DIGI.

Digi XBee3® 802.15.4

RF Module

Migration Guide

Contents

Introduction

Digi has updated and ported our XBee 802.15.4 firmware from the XBee/XBee-PRO 802.15.4 (S2C) hardware based on the SiLabs EM357 SoC, to the Digi XBee3 (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 XBee3 802.15.4 introduces some new features such as:

- Addition of the "Micro" (MMT) form factor
- Firmware migration capability to Zigbee and DigiMesh™ protocols
- Lower operating receive current
- Increased power on channel 26 on the PRO and removal of the power cap on channel 26 for the non-PRO

Specification considerations

XBee/XBee-PRO 802.15.4 (S2C) to Digi XBee3 802.15.4 (Micro).

XBee3 802.15.4			
Considerations	**Legacy XBee 802.15.4 (S2C)**	**New Digi XBee3 802.15.4**	**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
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

XBee3 802.15.4			
Considerations	**Legacy XBee 802.15.4 (S2C)**	**New Digi XBee3 802.15.4**	**Comments**
Operating current (receive)	31 mA (boost mode) 28 mA (normal mode)	15 mA	Improved
Supply voltage	2.1 – 3.6 V	2.1 - 3.6 V	Same
FCC ID	MCQ-S2C	MCQ-XBEE3	Customer will need to change the label on the end product to show the appropriate regulatory ID for the XBee3
Industry Canada (IC) ID	1846A-XBS2C	1846A-XBEE3	

XBee-PRO ZB 802.15.4			
Considerations	**Legacy XBee-PRO 802.15.4**	**New Digi XBee3 802.15.4**	**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)	15 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 XBee3
Industry Canada (IC) ID	1846A-PS2CSM	1846A-XBEE3	

Part number migration guide

The following table shows which Digi XBee3 802.15.4 to migrate to depending on which XBee/XBee-PRO 802.15.4 (S2C) module you are currently using.

S1 Part number	S2C part number	Description	Migrate to
XB24-API-001	XB24CAPIT-001	Digi XBee3, 2.4 Ghz ZB 3.0, PCB Ant, TH MT	XB3-24Z8PT-J
XBP24-API-001	XBP24CAPIT-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, PCB Ant, TH MT	XB3-24Z8PT
XB24-ASI-001	XB24CASIT-001	Digi XBee3, 2.4 Ghz ZB 3.0, SMA Ant, TH MT	XB3-24Z8ST-J
XBP24-ASI-001	XBP24CASIT-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, SMA Ant, TH MT	XB3-24Z8ST
XB24-AUI-001	XB24CAUIT-001	Digi XBee3, 2.4 Ghz ZB 3.0, U.FL Ant, TH MT	XB3-24Z8UT-J
XBP24-AUI-001	XBP24CAUIT-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, U.FL Ant, TH MT	XB3-24Z8UT
XB24-AWI-001	XB24CAWIT-001	XBee DigiMesh Wire whip	N/A
XBP24-AWI-001	XBP24CAWIT-001	XBee-Pro DigiMesh wire whip	N/A
	XB24CARIS-001	Digi XBee3, 2.4 Ghz ZB 3.0, RF Pad Ant, SMT	XB3-24Z8RS-J
	XBP24CARIS-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, RF Pad Ant, SMT	XB3-24Z8RS
	XB24CAPIS-001	Digi XBee3, 2.4 Ghz ZB 3.0, PCB Ant, SMT	XB3-24Z8PS-J
	XBP24CAPIS-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, PCB Ant, SMT	XB3-24Z8PS
	XB24CAUIS-001	Digi XBee3, 2.4 Ghz ZB 3.0, U.FL Ant, SMT	XB3-24Z8US-J
	XBP24CAUIS-001	Digi XBee3 PRO, 2.4 Ghz ZB 3.0, U.FL Ant, SMT	XB3-24Z8US

