

Product Overview

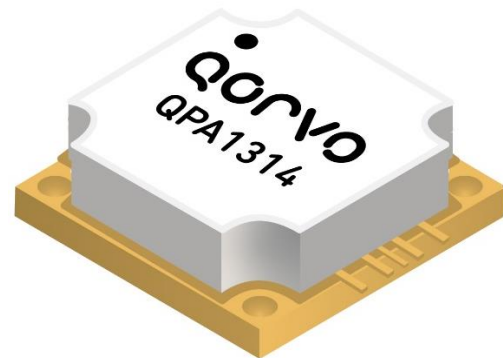
Qorvo's QPA1314 is a packaged high power MMIC amplifier, fabricated on Qorvo's production 0.15 μm GaN on SiC process (QGaN15). QPA1314 is targeted for 13.75 – 14.5 GHz Satcom band. Linear power is 20 W with 25 dBc third order intermodulation distortion products. It provides 40 W of output power with 27 dB of large signal gain while achieving 30% power-added efficiency. Operating frequency can extend to 12.75 – 15.35 GHz if desired.

The QPA1314 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 QPA1314 is fully matched to 50 ohms with DC grounded I/O ports for optimum ESD performance.

The QPA1314 is ideal for supporting communications and radar applications in both commercial and military markets.

The QPA1314 is 100% DC and RF tested to ensure compliance to electrical specifications.

Lead-free and RoHS compliant

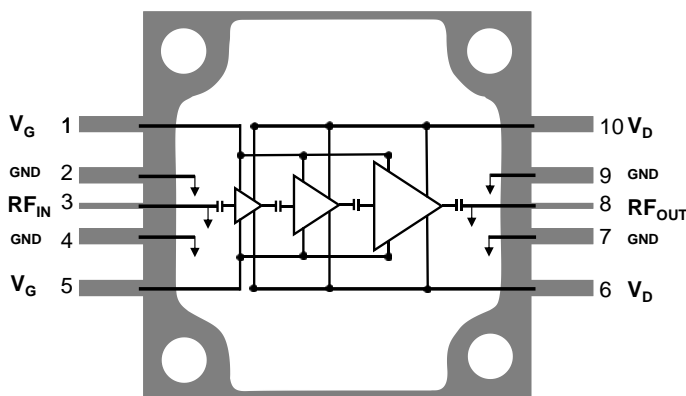


Key Features

- Frequency Range: 13.75 – 14.5 GHz
- Extended Frequency Range: 12.75 – 15.35 GHz
- Linear P_{OUT} : 43 dBm
- P_{OUT} ($P_{IN} = 19$ dBm): 46 dBm
- PAE ($P_{IN} = 19$ dBm): 30 %
- IM3 ($P_{OUT}/\text{Tone} = 40$ dBm): -25 dBc
- Small Signal Gain: 29 dB
- Bias: CW, $V_D = 24$ V, $I_{DQ} = 680$ mA, $V_G = -2.3$ V typical range
- Package Dimensions: 15.24 x 15.24 x 3.53 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

- Satellite Communications
- Datalinks

Ordering Information

Part No.	Description
QPA1314	13.75 - 14.5 GHz 40 Watt GaN PA
QPA1314EVB	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), $T_{BASE} = 85^\circ\text{C}$	20 A
Gate Current (I_G)	See plot p. 23
Power Dissipation (P_{DISS}), $T_{BASE} = 85^\circ\text{C}$	140 W
Input Power (P_{IN}), 50 Ω , CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $T_{BASE} = 85^\circ\text{C}$	32 dBm
Input Power (P_{IN}), 3:1 VSWR, CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $T_{BASE} = 85^\circ\text{C}$	32 dBm
Mounting Temperature	See Assembly Notes, p. 28
Storage Temperature	-55 to +150 $^\circ\text{C}$

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.

Electrical Specifications

Parameter	Conditions ^{(1) (2)}	Min	Typ.	Max	Units
Operational Frequency Range		13.75 ⁽³⁾		14.5 ⁽³⁾	GHz
Output Power ⁽⁴⁾ , P_{OUT}	$P_{IN} = 19\text{ dBm}$ ⁽⁴⁾ , Frequency = 13.75 – 14.5 GHz		46 ⁽⁴⁾		dBm
	$P_{IN} = 19\text{ dBm}$ ⁽⁴⁾ , Frequency = 12.75 – 15.35 GHz ⁽³⁾		45 ⁽⁴⁾		
Power Added Efficiency ⁽⁴⁾ , PAE	$P_{IN} = 19\text{ dBm}$ ⁽⁴⁾ , Frequency = 13.75 – 14.5 GHz		30		%
	$P_{IN} = 19\text{ dBm}$ ⁽⁴⁾ , Frequency = 12.75 – 15.35 GHz ⁽³⁾		25		
Large Signal Gain	$P_{IN} = 19\text{ dBm}$ ⁽⁴⁾		27		dB
3 RD Intermodulation Products, IM3	$P_{OUT}/\text{Tone} = 40\text{ dBm}$ (4dBm backoff from P_{SAT} ⁽⁴⁾)		-25		dBc
5 RD Intermodulation Products, IM5	Tone Spacing = 20 MHz		-35		
Small Signal Gain, S_{21}			29		dB
Input Return Loss, IRL	$P_{IN} = -30\text{ dBm}$		15		
Output Return Loss, ORL			7		
P_{SAT} Temperature Coefficient	$T_{DIFF} = 25^\circ\text{C}$ to 85°C ; $P_{IN} = 19\text{ dBm}$		-0.04		dBm/ $^\circ\text{C}$
S_{21} Temperature Coefficient	$T_{DIFF} = 25^\circ\text{C}$ to 85°C		-0.19		dB/ $^\circ\text{C}$

Notes:

- Test conditions unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_D = 680\text{ mA}$, $V_G = -2.3\text{ V} \pm 0.6\text{ V}$ typical, $T_{BASE} = +25^\circ\text{C}$, $Z_0 = 50\ \Omega$ (RF reference planes are at QPA1314')
- T_{BASE} is back side of QPA1314 (see p. 25 Offset Temperature based on Qorvo's EVB design for reference)
- Extended frequency range: 12.75 – 15.35 GHz
- Limited by T_{CH} , for P_{SAT} applications where $P_{IN} \geq 25\text{ dBm}$ the T_{BASE} must be reduced to $\leq 25^\circ\text{C}$, resulted $P_{SAT} = 47.5\text{ dBm}$ (55W), see plots page 6.

Recommended Operating Conditions

Parameter	Min	Typ.	Max	Units
Drain Voltage (V_D), CW ⁽¹⁾		24	24	V
Drain Current Quiescent (I_{DQ})		680		mA
Drain Current, RF (I_{D_Drive})	See plots p. 4,5,9,12,15			mA
Gate Voltage Typ. Range (V_G)	-1.9 to -3.1			V
Gate Current, RF (I_{G_Drive})	See plots p. 4,5			mA
Input Power (P_{IN}) ^{1/}	$T_{BASE} -40^\circ\text{C}$:	25		dBm
	$T_{BASE} +25^\circ\text{C}$:	25		
	$T_{BASE} +85^\circ\text{C}$:	19		
Operating Temp. Range (T_{BASE}) ⁽²⁾	-40		+85	$^\circ\text{C}$

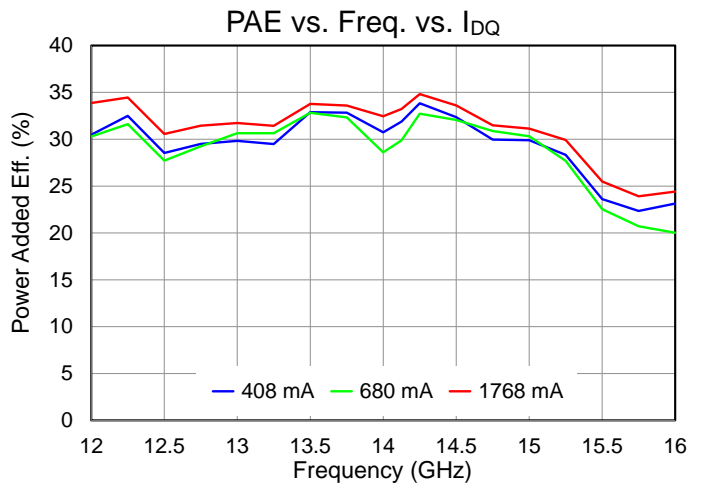
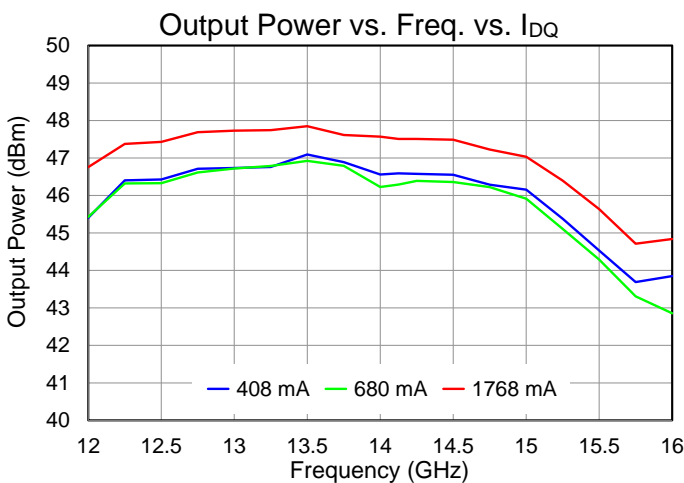
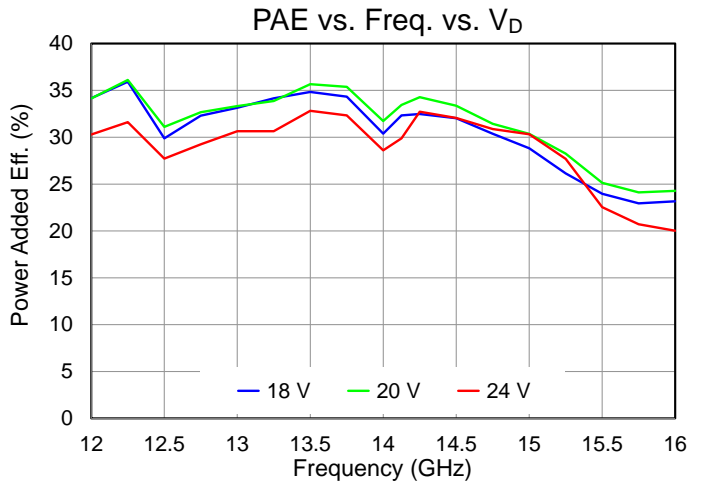
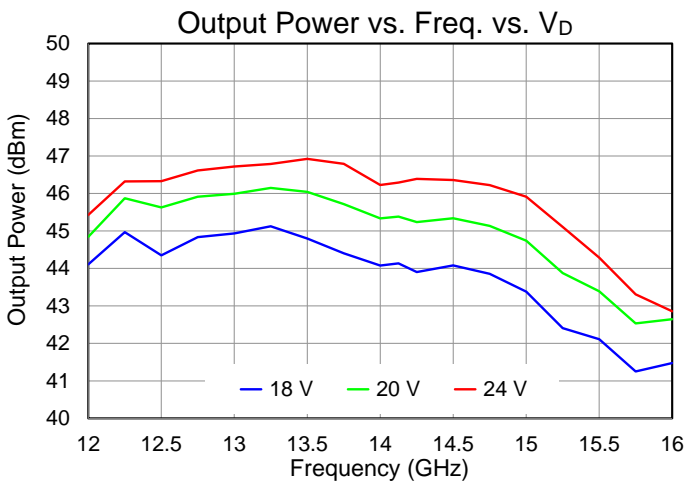
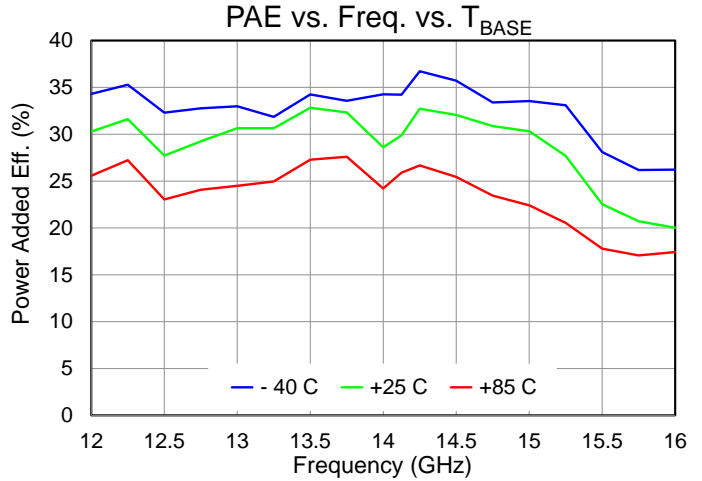
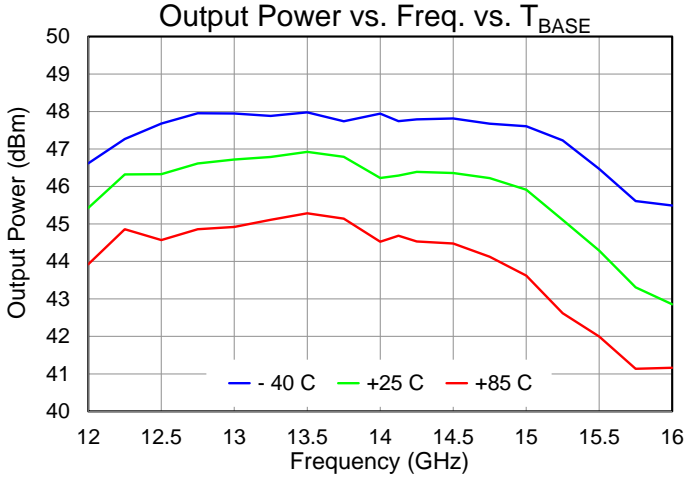
1. Limited by channel temperature T_{CH} . For pulsed applications P_{IN} can be handled up to 21 dBm for 85°C T_{BASE} . For P_{SAT} applications, see Electrical Specifications' note 4.

2. T_{BASE} is back side of QPA1314 (see p. 25 Offset Temperature based on Qorvo's EVB design for reference)

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

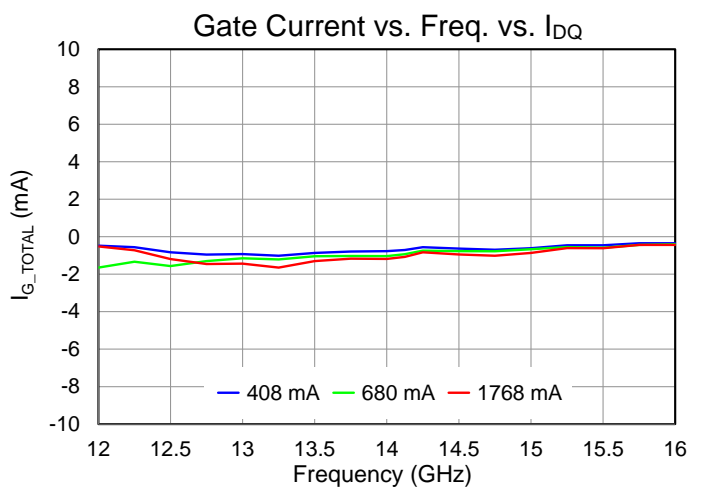
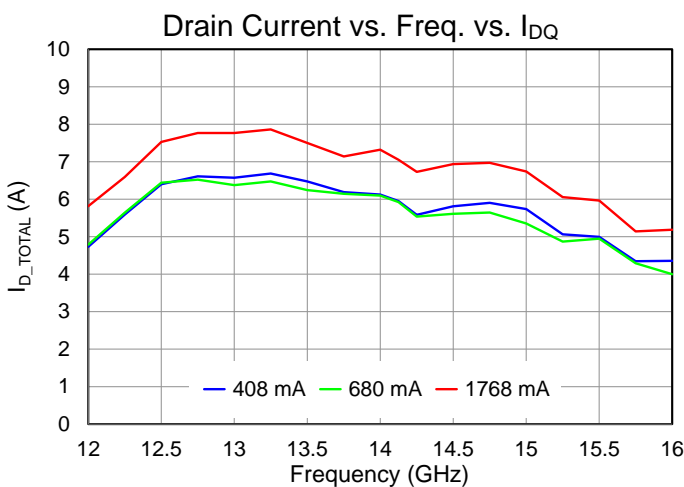
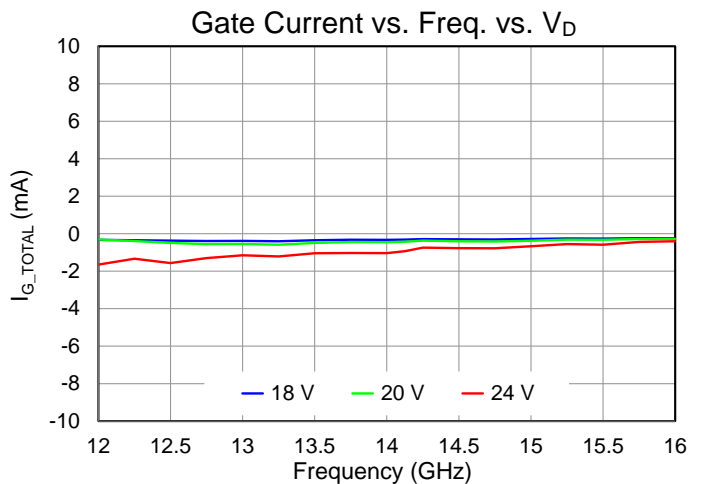
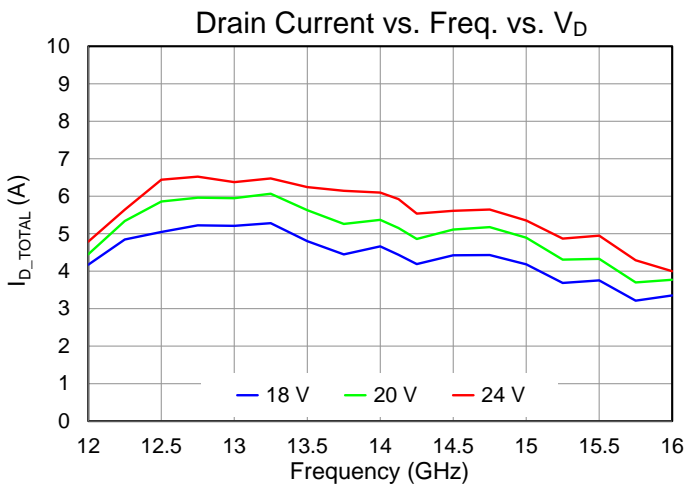
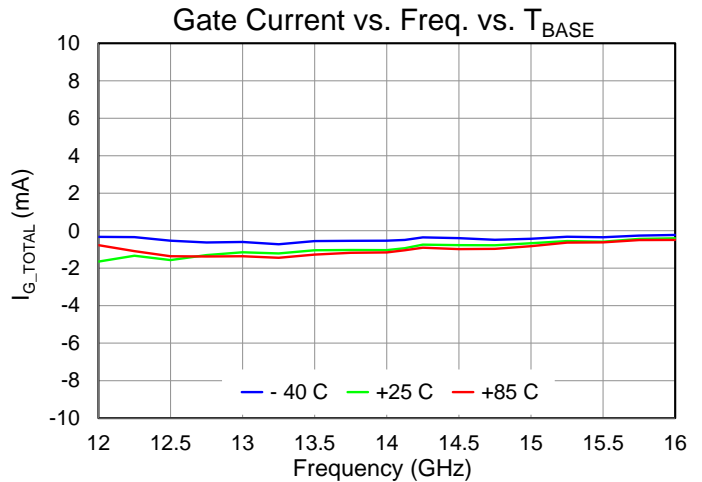
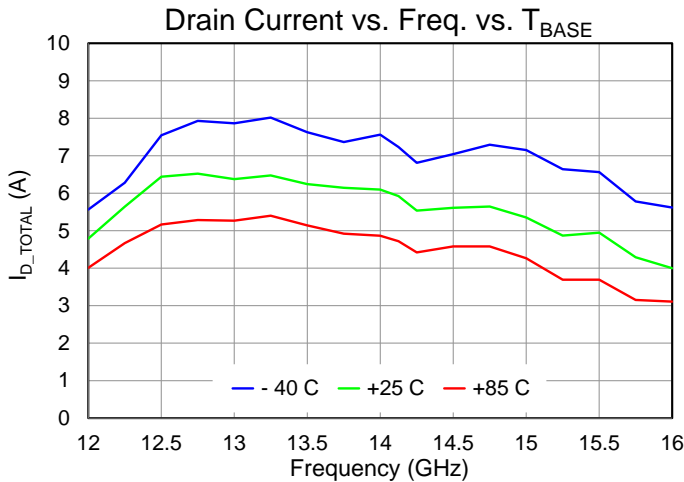
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $P_{IN} = 19\text{ dBm}$ (P_{IN} P_{OUT} are limited by T_{CH} , 19 dBm is not at P_{SAT} level), $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



