



StarLite USB™

USB to IEEE 802.15.4 Transceiver for Star, Broadcast & Addressed Communications

Summary

StarLite USB provides a transparent USB interface to 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 USB permits point-to-point, star, broadcast, and byte-addressed communications architectures.

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 end devices sleep poll for data when awake
- 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



Hardware Features:

- USBoot bootloader allows firmware interchange between:
 - **MACdongle™** IEEE 802.15.4 MAC layer and sniffer
 - **Zongle™** ZigBee RFD APS layer
 - **StarLite USB™** transparent IEEE 802.15.4 communications
- 2.4GHz IEEE 802.15.4 RF module
- FCC / CE / IC compliant
- Signature 'G' antenna, free-space range 120m, compact, low 'hand-effect' design
- Bind button
- Status indicator output
- 56mm x 20mm x 9mm

Ordering Information

Table 1. Ordering information	
Part No	Description
SLUC	StarLite USB (USB coordinator)
SLUF	StarLite USB (USB fast end device)
SLUS	StarLite USB (USB sleepy end device)
StarLite USB is free for use with FlexiPanel UZBee	

Manufactured to ISO9001:2000



StarLite USB 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 Types

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

- SLUC:** StarLite USB Coordinator, creates an IEEE 802.15.4 network
- SLUF:** StarLite USB Fast End Device, participates in an IEEE 802.15.4 network, cannot sleep, fast response
- SLUS:** StarLite USB End Device, participates in an IEEE 802.15.4 network, can be absent, lower responsiveness, cannot receive broadcast communications while absent

Note that for UZBee revision number UZBr7 (indicated in the antenna area of the PCB, the versions with the suffix **-UZBr7** should be used.

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.

Host Interface & Device Drivers

StarLite USB uses the `usbser.sys` device driver distributed with the Windows operating system. Installation requires only the `.inf` information file. Compatibility with other operating systems (Linux, Macintosh, etc.) is not known; let us know if you have any comments with respect to this.

When writing software for StarLite USB communications, bear in mind that serial data may arrive at any time. Overlapped file I/O must be used with a separate read thread.

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.

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 continue to retry.

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 a StarLite USB coordinator is powered-up, its LED will light while it selects a frequency channel. After a few seconds it will extinguish, indicating that it has initialized.

Once bound, when an end device is powered-up, its LED will light while it tries to find its parent. If it succeeds, the LED will extinguish. 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.

Once reconnection is complete, serial data input to the device will be output from on the destination device(s).

Both USB communications and the IEEE 802.15.4 communications protocol are 64-byte packet-based. Every USB data payload of 1-64 bytes is translated into exactly one IEEE 802.15.4 data payload and vice versa.

In Addressed mode, the first two bytes are interpreted as an address and the remainder of the packet will be sent to that address; every such packet must begin with a two-byte address and packets of two or fewer bytes will be ignored. As far as we can ascertain, in Windows programming, a single USB payload is created by a single file write operation of 64 or fewer bytes. (Since we did not write the driver, we cannot be absolutely sure it happens every time, but it appears to.)

If data is received via USB 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 than can be buffered. With USB data transfer speeds, this is unlikely; if this condition occurs, the status indicator on the packet receiving device will go high for approximately a quarter of a second.

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 USB 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 SLUS version is allowed to ‘sleep’. Power conservation is not usually at issue with USB devices. However, the operating mode is provided for USB devices which are not always in operation, for example if they are used for maintenance only.

If the coordinator is operating in Star mode, it can cache some data for ‘sleeping’ devices. While awake, a ‘sleepy’ StarLite USB must poll the coordinator to see if it has data. A high *PollRate* provides lower latency but is more demanding in terms of network traffic. 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 recessed button for 5 seconds until the LED begins to flash rapidly. An ‘>’ ASCII character will be output to the USB COM port.

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 may be sent to the StarLite USB. 25 characters should be sent in one USB packet, 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

Byte(s)	Setting	Description
6	Addressing	0x42 ('B') for Broadcast mode* 0x53 ('S') for Star mode 0x41 ('A') for Addressed mode
7	PollRate	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
8	PersistTime	0x31 ('1') for 1s persist time 0x32 ('2') for 10s persist time 0x33 ('3') for 60s persist time* 0x34 ('4') for 1hr persist time
9	TaskOnFail	0x43 ('C') carry on regardless if network error occurs 0x52 ('R') reset radio but not USB if network error occurs*
10-25	MAC address	MAC address as 16 hex digits 0-F. Ignored if address already valid.

