



Summary

StarLite provides a transparent serial interface for the IEEE 802.15.4 standard for low data-rate networks. It is ideal for OEMs who need to add command-free single-hop wireless serial communications to their products. It incorporates an FCC / CE certified IEEE 802.15.4 transceiver.

StarLite permits point-to-point, star, broadcast and addressed communications architectures. The PixieMAC firmware (refer to separate documentation) provides a more flexible command-oriented interface for more demanding applications.

StarLite may be used freely with FlexiPanel Pixie and UZBee+ products. Additionally, in quantities of 2500 or more, it may be purchased as design licenses for integration directly on your main PCB.

Firmware Features:

- Communications modes supported:
 - Point-to-point
 - Star
 - Broadcast
 - Addressed
- One coordinator can support up to 255 end devices
- Low latency fast end devices
- Sleepy USB end devices can be intermittently present
- Practical over-the-air data rate 19200 baud approx
- Coordinator packet cache of up to 32 messages of up to 64 bytes each

Compatible Products

- Fully compatible with other IEEE 802.15.4 products, including:
 - MACdongle
 - PixieMAC
 - StarLite USB
- FlexiPanel's ZigBee Demo Board may be used for evaluation

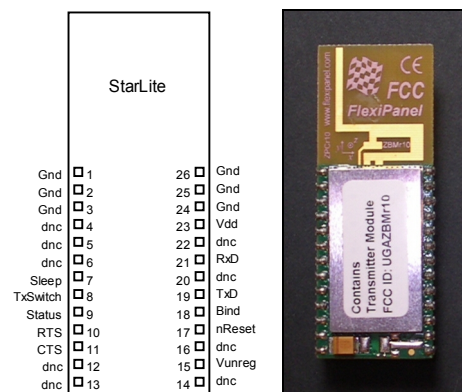


Fig 1. StarLite
(viewed from above)

Hardware Features:

- Coordinator based on FlexiPanel Pixie 2.4GHz IEEE 802.15.4 RF module, or UZBee+ USB adapter
- End devices based on FlexiPanel Pixie or Pixie Lite 2.4GHz IEEE 802.15.4 RF modules, or UZBee+ USB adapter
- Additionally available as design licenses for volume purchasers
- FCC / CE / IC compliant
- Signature 'G' antenna, free-space range 120m, compact, low 'hand-effect' design
- 9600-115200 baud serial interface with flow control
- Bind control input
- Status indicator output
- Sleep control input
- RS485 Tx Switch output
- 54mm x 20mm x 3mm

Firmware Codes

Table 1. Firmware Codes	
Part No	Description
PIXIE-SLLC	StarLite (coordinator)
PIXIE-SLLF	StarLite (fast end device)
PIXIE-SLLS	StarLite (sleepy end device)

Manufactured to ISO9001:2000



Pin Connections

Pin Number	Pin Name	Description
1,2,3	<i>Gnd</i>	Power supply ground
4	<i>dnc</i>	Do not connect
5	<i>dnc</i>	Do not connect
6	<i>dnc</i>	Do not connect
7	<i>Sleep</i>	Sleep control; sleeps when high
8	<i>TxSwitch</i>	Transmit control; high while TxD is active
9	<i>dnc</i>	Status indicator
10	<i>RTS</i>	Flow control output / device ready indicator. Data may be sent to the RxD pin if RTS is low.
11	<i>CTS</i>	Flow control input (note 3). To suspend data transmission on the TxD pin, set CTS high.
12	<i>dnc</i>	Do not connect
13	<i>dnc</i>	Do not connect
14	<i>dnc</i>	Do not connect
15	<i>Vunreg</i>	Unregulated voltage input (note 2)
16	<i>dnc</i>	(note 1)
17	<i>nReset</i>	Reset input (active low) (note 1)
18	<i>Bind</i>	Bind control input, active low
19	<i>TxD</i>	Serial data output (8N1, 9600 – 115200 baud)
20	<i>dnc</i>	Do not connect
21	<i>RxD</i>	Serial data input (8N1, 9600 – 115200 baud)
22	<i>dnc</i>	Do not connect
23	<i>Vdd</i>	Regulated power supply input Regulated power supply output (note 2)
24,25,26	<i>Gnd</i>	Power supply ground

Table 1. Pin descriptions for StarLite

1. Should be pulled high via a 10K resistor for normal operation.
2. Requires optional voltage regulator option to be fitted for onboard regulation to be functional.
3. Connect low if flow control is not required

StarLite Description

For a broad introduction to the different types of RF modules and firmware available from FlexiPanel, refer to *DS500, RF Transceiver Selection Guide*.

