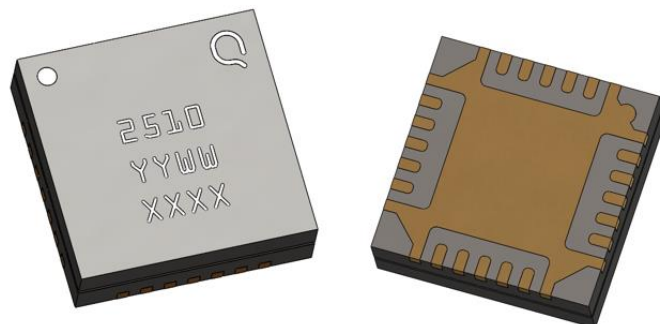


### Product Description

The QORVO TGC2510-SM is a Ku-Band image reject upconverter with integrated LO buffer amplifier and output variable gain amplifier. The TGC2510-SM operates from an RF of 10 to 16 GHz and LO from 6.5 to 19 GHz with IF inputs from DC to 3.5GHz and is designed using QORVO's 3MI DR 0.15  $\mu$ m pHEMT production process.

The TGC2510-SM typically provides 33 dBm of output TOI at -10 dBm input power per tone and has a conversion gain of 17 dB.

The TGC2510-SM is available in a low-cost, surface mount 28 lead 5x5mm QFN package and is ideally suited for Point-to-Point Radio, and Ku-Band VSAT Ground Terminal.



28-pin 5x5 mm QFN package

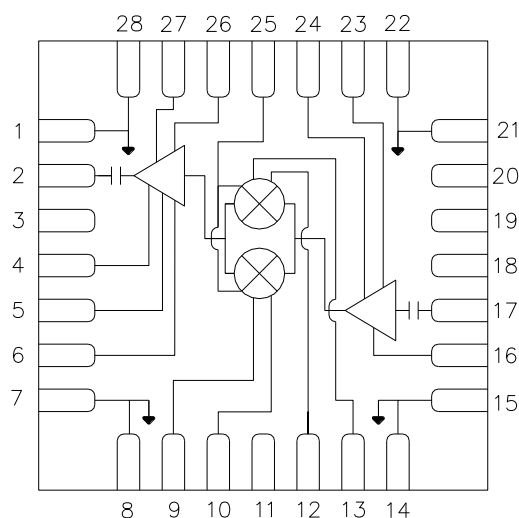
### Product Features

- RF Frequency Range: 10 - 16 GHz
- IF Frequency: DC – 3.5 GHz
- LO Frequency: 6.5 – 19 GHz
- LO Input Power: 0 to 6 dBm
- Conversion Gain: 17 dB
- OTOI: 33 dBm at max gain
- Attenuation Range: 15 dB typical
- Package Dimensions: 5.0 x 5.0 x 1.3 mm

### Ordering Information

| Part No.         | Description                                         |
|------------------|-----------------------------------------------------|
| TGC2510-SM       | Ku-Band Upconverter                                 |
| TGC2510-SMEVBLL  | TGC2510-SM EVB<br>LSB, Low IF Band, 1.3 to 2.45 GHz |
| TGC2510-SMEVBLH  | TGC2510-SM EVB<br>LSB, High IF Band, 2.5 to 4.0 GHz |
| TGC2510-SMEVBUL  | TGC2510-SM EVB<br>USB, Low IF Band, 1.3 to 2.45 GHz |
| TGC2510-SMEVBULH | TGC2510-SM EVB<br>USB, High IF Band, 2.5 to 4.0 GHz |

### Function Block Diagram



### Applications

- VSAT
- Point-to-Point Radio
- Test Equipment & Sensors

### Absolute Maximum Ratings

| Parameter                            | Rating       |
|--------------------------------------|--------------|
| VDRF                                 | 6 V          |
| VDLO                                 | 6 V          |
| IDRF                                 | 350 mA       |
| IDLO                                 | 100 mA       |
| VREF                                 | 3 V          |
| VGRF, VGLO, VGX                      | -2 to +1.5 V |
| VCTRL                                | 3 V          |
| IF1, IF2                             | -2 to +2 V   |
| IF Input Power, 50Ω, T = 25°C        | 10 dBm       |
| Channel Temperature, T <sub>ch</sub> | 200 °C       |
| Storage Temperature                  | -65 to 125°C |

These are stress ratings only, functional operation of the device at these conditions is not implied. Extended application of Absolute Maximum Rating conditions may reduce device reliability. Operation of this device outside the parameter ranges given above may cause permanent damage.

### Recommended Operating Conditions

| Parameter             | Min | Typ   | Max | Units |
|-----------------------|-----|-------|-----|-------|
| Operating Temp. Range | -40 | +25   | +85 | °C    |
| VDRF                  |     | 5     |     | V     |
| IDRF                  |     | 240   |     | mA    |
| VGRF                  |     | -0.70 |     | V     |
| VDLO                  |     | 5     |     | V     |
| IDLO                  |     | 60    |     | mA    |
| VGLO                  |     | -0.63 |     | V     |
| VREF                  |     | 2     |     | V     |
| VGX                   |     | -1.2  |     | V     |
| VCTRL                 |     | 0     |     | V     |
| LO Input Power        | 0   |       | 6   | dBm   |

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

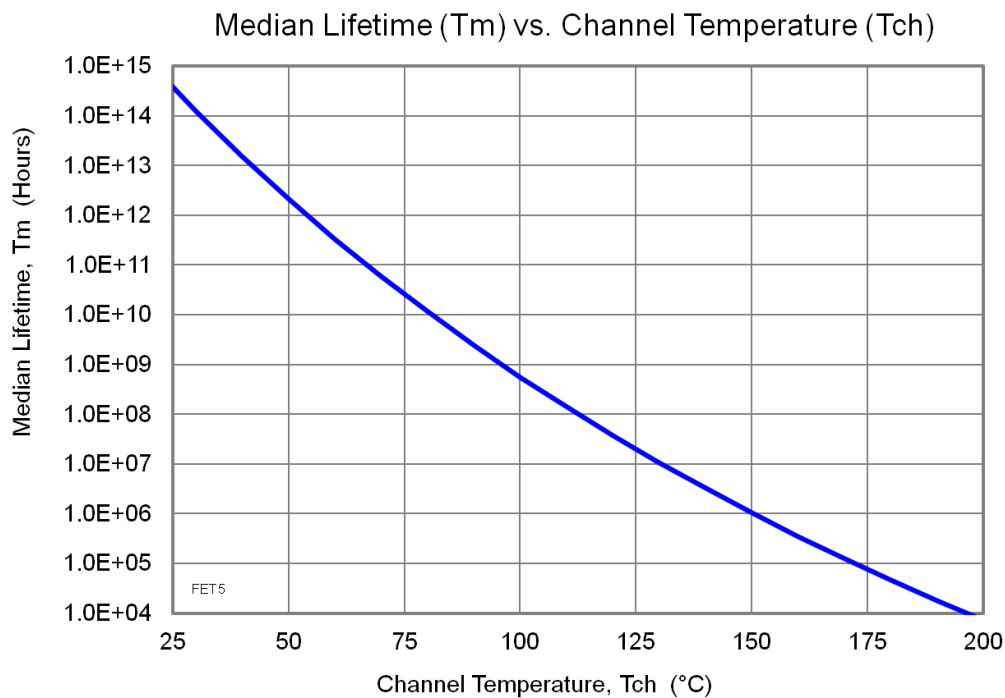
### Electrical Specifications

Test conditions unless otherwise noted: IF Input Power = -10 dBm, VGX = -1.2 V, VREF = 2 V, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA. VCTRL = 0 V for maximum gain.

| Parameter                                | Conditions                    | Min | Typ | Max | Units |
|------------------------------------------|-------------------------------|-----|-----|-----|-------|
| RF Frequency Range                       |                               | 10  |     | 16  | GHz   |
| LO Frequency Range                       |                               | 6.5 |     | 19  | GHz   |
| IF Frequency Range                       |                               | DC  |     | 3.5 | GHz   |
| LO Input Power                           |                               | 0   |     | 6   | dBm   |
| Conversion Gain                          | IF=2GHz                       | 15  | 17  |     | dBm   |
| Third Order Output Intercept Point, OIP3 | RF = 10 to 11.7GHz, IF=2GHz   | 24  | 33  |     | dBm   |
| Third Order Output Intercept Point, OIP3 | RF = 12.7 to 15.4GHz, IF=2GHz | 26  | 33  |     | dBm   |
| Image Rejection                          |                               |     | 25  |     | dB    |
| P1dB Output Power                        |                               |     | 22  |     | dBm   |

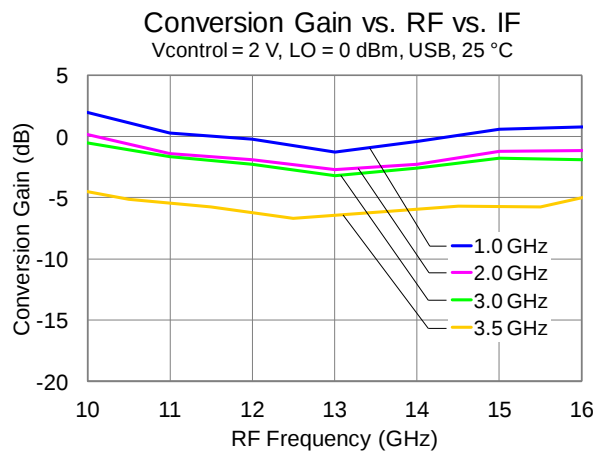
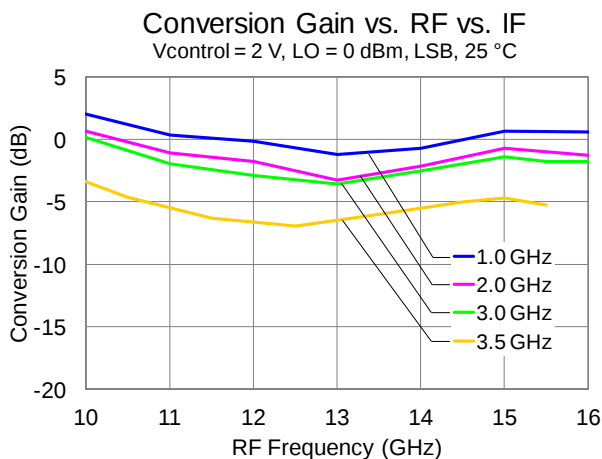
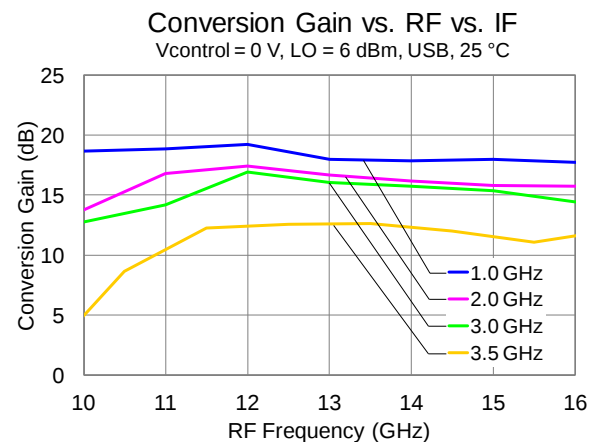
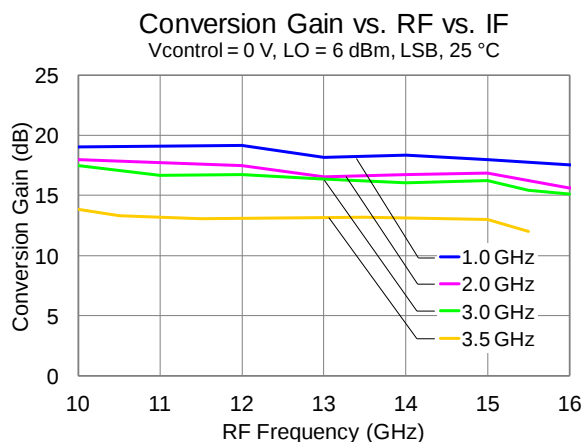
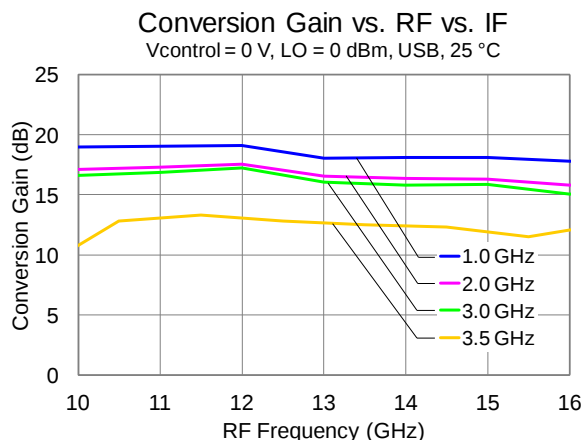
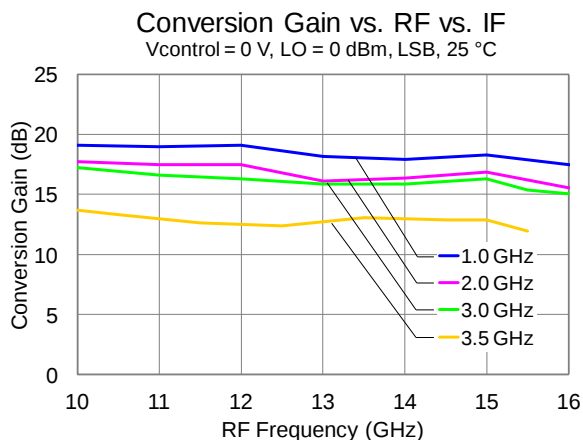
## Thermal and Reliability Information

