Wireless Communication

GT Off-Road Racing | Data Acquisition

Andrew Hellrigel

10/05/2021

Table of Contents

[1.0 Overview 2](#_Toc84369190)

[1.1 Introduction 2](#_Toc84369191)

[2.0 XBEE Configuration 3](#_Toc84369192)

[2.1 XBEE Types 3](#_Toc84369193)

[2.1.1 XBEE 3 Pro 3](#_Toc84369194)

[2.1.2 XBEE Pro S3B 3](#_Toc84369195)

[2.1.3 Antenna Selection 4](#_Toc84369196)

[2.2 XBEE Wiring 4](#_Toc84369197)

[2.2.1 XBEE Pinout 4](#_Toc84369198)

[2.2.2 XBEE Important Connections 4](#_Toc84369199)

[2.3 XCTU 4](#_Toc84369200)

[2.3.1 XCTU Installation and XBEE Connection 4](#_Toc84369201)

[2.3.2 XBEE Firmware 6](#_Toc84369202)

[2.3.3 XBEE Settings 7](#_Toc84369203)

[3.0 Testing 8](#_Toc84369204)

[4.0 Revision History 9](#_Toc84369205)

# 1.0 Overview

## 1.1 Introduction

The purpose of this documentation is to serve as an introduction in to the setup that we use for wireless communication and how to configure and test the XBEE’s.

# 2.0 XBEE Configuration

## 2.1 XBEE Types

### 2.1.1 XBEE 3 Pro

<https://www.digi.com/products/embedded-systems/digi-xbee/rf-modules/2-4-ghz-rf-modules/xbee3-zigbee-3>

A close-up of a computer chip

Description automatically generated with medium confidence

The XBEE 3 Pro was the first XBEE that we used on our team for wireless communication. Through our tests we found that we could get about a half a mile range before we started having problems with packet loss (Although we don’t have much experience in RF so this could probably be optimized).

### 2.1.2 XBEE Pro S3B

<https://www.digi.com/products/embedded-systems/digi-xbee/rf-modules/sub-1-ghz-rf-modules/xbee-pro-xsc>

**A picture containing text, electronics, circuit

Description automatically generated**

The XBEE Pro S3B is a more advanced RF radio module. It theoretically can operate up to 9 miles, but we really only need it to work at a range of about a mile without packet loss. It uses 1W of power which is more than the XBEE 3 Pro, but that is how it is able to reach such long ranges.

### 2.1.3 Antenna Selection

The most important thing in choosing an antenna is to make sure that it matches the frequency of the XBEE. For the XBEE Pro S3B this means that the antenna should be rated for 900MHz. The other important factor in choosing an antenna is the dBi rating of the antenna. More research needs to be done on what this number actually means for our application but a higher number doesn’t necessarily mean that it is a better antenna.

## 2.2 XBEE Wiring

### 2.2.1 XBEE Pinout

The pinout for each device can be found in the respective datasheet.

XBEE 3 Pro: <https://www.digi.com/resources/documentation/digidocs/pdfs/90001543.pdf>

XBEE Pro S3B: <https://www.digi.com/resources/documentation/digidocs/pdfs/90002173.pdf>

### 2.2.2 XBEE Important Connections

There are only 4 pins that need to be connected for the XBEE communication to work.

|  |  |  |
| --- | --- | --- |
| Pin Name | Pin # | Connection |
| VCC | 1 | Connect this to 3.3V (The XBEE is **not** 5V compatible) |
| DOUT | 2 | Connect this to a Teensy’s RX pin |
| DIN | 3 | Connect this to a Teensy’s TX pin |
| GND | 10 | Connect this to GND |

Diagram, schematic

Description automatically generated

## 2.3 XCTU

### 2.3.1 XCTU Installation and XBEE Connection

XCTU is the software that is used to update firmware for the XBEE’s and set the configuration of the XBEEs.

The installation for XCTU can be found here: <https://hub.digi.com/support/products/xctu/>

More information about XCTU can be found in this Sparkfun tutorial for configuring XBEE’s. <https://learn.sparkfun.com/tutorials/exploring-xbees-and-xctu/all>

Graphical user interface, text, application

Description automatically generated

This is the first page of the XCTU software. To connect to an XBEE, select the “Add Devices” button in the top left corner of the application. For this software to be able to find the XBEE, it has to be plugged into your computer through an XBEE explorer. <https://www.sparkfun.com/products/11812?_ga=2.31523646.1807256704.1633483130-1997756260.1628974791>

You will need to select the COM port that the XBEE is connected to and you will need to select the baud rate to be able to talk to the XBEE. If the XBEE has been configured previously, the baud rate will most likely be set at “115200”. Otherwise, it will probably be set at “9600”.

The XBEE explorer uses and FTDI chip so if you can’t find the XBEE for some reason you may need to install an FTDI driver. <https://learn.sparkfun.com/tutorials/how-to-install-ftdi-drivers>

### 2.3.2 XBEE Firmware

Once the XBEE shows up in the left pane, you can click on it to access the settings for that XBEE. If it doesn’t have the correct firmware on it or it needs a firmware update, that can be done by clicking the “Update” button.

Graphical user interface

Description automatically generated

We have been using the 802.15.4 TH protocol for communications which has been good for point-to-point communication. If we need something more advanced, we may need to look into a different protocol such as Zigbee. Select this protocol after hitting the “update” button, and then select the most recent version to be uploaded to the XBEE. This process might take a couple of minutes to complete.

### 2.3.3 XBEE Settings

Below are the settings that need to be changed for the XBEE’s to be able to communicate with each other. I will give example settings for two XBEE’s that will be able to talk to each other.

**XBEE 1**

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Notes |
| ID | 1998 | This tells the XBEE what network to communicate on. This number must be the same for all XBEE’s that want to communicate with each other. 1998 is an arbitrary value that we have chosen as the standard for our team. |
| MY | 1 | This is the individual ID of the XBEE. The XBEE will receive all messages sent to this address and it should probably be unique for each XBEE. |
| DL | 2 | This is the address of the ID that the XBEE will send message to. |
| BD | 115200 | This sets the baud rate for the XBEE. |

**XBEE 2**

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Notes |
| ID | 1998 | This tells the XBEE what network to communicate on. This number must be the same for all XBEE’s that want to communicate with each other. 1998 is an arbitrary value that we have chosen as the standard for our team. |
| MY | 2 | This is the individual ID of the XBEE. The XBEE will receive all messages sent to this address and it should probably be unique for each XBEE. |
| DL | 1 | This is the address of the ID that the XBEE will send message to. |
| BD | 115200 | This sets the baud rate for the XBEE. |

Once these settings have been changed, make sure to click the “Write” button so that the changes get saved to the XBEE.

# 3.0 Testing

# 4.0 Revision History

10/05/2021 (Andrew Hellrigel) – Created the documentation for our wireless communication standards.