Device Programming

Pixie products are available from distributors pre-loaded with StarLite firmware. Alternatively it may be loaded onto any Pixie module using a PIC programmer such as the low-cost TEAclipper. The firmware may be downloaded from www.hexwax.com.

Design Licensing

Design licensing allows you to integrate the Pixie design directly on your main PCB rather than as a separate module. This delivers exceptional cost savings in terms of labor and parts, and offers you much greater control over the supply chain.

We require an up-front purchase of a minimum quantity of 2500 encrypted *StarLite.wax* firmware licenses, and signature of a confidentiality agreement. In return we will give you a pack containing Gerber CAD files and bills of materials. Only the encrypted version of the firmware is compatible with the design supplied.

Contact support@flexipanel.com for more information.

Device Types

There are five types of StarLite device, each with different firmware. The device types are:

- SLPC:** StarLite Coordinator, creates an IEEE 802.15.4 network
- SLPF:** StarLite Fast End Device, participates in an IEEE 802.15.4 network, cannot sleep, fast response
- SLPS:** StarLite End Device, participates in an IEEE 802.15.4 network, can sleep, lower responsiveness, cannot receive broadcast communications while asleep
- SLLF:** StarLite Fast End Device, (Pixie Lite version)
- SLLS:** StarLite End Device, (Pixie Lite version)

In a StarLite network there is one coordinator and up to 255 end devices.

Interoperability

StarLite and StarLite USB have been tested to ascertain they can interoperate with each other. Other IEEE 802.15.4 devices should be interoperable; however, device-specific issues may need to be resolved with the technical support services of FlexiPanel and other product providers.

Frequency Channels

StarLite operates in the 2.4GHz frequency band. The coordinator will select one of sixteen channels during initialization; end devices will scan and find it automatically. Multiple StarLite networks can coexist without interfering each other. Interference from other 2.4GHz devices (ZigBee, Bluetooth, WiFi, etc) is negligible.

Electrical Setup

The StarLite description assumes that the Status output is connected to an active high LED, the Bind input is connected to an active low pushbutton, and RxD / TxD / RTS / CTS are connected to a device capable of serial communication. Unless otherwise configured, the baud rate will be set to 9600 baud. The TxSwitch output can be used to control the nRE and DE inputs of RS485 line drivers such as Texas Instruments SN65HVD3082ED.

Each StarLite must have a unique MAC address. If supplied pre-programmed, the StarLite should be pre-loaded with a unique address. If you programmed the firmware yourself, the device will automatically enter the device configuration mode on power-up (indicated by rapid flashing of the LED) and you will need to set a valid MAC address before using StarLite. (Refer to the device configuration section below.)

Binding

When first powered up, end devices are orphans. They need to be adopted by a parent coordinator before they can be used. This process is known as binding. Once bound, end devices will automatically locate their parent on initialization. A coordinator may have up to 255 children.

To start a network, first power-up the coordinator. Its Status LED will light while it selects a frequency channel. After a few seconds it will extinguish, indicating that it has initialized.

To bind an orphan end device, press the Bind button on the coordinator. The Status LED will light indicating that it will accept an orphan device. Power-up the orphan end device. Its Status LED will light while it locates the coordinator and binds to it. When binding is complete, both LEDs will extinguish. If it fails to bind, it will reset and retry, unless the Device Configuration or the state of the sleep pin dictates otherwise.

To re-initialize an end device as an orphan, or to erase a coordinator's list of children, enter the device configuration mode by holding the Bind button down for five seconds. (Refer to the *Device Configuration* section below.)

