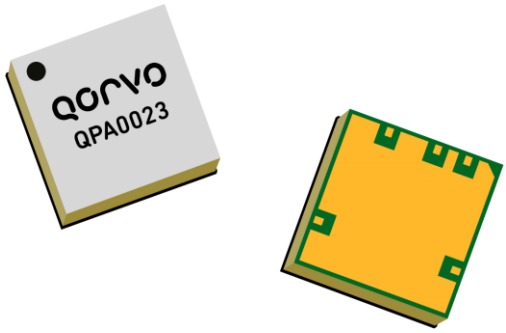
QPA0023

6 – 18 GHz Driver Amplifier

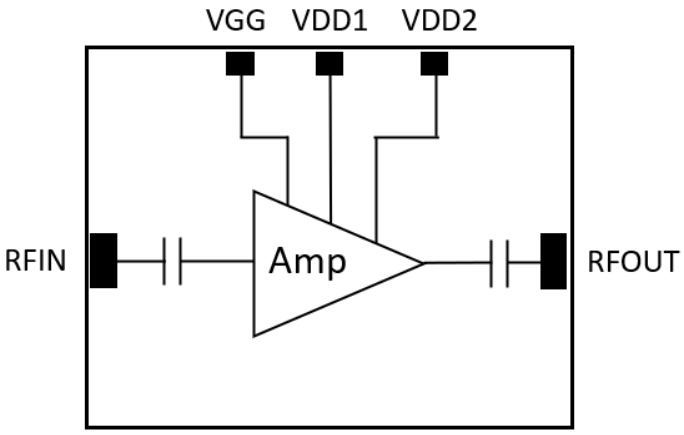
Product Overview

Qorvo's QPA0023 is a high-performance driver amplifier fabricated on Qorvo's production 0.15 um pHEMT process (QPHT15). Covering 6 – 18 GHz, the QPA0023 provides 14 dB small signal gain and 29 dBm P1dB and saturated power of 30 dBm. In addition, the device can provide low IMD3 level of −42 dBc at Pout = 20 dBm/tone.

QPA0023 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: 14 dB
- P1dB: 29 dBm
- Psat: 30 dBm
- Positive Gain Slope
- Gain Flatness < +/- 1dB
- IMD3: −42 dBc (typical) (Pout = 20 dBm/tone)
- Bias: VD = 5 V, IDQ = 400 mA
- Die Dimensions: 4.5 x 4.5 x 1.62 mm

Applications

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

Ordering Information

Part No.	Description
QPA0023SR	Tape & Reel, 7 ″, Qty 100
QPA0023TR7	Tape & Reel, 7 ″, Qty 500
QPA0023EVB	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
Mounting Temperature (30 seconds)	-	260	°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 [1]

Parameter	Value	Units
Drain Voltage (VDD1, VDD2)	5.0	V
Drain Current (VDD1, VDD2 Total)	400	mA
Gate Voltage (VGG, typical) [2]	Vary	V
Operating Temperature Range	−55 to 85	°C

1. Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.
2. Gate bias voltage may vary among manufacturing lots, typical value is -0.5V, consult Qorvo Supports if used for large quantity applications.

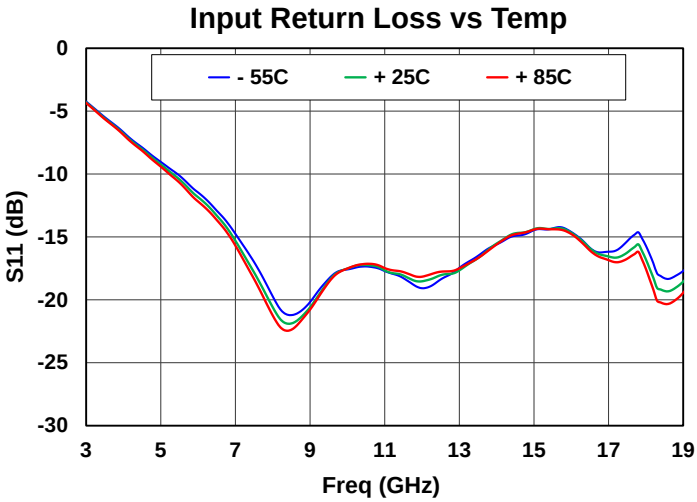
Electrical Specifications

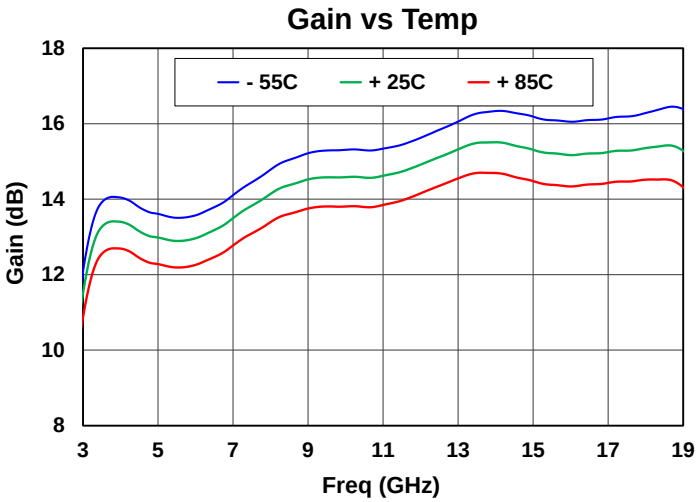
Test conditions unless otherwise noted: VDD = +5 V, IDQ = 400 mA, Temp. = +25 °C. Data de-embedded of fixture losses

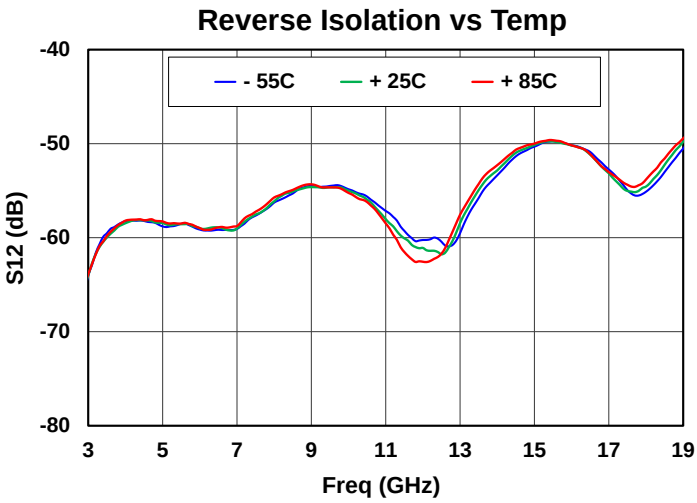
Parameter	Min	Typ	Max	Units
Operating Frequency	6		18	GHz
Small Signal Gain		14		dB
Input Return Loss		14.0		dB
Output Return Loss		15.0		dB
Power at 1-dB Compression Point		29		dBm
Psat (@ 20 dBm Pin)		30		dBm
3RD Order Intermodulation Level (P_{OUT} = 20 dBm / Tone)		−42		dBc
Noise Figure		5		dB
Gain (S21) Temperature Coefficient		−0.0127		dB/°C

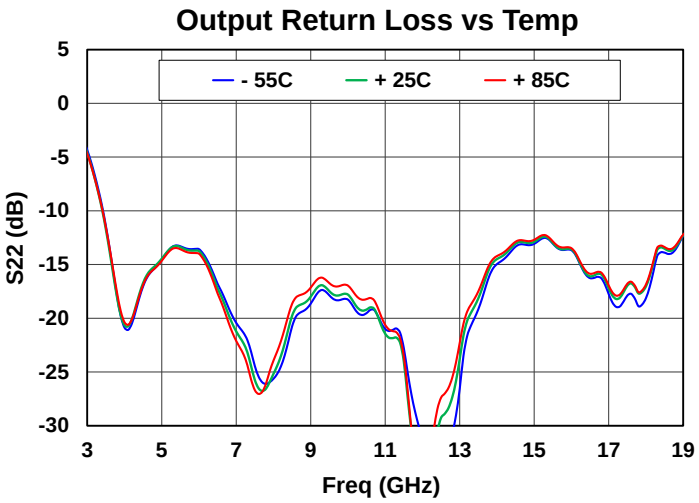
Performance Plots – Small Signal

Test conditions unless otherwise noted: VDD = +5V, IDQ = 400 mA, Temp. = +25 °C.





