

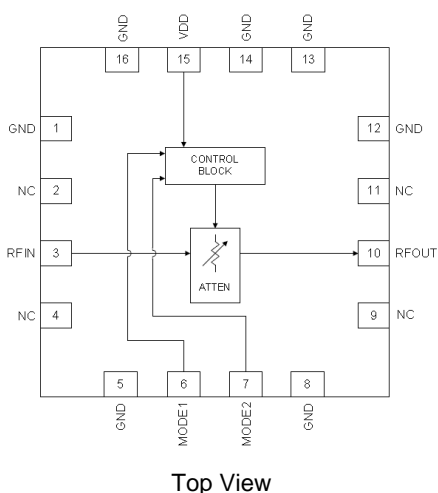
### Product Overview

The RFSA4013 is a monolithic analog temperature compensating attenuator (TCA) featuring exceptional linearity. It is designed to offset the gain reduction of an RF component over temperature without the need for closed loop feedback. Three customer selectable temperature coefficients provide a flexible solution for RF lineups. The RFSA4013 incorporates revolutionary new circuit architecture to solve a long-standing industry problem with regards to attenuator architecture: high IP3, low DC current and broad bandwidth. Traditional approaches require expensive co-fired ceramics with temperature sensitive materials or current hungry PIN diodes with elaborate area consuming control circuits. This temperature compensating attenuator requires only a single supply voltage and two logic bits to set the slope of attenuation versus temperature.

The RFSA4013 draws about 1mA current. This attenuator is internally matched to 50Ω over frequency and working modes with no external matching required.

The RFSA4013 is packaged in a RoHS-compliant, compact 3 mm x 3 mm QFN package.

### Functional Block Diagram



16-Pin mm x 3 mm leadless QFN Package

### Key Features

- Patented Circuit Architecture
- 50 – 6000 MHz Frequency Range
- 3 Selectable Slopes of Attenuation vs. Temperature
- +55 dBm IIP3 Typical
- +85 dBm IIP2 Typical
- High P1dB, > +30 dBm
- Low Current Consumption, 1 mA Typical
- Single 5 Volt DC Supply

### Applications

- Cellular Wireless Infrastructure
- WiBro, WiMax, LTE
- Microwave Radio
- High Linearity Level Control

### Ordering Information

| Part No.        | Description                    |
|-----------------|--------------------------------|
| RFSA4013TR7     | 2500 pcs on 7" reel (standard) |
| RFSA4013PCK-410 | 50 MHz-6.0 GHz Evaluation Kit  |

### Absolute Maximum Ratings

| Parameter                           | Rating         |
|-------------------------------------|----------------|
| Storage Temperature                 | -65 to +150 °C |
| Supply Voltage (VDD)                | -0.5 to +6.0 V |
| Mode Select Pin Voltage (MODE1 & 2) | -0.5 to +6.0 V |
| RF Input Power                      | +30 dBm        |

Operation of this device outside the parameter ranges given above may cause permanent damage.

### Recommended Operating Conditions

| Parameter             | Min   | Typ | Max   | Units |
|-----------------------|-------|-----|-------|-------|
| VDD                   | +4.75 | +5  | +5.25 | V     |
| Operating Temperature | -40   |     | +85   | °C    |
| RF Input Power        |       |     | +27   | dBm   |
| Tj, MTTF > 1e5 hours  |       |     | +125  | °C    |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions. Temperature reference point is 3mm from the corner between pins 16 and 17 on the PCB copper.

### Electrical Specifications

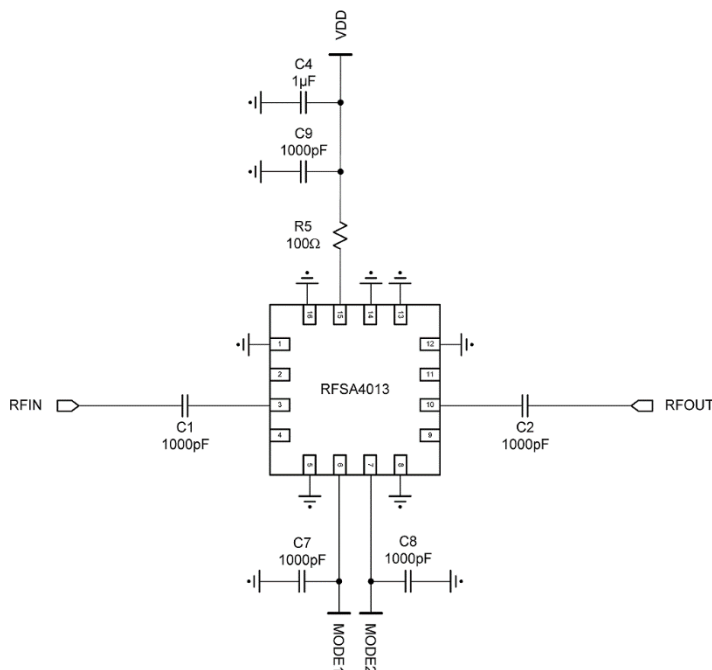
Test conditions unless otherwise noted: VDD = +5V, Temp = +25 °C on Qorvo EVB, 50 Ω system.

| Parameter                       | Conditions                               | Min  | Typ   | Max  | Units |
|---------------------------------|--|------|-------|------|-------|
| Operating Frequency             |  | 50   |       | 6000 | MHz   |
| Test Frequency                  |  |      | 2000  |      | MHz   |
| Attenuation Slope               | MODE1 Low and MODE2 High                 |      | 0.043 |      | dB/°C |
|                                 | MODE1 High and MODE2 High                |      | 0.058 |      | dB/°C |
|                                 | MODE1 High and MODE2 Low                 |      | 0.066 |      | dB/°C |
| Nominal Attenuation at +25°C    | MODE1 Low and MODE2 High                 |      | 5.40  |      | dB    |
|                                 | MODE1 High and MODE2 High                |      | 6.35  |      | dB    |
|                                 | MODE1 High and MODE2 Low                 |      | 7.40  |      | dB    |
| Relative Insertion Phase        |  |      | 3     |      | Deg   |
| Return Loss                     | Input and Output                         |      | 20    |      | dB    |
| Input P1dB                      |  |      | 30    |      | dBm   |
| Input IP3                       | PIN + IMD3(dBc)/2                        | 45   | 55    |      | dBm   |
| Input IP2                       | PIN + IMD2(dBc); IMD2 at F1+F2           |      | 85    |      | dBm   |
| Input IH2                       | PIN + H2(dBc); H2-Second order Harmonic  |      | 87    |      | dBm   |
| Input IH3                       | PIN + H3(dBc)/2; H3-Third order Harmonic |      | 59    |      | dBm   |
| Mode Control Threshold Voltages | MODE1 and MODE2 Logic Low                |      |       | +0.4 | V     |
|                                 | MODE1 and MODE2 Logic High               | +1.0 |       |      |       |

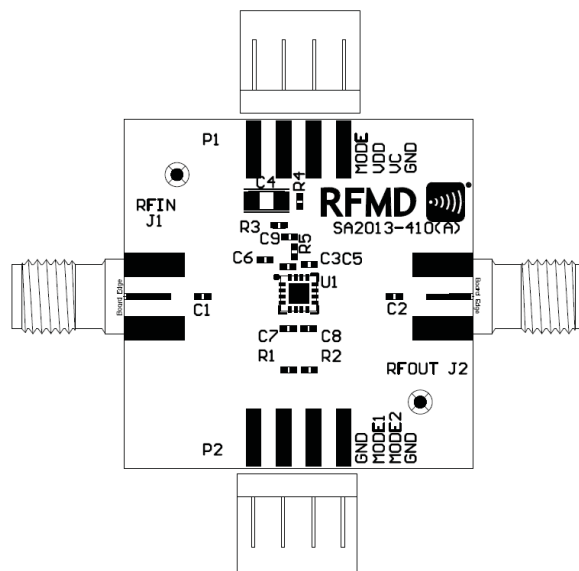
### Attenuation Temperature Coefficient Table

| MODE1 | MODE2 | Attn. Slope   | Attn. @ +25°C |
|-------|-------|---------------|---------------|
| 0     | 1     | 0.043 dB/°C   | 5.40 dB       |
| 1     | 1     | 0.058 dB/°C   | 6.35 dB       |
| 1     | 0     | 0.066 dB/°C   | 7.40 dB       |
| 0     | 0     | Not Supported |               |

