![FlexiPanel logo]

Pixie™

PIC microcontroller with 2.4GHz IEEE 802.15.4 transceiver and ZigBee stack

Summary

Pixie provides a complete ZigBee solution for OEMs, integrating IEEE 802.15.4 2.4GHz PHY / MAC layers with Microchip Technology's NWK / APL / ZDO layers. It provides a path for extremely rapid migration from Microchip's PICDEM Z ZigBee development environment to market-ready product.

Pixie is capable of full function device (FFD) operation and is suitable for router and coordinator nodes. The lower cost *Pixie Lite* version is used for reduced function devices, *e.g.* endpoints, with 2 fewer *I/O* lines and being 3mm more compact.

- *Free space range approx 120m*
- *FCC / CE / IC compliant*
- *MAC address allocation*
- *Signature G antenna, low "hand effect" design*
- *Output power 1mW / 0dBm*
- *Consumes less than 25mA when active, 2µA in sleep mode*
- *15 general I/O lines, featuring 6-channel 10-bit A/D, serial UART, 4 interrupts, counter input*
- *Master SPI*
- *Surface mount and DIL through-hole versions*
- *Wide temperature range -40ºC to +85ºC*
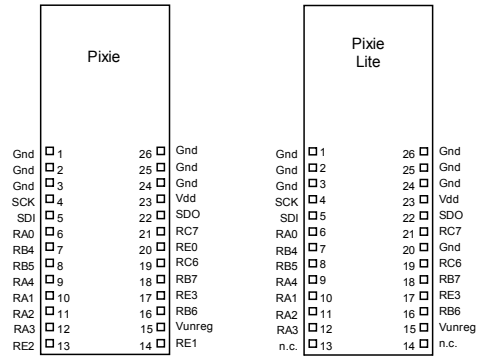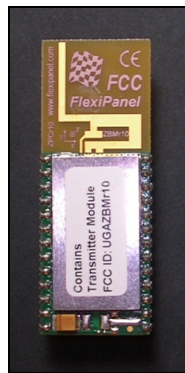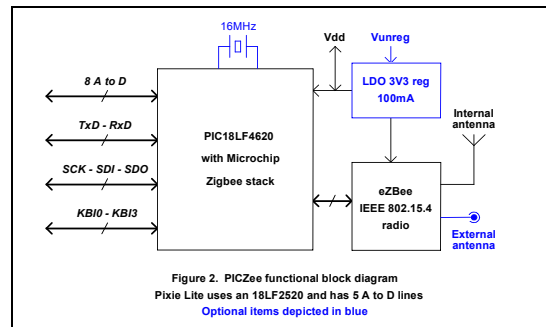- *2.1V - 3.6V supply, ideal for Li rechargeables*

Manufactured to ISO9001:2000

Fig 1. Pixie and Pixie Lite
(viewed from above)

Pixie					Pixie Lite			
Gnd	1	26	Gnd		Gnd	1	26	Gnd
Gnd	2	25	Gnd		Gnd	2	25	Gnd
Gnd	3	24	Gnd		Gnd	3	24	Gnd
SCK	4	23	Vdd		SCK	4	23	Vdd
SDI	5	22	SDO		SDI	5	22	SDO
RA0	6	21	RC7		RA0	6	21	RC7
RB4	7	20	RE0		RB4	7	20	Gnd
RB5	8	19	RC6		RB5	8	19	RC6
RA4	9	18	RB7		RA4	9	18	RB7
RA1	10	17	RE3		RA1	10	17	RE3
RA2	11	16	RB6		RA2	11	16	RB6
RA3	12	15	Vunreg		RA3	12	15	Vunreg
RE2	13	14	RE1		n.c.	13	14	n.c.

Firmware Features

Pixie is electrically virtually identical to the PICDEM Z ZigBee development environment and is fully compatible with Microchip Technology's free ZigBee stack, featuring:

- *Compatibility with ZigBee 1.0 specification*
- *FlexiPanel Ltd profiles in development for switching, serial data communications, UI servers, displays and sensors*
- *Only configuration bits and I/O pin definitions are changed during migration from* PICDEM Z

16MHz

Vdd   Vunreg

LDO 3V3 reg 100mA

8 A to D

TxD - RxD

SCK - SDI - SDO

KBI0 - KBI3

PIC18LF4620 with Microchip Zigbee stack

Internal antenna

eZBee IEEE 802.15.4 radio

External antenna

Figure 2. PICZee functional block diagram
Pixie Lite uses an 18LF2520 and has 5 A to D lines
Optional items depicted in blue

Ordering Information

Table 1. Ordering information	
Part No	**Description**
PIXIE-SO-XXXX	Pixie 26-contact surface mount module
PIXIE-DIL-XXXX	Pixie 26-pin 0.1" Dual-in-Line module
PIXLITE-SO-XXXX	Pixie Lite 24-contact surface mount module
PIXLITE-DIL-XXXX	Pixie Lite 24-pin 0.1" Dual-in-Line module
XXXX refer to preloaded firmware options, refer to firmware data sheets	
Refer to separate data sheets for all-weather enclosures	

