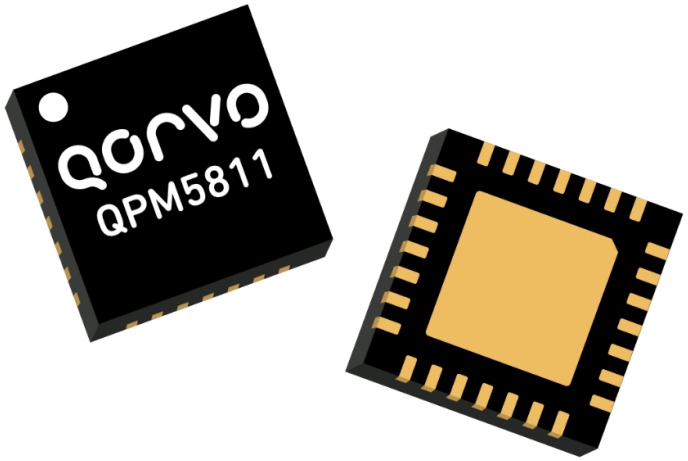
QPM5811

8.5 – 10.5 GHz 0.5 W T/R Module

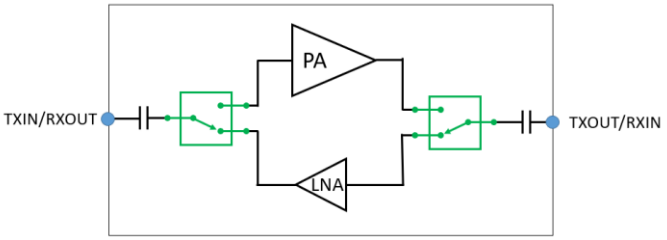
Product Description

The QPM5811 is a GaAs MMIC front-end module (FEM) designed for X-Band radar applications within the 8.5 – 10.5 GHz range. The MMIC combines a T/R switch, low-noise amplifier, and a power amplifier. The receive path offers 26 dB gain with low noise figure of 2.0 dB. The transmit path offers a small signal gain of 30 dB, it can deliver 0.5 W of saturated power with a PAE of 45 %, with a 23.5 dB of large signal gain.

The 6 x 6 mm QFN surface mount package with over-mold encapsulant, coupled with high thermal conductivity die-attach process, allows the QPM5811 to perform well in a high temperature environment. Its compact size supports tight lattice spacing requirements needed for X-Band phased array radar applications.



Functional Block Diagram



Product Features

- Frequency Range: 8.5 – 10.5 GHz
- RX Noise Figure: 2.0 dB
- RX Small Signal Gain: 26 dB
- RX Output TOI: 25 dBc @ - 5 dBm Pout / tone
- TX Small Signal Gain: 30 dB
- TX Large Signal Gain: 23.5 dB
- TX Saturated Power: 27.5 dBm, Pulsed
- TX PAE: 45 % @ 27.5 dBm Pout, Pulsed
- TX Harmonics Suppression: 30 dBc
- Package Dimensions: 6 x 6 x 0.85 mm

Performance is typical at room temperature.
Please reference electrical specification table and data plots for more details.

Applications

- Electronics Warfare (EW)
- Commercial and Military Radar
- Communications

Ordering Information

Part No.	Description
QPM5811TR7	QPM5811, Tape and Reel 7 ″, Qty 250
QPM5811EVB01	QPM5811 Evaluation Board, Qty 1

Absolute Maximum Ratings

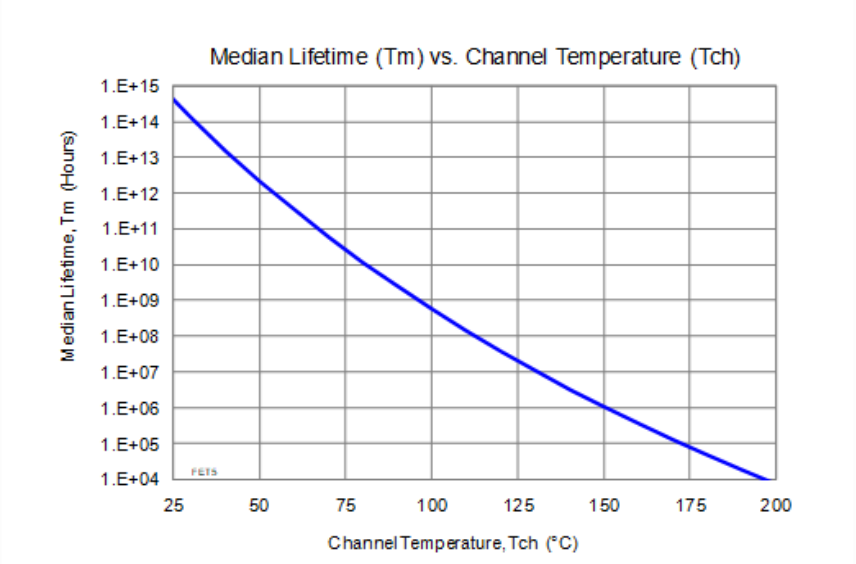
Parameter	Min Value	Max Value	Units
Drain Supply Voltages (VD_PA, VD_LNA)	-	6.5	V
PA Drain Current	-	653	mA
LNA Drain Current (self-biased)	-	50	mA
PA Gate Controls (VG_PA) and LNA Control Circuit Power Supply (VSS)	-5	0	V
PN Gate Control and LNA Control Circuit Power Supply Current	-	10	mA
PA Switch Control (TXSW)	-	4	V
LNA Switch Control (RXSW)	-	4	V
Reference Voltage (VREF)	0	6	V
RX RF Input Power (85C, 50 Ohm)	-	10	dBm
TX RF Input Power (85C, 50 Ohm)	-	12	dBm
Storage Temperature	−65	150	°C

1. Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied. Extended application of Absolute Maximum Rating conditions may reduce device reliability

Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC})	LNA, T_{base} = +85 °C, VD = 6.0 V, I_{DQ} = 10 mA, P_{DISS} = 0.06 W (each channel, quiescent, no RF)	101.6	ºC/W
Channel Temperature, T_{CH}		91.1	°C
Thermal Resistance (θ_{JC})	PA, T_{base} = +85 °C, VD = 5.0 V, I_{DQ} = 156 mA, P_{DISS} = 0.78 W (worst case, quiescent, no RF)	33.75	ºC/W
Channel Temperature, T_{CH}		111.3	°C
Thermal Resistance (θ_{JC})	PA, T_{base} = +85 °C, VD = 6.0 V, I_{DQ} = 156 mA, I_{D_Drive} = 299.8 mA, P_{OUT} = 28.74 dBm, P_{IN} = 4 dBm, Freq. = 8.5 GHz (worst case) P_{DISS} = 1.052 W (Pulse: 100us / 25%)	33.0	ºC/W
Channel Temperature, T_{CH}		119.7	°C

Note: Thermal resistance is referenced to the back of the package.



Normal Operating Conditions

Parameter	Min	Typ	Max	Units
PA Drain Supply Voltage (VD_PA)		5		V
PA Drain Quiescent Current (PA_IDQ)		156		mA
LNA Drain Supply Voltage (VD_LNA)		6		V
LNA Drain Quiescent Current (LNA_IDQ, self-bias, value is typical)		10		mA
PA Gate Control Voltage (VG_PA, Adjustable to achieve required quiescent drain currents)		-0.7 / -3.3		V
PA Switch Control (TXSW, ON / OFF)		0 / 3.3		V
LNA Switch Control (RXSW, ON / OFF))		0 / 3.3		V
Switch Control Current (TXSW, RXSW, each)			1	mA
LNA Control Circuit Power Supply (VSS)		-3.3		V
Reference Voltage (VREF)		3.3		V
LNA Control Circuit Power Supply current		-0.5		mA
Operating Temperature	-40		85	°C

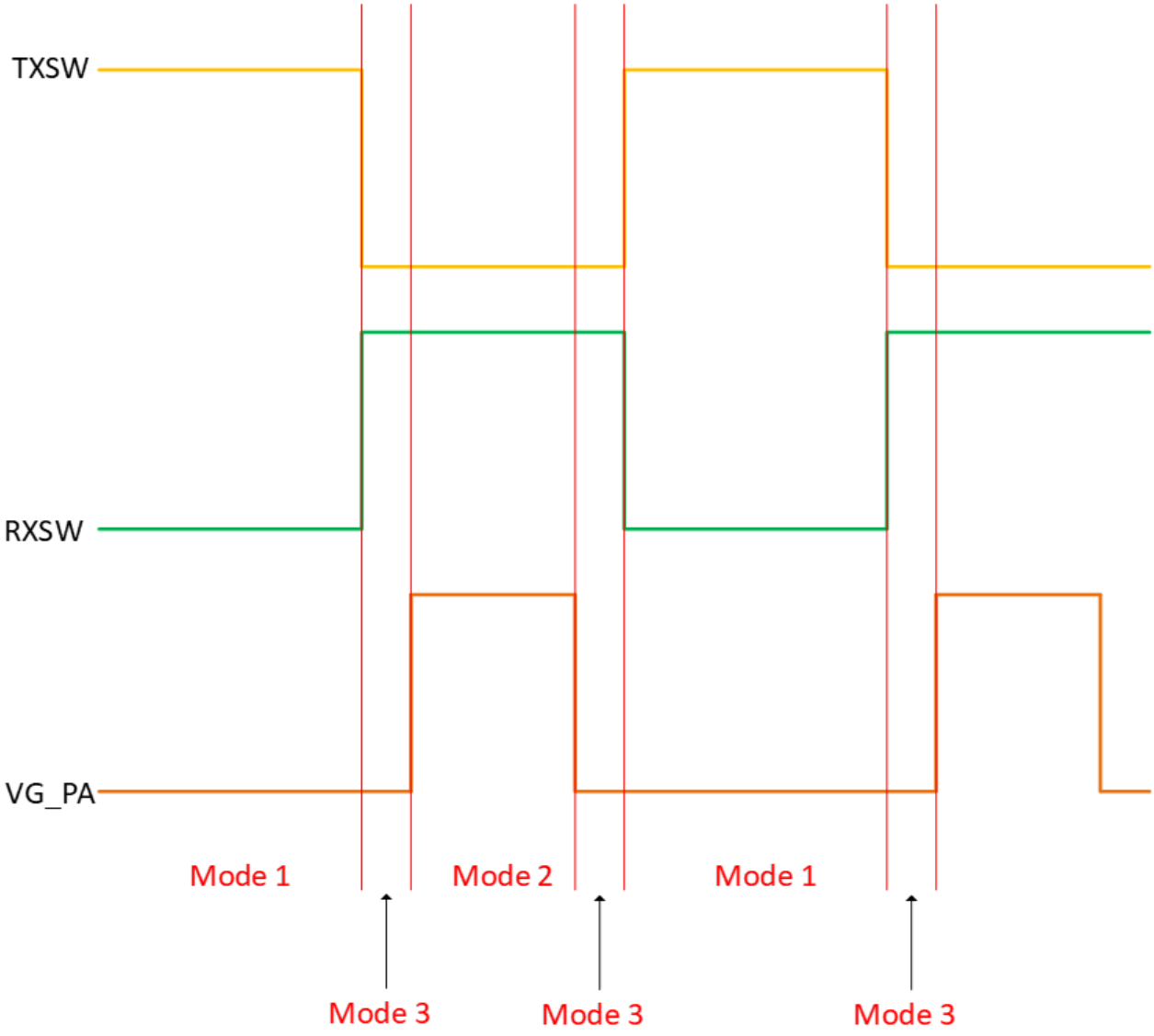
1 *Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.*
2 *VD_PA should be on for switch operations*

