QPB1500

Ku-Band 25 W GaN Power Amplifier

Product Description

Qorvo's QPB1500 is a packaged 25 W power amplifier operating over the 14.85 GHz to 15.75 GHz band. The active device is fabricated on Qorvo's QGaN15 0.15 um GaN on SiC technology. The QPB1500 offers > 30 dB small-signal gain with saturated output power of 44 dBm and PAE of 35% for operation in the middle of Ku-Band.

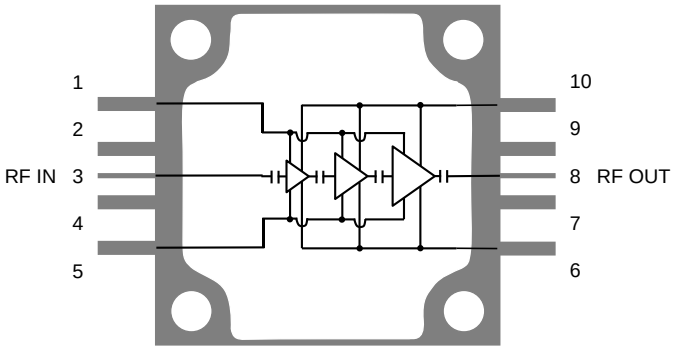
The QPB1500 is offered in a 10 pin leadless bolt-down package. Assembled with a pure copper base, coupled with its high efficiency, the QPB1500 minimizes the strain on system-level cooling requirements. Superior electrical performance and thermal management makes the QPB1500 ideal for supporting communication applications in both commercial and military applications.

Both RF ports are DC blocked and are fully matched to 50 ohms.

Product Features

- Frequency Range: 14.85 – 15.75 GHz
- P_{OUT}: 44 dBm @ P_{IN} = 20 dBm
- PAE: 35% @ P_{IN} = 20 dBm
- Power Gain: 24 dB @ P_{IN} = 20 dBm
- IM3: −29 dBc @ (P_{OUT}/Tone = 30 dBm)
- Bias: V_D = +28 V, I_{DQ} = 450 mA, V_G = −2.5 V typical
- Package Dimensions: 15.2 x 15.2 x 3.5 mm
- Package base is pure Cu offering superior thermal management

Functional Block Diagram



Applications

- Commercial VSAT
- Military SATCOM
- Datalinks

Ordering Information

Part No.	Description
QPB1500	Ku-Band 25 W GaN PA Module
QPB1500S2	Box (2 samples each)
QPB1500PCB4B01	Evaluation Board

Absolute Maximum Ratings

Parameter	Value / Range
Drain Voltage (V_D)	29.5 V
Gate Voltage Range (V_G)	−5 to 0 V
Drain Current (I_D)	7.2 A
Gate Current (I_G)	See plot page 10
Power Dissipation (P_{DISS}), 85 °C	80 W
Input Power (P_{IN}) CW, 50 Ω, V_D = +28 V, I_{DQ} = 450 mA, 85 °C	34 dBm
Input Power (P_{IN}), CW, VSWR 3:1, V_D = +28 V, I_{DQ} = 450 mA, 85 °C	31 dBm
Lead Soldering 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})	450 mA
Temperature Range	−40 to +85 °C

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

Electrical Specifications

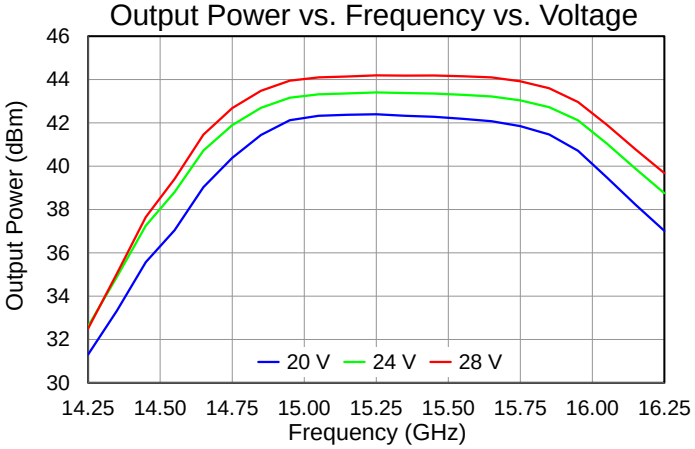
Parameter	Min	Typ	Max	Units
Operational Frequency Range	14.85		15.75	GHz
Small Signal Gain		33		dB
Input Return Loss		10		dB
Output Return Loss		18		dB
Output Power (@ P_{IN} = 20 dBm)		44.2		dBm
Power Added Efficiency (@ P_{IN} = 20 dBm)		35.5		%
Power Gain (@ P_{IN} = 20 dBm)		24.2		dB
IM3 @ 30 dBm/Tone		-29		dBc
Output Power Temperature Coefficient (25 °C to 85 °C only, P_{IN} = 20 dBm)		−0.024		dBm/°C

Test conditions unless otherwise noted: 25 °C, V_D = +28 V, I_{DQ} = 450 mA, V_G = −2.5 V typical, CW

