Pixie DARC™

Data Acquisition and Remote Control Sensor Module for ZigBee Mailbox

Summary

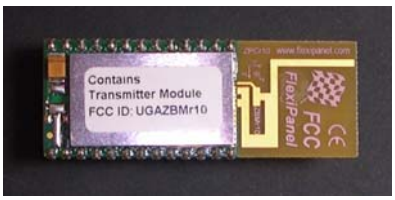
Pixie DARC is a data acquisition and remote control sensor device for ZigBee networks. It is compatible with all products using the MailBox ZigBee profile.

Pixie DARCs provide digital and analog I/O under the control of remote devices, so no device programming is required to configure them. The *sleepy end device* version spends most of its time asleep and can thus be used in battery powered applications.

Pixie DARC may not provide all the functionality required in a particular sensor device. However, the source code is available to allow the firmware to be customized by OEMs. It is based on the MailBox API, a very simple ZigBee application programming interface

Firmware Features:

- *Incorporates ZigBee stack and MailBox profile.*
- *Bind input to permit joining and erasing network data.*
- *Status output to indicate connection and permit join status.*
- *Pixie coordinator & routers feature:*
  - *Up to 12 digital inputs*
  - *Up to 12 digital outputs*
  - *Up to 7 digital 10-bit analog inputs*
- *Pixie end devices feature:*
  - *Up to 9 digital inputs*
  - *Up to 9 digital outputs*
  - *Up to 4 digital 10-bit analog inputs*



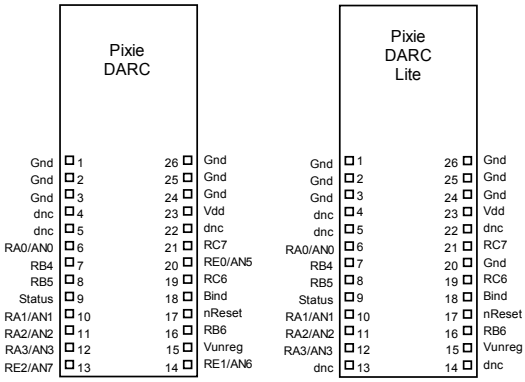


Fig 1. Pixie DARC
(viewed from above)

Hardware Features:

- *2.4GHz IEEE 802.15.4 RF module*
- *FCC / CE / IC compliant*
- *Signature 'G' antenna, free-space range 120m, compact, low 'hand-effect' design*
- *56mm x 20mm x 9mm*

Compatible Products

- *Pixie Gateway*
- *UZBee Gateway (when available)*
- *MailBox API*

Ordering Information

Table 1. Ordering information	
Part No	***Description***
PIXIE-yy-PxDC	Pixie DARC (coordinator)
PIXIE-yy -PxDR	Pixie DARC (router)
PIXLITE-yy -LxDF	Pixie DARC (fast end device)
PIXLITE -yy -LxDS	Pixie DARC (sleepy end device)
x indicates stack profile supported: H = Home Controls *yy* indicates package: DIL = Dual-in-line through hole SO = Surface mount	

Manufactured to ISO9001:2000

Pin Connections

Pin Number		Pin Name	Description
Coordinator, Router	End Devices		
1,2,3	1,2,3,20	*Gnd*	Power supply ground reference and ground plane connection
4	4	*dnc*	Do not connect
5	5	*dnc*	Do not connect
6	6	*RA0/AN0*	PIC digital I/O RA0 / analog input AN0
7	7	*RB4*	PIC digital I/O RB4
8	8	*RB5*	PIC digital I/O RB5 / interrupt input KBI1
9	9	*Status*	Status indication. High when initializing and permitting joining. Low when connected to a network and operating normally (note 2)
10	10	*RA1/AN1*	PIC digital I/O RA1 / analog input AN1
11	11	*RA2/AN2*	PIC digital I/O RA2 / analog input AN2
12	12	*RA3/AN3*	PIC digital I/O RA3 / analog input AN3
13		*RE2/AN7*	PIC digital I/O RE2 / analog input AN7
14		*RE1/AN6*	PIC digital I/O RE1 / analog input AN6
	13	*dnc*	Do not connect
	14	*dnc*	Do not connect
15	15	*Vunreg*	Unregulated voltage input (note 1)
16	16	*RB6*	PIC digital I/O RB6
17	17	*nReset*	Reset input, active low
18	18	*Bind*	Erase / permit join. Normally pulled high. Hold low during reset to erase all existing network data. Pulse low to permit devices to join this device (router, coordinator only).
19	19	*RC6*	PIC digital I/O RC6 / configuration TxD output
20		*RE0/AN5*	PIC digital I/O RE0 / analog input AN5
21	21	*RC7*	PIC digital I/O RC7 / configuration RxD input
22	22	*dnc*	Do not connect
23	23	*Vdd*	Regulated power supply input Regulated power supply output (note 1)
24,25,26	24,25,26	*Gnd*	Power supply ground reference and ground plane connection

