

RFMD Green, RoHS Compliant, Pb-Free (Z Part Number)  
Package: TSSOP, 16-Pin, 5.0mmx6.4mmx1.0mm

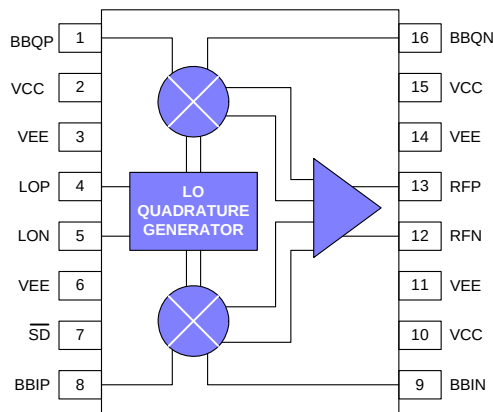
### Product Description

RFMD's STQ-2016 is a direct quadrature modulator targeted for use in a wide range of communications systems, including cellular/PCS, CDMA2000, UMTS, and ISM datacom. This device features a wide 700MHz to 2500MHz operating frequency band, excellent carrier and sideband suppression, and a low broadband noise floor.

The STQ-2016 uses silicon germanium (SiGe) device technology and delivers a typical output power of -11dBm with typical 60dB IM3 suppression. A digital input shut-down feature is included that, when enabled, attenuates the output by 60dB. The device is packaged in an industry standard 16-pin TSSOP with exposed paddle for superb RF and thermal ground.

#### Optimum Technology Matching® Applied

- ☐ GaAs HBT
- ☐ GaAs MESFET
- ☐ InGaP HBT
- ☐ SiGe BiCMOS
- ☐ Si BiCMOS
- ☒ SiGe HBT
- ☐ GaAs pHEMT
- ☐ Si CMOS
- ☐ Si BJT
- ☐ GaN HEMT
- ☐ InP HBT
- ☐ BiFET HBT
- ☐ LDMOS



### Features

- Excellent Carrier Feedthrough, -40dBm Constant with Output Power
- Output P1dB +3dBm
- Wide Baseband Input, DC to 500MHz
- Superb Phase Accuracy and Amplitude Balance,  $\pm 0.5^\circ\text{C}/\pm 0.2\text{dB}$
- Very Low Noise Floor, -155dBm/Hz
- Low LO Drive Requirement, -5dBm

### Applications

- Cellular/PCS/CDMA2000/UMTS Transceivers
- ISM Band Transceivers, 900MHz and 2400MHz
- GMSK, QPSK, QAM, SSB Modulators

| Parameter                           |        | 700 MHz to 1000 MHz |       |       | 1700 MHz to 2500 MHz |       |       |                                                                         |
|-------------------------------------|--------|---------------------|-------|-------|----------------------|-------|-------|-------------------------------------------------------------------------|
|                                     | Unit   | Min.                | Typ.  | Max.  | Min.                 | Typ.  | Max.  | Comments                                                                |
| RF Output:<br>T <sub>A</sub> =25 °C |        |                     |       |       |                      |       |       |                                                                         |
| RF Frequency Range                  | MHz    | 700                 |       | 1000  | 1700                 |       | 2500  |                                                                         |
| Output Power                        | dBm    | -13.0               | -10.5 | -9.0  | -15.0                | -11.5 | -9.0  | Baseband 200kHz @ 600mV <sub>P,P</sub> differential                     |
| RF Port Return Loss                 | dB     |                     | 20    |       |                      | 16    |       | Matched to 50Ω (refer to schematics on pages 6 and 7)                   |
| Output P1dB                         | dBm    | +3                  | +4    |       | 0                    | +3    |       | (I/Q inputs=3.74V <sub>P,P</sub> differential typical)                  |
| Carrier Feedthrough                 | dBm    |                     | -40   | -34   |                      | -40   | -32   |                                                                         |
| Sideband Suppression                | dB     | 34                  | 40    |       | 34                   | 40    |       |                                                                         |
| IM3 Suppression                     | dB     | 55                  | 60    |       | 55                   | 60    |       | Two-tone baseband input @ 600mV <sub>P,P</sub> differential per tone    |
| Broadband Noise Floor               | dBm/Hz |                     | -154  | -152  |                      | -155  | -153  | Baseband inputs tied to 1.9V <sub>DC</sub> , -20MHz offset from carrier |
| Quadrature Phase Error              | deg    | -2.0                | ±0.5  | +2.0  | -2.0                 | ±0.5  | +2.0  |                                                                         |
| I/Q Amplitude Balance               | dB     | -0.20               | ±0.05 | +0.20 | -0.20                | ±0.05 | +0.20 |                                                                         |
| Supply Voltage (V <sub>CC</sub> )   | V      | +4.75               | +5.00 | +5.25 | +4.75                | +5.00 | +5.25 |                                                                         |
| Supply Current                      | mA     |                     | 73    | 86    |                      | 73    | 86    |                                                                         |
| Device Thermal Resistance           | °C/W   |                     | 25    |       |                      | 25    |       |                                                                         |