Operation Mode Controls

Modes	VG_PA	TXSW	RXSW	VREF	VSS	Descriptions
Mode 1	-3.3	3.3	0	3.3	-3.3	RX Channel ON, TX Channel OFF
Mode 2	-0.7 (3)	0	3.3	3.3	-3.3	RX Channel OFF, TX Channel ON
Mode 3	-3.3	0	3.3	3.3	-3.3	Both RX and TX Channels OFF

1 *Values listed are for pin control voltages (V)*
2 *Each Channel can be controlled independently*
3 *If TX channel switched on (TXSW = 0), the RX channel power supply will be switched off automatically*
4 *Values shown are typical, can be adjusted to get different drain currents for PA*
5 *When switching from Mode 2 (TX On) to Mode 1 (RX on), or Mode 1 (RX on) to Mode 2 (TX on), using mode 3 as an interim state and staying in mode 3 for at least 5-10ns is recommended.*

Timing Diagram illustration



Electrical Specifications, Receive

Test conditions unless otherwise noted: VD_LNA = 6 V, LNA_IDQ = 10 mA, RXSW = 0 V, TXSW = 3.3 V, Transmit channel biased off.
Data de-embedded to device reference plane, 25 °C

Parameter	Min	Typical	Max	Units
Frequency	8.5		10.5	GHz
Small Signal Gain	23	26		dB
Noise Figure	1.0	2.0	3.0	dB
Input Return Loss		10		dB
Output Return Loss		10		dB
Saturated Output Power, CW Mode		1		dBm
Output IMD3 @ -5 dBm Pout / Tone, CW Mode		25		dBc
Switching Time		15		nS
Gain Temperature Coefficient		−0.016		dB/°C

Electrical Specifications, Transmit

Test conditions unless otherwise noted: VD_PA = 5 V, PA_IDQ = 156 mA, RXSW = 3.3V, TXSW = 0 V
Data de-embedded to device reference plane, 25 °C

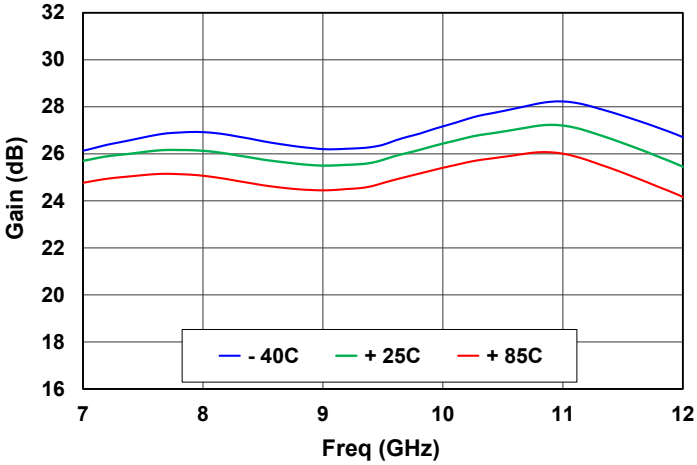
Parameter	Min	Typical	Max	Units
Frequency	8.5		10.5	GHz
Small Signal Gain		30		dB
Large Signal Gain		23.5		dB
Input Return Loss		10		dB
Output Return Loss		10		dB
Output Power (@ Pin = 4 dBm) [1]	26	27.5		dBm
PAE at Saturated Power (@ Pin =4 dBm) [1]	35	45	57	%
Output TOI @ 20 dBm Pout / tone, CW Mode		25		dBc
Harmonic Suppression, CW Mode		30		dBc
Switching Time		18		nS
Gain Temperature Coefficient		−0.027		dB/°C

1. *Power and PAE measured with DC drain pulsed, PW = 100 uS, Duty Cycle = 10%.*

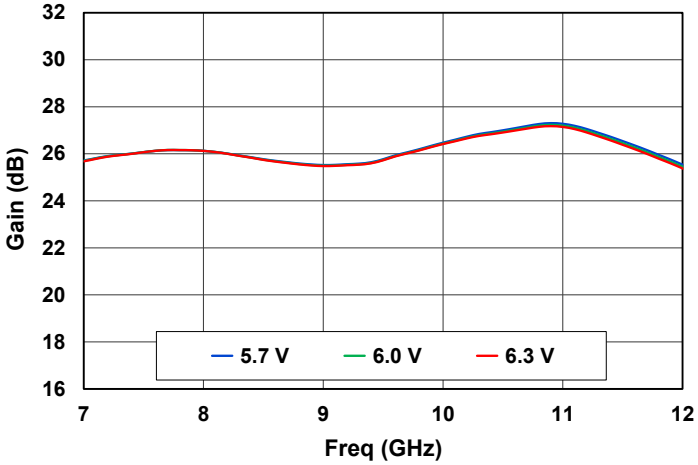
Small Signal Performance, Receive

Test Conditions unless otherwise stated: VD_LNA = 6 V, LNA_IDQ = 10 mA, 25 °C

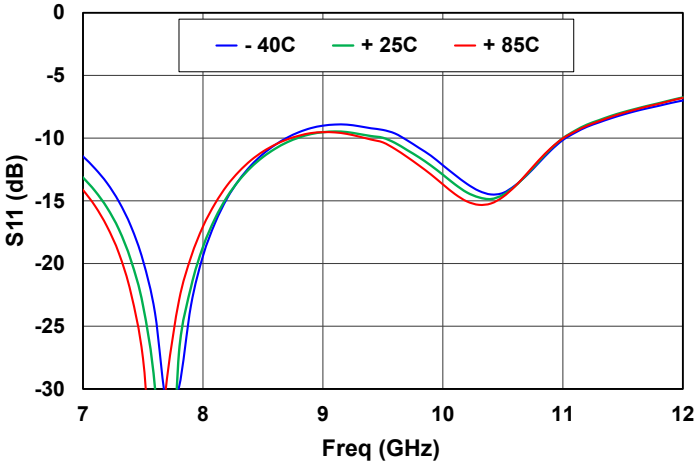
Gain vs Temp



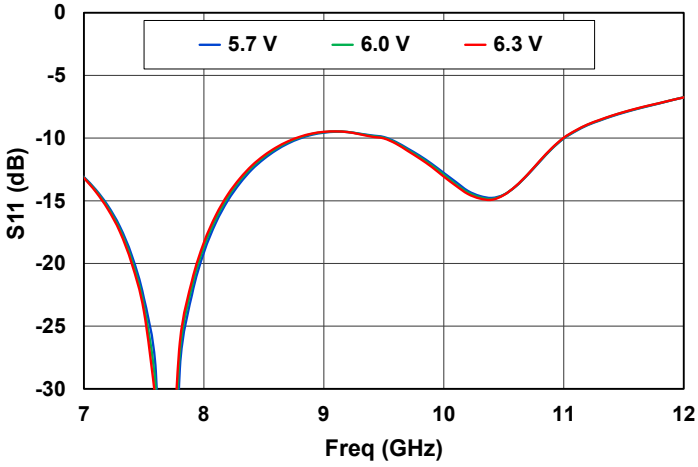
Gain vs Voltage



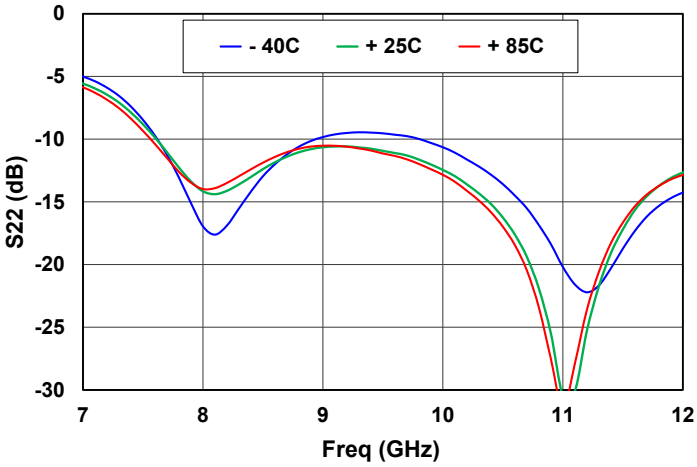
Input Return Loss vs Temp



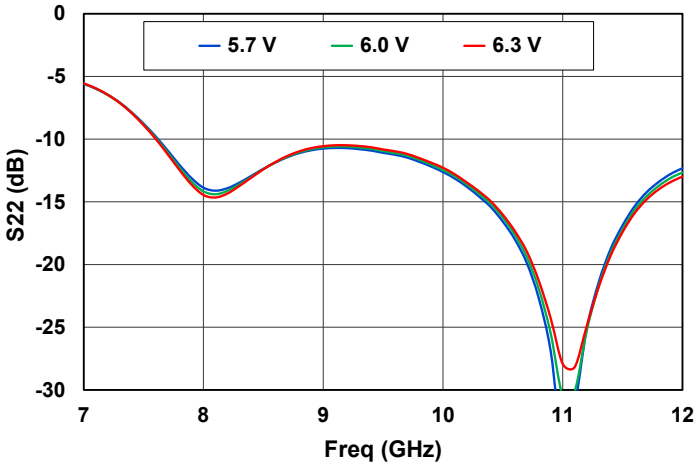
Input Return Loss vs Voltage



Output Return Loss vs Temp

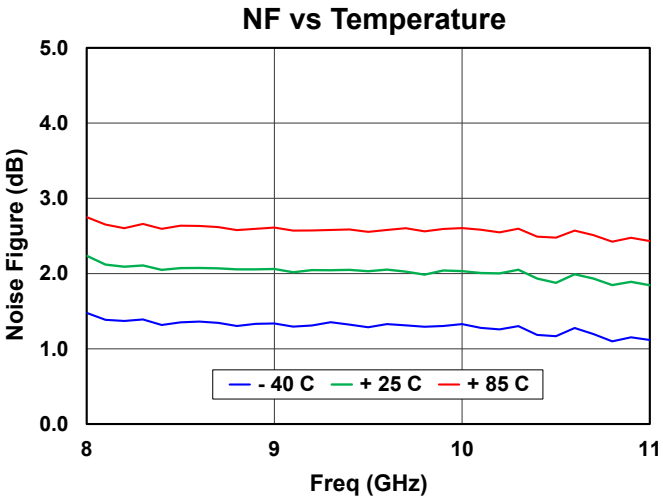


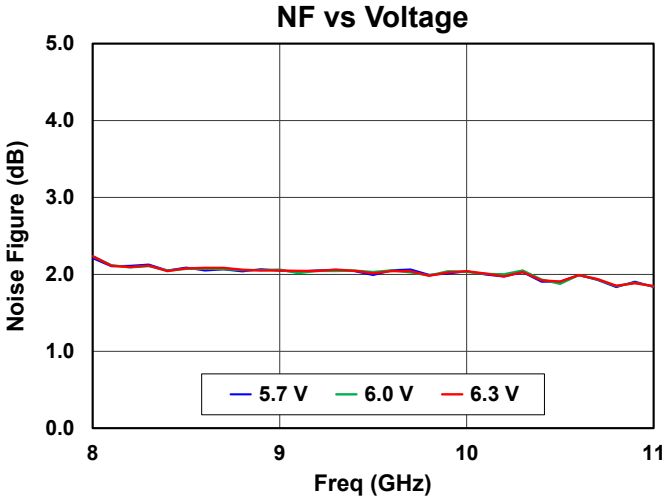
Output Return Loss vs Voltage



Noise Figure, Receive

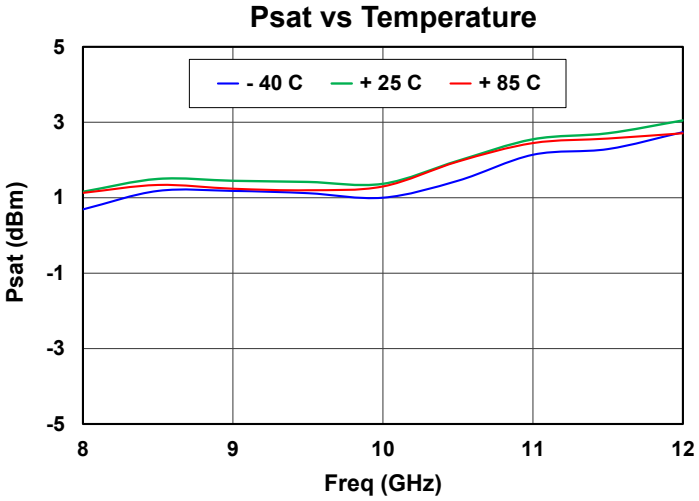
Test Conditions unless otherwise stated: VD_LNA = 6 V, LNA_IDQ = 10 mA, 25 °C

