QPC2108

2.5-4GHz 6-Bit Digital Phase Shifter

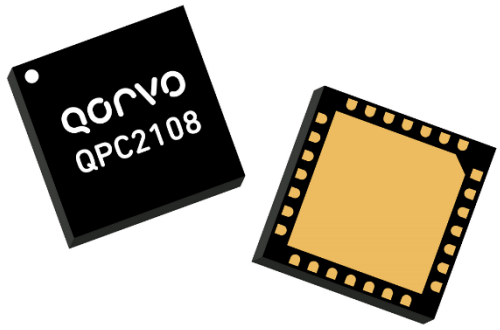
Product Description

The Qorvo QPC2108 is a packaged 6-bit digital phase shifter fabricated on Qorvo's high performance 0.15 um GaAs pHEMT process. It operates over 2.5-4 GHz while providing 360 of phase coverage with a LSB of 5.625. The QPC2108 offers an exceptional RMS phase error of <2.8 degrees and amplitude error of <0.4 dB over most of the operational band. With other equally impressive small signal and linearity characteristics, the QPC2108 delivers superior performance for your S-band phased array applications.

Housed in a small 6 x 6 mm plastic overmold QFN package, DC blocked on both ports with bi-directional operation and the use of positive only control logic, the QPC2108 supports ease of use and simply system integration. Low DC power consumption also provides the system designer more flexibility in the overall power management of the system.

The device is lead-free and RoHS compliant.

Evaluation Boards are available upon request.

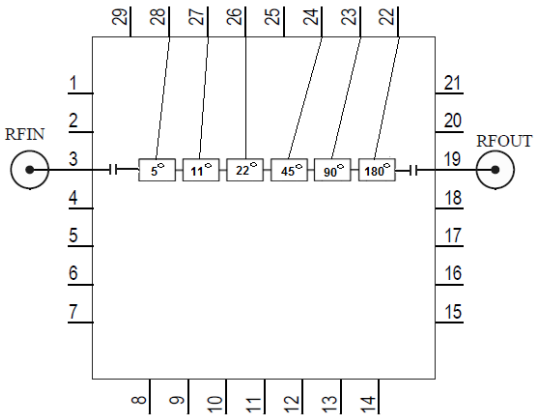


Product Features

- Frequency Range: 2.5 to 4 GHz
- 6-Bit Digital Phase Shifter
- Bi-Directional
- 360° Coverage, LSB = 5.625°
- RMS Phase Error: < 2.8° (2.5 – 3.8 GHz)
  < 5° (3.9 – 4 GHz)
- RMS Amplitude Error: < 0.4 dB
- Insertion Loss: 5 dB
- Return Loss: 16 dB
- Input $P_{0.1dB}$: 23 dBm
- Input IP3: 45 dBm
- Switching Speed: < 100 ns
- Control Voltage: 0 /+5 V
- QFN Package Dimensions: 6.0 x 6.0 x 0.79 mm

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

Block Diagram



Applications

- S-Band Radar

Ordering Information

Part No.	ECCN	Description
QPC2108	EAR99	2.5-4 GHz 6-Bit Digital Phase Shifter
QPC2108EVB01		Evaluation Board

Electrical Specifications

Test conditions unless otherwise noted: 25°C. Control Voltage (REF, 5^0, 11^0, 22^0, 45^0, 90^0, 180^0) = 0/+5 V; See Bias Truth Table.

Parameter	Phase	Freq. (GHz)	Min	Typical	Max	Units
Operational Frequency Range			2.5		4	GHz
Insertion Loss	5°			5		dB
	355°					
Input Return Loss				16		dB
Output Return Loss				13		dB
RMS Phase Error		2.5, 3.8		< 2.8		degree
		2.6 – 3.7		< 2		
		3.9, 4		< 5		
RMS Amplitude Error				< 0.5		dB
Relative Phase	5°	2.5		6.2		degree
		2.9		6.5		
		3.5, 4		5.8		
	11°	2.5		12.5		
		2.9		11		
		3.5, 4		11.7		
	22°	2.5		21.5		
		2.9		22.8		
		3.5		24.6		
		4		24		
	45°	2.5		45.4		
		2.9		43.8		
		3.5		44.4		
		4		44.2		
	90°	2.5		90.4		
		2.9		87.2		
		3.5		91		
		4		90.3		
	180°	2.5		182.4		
		2.9		177.5		
		3.5		180.2		
		4		188.3		
	355°	2.5		362.5		
		2.9		351.4		
		3.5		355.6		
		4		369		
Switching Speed				< 100		ns
Input $P_{0.1dB}$				23		dBm
Input IP3 (Spacing = 10 MHz, Pin/Tone = 10 dBm)				45		dBm
Insertion Loss Temperature Coefficient				0.003		dB/°C

