QPA1003P

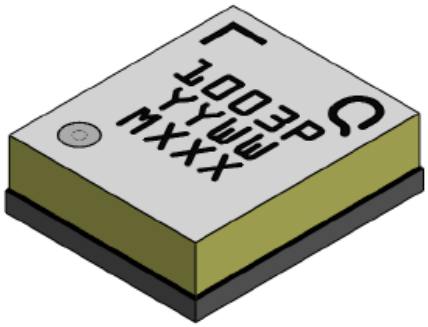
1 – 8 GHz 10 W GaN Power Amplifier

Product Description

Qorvo's QPA1003P is a wideband high power MMIC amplifier fabricated on Qorvo's production 0.15um GaN on SiC process (QGaN15). The QPA1003P 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 QPA1003P is matched to 50 Ω 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.

Lead-free and RoHS compliant.

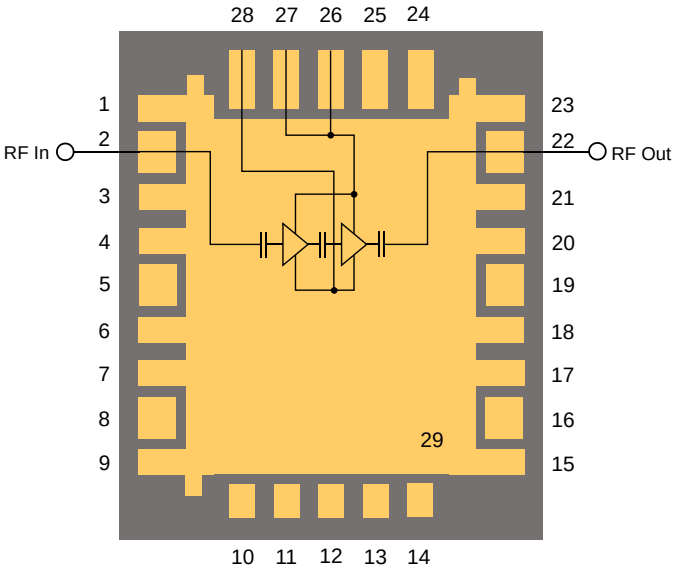


Product Features

- 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} = 15 dBm)
- Small Signal Gain: 30 dB
- Bias: V_D = +28 V, I_{DQ} = 650 mA
- Package Dimensions: 5.0 x 6.0 x 1.76 mm
- Process Technology: QGaN15

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

Functional Block Diagram



Applications

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

Ordering Information

Part No.	Description
QPA1003P	1 – 8 GHz 10 W GaN Power Amplifier
QPA1003PEVBP01	Evaluation Board

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(P_{IN}): CW, 50 Ω, V_D = +28 V, I_{DQ} = 650 mA, 85 °C	18 dBm
Input Power (P_{IN}); CW, VSWR 3:1, V_D = +28 V, I_{DQ} = 650 mA, 85 °C	18 dBm
Mounting Temperature (30 Seconds)	260 °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.

Recommended Operating Conditions

Parameter	Value / Range
Drain Voltage (V_D)	+28 V
Drain Current (I_{DQ})	650 mA
Gate Voltage Range (V_G)	−2.9 to −2.0 V
Temperature (T_{BASE})	−40 to 85 °C

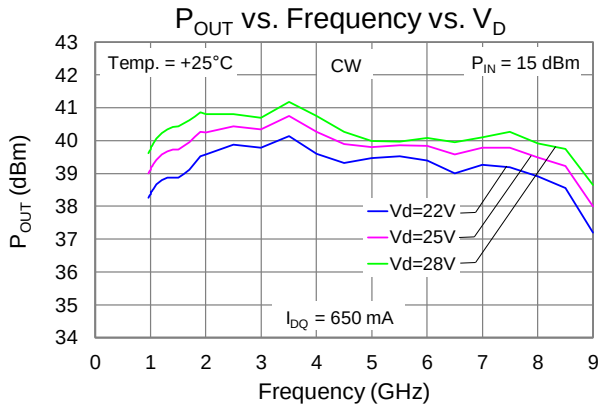
Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

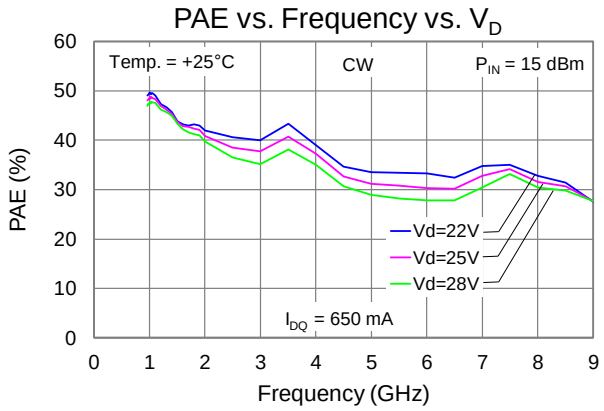
Electrical Specifications

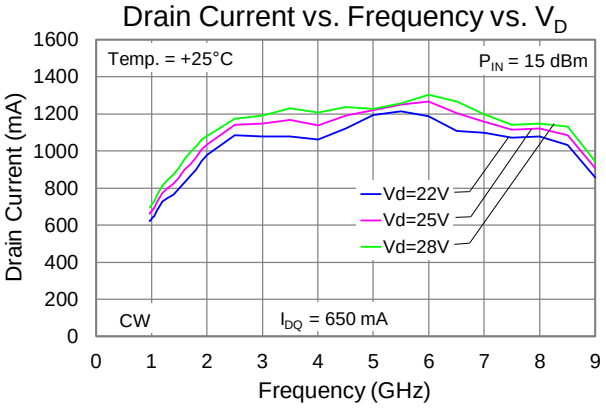
Test conditions unless otherwise noted: 25 °C, V_D = +28 V, I_{DQ} = 650 mA, CW.

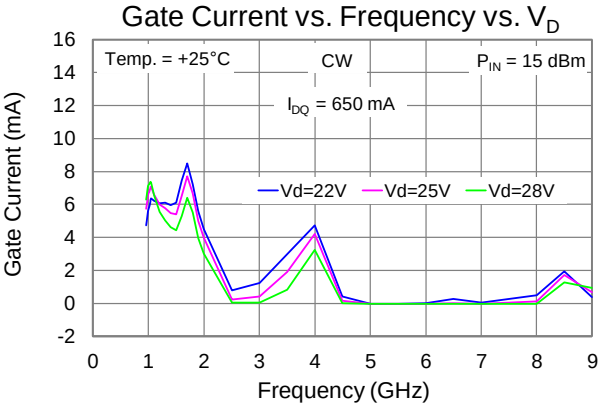
Parameter		Min	Typ	Max	Units
Operational Frequency Range		1	–	8	GHz
Output Power @ P_{IN} = 15 dBm	Frequency = 1 GHz		39.7	–	dBm
	Frequency = 4 GHz		40.7	–	
	Frequency = 8 GHz		39.9	–	
Power Added Efficiency @ P_{IN} = 15 dBm	Frequency = 1 GHz		47.5	–	%
	Frequency = 4 GHz		35	–	
	Frequency = 8 GHz		30.5	–	
Small Signal Gain	Frequency = 1 GHz		31.5	–	dB
	Frequency = 4 GHz		32.7	–	
	Frequency = 8 GHz		31.4	–	
Input Return Loss	Frequency = 1 GHz		12.7	–	dB
	Frequency = 4 GHz		12.1	–	
	Frequency = 8 GHz		9.8	–	
Output Return Loss	Frequency = 1 GHz		17.5	–	dB
	Frequency = 4 GHz		6.9	–	
	Frequency = 8 GHz		11.4	–	
Small Signal Gain Temperature Coefficient		–	–0.04	–	dB/°C
Output Power Temperature Coefficient		–	–0.014	–	dBm/°C

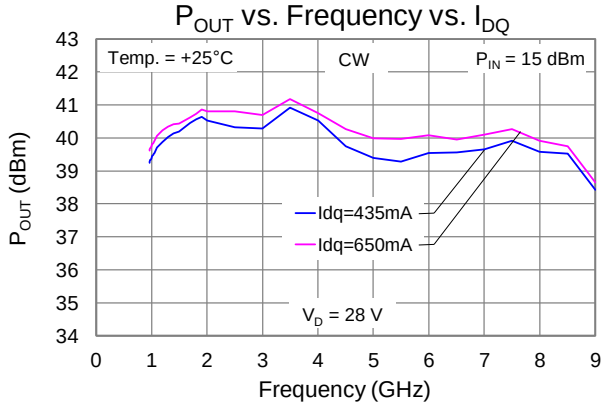
Performance Plots – Large Signal (CW)

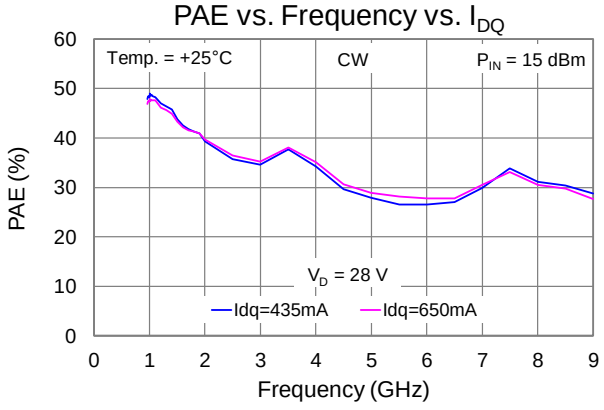






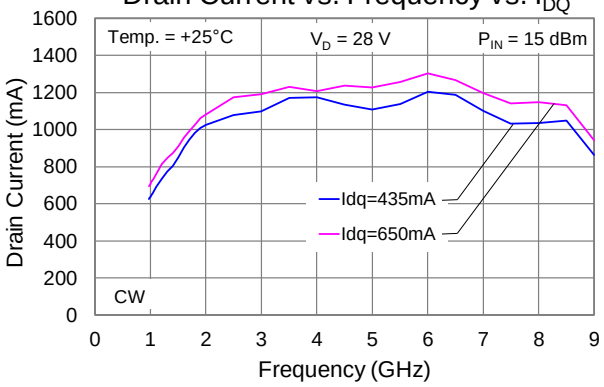




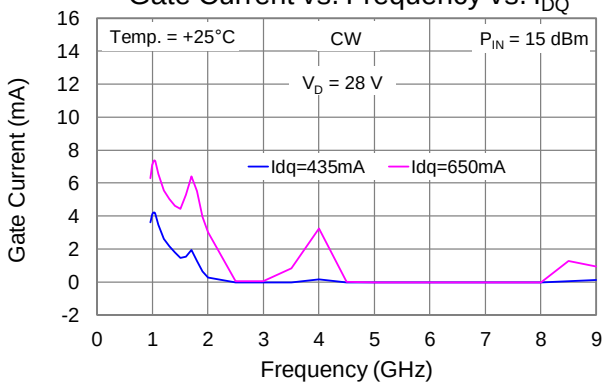


Performance Plots – Large Signal (CW)

