DATA SHEET
SE2432L: 2.4 GHz Smart Energy/ZigBee Front End Module

Applications

- Smart Meters
- In-home appliances
- Smart thermostats

Features

- Integrated PA with up to 24 dBm output power
- Integrated LNA with programmable bypass
- Integrated antenna switching with Tx and Rx diversity function
- Low FEM noise figure of 2 dB typical
- Differential Rx/Tx interface with integrated baluns
- Fast switch ON/OFF time <800 nsec
- 2.0 V - 3.6 V supply operation
- Sleep mode current 0.05 µA typical
- 3 x 4 x 0.9 mm 24 pin QFN, NiPdAu plated
- Pb-free, RoHS compliant and Halogen free

Ordering Information

Part No.	Package	Remark
SE2432L-S	24 pin QFN	Samples
SE2432L-R	24 pin QFN	Tape & Reel
SE2432L-EK1	N/A	Evaluation kit

Product Description

The SE2432L is a high performance, fully integrated RF Front End Module designed for ZigBee/Smart Energy applications.

The SE2432L is designed for ease of use and maximum flexibility, with integrated fully matched input baluns, integrated inter-stage matching and harmonic filter, and digital controls compatible with 1.6 – 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 2.0 to 3.6V allowing the SE2432L to be used in battery powered applications over a wide spectrum of the battery discharge curve.