Recommended Operating Conditions

Parameter	Value / Range
Control Voltage (REF, 5^0, 11^0, 22^0, 45^0, 90^0, 180^0)	0/+5 V
Current (I_{REF}, I_{CTRL})	< 0.3 mA
Temperature Range	-40 to +85 ^{0}C
Supply Current (I_S)	100 uA typical

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

Bias Truth Table

Logic “0” = 0 V, Logic “1” = +5 V

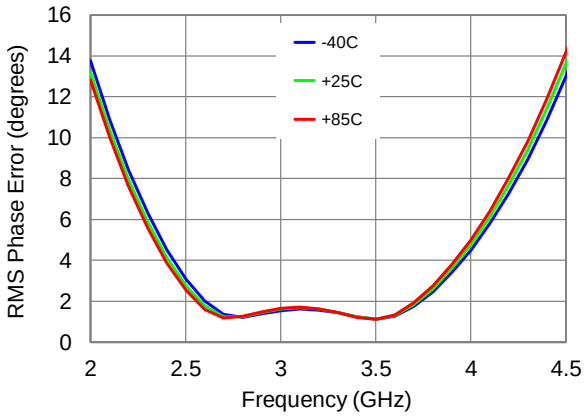
Phase Shifter	5^0	11^0	22^0	45^0	90^0	180^0	REF
0° (Reference)	0	0	0	0	0	0	1
5°	1	0	0	0	0	0	1
11°	0	1	0	0	0	0	1
22°	0	0	1	0	0	0	1
45°	0	0	0	1	0	0	1
90°	0	0	0	0	1	0	1
180°	0	0	0	0	0	1	1
355°	1	1	1	1	1	1	1

Performance Plots – Small Signal

Test conditions unless otherwise noted: 5V, 25 °C

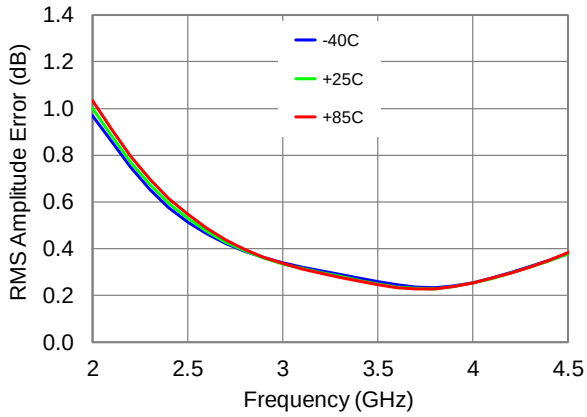
RMS Phase Error vs. Freq. vs. Temp

V_{REF} = 5 V, All Phase States



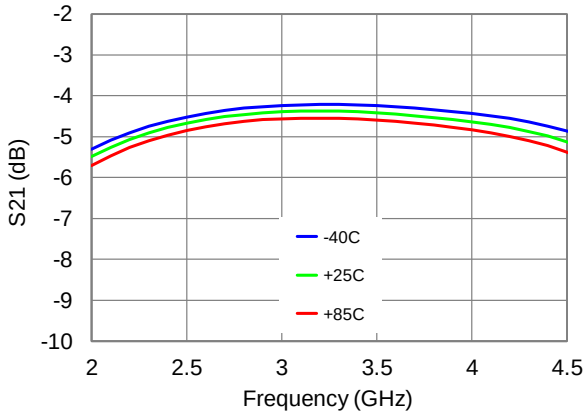
RMS Amplitude Error vs. Freq vs. Temp.

