

## DATA SHEET

# SE2431L: 2.4 GHz ZigBee®/802.15.4 Front-End Module

## Applications

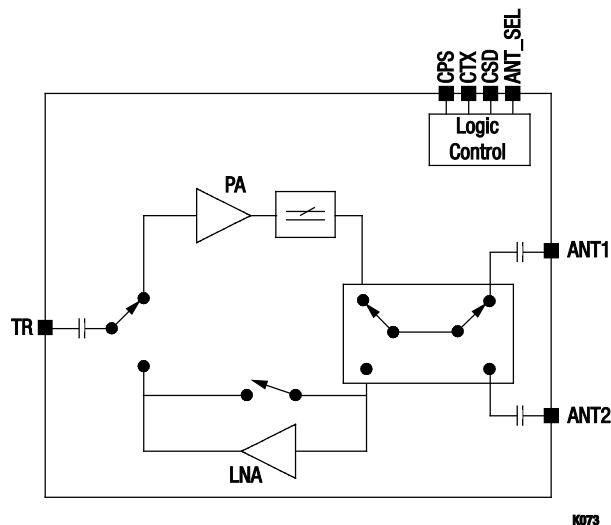
- Smart Meters
- In-home appliances
- Smart thermostats

## Features

- Integrated:
  - PA with up to +24 dBm output power
  - LNA with programmable bypass
  - Antenna switching with Tx and Rx diversity function
- Typical low NF: 2 dB
- Single-ended 50  $\Omega$  Tx/Rx RF interface
- Fast switch on/off time <1  $\mu$ s
- Supply operation: 2.0 V to 3.6 V
- Sleep mode current: 0.05  $\mu$ A typical
- Small QFN (24-pin, 3.0 mm x 4.0 mm x 0.9 mm Nickel-Palladium-gold [NiPdAu] plated) package (MSL1, 260°C per JEDEC J-STD-020)



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. SE2431L Block Diagram**

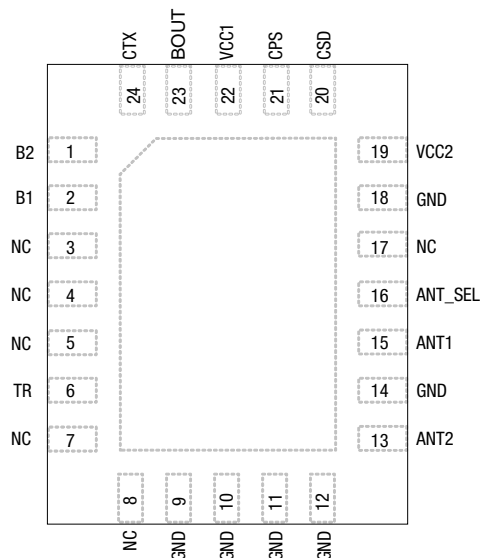
## Description

The SE2431L is a high-performance, fully integrated RF Front-End Module (FEM) that is designed for ZigBee®/Smart Energy and 802.15.4 applications.

The SE2431L is designed for ease of use and maximum flexibility, with fully matched 50  $\Omega$  input and output, integrated inter-stage matching and harmonic filter, and digital controls that are compatible with 1.6 V to 3.6 V Complementary Metal Oxide Semiconductor (CMOS) levels.

The RF blocks operate over a wide supply voltage range from 2.0 V to 3.6 V, which allows the SE2431L to be used in battery-powered applications over a wide spectrum of the battery discharge curve.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.



