QPA1003D

1 – 8 GHz 10 W GaN Power Amplifier

Product Description

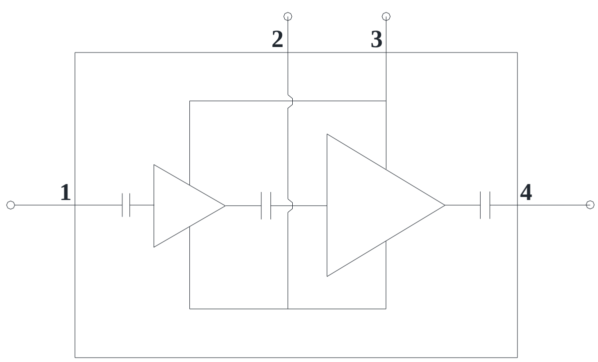
Qorvo's QPA1003D is a wideband high power MMIC amplifier fabricated on Qorvo's production 0.15um GaN on SiC process (QGaN15). The QPA1003D operates from 1 – 8 GHz and typically provides 10 W saturated output power with power-added efficiency of 30% and large-signal gain of 25 dB. This combination of wideband performance provides the flexibility designers are looking for to improve system performance while reducing size and cost.

The QPA1003D is matched to 50Ω with integrated DC blocking capacitors on both RF I/O ports simplifying system integration. The wideband performance makes it ideally suited in support of test instrumentation and electronic warfare, as well as, supporting multiple radar and communication bands.

The QPA1003D is 100% DC and RF tested on-wafer to ensure compliance to electrical specifications.

Lead-free and RoHS compliant.

Functional Block Diagram



Product Features

- Frequency Range: 1 – 8 GHz
- P_{OUT}: 40 dBm @ P_{IN} = 15 dBm
- PAE: 30 % @ P_{IN} = 15 dBm
- Large Signal Gain: 25 dB @ P_{IN} = 15dBm
- Small Signal Gain: 30 dB
- Bias: V_D = +28 V, I_{DQ} = 650 mA
- Chip Dimensions: 3.3 x 3.55 x 0.10 mm
- Process Technology: QGaN15

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

Applications

- Electronic Warfare (EW)
- Radar
- Communications
- Test Instrumentation

Ordering Information

Part No.	Description
QPA1003D	1 – 8 GHz 10 W GaN Power Amplifier
QPA1003DPCB4B01	Evaluation Board

Electrical Specifications

Test conditions unless otherwise noted: 25 °C, V_D = +28 V, I_{DQ} = 650 mA CW

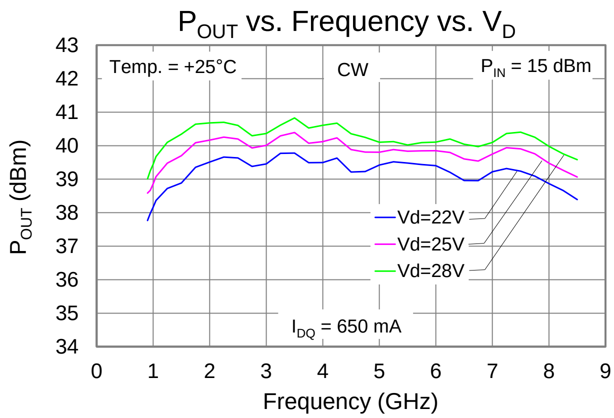
Parameter		Min	Typ	Max	Units
Operational Frequency Range		1	–	8	GHz
Output Power @ P_{IN} = 15 dBm	Frequency = 1 GHz		39.4	–	dBm
	Frequency = 4 GHz		40.6	–	
	Frequency = 8 GHz		40	–	
Power Added Efficiency @ P_{IN} = 15 dBm	Frequency = 1 GHz		46.8	–	%
	Frequency = 4 GHz		34.4	–	
	Frequency = 8 GHz		30.4	–	
Small Signal Gain	Frequency = 1 GHz		31.5	–	dB
	Frequency = 4 GHz		32.6	–	
	Frequency = 8 GHz		31	–	
Input Return Loss	Frequency = 1 GHz		13.2	–	dB
	Frequency = 4 GHz		14.7	–	
	Frequency = 8 GHz		14.4	–	
Output Return Loss	Frequency = 1 GHz		16.7	–	dB
	Frequency = 4 GHz		11	–	
	Frequency = 8 GHz		21	–	
Small Signal Gain Temperature Coefficient		–	−0.04	–	dB/°C
Output Power Temperature Coefficient		–	−0.012	–	dBm/°C

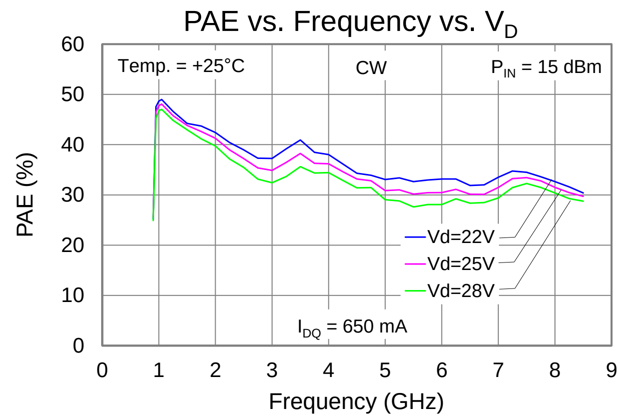
Recommended Operating Conditions

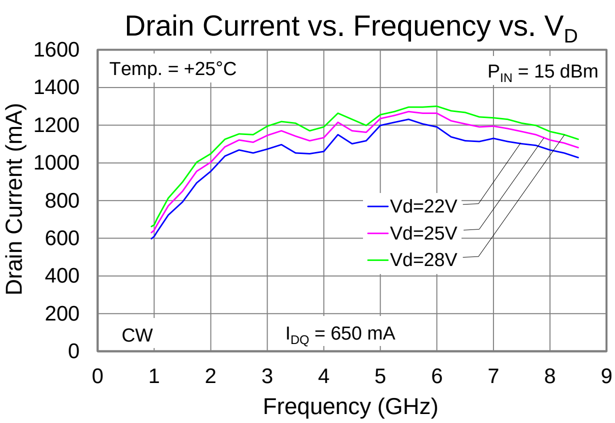
Parameter	Value / Range
Drain Voltage (V_D)	+28 V
Drain Current (I_{DQ})	650 mA
Gate Voltage Range (V_G)	−2.8 to −2.0 V
Temperature (T_{BASE})	−40 to 85 °C

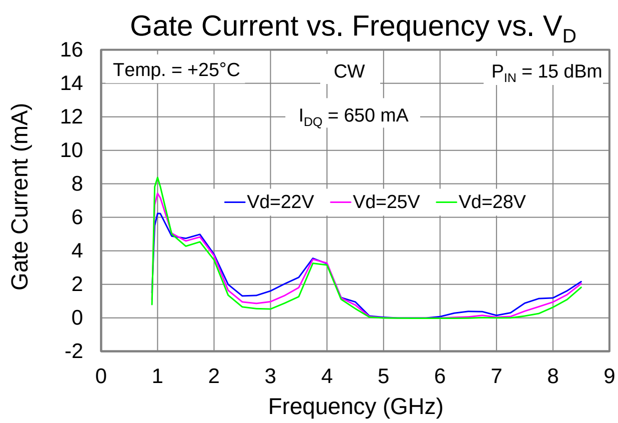
Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

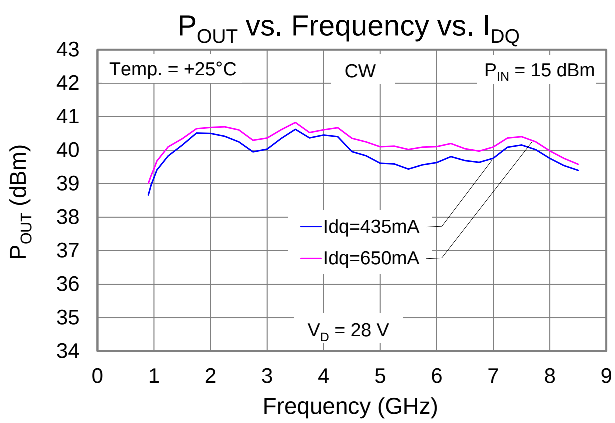
Performance Plots – Large Signal (CW)

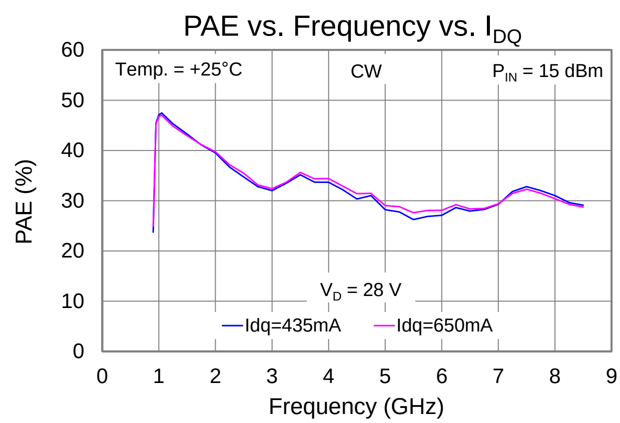












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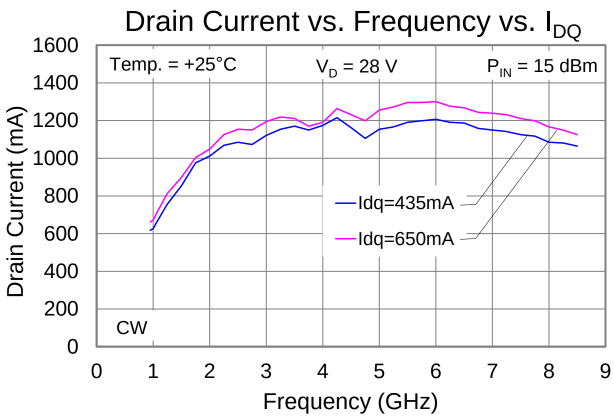