V_{REF} = 5 V, All Phase States



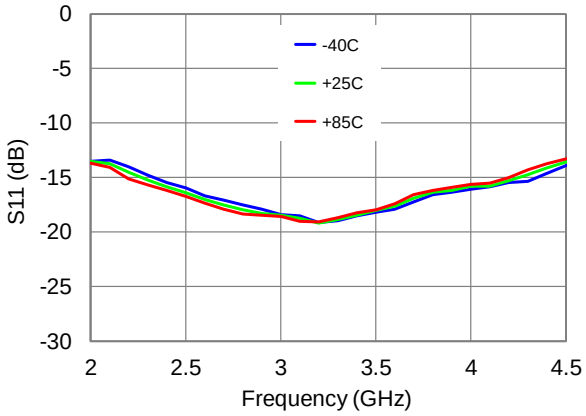
Avg. Insertion Loss vs. Freq. vs. Temp.

V_{REF} = 5 V, All Phase States



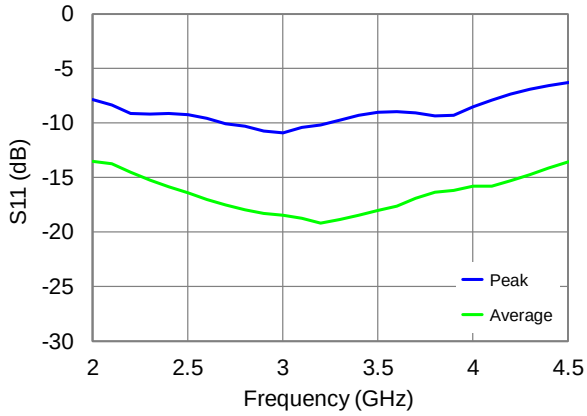
Avg. IRL vs. Freq. vs.Temp.

V_{REF} = 5 V, All Phase States



IRL vs. Freq.

V_{REF} = 5 V, All Phase States, 25 °C

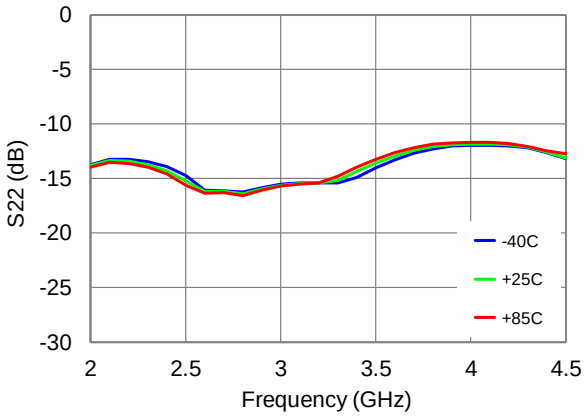


Performance Plots – Small Signal (Cont.)

Test conditions unless otherwise noted: 5V, 25 °C

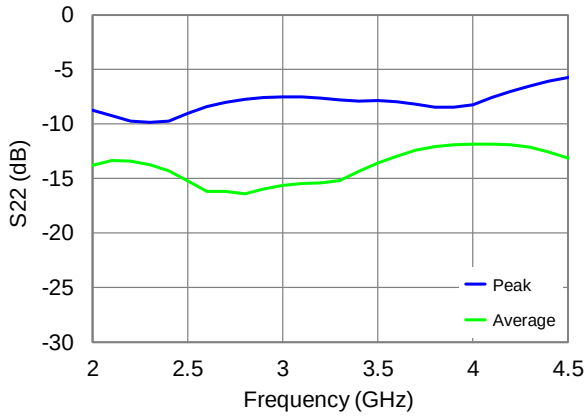
Avg. ORL vs. Freq. vs. Temp

V_{REF} = 5 V, All Phase States



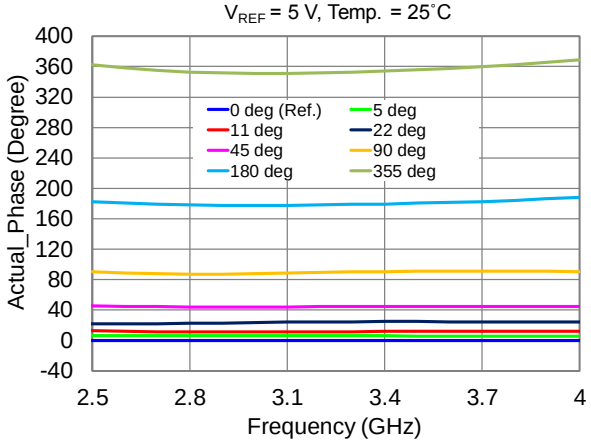
ORL vs. Freq.