Functional Block Diagram

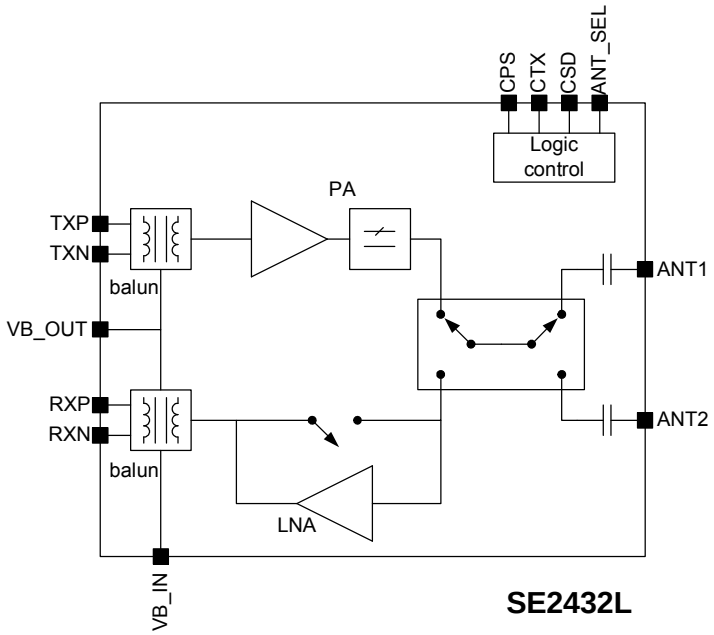


Figure 1: Functional Block Diagram

Pin Out Diagram

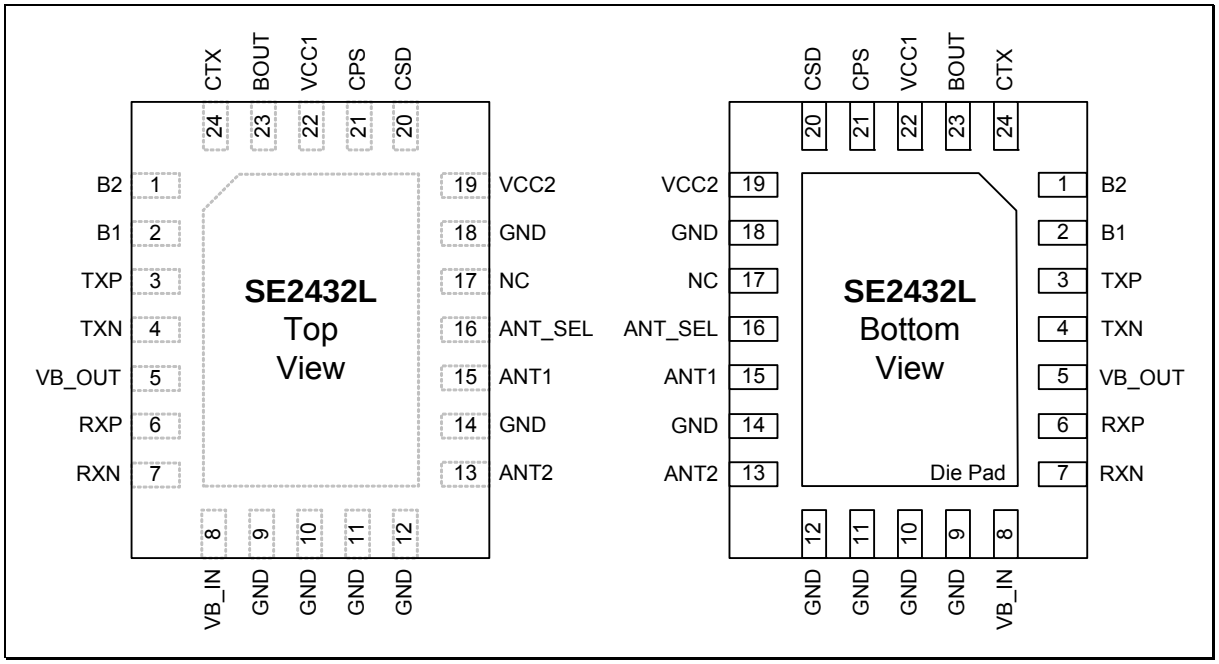


Figure 2: SE2432L Pinout

Pin Out Description

Pin No.	Name	Description
1	B2	Connect through bias resistor to Pin 23
2	B1	Connect through bias resistor to Pin 23
3	TXP	Transmit input signal from transceiver, 200 Ω differential
4	TXN	Transmit input signal from transceiver, 200 Ω differential
5	VB_OUT	Tx balun bias core supply from transceiver
6	RXP	Receiver output signal to transceiver, 200 Ω differential
7	RXN	Receiver output signal to transceiver, 200 Ω differential
8	VB_IN	Rx balun bias core supply from transceiver
9	GND	Connect to PCB ground
10	GND	Connect to PCB ground
11	GND	Connect to PCB ground
12	GND	Connect to PCB ground
13	ANT2	Connect to 50 Ω antenna
14	GND	Connect to PCB ground

Pin No.	Name	Description
15	ANT1	Connect to 50 Ω antenna
16	ANT_SEL	Connect to GPIO signal to control antenna switch (see “Logic controls” table)
17	NC	Not connected internally to the device
18	GND	Connect to PCB ground
19	VCC2	Connect to positive supply
20	CSD	Connect to GPIO signal to control SE2432L modes (see “Logic controls” table)
21	CPS	Connect to GPIO signal to control SE2432L modes (see “Logic controls” table)
22	VCC1	Connect to positive supply
23	BOUT	Star connect to Bias1 and Bias2 resistors
24	CTX	Connect to GPIO signal to control SE2432L modes (see “Logic controls” table)
Paddle	GND	Exposed die paddle; electrical and thermal ground; Connect to PCB ground

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
VCC1	Supply Voltage	-0.3	3.6	V
VCC2	Supply Voltage	-0.3	3.8	V
	Control pin voltages	-0.3	3.6	V
T_{OP}	Operating temperature	-40	85	°C
$T_{STORAGE}$	Storage temperature	-40	125	°C
	ESD Voltage ALL pins (HBM)	-	1000	V
Pout_Tx_max	Tx output power at ANT1 or ANT2 port into 50 Ω load	-	24	dBm
Pin_Tx_max	Tx input power at TR port	-	+6	dBm
Pin_Rx_max	Rx input power at ANT1 or ANT2 ports	-	+5	dBm

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_A	Ambient temperature	-40	25	85	°C
VB_IN VB_OUT	Supply voltage for baluns bias	1.6	-	3.6	V
VCC1	Supply voltage on VCC pins	2.0	3.0	3.6	V
VCC2	Supply voltage on VCC pins	2.0	3.0	3.6	V

DC Electrical Characteristics

Conditions: VCC1 = VCC2 = 3.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2432L-EK1 evaluation board (de-embedded to device), unless otherwise noted

