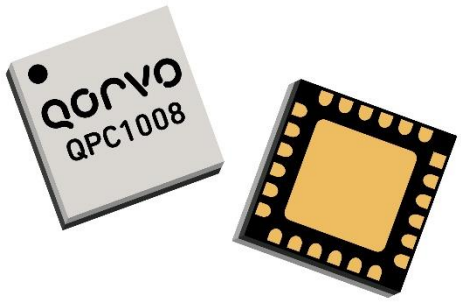
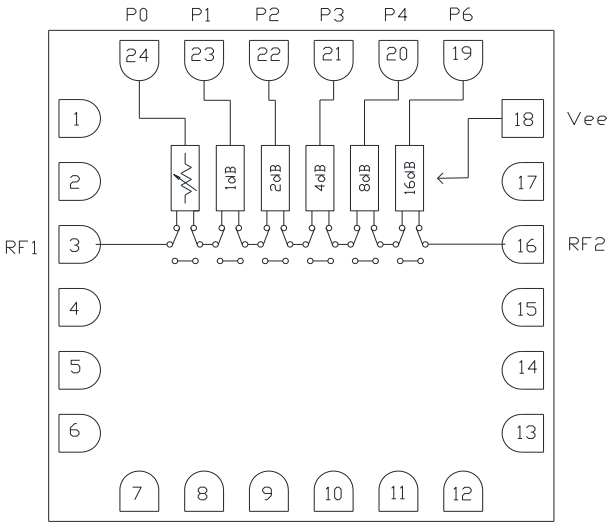
QPC1008
DC - 20 GHz Attenuator

Product Overview

Qorvo's QPC1008 is a negative voltage controlled, wideband GaAs MMIC 5-bit digital step attenuator combined with a 1 dB voltage variable attenuator (VVA), housed in a leadless 3.9 x 3.9 mm surface mount package. Each digital bit is controlled by a single voltage of either 0 V or -5 V, while the VVA is controlled using a single voltage varied from -5 V to 0 V. The digital bit values are 1 (LSB), 2, 4, 8, and 16 dB, when combined with the 1 dB analog bit, a total of 32 dB of attenuation is achieved. The QPC1008 has low insertion loss of 5.5 dB at 10 GHz and is 50 ohms matched eliminating the need for RF port matching.



Functional Block Diagram



Ordering Information

Part No.	Description
QPC1008EVB1	Evaluation Board, Qty=1
QPC1008SR	Tape and Reel, Qty = 100

Key Features

- Frequency Range: DC – 20 GHz
- 5-Bit Digital Attenuator
- Attenuation Range: 31 dB
- Attenuation Step Size (LSB): 1 dB
- Voltage Variable Attenuator (VVA) Range: 1 dB
- Total Attenuation Range: 32 dB
- Low Insertion Loss (Ref. State): 5 dB
- Digital Control Voltage (DCA): -2.5 to -5.5 V
- Analog Control Voltage (ACV): 0 to -5.0 V
- Package Size: 3.9 x 3.9 x 0.9 mm

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

Applications

- Electronic warfare
- Test and measurement
- Radar
- Phased Array

Absolute Maximum Ratings

Parameter	Rating
Bias Voltage, Vee	-8 V
Digital Control Voltage (DCV)	-8 V
Analog Control Voltage (ACV)	+0.3 to -8 V
Control Current for Vee/, DCV, ACV	1 mA
RF Input Power, CW, 25 °C	+27 dBm
Channel Temperate, Tch	150 °C
Operating Temperature	-40 to 85 °C
Storage Temperature	-55 to 150 °C

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions

Parameter	Min	Typ.	Max	Units
Vee	-5.5	-5	-2.5	V
Temperature Range	-40	+25	+85	°C

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

Truth Table – Analog Control Voltage

Control State	Attenuation State RF1 – RF2 (dB)	Bias Condition	Units
High	Reference (insertion loss)	-5	V
Low	1 dB	0	V

Truth Table – Digital Control Voltage

Digital Control Voltage Input					Attenuation State RF1 – RF2 (dB)
P1 1 dB	P2 2 dB	P3 4 dB	P4 8 dB	P5 16 dB	
Low	Low	Low	Low	Low	Reference (insertion loss)
High	Low	Low	Low	Low	1 dB
Low	High	Low	Low	Low	2 dB
Low	Low	High	Low	Low	4 dB
Low	Low	Low	High	Low	8 dB
Low	Low	Low	Low	High	16 dB
High	High	High	High	High	31 dB

State High = Vee ± 0.3 V. State Low = 0 ± 0.3 V

Any combination of the above states will result in an attenuation approximately equal to the sum of the bits selected.

