QPA2966D

2 – 20 GHz 20 Watt GaN Amplifier

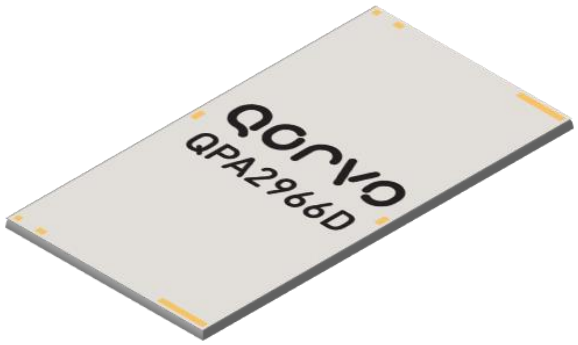
Product Overview

Qorvo's QPA2966D is a wideband power amplifier fabricated on Qorvo's QGaN15 GaN on SiC process. The QPA2966D operates from 2 to 20 GHz, providing > 20 W of saturated power with 13 dB large signal gain and 25 % power-added efficiency at 22 V drain bias. RF ports are matched to 50 Ω, including integrated DC blocking capacitors and a RF choke.

This combination of wideband power, gain and efficiency provides system designers the flexibility to improve system performance while reducing size and cost. QPA2966D is ideally suited for wideband communications systems, electronic warfare, test instrumentation, and radar applications, across both military and commercial markets.

QPA2966D is 100% DC and RF tested on-wafer to ensure compliance to electrical specifications.

Lead free and RoHS compliant.

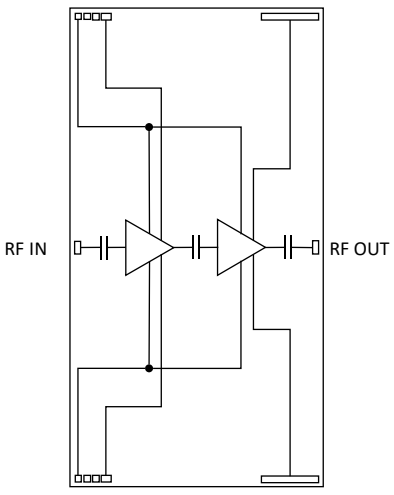


Key Features

- Frequency Range: 2 – 20 GHz
- P_{SAT} (P_{IN} = 31 dBm): 44 dBm
- PAE (P_{IN} = 31 dBm): 25 %
- Power Gain (P_{IN} = 31 dBm): 13 dB
- Small Signal Gain: 19 dB
- Bias: V_D = 22 V, I_{DQ} = 3360 mA
- Die Dimensions: 3.69 x 6.99 x 0.10 mm

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

Functional Block Diagram



Top View

Applications

- Communication Systems
- Electronic Warfare
- Radar
- Test Equipment

Ordering Information

Part No.	Description
QPA2966D	2 – 20 GHz 20 Watt GaN Amplifier (10 Pcs.)
QPA2966DEVB	Evaluation Board for QPA2966D

Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V_D)	29.5 V
Gate Voltage Range (V_G)	−4 V to 0 V
Drain Current (I_{D1_TOTAL})	1440 mA
Drain Current (I_{D2_TOTAL})	4256 mA
Gate Current (I_{G_TOTAL})	20 mA
Power Dissipation (P_{DISS}), 85 °C	90 W
Input Power (P_{IN}), 50 Ω, V_D = 22 V, I_{DQ} = 3360 mA, 85 °C	37 dBm
Input Power (P_{IN}), 3:1 VSWR, V_D = 22 V, I_{DQ} = 3360 mA, 85 °C	37 dBm
Soldering Temperature (30 s max.)	320 °C
Storage Temperature	−55 to +125 °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	Value / Range
Drain Voltage (V_D)	22 V
Drain Current (I_{DQ})	3360 mA
Operating Temperature	−40 to +85 °C

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

Electrical Specifications

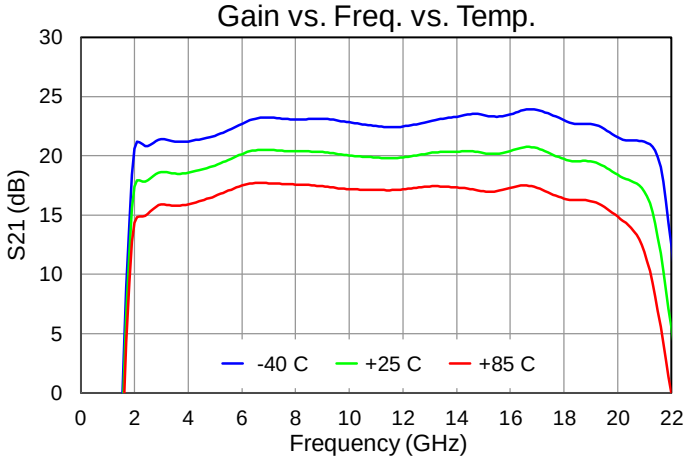
Parameter		Min	Typ	Max	Units
Operational Frequency		2		20	GHz
Output Power (P_{IN} = 31 dBm)	2 GHz		43.1		dBm
	6 GHz		44.9		dBm
	10 GHz		44.4		dBm
	15 GHz		44.5		dBm
	20 GHz		42.6		dBm
Power Added Efficiency (P_{IN} = 31 dBm)	2 GHz		24.9		%
	6 GHz		29.4		%
	10 GHz		26.4		%
	15 GHz		27.4		%
	20 GHz		18.0		%
Small Signal Gain	2 GHz		17.4		dB
	6 GHz		20.1		dB
	10 GHz		20.0		dB
	15 GHz		20.2		dB
	20 GHz		18.4		dB
Input Return Loss	2 GHz		17		dB
	6 GHz		44		dB
	10 GHz		16		dB
	15 GHz		11		dB
	20 GHz		7		dB
Output Return Loss	2 GHz		11		dB
	6 GHz		27		dB
	10 GHz		16		dB
	15 GHz		19		dB
	20 GHz		26		dB
IMD3 (P_{OUT}/Tone = 38 dBm) (100 MHz tone spacing)	2 GHz		−16		dBc
	6 GHz		−20		dBc
	10 GHz		−17		dBc
	15 GHz		−19		dBc
	20 GHz		−11		dBc
P_{OUT} Temp. Coeff. (85 °C to 25 °C, P_{IN} = 31 dBm))			−0.014		dB/°C
Sm. Sig. Gain Temp. Coefficient (85 °C to −40 °C)			−0.046		dB/°C
Gate Leakage (V_D = 10 V, V_G = −3.7 V)		−16.8			mA

Test conditions, unless otherwise noted: T = 25 °C, V_D = 22 V, I_{DQ} = 3360 mA

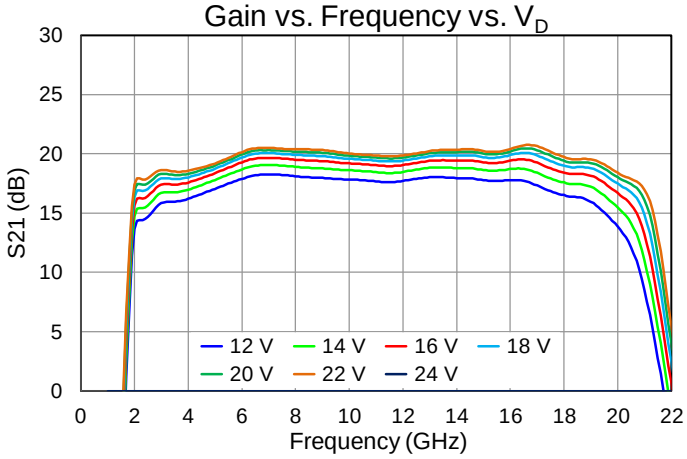
Performance Plots – Small Signal

Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C

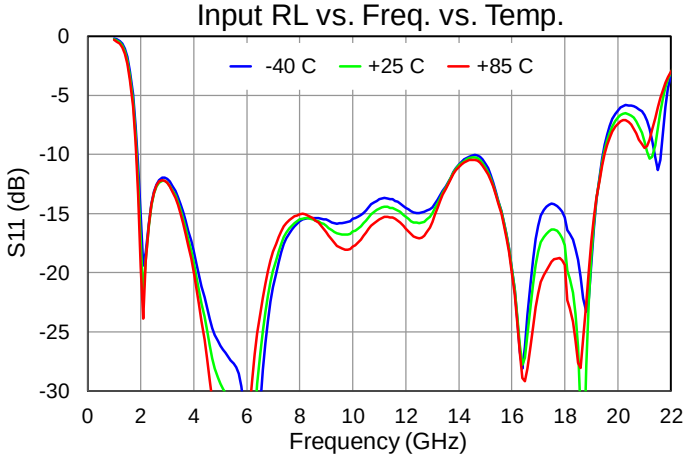
Gain vs. Freq. vs. Temp.



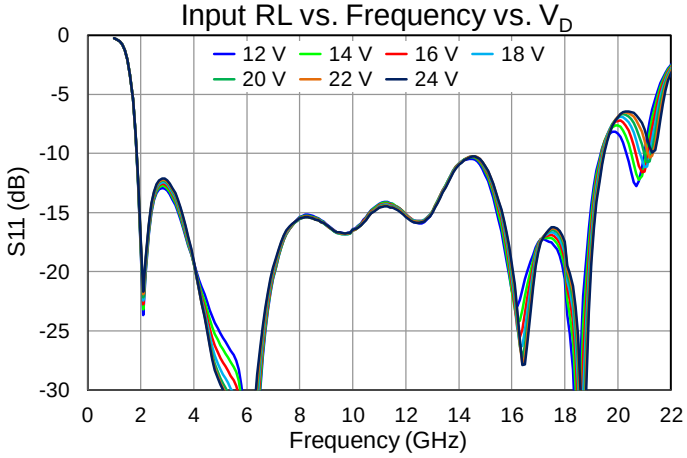
Gain vs. Frequency vs. V_D



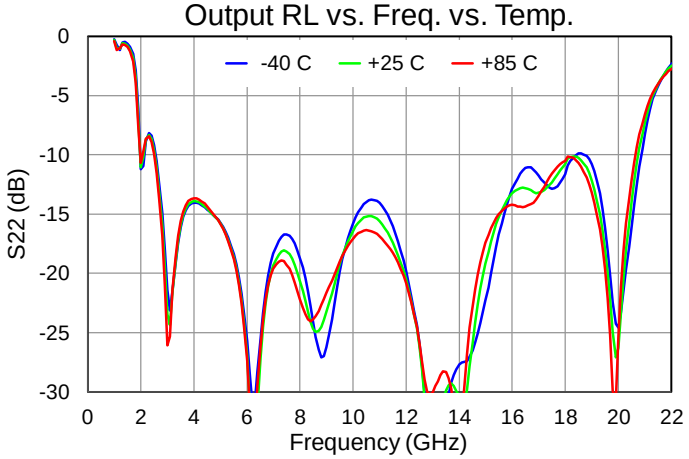
Input RL vs. Freq. vs. Temp.



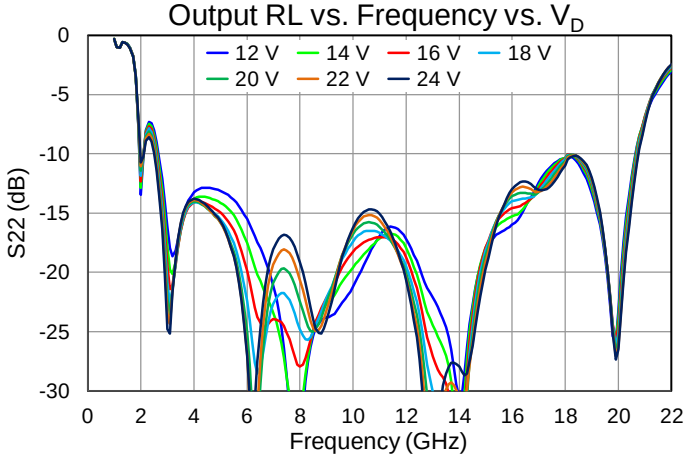
Input RL vs. Frequency vs. V_D



Output RL vs. Freq. vs. Temp.

