

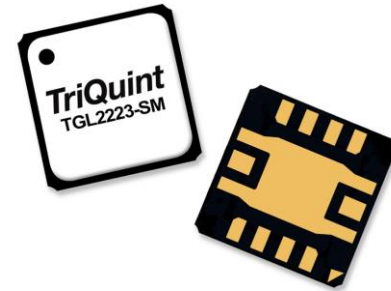
### Product Description

Qorvo's TGL2223-SM is a wideband, 5-bit digital attenuator fabricated using Qorvo's production 0.15 $\mu$ m 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 TGA2223-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.

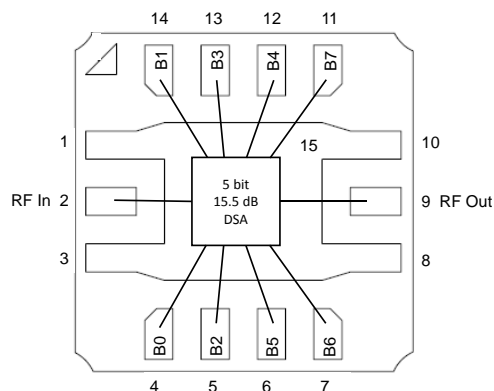


### Product Features

- 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



# TGL2223-SM

## 1 – 31GHz 5-Bit Digital Attenuator

### 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 ( $\Delta f = 1.0$ 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

### Recommended Operating Conditions

Parameter	Value / Range
Control Voltage (Logic L = 0)	-3.3 to -5 V
Control Voltage (Logic H = 1)	0 V
Operating Temperature Range	-40°C to +85°C

Electrical specifications are measured at specified test conditions.

Specifications are not guaranteed over all recommended operating conditions.

