Digi XBee 3® DigiMesh

RF Module

Migration Guide

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Introduction

Digi has updated and ported its XBee DigiMesh firmware from the XBee/XBee-PRO DigiMesh (S2C) hardware based on the SiLabs EM357 SoC, to the Digi XBee 3 (Micro) hardware based on the SiLabs EFR32 SoC.
This guide assists you with migration to the new platform. While basic functionality and communication are similar and compatible, there are some differences to consider. This newer platform provides several major advantages over the existing platform, which we describe in this guide, along with other migration considerations.

What's new

The Digi XBee 3 DigiMesh RF Module introduces some new features such as:

- Addition of the "Micro" (MMT) form factor
- Capable of firmware migration to Zigbee, DigiMesh™ or Digi 802.15.4 protocols
- New, reliable and secure, firmware over-the-air (FOTA) update process based on the ZCL OTA update standard
- Lower operating receive current
- Power on channel 26 is increased on the PRO and power cap on channel 26 is removed for non-PRO
- Improved RF sensitivity and output power without the need for boost mode
- Synchronized Cyclic Sleep is supported on XBee 3. This feature was not available on the S2C due to hardware limitations.
- Supports MicroPython and a file system with OTA update support
- Support for I^2C through MicroPython
- SRP authenticated remote access (Secure Session)

Specification considerations

Specification comparison between the legacy XBee/XBee-PRO DigiMesh (S2C) and the new Digi XBee 3 DigiMesh.

Low-Power (non-PRO) variant

Considerations	Legacy XBee DM (S2C)	New Digi XBee 3 DM	Comments
Indoor/urban range	Up to 60 m (200 ft)	Up to 60 m (200 ft)	Same
Outdoor RF line-of-sight	Up to 1200 m (4000 ft)	Up to 1200 m (4000 ft)	Same
Transmit power output	6.3 mW (+8 dBm), boost mode 3.1 mW (+5 dBm), normal mode Channel 26 max power is +3 dBm	6.3 mW (+8 dBm)	No power cap on channel 26
Receive sensitivity	-102 dBm, boost mode -100 dBm, normal mode	-103 dBm	Comparable to boost mode

Considerations	Legacy XBee DM (S2C)	New Digi XBee 3 DM	Comments
Operating current (transmit)	45 mA (+8 dBm, boost mode) 33 mA (+5 dBm, normal mode)	40 mA @ +3.3V, +8dBm	Lower operating current vs boost mode
Operating current (receive)	31 mA (boost mode) 28 mA (normal mode)	17 mA	Improved
Supply voltage	2.1 – 3.6 V	2.1 – 3.6 V	Same
FCC ID	MCQ-PS2C	MCQ-XBEE3	Customer will need to change the label on the end product to show the appropriate regulatory ID for the XBee 3
Industry Canada (IC) ID	1846A-XBS2C	1846A-XBEE3	

High-Power (PRO) variant

Considerations	Legacy XBee-PRO DM (S2C)	New XBee 3 DM Pro	Comments	
Indoor/urban range	Up to 90 m (300 ft)	Up to 90 m (300 ft)	Same	
Outdoor RF line-of sight	Up to 3200 m (2 mi)	Up to 3200 m (2 mi)	Same	
Transmit power output	63 mW (+18 dBm) Channel 26 max power is +1 dBm	79 mW (+19 dBm) Channel 26 max power is +8 dBm	Power on channel 26 is increased	
Receive sensitivity	-101 dBm	-103 dBm	Better sensitivity	
Operating current (transmit)	120 mA @ 3.3 V, +18 dBm	135 mA @ +3.3 V, +19 dBm	Comparable	
Operating current (receive)	31 mA (Boost mode) 28 mA (Normal mode)	17 mA	Improved	
Supply voltage	2.7 - 3.6 V	2.1 - 3.6 V	Larger voltage range	
FCC ID	MCQ-PS2C	MCQ-XBEE3	Customer will need to change the label on the end product to show the appropriate regulatory ID for the XBee 3	
Industry Canada (IC) ID	1846A-PS2CSM	1846A-XBEE3		

Part number migration guide

The following table shows which Digi XBee 3 DigiMesh to migrate to depending on which XBee/XBee-PRO DigiMesh (S2C) module you are currently using.

