EMCB0 High-Speed Flash Controller

Note – The photos used in this document are of a rev1.2c board. The rev1.2d is very similar, but has better markers on its silkscreen.

Description

The EMCB0 high-speed flash controller was designed to be a plug-and-play solution for building an LED-based high-speed flash. It is based on the ATMEGA328P microcontroller which is found in Arduino Uno development boards. The controller also uses a TC4452 to quickly turn multiple MOSFET's on and off. It is designed to run from eight AA batteries (1.1 – 1.5 V) but other power supplies can also be used.

Specifications

Parameter	**Min**	**Typ**	**Max**	**Unit**
Input Voltage	6		18	V
Input Current		20		mA
Clock Speed		8		MHz
Trigger Response Time			2	us
Gate Driver Current		2.6	13	A
Gate Driver High-Pass Filter	4		5	us

Operation Theory

The EMCB0 controller is designed specifically for the Edgerton high-speed LED flash, but it can control similar 'microsecond flash' units. The UI consists of an EC-1 rotary encoder and a TM1637 7-segment LED display. An optional sound element (piezo buzzer) can be installed.

A 3.5mm jack carries the trigger signal. The signal can be active-high (0V = no trigger, 5V = trigger) or active-low (5V = no trigger, 0V = trigger). Basic built-in input protection prevents damage from incorrect polarity or excessive voltage without introducing delay.

A high-voltage converter can be connected to the board. It is controlled by a solid-state relay which provides power directly from the input voltage. The high-voltage converter in the Edgerton Bill Of Materials (BOM) requires at least 8.5 volts input, so an input voltage of 8.5 – 15 V is recommended.

The controller can drive multiple N-channel MOSFET's with its TC4452 gate driver. The gate driver input has a hardware high-pass filter which is tuned to approximately 4.5 microseconds. This filter provides additional protection if the firmware is modified or a microcontroller lockup occurs due to a voltage fluctuation.

Repository

https://github.com/td0g/high_speed_flash/

Assembling Bare PCB

If you have a bare PCB and wish to assemble it, please refer to the Github repository.

