QPA0022D

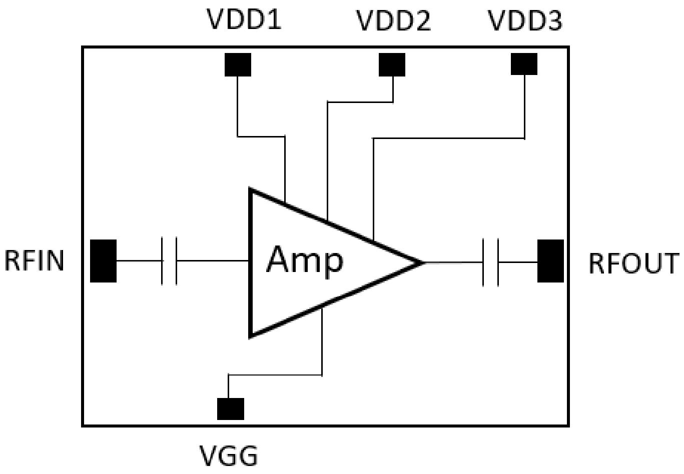
6 – 18 GHz Driver Amplifier

Product Overview

Qorvo's QPA0022D is a high-performance driver amplifier fabricated on Qorvo's production 0.15 um pHEMT process (QPHT15). Covering 6 – 18 GHz, the QPA0022D provides 24 dB small signal gain and 25 dBm P1dB with saturated power of 26 dBm. In addition, the device has low IMD3 level of −50 dBc at Pin = -10 dBm/tone.

QPA0022D 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: 24 dB
- P1dB: 25 dBm
- Psat: 26 dBm
- IMD3: −50 dBc (typical) (Pin = -10 dBm/tone)
- Bias: VDD = 5 V, IDQ = 175 mA
- Die Dimensions: 2.95 x 1.47 x 0.10 mm

Applications

- Broadband Communications
- Radar and Electronic Warfare (EW)
- Instrumentations

Ordering Information

Part No.	Description
QPA0022D	Gel Pack, Qty 50
QPA0022DEVB	Evaluation Board, Qty 1

Absolute Maximum Ratings

Parameter	Min Values	Max Values	Units
Drain Voltage (VDD1, VDD2, VDD3)	-1.4	6.5	V
Drain Current (VDD1)	-	58	mA
Drain Current (VDD2)	-	117	mA
Drain Current (VDD3)	-	176	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, VDD3)	5.0	V
Drain Current (Total)	175	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.

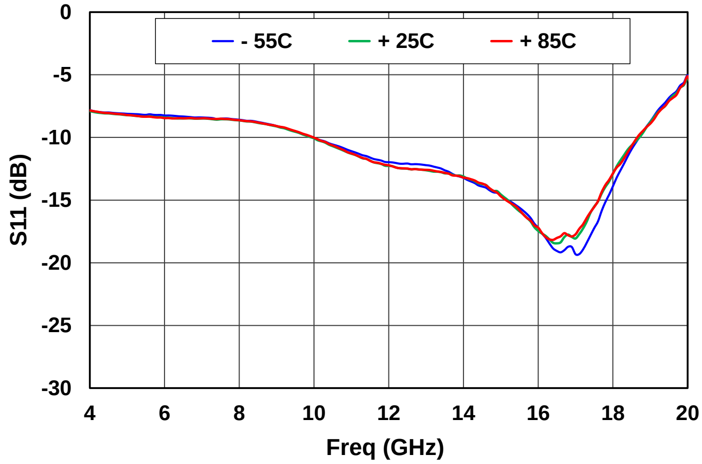
Electrical Specifications

Test conditions unless otherwise noted:
VDD = +5 V, IDQ = 175 mA, Temp. = +25 °C. Data de-embedded of fixture losses, data included bond wire effects.

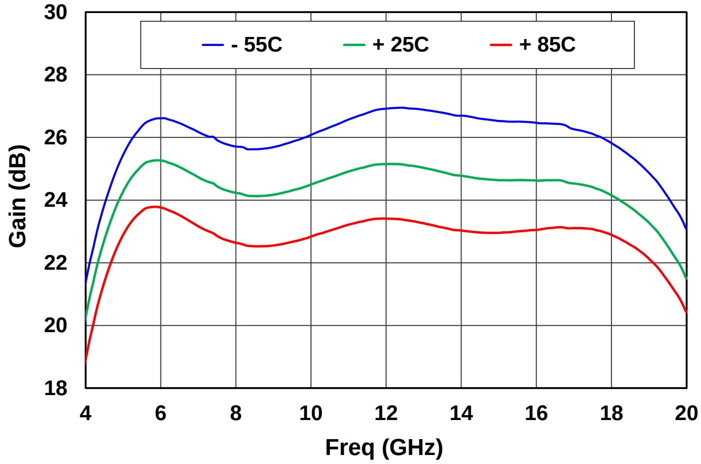
Parameter	Min	Typ	Max	Units
Operating Frequency	6		18	GHz
Small Signal Gain		24		dB
Input Return Loss		10.0		dB
Output Return Loss		8.0		dB
1-dB Compression Point		25		dBm
Saturated Power		26		dBm
Third Order Intermodulation (P_{IN} = -16 dBm / Tone)		34		dBm
Noise Figure		7		dB
Gain (S21) Temperature Coefficient		−0.025		dB/°C

Performance Plots – Small Signal

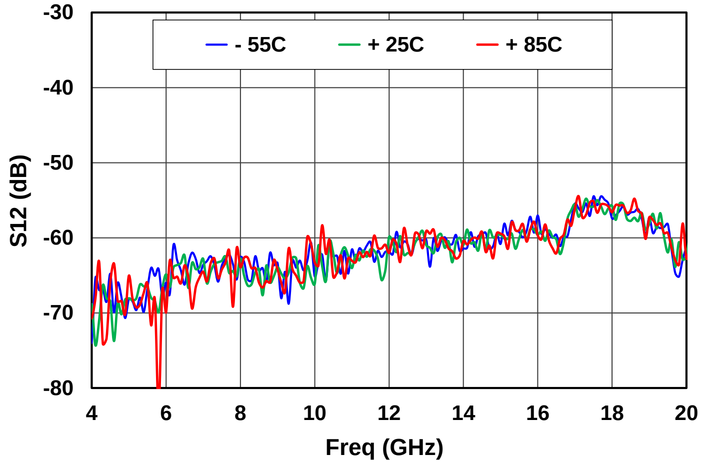
Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, Temp. = +25 °C.



