

ZigBee SMT RF Module Development Kit GETTING STARTED GUIDE

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Our support staff is available to assist with compiling code, embedded module examples, and explaining hardware and RF networking, but they cannot write or review your code. Support for this kit is always free and unlimited.

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Section 1: Objectives

This guide demonstrates how to set up a wireless link using the XBee ZB SMT RF Module, allowing the user to evaluate the hardware over varying ranges and conditions. It covers these tasks:

- Installing software
- Setting up the network
- Establishing over the air communications
- Setting up a range test
- Performing a range test
- Exploring advanced configurations

Create a long range wireless link in minutes!

Section 2: Installing and Using Software

Installing USB Drivers

The USB interface board is a "plug-and-play" device that should be detected by the PC automatically. If you are using **Windows 7**, driver installation is not required, and the USB interface board can be connected to the computer immediately. If you are using **Windows XP**, **Vista**, **or 2000**, download and install the driver as per the directions below.

To install the USB driver:

- 1. Download the driver setup file at: http://ftp1.digi.com/support/driver/FTDI_Windows_Driver_Setup.exe.
- 2. Double-click on the setup file. A window will pop up during installation and automatically close when the process is complete.

The USB interface board may now be connected to the computer.

Installing X-CTU Software

The software needed to use this kit is called **X-CTU**. Please download it at http://ftp1.digi.com/support/utilities/40003002_a.exe.

X-CTU is a stand-alone tool for configuring XBee modules and running a range test. To install X-CTU:

- 1. Browse to the folder to which you saved the above install file.
- 2. Double click on the installer file and follow the X-CTU Setup Wizard.
- 3. When asked if you would like to check Digi's website for firmware updates, click **Yes**.
- 4. After the firmware updates are complete, click **Close**.
- 5. Start X-CTU by double clicking on the X-CTU icon placed on your desktop, or by selecting **Start > Programs > Digi > X-CTU**.

The X-CTU software is now ready to be used.

Setting Up the Network

Each network requires one and only one coordinator. For more information on the function of the coordinator, see the Product Manual for the XBee ZB SMT RF Module, available online at http://www.digi.com/products/wireless/zigbee-mesh/xbee-smt.jsp#docs.

Running the X-CTU Software

 Under the PC Settings tab, select the PC serial COM port that will be used. The standard COM port for the 9-pin serial port is COM 1. The USB ports will be labeled as USB Serial Port and are assigned a number based on your PC's settings.

📭 х-сти				
About				
PC Settings Range Test Terminal Moden	n Configura	ation		
Com Port Setup				
Select Com Port				
Communications Port (COM1) USB Serial Port (COM14)		Baud	9600	-
		Flow Control	NONE	-
		Data Bits	8	•
		Parity	NONE	•
		Stop Bits	1	•
		Tes	t / Query	
Host Setup User Com Ports Network Inter	face			
- API	Benons	e Timeout		1
Enable API			1000	_
Use escape characters (ATAP = 2)	Timeout		1000	
AT command Setup				
Command Character (CC) + 2B				
Guard Time Before (BT) 1000				
Modem Flash Update				
T No baud change				

The X-CTU baud rate must match the module's BD parameter for proper communication. The module default is 9600 baud.

 Verify that the baud rate and data settings match the internal settings of the modules. The default settings for the modules are Baud Rate: 9600, Flow Control: HARDWARE, Data Bits: 8, Parity: None, and Stop Bits: 1.



3. In the X-CTU Modem Configuration tab, click Read.

X-CTU displays the available settings for the module.

- 4. Every network must start with a coordinator. The following procedure will set one device as the coordinator.
 - a. Click on CE Coordinator Enable and select 1-Enabled.
 - b. Then click the Write button.