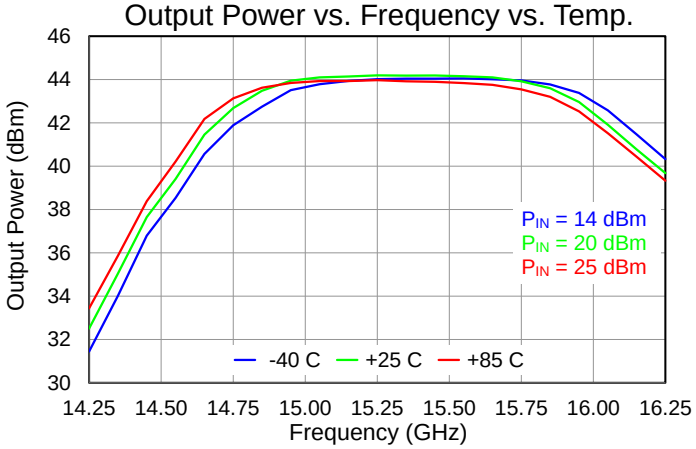
Typical Performance – Large Signal

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 °C

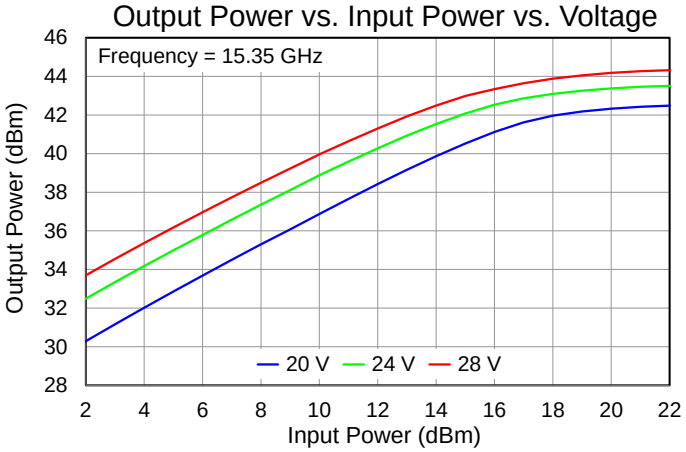
Output Power vs. Frequency vs. Voltage



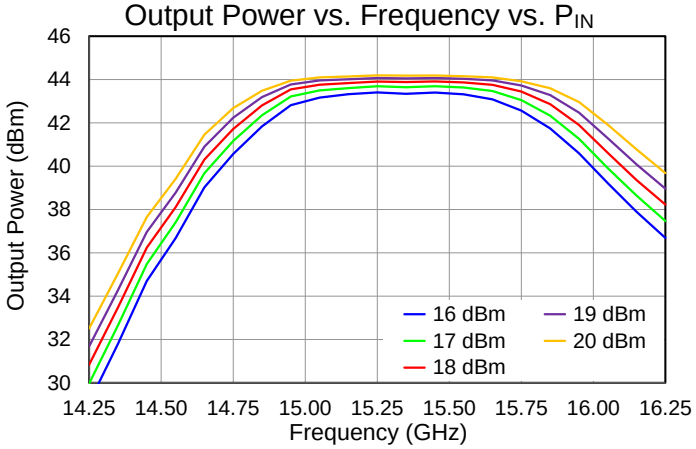
Output Power vs. Frequency vs. Temp.



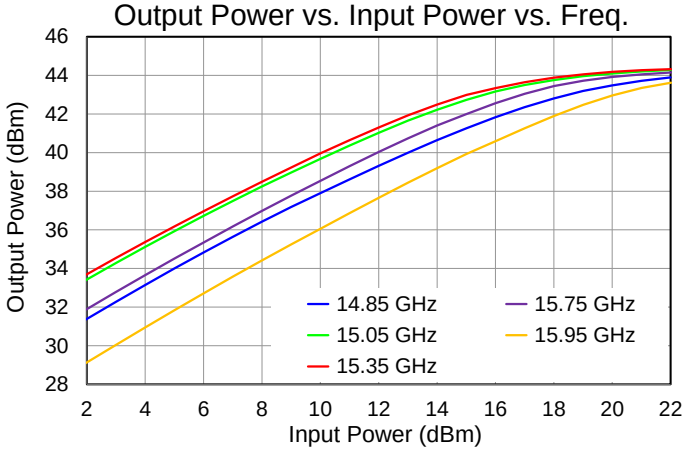
Output Power vs. Input Power vs. Voltage



Output Power vs. Frequency vs. P_{IN}



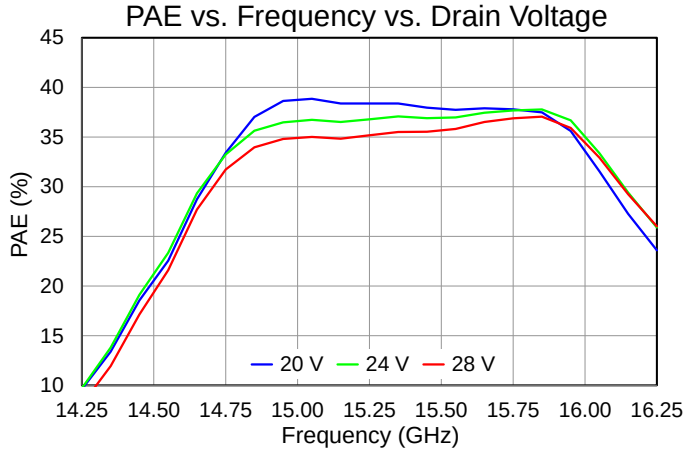
Output Power vs. Input Power vs. Freq.