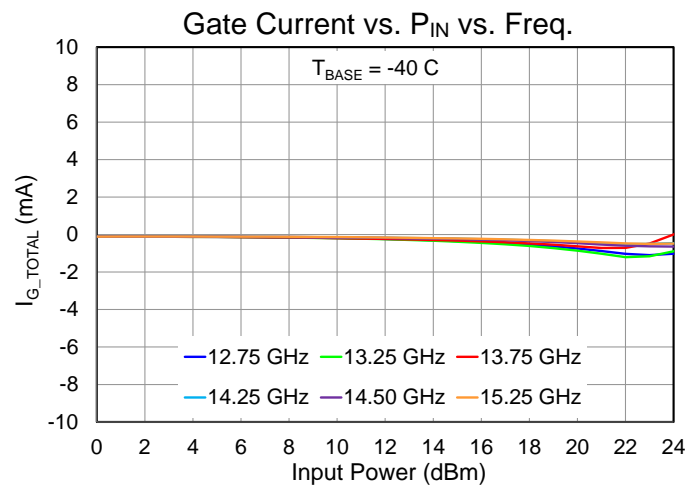
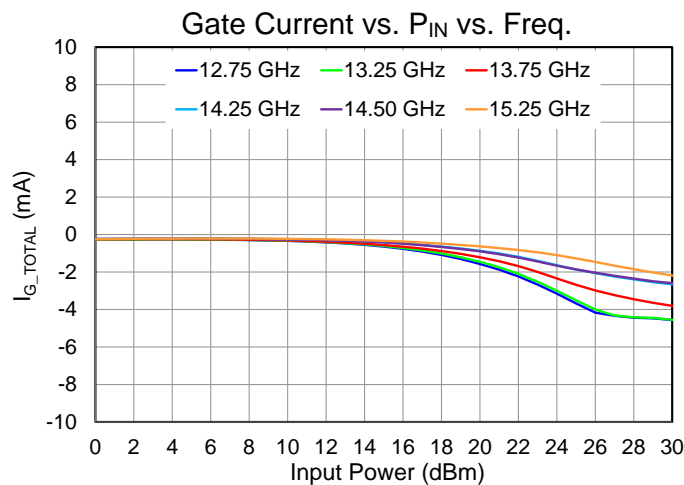
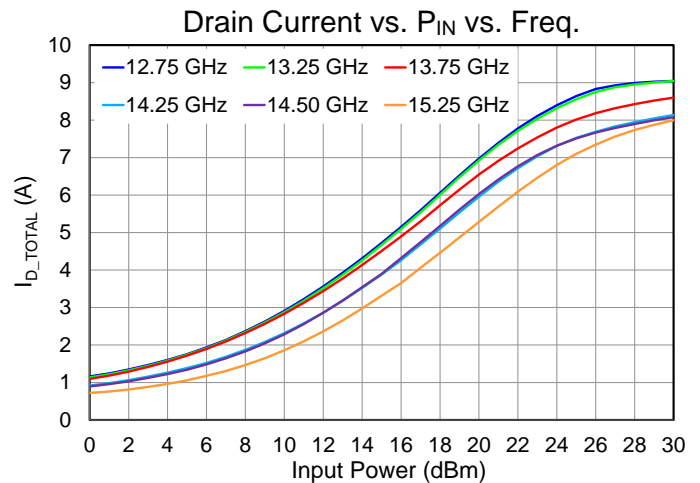
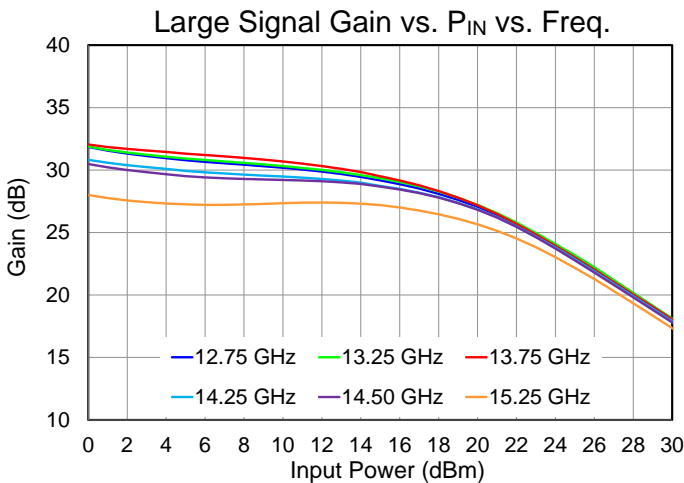
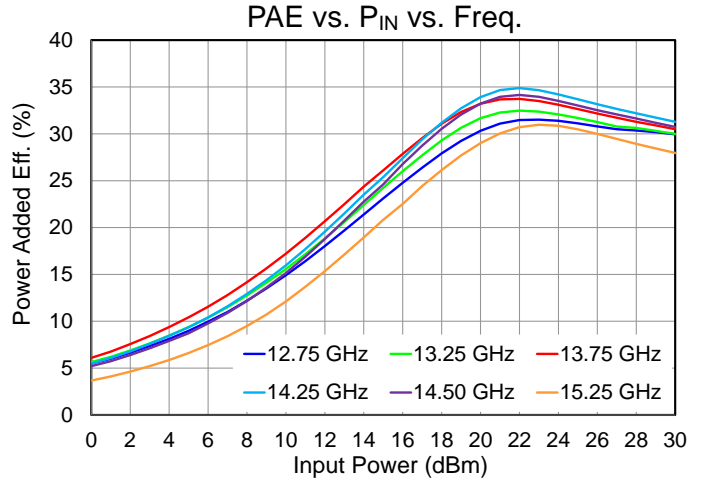
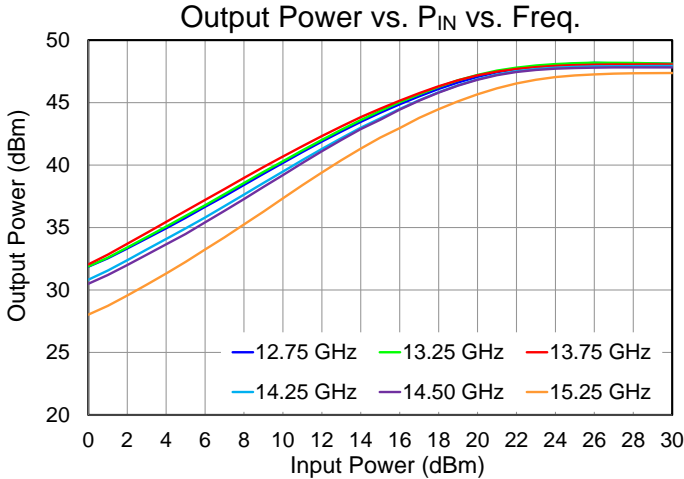
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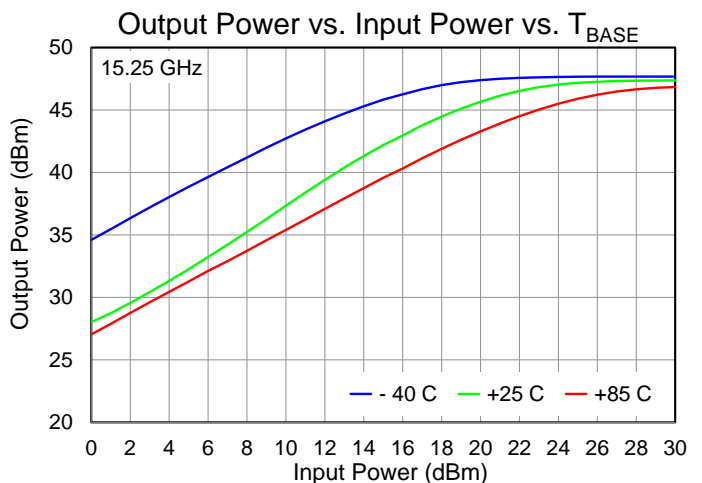
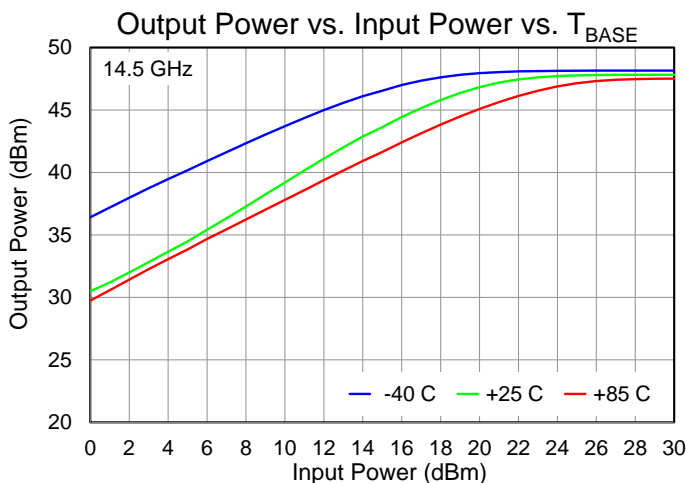
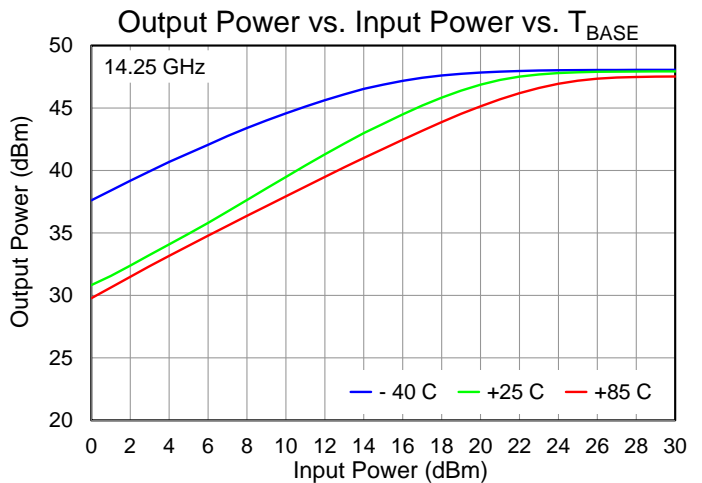
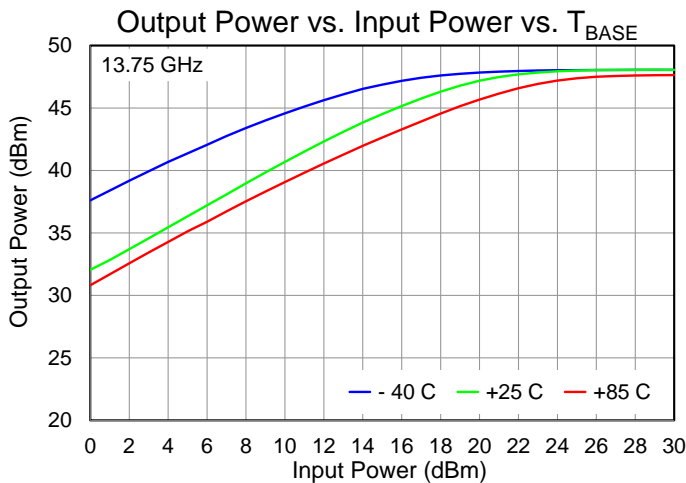
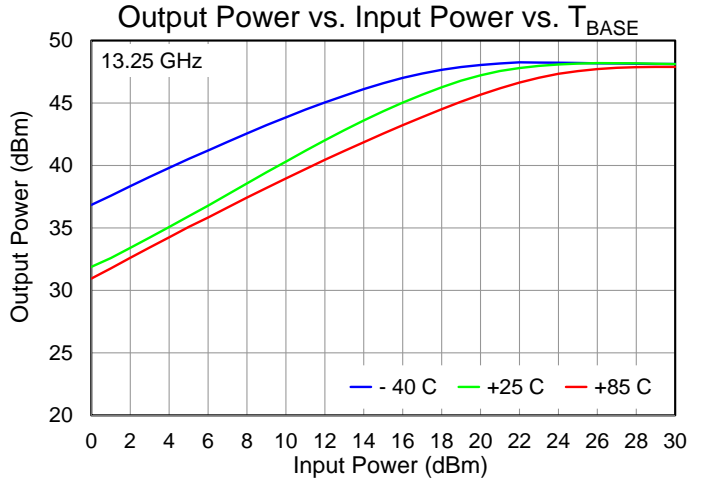
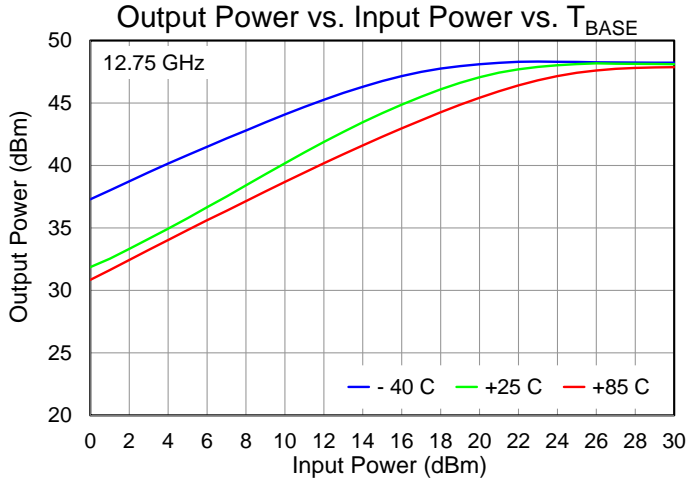
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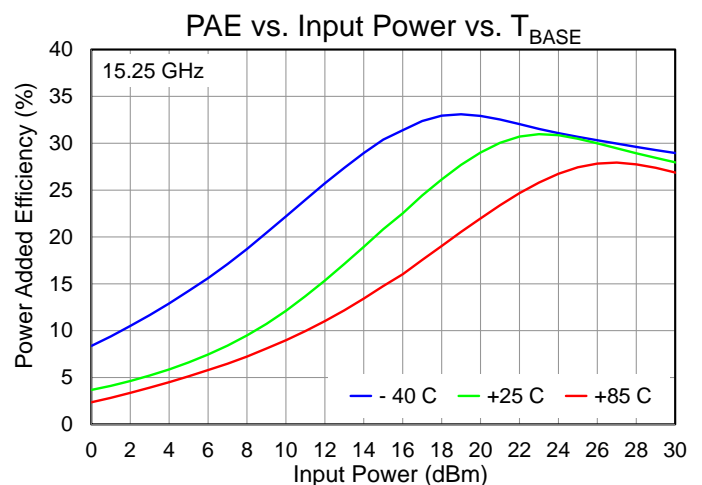
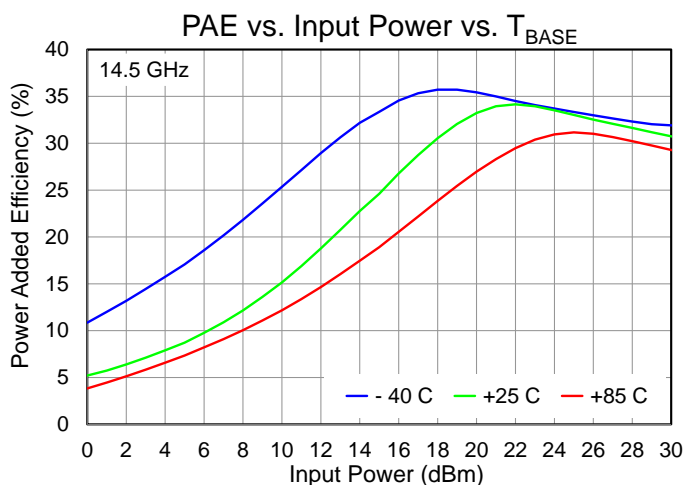
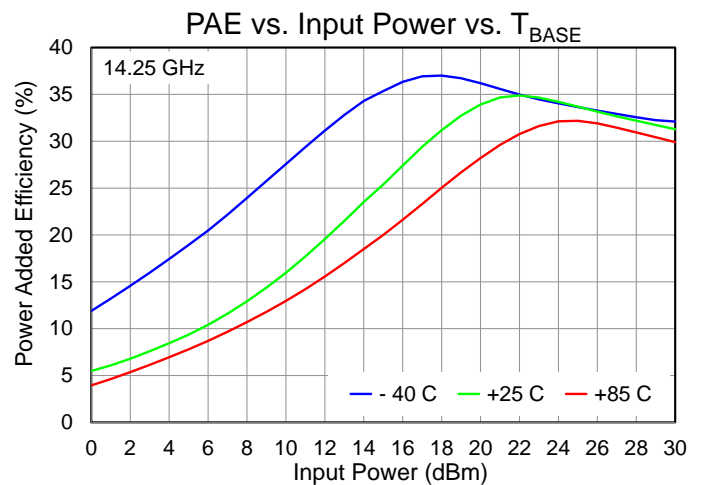
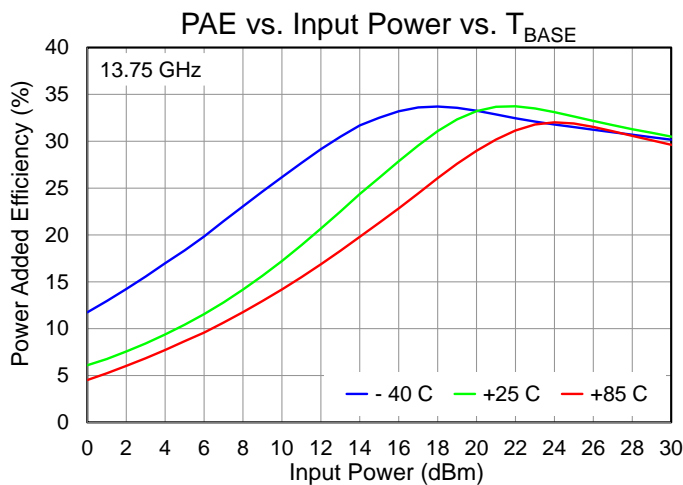
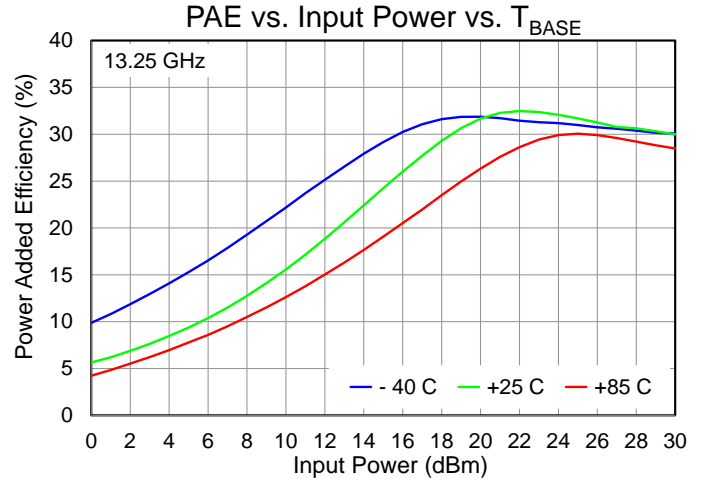
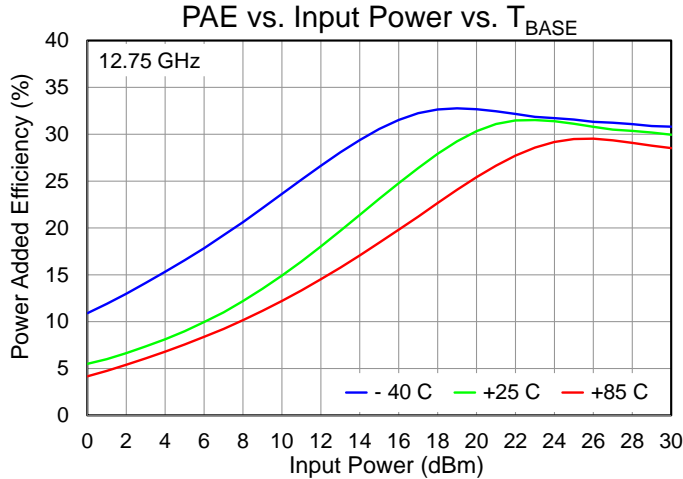
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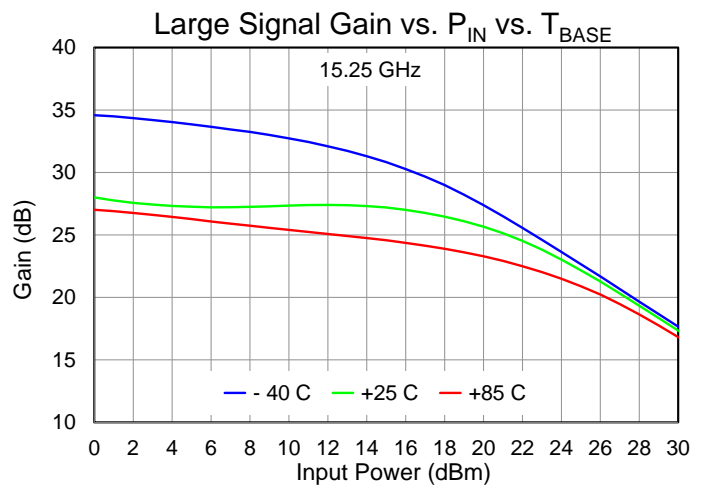
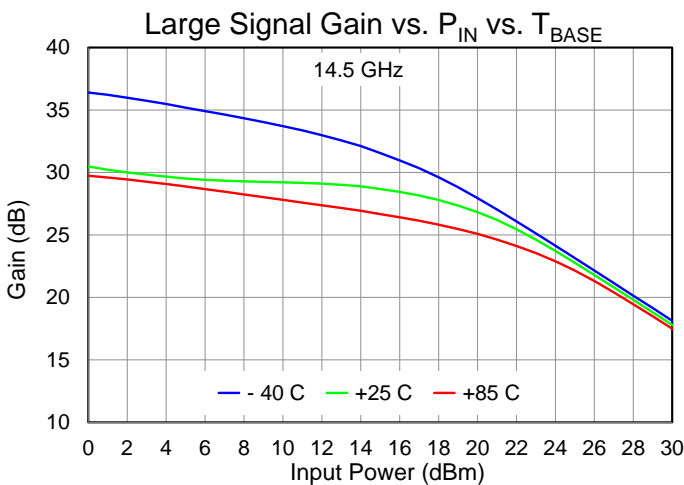
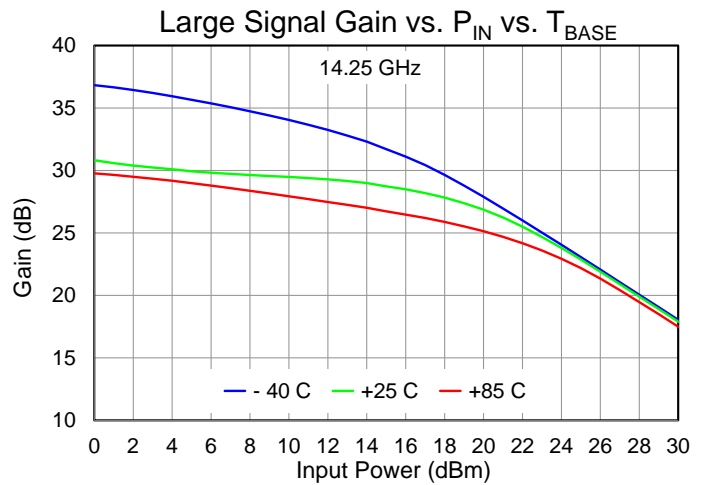
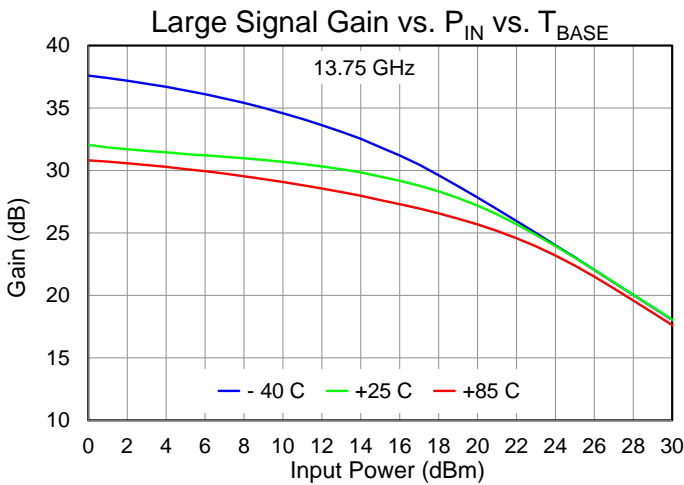
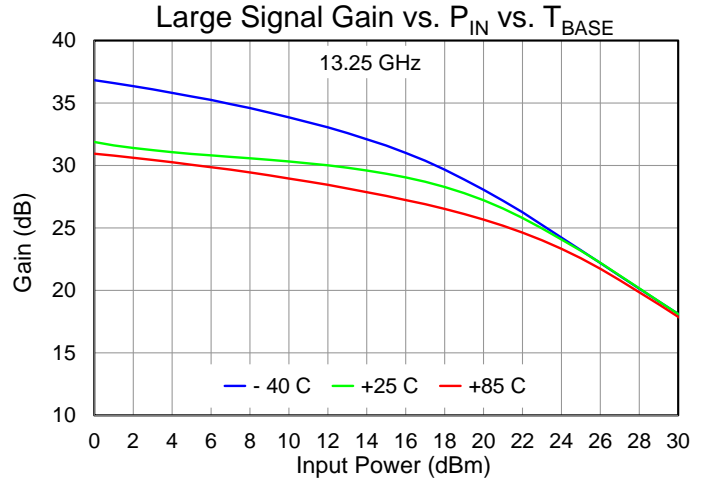
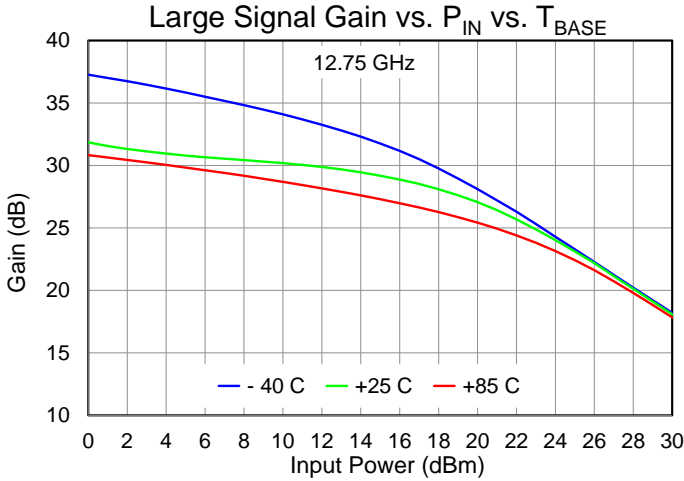
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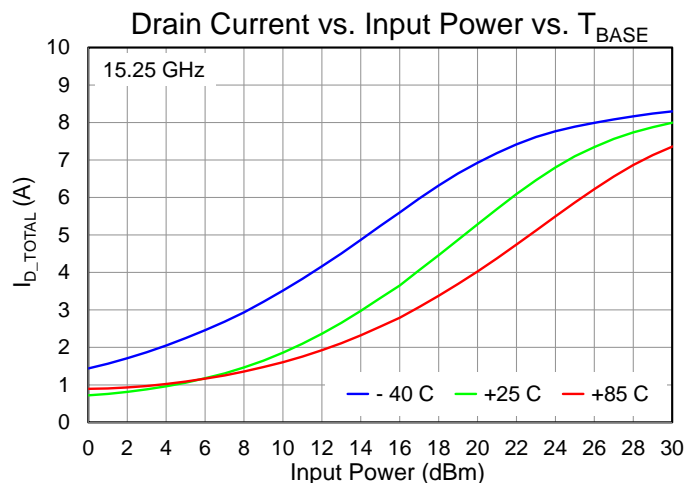
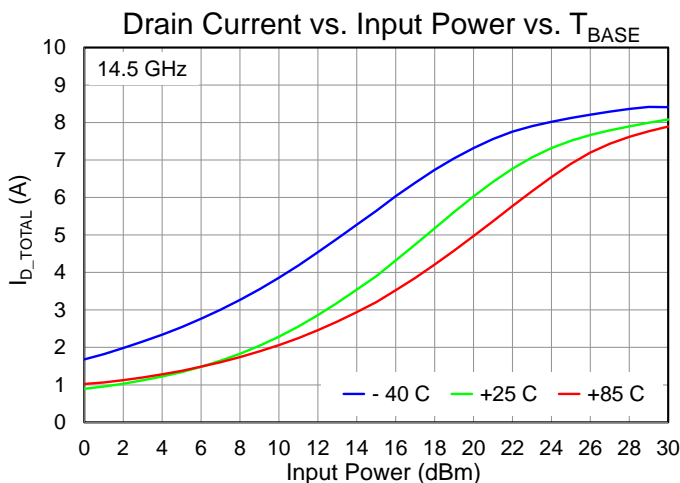
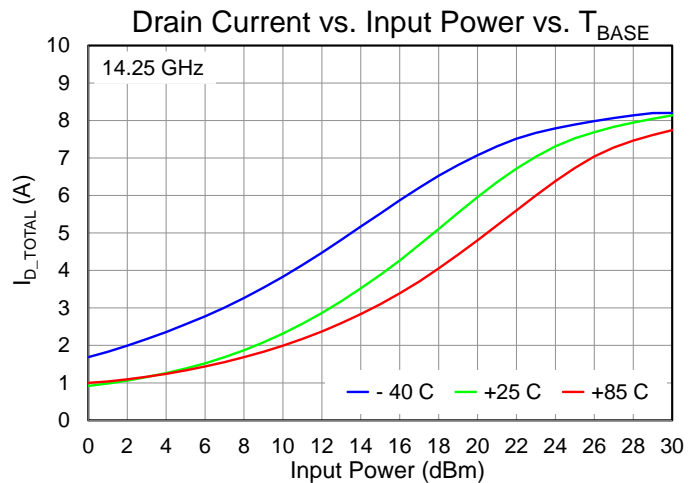
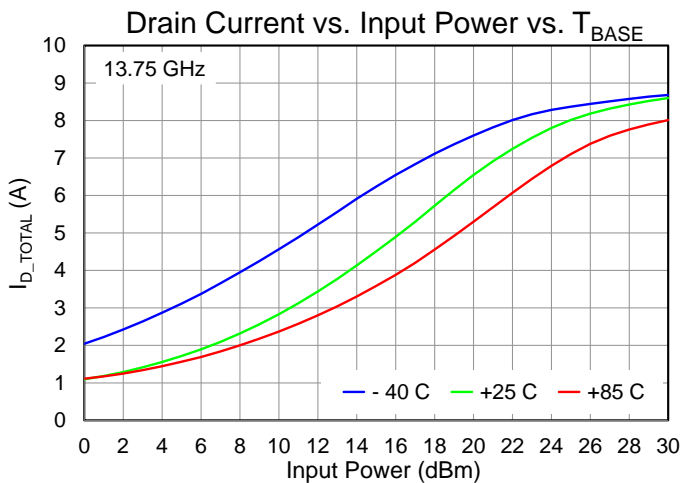
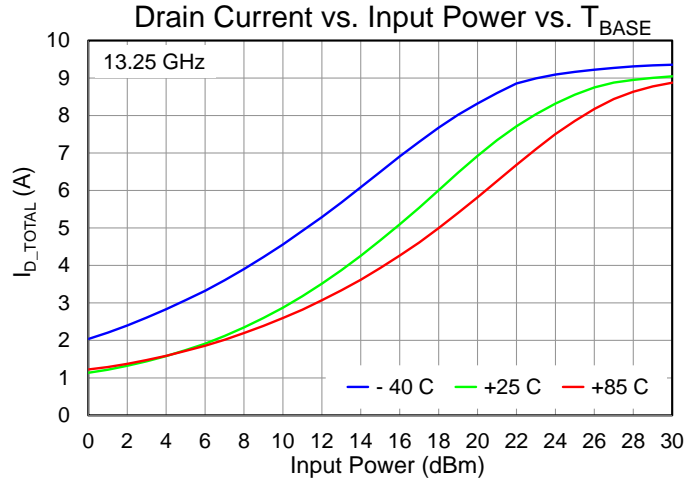
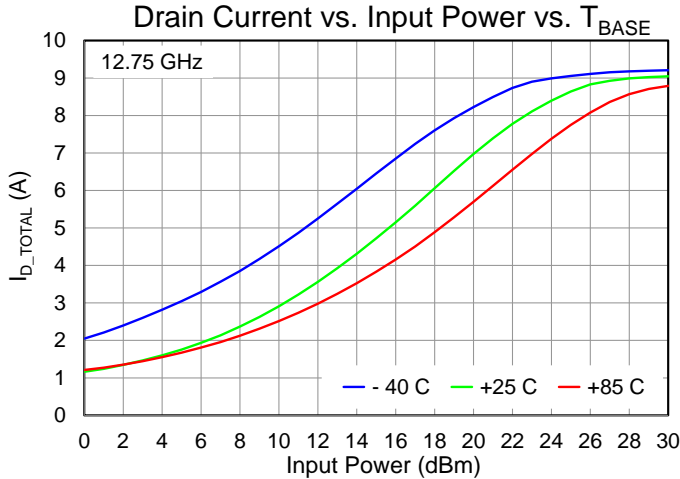
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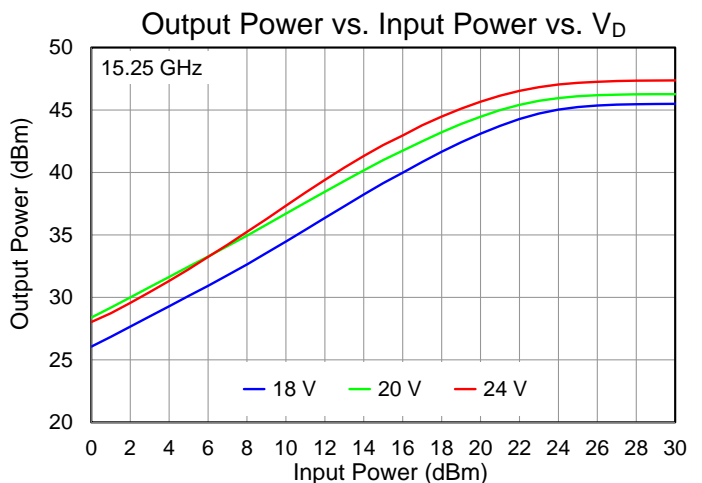
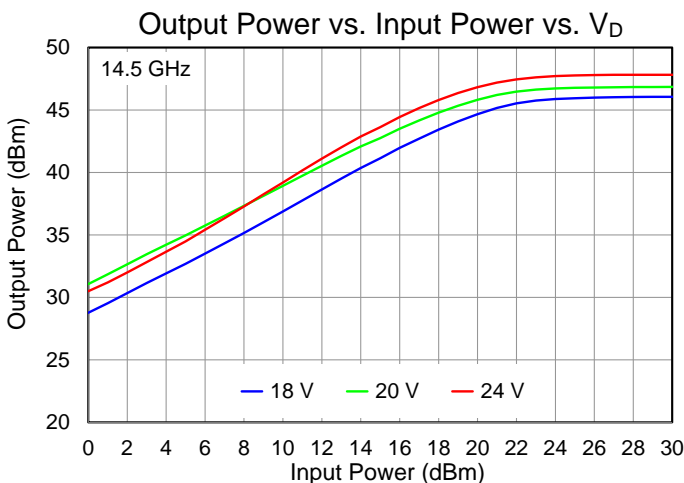
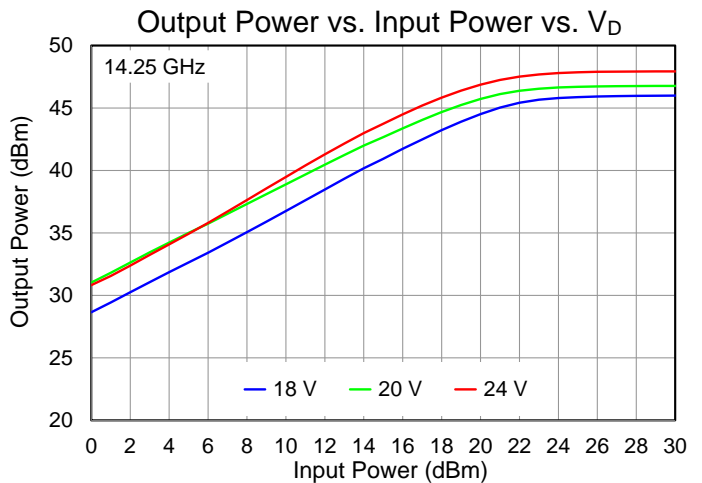
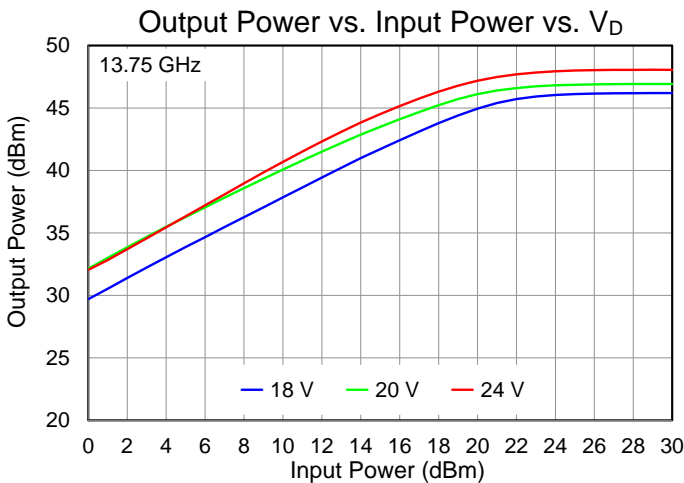
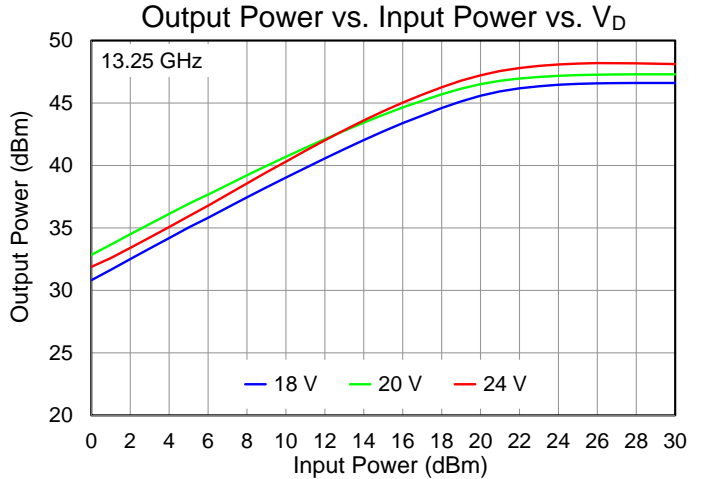
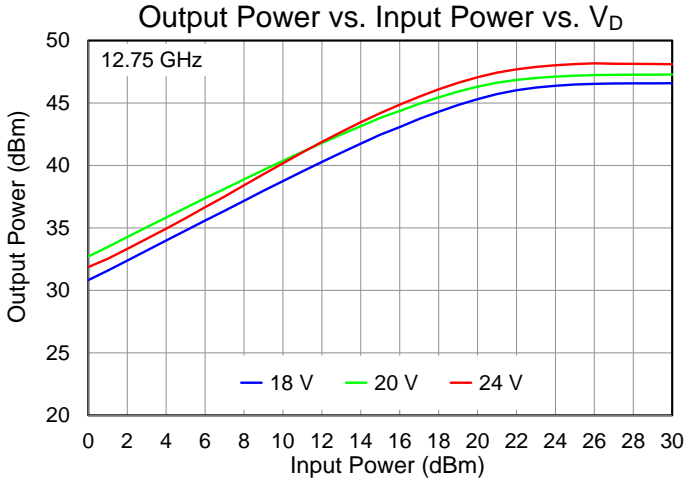
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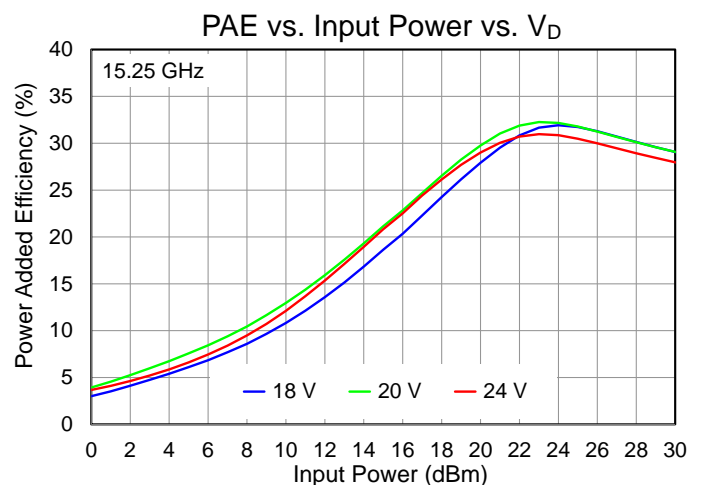
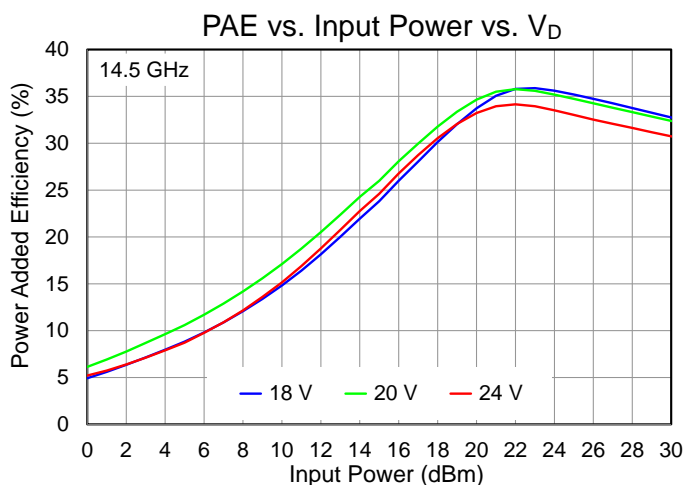
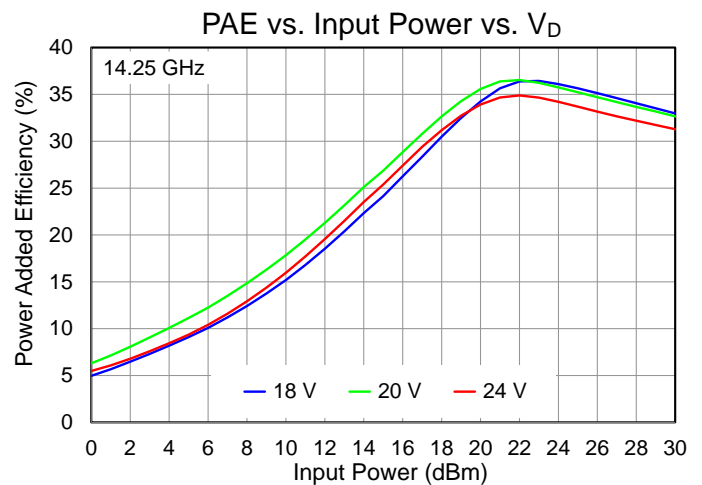
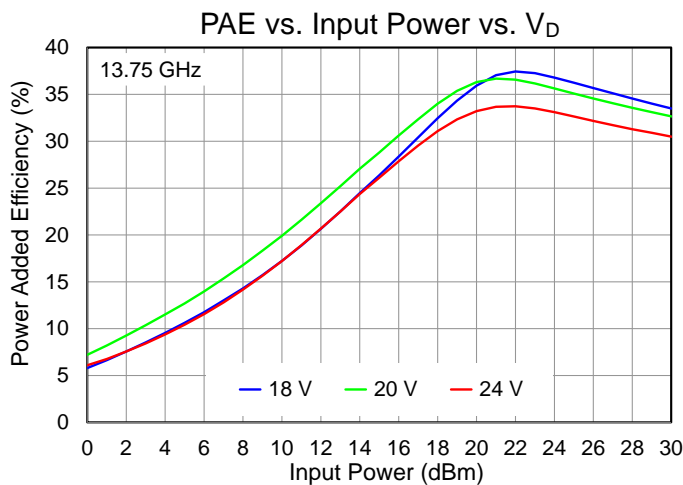
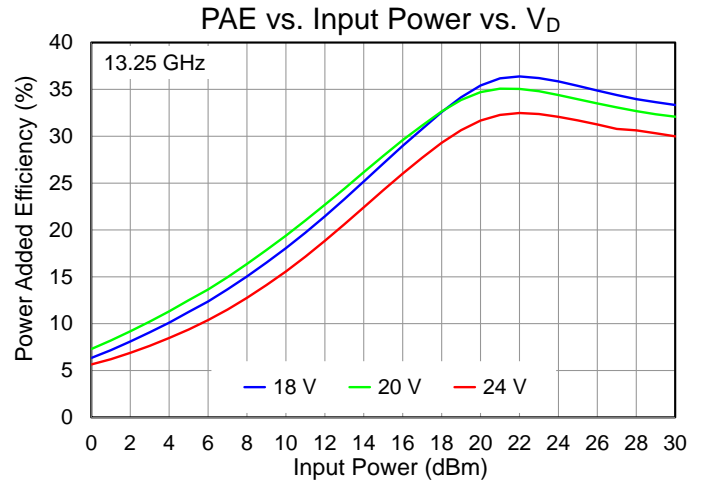
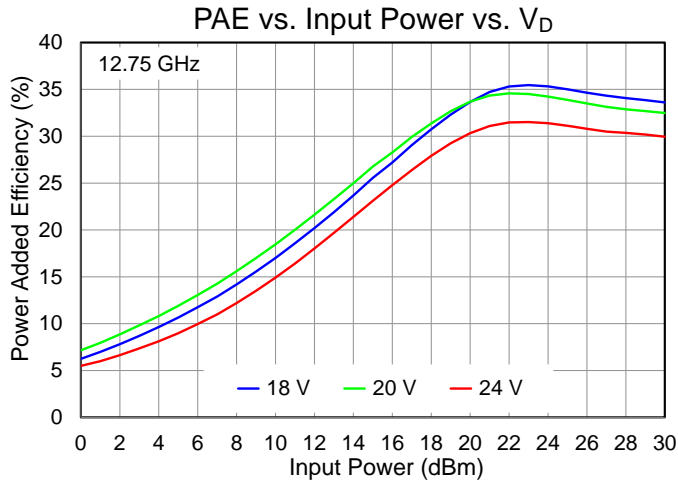
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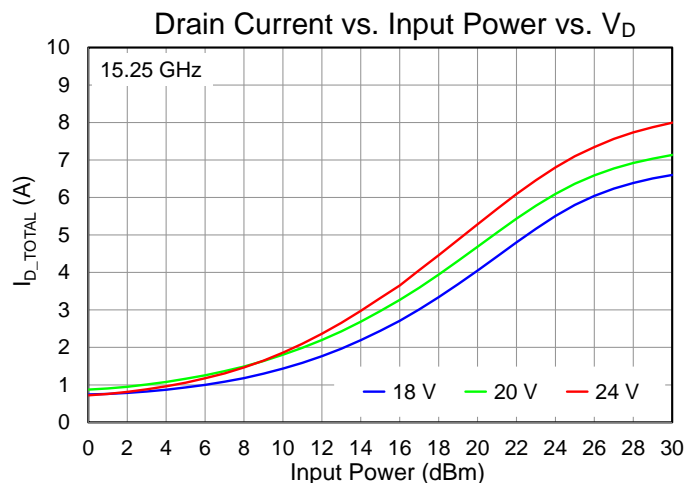
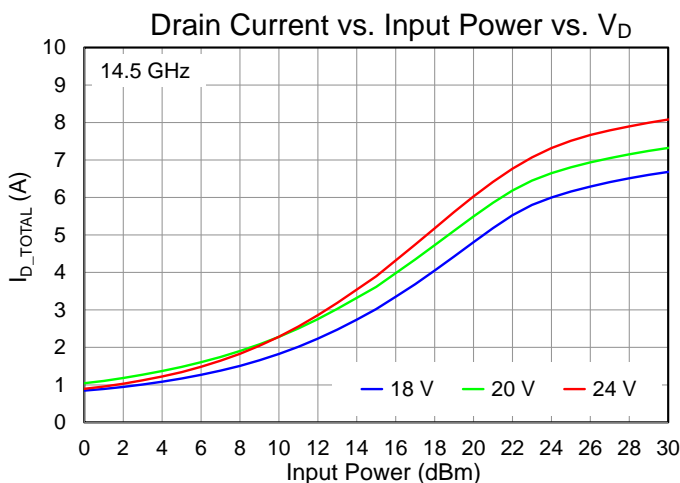
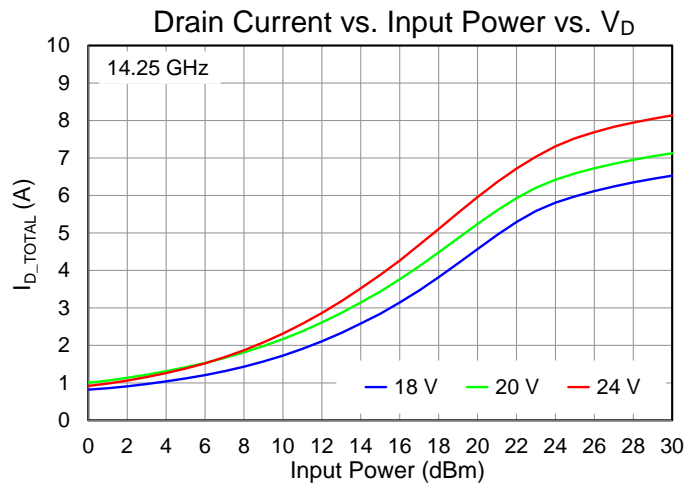
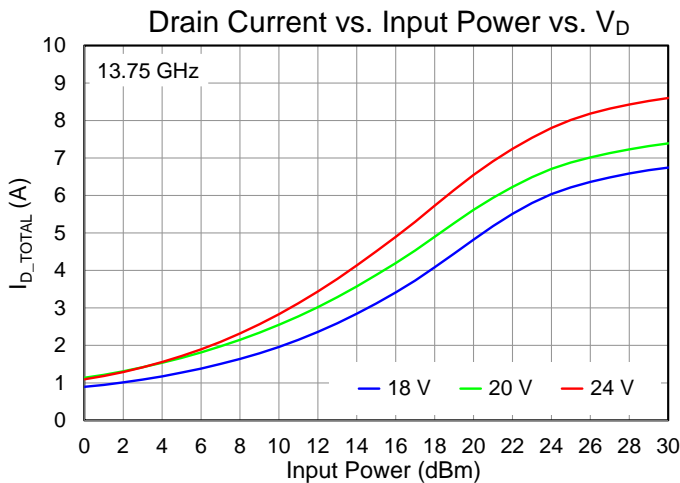
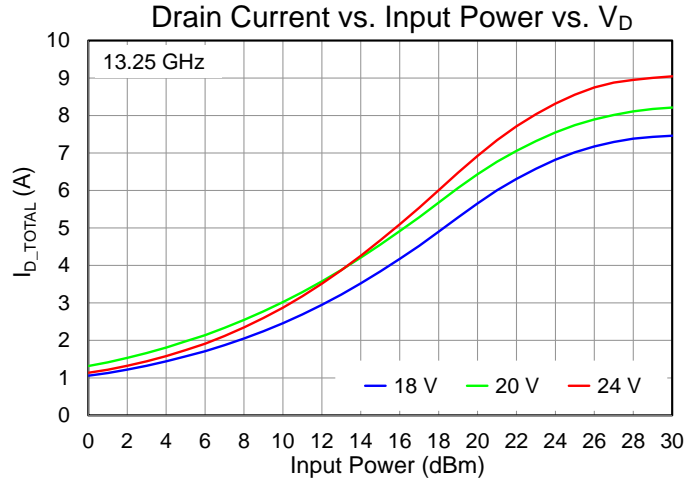
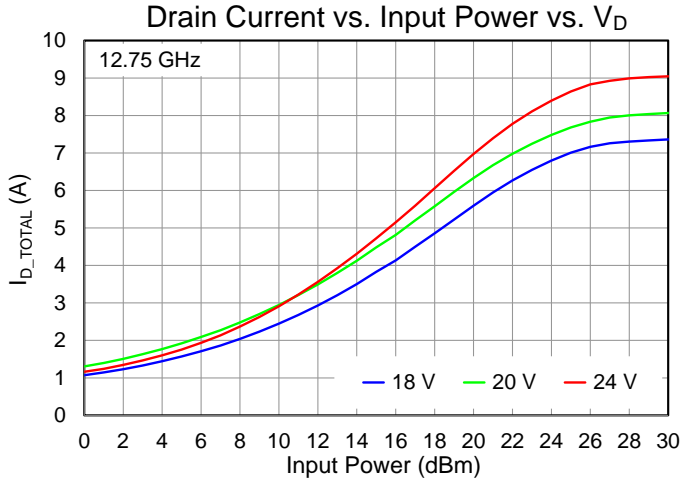
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, see Recommended Operating Conditions on page 2 for P_{IN} , $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



