XBee Buying Guide

Welcome to the wireless world of XBee. Maybe you've heard of it, maybe you haven't, either way you are in for a fun ride. XBees are tiny blue chips that can communicate wirelessly with each other. They can do simple thing like replacing a couple of wires in serial communication, which is nice when you want to make a remote for your paintball vehicle.

But which of the dozen or so modules do you want? What's the difference between Series 1 and Series 2? Why are there so many antenna? Why are some of them Pro, and does this make the regular models feel inadequate? And most importantly why does Sparkfun have so many boards for XBee and which ones do I need?

There are lots of different types of modules which we are going to go over, but one of the nice things about these is that all the modules regardless of the series or type have similar pinouts. Power, ground, and your TX/RX lines are in the same place making the chips pretty interchangeable for most of the simpler applications. Some of the more advanced features are not always compatible, but for starters its not something to worry about. Now that you are ready to start learning about XBee and what it all means here is a breakdown of the XBee world.

What's an XBee, what's a Zigbee, what's a Bumblebee?

- **XBee –** According to Digi "XBee modules are embedded solutions providing wireless end-point connectivity to devices. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are designed for high-throughput applications requiring low latency and predictable communication timing." So basically XBee is Digi's own Zigbee based protocol. In layman's term they are wicked cool, and fairly easy to use wireless modules.
- **Zigbee -** An alliance and a standard of cost and energy efficient mesh networks. XBee uses the Zigbee standard and adds to it and wraps it up in their own neat little package. http://www.zigbee.org/.
- **Bumblebee -** A tuna company, an insect of the family Apidae and the genus Bombus, or a small yellow Autobot. Which ever definition you choose they are fairly awesome and completely irrelevant to our talk of wireless XBee modules.

Series What?

- **XBee Series 1 (also called XBee 802.15.4) -** These are the easiest to work with, they don't need to be configured, although they can benefit from it. Because they are easy to work with we recommend these especially if you are just starting out. For point to point communication these modules work as well as the Series 2 but without all the work. A Series 1 module won't say Series 1 on it, but it also won't say Series 2. If it doesn't say then your module is a Series 1. Series 1 and Series 2/2.5/ZB hardware are NOT compatible. Don't try to mix and match, don't even think about it, it won't work, not even close. Nope, stop thinking about it…! Datasheet
- **XBee Znet 2.5 (Formerly Series 2) Retired -** These are the fun ones. Series 2 modules must be configured before they can be used. They can run in a transparent mode or work with API commands, but this all depends on what firmware you configure these with. These also can run in a mesh network making them highly configurable and awesome modules. It also makes them harder to use modules. These modules are in no way compatible with the Series 1 modules so stop thinking about trying! These modules are no longer sold but are being replaced with the mostly compatible ZB modules. Datasheet
- **ZB (the current Series2ish module) -** Basically the Znet2.5 hardware with new firmware. Meaning they can also run in a transparent mode or work with API commands. They can also run in a mesh network making them highly configurable and awesome modules. You can grab the new firmware and upgrade them yourself. The firmware between the two is not compatible (but is easily interchangeable) so you will have to pick which firmware you want to use on your network and stick with it. These are often call Series 2 modules, so if you hear someone talking about Series 2, they might be talking about these. It may not be the correct term, but it does distinguish these from the Series 1 modules which is usually all people want to know. These modules will not work in any way shape or form with the Series 1 so stop thinking about it. Stop it! Datasheet
- **2B(the even more current Series2ish module) -** These new modules improve on the hardware of the Series 2 modules improving things like power usage. They run the ZB firmware but because the hardware has been changed they can no longer run the Znet2.5 firmware. So if you are looking to add this to an existing 2.5Znet network beware. Currently some of our boards are 2B and others are ZB
- **900MHz -** Technically not a series but it is a family just like the others. The 900s can run 2 different types of firmware, the DigiMesh firmware and the Point to Multipoint firmware. Digi actually sells both modules, the hardware is the same just with different firmware. Sparkfun only sells the point to multipoint version, but hey, you can change the firmware yourself. These modules should be more or less plug and play but of course can benefit from all the cool features you can configure.
- **XSC -** Basically these are 900 modules that sacrifice data rate for range. The regular 900 modules have a data rate of 156KBps (the others are all around 250Kbps) but the XSC module is only about 10Kbps. On the other hand if you attach a high gain antenna you can get a range of about 15 miles and 6 miles with a regular antenna. These modules do not require configuration out of the box and have some other differences including a different command set so make sure you check out the datasheet.
- **XSC S3B -** This is an upgraded version of the XSC modules which is less power-hungry than the previous generation despite having a higher selectable transmitting power of 250mW. This higher Tx power allows for line-of-sight range up to 28 miles with the right antenna. The S3B modules also feature higher-throughput than the previous generation XSC modules.

Antenna, Antennas, Antennae...