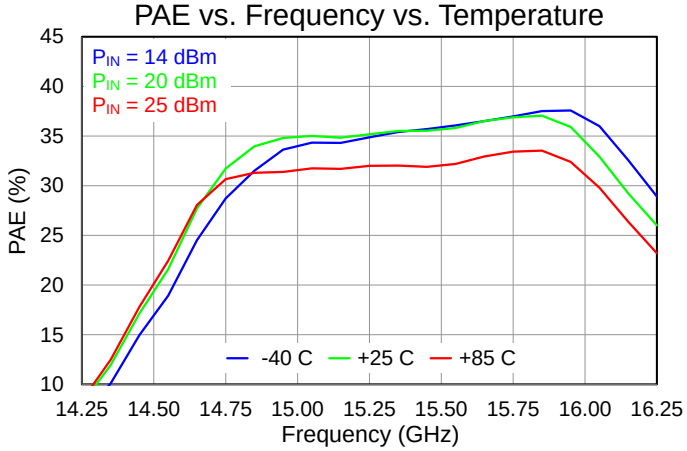
Typical Performance – Large Signal

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 °C

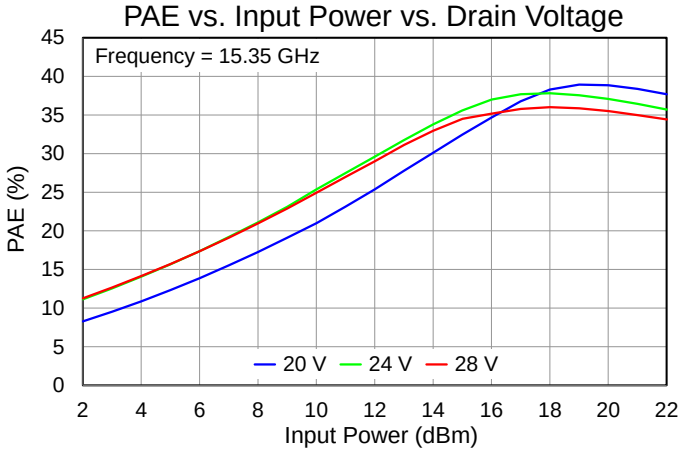
PAE vs. Frequency vs. Drain Voltage



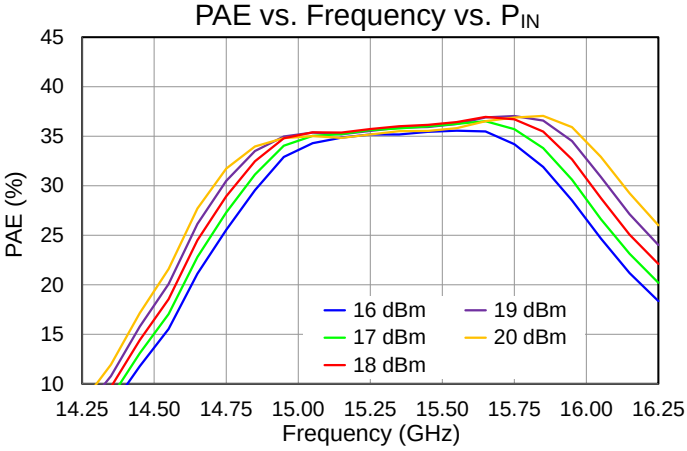
PAE vs. Frequency vs. Temperature



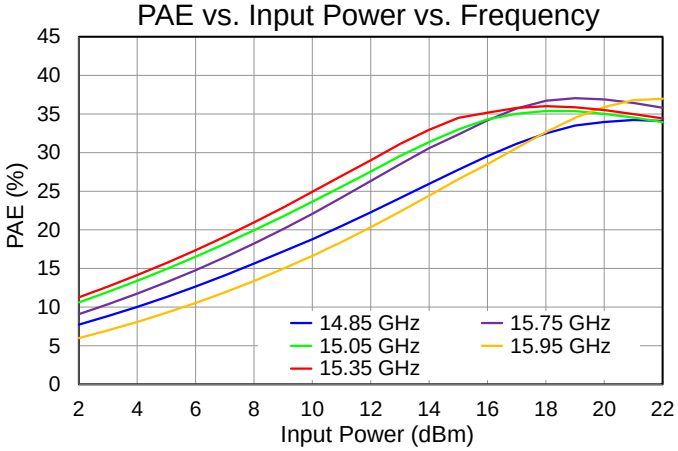
PAE vs. Input Power vs. Drain Voltage



PAE vs. Frequency vs. P_{IN}



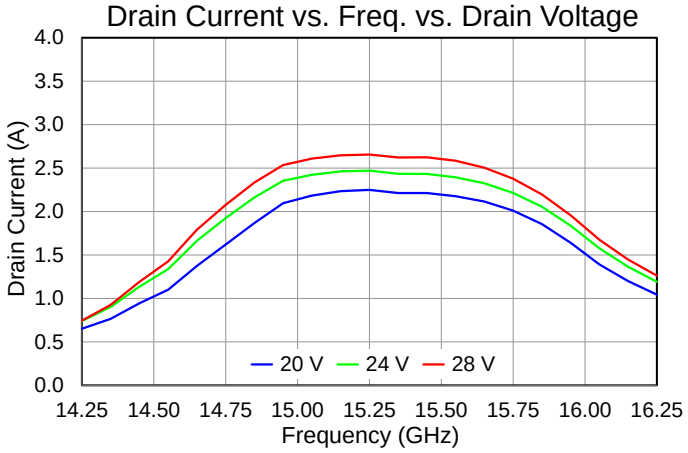
PAE vs. Input Power vs. Frequency



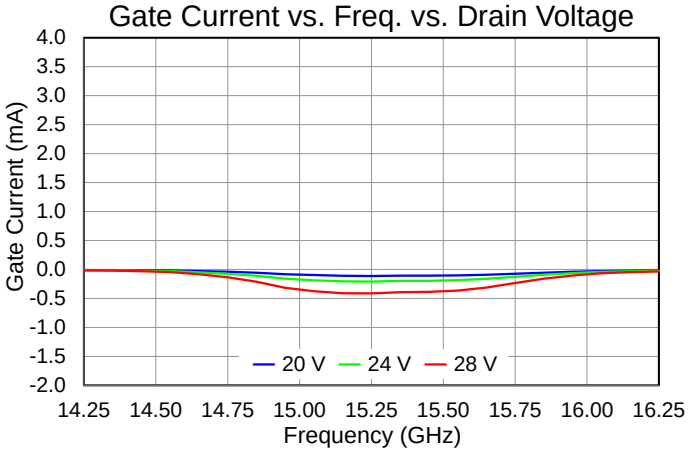
Typical Performance – Large Signal

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 °C

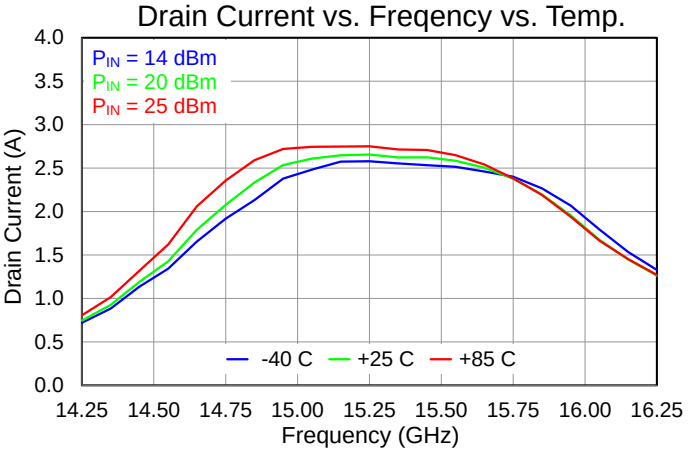
Drain Current vs. Freq. vs. Drain Voltage



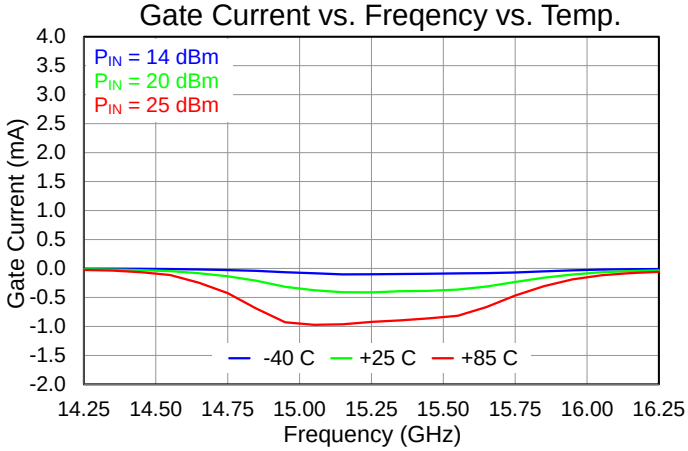
Gate Current vs. Freq. vs. Drain Voltage



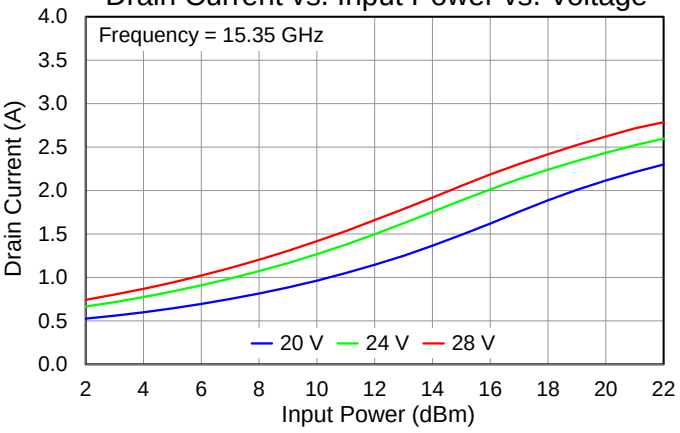
Drain Current vs. Freqency vs. Temp.



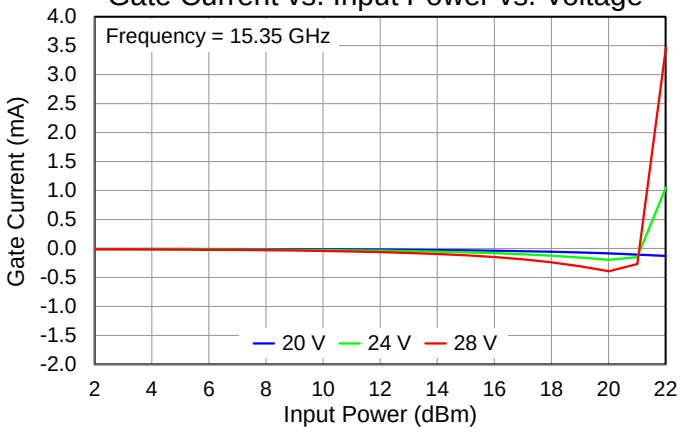
Gate Current vs. Freqency vs. Temp.