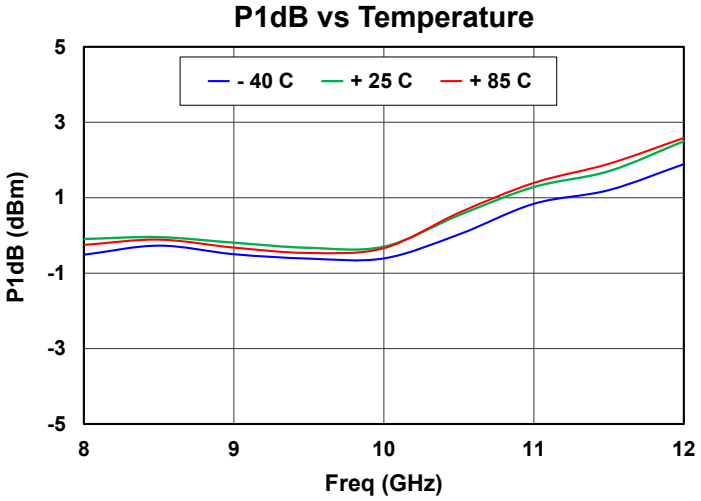


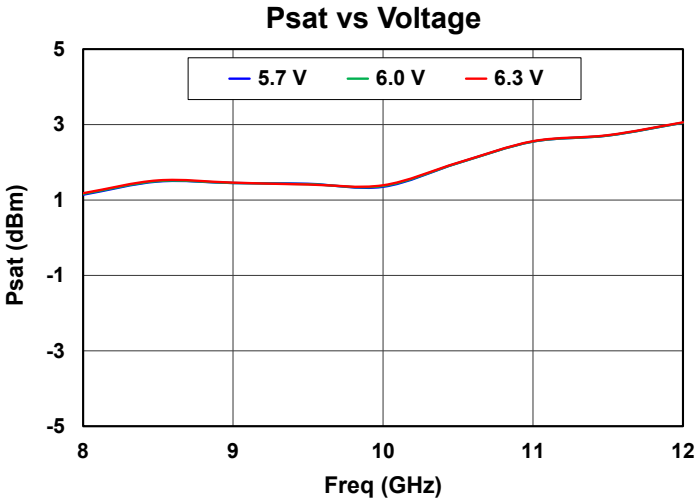


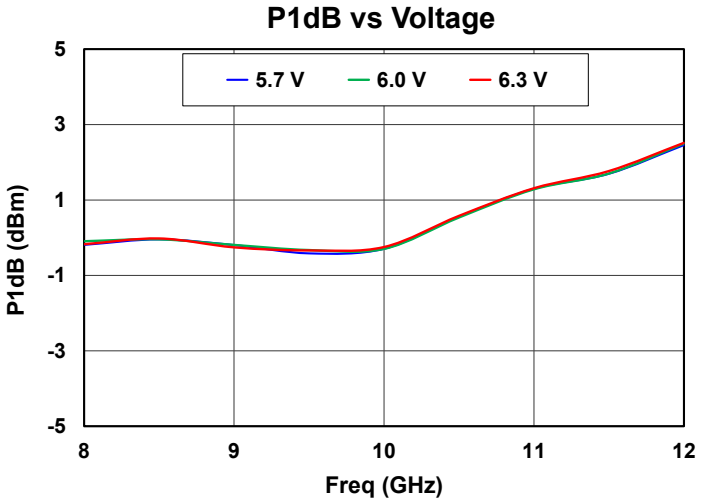
Power Performance, Receive

Test Conditions unless otherwise stated: VD = 6 V, LNA_IDQ = 10 mA, CW Mode, 25 °C



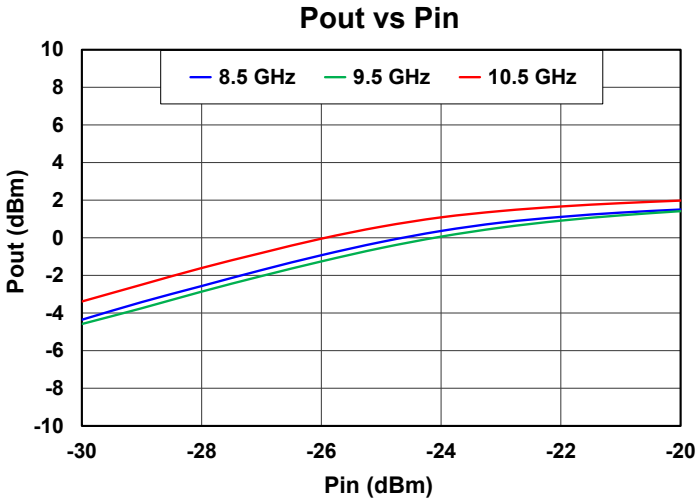


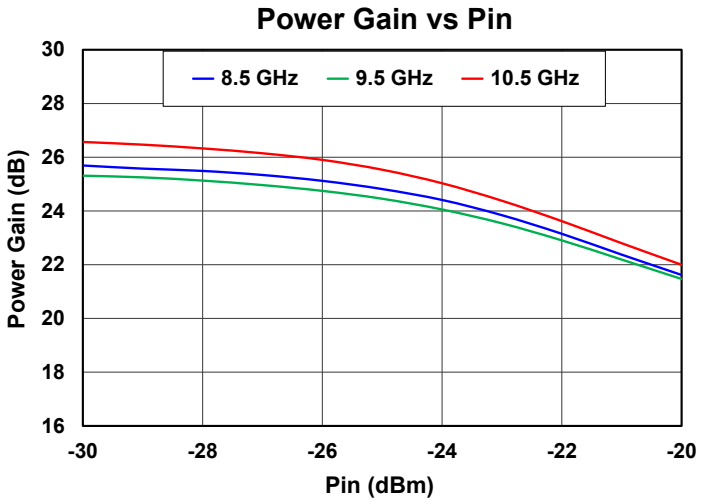


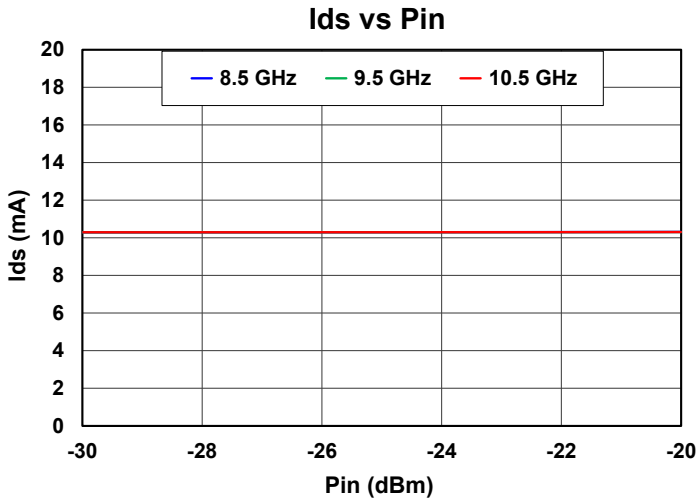


Power Sweep, Receive

Test Conditions unless otherwise stated: VD_LNA = 6 V, LNA_IDQ = 10 mA, CW Mode, 25 °C

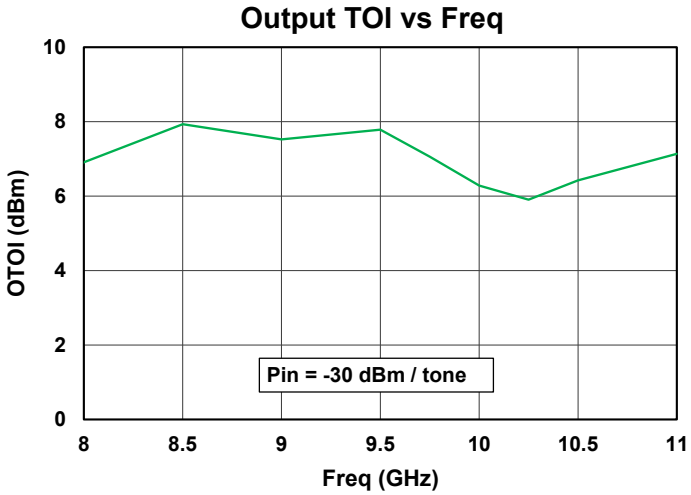


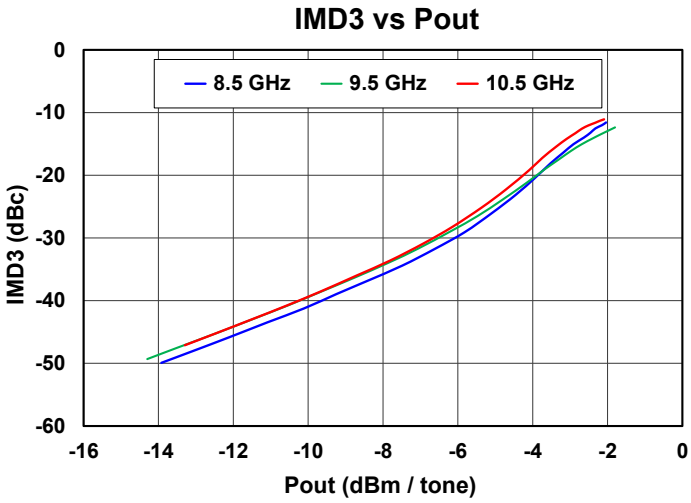


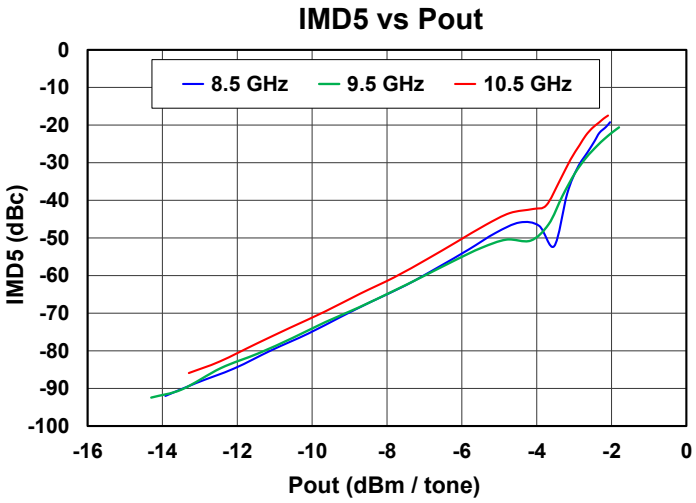


Linearity, Receive

Test Conditions unless otherwise stated: VD_LNA = 6 V, LNA_IDQ = 10 mA, CW Mode, Tone spacing = 10 MHz, 25 °C

