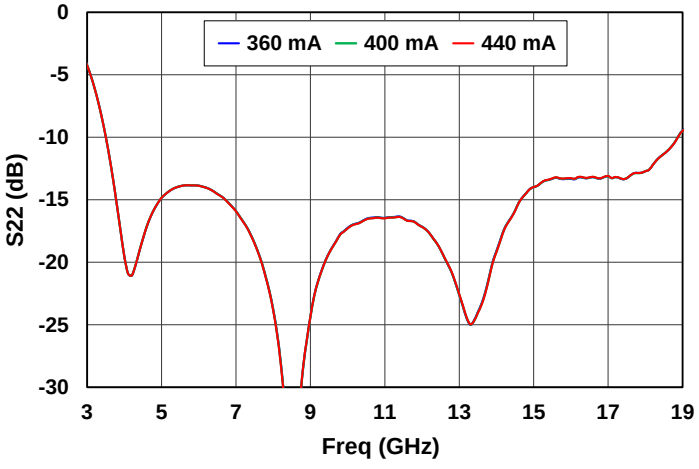
Input Return Loss vs Current



Output Return Loss vs Voltage

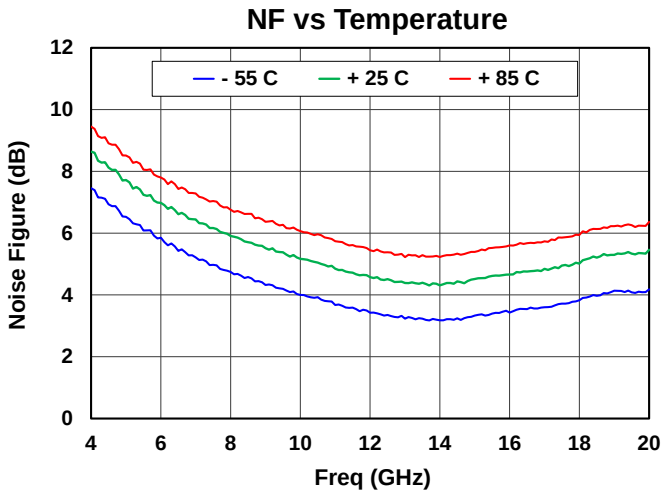


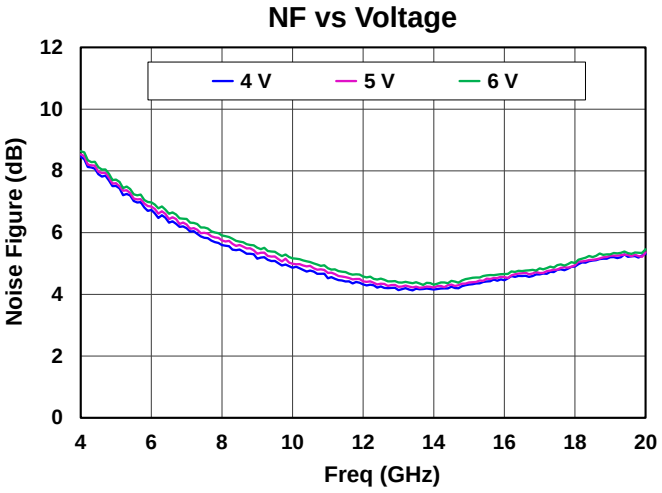
Output Return Loss vs Current

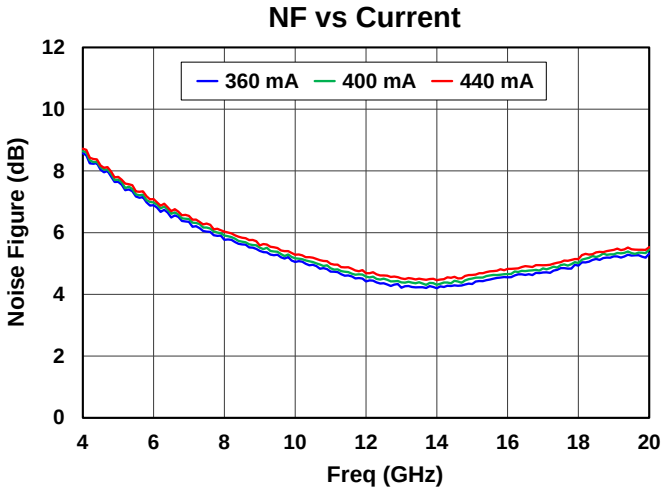


Performance Plots – Noise Figure

Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, Temp. = +25 °C.



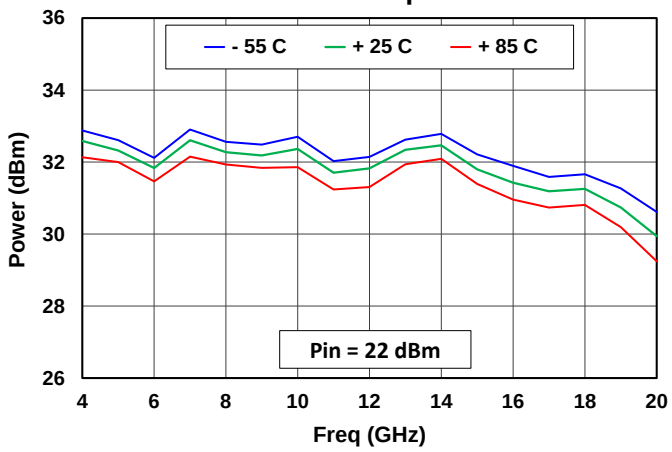




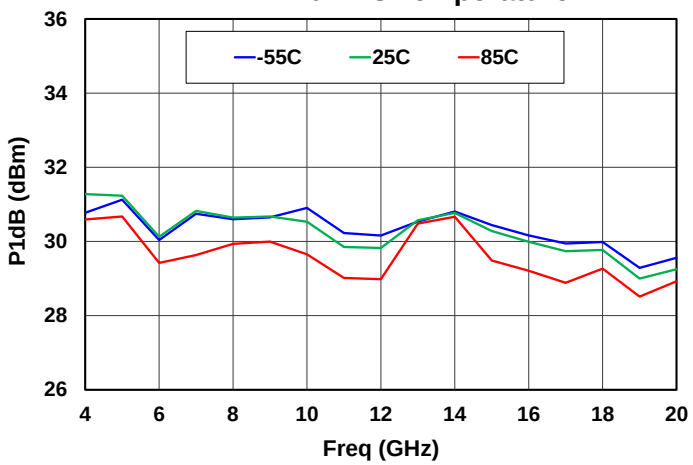
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, 25 °C

