**LED Blocks Inspired by Tetris®**

By Mouser Electronics Technical Support Team

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# **Summary**

From personal blogs to major tech sites, the internet is full of projects involving every type of addressable LEDs — from a simple pattern of lights to a streaming video display, this popular technology enables engineers of all skill levels to create exciting displays. When we saw a [Digilent](http://www.mouser.com/digilent/) project based on the widely popular Snake game, we wanted to see if we could incorporate the basic premise of the project and introduce a few updates. In this project sheet, we provide the instructions and materials needed to create an LED Blocks game with 900 addressable LEDs and a wireless controller.

**Materials**

**Wireless Controller**

| **Description** | **Mouser Part Number** |
| --- | --- |
| Enclosure | [563-HH-3600-B](http://www.mouser.com/ProductDetail/Bud-Industries/HH-3600-B/?qs=%2fha2pyFadug%2fCMNWAxIM%252bldxGcdH6wfJ0Y0WYvcRq5R40DcH0ZbBEA%3d%3d) |
| Battery holder | [563-HH-3634](http://www.mouser.com/ProductDetail/Bud-Industries/HH-3634/?qs=%2fha2pyFadug%2fCMNWAxIM%252bh3PrfhYQFpEGW7xY%2fDFKdsacMQpejub3Q%3d%3d) |
| Power switch | [612-R1966ABKBKESR](http://www.mouser.com/ProductDetail/E-Switch/R1966ABLKBLKESRED/?qs=%2fha2pyFadujlzskuv2rr47jONPDRcp1S%252bLPhpkNmmVlddo6YXkDERA%3d%3d) |
| LDO regulator | [998-MIC29500-5.0WT](http://www.mouser.com/ProductDetail/Micrel/MIC29500-50WT/?qs=%2fha2pyFadugs5eyBU5YYNei6hpXNyf1ojFHSN6V2Qb9Hv2z62AM4bygPK9oAT1bu) |
| Joystick | [619-27800](http://www.mouser.com/ProductDetail/Parallax/27800/?qs=sGAEpiMZZMt%252bN7NsCLrSa6qVSYP4aBVI7Y%252bcFmc3wT8%3d) |
| Microcontroller | [579-PIC16F1829-I/P](http://www.mouser.com/_/?Keyword=PIC16F1829-I%2FP) |
| XBee radio | [888-XB24-API-001](http://www.mouser.com/ProductDetail/Digi-International/XB24-API-001/?qs=%2fha2pyFadugUPNrm22F93cudmTvB8YVJgM1tmzF0Zvx85xX1vs%2fOPw%3d%3d) |
| XBee adapter | [992-Xbee-ADP5](http://www.mouser.com/ProductDetail/Gravitech/Xbee-ADP5/?qs=%2fha2pyFadujOgN1a9osq%2fZrYIQc61MM8KP8tY4nojCtRD0rdfjw04w%3d%3d) |
| 0.1µF capacitor | [581-SR211C104KARTR1](http://www.mouser.com/ProductDetail/AVX/SR211C104KARTR1/?qs=sGAEpiMZZMt3KoXD5rJ2NwG2NqU%2fTYWleL408hfC48M%3d) |
| 0.1µF tantalum capacitor | [581-TAP104M035DCS](http://www.mouser.com/ProductDetail/AVX/TAP104M035DCS/?qs=%2fha2pyFadujK0NokzDZImRA1Ka%252bW8QA4i3Klhr3IKIj%252bEU2SVgSAnw%3d%3d) |
| StripBoard | [854-ST1](http://www.mouser.com/ProductDetail/BusBoard-Prototype-Systems/ST1/?qs=%2fha2pyFadujmIiug7gND%252b%2fEREBdx3wvPHifMGRJO1LM%3d) |
| Pushbutton | [611-TP11-002](http://www.mouser.com/ProductDetail/CK-Components/TP11SHZQE/?qs=%2fha2pyFadujanC6xfDJBEsGzPUvnjcuH8v44zEcDt78%3d) |
| Pushbutton capacitor | [611-46580-2000](http://www.mouser.com/ProductDetail/CK-Components/465802000/?qs=%2fha2pyFadugsKIZn9S25h3H0hEN4m5gPlthL0FZ%252bod8%3d) |

**LED Display**

|  |  |
| --- | --- |
| **Description** | **Mouser Part Number** |
| LED strip | [485-2552](http://www.mouser.com/ProductDetail/Adafruit/2552/?qs=sGAEpiMZZMuSK2mCDyT9ctodWMIQnPhnDvSKmU%252bVgUs%3d) |
| chipKIT MAX32 | [424-CHIPKIT-MAX32](http://www.mouser.com/ProductDetail/Digilent/410-202P-KIT/?qs=%2fha2pyFadujYDKgQJiAOcJVBJJwZX8mWVgMy0hcgVp0jjOZy9w86%252bul%2fR7J8V7%2fU) |
| XBee radio | [888-XB24-API-001](http://www.mouser.com/ProductDetail/Digi-International/XB24-API-001/?qs=%2fha2pyFadugUPNrm22F93cudmTvB8YVJgM1tmzF0Zvx85xX1vs%2fOPw%3d%3d) |
| XBee adapter | [992-Xbee-ADP5](http://www.mouser.com/ProductDetail/Gravitech/Xbee-ADP5/?qs=%2fha2pyFadujOgN1a9osq%2fZrYIQc61MM8KP8tY4nojCtRD0rdfjw04w%3d%3d) |
| Power supply | [709-RSP320-5](http://www.mouser.com/ProductDetail/Mean-Well/RSP-320-5/?qs=%2fha2pyFaduhqXNKsyej9kF2Hf4FvWf3IiOj9Dzs8XmkN0JEqr2VGNQ%3d%3d) |
| StripBoard | [854-ST1](http://www.mouser.com/ProductDetail/BusBoard-Prototype-Systems/ST1/?qs=%2fha2pyFadujmIiug7gND%252b%2fEREBdx3wvPHifMGRJO1LM%3d) |