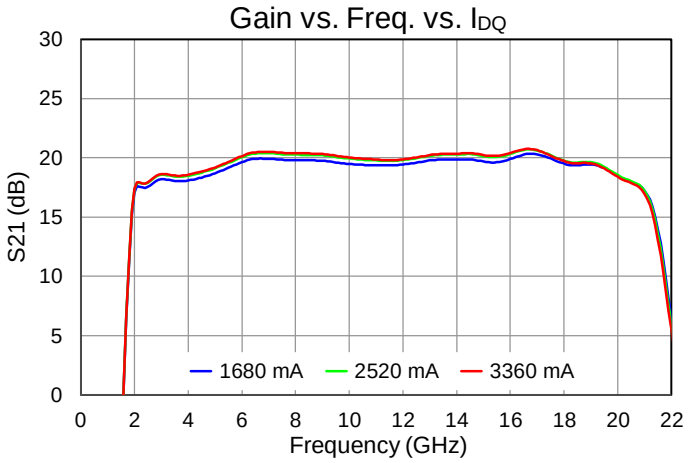


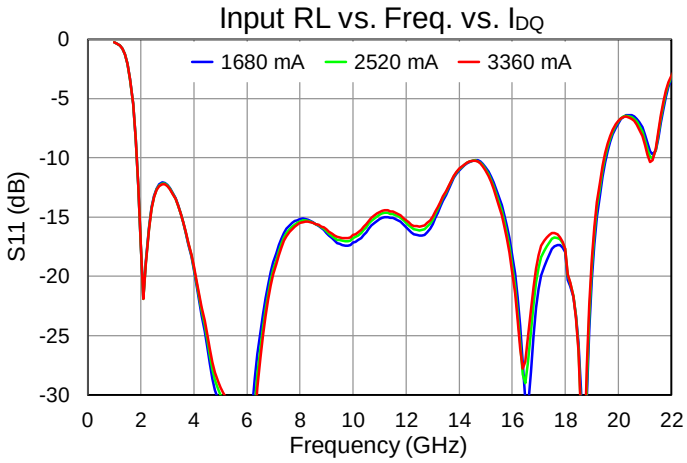
Output RL vs. Frequency vs. V_D

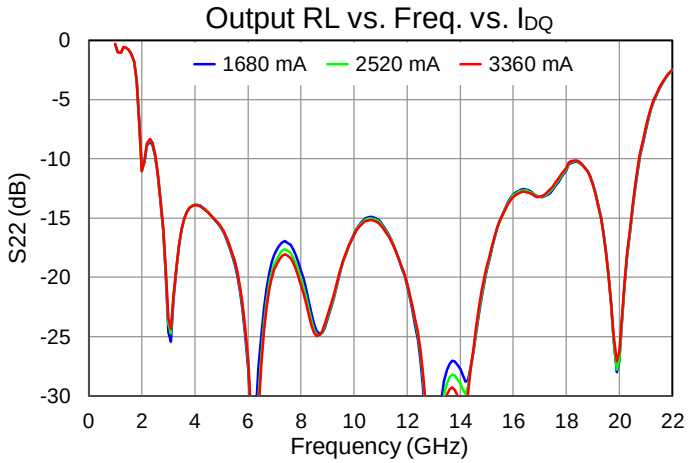


Performance Plots – Small Signal

Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C

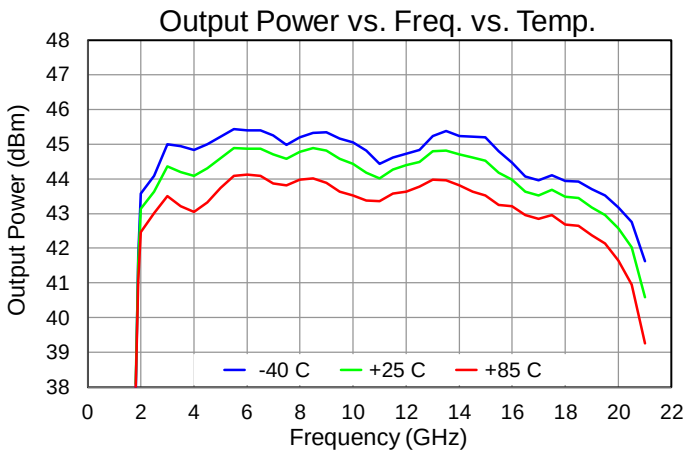


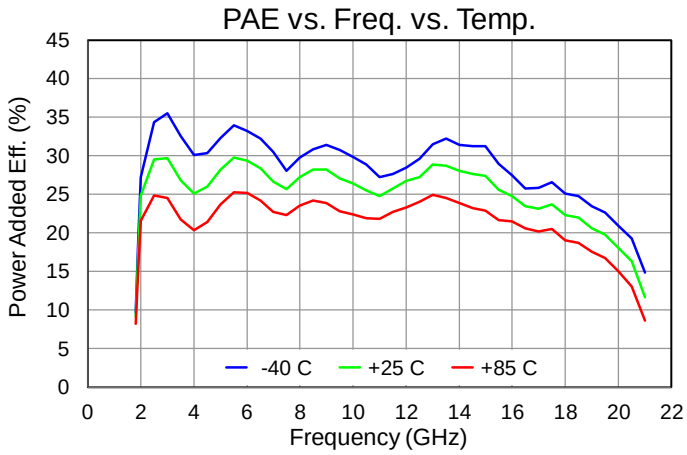


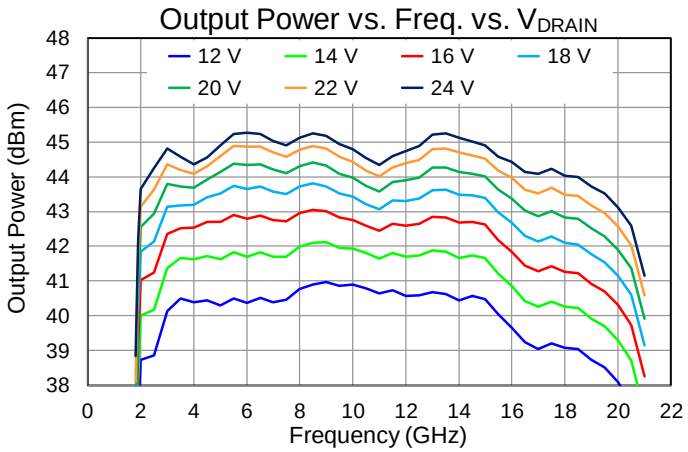


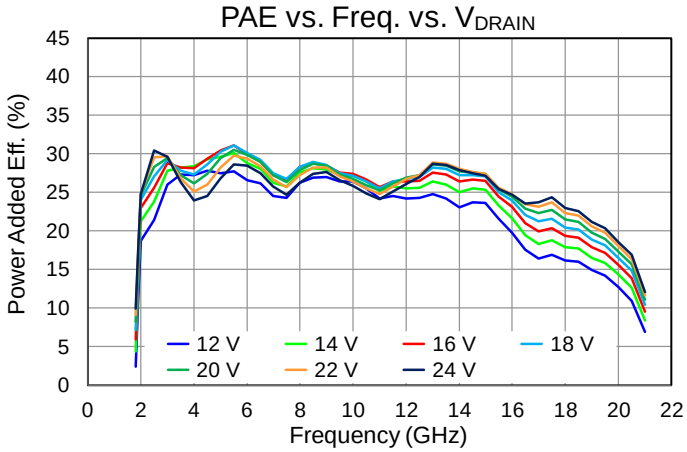
Performance Plots – Large Signal

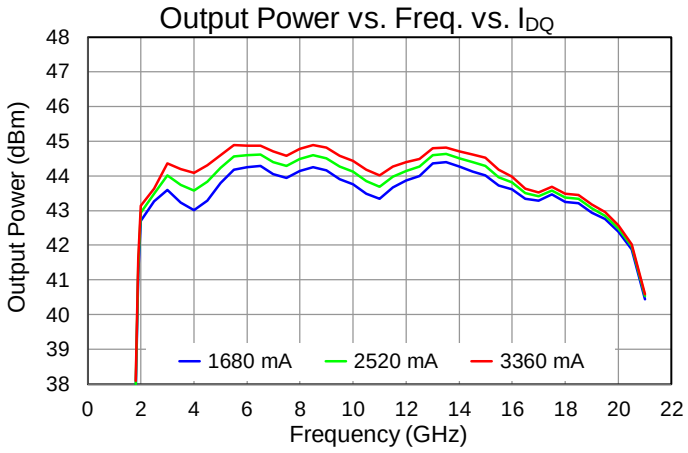
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C, Pin = 31 dBm

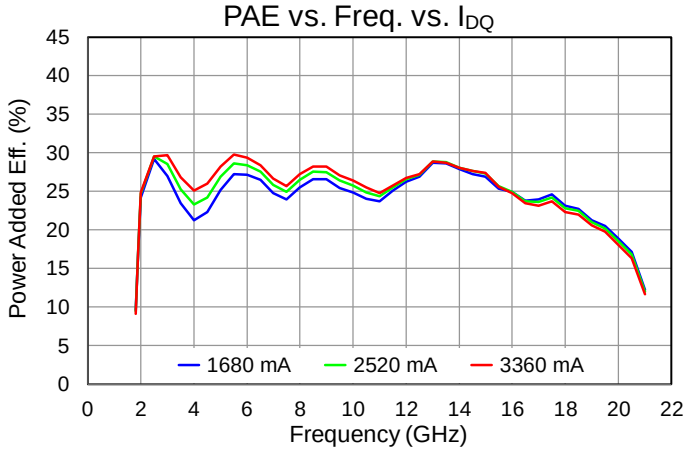












Performance Plots – Large Signal

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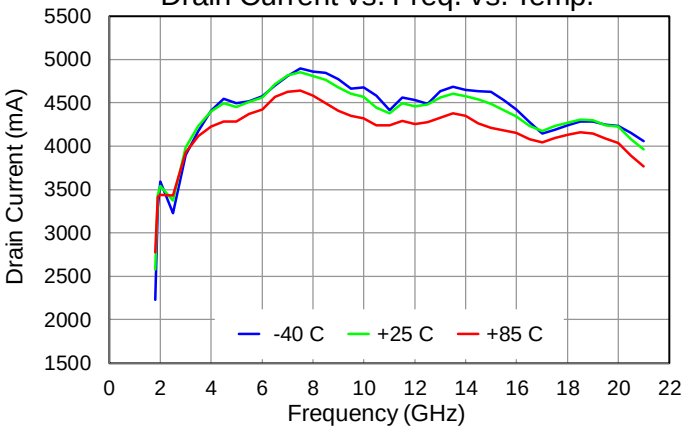
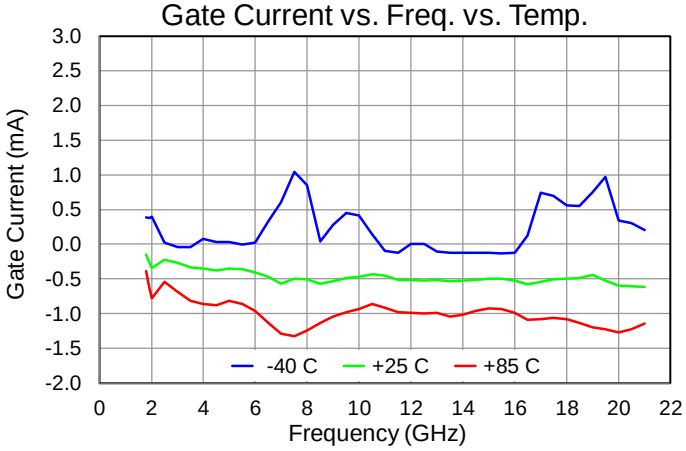
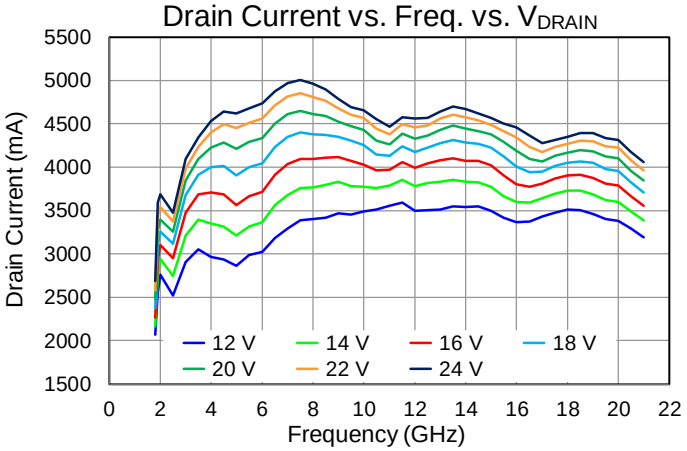
Drain Current vs. Freq. vs. Temp.



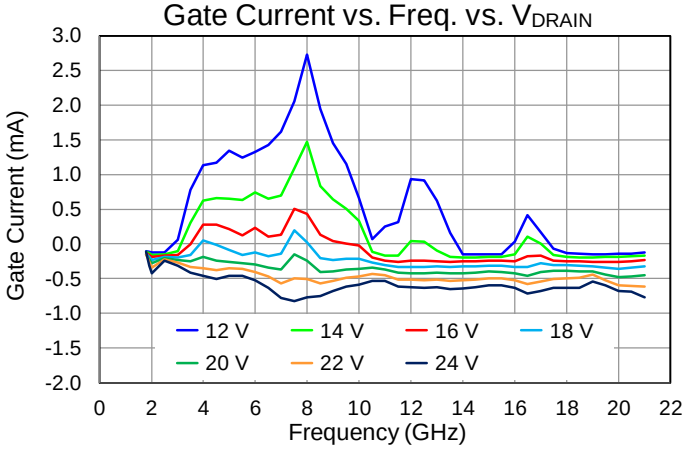
Gate Current vs. Freq. vs. Temp.