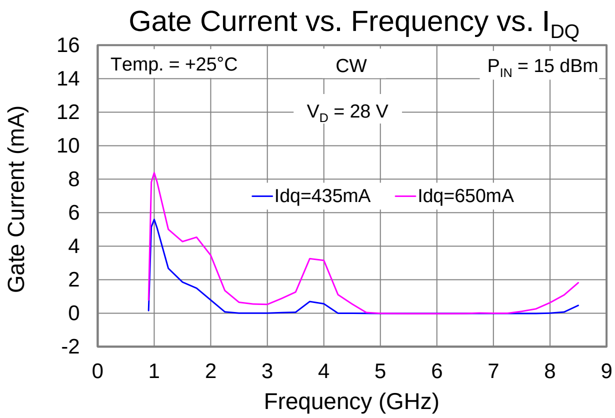

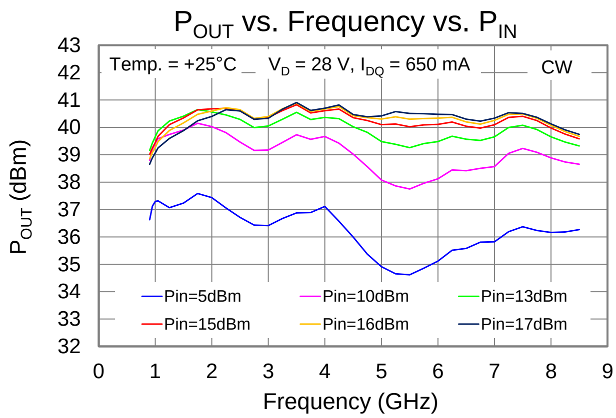

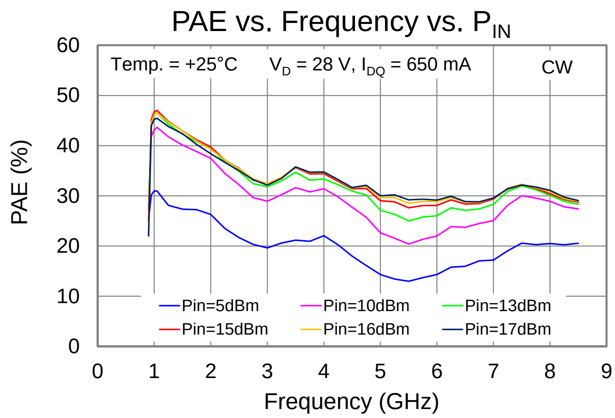

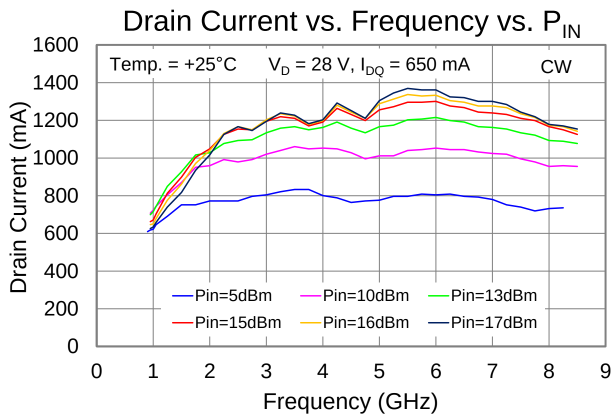

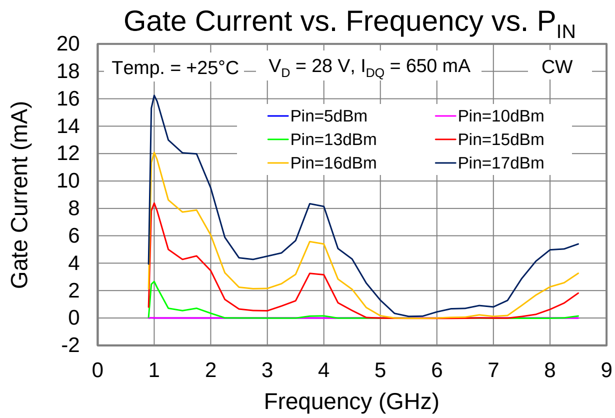

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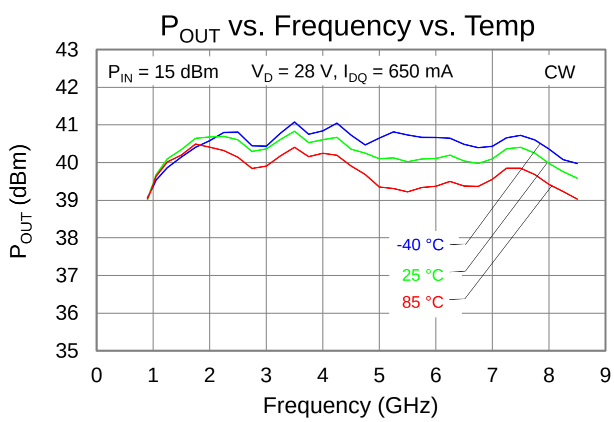