## Evaluation Board and Schematic – RFSA4013EVB-01



EVB Schematic



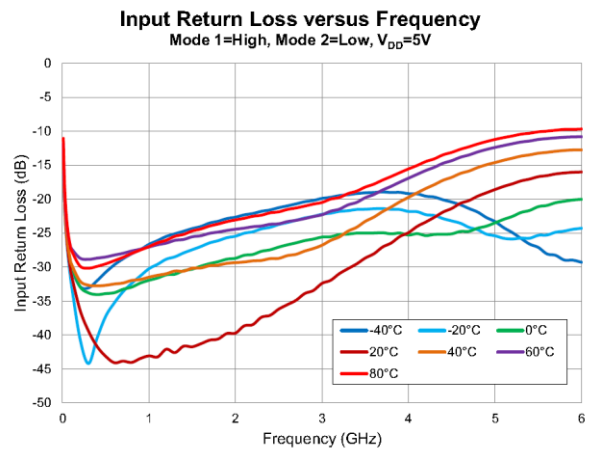
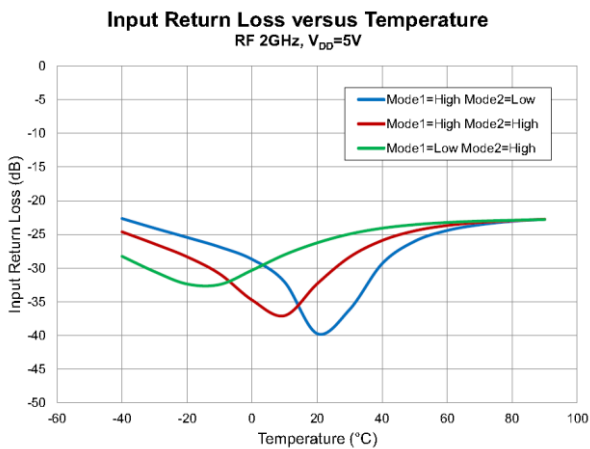
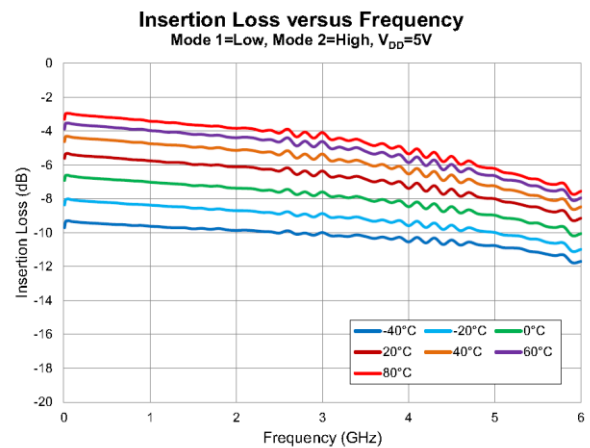
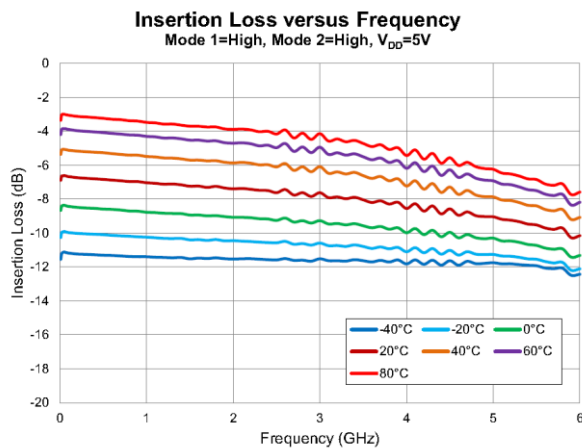
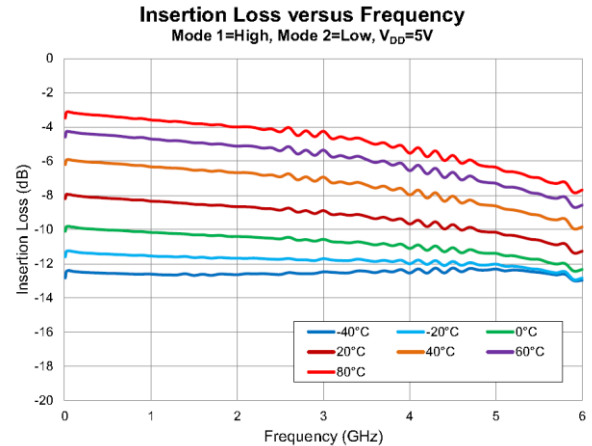
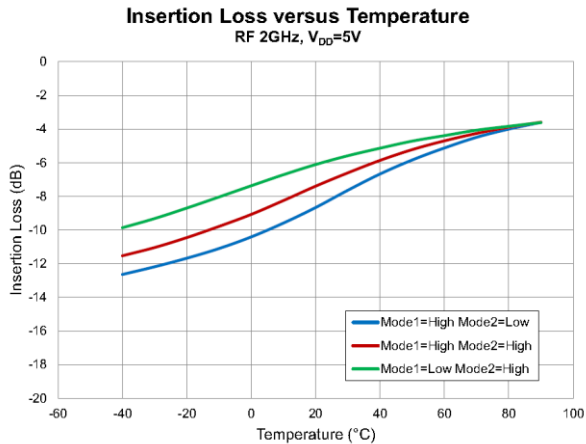
EVB Top View

## Bill of Material – RFSA4013EVB-01

| Reference Des.             | Value   | Description                      | Manuf.  | Part Number        |
|----------------------------|---------|----------------------------------|---------|--------------------|
| U1                         | -       | TCA, 50 to 4000MHz, 5V, SOI      | Qorvo   | RFSA4013           |
| PCB                        | -       | PCB, SA2013                      | Qorvo   | SA2013-410(A)      |
| C1, C2, C7, C8, C9         | 1000 pF | CAP, 1000 pF 10%, 50V, X7R, 0402 | Murata  | GRM155R71H102KA01D |
| C4                         | 1 μF    | CAP, 1 μF 10%, 16V, X7R, 1206    | Murata  | GRM31MR71E105KC01L |
| R5                         | 100 Ω   | RES, 100 Ω, 5%, 1/16W, 0402      | Various | -                  |
| J1, J2                     | SMA     | CON, SMA, EL MINI, 0.068"        | Aliner  | 20-001CF-T         |
| P1, P2                     | -       | CON, HDR ST, 4-PIN, 0.100", T/H  | MOLEX   | 22-28-4043         |
| C3, C5, C6, R1, R2, R3, R4 | DNP     | -                                | -       | -                  |