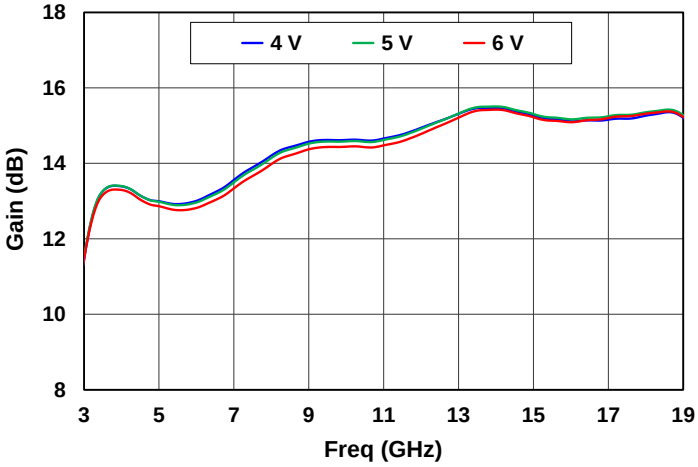




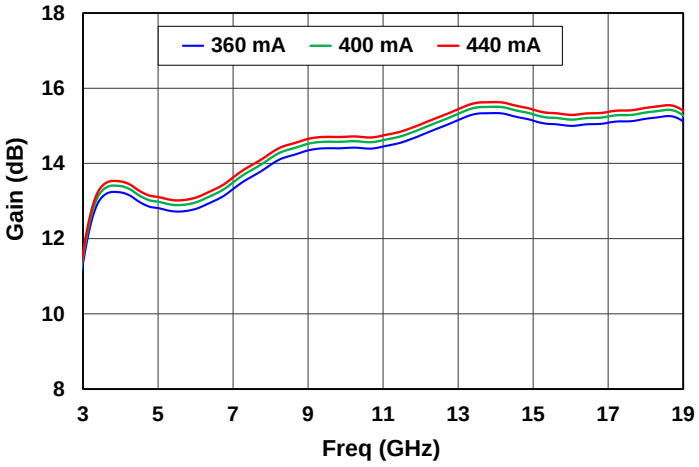
Performance Plots – Small Signal

Test conditions unless otherwise noted: VDD = +5 V, IDQ = 400 mA, Temp. = +25 °C.

