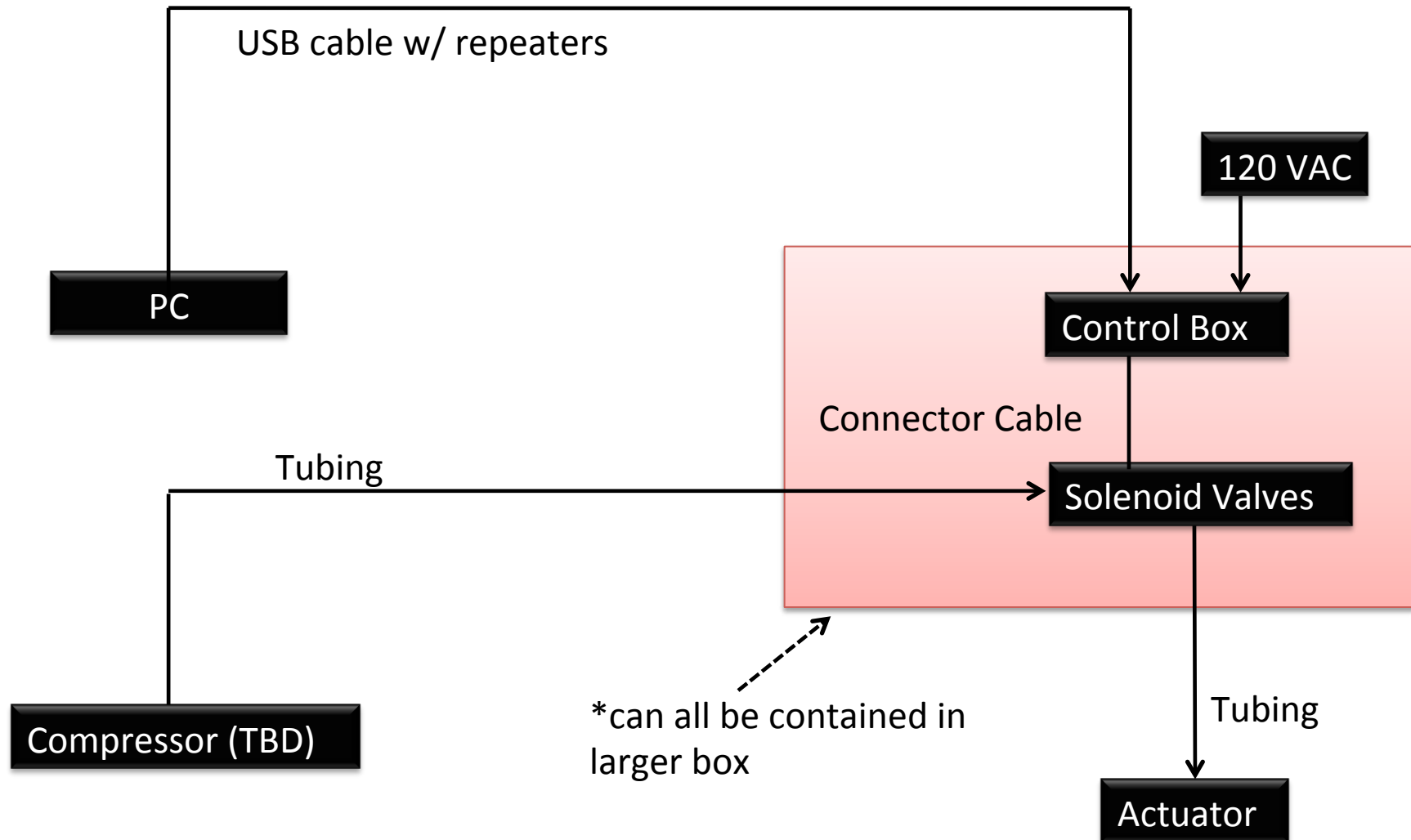
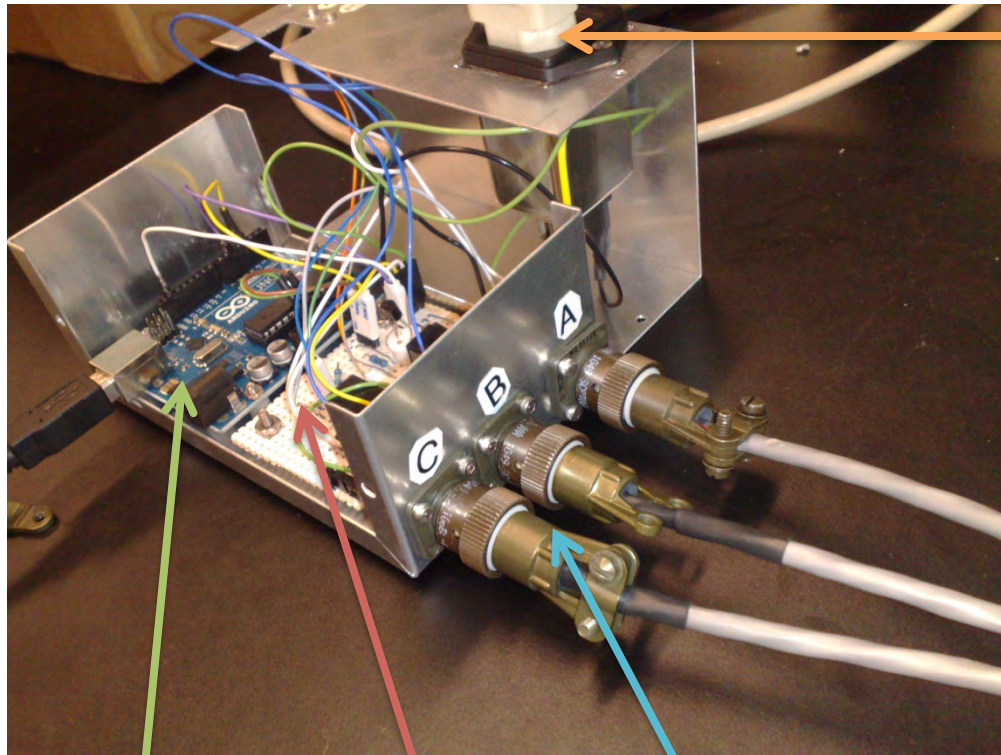


# Parts Layout



# Control Box: Overview

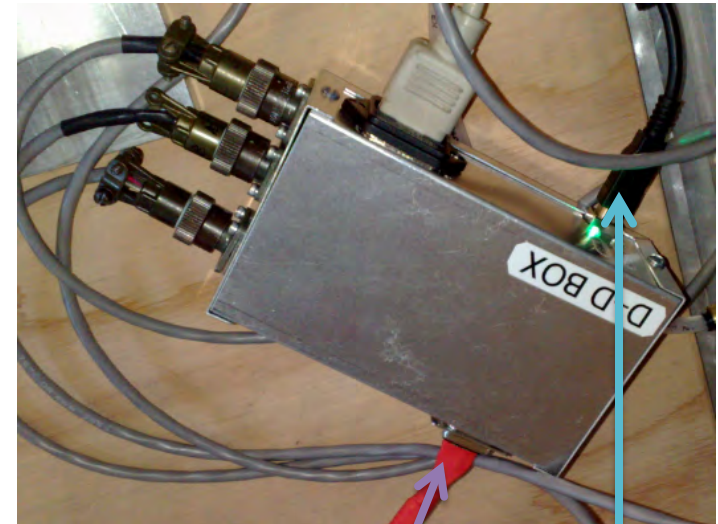


AC power connector

Arduino microcontroller

Stripboard

(3) 4 pin connector ports



USB Port

9 Pin TMC connector port

# Control Box Components

- (1) Arduino Uno Microcontroller
  - <http://www.makershed.com/ProductDetails.asp?ProductCode=MKSP4&CartID=1>
- (3) Relays (OJE-SH-105DM)
  - <http://www.radioshack.com/product/index.jsp?productId=2062480>
- (3) Three Way Solenoid Valves
  - McMaster # 8111K331
- (3) 2N2222 Transistor
- (2) LED one green one blue
- (3) 1N4004 Diode
- Resistors: (3) 100 (2) 500 (2) 10K (4) 1K
- (2) 10nF capacitor
- (2) mechanical switches



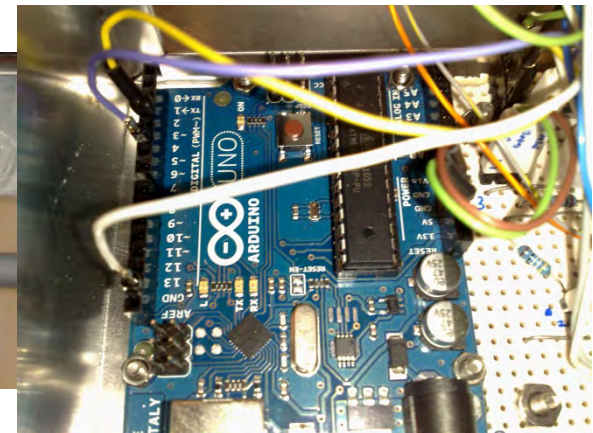
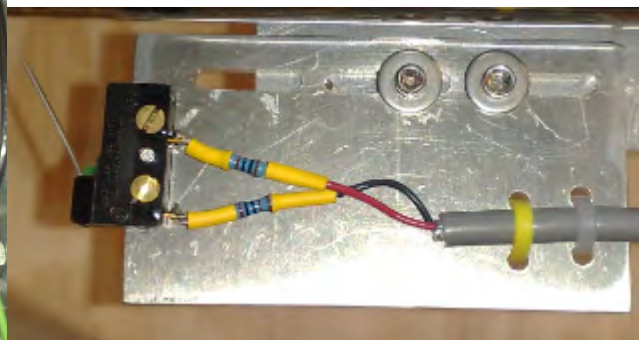
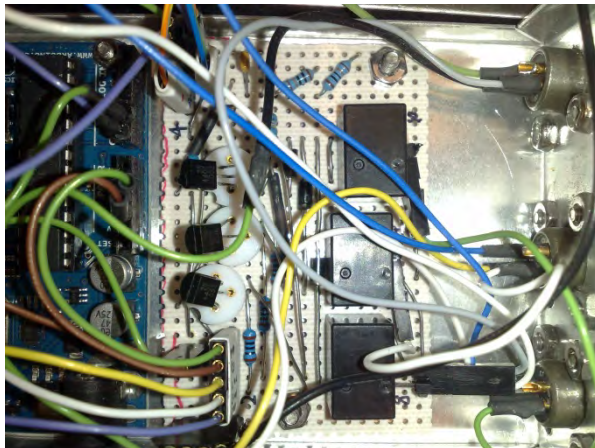
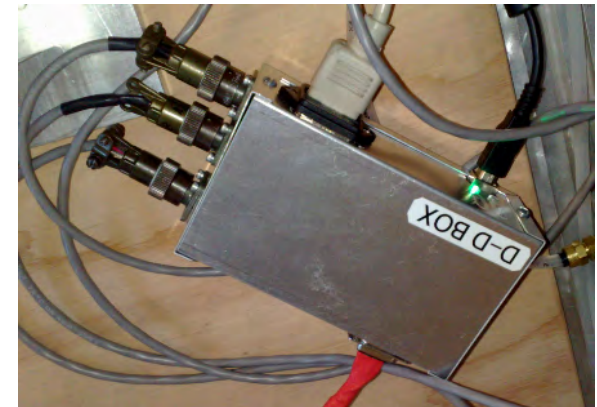
## Relay