**Connectors, Wires, and Enclosures**

| **Description** | **Mouser Part Number** |
| --- | --- |
| Power enclosure | [546-1554VB2GYSL](http://www.mouser.com/ProductDetail/Hammond/1554VB2GYSL/?qs=%2fha2pyFaduh1QsHIjjGlgQUhy8OxZZix92wx%2fkkmOCTAY3PCxOducQ%3d%3d) |
| Power enclosure plate | [546-1554VAPL](http://www.mouser.com/ProductDetail/Hammond/1554VAPL/?qs=%2fha2pyFaduh1QsHIjjGlgcfqxaCIIqRwUHobXI663MpxJ9RDcUC68g%3d%3d) |
| Power enclosure bracket | [709-MHS-012](http://www.mouser.com/ProductDetail/Mean-Well/MHS-012/?qs=%2fha2pyFaduiaxbJYmjR2qKMrsV0xfh2Gtl7Ke3mtJb2Bm1JrSPwjIw%3d%3d) |
| Wireless enclosure | [563-CU1874B](http://www.mouser.com/ProductDetail/Bud-Industries/CU-1874-B/?qs=%2fha2pyFaduixDZOAf8LiU7ukigRibmMOhcyaweWjXiU%3d) |
| AC power cord | [686-17249](http://www.mouser.com/Search/ProductDetail.aspx?R=17249_10_B1virtualkey68600000virtualkey686-17249) |
| AC inlet | [161-BZH01/Z0000/01](http://www.mouser.com/ProductDetail/Bulgin/BZH01-Z0000-01/?qs=%2fha2pyFaduhQuU2QinOOdS6eoV2OrqJKt4wwy1BWdOhorX6zjnLXdg%3d%3d) |
| 8A SB fuse | [576-0835008.MXP](http://www.mouser.com/search/ProductDetail.aspx?r=576-0835008%2eMXP) |
| 3 Cond. cable 14 AWG | [602-1896C-100](http://www.mouser.com/ProductDetail/Alpha-Wire/1896C-SL005/?qs=sGAEpiMZZMs5%2f3jTaGtq4FCpOxJaziCN9OOZ6K%252bw2Rg%3d) |
| 10 AWG hookup wire | [571-1986164-3](http://www.mouser.com/ProductDetail/TE-Connectivity/1986164-3/?qs=sGAEpiMZZMtW9UaYX5J1tML91VLzCa16Sc7RdxEID%2f8%3d) |
| 20 AWG hookup wire | [602-3053-100-09](http://www.mouser.com/ProductDetail/Alpha-Wire/3053-SL005/?qs=%2fha2pyFaduisEvRIqYS17xy2J0ywFreTcT6m8qtm48lBu9P0CvuytQ%3d%3d) |
| 20 AWG hookup wire | [602-3053-100-01](http://www.mouser.com/ProductDetail/Alpha-Wire/3053-WH005/?qs=sGAEpiMZZMtW9UaYX5J1tAuOV3xuveL1JARoMxCj2yY%3d) |
| 20 AWG hookup wire | [602-3053-100-03](http://www.mouser.com/ProductDetail/Alpha-Wire/3053-RD005/?qs=%2fha2pyFaduisEvRIqYS176s%252b6Fv%2fTf4oFk0XfHsos09QvPzeslNGrw%3d%3d) |
| Pin contact | [538-39-00-0041](http://www.mouser.com/ProductDetail/Molex/39-00-0041/?qs=sGAEpiMZZMs%252bGHln7q6pm%252bS0pk2Wo0Xx%2fByHu7j4G7c%3d) |
| Socket contact | [538-02-06-1103](http://www.mouser.com/ProductDetail/Molex/02-06-1103/?qs=sGAEpiMZZMuzXLcWrSfMr4AImWoNFp%252b4f0cLcHvCAeY%3d) |
| 4CT plug | [538-46992-0410](http://www.mouser.com/ProductDetail/Molex/46992-0410/?qs=%2fha2pyFaduhx2pG%252blS2iW15gkHG9iuSmWQ2amOVkYcP9%2fI60h3n6cA%3d%3d) |
| 4CT receptacle | [538-46993-0411](http://www.mouser.com/ProductDetail/Molex/46993-0411/?qs=%2fha2pyFaduhx2pG%252blS2iW9Q7Na6OcLobqTN6GOem4HewHPBPXTmlug%3d%3d) |
| 2CT plug | [538-46992-0210](http://www.mouser.com/ProductDetail/Molex/46992-0210/?qs=%2fha2pyFaduhx2pG%252blS2iW2u7ApFqveE3YEj6D%2f2%252b3FUzxGrkTJ2Kzw%3d%3d) |
| 2CT receptacle | [538-46993-0210](http://www.mouser.com/ProductDetail/Molex/46993-0210/?qs=sGAEpiMZZMs%252bGHln7q6pm6x1zIfoL%252bUqfUgC4XoMlM2WaKXAAvL5vw%3d%3d) |
| 4P MS plug | [654-MS3106F22-22P](http://www.mouser.com/ProductDetail/Amphenol-Industrial/MS3106F22-22P/?qs=sGAEpiMZZMv%2fye0hRulZR%2fS5ltx8gSydJkkyWm7FBjs%3d) |
| 4P MS BM Rec. | [654-MS3102E22-22S](http://www.mouser.com/ProductDetail/Amphenol-Industrial/MS3102E22-22S/?qs=sGAEpiMZZMv%2fye0hRulZR%2fS5ltx8gSydzi%252bhm7EPL8Y%3d) |
| Wireless plugs | [177-PX0731/P](http://www.mouser.com/ProductDetail/Bulgin/PX0731-P/?qs=%2fha2pyFaduiAi00J5UrvcsCX84iVwLDko4%2f3JDmQH3Ll9qApnaQZlQ%3d%3d) |
| Wireless receptacle | [167-PX0730/S](http://www.mouser.com/ProductDetail/Bulgin/PX0730-S/?qs=%2fha2pyFaduhp8zlFLQ7l8jo7N3OTi93r7B74wL5%252bWeV1cJYHkWp7CQ%3d%3d) |
| Cable tie | [514-08431](http://www.mouser.com/ProductDetail/Avery-Dennison/08431-0/?qs=%2fha2pyFaduj06z1owWp56sronzhSGpiW6%252bEUWlx0T6Y%3d) |
| 3/4" heat shrink | [5174-1341](http://www.mouser.com/ProductDetail/3M-Electronic-Specialty/FP301-3-4-48-Black-Bulk/?qs=sGAEpiMZZMua6gyn9EvwT5XS2cjrWLDr) |
| 3/8" heat shrink | [5174-1381](http://www.mouser.com/ProductDetail/3M/FP301-3-8-48-Black-bulk/?qs=%2fha2pyFaduhlKZ4xkFKhJdr4dhIXq1CGTpZkhp1pqg8%3d) |

