



# XBee ZigBee

SMT RF Module Development Kit

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## Getting Started Guide

# **XBee ZigBee SMT RF Module Development Kit Getting Started Guide—90002013**

| Revision | Date     | Description  |
|----------|----------|--|
| A - D    | N/A      | Initial release and subsequent releases for various editorial updates and technical content updates to keep current with product changes |
| E        | May 2016 | Updated the template and warranty information. Updated XCTU instructions.  |

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## Before you begin

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This guide provides instructions for setting up XBee ZigBee SMT RF Module. Use the instructions in this guide to do the following:

- Connect the hardware
- Install the necessary software
- Setup and perform a range test
- Configure advanced settings

## Gather required materials

To complete the steps in this guide, you will need the following items:

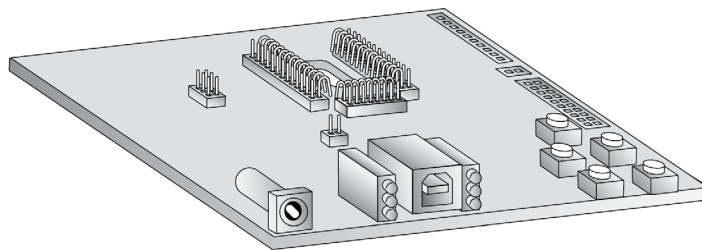
| Item                      | Description   |
|---------------------------|---|
| SMT RF Module Starter Kit | This kit contains all of the hardware you need for the device.                                |
| Computer                  | A laptop or desktop computer running Microsoft Windows with at least two available USB ports. |
| XCTU software             | Most current version  |

## Connect the hardware

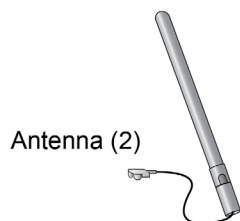
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### Identify kit contents

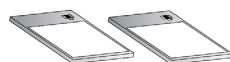
Carefully unpack and verify the contents of the development kit. Each kit should include the following items in the following drawing.



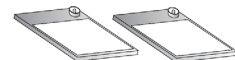
XBee Interface Board (4)



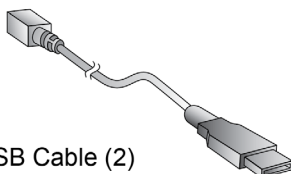
Antenna (2)



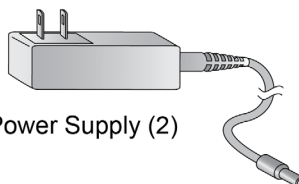
XBee/XBee-PRO PCB  
Module (2)



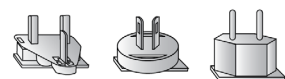
XBee/XBee-PRO U.FL  
Module (2)



USB Cable (2)



Power Supply (2)