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$I_{CC-Tx20}$	Total Supply Current	Tx mode P_{OUT} = 20 dBm CPS = CSD = CTX = 3.0 V	-	110	-	mA
$I_{CC-Tx17}$	Total Supply Current	Tx mode P_{OUT} = 17 dBm CPS = CSD = CTX = 3.0 V	-	90	-	mA
$I_{CC-Tx10}$	Total Supply Current	Tx mode P_{OUT} = 10 dBm CPS = CSD = CTX = 3.0 V	-	45	-	mA
I_{CQ-Tx}	Quiescent Current	No RF CPS = CSD = CTX = 3.0 V	-	30	-	mA
I_{CC-Rx}	Total Supply Current	Rx mode CPS = CSD = 3.0 V, CTX = 0 V	-	5	7	mA
$I_{CC-RxBypass}$	Total Supply Current	Rx bypass mode CSD = 3.0 V, CPS = CTX = 0 V	-	-	300	uA
I_{CC_OFF}	Sleep Supply Current	No RF, CTX=CPS=CSD = 0 V	-	0.05	1	µA

Logic Characteristics

Conditions: VCC1 = VCC2 = 3.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2432L-EK1 evaluation board (de-embedded to device), unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IH}	Logic input high		1.6	-	3.6	V
V_{IL}	Logic input low		0	-	0.3	V
I_{IH}	Logic input high		-	-	1	µA
I_{IL}	Logic input low		-	-	1	µA

Logic Controls

Conditions: VCC1 = VCC2 = 3.0 V, T_A = 25 °C

Mode	Mode description	Note	CPS	CSD	CTX
0	All off (sleep mode)	1, 3	0	0	0
1	Rx bypass mode	1, 2	0	1	0
2	Rx LNA mode	1, 2	1	1	0
4	Tx mode	1, 2	X	1	1

Note: (1) Logic '0' level compliant to V_{IL} as specified in the "Logic Characteristics" table
(2) Logic '1' level compliant to V_{IH} as specified in the "Logic Characteristics" table
(3) All controls must be at logic '0' in order to achieve the specified sleep current

Conditions: VCC1 = VCC2 = 3.0 V, T_A = 25 °C

Mode description	Note	CPS	CSD	CTX	ANT_SEL
ANT1 port enabled	1	X	X	X	0
ANT2 port enabled	2	X	X	X	1

Note: (1) Logic '0' level compliant to V_{IL} as specified in the "Logic Characteristics" table
(2) Logic '1' level compliant to V_{IH} as specified in the "Logic Characteristics" table

AC Electrical Characteristics, Transmit

Conditions: VB_IN = VB_OUT = 1.6 to 3.6 V, VCC1 = VCC2 = 3.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2432L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

Symbol	Parameter	Condition	Note	Min.	Typ.	Max.	Unit
F_{IN}	Frequency Range			2400	-	2483	MHz
Pout_Hi	Output power at ANT1 or ANT2 ports	VCC1 = VCC2 = 3.6 V VCC1 = VCC2 = 3.3 V VCC1 = VCC2 = 3.0 V VCC1 = VCC2 = 2.7 V VCC1 = VCC2 = 2.0 V	1, 6	-	24.0 22.5 21.0 20.5 17.0	-	dBm
S_{21_Hi}	Small Signal Gain high power mode	2400 – 2483 MHz		20	22	24	dB
ΔS_{21}	Small Signal Gain Variation	Gain variation across all ZigBee channels	1	-	-	1	dBp-p
HD2, HD3	2nd, 3rd Harmonics	P_{OUT} = 20 dBm	1, 2	-	-	-42	dBm/MHz
S_{22}	Output return loss	At ANT1 or ANT2 ports	1	-	-10	-5	dB

Symbol	Parameter	Condition	Note	Min.	Typ.	Max.	Unit
Z_{IN}	Transmit port impedance	Measured differentially between TXP and TXN		-	200	-	Ω
ACP	Spectral Mask		1, 3	-	-	-30	dBm
Trise	Turn on time		4	-	-	800	ns
Tfall	Turn off time		5	-	-	800	ns
STAB	Stability	CW, P_{IN} = 0 dBm 0.1 GHz – 20 GHz Load VSWR = 6:1		All non-harmonically related outputs less than -42 dBm/MHz			
RU	Ruggedness	CW, PIN = +6 dBm, Load VSWR = 10:1		No permanent damage			

Note: (1) 2400 – 2483 MHz
(2) IEEE 802.15.4 source
(3) Integrated power from band edges to Fc ± 3.5 MHz
(4) From 50% of CTX edge to 90% of final RF output power
(5) From 50% of CTX edge to 10% of final RF output power
(6) OEVM = 1% typ