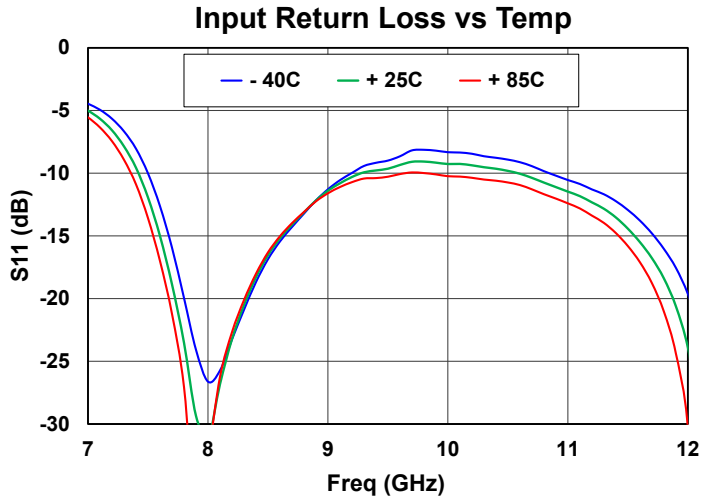


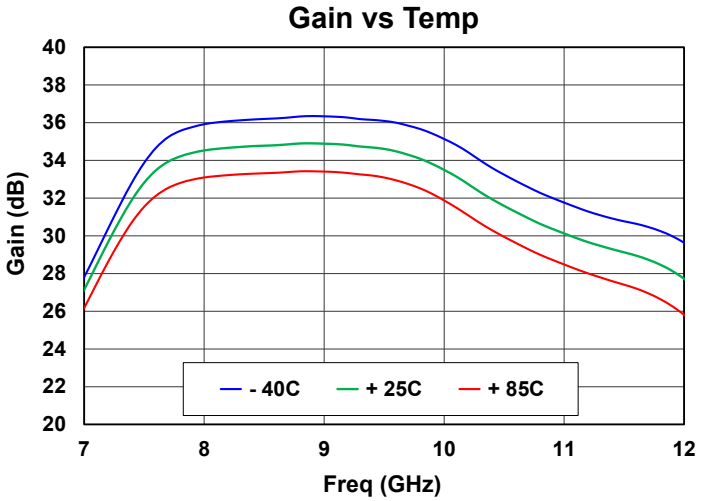


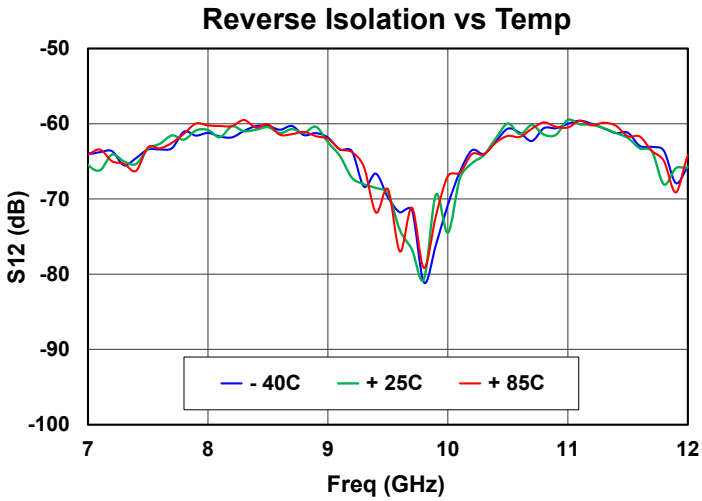


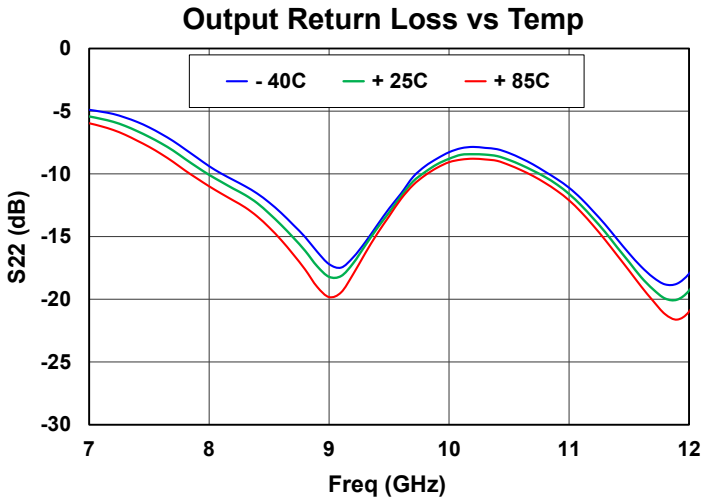
Small Signal Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA, 25 °C





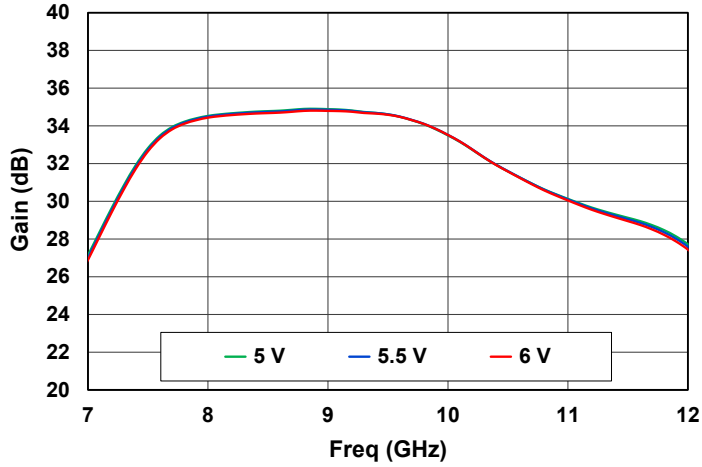




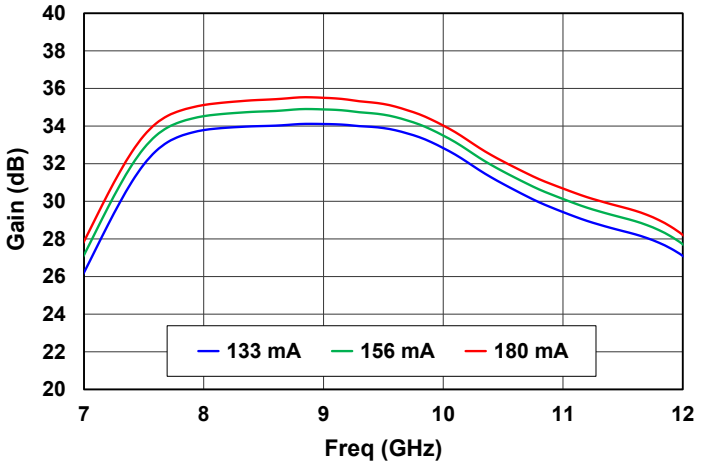
Small Signal Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA, 25 °C