Nominal Coil Voltage: 5VDC

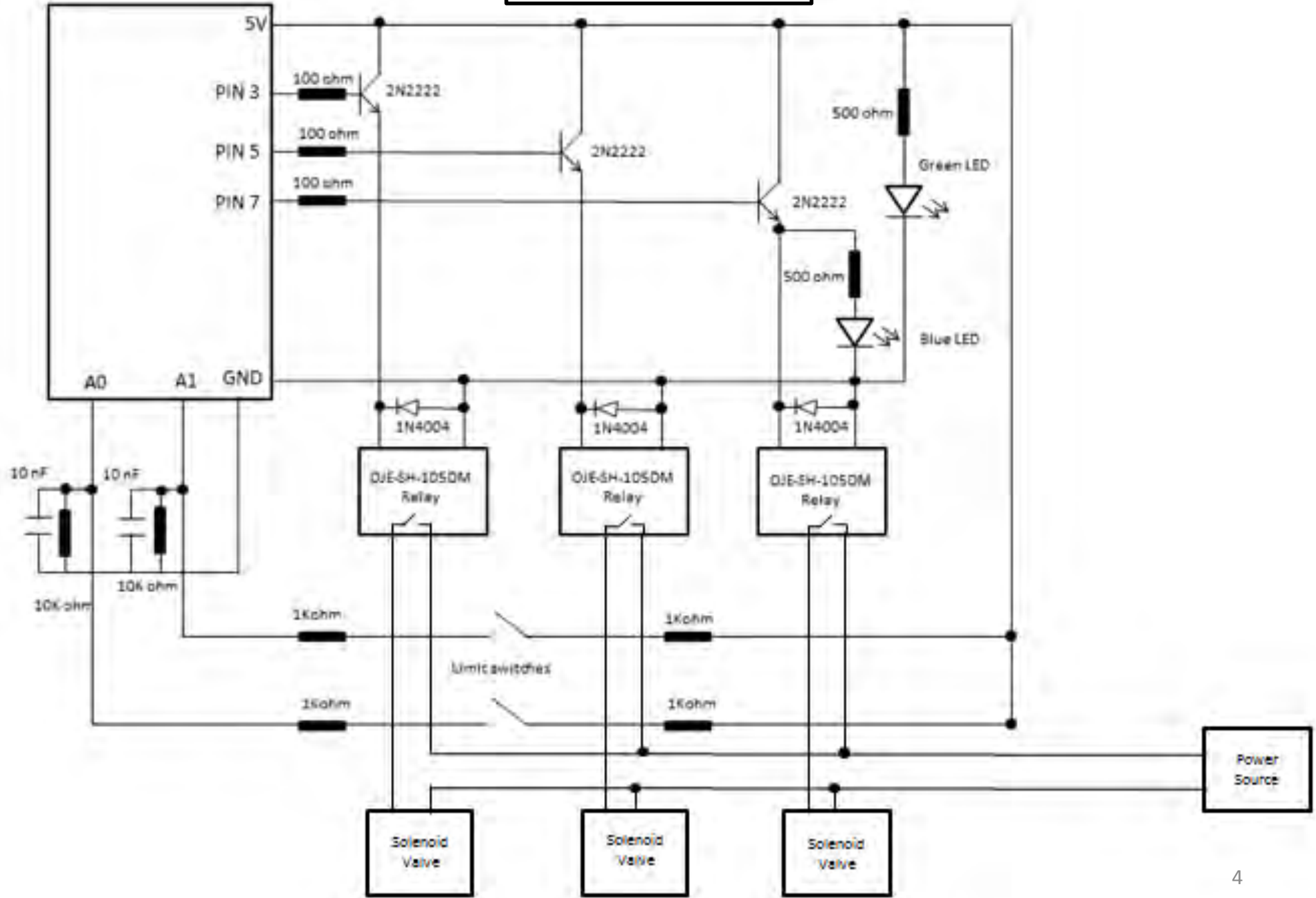
Nominal Coil Current: 89.3 mA

Coil Resistance: 56 ohms

Rated 1A at 120 VAC

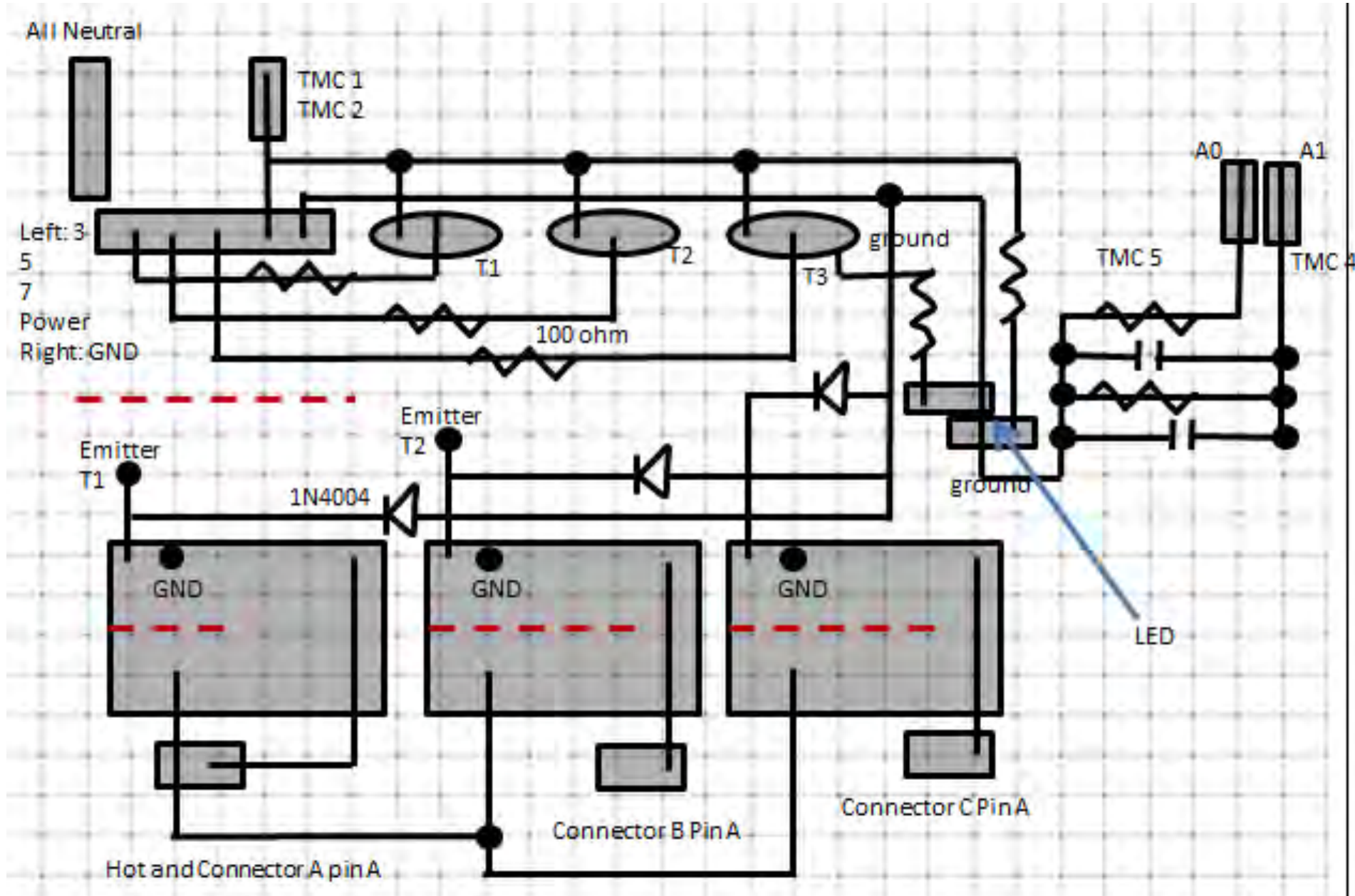


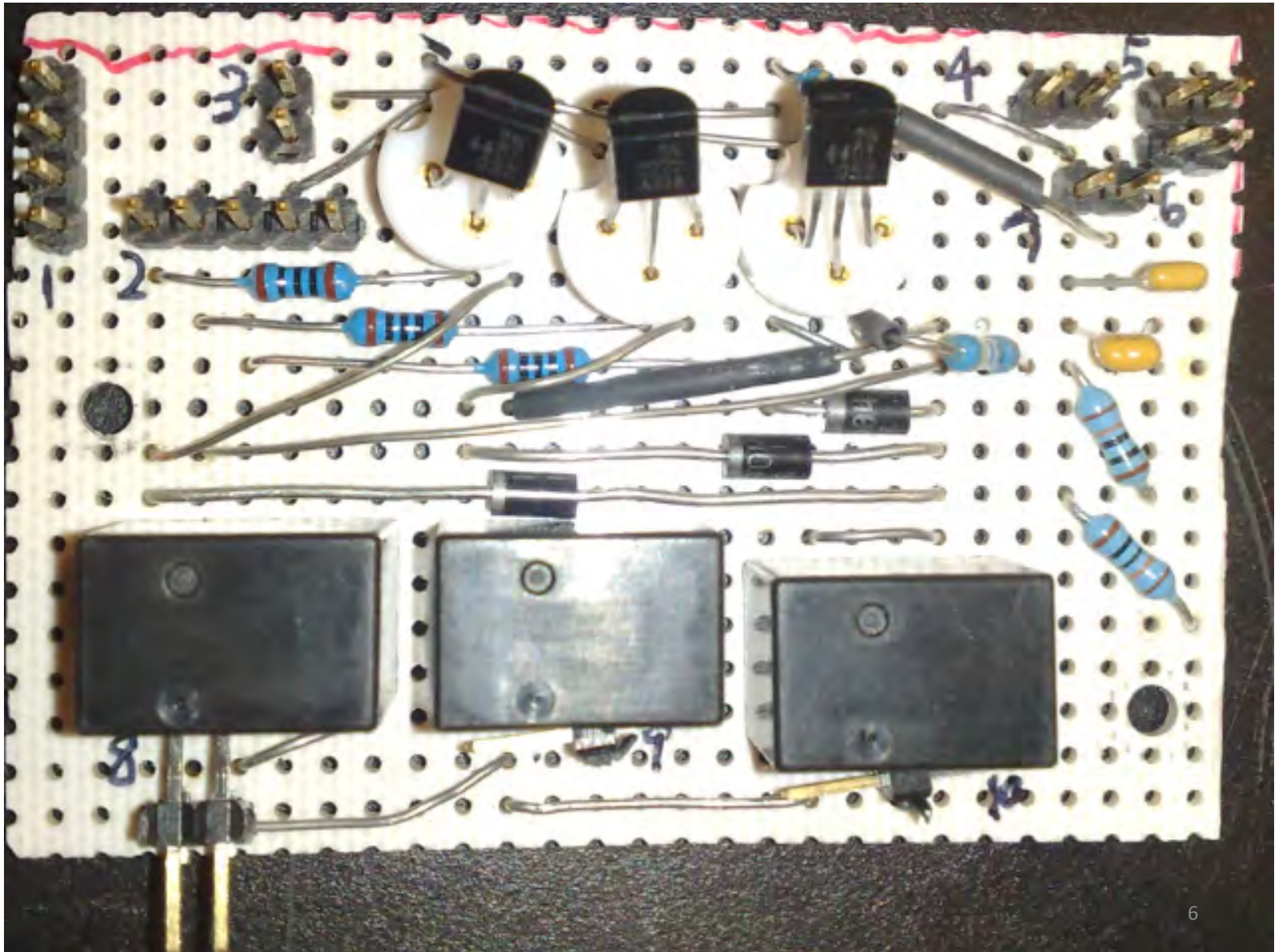
# Circuit Diagram





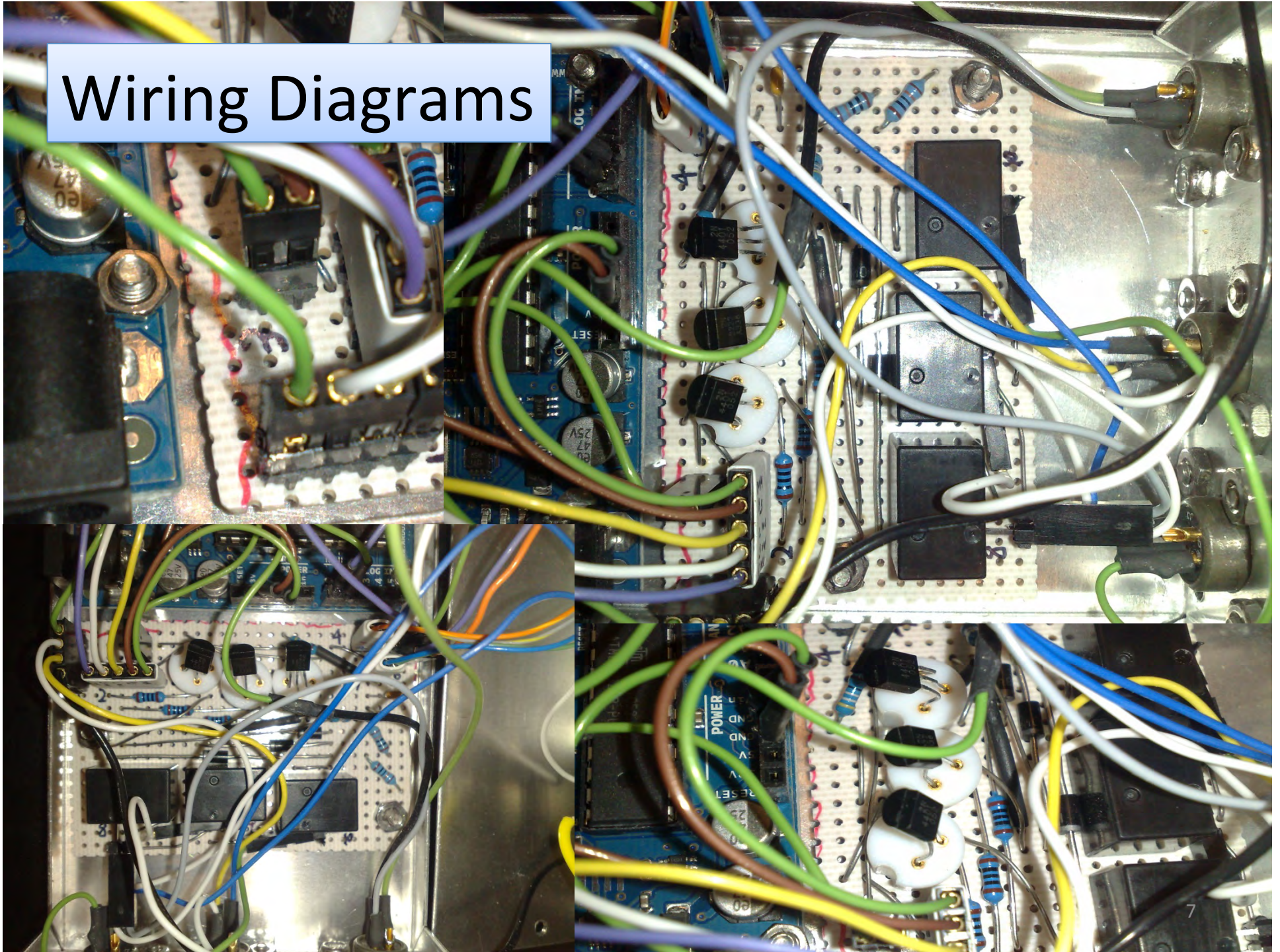
# Stripboard Layout



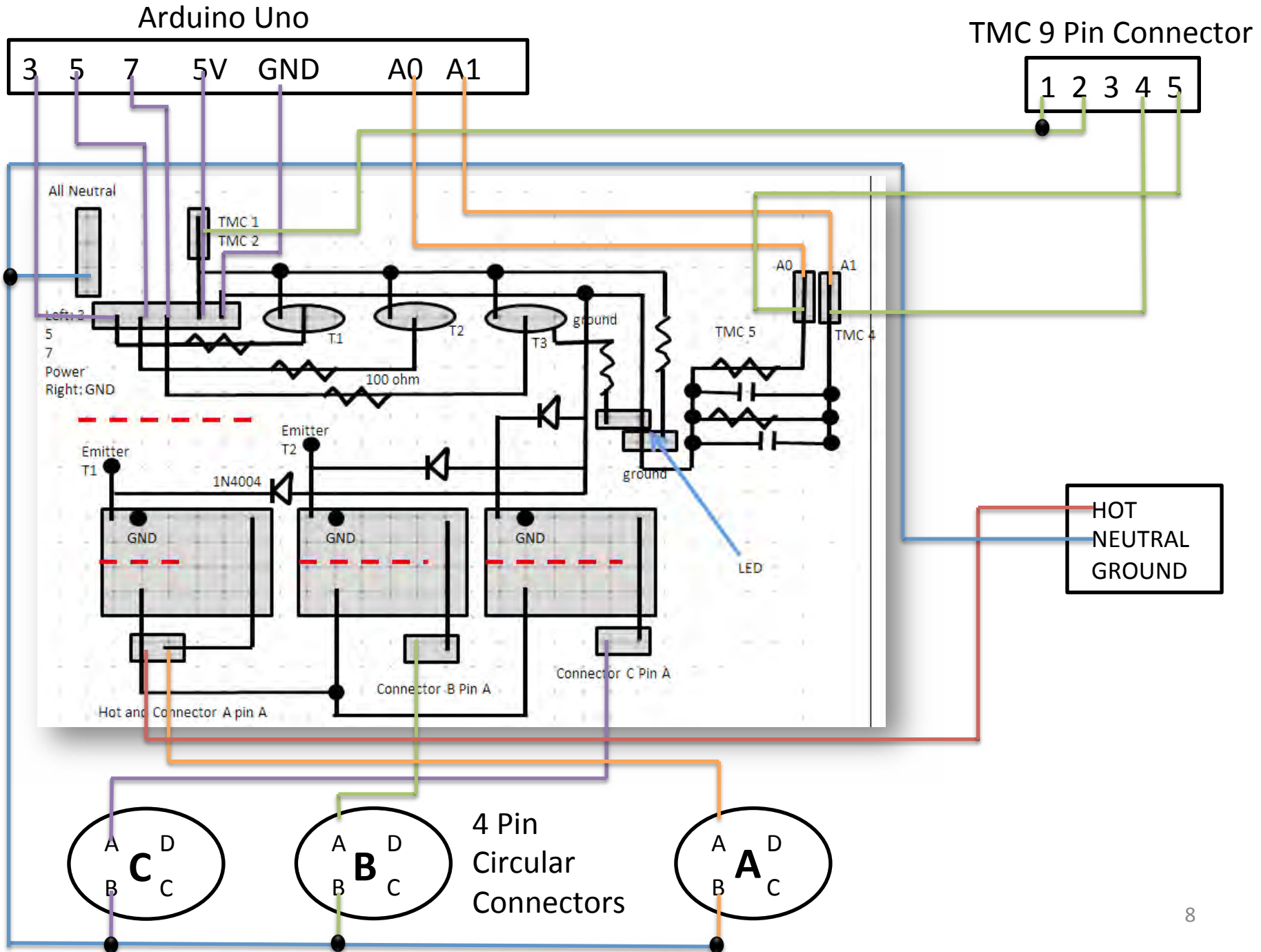




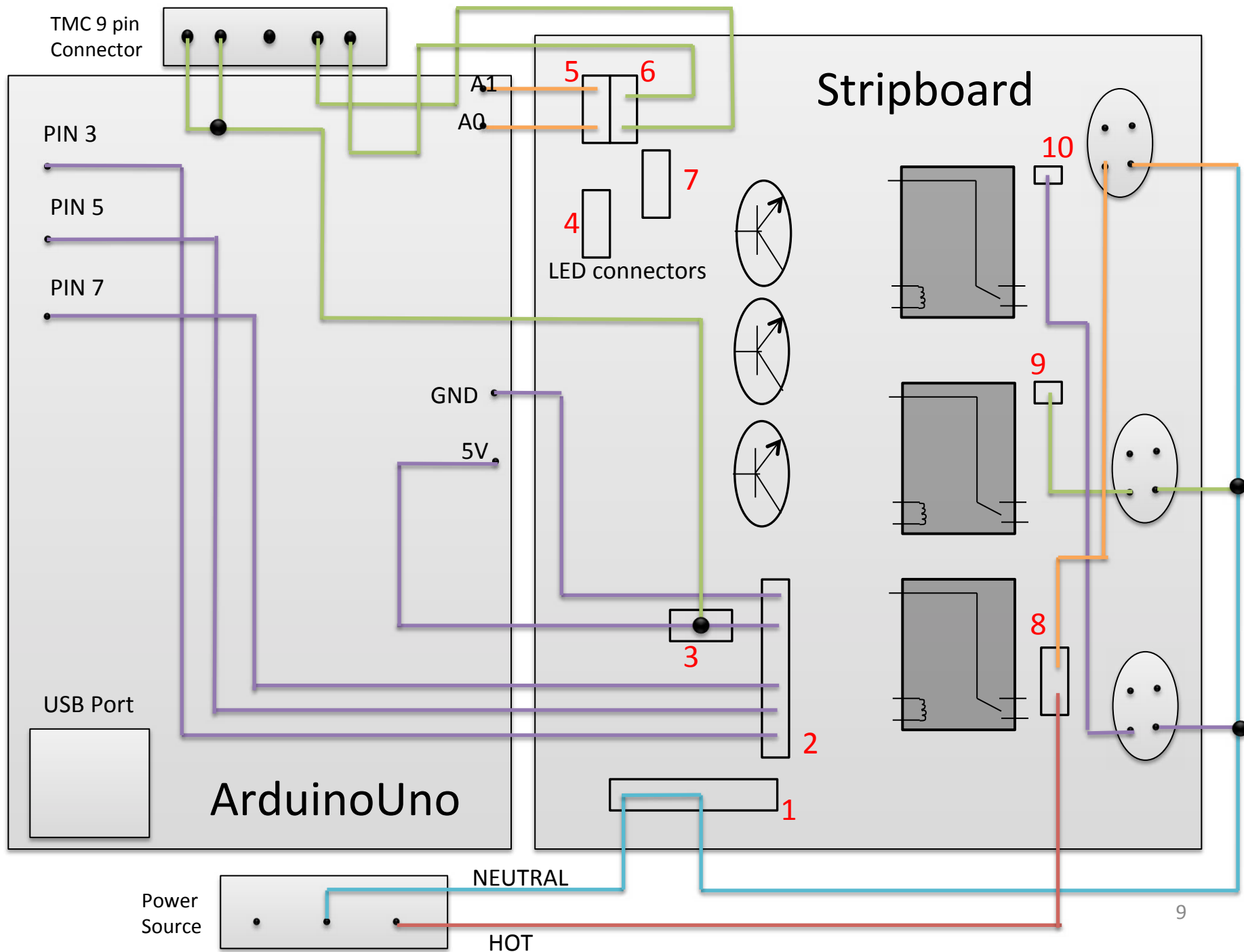