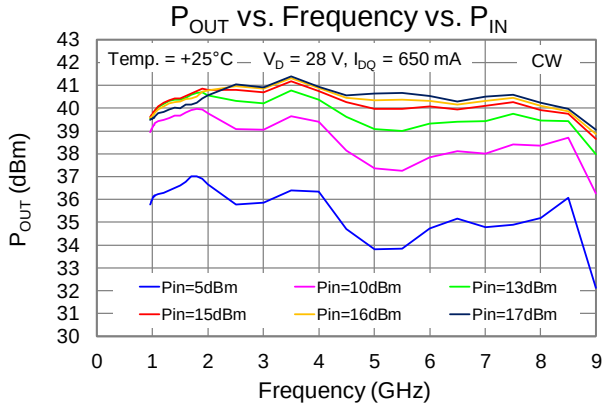
Drain Current vs. Frequency vs. I_{DQ}



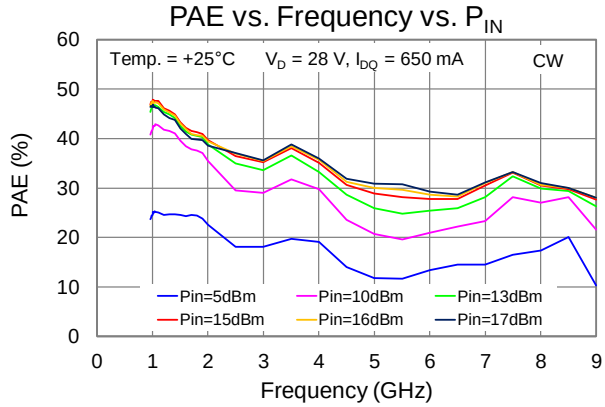
Gate Current vs. Frequency vs. I_{DQ}



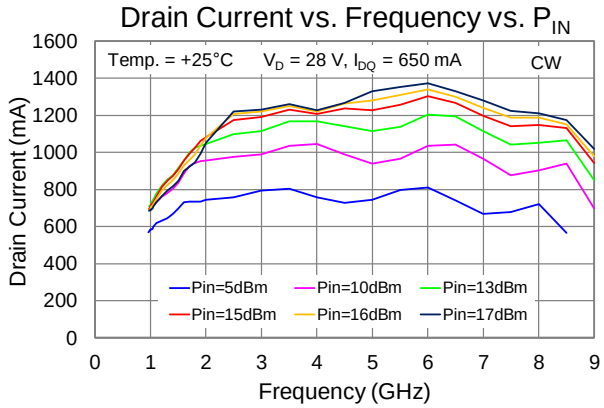
P_{OUT} vs. Frequency vs. P_{IN}



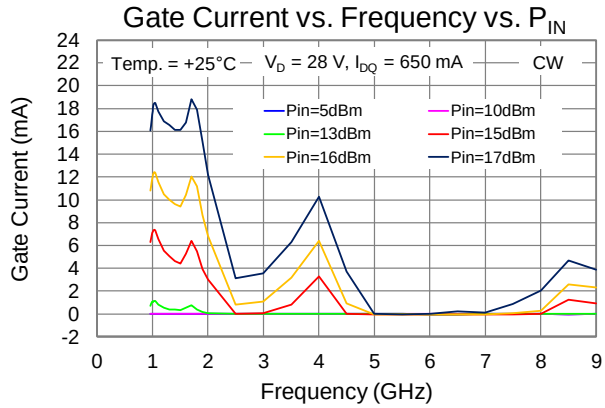
PAE vs. Frequency vs. P_{IN}



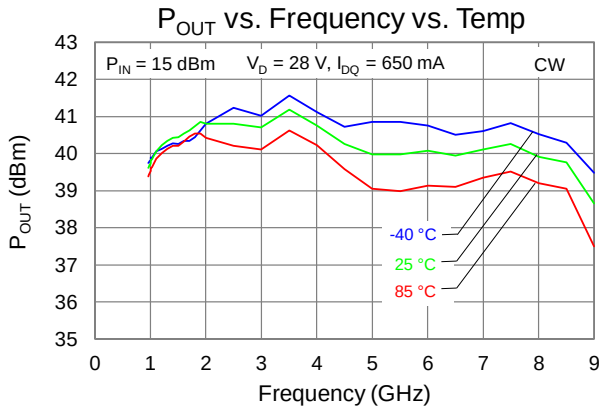
Drain Current vs. Frequency vs. P_{IN}

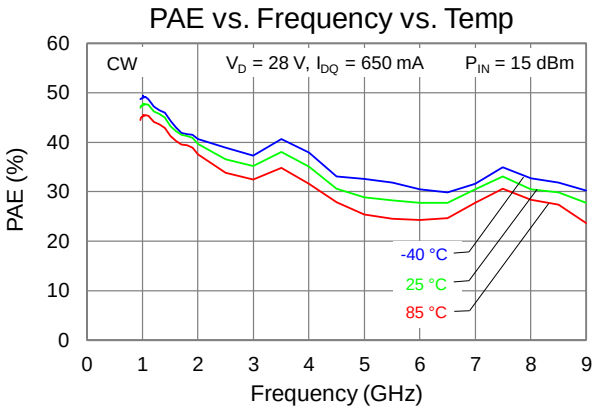


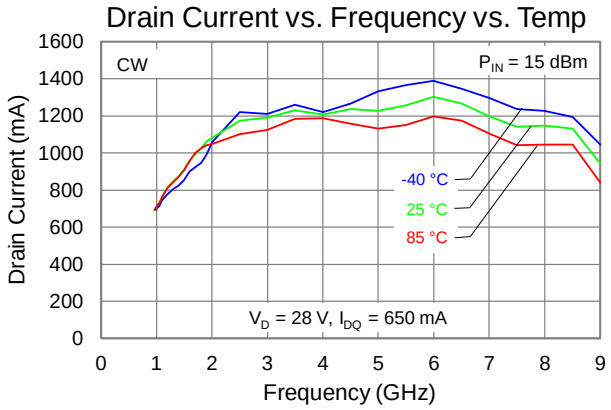
Gate Current vs. Frequency vs. P_{IN}

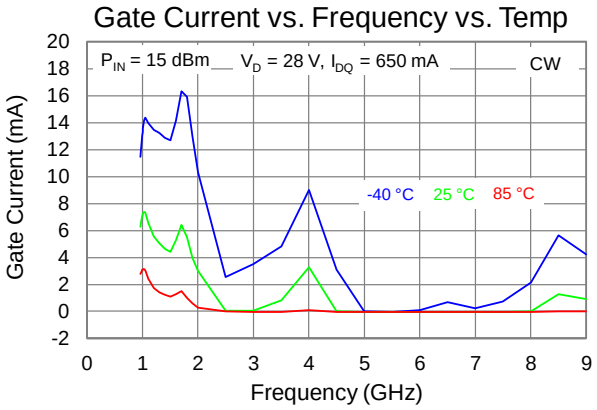


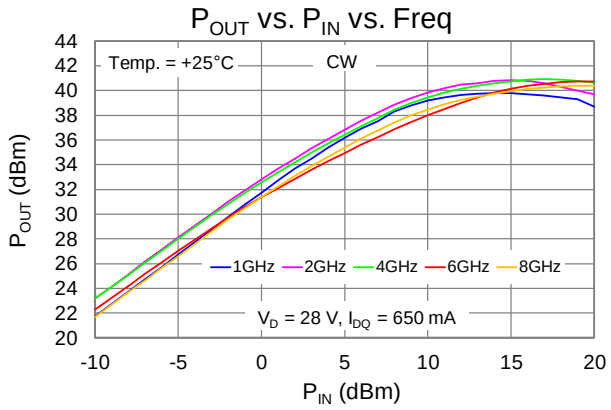
Performance Plots – Large Signal (CW)

