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 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.

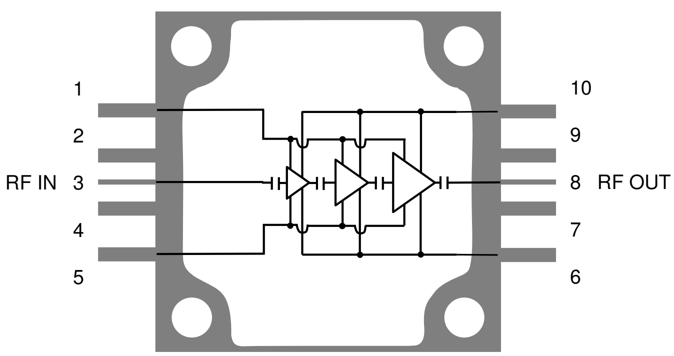
Both RF ports are DC blocked and are fully matched to 50 ohms.

Lead free and RoHS compliant.

Product Features

- Frequency Range: 14.85 – 15.75 GHz
- P_{OUT} (P_{IN} = 20 dBm): 44 dBm
- PAE (P_{IN} = 20 dBm): 35%
- Power Gain (P_{IN} = 20 dBm): 24 dB
- IM3 (P_{OUT}/Tone = 30 dBm) = –29 dBc
- Bias: V_D = +28 V, I_{DQ} = 450 mA, V_G = –2.4 V typical
- Package Dimensions: 15.2 x 15.2 x 5.2 mm
- Package base is pure Cu offering superior thermal management
- ECCN: EAR99

Functional Block Diagram



Applications

- Commercial VSAT
- Military SATCOM
- Datalinks

Ordering Information

Part No.	ECCN	Description
QPB1500	EAR99	Ku-Band 25 W GaN PA Module
QPB1500S2	EAR99	Box (2 samples each)
QPB1500PCB4B01	EAR99	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 3
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
Channel Temperature (T_{CH})	275 °C
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})	450 mA
Drain Current Under RF Drive (I_{D_DRIVE})	See plots page 6
Gate Voltage (V_G)	–2.5 V (Typ.)
Gate Current Under RF Drive (I_{G_DRIVE})	See plots p. 6
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

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 (at P_{IN} = 20 dBm)		44.2		dBm
Power Added Efficiency (at P_{IN} = 20 dBm)		35.5		%
Power Gain (at 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 = +20 V, I_{DQ} = 560 mA, V_G = –2.5 V typical.

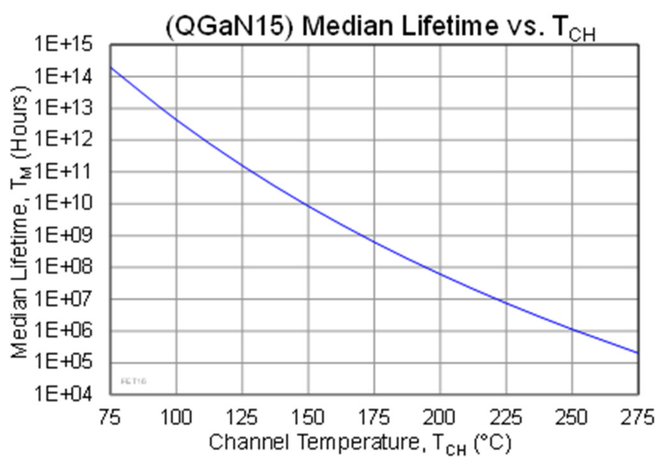
Thermal and Reliability Information

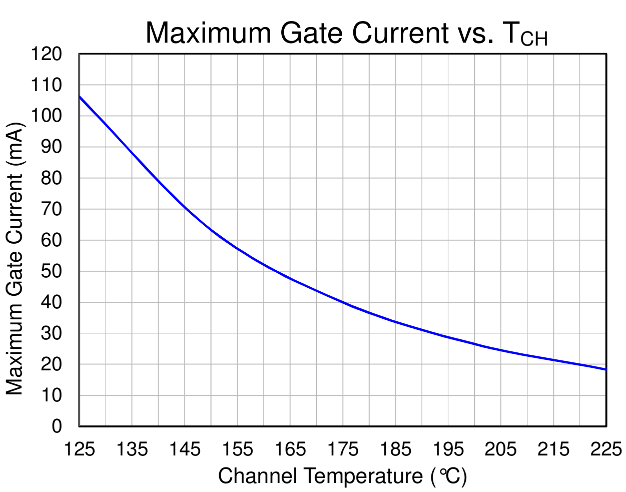
Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) [1]	CW, V_D = +28 V, I_{DQ} = 450 mA, T_{BASE} = 85 ℃ P_{DISS} = 12.8 W	2.38	℃/W
Channel Temperature (T_{CH}) (Quiescent)		115	℃
Median Lifetime (T_M)		5.58E+11	Hrs
Thermal Resistance (θ_{JC}) [1]	V_D = +28 V, I_{DQ} = 450 mA, T_{BASE} = 85 ℃, Freq = 15.15 GHz, P_{IN} = 20 dBm, P_{OUT} = 42.9 dBm, P_{DISS} = 41.4 W, I_{D_Drive} = 2.17 A	2.13	℃/W
Channel Temperature (T_{CH}) (under RF drive)		173	℃
Median Lifetime (T_M)		7.76E+08	Hrs

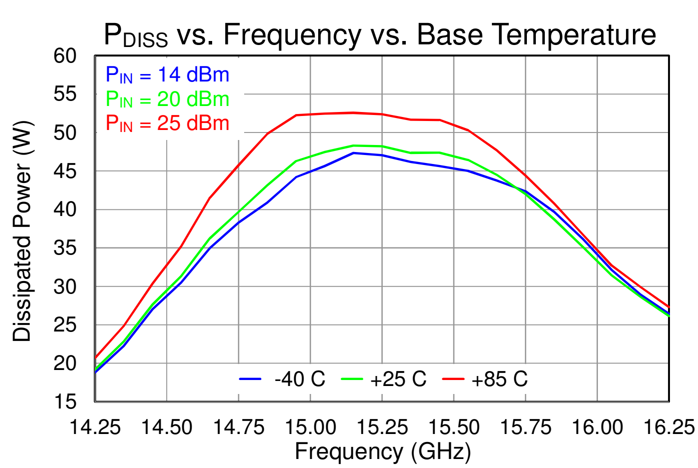
Notes:
1. Thermal resistance measured to back of package.

