



DATA SHEET

SE2593A20: Dual-Band 802.11n Wireless LAN Front-End Preliminary Information

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, RoHS compliant, MSL3 plated LGA package, 5 mm x 6 mm x 1.0 mm

Ordering Information

Part No.	Package	Remark
SE2593A20	30 pin LGA	Samples
SE2593A20-T * * Through Dec 2008	30 pin LGA	Tray
SE2593A20-R * * From Jan 2009	30 pin LGA	Tape and Reel
SE2593A20-EK1	N/A	Evaluation kit

Product Description

The SE2593A20 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 SE2593A20 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 SE2593A20 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.

The SE2593A20 packaged in 5mm x 6mm x 1.0mm, Halogen free, Lead free, ROHS compliant, MSL 3 LGA package.

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Functional Block Diagram

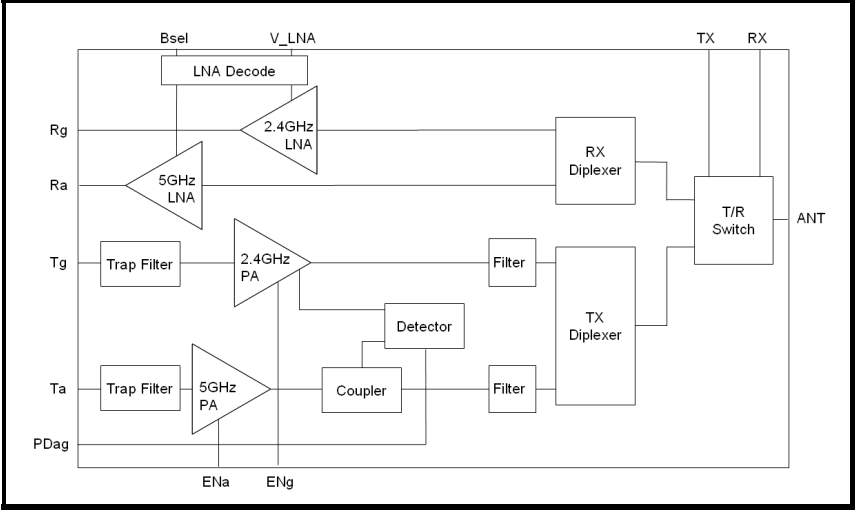


Figure 1: Functional Block Diagram

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Pin Out Diagram

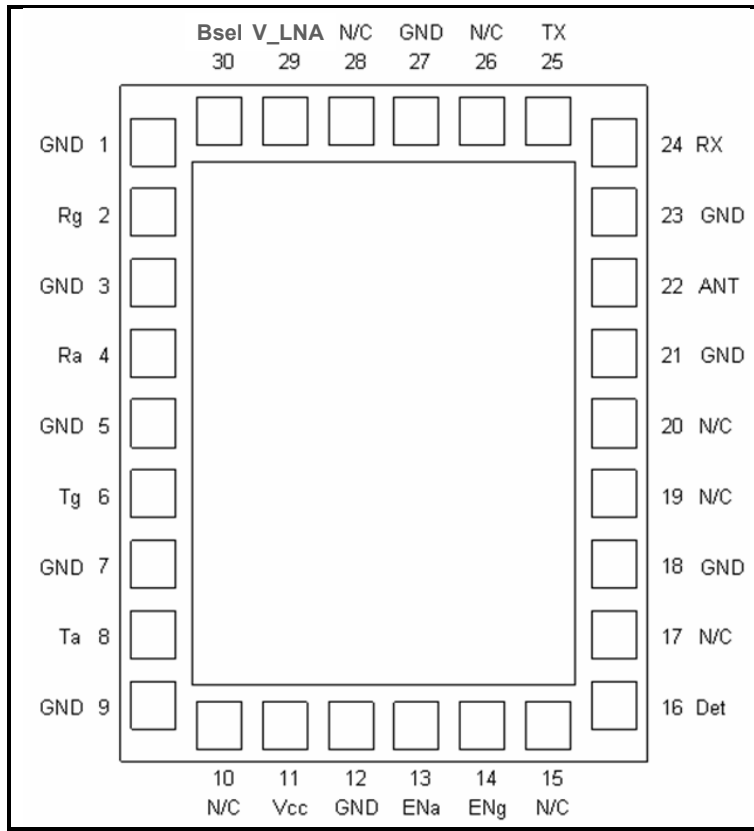


Figure 2: SE2593A20 Pin Out (Top View Through Package)