**Figure 2. SE2431L Pinout  
(Top View)**

**Table 1. SE2431L Signal Descriptions**

Pin #	Name	Description	Pin #	Name	Description
1	B2	Connect through the bias resistor to pin 23.	13	ANT2	Connect to 50 $\Omega$ antenna.
2	B1	Connect through the bias resistor to pin 23.	14	GND	Connect to PCB ground
3	NC	Not connected internally to the device.	15	ANT1	Connect to 50 $\Omega$ antenna.
4	NC	Not connected internally to the device.	16	ANT_SEL	Connect to the GPIO signal to control the antenna switch (see the “Logic Controls” Table)
5	NC	Not connected internally to the device.	17	NC	Not connected internally to the device.
6	T/R	Transmit/receive port from/to transceiver, single-ended 50 $\Omega$ .	18	GND	Connect to PCB ground
7	NC	Not connected internally to the device.	19	VCC2	Connect to positive supply
8	NC	Not connected internally to the device.	20	CSD	Connect to the GPIO signal to control the SE2431L modes (see the “Logic Controls” Table)
9	GND	Connect to PCB ground.	21	CPS	Connect to the GPIO signal to control the SE2431L modes (see the “Logic Controls” Table)
10	GND	Connect to PCB ground.	22	VCC1	Connect to positive supply
11	GND	Connect to PCB ground.	23	BOUT	Connect to pins 1 and 2 through the bias resistors
12	GND	Connect to PCB ground.	24	CTX	Connect to the GPIO signal to control the SE2431L modes (see the “Logic Controls” Table)

**Table 2. SE2431L Absolute Maximum Ratings**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage 1	V <sub>CC1</sub>	−0.3	3.6	V
Supply voltage 2	V <sub>CC2</sub>	−0.3	3.6	V
Control pin voltages		−0.3	3.6	V
Operating temperature	T <sub>OP</sub>	−40	85	°C
Storage temperature	T <sub>STG</sub>	−40	125	°C
Tx output power at ANT1 or ANT2 port into 50 $\Omega$ load	P <sub>OUT_TX_MAX</sub>		+24	dBm
Tx input power at TR port	P <sub>IN_TX_MAX</sub>		+6	dBm
Rx input power at ANT1 or ANT2 ports	P <sub>IN_RX_MAX</sub>		+5	dBm
Thermal resistance	$\Theta_{JC}$		40	°C/W
Electrostatic Discharge: All pins: Human Body Model (HBM), Class 1C	ESD		1000	V

**Note:** 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.

**CAUTION:** Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

**Table 3. Recommended Operating Conditions**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Ambient temperature	T <sub>A</sub>	−40	+25	+85	°C
Supply voltage on VCC pins	V <sub>CC1</sub>	2.0	3.0	3.6	V
Supply voltage on VCC pins	V <sub>CC2</sub>	2.0	3.0	3.6	V

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SE2431L are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 through 7.

The state of the SE2431L is determined by the logic provided in Table 8.

**Table 4. SE2431L Electrical Specifications: DC (Note 1)****(VCC = 3 V, TA = +25 °C, as Measured on Skyworks SE2431L-EK1 Evaluation Board [De-Embedded to the Device], Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Total supply current	I <sub>CC_TX20</sub>	Tx mode P <sub>OUT</sub> = +20 dBm		115		mA
Total supply current	I <sub>CC_TX17</sub>	Tx mode P <sub>OUT</sub> = +17 dBm		90		mA
Total supply current	I <sub>CC_TX10</sub>	Tx mode P <sub>OUT</sub> = +10 dBm		50		mA
Quiescent current	I <sub>CO_TX</sub>	No RF		30		mA
Total supply current	I <sub>CC_RX</sub>	Rx mode		5	7	mA
Total supply current	I <sub>CC_RXBYPASS</sub>	Rx Bypass mode			300	μA
Sleep supply current	I <sub>CC_OFF</sub>	No RF		0.05	1.0	μA

**Note 1:** Performance is guaranteed only under the conditions listed in the above Table.**Table 5. SE2431L Electrical Specifications: Logic Characteristics (Note 1)****(VCC = 3 V, TA = +25 °C, as Measured on Skyworks SE2431L-EK1 Evaluation Board [De-Embedded to the Device], Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Logic input high voltage	V <sub>IH</sub>		1.6		3.6	V
Logic input low voltage	V <sub>IL</sub>		0		0.3	V
Logic input high current	I <sub>IH</sub>				1	μA
Logic input low current	I <sub>IL</sub>				1	μA