**Tools**

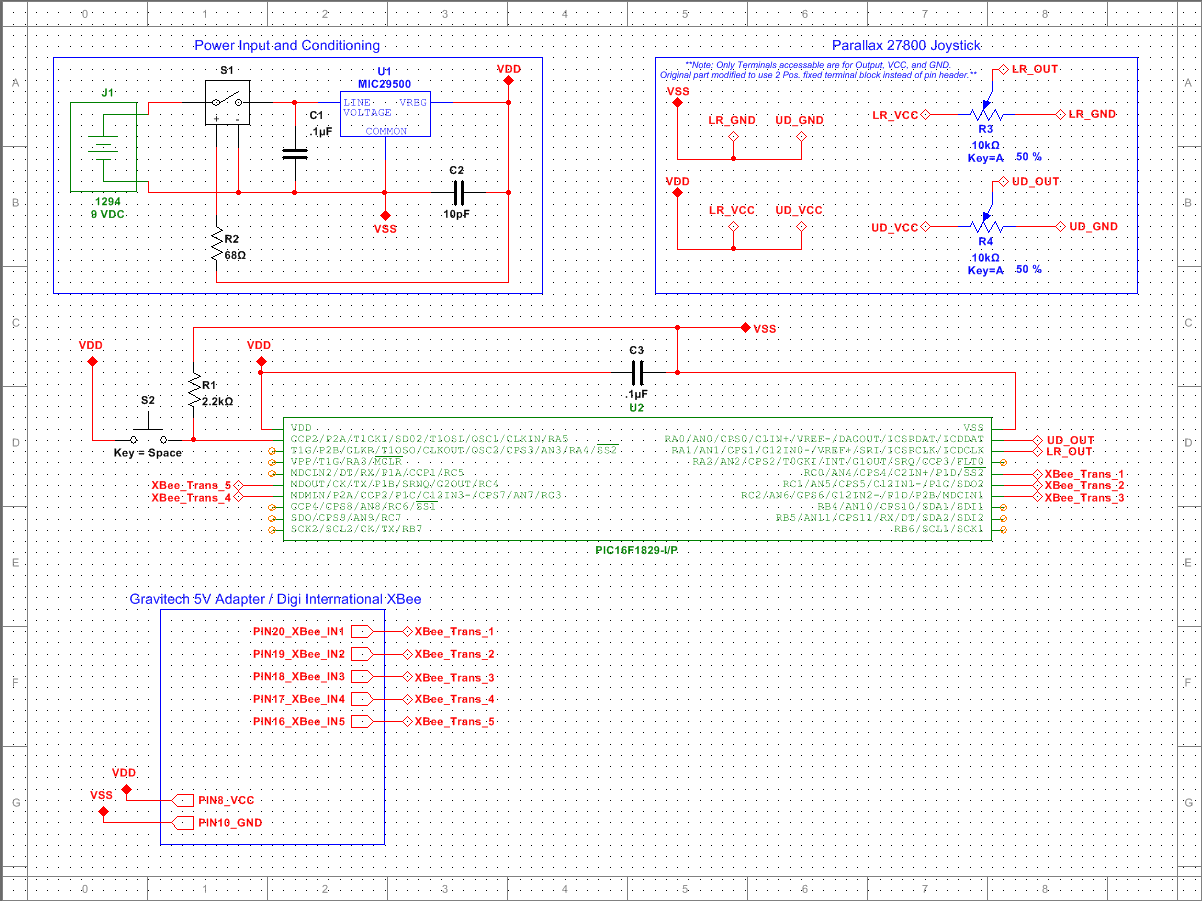
| **Description** | **Mouser Part Number** |
| --- | --- |
| XBee-to-USB adapter | [992-XBEE-USB](http://www.mouser.com/ProductDetail/Gravitech/XBee-USB/) |
| PICkit 3 Debugger | [579-PG164130](http://www.mouser.com/ProductDetail/Microchip/PG164130/) |
| Soldering iron |  |
| Wire cutter |  |
| Crimp tool |  |
| Solder |  |
| Heat gun |  |
| Drill |  |
| Sandpaper |  |
| Routing tool |  |

You might not use all of the mounting hardware for the display, as multiple mounting options are possible. You can substitute or even omit some of these parts, depending on how you decide to wire, power, and mount the display. However, we recommend that you use the chipKIT Max32 and the PIC16 microcontroller for this product, as the software is specifically written for these devices.

**Overview**

## **Wireless Controller Overview**

The following schematic shows the wireless controller assembly, including how to connect the different devices it contains. This controller allows an interface between the chipKIT Max32 running the Mouser Blocks software and a user. For the controller to function, you must first program both the PIC16 microcontroller and the XBee wireless transceiver.



