QPA2225D

28 – 38 GHz 0.4 Watt GaN Driver Amplifier

Product Overview

Qorvo's QPA2225D is a wide band MMIC driver amplifier fabricated on Qorvo's production 0.15 um GaN on SiC process (QGaN15). Covering 28 – 38 GHz, the QPA2225D provides > 0.4 W of saturated output power with >23 dB of small-signal gain.

The QPA2225D MMIC dimensions are 1.65 x 0.67 x 0.05 mm. It can support a variety of operating conditions to best support system requirements. With good thermal properties, it can support a range of bias voltages.

The QPA2225D has DC blocking capacitors on both RF ports, which are matched to 50 ohms.

The QPA2225D is ideal for supporting communications and radar applications in both commercial and military markets.

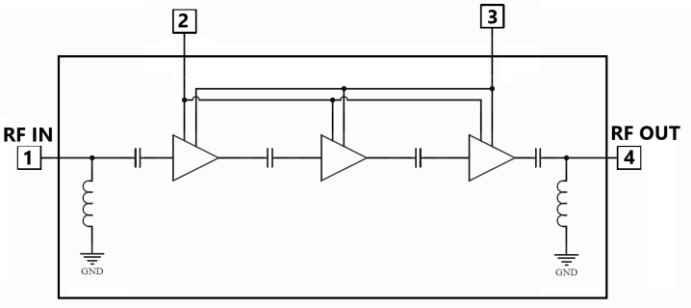
Lead-free and RoHS compliant.

Key Features

- Frequency Range: 28 – 38 GHz
- P_{SAT} (P_{IN} = 13 dBm): > 26 dBm
- Small Signal Gain: > 23 dB
- IM3 (P_{OUT}/Tone = 20 dBm): -20 dBc
- Bias: CW, V_D = +20 V, I_{DQ} = 64 mA, V_G = -2.5 V typ.
- Die Dimensions: 1.65 x 0.67 x 0.05 mm

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

Functional Block Diagram



Applications

- Communications
- Radar
- Satellite Communications
- Electronic Warfare

Ordering Information

Part No.	Description
QPA2225D	28 – 38 GHz 0.4 Watt GaN Amplifier (100 pcs.)
QPA2225DS2	Samples (2 pcs. pack)
QPA2225DEVBA	Evaluation Board for QPA2225D

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 (I_D)	456 mA
Gate Current (I_G)	See plot page 18
Power Dissipation (P_{DISS}), 85 °C	5 W
Input Power (P_{IN}), CW, 50 Ω, V_D = 20 V, I_{DQ} = 64 mA, T_{BASE} = 85 °C	18 dBm
Input Power (P_{IN}), CW, 3:1 VSWR, V_D = 20 V, I_{DQ} = 64 mA, T_{BASE} = 85 °C	18 dBm
Mounting Temperature (30 seconds)	320 ºC
Storage Temperature	-55 to +150 ºC

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)		+20		V
Drain Current, (I_{DQ})		64		mA
Drain Current, RF (I_{D_Drive})	See chart page 6			mA
Gate Voltage Range (V_G)	−2 to -2.9			V
Gate Current, RF (I_{G_Drive})	See chart page 6			mA
T_{BASE} Range	−40		+85	ºC

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		28		38	GHz
Output Power at Saturation, P_{SAT}	P_{IN} = +13 dBm		> 26		dBm
Large Signal Gain	P_{IN} = +13 dBm		> 13		dB
Small Signal Gain, S21			> 23		dB
Input Return Loss, IRL			5		dB
Output Return Loss, ORL			5		dB
3RD Intermodulation Products, IM3	P_{OUT}/Tone = 20 dBm; Freq. = 35 GHz; Δf = 100 MHz		-20		dBc
5TH Intermodulation Products, IM5	P_{OUT}/Tone = 20 dBm; Freq. = 35 GHz; Δf = 100 MHz		-30		dBc
P_{SAT} Temperature Coefficient	T_{DIFF} = −40 ºC to +85 ºC; P_{IN} = +13 dBm		-0.02		dBm/ºC
S21 Temperature Coefficient	T_{DIFF} = −40 ºC to +85 ºC		-0.07		dB/ºC

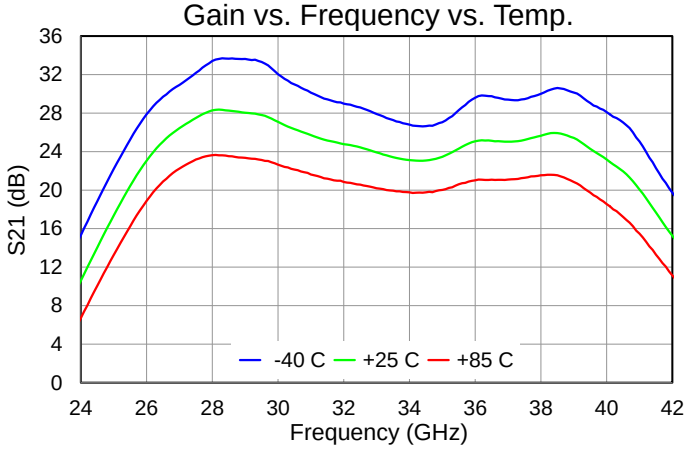
Notes:

1. Test conditions unless otherwise noted: CW, V_D = + 20 V, I_{DQ} = 64 mA, V_G = -2.5V +/- typical, T_{BASE} = +25 ºC, Z_0 = 50 Ω
2. T_{BASE} is back side of 20 mil CuMo carrier plate with AuSn solder

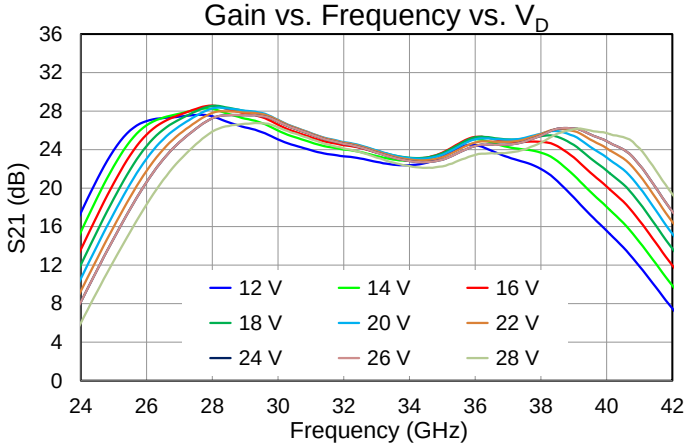
Performance Plots – Small Signal

Test conditions, unless otherwise noted: CW, V_D = 20 V, I_{DQ} = 64 mA, T_{BASE} = +25 ºC

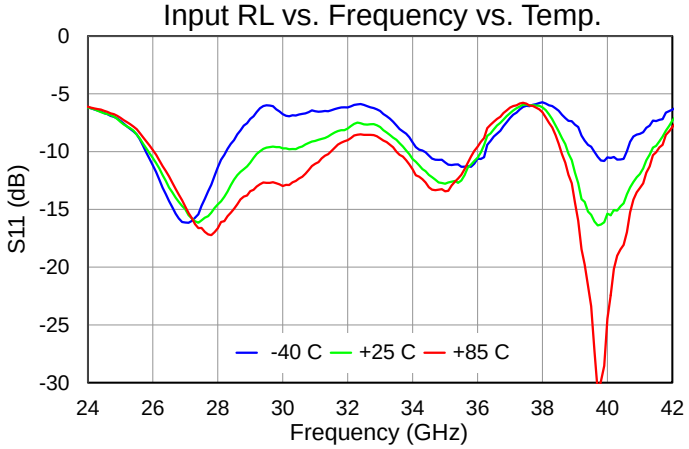
Gain vs. Frequency vs. Temp.



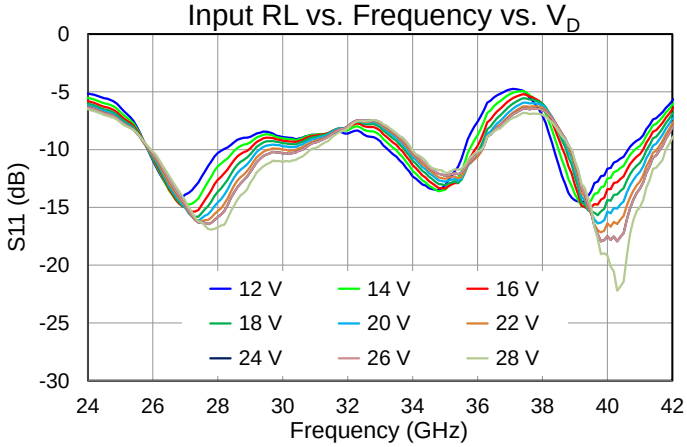
Gain vs. Frequency vs. V_D



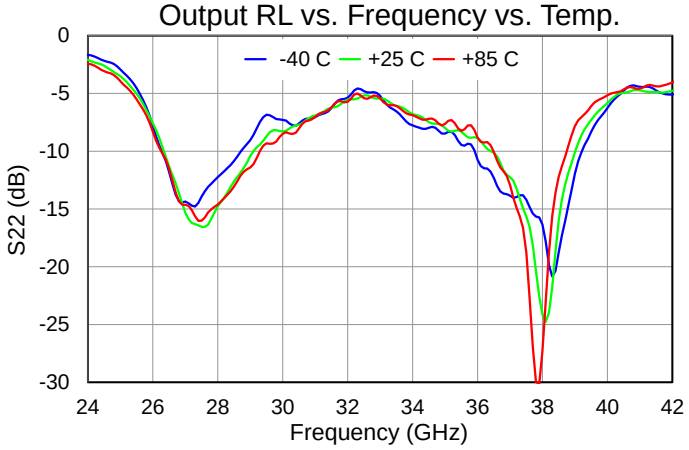
Input RL vs. Frequency vs. Temp.



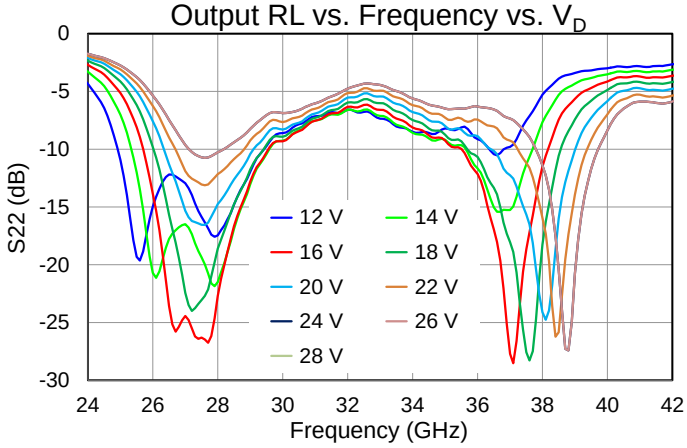
Input RL vs. Frequency vs. V_D



Output RL vs. Frequency vs. Temp.



Output RL vs. Frequency vs. V_D



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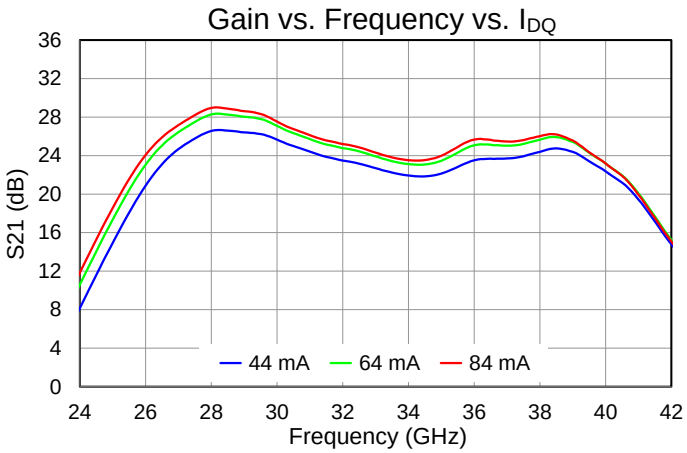
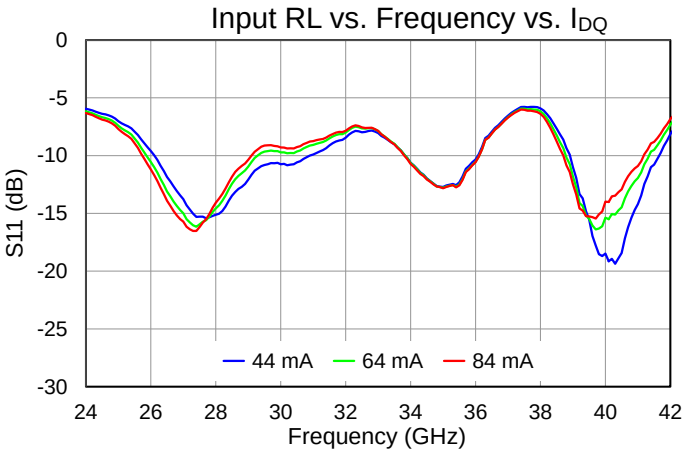
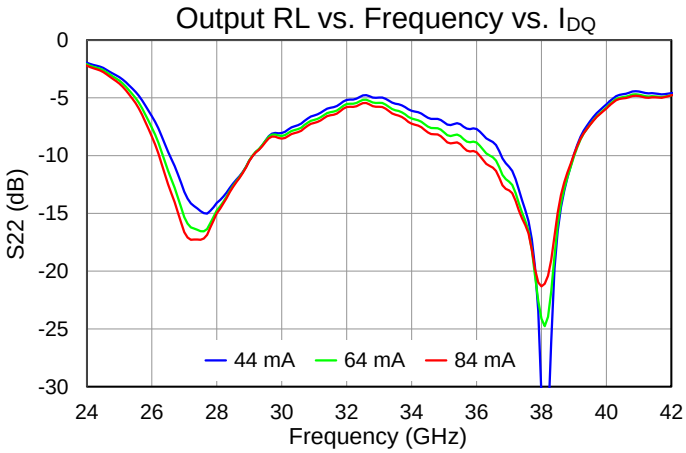
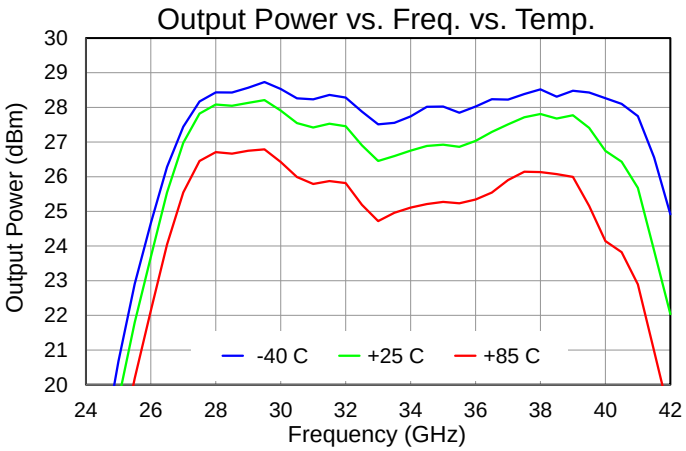