DigiMesh is initially only available in the Micro form factor, however the XBee 3 with Zigbee firmware is available in a wide variety of form factors. The software can be updated to DigiMesh using a variety of options (contact sales or support for more information).

For the latest list of available XBee 3 DigiMesh modules, see the XBee 3 DigiMesh Part Numbers & Accessories page.

Legacy part number migration

S1 part number	S2C part number	Description	Migrate to
XB24-DMPIT-250	XB24CDMPIT-001	Digi XBee 3, 2.4 Ghz ZB 3.0, PCB Ant, TH MT	XB3-24Z8PT-J
XBP24-DMPIT-250	XBP24CDMPIT-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, PCB Ant, TH MT	XB3-24Z8PT
XB24-DMSIT-250	XBP24CDMPIT-001	Digi XBee 3, 2.4 Ghz ZB 3.0, SMA Ant, TH MT	XB3-24Z8ST-J
XBP24-DMSIT-250	XBP24CDMSIT-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, SMA Ant, TH MT	XB3-24Z8ST
XB24-DMUIT-250	XB24CDMUIT-001	Digi XBee 3, 2.4 Ghz ZB 3.0, U.FL Ant, TH MT	XB3-24Z8UT-J
XB24-DMUIT-250	XBP24CDMUIT-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, U.FL Ant, TH MT	XB3-24Z8UT
XB24-DMWIT-250	XB24CDMWIT-001	XBee DigiMesh Wire whip	N/A
XBP24-DMWIT-250	XBP24CDMWIT-001	XBee-Pro DigiMesh wire whip	N/A
	XB24CDMRIS-001	Digi XBee 3, 2.4 Ghz ZB 3.0, RF Pad Ant, SMT	XB3-24Z8RS-J
	XBP24CDMRIS-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, RF Pad Ant, SMT	XB3-24Z8RS
	XB24CDMPIS-001	Digi XBee 3, 2.4 Ghz ZB 3.0, PCB Ant, SMT	XB3-24Z8PS-J
	XBP24CDMPIS-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, PCB Ant, SMT	XB3-24Z8PS
	XB24CDMUIS-001	Digi XBee 3, 2.4 Ghz ZB 3.0, U.FL Ant, SMT	XB3-24Z8US-J
	XBP24CDMUIS-001	Digi XBee 3 PRO, 2.4 Ghz ZB 3.0, U.FL Ant, SMT	XB3-24Z8US

Micro form factor - New to XBee 3

Part number	Description
XB3-24DMRM-J	Digi XBee 3, 2.4 Ghz, DigiMesh, Micro, RF Pad Ant, MMT
XB3-24DMUM-J	Digi XBee 3, 2.4 Ghz, DigiMesh, Micro, U.FL Ant, MMT
XB3-24DMCM-J	Digi XBee 3, 2.4 Ghz, DigiMesh, Micro, Chip Ant, MMT
XB3-24DMRM	Digi XBee 3 PRO, 2.4 Ghz, DigiMesh, Micro, RF Pad Ant, MMT
XB3-24DMUM	Digi XBee 3 PRO, 2.4 Ghz, DigiMesh, Micro, U.FL Ant, MMT
XB3-24DMCM	Digi XBee 3 PRO, 2.4 Ghz, DigiMesh, Micro, Chip Ant, MMT

Digi XBee 3 DigiMesh functional migration considerations

The following enhancements have been made to the Digi XBee DigiMesh firmware for the XBee 3 platform:

Hardware and I/O considerations

Pin signals

Digi XBee 3 is available in three different form factors: Surface Mount (SMT), Through Hole (TH), and the newly introduced XBee 3 Micro (MMT).

The SMT and TH versions are pin compatible with existing XBee/XBee-PRO (S2C) SMT and TH hardware. This hardware is drop-in replaceable.

In order to fit all necessary pin connections on the XBee 3 Micro, three pins on the SMT were removed and the remaining pins have been shifted. These pins were unused on the SMT module. See the *XBee 3 Hardware Reference Manual* for more information.

ADC voltage reference and accuracy

The default ADC voltage reference changed from 1.2 V to 1.25 V. The ADC internal voltage reference can be set to 1.25 V, 2.5 V or VDD using the **AV** command.