AC Electrical Characteristics, Receive

Conditions: VB_IN = VB_OUT = 1.6 to 3.6 V, VCC1 = VCC2 = 3.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2432L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

Symbol	Parameter	Condition	Note	Min.	Typ.	Max.	Unit
F_{IN}	Frequency Range			2400	-	2483	MHz
Rx_gain	Receive gain	CPS = CSD = logic '1', CTX = logic '0'	1	10	11.5	13	dB
NF	Receive noise figure	CPS = CSD = logic '1', CTX = logic '0'	1	-	2	2.5	dB
IIP3	Input 3rd order intercept	CPS = CSD = logic '1', CTX = logic '0'	1	-3	2	-	dBm
IP1dB	Input 1-dB compression point	CPS = CSD = logic '1', CTX = logic '0'	1	-13	-8	-	dBm
S_{11}	Input return loss	At ANT1 or ANT2 ports	1	-	-10	-5	dB
Z_{OUT}	Receive port impedance	Measured differentially between RXP and RXN		-	200	-	Ω
Trise	Turn on time		2	-	-	800	ns
Tfall	Turn off time		3	-	-	800	ns
G_bp	Gain in bypass mode	CPS = CTX = logic '0', CSD = logic '1'			-3	-	dB
IP1dB	Input 1-dB compression point in bypass mode	CPS = CTX = logic '0', CSD = logic '1'		10	-	-	dBm

Note: (1) 2400 – 2483 MHz
(2) From 50% of CTX edge to 90% of final RF output power
(3) From 50% of CTX edge to 10% of final RF output power

AC Electrical Characteristics, Dual Antenna Switch

Conditions: VCC1 = VCC2 = 3.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2432L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

Symbol	Parameter	Min.	Typ.	Max.	Unit
$ISOL_{ANTSW}$	Isolation Between ANT1 and ANT2 Ports	-	-20	-	dB
$T_{ANT1-ANT2}$	Antenna 1 to Antenna 2 switching time	-	400	-	nsec

Package Information

This package is Pb free, RoHS compliant and halogen free. The product is also rated MSL1.