Pin Out Description

Pin No.	Name	Description
1	GND	Ground
2	Rg	2.4 GHz Receive Output
3	GND	Ground
4	Ra	5 GHz Receive Output
5	GND	Ground
6	Tg	2.4 GHz Transmit Input
7	GND	Ground
8	Ta	5 GHz Transmit Input
9	GND	Ground
10	N/C	Not used, floating PIN
11	VCC	Supply Voltage
12	GND	Ground

Pin No.	Name	Description
13	ENa	5 GHz PA Enable
14	ENg	2.4 GHz PA Enable
15	N/C	Not used, floating PIN
16	Det	Power Detector
17	N/C	Not used, floating PIN
18	GND	Ground
19	N/C	Not used, floating PIN
20	N/C	Not used, floating PIN
21	GND	Ground
22	ANT	Antenna
23	GND	Ground
24	RX	Rx Switch Select

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Pin No.	Name	Description	Pin No.	Name	Description
25	TX	Tx Switch Select	28	N/C	Not used, floating PIN
26	N/C	Not used, floating PIN	29	V_LNA	LNA Enable
27	GND	Ground	30	Bsel	LNA Band Select

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	-10	+85	°C
T _{STG}	Storage Temperature Range	-40	+150	°C

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V _{CC}	Supply Voltage	3.0	3.3	3.6	V
T _A	Ambient Temperature	-10	25	85	°C

DC Electrical Characteristics

Conditions: V_{CC} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2593A20-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
TX _{ICC-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	-	140	165	mA
TX _{ICq-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
TX _{ICC-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	-	180	200	mA
TX _{ICq-A}	Quiescent current,	No RF applied	-	-	160	mA

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Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
	802.11a Transmit supply Current	ENa = 3.3V, ENg = 0V, TX = 3.3V, RX = 0V				
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	10	μA

Transmit Power Amplifier Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2593A20-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' SE2593A20-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)	-	2.5	-	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)	-	-	1	2	μA
I _{RENL}	Input Current Logic Low Voltage (V _{LNA} , Bsel)	-	-	0	-	μA

LNA Enable Logic	LNA Function	Comment

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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: $V_{CC} = V_{EN} = 3.3\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, as measured on Skyworks Solutions' SE2593A20-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	-	0.3	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

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2.4 GHz AC Electrical Characteristics

2.4 GHz Transmit Characteristics

Conditions: $V_{CC} = 3.3\text{ V}$, $ENg = TX = 3.3\text{ V}$, $V_{LNA} = ENa = RX = 0\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, as measured on Skyworks Solutions' SE2593A20-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	-	2500	MHz
$P_{802.11g}$	Output power	54 Mbps OFDM signal, 64QAM, EVM $\leq 3.0\%$	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	-	-	25	-	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, 802.11b CCK Pout = 17 dBm, 54Mbps OFDM signal	-	-50 -55	-45.2 -48.2	dBm
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	$P_{OUT} \leq PSAT$ Load VSWR = 10:1	All non-harmonically related outputs less than -50 dBc/1MHz			

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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' SE2593A20-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	11	13	-	dB
		800 – 1200 MHz	-	-	-10	
1200 – 1700 MHz		-	-	3		
1700 – 1900 MHz		-	-	+10		
3200 – 6000 MHz		-	-	+10		
	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		-	TBD	-	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	- -	-5 8	-3.5 -	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, TA = 25 °C, as measured on Skyworks Solutions' SE2593A20-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	-	-	22	-	dBm

