Digi XBee® Cellular 3G Global

Embedded Modem

User Guide

Revision history—90001541

Revision	Date	Description
A	June, 2017	Baseline release of the document.
B	June 2017	Updated the cellular service information.

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Digi XBee Cellular 3G Global Embedded Modem User Guide

The XBee Cellular Modem integrates an embedded Wideband Code Division Multiple Access (WCDMA) cellular module and enables original equipment manufacturers (OEMs) to incorporate 3G cellular technology into their devices and applications without painful, time-consuming, and expensive FCC and carrier end-device certifications.

With the full suite of standard XBee API frames and AT commands, existing XBee customers can seamlessly transition to this new device with only minor software adjustments. When OEMs add the XBee Cellular Modem to their product, they create a future-proof design with flexibility to switch between wireless protocols or frequencies as needed.

Applicable firmware and hardware

This manual supports the following firmware:

- 113xx

It supports the following hardware:

- XBC-M5-UT-xxx

Purchase the correct SIM cards

The XBee Cellular Modem requires a 4FF (Nano) size SIM card. The SIM interface supports both 1.8 V and 3 V SIM types.

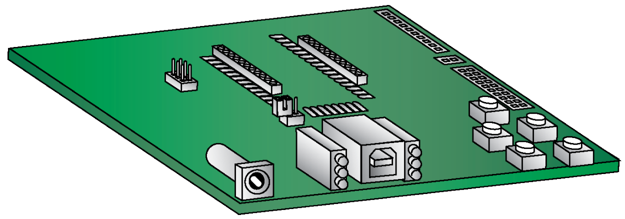
Getting started with the XBee Cellular Modem Development Kit

This section describes how to connect the hardware in the XBee Cellular Modem Development Kit, and provides some examples you can use to communicate with the device.

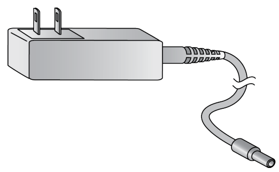
Identify the kit contents

The Developer's kit includes the following:

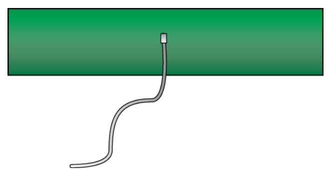
One XBIB-U-DEV board



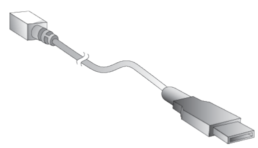
One 12 V power supply



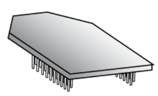
One antenna with U.FL connectors



One USB cable



One XBee Cellular Modem



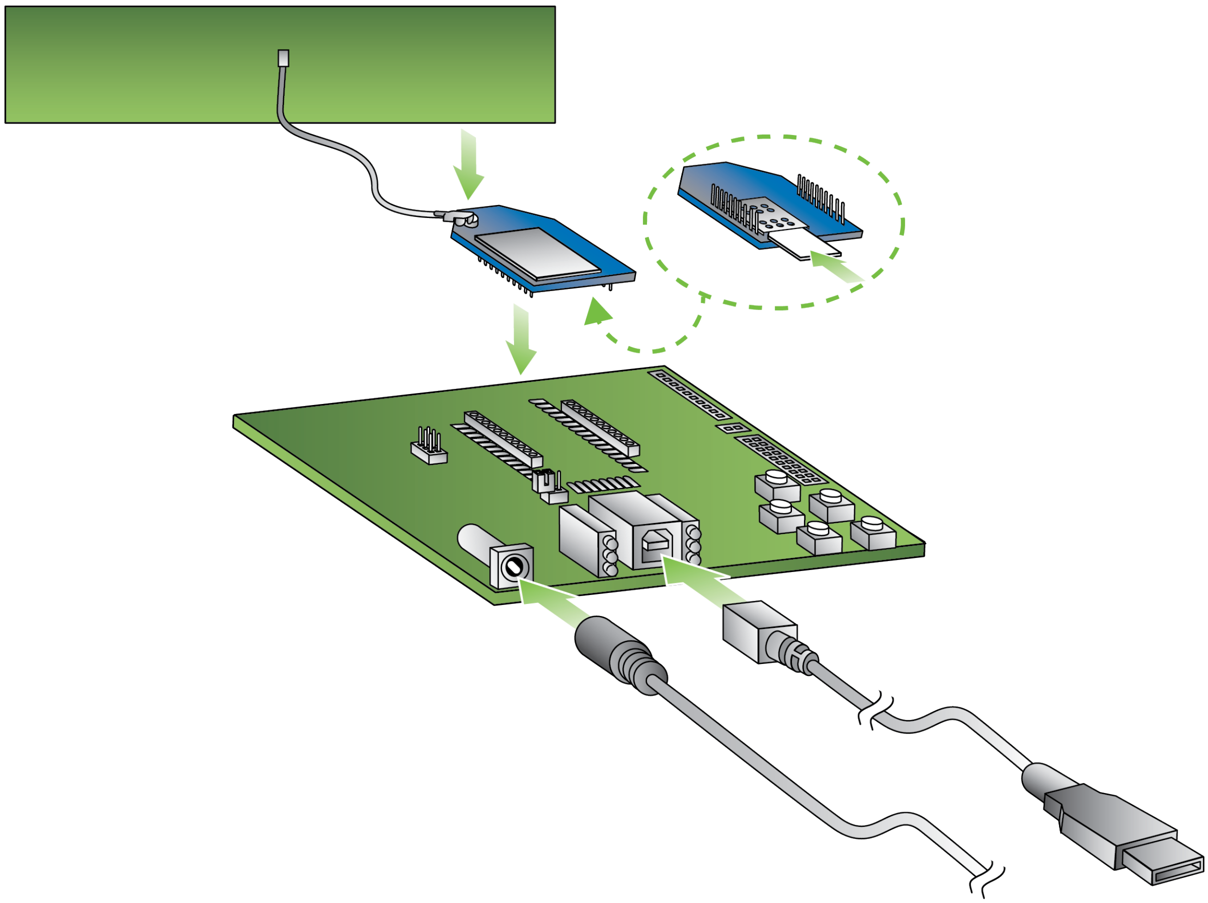
One SIM card

Cellular service

KIT USERS: The SIM card shipped with your 3G Global Kit is data-only and does not support SMS or phone numbers. These features are fully supported with full-service SIMs on XBee Cellular Modem. Contact Digi at 1.877.890.4014 for SIM card support.

The XBee Cellular kit includes six months of free cellular service.

Connect the hardware



1. The XBee Cellular Modem should already be plugged into the XBIB-U-DEV board.
2. The SIM card should be already be inserted into the XBee Cellular Modem. If not, install the SIM card into the XBee Cellular Modem.

WARNING! Never insert or remove the SIM card while the device is powered!

WARNING! The development board power supply only supports 3G mode. It does not support 2G mode.

3. Connect the antenna to the XBee Cellular Modem by aligning the U.FL connector carefully, then firmly pressing straight down to seat the connector. You should hear a snap when the antenna attaches correctly. U.FL is fragile and is not designed for multiple insertions, so exercise caution when connecting or removing the antennas. We recommend using a U.FL removal tool.
4. Plug the 12 V power supply to the power jack on the development board.

5. Connect the USB cable from a PC to the USB port on the development board. The computer searches for a driver, which can take a few minutes to install.

Configure the device using XCTU

XBee Configuration and Test Utility (XCTU) is a multi-platform program that enables users 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 instructions on downloading and using XCTU, see the XCTU User Guide.

Note If you are on a macOS computer and encounter problems installing XCTU, see Correct a macOS Java error.

Add a device

These instructions show you how to add the XBee Cellular Modem to XCTU. If XCTU does not find your serial port, see Cannot find the serial port for the device.

1. Launch XCTU .
2. Click the **Discover radio modules** button .
3. In the **Discover radio devices** dialog, select the serial ports where you want to look for XBee modules, and click **Next**.
4. In the **Set port parameters** window, maintain the default values and click **Finish**.
5. As XCTU locates radio modules, they appear in the **Discovering radio modules** dialog box.

If your module could not be found, XCTU displays the **Could not find any radio module** dialog providing possible reasons why the module could not be added.

Update to the latest firmware

Firmware is the program code stored in the device's persistent memory that provides the control program for the device. Use XCTU to update the firmware.

1. Click the **Configuration working modes** button .
2. Select a local or remote XBee module from the **Radio Modules** list.
3. Click the **Update firmware** button .

   The **Update firmware** dialog displays the available and compatible firmware for the selected XBee module.
4. Select the product family of the XBee module, the function set, and the latest firmware version.
5. Click **Update**. A dialog displays update progress.

See How to update the firmware of your modules in the XCTU User Guide for more information.

Software libraries

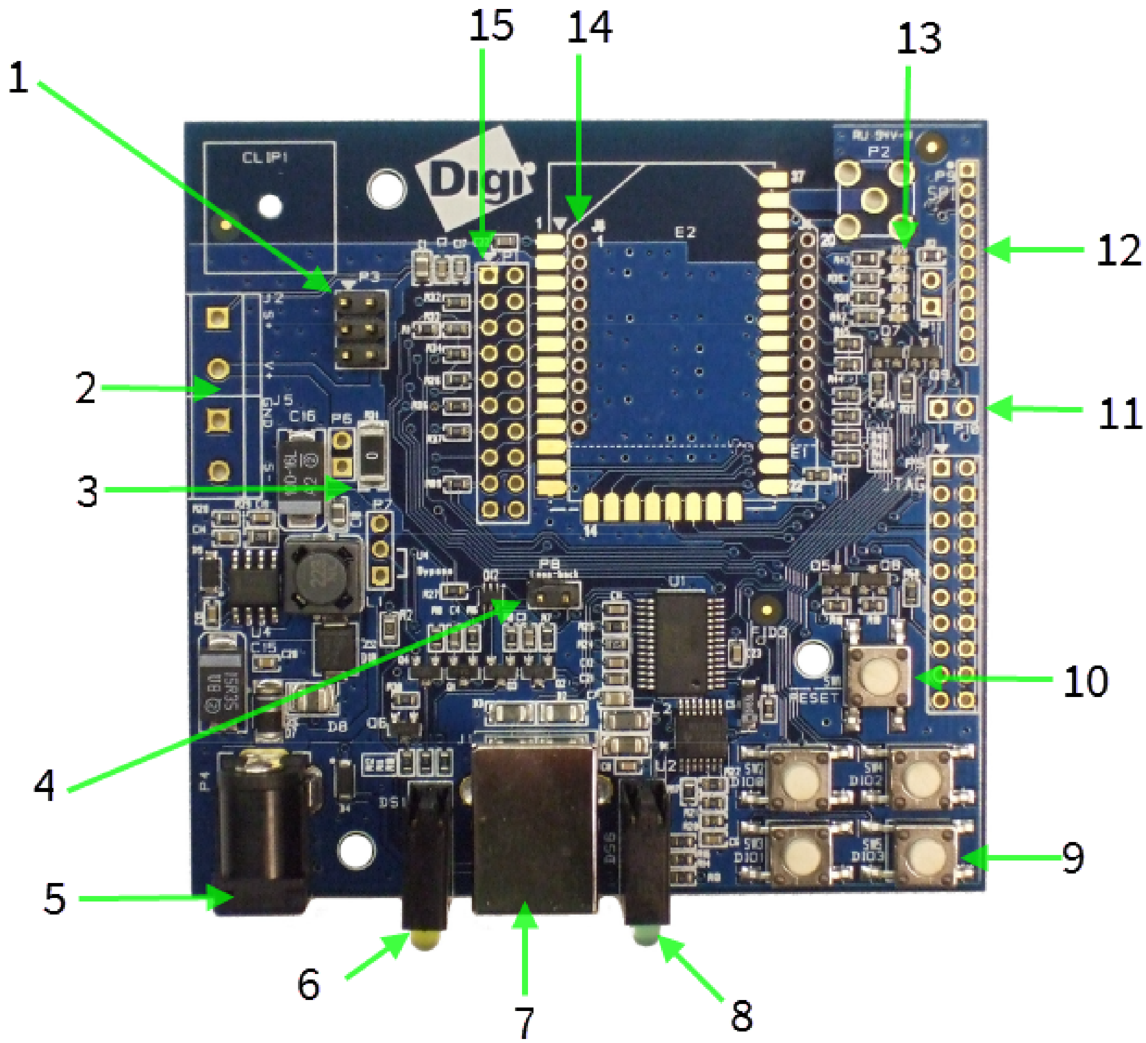
One way to communicate with the XBee device is by using a software library. The libraries available for use with the XBee Cellular Modem include:

- XBee Java library

The XBee Java Library is a Java API. The package includes the XBee library, its source code and a collection of samples that help you develop Java applications to communicate with your XBee devices.

XBIB-U-DEV reference

This picture shows the XBee USB development board and the table that follows explains the callouts in the picture.



Number	Item	Description
1	Programming header	Header used to program XBee Programmable devices.

Number	Item	Description
2	Self power module	Advanced users only—voids the warranty. Depopulate R31 to power the device using V+ and GND from J2 and J5. You can connect sense lines to S+ and S- for sensing power supplies.
		CAUTION: Voltage is not regulated. Applying the incorrect voltage can cause fire and serious injury.[1]
3	Current testing	Depopulating R31 allows a current probe to be inserted across P6 terminals. The current though P6/R31 powers the device only. Other supporting circuitry is powered by a different trace.
4	Loopback jumper	Populating P8 with a loopback jumper causes serial transmissions both from the device and from the USB to loopback.
5	DC barrel plug: 6-20 V	Greater than 500 mA loads require a DC supply for correct operation. Plug in the external power supply prior to the USB connector to ensure that proper USB communications are not interrupted.
6	LED indicator	Yellow: Modem sending serial/UART data to host. Green: Modem receiving serial/UART data from host. Red: Associate.
7	USB	
8	RSSI indicator	
9	User buttons	Connected to DIO lines for user implementation.
10	Reset button	
11	SPI power	Connect to the power board from 3.3 V.
12	SPI	Only used for surface-mount devices.
13	Indicator LEDs	DS5: ON/$\overline{\text{SLEEP}}$ DS2: DIO12, the LED illuminates when driven low. DS3: DIO11, the LED illuminates when driven low. DS4: DIO4, the LED illuminates when driven low.
14	Through-hole XBee sockets	
15	20-pin header	Maps to standard through-hole XBee pins.

Check for cellular registration and connection

In the following examples, proper cellular network registration and address assignment must occur successfully. The LED on the development board blinks when the XBee Cellular Modem registers to the cellular network; see The Associate LED. If the LED remains solid, registration has not occurred properly. Registration can take several minutes.

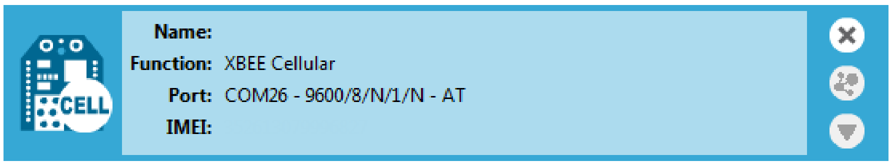
---

[1]Powering the board with J2 and J5 without R31 removed can cause shorts if the USB or barrel plug power are connected. Applying too high a voltage destroys electronic circuitry in the device and other board components and/or can cause injury.

Note Make sure you are in an area with adequate cellular network reception or the XBee Cellular Modem will not make the connection.

In addition to the LED confirmation, you can check the AT commands below in XCTU to check the registration and connection. To view these commands:

1. Open XCTU and click the **Configuration working mode** button.
2. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



3. On the Configuration toolbar, click the **Default** button to load the default values established by the firmware, and click **Yes** to confirm.

The relevant commands are:

Note To search for an AT command in XCTU, use the search box.

- **AI** (Association Indication) reads zero when the device successfully registers to the cellular network. If it reads 0x23 it is connecting to the Internet; 0x22 means it is registering to the cellular network.
- **MY** (Module IP Address) should display a valid IP address. If it reads **0.0.0.0**, it has not registered yet.

Flow control

We strongly encourage you to use flow control with the XBee Cellular Modem to prevent buffer overruns. See Serial communication for details on RTS and CTS flow control.

Connect to the ELIZA server

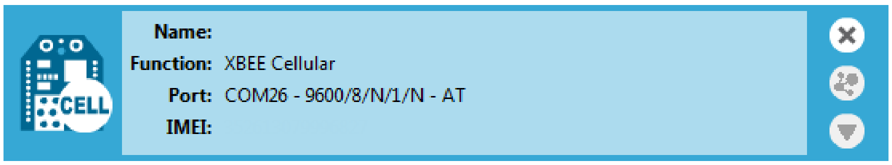
You can use the XBee Cellular Modem to chat with the ELIZA Therapist Bot. ELIZA is an artificial intelligence (AI) bot that emulates a therapist and can perform simple conversations.

The following table explains the AT commands that you use in this example.

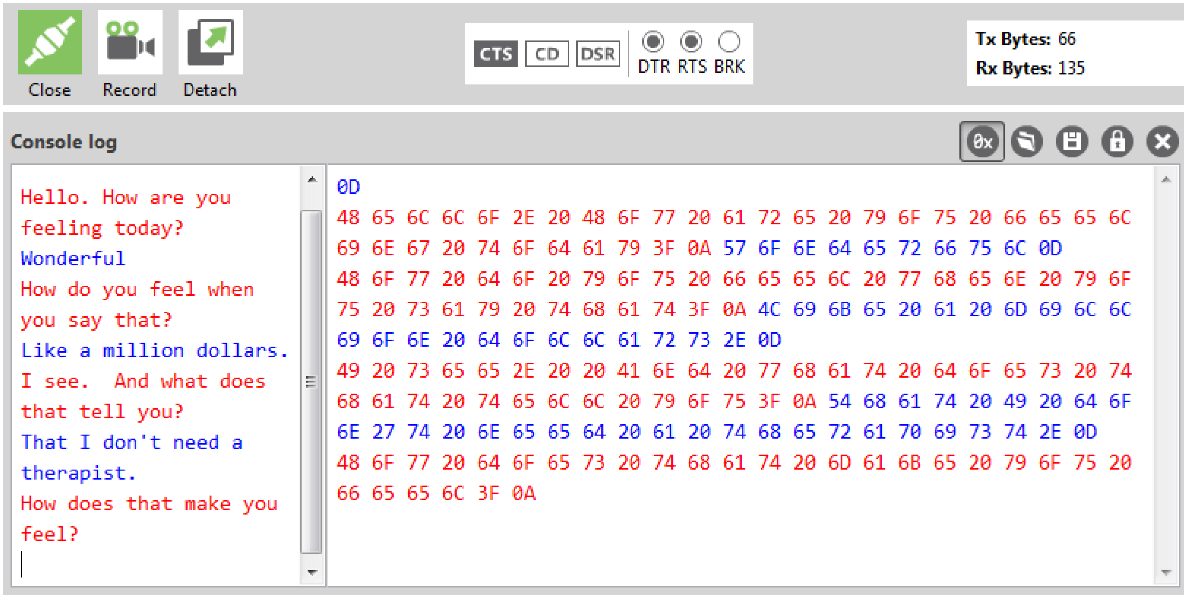
At command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
DL (Destination Address)	52.43.121.77	The target IP address of the Eliza server.
DE (Destination Port)	0x2328	The target port number of the Eliza server.

To communicate with the ELIZA Therapist Bot:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.
3. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



4. On the Configuration toolbar, click the **Default** button to load the default values established by the firmware, and click **Yes** to confirm.
5. Factory settings are loaded but not written to the device. To write them, click the **Write** button on the toolbar.
6. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button.
7. To enter the destination address of the ELIZA Therapist Bot, in the **DL** field, type **52.43.121.77** and click the **Write** button.
8. To enter the destination IP port number, in the **DE** field, type **2328** and click the **Write** button.
9. Click the **Consoles working mode** button on the toolbar to open a serial console to the device. For instructions on using the Console, see the AT console topic in the *XCTU User Guide*.
10. Click the **Open** button to open a serial connection to the device.
11. Click in the left pane of the **Console log**, then type in the Console to talk to the ELIZA Therapist Bot. The following screenshot provides an example of this chat.