Drain Current vs. Input Power vs. Voltage



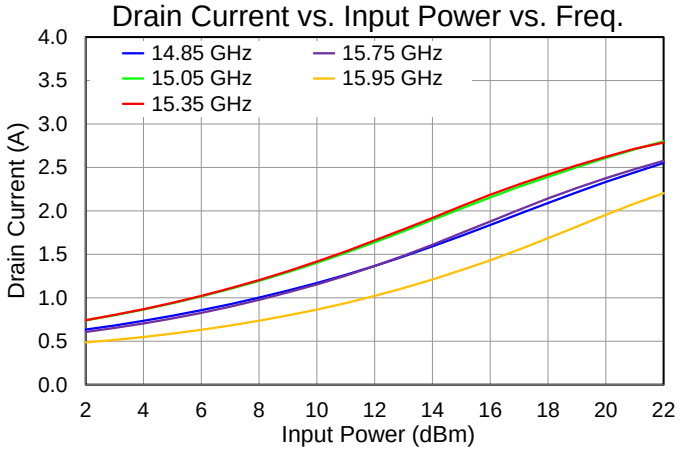
Gate Current vs. Input Power vs. Voltage



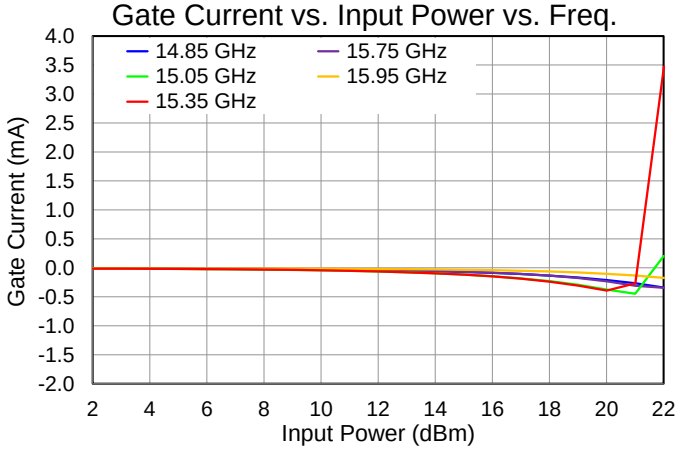
Performance Plots – Large Signal

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 °C

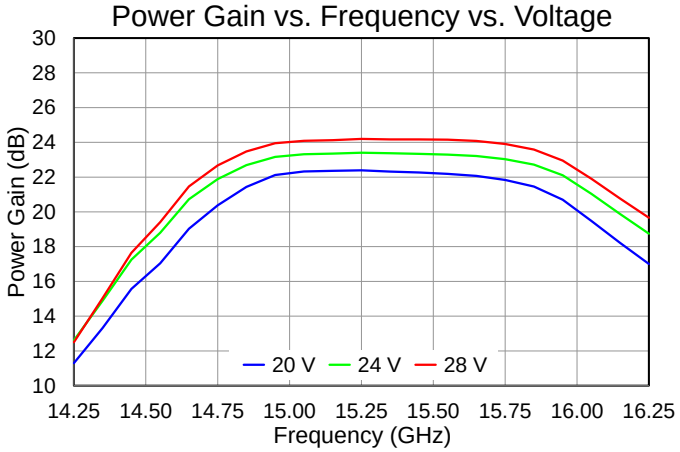
Drain Current vs. Input Power vs. Freq.



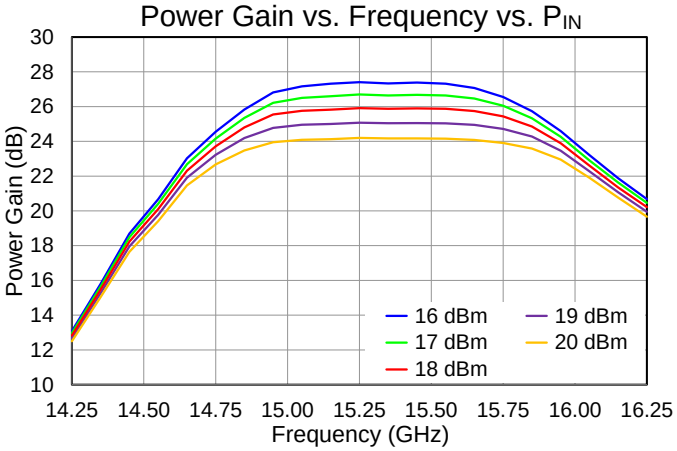
Gate Current vs. Input Power vs. Freq.



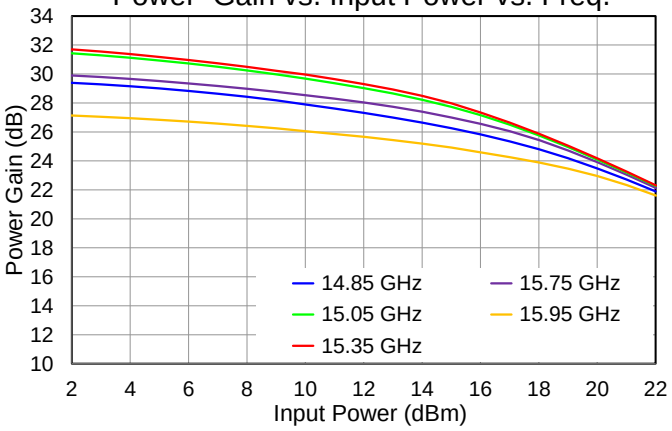
Power Gain vs. Frequency vs. Voltage



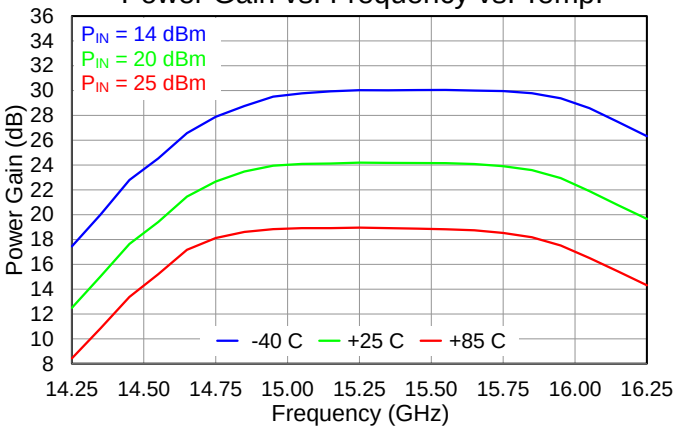
Power Gain vs. Frequency vs. P_{IN}



Power Gain vs. Input Power vs. Freq.

