## Applications

- DSSS 5 GHz WLAN (IEEE802.11a)
- DSSS 5 GHz WLAN (IEEE802.11n)
- Access Points, PCMCIA, PC cards

## Features

- High output power amplifier
  - 26dBm at 5V
- External Analog Reference Voltage ($V_{REF}$) for maximum flexibility
- Buffered, temperature compensated power detector
- 3% EVM, @26dBm, 64 QAM, 54 Mbps
- 32 dB Gain
- Lead Free, RoHS compliant, halogen free MSL3 package
- 20 pin 4 mm x 4 mm x 0.9 mm QFN

## Ordering Information

| Part Number | Package | Remark |
|---|---|---|
| SE5004L | 20 Pin QFN | Samples |
| SE5004L-R | 20 Pin QFN | Tape and Reel |
| SE5004L-EK1 | Evaluation Kit | Standard |

## Product Description

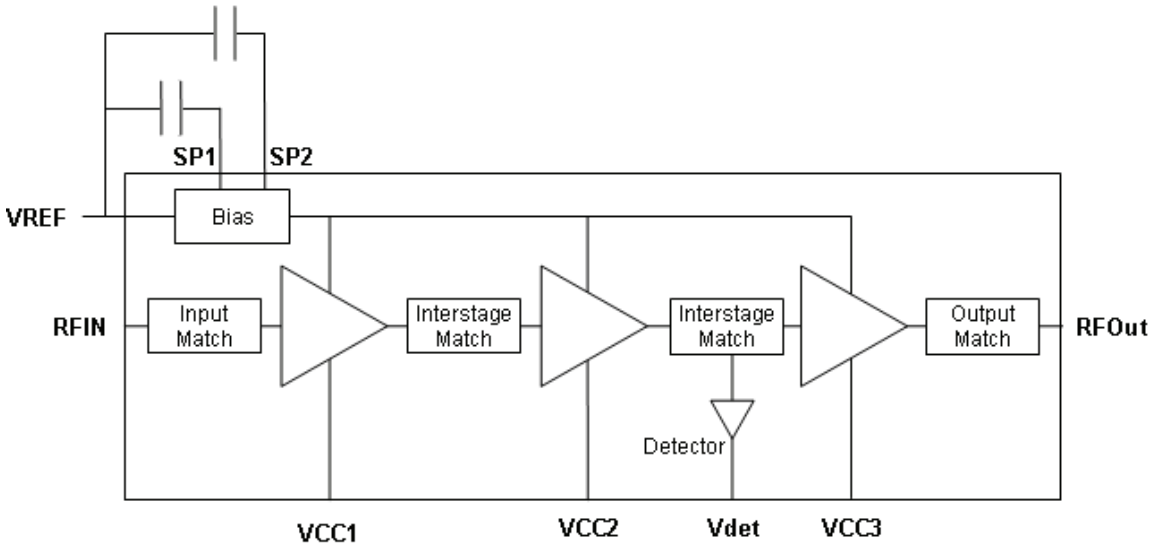
The SE5004L is a 5GHz power amplifier offering high linear power for wireless LAN applications. The SE5004L incorporates a power detector for closed loop monitoring and control of the output power.

The SE5004L offers high integration for a simplified design, providing quicker time to market and higher application board production yield. The device integrates the input match, the inter-stage match, the output match, the power detector with 15dB of dynamic range and a 3.8GHz notch filter. Only 6 external decoupling capacitors are required to complete the design.

For wireless LAN applications, the device meets the requirements of IEEE802.11a & 802.11n, and delivers approximately 26dBm of linear output power at 5V.

The SE5004L integrates temperature compensated bias voltage generators. A 2.85V reference voltage on VREF is all that is required to enable or disable the power amplifier.

## Functional Block Diagram




RFIN and RFOUT include DC shunt to Ground. External blocking capacitors are recommended.

