

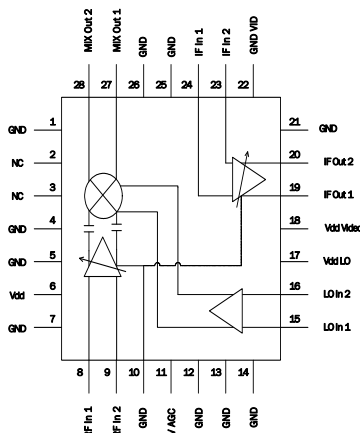


### Product Description

RFMD's S510065 is a downconverter designed to be used as an Out-of-Band Tuner for use in CATV set-top box and Digital Cable Ready TV applications. The S510065 consists of an input AGC amplifier, mixer, and a video/AGC amplifier. This device offers optimum performance with low power consumption and low distortion. The product is RoHS compliant. The smaller and more cost effective RFFC0085 is the new generation of this product.

#### 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
- ☐ RF MEMS
- ☐ LDMOS



### Features

- 3.3V Single Supply Operation
- Low Power Consumption (400mW)
- Low Distortion: -55dBc at 1V<sub>PP</sub>
- 82dB Total Conversion Gain
- 55dB Total Gain Control Range
- Low LO-RF Leakage

### Applications

- Cable Set-Top Boxes
- Digital Cable Ready TV Sets

| Parameter                    | Specification |      |      | Unit            | Condition                                      |
|------------------------------|---------------|------|------|-----------------|------------------------------------------------|
|                              | Min.          | Typ. | Max. |                 |                                                |
| RF Input Frequency Range     | 50            |      | 150  | MHz             | High Side L.O.                                 |
| LO Input Frequency Range     | 80            |      | 220  | MHz             | High Side L.O.                                 |
| Maximum Conversion Gain      |               | 82   |      | dB              | Includes saw filter loss                       |
| AGC Voltage                  | 0             |      | 3    | V               |                                                |
| AGC Dynamic Range            | 50            | 55   |      | dB              | V <sub>AGC</sub> =0V to 3V                     |
| Third Order Intermodulation  | 50            | 55   |      | dBc             | 1V <sub>PP</sub> Differential Output, 1KΩ load |
| IF Output Level              |               | 1    | 2    | V <sub>PP</sub> | Differential Output, 1KΩ load                  |
| Noise Figure                 |               | 13   | 15   | dB              | V <sub>AGC</sub> =3V                           |
| RF Amp/Mixer Conversion Gain |               | 41   |      | dB              | V <sub>AGC</sub> =3V                           |
| Video Amplifier Gain         |               |      | 55   | dB              | V <sub>AGC</sub> =3V                           |
| LO leakage at the RF port    |               | -95  | -85  | dBm             |                                                |
| <b>DC Performance</b>        |               |      |      |                 |                                                |
| Supply Voltage               | 3.2           | 3.3  | 3.4  | V               |                                                |
| Supply Current               |               | 117  | 140  | mA              |                                                |

Test Conditions: T<sub>A</sub>=25°C, V<sub>DD</sub>=3.3V, unless otherwise specified

## Absolute Maximum Ratings

| Parameter                            | Rating       | Unit |
|--------------------------------------|--------------|------|
| Supply Voltage ( $V_{DD}$ , GND)     | -0.3 to +3.6 | V    |
| Operating Temperature ( $T_{OP}$ )   | -40 to +85   | °C   |
| Storage Temperature ( $T_{STG}$ )    | -65 to +150  | °C   |
| Junction Temperature                 | +150         | °C   |
| Thermal Resistance ( $\theta_{JA}$ ) | 34           | °C/W |

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 EU Directive 2011/65/EU (at time of this document revision).