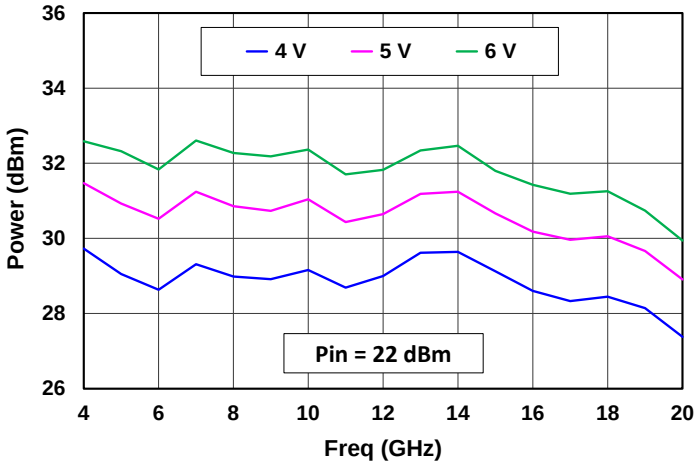
Power vs Temperature



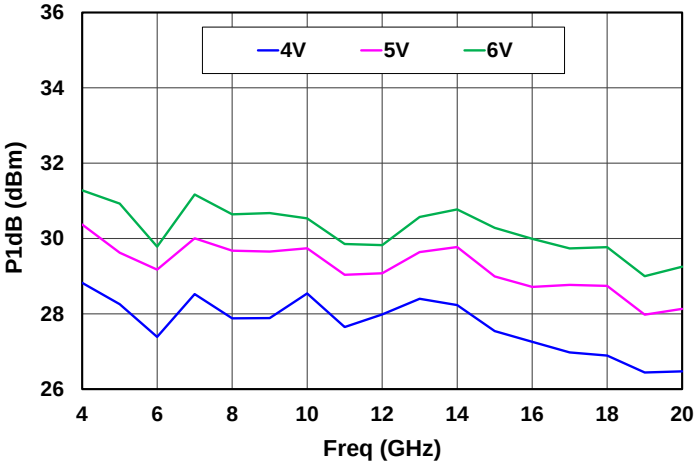
P1dB vs Temperature



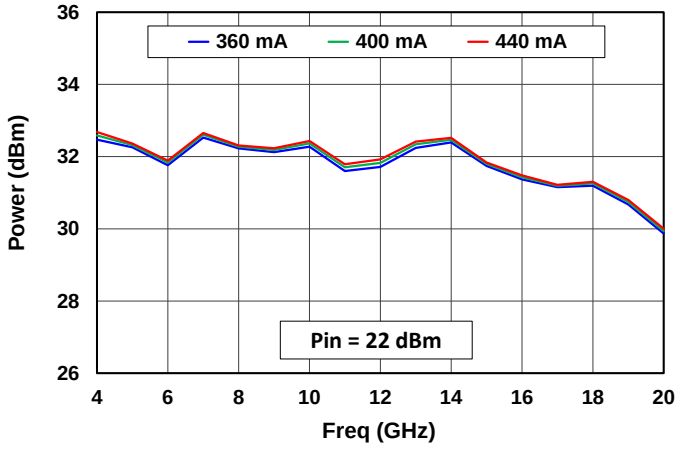
Power vs Voltage



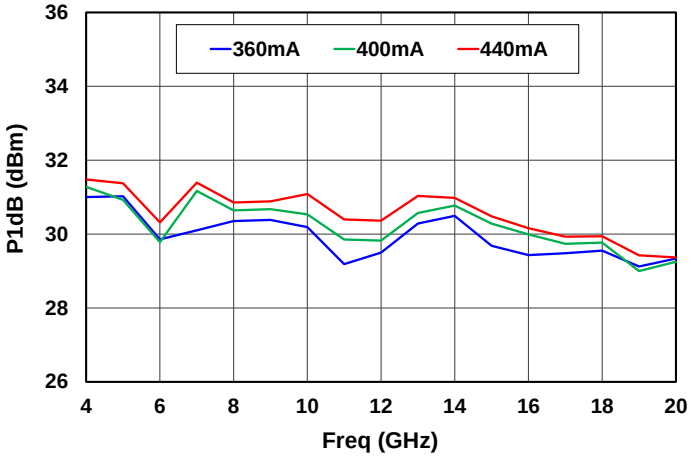
P1dB vs Voltage



Power vs Current



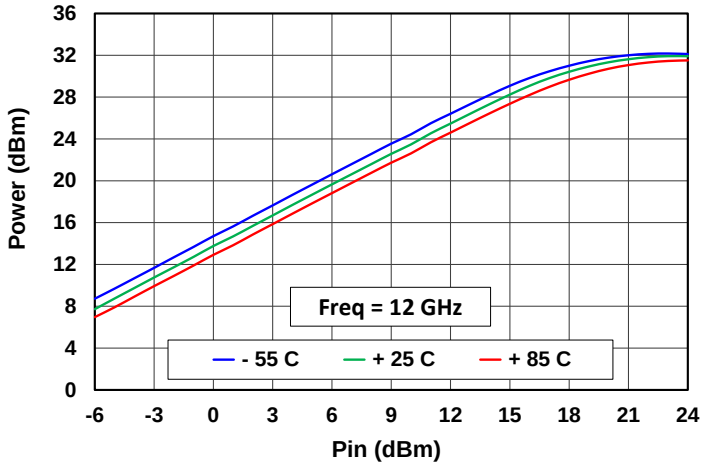
P1dB vs Current



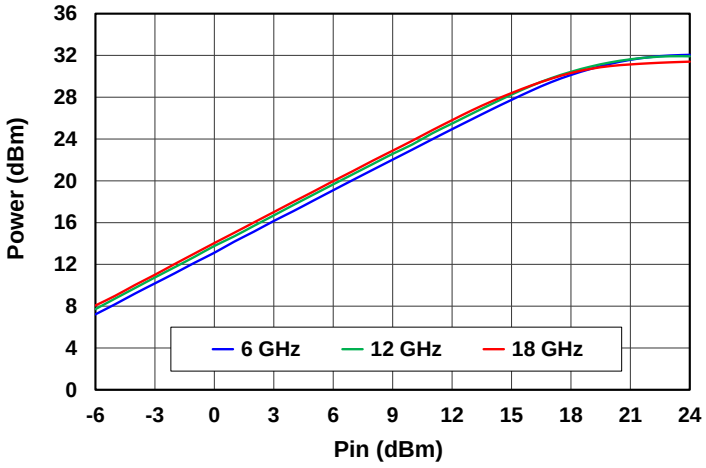
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = 6 V, IDQ = 400 mA, +25 °C

