QPA1027

2.8 – 3.5 GHz 60 W GaN Power Amplifier

Product Overview

Qorvo's QPA1027 is a packaged high-power, S-band amplifier fabricated on Qorvo's production 0.25 um GaN on SiC High Voltage process (QGaN25HV). Covering 2.8 – 3.5 GHz, the QPA1027 provides 60 W of saturated output power and 22 dB of large-signal gain while achieving 55% power-added efficiency.

The QPA1027 is packaged in a plastic overmold QFN with a Cu paddle offering easy handling with good thermal properties. As a result, the QPA1027 has bias flexibility allowing the user to vary the voltage to achieve optimum system performance while maintaining high reliability.

The QPA1027 is matched to 50 ohms with integrated DC blocking caps on both I/O ports. With the high performance, good thermal characteristics and ease of handling and system integration, the QPA1027 is ideal for radar and satellite communication systems.

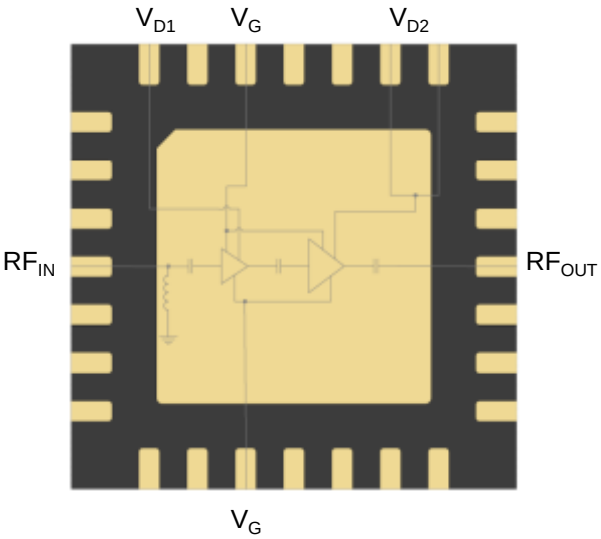
Lead-free and RoHS compliant.

Key Features

- Frequency Range: 2.8 – 3.5 GHz
- P_{SAT} (P_{IN}=26 dBm): 48 dBm
- PAE (P_{IN}=26 dBm): 55 %
- Small Signal Gain: > 31 dB
- Bias: Pulsed V_D = 50 V, I_{DQ} = 300 mA, V_G = −2.7 V typ.
- Package Dimensions: 6.0 x 6.0 x 0.85 mm

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

Functional Block Diagram



Applications

- S-Band Radar
- Satellite Communication

Ordering Information

Part No.	Description
QPA1027	S-Band 60 W GaN Power Amplifier
QPA1027S2	Samples (2 pcs. pack)
QPA1027TR7	250 pieces on a 7" reel (standard)
QPA1027EVB01	Evaluation Board for QPA1027

Absolute Maximum Ratings

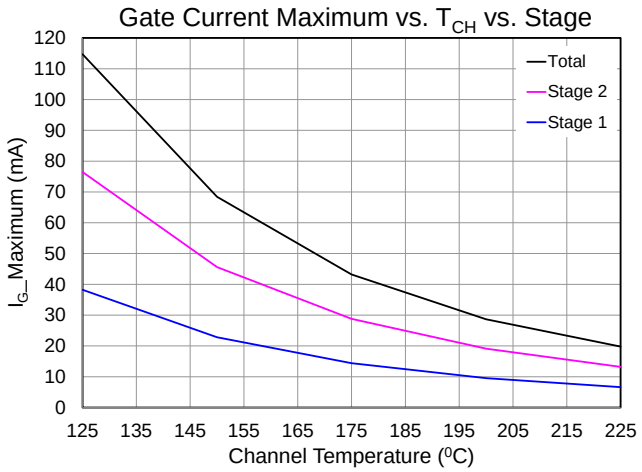
Parameter	Value / Range
Drain Voltage (V_D)	+55 V
Gate Voltage Range (V_G)	−6 to 0 V
Drain Current, average (I_{D1}, I_{D2})	0.192 A, 2.3 A
Gate Current (I_G)	See chart
Power Dissipation (P_{DISS}), Pulse, PW = 100 uS, DC = 10%, 85°C	80 W
Input Power (P_{IN}), Pulse, 50 Ω, V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, 85°C	32 dBm
Input Power (P_{IN}), Pulse, 3:1 VSWR, V_D = 50 V , I_{DQ} = 300 mA, PW = 100 us, DC = 10%, 85°C	29 dBm
Channel Temperature (T_{CH})	275 °C
Mounting Temperature (30 seconds)	260 °C
Storage Temperature	−55 to 150 °C

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.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Pulse (not recommended CW)				
Drain Voltage (V_D), Pulsed		50	50	V
Drain Current, Quiescent (I_{DQ})		300		mA
Drain Current, RF (I_{D_Drive})	See charts page 3 - 7			mA
Gate Voltage Typ. Range (V_G)	−2 to -3.4			V
Gate Current, RF (I_{G_Drive})	See charts page 5 - 7			mA
Pulse Width/Duty Cycle		100/10%	2000/20%	us/%
Operating Temp. Range T_{BASE} (T_{BASE} is backside of QPA1027)	−40	+25	+85	°C

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



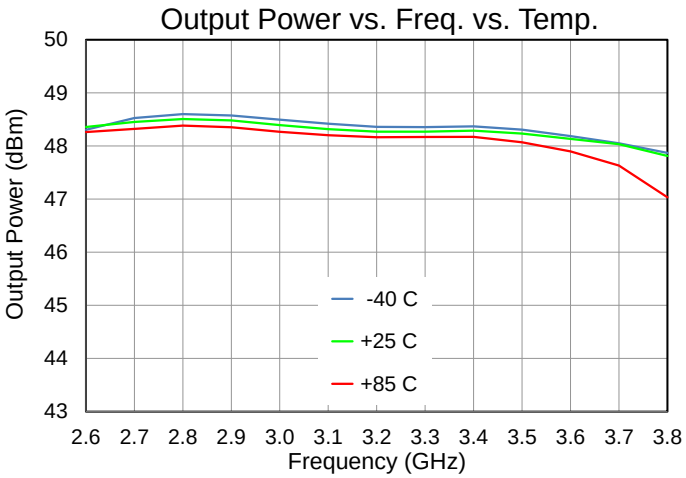
Electrical Specifications

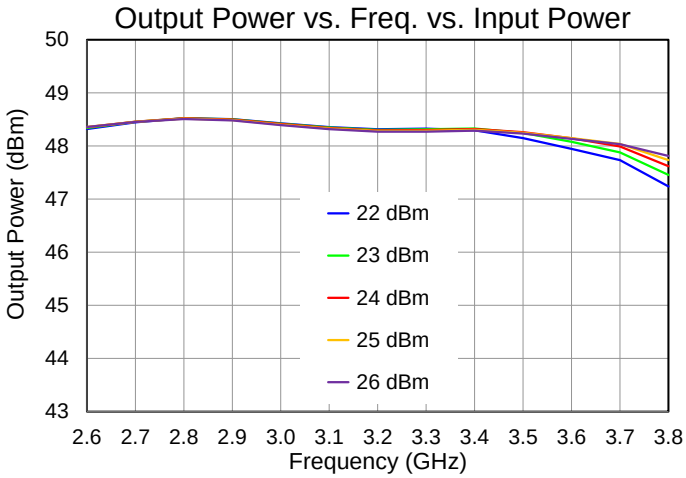
Parameter	Conditions (1) (2)	Min	Typ	Max	Units
Operational Frequency Range		2.8		3.5	GHz
Output Power at Saturation, P_{SAT}	P_{IN} = +26 dBm		48		dBm
Power Added Efficiency, PAE	P_{IN} = +26 dBm		55		%
Small Signal Gain, S21			31		dB
Input Return Loss, IRL			15		dB
Output Return Loss, ORL			7		dB
P_{SAT} Temperature Coefficient	T_{DIFF} = −40°C to +85°C; P_{IN} = +26 dBm		−0.002		dBm/°C
S21 Temperature Coefficient	T_{DIFF} = −40°C to +85°C		−0.04		dB/°C

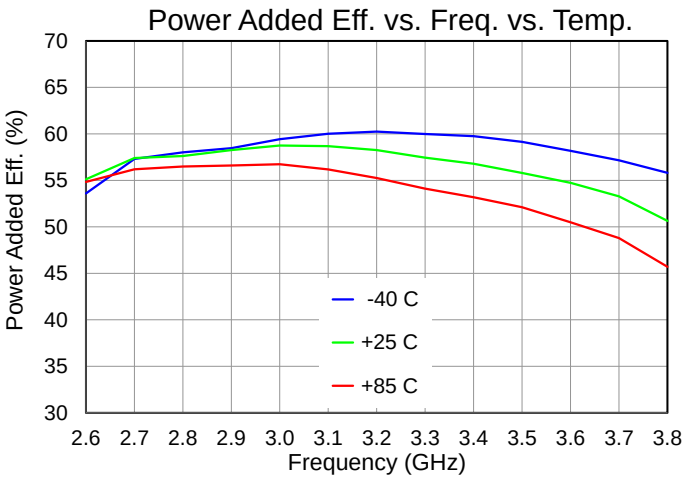
Notes:
1. Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, V_G = -2.7V +/- typical, PW = 100 us, DC = 10% T_{BASE} = +25 °C, Z_0 = 50 Ω
2. T_{BASE} is back side of QPA1027

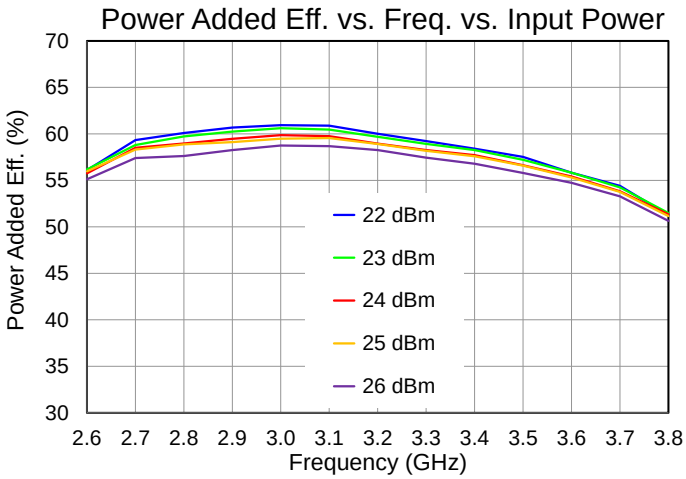
Performance Plots – Large Signal

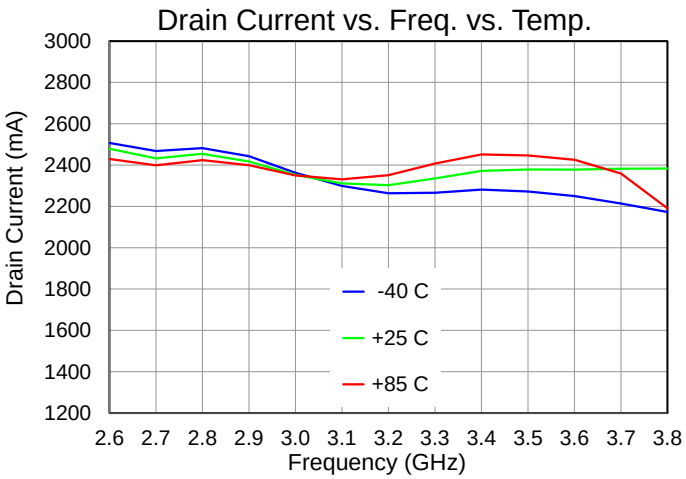
Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

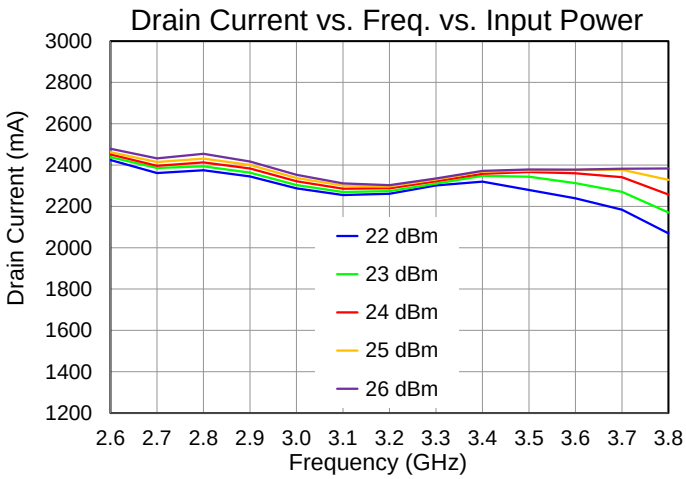












Performance Plots – Large Signal

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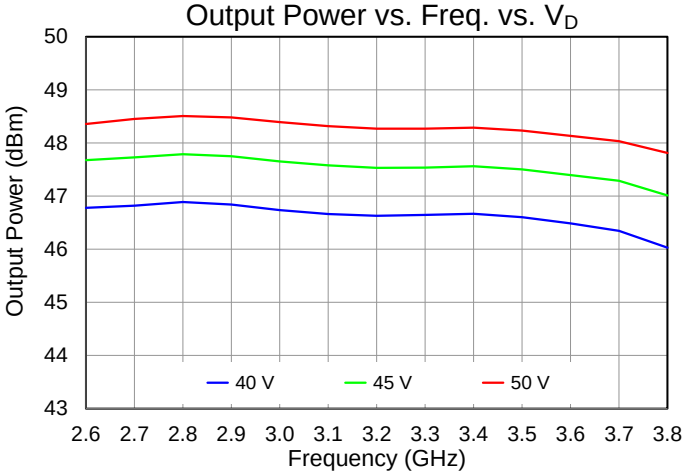
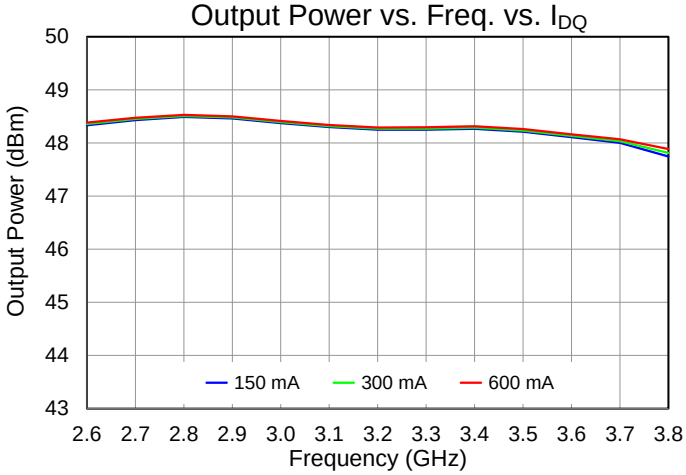
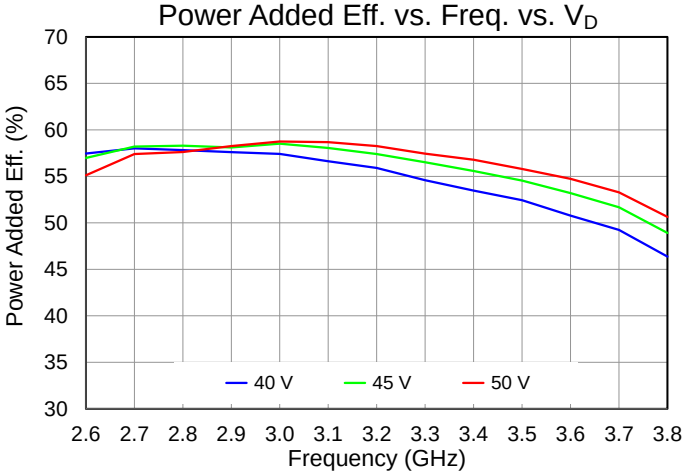
Output Power vs. Freq. vs. V_D



