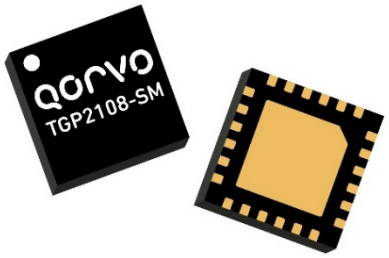
TGP2108-SM

2.5-4GHz 6-Bit Digital Phase Shifter

Applications

- S-Band Radar

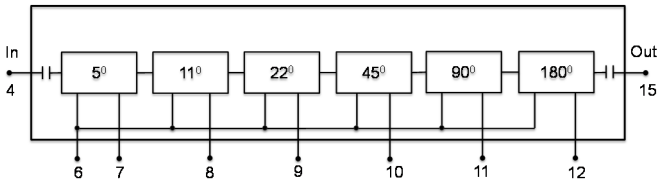


QFN 5x5 mm 24L

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° (2.7 – 3.7 GHz)
  < 5° (other frequencies)
- RMS Amplitude Error: < 0.4 dB
- Insertion Loss: 5 dB
- Return Loss: 15 dB
- Input P1dB: 29 dBm
- Input IP3: 45 dBm
- Control Voltage: 0 / +3V to +5 V
- QFN Package Dimensions: 5.0 x 5.0 x 0.85 mm

Functional Block Diagram



General Description

The Qorvo TGP2108-SM 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 TGP2108-SM offers an exceptional RMS phase error of <2⁰ and amplitude error of <0.4 dB over most of the operational band. With other equally impressive small signal and linearity characteristics, the TGP2108-SM delivers superior performance for your S-band phased array applications.

Housed in a small 5 x 5 mm plastic overmold QFN package, DC blocked on both ports with bi-directional operation and the use of positive only control logic, the TGP2108-SM 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.

Pin Configuration

Pin No.	Symbol
1-3, 5, 13-14, 16-24	N/C
4	RF In
6	REF
7	5° Bit
8	11° Bit
9	22° Bit
10	45° Bit
11	90° Bit
12	180° Bit
15	RF Out

Ordering Information

Part	ECCN	Description
TGP2108-SM	EAR99	2.5-4GHz 6-Bit Digital Phase Shifter

Absolute Maximum Ratings

Parameter	Value
Control and Reference Voltage	6 V
Control Current	1 mA
Power Dissipation	1.5 W
Input Power, CW, 50 Ω, 85℃	33 dBm
Channel Temperature	200 ℃
Mounting Temperature (30 Seconds)	260 ℃
Storage Temperature	-55 to 150 ℃

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
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

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

Electrical Specifications

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

Parameter	Min	Typical	Max	Units
Operational Frequency Range	2.5		4	GHz
Insertion Loss		5		dB
Input Return Loss		15		dB
Output Return Loss		15		dB
RMS Phase Error		2.7 – 3.7 GHz: < 2 Other Freq.: < 5		deg
RMS Amplitude Error		< 0.4		dB
Input P1dB		29		dBm
Input IP3 (Tone Spacing = 10 MHz, Pin/Tone = 8 dBm)		45		dBm
Insertion Loss Temperature Coefficient		0.002		dB/℃

Bias Truth Table

Logic “0” = 0 V, Logic “1” = +3V or +5 V

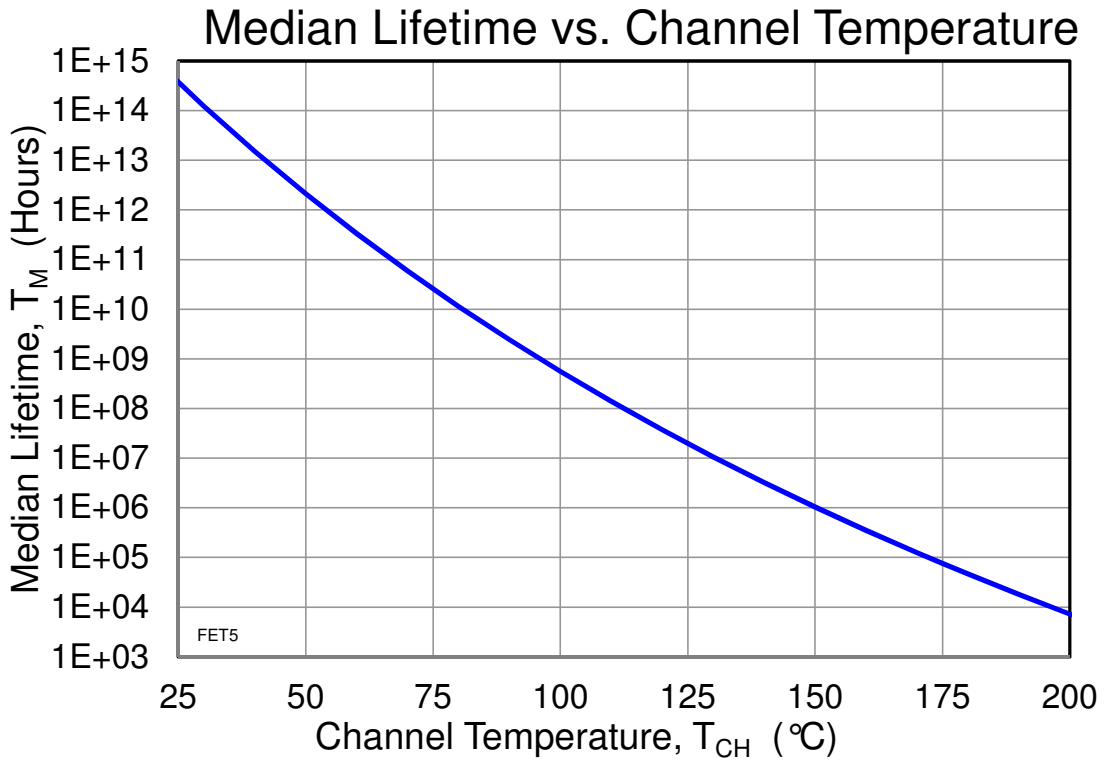
Phase Shifter	5^0	11^0	22^0	45^0	90^0	180^0	REF
0° (Reference)	0	0	0	0	0	0	1
5°	1	0	0	0	0	0	0
11°	0	1	0	0	0	0	0
22°	0	0	1	0	0	0	0
45°	0	0	0	1	0	0	1
90°	0	0	0	0	1	0	1
180°	0	0	0	0	0	0	1
355°	1	1	1	1	1	1	1

Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Channel Temperature (T_{CH})	$T_{BASEPLATE}$ = 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