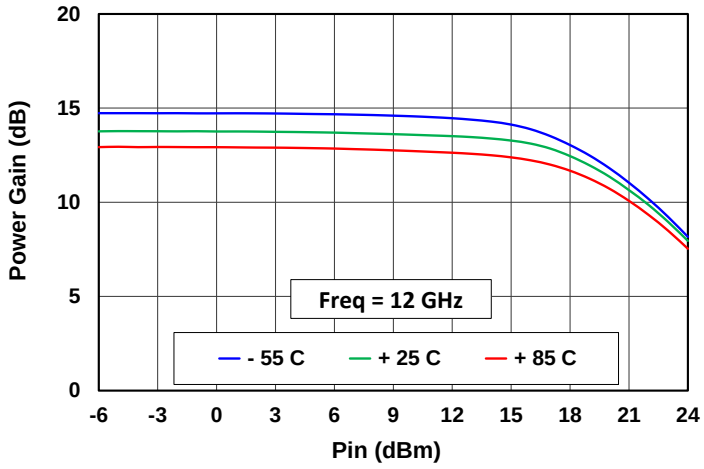
Power vs Pin vs Temp



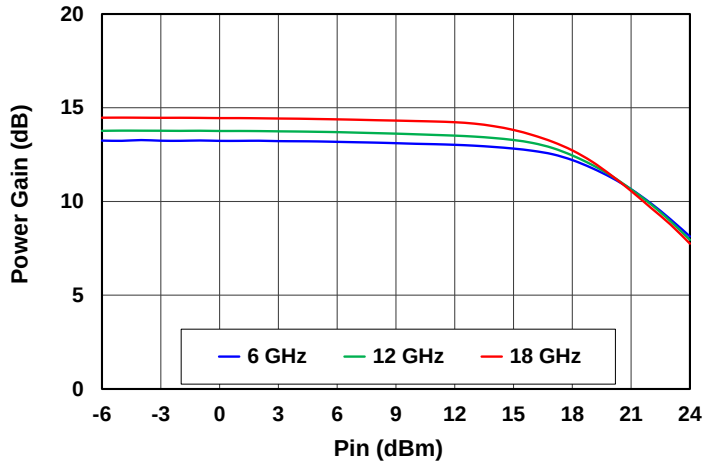
Power vs Pin



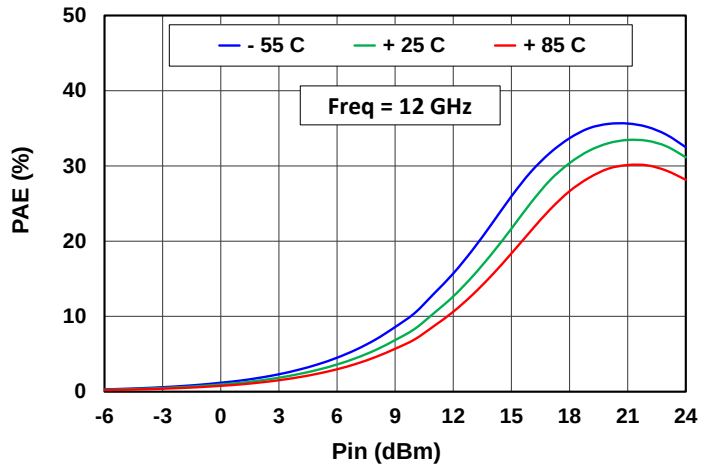
Power Gain vs Pin vs Temp



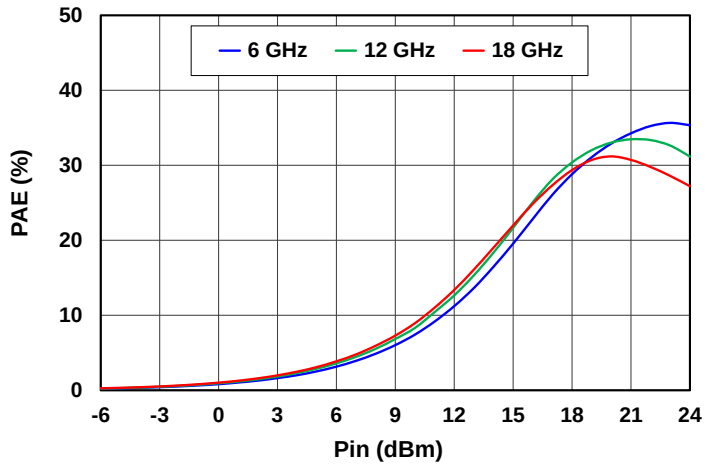
Power Gain vs Pin



PAE vs Pin vs Temp



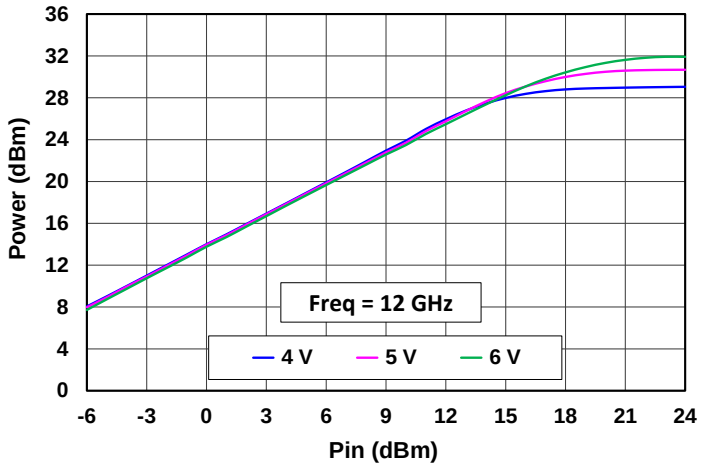
PAE vs Pin



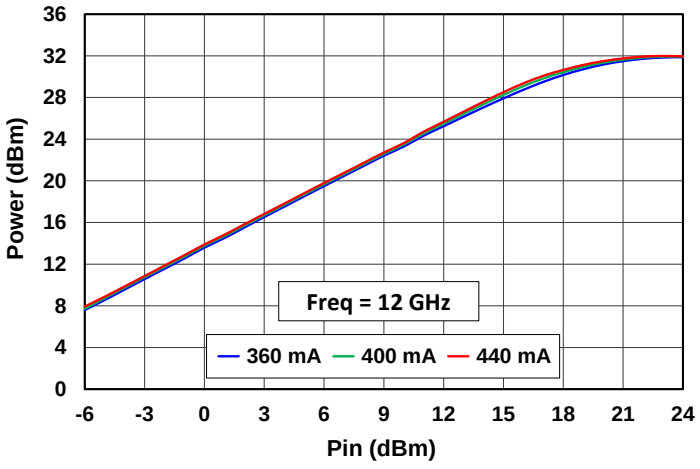
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = 6 V, IDQ = 400 mA, +25 °C