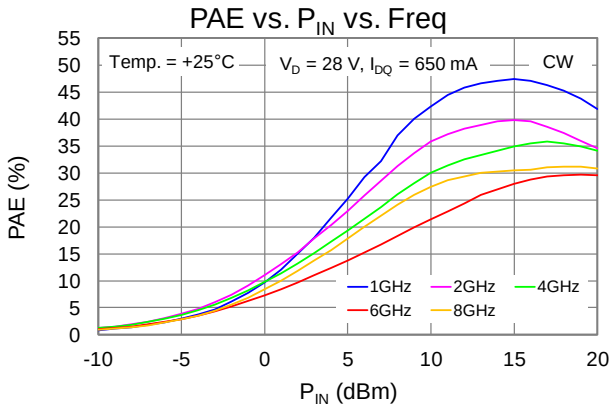






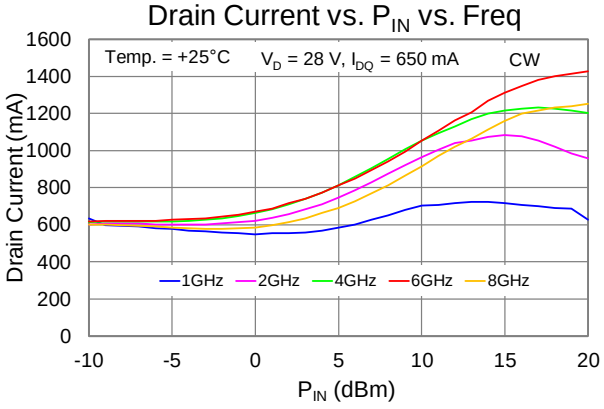




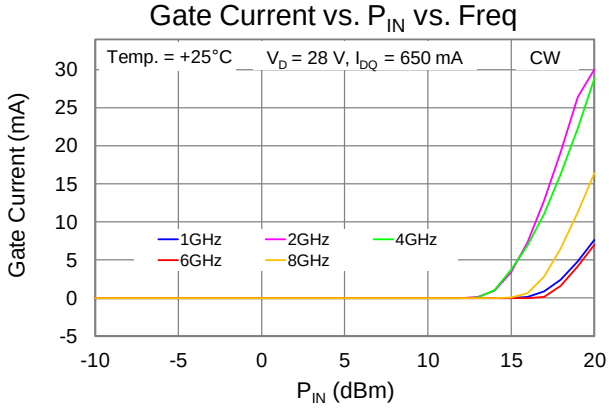


Performance Plots – Large Signal (CW)

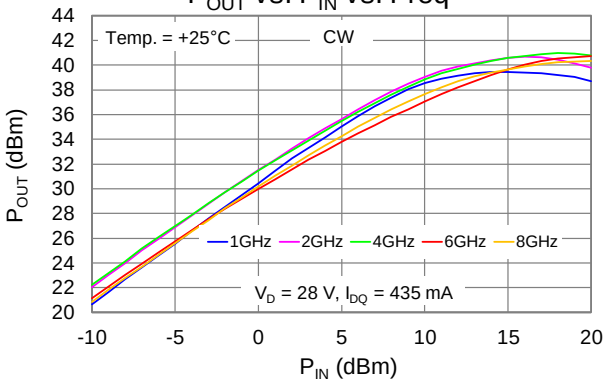
Drain Current vs. P_{IN} vs. Freq



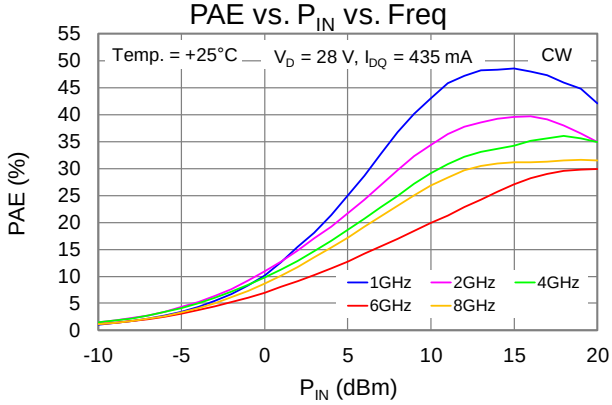
Gate Current vs. P_{IN} vs. Freq



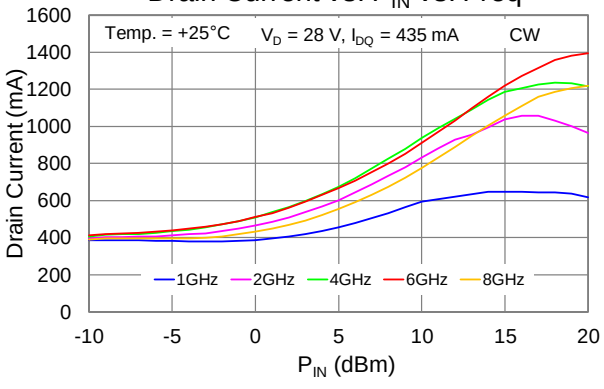
P_{OUT} vs. P_{IN} vs. Freq



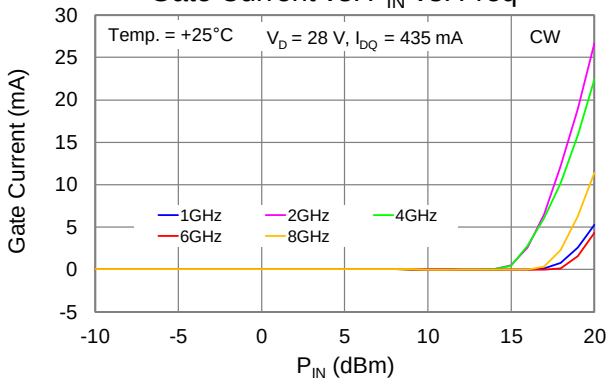
PAE vs. P_{IN} vs. Freq



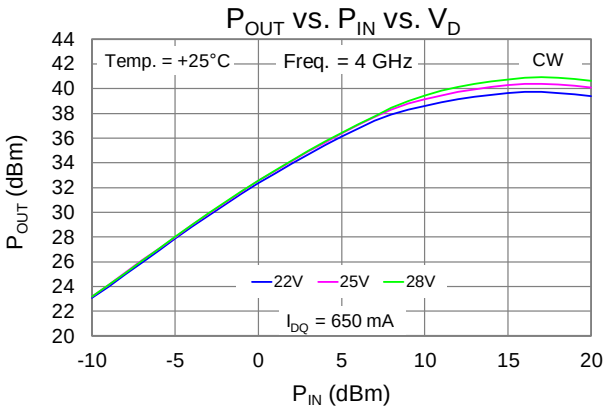
Drain Current vs. P_{IN} vs. Freq

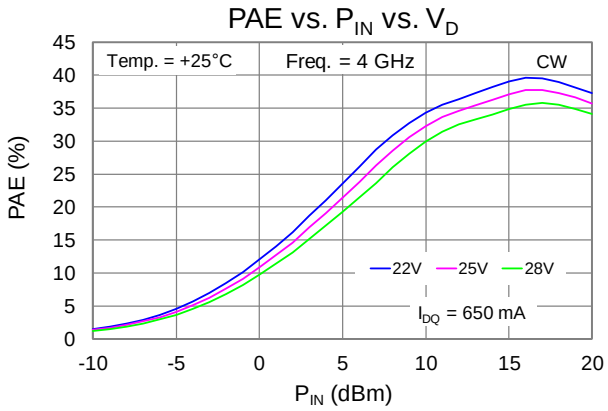


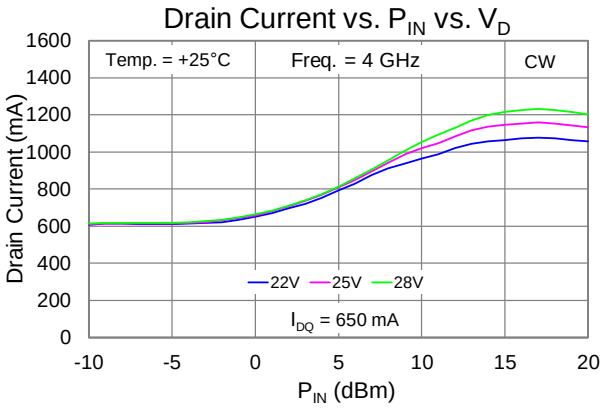
Gate Current vs. P_{IN} vs. Freq

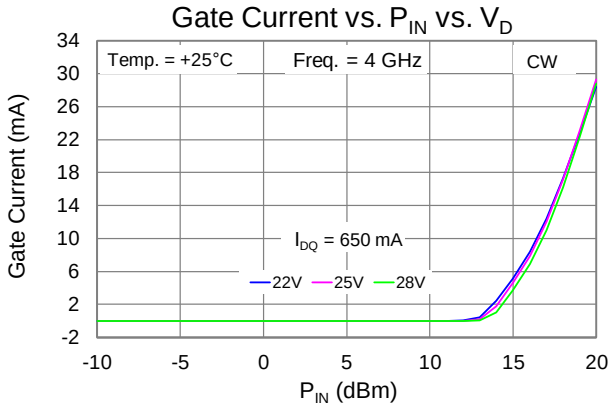


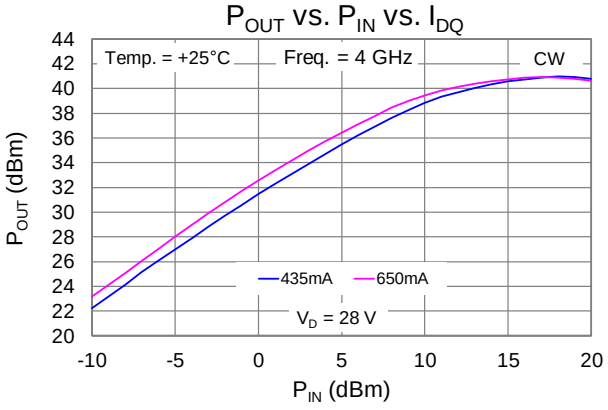
Performance Plots – Large Signal (CW)

