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

- One transmit and one 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 3

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.

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04–0074.

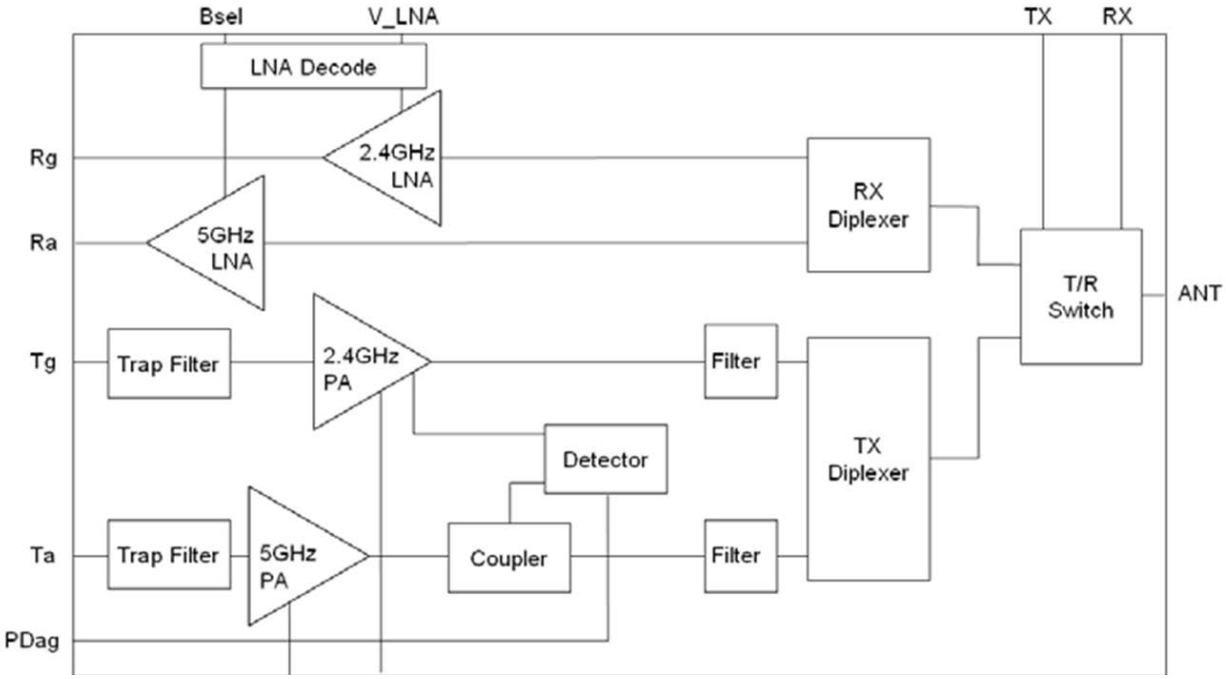


Figure 1. SE2595L Functional Block Diagram

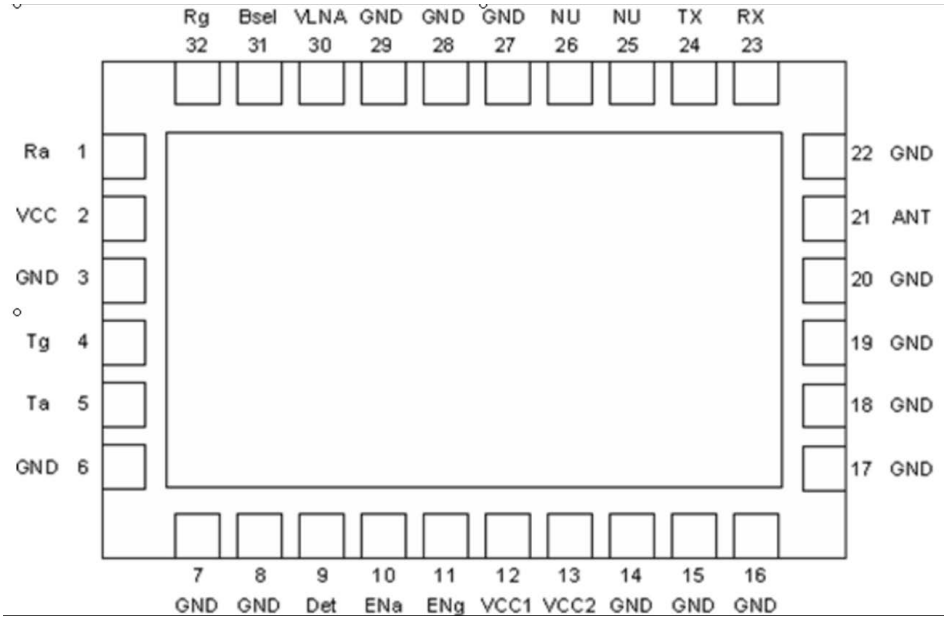


Figure 2. SE2595L (Top View)

Table 1. SE2595L Pinout Discriptions

Pin	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 and 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
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
27	GND	Ground
28	GND	Ground
29	GND	Ground
30	V_LNA	LNA enable
31	Bsel	LNA band select
32	Rg	2.4 GHz receive output

Electrical and Mechanical Specifications

The absolute maximum ratings of the SE2595L are provided in Table 2, recommended operating conditions are in Table 3, followed by the other electrical specifications.

Table 2. SE2595L Absolute Maximum Ratings[1]

Symbol	Defunition	Min.	Max.	Unit
Vcc	Supply voltage	-0.3	4.2	V
PU	ENg, ENa, V_LNA, Bsel	-0.3	4.0	V
TXrf	Ta, Tg, ANT terminated into 50 Ω match		10.0	dBm
Ta	Operating temperature range	-40	85	°C
Tstg	Storage temperature range	-40	150	°C
ESD HBM	JEDEC JESD22-A114 all pins	150		V

[1] Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

ESD Handling: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.

Table 3. SE2595L Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
Vcc	Supply voltage	3.0	3.3	3.6	V
Ta	Ambient temperature	-40	25	85	°C

Table 4. SE2595L DC Electrical Characteristics[1]