# Wiring Diagrams





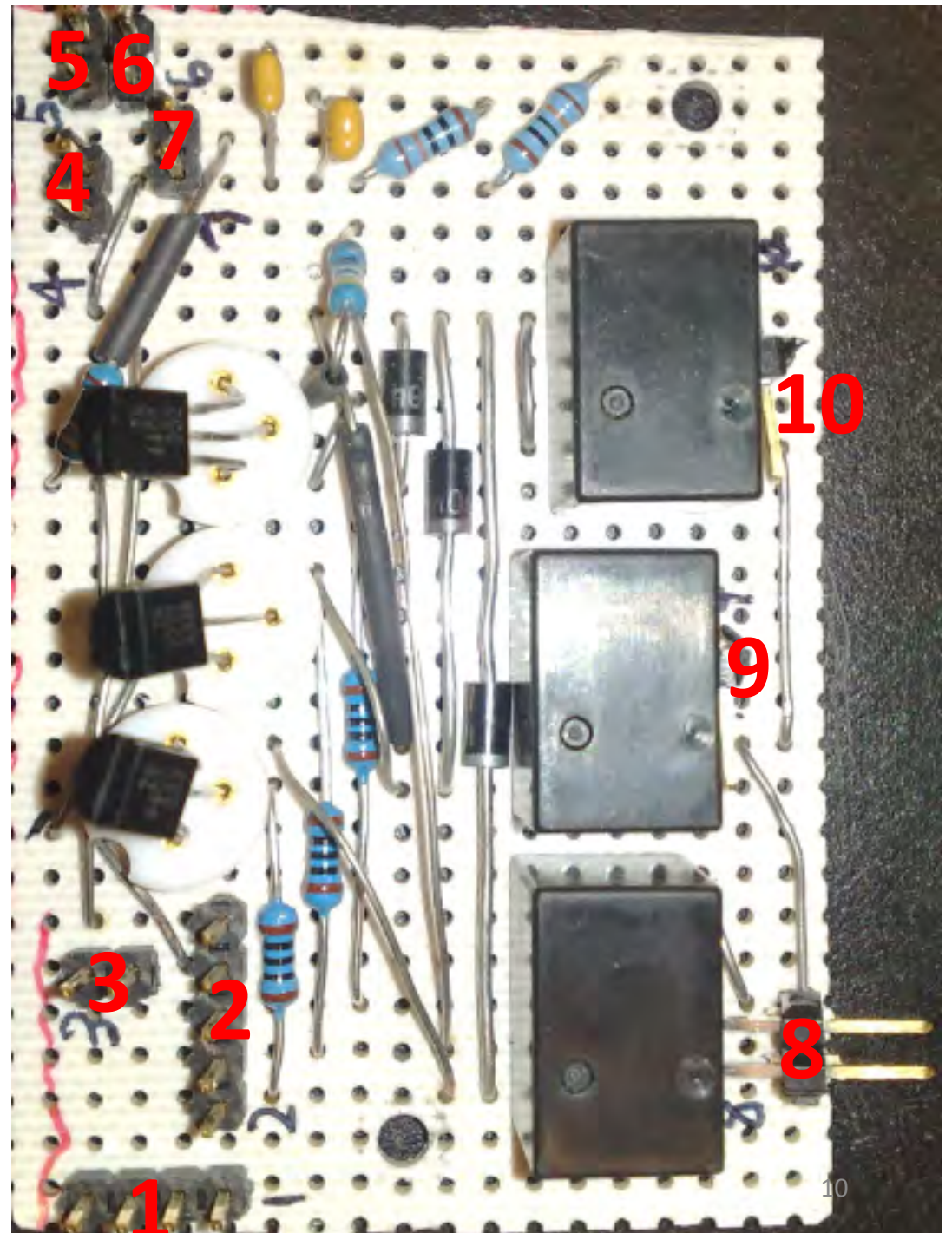






### ***Wiring Connectors:***

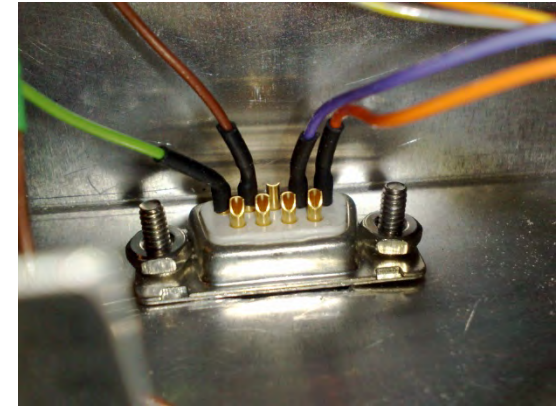
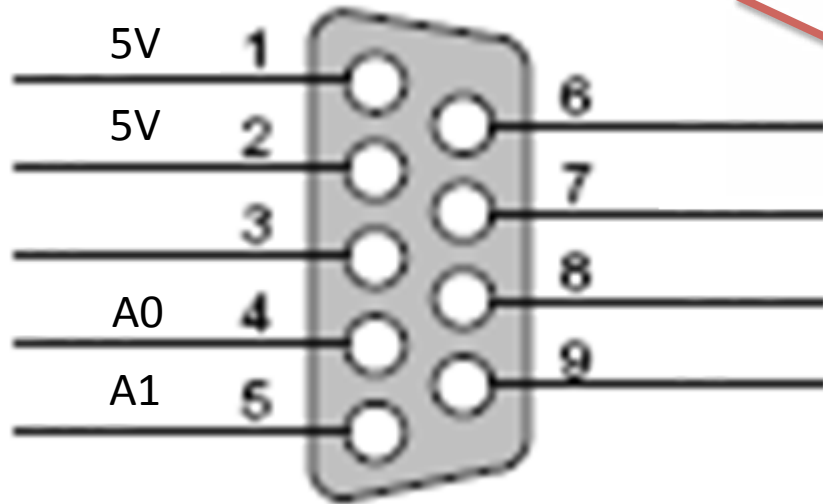
- 1) All neutral wires
- 2) Left to Right: Pin 3, 5, 7, 5V, GND
- 3) TMC 9 Pins 1 and 2
- 4) LED
- 5) Top: A1 Bottom: A0
- 6) Top: TMC pin 5 Bottom: TMC pin 6
- 7) LED
- 8) Top: Circular Connector A pin A Bottom: Hot wire
