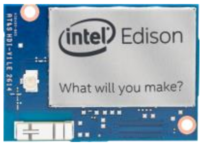


Intel Edison ® IR Receiver Kit

Table of Contents

Revision history		
Version	**Date**	**Comment**
1.0	2/27/2016	Initial release

Introduction

This document provides guidance on assembling the IR communication add-on board for use on the SparkFun GPIO Block. This tutorial [does not assume prior] requires soldering.

In this tutorial, you will learn to

1. Assemble the hardware,
2. Test the hardware, and
3. Read an input signal from the IR receiver.

Hardware for Assembly

1. An Intel® Edison
2. A SparkFun® GPIO Block
3. A SparkFun® Battery Block or a Base Block
    a. If you use a base block, you need a micro USB cable supply power.
4. Soldering tools, and
5. A IR communication add-on board kit
    a. The kit contains:
    b. (2) Header - 10-pin Female
    c. (1) IR communication add-on PCB (printed circuit board)
    d. (1) 330 Ohm Resistor (R1)
    e. (1) 1k Ohm Resistor (R2)
    f. (1) 100 microfarad Capacitor (C1)
    g. (1) TSOP38238 IR Receiver Diode
    h. (1) Heat Shrink Tubing
    i. (2) Arduino Stackable Header - 10 Pin

Hardware For Testing

1. Wires
2. A Digital Multi-meter
3. Either
    a. A television remote control, or
    b. (1) Current Limiting Resistor and (1) IR LED, 940 nm,
4. Optional: An oscilloscope, (This tutorial will use the National Instruments MyDAQ)
5. A PC or a Mac

1. Hardware Assembly

Part 1: GPIO Block

The SparkFun GPIO Block comes as a breakout board with 20 pins exposed and connected. To use it together with the IR communication add-on board, we need to attach part 4b from the kit – (2) Header - 10-pin Female to the board.

Components

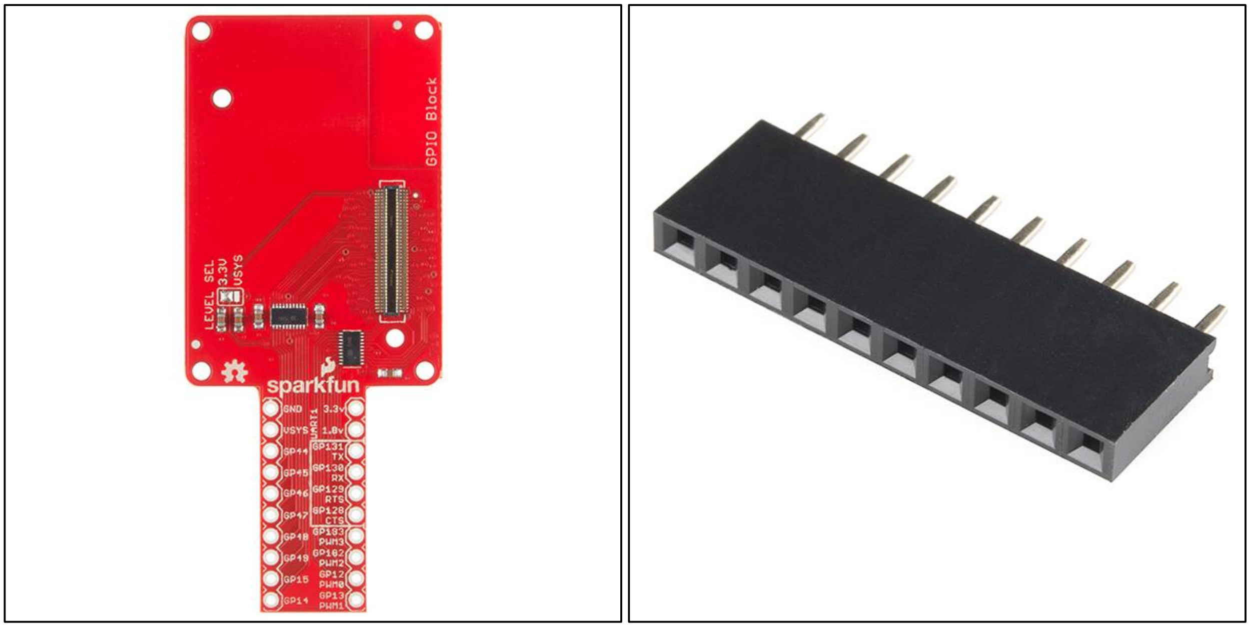


Figure 1 SparkFun GPIO Block and 10-pin Female Headers

Assembly

1. Take the female headers and insert them both into the slots on the GPIO block, taking care that they are on the correct side of the block. Specifically, we want to fix the headers such that they are on the female side of the GPIO block, so that Edison would be on the same side if attached to the block directly.

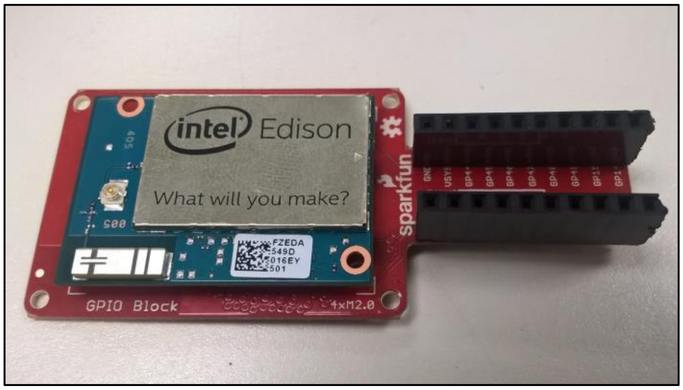


Figure 2 Female Header Pins inserted on the SAME side as Intel Edison

2. Flip the GPIO block and header pins over so that the Edison is face down and the pins are exposed to be soldered.
3. Solder all 20 pins, 10 pins on each side.
   a. Apply the hot tip of the soldering iron to the point where the pin and the GPIO board intersect such that the tip contacts both surfaces and heats them both.