Contents

Electronic

Pin Connections

Pin Number		Pin Name	Description
Pixie	Pixie Lite		
1,2,3	1,2,3,20	Gnd	Power supply ground reference and ground plane connection (note 3)
4	4	SCK	Serial Peripheral Interface (SPI) clock output (note 1)
5	5	SDI	Serial Peripheral Interface (SPI) data input (note 1)
6	6	RA0	PIC digital I/O RA0 / analog input AN0
7	7	RB4	PIC digital I/O RB4 / interrupt input KBI0
8	8	RB5	PIC digital I/O RB5 / interrupt input KBI1
9	9	RA4	PIC digital I/O RA4 / counter input T0CKI (note 3)
10	10	RA1	PIC digital I/O RA1 / analog input AN1
11	11	RA2	PIC digital I/O RA2 / analog input AN2 / negative voltage reference
12	12	RA3	PIC digital I/O RA3 / analog input AN3 / positive voltage reference
13		RE2	PIC digital I/O RE2 / analog input AN7
14		RE1	PIC digital I/O RE1 / analog input AN6
	13	n.c.	No connection
	14	n.c.	No connection
15	15	Vunreg	Unregulated voltage input (note 2)
16	16	RB6	PIC digital I/O RB6 / interrupt input KBI2 / ICD & ICSP programming pin PGC
17	17	RE3	PIC digital input RE3 / reset input (active low) / ICSP programming pin Vpp
18	18	RB7	PIC digital I/O RB7 / interrupt input KBI3 / ICD & ICSP programming pin PGD
19	19	RC6	PIC digital I/O RC6 / serial UART TxD output
20		RE0	PIC digital I/O RE0 / analog input AN5
21	21	RC7	PIC digital I/O RC7 / serial UART RxD output
22	22	SDO	Serial Peripheral Interface (SPI) data output (note 1)
23	23	Vdd	Regulated power supply input Regulated power supply output (note 2)
24,25,26	24,25,26	Gnd	Power supply ground reference and ground plane connection

Table 1. Pin descriptions for Pixie & Pixie Lite

1. Operates in master SPI mode. Slave devices need a chip select line as the SPI is also used for internal communications.
2. Requires optional voltage regulator option to be fitted for onboard regulation to be functional.
3. This pin may no longer function in future devices and will become a Vddcore power supply pin. Refer to the *Future releases of Pixie & Pixie Lite* section of this data sheet and the documentation for 18F46J10 and 18F25J10 series devices from Microchip Technology (www.microchip.com).
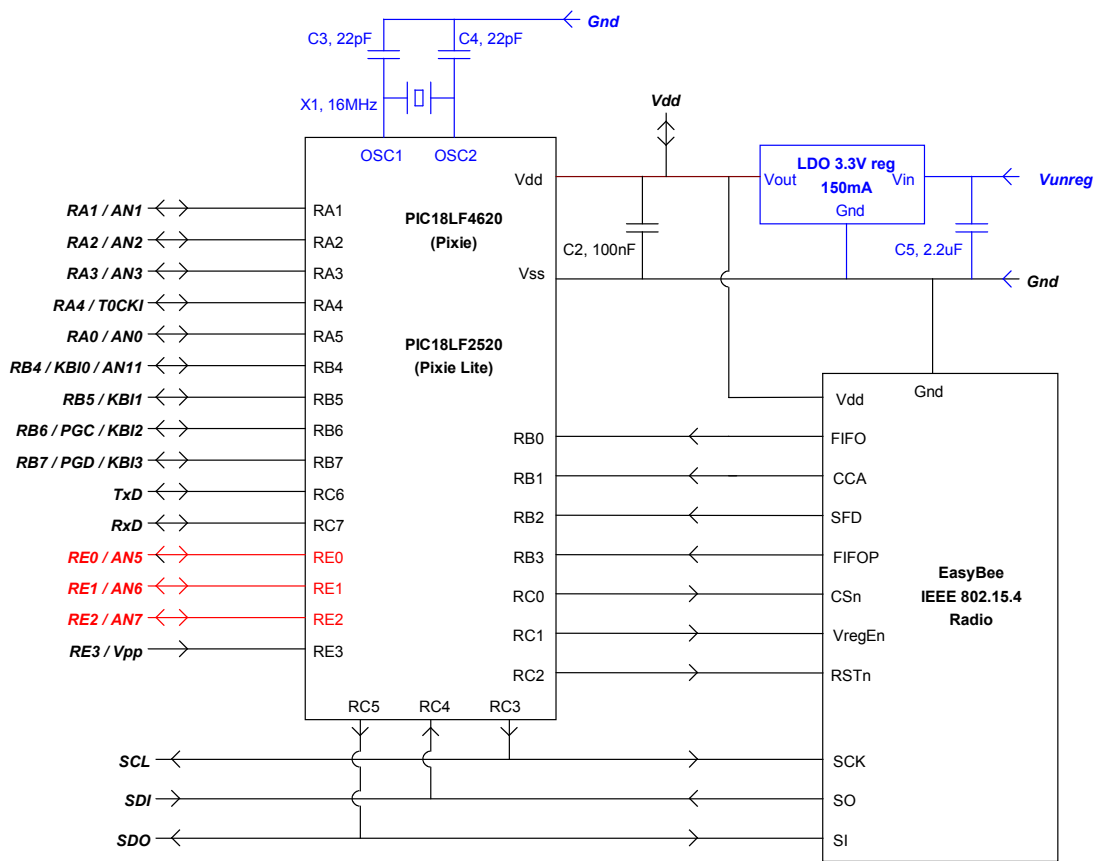
Schematic Diagram