Median Lifetime

Life Test Conditions: V_D = 28 V; Failure Criteria = 10 % reduction in ID_MAX during DC Life Testing

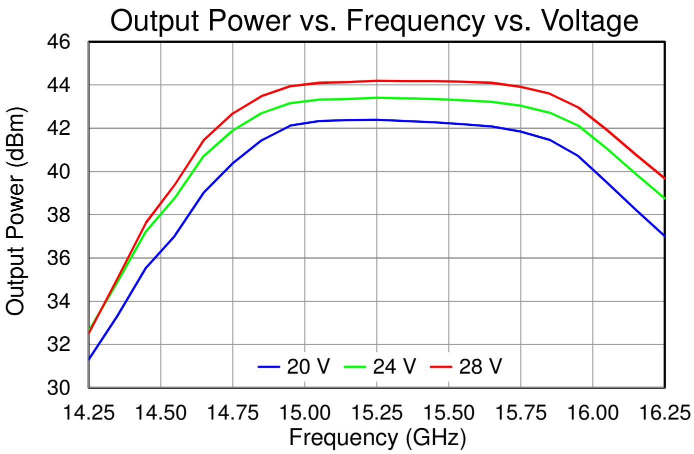


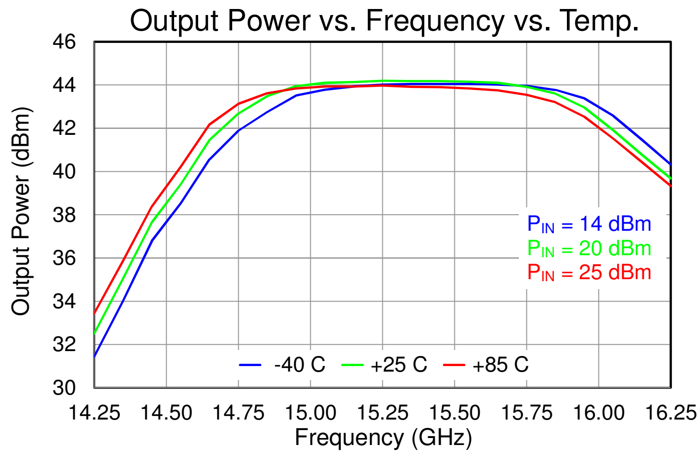


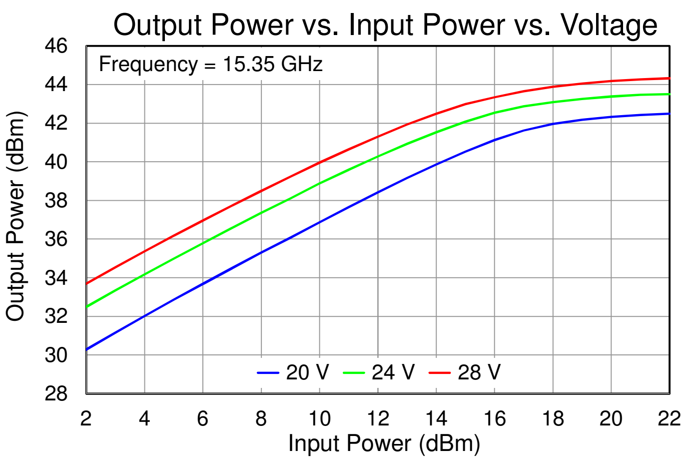


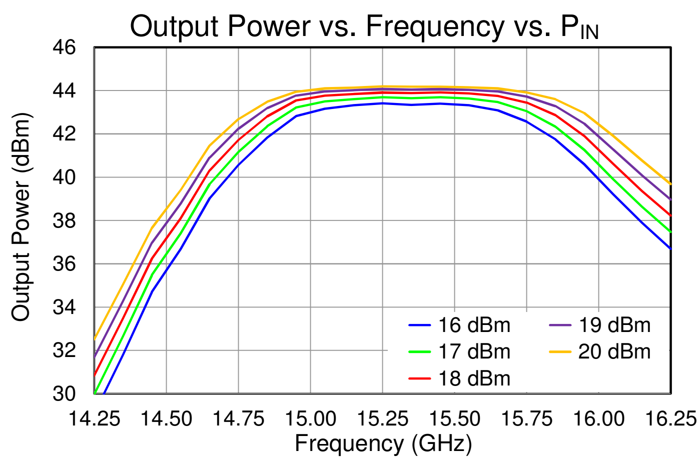
Typical Performance – Large Signal

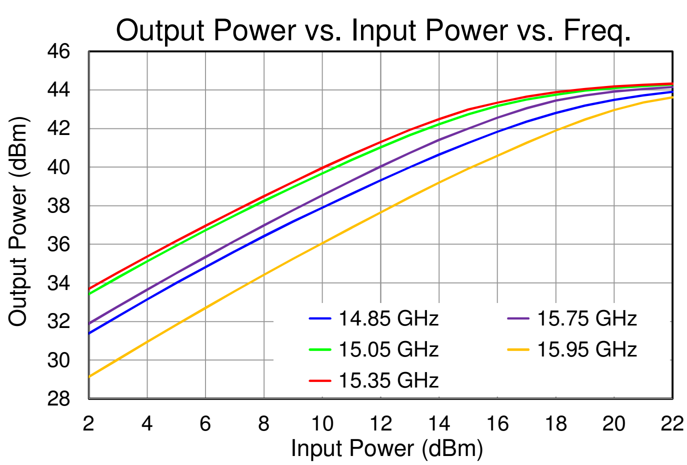
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 ℃