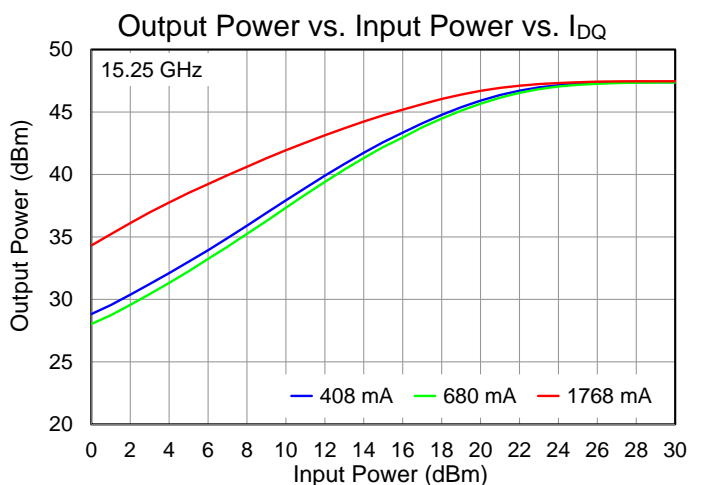
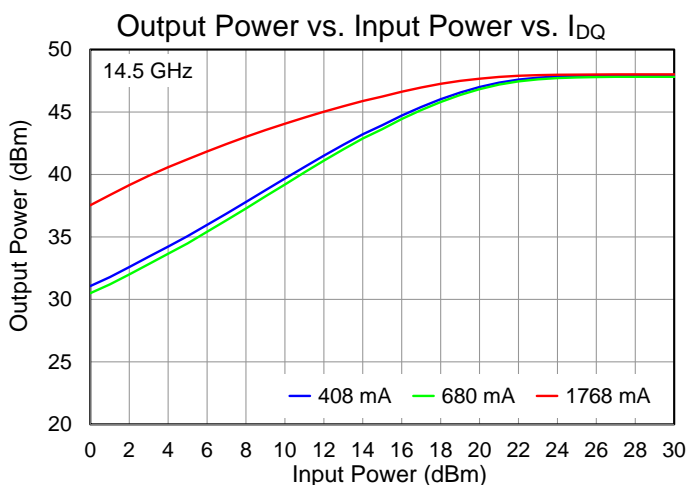
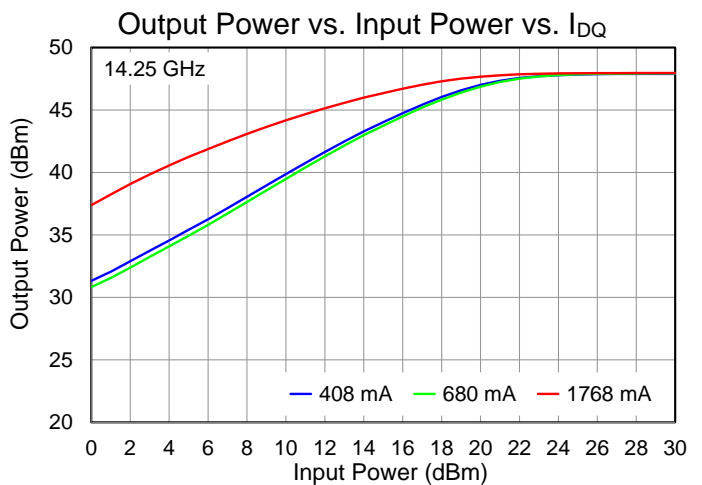
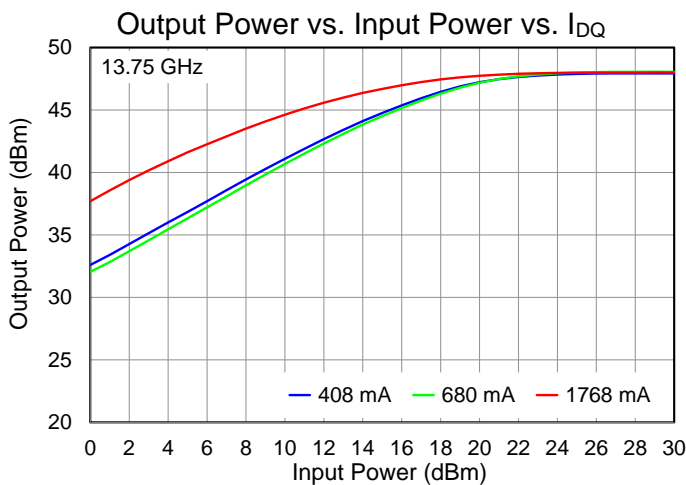
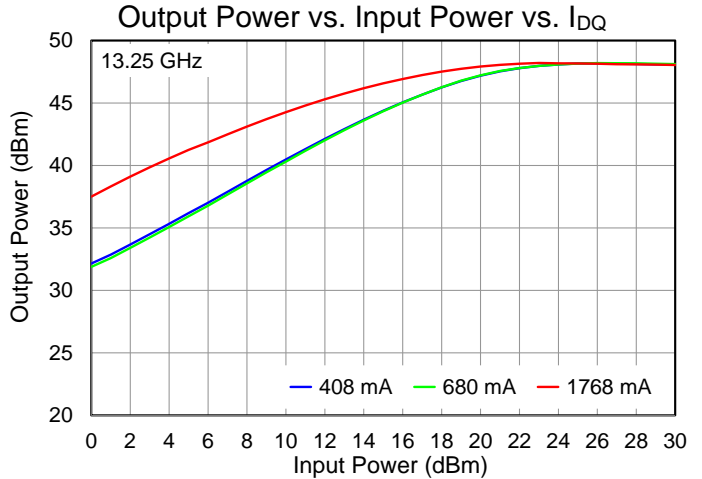
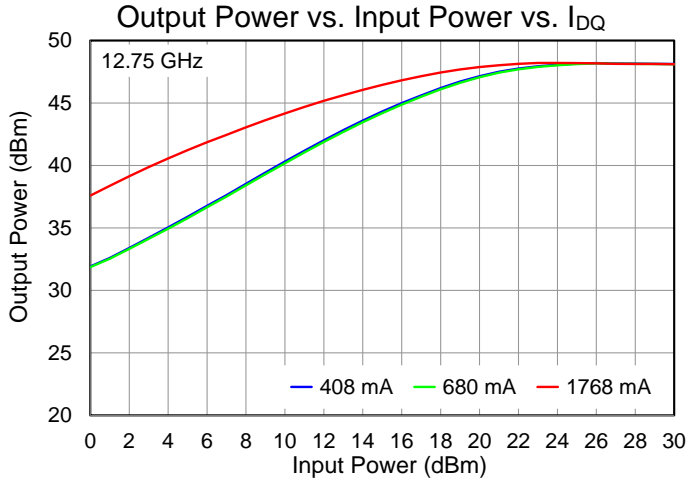
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, see Recommended Operating Conditions on page 2 for P_{IN} , $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