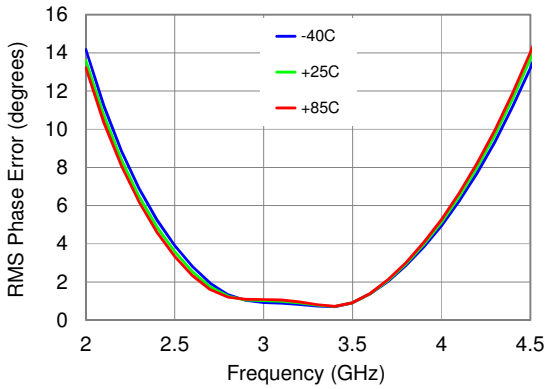


Typical Performance – Small Signal

Test conditions unless otherwise noted: 5V and 3V, 25 °C

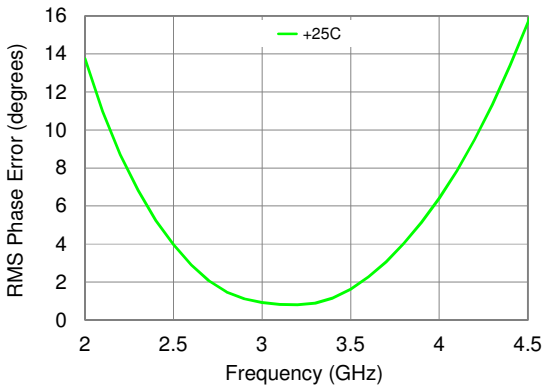
RMS Phase Error vs. Freq. vs. Temp

V_{REF} = 5 V, All Phase States



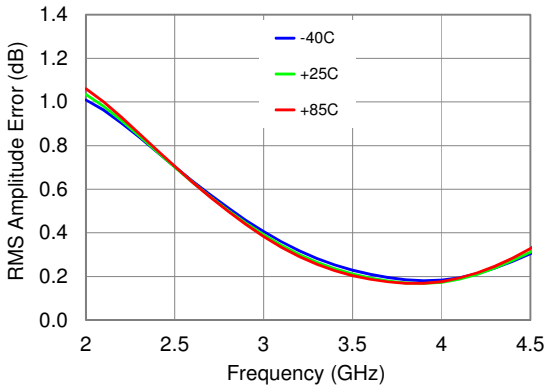
RMS Phase Error vs. Freq.

V_{REF} = 3 V, All Phase States



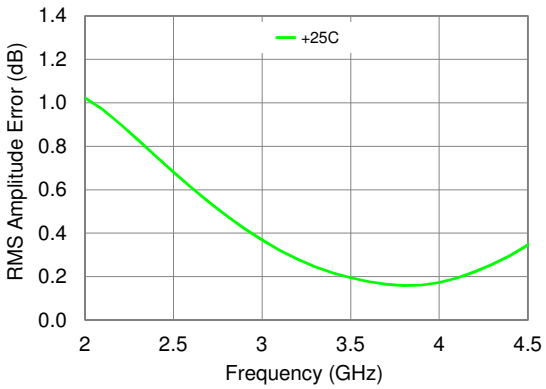
RMS Amplitude Error vs. Freq vs. Temp.

V_{REF} = 5 V, All Phase States



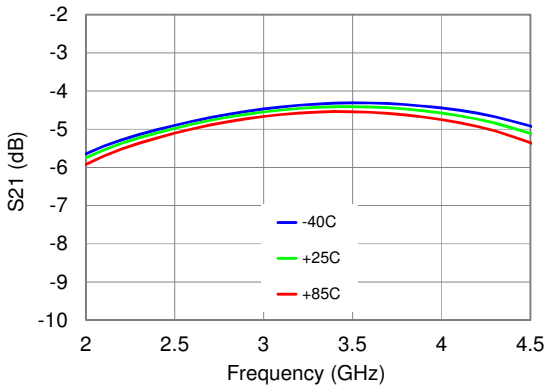
RMS Amplitude Error vs. Freq.

V_{REF} = 3 V, All Phase States



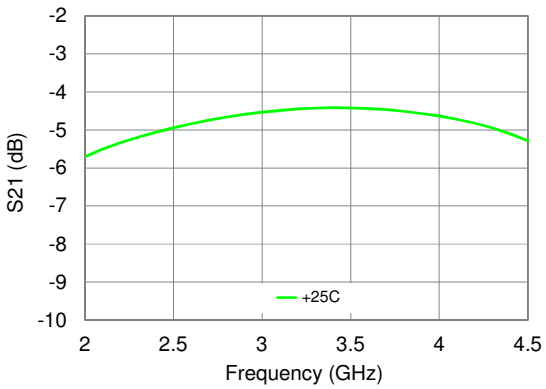
Avg. Insertion Loss vs. Freq. vs. Temp.

V_{REF} = 5 V, All Phase States



Avg. Insertion Loss vs. Freq.

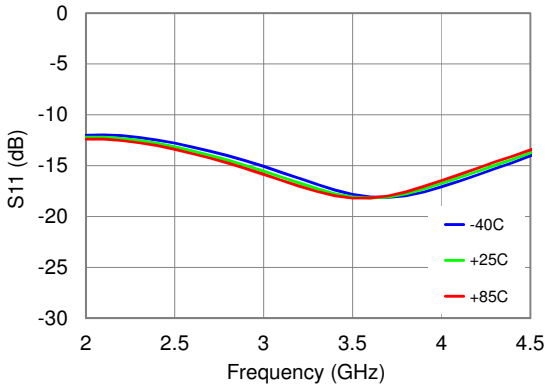
V_{REF} = 3 V, All Phase States



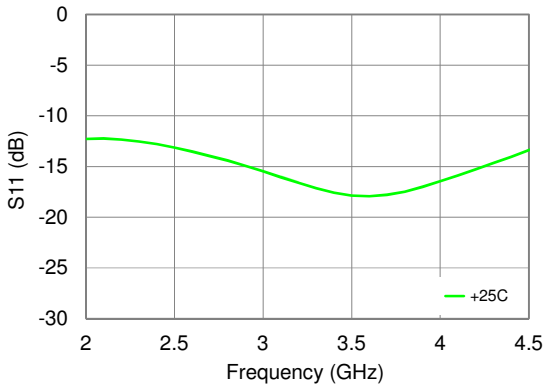
Typical Performance – Small Signal (Cont.)

Test conditions unless otherwise noted: 5V and 3V, 25 °C

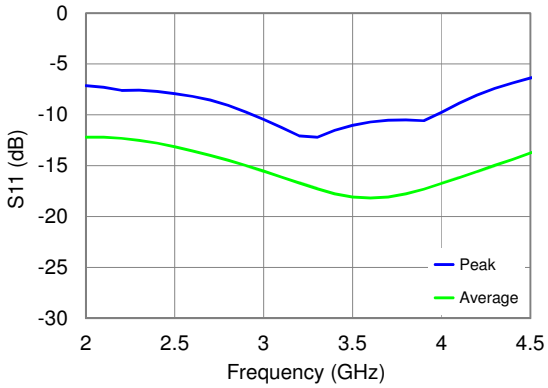
Avg. IRL vs. Freq. vs.Temp
V_{REF} = 5 V, All Phase States