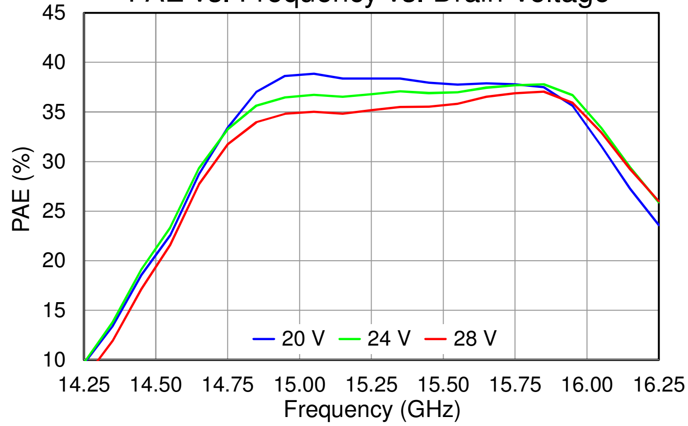




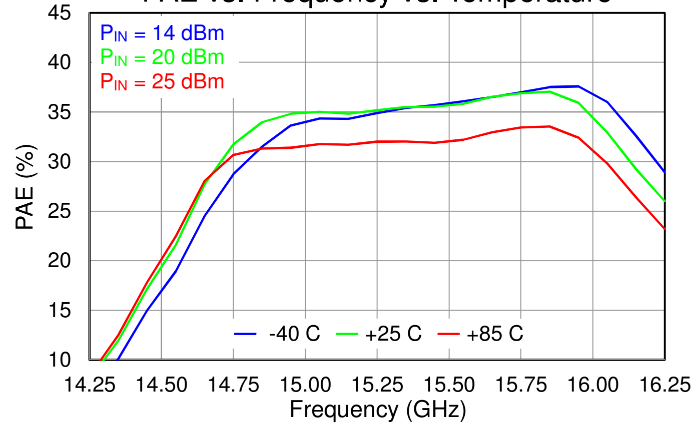
Typical Performance – Large Signal

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

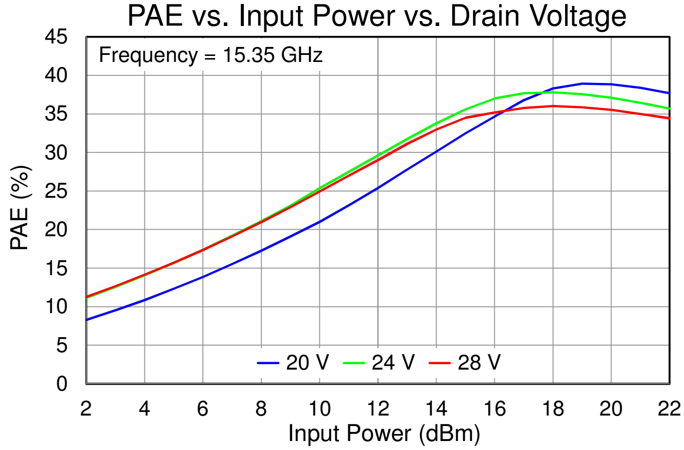
PAE vs. Frequency vs. Drain Voltage



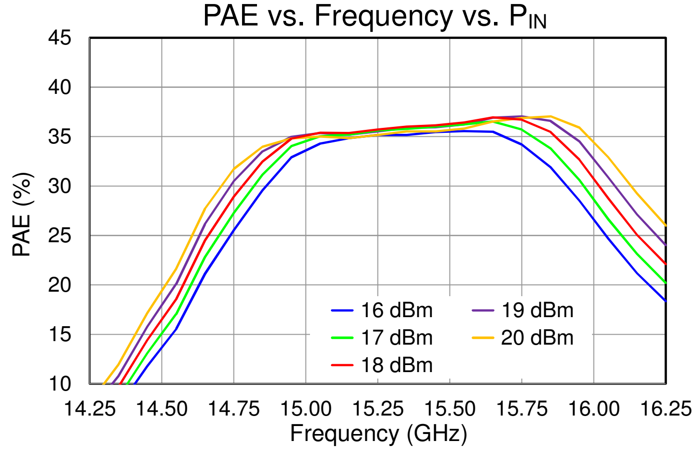
PAE vs. Frequency vs. Temperature



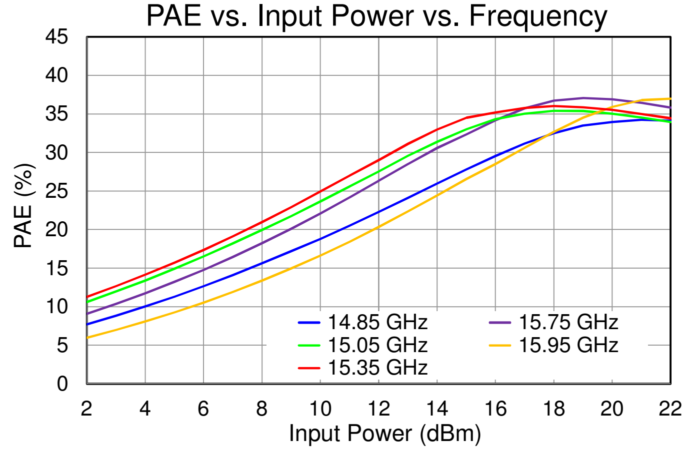
PAE vs. Input Power vs. Drain Voltage



PAE vs. Frequency vs. P_{IN}

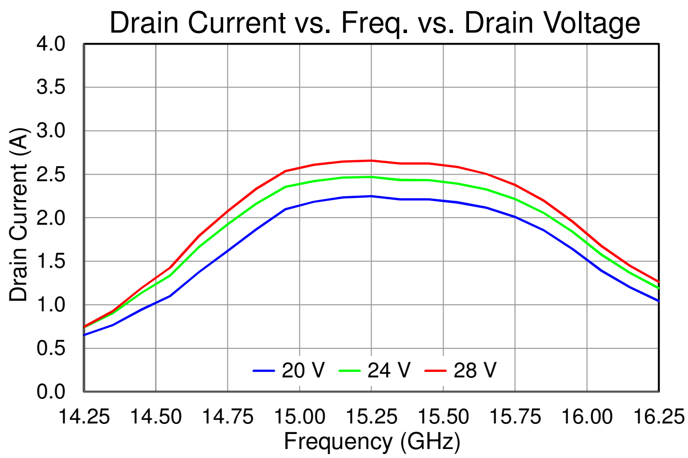


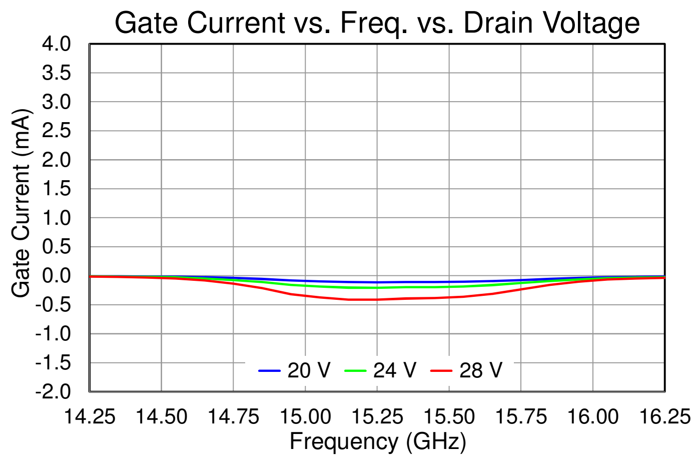
PAE vs. Input Power vs. Frequency