Normal Operation

When the coordinator is powered-up, its Status LED will light while it selects a frequency channel. After a few seconds it will extinguish, indicating that it has initialized. In addition, the RTS line will go low only when initialization is complete.

Once bound, when an end device is powered-up, its Status LED will light while it tries to find its parent. If it succeeds, the Status LED will extinguish and the RTS line will go low. In addition, the status indicator on the coordinator will go high for approximately a quarter of a second. If it fails to connect, it will continue to retry, or sleep according to the *SleepOnFail* device configuration setting.

Once reconnection is complete, serial data input to the RxD pin will be output from the TxD pin on the destination device(s). Data rates from 9600 baud to 115200 baud are possible. (Refer to the *Device Configuration* section below.) Flow control is implemented, so if flow control is not desired, ensure CTS is connected low. The flow control signals are locally generated; they do not reflect the flow control signal levels on other devices. Serial bytes are 8-bit, no parity, one stop bit.

The IEEE 802.15.4 communications protocol is packet-based, so the serial data is divided into packets. StarLite packets contain up to 64 bytes of data. A packet is transmitted whenever a total of 64 bytes is received or if there is a gap of more than *ReleaseTime* between serial data bytes. In Addressed mode, the first two bytes after a *ReleaseTime* delay are interpreted as an address and all further data will be sent to that address until a further gap in transmission of at least *ReleaseTime*. (Refer to the *ReleaseTime* in the device configuration section, and the *Addressing* section below.)

If data is received on the RxD pin but transmission to the remote device is not successful, the status indicator on the packet transmitting device will go high for approximately a quarter of a second.

Flow control does not account for the possibility that so many data packets are received that they cannot be buffered and output on the TxD pin. If this condition occurs, the status indicator on the packet receiving device will go high for approximately a quarter of a second. To avoid this possibility, it is recommended that the 115200 baud rate is used, since this is well above the over-the-air data transfer rate. (For watertight flow control, the PixieCOM firmware must be used.)

Addressing

Devices are configured to communicate in Broadcast, Star or Addressed Packet modes.

If a device is operating in Broadcast mode, all data input to it is sent to all StarLite devices in the network. Broadcast transmissions are not acknowledged and are only transmitted once. Sleepy devices cannot receive broadcast transmissions while sleeping.

If an end device is operating in Star mode, all data input to it are sent to the coordinator only. If the coordinator is operating in Star mode, all data are sent to the last end device to transmit to it (or the first device to connect, if no device has transmitted data to the coordinator yet).

If a device is operating in Addressed mode, the first two bytes in a *ReleaseTime*-delineated data packet are interpreted as an IEEE 802.15.4 short address rather than data, *i.e.*:

First byte	Second byte	Destination
0x00	0x00	Coordinator
0x00	0x01	1 st device to be bound
0x01	0x01	2 nd device to be bound
<i>n</i>	0x01	<i>n</i> th device to be bound
0xFF	0xFF	Broadcast

Non-broadcast transmissions are acknowledged. If transmission fails, three further attempts will be made to transmit the data. If all four attempts fail, the data is discarded and the Status LED will light for approximately one second.

It is permissible to mix and match device modes, for example having the end devices operating in star mode and the coordinator operating in broadcast mode. For point-to-point communications, use a coordinator and an end device in star mode; broadcast mode is less desirable because it is not acknowledged.

Sleep Management

The SLLS version is allowed to sleep. It goes into sleep mode when the sleep pin goes high; during sleep, the RTS pin will output high.

If the coordinator is operating in Star mode, it can cache some data for sleeping devices. While awake, sleepy devices poll the coordinator to see if it has data. A high *PollRate* provides lower latency but requires higher power. Data in the cache will be discarded if it is not polled for within a duration of *PersistenceTime*. (Refer to the *PollRate* and *PersistenceTime* in the device configuration section.)

