DATA SHEET

# RFX2411: 2.4 GHz Transmit / Receive Zigbee® RFEIC with Diversity Switch

## Applications

- ZigBee extended range devices
- ZigBee smart power
- RF4CE remote control
- 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 IC
- 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 (16-lead,3.0 x 3.0 x 0.55 mm) package with exposed ground pad

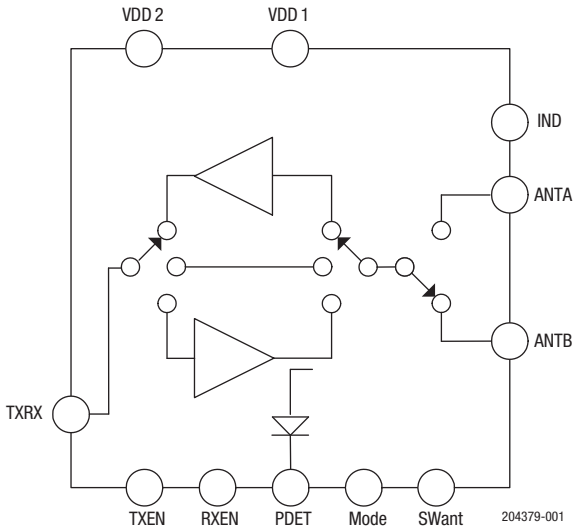


**Figure 1. RFX2411 Block Diagram**

## Description

The RFX2411 is a fully integrated, single-chip, single-die RFeIC (RF front-end integrated circuit) which incorporates 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. Typical high-power applications include home and industrial automation, smart power, and RF4CE, and others. Combining superior performance, high sensitivity and efficiency, low noise, 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.

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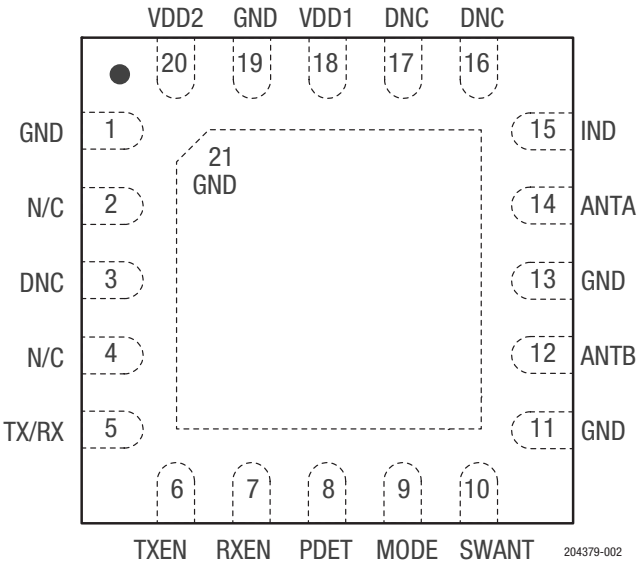



**Figure 2. RFX2411 Pinout (Top View)**

**Table 1. RFX2411 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

The absolute maximum ratings of the RFX2411 are provided in Table 2. The recommended operating conditions are specified in Table 3.

The TX/RX/Bypass mode electrical specifications are provided in Table 4. The state of the RFX2411 is determined by the logic provided in Table 5.

**Table 2. RFX2411 Absolute Maximum Ratings[1]**

| Parameter | Conditions | Minimum | Maximum | 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<br>Appropriate care required according to JEDEC Standards | –50 | +150 | °C |
| Electrstatic discharge:<br>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**: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

**Table 3. RFX2411 Recommended Operating Conditions[1]**

| Parameter | Conditions | Minimum | Typical | Maximum | 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 | See note 2 | | 1 | | µA |
| DC shutdown current | | | 300 | | nA |
| PA turn-on/turn-off time | | | | 1 | µsec |
| LNA turn on/turn-off time | | | | 1 | µsec |
| Antenna switch time | | | | 1 | µsec |
| Operating ambient temperature | | –40 | | +125 | °C |
| DC VDD voltage supply[1] | | | 35 | | °C/W |
| θja | See note 2 | 2.0 | 3.3 | 3.6 | V |

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.