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Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
S ₂₁	Small Signal Gain	4900 – 5850 MHz	22	-	28	dB
		960 – 3265 MHz	-	-30	10	
		3265 – 3900 MHz	-	-10	5	
		6900 – 7250 MHz	-	-10	3	
		7250 – 7800 MHz	-	-12	-10	
		7800 – 8500 MHz	-	-10	10	
ΔS ₂₁	Small Signal Gain Variation Over 40 MHz Channel		-	-	0.4	dB
	Small Signal Gain Variation Over Band		-	-	3	dB
2f,3f	Harmonics, 54Mbps, 802.11a signal	P _{out} = 16dBm 4900 – 5150 MHz 5150 – 5850 MHz	- -	-45 -50	-42 -48	dBm/MHz
NF	Noise Figure	P _{out} < 16 dBm 4900 – 5850 MHz	-	TBD	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	-	10	-	-	dB
SPUR	Spurious	P _{out} < 16dBm, VSWR = 2:1, 100 – 24000 MHz	-	-	-45	dBm/MHz
STAB	Stability	P _{OUT} ≤ 18 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' SE2593A20-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
S ₂₁	Receive Gain	4900 – 5850 MHz	-	12	-	dB
		800 – 2500 MHz	-	-10	-5	
		2500 – 3900 MHz	-	6	10	
		6500 – 7800 MHz	-	11	12	
	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		-	TBD	-	dBm

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Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
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	12	-	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, EN_G = TX = 3.3 V, LNA_a = LNA_g = RX = EN_a = 0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2593A20-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 _{P17}	Output Voltage, P _{OUT} = 21 dBm	-	-	-	1.0	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}	Power detect low pass filter -3dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	KHz

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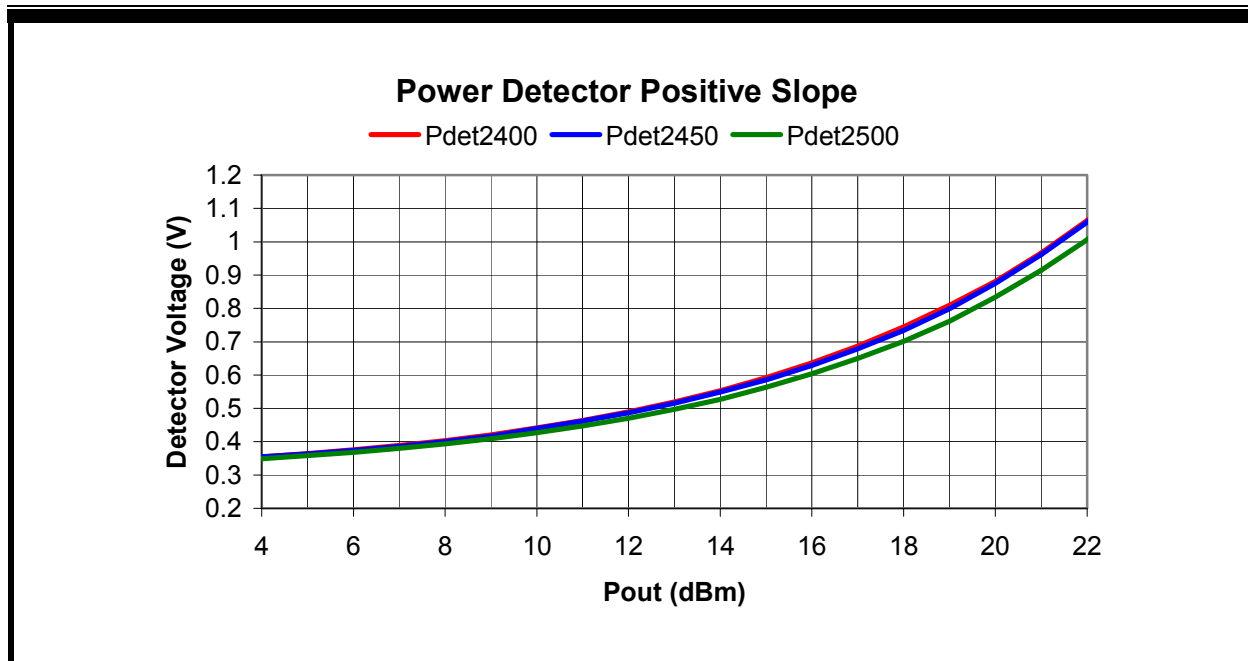


