

Product Overview

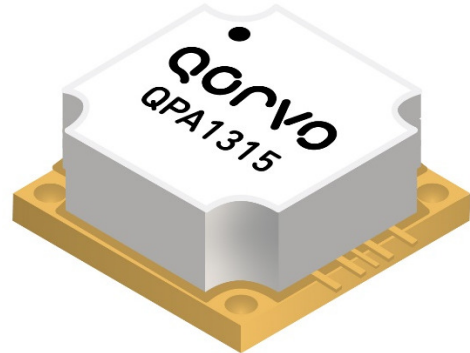
Qorvo's QPA1315 is a packaged high power MMIC amplifier, Ku-K band, fabricated on Qorvo's production 0.15 um GaN on SiC process (QGaN15). QPA1315 is targeted for 15.4 – 17.7 GHz band. It provides 35 W of saturated output power with 21 dB of large signal gain while achieving 20% power-added efficiency.

The QPA1315 is packaged in a 10-lead 15 x 15 mm bolt-down with a Cu base for superior thermal management. To simplify system integration, the QPA1315 is fully matched to 50 ohms with DC grounded I/O ports for optimum ESD performance. Also, there are on-chip blocking capacitors following the DC grounds on the input and output ports.

The QPA1315 is ideal for supporting radar applications in both commercial and military markets.

The QPA1315 is 100% DC and RF tested to ensure compliance to electrical specifications.

Lead-free and RoHS compliant

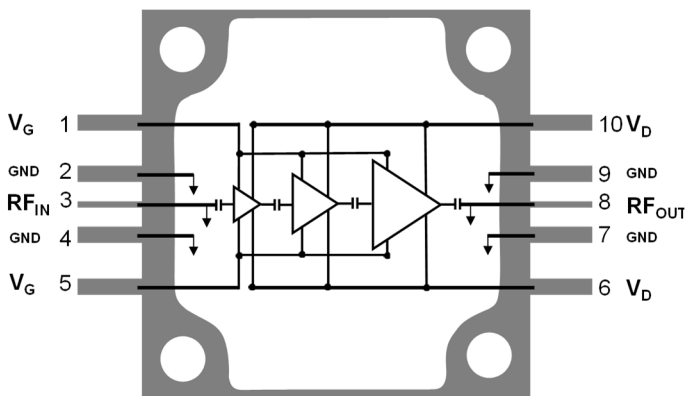


Key Features

- Frequency Range: 15.4 – 17.7 GHz
- P_{SAT} ($P_{IN} = 24$ dBm): 45.5 dBm
- PAE ($P_{IN} = 24$ dBm): 20 %
- Power Gain ($P_{IN} = 24$ dBm): 21 dB
- Small Signal Gain: 25 dB
- Bias: Pulsed $V_D = 26$ V, $I_{DQ} = 640$ mA, $V_G = -2.5$ V typ. Range, $PW = 100$ uS, DC = 10%
- Package Dimensions: 15.2 x 15.2 x 3.5 mm
- Package base is pure Cu offering superior thermal management.

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

Functional Block Diagram



Applications

- Radar

Ordering Information

Part No.	Description
QPA1315	15.4 - 17.7 GHz 35 Watt GaN PA
QPA1315EVB	Evaluation Board



Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V _D)	29.5 V
Gate Voltage Range (V _G)	-6 V to 0 V
Drain Current Total (I _D), T _{BASE} = 85 °C	14 A
Gate Current (I _G)	See plot page 24
Power Dissipation (P _{DISS}), Pulsed, T _{BASE} = 85 °C	100us/10%: 160W 300us/30%: 150W
Input Power (P _{IN}), 50 Ω, Pulsed, V _D = 28 V, I _{DQ} = 640 mA, PW = 100 us, DC = 10%, T _{BASE} = 85 °C	34 dBm
Input Power (P _{IN}), 10:1 VSWR, Pulsed, V _D = 28 V, I _{DQ} = 640 mA, PW = 100 us, DC = 10%, T _{BASE} = 85 °C	34 dBm
Mounting Temperature	Refer to Assembly Notes, page 29
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
Drain Voltage (V _D), Pulsed ^{1/}		26	28 ^{2/}	V
Drain Current Quiescent (I _{DQ})		640		mA
Drain Current, RF (I _{D_Drive})	See plots page 4,5,8,11,14			mA
Gate Voltage Typ. Range (V _G)	-1.9 to -3.1			V
Gate Current, RF (I _{G_Drive})	See plots page 4,5			mA
Input Power @ Saturation (P _{IN}) ^{3/}	T _{BASE} -40°C: 20			dBm
	T _{BASE} +25°C: 24			
	T _{BASE} +85 °C: 28			
Operating Temp. Range (T _{BASE}) ^{4/}	-40		+85	°C

1. CW operating requires thermal consideration. CW Applications are up to 7 dBm back off from saturated output power P_{SAT}.
2. Pulsed 28V requires thermal consideration
3. See plots page 6,7,18,19
4. T_{BASE} is back side of QPA1315

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

Electrical Specifications

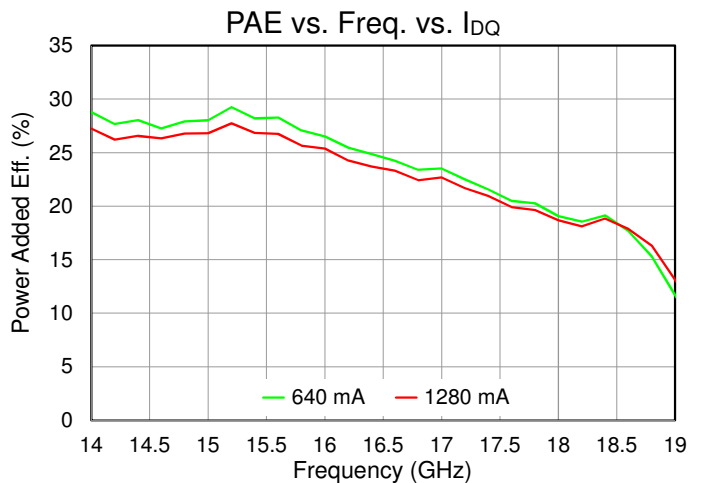
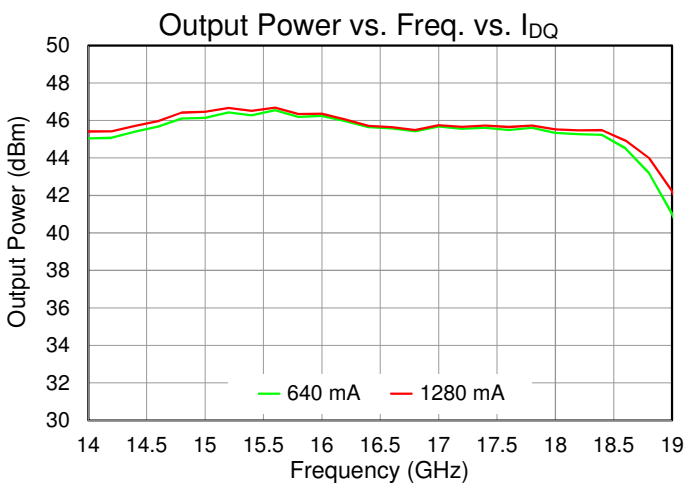
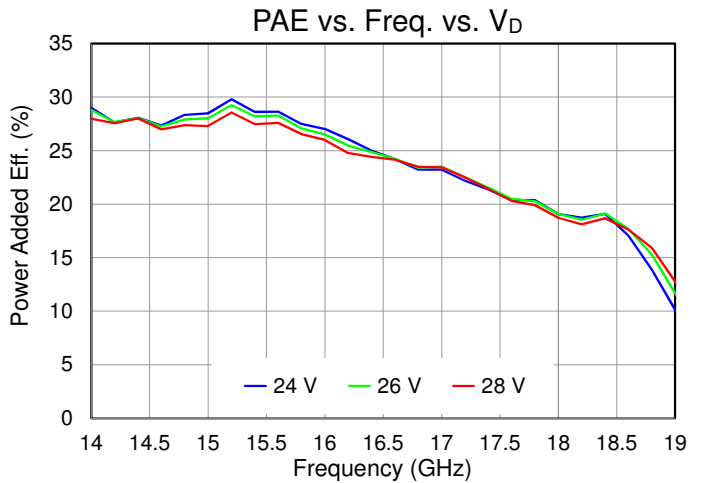
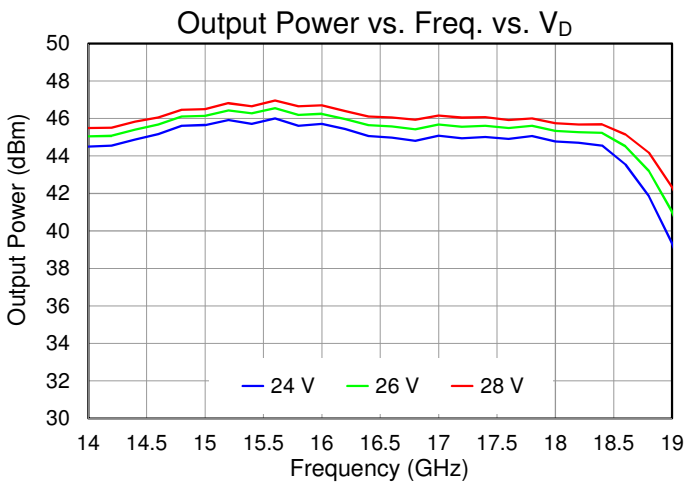
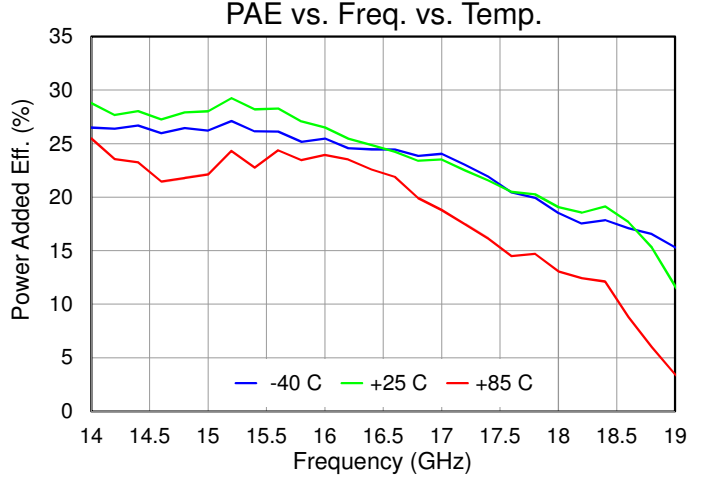
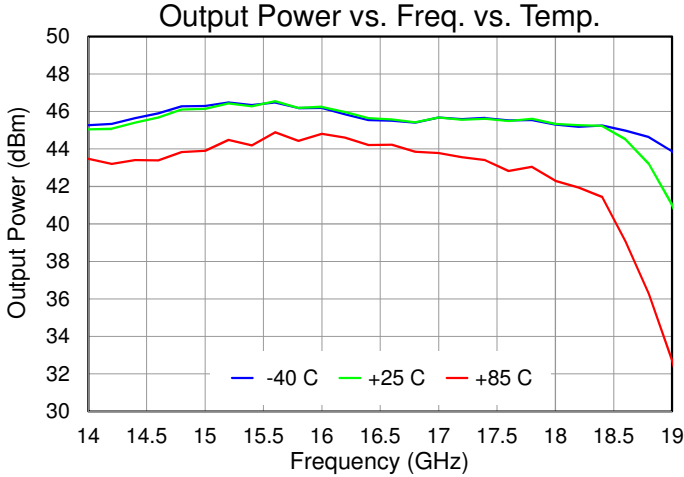
Parameter	Conditions ^{(1) (2)}	Min	Typ.	Max	Units
Operational Frequency Range		15.4		17.7	GHz
Output Power at Saturation, P _{SAT}	P _{IN} = 24 dBm		45.5		dBm
Power Added Efficiency, PAE	P _{IN} = 24 dBm		20		%
Small Signal Gain, S ₂₁	P _{IN} = -25 dBm		25		dB
Input Return Loss, IRL			7		
Output Return Loss, ORL			7		
P _{SAT} Temperature Coefficient	T _{DIFF} = 25 °C to 85 °C; P _{IN} = 24 dBm		-0.02		dBm/°C
S ₂₁ Temperature Coefficient	T _{DIFF} = 25 °C to 85 °C		-0.10		dB/°C

Notes:

1. Test conditions unless otherwise noted: Pulsed V_D = 26 V, I_{DQ} = 640 mA, V_G = -2.5 +/- 0.6 V typical, PW = 100 us, DC = 10%, T_{BASE} = 25°C, Z₀ = 50 Ω
2. T_{BASE} is back side of QPA1315 (not the ambient nor bottom of the board temperature)

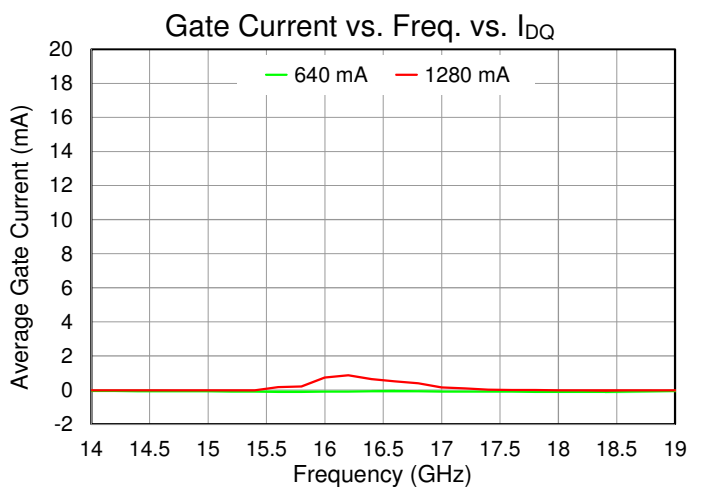
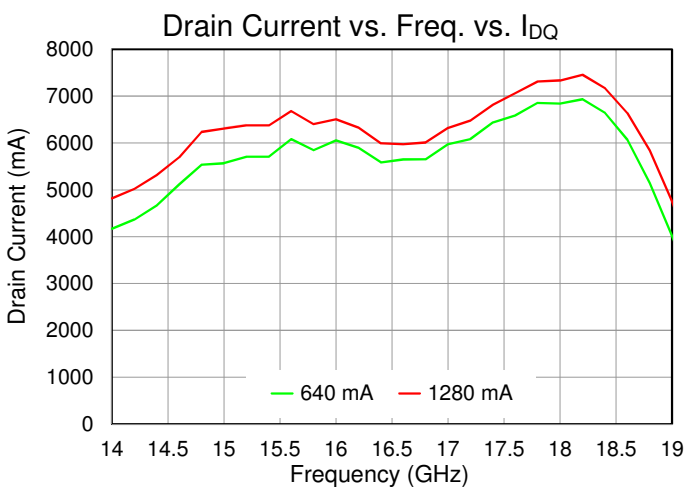
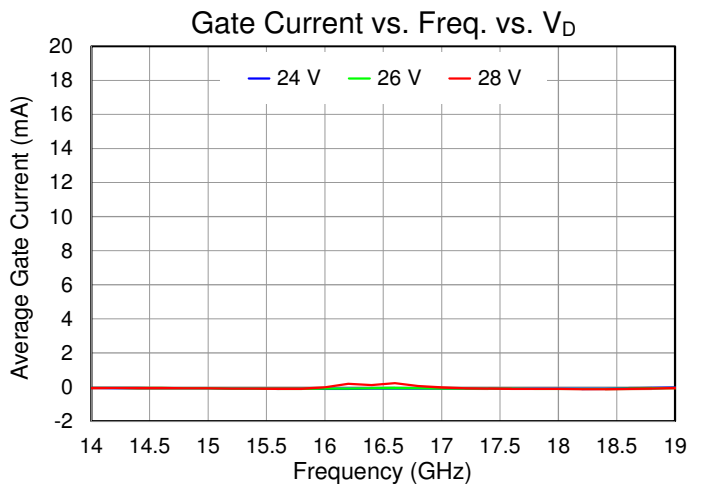
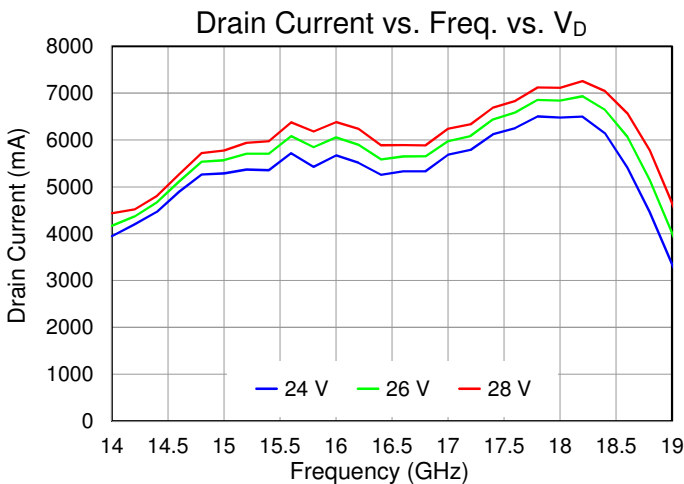
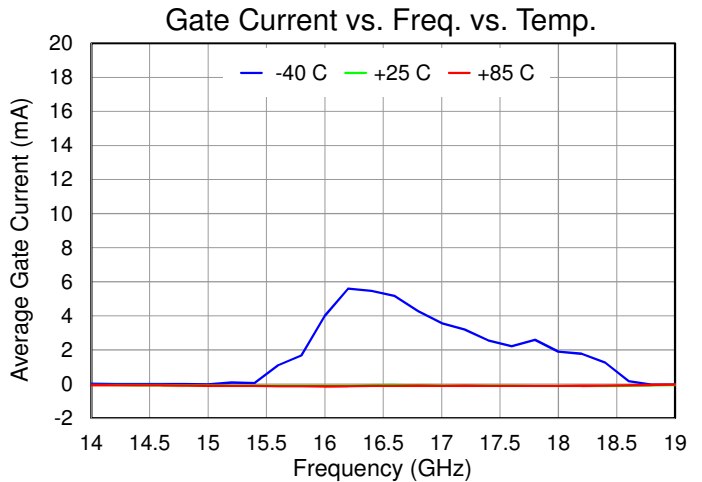
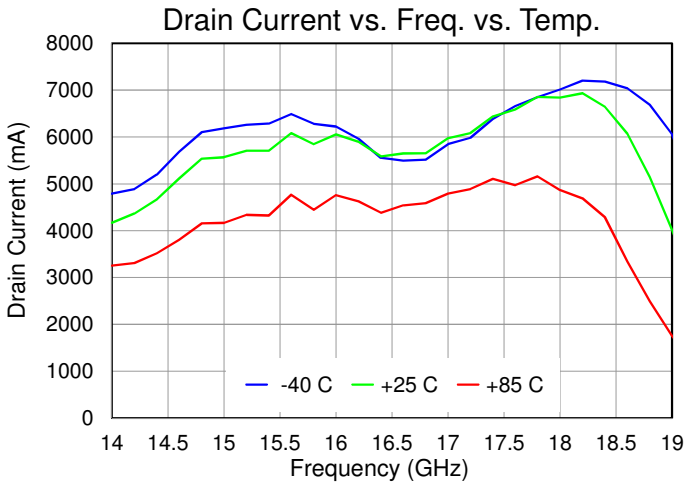
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 100\text{ us}$, $DC = 10\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