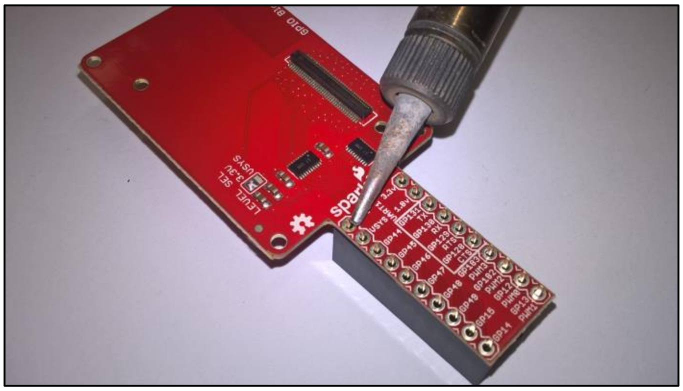


Figure 3 Applying hot soldering iron tip to GPIO board and pin contact point

   b. Simultaneously apply the solder to the intersection point on the heated metal surface and allow it to melt, filling in the gap cleanly as pictured.

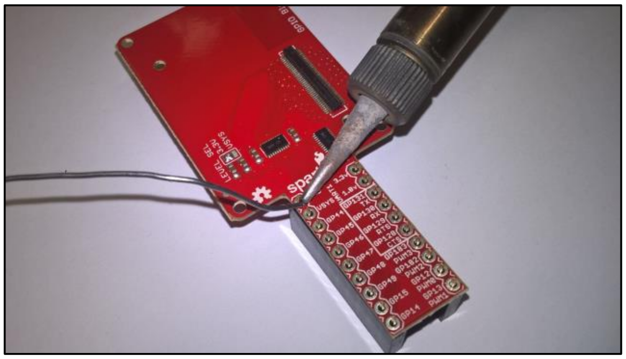


Figure 4 Applying solder to the pin/board contact point

c. To prevent damage to the board from the heat of the soldering iron, it is suggested that when soldering to the board, do not solder adjacent pins sequentially, but instead after soldering each pin, move to a pin on the opposite side of the board which has had time to cool off.

   If at any time the entire board is extremely hot, please let it cool before continuing to solder.

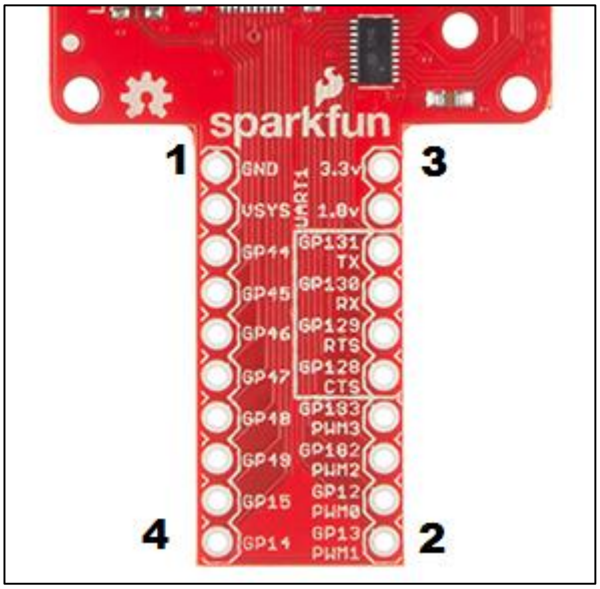


Figure 5 Suggested Pin Soldering Order

4. Afterwards, the GPIO Block will be completely ready for use.

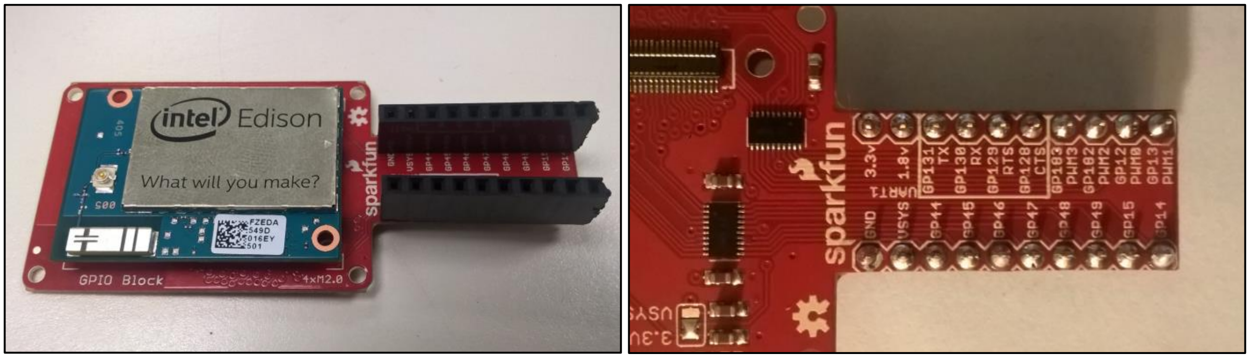


Figure 6 Complete GPIO block with Female Headers

Part 2: IR communication add-on PCB

The IR communication add-on board is a custom PCB that was made to facilitate rapid progress of IR communication development. This PCB was created using the free open source program Fritzing. Pictured here is the circuit diagram of the PCB, which was created using Fritzing.