## Absolute Maximum Ratings

| Parameter                                           | Rating      | Unit        |
|-----------------------------------------------------|-------------|-------------|
| Supply Voltage ( $V_{CC}$ )                         | 6.0         | $V_{DC}$    |
| LO, RF Input (LOP, LON, RFP, RFN)                   | +10         | dBm         |
| Baseband Min Input Voltage (BBIP, BBIN, BBQP, BBQN) | 0           | $V_{DC}$    |
| Baseband Max Input Voltage (BBIP, BBIN, BBQP, BBQN) | 3           | $V_{DC}$    |
| Operating Temperature                               | -40 to +85  | $^{\circ}C$ |
| Storage Temperature                                 | -65 to +150 | $^{\circ}C$ |

Operation of this device beyond any one of these limits may cause permanent damage. For reliable continuous operation, the device voltage and current must not exceed the maximum operating values specified in the table on page one.



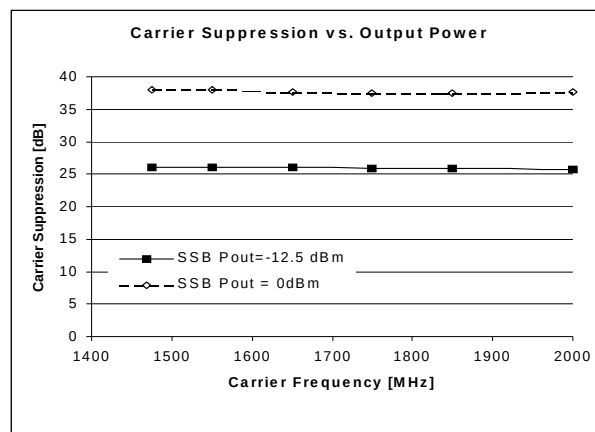
Caution! ESD sensitive device.

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. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

RoHS status based on EUDirective 2002/95/EC (at time of this document revision).

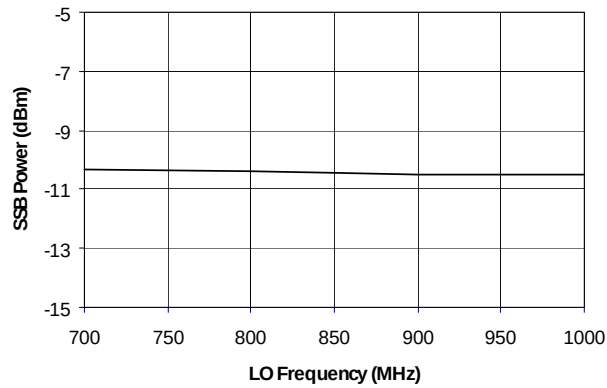
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| Parameter                                                                                                                                                                                                                                                                                                                      | Specification |      |                 | Unit | Condition                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|-----------------|------|---------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                | Min.          | Typ. | Max.            |      |                                                   |
| Product Specifications                                                                                                                                                                                                                                                                                                         |               |      |                 |      | Baseband Modulation Input: T <sub>A</sub> =25 °C  |
| Baseband Frequency Input                                                                                                                                                                                                                                                                                                       | DC            |      | 500             | MHz  | -3dB bandwidth, baseband inputs terminated in 50Ω |
| Baseband Input Resistance                                                                                                                                                                                                                                                                                                      |               | 4.4  |                 | kΩ   | per pin                                           |
| Baseband Input Capacitance                                                                                                                                                                                                                                                                                                     |               | 0.5  |                 | pF   | per pin                                           |
| Product Specifications                                                                                                                                                                                                                                                                                                         |               |      |                 |      | LO Input: T <sub>A</sub> =25 °C                   |
| LO Frequency                                                                                                                                                                                                                                                                                                                   | 700           |      | 2500            | MHz  |                                                   |
| LO Drive Level                                                                                                                                                                                                                                                                                                                 | -8            | -5   | -2              | dBm  |                                                   |
| LO Port Return Loss                                                                                                                                                                                                                                                                                                            |               | 16   |                 | dB   | Matched to 50Ω (refer to schematics)              |
| Product Specifications                                                                                                                                                                                                                                                                                                         |               |      |                 |      | Miscellaneous: T <sub>A</sub> = 25 °C             |
| Shut-Down Attenuation                                                                                                                                                                                                                                                                                                          |               | 60   |                 | dB   |                                                   |
| Shut-Down Pin Resistance                                                                                                                                                                                                                                                                                                       |               | 11.9 |                 | kΩ   | at 1MHz                                           |
| Shut-Down Pin Capacitance                                                                                                                                                                                                                                                                                                      |               | 5.2  |                 | pF   | at 1MHz                                           |
| Shut-Down Control Voltage Thresh-olds                                                                                                                                                                                                                                                                                          | 3.75          |      | V <sub>CC</sub> | V    | Shut-Down disabled (normal operation)             |
| Shut-Down Control Voltage Thresh-olds                                                                                                                                                                                                                                                                                          | 0.0           |      | 1.5             | V    | Shut-Down enabled                                 |
| Shut-Down Settling Time                                                                                                                                                                                                                                                                                                        |               | <450 |                 | ns   |                                                   |
| Test Conditions: (for all product specifications unless otherwise noted) V <sub>CC</sub> (pins 2, 10, 15): +5V, T <sub>A</sub> = +25 °C, Baseband Input (pins 1, 8, 9, 18): 1.9V DC bias, 200kHz frequency; 300mVp-p per pin=600mVp-p differential drive, I and Q signals in quadrature, LO Input (pins 4, 5)=-5dBm at 1960MHz |               |      |                 |      |                                                   |