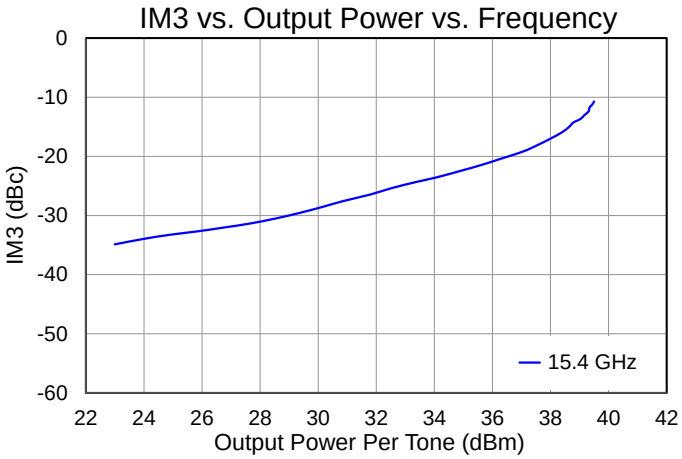


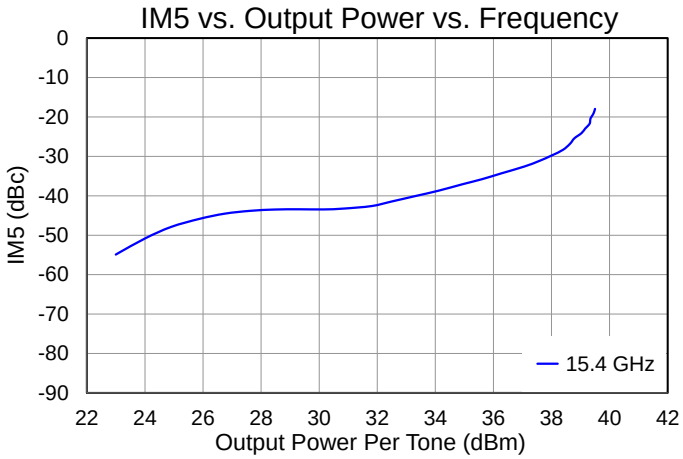
Power Gain vs. Frequency vs. Temp.

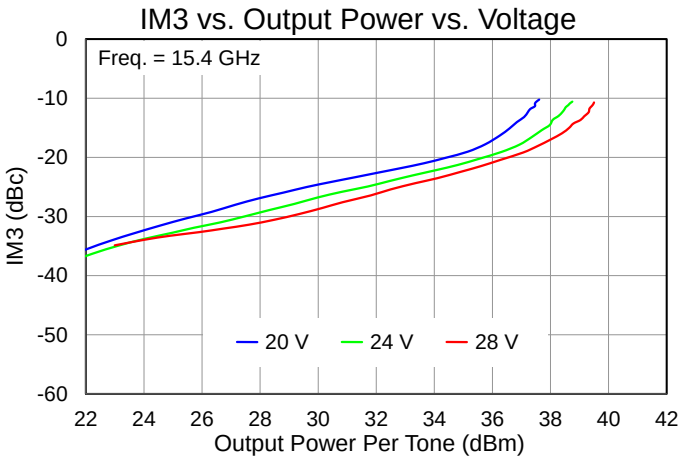


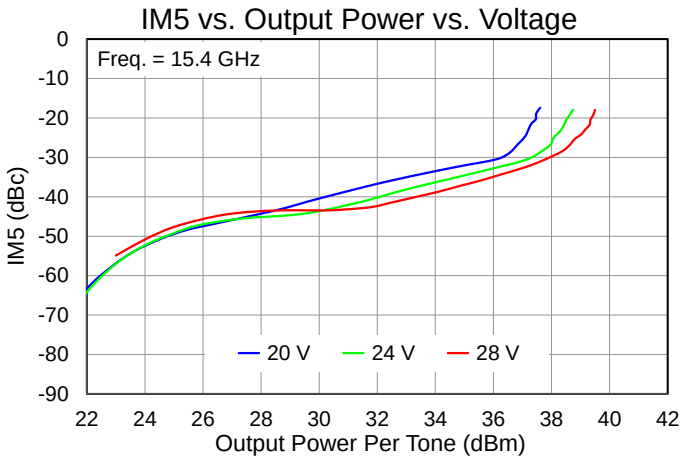
Performance Plots – Linearity

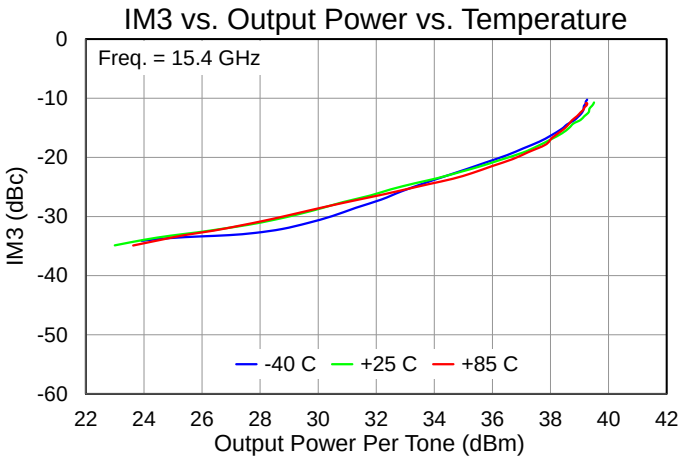
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Tone Separation = 1 MHz, Temp = 25 °C