Figure 3: Power Detector Characteristics

5 GHz Power Detector Characteristic

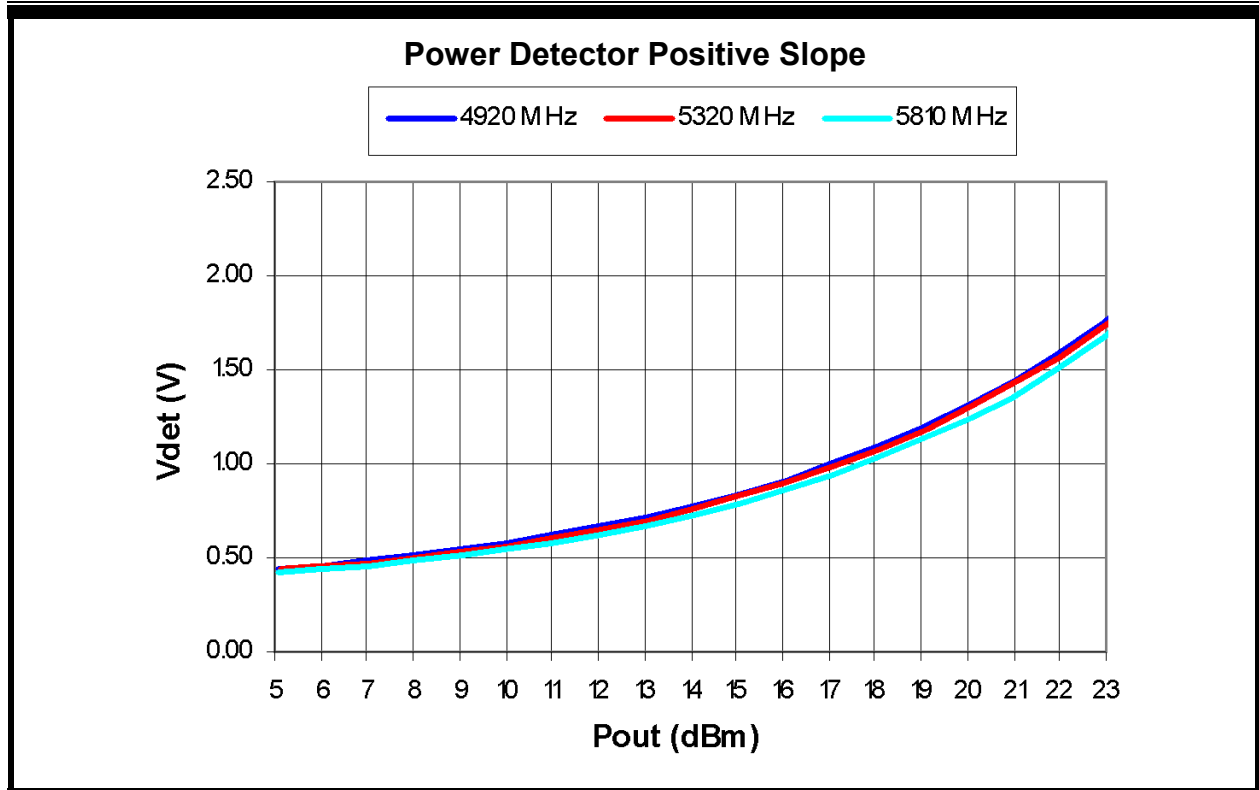
Conditions: $V_{CC} = 3.3\text{ V}$, $EN_A = TX = 3.3\text{ V}$, $LNA_A = LNA_G = RX = EN_G = 0\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, as measured on Skyworks Solutions' SE2593A20-EV1 evaluation board (de-embedded to device), all unused ports terminated with 50 ohms, unless otherwise noted.

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 _{P17}	Output Voltage, P _{OUT} = 17 dBm	-	-	-	1.0	V
PDV _{p0}	Output Voltage, P _{OUT} = 3 dBm	-	-	0.35	-	V
PDV _{pnoRF}	Output Voltage, P _{OUT} = No RF	-	-	0.32	-	V
LPF _{-3dB}	Power detect low pass filter -3dB corner frequency	Load = high impedance Typ: 500 kΩ	270	300	400	KHz



