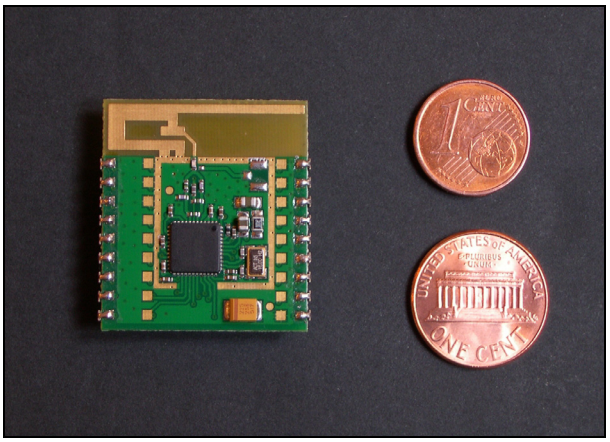

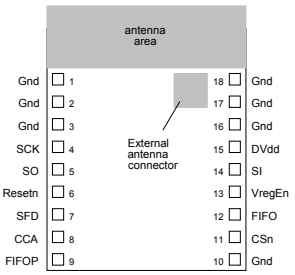

Figure 1. EasyBee pinout

Summary

EasyBee is an IEEE 802.15.4 compliant RF transceiver. It enables designers to easily add ZigBee / IEEE 802.15.4 wireless capability to their products without the need for RF or antenna design expertise.

The module contains all RF circuitry, including integral antenna and controller in a simple-to-use, plug-in or surface mount module. A 4-wire SPI port interfaces to a baseband microcontroller.

The PHY (Physical) layer includes an impedance matched balun and integral antenna. Options include screen can or external antenna connector. The MAC (Media Access Control) layer includes CRC-16 generation, clear channel assessment, signal energy detection, security, encryption and authentication.

EasyBee is a fully capable device and a ZigBee networking layer is not required for point-to-point communication. If ZigBee is required, compatible ZigBee stacks include Microchip Technology's free ZigBee stack, and Figure-8's ZigBee stack.

This module is an application-ready solution for fast-to-market ZigBee and IEEE 802.15.4 communications, providing the development engineer unlimited choice of host controller and stack firmware provider.

Manufactured to ISO9001:2000 FM76316

Features

- *2.4GHz IEEE 802.15.4 / ZigBee RF module*
- *Free space range approx 200m*
- *Raw data rate 250kbps*
- *FCC / CE compliance planned*
- *Integral antenna*
- *External antenna and screening-can options*
- *Based on ChipCon CC2420 RF controller:*
  - *4-wire SPI interface*
  - *separate 128-byte Rx & Tx FIFO buffers*
- *For ZigBee use controller of developer's choice, e.g. PIC running Microchip stack or ATMEL running Figure-8 stack*
- *Output power 1mW / 0dBm*
- *Consumes just 20mA (Rx), 18mA (Tx)*
- *2.1V – 3.6V supply*
- *Surface mount or with PCB headers*
- *Wide temperature range -40ºC to +85ºC*
- *Just 26mm x 20mm*

Applications

- *IEEE 802.15.4 & ZigBee networks*
- *Cable replacement*
- *Home / building automation*
- *Industrial control & networking*
- *Wireless sensor networks*

Ordering Information

Table 1. Ordering information	
Part No	***Description***
EasyBee SO	EasyBee 18-contact surface mount module
EasyBee	EasyBee 18-pin 0.1" Dual-in-Line module
EasyBee DEMO	EasyBee 12-pin 0.1" androgynous header module
Contact us for screening-can & external antenna connector options	

Contents

Electronic

Pin Connections

Pin Number	***Pin Name***	***Description*** (note 1)
1,2,3	*Gnd*	Power supply ground reference and ground plane connection
4	*SCK*	SPI clock input, up to 10 MHz
5	*SO*	SPI slave output. Updated on the negative edge of SCLK. Tristate when *CSn* high.
6	*Resetn*	Asynchronous, active low digital reset
7	*SFD*	SFD (Start of Frame Delimiter)
8	*CCA*	CCA (Clear Channel Assessment)
9	*FIFOP*	High when number of bytes in FIFO exceeds threshold
10	*Gnd*	Power supply ground reference and ground plane connection
11	*CSn*	SPI chip select, active low
12	*FIFO*	High when data in FIFO
13	*VregEn*	Voltage regulator enable, active high, held at *DVdd* voltage level when active
14	*SI*	SPI Slave Input. Sampled on the positive edge of SCLK
15	*DVdd*	Power supply input 2.1V – 3.6V
16,17,18	*Gnd*	Power supply ground reference and ground plane connection

