

# Rocket Launcher Design Document

*Its more like a mortar but ok.*



CSE 453  
SUNY University at Buffalo

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# 1 Parts List

## 1.1 Air Reservoir Parts

- $1\frac{1}{2}$ " PVC pipe
- $1\frac{1}{2}$ " PVC tee ( $x6$ )
- $1\frac{1}{2}$ " x  $\frac{1}{2}$ " SxFNPT adapter ( $x5$ )
- $\frac{1}{2}$ " NC solenoid valve ( $x2$ )
- $\frac{1}{2}$ " NO solenoid valve
- $\frac{1}{2}$ " x  $\frac{1}{4}$ " MNPTxFNPT adapter ( $x3$ )
- $\frac{1}{4}$ " MNPT quick connect plug
- $\frac{1}{4}$ " MNPT pressure gauge
- $\frac{1}{4}$ " MNPT pressure transducer

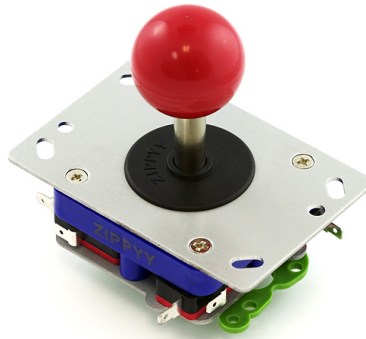
## 1.2 Controller Parts & Other Electronics

- Joystick ( $x2$ )
- Ultrasonic sensor
- LCD screen 16x2
- Alarm Module
- Arduino Mega 2560
- Push button ( $x2$ )
- Servo Motor ( $x2$ )
- 5V relay ( $x3$ )
- 12V battery
- Voltage regulator

# 2 Controller

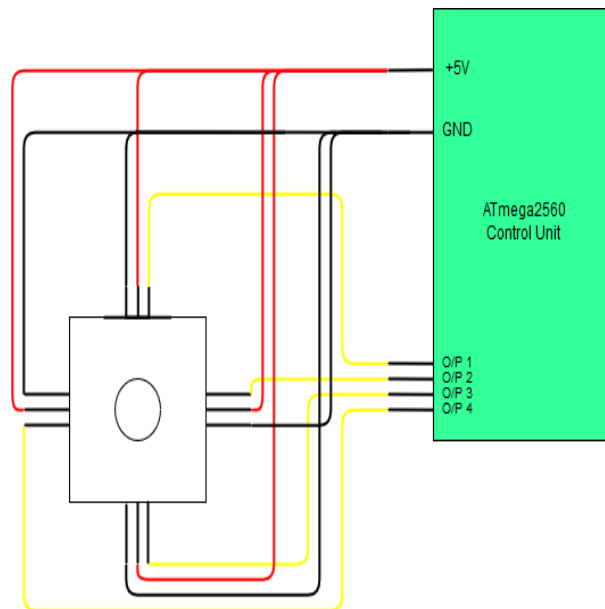
## 2.1 Joysticks

Mfr.	Zippy
Model#	6048
Dimensions(mm)	97 x 65 x 103
Accuracy	10,000,000 cycles
I/O Pins	33, 32, 12, 11, 10, 9 (INPUT_PULLUP)



There are two joysticks installed one for manipulating pressure of the rocket launch and one for manipulating the angle of the rocket launch. Both joysticks are mounted onto the controller box.

### 2.1.1 Joystick Wiring



Color	Fn.
Red	+5V
Black	GND
Yellow	SIG INPUT PULLUP

### 2.1.2 Left joystick Control Pins

- Pin 12: Angle up
- Pin 11: Angle down
- Pin 10: Angle left
- Pin 9: Angle right

### 2.1.3 Right joystick Control Pins

- Pin 32: Pressure up
- Pin 33: Pressure down

## 2.2 Big Buttons

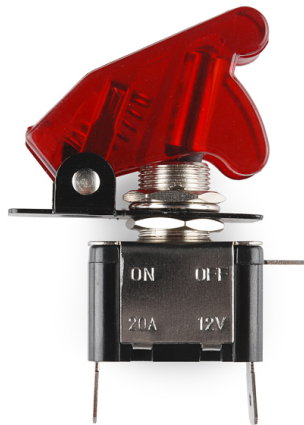
Mfr.	Easyget
Model#	1X-100#-BUT-RED or BLUE
Circumference(mm)	100
Accuracy	10,000,000 cycles
I/O Pin	39, 43 (INPUT)



There are two big buttons included. One is mounted onto the controller for initiating the launching process. This is the red button. One is loose from the controller attached with ten-foot cable and used as a deadman switch. The rocket launching process is incapable of starting without the deadman switch being held.

