QPM1021

10 – 12 GHz 100 W GaN Power Amplifier

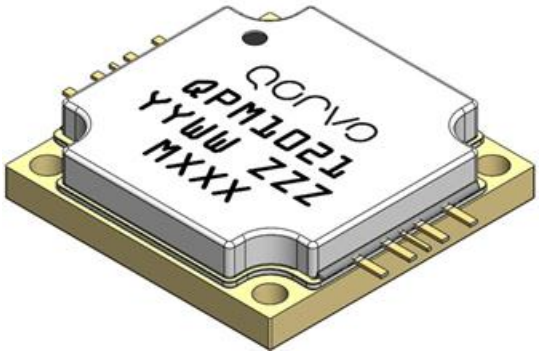
Product Overview

Qorvo's QPM1021 is a packaged, high power amplifier fabricated on Qorvo's production 0.15 um GaN on SiC process. The QPM1021 operates from 10 – 12 GHz and provides 100 W (50 dBm) of saturated output power with 20 dB of large signal gain and greater than 32 % power–added efficiency.

The QPM1021 is packaged in a 10-lead 19.05 x 19.05 mm bolt-down package, with a pure copper base for superior thermal management. Both RF ports are internally DC blocked and matched to 50 ohms allowing for simple system integration.

The QPM1021 is ideally suited for both commercial and military radar systems, satellite communications systems, and data links.

RoHS compliant.

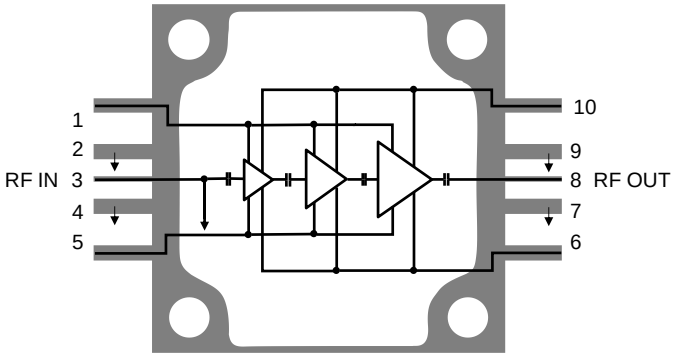


Key Features

- Frequency Range: 10 – 12 GHz
- P_{SAT}: > 50 dBm (P_{IN} = 28 dBm)
- PAE: > 32% (P_{IN} = 28 dBm)
- Large Signal Gain: > 20 dB (P_{IN} = 28 dBm)
- Small Signal Gain: > 26 dB
- Bias: V_D = 28 V, I_{DQ} = 2.0 A
- Package Dimensions: 19.05 x 19.05 x 4.52 mm
- Performance Under Pulsed Operation

Performance is typical across frequency. Please reference electrical specification table and data plots for more details.

Functional Block Diagram



Top View

Applications

- Radar
- Electronic Warfare

Ordering Information

Part No.	Description
QPM1021	10–12 GHz 100 Watt GaN Power Amplifier (20 pcs.)
QPM1021S2	QPM1021 Samples (2 pcs.)
QPM1021EVB	QPM1021 Evaluation Board

Absolute Maximum Ratings

Parameter	Min Values	Max Values	Units
Drain Voltage (V_D)		29.5	V
Gate Voltage Range (V_G)	-5	0	V
Drain Current (I_D)		18.2	A
Gate Current (I_G)	See plot pg. 12		
Power Dissipation (P_{DISS}), 85 °C, Pulsed; PW = 150 us, DC = 20%		435	Watts
Input Power (P_{IN}), 50 Ω, 85 °C , V_D = 28 V, Pulsed; PW = 150 us, DC = 20%		32	dBm
Input Power (P_{IN}), 85 °C, VSWR 3:1, V_D = 28 V, Pulsed; PW = 150 us, DC = 20%		38	dBm
Mounting Temperature	Refer to Assembly Notes, page 16		
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	Min	Typ	Max	Units
Drain Voltage (V_D)		28		V
Drain Current (I_{DQ})		2.0		A
Operating Temperature Range	−40	25	85	°C

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

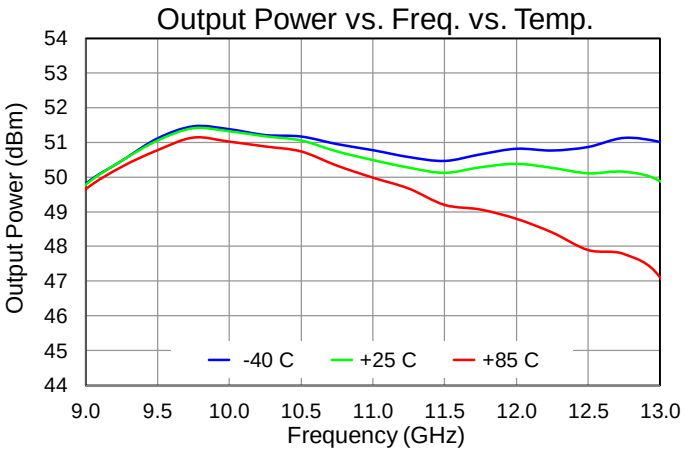
Electrical Specifications

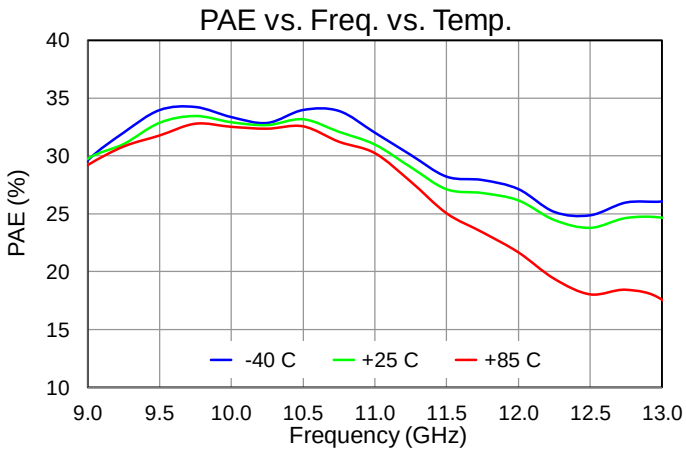
Parameter	Conditions [1]		Min	Typ	Max	Units
Frequency Range			10		12	GHz
Output Power	P_{IN} = 28 dBm, Pulsed	10.0 GHz 11.2 GHz 12.0 GHz	49.5 48.0 48.0	51.3 50.3 50.4		dBm
Power Added Efficiency	P_{IN} = 28 dBm, Pulsed	10.0 GHz 11.2 GHz 12.0 GHz	22.0 20.8 19.2	32.9 29.4 26.2		%
P_{OUT} Temperature Coefficient	Temp: 25 °C to 85 °C, P_{IN} = 28 dBm)			–0.012		dB/°C
Small Signal Gain		10.0 GHz 11.2 GHz 12.0 GHz		26.6 22.8 20.2		dB
Input Return Loss				13		dB
Output Return Loss				11		dB
Small Sig. Gain Temp. Coefficient	Temp: –40°C to 85 °C			-0.110		dB/°C
Recommended Operating Voltage			24	28	28	V

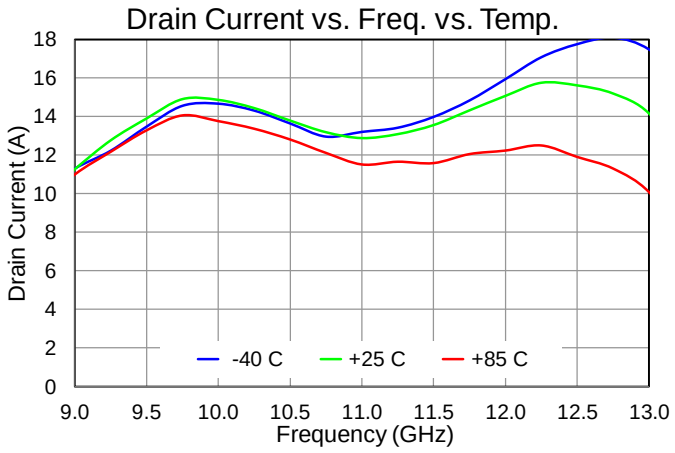
Notes:
Test conditions unless otherwise noted: T = 25 °C , V_D = 28 V, I_{DQ} = 2.0 A, PW = 150 us, Duty Cycle = 20%