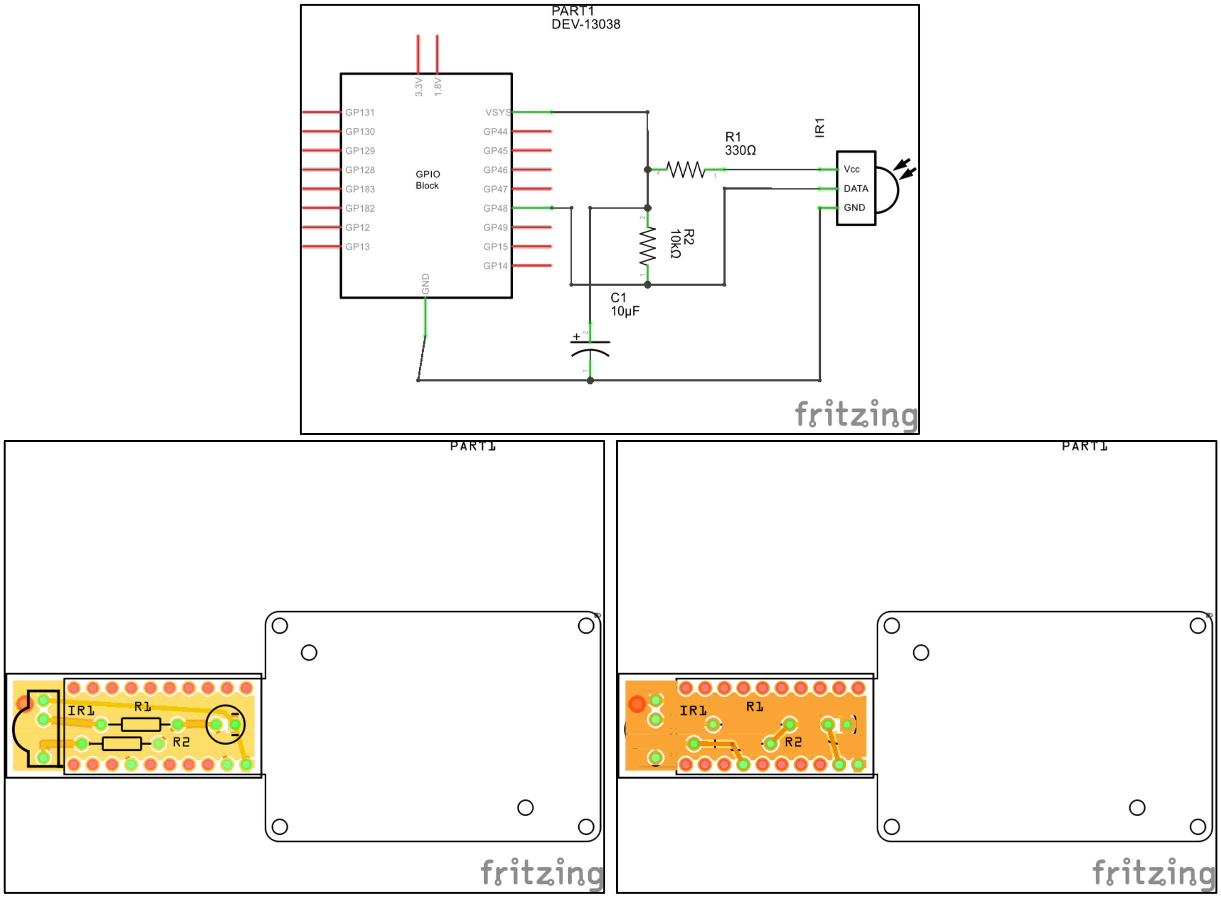


Figure 7 Circuit Diagram and PCB Design, Top View and Bottom View

You may notice that this circuit is different than the circuit presented in the datasheet for the TSOP38238; it has an extra resistor. This resistor is acting as a pull-up resistor on DATA pin of the IR receiver, which is required for the receiver to operate on the SparkFun GPIO board. A more detailed investigation about the circuit can be found in Appendix A. If you want to perform the investigation, you may want to do it before completing this section, because you need to use these components on a breadboard.

The investigation is completely optional and your ability to use the IR receiver will not be hindered in any way if you choose to skip it.

Components

We need all of the remaining components from our IR communication add-on kit, parts 4c-4i.

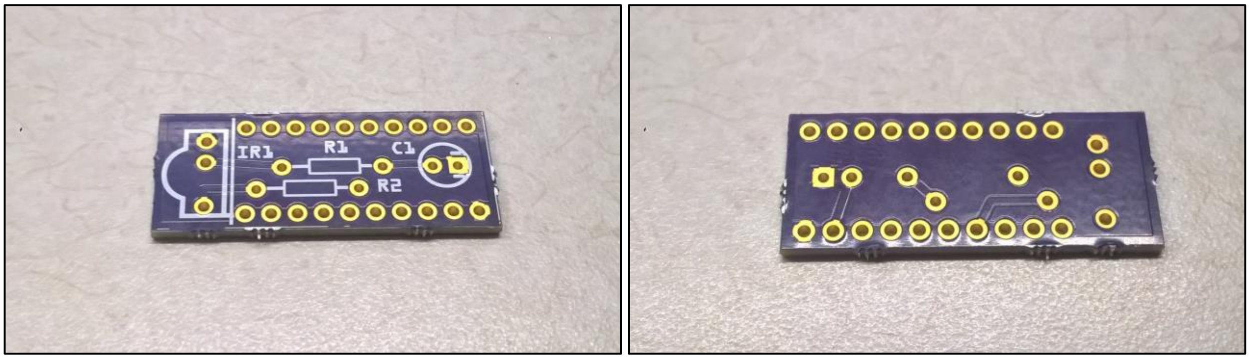


Figure 8 Part 4c, IR add-on PCB, Top View and Bottom View

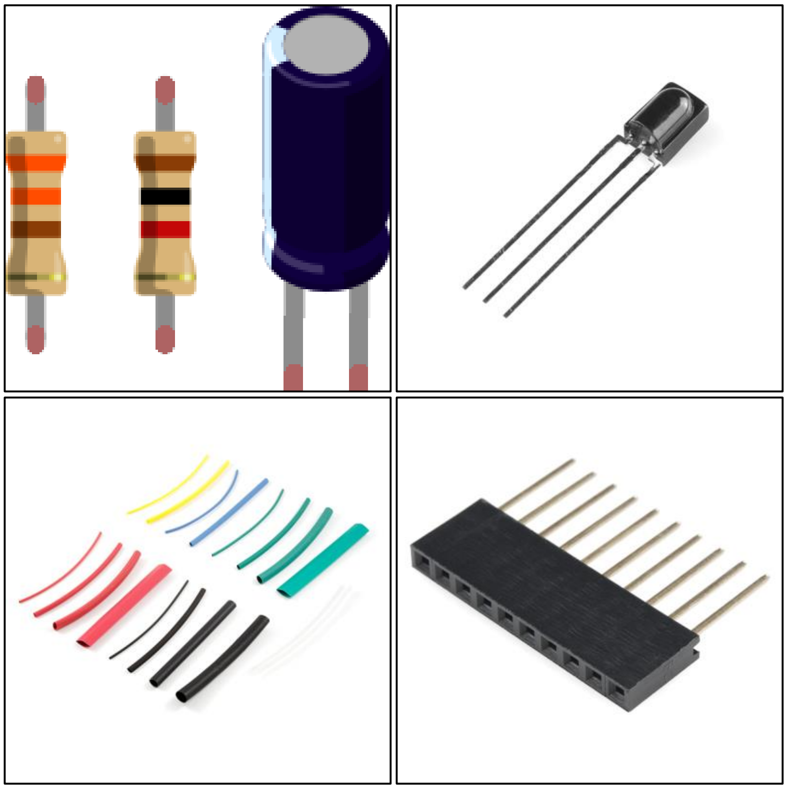


Figure 9 Parts 4d – 4i, pictured from left to right

Several pieces of heat shrink tubing are pictured however only one small piece will be needed.