Connect to the echo server

This server echoes back the messages you type.

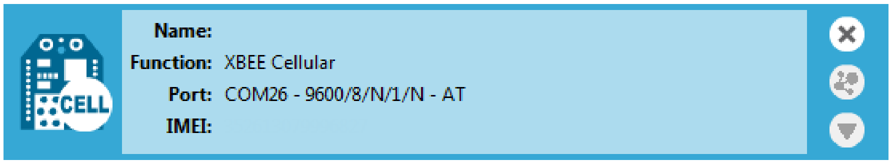
The following table explains the AT commands that you use in this example.

At command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
TD (Text Delimiter)	D (0x0D)	The text delimiter to be used for Transparent mode, as an ASCII hex code. No information is sent until this character is entered, unless the maximum number of characters has been reached. Set to zero to disable text delimiter checking. Set to **D** for a carriage return.
DL (Destination Address)	52.43.121.77	The target IP address of the echo server.
DE (Destination Port)	0x2329	The target port number of the echo server.

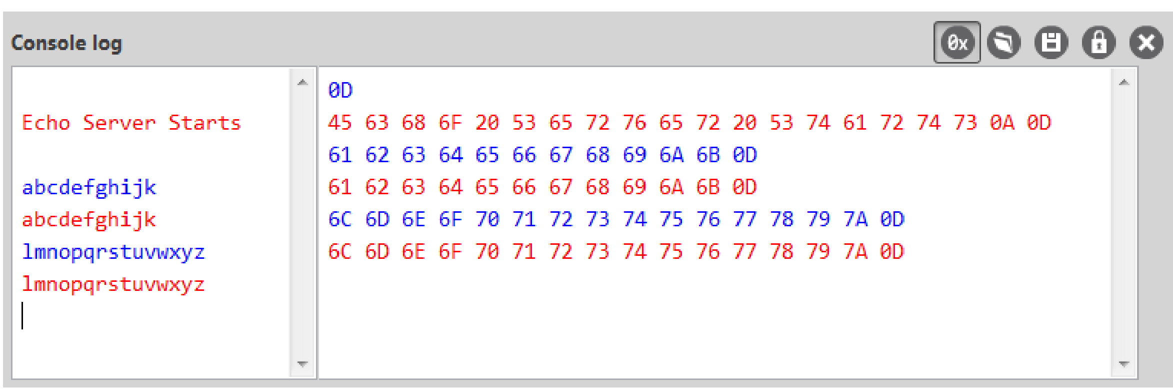
To communicate with the echo server:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.

3. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



4. On the Configuration toolbar, click the **Default** button to load the default values established by the firmware, and click **Yes** to confirm.
5. Factory settings are loaded but not written to the device. To write them, click the **Write** button on the toolbar.
6. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button .
7. To enable the XBee Cellular Modem to recognize carriage return as a message delimiter, in the **TD** field, type **D** and click the **Write** button.
8. To enter the destination address of the echo server, in the **DL** field, type **52.43.121.77** and click the **Write** button.
9. To enter the destination IP port number, in the **DE** field, type **2329** and click the **Write** button.
10. Click the **Consoles working mode** button on the toolbar to open a serial console to the device. For instructions on using the Console, see the AT console topic in the *XCTU User Guide*.
11. Click the **Open** button to open a serial connection to the device.
12. Click in the left pane of the **Console log**, then type in the Console to talk to the echo server. The following screenshot provides an example of this chat.



Connect to the Daytime server

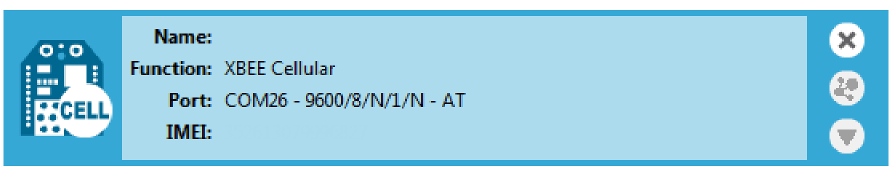
The Daytime server reports the current Coordinated Universal Time (UTC) value responding to any user input.

The following table explains the AT commands that you use in this example.

At command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
DL (Destination Address)	52.43.121.77	The target IP of the Daytime server.
DE (Destination Port)	0x232A	The target port number of the Daytime server.
TD (Text Delimiter)	0	The text delimiter to be used for Transparent mode, as an ASCII hex code. No information is sent until this character is entered, unless the maximum number of characters has been reached. Set to zero to disable text delimiter checking.

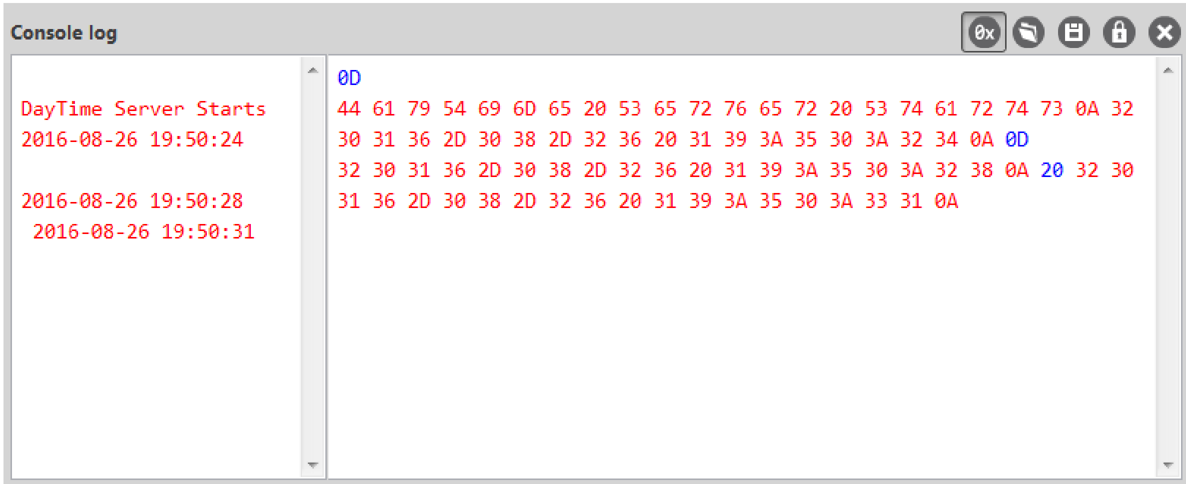
To communicate with the Daytime server:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.
3. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



4. On the Configuration toolbar, click the **Default** button to load the default values established by the firmware, and click **Yes** to confirm.
5. Factory settings are loaded but not written to the device. To write them, click the **Write** button on the toolbar.
6. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button.
7. To enter the destination address of the daytime server, in the **DL** field, type **52.43.121.77** and click the **Write** button.
8. To enter the destination IP port number, in the **DE** field, type **232A** and click the **Write** button.
9. To disable text delimiter checking, in the **TD** field, type **0** and click the **Write** button.
10. Click the **Consoles working mode** button on the toolbar to open a serial console to the device. For instructions on using the Console, see the AT console topic in the *XCTU User Guide*.
11. Click the **Open** button to open a serial connection to the device.

12. Click in the left pane of the **Console log**, then type in the Console to query the Daytime server. The following screenshot provides an example of this chat.



Connect to a TCP/IP address

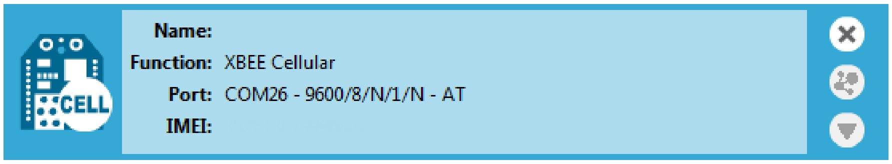
The XBee Cellular Modem can send and receive TCP messages while in Transparent mode; see Transparent operating mode.

You can use this example as a template for sending and receiving data from a user. The following table explains the AT commands that you use in this example.

Command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communication.
DL (Destination IP Address)	<Target IP address>	The target IP address that you send and receive from. For example, a data logging server's IP address that you want to send measurements to.
DE (Destination Port)	<Target port number>	The target port number that the device sends the transmission to. This is represented as a hexadecimal value.

To connect to a TCP/IP address:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.
3. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



4. On the Configuration toolbar, click the **Default** button to load the default values established by the firmware, and click **Yes** to confirm.
5. Factory settings are loaded but not written to the device. To write them, click the **Write** button on the toolbar.
6. In the **IP** field, select 1 and click the **Write** button .
7. In the **DL** field, type the <**target IP address**> and click the **Write** button. The target IP address is the IP address that you send and receive from.
8. In the **DE** field, type the <**target port number**>, converted to hexadecimal, and click the **Write** button.
9. Exit Command mode; see Exit Command mode.

After exiting Command mode, any UART data sent to the device is sent to the destination IP address and port number after the RO (Packetization Timeout) occurs.

Perform a (GET) HTTP request

You can use the XBee Cellular Modem to perform a GET Hypertext Transfer Protocol (HTTP) request using XCTU. This example uses http://httpbin.org/ (IP address: 54.175.219.8) as the target website that responds to the HTTP request.

To perform a GET request:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.
3. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.
4. To enter the destination address of the target website, in the **DL** field, type **httpbin.org** and click the **Write** button .
5. To enter the HTTP request port number, in the **DE** field, type **50** and click the **Write** button. Hexadecimal **50** is 80 in decimal.
6. To switch to TCP communication, in the **IP** field, select **1** and click the **Write** button.
7. To move into Transparent mode, in the **AP** field, select **0** and click the **Write** button.
8. Wait for the **AI** (Association Indication) value to change to **0** (Connected to the Internet).
9. Click the **Consoles working mode** button on the toolbar.

10. From the AT console, click the **Add new packet button** in the Send packets dialog. The **Add new packet** dialog appears.
11. Enter the name of the data packet.
12. Type the following data in the **ASCII** input tab:

    GET /ip HTTP/1.1
    Host: httpbin.org
13. Click the **HEX** input tab and add **0A** (zero A) after each **0D** (zero D), and add an additional **0D 0A** at the end of the message body. For example, copy and past the following text into the **HEX** input tab:

    47 45 54 20 2F 69 70 20 48 54 54 50 2F 31 2E 31 0D 0A 48 6F 73 74 3A 20 68 74 74 70 62 69 6E 2E 6F 72 67 0D 0A 0D 0A

Note The HTTP protocol requires an empty line (a line with nothing preceding the CRLF) to terminate the request.

14. Click **Add packet**.
15. Click the **Open** button.
16. Click **Send selected packet**.
17. A GET HTTP response from httpbin.org appears in the Console log.

Get started with MQTT

MQ Telemetry Transport (MQTT) is a messaging protocol that is ideal for the Internet of Things (IoT) due to a light footprint and its use of the publish-subscribe model. In this model, a client connects to a broker, a server machine responsible for receiving all messages, filtering them, and then sending messages to the appropriate clients.

The first two MQTT examples do not involve the XBee Cellular Modem. They demonstrate using the MQTT libraries because those libraries are required for Use MQTT over the XBee Cellular Modem with a PC.

The examples in this guide assume:

- Some knowledge of Python.
- An integrated development environment (IDE) such as PyCharm, IDLE or something similar.

The examples require:

- An XBee Cellular Modem.
- A compatible development board, such as the XBIB-U.
- XCTU. See Configure the device using XCTU.
- That you install Python on your computer. You can download Python from: https://www.python.org/downloads/.
- That you install the **pyserial** and **paho-mqtt** libraries to the Python environment. If you use Python 2, install these libraries from the command line with **pip install pyserial** and **pip install paho-mqtt**. If you use Python 3, use **pip3 install pyserial** and **pip3 install paho-mqtt**.

- The full MQTT library source code, which includes examples and tests, which is available in the paho-mqtt github repository at https://github.com/eclipse/paho.mqtt.python. To download this repository you must have Git installed.

Example: MQTT connect

This example provides insight into the structure of packets in MQTT as well as the interaction between the client and broker. MQTT uses different packets to accomplish tasks such as connecting, subscribing, and publishing. You can use XCTU to perform a basic example of sending a broker a connect packet and receiving the response from the server, without requiring any coding. This is a good way to see how the client interacts with the broker and what a packet looks like. The following table is an example connect packet:

	Description	Hex value
CONNECT packet fixed header		
byte 1	Control packet type	0x10
byte 2	Remaining length	0x10
CONNECT packet variable header		
Protocol name		
byte 1	Length MSB (0)	0x00
byte 2	Length LSB (4)	0x04
byte 3	(M)	0x4D
byte 4	(Q)	0x51
byte 5	(T)	0x54
byte 6	(T)	0x54
Protocol level		
byte 7	Level (4)	0x04
Connect flags		
byte 8	CONNECT flags byte, see the table below for the bits.	0X02
Keep alive		
byte 9	Keep Alive MSB (0)	0X00
byte 10	Keep Alive LSB (60)	0X3C
Client ID		
byte 11	Length MSB (0)	0x00
byte 12	Length LSB (4)	0x04
byte 13	(D)	0x44

	Description	Hex value
byte 14	(I)	0x49
byte 15	(G)	0x47
byte 16	(I)	0x49

The following table describes the fields in the packet:

Field name	Description
Protocol Name	The connect packet starts with the protocol name, which is MQTT. The length of the protocol name (in bytes) is immediately before the name itself.
Protocol Level	Refers to the version of MQTT in use, in this case a value of 4 indicates MQTT version 3.1.1.
Connect Flags	Indicate certain aspects of the packet. For simplicity, this example only sets the Clean Session flag, which indicates to the client and broker to discard any previous session and start a new one.
Keep Alive	How often the client pings the broker to keep the connection alive; in this example it is set to 60 seconds.
Client ID	The length of the ID (in bytes) precedes the ID itself. Each client connecting to a broker must have a unique client ID. In the example, the ID is DIGI. When using the Paho MQTT Python libraries, a random alphanumeric ID is generated if you do not specify an ID.

The following table provides the CONNECT flag bits from byte 8, the CONNECT flags byte.

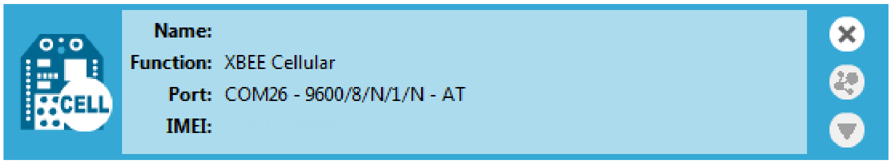
CONNECT Flag Bit(s)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
User name flag	0							
Password flag		0						
Will retain			0					
Will QoS				0	0			
Will flag						0		
Clean session							1	
Reserved								0

Send a connect packet

Now that you know what a connect packet looks like, you can send a connect packet to a broker and view the response. Open XCTU and click the Configuration working mode button.

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.

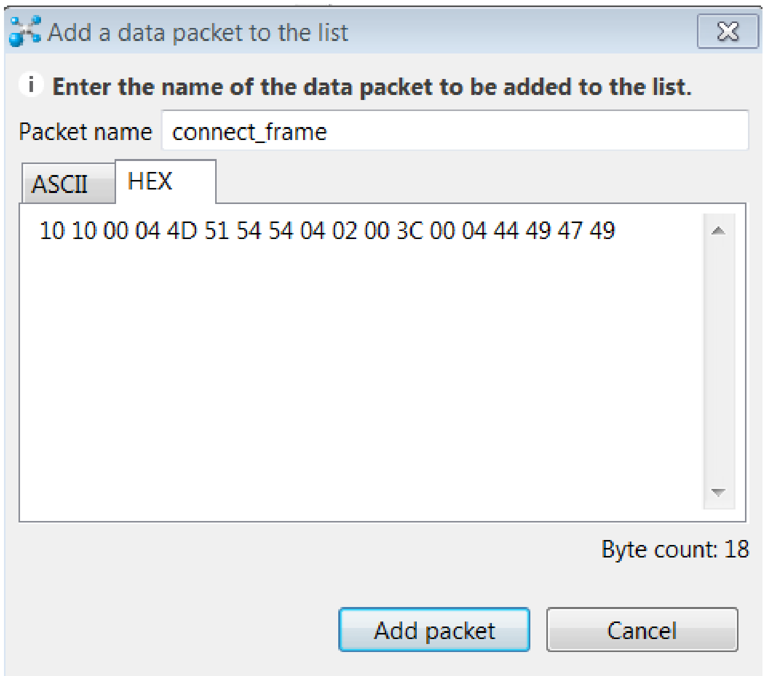
2. Open XCTU and click the **Configuration working mode** button.
3. Add the XBee Cellular Modem to XCTU; see Add a device.
4. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.



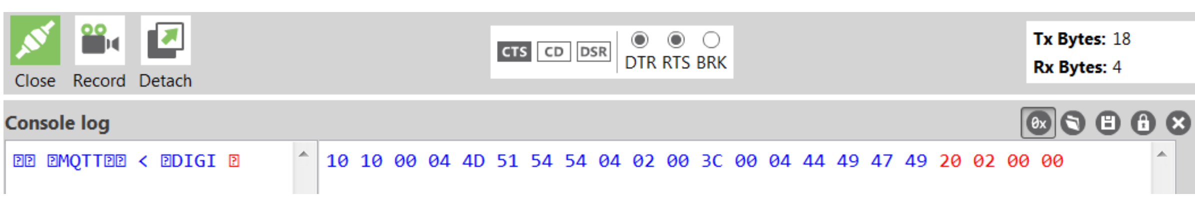
5. In the **AP** field, set **Transparent Mode** to **[0]** if it is not already and click the **Write** button.
6. In the **DL** field, type the IP address of the broker you wish to use. This example uses **198.41.30.241**, which is the IP address for m2m.eclipse.org, a public MQTT broker.
7. In the **DE** field, type **75B** and set the port that the broker uses. This example uses **75B**, because the default MQTT port is 1883 (0x75B).
8. Once you have entered the required values, click the **Write** button to write the changes to the XBee Cellular Modem.
9. Click the **Consoles working mode** button on the toolbar to open a serial console to the device. For instructions on using the Console, see the AT console topic in the *XCTU User Guide*.
10. Click the **Open** button to open a serial connection to the device.
11. From the AT console, click the **Add new packet button** in the Send packets dialog. The **Add new packet** dialog appears.
12. Enter the name of the data packet. Name the packet **connect_frame** or something similar.

13. Click the **HEX** input tab and type the following (these values are the same values from the table in Example: MQTT connect):

    10 10 00 04 4D 51 54 54 04 02 00 3C 00 04 44 49 47 49



14. Click **Add packet**. The new packet appears in the Send packets list.
15. Click the packet in the **Send packets** list.
16. Click **Send selected packet**.
17. A CONNACK packet response from the broker appears in the **Console log**. This is a connection acknowledgment; a successful response should look like this:



You can verify the response from the broker as a CONNACK by comparing it to the structure of a CONNACK packet in the MQTT documentation, which is available at http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.html#_Toc398718081).

Example: send messages (publish) with MQTT

A basic Python example of a node publishing (sending) a message is:

```
mqttc = mqtt.Client("digitest")  # Create instance of client with client ID
“digitest”
mqttc.connect("m2m.eclipse.org", 1883)  # Connect to (broker, port,
```

```
keepalive-time)
mqttc.loop_start()  # Start networking daemon
mqttc.publish("digitest/test1", "Hello, World!")  # Publish message to
“digitest /test1” topic
mqttc.loop_stop()  # Kill networking daemon
```

Note You can easily copy and paste code from the online version of this Guide. Use caution with the PDF version, as it may not maintain essential indentations.

This example imports the MQTT library, allowing you to use the MQTT protocol via APIs in the library, such as the **connect()**, **subscribe()**, and **publish()** methods.