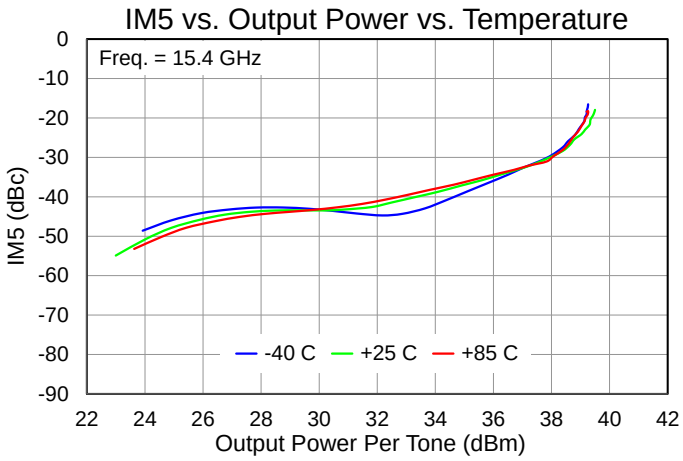






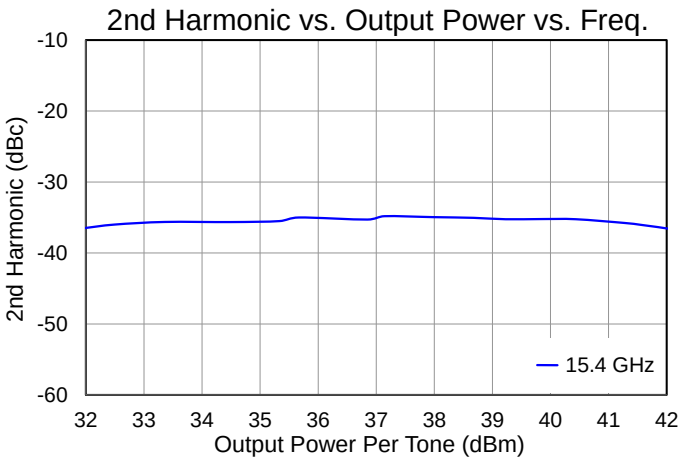


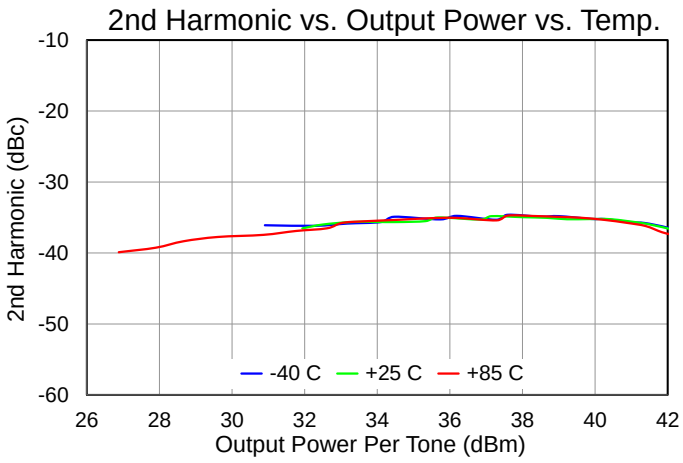




Performance Plots – Harmonic

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Temp = 25 °C

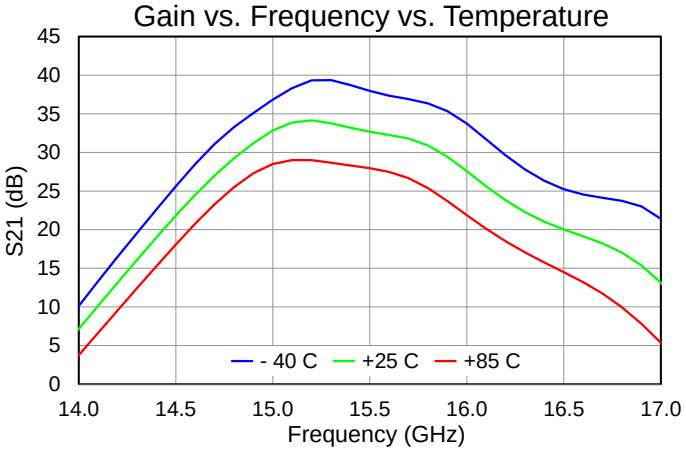




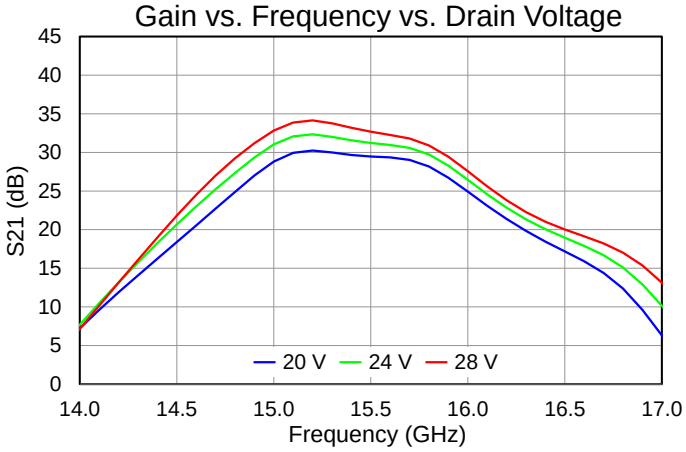
Performance Plots – Small Signal

Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Temp = 25 °C

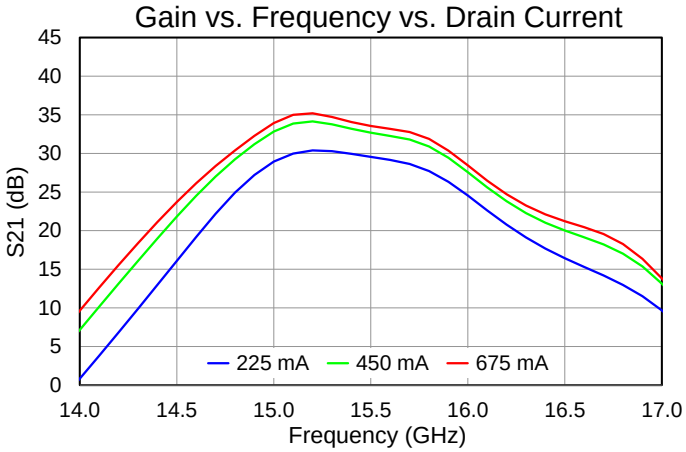
Gain vs. Frequency vs. Temperature



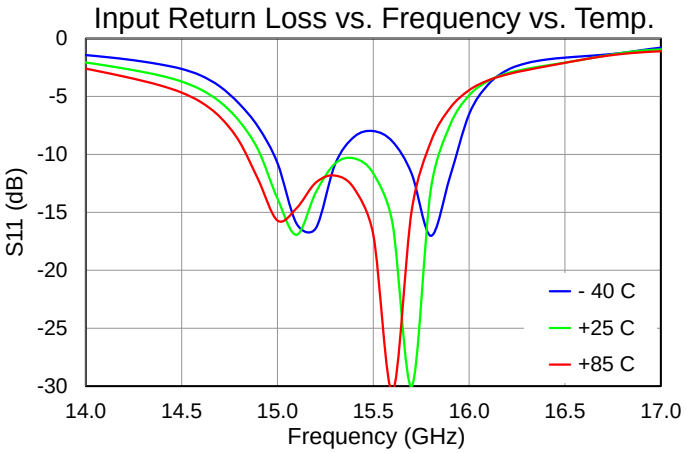
Gain vs. Frequency vs. Drain Voltage



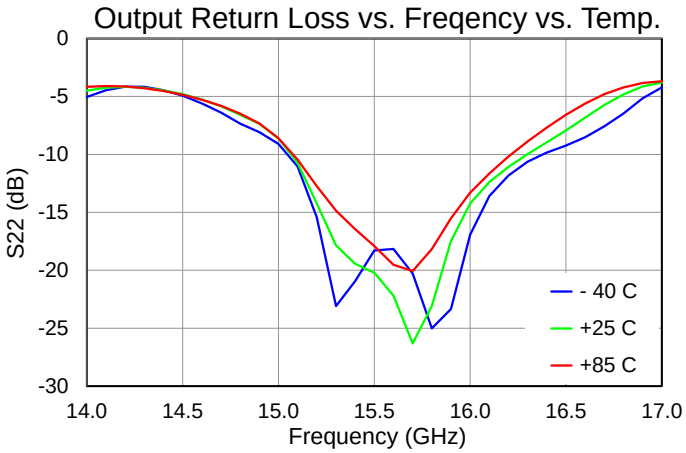
Gain vs. Frequency vs. Drain Current



Input Return Loss vs. Frequency vs. Temp.



Output Return Loss vs. Freqency vs. Temp.