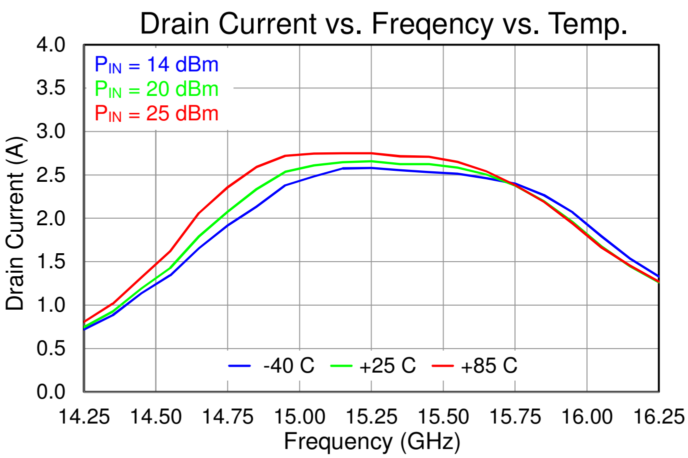


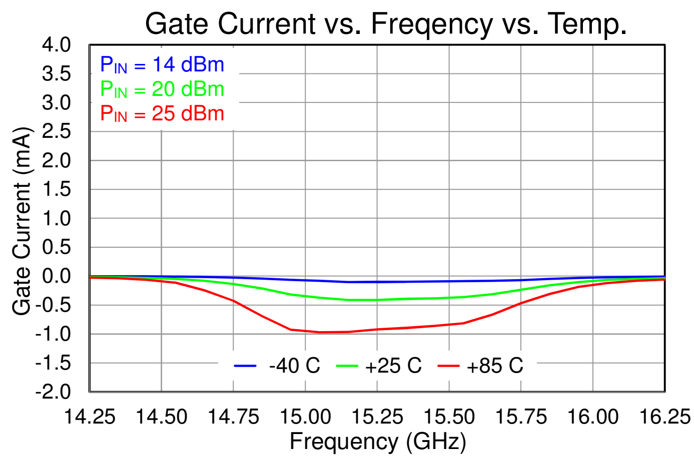
Typical Performance – Large Signal

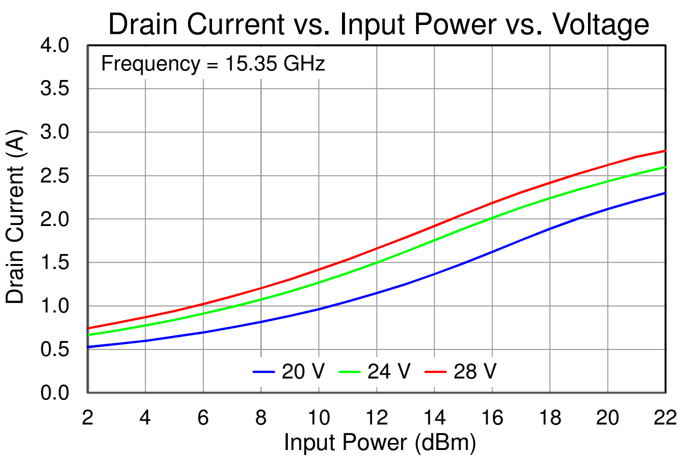
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, P_{IN} = 20 dBm, Temp = 25 °C

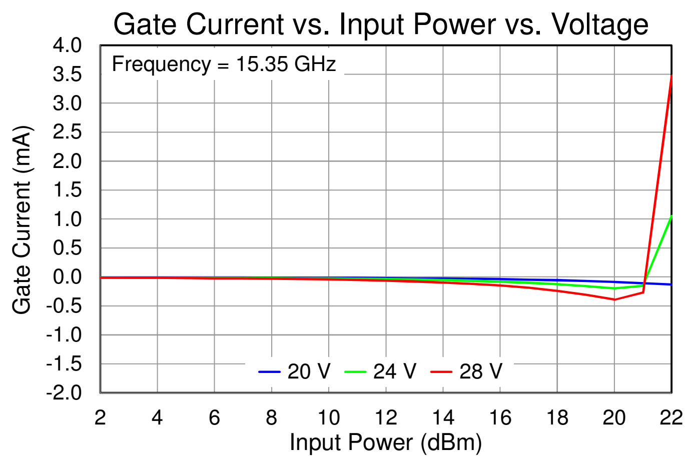








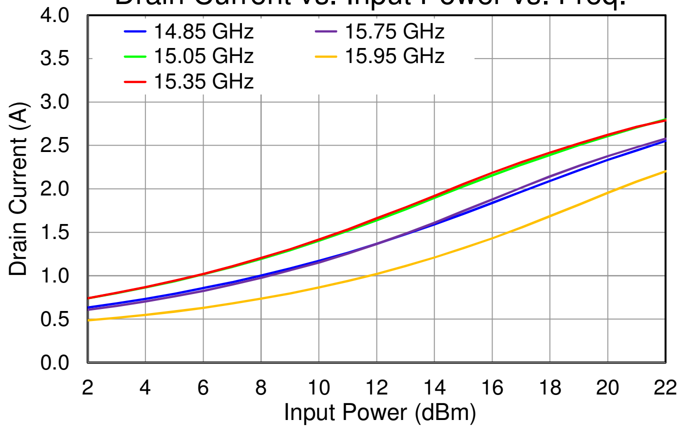




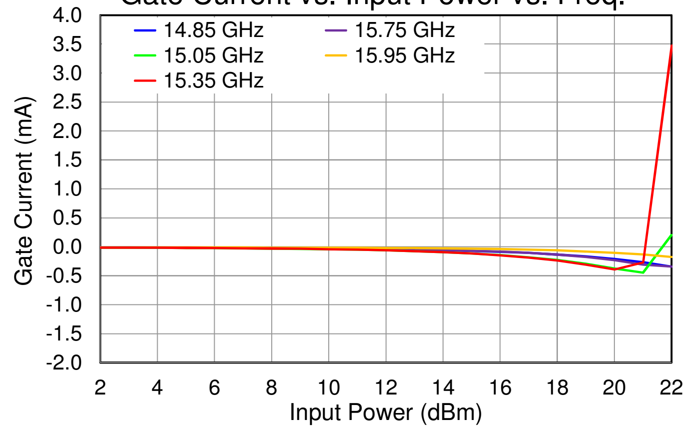
Performance Plots – Large Signal

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

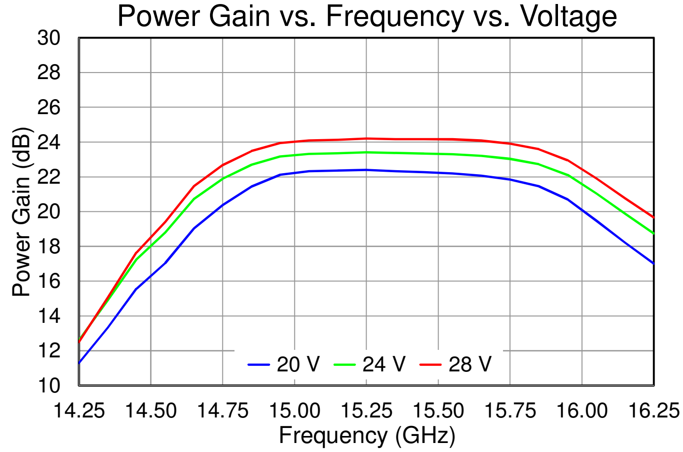
Drain Current vs. Input Power vs. Freq.