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About Parameter Profile Remote Configuration Versions	
PC Settings Range Test Terminal Modern Configuration	
Modern Parameter and Firmware Parameter View Profile Ver	sions
Read Write Restore Clear Screen Save D	
C Always Update Firmware Show Defaults Load	versions
Modem: XBEE Function Set	Version
XB24C ZIGBEE	400E 🗾
📮 🔄 Networking	^
📓 (0) ID - PAN ID	
	=
- 📓 (3) SD - Scan Duration	
U) ZS - ZigBee Stack Profile	
(D) IN Leis Nevicester	
(U) JN - Join Notification (U) JN - Join Notification	
(JF 10) OF - Operating FAN 1D	
(1110) OF Operating Tools FAN 10	
(13) Chi Operating Channel (14) NC - Number of Remaining Children	
(1) CE - Coordinator Enable 1 - ENABLED	
🔲 📮 (13A200) SH - Serial Number High	
405816AB) SL - Serial Number Low	
E2DA) MY - 16-bit Network Address	
- 🔄 (0) DH - Destination Address High	
🚽 🔄 (0) DL - Destination Address Low	
🔤 🔄 🛛 🔤 🔤	1000
🖿 🛅 (1F) NH - Mavimum Hone	<u>×</u>
Set/read if this device is a coordinator (1) or not (0)	
COM31 9600 8-N-1 FLOW:NONE X824C Ver:400E	

Use the parameter window shown above to designate one device as the coordinator.

- 5. (Optional) If you are working in an area where other ZigBee networks are running, it is possible for non-coordinator modules to join an unintended network. To avoid this situation, you can set a unique PAN ID for all of the modules you need to be on the same network. To set the PAN ID:
 - a. Click on **ID PAN ID** and enter a hex number (for example, A3 in the figure below) from 0x00 to 0xFF.
 - b. Then click the Write button.

🖳 🔲 🔀
About Parameter Profile Remote Configuration Versions
PC Settings Range Test Terminal Modern Configuration
Modem Parameter and Firmware — Parameter View – Profile — Versions
Bead Write Bestore Clear Screen Save Double
Ender Charles Charles Load Versions
Always Opdate Firmware
Modem: XBEE Function Set Version
XB24C \star ZIGBEE \star 400E \star
🖃 🔄 Networking 🔨
📓 (A3) ID - PAN ID A3
🖥 (7FFF) SC - Scan Channels
📱 (3) SD - Scan Duration
- 🖥 (0) ZS - ZigBee Stack Profile
- 📱 (FF) NJ - Node Join Time
📓 (0) JN - Join Notification
- 🚡 (3F10) OP - Operating PAN ID
📓 (1F18) OI - Operating 16-bit PAN ID
🚽 🔚 (15) CH - Operating Channel
🚽 🔚 (14) NC - Number of Remaining Children
📓 (1) CE - Coordinator Enable
🖻 🔄 Addressing
- 🔚 (13A200) SH - Serial Number High
📓 (405816AB) SL - Serial Number Low
— 📓 (E2DA) MY - 16-bit Network Address
📓 (0) DH - Destination Address High
🖢 (0) DL - Destination Address Low
- 🖥 () NI - Node Identifier 🛛 🙀
🛄 🛅 (1F) NH - Mavimum Hone 🔛
Set/Read the ZigBee extended PAN ID. Valid range is 0 - 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
COM31 9600 8-N-1 FLOW:NONE XB24C Ver:400E

- Note: You can set multiple parameters at once and then click the **Write** button to save them in the module.
- 7. Once the modules are configured, a network can be established. To establish network connections, do the following:
 - a. Connect non-coordinator modules in the network to the computer using the USB cable (two are included in the kit). The modules will form a network within a few seconds. In order to interact with the module, you will need to connect it to the computer using a USB cable. 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 X-CTU window for each module connected to the computer, select the appropriate COM port, and go to the **Terminal** tab. USB interface boards

can be connected one by one to the network and computer so you can identify which module goes with which COM port.

- Note: X-CTU only looks for available COM ports on start-up. If you plug in a USB interface board after starting X-CTU, it will not be detected unless you close and re-start X-CTU.
- 8. In this configuration, the modules are set up to communicate with the coordinator. Using the Terminal tab as shown below, any text entered in the window of a non-coordinator module's window will show up in the window of the coordinator. Text entered in the coordinator window will show up in the coordinator window as a repeat of the character. This is because the default destination address is the coordinator address (0x00). Text transmitted is shown in blue while text received is shown in red.