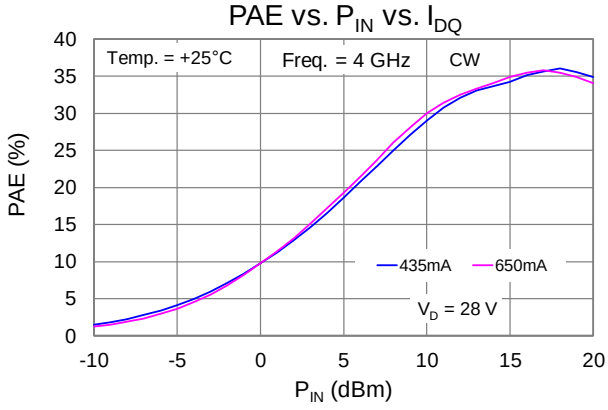






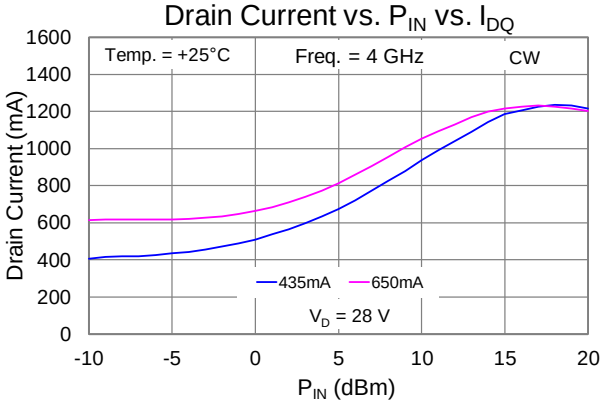




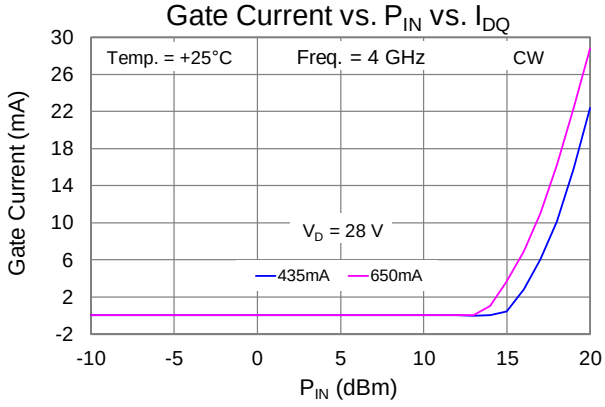


Performance Plots – Large Signal (CW)

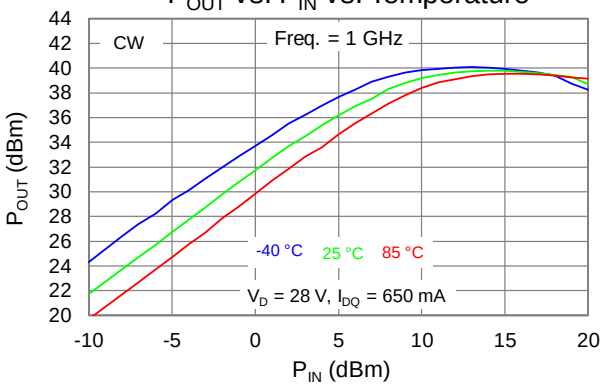
Drain Current vs. P_{IN} vs. I_{DQ}



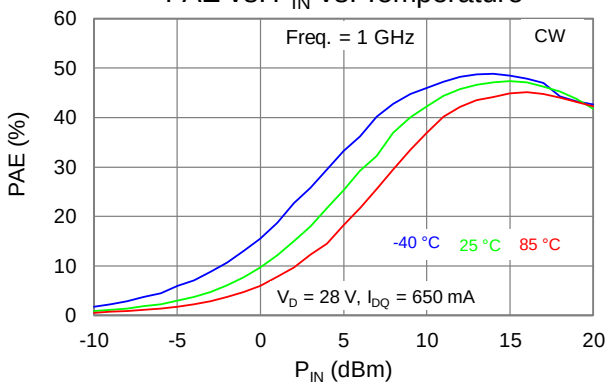
Gate Current vs. P_{IN} vs. I_{DQ}



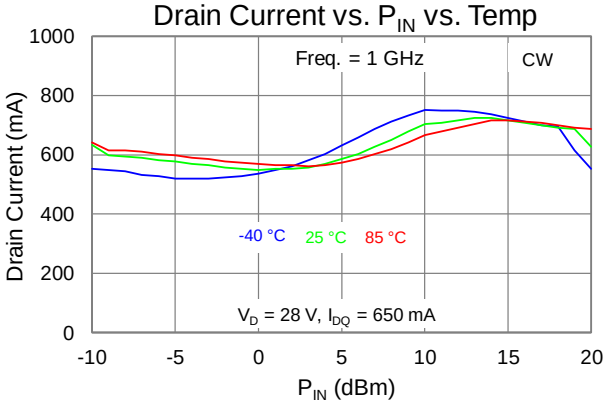
P_{OUT} vs. P_{IN} vs. Temperature



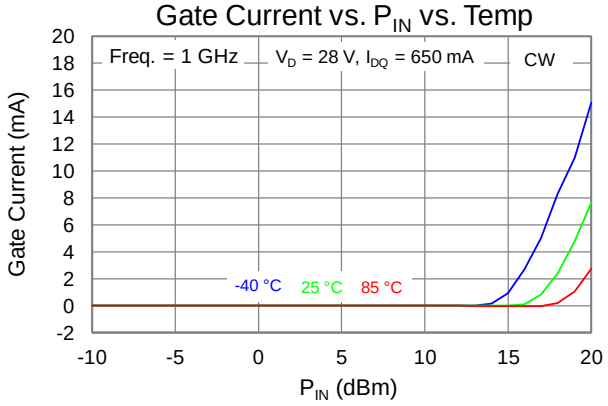
PAE vs. P_{IN} vs. Temperature



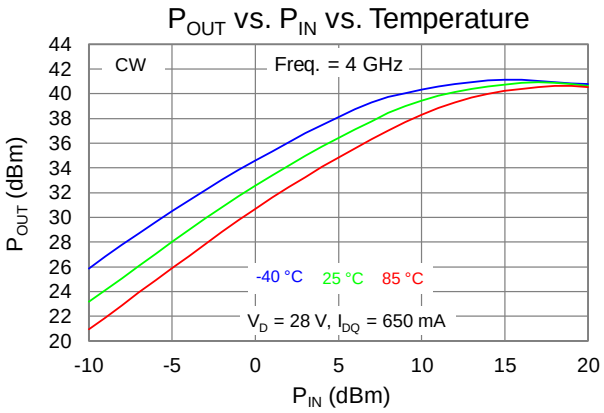
Drain Current vs. P_{IN} vs. Temp

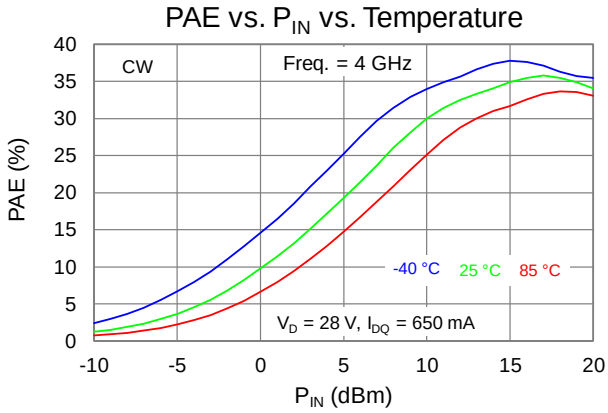


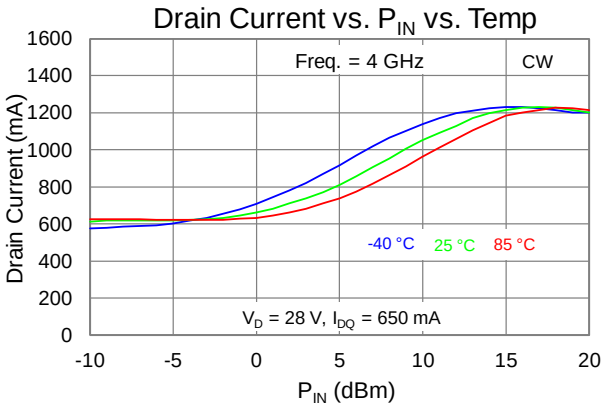
Gate Current vs. P_{IN} vs. Temp

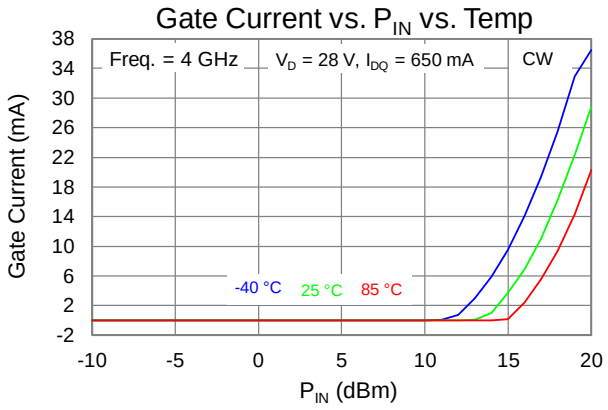


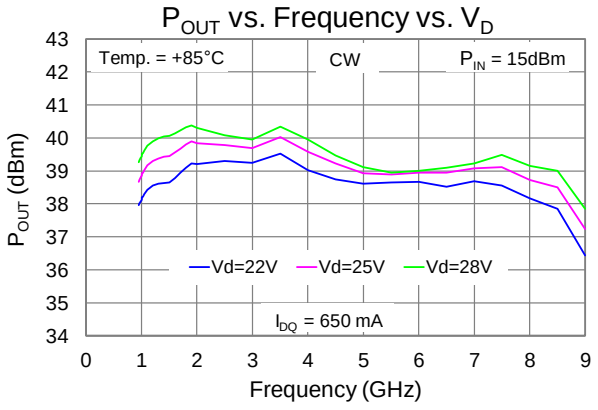
Performance Plots – Large Signal (CW)