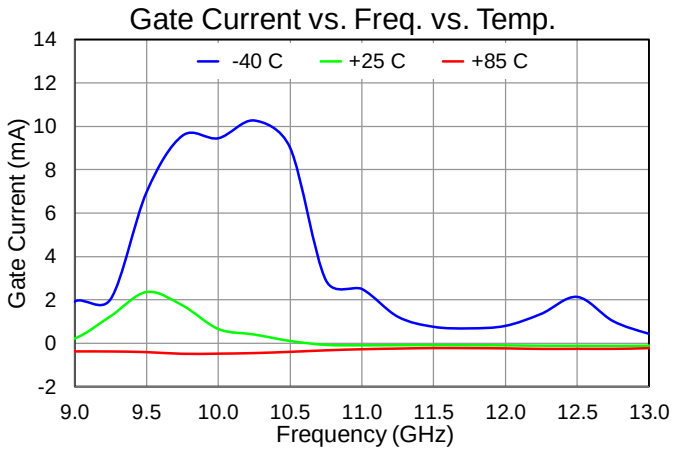
Performance Plots – Large Signal

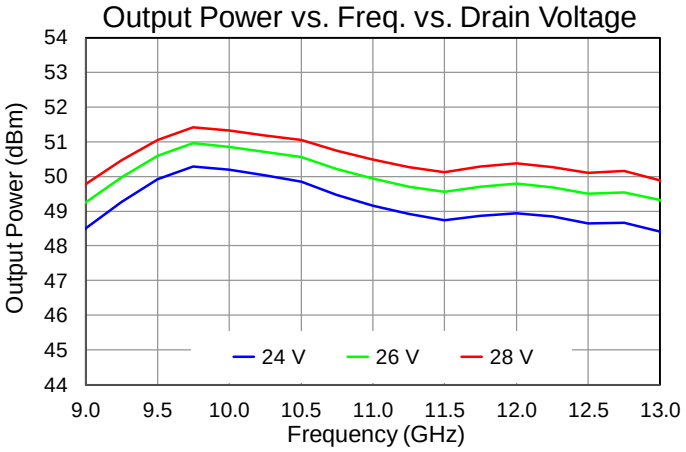
Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, P_{IN} = 28 dBm, PW = 150 us, Duty Cycle = 20%

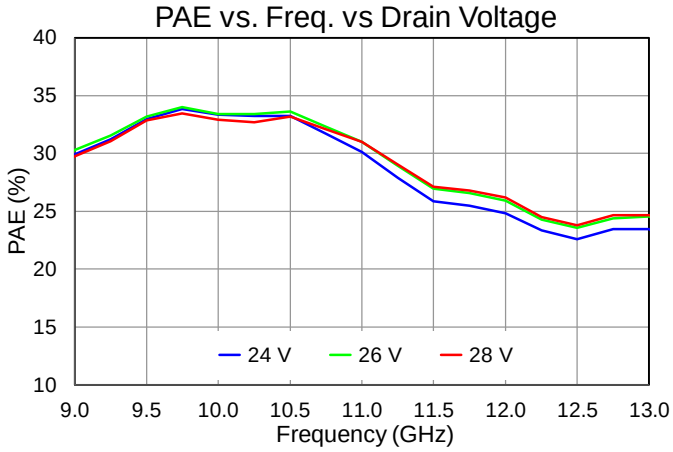






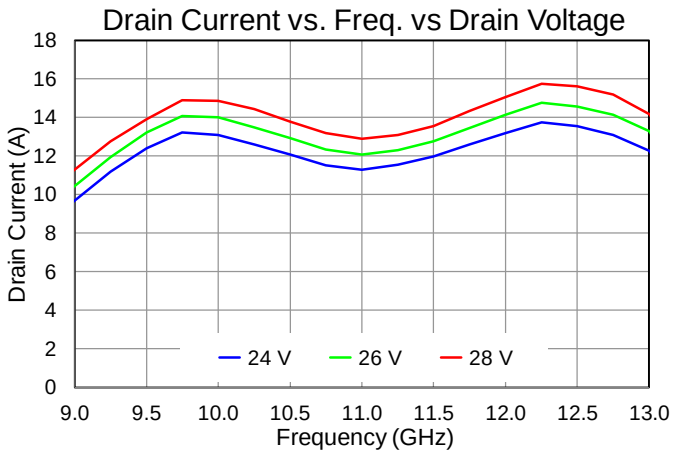


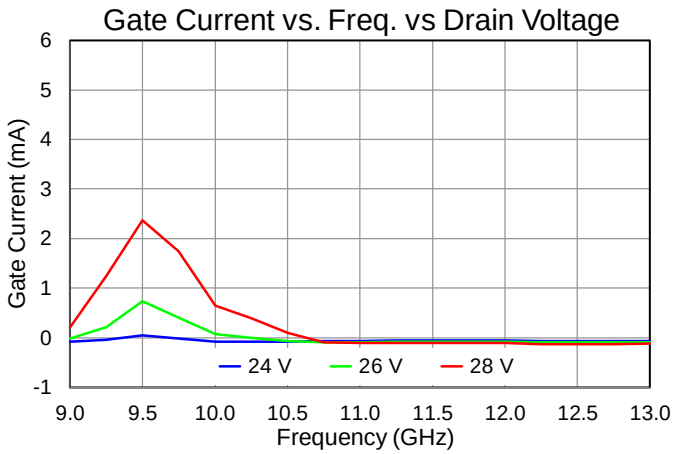


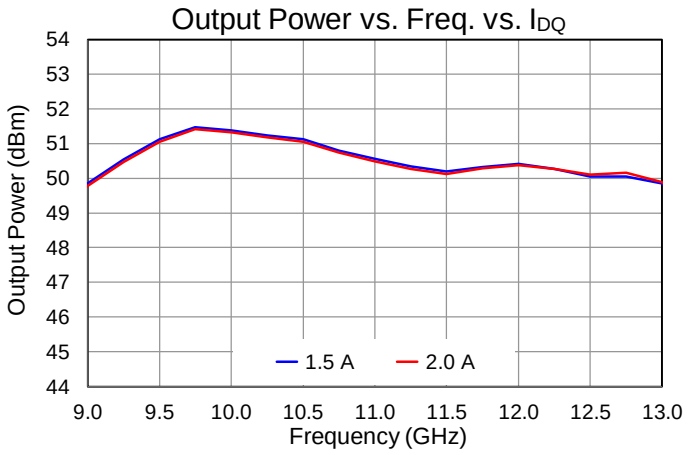


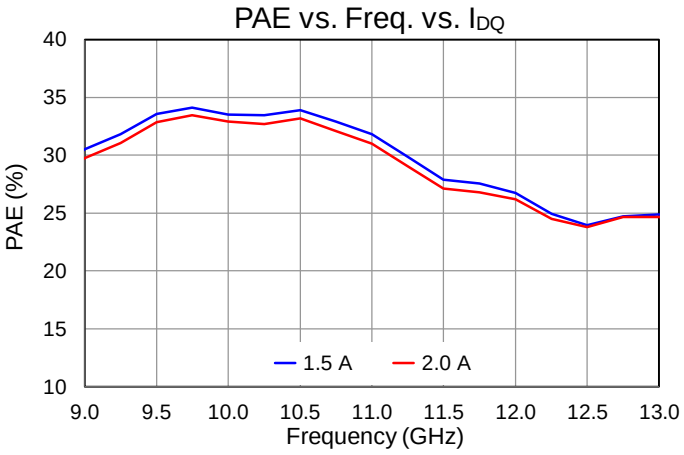
Performance Plots – Large Signal

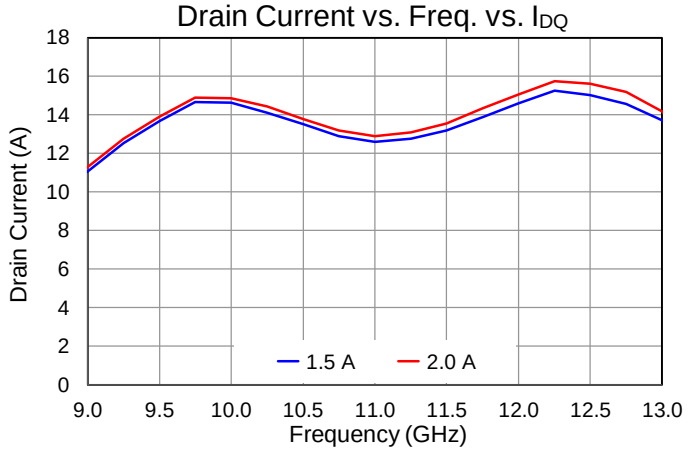
Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, P_{IN} = 28 dBm, PW = 150 us, Duty Cycle = 20%

