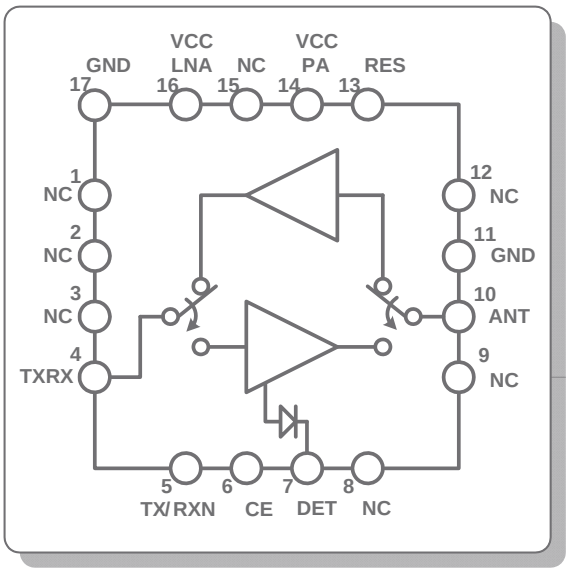
2.4GHZ TRANSMIT/RECEIVE ZIGBEE RFeIC



Description

The RFX2401 is a fully integrated, single-chip, single-die RFeIC (RF Front-end Integrated Circuit) which incorporates all the RF functionality needed for today's wireless ZigBee communications. The RFX2401 architecture integrates the PA, LNA, Transmit and Receive switching circuitry, the associated matching network, and the harmonic filter all in a BiCMOS single-chip device. This RFeIC is designed for use in 2.4GHz ISM band and supports the 802.15.4 and ZigBee 2007 standard. Typical high power applications include home and industrial automation, smart power, and RF4C among others.

Combining superior performance, high sensitivity and efficiency, low noise, small form factor, and low cost, RFX2401 is the perfect solution for applications requiring extended range and bandwidth. RFX2401 has simple and low-voltage CMOS control logic, and requires minimal external components for system implementation. The PA power detect circuit is also integrated.

Applications

- ZigBee Extended Range Devices
- ZigBee Smart Power
- Mobile and Battery ZigBee Systems
- Home and Industrial Automation
- RF4CE Remote Control
- Custom 2.4GHz Radio Systems

FEATURES

- 2.4GHz ZigBee High Power Single-Chip, Single-Die RF Front-End IC
- Combined TX/RX Transceiver Port and Single Antenna Port
- 2.4GHz Transmit High Power Amplifier with Low-Pass Harmonic Filter
- Low Noise Amplifier
- Transmit/Receive Switch Circuitry
- High Transmit Signal Linearity Meeting Standards for 8-PSK Modulation
- Integrated Power Detector for Transmit Power Monitor and Control
- Low Voltage (1.2V) CMOS Control Logic
- ESD Protection Circuitry on All Ports
- DC Decoupled RF Ports
- Internal RF Decoupling on All VCC Bias Pins
- Low Noise Figure for the Receive Channel
- High Power Capability for Received Signals
- Very Low DC Power Consumption
- Full On-chip Matching and Decoupling Circuitry
- Minimal External Components Required
- 50-Ohm Input / Output Matching
- Market Proven Low Cost BiCMOS Technology
- 3 x 3 x 0.5mm Small Outline QFN-16 Package with Exposed Ground Pad

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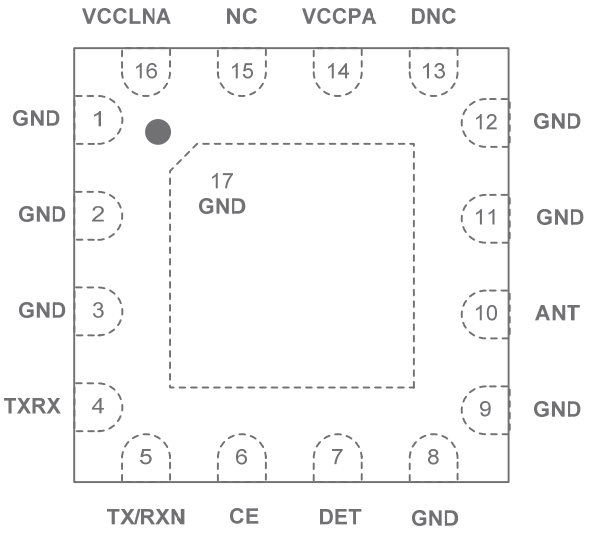
Feb '11

PIN ASSIGNMENTS:

Pin Number	Pin Name	Description
4	TXRX	RF signal to/from the Transceiver: DC shorted to GND
5	TX/RXN	CMOS Input to Control TX and RX
4	CE	CMOS Input to Control Chip Enable
7	DET	Analog Voltage Proportional to the PA Power Output
10	ANT	RF Signal from the PA or RF Signal Applied to the LNA; DC Shorted to GND
1, 2, 3, 8, 9, 11, 12, 15, 17	GND	Ground – Must be connected to Ground in the Application Circuit
13	DNC	Reserved – Do Not Connect in the Application Circuit
14	VCCPA	Voltage Supply Connection for the PA
16	VCCLNA	Voltage Supply Connection for the LNA

PIN-OUT DIAGRAM:



(Top View)

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ABSOLUTE MAXIMUM RATINGS:

Parameters	Units	Min	Max	Conditions
DC VCC Voltage Supply	V	0	4.5	All VCC Pins
DC Control Pin Voltage	V	0	4.5	Either TX/RXN or CE Pins
DC VCC Current Consumption	mA		350	Through VCC Pins when TX is "ON"
TX RF Input Power	dBm		+10	All Operating Modes
ANT RF Input Power	dBm		+10	When RX is "ON"
Storage Ambient Temperature	^oC	-50	+125	No RF and DC Voltages Applied Appropriate care required according to JEDEC Standards

Sustained operation at the Absolute Maximum Ratings will result in damage to the device and is not recommended.

RECOMENDED OPERATING CONDITIONS:

Parameters	Units	Min	Typ	Max	Conditions
DC VCC Voltage Supply *(Note 1)*	V	1.8	3.3	3.6	All VCC Pins
Control Voltage "High"	V	1.2		VCC	CE and TX/RXN Pins
Control Voltage "Low"	V			0.3	CE and TX/RXN Pins
DC Control Pin Current Consumption	µA		1		Either CE or TX/RXN Pins
DC Shutdown Current	µA		0.05		CE "OFF", TX/RXN "OFF"
Transmit-Receive Switching Time	nsec			400	All Operating Modes
Shut-Down and "ON" State Switching Time	nsec			400	All Operating Modes
Operating Ambient Temperature	^oC	-30		+85	All Operating Modes

Note 1 – For proper operation of the RFX2401, VCC must be continuously applied to all VCC supply pins.

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TRANSMIT TECHNICAL PARAMETERS (VCC=3.3V; T=+25 °C)

Parameters	Units	Min	Typ	Max	Conditions
Operating Frequency Band	GHz	2.4		2.5	All RF Pins Terminated by 50 Ohm
Output P1dB	dBm		+22		CW, TX Active
Saturated Output Power	dBm		+23.5		
Small-Signal Gain	dB		24.5		Between TXRX and ANT Pins
Power Detector Voltage in All Modes	mV	20		2000	POUT = +5 to +20dBm
Second Harmonic	dBc		-40		P_{OUT} = +20dBm, CW at ANT Pin
Third Harmonic	dBc		-40		P_{OUT} = +20dBm, CW at ANT Pin
Input Return Loss	dB		-10		At TXRX Pin when TX is “ON”
Output Return Loss	dB		-10		At ANT Pin when TX is “ON”
Input Output Impedance Single-Ended	Ohm		50		At TXRX and ANT Pins, TX is “ON”
TX Quiescent Current	mA		25		No RF Applied, TX "ON"
TX High Power Current	mA		100		P_{OUT} = +20dBm, through VCC

RECEIVE TECHNICAL PARAMETERS (VCC=3.3V; T=+25 °C)

Parameters	Units	Min	Typ	Max	Conditions
Operating Frequency Band	GHz	2.4		2.5	All RF Pins are Loaded by 50-Ohm
Gain	dB		15		Between ANT and TXRX Pin, RX “ON”
Noise Figure	dB		2.7		Between ANT and TXRX Pins, RX “ON”
Input Return Loss	dB		-10		At ANT Pin
Output Return Loss	dB		-13		At TXRX Pin
RF Port Impedance	Ohm		50		At TXRX and ANT Pins, RX “ON”
RX Quiescent Current	mA		7.5		No RF Applied, RX "ON"
Input P_{1dB}	dBm		0		At ANT Pin, RX “ON”