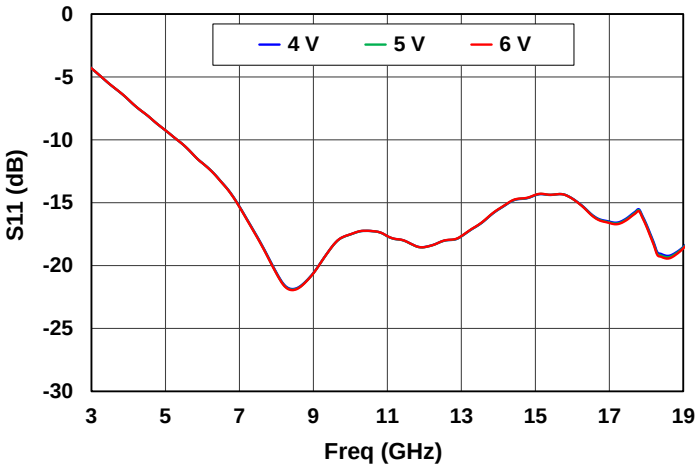
Gain vs Voltage



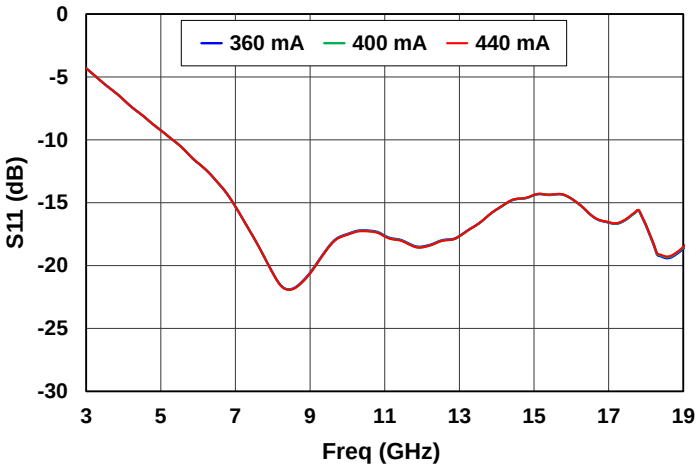
Gain vs Current



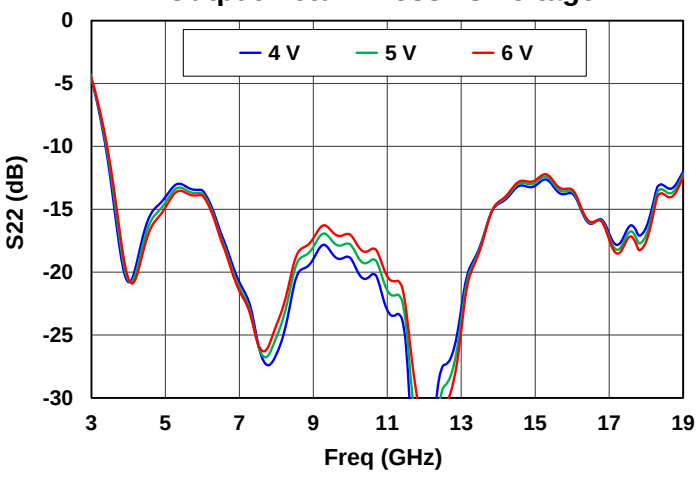
Input Return Loss vs Voltage



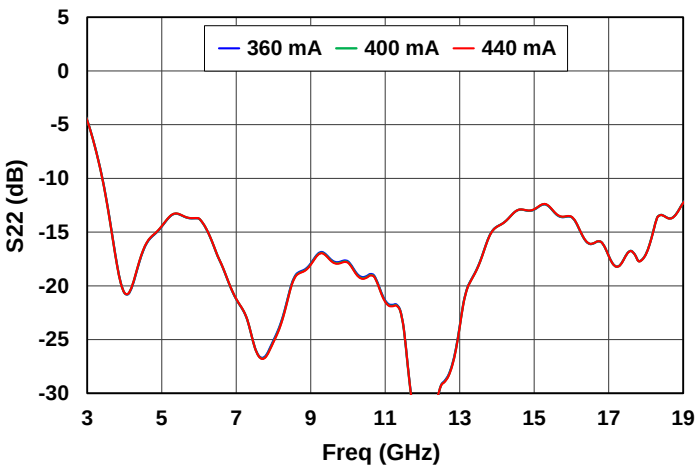
Input Return Loss vs Current



Output Return Loss vs Voltage

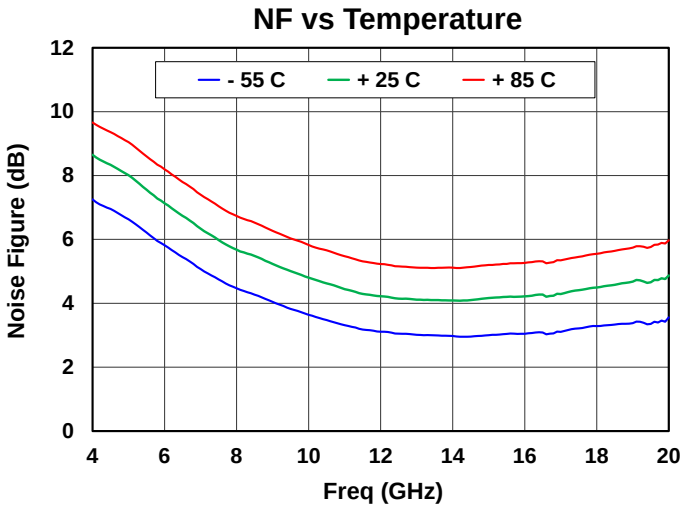


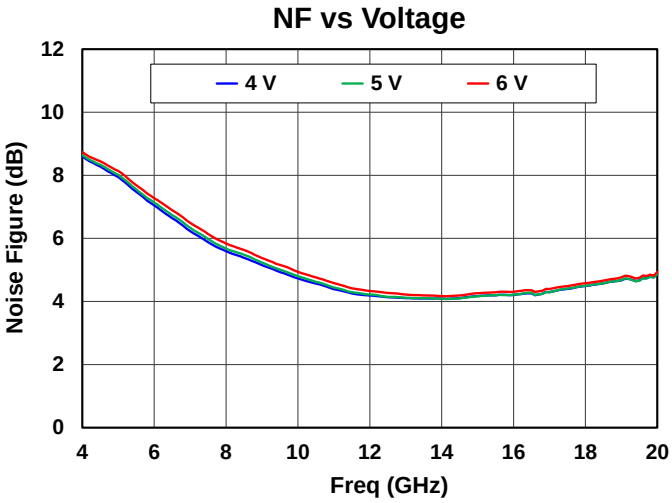
Output Return Loss vs Current

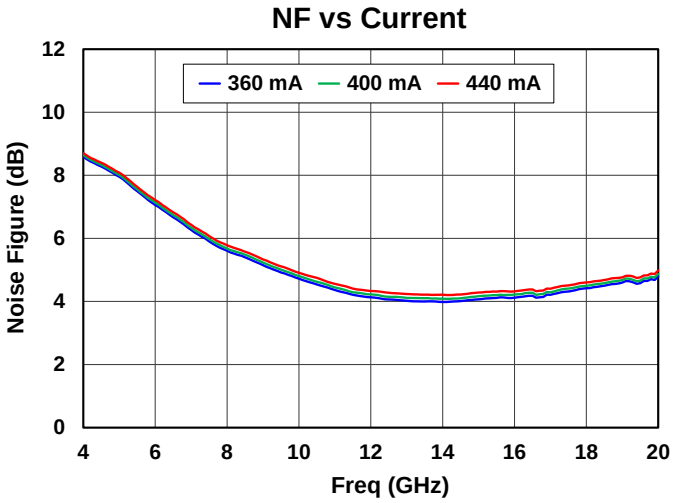


Performance Plots – Noise Figure

Test conditions unless otherwise noted: VDD = +5 V, IDQ = 400 mA, Temp. = +25 °C.



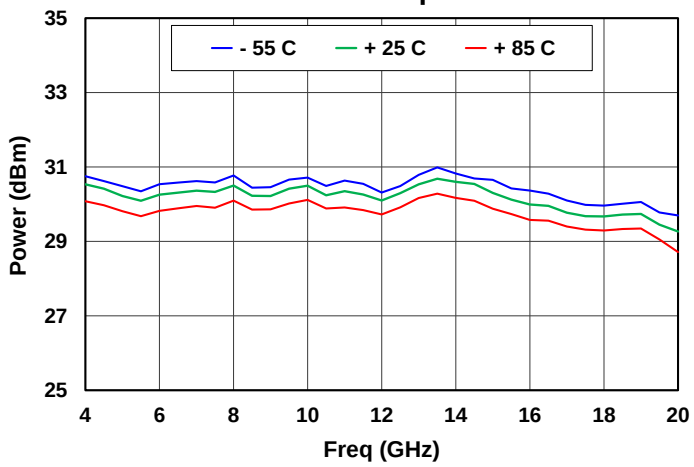




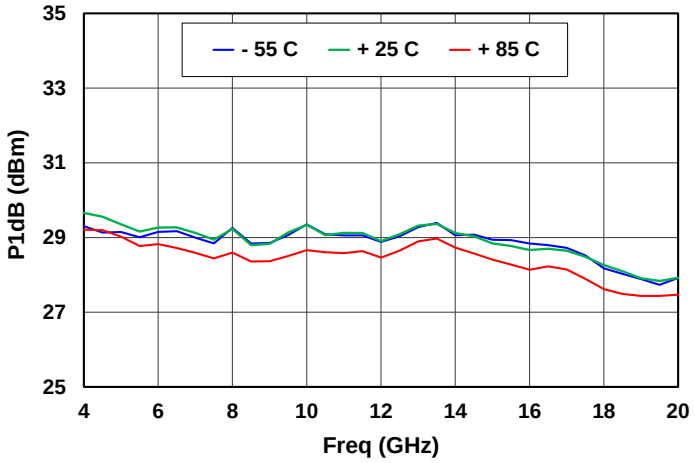
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = +5 V, IDQ = 400 mA, Pin = 20 dBm, 25 °C