Conditions: VCC = 3.3 V, TA = 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

Table 4. SE2595L DC Electrical Characteristics[1] (Continued)

Conditions: VCC = 3.3 V, TA = 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**
$TxIc_{q-A}$	Quiescent current , 802.11a transmit supply current	No RF applied ENa = 3.3V, ENg = 0V, TX = 3.3V, RX = 0V		155		mA
$RxIc_{CC-G}$	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
$RxIc_{CC-a}$	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
Icc_off	Total supply current	No RF, ENg = ENa = 0 V, V_LNA = 0 V, TX = RX = 0 V		2	100	µA
Note 1: Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.						

Table 5. SE2595L Transmit Power Amplifier Logic Characteristics[1]

Conditions: VCC = 3.3 V, TA = 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**	**Min.**	**Typ.**	**Max.**	**Unit**
Venh	Logic High Voltage for ENg, ENa (Module On)		2.0	Vcc	V
Venl	Logic Low Voltage ENg, ENa (Module Off)	0	0.5		V
Ienh	Input Current Logic High Voltage (ENg, ENa)		100	150	µA
Ienl	Input Current Logic Low Voltage (ENg, ENa)		0.2		µA
Note 1: Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.					

Table 6. SE2595L Receive LNA Logic Characteristics

Conditions: VCC = 3.3 V, TA = 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**	**Min.**	**Typ.**	**Max.**	**Unit**
Vrenh	Logic High Voltage for V_LNA, Bsel (Module On)		3.2	Vcc	V
Vrenl	Logic Low for V_LNA, Bsel (Module Off)	-0.5	0.3		V
Irenh	Input Current Logic High Voltage (V_LNA, Bsel)			400	µA
Irenl	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