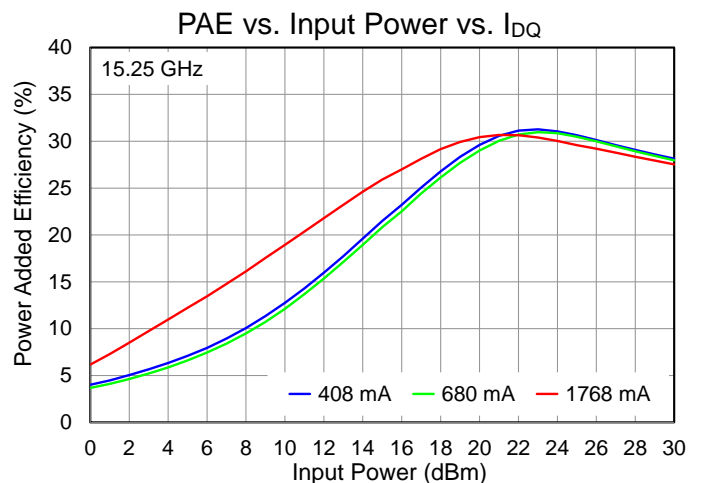
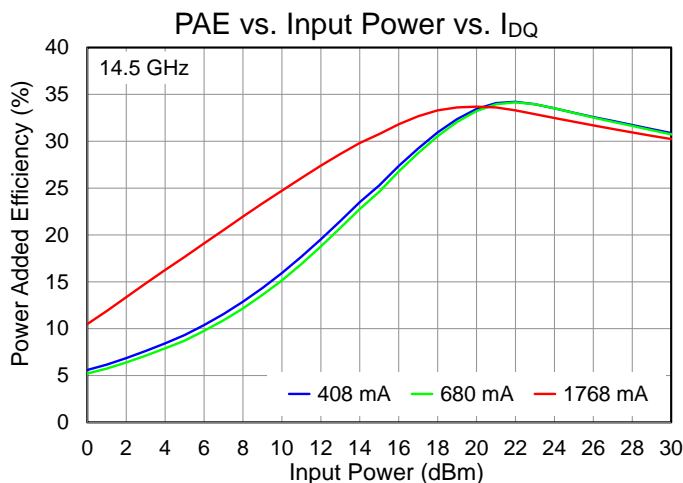
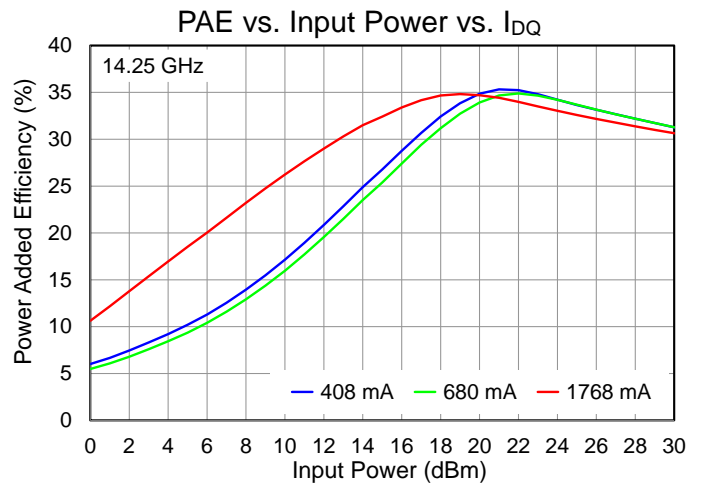
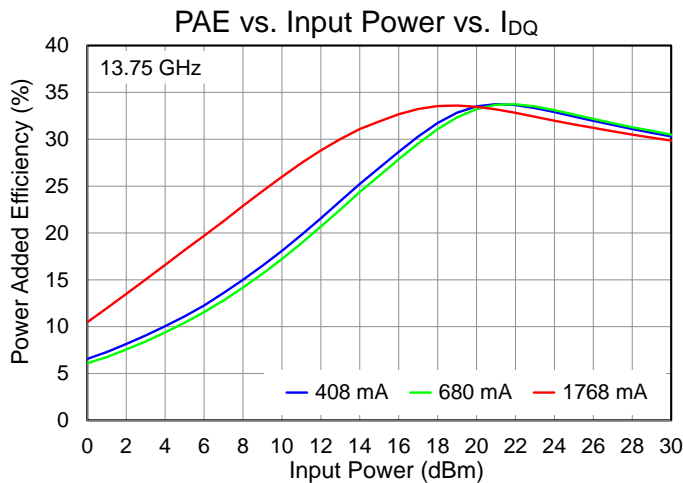
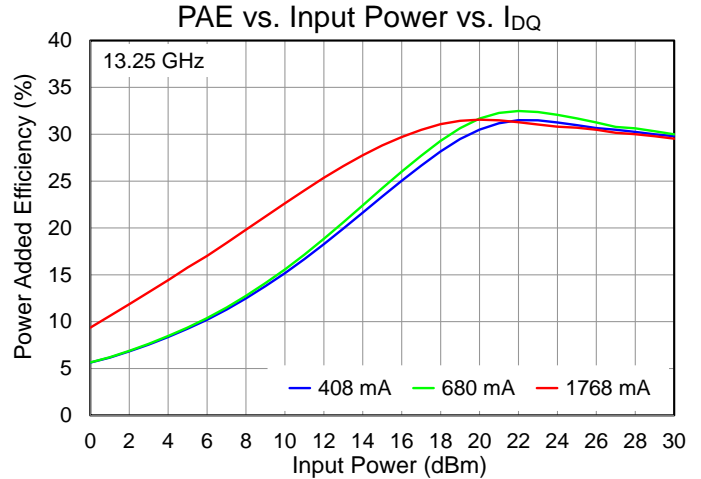
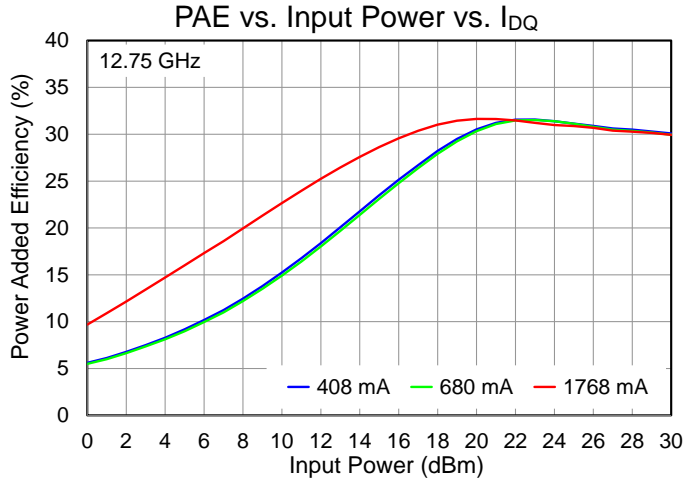
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, see Recommended Operating Conditions on page 2 for P_{IN} , $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