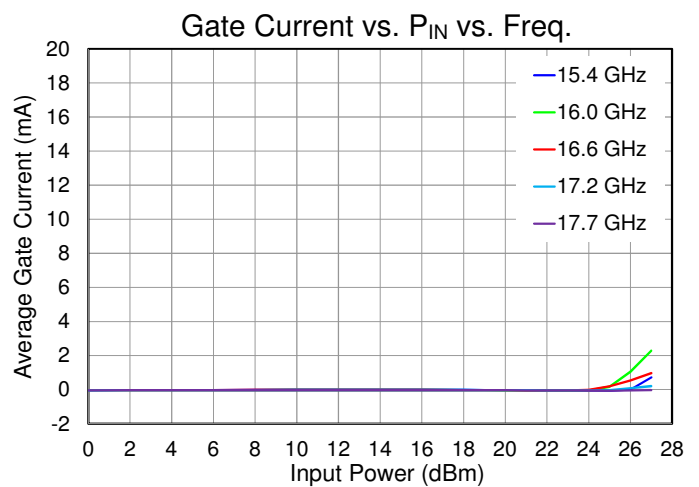
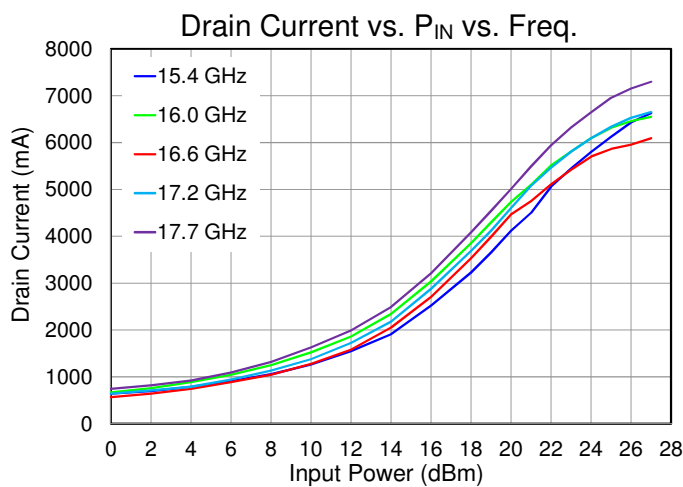
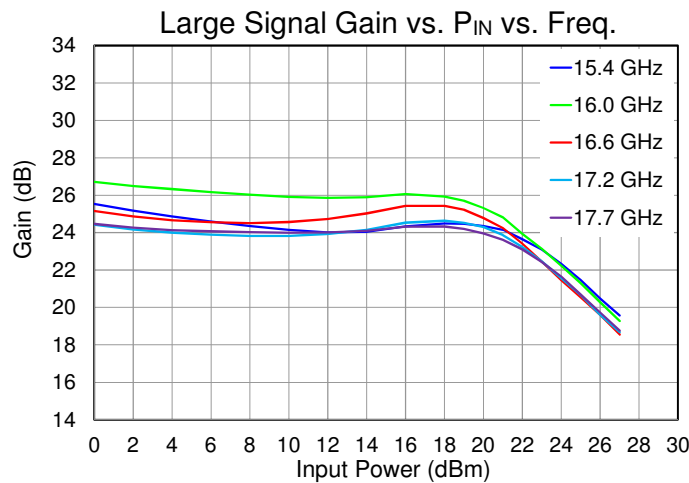
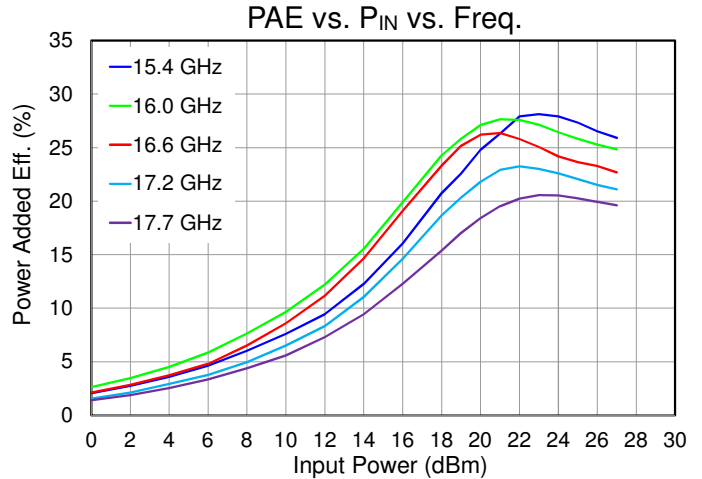
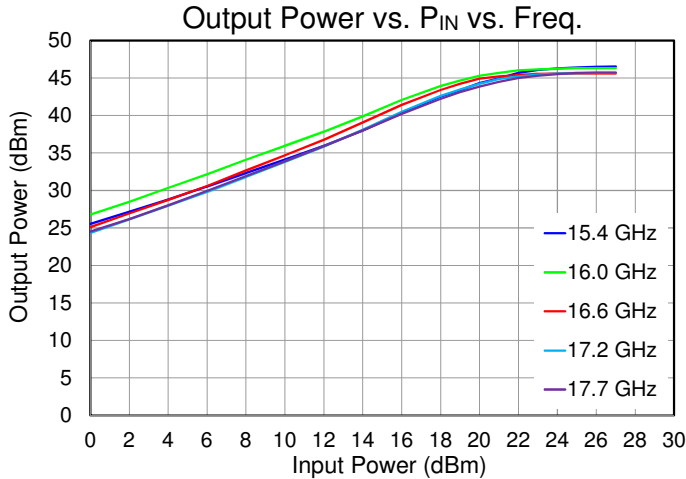
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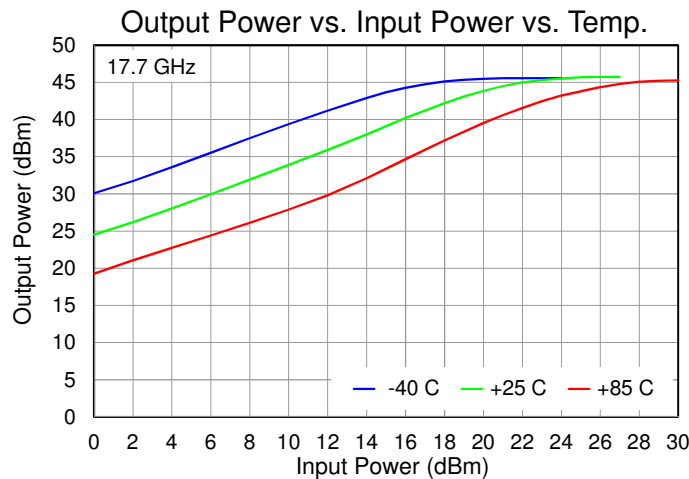
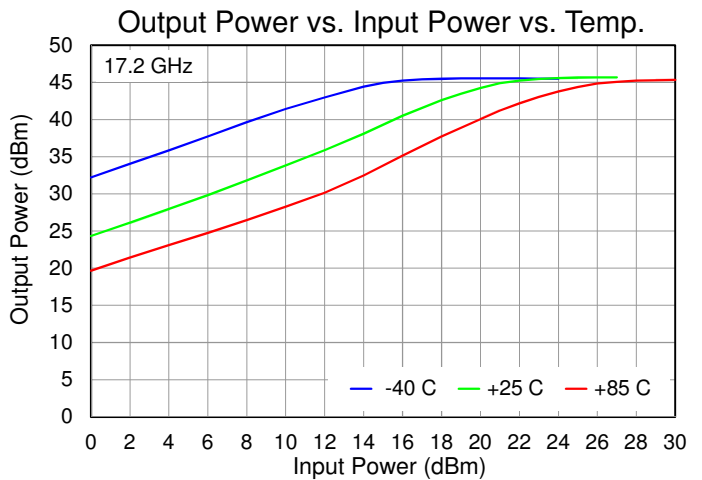
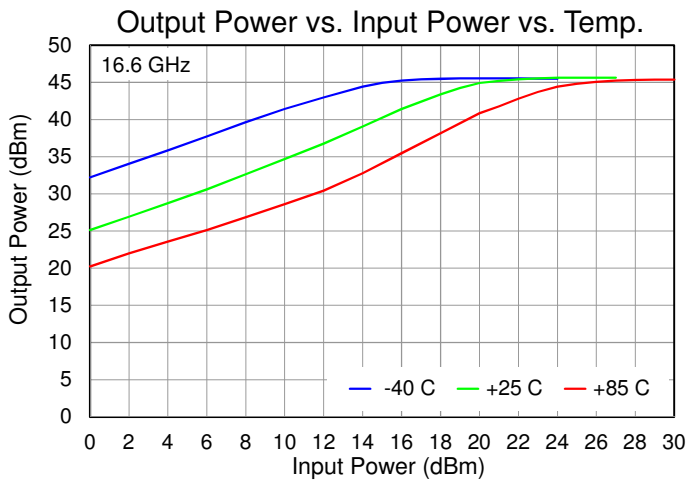
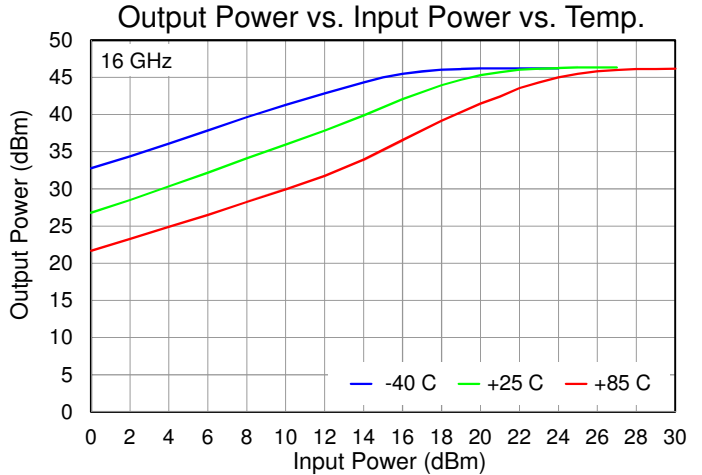
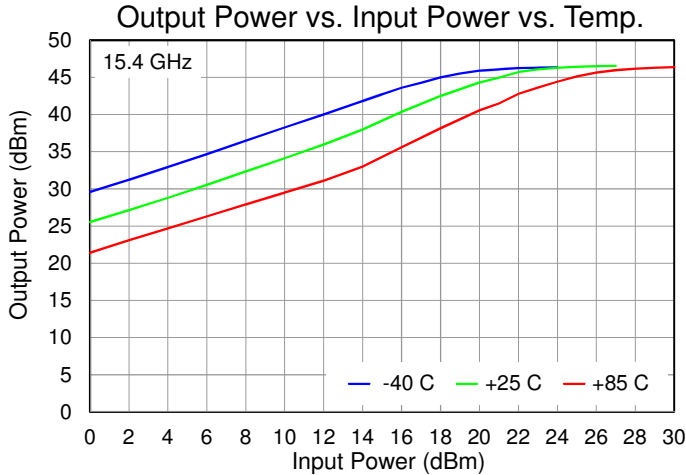
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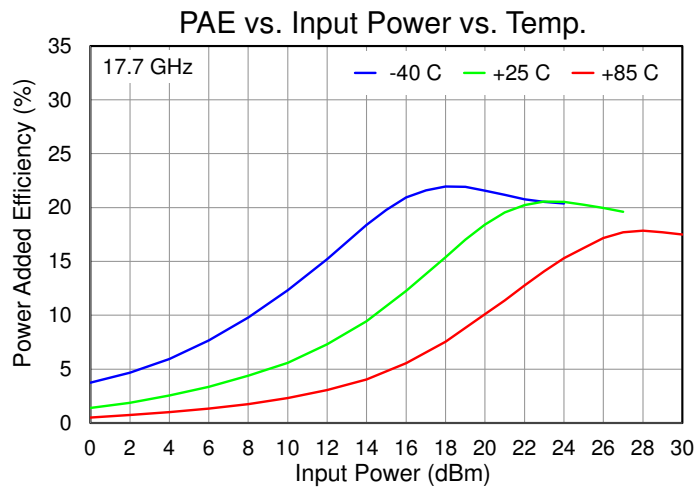
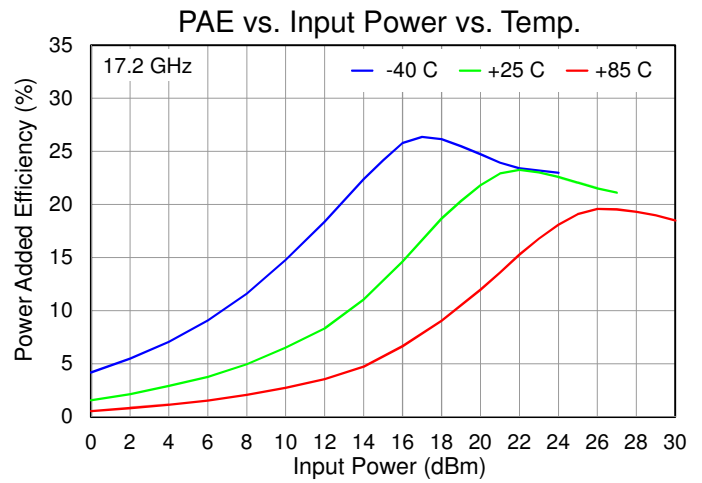
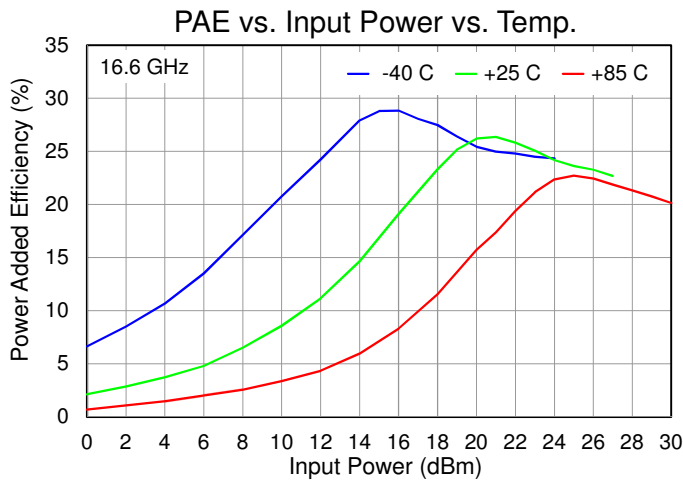
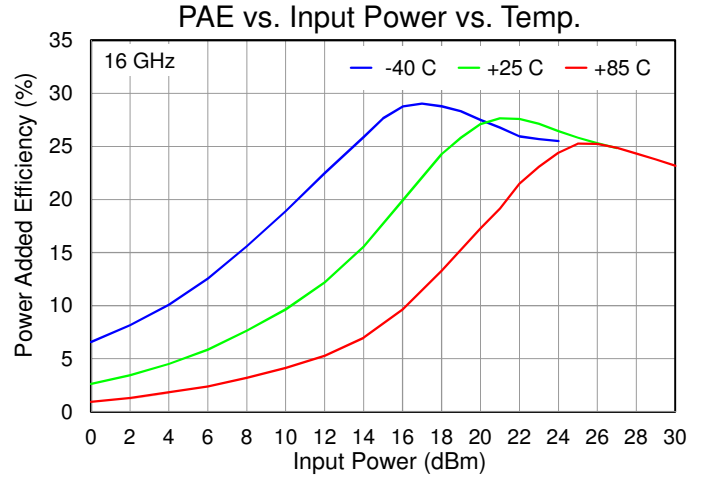
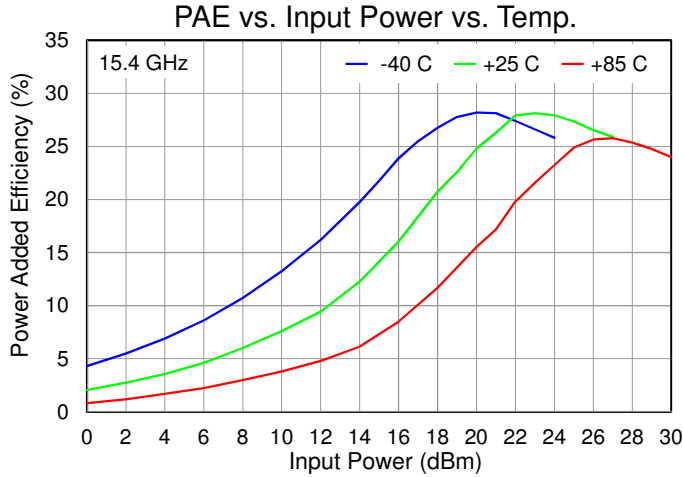
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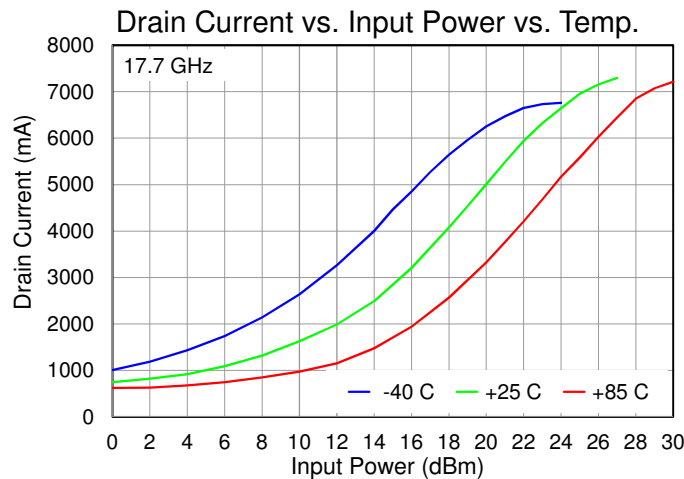
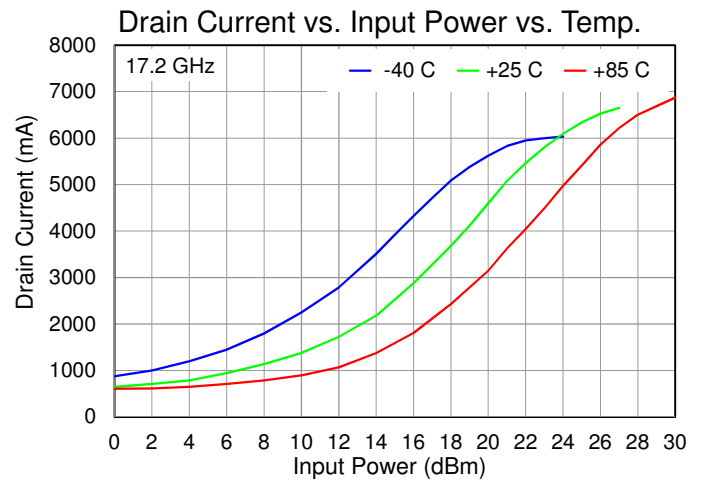
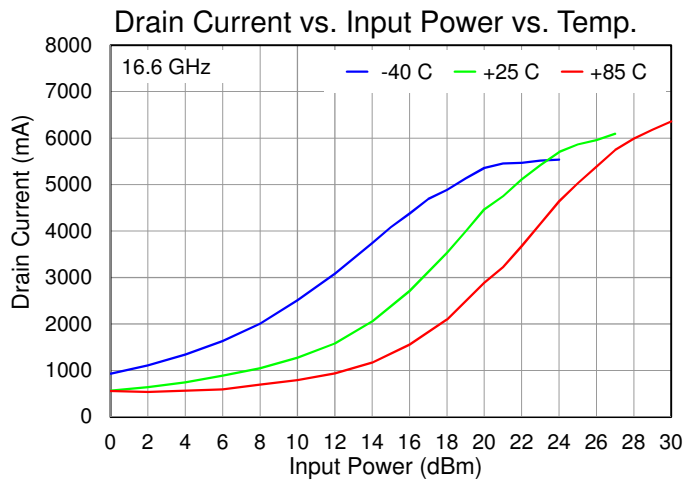
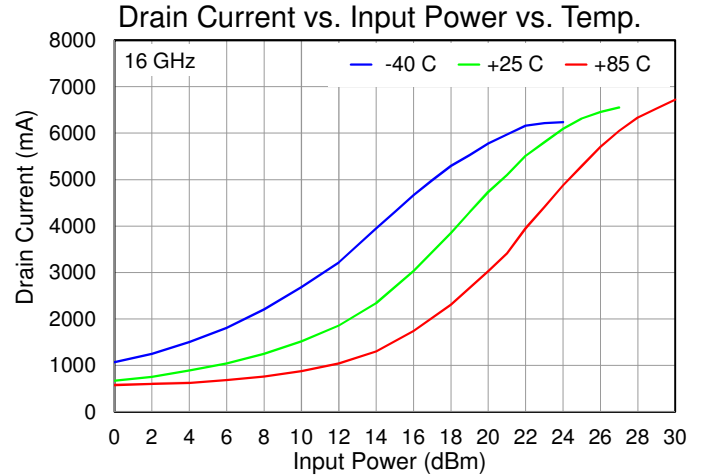
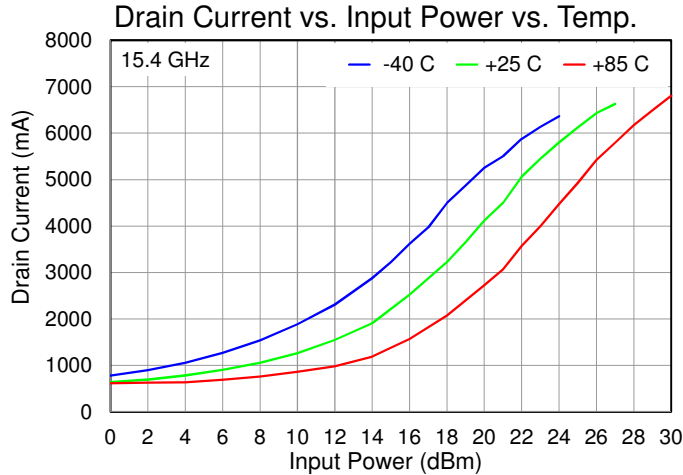
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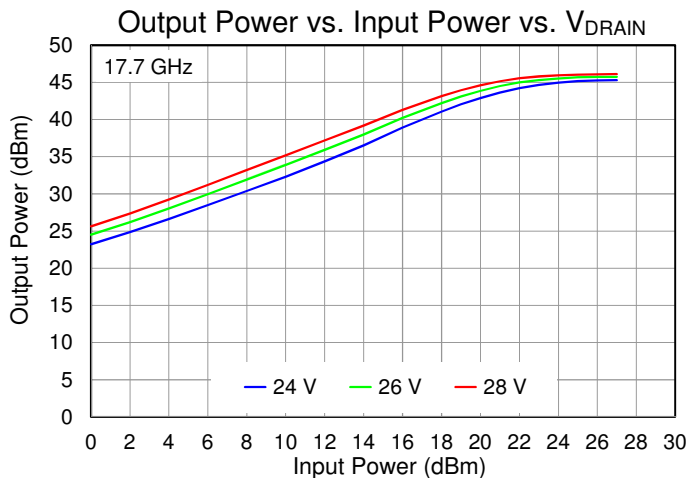
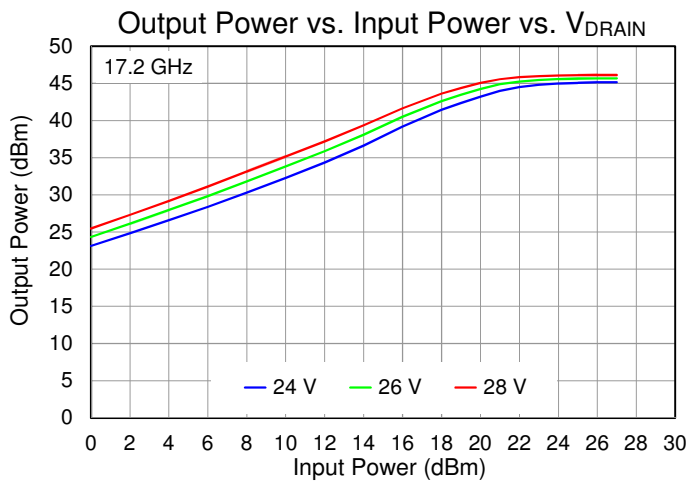
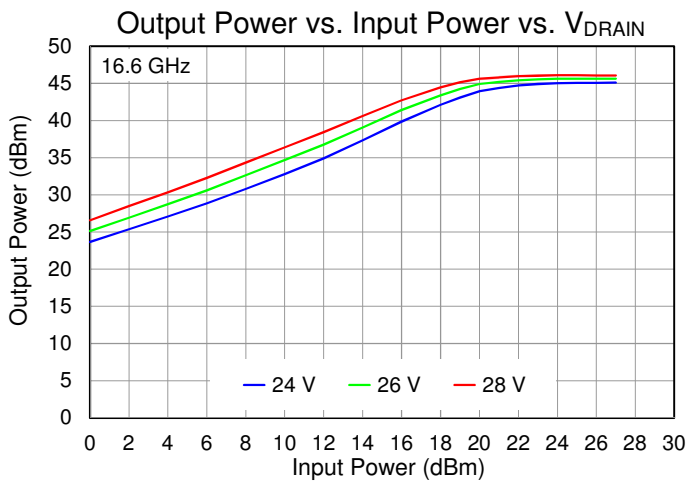
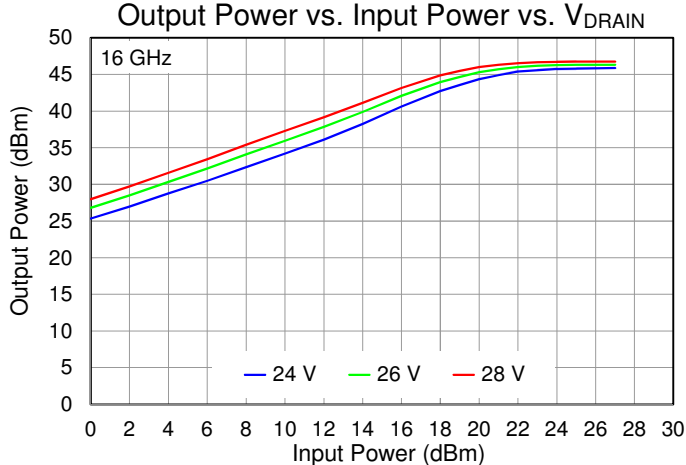
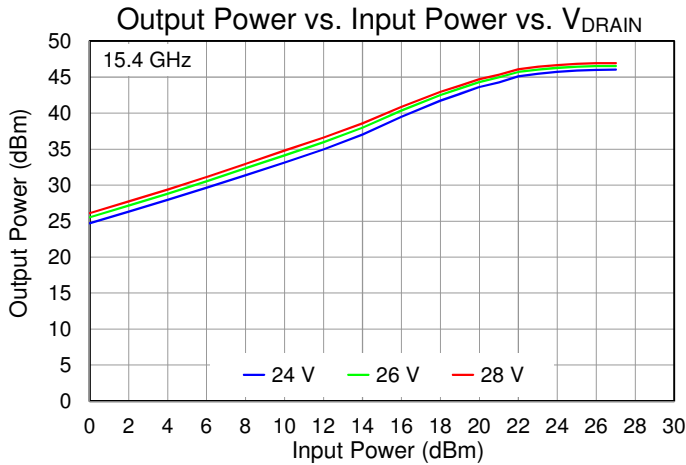
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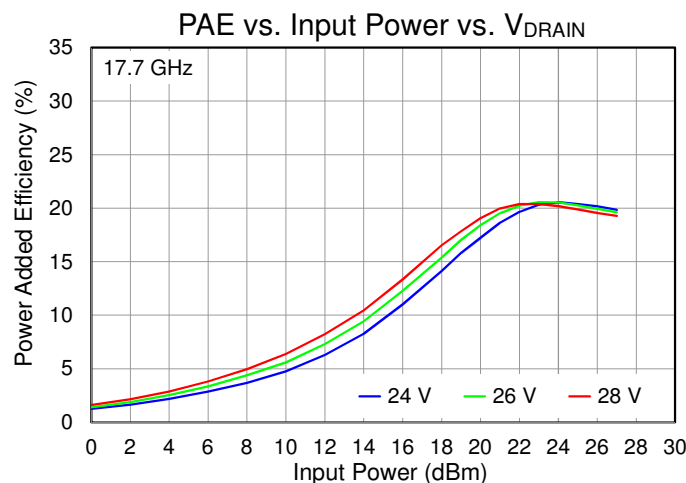
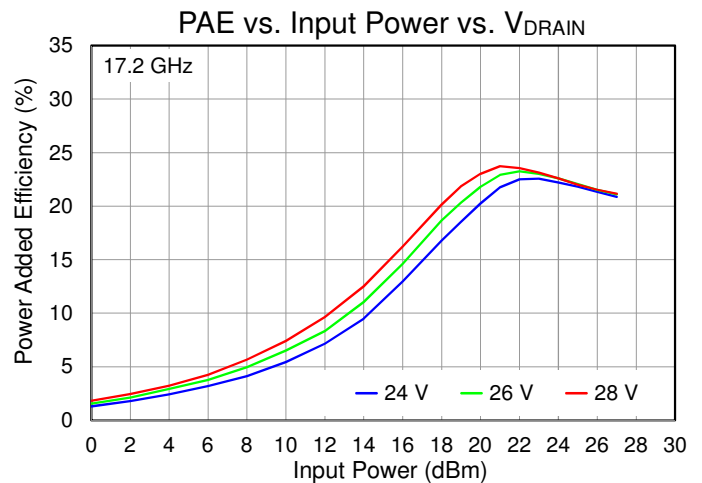
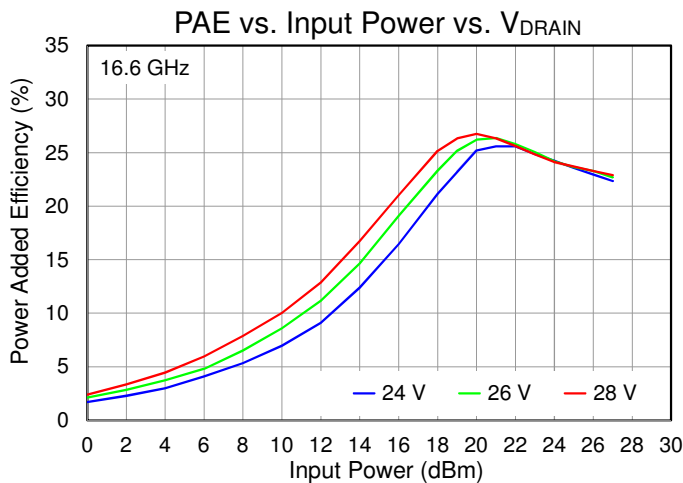
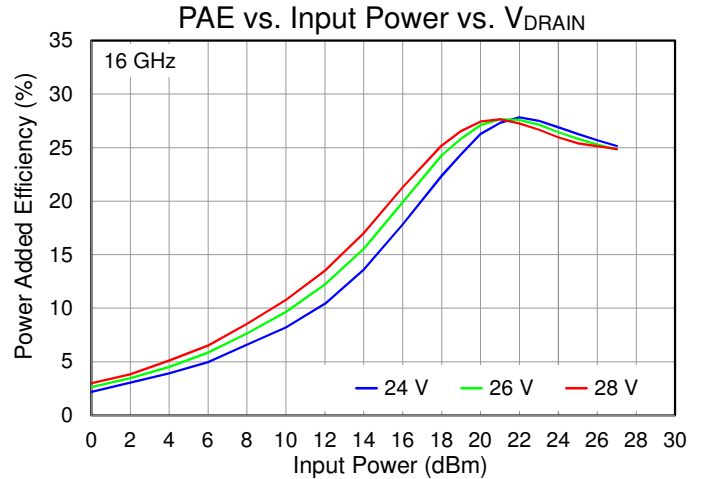
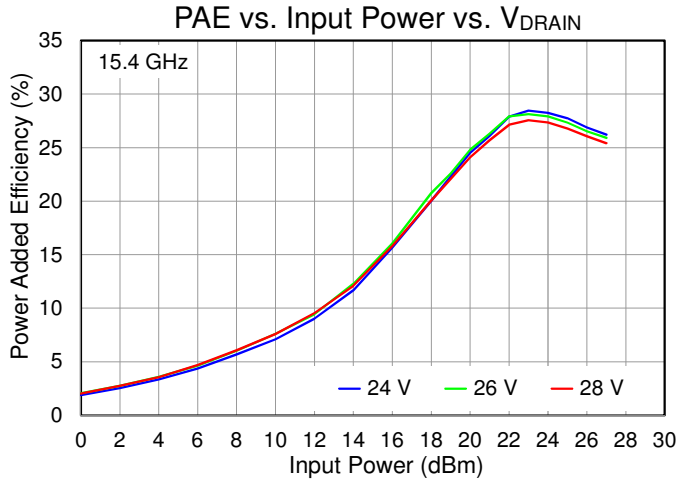
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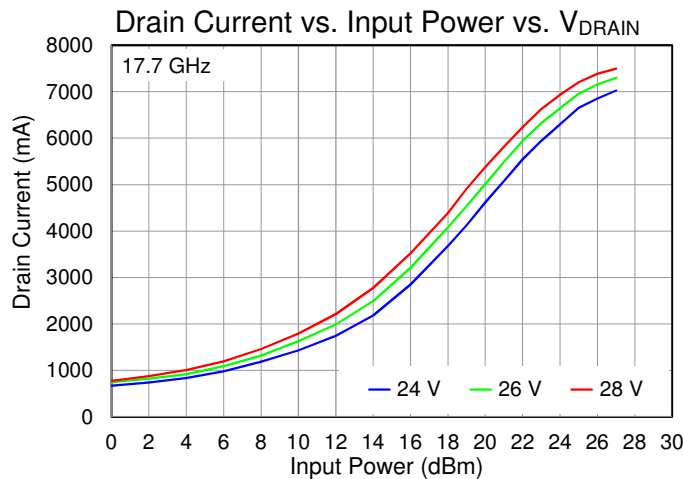
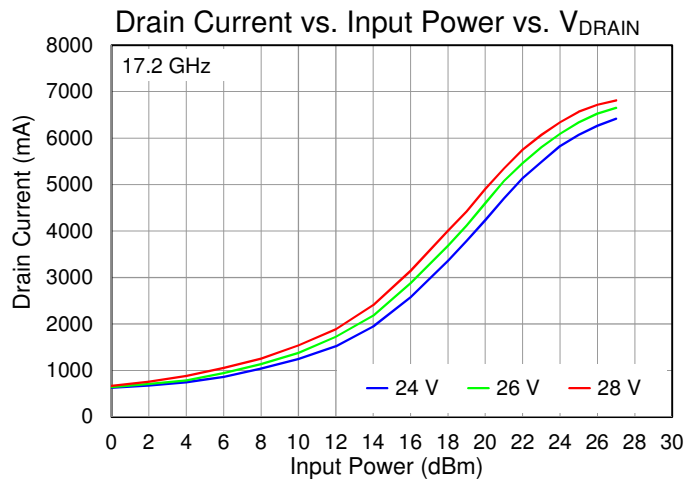
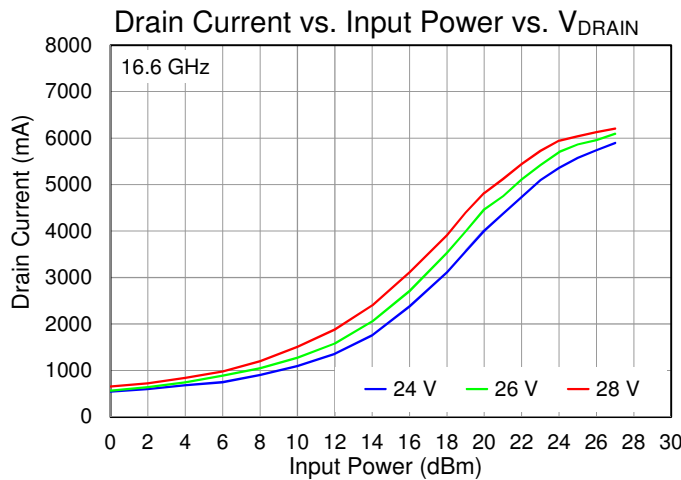
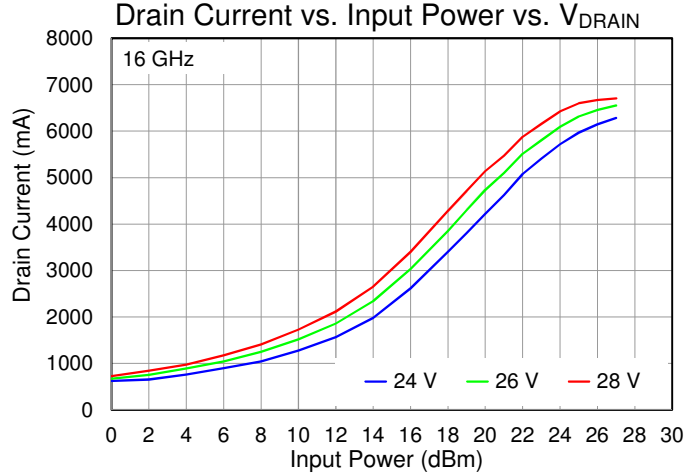
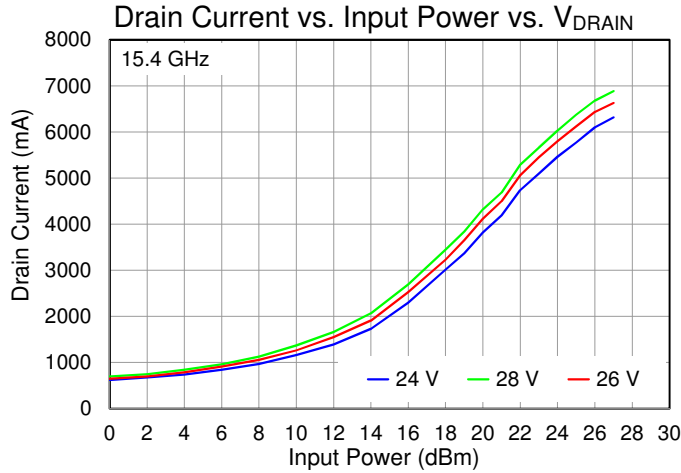
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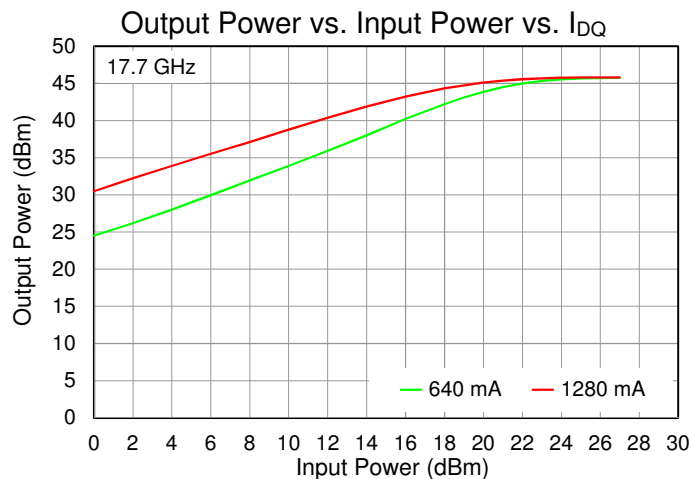
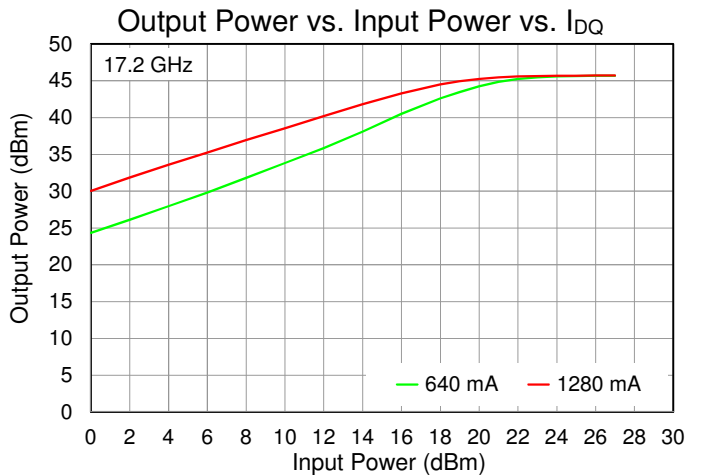
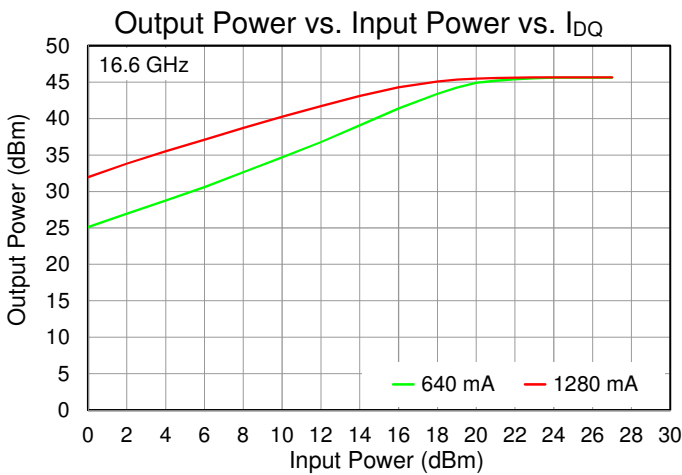
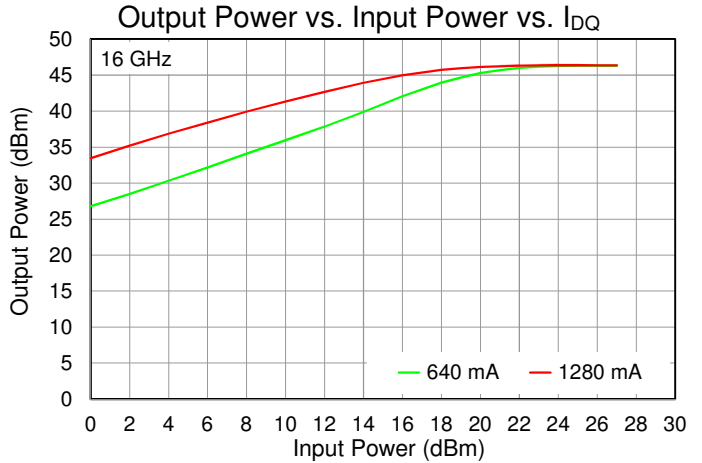
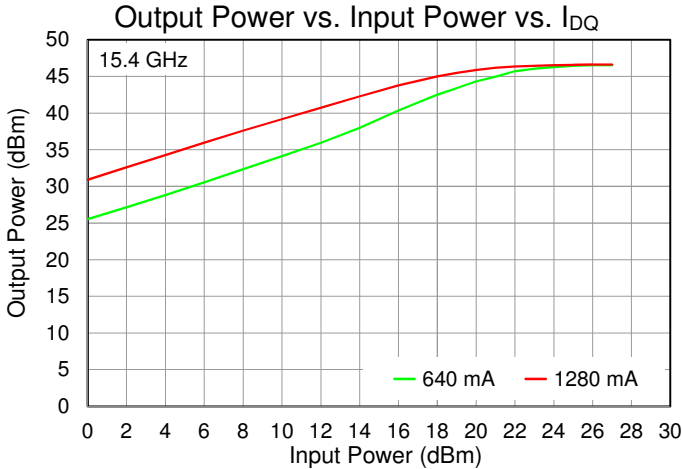
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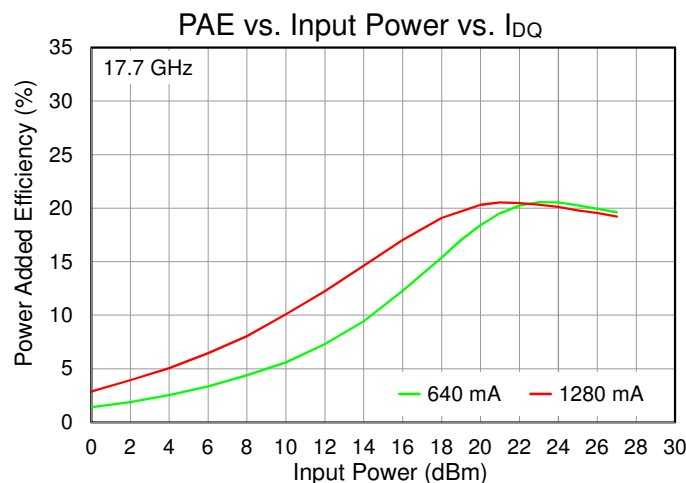
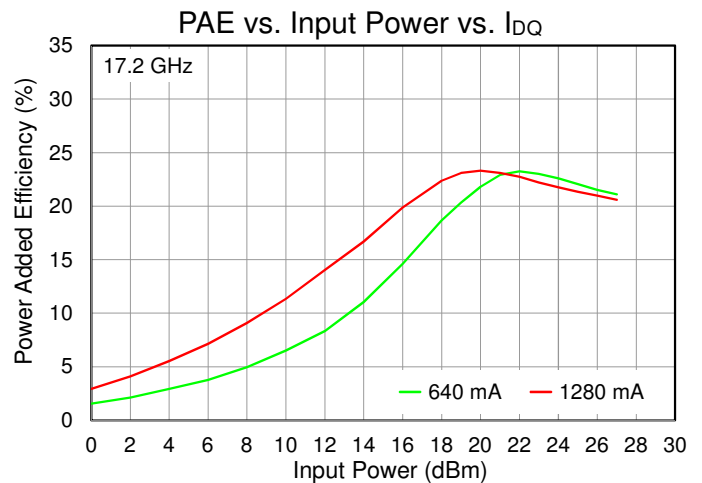
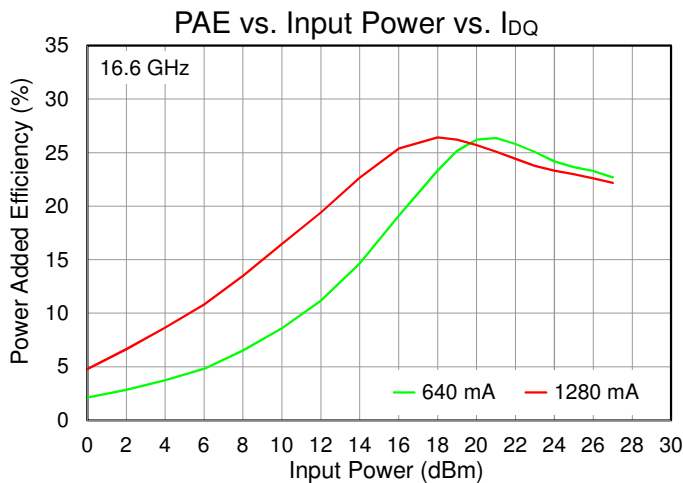
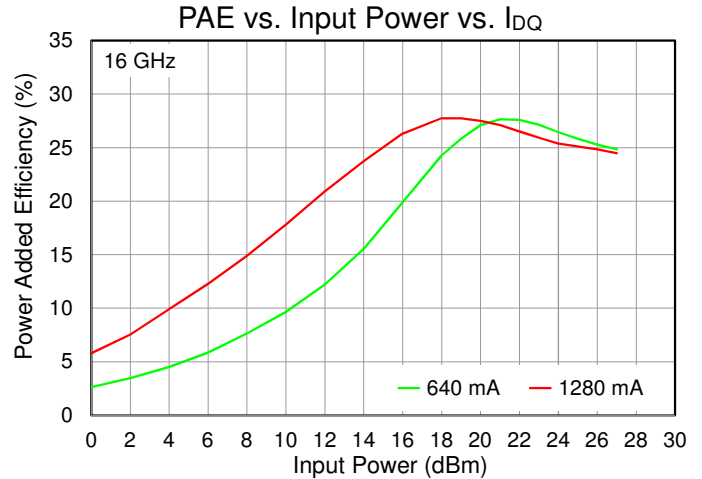
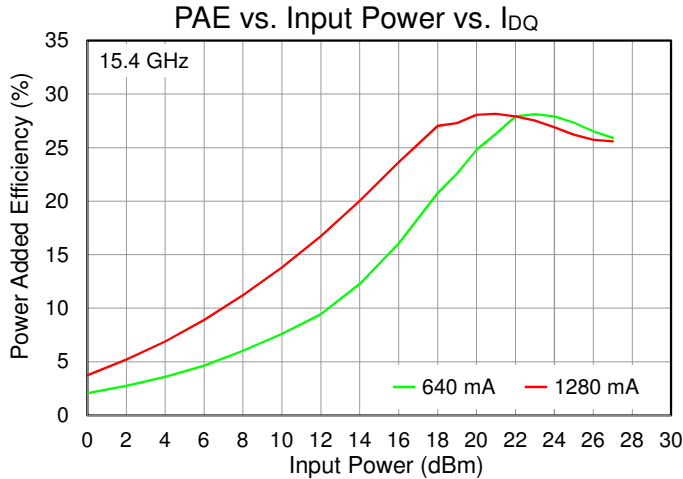
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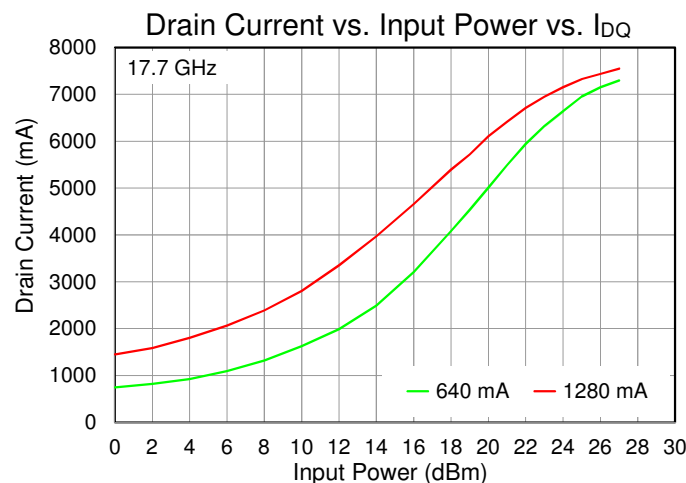
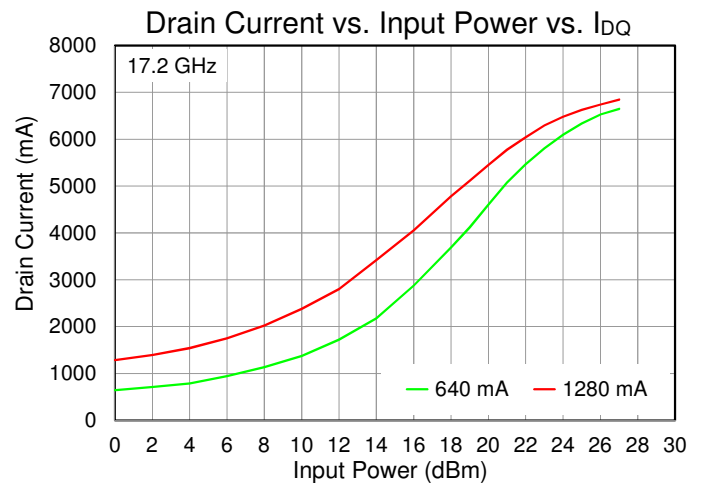
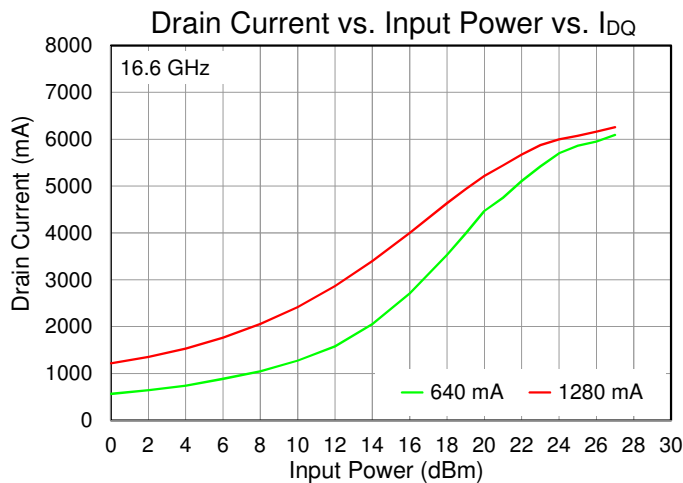
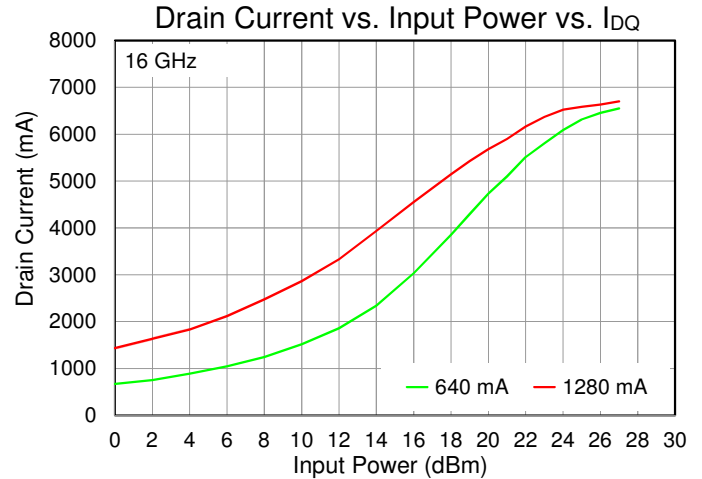
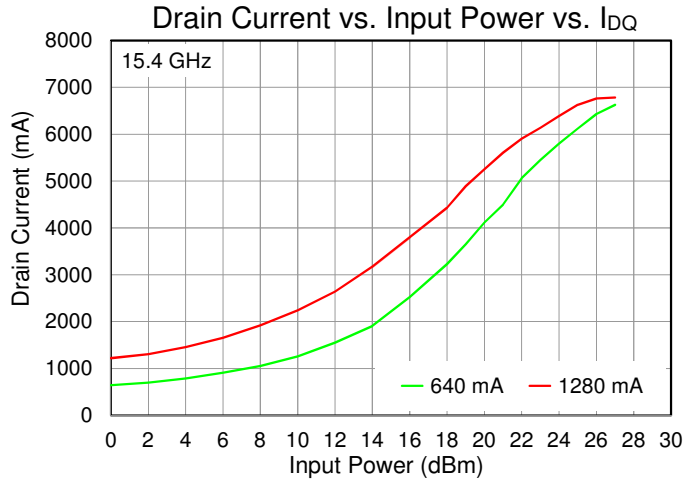
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 100\text{ us}$, $DC = 10\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