*Schematic for the wireless controller.*

## **Display Overview**

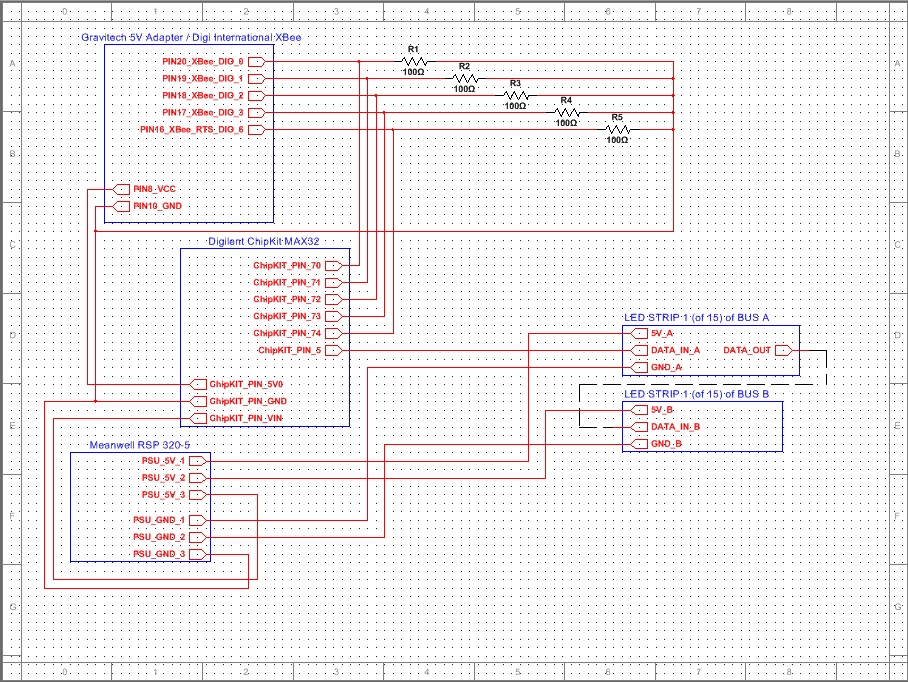
The display consists of 30 one-meter LED strips with WS2812 assignable RGB LEDs. The LED strips are powered in parallel using a 5-volt power supply with the communication line running in series between each, driven by the chipKIT Max32. The following schematic shows the connections between devices.

## Power Considerations

Each LED strip draws approximately 1800mA at full white. By providing a common bus for the power and ground, you can connect the strips in either a strictly parallel circuit or a series/parallel configuration.

NOTE: Do not confuse the power and ground bus with the data line, which must maintain its series configuration.

For our design, we built a power supply enclosure using a fuse/switched AC input, four-conductor mil-spec connector for our power and ground bus, and a three-conductor power/data cable that will connect to our chipKIT enclosure. We also provided two separate power and ground buses.



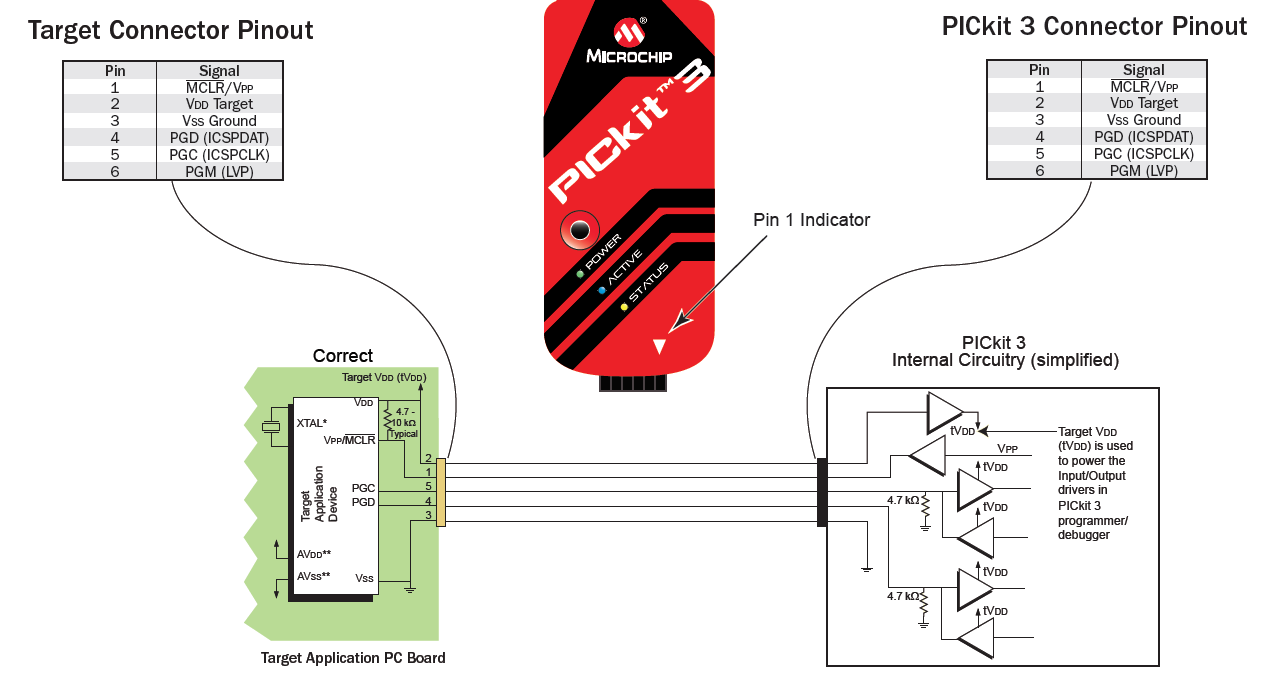
*Schematic for the LED display.*

**Software**

## **Wireless Controller Software**

Program the controller software by using the PICkit 3 in-circuit Debugger, Microchip MPLABX, and XC8 Compiler. Find the necessary files in the GameController.zip file, and then unzip and import them as a project into MPLAB X.

We recommend that you use a daughter card (such as the Microchip PICkit 3 Low Pin Count Board, Mouser part # [579-DM164130-9](http://www.mouser.com/ProductDetail/Microchip-Technology/DM164130-9/?qs=sGAEpiMZZMv8qfsbmFratHpx1tbrEodv)) for programming the PIC16, but you can also use simply a breadboard and header pins. The following image shows the correct pinout of the target and PICkit debugger.



*Pinouts of PICkit 3 board.*

## **Display Software**

The software installation for the chipKIT Max32 used to drive the LED display require the Arduino integrated development environment (IDE) and chipKIT board manager libraries.