Device Configuration

In the device configuration mode, various non-volatile settings may be selected. To enter the Device Configuration mode, press and hold the Bind button for 5 seconds until the LED begins to flash rapidly. An '>' ASCII character will be output from TxD at 9600 baud.

Entering device configuration mode will also erase network information. If the device is a coordinator, it will erase its list of children; if it is an end device, it will mark itself as an orphan, ready to join a new network.

Once in the Device Configuration mode, configuration data is sent at 9600 baud to the RxD pin. Flow control is ignored. 27 characters should be sent, and they are interpreted as follows:

Byte(s)	Setting	Description
1-4	<i>Key</i>	Must be 0x23, 0x47, 0x5E, 0x3D (i.e. ASCII "#G^9"). If it is not, device configuration is aborted
5	<i>Erase Lock</i>	0x55 ('U') if network information should be in future erased immediately entering configuration mode* 0x4C ('L') if network information should be in future erased only if <i>Key</i> is correctly input
6	<i>Addressing</i>	0x42 ('B') for Broadcast mode* 0x53 ('S') for Star mode 0x41 ('A') for Addressed mode
7	<i>Baud rate</i>	0x39 ('9') for 9600 baud* 0x32 ('2') for 19200 baud 0x33 ('3') for 38400 baud 0x35 ('5') for 57600 baud 0x31 ('1') for 115200 baud (Note: device configuration is always 9600 baud)
8	<i>PollRate</i>	0x31 ('1') for 250ms poll rate 0x32 ('2') for 500ms poll rate 0x33 ('3') for 1s poll rate* 0x34 ('4') for 2s poll rate 0x35 ('5') for 5s poll rate 0x36 ('6') for 15s poll rate 0x37 ('7') for 60s poll rate
9	<i>PersistTime</i>	0x31 ('1') for 1s persist time 0x32 ('2') for 10s persist time 0x33 ('3') for 60s persist time* 0x34 ('4') for 1hr persist time
10	<i>ReleaseTime</i>	0x31 ('1') for 1ms release time 0x32 ('2') for 3ms release time 0x33 ('3') for 10ms release time* 0x34 ('4') for 30ms release time 0x35 ('5') for 100ms release time
11	<i>TaskOnFail</i>	0x43 ('C') carry on regardless if network error occurs 0x52 ('R') reset if network error occurs* 0x53 ('S') sleep if network error occurs & reset if woken up
12-27	<i>MAC address</i>	MAC address as 16 hex digits 0-F. Ignored if address already valid.
* = default value		

Other than for erasing network settings, all 27 characters must be sent for the settings to take effect. Letter characters must be in upper case. Once completed, an '<' ASCII character will be output on from TxD and the device will reset.

The following example ASCII string sets the values back to the default, plus sets the MAC address to 0015C83841000000:

#G^9UB9333R0015C83841000000

IEEE 802.15.4 Compatibility

StarLite is fully compatible with other IEEE 802.15.4 devices provided no data payloads are greater than 64 bytes. This limitation is imposed because USB payloads are 64 bytes and applying the limitation allows for one-to-one correspondence between IEEE 802.15.4 packets and USB packets. To increase the payload size to the maximum possible (approx 115 bytes), the source code should be modified or PixieMAC should be used.

Security

Security is not implemented in this version of StarLite.

Copy Protection

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

Evaluation

The easiest way to get to know StarLite 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 Pixie / Pixie Lite supplied.