Figure 3. PICZee / PICZee Lite schematic diagram

Optional items shown in blue

Items in red are omitted on Pixie Lite

Circuit Description

The schematic diagram in figure 3 details the electrical configuration of the Pixie and Pixie Lite modules. Items shown in blue are options and are not fitted as standard. For stock management reasons, units may occasionally be supplied with unrequested options fitted.

The EasyBee radio provides PHY and MAC layers conforming to the IEEE 802.15.4 standard. It is electrically identical to the EasyBee radio marketed by FlexiPanel Ltd and for which detailed documentation is separately available.

The EasyBee radio in turn matches both the PICDEM Z radio board and the reference circuit supplied by Chipcon, suppliers of the circuit's main component, a

CC2420 MAC/PHY transceiver. The main difference is the smaller size.

The remainder of the circuit, centered on the PIC18LF4620, is intended to provide the higher stack layers. In the case of ZigBee, these would be the NWK, APS, APL and ZDO layers. In addition, it provides the application layer or, if the application resides off-chip, an interface to it.

The OEM may choose to develop firmware in-house, make use of free Microchip's ZigBee Stack, and/or make use of the free firmware solutions provided by FlexiPanel Ltd as needed.

The circuit is electrically very similar to the PICDEM Z Microchip ZigBee Stack evaluation kit, with the following exceptions:

- A 16MHz oscillator is normally fitted.

- No voltage regulator is normally fitted. If the PIC is clocked at 4MHz, DC power between 2.1V and 3.6V should be supplied to *Vdd*. If the PIC is clocked at 16MHz, *Vdd* should be between 2.7V and 3.6V.

- A few I/O lines are not available for external connection.

- Some peripheral components, such as the RS232 converter, LEDs and pushbuttons, have been omitted.

- Pixie considerably smaller and lighter.

- Pixies are FCC and CE certified.

- A unique MAC address may be obtained from FlexiPanel for use with the module.

When used with the ZigBee stack as supplied from Microchip Technology, the following resources are used by the stack for internal communications:

- RB0-RB3

- RC0-RC2

- SPI (RC3-RC5) operating in master mode, although this may be shared with external components as detailed in the SPI section below.

- Watchdog timer (software enabled)

- Timer 0

- CCP2

- High priority interrupts on CCP2 (FIFOP), INT2 (SFD)

Hardware Options

The following options may be requested for volume orders:

Crystal: If requested, the crystal oscillator X1 and oscillator capacitors C3, C4 may be omitted.

Where fitted, X1 is a 16MHz crystal rather than the 4MHz crystal used in the PICDEM Z evaluation kit. This is in order to reduce the overall size of the module. To compensate for this difference, disable the oscillator PLL mode, which the 4MHz oscillator uses to mimic a 16MHz oscillator.

Voltage regulator: The power supply to *Vdd* should be 2.1V to 3.3V. If requested, a voltage regulator may be fitted to regulate this from a DC supply to *Vunreg* within the limits 2.4V to 20V, 100mA maximum current.

If the voltage regulator is populated, the *Vdd* pin may be used as a regulated power output, or as an alternate regulated power input if *Vunreg* is not powered.

Note that the 2.1V minimum voltage value quoted assumes that the PIC is clocked at 4MHz.

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.

SPI Port

The internal circuitry of the module uses the PIC MSSI peripheral in SPI Master mode. With care, other SPI slaves may also be connected.

- Chip select lines must be provided to avoid collision with internal communications.

- Microchip Stack firmware should be carefully understood to ensure communication does not occur while internal chip select lines are activated. Specifically, no external slaves should be selected between calls to `PHYSelect()` and `PHYDeselect()`.

MRF24J40 migration

As Microchip roll out their MRF242J40 IEEE 802.15.4 radio chip, their ZigBee stack support will be increasingly focused on it rather than the CC2420. We are working with Microchip to provide a seamless, pin compatible migration path for the Pixie range. Our intention is to develop MRF24J40-based Pixie devices as soon as possible. CC2420-based Pixies will continue to be manufactured.
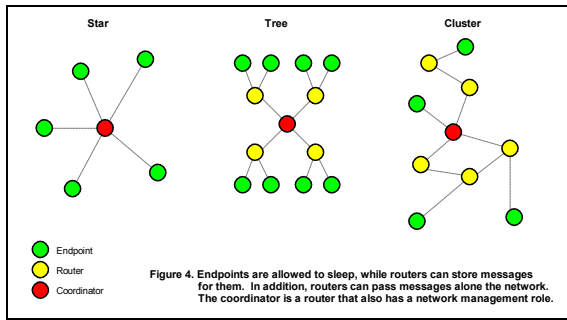
Firmware