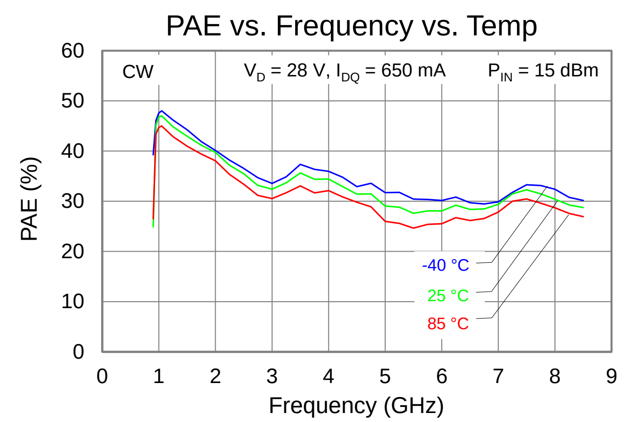

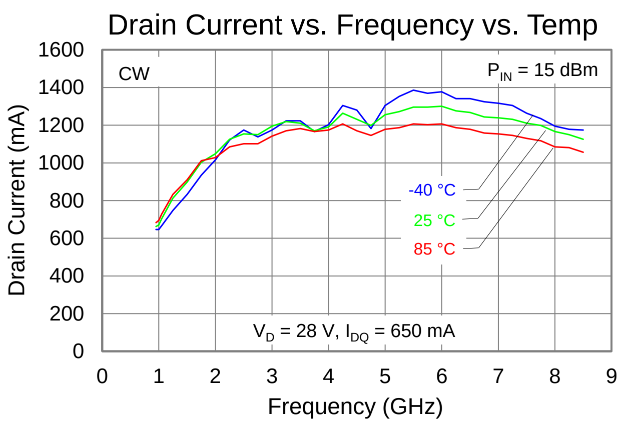

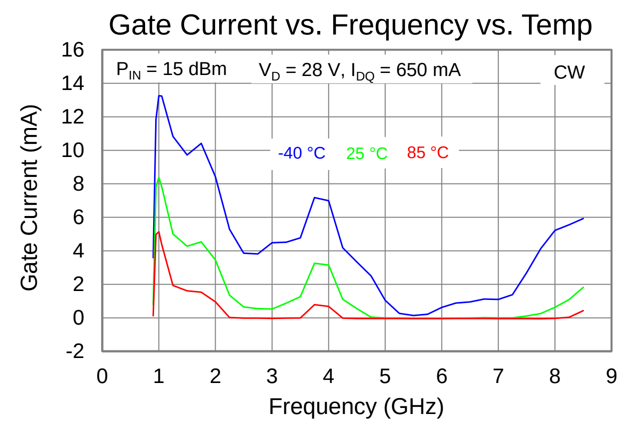

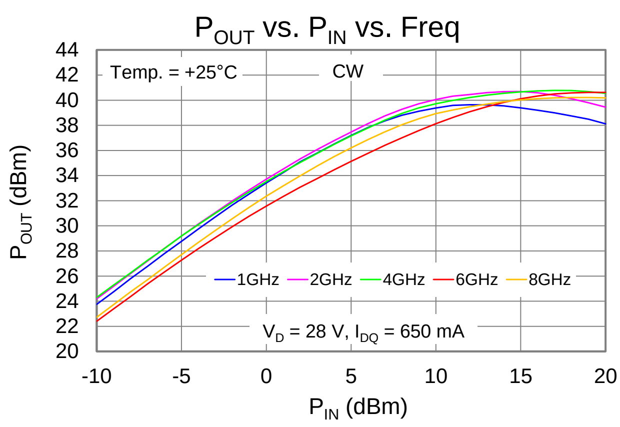

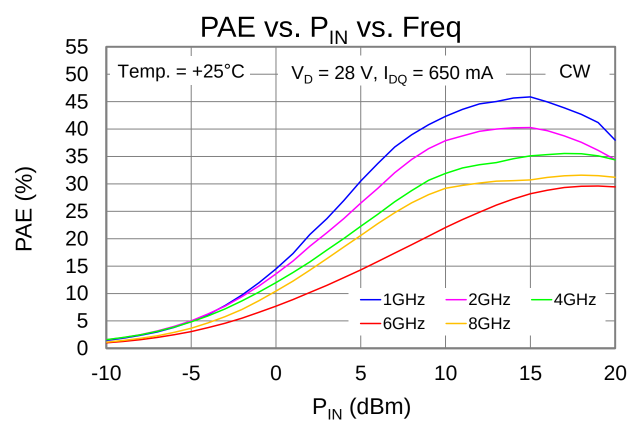

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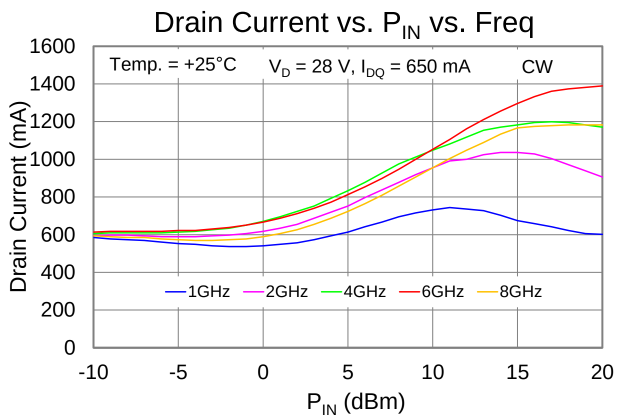

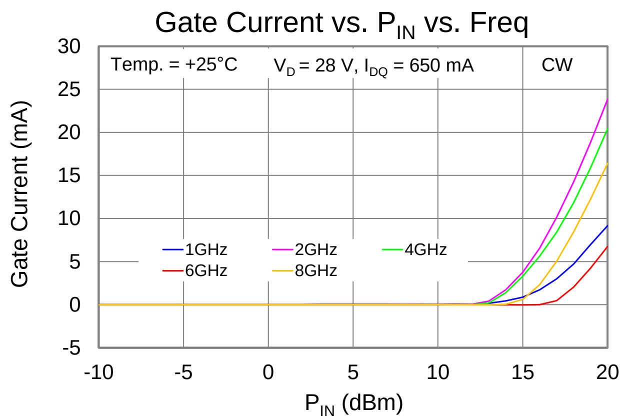

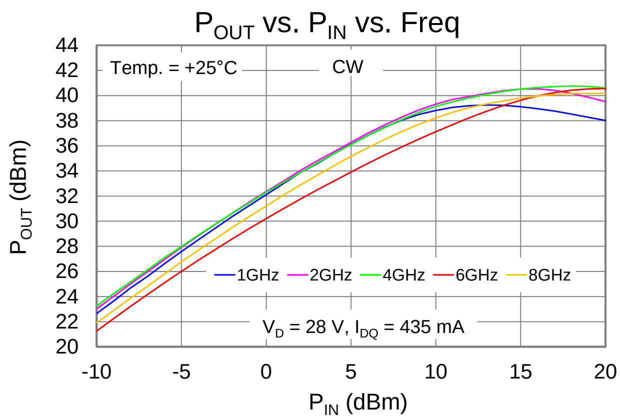

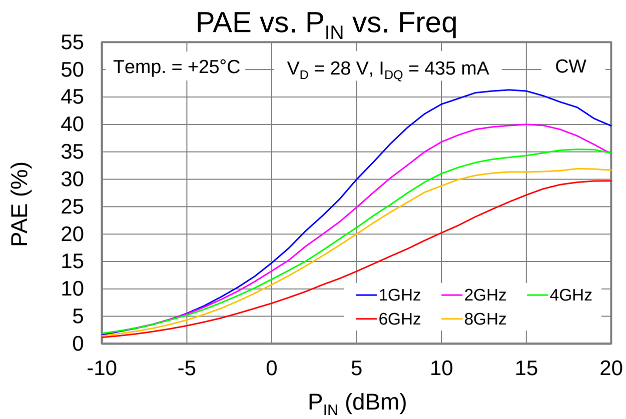

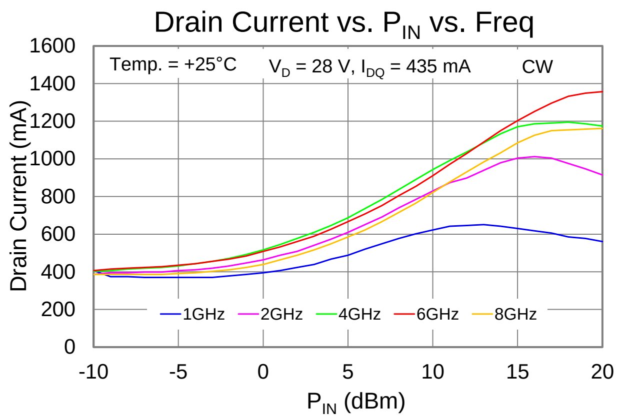

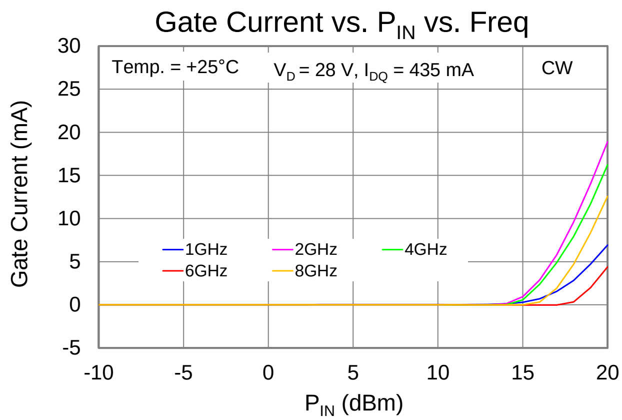

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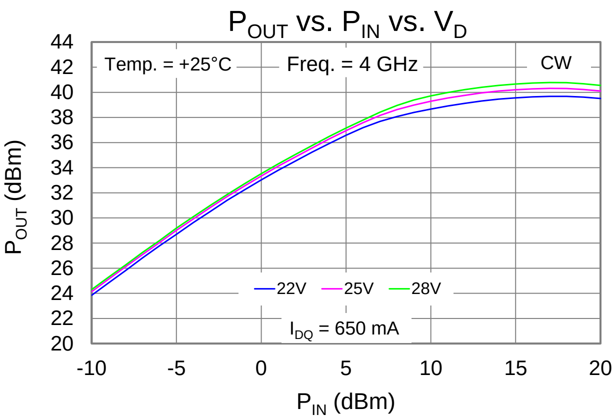