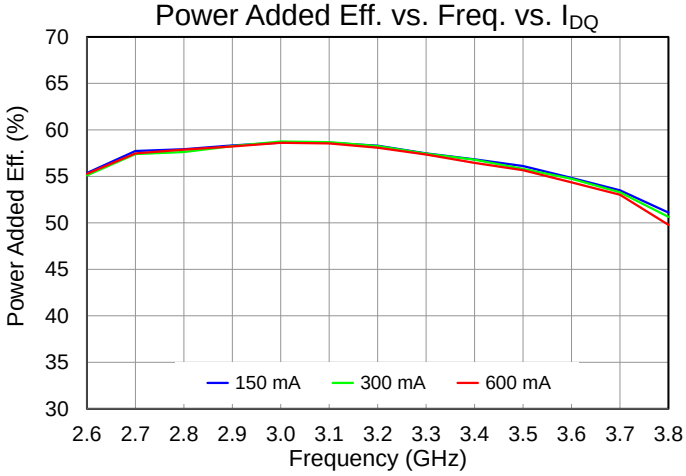
Output Power vs. Freq. vs. I_{DQ}



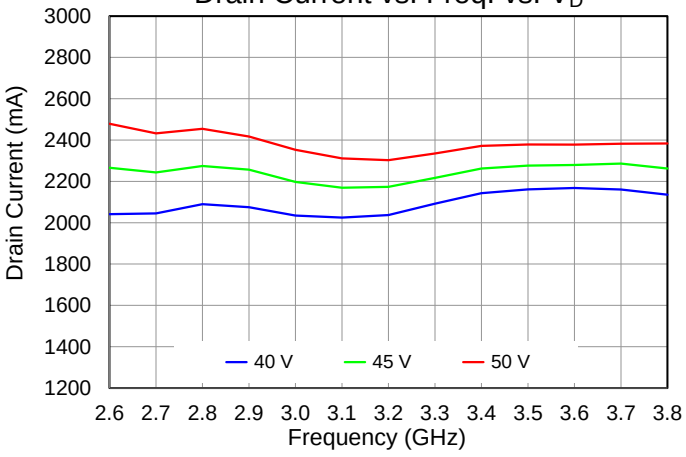
Power Added Eff. vs. Freq. vs. V_D



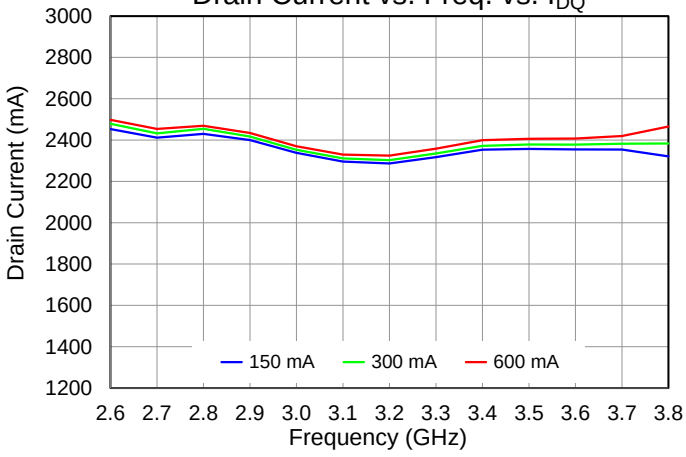
Power Added Eff. vs. Freq. vs. I_{DQ}



Drain Current vs. Freq. vs. V_D



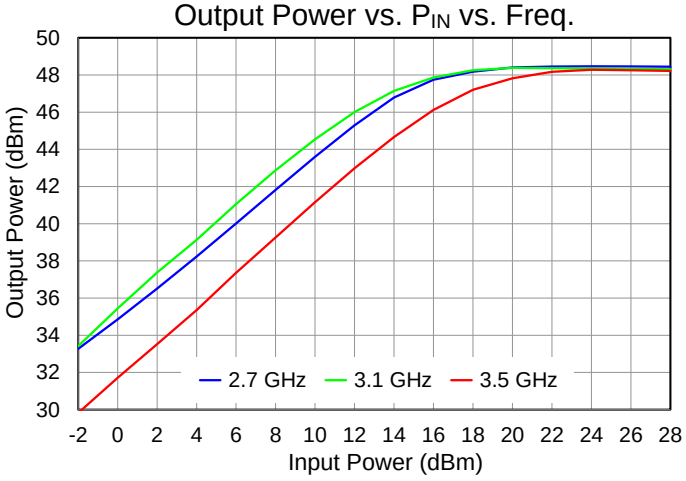
Drain Current vs. Freq. vs. I_{DQ}



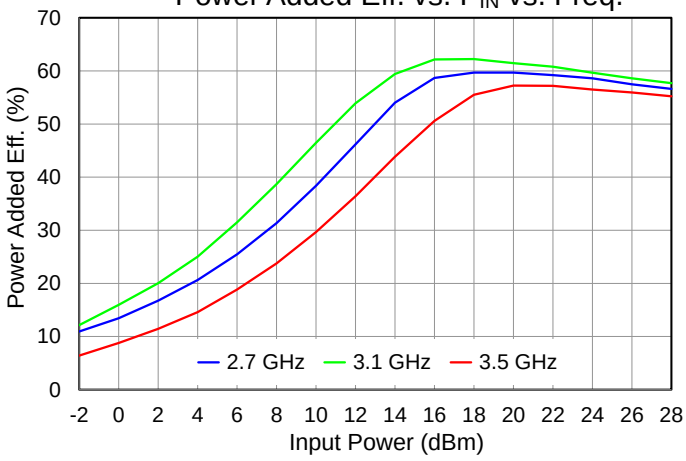
Performance Plots – Large Signal

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

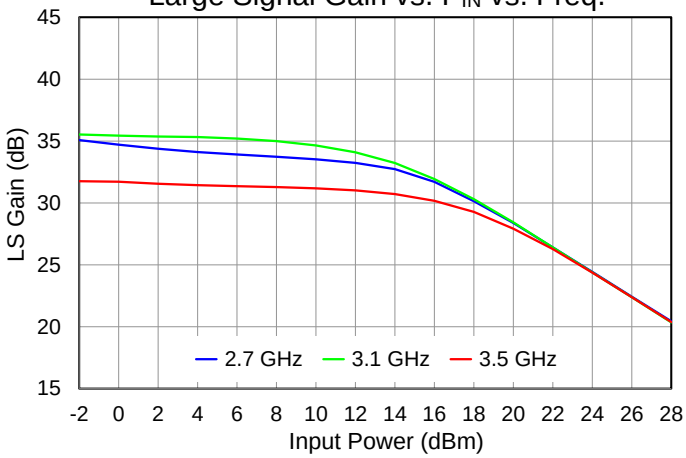
Output Power vs. P_{IN} vs. Freq.



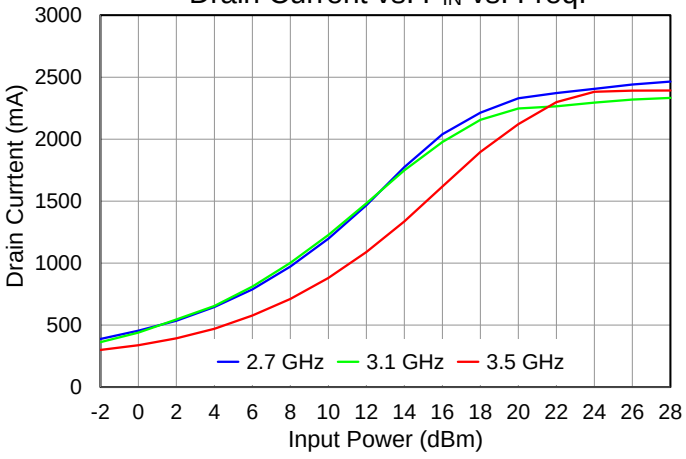
Power Added Eff. vs. P_{IN} vs. Freq.



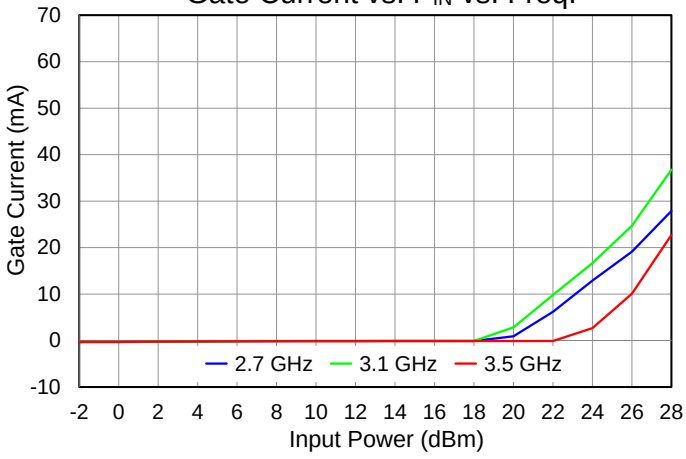
Large Signal Gain vs. P_{IN} vs. Freq.



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



Gate Current vs. P_{IN} vs. Freq.



Performance Plots – Large Signal

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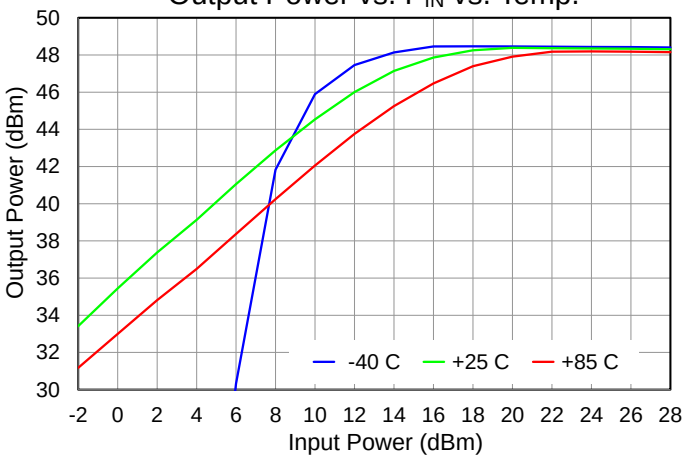
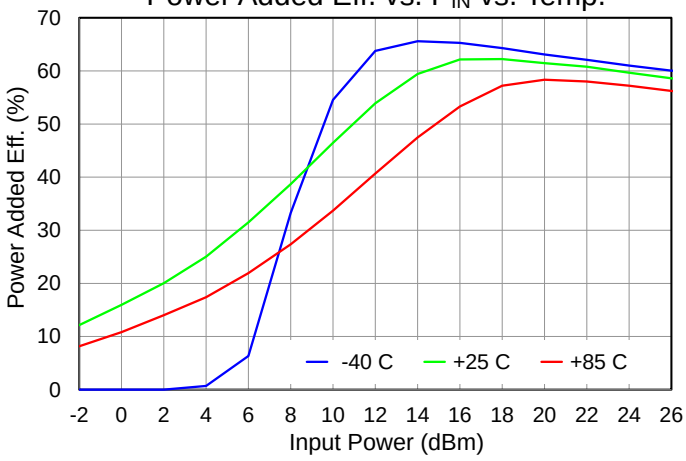
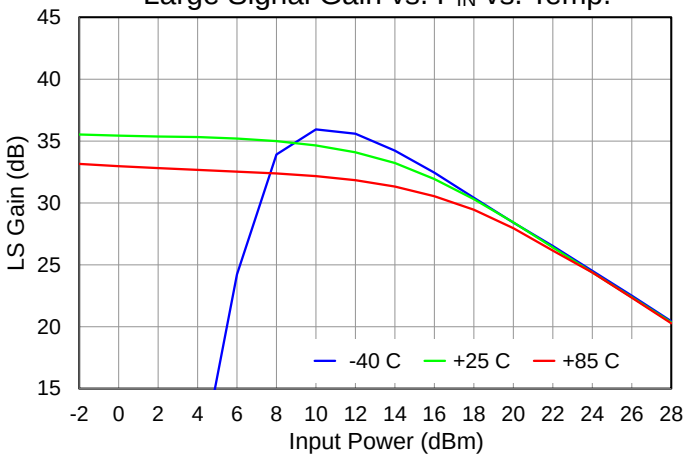
Output Power vs. P_{IN} vs. Temp.



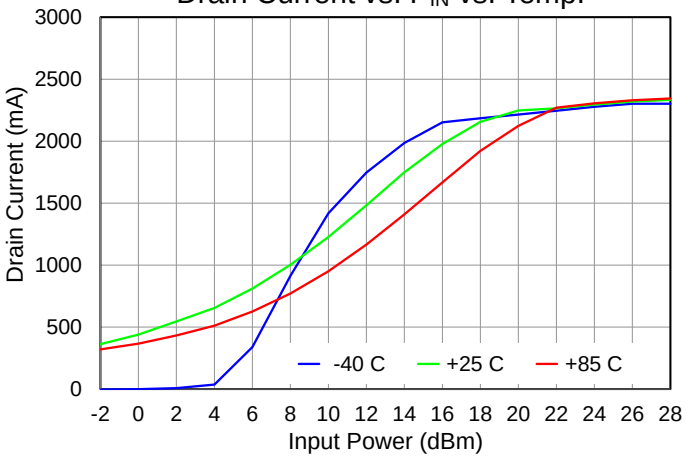
Power Added Eff. vs. P_{IN} vs. Temp.