Table 1. Pin descriptions for EasyBee

1. Refer to CC2420 documentation for further details of these pin function. (See bibliography)

Functional Block Diagram

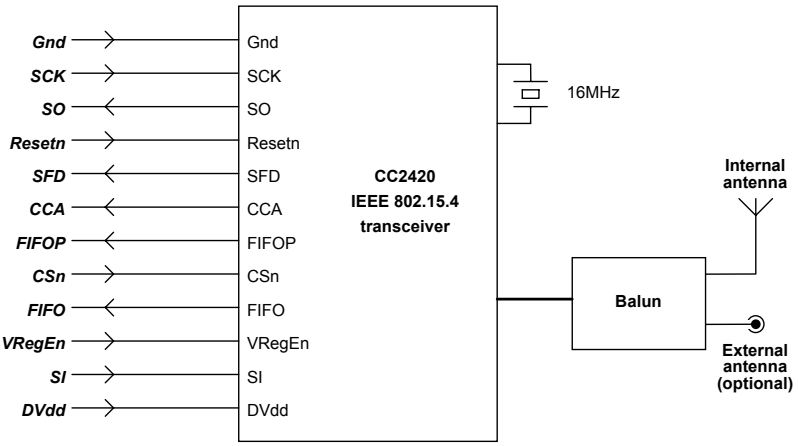

Figure 2. eZBee Functional Block Diagram

Circuit Description

The functional block diagram in figure 2 summarizes the electrical EasyBee module. The actual circuit closely follows the reference design specified by ChipCon AS for single ended operation with discrete balun. (See bibliography.) Actual component choices may differ.

The module is also electrically identical to the PICDEM Z radio board supplied by Microchip Technology Inc. The main difference is the smaller size.

If the device being designed is to be battery powered, aim to use lithium batteries rather than alkaline since they generally have much better ageing characteristics and reduced voltage decline over their lifetime.

Hardware Options

Screening-can: Provision has been made for a screening-can to shield the antenna from the transceiver electronics and vice versa. An appropriate screening-can will be commissioned according to customer demand and/or EMI requirements.

External antenna connection: An external antenna receptacle can be provided in place of the internal antenna. The U.FL receptacle is designed for connection to a U.FL-plugged 50Ω transmission line. Keep transmission lines as short as possible in order to minimize losses. If fitted, any EMI certifications we have obtained for the module may no longer apply. For details of the U.FL series connectors, refer to the bibliography.

Please note that the use of an external antenna is not recommended due to coax losses and requirements for recertification. If an external antenna is required because the product is to be housed in a metal enclosure, please enquire about our puck antenna housings. These enclose the entire module and permit it to be externally mounted.

Interfacing to the RF module

Refer to ChipCon's documentation for information on how to interface to the CC2420 module. Most ZigBee stack firmware also details how to communicate with the CC2420 using the SPI port.

Development Kits

OEMs intending to use EasyBee with Microchip PIC microcontrollers can use the PICDEM Z ZigBee development kit available from Microchip Technology. Microchip also provide a free ZigBee stack. The *EasyBee DEMO* version of the module is designed to plug directly into the PICDEM Z motherboard. Migration to EasyBee simply requires choosing an appropriate PIC microcontroller for the application.

OEMs wanting to use EasyBee with other baseband microcontrollers should use ZigBee stack software which is designed for interfacing to the CC2420 chip. An example is Figure8's ZigBee Stack (*www.figure8wireless.com*), which has a development kit is available.

Circuit diagnosis is much aided through the use of a packet sniffer such as Pixie Sniffer. Pixie Sniffer is

freely available from FlexiPanel Ltd for use with Pixie modules and PIXDEM-Z.

Regulatory

EMI ratings

FlexiPanel Ltd intends to acquire FCC and CE qualifications for EasyBee. Since modifications to the board designs may be required, compliance cannot be guaranteed for modules sold prior to obtaining qualification.

ZigBee Logo

It is our current understanding that to obtain permission to use the ZigBee logo requires certification of EasyBee in combination with application firmware and ZigBee stack. Therefore OEMs will need to seek ZigBee Alliance qualification before using the ZigBee logo.

OUI number / MAC address

All IEEE 802.15.4 devices such as EasyBee must carry a unique 8-byte MAC address. The first 3 bytes (the 'OUI' number) are licensed to a company by IEEE for an annual fee. The licensee is then free to uniquely assign the remaining 5 bytes.