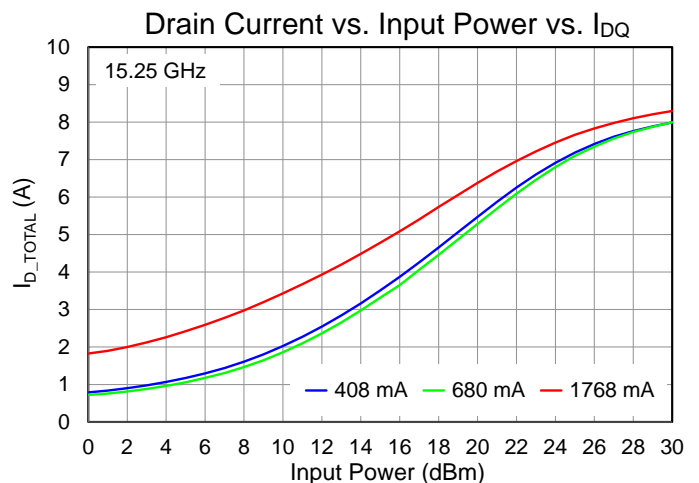
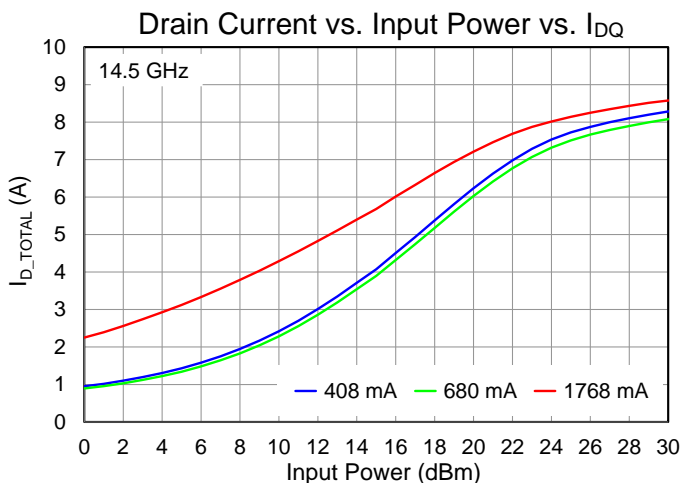
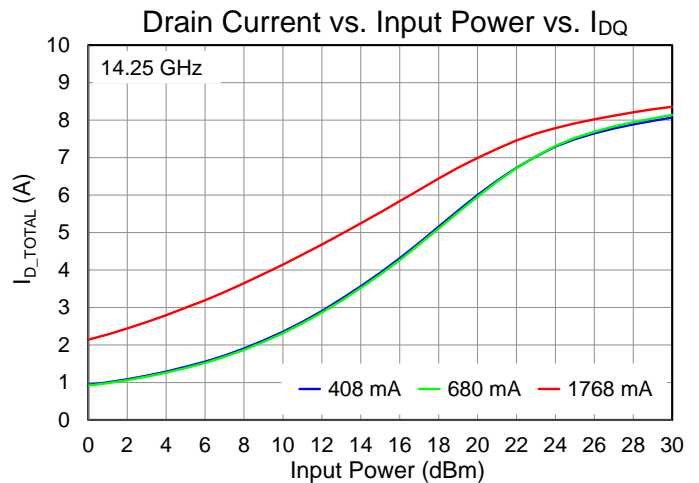
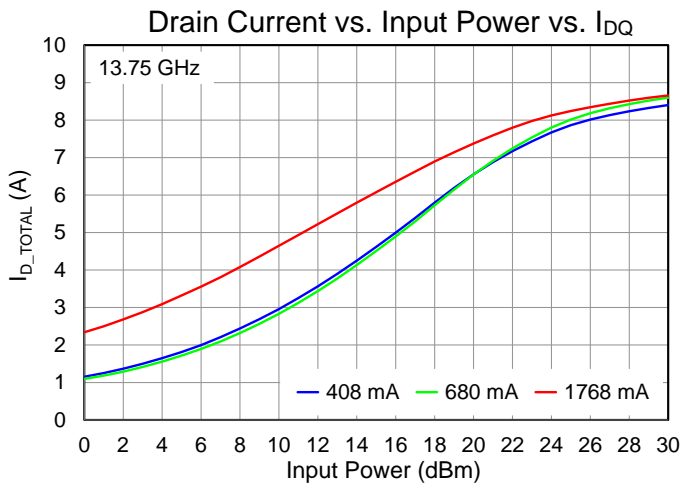
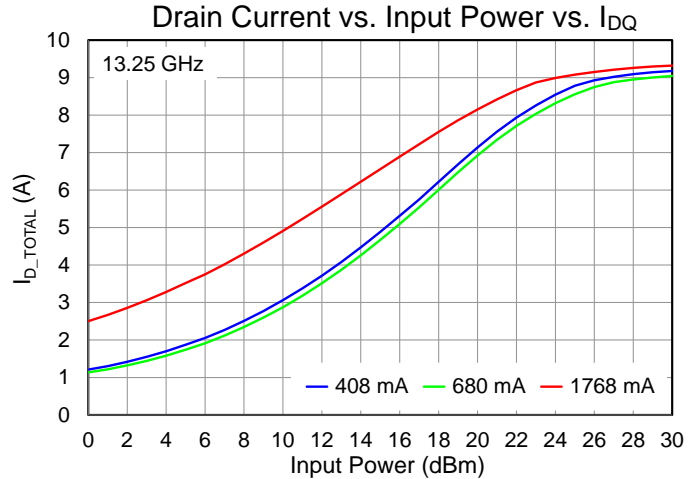
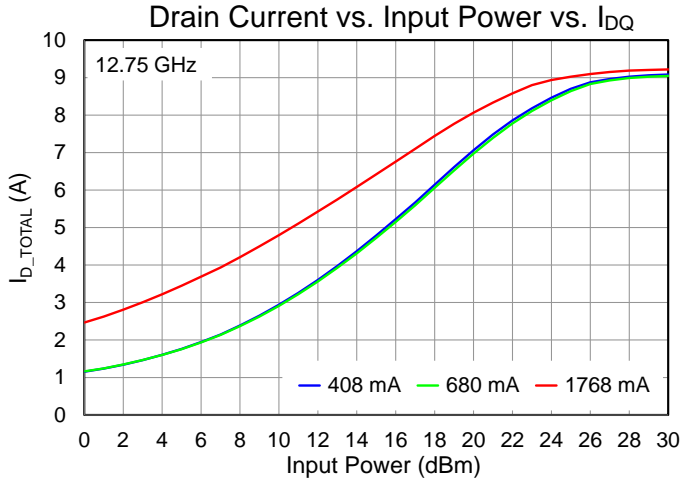
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, see Recommended Operating Conditions on page 2 for P_{IN} , $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



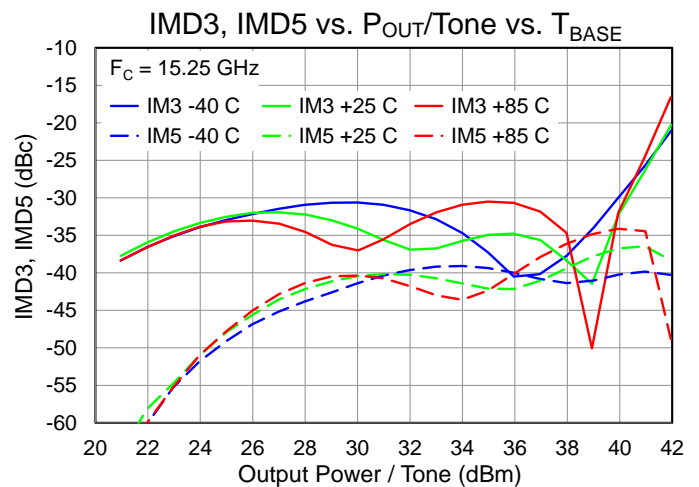
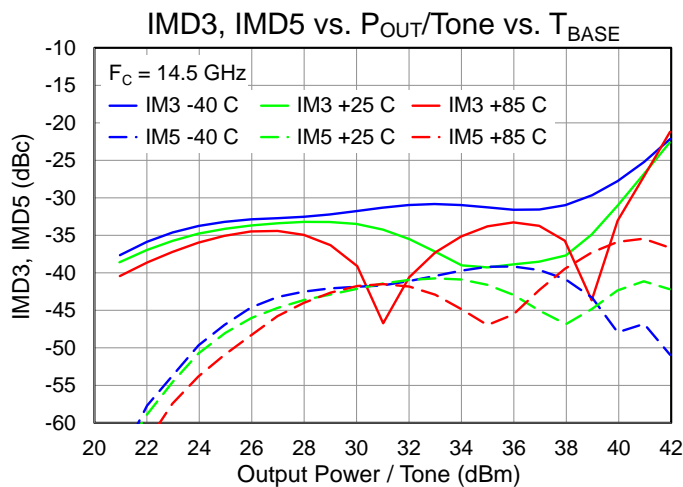
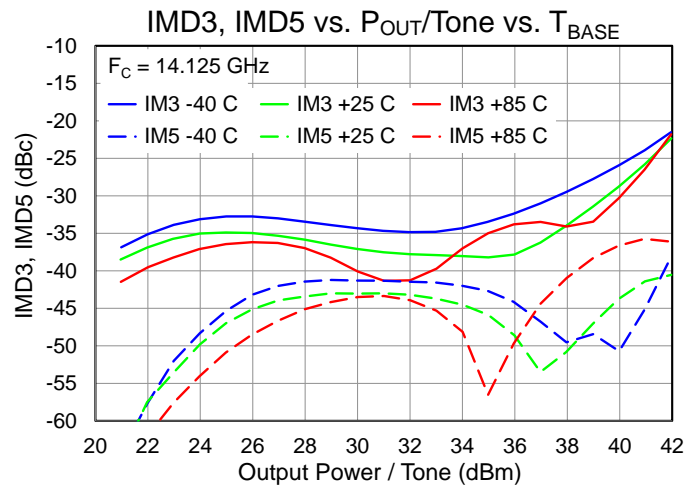
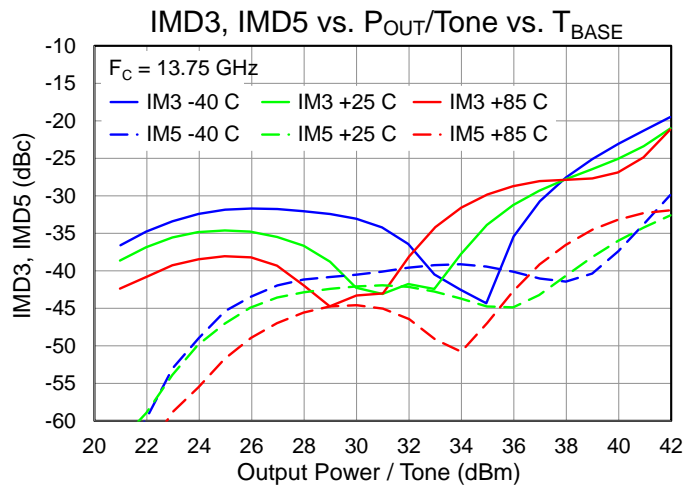
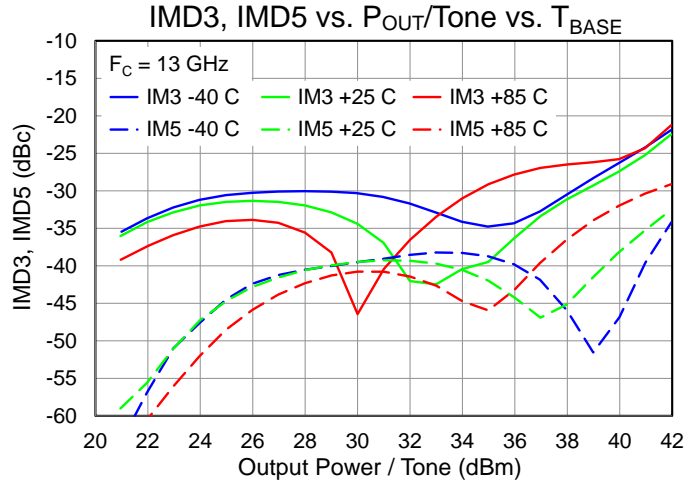
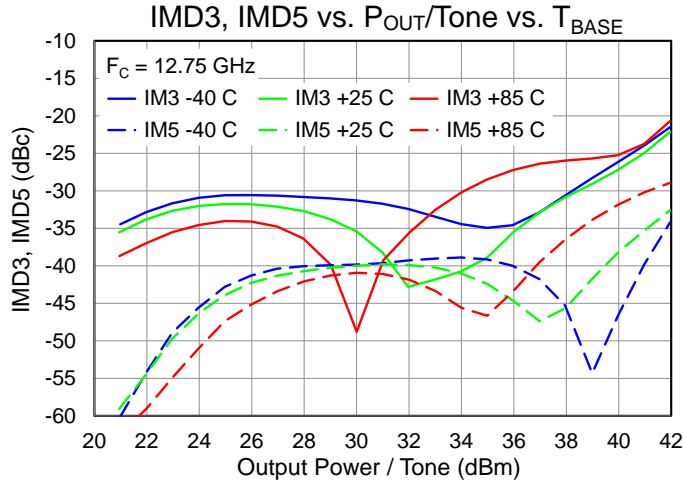
Performance Plots – Large Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, see Recommended Operating Conditions on page 2 for P_{IN} , $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