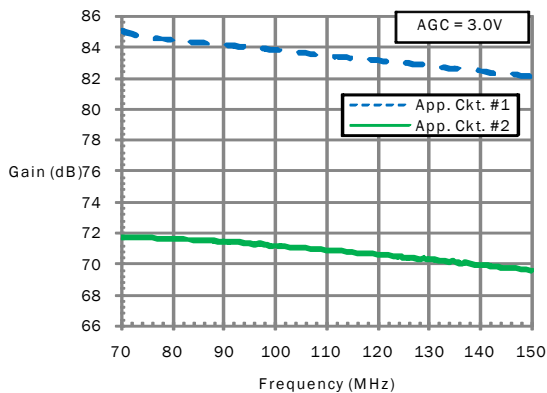
The information in this publication is believed to be accurate and reliable. However, no responsibility is assumed by RF Micro Devices, Inc. ("RFMD") for its use, nor for any infringement of patents, or other rights of third parties, resulting from its use. No license is granted by implication or otherwise under any patent or patent rights of RFMD. RFMD reserves the right to change component circuitry, recommended application circuitry and specifications at any time without prior notice.



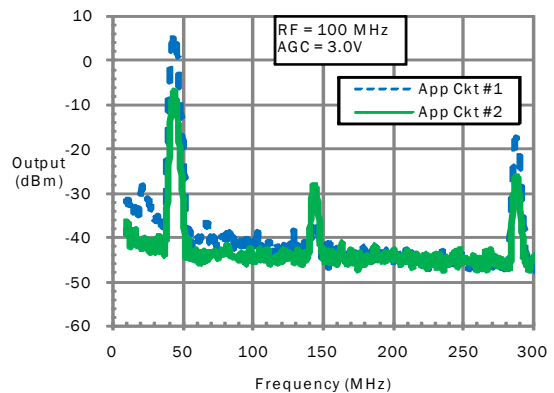
RFMD Green: RoHS compliant per EU Directive 2011/65/EU, halogen free per IEC 61249-2-21, < 1000 ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