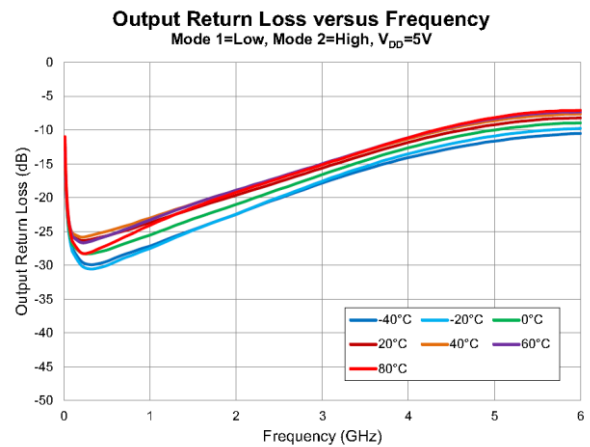
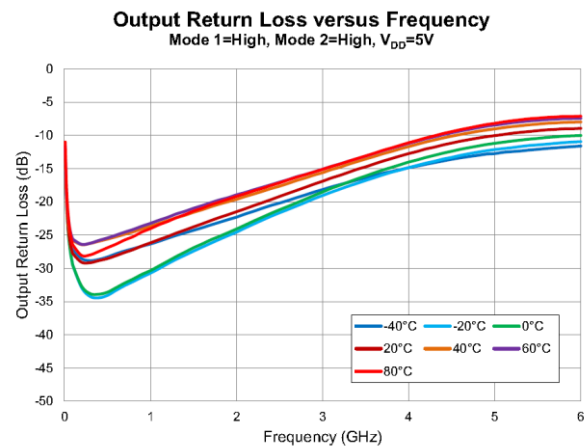
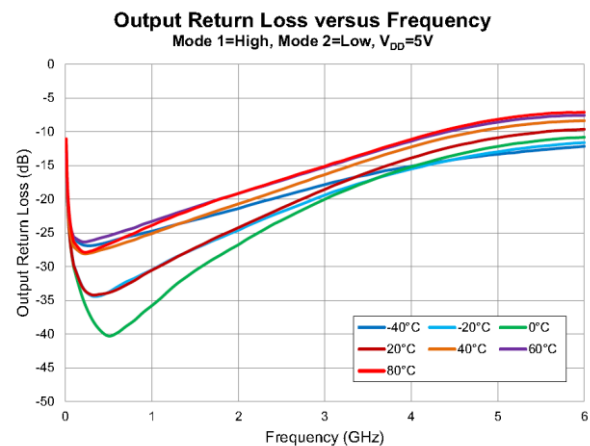
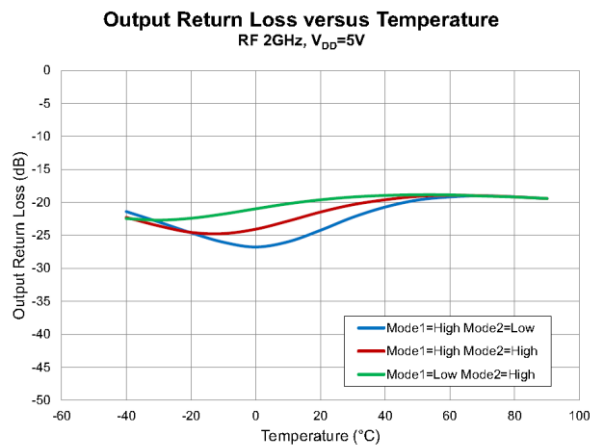
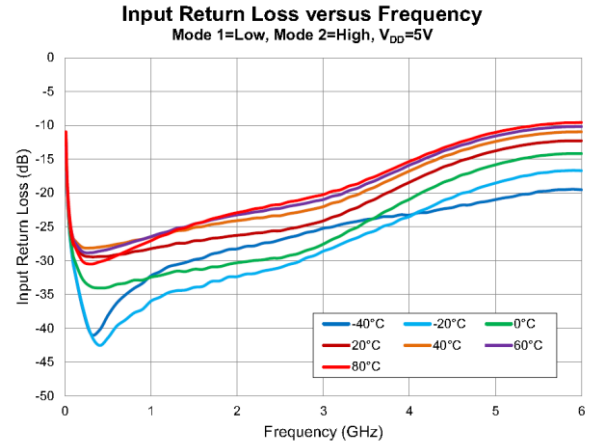
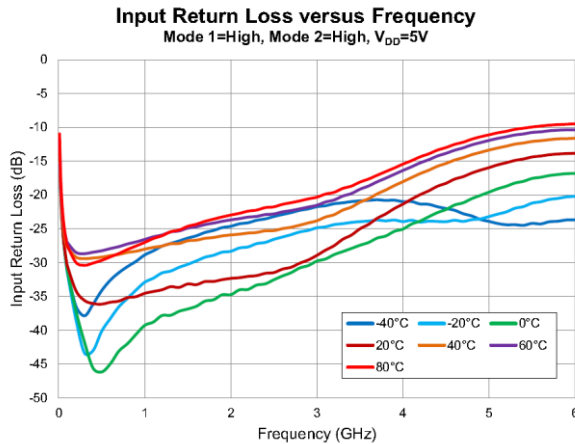
## Performance Plots – RFSA4013PCK-410

Test conditions unless otherwise noted: VDD = +5.0 V, Temp = +25°C, on Qorvo EVB.



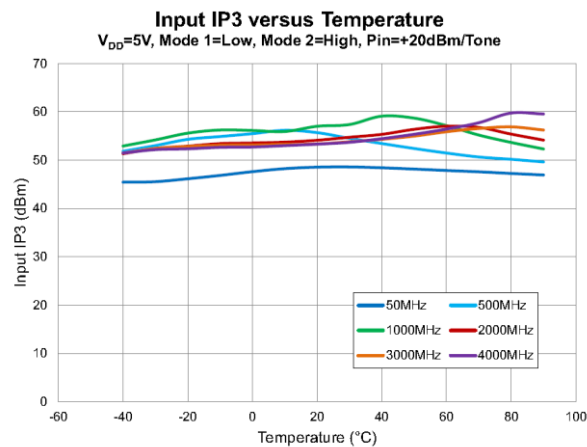
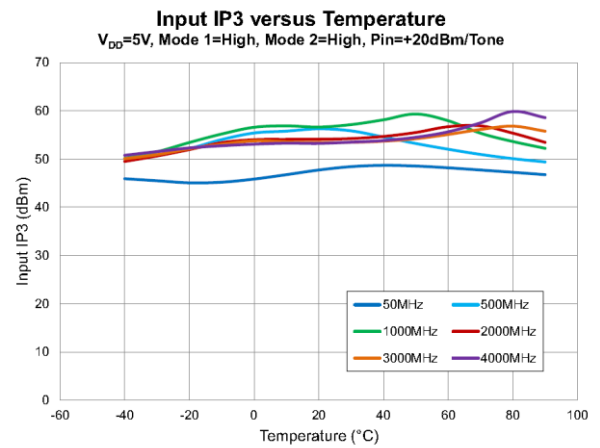
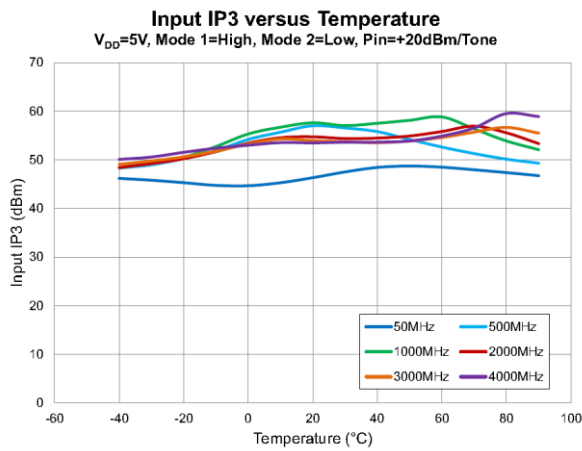
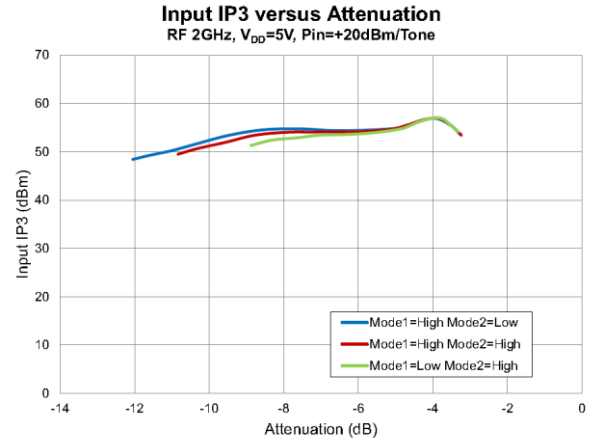
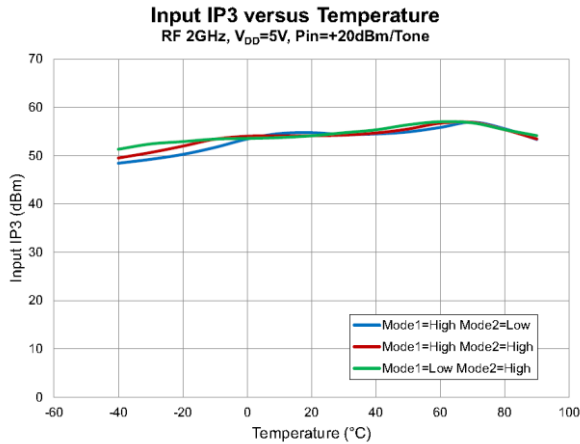
## Performance Plots – RFSA4013PCK-410 (continued 1)

Test conditions unless otherwise noted: VDD = +5.0 V, Temp = +25°C, on Qorvo EVB.