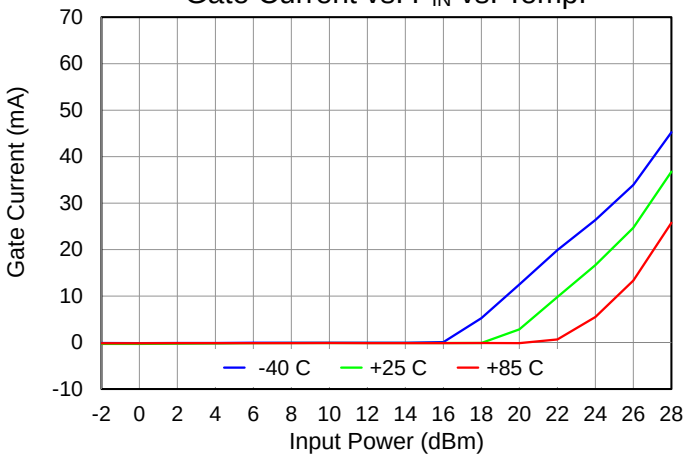
Large Signal Gain vs. P_{IN} vs. Temp.



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

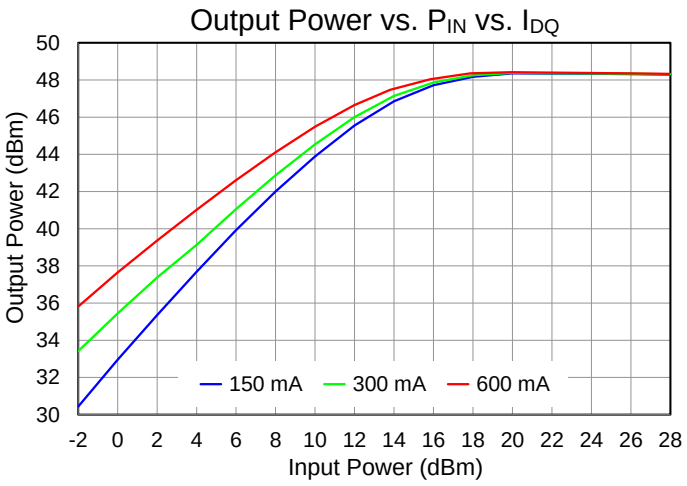


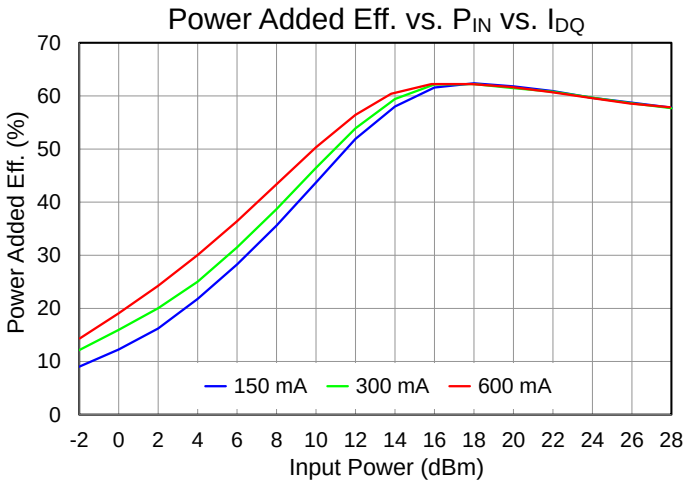
Gate Current vs. P_{IN} vs. Temp.

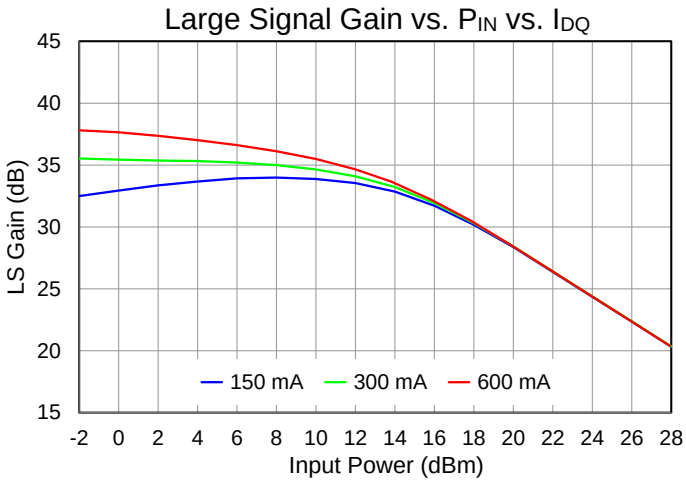


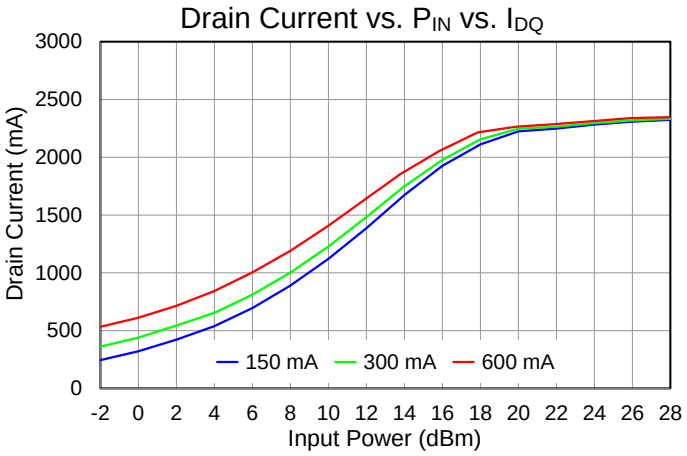
Performance Plots – Large Signal

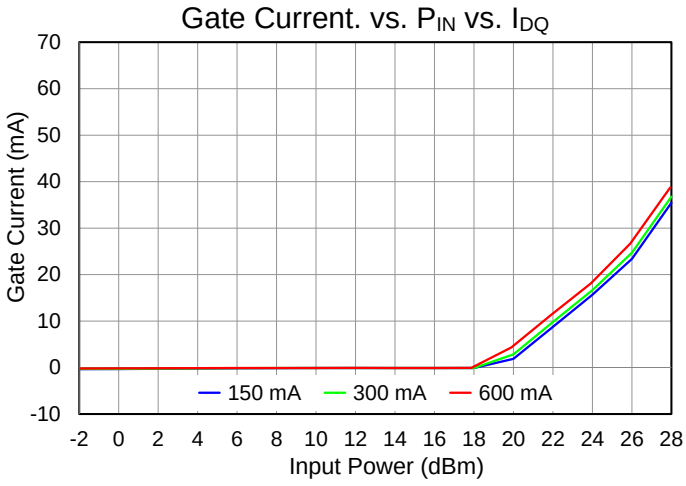
Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, CW RF_{IN} = 26 dBm, Frequency = 3.1 GHz, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)







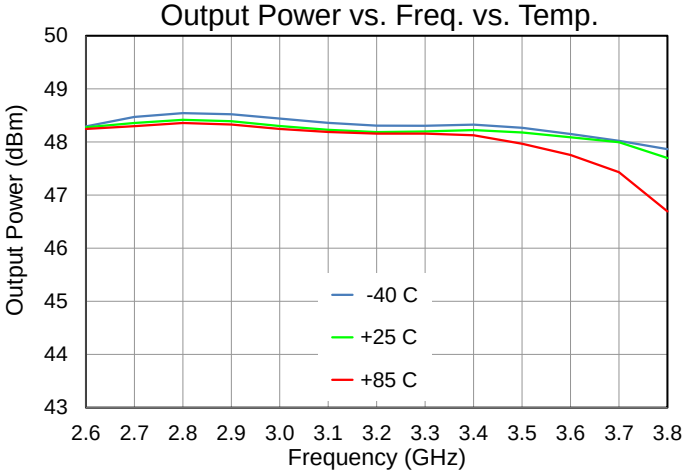




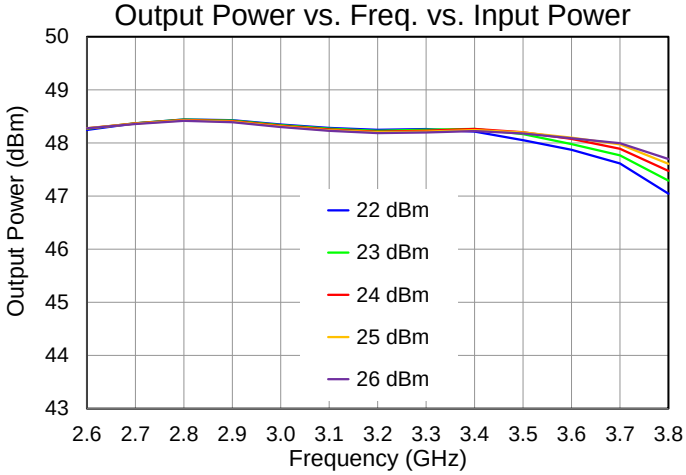
Performance Plots – Large Signal

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 700 us, DC = 20%, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

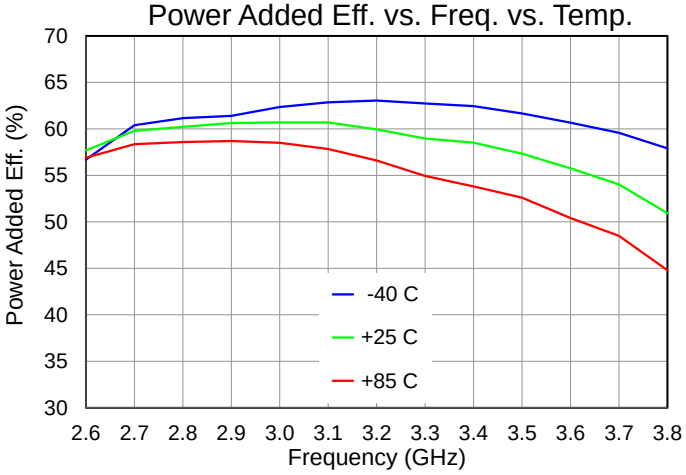
Output Power vs. Freq. vs. Temp.



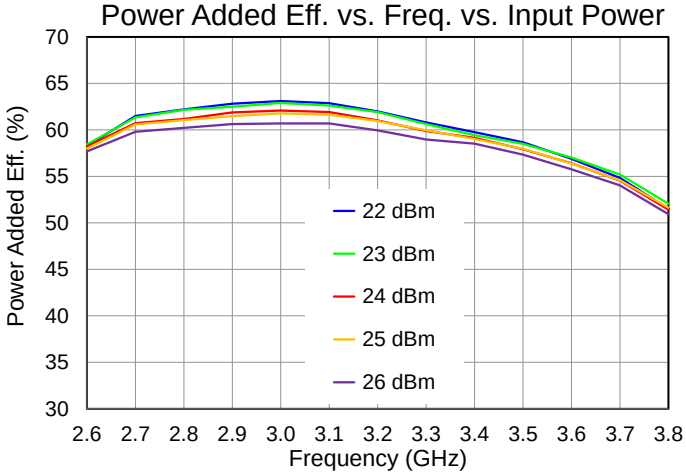
Output Power vs. Freq. vs. Input Power



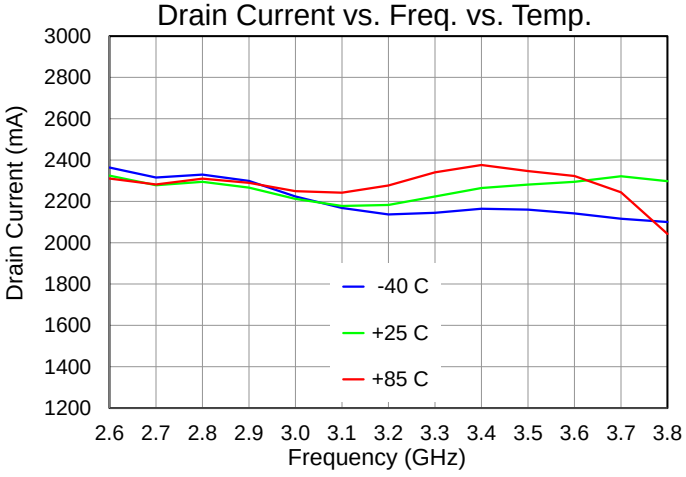
Power Added Eff. vs. Freq. vs. Temp.



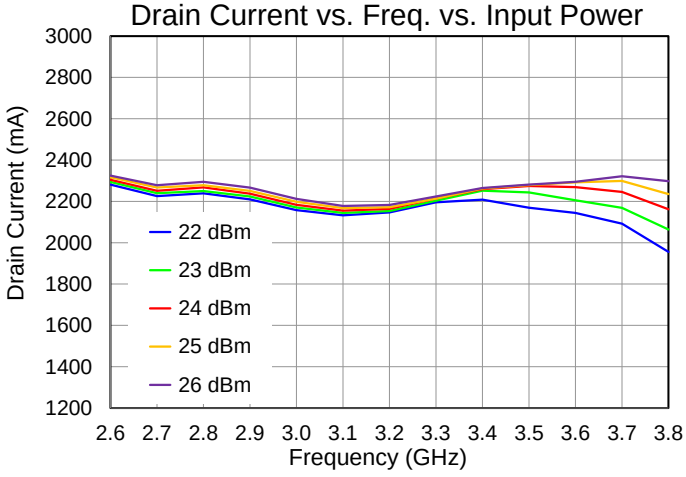
Power Added Eff. vs. Freq. vs. Input Power



Drain Current vs. Freq. vs. Temp.



