

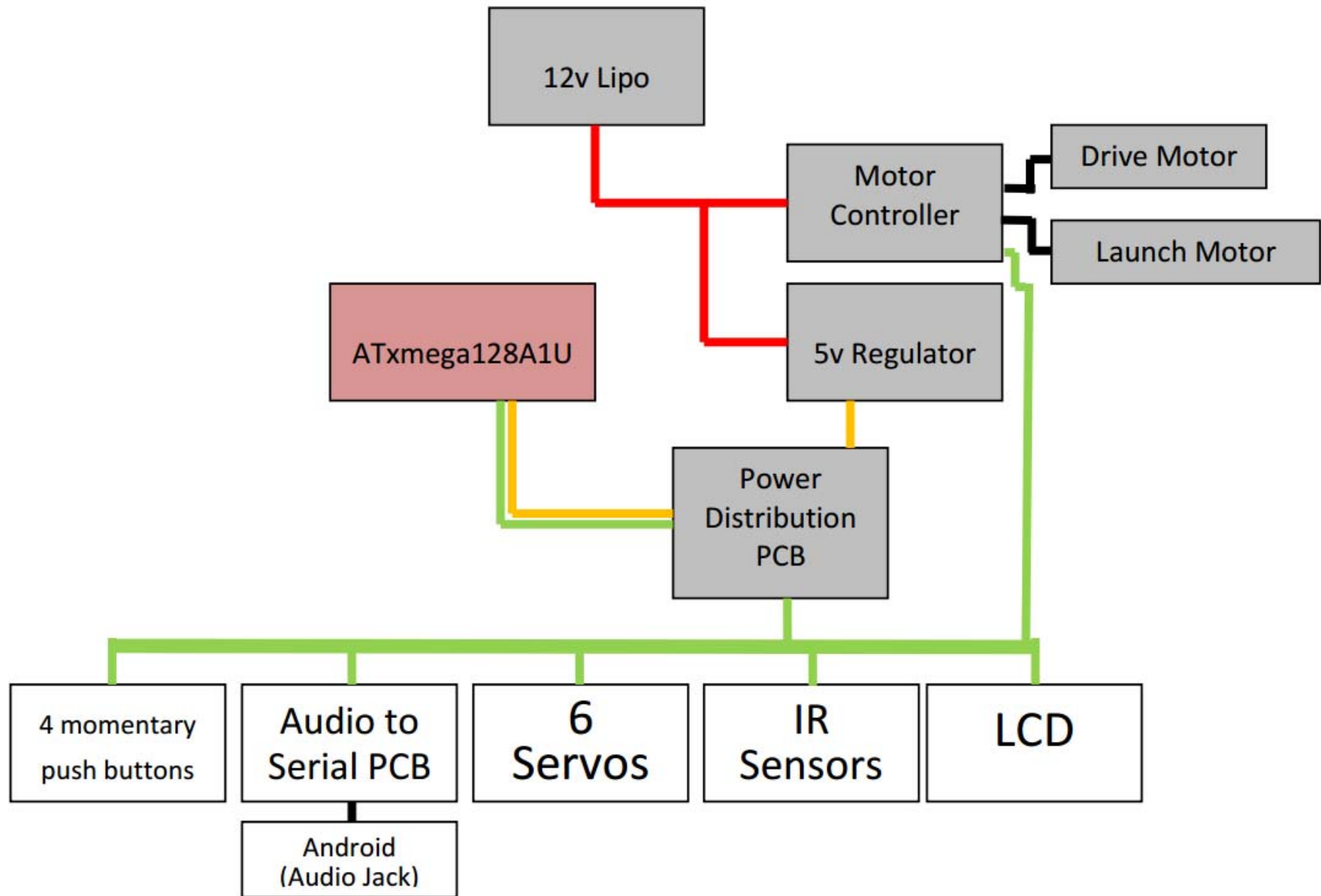
Electrical Systems and Layouts

Andy Gray

Objectives

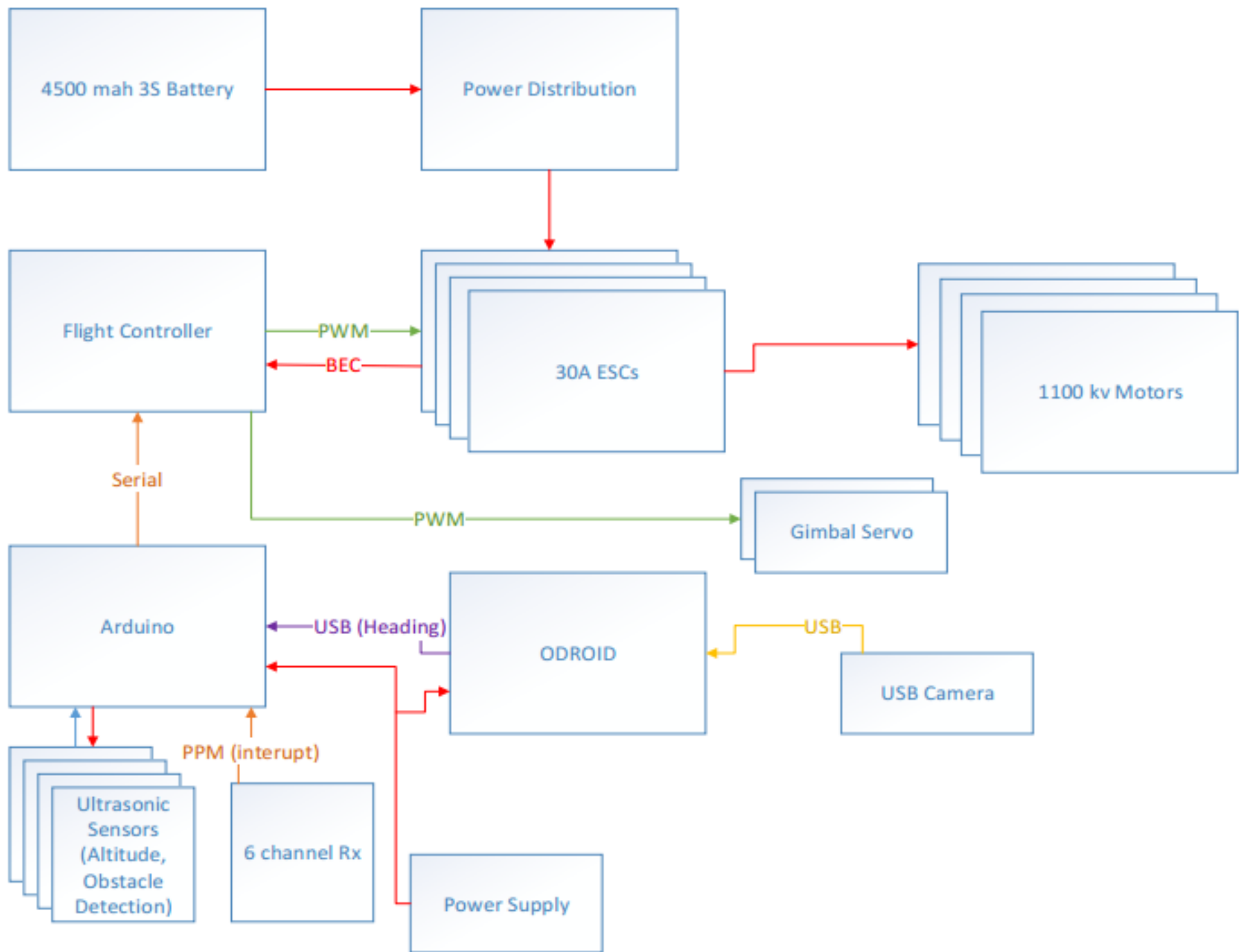
- Electrical system diagrams
- Boards
- Merge board
- Analog circuitry
- Wire gauge
- Regulators
- Wire management

Electrical Layout Diagram

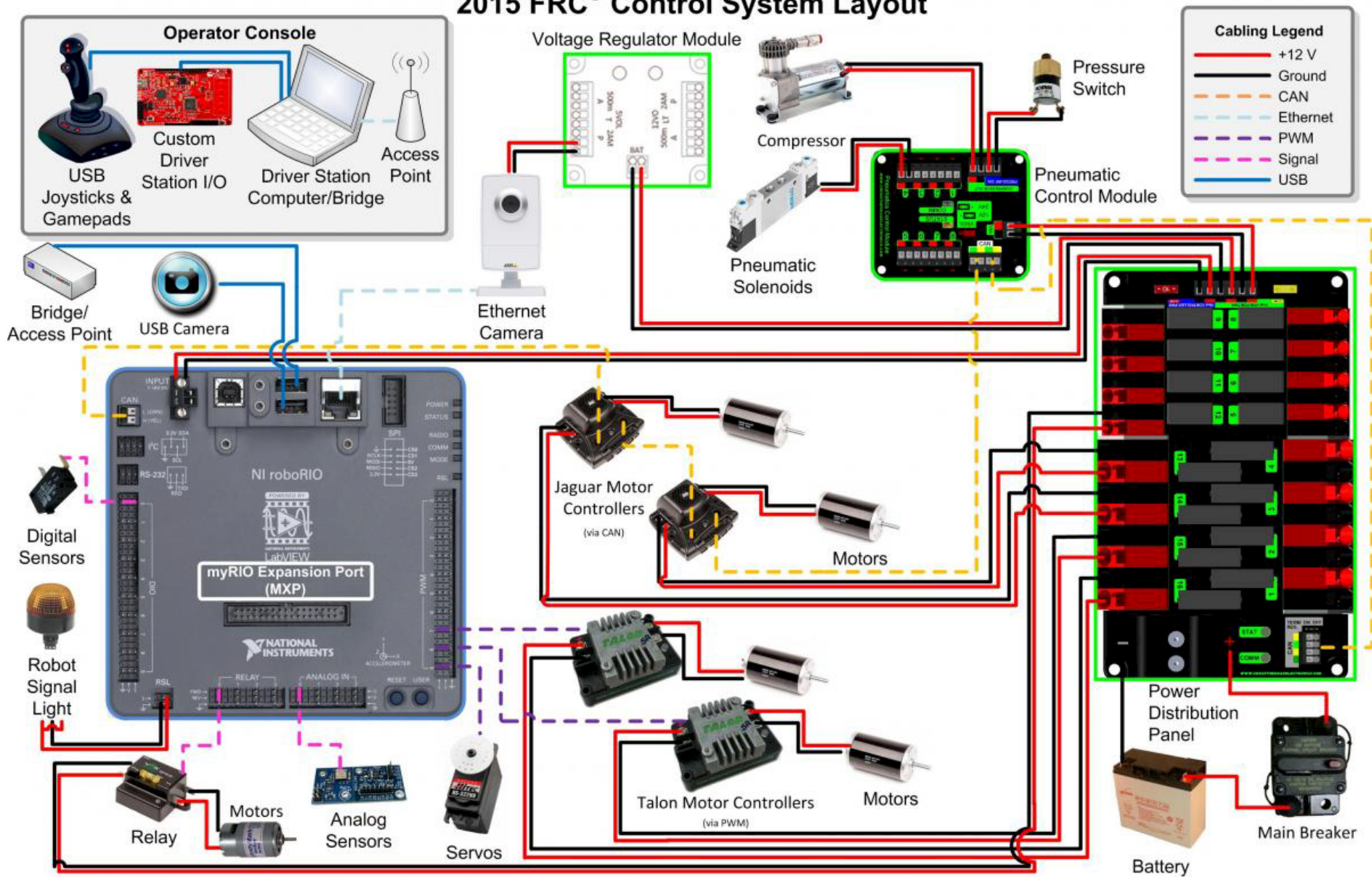


(Figure-2)

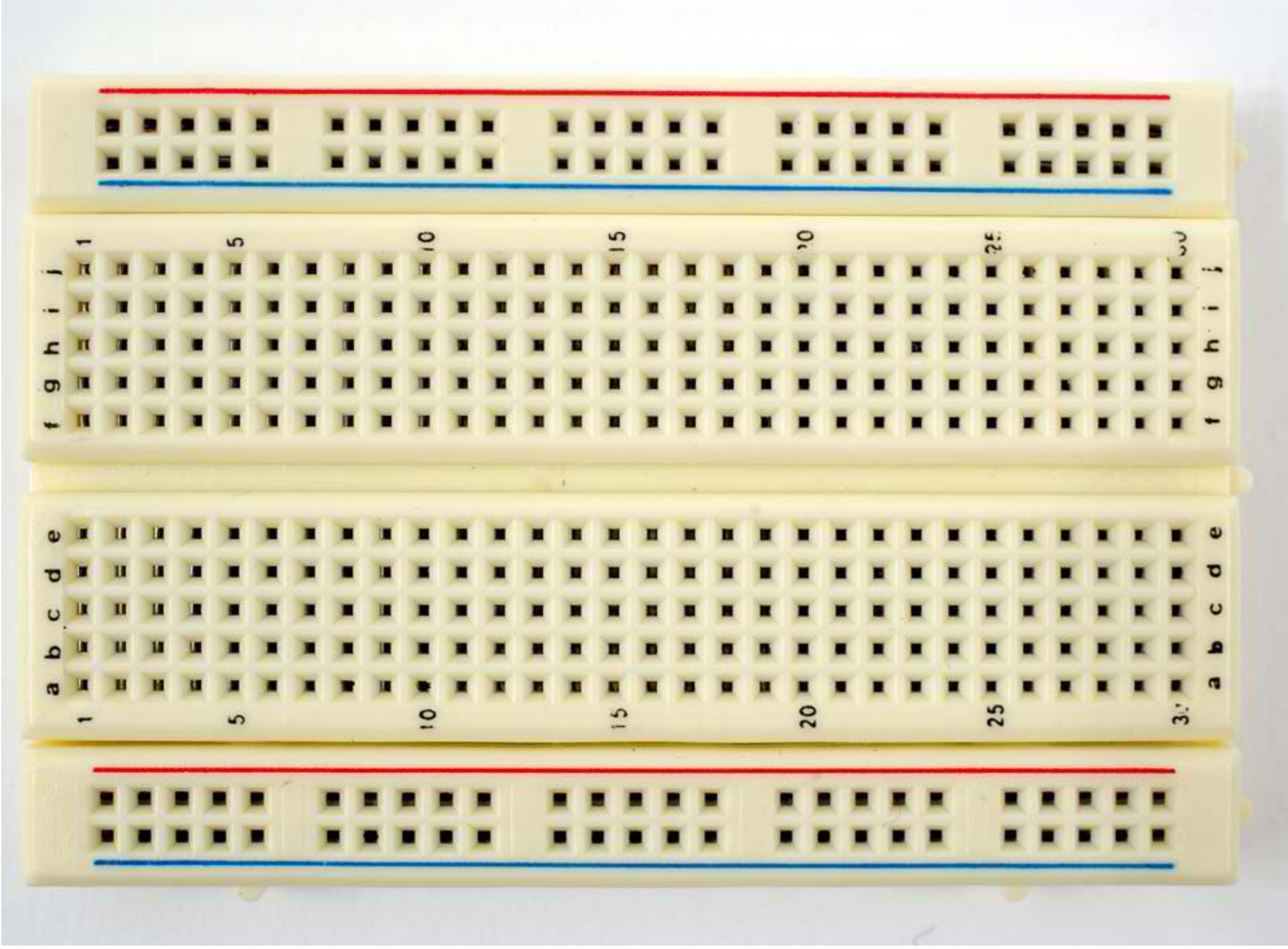
MinuteMachine system block diagram

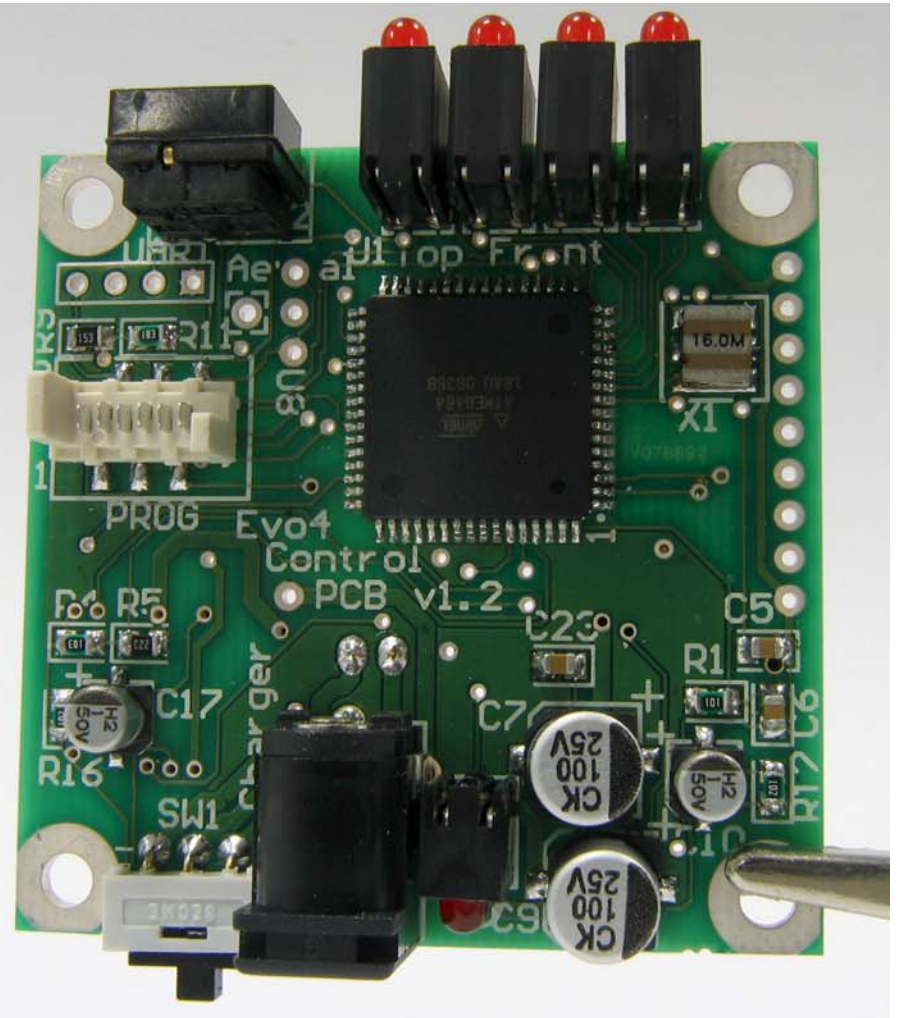
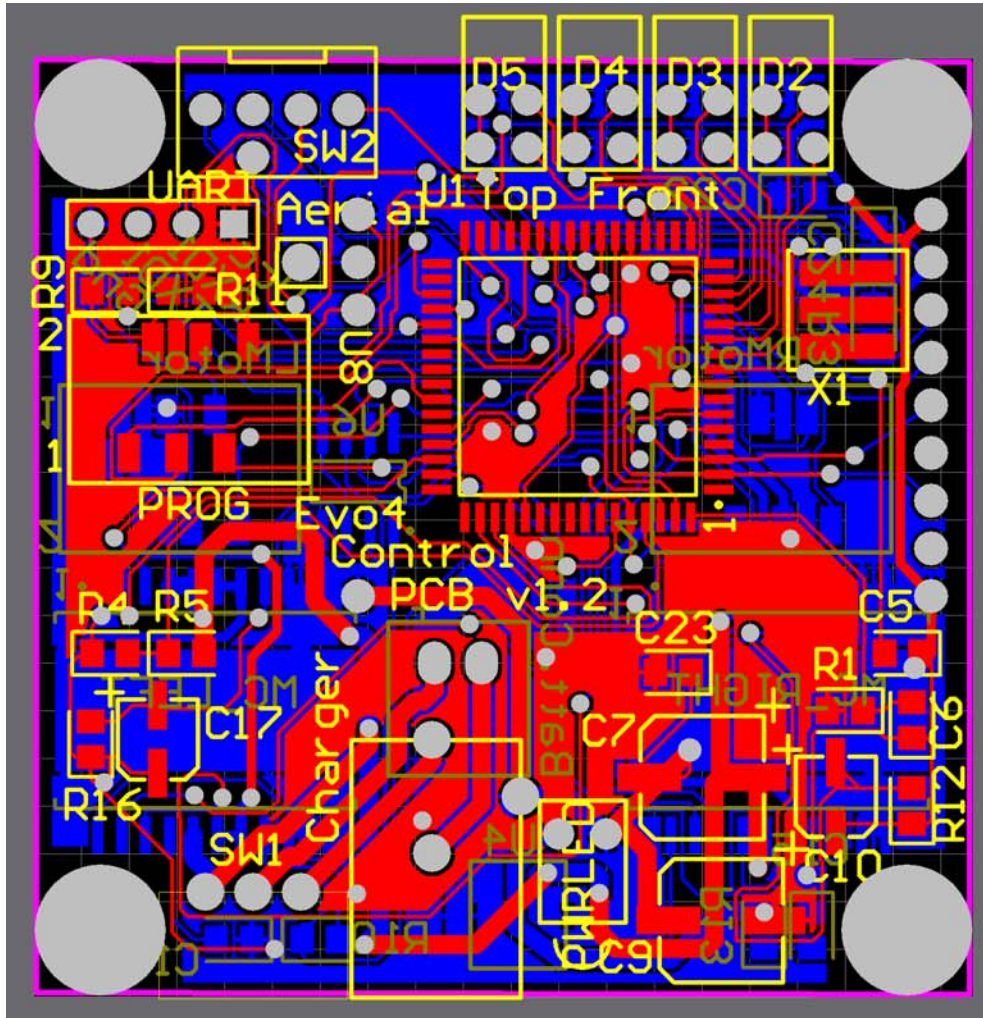