Table 7. SE2595L RF Switch Characteristics

Conditions: VCC = 3.3 V, TA = 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**
Vctl_on	Control voltage (On state)		3.0		3.6	V
Vctl_off	Control voltage (OFF state)		0.0		0.2	V
SWon	Low loss switch control voltage	High state = V_{CTL_ON} - V_{CTL_OFF}	2.8		Vcc	V
SWoff	High loss switch control voltage	Low state = V_{CTL_OFF} - V_{CTL_OFF}	0		0.2	V
Ictl_on	Switch control bias current (RF applied)	On pin (TX, RX) being driven high. RF applied			100	µA
Ictl_on	Switch control bias current (no RF)	On pin (TX, RX) being driven high. No RF			30	µA
Cctl	Control input capacitance				100	pF

RF Switch Logic		**RF Switch Function**	
CTRL_T	**CTRL_R**	**Tg, Ta – ANT**	**Rg, Ra – ANT**
SWon	SWoff	ON	OFF
SWoff	SWon	OFF	ON

Table 8. SE2595L 2.4 GHz Transmit Characteristics

Conditions: VCC = 3.3 V, ENg = TX = 3.3 V, V_LNA = ENa = RX = 0 V, TA = 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**
Fin	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			

Table 9. SE2595L 2.4 GHz Receive Characteristics

Conditions: VCC = V_LNA = Bsel = RX = 3.3V, ENg = ENa = TX = 0 V, TA = 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**
Fout	Frequency range		2400		2500	MHz
S_{21}	Receive gain, LNA enabled.	2400 to 2485 MHz 800 to 1200 MHz 1200 to 1700 MHz 1700 to 1900 MHz 3200 to 6000 MHz	11	13 - 10	-10 3 10	dB
	Receive gain, bypass mode	V_LNA = 0 V 2400 to 2485 MHz		-7		dB
ΔS_{21}	Gain variation	2400 to 2485 MHz, Over any 40 MHz band			.5	dB
NF	Noise figure			2.6 7	2.8	dB
IIP3	Third order intercept	2.45 GHz, 1 MHz 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

Table 10. SE2595L 5 GHz Transmit Characteristics

Conditions: VCC = 3.3 V, ENa = TX = 3.3 V, V_LNA = ENg = RX = 0 V, TA = 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**
Fin	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

Table 10. SE2595L 5 GHz Transmit Characteristics

Conditions: VCC = 3.3 V, ENa = TX = 3.3 V, V_LNA = ENg = RX = 0 V, TA = 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**
S21	Small signal gain	4900 to 5850 MHz 960 to 3265 MHz 3265 to 3900 MHz 6900 to 7250 MHz 7250 to 7800 MHz 7800 to 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, 54 Mbps, 802.11a signal	Pout = 16dBm 4900 to 5150 MHz 5150 to 5850 MHz		-45 -50	-42 -48	dBm/MHz
NF	Noise figure	Pout < 16 dBm 4900 to 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 to 24000 MHz			-45	dBm/MHz
STAB	Stability	$P_{OUT} \leq 17$ dBm Load VSWR = 10:1	All non-harmonically related outputs less than -50 dBc/1MHz			

Table 11. SE2595L 5 GHz Receive Characteristics

Conditions: VCC = V_LNA = RX = 3.3 V, Bsel = ENg = ENa = TX = 0 V, TA = 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**
Fout	Frequency range		4900		5850	MHz
S21	Receive gain	4900 to 5850 MHz 800 to 2500 MHz 2500 to 3900 MHz 6500 to 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 40 MHz band			0.5	dB
NF	Noise figure			2.8	3.2	dB

Table 11. SE2595L 5 GHz Receive Characteristics

Conditions: VCC = V_LNA = RX = 3.3 V, Bsel = ENg = ENa = TX = 0 V, TA = 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**
IIP3	Third order intercept	5.45 GHz, 1 MHz 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