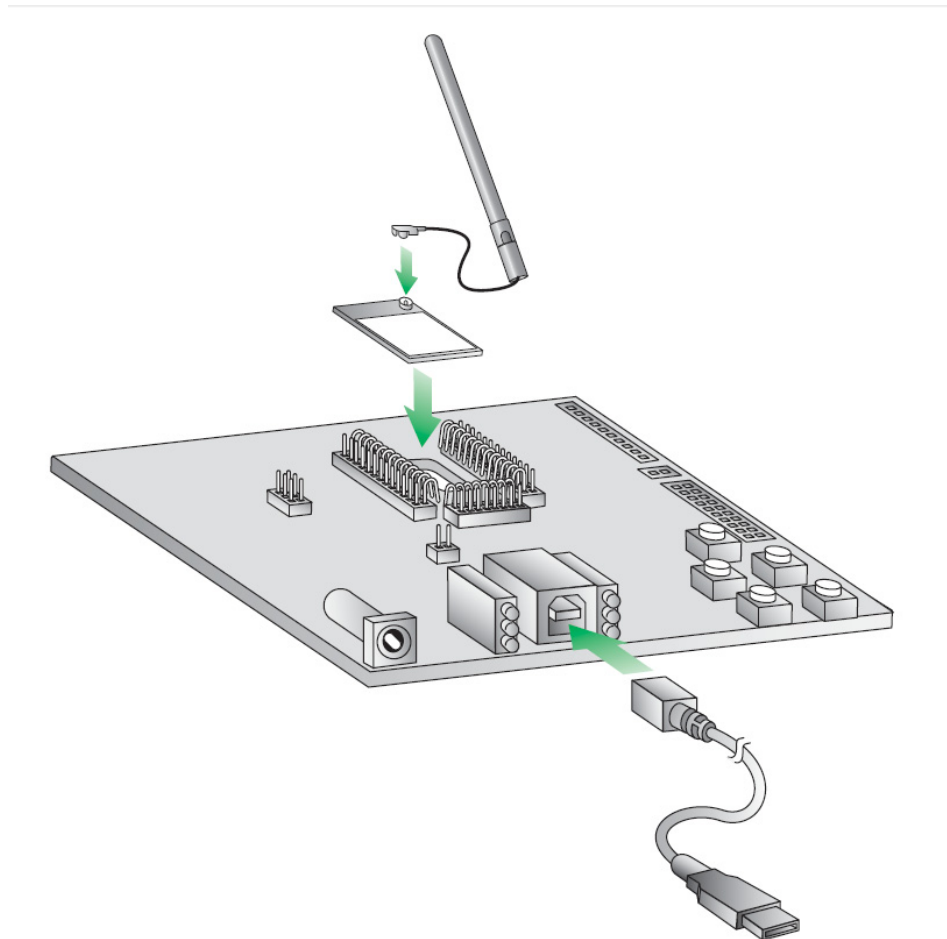
Power Adapters (1 set)  
International only

## Connect the hardware

The following steps describe how to connect the hardware:

1. Install the modules on the XBee interface boards by aligning pins with the headers and pressing the modules into place.
2. Attach the dipole antennas to the modules.
3. Connect the first XBee interface boards to your computer using a USB cable. This first device will be designated as your coordinator.
4. Connect the remaining modules and interface boards, which you will use later.

The following figure shows how to connect the hardware.



## Download XCTU

---

XBee Configuration and Test Utility (XCTU) is a multi-platform program that enables developers to interact with Digi radio frequency (RF) devices through a graphical interface. The application includes built-in tools that make it easy to set up, configure, and test Digi RF devices.

For full support of the XBee ZigBee SMT RF Module, you must use XCTU version 6.3.0 or higher.

For instructions on downloading and using XCTU, go to:

<http://www.digi.com/products/xbee-rf-solutions/xctu-software/xctu>

## Range testing

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### Add and configure modules

Using your Product Names, set up a coordinator module and router modules.

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**Note** Each network requires only one coordinator module.

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For more information about setting up modules, see the [XBee/XBee-PRO ZigBee RF Module User Guide](#).

1. Connect an XBee USB interface board (with module installed) to your computer.
2. Start XCTU.
3. Click **Discover devices** and follow the instructions. XCTU should discover two product models.
4. Click **Add selected devices**. The devices appear in the **Radio Modules** list. You can click a module to view and configure its individual settings.
5. Verify that the baud rate and data settings match the internal settings of the devices:
  - **Baud Rate:** 9600
  - **Flow Control:** NONE
  - **Data Bits:** 8
  - **Parity:** NONE
  - **Stop Bits:** 1
6. In the XCTU **Radio Configuration** tab, click **Read**.

The following procedure sets one device as the coordinator. Perform this procedure on the first module that you connect to a computer during kit assembly.

7. Select the first product model and click the **Load default firmware settings** button.
8. Configure the following parameters:




| Parameter | Setting     | Effect  |
|-----------|-------------|---|
| <b>CE</b> | Enabled [1] | Sets the device as coordinator.   |
| <b>DL</b> | Type FFFF   | Typing FFFF for <b>DL</b> assigns the coordinator to broadcast transmission. Unicast transmission is covered later in this guide. |

9. Click the **Write radio settings** button.
10. (Optional) If you are working in an area where other ZigBee networks are running, it is possible for router modules to join an unintended network. To avoid this situation, you can set a single PAN ID for all of modules you wish to be on the same network. To set the PAN ID:
  - a. Click **ID - PAN ID** and enter a hex number, for example, A3.
  - b. Click the **Write radio settings** button.

