SKYWORKS®

RFX2411: 2.4 GHz Transmit/Receive RFeIC with Diversity Switch for Zigbee® Applications

Applications

- Zigbee® extended range devices
- Zigbee smart power systems
- RF4CE remote controls
- Home and industrial automation
- Custom 2.4 GHz radio systems
- Mobile and battery Zigbee systems

Features

- 2.4 GHz Zigbee high-power single-chip, single-die RF front-end integrated circuit (RFeIC)
- Antenna diversity switch
- 2.4 GHz transmit high-power amplifier with low-pass harmonic filter
- Low-noise amplifier
- Transmit/receive switch circuitry
- High transmit signal linearity meeting standards for OQPSK modulation
- Integrated power detector for transmit power monitor and control
- Low voltage (1.2 V) CMOS control logic
- ESD protection circuitry on all ports
- DC-decoupled RF ports
- Internal RF decoupling on all VDD bias pins
- Low noise figure for the receive channel
- Very low dc power consumption
- Full on-chip matching and decoupling circuitry
- Minimal external components required
- 50 Ω input/output matching
- Market-proven CMOS technology
- Small QFN (20-lead, 3.0 x 3.0 x 0.55 mm) package with exposed ground pad
- For RoHS and other product compliance information, see the Skyworks Certificate of Conformance.
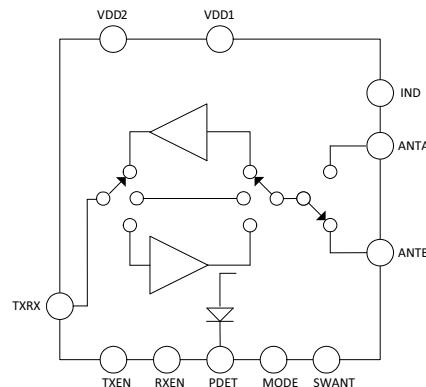
**Figure 1. Functional Block Diagram**

Description

The RFX2411 is a fully integrated, single-chip, single-die RFeIC incorporating all the RF functionality needed for wireless Zigbee/smart energy applications. The RFX2411 architecture integrates the PA, LNA, transmit and receive switching circuitry, the associated matching network, a harmonic filter, and a diversity switch all in a CMOS single-chip device. It also includes a bypass mode to provide maximal level of flexibility for system implementations.

This RFeIC is designed for use in 2.4 GHz ISM band and supports the 802.15.4 and Zigbee standard. Combining high performance, high sensitivity and efficiency, low noise, a small form factor, and low cost, the RFX2411 is the perfect solution for applications requiring extended range and bandwidth.

The RFX2411 has simple and low-voltage CMOS control logic, and requires minimal external components for system implementation. The PA power detect circuit is also integrated.
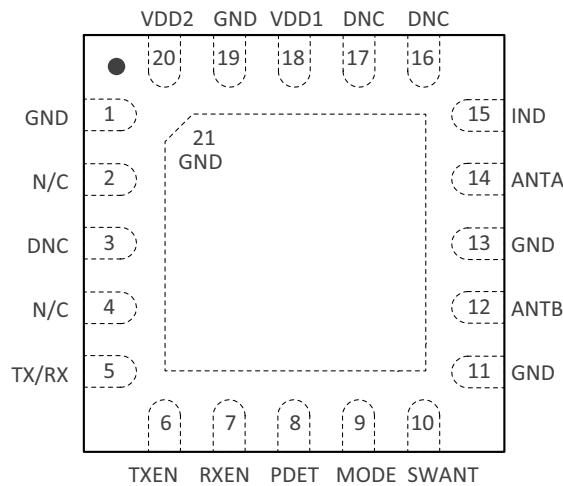
Figure 2. Pinout (Top View)

Table 1. Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1, 11, 13, 19, 21	GND	Ground, must be connected to ground in the application circuit	10	SWANT	CMOS input to select antenna for diversity
2, 4	N/C	No internal connection	12	ANTB	RF signal from the PA or RF signal applied to the LNA; dc shorted to ground
5	TXRX	RF signal to/from the transceiver dc shorted to GND	14	ANTA	RF signal from the PA or RF signal applied to the LNA; dc shorted to ground
6	TXEN	CMOS input to control TX enable	15	IND	Inductor to GND
7	RXEN	CMOS input to control RX enable	3, 16, 17	DNC	Reserved Do not connect in the application circuit
8	PDET	Analog voltage proportional to the PA power output	18	VDD1	Voltage supply connection
9	MODE	CMOS input to control mode of operation	20	VDD2	Voltage supply connection