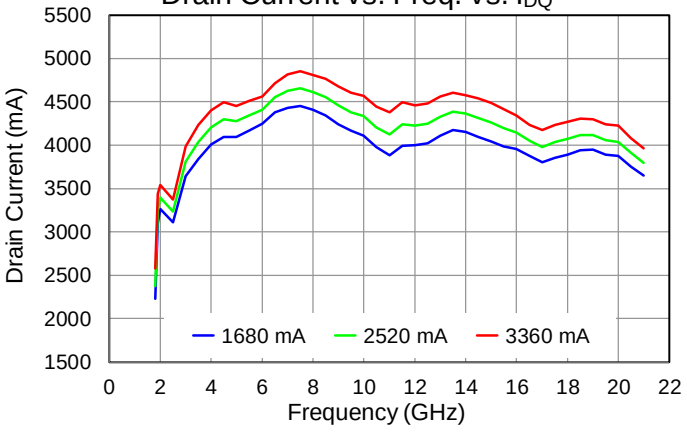
Drain Current vs. Freq. vs. V_{DRAIN}



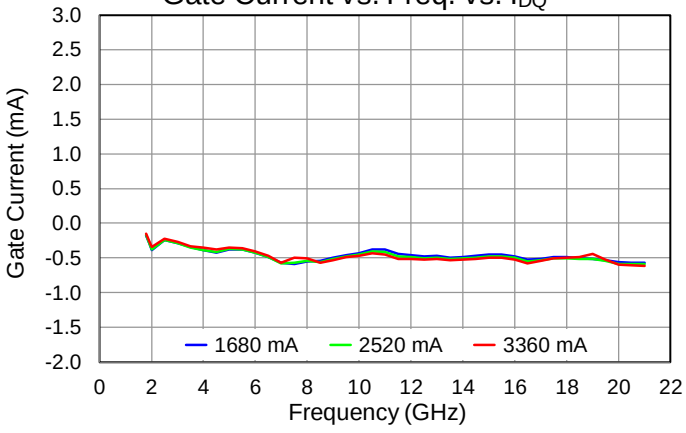
Gate Current vs. Freq. vs. V_{DRAIN}



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

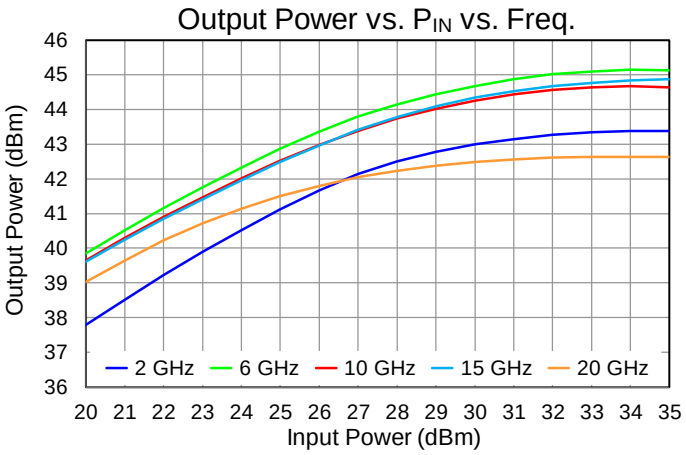


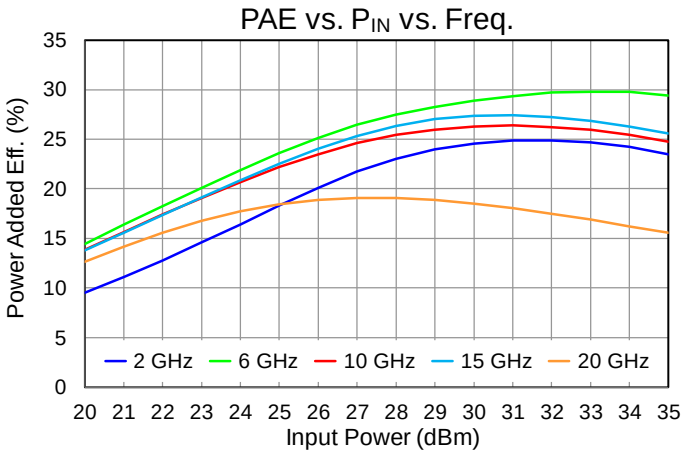
Gate Current vs. Freq. vs. I_{DQ}

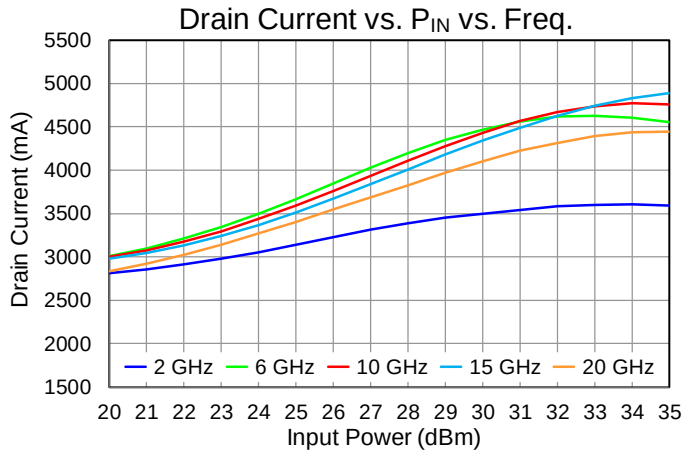


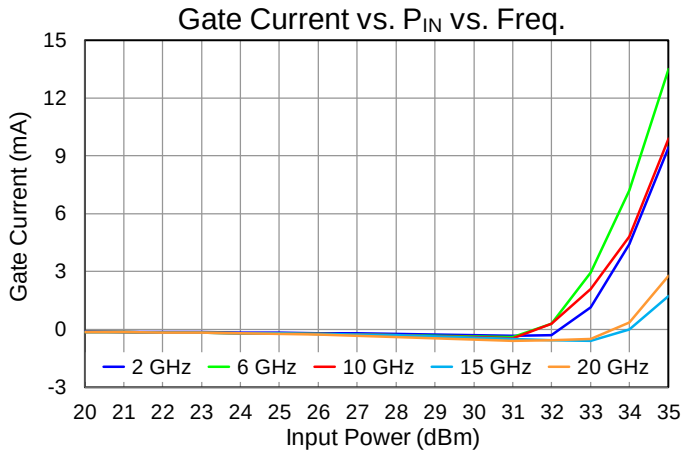
Performance Plots – Large Signal

Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C









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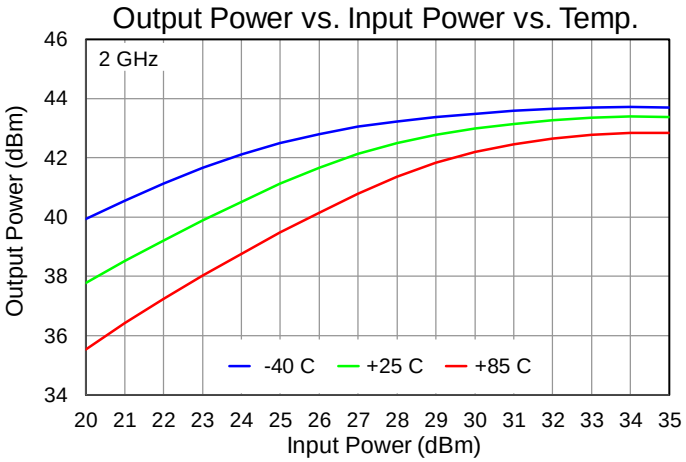

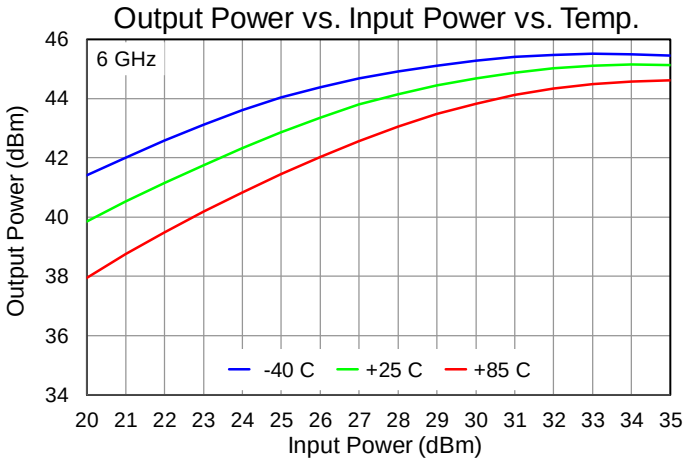

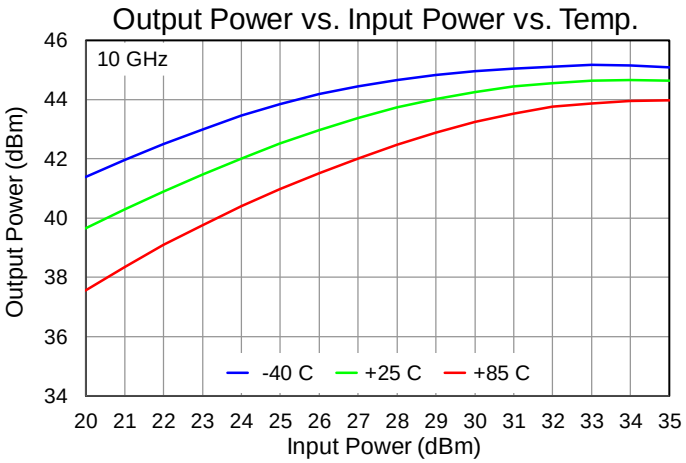

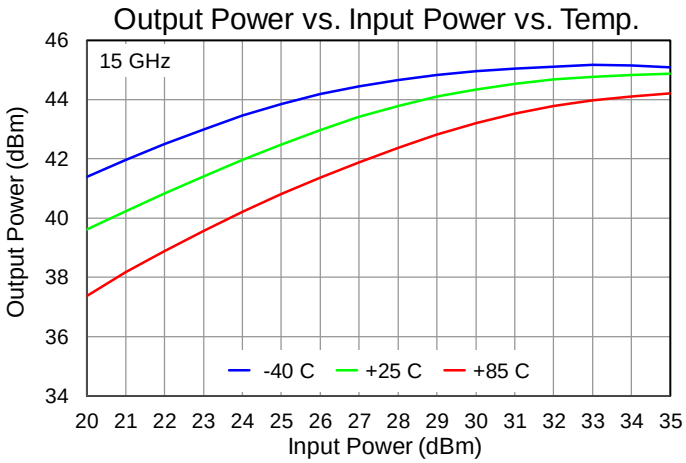

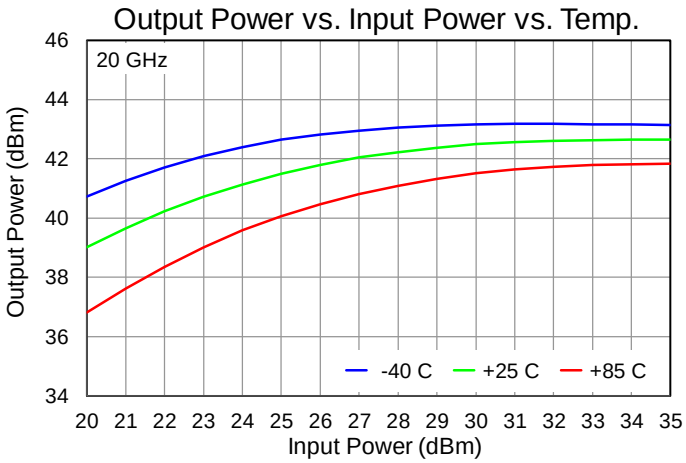

Performance Plots – Large Signal

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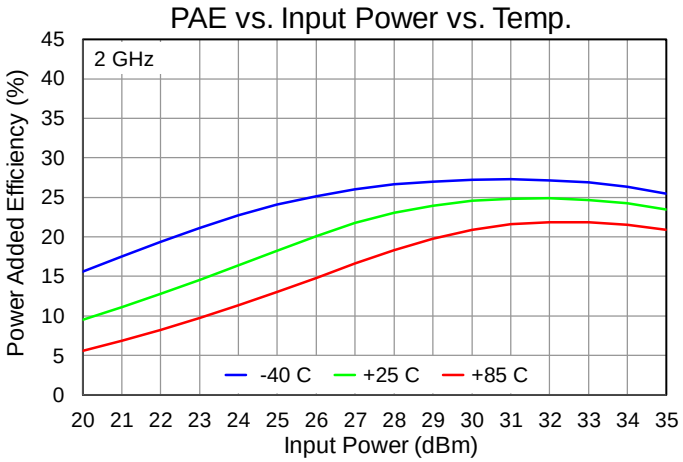
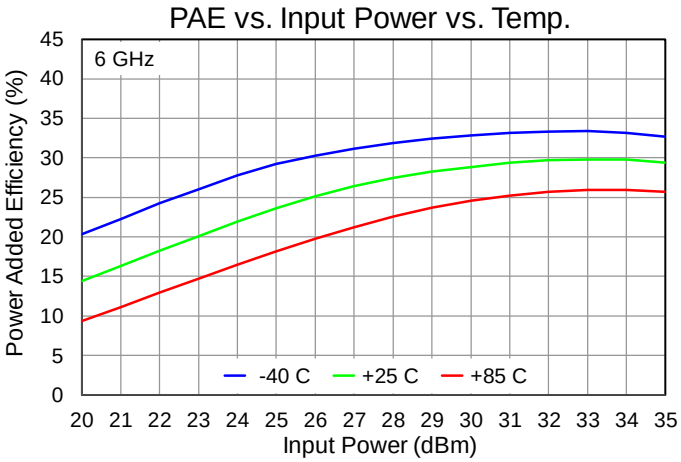
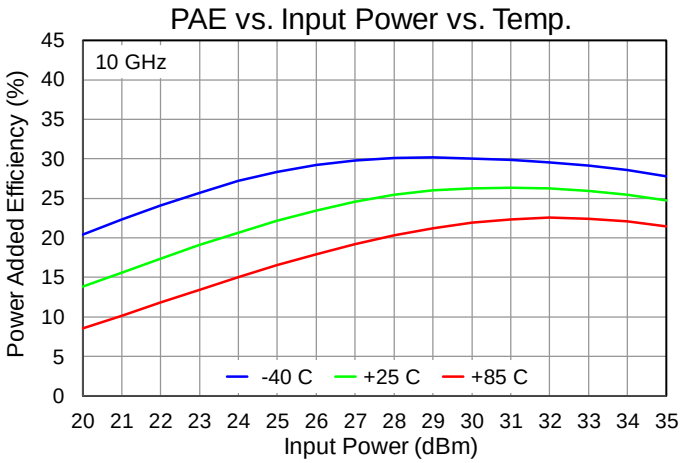
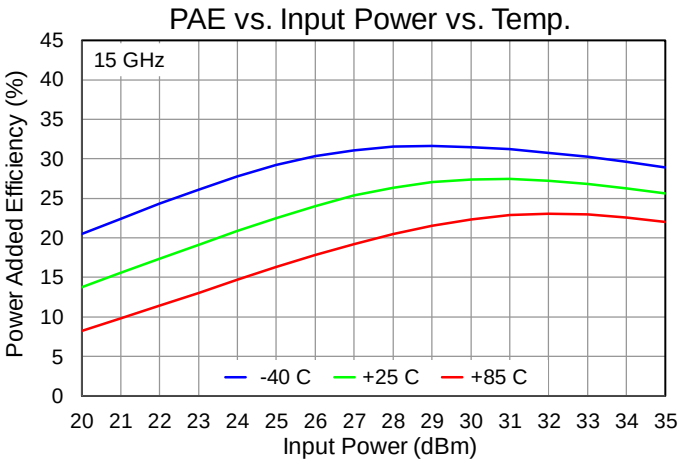
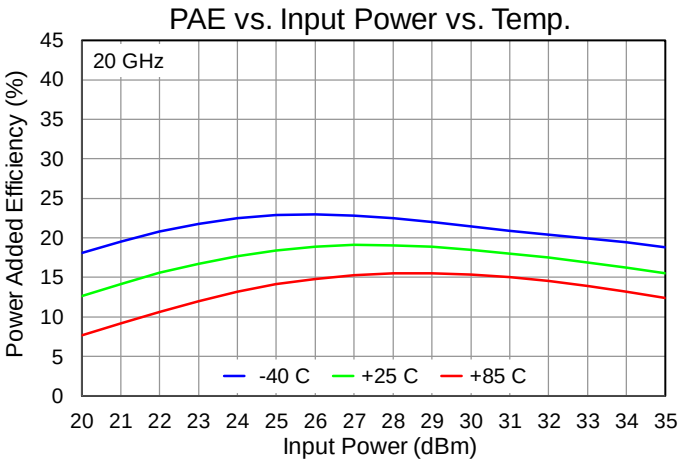