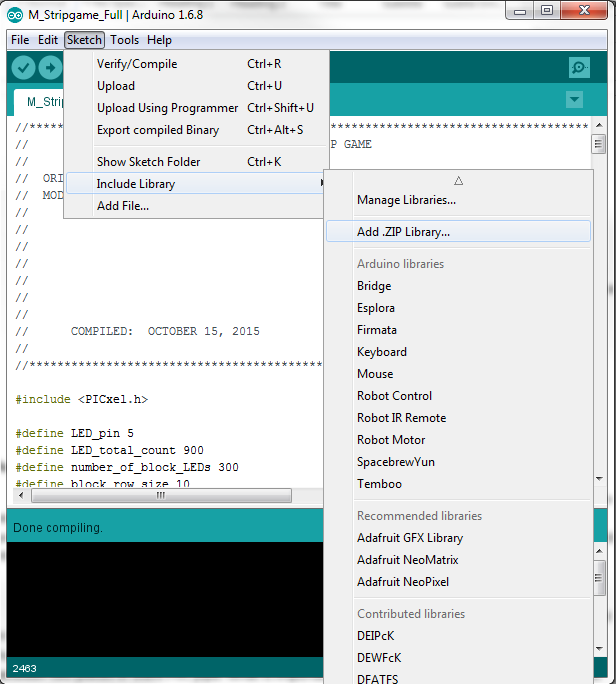
To download the Arduino IDE, go to <https://www.arduino.cc/en/Main/Software>.

After installing and opening the Arduino IDE follow these steps to add the chipKIT board manager libraries.

1. In the Arduino IDE, click **File**, and then click **Preferences**.
2. In the **Preferences** dialog box, locate the **Additional Boards Manager URLs:** field.
   1. If the field is blank, paste the following URL, and then click **OK**: <https://github.com/chipKIT32/chipKIT-core/raw/master/package_chipkit_index.json>.
   2. If there is already a URL in the field, click the box icon to the right of the text field to open a dialog box, paste the following URL, and then click **OK**: <https://github.com/chipKIT32/chipKIT-core/raw/master/package_chipkit_index.json>.
3. Click **OK** to close the **Preferences** dialog box.
4. Click **Tools**, select **Board**, and then click **Boards Manager**.
5. In the **Boards Manager** dialog box, scroll down to the entry for the chipKIT board, and then click anywhere in the entry to bring up the **Install** button. Click the **Install** button.
6. Once the installation is complete, click **Close**.
7. Click **Tools**, select **Board**, and then click **chipKIT MAX32**.

After adding the chipKIT to the Boards Manager but before verifying or uploading your software (called a “sketch”), use the following steps to add the PICxel library:

1. Click **Sketch**, select **Include Library**, and then click **Add .ZIP Library…**.
2. Browse to the location of your .ZIP file, select the PICxel.h file, and then click **Open**.
3. #include <PICxel.h> appears in your sketch.

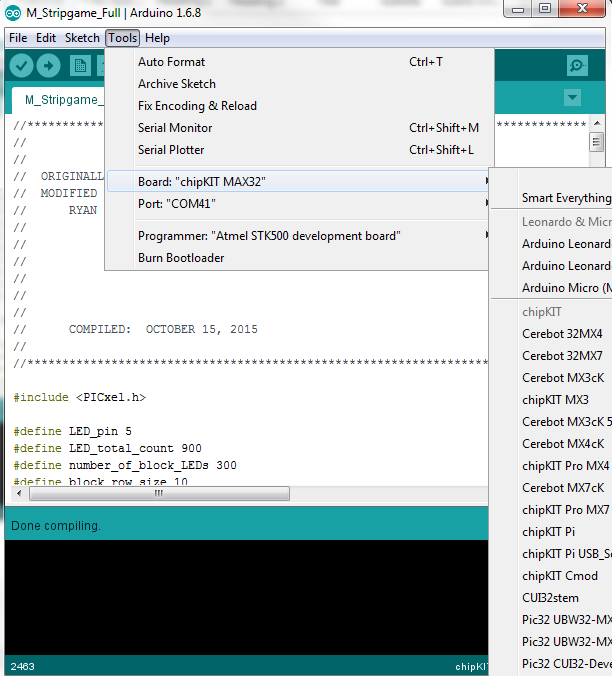


*Selecting a library in the Arduino IDE.*

Now that you have the IDE, Boards Manager, and libraries installed, you can begin loading the sketch onto the chipKIT. Connect the board to the computer using a Mini USB-to-USB A cable and wait for the automatic driver installation. Once the drivers are installation, ensure you have selected the correct board and serial port for communication.

Click **Tools**, select **Ports**, and then choose the correct port.

In the following image, we’ve selected the chipKIT MAX32 board and the COM41 serial port, but your port may be different:

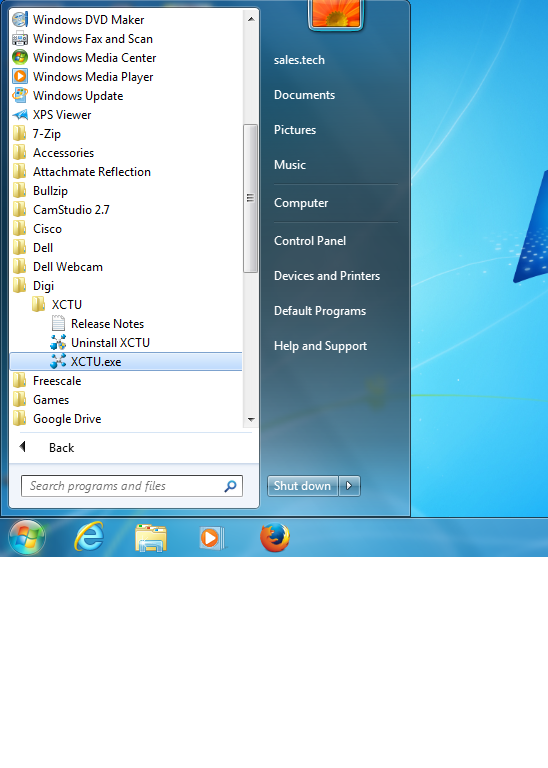


*Selecting a board and COM port in the Arduino IDE.*

To load the sketch onto the chipKIT, click the arrow (Upload) button, and wait for the message “Done compiling.”