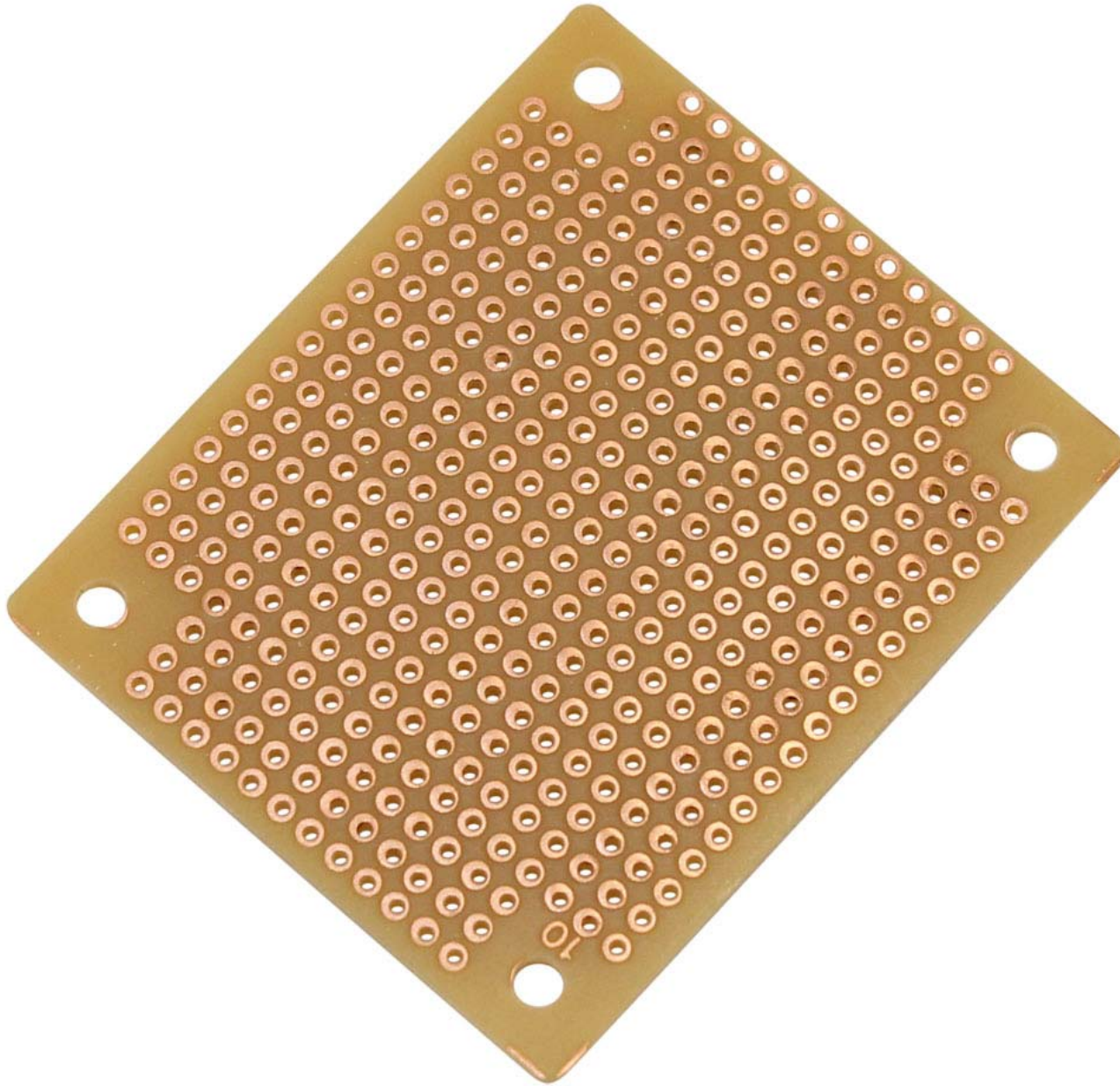
2015 FRC® Control System Layout

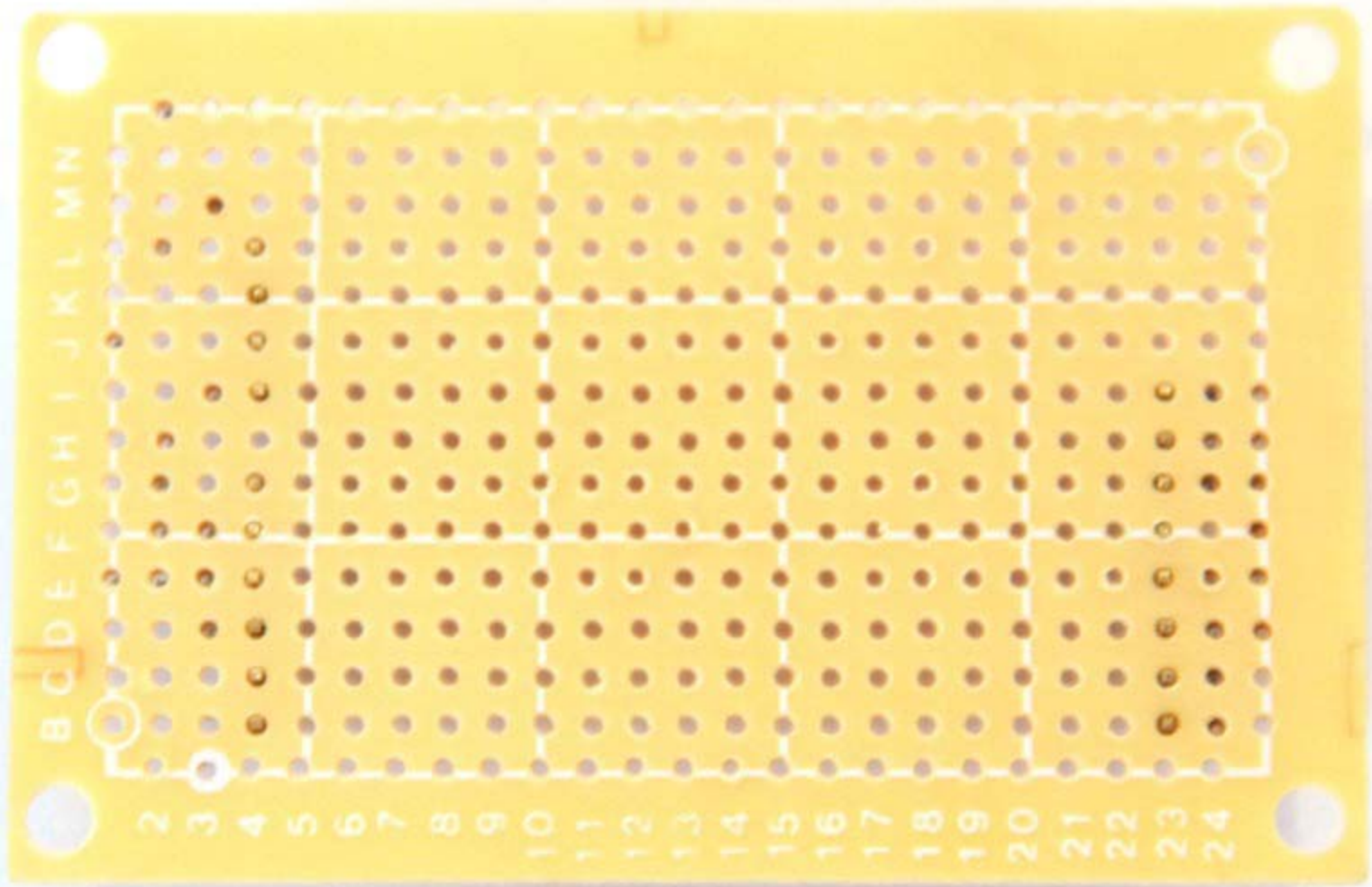


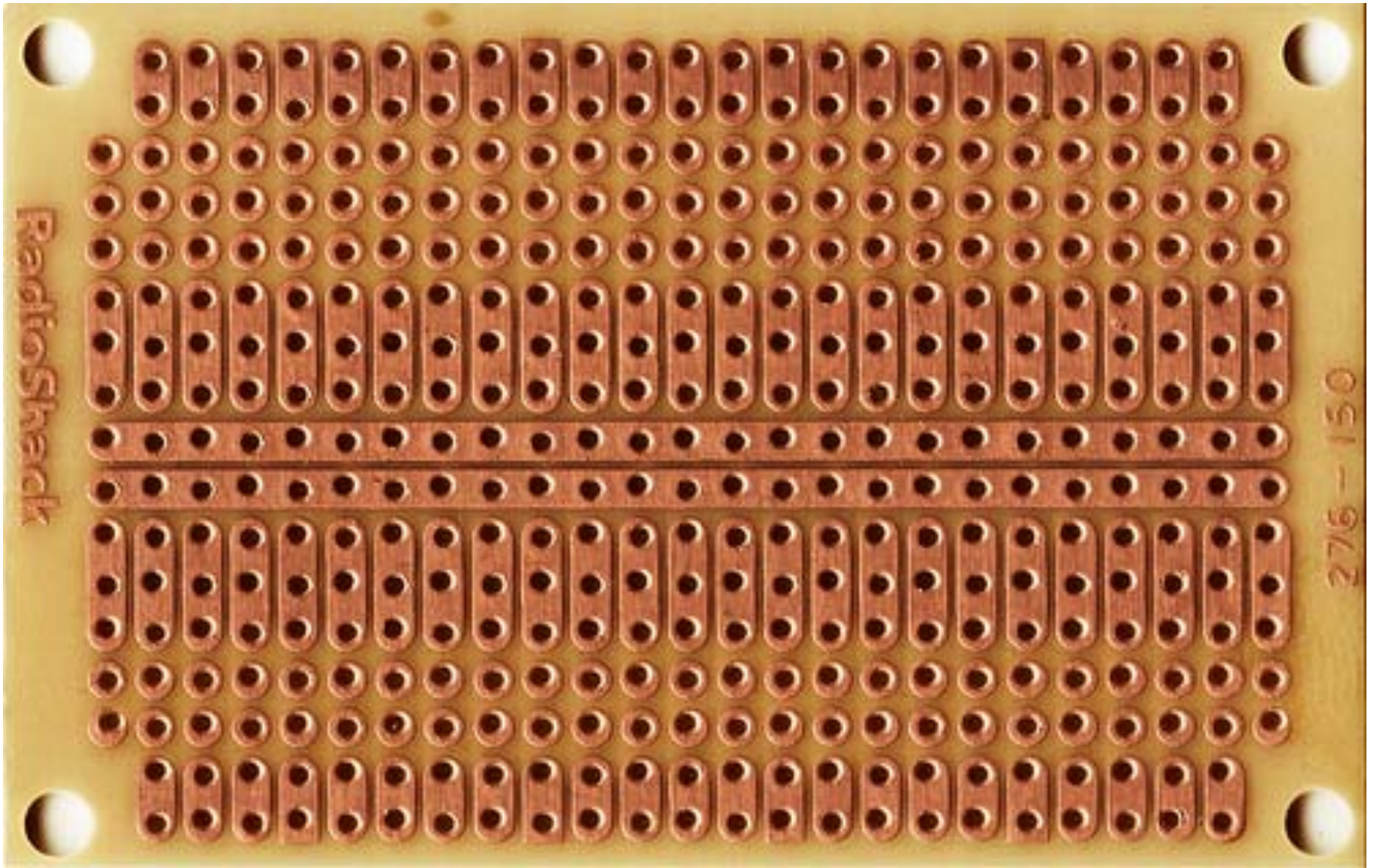
Circuit Boards

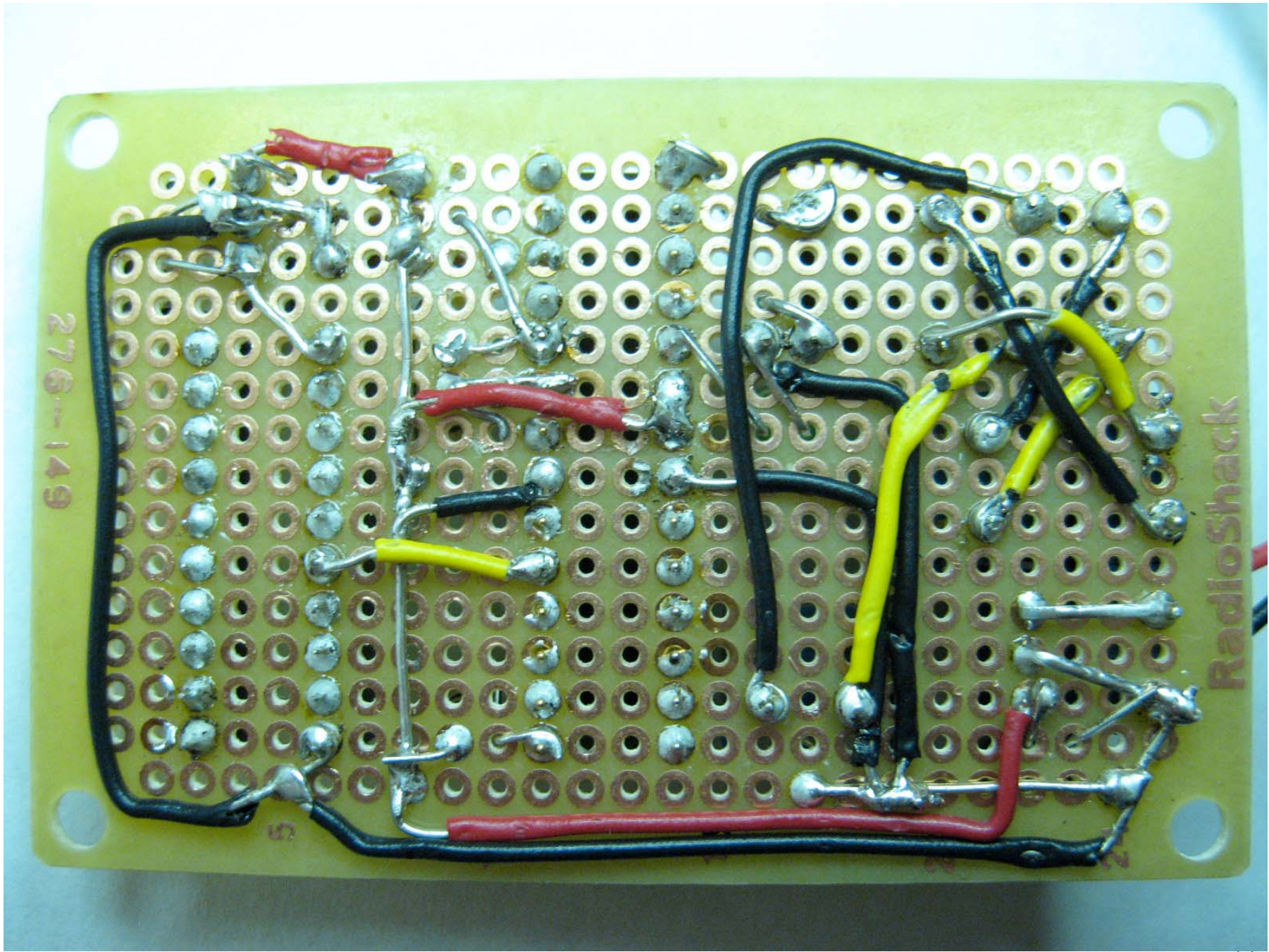


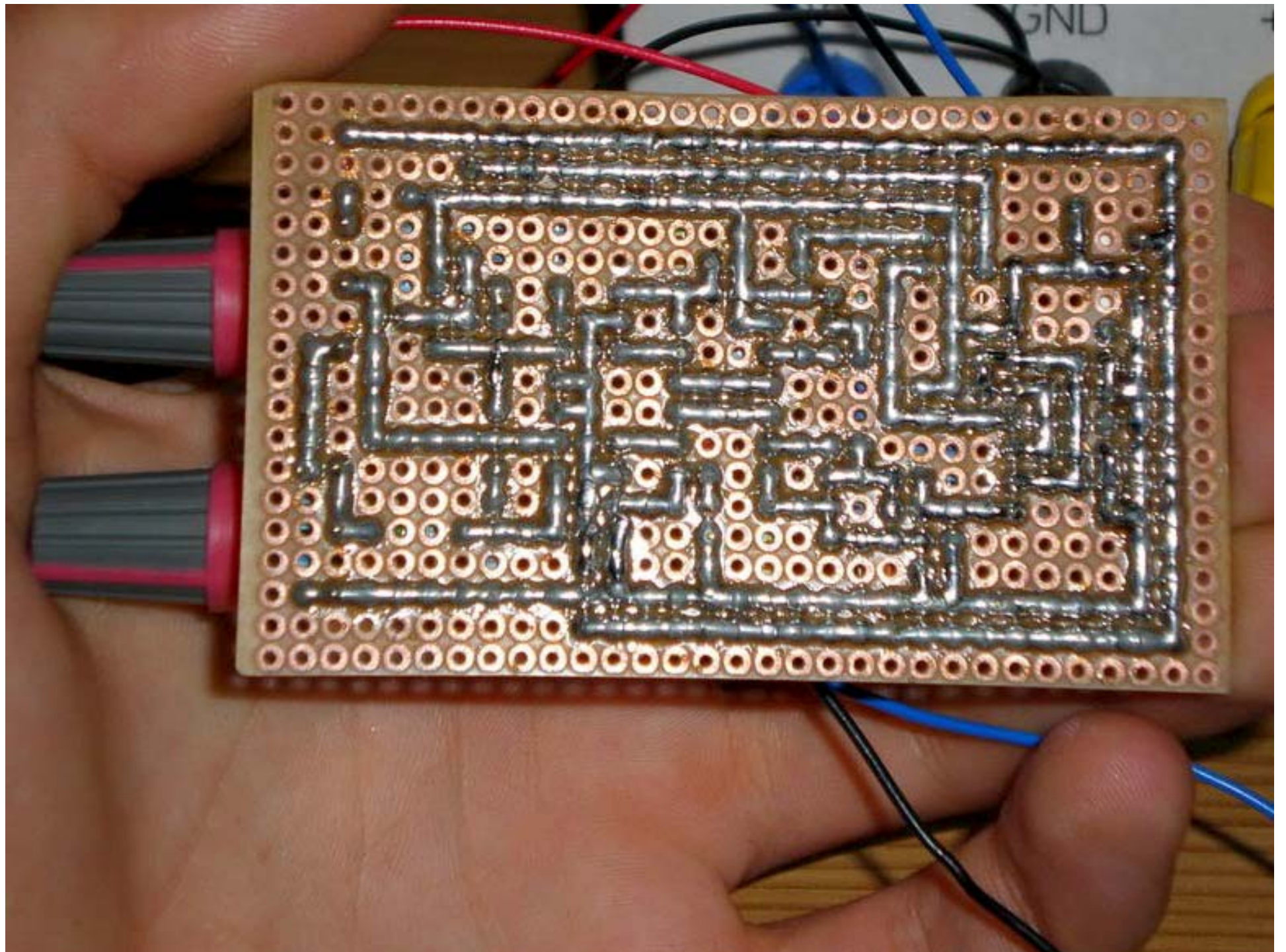


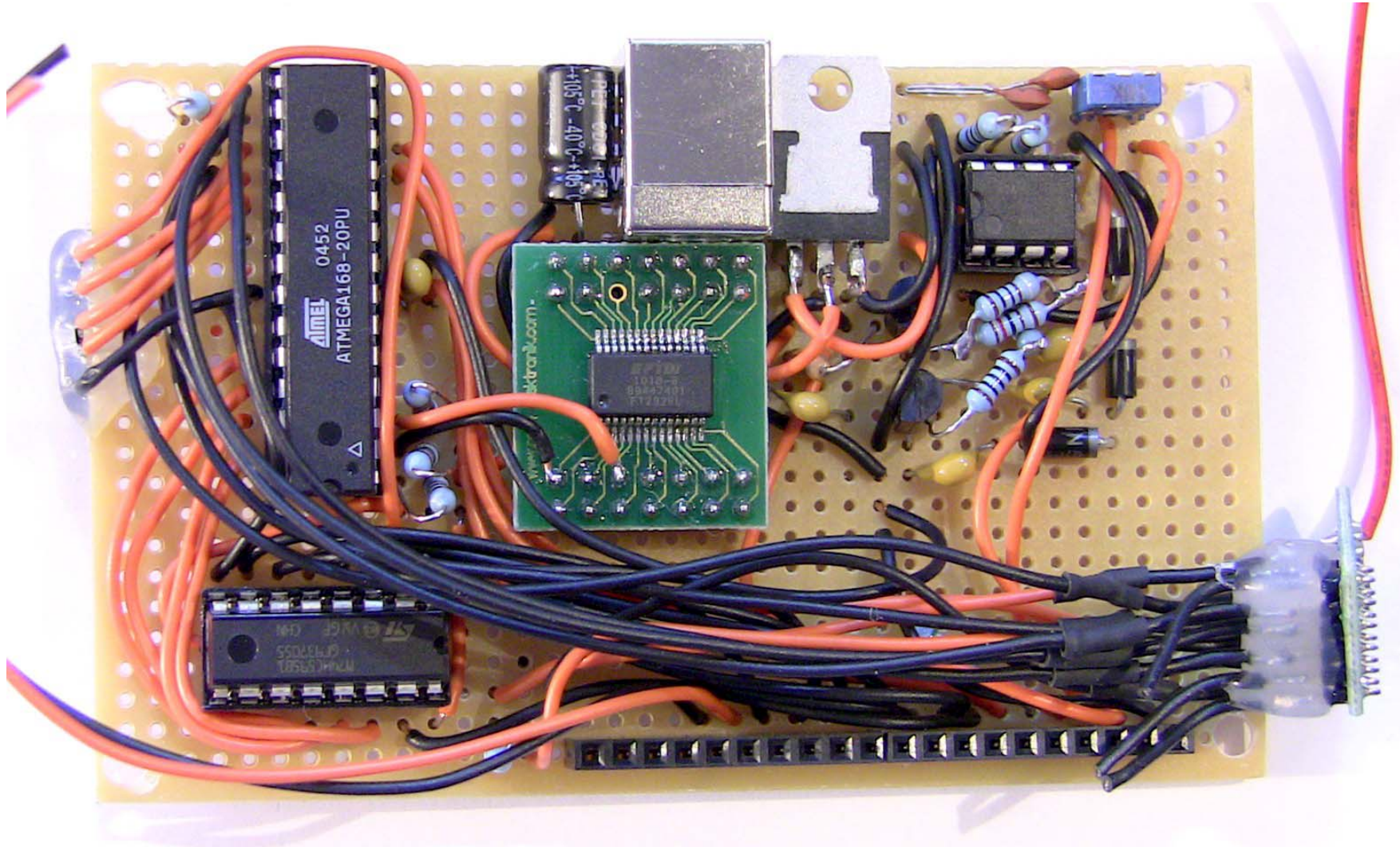