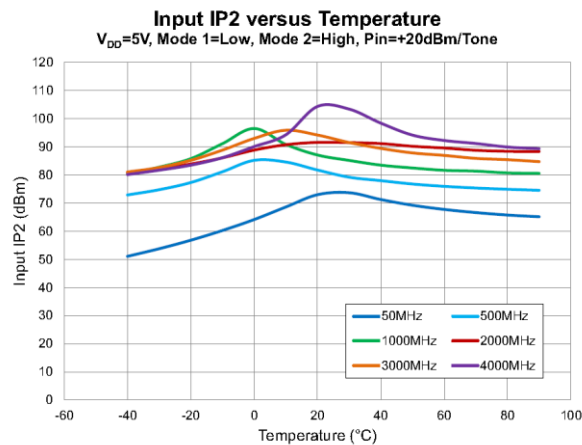
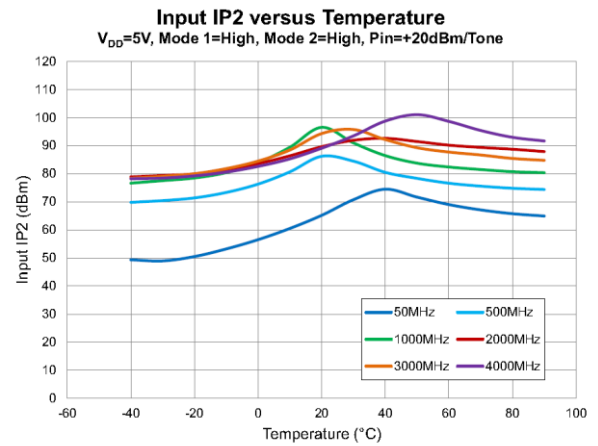
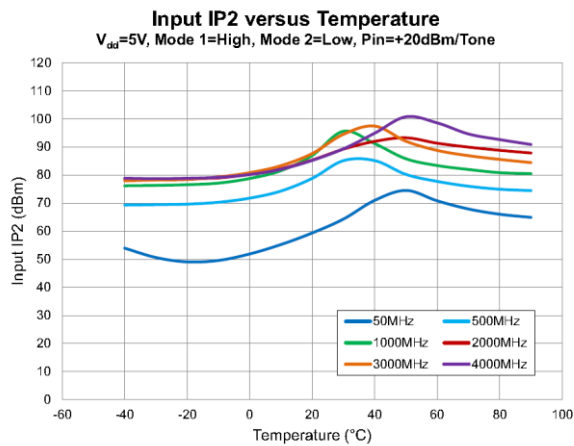
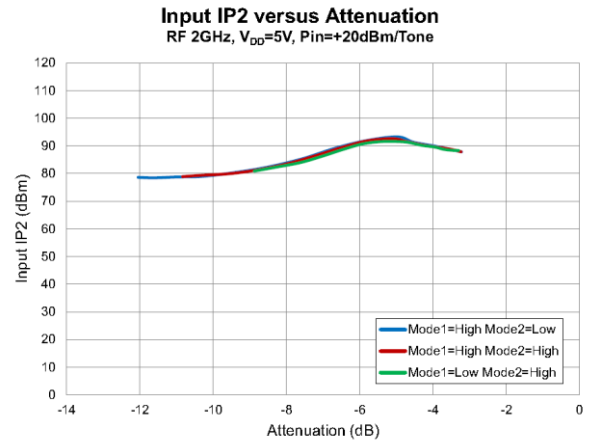
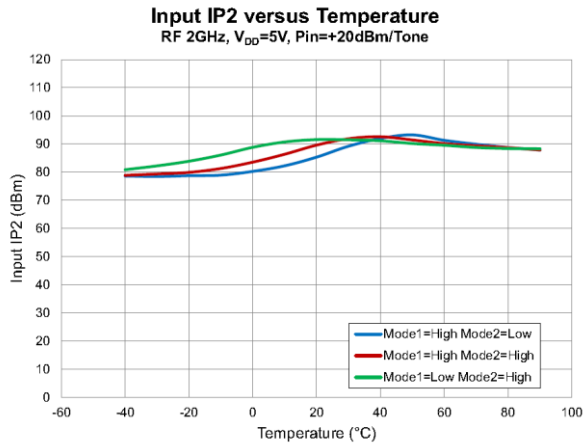
## Performance Plots – RFSA4013PCK-410 (continued 2)

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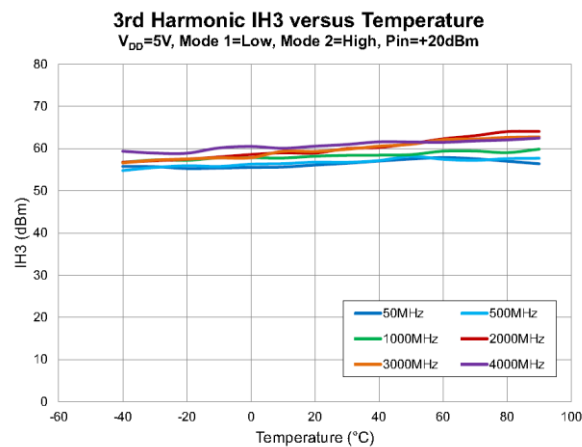
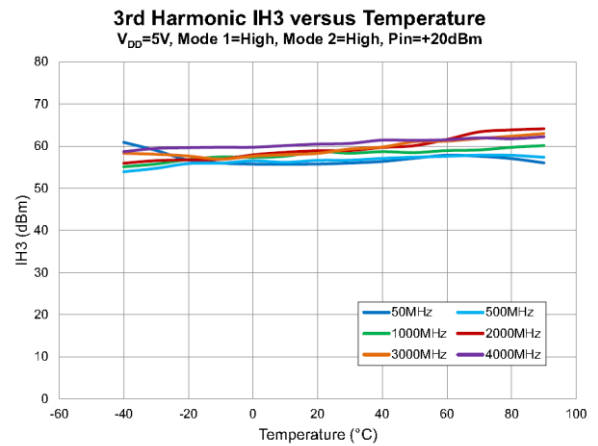
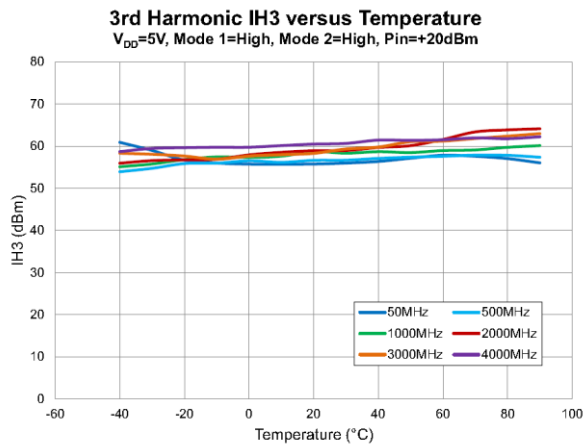
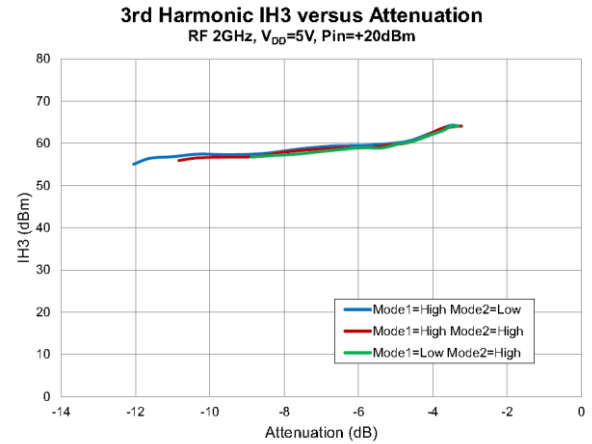
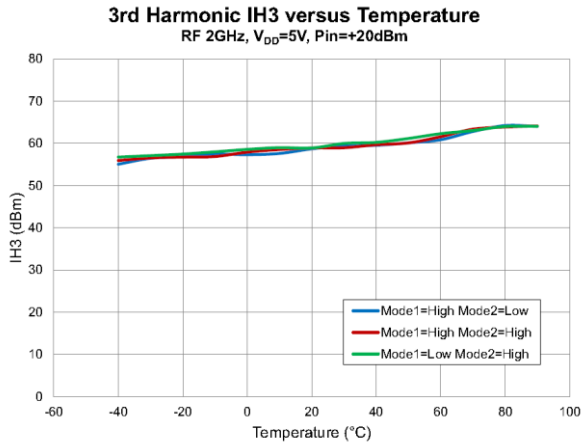
## Performance Plots – RFSA4013PCK-410 (continued 3)

Test conditions unless otherwise noted: VDD = +5.0 V, Temp = +25°C, on Qorvo EVB.