**Figure 1: Functional Block Diagram**

## Pin Out Diagram

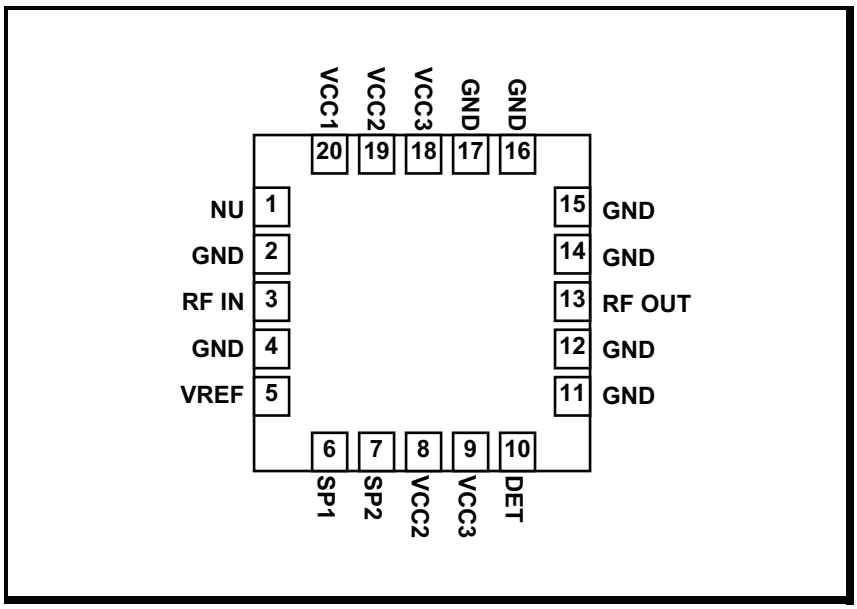



**Figure 2: SE5004L Pin Out (Top View Through Package)**

## Pin Out Description

| Pin No. | Name | Description |
|---|---|---|
| 1 | NU | Pin is not used, and is open circuit in the package |
| 2 | GND | Ground |
| 3 | RFin | Power Amplifier RF input, DC block required |
| 4 | GND | Ground |
| 5 | $V_{REF}$ | Reference Voltage |
| 6 | SP1 | Port for optional capacitor to improve dynamic EVM |
| 7 | SP2 | Port for optional capacitor to improve dynamic EVM |
| 8 | VCC2 | Second Stage Supply Voltage |
| 9 | VCC3 | Third Stage Supply Voltage |
| 10 | DET | Analog Power Detector Output |
| 11,12 | GND | Ground |
| 13 | RF OUT | Power Amplifier RF Output |
| 14-17 | GND | Ground |
| 18 | VCC3 | Third Stage Supply Voltage |
| 19 | VCC2 | Second Stage Supply Voltage |
| 20 | VCC1 | First Stage Supply Voltage |

## Absolute Maximum Ratings

These are stress ratings only. Exposure to stresses beyond these maximum ratings for a long period of time may cause permanent damage to, or affect the reliability of the device. Avoid operating the device outside the recommended operating conditions defined below. This device is ESD sensitive. Handling and assembly of this device should be at ESD protected workstations.

| Symbol | Definition | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage on pins VCC3 | -0.3 | +6 | V |
| | Supply Voltage on pins VCC1, VCC2 | -0.3 | VCC3 | |
| $V_{REF}$ | Power Amplifier Enable and Reference Voltage | -0.3 | 3.6 | V |
| $RF_{IN}$ | RF Input Power, RFout into 50Ω match, $T_{CASE\_MAX}$ = 85C | - | 6 | dBm |
| $T_{STG}$ | Storage Temperature Range | -40 | 160 | °C |
| $T_j$ | Maximum Junction Temperature | - | 160 | °C |
| $ESD_{HBM}$ | JEDEC JESD22-A114 all pins | - | 500 | V |

## Recommended Operating Conditions

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage VCC3 | 3.0 | 5.5 | V |
| | Supply Voltage VCC1, VCC2 | 3.0 | VCC3 | |
| $T_{CASE\_MAX}$ | Maximum Case Temperature | -40 | 85 | °C |
| $V_{REF}$ | Reference Voltage | 2.8 | 2.9 | V |

## DC Electrical Characteristics

Conditions: $V_{CC}$ = 5.0V, $V_{REF}$ = 2.85 V, $T_A$ = 25 °C, as measured on SiGe Semiconductor's SE5004L-EK1 evaluation board, unless otherwise noted.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{CC-802.11a}$ | Supply Current | $P_{OUT}$ = 26 dBm, 54 Mbps, 64 QAM | - | 600 | - | mA |
| $I_{QC}$ | Quiescent Current | No RF | - | 300 | - | mA |
| $I_{OFF}$ | Supply Current | $V_{REF}$ = 0 V, No RF | - | 0.5 | 10 | µA |
| IEN | Bias Control Current | $V_{REF}$ = $V_{REF\ H}$<br>Internal 2KΩ pull down resistor | - | 10 | - | mA |
| $V_{REF\ H}$ | Reference Voltage Enabled | - | 2.80 | 2.85 | 2.9 | V |
| $V_{REF\ L}$ | Reference Voltage Disabled | - | 0 | - | 0.5 | V |