Table 12. SE2595L 2.4 GHz Power Detector Characteristics

Conditions: VCC = 3.3 V, ENg = TX = 3.3 V, V_LNA = RX = ENa = 0 V, TA = 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**
Fout	Frequency range		2400		2500	MHz
PDR	Power detect range, peak power	Measured at ANT	0		22	dBm
PDZload	DC load impedance			2.7	3	kΩ
PDVp22	Output voltage, P_{OUT} = 21 dBm			0.86		V
PDV_{p0}	Output voltage, P_{OUT} = 5 dBm			0.35		V
PDV_{pnoRF}	Output voltage, P_{OUT} = No RF			0.32		V
LPF_{-3dB} (Note 2)	Power detect low pass filter -3 dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	V

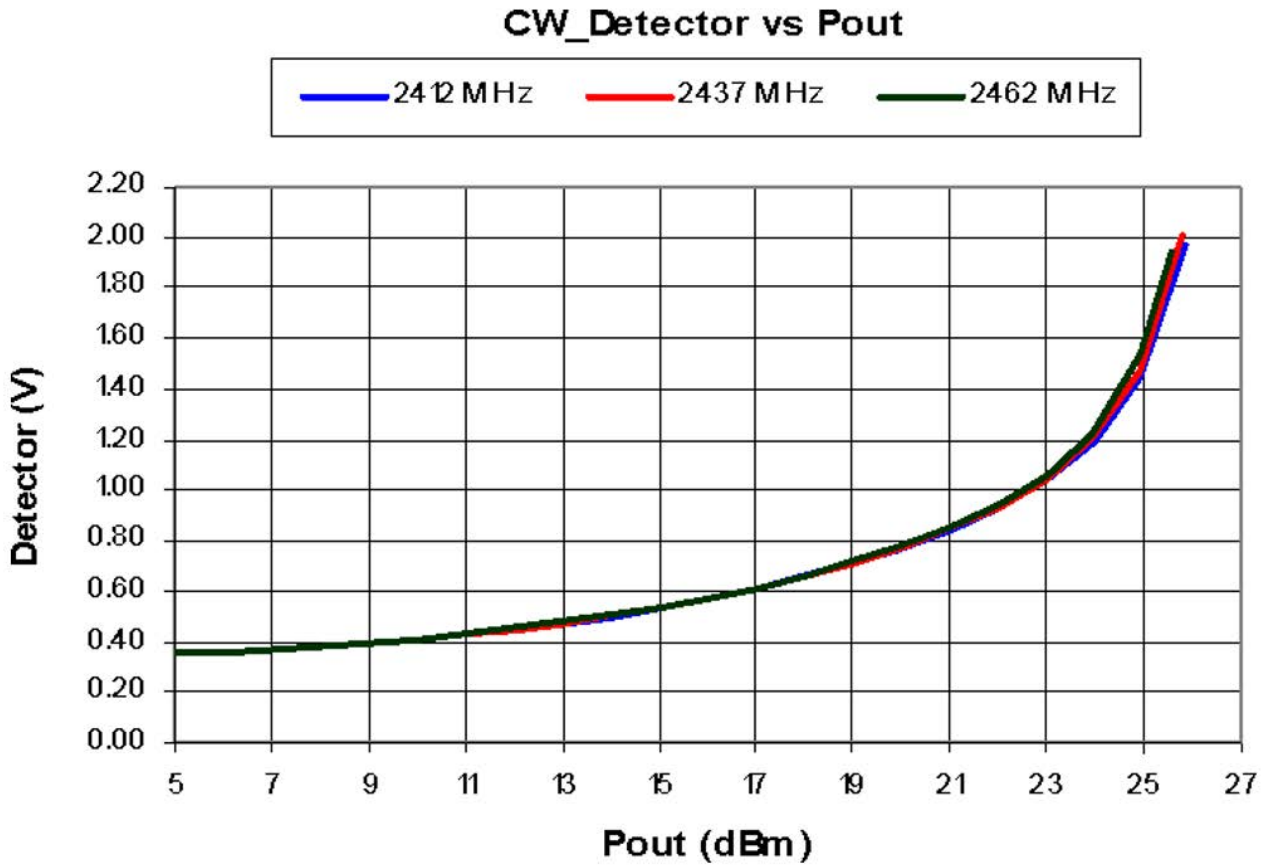


Figure 3. SE2595L2.4 GHz Power Detector Characteristics

Table 13. SE2595L 5 GHz Power Detector Characteristics

Conditions: VCC = 3.3 V, ENa = TX = 3.3 V, V_LNA = RX = ENg = 0 V, TA = 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**
Fout	Frequency range		4900		5850	MHz
PDR	Power detect range, peak power	Measured at ANT	0		20	dBm