Electrical and Mechanical Specifications

Table 2. Absolute Maximum Ratings[1]

Parameter	Conditions	Min	Max	Units
DC VDD voltage supply	All VDD pins	0	4.0	V
DC control pin voltage	Through 1 kΩ resistor	0	3.6	V
DC VDD current consumption	Through VDD pins when TX is ON		350	mA
TX RF input power			+5	dBm
ANT RF RX input power	LNA mode		+5	dBm
ANT RF RX input power	Bypass mode		+16	dBm
Junction temperature			+150	°C
Storage ambient temperature	No RF and dc voltages applied Appropriate care required according to JEDEC Standards	−50	+150	°C
Electrostatic discharge: Human Body Model (HBM)	ESD HBM	> 1000		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. All maximum RF input power ratings assume 50 Ω terminal impedance.

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

Table 3. Recommended Operating Conditions[1]

Parameter	Conditions	Min	Typ	Max	Units
DC VDD voltage supply[1]	All VDD pins	2.0	3.3	3.6	V
Control voltage high	RXEN, TXEN, and MODE pins	1.2		VDD	V
Control voltage low	RXEN, TXEN, and MODE pins	0		0.3	V
DC control pin current consumption[2]			1		µA
DC shutdown current			300		nA
PA turn-on/turn-off time				1	µs
LNA turn on/turn-off time				1	µs
Antenna switch time				1	µs
Operating ambient temperature		−40		+125	°C
DC VDD voltage supply[1]		2.0	3.3	3.6	V
Θja[2]			35		°C/W

1. For normal operation of the RFX2411, VDD must be continuously applied to all VDD supply pins.
2. For operation above +85 °C, use the Θja as guidance for system design to assure the junction temperature will not exceed the maximum of +150 °C.

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Table 4. TX/RX/Bypass Mode Electrical Characteristics
(VDD = 3.3 V, TA = +25°C, Unless Otherwise Specified)

Parameter	Test Condition	Min	Typ	Max	Units
Transmit Mode					
Operating frequency band	All RF pins terminated by 50 Ω	2.4		2.5	GHz
Saturated output power			+21		dBm
Output P1dB	CW input		+19		dBm
Small signal gain	High Idq TX mode		26		dB
	Low Idq TX mode		24		dB
Second harmonic	$P_{OUT} \leq$ +20 dBm, CW at ANT pin		−35		dBc
Third harmonic	$P_{OUT} \leq$ +20 dBm, CW at ANT pin		−35		dBc
Total supply current	P_{OUT} = +20 dBm, High Idq TX mode		95		mA
	P_{OUT} = +20 dBm, Low Idq TX mode		95		mA
TX quiescent current	High Idq TX mode		18		mA
	Low Idq TX mode		15		mA
Input return loss			−15		dB
Output return loss			−7		dB
Power detector voltage	P_{OUT} = +5 dBm, 10 kΩ load		0.14		V
	P_{OUT} = +20 dBm, 10 kΩ load		0.9		V
Receive Mode					
Operating frequency band	All RF pins are loaded by 50 Ω	2.4		2.5	GHz
Gain	Low noise figure mode		14		dB
	Low current mode		10		
Noise figure	Low noise figure mode		2.5		dB
	Low current mode		3.5		
Input P_{1dB}	Low noise figure mode		-8		dBm
	Low current mode		-3		
RX quiescent current	Low noise figure mode		9		mA
	Low current mode		4		
RF port impedance	At TXRX and ANT pins		50		Ω
Input return loss	At ANT pin, low NF mode		−8		dB
	At TXRX pin, low NF mode		−12		
Bypass Mode					
Operating frequency		2.4		2.5	GHz
Insertion loss			5		dB
Input P_{1dB}	At ANTA or ANTB	>16			dBm
Current consumption	Through VDD supply pins		700		nA

Table 5. Mode Logic Control[1]

Mode	TXEN	RXEN	MODE
Shutdown	0	0	0
Bypass	0	0	1
Low I_{DQ} TX	1	X	0
High I_{DQ} TX	1	X	1
Low noise figure RX	0	1	0
Low current RX	0	1	1

1. "1" denotes control voltage high state.
   "0" denotes control voltage low state.
   "X" denotes do not care: floating control pins not allowed.