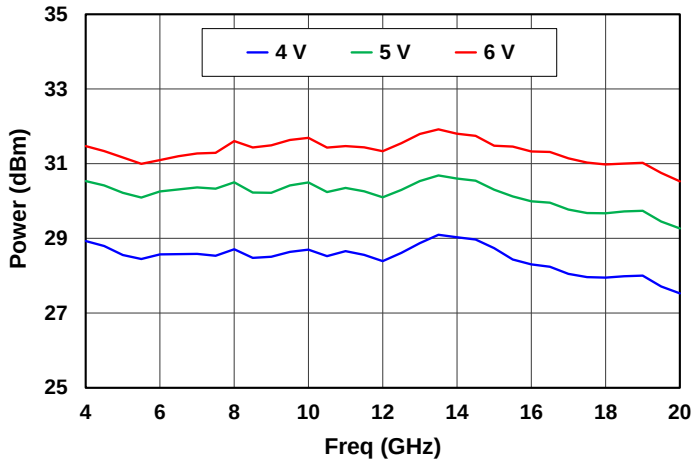
Power vs Temperature



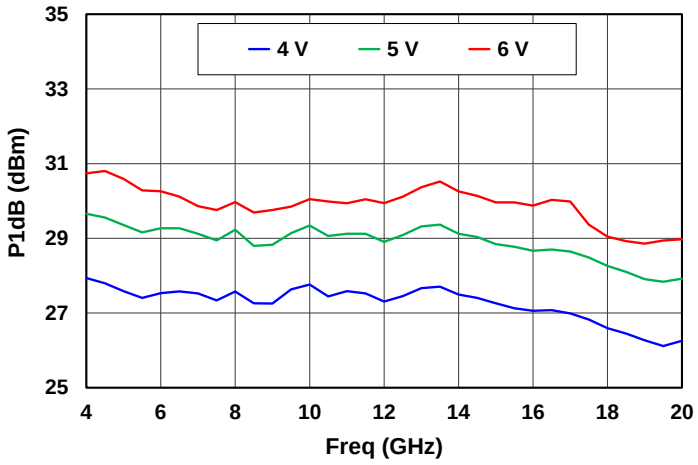
P1dB vs Temperature



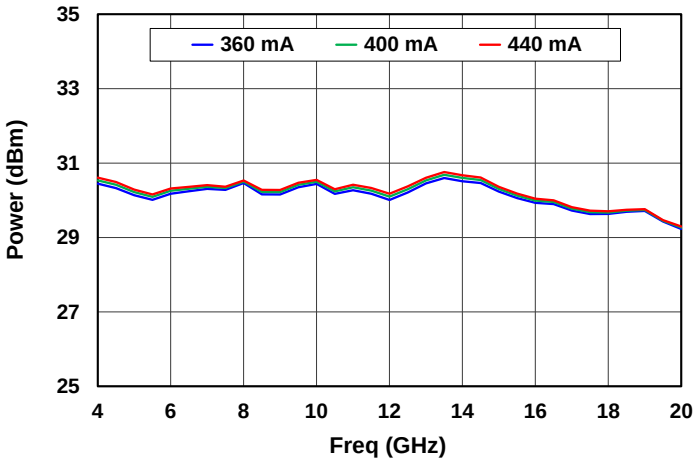
Power vs Voltage



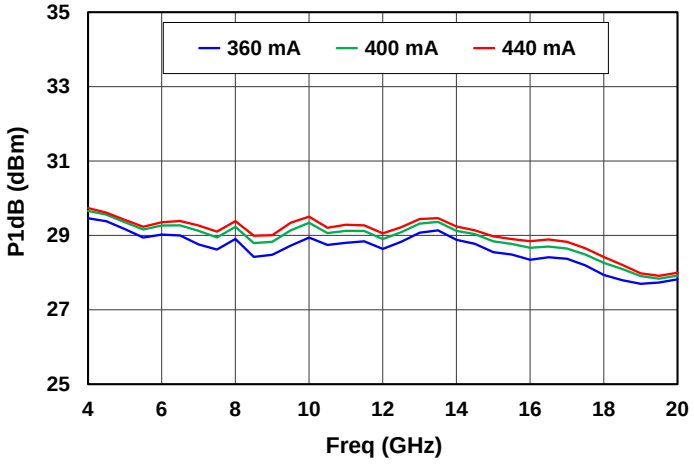
P1dB vs Voltage



Power vs Current



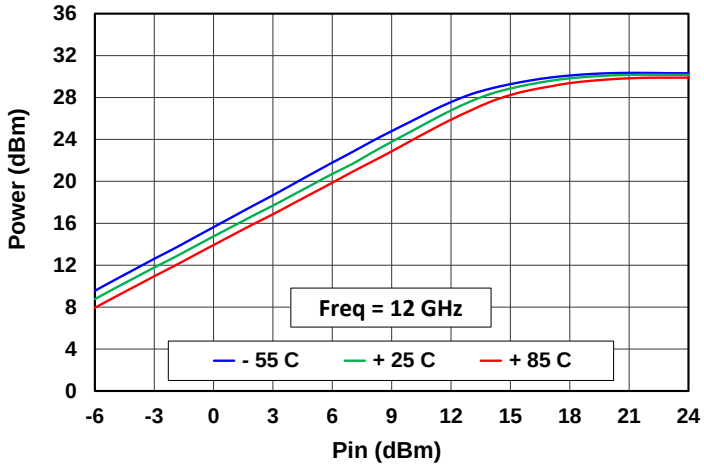
P1dB vs Current



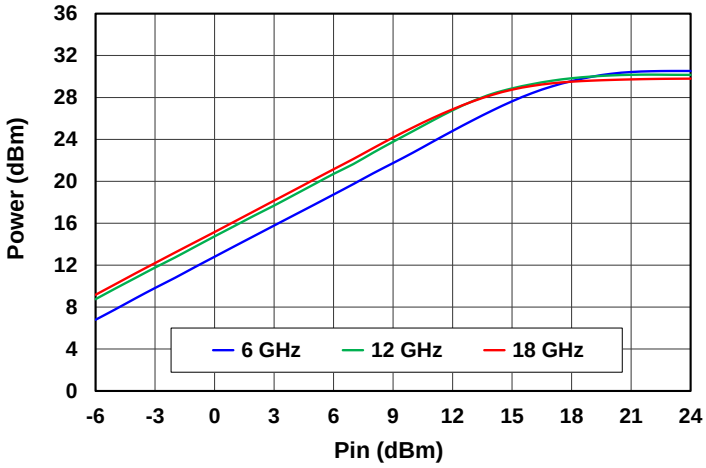
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = 5 V, IDQ = 400 mA, +25 °C