Table 1. Pin descriptions for Pixie DARC & Pixie DARC Lite

1. Requires optional voltage regulator option to be fitted for onboard regulation to be functional.
2. In future devices, this pin may become a Vddcore power supply pin. Refer to the *Future releases of Pixie & Pixie Lite* section of this data sheet and the documentation for 18F46L10 and 18F45L10 series devices from Microchip Technology (www.microchip.com). In this event, the Status output may be moved or omitted.

Overview

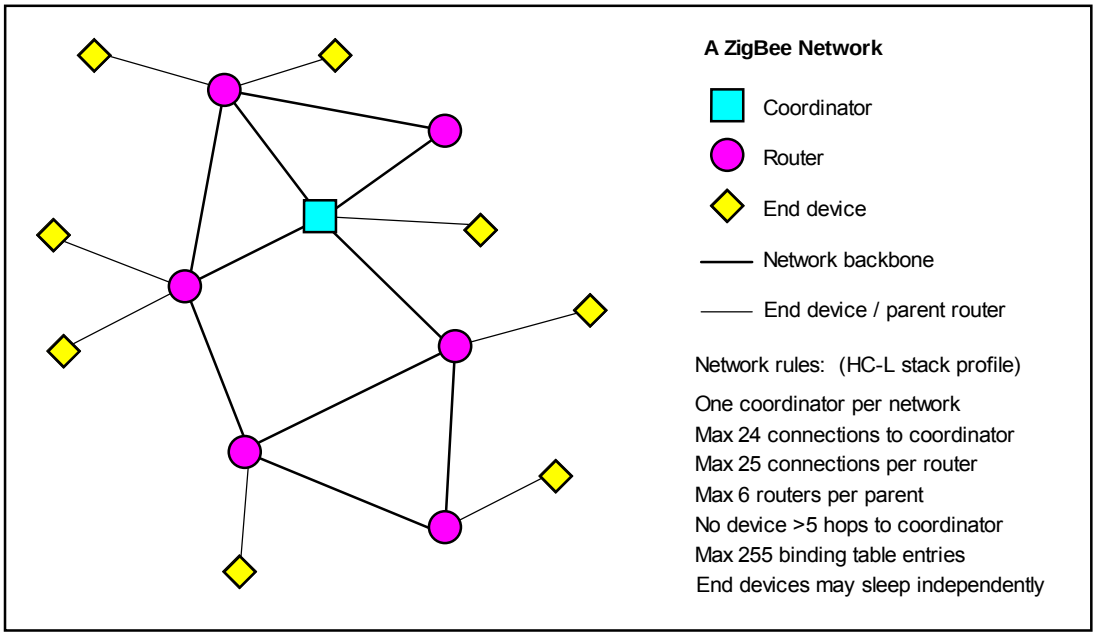
Pixie DARC is a ZigBee sensor / remote controller. It can accept commands from other ZigBee devices to set digital outputs, and read analog / digital inputs, and report the result to the requesting ZigBee node. Typically, the device that sends the Pixie DARC messages will be a MailBox Gateway device. Any number of Gateways and DARCs can exist on a network.

Several device types are employed in a ZigBee network. The *coordinator* is the device which dictates network-wide rules such as operating frequency. There must be one coordinator in a network and it is the first member of the network. The network is then built by joining new devices on to existing devices in the network.

Routers are devices which can forward messages on behalf of other devices. They form the basis of the multi-hop messaging system.