The second line creates an instance of the client, named **mqttc**. The client ID is the argument you passed in: **digitest** (this is optional).

In line 3, the client connects to a public broker, in this case **m2m.eclipse.org**, on port **1883** (the default MQTT port, or 8883 for MQTT over SSL). There are many publicly available brokers available, you can find a list of them here: https://github.com/mqtt/mqtt.github.io/wiki/brokers.

Line 4 starts the networking daemon with **client.loop_start()** to handle the background network/data tasks.

Finally, the client publishes its message **Hello, World!** to the broker under the topic **digitest/backlog/test1**. Any nodes (devices, phones, computers, even microcontrollers) subscribed to that same topic on the same broker receive the message.

Once no more messages need to be published, the last line stops the network daemon with **client.loop_stop()**.

Example: receive messages (subscribe) with MQTT

This example describes how a client would receive messages from within a specific topic on the broker:

```
import paho.mqtt.client as mqtt


def on_connect(client, userdata, flags, rc):  # The callback for when the
client connects to the broker
    print("Connected with result code {0}".format(str(rc)))  # Print result
of connection attempt
    client.subscribe("digitest/test1")  # Subscribe to the topic
“digitest/test1”, receive any messages published on it


def on_message(client, userdata, msg):  # The callback for when a PUBLISH
message is received from the server.
    print("Message received-> " + msg.topic + " " + str(msg.payload))  #
Print a received msg


client = mqtt.Client("digi_mqtt_test")  # Create instance of client with
client ID “digi_mqtt_test”
client.on_connect = on_connect  # Define callback function for successful
connection
client.on_message = on_message  # Define callback function for receipt of a
message
# client.connect("m2m.eclipse.org", 1883, 60)  # Connect to (broker, port,
keepalive-time)
```

```
client.connect('127.0.0.1', 17300)
client.loop_forever()  # Start networking daemon
```

Note You can easily copy and paste code from the online version of this Guide. Use caution with the PDF version, as it may not maintain essential indentations.

The first line imports the library functions for MQTT.

The functions **on_connect** and **on_message** are callback functions which are automatically called by the client upon connection to the broker and upon receiving a message, respectively.

The **on_connect** function prints the result of the connection attempt, and performs the subscription. It is wise to do this in the callback function as it guarantees the attempt to subscribe happens only after the client is connected to the broker.

The **on_message** function prints the received message when it comes in, as well as the topic it was published under.

In the body of the code, we:

- Instantiate a client object with the client ID **digi_mqtt_test**
- Define the callback functions to use upon connection and upon message receipt
- Connect to an MQTT broker at **m2m.eclipse.org**, on port **1883** (the default MQTT port, or 8883 for MQTT over SSL) with a keepalive of 60 seconds (this is how often the client pings the broker to keep the connection alive).

The last line starts a network daemon that runs in the background and handles data transactions and messages, as well as keeping the socket open, until the script ends.

Use MQTT over the XBee Cellular Modem with a PC

To use this MQTT library over an XBee Cellular Modem, you need a basic proxy that transfers a payload received via the MQTT client's socket to the serial or COM port that the XBee Cellular Modem is active on, as well as the reverse; transfer of a payload received on the XBee Cellular Modem's serial or COM port to the socket of the MQTT client. This is simplest with the XBee Cellular Modem in Transparent mode, as it does not require code to parse or create API frames, and not using API frames means there is no need for them to be queued for processing.

1. To put the XBee Cellular Modem in Transparent mode, set **AP** to **0**.
2. Set **DL** to the IP address of the broker you want to use.
3. Set **DE** to the port to use, the default is 1883 (0x75B). This sets the XBee Cellular Modem to communicate directly with the broker, and can be performed in XCTU as described in Example: MQTT connect.
4. You can make the proxy with a dual-threaded Python script, a simple version follows:

```
import threading
import serial
import socket


def setup():
    """
    This function sets up the variables needed, including the serial port,
    and it's speed/port settings, listening socket, and localhost adddress.
```

```
    """
    global clisock, cliaddr, svrsock, ser
    # Change this to the COM port your XBee Cellular module is using.  On
    # Linux, this will be /dev/ttyUSB#
    comport = 'COM44'
    # This is the default serial communication speed of the XBee Cellular
    # module
    comspeed = 115200
    buffer_size = 4096  # Default receive size in bytes
    debug_on = 0  # Enables printing of debug messages
    toval = None  # Timeout value for serial port below
    # Serial port object for XBCell modem
    ser = serial.Serial(comport,comspeed,timeout=toval)
    # Listening socket (accepts incoming connection)
    svrsock = socket.socket(socket.AF_INET,socket.SOCK_STREAM)
    # Allow address reuse on socket (eliminates some restart errors)
    svrsock.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)
    clisock = None
    cliaddr = None  # These are first defined before thread creation
    addrtuple = ('127.0.0.1', 17300)  # Address tuple for localhost
    # Binds server socket to localhost (allows client program connection)
    svrsock.bind(addrtuple)
    svrsock.listen(1)  # Allow (1) connection


def ComReaderThread():
    """
    This thread listens on the defined serial port object ('ser') for data
    from the modem, and upon receipt, sends it out to the client over the
    client socket ('clisock').
    """
    global clisock
    while (1):
        resp = ser.read()  ## Read any available data from serial port
        print("Received {} bytes from modem.".format(len(resp)))

        clisock.sendall(resp)  # Send RXd data out on client socket
        print("Sent {} byte payload out socket to client.".format(len
(resp)))


def SockReaderThread():
    """
    This thread listens to the MQTT client's socket and upon receiving a
    payload, it sends this data out on the defined serial port ('ser') to
the
    modem for transmission.
    """

    global clisock
    while (1):
        data = clisock.recv(4096)  # RX data from client socket
        # If the RECV call returns 0 bytes, the socket has closed
        if (len(data) == 0):
            print("ERROR - socket has closed.  Exiting socket reader
thread.")
            return 1  # Exit the thread to avoid a loop of 0-byte receptions
        else:
            print("Received {} bytes from client via socket.".format(len
```

```
(data)))
            print("Sending payload to modem...")
            bytes_wr = ser.write(data)  # Write payload to modem via
UART/serial
            print("Wrote {} bytes to modem".format(bytes_wr))

def main():
    setup()  # Setup the serial port and socket
    global clisock, svrsock
    if (not clisock):  # Accept a connection on 'svrsock' to open 'clisock'
        print("Awaiting ACCEPT on server sock...")
        (clisock,cliaddr) = svrsock.accept()  # Accept an incoming
connection
        print("Connection accepted on socket")
    # Make thread for ComReader
    comthread = threading.Thread(target=ComReaderThread)
    comthread.start()  # Start the thread
    # Make thread for SockReader
    sockthread = threading.Thread(target=SockReaderThread)
    sockthread.start()  # Start the thread

main()
```

Note This script is a general TCP-UART proxy, and can be used for other applications or scripts that use the TCP protocol. Its functionality is not limited to MQTT.

Note You can easily copy and paste code from the online version of this Guide. Use caution with the PDF version, as it may not maintain essential indentations.

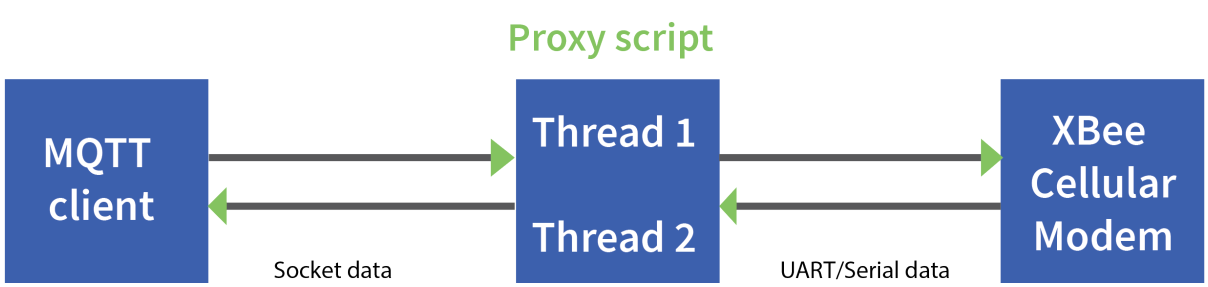
This proxy script waits for an incoming connection on localhost (**127.0.0.1**), on port **17300**. After accepting a connection, and creating a socket for that connection (**clisock**), it creates two threads, one that reads the serial or COM port that the XBee Cellular Modem is connected to, and one that reads the socket (**clisock**), that the MQTT client is connected to.

With:

- The proxy script running
- The MQTT client connected to the proxy script via localhost (**127.0.0.1**)
- The XBee Cellular Modem connected to the machine via USB and properly powered
- **AP**, **DL**, and **DE** set correctly

the proxy acts as an intermediary between the MQTT client and the XBee Cellular Modem, allowing the MQTT client to use the data connection provided by the device.

Think of the proxy script as a translator between the MQTT client and the XBee Cellular Modem. The following figure shows the basic operation.



The thread that reads the serial port forwards any data received onward to the client socket, and the thread reading the client socket forwards any data received onward to the serial port. This is represented in the figure above.

The proxy script needs to be running before running an MQTT publish or subscribe script.

1. With the proxy script running, run the subscribe example from Example: receive messages (subscribe) with MQTT, but change the connect line from **client.connect("m2m.eclipse.org", 1883, 60)** to **client.connect("127.0.0.1", port=17300, keepalive=20**). This connects the MQTT client to the proxy script, which in turn connects to a broker via the XBee Cellular Modem's internet connection.
2. Run the publish example from Example: send messages (publish) with MQTT in a third Python instance (while the publish script is running you will have three Python scripts running at the same time).

The publish script runs over your computer's normal internet connection, and does not use the XBee Cellular Modem. You are able to see your published message appear in the subscribe script's output once it is received from the broker via the XBee Cellular Modem. If you watch the output of the proxy script during this process you can see the receptions and transmissions taking place.

The proxy script must be running before you run the subscribe and publish scripts. If you stop the subscribe script, the socket closes, and the proxy script shows an error. If you try to start the proxy script after starting the subscribe script, you may also see a socket error. To avoid these errors, it is best to start the scripts in the correct order: proxy, then subscribe, then publish.

Get started with CoAP

Constrained Application Protocol (CoAP) is based on UDP connection and consumes low power to deliver similar functionality to HTTP. This guide contains information about sending GET, POST, PUT and DELETE operations by using the Coap Protocol with XCTU and Python code working with the XBee Cellular Modem and Coapthon library (Python 2.7 only).

The Internet Engineering Task Force describes CoAP as:

> The protocol is designed for machine-to-machine (M2M) applications such as smart energy and building automation. CoAP provides a request/response interaction model between application endpoints, supports built-in discovery of services and resources, and includes key concepts of the Web such as URIs and Internet media types. CoAP is designed to easily interface with HTTP for integration with the Web while meeting specialized requirements such as multicast support, very low overhead, and simplicity for constrained environments (source).

CoAP terms

When describing CoAP, we use the following terms:

Term	Meaning
Method	COAP's method action is similar to the HTTP method. This guide discusses the GET, POST, PUT and DELETE methods. With these methods, the XBee Cellular Modem can transport data and requests.
URI	URI is a string of characters that identifies a resource served at the server.

Term	Meaning
Token	A token is an identifier of a message. The client uses the token to verify if the received message is the correct response to its query.
Payload	The message payload is associated with the POST and PUT methods. It specifies the data to be posted or put to the URI resource
Message ID	The message ID is also an identifier of a message. The client matches the message ID between the response and query.

CoAP quick start example

The following diagram shows the message format for the CoAP protocol; see ISSN: 2070-1721 for details:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Ver| T |  TKL  |      Code     |          Message ID           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Token (if any, TKL bytes) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Options (if any) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|1 1 1 1 1 1 1 1|    Payload (if any) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

This is an example GET request:

44 01 C4 09 74 65 73 74 B7 65 78 61 6D 70 6C 65

The following table describes the fields in the GET request.

Field	HEX	Bits	Meaning
Ver	44	01	Version 01, which is mandatory here.
T		00	Type 0: confirmable.
TKL		0100	Token length: 4.
Code	01	000 00001	Code: 0.01, which indicates the GET method.
Message ID	C4 09	2 Bytes equal to hex at left	Message ID. The response message will have the same ID. This can help out identification.
Token	74 65 73 74	4 Bytes equal to hex at left	Token. The response message will have the same token. This can help out identification.
Option delta	B7	1011	Delta option: 11 indicates the option data is Uri-Path.
Option length		0111	Delta length: 7 indicates there are 7 bytes of data following as a part of this delta option.
Option value	65 78 61 6D 70 6C 65	7 Bytes equal to hex at left	Example.

Configure the device

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in Connect the hardware.
2. Open XCTU and click the **Configuration working mode** button.
3. Add the XBee Cellular Modem to XCTU; see Add a device.
4. Select a device from the **Radio Modules** list. XCTU displays the current firmware settings for that device.
5. To switch to UDP communication, in the **IP** field, select **0** and click the **Write** button .
6. To set the target IP address that the XBee Cellular Modem will talk to, in the **DL** field type **52.43.121.77**and click the **Write** button . A CoAP server is publicly available at address 52.43.121.77.
7. To set the XBee Cellular Modem to send data to port 5683 in decimal, in the **DE** field, type **1633** and click the **Write** button.
8. To move into Transparent mode, in the **AP** field, select **0** and click the **Write** button.
9. Wait for the **AI** (Association Indication) value to change to **0** (Connected to the Internet). You can click **Read** to get an update on the **AI** value.

Example: manually perform a CoAP request

Follow the steps in Configure the device prior to this example. This example performs the CoAP GET request:

- Method: GET
- URI: example
- Given message token: test

1. Click the **Consoles working mode** button on the toolbar to add a customized packet.
2. From the AT console, click the **Add new packet button** in the Send packets dialog. The **Add new packet** dialog appears.
3. Click the **HEX** tab and type the name of the data packet: **GET_EXAMPLE**.
4. Copy and past the following text into the **HEX** input tab:
   44 01 C4 09 74 65 73 74 B7 65 78 61 6D 70 6C 65
   This is the CoAP protocol message decomposed by bytes to perform a GET request on an example URI with a token test.
5. Click **Add packet**.
6. Click the **Open** button .

7. Click **Send selected packet**. The message is sent to the public CoAP server configured in Configure the device. A response appears in the Console log. Blue text is the query, red text is the response.

The payload is **Get to uri: example**, which specifies that this is a successful CoAP GET to URI end example, which was specified in the query.

Click the **Close** button to terminate the serial connection.

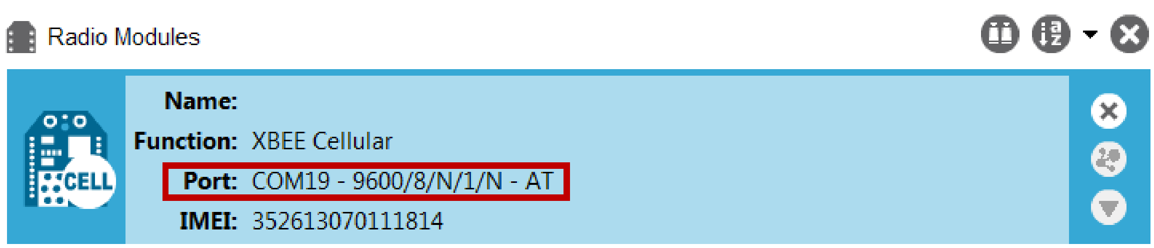
Example: use Python to generate a CoAP message

This example illustrates how the CoAP protocol can perform GET/POST/PUT/DELETE requests similarly to the HTTP protocol and how to do this using the XBee Cellular Modem. In this example, the XBee Cellular Modem talks to a CoAP Digi Server. You can use this client code to provide an abstract wrapper to generate a CoAP message that commands the XBee Cellular Modem to talk to the remote CoAP server.

Note It is crucial to configure the XBee Cellular Modem settings. See Configure the device and follow the steps. You can target the IP address to a different CoAP public server.

1. Install Python 2.7. The Installation guide is located at: https://www.python.org/downloads/.
2. Download and install the Coapthon library in the python environment from https://pypi.python.org/pypi/CoAPthon.
3. Download these two .txt files: Coap.txt and CoapParser.txt. After you download them, open the files in a text editor and save them as .py files.
4. In the folder that you place the Coap.py and CoapParser.py files, press **Shift** + **right-click** and then click **Open command window**.
5. At the command prompt, type **python Coap.py** and press **Enter** to run the program.
6. Type the USB port number that the XBee Cellular Modem is connected to and press **Enter**. Only the port number is required, so if the port is COM19, type 19.

Note If you do not know the port number, open XCTU and look at the XBee Cellular Modem in the **Radio Modules** list. This view provides the port number and baud rate, as in the figure below where the baud rate is 9600 b/s.



7. Type the baud rate and press **Enter**. You must match the device's current baud rate. XCTU provides the current baud rate in the **BD Baud Rate** field. In this example you would type **9600**.
8. Press **Y** if you want an auto-generated example. Press **Enter** to build your own CoAP request.
9. If you press **Y** it generates a message with:

- Method: POST
- URI: example
- payload: hello world
- token: test

The send and receive message must match the same token and message id. Otherwise, the client re-attempts the connection by sending out the request.

In the following figure, the payload contains the server response to the query. It shows the results for when you press **Enter** rather than **Y**.

```
C:\Users\jzhang\Desktop\example>python Coap.py
Please enter the serial port number for Xbee: 18
Please enter the baudrate number of Xbee: (9600 or 115200): 9600
Do you want an auto-generated example (Press Y) or build your own (Press ENTER):

Please enter the HTTP method (GET, POST, PUT, DELETE): PUT
Please enter the uri end path: example
Please enter the payload content. And it cannot be empty: hello world
Please enter the token: digi

##############################################

This is the send out message:
Source: (None, None)
Destination: None
Type: CON
MID: 56045
Code: PUT
Token: digi
Uri-Path: example
Payload:
hello world

This is the received message
Source: (None, None)
Destination: None
Type: ACK
MID: 56045
Code: CHANGED
Token: digi
Payload:
Put hello world to uri: example
```

Configure the XBee Cellular Modem using Digi Remote Manager

Use Digi Remote Manager (https://remotemanager.digi.com/) to perform the operations in this section. Each operation requires that you enable Remote Manager with the **DO** command and that you connect the XBee Cellular Modem to an access point that has an external Internet connection to allow access to Digi Remote Manager.

Note Digi is consolidating our cloud services, Digi Device Cloud and Digi Remote Manager®, under the Remote Manager name. This phased process does not affect device functionality or the functionality of the web services and other features. However, customers will find that some user interface and firmware functionality mention both Device Cloud and Digi Remote Manager.

Create a Remote Manager account

Digi Remote Manager is an on-demand service with no infrastructure requirements. Remote devices and enterprise business applications connect to Remote Manager through standards-based web services. This section describes how to configure and manage an XBee using Remote Manager. For detailed information on using Remote Manager, refer to the Remote Manager User Guide, available via the Documentation tab in Remote Manager.

Before you can manage an XBee with Remote Manager, you must create a Remote Manager account. To create a Remote Manager account:

1. Go to https://www.digi.com/products/cloud/digi-remote-manager.
2. Click **30 DAY FREE TRIAL/LOGIN**.
3. Follow the online instructions to complete account registration. You can upgrade your Developer account to a paid account at any time.

When you are ready to deploy multiple XBee Cellular Modems in the field, upgrade your account to access additional Remote Manager features.