- 9) Circular Connector B pin A
- 10) Circular Connector C pin A





# Connectors

## 9 Pin TMC Connector

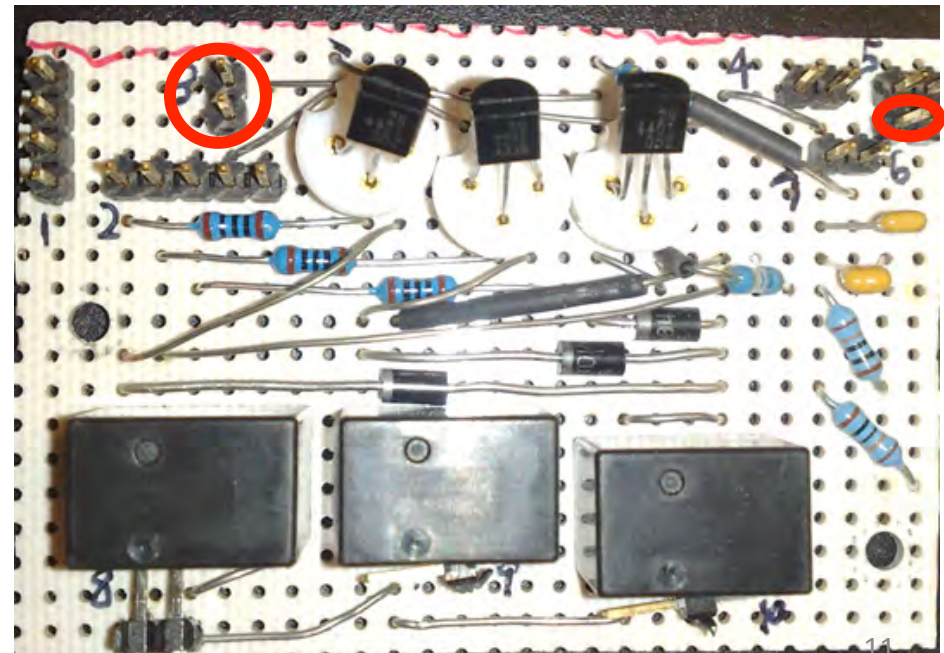
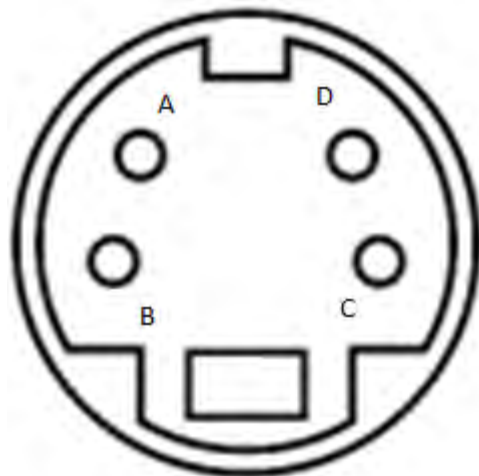


Pins 1 and 2 into connector 3  
Pin 4 and 5 into connector 6  
• (4 top 5 bottom)

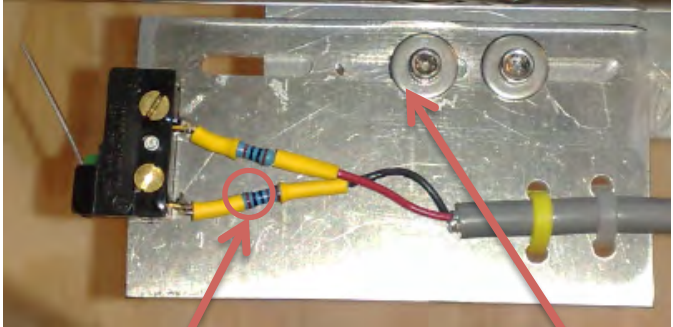
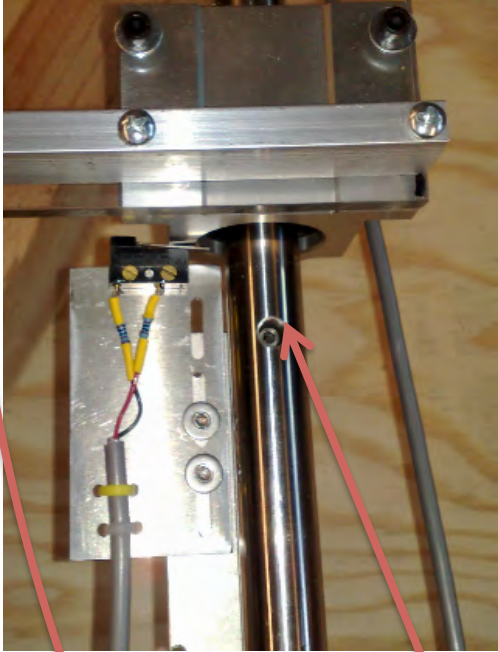
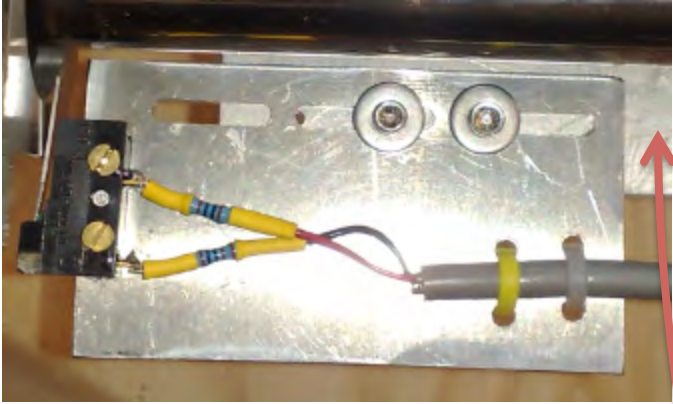