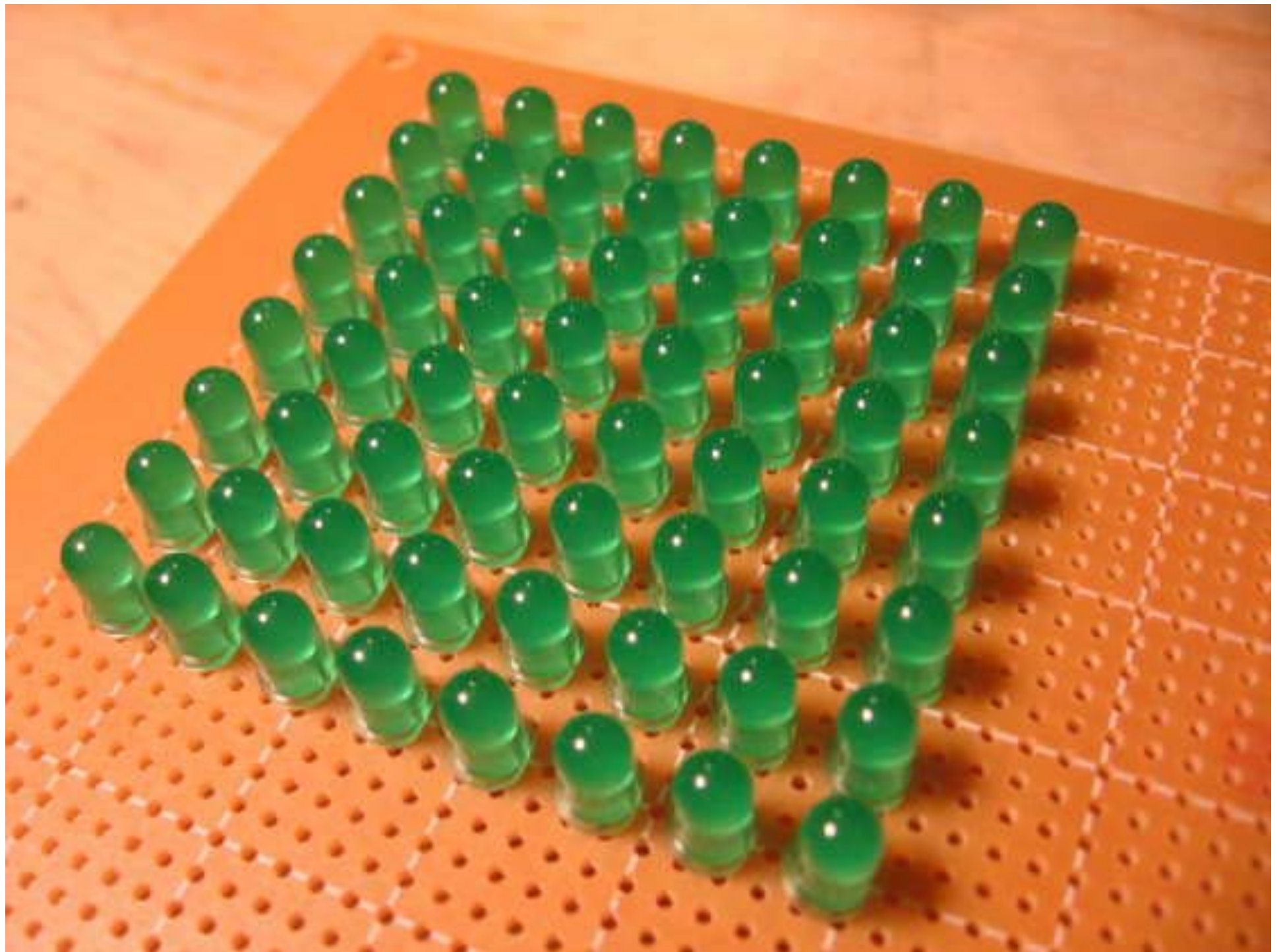


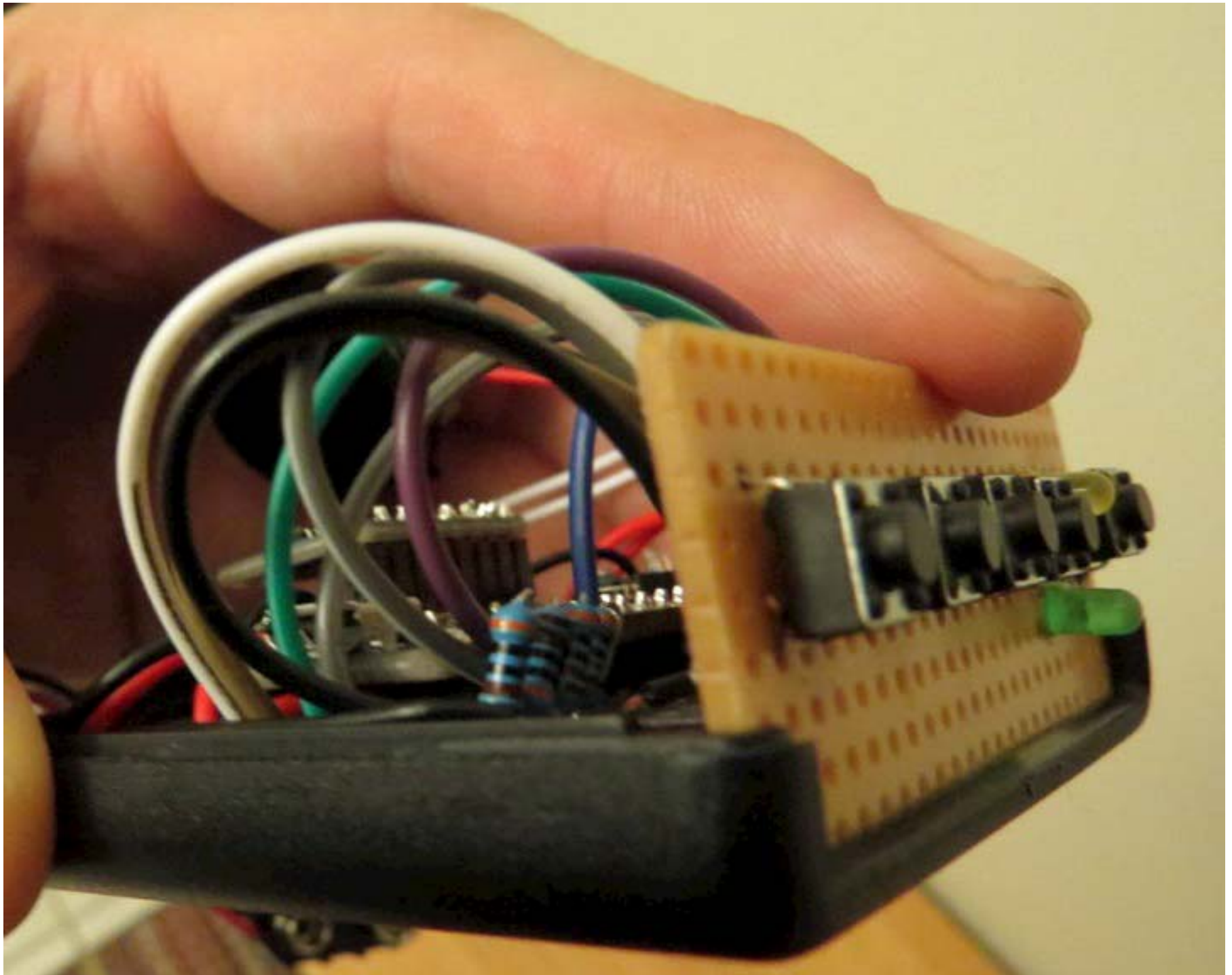




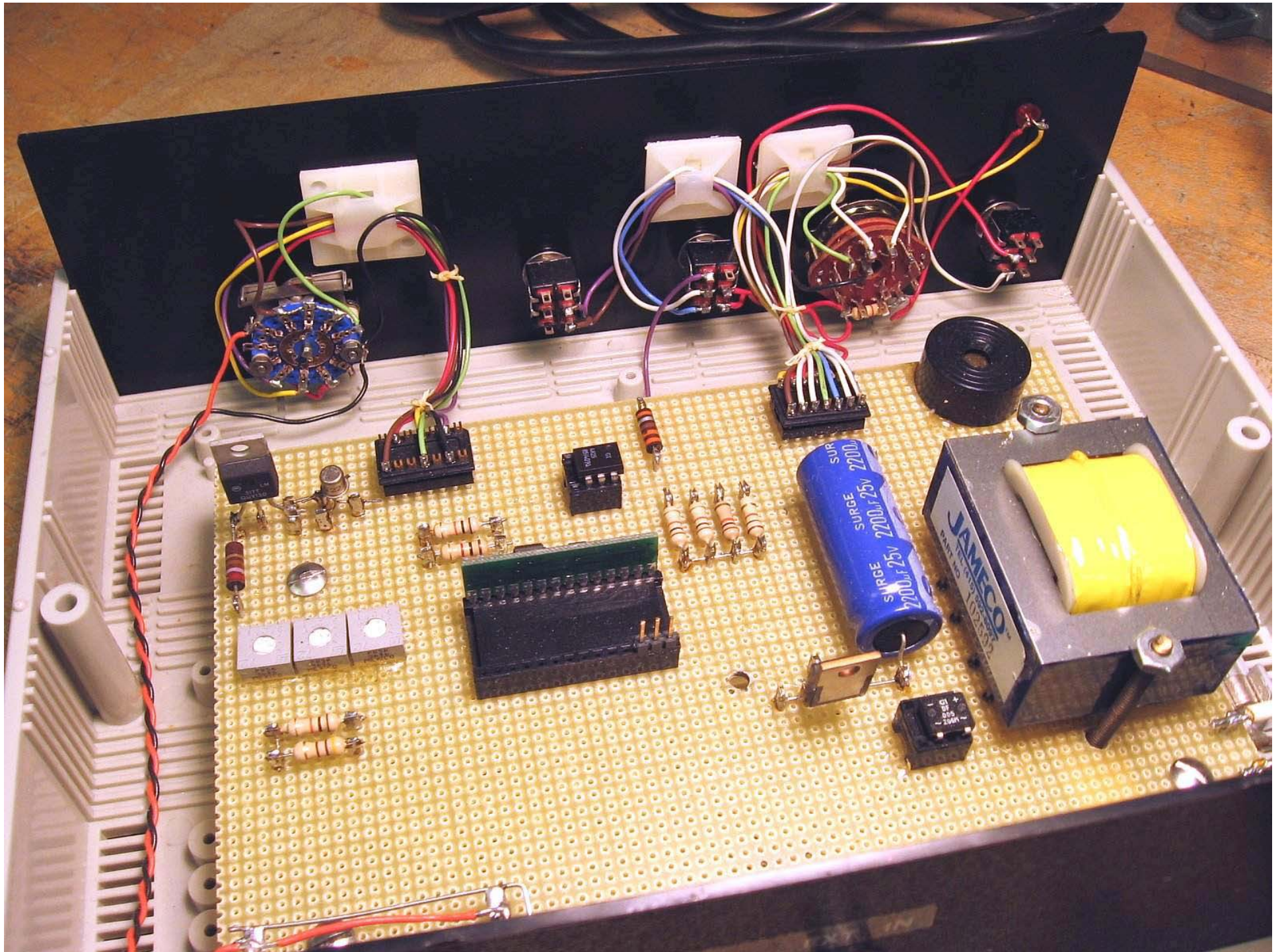




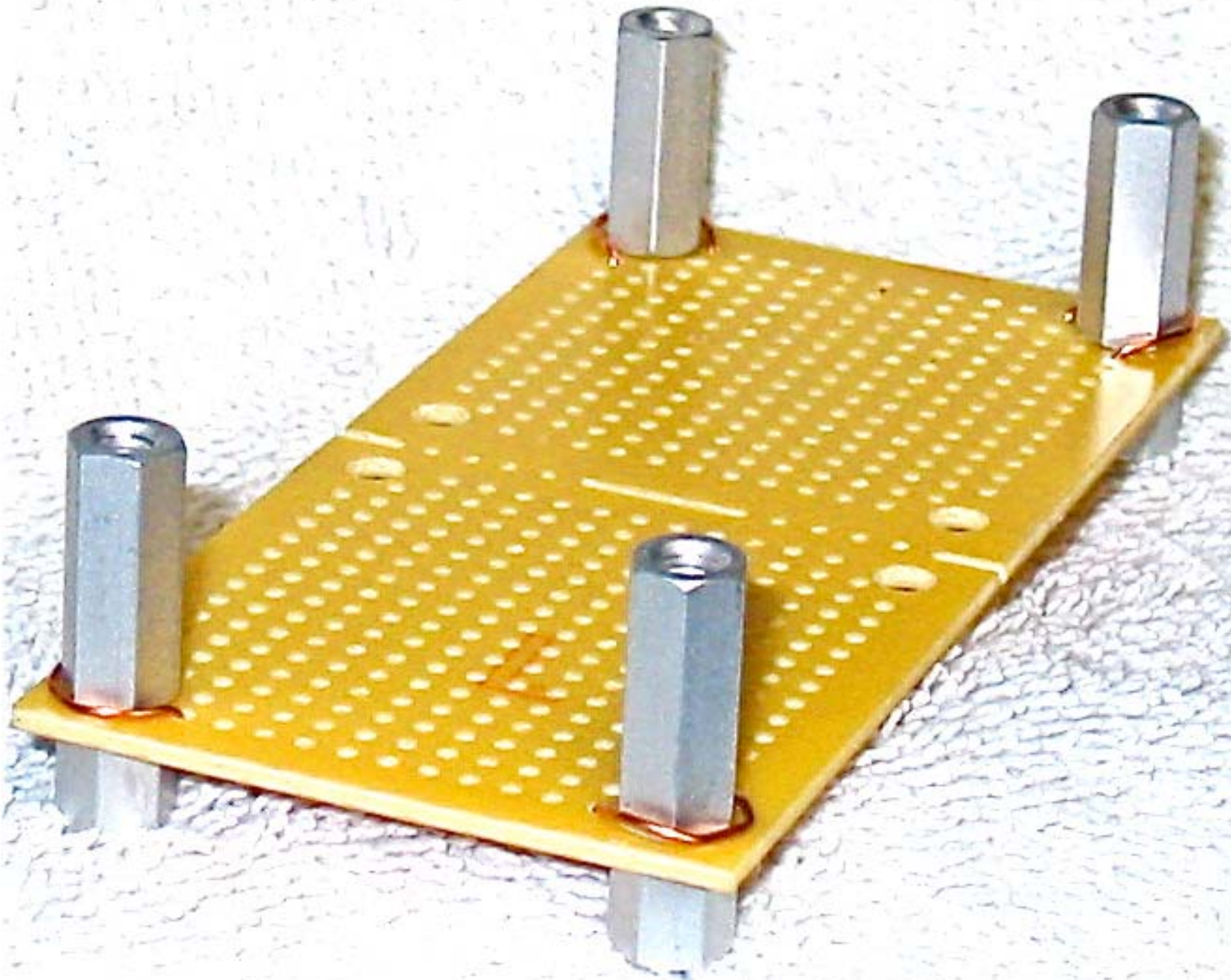


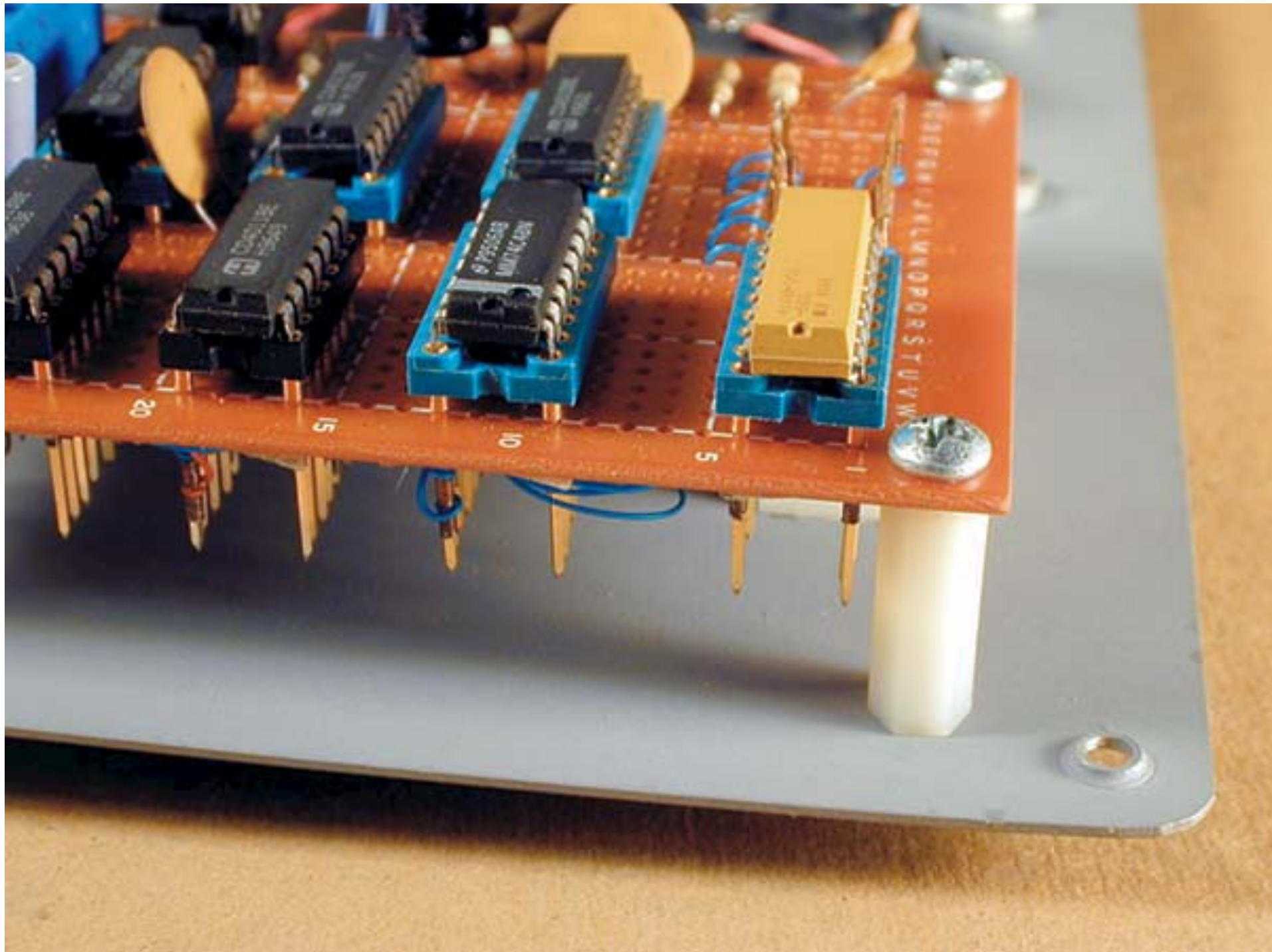


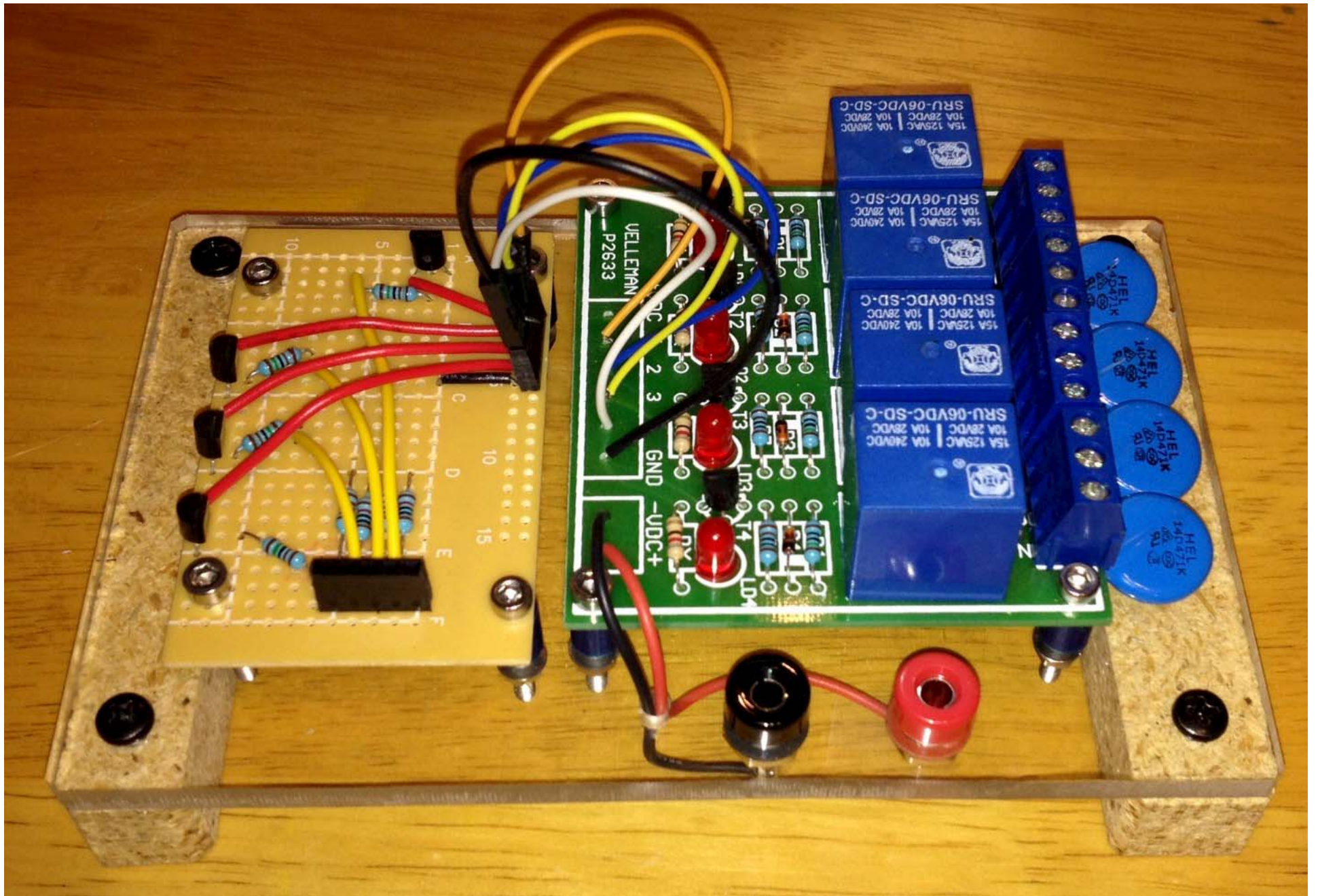