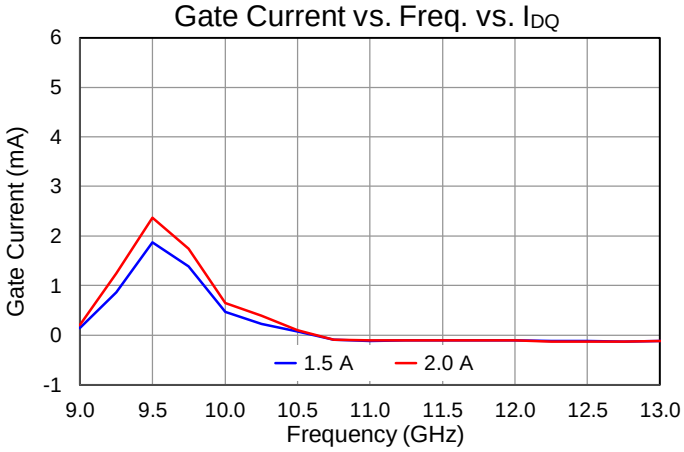






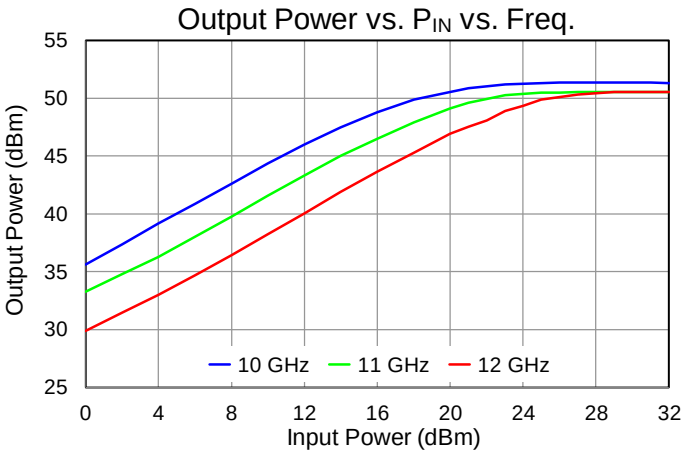


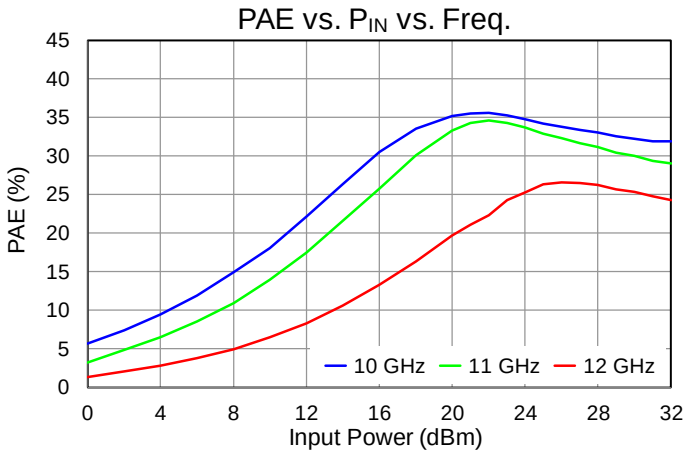


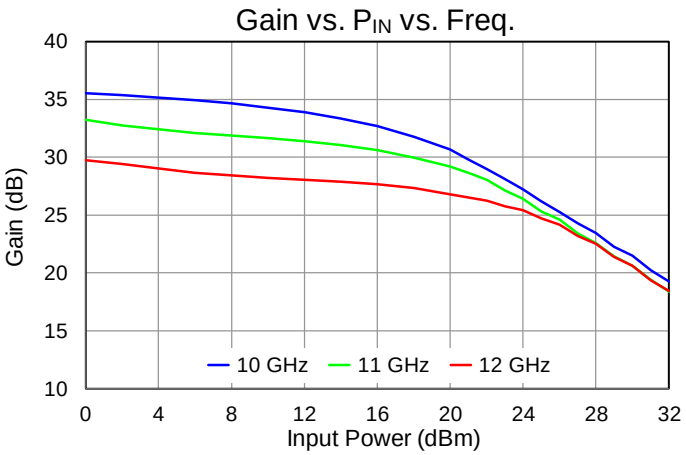


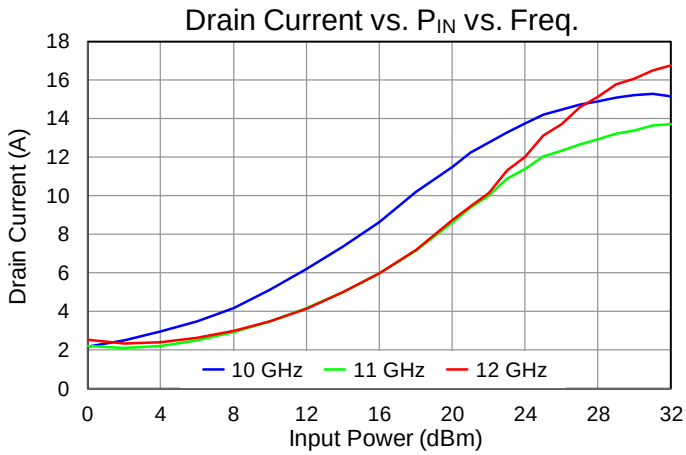
Performance Plots – Large Signal

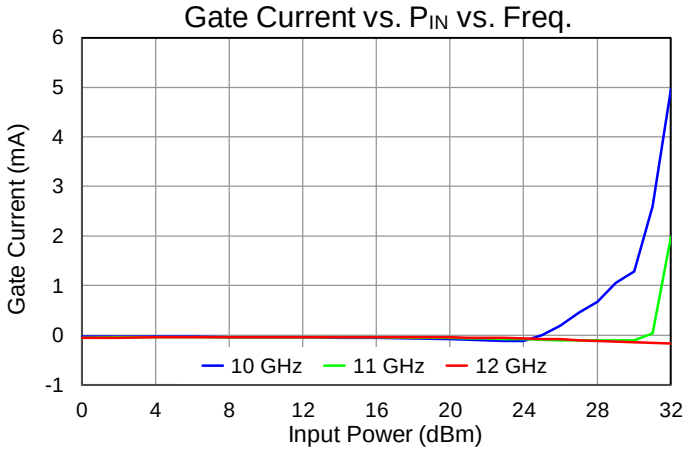
Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, P_{IN} = 28 dBm, PW = 150 us, Duty Cycle = 20%







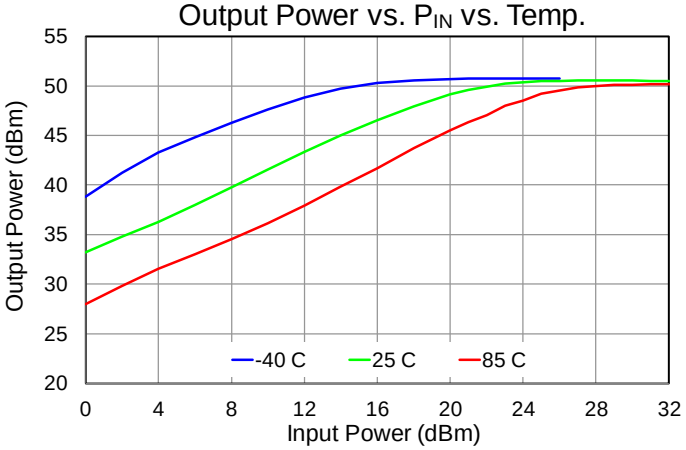




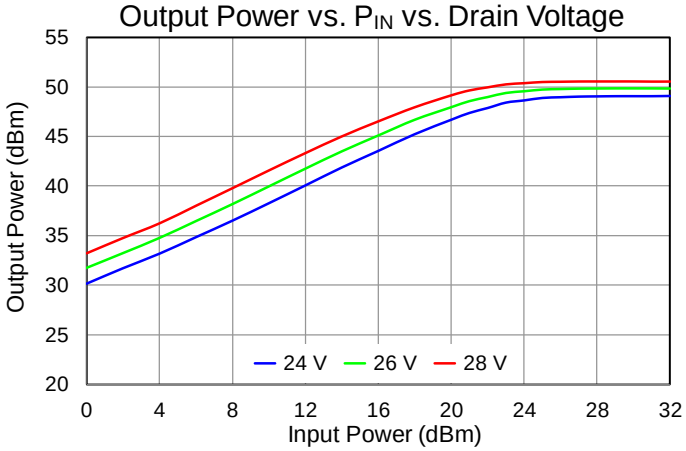
Performance Plots – Large Signal

Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, Freq = 11 GHz, PW = 150 us, Duty Cycle = 20%

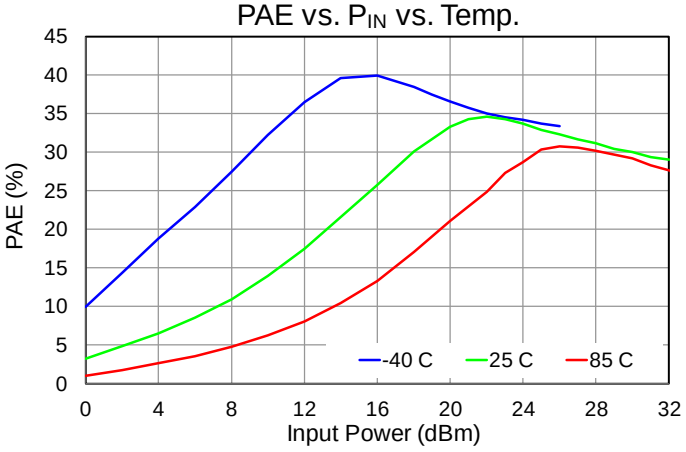
Output Power vs. P_{IN} vs. Temp.