## AC Electrical Characteristics

### *802.11a AC Electrical Characteristics*

Conditions: $V_{CC}$ = 5.0 V, $V_{REF}$ = 2.85 V, f = 5.4 GHz, $T_A$ = 25 °C, as measured on SiGe Semiconductor's SE5004L-EK1 evaluation board, unless otherwise noted

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $f_{L-U}$ | Frequency Range | - | 5.15 | - | 5.85 | GHz |
| $P_{OUT}$ | Output Power | 802.11a, 54Mbps, 64 QAM, 3% EVM | - | 26 | - | dBm |
| | | 802.11n, MCS0, Mask Compliant | - | 29 | - | |
| $P_{1dB}$ | Output 1dB compression point | No modulation | - | 34 | - | dBm |
| $S_{21}$ | Small Signal Gain | $P_{IN}$ = -25 dBm | - | 32 | - | dB |
| $\Delta S_{21}$ | Gain Variation | Within each UNII Band | - | 3 | - | dB |
| $\Delta S_{21\ 3.8}$ | Gain at 3.8GHz | $P_{IN}$ = -25 dBm | - | - | 0 | dB |
| 2f | Harmonic | $P_{OUT}$ = 26 dBm, 5V | - | - | -45 | dBm/MHz |
| 3f | | | | | | |
| $t_r$, $t_f$ | Rise and Fall Time | - | - | 0.15 | 0.3 | us |
| STAB | Stability | $P_{OUT}$ = 26 dBm, VCC = 5V, 54 Mbps, 64 QAM, VSWR = 6:1, all phases | All non-harmonically related outputs less than -50 dBc/100 kHz | | | |
| Rugged | Tolerance to constant input power into a mismatch load | $P_{IN}$ = -10dBm, CW, VSWR = 6:1, all phases | No damage | | | |

### *Power Detector*

Conditions: $V_{CC}$ = 5.0 V, $V_{REF}$=2.85V, f = 5.4 GHz, $T_A$ = 25 °C, as measured on SiGe Semiconductor's SE5004L-EK1 evaluation board, unless otherwise noted

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| PDR | $P_{OUT}$ detect range | - | 0 | - | $P_{1dB}$ | dBm |
| VDET | Detector voltage | $P_{OUT}$ = 27 dBm | - | 1.000 | - | V |
| | | $P_{OUT}$ = NO RF | - | 0.325 | - | V |
| $ERR_{DET}$ | Detector Accuracy | $\Delta P_{OUT}$ at constant $V_{DET}$,<br>5.15 GHz – 5.70 GHz<br>5.70 GHz – 5.85 GHz | <br>-0.5<br>-0.5 | <br>-<br>- | <br>+0.5<br>+0.5 | dB |
| | | $\Delta P_{OUT}$ at constant $V_{DET}$, VSWR = 3:1 | -1.5 | | +1.5 | dB |
| $PDZ_{OUT}$ | Output Impedance | - | - | 0.7 | - | KΩ |
| $PDZ_{LOAD}$ | DC load impedance | - | - | 26.5 | - | KΩ |