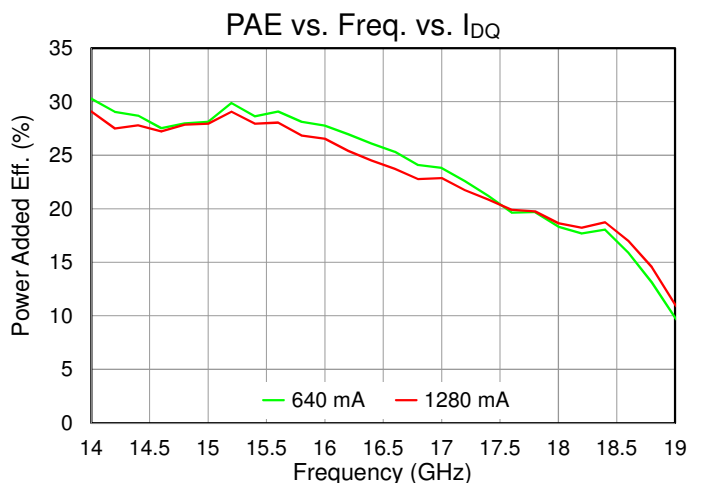
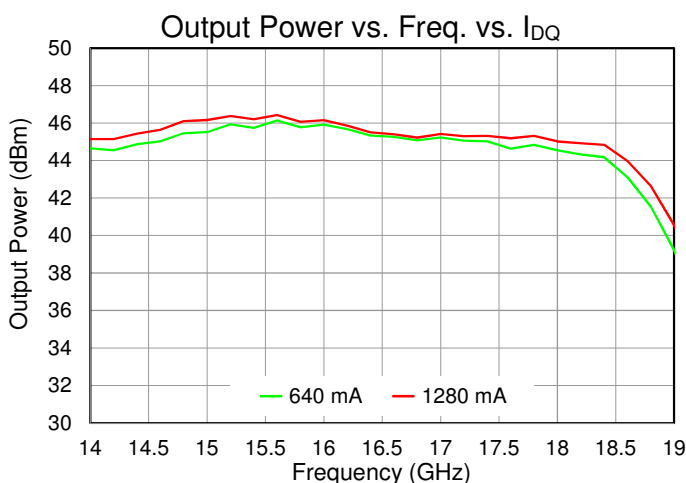
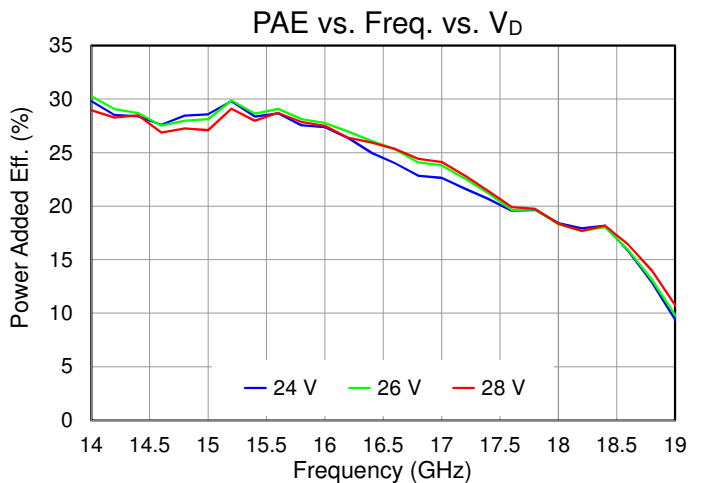
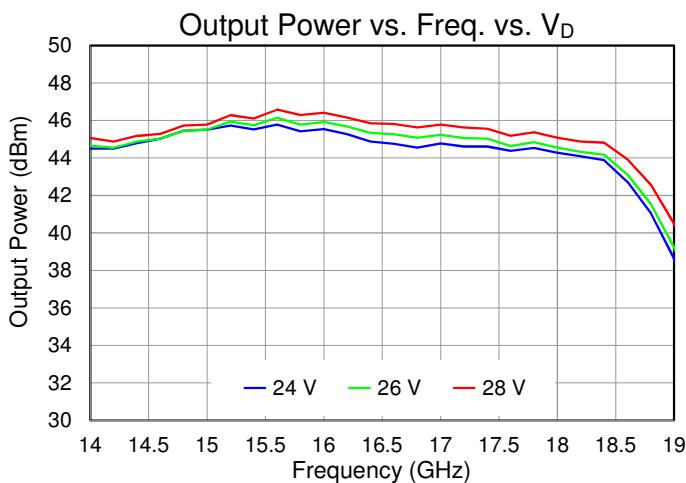
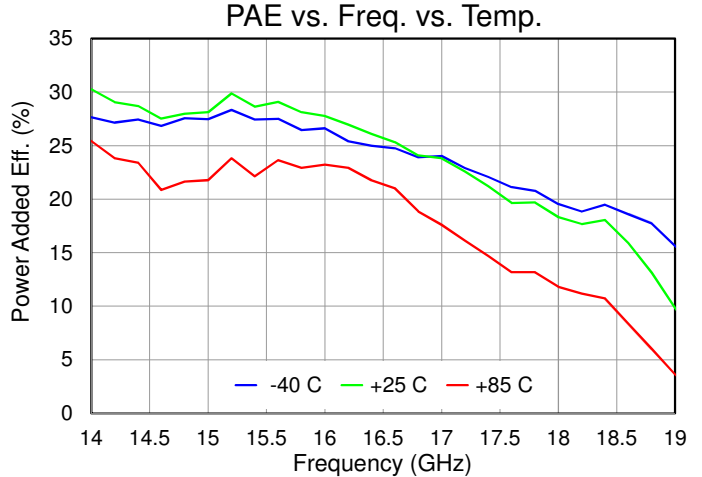
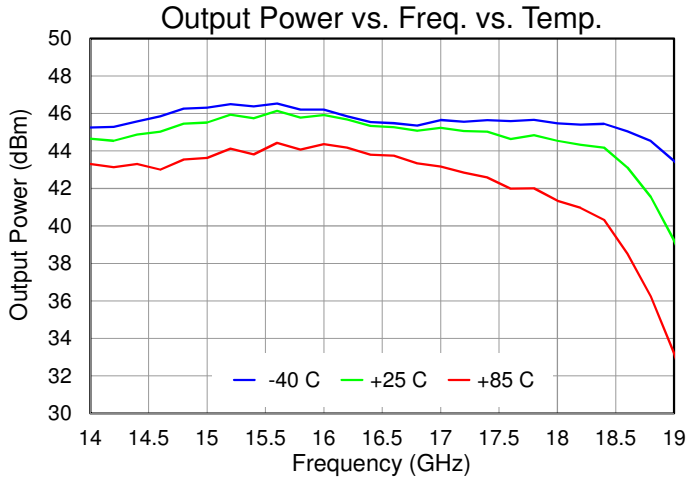
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26$ V, $I_{DQ} = 640$ mA, $PW = 100$ us, $DC = 10\%$, $P_{IN} = 24$ dBm, $T_{BASE} = +25$ °C (T_{BASE} is backside of QPA1315).