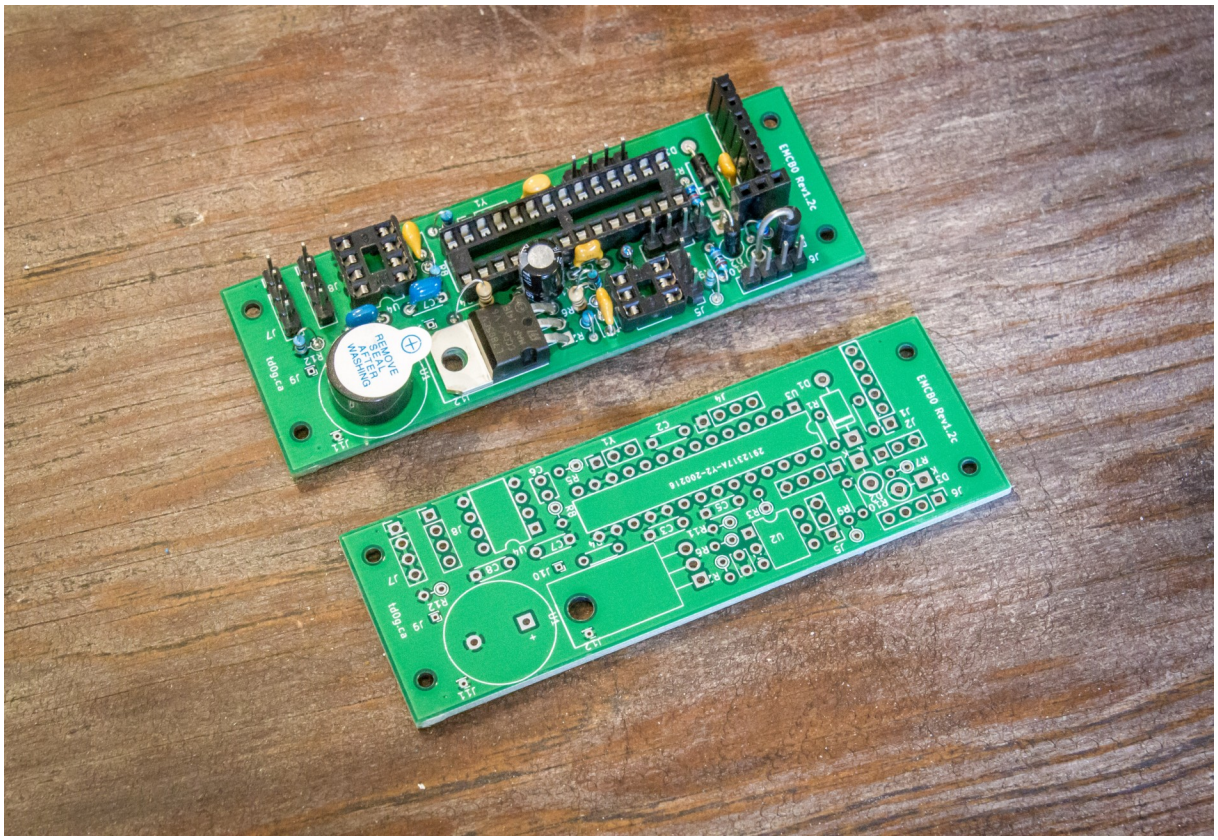

Figure 1: EMCB0 Fully Populated (top) and Bare PCB (bottom)

Connections

There are 8 connector headers on the EMCB0 board:

1. Supply Power
2. FTDI
3. TM1637 Display
4. Encoder
5. Trigger
6. High-Voltage Converter
7. LED Capacitor Positive
8. LED Capacitor Ground
9. LED MOSFET Gate

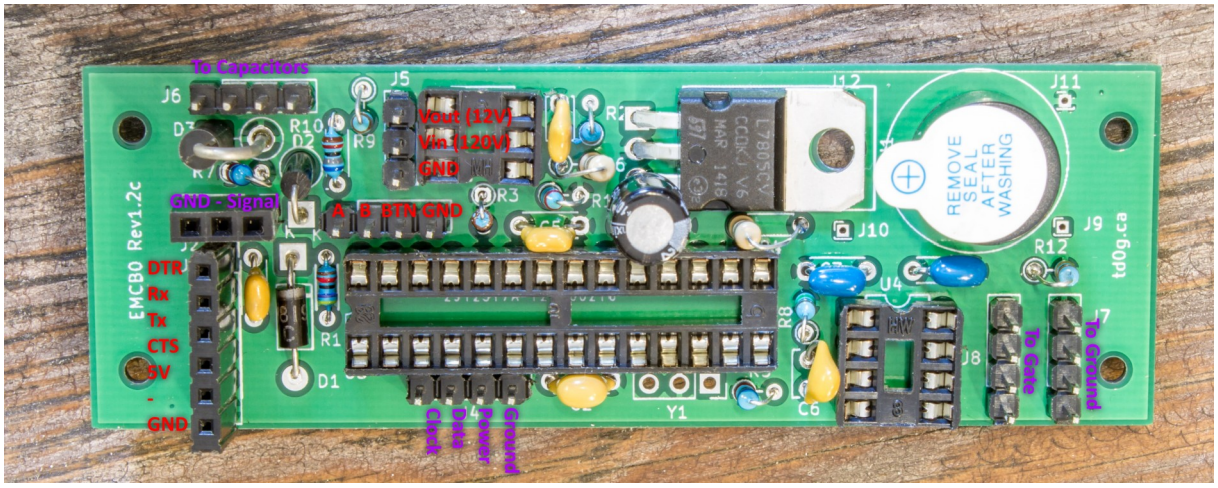

Figure 2: EMCB0 Headers

1 Supply Power

Connect battery voltage to the pins as shown. These pads need to be soldered, there are no headers installed. Be sure to add a switch to the V+ line so that the control board can be turned off.

