TGL2226-SM

0.1 – 15GHz 6-Bit Digital Attenuator

Product Description

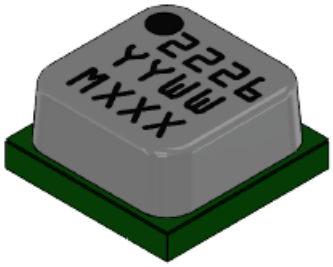
Qorvo's TGL2226–SM is a wideband, 6–bit digital attenuator fabricated using Qorvo's production 0.15um GaAs pHEMT process (QPHT15). Operating from 0.1–15 GHz, the TGL2226–SM offers a low LSB of 0.5 dB and provides 31.5 dB of attenuation range while supporting low insertion loss and RMS attenuation errors.

Using standard, negative control voltages from −3.0 V to −5.0 V coupled with excellent broadband performance, the TGL2226–SM is ideal for supporting a variety of commercial and military applications.

The TGL2226–SM is packaged in a 3.0 x 3.0 mm surface mount package, with both RF ports matched to 50 ohms for simple system integration.

Lead-free and RoHS compliant.

Evaluation Boards available on request.

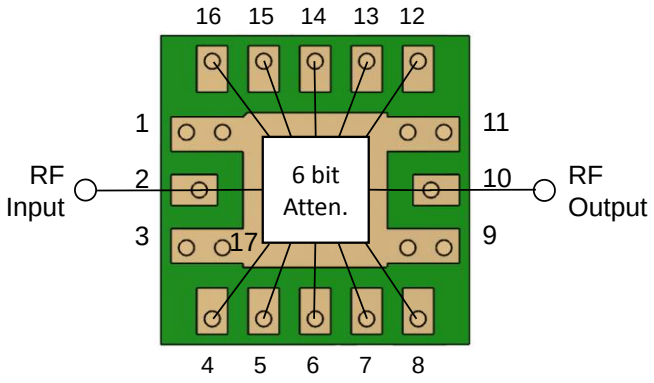


Product Features

- Frequency Range: 0.1 – 15 GHz
- 6-Bit Digital Attenuator
- Attenuation Step Size (LSB): 0.5 dB
- Attenuation Range: 31.5 dB
- Insertion Loss (Ref. State): 3.0 – 4.0 dB
- RMS Attenuation Error: < 2.2 dB
- Control Voltage: -3.0 to 5.0 V
- Package Size: 3.0 x 3.0 x 1.5 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.	ECCN	Description
TGL2226-SM	EAR99	0.1–15 GHz 6-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	0.1	–	15	GHz
LSB Attenuation		0.5		dB
Attenuation Range		31.5		dB
Reference State Insertion Loss: 0.1 – 5 GHz		< 3.0		dB
Reference State Insertion Loss: 5 – 10 GHz		< 3.6		dB
Reference State Insertion Loss: 10 – 15 GHz		< 4.0		dB
Input Return Loss		> 13		dB
Output Return Loss		> 11		dB
IIP3 (Δf= 1.0 MHz, P_{IN}/Tone = 5 dBm, 8 GHz)		> 31.5		dBm
Switching Speed (10%-90%, 90%-10%)		< 30		ns
RMS Attenuation Error		< 2.2		dB
Max. Attenuation Error		< 5.7		dB

Recommended Operating Conditions

Parameter	Value / Range
Control Voltage Logic 0 (L) [1]	-5 V
Control Voltage Logic 1 (H)	0 V