V_{REF} = 5 V, All Phase States, 25 ^{0}C



Phase Shift vs. Frequency

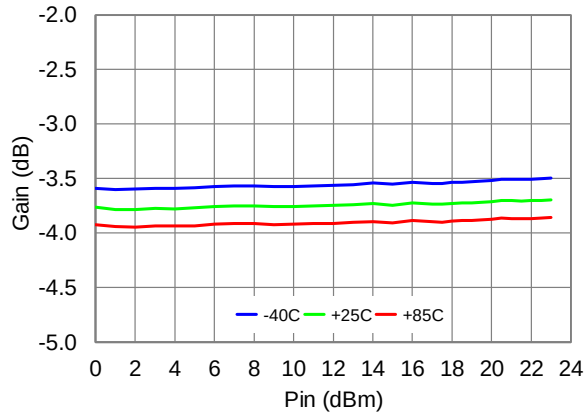
V_{REF} = 5 V, Temp. = 25˚C



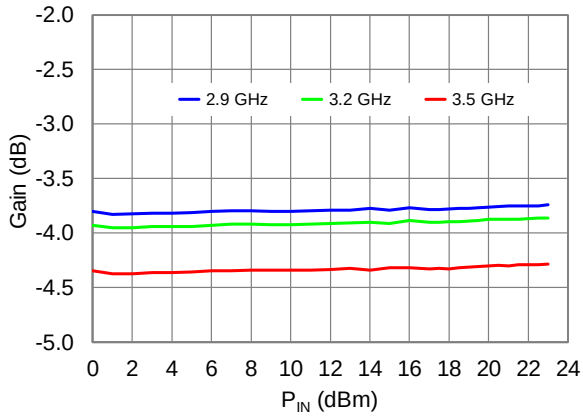
Performance Plots – Large Signal & Linearity

Test conditions unless otherwise noted: 5V, 25 °C

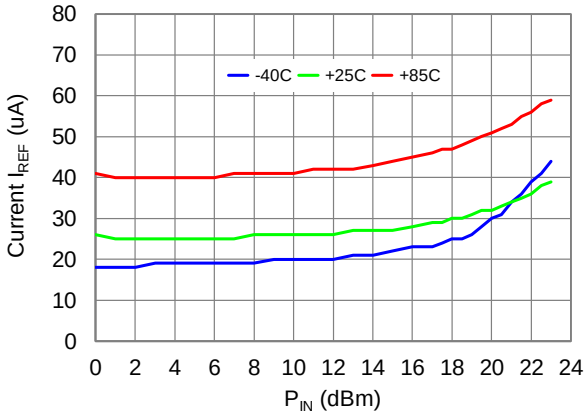
Gain vs. Pin vs. Temperature
V_{REF} = 5 V, Freq. = 3 GHz, Phase State = 0 deg



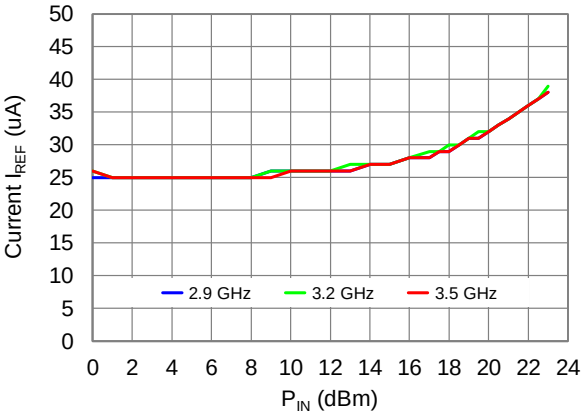
Gain vs. P_{IN} vs. Frequency
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