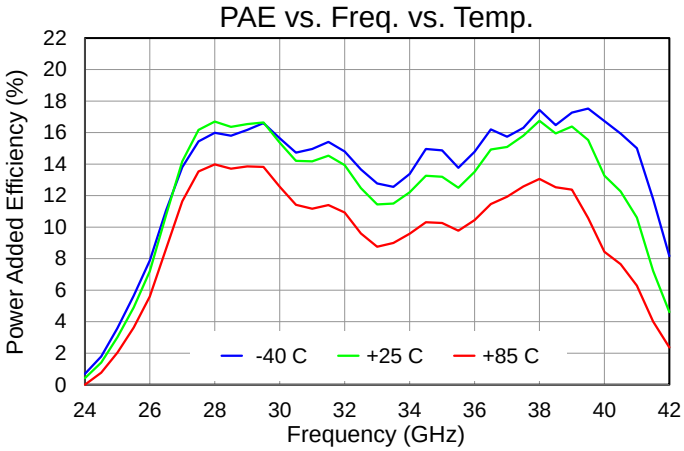


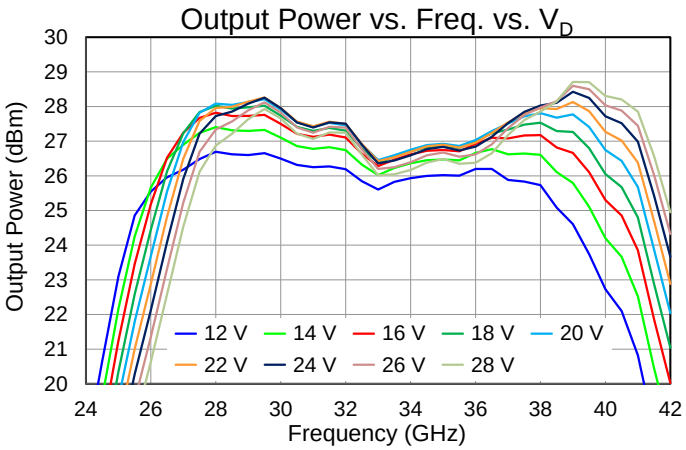


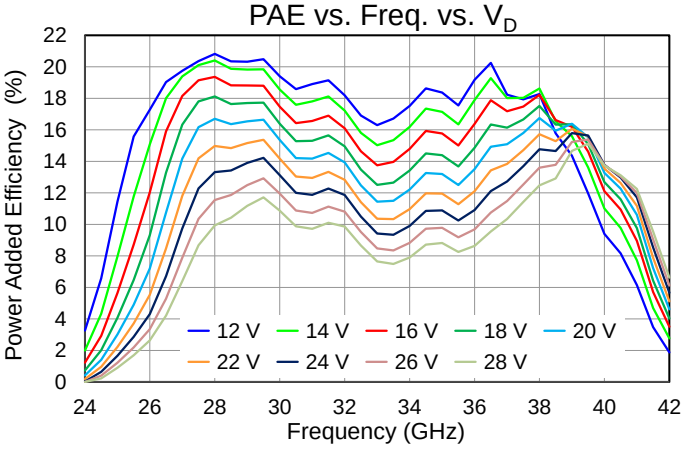
Performance Plots – Large Signal (CW)

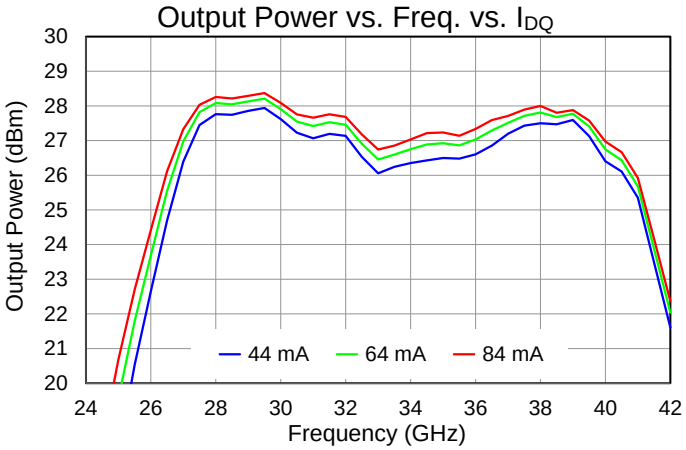
Test conditions, unless otherwise noted: **CW**, V_D = 20 V, I_{DQ} = 64 mA, P_{IN} = +13dBm, T_{BASE} = +25 ºC

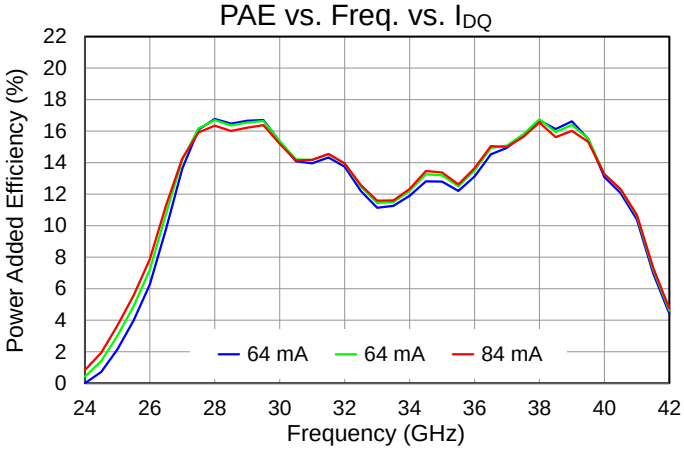












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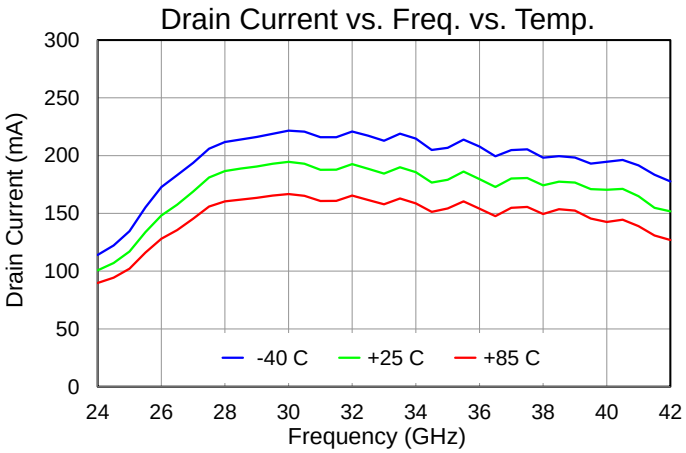

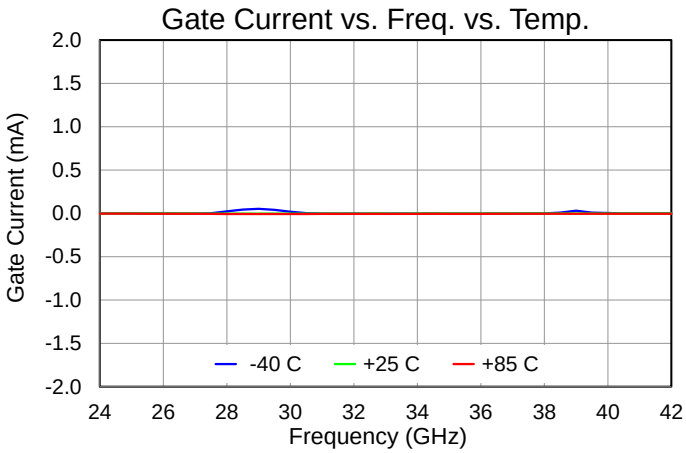

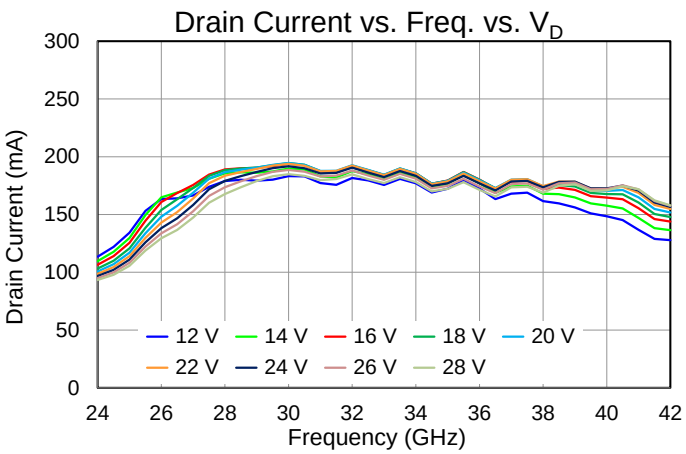

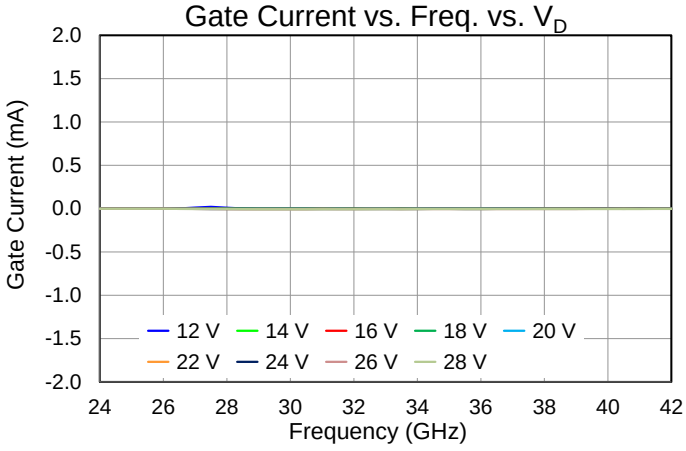

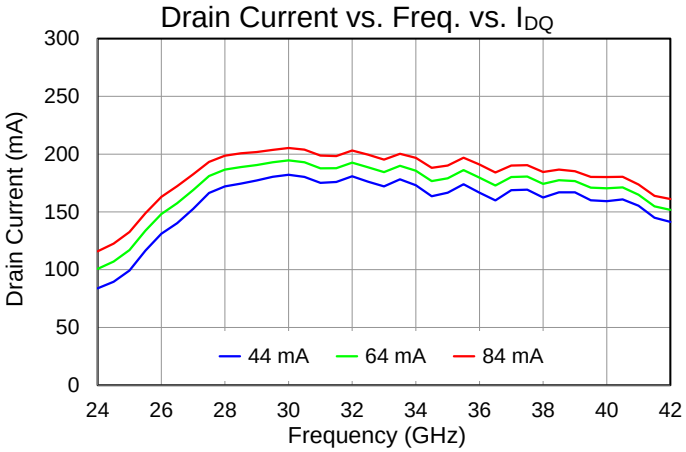

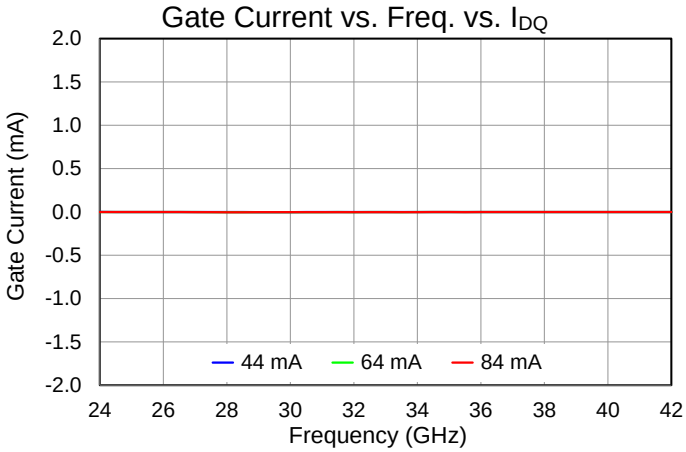

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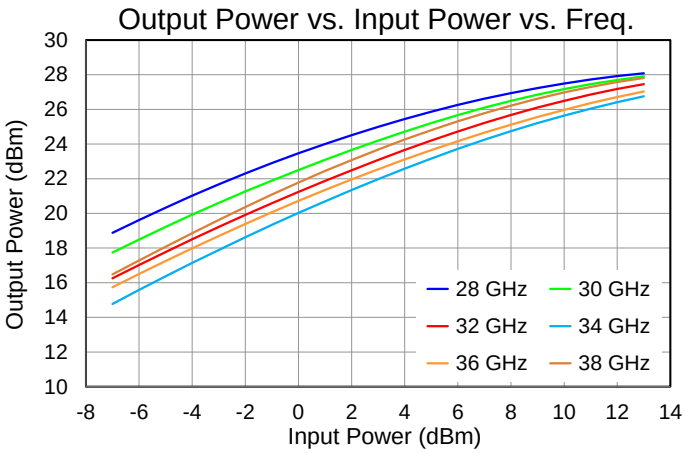