## 4 Pin Circular Connector

- A) Hot
- B) Neutral
- C) Ground
- D) Unused

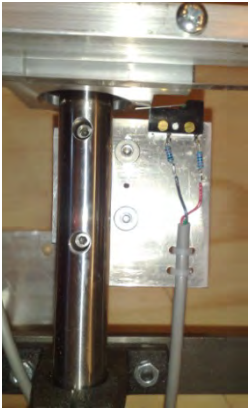
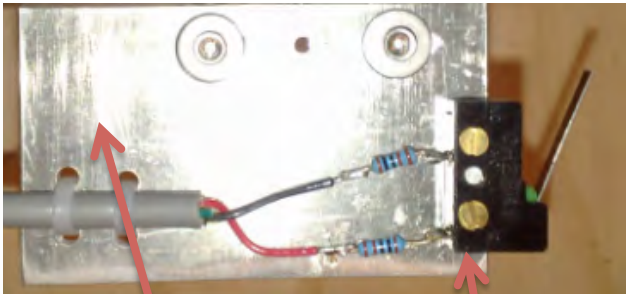


# Limit Switches



1K ohm resistors

Adjustable



Parts Layout



Shaft

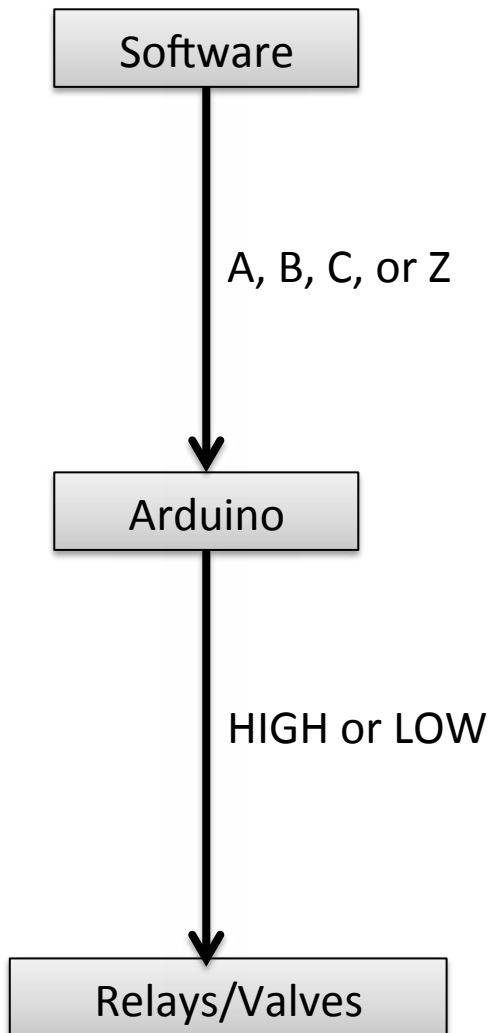
Switch

Adjustable Plate

Adapter Plate



# Actuator Control Overview



- Input: Arduino accepts characters A, B, C, or Z
- A, B, and C control relay and valve states (more information in “Solenoid Valves” page)
- Z returns the state of the limit switches (“Extended”, “Intermediate”, or “Retracted”)

```
if(state.equals("Z")){  
  //prints out all details about limit switches and state  
  if(switchA && switchB){  
    Serial.println("Error: both switches closed");  
  }  
  if(!switchA && !switchB){  
    Serial.println("Intermediate");  
  }  
  if(switchA && !switchB){  
    Serial.println("Extended");  
  }  
  if(switchB && !switchA){  
    Serial.println("Retracted");  
  }  
}
```

```
if(state.equals("A")) //extend  
{  
  Serial.println("A is the state");  
  digitalWrite(RelayA, HIGH);  
  digitalWrite(RelayB, HIGH);  
  digitalWrite(RelayC, HIGH);  
}  
if(state.equals("B")) //retract  
{  
  Serial.println("B is the state");  
  digitalWrite(RelayA, LOW);  
  digitalWrite(RelayB, LOW);  
  digitalWrite(RelayC, LOW);  
}  
if(state.equals("C")) //exhaust air  
{  
  Serial.println("C is the state");  
  digitalWrite(RelayA, HIGH);  
  digitalWrite(RelayB, HIGH);  
  digitalWrite(RelayC, LOW);  
}
```

# Control Box Arduino Firmware

```
/*
  David Liu and David Kooi
  July 2011
*/
#define RelayA 3
#define RelayB 5
#define RelayC 7

boolean switchA;
boolean switchB;

void setup()
{
  pinMode(RelayA, OUTPUT);
  pinMode(RelayB, OUTPUT);
  pinMode(RelayC, OUTPUT);
  Serial.begin(9600); // open serial
  Serial.println("Arduino Plugged In");
}
void loop()
{
  String state="";
  switchB=false;
  switchA=false;
  while (Serial.available() > 0)
  {
    char x=Serial.read();
    state+=x;
  }

  if(analogRead(A0)>1000){
    switchA=true;
  }
  if(analogRead(A1)>1000){
    switchB=true;
  }
}
```

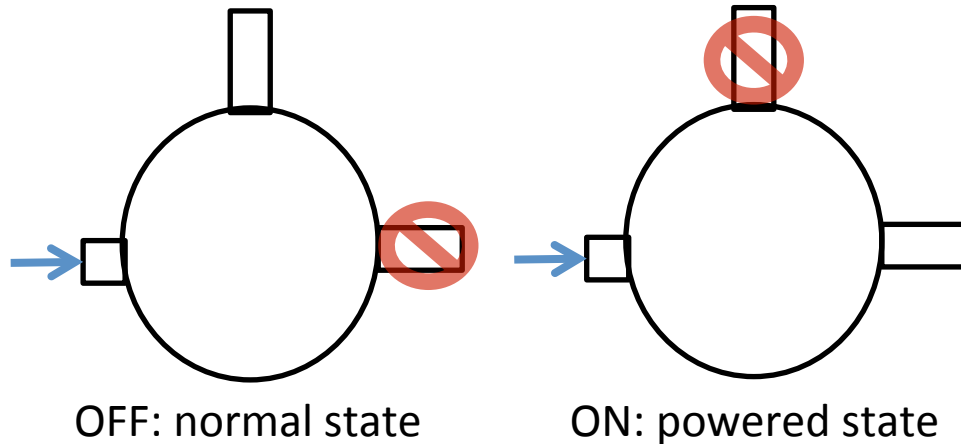
```
if(state.equals("Z")){
//prints out all details about limit switches and state
  if(switchA && switchB){
    Serial.println("Error: both switches closed");
  }
  if(!switchA && !switchB){
    Serial.println("Intermediate");
  }
  if(switchA && !switchB){
    Serial.println("Extended");
  }
  if(switchB && !switchA){
    Serial.println("Retracted");
  }
}
if(state.equals("A")) //extend
{
  Serial.println("A is the state");
  digitalWrite(RelayA, HIGH);
  digitalWrite(RelayB, HIGH);
  digitalWrite(RelayC, HIGH);
}
if(state.equals("B")) //retract
{
  Serial.println("B is the state");
  digitalWrite(RelayA, LOW);
  digitalWrite(RelayB, LOW);
  digitalWrite(RelayC, LOW);
}
if(state.equals("C")) //exhaust air
{
  Serial.println("C is the state");
  digitalWrite(RelayA, HIGH);
  digitalWrite(RelayB, HIGH);
  digitalWrite(RelayC, LOW);
}
}
```

- Main body of code contained in loop
- If statements check for if input matches one of the states ("A" "B" "C" or "Z")



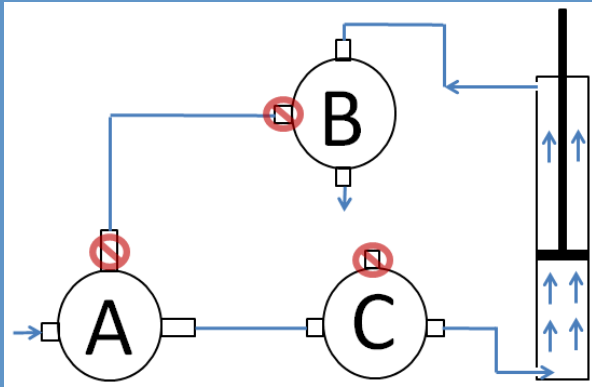
# Solenoid Valves

- Three way solenoid valves
- 1/8 NPT female ports
- Solenoid Valves:  
McMaster #8111K331
- Mounted in a row  
– (C-A-B)

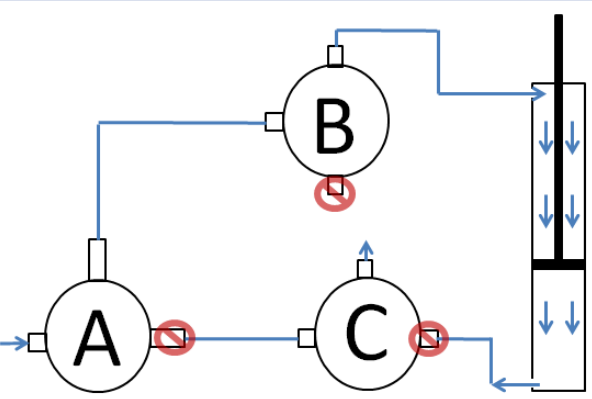


Pipe Size	Max. psi	Cv Factor	Lg.	Ht.	Amps @		Temp. Range	w/Buna-N Seals	
					120 VAC	24 VAC		Each	
<b>With Side Port</b>									
<b>Closed Until Electrically Energized (Normally Closed)</b>									
1/8"	40	0.21	1 3/16"	2 7/8"	0.13	0.67	+32° to +180° F	8111K31	\$93.66
1/8"	200	0.06	1 3/16"	2 7/8"	0.13	0.67	+32° to +180° F	8111K33	96.78
1/4"	125	0.09	1 9/16"	3 5/16"	0.13	0.67	+32° to +180° F	8111K35	107.15

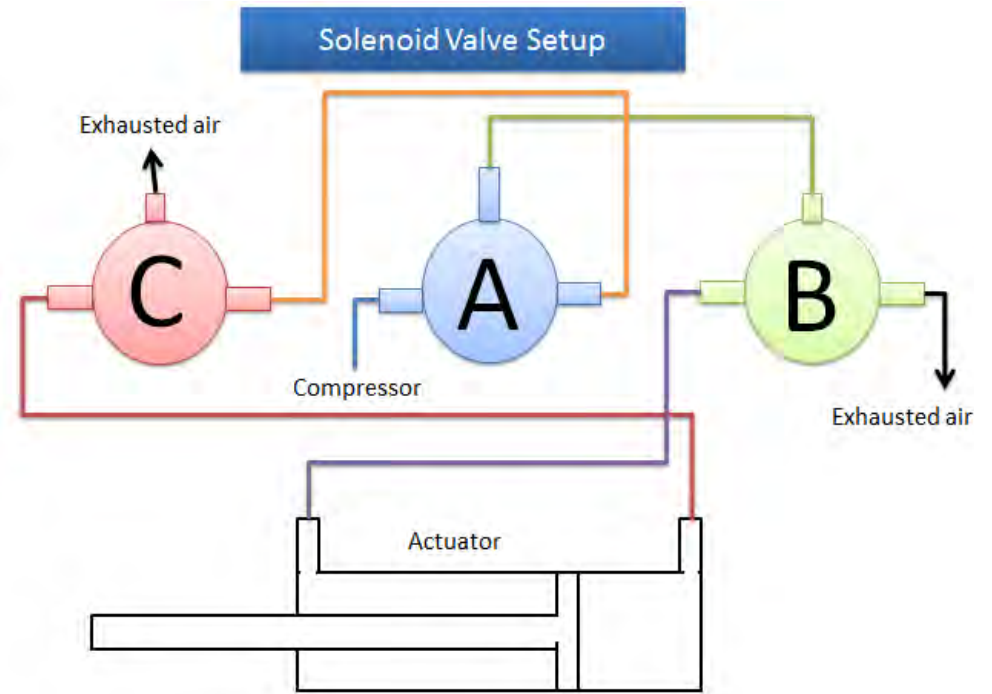
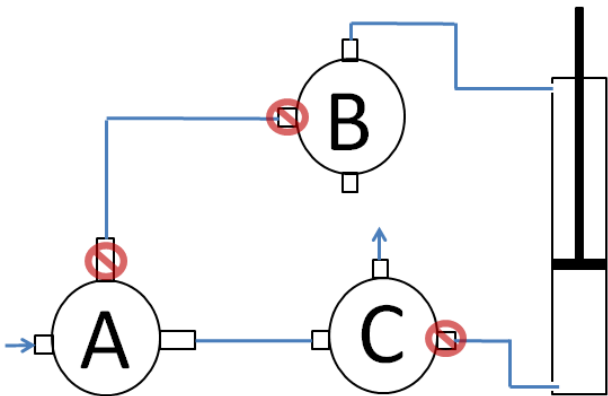
### A) Extend