**Note 1:** Performance is guaranteed only under the conditions listed in the above Table.

**Table 6. SE2431L Electrical Specifications: AC Characteristics (Note 1)****(VCC = 3 V, TA = +25 °C, as Measured on Skyworks SE2431L-EK1 Evaluation Board [De-Embedded to the Device], All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Transmit (Tx)						
Frequency range	f <sub>IN</sub>		2400		2483	MHz
Output power at ANT1 or ANT2 ports (Notes 2, 3)	P <sub>OUT</sub>	VCC = +3.6 V VCC = +3.3 V VCC = +3.0 V VCC = +2.7 V VCC = +2.0 V		+24.0 +22.5 +21.0 +20.5 +17.0		dBm
Small signal gain	S <sub>21</sub>	2400 MHz to 2483 MHz	19	22	25	dB
Small signal gain variation (Note 2)	ΔS <sub>21</sub>	Gain variation across all ZigBee channels			1	dBp-p
Harmonics (Notes 2, 4)	H <sub>D2</sub> , H <sub>D3</sub>	P <sub>OUT</sub> = +20 dBm		−10	−42	dBm/MHz
Output return loss (Note 2)	S <sub>22_ANT</sub>	At ANT1 or ANT2 ports		−10	−5	dB
Input return loss (Note 2)	S <sub>11</sub>	At TR port, Tx mode			−5	dB
Spectral mask (Notes 2, 5)	ACP				−30	dBm
Rise and fall times	t <sub>R</sub> (Note 6) t <sub>F</sub> (Note 7)				800	ns
Stability	S <sub>TAB</sub>	CW, P <sub>IN</sub> = 0 dBm 0.1 GHz to 20.0 GHz Load VSWR = 6:1	All non-harmonically related outputs <−42.0 dBm/MHz			
Ruggedness	R <sub>U</sub>	CW, P <sub>IN</sub> = +6 dBm, Load VSWR = 10:1	No permanent damage			
Receive (Rx)						
Frequency range	f <sub>IN</sub>		2400		2483	MHz
Receive gain (Note 2)	R <sub>X_GAIN</sub>		10.0	12.5	15.0	dB
Receive Noise Figure (Note 2)	NF			2.0	2.5	dB
3 <sup>rd</sup> Order Input Intercept Point (Note 2)	IIP3		−3	+2		dBm
1 dB Input Compression Point (Note 2)	IP1dB		−13	−8		dBm
Antenna port return loss (Note 2)	S <sub>11_ANT</sub>			−10	−5	dB
Output return loss (Note 2)	S <sub>22</sub>	At TR port, Rx mode		−10	−5	dB
Rise and fall times	t <sub>R</sub> (Note 6) t <sub>F</sub> (Note 7)				800	ns
Interferer amplitude (maximum 2.4 GHz)	G_BP		−3	−2		dB
1 dB Input Compression Point	IP1dB		+10			dBm

**Note 1:** Performance is guaranteed only under the conditions listed in the above Table.**Note 2:** 2400 MHz to 2483 MHz.**Note 3:** Offset EVM = 1% typical.**Note 4:** IEEE 802.15.4 source.**Note 5:** Integrated power from the band edges to Fc ± 3.5 MHz.**Note 6:** From 50% of the CTX edge to 90% of the final RF output power.**Note 7:** From 50% of the CTX edge to 10% of the final RF output power.

**Table 7. SE2431L Electrical Specifications: AC Characteristics, Diversity Antenna Function (Note 1)**  
**(VCC1 = VCC2 = 3 V, TA = +25 °C, as Measured on Skyworks SE2432L-EK1 Evaluation Board [De-Embedded to the Device], All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)**

Parameter	Symbol	Min	Typical	Max	Units
Isolation between ANT1 and ANT2 ports	ISOLANTSW		–20		dB
Antenna 1 to antenna 2 switching time	tANT1-ANT2		400		ns

**Note 1:** Performance is guaranteed only under the conditions listed in the above Table. Unused antenna port should be connected to 50 Ω.