- **Chip Antenna –** Basically a small chip that acts as an antenna. Quick, easy, cheap, not in the way. These are being phased out in favor of trace antennas, which are essentially the same but printed directly to the circuit board.
- **Wire Antenna –** Well its a small wire sticking up, a little more of what you think of when you think of antenna.
- **u.FL Antenna –** A tiny connector to connect your own antenna, this is great if your object is in a box and you want your antenna outside the box.
- **RPSMA Antenna –** A bigger connector to connect your own antenna, once again great if your object is in a box and you want your antenna outside the box.
- **Trace Antenna –** Also called a PCB antenna, these are formed directly on the module with conductive traces. They perform about the same as wire antennas.

Regular, Pro and other things

- **Regular vs Pro -** There are a few difference between the regular XBees and the XBee Pros. The Pros are a bit longer, use more power and cost more money. That's pretty much it. The greater power means longer range (1 mile instead of 300ft) so if you need the range or like to spend more money, then use the Pros, otherwise stick with the regular models. You can mix and match these on the same network.
- **900 vs 2.4 -** Most of the Xbee modules operate at 2.4GHz, but there are a few that operate at 900MHz. Basically 900MHz can go a lot farther with a high gain antenna (up to 15miles for the Pro modules and a high gain antenna). Also the lower the frequency the greater penetration the signal has. 900MHz is also not allowed in many countries (although there are 868MHz versions available from Digi that are allowed in many other countries). You can NOT mix and match these on the same network.

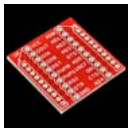
XBee Device	Range	Power Consumption	Frequency	Protocol	Tx Power	Data Rate	Antenna
 XBee 1mW Chip Antenna - Series 1	300 Ft	50mA @ 3.3v	2.4GHz	802.15.4	1mW	250kbps	Chip
 XBee 1mW U.FL Connection - Series 1	300 Ft	50mA @ 3.3v	2.4GHz	802.15.4	1mW	250kbps	Ext./Not Included
 XBee 1mW Wire Antenna - Series 1	300 Ft	50mA @ 3.3v	2.4GHz	802.15.4	1mW	250kbps	Wire
 XBee 1mW Trace Antenna - Series 1	300 Ft	50mA @ 3.3v	2.4GHz	802.15.4	1mW	250kbps	PCB
 XBee 2mW PCB Antenna - Series 2	400 Ft	40mA @ 3.3v	2.4GHz	ZigBee Mesh	2mW	250kbps	PCB
 XBee 2mW RPSMA - Series 2	400 Ft	40mA @ 3.3v	2.4GHz	ZigBee Mesh	2mW	250kbps	Ext./Not Included
 XBee 2mW U.FL Connection - Series 2	400 Ft	40mA @ 3.3v	2.4GHz	ZigBee Mesh	2mW	250kbps	Ext./Not Included
 XBee 2mW Wire Antenna - Series 2	400 Ft	40mA @ 3.3v	2.4GHz	ZigBee Mesh	2mW	250kbps	Wire

XBee Device	Range	Power Consumption	Frequency	Protocol	Tx Power	Data Rate	Antenna
 XBee Pro 63mW PCB Antenna - Series 2B	1 Mile	295mA @ 3.3v	2.4GHz	ZigBee Mesh	63mW	250kbps	PCB
 XBee Pro 63mW RPSMA - Series 2B	1 Mile	295mA @ 3.3v	2.4GHz	ZigBee Mesh	63mW	250kbps	Ext./Not Included
 XBee Pro 50mW U.FL Connection - Series 2	1 Mile	295mA @ 3.3v	2.4GHz	ZigBee Mesh	50mW	250kbps	Ext./Not Included
 XBee Pro 63mW Wire Antenna - Series 2B	1 Mile	295mA @ 3.3v	2.4GHz	ZigBee Mesh	63mW	250kbps	Wire
 XBee Pro 60mW PCB Antenna - Series 1	1 Mile	215mA @ 3.3v	2.4GHz	802.15.4	60mW	250kbps	PCB
 XBee Pro 60mW U.FL Connection - Series 1	1 Mile	215mA @ 3.3v	2.4GHz	802.15.4	60mW	250kbps	Ext./Not Included
 XBee Pro 60mW Wire Antenna - Series 1	1 Mile	215mA @ 3.3v	2.4GHz	802.15.4	60mW	250kbps	Wire
 XBee Pro 900 RPSMA	6 Miles	210mA @ 3.3v	900MHz	Multi-Point	50mW	156kbps	Ext./Not Included
 XBee Pro 900 U.FL Connection	6 Miles	210mA @ 3.3v	900MHz	Multi-Point	50mW	156kbps	Ext./Not Included

XBee Device	Range	Power Consumption	Frequency	Protocol	Tx Power	Data Rate	Antenna
 XBee Pro 900 Wire Antenna	6 Miles	210mA @ 3.3v	900MHz	Multi-Point	50mW	156kbps	Wire
 XBee Pro 900 XSC RPSMA	15 Miles	256mA @ 3.3v	900MHz	Multi-Point	100mW	9.6kbps	Ext./Not Included
 XBee Pro 900 XSC U.FL (retired)	15 Miles	256mA @ 3.3v	900MHz	Multi-Point	100mW	9.6kbps	Ext./Not Included
 XBee Pro 900 XSC Wire (retired)	15 Miles	256mA @ 3.3v	900MHz	Multi-Point	100mW	9.6kbps	Wire
 XBee Pro 900 XSC S3B Wire	28 Miles	215mA @ 3.3v	900MHz	Multi-Point	250mW	10 or 20 Kbps	Wire
 XTend 900 1W RPSMA	40 Miles	730mA @ 5v	900MHz	Multi-Point	1W	9,600 or 115,200bps	Ext./Not Included

Xbee Compatible Devices

Here's a table of stuff we sell that you can plug an XBee into!