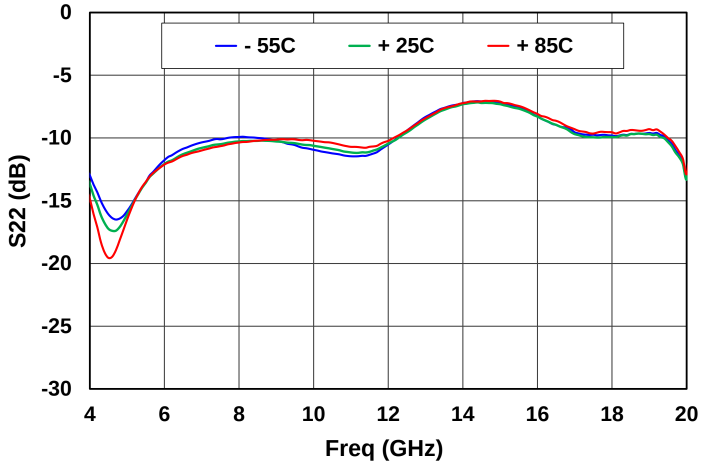
Input Return Loss vs Temp



Gain vs Temp



Reverse Isolation vs Temp

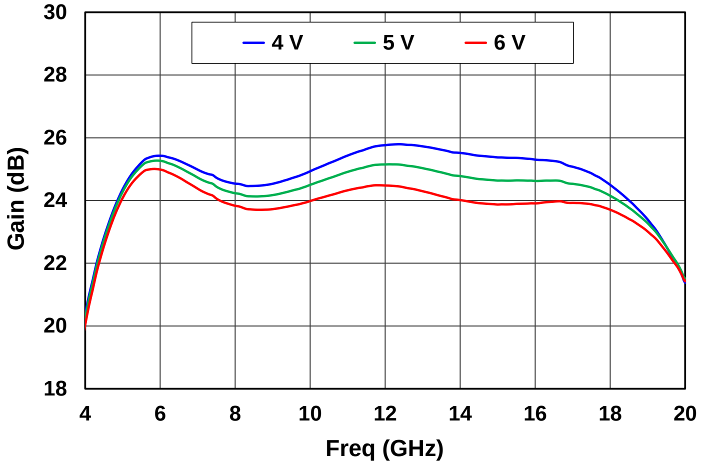


Output Return Loss vs Temp

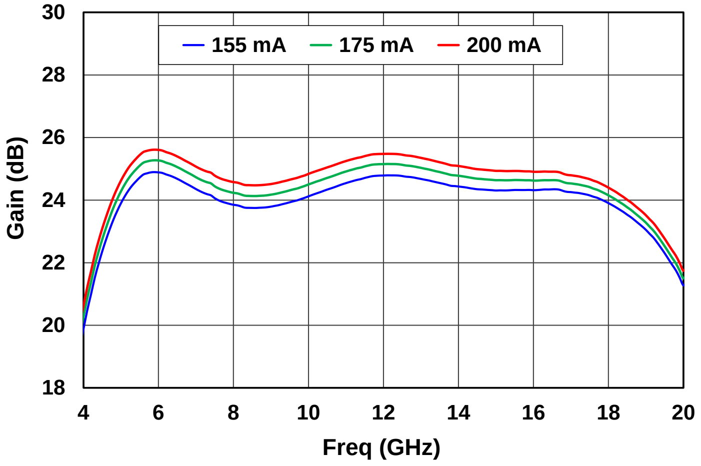
Performance Plots – Small Signal

Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, Temp. = +25 °C.