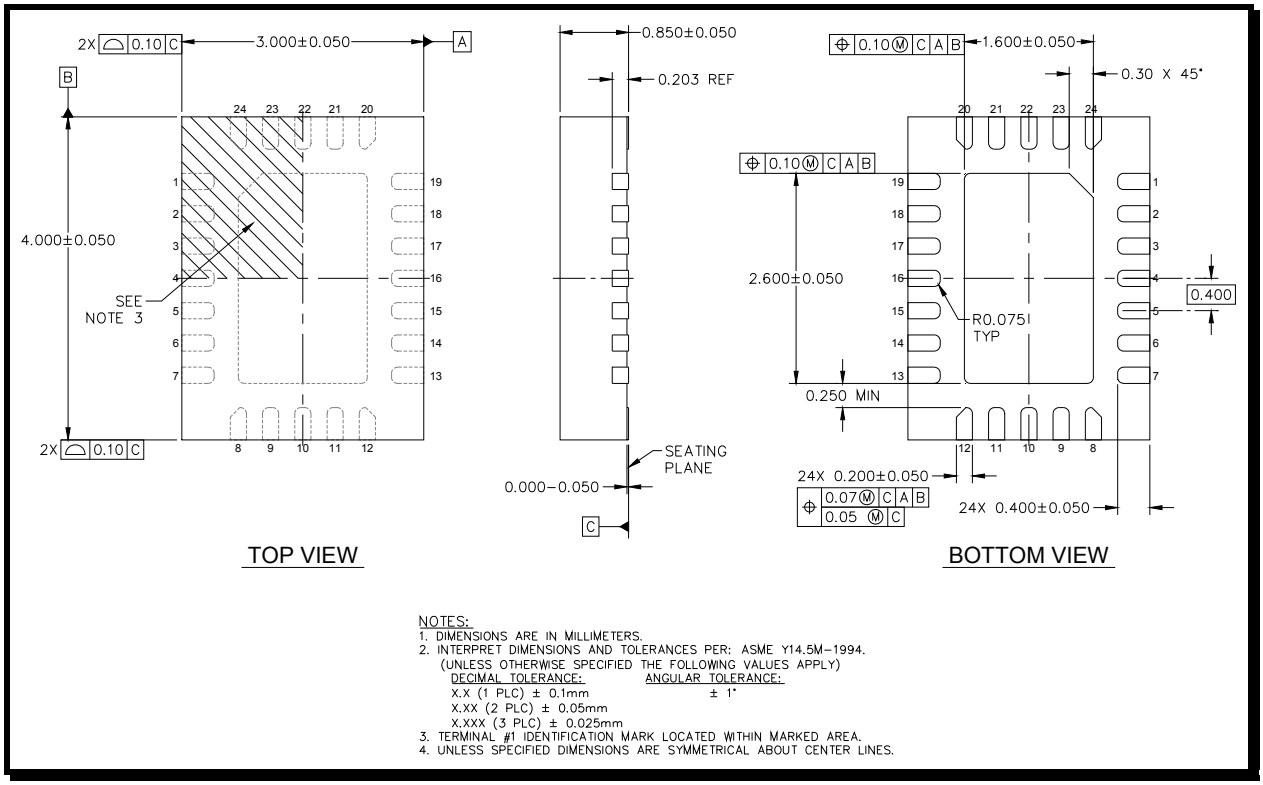


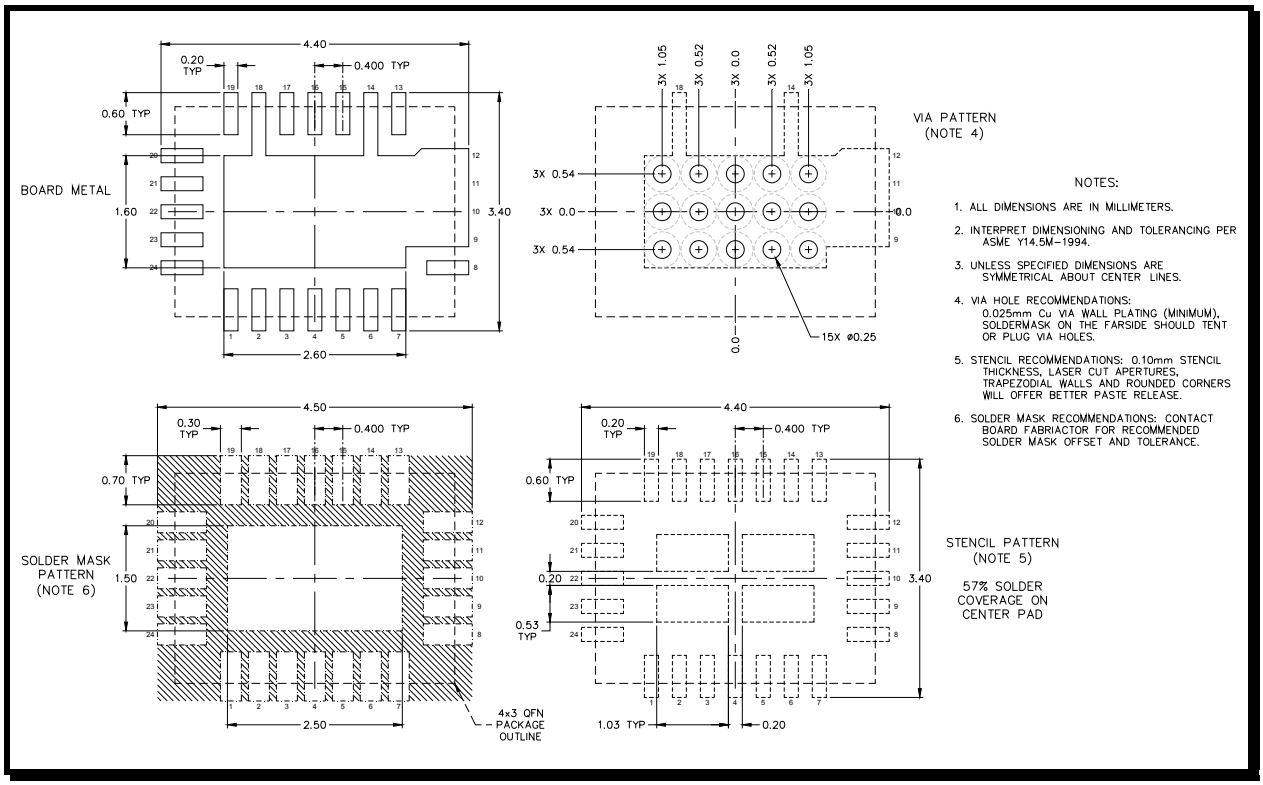
Figure 3: SE2432L Package Diagram

Recommended PCB Footprint

The PCB footprint below is only for reference.