| Parameter                                                             | Conditions                                                                                               | Rating                                          |
|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Thermal Resistance, $\theta_{JC}$ , measured to back of package       | Tbase = 85 °C                                                                                            | $\theta_{JC} = 26.1 \text{ }^{\circ}\text{C/W}$ |
| Channel Temperature (Tch), and Median Lifetime (Tm)                   | Tbase = 85 °C,<br>VDRF = 5 V, IDRF = 240 mA<br>VDLO = 5 V, IDLO = 60 mA<br>Pdis = 1.5 W                  | Tch = 124 °C<br>Tm = 2.3 E+7 Hours              |
| Channel Temperature (Tch), and Median Lifetime (Tm)<br>Under RF Drive | Tbase = 85 °C<br>VDRF = 5 V, IDRF = 240 mA<br>VDLO = 5 V, IDLO = 85 mA<br>Pin = -10 dBm<br>Pdis = 1.63 W | Tch = 128 °C<br>Tm = 1.4 E+7 Hours              |



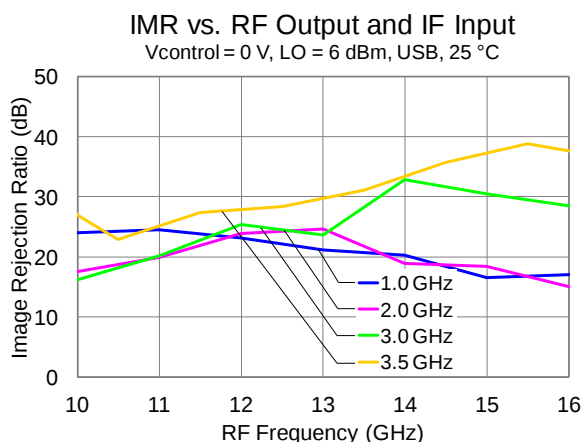
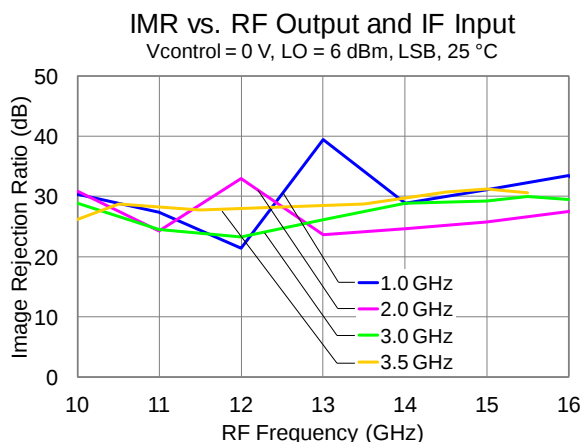
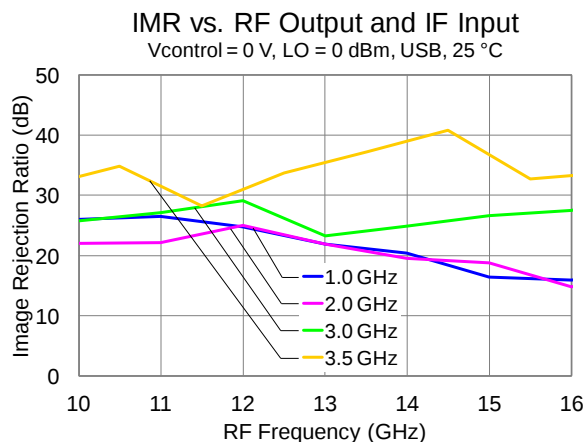
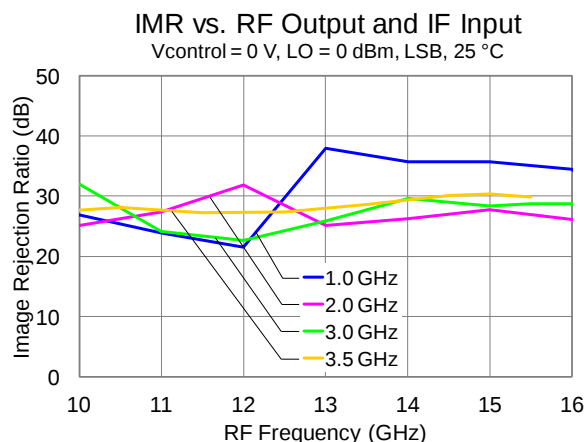
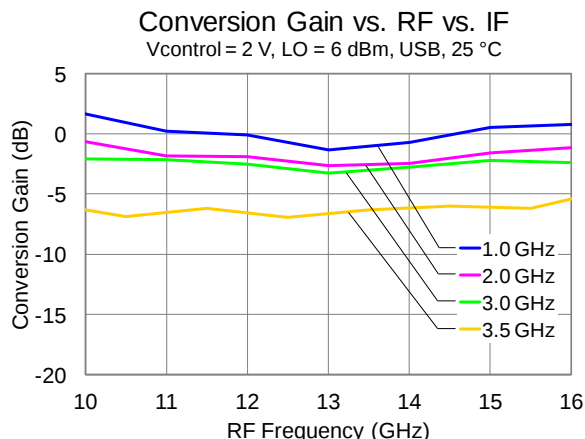
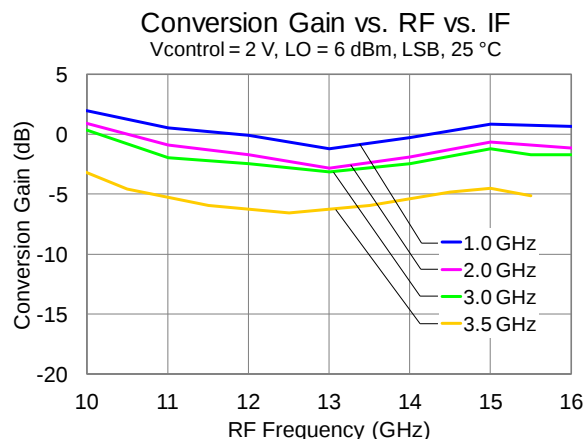
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA. VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



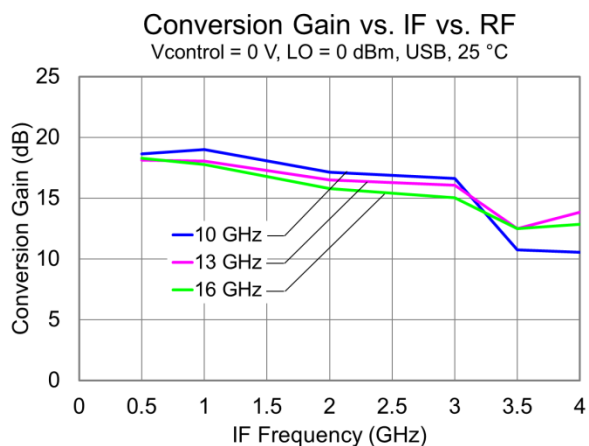
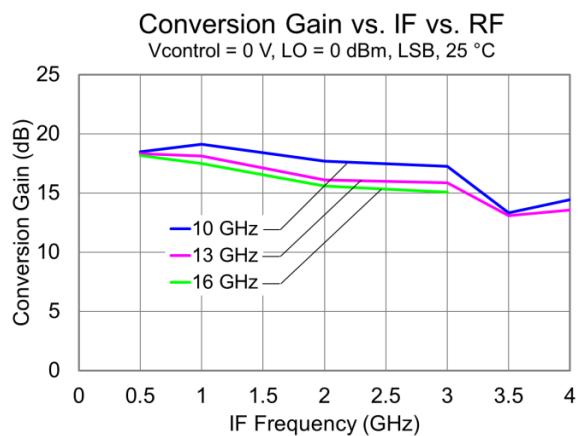
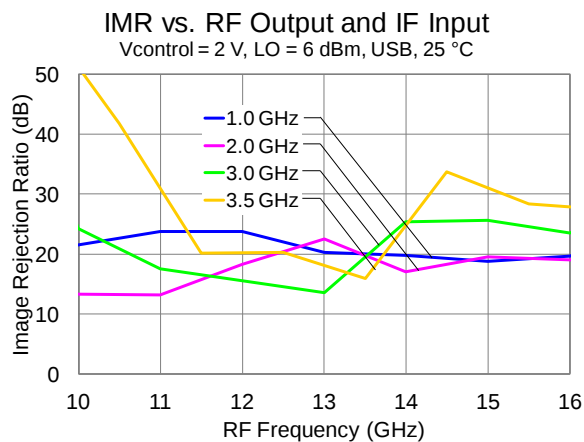
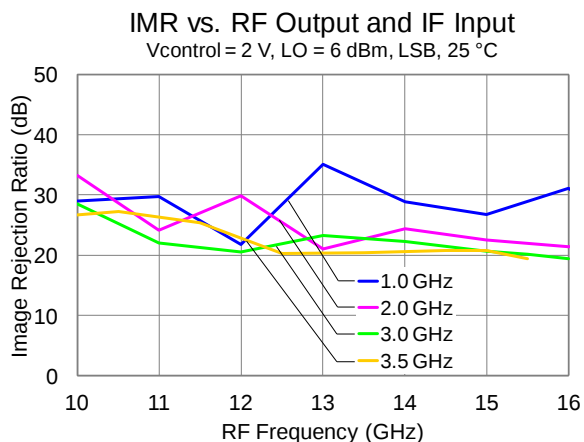
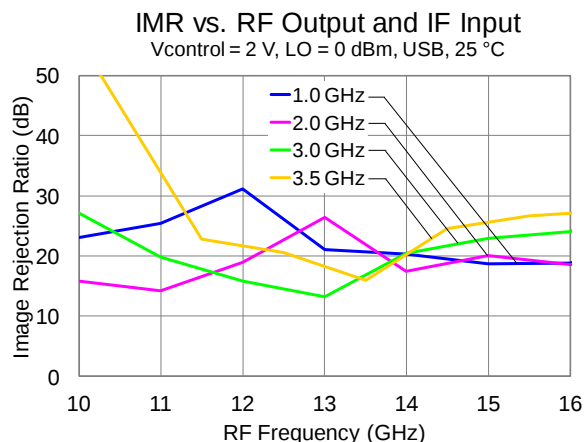
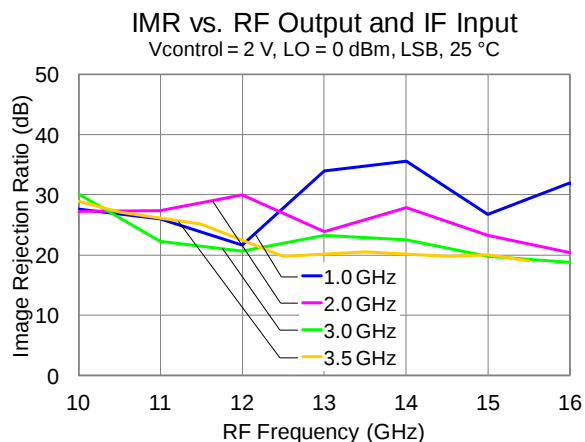
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