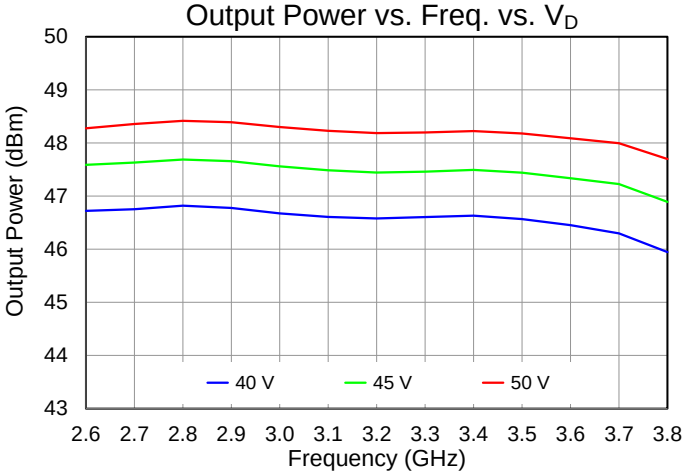
Drain Current vs. Freq. vs. Input Power



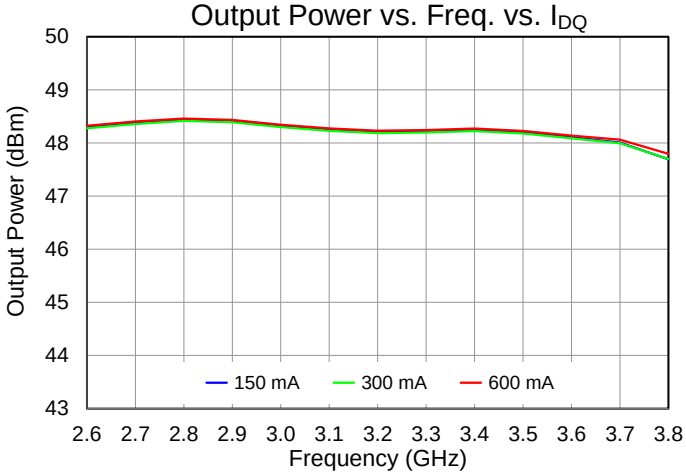
Performance Plots – Large Signal

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 700 us, DC = 20%, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

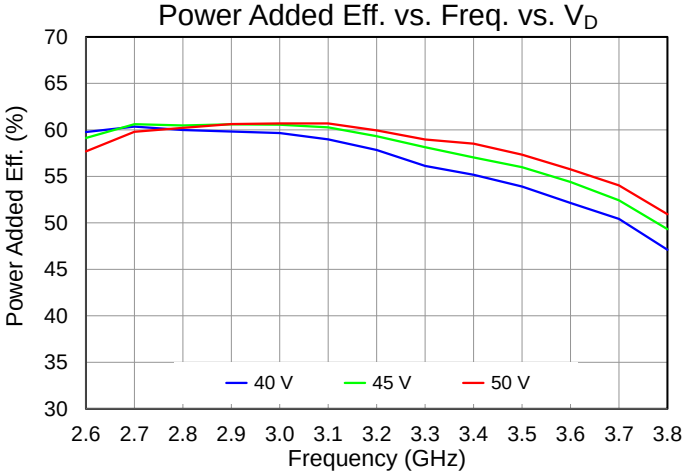
Output Power vs. Freq. vs. V_D



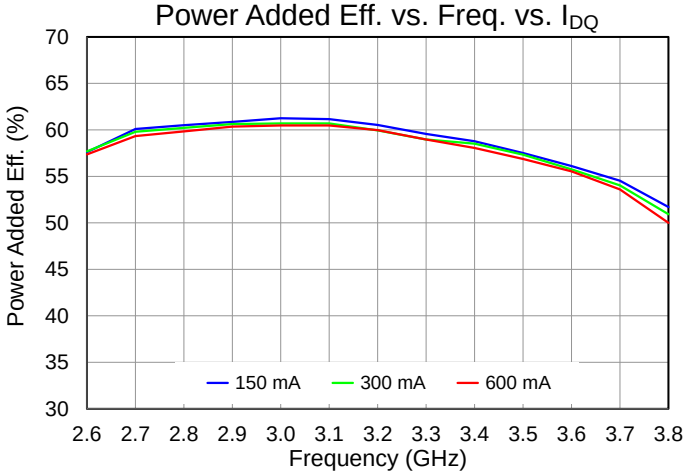
Output Power vs. Freq. vs. I_{DQ}



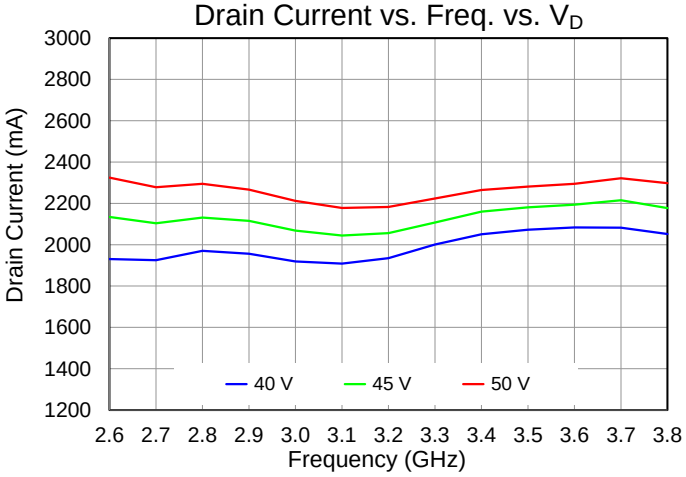
Power Added Eff. vs. Freq. vs. V_D



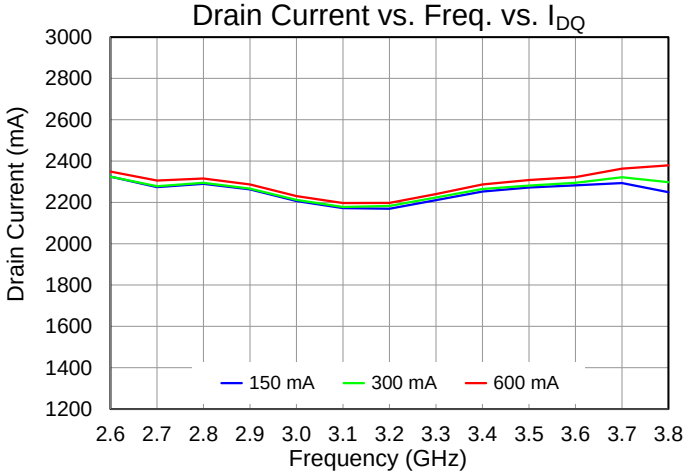
Power Added Eff. vs. Freq. vs. I_{DQ}



Drain Current vs. Freq. vs. V_D



Drain Current vs. Freq. vs. I_{DQ}



Performance Plots – Large Signal

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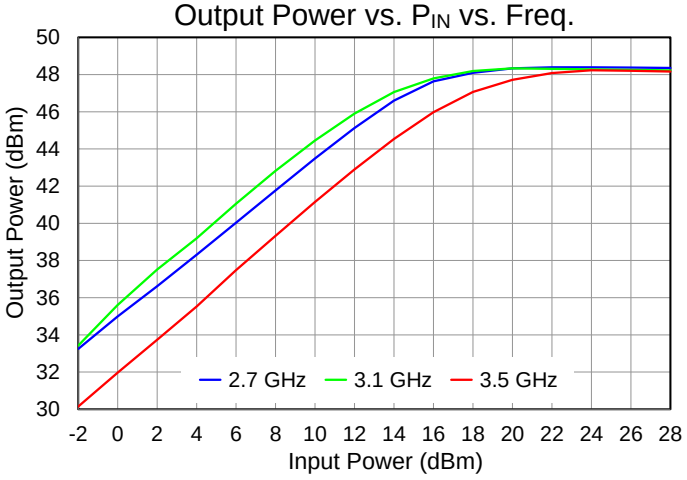
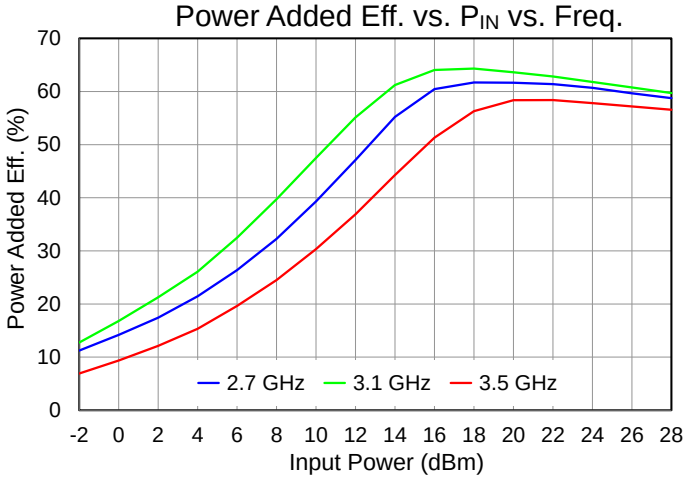
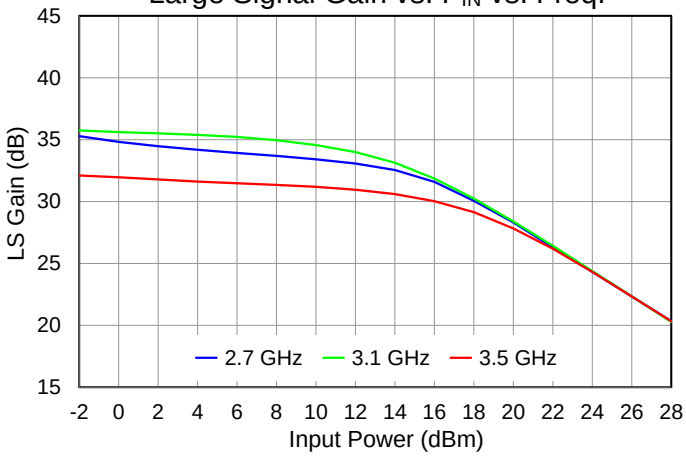
Output Power vs. P_{IN} vs. Freq.



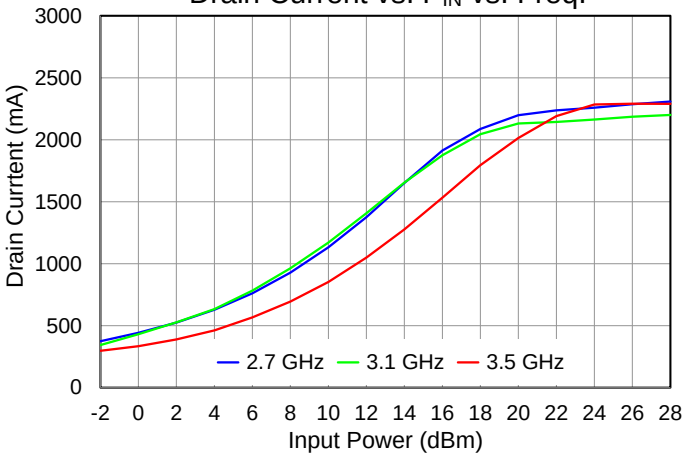
Power Added Eff. vs. P_{IN} vs. Freq.



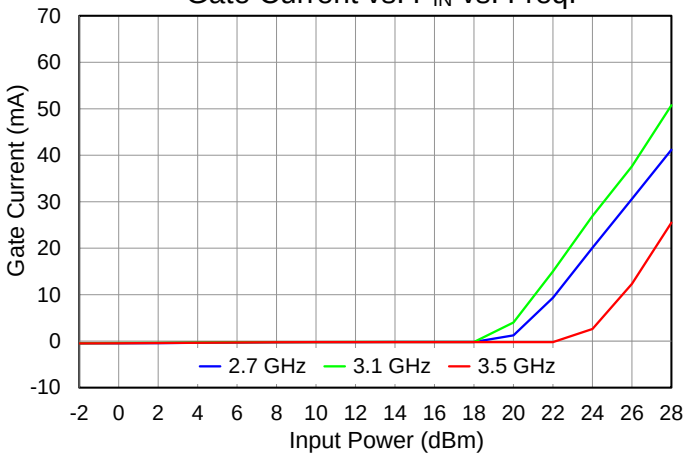
Large Signal Gain vs. P_{IN} vs. Freq.



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



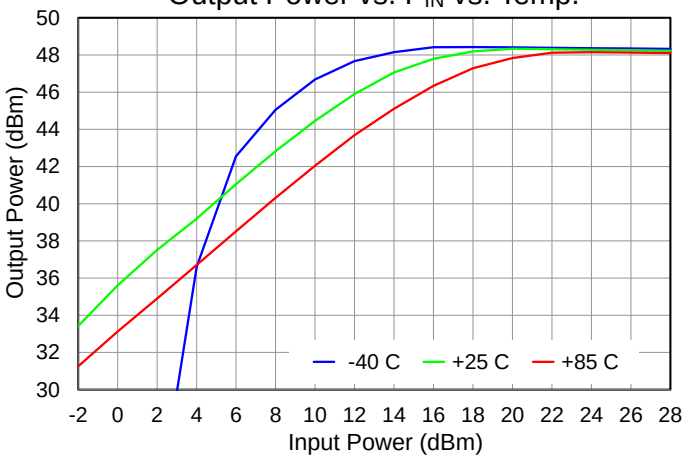
Gate Current vs. P_{IN} vs. Freq.



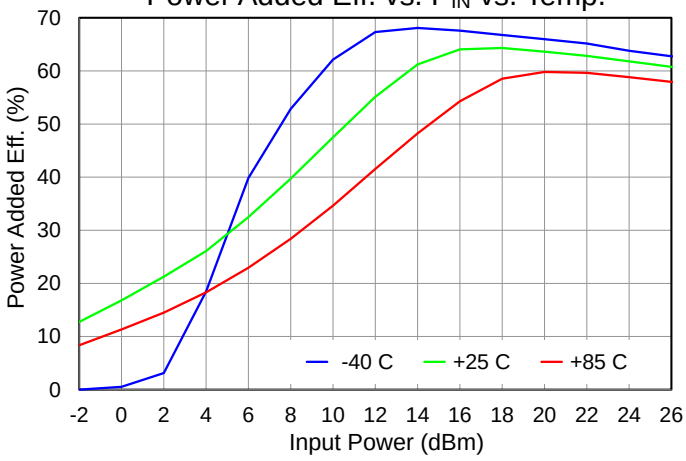
Performance Plots – Large Signal

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 700 us, DC = 20%, CW RF_{IN} = 26 dBm, Frequency = 3.1 GHz, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

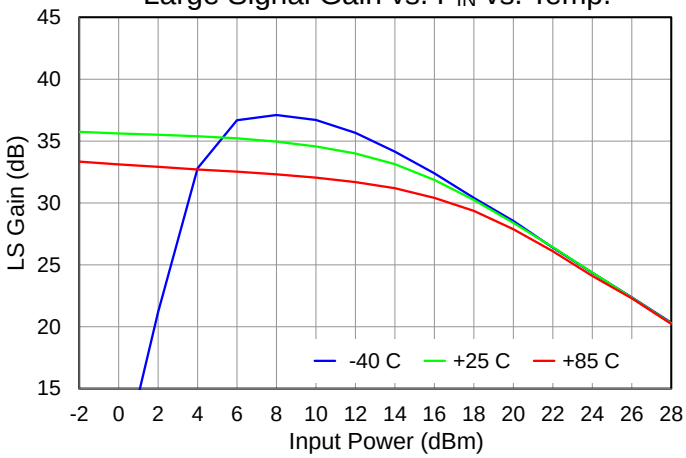
Output Power vs. P_{IN} vs. Temp.