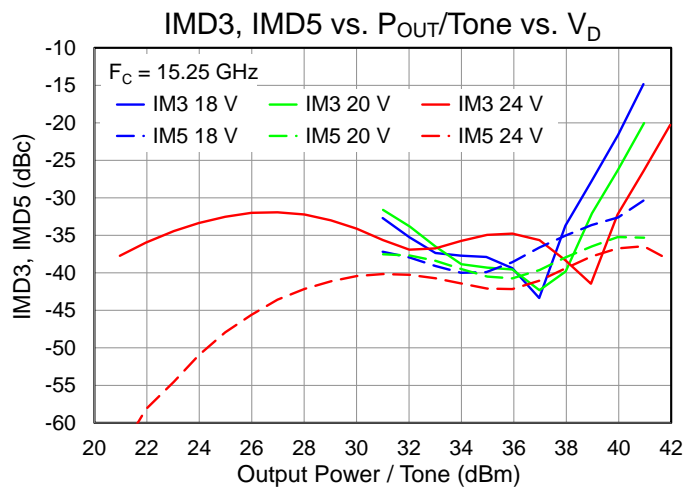
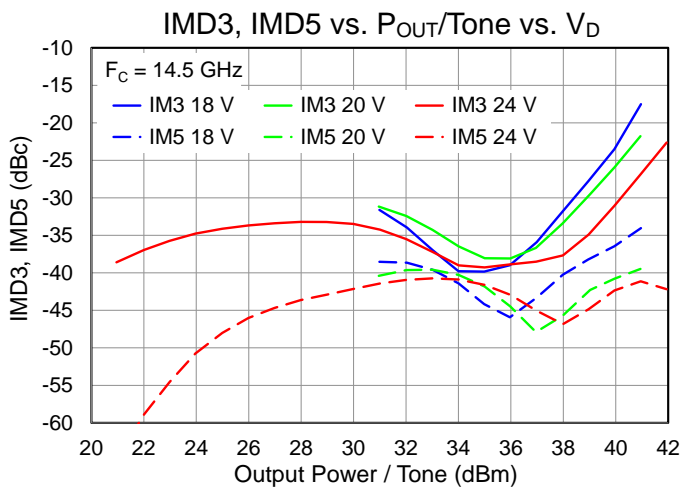
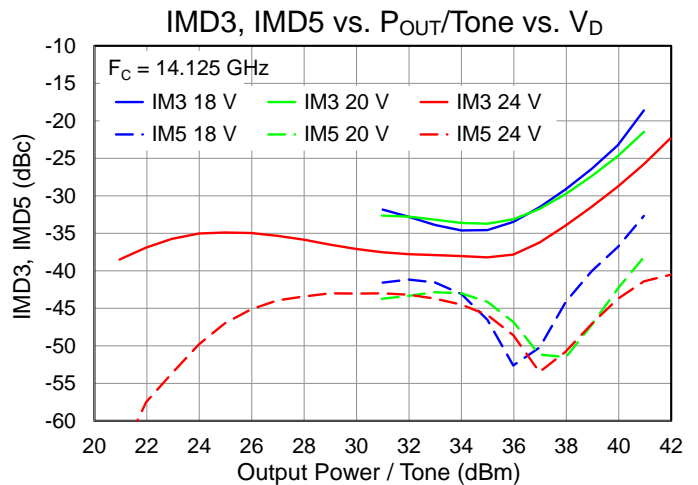
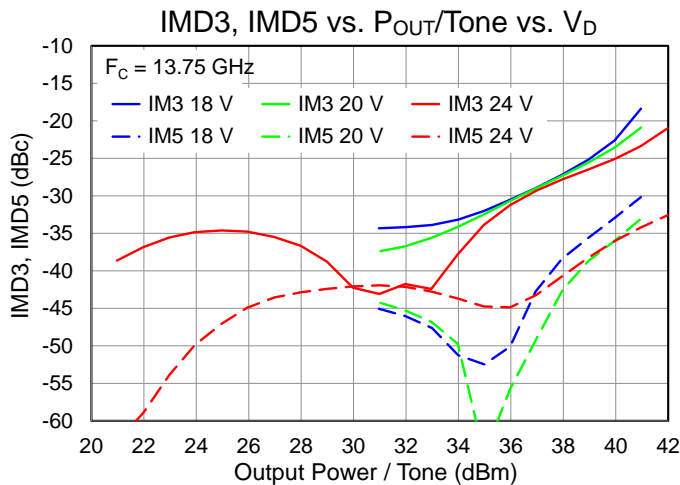
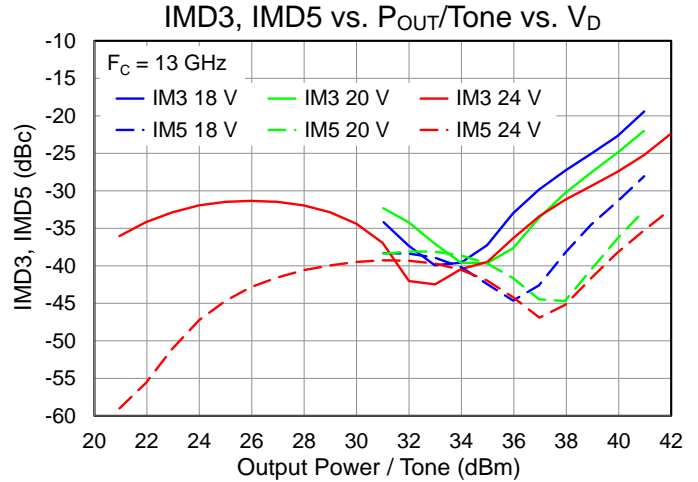
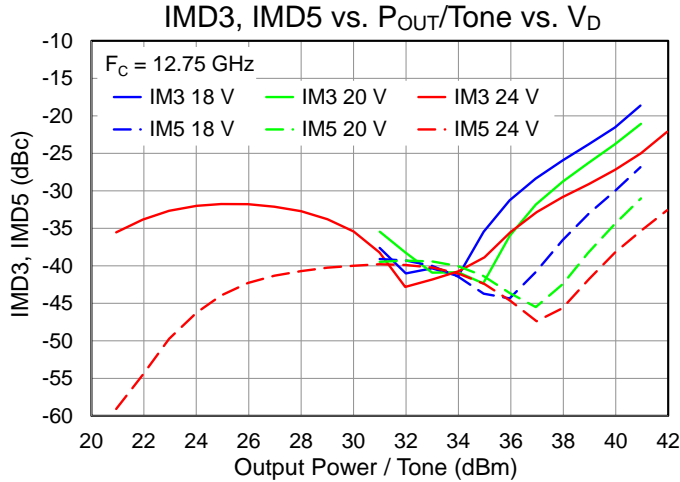
Performance Plots – Linearity (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, Tone Spacing = 20 MHz, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



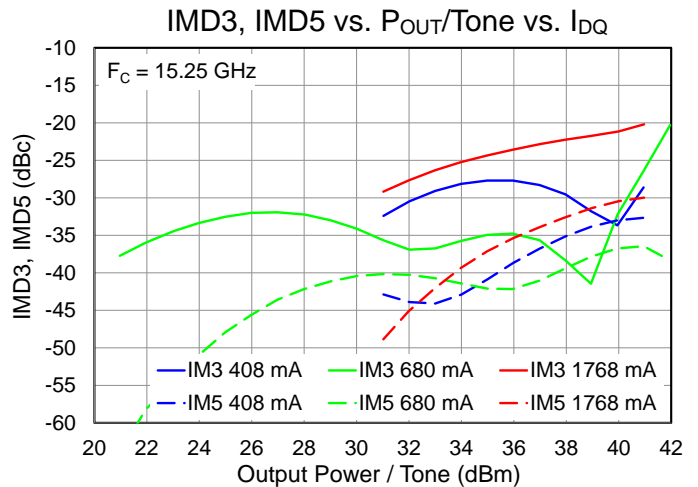
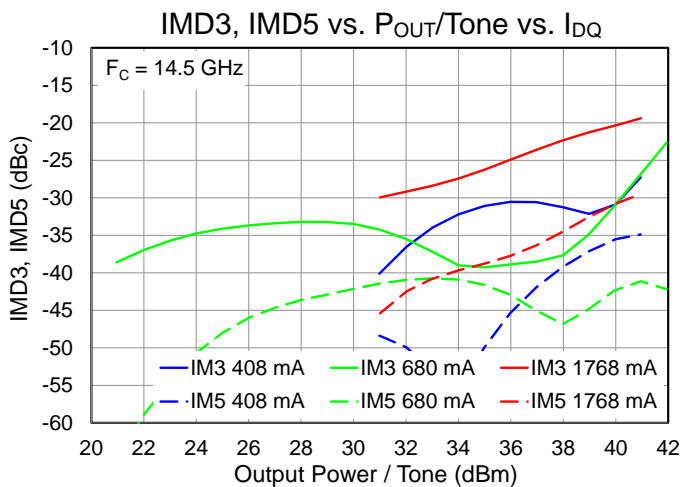
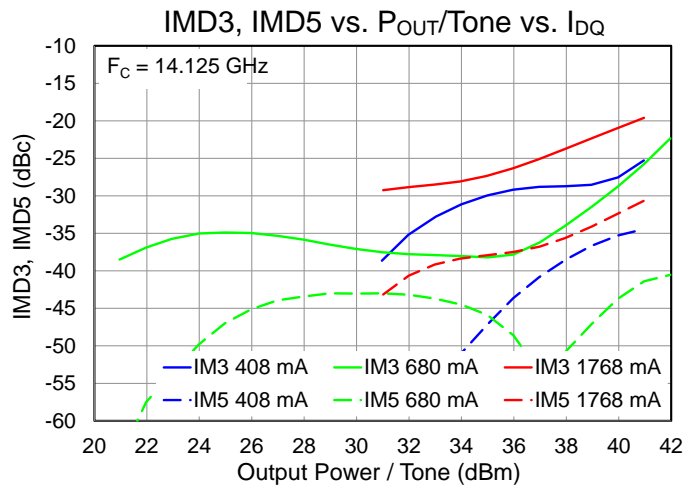
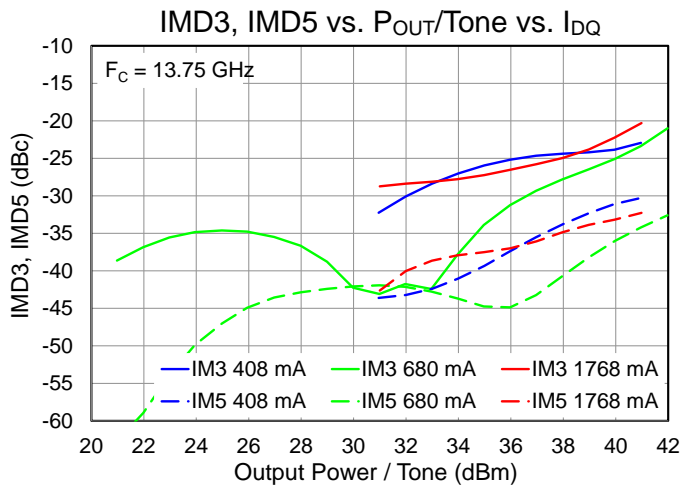
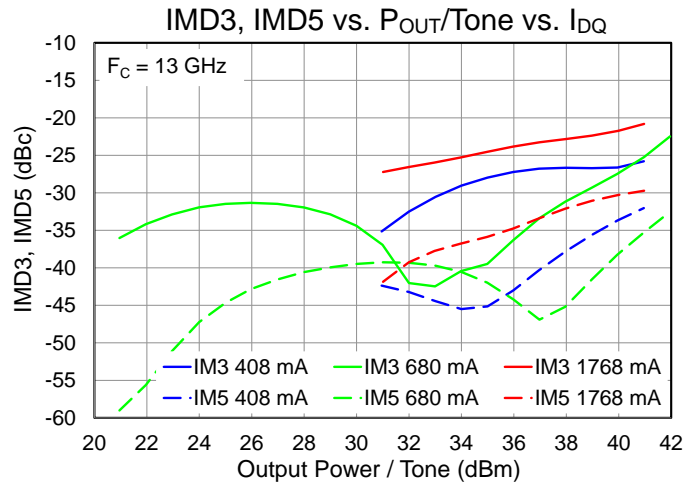
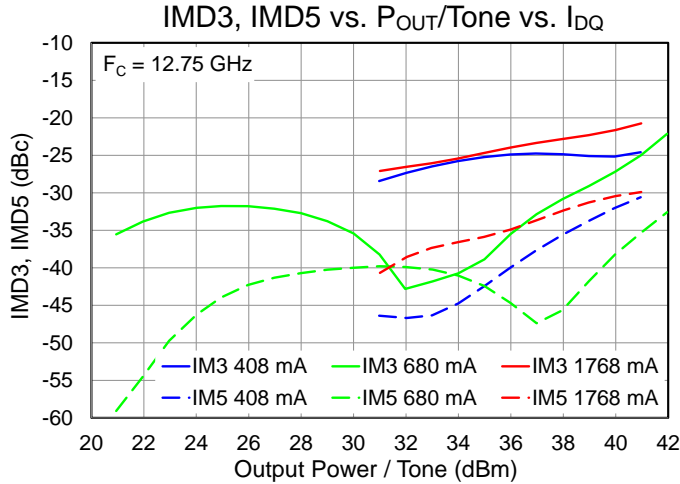
Performance Plots – Linearity (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, Tone Spacing = 20 MHz, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



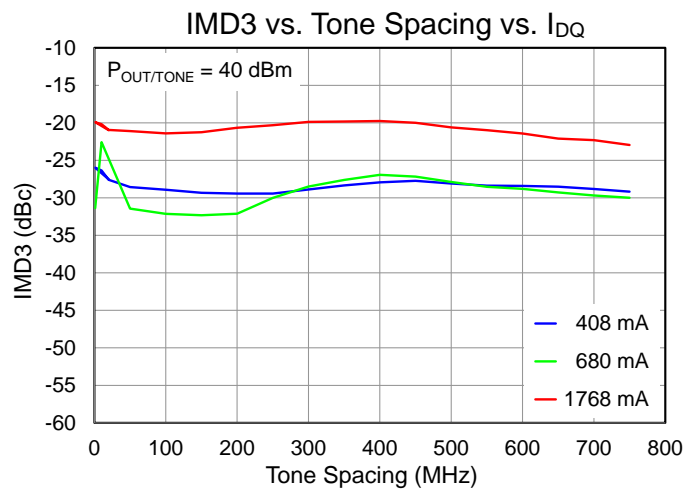
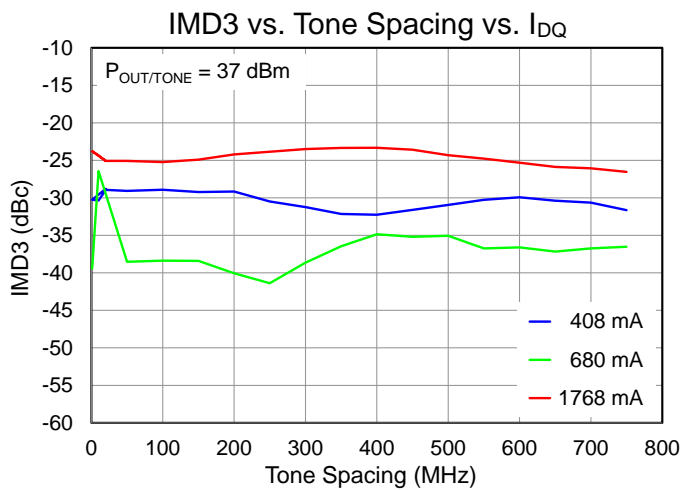
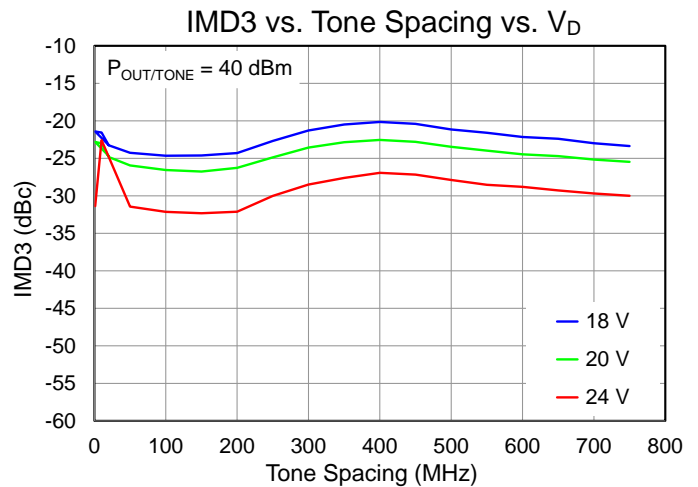
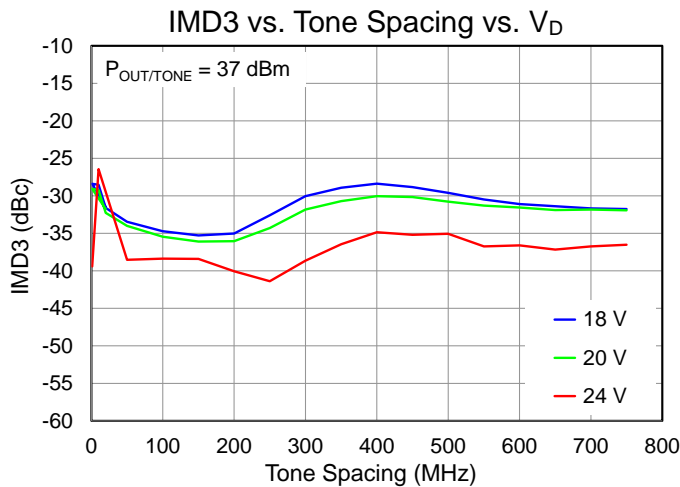
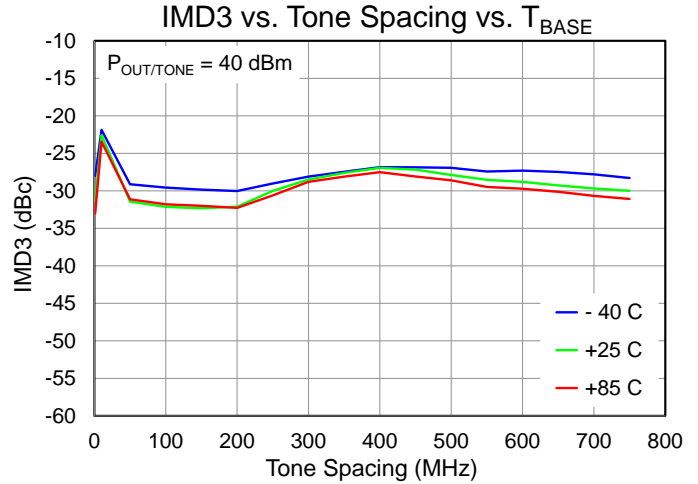
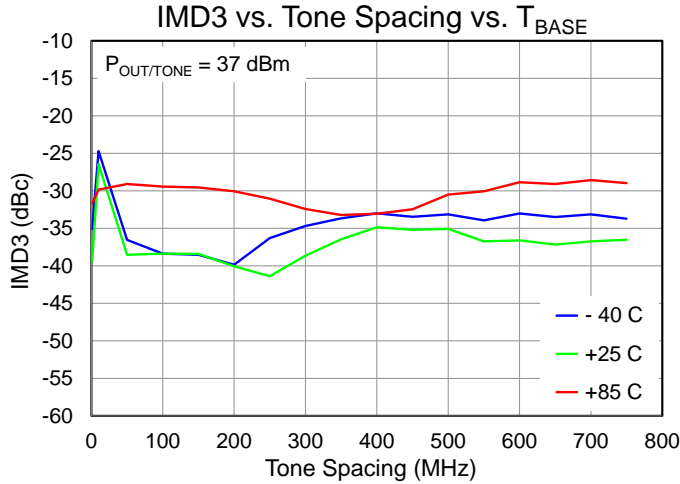
Performance Plots – Linearity (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, Tone Spacing = 20 MHz, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