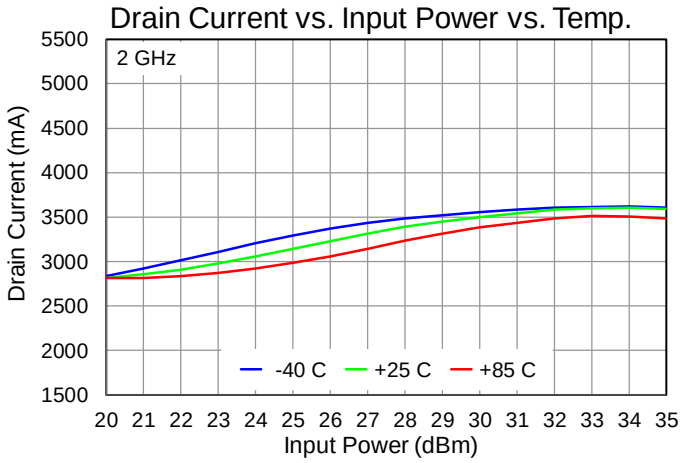


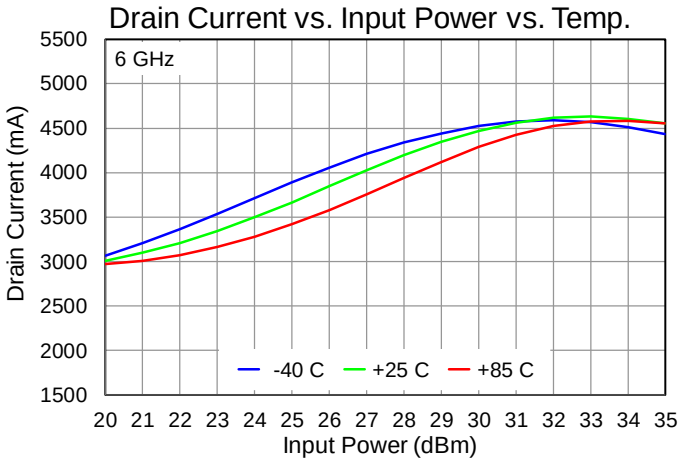


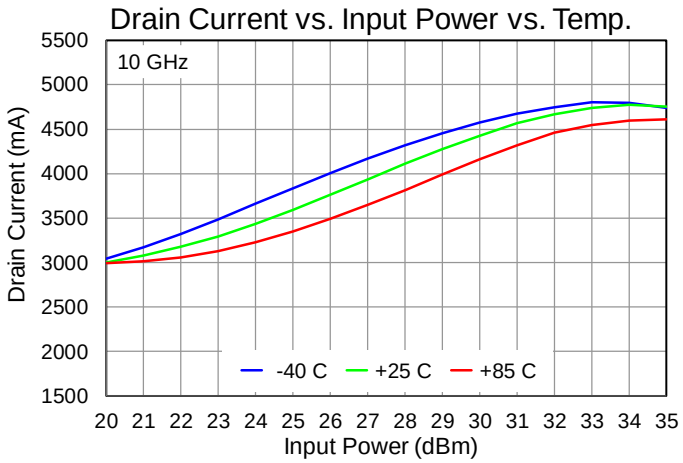


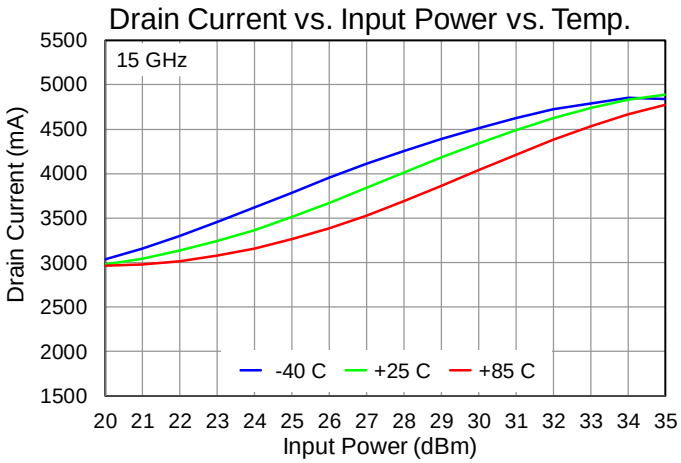
Performance Plots – Large Signal

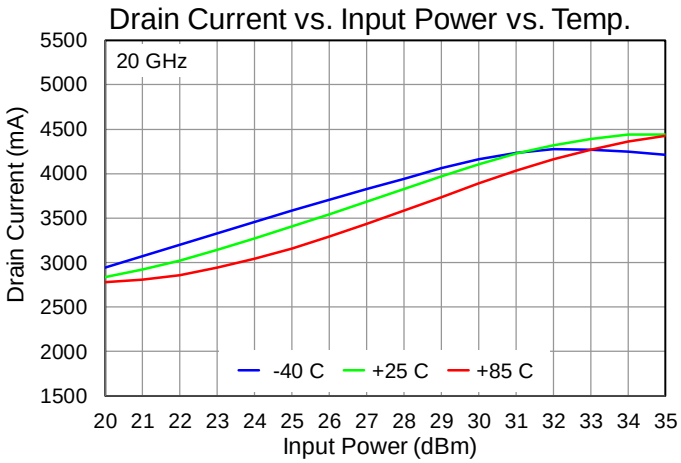
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C











Performance Plots – Large Signal

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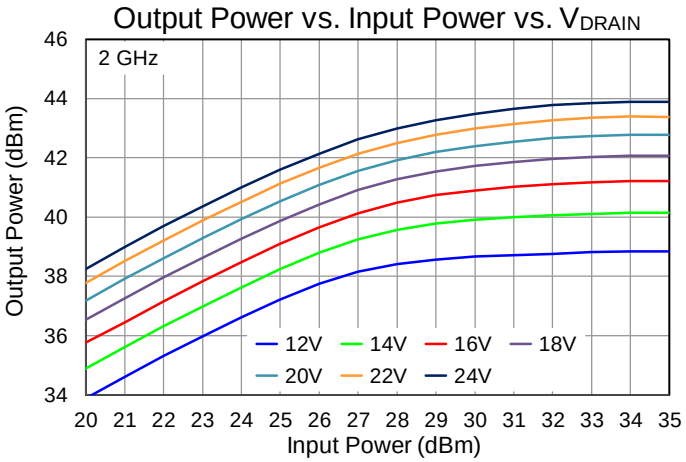

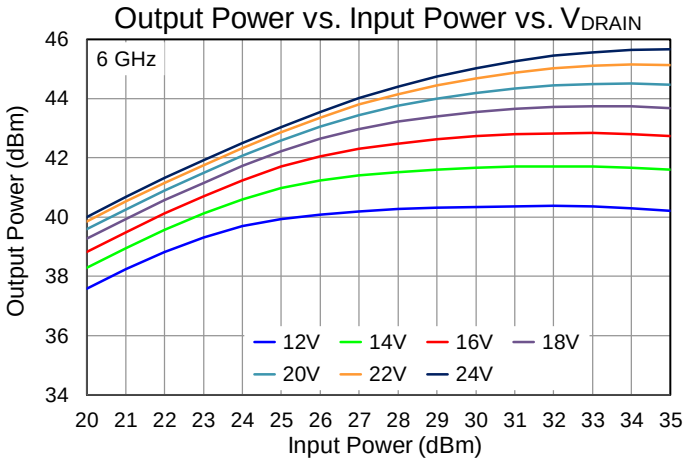

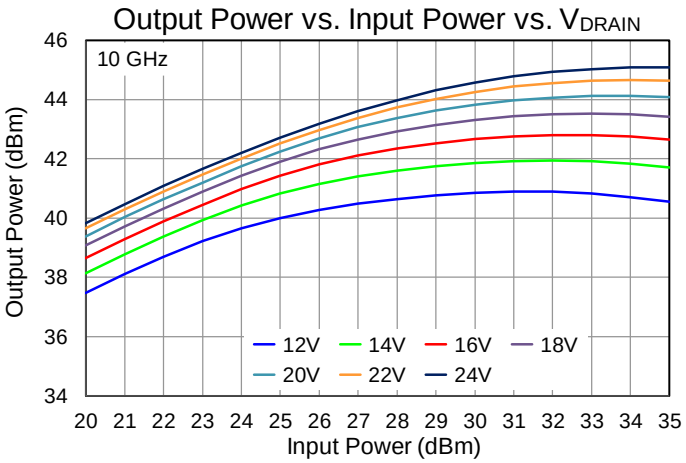

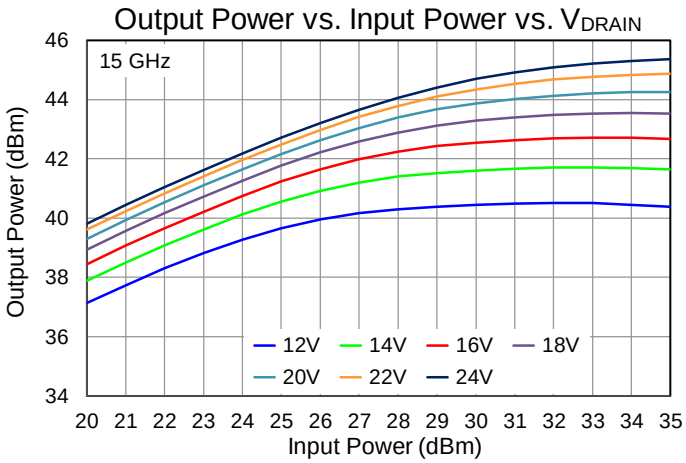

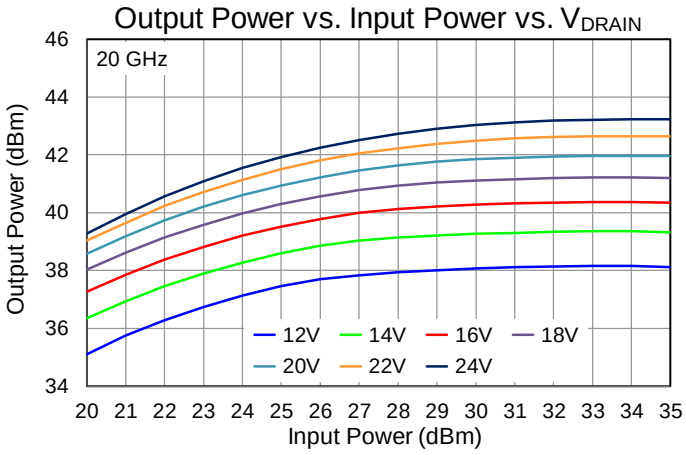

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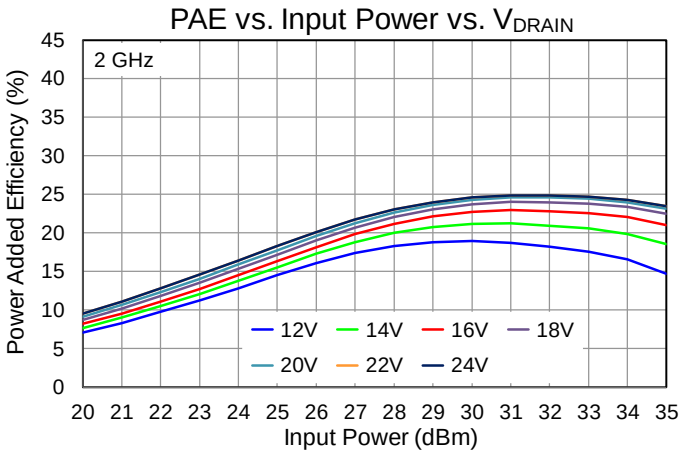
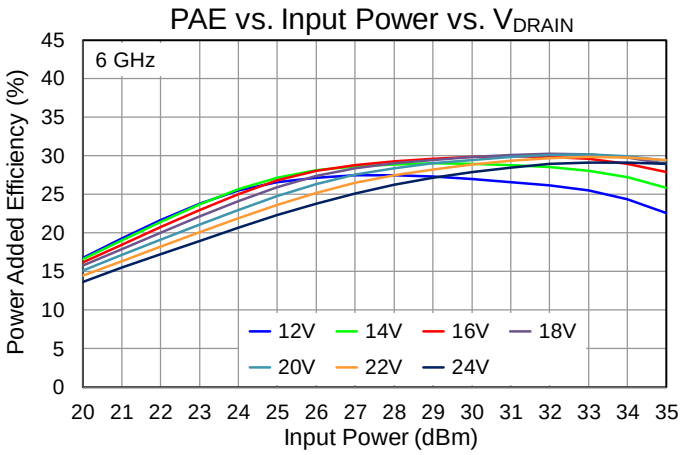
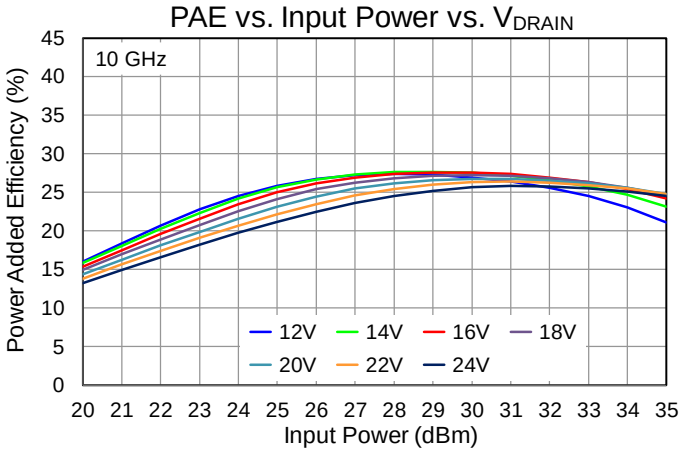
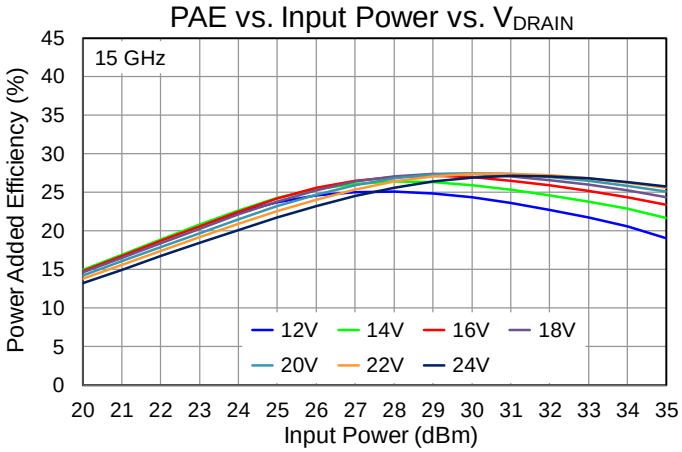
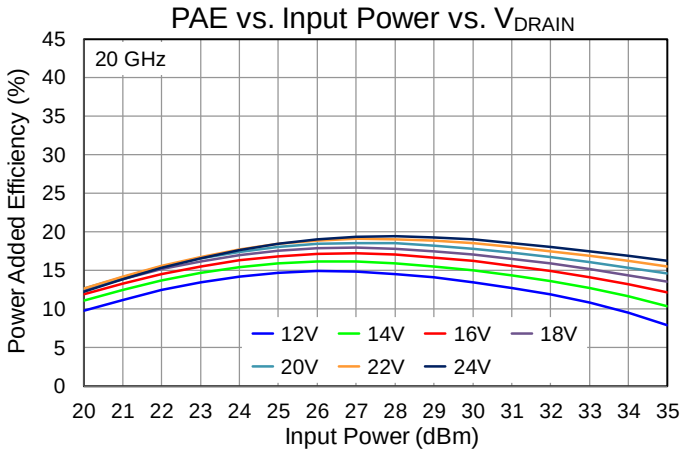
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C