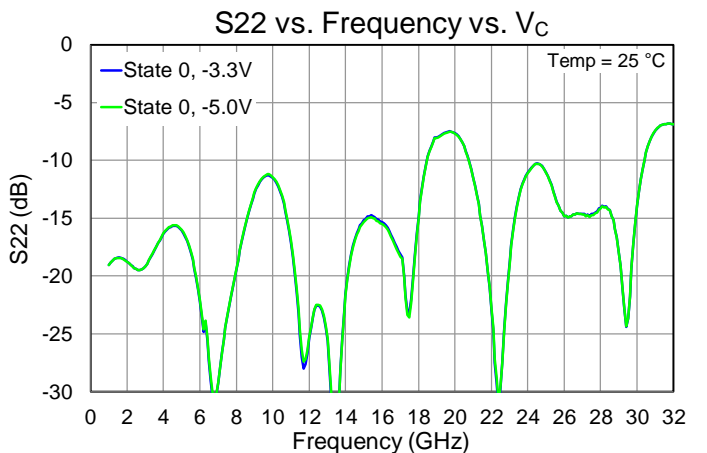
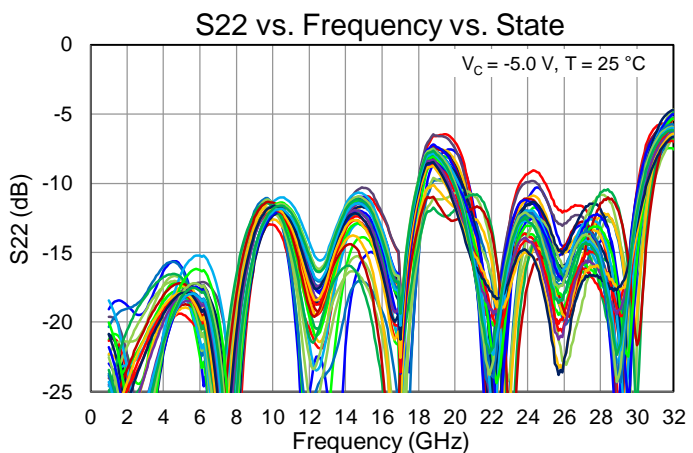
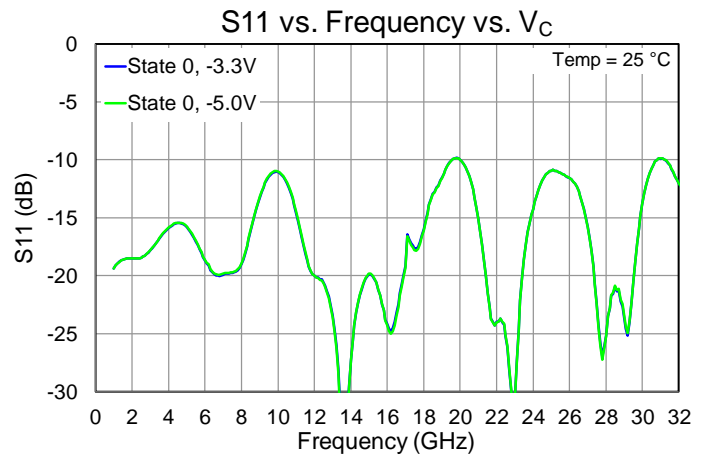
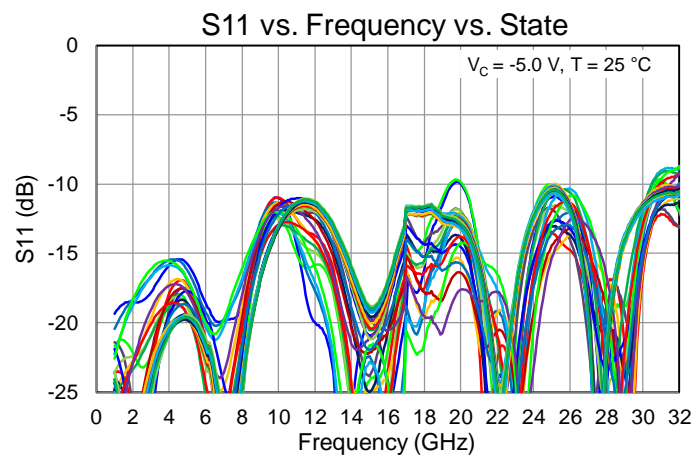
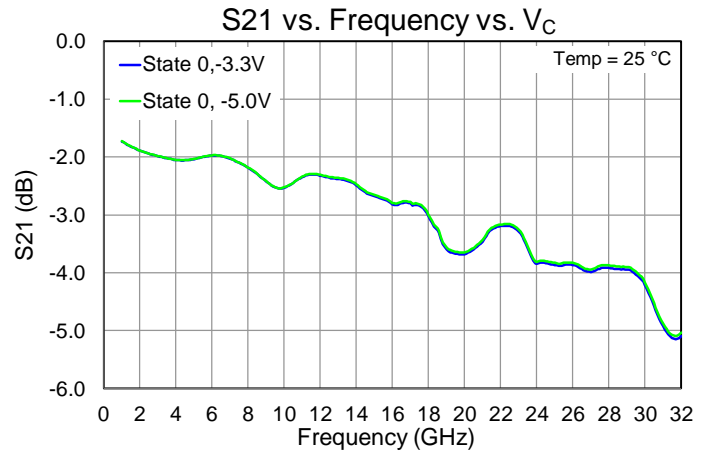
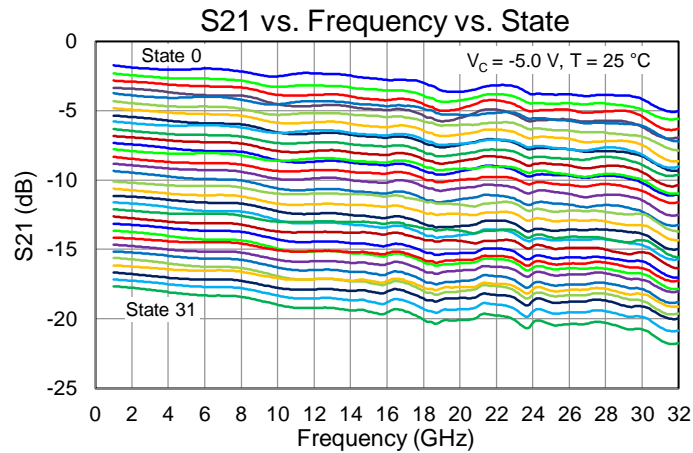
### Absolute Maximum Ratings

Parameter	Value / Range
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

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.