## Typical Performance Curves

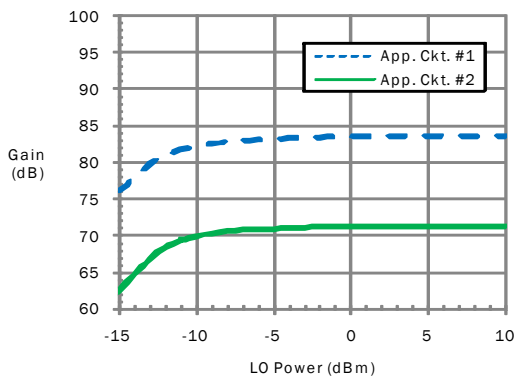
Conversion Gain vs. RF



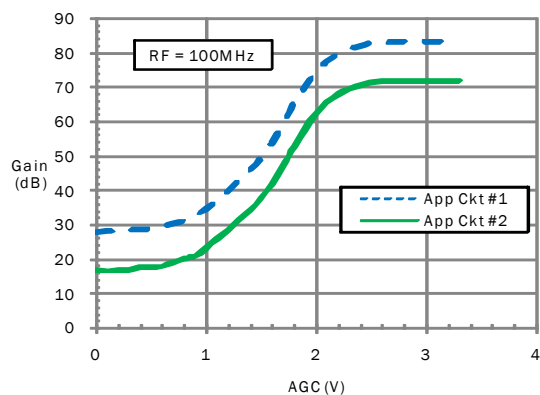
IF Output vs. Frequency



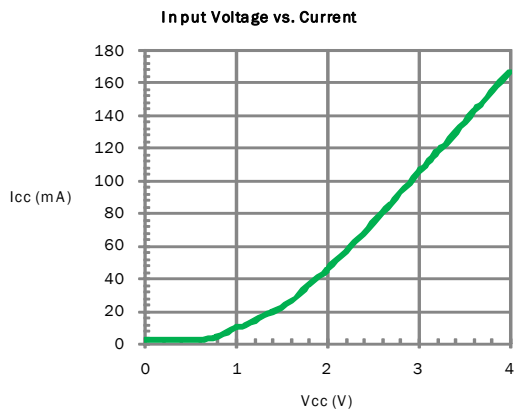
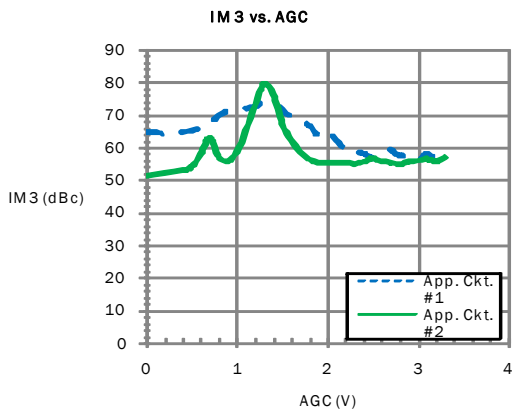
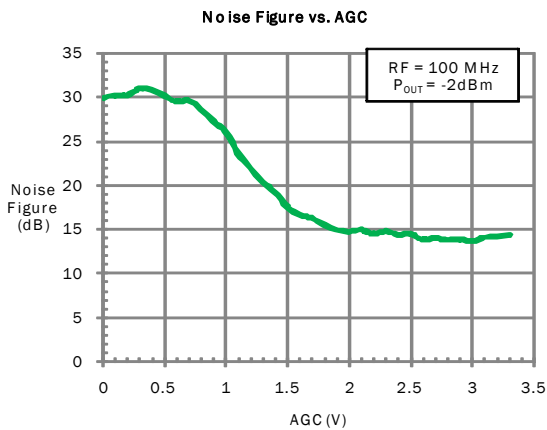
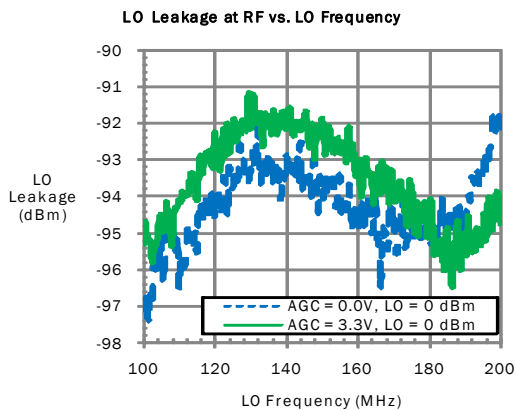
Conversion Gain vs. LO Power