The VREF pin from the XBee Series 1 is not supported by the XBee 3 hardware and has been removed from the Micro (MMT) form factor.

The ADCs on the XBee 3 are 10-bit when sampled from the XBee application (**IS**, **IR, IC**), if sampled through MicroPython, the resolution is increased to 12-bit.

Overvoltage detection

An overvoltage 0x8A modem status frame with a 0x0D status byte will warn the user of VCC input voltages exceeding the maximum rated 3.6 Volts with a 0.1 Volt margin. API mode (**AP** set to **1** or **2**) must be enabled to see this status message. When an overvoltage occurs the module will continue to operate with the RF power limited to max value of **PL**=**3** to meet FCC requirements.

Boot time

The boot time of the XBee 3 Zigbee module has increased compared to the previous XBee S2C Zigbee. This is due to enhanced functionality compared to the previous hardware platform as well as a secure boot operation.

Measured time from power-on to CTS asserting:

- XBee S2C Zigbee: ~75 ms
- XBee 3 Zigbee: ~290 ms

PWM output

The RSSI PWM period on the S2C was 200 µS, this has been changed to match other XBee firmwares and now outputs a signal with a 64 µS period. The **M0** and **M1** commands can be used to output a fixed duty cycle PWM signal on **P0** and **P1** if configured as a PWM output.

Module Temperature

The **TP** command (module temperature) is available on both Pro and Non-Pro variants. On the S2C, this command was only available on the PRO variant.

SPI and UART pins - non-peripheral behavior

On the SMT and Micro (MMT) form factors, the SPI lines (**P5**, **P6**, **P7**, **P8**, **P9**) can now be set as digital output High and Low.

The UART lines (**P3** and **P4**) can now be configured for I/O (peripheral, digital input, or digital output). These pins are also included in the **IC** (change detect) mask.

RF Considerations

Expanded channel selection

The IEEE 802.15.4 standard allows for 16 channels to be used for communication: from 2.405 GHz (Channel 11) through 2.480 GHz (Channel 26). On the previous XBee-PRO S1 DigiMesh and XBee-PRO S2C DigiMesh modules, the range of available channels (via the **CH** command) was restricted on the PRO variant. This restriction is alleviated on the XBee 3 and all 16 channels are available for use regardless of the variant.

If you are designing an application that will be interoperating with legacy S1 and/or S2C PRO modules, the **CH** parameter on the XBee 3 should be within 0x0C and 0x17 to guarantee communication.

Display output power and boost mode

The **PP** AT Command will return the operating power level of the XBee 3 in dBm based on the current operating configuration.

Boost Mode (**PM**) is no longer available, as both the Pro and Non-PRO variants of the XBee 3 hardware have enhanced receive sensitivity.

Reduced Energy Detection parameter range

The **ED** command, used to perform an energy detect scan, accepts a parameter value from 0 to 0x80 (1280 ms) which determines how long to perform the scan for. On the S1 and S2C, you could perform an energy detection up to 15 seconds in length (0x3A98).

UART considerations

UART Parity

The XBee 3 802.15.4 supports the following serial communication parity bit modes:

- No parity bit (**NB** = **0**)
- Even parity bit (**NB** = **1**)
- Odd parity bit (**NB** = **2**)

Support for mark parity has been removed.

Expanded baud rate

The XBee S2C only supported standard baud rates up to 230400. For the XBee 3, standard UART baud rates 460800 (**BD** = 0x9) and 921600 (**BD** = 0xA) have been added.

When setting a custom baud rate, **BD** now accepts a value up to 0x0EC400 (967680 baud).

Sleep considerations

Asynchronous sleep with pin wake

The behavior of asynchronous sleep with pin wake (**SM** = **5**) has been updated on the XBee 3. While sleeping, the XBee/XBee-PRO ZB (S2C) module would respond to a falling edge on nDTR/SLEEP_RQ by waking and would

return to sleep immediately when DTR/SLEEP_RQ again transitioned high. The XBee 3 will respond to a falling edge on nDTR/SLEEP_RQ by waking for a minimum of **ST** (sleep wake) time. If DTR/SLEEP_RQ again transitions high prior to a **ST** time period, the XBee 3 will remain awake for **ST** time then return to sleep. In other words, the XBee 3 will minimally sleep for **ST** time if a momentary pulse is observed on the nDTR/SLEEP_RQ line.