Get the XBee Cellular Modem IMEI number

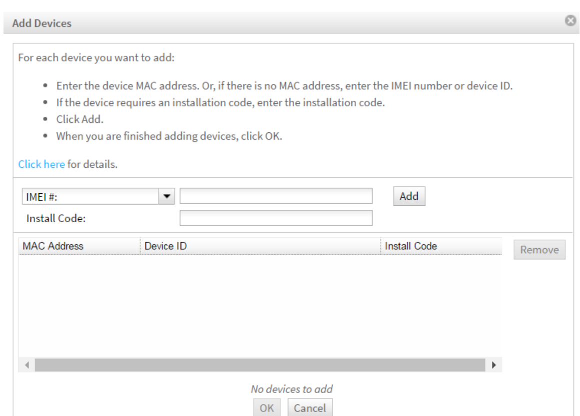
Before adding an XBee to your Remote Manager account inventory, you need to determine the International Mobile Equipment Identity (IMEI) number for the device. Use XCTU to view the IMEI number by querying the **IM** parameter.

Add a XBee Cellular Modem to Remote Manager

To add an XBee to your Remote Manager account inventory, follow these steps:

Go to https://remotemanager.digi.com/.

1. Log in to your account
2. Click **Device Management** > **Devices**.
3. Click **Add Devices**. The Add Devices dialog appears.
4. Select **IMEI #**, and type or paste the IMEI number of the XBee you want to add. The IM (IMEI) command provides this number.



5. Click **Add** to add the device. The XBee is added to your inventory.
6. Click **OK** to close the Add Devices dialog and return to the Devices view.

Update the firmware

XBee Cellular Modem supports Remote Manager firmware updates. To perform a firmware update, use the following steps.

1. Download the updated firmware file for your device from Digi's support site. This is a zip file containing .ebin and .mxi files for import.

2. Unzip the file.
3. In your Remote Manager account, click **Device Management > Devices**.
4. Select the first device you want to update.
5. To select multiple devices (must be of the same type), press the Control key and select additional devices.
6. Click **More** in the Devices toolbar and select **Update Firmware** from the Update category of the More menu. The Update Firmware dialog appears.
7. Click **Browse** to select the .ebin file that you unzipped earlier.
8. Click **Update Firmware**. The updated devices automatically reboot when the updates are complete.

Get started with MicroPython

This guide provides an overview of how to use MicroPython with the XBee Cellular Modem. For in-depth information and more complex code examples, refer to the Digi MicroPython Programming Guide. Continue with this guide for simple examples to get started using MicroPython on the XBee Cellular Modem.

About MicroPython

MicroPython is an open-source programming language based on Python 3, with much of the same syntax and functionality, but modified to fit on small devices with limited hardware resources, such as microcontrollers, or in this case, a cellular modem.

Why use MicroPython

MicroPython enables on-board intelligence for simple sensor or actuator applications using digital and analog I/O. MicroPython can help manage battery life. Cryptic readings can be transformed into useful data, excess transmissions can be intelligently filtered out, modern sensors and actuators can be employed directly, and logic can glue inputs and outputs together in an intelligent way.

For more information about MicroPython, see www.micropython.org.

For more information about Python, see www.python.org.

MicroPython on the XBee Cellular Modem

The XBee Cellular Modem has MicroPython running on the device itself. You can access a MicroPython prompt from the XBee Cellular Modem when you install it in an appropriate development board (XBDB or XBIB), and connect it to a computer via a USB cable.

The examples in this guide assume:

- You have XCTU on your computer. See Configure the device using XCTU.
- You have a terminal program installed on your computer. We recommend using the Use the MicroPython Terminal in XCTU. This requires XCTU 6.3.7 or higher.
- You have an XBee Cellular Modem installed in an appropriate development board such as an XBIB-U-DEV or an XBIB-2.

Note Most examples in this guide require the XBIB-U-DEV board.

- The XBee Cellular Modem is connected to the computer via a USB cable and XCTU recognizes it.
- The board is powered by an appropriate power supply, 12 VDC and at least 1.1 A.

Use XCTU to enter the MicroPython environment

To use the XBee Cellular Modem in the MicroPython environment:

1. Use XCTU to add the device(s); see Configure the device using XCTU and Add a device.
2. The XBee Cellular Modem appears as a box in the **Radio Modules** information panel. Each module displays identifying information about itself.
3. Click this box to select the device and load its current settings.
4. To set the device's baud rate to 115200 b/s, in the **BD** field select **115200 [7]** and click the **Write** button. We recommend using flow control to avoid data loss, especially when pasting large amounts of code/text.

5. To put the XBee Cellular Modem into MicroPython mode, in the **AP** field select **MicroPython REPL [4]** and click the **Write** button .
6. Note what COM port(s) the XBee Cellular Modem is using, because you will need this information when you use terminal communication.

Use the MicroPython Terminal in XCTU

You can use the MicroPython Terminal to communicate with the XBee Cellular Modem when it is in MicroPython mode.[1] This requires XCTU 6.3.7 or higher. To enter MicroPython mode, follow the steps in Use XCTU to enter the MicroPython environment. To use the MicroPython Terminal:

1. Click the **Tools** drop-down menu and select **MicroPython Terminal**. The terminal opens.
2. Click **Open**.
3. In the **Select the Serial/USB port** area, click the COM port that the device uses.
4. Verify that the baud rate and other settings are correct.
5. Click **OK**. The **Open** icon changes to **Close** , indicating that the device is properly connected.

You can now type or paste MicroPython code in the terminal.

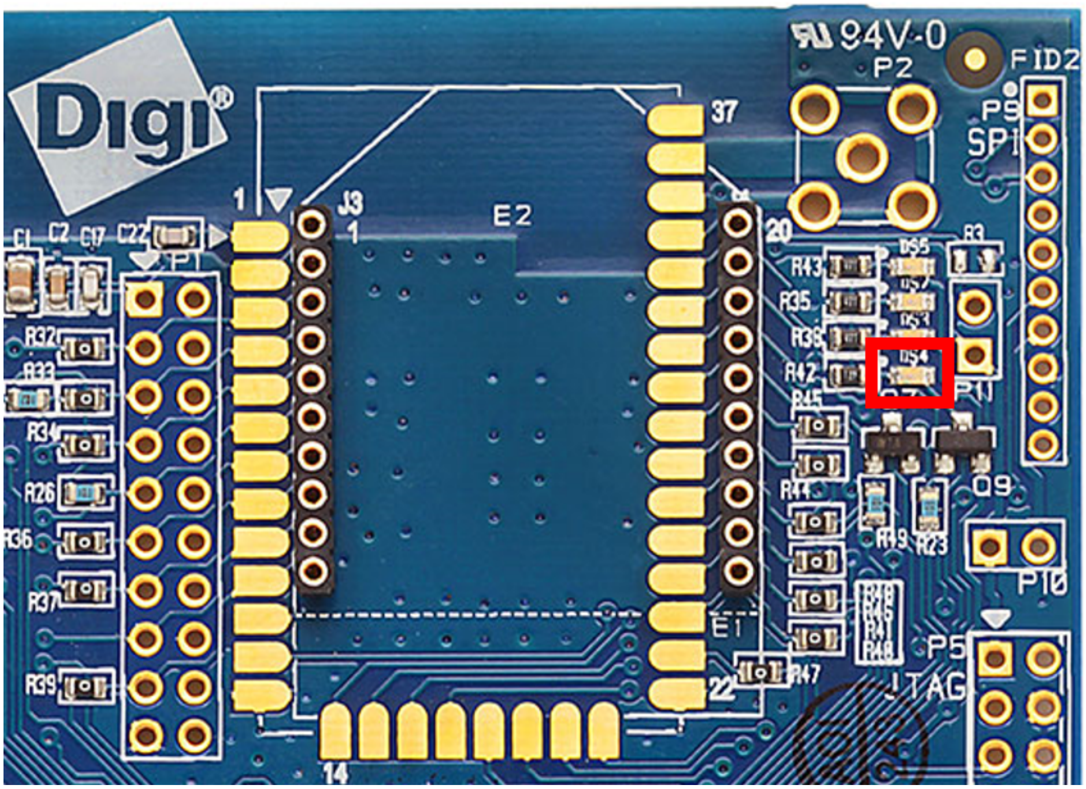
Example: hello world

1. At the MicroPython **>>>** prompt, type the Python command: **print("Hello, World!")**
2. Press **Enter** to execute the command. The terminal echos back **Hello, World!**.

Example: turn on an LED

1. Note the **DS4** LED on the XBIB board. The following image highlights it in a red box. The LED is normally off.

[1]See Other terminal programs if you do not use the MicroPython Terminal in XCTU.



2. At the MicroPython **>>>** prompt, type the commands below, pressing **Enter** after each one. After entering the last line of code, the LED illuminates. Anything after a **#** symbol is a comment, and you do not need to type it.

Note You can easily copy and paste code from the online version of this Guide. Use caution with the PDF version, as it may not maintain essential indentations.

```
import machine
from machine import Pin
led = Pin("D4", Pin.OUT, value=0)  # Makes a pin object set to output 0.
# One might expect 0 to mean OFF and 1 to mean ON, and this is normally the
case.
# But the LED we are turning on and off is setup as what is# known as
"active low".
# This means setting the pin to 0 allows current to flow through the LED and
then through the pin, to ground.
```

3. To turn it off, type the following and press **Enter**:

```
led.value(1)
```

You have successfully controlled an LED on the board using basic I/O!

Exit MicroPython mode

To exit MicroPython mode:

1. In the XCTU MicroPython Terminal, click the green **Close** button .
2. Click **Close** at the bottom of the terminal to exit the terminal.
3. In XCTU's Configuration working mode , change **AP API Enable** to another mode and click the **Write** button . We recommend changing to Transparent mode **[0]**, as most of the examples use this mode.

Other terminal programs

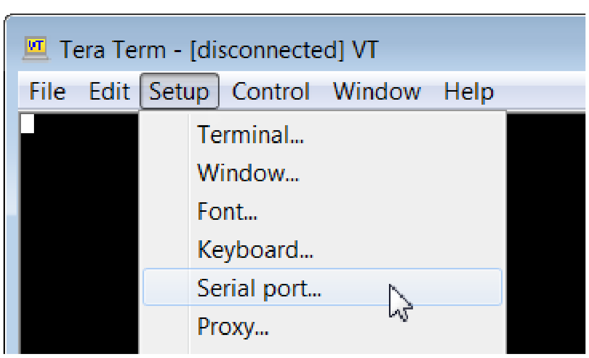
If you do not use the MicroPython Terminal in XCTU, you can use other terminal programs to communicate with the XBee Cellular Modem. If you use Microsoft Windows, follow the instructions for Tera Term, if you use Linux, follow the instructions for picocom. To download these programs:

- Tera Term for Windows; see https://ttssh2.osdn.jp/index.html.en.
- Picocom for Linux; see https://developer.ridgerun.com/wiki/index.php/Setting_up_Picocom_-_Ubuntu and for the source code and in-depth information https://github.com/npat-efault/picocom.

Tera Term for Windows

With the XBee Cellular Modem in MicroPython mode (**AP** = **4**), you can access the MicroPython prompt using a terminal.

1. Open Tera Term. The **Tera Term: New connection** window appears.
2. Click the **Serial** radio button to select a serial connection.
3. From the **Port:** drop-down menu, select the COM port that the XBee Cellular Modem is connected to.
4. Click **OK**. The **COMxx - Tera Term VT** terminal window appears and Tera Term attempts to connect to the device at a baud rate of 9600 b/s. The terminal will not allow communication with the device since the baud rate setting is incorrect. You must change this rate as it was previously set to 115200 b/s.
5. Click **Setup** and **Serial Port**. The **Tera Term: Serial port setup** window appears.



6. In the **Tera Term: Serial port setup** window, set the parameters to the following values:
   - **Port**: Shows the port that the XBee Cellular Modem is connected on.
   - **Baud rate**: 115200
   - **Data**: 8 bit
   - **Parity**: none
   - **Stop**: 1 bit
   - **Flow control**: hardware
   - **Transmit delay**: N/A
7. Click **OK** to apply the changes to the serial port settings. The settings should go into effect right away.
8. To verify that local echo is not enabled and that extra line-feeds are not enabled:
   a. In Tera Term, click **Setup** and select **Terminal**.
   b. In the **New-line** area of the **Tera Term: Serial port setup** window, click the **Receive** drop-down menu and select **CR** if it does not already show that value.
   c. Make sure the **Local echo** box is not checked.
9. Click **OK**.
10. Press **Ctrl**+**B** to get the MicroPython version banner and prompt.

```
MicroPython v1.8.7 on 2017-04-06; XBee Cellular with EFM32G
Type "help()" for more information.
>>>
```

Now you can type MicroPython commands at the **>>>** prompt.

Use picocom in Linux

With the XBee Cellular Modem in MicroPython mode (**AP** = **4**), you can access the MicroPython prompt using a terminal.

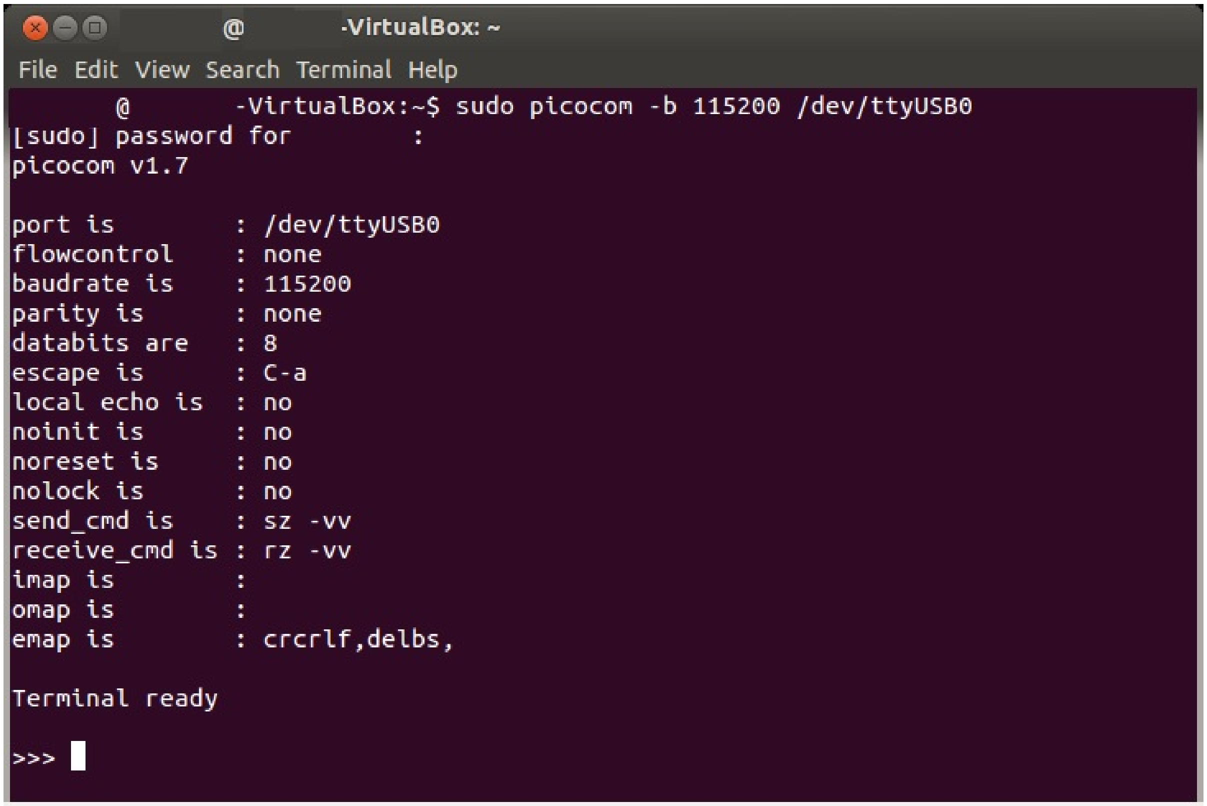
Note The user must have read and write permission for the serial port the XBee Cellular Modem is connected to in order to communicate with the device.

1. Open a terminal in Linux and type **picocom -b 115200 /dev/ttyUSB0**. This assumes you have no other USB-to-serial devices attached to the system.
2. Press **Ctrl**+**B** to get the MicroPython version banner and prompt. You can also press **Enter** to bring up the prompt.

If you do have other USB-to-serial devices attached:

1. Before attaching the XBee Cellular Modem, check the directory **/dev/** for any devices named **ttyUSBx**, where **x** is a number. An easy way to list these is to type: **ls /dev/ttyUSB***. This produces a list of any device with a name that starts with **ttyUSB**.
2. Take note of the devices present with that name, and then connect the XBee Cellular Modem.

3. Check the directory again and you should see one additional device, which is the XBee Cellular Modem.
4. In this case, replace **/dev/ttyUSB0** at the top with **/dev/ttyUSB<number>**, where **<number>** is the new number that appeared.
5. It should connect and show Terminal ready.



Now you can type MicroPython commands at the **>>>** prompt.

Technical specifications

Interface and hardware specifications

The following table provides the interface and hardware specifications for the device.

Specification	Value
Dimensions	2.438 x 3.294 cm (0.960 x 1.297 in)
Weight	5 g (0.18 oz)
Operating temperature	-40 to +85 °C -30 to +70 °C if 2G fallback mode is enabled
Antenna connector	U.FL
Digital I/O	13 I/O lines
ADC	4 10-bit analog inputs

RF characteristics

The following table provides the RF characteristics for the device.

Specification	Value
Transmit power	Up to 24 dBm, Power Class 3 2G fallback: up to 33 dBm, Power Class 4
Receive sensitivity	Up to -111 dBm
Data throughput	TBD

Networking specifications

The following table provides the networking specifications for the device.

Specification	Value
Addressing options	TCP/IP, UPD, and SMS
Technology	3G Universal Mobile Telecommunications Service (UMTS)/High Speed Packet Access (HSPA) with 2G fallback[1]
Supported bands	Band 19 (800 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 2 (1900 MHz) Band 1 (2100 MHz)

[1]See DO (Device Options) for more information on enabling and using the 2G fallback feature.

Specification	Value
Security	Digi Trustfence™ security with secure boot, encrypted storage, protected JTAG, SSL/TLS 1.2
Downlink/uplink speeds	Up to 7.2 Mb/s / 5.76 Mb/s

Power requirements

The following table provides the power requirements for the device.

Specification	Value
Normal supply voltage range	3.0 to 5.5 VDC (3.8 to 5 V for 2G fallback mode)
Extended supply voltage range[1]	2.7 to 5.5 VDC (3.6 to 5.5 VDC for 2G fallback mode)

Power consumption

The peak current was measured from multiple tested units.

Specification	State	Average current (3G mode)
Connected mode (TX + RX) current	Active transmit, 24 dBm @ 3.3 V	702 mA
Tx + RX current	Active transmit, 24 dBm @ 5.0 V	425 mA
Rx + ACK current	Active receive @ 3.3 V	224 mA
Rx + ACK current	Active receive @ 5 V	160 mA
Idle current	Idle/connected, listening @ 3.3 V	87 mA
Idle current	Idle/connected, listening @ 5 V	72 mA
Sleep current	Not connected, Deep Sleep @ 3.3 V	10 µA

See the 2G fallback power consumption table for further details.

Electrical specifications

The following table provides the electrical specifications for the XBee Cellular Modem.

[1]The device is functional over the extended voltage range but performance may be degraded.