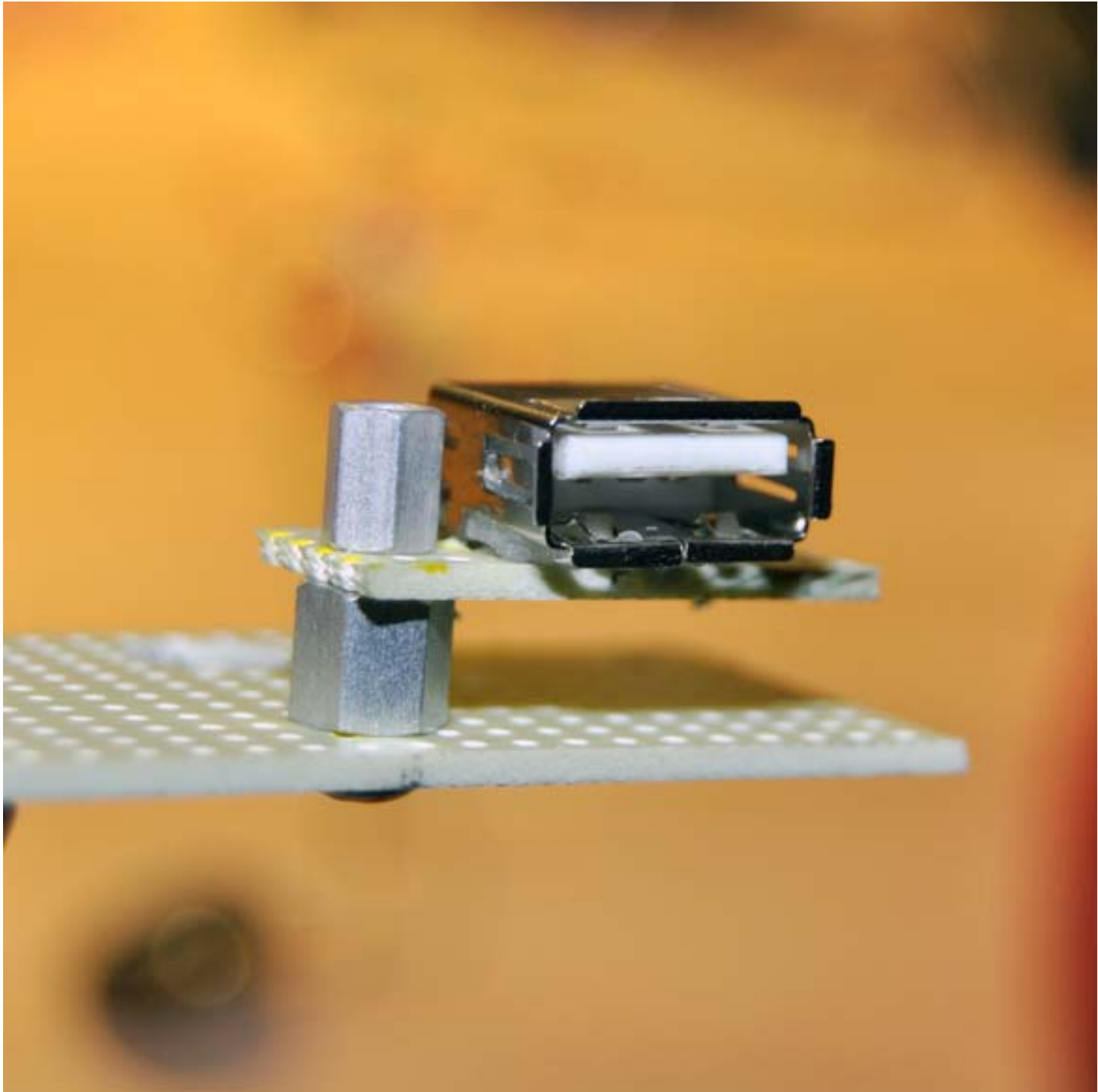


Mounting Circuit Boards



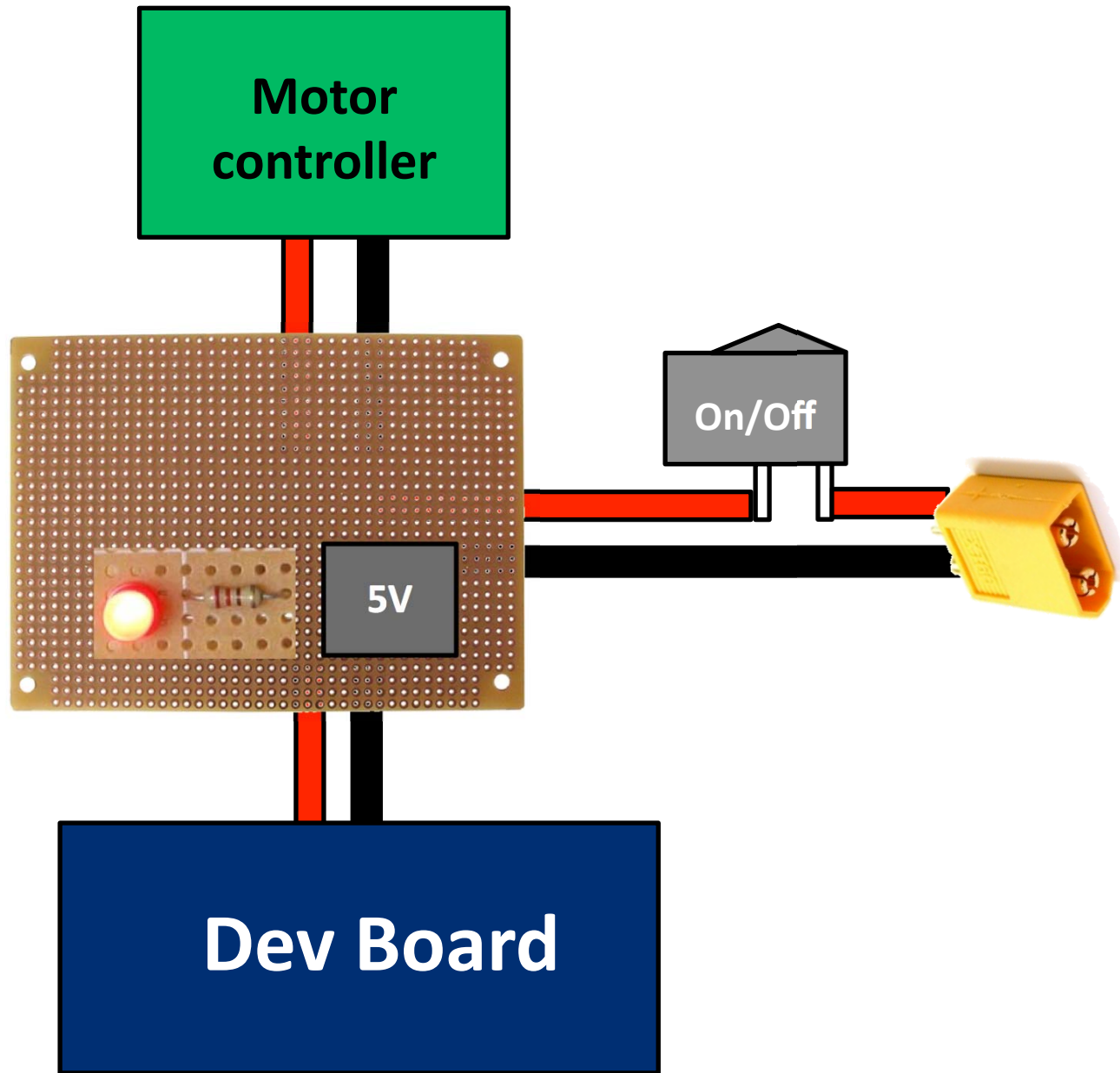


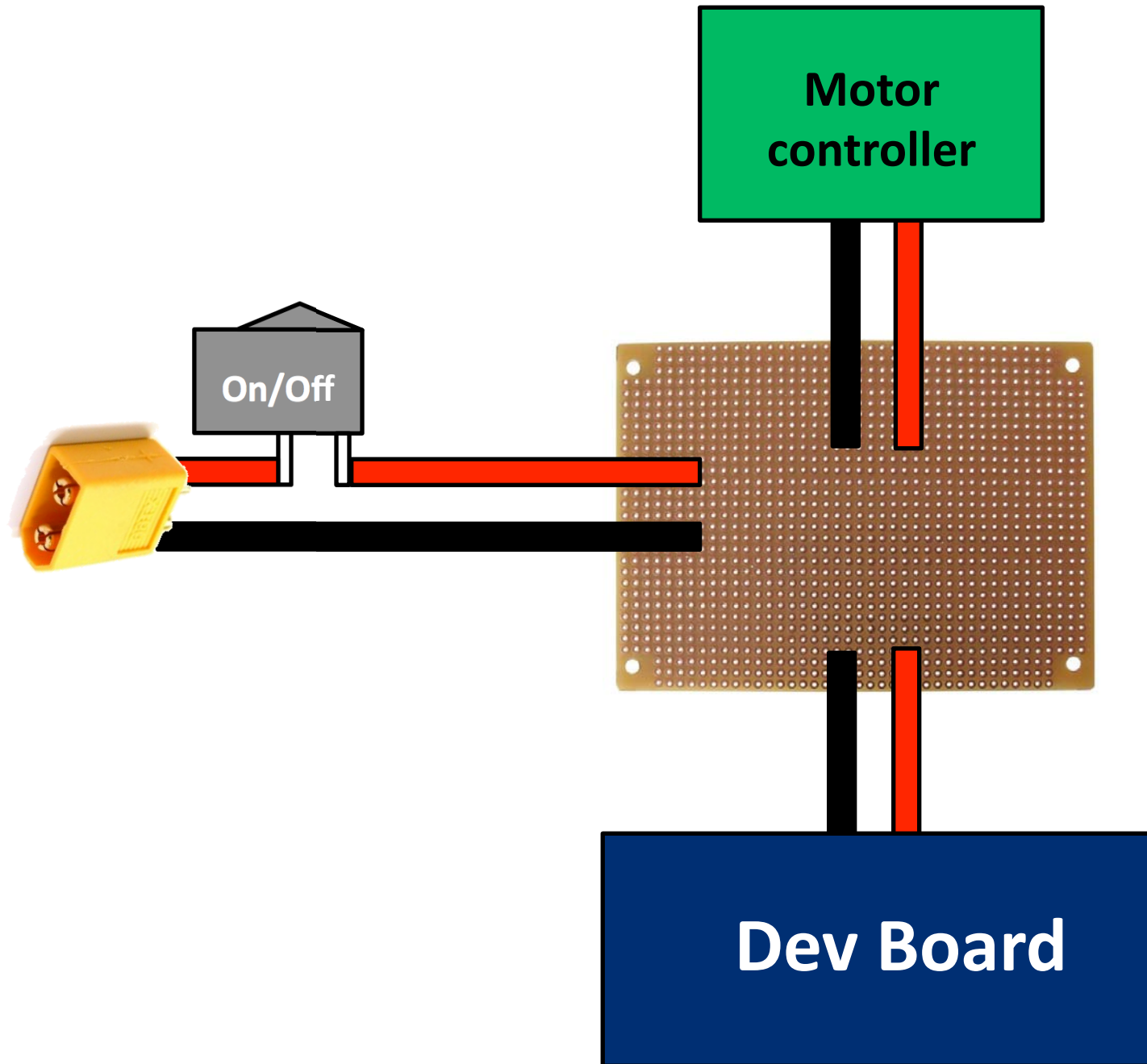


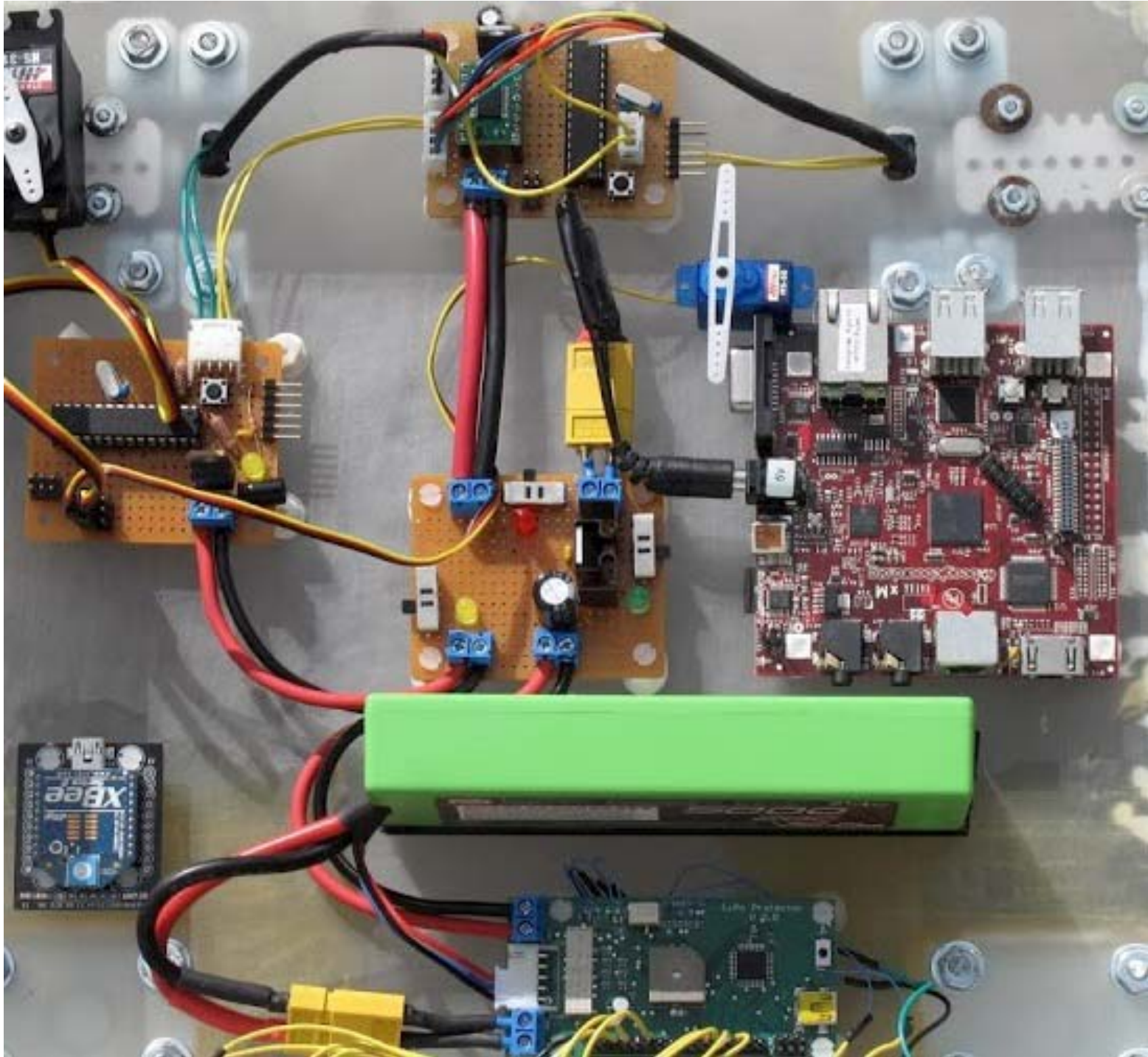


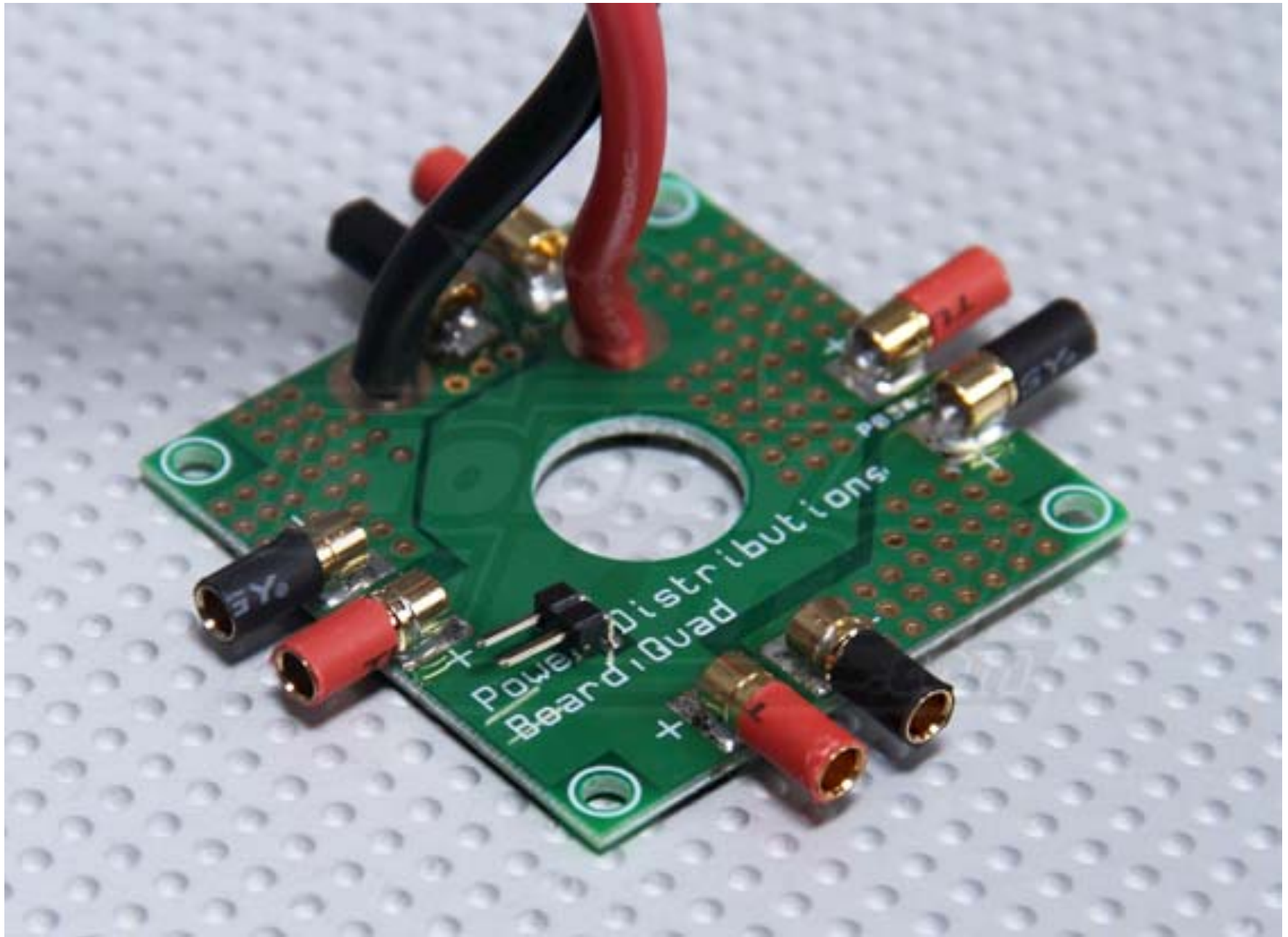
Merging Power



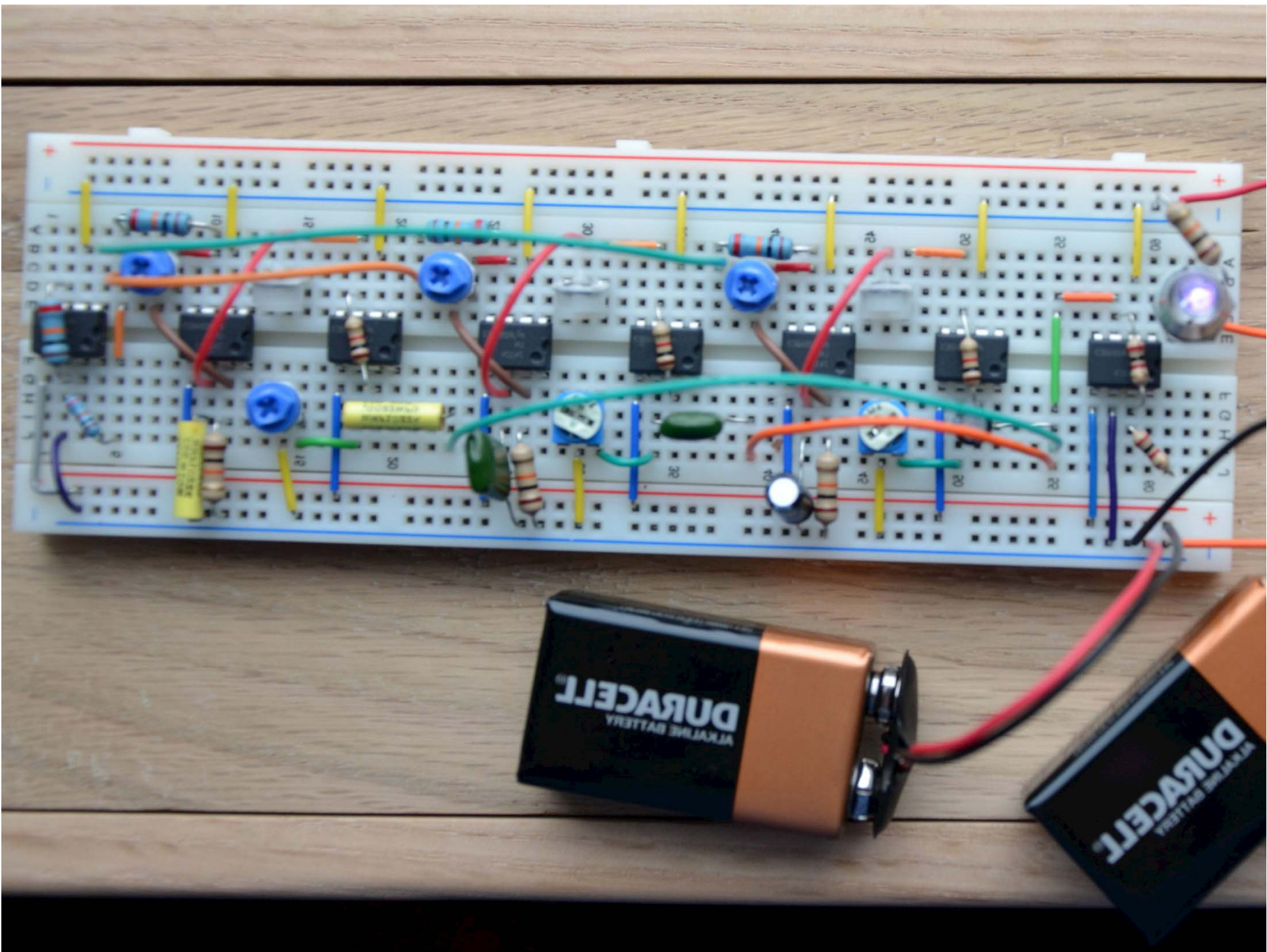