Micro options - new to Digi XBee3 802.15.4

New part number	Description
XB3-24ARM-J	XBee3, 2.4 GHz, 802.15.4, RF Pad Ant, MMT
XB3-24AUM-J	XBee3, 2.4 GHz, 802.15.4, U.FL Ant, MMT
XB3-24ACM-J	XBee3, 2.4 GHz, 802.15.4, Chip Ant, MMT
XB3-24ARM	XBee3 PRO, 2.4 GHz, 802.15.4, RF Pad Ant, MMT
XB3-24AUM	XBee3 PRO, 2.4 GHz, 802.15.4, U.FL Ant, MMT
XB3-24ACM	XBee3 PRO, 2.4 GHz, 802.15.4, Chip Ant, MMT

Pin signals

The Digi XBee3 802.15.4 will be released in three different form factors, Surface Mount (SMT), Through Hole (TH), and the newly introduced XBee3 Micro (MMT). The SMT version is pin compatible with existing XBee/XBee-PRO 802.15.4 (S2C) SMT hardware. The TH version is pin compatible with existing XBee/XBee-PRO 802.15.4 (TH) through-hole hardware.

This hardware is drop-in replaceable. In order to fit all necessary pin connections on the XBee3 Micro, three pins on the SMT were removed and the remaining pins were shifted. These pins were unused on the SMT module. See the *XBee3 Hardware Reference Manual* for more information.

Configuration

The Digi XBee3 802.15.4 family of modules will enable the user to reconfigure the firmware as new protocol support is released. Other protocols available are Digi's proprietary DigiMesh and Zigbee. Using XCTU, you can load the appropriate firmware to fit your current needs within the regulatory guidance of the region of deployment. See the *XBee3 802.15.4 User Guide* for more information.

Digi XBee3 802.15.4 functional migration considerations

The following enhancements have been made to the 802.15.4 XBee firmware for the XBee3 platform:

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 module configuration is available.

New AT commands

- **PP** - Output power level in dBm
- **SB** - UART Stop Bits
- **FT** - Flow control threshold
- **D9** - On/nSleep indicator
- **LT** - Association LED blink rate
- **TP** - Module temperature
- **%V** - Supply voltage
- **CK** - Configuration CRC
- **AO** - API Output Mode
- **AZ** - API Extended Options
- **AV** - Analog VREF Configuration
- **T8** - D8 Output Timeout
- **T9** – D9 Output Timeout
- **Q0** - P0 Output Timeout
- **Q1** – P1 Output Timeout
- **Q2** – P2 Output Timeout
- **VH** - Bootloader Version
- **NP** - Maximum Payload Length
- **!C** - Clear custom defaults
- **%F** - Set custom defaults
- **R1** - Restore factory defaults

Command default and ranges

The following AT commands have different defaults and/or ranges on the XBee3 compared to the S2C. This is to enhance existing functionality or to support new features.

AT Command	S2C Default	S2C Range	XBee3 Default	XBee3 Range
SO	0	0 - 3	0	0 - 0x103
PR	0xFF	0 - 0xFF	0xFFFFF	0 - 0xFFFFF
PD	0xFF	0 - 0xFF	0xFFFFF	0 - 0xFFFFF
IC	0	0 - 0xFF	0	0 - 0x7FFF
SP	0	0 - 0x68B0	0	0 - 0x15F900
ST	0x1388	1 - 0xFFFF	0x7D0	0 - 0x36EE80
DP	0x3E8	1 - 0x68B0	0x3E8	1 - 0x15F900
CA	0x2C	0x28 - 0x50	0x41	0x28 - 0x64
BD	3	0 - 8	3	0 - 0xA

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 802.15.4 and XBee-PRO S2C 802.15.4 modules, the range of available channels (via the CH command) was restricted on the PRO variant. This restriction is alleviated on the XBee3 and all 16 channels are available for use regardless of the variant.

For more information, see the [XBee-PRO ZB 802.15.4](#) table.

If you are designing an application that will be interoperating with legacy S1 and/or S2C PRO modules, the **CH** parameter on the XBee3 needs to be within 0x0C and 0x17 to communicate.

Clear Channel Assessment

CCA (clear channel assessment) can be disabled by setting the **CA** parameter to 0. Doing so will reduce latency in noisy environments at a risk of data loss and causing interference.

The CCA threshold is set upon device initialization. Any change made to the **CA** parameter value must be written to flash using the **WR** command and will be used upon the next power cycle. Disabling CCA (**CA** = 0) can be done at runtime and does not require a reboot to take effect.