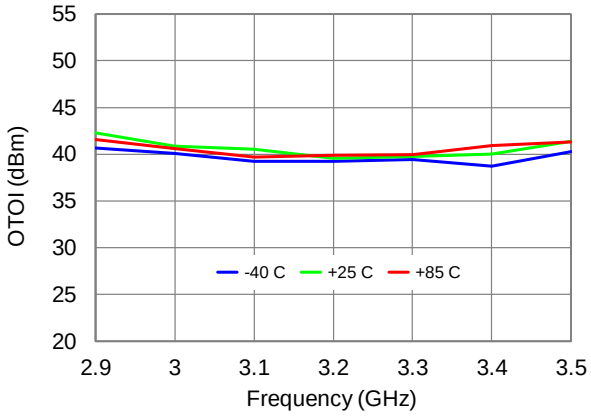
Current I_{REF} vs. P_{IN} vs. Temperature
V_{REF} = 5 V, Freq. = 3 GHz, Phase State = 0 deg



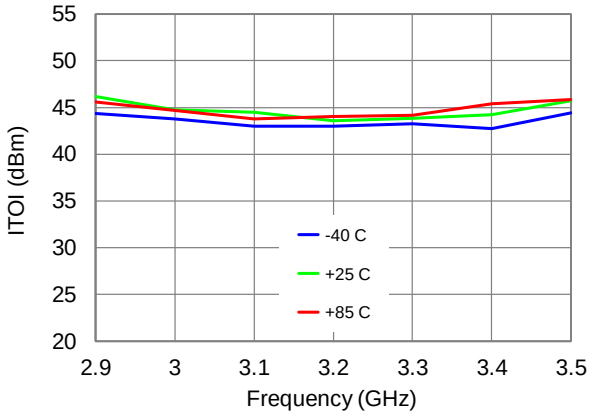
Current I_{REF} vs. P_{IN} vs. Frequency
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



OTOI vs. Freq. vs. Temperature
V_{REF} = 5 V, P_{IN}/Tone = 10 dBm, Phase State = 0 deg



ITOI vs. Freq. vs. Temperature
V_{REF} = 5 V, P_{IN}/Tone = 10 dBm, Phase State = 0 deg

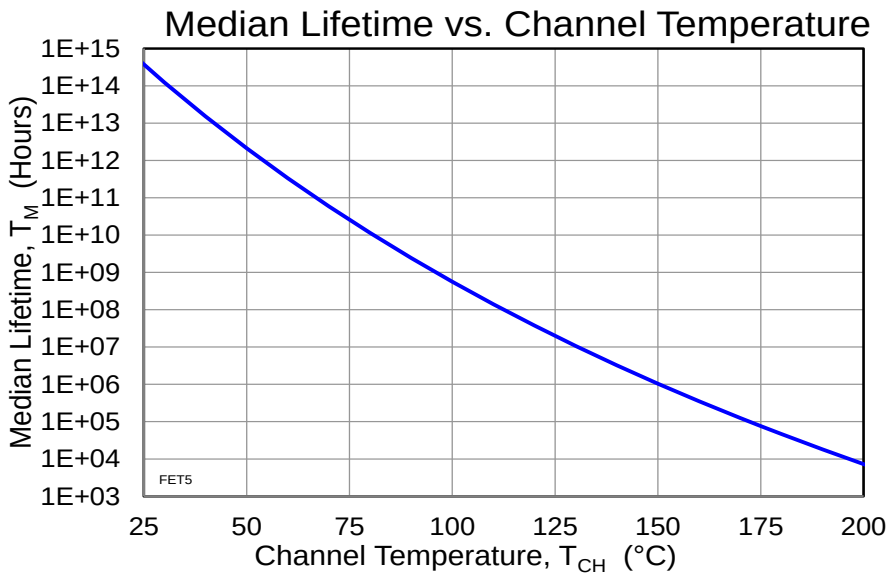


Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Channel Temperature (T_{CH})	T_{BASE} = 85°C	85	°C
Median Lifetime (T_M)		5.2E+9	Hrs