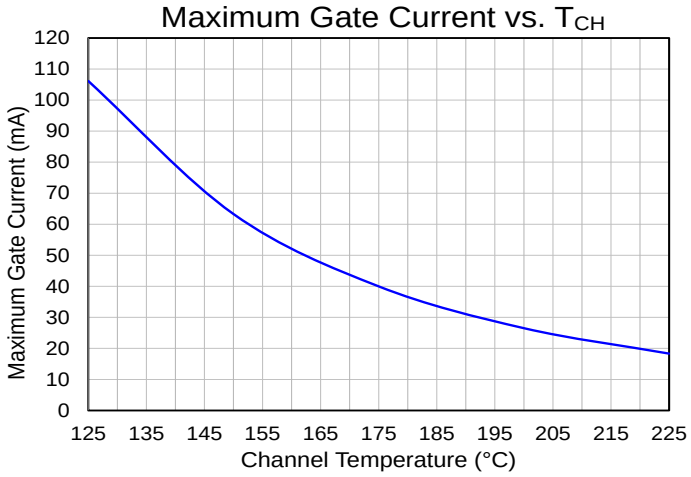
Thermal and Reliability Information

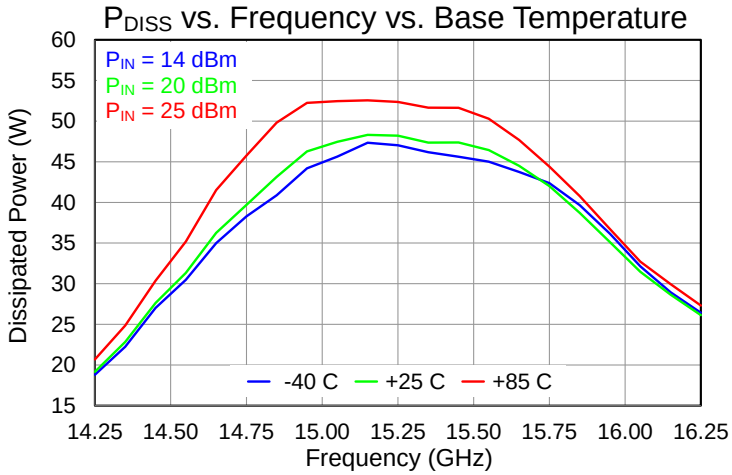
Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 ºC, V_D = 28 V, I_{DQ} = 450 mA, P_{DISS} = 12.8 W, CW, No RF (quiescent DC operation)	1.56	ºC/W
Channel Temperature, T_{CH} (No RF) (2)		105	ºC
Thermal Resistance (θ_{JC}) (1)	T_{base} = 85 ºC, V_D = 28 V, I_{DQ} = 450 mA, CW Freq = 15.15 GHz, I_{D_Drive} = 2.17 A, P_{IN} = 20 dBm, P_{OUT} = 42.9 dBm, P_{DISS} = 41.4 W	1.43	ºC/W
Channel Temperature, T_{CH} (Under RF) (2)		144	ºC

Notes:

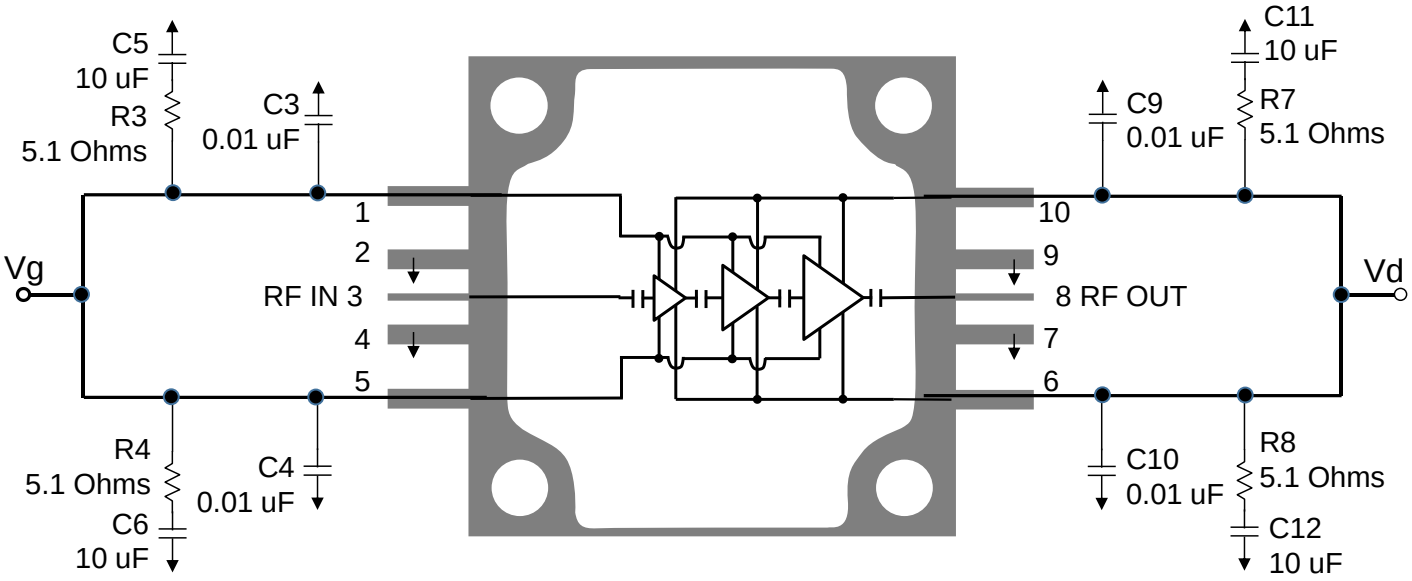
1. Thermal resistance is referenced to the back of package (85 ºC)
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Dissipated Power and Maximum Gate Current





Applications Information and Pin Layout



Bias Up Procedure

1. Set I_D limit to 3.5 A, I_G limit to 65 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} = 450 mA (V_G ~ −2.5 V Typ.).
5. Turn on RF supply