Symbol	Parameter	Condition	Min	Typical	Max	Units
VCC_IO	Internal supply voltage for I/O	While in deep sleep and during initial power up	VCC - 0.3 V or 3.3 V, whichever is lower		3.3	V
VCC_IO	Internal supply voltage for I/O	In normal running mode		3.3 V		V
VI	Input voltage range on any I/O pin		-0.3		VCC_ IO + 0.3	V
VIL	Input low voltage				0.3*VCC_ IO	V
VIH	Input high voltage		0.7*VCC_IO			V
VOL	Voltage output low	Sinking 1 mA, VCC_ IO = 3.3 V		0.05*VCC_ IO		V
VOH	Voltage output high	Sourcing 1 mA, VCC_ IO = 3.3 V		0.9*VCC_ IO		V
I_IN	Input leakage current on I/O pins	High Z state; I/O connected to Ground or VCC_IO		0.1	100	nA
RPU	Internal pull-up resistor	Enabled		40		kΩ
RPD	Internal pull-down resistor	Enabled		40		kΩ

Regulatory approvals

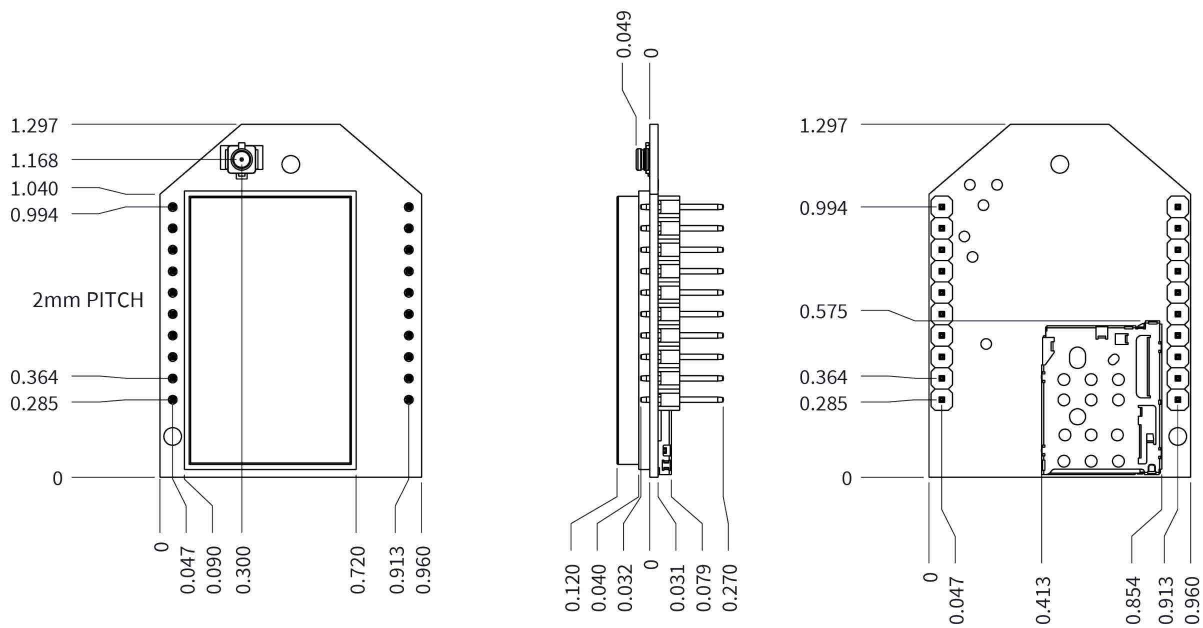
The following table provides the regulatory and carrier approvals for the device.

Specification	Value
United States	Contains FCC ID: XPY1CGM5NNN
Industry Canada	Contains IC: 8595A-1CGM5NNN
Europe (CE)	Pending
RoHS	Lead-free and RoHS compliant
PTCRB certification	Yes
AT&T end device certified	Pending

Hardware

Mechanical drawings

The following figures show the mechanical drawings for the XBee Cellular Modem. All dimensions are in inches.



Pin signals

The following table shows the pin assignments for the through-hole device. In the table, low-asserted signals have a horizontal line above signal name.

Pin	Name	Direction	Default	Description
Pin	Name	Direction	Default	Description
1	V_{CC}			Power supply
2	DOUT	Output	Output	UART Data Out
3	DIN / $\overline{\text{CONFIG}}$	Input	Input	UART Data In
4	DIO12	Either	Disabled	Digital I/O 12
5	$\overline{\text{RESET}}$	Input		
6	PWM0 / RSSI / DIO10	Either	Output	PWM Output 0 / RX Signal Strength Indicator / Digital I/O 10
7	PWM1 / DIO11	Either	Disabled	PWM Output 1 / Digital I/O 11
8	[reserved]			Do not connect

Pin	Name	Direction	Default	Description
9	DTR / SLEEP_RQ/ DIO8	Either	Disabled	Pin Sleep Control Line or Digital I/O 8
10	GND			Ground
11	DIO4	Either	Disabled	Digital I/O 4
12	CTS / DIO7	Either	Output	Output Clear-to-Send Flow Control or Digital I/O 7
13	ON /SLEEP/DIO9	Output	Output	Module Status Indicator or Digital I/O 9
14	VREF	-		Feature not supported on this device. Used on other XBee devices for analog voltage reference.
15	Associate / DIO5	Either	Output	Associated Indicator, Digital I/O 5
16	RTS / DIO6	Either	Disabled	Input Request-to-Send Flow Control, Digital I/O 6
17	AD3 / DIO3	Either	Disabled	Analog Input 3 or Digital I/O 3
18	AD2 / DIO2	Either	Disabled	Analog Input 2 or Digital I/O 2
19	AD1 / DIO1	Either	Disabled	Analog Input 1 or Digital I/O 1
20	AD0 / DIO0	Either	Input	Analog Input 0, Digital I/O 0

Pin connection recommendations

The recommended minimum pin connections are VCC, GND, DIN, DOUT, RTS, DTR and RESET. Firmware updates require access to these pins.

SIM card

The XBee Cellular Modem uses a 4FF (Nano) size SIM card.

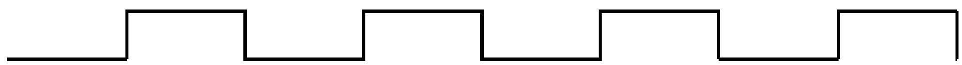
CAUTION! Never insert or remove SIM card while the power is on!

The Associate LED

The following table describes the Associate LED functionality. For the location of the Associate LED on the XBIB-U development board, see number 6 on the XBIB-U-DEV reference.

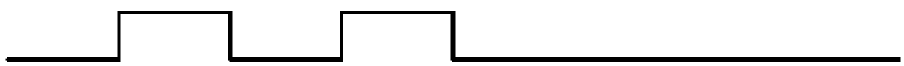
LED status	Blink timing	Meaning
On, solid		Not joined to a mobile network.
Double blink	½ second	The last TCP/UDP/SMS attempt failed. If the LED has this pattern, you may need to check DI (Device Cloud Indicator) or CI (Protocol/Connection Indication) for the cause of the error.
Standard single blink	1 second	Normal operation.

The normal association LED signal alternates evenly between high and low as shown below:



Where the low signal means LED off and the high signal means LED on.

When **CI** is not **0** or **0xFF**, the Associate LED has a different blink pattern that looks like this:



Antenna recommendations

Antenna placement

For optimal cellular reception, keep antenna as far away from metal objects and other electronics (including the XBee Cellular Modem) as possible. Often, small antennas are desirable, but come at the cost of reduced range and efficiency.

Design recommendations

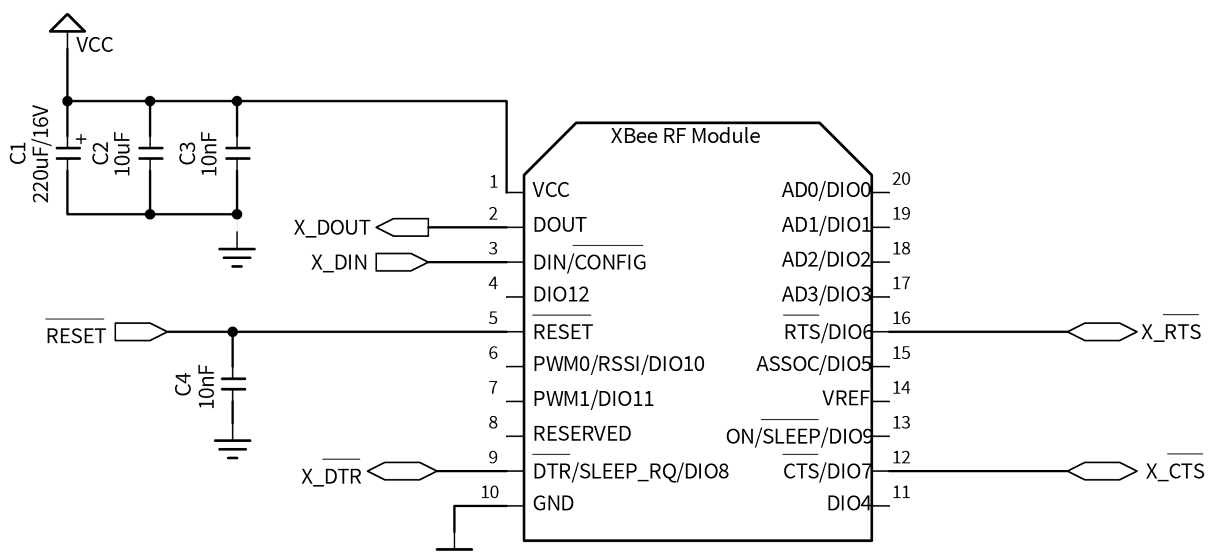
Power supply considerations

When considering a power supply, use the following design practices.

1. Power supply ripple should be less than 75 mV peak to peak.
2. The power supply should be capable of providing a minimum of 1.5 A at 3.3 V (5 W). Keep in mind that operating at a lower voltage requires higher current capability from the power supply to achieve the 5 W requirement.
3. Place sufficient bulk capacitance on the XBee VCC pin to maintain voltage above the minimum specification during inrush current. Inrush current for VCC = 3.3 V is about 2 A during initial power up of cellular communications and wakeup from sleep mode. We recommend a minimum of 220 µF of capacitance on the VCC pin.
4. Place a 10 nF ceramic capacitor very close to the XBee Cellular Modem VCC pin to decrease high frequency noise.
5. Use a wide power supply trace or power plane to ensure it can handle the peak current requirements with minimal voltage drop. We recommend that the power supply and trace be designed such that the voltage at the XBee VCC pin does not vary by more than 0.1 V between light load (~0.5 W) and heavy load (~3 W).
6. If you use DO (Device Options) to enable 2G fallback mode, the power supply must be capable of supplying 11.5 W and the minimum input voltage is 3.8 V (for example 3.0 A @ 3.8 V). In addition, we recommend 1000 µF of bulk capacitance on the VCC pin. The supply should never drop below 3.6 V during TX bursts.

Add a capacitor to the RESET line

In high EMI noise environments, we recommend adding a 10 nF ceramic capacitor very close to pin 5.



Heat considerations

Depending on the use case, your application may require a heat sink. Use a non-conductive thermal gasket to make contact to the heat sink. The gasket should be thick enough to ensure that contact with the tallest component does not cause damage when pressure is applied to a secure heat sink.

We recommend connecting the heat sink to the bottom side of the XBee Cellular Modem (SIM card side). Alternatively, you can attach the heat sink to the top side of the unit (U.FL side), but cooling is less effective on this side.

We do not recommend operating at hot temperatures without verifying that the device will not overheat in the operating circumstances.

The operation temperature of the unit can be approximated for different current draws and extreme cases by the equation below. For best results, attach a temperature probe on the bottom of the XBee Cellular Modem, about 5 mm higher than the SIM card slot. Alternatively use TP (Temperature) to query the current temperature of the device's processor.

$$MaxOperatingAmbientTemp^{\circ}C = 85^{\circ}C - (XBeeBoardTemp - RoomTemp) * ScenarioMaxCurrent/AverageCurrentDuringTest$$

Where

1. *XBeeBoardTemp* is the temperature of the XBee Cellular Modem at steady state.
   a. Use the **TP** command to help estimate the temperature when attaching a temperature probe is not practical, but for reliable results, you must use a temperature probe.
2. *RoomTemp* is the temperature of the ambient air.
3. *AverageCurrentDuringTest* is the average current measured during test.
4. *ScenarioMaxCurrent* is the maximum current expected for the device.

The results may vary by implementation and scenario. You should always perform sufficient testing to ensure that the XBee Cellular Modem does not exceed temperature specifications.

Add a fan to provide active cooling

The XBee Cellular Modem can become hot if you use it in the maximum upload or download scenarios, see Heat considerations. One method of heat mitigation is to attach a fan to the device to provide active cooling.

If you attach a fan, use P1 (DIO11/PWM1 Configuration) to enable this functionality on pin 7. Set **P1** to **1**, which turns the fan on when the device gets above 70 °C and the cellular component is running, and off below 65 °C.

Cellular connection process

Connecting

In normal operations, the XBee Cellular Modem automatically attempts both a cellular network connection and a data network connection on power-up. The sequence of these connections is as follows:

Cellular network

1. The device powers on.
2. It looks for cellular towers.
3. It chooses a candidate tower with the strongest signal.
4. It negotiates a connection.
5. It completes cellular registration; the phone number and SMS are available.

Data network connection

1. The network enables the evolved packet system (EPS) bearer with an access point name (APN). See AN (Access Point Name) if you have APN issues.
2. The device negotiates a data connection with the access point.
3. The device receives its IP configuration and address.
4. The AI (Association Indication) command now returns a **0** and the sockets become available.

Data communication with remote servers (TCP/UDP)

Once sockets become available, communication with remote servers can be initiated in several ways:

- Transparent mode data received over a serial connection (see TD (Text Delimiter) and RO (Packetization Timeout) for timing).
- API mode: Transmit (TX) Request: IPv4 - 0x20 received over the serial connection.
- Digi Remote Manager connectivity begins.

Data communication begins when:

1. A socket opens to the remote server.
2. Data is sent.
3. The XBee Cellular Modem listens for incoming data.

Data connectivity ends when:

1. The server closes the connection.
2. The **TM** timeout expires (see TM (TCP Client Connection Timeout)).
3. The cellular network may also close the connection after a timeout set by the network operator.

Disconnecting

When the XBee Cellular Modem is put into Airplane mode or deep sleep is requested:

1. Sockets are closed, cleanly if possible.
2. The EPS bearer data connection is shut down.
3. The cellular connection is shut down.
4. The cellular component is powered off.

Note We recommend entering Airplane mode before resetting or rebooting the device to allow the cellular module to detach from the network.

SMS encoding

The XBee Cellular Modem transmits SMS messages using the standard GSM 03.38 character set.[1] Because this character set only provides 7 bits of space per character, the XBee Cellular Modem ignores the most significant bit of each octet in an SMS transmission payload.

The device converts incoming SMS messages to ASCII. Characters that cannot be represented in ASCII are replaced with a space (' ', or 0x20 in hex). This includes emoji and other special characters.

[1] Also referred to as the GSM 7-bit alphabet.

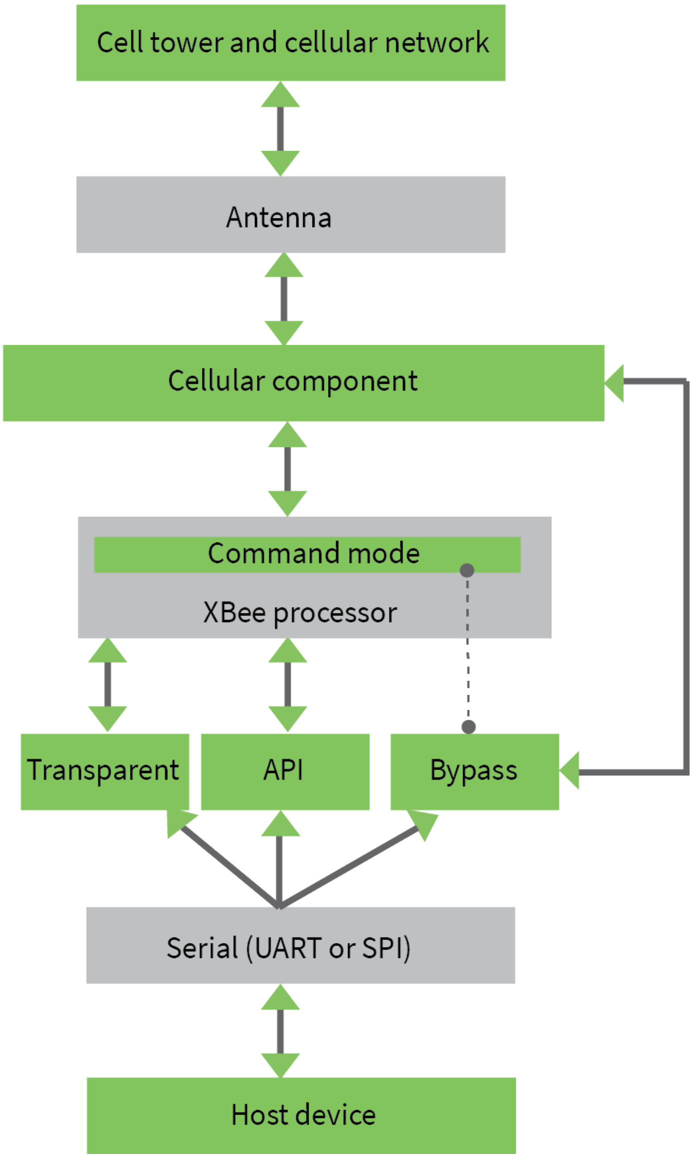
Modes

Select an operating mode

The XBee Cellular Modem interfaces to a host device such as a microcontroller or computer through a logic-level asynchronous serial port. It uses a UART for serial communication with those devices.

The XBee Cellular Modem supports three operating modes: Transparent operating mode, API operating mode, and Bypass operating mode. The default mode is Transparent operating mode. Use the API Enable command to select a different operating mode.

The following flowchart illustrates how the modes relate to each other.



Transparent operating mode

Devices operate in this mode by default. The device acts as a serial line replacement when it is in Transparent operating mode. The device queues all serial data it receives through the DIN pin for RF transmission. When a device receives RF data, it sends the data out through the DOUT pin. You can set the configuration parameters using Command mode.

The IP (IP Protocol) command setting controls how Transparent operating mode works for the XBee Cellular Modem.

API operating mode

API operating mode is an alternative to Transparent operating mode. API mode is a frame-based protocol that allows you to direct data on a packet basis. The device communicates UART data in packets, also known as API frames. This mode allows for structured communications with computers and microcontrollers.

The advantages of API operating mode include:

- It is easier to send information to multiple destinations
- The host receives the source address for each received data frame
- You can change parameters without entering Command mode

Bypass operating mode

CAUTION! Bypass operating mode is an alternative to Transparent and API modes for advanced users with special configuration needs. Changes made in this mode might change or disable the device and we do not recommended it for most users.

In Bypass mode, the device acts as a serial line replacement to the cellular component. In this mode, the XBee Cellular Modem exposes all control of the cellular component's AT port through the UART.

Note The cellular component can become unresponsive in Bypass mode. See Unresponsive cellular component in Bypass mode for help in this situation.

When Bypass mode is active, most of the XBee Cellular Modem's AT commands do not work. For example, **IM** (IMEI) may never return a value, and **DB** does not update. In this configuration, the firmware does not test communication with the cellular component (which it does by sending AT commands). This is useful in case you have reconfigured the cellular component in a way that makes it incompatible with the firmware. Bypass operating mode exists for users who wish to communicate directly with the cellular component settings and do not intend to use XBee Cellular Modem software features such as API mode.

Command mode is available while in Bypass mode; see Enter Command mode for instructions.

Enter Bypass operating mode

To configure a device for Bypass operating mode:

1. Set the API Enable parameter value to **5**.
2. Send WR (Write) to write the changes.
3. Send FR (Force Reset) to reboot the device.
4. After rebooting, enter Command mode and verify that Bypass operating mode is active by querying AI (Association Indication) and confirming that it returns a value of **0x2F**.

It may take a moment for Bypass operating mode to become active.

Leave Bypass operating mode

To configure a device to leave Bypass operating mode:

1. Set API Enable to something other than 5.
2. Send WR (Write) to write the changes.
3. Send FR (Force Reset) to reboot the device.
4. After rebooting, enter Command mode and verify that Bypass operating mode is not active by querying AI (Association Indication) and confirming that it returns a value other than **0x2F**.

Restore cellular settings to default in Bypass operating mode

Send **AT&F1** to reset the cellular component to its factory profile.

Command mode

The three operating modes are controlled by the API Enable setting, but Command mode is always available as a mode the device can enter while configured for any of the operating modes.