Any communications system based on the IEEE 802.15.4 standard could use the Pixie module. However, it is intended for use as a ZigBee transceiver using the Microchip ZigBee stack.
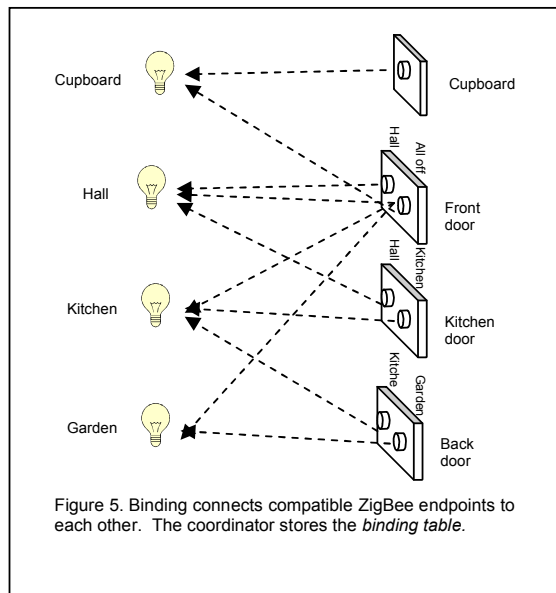
ZigBee overview

This section provides a brief overview of the ZigBee communications protocol. For further details, refer to the bibliography.

ZigBee's primary aim is to make low data rate, battery power communications feasible. Primarily it does this by using mesh networks of adjacent devices rather than point-to-point communications over long distances. (Figure 4.) Additionally, devices are divided into those which are battery powered *end devices* which can enter sleep modes, and *routers*, which can pass multi-hop messages through the network and store messages for end devices while they sleep. One router, called the *coordinator*, has special roles relating to overall network management.

Figure 4. Endpoints are allowed to sleep, while routers can store messages for them. In addition, routers can pass messages alone the network. The coordinator is a router that also has a network management role.

Each end device can have up to 240 *endpoints,* which are separate applications sharing the same radio. For example, a three-gang light switch would have two distinct endpoints sharing the same radio electronics and battery.

Figure 5. Binding connects compatible ZigBee endpoints to each other. The coordinator stores the *binding table.*

The coordinator also manages the *Binding Table* This saves an endpoint such as a light switch from knowing which other endpoints (*i.e.* light) it is connected to. The coordinator, and possibly the routers, store this information for the end devices in a lookup table. Endpoints are associated by adding entries to this lookup table in a process known as *binding* (Figure 5).

FlexiPanel Ltd has a continuing program of firmware development for Pixie devices. In general, firmware is provided free for use with Pixie devices.

The ZigBee Stack

Figure 6:

The IEEE 802.15.4 / ZigBee stack
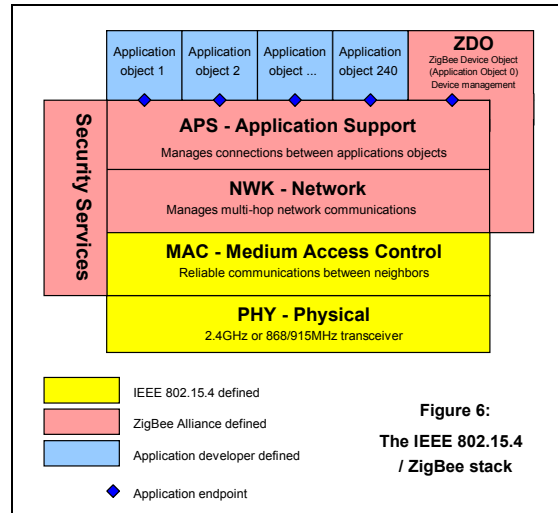
The ZigBee stack is loosely based on the Open Systems Interconnection model. Referring to figure 6, the basic tasks of each layer in the stack are as follows:

Physical Layer (PHY): The PHY layer consists of a half duplex IEEE 802.15.4 radio transceiver. Pixie uses the 16-channel 2.4GHz ISM band, which is the most widely accepted worldwide.

Medium Access Control (MAC): The MAC layer provides reliable, error-free communications between a node and its immediate neighbors.

Network Layer (NWK): The NWK layer provides the routing and multi-hop capability required to turn MAC-level communications into a star, tree or mesh network.

Application Support Layer (APS): The APS layer routes messages on the network to the different application end points on the node.

Applications Objects: An application object is the software at an endpoint which achieves what the device is designed to do.

ZigBee Device Object (ZDO): The ZDO is a special application object responsible for overall device management, security keys and security policies. Its ZigBee Device Profile (ZDP) is always end point zero, while other application end points are numbered 1 to 240.

Security Services: The security services provided for establishing and exchanging security keys to secure the communications. The MAC, NWK and APS layers use them for encrypting data prior to transmission and authenticating it when it is received.

Firmware Development guide

In most applications, nodes will be divided into full function devices (FFDs) implemented on Pixie modules and reduced function devices (RFDs) implemented on lower-cost Pixie Lite modules. Routers and coordinators need to be mains-powered FFDs, whereas

end devices are more likely to be RFDs and may be battery powered.