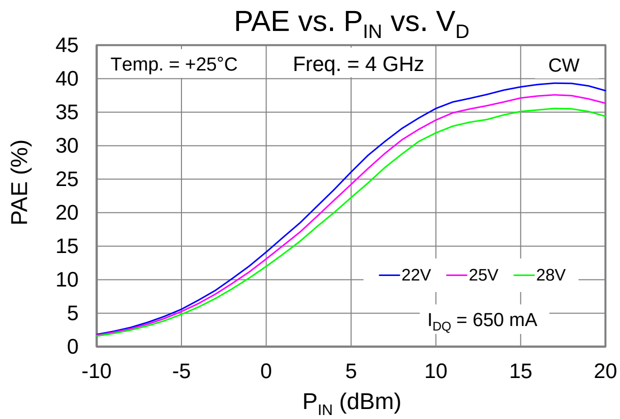

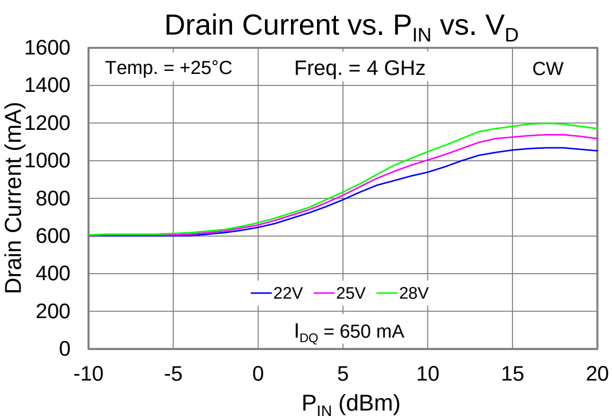

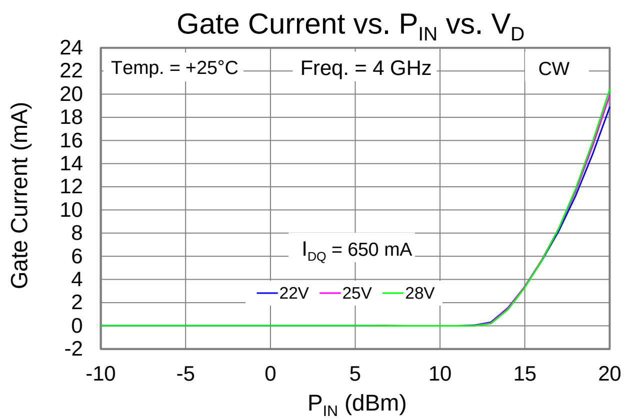

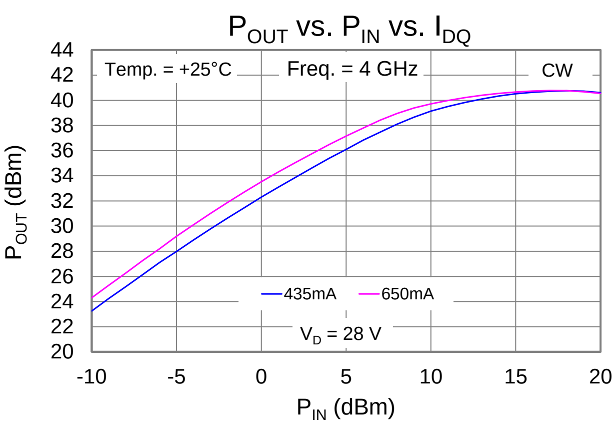

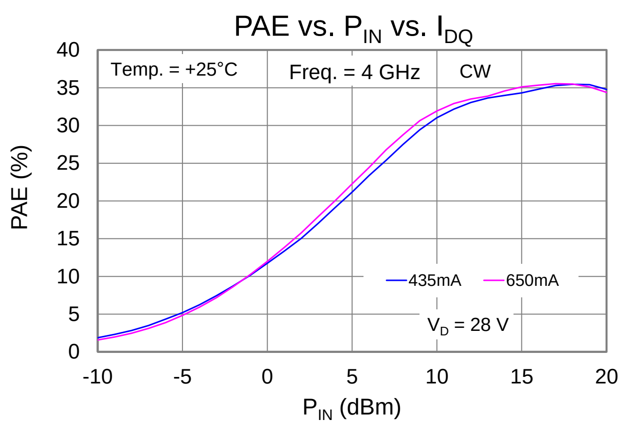

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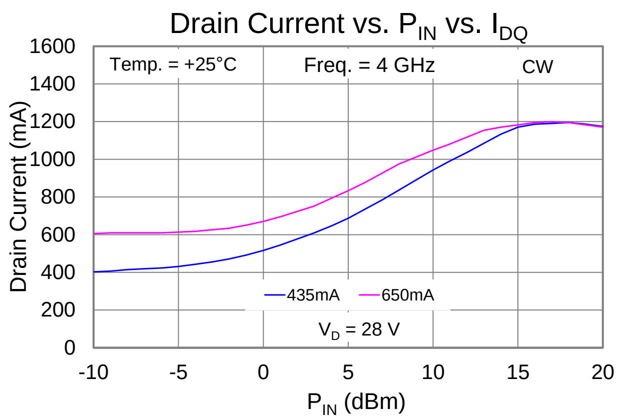

