

Maxon Motor GB 2008



Motor Speed Controller PCB

Kit Documentation

Version 1.6
September 2008

Versions History

1.0	Dec 27,2007	First version
1.1	Dec 28,2007	Added completed PCB picture
1.2	Dec 31,2007	New complete Schematic and PCB Sections Picture
1.3	Jan 14, 2008	Updated FAQ, Updated Schematic with measurements
1.4	May 14,2008	D56 Part Number correction on Schematic
1.5	Aug 25,2008	R52 Part Number correction and FAQ update
1.6	Sept 3,2008	Schematic correction (ver 2.3) and FAQ update



Integrated
Battery Charge
Supply

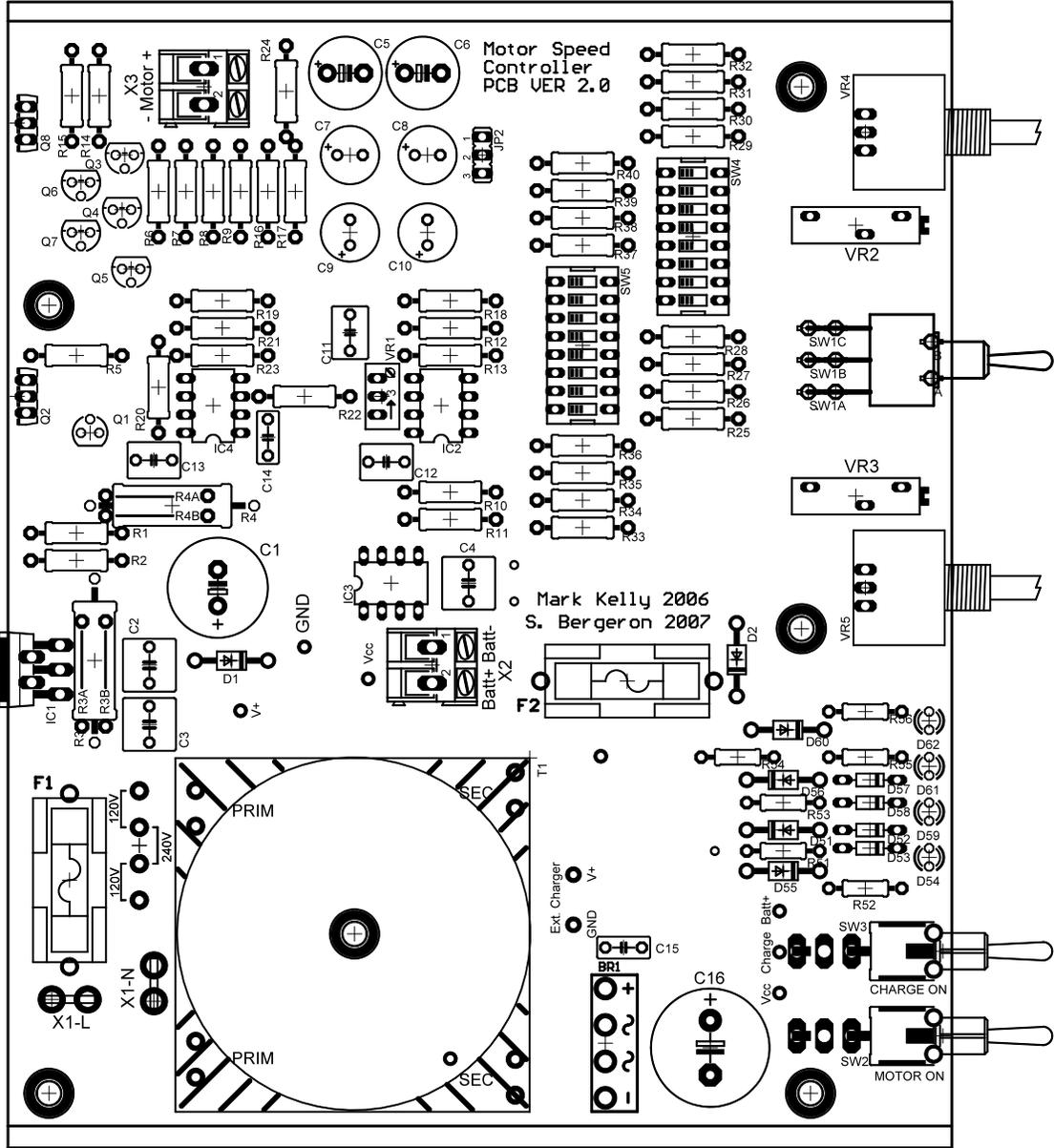
Mark's Controller Board

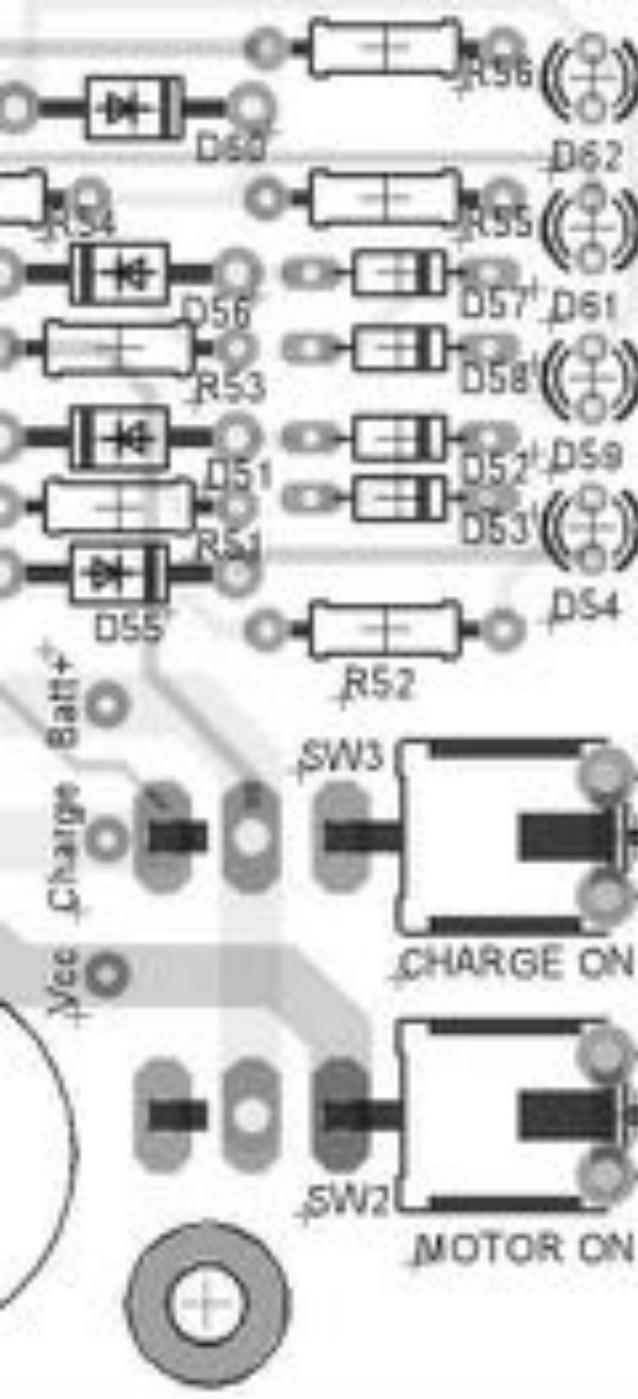
Batt Fuse

LEDs
Indicators

Pwr & Charge
Switches

Mark's Adjustment Board





- ✦ BLU - Power On
 - ✦ RED - Charge On
 - ✦ YEL - Trickle Charge
 - ✦ GRN - Battery Ok
- (Led longer leg = Anode)

	SW2	SW3	Function
+ UP	UP	UP	Motor ON / Charger OFF
+ DN	DN	DN	Motor OFF / Charger ON
+ UP	DN	DN	Motor ON / Charger ON
+ DN	UP	UP	Motor OFF / Charger OFF

MOTOR CONTROLER PARTS LIST

ea

Ref	PART NO.	DESCRIPTION	Manufacturer	VENDOR	Price US\$	QTY	Total
MAIN PCB							
SEMI-CONDUCTORS							
BRG1	RS402LDI-ND	Bridge rectifier, 100V / 4A		Digikey	\$1.50	1	\$1.50
D1	1N4004DICT-ND	1N4004, Rectifier Diode, 1A, 400V		Digikey	\$0.26	1	\$0.26
D2	1N4936	Diode, Fast Recovery, 1A, 400V, DO-41		Digikey	\$0.27	1	\$0.27