Microchip Technology Inc provides a ZigBee stack, complete with source code, for use with PIC microcontrollers, including Pixies. Please refer to www.microchip.com to obtain the stack and for technical support. Typical Microchip development components required include:
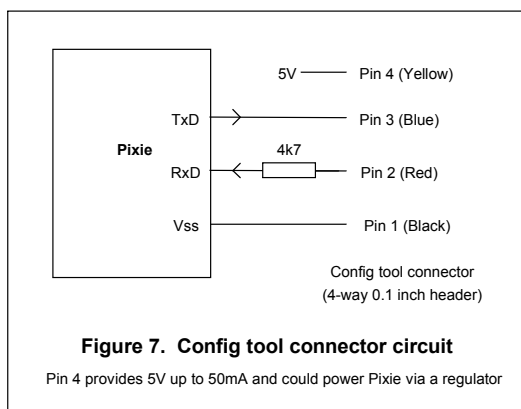
- MPLAB development environment
- IDC2 Programmer / Debugger
- C18 compiler
- Pixie Evaluation Boards

Refer to Microchip Technology's documentation for full details of the capabilities of the 18LF4520 and 18LF2520 microprocessors.

The Pixie Evaluation Kit contains two Pixie Evaluation Boards and may be used for evaluation and development work. Circuit diagnosis is much aided through the use of a packet sniffer such as Pixie Sniffer. Sniffer software is freely available from FlexiPanel Ltd for use with MACdongle, FlexiPanel's USB Sniffer device.

It is difficult to use breakpoints to debug ZigBee stack code, since they halt the processing of the stack. The UART provides an invaluable tool for debugging and diagnostics. The Pixie Evaluation Boards provide RS232 level converters so that diagnostic messages may be viewed in terminal emulators such as Microsoft Windows HyperTerminal.

The Pixie Configuration Tool may be used to connect the Pixie UART to a USB port. The Configuration Tool generates 5V TTL serial data, so the level converter shown in figure 7 should be used to interface to the Pixie. This is provided in the Pixie Evaluation Boards and may also be used to implement a very low cost configuration and diagnostics port in commercial products.

Figure 7. Config tool connector circuit

Pin 4 provides 5V up to 50mA and could power Pixie via a regulator

When working from demo code provided by Microchip Technology, bear in mind the following:

- Pin RE3 may be configured to operate as a reset pin or as a digital input, according to the configuration bits. If configured as a reset pin, appropriate reset circuitry should be provided by the OEM.

- The oscillator operates at 16MHz; the Microchip demo code expects a 4MHz oscillator. To convert to 16MHz, simply change the oscillator configuration from "HS PLL" to "HS". In some examples, this is achieved by changing the line:

  ```
  rom unsigned char config1H = 0b00000110;
  ```

  to:

  ```
  rom unsigned char config1H = 0b00000010;
  ```

- Operation at 16MHz is only guaranteed down to 2.7V. For operation down to 2.1V, consider reducing the clock speed to 4MHz. This may be achieved by using the internal oscillator block at 4MHz. The CLOCK_FREQ definition in the ZigBee stack should then be adjusted to 4000000.

PIC Programming

The PIC microcontroller may be programmed and/or debugged with Microchip Technology's ICD2 debugger or PM3 programmer using the connections shown in table 3.

Table 3. Programming connections	
Pin	**Description**
RE3	Vpp programming voltage
RB6	PGC programming clock
RB7	PGD programming data
Gnd	Power ground reference
Vdd	Power supply reference

An RJ11 connector is provided on the Pixie Evaluation Boards for connection to the ICD2 programmer. The module should be independently powered at 3.3V during programming.

If pins RE3 / RB6 / RB7 are used for purposes other than programming / debugging, steps should be taken to isolate them from the rest of the circuit during programming/debugging. Refer to the ICSP application notes in the bibliography.

Configuration Bits & Compile Options

Consider the following issues when setting compiler options and configuration bits, etc:

- The Microchip ZigBee Stack expects the following C18 compiler settings: Small Code Model, Large Data Model. Single or Multi Bank Stack will depend on requirements. Most likely, Pixie running FFD firmware will require a multi-bank stack, whereas Pixie Lite running RFD firmware will only require a single-bank stack.

- To fit an entire application and the ZigBee stack onto the PICs provided, most object files will have to be compiled with *all optimizations* enabled.

Debug optimizations only should be reserved for files that require debugging.

- Oscillator configuration bits must be set according to the oscillator mode in use.

- Brownout reset is recommended at 2.0V for 4MHz devices and 2.7V for 16MHz devices.

- The watchdog timer should be enabled in software as required. For battery powered devices, the postscaler value should be set according to the desired wakeup rate (1:256 being approximately 1 second).

- CCP2 Mux should be set to RB3.

- PORTB<4:0> should be configured as digital I/O on reset.

- If MCLR is enabled, the OEM must ensure its correct operation. No on-board circuitry is provided.

Regulatory

EMI ratings

The Pixie and Pixie Lite modules integrate the EasyBee reference design which has been independently tested for FCC and CE compliance.