FlexiPanel Ltd allocates MAC addresses under its OUI license for the transceivers it manufactures. OEMs therefore do not need to apply for an OUI number. When sold in individual units, each device will be issued with an individual MAC address. Volume customers may reserve a contiguous block of MAC addresses.

FlexiPanel Ltd's OUI number is 00-15-C8.

Safety concerns

Occasionally, public health and safety concerns are raised regarding the use of personal microwave devices. Such concerns are unfounded: EasyBee's maximum power is 1mW. No known risks exist for cellphones operating at over 1000 times that power output (up to 2 Watts).

Radio Frequency

Optimizing RF Performance

The integral antenna supplied with Pixie is a modified quarter wave F antenna with efficiency of approximately 70%. This is comparable to a dipole and about as high as physically possible. It develops and detects electromagnetic fields with reference to a ground plane, which should be considered a vital component of the antenna. Its radiation pattern is approximately omnidirectional.

Free space range is approximately 200m with the 1mW internal antenna. In-building ranges of 20m to 40m would normally be expected.

EasyBee's copper fill areas provide as good a ground plane as can be provided in such a compact area. Marginally superior performance may be obtained, space permitting, if this ground plane can be extended a further 50mm either side of the module. Refer to the section on PCB pad layout for guidance. The limited size of the ground plane results in reasonably omnidirectional antennal radiation patterns.

The enclosure employed may affect antenna performance. Avoid the use of metal enclosures. Gray and black plastics should be used with caution. They often contain carbon, which degrades performance considerably. To test for the presence of carbon, heat the plastic in a microwave oven for one minute. If it melts, it probably contains carbon.

A high location is recommended, particularly for avoiding interference from transient objects such as passers-by and their cellphones. Microwave ovens are particularly problematic for the short periods in which they and operational. Where possible, orient all the antennas in the same direction so that their polarizations are the same. In a mesh network, a highly attenuating medium such as a floor may be bridged by placing two routers close to each other, one on either side of the barrier.

Table 2. Attenuation of typical bulk materials

Material	***Reduces range by factor of***
Reinforced concrete floor	30
Brick wall with window	1.25
Office wall	2
Metal cabinet / enclosure	3
Vegetation	1.25 per meter
Compact materials, e.g. humans, have an complex effect, In general attenuating most noticeably when closest to the antenna.	

RF Performance Testing

The antenna issued is optimized for operation without any significant surrounding enclosure. It is possible that certain types of enclosure may attenuate or detune the antenna. This may be tested using a transmission test pattern, and an alternate enclosure sourced if necessary.

Commands can be sent to the CC2420 to generate unmodulated (figure 3) and modulated (figure 4) test patterns on each of the 16 channels. (Refer to the CC2420 documentation for specific details.)

The firmware solution `ZBTestPatt.hex` may be used to generate a test pattern. It should be programmed into a PIC18LF4620 connected to the EasyBee as shown in the circuit diagram for the Pixie product. (Indeed the easiest way to tune the antenna is to perform these tests using a Pixie in place of the EasyBee.) It cycles through channels 1, 6, 11 and 16, emitting an unmodulated carrier wave for six seconds

(figure 3). Then it repeats with a modulated carrier wave (figure 4). The whole cycle repeats every 48 seconds.

A typical test spectrum obtained when two devices are transmitting on adjacent channels is shown in figure 5.

These patterns in figures 3-5 were generated using a spectrum analyzer connected to a 2.45GHz antenna placed close to EasyBee. Performance testing will typically involve comparing device performance to an unencumbered EasyBee board. OEMs without appropriate test equipment may contact FlexiPanel Ltd or RF Solutions to book time on facilities in Paris, France, or Lewes, UK.

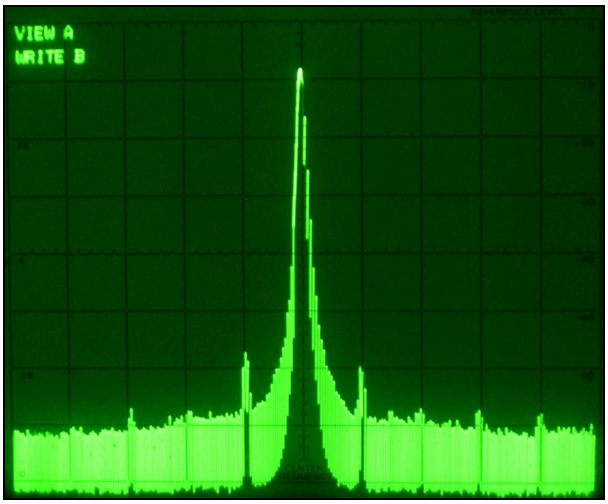

Figure 3. Typical spectrum of an unmodulated carrier. (Horz: 2MHz/div. Vert: 10dB/div.)