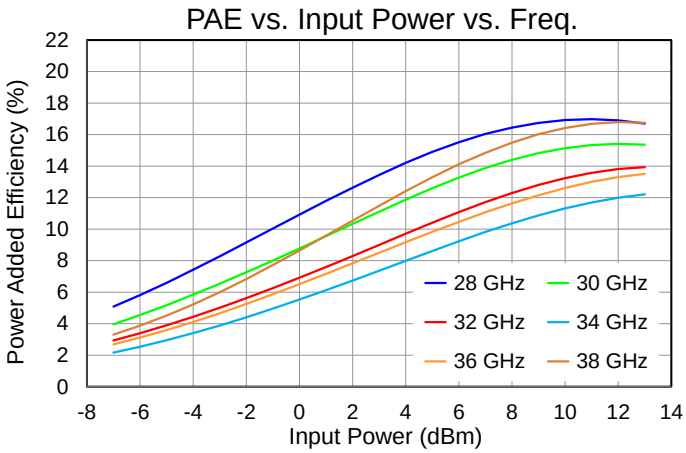

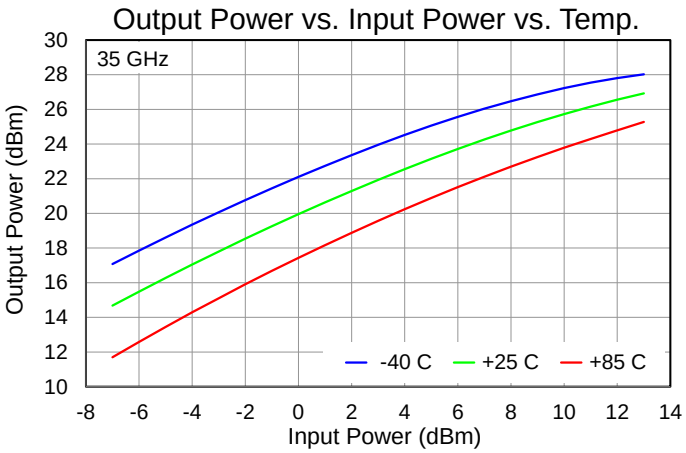

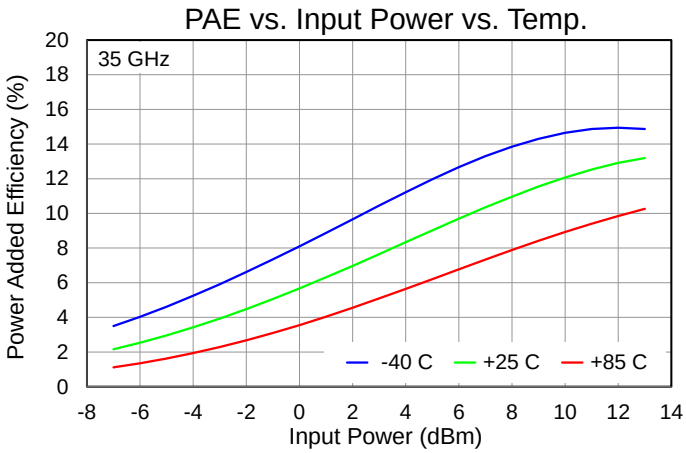

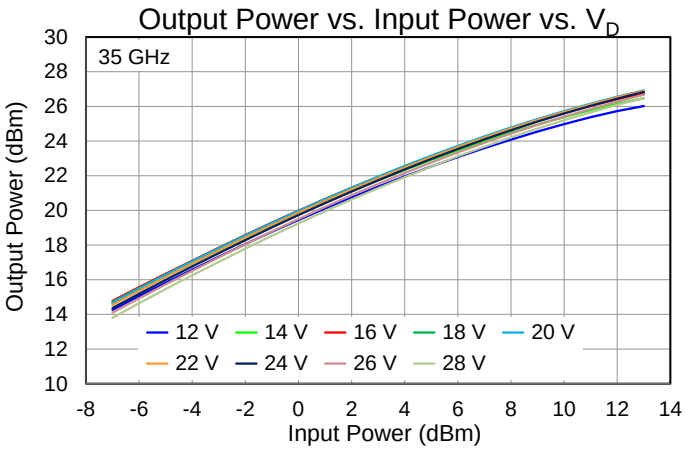

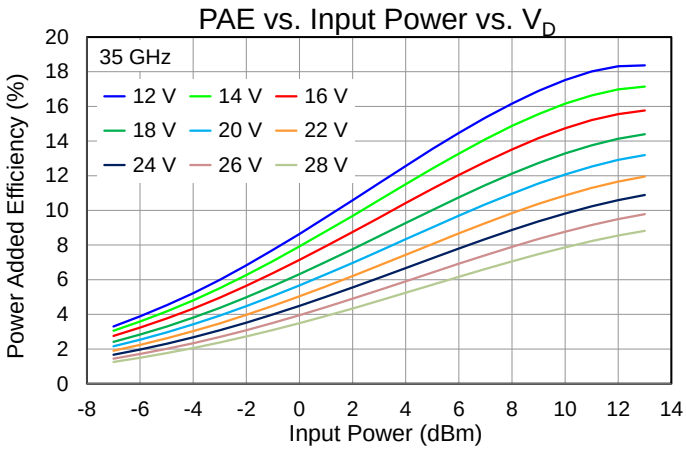

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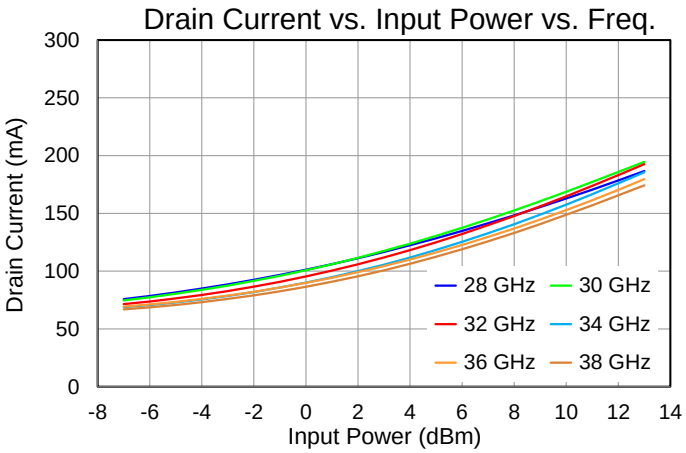