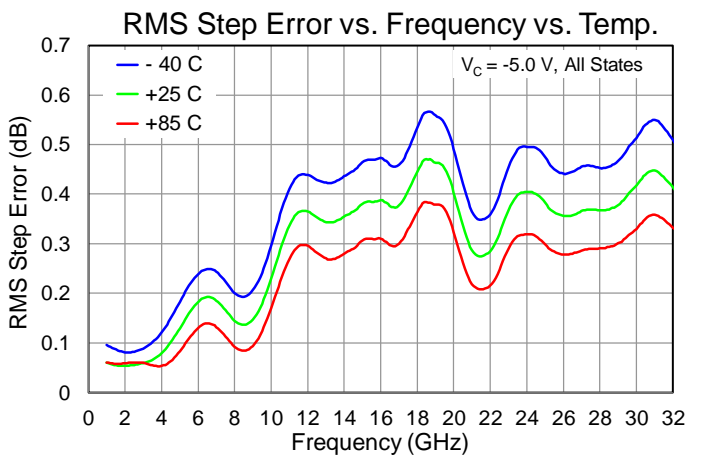
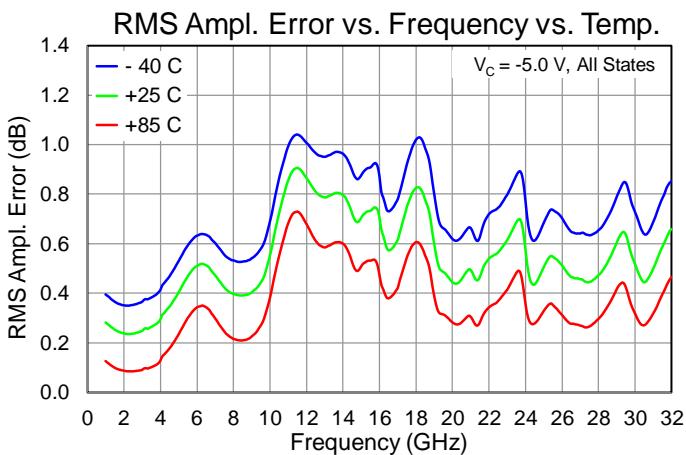
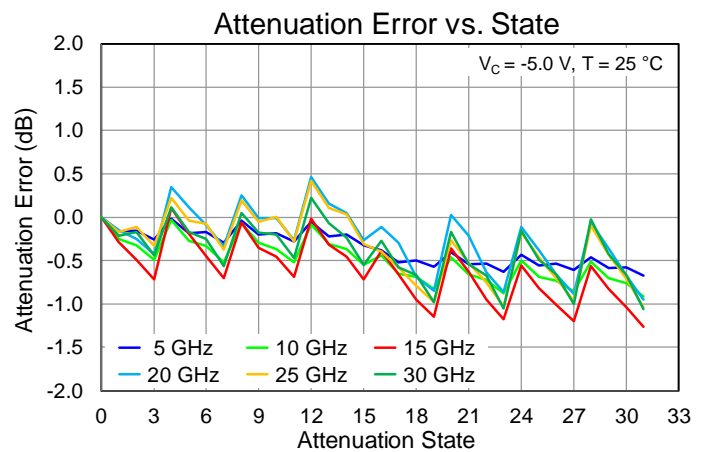
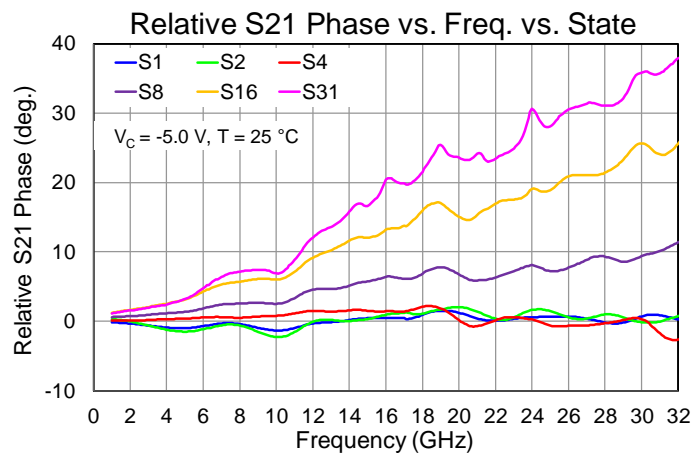
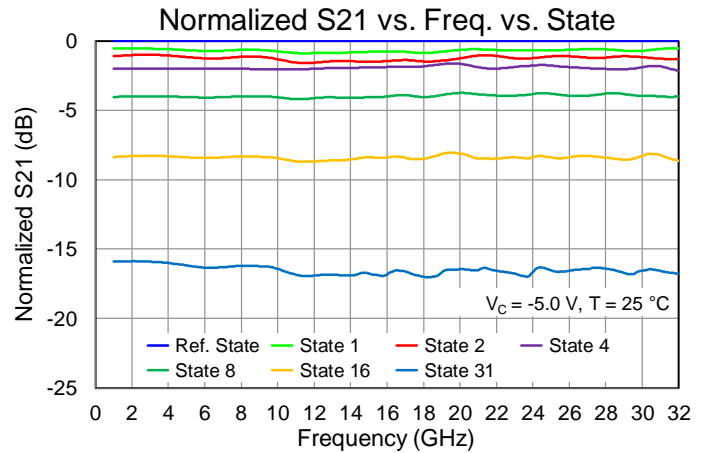
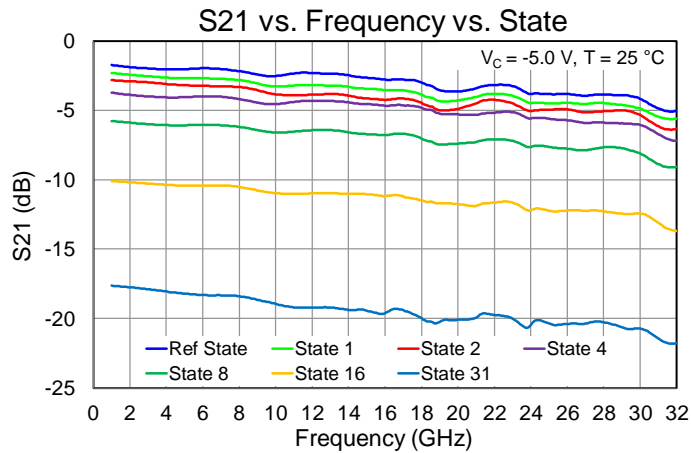
### Performance Plots – Small Signal