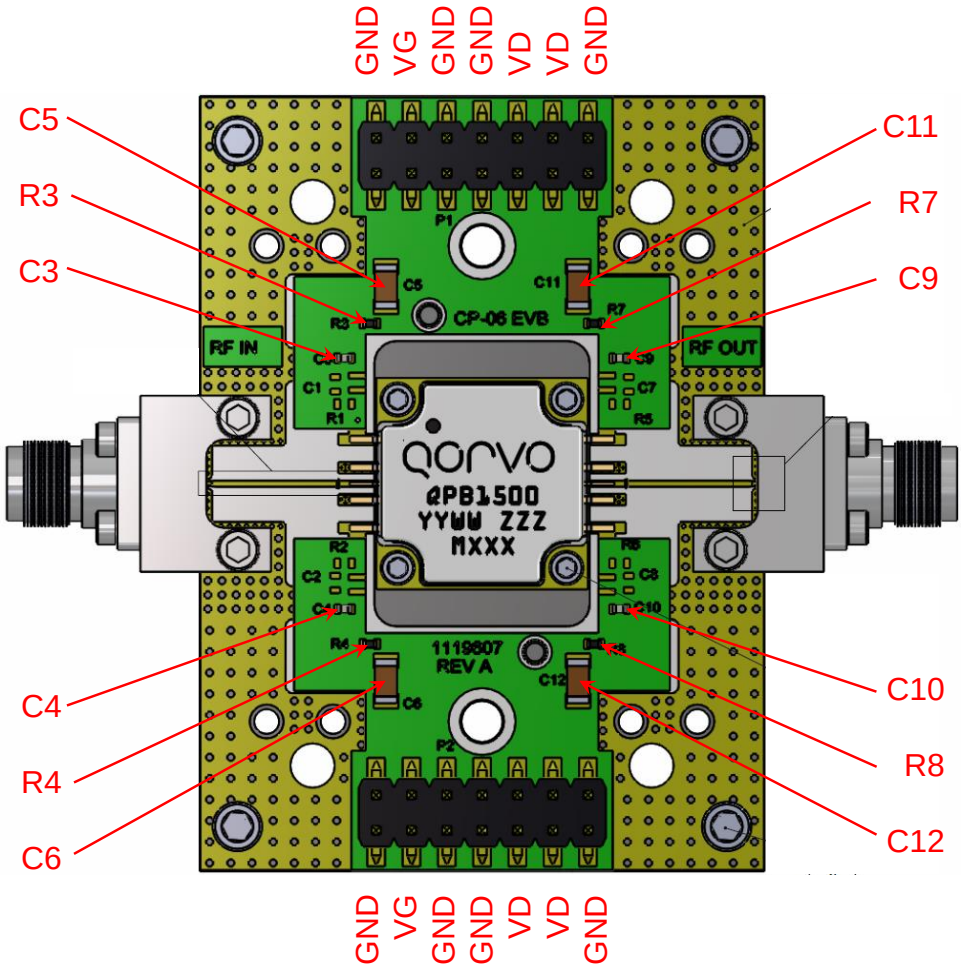
Bias Down Procedure

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

Pin Description

Pad No.	Symbol	Description
1,5	V_G	Gate Voltage; Bias network is required; must be biased from both sides; see recommended Application Information above.
2,4,7,9	GND	Must be grounded on the PCB.
3	RF_{IN}	Input; matched to 50 Ω; DC blocked
6,10	V_D	Drain voltage; Bias network is required; must be biased from both sides; see recommended Application Information above.
8	RF_{OUT}	Output; matched to 50 Ω; DC blocked

Evaluation Board (EVB) Assembly Drawing



PCB NOTES:

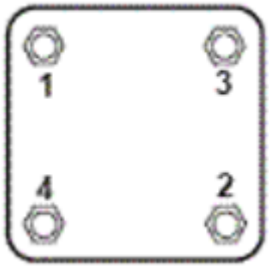
1. PCB is made from Rogers 4003C dielectric, 0.008 inch thick, 0.5 oz. copper both sides.
2. Both Top and Bottom Vd and Vg must be biased.

Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
C3, C4, C9, C10	0.01 uF	CAP 0.01UF +/-10% 50V 0402 X7R ROHS	Various	–
C5, C6, C11, C12	10 uF	CAP1206, 10uF, 20%, 50V, 20%, X5R	Various	–
R3, R4, R7, R8	5.1 Ohm	RES, 5.1 OHM, 5%, 50V, SMT, 0402	Various	–

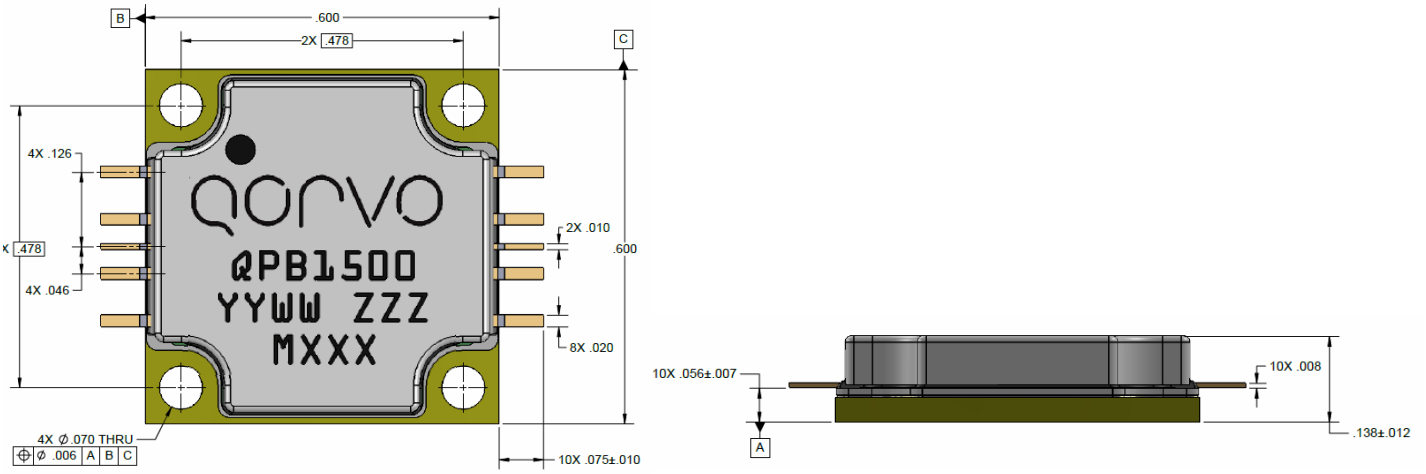
Assembly Notes

1. Carefully clean the PC board and package leads with alcohol. Allow it to dry fully.
2. To improve the thermal and RF performance, Qorvo recommends attaching a heat sink to the bottom of the PCB and apply thermal compound (Arctic Silver 5 recommended) or 4 mil indium shim between the heat sink and the package.
3. (The following is for *information only*. There are many variables in a second level assembly that Qorvo does not control, so Qorvo does not recommend an absolute torque value.) Use screws to attach the component to the heat sink. A suggested torque value is 16 in-oz. for a 0-80 screw. Start with screws finger tight, then torque to 8 in-oz., then torque to final value. Use the following tightening pattern:



4. Apply no-flux solder to each pin of the QPB1500. The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. The use of no-clean solder to avoid washing after soldering is recommended.

Mechanical Information



Units: inches
Tolerances: (unless specified)
x.xx = ± 0.01
x.xxx = ± 0.005
Materials:
Base: Copper
Leads: Alloy 194
Lid: LCP (liquid crystal polymer)
All metalized features are gold plated
Part is epoxy sealed
Marking:
QPB1500: Part number
YY: Part Assembly year
WW: Part Assembly week
ZZZ: Serial Number (unique for all parts within one assembly lot)
MXXX: Batch ID

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 0B	JEDEC Standard JESD22 A114
ESD – Charge Device Model (CDM)	TBD	JEDEC Standard JESD22-C101F
MSL – Moisture Sensitivity Level	N/A	

Caution!
ESD-Sensitive Device

Solderability

The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. Soldering of the component leads is compatible with the latest version of J-STD-020, lead-free solder, 260 °C. The use of no-clean solder to avoid washing after soldering is recommended.

RoHS Compliance

This product is compliant with the 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:

- Product uses RoHS Exemption 7c-I to meet RoHS compliance requirements
- 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

Email: customer.support@qorvo.com

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