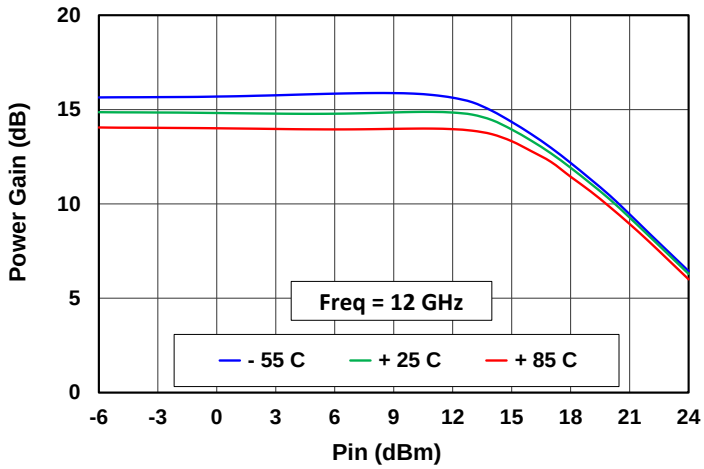
Power vs Pin vs Temp



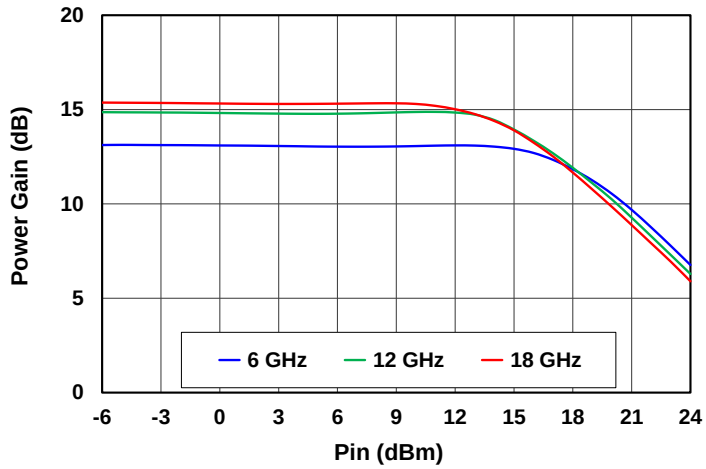
Power vs Pin



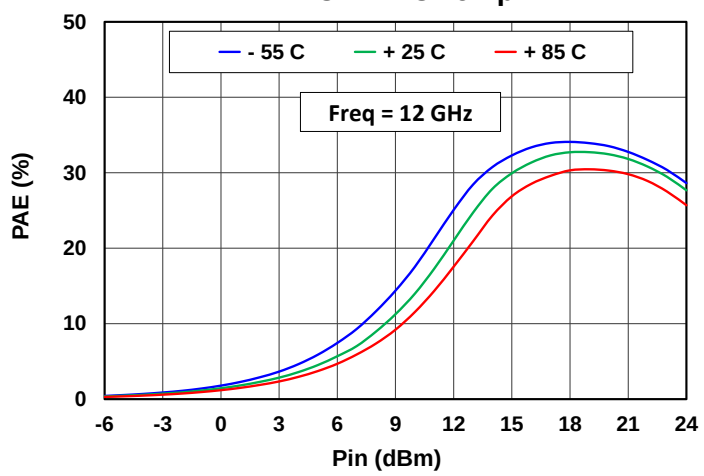
Power Gain vs Pin vs Temp



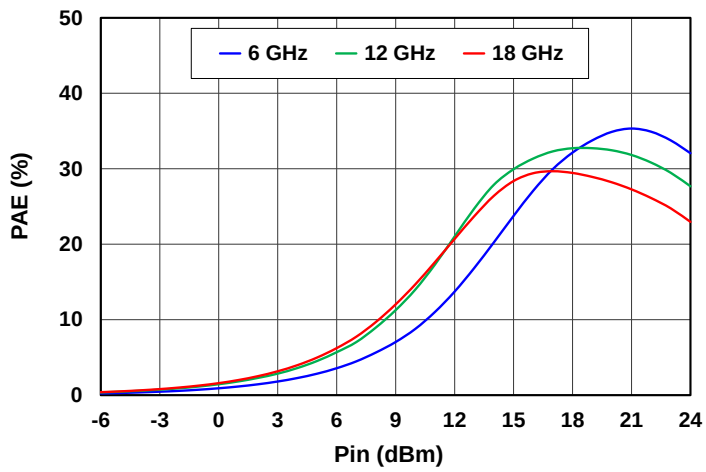
Power Gain vs Pin



PAE vs Pin vs Temp



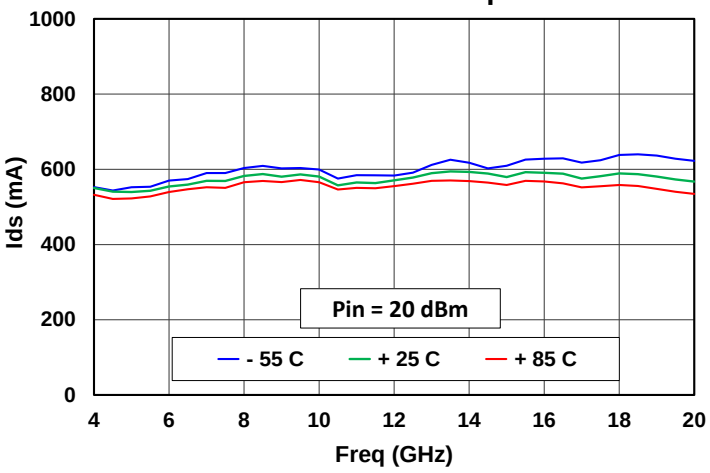
PAE vs Pin



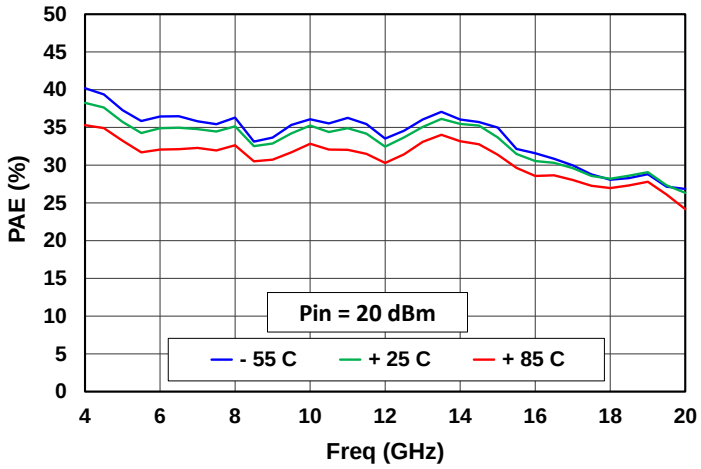
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = 5 V, IDQ = 400 mA, +25 °C