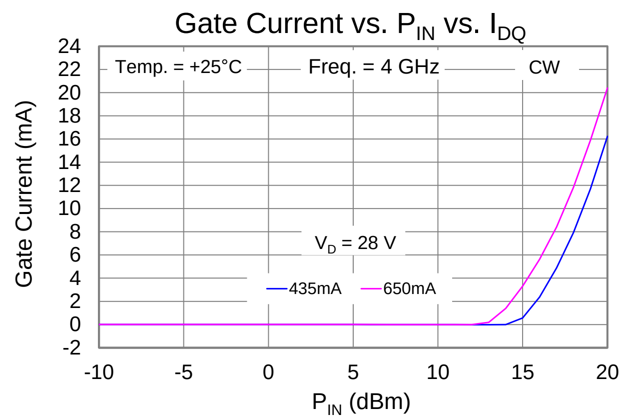

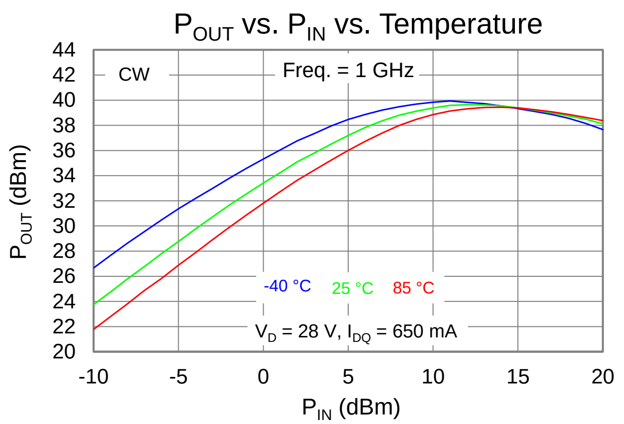

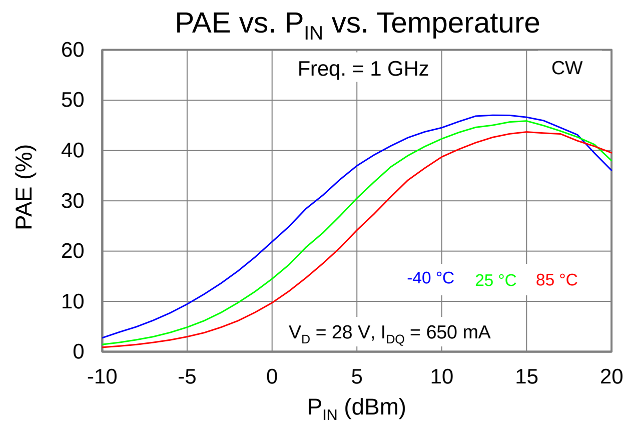

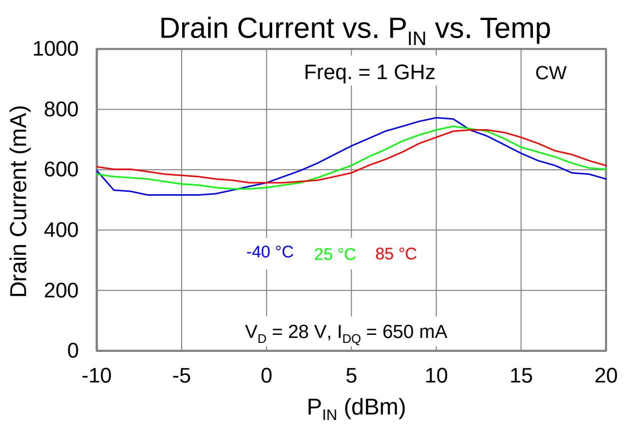

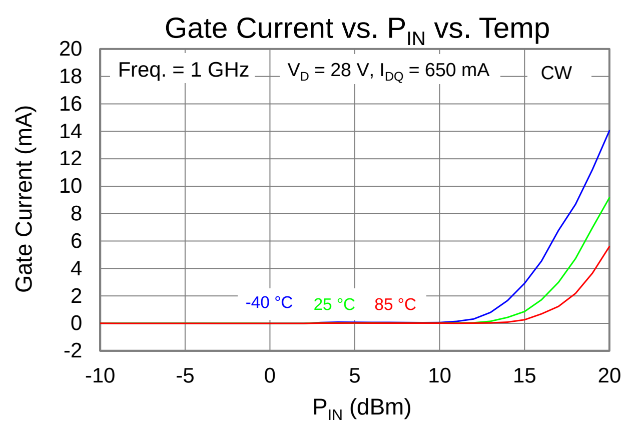

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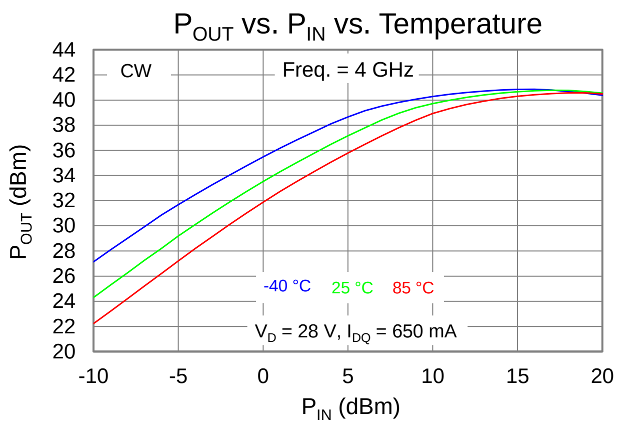
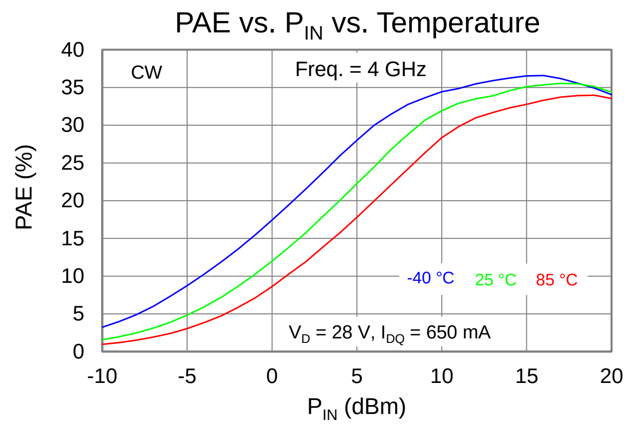
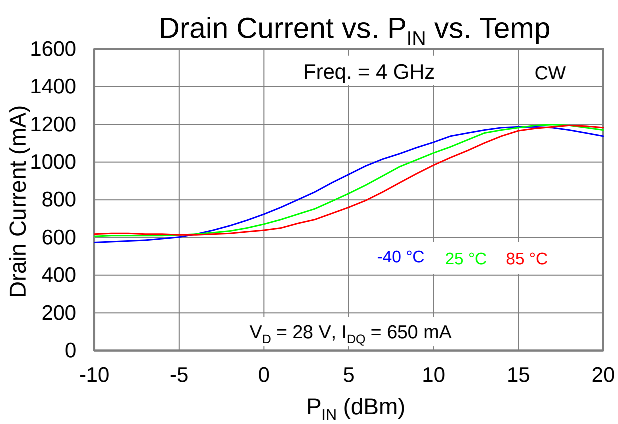
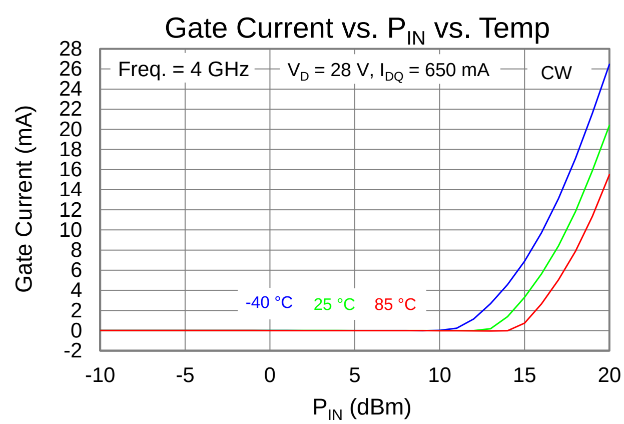
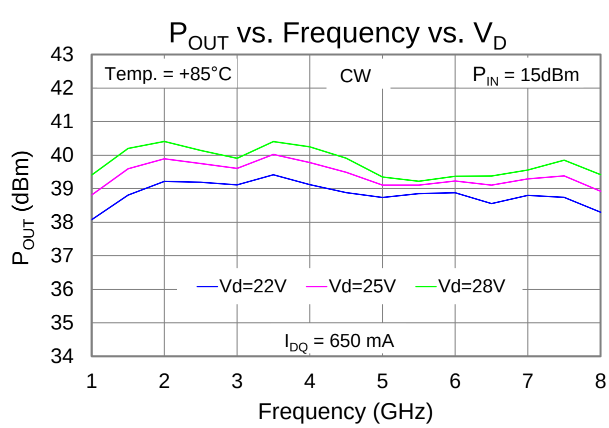
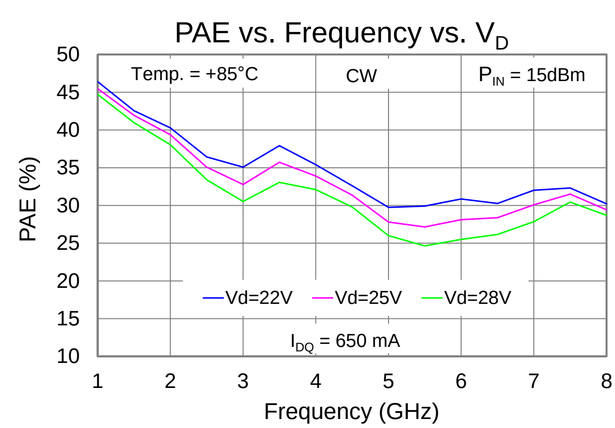




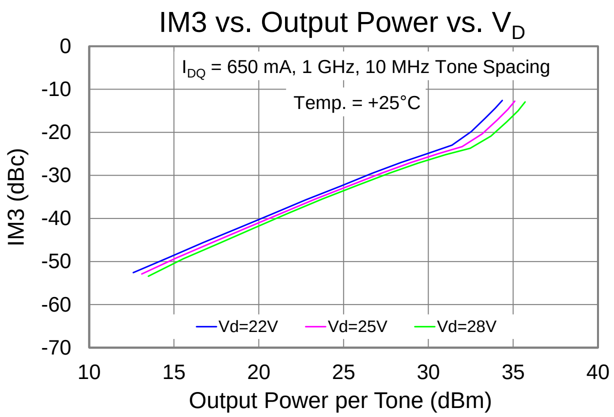


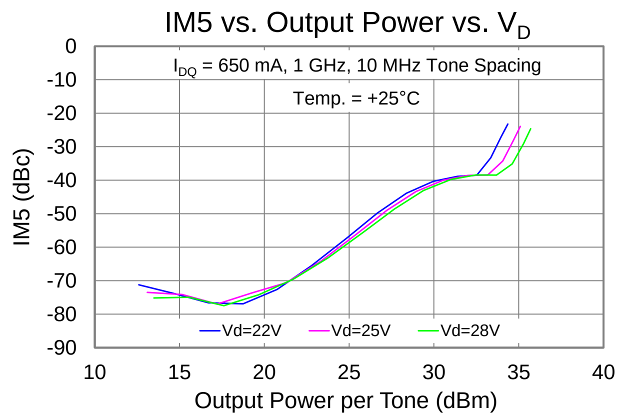


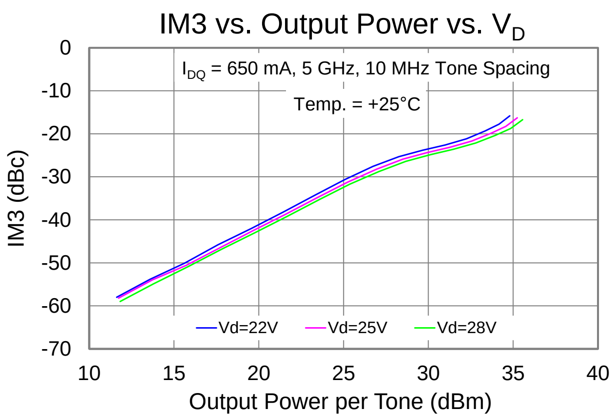


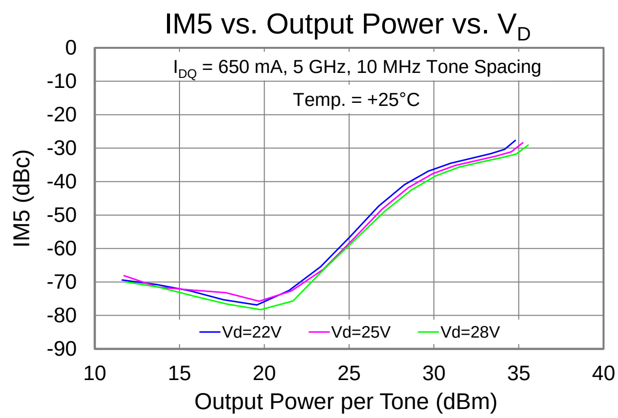


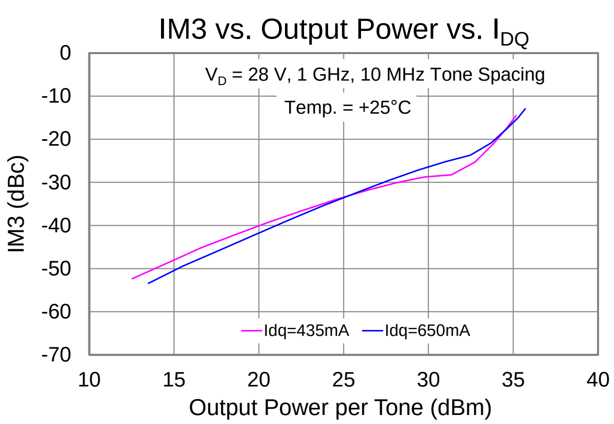
Performance Plots – Linearity

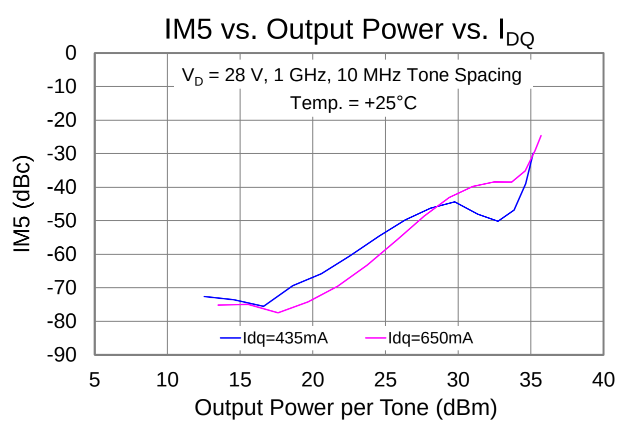












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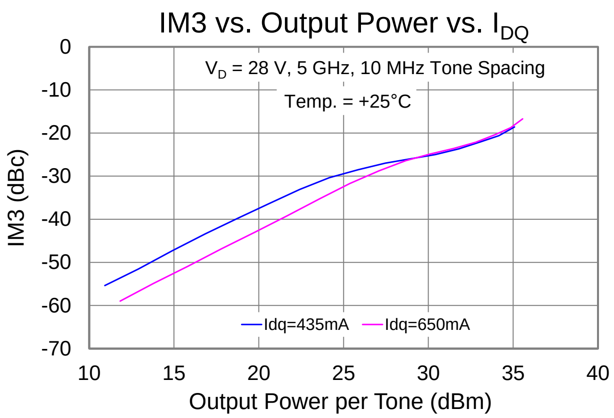