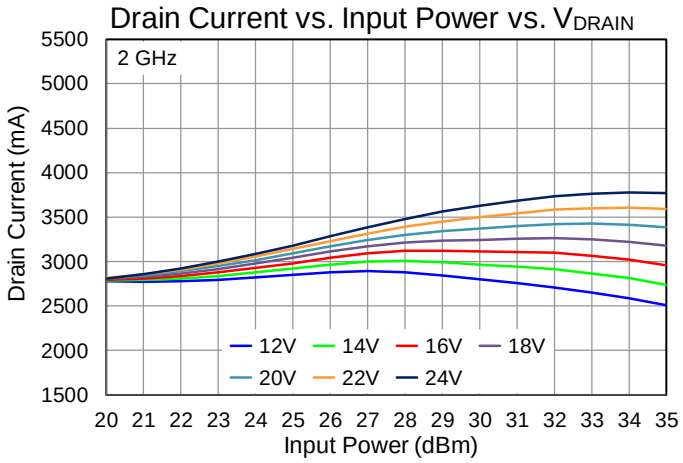


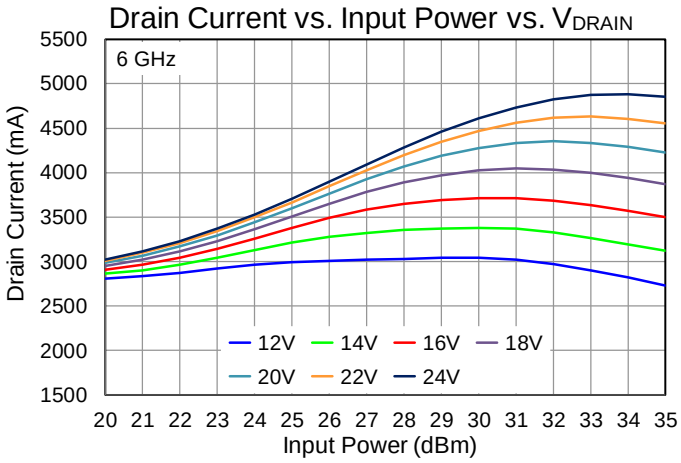


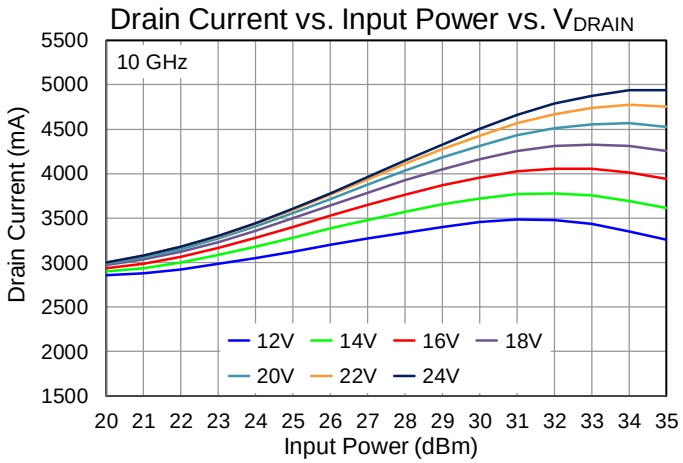


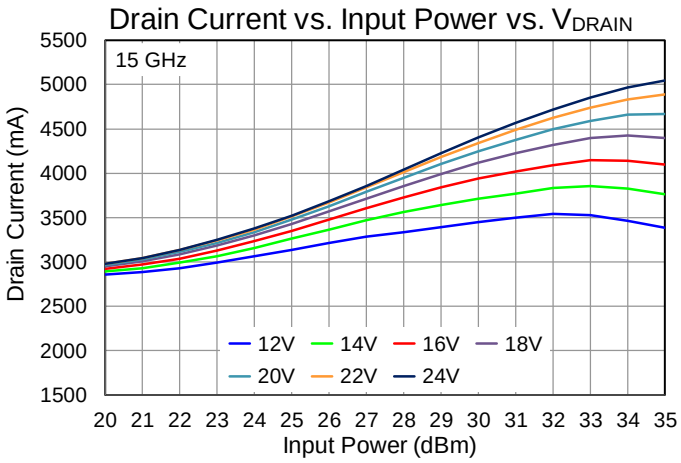
Performance Plots – Large Signal

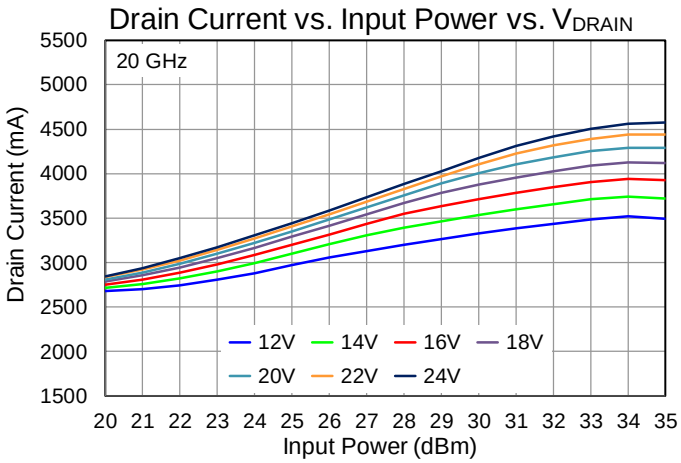
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C





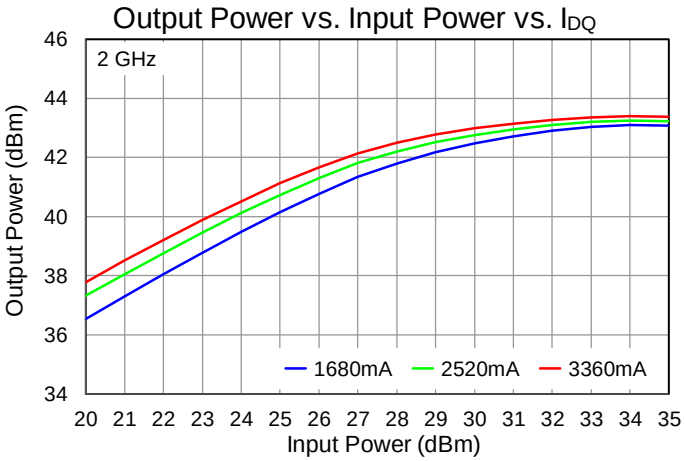


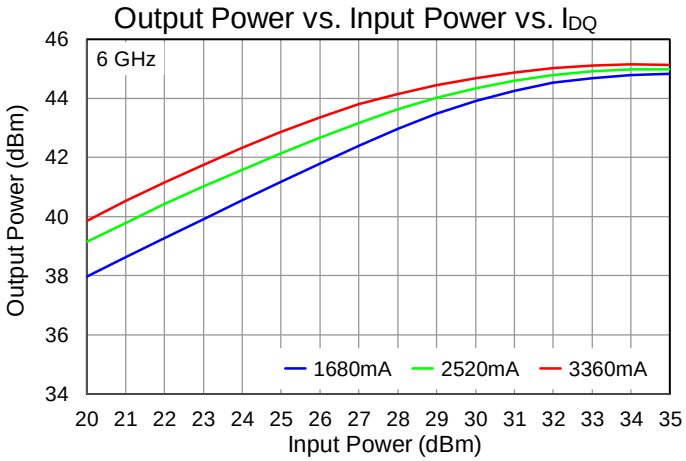


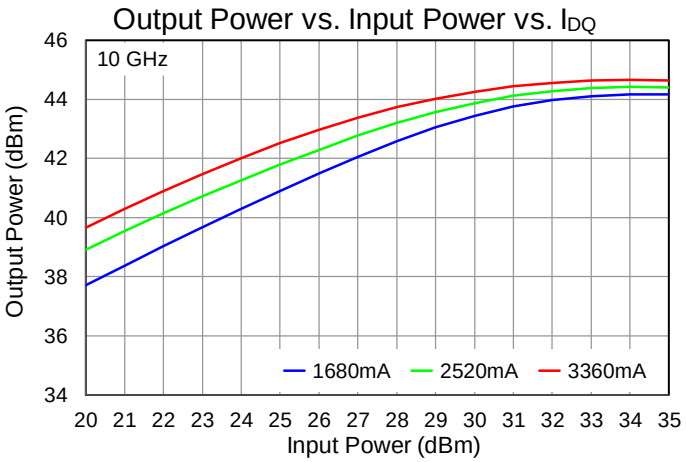


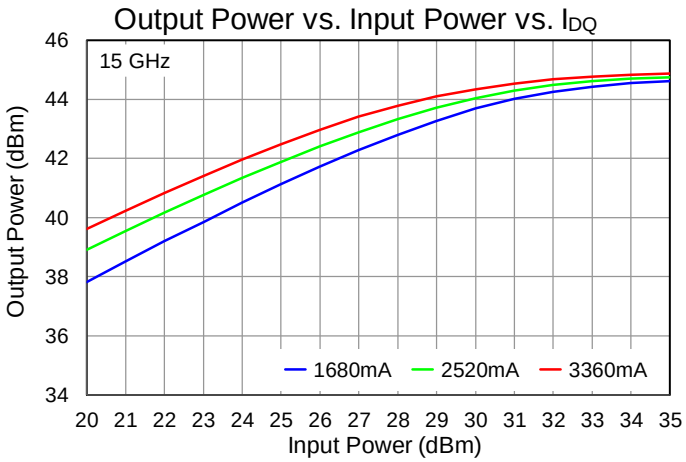
Performance Plots – Large Signal

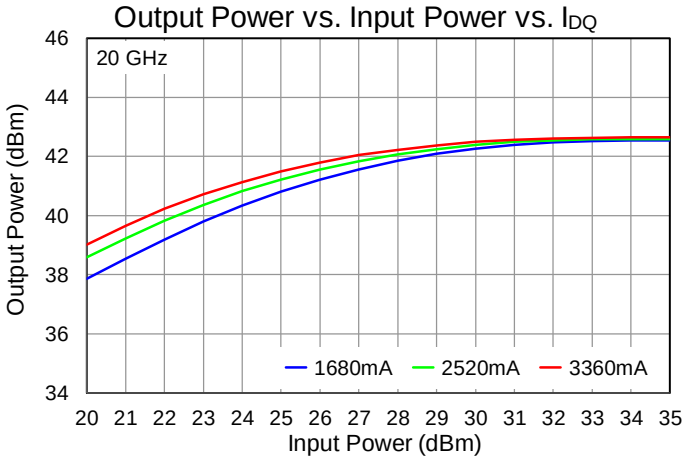
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C