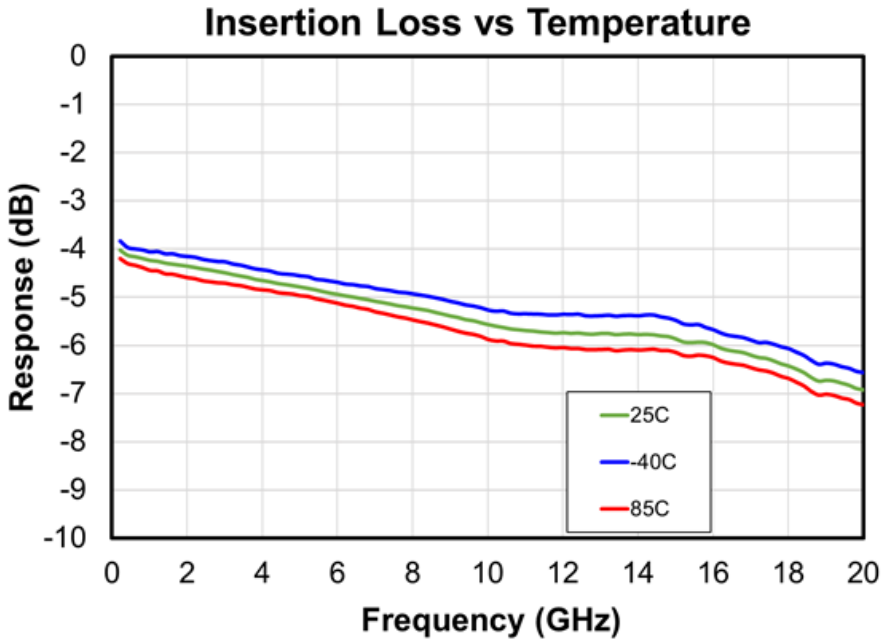
Electrical Specifications

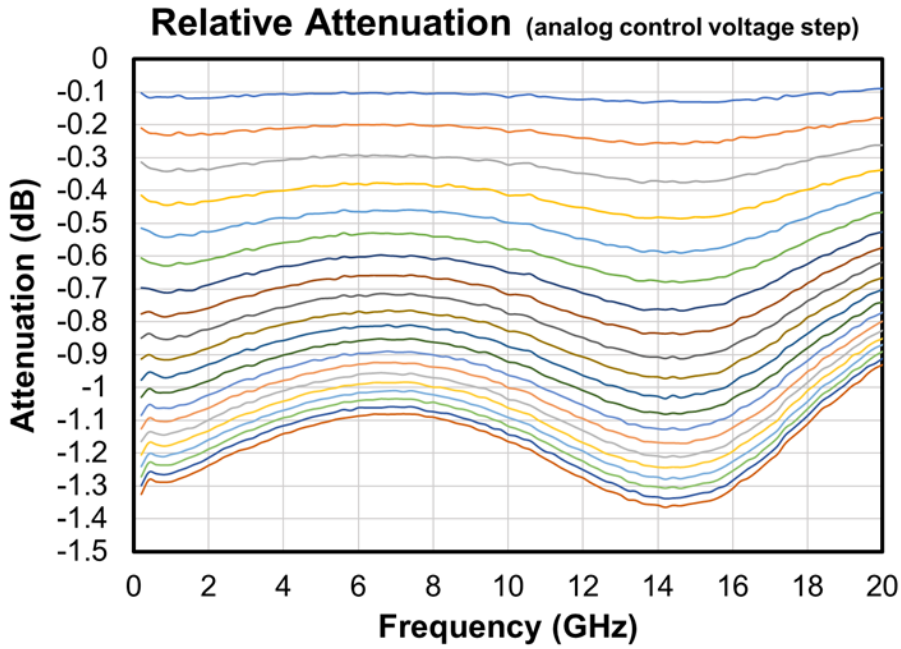
Test conditions unless otherwise noted: 25 °C, Vee = -5 V, DCV = 0/-5 V, ACV = 0/-5 V, F = 10 GHz

Parameter		Min	Typ.	Max	Units
Frequency Range		DC	–	20	GHz
Insertion Loss		–	5	–	dB
Attenuation Range	ACV	–	1	–	dB
	DCV	–	31	–	
Digital Attenuation Accuracy	1 – 8 dB States	± 0.3			dB
	16 – 31 dB States	± 0.5 + 6% Atten. Settling Max			
Relative Phase	ACV	–	1	–	deg
	DCV	–	30	–	
Input Return Loss		–	12	–	dB
Output Return Loss		–	12	–	dB
Input Power ($P_{0.1dB}$)		–	22	–	dBm
Input IP3		–	33	–	dBm
Switching Speed	tRise / tFall	–	24/6	–	ns
	tOn / tOff	–	33/21	–	

Typical Performance – Small Signal

Test conditions unless otherwise noted: 25 °C, Vee = -5 V, DCV = 0/-5 V, ACV = 0/-5 V





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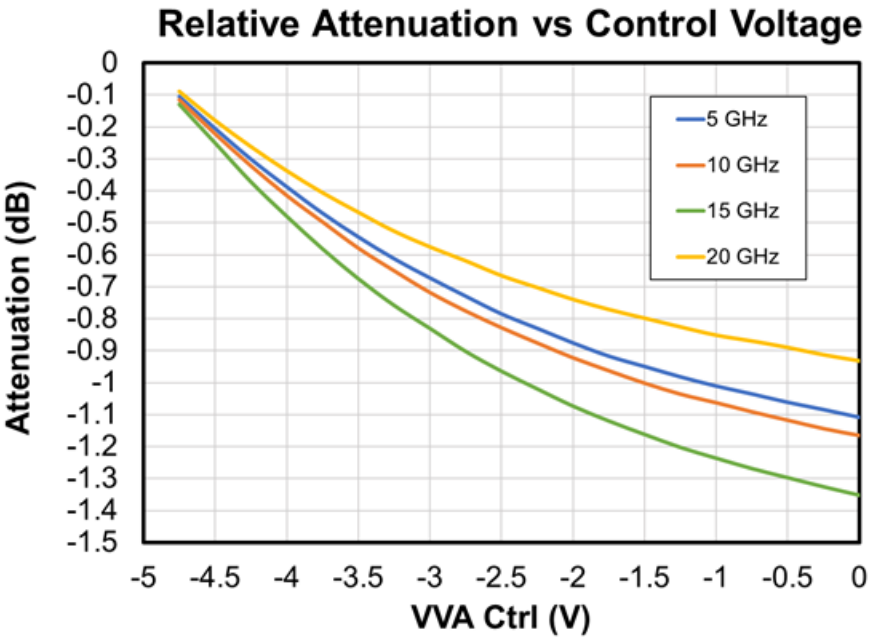