Test conditions unless otherwise noted: Tested with DUT on EVB

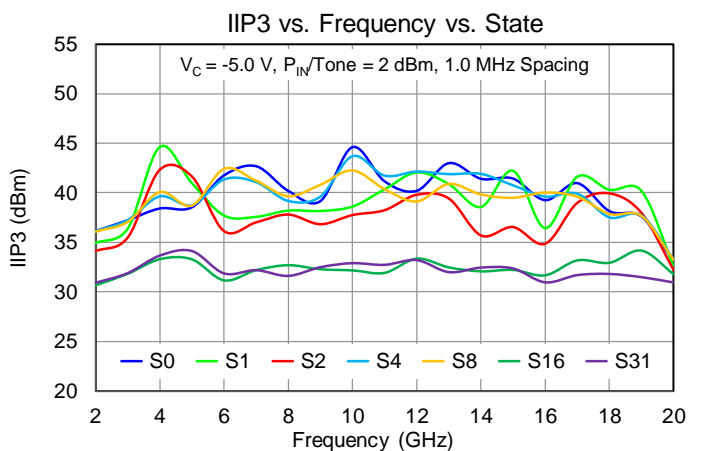
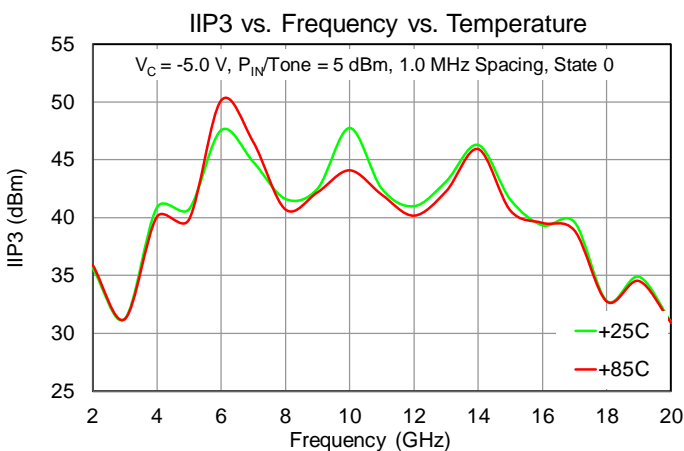
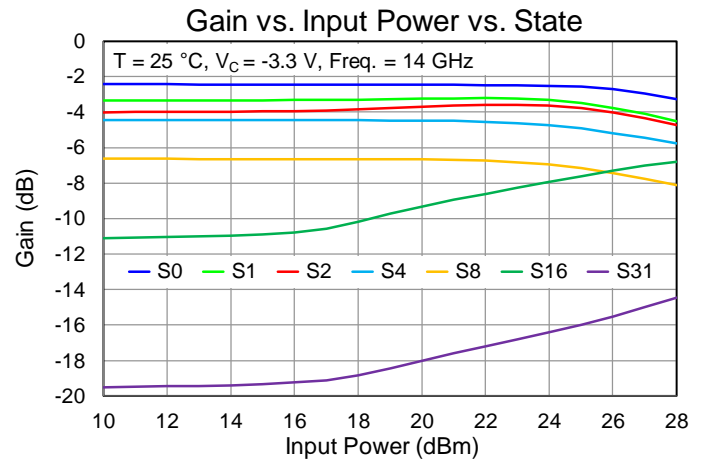
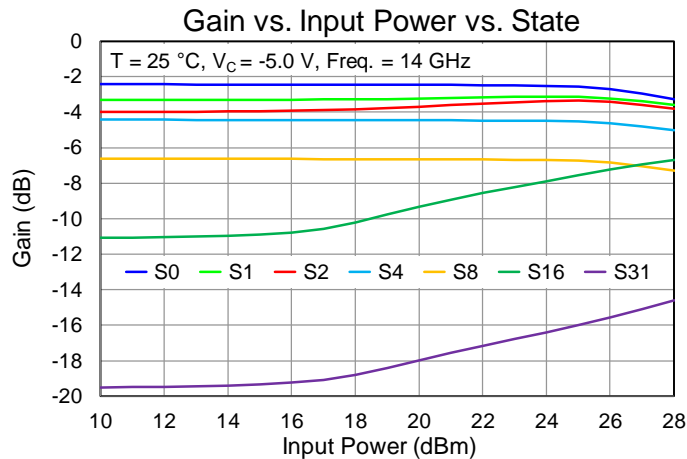
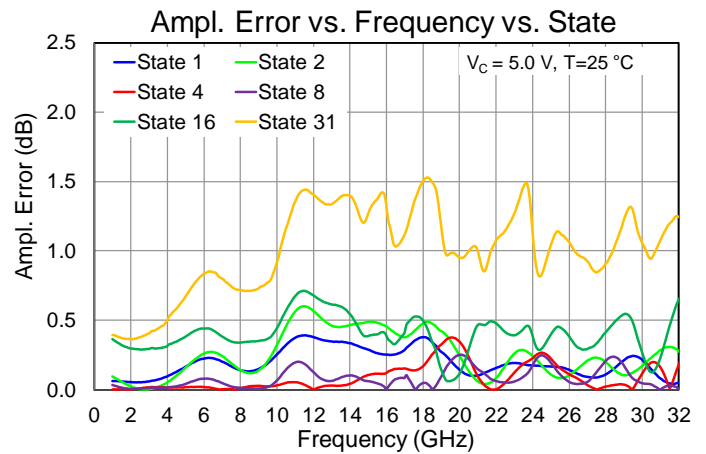
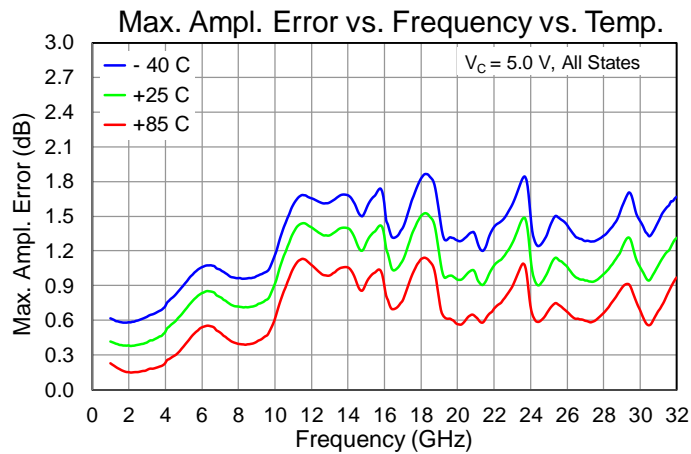