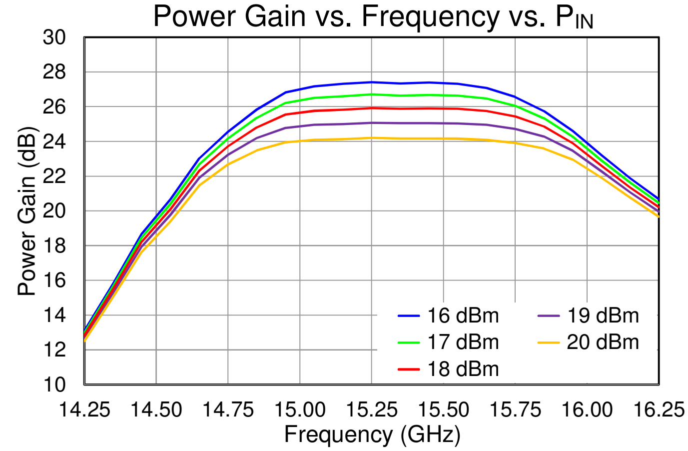
Gate Current vs. Input Power vs. Freq.



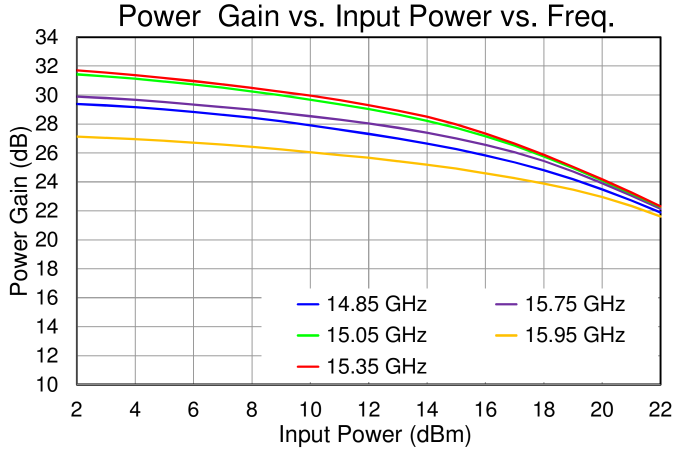
Power Gain vs. Frequency vs. Voltage



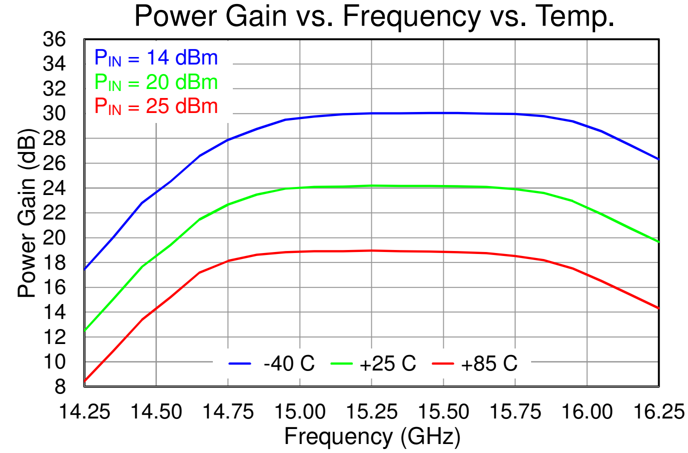
Power Gain vs. Frequency vs. P_{IN}



Power Gain vs. Input Power vs. Freq.

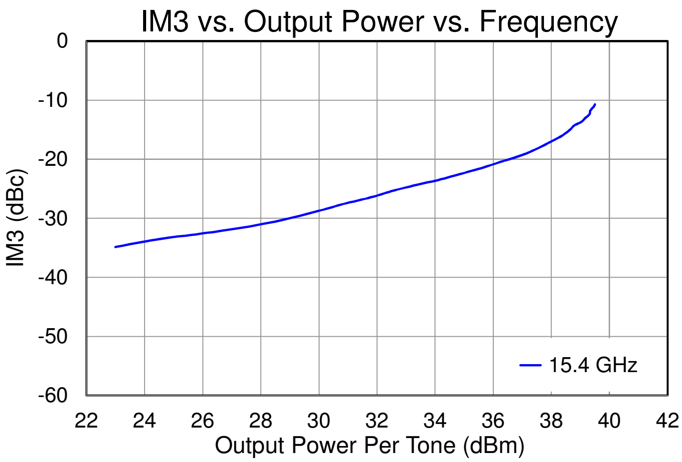


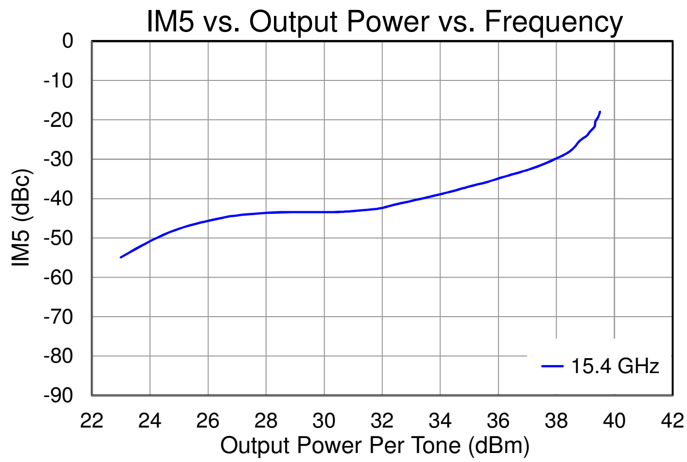
Power Gain vs. Frequency vs. Temp.