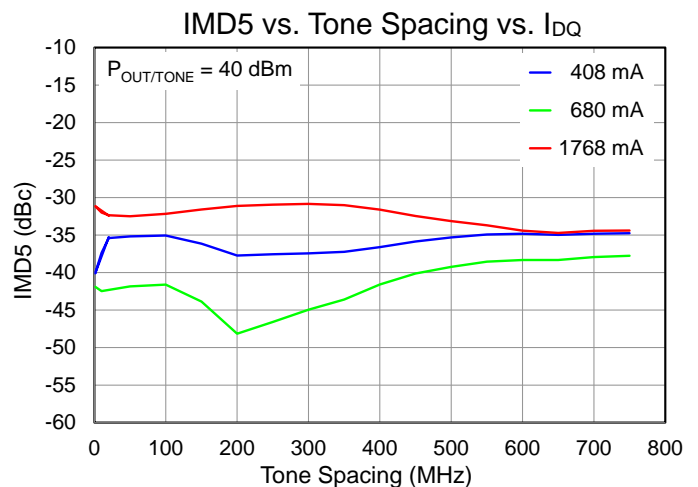
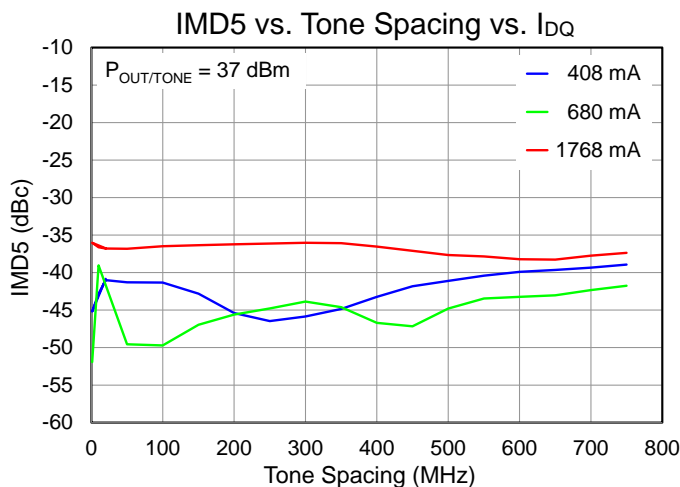
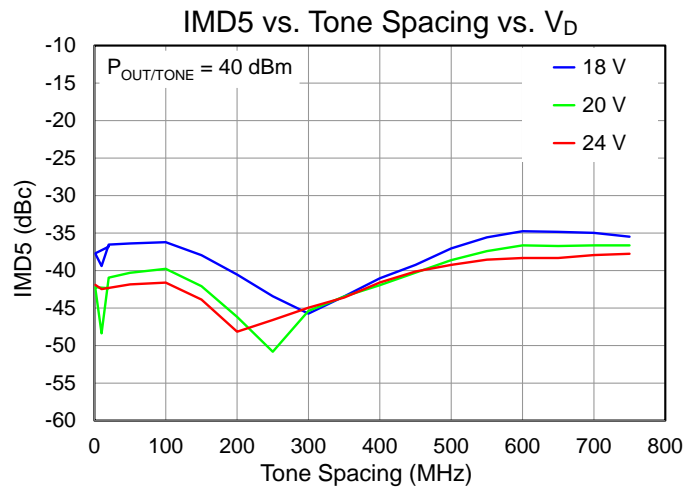
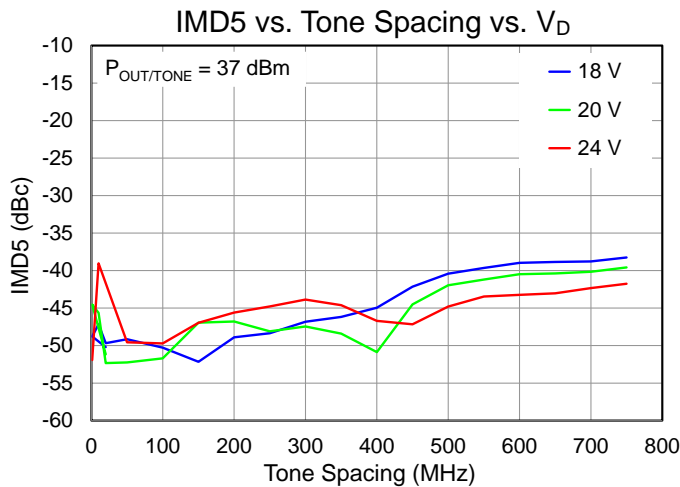
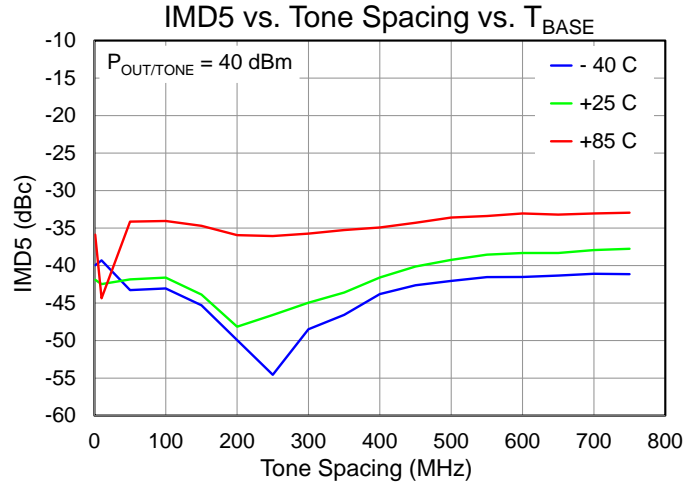
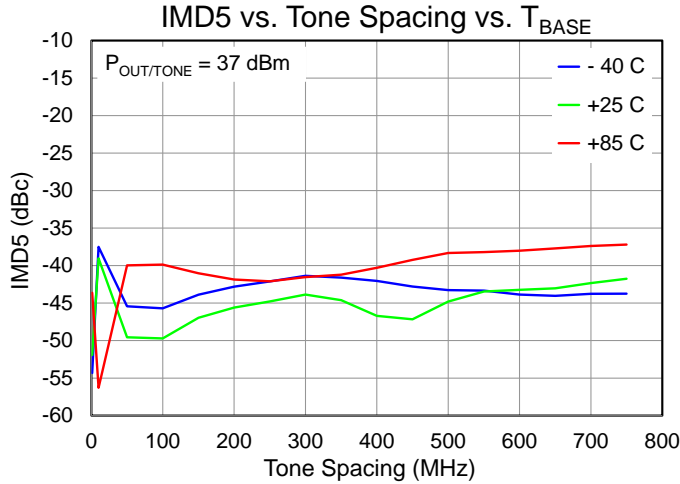
Performance Plots – Linearity (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



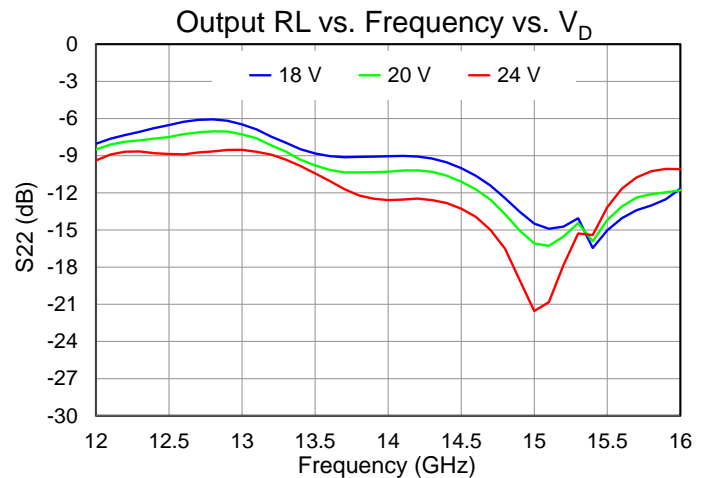
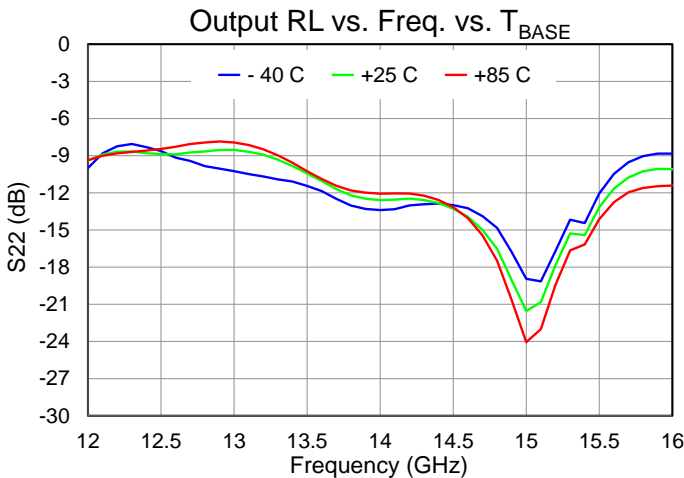
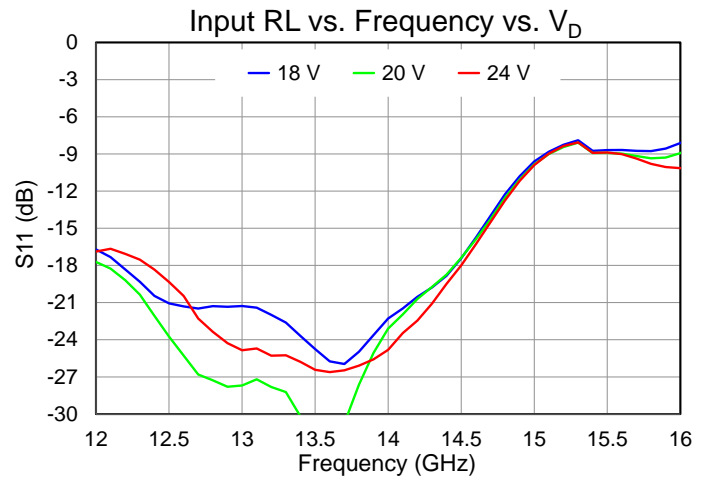
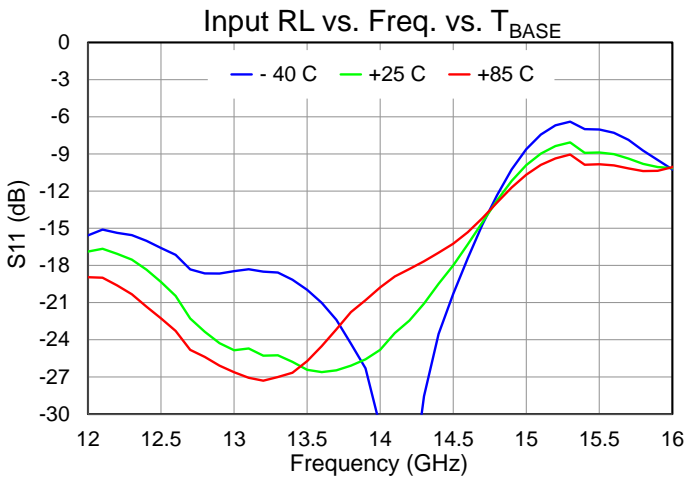
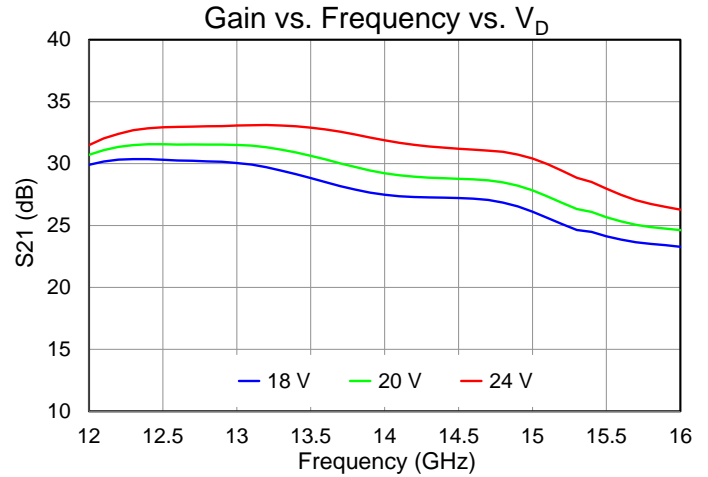
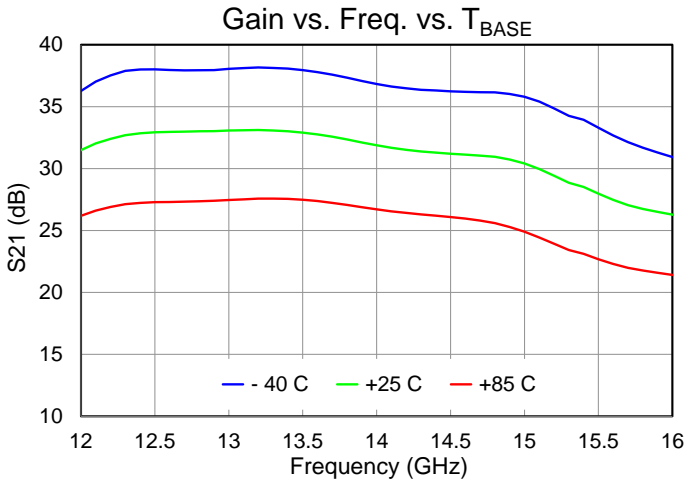
Performance Plots – Linearity (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



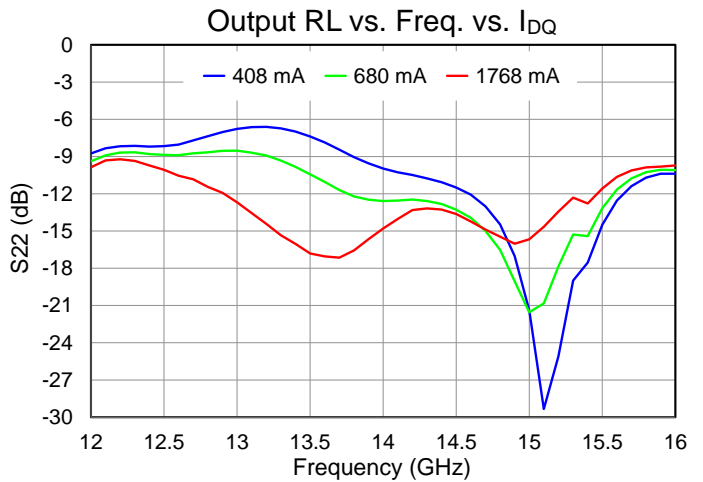
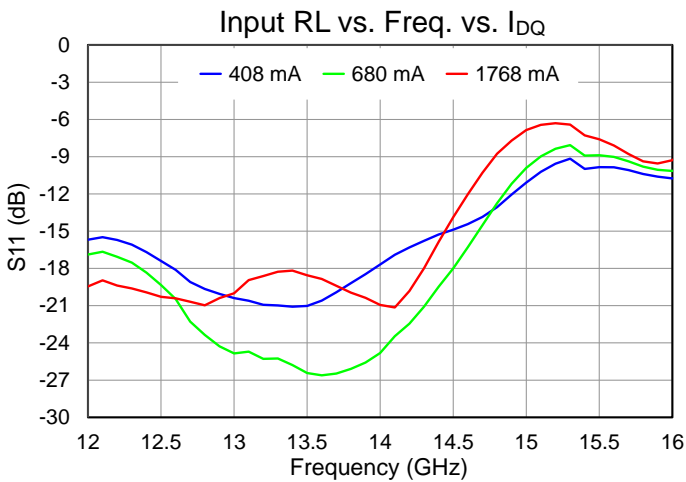
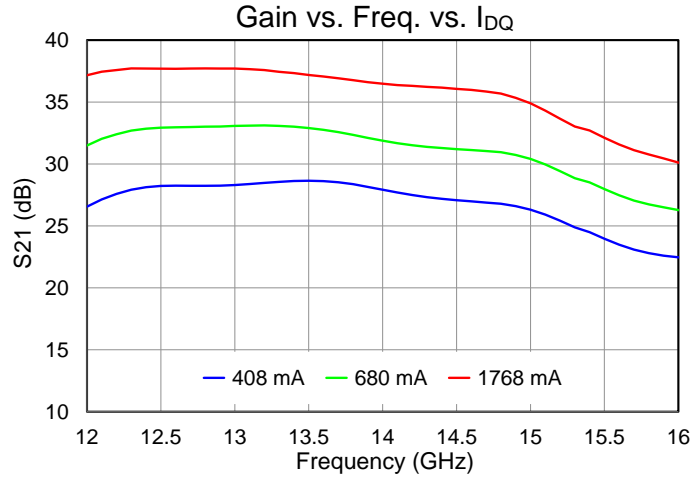
Performance Plots – Small Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $P_{IN} = -30\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



Performance Plots – Small Signal (CW)

Test conditions, unless otherwise noted: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $P_{IN} = -30\text{ dBm}$, $T_{BASE} = +25\text{ }^\circ\text{C}$ (T_{BASE} is backside of QPA1314).