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

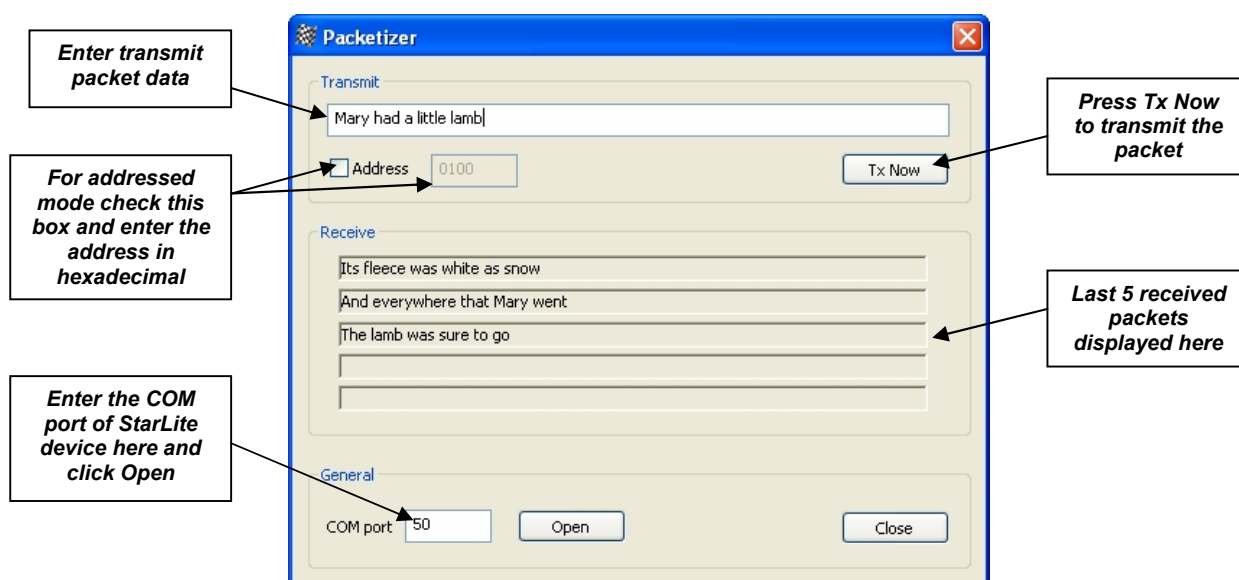
Pin Number	Pin Name	Description
7	<i>Sleep</i>	Switch labeled "EP2 A2"
9	<i>Status</i>	LED labeled "Status"
10	<i>RTS</i>	LED labeled "A4 / EP5 / RTS"
11	<i>CTS</i>	Switch labeled "Config SW" <i>Ensure jumper A8 – A9 is fitted.</i>
17	<i>nReset</i>	Reset push switch
18	<i>Bind</i>	Pushbutton labeled "Bind"
19	<i>TxD</i>	Serial data output
21	<i>RxD</i>	Serial data input

Please note the following:

1. Remove A1-B1, A2-B2, A3-B3 during programming and fit them again after. The configuration bits are specified in the file "FCS StarLite". The coordinator should be programmed onto a Pixie and end devices onto Pixie Lites.

2. For RS232 connection, fit jumper A4-B4. For Pixie Config Tool connection, remove the jumper. (Applies to ZEVr4 and higher board revisions.)
3. Fit jumpers A5-B5, A6-B6, A10-B10.
4. Fit jumper A8-A9. This connects the CTS input to the switch labeled “Config SW” so you can simulate flow control being halted by the host device. *In normal operation, it must be in the low position or you will not get a response from the StarLite!*
5. The sleep input connects to the switch labeled “EP2”. Normally this should be in the low position. If you put it in the high position, Pixie will enter its sleep mode. This will be indicated by the RTS line going high and the RTS led lighting. (Applies to SLLS firmware only; the others can’t sleep.)
6. The Status output connects to the LED marked “Status”.
7. The Bind input connects to the Pushbutton marked “Bind”.

For evaluation purposes, the Packetizer application in the developer’s kit may be used to type in up to 64 bytes of data and transmit it as an unbroken stream. It also allows addressed-mode addresses to be entered in hexadecimal. Data is transmitted at 9600 baud.