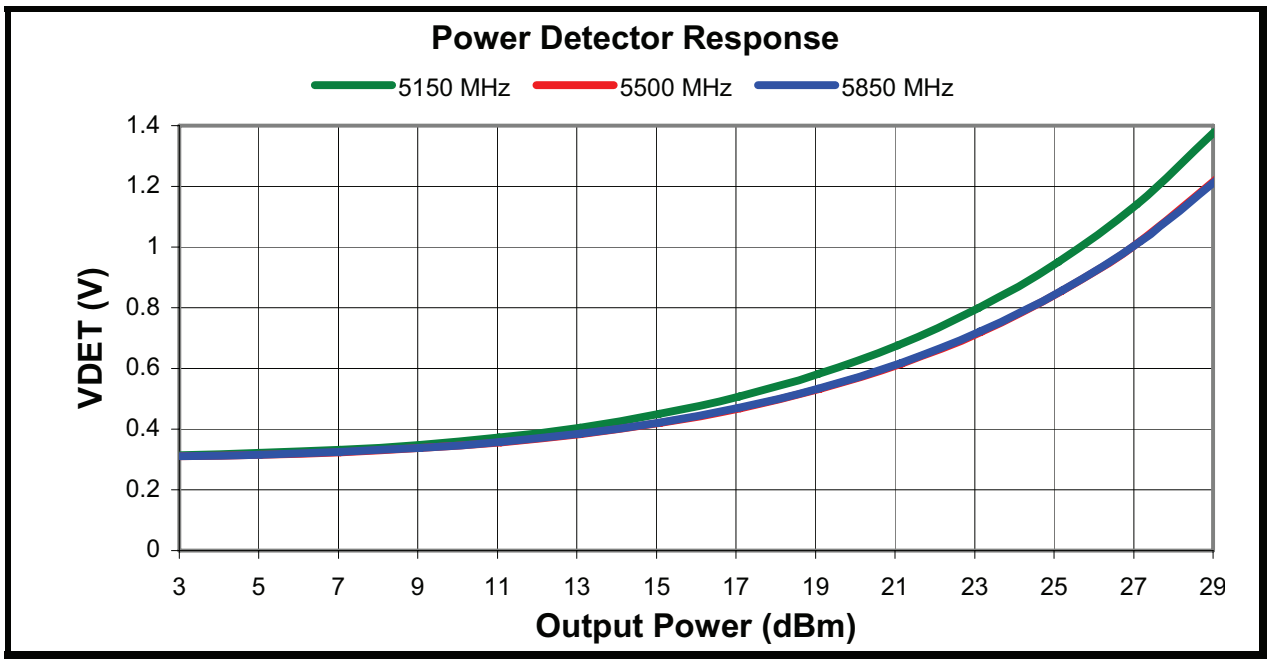



**Figure 3: SE5004L Power Detector Characteristic over Frequency**

## Package Diagram

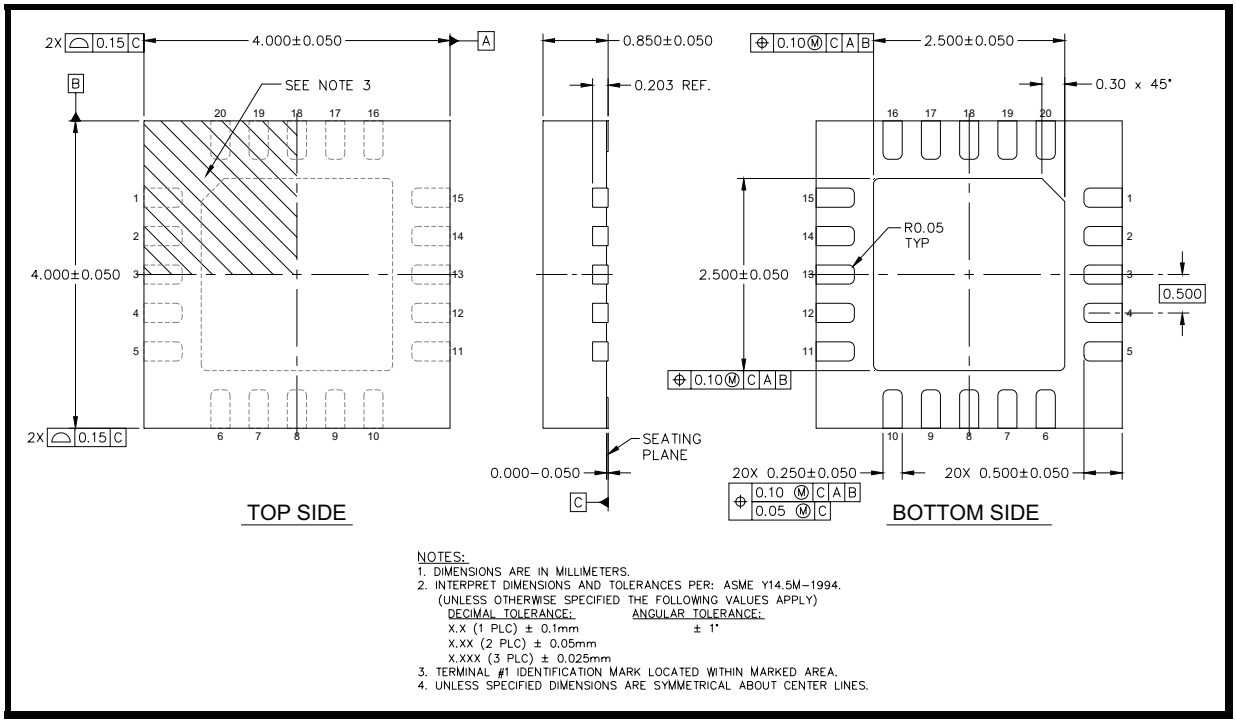



**Figure 4: SE5004L Package Information**

## Recommended Land and Solder Pattern

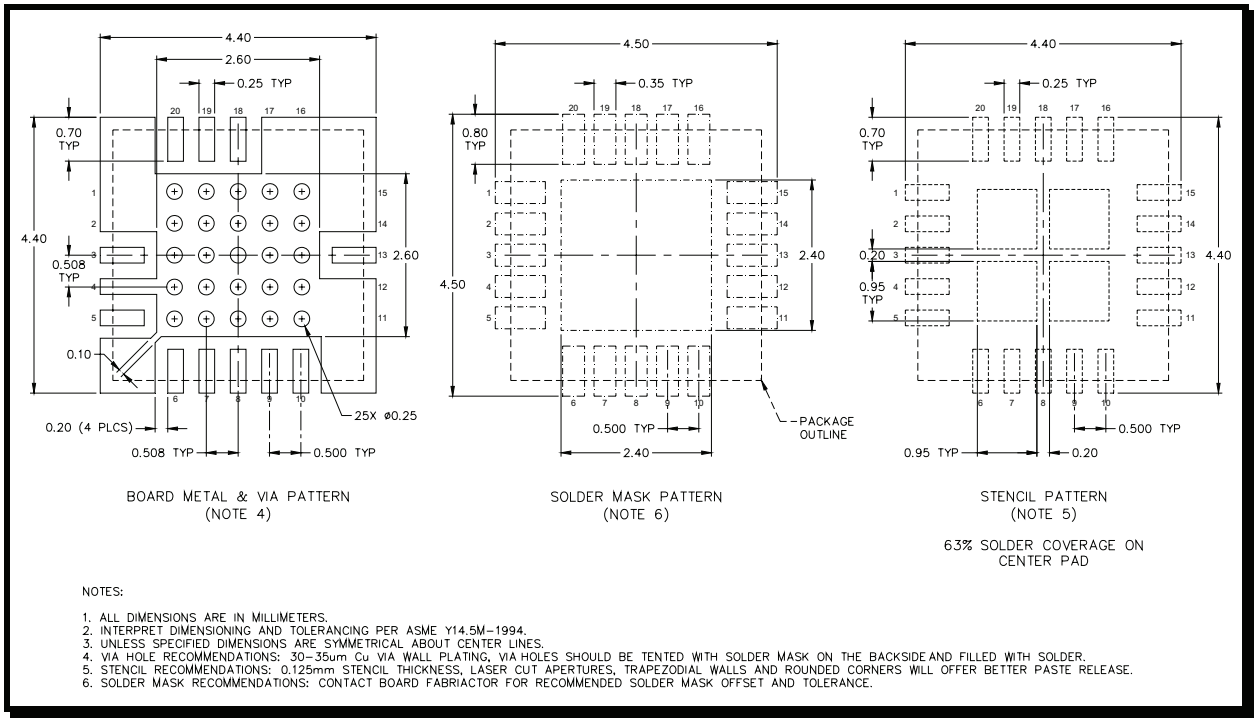



**Figure 5: SE5004L Recommended Land Pattern**

## Package Handling Information

Because of its sensitivity to moisture absorption, instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly. The SE5004L is capable of withstanding a Pb free solder reflow. Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. If the part is manually attached, precaution should be taken to insure that the device is not subjected to temperatures above its rated peak temperature for an extended period of time. For details on both attachment techniques, precautions, and handling procedures recommended by SiGe, please refer to:

- SiGe's Application Note: "Quad Flat No-Lead Module Solder Reflow & Rework Information", *Document Number QAD-00045*
- SiGe's Application Note: "Handling, Packing, Shipping and Use of Moisture Sensitive QFN", *Document Number QAD-00044*