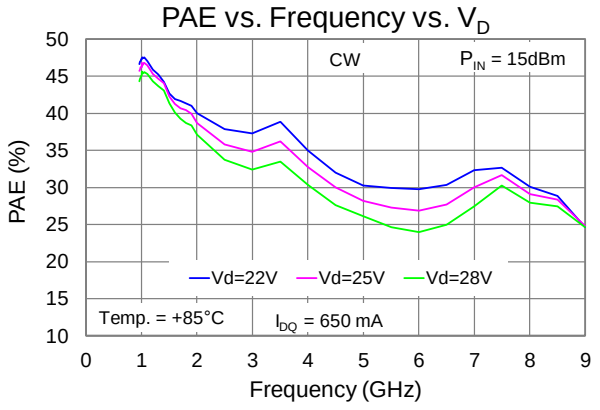




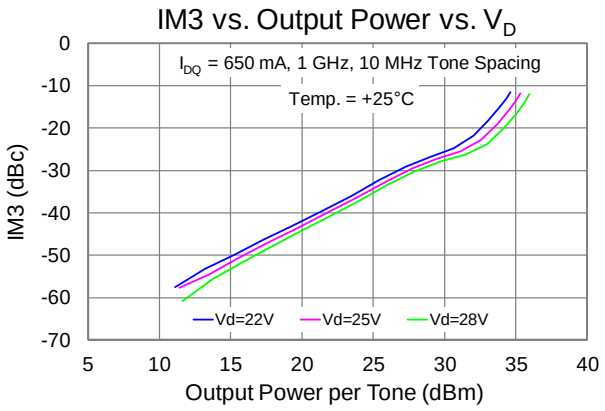


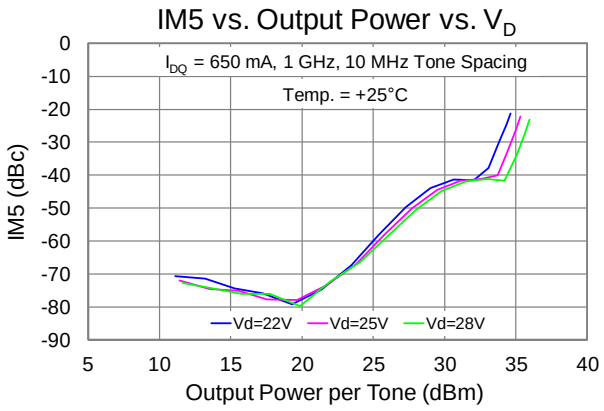


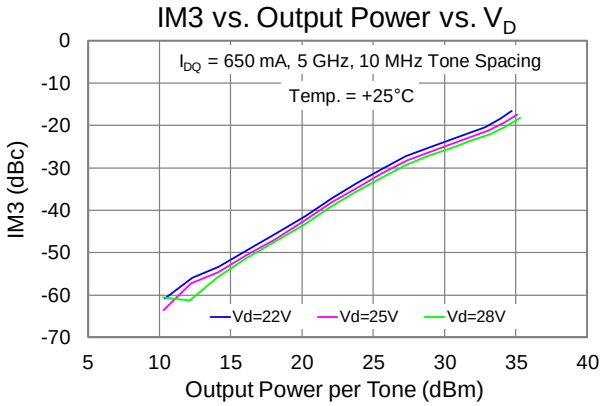


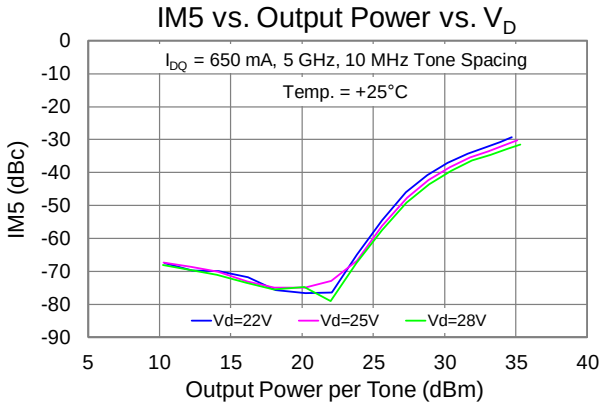


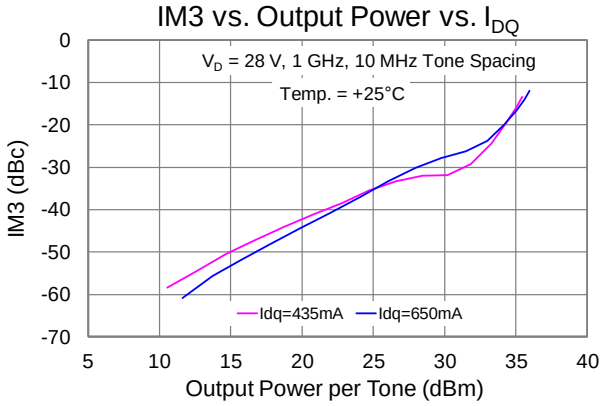
Performance Plots – Linearity

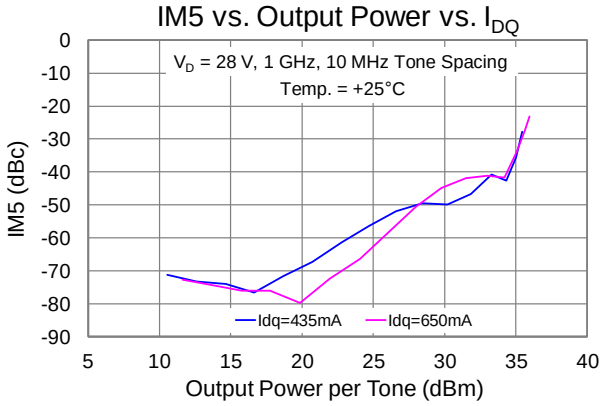




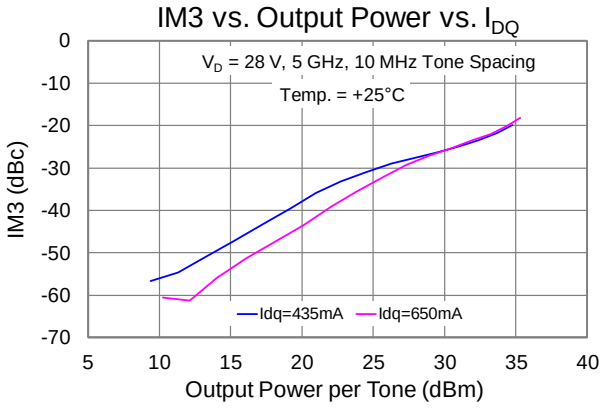


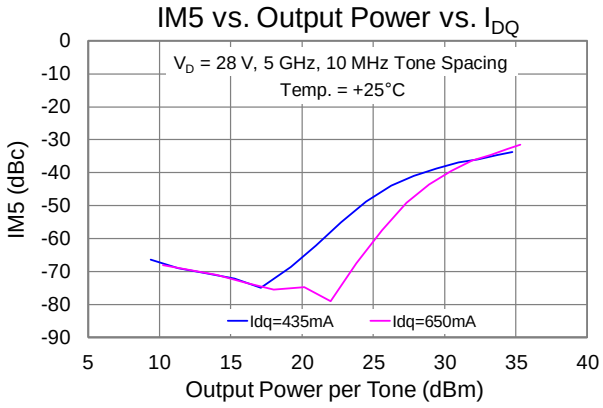


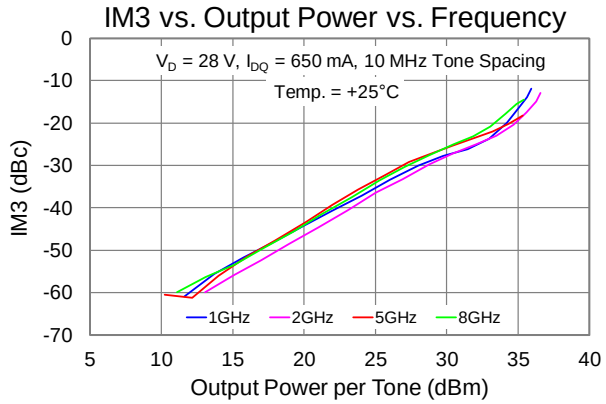


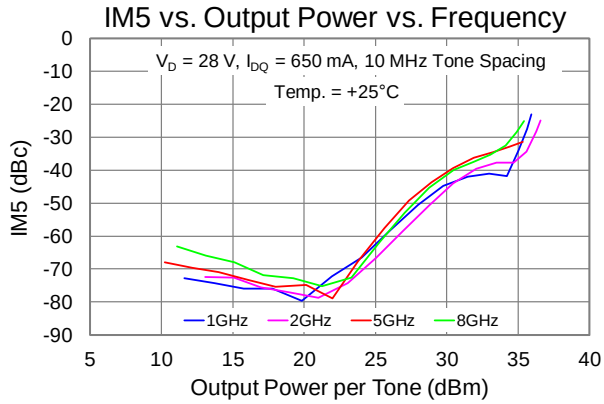


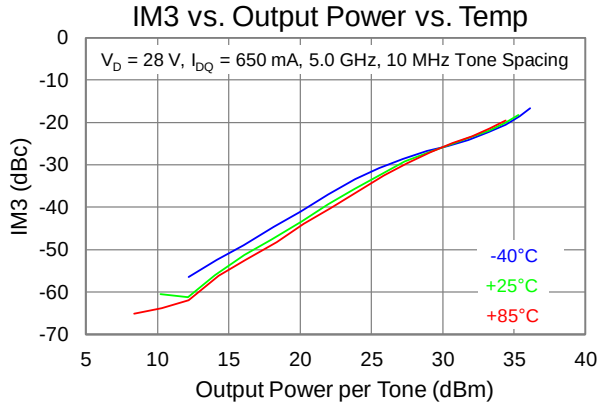
Performance Plots – Linearity

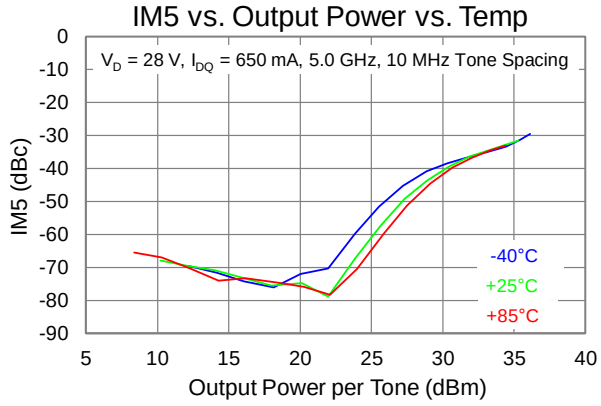




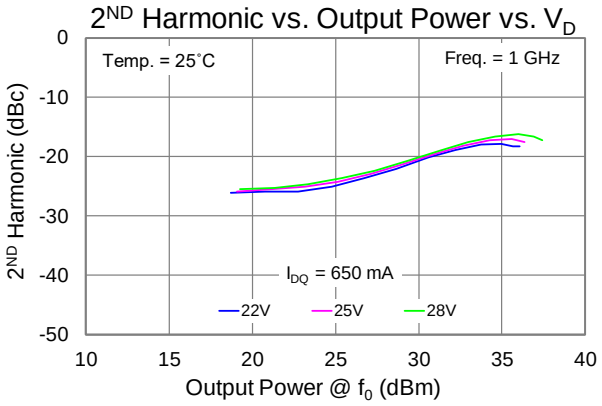


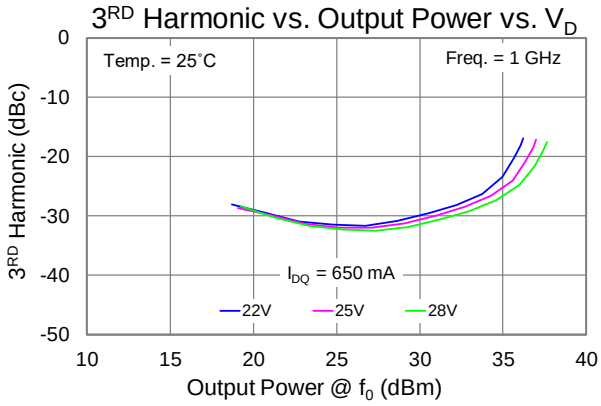


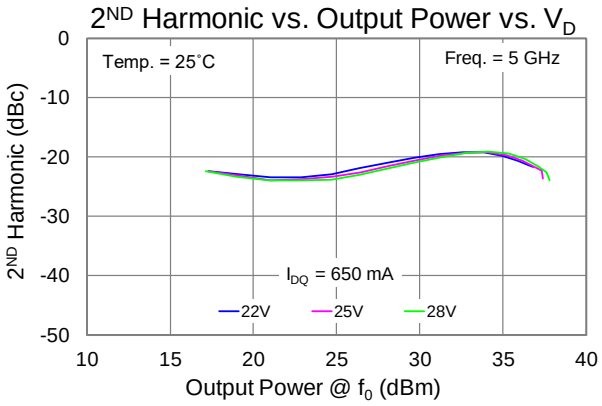


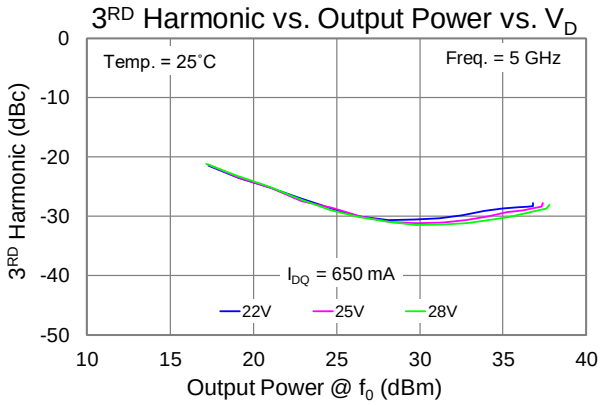