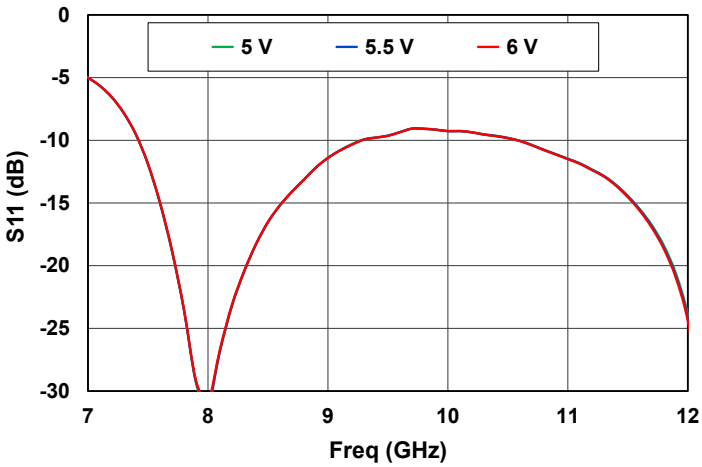
Gain vs Voltage



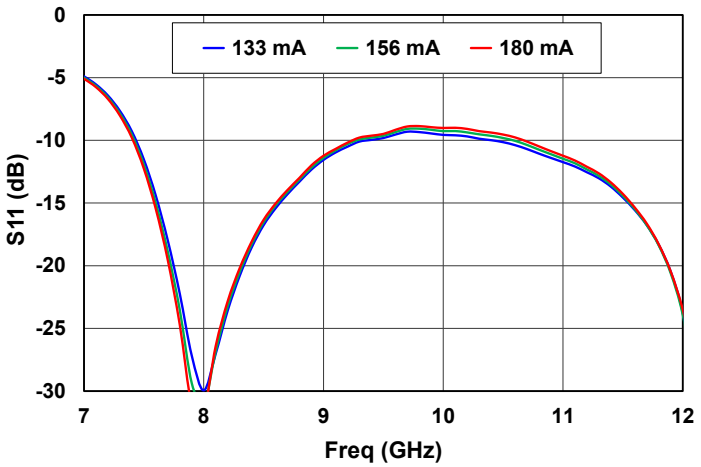
Gain vs Current



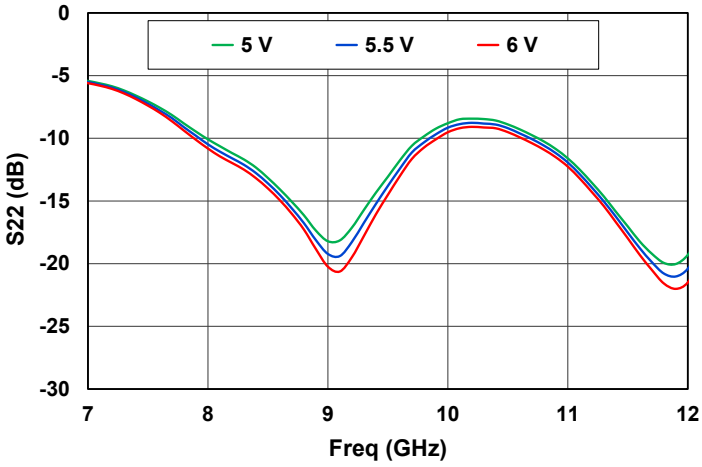
Input Return Loss vs Voltage



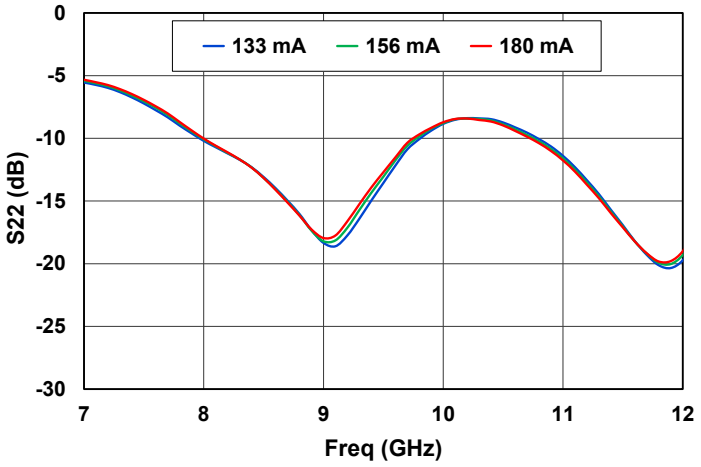
Input Return Loss vs Current



Output Return Loss vs Voltage



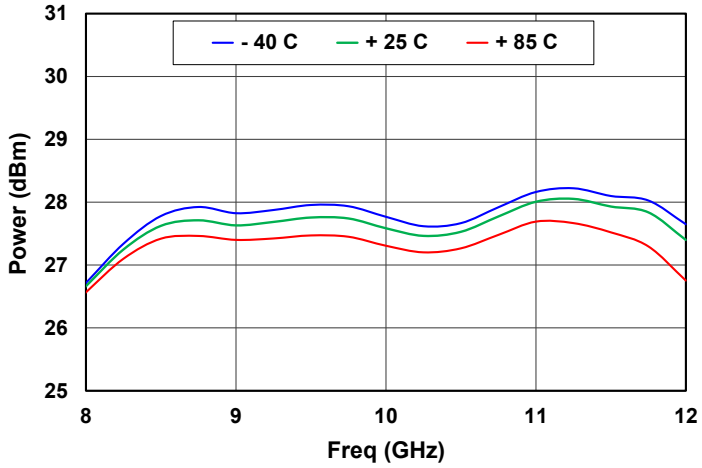
Output Return Loss vs Current



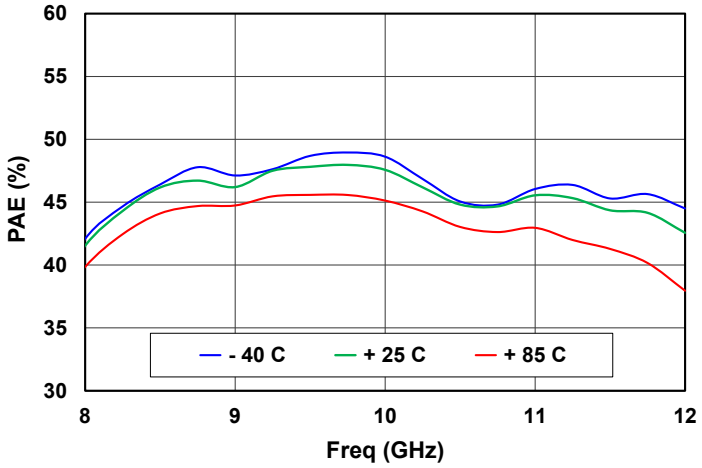
Power Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA,
Pulse Mode, Pin = 4 dBm, PW = 100 uS, DC = 10%, 25 °C

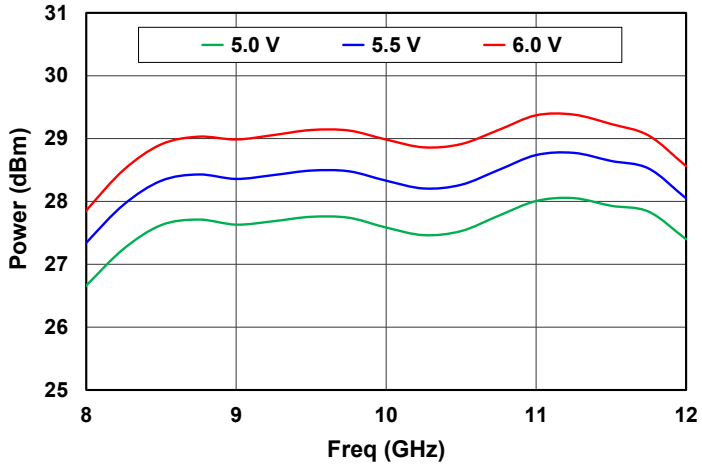
Power vs Temperature



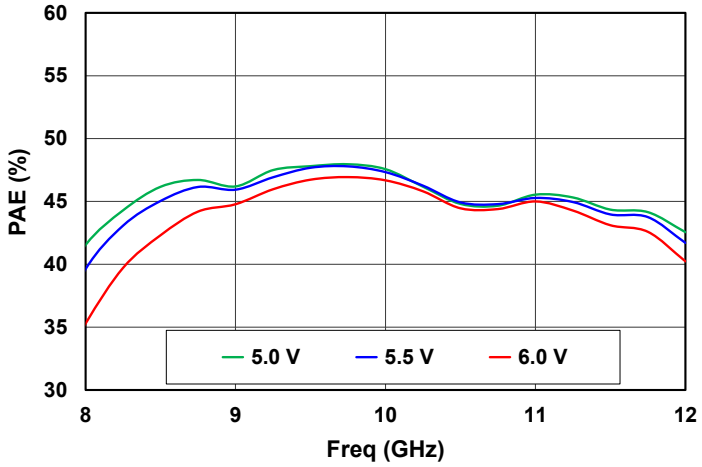
PAE vs Temperature



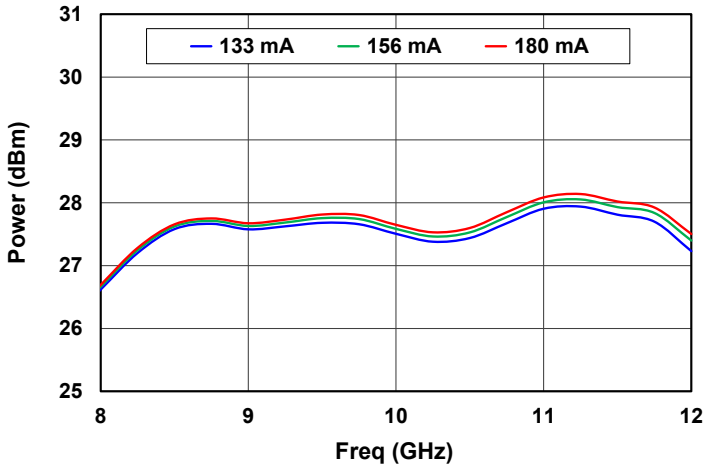
Power vs Voltage



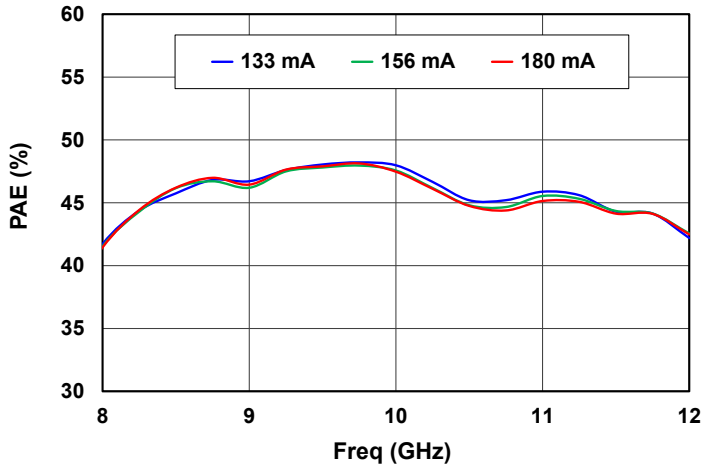
PAE vs Voltage



Power vs Current



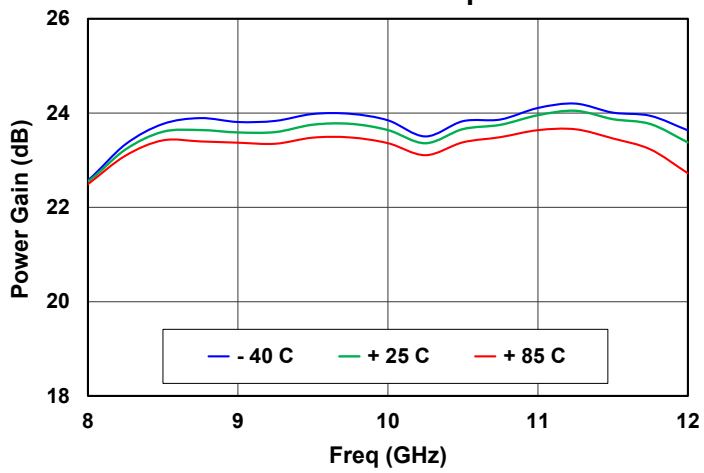
PAE vs Current



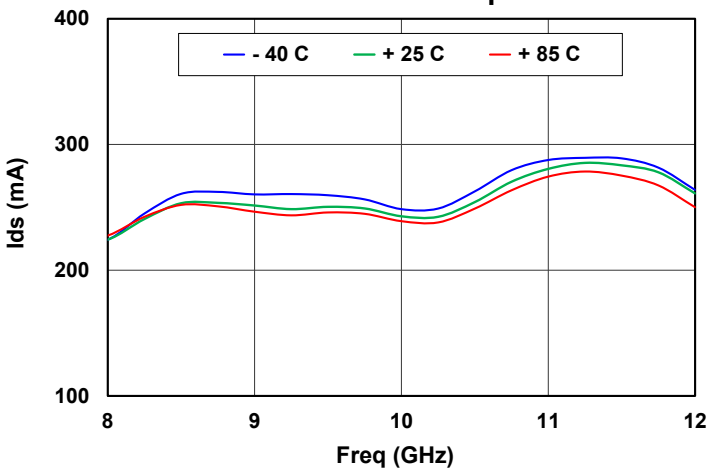
Power Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA
Pulse Mode, Pin = 4 dBm, PW = 100 uS, DC = 10%, 25 °C