### Performance Plots – Small Signal

Test conditions unless otherwise noted: Tested with DUT on EVB



### Performance Plots – Small, Large Signal & Linearity



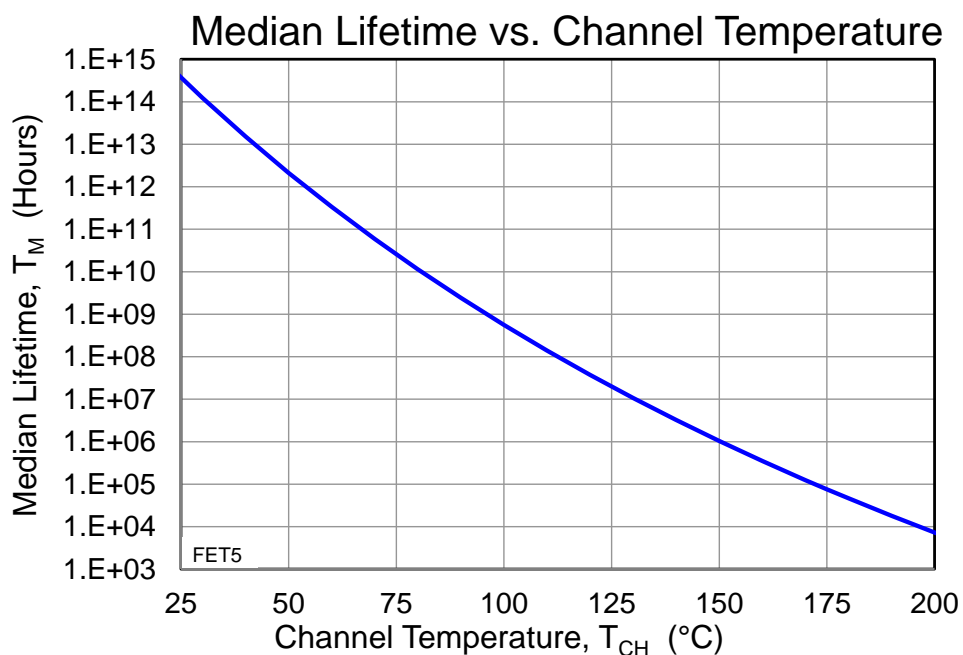
### Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance ( $\theta_{JC}$ ) <sup>(1)</sup>	$T_{BASE} = 85\text{ }^{\circ}\text{C}$ , $V_C = -5.0\text{ V}$ , $P_{DISS} = 0.222\text{ W}$	103.6	$^{\circ}\text{C/W}$
Channel Temperature ( $T_{CH}$ )		108	$^{\circ}\text{C}$
Median Lifetime ( $T_M$ )		2.24E+8	Hrs

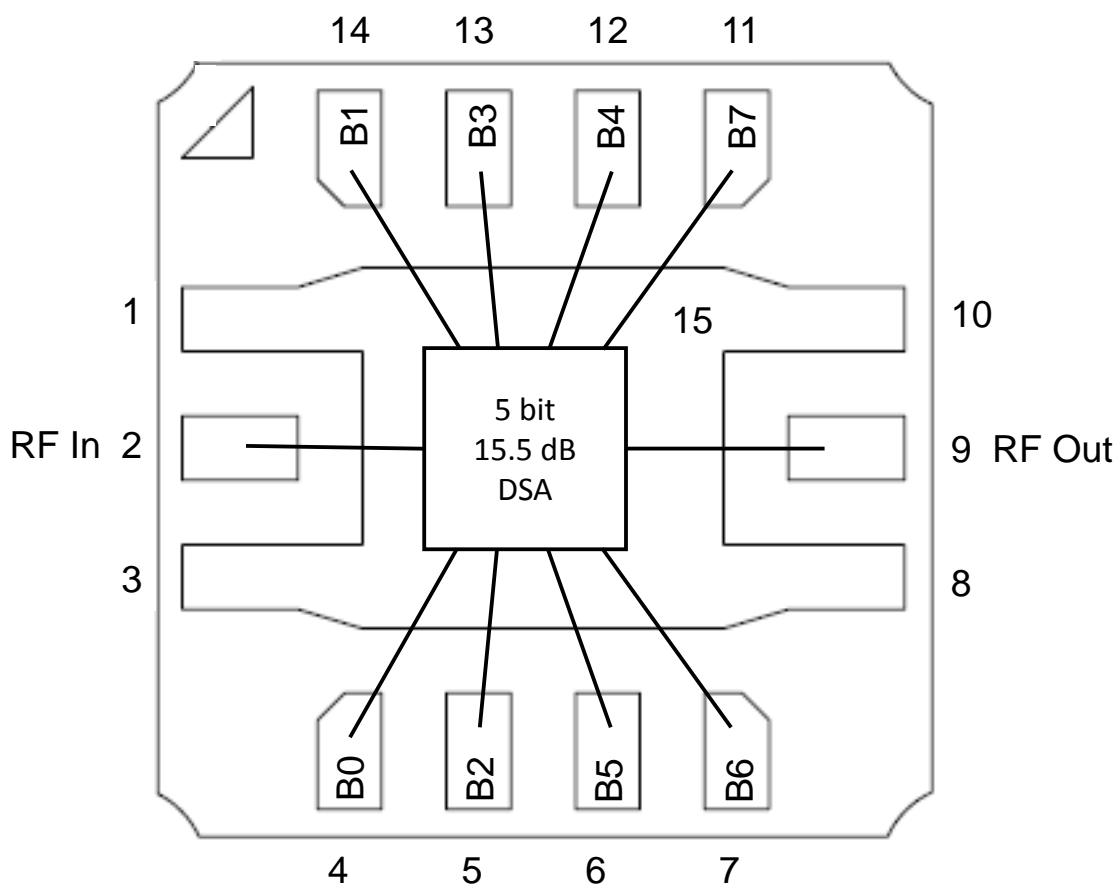
1. Package base backside temperature fixed at 85  $^{\circ}\text{C}$ .