End devices cannot route messages on behalf of other devices, and they cannot have admit new devices into the network. *Fast end devices* keep their radios on all the time. *Sleepy end devices* spend most of their time asleep; when they wake, they must check with their parent router to see if there are any messages waiting for them.

With any ZigBee network, there are rules about how many child devices a router may have, how far a device may be from the coordinator, etc. These rules are referred to collectively as the stack profile. Devices with different stack profiles are not compatible. Since Pixie DARC is intended to piggyback on any ZigBee network, it can be made available in any stack profile implementation. The default implementation is the Home Controls profile, whose rules are indicated in the figure below.



Electrical Setup

2.1V – 3.6V power should be connected to Vdd. Analog voltage readings will be relative to Vdd, so the supply should be regulated for accurate analog readings. (This limitation may be removed through custom programming.)

The Status pin indicates the state of Pixie DARC. It is recommended that it is connected to an LED so that the LED lights when the output is high. The Bind input controls the operation of the Pixie DARC. It is recommended that it is connected to a pushbutton so that input is low when the pushbutton is pressed.

Copy Protection

To protect against copying, if the Pixie DARC firmware is run on any hardware except FlexiPanel Pixie and Pixie Lite products, it will cease to function after approximately two minutes. Steinlaus tags are also included in the code.

Evaluation Kit

The easiest way to get to know Pixie DARC is with the ZigBee Evaluation Kit available from FlexiPanel. This will also require a Microchip ICD2 In-Circuit Debugger to program the firmware into the Pixies supplied.

In the evaluation boards, the I/O pins are connected as follows:

Pin Number		***Pin Name***	***Description***
Coordinator, Router	***End Device***		
6	6	*RA0/AN0*	LED labeled “A4 / EP4”
7	7	*RB4*	Switch labeled “EP2 A2”
8	8	*RB5*	Push switch labeled “A1 / EP1”
9	9	*Status*	LED labeled “Status”
10	10	*RA1/AN1*	LED labeled “A5 / EP5 / RTS”
11	11	*RA2/AN2*	Preset pot (for analog readings) *Ensure jumper A8 – B8 is fitted.*
12	12	*RA3/AN3*	Switch labeled “ModeA”
13		*RE2/AN7*	Switch labeled “ModeB”
14		*RE1/AN6*	Push switch labeled “A8 / EP6”
16	16	*RB6*	Push switch labeled “A3 / EP3”
18	18	*Bind*	Push switch labeled “Bind”
19	19	*RC6*	Serial output / TxD led
20		*RE0/AN5*	LED labeled “A7 / EP7”
21	21	*RC7*	Serial input

Setting a MAC address

If you program the Pixie DARC firmware into a Pixie module, you will need to set its MAC address. To do this, set up a HyperTerminal session (19200 baud, 8N1, no flow control) to communicate with the module over the TxD and RxD serial pins. This is easiest to do using the Evaluation board. The first time the firmware is run, it will output “MAC->” to HyperTerminal. It is prompting you for a 16-hex-digit Mac address. Enter the unique MAC address allocated to the Pixie and you will see the prompt “OK”, indicating that the MAC address was set. You can then reset and continue as normal.

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

0015C83841000000 to 0015C8384100FFFF

For commercial purposes, contact FlexiPanel or your distributor for an allocation of MAC addresses. Note that bulk allocated MAC addresses may be automatically programmed using the SQTP feature of the Microchip Technology PM3 programmer. Refer to the Pixie data sheet for details.

Joining a Network

If the Pixie DARC has not yet joined a network, it will attempt to do so as soon as it is switched on. A router or coordinator within range must be in the "permit join" state. The Status LED will extinguish when it is successful and it will broadcast a "Present" mailbox message to all devices on the network.

If the Pixie DARC has already joined a network, each time it is powered up it will attempt to reconnect. The Status LED will extinguish when it is successful and it will broadcast a "Present" mailbox message to all devices on the network. To erase old network information and join a new network, power up with the Bind button pressed down.

If the Pixie DARC is a router or coordinator, it may admit other devices into the network. To do so, it must be placed in the "Permit Join" state by pressing the Bind button. The LED will light and the device will stay in this state until a device joins or it is reset.

Normal Operation

In normal operation, the Pixie DARC will wait to be sent commands and will respond to them. If it is a sleepy end device, it will sleep for approximately one second, check for messages, then sleep again. Sleepy end devices are slow to respond but operate at low power.