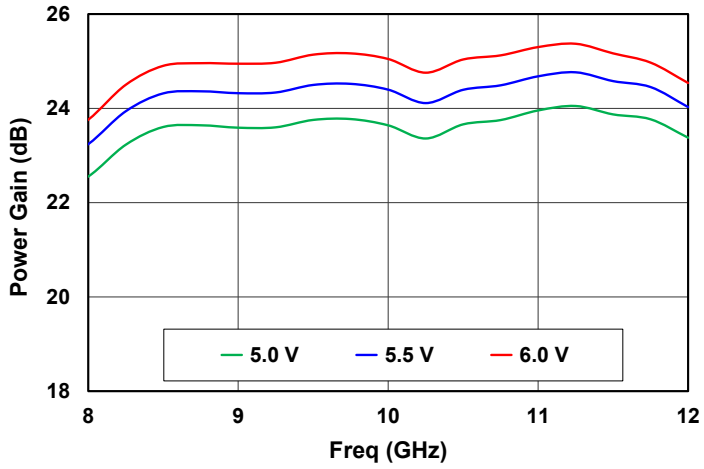
Power Gain vs Temperature



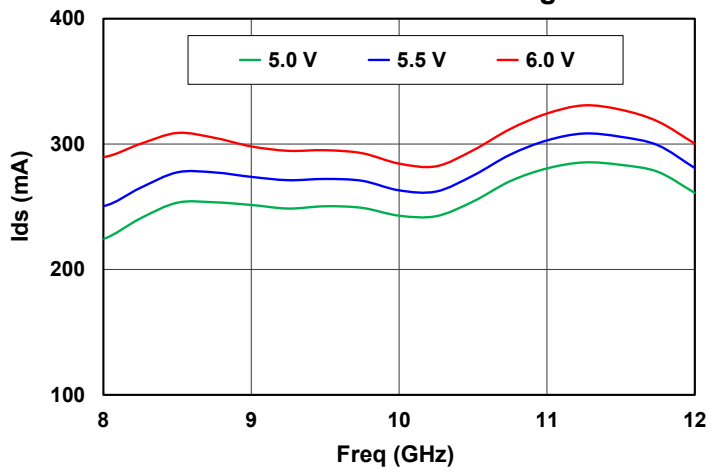
Drain Current vs Temperature



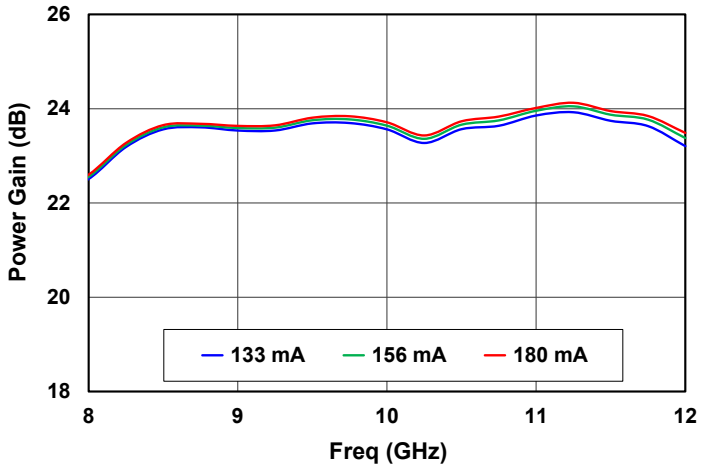
Power Gain vs Voltage



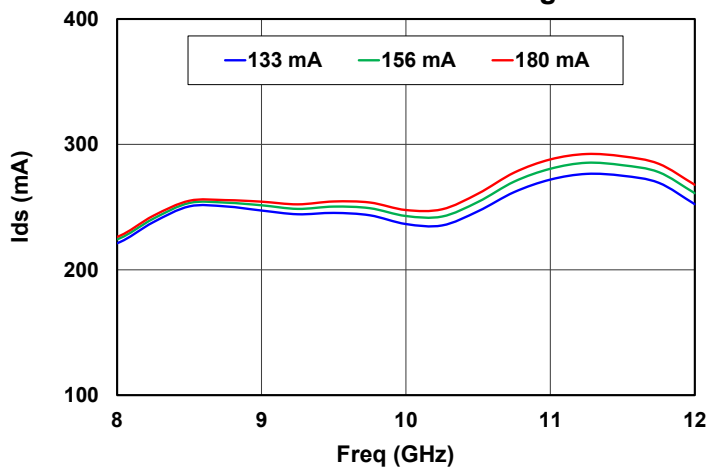
Drain Current vs Voltage



Power Gain vs Current



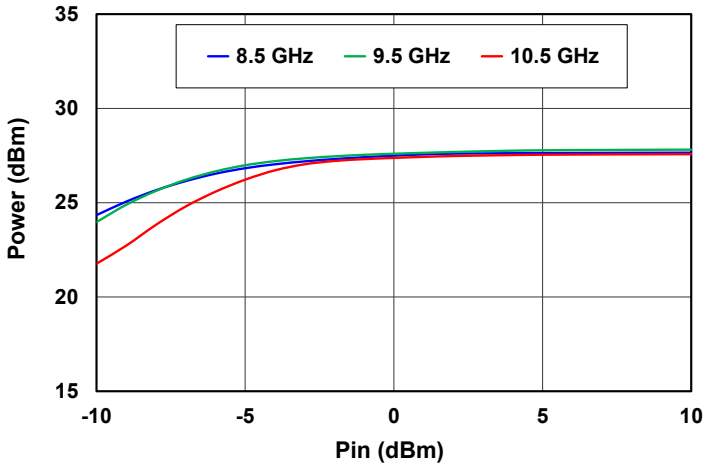
Drain Current vs Voltage



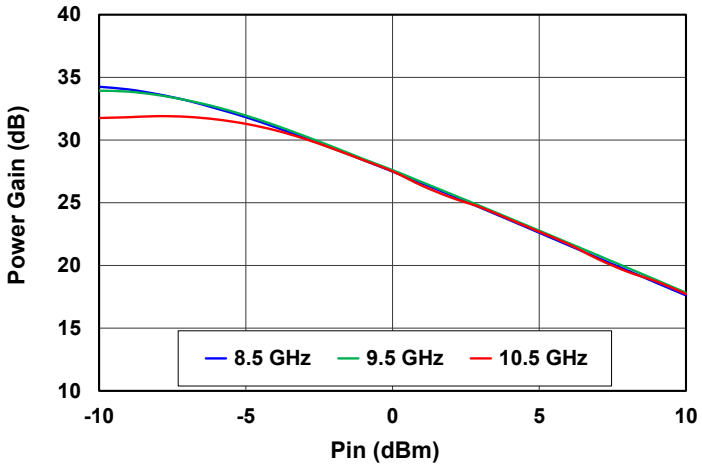
Power Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA
Pulse Mode, PW = 100 uS, DC = 10%, 25 °C

