TGL2223-SM

1 – 31GHz 5-Bit Digital Attenuator

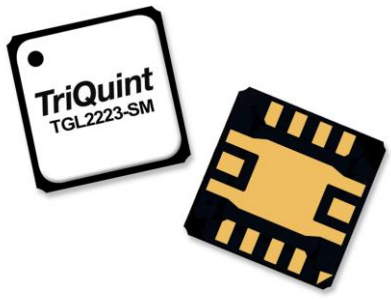
Product Description

Qorvo's TGL2223–SM is a wideband, 5–bit digital attenuator fabricated using Qorvo's production 0.15um GaAs pHEMT process (QPHT15). Operating from 1–31 GHz, the TGL2223–SM offers a low LSB of 0.5 dB and provides 15.5 dB of attenuation range while supporting low RMS step error of less than 0.5 dB.

Using standard, negative control voltages from -3.3 V to -5 V coupled with excellent broadband performance, the TGL2223-SM is ideal for supporting of a variety of commercial and military applications.

The TGL2223-SM is packaged in a 3 x 3 (mm) ceramic air-cavity QFN with both RF ports matched to 50 ohms for simple system integration.

Lead-free and RoHS compliant.



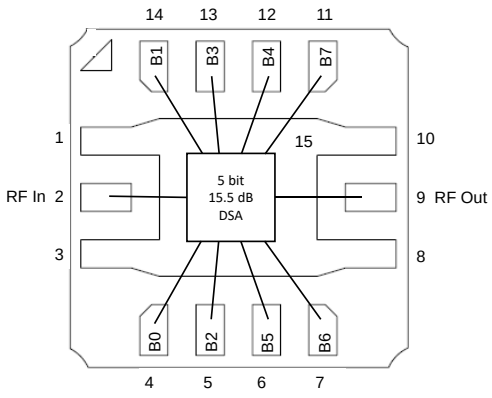
14 Pad 3 x 3 mm Air Cavity QFN Package

Product Features

- Frequency Range: 1 – 31 GHz
- 5-Bit Digital Attenuator
- Attenuation Step Size (LSB): 0.5 dB
- Attenuation Range: 15.5 dB
- Insertion Loss (Ref. State): 1.8 – 4.2 dB
- RMS Attenuation Error: < 0.9 dB
- RMS Step Error: < 0.5 dB
- Control Voltage: -3.3 to -5.0 V
- Package Size: 3.0 x 3.0 x 1.45 mm

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

Block Diagram



Applications

- Commercial and Military Radar
- Electronic Warfare
- Satellite Communications
- Point to Point Radio
- General Purpose

Ordering Information

Part No.	Description
TGL2223-SM	1–31 GHz 5-Bit Digital Attenuator
1118396	TGL2223-SM Evaluation Board

Absolute Maximum Ratings

Parameter	Rating
Control Voltage (V_C)	-6 V
Control Current (I_C)	1 mA
Input Power, (P_{IN})	30 dBm
Power Dissipation (P_{DISS})	0.7 W
Operating Channel Temperature (T_{CH})	150 °C
Mounting Temperature (30 s max)	260 °C
Storage Temperature	-40 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
Operating Temperature Range	-40	+25	+85	°C
Control Voltage (Logic L = 0)		-5.0	-3.3	V
Control Voltage (Logic H = 1)		0V		

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

Electrical Specifications

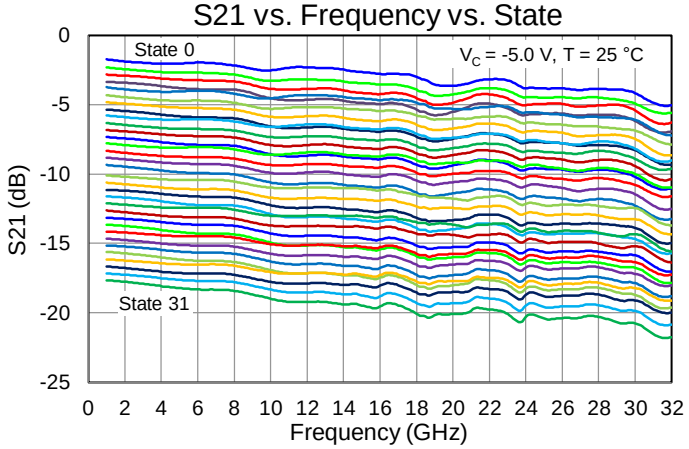
Test conditions, unless otherwise noted: 25 °C, V_C = 0 / −5.0 V. Tested with DUT on EVB, reference plane at package.