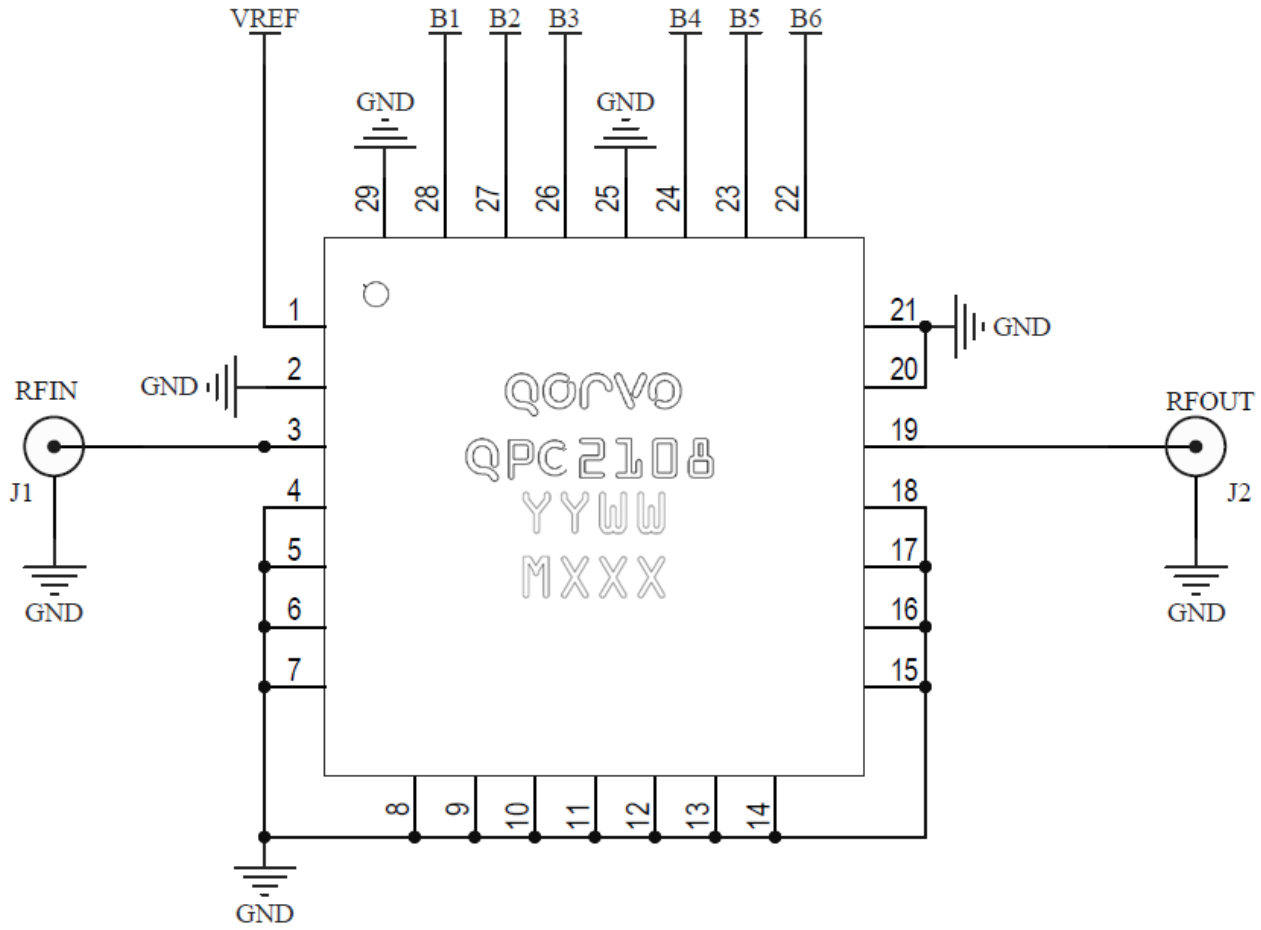
Notes:
1. Under normal (lifetime) operating conditions, self-heating is not a significant contributor to channel temperature.