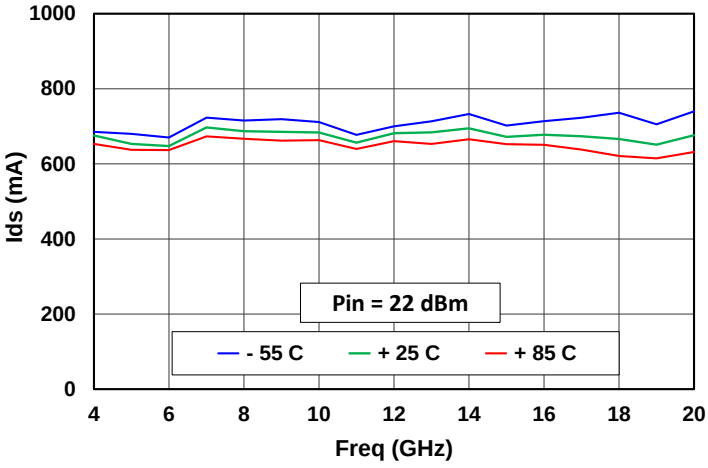
Power vs Pin vs Voltage



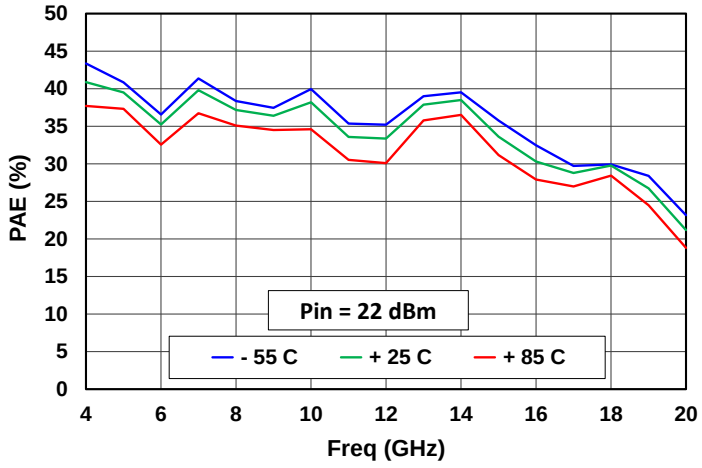
Power vs Pin vs Voltage



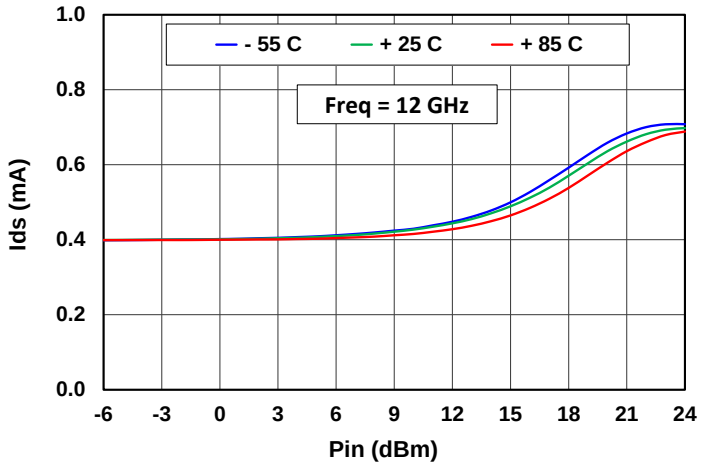
Drain Current vs Temperature



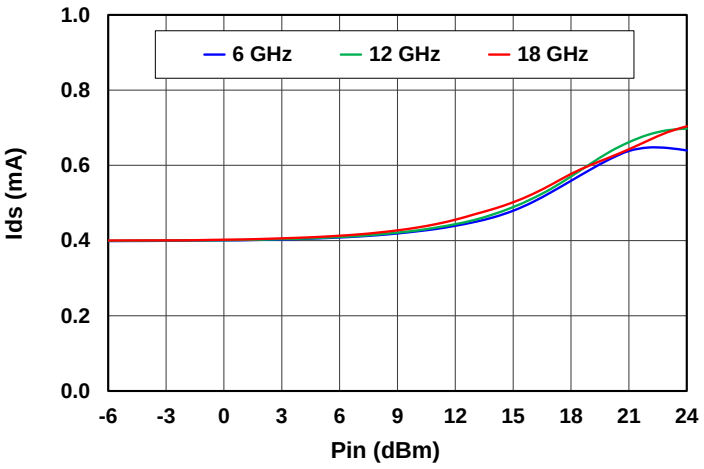
PAE vs Temperature



Current vs Pin vs Temp



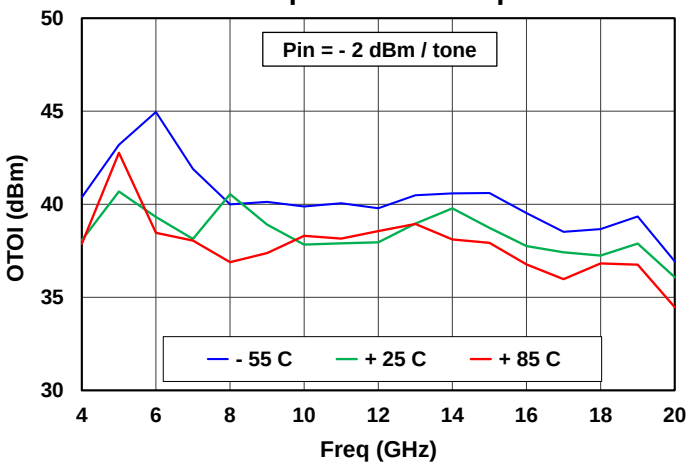
Drain Current vs Pin



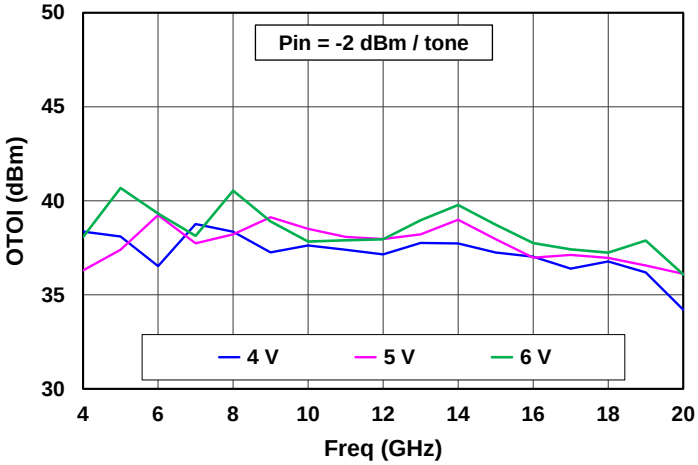
Performance Plots – Linearity

Test conditions unless otherwise noted: VDD = +6 V, IDQ = 400 mA, Δf = 1 MHz, 25 °C.