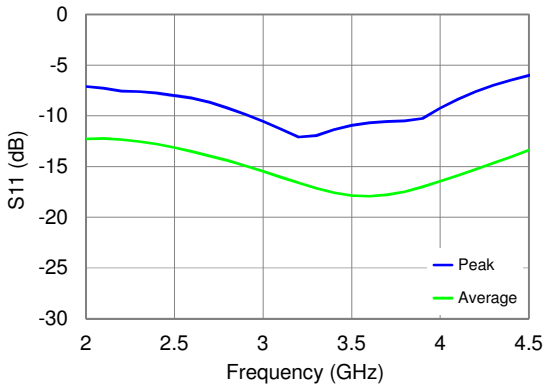
Avg. IRL vs. Freq.
V_{REF} = 3 V, All Phase States



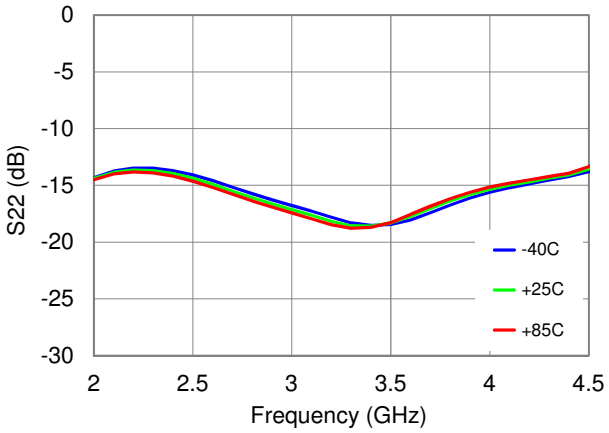
IRL vs. Freq.
V_{REF} = 5 V, All Phase States, 25 °C



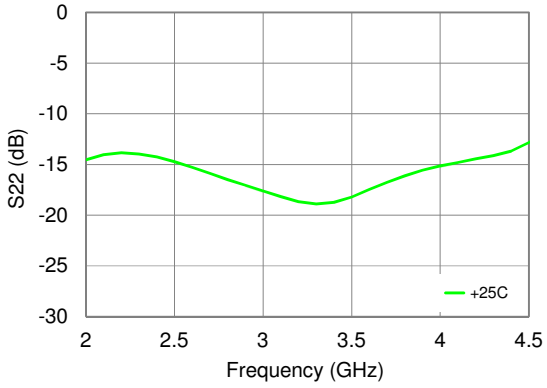
IRL vs. Freq.
V_{REF} = 3 V, All Phase States, 25 °C



Avg. ORL vs. Freq. vs. Temp
V_{REF} = 5 V, All Phase States

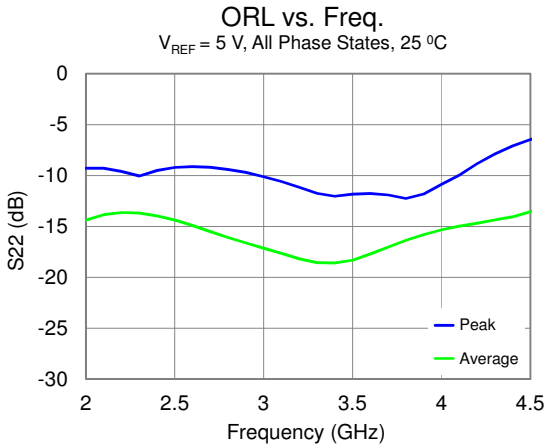


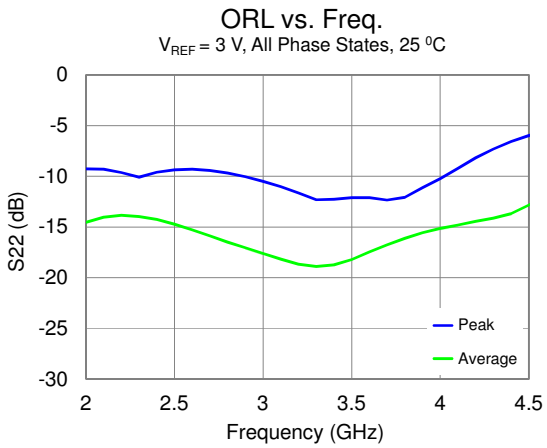
Avg. ORL vs. Freq.
V_{REF} = 3 V, All Phase States



Typical Performance – Small Signal (Cont.)

Test conditions unless otherwise noted: 5V and 3V, 25 °C

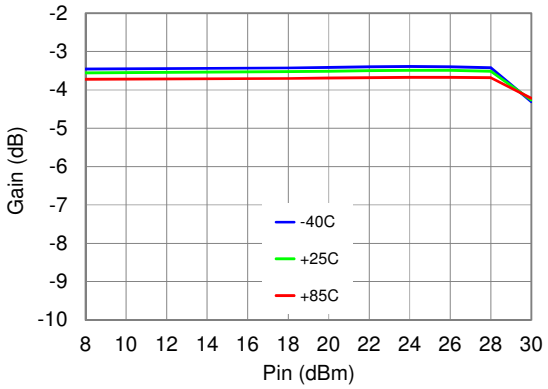




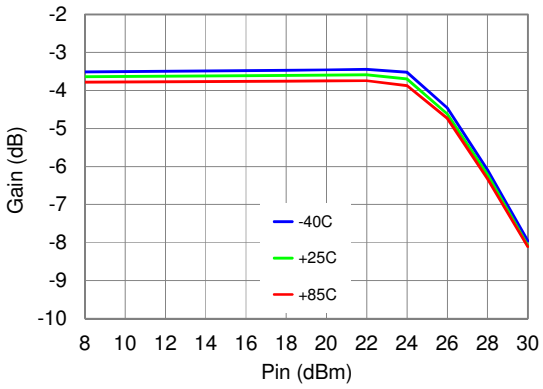
Typical Performance – Large Signal

Test conditions unless otherwise noted: 5V and 3V, 25 °C

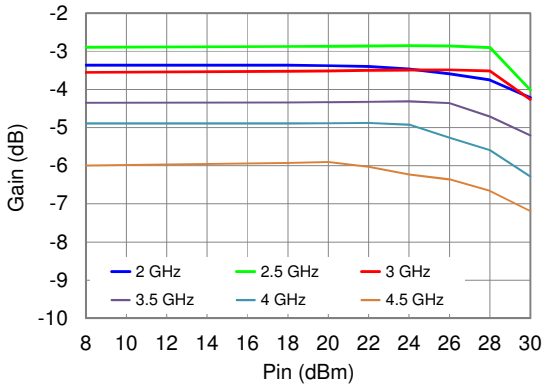
Gain vs. Pin vs. Temperature
V_{REF} = 5 V, Freq. = 3 GHz, Phase State = 0 deg



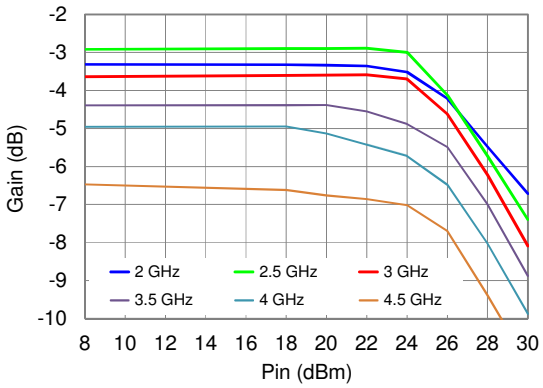
Gain vs. Pin vs. Temperature
V_{REF} = 3 V, Freq. = 3 GHz, Phase State = 0 deg