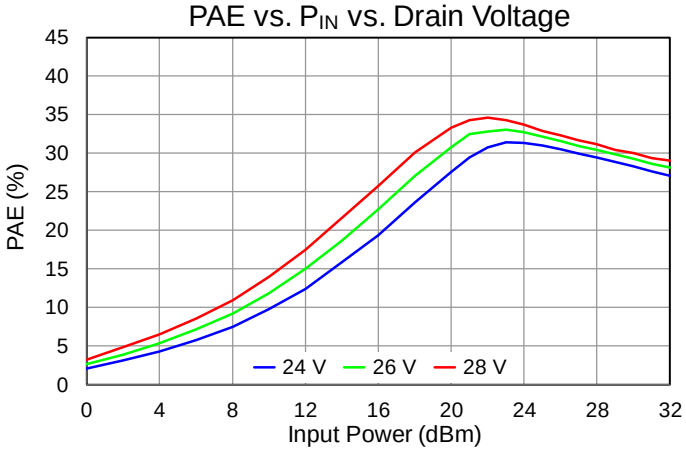
Output Power vs. P_{IN} vs. Drain Voltage



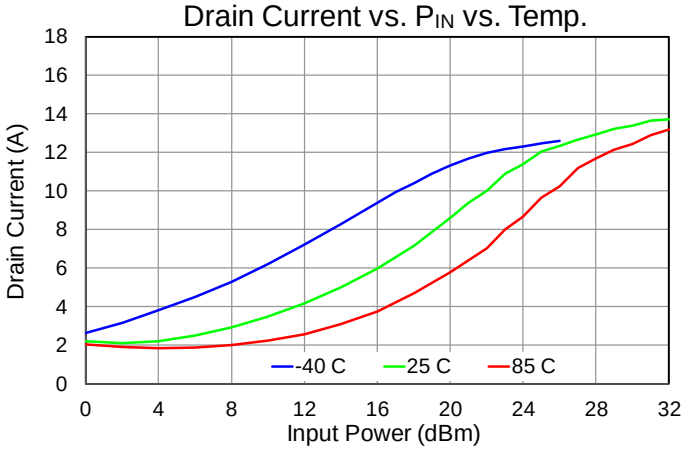
PAE vs. P_{IN} vs. Temp.



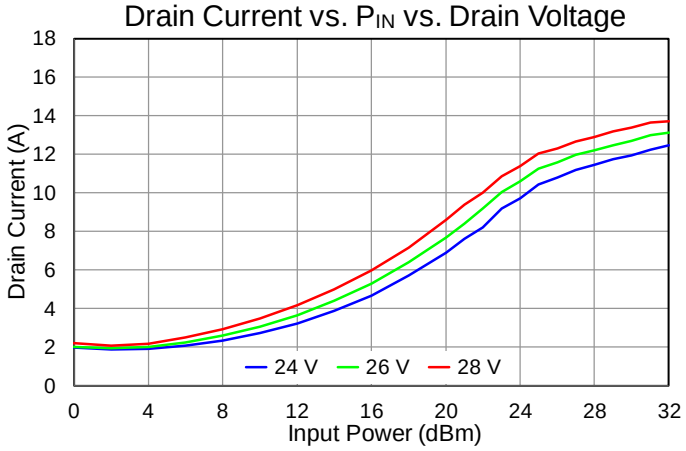
PAE vs. P_{IN} vs. Drain Voltage



Drain Current vs. P_{IN} vs. Temp.

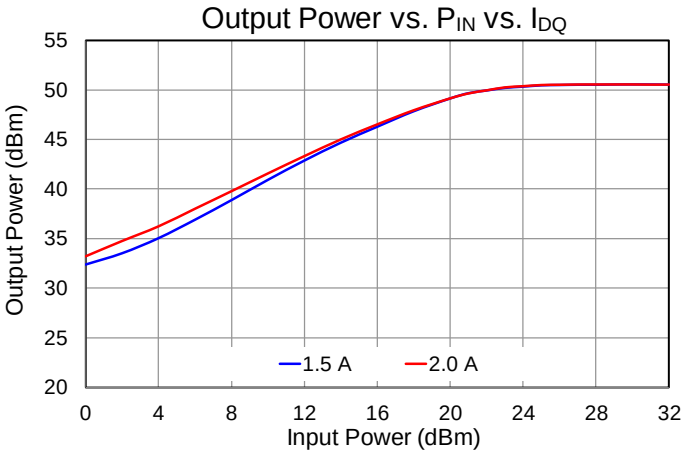


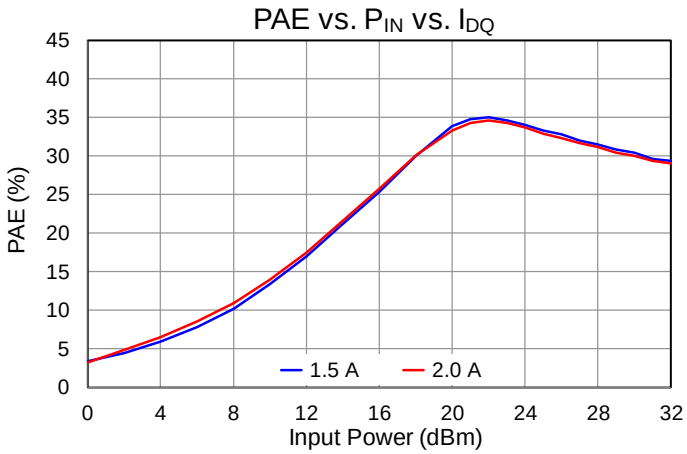
Drain Current vs. P_{IN} vs. Drain Voltage

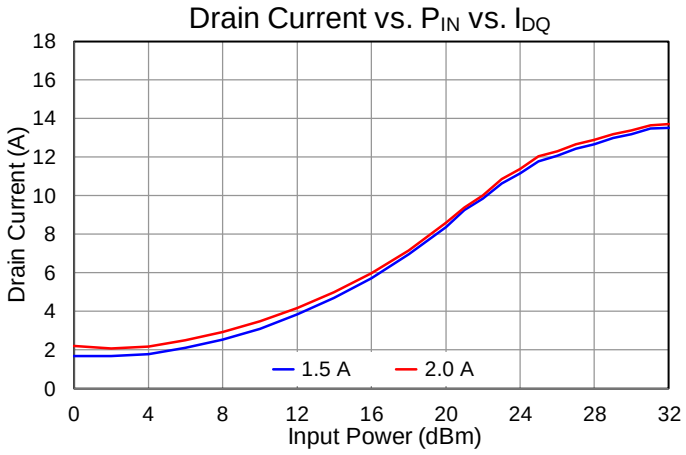


Performance Plots – Large Signal

Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, Freq = 11 GHz, PW = 150 us, Duty Cycle = 20%