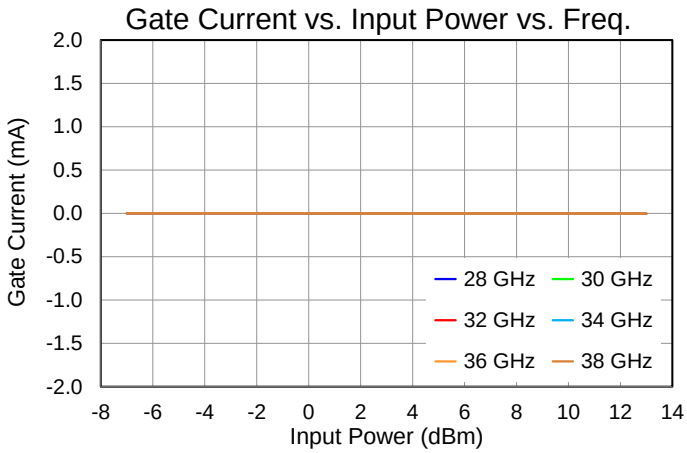

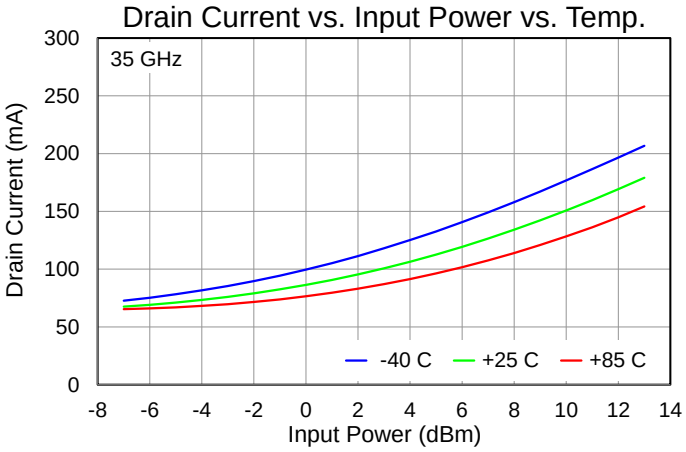

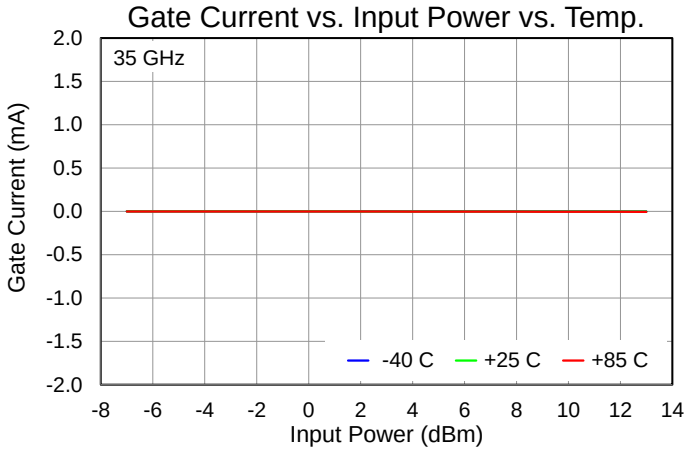

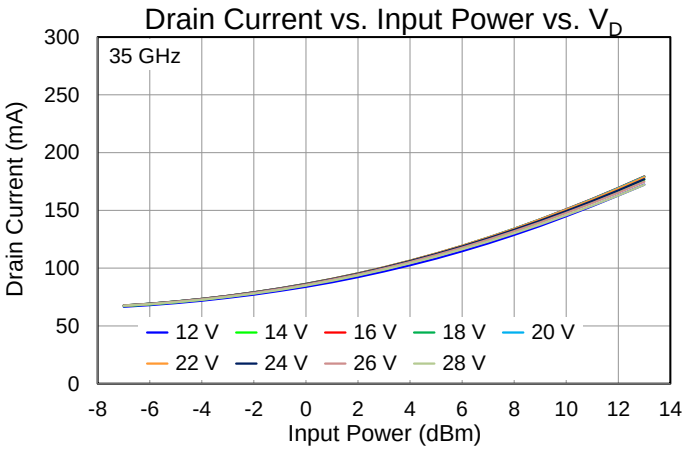

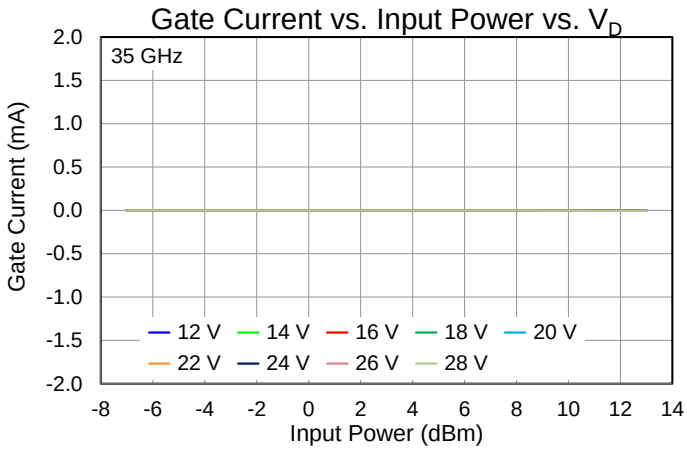

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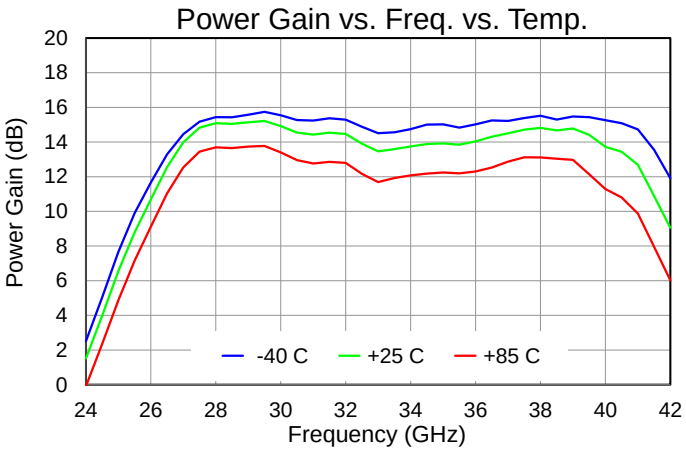
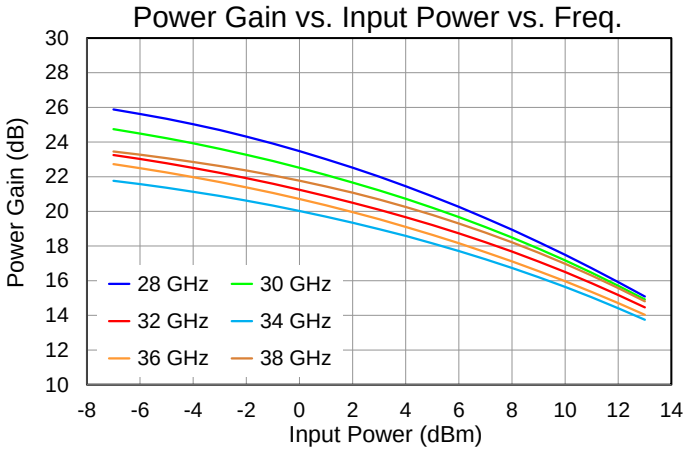
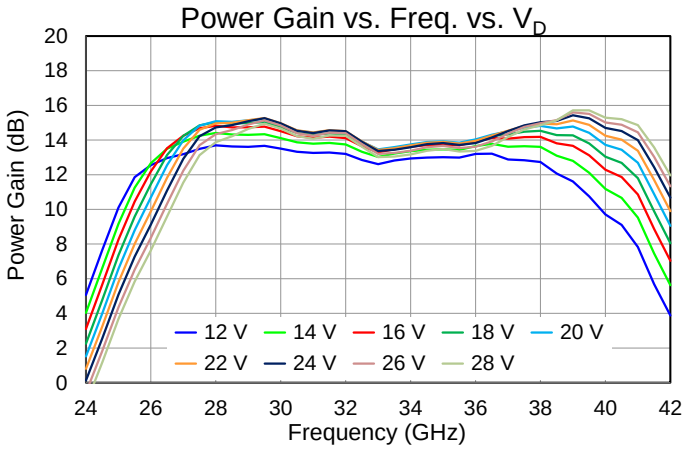
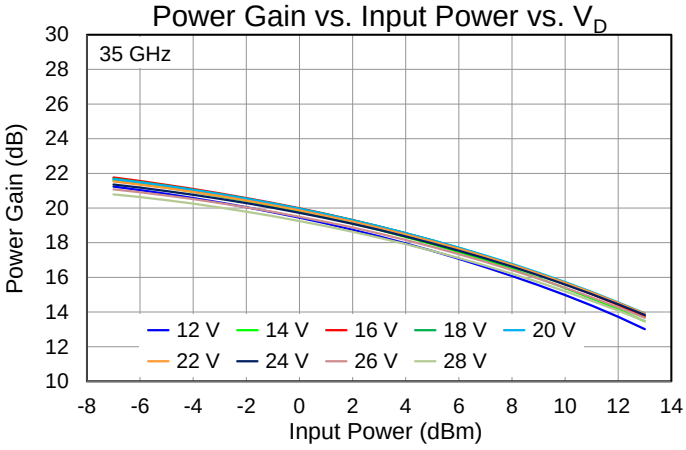
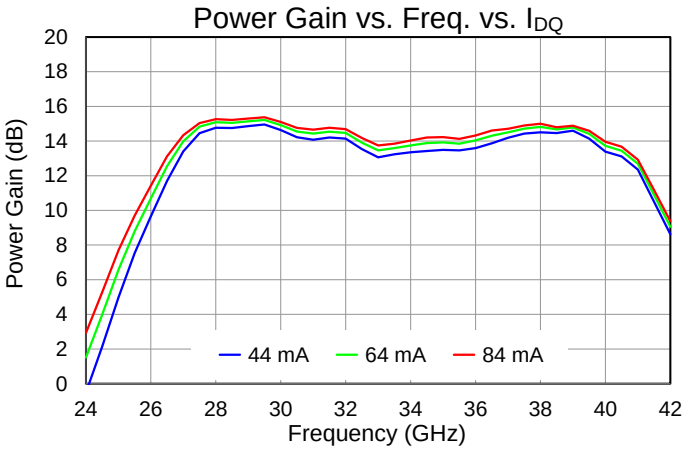
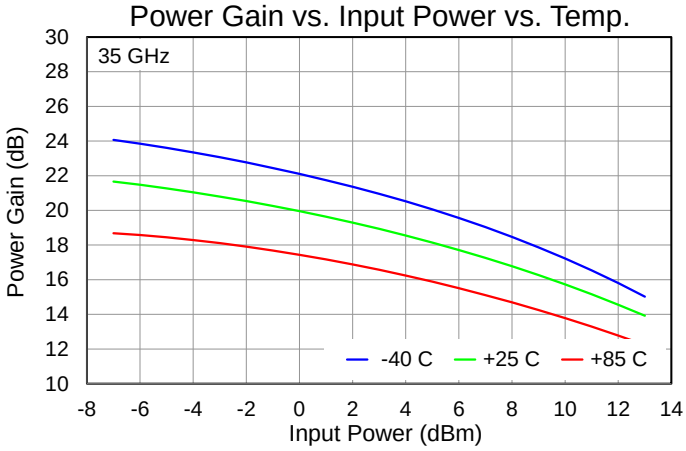






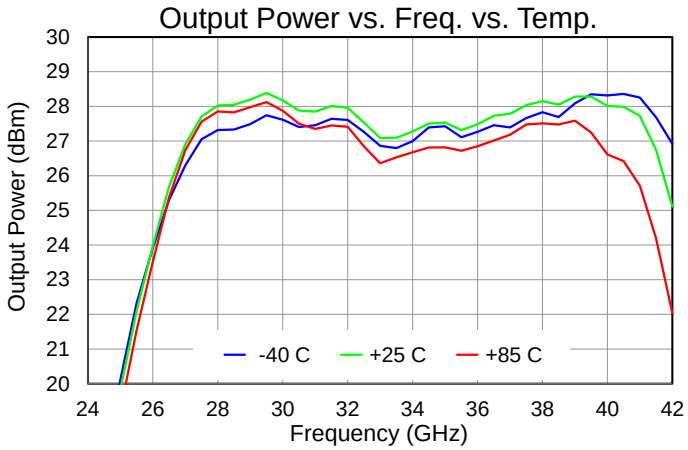


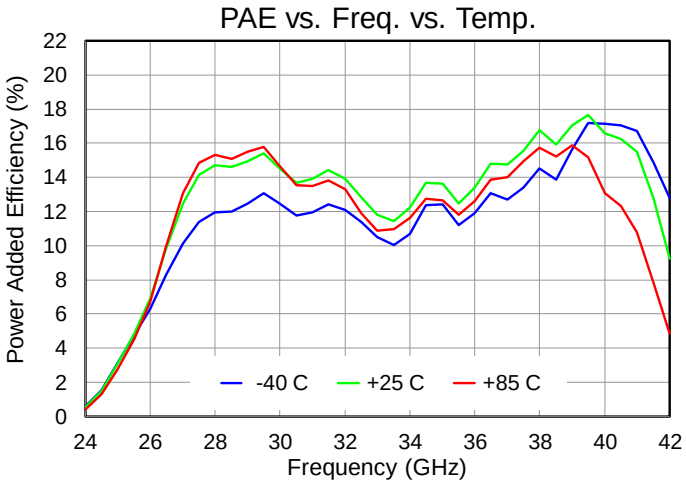


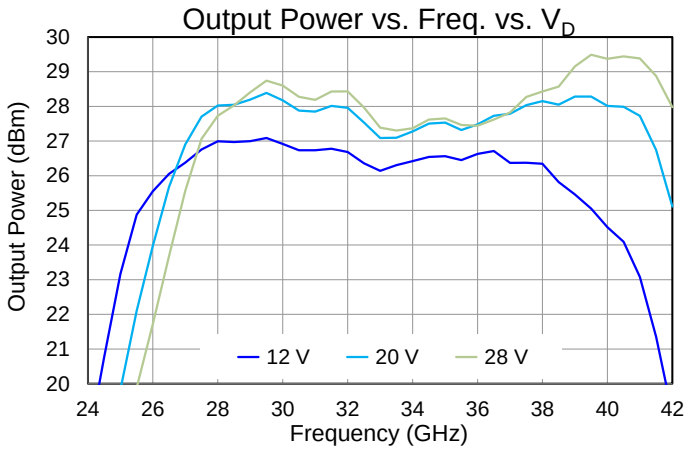


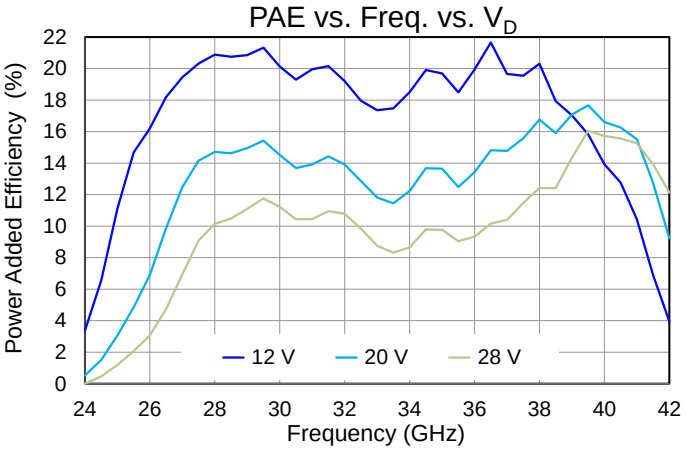
Performance Plots – Large Signal (Pulsed)

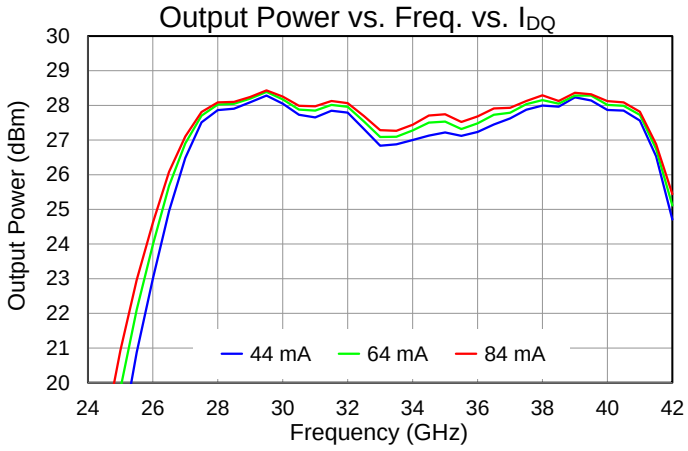
Test conditions, unless otherwise noted: **Pulsed** V_D = 20 V, I_{DQ} = 64 mA, PW = 100 µs, DC = 10%, P_{IN} = +13dBm, T_{BASE} = +25 ºC