Table 13. SE2595L 5 GHz Power Detector Characteristics

Conditions: VCC = 3.3 V, ENa = TX = 3.3 V, V_LNA = RX = ENg = 0 V, TA = 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**
PDZload	DC load impedance			2.7	3	kΩ
PDVp20	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 -3 dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	kHz

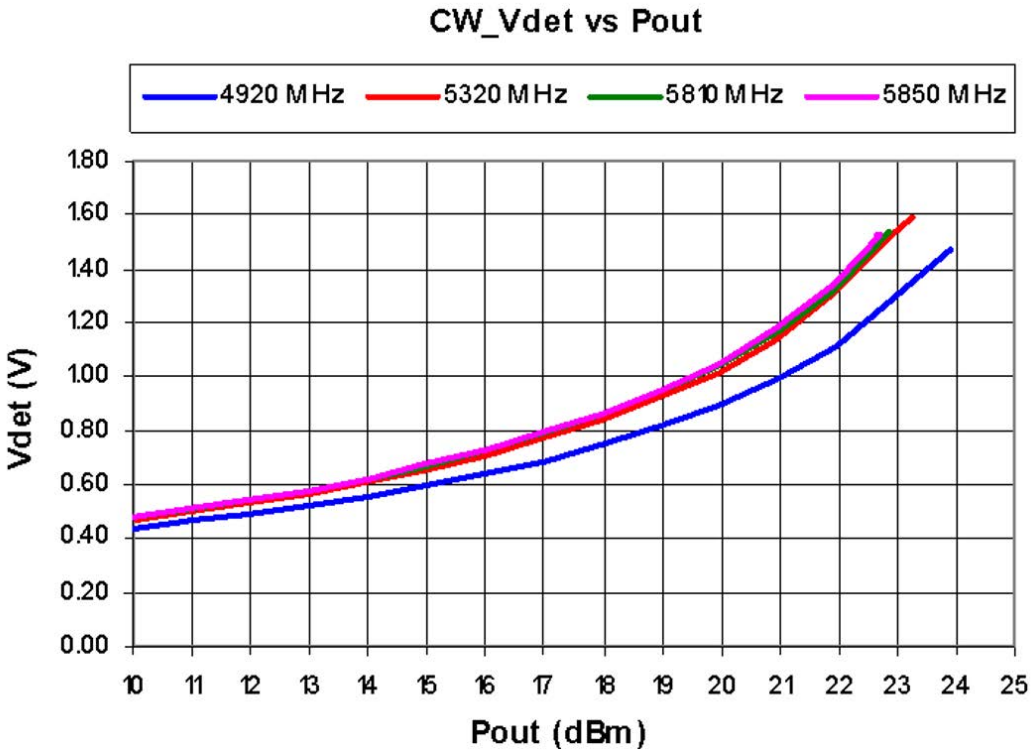
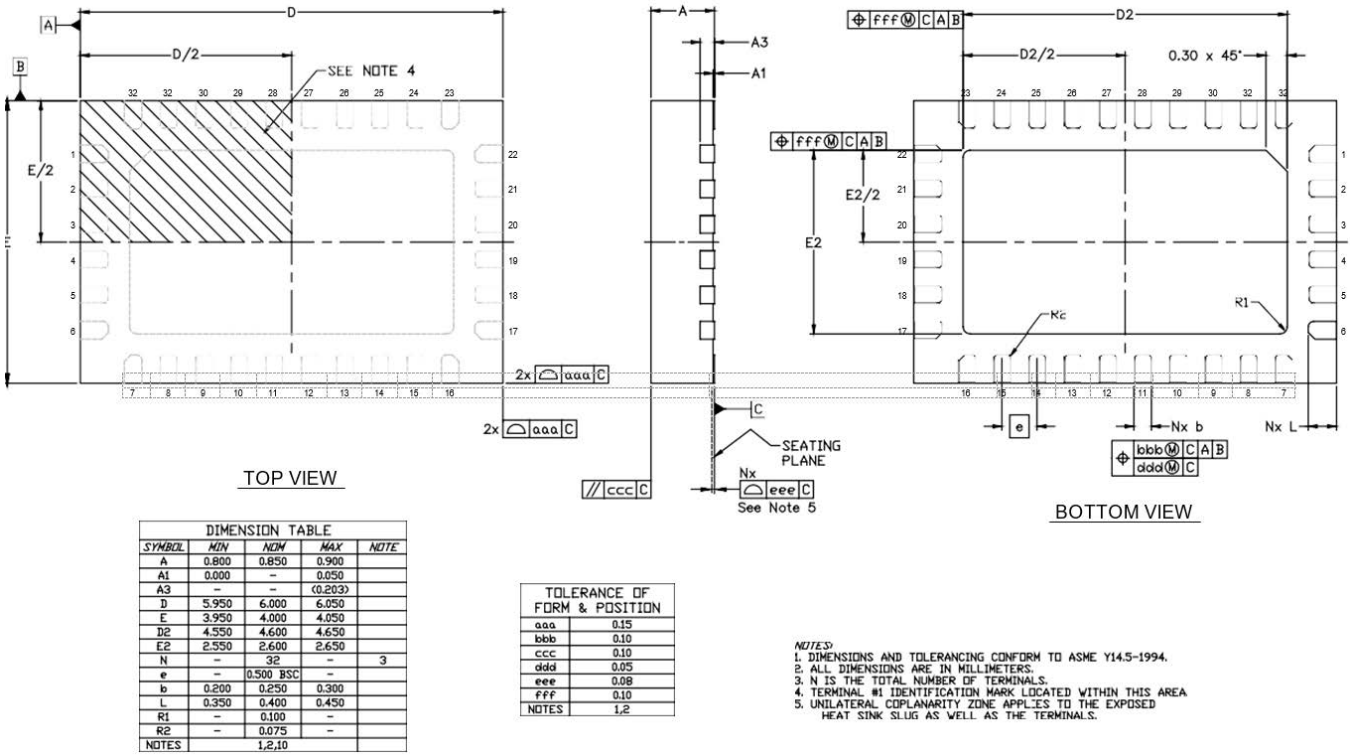