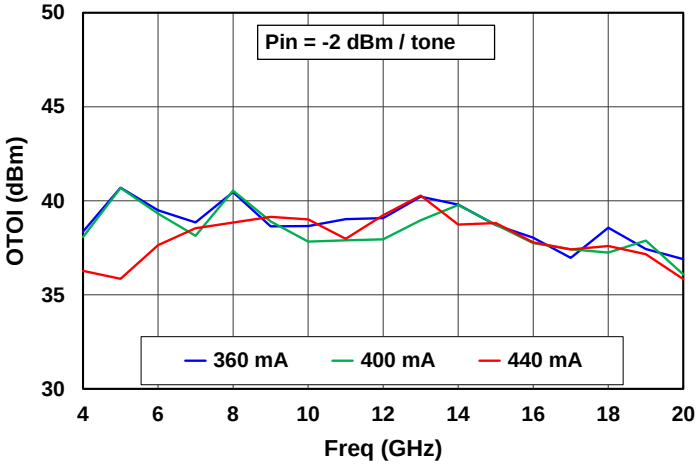
Output TOI vs Temp



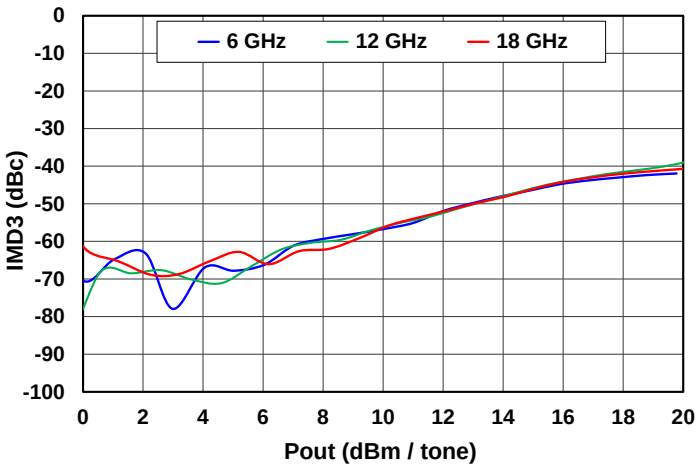
Output TOI vs Voltage



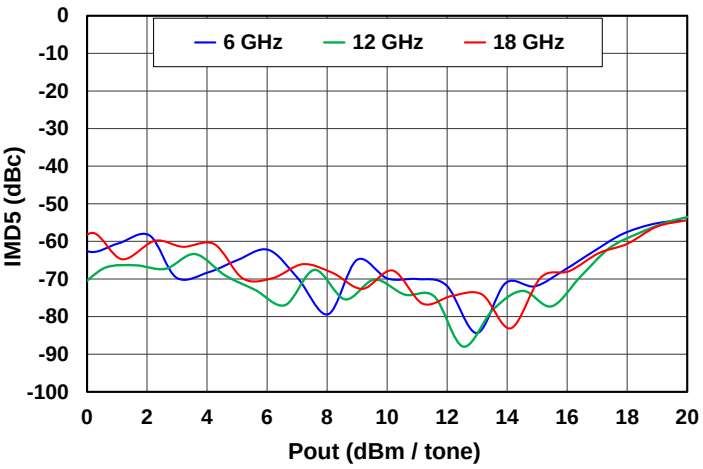
Output TOI vs Current



IMD3 vs Pout

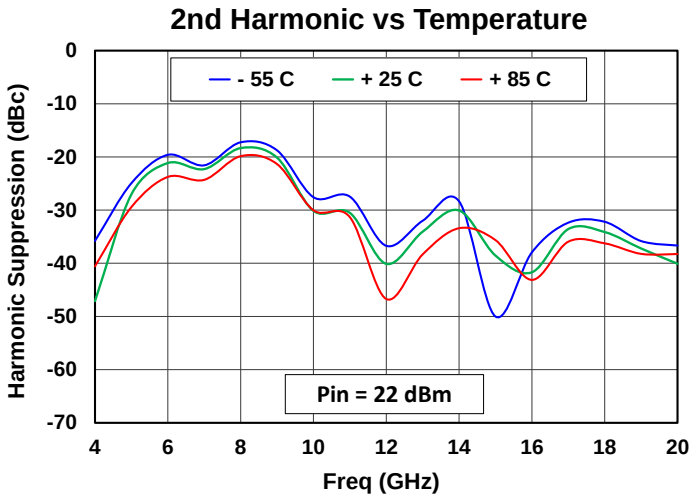