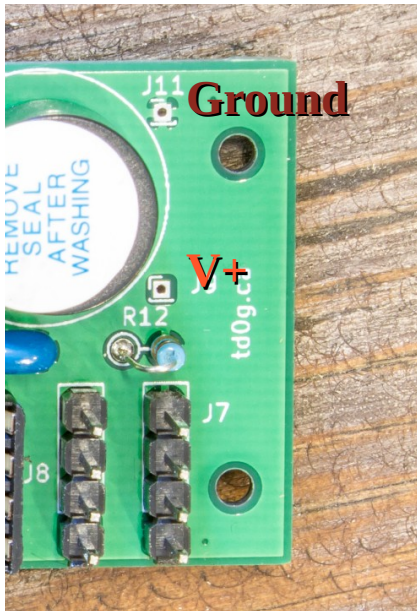

Figure 3: Supply Power

2 FTDI

The firmware for the ATMEGA328P microcontroller has serial communications enabled by default. For more information on the firmware serial communications, please refer to the most recent user manual (available in the Github repository). Additionally, the microcontroller has a Lilypad Arduino bootloader and can be programmed from the Arduino IDE.

To use the FTDI header for serial communications or programming, install an FTDI adapter as shown:

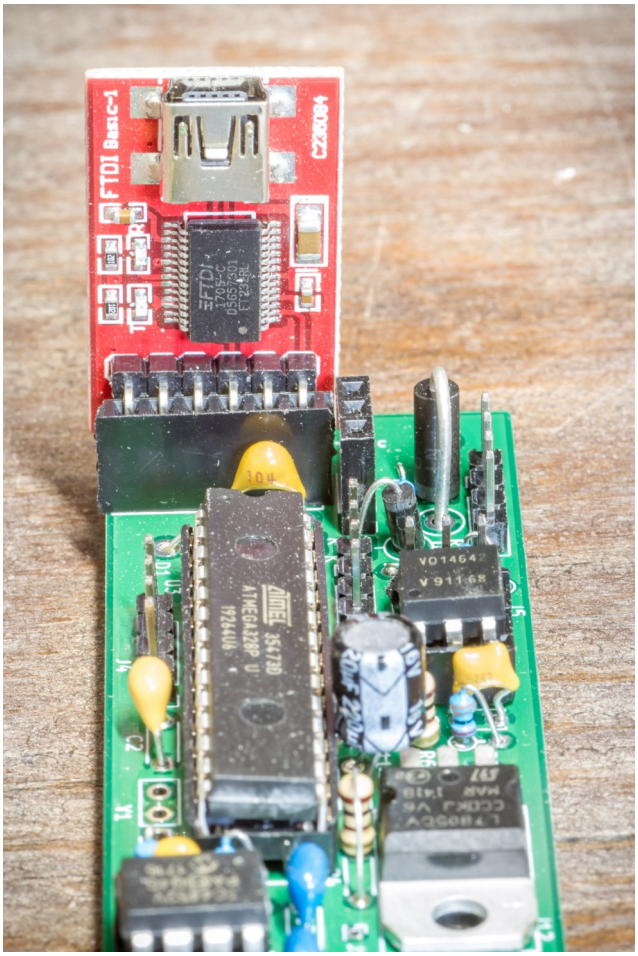

Figure 4: FTDI Adapter installed

3 TM1637 Display

The figure below shows the connections for the display. Use jumper wires or build you own wire harness using Dupont connectors.