FCC compliance requires us to state the following:

1. *This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

2. *OEM products incorporating EasyBee must include an external label containing the following text legible to the naked eye:*

   Contains Transmitter Module
   FCC ID:UGAZBMR10

3. *Changes or modifications to the module may void its certification.*

ZigBee Alliance Membership

FlexiPanel is an Adopter Member of the Zigbee Alliance. To use the Microchip Stack for ZigBee, either you must be a member of the Zigbee Alliance. Alternatively we as alliance members can program your firmware into the Pixies and sell you pre-programmed ZigBee devices for commercial use.

OUI number / MAC address

All IEEE 802.15.4 devices such as Pixie must use 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 can provide MAC addresses under its OUI license for the transceivers it manufactures. OEMs therefore do not need to apply for an OUI number. FlexiPanel Ltd's OUI number is 00-15-C8.

For R&D purposes (i.e. in the lab or classroom), the following MAC addresses may be used:

  00:15:C8:38:41:00:00:00 to 00:15:C8:38:41:00:FF:FF

(Remember that PICs are little-endian, so MAC[7] = 00, MAC[6] = 15, MAC[2] = C8, etc.) Volume customers may reserve a contiguous block of MAC addresses.

For commercial purposes, contact FlexiPanel Ltd or your distributor for an allocation of MAC addresses.

Preloading the MAC Address

All firmware from FlexiPanel Ltd permits the use of SQTP to automatically set MAC addresses when programming using Microchip Technology's PM3 programmer. The ROM locations 0x006A to 0x007B contain the following assembler code:

```
0x006A    RETLW    Macbyte0
0x006C    RETLW    Macbyte1
0x006E    RETLW    Macbyte2
0x0070    RETLW    Macbyte3
0x0072    RETLW    Macbyte4
0x0074    RETLW    Macbyte5
0x0076    RETLW    Macbyte6
0x0078    RETLW    Macbyte7
0x007A    RETLW    AddrValid
```

During initialization, the firmware checks to see whether the MAC address has been set. If it has not, and `AddrValid` is nonzero, it will set the MAC address to the values given in `Macbyte0` to `Macbyte7`. The firmware ships with `AddrValid` equal to zero, but it may be set during programming using SQTP.

SQTP is a feature of the PM3 programmer that allows you to generate a file of IDs, in this case MAC addresses, and allocated them uniquely during programming. To set up SQTP to allocate MAC addresses:

1. In MPLAB, ensure the PM3 programmer is selected.

2. From the Programmer menu, select *Settings…*

3. Fill in the SQTP tab as shown in the following graphic, except insert the start of your personal MAC allocation in the "Start Value" box, and the number of sequential MAC addresses to allocate in the "Number of parts" box. (Note the Start value is FF, specifying the `AddrValid` value, followed by the MAC address, most significant byte first.)
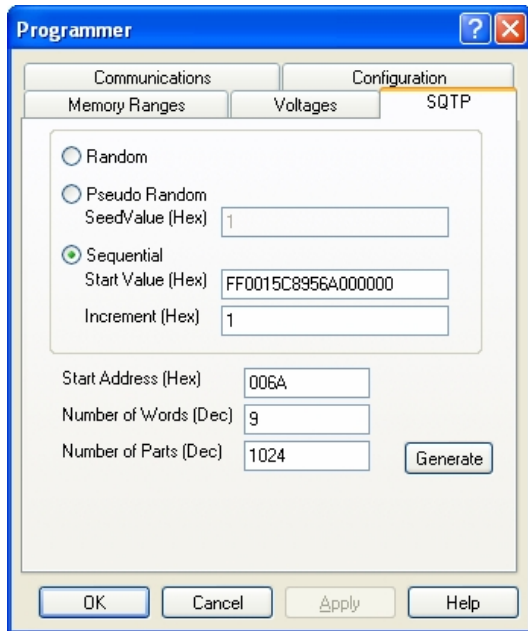
4. Press the generate button to create a file of MAC addresses. When the file is created, dismiss the Settings… dialog by pressing OK. The file that was created contains a hex record each MAC address containing nine RETLW instructions encoding the address.

5. .Each time programming session, select *Load SQTP file…* form the *Programmer* menu. In each programming cycle, MPLAB will read one hex record and inset the values into ROM locations 0x006A to 0x007B. It will then comment out the line so it is not used again. In this way the MAC addresses will be automatically allocated in sequence. NEVER maintain more than one copy of the SQTP file, otherwise you risk duplicating MAC addresses.

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. Its radiation pattern is approximately omnidirectional.

Free space range is approximately 120m. In-building ranges of 20m to 40m would normally be expected.

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	3
5mm potting compound	2 - 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.	

Mechanical

PCB Layout

For PCB pad layout, refer to the engineering drawing on page 10. 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.

Soldering

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.

The recommended reflow profile is shown in figure 8. Small increases in temperature (no larger than 15ºC) may be needed depending on the density of the main board. The module should be reflowed one time only.