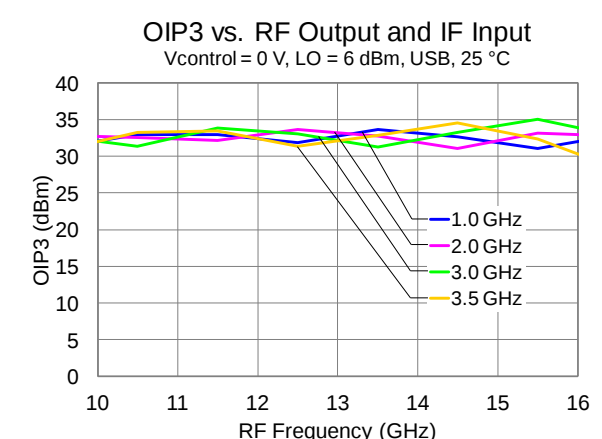
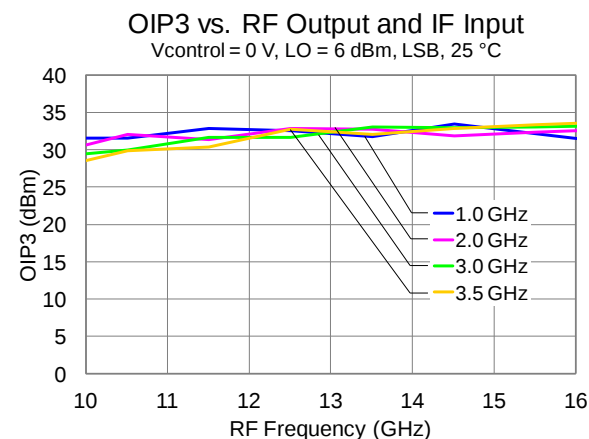
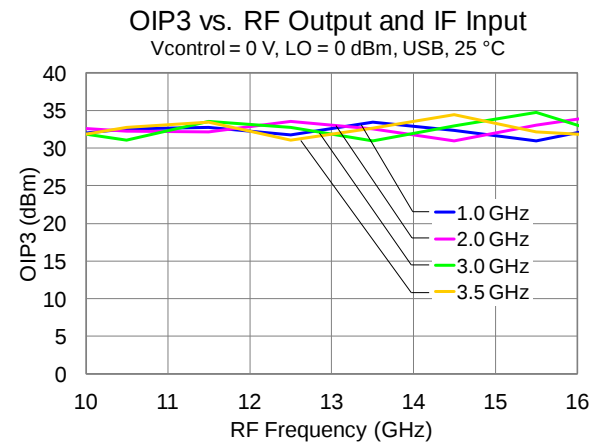
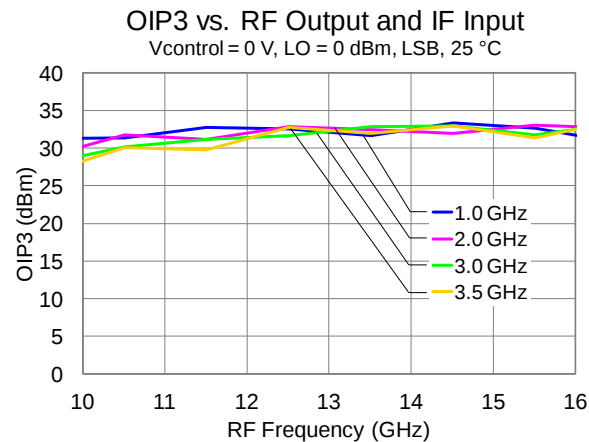
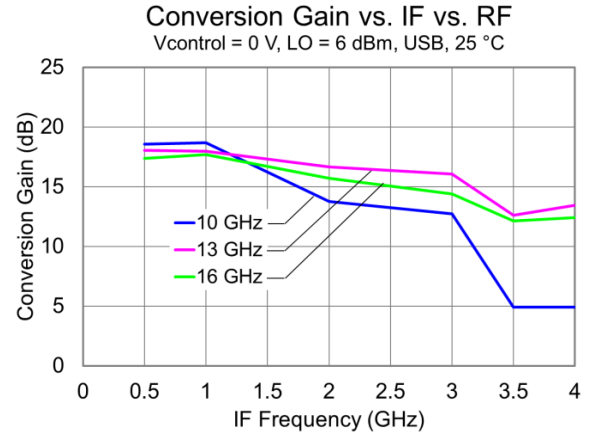
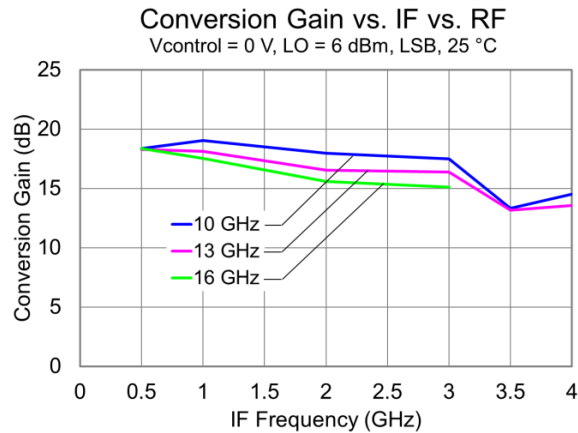
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



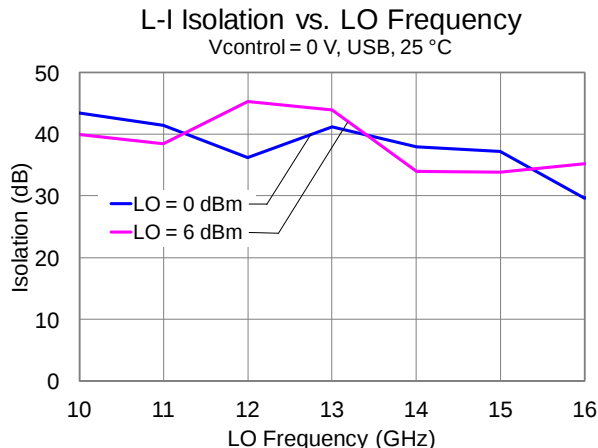
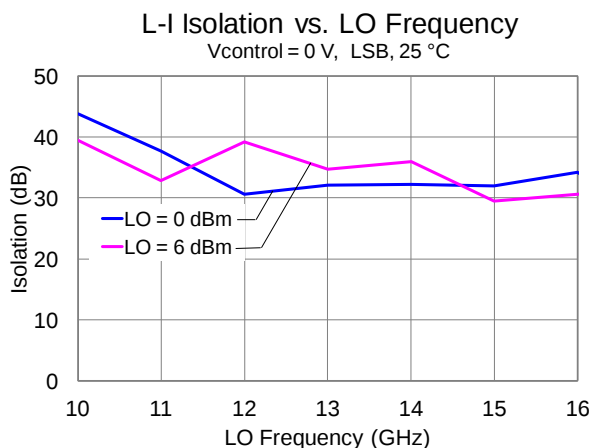
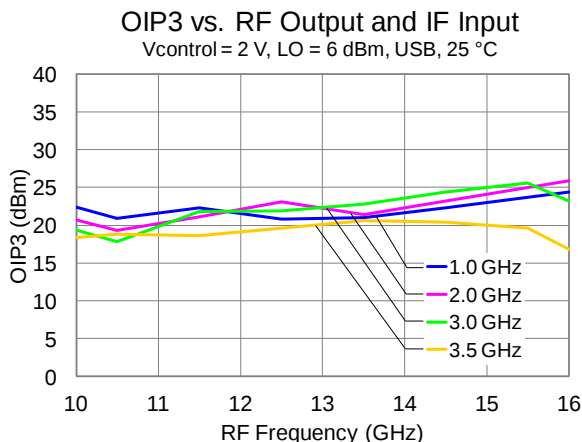
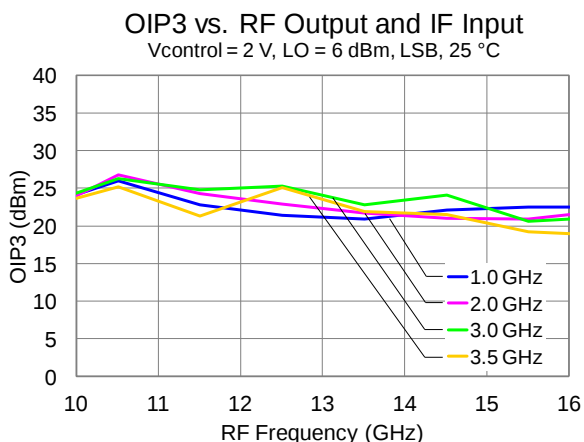
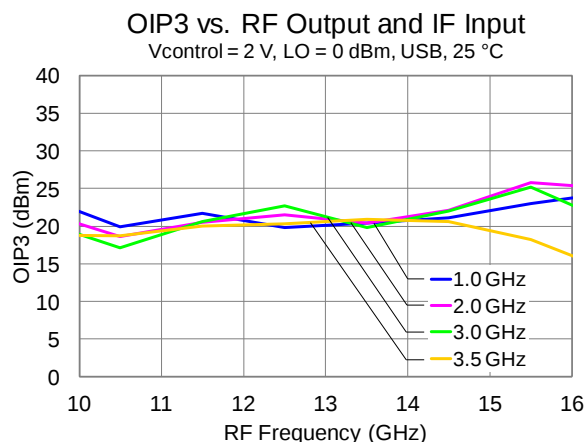
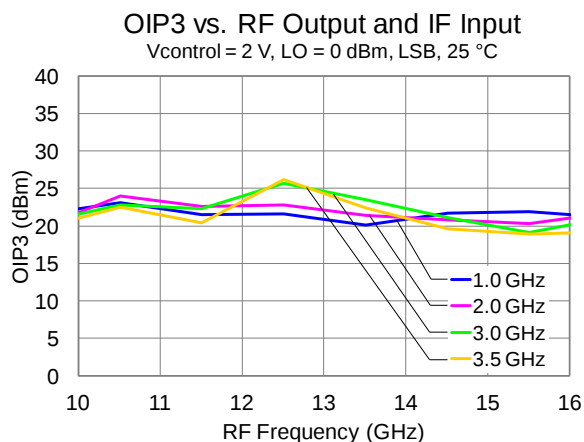
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



