**SKYWORKS**®

**DATA SHEET**
**SE5502L:Dual Band 802.11a/b/g/n Wireless LAN Front End**
**Preliminary Information**

## Applications

- IEEE802.11b DSSS WLAN
- IEEE802.11g OFDM WLAN
- IEEE802.11a OFDM WLAN
- IEEE802.11n WLAN
- Access Points, PCMCIA, PC cards

## Features

- All RF ports matched to 50 Ω
- Integrated 2.4 GHz PA, 5 GHz PA, T/R switch, 2.5GHz LNA, 5GHz LNA
- Integrated Power Detector for each TX Chain
- 21 dBm O/P Power, 802.11b, 11 Mbits, ACPR = 35 dBc
- 18 dBm @ 3.0 % EVM, 802.11g, 54 Mbits
- 16 dBm @ 3.0 % EVM, 802.11a, 54 Mbits
- Single supply voltage:  3.3 V ± 10 %
- Lead free, Halogen free, RoHS compliant, MSL 1
- 4mm x 4mm x 0.9mm, QFN Package

## Ordering Information

| Part No. | Package | Remark |
|---|---|---|
| SE5502L | 24 pin QFN | Samples |
| SE5502L-R | 24 pin QFN | Tape and Reel |
| SE5502L-EK1 | N/A | Evaluation kit |

## Product Description

The SE5502L is a complete 802.11a/b/g/n WLAN RF front-end module providing all the functionality of the power amplifiers, filtering, power detector, T/R switch, diplexers, LNA and associated matching. The SE5502L provides a complete 2.4 GHz and 5 GHz WLAN RF solution from the output of the transceiver to the antenna in an ultra compact form factor.

Designed for ease of use, all RF ports are matched to 50 Ω to simplify PCB layout and the interface to the transceiver RFIC.  The SE5502L also includes a transmit power detector with 20 dB of dynamic range for each transmit chain.  Each transmit chain has a separate digital enable control for transmitter power ramp on/off control. The power ramp rise/fall time is less than 0.7 μsec.

The device also provides a notch filter from 3.260-3.267 GHz and 3.28-3.89 GHz prior to the input of each 2.4 GHz and 5 GHz power amplifiers, respectively.
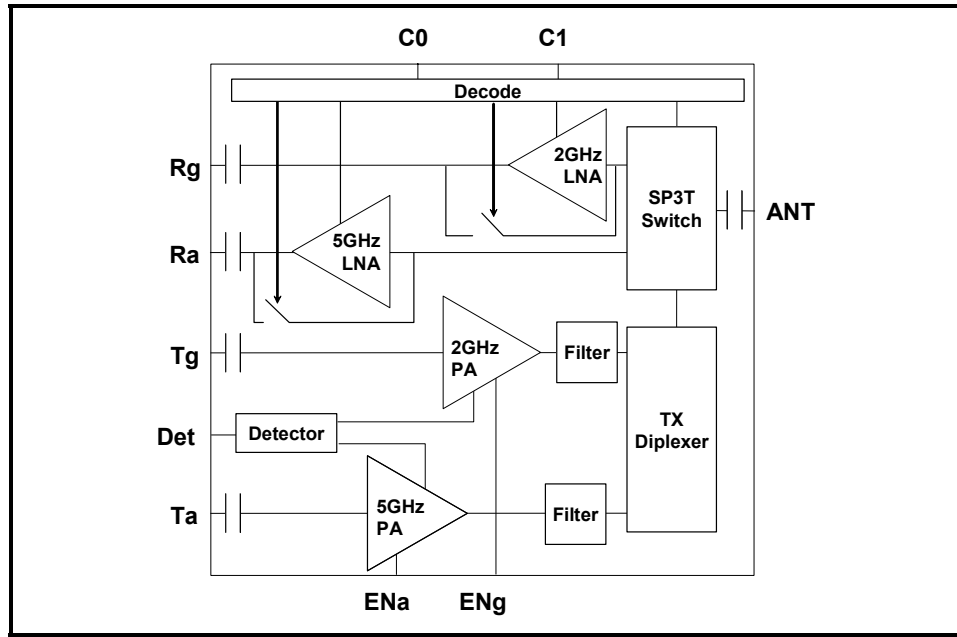
The SE5502L packaged in 4mm x 4mm x 0.9mm, Halogen free, Lead free, ROHS compliant, MSL 3 QFN package.
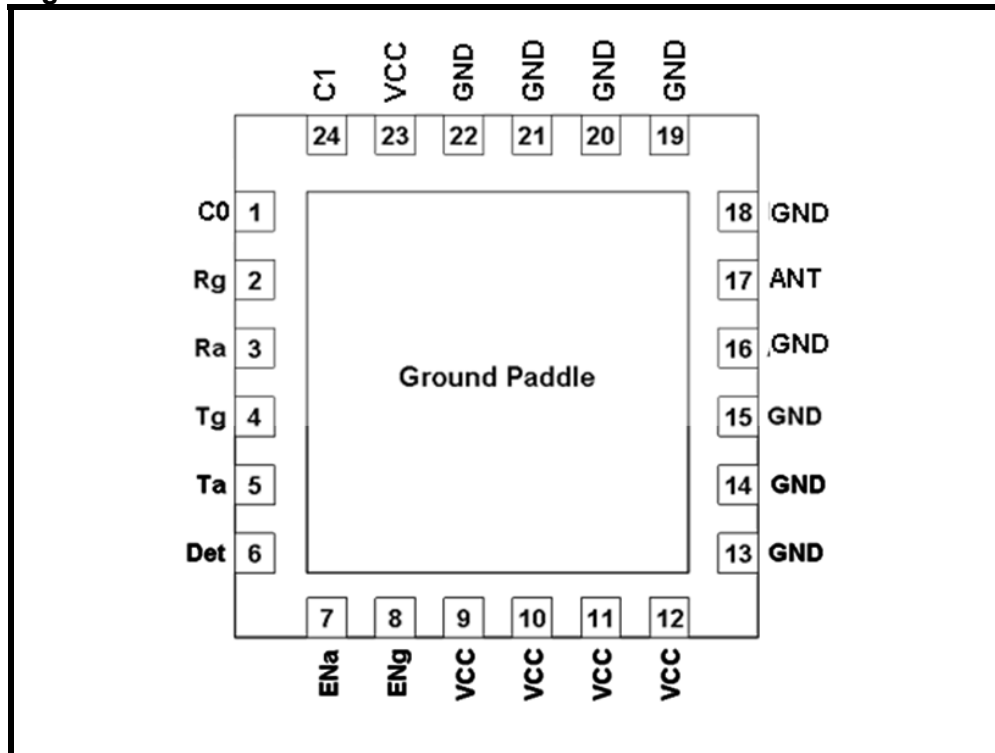
## Functional Block Diagram



**Figure 1:  SE5502L Functional Block Diagram**

## Pin Out Diagram



**Figure 2: SE5502L Pin Out (Top View Through Package)**

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## Pin Out Description

| Pin No. | Name | Description | Pin No. | Name | Description |
|---|---|---|---|---|---|
| 1 | C0 | Switch Control | 13 | GND | Ground |
| 2 | Rg | 2.4 GHz RF Receive Output | 14 | GND | Ground |
| 3 | Ra | 5 GHz RF Receive Output | 15 | GND | Ground |
| 4 | Tg | 2.4 GHz RF Transmit Input | 16 | GND | Ground |
| 5 | Ta | 5 GHz RF Transmit Input | 17 | ANT | Antenna |
| 6 | Det | 2.4/5 GHz Power Detector Output | 18 | GND | Ground |
| 7 | ENa | 5 GHz Power Amplifier Enable | 19 | GND | Ground |
| 8 | ENg | 2.4 GHz Power Amplifier Enable | 20 | GND | Ground |
| 9 | VCC | Supply Voltage | 21 | GND | Ground |
| 10 | VCC | Supply Voltage | 22 | GND | Ground |
| 11 | VCC | Supply Voltage | 23 | VCC | Supply Voltage |
| 12 | VCC | Supply Voltage | 24 | C1 | Switch Control |

## Absolute Maximum Ratings

These are stress ratings only. Exposure to stresses beyond these maximum ratings 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 | -0.3 | 3.6 | V |
| PU | ENa, ENg, C0, C1 | -0.3 | 3.6 | V |
| $TX_{RF}$ | Ta, Tg, ANT terminated in 6:1 load or better | - | 12.0 | dBm |
| $T_A$ | Operating Temperature Range | -40 | 85 | °C |
| $T_{STG}$ | Storage Temperature Range | -40 | 150 | °C |
| $ESD_{HBM}$ | JEDEC JESD22-A114 all pins | - | 1000 | V |

## Recommended Operating Conditions

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 3.0 | 3.3 | 3.6 | V |
| $T_A$ | Ambient Temperature | -40 | 25 | 85 | °C |

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**SE5502L:Dual Band 802.11a/b/g/n Wireless LAN Front End**
**Preliminary Information**

## DC Electrical Characteristics

Conditions: $V_{CC}$ = 3.3 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------|------|------|------|------|
| $I_{CC-G}$ | Total 802.11g Transmit Supply Current | $P_{OUT}$ = 18 dBm, 54 Mbps OFDM signal, 64 QAM ENg = 3.3 V, ENa = 0 V, 100% duty cycle | - | 150 | - | mA |
| $I_{CC-B}$ | Total 802.11b Transmit Supply Current | $P_{OUT}$ = 21 dBm, 11 Mbps CCK signal, BT = 0.45, ENg = 3.3 V, ENa = 0 V, 100% duty cycle | - | 175 | - | mA |
| $I_{CC-A}$ | Total 802.11a Transmit Supply Current | $P_{OUT}$ = 16 dBm, 54 Mbps OFDM signal, 64 QAM, ENa = 3.3 V, ENg = 0 V, 100% duty cycle | - | 210 | - | mA |
| Icc-Rxa | Total Icc in Rx 5G band | 5G LNA enabled | - | 19 | - | mA |
| Icc-Rxg | Total Icc in Rx 2G band | 2G LNA enabled | - | 18 | - | mA |
| $I_{CC\_OFF}$ | Total Supply Current | No RF, ENg = ENa = 0 V | - | 50 | 180 | µA |

## PA Logic Characteristics

Conditions: $V_{CC}$ = 3.3 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{ENH}$ | Logic High Voltage for ENg, ENa (Module On) | - | 1.8 | - | $V_{CC}$ | V |
| $V_{ENL}$ | Logic Low Voltage ENg, ENa (Module Off) | - | 0 | - | 0.4 | V |
| $I_{ENH}$ | Input Current Logic High Voltage (ENg, ENa) | - | - | 50 | 400 | µA |
| $I_{ENL}$ | Input Current Logic Low Voltage (ENg, ENa) | VCC = 0.4V | - | 0 | 40 | µA |

## Switch/LNA Logic Characteristics

Conditions: $V_{CC}$ = 3.3 V, $V_{EN}$ = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CTL\_ON}$ | Control Voltage C0, C1 (On State) | - | 3.0 | - | 3.6 | V |
| $V_{CTL\_OFF}$ | Control Voltage C0, C1 (OFF State) | - | 0.0 | - | 0.4 | V |
| $I_{CTL\_ON}$ | Switch Control Bias Current (RF Applied) | On pin (TX, RX) being driven high. RF Applied | - | - | 100 | µA |
| $I_{CTL\_ON}$ | Switch Control Bias Current (No RF) | On pin (TX, RX) being driven high. No RF | - | - | 30 | µA |

## Switch & LNA Control Logic Table

| C0 | C1 | EnG | EnA | Tg ↔ ANT | Ta ↔ ANT | Rg ↔ ANT | Ra ↔ ANT |
|---|---|---|---|---|---|---|---|
| $V_{CTL\_OFF}$ | $V_{CTL\_OFF}$ | $V_{ENH}$ | $V_{ENL}$ | **ON** | OFF | OFF | OFF |
| $V_{CTL\_OFF}$ | $V_{CTL\_OFF}$ | $V_{ENL}$ | $V_{ENH}$ | OFF | **ON** | OFF | OFF |
| $V_{CTL\_OFF}$ | $V_{CTL\_ON}$ | $V_{ENL}$ | $V_{ENL}$ | OFF | OFF | **LNA Bypass ON** | **LNA Bypass ON** |
| $V_{CTL\_ON}$ | $V_{CTL\_OFF}$ | $V_{ENL}$ | $V_{ENL}$ | OFF | OFF | OFF | **LNA ON** |
| $V_{CTL\_ON}$ | $V_{CTL\_ON}$ | $V_{ENL}$ | $V_{ENL}$ | OFF | OFF | **LNA ON** | OFF |
| $V_{CTL\_OFF}$ | $V_{CTL\_OFF}$ | $V_{ENL}$ | $V_{ENL}$ | Stand By Mode, PAs and LNAs OFF – Low Current Consumption ||||
| All Other States || | | Not Supported ||||

## 2.4 GHz AC Electrical Characteristics

### 2.4 GHz Transmit Characteristics

Conditions: $V_{CC}$ = 3.3 V, ENg = 3.3 V, ENa = C0 = C1 = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------|------|------|------|------|
| $F_{IN}$ | Frequency Range | - | 2400 | - | 2500 | MHz |
| $P_{802.11g}$ | Output power | 54 Mbps OFDM signal, 64QAM, EVM = 3.0 % | - | 18 | - | dBm |
| $P_{802.11b}$ | Output power | 11 Mbps CCK signal, BT = 0.45 ACPR(± 11MHz offset) < -35 ACPR(± 22MHz offset) < -56 | - | 21 | - | dBm |
| $P_{1dB}$ | P1dB | - | 23 | 25.5 | - | dBm |
| $S_{21}$ | Small Signal Gain | - | 25 | 28 | 30 | dB |
| $\Delta S_{21}$ | Small Signal Gain Variation Over Band | - | - | 1.0 | 2.0 | dB |
| $S_{21}3.2$ | Gain at Ref-VCO | 3200.00 to 3300.00 MHz | - | - | 0 | dB |
| 2f,3f | Harmonics | Pout ≤ 21 dBm typ, 1Mbps, CCK | - | - | -45.2 | dBm/MHz |
| $t_r$ | Rise Time | 10 % to 90% of final output power level | - | - | 0.5 | µs |
| $t_{dr}$, $t_{df}$ | Delay and rise/fall Time | 50 % of $V_{EN}$ edge and 90/10 % of final output power level | - | - | 0.5 | µs |
| $S_{11}$ | Input Return Loss | - | 8 | 10 | - | dB |
| STAB | Stability | CW, $P_{OUT}$ = 21 dBm 0.1 GHz – 21 GHz Load VSWR = 6:1 | All non-harmonically related outputs less than -42 dBm/MHz | | | |
| Ru | Ruggedness | Tg = 12dBm, ANT load varies over 6:1 VSWR | No Irreversible damage | | | |

## 2.4 GHz Receive Characteristics

Conditions:  $V_{CC}$ = C0 = C1 = 3.3 V, ENg = ENa = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $F_{OUT}$ | Frequency Range | - | 2400 | - | 2500 | MHz |
| $S_{21}$ | Receive Gain, LNA Enabled. | 2400 – 2485 MHz | 10 | 15 | - | dB |
| | Receive Gain, Bypass mode | C0 = 0 V;  C1 = 3.3 V 2400 – 2485 MHz | - | -7.5 | - | dB |
| $\Delta S_{21}$ | Gain Variation | 2400 – 2485 MHz, Over any 40MHz band | - | 0.25 | 0.5 | dB |
| NF | Noise Figure | De-embedded to device | - | 2.5 | 2.8 | dB |
| INT | Interferer @1710-1990MHz | With this input , IIP3 can only degrade by 1dB | -10 | - | - | dBm |
| $S_{11}$ | Input Return Loss | - | - | 8 | - | dB |
| IP1dB | Input P1dB | C0 = 3.3 V | - | -7 | - | dBm |
| $T_{EN}$ | Enable Time | 10% to 90% of RX RF power, from time that C0 is at 50% | - | 500 | - | nsec |

## 5 GHz AC Electrical Characteristics

### 5 GHz Transmit Characteristics

Conditions:  $V_{CC}$ = 3.3 V, ENa = 3.3 V, ENg = C0 = C1 = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $F_{IN}$ | Frequency Range | - | 4900 | - | 5875 | MHz |
| $P_{802.11a}$ | Nominal Output Power | 54 Mbps OFDM signal, 64 QAM, EVM = 3.0 % | - | 16 | - | dBm |
| $P_{1dB}$ | P1dB | - | 21 | 22.5 | - | dBm |
| $S_{21}$ | Small Signal Gain | - | 24 | - | 32 | dB |
| $\Delta S_{21}$ | Small Signal Gain Variation Over 40 MHz Channel | | - | - | 0.5 | dB |
| | Small Signal Gain Variation Over sub-bands | | - | - | 3 | dB |
| $S_{21}$3.2 | Gain | 3280 to 3900 MHz | - | 3 | 9 | dB |
| 2f,3f | Harmonics | Pout ≤ 16 dBm typ, 54Mbps, 802.11a OFDM | - | - | -45.2 | dBm/MHz |
| $t_r$ | Rise Time | 10 % to 90% of final output power level | - | - | 0.5 | µs |
| $t_{dr}$, $t_{df}$ | Delay and rise/fall Time | 50 % of $V_{EN}$ edge and 90/10 % of final output power level | - | - | 0.5 | µs |
| $S_{11}$ | Input Return Loss | - | 5 | 7 | - | dB |
| STAB | Stability | 64 QAM, $P_{OUT}$ = 16 dBm 0.1 GHz – 21 GHz Load VSWR = 6:1 | All non-harmonically related outputs less than –42 dBm/MHz | | | |
| Ru | Ruggedness | TXa  = 12dBm, ANT load varies over 6:1 VSWR | No Irreversible damage | | | |

### 5 GHz Receive Characteristics

Conditions:    $V_{CC}$ = C0 = 3.3 V, ENg = ENa = C1 = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions' SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------|------|------|------|------|
| $F_{OUT}$ | Frequency Range | - | 4900 | - | 5850 | MHz |
| S21 | Receive Gain | 4900 – 5850 MHz | 10 | 12 | - | dB |
| | Receive Gain, Bypass mode | C0 = 0.0 V; C1 = 3.3V | - | -20 | - | dB |
| $\Delta S_{21}$ | Gain Variation | 4900 – 5850 MHz, Over any 40MHz band | - | 1 | - | dB |
| NF | Noise Figure | De-embedded to device | - | 2.8 | 3.0 | dB |
| $S_{11}$ | Return Loss | - | 10 | 15 | - | dB |
| IP1dB | Input P1dB | C0 = 3.3 V | -6.5 | - | - | dBm |
| $T_{EN}$ | Enable Time | 10% to 90% of RX RF power, from time that C0 is at 50% | - | 500 | - | nsec |

## 2.4 GHz Power Detector Characteristic

Conditions:   $V_{CC}$ = 3.3 V, ENg = 3.3 V, ENa = C0 = C1 = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions'
SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------|------|------|------|------|
| $F_{OUT}$ | Frequency Range | - | 2400 | - | 2500 | MHz |
| PDR | Power detect range, peak power | Measured at ANT0 or ANT1 | 0 | - | 22 | dBm |
| $PDZ_{OUT}$ | DC Output impedance | - | - | 2.7 | 3 | kΩ |
| $PDV_{P21}$ | Output Voltage, $P_{OUT}$ = 21dBm | - | - | 0.85 | - | V |
| $PDV_{p18}$ | Output Voltage, $P_{OUT}$ = 18dBm | - | - | 0.65 | - | V |
| $PDV_{pnoRF}$ | Output Voltage, $P_{OUT}$ = No RF | - | - | 0.35 | - | V |
| $LPF_{-3dB}$ | Power detect low pass filter -3dB corner frequency | Load = high impedance Typ:  500 kΩ | - | 1500 | - | kHz |
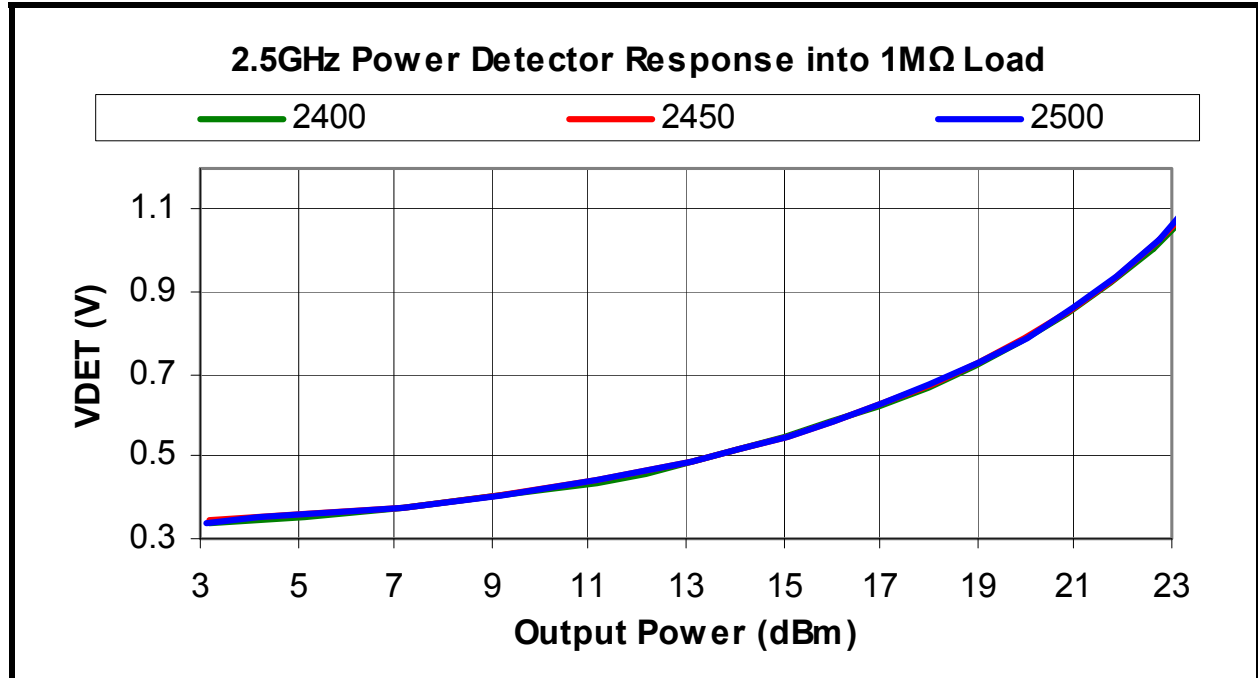


**Figure 3:  SE5502L Power Detector vs. Output Power over Frequency (CW Signal)**

## 5 GHz Power Detector Characteristic

Conditions:   $V_{CC}$ = 3.3 V, ENa = 3.3 V, ENg = C0 = C1 = 0 V, $T_A$ = 25 °C, as measured on Skyworks Solutions'
SE5502L-EV1 evaluation board, all unused ports terminated with 50 ohms, unless otherwise noted.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $F_{OUT}$ | Frequency Range | - | 4900 | - | 5850 | MHz |
| PDR | Power detect range, peak power | Measured at ANT | 0 | - | 21 | dBm |
| $PDZ_{OUT}$ | DC Output impedance | - | - | 2.7 | 3.0 | kΩ |
| $PDV_{p18}$ | Output Voltage, $P_{OUT}$ = 18dBm | - | - | 0.78 | - | V |
| $PDV_{p16}$ | Output Voltage, $P_{OUT}$ = 16dBm | - | - | 0.65 | - | V |
| $PDV_{NoRF}$ | Output Voltage, $P_{OUT}$ = No RF | - | - | 0.35 | - | V |
| $LPF_{-3dB}$ | Power detect low pass filter -3dB corner frequency | Load = high impedance Typ:  500 kΩ | - | 1500 | - | kHz |
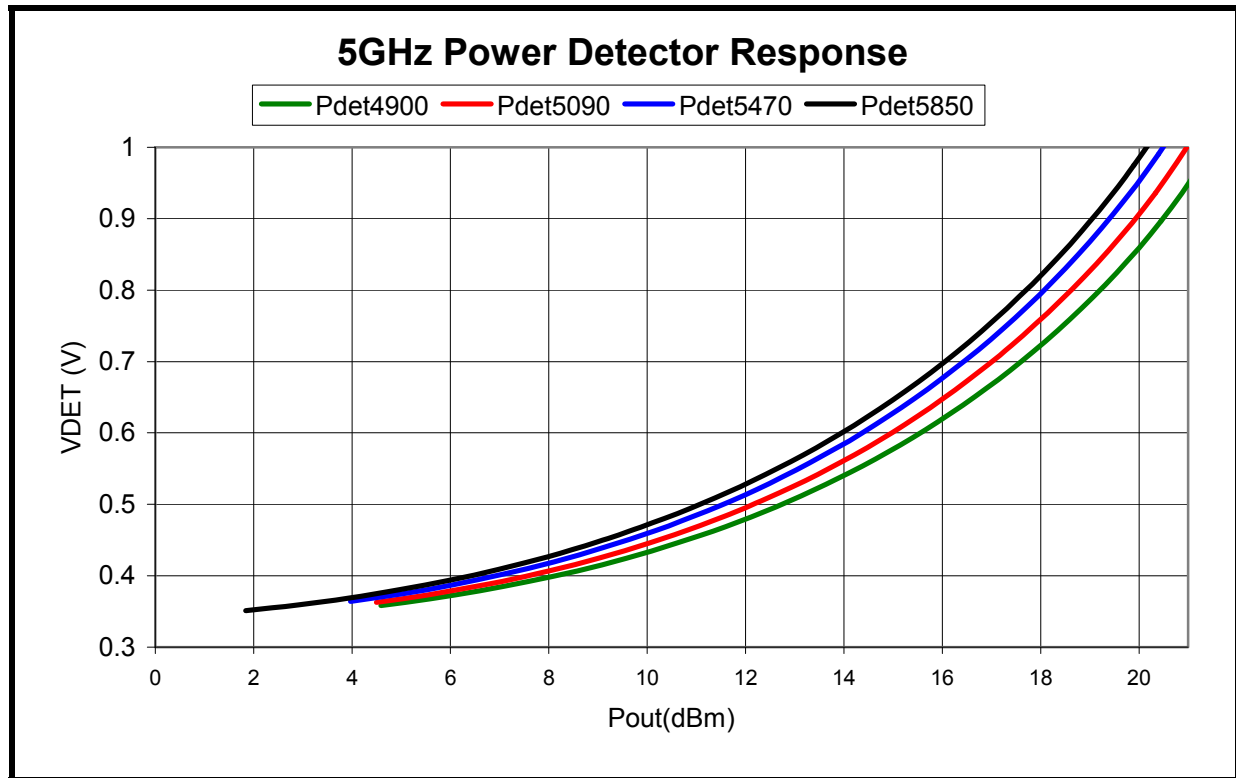


**Figure 4:  Preliminary SE5502L Power Detector vs. Output Power over Frequency (CW Signal)**
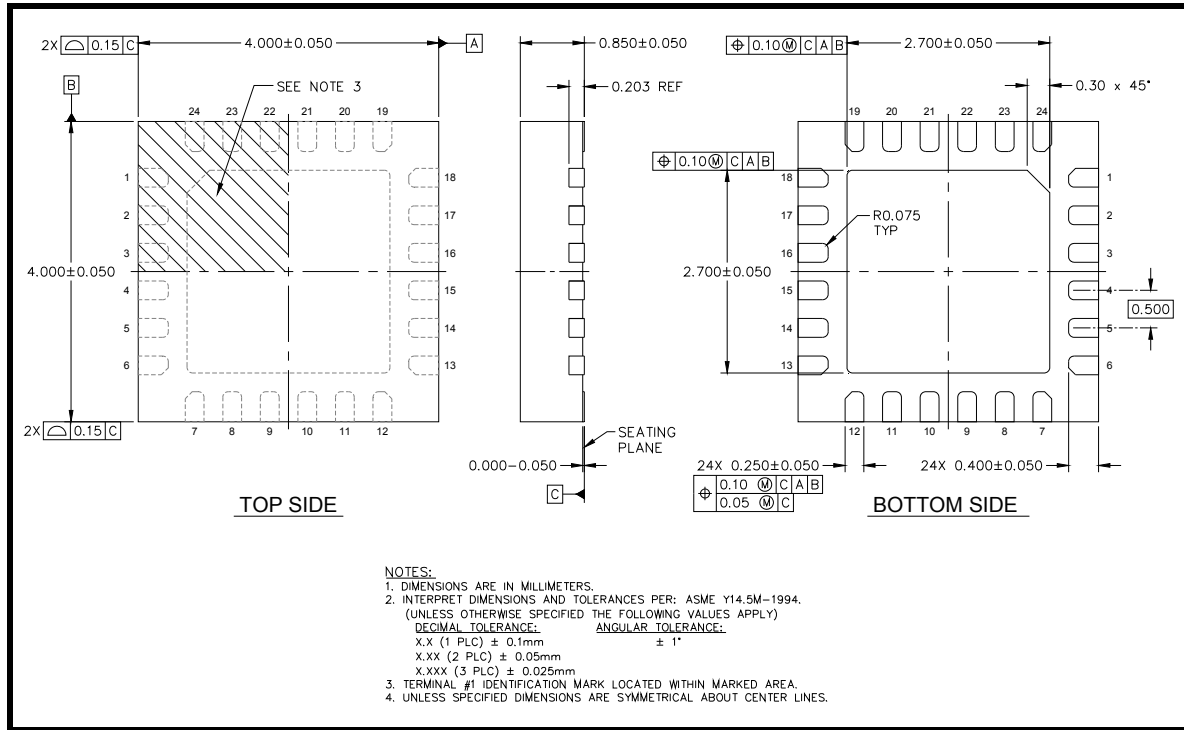
## Package Drawing



**Figure 5:  Package Drawing:  Topside**

## Recommended Land and Solder Patterns
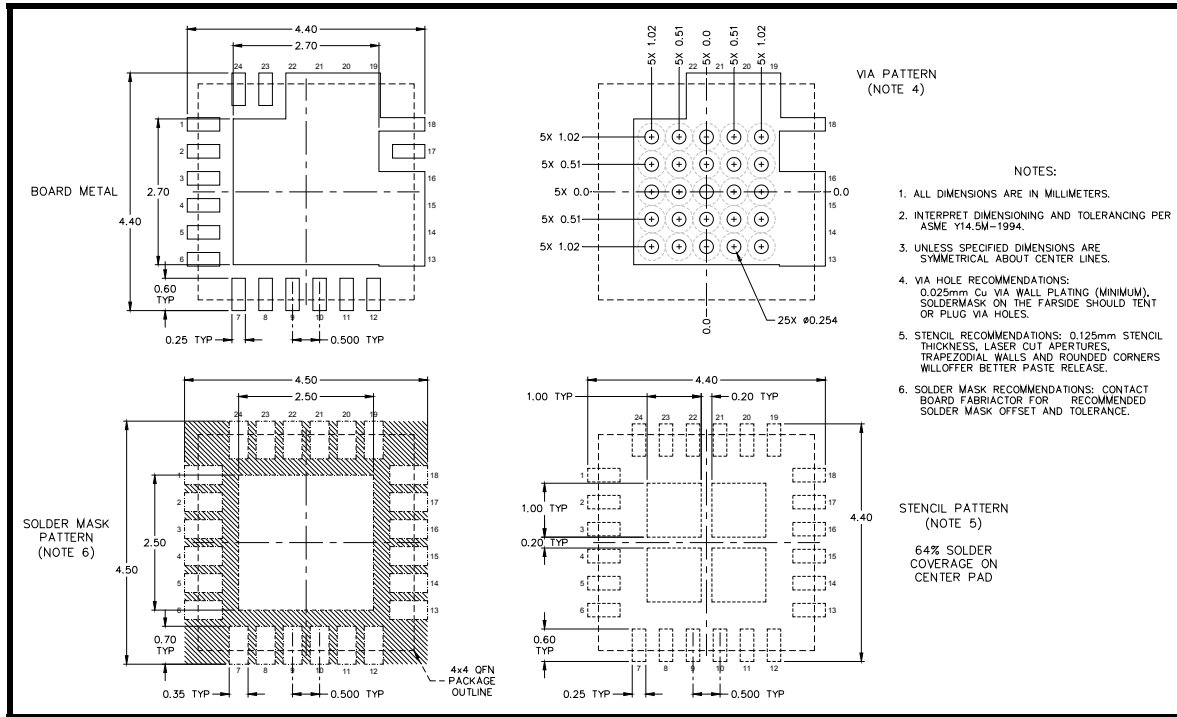


**Figure 6: Recommended Land and Solder Patterns**

## 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 SE5502L 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, please refer to:

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

Caution! Class 1C ESD sensitive device

## Product Branding
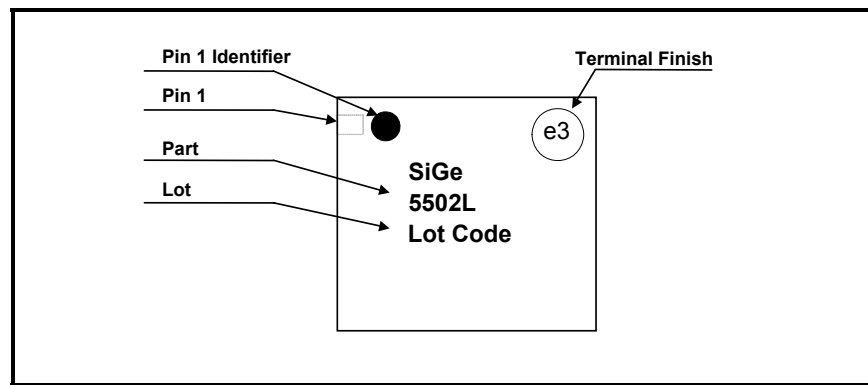


**Figure 7: SE5502L Branding Information**

## Tape and Reel Information

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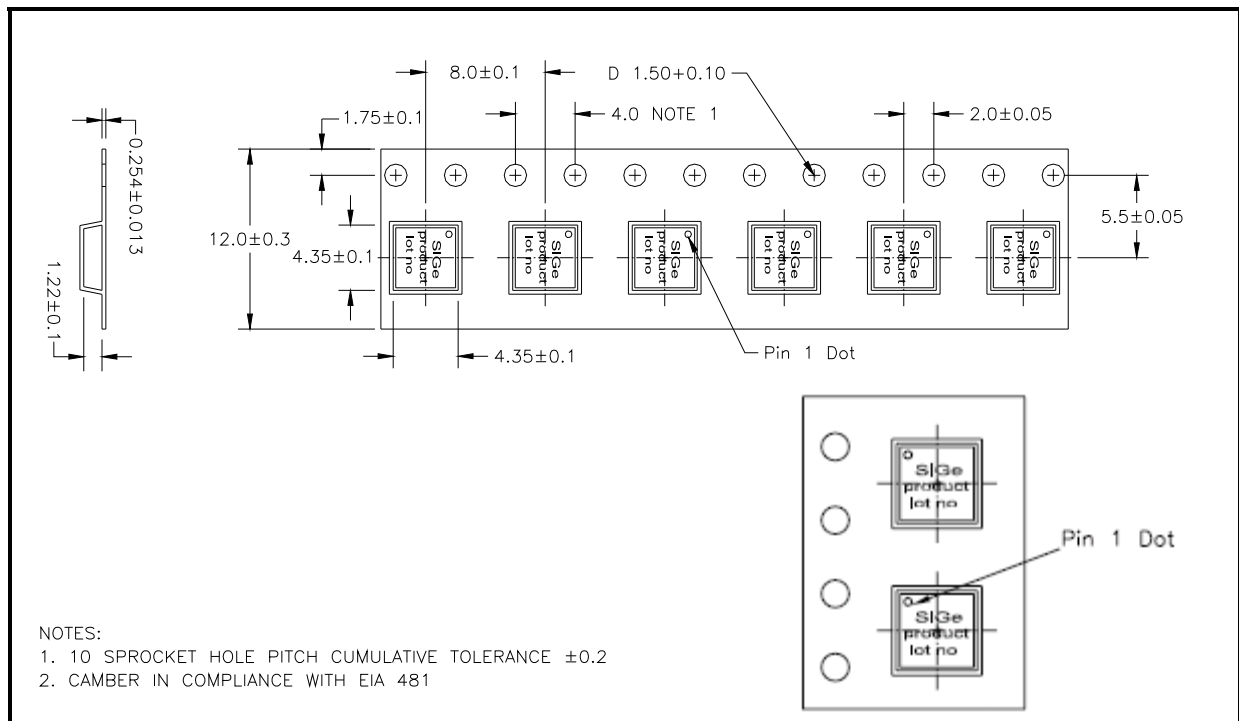


**Figure 8: Detailed Tape and Reel Information (All diminensions in Millimeters)**

## Document Change History

| Revision | Date | Notes |
|---|---|---|
| 1.0 | Aug 25, 2009 | Created |
| 1.1 | Feb 22, 2010 | Updated |
| 1.2 | Jul 12, 2010 | Updated switch control table and corrected block diagram |
| 1.3 | Sep 18, 2010 | Updated 2GHz LNA gain variation over band.<br>Updated 5GHz TX gain min spec<br>Updated EN high current consumption. |
| 1.4 | Oct 7, 2010 | Added "Stand By" mode setting to switch control logic table |
| 1.5 | Jan 27, 2011 | Updated MSL rating to MSL1<br>Updated ESD rating to Class 1C |
| 1.6 | Apr 9, 2011 | Updated to Industrial Temperature Range |
| 1.7 | Feb 17, 2012 | Updated marking diagram |
| 1.8 | Apr 03, 2012 | Updated with Skyworks logo and disclaimer statement |