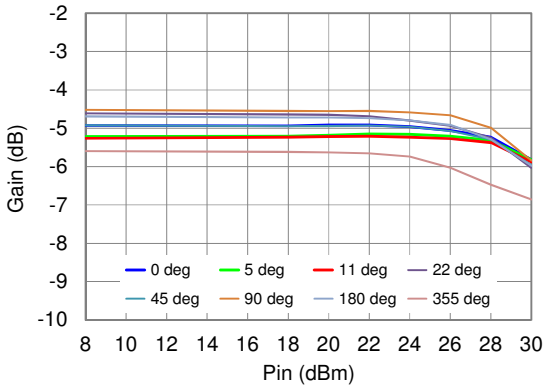
Gain vs. Pin vs. Frequency
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



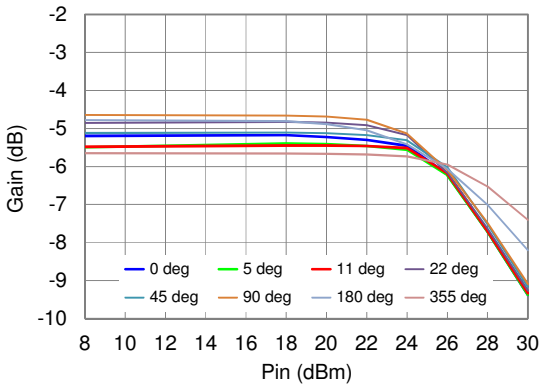
Gain vs. Pin vs. Frequency
V_{REF} = 3 V, 25 °C, Phase State = 0 deg



Gain vs. Pin vs. Major Phase States
V_{REF} = 5 V, Freq. = 3 GHz, 25 °C



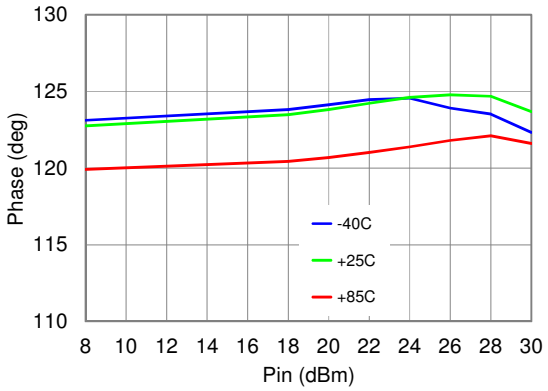
Gain vs. Pin vs. Major Phase States
V_{REF} = 3 V, Freq. = 3 GHz, 25 °C



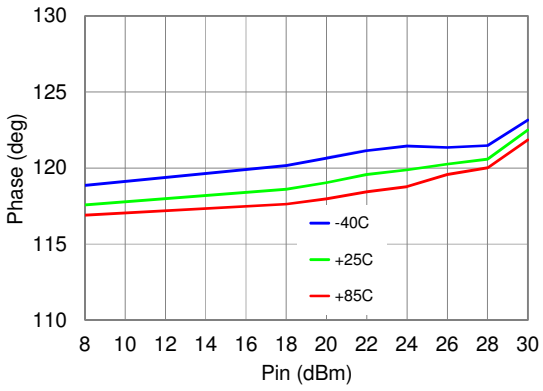
Typical Performance – Large Signal (Cont.)

Test conditions unless otherwise noted: 5V and 3V, 25 °C

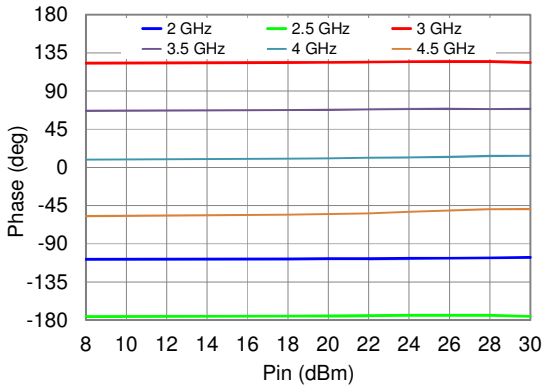
Phase vs. Pin vs. Temperature
V_{REF} = 5 V, Freq. = 3 GHz, Phase State = 0 deg



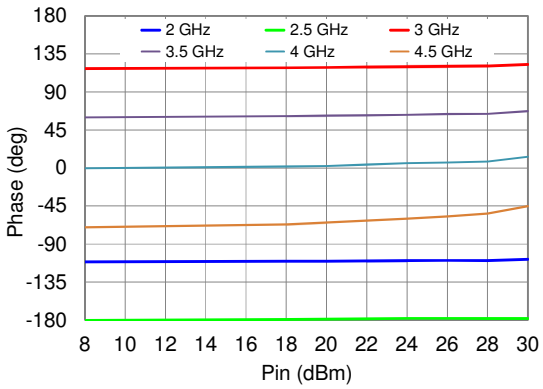
Phase vs. Pin vs. Temperature
V_{REF} = 3 V, Freq. = 3 GHz, Phase State = 0 deg



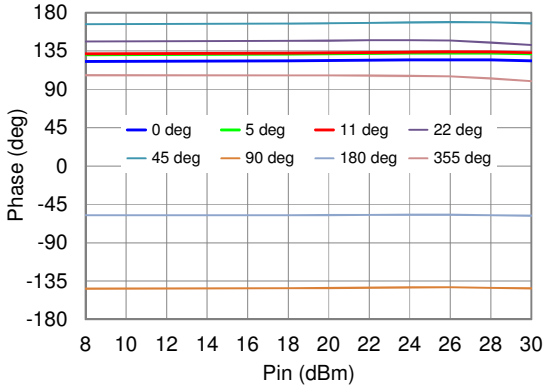
Phase vs. Pin vs. Frequency
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



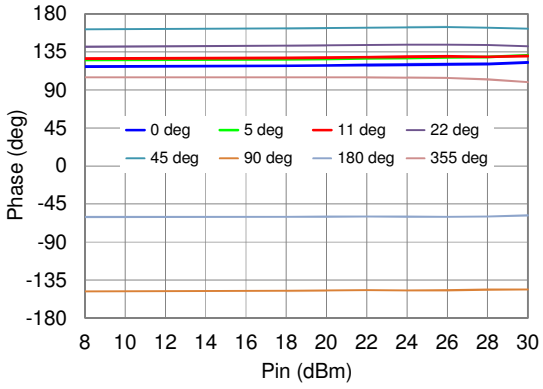
Phase vs. Pin vs. Frequency
V_{REF} = 3 V, 25 °C, Phase State = 0 deg