Parameter	Min	Typ.	Max	Units
Operational Frequency Range	1	–	31	GHz
LSB Attenuation		0.5		dB
Attenuation Range		15.5		dB
Reference State Insertion Loss: 1 – 6 GHz		< 2.0		dB
Reference State Insertion Loss: 6 – 18 GHz		< 3.0		dB
Reference State Insertion Loss: 18 – 30 GHz		< 4.5		dB
Input Return Loss		> 10		dB
Output Return Loss		> 7		dB
IIP3 (Δf = 1.0 MHz, P_{IN}/Tone = 5 dBm, 14 GHz)		> 32		dBm
Switching Speed (10%-90%, 90%-10%)		< 30		ns
RMS Attenuation Error		< 0.9		dB
RMS Step Error		< 0.5		dB
Max. Attenuation Error		< 1.5		dB

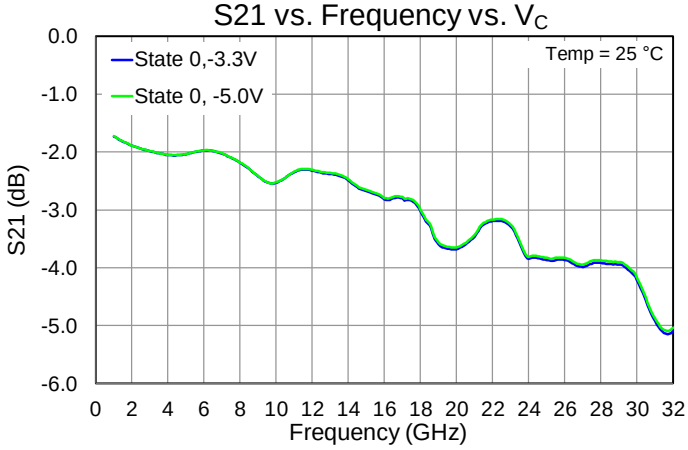
Performance Plots – Small Signal

Test conditions unless otherwise noted: Tested with DUT on EVB

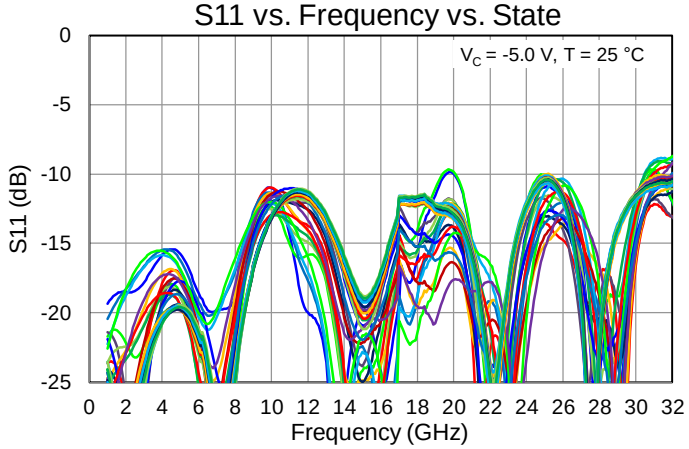
S21 vs. Frequency vs. State



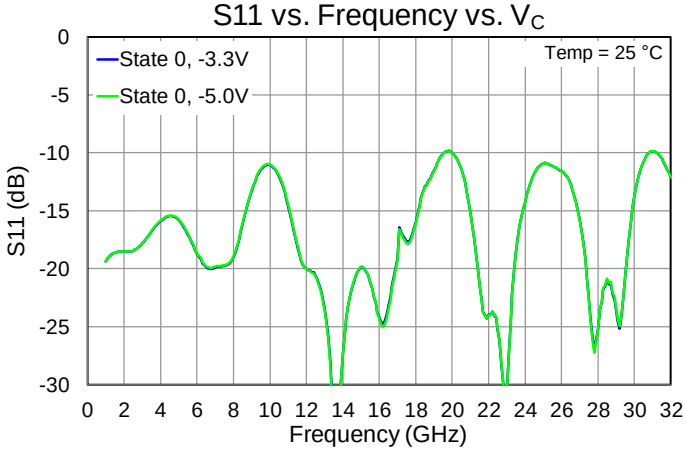
S21 vs. Frequency vs. V_C



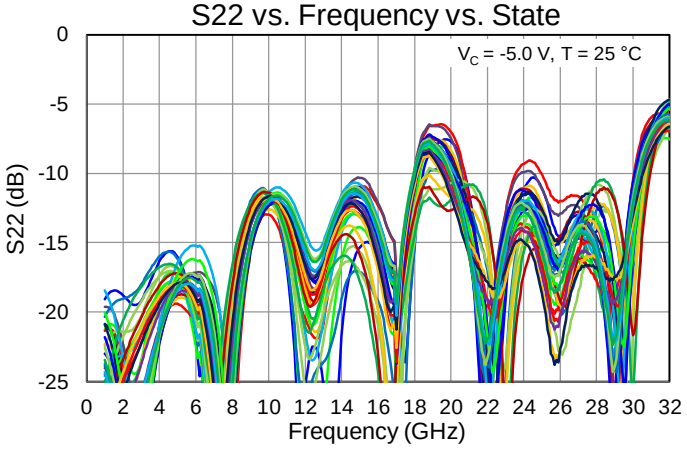
S11 vs. Frequency vs. State



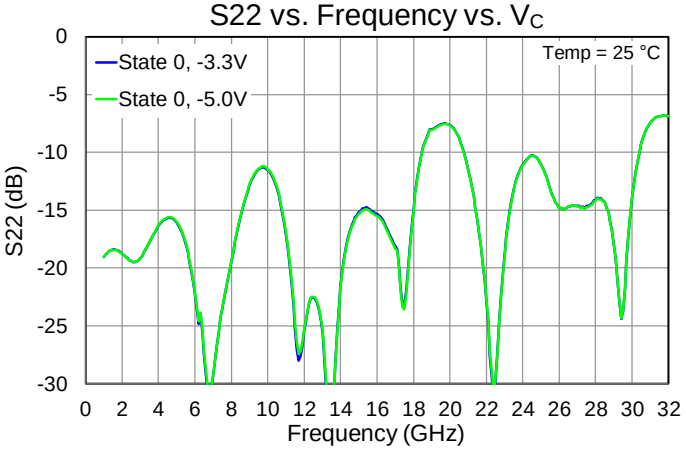
S11 vs. Frequency vs. V_C



S22 vs. Frequency vs. State



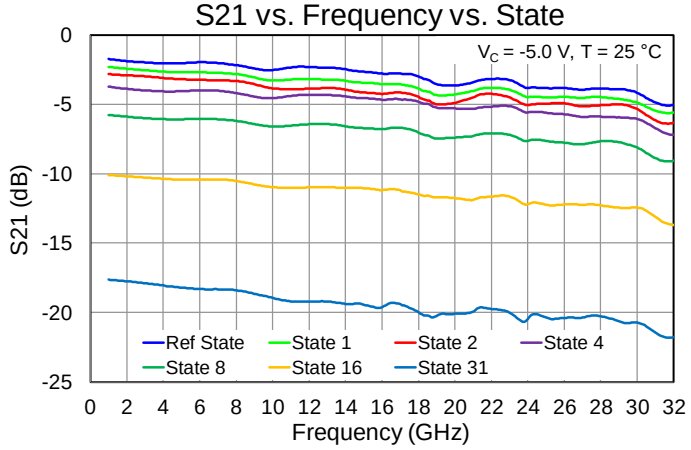
S22 vs. Frequency vs. V_C



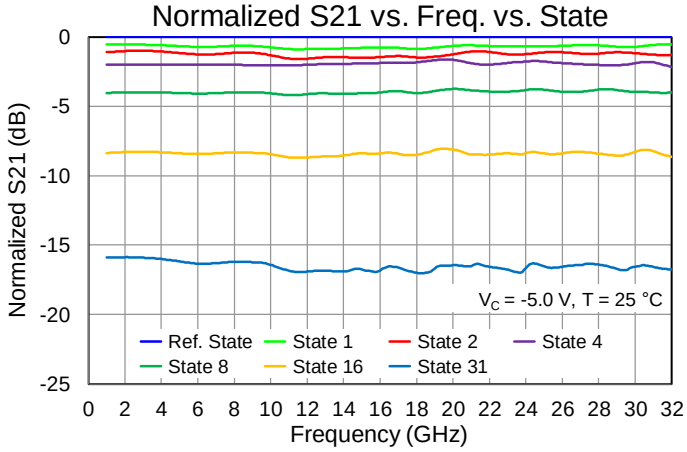