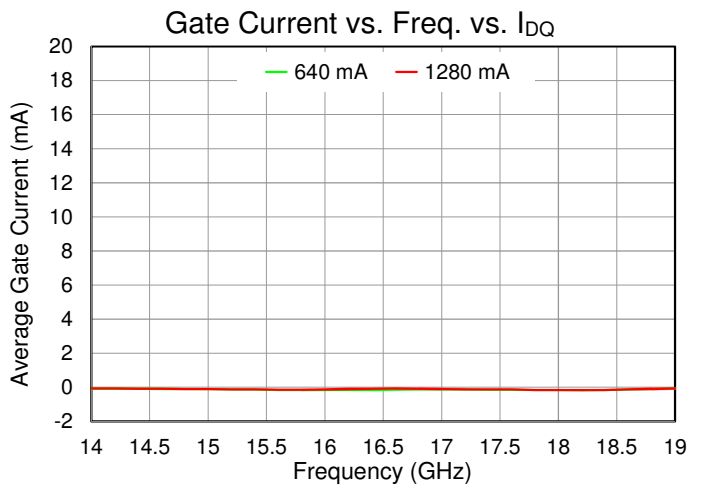
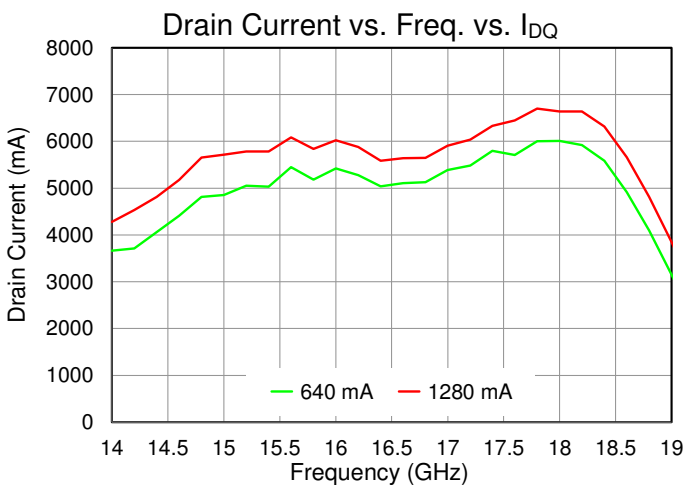
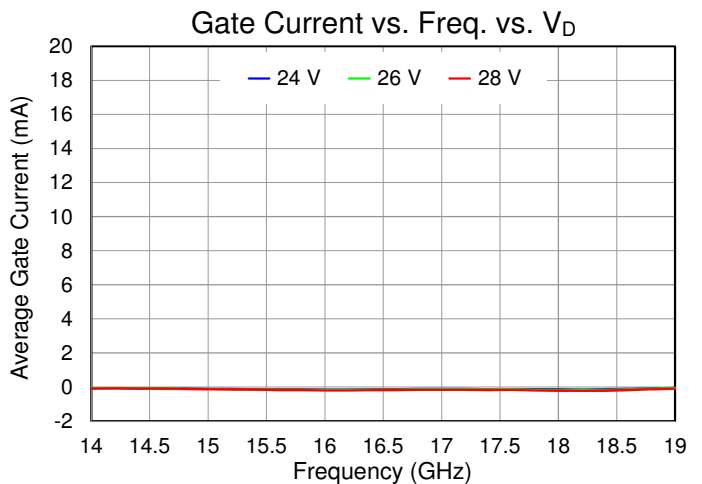
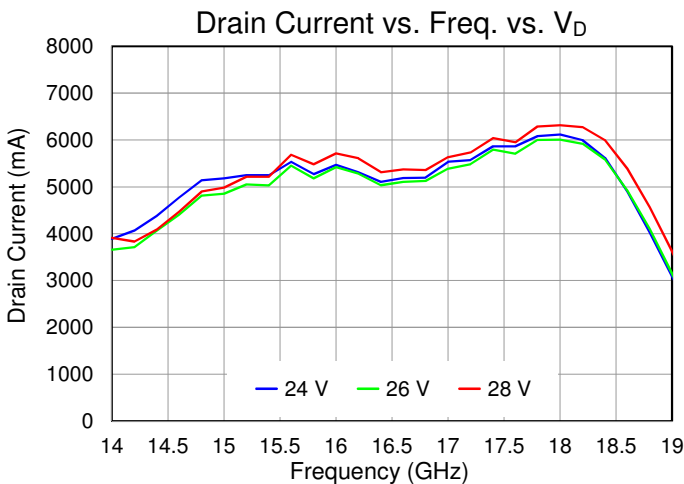
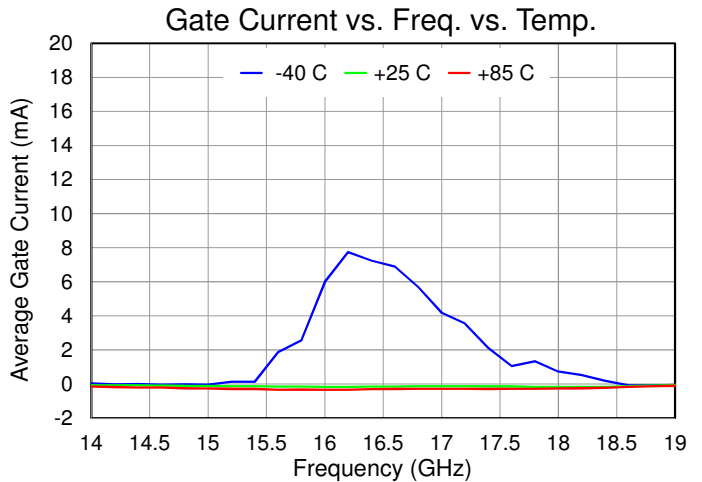
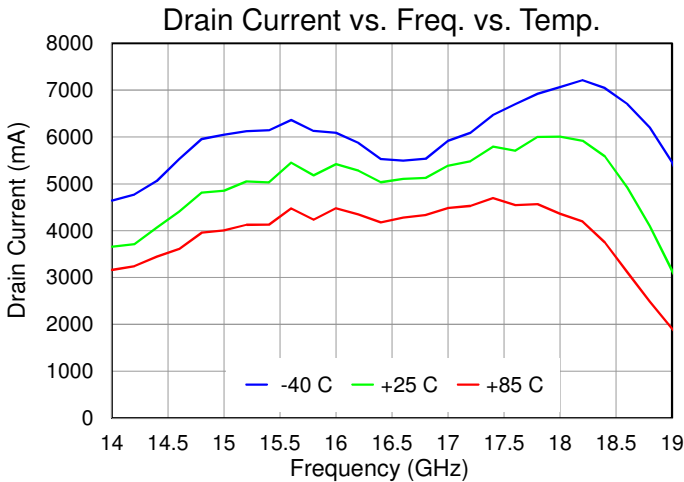
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 300\text{ us}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