Assembly

Part 1: Passive Components: 4d/4e/4f

1. Take the 330 Ohm resistor, R1, and pass the leads through from the top of the PCB to the bottom of the PCB, and then bend the leads 90 degrees to firmly hold the components in place. The direction of the resistor does not matter.

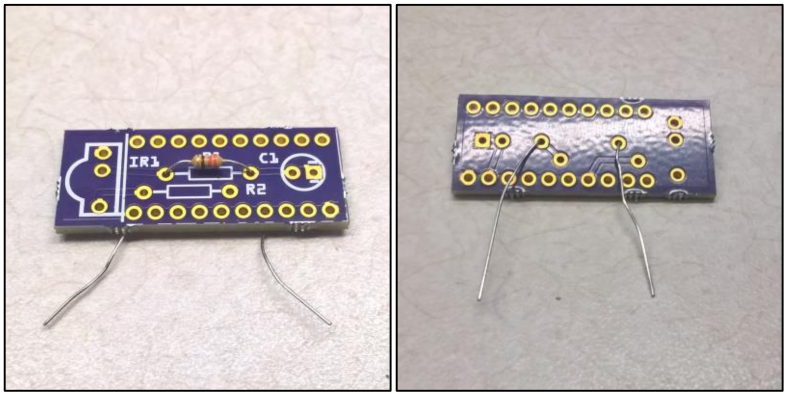


Figure 10 330 Ohm Resistor fixed to PCB, Top and Bottom Views

2. Solder the two connections from the bottom and then cut the excess leads.

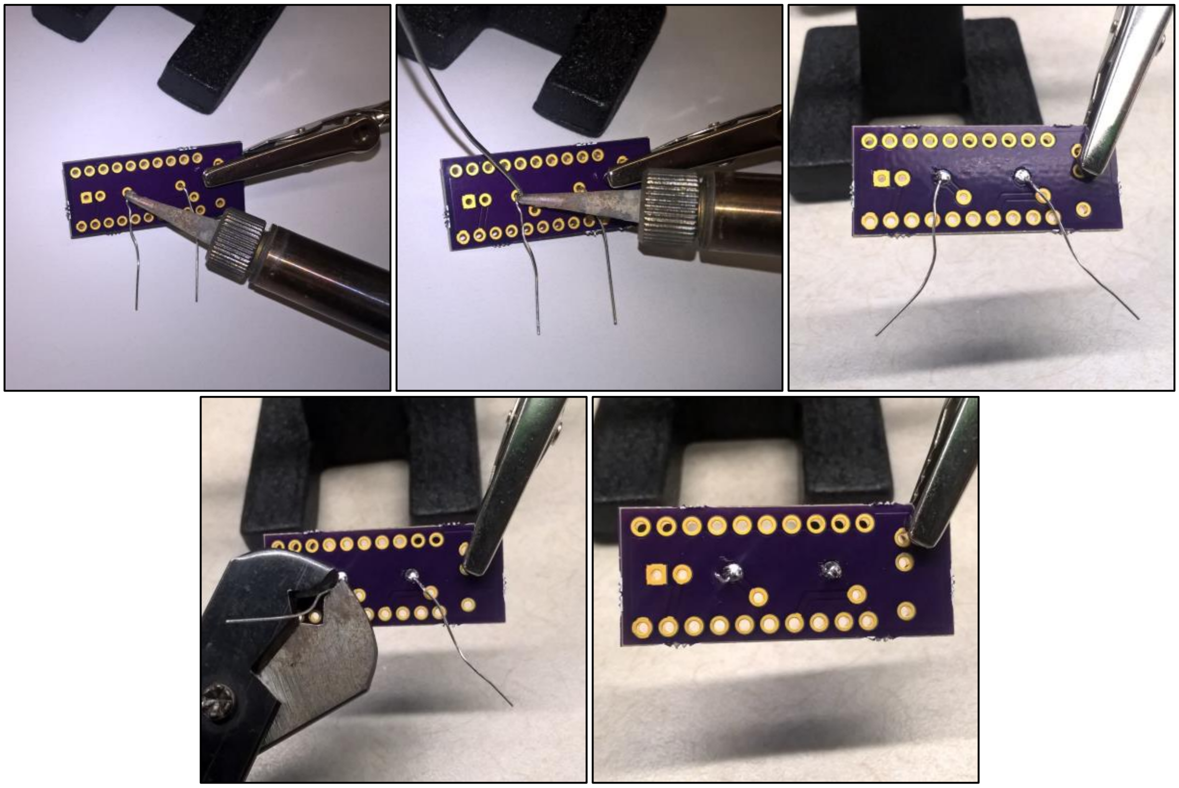


Figure 11 Sodering the 330 Ohm Resistor

3. Repeat for the 1K Ohm resistor R1.
4. For the capacitor C1, this time the direction of the capacitor does matter. Take care that the negative pin of the electrolytic capacitor (the pin by the gold strip, with the shorter lead) matches up with the negative markings on the PCB.

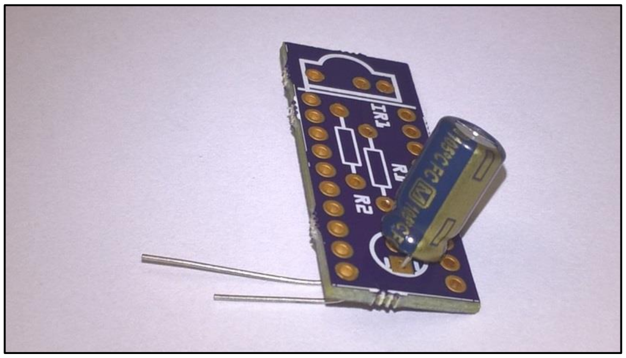


Figure 12 Capacitor, oriented correctly

Part 2: IR Receiver Diode

We could put the IR receiver in directly and it would work fine, however the robustness of the circuit is greatly improved by adding the heat shrink tubing around each of the 3 leads of the receiver.

1. Using the wire cutter, cut the heat shrink tubing into 3 equal length pieces and then slot each piece of tubing onto a lead of the receiver.