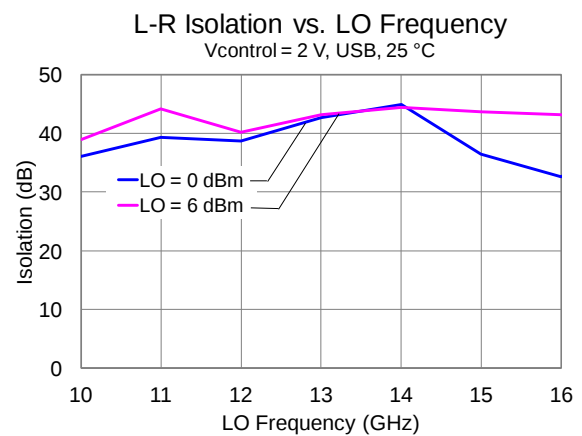
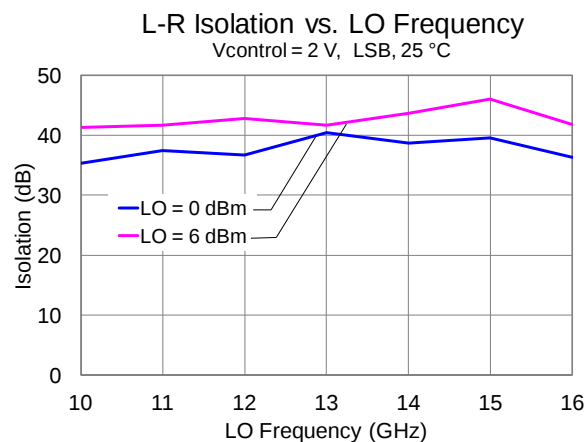
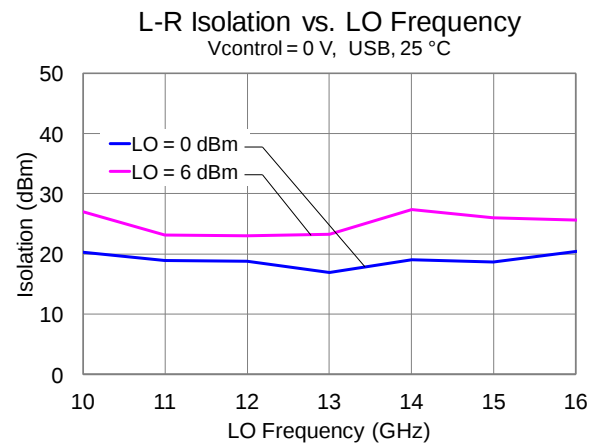
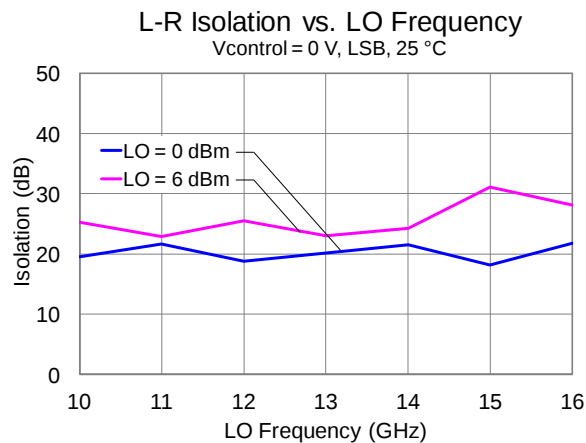
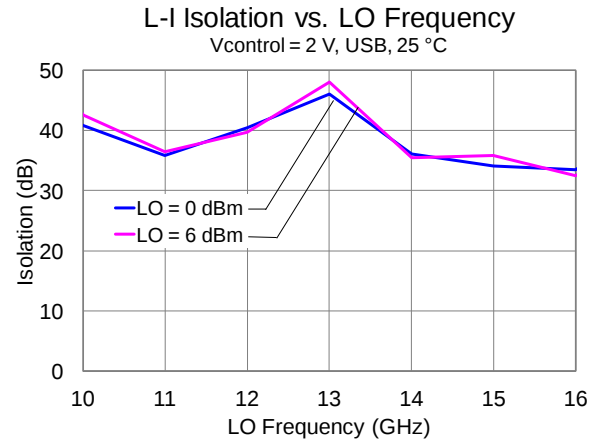
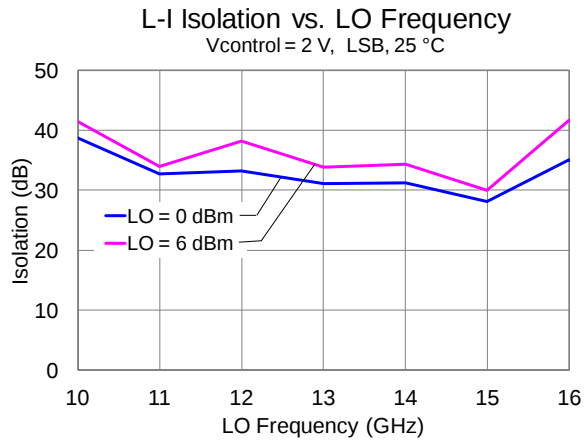
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



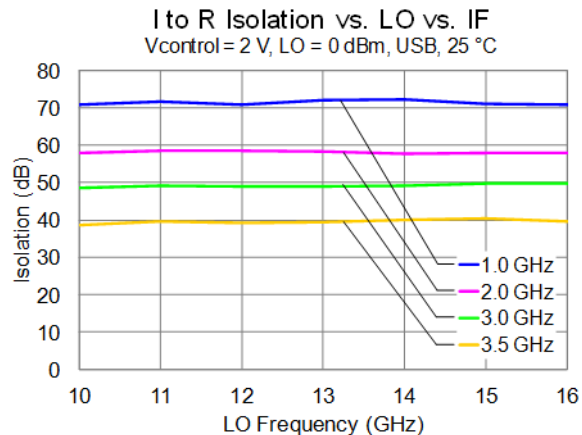
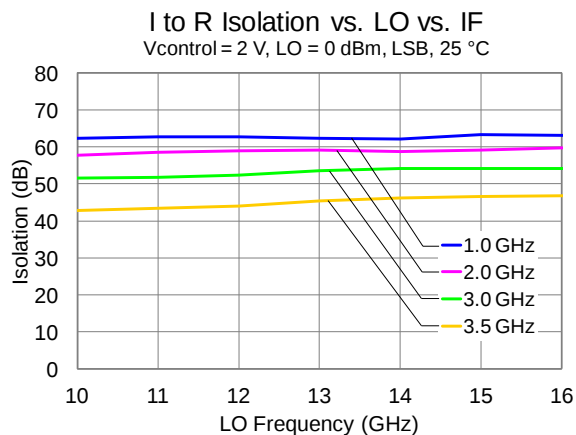
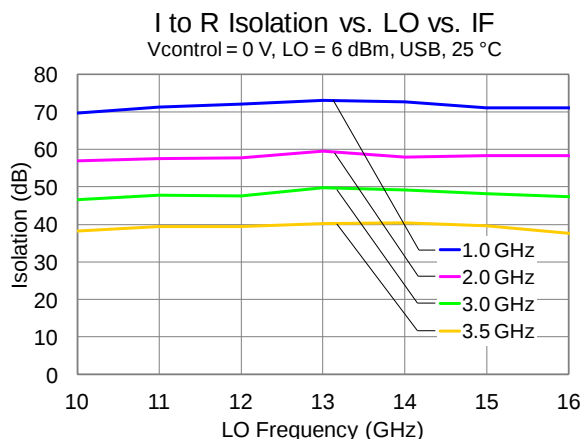
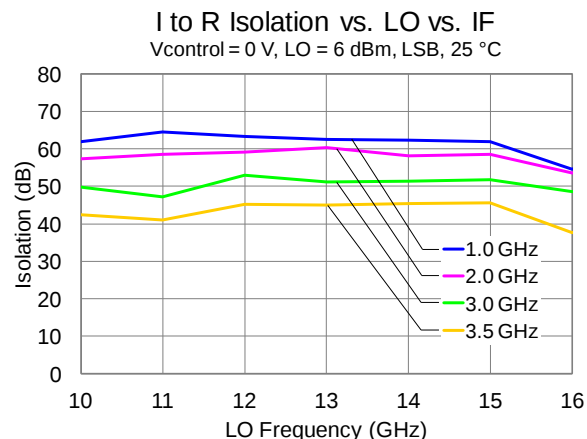
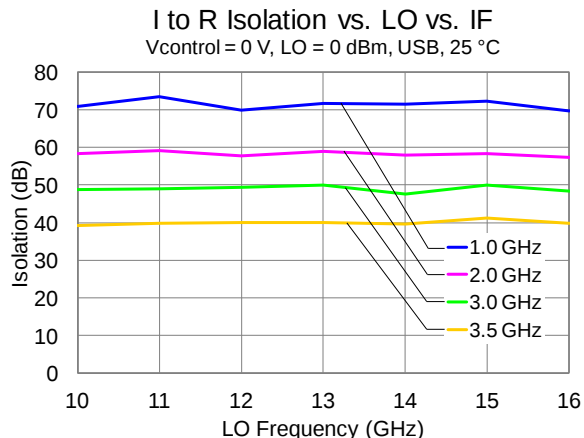
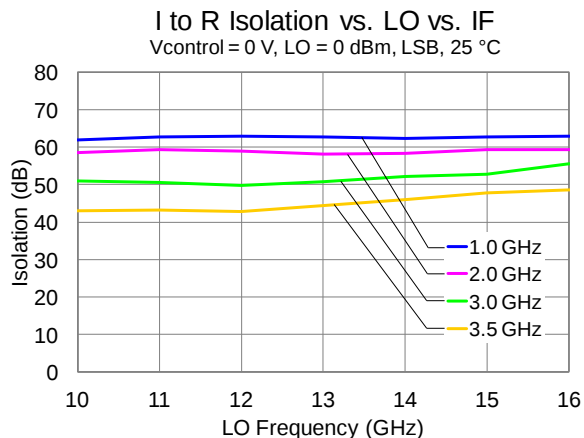
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