Median Lifetime

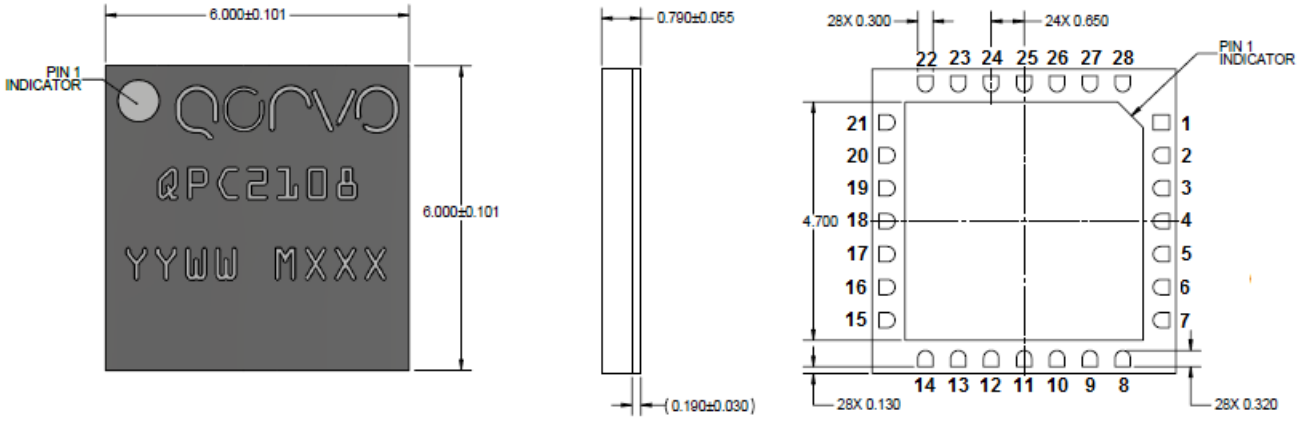


Applications Circuit

De-Quing network is not required



Mechanical Information

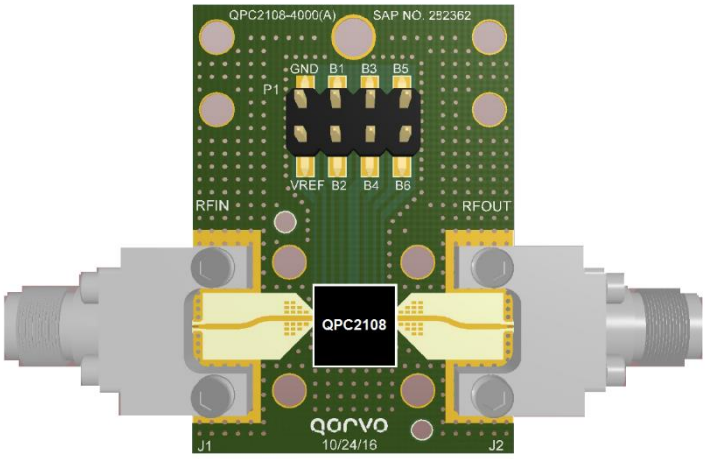


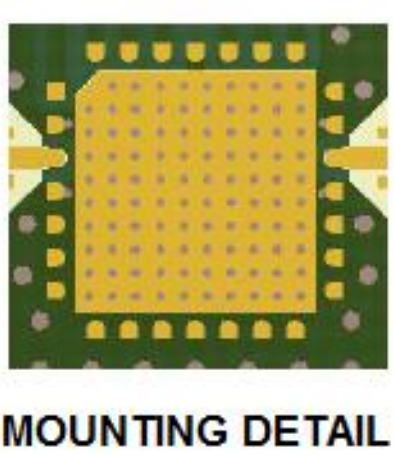
Units: millimeters
Materials:
Base: Laminate
Packaged Exposed Metallization is gold plated
Marking:
QPC2108: Part number
YY: Part Assembly year
WW: Part Assembly week
MXXX: Batch ID