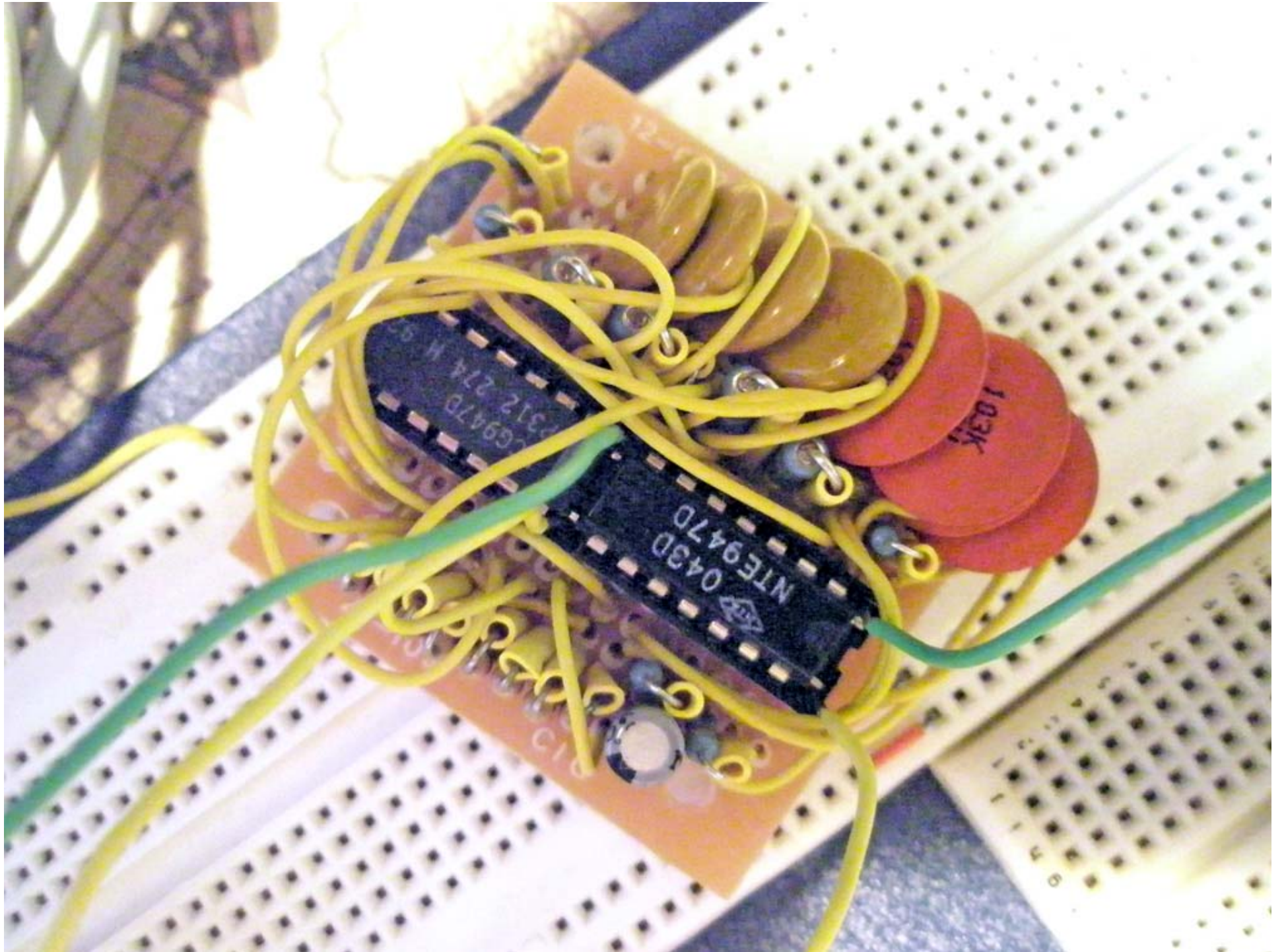






Analog Circuits





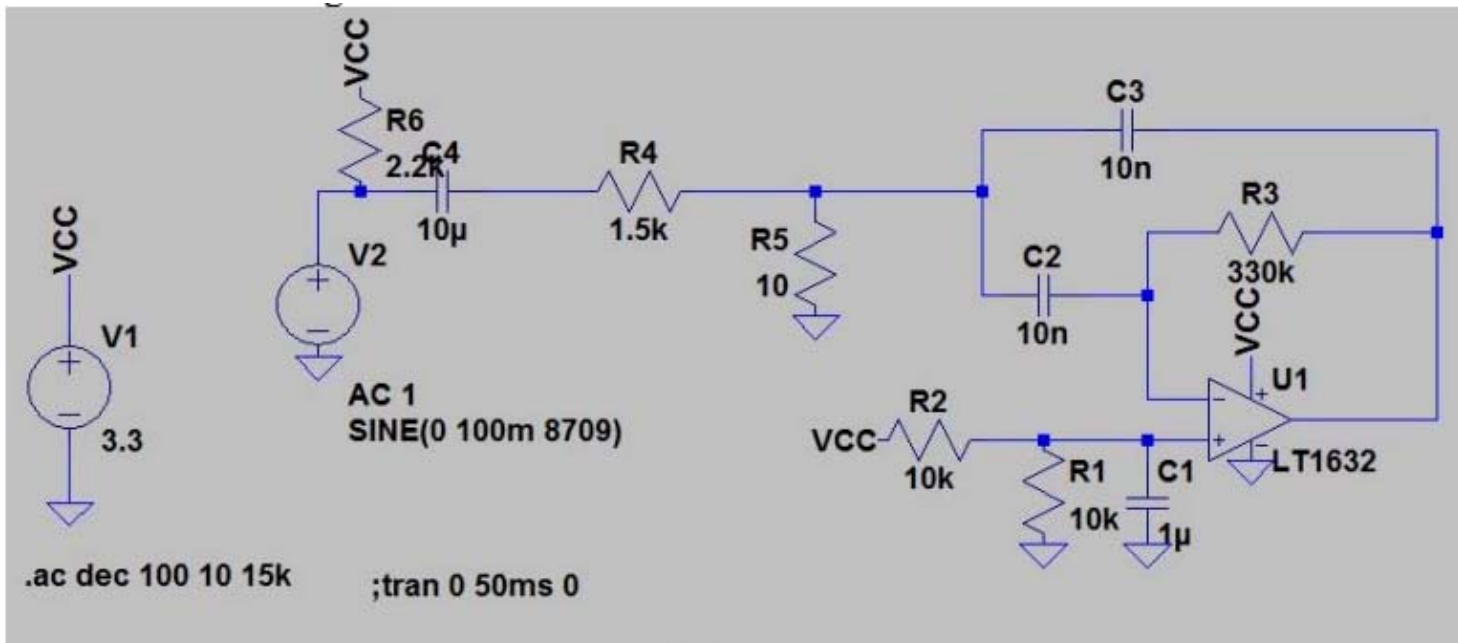
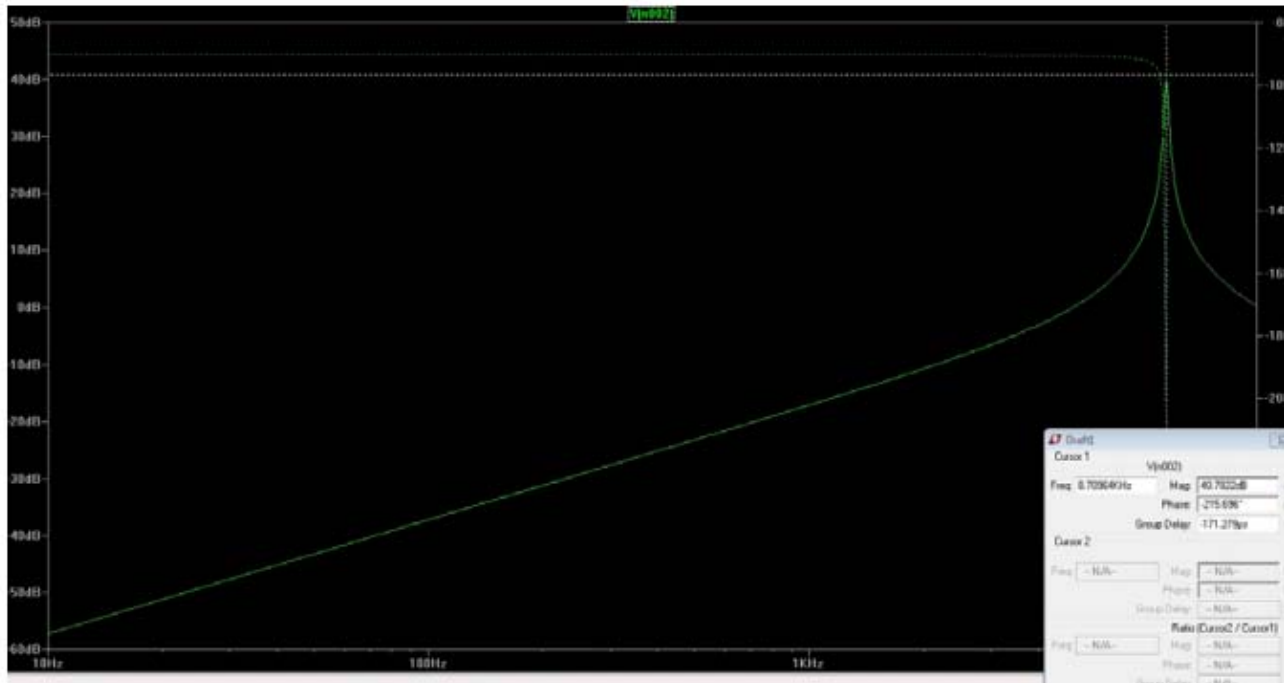


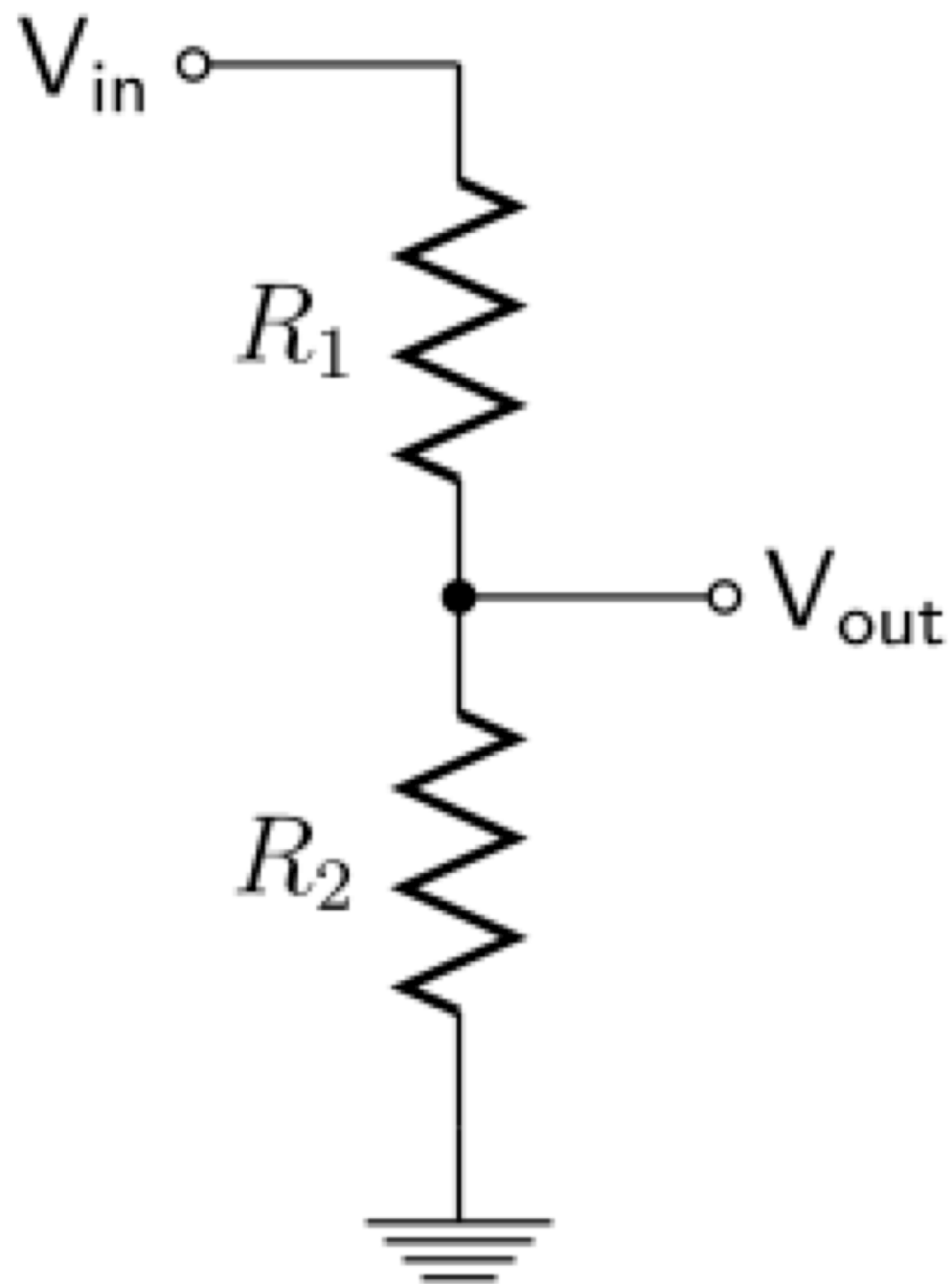
Fig 3

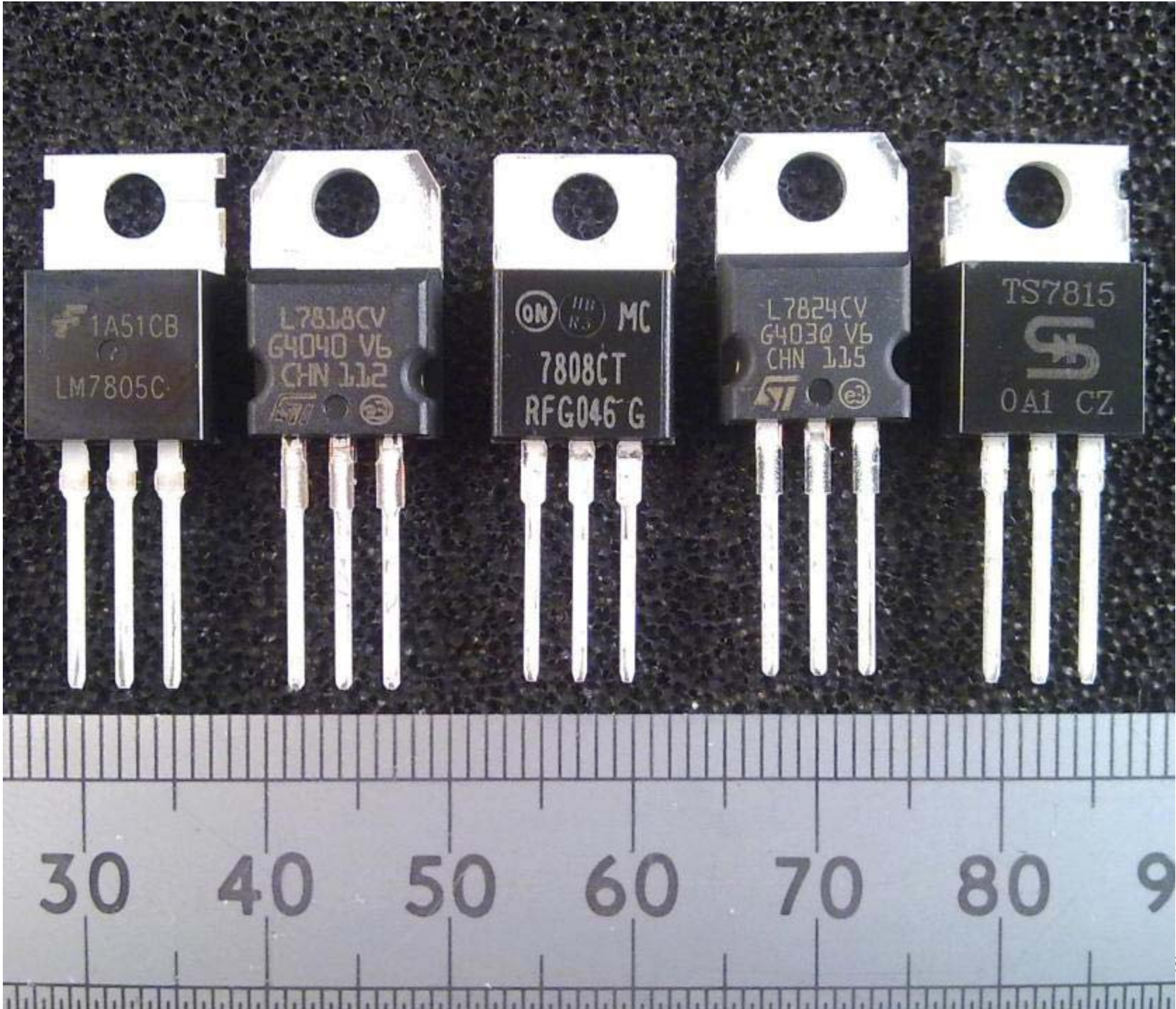
The frequency response is shown in Fig 4.