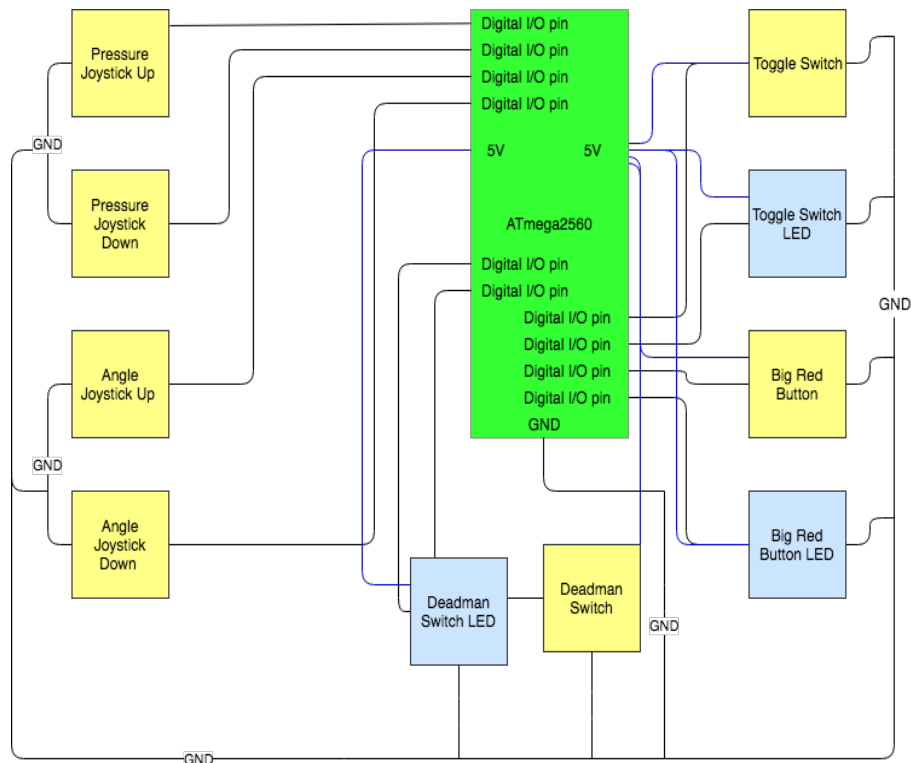
## 2.3 Toggle Switch

Mfr.	Sparkfun
Model#	COM-11310
Circumference(mm)	12
Max Voltage	12V
Max Amperage	20A
I/O Pin	35 (INPUT)



The Toggle Switch is used to turn the controller on/off. This component is mounted onto the controller box.

## 2.4 Controller Wiring



Key	
Green Box	Arduino
Yellow Box	Button
Blue Box	LED
Blue Line	5V
Black Line	Ground

## 2.5 Relays

Since our solenoid valves do not simple have on and off switches, we can use relay to control them. The relay function as a switch, when triggered, the solenoid will actuate.