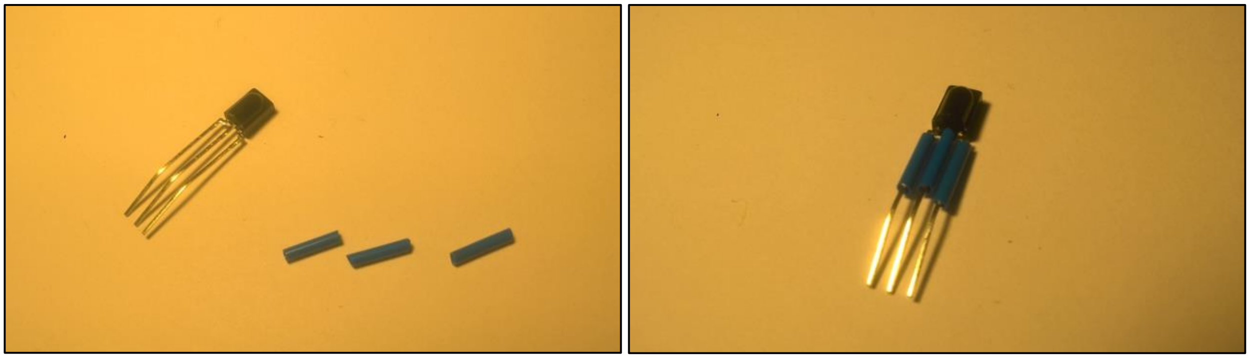


Figure 13 Safely covering IR Receiver leads with heat shrink tubing

2. Connect the three leads of the IR receiver through the appropriately labeled pins

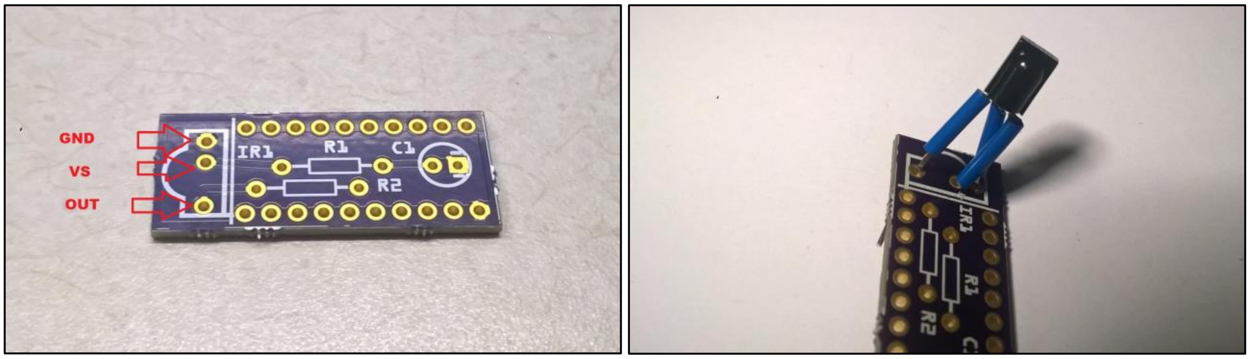


Figure 14 Connecting the IR receiver

3. Solder in the leads and cut the excess length.

Part 3: Arduino Stacking Headers

1. Once the other components are on, the headers can be added last.
    a. When soldering them, the soldering pattern can be used as for the female headers on the GPIO block. Take care not to use too much solder when attaching the headers otherwise it may be more difficult to stack them.

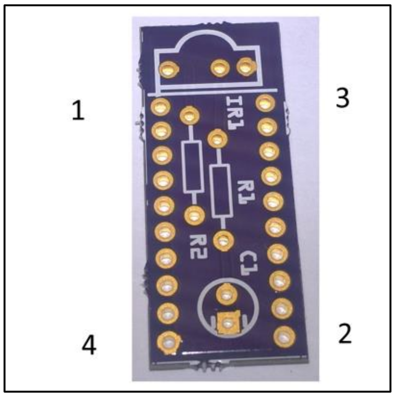


Figure 15 Suggested Pin Soldering Order

2. After soldering the pins in, the assembly of the IR Receiver Kit onto the PCB will be completed.

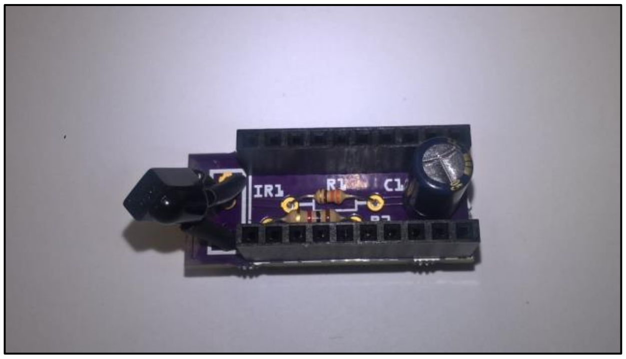


Figure 16 Completed PCB8 Part 4c, IR add-on PCB

Part 3: Final Assembly

At this point, you have finished all of the soldering and can now assemble the final product.

First, assemble the Intel Edison onto the GPIO block. The following three steps are repeated from the SparkFun GPIO Block Programming Guide and do not show the female headers.

It is important to note that you must assemble the hardware BEFORE you supply power. Otherwise, you may damage the devices.