## Performance Plots – RFSA4013PCK-410 (continued 4)

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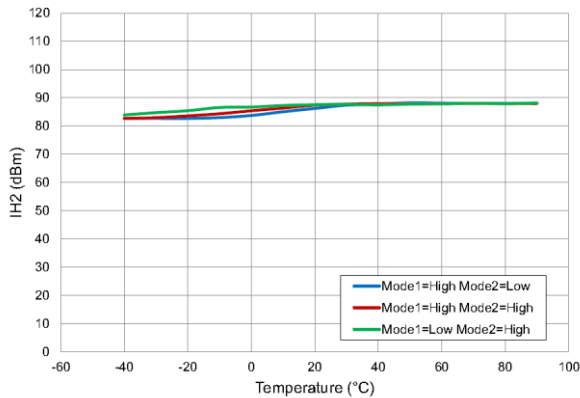




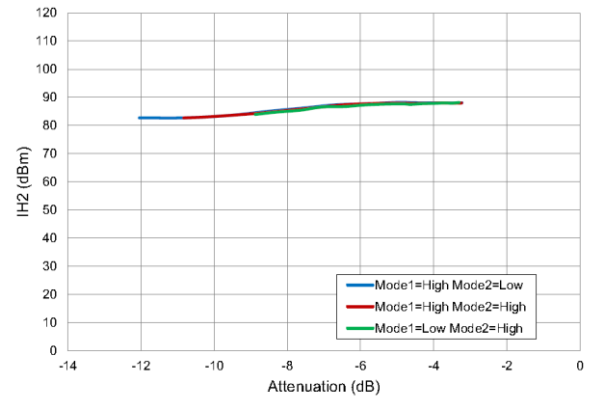
## Performance Plots – RFSA4013PCK-410 (continued 5)

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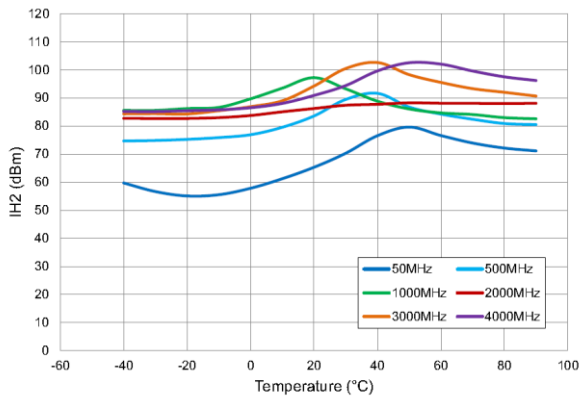
**2nd Harmonic IH2 versus Temperature**  
RF 2GHz, V<sub>DD</sub>=5V, Pin=+20dBm



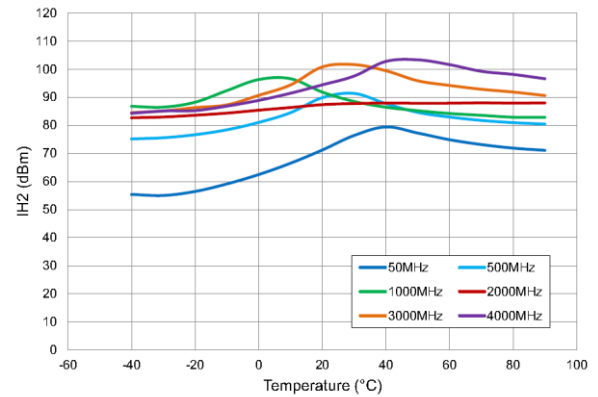
**2nd Harmonic IH2 versus Attenuation**  
RF 2GHz, V<sub>DD</sub>=5V, Pin=+20dBm



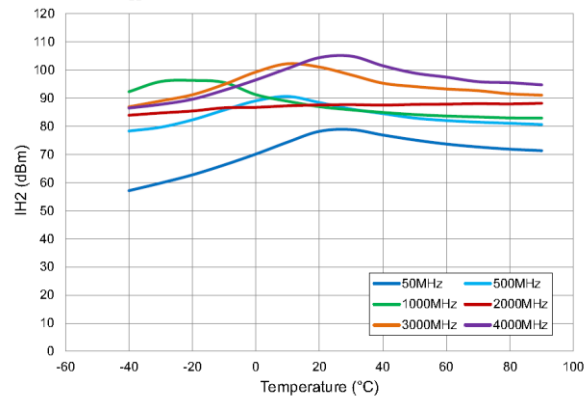
**2nd Harmonic IH2 versus Temperature**  
V<sub>DD</sub>=5V, Mode 1=High, Mode 2=Low, Pin=+20dBm



**2nd Harmonic IH2 versus Temperature**  
V<sub>DD</sub>=5V, Mode 1=High, Mode 2=High, Pin=+20dBm

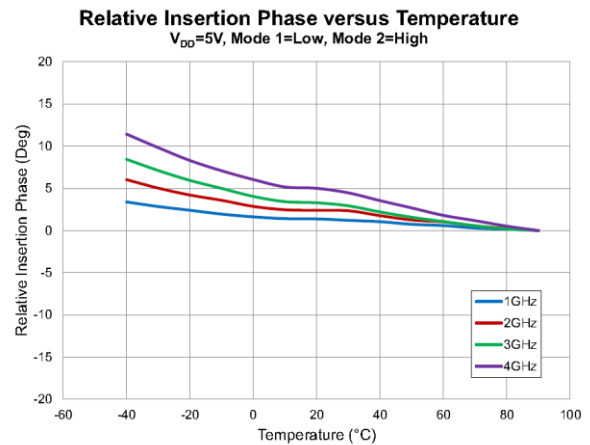
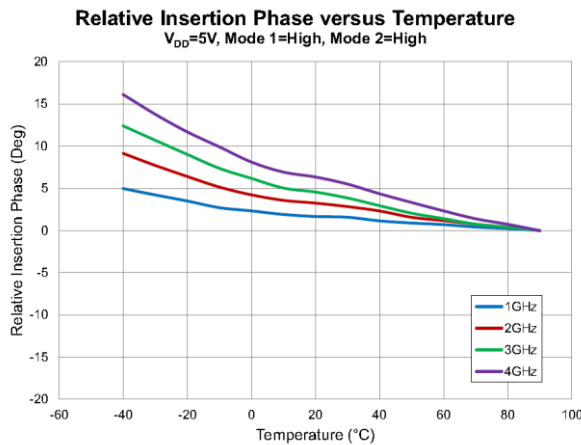
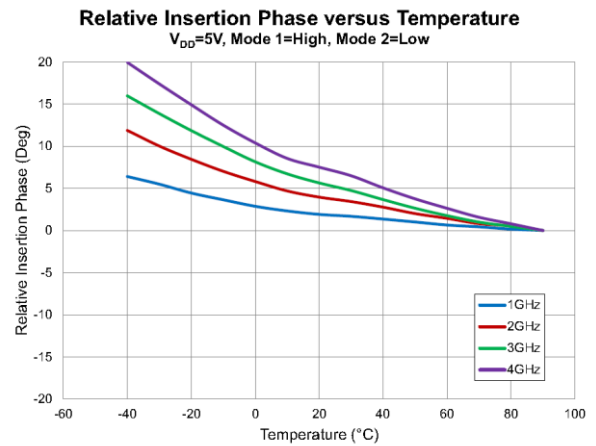
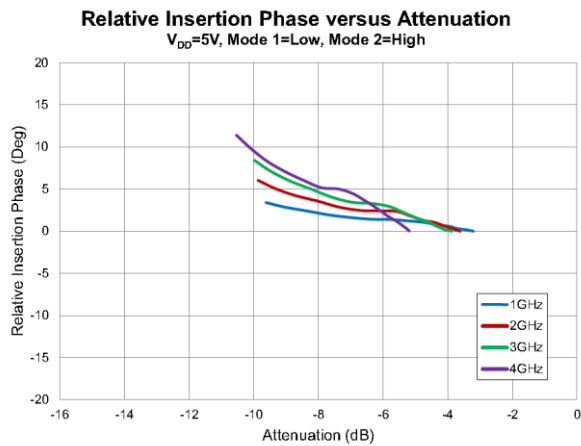
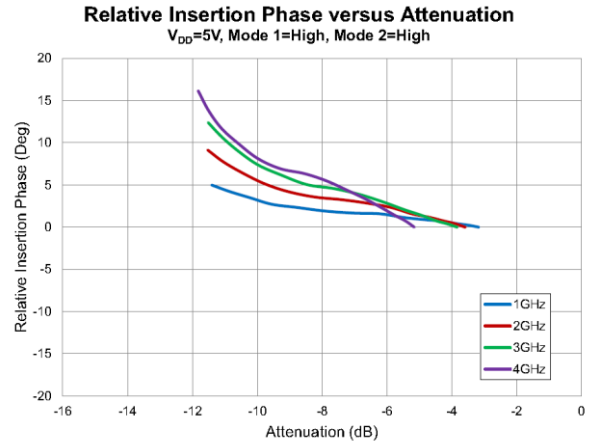
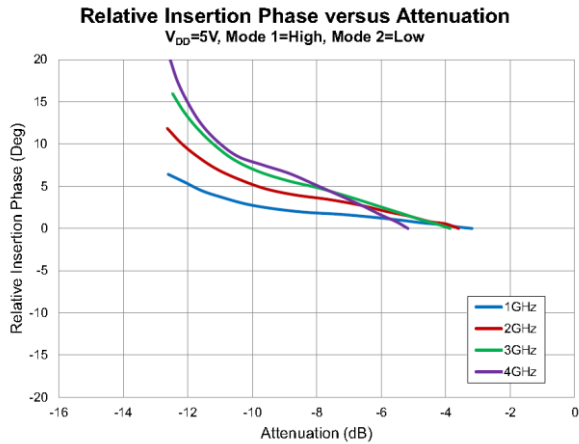