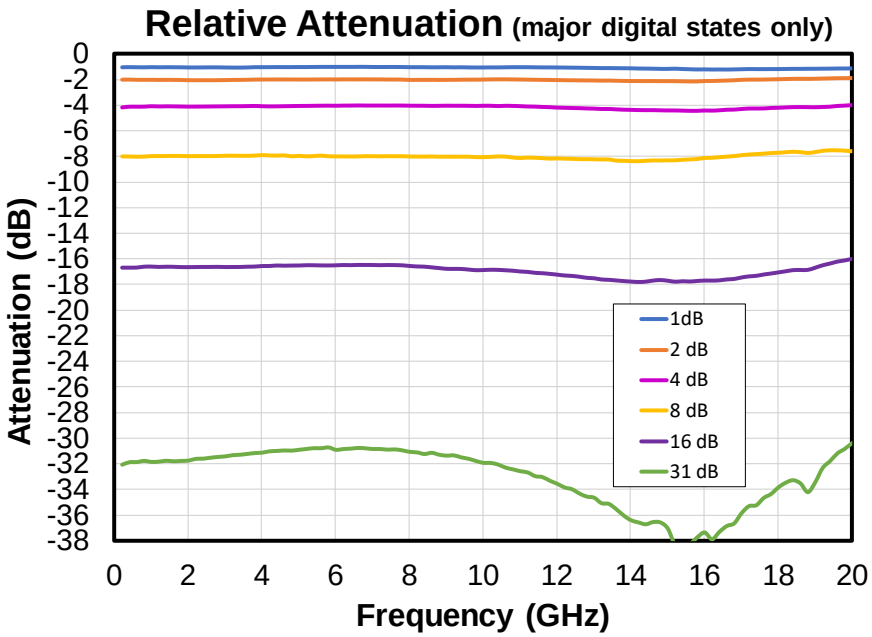

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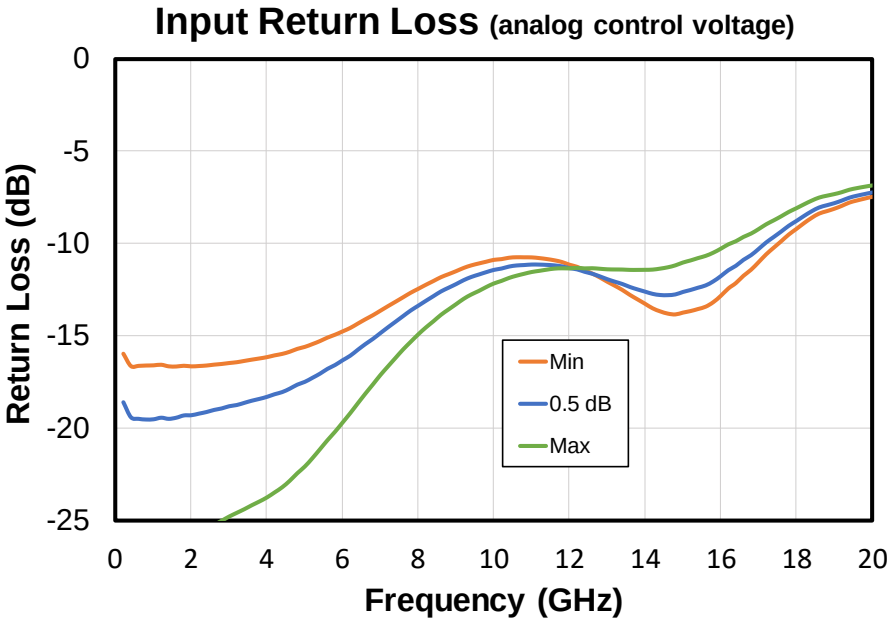