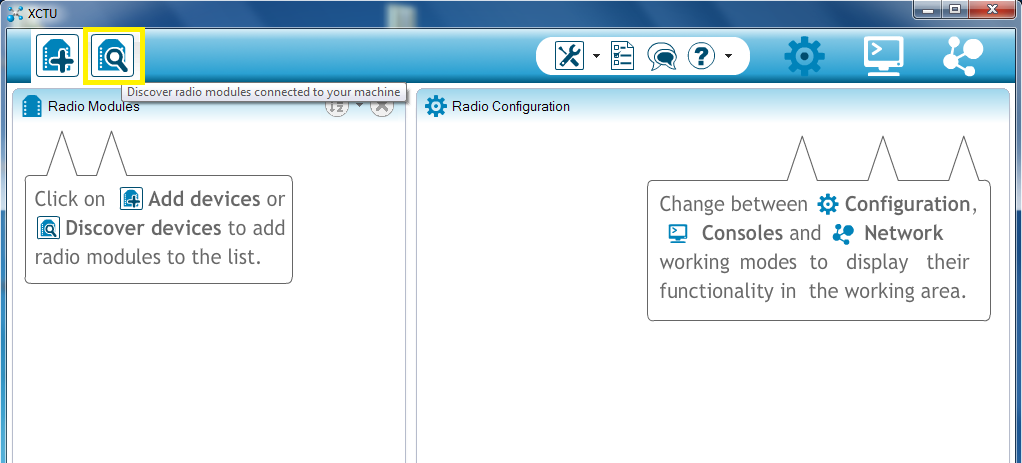
## **XBee Programming**

For ease of programming, we have provided the transmitter (wireless controller) and receiver (chipKIT) profile files, which you upload to the XBee modules using the XCTU software. For the wireless controller, use the Transmit\_XBEE file; for the chipKIT, use the Receive\_XBEE file. Use the XBee-to-USB adapter to interface and program the modules. When plugging the XBee module into the adapter, align pin 1 on the module with pin 1 of the adapter.



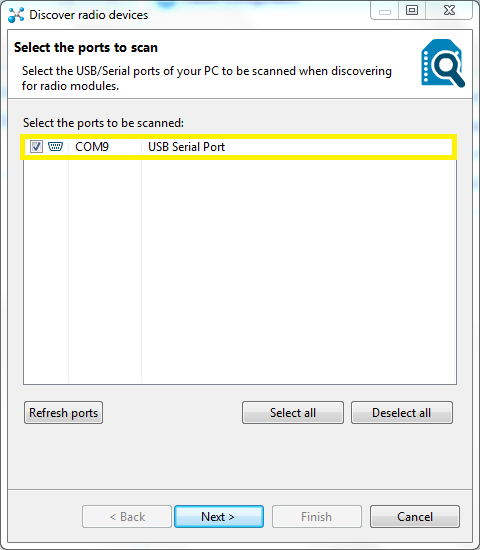
*Launching the XCTU software.*

On your computer, find and launch the XCTU software. In the XTCU window, click the Discover Device icon to detect the XBee modules connected to the system.



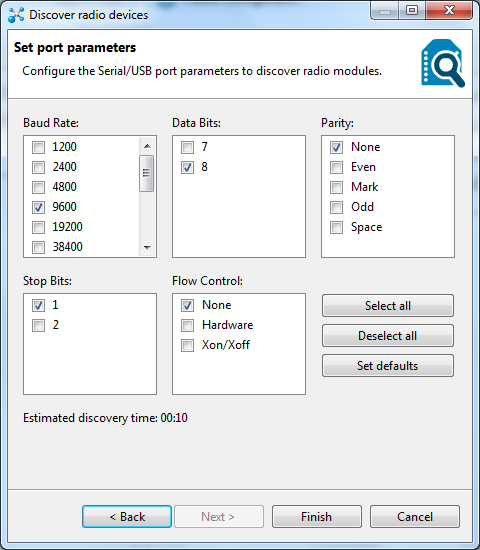
*Detecting XBee modules in XCTU.*

Plug the XBee-to-USB adapter into your computer using a Mini-USB cable. Once the driver installation is complete, click the Discover Device icon. If multiple COM ports are displayed, select the one listed as USB Serial Port.



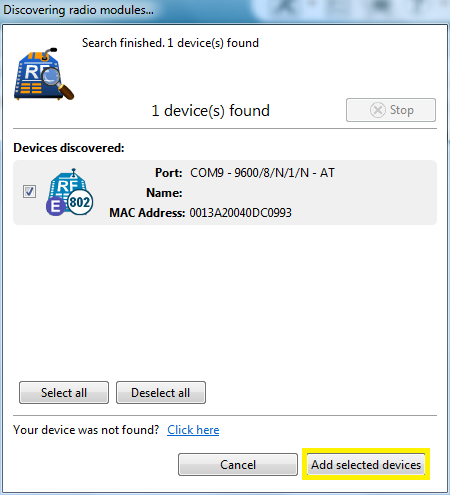
*Select the correct COM port.*

Click **Next** to launch the **Set port parameters** dialog box. You do not need to change any parameters, so click **Finish** to close the dialog box.



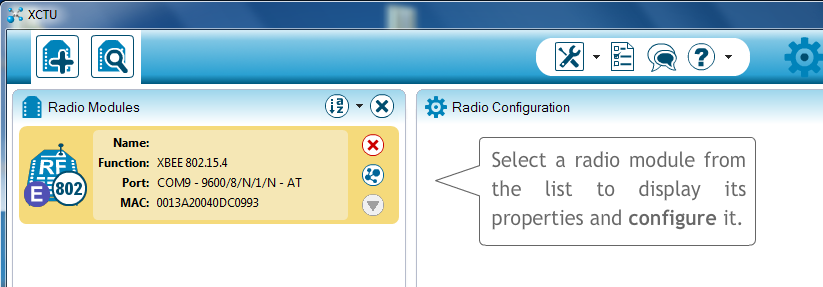
*Reviewing the port parameters.*

Once the selected device is found, a window will display relevant information such as port configurations and MAC address. Click **Add selected devices**.