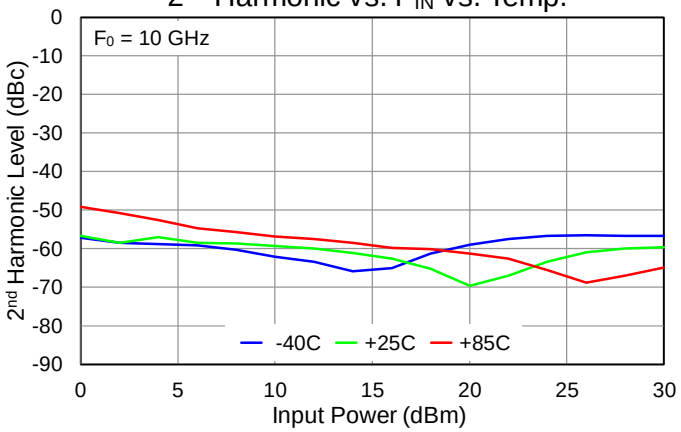




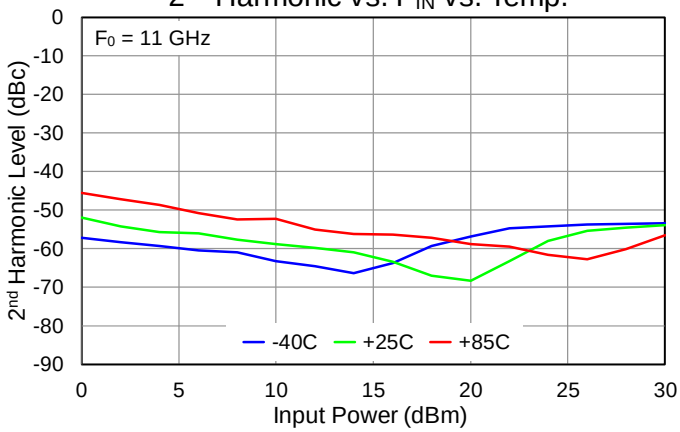
Performance Plots – Harmonics

Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A, PW = 150 us, Duty Cycle = 20%

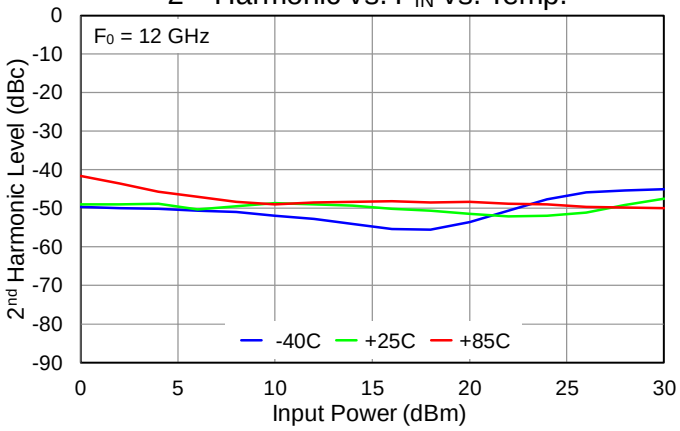
2nd Harmonic vs. P_{IN} vs. Temp.



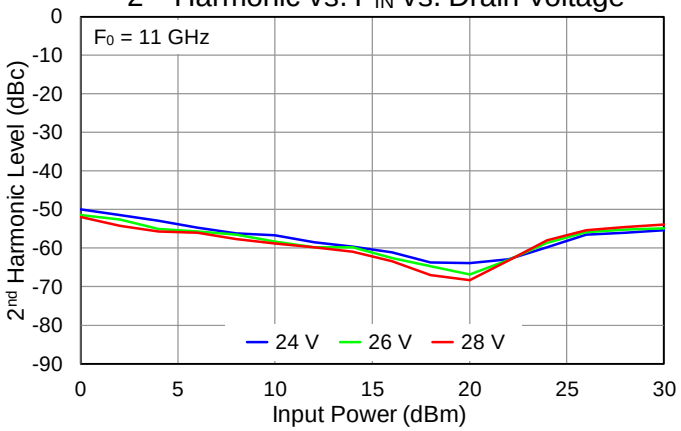
2nd Harmonic vs. P_{IN} vs. Temp.



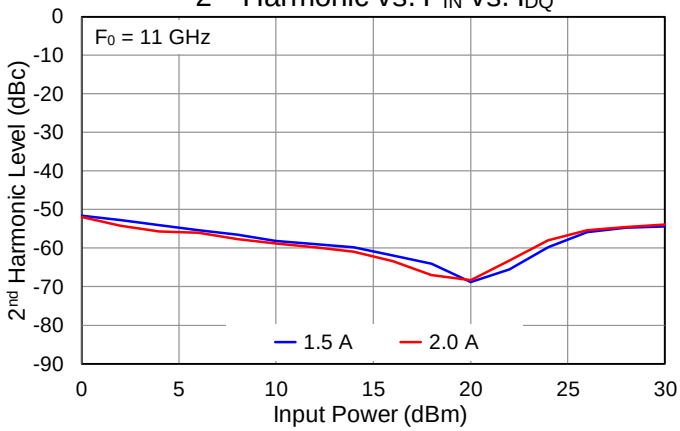
2nd Harmonic vs. P_{IN} vs. Temp.



2nd Harmonic vs. P_{IN} vs. Drain Voltage

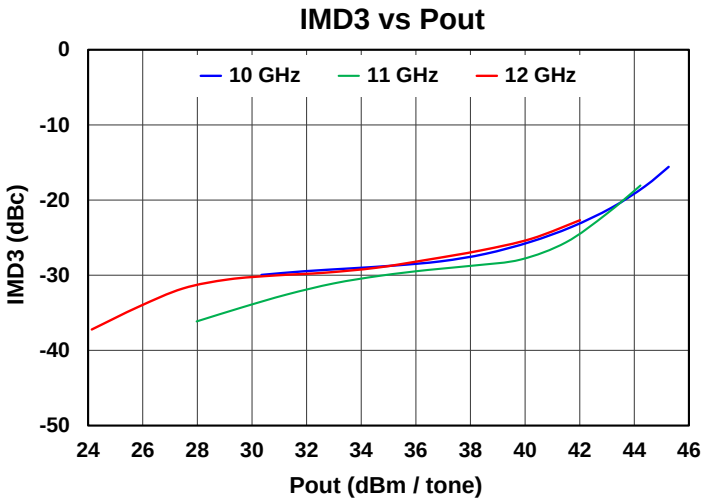


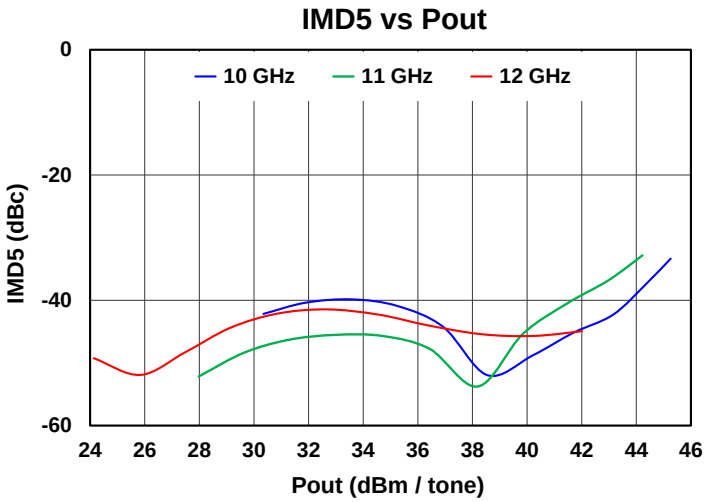
2nd Harmonic vs. P_{IN} vs. I_{DQ}



Performance Plots – Linearity

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 2.0 A, PW = 150 us, Duty Cycle = 20%, Tone Spacing = 100 MHz, 25 °C