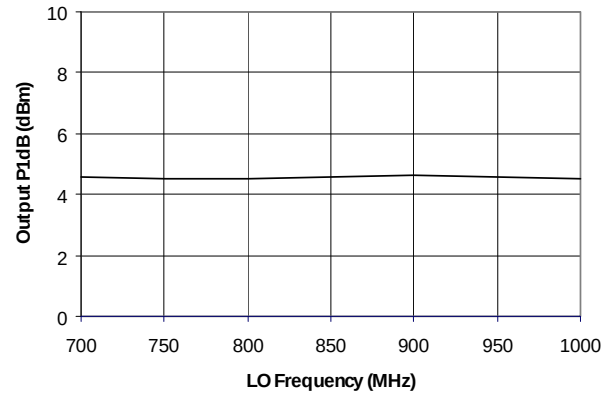


## 700MHz to 1000MHz Typical Device Performance

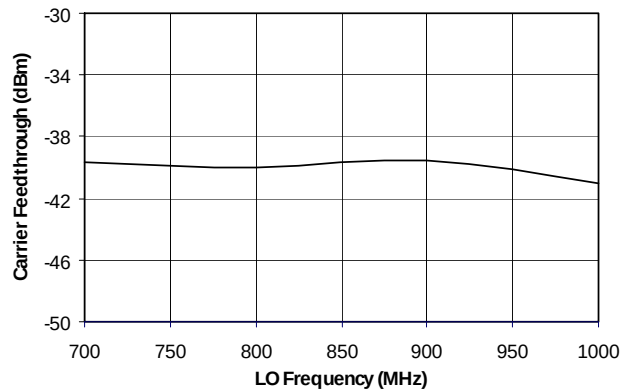
SSB Power vs. LO Frequency



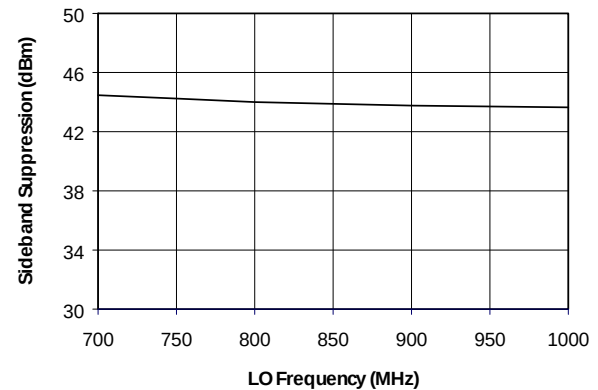
Output P1dB vs. LO Frequency



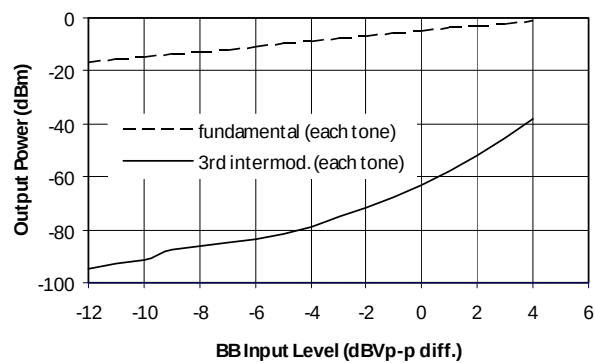
Carrier Feedthrough vs. LO Frequency



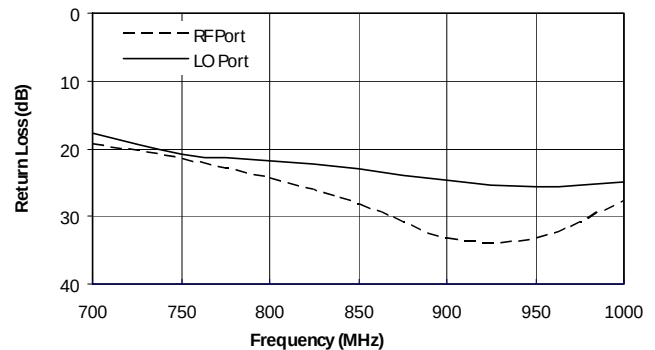
Sideband Suppression vs. LO Frequency



Intermodulation Distortion vs. SSB Output Power @ 880 MHz

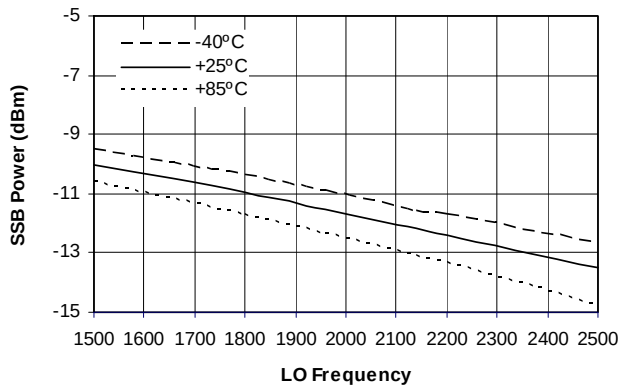


RF & LO Port Return Losses

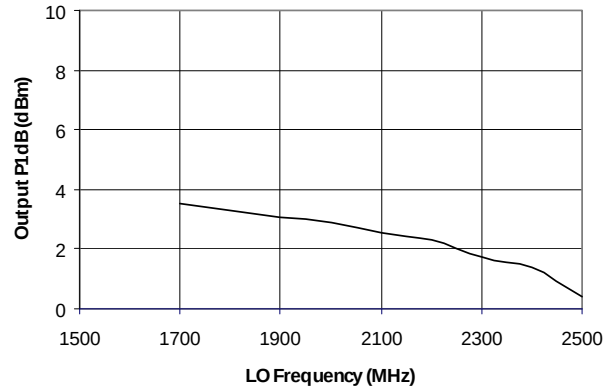


## 1500MHz to 2500MHz Typical Device Performance

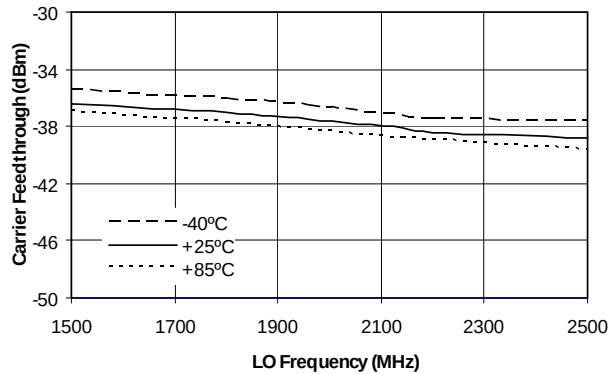
SSB Power vs. LO Frequency



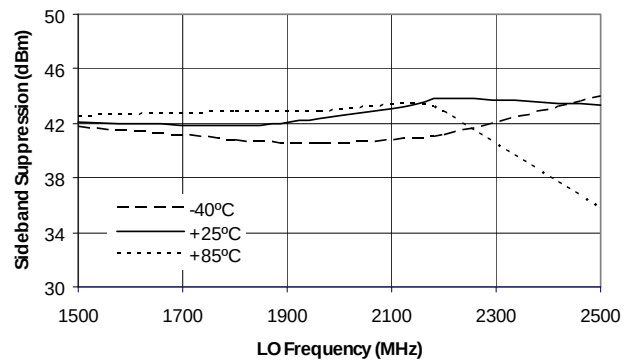
Output P1dB vs. LO Frequency



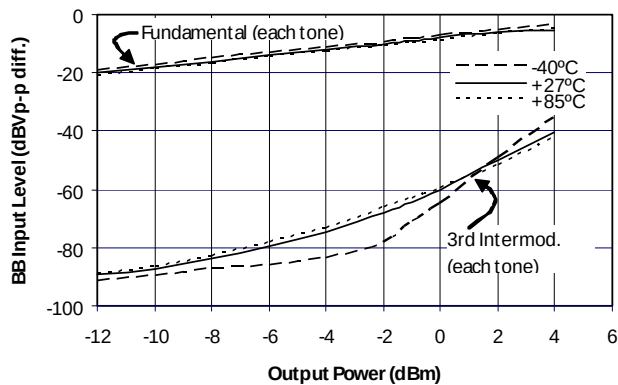
Carrier Feedthrough vs. LO Frequency



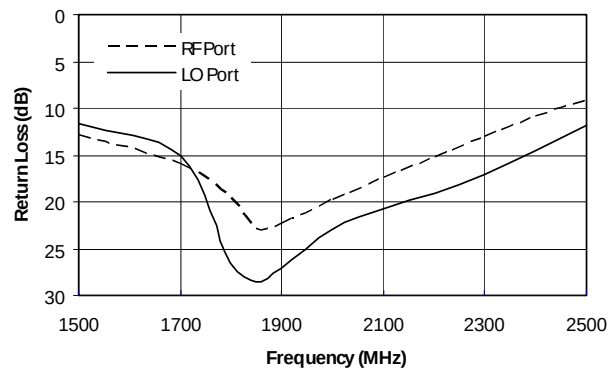
Sideband Suppression vs. LO Frequency