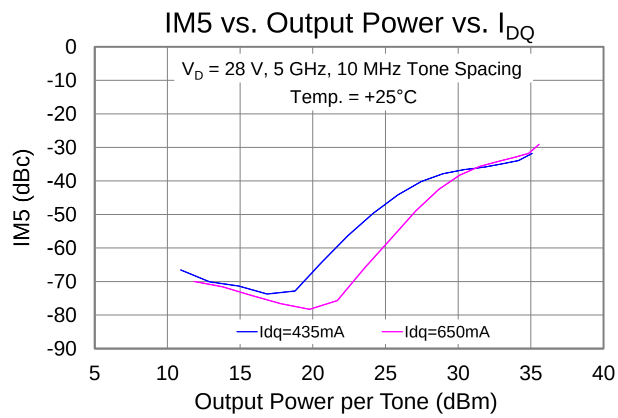

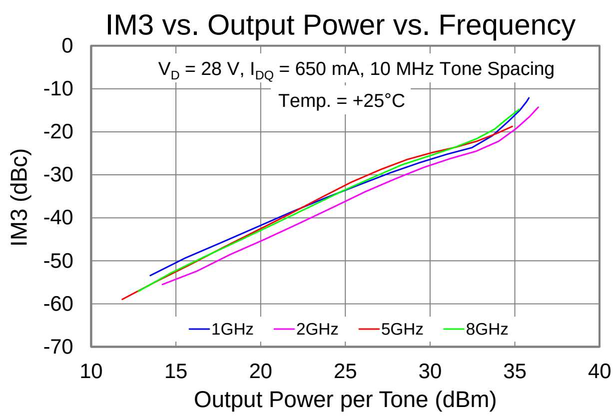

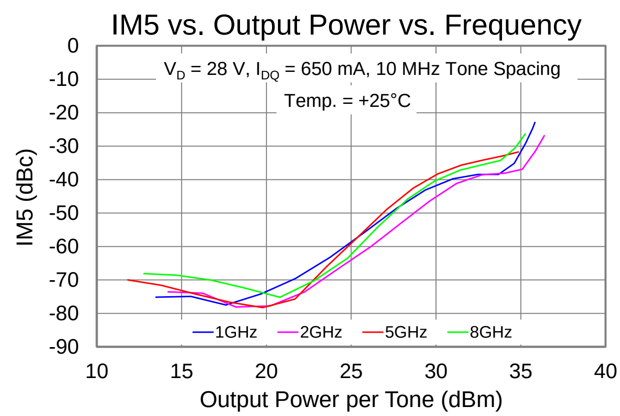

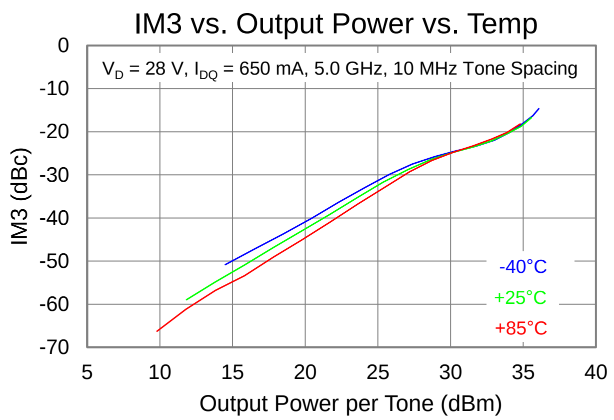

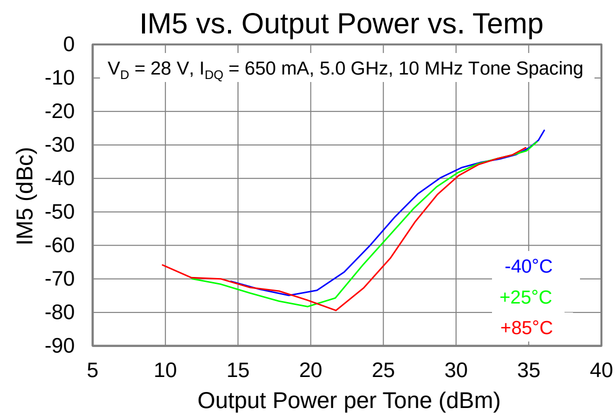

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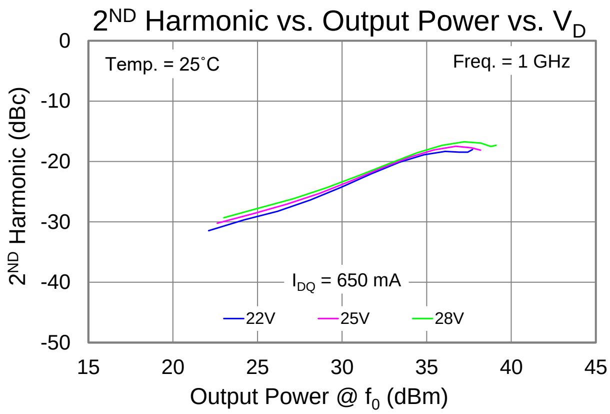