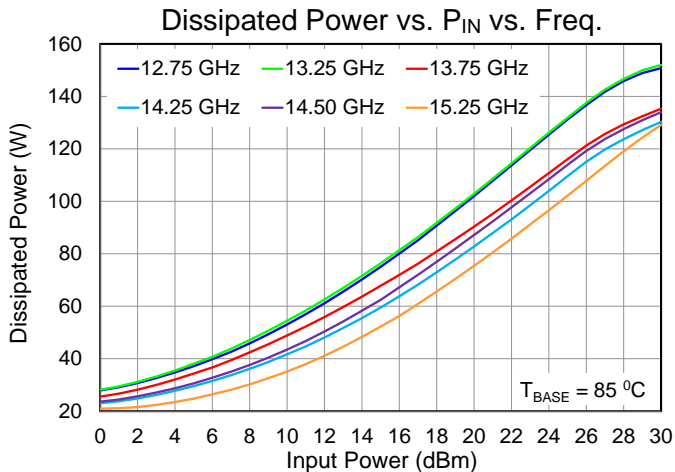
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC}	Quiescent, no RF $T_{BASE} = 85\text{ }^{\circ}\text{C}$, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$	0.73	$^{\circ}\text{C}/\text{W}$
Channel Temperature, T_{CH}	$P_{DISS} = 16.32\text{ W}$	97	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	For 13.75 – 14.5 GHz: $P_{IN} = 19\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, Freq = 14 GHz (frequency at highest P_{DISS}), $I_{D_DRIVE} = 4.87\text{ A}$, $P_{OUT} = 44.5\text{ dBm}$,	0.75	$^{\circ}\text{C}/\text{W}$
Channel Temperature, T_{CH}	$P_{DISS} = 88.5\text{ W}$	151	$^{\circ}\text{C}$
Thermal Resistance, θ_{JC}	For extended 12.75 – 15.35 GHz: $P_{IN} = 19\text{ dBm}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$, CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, Freq = 13.25 GHz (frequency at highest P_{DISS}), $I_{D_DRIVE} = 5.4\text{ A}$, $P_{OUT} = 45.1\text{ dBm}$,	0.76	$^{\circ}\text{C}/\text{W}$
Channel Temperature, T_{CH}	$P_{DISS} = 97.3\text{ W}$	159	$^{\circ}\text{C}$

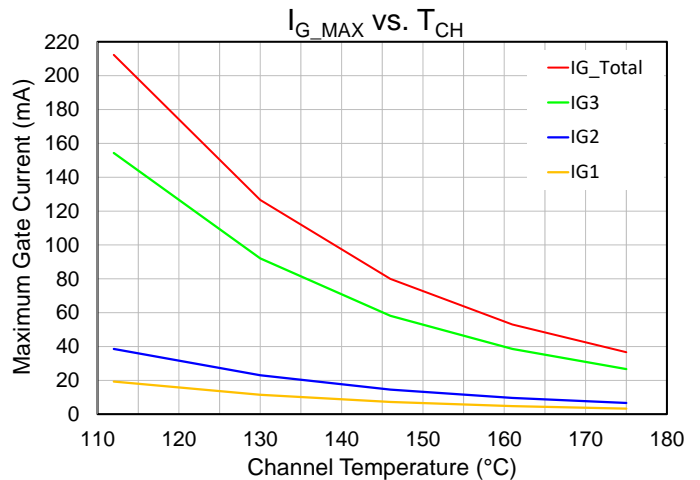
Notes:

1. Thermal resistance determined to T_{BASE} (T_{BASE} is backside of package QPA1314)
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 and Maximum Gate Current

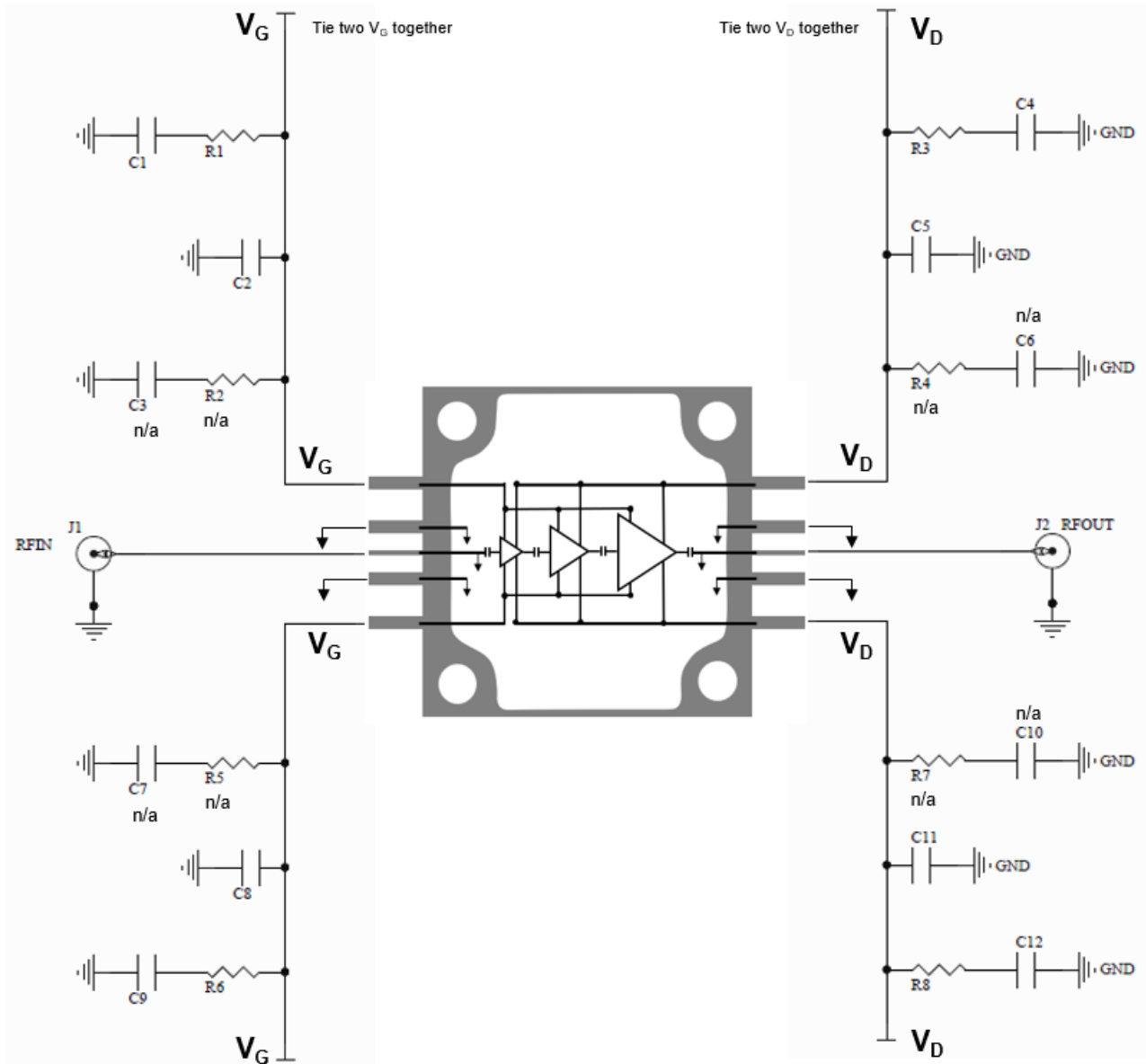


Test conditions: CW, $V_D = 24\text{ V}$, $I_{DQ} = 680\text{ mA}$, $T_{BASE} = 85\text{ }^{\circ}\text{C}$
 T_{BASE} is back side of QPA1314



Channel Temperature is an IR scan equivalent

Applications Information



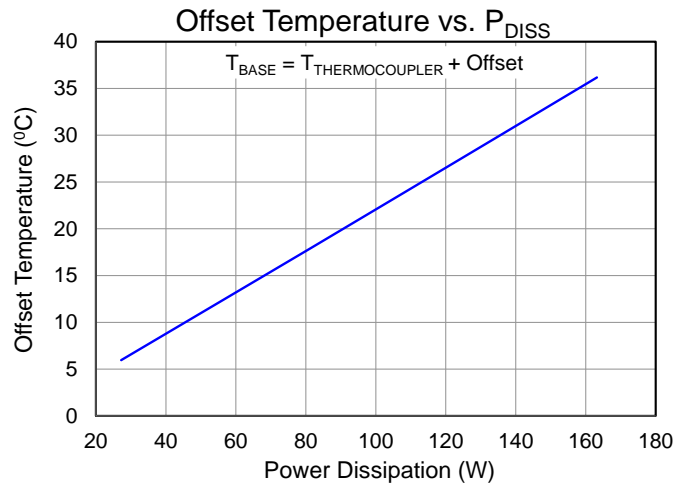
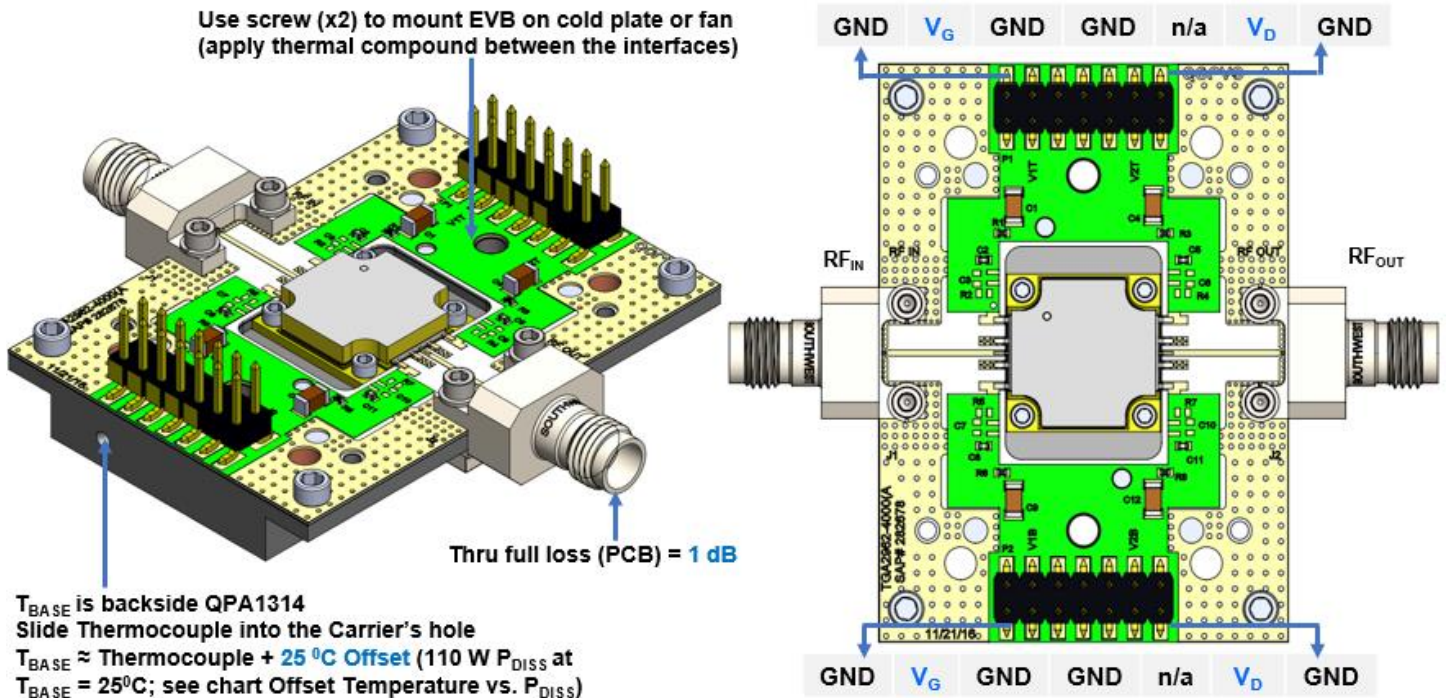
Bias-Up Procedure

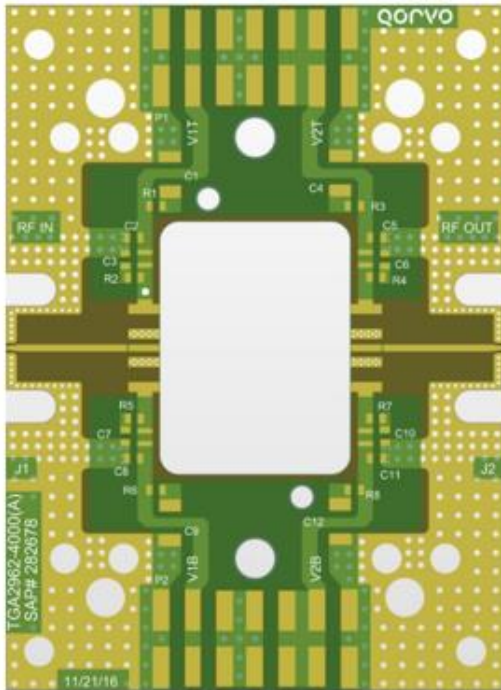
1. Set I_D limit to 10 A, I_G limit to 15 mA
2. Apply V_G to -5 V
3. Apply V_D to 24 V; ensure $I_{DQ} \sim 0$ mA
4. Adjust V_G more positive until $I_{DQ} = 680$ mA;
 $V_G \approx -2.3 \pm 0.6$ V typical range
5. Apply RF signal

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

Evaluation Board (EVB) Layout





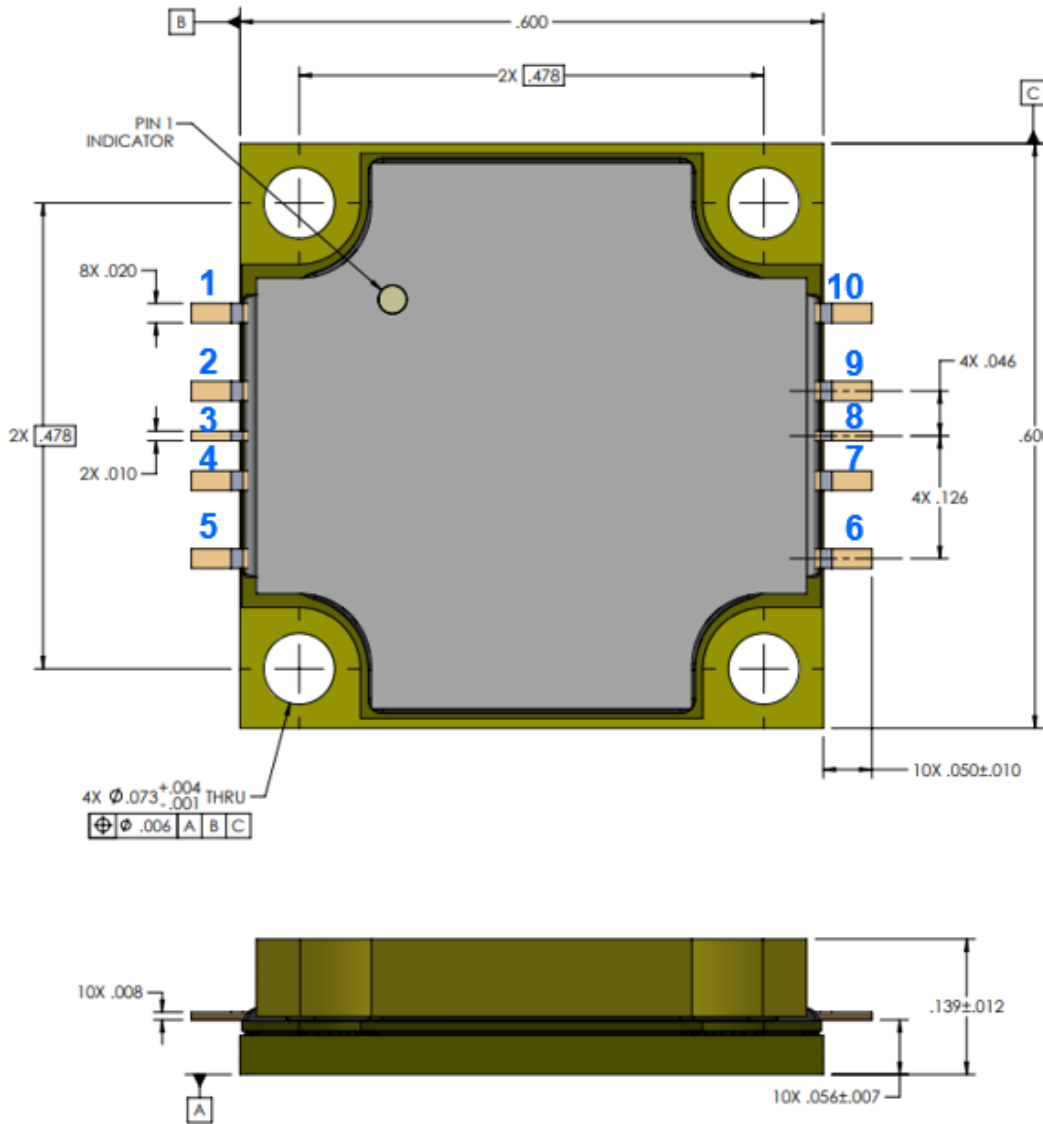
Layer Stack Legend (Copper Thickness is Finished Copper Thickness)

Material	Layer	Thickness	Dielectric Material	Type	Legend
	Silkscreen_Top				
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					

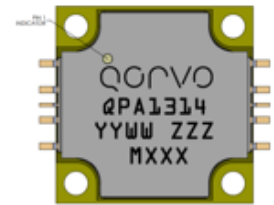
Bill of Materials

Reference Des.	Qty	Value	Description	Part Number
C1, C4, C9, C12	4	10 uF	CAP, 10uF, ±20%, 50V, X5R, 1206	
C2, C5, C8, C11	4	0.01 uF	CAP, 0.01uF, ±10%, 50V, X7R, 0402	
R1, R3, R6, R8	4	0.5 Ω	RES, 0.5 Ohm, ±1%, 1/8W, 0402	
PCB	1		PCB for QPA1314, see above	Qorvo, Custom
H1, H2	2		DC Header, 2x7, SMD	
J1, J2	2		RF Connector, SMA, Female	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 – S8	4		Screw, Cap, Socket Head, 2-56X1/8"	
Epoxy	-		Epoxy, preform, 5025E, 0.003" thickness	
Thermal Compound	-		Thermal Compound, Arctic Silver	
Solder	-		Solder, paste, Sn63Pb37	
Solder	-		Solder, wire, Sn96.5Ag3Cu.5, 0.020"	

Mechanical Information



- NOTES:
- MATERIALS
LID: LAMINATE
BASE: COPPER; FINISH: GOLD
LEADS: ALLOY 194; FINISH: GOLD
 - PART IS EPOXY SEALED
 - UNITS: INCHES
 - TOLERANCES (UNLESS NOTED):
.XX = ± .01
.XXX = ± .005
ANGLES = 0.5°
 - MARKINGS
QPA1314: PART NUMBER
YY: ASSEMBLY YEAR
WW: ASSEMBLY WEEK
ZZ: 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 24 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 QPA1314. 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)	1C	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	C3	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	N/A	



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:

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