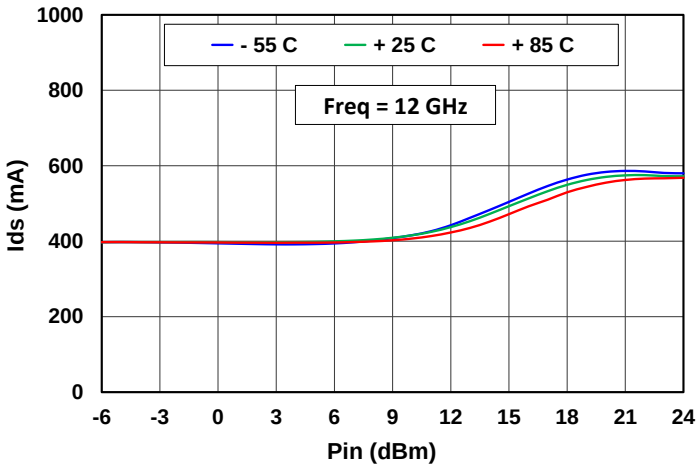
Drain Current vs Temperature



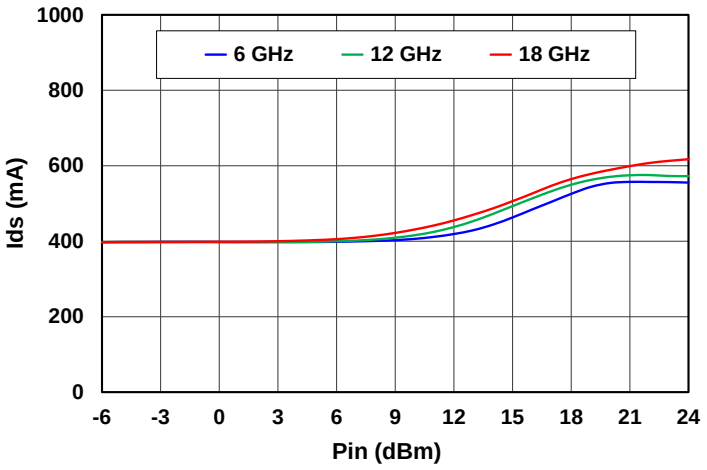
PAE vs Temperature



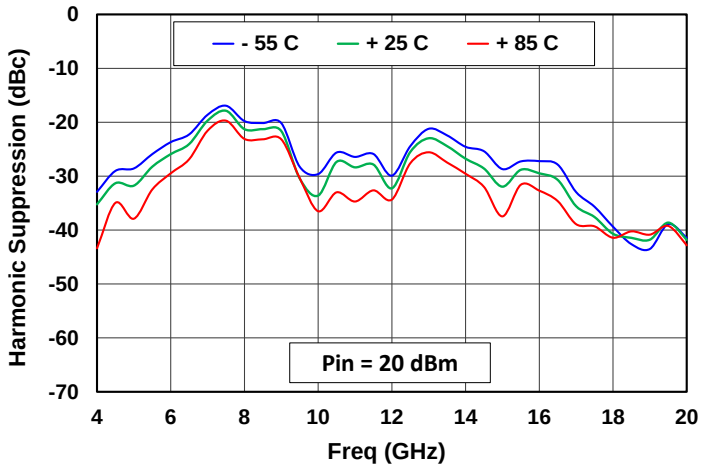
Current vs Pin vs Temp



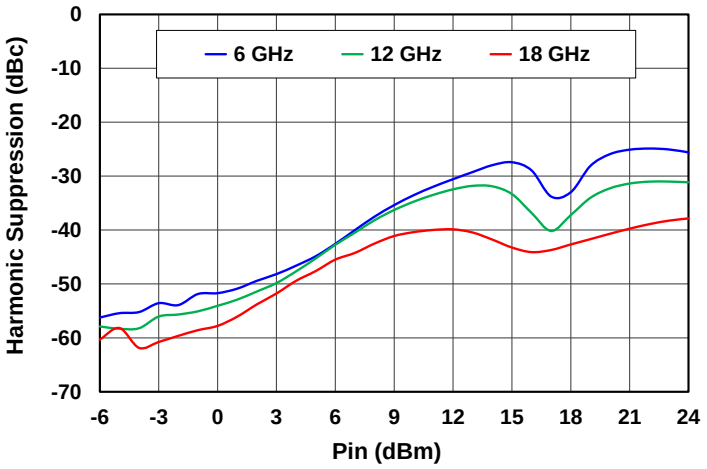
Drain Current vs Pin



2nd Harmonic vs Temperature



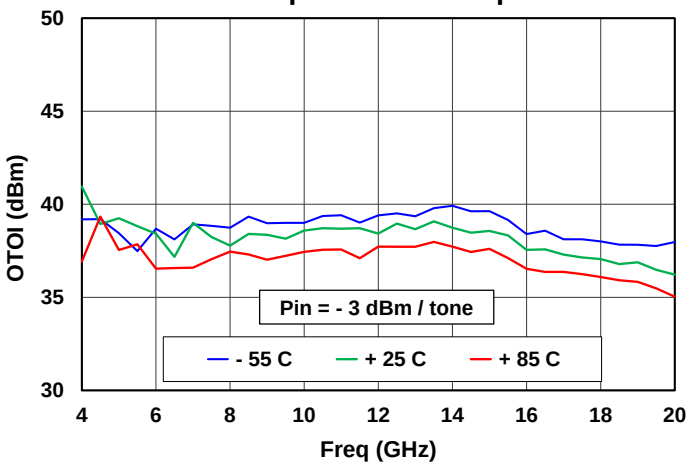
2nd Harmonic vs Pin



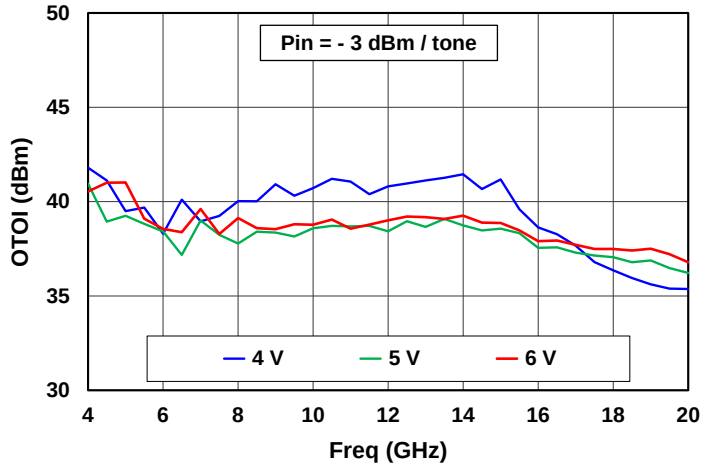
Performance Plots – Linearity

Test conditions unless otherwise noted: VDD = +5 V, IDQ = 400 mA, Δf = 1 MHz, 25 °C.