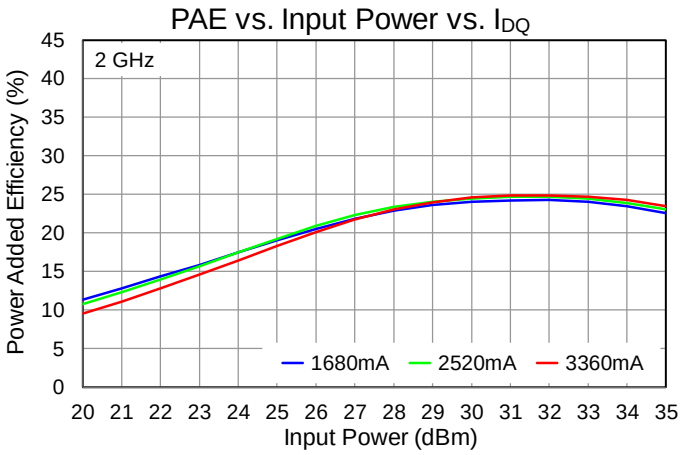


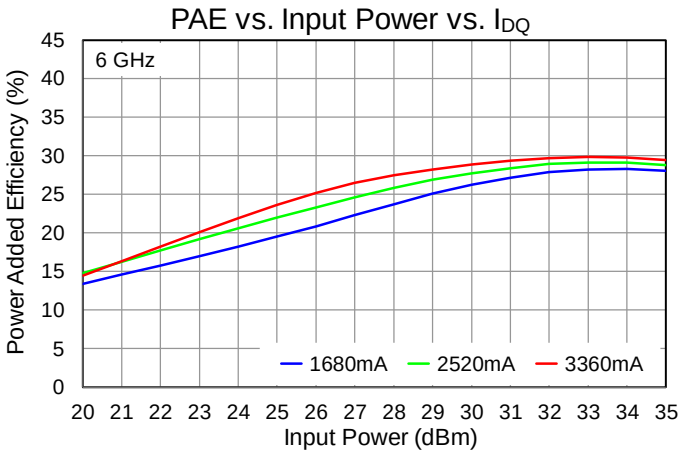


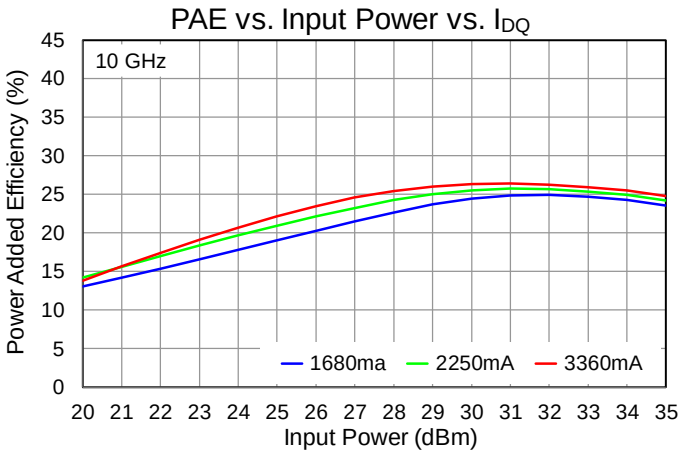


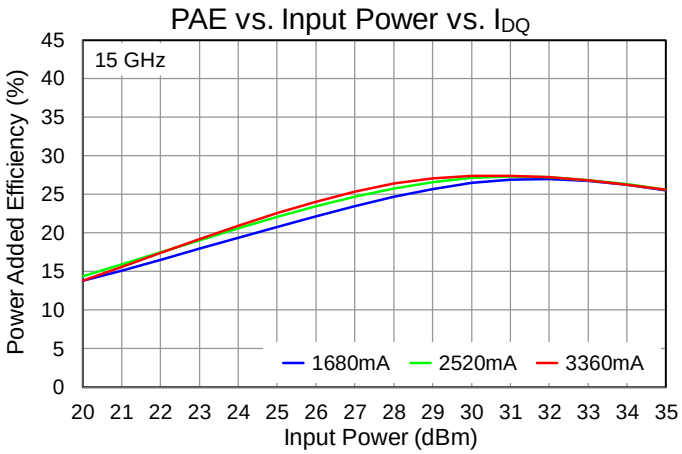
Performance Plots – Large Signal

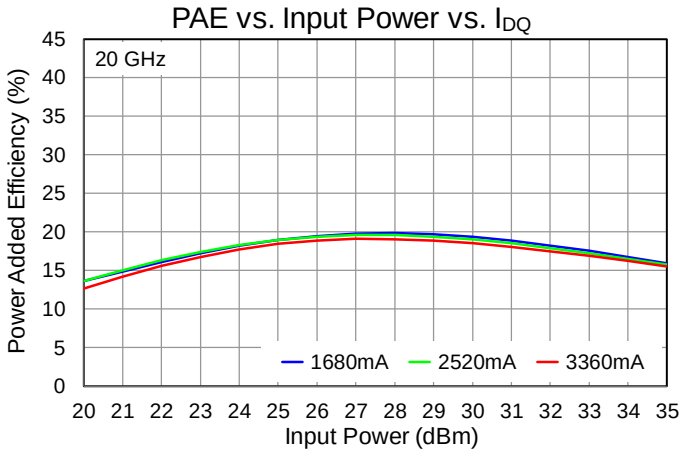
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C





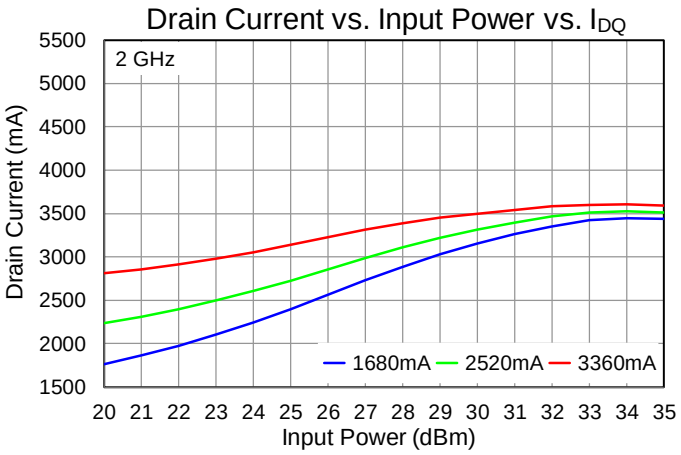


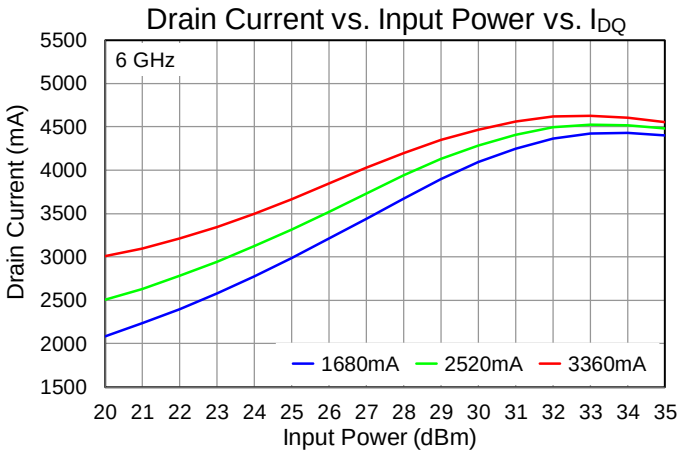


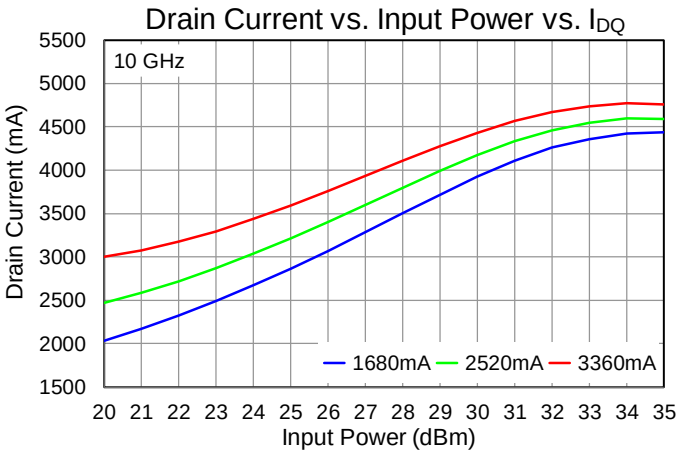


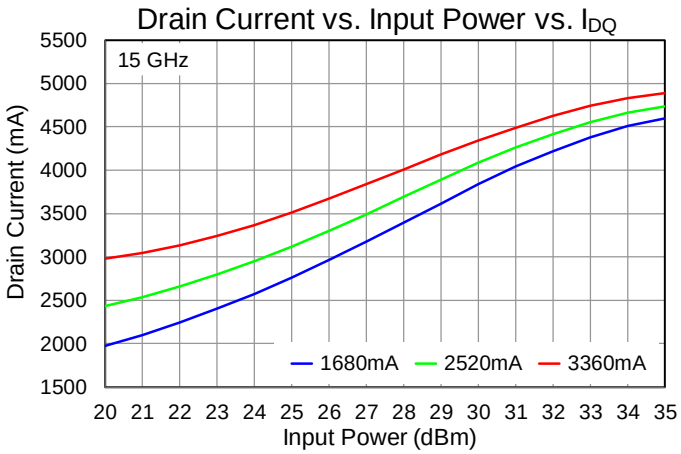
Performance Plots – Large Signal

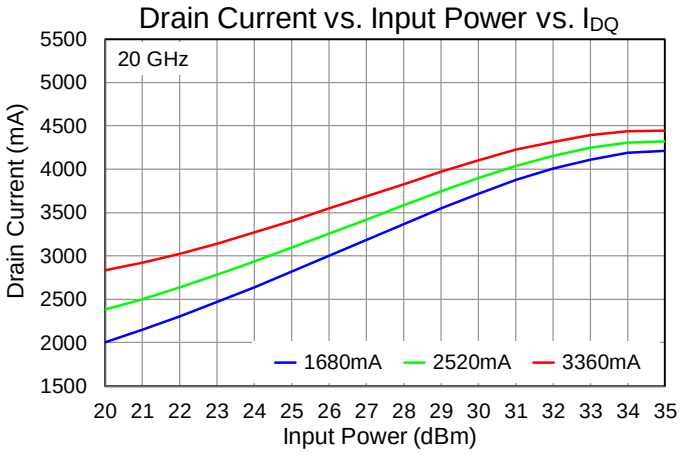
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C





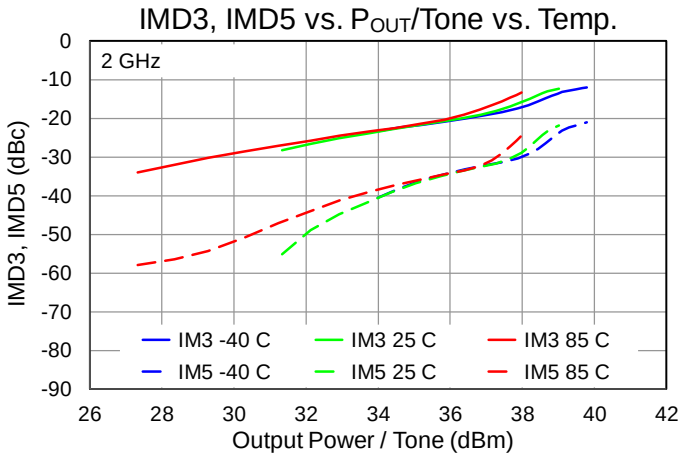


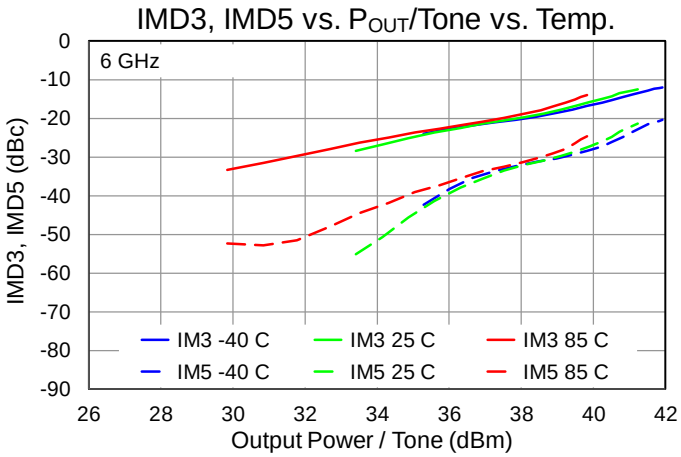


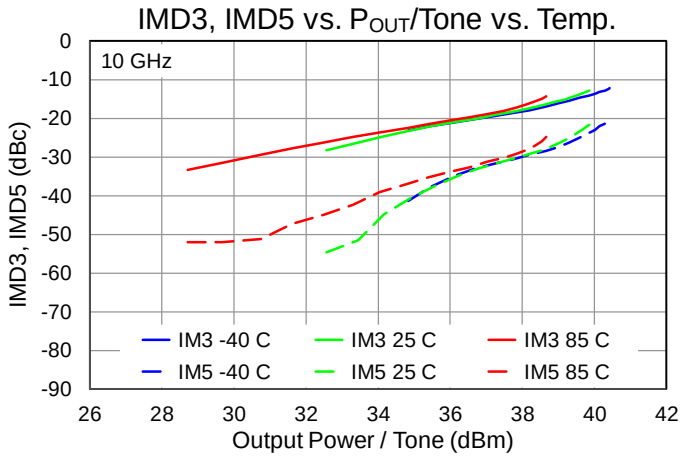


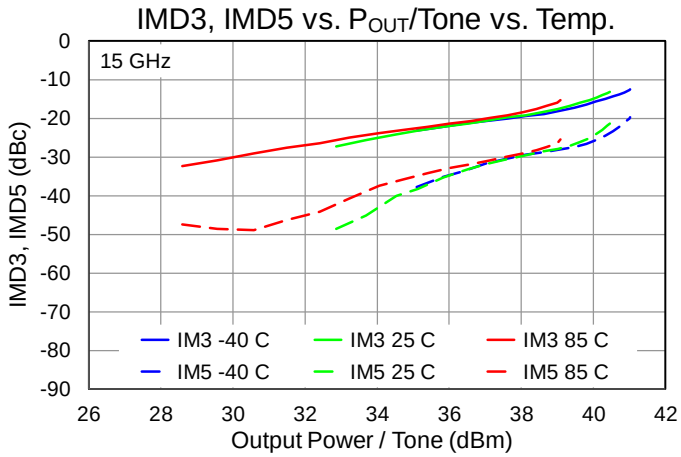
Performance Plots – Linearity

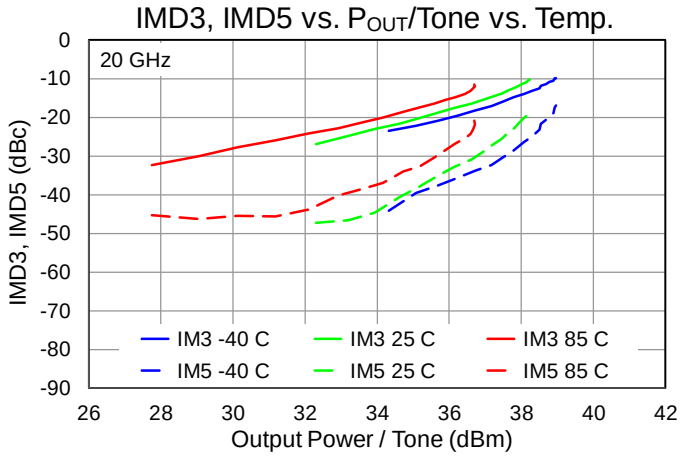
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C, 100 MHz tone spacing