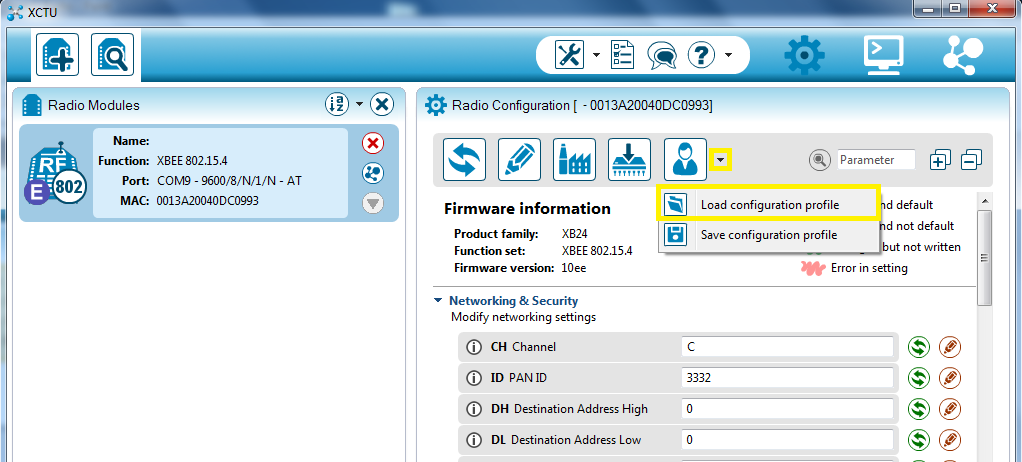
*Adding the XBee device to selected devices.*

The connected XBee module appears on the home screen under Radio Modules.



*Connected radio modules.*

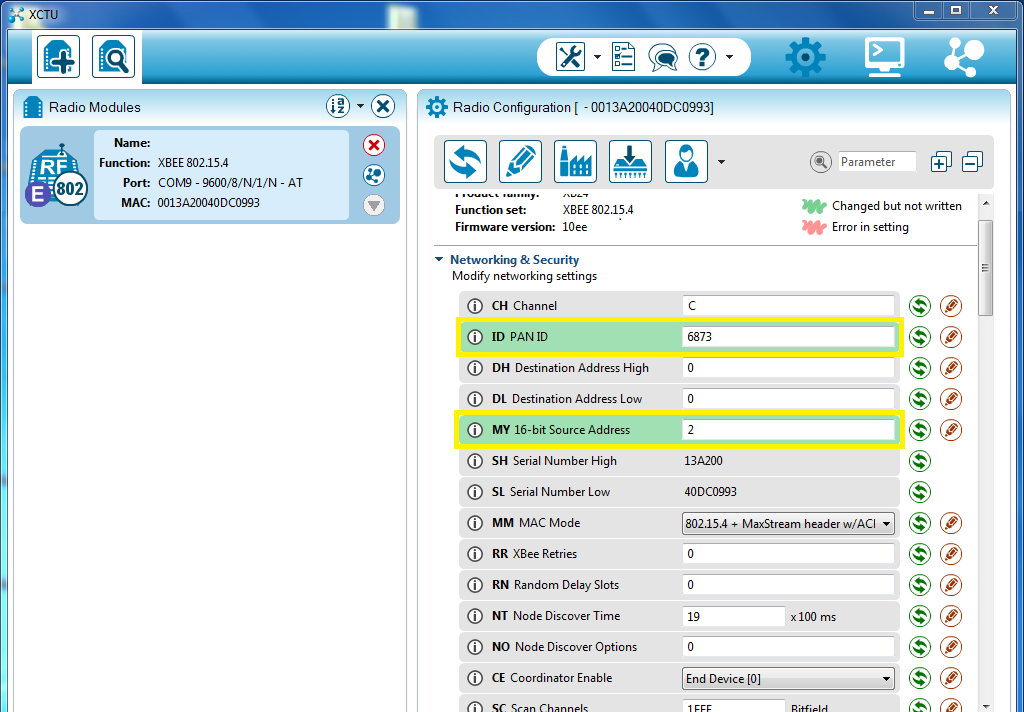
Select the Radio Module to load and list the device’s default or configured parameters.



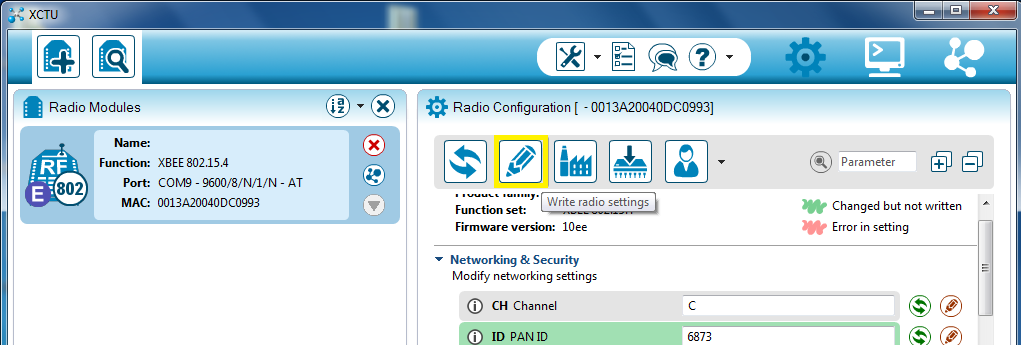
*Loading the configuration profile.*

Click the **Profile** icon and select **Load configuration profile**. Browse to and select either the Receive or Transmit file, depending on which device you are programming.

Changes to the profile will appear as either a highlighted green box or a green arrow to the right.



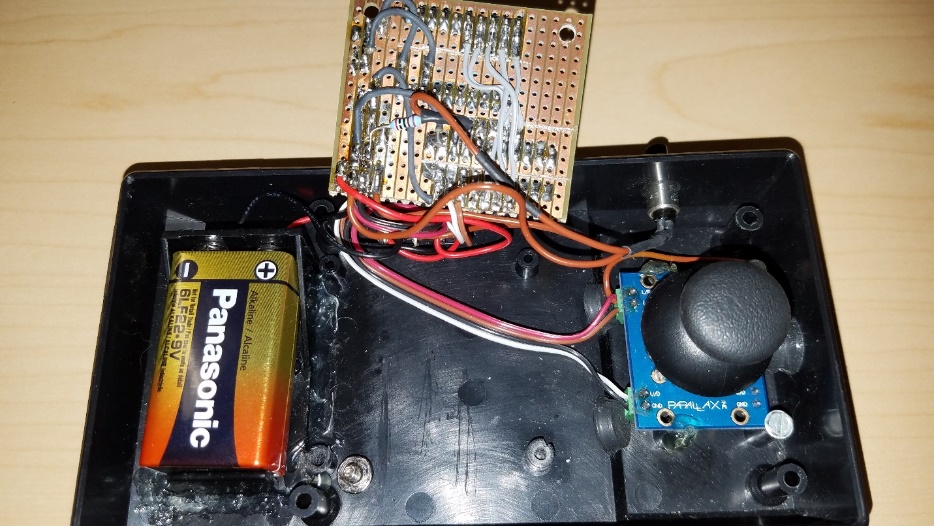
Click the **Write radio settings** icon. When you receive confirmation that the programming is complete, unplug the configured XBee module. Repeat this procedure to configure the second module.