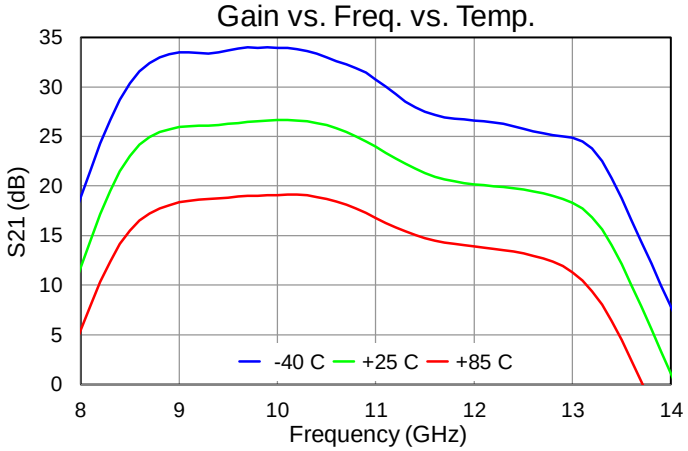




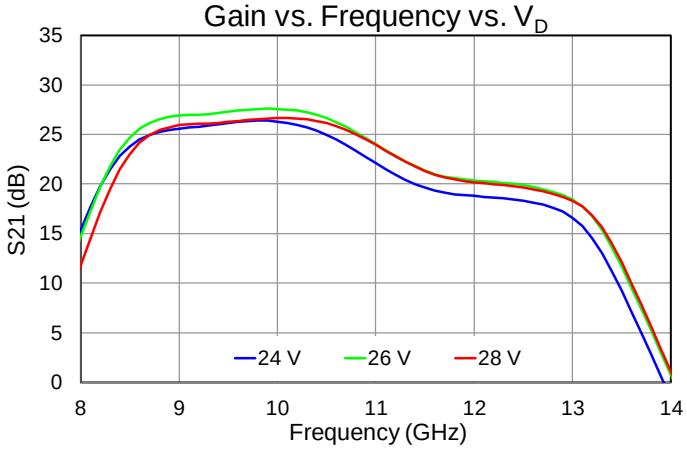
Performance Plots – Small Signal

Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A

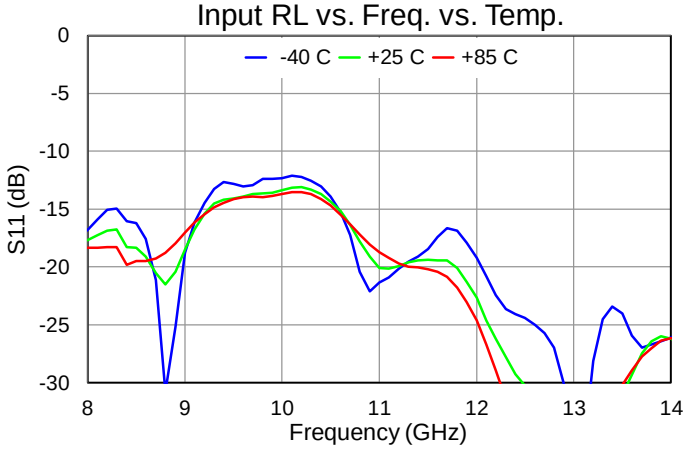
Gain vs. Freq. vs. Temp.



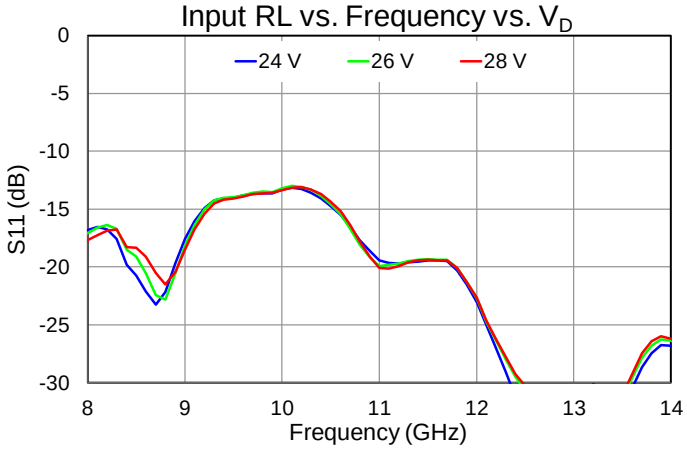
Gain vs. Frequency vs. V_D



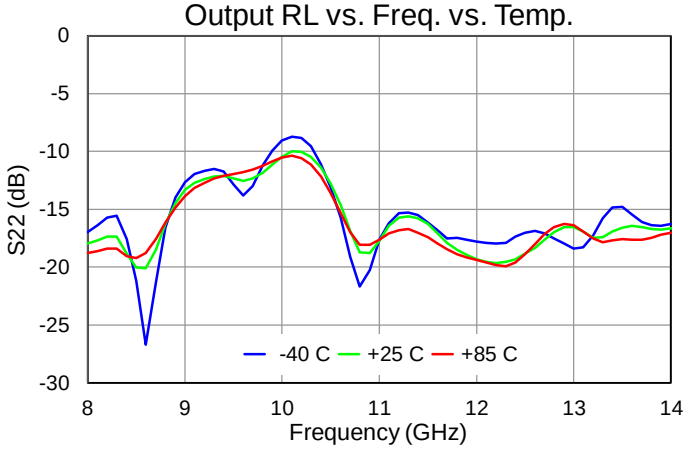
Input RL vs. Freq. vs. Temp.



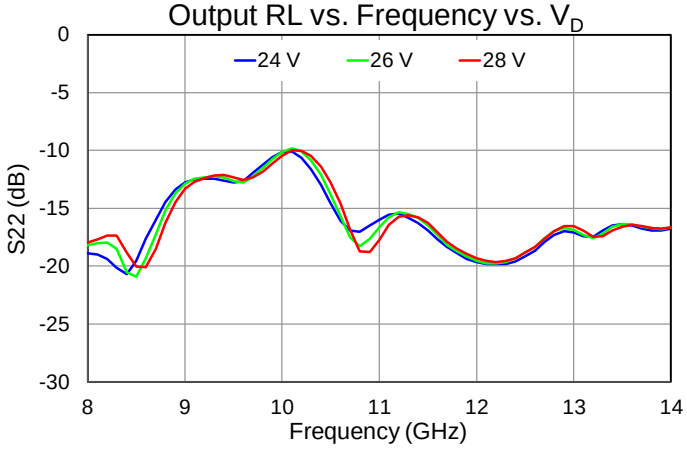
Input RL vs. Frequency vs. V_D



Output RL vs. Freq. vs. Temp.