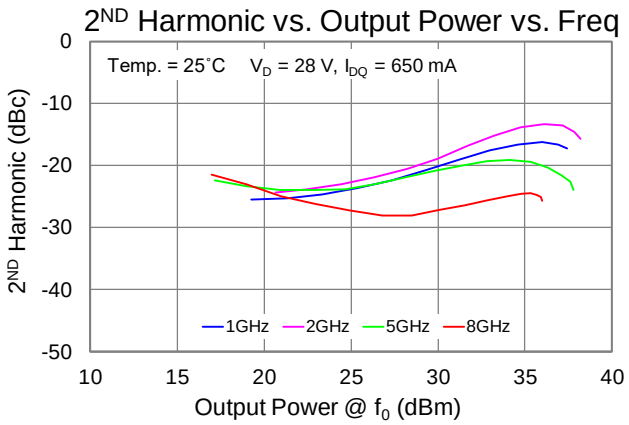
Performance Plots – Linearity

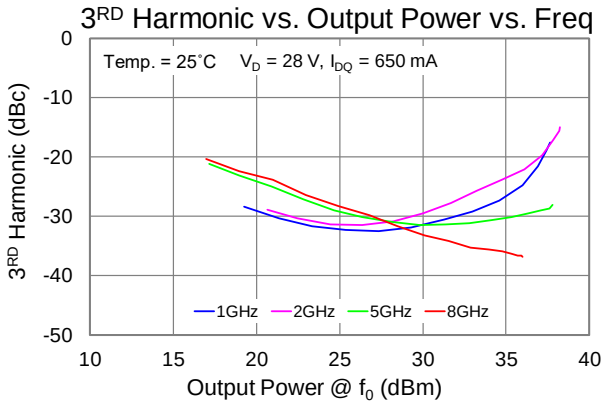




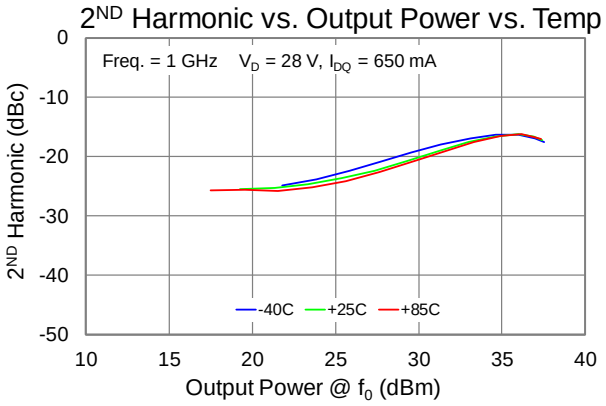


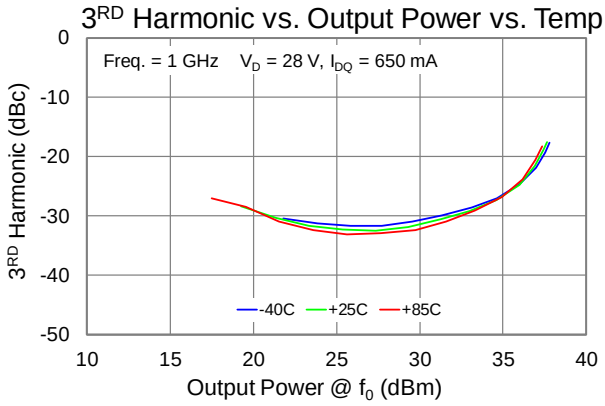


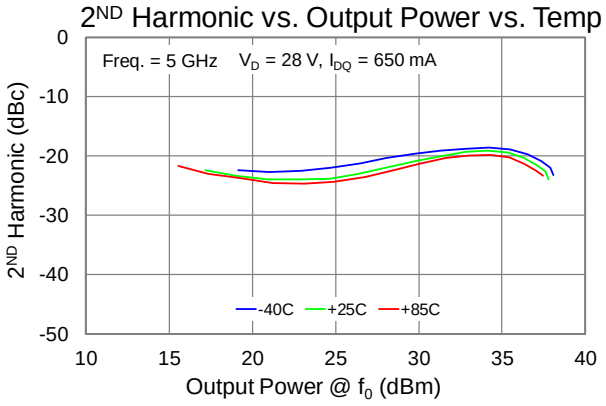


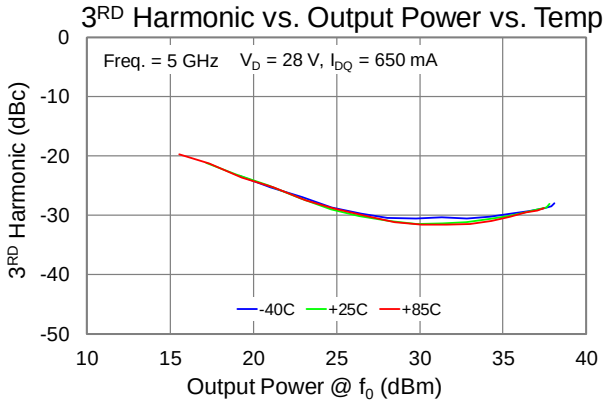


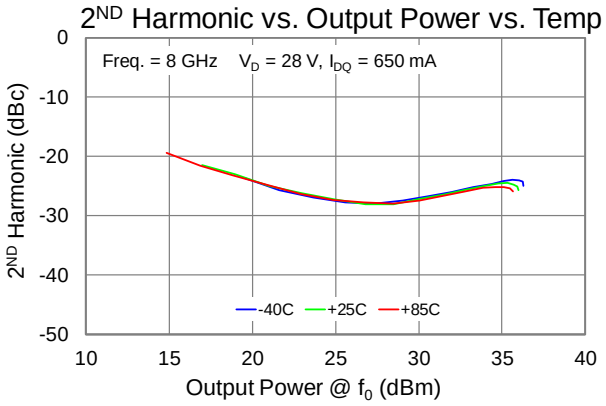
Performance Plots – Linearity

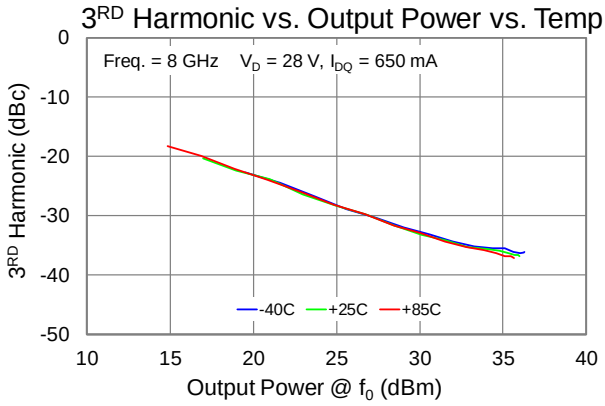




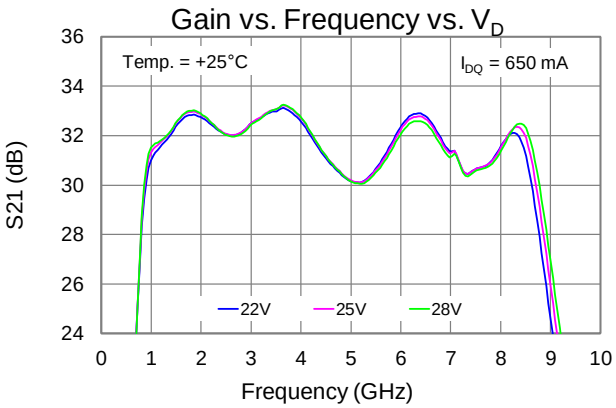


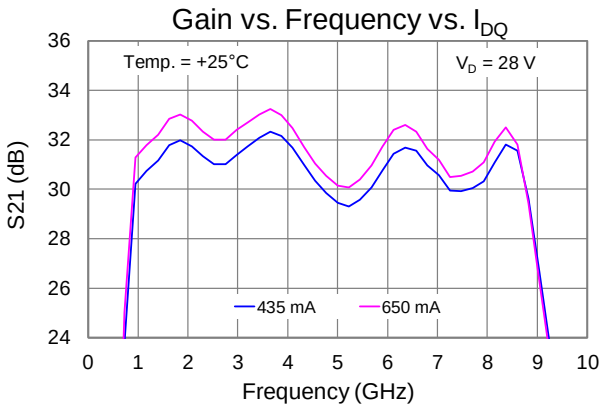


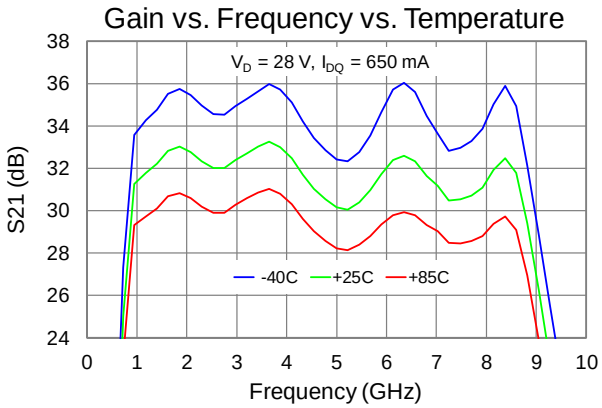


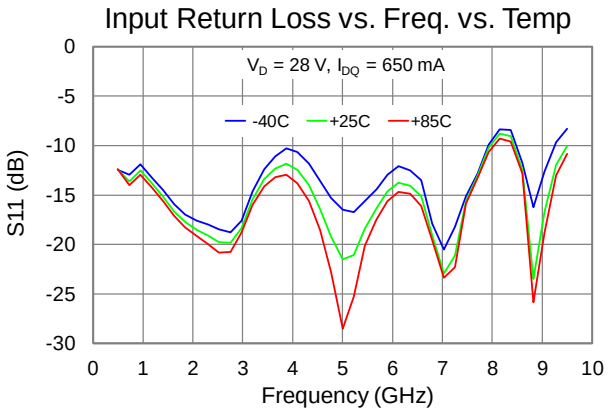


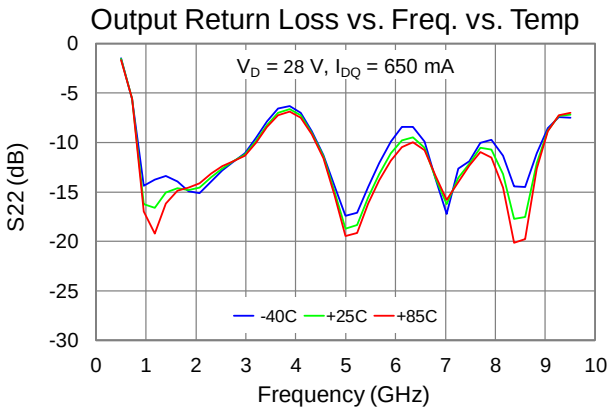
Performance Plots – Small Signal









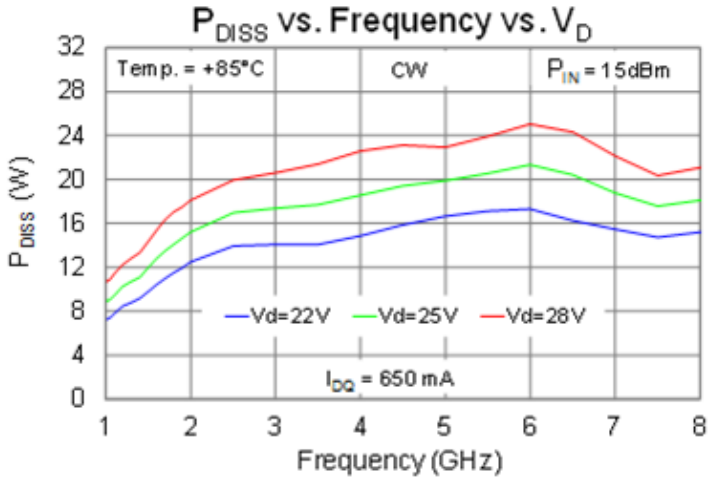


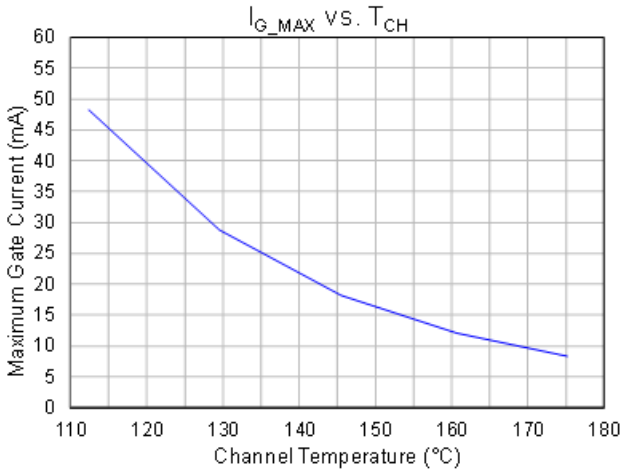
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85°C, V_D = +28 V (CW) At I_{DQ} = 650 mA, P_{DISS} = 18.2 W	3.62	°C/W
