RedStick Hookup Guide

Introduction

The RedStick

The SparkFun RedStick is a production version of the BadgerStick, which made an appearance at a trade show near you in the BadgerHack Badge. This version carries an NCP1402 boost regulator (as seen in the SparkFun 5.0v Step-Up Breakout Board, so it can run at **16MHz** from a 6V down to a 2V input!

The RedStick operates as an Arduino Uno in the Arduino IDE!

Covered in This Tutorial

- Hardware Overview – A tour of the PCB.
- Powering the RedStick
- The Blink Sketch – An example using codebender, straight from your browser.
- Using the 8x7 LED Array – The 8x7 LED array library has been updated to work on this board!
- Adding a second voltage rail – How to build an LDO onto the RedStick.
- Conclusion and Resources

Suggested Reading

- RedBoard Hookup Guide – The RedBoard and RedStick have many similarities. Learn the ins-and-outs of getting either up and running in the Arduino IDE in this tutorial.
- BadgerHack – The original BadgerStick (promo) documentation.
- Charlieplexed 8x7 LED Array Github – If you would like more information on how the 8x7 LED array is programmed, check out the code files.

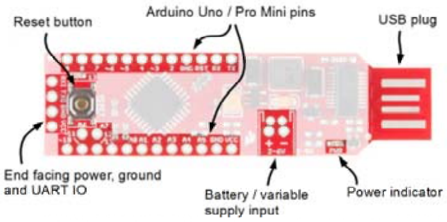
Hardware Overview

The following lists the features of the RedStick:

- A boost regulator providing 5V to the Atmega328p from an input range of 2 to 6 volts.
- 16 MHz system clock (allowed because of the additional supply voltage)
- Uno compatible in the Arduino IDE. Simply select the board “Arduino/Genuino Uno” and go!
- USB end matches standard USB thickness and width.

What the RedStick is not:

- A RedBoard – it doesn’t provide 3.3 volts, only 5.
- A battery charger – The RedStick turns off the battery when plugged into a USB port.


Reset button
Arduino Uno / Pro Mini pins
USB plug
End facing power, ground and UART IO
Battery / variable supply input
Power indicator

Parts of the RedStick

The following table lists all of the pins on the RedStick and their functionality.

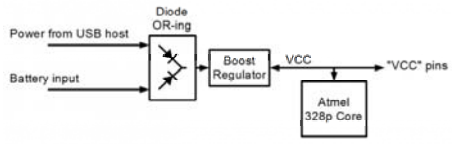
Pin Silk	Function	Notes
TX	Serial transmit	This is serial data coming out of the RedStick.
RX	Serial Receive	This is serial data coming in
2	Digital	
~3	Digital with PWM	
4	Digital	
~5	Digital with PWM	
~6	Digital with PWM	
7	Digital	
8	Digital	
9	Digital	
~10	Digital / PWM / SS	
~11	Digital / PWM / MOSI	SPI bus
12	PWM / MISO	SPI bus
13	Digital / SCK / LED	SPI bus
A0	Digital / Analog	

A1	Digital / Analog	
A2	Digital / Analog	
A3	Digital / Analog	
A4	Digital / Analog / SDA	I2C bus -- some applications require pull-up
A5	Digital / Analog / SCL	I2C bus-- some applications require pull-up
A6	Analog	Analog only!
A7	Analog	Analog only!
RXI	Serial Receive	Electrically tied to RX
TXI	Serial Transmit	Electrically tied to TX
VCC	Microprocessor Power (Boost output)	If using as input, supply regulated 5.0 v
GND	Ground	
+	Battery Positive	Supply 2.0 to 6.0 volts
-	Battery Negative	This is also GND

Powering the RedStick

The RedStick was designed to allow two sources of power.

- Power directly from the USB port.
- Power with 2-6 volts on the battery terminals.



A block diagram showing how the power flows in this board

Functional Description

When power is applied to the USB port, it will not flow into the battery. Alternately, if the USB voltage is lower than the battery, power will not flow into the USB host.

To use AA cells, for example in a battery holder such as a 2xAA Holder with switch, solder the wires directly into the battery terminal holes, matching red to positive.

To use a rechargeable battery, such as a 1 Ah Lithium Ion battery, solder a JST connector into the smaller, 2mm spaced holes and attach the battery. Again match red with positive.

> **Note on VCC:** It's conceivable that power might be applied to the VCC pin instead. This is OK as long as the input voltage is regulated while the USB and battery inputs are left open.