**2nd Harmonic IH2 versus Temperature**  
V<sub>DD</sub>=5V, Mode 1=Low, Mode 2=High, Pin=+20dBm



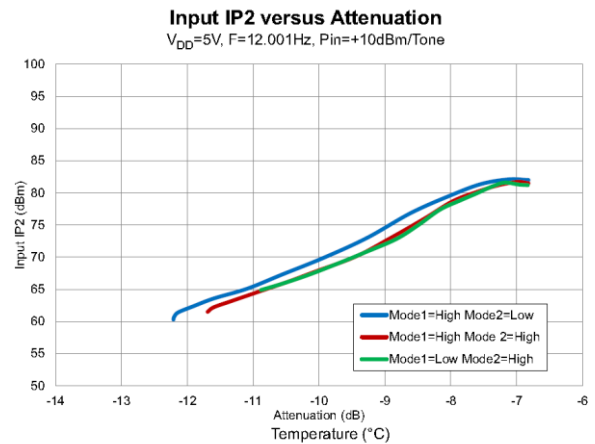
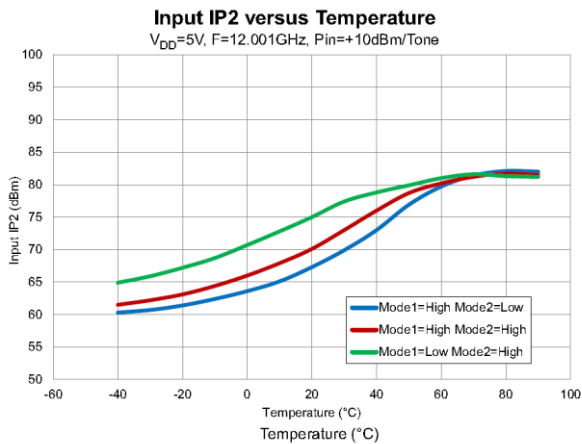
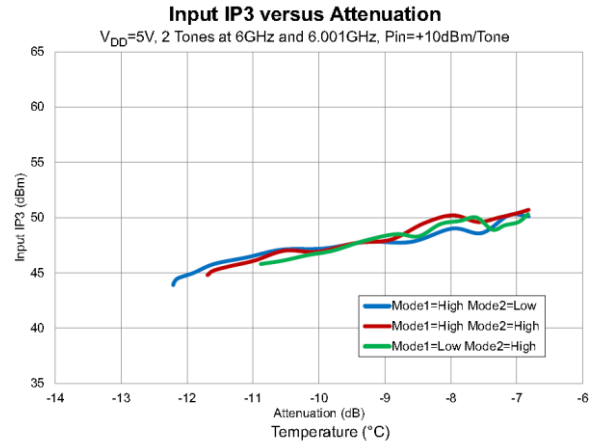
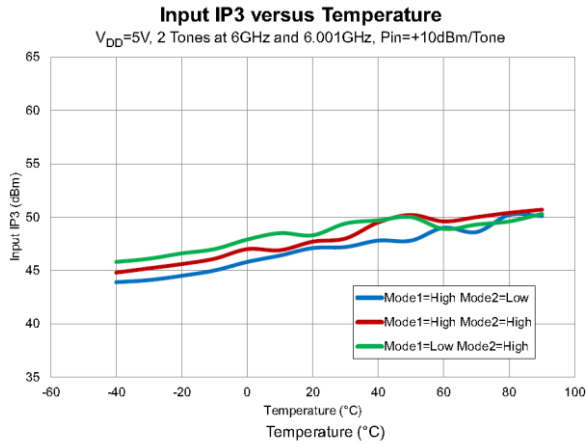
## Performance Plots – RFSA4013PCK-410 (continued 6)

Test conditions unless otherwise noted: VDD = +5.0 V, Temp = +25°C, on Qorvo EVB.



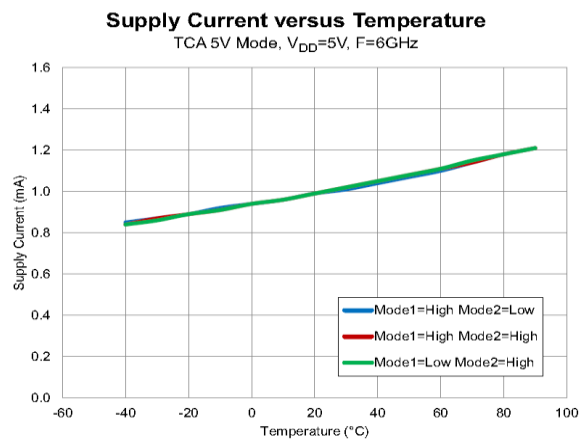
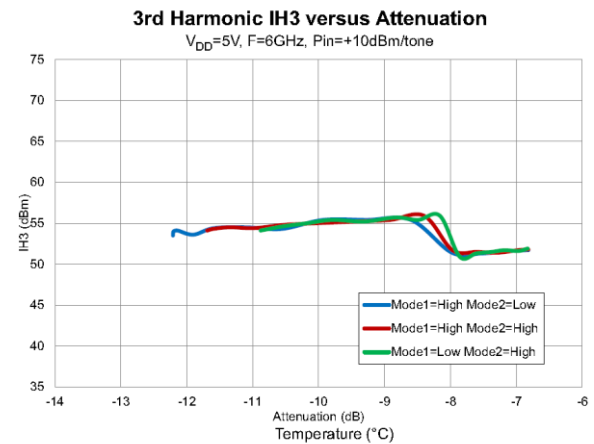
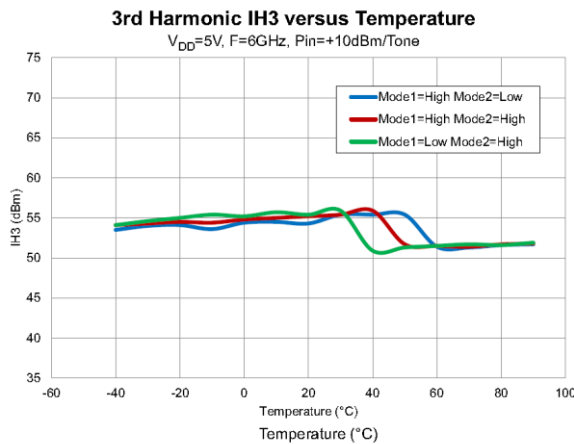
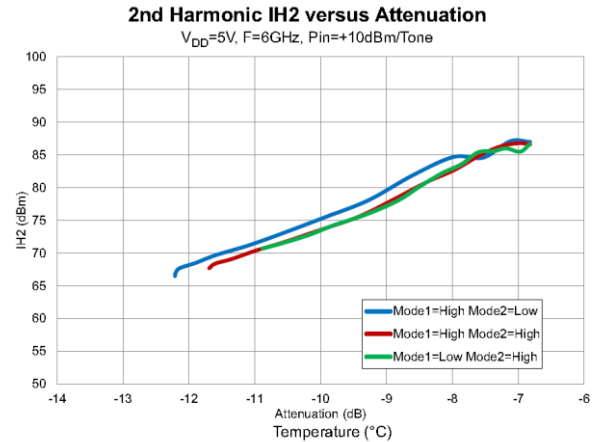
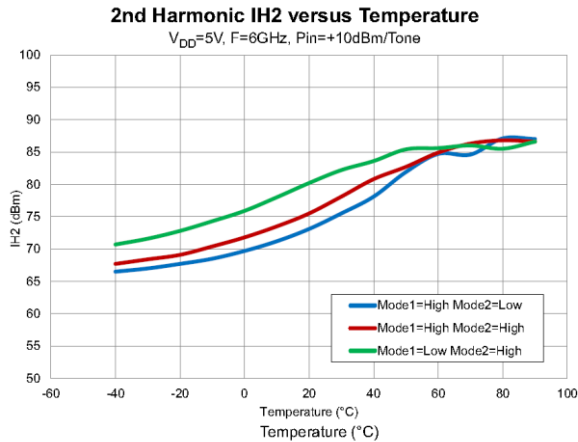
## Performance Plots – RFSA4013PCK-410 (continued 7)

Test conditions unless otherwise noted:  $V_{DD} = +5.0$  V, Temp =  $+25^{\circ}\text{C}$ , on Qorvo EVB.