### Median Lifetime

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



## Applications Circuit



## Function Table – Major States

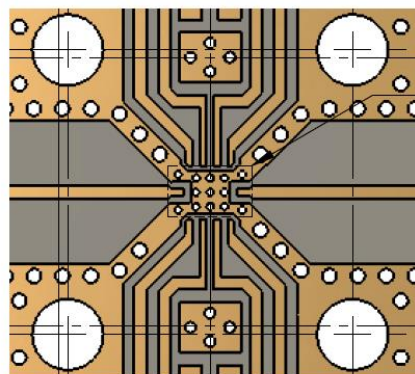
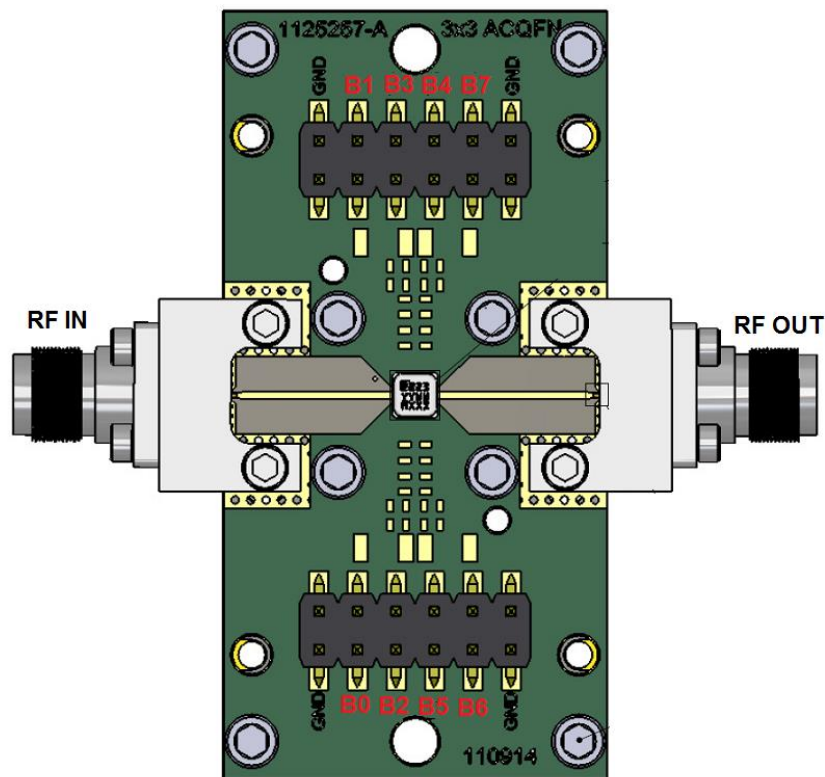
Parameter	State	B0	B1	B2	B3	B4	B5	B6	B7
0.0 dB Attenuation (Ref. State)	State 0	1	0	0	0	1	0	1	0
0.5 dB Attenuation	State 1	1	0	1	0	1	0	1	0
1.0 dB Attenuation	State 2	1	0	0	0	1	1	1	0
2.0 dB Attenuation	State 4	1	0	0	1	0	0	1	0
4.0 dB Attenuation	State 8	1	0	0	0	1	0	0	1
8.0 dB Attenuation	State 16	0	1	0	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,  $\epsilon_r = 3.38$ . 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.

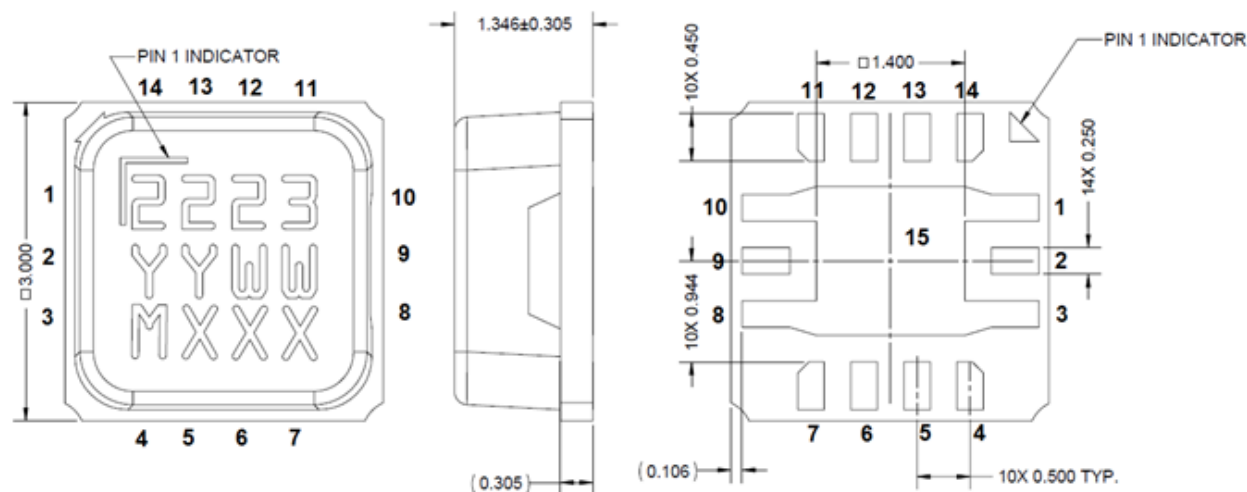
Reference plane is at the package.