Figure 4. SE2595L 5 GHz Power Detector Characteristics



DIMENSION TABLE				
SYMBOL	MIN	NOM	MAX	NOTE
A	0.800	0.850	0.900	
A1	0.000	–	0.050	
A3	–	–	(0.203)	
D	5.950	6.000	6.050	
E	3.950	4.000	4.050	
D2	4.550	4.600	4.650	
E2	2.550	2.600	2.650	
N	–	32	–	3
e	–	0.500 BSC	–	
b	0.200	0.250	0.300	
L	0.350	0.400	0.450	
R1	–	0.100	–	
R2	–	0.075	–	
NOTES	1,2,10			

TOLERANCE OF FORM & POSITION	
aaa	0.15
bbb	0.10
ccc	0.10
ddd	0.05
eee	0.08
fff	0.10
NOTES	1,2

NOTES:
1. DIMENSIONS AND TOLERANCING CONFORM TO ASME Y14.5-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. TERMINAL #1 IDENTIFICATION MARK LOCATED WITHIN THIS AREA.
5. UNILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

Figure 5. SE2595L Package Outline Drawing

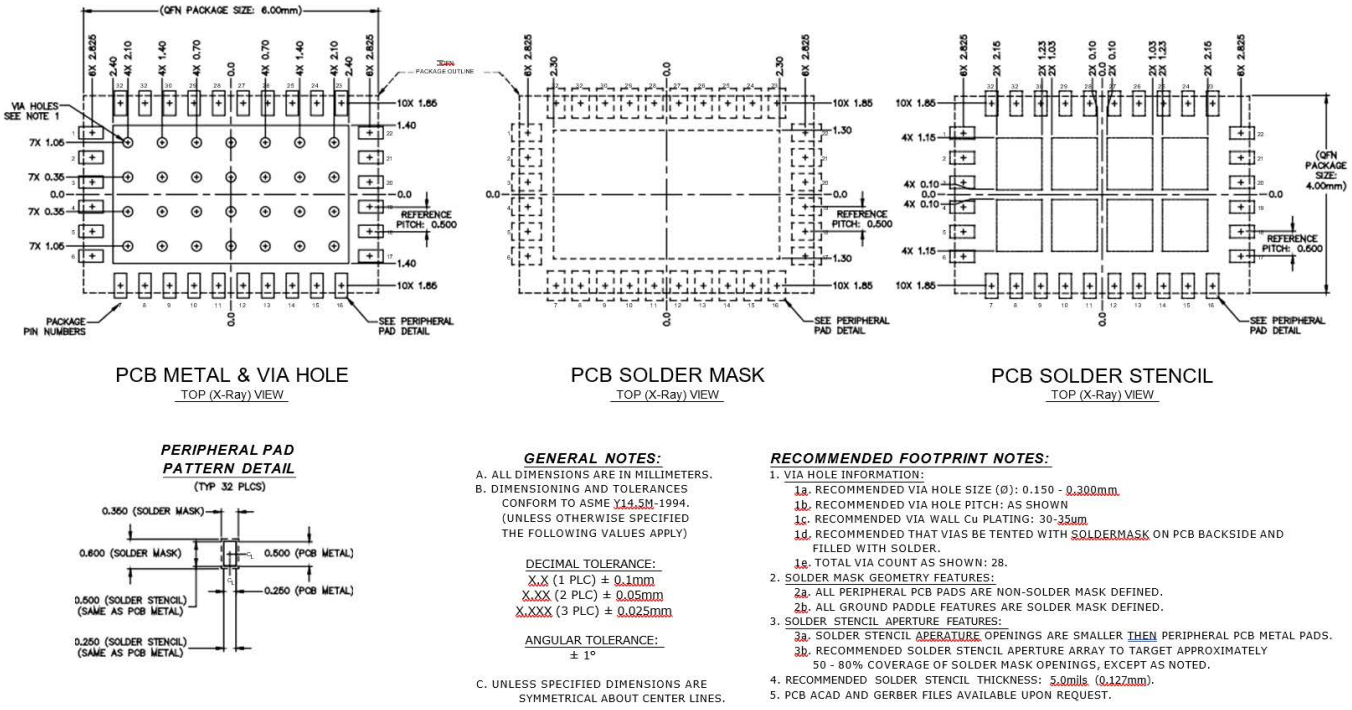


Figure 6. SE2595L Recommended Land and Solder Pattern

Package and Handling Information

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY85500-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, Solder Reflow Information, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