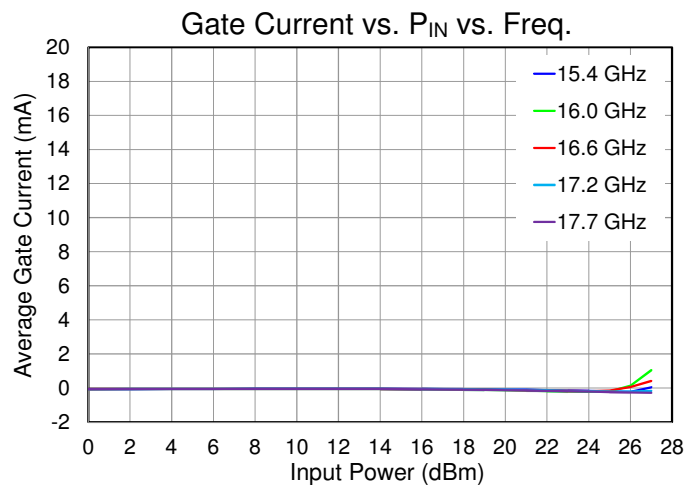
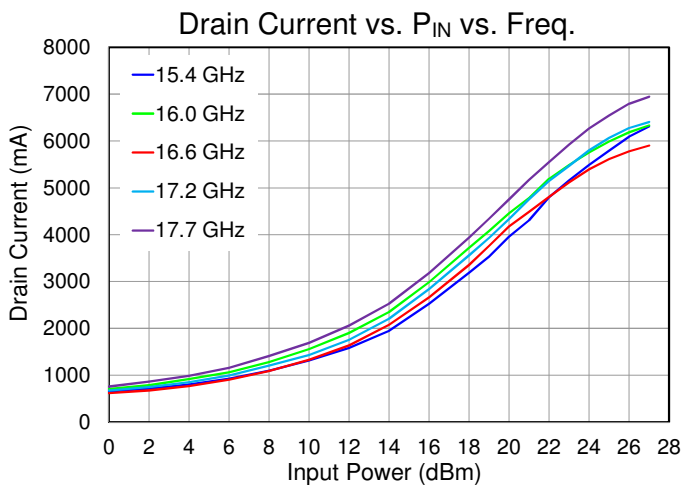
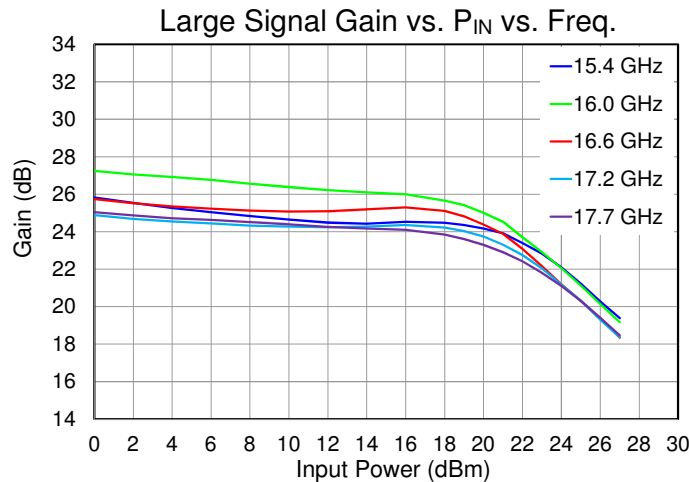
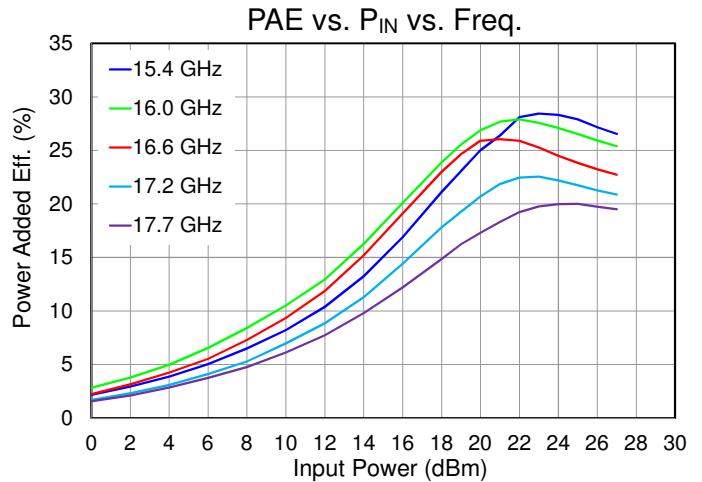
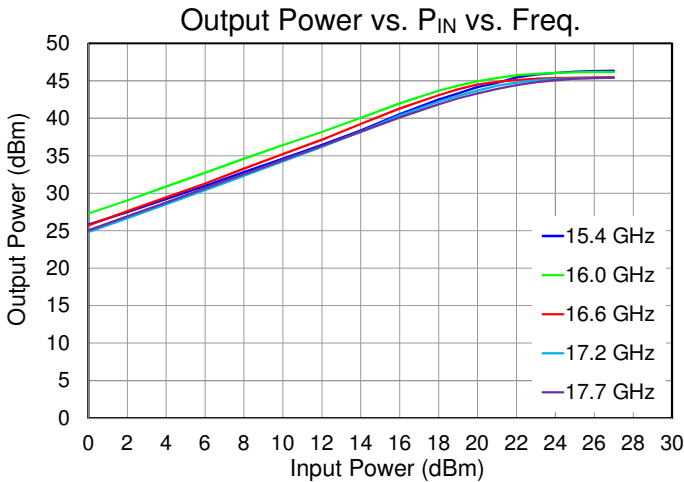
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 300\text{ us}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