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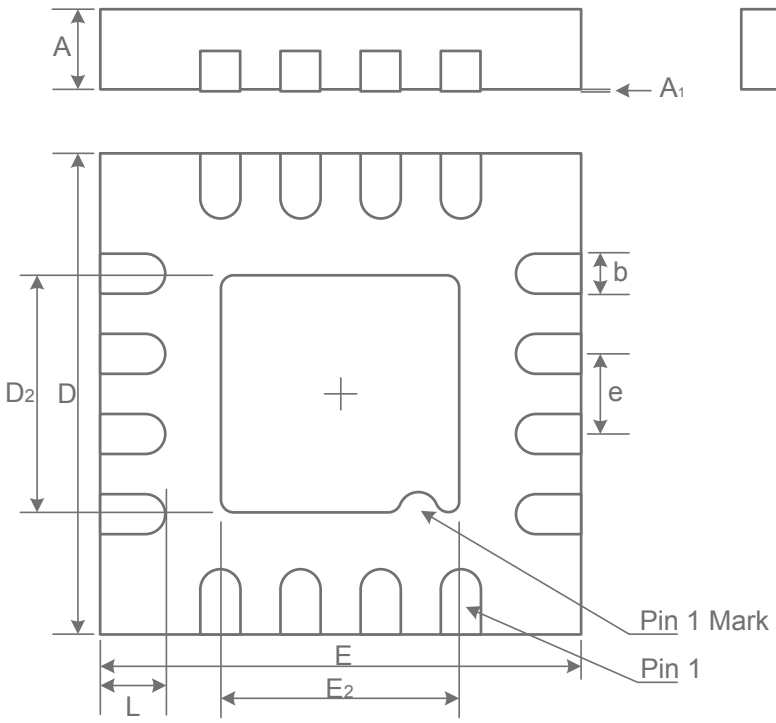
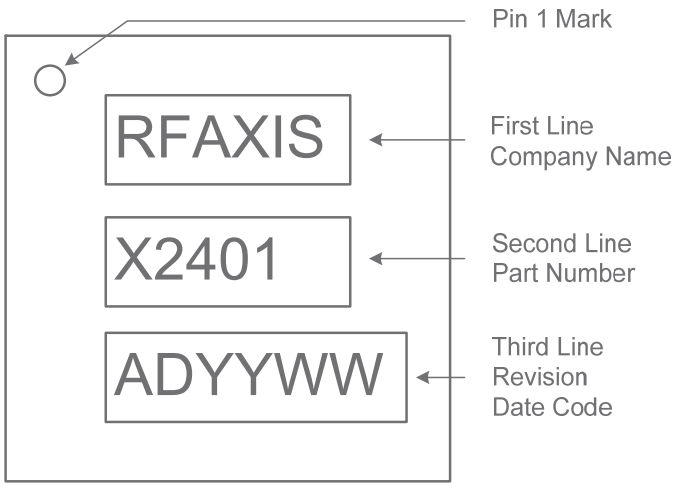
PACKAGE DIMENSIONS:



Dimensions (mm)			
	Min	Nom	Max
A	0.45	0.5	0.55
A_1	0.00	0.02	0.05
b	0.20	0.25	0.30
D	2.90	3.00	3.10
D_2	1.65	1.70	1.75
E	2.90	3.00	3.10
E_2	1.65	1.70	1.75
e	0.45	0.50	0.55
L	0.35	0.40	0.45

PACKAGE MARKING:



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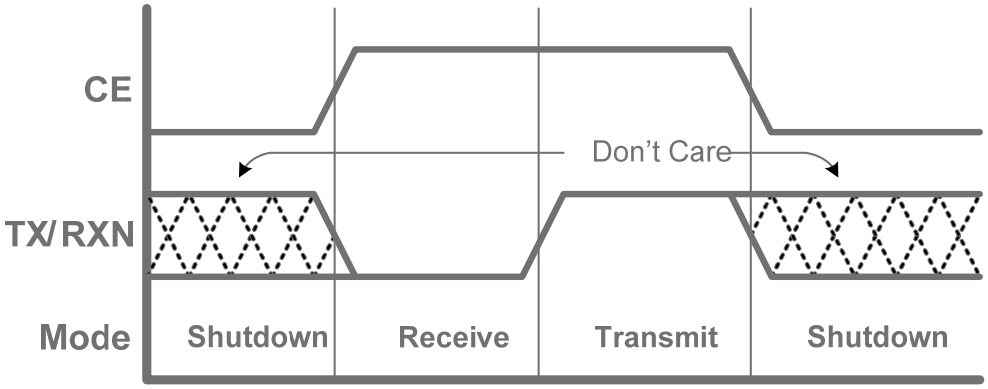
CONTROL SIGNAL TIMING DIAGRAM



CONTROL LOGIC TRUTH TABLE

TX/RXN	CE	Operating Conditions
1	1	TX Active
0	1	RX Active
X	0	Chip is Shut-down

Note: "1" denotes high voltage state (> 1.2V)
"0" denotes low voltage stage (<0.3V) at Control Pins
"X" denotes the don't care state

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APPLICATION CIRCUIT GUIDELINES:

The RFX2401 is a front end device intended for use with an integrated transceiver in order to boost range and data performance. The application of this IC is straightforward as the RF ports are matched to 50 ohm. On the antenna side, a standard 50 ohm antenna can be directly connected to the device through a 50 ohm transmission line to the antenna port. The same is true for the transceiver side as well. A 50 ohm transmission line should be used in the layout between the base band transceiver and the RFX2401. It is important to note that the RF ports on the RFX2401 are DC grounded. If there is a DC path or DC potential on the devices connected to this RFeIC on either the antenna or transceiver side, provisions need to be taken to block the DC through the use of a high quality RF capacitor or other device that will block the DC.