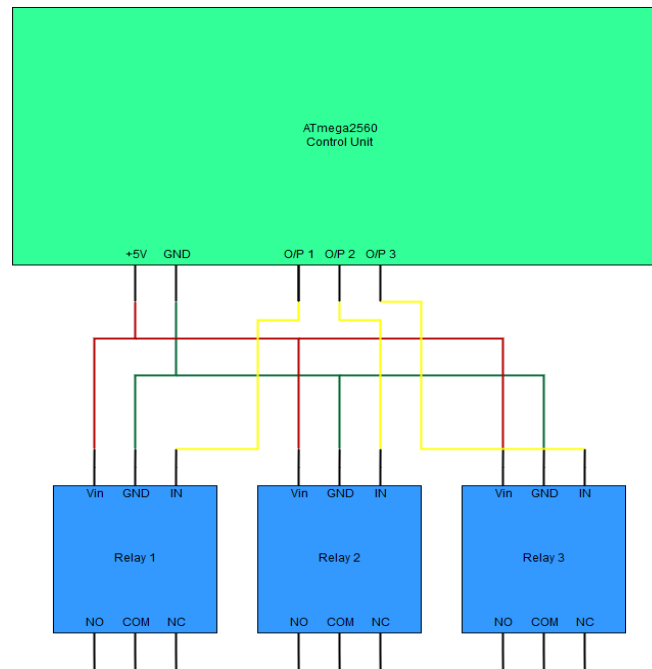
Voltage	5V
Channel	Dual Channel
Max Load	30VDC/10A
Trigger	High/Low
I/O Pins	4, 7, 8 (OUTPUT)



Pin	Fn
DC+	5V input Pin
DC-	GND Pin
IN1	Relay 1 Control Pin
NC1	Relay 1 Normally Closed Pin
COM1	Relay 1 Common Pin
NO1	Relay 1 Normally Open Pine
IN2	Relay 2 Control Pin
NC2	Relay 2 Normally Closed Pin
COM2	Relay 2 Common Pin
NO2	Relay 2 Normally Open Pine

**Note:** A dual channel relay is not necessary, any 5V relay should suffice.

### 2.5.1 Relay Wiring



Color	Fn.
Red	Vcc
Green	GND
Yellow	SIG OUTPUT

### 2.5.2 Contolling Solenoids with Relays

On the relay module there are 3 pins, normally closed (NC), common (COM), and normally open (NO). By default the NC and COM pins are connected. When the relay is triggered, the NO and COM pins will be connected. In section 4.4, the diagram shows that the positive terminal of the 12V battery is connected to the NO pin on the relay. The COM pin is connected with one of the terminals on the solenoid through the cathode end of a 1N4001 diode. When the relay is triggered, the NO and COM pins are connected and the solenoid will actuate.

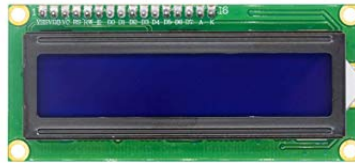
- **Relay Relay\_Name(*pin#*, *bool*)**: Relay declaration, in the example we have 3 relays declared, EV, BV, and FV. Each of these relays controls one of the solenoid valves. Each relay is also assigned a pin on the control unit. The boolean value is set to either true or false; depending on whether you want normally open or closed functionality, In our case we want normally open functionality so we set it as true. Our relay is high level so we set the value as false.
- **turnOn()**: Activates the relay, connecting the NO and COM pins. In our case it actuates a corresponding solenoid.
- **turnOff()**: Deactivates the relay, disconnecting the NO and COM pins. In our case it set a corresponding valve to its default configuration.



### 3 Other Electronics

#### 3.1 LCD Display

Mfr.	Sparkfun
Model#	COM-11310
Circumference(mm)	12
Voltage	12V
Amperage	20A
I/O Pin	13 (OUTPUT)



The LCD Screen is used to display the current angle and pressure as both variables are being manipulated with the joysticks. This component is mounted to the controller box.

#### 3.2 Servo Motors

##### 3.2.1 Servo Motor A

Mfr.	Sparkfun
Model	HITEC HS422
Voltage	4.8-6.0V
Range	0-180 degrees
I/O Pin	2 (OUTPUT)



This servo is used to provide a vertical axis of rotation.