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About	About
PC Settings Range Test Terminal Modern Configuration	PC Settings Range Test Terminal Modern Configuration
Line Status Assent DTR V RTS V Break Close Close Com Port Packet Screen Hex	Line Status Assert Close Close Com Port Packet Screen Hex
TThhiiss iiss tthhee CCoooorrddiinnaattoorr 🔺	
Digi Making Wireless M2M Easy	Digi Making Wireless M2M Easy
	-
COM31 9600 8-N-1 FLOW:NONE Rx: 54 bytes	COM33 9600 8-N-1 FLOW:NONE

- 9. Unicast transmission is also possible. More information on unicast transmissions is available in the Product Manual.
- 10. The other form of communication is broadcast transmission, where one module transmits to all the other modules in the network. More information on broadcast communication is available in the Product Manual.
 - Note: Examples of different transmission modes are in the Product Manual under Data Transmission Examples.

Section 3: Performing a Range Test

What Is a Range Test?

A range test demonstrates the real-world RF range of the XBee embedded modules in the Development Kit.

This range information is useful when planning for and deploying an actual network.

Setting Up the Modules for the Range Test

Select two modules to use in the range test, and do the following:

- 1. Connect them to the computer using USB cables. (You should have already done this in the previous section.) On the **Modem Configuration** tab, click **Read** to view the configuration on each module.
- 2. Enter the SH Serial Number High from the first module into the DH Destination Address High of the second module.
- 3. Enter the SL Serial Number Low from the first module into the DL Destination Address Low of the second module.
- 4. Click the Write button to save the addresses into the first module.
- 5. Repeat this process for the second module. (See figure below)

🦉 [СОМЗ2] X-СТU 📃 📃 🔁	🕻 🖳 [СОМЗЗ] X-СТU 💦 🔲 🗖
About Parameter Profile Remote Configuration Versions	About Parameter Profile Remote Configuration Versions,
PC Settings Range Test Terminal Modern Configuration	PC Settings Range Test Terminal Modern Configuration
Modem Parameter and Firmware Parameter View Profile Versions Read Write Restore Clear Screen Save Download new versions Always Update Firmware Show Defaults Load Versions Versions	Modem Parameter and Firmware Parameter View Profile Versions Read Write Restore Clear Screen Save Download new versions Always Update Firmware Show Defaults Load Versions Versions
Modem: XBEE Function Set Version	Modem: XBEE Function Set Version
XB24C 🗾 ZIGBEE 🔄 🛨 400E 💌	XB24C ZIGBEE 400E
(B1)ID - PAN ID (7FF) SC - Scan Channels (3) SD - Scan Duration (0) ZS - ZigBee Stack Profile (FF) NJ - Node Join Time (0) JN - Join Notification (B1) OP - Operating PAN ID (5CB4) OI - Operating T6-bit PAN ID (14) NC - Number of Remaining Children (14) NC - Number of Remaining Children (14) NC - Coordinator Enable (13A200) SH - Serial Number High (105816AD) SL - Serial Number Low (13A200) SH - Serial Number Low (13A200) SH - Serial Number Low (13A200) SH - Serial Number Kigh (1405816AD) SL - Serial Number Kigh (1405816AD) SL - Serial Number Low (13A200) DH - Destination Address Low (405816AE (13A200) DH - Destination Address Low (14D80400) DH - DH	IB1 (ID - PAN ID IGT (ID - PAR ID) IGT (ID - PAR ID)
COM32 9600 8-N-1 ELOW/NONE	COM33 9600 8-N-1 FLOW:NONE

Note: The default destination address is 0x00 (the coordinator). If you are using the coordinator as one of the range test modules, then only the coordinator's DH and DL parameters need to be configured with the SH and SL values of the non-coordinator.

Note: This process can be done one module at a time, by recording the address from one module to enter into the other module.

Select one module to be the loopback module, and install the jumper as shown below:



Remove the USB cable.