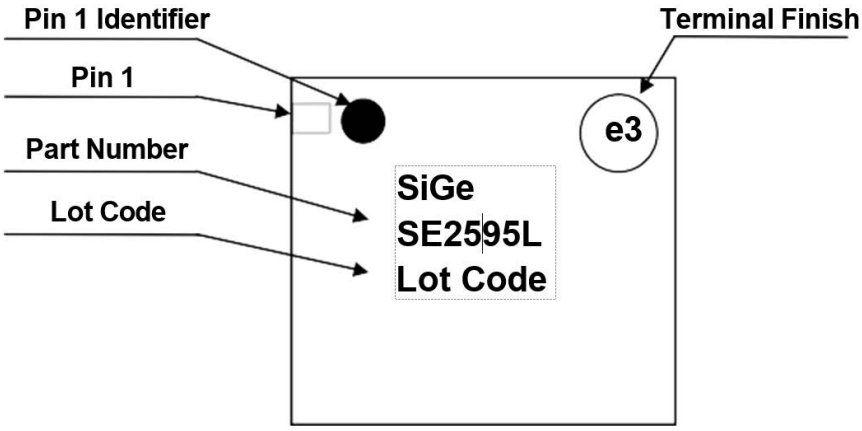
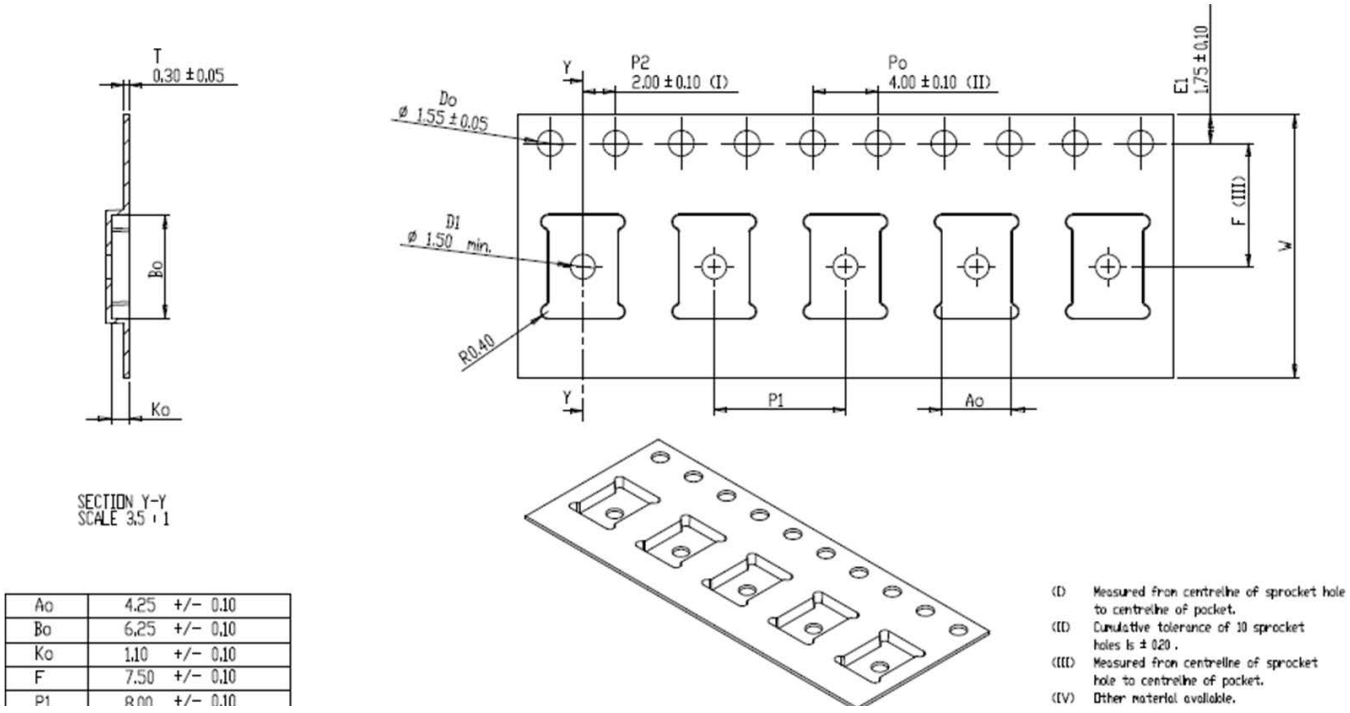


Figure 7. SE2595L Typical Package Marking



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

Figure 8. SE2595L Tape and Reel Information

Parameter	Value
Devices per reel	3000
Reel diameter	13 inches
Tape width	16 millimeters

Ordering Information

Part Number	Part Description	Evaluation Board Part Number
SE2595L	SE2595L: Dual-Band 802.11n Wireless LAN Front-End	SE2595L-EK1
SE2595L	Samples	
SE2595L-R	32 pin QFN, tape and reel	

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
B	January 16, 2023	Revised MSL rating. Updated to current format, disclaimer statement, and revision letter.

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