Power Regulation

AWG gauge	Conductor Diameter Inches	Conductor Diameter mm	Ohms per 1000 ft.	Ohms per km	Maximum amps for chassis wiring
15	0.0571	1.45034	3.184	10.44352	28
16	0.0508	1.29032	4.016	13.17248	22
17	0.0453	1.15062	5.064	16.60992	19
18	0.0403	1.02362	6.385	20.9428	16
19	0.0359	0.91186	8.051	26.40728	14
20	0.032	0.8128	10.15	33.292	11
21	0.0285	0.7239	12.8	41.984	9
22	0.0254	0.64516	16.14	52.9392	7
23	0.0226	0.57404	20.36	66.7808	4.7
24	0.0201	0.51054	25.67	84.1976	3.5
25	0.0179	0.45466	32.37	106.1736	2.7
26	0.0159	0.40386	40.81	133.8568	2.2





s) > [PMIC - Voltage Regulators - Linear \(LDO\)](#) > STMicroelectronics L7805CV

All prices are in US dollars.			
497-1443-5-ND	Price Break	Unit Price	Extended Price
Digi-Key Stock: 22,479 Can ship immediately	1	0.48000	0.48
	10	0.32500	3.25
50	100	0.21500	21.50
	1,000	0.16600	166.00
STMicroelectronics	2,500	0.14000	350.00
L7805CV	10,000	0.13500	1,350.00
IC REG LDO 5V 1.5A TO220AB	25,000	0.12800	3,200.00
Lead free / RoHS Compliant	50,000	0.12500	6,250.00

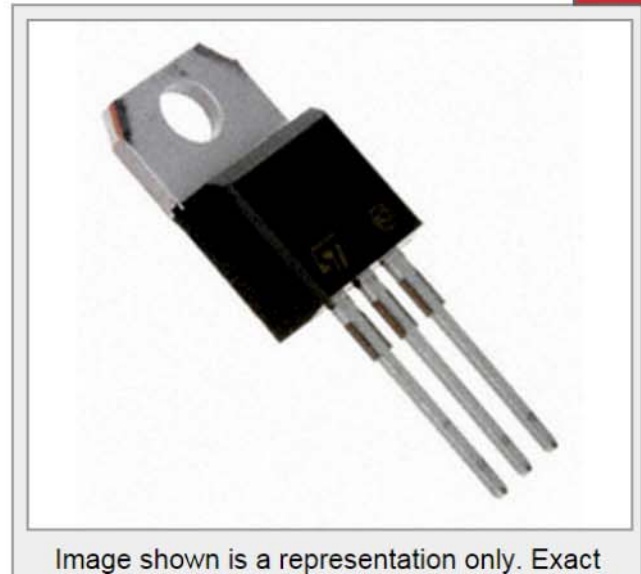


Table 10. Electrical characteristics of L7805C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$T_J = 25^\circ\text{C}$	4.8	5	5.2	V
V_O	Output voltage	$I_O = 5\text{ mA to }1\text{ A}, V_I = 7\text{ to }18\text{ V}$	4.75	5	5.25	V
V_O	Output voltage	$I_O = 1\text{ A}, V_I = 18\text{ to }20\text{ V}, T_J = 25^\circ\text{C}$	4.75	5	5.25	V
$\Delta V_O^{(1)}$	Line regulation	$V_I = 7\text{ to }25\text{ V}, T_J = 25^\circ\text{C}$		3	100	mV
		$V_I = 8\text{ to }12\text{ V}, T_J = 25^\circ\text{C}$		1	50	
$\Delta V_O^{(1)}$	Load regulation	$I_O = 5\text{ mA to }1.5\text{ A}, T_J = 25^\circ\text{C}$			100	mV
		$I_O = 250\text{ to }750\text{ mA}, T_J = 25^\circ\text{C}$			50	
I_d	Quiescent current	$T_J = 25^\circ\text{C}$			8	mA
ΔI_d	Quiescent current change	$I_O = 5\text{ mA to }1\text{ A}$			0.5	mA
		$V_I = 7\text{ to }23\text{ V}$			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	$I_O = 5\text{ mA}$		-1.1		mV/ $^\circ\text{C}$
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}, T_J = 25^\circ\text{C}$		40		$\mu\text{V}/V_O$
SVR	Supply voltage rejection	$V_I = 8\text{ to }18\text{ V}, f = 120\text{ Hz}$	62			dB
V_d	Dropout voltage	$I_O = 1\text{ A}, T_J = 25^\circ\text{C}$		2		V
R_O	Output resistance	$f = 1\text{ kHz}$		17		m Ω
I_{sc}	Short circuit current	$V_I = 35\text{ V}, T_J = 25^\circ\text{C}$		0.75		A
I_{scp}	Short circuit peak current	$T_J = 25^\circ\text{C}$		2.2		A

1 Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be

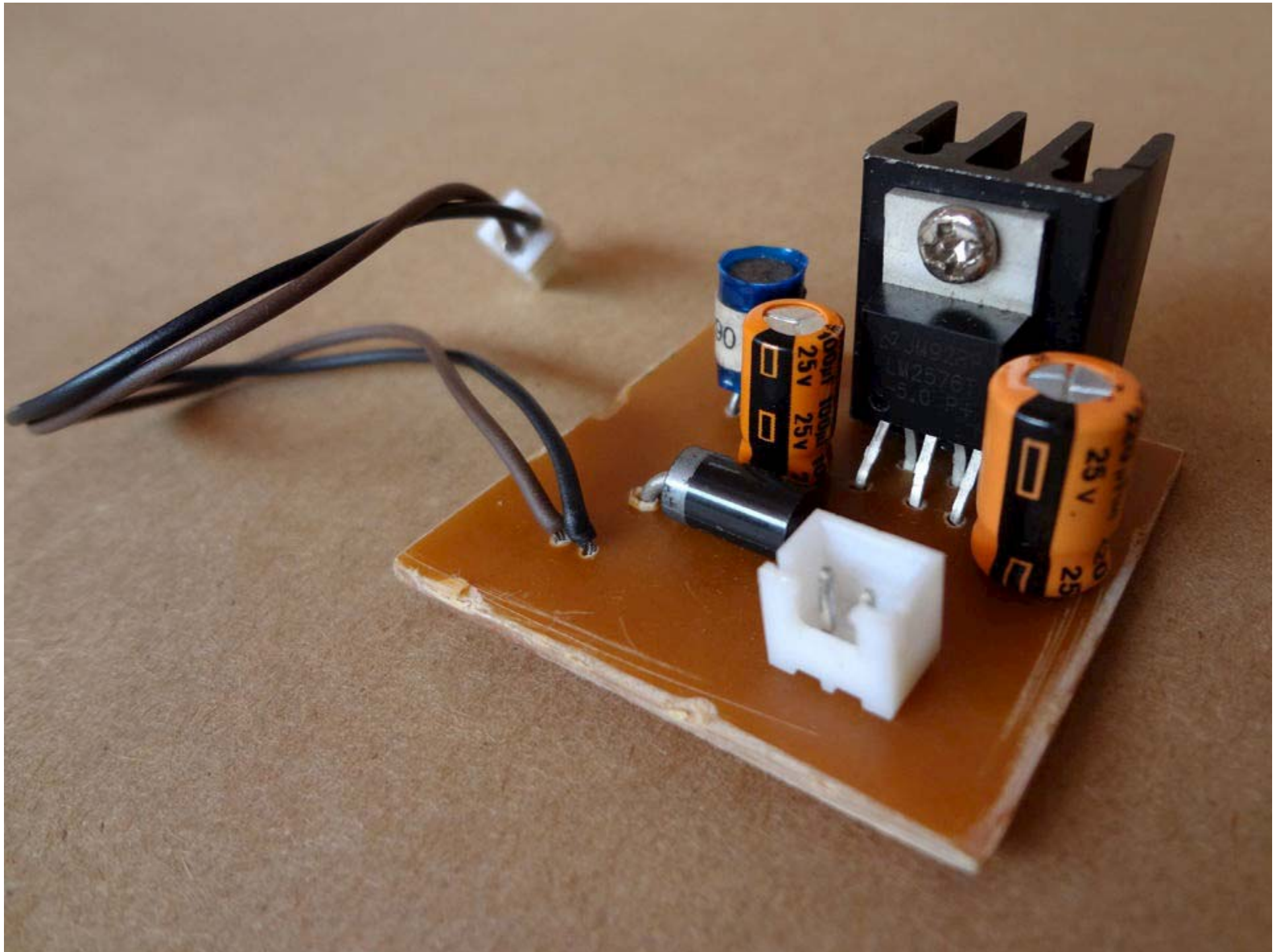
Table 2. Thermal data

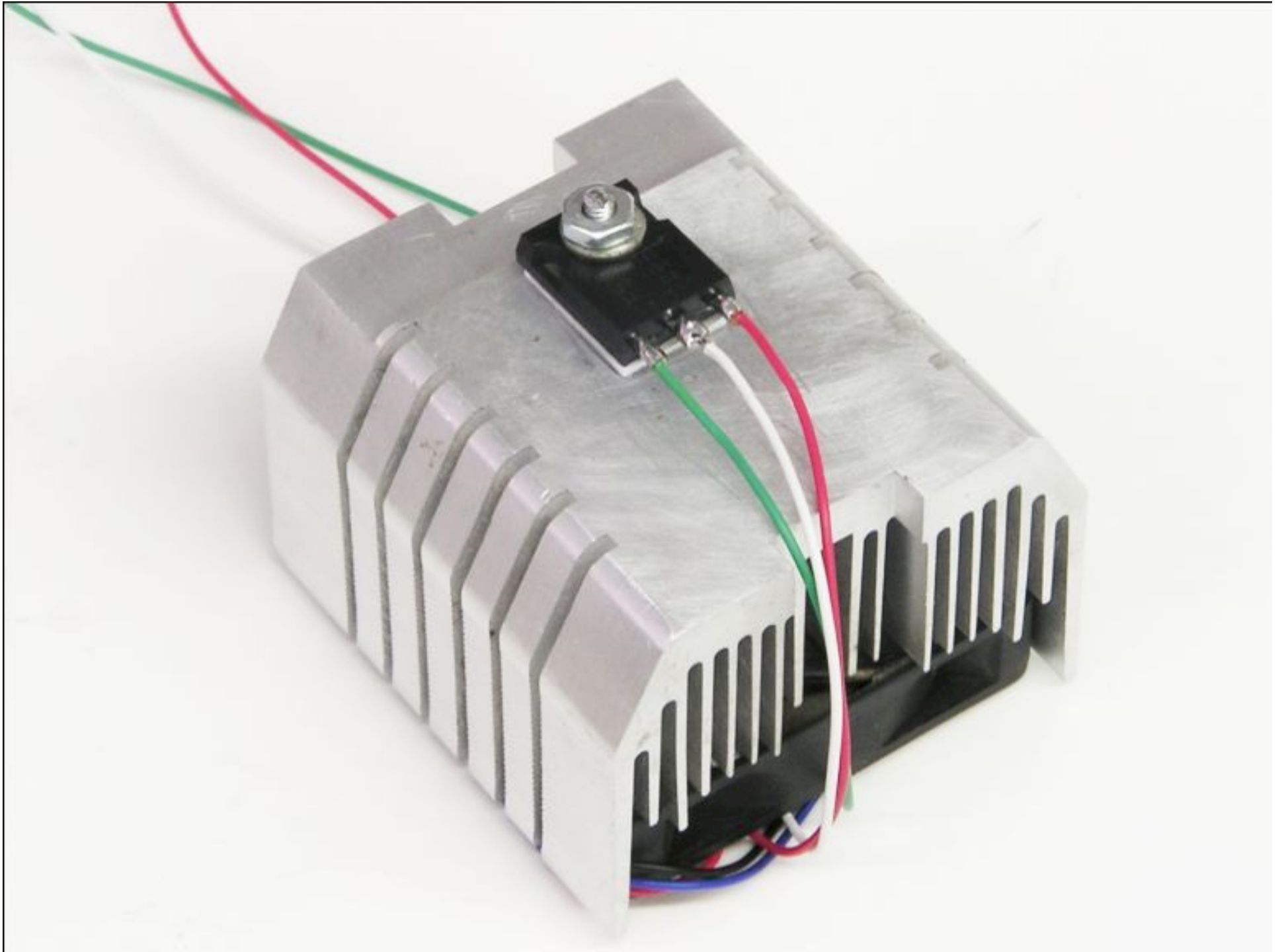
Symbol	Parameter	D ² PAK	DPAK	TO-220	TO-220FP	Unit
R _{thJC}	Thermal resistance junction-case	3	8	5	5	°C/W
R _{thJA}	Thermal resistance junction-ambient	62.5	100	50	60	°C/W

$$V_{in} - V_{out} / A = \Omega$$

$$12V - 5V / 500 \text{ mA} = 14\Omega$$

~3.5 watts of heat





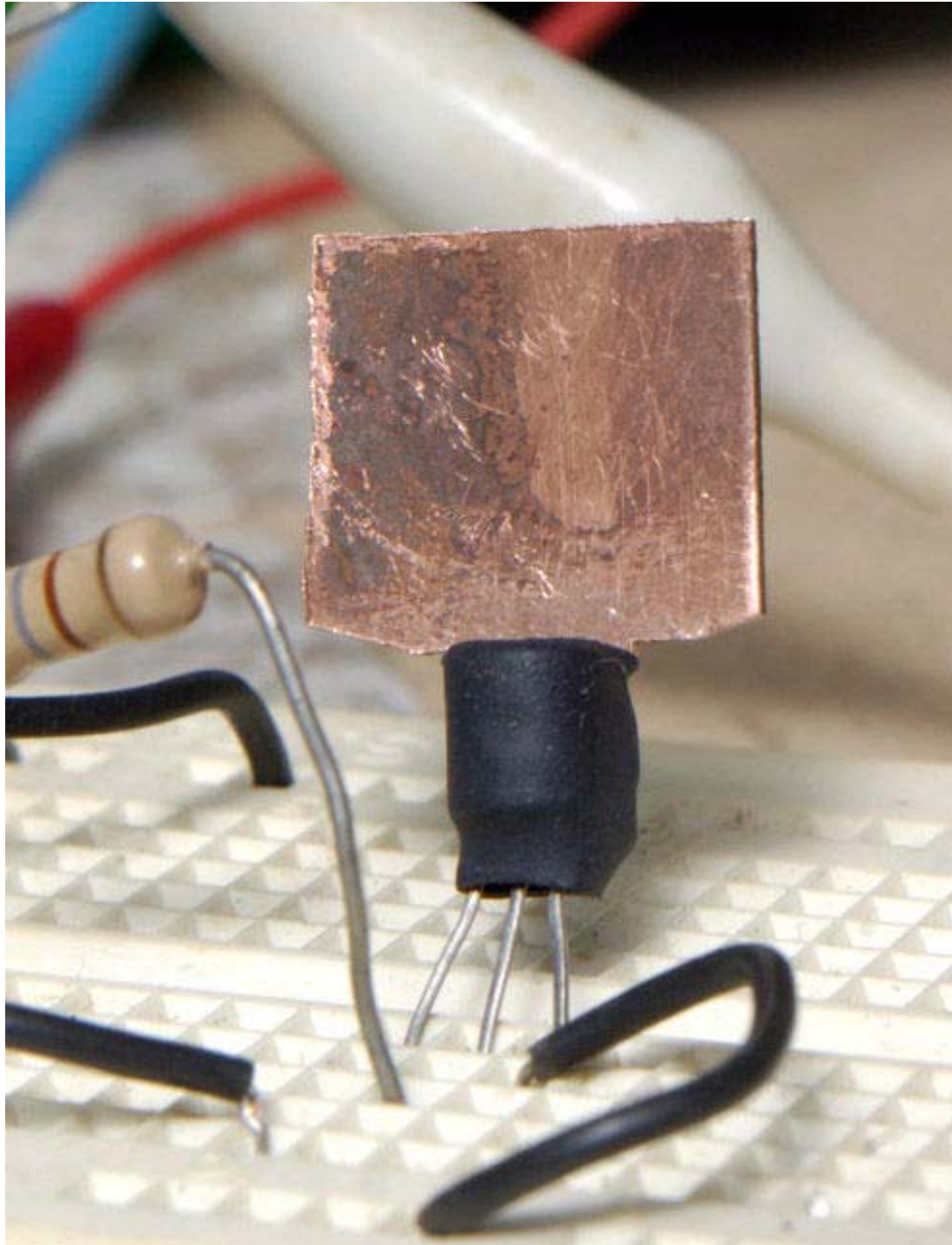
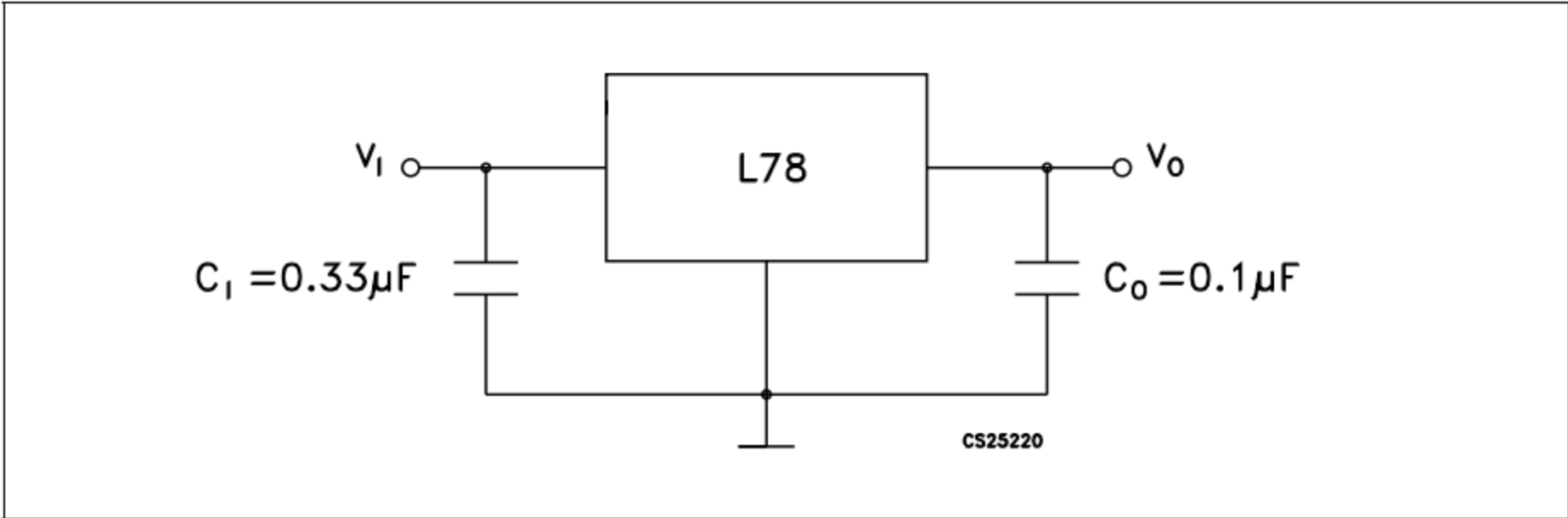


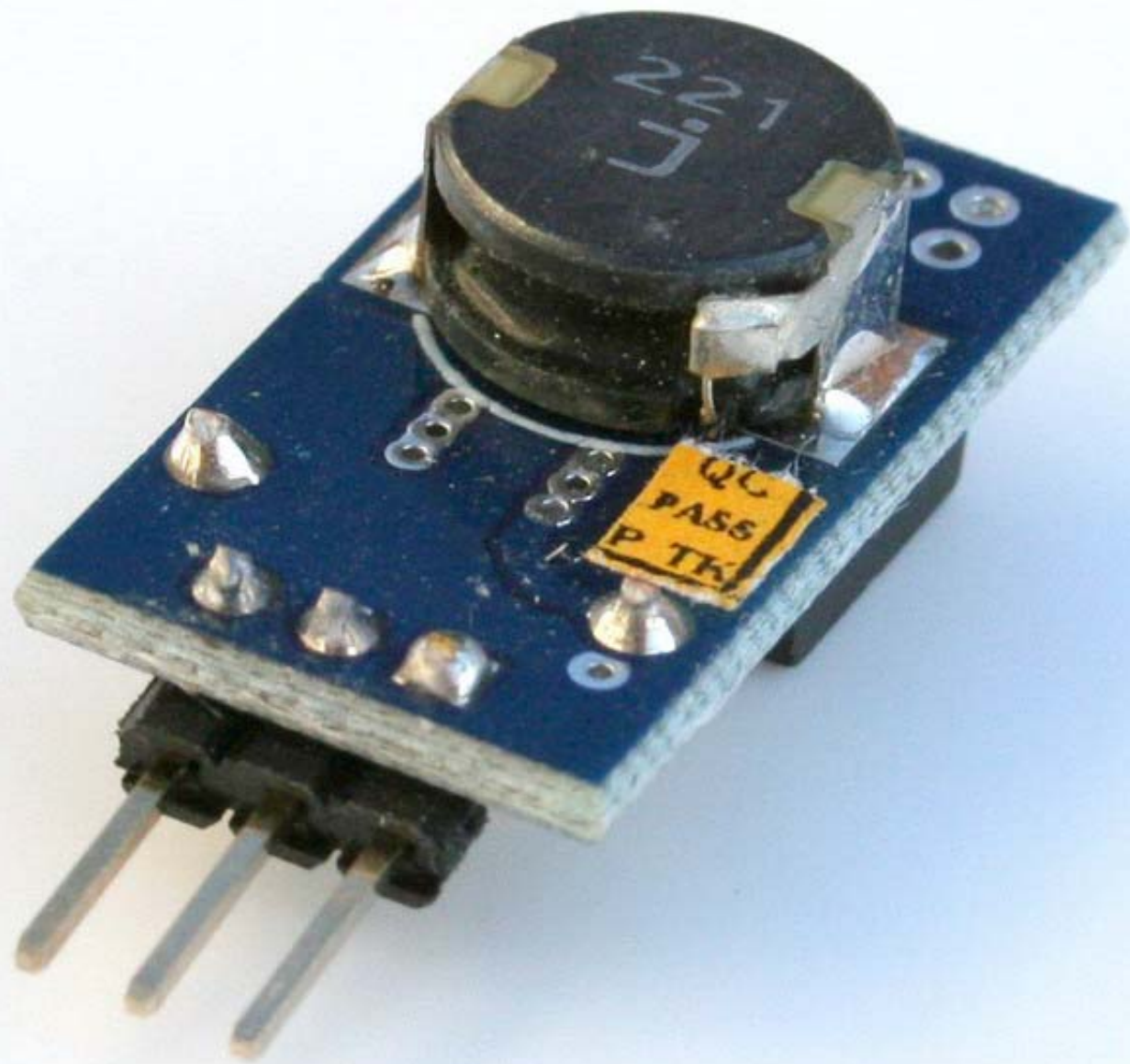


Figure 4. Application circuits



Linear Regulator

- Pros:
 - Cheap
 - Compact package
 - Clean power
- Cons:
 - Inefficient
 - May require heat sink
 - Difficult to drop high voltages