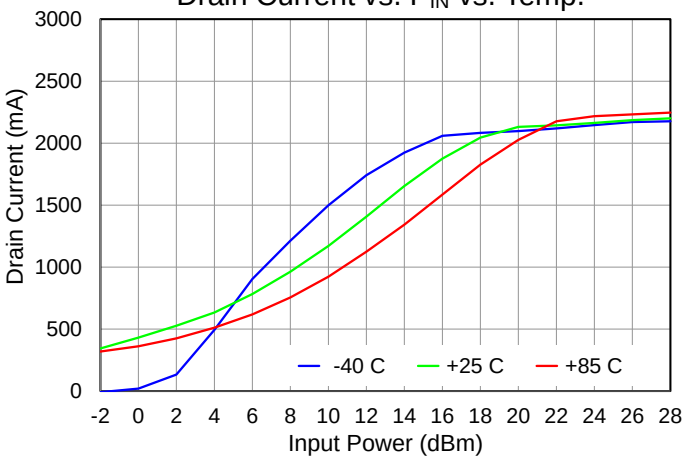
Power Added Eff. vs. P_{IN} vs. Temp.



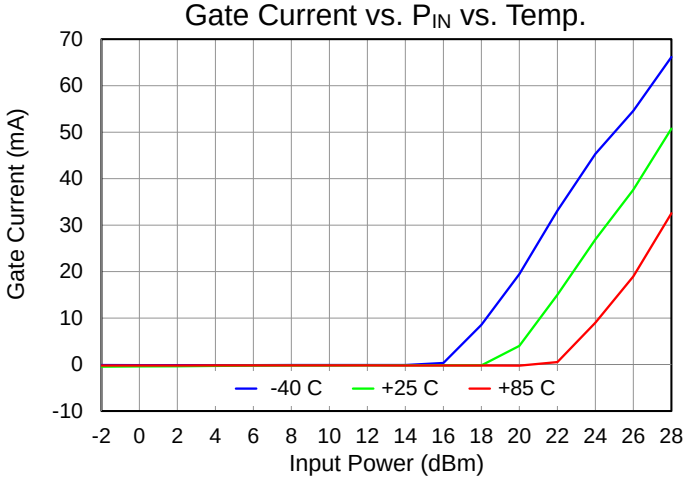
Large Signal Gain vs. P_{IN} vs. Temp.



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



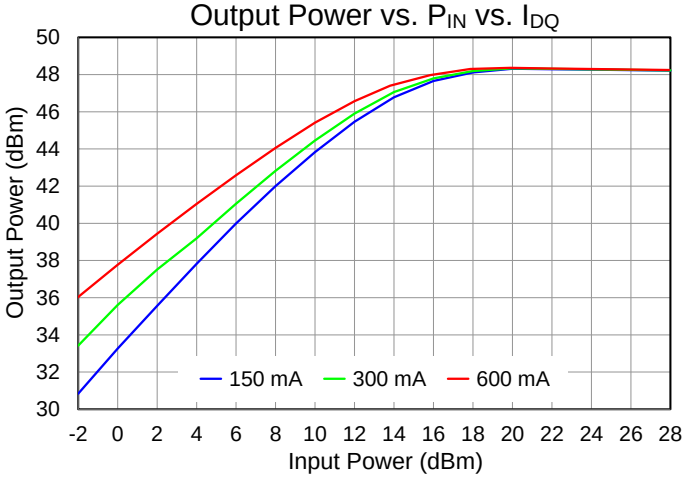
Gate Current vs. P_{IN} vs. Temp.



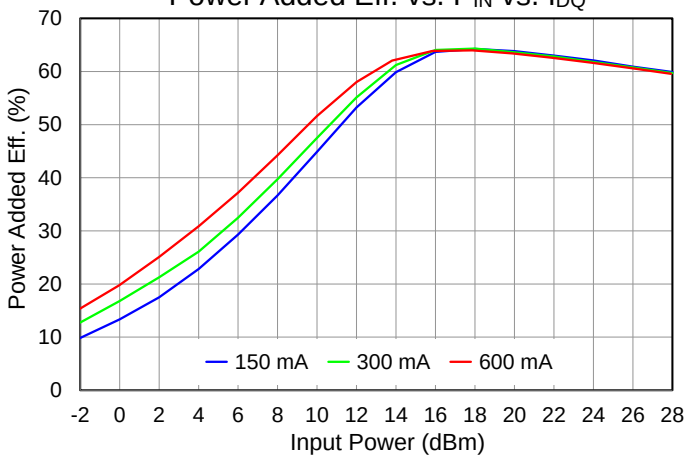
Performance Plots – Large Signal

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 700 us, DC = 20%, CW RF_{IN} = 26 dBm, Frequency = 3.1 GHz, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

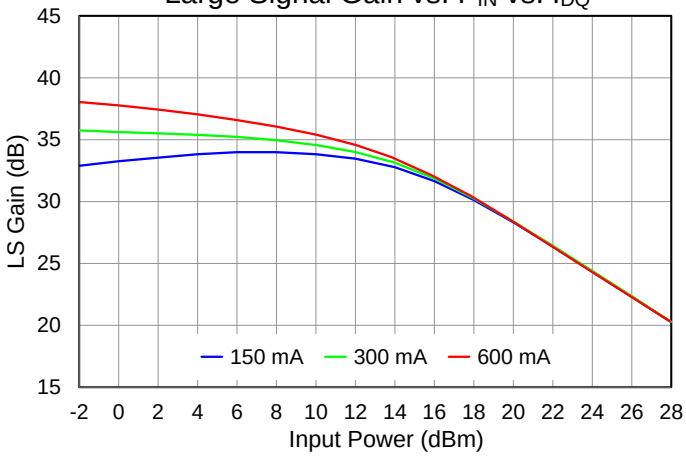
Output Power vs. P_{IN} vs. I_{DQ}



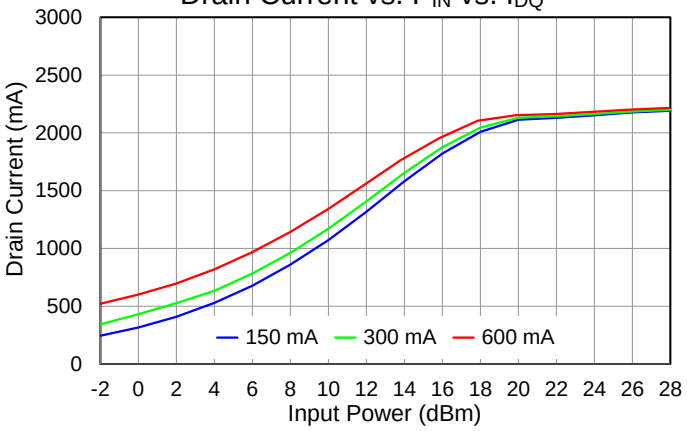
Power Added Eff. vs. P_{IN} vs. I_{DQ}



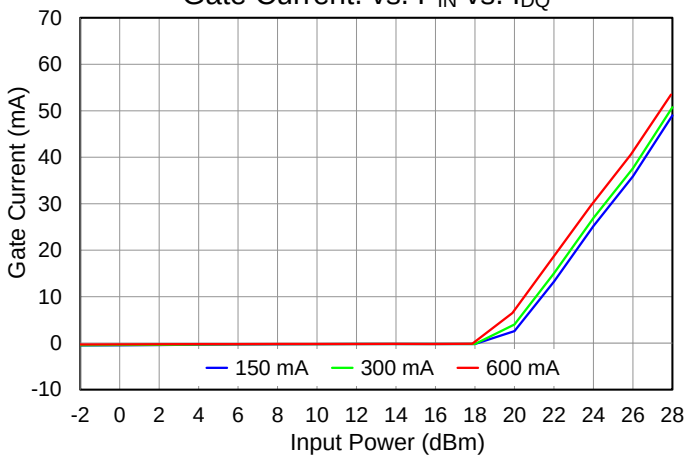
Large Signal Gain vs. P_{IN} vs. I_{DQ}



Drain Current vs. P_{IN} vs. I_{DQ}

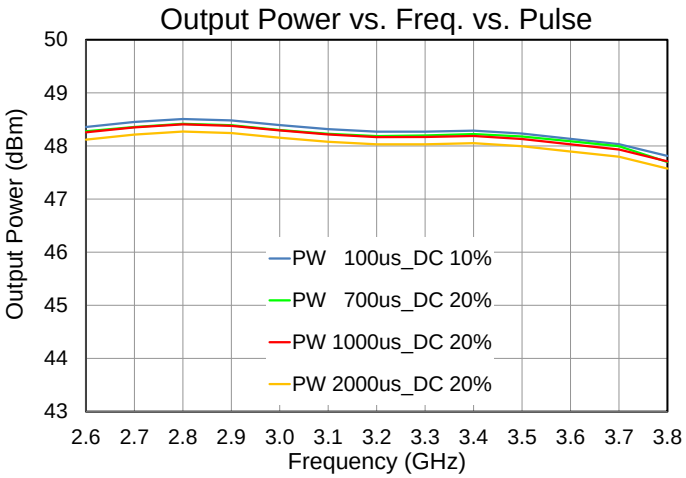


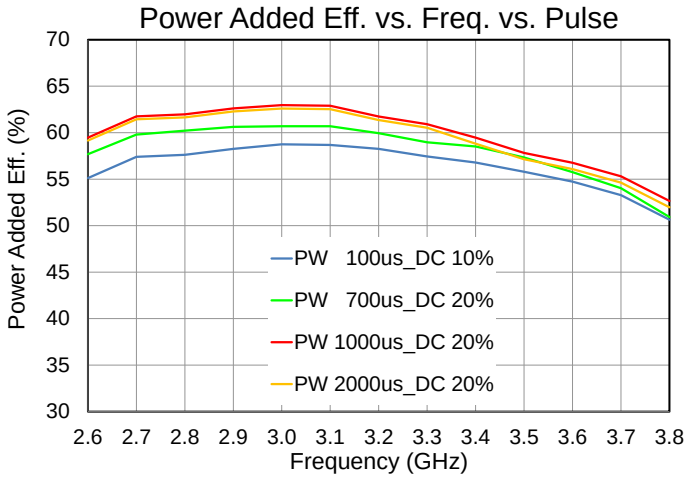
Gate Current. vs. P_{IN} vs. I_{DQ}

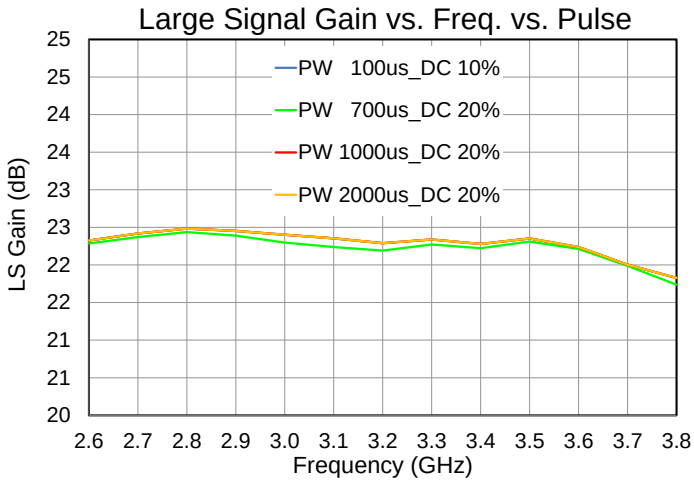


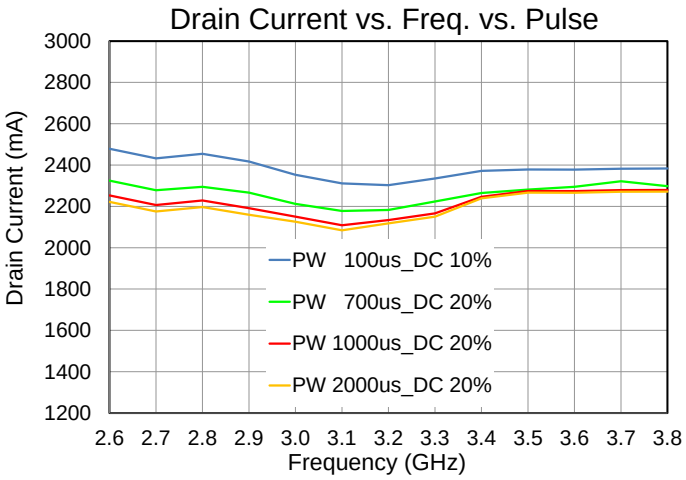
Performance Plots – Large Signal

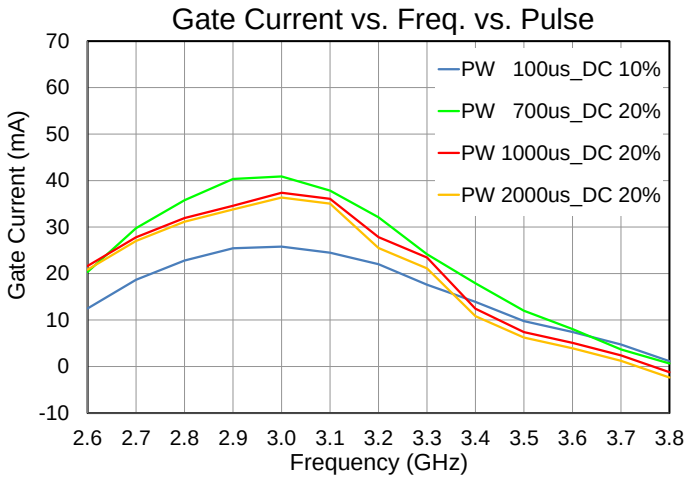
Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)