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.



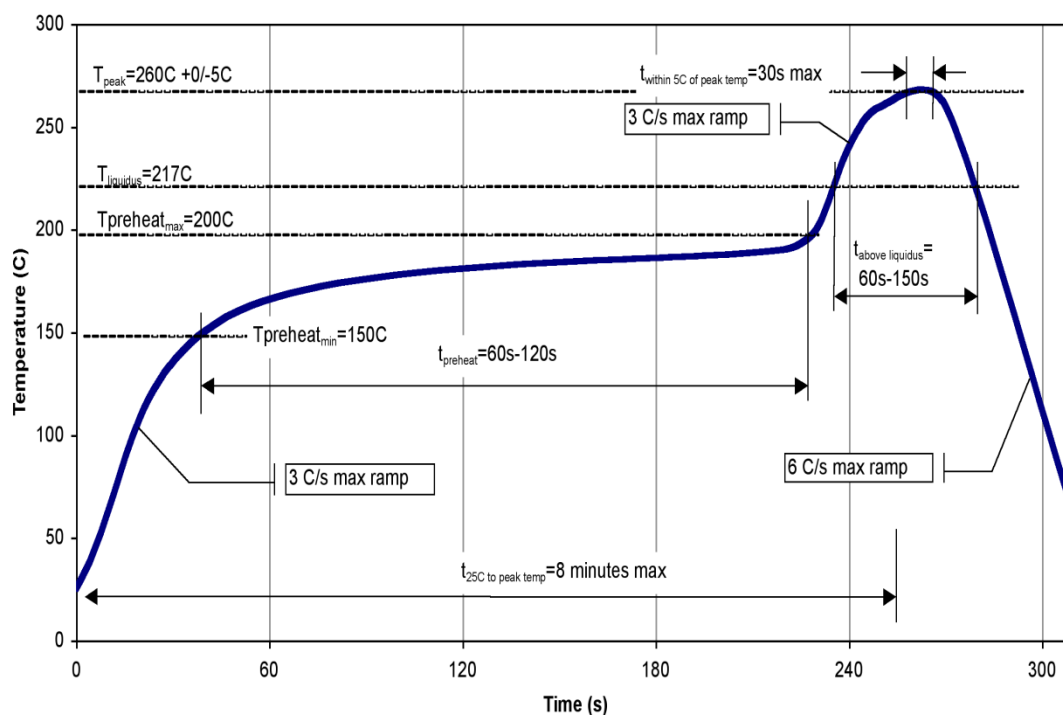
NOTES:  
 1. PACKAGE BASE: CERAMIC  
 2. PACKAGE LID: PLASTIC  
 3. ALL METALIZED FEATURES ARE GOLD PLATED.  
 4. THE PART IS EPOXY SEALED  
 5. PART MARKING:  
 2223: PART NUMBER  
 YY: PART ASSY YEAR  
 WW: PART ASSY WEEK  
 MXXX: BATCH ID

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

### Solderability

1. Compatible with the latest version of J-STD-020, Lead-free solder, 260 °C
2. The use of no-clean solder to avoid washing after soldering is recommended.
3. Package lead plating: NiAu

### Recommended Soldering Profile



### Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 0A	ESDA / JEDEC JS-001-2012
ESD – Charge Device Model (CDM)	Class C1	EIA/JESD22-C101E
MSL – Moisture Sensitivity Level	Level 3	IPC/JEDEC J-STD-020



Caution!  
ESD-Sensitive Device

### 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<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) 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](http://www.qorvo.com)

**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

For technical questions and application information: **Email:** [appsupport@qorvo.com](mailto:appsupport@qorvo.com)

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