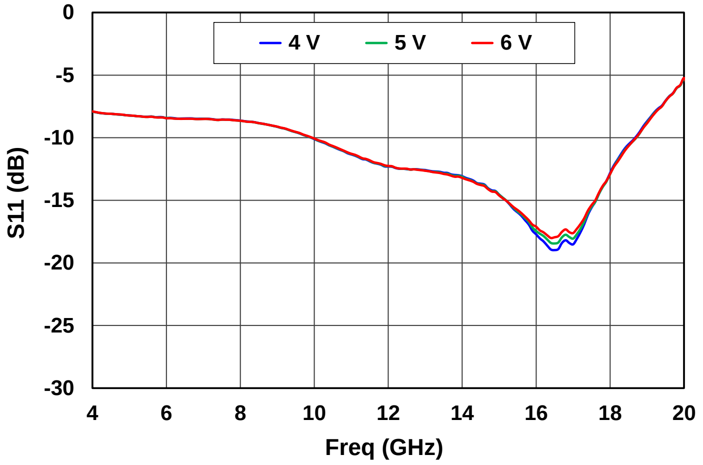
Gain vs Voltage



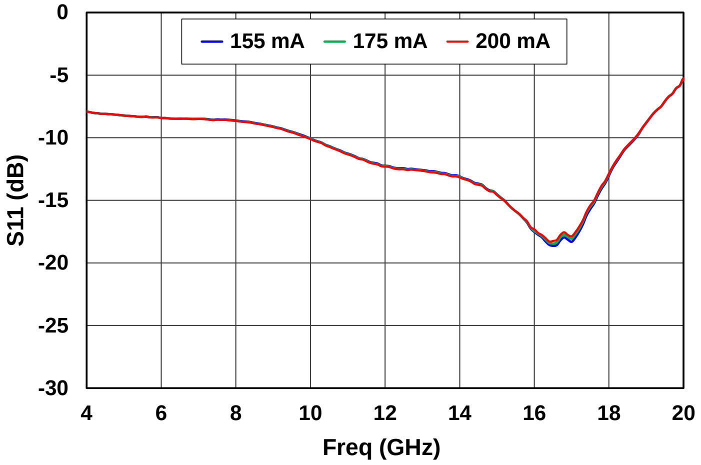
Gain vs Current



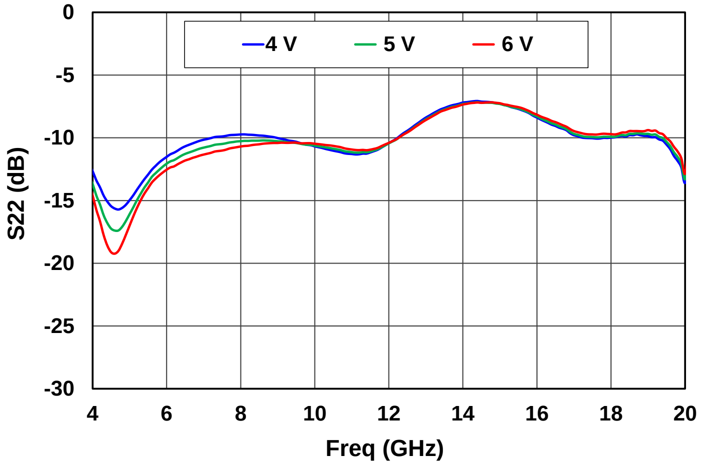
Input Return Loss vs Voltage



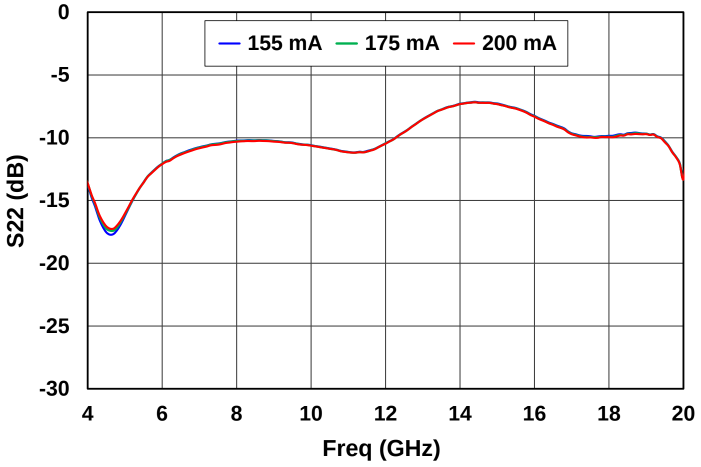
Input Return Loss vs Current



Output Return Loss vs Voltage

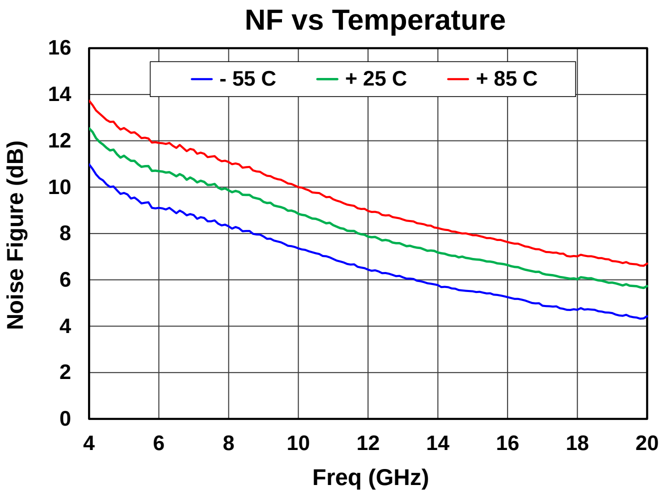


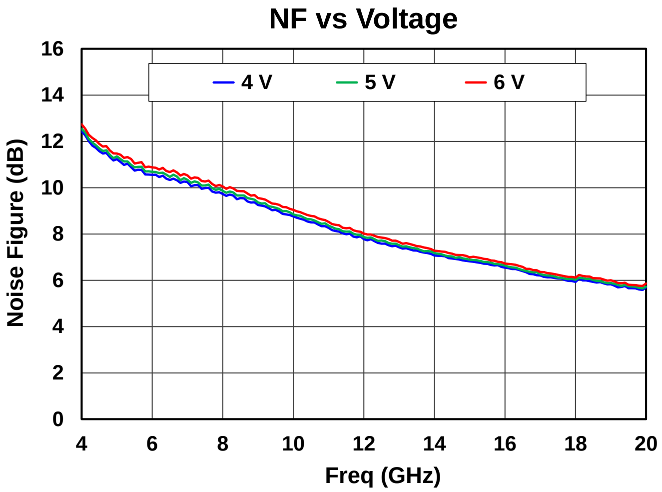
Output Return Loss vs Current

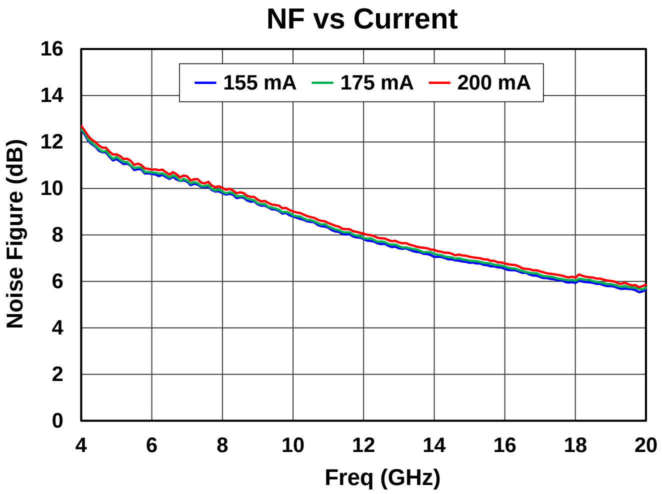


Performance Plots – Noise Figure

Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, Temp. = +25 °C.