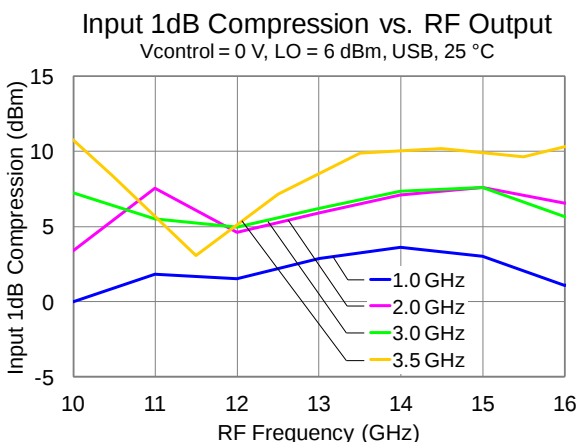
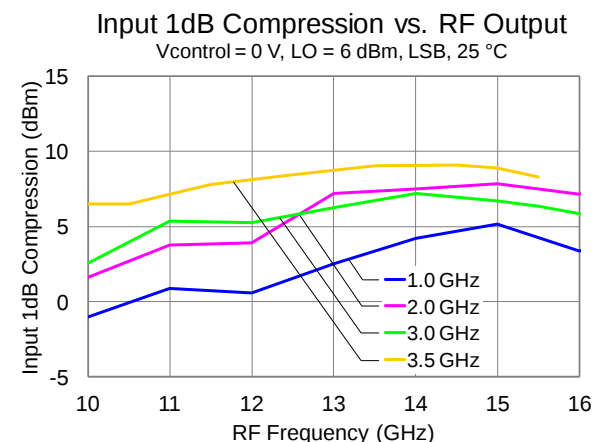
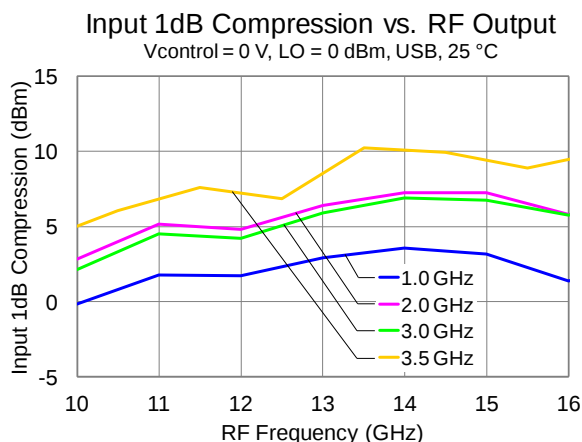
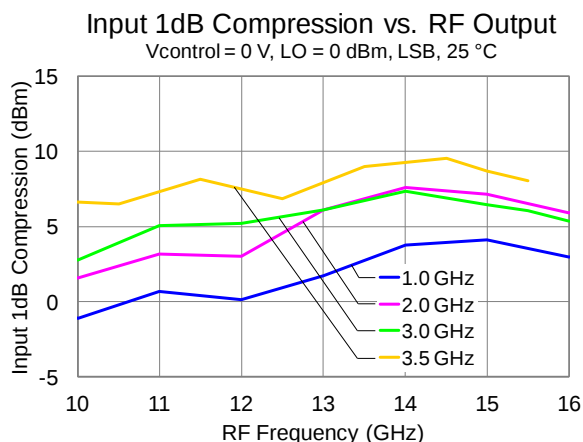
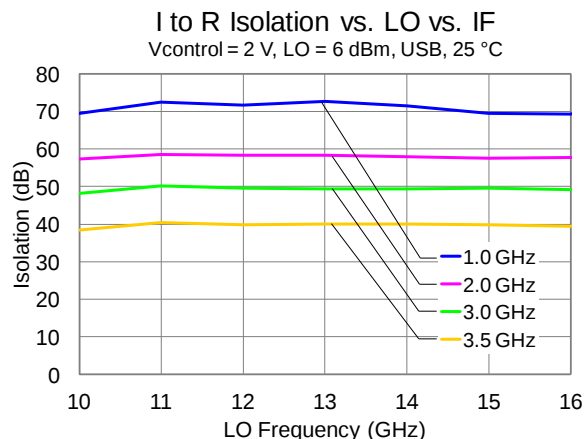
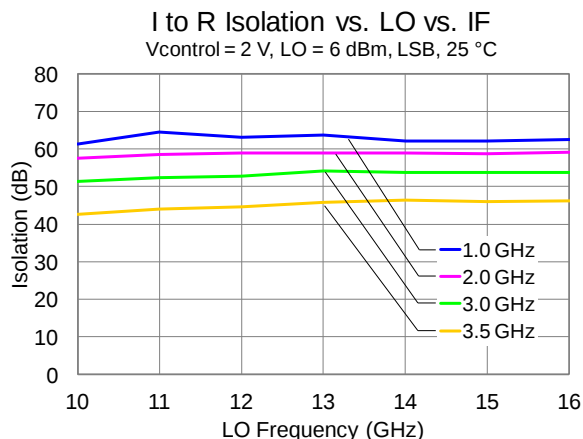
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



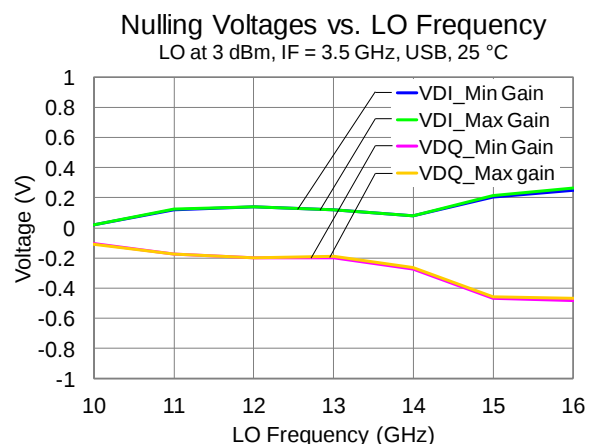
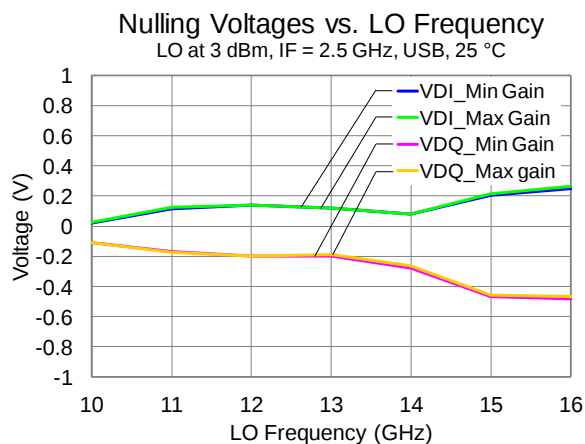
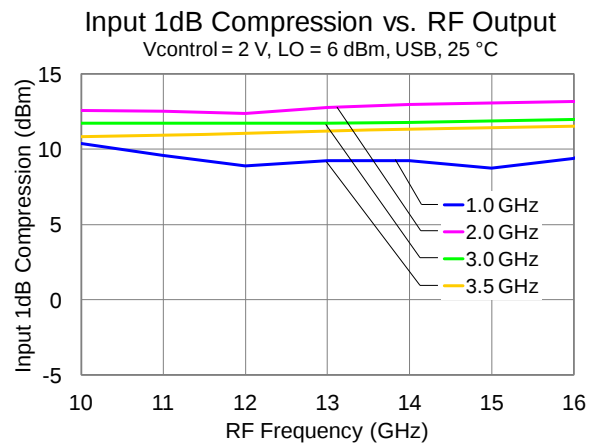
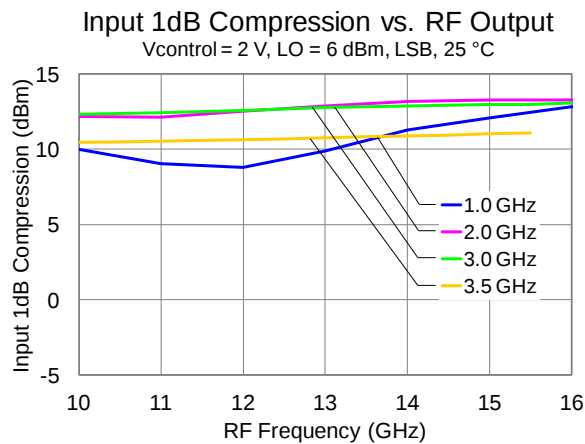
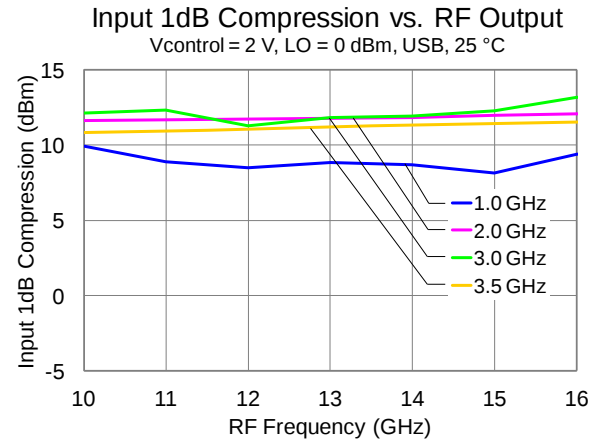
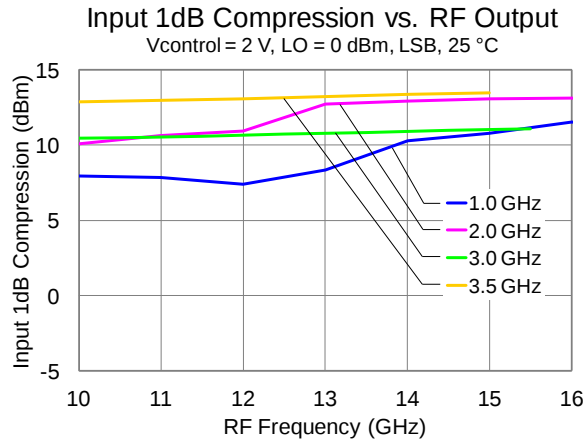
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



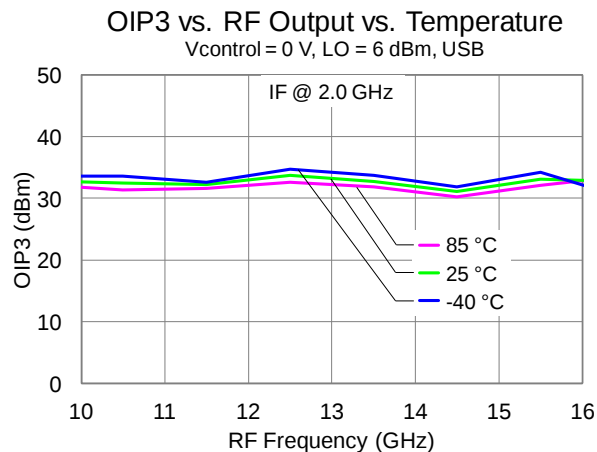
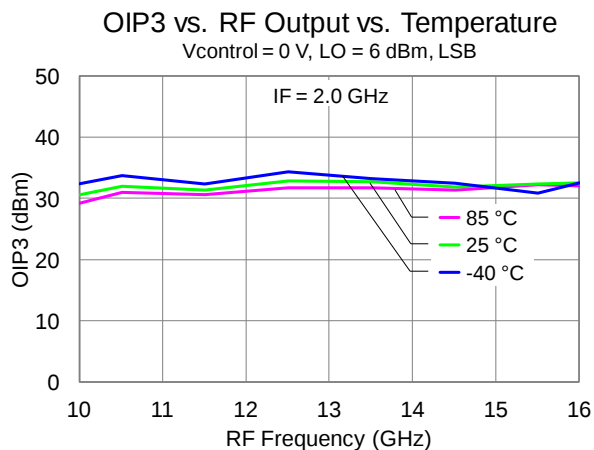
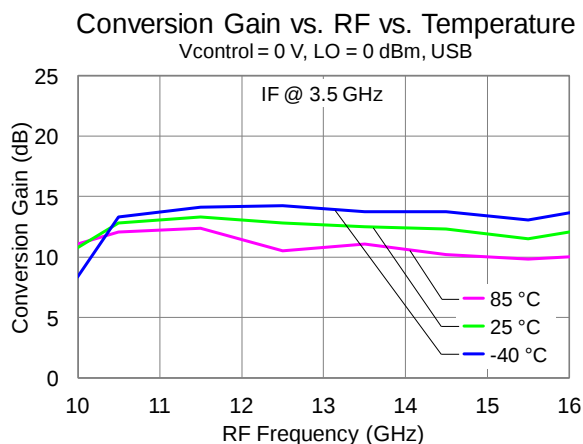
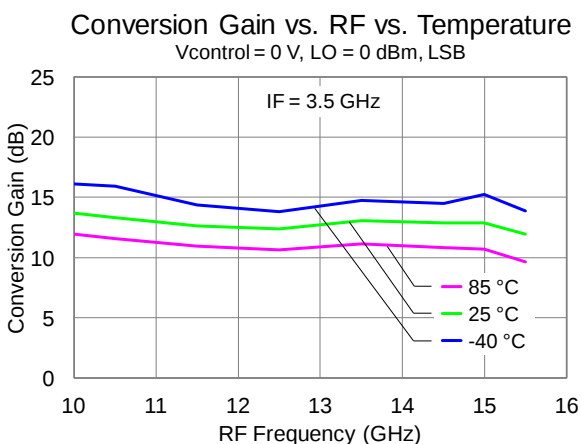
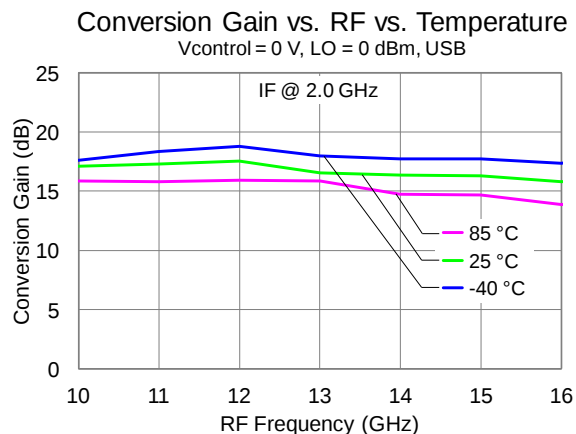
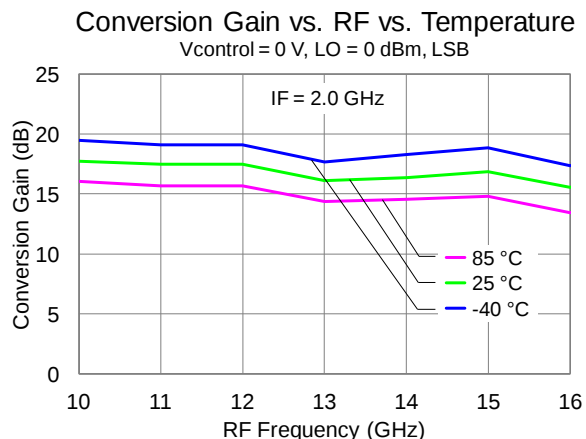
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