An RF filter is recommended for use with most ZigBee systems to limit external interference and system harmonics, depending on the system requirements of the application platform. These devices come in a range of configurations and filter response curves. Many of these devices have a balanced RF port on one side of the filter, and a single-ended RF port on the other. Most of the integrated ZigBee transceivers have a balanced RF port that is part of the transceiver design. Putting the filter between the transceiver and the RFX2401 is a good way to convert the balanced signal to a single-ended signal without the use of a balun. A filter that is single-ended on both ports can also be used between the RFX2401 antenna port and the antenna. Using the filter in this configuration will impact the system noise figure and transmit power, but will also provide additional protection from strong interfering signals that are near in frequency to the bandwidth of interest. It is worth noting that most of these filters generally block DC through the RF ports. The RFX2401 has been designed with a high power capability within the LNA to tolerate large blocking signals.

A simple circuit can be substituted in the place of the band pass filter at the antenna for additional harmonic suppression. With the addition of an inductor and two capacitors, system performance can often exceed regulation requirements without the need for an additional band pass filter either at the transceiver side, or at the antenna side of the RFX2401. Please note the details in the application circuit.

The DC supplied to the two power connections of the RFX2401 needs to be of reasonably good quality and free from frequencies that could cause unwanted interfering spurs in the signal path. A star configuration is recommended for decoupling of the two VCC pins of RFX2401. The capacitor values should be chosen based on the ripple frequency of the power converter and other system considerations. Further details can be found in application notes of RFX2401.

The RF signal path from the transceiver through the RFX2401 to the antenna needs to be carefully chosen, and should be kept as short as possible. The signal path also should not be routed near other RF devices or their signal paths. It is generally a good practice to also avoid vias and keep the signal routed on one layer. If other RF devices are in the vicinity of the RFX2401 signal path, great care should be exercised to assure adequate isolation between them. If a balanced output is used into the RF filter from the transceiver, this signal path should be made very short, and the line lengths and impedances matched very closely.

Power dissipation is important for the performance of the RFX2401, and the ground pad on the bottom center of the chip will help to carry the heat away. Though the device is very efficient and generates very little heat, the device itself is very small and can realize a large temperature rise if the heat isn't dissipated properly.

All the ground pins and NC pins should be connected to ground, and tied to the ground plane to help accomplish the heat transfer. The center ground paddle should have no fewer than 9 vias to connect directly to the ground plane, and the NC and GND pins can be connected to this paddle. Additional vias to GND adjacent to the GND and NC pins beyond the boundary of the chip can also be provided if the board layout has room to accommodate them.

To guarantee optimal RF performance, all shunt capacitors/inductors should have vias located as close to the ground pad as possible. It is recommended that 2~3 ground vias are placed in the vicinity of each of these shunt components.

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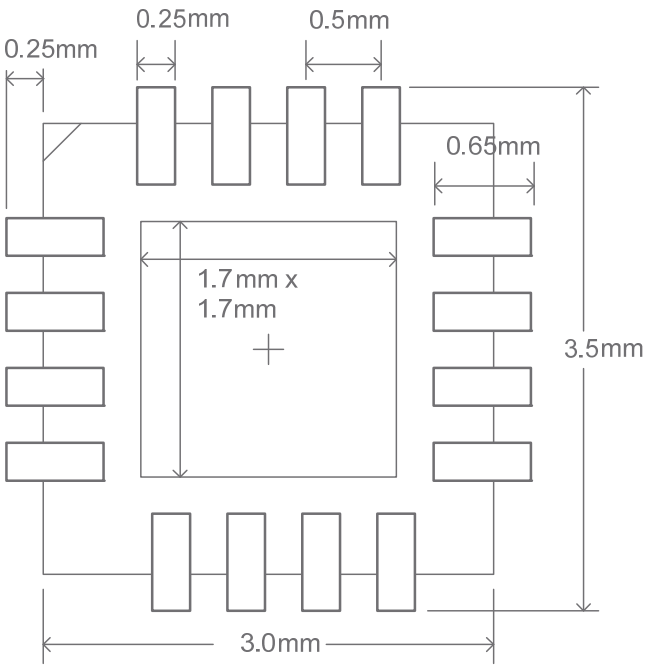
PCB LAND PATTERN



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