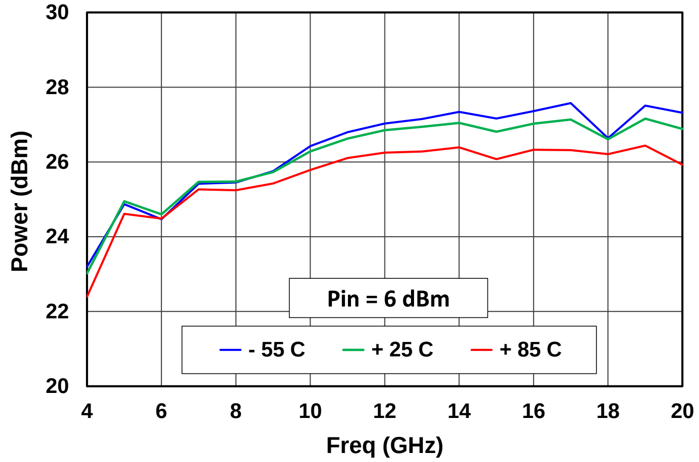




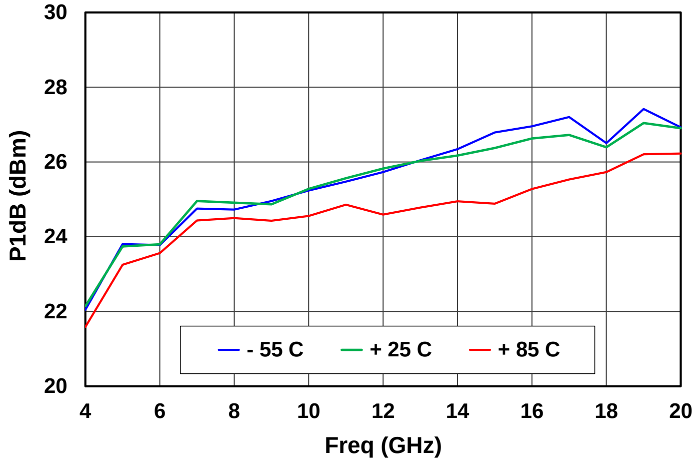
Performance Plots – Large Signal

Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, 25 °C

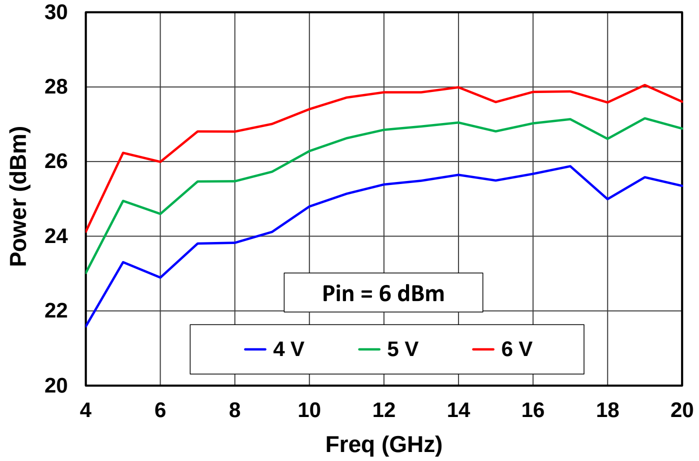
Power vs Temperature



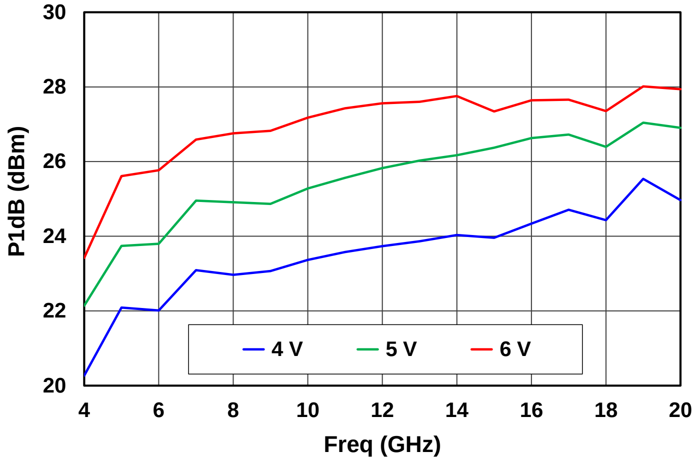
P1dB vs Temperature



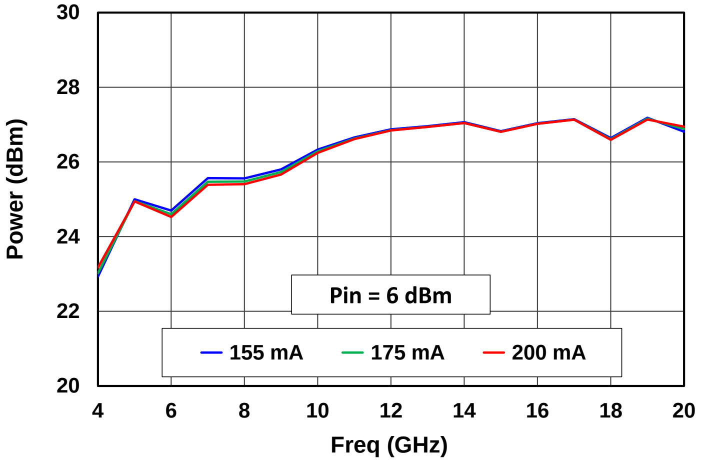
Power vs Voltage



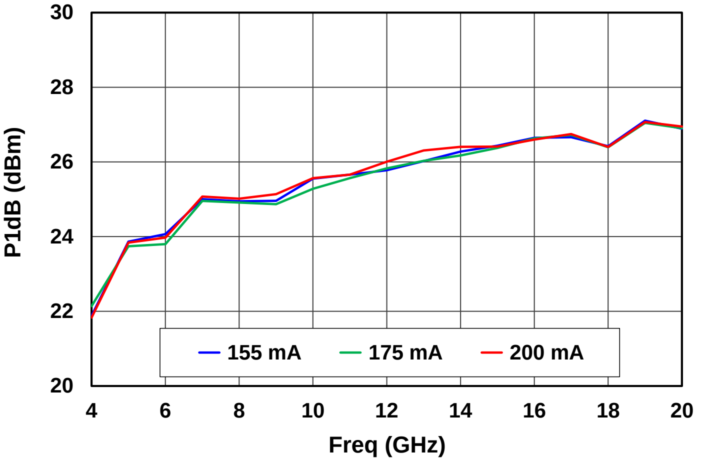
P1dB vs Voltage



Power vs Current

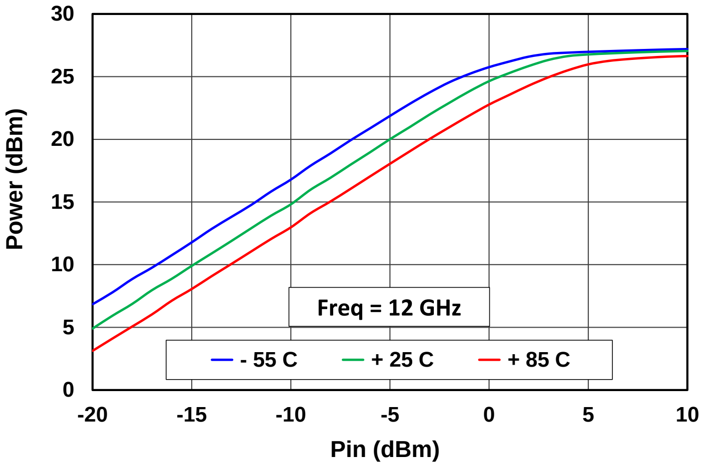


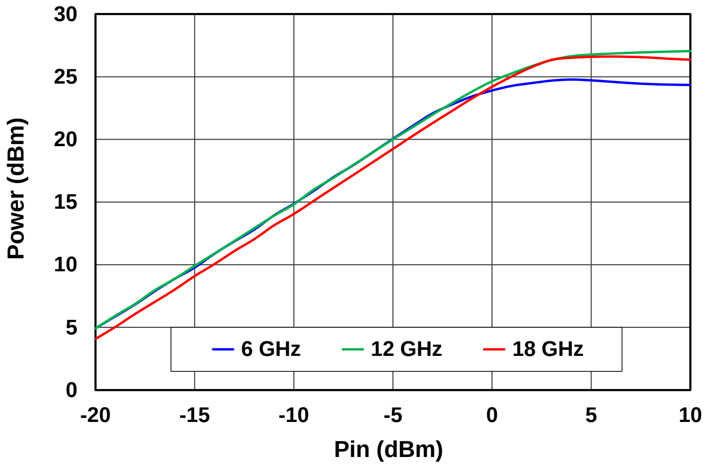
P1dB vs Current

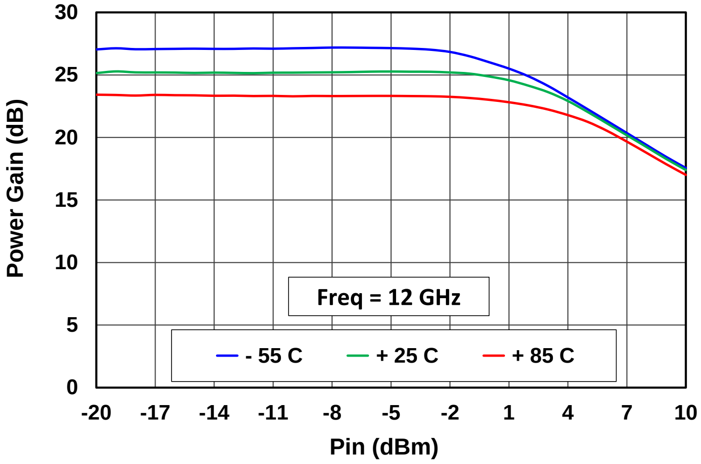


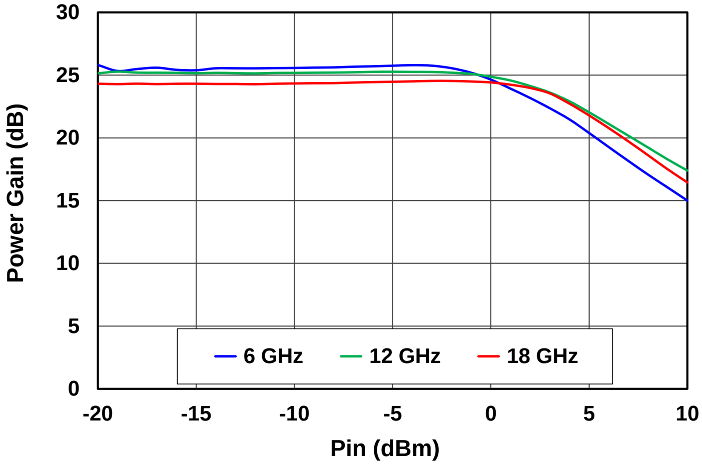
Performance Plots – Large Signal

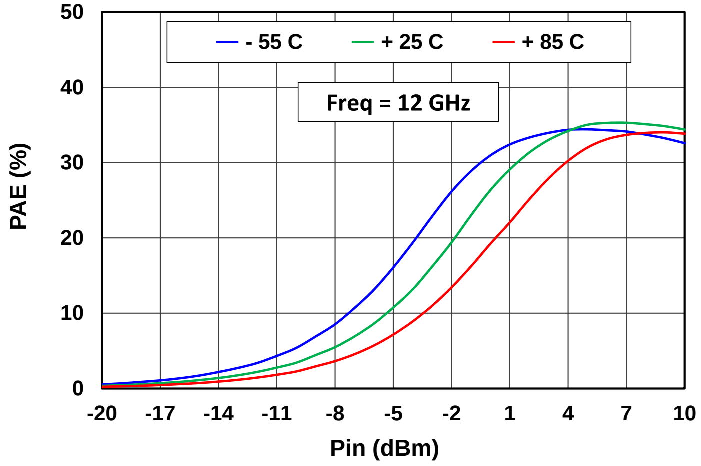
Test conditions unless otherwise noted: VDD = 5 V, IDQ = 175 mA, +25 °C