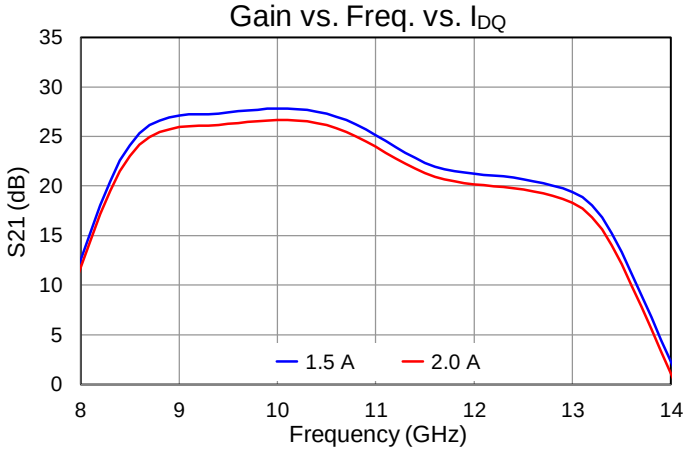
Output RL vs. Frequency vs. V_D



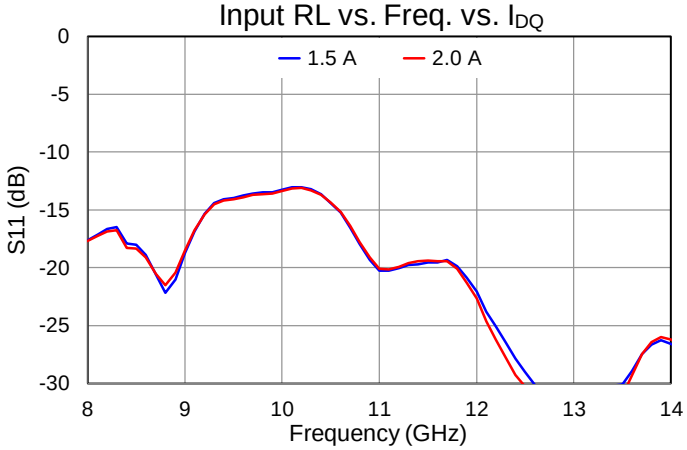
Performance Plots – Small Signal

Test conditions unless otherwise noted: T = 25 °C, V_D = 28 V, I_{DQ} = 2.0 A

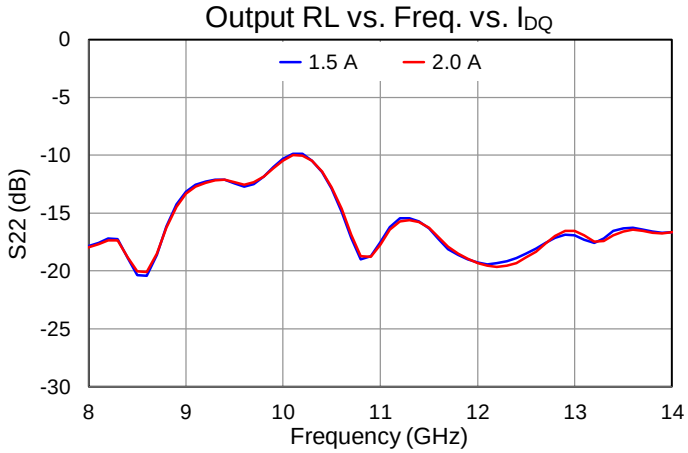
Gain vs. Freq. vs. I_{DQ}



Input RL vs. Freq. vs. I_{DQ}



Output RL vs. Freq. vs. I_{DQ}



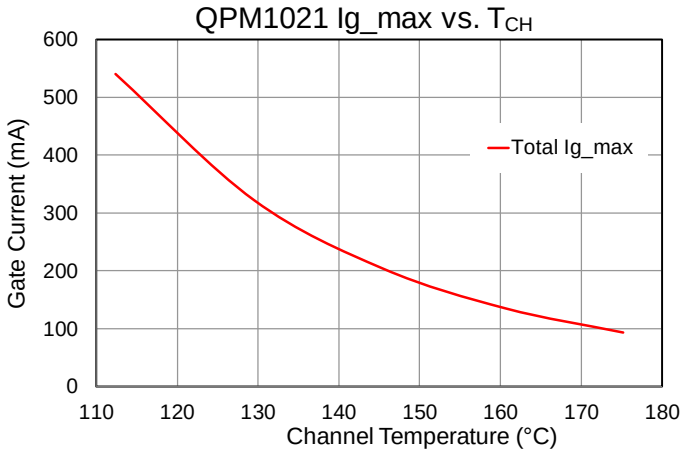
Thermal and Reliability Information

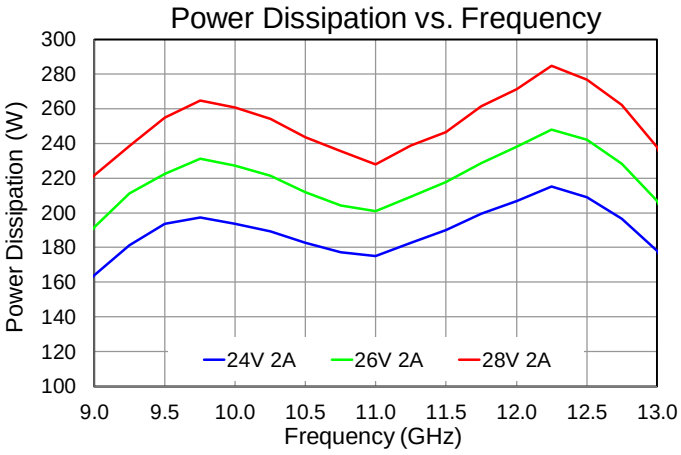
Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85°C, V_D = +28 V, I_{DQ} = 2.0 A, P_{DISS} = 56 W	0.200	ºC/W
Channel Temperature, T_{CH} (No RF)		96.1	°C
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, V_D = +28 V, Freq = 12 GHz, P_{IN} = 28 dBm, I_{DQ} = 2.0 A, I_{D_Drive} = 12.3 A, P_{OUT} = 48.8 dBm, P_{DISS} = 271.3 W	0.258	ºC/W
Channel Temperature, T_{CH} (Under RF)		154.9	°C
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, V_D = +28 V, Freq = 12 GHz, P_{IN} = 32 dBm, I_{DQ} = 2.0 A, I_{D_Drive} = 15.6 A, P_{OUT} = 50.1 dBm, P_{DISS} = 333.2 W	0.264	ºC/W
Channel Temperature, T_{CH} (Under RF)		172.9	°C

Notes:
1. Thermal resistance measured to back of package (T = 85 °C).
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

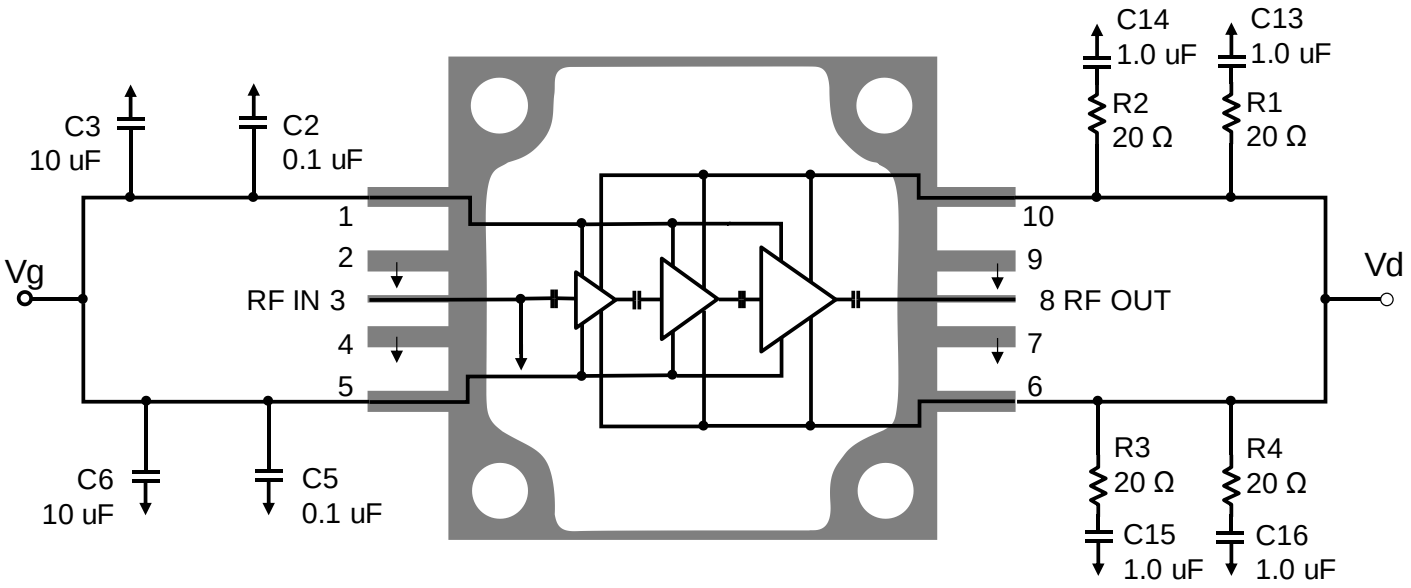
Gate Current and Dissipated Power

Test conditions unless otherwise noted: T = 85 °C, I_{DQ} = 2.0 A, P_{IN} = 28 dBm, PW = 150 us, Duty Cycle = 20%





Applications Information



Notes:
1. V_G & V_D need to be biased from both sides.