The user should modify the design layout in order to meet their specific solder fillet requirements & solder joint reliability requirements.

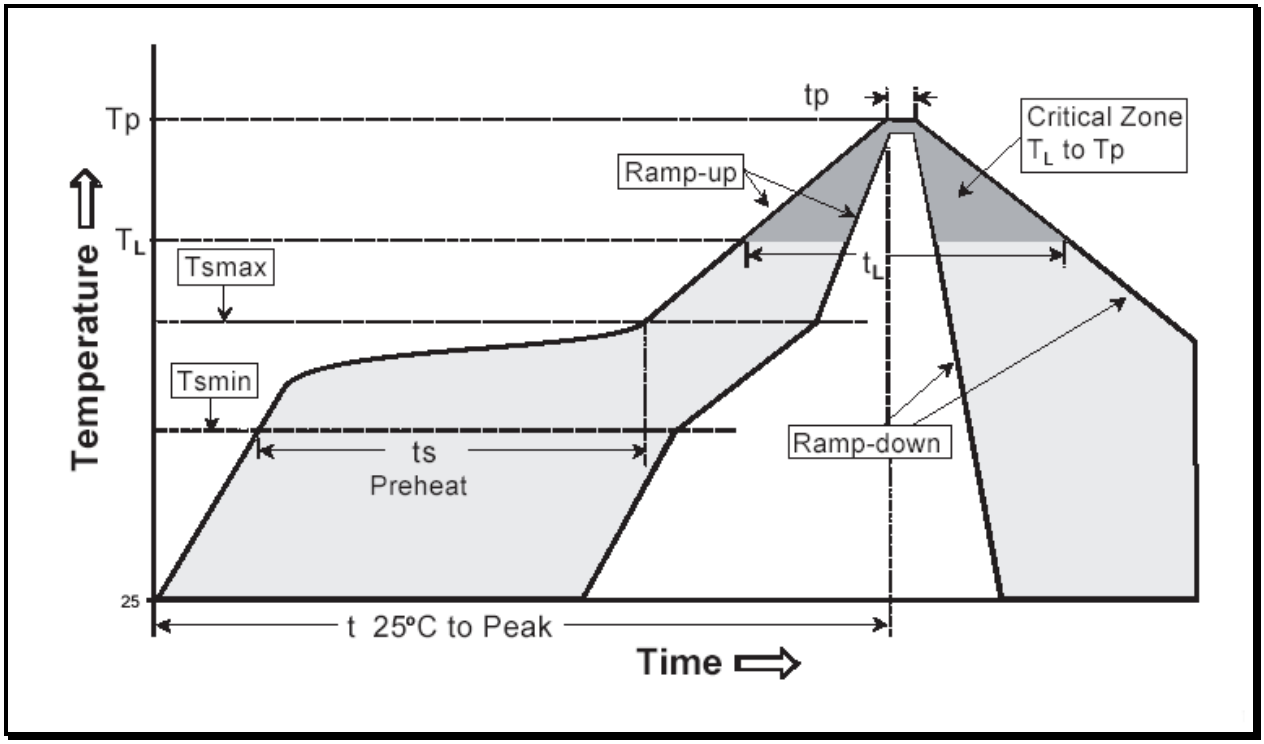
All dimensions in the figure below are in mm.



Recommended Reflow Temperature Profile

Profile Feature	SnPb Eutectic Assembly	Lead (Pb) Free Assembly
Average Ramp-up Rate (T_L to T_P)	3°C/s (max)	3°C/s (max)
Preheat		
Temperature Min. (T_{smin})	100°C	150°C
Temperature Max. (T_{smax})	150°C	200°C
Time (Min. to Max) (t_s)	60 - 120s	60 - 80s
Ramp Up		
Tsmax to t_L	-	3°C/s (max)
Time 25°C to Peak Temperature	6 mins. (max)	8 mins. (max)
Reflow		
Temperature (t_L)	183°C	217°C
Time maintained above t_L	60 - 150s	60 - 150s
Peak Temperature (t_p)	240 ±5°C	260 +0/-5°C
Time Within 5°C of Actual Peak Temperature (t_p)	10 - 30s	20 - 40s
Ramp-Down		
Ramp-Down Rate	6°C/s (max)	6°C/s (max)