* = default value

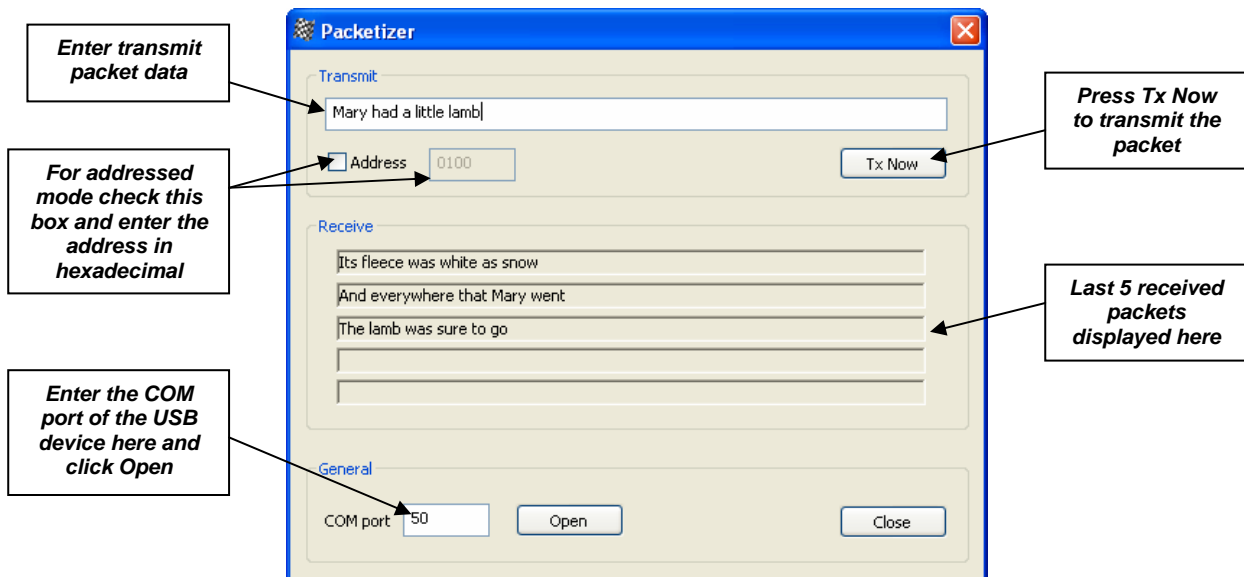
Other than for erasing network settings, all 25 characters must be sent in one USB packet to take effect. (You can't do this with HyperTerminal – use the Packetizer program in the development kit.) Once completed, an '<' ASCII character will be output on from TxD and the device will reset.

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

#G^9UB33R0015C83841000000

Evaluation

HyperTerminal transmits every character as a separate USB packet, so it cannot easily be used for evaluation of StarLite USB. For evaluation purposes, the Packetizer application in the developer's kit may be used to send data in USB packets of up to 64 bytes.



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

IEEE 802.15.4 Compatibility

StarLite USB 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 up to 64 bytes long 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 MACdongle firmware should be used.

Security

Security is not implemented in this version of StarLite USB.

Bibliography

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

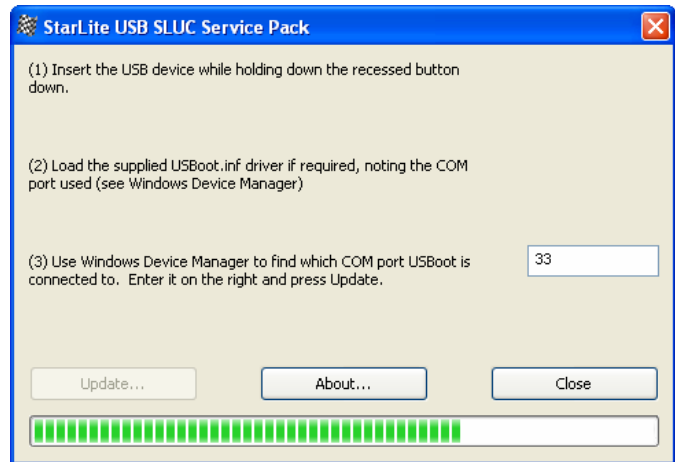
DS500, RF Transceiver Selection Guide downloadable from www.FlexiPanel.com.