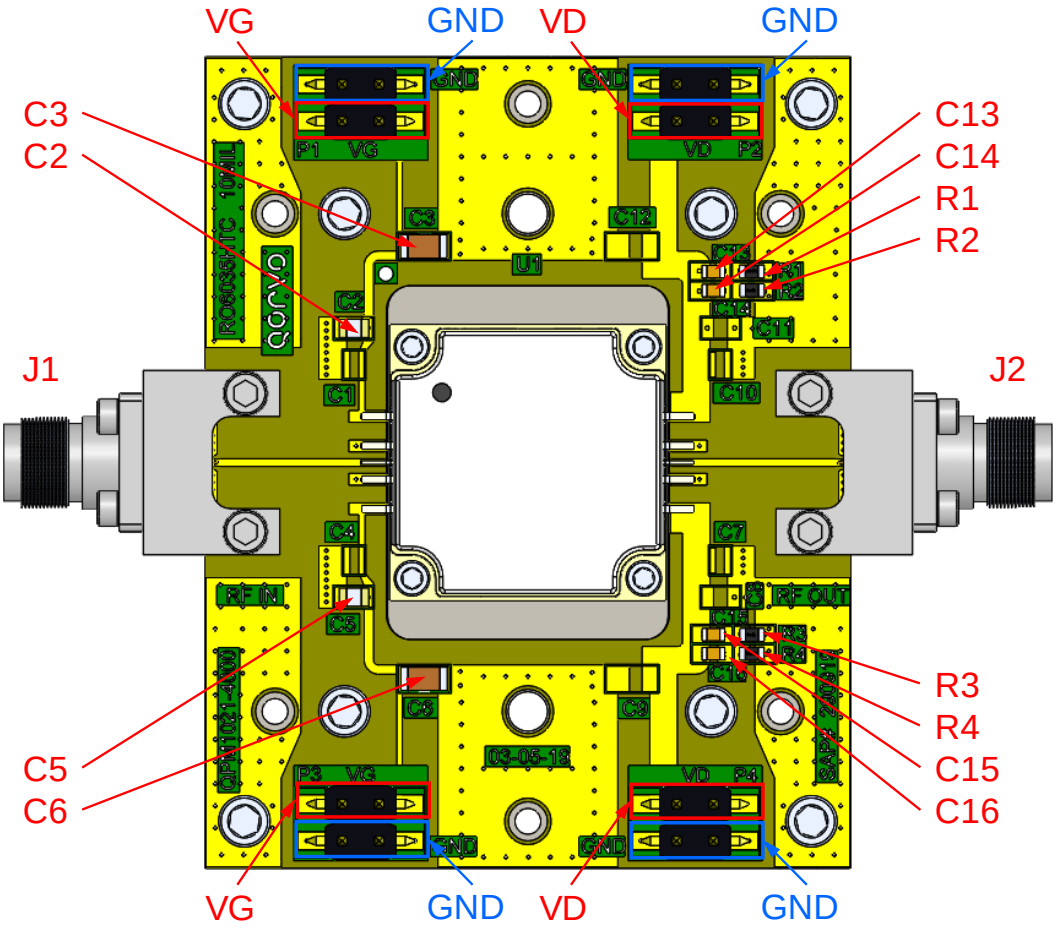
Bias-Up Procedure

1. Set I_D limit to 17 A (peak), I_G limit to 60 mA
2. Set V_G to −5.0 V
3. Set V_D +28 V
4. Adjust V_G more positive until I_{DQ} = 2.0 A, peak
5. Apply RF signal

Bias-Down Procedure

1. Turn off RF signal
2. Reduce V_G to −5.0 V. Ensure I_{DQ} ~ 0mA
4. Set V_D to 0 V
5. Turn off V_D supply
6. Turn off V_G supply

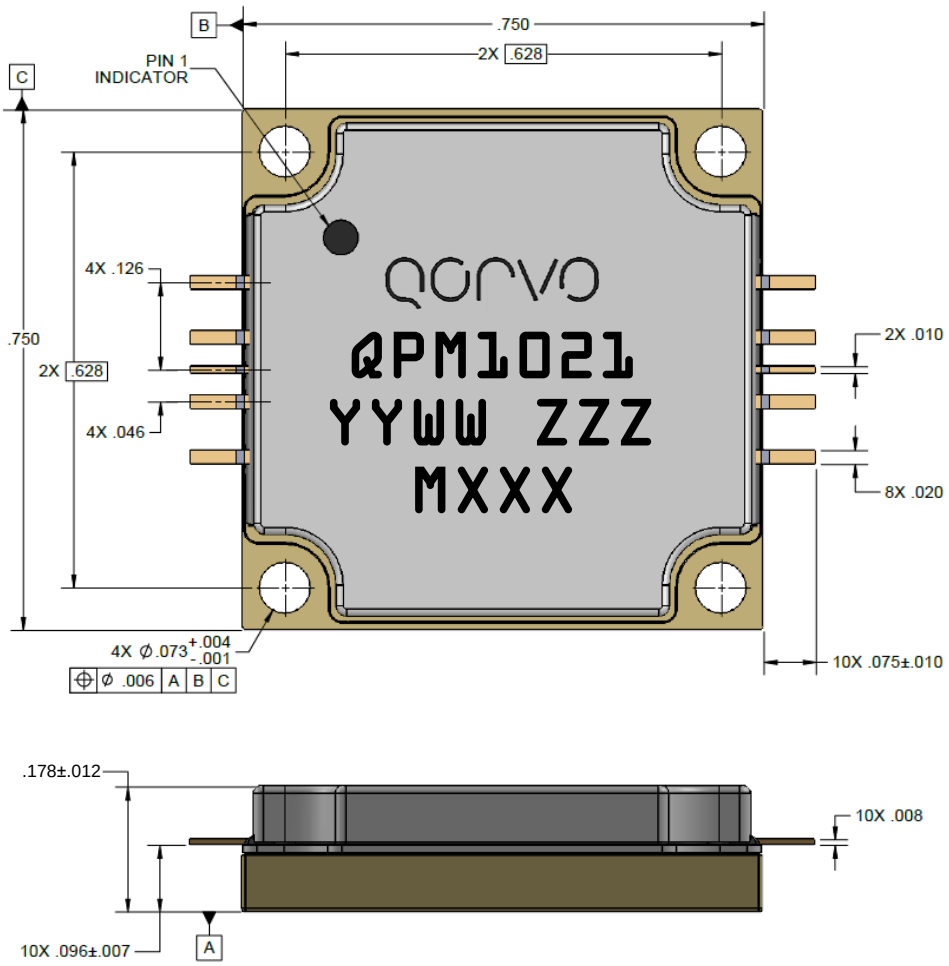
Evaluation Board (EVB) Layout Assembly



Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C3, C6	10 uF	CAP, CER, 10 uF, 50 V, 20%, X5R, 1206	Various	
C2, C5	0.1 uF	CAP, 0.1uF, 10%, 50V, X7R, 0805	Various	
C13, C14, C15, C16		CAP, 1uF, 10%, 50V, X7R, 0603	Various	
R1, R2, R3, R4	20 Ohm	RES 0603 20Ohms 200mW 1% -55 to +155C	Various	
J1, J2	2.92 mm	Female End Launch Connector	Southwest Microwave	1092-02A-5
PCB	-----	Rogers 6035HTC, 10 mil dielectric, 0.5 oz. copper (gold plated)	Rogers Corp.	

Mechanical Information and Bond Pad Description



NOTES:

1. MATERIALS
- PACKAGE BASE: COPPER
- LEADS: ALLOY 194
- LID: PLASTIC
- FINISH: GOLD

2. PART IS EPOXY SEALED

3. UNITS: INCHES

4. TOLERANCES (UNLESS NOTED):
- .XX = ± .01
- .XXX = ± .005

5. MARKINGS
- PART NUMBER: QPM1021
- WORK YEAR: YY
- WORK WEEK: WW
- SERIAL NUMBER: ZZZ
- BATCH ID: MXXX

Package Lead Description

Pad No.	Symbol	Description
1, 5	V_G	Gate voltage. Bias network is required; see Application Circuit on page 12. Gate must be biased from both sides.
2, 4, 7, 9	Ground	Must be grounded to PCB
3	RF Input	RF Input; matched to 50 Ω, DC blocked, DC grounded
6, 10	V_D	Drain voltage. Bias network is required; see Application Circuit on page 12.
8	RF Output	RF Output; matched to 50 Ω, DC blocked

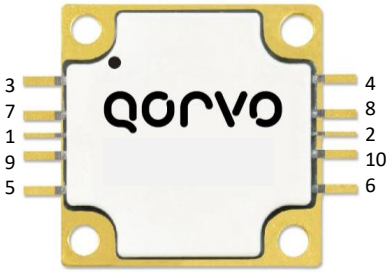
Assembly Notes

1. Carefully clean the PC board, base plate, and package leads with alcohol. Allow it to dry fully.

2. To improve the thermal and RF performance, Qorvo recommends attaching a heat sink to the bottom of the package and apply either a thermal compound (Arctic Silver 5 recommended) or a .004 inch (maximum thickness) Indium shim between the heat sink and the package. Refer to the applications note Application of Arctic Silver 5 Thermal Compound and Indium Shims for Qorvo CP-style Packaged Components for more information.

3. The component leads should be manually soldered. Apply a low residue solder alloy meeting J-STD-001 (ROL0, ROL1 or equivalent) with a liquidus temperature below 220 °C to each pin of the QPM1021. The use of low residue/no-clean flux (ROL0, ROL1) is recommended. The package lead temperature should not exceed 260 deg C. Each solder connection should be completed within 2 to 5 seconds. Adding flux during hand soldering of the component leads with localized spot cleaning is acceptable. Soldering irons meeting the requirements of J-STD-001, Appendix A are acceptable.

4. The leads should be soldered in a staggered or star pattern from side to side, and never solder two adjacent leads. This allows the heat to dissipate on each lead, and not cause the adjacent leads to become de-soldered and damaged or displaced.



5. The packaged part should not be subjected to conventional SMT automated solder reflow processes.

6. (The following is for information only. There are many variables in a second level assembly that Qorvo does not control, so Qorvo does not recommend an absolute torque value.) Use screws to attach the component to the heat sink. A suggested final torque value is 16 in-oz. for a 0-80 screw. Start with screws finger tight, then torque to 8 in-oz., then torque to final value. Use the following tightening pattern:

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1C	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	C3	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	NA	

Caution!
ESD-Sensitive Device

Solderability

The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. The use of no-clean solder to avoid washing after soldering is recommended.

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:

- 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:

Web: www.qorvo.com

Tel: 1-844-890-8163

Email: customer.support@qorvo.com

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