Table 6. Antenna Select Control[1]

Mode	SWANT
ANTA port enabled	1
ANTB port enabled	0

1. "1" denotes control voltage high state.
   "0" denotes control voltage low state.
   "X" denotes do not care: floating control pins not allowed.

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 temperature during solder assembly.

The RFX2411 is rated to Moisture Sensitivity Level 1 (MSL1) 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.
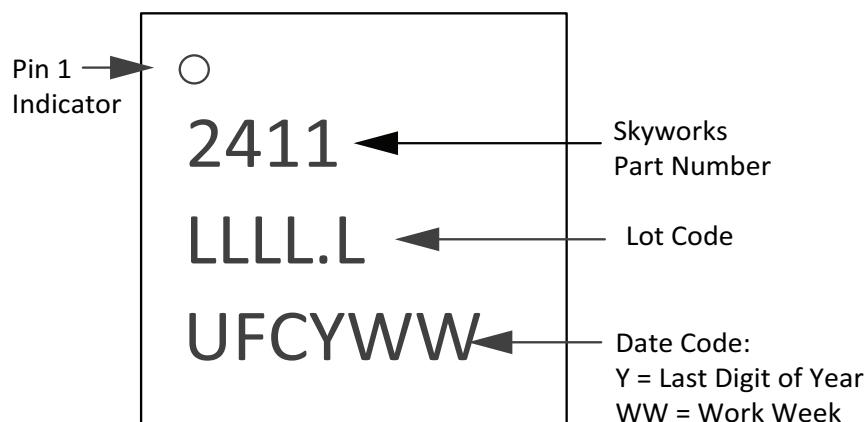
Figure 3. Typical Part Marking
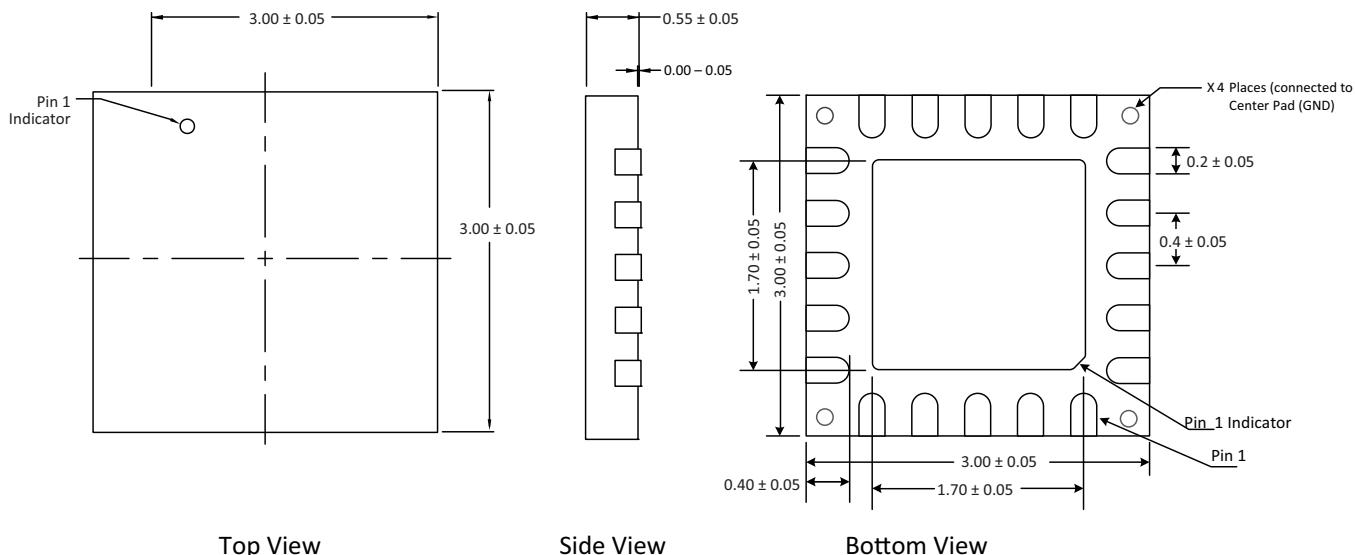
All dimensions are in millimeters.