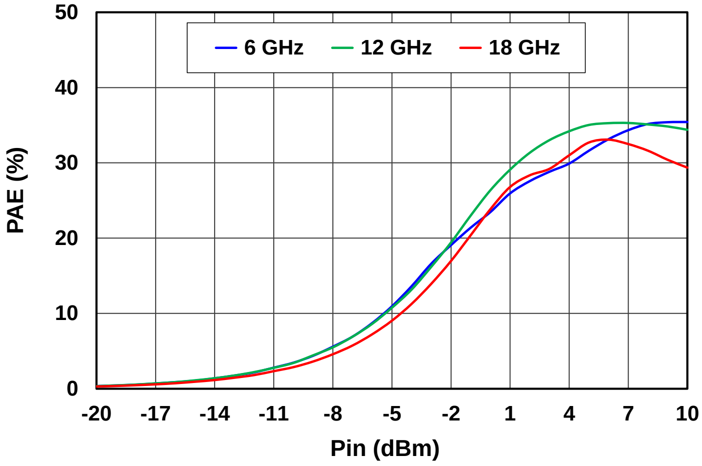

Power vs Pin vs Temp


Power vs Pin


Power Gain vs Pin vs Temp

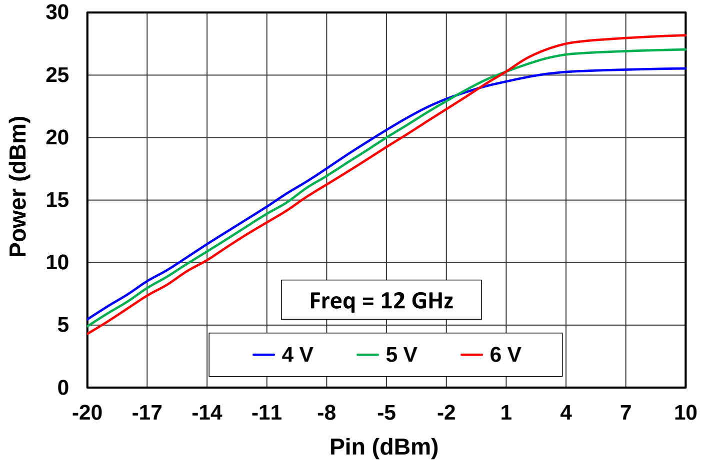

Power Gain vs Pin

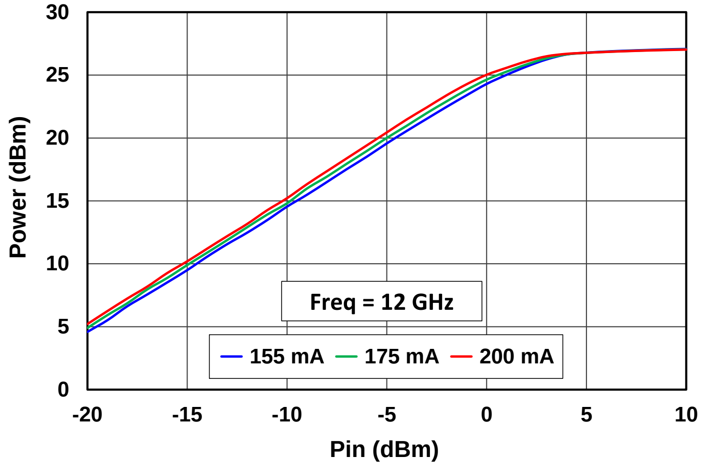

PAE vs Pin vs Temp

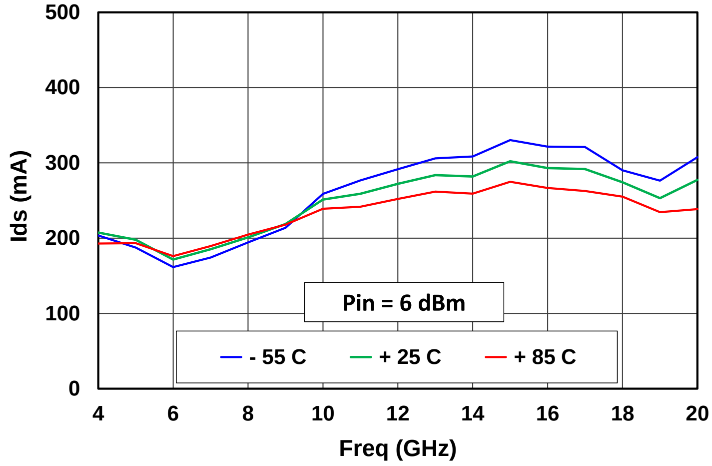

PAE vs Pin

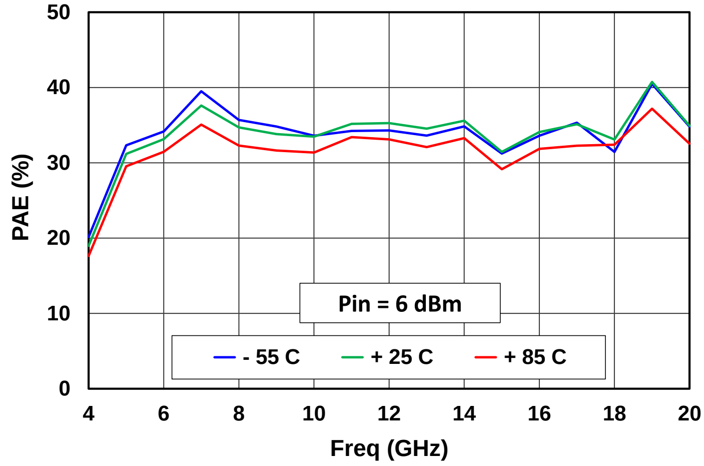
Performance Plots – Large Signal

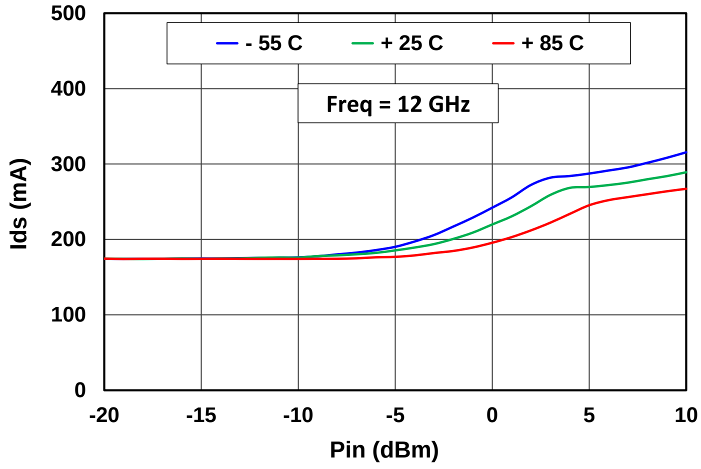
Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, +25 °C