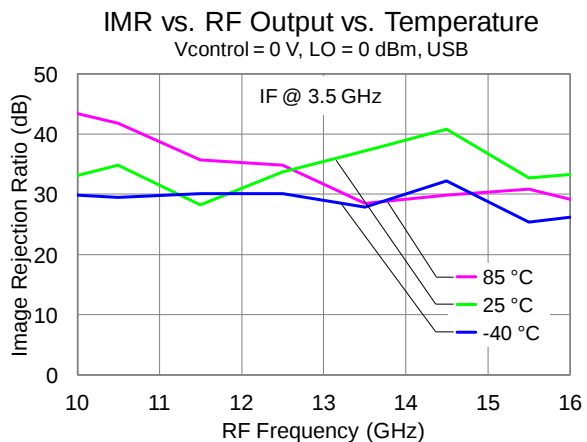
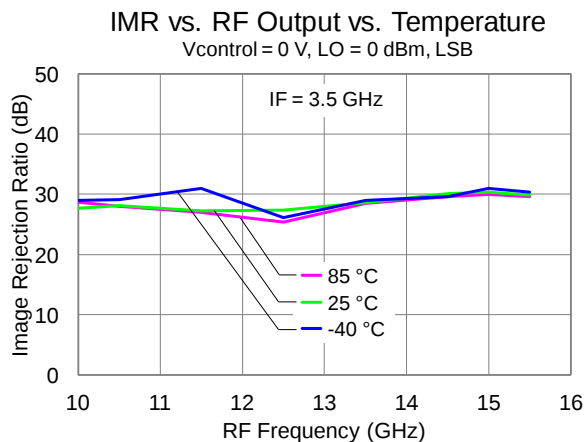
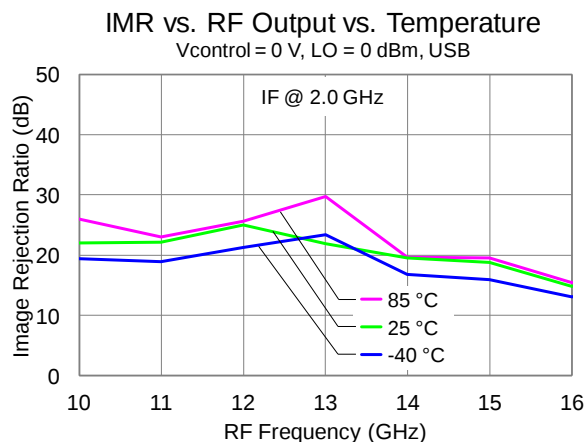
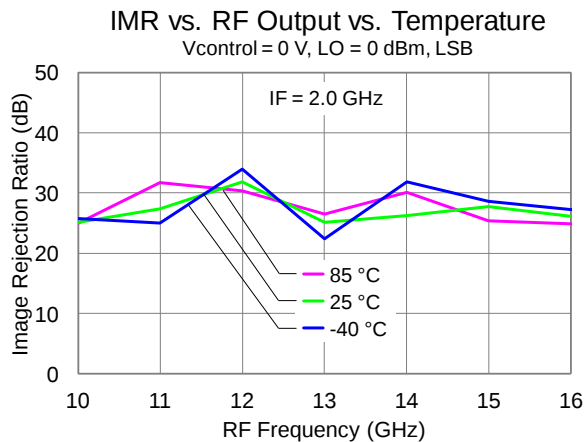
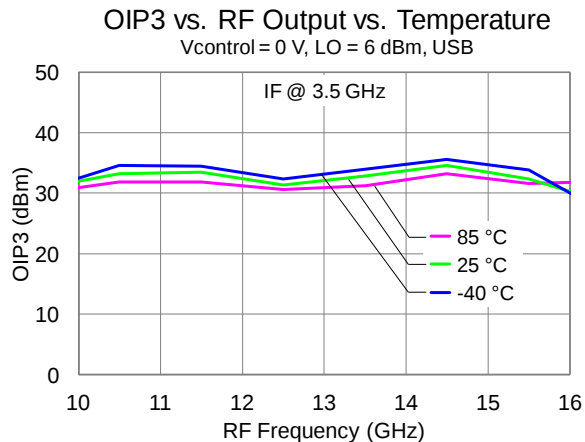
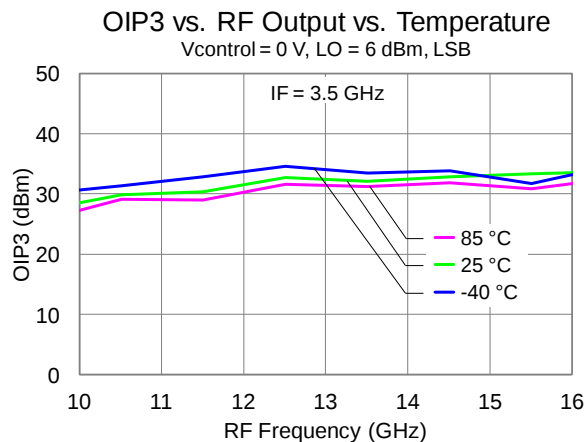
### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



### Performance Plots

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA, VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.



## Mixing Products

IF Input Power = -10 dBm, VDLO = 5 V, IDLO = 60 mA, VDRF = 5 V, IDRF = 240 mA. VGX = -1.2 V, VREF = 2 V.  
Data taken with external IF hybrid and LO nulling applied.

### M x N Spurious Outputs for LSB

LO = 0 – 6 dBm, 25 °C; All values are in dBc.

For LSB IF = 2.0 GHz: LO = 12.0 GHz to 18.0 GHz; IF = 3.5 GHz: LO = 13.5 GHz to 19.0 GHz.

| Spurious Suppresion (dBc) for IF = 2.0 GHz |     |    |    |    |
|--------------------------------------------|-----|----|----|----|
| RF/LO                                      | 0   | 1  | 2  | 3  |
| -3                                         | --- | 70 | 79 | 76 |
| -2                                         | --- | 44 | 40 | 75 |
| -1                                         | --- | 0  | 38 | 69 |
| 0                                          | --- | 24 | 30 | 38 |
| 1                                          | 61  | 24 | 69 | 68 |
| 2                                          | 62  | 44 | 79 | 75 |
| 3                                          | 72  | 78 | 78 | 76 |

| Spurious Suppresion (dBc) for IF = 3.5 GHz |     |    |    |     |
|--------------------------------------------|-----|----|----|-----|
| RF/LO                                      | 0   | 1  | 2  | 3   |
| -3                                         | --- | 84 | 75 | 73  |
| -2                                         | --- | 50 | 45 | 71  |
| -1                                         | --- | 0  | 59 | 63  |
| 0                                          | --- | 21 | 28 | 34  |
| 1                                          | 51  | 27 | 64 | 69  |
| 2                                          | 49  | 64 | 74 | 74  |
| 3                                          | 85  | 77 | 70 | --- |

### M x N Spurious Outputs for USB

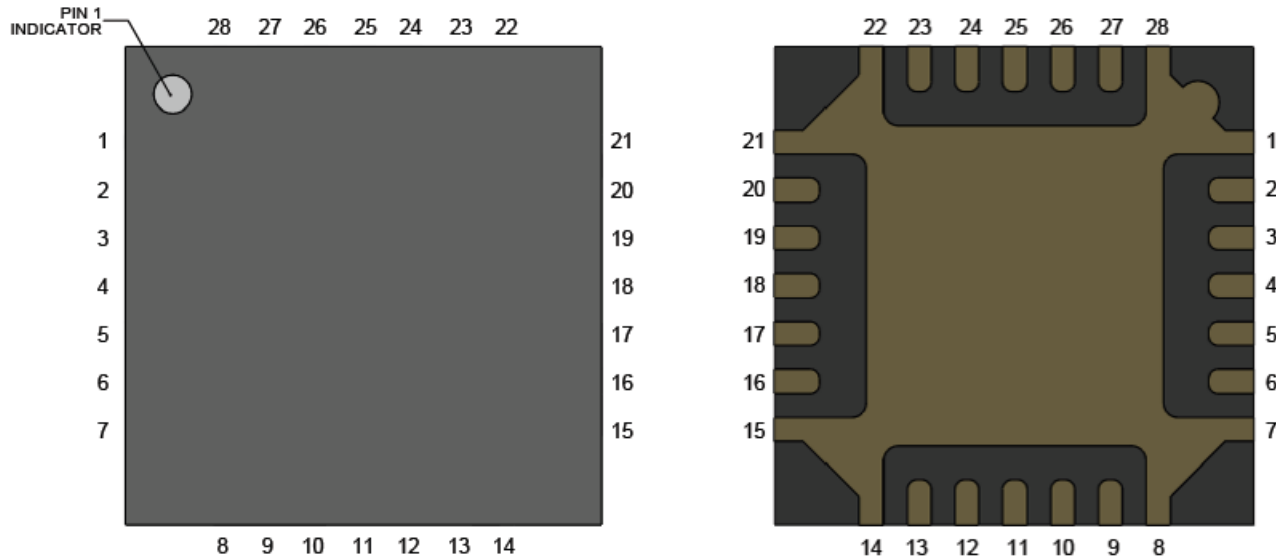
LO = 0 – 6 dBm, 25 °C; All values are in dBc.