Conversion Gain vs. AGC



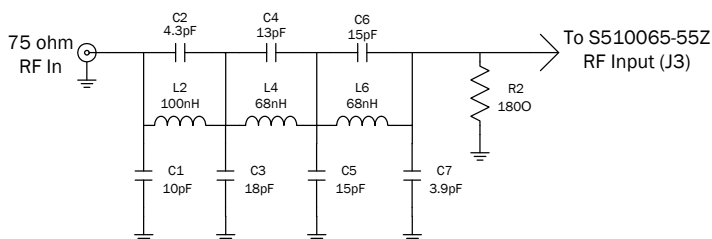
## Typical Performance Curves Continued



| Pin                                                   | Function        | Description                                                                                                       |
|-------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------|
| <b>1,4,5,<br/>10,12,<br/>13,14,<br/>21,25,<br/>26</b> | <b>GND</b>      | Ground pins. Connect to the ground plane with shortest possible length to minimize inductance.                    |
| <b>2</b>                                              | <b>MIX IN2</b>  | No connection.                                                                                                    |
| <b>3</b>                                              | <b>MIX IN1</b>  | No connection.                                                                                                    |
| <b>6</b>                                              | <b>VDD RF</b>   | RF AMP Supply, +3.3V                                                                                              |
| <b>7</b>                                              | <b>GND RF</b>   | RF AMP Ground. See GND.                                                                                           |
| <b>8</b>                                              | <b>RF IN1</b>   | RF AMP Positive Input, Input Impedance, 1K $\Omega$ single ended. SEE APPLICATION.                                |
| <b>9</b>                                              | <b>RF IN2</b>   | RF AMP Negative Input. SEE APPLICATION.                                                                           |
| <b>11</b>                                             | <b>AGC</b>      | Automatic Gain Control, Min Gain at AGC=0V, Max Gain at AGC=3.0V.                                                 |
| <b>15</b>                                             | <b>LO IN1</b>   | LO Buffer Positive Input                                                                                          |
| <b>16</b>                                             | <b>LO IN2</b>   | LO Buffer Negative Input.                                                                                         |
| <b>17</b>                                             | <b>VDD LO</b>   | LO Buffer Supply, +3.3V.                                                                                          |
| <b>18</b>                                             | <b>VDD VID</b>  | VIDEO AMP Input Stage Supply, +3.3V.                                                                              |
| <b>19</b>                                             | <b>IF OUT1</b>  | VIDEO AMP Negative Output. This pin and IF OUT2 form a 1K $\Omega$ output impedance. Open Drain. SEE APPLICATION. |
| <b>20</b>                                             | <b>IF OUT2</b>  | VIDEO AMP Positive Output. See IF OUT1.                                                                           |
| <b>22</b>                                             | <b>GND VID</b>  | VIDEO AMP Ground. See GND.                                                                                        |
| <b>23</b>                                             | <b>IN IN1</b>   | VIDEO AMP Negative Input.                                                                                         |
| <b>24</b>                                             | <b>IF IN2</b>   | VIDEO AMP Positive Input.                                                                                         |
| <b>27</b>                                             | <b>MIX OUT1</b> | MIXER Positive Output. Open Drain. SEE APPLICATION.                                                               |
| <b>28</b>                                             | <b>MIX OUT2</b> | MIXER Negative Output. Open Drain. SEE APPLICATION.                                                               |

## **\*Important Application Note:**

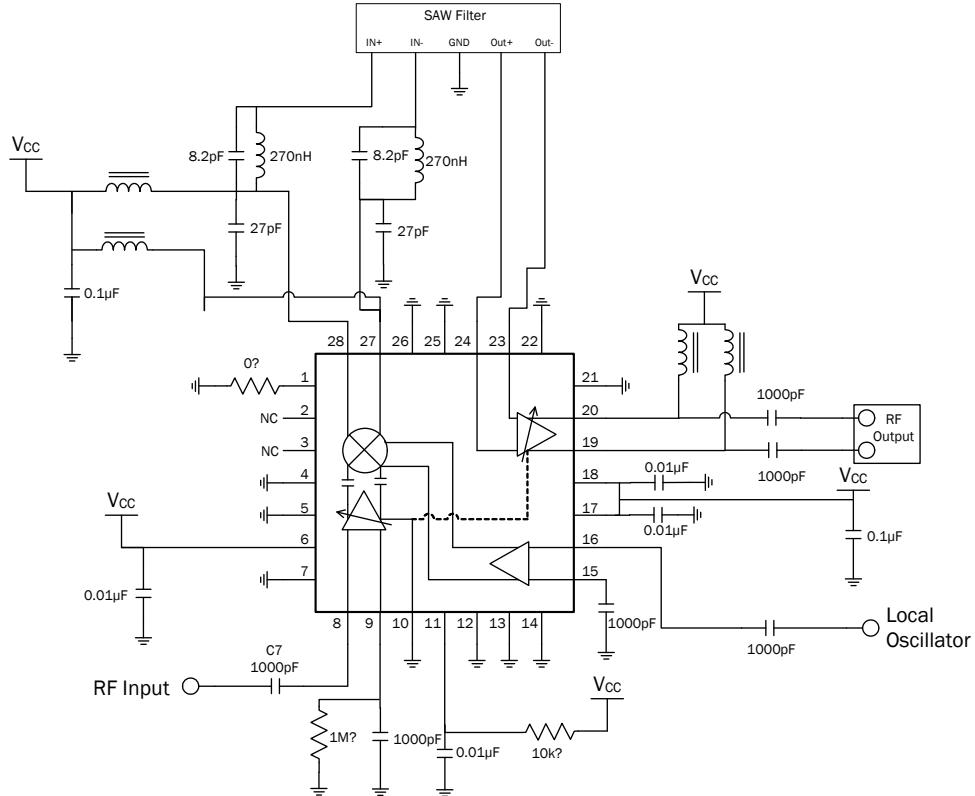
The following low pass filter should proceed the S510065-55Z in all applications. This filter is used to prevent or reduce down stream interference.