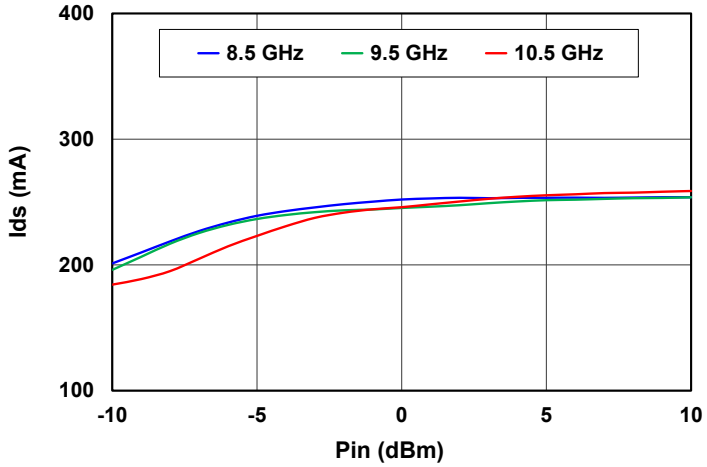
Power vs Pin



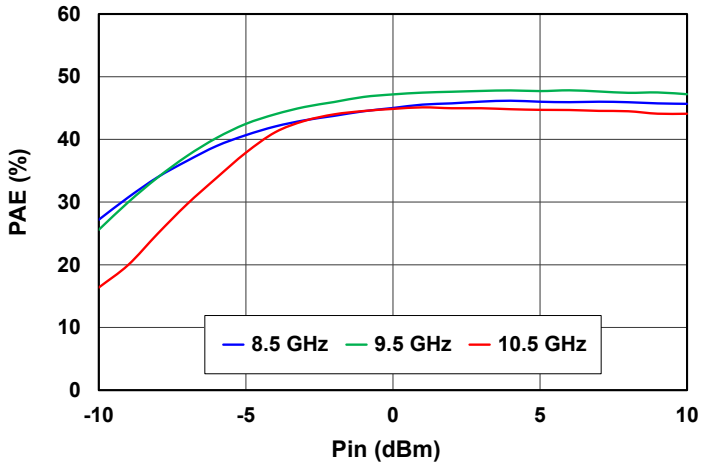
Power Gain vs Pin



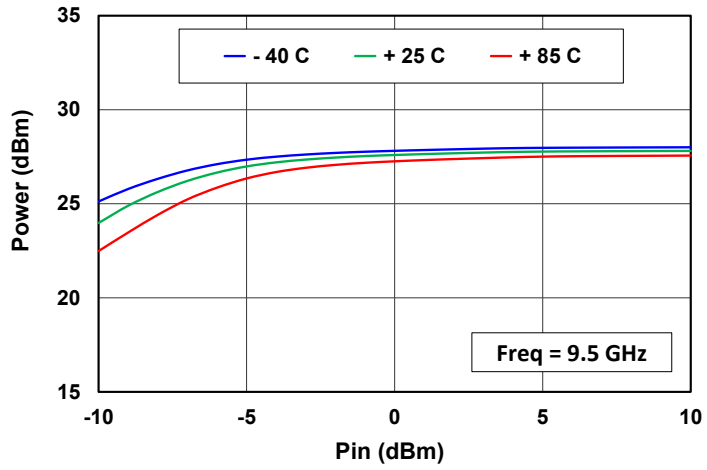
Drain Current vs Pin



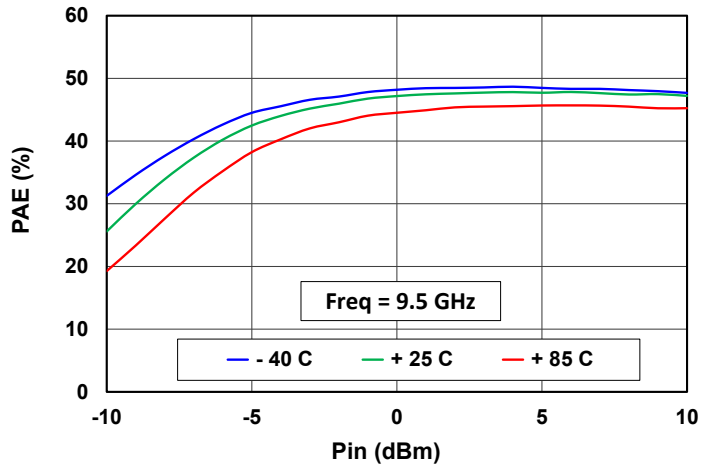
PAE vs Pin



Power vs Pin vs Temp

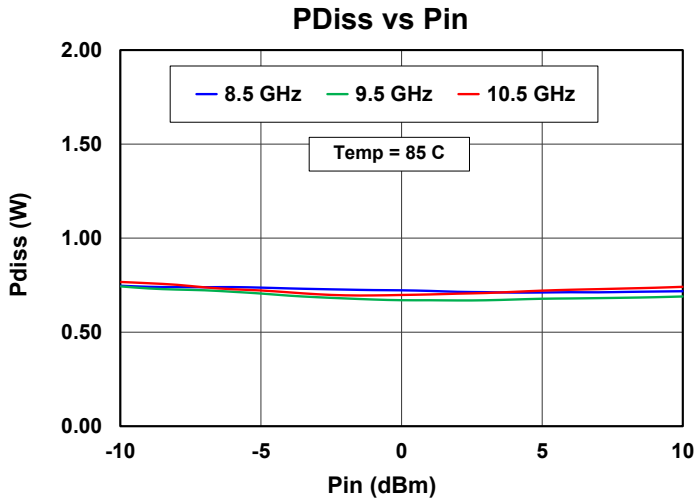


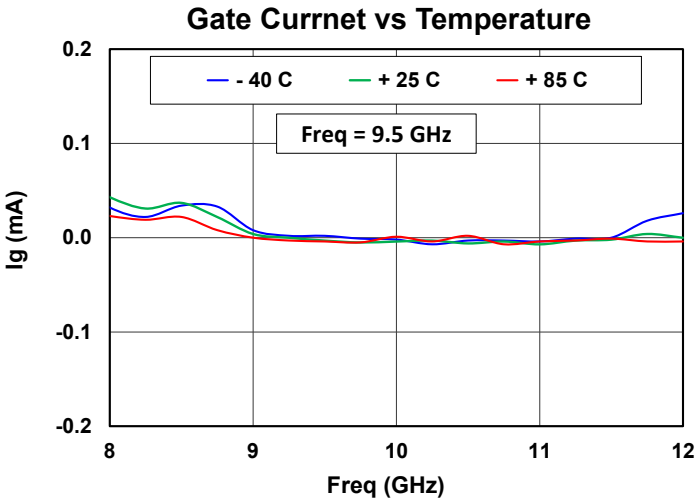
PAE vs Pin vs Temp

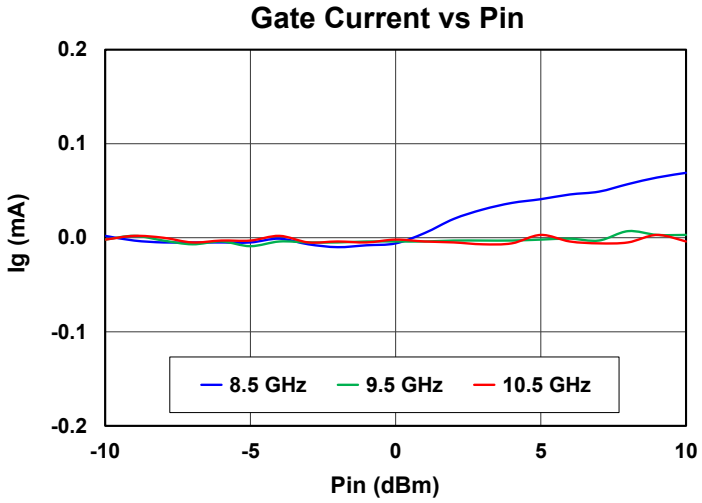


Power Performance, Transmit

Test Conditions unless otherwise stated: VD_PA = 5 V, PA_IDQ = 156 mA
Pulse Mode, PW = 100 uS, DC = 10%, 25 °C

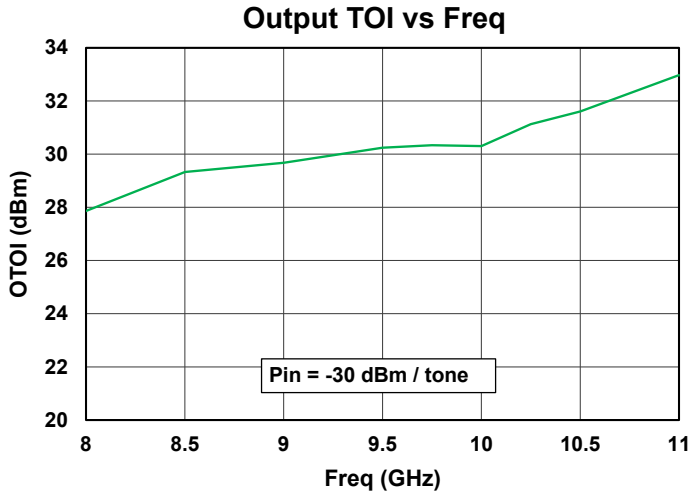


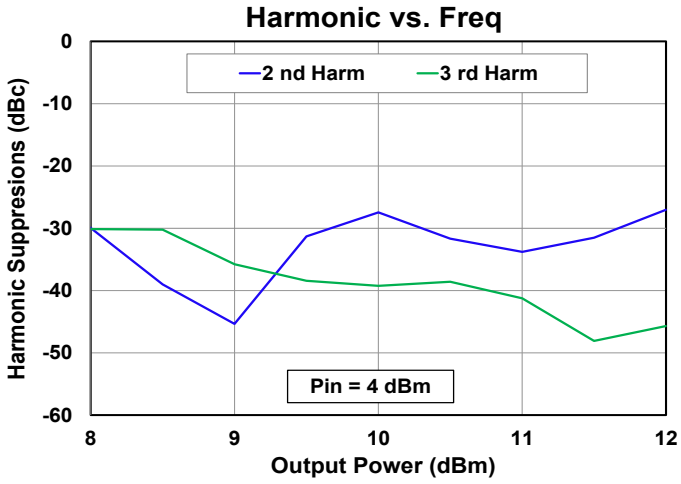


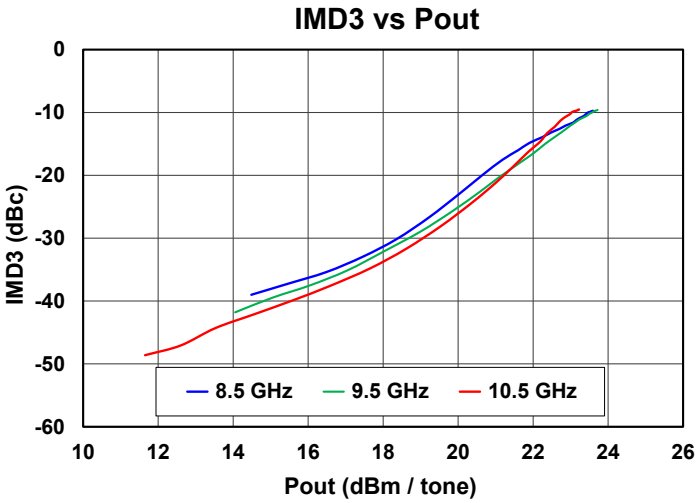


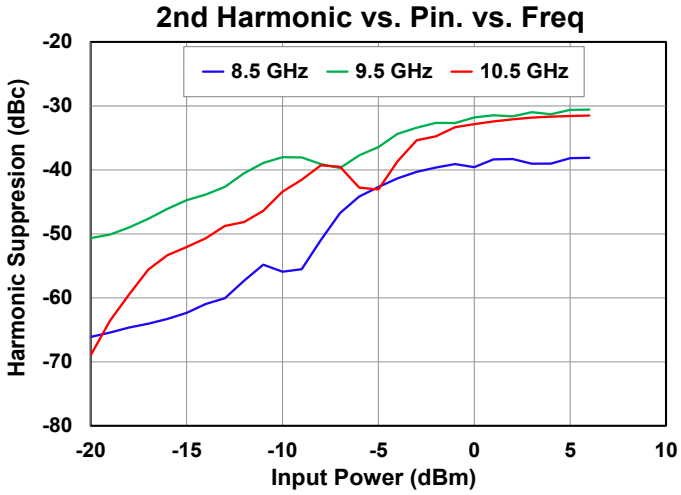
Linearity, Transmit

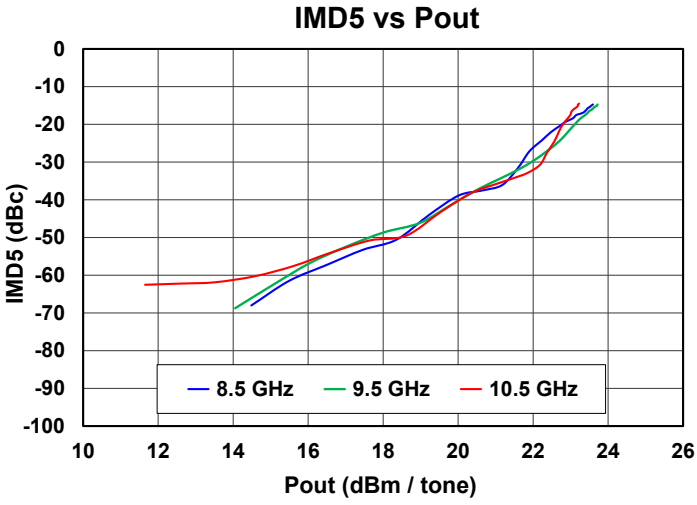
Test Conditions unless otherwise stated: 25 °C
VD_PA = 5 V, PA_IDQ = 156 mA, CW Mode, TOI Tone Spacing = 10 MHz