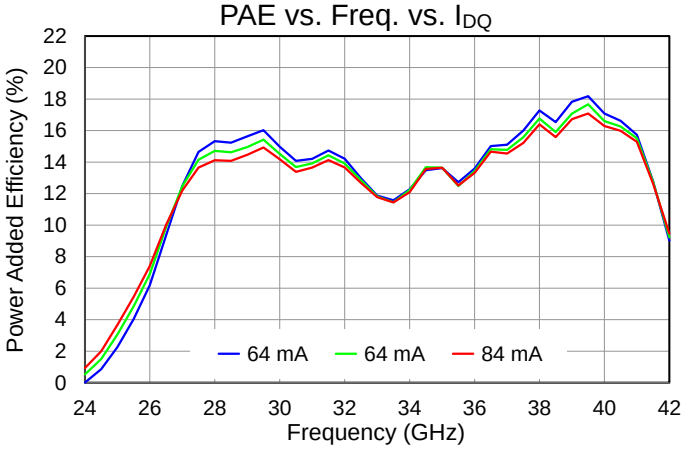












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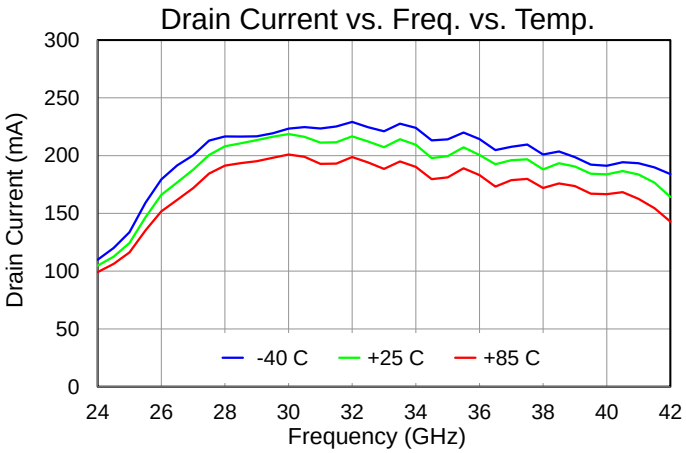
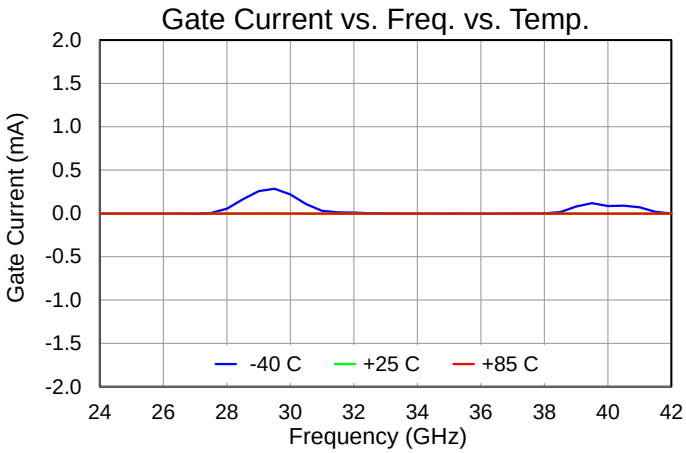
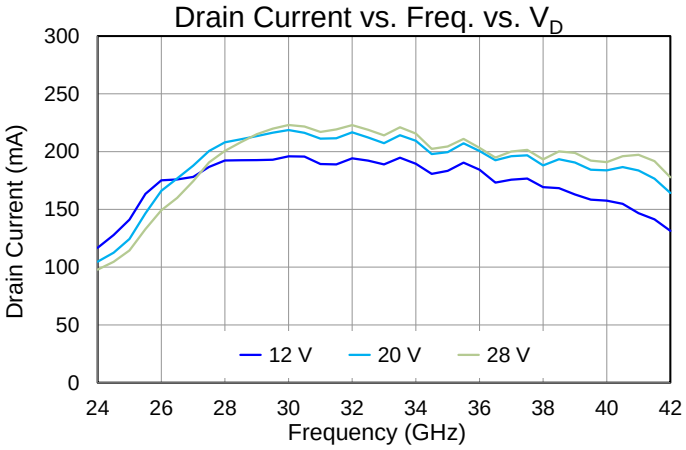
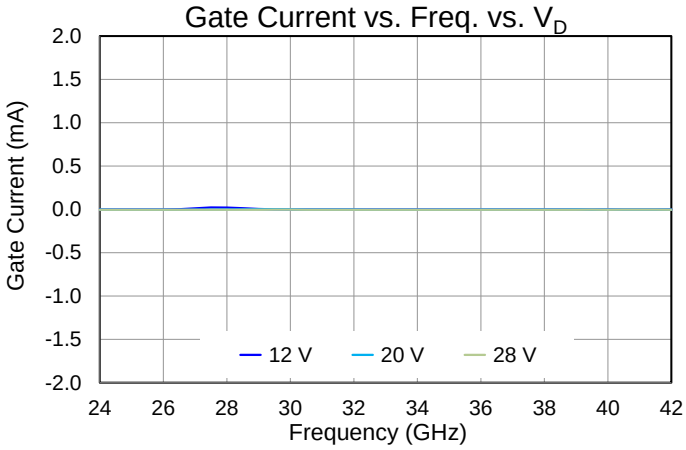
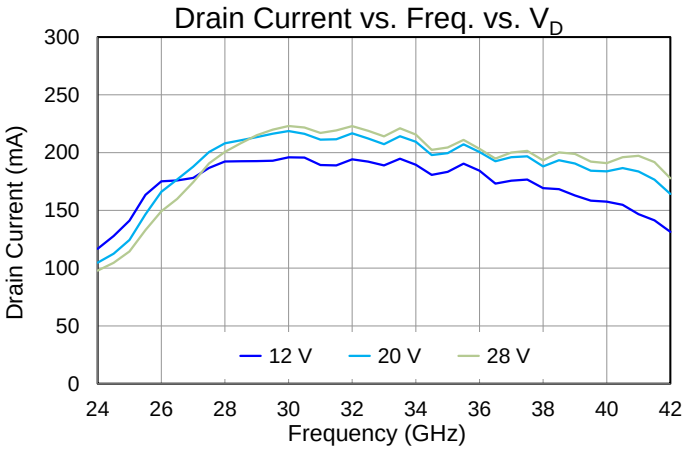
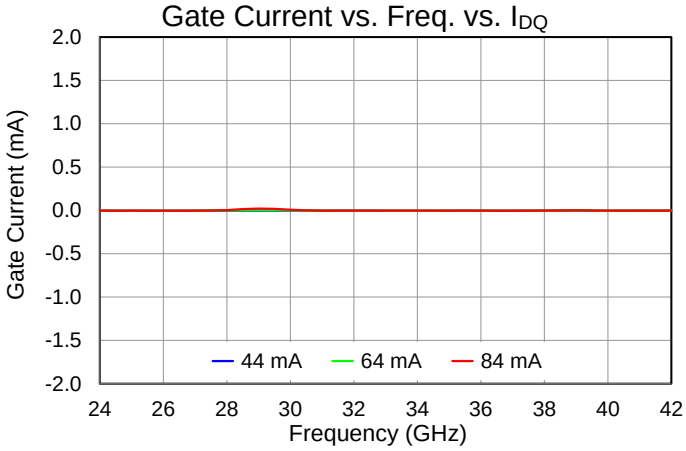






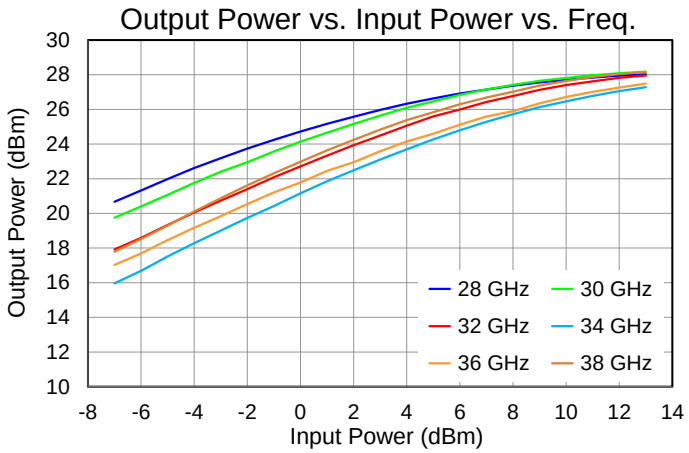


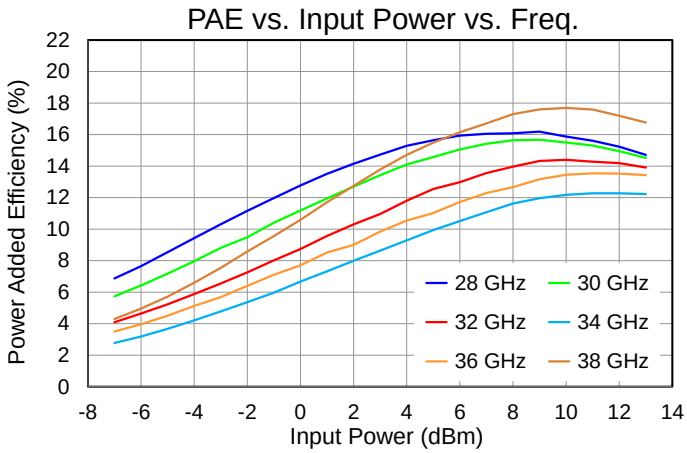


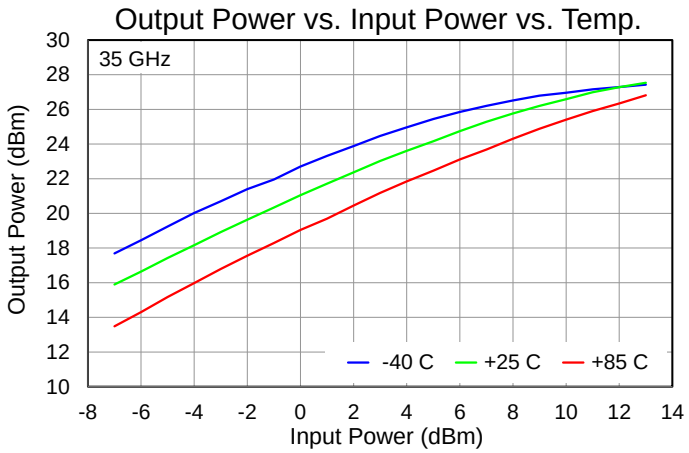


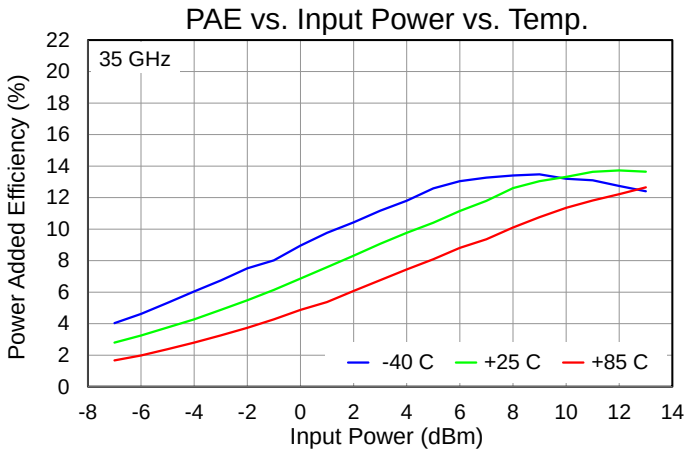
Performance Plots – Large Signal (Pulsed)

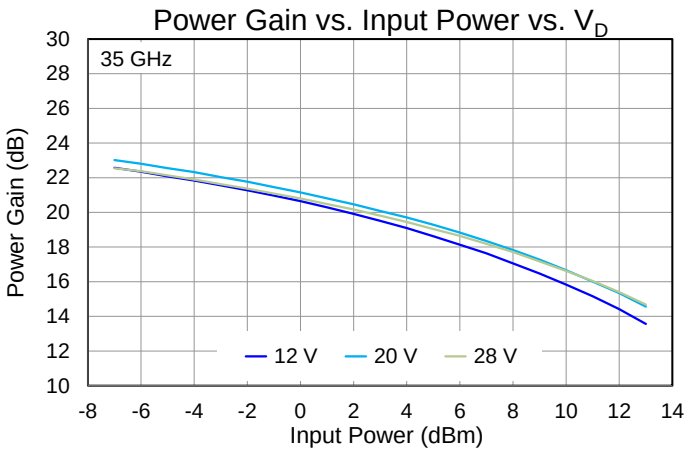
Test conditions, unless otherwise noted: **Pulsed** V_D = 20 V, I_{DQ} = 64 mA, PW = 100 µs, DC = 10%, P_{IN} = +13dBm, T_{BASE} = +25 ºC

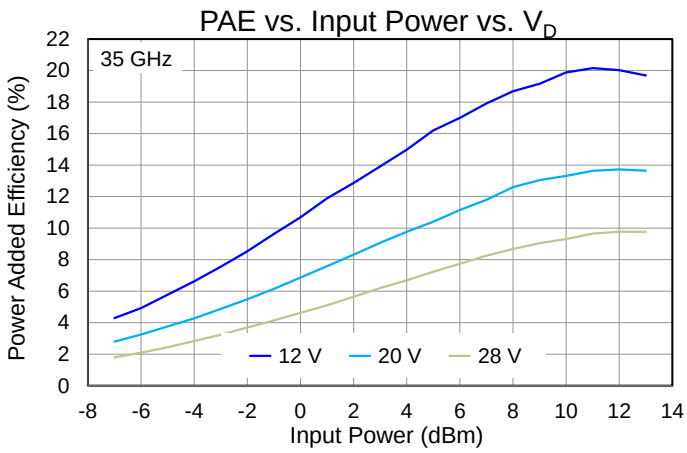






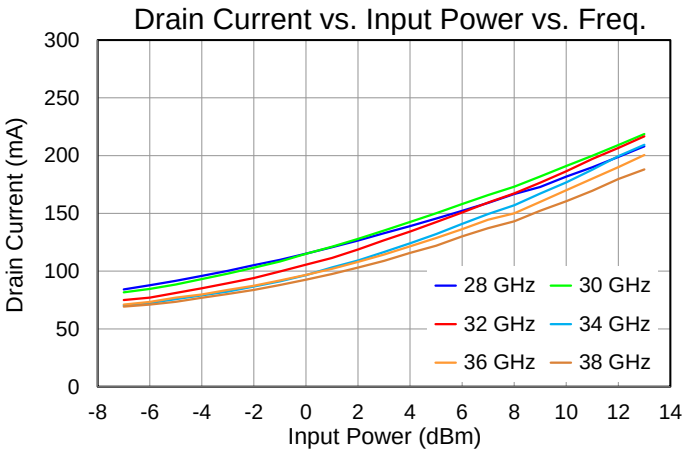


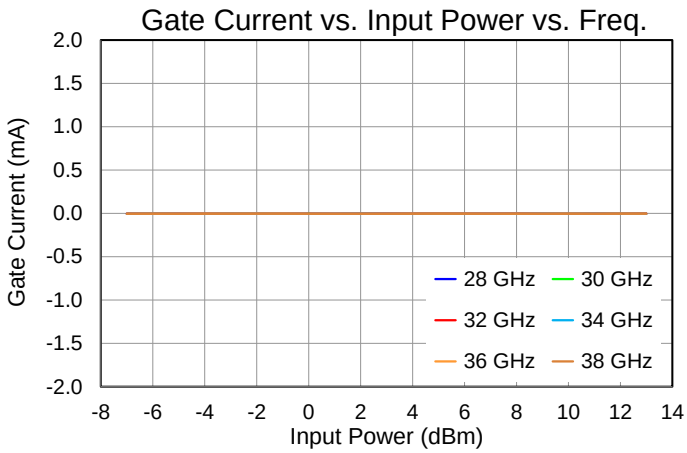


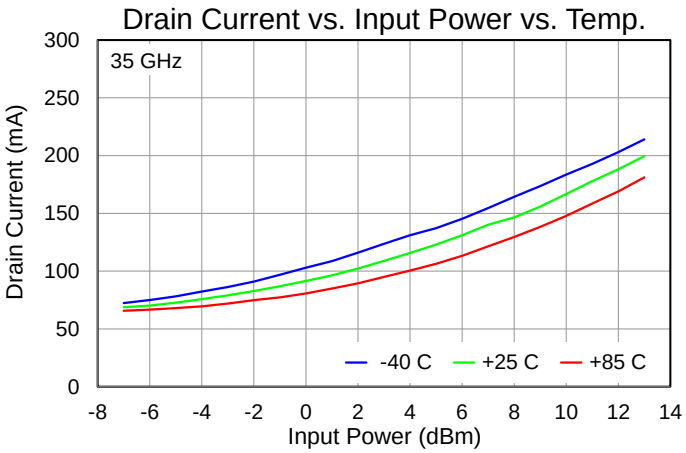


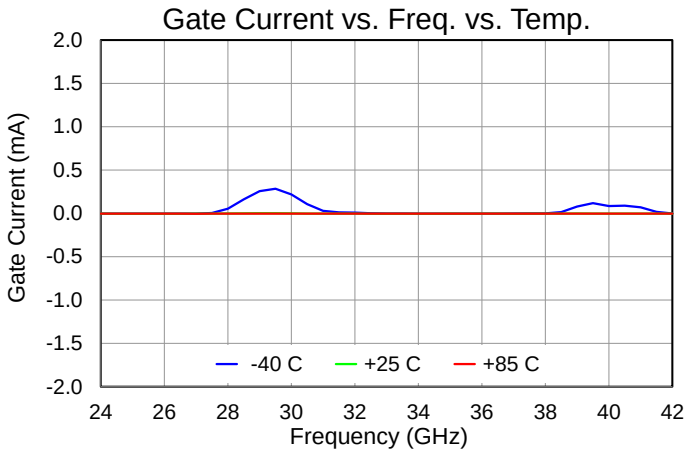
Performance Plots – Large Signal (Pulsed)