[1] Control voltage down to −3.0V is acceptable

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

Absolute Maximum Ratings

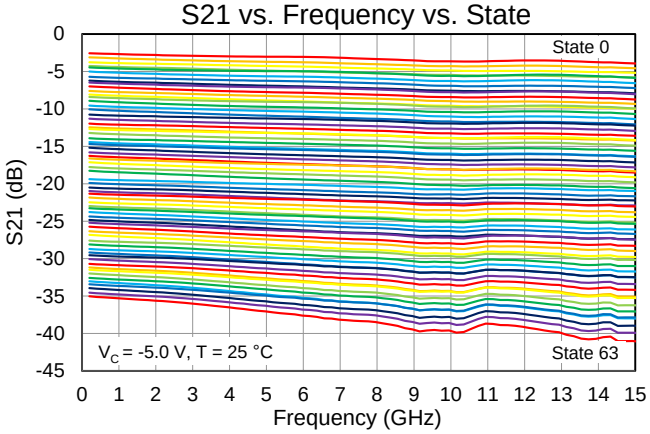
Parameter	Value / Range
Control Voltage (V_C)	-6 V
Control Current (I_C)	1 mA
Input Power, (P_{IN})	23 dBm
Power Dissipation (P_{DISS})	0.7 W
Operating Channel Temperature (T_{CH})	150 °C

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.