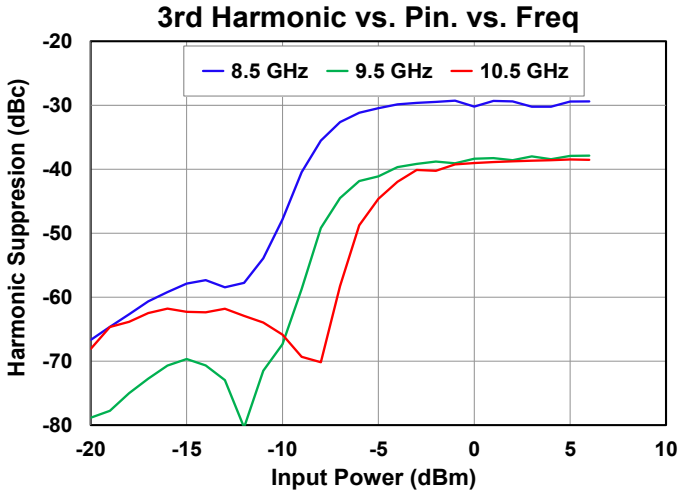




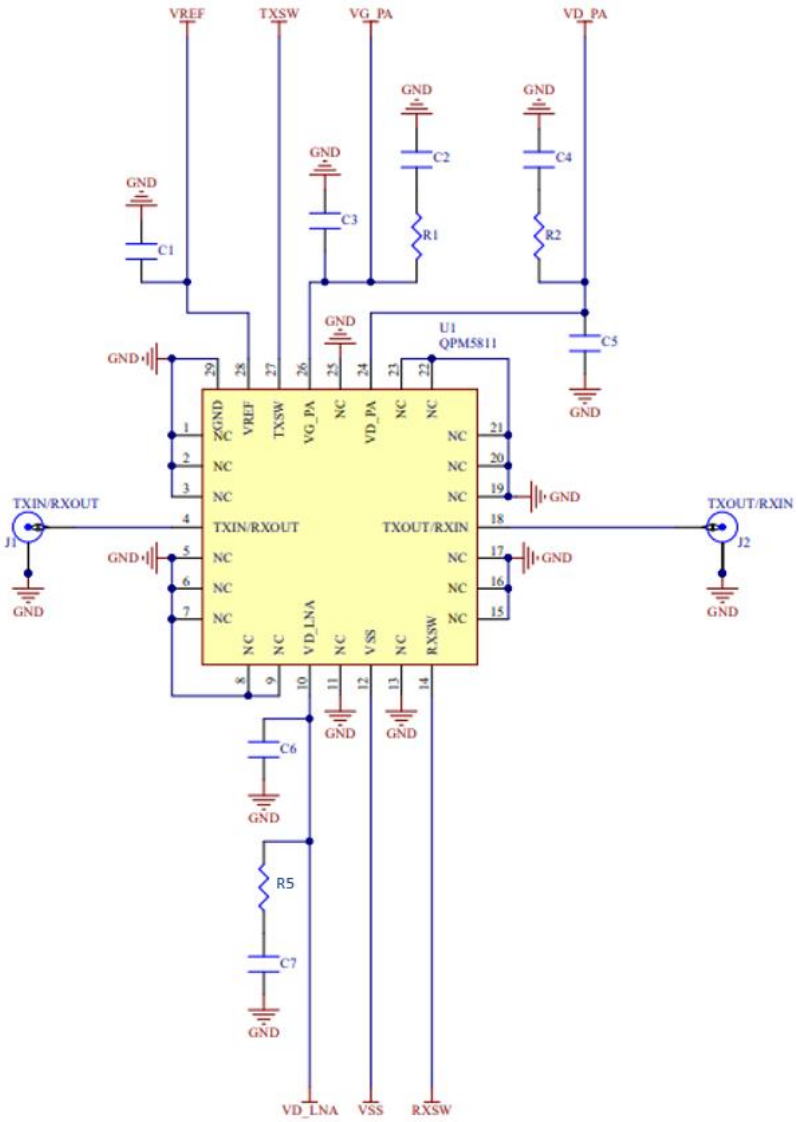








Application Circuit



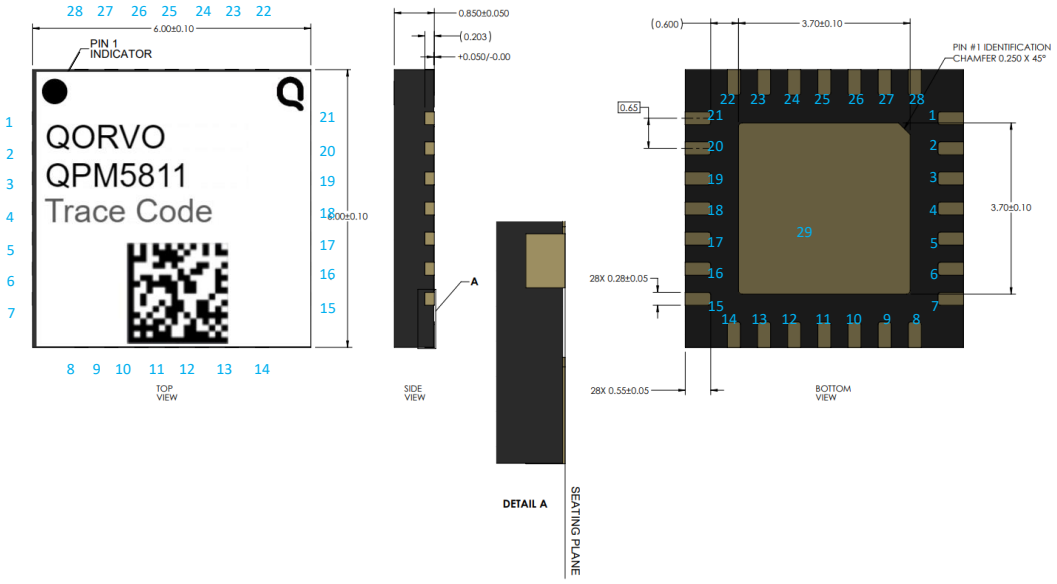
Bias-up Procedure

1. Set TXVD current limit to 600 mA, RXVD current limit to 50mA, gate current limit to 10 mA, switch control current limit to 10mA
2. Set VG_PA to – 3.3 V, VSS = -3.3 V, VREF = 3.3 V
3. Set TXSW = 3.3 V (or 0 V), RXSW = 0 V (or 3.3 V) for Receive (Transmit)
4. Set VD_LNA = + 6 V, VD_PA = + 5 V (for receive mode, should set VG_PA = - 3.3 V).
5. Adjust VG_PA to achieve required drain current for PA (typical is - 0.7 V). The RX LNA is self-biased.
6. Apply RF signal

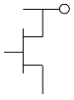
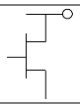
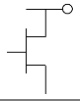
Bias-down Procedure

1. Turn off RF signal
2. Set VG_PA to −3.3 V
3. Set RXSW = 3.3 V, TXSW = 3.3 V
4. Turn off drain supplies
5. Turn off control signals
6. Turn off gate supplies

Mechanical Drawing & Pad Description

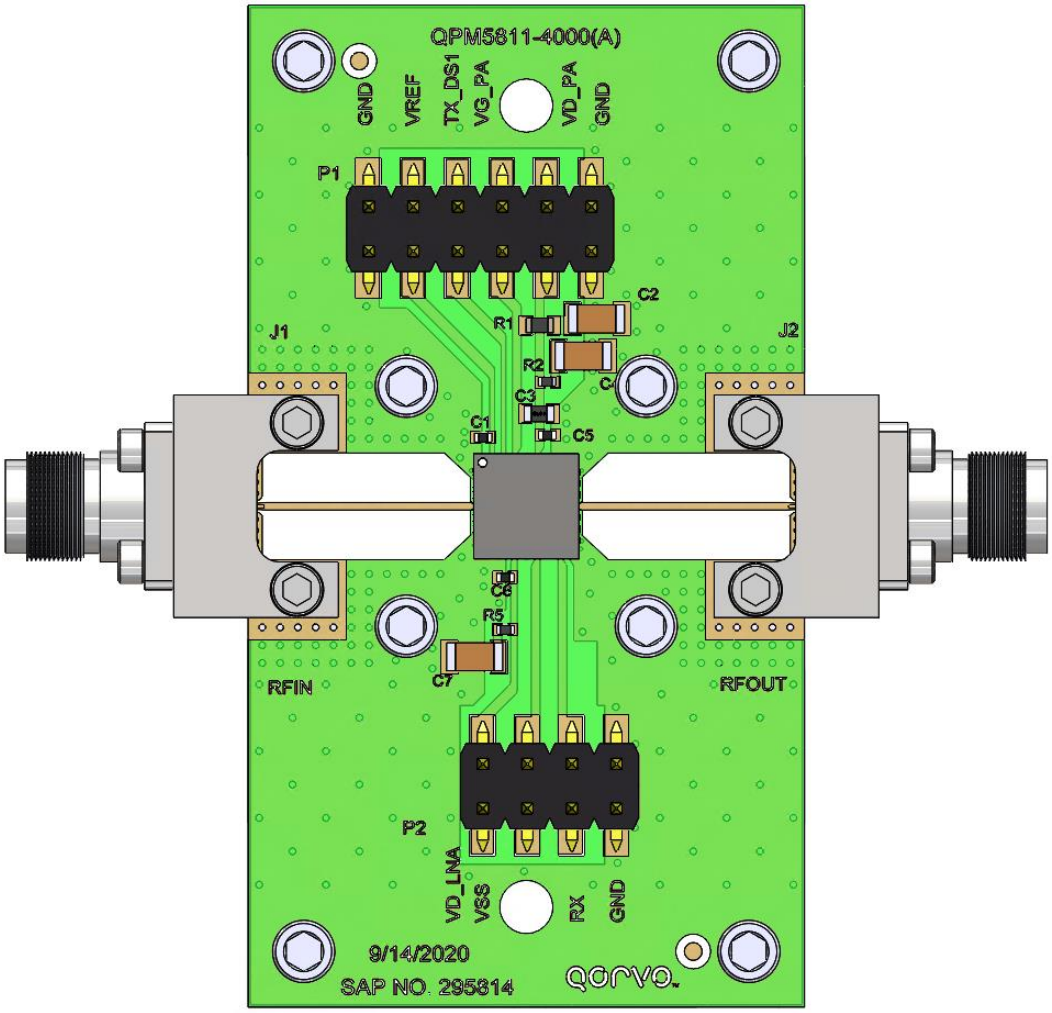


Dimensions in mm, Package is mold encapsulated with Ni/Pd/Au plated leads
Part Marking: QPM5811 = Part Number, Trace Code and 2DID can be used to trace part manufacturing information

Pin Number	Label	Functional Schematic	Description
4	TXIN/RXOUT		Common Port for TXIN and RXOUT, DC Blocked
10	VD_LNA		LNA Drain Supply
12	VSS		LNA Bias Control Power Supply
14	RXSW		RX Receiving Switch Control
18	TXOUT/RXIN		Common Port for TXOUT and RXIN, DC Blocked
24	VD_PA		PA Drain Supply
26	VG_PA		PA Gate Control
27	TXSW		TX Transmit Switch Control
28	VREF		Switch Control Reference
1 - 3, 5 - 9, 11, 13, 15 - 17, 19 - 23, 25	N/C		No Internal Connections, can be grounded

29	GND		GROUND

Evaluation Board and Assembly

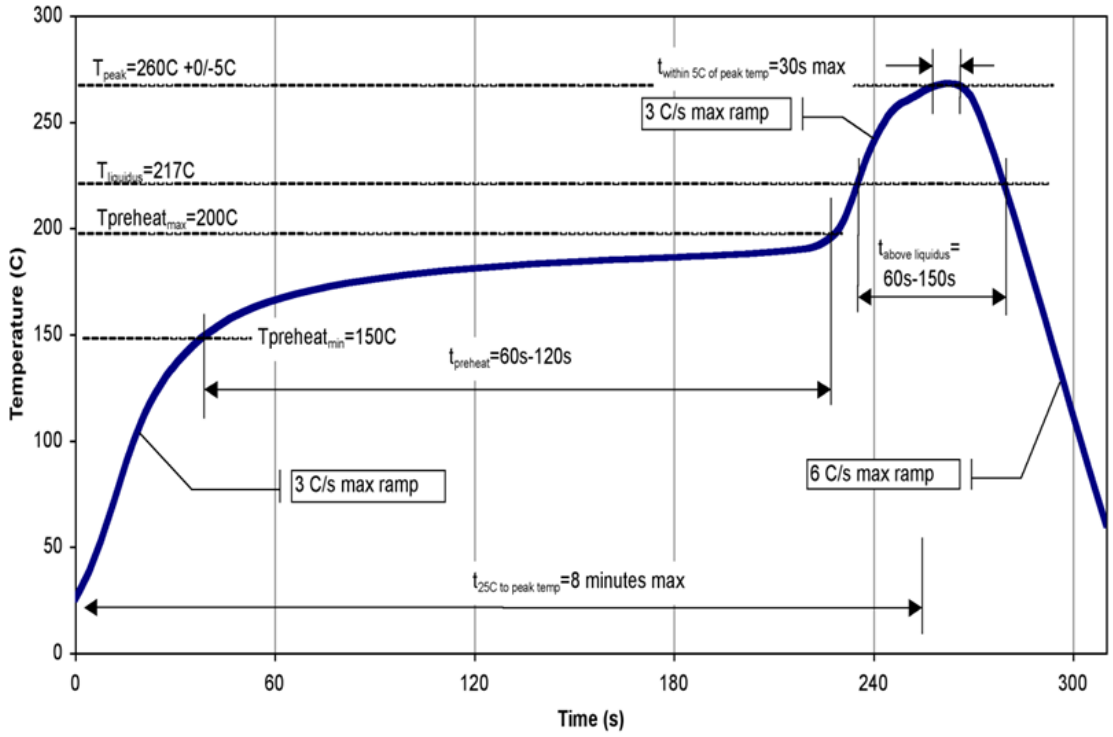


RF Layer is 0.008” thick Rogers Corp. RO4003C (ε_r = 3.35). Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-5.

Ref. Des.	Component	Value	Manuf.	Part Number
C1, C5, C6,	SMT Cap.	CAP, 0402 1000 pF +/-10% 16V X7R ROHS	Various	
C3	SMT Cap.	CAP, 0603 1000 pF +/-10% 16V	Various	
C2, C4, C7	SMT Res.	CAP, 1206 10 uF, 20% 16V, X5R	Various	
R2, R5	SMT Res.	RES, 0402 10 OHM, 5% 1/10W	Various	
R1	SMT Res.	RES, 0603 10 OHM, 5% 1/10 W	Various	
J1, J2	CONN	CONN, 2.92 mm, F End Launch	Southwest Microwave	1092-01A-5

Solderability and Recommended Soldering Temperature Profile

1. Compatible with the latest version of J-STD-020, Lead-free solder, peak reflow temperature 260 °C.



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1A	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	C3	ESDA / JEDEC JS-002-2014
MSL – Convection Reflow 260 °C	3	JEDEC standard IPC/JEDEC J-STD-020

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

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