Performance Plots – Small Signal

Test conditions unless otherwise noted: Tested with DUT on EVB

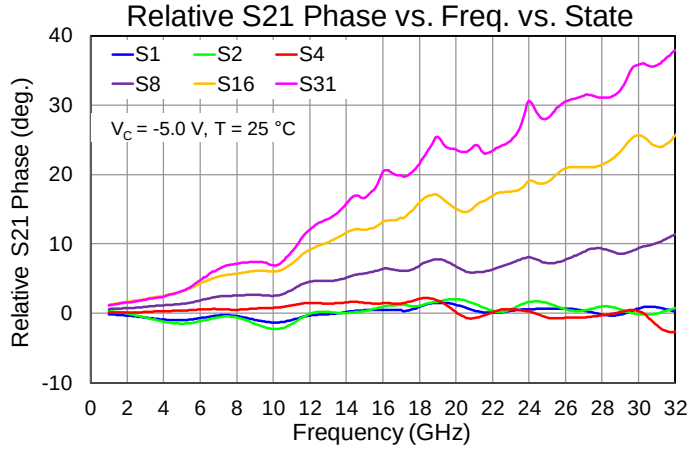
S21 vs. Frequency vs. State



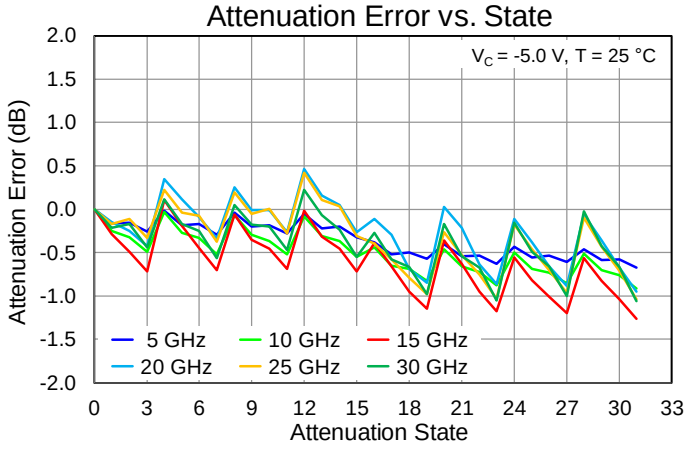
Normalized S21 vs. Freq. vs. State



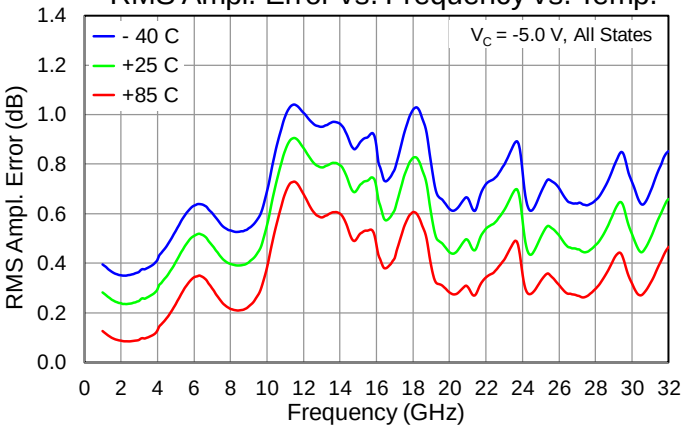
Relative S21 Phase vs. Freq. vs. State



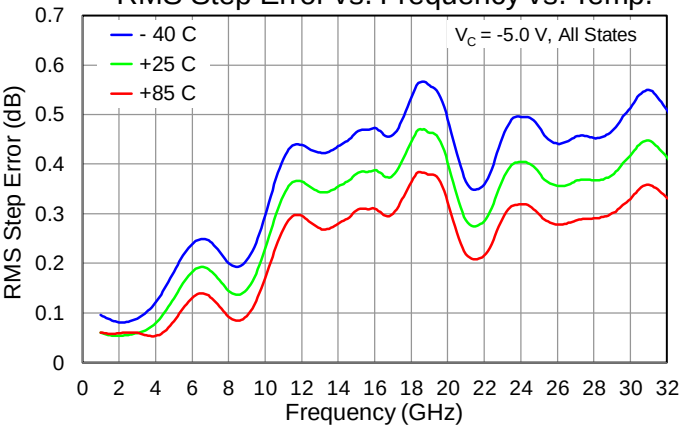
Attenuation Error vs. State



RMS Ampl. Error vs. Frequency vs. Temp.

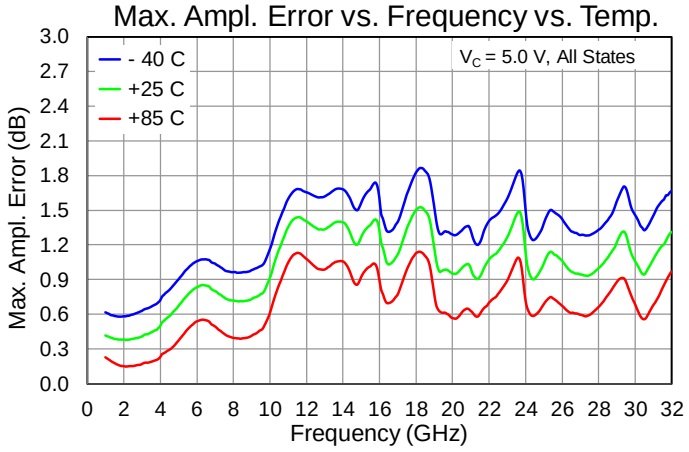


RMS Step Error vs. Frequency vs. Temp.