For USB IF = 2.0 GHz: LO = 8.0 GHz to 14.0 GHz; IF = 3.5 GHz: LO = 6.5 GHz to 12.5 GHz.

| Spurious Suppresion (dBc) for IF = 2.0 GHz |     |    |     |    |
|--------------------------------------------|-----|----|-----|----|
| RF/LO                                      | 0   | 1  | 2   | 3  |
| -3                                         | --- | 70 | 46  | 44 |
| -2                                         | --- | 46 | 29  | 54 |
| -1                                         | --- | 17 | 20  | 15 |
| 0                                          | --- | 23 | -17 | 25 |
| 1                                          | 56  | 0  | 8   | 26 |
| 2                                          | 28  | 33 | 32  | 62 |
| 3                                          | 48  | 43 | 66  | 71 |

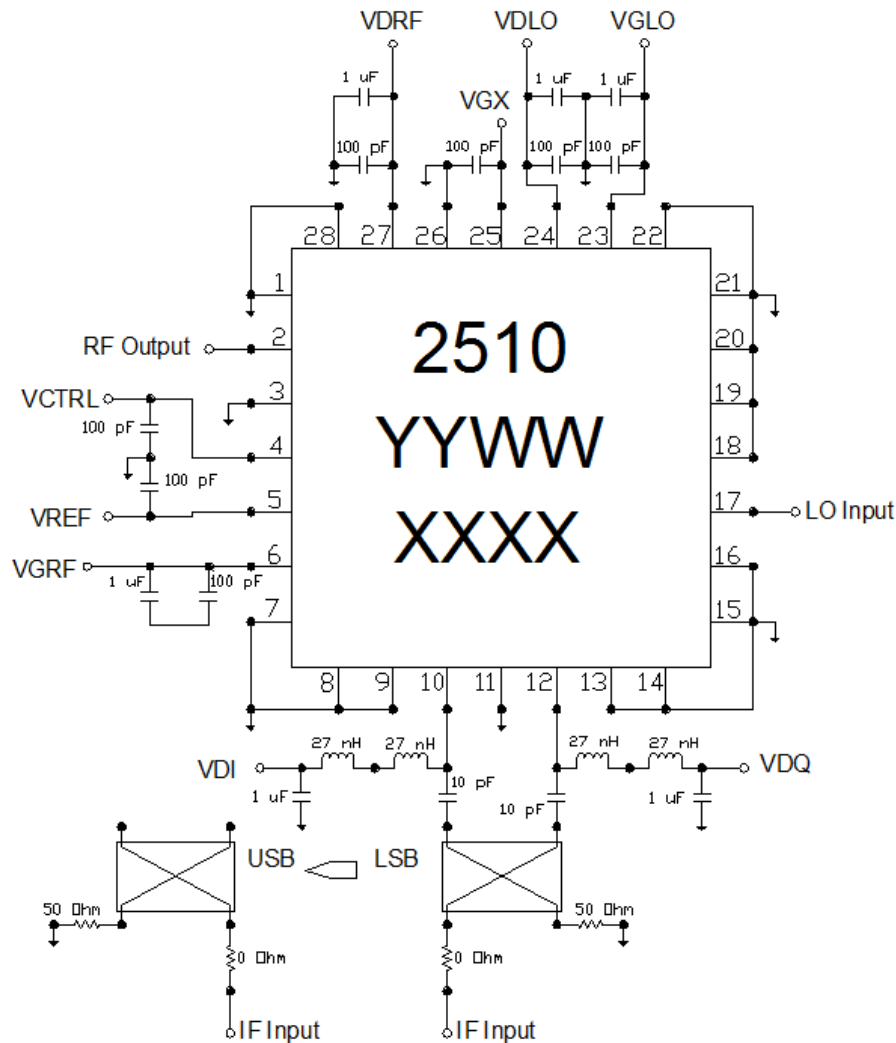
| Spurious Suppresion (dBc) for IF = 3.5 GHz |     |    |     |     |
|--------------------------------------------|-----|----|-----|-----|
| RF/LO                                      | 0   | 1  | 2   | 3   |
| -3                                         | --- | 62 | 66  | 49  |
| -2                                         | --- | 70 | 33  | 41  |
| -1                                         | --- | 23 | 8   | 14  |
| 0                                          | --- | 19 | -29 | -17 |
| 1                                          | 23  | 0  | 4   | 11  |
| 2                                          | 27  | 30 | 38  | 41  |
| 3                                          | 56  | 58 | 64  | 72  |

## Pin Configuration and Description



| Pin No.                                    | Label  | Description                                                                                                                                                     |
|--------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 7, 8, 9, 13, 14, 15, 16, 21, 22, 26, 28 | GND    | Internal Grounding; must be grounded on PCB.                                                                                                                    |
| 2                                          | RF OUT | RF Output matched to 50 ohms, AC Coupled.                                                                                                                       |
| 3, 11, 18, 19, 20                          | NC     | No internal connection; must be grounded on PCB.                                                                                                                |
| 4                                          | VCTRL  | Control Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                    |
| 5                                          | VREF   | Reference Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                  |
| 6                                          | VGRF   | RF Gate Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                    |
| 10                                         | IF1    | IF Input matched to 50 ohms, DC coupled.                                                                                                                        |
| 12                                         | IF2    | IF Input matched to 50 ohms, DC coupled.                                                                                                                        |
| 17                                         | LO IN  | LO Input, matched to 50 ohms, AC coupled.                                                                                                                       |
| 23                                         | VGLO   | LO Gate Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                    |
| 24                                         | VDLO   | LO Drain Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                   |
| 25                                         | VGX    | Mixer Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                      |
| 27                                         | VDRF   | RF Drain Voltage. Bias network is required; see Application Circuit on page 17 as an example.                                                                   |
| 29                                         | GND    | Backside Paddle. Multiple vias should be employed to minimize inductance and thermal resistance; see Mounting Configuration on page 20 for suggested footprint. |

### Applications Circuit



#### Bias-up Procedure

Set VGX = -1.2 V, Set VREF = 2.0 V, Set VCTRL = 0 V  
Set VGLO = -1.5 V, Set VDLO = 5.0 V

Set VGX, VREF, VCTRL, VGLO, VGRF, VDI, VDQ  
current limits to 10 mA

Set IDLO limit to 100 mA, Set IDRF limit to 350 mA

Increase VGLO to get IDLO = 60 mA

Set VGRF = -1.5 V, Set VDRF = 5.0 V

Increase VGRF to get IDRF = 240 mA

Set VDI, VDQ to 0V; or no connection

Apply LO and RF signals

#### Bias-down Procedure

Turn off RF and LO signals

Reduced VDLO = 0 V

Reduce VDRF = 0 V

Set VDI = 0 V, if used for LO nulling

Set VDQ = 0 V, if used for LO nulling

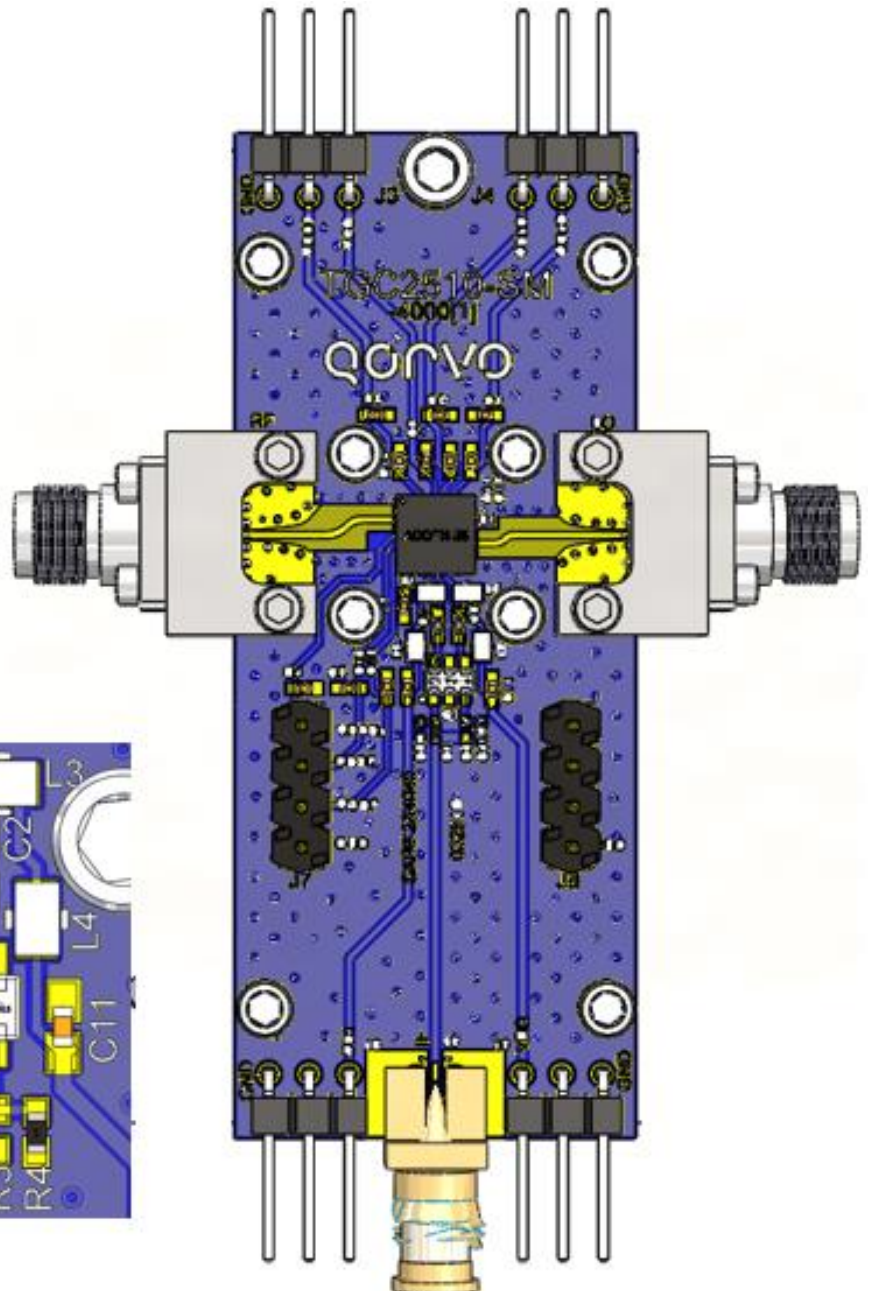
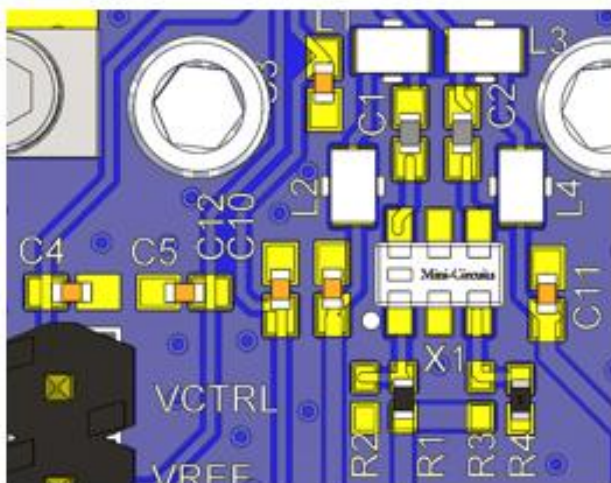
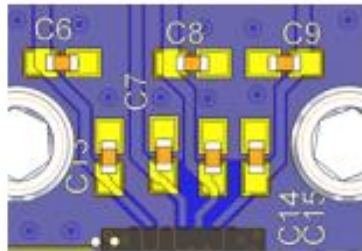
Reduced VGLO = 0V, VGRF = 0 V, VREF = 0 V

Reduce VCTRL = 0 V

Reduced VGX = 0 V

### Evaluation Board (EVB) Assembly Layout

Board material is RO4003 0.008" thickness with ½ oz copper cladding.