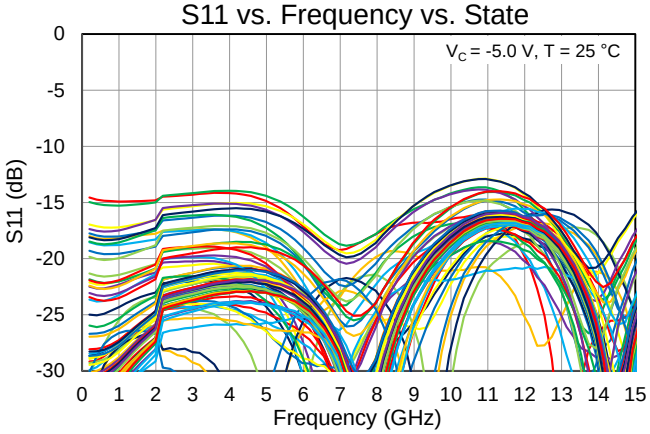
Performance Plots – Small Signal

2 GHz discontinuity on S11 & S22 plots are due to calibration artifact

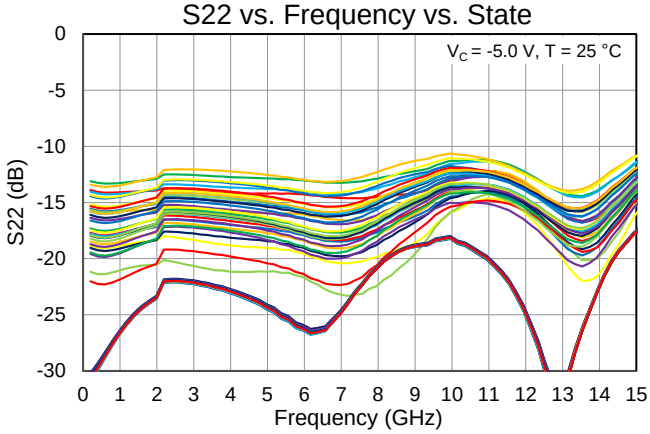
S21 vs. Frequency vs. State



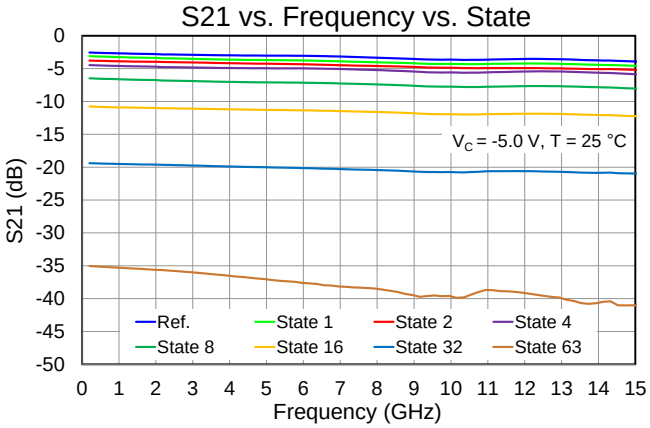
S11 vs. Frequency vs. State



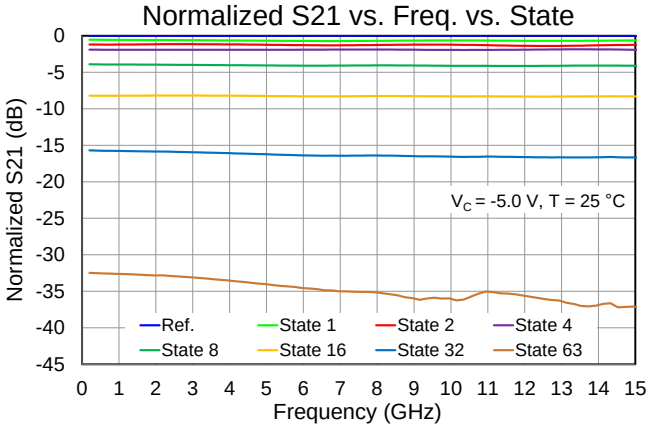
S22 vs. Frequency vs. State