If an error occurs, the device will reset and attempt to rejoin.

Commands

There are five command / response pairs. Several refer to the I/O pins using the ID values in the table below (where 0x indicates a hexadecimal value). A different ID value is used to refer to pins when they are used as analog input than when they are used as digital inputs. Note AN4 is not accessible.

Pin Name	*Pin ID value*
RA0	0x00
RA1	0x01
RA2	0x02
RA3	0x03
RB4	0x14
RB5	0x15
RB6	0x16
RC6	0x26
RC7	0x27
RE0	0x40
RE1	0x41
RE2	0x42
AN0	0x80
AN1	0x81

AN2	0x82
AN3	0x83
AN5	0xC5
AN6	0xC6
AN7	0xC7

A response from Pixie DARC will be received in response to every command. The first byte will always be a response status code, as follows:

Response	***Response Code***
Command processed successfully	0x00
Command not understood	0x01
Pin ID value not valid	0x02
Command argument not valid	0x03

Set I/O Val

Set I/O Val instructs the Pixie DARC to set a pin as a digital output and set the value either high or low. The MailBox message consists of three bytes. The first byte is *0x01*, signifying the *Set I/O Val* command. The second is the Pin ID Value. The third is 0x00 for output logic low, or 0x01 for output logic high. A response will always be issued consisting of one byte which will be the Response Code.

Example (in hexadecimal notation):

01 01 01	(set RA1 as high)
00	*(confirmation – command completed OK)*

Get I/O Val

Get I/O Val instructs the Pixie DARC to read a pin as a digital input and report the result. The MailBox message consists of two bytes. The first byte is *0x02*, signifying the *Get I/O Val* command. The second is the Pin ID Value.

A response will always be issued. The first byte will be the Response Code. If the Response Code indicates that the command completed successfully, the second byte will be 0x00 if the input was logic low, or 0x01 if it was logic high.

Example (in hexadecimal notation):

02 14	(read RB4)
00 01	*(confirmation – command completed OK, value was high)*

Get Analog Val

Get Analog Val instructs the Pixie DARC to read a pin as a 10-bit analog input and report the result. The MailBox message consists of two bytes. The first byte is *0x03*, signifying the *Get Analog Val* command. The second is the Pin ID Value.

A response will always be issued. The first byte will be the Response Code. If the Response Code indicates that the command completed successfully, the second byte will be the least significant byte of the result; the third will be the most significant byte. The value quoted will vary linearly in the range 0x0000 (Vss) to 0x03FF (Vdd).

Example (in hexadecimal notation):

03 02	(read AN2)
00 E8 01	*(confirmation – command completed OK, value was 0x01E8)*

Set Analog Channels

Switching between analog and digital inputs is not automatic. A number of analog *x* channels must be specified; the channels allocated will be AN0 – AN*(x-1)* and these pins will not be available as digital I/O. The MailBox message consists of two bytes. The first byte is *0x04*, signifying the *Set Analog Channels* command. The second specifies *x*. A response will always be issued consisting of one byte which will be the Response Code.

Example (in hexadecimal notation):

04 02	(set AN0 and AN1 as analog inputs, the rest are digital I/O)
00	*(confirmation – command completed OK)*