### 3.2.2 Servo Motor B

Mfr.	LewanSoul
Model	LD-20MG
Voltage	6.0-7.4V
Range	0-180 degrees
I/O Pin	3 (OUTPUT)



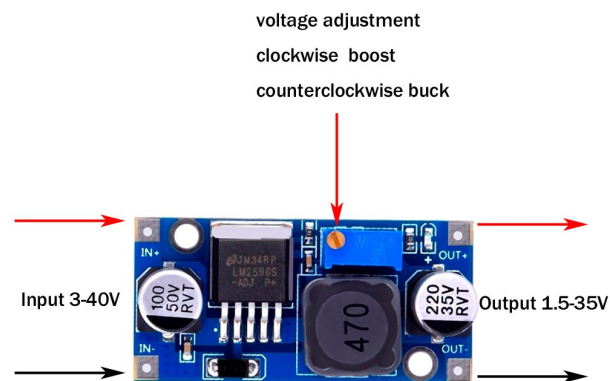
This servo is used to provide a horizontal axis of rotation.

### 3.2.3 Servo Control Methods

- **servo\_Name.writeMicroseconds(value)**: If you know the servos range in microseconds, you can easily manipulate the servo rotation angle with a single function call. I recommend using this method.
- **servo\_Name.write(value)**: If you do not know the servos range in microseconds you can use this sweep method. Servo rotation will have to be adjusted incrementally in for example a "for" or "while" loop.

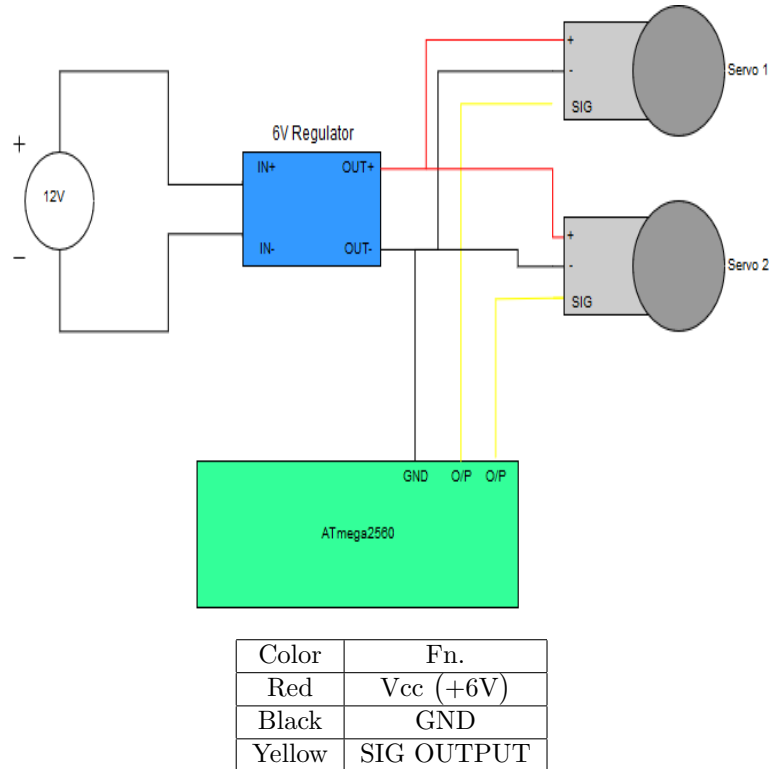
### 3.3 Voltage Regulator

Mfr.	eBoot
Model #	EXPSFD005794
Input Voltage Range	3-40V
Output Voltage Range	1.5-35V



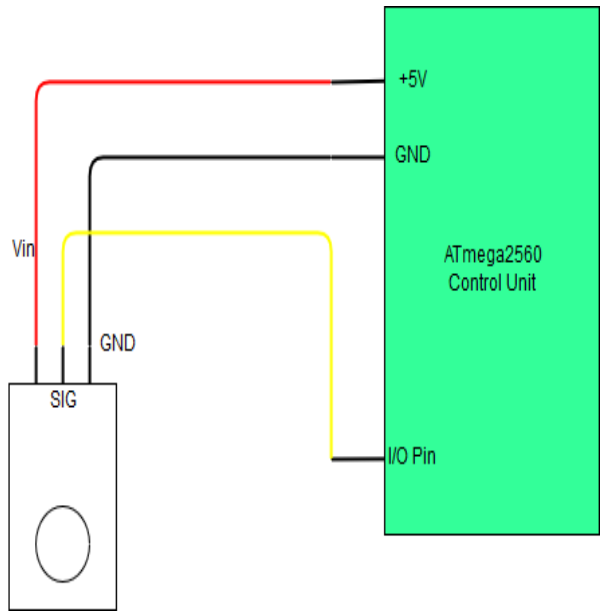
The ATmega2560 control unit cannot provide sufficient power to the servos. Therefore the servos are connected to the 12V battery. This voltage regulator module reduces the voltage from the battery from 12V to 6V for safe operation.