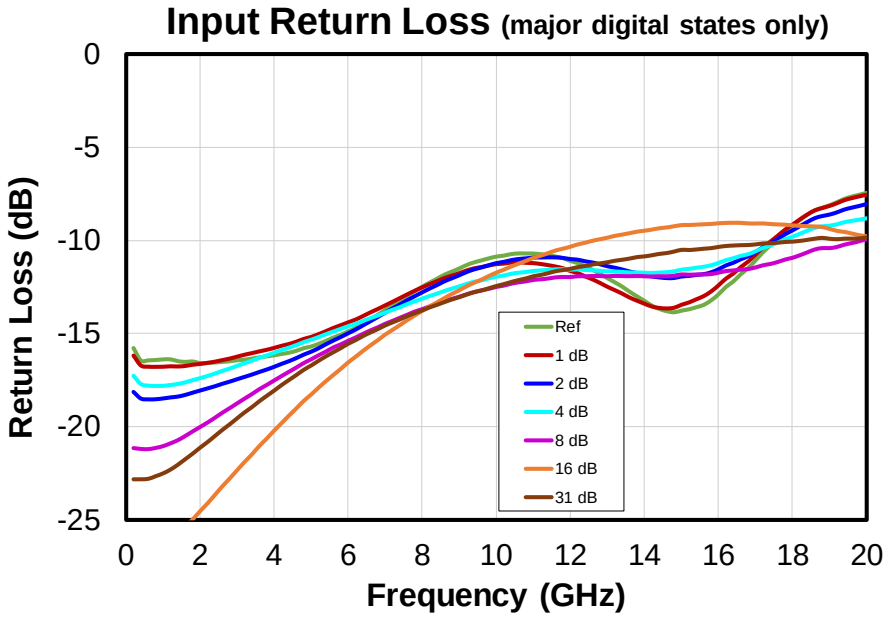

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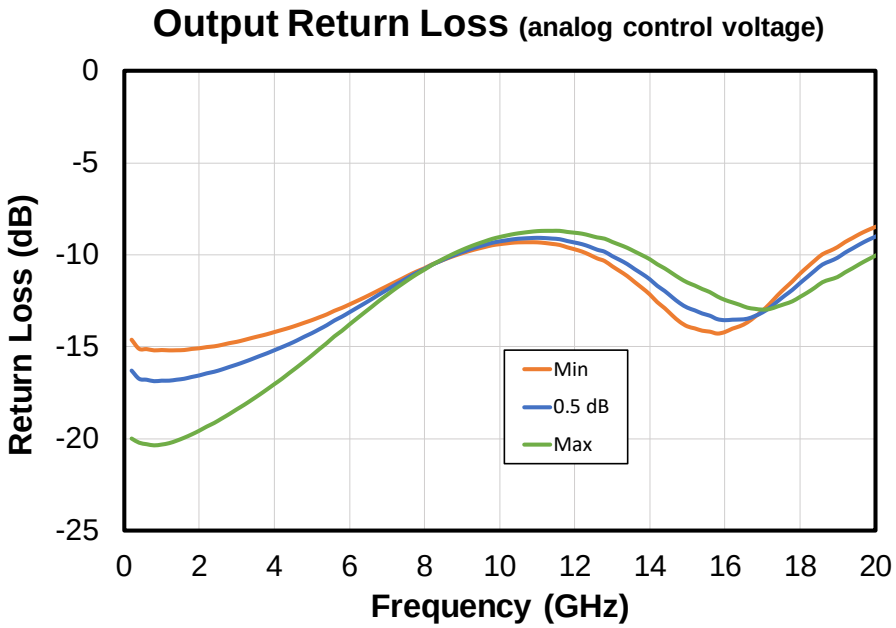
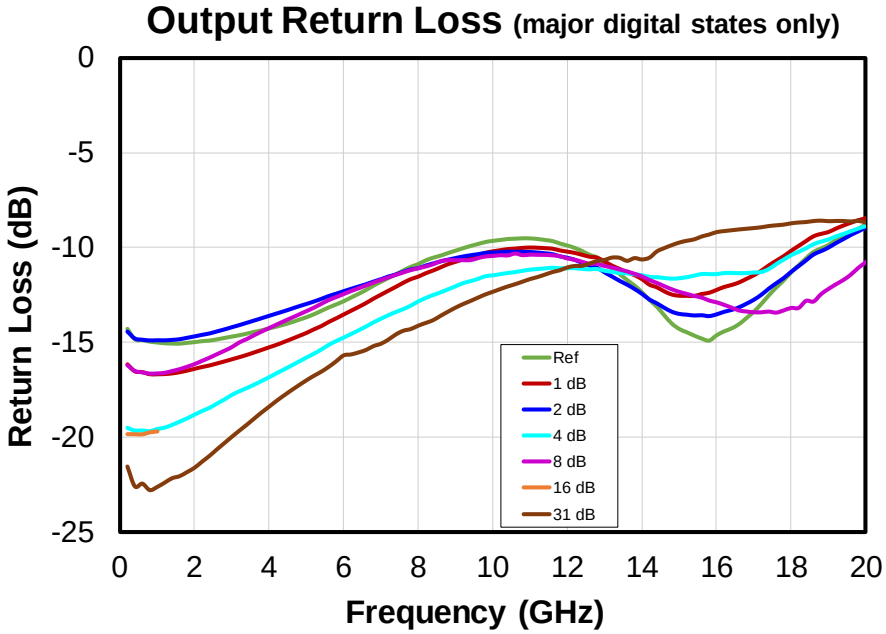
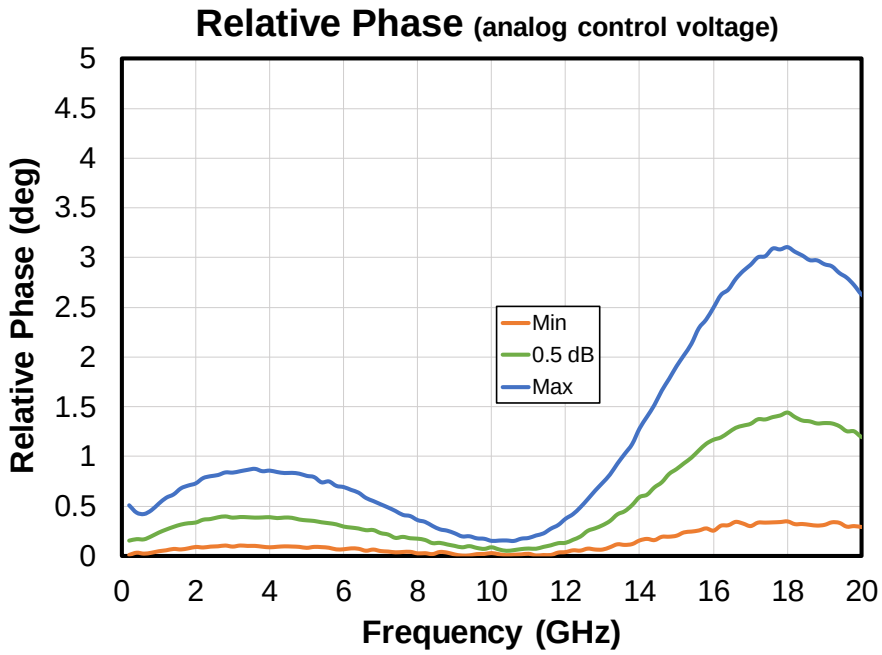
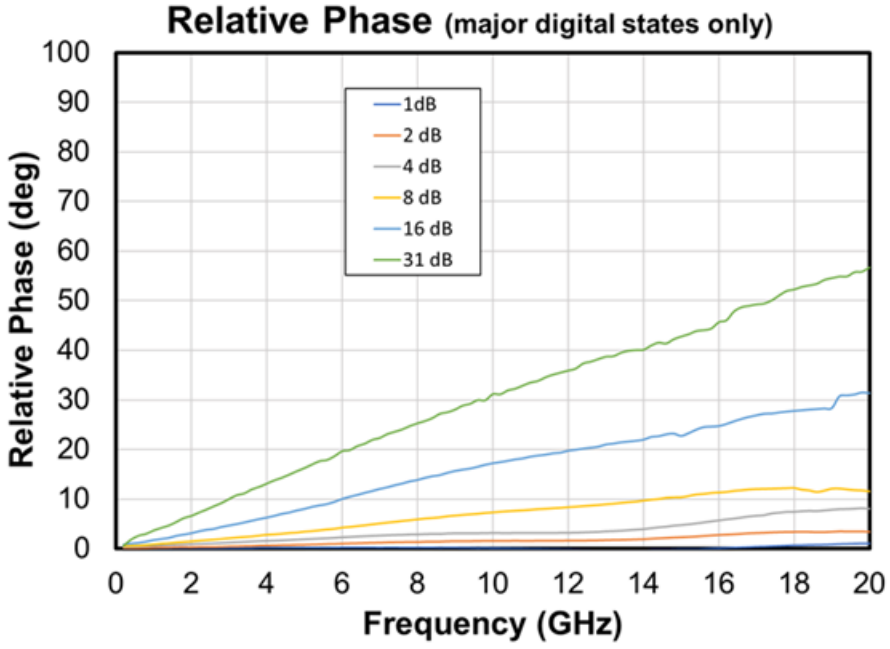