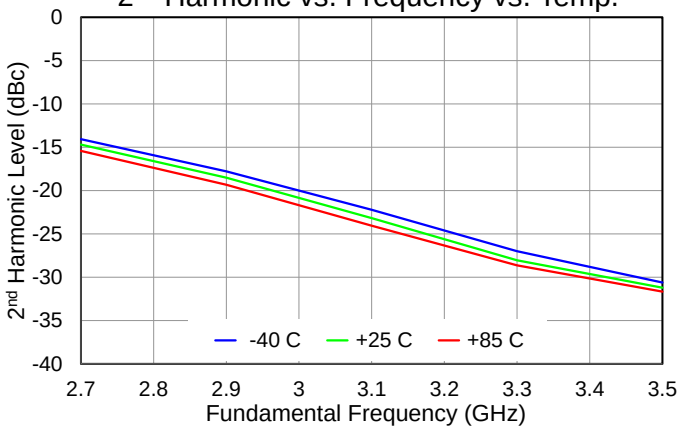




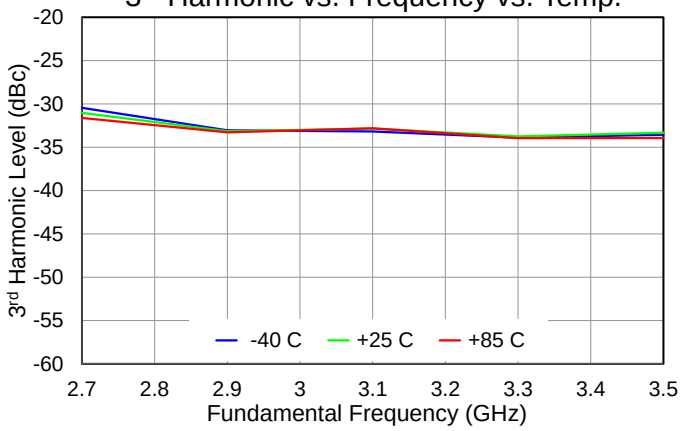
Performance Plots – Harmonics

Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, CW RF_{IN} = 26dBm, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

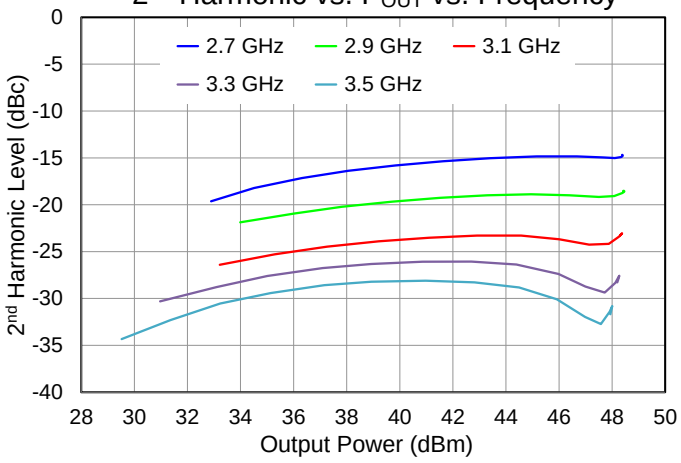
2nd Harmonic vs. Frequency vs. Temp.



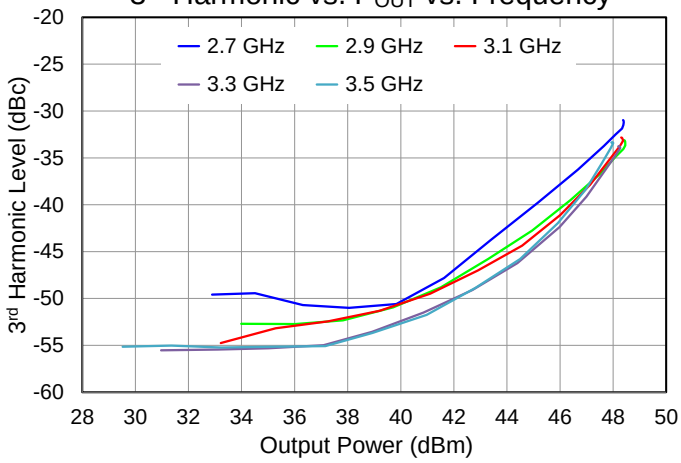
3rd Harmonic vs. Frequency vs. Temp.



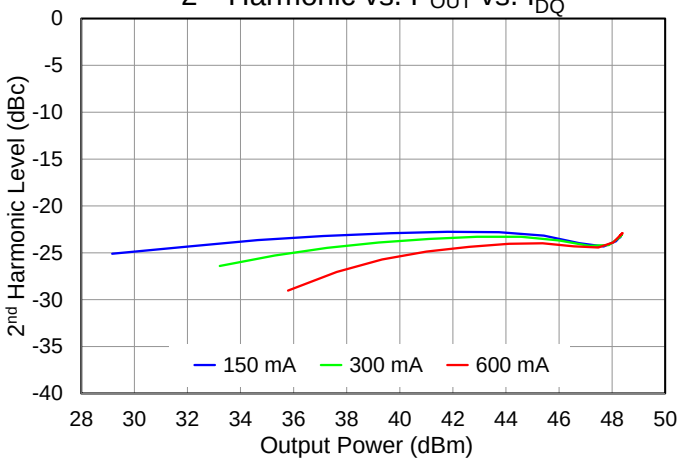
2nd Harmonic vs. P_{OUT} vs. Frequency



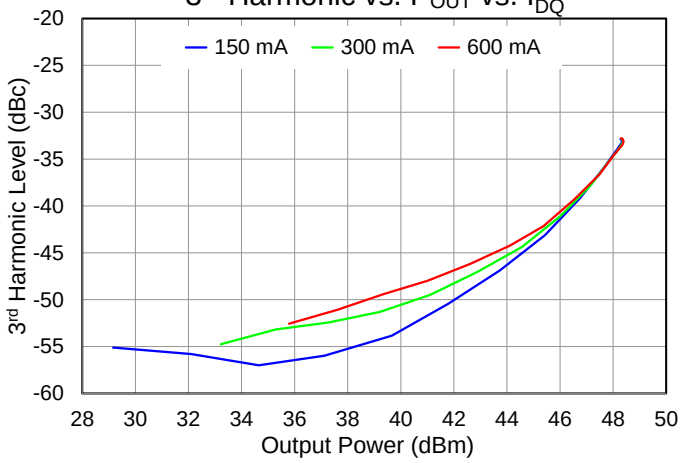
3rd Harmonic vs. P_{OUT} vs. Frequency



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

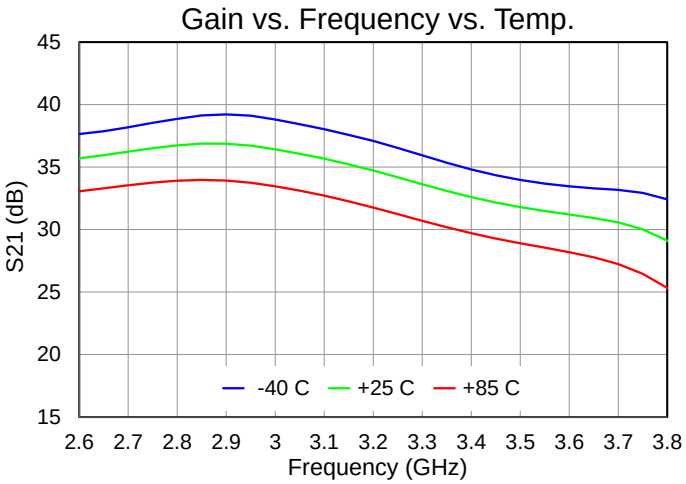


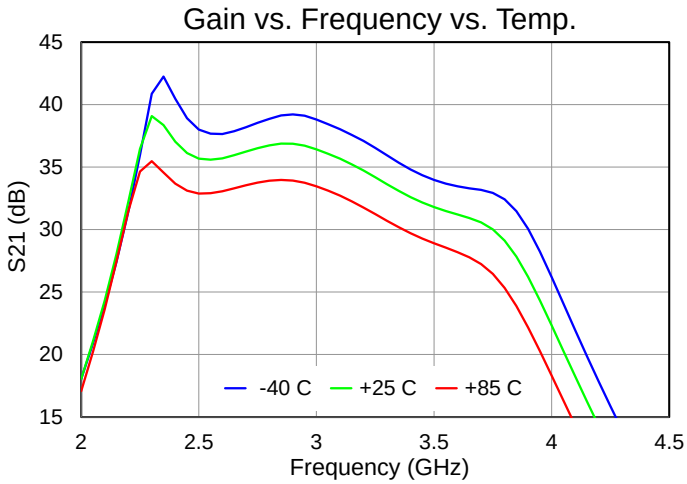
3rd Harmonic vs. P_{OUT} vs. I_{DQ}

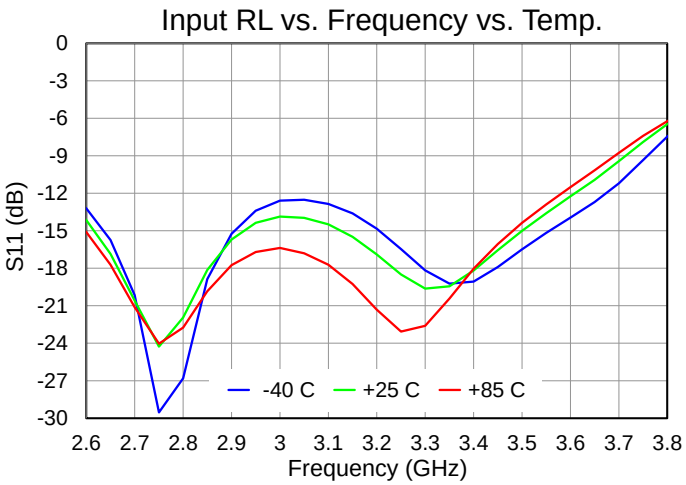


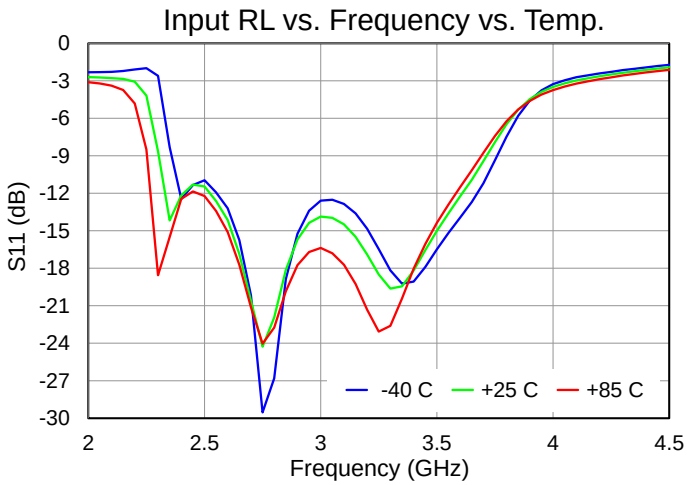
Performance Plots – Small Signal

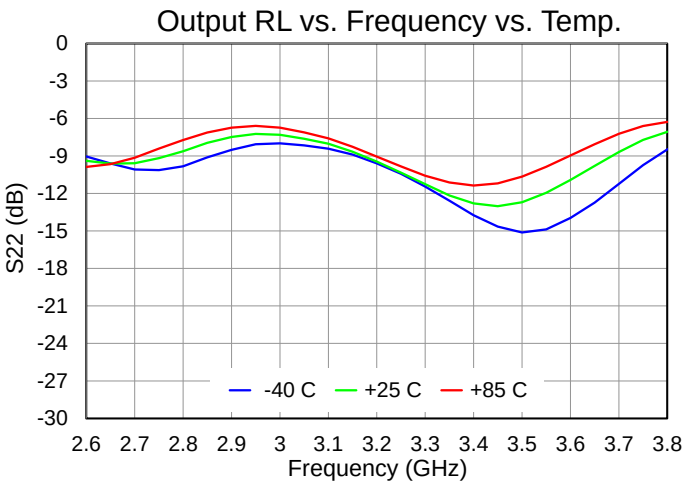
Test conditions unless otherwise noted: CW V_D = 50 V, I_{DQ} = 300 mA, CW RF_{IN}, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

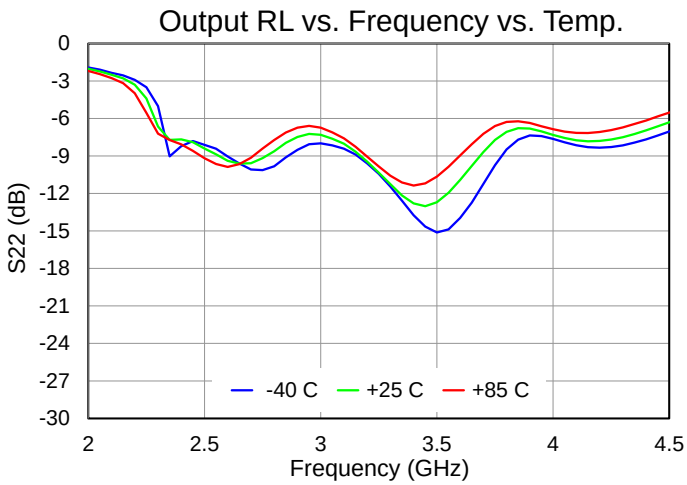








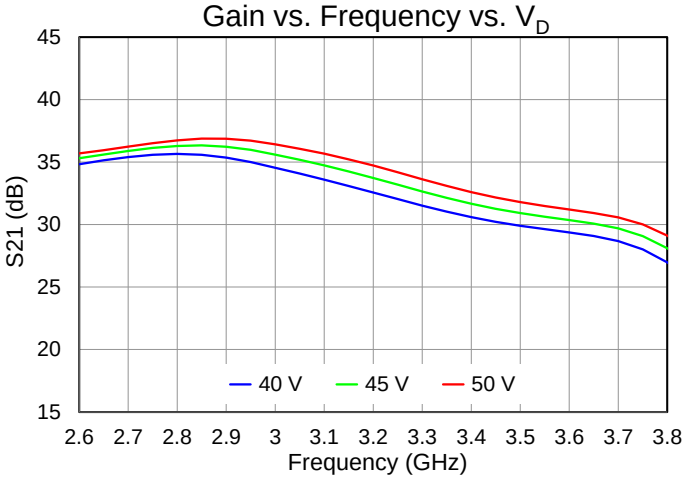




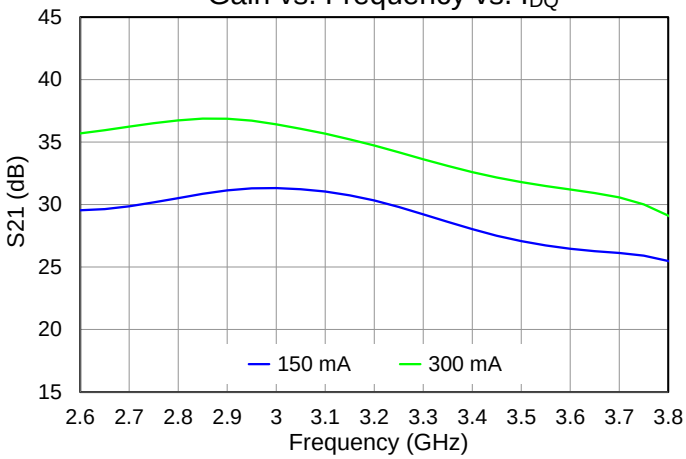
Performance Plots – Small Signal

Test conditions unless otherwise noted: CW V_D = 50 V, I_{DQ} = 300 mA, CW RF_{IN}, T_{BASE} = +25 °C (T_{BASE} is backside of QPA1027)