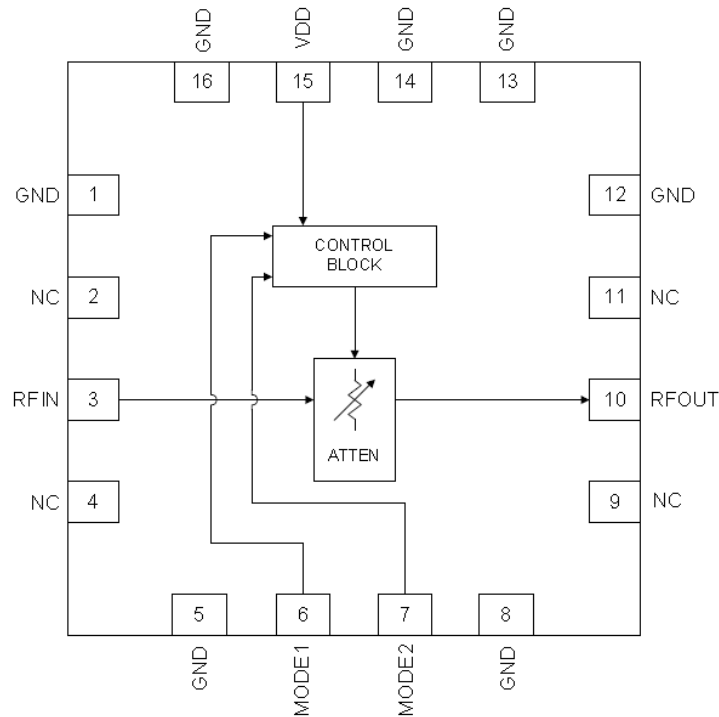


## Performance Plots – RFSA4013PCK-410 (continued 8)

Test conditions unless otherwise noted:  $V_{DD} = +5.0\text{ V}$ , Temp =  $+25^\circ\text{C}$ , on Qorvo EVB.



## Pin Configuration and Description

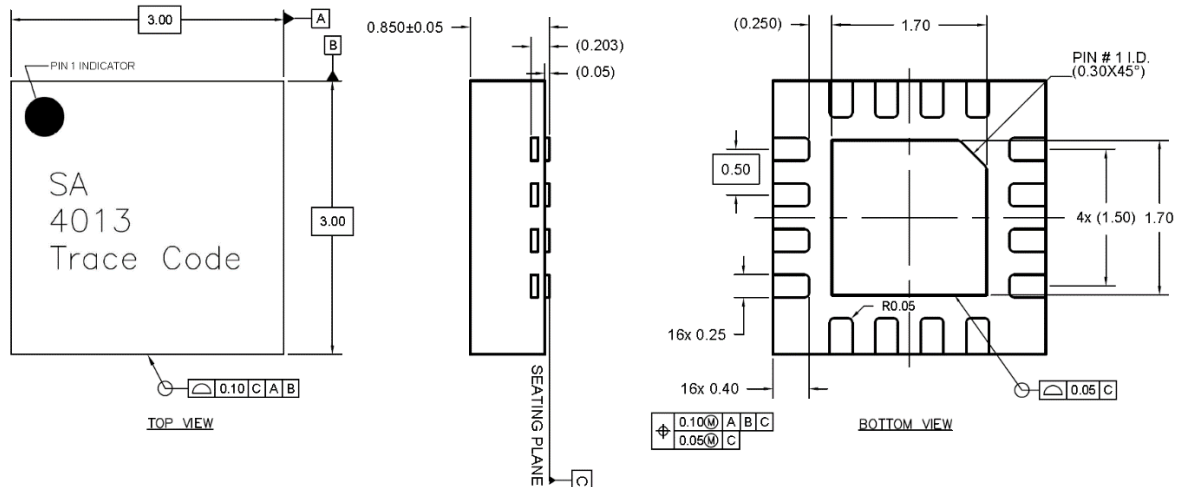


Top View

| Pin No.                 | Label | Description   |
|-------------------------|-------|---|
| 1, 5, 8, 12, 13, 14, 16 | GND   | RF/DC ground connection   |
| 2, 4, 9, 11             | NC    | No Connection internally, NC on evaluation PCB, can be connected to GND externally  |
| 3                       | RFIN  | RF Input, External DC blocking require  |
| 6                       | MODE1 | Logic control Input 1, Attenuation temperature coefficient slope selection  |
| 7                       | MODE2 | Logic control Input 2, Attenuation temperature coefficient slope selection  |
| 10                      | RFOUT | RF Output, External DC blocking require   |
| 15                      | VDD   | DC supply voltage input   |
| Backside Paddle         | GND   | RF & DC Ground. Use recommended via hole pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

### Package Marking and Dimensions

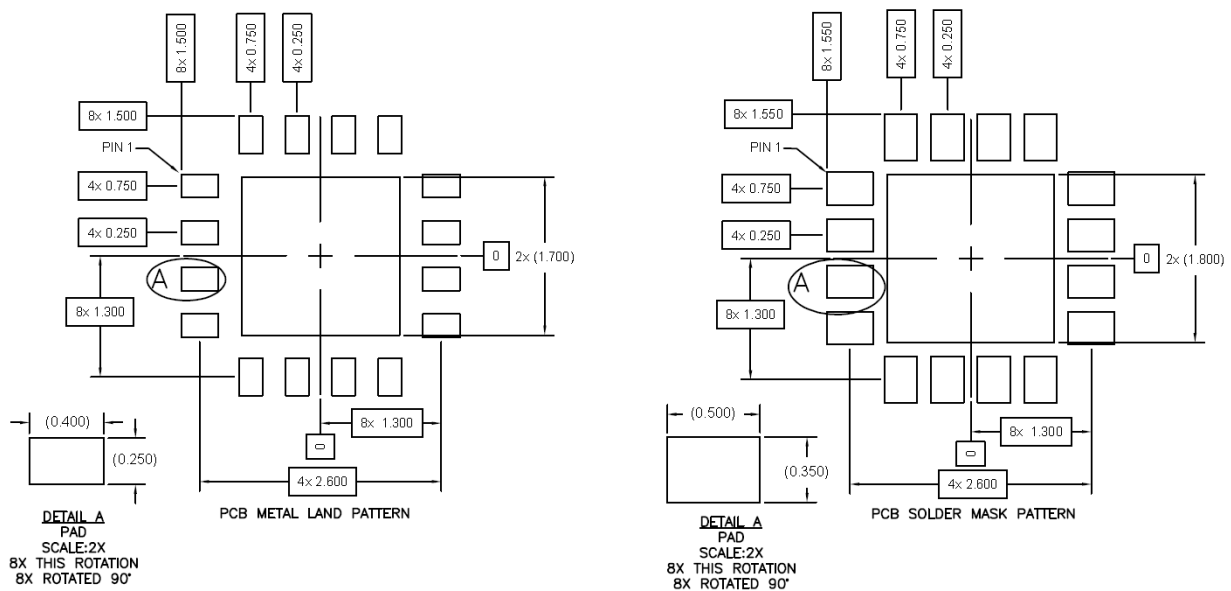
Marking: • – Pin 1 Marker  
SA4013 – Part Number  
Trace Code – Assigned by Contract Manufacture