Notes on DC-DC converters

The RedStick uses a boost circuit to convert a low voltage (> 2.0 volts DC) to 5 volts DC. This DC-DC conversion is fairly common in today's world where a liner regulator is not efficient enough. This boost circuit measured around 83% efficient.

Here's a couple concepts to think about related to DC-DC converters

DC-DC converters and power

Ideally, DC-DC converters would be 100% efficient. In the math model, this means that power out = power in. So, if the converter is delivering 200mA at 5V, by the definition of electrical power, that's 1W (P = V * I). If we're consuming 1W from the output, we must be supplying 1W to the input. If the input is a battery at 3V, supplying 1W, it must be supplying 330mA. That's more than we're getting out!

As the input voltage to a DC-DC converter drops, the current consumption increases to maintain the output load.

This also applies to LED and CCFL bulbs that aren't dimmer compatible. As the dimmer decreases the voltage, the current *increases* and fries the dimmer circuit because it was designed for resistive loads (incandescents) that behave as Ohm's law indicates.

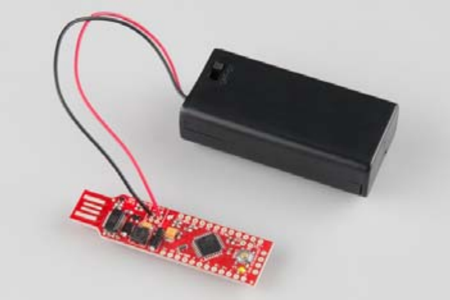
Drawbacks of DC-DC converters

The appeal of DC-DC converters is the low cost of the completed circuit. This is because inductors are used in place of transformers. The inductors operate at a high frequency so that the size can be made small, which makes them cheap. The control circuitry is a logic system that chooses when, and how fast, to operate the inductor in order to build up the necessary voltage on the output. This switching frequency can be seen as ripple on the output side of the DC-DC converter, depending on the loading of the circuit.

This DC-DC converter produces between 30 and 170 mV ripple in the 5kHz to 250kHz range, with optimal performance between 2.5-4.5 volts (typical battery voltages).

Example: The Blink Sketch

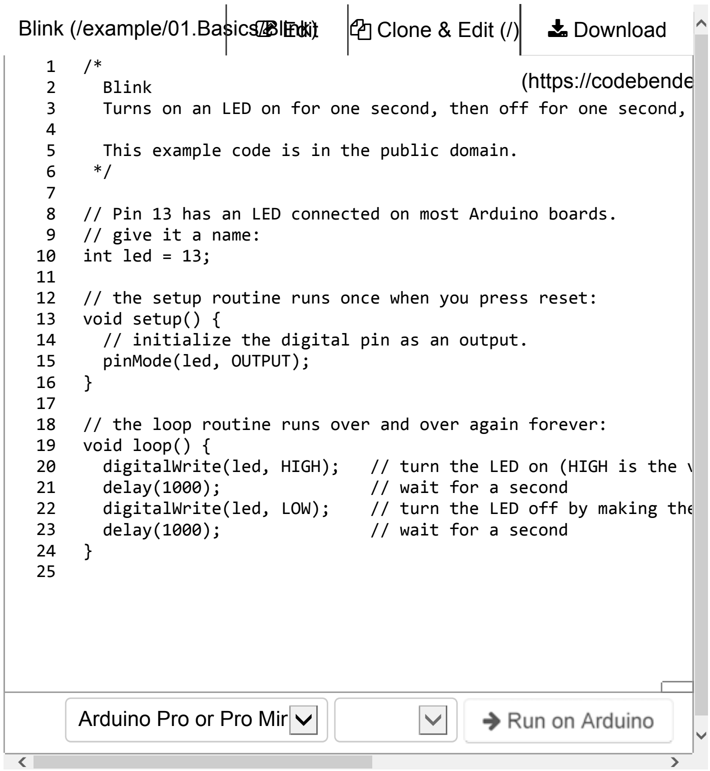
The RedStick comes with the blink sketch loaded and running, so the LED (pin 13) will toggle every second. This section shows how to get back to this basic sketch using codebender and by using the Arduino IDE.



The RedStick running the blink application to insure basic function. In this photo, the RedStick is being powered from two AA cells.

Using codebender

With codebender, you'll have to install the small browser Arduino plugin, if you have not done so already. Without a codebender account you can modify and run from this webpage, but you won't be able to save or share without making a free account.