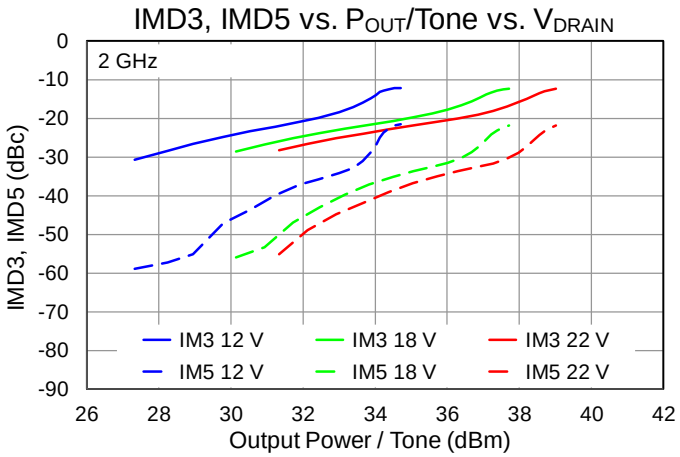


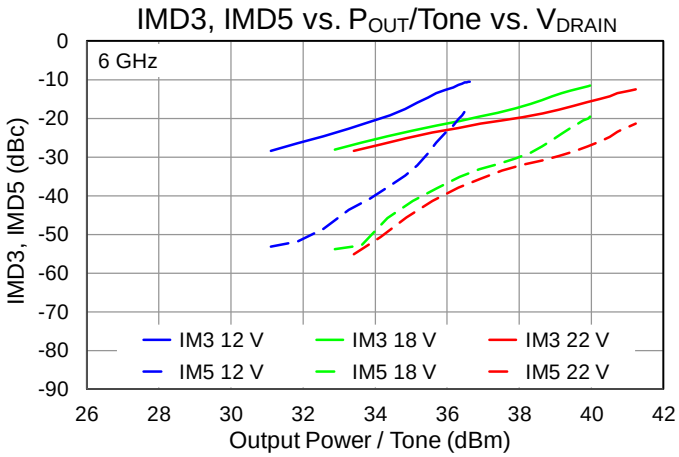


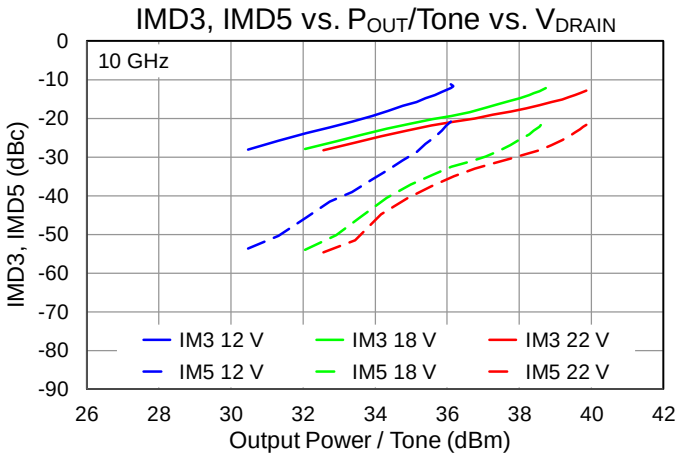


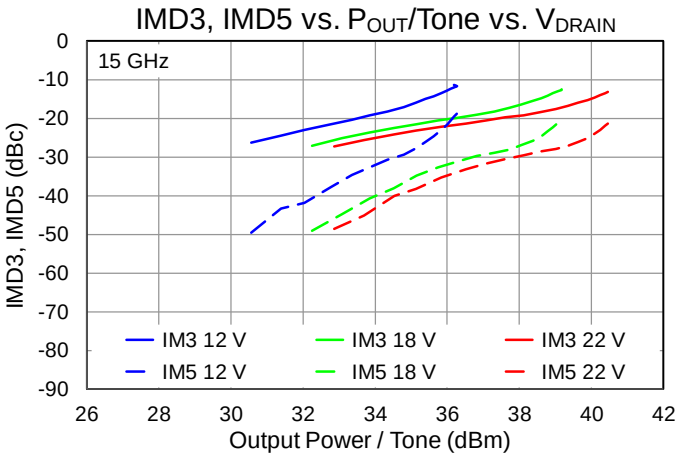
Performance Plots – Linearity

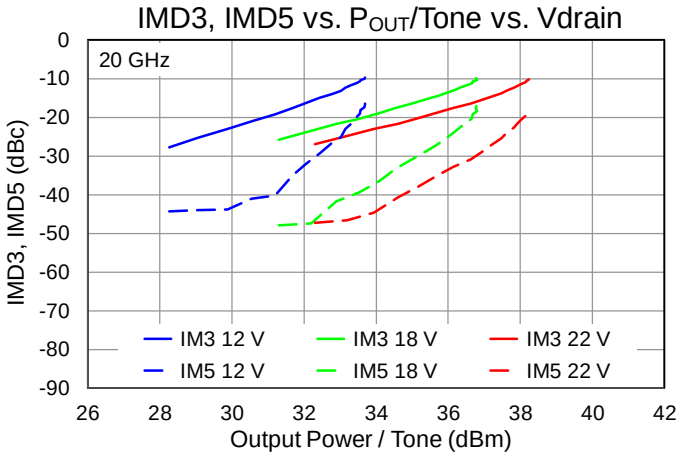
Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C, 100 MHz tone spacing







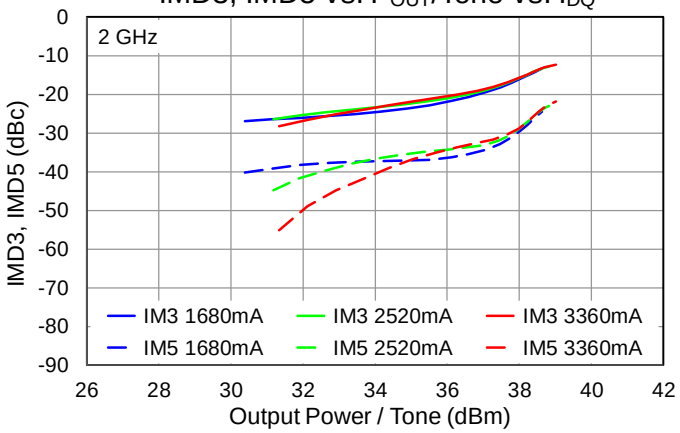




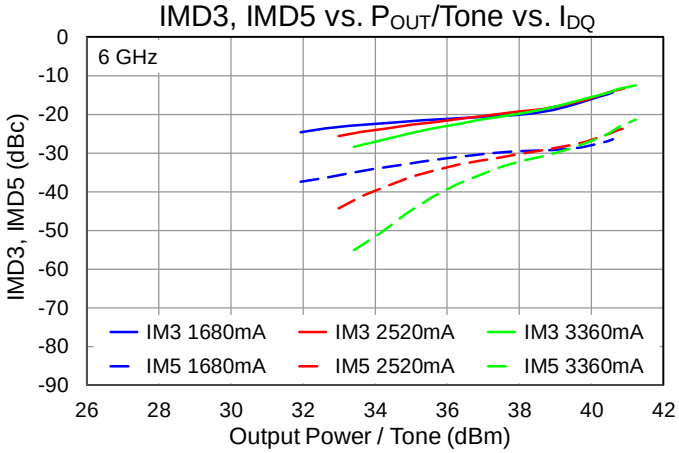
Performance Plots – Linearity

Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C, 100 MHz tone spacing

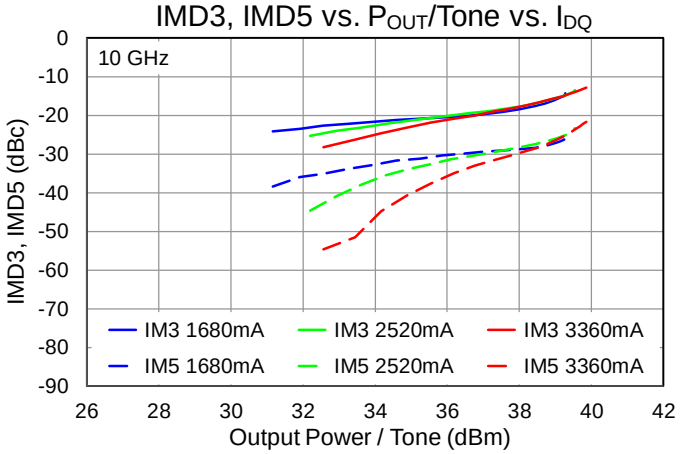
IMD3, IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



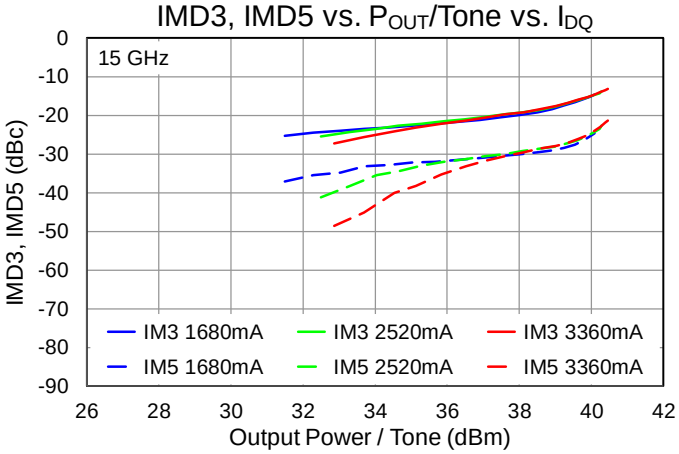
IMD3, IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



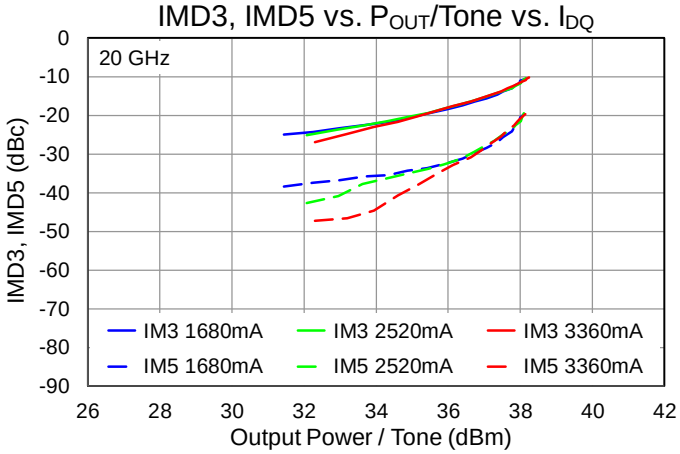
IMD3, IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



IMD3, IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



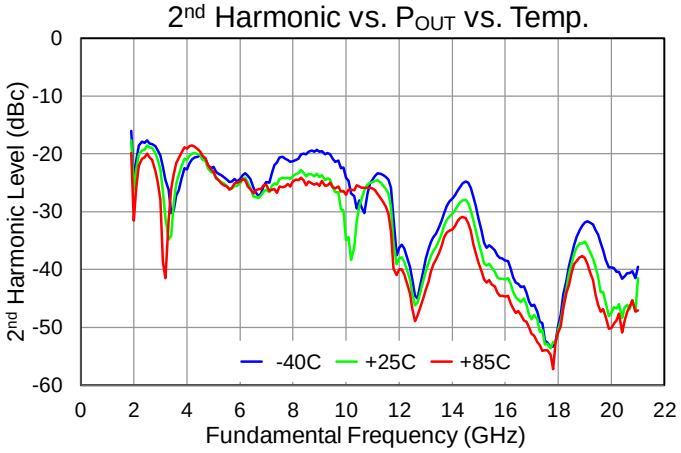
IMD3, IMD5 vs. P_{OUT}/Tone vs. I_{DQ}



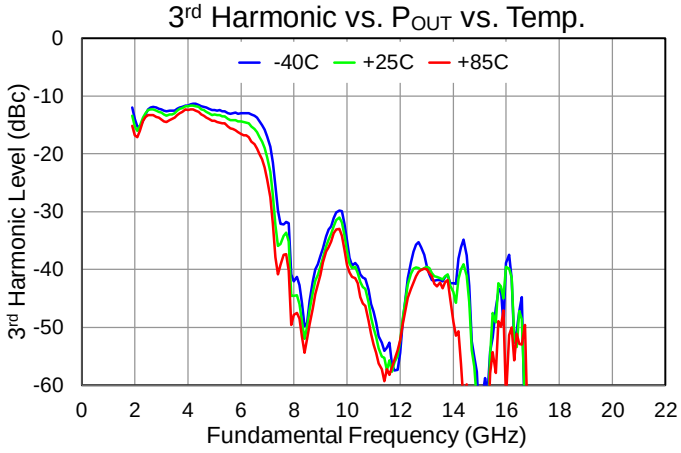
Performance Plots – Harmonics

Test conditions, unless otherwise noted: V_D = 22 V, I_{DQ} = 3360 mA, T=+25 °C, Pin = 31 dBm

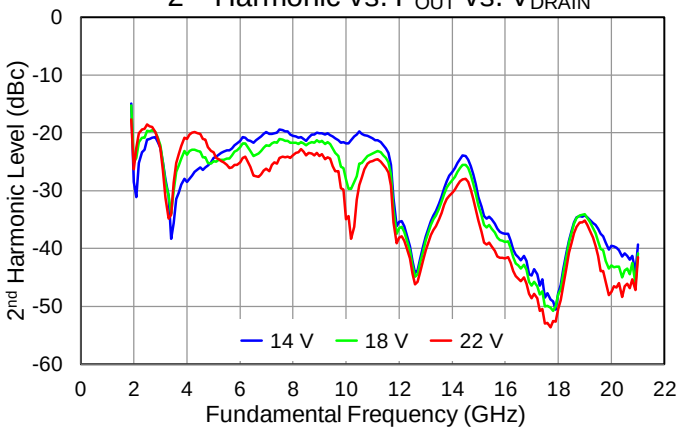
2nd Harmonic vs. P_{OUT} vs. Temp.



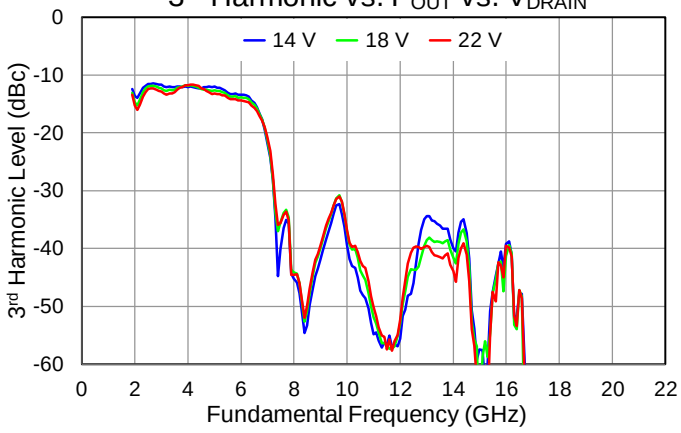
3rd Harmonic vs. P_{OUT} vs. Temp.