### 3.3.1 Servo regulator wiring



3.4 Alarm Module

Mfr.	Willwin
Item #	B0777P6FN5
Voltage	3.3-5V
I/O Pin	6 (OUTPUT)



Color	Fn.
Red	+5V
Black	GND
Yellow	SIG OUTPUT

Makes a beep noise when triggered, the noise is very annoying so its great for getting peoples attention.

## 4 Measuring Pressure

### 4.1 Pressure Gauge

Mfr.	DuraChoice
Model#	PA204B-160
Range	0-160 PSI
Fitting	1/4" MNPT



Simply put, it measures the pressure currently stored inside of the reservoir in PSI. The pressure gauge is also quite useful when calibrating the pressure transducer.

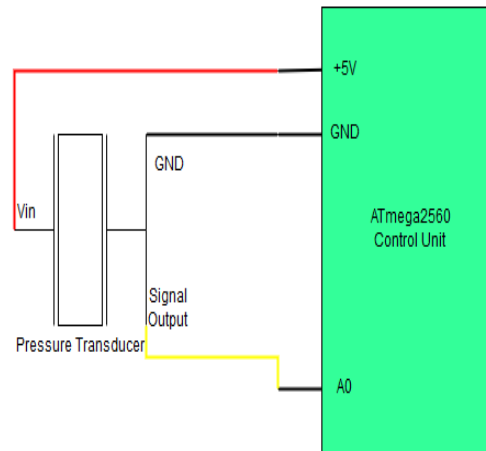
### 4.2 Pressure Transducer

Mfr.	Yosoo
Model#	IB-001
Voltage	5V
Range	0-1.2MPa (0-174 PSI)
Fitting	1/4" MNPT
Analog Pin	A0



Reacts to the pressure inside the reservoir, sending an analog signal to the ATmega2560 control unit. The transducer comes with 3 wires, Vin (red), GND (black), and the signal output. This particular transducer was quite cheap, it is also quite bad.

Color	Wire	Fn.
Red	+5V	Voltage input
Black	GND	Ground Wire
Yellow	SIG	0V-5V output (0-174PSI)



#### 4.2.1 Reading the Transducer

The ATmega2560 has analog input pins that can read the signal output from the transducer. The output wire (yellow) on the transducer will run into one of the analog input (labeled A0, A1, .... etc) pins on the control unit.

- **analogRead(*pin#*):** Returns analog signal transmitted to *pin#* (in this example the *pin#* is A0). Analog reading will range from 100 - 1023 based on the 0V - 5V output from the transducer signal. Return value can be assigned to a variable such as an integer.
- **map(*src, src\_low\_bound, src\_high\_bound, tgt\_low\_bound, tgt\_high\_bound*):** This function is handy when translating the analog reading into a pressure reading. In the sample code, *pressure\_output* will be assigned a value from 0-174, depending on the analog reading from 100-1023. Note that this function is not useful if your transducer has a non linear output.

## 5 Solenoids

### 5.1 NC Solenoid A

<b>Mfr.</b>	Asco
<b>Model #</b>	8210G002
<b>Voltage</b>	12VDC
<b>Power</b>	11.6W
<b>Size</b>	1/2" x 1/2"
<b>Fitting</b>	FNPT x FNPT
<b>Cinfiguration</b>	Normally Closed
<b>I/O Pin (Relay)</b>	4 (OUTPUT)



This elegant brass bodied solenoid valve from Asco operates at approximately 1 Amp (0.967A). With a normally closed configuration, this valve can be used interchangeably as the firing or entry valve. Due to its relatively low power consumption, I would recommend using it as the entry valve. This valve comes with 3 wires, 2 red wires and 1 green/yellow (ground) wire. The two red wires hook up to the positive and negative/neutral terminals on the source. The Solenoid will actuate regardless of which red wire goes where. Actuation will also occur regardless of whether or not the ground wire is connected.