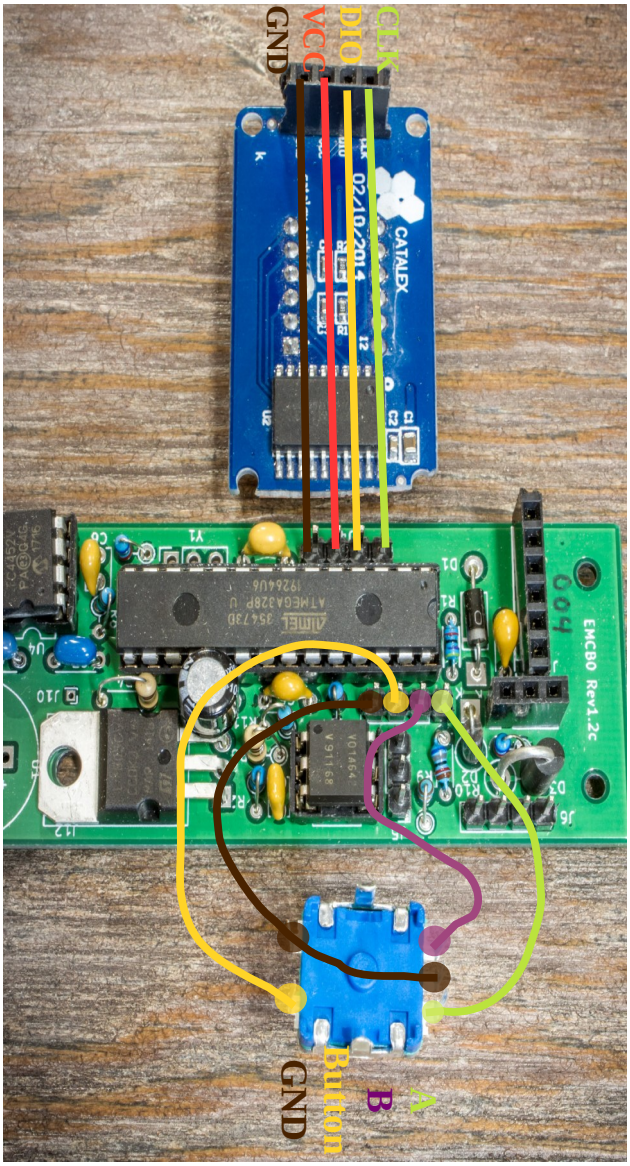

Figure 5: TM1637 Display and EC-11 Encoder Connected

4 EC-11 Encoder

Refer to Figure 5 for the encoder connections. Note that the thick tabs on each side of the encoder are not connected. Also, the ground wire is connected to two pins: the middle pin on the side with three pins, and either pin on the side with two pins.

5 Trigger

The external trigger connection uses a 3.5mm jack. Install as shown below.

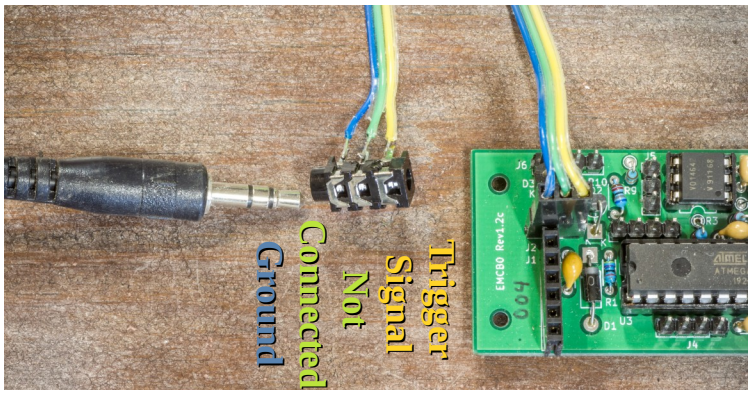

Figure 6: 3.5mm Trigger Jack Connection

6 High-Voltage Converter

Connect the high-voltage converter as shown below. Note that both V- connections on the boost converter are common – you only need to connect one GND.

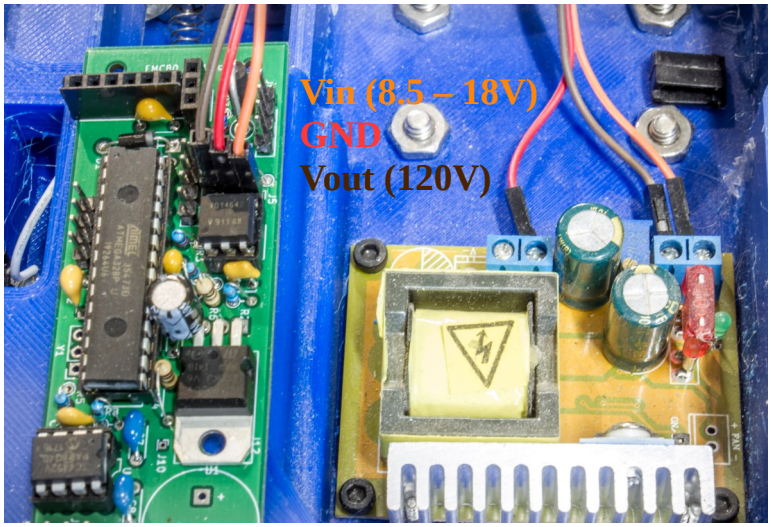

Figure 7: High-Voltage Converter

7 LED Capacitor Positive, 8 LED Capacitor Ground, 9 LED MOSFET Gate

The controller has four header pins for each LED bank. Connect as shown below. Soldering the pin connections is recommended to reduce impedance.