### B) Retract



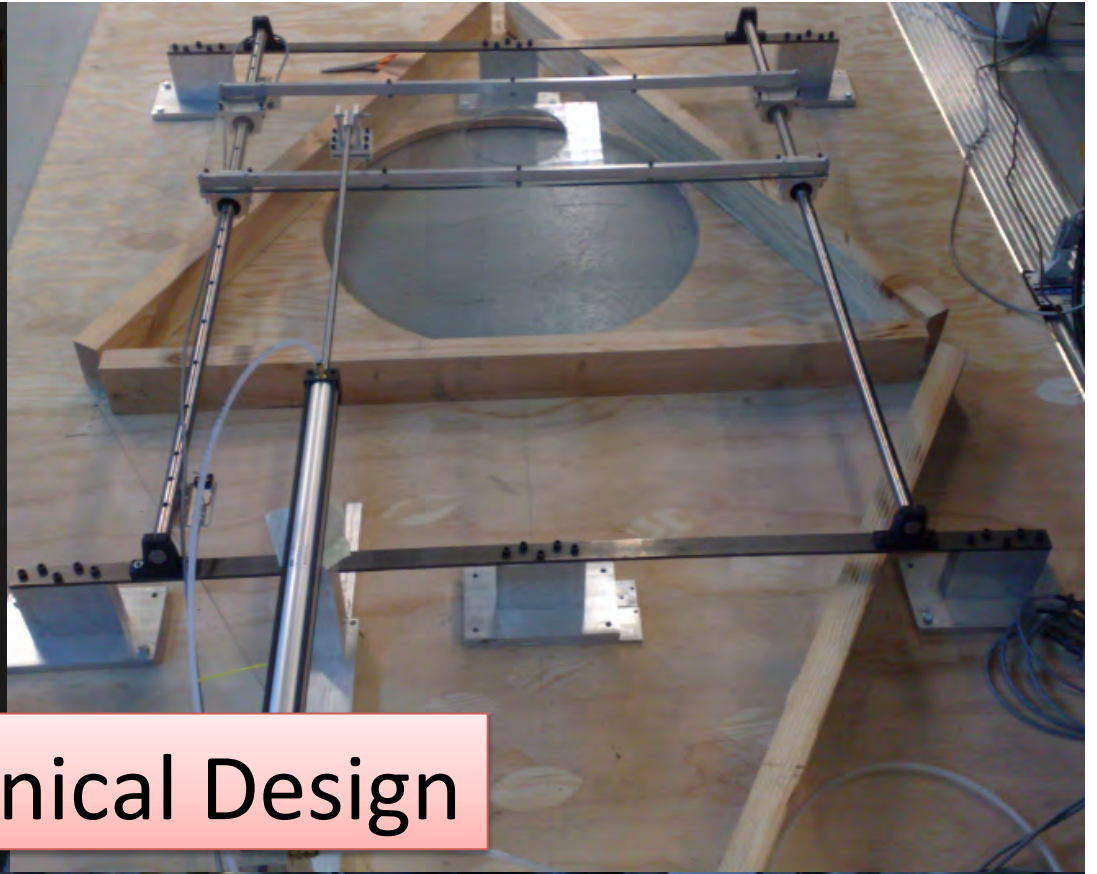
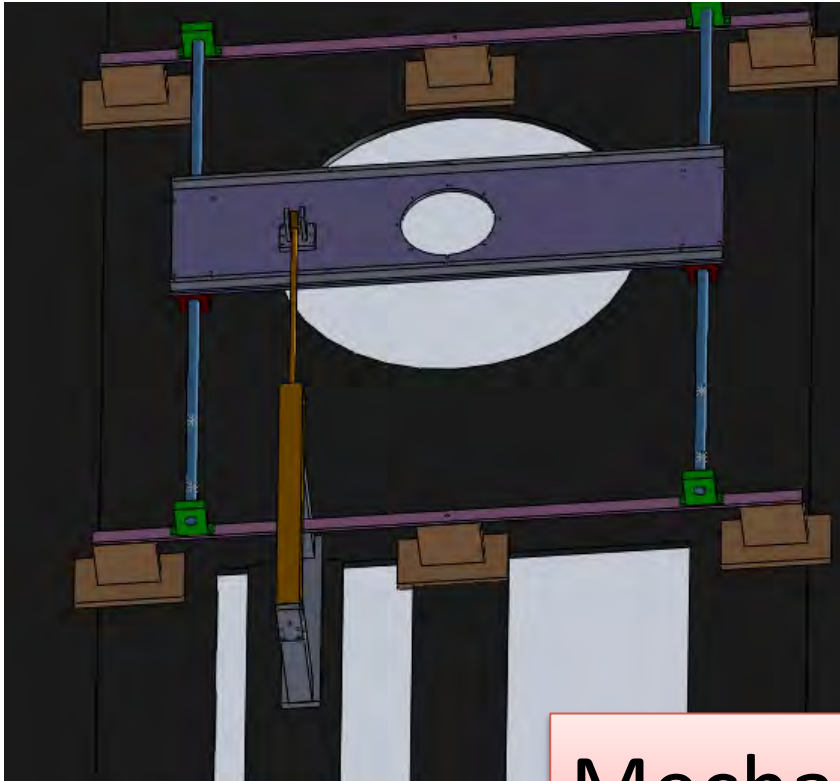
### C) Exhaust



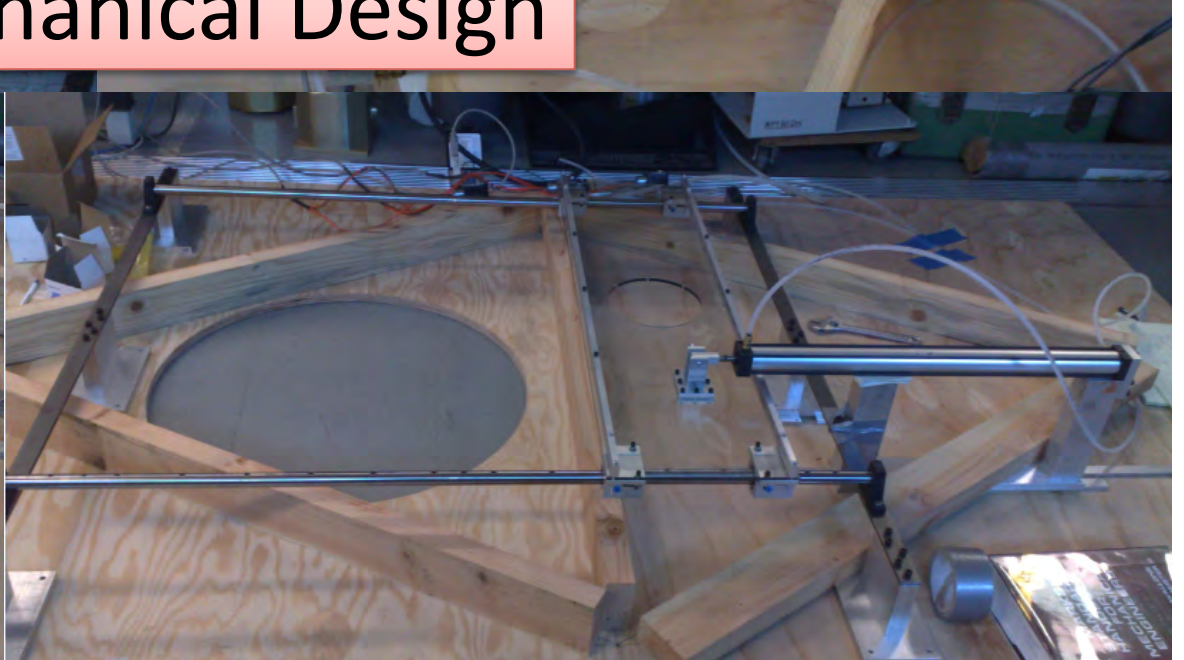
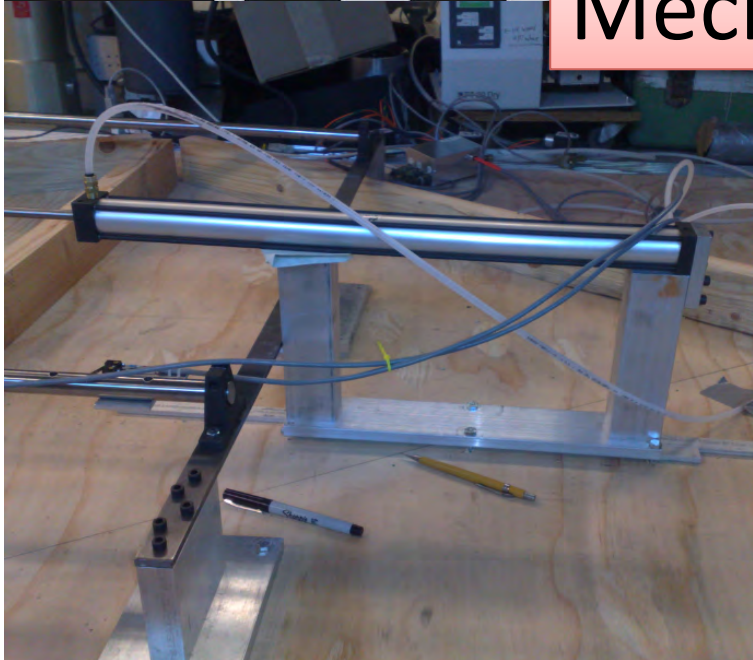
	Valve A	Valve B	Valve C
A) Extend	ON	ON	ON
B) Retract	OFF	OFF	OFF
C) Exhaust	ON	ON	OFF