Synchronized cyclic sleep

Synchronized cyclic sleep was supported on the XBee/XBee-PRO Series 1 module. The S2C lacked the hardware necessary to keep the network in sync over long periods of time, so no support was included. This feature has now been reintroduced on XBee 3.

If operating in a mixed network of XBee S1 and XBee 3 modules, you must set a configuration option on the XBee 3 in order for the devices to remain in sync. Setting *Bit 3* of the **C8** (**C8** | 0x4) command will enable XBee S1 compatible synchronous sleep messages. This bit **must** be set if there are **any** Xbee S1 modules in a network using Synchronous Sleep. If only XBee 3 is being deployed, the bit should be left off for greater accuracy of synchronous sleeping network.

Security considerations

Enhanced security

On the previous XBee S1 DigiMesh and XBee S2C DigiMesh modules, 128-bit AES encryption was used to secure RF traffic. The default security on the XBee 3, when enabled, is 256-bit AES with counter mode to protect against replay attacks. As a result, the KY parameter has been increased to a 256-bit value (64 ASCII characters) on the XBee 3.

In order to provide compatibility with legacy DigiMesh networks, a bit in the C8 command has been created. Bit 2 of the C8 bitfield (C8 | 0x4), when set, reduces the security mode of the XBee 3 to 128-bit AES; this is over-the-air compatible with legacy 2.4 GHz DigiMesh devices.

When this compatibility mode is enabled, only the last 32 ASCII chars (128 least significant bits) of the 256-bit KY parameter will be used. KY cannot be read and is write-only. i.e.

Examples:

- If **EE** = 1 and **C8** = 0, then **KY** is a 256-bit Link key and will only communicate with other XBee 3 DM devices with the same **C8** and **KY** values.

- If **EE** = 1 and **C8** = 4, then **KY** is a 128-bit Link key that is compatible with S1, S2C, and XB3 DigiMesh using with the same 128-bit **KY** value.

If **KY** = 11112222333344445555666677778888<u>ZZZZYYYYXXXXWWWWVVVVUUUUTTTTSSSS</u>, the underlined portion would be the 128-bit link key.

Firmware update considerations

XBee file system

XBee 3 DigiMesh RF Module firmware versions 3002 and later include support for storing files in internal flash memory. Through the XBee application, the file system is accessed through the **FS** command, however the file system is primarily used to support micropython applications. XCTU has full support for local and remote file system access and can be used to generate and sign

FOTA (firmware over-the-air) updates are stored in the same memory location as the file system. Initiating an OTA update will erase the contents of the file system. A bundled file system image can be sent over the air using the same mechanism as FOTA updates; this should be utilized in order to restore device operation after a firmware update is completed. In order to allow remote images to be uploaded, a File system public key (**FK**

command) must be set on the target device and the bundled image signed before it can be validated and applied by the remote node. To ensure unauthorized code cannot be arbitrarily uploaded to devices on the network, the **FK** command must be set locally.

OTA firmware update process

The firmware update process has changed on the Digi XBee 3 DigiMesh. The XBee/XBee-PRO DM (S2C) module required a source, updater, and target node. Under certain circumstances, nodes could be put in bootloader mode, and were therefore unavailable on the network. Additionally, if the firmware upload was interrupted at any point in the update process, the target module would then need to be "recovered". This can be very taxing on a network, especially across multiple hops.

The FOTA update process for Digi XBee 3 DigiMesh is improved over the S2C. First, the firmware update requires only the use of a server (node sending the firmware file), and a client node (node receiving the firmware file). The firmware image is sent in blocks using standard Zigbee Cluster Library (ZCL) frames as described in Zigbee document 07-5123-06 chapter 11. These frames are supported using the 0x11 Explicit Transmit Frame. The client device never goes offline. The image is simply stored in an internal flash slot of the module's memory. Note that this slot is utilized by the XBee file system, the act of initiating an FOTA update will irreversibly erase the file system. Once the entire firmware file has been uploaded, the client can switch to the new firmware image. If at any point in the process the transfer was interrupted, the image will simply not pass a security check and the module will not boot into the new image.