## Application Circuit Component

### Bill of Material

| Ref Des                | Value     | Description                | Manufacturer | Part Number |
|------------------------|-----------|----------------------------|--------------|-------------|
| C1 – C2                | 10 pF     | Cap, 0402, 50V, 5%, NPO    | various      |             |
| C3 - C5, C7, C13 - C15 | 100 pF    | Cap, 0402, 50V, 5%, NPO    | various      |             |
| C10 – C12, C6, C8, C9  | 1 $\mu$ F | Cap, 0805, 25V, 5%, X5R    | various      |             |
| L1 – L4                | 27 nH     | Ind, 0201, 100 mA, 5%, SMD | various      |             |
| Q1                     |           | Ku-Band Up-Converter       | QORVO        | TGC2510-SM  |

### LSB Configuration

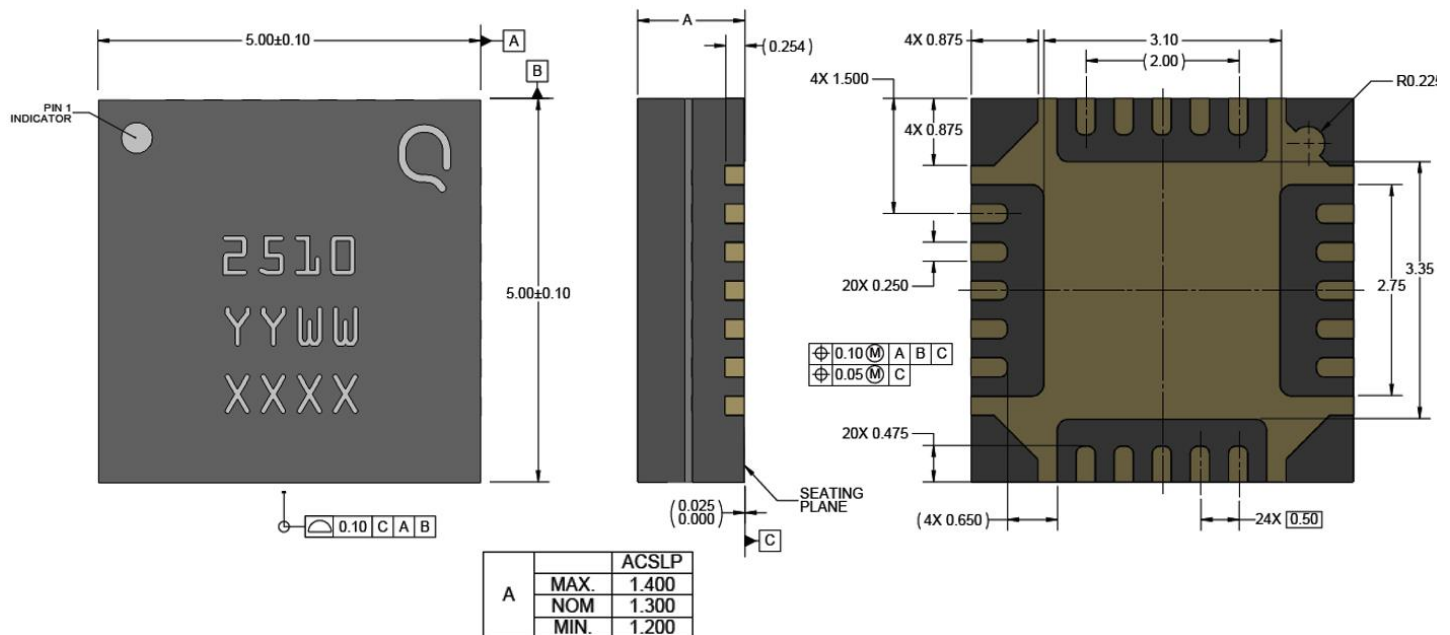
| Ref Des | Value       | Description                       | Manufacturer  | Part Number |
|---------|-------------|-----------------------------------|---------------|-------------|
| X1      |             | IF Quad Coupler, 1.35 to 2.45 GHz | Mini-Circuits | QCN-25+     |
| X1      |             | IF Quad Coupler, 2.5 to 4.0 GHz   | Mini-Circuits | QCN-45+     |
| R1      | 0 $\Omega$  | Res, 0402, 0.01W, SMD             | various       |             |
| R4      | 50 $\Omega$ | Res, 0402, 0.05W, 0.1%, SMD       | various       |             |
| R2, R3  |             | DNP                               |               |             |

### USB Configuration

| Ref Des | Value       | Description                       | Manufacturer  | Part Number |
|---------|-------------|-----------------------------------|---------------|-------------|
| X1      |             | IF Quad Coupler, 1.35 to 2.45 GHz | Mini-Circuits | QCN-25+     |
| X1      |             | IF Quad Coupler, 2.5 to 4.0 GHz   | Mini-Circuits | QCN-45+     |
| R3      | 0 $\Omega$  | Res, 0402, 0.01W, SMD             | various       |             |
| R2      | 50 $\Omega$ | Res, 0402, 0.05W, 0.1%, SMD       | various       |             |
| R1, R4  |             | DNP                               |               |             |

Note: Due to bandwidth limitations of IF quad coupler, two versions of coupler were used on EVBs, users need to choose low or high band of IF to be used, in addition to LSB and USB selection. Refer to ordering information section for details.

## Package Marking and Dimensions



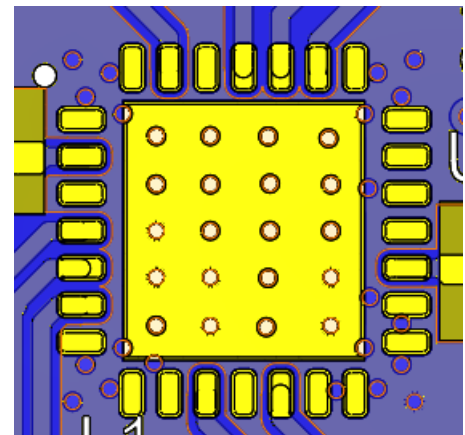
The TGC2510-SM will be marked with the “2510” designator. The “YY” represents the last two digits of the year the part was manufactured, the “WW” is the work week, and the “XXXX” is batch ID.

This package is lead-free/RoHS-compliant with a copper alloy base (CDA194), and the plating material on the leads is NiPdAu. It is compatible with a lead-free (maximum 260 °C reflow temperature) soldering process.

## PCB Mounting Pattern

Notes:

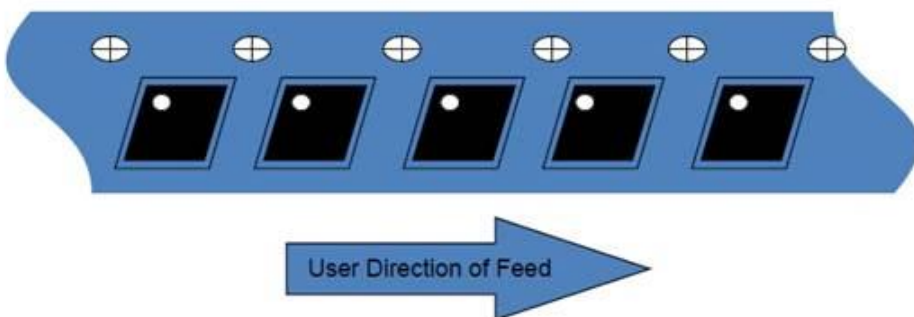
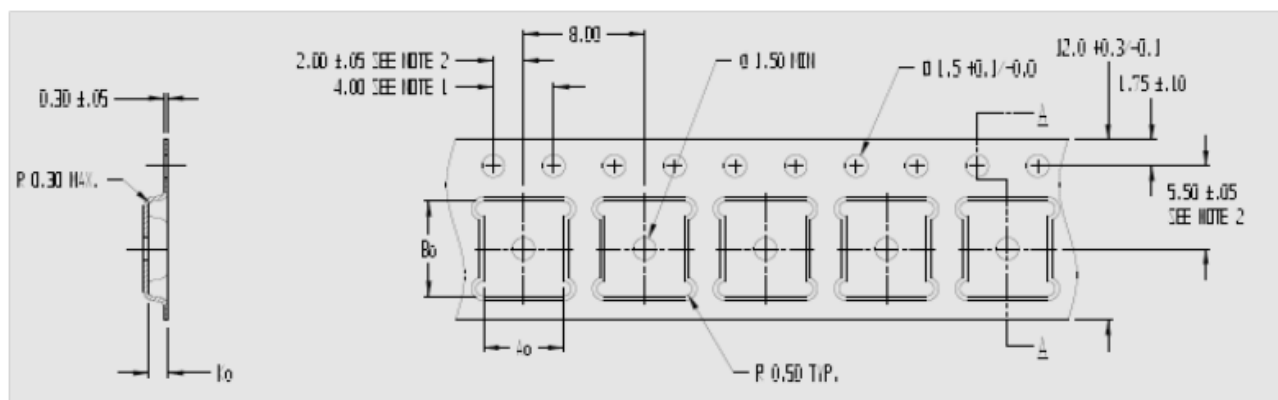
1. The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from company to company, careful process development is recommended.
2. Ground / thermal vias are critical for the proper performance of this device. Vias should use a .35mm diameter drill and have a final plated thru diameter of .25 mm.



### Tape and Reel Information

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

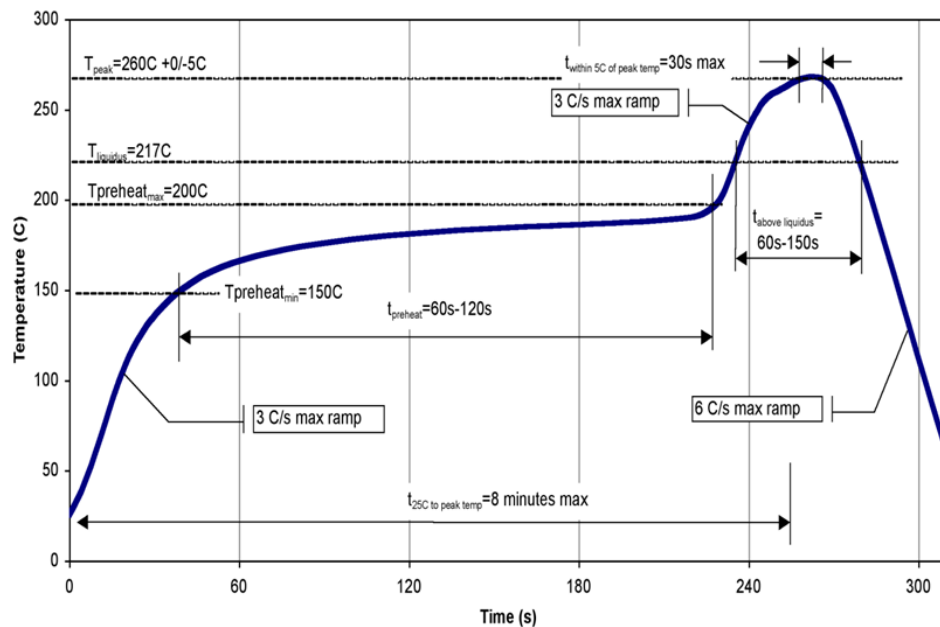
| Material |                    | Cavity (mm) |            |            |            | Distance Between Centerline (mm) |                     | Carrier Tape (mm) | Cover Carrier (mm) |
|----------|--------------------|-------------|------------|------------|------------|----------------------------------|---------------------|-------------------|--------------------|
| Vendor   | Vendor P/N         | Length (A0) | Width (B0) | Depth (K0) | Pitch (P1) | Length direction (P2)            | Width Direction (F) | Width (W)         | Width (W)          |
| Tek-Pak  | QFN0500X0500F-L500 | 5.3         | 5.3        | 1.65       | 8.0        | 2.00                             | 5.50                | 12.0              | 9.20               |



## 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.

## Recommended Soldering Temperature Profile



### Handling Precautions

| Parameter                        | Rating  | Standard                 |
|----------------------------------|---------|--------------------------|
| ESD – Human Body Model (HBM)     | Class 0 | ESDA / JEDEC JS-001-2012 |
| MSL – Moisture Sensitivity Level | Level 1 | 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 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)

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

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