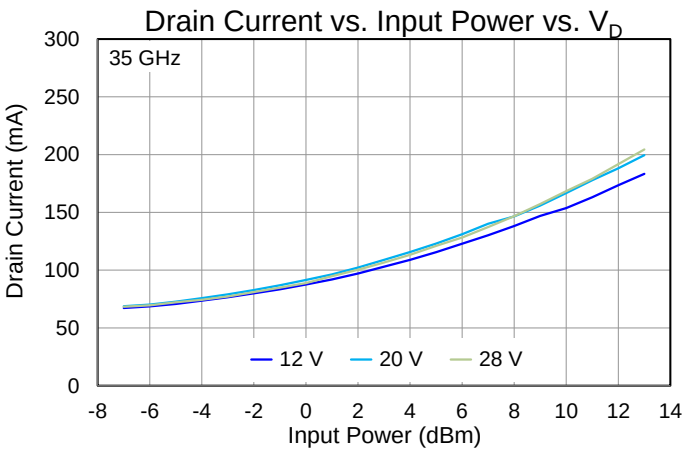
Test conditions, unless otherwise noted: **Pulsed** V_D = 20 V, I_{DQ} = 64 mA, PW = 100 µs, DC = 10%, P_{IN} = +13dBm, T_{BASE} = +25 ºC

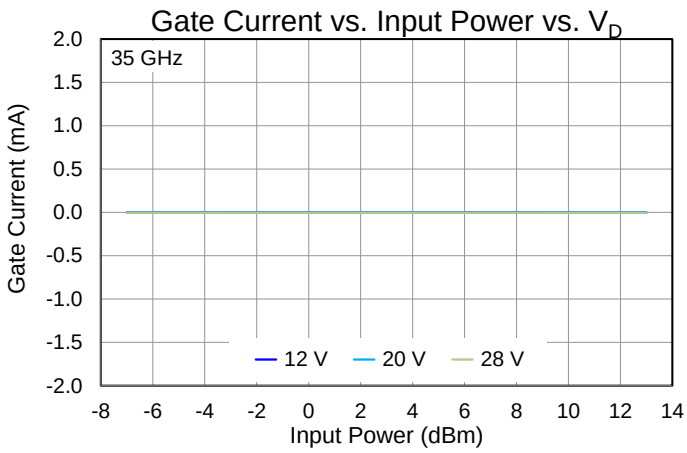






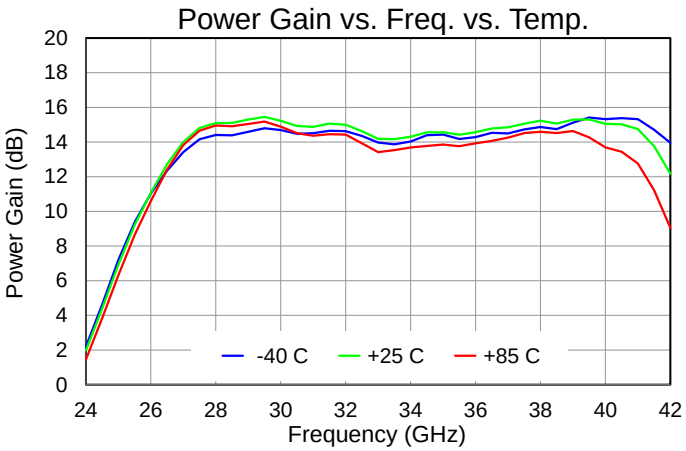


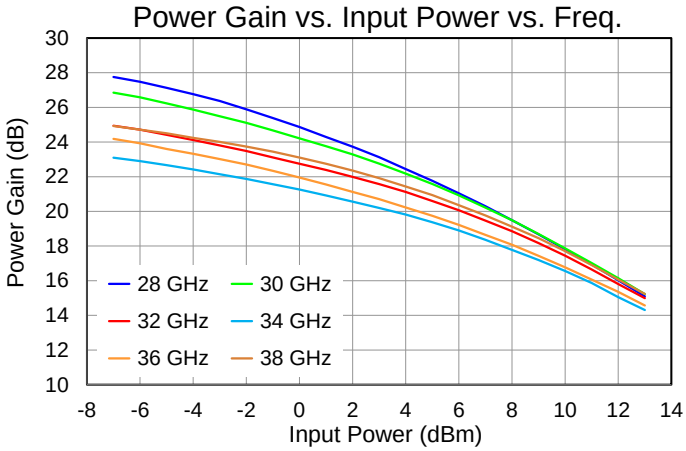


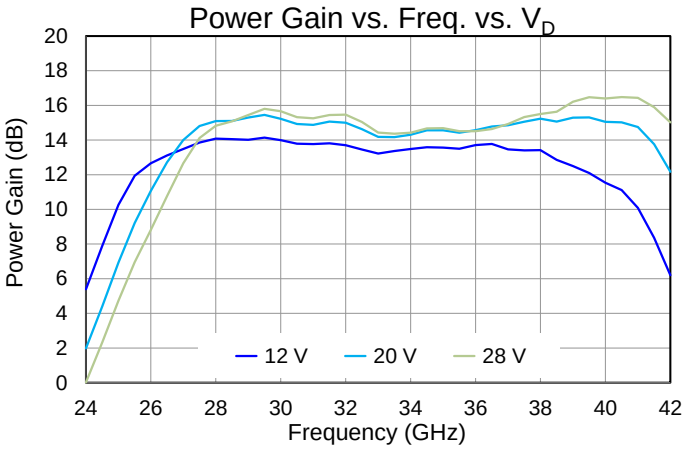


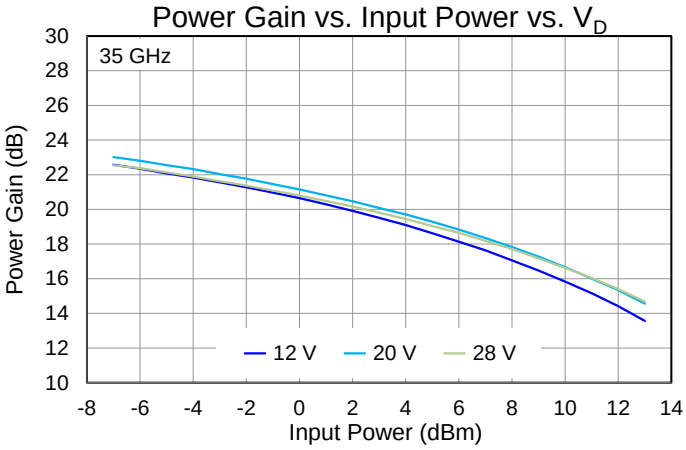
Performance Plots – Large Signal (Pulsed)

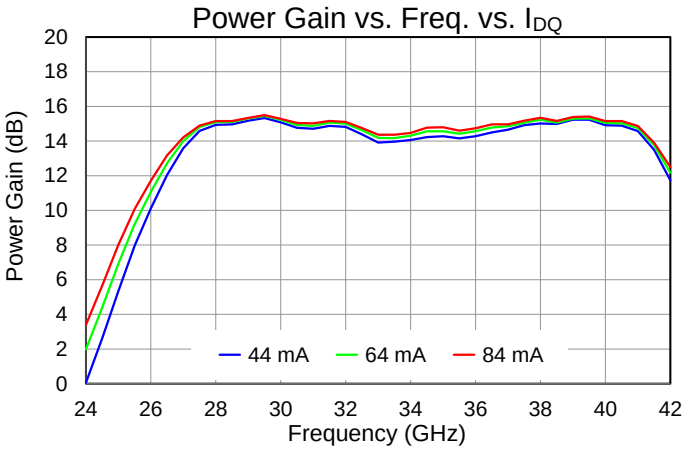
Test conditions, unless otherwise noted: **Pulsed** V_D = 20 V, I_{DQ} = 64 mA, PW = 100 µs, DC = 10%, P_{IN} = +13dBm, T_{BASE} = +25 ºC

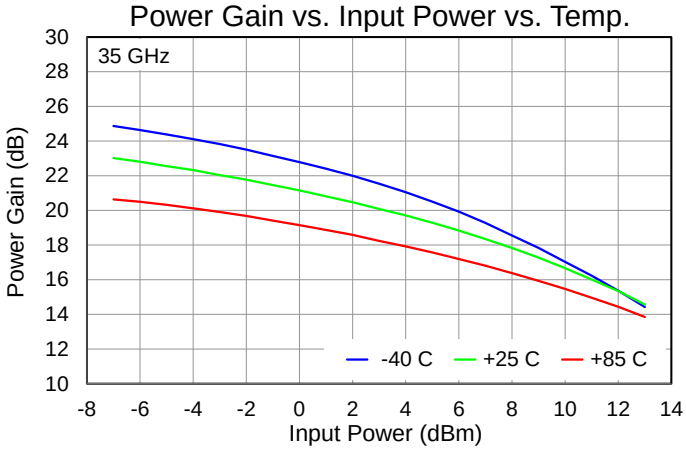








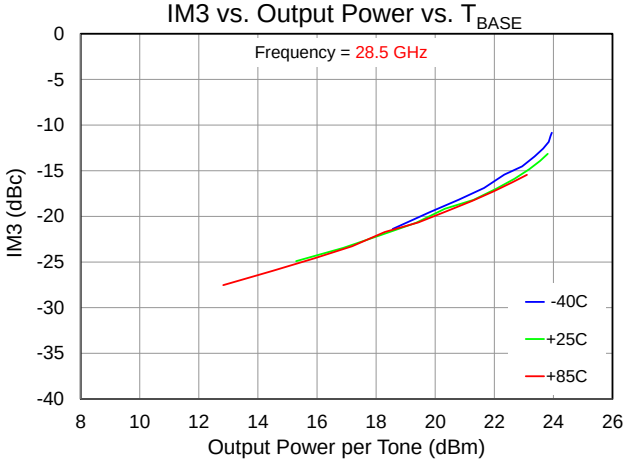




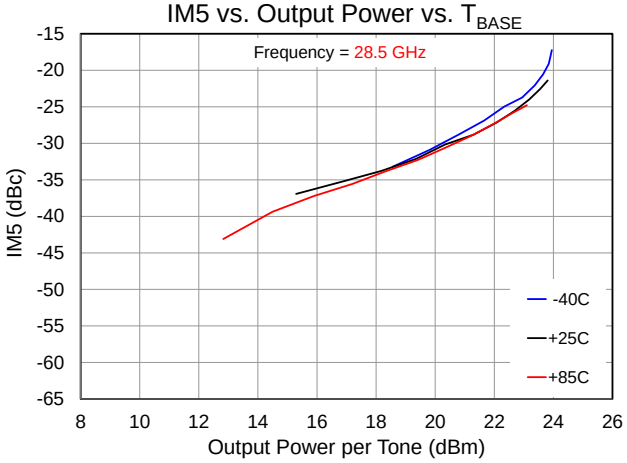
Performance Plots – Linearity

Test conditions, unless otherwise noted: CW, V_D = 20 V, I_{DQ} = 64 mA, **F_C = 28.5 GHz**, Tone Spacing = 100 MHz, T_{BASE} = +25 ºC