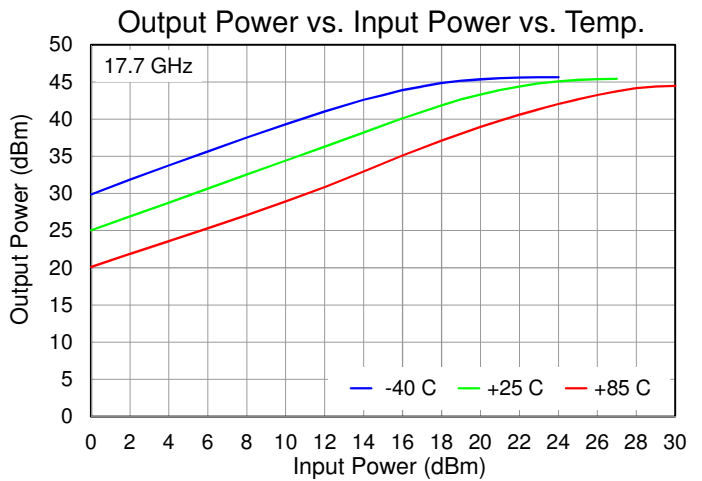
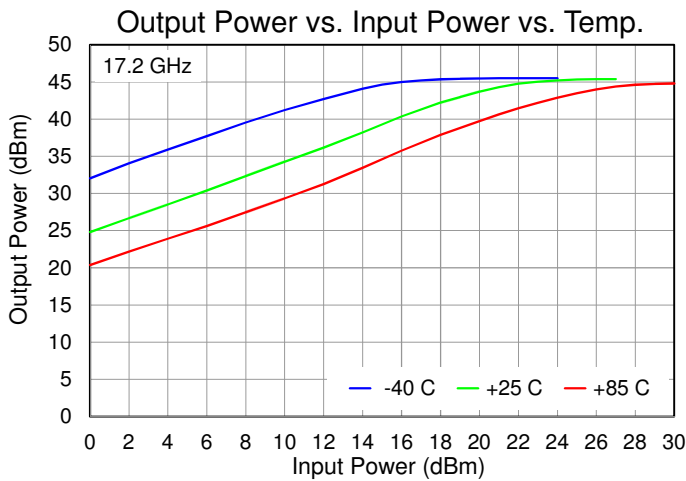
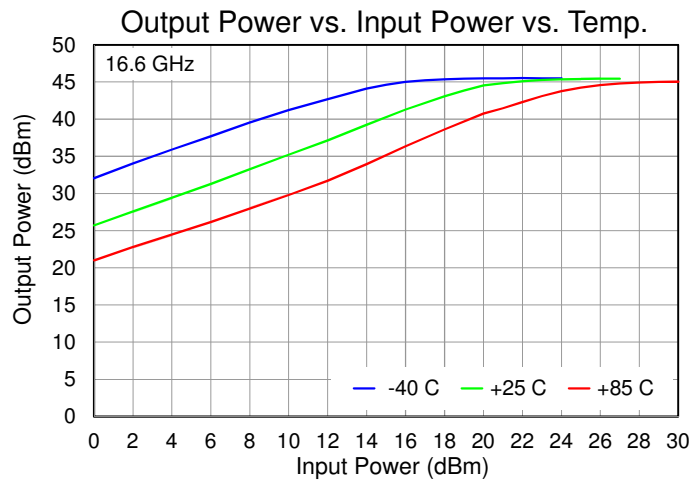
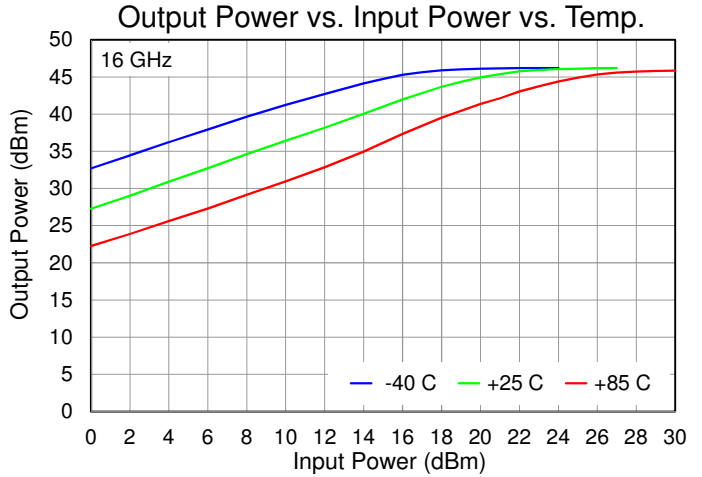
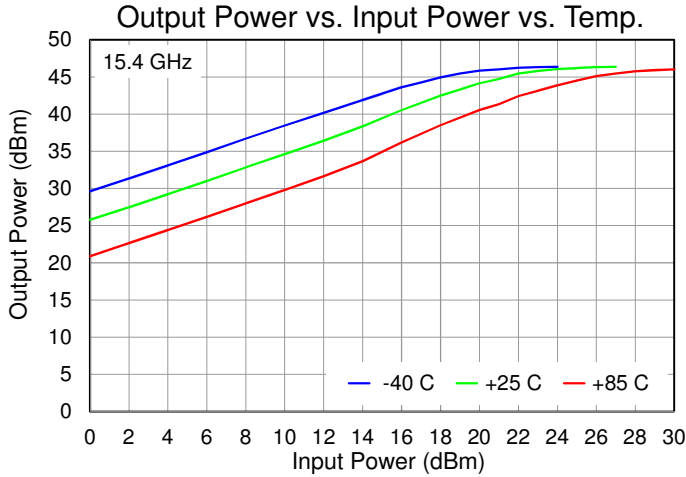
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 300\text{ us}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



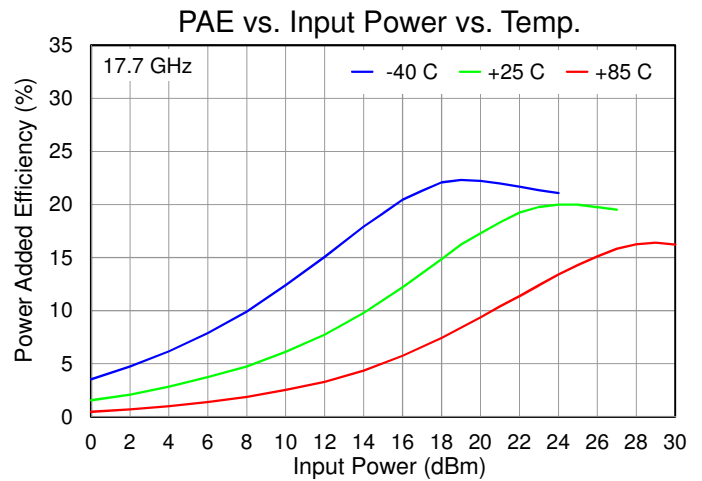
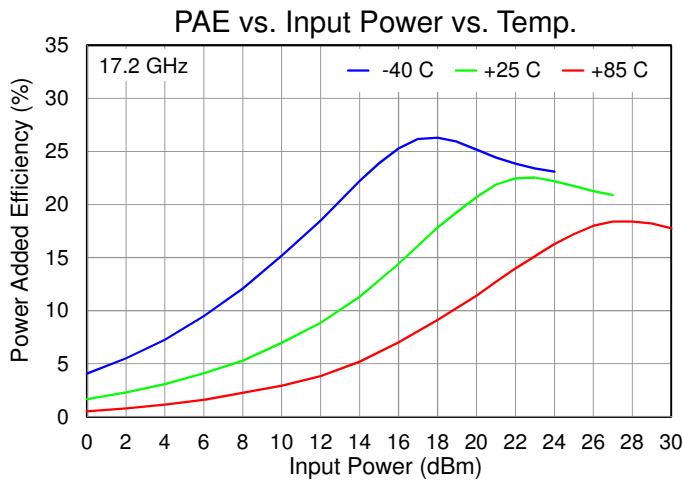
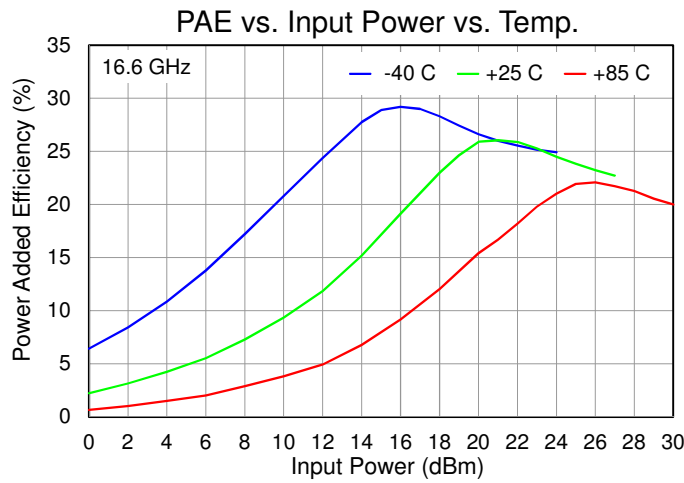
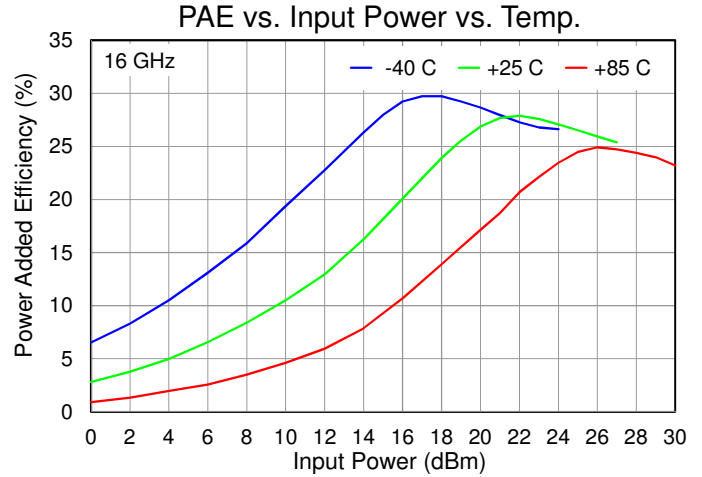
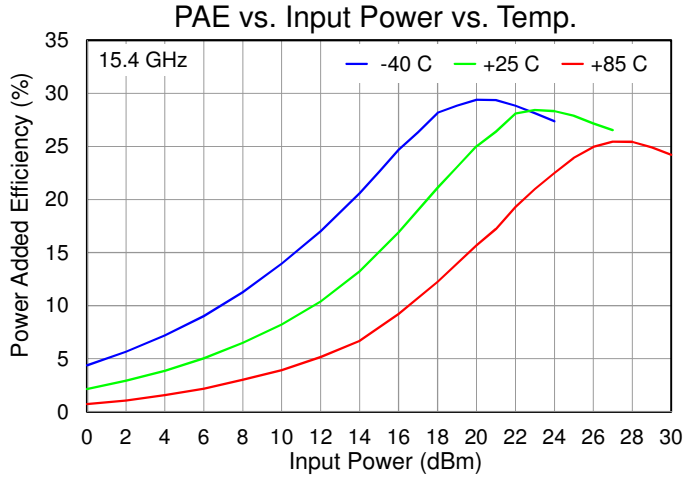
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 300\text{ }\mu\text{s}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