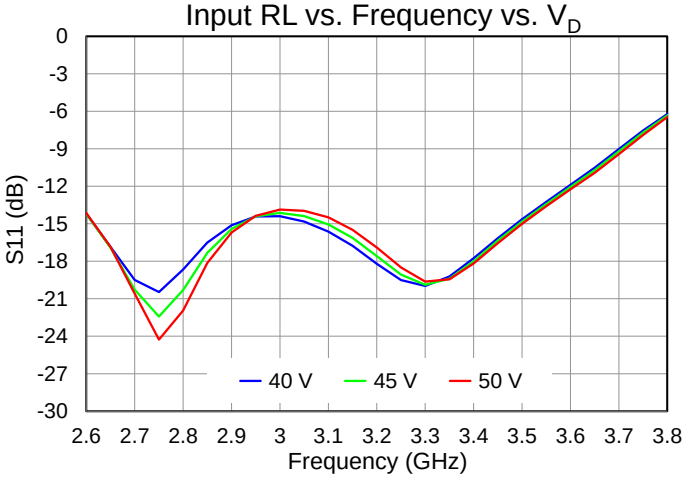
Gain vs. Frequency vs. V_D



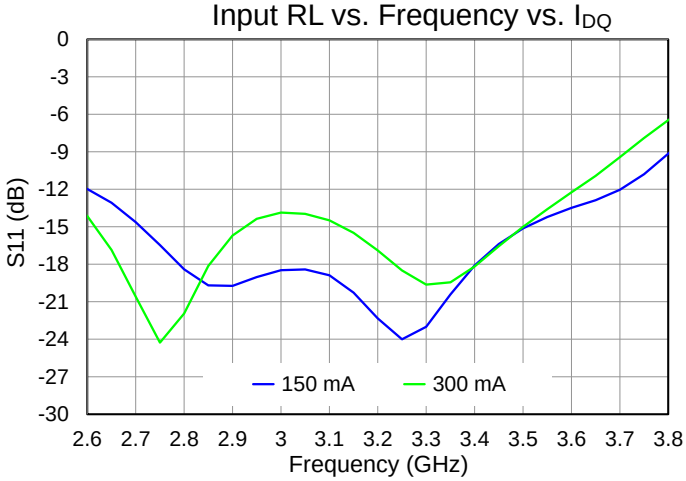
Gain vs. Frequency vs. I_{DQ}



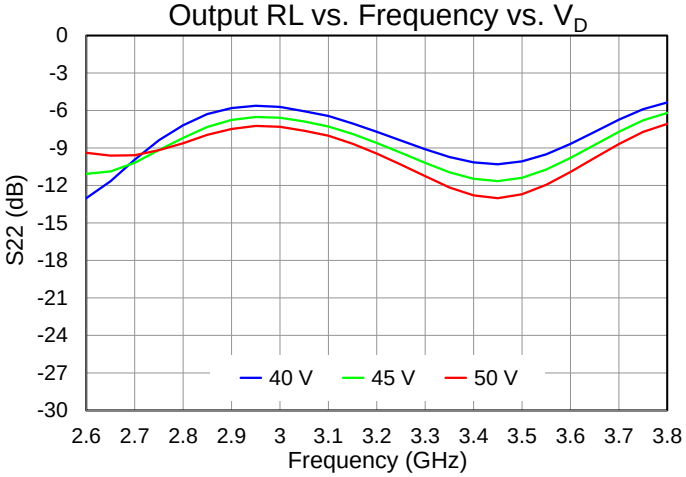
Input RL vs. Frequency vs. V_D



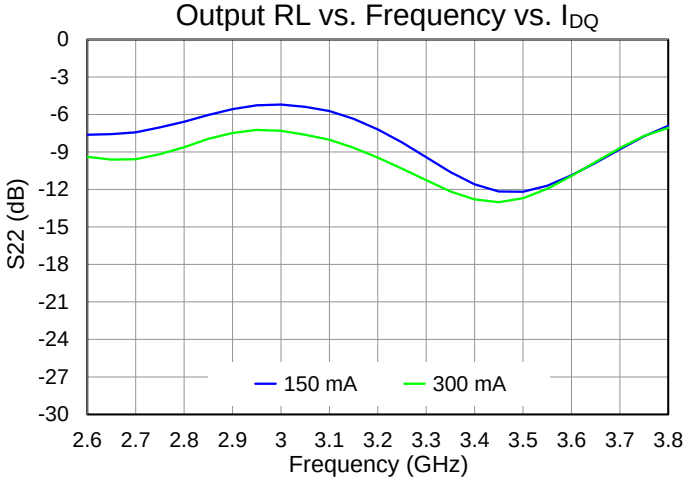
Input RL vs. Frequency vs. I_{DQ}



Output RL vs. Frequency vs. V_D



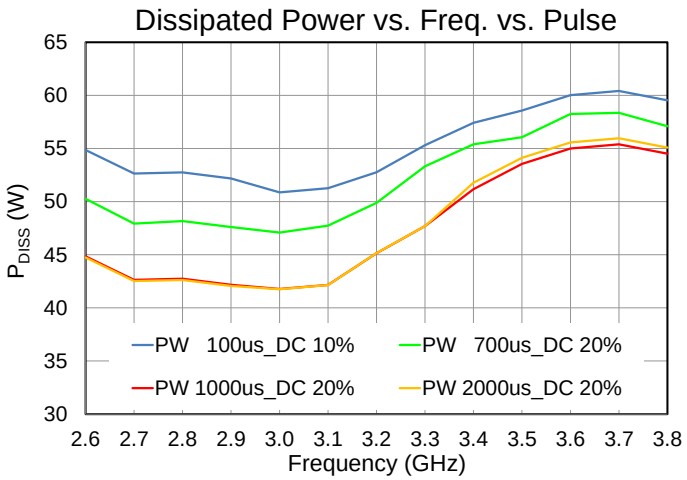
Output RL vs. Frequency vs. I_{DQ}

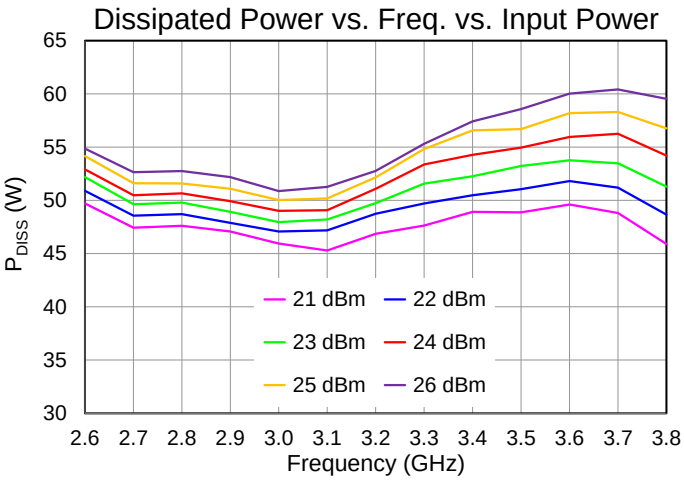


Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, **Pulsed PW = 100 us, DC = 10%,** V_D = 50 V, I_{DQ} = 300 mA, Freq = 3.5 GHz, $I_{D\_Drive,\ peak}$ ≈ 2.45 A, P_{IN} = 26 dBm, P_{OUT} ≈ 48 dBm, P_{DISS} = 59 W	0.91	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		138	°C
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, **Pulsed PW = 700 us, DC = 20%,** V_D = 50 V, I_{DQ} = 300 mA, Freq = 3.5 GHz, $I_{D\_Drive,\ peak}$ ≈ 2.35 A, P_{IN} = 26 dBm, P_{OUT} ≈ 47.9 dBm, P_{DISS} = 56 W	1.55	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		172	°C
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, **Pulsed PW = 1000 us, DC = 20%,** V_D = 50 V, I_{DQ} = 300 mA, Freq = 3.5 GHz, $I_{D\_Drive,\ peak}$ ≈ 2.3 A, P_{IN} = 26 dBm, P_{OUT} ≈ 47.9 dBm, P_{DISS} = 54 W	1.71	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		177	°C
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, **Pulsed PW = 2000 us, DC = 20%,** V_D = 50 V, I_{DQ} = 300 mA, Freq = 3.5 GHz, $I_{D\_Drive,\ peak}$ ≈ 2.3 A, P_{IN} = 26 dBm, P_{OUT} ≈ 47.9 dBm, P_{DISS} = 54 W	1.86	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		185	°C

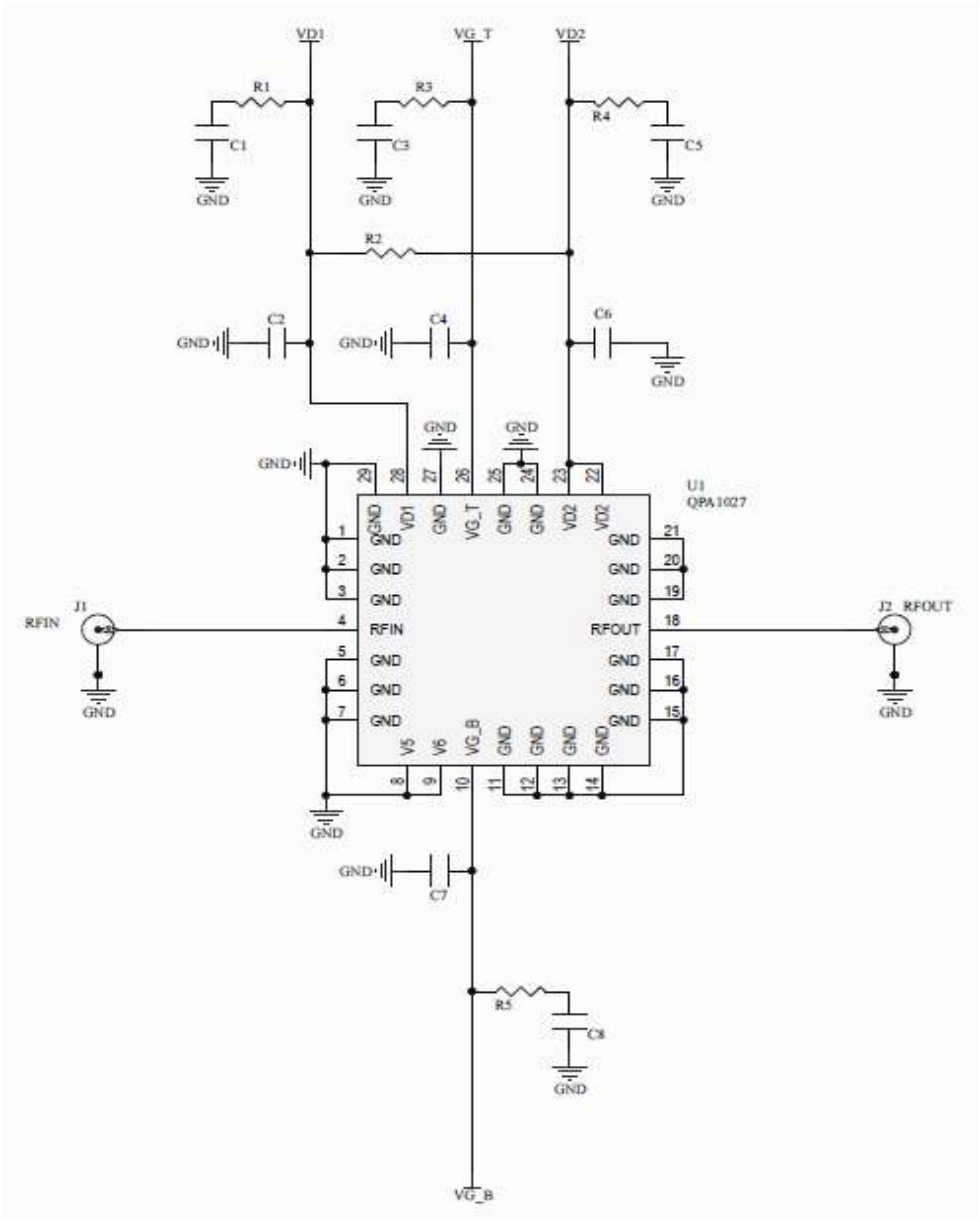
Notes:
1. Thermal resistance determined to the back of QPA1027 T_{BASE} = 85 °C
2. Channel temperature indicated is an IR scan equivalent temperature. Thermal resistance is calculated using this value. Additional information can be found in the Qorvo Applications Note “GaN Device TCHMAX Theta-JC and Reliability Estimates,” located here https://www.qorvo.com/products/d/da006480





Test conditions unless otherwise noted: Pulsed V_D = 50 V, I_{DQ} = 300 mA, PW = 100 us, DC = 10%, CW RF_{IN} = 26dBm, T_{BASE} = +85 °C

Applications Circuit (Pulse)



Note:

1. Vg can be applied to either side; external bypassing required on both sides
2. Remove R2 to bias Vd's independently

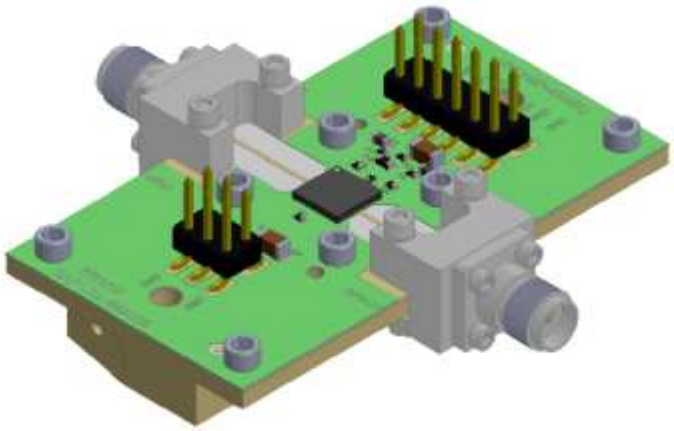
Bias-Up Procedure

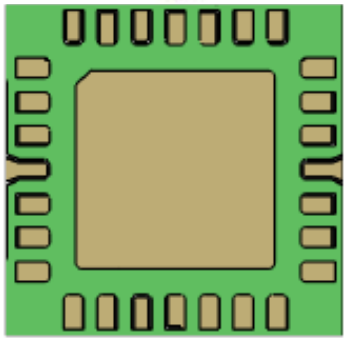
1. Set I_D limit (CW) to 3000 mA, I_G limit to 200 mA
2. Set V_G to −5.0 V
4. Set V_D +50 V
5. Adjust V_G more positive until I_{DQ} = 300 mA ($V_G \approx -2.7$ V +/- Typical)

Bias-Down Procedure

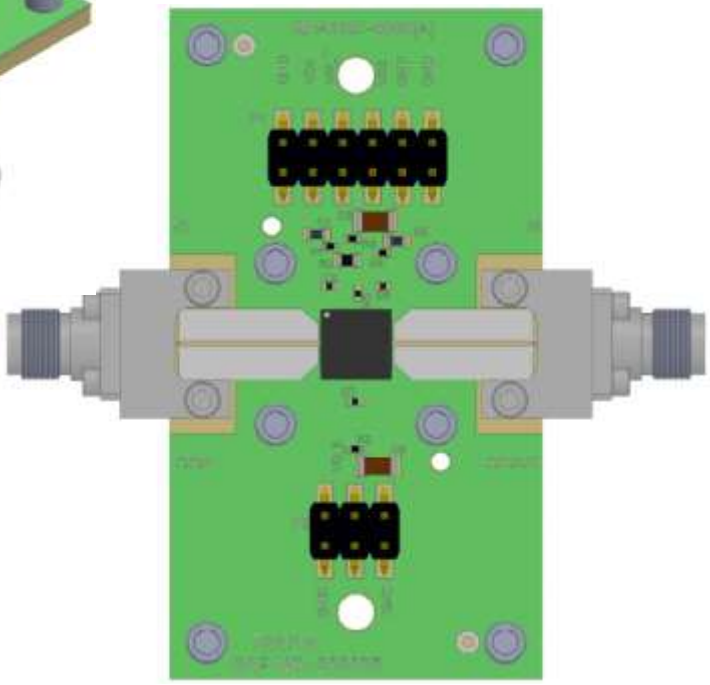
1. Turn off RF signal
2. Reduce V_G to −5.0 V. Ensure I_{DQ} ~ 0mA
4. Set V_D to 0 V
5. Turn off V_D supply

Application Evaluation Board (Pulse)





PCB Mounting



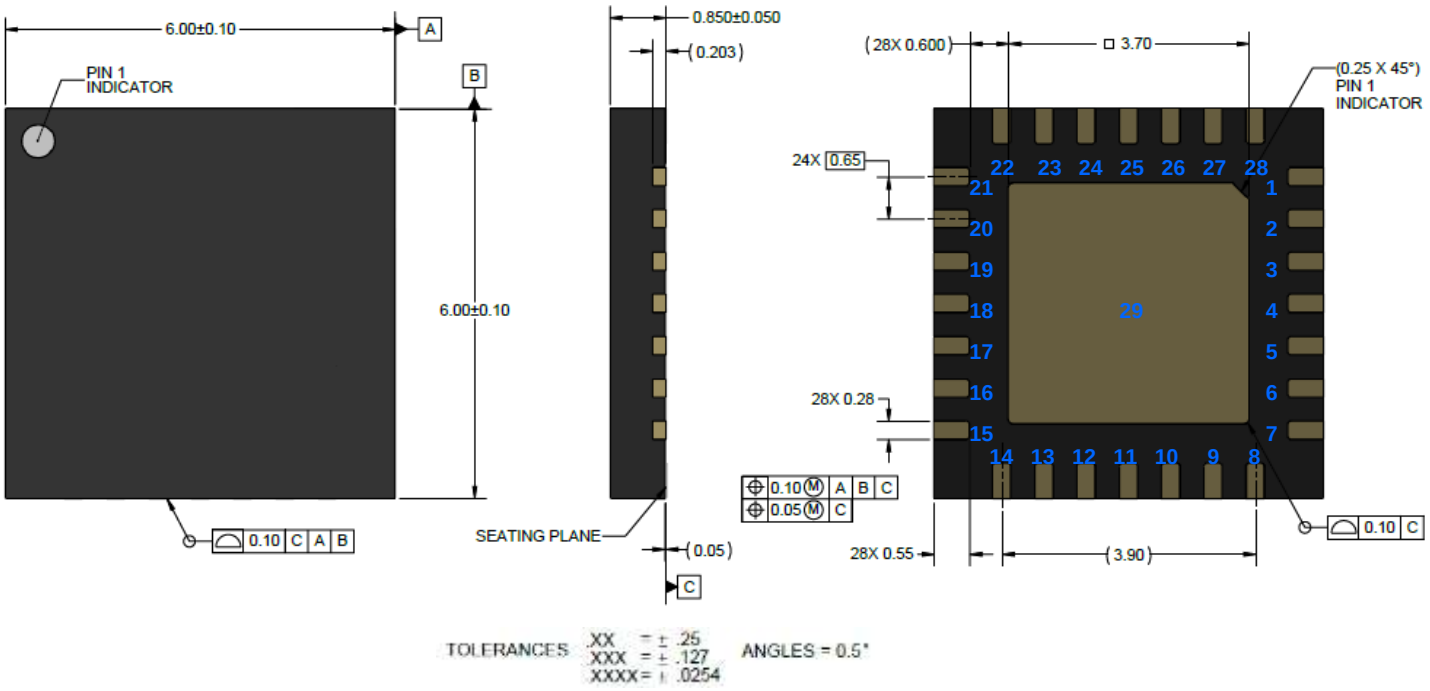
Notes:

1. RF PCB is Rogers 4003C; dielectric is 8 mil thick, copper cladding is ½ oz. copper both sides, plated to 1 oz
2. Copper Slug placed under the DUT to improve thermal and electrical performance

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1, C5	0.1 uF	CAP, 0.1uF, ±10%, 50V, X7R, 0603	Various	
C2, C4, C6, C7	1000 pF	CAP, 1000pF, ±10%, 100V, X7R, 0402	Various	
C3, C8	10 uF	CAP, 10uF, ±20%, 50V, X5R, 1206	Various	
R1, R4	10 Ω	RES, 10 OHM, 5%, 0.1W, 0402	Various	
R2	0 Ω	RES, 0 OHM, 0.1W, 0603	Various	
R3, R5	0 Ω	RES, 0 OHM, JMPR, 0402	Various	
H1, H2	-	Header, connector 2x6, SMD		
J1, J2	-	Connector, Female, End Launch, 2.9mm	Southwest Microwave	1092-01A-5
S1 – S8		Screw, cap, socket head, 2-56x1/8”		
PCB	-	Rogers 4003C, 8 mil dielectric, 1 oz. copper (gold plated), 2 layers	Rogers Corp.	Custom
Carrier	-	T-Carrier, Copper C110, 1.248 x 2.246 x 0.275”		Custom
Solder	-	Paste, solder, syntech, Sn62/Pb36/Ag2		
Epoxy	-	Preform Epoxy, 0.986 x 1.996 x 0.003T		

Mechanical Information



Notes: unless otherwise specified;

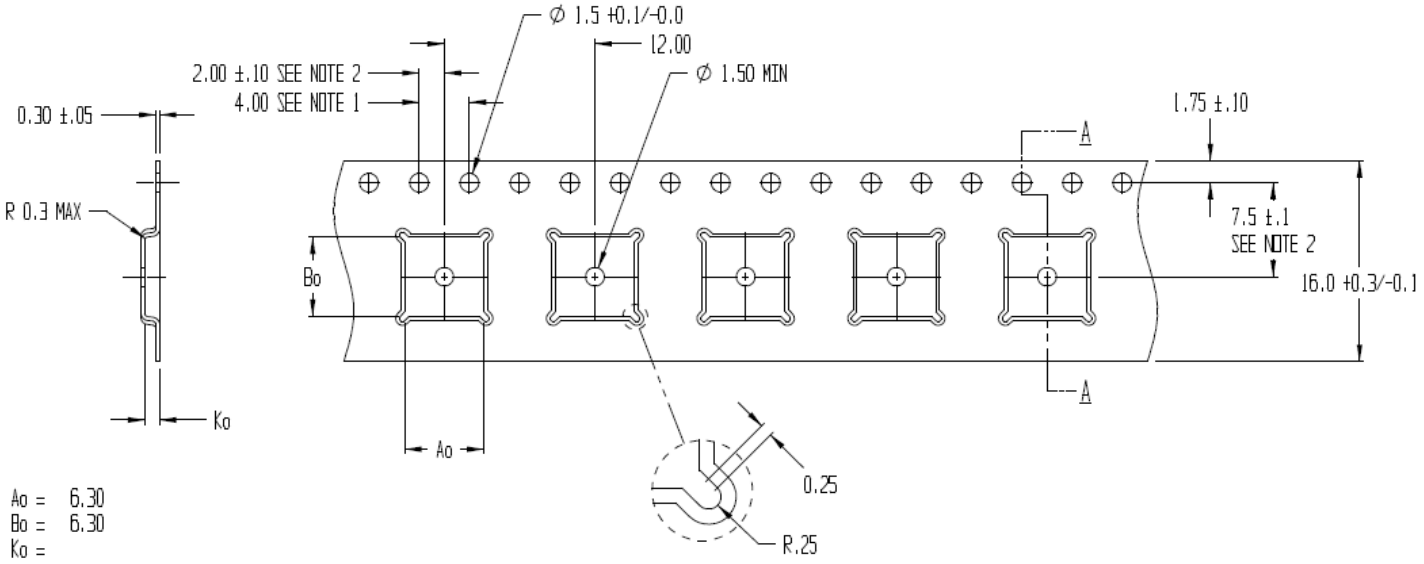
1. Dimensions: millimeters (mm)
2. Package leads are gold (Au) plated; Part is mold encapsulated
3. Marking: YY is calendar year; WW is assembly week; MXXX is batch ID

Pin Description

Pin Number	Symbol	Description
1-3, 5-9, 11-17, 19-21, 24-25 27	N/C	No internal connection. Connect pads to PCB ground
4	RF Input	RF Input. Matched to 50 Ω; DC blocked; DC shorted to ground
10, 26	V_G	Gate voltage. External bypassing required; refer to page 17 for recommendation
18	RF Output	RF Output. Matched to 50 Ω; DC blocked
22, 23	V_{D2}	Drain voltage for stage 2. External bypassing required; refer to page 17 for recommendation
28	V_{D1}	Drain voltage for stage 1. External bypassing required; refer to page 17 for recommendation
29	Center Pad	Ground connection

Tape and reel Information

Standard T/R size = 250 pieces on a 7” reel
Dimensions: millimeters (mm)
Tolerances unless otherwise noted: .X = ± .2; .XX = ± .10

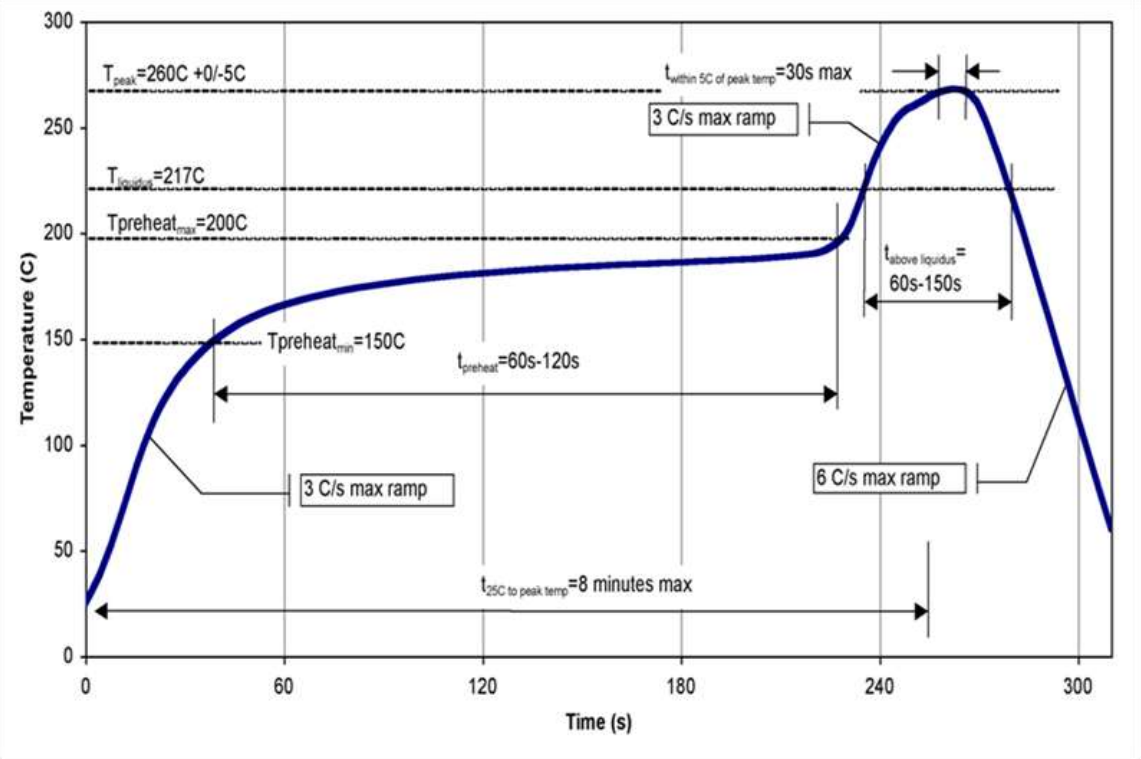


NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE
3. Ao AND Bo ARE CALCULATED ON A PLANE AT A DISTANCE "R" ABOVE THE BOTTOM OF THE POCKET.

Solderability

- Compatible with the latest version of J-STD-020, Lead-free solder, 260 °C
- Do not expose the package lid to temperatures > 280 °C

Recommended Soldering Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1A	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	C3	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	3	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, 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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