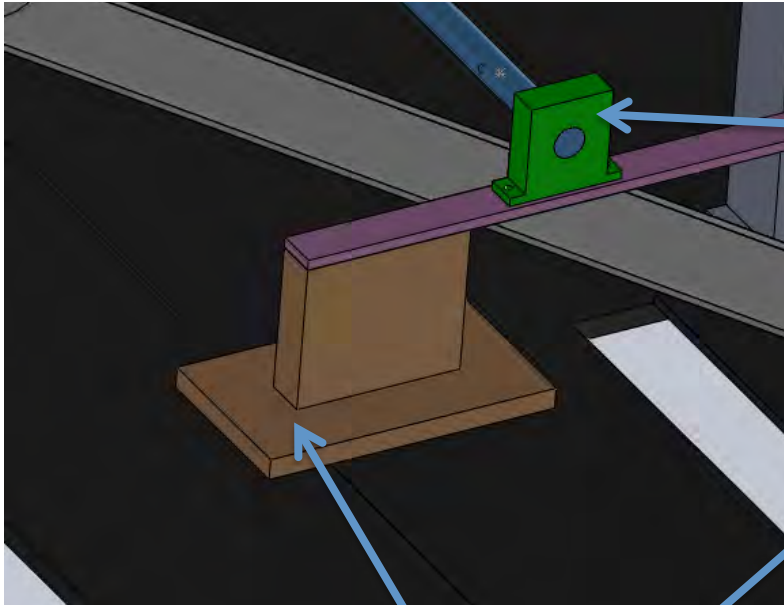
\*More information on valve states on previous page ("Actuator Control")



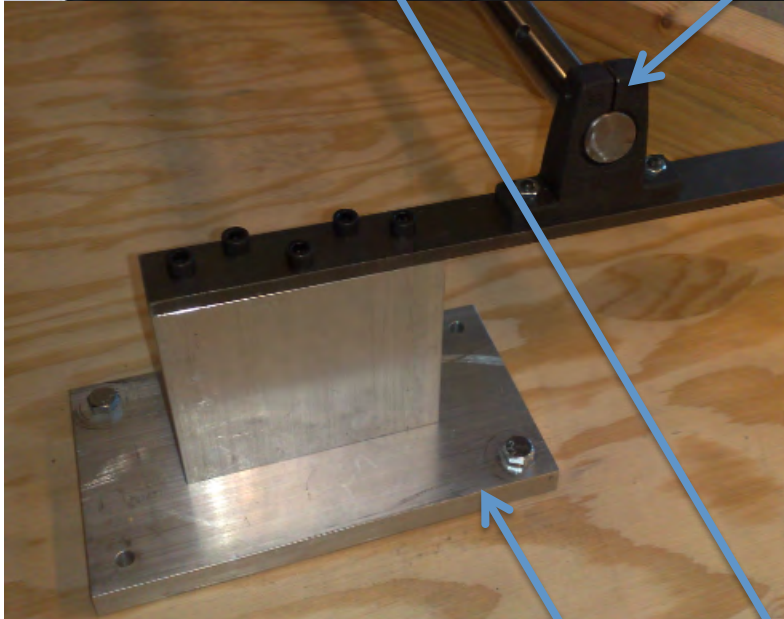
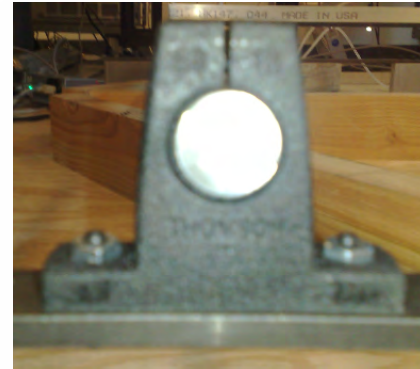


# Mechanical Design

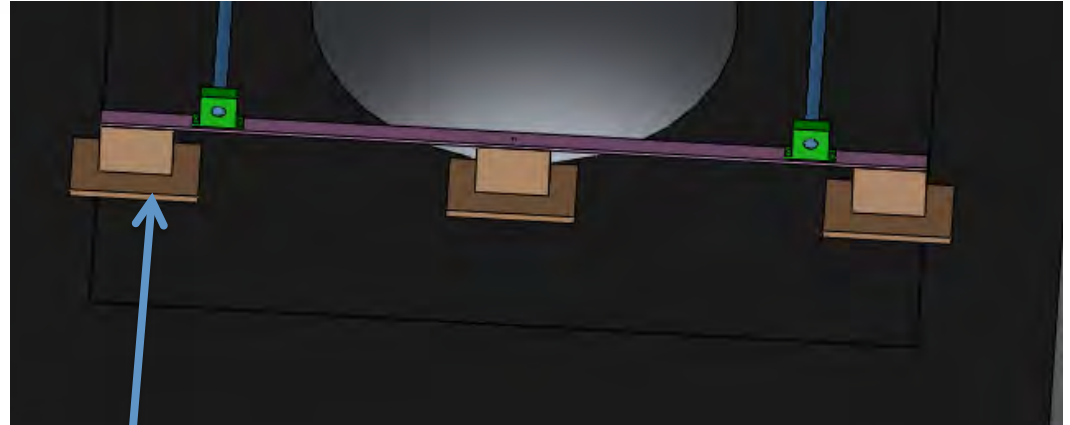




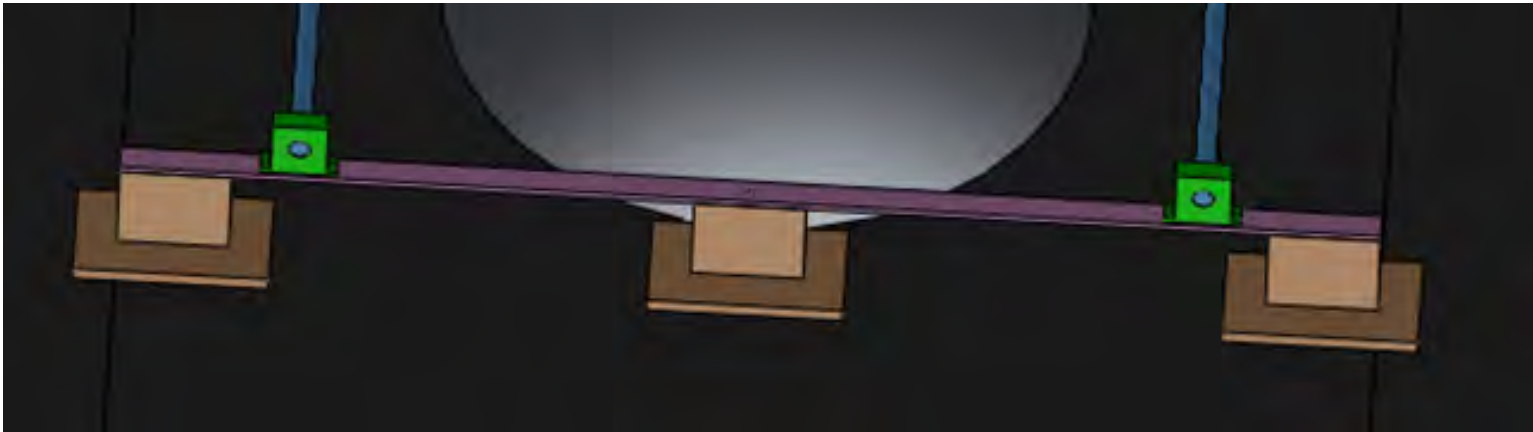
End Support Blocks  
#6068K25



Aluminum Mounting Blocks  
¼ inch holes for mounting

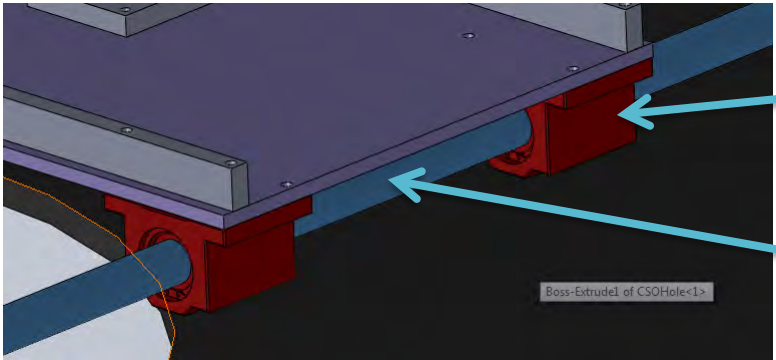






10 - 32 x  $\frac{3}{4}$  screws with nuts

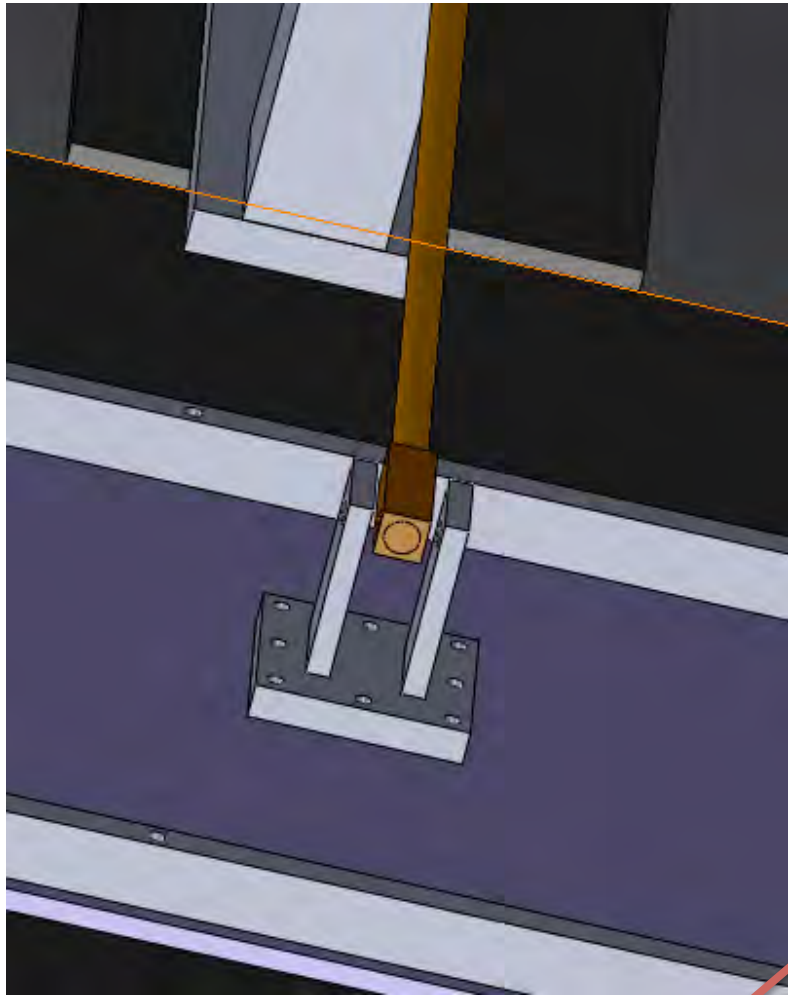
$\frac{1}{4}$  - 20 x  $\frac{3}{4}$  screws