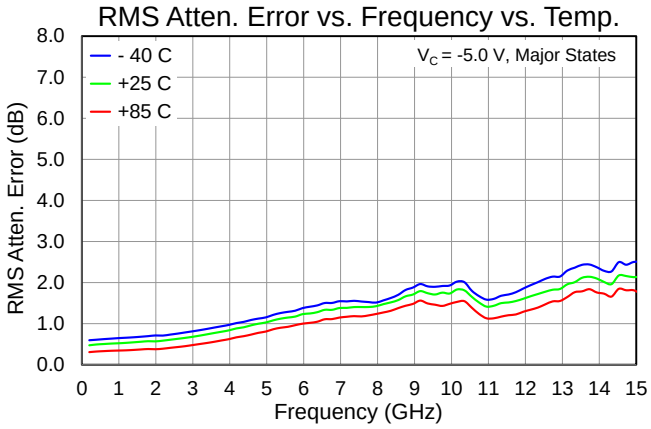
S21 vs. Frequency vs. State

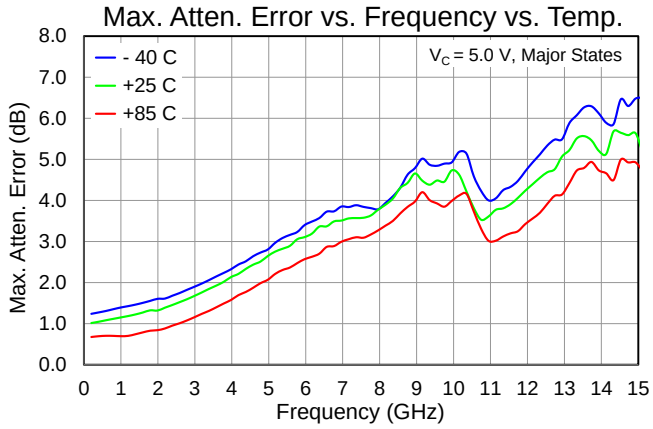


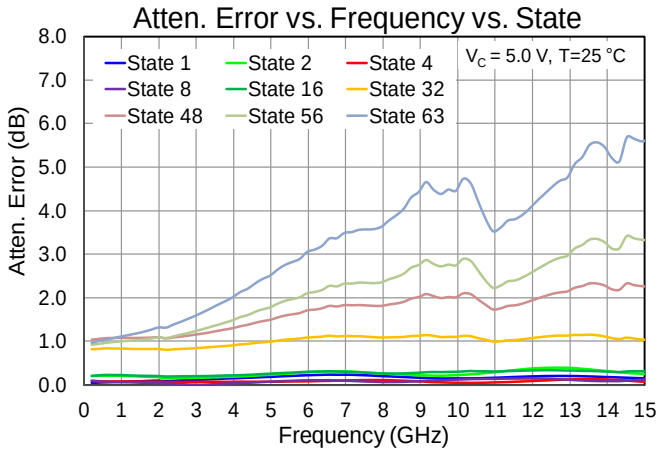
Normalized S21 vs. Freq. vs. State

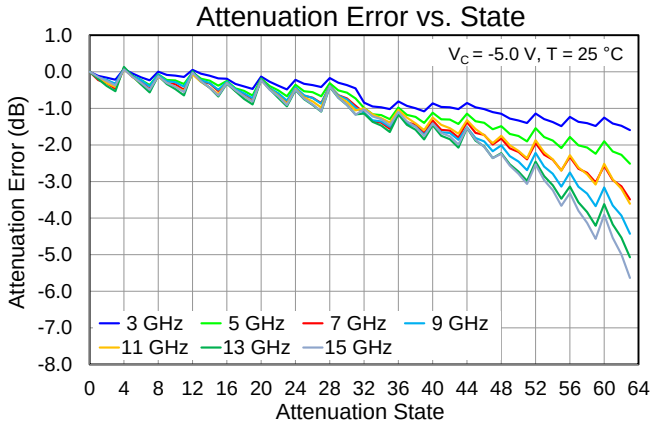


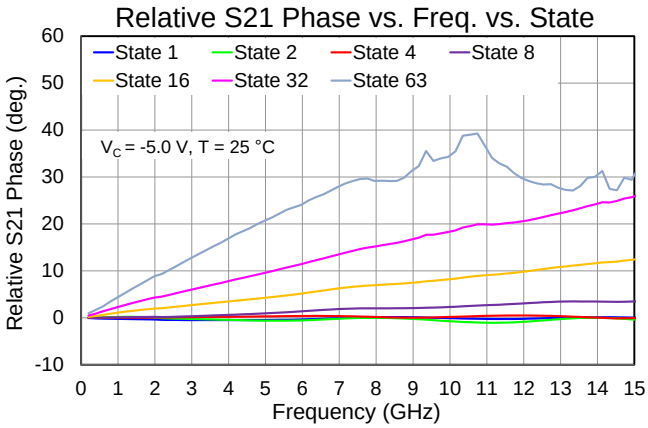
Performance Plots – Small Signal



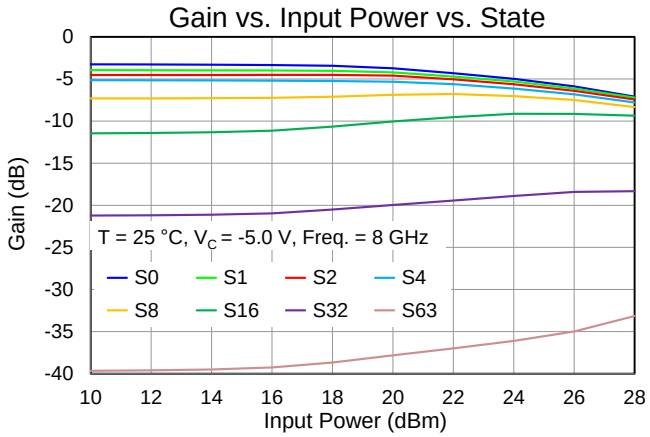


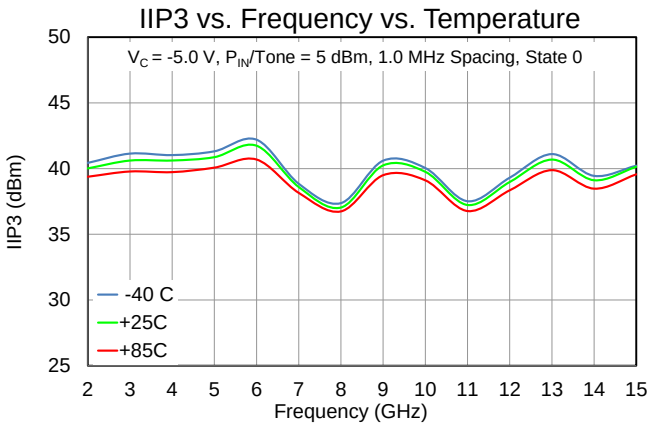