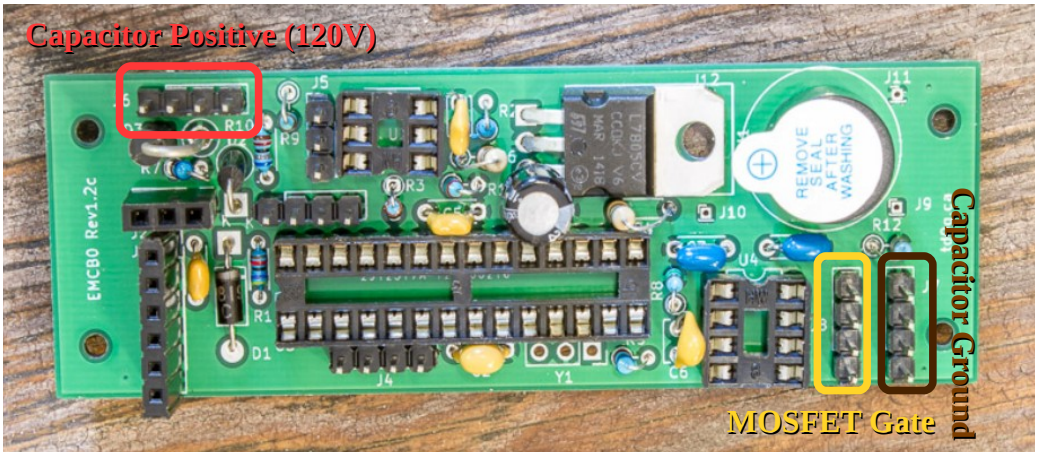

Figure 8: Capacitor and MOSFET Connections

Increasing Clock Speed

The ATMEGA328P, by default, is set to use an internal oscillator. The internal oscillator frequency is 8MHz. A 16 MHz ceramic resonator can be installed by following these steps:

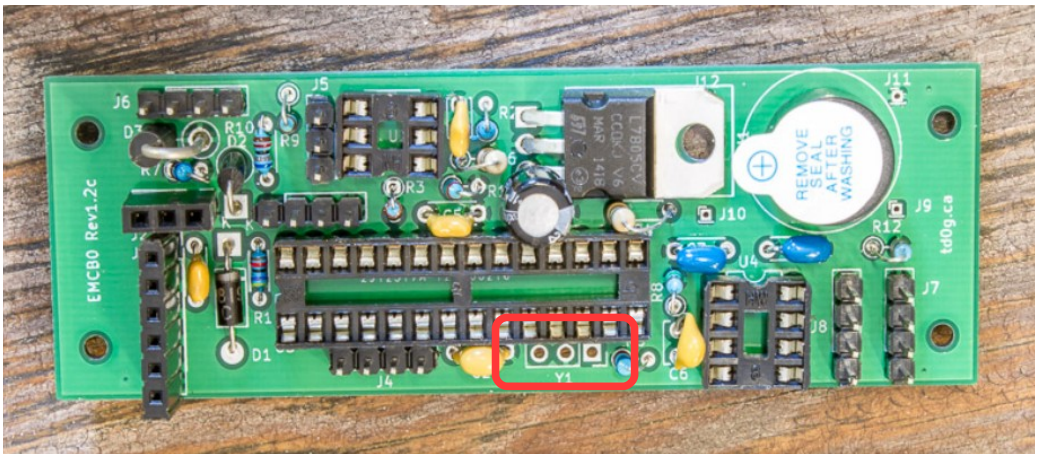

Figure 9: 16MHz Resonator Pads Circled

1. Source a 16 MHz ceramic resonator (eg. Adafruit)
2. Solder the resonator into the Y1 pads
3. Burn an Arduino Uno bootloader on the ATMEGA328P board. See https://www.gammon.com.au/bootloader
4. Download the most recent Edgerton firmware from the repository. Comment out the line that says ‘EIGHT_MHZ’. Upload the firmware to the board.

Example Usage

https://td0g.ca/2019/05/14/edgerton-a-high-speed-led-flash-diy/

License

Changelog

2020-07-07	Initial commit	VTG