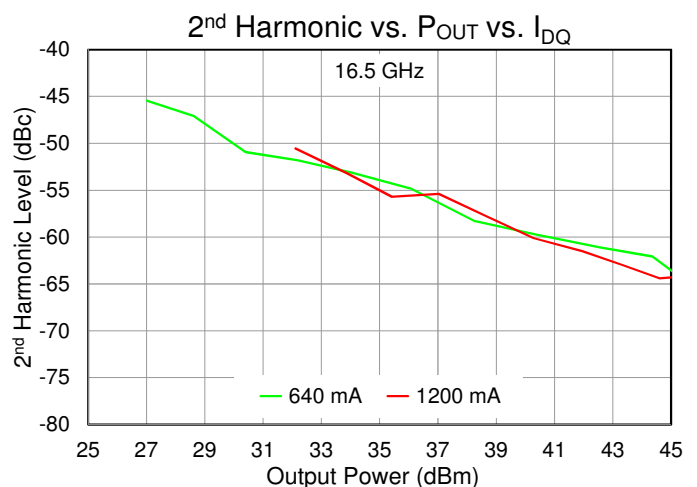
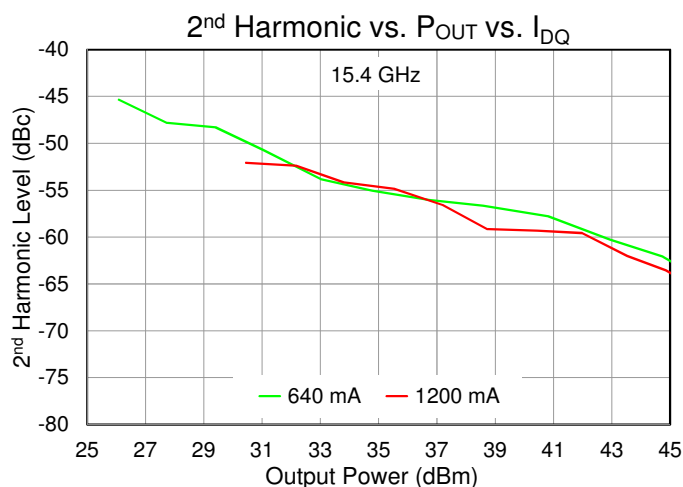
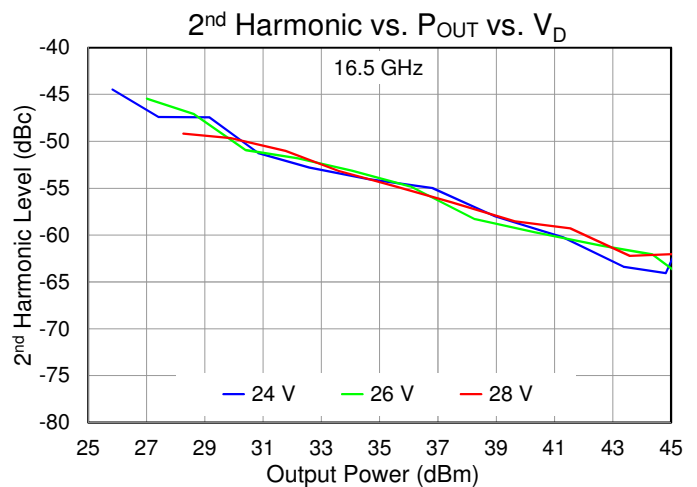
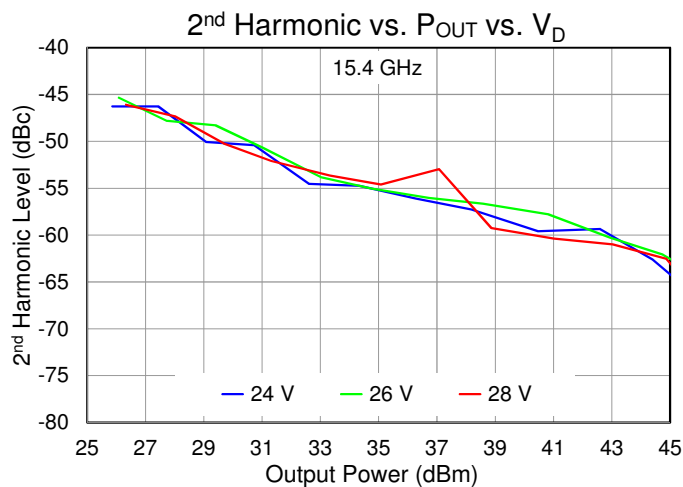
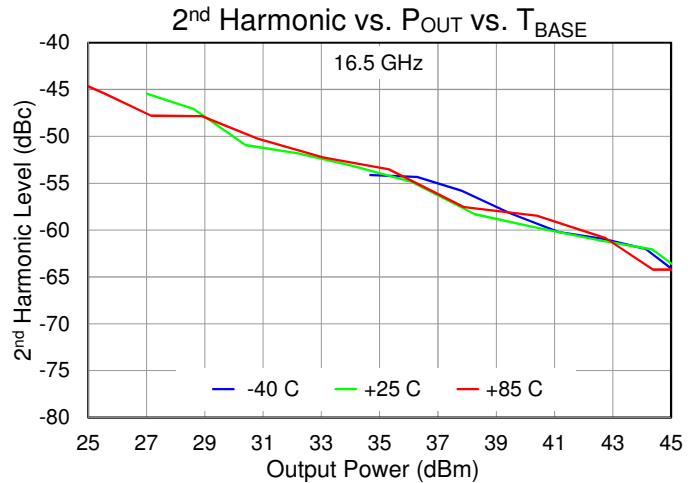
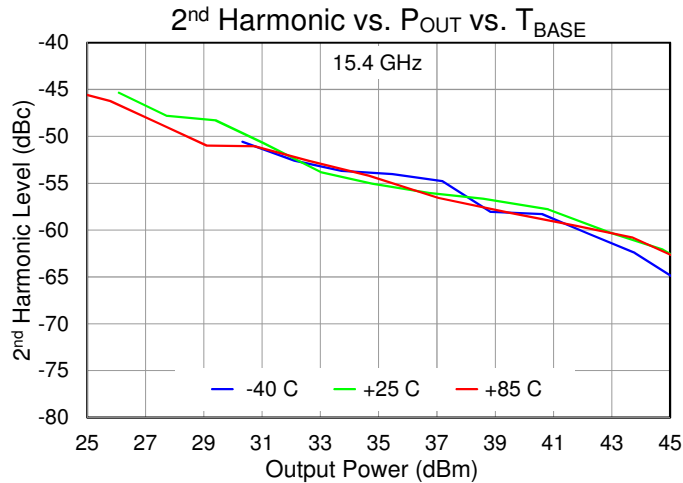
Performance Plots – Large Signal (Pulsed)

Test conditions, unless otherwise noted: Pulsed $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 300\text{ us}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



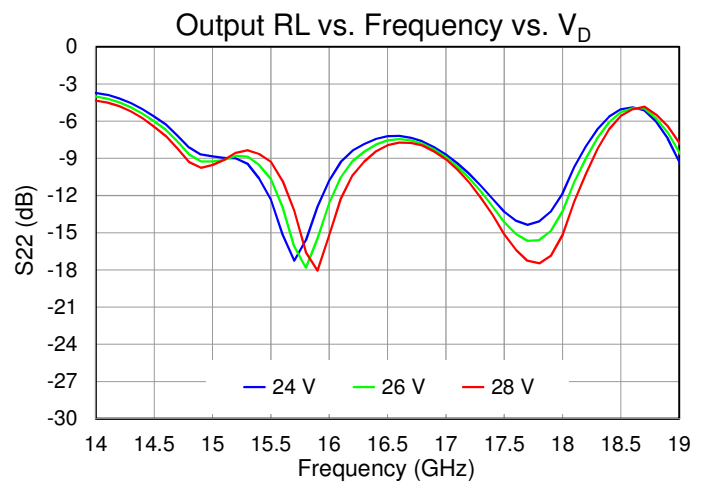
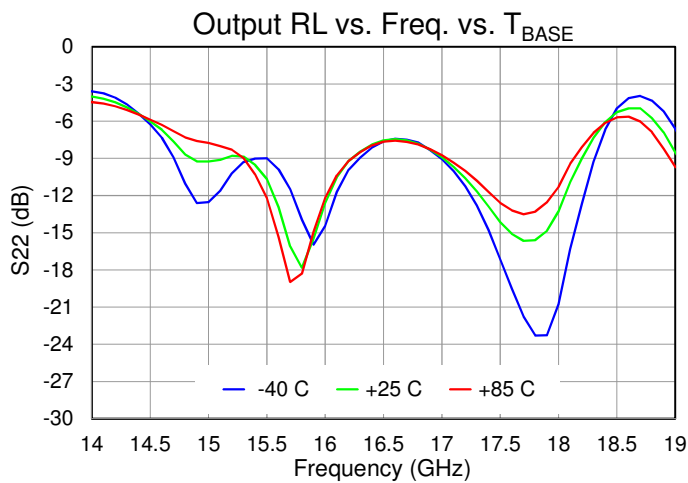
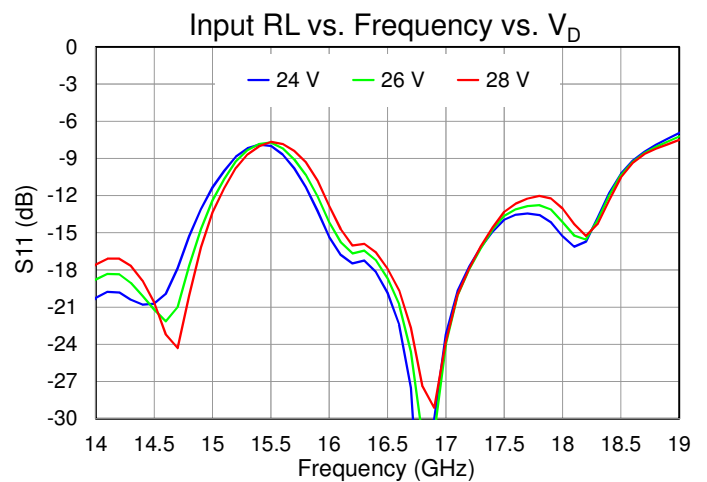
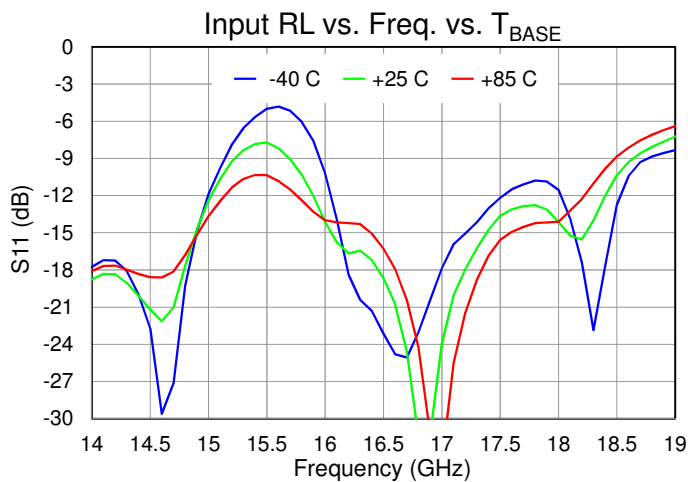
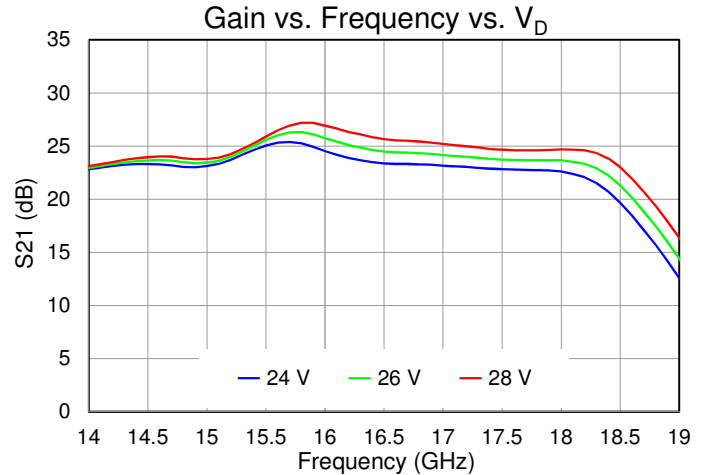
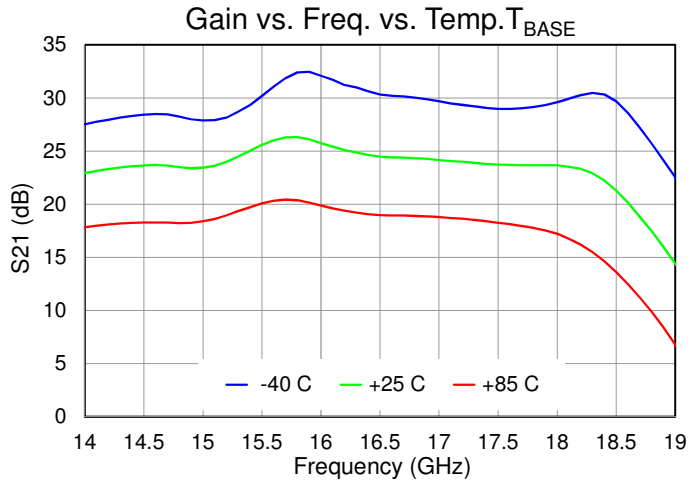
Performance Plots – Harmonics (Pulsed)

Test conditions, unless otherwise noted: CW, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $PW = 100\text{ }\mu\text{s}$, $DC = 10\%$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



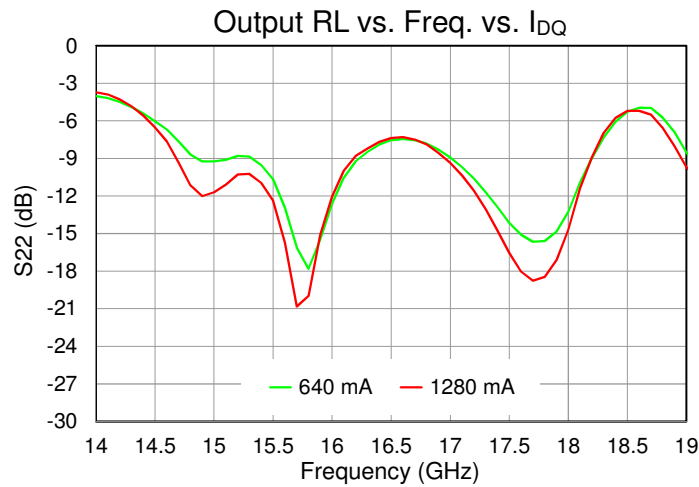
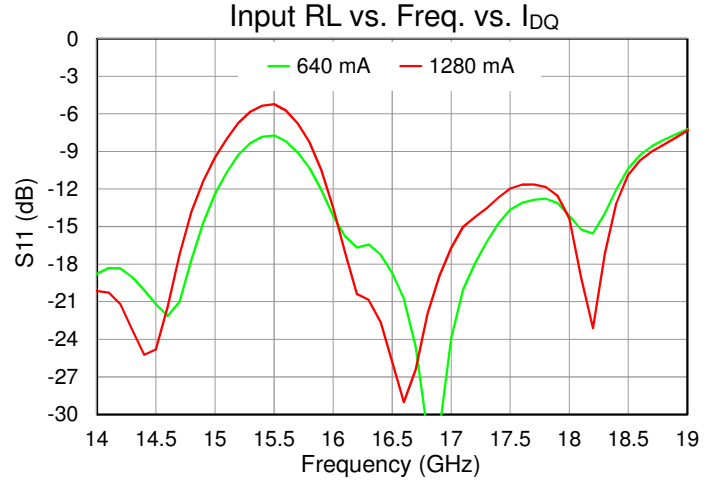
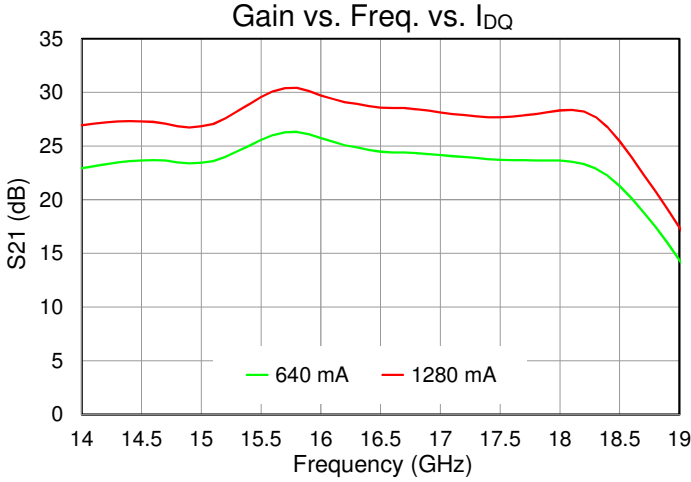
Performance Plots – Small Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



Performance Plots – Small Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1315).