Figure 8. Recommended reflow profile
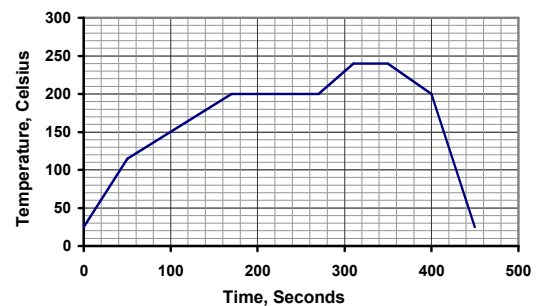
If soldering manually, use the following procedure:

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.

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 grounded fill 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. The main board should contain as much grounded copper fill as possible in order to reduce circuit noise.

Enclosures

Metal enclosures are not recommended for attenuation reasons. If one must be used, aim to put as many holes in it as possible at least 3cm long.

For mains isolation and intrinsic safety applications, potting in a shallow layer of clear potting compound is recommended. A 5mm layer of potting compound (RS Components p/n 199-1468) has been measured to attenuate the signal by approximately 3dB. LEDs can be clearly seen through the potting compound and bind switches, etc, can be implemented using reed switches.

For all-weather and external mounting applications, contact us for a range of puck antenna enclosures.

Pixie Lite

Pixie Lite is a reduced function device based on the 18LF2520 microprocessor. It has sufficient memory to implement end devices only.

Bear the following points in mind when developing applications with Pixie Lite:

- Pin connections RE1 and RE2 are not present and their pads should be omitted on the PCB layout.
- The firmware must be recompiled to suit an 18LF2520 target.
- Flash table writes are 32 bytes instead of 64 so the `WRITE_BLOCK_SIZE` value in `zNVM.c` must be set to `32ul`. (See Microchip DS80229B.)
- A single-bank stack model is recommended.
- ROM reduces from 64K to 32K.
- RAM reduces from 3986 bytes to 1536.

See Appendix I for a suitable linker script for the Microchip Stack for ZigBee running on the PIC18LF2520.

Future releases of Pixie & Pixie Lite

The following changes are anticipated in future revisions of Pixie and Pixie Lite.

- The 18LF2520 on the Pixie Lite may be replaced by an 18LF2620 if new features in the ZigBee stack, such as security, require the extra memory.

Bibliography

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

ZigBee Specification, downloadable from *www.zigbee.org*.

EasyBee 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*.
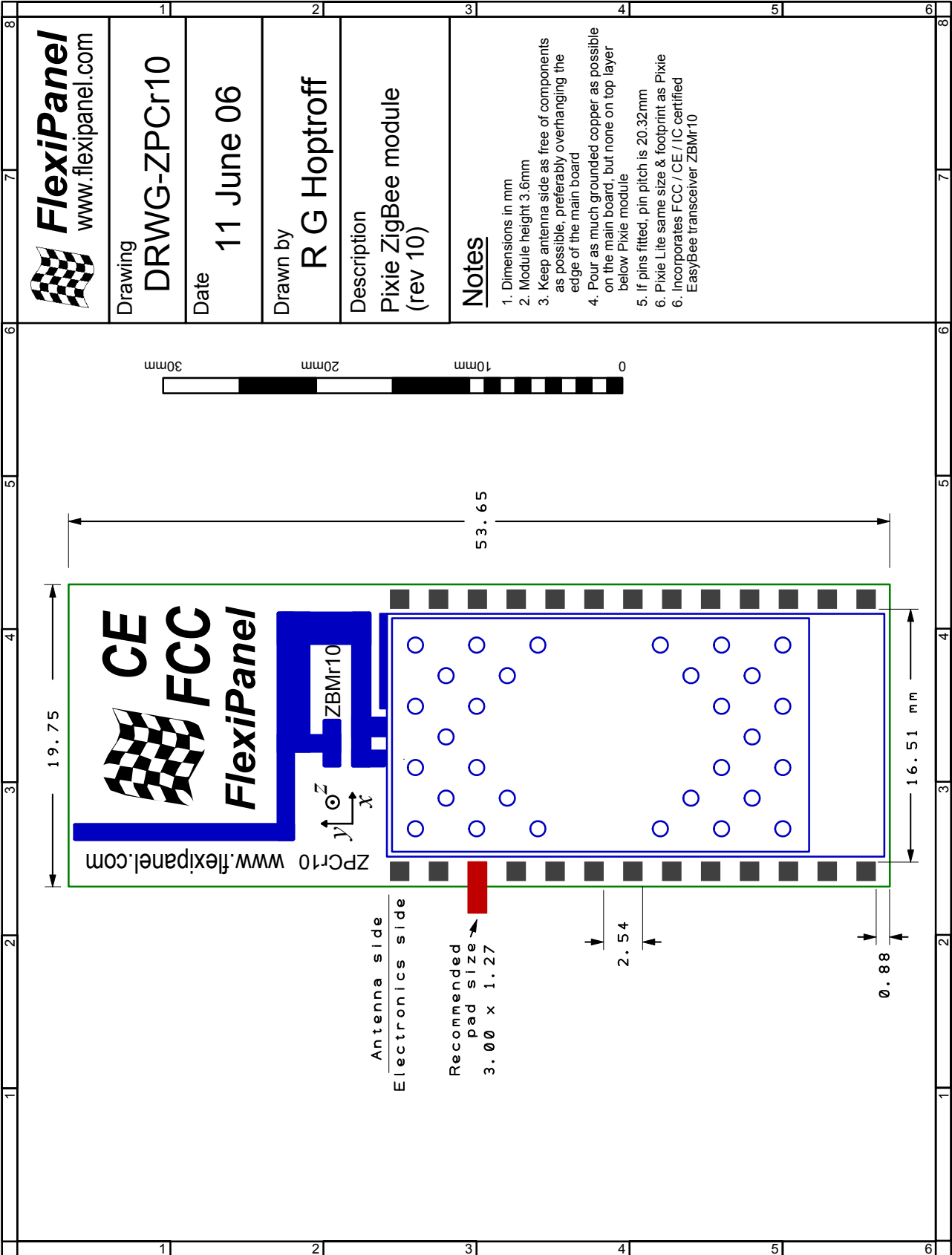
PIC18F4620 Data Sheet, downloadable from *www.microchip.com*.