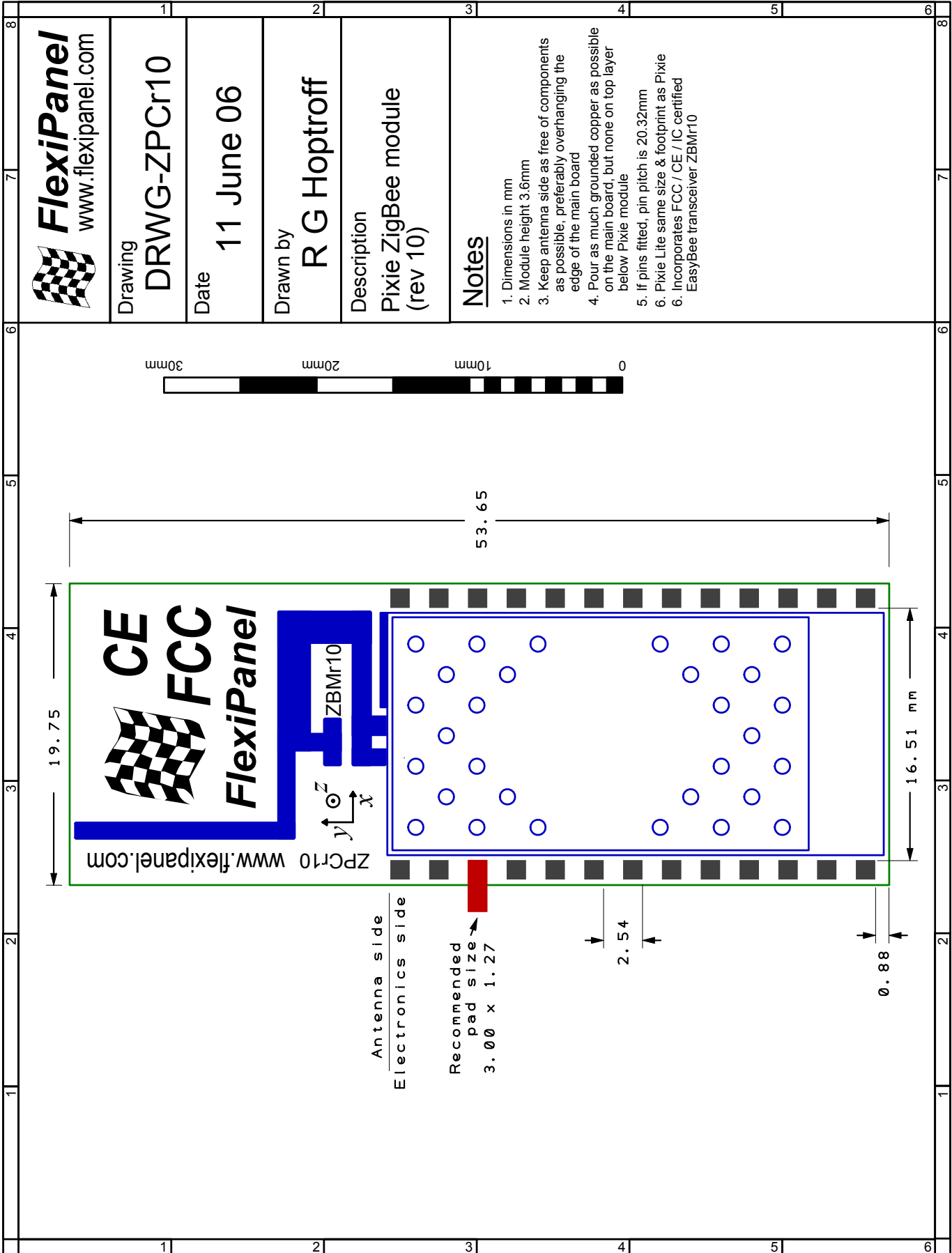


The FlexiPanel Sniffer is a free application which may be used to detect IEEE 802.15.4 packets.

Bibliography

IEEE 802.15.4 specification, downloadable from www.ieee.org.

DS500, RF Transceiver Selection Guide downloadable from www.FlexiPanel.com.



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	Approx 120m

Electrical

Current consumption, excluding I/O pins	≤30mA
Current consumption, sleep mode	2µA est
Supply Voltage (regulated) Vcc	2.1V to 3.6V

Mechanical

Max operating/storage temperature	-40°C to +85 °C
Dimensions L×W×H mm	54 × 20 × 3 (excluding legs in DIL version)

Regulatory

FCC compliance	Compliant
CE compliance	Compliant

Contact Information



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