Typical Performance – Small Signal

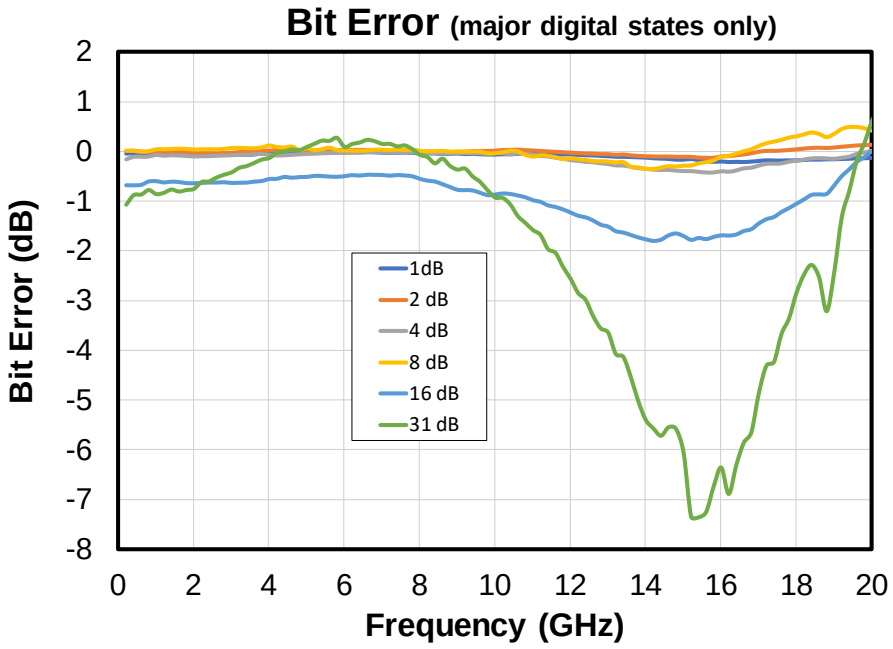
Test conditions unless otherwise noted: 25 °C, Vee = -5 V, DCV = 0/-5 V, ACV = 0/-5 V