Enter Command mode

To get a device to switch into this mode, you must issue the following sequence: **+++** within one second. There must be at least one second preceding and following the **+++** sequence. Both the command character (**CC**) and the silence before and after the sequence (**GT**) are configurable. When the device sees a full second of silence in the data stream (the guard time, **GT**) followed by the string **+++** (without Enter or Return) and another full second of silence, it knows to stop sending data and start accepting commands locally.

Note Do not press Return or Enter after typing **+++** because it will interrupt the guard time silence and prevent you from entering Command mode.

When the device is in Command mode, it listens for user input and is able to receive AT commands on the UART. If **CT** time (default is 10 seconds) passes without any user input, the device drops out of Command mode and returns to the previous operating mode (Transparent, Bypass, API, Python, and so forth).

You can customize the command character, the guard times and the timeout in the device's configuration settings. For more information, see CC (Command Sequence Character), CT (Command Mode Timeout) and GT (Guard Times).

Troubleshooting

Failure to enter Command mode is often due to baud rate mismatch. Ensure that the baud rate of the connection matches the baud rate of the device. By default, the **BD** parameter = 3 (9600 b/s).

There are two alternative ways to enter Command mode:

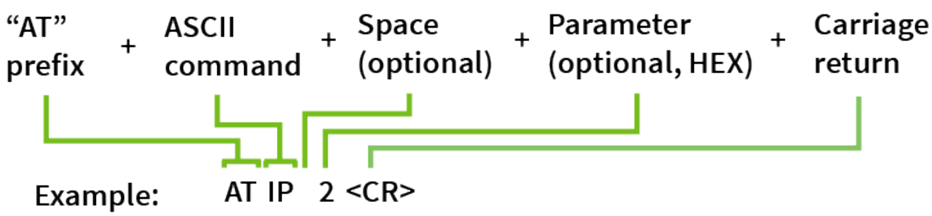
- A serial break for six seconds enters Command mode. The "break" command can be issued from a serial console, and is often a button or menu item.
- Asserting DIN (serial break) upon power up or reset enters Command mode. XCTU guides you through a reset and automatically issues the break when needed.

Both of these methods temporarily set the device's baud rate to 9600 and return an **OK** on the UART to indicate that Command mode is active. When Command mode exits, the device returns to normal operation at the baud rate the **BD** parameter is set to.

Send AT commands

Once the device enters Command mode, use the syntax in the following figure to send AT commands. Every AT command starts with the letters **AT**, which stands for "attention." The **AT** is followed by two characters that indicate which command is being issued, then by some optional configuration values.

To read a parameter value stored in the device’s register, omit the parameter field.



The preceding example changes the IP protocol to SMS.

Multiple AT commands

You can send multiple AT commands at a time when they are separated by a comma in Command mode; for example, **ATSH**,**SL**.

Parameter format

Refer to the list of AT commands for the format of individual AT command parameters. Valid formats for hexidecimal values include with or without a leading **0x** for example **FFFF** or **0xFFFF**.

Response to AT commands

When reading parameters, the device returns the current parameter value instead of an **OK** message.

Apply command changes

Any changes you make to the configuration command registers using AT commands do not take effect until you apply the changes. For example, if you send the **BD** command to change the baud rate, the actual baud rate does not change until you apply the changes. To apply changes:

1. Send the **AC** (Apply Changes) command.

   or:

2. Exit Command mode.

Make command changes permanent

Issue a WR (Write) command to save the changes. WR writes parameter values to non-volatile memory so that parameter modifications persist through subsequent resets.

Exit Command mode

1. Send CN (Exit Command mode) followed by a carriage return.

   or:

2. If the device does not receive any valid AT commands within the time specified by CT (Command Mode Timeout), it returns to the mode that the device was last in.

Sleep modes

About sleep modes

A number of low-power modes exist to enable devices to operate for extended periods of time on battery power. Use SM (Sleep Mode) to enable these sleep modes.

Normal mode

Set **SM** to 0 to enter Normal mode.

Normal mode is the default sleep mode. If a device is in this mode, it does not sleep and is always awake.

Devices in Normal mode are typically mains powered.

Pin sleep mode

Set **SM** to 1 to enter pin sleep mode.

Pin sleep allows the device to sleep and wake according to the state of the SLEEP_RQ pin (pin 9).

When you assert SLEEP_RQ (high), the device finishes any transmit or receive operations, closes any active connection, and enters a low-power state.

When you de-assert SLEEP_RQ (low), the device wakes from pin sleep.

Cyclic sleep mode

Set **SM** to 4 to enter Cyclic sleep mode.

Cyclic sleep allows the device to sleep for a specific time and wake for a short time to poll.

If you use the **D7** command to enable hardware flow control, the CTS pin asserts (low) when the device wakes and can receive serial data, and de-asserts (high) when the device sleeps.

Cyclic sleep with pin wake up mode

Set **SM** to 5 to enter Cyclic sleep with pin wake up mode.

This mode is a slight variation on Cyclic sleep mode (**SM** = 4) that allows you to wake a device prematurely by de-asserting the SLEEP_RQ pin (pin 9).

In this mode, you can wake the device after the sleep period expires, or if a high-to-low transition occurs on the SLEEP_RQ pin.

Airplane mode

While not technically a sleep mode, airplane mode is another way of saving power. When set, the cellular component of the XBee Cellular Modem is fully turned off and no access to the cellular network is performed or possible. Use AM (Airplane Mode) to configure this mode.

The sleep timer

If the device receives serial or RF data in Cyclic sleep mode and Cyclic sleep with pin wake up modes (**SM** = 4 or **SM** = 5), it starts a sleep timer (time until sleep).

- Use ST (Wake Time) to set the duration of the timer.
- When the sleep timer expires the device returns to sleep.

MicroPython sleep behavior

When the XBee Cellular Modem enters deep sleep mode, any MicroPython code currently executing is suspended until the device comes out of sleep. When the XBee Cellular Modem comes out of sleep mode, MicroPython execution continues where it left off.

Upon entering deep sleep mode, the XBee Cellular Modem closes any active TCP/UDP connections and turns off the cellular component. As a result, any sockets that were opened in MicroPython prior to sleep report as no longer being connected. This behavior appears the same as a typical socket disconnection event will:

- **socket.send** raises **OSError: ENOTCONN**
- **socket.sendto** raises **OSError: ENOTCONN**
- **socket.recv** returns the empty string, the traditional end-of-file return value
- **socket.recvfrom** returns an empty message, for example:

  (b'', (<address from connect()>, <port from connect()>))

  The underlying UDP socket resources have been released at this point.

Serial communication

Serial interface

The XBee Cellular Modem interfaces to a host device through a serial port. The device can communicate through its serial port with:

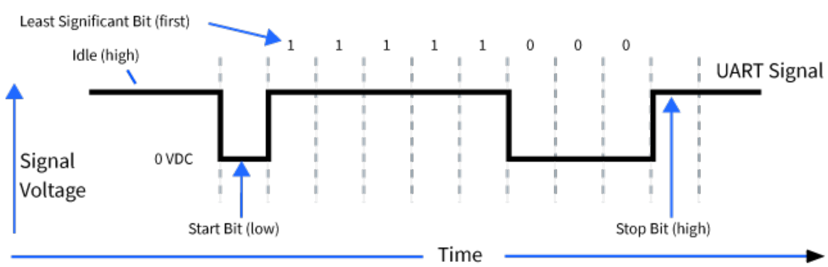
- Through logic and voltage compatible universal asynchronous receiver/transmitter (UART).
- Through a level translator to any serial device, for example, through an RS-232 or USB interface board.

Serial data

A device sends data to the XBee Cellular Modem's UART through pin 3 (DIN) as an asynchronous serial signal. When the device is not transmitting data, the signals should idle high.

For serial communication to occur, you must configure the UART of both devices (the microcontroller and the XBee Cellular Modem) with compatible settings for the baud rate, parity, start bits, stop bits, and data bits.

Each data byte consists of a start bit (low), 8 data bits (least significant bit first) and a stop bit (high). The following diagram illustrates the serial bit pattern of data passing through the device. The diagram shows UART data packet 0x1F (decimal number 31) as transmitted through the device.

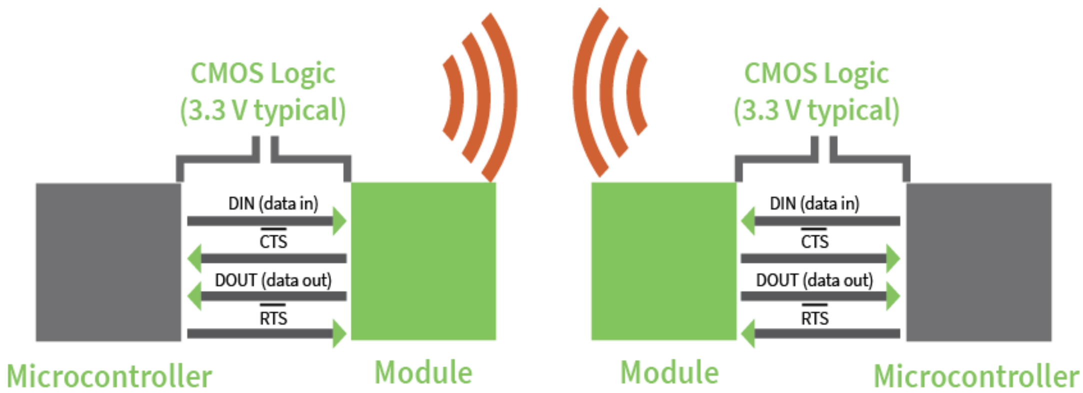


You can configure the UART baud rate, parity, and stop bits settings on the device with the **BD**, **NB**, and **SB** commands respectively. For more information, see Serial interfacing commands.

In the rare case that a device has been configured with the UART disabled, you can recover the device to UART operation by holding DIN low at reset time. DIN forces a default configuration on the UART at 9600 baud and it brings the device up in Command mode on the UART port. You can then send the appropriate commands to the device to configure it for UART operation. If those parameters are written, the device comes up with the UART enabled on the next reset.

UART data flow

Devices that have a UART interface connect directly to the pins of the XBee Cellular Modem as shown in the following figure. The figure shows system data flow in a UART-interfaced environment. Low-asserted signals have a horizontal line over the signal name.



Serial buffers

The XBee Cellular Modem maintains internal buffers to collect serial and RF data that it receives. The serial receive buffer collects incoming serial characters and holds them until the device can process them. The serial transmit buffer collects the data it receives via the RF link until it transmits that data out the serial port.

CTS flow control

CTS flow control is enabled by default; you can disable it with D7 (DIO7/CTS). When the serial receive buffer fills with the number of bytes specified by FT (Flow Control Threshold), the device de-asserts CTS (sets it high) to signal the host device to stop sending serial data. The device re-asserts CTS when less than FT-16 bytes are in the UART receive buffer.

RTS flow control

If you send D6 (DIO6/RTS) to enable RTS flow control, the device does not send data in the serial transmit buffer out the DOUT pin as long as RTS is de-asserted (set high). Do not de-assert RTS for long periods of time or the serial transmit buffer will fill.

AT commands

MicroPython commands

The following commands relate to using MicroPython on the XBee Cellular Modem.

PS (Python Startup)

Sets whether or not the XBee Cellular Modem runs the stored Python code at startup.

Range

0 - 1

Parameter	Description
0	Do not run stored Python code at startup.
1	Run stored Python code at startup.

Default

0

PY (MicroPython Command)

Interact with the XBee Cellular Modem using MicroPython. **PY** is a command with sub-commands. These sub-commands are arguments to **PY**.

PYC(Code Report)

You can store compiled code in flash using the **Ctrl-F** command from the MicroPython REPL; refer to the Digi MicroPython Programming Guide. The **PYC** sub-command reports details of the stored code. In Command mode, it returns three lines of text, for example:

```
source: 1662 bytes (hash=0xC3B3A813)
bytecode: 619 bytes (hash=0x0900DBCE)
compiled: 2017-05-09T15:49:44
```

The messages are:

- **source**: the size of the source code used to generate the bytecode and its 32-bit hash.
- **bytecode**: the size of bytecode stored in flash and its 32-bit hash. A size of **0** indicates that there is no stored code.
- **compiled**: a compilation timestamp. A timestamp of **2000-01-01T00:00:00** indicates that the clock was not set during compilation.

In API mode, **PYC** returns five 32-bit big-endian values:

- source size
- source hash
- bytecode size
- bytecode hash
- timestamp as seconds since 2000-01-01T00:00:00

PYD (Delete Code)

PYD interrupts any running code, erases any stored code and then does a soft-reboot on the MicroPython subsystem.

PYV (Version Report)

Report the MicroPython version.

PY^ (Interrupt Program)

Sends **KeyboardInterrupt** to MicroPython. This is useful if there is a runaway MicroPython program and you have filled the stdin buffer. You can enter Command mode (**+++**) and send **ATPY^** to interrupt the program.

Default

N/A

Special commands

The following commands are special commands.

AC (Apply Changes)

Immediately applies new settings without exiting Command mode.

Applying changes means that the device re-initializes based on changes made to its parameter values. Once changes are applied, the device immediately operates according to the new parameter values.

This behavior is in contrast to issuing the **WR** (Write) command. The **WR** command saves parameter values to non-volatile memory, but the device still operates according to previously saved values until the device is rebooted or you issue the **CN** (Exit AT Command Mode) or **AC** commands.

Parameter range

N/A

Default

N/A

FR (Force Reset)

Resets the device. The device responds immediately with an **OK** and performs a reset 100 ms later.

If you issue **FR** while the device is in Command Mode, the reset effectively exits Command mode.

Note We recommend entering Airplane mode before resetting or rebooting the device to allow the cellular module to detach from the network.

Parameter range

N/A

Default

N/A

RE (Restore Defaults)

Restore device parameters to factory defaults.

The **RE** command does not write restored values to non-volatile (persistent) memory. Issue the **WR** (Write) command after issuing the **RE** command to save restored parameter values to non-volatile memory.

Parameter range

N/A

Default

N/A

WR (Write)

Writes parameter values to non-volatile memory so that parameter modifications persist through subsequent resets.

Note Once you issue a **WR** command, do not send any additional characters to the device until after you receive the **OK** response.

Parameter range

N/A

Default

N/A

Cellular commands

The following AT commands are cellular configuration and data commands.

PH (Phone Number)

Reads the SIM card phone number. If **PH** is blank, the XBee Cellular Modem is not registered to the network.

Parameter range

N/A

Default

Set by the cellular carrier via the SIM card

S# (ICCID)

Reads the Integrated Circuit Card Identifier (ICCID) of the inserted SIM.

Parameter range

N/A

Default

Set by the SIM card

IM (IMEI)

Reads the device's International Mobile Equipment Identity (IMEI).

Parameter range

N/A

Default

Set in the factory

MN (Operator)

Reads the network operator on which the device is registered.

Parameter range

N/A

Default

N/A

MV (Modem Firmware Version)

Read the firmware version string for cellular component communications. See the related VR (Firmware Version) command.

Parameter range

N/A

Default

Set in the currently loaded firmware

DB (Cellular Signal Strength)

Reads the absolute value of the current signal strength to the cell tower in dB. If **DB** is blank, the XBee Cellular Modem has not received a signal strength from the cellular component.

Parameter range

0x71 - 0x33 (-113 dBm to -51 dBm) [read-only]

Default

N/A

AN (Access Point Name)

Specifies the packet data network that the modem uses for Internet connectivity. This information is provided by your cellular network operator. After you set this value, applying changes with AC (Apply Changes) or CN (Exit Command mode) triggers a network reset.

Parameter range

1 - 100 ASCII characters

Default

-

AM (Airplane Mode)

When set, the cellular component of the XBee Cellular Modem is fully turned off and no access to the cellular network is performed or possible.

Parameter range

0 - 1

0 = Normal operation

1 = Airplane mode

Default

0

Network commands

The following commands are network commands.

IP (IP Protocol)

Sets or displays the IP protocol used for client and server socket connections in IP socket mode.

Parameter range

0 - 4

Value	Description
0x00	UDP
0x01	TCP
0x02	SMS
0x03	Reserved
0x04	SSL over TCP communication

Default

0x01

TL (SSL/TLS Protocol Version)

Sets the SSL/TLS protocol version used for the SSL socket. If you change the **TL** value, it does not affect any currently open sockets. The value only applies to subsequently opened sockets.

Note Due to known vulnerabilities in prior protocol versions, we strongly recommend that you use the latest TLS version whenever possible.

Range

Value	Description
0x00	SSL v3
0x01	TLS v1.0
0x02	TLS v1.1
0x03	TLS v1.2

Default

0x03

TM (TCP Client Connection Timeout)

Sets or reads the TCP client connection timeout. If there is no activity for this timeout then the connection is closed. If you set **TM** to 0, the connection is closed immediately after the device sends data.

If you change the **TM** value while in Transparent Mode, the current connection is immediately closed. Upon the next transmission, the **TM** value applies to the newly created socket.

If you change the **TM** value while in API Mode, the value only applies to subsequently opened sockets.

Parameter range

0 - 0xFFFF [x 100 ms]

Default

0xBB8 (5 minutes)

DO (Device Options)

Enables and disables special features on the XBee Cellular Modem according to the following table.

Value	Remote Manager	2G fallback
0x00	Disabled	Disabled
0x01 (default)	Enabled	Disabled
0x02	Disabled	Enabled
0x03	Enabled	Enabled

Remote Manager support

Bit 0

If the XBee Cellular Modem cannot establish a connection with Remote Manager , it waits 30 seconds before trying again. On each successive connection failure, the wait time doubles (60 seconds, 120, 240, and so on) up to a maximum of 1 hour. This time resets to 30 seconds once the connection to Remote Manager succeeds or if the device is reset.

Bits 1 - 7

Reserved

2G fallback

The XBee Cellular Modem is capable of supporting 2G (GSM/GPRS) fallback when a 3G network is not available. However, connecting to a 2G network draws bursts of current from the power supply in excess of 2.5 A. This may cause host equipment, including the standard XBee development board, to brown out. Therefore, if you enable 2G fallback mode you must observe the special considerations given in Power supply considerations.

The following table provides the 2G power consumption at 3.8 V and room temperature.

2G Fallback mode (3.8 V)	Average current	Peak current
GSM connected mode, max TX power (1 TX, 1 RX slot)	220 mA	2.6 A
GPRS connected mode, max TX power (4 TX, 1 RX slot)	700 mA	2.6 A
EDGE connected mode, max TX power (4 TX, 1 RX slot)	280 mA	2.6 A
2G active mode	80 mA	

After changing this setting, you must:

1. Use WR (Write) to write all values to flash.
2. Use FR (Force Reset) to reset the device.
3. Wait for the cellular component to be initialized: AI (Association Indication) reaches **0x00**.

Range

0x00 - 0x03

Default

0x01

EQ (Device Cloud FQDN)

Sets or display the fully qualified domain name of the Remote Manager server.

Range

From 0 through 63 ASCII characters.

Default

my.devicecloud.com

Addressing commands

The following AT commands are addressing commands.

SH (Serial Number High)

The upper digits of the unique International Mobile Equipment Identity (IMEI) assigned to this device.

Parameter range

0 - 0xFFFFFFFF [read-only]

Default

N/A

SL (Serial Number Low)

The lower digits of the unique International Mobile Equipment Identity (IMEI) assigned to this device.

Parameter range

0 - 0xFFFFFFFF [read-only]

Default

N/A

DL (Destination Address)

The destination IPv4 address or fully qualified domain name.

To set the destination address to an IP address, the value must be a dotted quad, for example **XXX.XXX.XXX.XXX**.

To set the destination address to a domain name, the value must be a legal Internet host name, for example **remotemanager.digi.com**

Parameter range

0 - 128 ASCII characters

Default

0.0.0.0

P# (Destination Phone Number)

Sets or displays the destination phone number used for SMS when IP (IP Protocol) = **2**. Phone numbers must be fully numeric, 7 to 20 ASCII digits, for example: 8889991234.