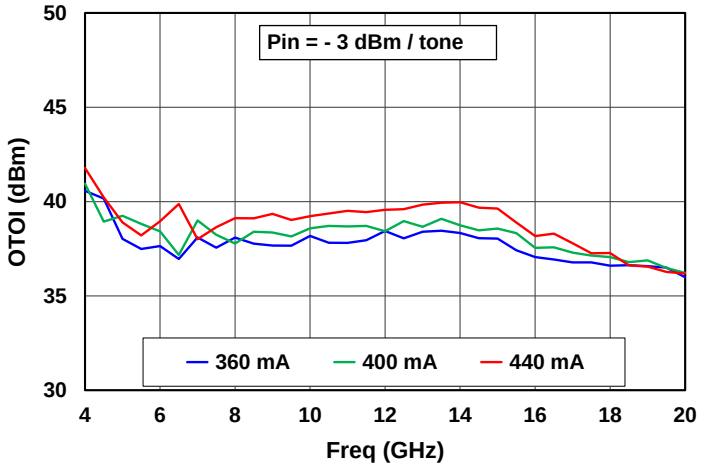
Output TOI vs Temp



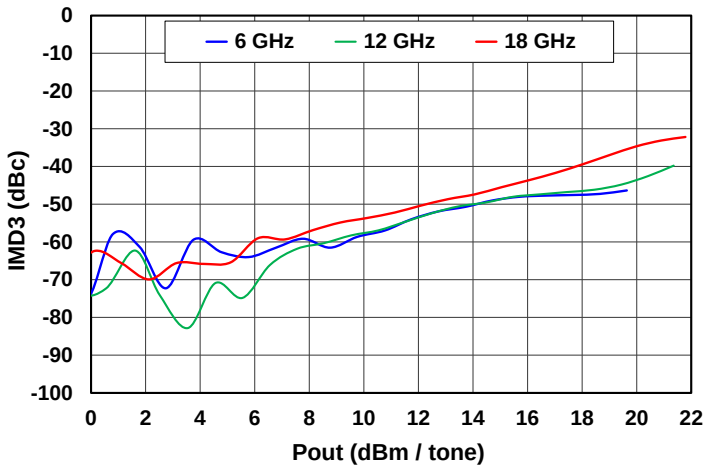
Output TOI vs Voltage



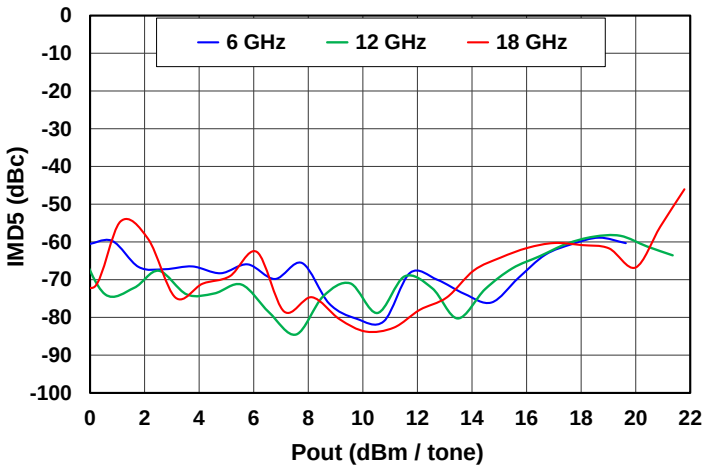
Output TOI vs Current



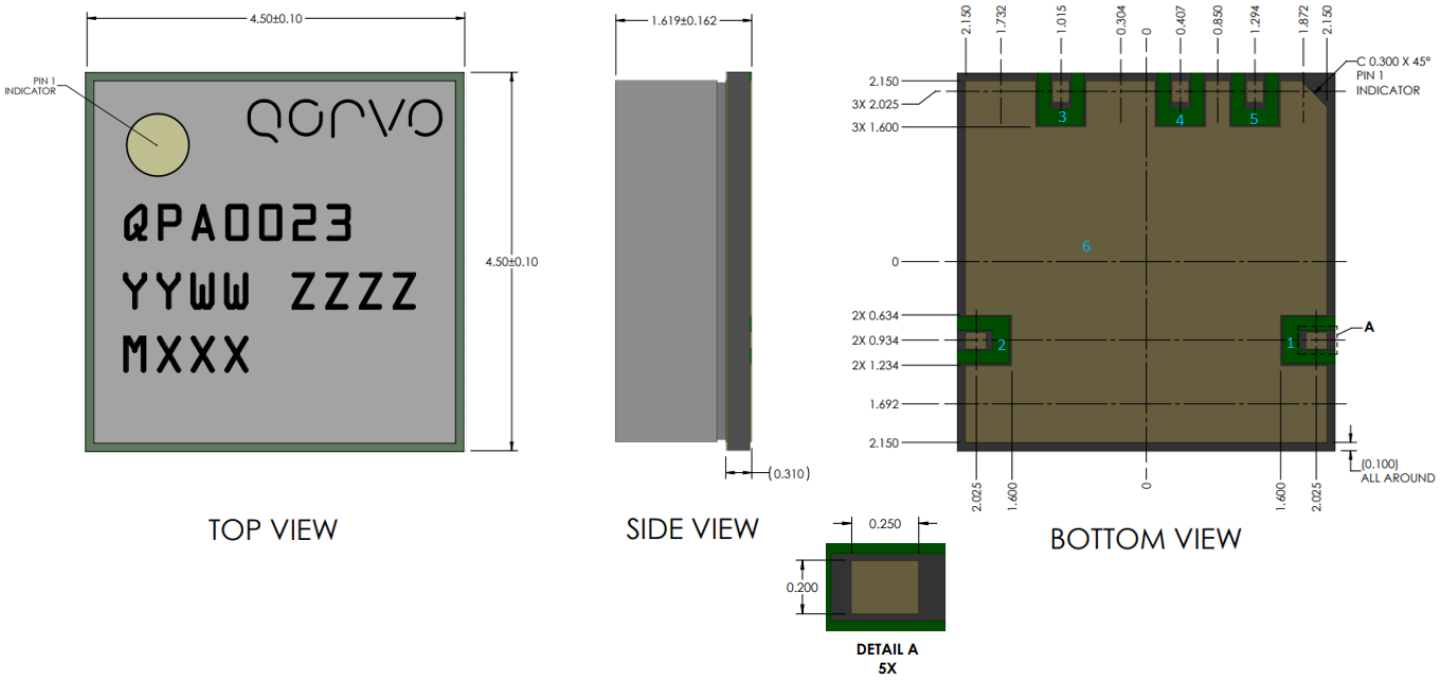
IMD3 vs Pout



IMD5 vs Pout



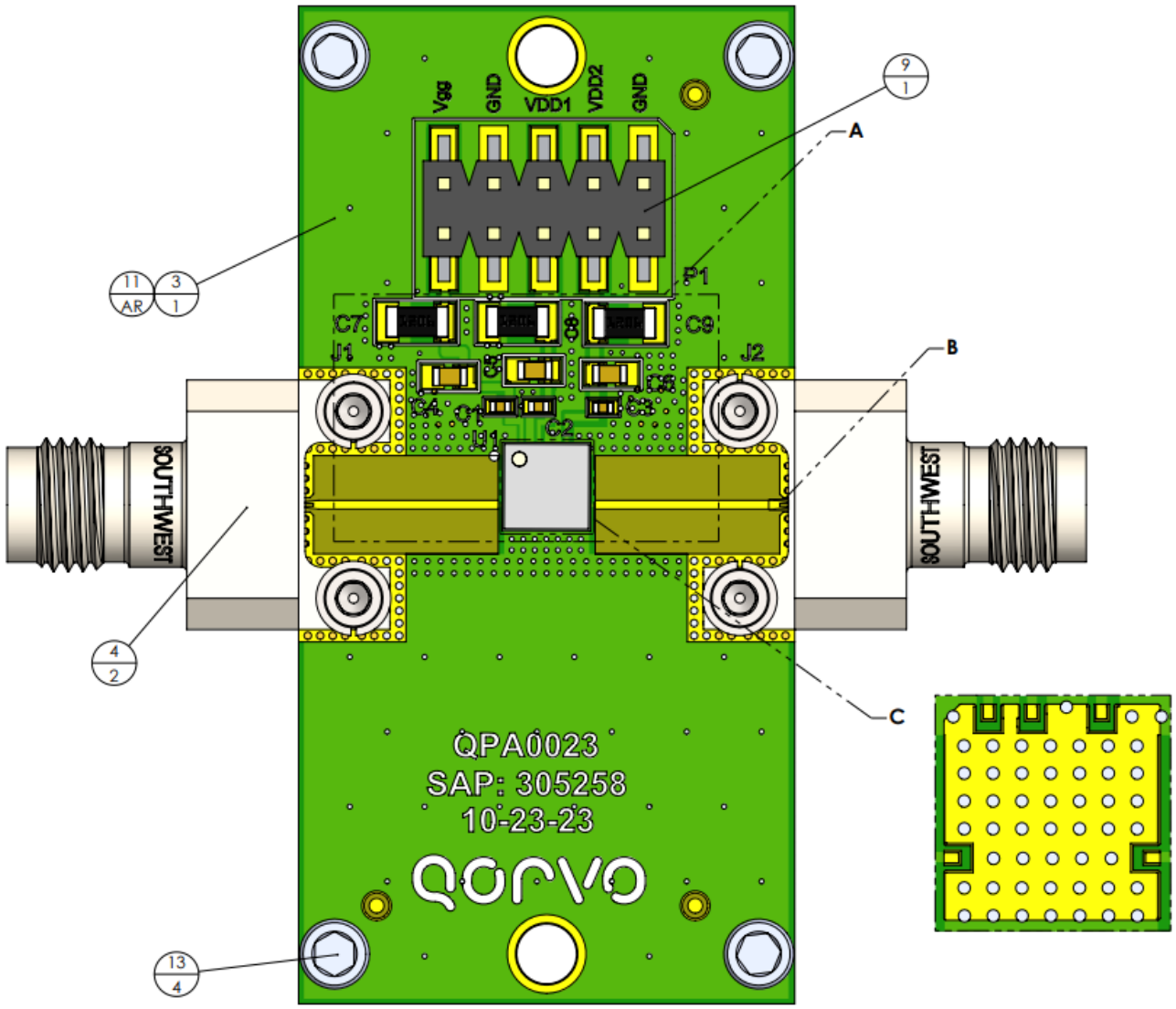
Mechanical Drawing & Pad Description



Dimensions in mm
Package is air-cavity PHS laminate with gold plated leads, minimum plated gold thickness is 0.1 um
Part Marking: QPA0023: Part Number; YY = Part Assembly Year; WW = Part Assembly Week;
ZZZZ: Assembly Lot Identifier; MXXX = Batch ID

Pin Number	Label	Description
1	RF Input	Matched to 50 ohms, DC blocked
2	RF Output	Matched to 50 ohms, DC blocked
3	VDD2	Stage 2 drain voltage
4	VDD1	Stage 2 drain voltage
5	VGG	Gate Voltage
6	GND	Package base, ground