For the other modules, the jumper can either be removed or placed so it is only on one pin, as shown below.



Running the Range Test

1. In X-CTU, select the Range Test tab.

[COM63] X-CTU	
bout	
PC Settings Range Test Terminal	Modem Configuration
Chur	Percent -40
Stop	R 100.0 R
1	a S
Clear Stats	9
Advancedsss	e S
Auvanceu>>>	Т
Test	s Good
🕫 Loop Back	t <u>10</u>
Torrest Deserve	
I ransmit Neceive	

Clicking the **Advanced>>>** button displays several more options. If you run the range test with several more mesh radios acting as intermediaries, you will want to increase the **Data receive timeout** value to compensate for the additional latency.

- 2. (Optional) Check the RSSI box to enable the Received Signal Strength Indicator. The RSSI value indicates the signal strength of the last packet that the module received.
- 3. Click **Start** to begin the range test.
- 4. Monitor the link quality by reading the **Percent** section of the **Range Test** tab. This section displays the running percentage of good packets sent to the receiving radio and looped back to the base.
- 5. Leave the loopback module in place as the remote loopback radio.

- 6. To increase the range, move to a position where you are receiving packets. Put another module from the kit in this position and connect it to a power supply. Within ten seconds, your roving module should be able to receive packets at a longer range as the mesh network transmits the packets from radio to radio.
- 7. Click **Stop** to end the range test.

Section 4: Exploring Advanced Configurations

Embedding the RF Module

XBee modules are designed for embedding into systems. They are designed for both UART and SPI capability for ease of communication with other parts of the system. Information on UART and SPI communication can be found in the Product Manual online at http://www.digi.com/products/wireless/zigbee-mesh/xbee-smt.jsp#docs.

The Product Manual also contains information on manufacturing considerations, antenna keepout areas, design considerations, programming commands, etc. This is a useful reference for including the XBee in your system.

Configuring the RF Module

In the X-CTU **Modem Configuration** tab, click Read (see **Setting Up the Network** in Section 2). Select any module parameters you want to change (e.g. Destination Address, Encryption, etc.) and type in or select the desired value. Then click **Write** to save the changes to non-volatile memory.

Parameters shown in green are still set to default values. Parameters in blue have been changed. Parameters in black are read-only, with the exception of the encryption key, KY.

This is one of several configuration methods. Refer to the Product Manual for more information. To restore the module back to default settings, click **Restore**.

Configuring Remote Modules

XBee modules can also be configured "over-the-air" using X-CTU. In order to use this feature, your base device must be configured for API mode.



To configure parameters on a remote module, set **AP-API Enable = 1 API ENABLED** on your base module and then click **Write** to save to non-volitile memory. For more information on the different API settings, see the API section of the Product Manual.

To send "over-the-air" commands:

- 1. Click the **Remote Configuration** option at the top of the window.
- 2. Click **Open COM Port** and **Discover** from the menu bar at the top of the Network window. A list of all the nodes in the network will appear.
- 3. Select a node from the list to configure. You can interact with it as though it were connected to your computer directly.
- 4. Click **Read**, **Write**, or **Restore** parameters on the main X-CTU window, and those changes will occur over the air on the remote module selected in the Network window.