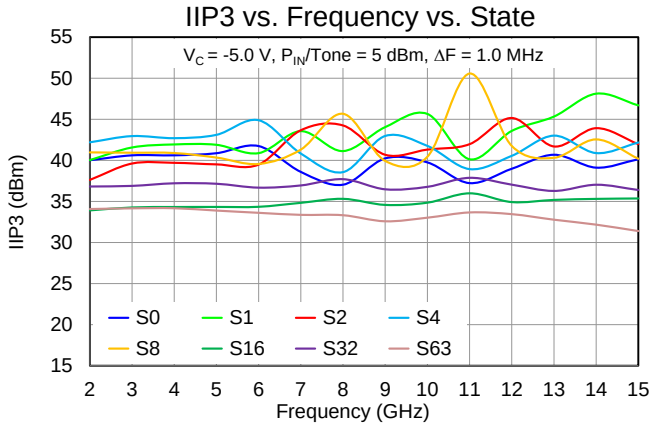




Performance Plots – Large Signal & Linearity







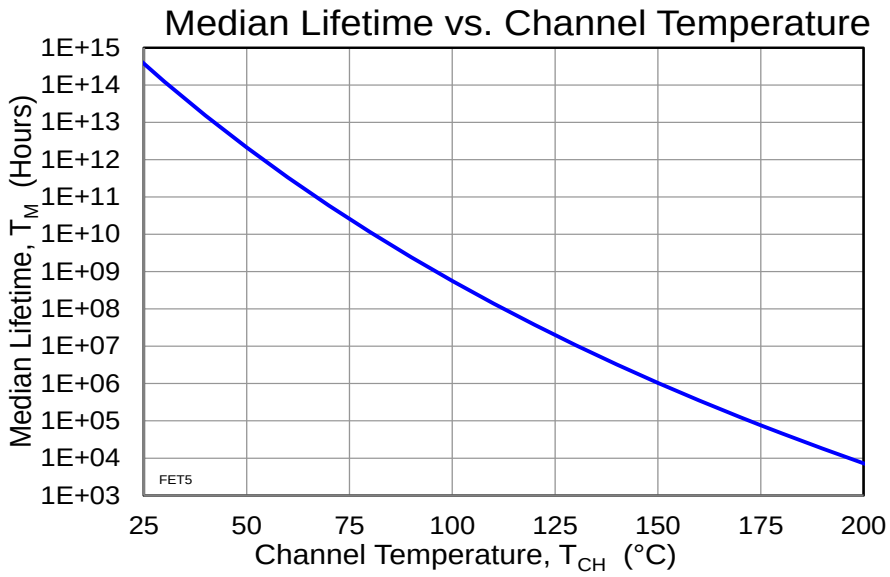
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Thermal Resistance (θ_{JC}) (1)	T_{BASE} = 85 °C, V_C = -5.0 V, P_{IN} = 23 dBm, P_{DISS} = 0.105 W	56.9	°C/W
Channel Temperature (T_{CH})		102	°C
Median Lifetime (T_M)		5.6E+8	Hrs