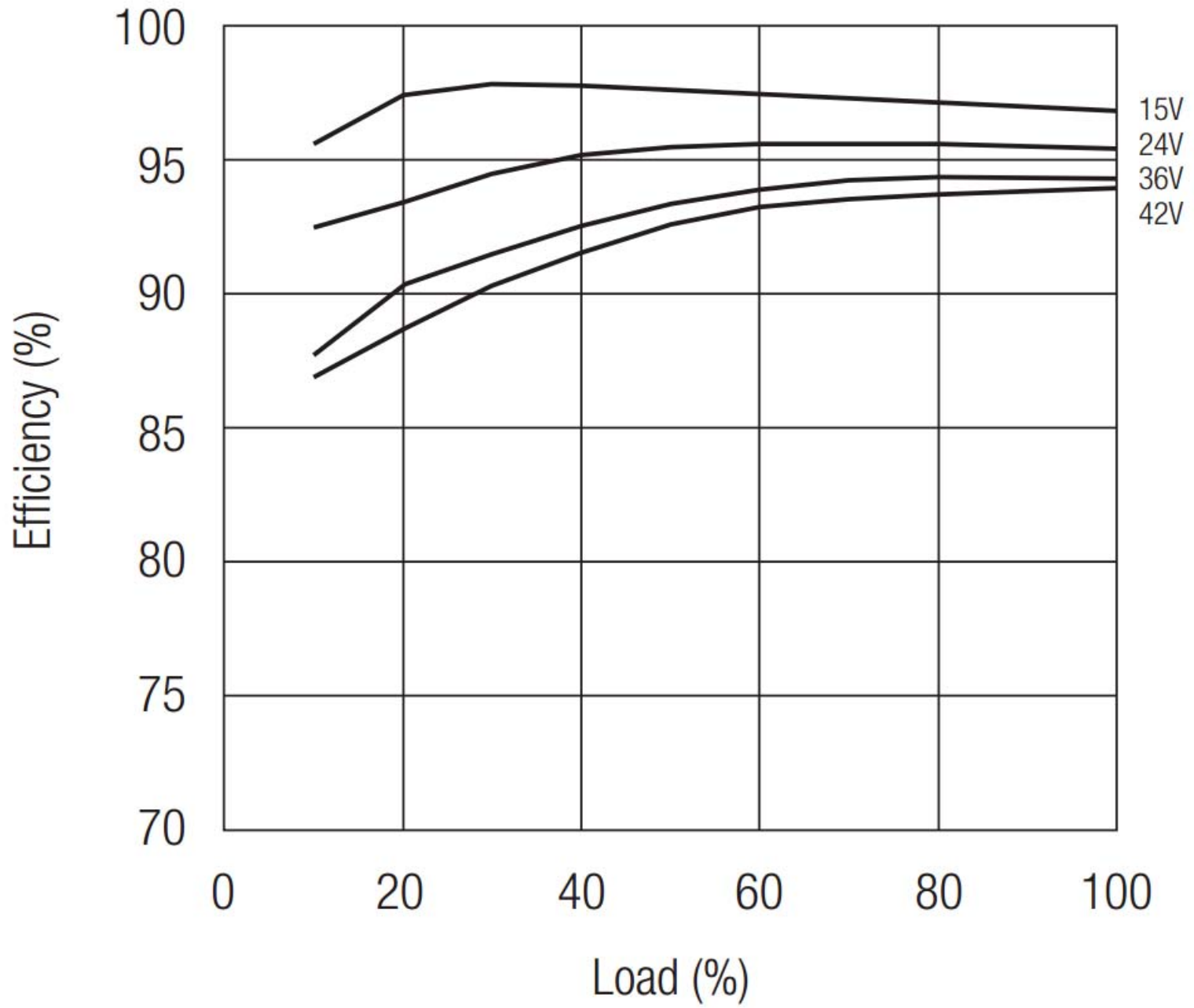
om Power R-78T12-1.0/AC-R

All prices are in US dollars.

Price Break	Unit Price	Extended Price
1	11.92000	11.92
5	11.83000	59.15
10	11.74200	117.42
25	11.56640	289.16
50	11.21600	560.80



Image shown is a representation only. Exact specifications should be obtained from the product data sheet.





Max Amps

10 amps peak**
Max continuous current**
<12 volts input = 7 amps
<24 volts input = 5 amps

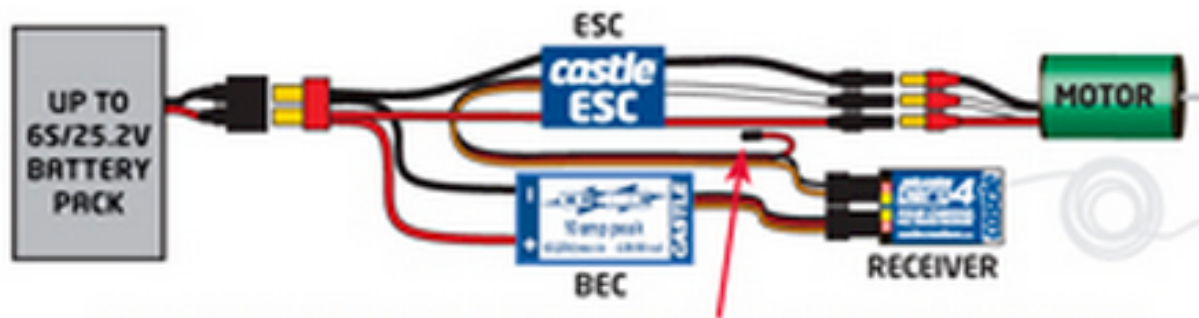
Max Volts

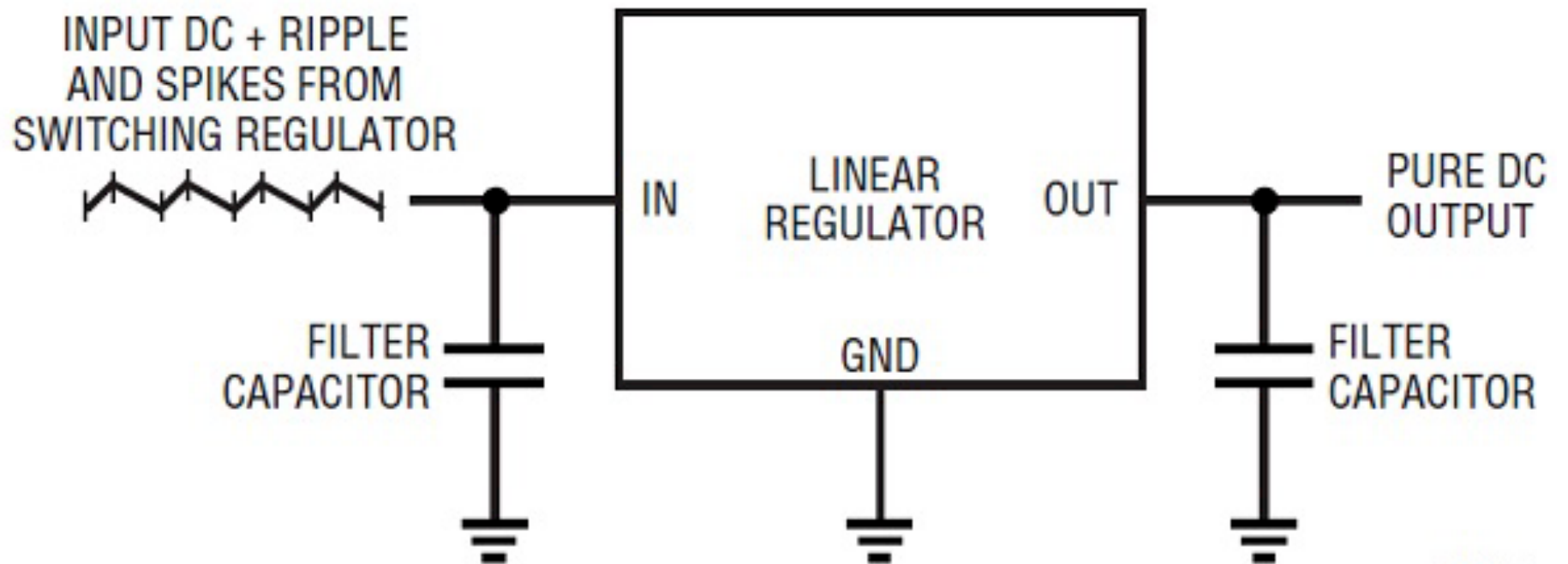
5v to 25v
2s to 6s LiPo

Adjustable Output Voltage

4.8V to 9 volts.

Wiring Diagrams (click image to open)



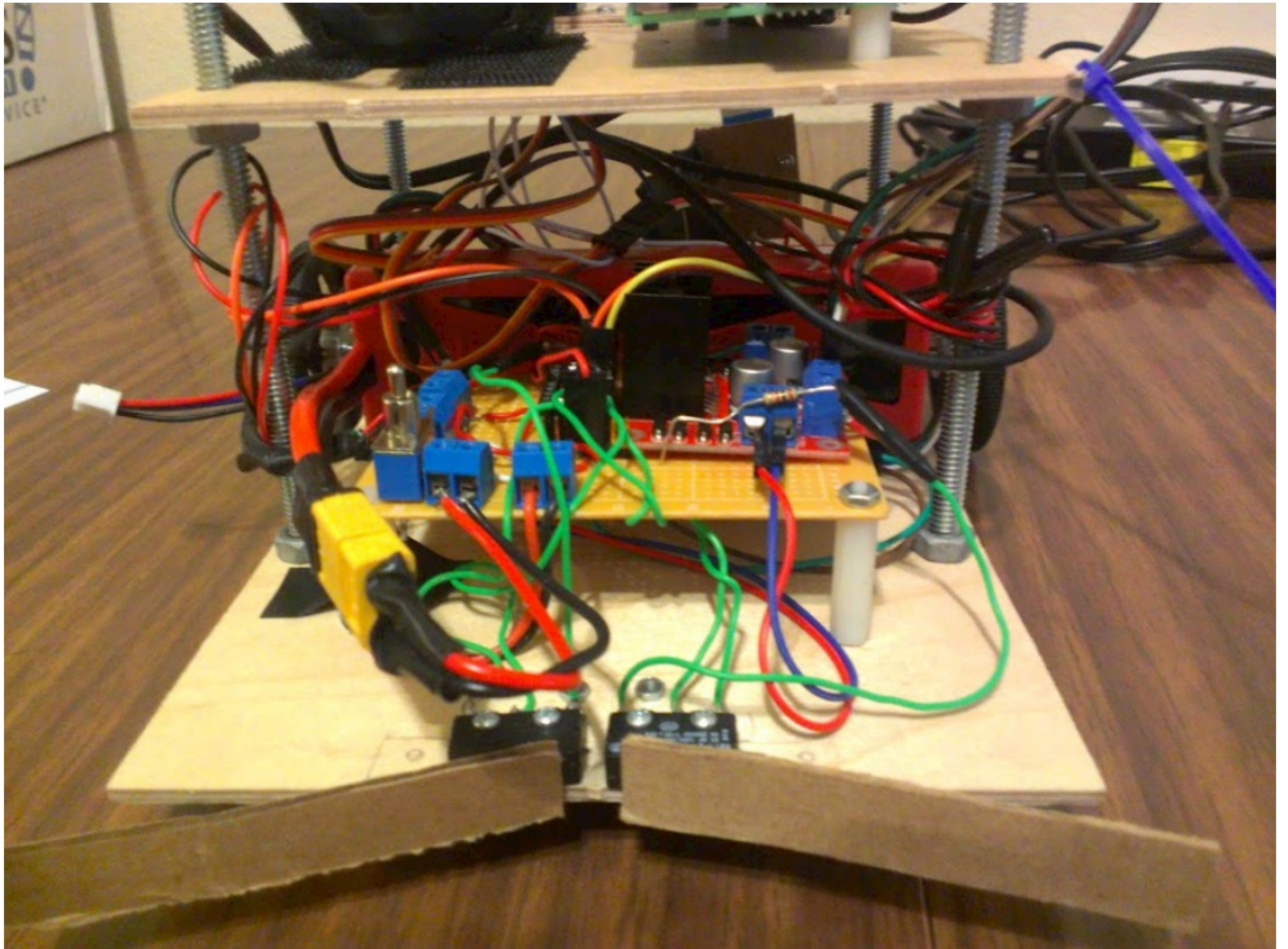


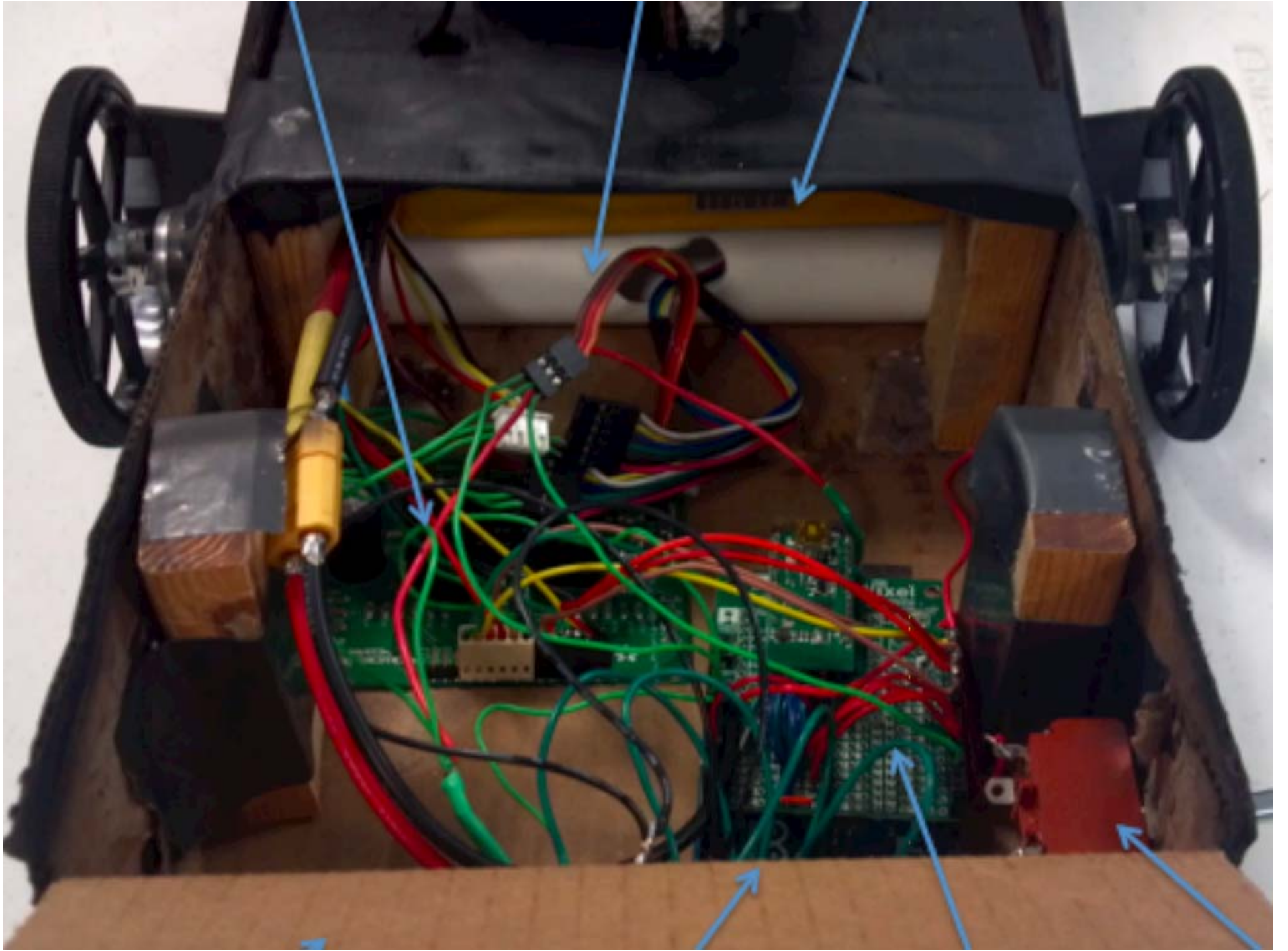
AN101 F01

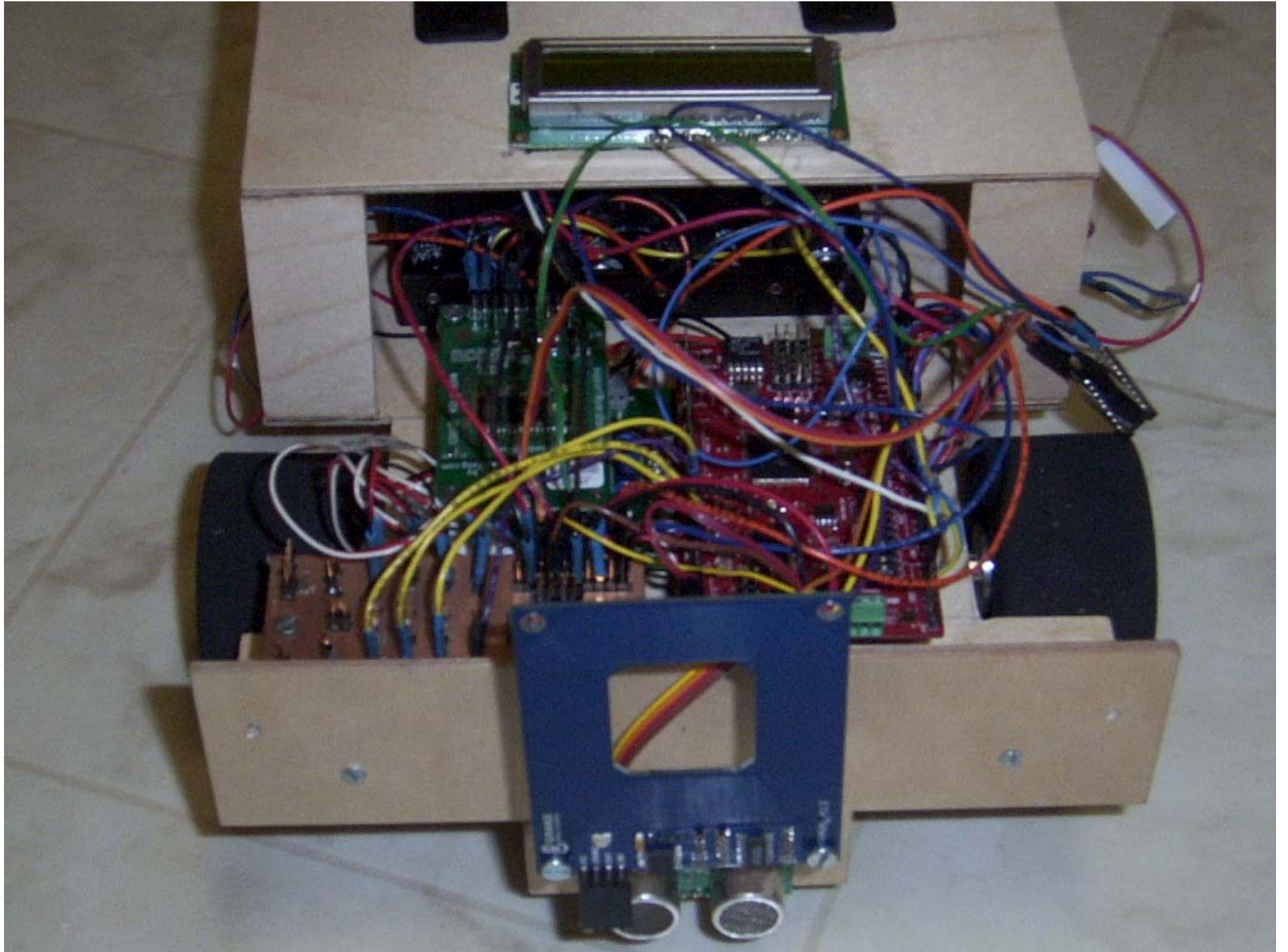
Switching Regulator

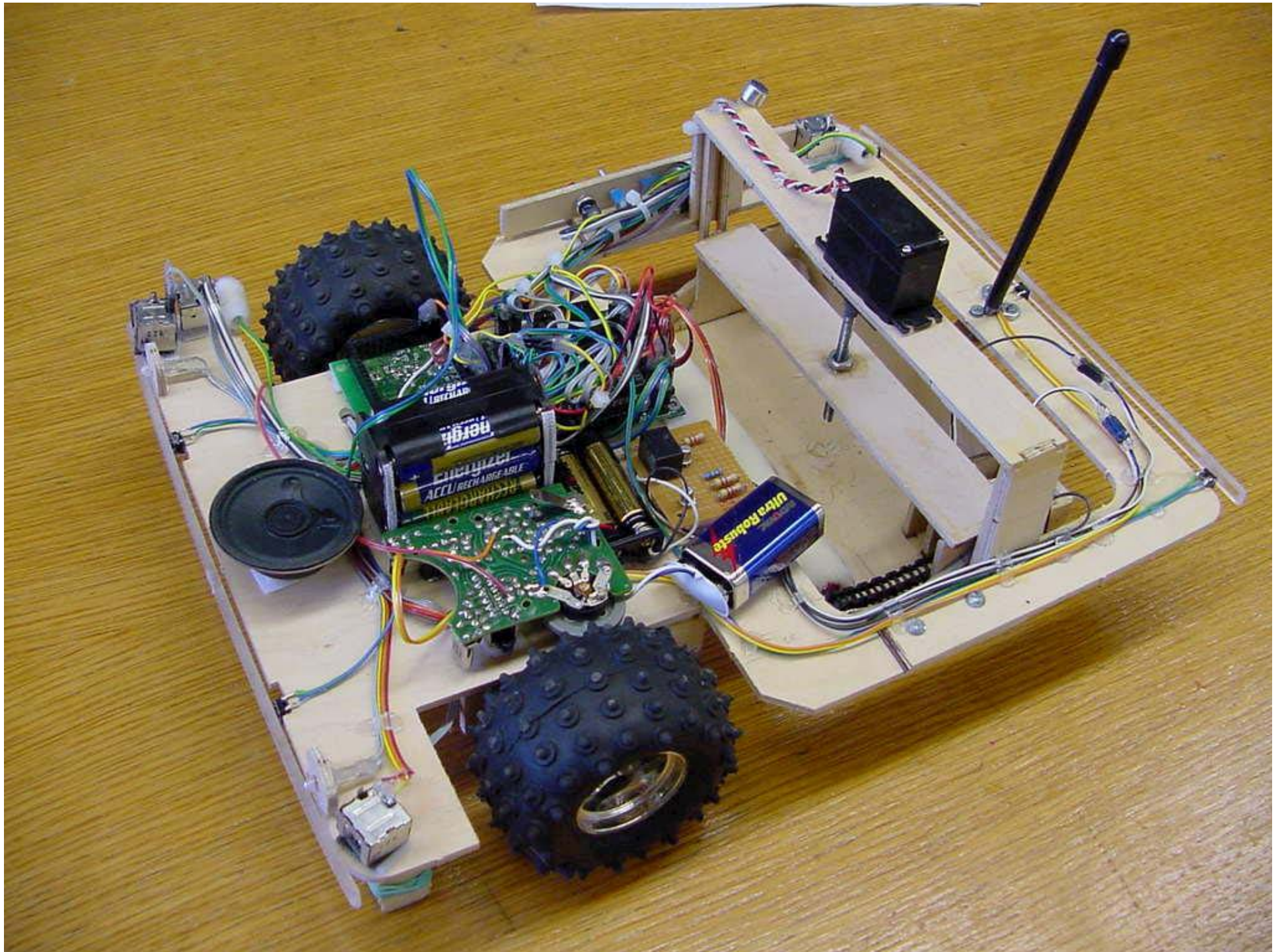
- Pros:
 - Efficient
 - Able to drop high voltages
- Cons:
 - More Expensive
 - Larger package
 - Noisy power