## 5.2 NC Solenoid B

<b>Mfr.</b>	U.S Solid
<b>Model #</b>	USS2-00012
<b>Voltage</b>	12VDC
<b>Power</b>	20W
<b>Size</b>	1/2" x 1/2"
<b>Fitting</b>	FNPT x FNPT
<b>Cinfiguration</b>	Normally Closed
<b>I/O Pin (Relay)</b>	7 (OUTPUT)



This brass valve from U.S. Solid is a nice cheap alternative to the Asco valves. However, its operating current of 1.667A is much higher than NC Solenoid A. Also having a normally closed configuration, it can be used as the entry or firing valve. It is recommended that this valve be used as the firing valve; as it will only be energized for a fraction of a second. This valve comes with 2 hot wires; and will actuate regardless of which wire connects to the terminals on the source.

### 5.3 NO Solenoid A

<b>Mfr.</b>	U.S Solid
<b>Model #</b>	USS2-00078
<b>Voltage</b>	12VDC
<b>Power</b>	19W
<b>Size</b>	1/2" x 1/2"
<b>Fitting</b>	FNPT x FNPT
<b>Configuration</b>	Normally Open
<b>I/O Pin (Relay)</b>	8 (OUTPUT)



Another brass valve from U.S. Solid operating at 1.583A. With a normally open configuration, it is used as a bleed valve. When the launcher is powered off or in the case of a power failure, the air reservoir will not pressurize.

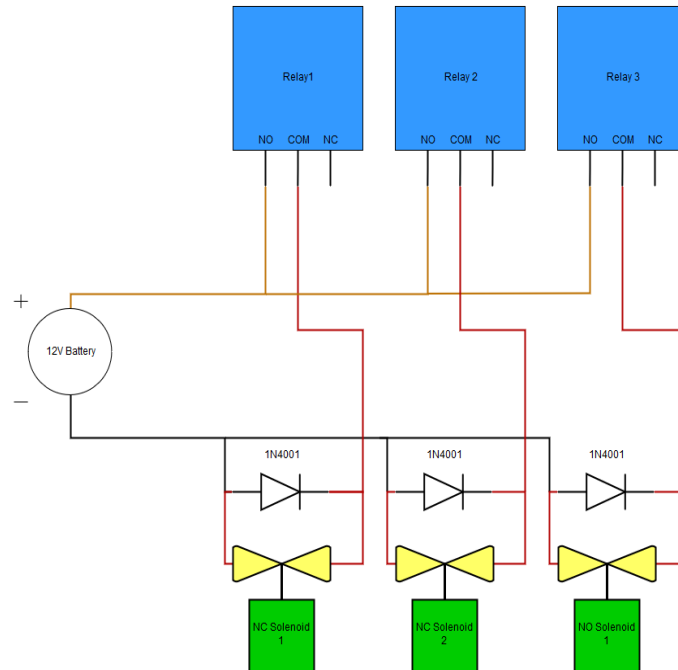
### 5.4 Wiring

**IMPORTANT:** De-energizing a solenoid valve's induction coil can cause voltage spikes through the rest of your circuitry due to the sudden collapse of its electromagnetic field. These voltage spikes can potentially cause damage to other modules. In our case, to protect the relays we were using to switch the solenoids on and off, we use a suppression or flyback diode. A 1N4001 general purpose diode should suffice.



When wiring the diode it is imperative that whatever lead wire coming from the positive terminal of your source is connected to the cathode end of the diode (the end with the gray strip). The negative/neutral

terminal on the source connects to the other end of the diode. When connecting the solenoid, either red wire can connect to either end of the diode. A wiring diagram is shown below.



As seen in the diagram, the positive terminal (orange) of the source is connected to the normally open (NO) pin on the relay. One of the hot wires (red) of the solenoid is connected to the common (COM) pin on the relay. Note that the diode runs in parallel with the solenoid, with the cathode end connected to the COM pin. When the relay is switched on, the COM and NO pins are connected and the circuit is complete, actuating the solenoids.