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**Note** You can set multiple parameters at once and then click the **Write radio settings** button to save them in the module.

---

11. Configure the remaining three modules following Steps (1)-(10). Ensure that you set CE to 0 on these modules. They are designated as router (non-coordinator) modules.
  - a. Connect router modules in the network to the computer using a USB cable (two are included in the kit). Once the network is established, the red LED near the USB connector on the USB interface board will flash. Coordinators will flash at a rate of about once per second, and routers will flash at a rate of about twice per second.
  - b. Open an XCTU window for each module connected to the computer, select the appropriate COM port, and go to **Consoles working mode** . Connect the USB interface boards one by one to the network and computer so you can identify which module goes with which COM port.

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**Note** XCTU only looks for available COM ports on start-up. If you plug in a USB interface board after starting XCTU, it will not be detected unless you close and re-start XCTU.

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12. In this configuration, the routers are set up to communicate with the coordinator. Using **Consoles working mode** to enter text, any text entered in the window of a router module's terminal will show up in the coordinator's window as a repeat of the character; see <https://docs.digi.com/display/XCTU/AT+Console> for details. Text transmitted is shown in blue while text received is shown in red.

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**Note** In this configuration, the coordinator is broadcasting its data to the routers (the destination address of 0xFFFF is the broadcast address). The routers are unicasting their data to the coordinator (the destination address of 0x00 is the coordinator). You might notice that if data is rapidly entered into the terminal window of the coordinator, there will be a long delay before it reaches the routers. This is because broadcast transmissions in a ZigBee network require a large amount of network overhead and are not practical in most situations.

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In the next step, you will change the addressing of the coordinator to Unicast to a specific router.

1. In order to address to a specific router, we need to determine what the serial number of the router is:
  - a. In XCTU click **Configuration working mode** of the router that is connected to your PC and click **Read**.
  - b. Make a note of the **SH** (Serial Number High) and **SL** (Serial Number Low) parameters.

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**Note** The serial number is also printed on the label located on the RF shield of the XBee device.

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2. Now you need to assign this serial number as the destination address on the coordinator:
  - a. On the coordinator, click **Configuration working mode** and click the **DH** (Destination Address High) parameter. Type the **SH** (Serial Number High) of the router.
  - b. Click the **DL** (Destination Address Low) and enter the **SL** (Serial Number Low) of the router.
  - c. Click the **Write** button.

You can now open **Consoles working mode** for both modules as you did before to verify that the addressing is assigned correctly.

The next section uses this router to perform a range test.

## Perform a range test

A range test is a simple point to point wireless demonstration that tests the devices' ability to transmit to and receive from each other. Wireless environments vary dramatically depending on many factors and the range test allows you to experiment with the devices in your own environment.

1. While the coordinator module remains plugged into the computer, apply power to the router you addressed earlier using a power supply in a fixed location. This module will be designated as the remote module.

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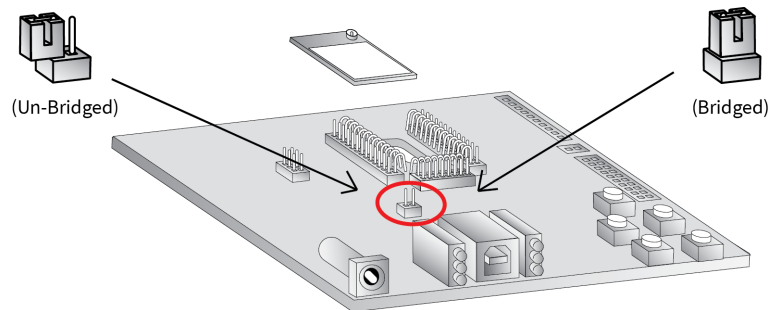
**Note** You will need to have a jumper at P8 on the loopback header on the XBIB board for the remote module.