About Paramete	Profile Remote Configuration	Versions		
Read Vite	e Restore Show Defaults	Profile Ver Save D Load	sions ownload new	
Moder XBEE	Function Set		Version	
24C	ZIGBEE TX Power Level	<u>•</u>	400E	
	- Power Mode			
(0) PP	- Power at PL4			1
E Security	English English			
- U)EE	Encryption Enable			
and the second se				
Network [COM3	11]			
Network [COM3 se Com Port Disco	ver Node List Network S	Settings		
Network [COM3 ise Com Port Disco ides 4 #End Nodes	11] wer Node List Network 5 0	Settings		
Network [COM3 se Com Port Disco ides 4 #End Nodes dress	ver Node List Network 5 0 Node Identifier	Settings Type	Short Address	Profile
Network [COM3 se Com Port Disco odes 4 #End Nodes dress A200405816AB	1] ver Node List Network 5 0 Node Identifier	Settings Type Coordinator	Short Address	Profile
Network [COM3 se Com Port Disco odes 4 #End Nodes dress A200405816AB A200405816AD	1] ver Node List Network 5 0 Node Identifier	Settings Type Coordinator Router	Short Address B96F	Profile
Network [COM3 secon Port Disco ides 4 #End Nodes idress A200405816AB A200405816AC A200405816AC A200405816AF	ver Node List Network 3 0 Node Identifier	Settings Type Coordinator Router Router	Short Address 896F 6727 F175	Profile
Network [COM3 se Com Port Disco ides 4 #End Nodes dress A200405816AB A200405816AD A200405816AC A200405816AE	1] ver Node List Network 3 0 Node Identifier	Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 see Com Port Disco ides 4 #End Nodes idress A200405816AB A200405816AD A200405816AC A200405816AE	Node List Network 3	Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 see Com Port Disco odes 4 #End Nodes Idress A200405816AB A200405816AD A200405816AC A200405816AE	Node List Network 3 Node Identifier Node Identifier	Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 se Com Port Disco ides 4 #End Nodes idress A200405816AB A200405816AC A200405816AC A200405816AC A200405816AC A200405816AC A200405816AC A200405816AC	Node List Network 3 Node Identifier Node Identifier API Output Mode and Options I - ATI Command Mode Timeout GT - Guard Times	Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 secom Port Disco odes 4 #End Nodes idress A200405816AB A200405816AC A200405816AC A200405816AC A200405816AE	Node List Network 3 Node Identifier Node Identifier I Node Identifier I	Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 secon Port Disco odes 4 #End Nodes Idress A200405816AB A200405816AC A200405816AC A200405816AC A200405816AE	Node List Network 3 Node Identifier Node Identifier Node Identifier I API Output Mode and Options T - AT Command Mode Timeout GT - Guard Times P - Command Samuence Character e	Settings Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 se Com Port Disco odes 4 #End Nodes dress A200405816AB A200405816AC A200405816AC A200405816AC A200405816AC Getting nodem typ Modem's firmware Setting AT parameter	Node List Network 3 Node List Network 3 Node Identifier Node Identifier	Settings Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile
Network [COM3 secon Port Disco odes 4 #End Nodes idress A200405816AB A200405816AC A200405816AC A200405816AC A200405816AC Getting nodem typ Modem's firmware Vrite Parameters	Node List Network 3 Node List Network 3 Node Identifier Node Identifier Identifier	Settings Type Coordinator Router Router Router	Short Address B96F 6727 F175	Profile

Setting Module as End Device

- 1. In the Modem Configuration tab, click **Read**.
- 2. Scroll through the list of displayed parameters and find the Sleep Modes section.
- 3. Click on **SM-Sleep Mode** and select **4-Cyclic Sleep** from the drop-down box.

🖳 🗖 🔀 ССТИ_ХМОДЕМ
About Parameter Profile Remote Configuration Versions
PC Settings Range Test Terminal Modern Configuration
Modem Parameter and Firmware Parameter View Profile Versions
Read Write Restore Clear Screen Save Download new
Always Update Firmware Show Defaults Load versions
Modem: XBEE Function Set Version
XB24C I ZIGBEE I 400E I
🔲 (0) AP - API Enable 🔨
🔚 🔚 (0) AO - API Output Mode
E AT Command Options
G54) CT - AT Command Mode Timeout
GLS GLI - Guard Times GP (30) CC Conserved Services Character
Sleen Modes
La (20) SP - Cuclic Sleep Period
I) SN - Number of Cyclic Sleep Periods
(4) SM - Sleep Mode 4 - CYCLIC SLEEP
- 🔄 (1388) ST - Time before Sleep
🔄 🔚 (0) SO - Sleep Options
🖻 🔄 I/D Settings 👘
(1) D0 - AD0/DI00 Configuration
(0) D1 - AD1/DI01 Configuration
(U) D2 - AD2/DI02 Configuration (0) D2 - AD2/DI02 Configuration
 (i) D3 - AD3/D103 Configuration (ii) D4 - DID4 Configuration
(i) 04 DI04 Configuration
🔚 🖬 (1) PD - DIO10/PW/MO Configuration 🛛 🔛
Set/read sleep mode: Pin Hibernate is lowest power, Cyclic Sleep wakes on timer expiration,
transitions from a high to a low state. If SM is set to 0, the XBee is a router, otherwise it is an
end device.
COM59 9600 8-N-1 FLOW:NONE XB24C Ver:400E