1. Insert your Edison module into the GPIO block.

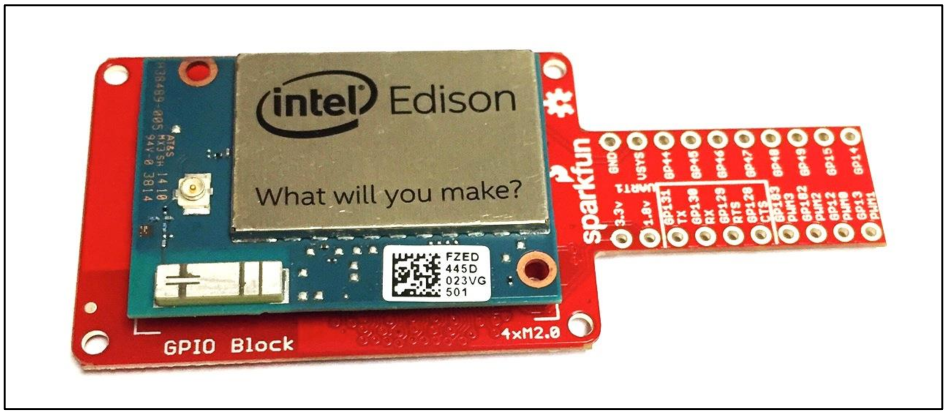


Figure 17 Edison and GPIO Block

2. Connect a battery block or a base block.

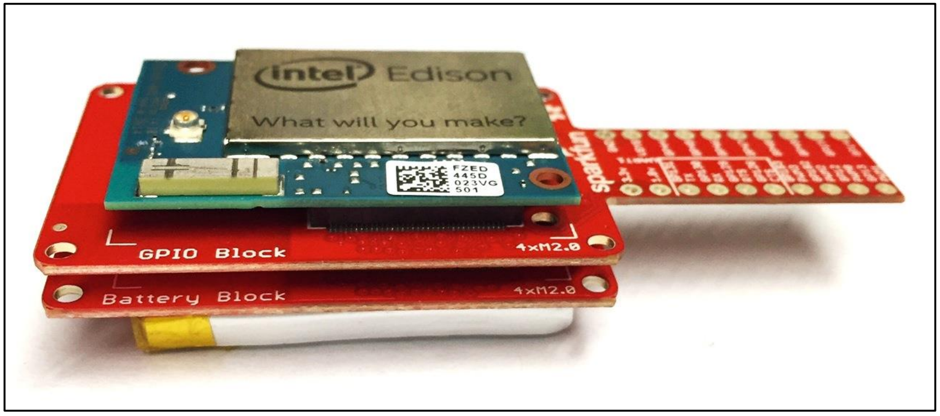


Figure 18 Edison, GPIO Block, and Battery Block

3. This is the general hardware installation. You can add more SparkFun® blocks. If you have a hardware pack (screws and nuts), you can use them to secure the connection.

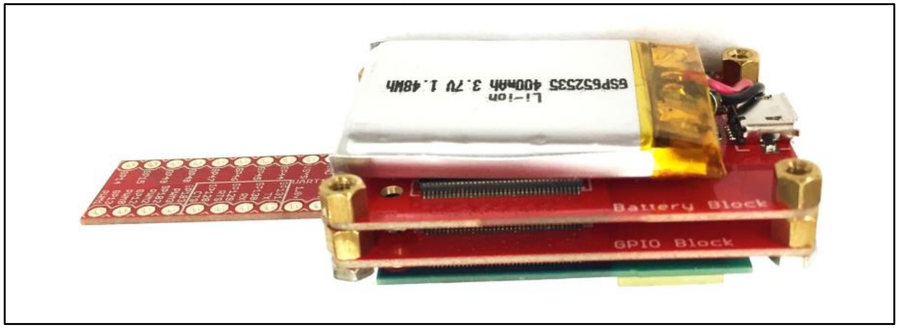


Figure 19 Hardware Pack

4. With three SparkFun blocks and the Edison put together, the final result will resemble the left figure. On the right is the completed PCB, ready to stack on top of the GPIO block.

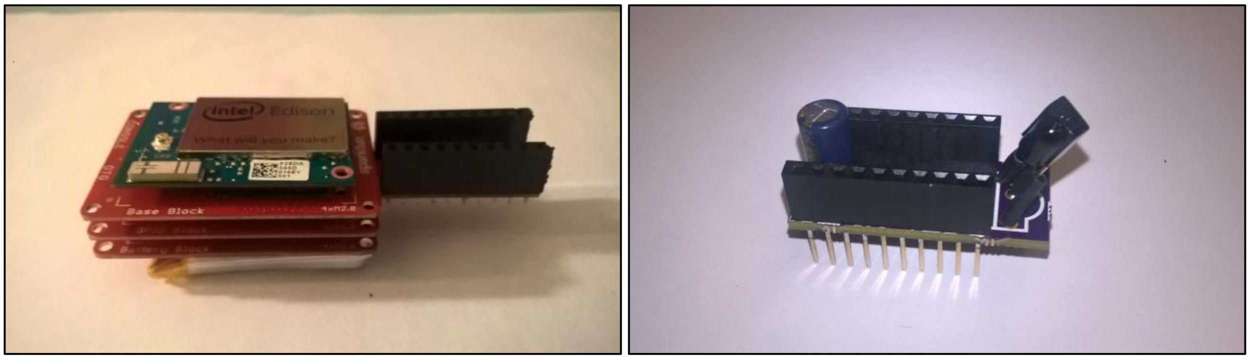


Figure 20 Completely assembled SparkFun Boards

5. Place the completely assembled PCB on top of the female headers on the GPIO block. Take care to make sure that the IR receiver faces away from the Intel Edison, and not towards it.

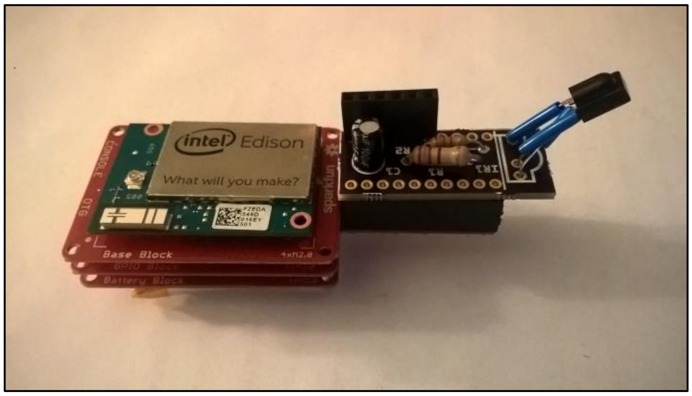


Figure 21 Completely assembled SparkFun Boards

3. Testing the Hardware

Assembling the board is just the beginning. Now we need to test it to make sure that it works correctly. What does it mean for the board to work correctly? If the IR receiver board is working correctly, the voltage at the OUT pin otherwise called the DATA pin of the TSOP38238 should display either **high** or **low** voltage depending on whether or not an IR signal is being detected. Looking at the datasheet for the device, on the second page, figure in the bottom left, you can see that the TSOP38238 is an active low device.

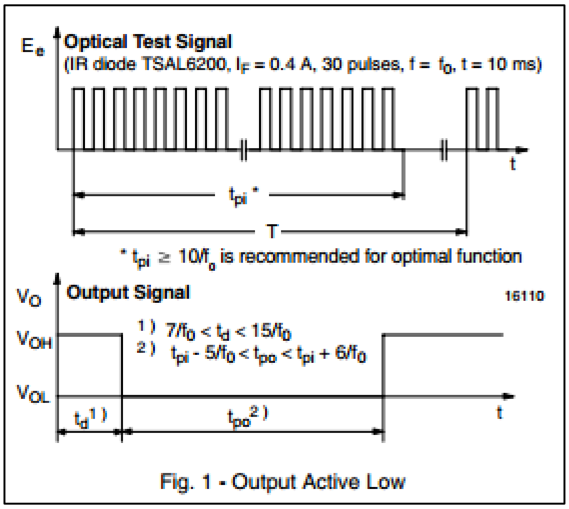

E_e
Optical Test Signal
(IR diode TSAL6200, I_F = 0.4 A, 30 pulses, f = f_0, t = 10 ms)
t
t_{pi} *
T
* $t_{pi} \geq 10/f_0$ is recommended for optimal function
V_O
Output Signal
16110
V_{OH}
V_{OL}
1) $7/f_0 < t_d < 15/f_0$
2) $t_{pi} - 5/f_0 < t_{po} < t_{pi} + 6/f_0$
t_d 1)
t_{po} 2)
t
Fig. 1 - Output Active Low