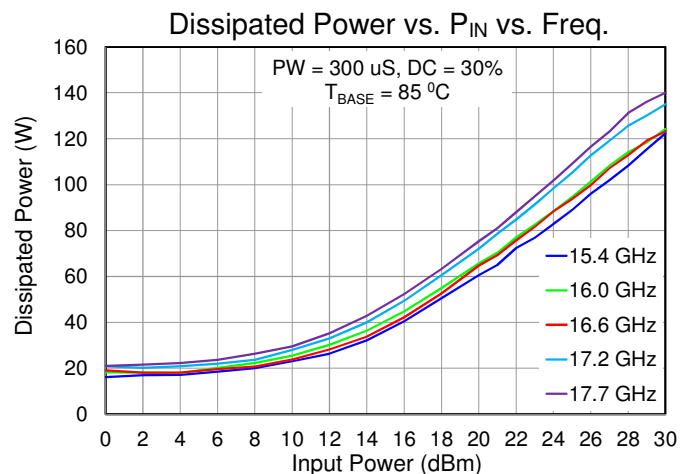
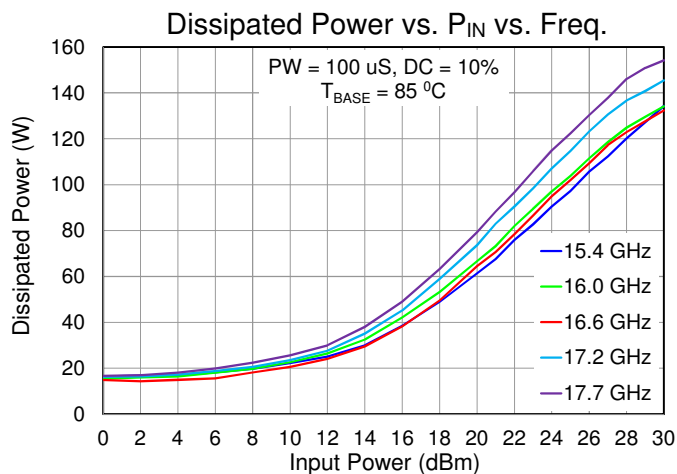
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC}	Quiescent, no RF, CW $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$,	0.75	$^{\circ}\text{C/W}$
Channel Temperature, T_{CH}	$P_{DISS} = 16.6\text{ W}$	98	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	Pulsed $PW = 100\text{ }\mu\text{s}$, $DC = 10\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $Freq = 17.7\text{ GHz}$, $I_{D_DRIVE, PEAK} = 5.16\text{ A}$, $P_{OUT, PEAK} = 42.5\text{ dBm}$,	0.51	$^{\circ}\text{C/W}$
Channel Temperature, T_{CH}	$P_{DISS, PEAK} = 115.5\text{ W}$	144	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	Pulsed $PW = 100\text{ }\mu\text{s}$, $DC = 10\%$, $P_{IN} = 28\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $Freq = 17.7\text{ GHz}$, $I_{D_DRIVE, PEAK} = 6.85\text{ A}$, $P_{OUT, PEAK} = 45\text{ dBm}$,	0.52	$^{\circ}\text{C/W}$
Channel Temperature, T_{CH}	$P_{DISS, PEAK} = 146\text{ W}$	161	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	Pulsed $PW = 300\text{ }\mu\text{s}$, $DC = 30\%$, $P_{IN} = 24\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $Freq = 17.4\text{ GHz}$, $I_{D_DRIVE, PEAK} = 4.7\text{ A}$, $P_{OUT, PEAK} = 43\text{ dBm}$,	0.57	$^{\circ}\text{C/W}$
Channel Temperature, T_{CH}	$P_{DISS, PEAK} = 104\text{ W}$	144	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	Pulsed $PW = 300\text{ }\mu\text{s}$, $DC = 30\%$, $P_{IN} = 28\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 26\text{ V}$, $I_{DQ} = 640\text{ mA}$, $Freq = 17.4\text{ GHz}$, $I_{D_DRIVE, PEAK} = 6.13\text{ A}$, $P_{OUT, PEAK} = 44\text{ dBm}$,	0.58	$^{\circ}\text{C/W}$
Channel Temperature, T_{CH}	$P_{DISS, PEAK} = 131\text{ W}$	161	$^{\circ}\text{C}$

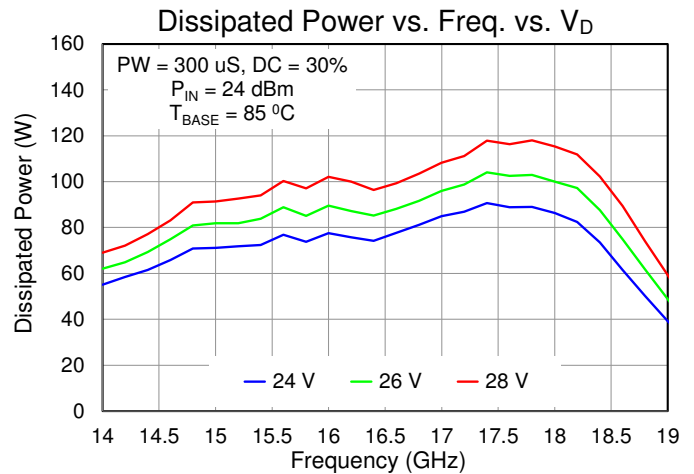
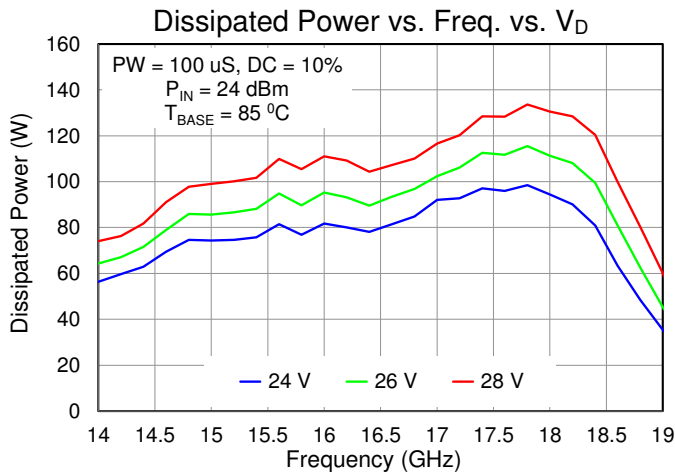
Notes:

1. Thermal resistance determined to T_{BASE} (T_{BASE} is backside of package QPA1315)
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>

Dissipated Power

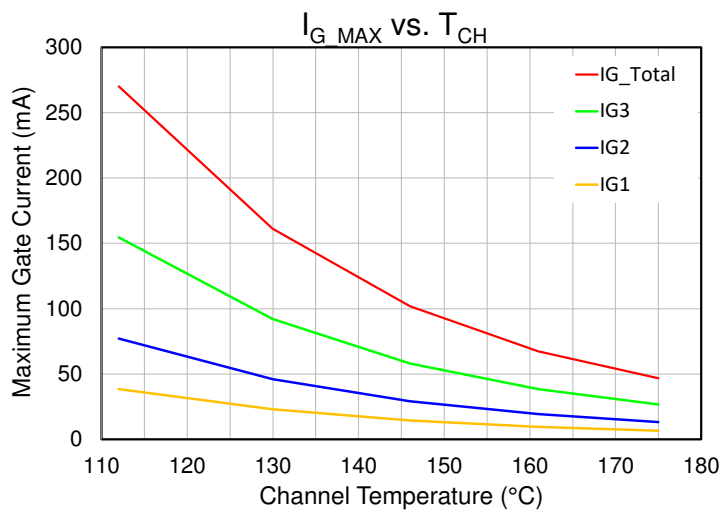


Dissipated Power (cont.)



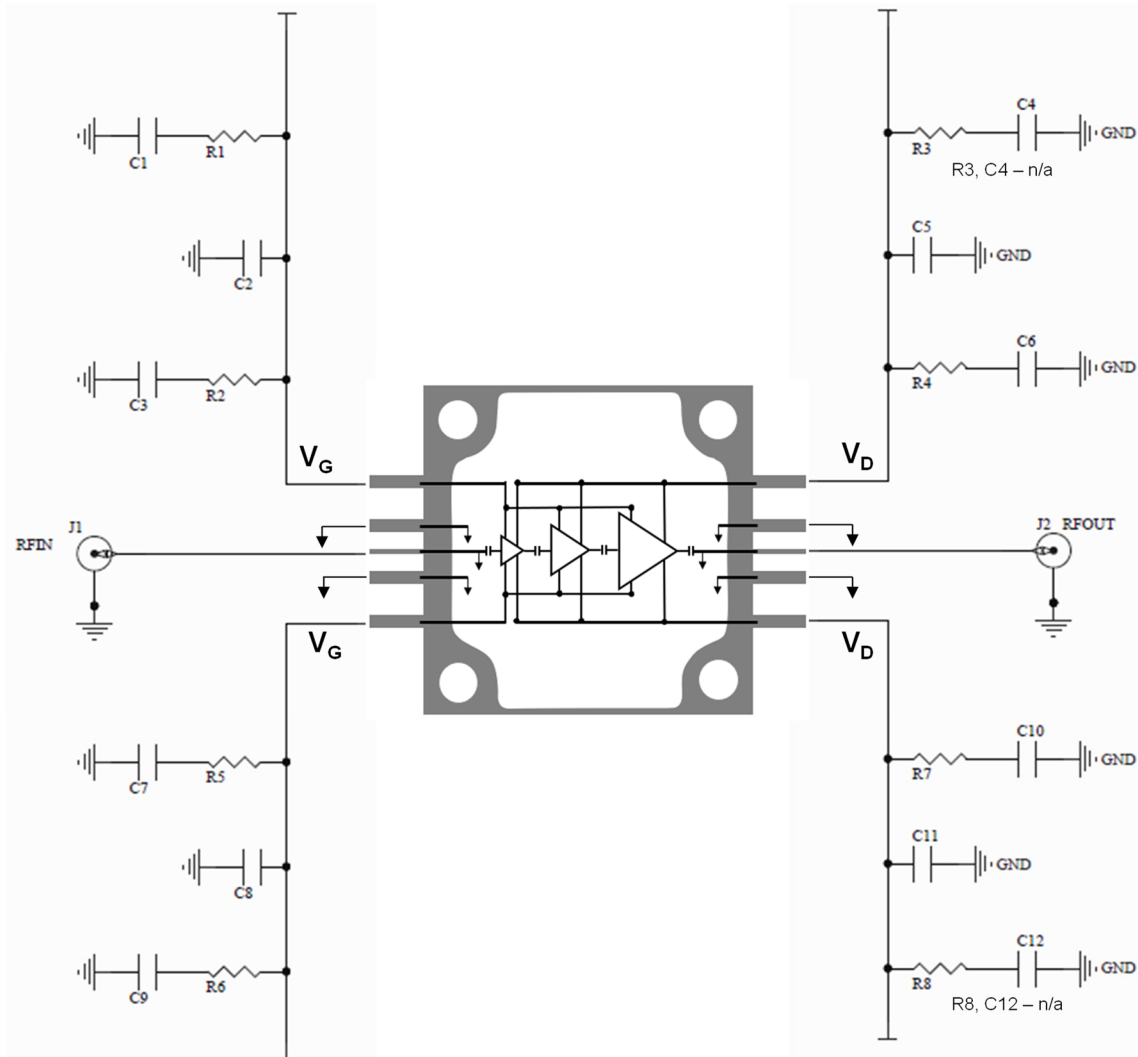
Test conditions, unless otherwise noted: Pulsed V_D = 26 V, I_{DQ} = 640 mA, T_{BASE} = 85 $^{\circ}$ C
 T_{BASE} is back side of QPA1315

Maximum Gate Current



Channel Temperature is an IR scan equivalent

Applications Information

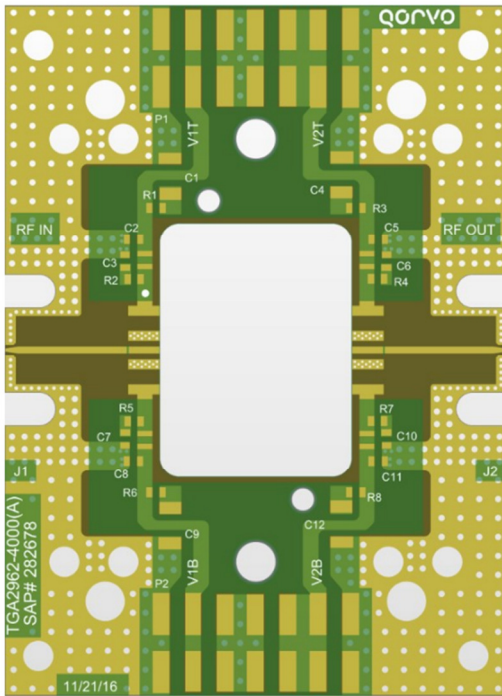


Bias-Up Procedure

1. Set I_D limit to 12 A, I_G limit to 20 mA
2. Apply V_G to -5 V
3. Apply V_D to 26 V; ensure $I_{DQ} \sim 0$ mA
4. Adjust V_G more positive until $I_{DQ} = 640$ mA;
 $V_G \approx -2.5 \pm 0.6$ V typical range
5. Turn on RF signal

Bias-Down Procedure

1. Turn off RF signal
2. Reduce V_G to -5 V; ensure $I_{DQ} \sim 0$ mA
3. Set V_D to 0 V
4. Turn off V_D supply
5. Turn off V_G supply



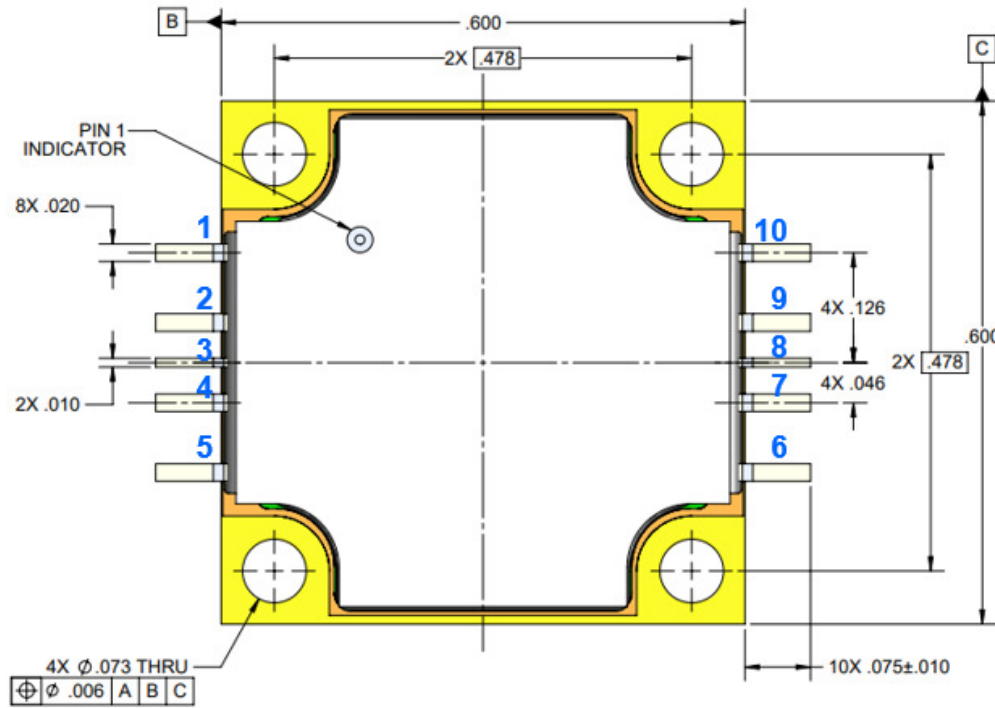
Layer Stack Legend (Copper Thickness is Finished Copper Thickness)

Material	Layer	Thickness	Dielectric Material	Type
	Silkscreen_Top			Legend
Surface Material	Soldermask_Top	0.10mil	Solder Resist	Solder Mask
Copper	Metal1_Top	1.40mil		Signal
Core		10.00mil	ROGERS 6035HTC	Dielectric
Copper	Metal2_Bot	1.40mil		Signal
Total thickness: 12.90mil				

Bill of Materials

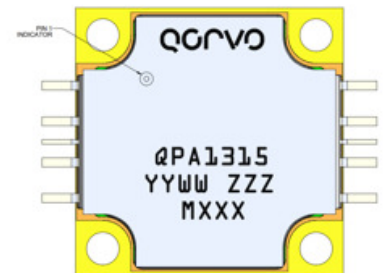
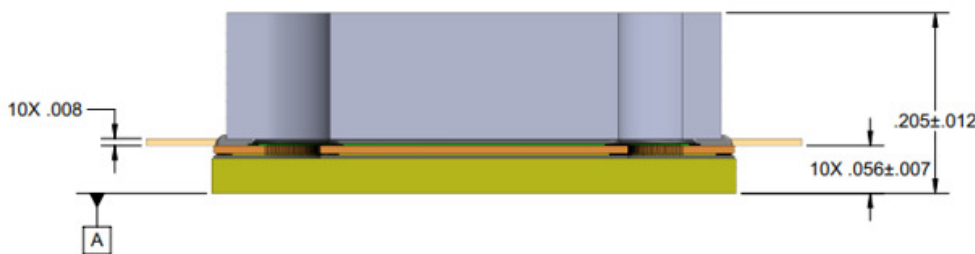
Reference Des.	Qty	Value	Description	Part Number
C1, C9	2	10 uF	CAP, 10uF, ±20%, 50V, X5R, 1206	
C2, C5, C6, C8, C10, C11	6	0.1 uF	CAP, 0.1uF, ±10%, 50V, X7R, 0402	
C3, C7	2	0.01 uF	CAP, 0.01uF, ±10%, 50V, X7R, 0402	
R1, R6	2	5.1 Ω	RES, 5.1 Ohm, ±5%, 50V, 0402	
R2, R5	2	10 Ω	RES, 10 Ohm, ±5%, 1/10W, 0402	
R4, R7	2	20 Ω	RES, 20 Ohm, ±5%, 1/10W, 0402	
PCB	1		PCB for QPA1315, see above	Qorvo, Custom
H1, H2	2		DC Header, 2x7, 14 POS, SMD	
J1, J2	2		RF Connector, 2.92mm, F, Pin 0.007, Diel. 0.048	Southwest Microwave
H-Block	1		H-Block, Copper C110, 1.594 x 2.200 x 0.275 in	Qorvo, Custom
S1 – S4	4		Screw, Cap, Socket Head, 0-80X3/32"	
S5 – S12	8		Screw, Cap, Socket Head, 2-56X1/8"	
Epoxy	-		Epoxy, Ablebond 84-1LMI	
Solder	-		Paste, solder, Sn63/Pb37	

Mechanical Information



NOTES:

1. MATERIALS
LID: FR4
BASE: COPPER; FINISH: GOLD
LEADS: ALLOY 194; FINISH: GOLD
2. PART IS EPOXY SEALED
3. UNITS: INCHES
4. TOLERANCES (UNLESS NOTED):
.XX = ± .01
.XXX = ± .005
5. MARKINGS
QPA1315: PART NUMBER
YY: ASSEMBLY YEAR
WW: ASSEMBLY WEEK
ZZZ: SERIAL NUMBER
MXXX: BATCH ID



Pin Description

Pin Number	Symbol	Description
1, 5	V _G	Gate voltage ⁽¹⁾ . Must be biased on both pins
2, 4, 7, 9	Ground	Ground. Must be grounded on PCB
3	RF _{IN}	RF Input. Matched to 50 Ω, DC blocked, DC shorted to ground
6, 10	V _D	Drain voltage ⁽¹⁾ . Must be biased on both pins
8	RF _{OUT}	RF Output. Matched to 50 Ω, DC blocked, DC shorted to ground

1. External bypassing required; refer to page 25 for recommendation.

Assembly Notes

- Carefully clean the PC board, base plate, and package leads with alcohol. Allow it to dry fully.
- 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.
- 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 TGA/QPA/QPMxxxx. 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.
- 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.



- The packaged part should not be subjected to conventional SMT automated solder reflow processes.
- (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)	1A	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	C2A	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	N/A	Blank, null, no content



Caution!

ESD-Sensitive Device

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Antimony Free
- TBBP-A (C₁₅H₁₂Br₄O₂) 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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