**Table 4. RFX2411 TX/RX/Bypass Mode Electrical Characteristics (VDD = 3.3 V, $T_A$ = +25°C, Unless Otherwise Specified)**

| Parameter | Test Condition | Min | Typical | 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 | $P_{OUT}$ ≤ +20 dBm, CW at ANT pin | | –35 | | dBc |
| Third harmonic | $P_{OUT}$ ≤ +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 |
| RF port impedance | Low current mode | | 4 | | |
| | 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. RFX2411 Control Logic[1]**

| Mode of Operation | TXEN | RXEN | MODE | SWant |
|---|---|---|---|---|
| Shutdown | 0 | 0 | 0 | |
| Bypass | 0 | 0 | 1 | |
| Low Idq TX | 1 | X | 0 | |
| High Idq TX | 1 | X | 1 | |
| Low noise figure receive | 0 | 1 | 0 | |
| Low current receive | 0 | 1 | 1 | |
| ANTA port enabled | | | | 1 |
| ANTB port enabled | | | | 0 |

1 "1" denotes high voltage state (> 1.2 V)
"0" denotes low voltage stage (< 0.3 V) at control pins
"X" denotes do not care: floating control pins not allowed

## Package Dimensions

The PCB layout footprint for the RFX2411 is shown in Figure 3. The typical part marking is shown in Figure 4. Package dimensions are shown in Figure 5. 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 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.

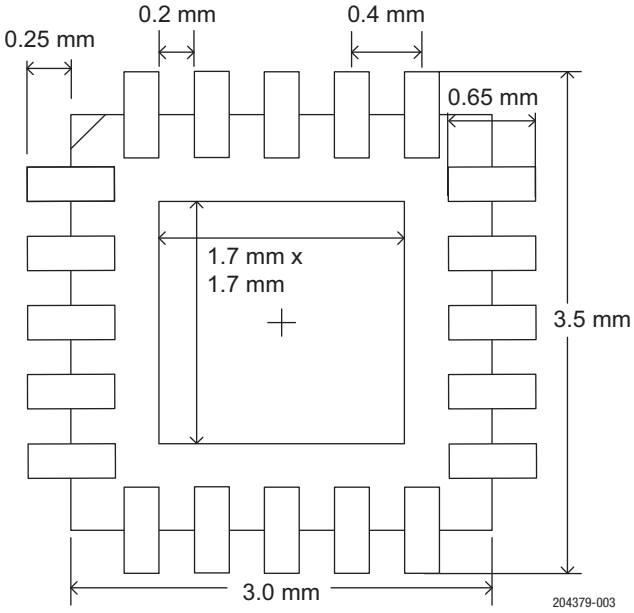



**Figure 3. RFX2411 Typical Part Marking**

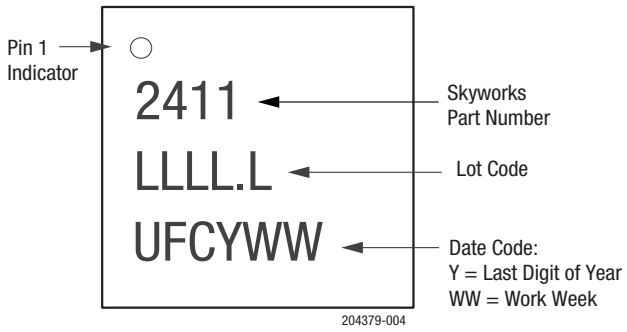
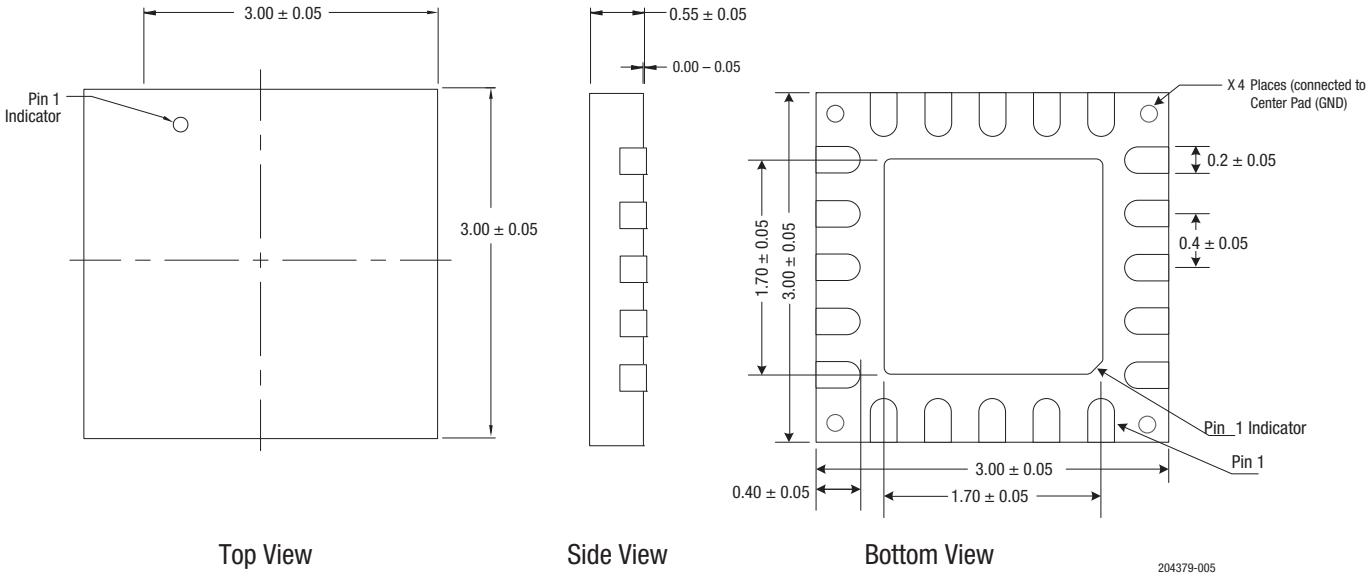