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**CAUTION!** Ensure that the P8 jumper is not bridging the two pins together on the base module. This could cause XCTU to stall if the jumper is populated and requests are sent to the module.

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2. In XCTU, click **Tools > Range Test**.
3. Your local devices are listed on the left side of the Devices Selection section. Select the LOCAL\_XBEE device and click **Discover remote devices** button.
4. When the discovery process finishes, the other device (REMOTE\_XBEE) is displayed in the **Discovering remote devices...** dialog. Click **Add selected devices**.
5. Select the REMOTE\_XBEE module from the **Discovered device** drop-down menu.
6. Click **Start Range Test**.
7. Range test data is represented in the chart. By default, 100 packets are sent for the test. XCTU displays the instant local and remote RSSI in two separate controls, as well as the number of packets sent and received. Remote devices only report their RSSI value when the local device is operating in API mode (by setting **AP** to 1).

8. Test the wireless link by moving your laptop and local device setup away from the remote device. Watch the range test status indicators: RSSI will decrease as you get farther away, and eventually you will see the percentage of successful packets drop below 100%, indicating you are approaching the limits of the range.
9. Click **Stop Range Test** to stop the process at any time.

If you are running the range test with several mesh modules acting as intermediaries, increase the **Rx timeout (ms)** value to compensate for additional latency.

## Create a mesh network

You have already established a point-to-multipoint network. Now it is time to extend the network by creating a self-healing mesh network.

1. Restart the **Range Test**.
2. Move the remote further away from the base until the signal is lost.
3. Assemble and power on another module and interface board.
4. Place this radio halfway between the remote and the base.

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**Note** The intermediate radio bridges the gap between the remote and the base and reestablishes communication. The network “self-healed” by redirecting communications as soon as a pathway became available.

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## Configure remote modules

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You can configure the XBee modules over-the-air using XCTU. To use this feature, the coordinator must be configured for API mode. For more information about API mode, see the [XBee/XBee-PRO ZigBee RF Module User Guide](#).

1. In XCTU, select the base module and go to **Configuration working mode**.
2. Click **Read**.
3. Click the **AP** command and select **API Mode Without Escapes [1]**.
4. Click **Write**.
5. Again using the base module, click the **Discover radio nodes in the same network** button  .
6. When XCTU discovers the remote devices, click **Add selected devices**.
7. Select the remote module.
8. Click the **Update firmware** button.
9. Select the **Product family**, **Function set**, **Firmware version**, and click **Update**. XCTU flashes the new firmware to the remote module over-the-air.
10. Verify that the firmware version has changed.

## Design considerations

### Software Design Considerations

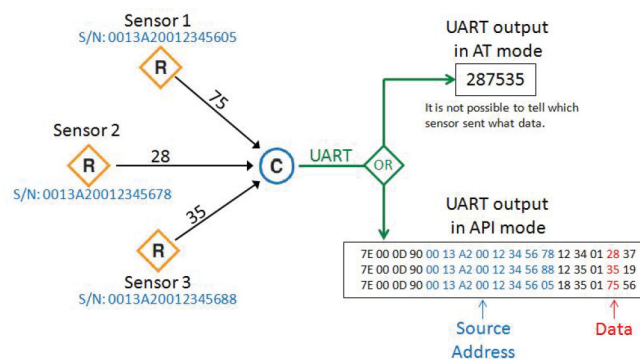
So far, we have been transmitting data between the modules in AT (transparent) mode. AT mode on the XBee is beneficial because it is very simple to send and receive data. In this configuration, it acts as though you had connected the two modules with a wire: whatever data goes into one module comes out of the other transparently.

The other operating mode is API. This is a much more powerful way of transmitting data and remotely controlling the module. If you performed the over-the-air configuration earlier in this guide, you have already performed some operations using API (Remote AT commands through XCTU).

Here is an example of API mode in a real-world application:

A user has installed three sensors to monitor his factory equipment. He would like to wirelessly gather the sensor data to a base module and be able to remotely control a relay located at each sensor. If he were to use AT (transparent) mode, there would be no way to determine which sensor sent what data. The data from the three sensors would come out of the base module's UART in a jumbled mess.