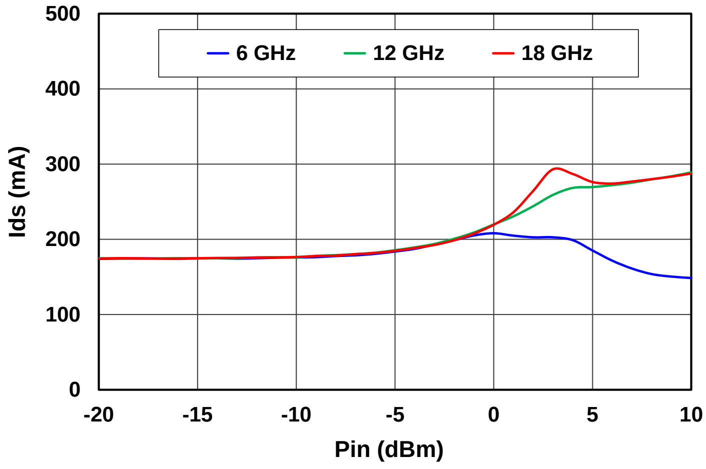

Power vs Pin vs Voltage


Power vs Pin vs Current


Drain Current vs Temperature

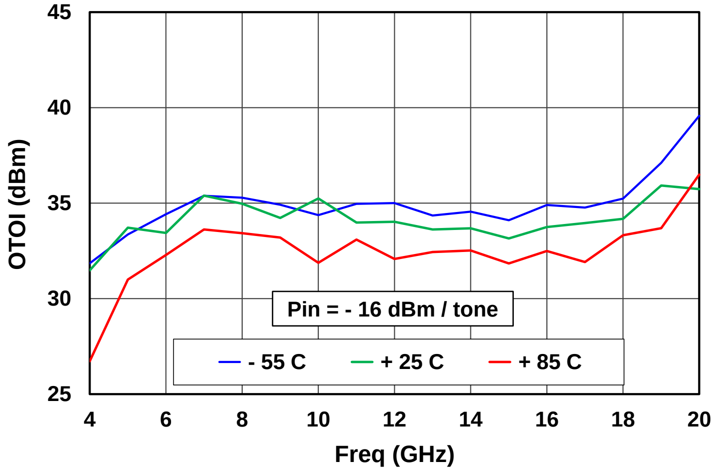

PAE vs Temperature

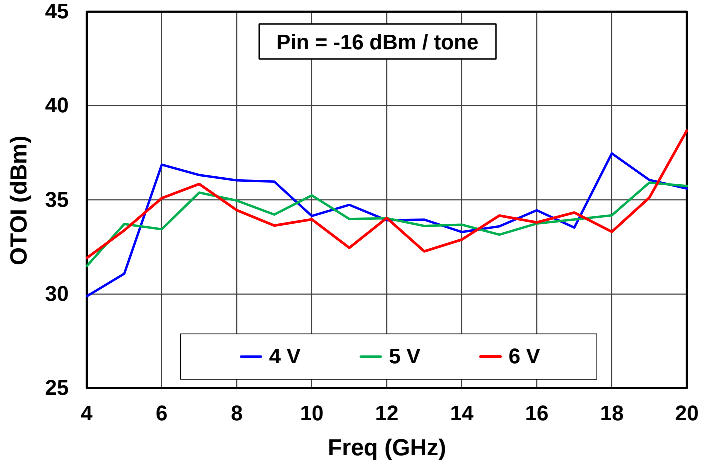

Current vs Pin vs Temp

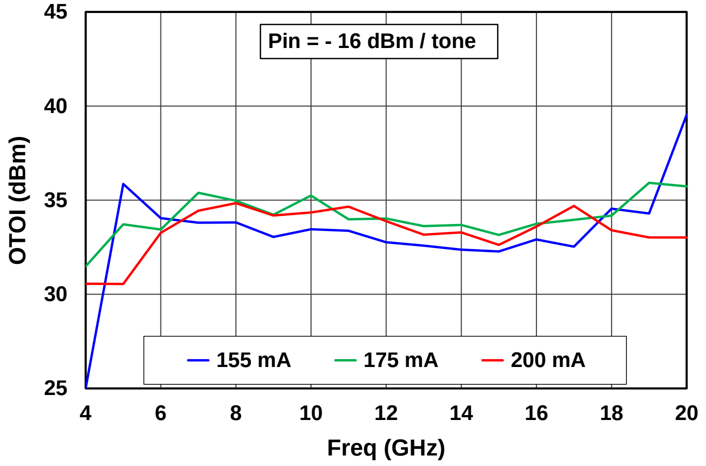

Drain Current vs Pin

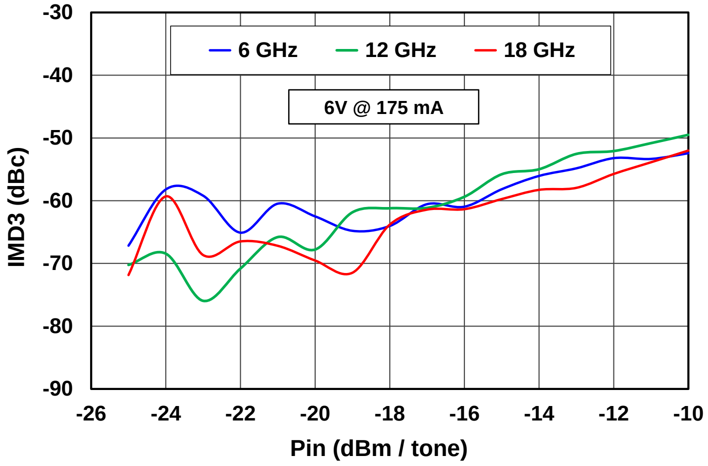
Performance Plots – Linearity

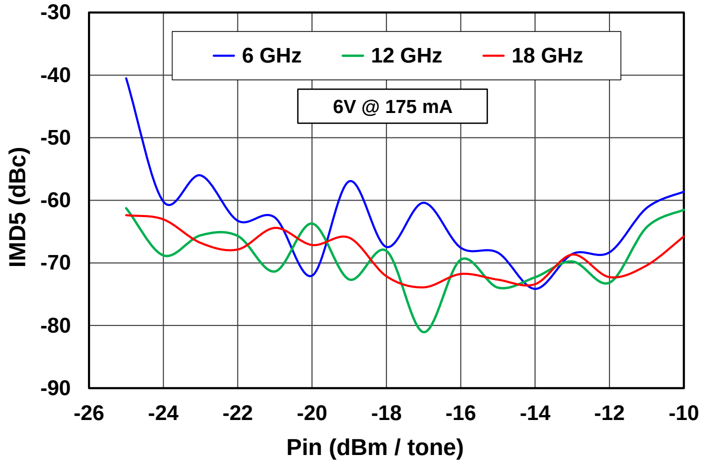
Test conditions unless otherwise noted: VDD = + 5 V, IDQ = 175 mA, ∆f = 1 MHz, 25 °C