#### Notes:

1. All dimensions are in mm. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

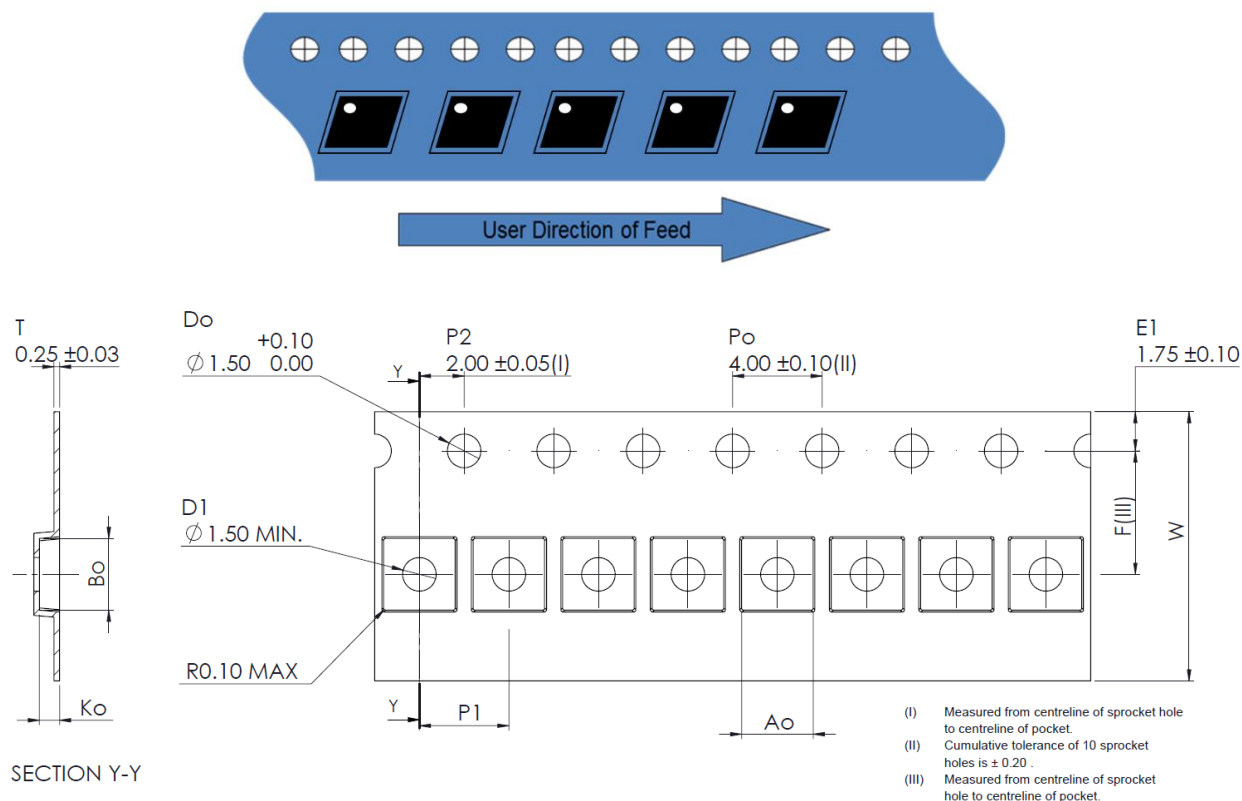
### PCB Mounting Pattern



#### Notes:

1. All dimensions are in mm. Angles are in degrees.
2. A heat sink underneath the area of the PCB for the mounted device is recommended for proper thermal operation.
3. Ground / thermal via holes on center slug are critical for the proper performance of this device. Via holes should use a .35mm (#80 / .0135") diameter drill and have a final plated through diameter of .25 mm (.010").
4. Add as much copper as possible to inner and outer layers near the part to ensure optimal thermal performance.

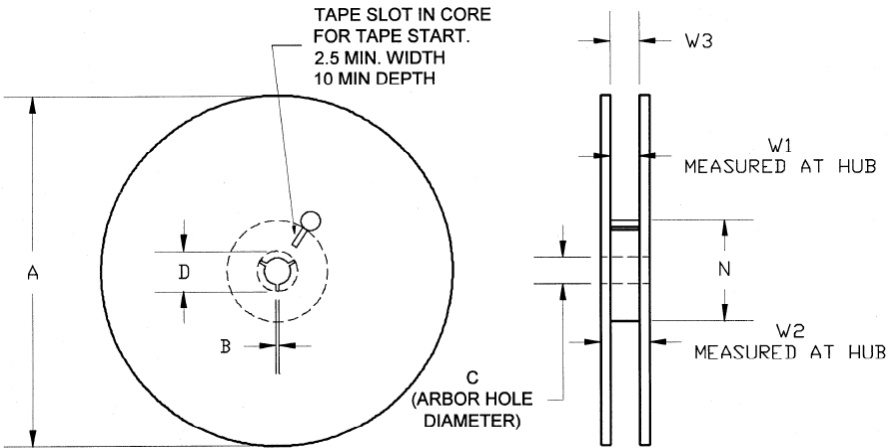
## Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.125     | 3.20      |
|                     | Width                                    | B0     | 0.125     | 3.20      |
|                     | Depth                                    | K0     | 0.040     | 1.00      |
|                     | Pitch                                    | P1     | 0.157     | 4.00      |
| Centerline Distance | Cavity to Perforation - Length Direction | P2     | 0.079     | 2.00      |
|                     | Cavity to Perforation - Width Direction  | F      | 0.217     | 5.50      |
| Cover Tape          | Width (Reference Only)                   | C      | 0.362     | 9.20      |
| Carrier Tape        | Width                                    | W      | 0.472     | 12.0      |

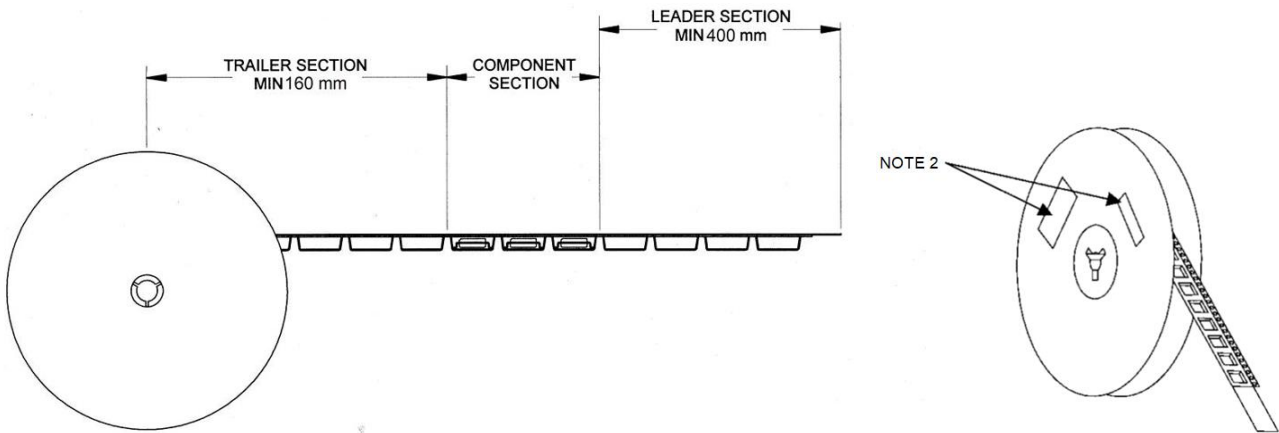
Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 7" reel.



| Feature | Measure              | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange  | Diameter             | A      | 6.969     | 177.0     |
|         | Thickness            | W2     | 0.717     | 18.2      |
|         | Space Between Flange | W1     | 0.504     | 12.8      |
| Hub     | Outer Diameter       | N      | 2.283     | 58.0      |
|         | Arbor Hole Diameter  | C      | 0.512     | 13.0      |
|         | Key Slit Width       | B      | 0.079     | 2.0       |
|         | Key Slit Diameter    | D      | 0.787     | 20.0      |

Tape and Reel Information – Tape Length and Label Placement



- Notes:
1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
  2. Labels are placed on the flange opposite the sprockets in the carrier tape.



## Handling Precautions

| Parameter                        | Rating   | Standard                   |
|----------------------------------|----------|----------------------------|
| ESD – Human Body Model (HBM)     | Class 1C | ANSI / ESDA / JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | Class C5 | ANSI / ESDA / JEDEC JS-002 |
| MSL – Moisture Sensitivity Level | Level 1  | 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.

Contact plating: Matte Sn (*Thickness: 8  $\mu$ m ~ 23  $\mu$ m*)

## RoHS Compliance

This part 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

## Contact Information

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

**Tel: 1-844-890-8163**

**Web: [www.qorvo.com](http://www.qorvo.com)**

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

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