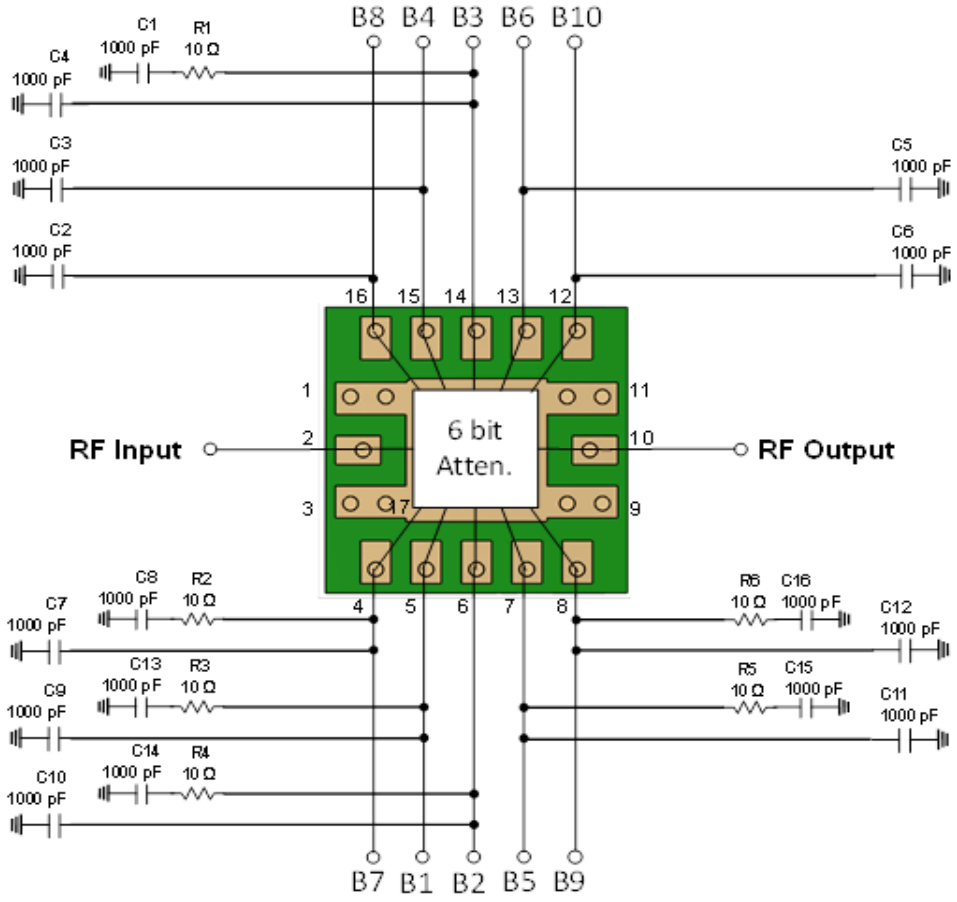
1. Package base backside temperature fixed at 85 °C.