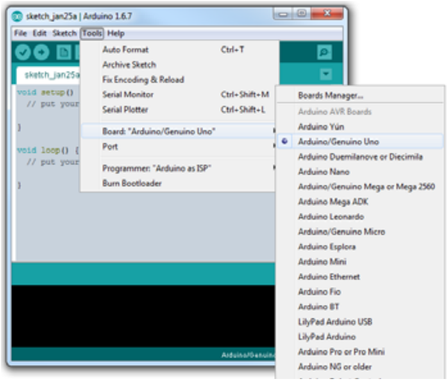


```
/*
  Blink
  Turns on an LED on for one second, then off for one second,

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the v
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the
  delay(1000);               // wait for a second
}

```

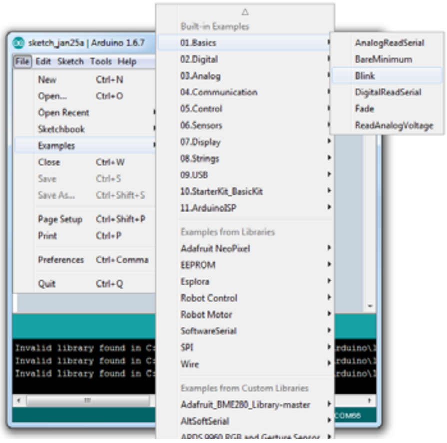
Select Arduino Uno for device and the RedStick's COM port number. You can edit this code (try reducing the delay time in the loop() to 500) and click "Run on Arduino" to make sure everything is working. The codebender browser must be installed.

Using the Arduino IDE

To re-load the sketch, select the Arduino/Genuino Uno board from the menu, select the basic example blink, and press upload.



Selecting the Arduino Uno board. Don't forget to select your com port too if it wasn't auto-selected



```
Invalid library found in C:
Invalid library found in C:
Invalid library found in C:
```

```
rduino\l
rduino\l
rduino\l
```

Select the blink.ino sketch from the basic examples menu

Now compile and run! That’s all there is to it!

Example: Using the 8x7 LED Array

If you would like to use an 8x7 LED array with the RedStick as with the BadgerStick, you can! The libraries have been updated to use F_CPU to set scroll speeds for 4, 8, and 16MHz boards.

> **Using a promo 8x7:** The original promo 8x7 LED array was designed for 3.3v operation but the RedStick operates at 5. Appling a 8x7 from a show (has badger logo on back) will have increased brightness and current consumption. For proper compatibility remove the 8 SMD resistors and replace with 82 ohms each, though it'll probably be ok if you choose not to alter it. SparkFUn will be releasing a 5V compatible version of the LED array in the near future.

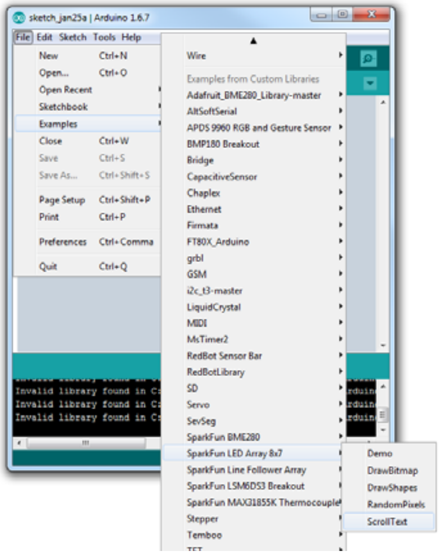
Install the Arduino library

The 8x7 LED array has its own library. It is available as a github repository called SparkFun_LED_Array_8x7_Arduino_Library. It is not part of the library manager and will need to be manually installed (Drop it in your /libraries folder).

For more information, view this guide to installing Arduino libraries

Run the example sketch

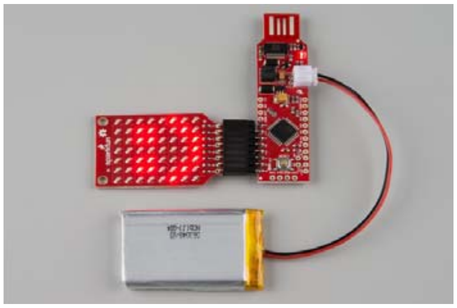
Under examples, select the 8x7 library, then the example sketch “ScrollText”. This sketch displays scrolling text on the 8x7 LED array, but the library can also be used to draw individual pixels, shapes, and bitmaps.



```
Invalid library found in C:
Invalid library found in C:
Invalid library found in C:
```

Selecting the example sketch

Compile and run the sketch. The example text `Hello. :)` and `Let's scroll!` should scroll across the array. From this point the text can be changed, or the other features of the library can be used. Check out the BadgerHack 'Make a Game' section for example code that uses the 8x7 API.