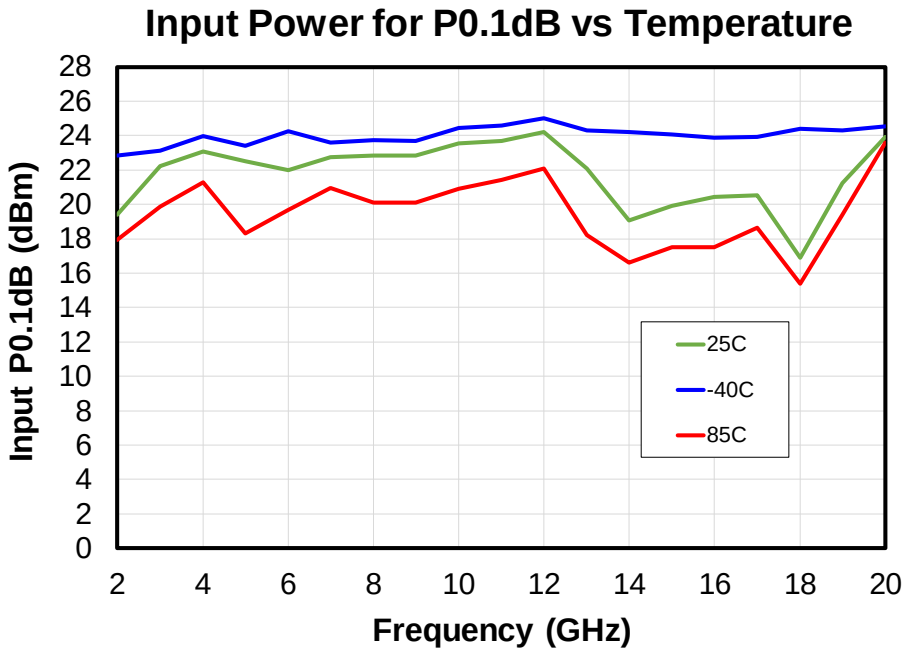




Typical Performance – Small Signal and Large Signal

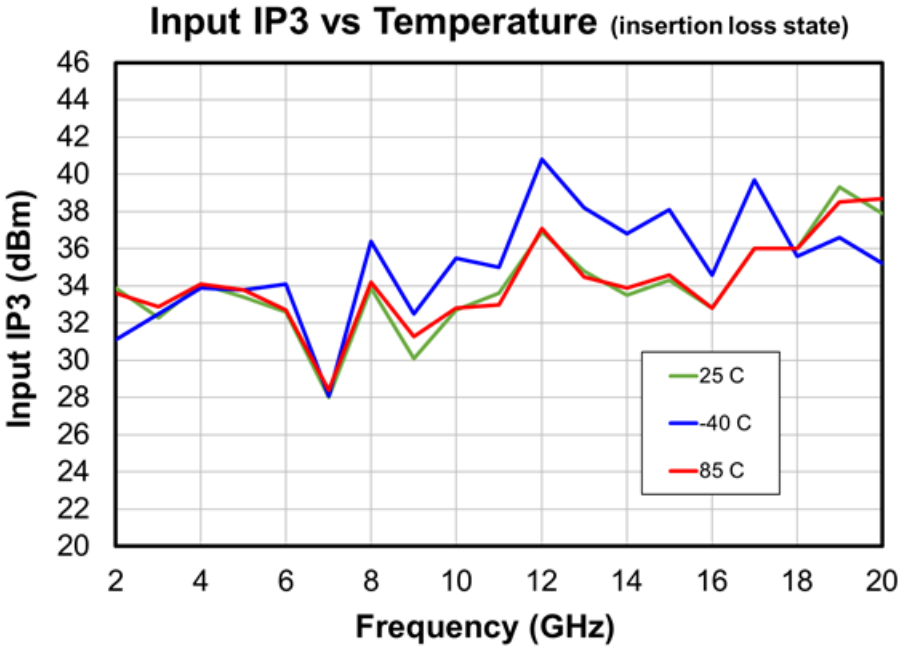
Test conditions unless otherwise noted: 25 °C, Vee = -5 V, DCV = 0/-5 V, ACV = 0/-5 V

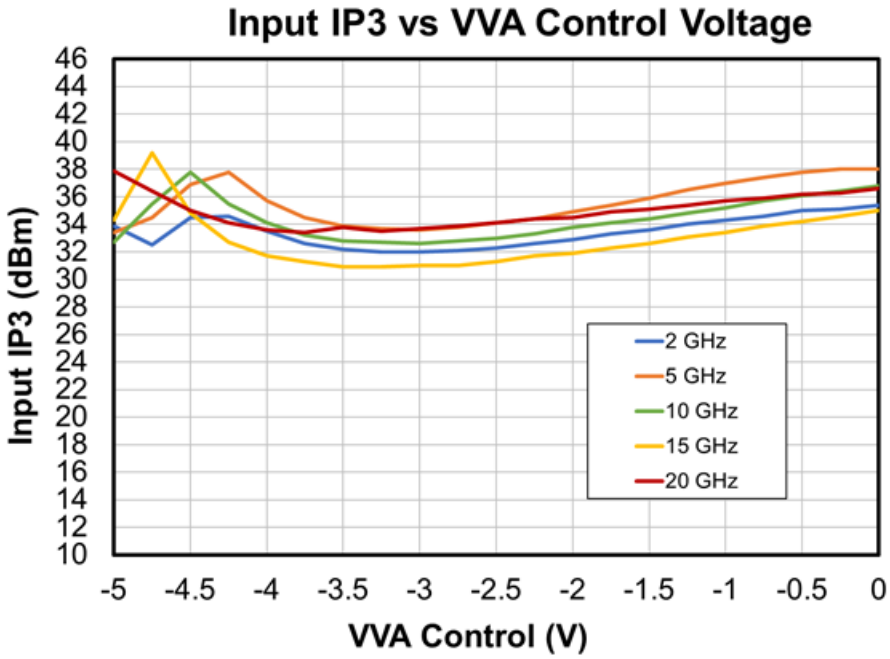




Typical Performance – Linearity

Test conditions unless otherwise noted: 25 °C, Vee = -5 V, DCV = 0/-5 V, ACV = 0/-5 V