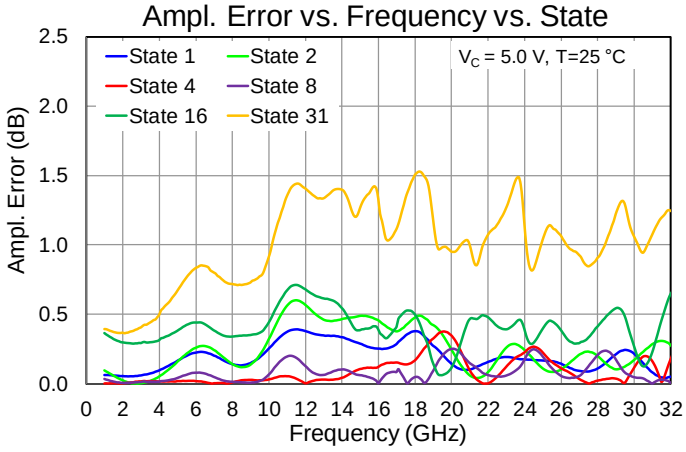


Performance Plots – Small, Large Signal & Linearity

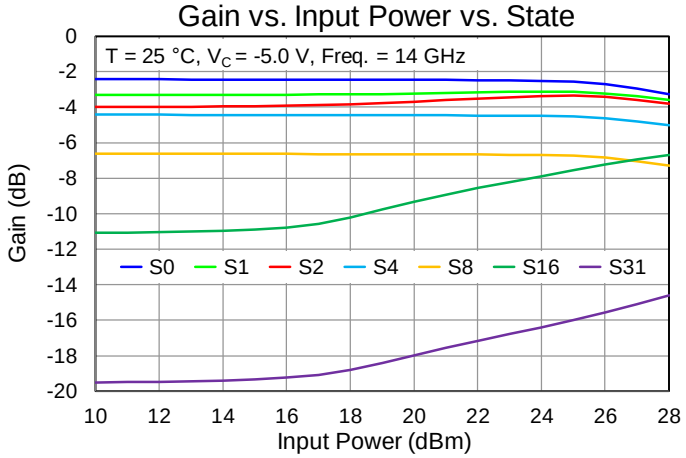
Max. Ampl. Error vs. Frequency vs. Temp.