Intermodulation Distortion vs. SSB Output Power @1960 MHz

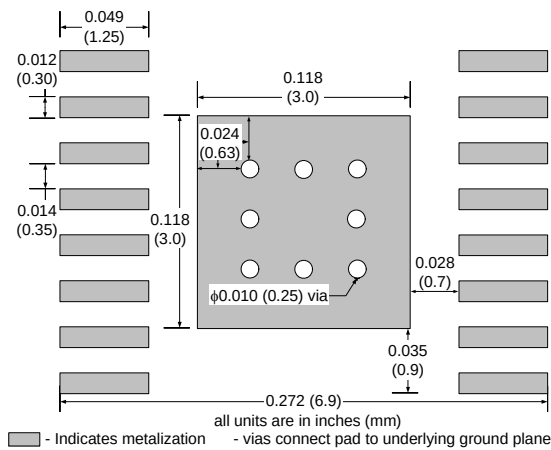


RF & LO Port Return Losses



| Pin          | Function | Description                                                                                        |
|--------------|----------|----------------------------------------------------------------------------------------------------|
| 1            | BBQP     | Q-channel baseband input, positive terminal. Nominal DC voltage is 1.9V (biased internally).       |
| 2, 10, 15    | VCC      | Positive supply (+5V).                                                                             |
| 3, 6, 11, 14 | VEE      | Ground.                                                                                            |
| 4            | LOP      | Local oscillator input, positive terminal. Nominal DC voltage is 2.0V. Input should be AC-coupled. |
| 5            | LON      | Local oscillator input, negative terminal. Nominal DC voltage is 2.0V. Input should be AC-coupled. |
| 7            | SD       | Shut-down control. Logic high=normal operation; logic low=shut-down enabled.                       |
| 8            | BBIP     | I-channel baseband input, positive terminal. Nominal DC bias voltage is 1.9V (biased internally).  |
| 9            | BBIN     | I-channel baseband input, negative terminal. Nominal DC bias voltage is 1.9V (biased internally).  |
| 12           | RFN      | RF output, negative terminal. Nominal DC voltage is 2.4V. Output should be AC-coupled.             |
| 13           | RFP      | RF output, positive terminal. Nominal DC voltage is 2.4V. Output should be AC-coupled.             |
| 16           | BBQN     | Q-channel baseband input, negative terminal. Nominal DC bias voltage is 1.9V (biased internally).  |