**Table 8. SE2431L Logic Controls (Note 1)**  
**(VCC = 3 V, TA = +25 °C, Unless Otherwise Noted)**

Mode	Description	CPS	CSD	CTX	ANT_SEL
0	All off (sleep mode) (Note 2)	0	0	0	X
1	Rx bypass mode	0	1	0	X
2	Rx LNA mode	1	1	0	X
3	Tx mode	X	1	1	X
	ANT1 port enabled	X	1	X	0
	ANT2 port enabled	X	1	X	1

**Note 1:** The logic 0 and 1 levels are compliant to V<sub>IL</sub> and V<sub>IH</sub>, respectively, as specified in the “Logic Characteristics” Table.

**Note 2:** All controls must be at logic 0 to achieve the specified sleep current.

## Package Dimensions

The PCB layout footprint for the SE2431L is provided in Figure 3. A typical part marking diagram is shown in Figure 4. Package dimensions are shown in Figure 5, and tape and reel dimensions are provided in Figure 6.

## Package and Handling Information

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 temperatures during solder assembly.

The SE2431L is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C, and 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.



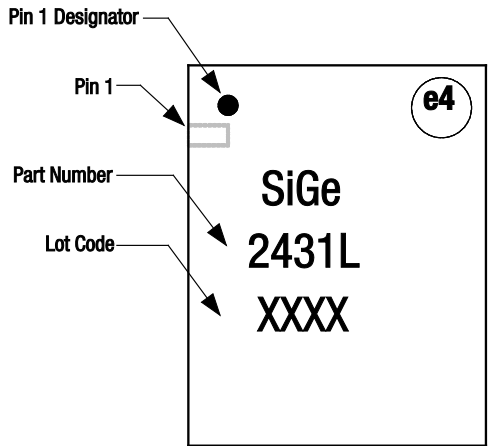


Figure 4. SE2431L Typical Part Marking

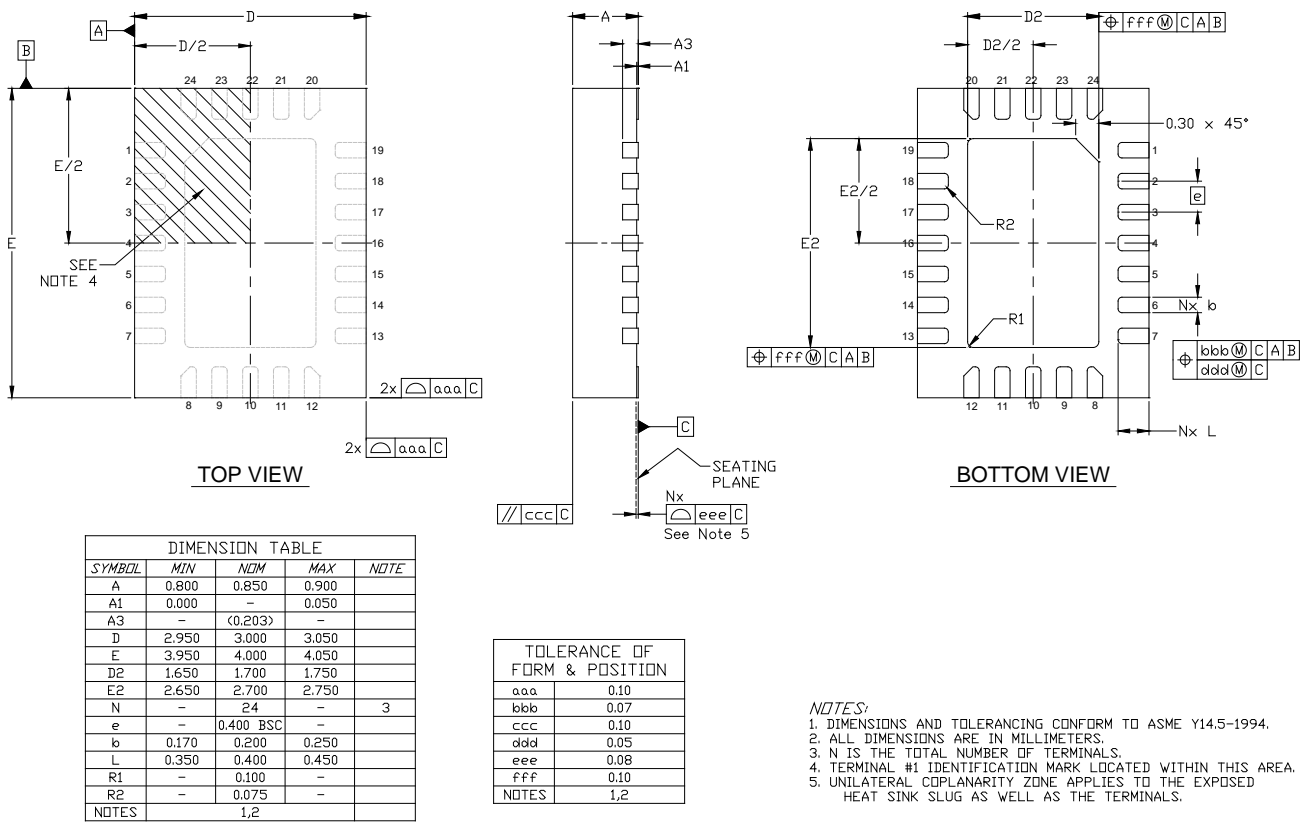
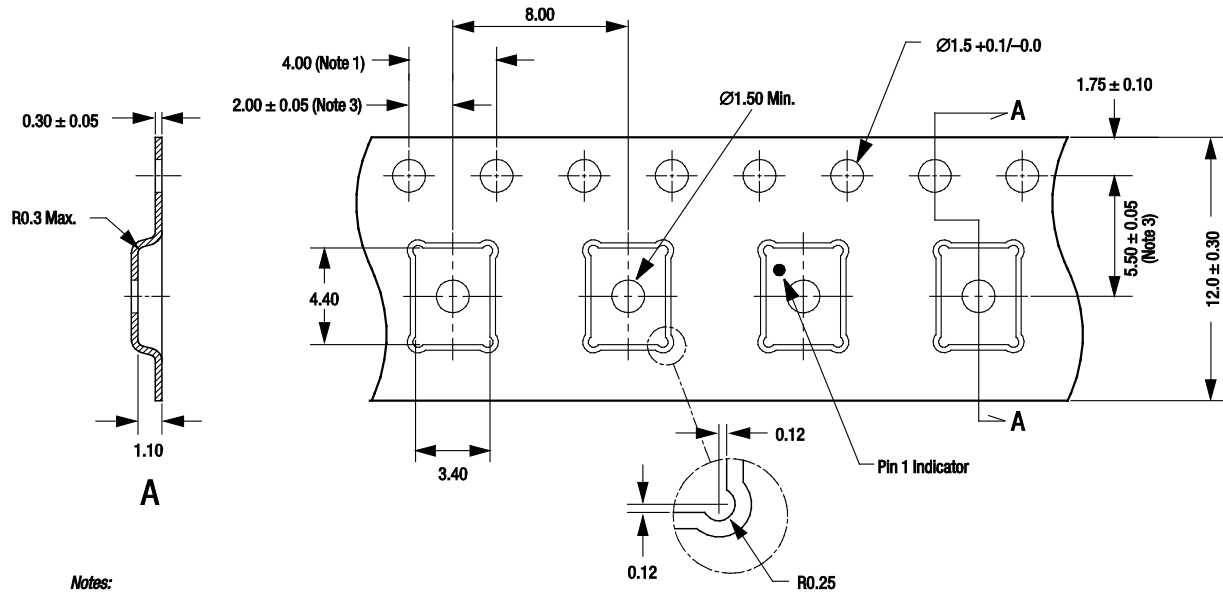


Figure 5. SE2431L Package Dimensions





**Notes:**

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$ .
2. Camber in compliance with EIA 481.
3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
4. All measurements are in millimeters.

S2742

**Figure 6. SE2431L-R Tape and Reel Dimensions**

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SE2431L: 2.4 GHz ZigBee/802.15.4 Front-End Module	SE2431L	SE2431L-EK1

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