- 4. Click **Write**. Again, a progress bar will be displayed in the Network window as the new parameter is written into memory.
- 5. Using the other default sleep settings the remote module will sleep for 320 ms at a time. To illustrate, the Associate LED should be flashing approximately 3 times per second as the radio alternately sleeps and checks for input.
- 6. You may close the Network window when finished.

Managing the Network

Using Gateways

Now that you have an RF network running, it is important to know how to manage the network. X-CTU software and the various RF module features provide good tools for on-site XBee configuration, firmware upgrades, and network diagnostics. However, in many cases it is necessary for the end user to be able to perform these functions from a remote location via the Internet. Digi has solved this problem by creating RF-to-Internet gateways to allow monitoring and control of your RF network through the Internet.



In the diagram above, a Digi ConnectPort gateway is used to connect an RF network (plus other peripherals) to the Internet via either the Ethernet port or a cellular WAN connection. Note that gateways are programmable and can also be used to run local monitoring/control of the RF network, with or without Internet connectivity. See www.digi.com/products/wirelessdropinnetworking/gateways for an overview of Digi gateways.

Understanding Cloud Connectivity

On a larger scale, the next task is to manage several gateways with multiple RF networks. Challenges with managing gateways include knowledge of IP addresses, access through firewalls, security and reliability of servers, scalability as the number of gateways grows, and ongoing maintenance for each of these functions. iDigi[™] Manager Pro is Digi's device management solution.

iDigi Manager Pro is a subscription-based solution that offers robust network management capability and on-demand scalability hosted on a high-availability, commercial-class cloud platform. iDigi is monitored by Digi's operations organization continuously and provides both Tier 1 and Tier 2 support.

[®]Dıgı [•]					
Home	XBee Networks				
Welcome Documentation	XBee Networks 00:13:a2:00:40:34:02:30!				
Management	Search: Q, x ¥				
Devices	Network Gateway	Node Address	Node ID	Module Type	Product Type
XBee Networks	5 00409DFF-FF29789A	A 00 13 s2 00 40 34 02 30		XBee ZB	X8 Gateway
Storage	📩 00409DFF-FF316347	🔆 00 13 a2 00 40 0a 29 2a		XBee ZB	X2 Gateway
Web Services Console	🖧 00409DFF-FF3238A5	A 00:13:a2:00:40:0a:15:b7!		XBee ZB	X8 Gateway
Subscriptions	🖧 00409DFF-FF33875D	🔆 00:13:a2:00:40:0a:38:6a!	X8 Coordinator	×Bee ZB	X8 Gateway
Summary Details		(m) + 00:13:a2:00:40:3e:26:1f	Upstairs	×Bee ZB	Wall Router
		(m) 1 00:13:a2:00:40:48:59:bd	Downstairs	×Bee ZB	Smart Plug
	🖧 00409DFF-FF33B89D	A 00:13:a2:00:40:0a:38:bf		XBee ZNet 2.5	X8 Gateway
P Administration	\$ 00409DFF-FF36DF43	A 00:13:a2:00:40:54:1d.fo!		XBee ZB	X4 Gateway
My Account Messages	🖧 00409DFF-FF382CF3	% 00:13:a2:00:40:52:6f.7e	X4_Gateway	XBee ZB	X4 Gateway
Operations		(m) + 00 13 a2 00 40 34 0a 6d	Smart_Plug_1	XBee ZB	Smart Plug

The image above shows the secure connection to your gateway or end device after logging on to your iDigi account. Learn more about managing your remote devices at www.idigi.com. Digi provides end-to-end products and services in order to make wireless M2M easy.