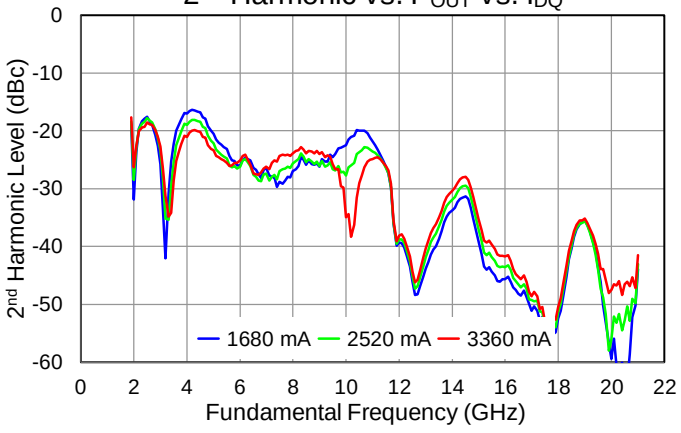
2nd Harmonic vs. P_{OUT} vs. V_{DRAIN}



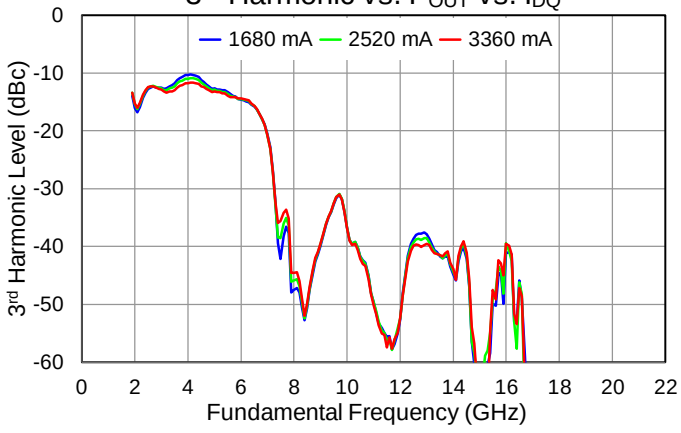
3rd Harmonic vs. P_{OUT} vs. V_{DRAIN}



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



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



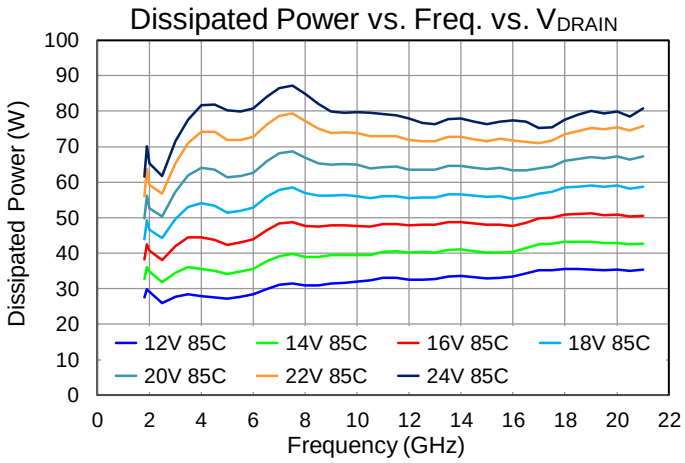
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 °C, V_D = 22 V, I_{DQ} = 3360 mA, P_{DISS} = 73.9 W, No RF (quiescent DC operation)	1.515	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		196.9	°C
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 °C, V_D = 22 V, I_{DQ} = 3360 mA, Freq = 4.5 GHz, I_{D_Drive} = 4287 mA, Pin = 31 dBm, P_{OUT} = 43.3 dBm, P_{DISS} = 74.2 W (CW operation)	1.516	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		197.5	°C

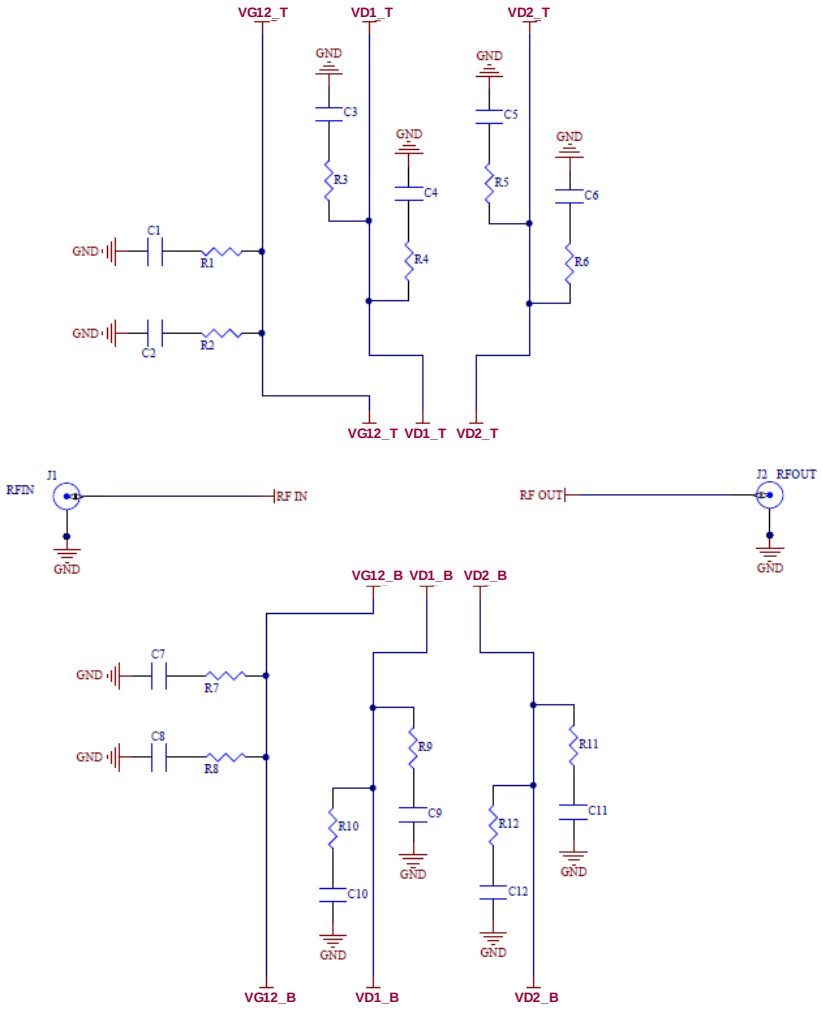
Notes:
1. Thermal resistance calculated to the back of 20 mil CuMo carrier plate, eutectic die attach (85 °C)
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Dissipated Power

Test conditions, unless otherwise noted:
V_D = 22 V, I_{DQ} = 3360 mA, T = +25 °C, P_{IN} = 31 dBm



Applications Information



Connect VG12_T and VG12_B togetherto a common VG. Connect VD1_T and VD1_B to a common VD1. Connect VD2_T and VD2_B to a common VD2. VD1 and VD2 may then also be tied together.

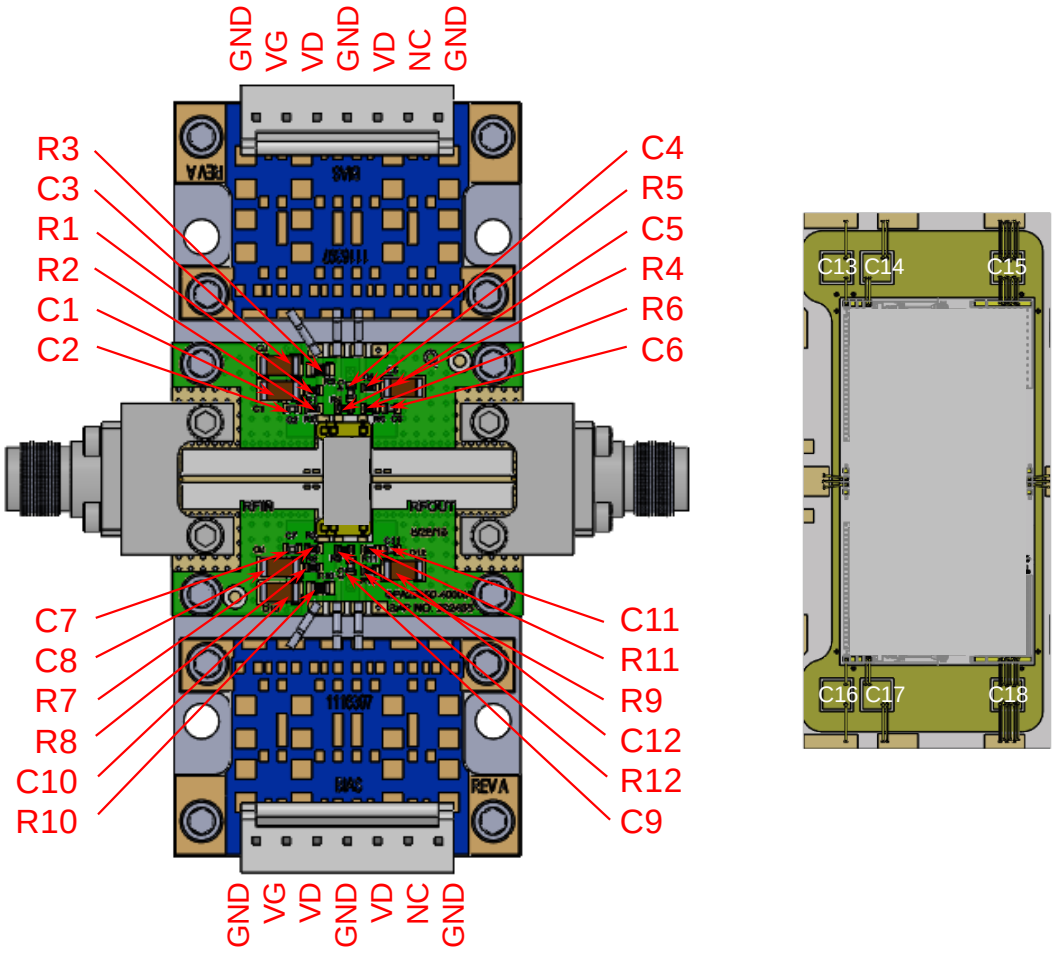
Bias-Up Procedure

1. Set I_D limit to 5500 mA, I_G limit to 20 mA
2. Set V_G to −4.0 V
3. Set V_D +22 V
4. Adjust V_G more positive until $I_{DQ} \approx$ 3360 mA
5. Apply RF signal

Bias-Down Procedure

1. Turn off RF signal
2. Reduce V_G to −4.0 V. Ensure I_{DQ} ~ 0 mA
4. Set V_D to 0 V
5. Turn off V_D supply
6. Turn off V_G supply

Evaluation Board (EVB) Layout Assembly

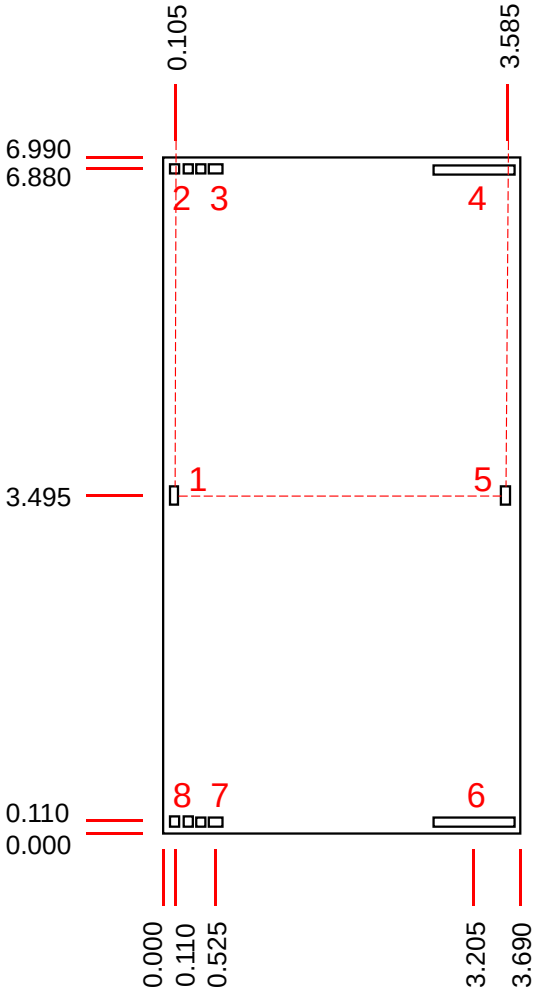


PCB is made from Rogers 6035HTC dielectric, .010 inch thick, 0.5 oz. copper both sides.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1,C3,C5,C8,C10,C12	10 uF	CAP, 10 uF, 20%, 50 V, 20%, X5R, 1206	Various	
C2,C4,C6,C7,C9,C11	0.01 uF	CAP, 0.01 uF, 10%, 50 V, X7R, 0402	Various	
C13 – C18	820 pF	CAP, 820pF, 10%, 50V, SL, BORDER	Various	
R1,R8	5.1 Ω	RES, 5.1 OHM, 5%, 50 V, 0402	Various	
R3,R10	5.1 Ω	RES, 5.1 OHM, 5%, 0.1W, 0603	Various	
R2,R4 – R7,R9,R11,R12	0 Ω	RES, 0 OHM, JMPR, 0402	Various	
J1, J2	2.92 mm	CONNECTOR, FEMALE, ENDLAUNCH	Southwest Microwave	1092-01A-5

Mechanical Information



Dimensions are in mm
Thickness: 0.100
Die x, y size tolerance: ± 0.050
Ground is backside of die

Bond Pad Description

Pad No.	Symbol	Pad Size (um)	Description
1	RF IN	90 x 190	RF input. 50 Ohms. DC blocked.
2, 8	VG12	100 x 100	Gate voltage. Bypass network required; refer to page 24.
3, 7	VD1	150 x 100	Drain voltage, stage 1. Bypass network required; refer to page 23.
4, 6	VD2	850 x 100	Drain voltage, stage 2. Bypass network required; refer to page 23.
5	RF OUT	90 x 190	RF output. 50 Ohms. DC blocked.

Assembly Notes

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.

Reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300 °C to 3 – 4 minutes, maximum.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Interconnect process assembly notes:

- Thermosonic ball bonding is the preferred interconnect technique.
- Force, time, and ultrasonic are critical parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1A	ANSI/ESD/JEDEC JS-001

Caution!

ESD-Sensitive Device

Solderability

Use only AuSn (80/20) solder, and limit exposure to temperatures above 300 °C to 3 – 4 minutes, maximum.

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
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) 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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