The RedStick driving a modified 8x7 LED array (promo item). Here, it scrolls ":)" as part of the example

Example: Adding a Second Voltage Rail

Not all projects are LEDs and digital logic. If you want to add devices that operate at voltages *other* than 5.0 volts, a low-dropout regulator (LDO) can be added to solve the problem. Here, I've used basic components to attach a BME280 atmospheric sensor to my RedStick. Of course, you could use a breadboard power supply stick. I didn't want the barrel jack and extra space used up, so I used discrete components.

This inexpensive wishlist gets you the regulator, plenty of caps, and plenty of proto board to get going.

3.3v Regulator Circuit SparkFun Wish List

SparkFun Snappable Protoboard
PRT-13268
Sometimes it's nice to have a protoboard that's super long and skinny…

Voltage Regulator - 3.3V
COM-00526
This is the basic LD1117V33 voltage regulator, a low drop positive re…

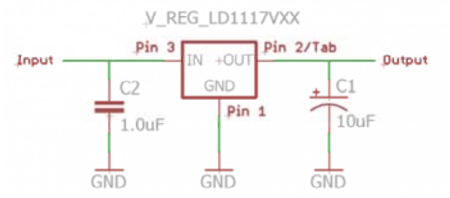
SparkFun Capacitor Kit

KIT-13698

This is a kit that provides you with a basic assortment of capacitors to…

Build the LDO circuit

Build the following circuit. Remember to mind polarity on the electrolytic capacitor, that the pin ordering is kind of counter-intuitive, and that the TO-220's tab is connected to the pin 2 and not ground.



Connect the LDO circuit

To connect the LDO circuit to the RedStick,

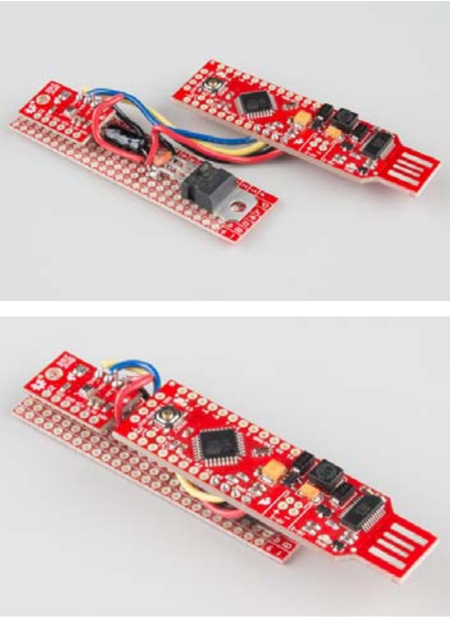
- connect "GND" to a spare GND pin
- connect "Input" to VCC.

Now the "Output" is a regulated rail! In this case, 3.3 volts.

For this example, a BME280 is used. The BME280's ground is connected to the common GND pin while 3.3V is connected to the LDO's Output terminal. I2C serial lines are directly connected to the RedStick's A4 (SDA) and A5 (SCL) pins. The BME280's circuit board pulls these lines safely up to 3.3V.

Run the example

Run the BME280's example sketches. For information on use of the BME280, see the hookup guide.



The final product. This USB stick / BME280 combo is great for determining the local weather conditions, altough it's usually about 2 degrees Celsius hotter around my computer than in the center of a room

Resources and Going Further

Here's a recap of the useful links from the guide and some extras that have information not covered. Remember, if you get stuck on a problem take a step back and list off what you *do* know, and have fun!

Resources used in this guide

- RedStick Schematic
- RedStick Eagle Files
- Datasheets (ATmega328p & NCP1402)
- BadgerStick GitHub repository
- BadgerArray GitHub repository
- BadgerHack Demos GitHub repository
- Codebender LED Array library

Additional information and related topics

- RedBoard Hookup Guide – Learn how to download and install the Arduino IDE.
- Unregulated Power Supply Tutorial – notes on transformer ripple.
- Button Pad Hookup Guide – creating button matrices.
- Diode Primer – includes biasing LEDs.