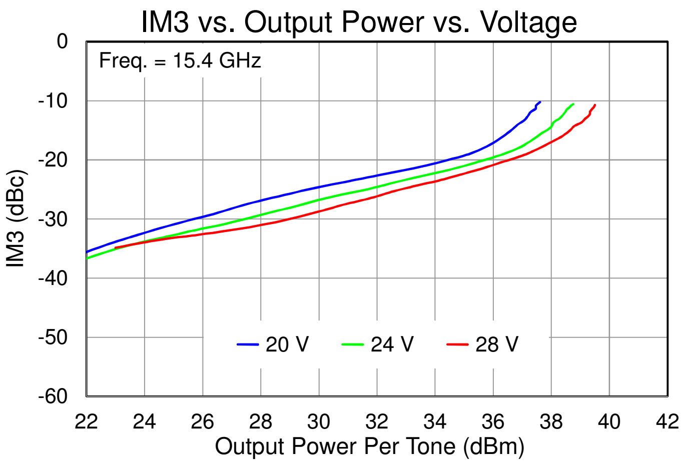


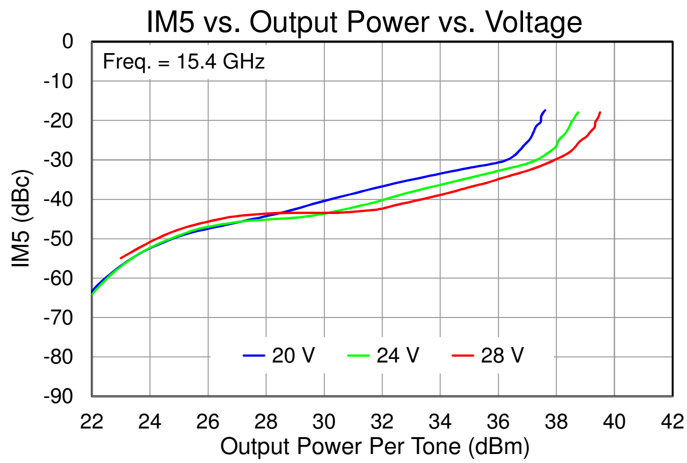
Performance Plots – Linearity

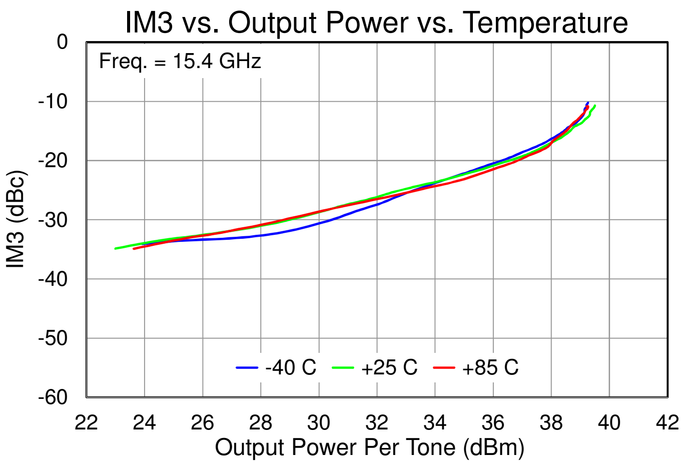
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Tone Separation = 1 MHz, sTemp = 25 °C

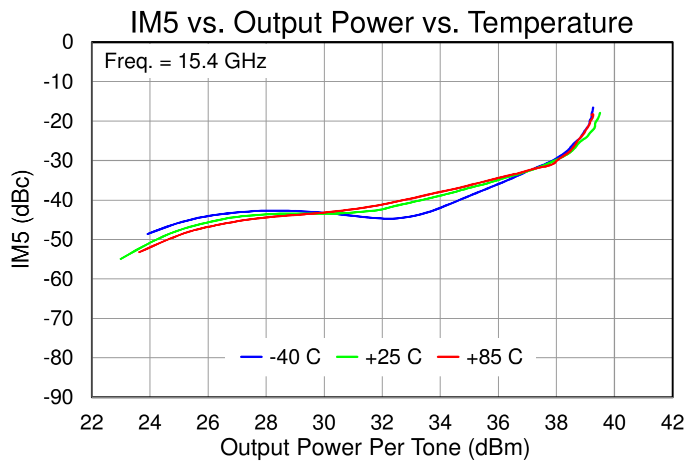






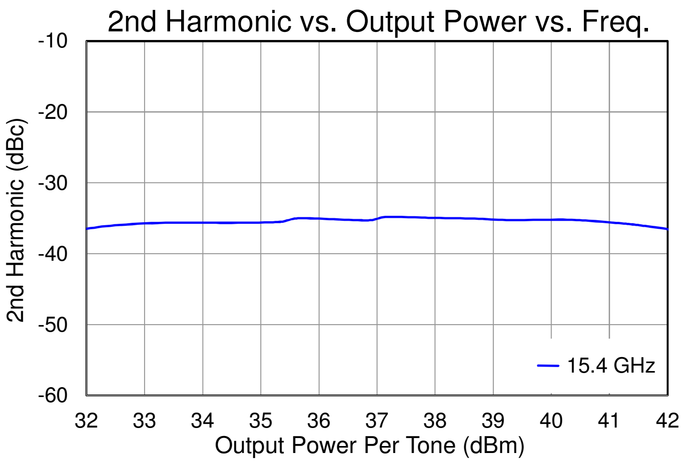


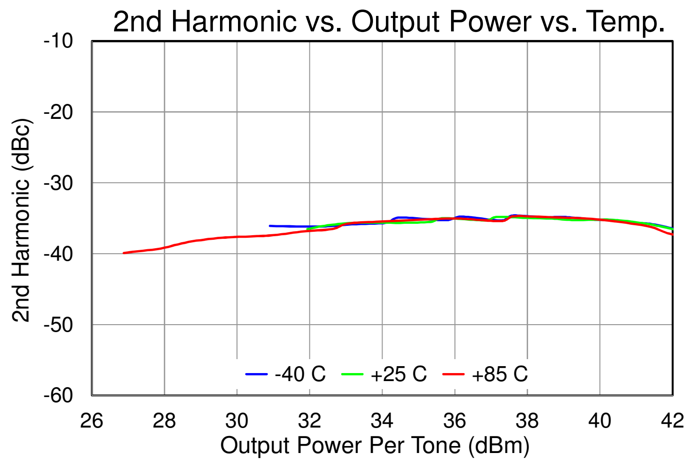




Performance Plots – Harmonic

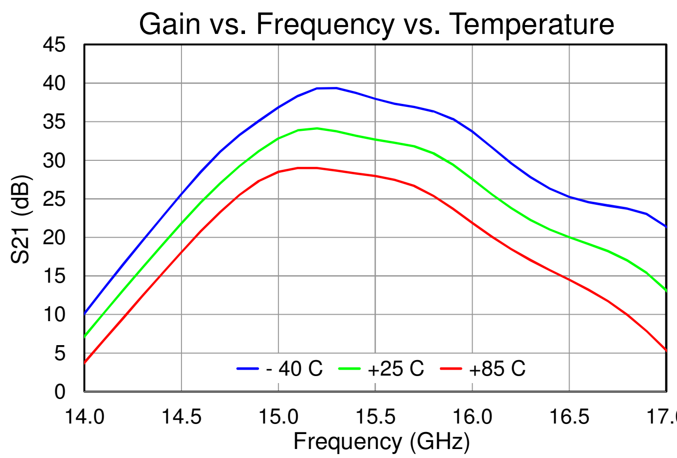
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Temp = 25 °C