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Package Diagram

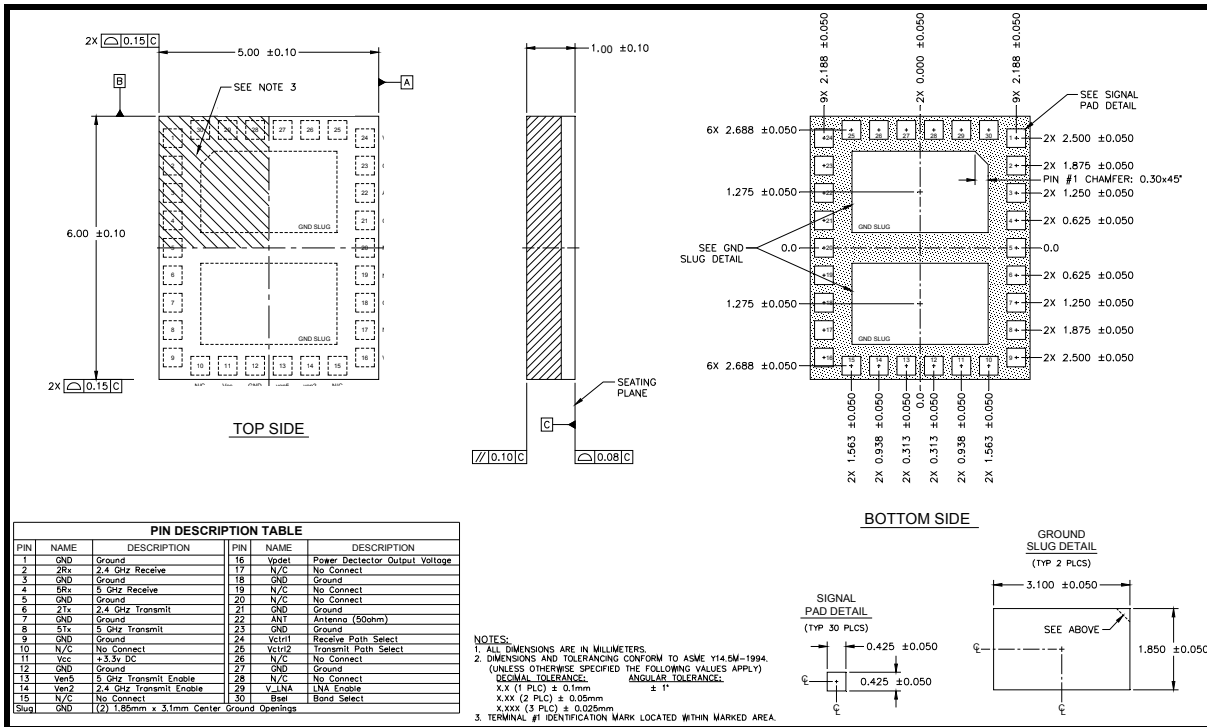


Figure 4: Package Outline Drawing

Recommended Land and Solder Patterns



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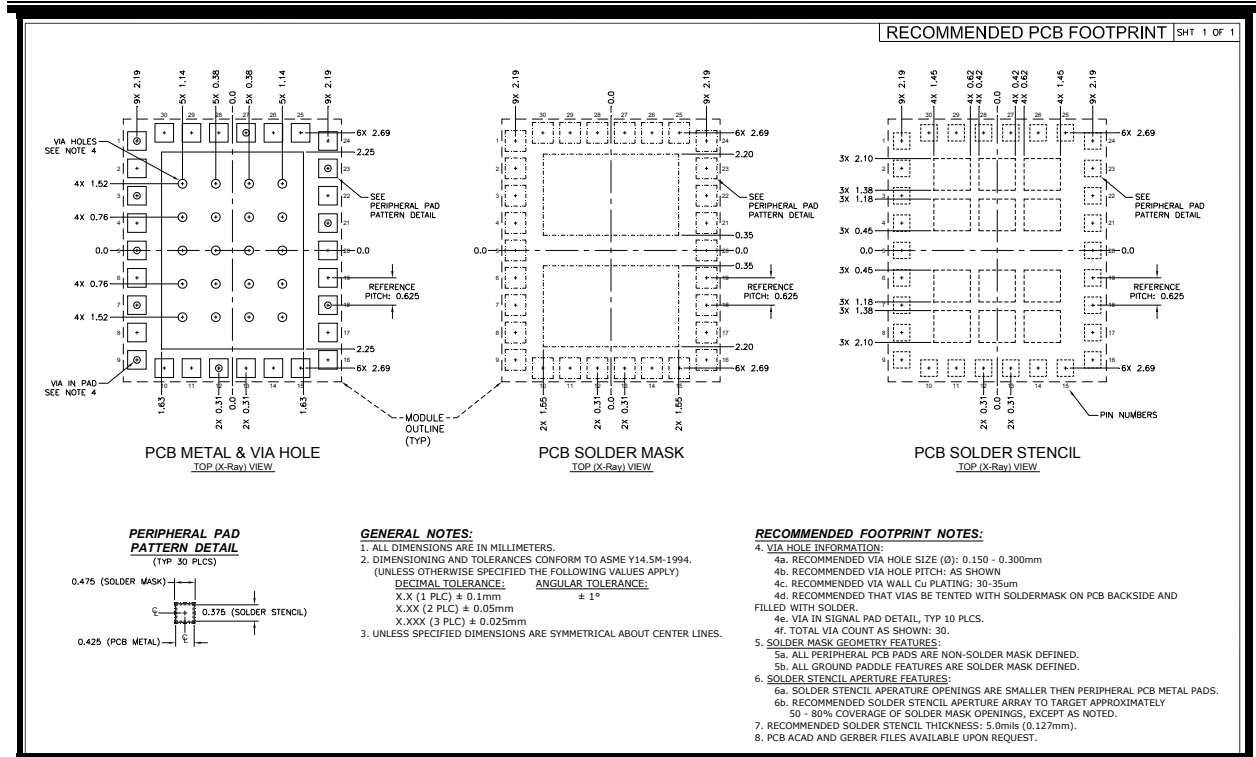