Channel Temperature (T_{CH}) (Quiescent) [2]		151	°C
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85 °C, V_D = +25 V (CW), Freq = 6.0 GHz, P_{IN} = 15 dBm, I_{DQ} = 650 mA, I_{D_Drive} = 1.2 A, P_{OUT} = 39 dBm, P_{DISS} = 21 W	4.19	°C/W
Channel Temperature (T_{CH}) (Under RF drive) [2]		173	°C
Thermal Resistance (θ_{JC}) [1]	T_{BASE} = 85 °C, V_D = +28 V (CW), Freq = 6.0 GHz, P_{IN} = 15 dBm, I_{DQ} = 650 mA, I_{D_Drive} = 1.2 A, P_{OUT} = 39 dBm, P_{DISS} = 25 W	4.16	°C/W
Channel Temperature (T_{CH}) (Under RF drive) [2]		189	°C

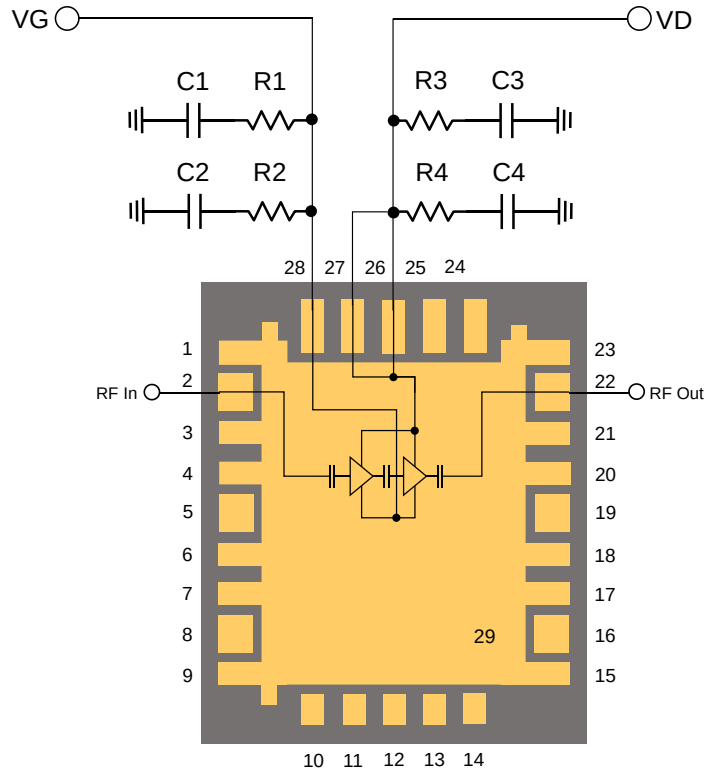
Notes:
1. Thermal resistance referenced to the back of the package.
2. IR scan equivalent. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Power Dissipation and Maximum Gate Current