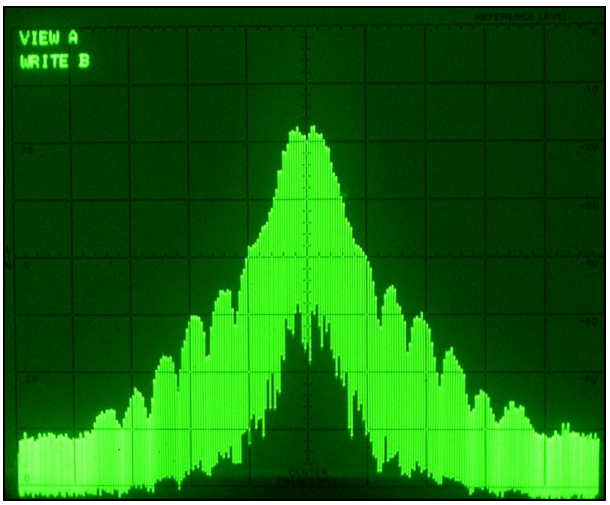

Figure 4. Typical spectrum of a modulated carrier.

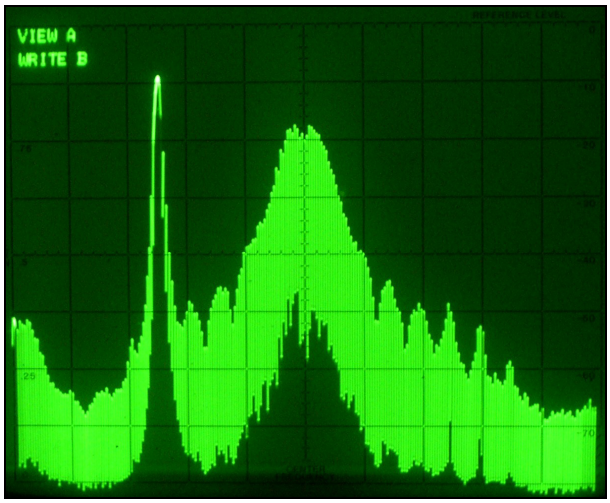

Figure 5. Typical spectrum of a modulated carrier and, in the adjacent channel, an unmodulated carrier.

Mechanical

PCB Pad Layout

Where supplied as a Dual-in-Line package, use the PCB pad layout shown in figure 6.

The large ground planes are recommended where space permits to marginally improve directional performance. They are not required; however, in general, have as much grounded copper on the as possible. This guideline applies to all products with quarter wave antennas.

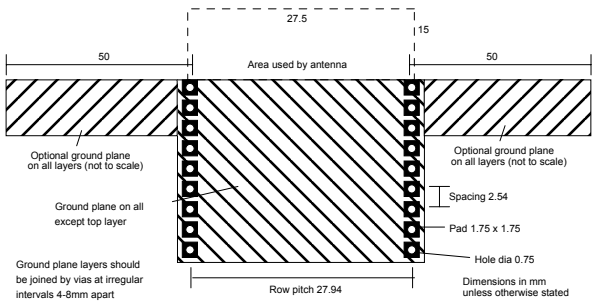

Figure 6. PCB pad layout for DIL module

The surface mount package has pads on the upper side of the board which are located directly above their counterparts on the lower side and are electrically connected to them. The PCB pad layout shown in figure 7 should be used.

Note how the pads on the main board protrude out from beneath the module. This provides a point to apply heat when manually soldering and also for continuity testing. In addition, the size of the pad ensures a large reservoir of solder is available to the actual contact area.

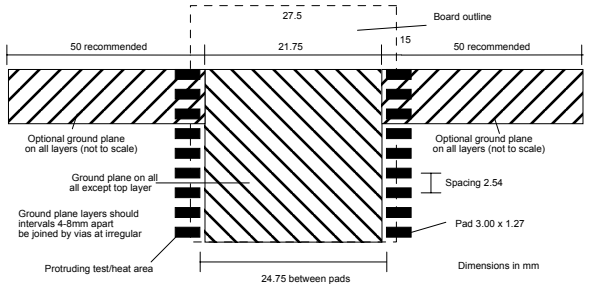

Figure 7. PCB pad layout for the SO module

If soldered using a reflow oven, the surface mount module may be treated like a BGA package. The quality of the joint may be tested by checking for continuity between the pad on the upper side of the board and the protruding part of the pad on the main board.