Evaluation Board and BOM

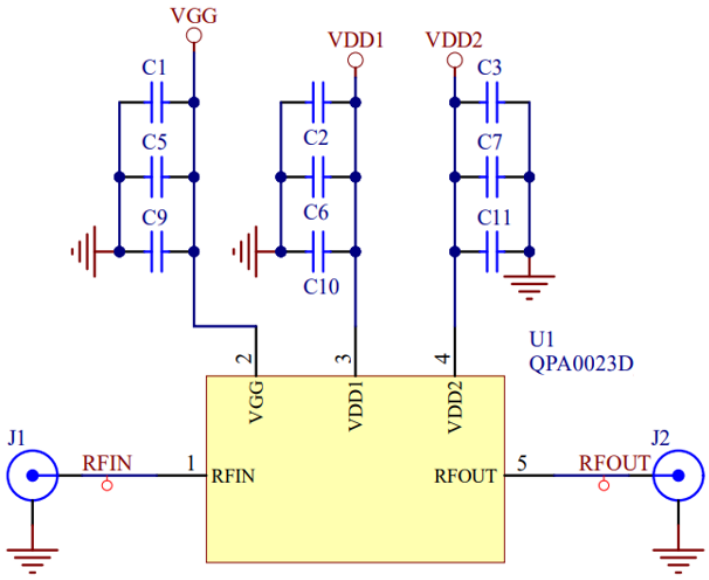


RF Layer is 0.008” thick Rogers Corp. RO4003C (ε_r = 4.0). Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-12.

Bias-up Procedure
1. Set VDD (VDD1 and VDD2) current limit to 1000mA (total), Set VGG current limit to 10 mA
2. Set VGG to −2.0 V
3. Set VDD1 and VDD2 +5 V
4. Adjust VGG more positive to get required drain current
5. Apply RF signal

Bias-down Procedure
1. Turn off RF signal
2. Reduce VGG to −2.0 V. Ensure IDQ ≈ 0mA
3. Set VDD1 and VDD2 to 0V
4. Turn off VDD1 and VDD2 supply
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	
C5, C6, C7	1000 pF	CAP 1000 pF +/-10% 16V 0603 X7R	Various	
C9, C10, C11	100 pF	CAP 100 pF +/-10% 16V 0402 C0G	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.

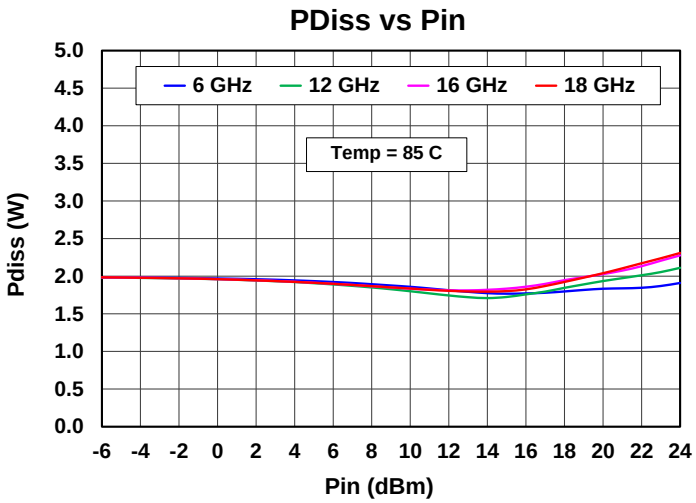
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85°C, VDD = 5 V, I_{DQ} = 400 mA Quiescent/Small Signal operation, P_{DISS} = 2.0 W	22.49	ºC/W
Channel Temperature, T_{CH} (Under RF)		130.00	°C
Median Lifetime (T_M)		4.9E06	Hrs
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85°C, VDD = 5 V, I_{DQ} = 400 mA CW, Pin = 15.00 dBm, Pout = 28.13 dBm, Freq = 16 GHz (worst case), Ids = 491 mA, P_{DISS} = 1.835 W (P1dB condition)	26.88	ºC/W
Channel Temperature, T_{CH} (Under RF)		134.34	°C
Median Lifetime (T_M)		7.4E05	Hrs

Notes:
1. Thermal resistance referenced to the bottom of the package.

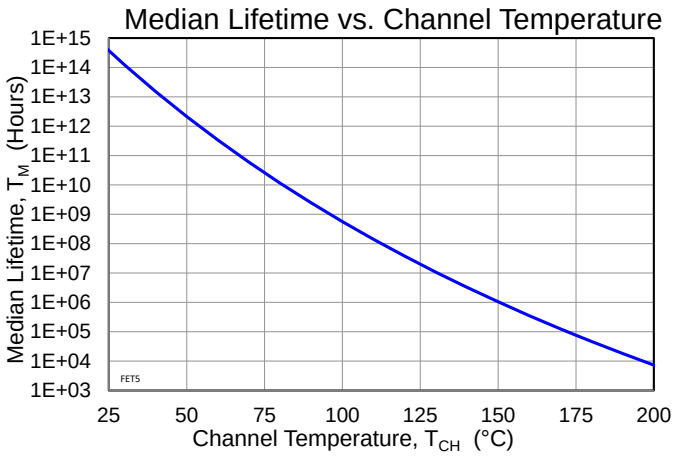
Power Dissipation

Based on 85 ºC, 5V, 400mA



Median Lifetime

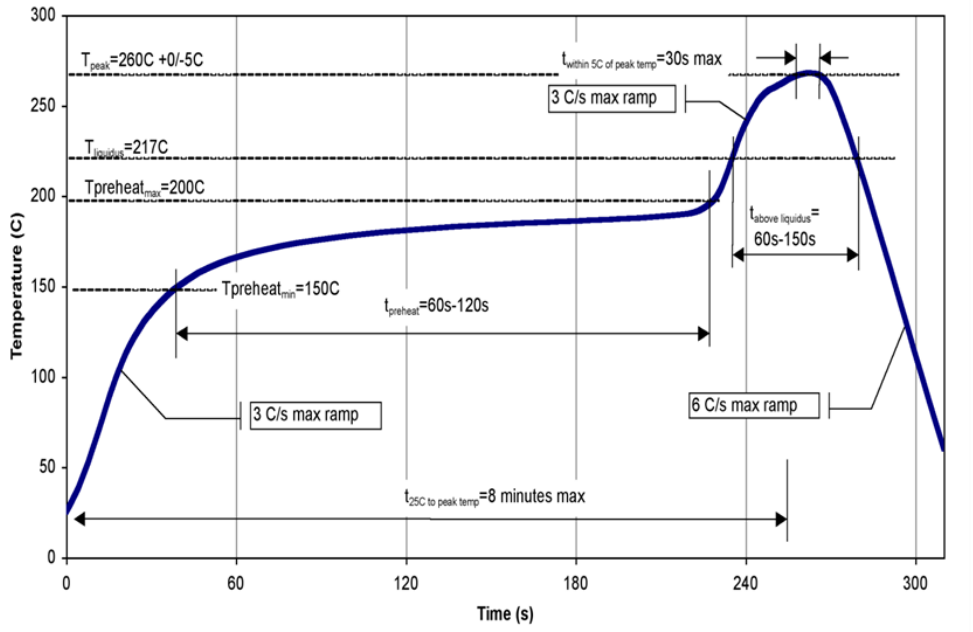
Test Conditions: V_D = +4 V
Failure Criteria is 10% reduction in I_{D_MAX}



Solderability

1. Compatible with the latest version of J-STD-020, Lead-free solder, peak reflow temperature: 260 °C.
2. This package is non-hermetic, and therefore cannot be subjected to aqueous washing. The use of no-clean solder to avoid washing is highly recommended.

Recommended Soldering Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1a	ANSI/ESD/JEDEC JS-001
ESD – Charge Device Model (CDM)	C2b	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	TBD	IPC/JEDEC J-STD-020

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
- Antimony Free
- SVHC Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS 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.