Phase vs. Pin vs. Major Phase States
V_{REF} = 5 V, Freq. = 3 GHz, 25 °C



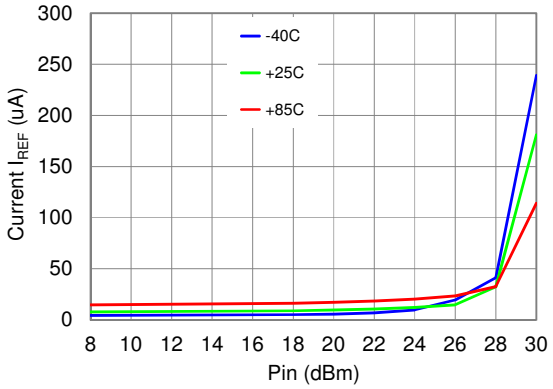
Phase vs. Pin vs. Major Phase States
V_{REF} = 3 V, Freq. = 3 GHz, 25 °C



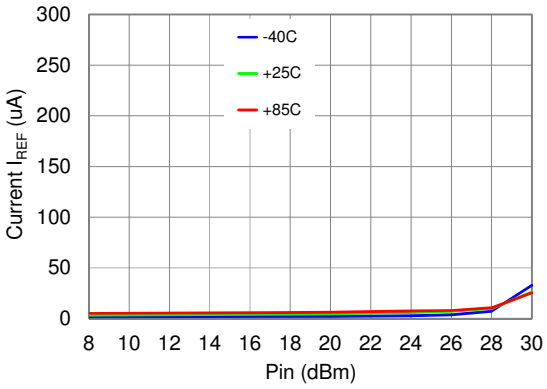
Typical Performance – Large Signal (Cont.)

Test conditions unless otherwise noted: 5V and 3V, 25 °C

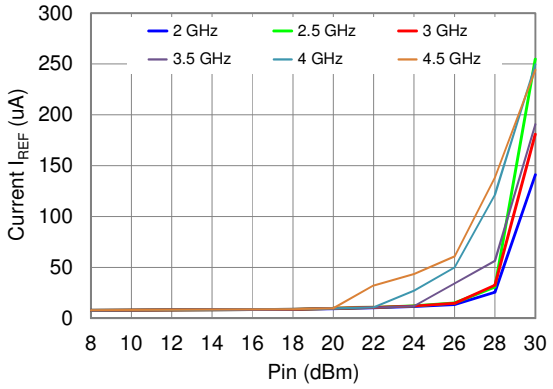
Current I_{REF} vs. Pin vs. Temperature
V_{REF} = 5 V, Freq. = 3 GHz, Phase State = 0 deg



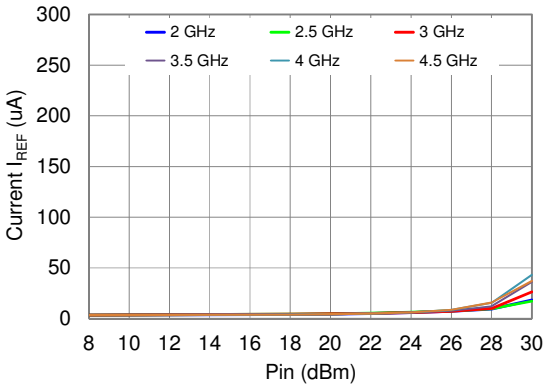
Current I_{REF} vs. Pin vs. Temperature
V_{REF} = 3 V, Freq. = 3 GHz, Phase State = 0 deg



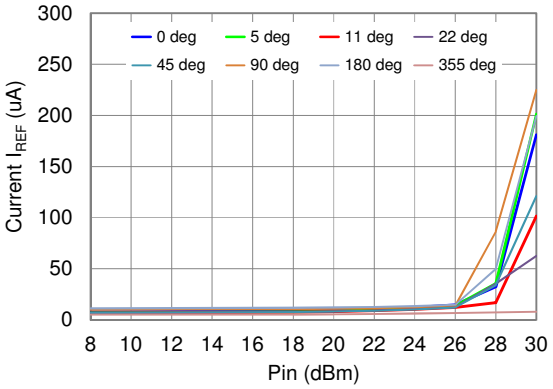
Current I_{REF} vs. Pin vs. Frequency
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



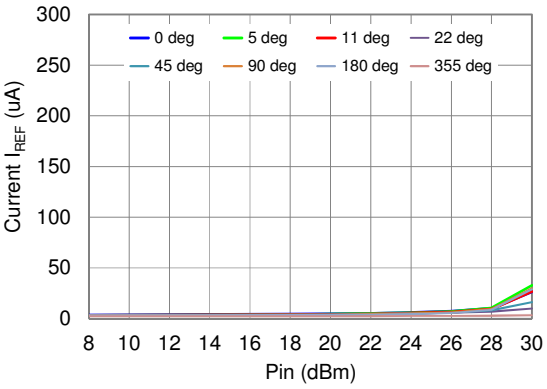
Current I_{REF} vs. Pin vs. Frequency
V_{REF} = 3 V, 25 °C, Phase State = 0 deg



Current I_{REF} vs. Pin vs. Phase States
V_{REF} = 5 V, Freq. = 3 GHz, 25 °C



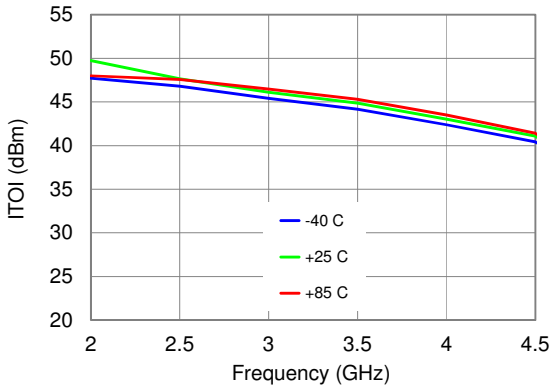
Current I_{REF} vs. Pin vs. Phase States
V_{REF} = 3 V, Freq. = 3 GHz, 25 °C



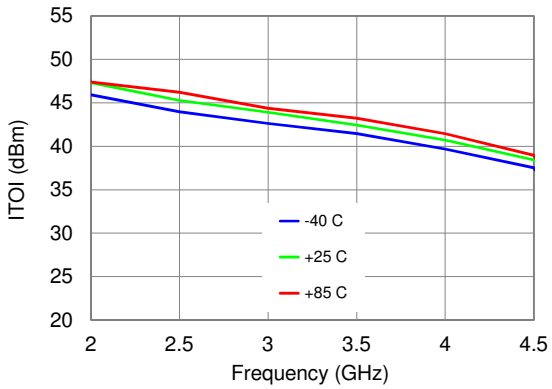
Typical Performance – Linearity

Test conditions unless otherwise noted: 5V and 3V, Tone Spacing = 10 MHz, 25 °C

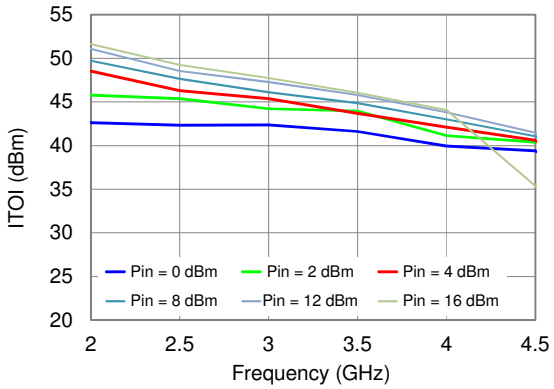
ITOI vs. Freq. vs. Temperature
V_{REF} = 5 V, Pin/Tone = 8 dBm, Phase State = 0 deg