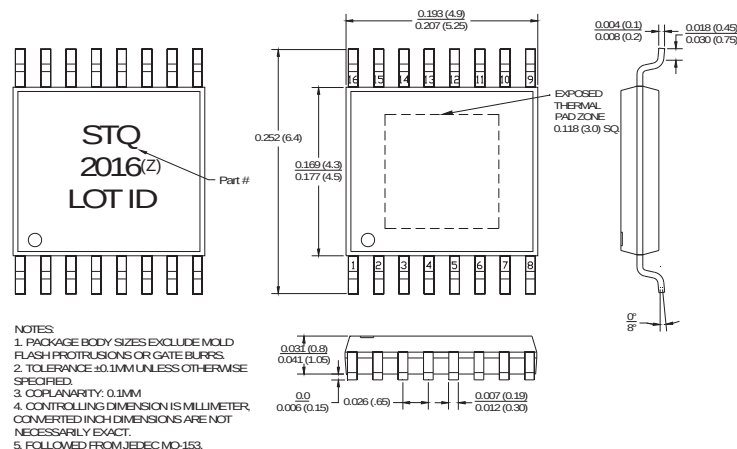
### Suggested Pad Layout



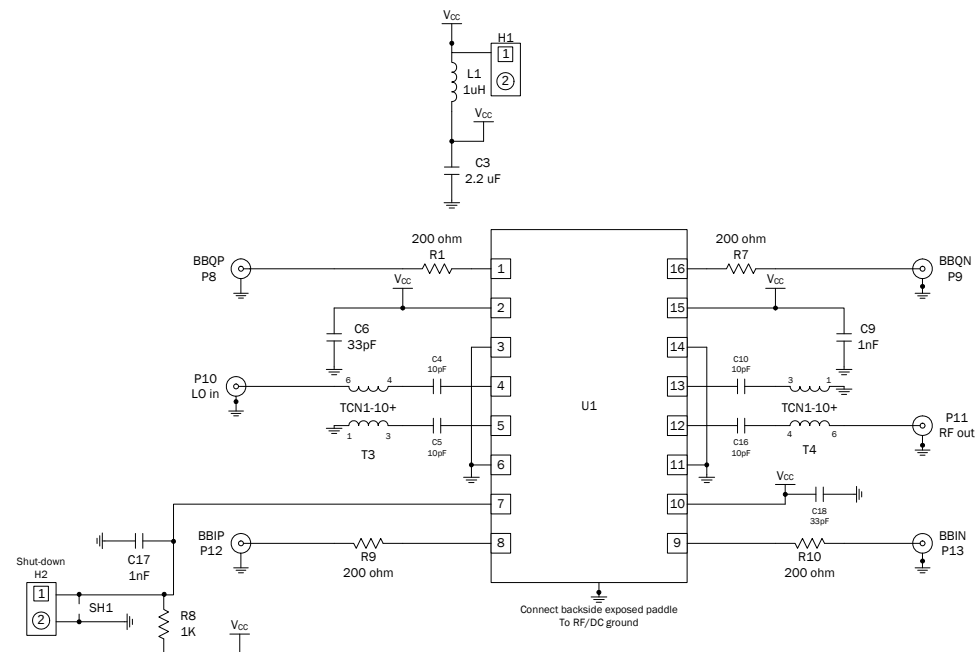
### Package Drawing

Dimensions in inches (millimeters)

Refer to drawing posted at [www.rfmd.com](http://www.rfmd.com) for tolerances.



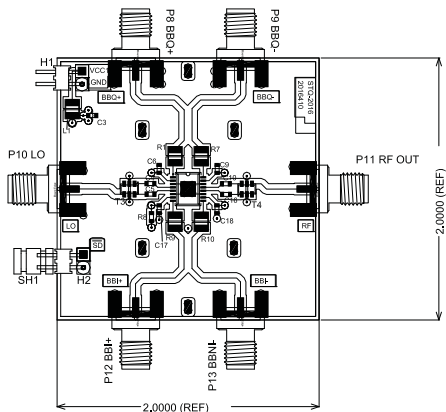
700MHz to 1000MHz Application Schematic



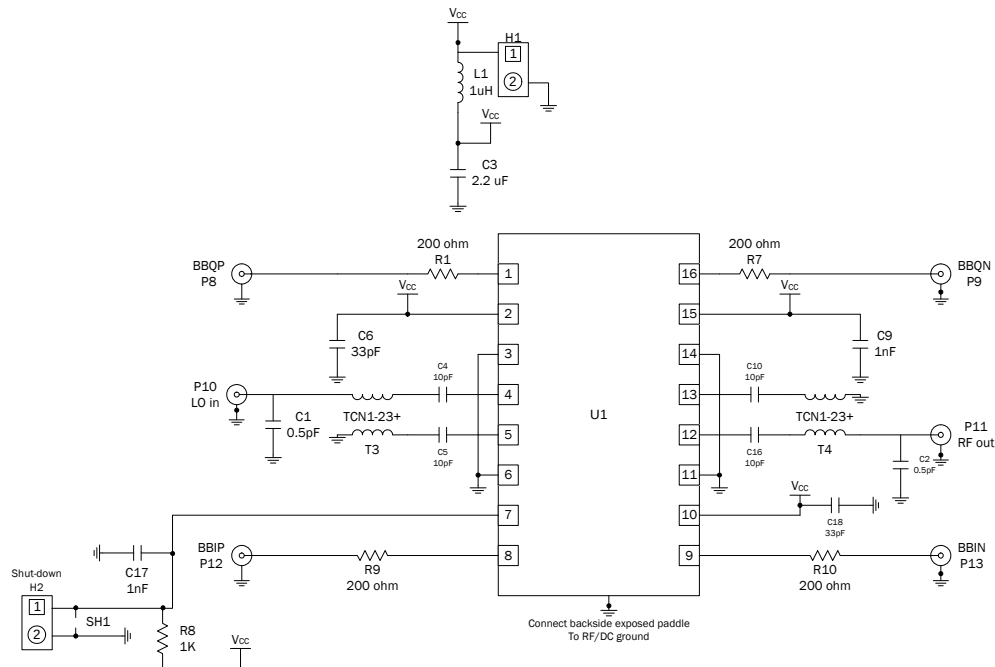
Bill of Materials (for 700MHz to 1000MHz Evaluation Board P/N STQ-2016EVB-1)