P# allows international numbers with or without the **+** prefix. If you omit **+** and are dialing internationally, you need to include the proper International Dialing Prefix for your calling region, for example, 011 for the United States.

Range

7 - 20 ASCII digits including an optional **+** prefix

Default

N/A

DE (Destination Port)

Sets or reads the destination IP port number.

Parameter range

0x0 - 0xFFFF

Default

0x2616

TD (Text Delimiter)

The ASCII character used as a text delimiter for Transparent mode. When you select a character, information received over the serial port in Transparent mode is not transmitted until that character is received. To use a carriage return, set to 0xD. Set to zero to disable text delimiter checking.

Parameter range

0 - 0xFF

Default

0x0

MY (Module IP Address)

Reads the device's IP address. This command is read-only because the IP address is assigned by the mobile network.

In API mode, the address is represented as the binary four byte big-endian numeric value representing the IPv4 address.

In Transparent or Command mode, the address is represented as a dotted-quad string notation.

Parameter range

0- 15 IPv4 characters

Default

0.0.0.0

LA (Lookup IP Address of FQDN)

Performs a DNS lookup of the given fully qualified domain name (FQDN) and outputs its IP address.

When you issue the command in API mode, the IP address is formatted in binary. In all other cases (for example, Command mode) the format is dotted decimal notation.

Range

Valid FQDN.

Default

-

OD (Operating Destination Address)

Read the destination IPv4 address currently in use by Transparent mode. The value is **0.0.0.0** if no Transparent IP connection is active.

In API mode, the address is represented as the binary four byte big-endian numeric value representing the IPv4 address.

In Transparent or Command mode, the address is represented as a dotted-quad string notation.

Parameter range

-

Default

0.0.0.0

C0 (Source Port)

Set or get the port number used to provide the serial communication service. Data received by this port on the network is transmitted on the XBee Cellular Modem's serial port. As long as a network connection is established to this port (for TCP) data received on the serial port is transmitted on the established network connection.

IP (IP Protocol) sets the protocol used when UART is in Transparent mode.

Parameter range

0 - 0xFFFF

Value	Description
0	Disabled
Non-0	Enabled on that port

Default

0

Serial interfacing commands

The following AT commands are serial interfacing commands.

BD (Baud Rate)

Sets or reads the serial interface baud rate for communication between the device's serial port and the host.

Parameter range

0x1 - 0xA (standard rates) 0x5B9 to 0x5B8D80 (non-standard rates up to 6 Mb/s)

Parameter	Description
0x1	2400 b/s
0x2	4800 b/s
0x3	9600 b/s
0x4	19200 b/s
0x5	38400 b/s

Parameter	Description
0x6	57600 b/s
0x7	115200 b/s
0x8	230400 b/s
0x9	460800 b/s
0xA	921600 b/s

Default

0x3 (9600 b/s)

NB (Parity)

Set or read the serial parity settings for UART communications.

Parameter range

0x00 - 0x02

Parameter	Description
0x00	No parity
0x01	Even parity
0x02	Odd parity

Default

0x00

SB (Stop Bits)

Sets or reads the number of stop bits for UART communications.

Parameter range

0x00 - 0x01

Parameter	Configuration
0x00	One stop bit
0x01	Two stop bits

Default

0x00

RO (Packetization Timeout)

Set or read the number of character times of inter-character silence required before transmission begins when operating in Transparent mode.

Set **RO** to 0 to transmit characters as they arrive instead of buffering them into one RF packet.

Set to **FF** for realtime typing by humans. Also, see TD (Text Delimiter).

Parameter range

0 - 0xFF (x character times)

Default

3

FT (Flow Control Threshold)

Set or display the flow control threshold.

The device de-asserts $\overline{\text{CTS}}$ when **FT** bytes are in the UART receive buffer.

Parameter range

0x9D - 0x82D

Default

0x681

API Enable

The API mode setting. The device can format the RF packets it receives into API frames and send them out the UART. When API is enabled the UART data must be formatted as API frames because Transparent mode is disabled. See Modes for more information.

Parameter range

0x00 - 0x05

Parameter	Description
0x00	API disabled (operate in Transparent mode)
0x01	API enabled
0x02	API enabled (with escaped control characters)
0x03	N/A
0x04	MicroPython REPL
0x05	Bypass mode

Default

0

PD (Pull Direction)

The resistor pull direction bit field (**1** = pull-up, **0** = pull-down) for corresponding I/O lines that are set by PR (Pull-up/down Resistor Enable).

If the bit is not set in **PR**, the device uses **PD**.

Note Resistors are not applied to disabled lines.

See PR (Pull-up/down Resistor Enable) for bit mappings, which are the same.

Parameter range

0x0 – 0x7FFF

Default

0 – 0x7FFF

PR (Pull-up/down Resistor Enable)

Sets or reads the bit field that configures the internal resistor status for the digital input lines. Internal pull-up/down resistors are not available for digital output pins, analog input pins, or for disabled pins.

Use the **PD** command to specify whether the resistor is pull-up or pull-down.

- If you set a **PR** bit to 1, it enables the pull-up/down resistor
- If you set a **PR** bit to 0, it specifies no internal pull-up/down resistor.

The following table defines the bit-field map for both the **PR** and **PD** commands.

Bit	I/O line	Module pin
0	DIO4	pin 11
1	DIO3/AD3	pin 17
2	DIO2/AD2	pin 18
3	DIO1/AD1	pin 19
4	DIO0/AD0	pin 20
5	DIO6/$\overline{\text{RTS}}$	pin 16
6	DIO8/SLEEP_REQUEST	pin 9
7	DIO14/DIN	pin 3
8	DIO5/ASSOCIATE	pin 15
9	DIO9/On/$\overline{\text{SLEEP}}$	pin 13
10	DIO12	pin 4
11	DIO10	pin 6
12	DIO11	pin 7
13	DIO7/$\overline{\text{CTS}}$	pin 12
14	DIO13/DOUT	pin 2

Parameter range

0 - 0x7FFF (bit field)

Default

0x7FFF

I/O settings commands

The following AT commands are I/O settings commands.

D0 (DIO0/AD0)

The DIO0/AD0 pin configuration (pin 20).

Parameter range

0, 2 - 5

Parameter	Description
0	Disabled
1	N/A
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D1 (DIO1/AD1)

The DIO1/AD1 pin configuration (pin 19).

Parameter range

0, 2 - 5

Parameter	Description
0	Disabled
1	N/A
2	ADC
3	Digital input
4	Digital output, low
5	Digital output, high

Default

0

D2 (DIO2/AD2)

The DIO2/AD2 pin configuration (pin 18).

Parameter range

0, 2 - 5

Parameter	Description
0	Disabled
1	N/A
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D3 (DIO3/AD3)

The DIO3/AD3 pin configuration (pin 17).

Parameter range

0, 2 - 5

Parameter	Description
0	Disabled
1	N/A
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D4 (DIO4)

The DIO4 pin configuration (pin 11).

Parameter range

0, 3 - 5

Parameter	Description
0	Disabled
1	N/A
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D5 (DIO5/ASSOCIATED_INDICATOR)

The DIO5/ASSOCIATED_INDICATOR pin configuration (pin 15).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	Associated LED
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

1

D6 (DIO6/$\overline{\text{RTS}}$)

Sets or displays the DIO6/$\overline{\text{RTS}}$ pin configuration (pin 16).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	$\overline{\text{RTS}}$ flow control

Parameter	Description
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D7 (DIO7/$\overline{\text{CTS}}$)

Sets or displays the DIO7/$\overline{\text{CTS}}$ pin configuration (pin 12).

Parameter range

0 - 1

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	$\overline{\text{CTS}}$ flow control
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0x1

D8 (DIO8/SLEEP_REQUEST)

Set or read the DIO8/$\overline{\text{DTR}}$/SLP_RQ pin configuration (pin 9).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	SLEEP_REQUEST input
3	Digital input

Parameter	Description
4	Digital output, default low
5	Digital output, default high

Default

1

D9 (DIO9/ON_SLEEP)

The DIO9/ON_SLEEP pin configuration (pin 13).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	ON/SLEEP output
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

1

P0 (DIO10 Configuration)

The DIO10 pin configuration.

Parameter range

0, 3 - 5

Parameter	Description
0	Disabled
1	N/A
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

P1 (DIO11/PWM1 Configuration)

The DIO11/PWM1 pin configuration (pin 7).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	Fan enable. Output is low when the XBee Cellular Modem is sleeping, turning an attached fan off when the cellular component is in a power saving mode, and also during Airplane Mode
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

P2 (DIO12 Configuration)

The DIO12 pin configuration (pin 4).

Parameter range

0, 3 - 5

Parameter	Description
0	Disabled
1	N/A
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

I/O sampling commands

The following AT commands configure I/O sampling parameters.

TP (Temperature)

Displays the temperature of the XBee Cellular Modem in degrees Celsius. The temperature value is displayed in 8-bit two's compliment format. For example, **0x1A** = 26 °C, and **0xF6** = -10 °C.

Parameter range

0 - 0xFF which indicates degrees Celsius displayed in 8-bit two's compliment format.

Default

N/A

The following AT commands are sleep commands.

SM (Sleep Mode)

Sets or reads the sleep mode of the device.

The sleep mode determines how the device enters and exits a power saving sleep.

Sleep mode is also affected by the **SO** command, option bit 6. See Sleep modes for more information about sleep modes.

Parameter range

0, 1, 4, 5

Parameter	Description
0	Normal. In this mode the device never sleeps.
1	Pin Sleep. In this mode the device honors the SLEEP_RQ pin. Set D8 (DIO8/SLEEP_REQUEST) to the sleep request function: **1**.
4	Cyclic Sleep. In this mode the device repeatedly sleeps for the value specified by **SP** and spends **ST** time awake.
5	Cyclic Sleep with Pin Wake. In this mode the device acts as in Cyclic Sleep but does not sleep if the SLEEP_RQ pin is inactive, allowing the device to be kept awake or woken by the connected system.

Default

0

SP (Sleep Period)

Sets or reads the time to spend asleep in cyclic sleep modes. In Cyclic sleep mode, the node sleeps with CTS disabled for the sleep time interval, then wakes for the wake time interval.

Parameter range

0x1 - 0x83D600 (x 10 ms)

Default

0x7530 (5 minutes)

ST (Wake Time)

Sets or reads the time to spend awake in cyclic sleep modes.

Parameter range

0x1 - 0x36EE80 (x 1 ms)

Default

0xEA60 (60 seconds)

Command mode options

The following commands are Command mode option commands.

CC (Command Sequence Character)

The character value the device uses to enter Command mode.

The default value (**0x2B**) is the ASCII code for the plus (**+**) character. You must enter it three times within the guard time to enter Command mode. To enter Command mode, there is also a required period of silence before and after the command sequence characters of the Command mode sequence (**GT** + **CC** + **GT**). The period of silence prevents inadvertently entering Command mode.

Parameter range

0 - 0xFF

Recommended: 0x20 - 0x7F (ASCII)

Default

0x2B (the ASCII plus character: **+**)

CT (Command Mode Timeout)

Sets or reads the Command mode timeout parameter. If a device does not receive any valid commands within this time period, it returns to Idle mode from Command mode.

Parameter range

2 - 0x1770 (x 100 ms)

Default

0x64 (10 seconds)

GT (Guard Times)

Set the required period of silence before and after the command sequence characters of the Command mode sequence (**GT** + **CC** + **GT**). The period of silence prevents inadvertently entering Command mode.

Parameter range

0x2 - 0x576 (x 1 ms)

Default

0x3E8 (one second)

Firmware version/information commands

The following AT commands are firmware version/information commands.

VR (Firmware Version)

Reads the firmware version on a device.

The firmware version returns four hexadecimal values (2 bytes) **ABCD**. Digits **ABC** are the main release number and **D** is the revision number from the main release. **B** is a variant designator where **0** means standard release.

Parameter range

0 - 0xFFFF [read-only]

Default

Set in firmware

VL (Version Long)

Shows detailed version information including the application build date and time.

Parameter range

N/A

Default

Set in firmware

HV (Hardware Version)

Display the hardware version number of the device.

Read the device's hardware version. Use this command to distinguish between different hardware platforms. The upper byte returns a value that is unique to each device type. The lower byte indicates the hardware revision.

Parameter range

0 - 0xFFFF [read-only]

Default

Set in firmware

AI (Association Indication)

Reads the Association status code to monitor association progress. The following table provides the status codes and their meanings.

Status code	Meaning
0x00	Connected to the Internet.

Status code	Meaning
0x22	Registering to cellular network.
0x23	Connecting to the Internet.
0x24	The cellular component is missing, corrupt, or otherwise in error. The cellular component requires a new firmware image.
0x25	Cellular network registration denied.
0x2A	Airplane mode.
0x2F	Bypass mode active.
0xFF	Initializing.

Parameter range

0 - 0xFF [read-only]

Default

N/A

HS (Hardware Series)

Read the device's hardware series number.

Parameter range

N/A

Default

Set in the firmware

CK (Configuration CRC)

Displays the cyclic redundancy check (CRC) of the current AT command configuration settings.

Parameter range

0 - 0xFFFFFFFF

Default

N/A

Diagnostic interface commands

The following AT commands are diagnostic interface commands.

DI (Device Cloud Indicator)

Displays the current Remote Manager status for the XBee.

Range

Value	Description
0x00	Connected
0x01	Before connection to the Internet
0x02	Remote Manager connection in progress
0x03	Disconnecting from Remote Manager
0x04	Not configured for Remote Manager

Default

N/A

CI (Protocol/Connection Indication)

Displays information regarding the last IP connection (when the **IP** command = **0**, **1** or **4**) or SMS transmission (when **IP** = 2).

The value for this parameter resets to **0xFF** when the device switches between IP (IP Protocol) modes.

When **IP** is set to **0**, **1**, or **4** (UDP, TCP, over SSL over TCP), **CI** resets to **0xFF** when you apply changes to any of the following settings:

- DL (Destination Address)
- DE (Destination Port)
- TM (TCP Client Connection Timeout)

When **IP** is set to **2** (SMS), **CI** resets to **0xFF** when P# (Destination Phone Number) is changed.

The following table provides the parameter's meaning when **IP** = **0** for UDP connections.

Parameter	Description
0x00	The socket is open.
0x01	Tried to send but could not.
0x02	Invalid parameters (bad IP/host).
0x03	TCP not supported on this cellular component.
0x10	Not registered to the cell network.
0x11	Cellular component not identified yet.
0x12	DNS query lookup failure.
0x20	Bad handle.
0x21	User closed.
0x22	Unknown server - DNS lookup failed.

Parameter	Description
0x23	Connection lost.
0x24	Unknown.
0xFF	No known status.

The following table provides the parameter's meaning when **IP** = **1** or **4** for TCP connections.

Parameter	Description
0x00	The socket is open.
0x01	Tried to send but could not.
0x02	Invalid parameters (bad IP/host).
0x03	TCP not supported on this cellular component.
0x10	Not registered to the cell network.
0x11	Cellular component not identified yet.
0x12	DNS query lookup failure.
0x20	Bad handle.
0x21	User closed.
0x22	No network registration.
0x23	No internet connection.
0x24	No server - timed out on connection.
0x25	Unknown server - DNS lookup failed.
0x26	Connection refused.
0x27	Connection lost.
0x28	Unknown.
0xFF	No known status.

The following table provides the parameter's meaning when **IP** = **2** for SMS connections.

Parameter	Description
0x00	SMS successfully sent.
0x01	SMS failed to send.
0x02	Invalid SMS parameters - check P# (Destination Phone Number).
0x03	SMS not supported.

Parameter	Description
0x10	No network registration.
0x11	Cellular component stack error.
0xFF	No SMS state to report (no SMS messages have been sent).

Parameter range

0 - 0xFF (read-only)

Default

-

Execution commands

The location where most AT commands set or query register values, execution commands execute an action on the device. Execution commands are executed immediately and do not require changes to be applied.

NR (Network Reset)

NR resets the network layer parameters.

The XBee Cellular Modem responds immediately with an **OK** on the UART and then causes a network restart.

If **NR** = **0**, the XBee Cellular Modem tears down any TCP/UDP sockets and resets Internet connectivity. You can also send **NR**, which acts like **NR** = **0**.

Parameter range

0

Default

N/A

!R (Modem Reset)

Forces the cellular component to reboot.

CAUTION! This command is for advanced users, and you should only use it if the cellular component becomes completely stuck while in Bypass mode. Normal users should never need to run this command. See the FR (Force Reset) command instead.

Range

N/A

Default

N/A

IS (Force Sample)

When run, **IS** reports the values of all of the enabled digital and analog input lines. If no lines are enabled for digital or analog input, the command returns an error.

Command mode

In Command mode, the response value is a multi-line format, individual lines are delimited with carriage returns, and the entire response terminates with two carriage returns. Each line is a series of ASCII characters representing a single number in hexadecimal notation. The interpretation of the lines is:

- Number of samples. For legacy reasons this field always returns 1.
- Digital channel mask. A bit-mask of all I/O capable pins in the system. The bits set to **1** are configured for digital I/O and are included in the digital data value below. Pins D0 - D9 are bits 0 - 9, and P0 - P2 are bits 10 - 12.
- Analog channel mask. The bits set to **1** are configured for analog I/O and have individual readings following the digital data field.
- Digital data. The current digital value of all the pins set in the digital channel mask, only present if at least one bit is set in the digital channel mask.
- Analog data. Additional lines, one for each set pin in the analog channel mask. Each reading is a 10-bit ADC value for a 2.5 V voltage reference.

API operating mode

In API operating mode, **IS** immediately returns an **OK** response.

The API response is ordered identical to the Command mode response with the same fields present. Each field is a binary number of the size listed in the following table. Multi-byte fields are in big-endian byte order.

Field	Size
Number of samples	1 byte
Digital channel mask	2 bytes
Analog chanel mask	1 byte
Samples	2 bytes each

Parameter range

N/A

Default

N/A

Operate in API mode

API mode overview

As an alternative to Transparent operating mode, you can use API operating mode. API mode provides a structured interface where data is communicated through the serial interface in organized packets and in a determined order. This enables you to establish complex communication between devices without having to define your own protocol. The API specifies how commands, command responses and device status messages are sent and received from the device using the serial interface.

We may add new frame types to future versions of firmware, so build the ability to filter out additional API frames with unknown frame types into your software interface.

Use the AP command to set the operation mode

Use API Enable to specify the operation mode:

AP command setting	Description
AP = 0	Transparent operating mode, UART serial line replacement with API modes disabled. This is the default option.
AP = 1	API operation.
AP = 2	API operation with escaped characters (only possible on UART).
AP = 3	N/A
AP = 4	MicroPython REPL
AP = 5	Bypass mode. This mode is for direct communication with the underlying chip and is only for advanced users.

The API data frame structure differs depending on what mode you choose.

API frame format

An API frame consists of the following:

- Start delimeter
- Length
- Frame data
- Checksum

API operation (AP parameter = 1)

This is the recommended API mode for most applications. The following table shows the data frame structure when you enable this mode:

Frame fields	Byte	Description
Start delimiter	1	0x7E

Frame fields	Byte	Description
Length	2 - 3	Most Significant Byte, Least Significant Byte
Frame data	4 - number (n)	API-specific structure
Checksum	n + 1	1 byte

Any data received prior to the start delimiter is silently discarded. If the frame is not received correctly or if the checksum fails, the XBee replies with a radio status frame indicating the nature of the failure.

API operation with escaped characters (AP parameter = 2)

Setting API to 2 allows escaped control characters in the API frame. Due to its increased complexity, we only recommend this API mode in specific circumstances. API 2 may help improve reliability if the serial interface to the device is unstable or malformed frames are frequently being generated.

When operating in API 2, if an unescaped 0x7E byte is observed, it is treated as the start of a new API frame and all data received prior to this delimiter is silently discarded. For more information on using this API mode, see the Escaped Characters and API Mode 2 in the Digi Knowledge base.