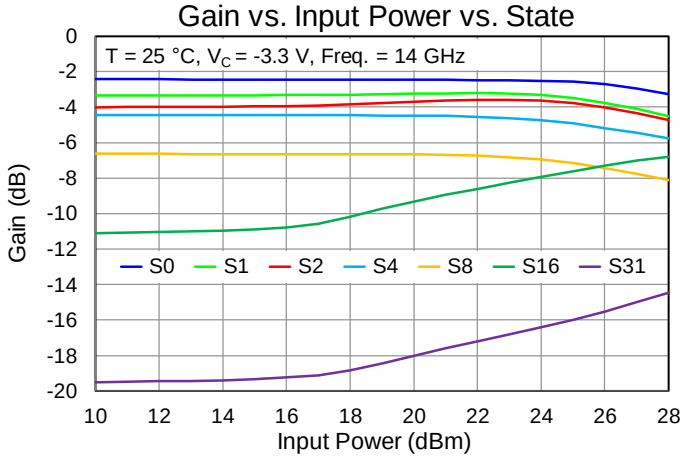
Ampl. Error vs. Frequency vs. State



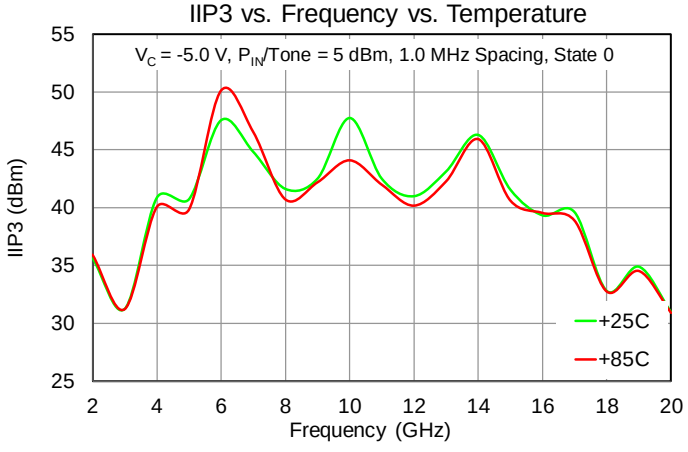
Gain vs. Input Power vs. State



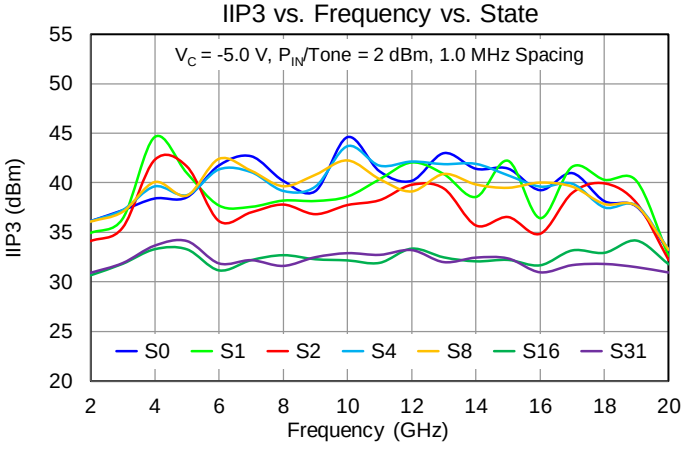
Gain vs. Input Power vs. State



IIP3 vs. Frequency vs. Temperature



IIP3 vs. Frequency vs. State



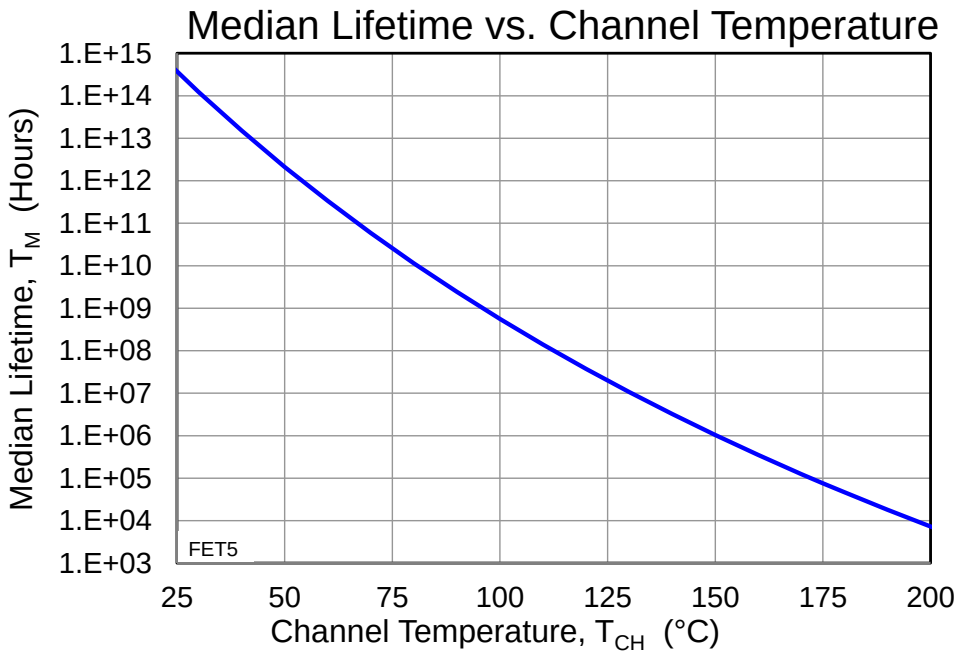
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, V_C = -5.0 V, P_{DISS} = 0.222 W	103.6	°C/W
Channel Temperature (T_{CH})		108	°C
Median Lifetime (T_M)		2.24E+8	Hrs