### **Component List for Low Pass Filter:**

| Circuit Symbol | Value   |
|----------------|---------|
| C7             | 3.9pF   |
| C2             | 4.3pF   |
| C1             | 10pF    |
| C4             | 13pF    |
| C5, C6         | 15pF    |
| C3             | 18pF    |
| L4, L6         | 68nH    |
| L2             | 100nH   |
| R2             | 180 ohm |

## Application Schematic - 1



### RF Amplifier

This amplifier provides a maximum gain of 29 dB. The gain is programmed by applying a DC voltage (from 0V to 3V) to the AGC pin, providing 27 dB of range.

### Downconversion Mixer

This double balanced mixer has 12 dB of conversion gain. The outputs of the mixer are both open drain and require pull-up inductors to  $V_{DD}$ .

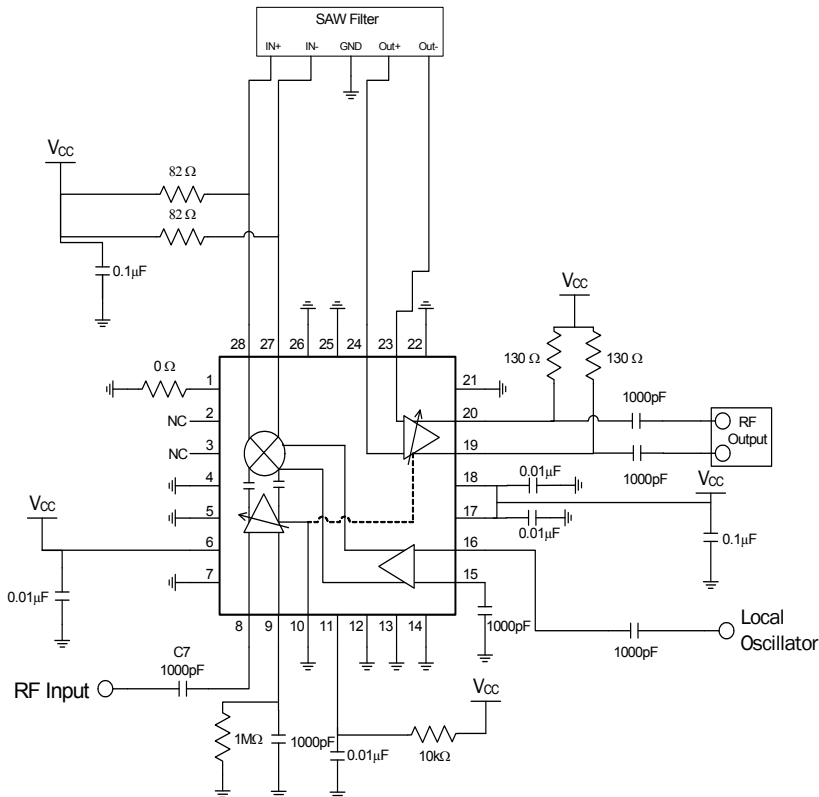
### Video Amplifier

This amplifier provides a maximum gain of 55 dB. The gain is programmed by applying a DC voltage (from 0V to 3V) to the AGC pin, providing 28 dB of range. The outputs of the video amp are both open drain and require pull-up inductors to  $V_{DD}$ .