By changing the base module to API mode, the data that is sent by the remote modules will come out of the UART in an API frame. Included in this frame is the source address, as well as the sensor data, so it is very easy to keep track of each sensor. This process works similarly for sending data back to a specific module. The user can also send a Remote AT command to toggle a pin on one of the sensor modules, allowing him to remotely control the relay.



API mode is covered in detail in Section 9 (API Operation) of the manual.

## Hardware design considerations

We highly recommend that you review the Design Notes section of the [XBee/XBee-PRO ZigBee RF Module User Guide](#). This will provide you with board layout considerations, power supply design, and recommended pin connections.

There are some additional recommendations for implementing the XBee into your hardware design.

The XBee ZB SMT module is designed to be soldered in place. This creates some unique challenges for troubleshooting and reprogramming the XBee. The primary means of updating and configuring the module will be via over-the-air configuration, however there are some factors that will cause the module to not be accessible in this way (bad firmware flash, unknown PAN ID, etc.) Reworking the module after it has been installed will void the warranty, so it is recommended to have a physical programming header installed on your board. This header will allow you to access the necessary pins of the XBee to configure the module or perform a recovery if needed. Note that two devices cannot share the same UART connection, so if a programming header is installed there should be some way to allow the header exclusive access to the XBee, either with a physical jumper or software solution. The recommended pin connections are listed in the manual.

The XBee ZB SMT module is 3.3 V only; it is not 5 V tolerant on any pin. Applying a voltage higher than 3.3 V will damage the module and void the warranty.

You may also want to consider implementing a dual-footprint design. This footprint gives you the flexibility to implement either an SMT or through-hole XBee. Details on this dual-footprint are in the user guide.

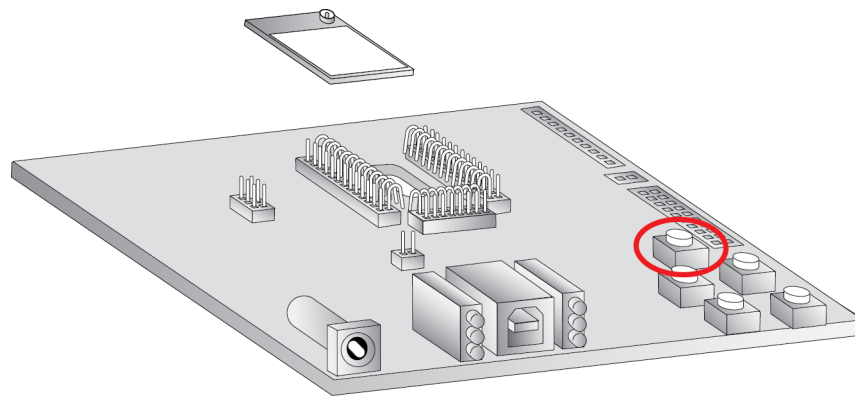
There is a [schematic](#) available for the X-BIB-U interface board; you can use it as a reference for how to design a proper interface to the device.

## Troubleshooting

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### Reset the XBee ZB SMT RF Module

Each XBee USB Development Board has a reset button (as shown):



Pressing this button power cycles the module, but will not clear any changes written to the module. This is useful if you are having issues accessing the COM port. This will also reset any parameters that were changed but not written into memory. If your module is sleeping, pressing the reset button will wake it temporarily.

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**Note** The remaining buttons are connected to various I/O lines and are not used in this kit. See the [XBee/XBee-PRO ZigBee RF Module User Guide](#) for more details relating to this functionality.

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### Why are the modules no longer communicating with one another?

Network settings that can cause loss of communication include **BD** (Baud Rate), **NB** (Parity), and **EE** (Encryption Enable) among others. Check to see if these parameters are set. If you are unsure if the settings are affecting communication, restore the modules back to their default settings.

To restore the default settings:

1. In XCTU, go to **Configuration working mode**.
2. Click **Default**.