PIC18F2520 Data Sheet, downloadable from *www.microchip.com*.

In-Circuit Serial Programming (ICSP) Guide, downloadable from *www.microchip.com*.

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

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

FlexiPanel
www.flexipanel.com

Drawing
DRWG-ZPCr10

Date 11 June 06

Drawn by
R G Hoptroff

Description
Pixie ZigBee module
(rev 10)

Notes

1. Dimensions in mm
2. Module height 3.6mm
3. Keep antenna side as free of components as possible, preferably overhanging the edge of the main board
4. Pour as much grounded copper as possible on the main board, but none on top layer below Pixie module
5. If pins fitted, pin pitch is 20.32mm
6. Pixie Lite same size & footprint as Pixie
6. Incorporates FCC / CE / IC certified EasyBee transceiver ZBMr10

30mm 20mm 10mm 0

53.65

19.75

16.51 mm

2.54

0.88

CE
FCC
FlexiPanel

ZBMr10

ZPCr10 www.flexipanel.com

Antenna side
Electronics side

Recommended
pad size
3.00 x 1.27

Appendix I

Linker script for 18F2520

The following linker script is used by the Pixie Switcher Lite firmware and serves as an example for migration of the Microchip Stack to the PIC18F2520. Note that a single bank stack (256 bytes) is used, and the heap size has been reduced to 512 bytes.

```
// File: zc2520i.lkr
// Sample ICD2 linker script for the PIC18F2520 processor

LIBPATH .

FILES c018i.o
FILES clib.lib
FILES p18f2520.lib

CODEPAGE   NAME=vectors   START=0x0        END=0x29        PROTECTED
CODEPAGE   NAME=page      START=0x2A       END=0x7D7F
CODEPAGE   NAME=debug     START=0x7D80     END=0x7FFF      PROTECTED
CODEPAGE   NAME=idlocs    START=0x200000   END=0x200007    PROTECTED
CODEPAGE   NAME=config    START=0x300000   END=0x30000D    PROTECTED
CODEPAGE   NAME=devid     START=0x3FFFFE   END=0x3FFFFF    PROTECTED

ACCESSBANK NAME=accessram START=0x0        END=0x7F
DATABANK   NAME=gpr0      START=0x80       END=0xFF

// Stack
DATABANK   NAME=gpr1      START=0x100      END=0x1FF

// Spare
DATABANK   NAME=gpr2      START=0x200      END=0x2FF

// Heap – set MAX_HEAP_SIZE to 512
DATABANK   NAME=gpr3      START=0x300      END=0x4FF       PROTECTED

// Spare
DATABANK   NAME=gpr5      START=0x500      END=0x5F3

DATABANK   NAME=dbgspr    START=0x5F4      END=0x5FF       PROTECTED
ACCESSBANK NAME=accesssfr START=0xF80      END=0xFFF       PROTECTED

SECTION    NAME=CONFIG    ROM=config

STACK SIZE=0x100 RAM=gpr1
```

Reference

Electrical

Supply Voltage (regulated) Vcc	2.1V to 3.6V
Supply Voltage (unregulated) Vunreg	2.4V to 20.0V, if regulator fitted
Current consumption, active	25mA
Current consumption, sleep mode	2µA

For more information electrical specifications, consult the PIC18LF4620 and PIC18LF2520 data sheets. (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

Mechanical

Max operating/storage temperature	−40ºC to +85 ºC
Dimensions L×W×H mm	53.7 × 19.75 x 3.1 (excluding DIL pins)

Regulatory

FCC compliance	Certified
CE compliance	Certified
FCC external labeling requirement	*"Contains Transmitter Module FCC ID:UGAZBMR10"*

FlexiPanel is an Adopter Member of the Zigbee Alliance. To use the Microchip Stack for ZigBee, either you must be a member of the Zigbee Alliance. Alternatively, we as Alliance members can program your firmware into the Pixies and sell you pre-programmed ZigBee devices for commercial use.

Manufacturer Contact Details

Pixie is assembled by agreement by RF Solutions Ltd:

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www.rfsolutions.co.uk
Tel: +44 (0)1273 898 000, Fax: +44 (0)1273 480 661
email: sales@rfsolutions.co.uk

Developer Contact Details

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