**Figure 4. Typical Part Markings (Top View)**




All dimensions are in millimeters.

**Figure 5. RFX2411 Package Dimensions**

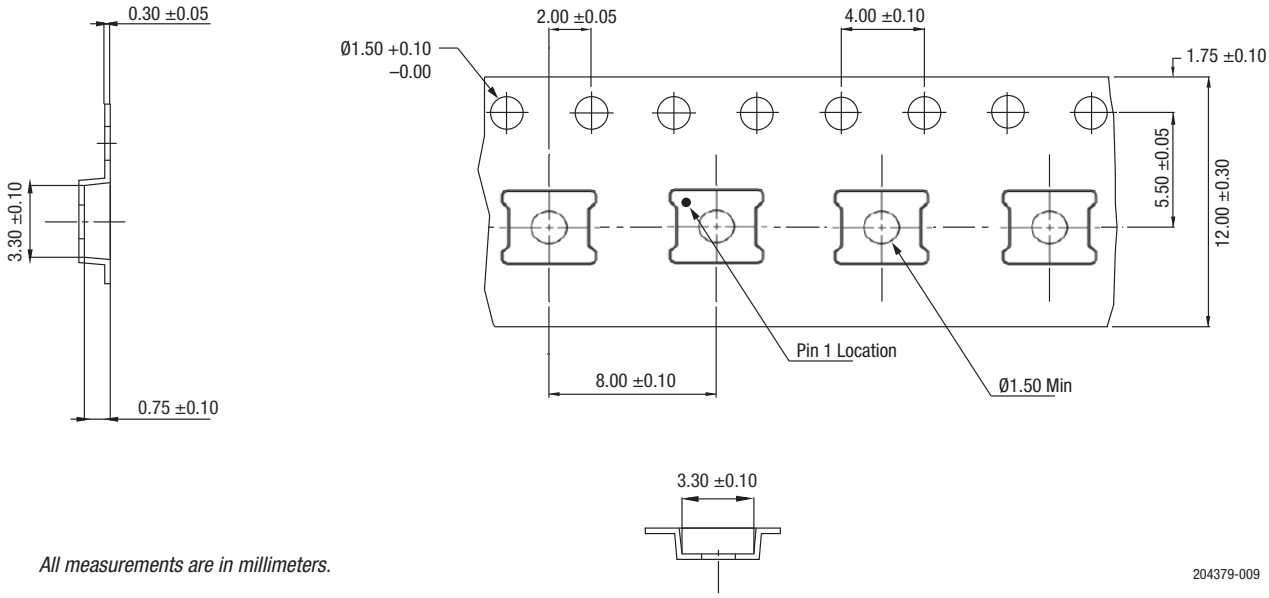



**Figure 6. RFX2411 Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| RFX2411: 2.4 GHz Transmit/Receive Zigbee® RFEIC with Diversity Switch | RFX2411 | RFX2411-EK1 |

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