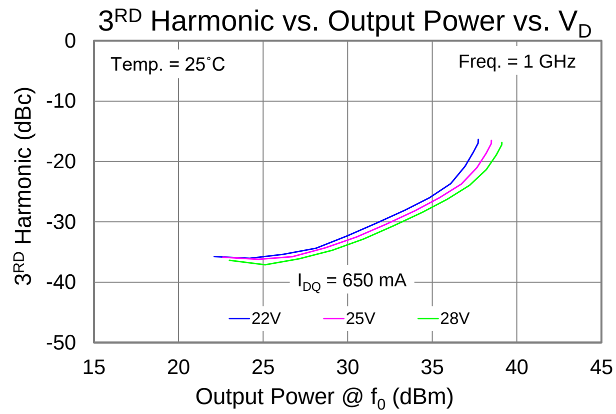

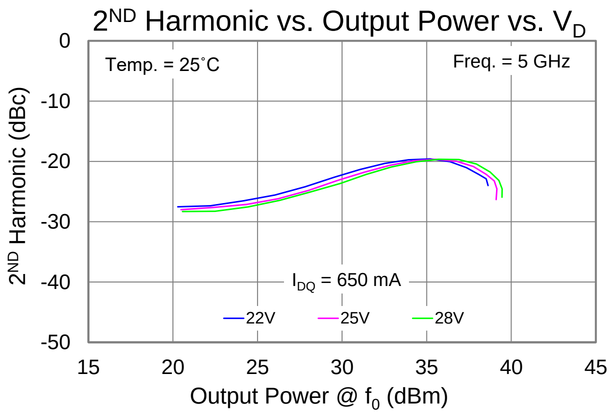

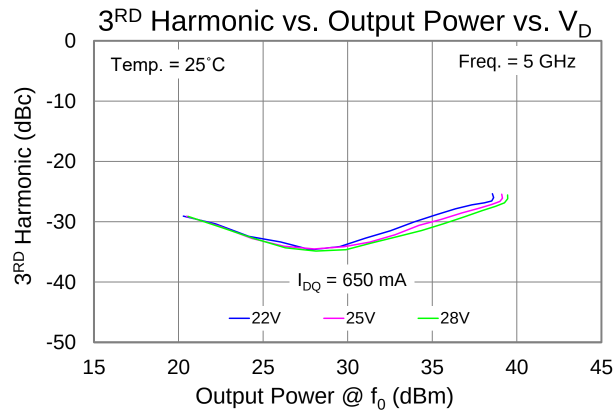

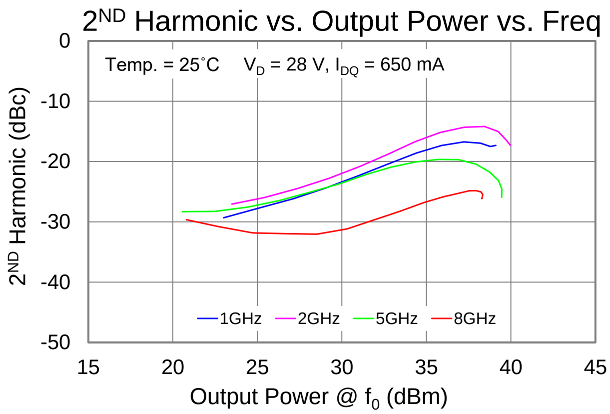

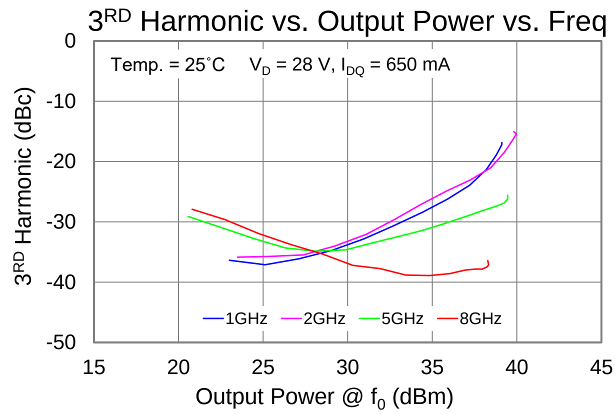

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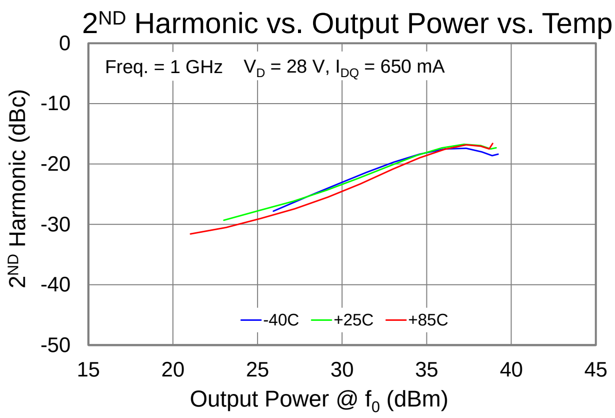
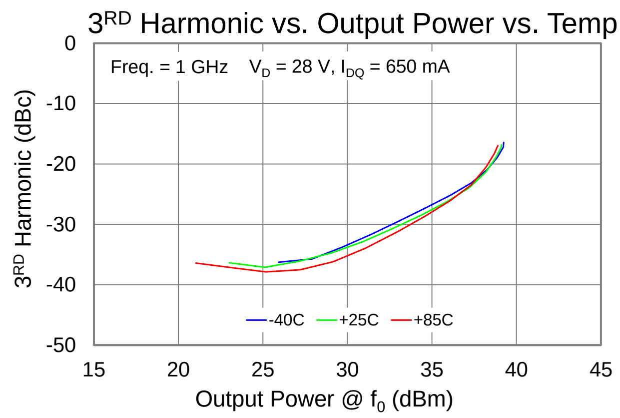
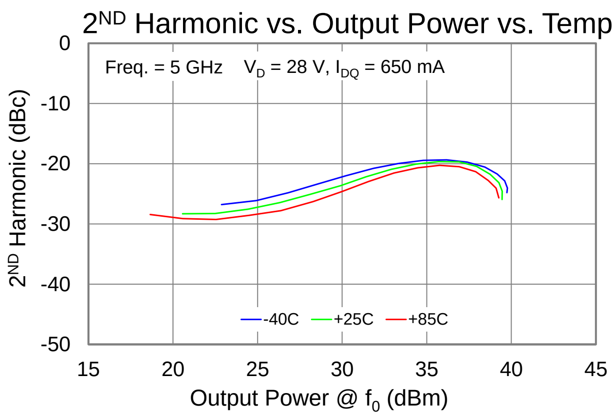
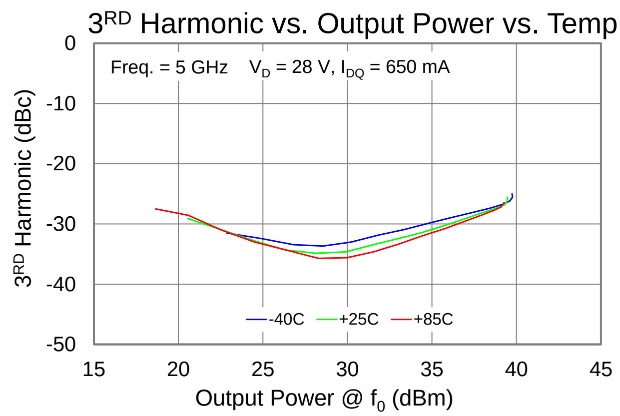
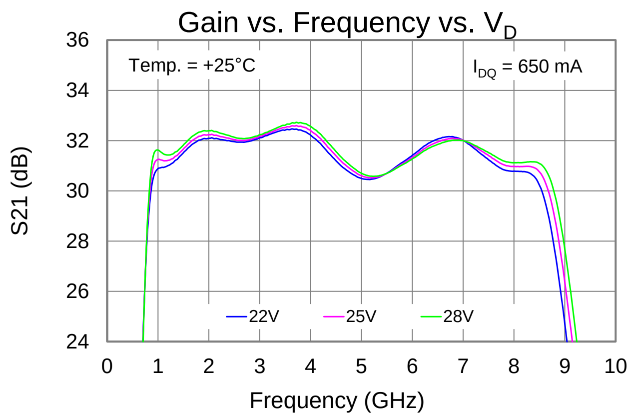


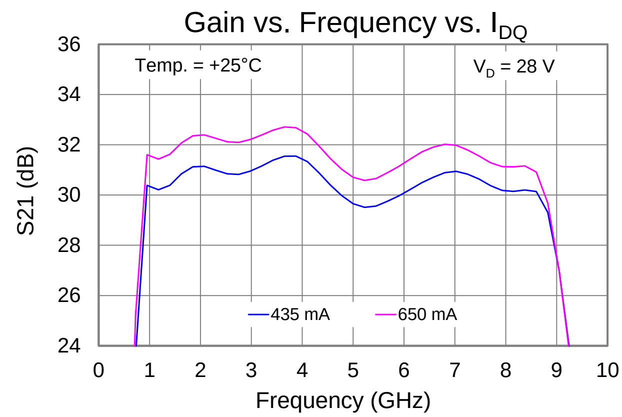


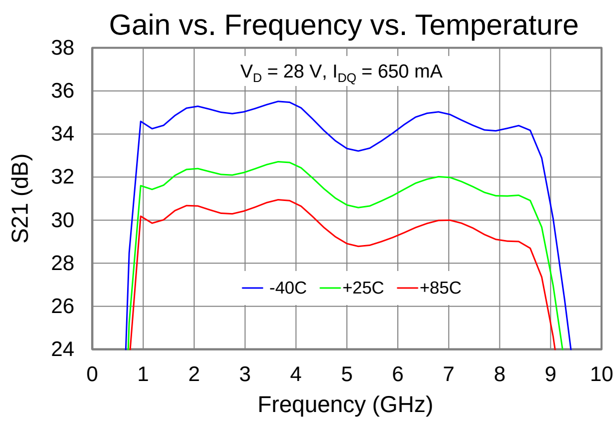


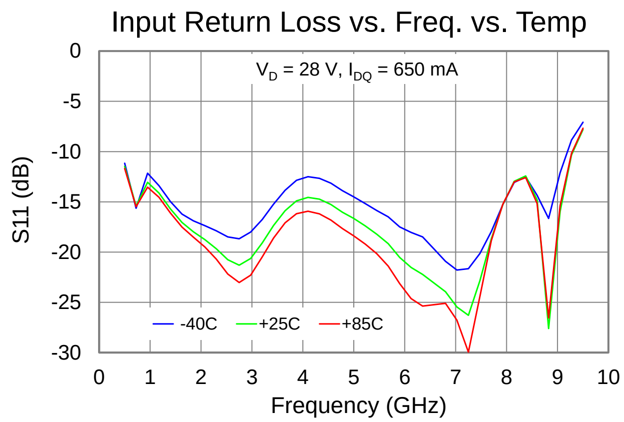


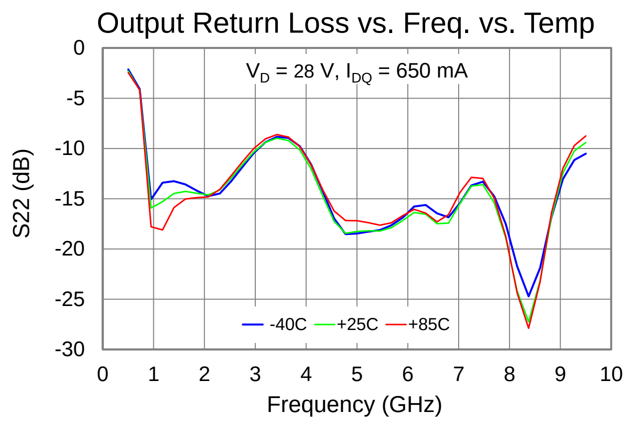
Performance Plots – Small Signal









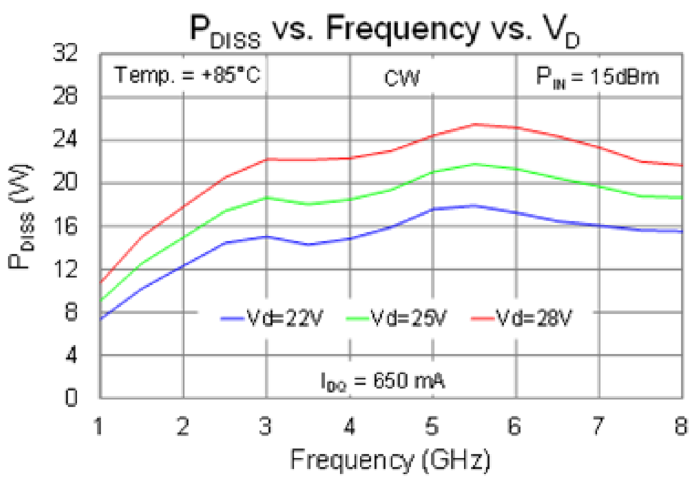


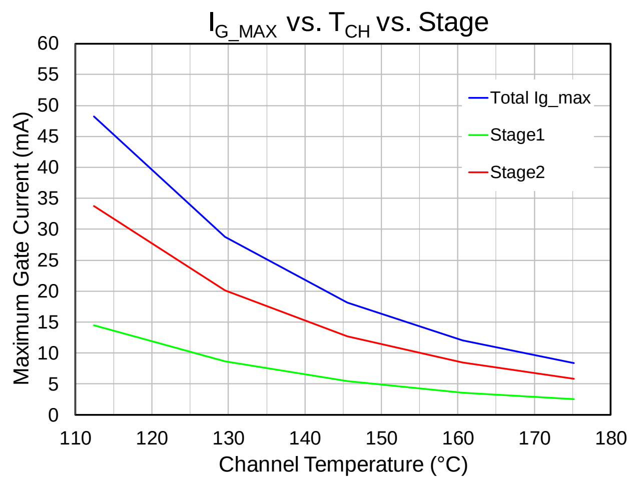
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85°C, V_D = +28 V (CW), I_{DQ} = 650 mA, P_{DISS} = 18.2 W	3.53	°C/W
Channel Temperature (T_{CH}) (Quiescent)		149.2	°C
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85 °C, V_D = +25 V (CW), Freq = 5.5 GHz P_{IN} = 15 dBm, I_{DQ} = 650 mA, I_{D_Drive} = 1.2 A, P_{OUT} = 39 dBm, P_{DISS} = 22 W	3.92	°C/W
Channel Temperature (T_{CH}) (Under RF drive)		171.2	°C
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85 °C, V_D = +28 V (CW), Freq = 5.5 GHz P_{IN} = 15 dBm, I_{DQ} = 650 mA, I_{D_Drive} = 1.2 A, P_{OUT} = 39 dBm, P_{DISS} = 25.5 W	4.01	°C/W
Channel Temperature (T_{CH}) (Under RF drive)		187.2	°C