Applications Circuit and Pin Layout



Bias Up Procedure

1. Set I_D limit to 1.3 A, I_G limit to 10 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
5. Turn on RF supply

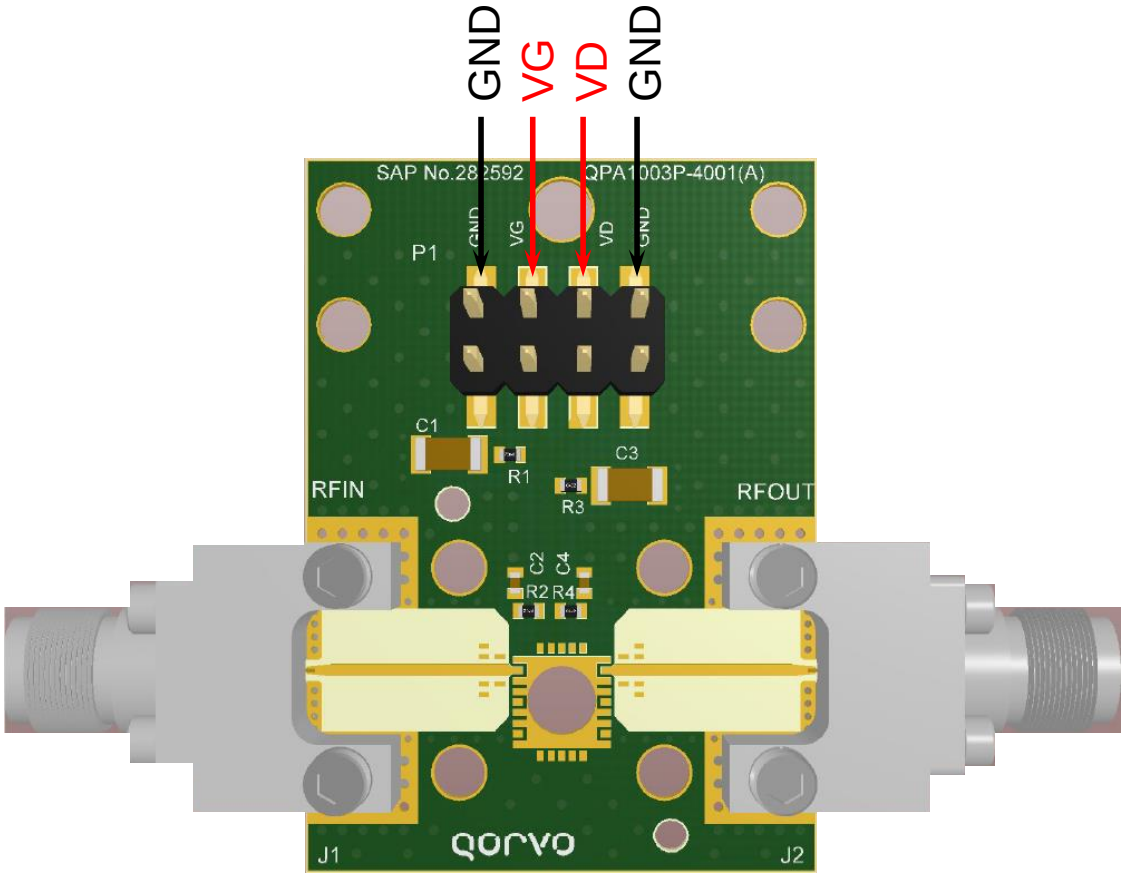
Bias Down Procedure

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

Pin Description

Pin No.	Symbol	Description
1, 3, 4, 6, 7, 9, 15, 17, 18, 20, 21, 23	GND	Must be grounded on the PCB
2	RF IN	RF Input; matched to 50 Ω, DC blocked
5, 8, 10-14, 16, 19, 24, 25	NC	No internal connection. Should be connected to PCB ground
22	RF OUT	RF Output; matched to 50 Ω, DC blocked
26, 27	VD	Drain voltage, bias network is required; see Application Circuit as an example
28	VG	Gate voltage, bias network is required; see Application Circuit as an example
29	GND	Center pad ground connection

Evaluation Board (EVB) Layout Assembly



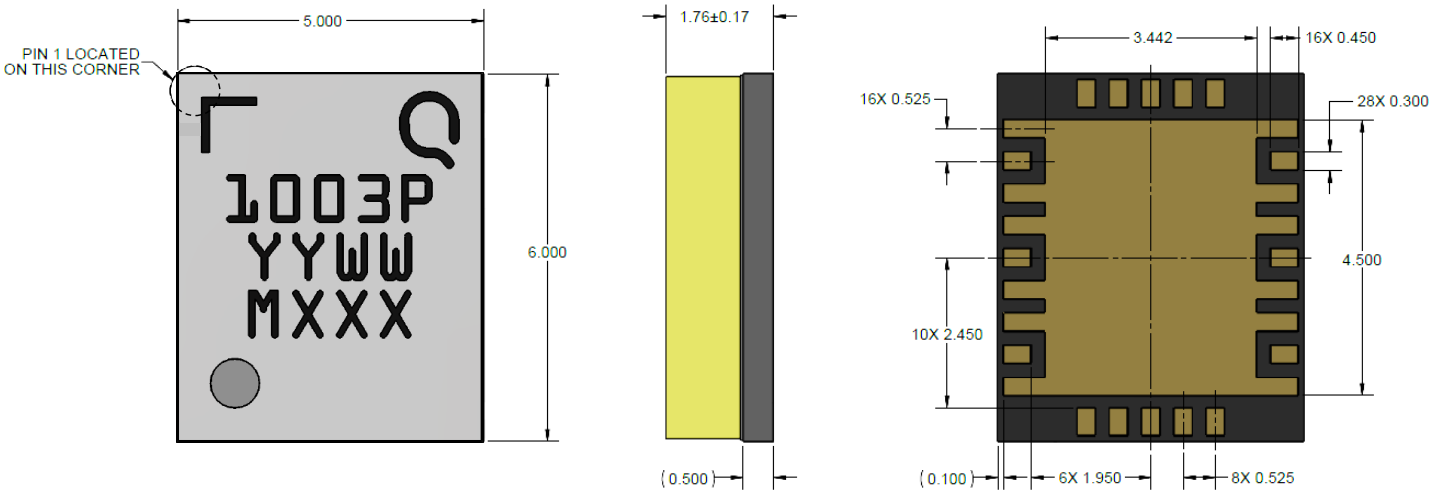
Notes:

1. PCB is 4 metal layers, each 0.5 oz. copper.
   Core 1 – Taconics TSM-DS, 0.010 in. thick
   Core 2 – Epoxy coated glass fabric
   Core 3 – 370HR, 0.006 in. thick
2. Center of PCB mounting area is a copper coin for thermal management and RF grounding.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C1, C3	1 uF	CAP, 1UF, 10%, 50V, X7R, 1206	Various	–
C2, C4	1000 pF	CAP, 1000pF, 10%, 50V, X7R, 0402	Various	–
R1, R2, R3, R4	5.1 Ohm	RES, 5.1 OHM, 5%, 50V, 0402	Various	–
J1, J2	2.92 mm	RF CONN, F, 2.92 mm	Southwest Microwave	1092-01A-5

Mechanical Information



Units: Millimeter (mm)
Tolerances: unless specified
x.xx = ± 0.25
x.xxx = ± 0.100
Materials:
Base: EHS Laminate
Lid: Laminate
All metalized features are gold plated
Part is epoxy sealed
Marking:
1003P: Part number
YY: Part Assembly year
WW: Part Assembly week
MXXX: Batch ID

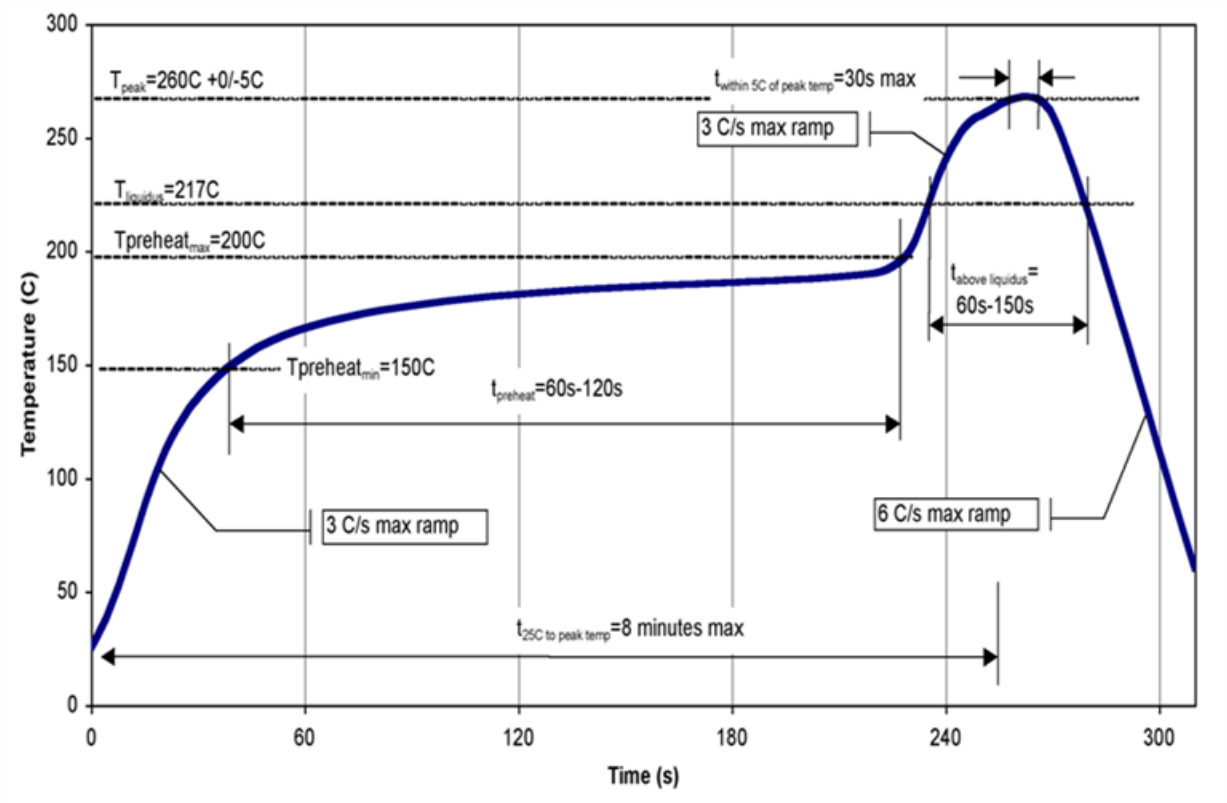
Assembly Notes

Compatible with lead-free soldering processes with 260°C peak reflow temperature.

This package is air-cavity and non-hermetic, and therefore cannot be subjected to aqueous washing. The use of no-clean solder to avoid washing after soldering is highly recommended.

Contact plating: Ni-Au

If rework is required, do not expose the package lid to temperatures > 280 °C



Recommended Soldering Temperature Profile