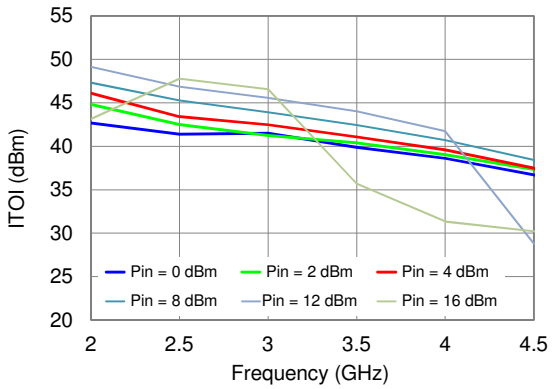
ITOI vs. Freq. vs. Temperature
V_{REF} = 3 V, Pin/Tone = 8 dBm, Phase State = 0 deg



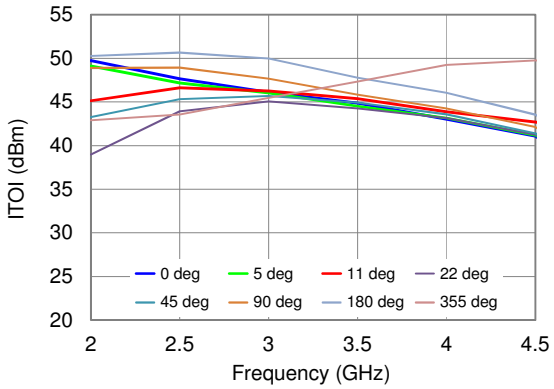
ITOI vs. Freq. vs. Pin/Tone
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



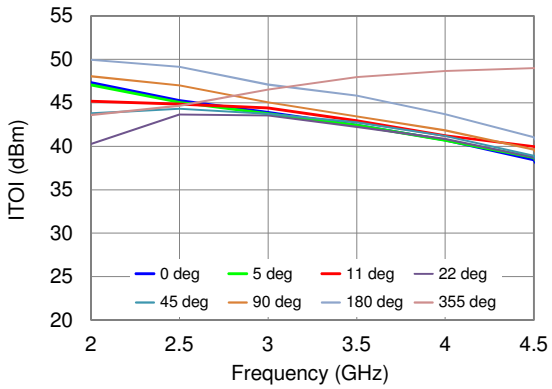
ITOI vs. Freq. vs. Pin/Tone
V_{REF} = 3 V, 25 °C, Phase State = 0 deg



ITOI vs. Freq. vs. Major Phase States
V_{REF} = 5 V, Pin/Tone = 8 dBm, 25 °C



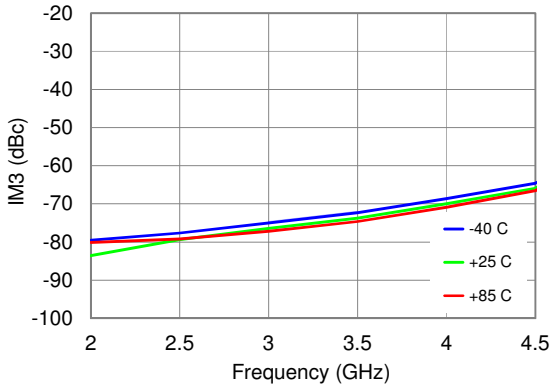
ITOI vs. Freq. vs. Major Phase States
V_{REF} = 3 V, Pin/Tone = 8 dBm, 25 °C



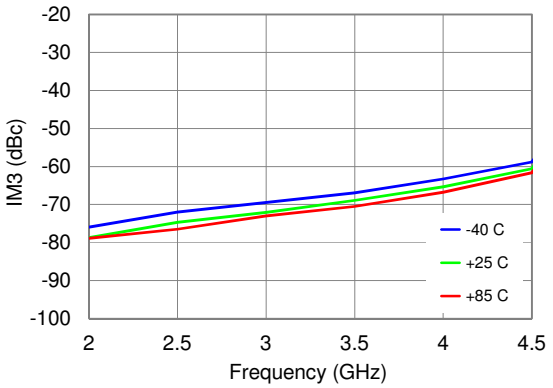
Typical Performance – Linearity (Cont.)

Test conditions unless otherwise noted: 5V and 3V, Tone Spacing = 10 MHz, 25 °C

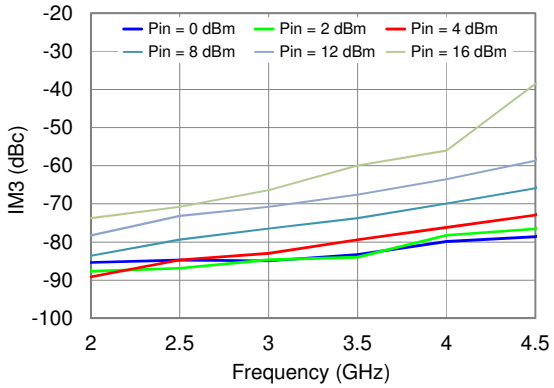
IM3 vs. Freq. vs. Temperature
V_{REF} = 5 V, Pin/Tone = 8 dBm, Phase State = 0 deg



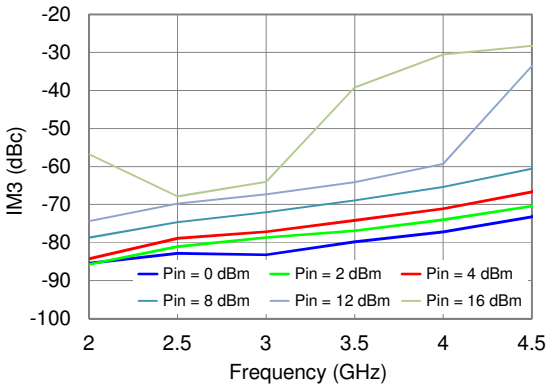
IM3 vs. Freq. vs. Temperature
V_{REF} = 3 V, Pin/Tone = 8 dBm, Phase State = 0 deg



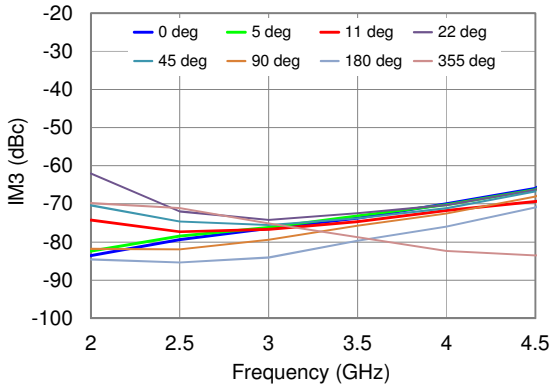
IM3 vs. Freq. vs. Pin/Tone
V_{REF} = 5 V, 25 °C, Phase State = 0 deg