| Qty | Description                              | Ref. Designator       | Manufacturer            | Mfg Part Number    | Sub Ok? |
|-----|------------------------------------------|-----------------------|-------------------------|--------------------|---------|
| 1   | SiGe (HBT) Quad Modulator, 70mA          | U1                    | RFMD                    | STQ-2016           | N       |
| 6   | CONN, SMA END LAUNCH, 0.062"             | P8, 9, 10, 11, 12, 13 | Johnson Components, INC | 142-0701-851       | Y       |
| 2   | 2-pin header, right angle                | H1, H2                | MOLEX                   | 68142-0221         | Y       |
| 1   | PCB, 2016                                |                       | DDI                     | STQ2016410(A)      | N       |
| 2   | RF transormer, 680-1050MHz               | T3, T4                | Mini-Circuits           | TCN1-10+           | N       |
| 1   | Inductor, 1210 footprint, ±10% tol. 1uH  | L1                    | Panasonic               | ELJ-FA1R0KF2       | Y       |
| 4   | Resistor, 1206 footprint, ±10% tol. 200Ω | R1, 7, 9, 10          | Panasonic               | ERJ-8ENF2000       | Y       |
| 1   | Resistor, 0603 footprint, ±1% tol. 1KΩ   | R8                    | Panasonic               | ERA-3YEB102V       | Y       |
| 2   | Capacitor, 0603 footprint, ±5% tol. 33pF | C6, C18               | Panasonic               | ECJ-1VC1H330J      | Y       |
| 2   | Capacitor, 0603 footprint, ±5% tol. 1nF  | C9, 17                | Panasonic               | ECJ-1VB2A102K      | Y       |
| 1   | CAP, 2.2uF, 10%, 10V, X5R, 0603          | C3                    | Murata Electronics      | GRM188R61A225KE34D | Y       |
| 4   | Capacitor, 0603 footprint, ±5% tol. 10pF | C4, 5, 10, 16         | Panasonic               | ECJ-1VC1H100D      | Y       |
| 1   | Shunt for two pin header                 | SH1                   | 3M                      | 929950-00          | Y       |

Fully Assembled PCB



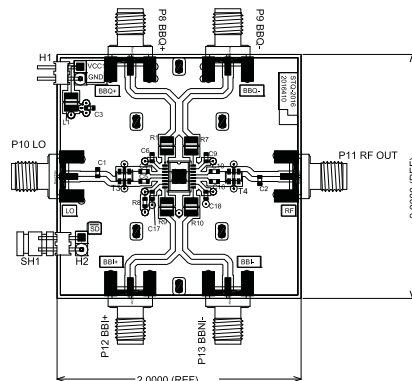
## 1.7 GHz to 2.5 GHz Application Schematic