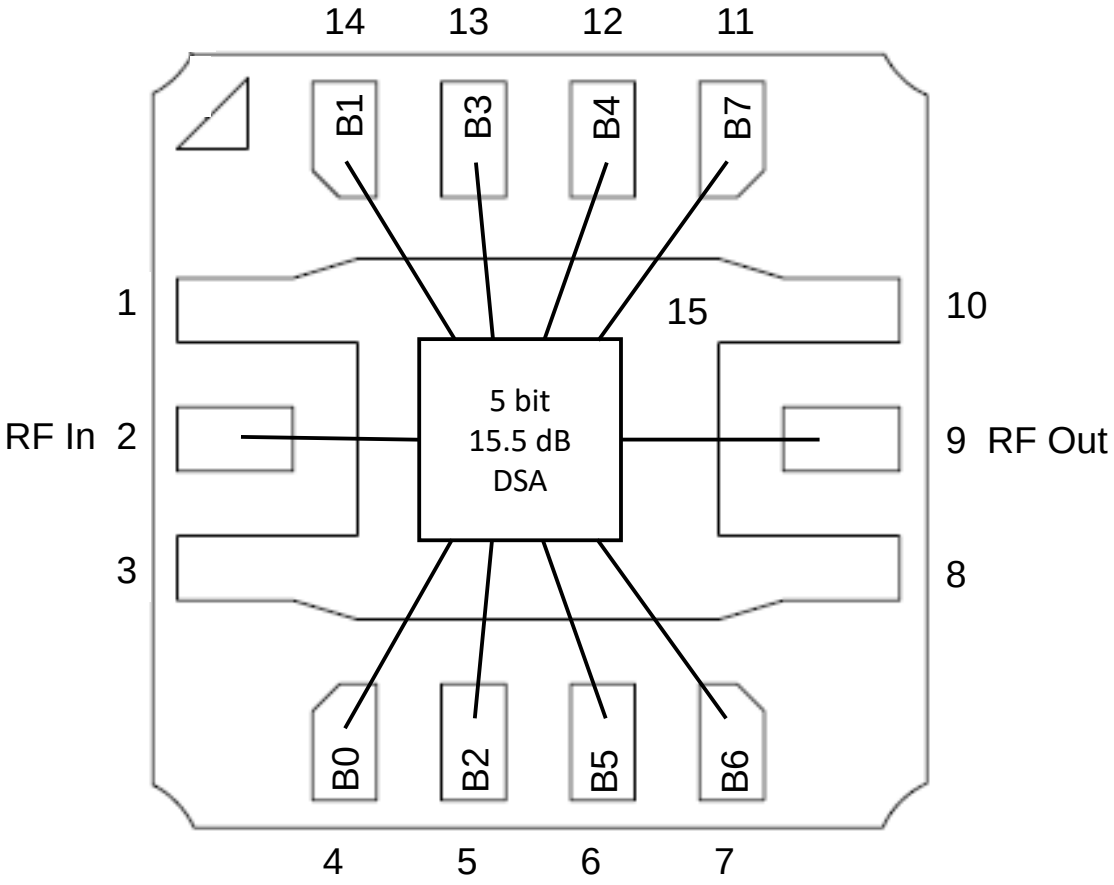
1. Package base backside temperature fixed at 85 °C.