**Assembly**

## **Wireless Controller Assembly**

Before assembling your controller, plan your board organization and layout. Pay attention to where you place components and how you will create traces and run wire. In this and later examples, we use a combination of solder bridges and wires to make connections between devices. For ease of programming and replacement, consider using a DIP socket adapter instead of soldering the PIC16 directly to the StripBoard. On the board, the switch allows users to turn the controller on and off, while the pushbutton acts as a start/reset for the display driver.

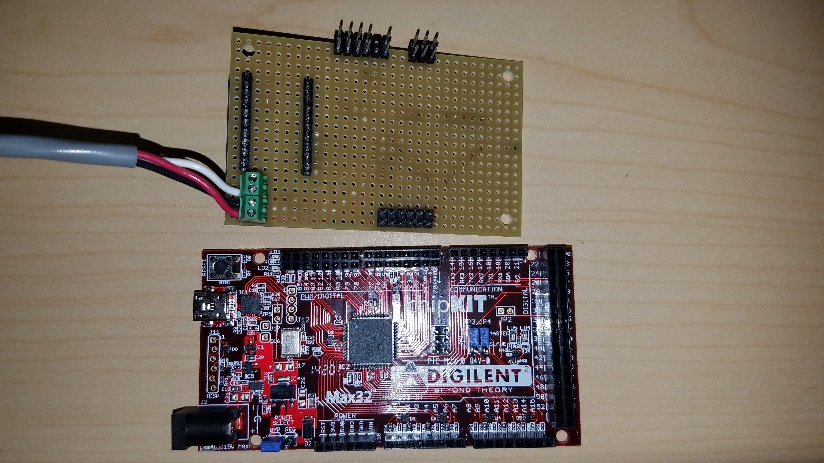


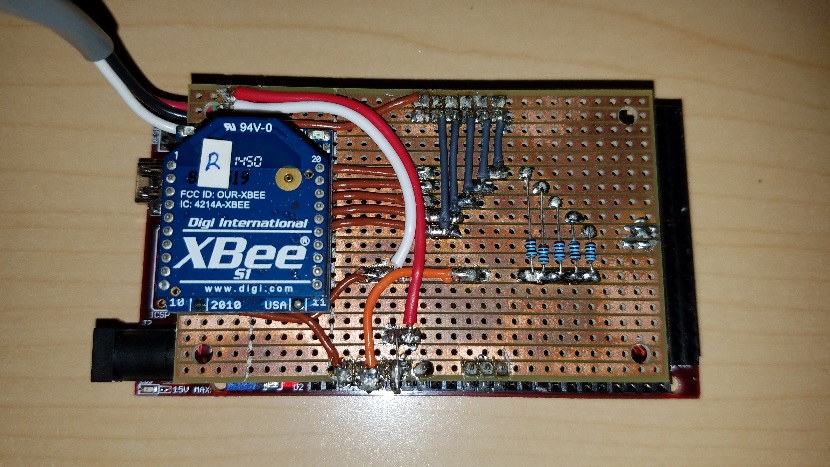


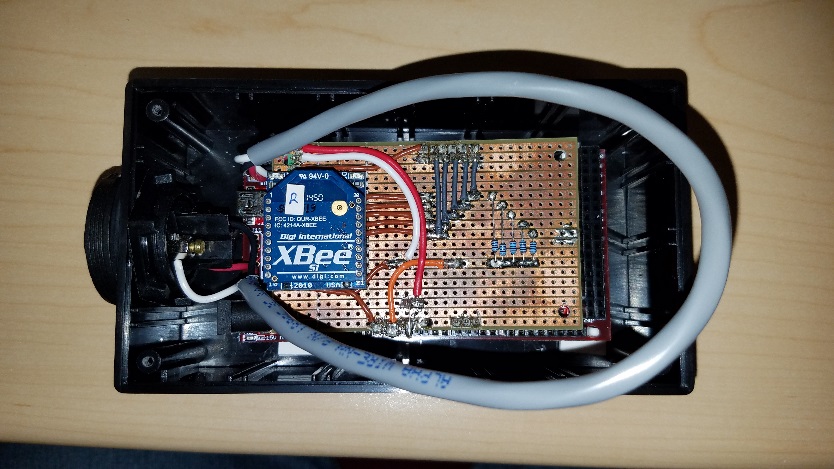
*Sample layout of the wireless controller.*

## **Display Assembly**

Now that you’ve programmed the chipKIT, you need to create a second RF module to act as a receiver for the wireless controller. These connections, included in the schematic image and as displayed in the following images, will allow you to seat the receiver module like a shield into the chipKIT.







When laying out the LEDs, note the direction of the signal. The LED strips used in this project have arrows indicating the data line direction and need to be kept in series and zig zag from top to bottom. Be sure to maintain uniform spacing between the strips and keep the LEDs even from one strip to the next. If the display will be stationary, you can adhere the strips to acrylic or plywood to ensure proper spacing. In the following image, we’ve mounted the strips by suspend them between furniture-grade PVC pipes so we can easily assemble and disassemble the display.



*LED strips mounted to a PVC frame for easy transportation.*





*Power supply for the LED Block Game.*

# **Resources**

[Digilent LED Board Display Demo](https://reference.digilentinc.com/chipkit_ledboard)

[Parallax KickStart Downloads](http://learn.parallax.com/KickStart)

[Adafruit WS2812 Specifications](https://cdn-shop.adafruit.com/datasheets/WS2812.pdf)

[Arduino Tetris® information](https://github.com/mtbnunu/arduino-tetris)

[MPLAB X Integrated Development Environment](http://www.microchip.com/mplab/mplab-x-ide)

[MPLAB XC Compilers](http://www.microchip.com/mplab/compilers)

[XCTU Software](http://www.digi.com/products/xbee-rf-solutions/xctu-software/xctu)