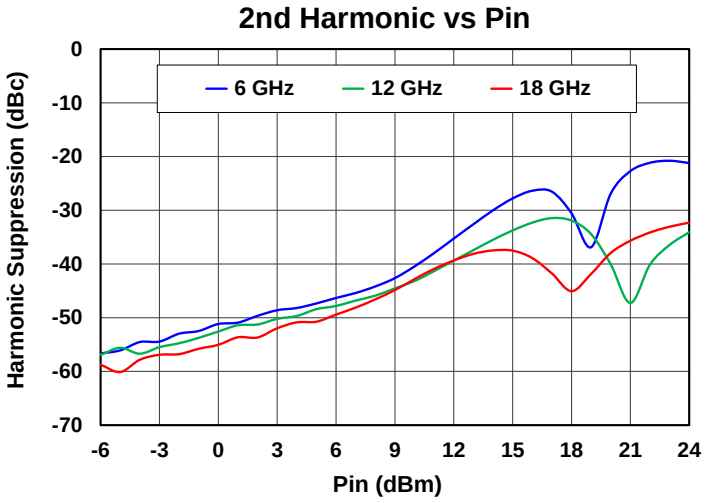
IMD5 vs Pout

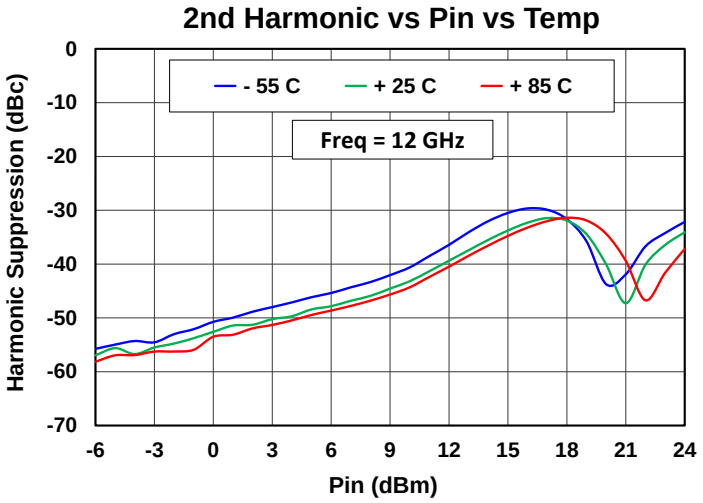


Performance Plots – Harmonics

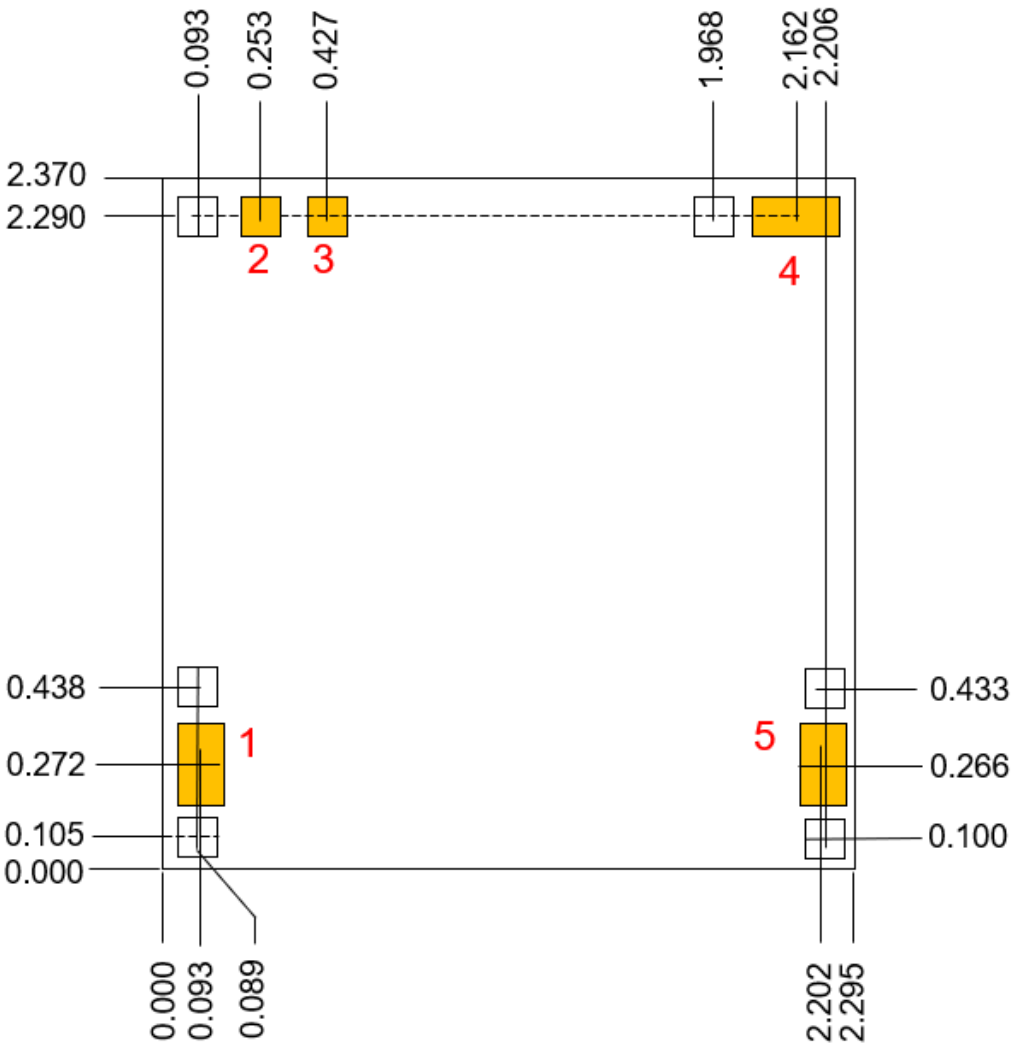
Test conditions unless otherwise noted: VDD = + 6 V, IDQ = 400 mA, 25 °C.