Figure 5: Recommended Land and Solder Patterns

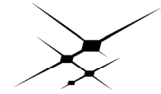
Package Handling Information

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 SE2593A20 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:

- “Land Grid Array Module Solder Reflow & Rework Information”, *Document Number QAD-00046*.
- “Handling, Packing, Shipping and Use of Moisture Sensitive LGA”, *Document Number QAD-00047*.



Caution! Class 0 ESD sensitive



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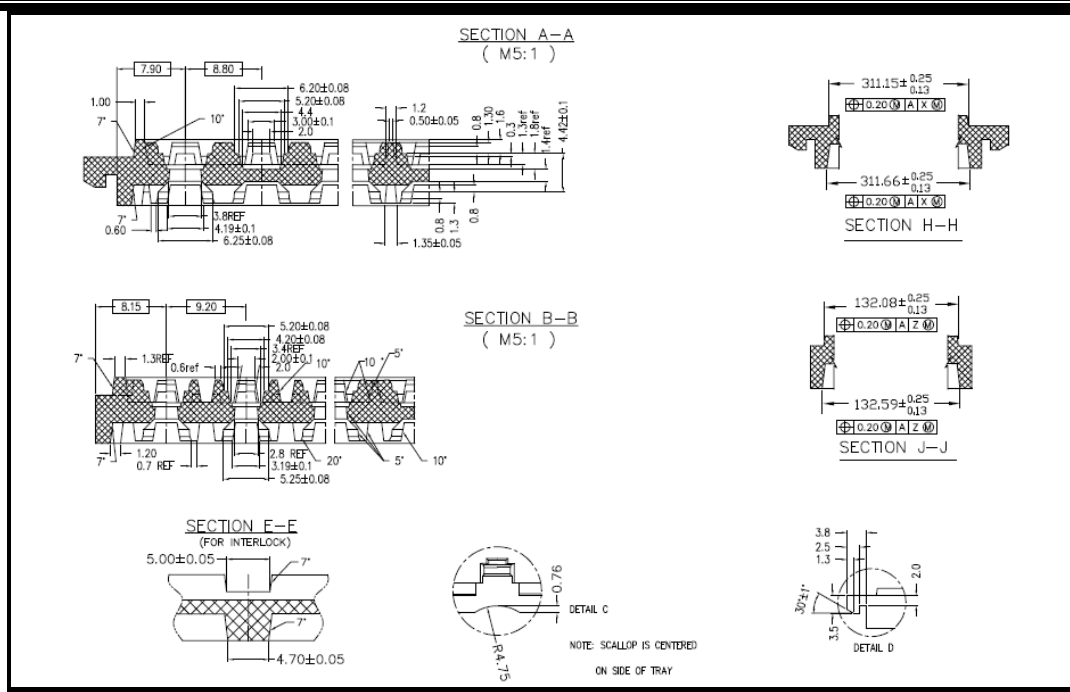


Figure 7: Tray Pocket Mechanical Drawing

Tape and Reel Information - Available from Jan 2009

Parameter	Value
Devices per Reel	3,000
Reel Diameter	13 Inches
Tape Width	12 millimetres