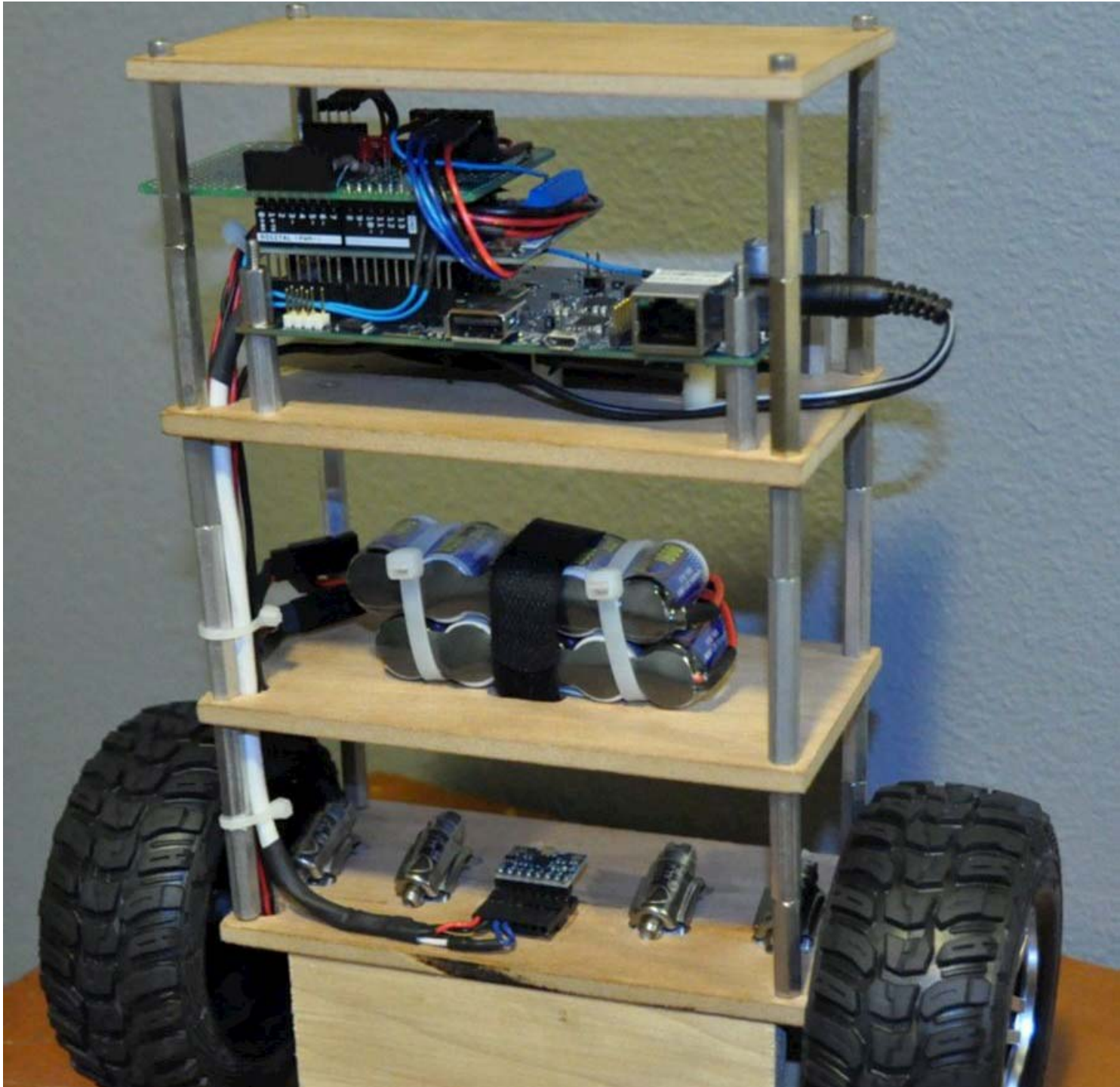
Wire Management



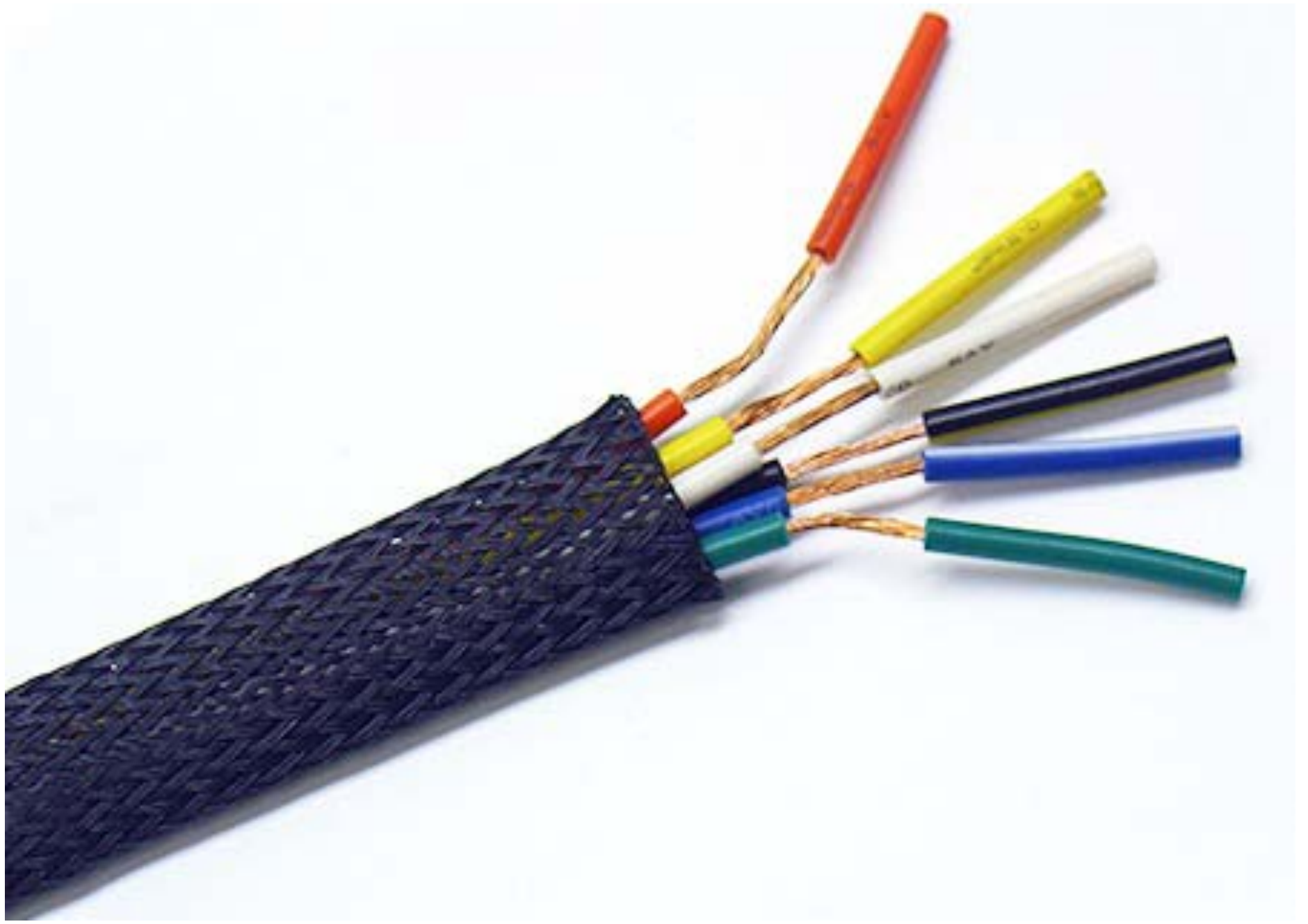






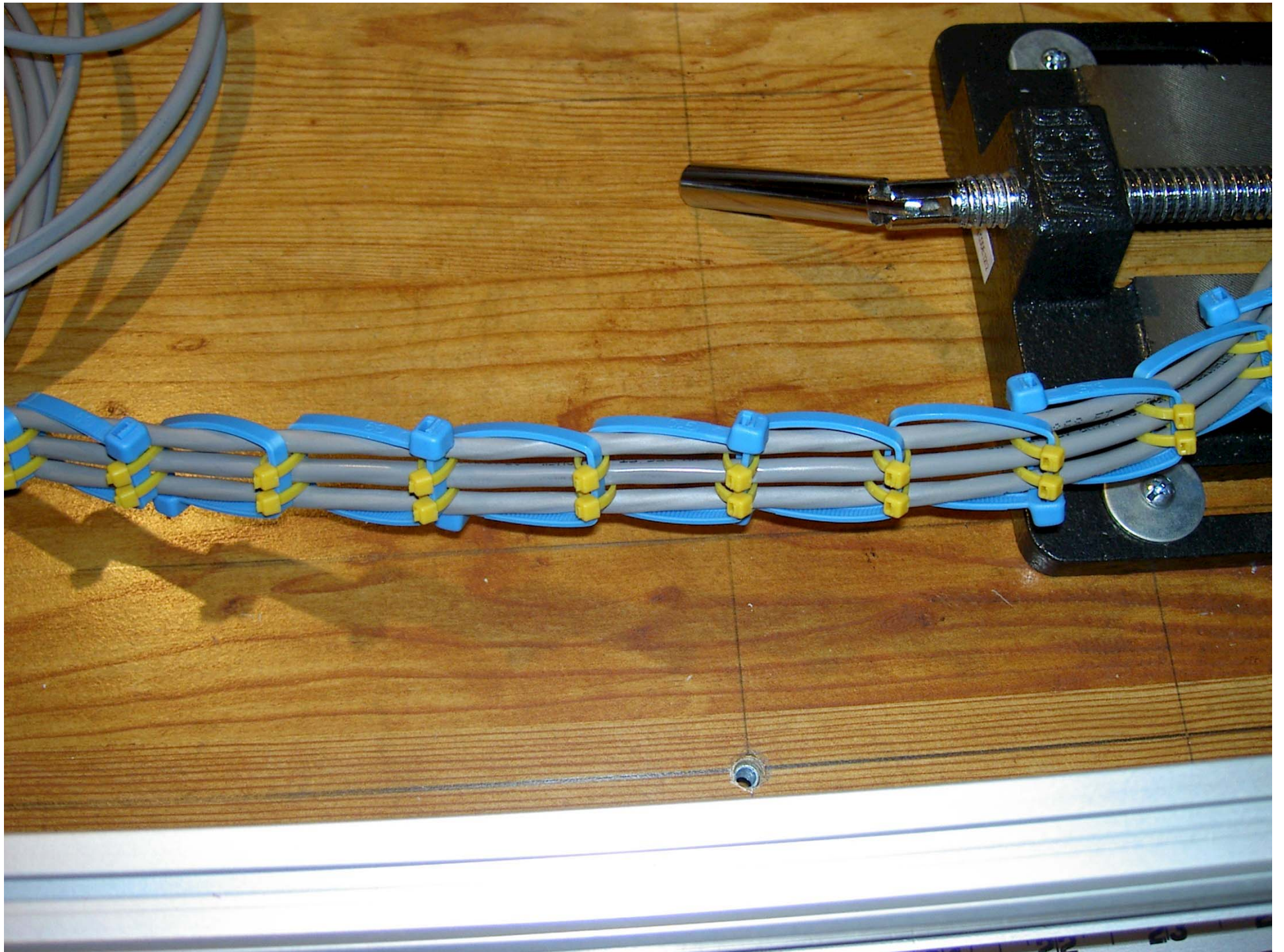


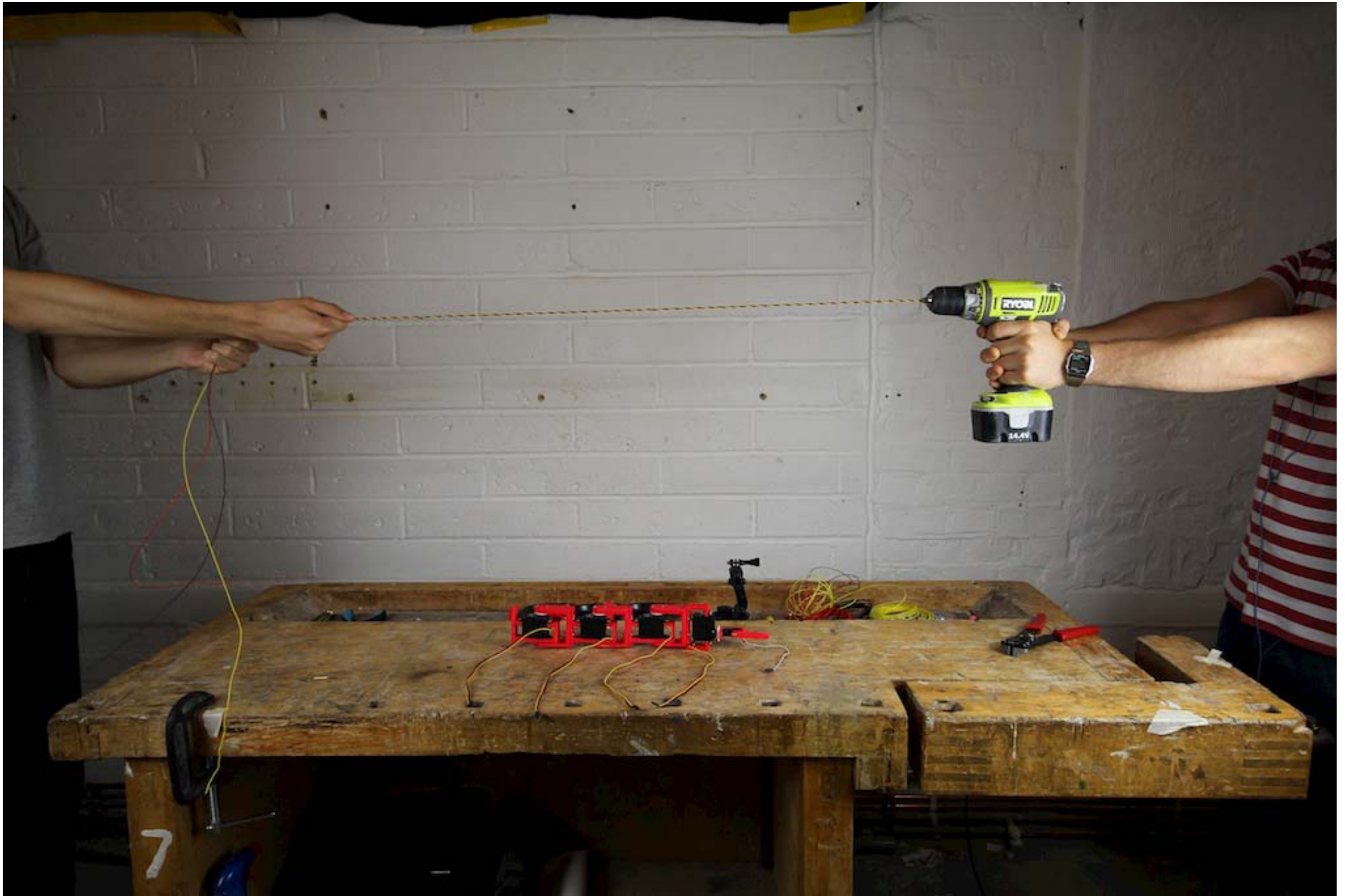
Wire Management tools

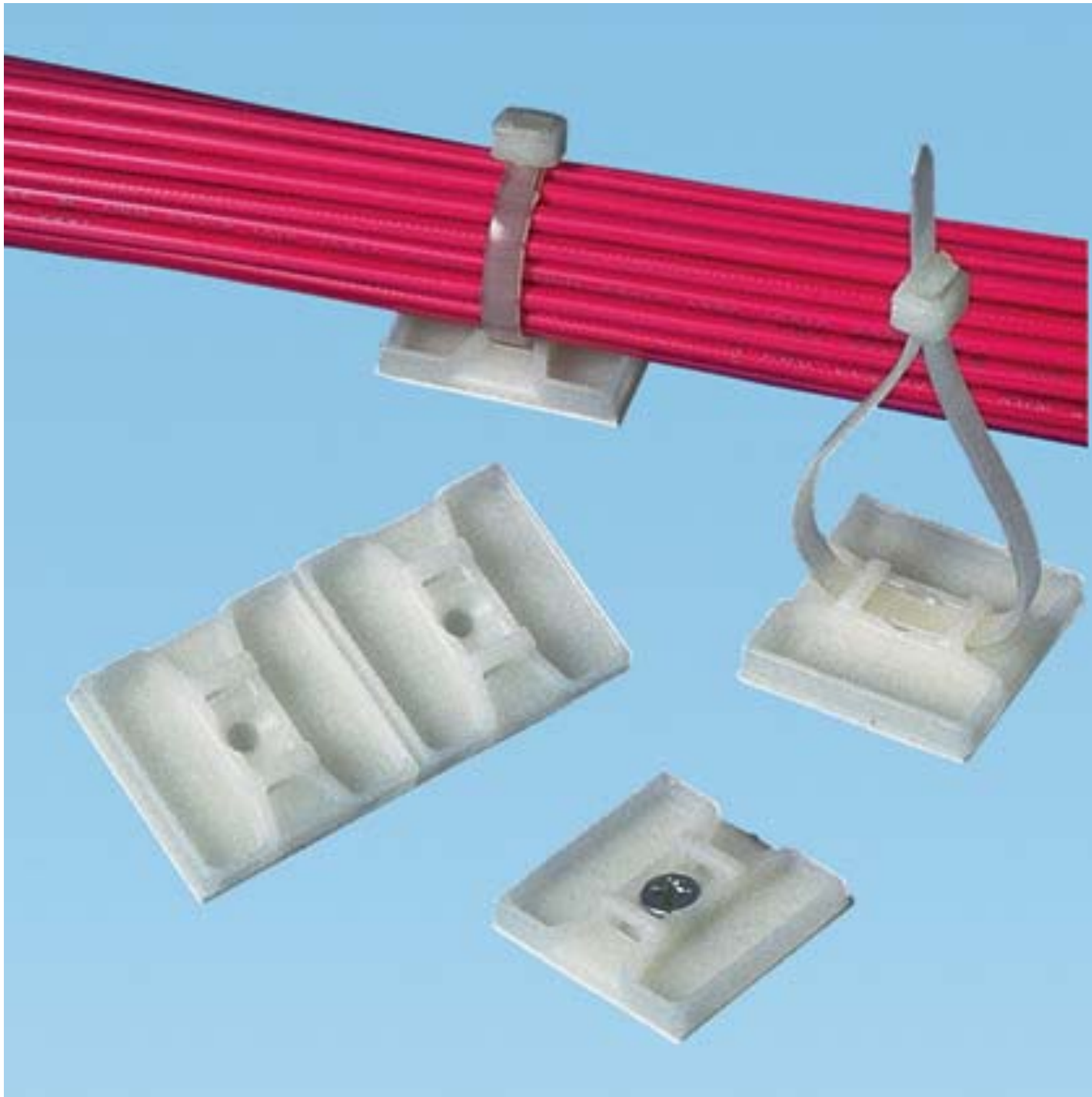












Questions