The radio serving up the firmware image can be either a Digi XBee 3 DigiMesh or XBee/XBee-PRO DM(S2C). However, since the XBee/XBee-PRO DM (S2C) requires that another XBee/XBee-PRO DM(S2C) be a nearest neighbor to act as the updater node, there is some limitation as to how nodes can be updated in a mixed network.

The image below describes how it is determined whether nodes in a mixed network arrangement can be updated from a single firmware image server. The image server can be either Digi XBee 3 DigiMesh or XBee/XBee-PRO DM(S2C). S2C modules must be within range of another S2C module to be updated.
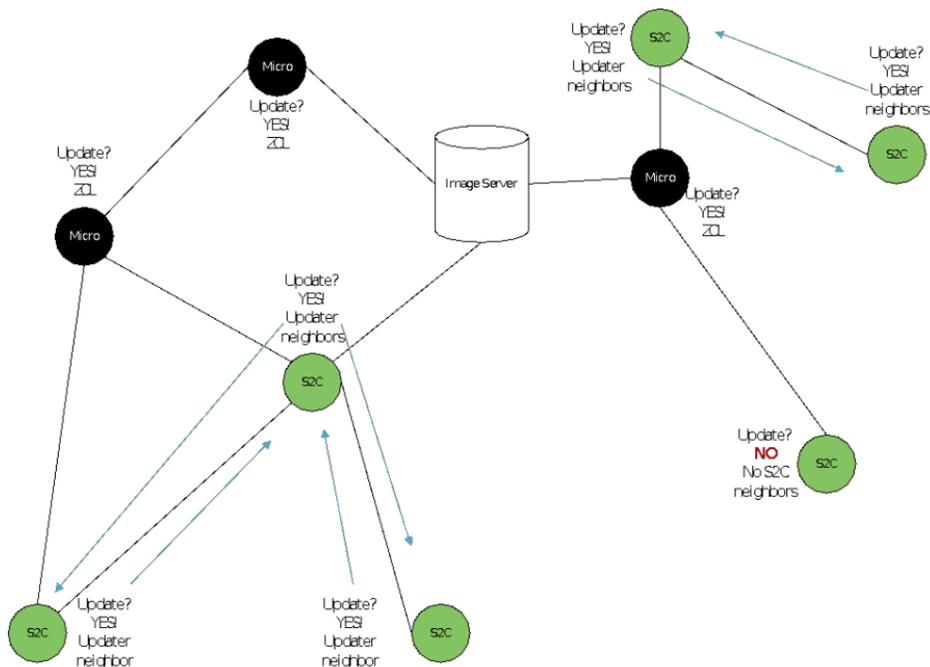
Bootloader update support

The bootloader of the XBee 3 can be updated in addition to the XBee application. The bootloader update can be performed serially or over the air. When the bootloader is updated serially, the XBee application is erased and must be reinstalled. If updating from bootloader version 118 or earlier to version 166 or newer, the memory layout was updated in order to support the file system. In this instance, device configuration will be lost. If running version 166 or newer, when performing a bootloader update, the device configuration is retained. As long as the same firmware type (e.g. DigiMesh to DigiMesh) is installed and ran after the bootloader update, the device configuration will be retained.

The bootloader version can be read using the **VH** command. If using XCTU to update your device, you will be prompted to update the bootloader if an update is needed. The bootloader can never be downgraded.

The bootloader can be updated over the air if the target device is running application version 3001 and bootloader version 166. This is done by performing an FOTA update using a combined image that contains the XBee application and bootloader; the image type for this is an *.otb file format.

Other considerations

Custom defaults

The XBee 3 supports custom defaults. This allows you to specify the parameter values that are loaded into configuration when defaults are restored using the **RE** command or 4-button presses of the commissioning button.

Enhanced XCTU support

To improve usability within XCTU, AT commands have been rearranged and additional categories have been created.
Legacy X-CTU (5.2.8.10 and older) can be used for serial firmware updates only; no bootloader update or module configuration is available.

Future updates

For the most up-to-date information on what features and enhancements have been added in the XBee software, refer to the release notes that are included with each software update.