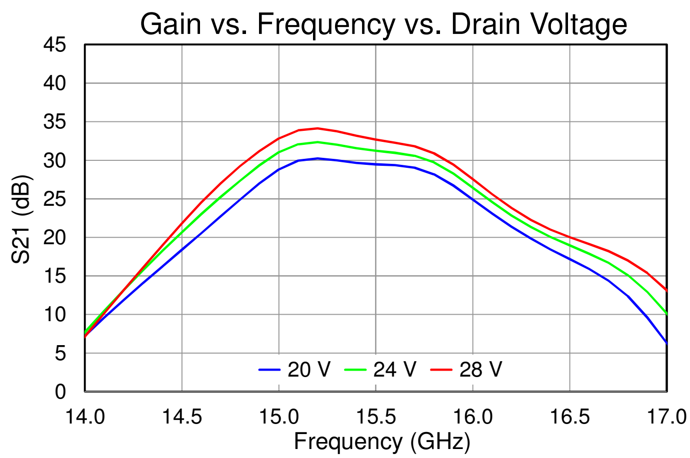


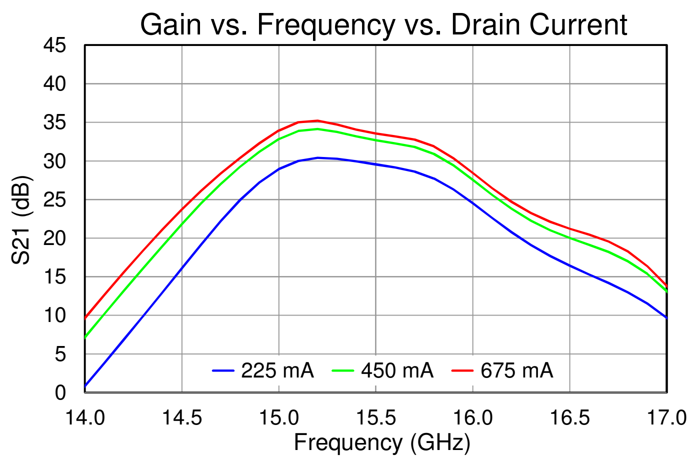


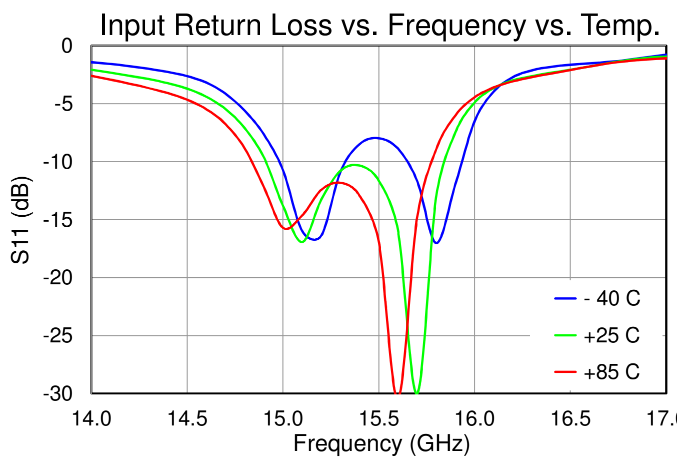
Performance Plots – Small Signal

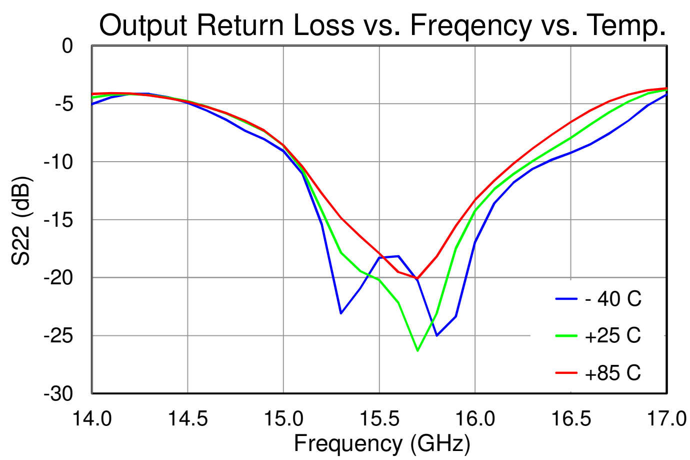
Conditions unless otherwise specified: V_D = 28 V, I_{DQ} = 450 mA, Temp = 25 °C