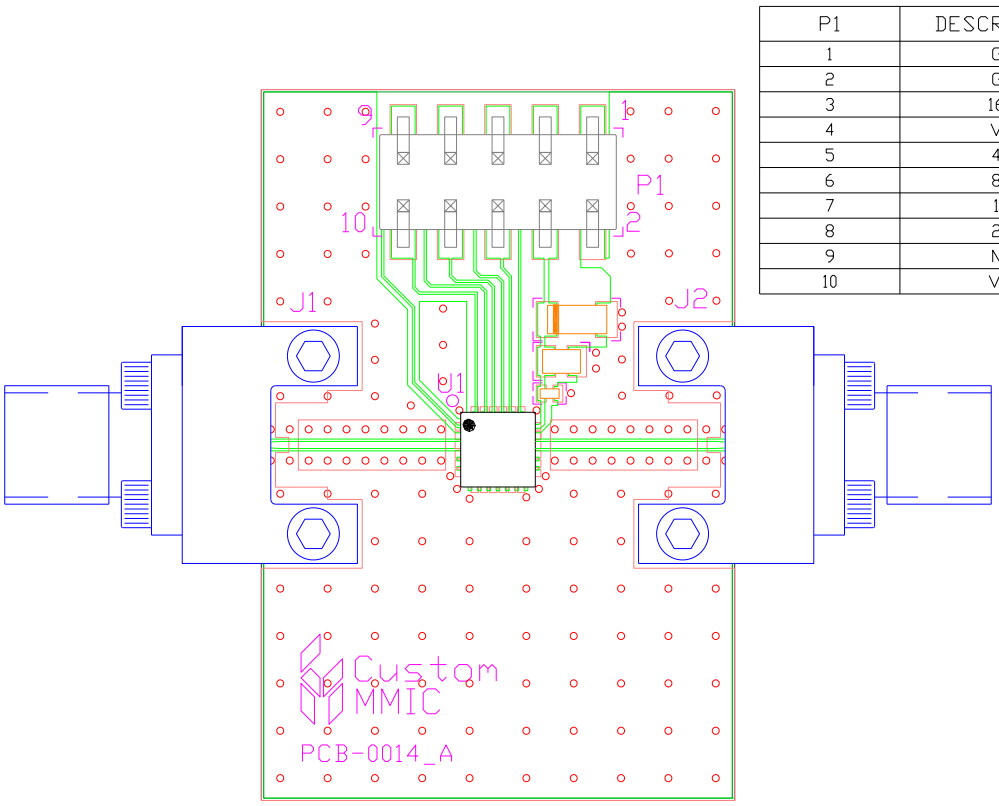


Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, CW, Frequency = 10 GHz, P_{IN} = 24 dBm (0.25 W), P_{DISS} = 0.49 W	131.3	ºC/W
Channel Temperature (T_{CH}) (1)		118.7	°C
Median Lifetime (T_M)		1.0E7	Hrs

Notes:
1. Measured to the back of the package.

Evaluation Board (EVB) Layout Assembly



RF Layer is 0.008” thick Rogers Corp. RO350B, er = 3.66. Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1492-04A-5.

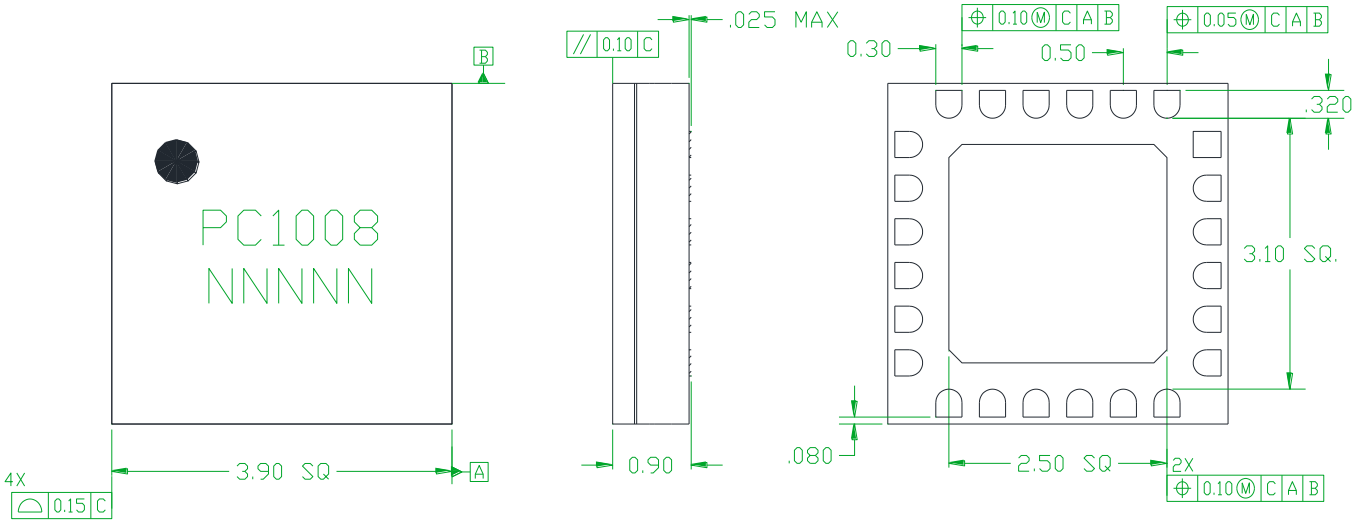
Reference plane is at the package.

Note: Multiple vias should be employed under die to minimize inductance and thermal resistance.

Bill of Materials for QPC1008EVB1

Reference Des.	Value	Description	Manuf.	Part Number
J1, J2		2.92 mm End Launch Connector		
U1		QPC1008 Attenuator	Qorvo	
PCB		PCB-0014 Evaluation PCB		

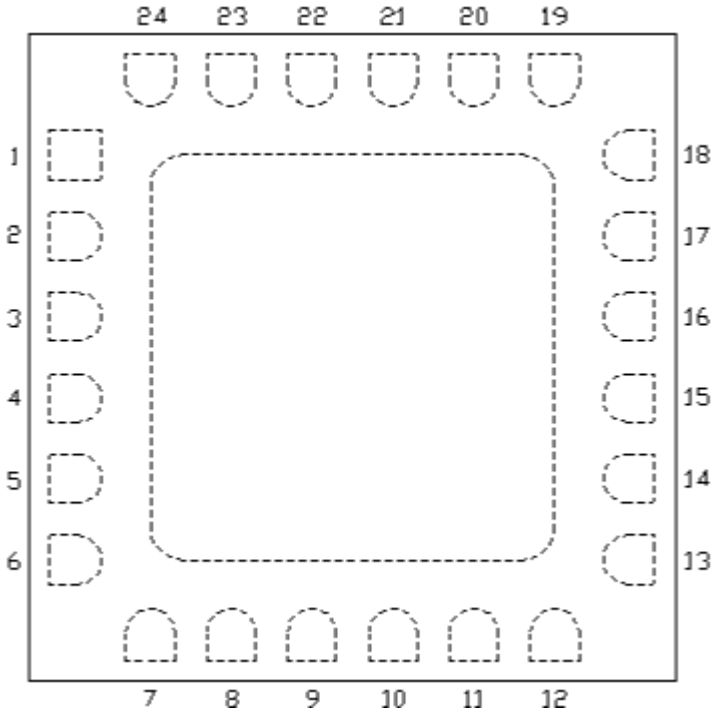
Mechanical Information



NOTES:

1. ALL DIMENSIONS AND TOLERANCES ARE WITHIN THOSE INDICATED IN JEDEC MO-220 WITH EXCEPTION OF TOTAL THICKNESS. ALL DIMENSION SHOWN AS mm. CONTROLLING DIMENSION ARE IN mm.
2. LEAD FINISH: ELECTROLESS NICKEL ELECTROLESS PALLADIUM IMMERSION GOLD (ENEPIG) PLATING IN ACCORDANCE WITH IPC-4556
3. MARKING: ALL MARKING SHALL BE PERMANENT AND LEGIBLE
   LINE 1: PIN 1 ORIENTATION MARK.
   LINE 2: PART NUMBER.
   LINE 3: LOT CODE.
4. INDICATED DIMENSION/TOLERANCE APPLIES TO LEADS AND EXPOSED PAD.
5. REFERENCE ASSEMBLY DRAWING DRAW-AD-0056 FOR ASSEMBLY INFORMATION.
6. ALTERNATE PIN #1 IDENTIFIER WITH CORNER CHAMFER ON GROUND PADDLE IS ACCEPTABLE.

Pin Diagram



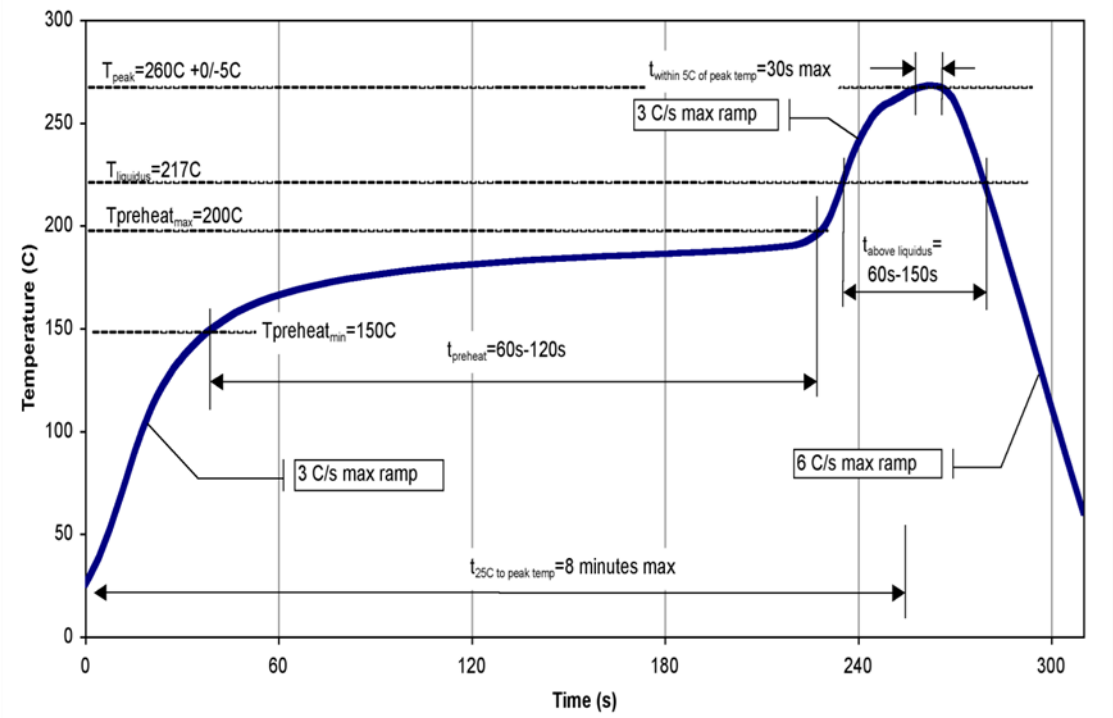
Pins Description

Pin No.	Symbol	Description
1, 3 - 14	N/C	Pins are not connected internally. May be connected to RF/DC ground
3, 16	RF In, RF Out	These pins are DC coupled and matched to 50 Ohms.
2, 4, 15, 17	Ground	Connect to RF/DC ground
18	Vee	Negative bias, -5 V
19 - 23	P1 – P5	Digital control voltages (DCV)
24	P0	Analog Control Voltage (ACV)
Backside	Ground	Connect to RF/DC ground

Assembly Guidelines

1. Compatible with lead-free soldering processes with 260°C peak reflow temperature.
2. Contact plating: ENEPIG
3. Solder rework not recommended.
4. See Application Note AN102 for further information regarding soldering.
5. See Application Note AN105 for recommended land pattern approach.
6. See Application Note AN101 for tape and reel packaging information.

Recommended Soldering Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A	ESDA / JEDEC JS-001-2012
MSL – Moisture Sensitivity Level	Level 1	JEDEC standard IPC/JEDEC J-STD-020

Caution!
ESD-Sensitive Device

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:

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Email: customer.support@qorvo.com

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