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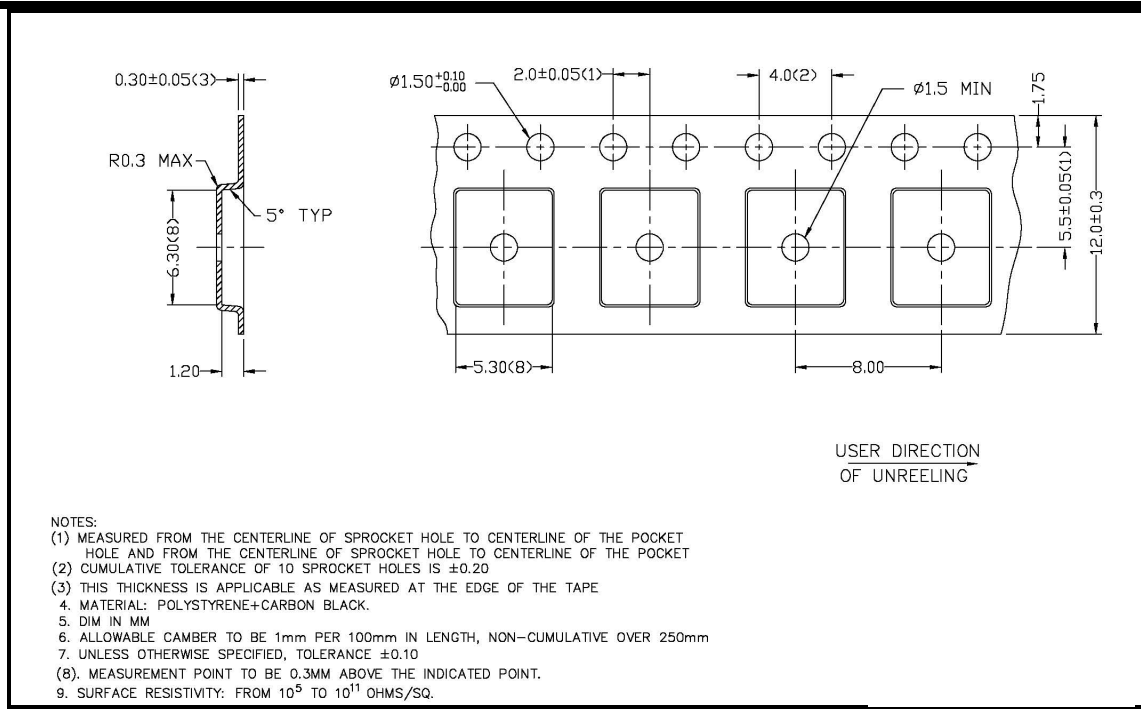


Figure 7: Tape Mechanical Drawing

Document Change History

Revision	Date	Notes
1.0	November 9, 2006	Create
1.1	February 8, 2007	Standardize Pin Naming.
1.2	March 28, 2007	Update 5GHz detector characteristics
1.3	March 28, 2007	Updated package thickness
1.4	June 29, 2007	Modify LNA controls from LNAg & LNAa to BSEL & V_LNA. Updated current consumption in 2GHz and 5GHz TX channels Updated spurious rejection specifications in 2GHz and 5GHz TX channels Updated noise figure specification in 2GHz and 5GHz RX channels. Updated gain profiles in 2GHz and 5GHz RX chains Updated 5GHz detector characteristics
1.5	August 23, 2007	Updated schematic
1.6	January 28, 2008	Updated product name from SE2593A to SE2593A20. Updated quiescent current in 2GHz and 5GHz TX chains. Added shipping tray information
1.7	March 5, 2008	Updated harmonics specification in 2GHz TX chain.
1.8	April 15, 2008	Add 5GHz detector plot Update tray specification and MOQ
1.9	Jun 15, 2008	Updated packaging for halogen free



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Revision	Date	Notes
		Updated to include recommended land patterns, solder patterns.
2.0	Sep 24, 2008	Updated for 3.2GHz LO gain in the 2GHz channel Added Tape and Reel Packing information and discontinued Tray Packing.
2.1	May 26, 2009	Amended back page.
2.2	Mar 28, 2012	Updated with Skyworks logo and disclaimer statement

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