Output TOI vs Temp

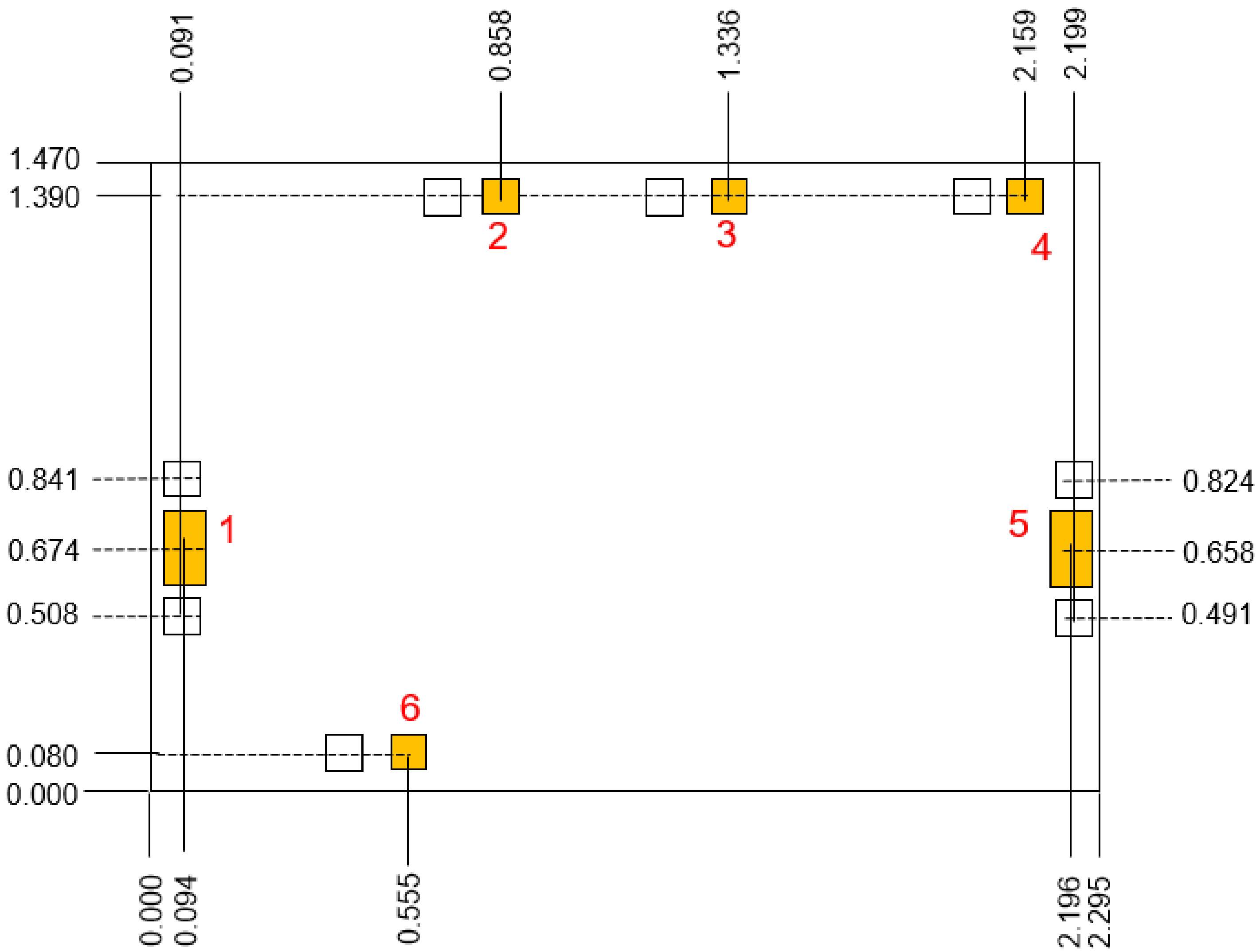

Output TOI vs Voltage


Output TOI vs Current


IMD3 vs Pin


IMD5 vs Pin

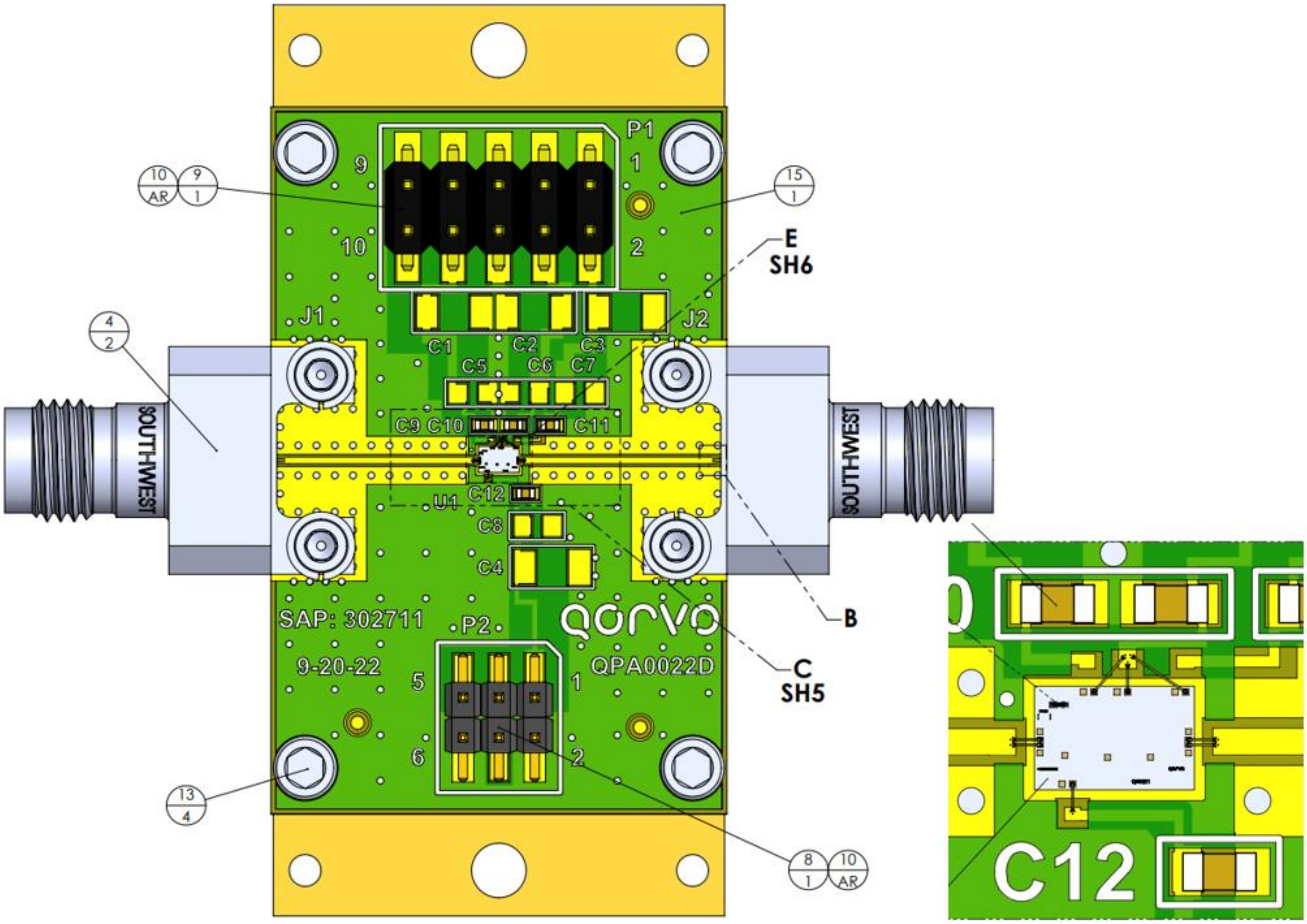
Mechanical Drawing and Bond Pad Description