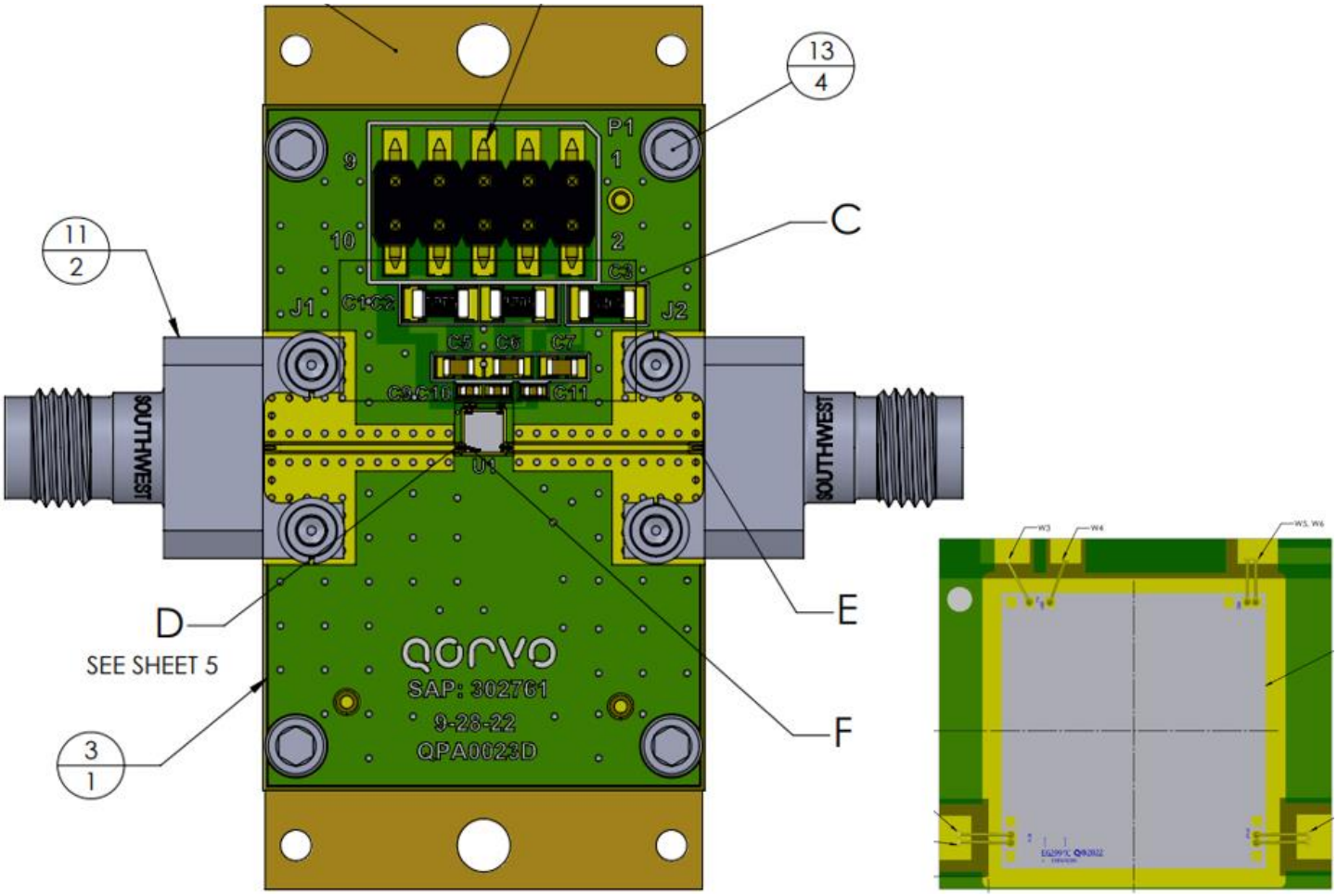
Mechanical Drawing and Bond Pad Description



Unit: millimeters
Die x, y size tolerance: +/- 0.010, die thickness: 0.10
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	82 x 132	Matched to 50 ohms, DC blocked
2	VGG	82 x 82	Gate Control
3	VDD1	82 x 82	Stage 1 Drain Supply Stage
4	VDD2	163 x 82	Stage 2 Drain Supply Stage
5	RF Output	82 x 132	Matched to 50 ohms, DC blocked

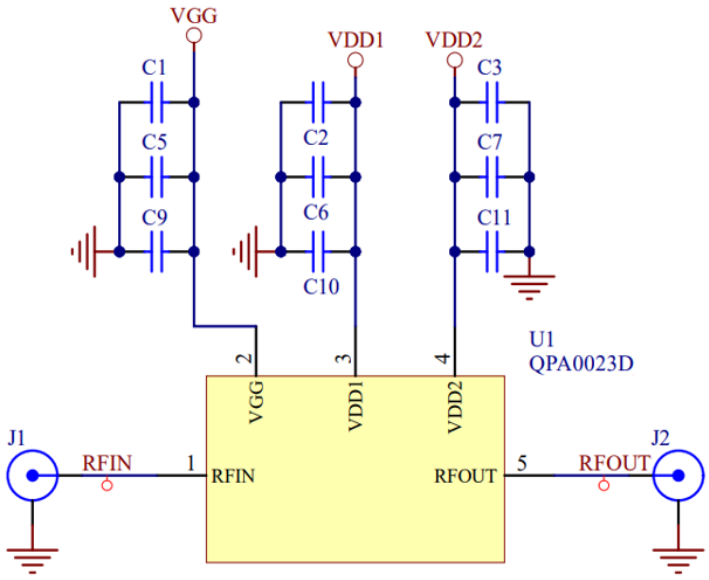
Evaluation Board and BOM



RF Layer is 0.01” thick Rogers Corp. RO4350 (ε_r = 3.48). 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. PCB level tuning at input side is recommended for optimal performance.