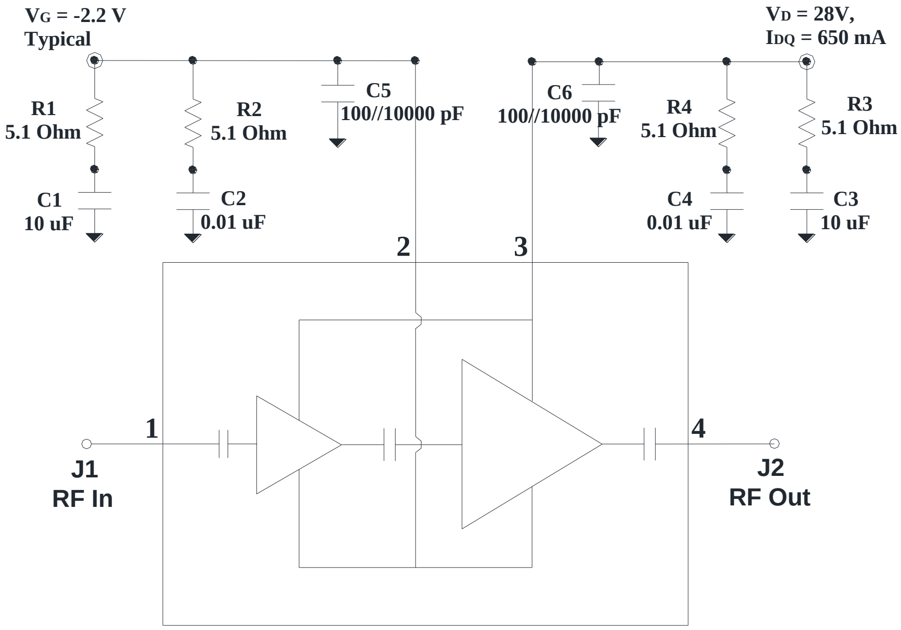
Notes:
1. Thermal resistance measured to back of carrier plate. MMIC mounted to 20 mil CuMo carrier using eutectic die attach
2. IR scan equivalent. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Power Dissipation and Maximum Gate Current





Applications Information and Pad Layout



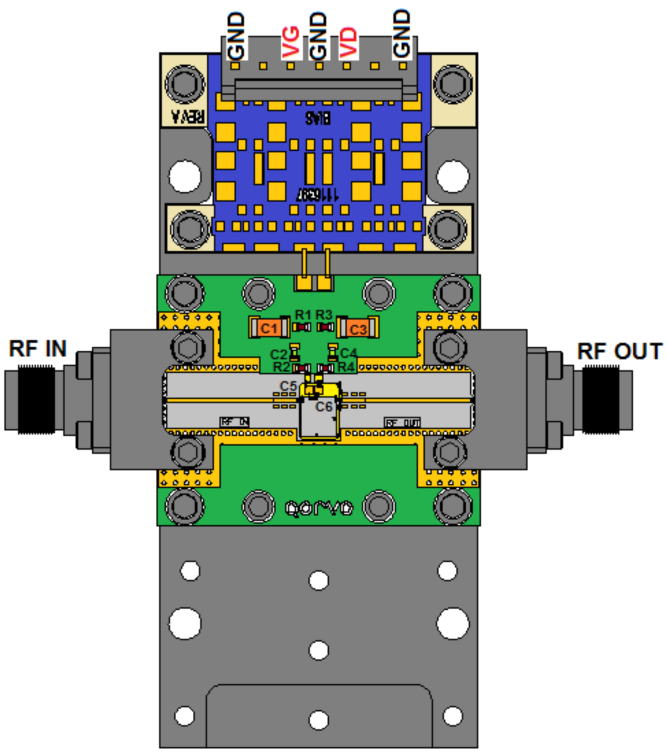
Bias Up Procedure

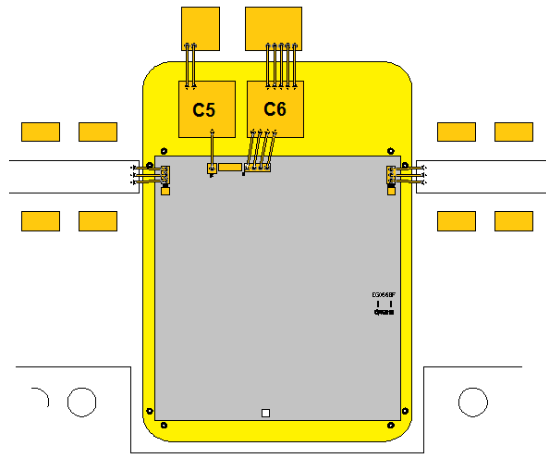
1. Set I_D limit to 1.3 A, I_G limit to 6 mA
2. Apply −5 V to V_G
3. Apply +28 V to V_D; ensure I_{DQ} is approx. 0 mA
4. Adjust V_G until I_{DQ} = 650 mA (V_G ~ −2.2 V Typ.).
5. Turn on RF supply

Bias Down Procedure

1. Turn off RF supply
2. Reduce V_G to −5 V; ensure I_{DQ} is approx. 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 Assembly



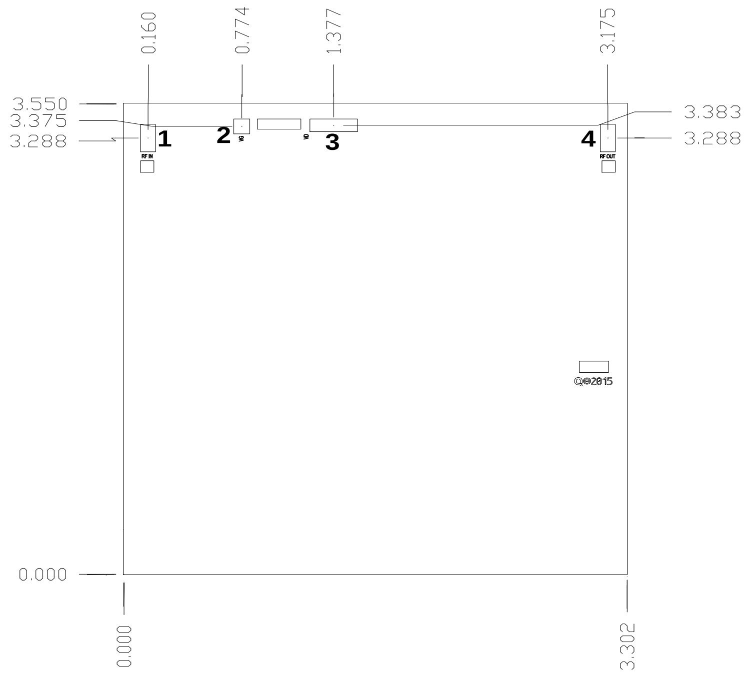


MMIC mounting/wire bonding detail

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1, C3	10 µF	Cap, 1205, 50 V, 20 %, X7R	Various	–
C2, C4	0.01 µF	Cap, 0402, 50 V, 10 %, X5R	Various	–
C5, C6	100pF/10000 pF	Cap, 30 x 30, 50V, Single Layer	Various	–
R1, R2, R3, R4	5.1 Ohm	Res, 0402, 50 V, 5 %	Various	–

Mechanical Information



Units: millimeters
Thickness: 0.10
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	0.097 x 0.207	RF Input; matched to 50 Ω, DC blocked
2	VG	0.105 x 0.112	Gate voltage, bias network is required; see Application Circuit on page 16 as an example.
3	VD	0.312 x 0.096	Drain voltage, bias network is required; see Application Circuit on page 16 as an example.
4	RF Out	0.097 x 0.207	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.

Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V_D)	+29.5 V
Gate Voltage Range (V_G)	−8 to 0 V
Drain Current	1300 mA
Forward Gate Current (I_G)	See I_{G_MAX} plot
Power Dissipation (P_{DISS}), 85 °C, CW	30 W
Input Power, CW, 50 Ω, (P_{IN}), V_D = +28 V, I_{DQ} = 650 mA, 85 °C,	18 dBm
Input Power, CW, VSWR 3:1, (P_{IN}) V_D = +28 V, I_{DQ} = 650 mA, 85 °C	18 dBm
Mounting Temperature (30 Seconds)	320 °C
Storage Temperature	−55 to 150 °C

Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied.