DATA SHEET
SE2595L: Dual Band 802.11n Wireless LAN Front End

Applications

- 802.11n, MIMO solutions
- IEEE802.11b DSSS WLAN
- IEEE802.11g OFDM WLAN
- IEEE802.11a OFDM WLAN
- Access Points, PCMCIA, PC cards

Features

- 1 Transmit and 1 receive path architecture for use as MIMO building block.
- All RF ports matched to 50 Ω
- Integrated 2.4/5 GHz PA, 2.4/5 GHz LNA, TX Filter, T/R switches and diplexers
- Integrated Power Detector
- 19 dBm O/P Power, 802.11b, 11 Mbits, ACPR = 32 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 and RoHS compliant
- Thin lead free plated package, 4 mm x 6 mm x 0.9 mm, MSL 1

Ordering Information

Part No.	Package	Remark
SE2595L	32 pin QFN	Samples
SE2595L-R	32 pin QFN	Tape & Reel
SE2595L-EK1	N/A	Evaluation kit

Product Description

The SE2595L is a complete 802.11n WLAN RF front-end module providing all the functionality of the power amplifiers, LNA, power detector, T/R switch, diplexers and associated matching. The SE2595L provides a complete 2.4 GHz and 5 GHz WLAN Multiple Input, Multiple Output (MIMO) RF solution from the output of the transceiver to the antennas in a compact form factor.

The receive path is designed to maximize performance by providing both a low noise amplifier as well as a bypass state, for use when high power signals are being received.

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 SE2595L also includes a transmitter power detector for each band with 20 dB of dynamic range. The power ramp rise/fall time is less than 0.5 µs.

The device also provides band pass filters for both the a and b/g bands prior to the input of each 2.4 GHz and 5 GHz power amplifiers, respectively.

Functional Block Diagram

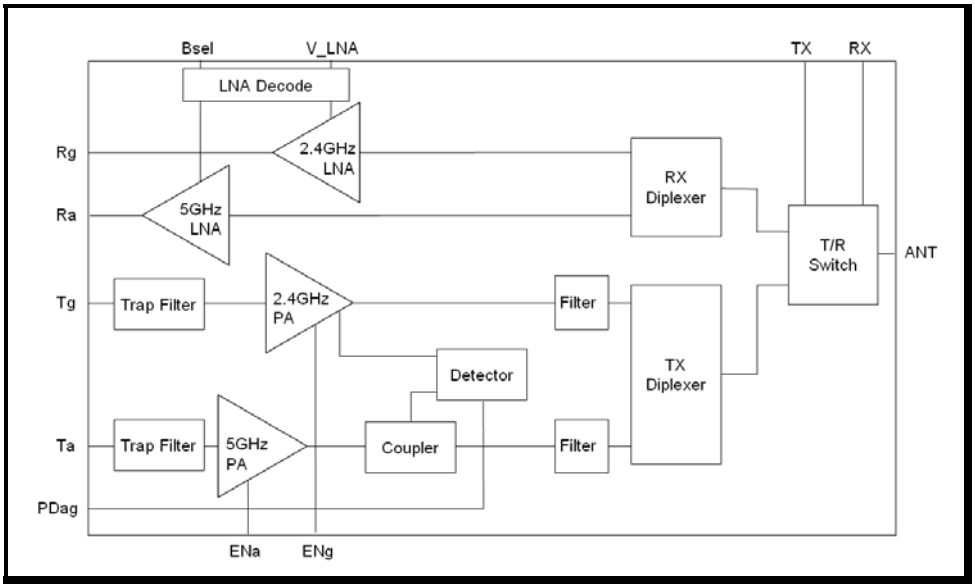


Figure 1: Functional Block Diagram

Pin Out Diagram

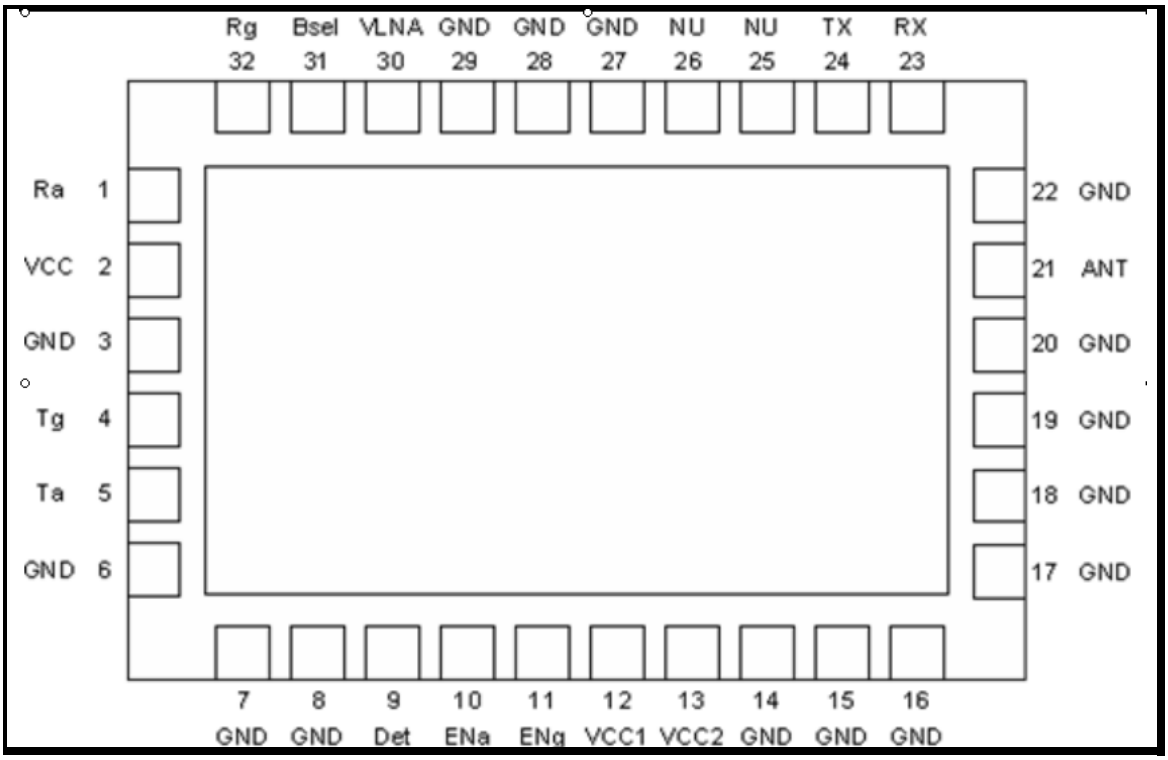


Figure 2: SE2595L Pin Out (Top View Through Package)

Pin Out Description

Pin No.	Name	Description
1	Ra	5 GHz Receive Output
2	VCC	Supply Voltage, LNA
3	GND	Ground
4	Tg	2.4 GHz Transmit Input
5	Ta	5 GHz Transmit Input
6	GND	Ground
7	GND	Ground
8	GND	Ground
9	Det	Power Detector, 2.5 & 5 GHz
10	ENa	5 GHz PA Enable
11	ENg	2.4 GHz PA Enable
12	VCC1	Supply Voltage, Driver Stage
13	VCC2	Supply Voltage, Power Stage

Pin No.	Name	Description
14	GND	Ground
15	GND	Ground
16	GND	Ground
17	GND	Ground
18	GND	Ground
19	GND	Ground
20	GND	Ground
21	ANT	Antenna
22	GND	Ground
23	RX	Rx Switch Select
24	TX	Tx Switch Select
25	NU	Not Used
26	NU	Not Used

Pin No.	Name	Description
27	GND	Ground
28	GND	Ground
29	GND	Ground

Pin No.	Name	Description
30	V_LNA	LNA Enable
31	Bsel	LNA Band Select
32	Rg	2.4 GHz Receive Output

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	4.2	V
PU	ENg, ENa, V_LNA, Bsel	-0.3	4.0	V
TX_{RF}	Ta, Tg, ANT terminated into 50Ω match	-	10.0	dBm
T_A	Operating Temperature Range	-40	85	°C
T_{STG}	Storage Temperature Range	-40	150	°C
ESD_{HBM}	JEDEC JESD22-A114 all pins	150	-	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

DC Electrical Characteristics

Conditions: V_{CC} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
TxI_{CC-G}	Total 802.11g Transmit Supply Current	P_{OUT} = 17 dBm, 54 Mbps OFDM signal, 64QAM, ENg = 3.3 V, ENa = 0 V, TX = 3.3 V, RX = 0 V	-	180	-	mA
TxI_{Cq-G}	Quiescent current , 802.11g Transmit supply Current	No RF applied ENg = 3.3 V, ENa = 0 V, TX = 3.3V, RX = 0 V	-	110	-	mA
TxI_{CC-A}	Total 802.11a Transmit Supply Current	P_{OUT} = 17 dBm, 54 Mbps OFDM signal, 64QAM, ENa = 3.3 V, ENg = 0 V, TX = 3.3 V, RX = 0 V	-	230	-	mA

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
TxI_{Cq-A}	Quiescent current , 802.11a Transmit supply Current	No RF applied ENa = 3.3V, ENg = 0V, TX = 3.3V, RX = 0V	-	155	-	mA
RxI_{CC-G}	Total 802.11b/g Receive Supply Current	V_LNA = 3.3 V, Bsel = 3.3 V, RX = 3.3 V, TX = 0 V	-	8.5	15	mA
RxI_{CC-a}	Total 802.11a Receive Supply Current	V_LNA = 3.3 V, Bsel = 0 V, RX = 3.3 V, TX = 0 V	-	8.5	15	mA
I_{CC_OFF}	Total Supply Current	No RF, ENg = ENa = 0 V, V_LNA = 0 V, TX = RX = 0 V	-	2	100	µA

Transmit Power Amplifier Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-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)	-	-	2.0	V_{CC}	V
V_{ENL}	Logic Low Voltage ENg, ENa (Module Off)	-	0	0.5	-	V
I_{ENH}	Input Current Logic High Voltage (ENg, ENa)	-	-	100	150	µA
I_{ENL}	Input Current Logic Low Voltage (ENg, ENa)	-	-	0.2	-	µA

Receive LNA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-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_{RENH}	Logic High Voltage for V_LNA, Bsel (Module On)	-	-	3.2	V_{CC}	V
V_{RENL}	Logic Low for V_LNA, Bsel (Module Off)	-	-0.5	0.3	-	V
I_{RENH}	Input Current Logic High Voltage (V_LNA, Bsel)	-	-	-	400	µA
I_{RENL}	Input Current Logic Low Voltage (V_LNA, Bsel)	-	-	0	-	µA

LNA Enable Logic		LNA Function		Comment
V_LNA	Bsel	2.4 GHz LNA	5 GHz LNA	
VRENL	VRENL	Bypass Mode	Bypass Mode	No gain in either path. This can be used for high input signal conditions.
VRENL	VRENH	Bypass Mode	Bypass Mode	No gain in either path. This can be used for high input signal conditions.
VRENH	VRENL	Off	On	Activates a-band LNA
VRENH	VRENH	On	Off	Activates bg-band LNA

RF Switch Characteristics

Conditions: V_{CC} = V_{EN} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-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 (On State)	-	3.0	-	3.6	V
V_{CTL_OFF}	Control Voltage (OFF State)	-	0.0	-	0.2	V
SW_{ON}	Low Loss Switch Control Voltage	High State = V_{CTL_ON} - V_{CTL_OFF}	2.8	-	V_{CC}	V
SW_{OFF}	High Loss Switch Control Voltage	Low State = V_{CTL_OFF} - V_{CTL_OFF}	0	-	0.2	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
C_{CTL}	Control Input Capacitance	-	-	-	100	pF

RF Switch Logic		RF Switch Function	
CTRL_T	CTRL_R	Tg, Ta – ANT	Rg, Ra – ANT
SW_{ON}	SW_{OFF}	ON	OFF
SW_{OFF}	SW_{ON}	OFF	ON

2.4 GHz AC Electrical Characteristics

2.4 GHz Transmit Characteristics

Conditions: V_{CC} = 3.3 V, ENg = TX = 3.3 V, V_LNA = ENa = RX = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
F_{IN}	Frequency Range	-	2400	-	2485	MHz
$P_{802.11g}$	Output power	54 Mbps OFDM signal, 64QAM, EVM ≤ 3.0 %	17	18	-	dBm
$P_{802.11b}$	Output power	11 Mbps CCK signal, BT = 0.45 ACPR(Adj) < -32 ACPR(Alt) < -52	19	20	-	dBm
BEVM	Backed Off EVM	54 Mbps, OFDM signal, 64 QAM, P ≤ 12 dBm	-	1.5	-	%
P_{1dB}	P1dB	-	-	23	-	dBm
S_{21}	Small Signal Gain	2400 – 2485 MHz 960 – 1600 MHz 1600 – 1660 MHz 3260 – 3267 MHz	23 - - -	- - - -	30 0 0 2	dB
ΔS_{21}	Small Signal Gain Variation Over Band	Over any 40 MHz band	-	-	0.5	dB
2f,3f	Harmonics	Pout = 18 dBm, 1 Mbps, BPSK	-	-50	-45.2	dBm
		Pout = 17 dBm, 54Mbps OFDM signal		-55	-48.2	
NF	Noise Figure	Pout < 20 dBm	-	-	10	dB
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	-	-	10	-	dB
Spur	Spurious	Pout < 20 dBm, VSWR = 2:1 100 MHz to 10 GHz	-	-	-45	dBm/MHz
STAB	Stability	P_{OUT} ≤ 20dBm Load VSWR = 10:1	All non-harmonically related outputs less than -50 dBc/1MHz			

2.4 GHz Receive Characteristics

Conditions: VCC = V_LNA = Bsel = RX = 3.3V, ENg = ENa = TX = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), 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 800 – 1200 MHz 1200 – 1700 MHz 1700 – 1900 MHz 3200 – 6000 MHz	11 - - - -	13 - - - 10	- -10 3 10 -	dB
	Receive Gain, Bypass mode	V_LNA = 0 V 2400 – 2485 MHz	-	-7	-	dB
ΔS_{21}	Gain Variation	2400 – 2485 MHz, Over any 40MHz band	-	-	.5	dB
NF	Noise Figure		- -	2.6 7	2.8 -	dB
IIP3	Third Order Intercept	2.45GHz, 1MHz offset	-	9	-	dBm
$ISOL_{RRX}$	Reverse Isolation	V_LNA = 0V, RX = 0 V	-	-23	-	dB
INT	Interferer	With this input , IIP3 can only degrade by 1dB	-10	-	-	dBm
S_{11}	Input Return Loss	-	10	12	-	dB
IP1dB	Input P1dB	V_LNA = 3.3 V V_LNA = 0 V	- -	-3.5 8	- -	dBm
T_{EN}	Enable Time	10% to 90% of RX RF power, from time that V_LNA is at 50%	-	-	500	nsec

5 GHz AC Electrical Characteristics

5 GHz Transmit Characteristics

Conditions: VCC = 3.3 V, ENa = TX = 3.3 V, V_LNA = ENg = RX = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
F_{IN}	Frequency Range	-	4900	-	5850	MHz
$P_{802.11a}$	Nominal Output Power	54 Mbps OFDM signal, 64 QAM, EVM = 3.0 %	-	16	-	dBm
BEVM	Backed Off EVM	54 Mbps, OFDM signal, 64 QAM, P ≤ 7 dBm	-	1.5	-	%
P_{1dB}	P1DB	-	-	21	-	dBm
S21	Small Signal Gain	4900 – 5850 MHz 960 – 3265 MHz 3265 – 3900 MHz 6900 – 7250 MHz 7250 – 7800 MHz 7800 – 8500 MHz	22 - - - - -	- -30 -10 -10 -12 -10	31 10 8 6 -10 10	dB
ΔS_{21}	Small Signal Gain Variation Over 40 MHz Channel		-	0.4	-	dB
	Small Signal Gain Variation Over Band		-	6	-	dB
2f,3f	Harmonics, 54Mbps, 802.11a signal	Pout = 16dBm 4900 – 5150 MHz 5150 – 5850 MHz	 - -	 -45 -50	 -42 -48	dBm/MHz
NF	Noise Figure	Pout < 16 dBm 4900 – 5850 MHz	-	-	10	dB
t_r	Rise Time	10 % to 90% of final output power level	-	-	0.8	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	-	dB
SPUR	Spurious	Pout < 16dBm, VSWR = 2:1, 100 – 24000 MHz	-	-	-45	dBm/MHz
STAB	Stability	P_{OUT} ≤ 17 dBm Load VSWR = 10:1	All non-harmonically related outputs less than -50 dBc/1MHz			

5 GHz Receive Characteristics

Conditions: VCC = V_LNA = RX = 3.3 V, Bsel = ENg = ENa = TX = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), 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 800 – 2500 MHz 2500 – 3900 MHz 6500 – 7800 MHz	- - - -	12 -10 6 11	- -5 - -	dB
	Receive Gain, Bypass mode	V_LNA = 0.0 V	-	-7	-	dB
ΔS_{21}	Gain Variation	4900 – 5850 MHz, Over any 40MHz band	-	-	0.5	dB
NF	Noise Figure		-	2.8	3.2	dB
IIP3	Third Order Intercept	5.45GHz, 1MHz offset	-	-3	-	dBm
$ISOL_{RRX}$	Reverse Isolation	V_LNA = 0V, RX = 0V	-	20	-	dB
INT	Interferer	With this input IIP3 can only degrade by 1dB	-10	-	-	dBm
S_{11}	Return Loss	-	-	8	-	dB
IP1dB	Input P1dB	V_LNA = 3.3 V V_LNA = 0 V	-	-3 10	-	dBm
T_{EN}	Enable Time	10% to 90% of RX RF power, from time that V_LNA is at 50%	-	-	500	nsec

2.4 GHz Power Detector Characteristics

Conditions: V_{CC} = 3.3 V, ENg = TX = 3.3 V, V_LNA = RX = ENa = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), 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 ANT	0	-	22	dBm
PDZ_{LOAD}	DC load impedance	-	-	2.7	3	kΩ
PDV_{P22}	Output Voltage, P_{OUT} = 21 dBm	-	-	0.86	-	V
PDV_{p0}	Output Voltage, P_{OUT} = 5 dBm	-	-	0.35	-	V

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
PDV_{pnoRF}	Output Voltage, P_{OUT} = No RF	-	-	0.32	-	V
LPF_{-3dB} (Note 2)	Power detect low pass filter -3dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	KHz

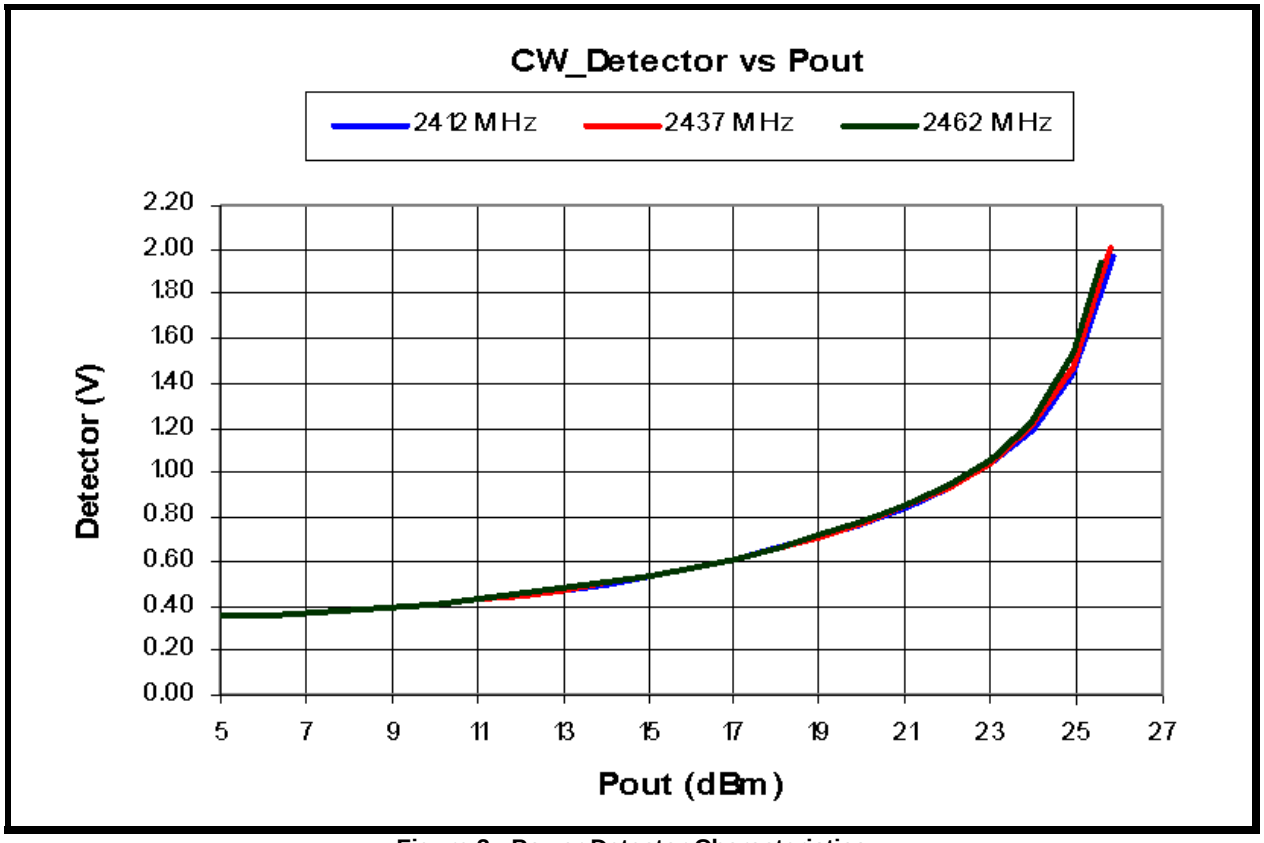
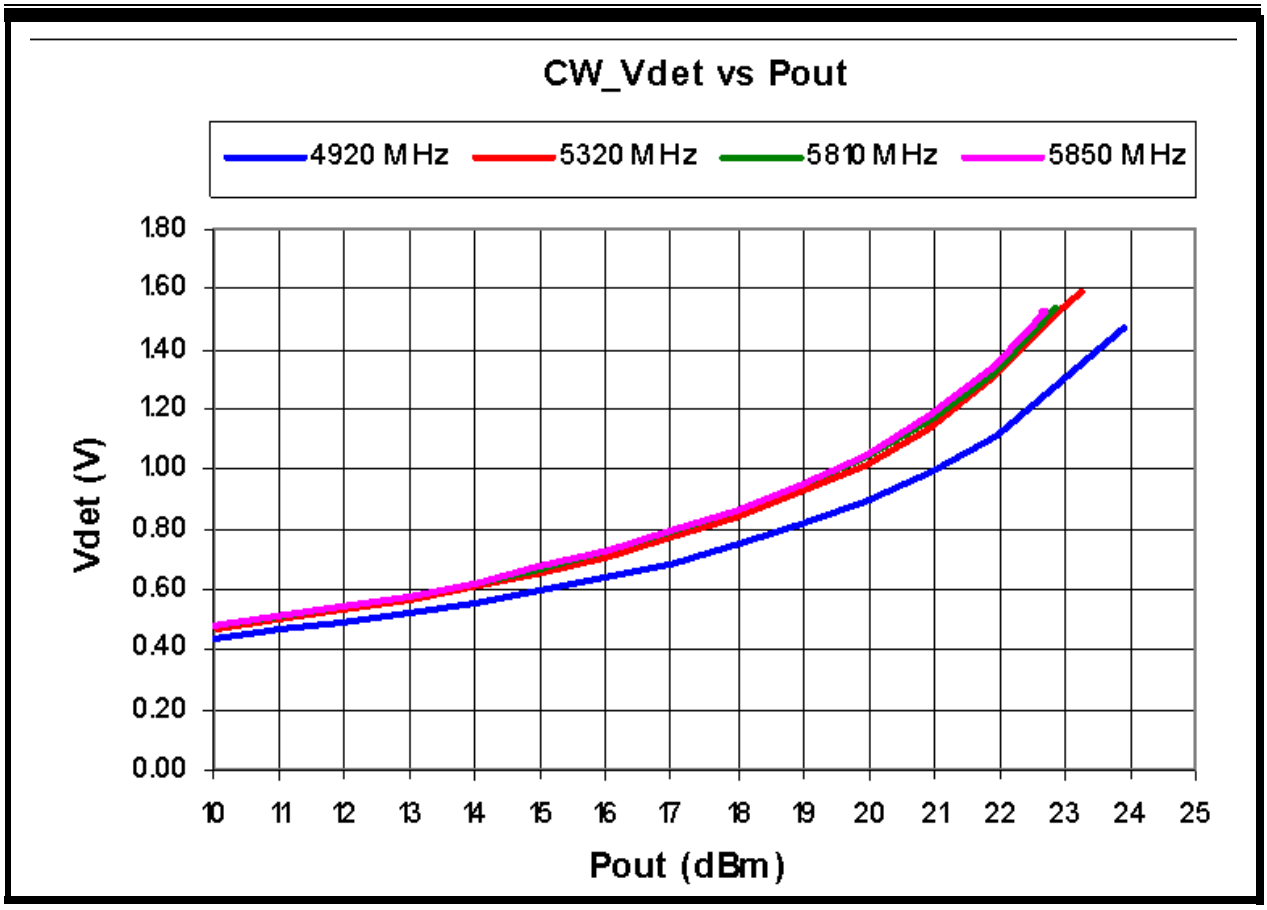


Figure 3: Power Detector Characteristics

5 GHz Power Detector Characteristic

Conditions: V_{CC} = 3.3 V, ENa = TX = 3.3 V, V_LNA = RX = ENg = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2595L-EV1 evaluation board (de-embedded to device), 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	-	20	dBm
PDZ_{LOAD}	DC load impedance	-	-	2.7	3	kΩ
PDV_{P20}	Output Voltage, P_{OUT} = 17 dBm	-	-	0.80	-	V
PDV_{p0}	Output Voltage, P_{OUT} = 3 dBm	-	-	0.34	-	V
PDV_{pnoRF}	Output Voltage, P_{OUT} = No RF	-	-	0.32	-	V
LPF_{-3dB} (Note 3)	Power detect low pass filter -3dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	KHz


CW_Vdet vs Pout
4920 MHz
5320 MHz
5810 MHz
5850 MHz
Vdet (V)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Pout (dBm)

Package Diagram

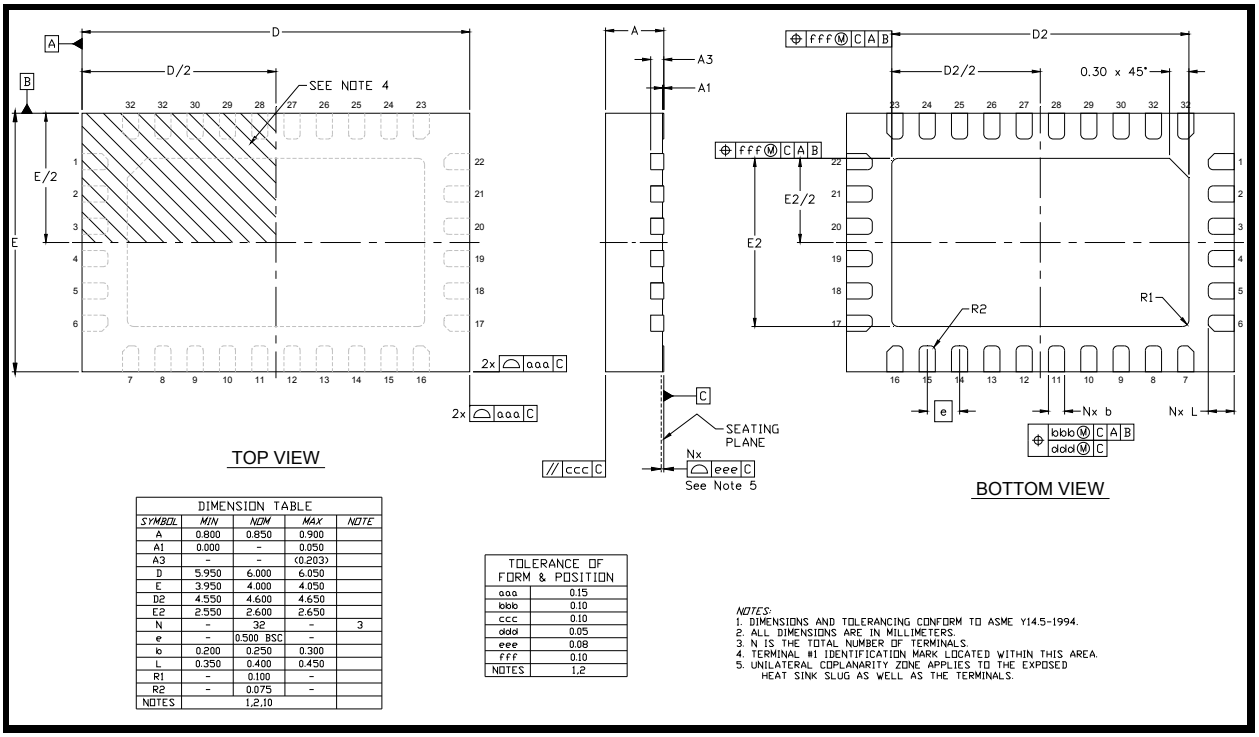


Figure 4: Package Outline Drawing

Recommended Land and Solder Patterns

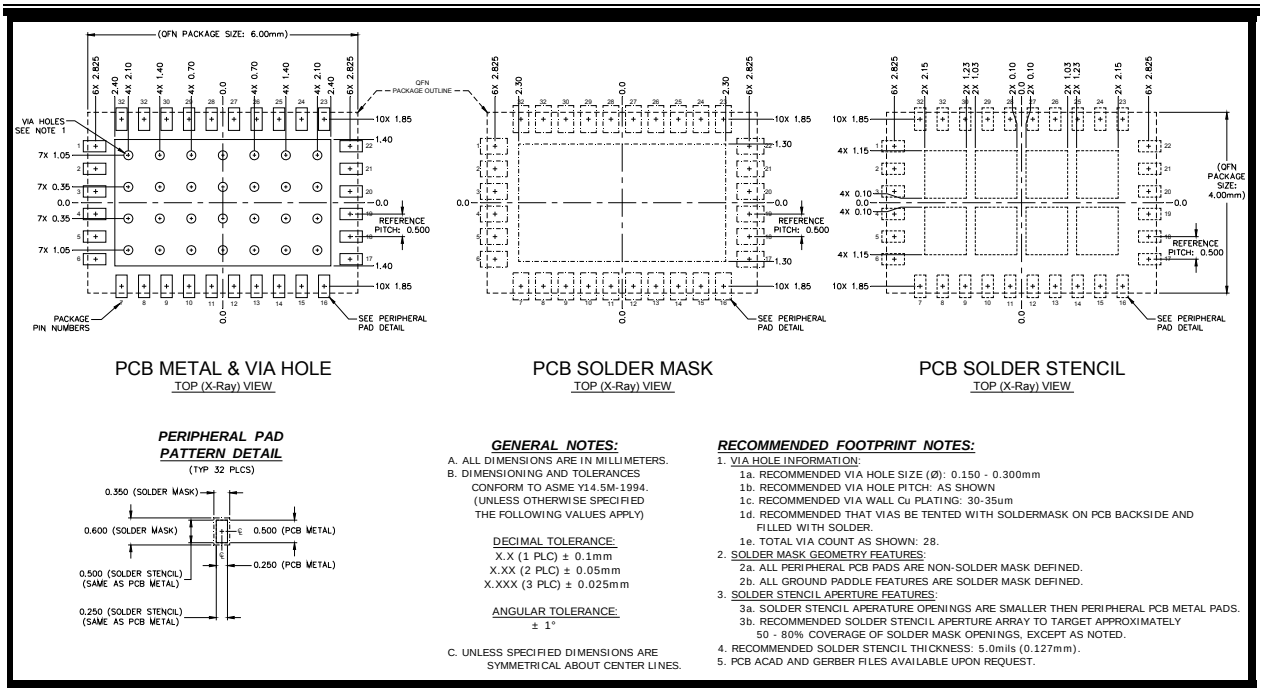


Figure 5: Recommended Land and Solder Pattern

Package Handling Information

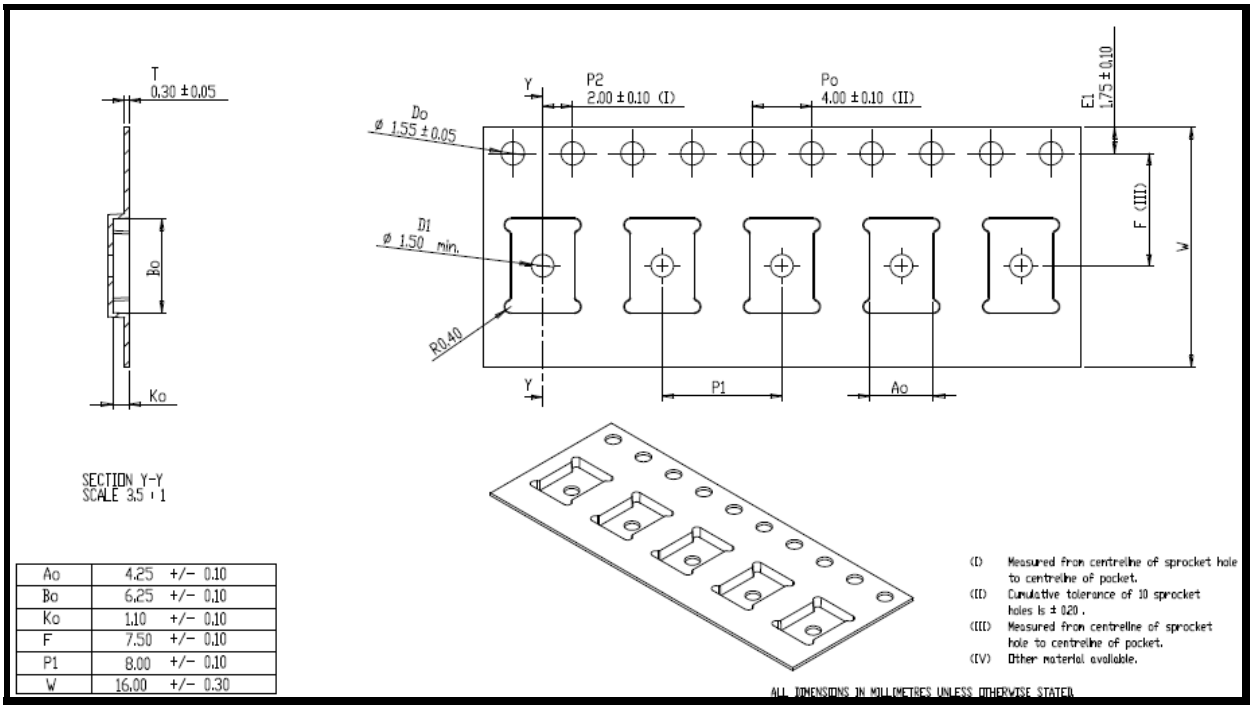
Because of its sensitivity to moisture absorption, instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly. The SE2595L 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*
- "ESD Control Policy", *Document Number SQ03-0062*

Caution! Class 0 ESD sensitive device