Caution! Class 1B ESD sensitive device

## Branding Information

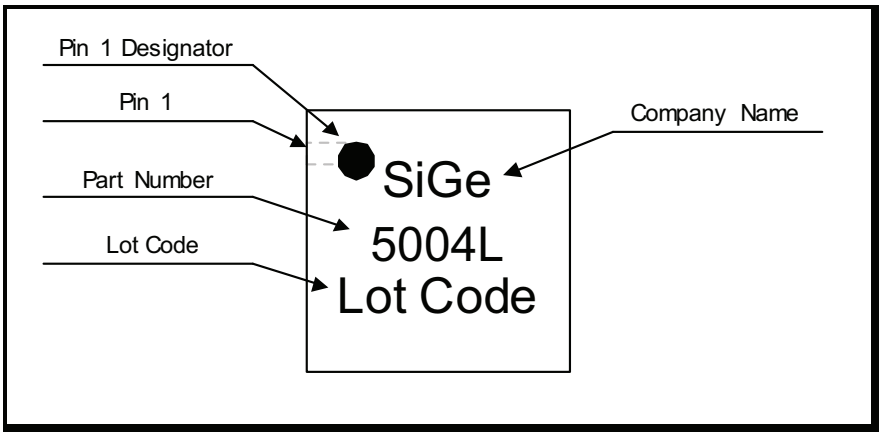



**Figure 6: SE5004L Branding Information**

## Tape and Reel Information

| Parameter | Value |
|---|---|
| Devices Per Reel | 3000 |
| Reel Diameter | 13 inches |
| Tape Width | 12 millimeters |

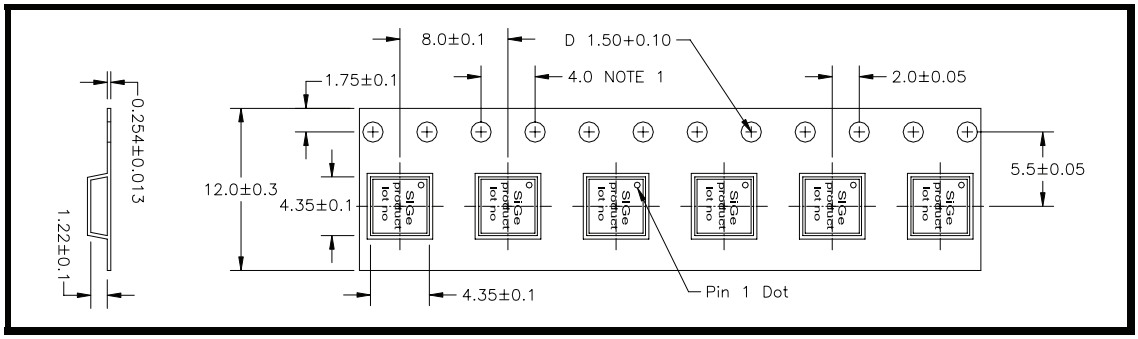



**Figure 7: SE5004L-R Tape and Reel Information**

## Document Change History

| Revision | Date | Notes |
|---|---|---|
| 1.0 | Aug 18, 2009 | Created |
| 1.1 | Jan 14, 2010 | Updated Pinout |
| 1.2 | May 4, 2010 | Updated harmonic specification |
| 1.3 | May 7, 2010 | Update $T_{RISE}$ and $T_{FALL}$ time<br>Added MSL rating |
| 1.4 | May 20, 2010 | Update Recommended Land and Solder Pattern<br>Update detector plot. |
| 1.5 | Jul 20, 2010 | Extended operating temperature range to -40C to +85C<br>Updated absolute maximum ratings for VCC1 and VCC2<br>Updated EN pull down resistor value |
| 1.6 | Nov 20, 2010 | Update Maximum Junction Temperature<br>Updated ESD rating |
| 1.7 | Feb 25, 2011 | Added Mask compliance<br>Added Vref min/max limits to recommended operating conditions |

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Product Preview
The datasheet contains information from the product concept specification. SiGe Semiconductor, Inc. reserves the right to change information at any time without notification.

Preliminary Information
The datasheet contains information from the design target specification. SiGe Semiconductor, Inc. reserves the right to change information at any time without notification.

Production testing may not include testing of all parameters.

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