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	VDD1	82 x 82	Stage 1 Drain Supply
3	VDD2	82 x 82	Stage 2 Drain Supply
4	VDD3	82 x 82	Stage 3 Drain Supply
5	RF Output	82 x 132	Matched to 50 ohms, DC blocked
6	VGG	82 x 82	Gate Control

Evaluation Board and BOM

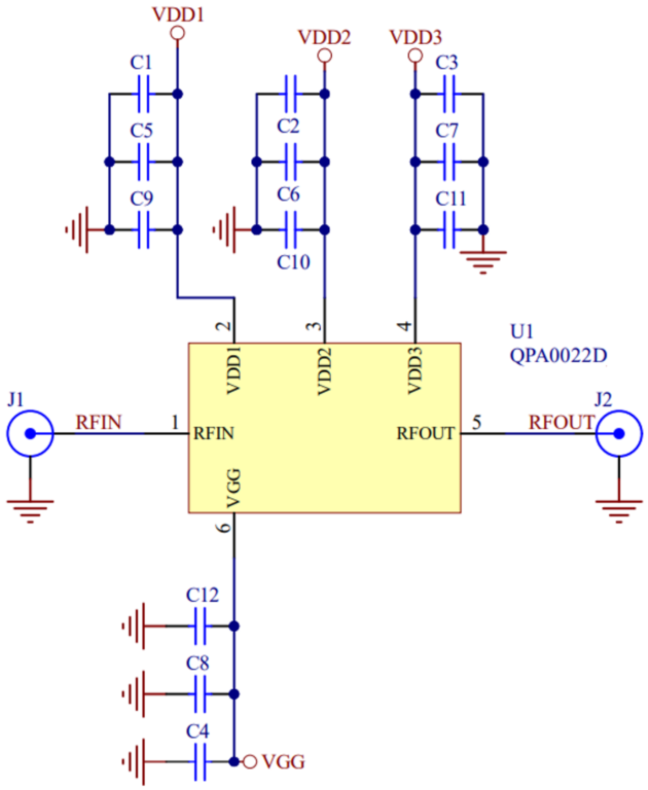


RF Layer is 0.01” thick Rogers Corp. RO4350 ($\varepsilon_r = 3.48$). Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-12.

Bias-up Procedure
1. Set VDD (VDD1, VDD2 and VDD3 tied together on EVB) current limit to 500 mA (total), Set VGG current limit to 10 mA
2. Set VGG to −1.5 V
3. Set VDD to +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 −1.5 V. Ensure IDQ ≈ 0mA
3. Set VDD to 0V
4. Turn off VDD supply
5. Turn off VGG supply

Application Circuit and Biasing Sequence



Notes:

1. Drains are tied together to VDD2 on EVB (referred as VDD), can use separate drain pads for individual stage controls.

Bill of Material – Evaluation Board

Ref. Des.	Value	Description	Manuf.	Part Number
C9, C10, C11, C12	0.01 uF	CAP 0.01uF +/-10% 16V 0402 X7R	Various	
RF IN, RF OUT	-	2.92 MM END LAUNCH CONNECTOR	Southwest Microwave	1092-01A-12

Note 1. Off-chip components (capacitors, resistors and inductors) not shown in BOM are not populated.

Thermal and Reliability Information

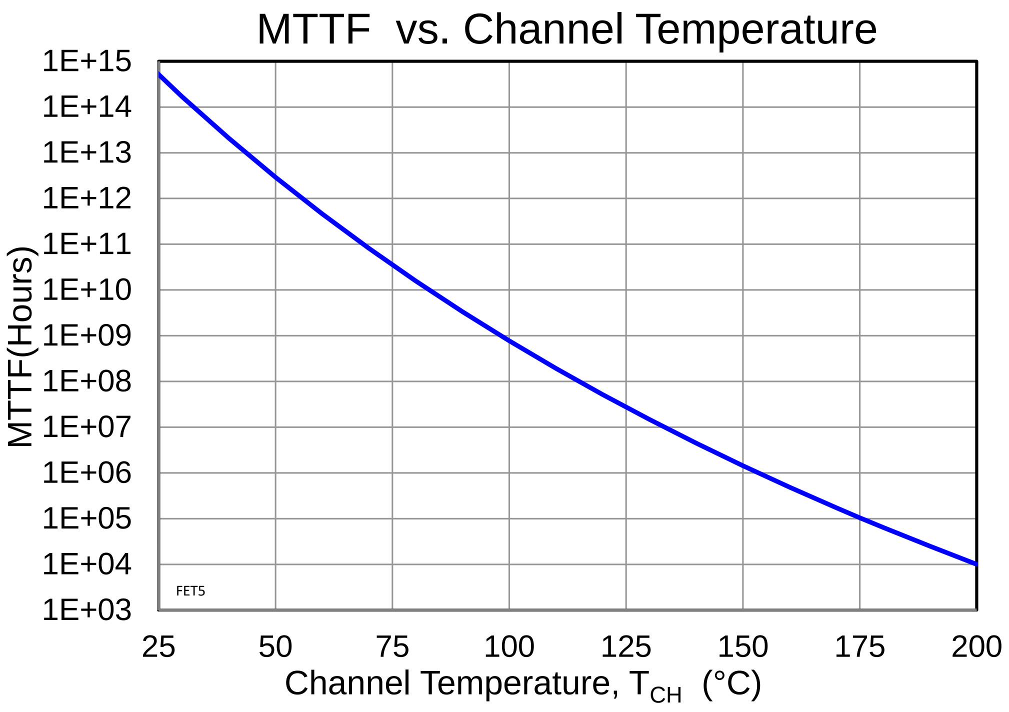
Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) [1]	T_{base} = 85°C, VDD = 5 V, I_{DQ} = 175 mA Quiescent/Small Signal operation, P_{DISS} = 0.875 W	59.13	ºC/W
Channel Temperature, T_{CH} (Under RF)		136.74	°C
Median Lifetime (T_M)		6.5E06	Hrs
Thermal Resistance (θ_{JC}) [1]	T_{base} = 85°C, VDD = 5 V, I_{DQ} = 175 mA CW, Pin = 3.12 dBm, Pout = 24.89 dBm, Freq = 15 GHz (worst case), Ids = 246 mA, P_{DISS} = 0.924 W (P1dB condition)	56.86	ºC/W
Channel Temperature, T_{CH} (Under RF)		137.54	°C
Median Lifetime (T_M)		6.0E06	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 0.7 mil 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**

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