Bias-up Procedure	Bias-down Procedure
1. Set VDD current limit to 1000 mA (Total, VDD1 and VDD2 can be tied together), Set VGG current limit to 10 mA	1. Turn off RF signal
2. Set VGG to −2.0 V	2. Reduce VGG to −2.0 V. Ensure IDQ ≈ 0mA
3. Set VDD (VDD1 and VDD2) to +6 V	3. Set VDD1 and VDD2 to 0V
4. Adjust VGG more positive until IDQ = 400 mA total (VGG ≈ −0.5 V Typical)	4. Turn off VDD1 and VDD2 supply
5. Apply RF signal	5. Turn off VGG supply

Application Circuit and Biasing Sequence



Bill of Material – Evaluation Board

Ref. Des.	Value	Description	Manuf.	Part Number
C1, C2, C3	4.7 uF	CAP 4.7uF +/-10% 16V 1206 X7R	Various	
C9, C10, C11	0.01 uF	CAP 0.01uF +/-10% 16V 0402 X7R	Various	
RF IN, RF OUT	2.92 mm	2.92 MM End Launch Connector	Southwest Microwave	1092-01A-12

Note 1. Components (Capacitors, Resistors and Inductors not shown in the BOM list are not populated.

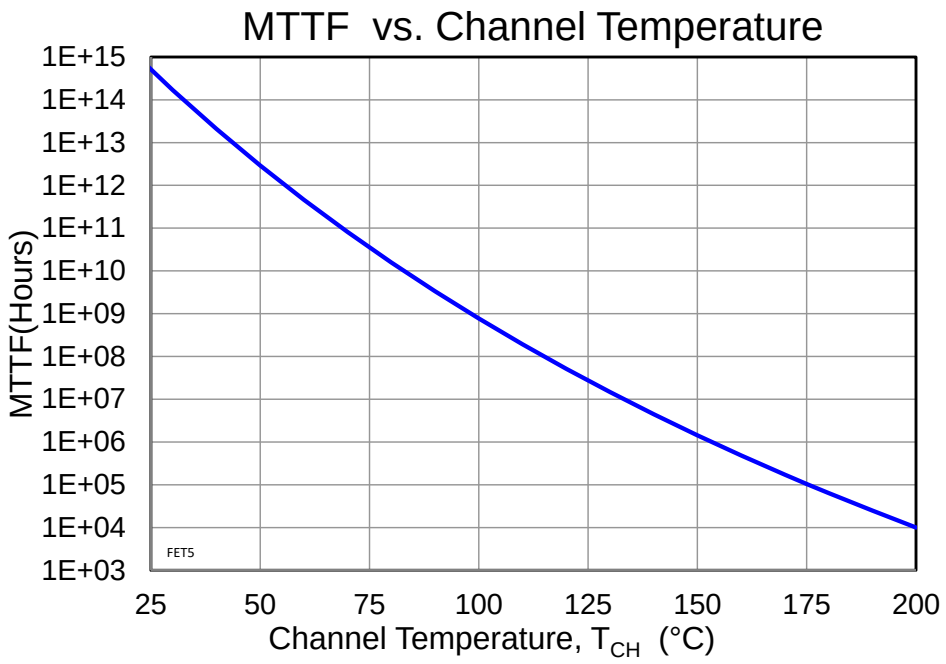
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85°C, VDD = 6 V, I_{DQ} = 400 mA Quiescent/Small Signal operation, P_{DISS} = 2.4 W	22.97	ºC/W
Channel Temperature, T_{CH} (Under RF)		140.14	°C
Median Lifetime (T_M)		4.4E06	Hrs
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85°C, VDD = 6 V, I_{DQ} = 400 mA CW, Pin = 16.67 dBm, Pout = 29.02 dBm, Freq = 15 GHz (worst case), Ids = 542 mA, P_{DISS} = 2.50 W (P1dB condition)	28.46	ºC/W
Channel Temperature, T_{CH} (Under RF)		156.15	°C
Median Lifetime (T_M)		7.3E05	Hrs

Notes:
1. Die mounted to 20 mil CuMo carrier plate with AuSn eutectic. Thermal resistance referenced to the bottom of the carrier plate.

Median Lifetime

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



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.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1A	ESDA / JEDEC JS-001-2012

Caution!
ESD-Sensitive Device

RoHS Compliance

This part is compliant with 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:

Tel: **1-844-890-8163**

Web: www.qorvo.com

Email: customer.support@qorvo.com

Important Notice

The information contained in this Data Sheet and any associated documents (“Data Sheet Information”) is believed to be reliable; however, Qorvo makes no warranties regarding the Data Sheet Information and assumes no responsibility or liability whatsoever for the use of said information. All Data Sheet Information is subject to change without notice. Customers should obtain and verify the latest relevant Data Sheet Information before placing orders for Qorvo® products. Data Sheet Information or the use thereof does not grant, explicitly, implicitly or otherwise any rights or licenses to any third party with respect to patents or any other intellectual property whether with regard to such Data Sheet Information itself or anything described by such information.

DATA SHEET INFORMATION DOES NOT CONSTITUTE A WARRANTY WITH RESPECT TO THE PRODUCTS DESCRIBED HEREIN, AND QORVO HEREBY DISCLAIMS ANY AND ALL WARRANTIES WITH RESPECT TO SUCH PRODUCTS WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Without limiting the generality of the foregoing, Qorvo® products are not warranted or authorized for use as critical components in medical, life-saving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death. Applications described in the Data Sheet Information are for illustrative purposes only. Customers are responsible for validating that a particular product described in the Data Sheet Information is suitable for use in a particular application.