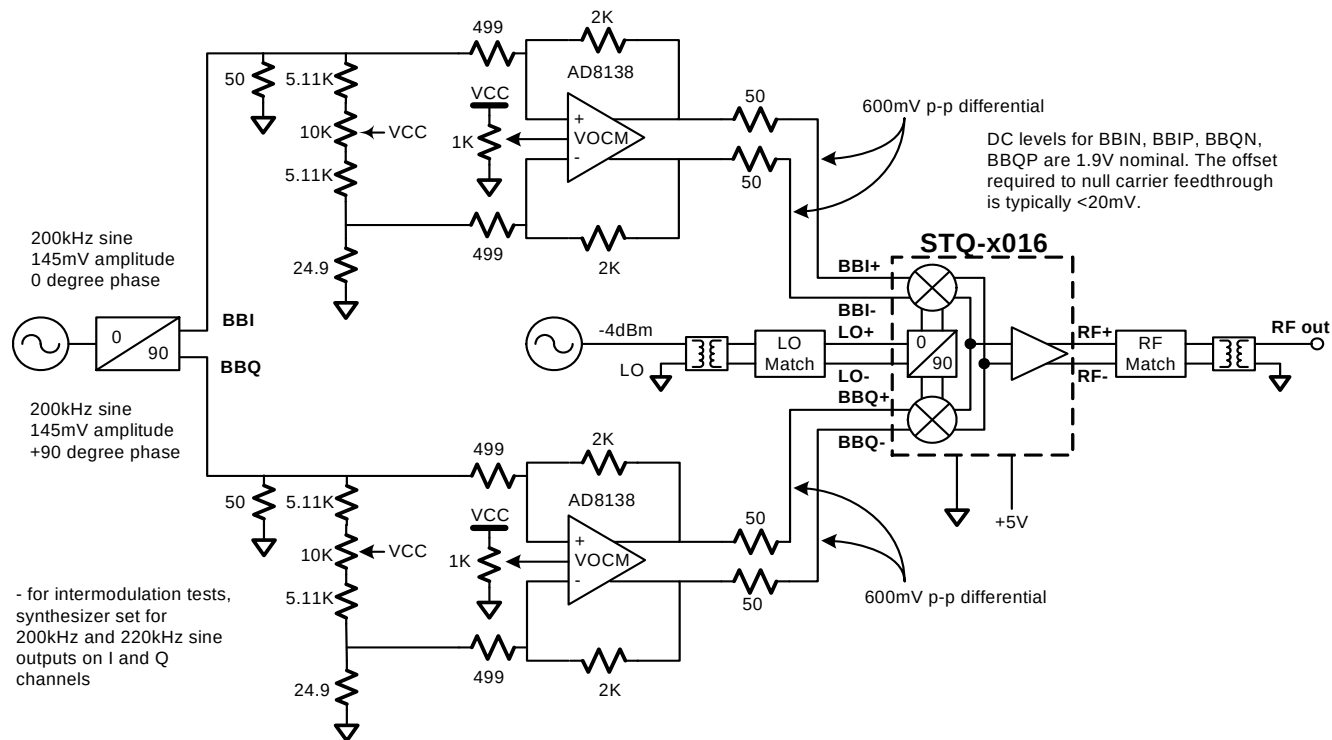
Bill of Materials (for 1700MHz to 2500MHz Evaluation Board P/N STQ-2016EVB2)

| Qty | Description                                            | Ref. Designator       | Manufacturer            | Mfg Part Number     | Sub Ok? |
|-----|--------------------------------------------------------|-----------------------|-------------------------|---------------------|---------|
| 1   | SiGe (HBT) Quad Modulator, 70mA                        | U1                    | RFMD                    | STQ-2016            | N       |
| 6   | CONN, SMA END LAUNCH, 0.062"                           | P8, 9, 10, 11, 12, 13 | Johnson Components, INC | 142-0701-851        | Y       |
| 2   | 2-pin header, right angle                              | H1, H2                | MOLEX                   | 68142-0221          | Y       |
| 1   | PCB, 2016                                              |                       | DDI                     | STQ2016410(A)       | N       |
| 2   | RF transformer, 1300-2300MHz                           | T3, T4                | Mini-Circuits           | TCN1-23+            | N       |
| 1   | Inductor, 1210 footprint, $\pm 10\%$ tol. 1uH          | L1                    | Panasonic               | ELJ-FA1R0KF2        | Y       |
| 4   | Resistor, 1206 footprint, $\pm 10\%$ tol. 200 $\Omega$ | R1, 7, 9, 10          | Panasonic               | ERJ-8ENF2000        | Y       |
| 1   | Resistor, 0603 footprint, $\pm 1\%$ tol. 1K $\Omega$   | R8                    | Panasonic               | ERA-3YEB102V        | Y       |
| 2   | Capacitor, 0603 footprint, $\pm 5\%$ tol. 33pF         | C6, C18               | Panasonic               | ECJ-1VC1H330J       | Y       |
| 2   | Capacitor 0603 footprint, $\pm 5\%$ tol. 0.5pF         | C1, C2                | Murata                  | GRM1885C1HR050BZ01D | Y       |
| 2   | Capacitor, 0603 footprint, $\pm 5\%$ tol. 1nF          | C9, 17                | Panasonic               | ECJ-1VB2A102K       | Y       |
| 1   | CAP, 2.2uF, 10% 10V, X5R, 0603                         | C3                    | Murata Electronics      | GRM188R61A225KE34D  | Y       |
| 4   | Capacitor, 0603 footprint, $\pm 5\%$ tol. 10pF         | C4, 5, 10, 16         | Panasonic               | ECJ-1VC1H100D       | Y       |
| 1   | Shunt for two pin header                               | SH1                   | 3M                      | 929950-00           | Y       |

## Fully Assembled PCB



Direct Quadrature Modulator: General Test Set-Up



Ordering Information

| Part Number | Reel Size | Devices/Reel |
|-------------|-----------|--------------|
| STQ-2016    | 7"        | 1000         |
| STQ-2016Z   | 7"        | 1000         |