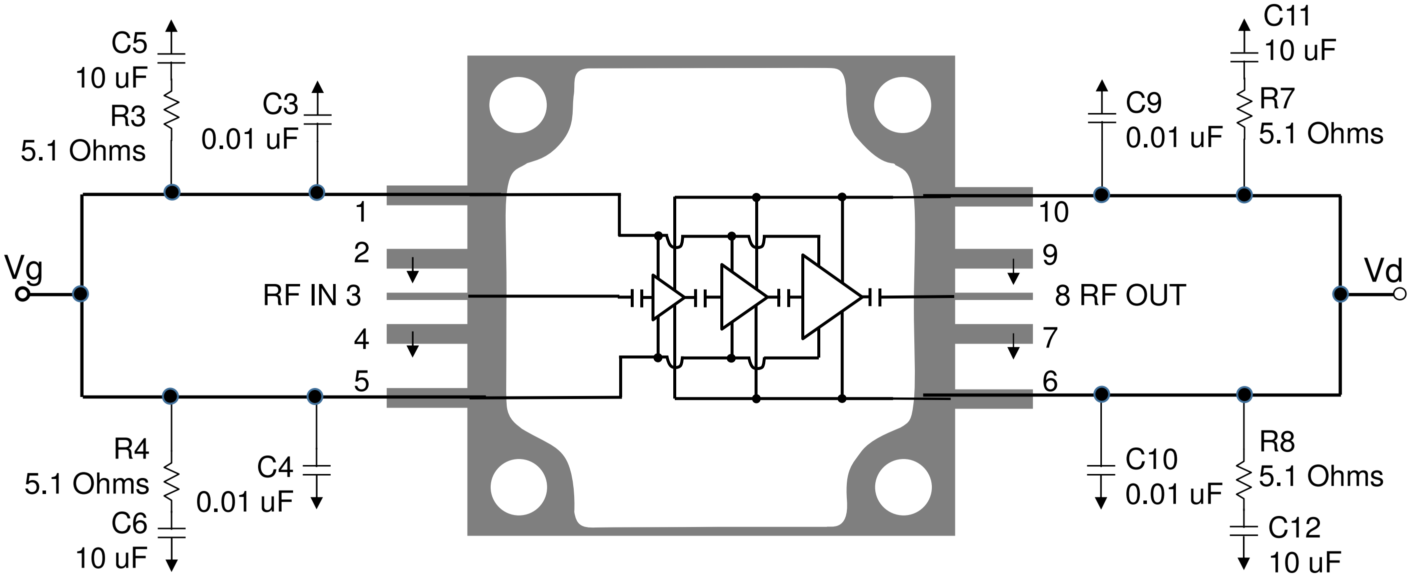








Applications Information and Pin Layout



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

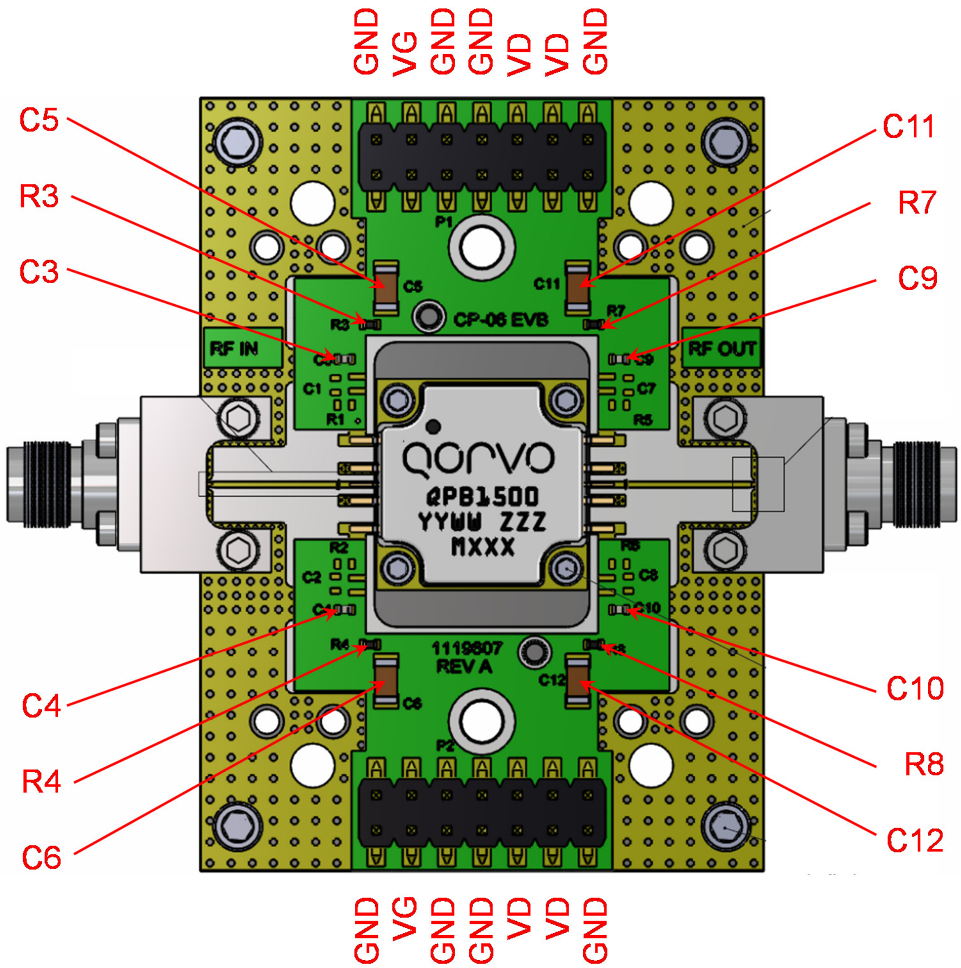
Bias Down Procedure

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.
3	RF_{IN}	Input; matched to 50 Ω; DC blocked
2,4,7,9	GND	Must be grounded on the PCB.
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) Both Top and Bottom Vd and Vg must be biased.

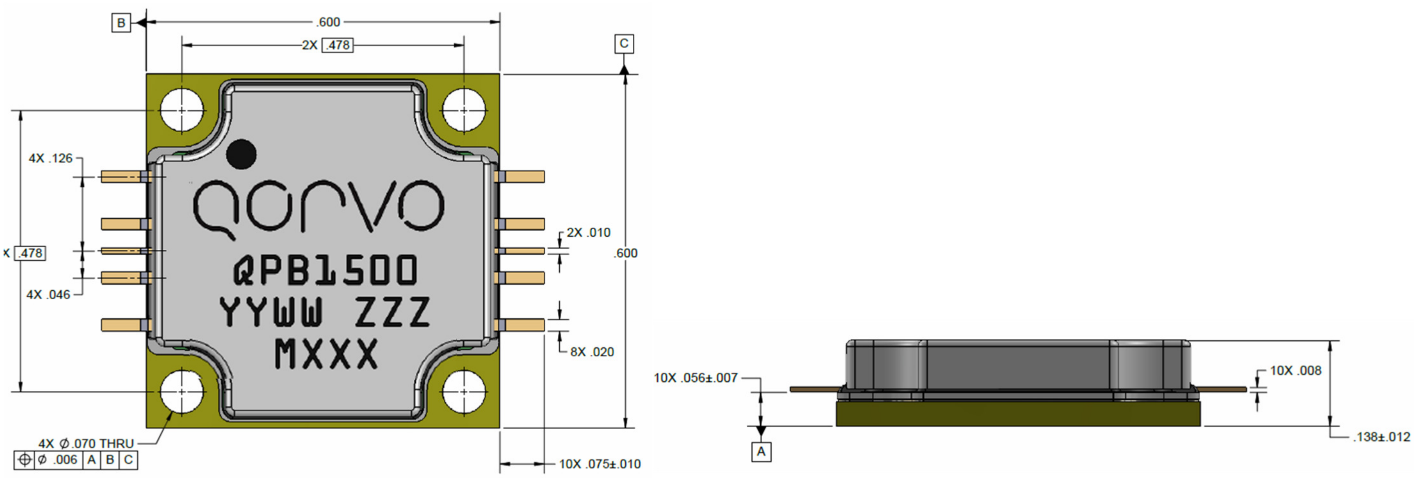
Bill of Materials

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. Clean the board or module with alcohol. Allow it to dry fully.
2. Screws are recommended for mounting the QPB1500 to the T-Carrier.
3. To improve the thermal and RF performance, we recommend the following:
   a. Apply 4 mils indium shim or thermal compound between the package and the T-Carrier.
   b. Attach a heat sink to the bottom of the T-Carrier and apply 4 mils indium shim or thermal compound between the heat sink and the T-Carrier.
4. Apply solder to each pin of the QPB1500.
5. Clean the assembly with alcohol.

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 – Convection Reflow 260 °C	5A	JEDEC standard IPC/JEDEC J-STD-020.

Caution!
ESD-Sensitive Device

Solderability

Compatible with the latest version of J-STD-020, Lead-free solder, 260 °C

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:

- 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, and information about Qorvo:

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Email: info-sales@qorvo.com **Fax:** +1.972.994.8504

For technical questions and application information:

Email: info-products@qorvo.com

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