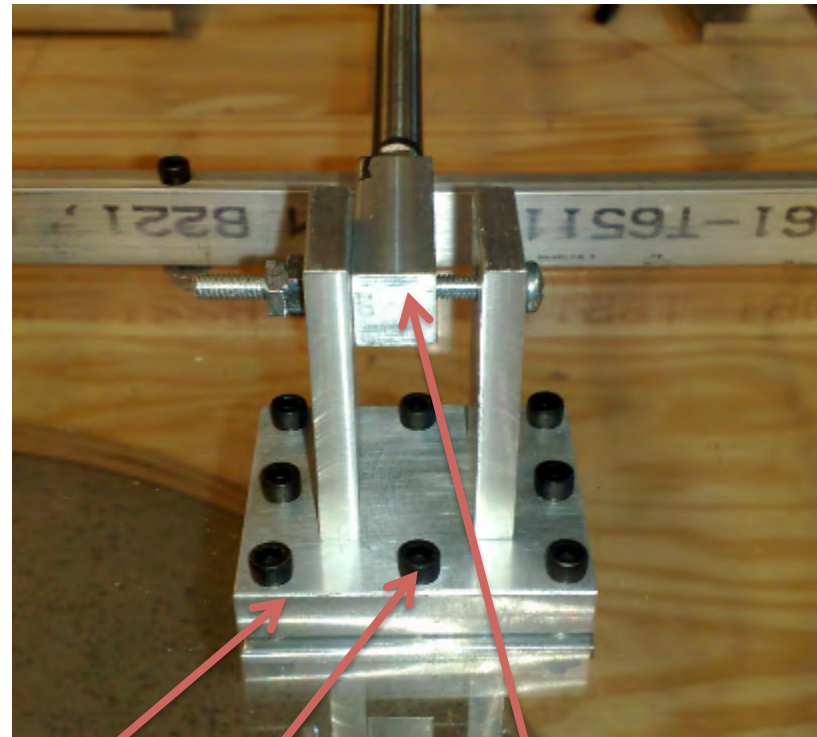
Closed Bearings #9338T3

$\frac{3}{4}$  diameter x 44 inch Shafts #6499K74



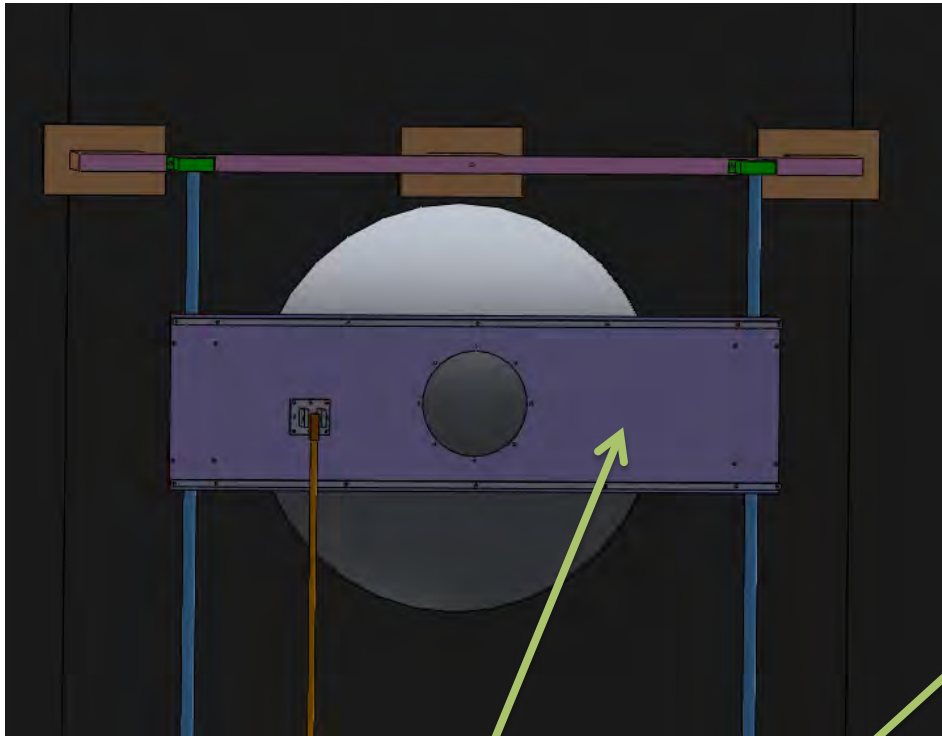


Actuator attached to plate with clevis and pin

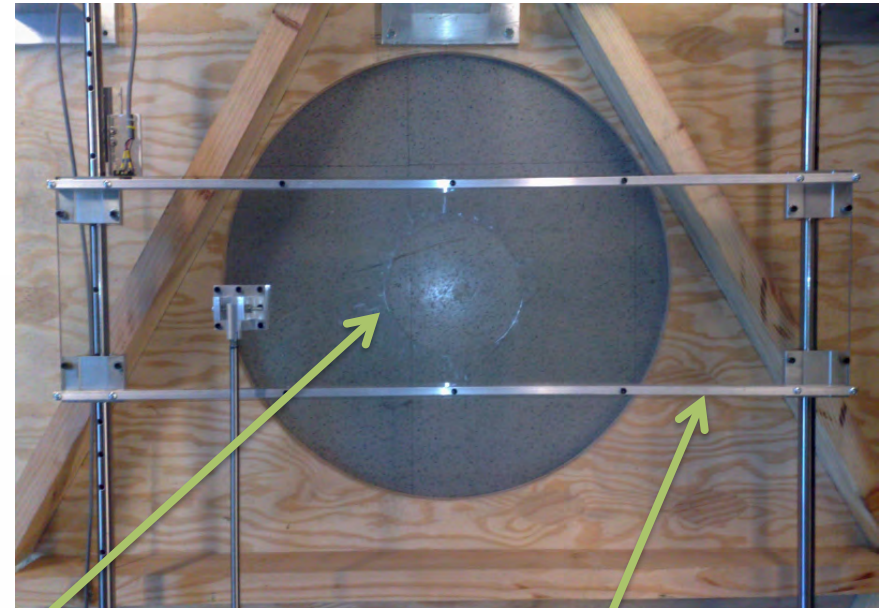


8 – 32 x ¾ screws with nuts

Aluminum piece for actuator to attach to clevis

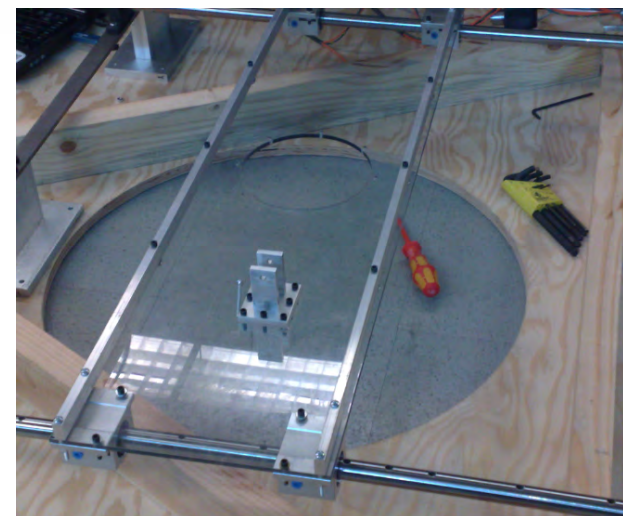


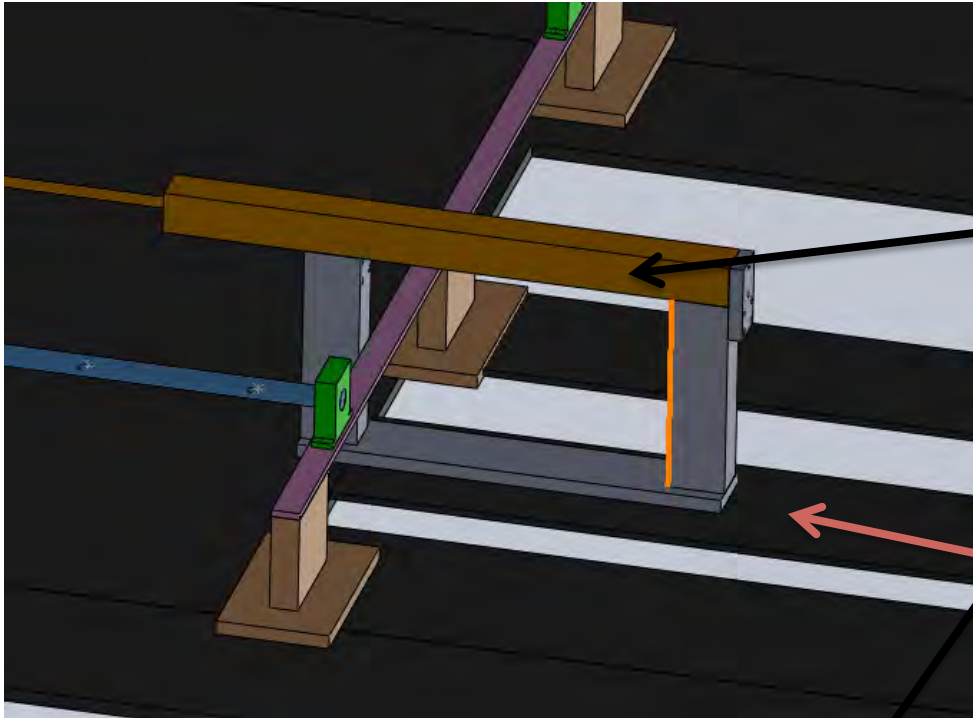
Lexan plate:  
¼ x 24 x 48 inch sheet



Aluminum support bars  
Fasteners are all #8 screws

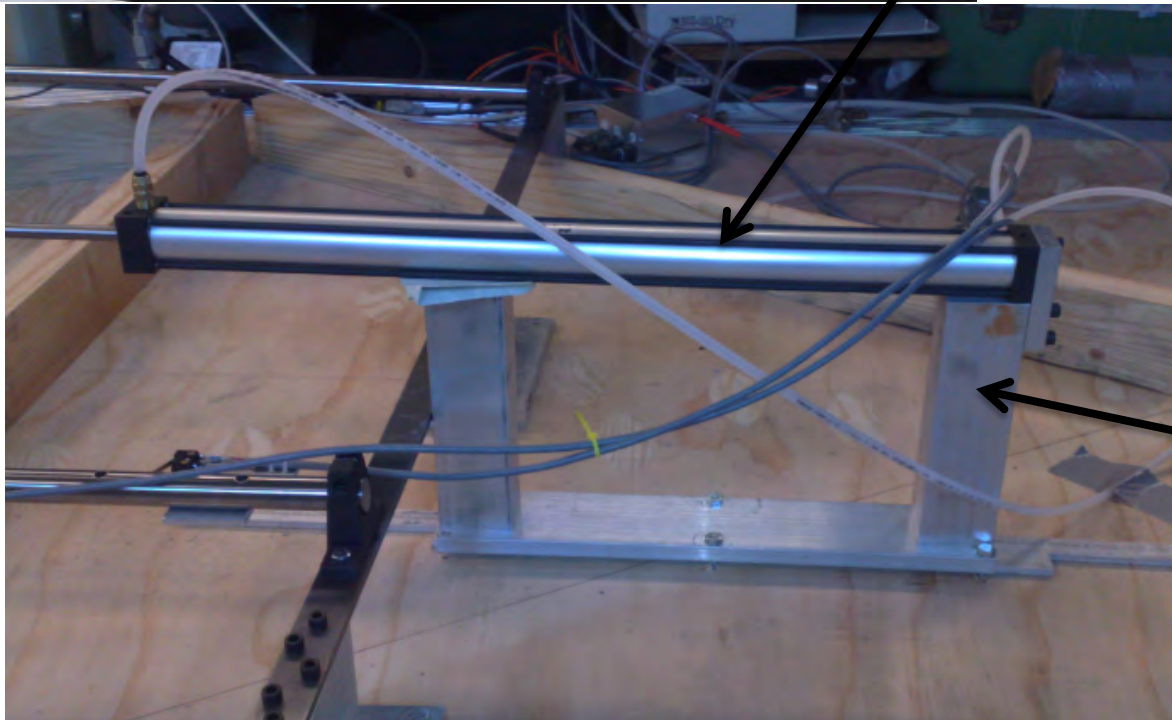
[http://www.eplastics.com/Plastic/Lexan Clear Polycarbonate Sheet/LEXAN-CLR-0-250AM24X48](http://www.eplastics.com/Plastic/Lexan%20Clear%20Polycarbonate%20Sheet/LEXAN-CLR-0-250AM24X48)





Pneumatic Actuator  
#6453K43  
20 inch stroke length  
1 and 1/8 inch bore size

Additional welded steel plate needed  
to cover rectangular hole



Aluminum  
Actuator Mount