XBee Board	Function	Compatible With
 Breakout Board for XBee Module	Breaks out XBee header to breadboard-friendly 0.1"-spaced headers for easy prototyping.	Series 1/2 and Pro Series XBee Modules
 XBee Shield	Makes it easy to add XBee wireless communication to Arduino based projects!	Series 1/2 and Pro Series XBee Modules

XBee Board	Function	Compatible With
 XBee Explorer Regulated	Handles 3.3V regulation, signal conditioning, and basic activity indicators (Power, RSSI and DIN/DOUT activity LEDs) making it easier to work with XBee radios.	Series 1/2 and Pro Series XBee Modules
 XBee Explorer USB	Simple to use, USB to serial base unit for the XBee line.	Series 1/2 and Pro Series XBee Modules
 XBee Explorer Dongle	Like the USB Explorer, except you can plug it directly into your computer's USB port!	Series 1/2 and Pro Series XBee Modules
 LilyPad XBee	Sewable breakout for XBee Modules, so you can add XBee wireless functionality to your e-textiles project!	Series 1/2 and Pro Series XBee Modules

Glossary of Terms:

Range: The range of an XBee device is affected by several factors including the transmit power of the device, the type of antenna connected and the surrounding obstacles or conditions. The range listed here reflects the maximum range of the device in ideal conditions and in open air, line-of-sight. Expect this distance to be smaller if you're trying to communicate indoors or through walls, trees or other barriers.

Power Consumption: This represents the amount of power that the device will typically consume during transmission, your system should be capable of sourcing at least this much current and then some to avoid erratic behavior or brown-out conditions.

Frequency: The operating frequency of the device will affect its range and penetrative force as well as its tendency for interference. Lower frequencies require larger antennas to be effective but they also have greater penetrating power when it comes to transmitting through walls and barriers.

Protocol: This is the language that the device "speaks" when transmitting and receiving data. XBee modules are designed to communicate using a specific protocol, although certain devices can be made to use a different protocol by changing the firmware. Series 1 modules are designed to use 802.15.4 which is a point-to-point communication protocol. This is great for networks which contain only a transmitter and a receiver or multiple receivers. The Series 2 modules are set up for the ZigBee Mesh protocol which is a mesh network standard, this is great if you have a lot of 'nodes' that need to all talk to each other. Series 1 modules aren't capable of mesh networking and can't communicate with other devices running the ZigBee Mesh firmware, however, Series 2 modules are backwards compatible and can be firmware configured for point-to-point networking. 900MHz modules use a different protocol altogether for multi-point networks.

Tx Power: The Tx (Transmit) Power is the amount of power that the device actually broadcasts. While this is closely tied to range, it isn't the only factor. This number is important to keep in mind when selecting an antenna for a device to ensure that you comply with your local radio communication laws. The power listed on this chart is the maximum output power and it can be adjusted in firmware in case you need to dial it back.

Data Rate: The speed at which the device can communicate over the air will effect not only how much data you can push over the network at once, but also how reliably the device will communicate at long distance. Slower transmission rates can be beneficial if your network spans a large distance, a fact exploited by the XSC line of devices. The speeds listed here are maximums and can be adjusted in firmware for several of these devices.

Antenna: The type of antenna, if any, that the module comes equipped with. There are several things to keep in mind when it comes to selecting the proper antenna or antenna connector for your project. A chip antenna is small and easy to enclose, but it doesn't give the best gain. A wire antenna is simple and effective but it's also not as small as the chip antenna and can be more difficult to incorporate into your design; For that reason, most new XBee modules feature a trace antenna instead. Trace or PCB antennas are made from conductive traces on the module itself and have performance comparable to wire antennas while taking up less space. If you're building your wireless device into an enclosure it can be beneficial to attach an external antenna, this can be achieved either by U.FL or RPSMA connection. U.FL is the type of connector often found on the wireless adapters in laptop computers and other small devices, routers and larger devices often have RPSMA connectors. Remember that whenever you add an external antenna to a device you change the gain of the transmitter, so be sure you stay in compliance with your local radio communication regulations.

Resources:

X-CTU software - This is what you need to configure the XBee modules.

XBee Series 1 product page - The product page for the Series 1 module.

XBee ZB product page - The product page for the current Series2ish module.

Government Regulations - Wireless communication has different restrictions in different countries. The ones we sell are all fine for use in the US, but for more information check out Digi's information on what XBees are acceptable where.

Building Wireless Sensor Networks - great book on Series 2ish modules. This is an amazing book on XBees, it covers everything from configuring the modules to using the I/Os and sleep functions. It also has projects throughout the book to help you put to use what you've learned.