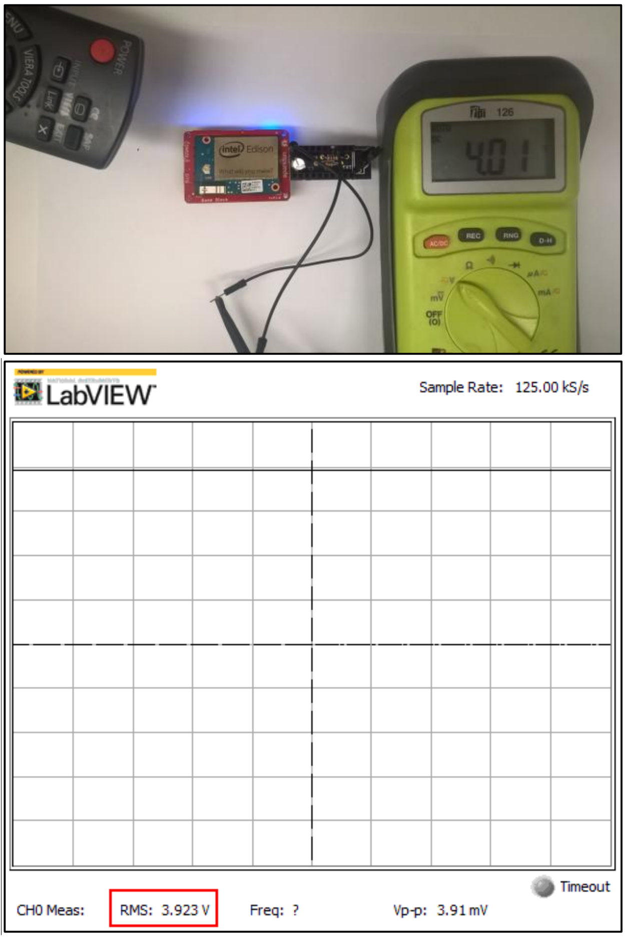
Figure 22 Sample output signal of IR Receiver

For an active low device, this means that the output of the device will go **low** when it receives a signal, and otherwise the output of the device will remain at a constant **high** value. The **low** value will typically be **0 V**, and the **high** value will be equal to the input voltage **V_S = 4 V**. Therefore to test to the board, we want to measure the voltage at the output and verify that the voltage is **V_S = 4 V** when there is no IR signal being sent at it, and that it goes to **0 V** when there is an IR signal present.

Television Remote Control

The easiest way to test the functionality of the board is to use a TV remote control.

1. Configure your digital multimeter to measure voltage, and connect the probes to GP48 and GND. If the Edison is off it should measure 0 V.
    a. If you have a oscilloscope available to you, you can also use it to visualize the voltage vs time, which will be very valuable to see the shape of IR signals. Configure the window so that the time-axis is on the order of tens of milliseconds, and the voltage-axis will show a 4 V signal.
2. Turn on the Edison and the voltage should measure roughly 4 V, the same voltage at the VSYS pin.
3. Point your TV remote so that it is pointed toward the curved side of the IR Receiver as in the figure here. The multimeter reads approximately 4 V because this is the voltage of the battery. Likewise the voltage level of the oscilloscope will also be close to 4 V.

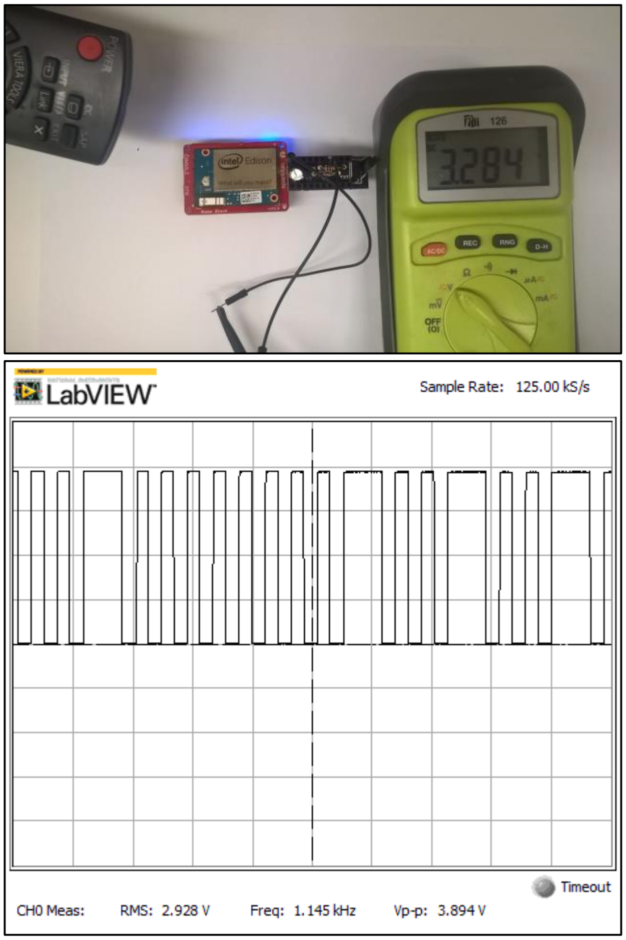


Sample Rate: 125.00 kS/s

CH0 Meas: RMS: 3.923 V Freq: ? Vp-p: 3.91 mV

Figure 23 TV remote testing configuration

4. Press the button on the TV remote and you should see the voltage drop on the multimeter. It will not drop all the way to zero because the signal is PWM. If viewed using the oscilloscope, you will be able to see the pattern of the signal, which should have sequences of high and low values.