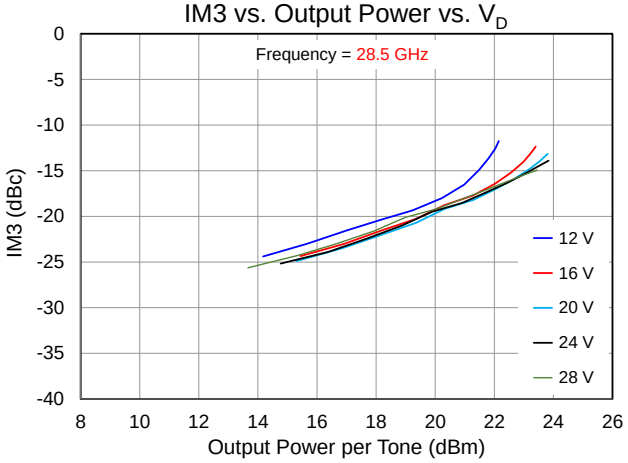
IM3 vs. Output Power vs. T_{BASE}



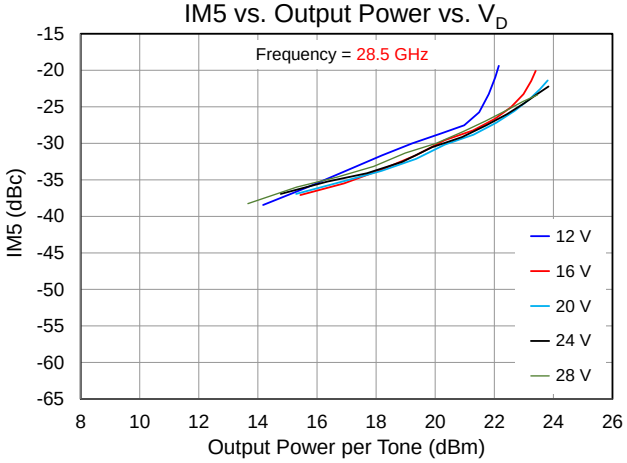
IM5 vs. Output Power vs. T_{BASE}



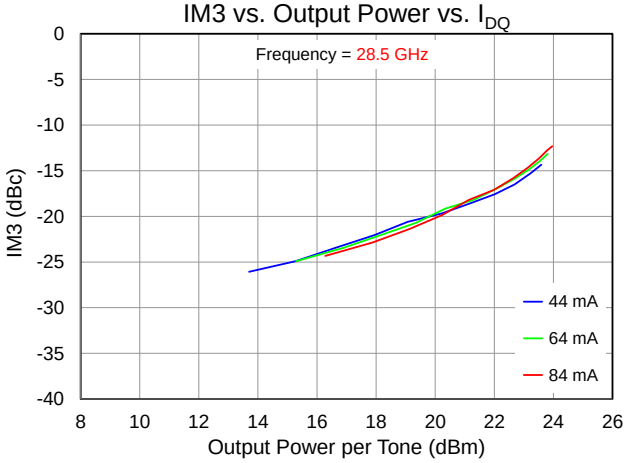
IM3 vs. Output Power vs. V_D



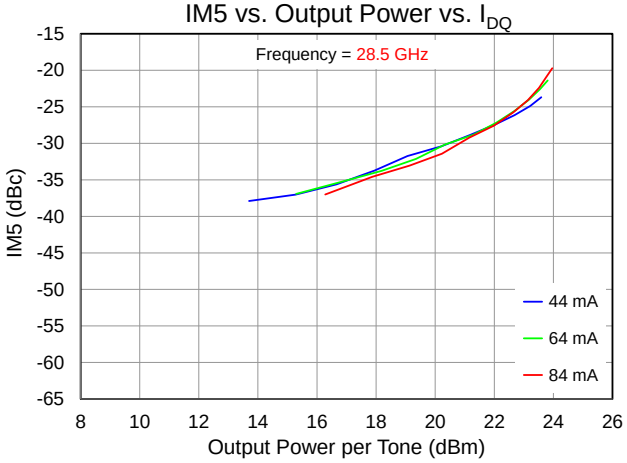
IM5 vs. Output Power vs. V_D



IM3 vs. Output Power vs. I_{DQ}



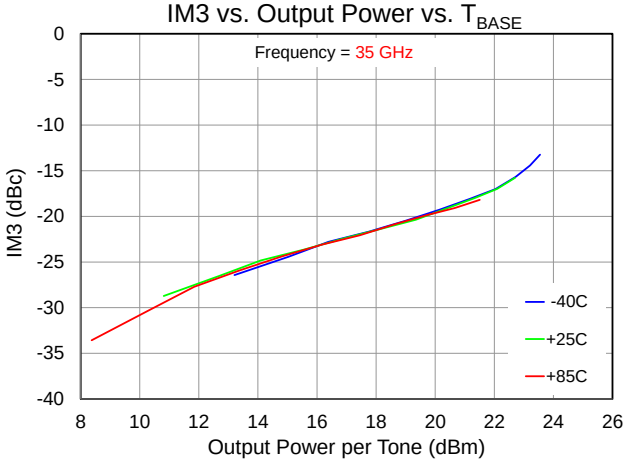
IM5 vs. Output Power vs. I_{DQ}



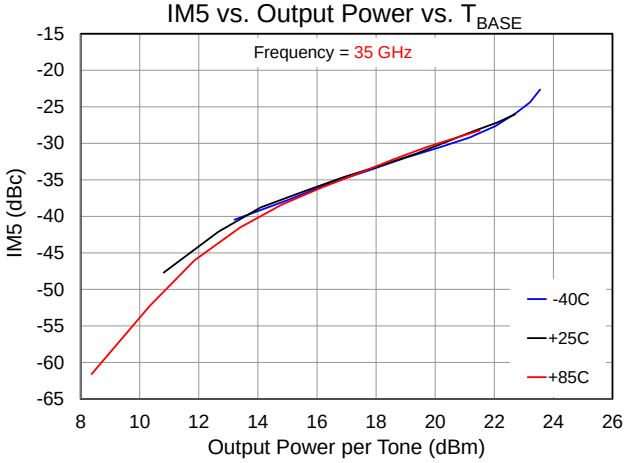
Performance Plots – Linearity

Test conditions, unless otherwise noted: CW, V_D = 20 V, I_{DQ} = 64 mA, **F_C = 35 GHz**, Tone Spacing = 100 MHz, T_{BASE} = +25 ºC

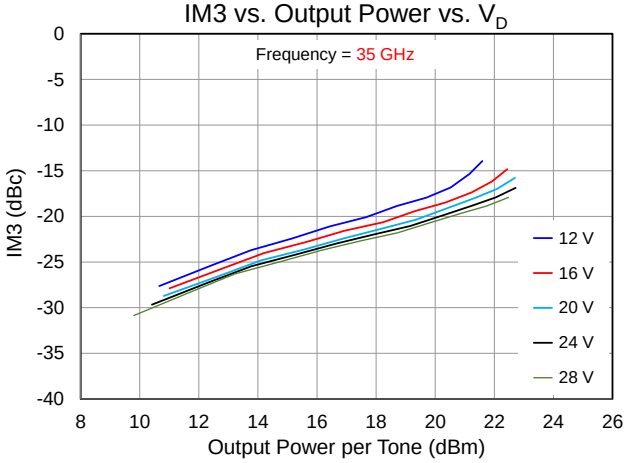
IM3 vs. Output Power vs. T_{BASE}



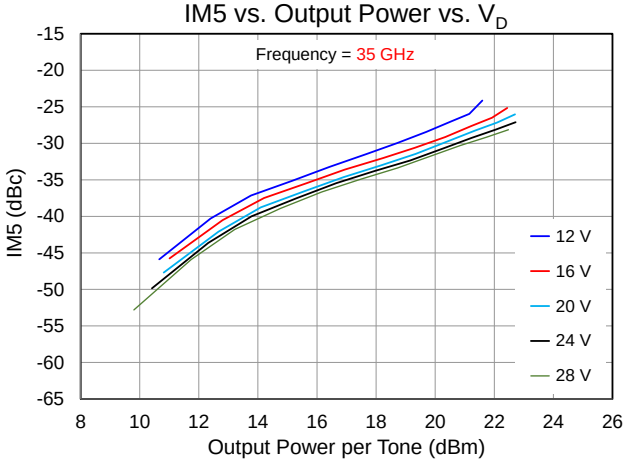
IM5 vs. Output Power vs. T_{BASE}



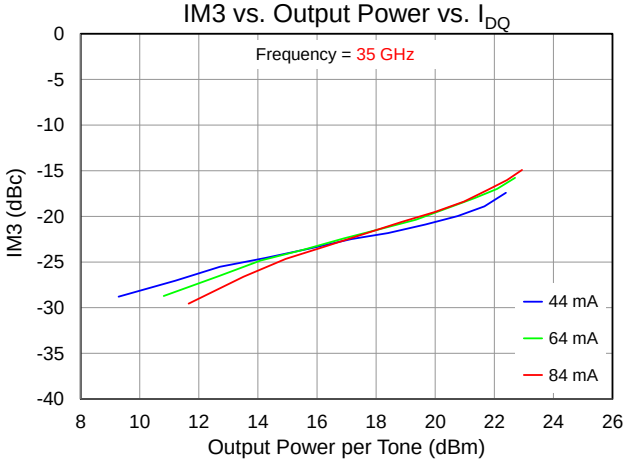
IM3 vs. Output Power vs. V_D



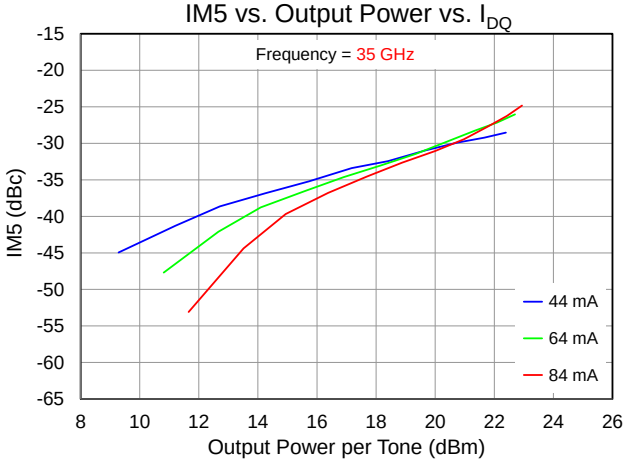
IM5 vs. Output Power vs. V_D



IM3 vs. Output Power vs. I_{DQ}



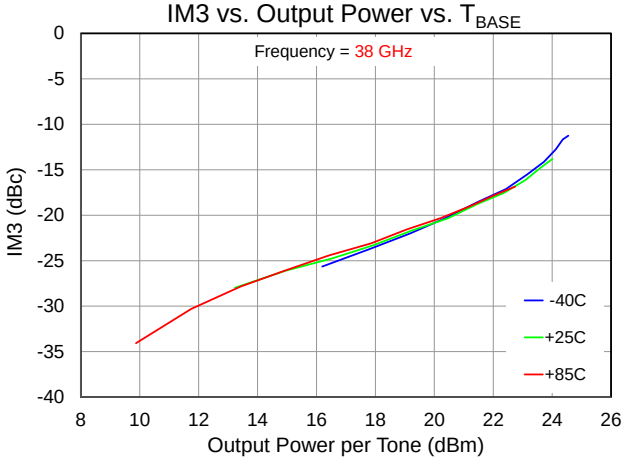
IM5 vs. Output Power vs. I_{DQ}



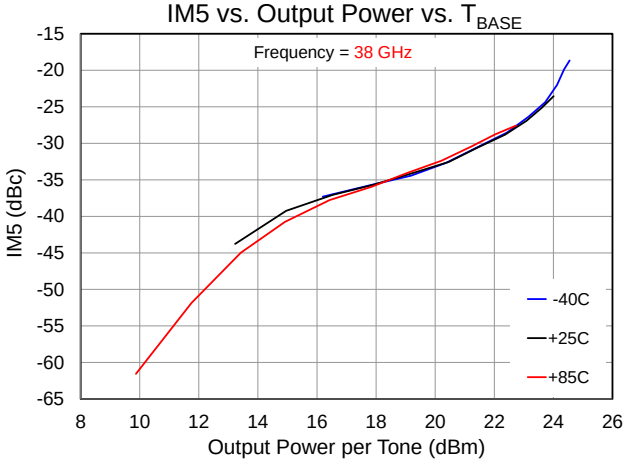
Performance Plots – Linearity

Test conditions, unless otherwise noted: CW, V_D = 20 V, I_{DQ} = 64 mA, **F_C = 38 GHz**, Tone Spacing = 100 MHz, T_{BASE} = +25 ºC