Median Lifetime

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



Applications Circuit



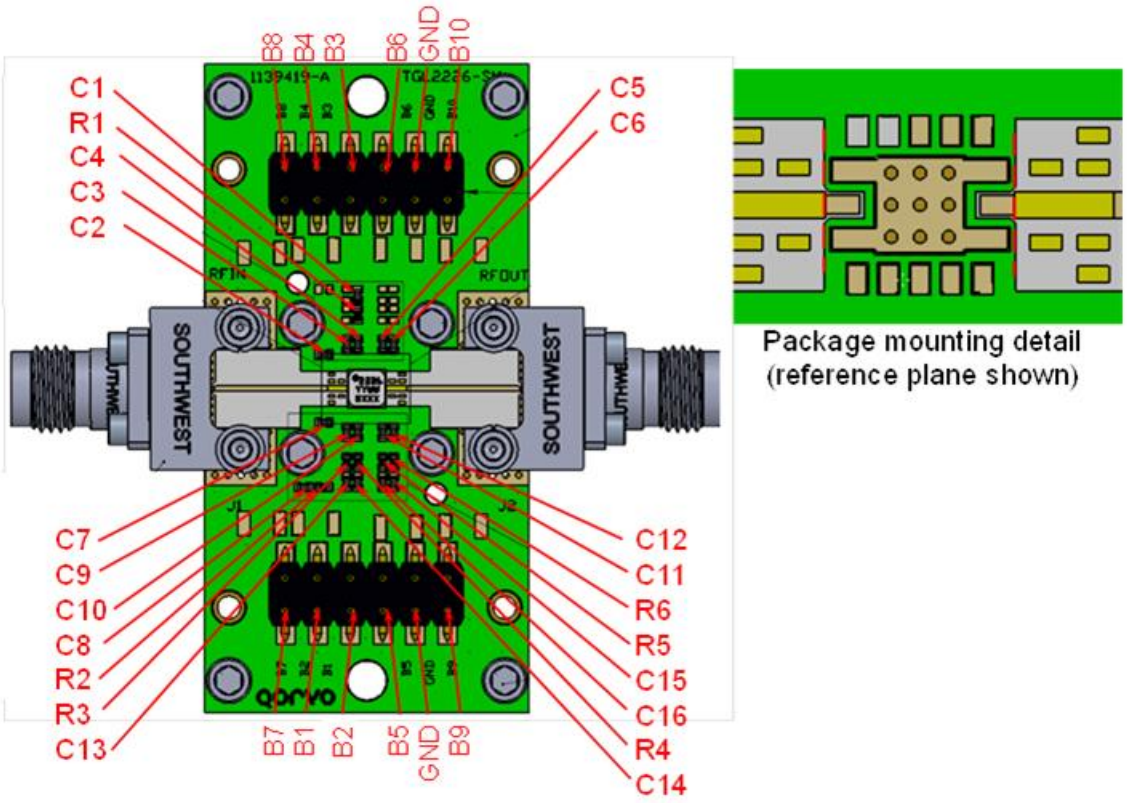
Function Table – Major States

Parameter	State	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
0.0 dB Attenuation (Ref. State)	State 0	0	0	1	0	1	0	1	0	1	0
0.5 dB Attenuation	State 1	1	0	1	0	1	0	1	0	1	0
1.0 dB Attenuation	State 2	0	1	1	0	1	0	1	0	1	0
2.0 dB Attenuation	State 4	0	0	0	1	1	0	1	0	1	0
4.0 dB Attenuation	State 8	0	0	1	0	0	1	1	0	1	0
8.0 dB Attenuation	State 16	0	0	1	0	1	0	0	1	1	0
16.0 dB Attenuation	State 32	0	0	1	0	1	0	1	0	0	1
24.0 dB Attenuation	State 48	0	0	1	0	1	0	0	1	0	1
28.0 dB Attenuation	State 56	0	0	1	0	0	1	0	1	0	1
31.5 dB Attenuation	State 63	1	1	0	1	0	1	0	1	0	1

Intermediate attenuation states are combinations of the above major states.
Logic 1 (H) = 0 V. Logic 0 (L) = -3.0 to -5.0 V

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

Evaluation Board (EVB) Layout Assembly & Mounting Detail



RF Layer is 0.008” thick Rogers Corp. RO4003C, er = 3.38. 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.

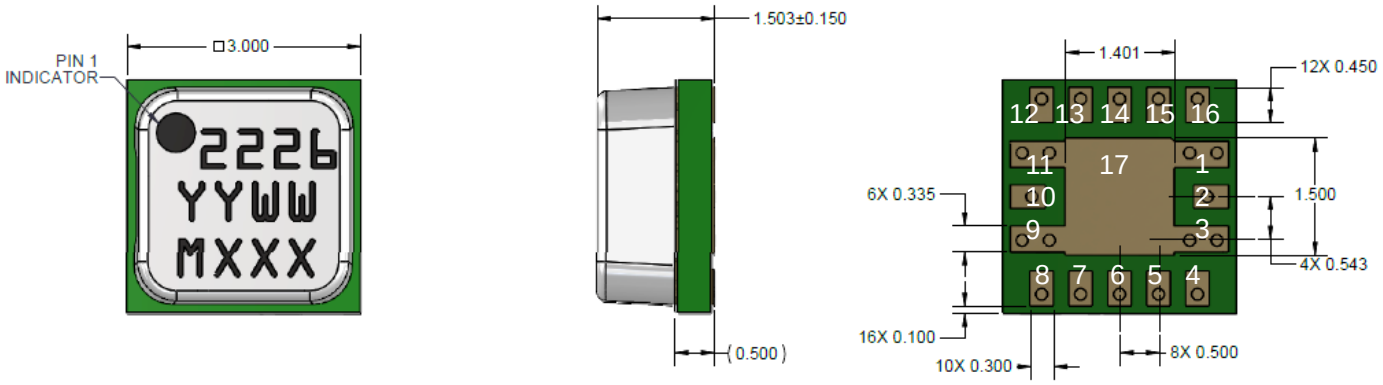
Reference plane is at the package.