Reflow Profile (Reference JEDEC J-STD-020)



Branding Information

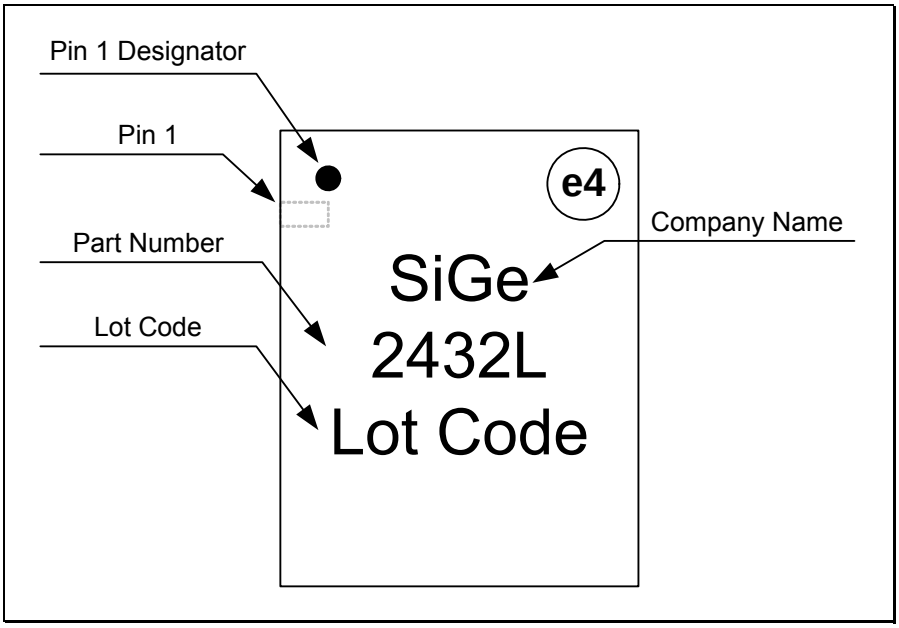


Figure 4: SE2432L Branding

Tape and Reel Information

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

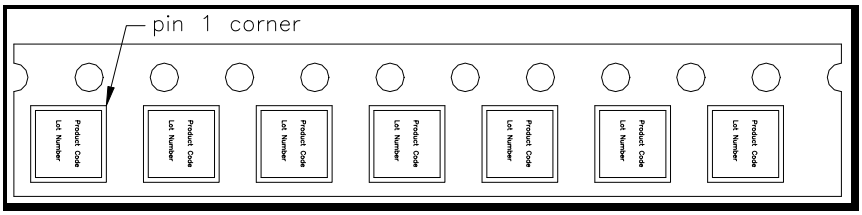


Figure 5: SE2432L-R Tape and Reel Information

SKYWORKS®

DATA SHEET
SE2432L: 2.4 GHz Smart Energy/ZigBee Front End Module

Copyright © 2012 Skyworks Solutions, Inc. All Rights Reserved.

Information in this document is provided in connection with Skyworks Solutions, Inc. ("Skyworks") products or services. These materials, including the information contained herein, are provided by Skyworks as a service to its customers and may be used for informational purposes only by the customer. Skyworks assumes no responsibility for errors or omissions in these materials or the information contained herein. Skyworks may change its documentation, products, services, specifications or product descriptions at any time, without notice. Skyworks makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Skyworks assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Skyworks products, information or materials, except as may be provided in Skyworks Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. SKYWORKS DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. SKYWORKS SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Skyworks products are not intended for use in medical, lifesaving or life-sustaining applications, or other equipment in which the failure of the Skyworks products could lead to personal injury, death, physical or environmental damage. Skyworks customers using or selling Skyworks products for use in such applications do so at their own risk and agree to fully indemnify Skyworks for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Skyworks products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Skyworks assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Skyworks products outside of stated published specifications or parameters.

Skyworks, the Skyworks symbol, and "Breakthrough Simplicity" are trademarks or registered trademarks of Skyworks Solutions, Inc., in the United States and other countries. Third-party brands and names are for identification purposes only, and are the property of their respective owners. Additional information, including relevant terms and conditions, posted at www.skyworksinc.com, are incorporated by reference.