Stream Data

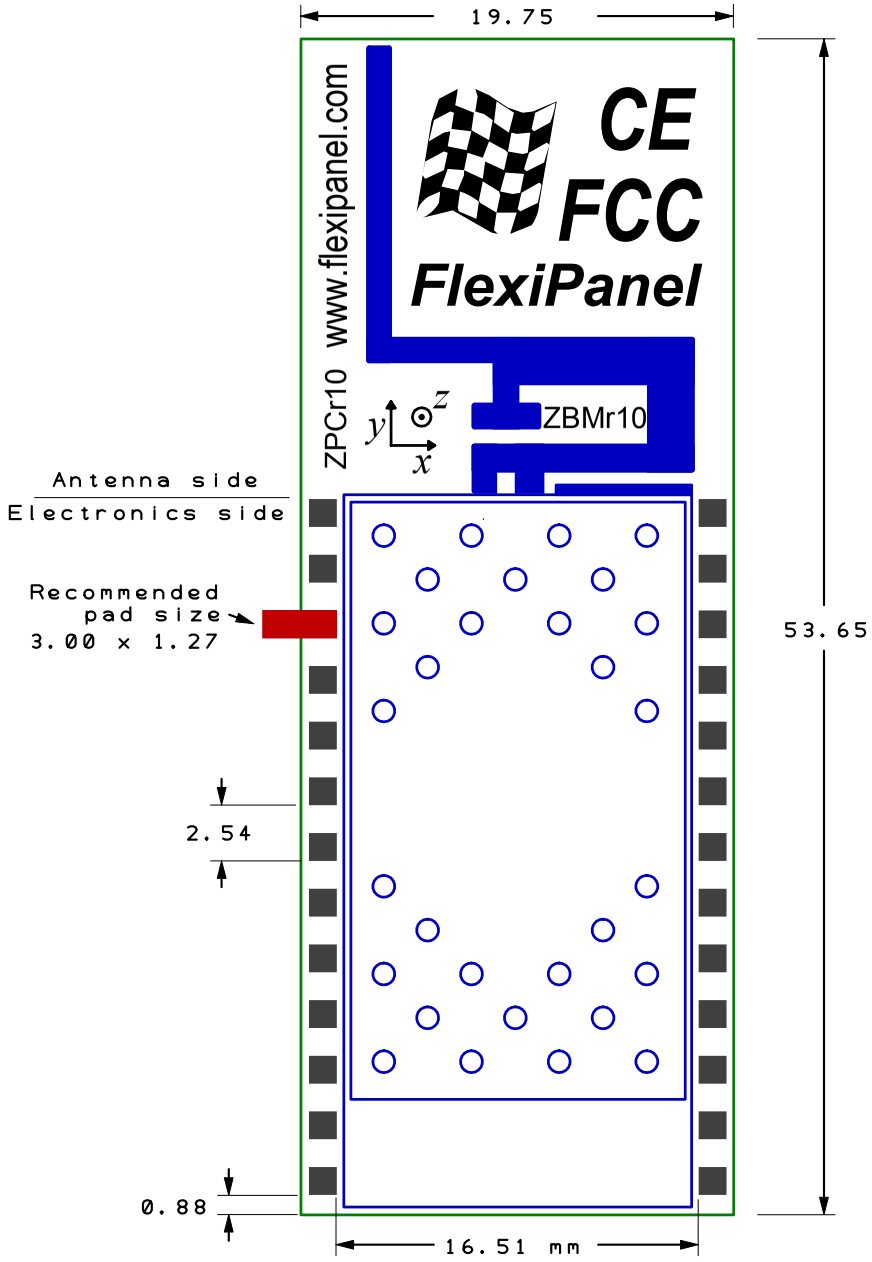
The Pixie DARC can report a digital or analog reading at regular intervals using the Stream Data command. The interval is expressed in units of the wakeup period (approx 1 second) for sleepy devices, or approximate seconds for other devices. (To specify no streaming, send a zero interval value.) The MailBox message consists of three bytes. The first byte is *0x05*, signifying the *Stream Data* command. The second interval value. The third is the Pin ID Value. Responses will be at regular intervals using the same format as the *Get I/O Val* or *Get Analog Val* responses, as applicable.

Example (in hexadecimal notation):

05 02 82	(transmit the value of AN2 every 2 seconds, approx)
00 E8 01	*(example response value was 0x01E8)*
05 00 82	(stop streaming)

Customization

Pixie DARC source code is freely available for customization. Please refer to the MailBox API data sheet & development kit 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

Reference

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

Electrical

Current consumption, excluding I/O pins	≤30mA
Current consumption, sleep mode	2µA
Maximum current draw on any I/O pin	25mA
Maximum current draw total	200mA
Supply Voltage (regulated) Vcc	2.1V to 3.6V

Mechanical

Max operating/storage temperature	-40ºC to +85 ºC
Dimensions L×W×H mm	55.7 × 20.3 x 10.5 (note 1)

Regulatory

FCC compliance	G-antenna version compliant, awaiting certificate
CE compliance	G-antenna version compliant, awaiting certificate
IC (Industry Canada) compliance	G-antenna version compliant, awaiting certificate

Contact Information

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