Pin Description

Pin No.	Symbol	Description
1	V REF	Voltage Reference
2, 4 – 18, 20, 21, 25	GND	Ground.
3	RF IN	Input; matched to 50 Ohms; DC blocked; interchangeable to RF Output
19	RF OUT	Output; matched to 50 Ohms; DC blocked; interchangeable to RF Input
22	180°	180° Bit
23	90°	90° Bit
24	45°	45° Bit
26	22°	22° Bit
27	11°	11° Bit
28	5°	5° Bit
29	GND	Package Base Ground

Evaluation Board (EVB) Layout Assembly





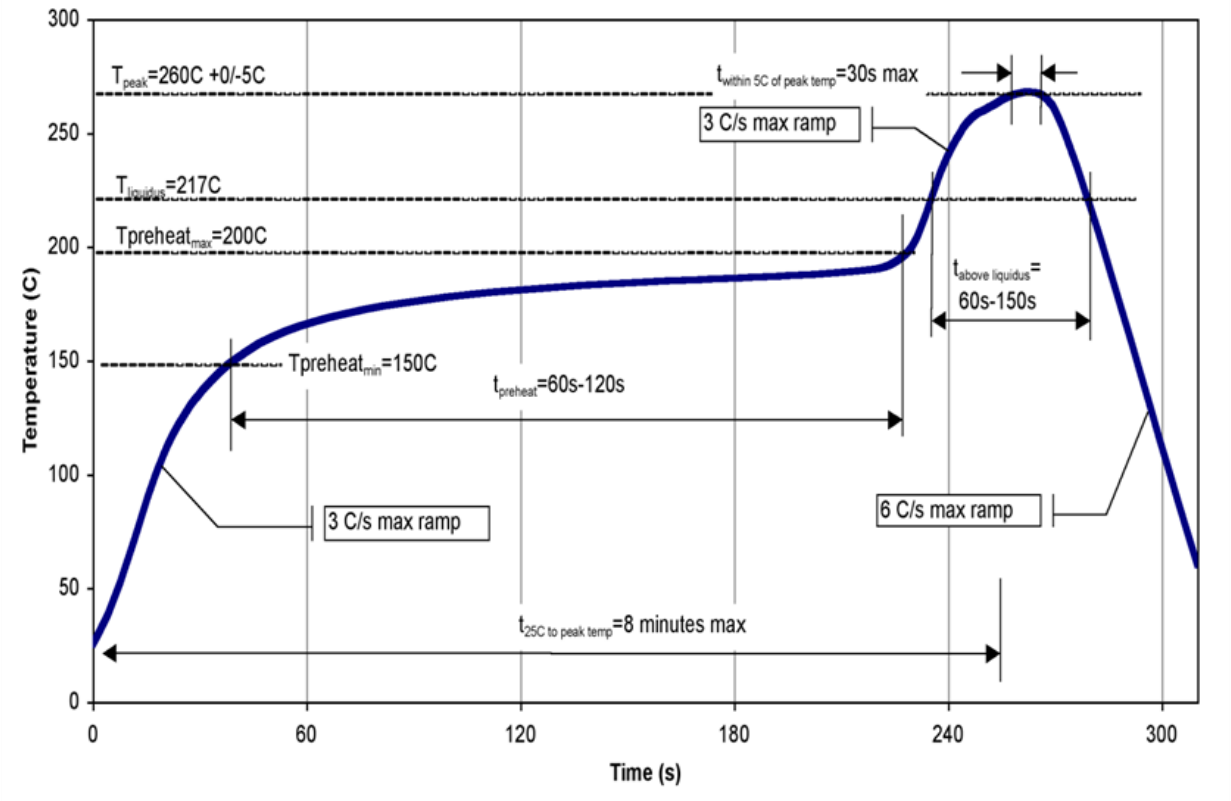
MOUNTING DETAIL

Absolute Maximum Ratings

Parameter	Value / Range
Control and Reference Voltage	6 V
Control Current	1 mA
Power Dissipation	1.5 W
Input Power, CW, 50 Ω, 85°C	33 dBm
Channel Temperature	200 °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 Soldering Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 0B	ESDA / JEDEC JS-001-2012
MSL – Moisture Sensitivity Level	Level 3	IPC/JEDEC J-STD-020

Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.
Solder profiles available upon request.

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
- Qorvo Green

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

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Web: **www.qorvo.com**

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