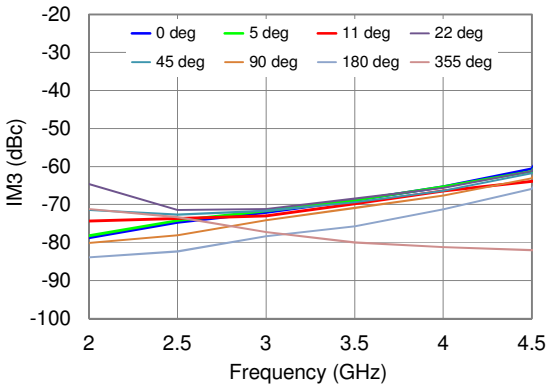
IM3 vs. Freq. vs. Pin/Tone
V_{REF} = 3 V, 25 °C, Phase State = 0 deg



IM3 vs. Freq. vs. Major Phase States
V_{REF} = 5 V, Pin/Tone = 8 dBm, 25 °C

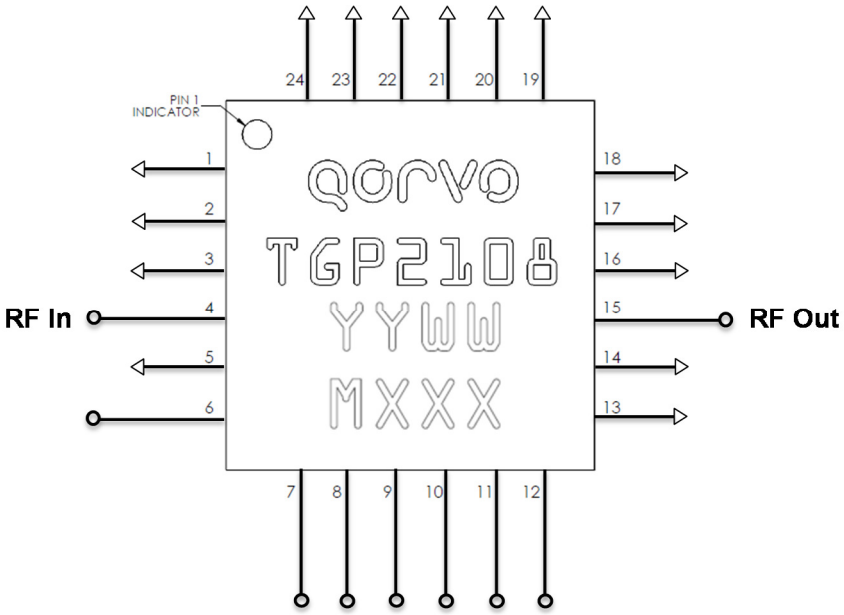


IM3 vs. Freq. vs. Major Phase States
V_{REF} = 3 V, Pin/Tone = 8 dBm, 25 °C



Applications Information

De-Quing network is not required



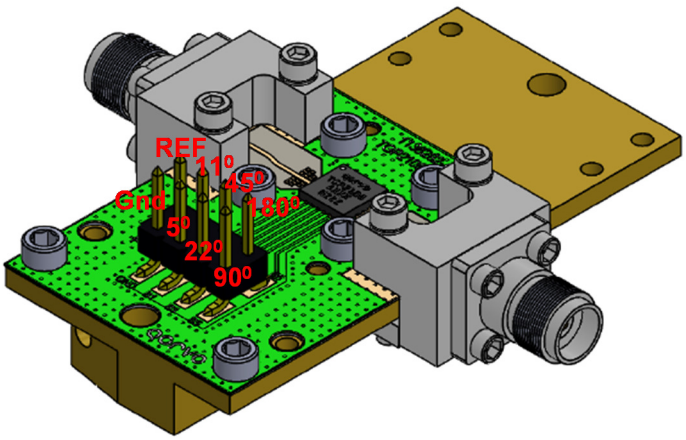
Evaluation Board

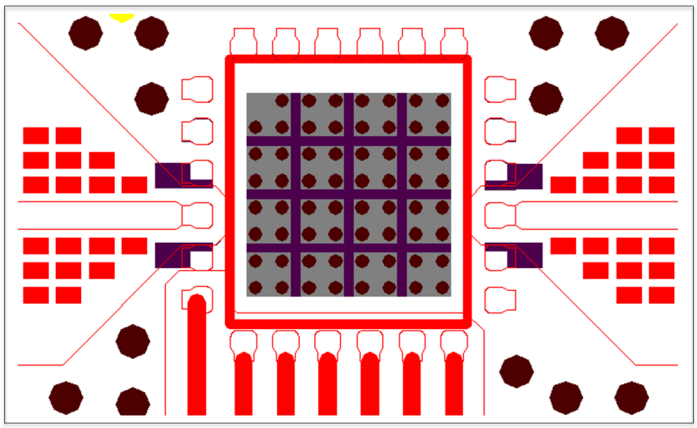
RF layer is 0.008" thick Rogers RO4003C. Metal layers are 0.5-oz copper. Microstrip 50 Ω line width is 0.050". The microstrip line taper at the connector interface is optimized for the Southwest Microwave end-launch connector 1092-02A-5.

Ground / thermal vias under the DUT are critical for the proper performance of this device. The PCB shown herein utilizes copper filled vias (8 mils diameter) under the DUT.

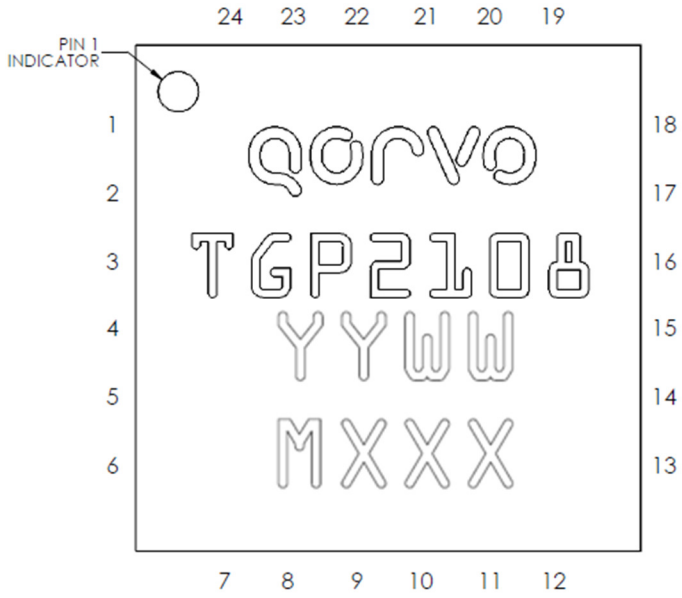
The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from company to company, careful process development is recommended.