Display output power

The **PP** AT Command will return the operating power level of the device 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 XBee3 hardware have enhanced receive sensitivity.

Energy Detect and Active Scan

The Energy Detect (**ED**) and Active Scan (**AS**) commands no longer have adjustable scan durations, so the **SD** command has been removed. As such, the **ED** and **AS** commands no longer accepts a parameter to specify the scan duration.

The **ED** command in transparent mode (**AP** = 0) also now returns the detected energy levels delimited by commas instead of carriage returns (as was done on legacy products). This matches the output of **ED** on other XBee protocols. Remote **ED** AT commands are also now fully functional.

Some of the unused fields in the **AS** superframe have been populated with 0xFF by default. On the S1 and S2C, these unused fields are populated with a 0 value.

Maximum Payload command (NP)

Due to the complexity of determining the maximum payload size, an AT command was included to help facilitate this. The **NP** command can be queried to determine what the maximum achievable payload size is based on current configuration.

Note that this command assumes long addressing is used, which means utilizing short addressing will slightly increase the payload size.

UART Parity

The XBee3 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.

UART Stop bits

It is now possible to specify the number of Stop bits used for incoming and outgoing UART frames. The **SB** command can be used to specify either one or two stop bits.

RS-485 support

RS-485 support can be enabled via the **D7** pin. When enabled, this will cause the CTS pin to assert high or low whenever data is transmitted on the UART, facilitating the half-duplex nature of RS-485.

Expanded internal resistor coverage

Internal pull-up/down resistors are expanded to cover the entire range of I/O lines. On the S1 and S2C firmware, the **PR** and **PD** commands only allow for internal pull-up/down resistors to cover the first 8 I/O lines. This has been expanded to cover all 20 I/O lines on the XBee3. Be aware that instead of an 8-bit value (max of 0xFF), **PR** and **PD** on the XBee3 support a 32-bit range of up to 0xFFFFF.

Enhanced I/O pin support

Due to the wide-sweeping changes made to I/O on the XBee3 802.15.4 firmware, please refer to the I/O support portion of the user guide for more information on compatibility and how to use the enhanced I/O support: https://www.digi.com/resources/documentation/digidocs/90002273/Default.htm

Highlights are included below:

- Every I/O line (**D0** through **D9**, **P0** through **P9**) can now be set as a Digital Output high (4) or low (5).
- XBee3 802.15.4 now has support for up to 15 Digital Inputs.
  - **D0** through **D9** and **P0** through **P4** can be set as Digital Inputs for I/O sampling and/or Digital I/O line passing.

- In order to take advantage of these inputs for sampling, **AO** must be set to 0 or 1 on the sampling radio. The receiving radio must be an XBee3 in order to interpret the enhanced I/O sample data packet.
- The API frame that gets output on the receiver is a 0x92 API frame when configured in this way.
  - S1 and S2C compatible support is enabled by default (the **AO** command is set to 2) which will allow seamless integration of the XBee3 into a mixed network or application that was designed for these devices. This does, however, restrict the digital inputs to **D0** through **D8**.
  - The number of analog inputs is unchanged from the S2C 802.15.4. The four 10-bit ADC lines are **D0** through **D3** when set to 2.

Voltage reference

The default ADC voltage reference changed from 1.2 V to 1.25 V.

The VREF pin from the XBee Series 1 is not supported by the XBee3 hardware and has been removed from the Micro (MMT) form factor.

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

Input voltage sampling and overvoltage detection

The **%V** AT command has been added and detects the input voltage over the range of hardware supported input voltages (2.1V to 3.6V).

An overvoltage 0x8A modem status has been added to warn the user of VCC input voltages exceeding the maximum rated 3.6 Volts. API mode (**AP** is set to 1 or 2) must be enabled to see this status message.

Module temperature sampling

The **TP** AT command has been added to return the current module temperature in degrees Celsius.

I/O sample API output

The XBee S1 and S2C 802.15.4 modules would output API frames for incoming I/O samples even when operating in transparent interface mode (**AP** = 0). I/O sample frames on the XBee3 are suppressed when in transparent mode. To output incoming I/O samples with the XBee3 802.15.4, an API interface mode (**AP** = 1) or (**AP** = 2) must be used.