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

Bill of Materials for EVB

Reference Des.	Value	Description	Manuf.	Part Number
C1 – C16	1000 pF	CAP, 0402, 50 V, 10 %, X7R	Various	–
R1 – R6	10 Ohm	RES, 0402, 5 %, SMD	Various	–

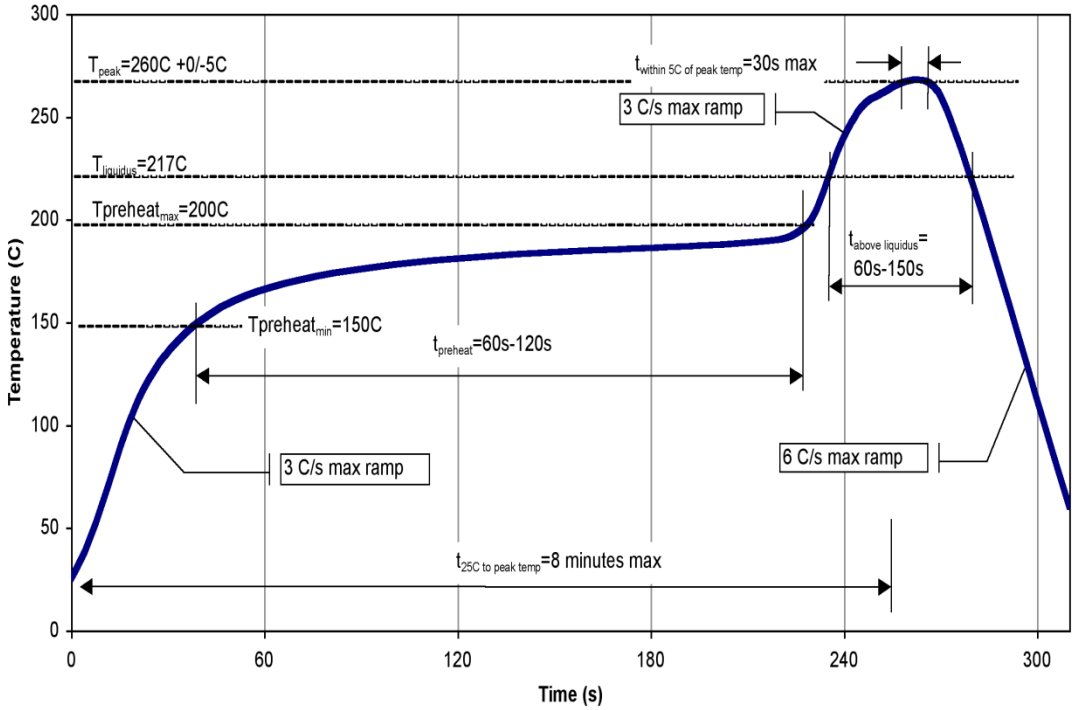
Mechanical Information and Pins Description



PART MARKING:
2226 = PART NUMBER
YY= LOT YEAR
WW = LOT WEEK
MXXX: LOT NUMBER
Dimensions are in millimeters

Pin No.	Symbol	Description
1, 3, 9, 11, 17 (slug)	GND	Ground
2	RF IN	RF Input; Matched to 50 ohms; DC coupled
4	B7	Control Line for 8.0 dB bit (complement of B8)
5	B1	Control Line for 0.5 dB bit
6	B2	Control Line for 1.0 dB bit
7	B5	Control Line for 4.0 dB bit (complement of B6)
8	B9	Control Line for 16.0 dB bit (complement of B10)
10	RF OUT	RF Output; Matched to 50 ohms; DC coupled
12	B10	Control Line for 16.0 dB bit
13	B6	Control Line for 4.0 dB bit
14	B3	Control Line for 2.0 dB bit (complement of B4)
15	B4	Control Line for 2.0 dB bit
16	B8	Control Line for 8.0 dB bit

Recommended Soldering Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 0A	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
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free
- Qorvo Green

Contact Information

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