Tape and Reel Information

Parameter	Value
Devices Per Reel	3000
Reel Diameter	13 inches
Tape Width	16 millimeters



Ao	4.25	+/- 0.10
Bo	6.25	+/- 0.10
Ko	1.10	+/- 0.10
F	7.50	+/- 0.10
P1	8.00	+/- 0.10
W	16.00	+/- 0.30

Figure 6: Tape and Reel Information

Branding Information

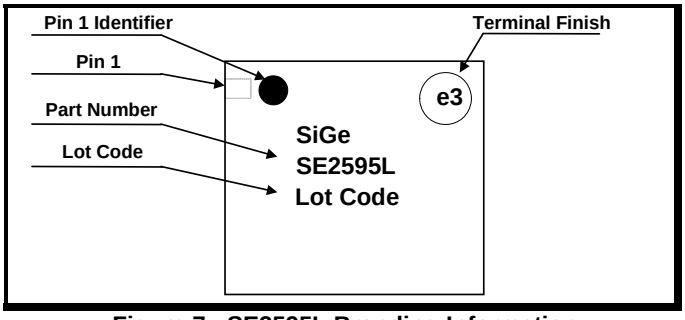


Figure 7: SE2595L Branding Information

Document Change History

Revision	Date	Notes
1.0	June 29, 2008	Create
1.1	March 11, 2009	Update Gain in both bands Updated detector characteristics Updated packing method to Tape & Reel Added package outline drawing and recommended land pattern Updated input return loss. Updated RX IIP3
1.2	April 6, 2009	Updated LNA characteristics. Corrected product and terminal finish marking on Branding information
1.3	April 29, 2009	Updated LNA Logic Characteristics (I_{RENH}) to 400uA
1.4	May 1, 2009	Updated detector characteristics
1.5	July 30, 2009	Updated 5GHz Gain Characteristics
1.6	Aug 28, 2009	Updated Tape and Reel drawings.
1.7	Jan 11, 2010	Updated ICC_OFF specification.
1.8	Jan 8, 2011	Updated MSL rating to MSL 1
1.9	Apr 9, 2011	Updated recommended operating conditions to industrial temperature range
2.0	Mar 28, 2012	Updated with Skyworks logo and disclaimer statement

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