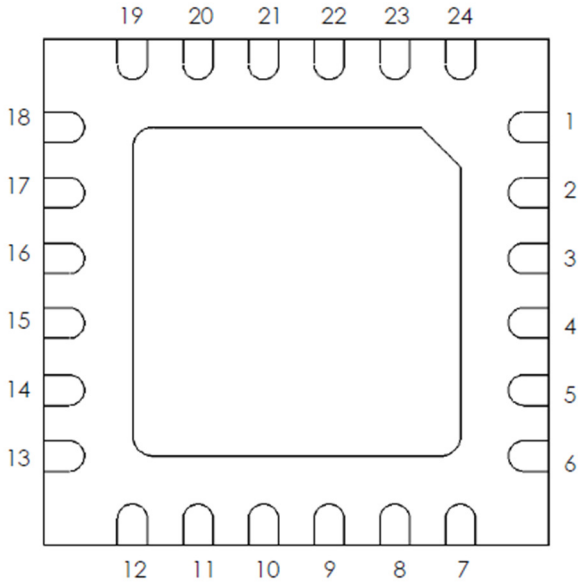
Vias Pattern





Pin Description

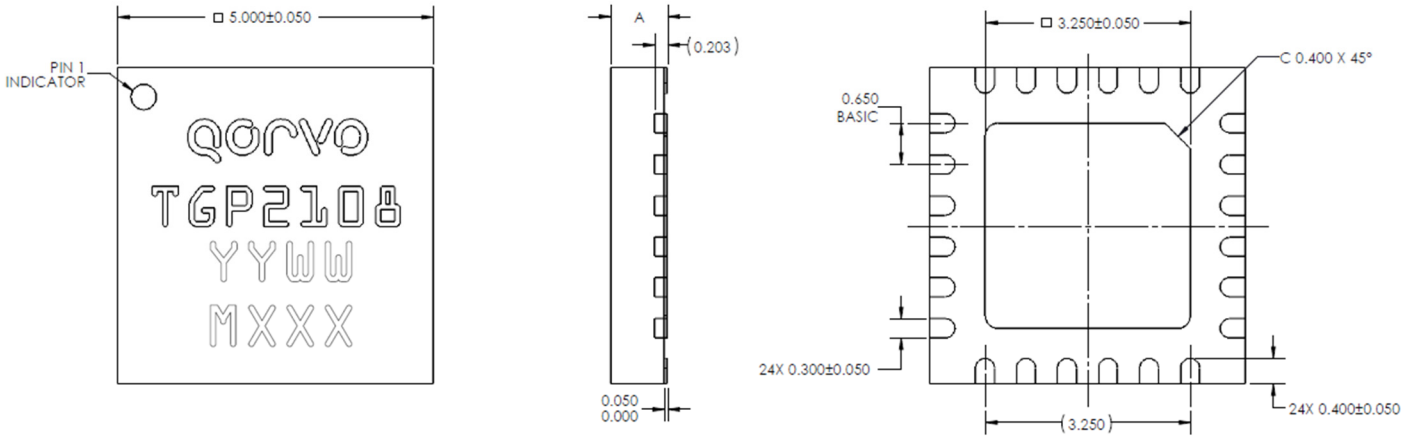




Package Pad	Symbol	Description
1-3, 5, 13-14, 16-24	N/C	No Connection; recommend GND at the EVB level
4	RF Input	Input; matched to 50 Ohms; DC blocked; interchangeable to RF Output
6	REF	Reference
7	5°	5° Bit
8	11°	11° Bit
9	22°	22° Bit
10	45°	45° Bit
11	90°	90° Bit
12	180°	180° Bit
15	RF Output	Output; matched to 50 Ohms; DC blocked; interchangeable to RF Input
25 (Slug)	GND	On PCB; multiple vias should be employed under the center pad (25) to minimize inductance and thermal resistance; see page 12 for suggested vias layout

Mechanical Information

Package Information and Dimensions



		QFN
A	MAX.	0.900
	NOM.	0.850
	MIN.	0.800

Units: mm

Tolerances: unless specified

.xx = ± 0.25

.xxx = ± 0.127

Materials:

Lid: Plastic

Plating: All metalized features are NiPdAu plated

Part is lead-free/PoHS-compliant; epoxy sealed

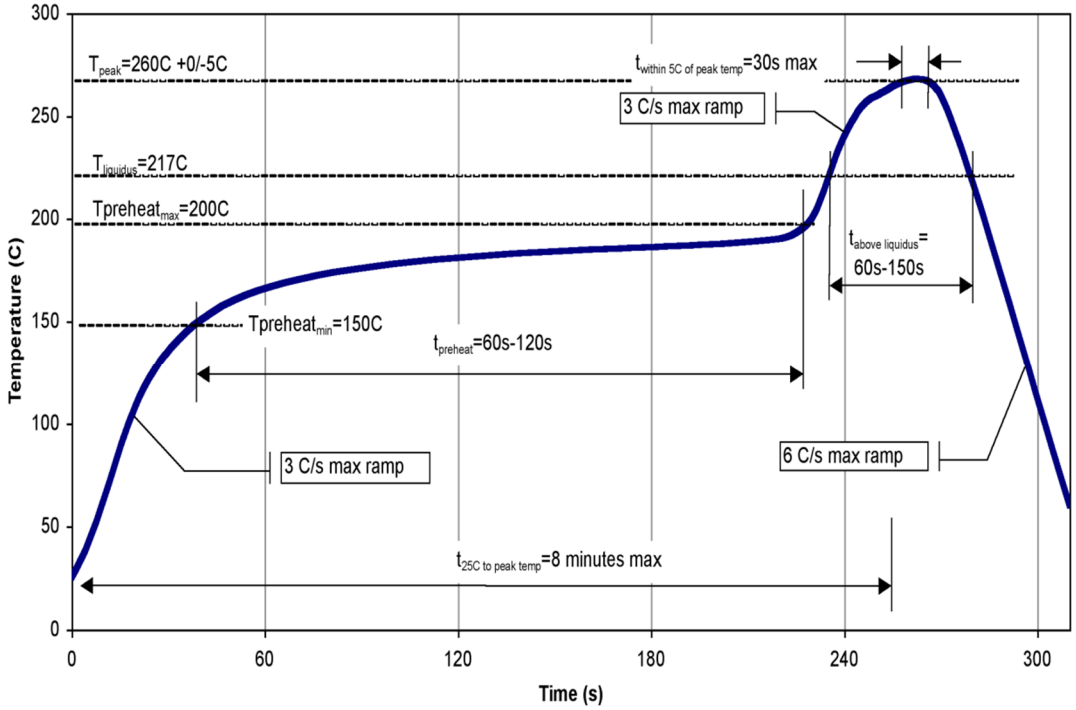
Marking:

2108: Part number

XXX: Assembly number

ZZZ: Serial number

Recommended Soldering Temperature Profile



Epoxies Attachment Notes:

- Epoxies can be used.
- Epoxies cure at temperatures of 100 to 200℃.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: TBD
Value: TBD
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

ECCN

U.S. Department of Commerce: EAR99

Solderability

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

MSL Rating

TBD at 260 °C convection reflow
The part is rated Moisture Sensitivity Level TBD JEDEC standard IPC/JEDEC J-STD-020.

RoHS Compliance

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

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 TriQuint:

Web: www.Qorvo.com **Tel: +1.972.994.8465**
Email: info-sales@Qorvo.com **Fax: +1.972.994.8504**

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