Median Lifetime

Test Conditions: 6.0 V; Failure Criterion = 10% reduction in $I_{D\ MAX}$



Applications Circuit



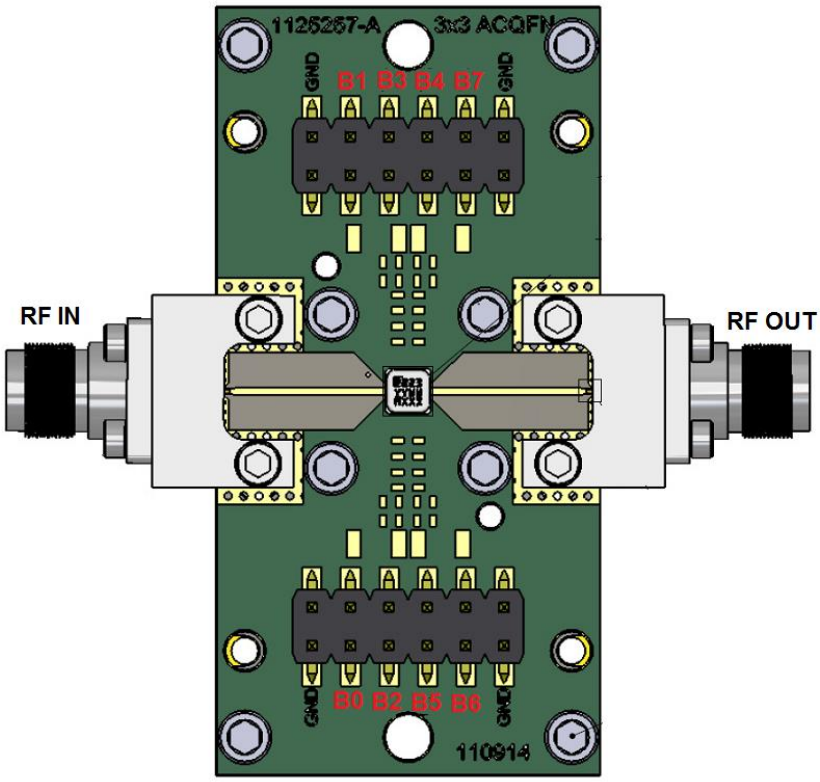
Function Table – Major States

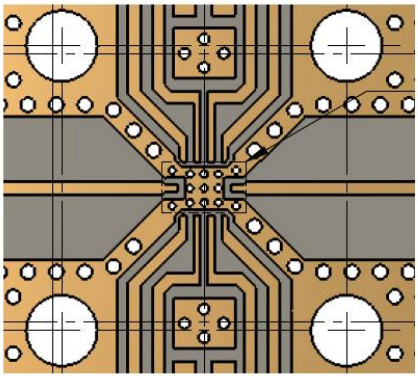
Parameter	State	B0	B1	B2	B3	B4	B5	B6	B7
0.0 dB Attenuation (Ref. State)	State 0	1	0	0	0	1	0	1	0
0.5 dB Attenuation	State 1	1	0	1	0	1	0	1	0
1.0 dB Attenuation	State 2	1	0	0	0	1	1	1	0
2.0 dB Attenuation	State 4	1	0	0	1	0	0	1	0
4.0 dB Attenuation	State 8	1	0	0	0	1	0	0	1
8.0 dB Attenuation	State 16	0	1	0	0	1	0	1	0
15.5 dB Attenuation	State 31	0	1	1	1	0	1	0	1

Intermediate attenuation states are combinations of the above major states.
Logic H = 1 = 0 V. Logic L = 0 = -3.3 to -5.0 V

Note: RF Input and RF Output are both DC coupled.

Evaluation Board (EVB) Layout Assembly & Mounting Detail





MOUNTING DETAIL

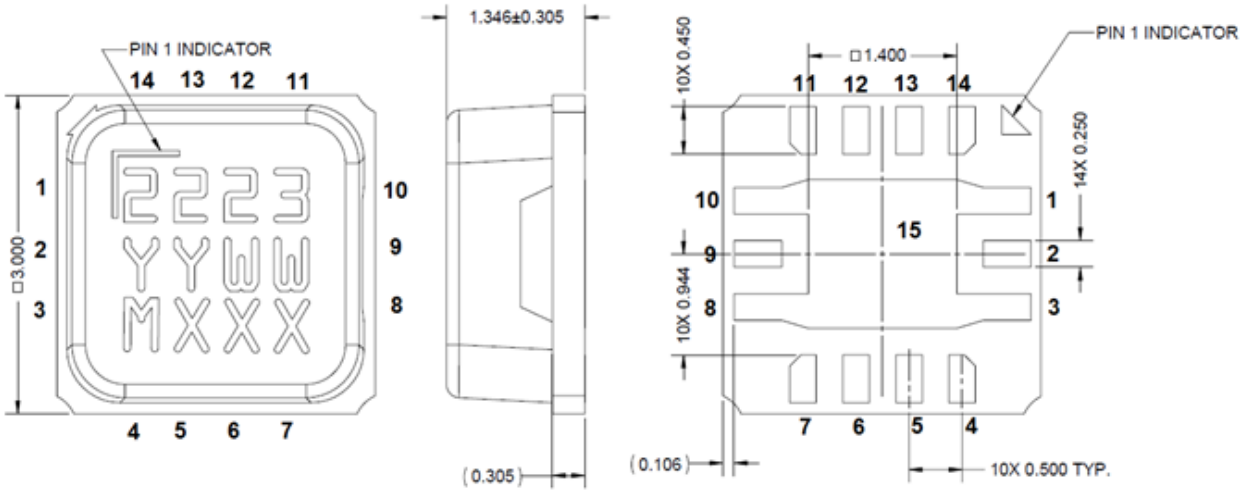
RF Layer is 0.008” thick Rogers Corp. RO4003C, er = 3.38. Metal layers are 0.5 oz. copper. The micro strip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-5.

Reference plane is at the package.

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

Mechanical Information and Pins Description

The dimensions are in millimeters and that unless otherwise noted the tolerance is +/- 0.127mm.



NOTES:
1. PACKAGE BASE: CERAMIC
2. PACKAGE LID: PLASTIC
3. ALL METALIZED FEATURES ARE GOLD PLATED.
4. THE PART IS EPOXY SEALED
5. PART MARKING:
   2223: PART NUMBER
   YY: PART ASSY YEAR
   WW: PART ASSY WEEK
   MXXX: BATCH ID

Pin No.	Symbol	Description
1, 3, 8, 10, 15	GND	Package Ground
2	RF IN	RF Input
4	B0	Complementary control line for 8.0 dB bit
5	B2	Control Line for 0.5 dB bit
6	B5	Control Line for 1.0 dB bit
7	B6	Complementary control line for 4.0 dB bit
9	RF OUT	RF Output
11	B7	Complementary control line for 4.0 dB bit
12	B4	Complementary control line for 2.0 dB bit
13	B3	Complementary control line for 2.0 dB bit
14	B1	Complementary control line for 8.0 dB bit

Assembly Notes

- Compatible with lead-free soldering process with 260°C peak reflow temperature.
- This package is non-hermetic, and therefore cannot be subjected to aqueous washing. The use of no-clean solder to avoid washing after soldering is recommended
- Solder rework not recommended.
- Contact plating: Ni-Au

Recommended Soldering Profile