Installation Procedure

Service Pack Installation

StarLite USB is firmware for the UZBee USB IEEE 802.15.4 transceiver. This section explains how to load the StarLite USB firmware onto UZBee using FlexiPanel's *USBoot* bootloading procedure. You can skip the *Service Pack Installation* section if you know StarLite USB is already loaded. To install StarLite USB:

1. Insert the UZBee into a USB port while holding the recessed pushbutton down. The LED should flash. If this is the first time you have run any USBoot product, you will be asked for the `USBoot.inf` driver information file, which may be downloaded from www.flexipanel.com.
2. Download and unzip the StarLite development kit from www.flexipanel.com. Run the appropriate application for the firmware you want (e.g. `SLUC.exe` – see StarLite USB Description for further information).



3. To determine which COM port number has been assigned to USBoot:
 - a. Click on *Start*
 - b. Right click on *My Computer*, select *Properties*
 - c. Click on the *Hardware* tab, press the *Device Manager* button.
 - d. Open the *Ports (COM & LPT)* section. You will see the device name *USBoot* and the COM port number.
4. Enter the COM port number in the box provided.
5. Press the Update button. The firmware will load automatically and then start running as if you had just inserted StarLite USB into a USB slot.

Note that when installed in this way, the MAC address is not preloaded and, on startup, it will automatically immediately enter the device configuration mode, indicated by rapid flashing of the LED. (Refer to the Device Configuration section below.) If you use the service pack when you load StarLite USB into OEM products for distribution to your customers, it is your responsibility to set the MAC address on behalf your customers. Contact us to obtain an allocation of addresses if you wish to have a contiguous block.

StarLite USB Installation

If this is the first time you have run StarLite USB, you will be asked for the `StarLite USB.inf` driver information file, which may be downloaded from www.flexipanel.com. The file will be required by users of your products, so it should be packaged with the product or be made readily available on a web-site.

When the USB device is first plugged into a new USB port, Windows will request the `.inf` file. A dialog box will note that the driver is not certified, to which you should select *Continue Anyway*. The USB device will be assigned an unused COM port number. To determine which number has been assigned:

1. Click on *Start*
2. Right click on *My Computer*, select *Properties*
3. Click on the *Hardware* tab, press the *Device Manager* button.
4. Open the *Ports (COM & LPT)* section. You will see the device name StarLite USB and the COM port number.

Your users will also need these instructions.

If you plug the StarLite USB into a different socket, the driver may need to reinstall itself a second time, but this time the computer should find `.inf` file by itself. A different COM port will be assigned, but otherwise the StarLite USB will function as normal.

StarLite USB should be plugged in before the application attempts to open the COM port. Failure to do so may require the application to be closed and StarLite USB to be re-inserted.

.inf File Customization

StarLite USB uses the standard CDC Windows drivers for data transfer. During installation, only a `.inf` driver information file is needed. This is called `StarLite USB.inf`, and can be downloaded from www.flexipanel.com.

If you wish to develop your own-brand applications for StarLite USB, the `.inf` driver information file may be customized. It is a text file that may be modified in Windows Notepad as follows. (These steps are optional – you may distribute the `StarLite USB.inf` file as-is.)

- Modify `MFGNAME` and `DESCRIPTION` to suit your application.
- The filename may be modified but the `.inf` suffix should remain.

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 100m

Electrical

USB specification version	2.0
USB driver	<code>usbser.sys</code> (Supplied with Microsoft Windows)
USB plug	Type A
Maximum current draw	30mA

Mechanical

Max operating/storage temperature	-40°C to +85 °C
Dimensions LxWxH mm	55.7 x 20.3 x 10.5 (note 1)

1. Excludes USB plug

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



Developed by:
FlexiPanel Ltd
2 Marshall St, 3rd Floor,
London W1F 9BB, United Kingdom
email: support@flexipanel.com
www.flexipanel.com



Manufactured and distributed by:
R F Solutions Ltd
Unit 21, Cliffe Industrial Estate,
Lewes, BN8 6JL, United Kingdom
email : sales@rfsolutions.co.uk
<http://www.rfsolutions.co.uk>
Tel: +44 (0)1273 898 000