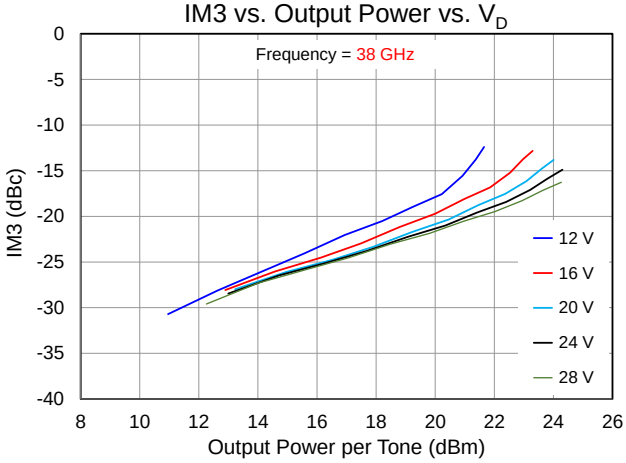
IM3 vs. Output Power vs. T_{BASE}



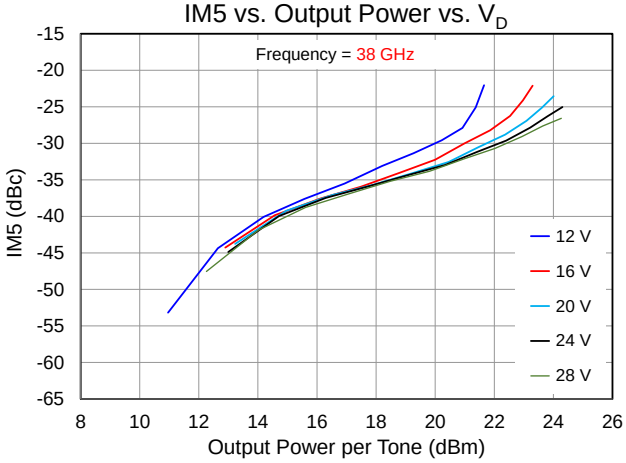
IM5 vs. Output Power vs. T_{BASE}



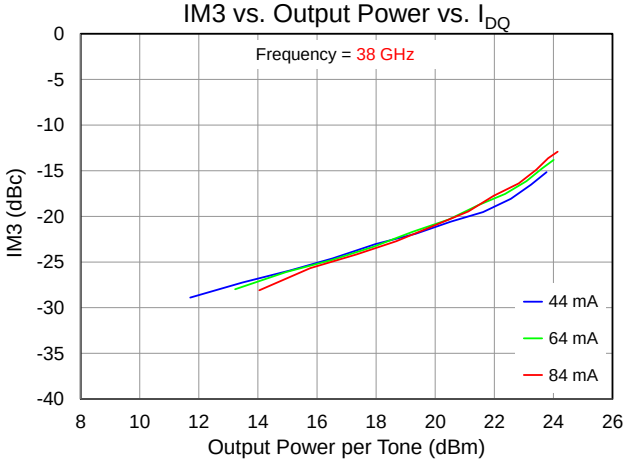
IM3 vs. Output Power vs. V_D



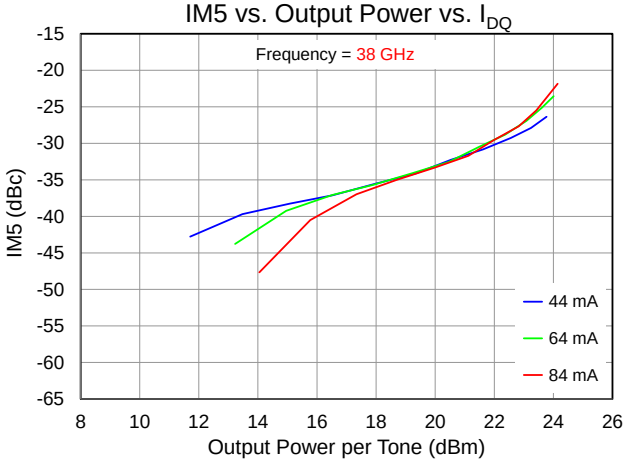
IM5 vs. Output Power vs. V_D



IM3 vs. Output Power vs. I_{DQ}



IM5 vs. Output Power vs. I_{DQ}

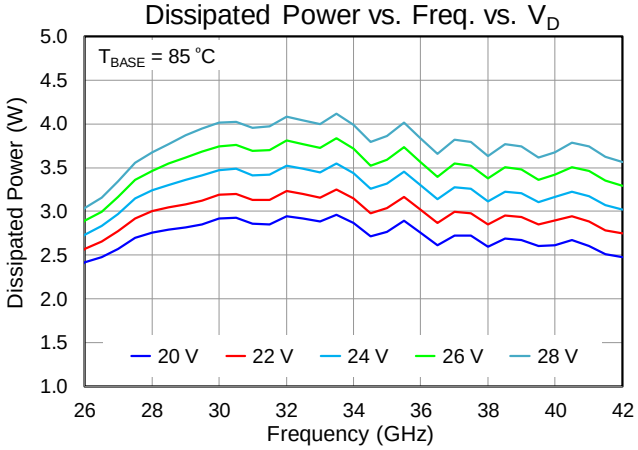


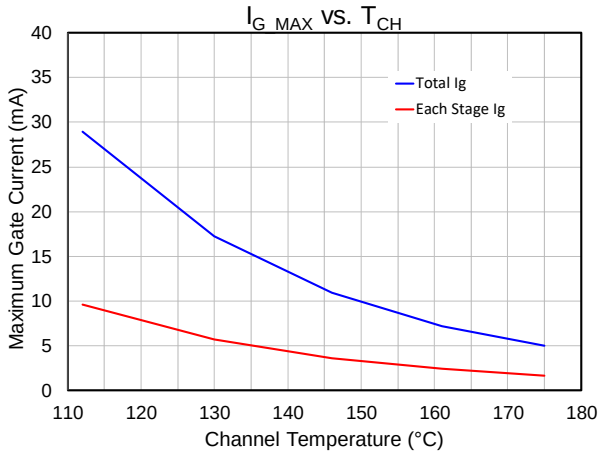
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 ºC, V_D = 20 V, I_{DQ} = 64 mA, P_{DISS} = 1.28 W, No RF (quiescent DC operation)	26.9	ºC/W
Channel Temperature, T_{CH} (No RF) (2)		106	°C
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 ºC, V_D = 20 V, I_{DQ} = 64 mA, Freq = 32 GHz, I_{D_Drive} = 165 mA, P_{IN} = 13 dBm, P_{OUT} = 25.8 dBm, P_{DISS} = 2.95 W	17.3	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		136	°C
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 ºC, V_D = 28 V, I_{DQ} = 64 mA, Freq = 32 GHz, I_{D_Drive} = 158 mA, P_{IN} = 13 dBm, P_{OUT} = 25.5 dBm, P_{DISS} = 4.1 W	18.1	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		159	ºC

Notes:
1. Thermal resistance determined to the back of a 20 mil Cu-Mo carrier plate with eutectic die attach (85 ºC)
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

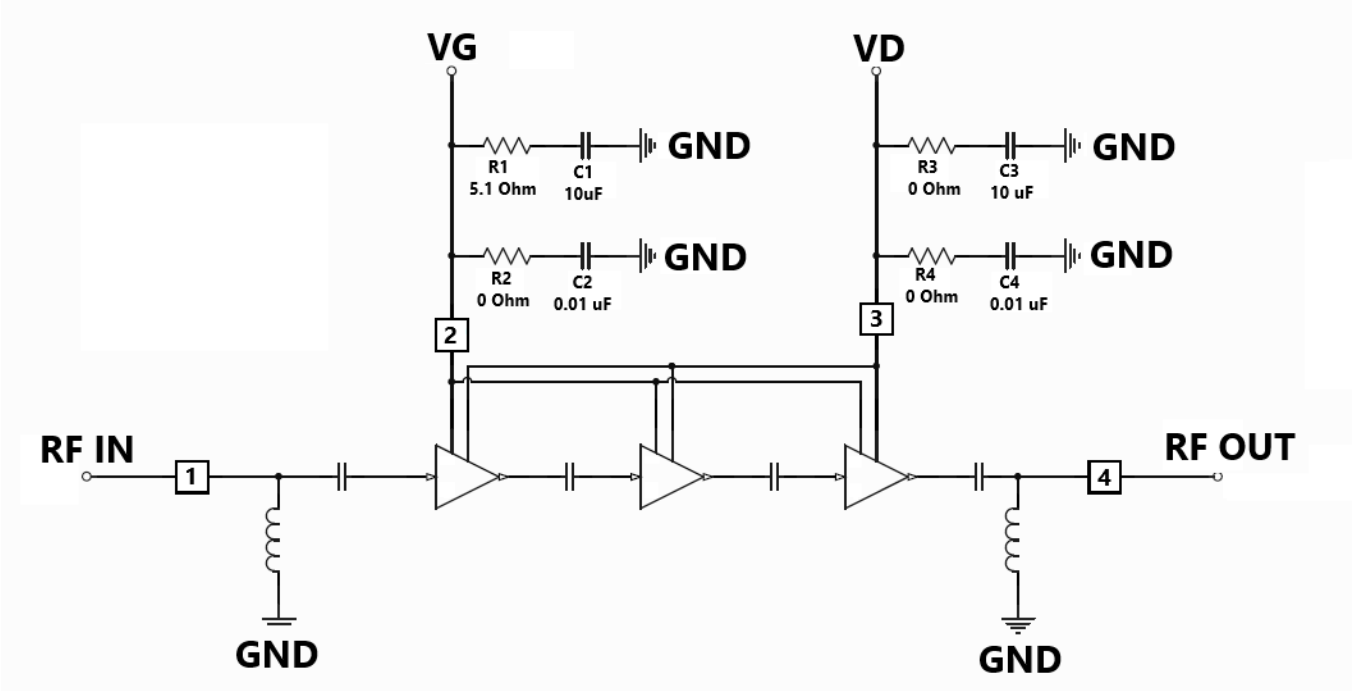
Dissipated Power and Maximum Gate Current





Test conditions, unless otherwise noted: CW, V_D = 20 V, I_{DQ} = 64 mA, P_{IN} = +13dBm, T_{BASE} = +85 ºC

Applications Information



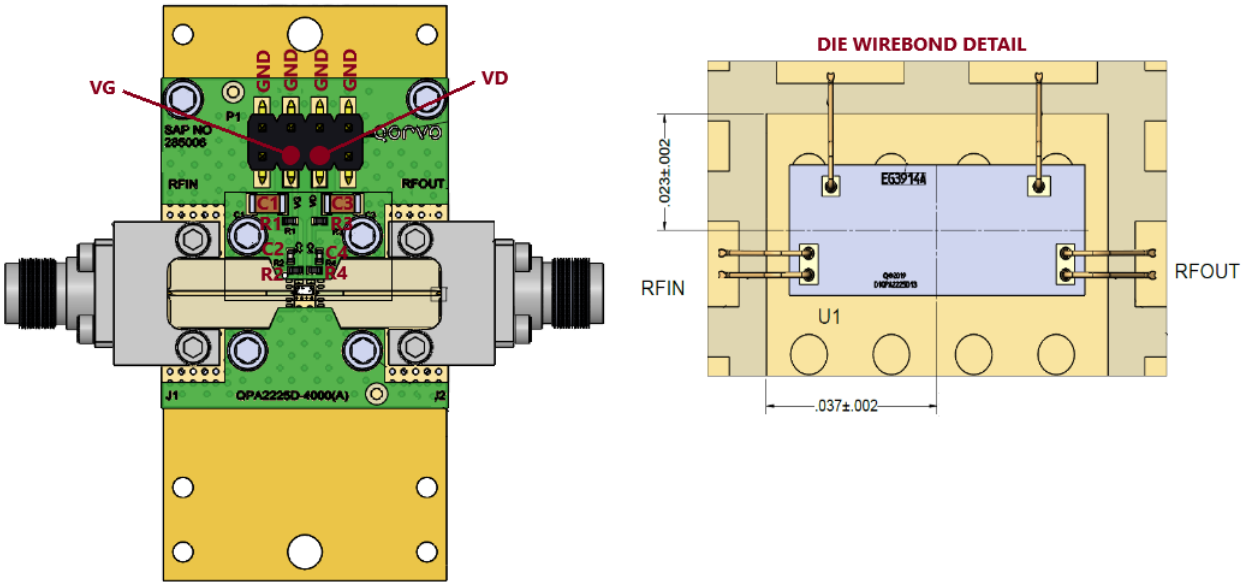
Bias-Up Procedure

1. Set I_D limit to 250 mA, I_G limit to 10 mA
2. Set V_G to −4.0 V
3. Set V_D +20 V
4. Adjust V_G more positive until $I_{DQ} \approx 64$ 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

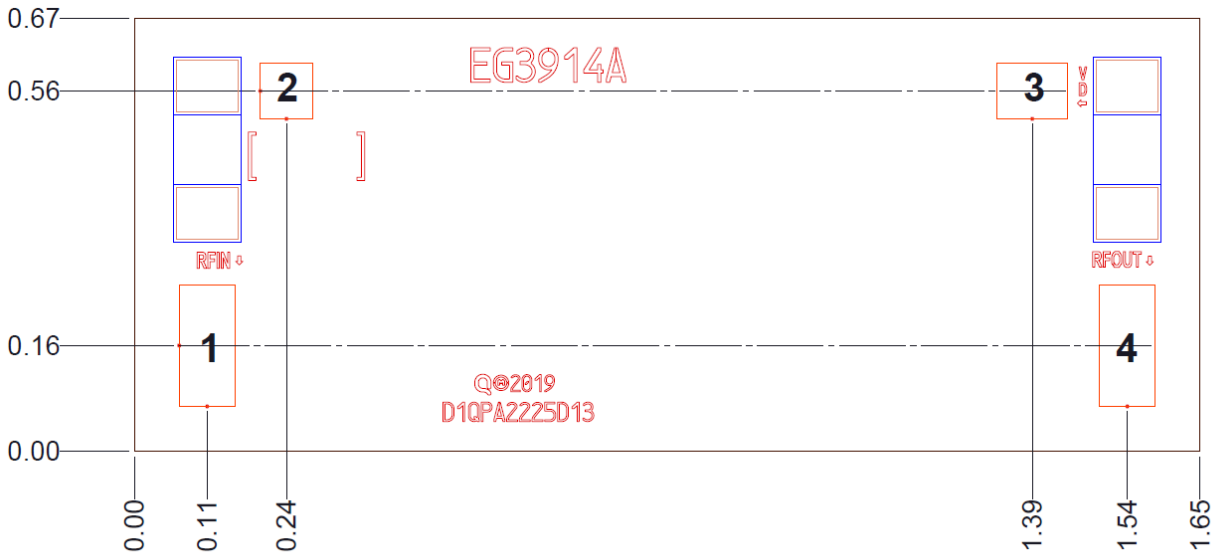


PCB is made from Rogers 4003C dielectric, 0.008 inch thick, 0.5 oz. copper both sides.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1, C3	10 uF	CAP, 10 uF, 20%, 50 V, 20%, X5R, 1206	Various	
C2, C4	0.01 uF	CAP, 0.01 uF, 10%, 50 V, X7R, 0402	Various	
R1	5.1 Ω	RES, 5.1 OHM, 5%, 50 V, 0402	Various	
R2, R3, R4	0 Ω	RES, 0 OHM, JMPR, 0402	Various	
J1, J2	2.4 mm	CONNECTOR, FEMALE, ENDLAUNCH	Southwest Microwave	1492-04A-5

Mechanical Information



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

Bond Pad Description

Pad No.	Symbol	Pad Size (mm)	Description
1	RF In	0.087 x 0.188	RF Input; matched to 50 Ω, DC blocked
2	VG	0.081 x 0.086	Gate voltage, bias network is required; see Application Circuit on page 19 as an example.
3	VD	0.110 x 0.086	Drain voltage, bias network is required; see Application Circuit on page 19 as an example.
4	RF Out	0.087 x 0.188	RF Output; matched to 50 Ω, 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)	1B	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
- 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

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