Figure 4. Package Dimensions
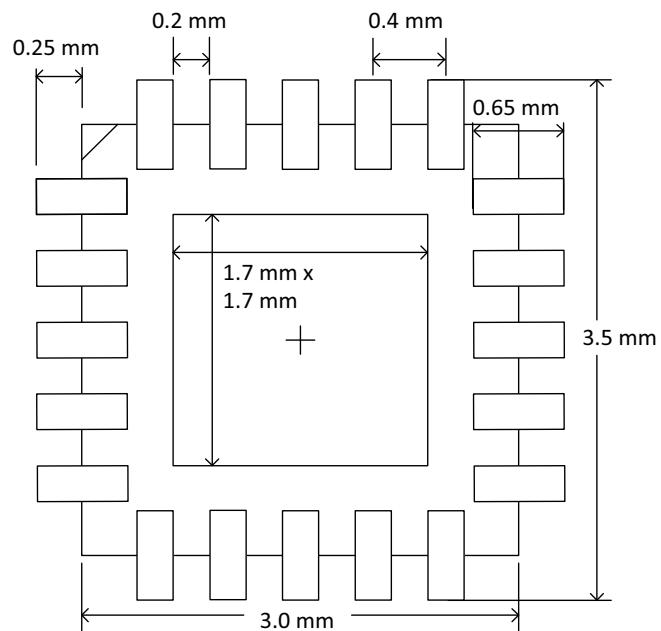
Figure 5. PCB Layout Footprint
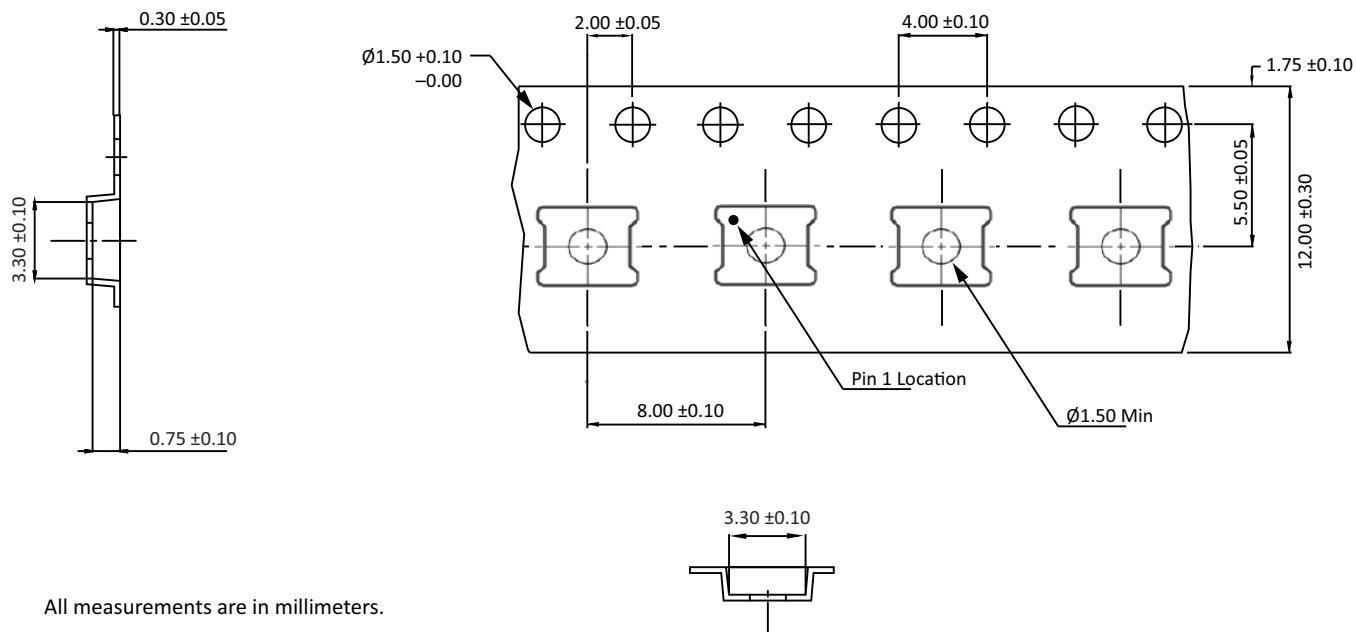
All measurements are in millimeters.

Figure 6. Tape and Reel Information

Ordering Information

Part Number	Description	Evaluation Board Part Number
RFX2411	2.4 GHz Transmit/Receive RFeIC with Diversity Switch for Zigbee® Applications	RFX2411-EK1

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