Sample Rate: 125.00 kS/s

Timeout

CH0 Meas: RMS: 2.928 V Freq: 1.145 kHz Vp-p: 3.894 V

Figure 24 TV Remote Signal

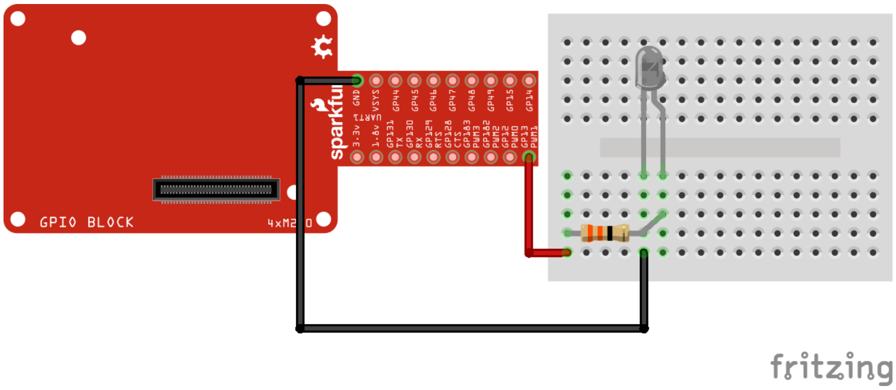
5. Congratulations. You have a working kit!

IR LED

If you do not have a TV remote control handy, you can use an IR LED and current limiting resistor instead. Please prepare the following circuit:

This can be done on the same Edison connected to the IR Receiver if you have long wires or it can be done on a different Edison.

2. Make sure the IR LED is pointed at the curved end of the IR receiver. It should resemble the picture here:
3. The hardware setup for testing is complete. Now we will set up the code:



4. Insert picture of the code here.
5. Vi ir_emitter_test.c
6. Gcc -lmraa -o ir_emitter_test ir_emitter_test.c
7. ./ir_emitter_test
8. Now, the IR LED will be emitting a constant signal. If you look at the DMM, you will see a reading of 0 V, because a constant signal is being read:
9. You can also see the same reading on the oscilloscope:
10.

Appendix A: SparkFun GPIO Block and Pull Up Resistors

This section is incomplete.

In this appendix, I provide a short investigation/lab illustrating Pull Up Resistors and why they are needed to properly use the SparkFun GPIO block.

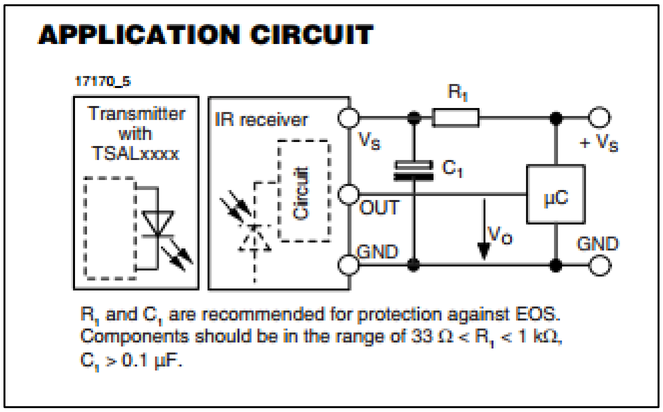

APPLICATION CIRCUIT
17170_5
Transmitter with TSALxxxx
IR receiver
Circuit
V_S
OUT
GND
R_1
C_1
$+V_S$
µC
V_O
GND
R_1 and C_1 are recommended for protection against EOS.
Components should be in the range of 33 Ω < R_1 < 1 kΩ,
C_1 > 0.1 µF.

Figure 21: Recommended Application Circuit for TSOP38238. Taken from official datasheet.

As discussed in the main tutorial, the TSOP38238 is an active low device. However, as you will see during this tutorial, in the absence of the pull up resistor, the TSOP38238 will not behave correctly. Let's investigate.

Connect this circuit:

Notice that there is no pull up resistor; this is precisely the same circuit as the sample circuit provided on the datasheet.

If you connect this circuit to the Arduino Breakout board for Intel Edison, you will see that there are no problems. If you follow the steps in the “Testing the hardware” section, the results that you observe will be exactly identical to the screenshots attached above.

Next, try connecting this circuit to the SparkFun GPIO Block. Initially, the voltage looks fine.
Screenshot: the voltage looks fine
However, after you send a signal to the IR Receiver, and then you look at the voltage again, you will see that it does not look fine.
Screenshot: The voltage does not look fine on the DMM
The voltage does not look fine on the Oscilloscope.

If you have both the oscilloscope and the TV remote control, take a closer look at the scope when the TV remote is pointed at it:

Screenshot: signal at .37 V.

The IR Receiver is actually still working, and the signal decoding is still functioning properly. The only problem is that the voltage level is extremely low; now “.37 V” becomes the “HIGH” value and “0 V” remains the “LOW” value. However, if you

What has happened? What is the difference between the Arduino Breakout Board and the SparkFun GPIO board?

That would be the pull-up resistors. Specificlaly these pull up resistors:

Insert Picture of the Pull Up resistors on the Arduino Breakout board.

Clearly these resistors are not present on the SparkFun GPIO board.

Actually, that was a lie. Those resistors are not actually the Pull Up Resistors.

These ones are.

Insert Picture of the Pull Up Resistors.

According to the datasheet, these resistors have a value of 100K Ohm, and they provide a connection between the input pins and Vin for the board.

Given this information from the datasheet, that makes us think that we should also do the same thing as the Arduino Breakout board and also place a 100K Ohm resistor between the signal pin and Vin. Give it a try.

After you have run through the test instructions, you will probably have seen pictures that look similar to this:

Insert DMM and Scope picture(s) for 100 K pull up resistor.

As you can see, this is a bit better than 0.37 V, but these voltages are still not valid logic levels for the Edison to process as high and low.

Now, a lot of places recommend using a pull up resistor of 10K. Let’s see if that works.
Nope.

So it’s looking like none of these resistors are working. What value should we actually use?
It turns out that any value lower than about 5K will function properly as a pull up resistors:
Insert Graph Here
In the kit, we included a pull up resistor with value 1K. This value was chosen because it was experimentally shown to be a reliable value for the pull up. But by looking at the chart, any resistor with value between 0 Ohms and 5K Ohms appeared to be working just fine for the pull up. Why pick 1K. it turns out there are two important properties that we should consider when picking a pull up resistor. The first one is “does it pull up successfully. The second is how much leakage current it has.

References

1. https://learn.sparkfun.com/tutorials/sparkfun-blocks-for-intel-edison---gpio-block/all
2. http://www.emutexlabs.com/project/215-intel-edison-gpio-pin-multiplexing-guide
3. https://www.sparkfun.com/products/10266
4. https://learn.sparkfun.com/tutorials/pull-up-resistors
5. Professor Dennis Briggs