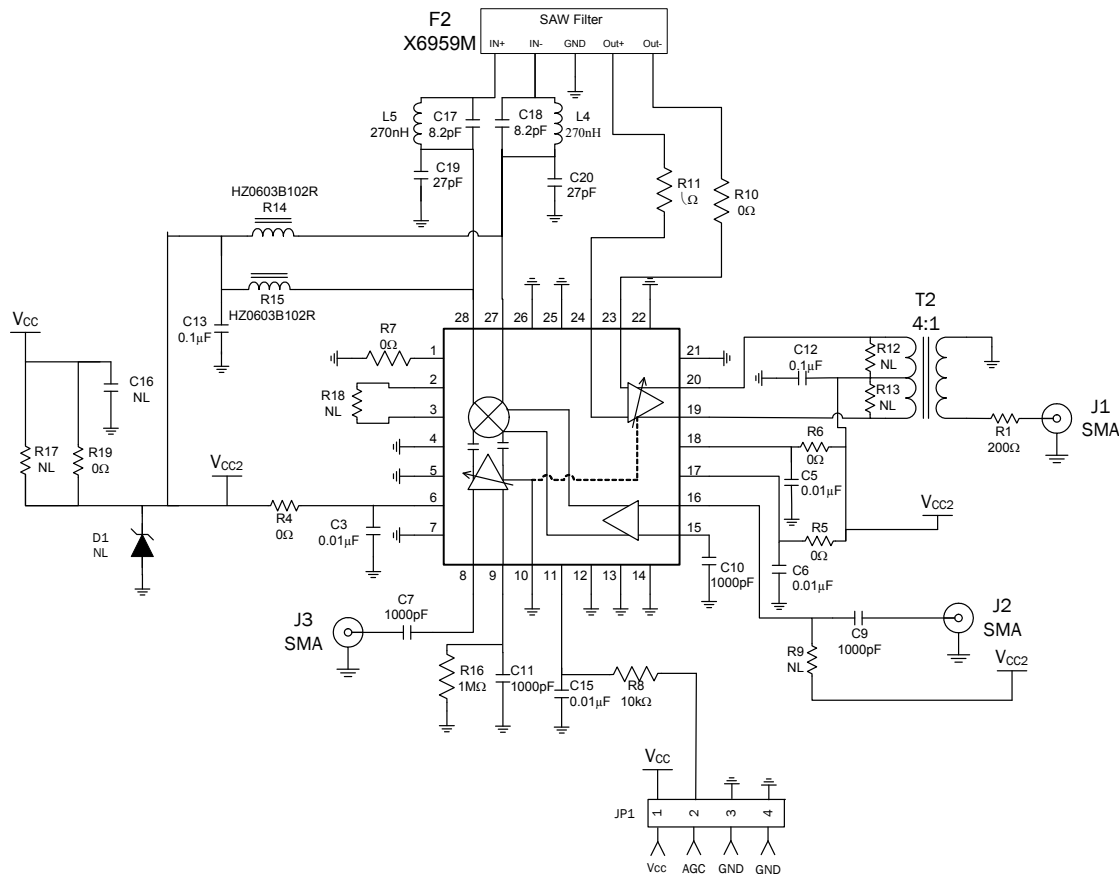
Note:

1. The RF amplifier and video amplifier are controlled by a single AGC so the overall dynamic range is the sum of the RF amplifier range and the video amplifier range.