API escaped operating mode works similarly to API mode. The only difference is that when working in API escaped mode, the software must escape any payload bytes that match API frame specific data, such as the start-of-frame byte (0x7E). The following table shows the structure of an API frame with escaped characters:

<table>
<tr><th>Frame fields</th><th>Byte</th><th colspan="2">Description</th></tr>
<tr><td>Start delimiter</td><td>1</td><td colspan="2">0x7E</td></tr>
<tr><td>Length</td><td>2 - 3</td><td>Most Significant Byte, Least Significant Byte</td><td rowspan="3">Characters escaped if needed</td></tr>
<tr><td>Frame data</td><td>4 - n</td><td>API-specific structure</td></tr>
<tr><td>Checksum</td><td>n + 1</td><td>1 byte</td></tr>
</table>

Start delimiter field

This field indicates the beginning of a frame. It is always 0x7E. This allows the device to easily detect a new incoming frame.

Escaped characters in API frames

If operating in API mode with escaped characters (**AP** parameter = 2), when sending or receiving a serial data frame, specific data values must be escaped (flagged) so they do not interfere with the data frame sequencing. To escape an interfering data byte, insert 0x7D and follow it with the byte to be escaped (XORed with 0x20).

The following data bytes need to be escaped:

- 0x7E: start delimiter
- 0x7D: escape character
- 0x11: XON
- 0x13: XOFF

To escape a character:

1. Insert 0x7D (escape character).
2. Append it with the byte you want to escape, XORed with 0x20.

In API mode with escaped characters, the length field does not include any escape characters in the frame and the firmware calculates the checksum with non-escaped data.

Example: escape an API frame

To express the following API non-escaped frame in API operating mode with escaped characters:

Start delimiter	Length	Frame type	Frame Data	Checksum
			Data	
7E	00 0F	17	01 00 13 A2 00 40 AD 14 2E FF FE 02 4E 49	6D

You must escape the 0x13 byte:

1. Insert a 0x7D.
2. XOR byte 0x13 with 0x20: 13 ⊕ 20 = 33

The following figure shows the resulting frame. Note that the length and checksum are the same as the non-escaped frame.

Start delimiter	Length	Frame type	Frame Data	Checksum
			Data	
7E	00 0F	17	01 00 7D 33 A2 00 40 AD 14 2E FF FE 02 4E 49	6D

The length field has a two-byte value that specifies the number of bytes in the frame data field. It does not include the checksum field.

Length field

The length field is a two-byte value that specifies the number of bytes contained in the frame data field. It does not include the checksum field.

Frame data

This field contains the information that a device receives or will transmit. The structure of frame data depends on the purpose of the API frame:

Start delimiter	Length		Frame data								Checksum
			Frame type	Data							
1	2	3	4	5	6	7	8	9	...	n	n+1
0x7E	MSB	LSB	API frame type	Data							Single byte

- **Frame type** is the API frame type identifier. It determines the type of API frame and indicates how the Data field organizes the information.
- **Data** contains the data itself. This information and its order depend on the what type of frame that the Frame type field defines.

Multi-byte values are sent big-endian.

Calculate and verify checksums

To calculate the checksum of an API frame:

1. Add all bytes of the packet, except the start delimiter 0x7E and the length (the second and third bytes).
2. Keep only the lowest 8 bits from the result.
3. Subtract this quantity from 0xFF.

To verify the checksum of an API frame:

1. Add all bytes including the checksum; do not include the delimiter and length.
2. If the checksum is correct, the last two digits on the far right of the sum equal 0xFF.

Example

Consider the following sample data packet: **7E 00 0A 01 01 50 01 00 48 65 6C 6C 6F B8**

Byte(s)	Description
7E	Start delimeter
00 0A	Length bytes
01	API identifier
01	API frame ID
50 01	Destination address low
00	Option byte
48 65 6C 6C 6F	Data packet
B8	Checksum

To calculate the check sum you add all bytes of the packet, excluding the frame delimiter **7E** and the length (the second and third bytes).

7E 00 0A 01 01 50 01 00 48 65 6C 6C 6F B8

Add these hex bytes:

01 + 01 + 50 + 01 + 00 + 48 + 65 + 6C + 6C + 6F = 247

Now take the result of 0x247 and keep only the lowest 8 bits which in this example is 0x47 (the two far right digits). Subtract 0x47 from 0xFF and you get 0xB8 (0xFF - 0x47 = 0xB8). 0xB8 is the checksum for this data packet.

If an API data packet is composed with an incorrect checksum, the XBee Cellular Modem will consider the packet invalid and will ignore the data.

To verify the check sum of an API packet add all bytes including the checksum (do not include the delimiter and length) and if correct, the last two far right digits of the sum will equal FF.

01 + 01 + 50 + 01 + 00 + 48 + 65 + 6C + 6C + 6F + B8 = 2FF

Frame descriptions

The following sections describe the API frames.

AT Command - 0x08

Description

Use this frame to query or set parameters on the local device. Changes this frame makes to device parameters take effect after executing the AT command.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x08	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to **0**, the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Parameter value		Byte	If present, indicates the requested parameter value to set the given register. If no characters are present, it queries the register.

AT Command: Queue Parameter Value - 0x09

Description

This frame allows you to query or set device parameters. In contrast to AT Command - 0x08, this frame queues new parameter values and does not apply them until you issue either:

- The AT Command (0x08) frame
- The **AC** command

When querying parameter values, the 0x09 frame behaves identically to the 0x08 frame. The device returns register queries immediately and not does not queue them. The response for this command is also an AT Command Response frame (0x88).

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x09	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to **0**, the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Parameter value		Byte	If present, indicates the requested parameter value to set the given register. If no characters are present, it queries the register.

Transmit (TX) SMS - 0x1F

Description

Transmit an SMS message. The frame allows international numbers with or without the **+** prefix. If you omit **+** and are dialing internationally, you need to include the proper International Dialing Prefix for your calling region, for example, 011 for the United States.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x1F	Byte	
Frame ID		Byte	Reference identifier used to match status responses. **0** disables the TX Status frame.
Options		Byte	Reserved for future use.
Phone number		20 byte string	String representation of phone number terminated with a null (0x0) byte. Use numbers and the **+** symbol only, no other symbols or letters.
Payload		Variable (160 characters maximum)	Data to send as the body of the SMS message.

Transmit (TX) Request: IPv4 - 0x20

Description

A TX Request message causes the device to transmit data in IPv4 format.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x20	Byte	
Frame ID		Byte	Reference identifier used to match status responses. **0** disables the TX Status frame.
Destination address		32-bit big endian	
Destination port		16-bit big endian	
Source port		16-bit big endian	If the source port is **0**, the device attempts to send the frame data using an existing open socket with a destination that matches the destination address and destination port fields of this frame. If there is no matching socket, then the device attempts to open a new socket. If the source port is non-zero, the device attempts to send the frame data using an existing open socket with a source and destination that matches the source port, destination address, and destination port fields of this frame. If there is no matching socket, it returns an error.
Protocol		Byte	0 = UDP 1 = TCP 4 = SSL over TCP
Transmit options		Byte bitfield	Bit fields are offset 0 Bit field 0 - 7. Bits 0, and 2-7 are reserved, bit 1 is not. BIT 1 = **1** - Terminate the TCP socket after transmission is complete **0** - Leave the socket open (use TCP timeout) Ignore this bit for UDP packets. All other bits are reserved and should be **0**.
Payload		Variable	Data to be transferred to the destination, may be up to 1500 bytes.

AT Command Response - 0x88

Description

A device sends this frame in response to an AT Command (0x08) frame. Some commands send back multiple frames.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x88	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to **0**, the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Status	##	Byte	0 = OK 1 = ERROR 2 = Invalid command 3 = Invalid parameter
Parameter value		Byte	Register data in binary format. If the register was set, then this field is not returned.

Transmit (TX) Status - 0x89

Description

Indicates the success or failure of a transmit operation.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x89	Byte	
Frame ID		Byte	Refers to the frame ID specified in a previous transmit frame
Status		Byte	Status code (see the table below)

The following table shows the SMS status codes.

Code	Description
0x0	Successful transmit
0x21	Failure to transmit to cell network
0x22	Not registered to cell network
0x2c	Invalid frame values (check the phone number)
0x31	Internal error
0x32	Resource error (retry operation later)
0x74	Message too long
0x78	Invalid UDP port
0x79	Invalid TCP port
0x7A	Invalid host address
0x7B	Invalid data mode
0x80	Connection refused
0x81	Socket connection lost
0x82	No server
0x83	Socket closed
0x84	Unknown server
0x85	Unknown error

Modem Status - 0x8A

Description

Cellular component status messages are sent from the device in response to specific conditions.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame type	0x8A	Byte	
Status	##	Byte	0 = Hardware reset or power up 1 = Watchdog timer reset 2 = Registered with cellular network 3 = Unregistered with cellular network 0x0E = Remote Manager connected 0x0F = Remote Manager disconnected

Receive (RX) Packet: SMS - 0x9F

Description

This XBee Cellular Modem uses this frame when it receives an SMS message.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Field name	Field value	Data type	Description
Frame Type	0x9F	Byte	
Phone number		20 byte string	String representation of the phone number, padded out with null bytes (0x0).
Payload		Variable	Body of the received SMS message.

Receive (RX) Packet: IPv4 - 0xB0

Description

The XBee Cellular Modem uses this frame when it receives RF data on the port defined by the C0 (Source Port) command.

Format

The following table provides the contents of the frame. For details on frame structure, see API frame specifications.

Frame data fields	Offset	Description
Frame type	3	0xB0
IPv4 32-bit source address	MSB 4	The address in the example below is for a source address of **192.168.0.104**. 32-bit big endian.
	5	
	6	
	7	
16-bit destination port	MSB 8	Same value as the **C0** command. 16-bit big endian.
	LSB 9	
16-bit source port	MSB 10	16-bit big endian.
	LSB 11	
Protocol	MSB 12	0 = UDP 1 = TCP 4 = SSL over TCP
Status	13	Reserved
Payload	14	Data received from the source. The maximum size is 1500 bytes.
	15	
	16	
	17	
	18	

Socket behavior

Secure Sockets Layer (SSL) certificate checking

Currently, the XBee Cellular Modem is not capable of checking the certificate of the remote end of the socket connection. We will add this support in the future.

This means that the device cannot authenticate the remote end of the connection. Although the connection is encrypted, there is no way to verify that the remote server is the expected server.

Socket timeouts

The XBee Cellular Modem implicitly opens the socket any time there is data to be sent, and closes it according to the timeout settings. The TM (TCP Client Connection Timeout) command controls the timeout settings.

Enable incoming TCP sockets in API mode

In API mode, you can enable incoming connections to the XBee Cellular Modem.

1. To enable listening, set C0 (Source Port) to the value of the listening port.
2. To use TCP for client and server socket connections, set IP (IP Protocol) to **0x01**.

The listener allows multiple clients (incoming connections), up to the limit of the maximum number of sockets on the system.

When the XBee Cellular Modem receives RF data on the port defined by **C0**, you get a Receive (RX) Packet: IPv4 - 0xB0 with the incoming address and port.

If you want to communicate back to the incoming connection, use the Transmit (TX) Request: IPv4 - 0x20 and enter the received address and port as the destination address and port, along with the listening (**C0**) local source port.

Troubleshooting

This section contains troubleshooting steps for the XBee Cellular Modem.

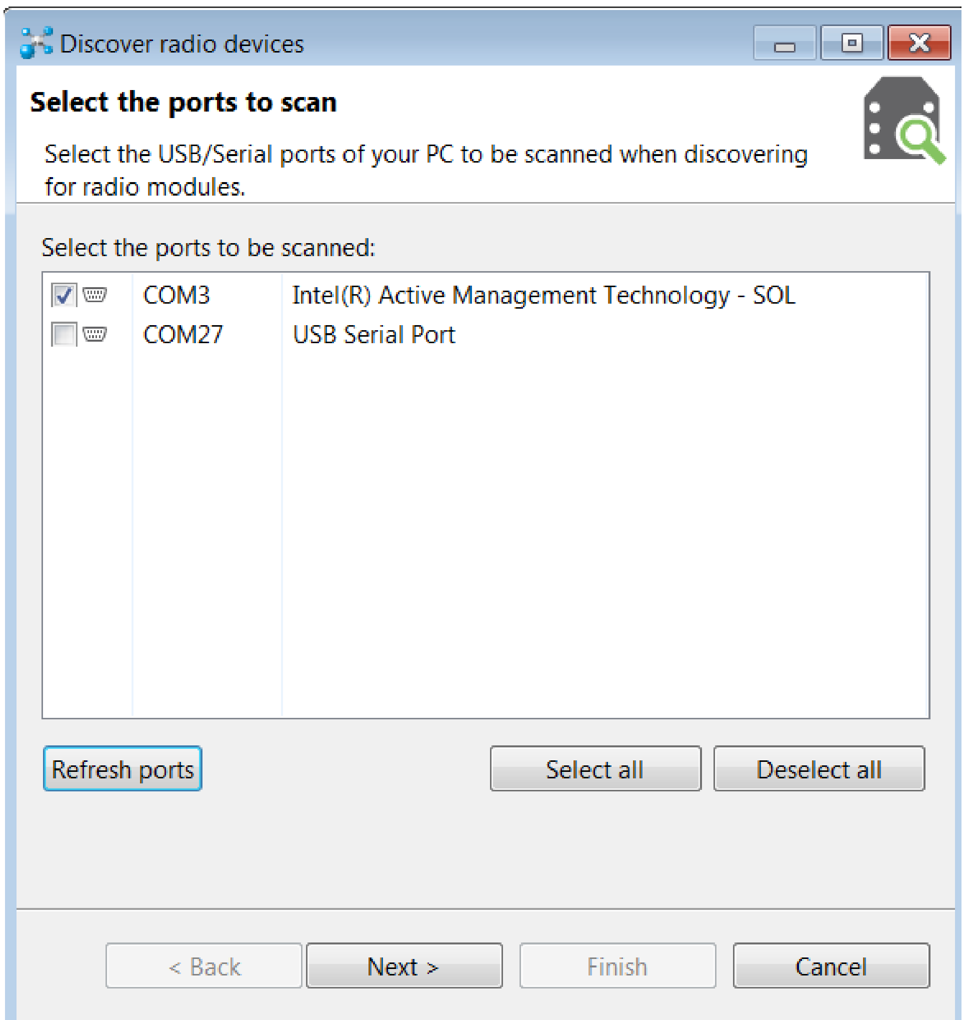
Cannot find the serial port for the device

Condition

In XCTU, the serial port that your device is connected to does not appear.

Solution

1. Click the **Discover radio modules** button .
2. Select all of the ports to be scanned.
3. Click **Next** and then **Finish**. A dialog notifies you of the devices discovered and their details.



4. Remove the development board from the USB port and view which port name no longer appears in the **Discover radio devices** list of ports. The port name that no longer appears is the correct port for the development board.

Other reasons that the XBee Cellular Modem is not discoverable include:

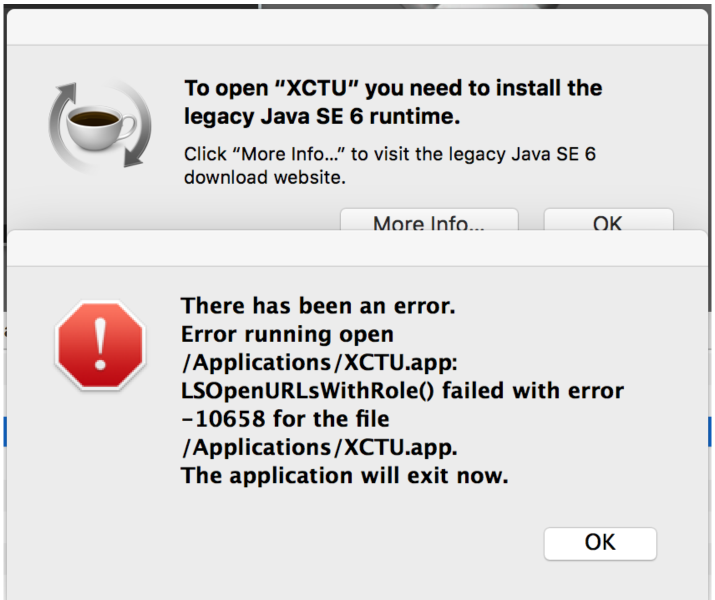
1. If you accidentally have the loopback pins jumpered.
2. You may not be using an updated FTDI driver.
    a. This may require you to reboot your computer.
    b. Disconnect the power and USB from the XBIB-U-DEV board and reconnect it.

Correct a macOS Java error

When you use XCTU on macOS computer, you may encounter a Java error.

Condition

When opening XCTU for the first time on a macOS computer, you may see the following error:



Solution

1. Click **More info** to open a browser window.
2. Click **Download** to get the file javaforosx.dmg.
3. Double-click on the downloaded javaforosx.dmg.
4. In the dialog, double-click the JavaForOSX.pkg and follow the instructions to install Java.

Unresponsive cellular component in Bypass mode

When in Bypass mode, the XBee Cellular Modem does not automatically reset or reboot the cellular component if it becomes unresponsive.

Condition

In Bypass mode, the XBee Cellular Modem does not respond to commands.

Solution

1. Query the AI (Association Indication) parameter to determine whether the cellular component is connected to the XBee Cellular Modem software. If **AI** is **0x2F**, Bypass mode should work. If not, look at the status codes in AI (Association Indication) for guidance.
2. You can send the !R (Modem Reset) command to reset only the cellular component.

Not on expected network after APN change

Condition

The XBee Cellular Modem is not on the expected network after a change to the AN (Access Point Name) command.

Solution

Send **ATNR0** to reset Internet connectivity. See NR (Network Reset) for more information.

Syntax error at line 1

You may get a **syntax error at line 1** error after pasting example MicroPython code and pressing **Ctrl**+**D**.

Solution

This commonly happens when you accidentally type a character at the beginning of line 1 before pasting the code.

Error Failed to send SMS

In MicroPython, you consistently get **Error Failed to send SMS** messages.

Solution

Your device cannot connect to the cell network. The reason may be:

1. The antenna is improperly or loosely connected.
2. The device is at a location where cellular service cannot reach. If the device is connected to the network, the red LED blinks about twice in a second. If it is not connected it does not blink; see The Associate LED.
3. You SIM card is out of SMS text quota.
4. The device is not getting enough current, for example if power is being supplied only by USB to the XBIB development board, rather than using an additional external power supply.

Regulatory information

Modification statement

Digi International has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Digi International n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and Industry Canada license-exempt RSS standard (s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Antennas

FCC (USA) exposure notice

This equipment complies with FCC radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions.

This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC procedures and as authorized in the module certification filing.

The gain of the system antenna(s) used for SARA-U201 modules (i.e. the combined transmission line, mconnector, cable losses and radiating element gain) must not exceed 3.42 dBi (850 MHz) and 1.51 dBi (1900 MHz) for mobile and fixed or mobile operating configurations.

Frequency band gain	Maximum
Band 5 (850 MHz)	3.42 dBi
Band 2 (1900 MHz)	1.51 dBi

ISED (Canada) exposure notice

This equipment complies with radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions.

This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with ISED procedures and as authorized in the module certification filing.

The gain of the system antenna(s) used for SARA-U201 modules (i.e. the combined transmission line, connector, cable losses and radiating element gain) must not exceed 0.61 dBi (850 MHz) and 1.51 dBi (1900 MHz) for mobile and fixed or mobile operating configurations.

Frequency band gain	Maximum
Band 5 (850 MHz)	0.61 dBi
Band 2 (1900 MHz)	1.51 dBi

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Labelling requirements for the host device

The device shall be properly labelled to identify the product within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID and IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: XPY1CGM5NNN

Contains IC: 8595A-1CGM5NNN

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. L'étiquette de certification du module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le FCC ID et le IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit :

Contains FCC ID: XPY1CGM5NNN

Contains IC: 8595A-1CGM5NNN

CAN ICES-3 (B) / NMB-3 (B)

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.