It is possible to suppress I/O sample frames when using I/O line passing if (**IU** = 0). In this case if the source address of the incoming sample matches **IA** or (**IA** = 0xFFFF) then the I/O frame will be suppressed. On the S1 and S2C, the IU command would suppress all I/O samples regardless of whether they were being utilized for line passing or not.

Enhanced API frame support

Additional API frame support has been added and is configured with the **AO** command. When AO is configured as either 0 or 1, this will output an API frame format that matches XBee DigiMesh and XBee Zigbee. This allows for easy migration from these other software releases to the XBee3 802.15.4.

API support for the S1 and S2C is enabled by setting **AO** to 2. This is the default configuration of the XBee3 802.15.4, which allows it to act as a drop-in replacement for existing deployments.

AO affects API frame output as follows:

AO value	Incoming data packet	Incoming I/O sample data
0	0x90 – Rx Frame	0x92 – I/O Sample
1	0x91 – Explicit Rx Frame	0x92 – I/O Sample
2 (default)	0x80 – 64-bit Rx Frame 0x81 – 16-bit Rx Frame	0x82 – 64-bit I/O sample 0x83 – 16-bit I/O sample

The XBee3 802.15.4 also supports receiving 0x10 and 0x11 transmit request frames. These frames are identical to XBee DigiMesh and XBee Zigbee firmwares, providing an easy migration path to 802.15.4 from applications built for those protocols.

Sleep configuration

The XBee S1 and S2C 802.15.4 modules allowed DIO8 to trigger pin sleep when configured as disabled (**D8** = 0) or digital input (**D8** = 3). This could lead to some misleading device behavior since a disabled pin should not be providing functionality.

The **D8** pin can now be set as a peripheral (1) to provide pin sleep support. Pin sleep (**SM** = 1) now requires **D8** be set as a peripheral and asserted before the module will sleep.

When using cyclic sleep with pin wake (**SM** = 5), the DTR/Sleep_Rq line (**D8** = 1) now wakes the module for the entire duration that the pin is asserted. On S2C this pin would only wake the module for a single **ST** period.

Momentary wake has been added to **D0** as a commissioning button option (**D0** = 1). Pressing the commissioning button on a sleeping module will wake the device for 30 seconds.

The bit field for **SO** has been updated to be more like other protocols. Setting bit 0x100 (bit 8) will now cause the XBee to stay awake for the complete **ST** time when cyclic sleep modes are enabled after the expiration of every **SP** period.

Now the XBee3 802.15.4 Cyclic sleep with pin wake will work as follows:

The module will cyclically sleep while DTR is HIGH and will continue in its cyclic sleep patterns while DTR is held LOW. Begging with version 2003 the module SM = 5 will behave as expected. Unlike past designs turning DTR LOW will not only keep the module for only ST but rather for the whole duration while DTR is kept LOW.

Coordinator limitations

The XBee S1 and the S2C 802.15.4 operating as end devices (bit 2 of **A1** set to 1) are currently unable to associate with an XBee3 802.15.4 acting as a coordinator (bit 2 of **A2** set to 1 and **CE** = 1). An XBee3 acting as an end device can associate with any coordinator (an XBee3 802.15.4, S2C 802.15.4, and the S1). Support for legacy device association will be added in a future firmware release.

Coordinator	End Device	Association possible?
XBee3	XBee3	Yes
S2C (and S1)	XBee3	Yes
S2C (and S1)	S2C (and S1)	Yes
XBee3	S2C (and S1)	**No**

Bootloader update support

The bootloader of the XBee3 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.

The bootloader can also be updated over the air. This is done by updating the XBee application and bootloader as a single image.

OTA firmware update process

The OTA firmware update process for the XBee3 802.15.4 is different than the process on the S2C. The XBee S1 did not have OTA firmware update capabilities. When performing an OTA firmware update, both the server and client nodes must be of the same type (XBee3 to XBee3, S2C to S2C).

The firmware image is sent in blocks using standard Zigbee Cluster Library (ZCL) frames. 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. 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 and will continue operating using the existing image.

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.