## Application Schematic - 2



Evaluation Test Circuit



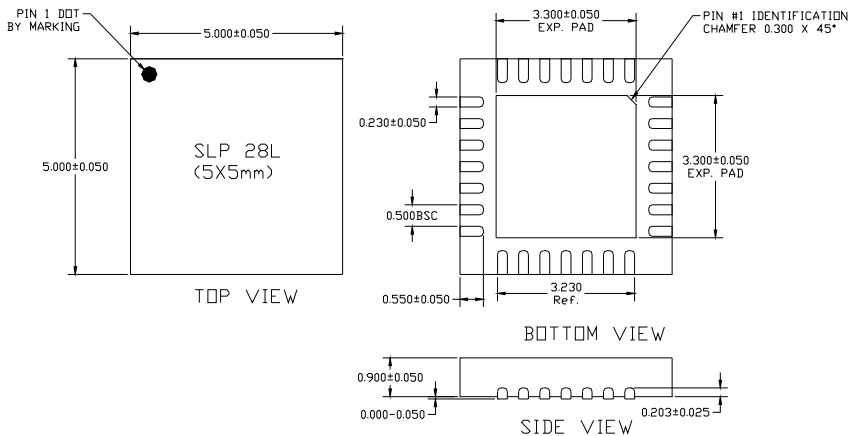
| Component Table:                |        |              |
|---------------------------------|--------|--------------|
| Circuit Symbol                  | Value  | Comments     |
| L4, L5                          | 270nH  |              |
| C12, C13                        | 0.1μH  |              |
| C17, C18                        | 8.2pF  |              |
| C19, C20                        | 27pF   |              |
| C3, C5, C6, C15                 | 0.01μH |              |
| C7, C9, C10, C11                | 1000pF |              |
| R4, R5, R6, R10, R11, R19       | 0Ω     |              |
| R8                              | 10KΩ   |              |
| R1                              | 200Ω   |              |
| R14, R15                        |        | Ferrite Bead |
| R16                             | 1MΩ    |              |
| T2                              | 4:1    |              |
| C16, D1, R9, R12, R13, R17, R18 |        | Not Placed   |
| J1, J2, J3                      |        | SMA          |
| JP1                             |        | 4 Pin Header |
| F2                              | SAW    | EPCOS X6959M |

## Package Drawing

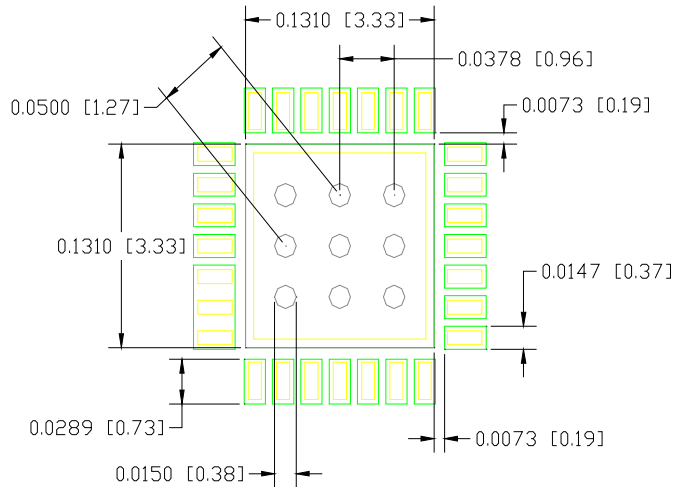
Dimensions in inches (millimeters)

QFN 28

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



## Land Pattern For Terminals and Thermal/Ground Pad



## Ordering Information

| Part Number  | Description            | Reel Size | Devices/Reel |
|--------------|------------------------|-----------|--------------|
| S51006555ZSB | 5 pcs Sample Bag       | N/A       | N/A          |
| S51006555ZSQ | 25 pcs Sample Bag      | N/A       | N/A          |
| S51006555ZSR | CATV Out of Band Tuner | 7"        | 100 pcs      |
| S51006555Z   | CATV Out of Band Tuner | 7"        | 3000 pcs     |