If soldering manually, use the following procedure:

1. Tin the contact pads on the module, trying to get more or less the same amount of solder on each. Work on a soft surface so that the components on the topside are not damaged.

2. Tin contact pads on main board.

3. Place the module in position on the main board.

4. Starting with the pads most likely to be in physical contact, apply heat with a soldering iron to the exposed part of the main board pads. Abut the iron against the edge of the module so that the heat is transmitted to the contact area of the pads. After 10-15 seconds, remove heat. Around 90% of pads should be successfully soldered.

5. Test for continuity between the pad on the upper side of the board and the protruding part of the pad on the main board.

6. Rework non-conducting contacts by applying heat again and a little extra solder.

Ground plane

The ground plane should be considered a vital part of the antenna. If space permits, the ground plane should be extended on the main board as shown in the PCB layout. All ground pads should connect to the ground plane. Vias should join the layers at irregular intervals approximately 4-8mm apart.

Location on main board

The module should be located so that the antenna abuts the edge of the board or overhangs it. It should be placed so that it is unlikely that interfering items such as metal, water, cellphones, body tissue, etc, can come into close proximity.

It is recommended that tracks and components are not placed in PCB layers below the module. However, if space limitations require it, leave the surface in contact with the module uncoppered and place a ground plane in the layer immediately below. Any vias that might come in contact with the module should be completely covered with resist to avoid shorting to vias on the module.

Future releases of EasyBee

The following changes are anticipated in future revisions of EasyBee. To provide forward compatibility, provision should be made for the narrower pin row pitch:

- The module will narrow in width by 7.62mm, and the pin row pitch will be correspondingly narrower.
- The antenna area will extend out a further 7mm to a total of 15mm. (Note, this has already been accounted for in figures 6 and 7, where the full 15mm length is shown.)

Bibliography

CC2420 Data Sheet, downloadable from *www.chipcon.com*.

ZigBee for Applications Developers, white paper downloadable from *www.flexipanel.com*.

Pixie Data Sheet, downloadable from *www.flexipanel.com*.

PICDEM Z User Guide*,* downloadable from *www.microchip.com*.

AN965 Microchip Stack for the ZigBee Protocol*,* application note, downloadable from *www.microchip.com*.

Microchip Stack for ZigBee Protocol*,* supplementary notes included with the Microchip Stack for ZigBee firmware downloadable from *www.microchip.com*.

U.FL connector data sheet, contact FlexiPanel Ltd for details.

Reference

Electrical

Supply Voltage (regulated) Vcc	2.1V to 3.6V
Power requirement, transmit	18mA
Power requirement, receive	20mA

For more information electrical specifications, consult the CC2420 data sheet. (See bibliography.)

Radio Frequency

Max RF output power	1mW = 0dBm
RF frequency range	2400MHz to 2485MHz
Communications protocol	IEEE 802.15.4 (DSSS O-QPSK chip encoding)
Raw data rate	250kbit/s
RF channels	16
Free space range with integral antenna	Approx 120m any antenna orientation. Approx 180m with carefully aligned antennas.

Mechanical

Max operating/storage temperature	−40ºC to +85 ºC
Pixie Lite Dimensions L×W×H mm	28.0 × 31.0 x 4.8 (note 1,2)
Pixie Lite SO Dimensions L×W×H mm	27.5 × 31.0 x 3.1 (note 1,2)

1. Refer to the section *Future releases of Pixie & Pixie Lite* for details of future dimension changes
2. Height profile may be reduced by omission of power supply smoothing capacitor, contact us for details

Regulatory

FCC qualification	Awaiting certification
CE qualification	Awaiting certification

Sales & Technical Support

Master Distributor Contact Details

EasyBee is assembled and distributed by agreement by RF Solutions Ltd:

R F Solutions Ltd
Unit 21, Cliffe Industrial Estate,
Lewes, E. Sussex, BN8 6JL, United Kingdom
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Tel: +44 (0)1273 898 000, Fax: +44 (0)1273 480 661
email: sales@rfsolutions.co.uk

Manufacturer Contact Details

EasyBee is designed and owned by FlexiPanel Ltd:

FlexiPanel

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email: support@flexipanel.com

PICDEM Z, ZigBee Stack Provider Contact Details

PICDEM Z and the Microchip Stack for ZigBee are provided by Microchip Technology Inc:

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Technical support: *support.microchip.com*