IC1	497-1382-5-ND	IC, L200C, Volt & Cur. Regulator		Digikey	\$1.92	1	\$1.92
IC2,4	OPA2277PA-ND	IC DUAL PRECISION OPAMP		Digikey	\$3.53	2	\$7.06
IC3	296-12732-5-ND	IC REF02, +5V VOLTAGE REFERENCE		Digikey	\$3.11	1	\$3.11
Q1,6,7	512-BC557	Trans. BC557, PNP, -45V, 100ma		Mouser	\$0.11	3	\$0.33
Q2	511-BD140	Trans. BD140, PNP, -80V, 1.5A		Mouser	\$0.41	1	\$0.41
Q3,4	512-BC337	Trans. BC337, NPN, 45V, 0.8A		Mouser	\$0.15	2	\$0.30
Q5	512-BC547	Trans. BC547, NPN, -45V, 100ma		Mouser	\$0.09	1	\$0.09
Q8	511-BD139	Trans. BD139, NPN, 80V, 1.5A		Mouser	\$0.41	1	\$0.41
CAPACITORS							
C1	P5555-ND	Cap. 1000uF, 35V, Panasonic NHG		Digikey	\$1.11	1	\$1.11
C5,6	P10253-ND	Cap. 1000uF, 16V, Panasonic FC		Digikey	\$0.77	2	\$1.54
C2,3	505mpk20.22/100/5	Cap. 220nF, Wima MKP 100V		Mouser	\$1.02	2	\$2.04
C4	505mpk20.33/100/5	Cap. 330nF, Wima MKP 100V		Mouser	\$1.18	1	\$1.18
C7-10	P10274-ND	Cap. 470uF, 16V, Panasonic FC		Digikey	\$0.53	4	\$2.12
C11-13,15	505mpk20.1/100/5	Cap. 100nF, Wima MKP 100V		Mouser	\$0.65	4	\$2.60
C14	5982-15500V100	Cap. 100pF, CDE Mica x15		Mouser	\$0.58	1	\$0.58
C16	P5556-ND	Cap. 2200uF, 35V, Panasonic NHG		Digikey	\$1.71	1	\$1.71
RESISTORS - 1/4W, 1% (Otherwise Noted)							
R1	750XBK-ND	Res. 750R, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R2	3.01KXBK-ND	Res. 3K01, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R3	71-RS1A-0.75	Res. 0R75, 1W, 1%, RS1A1 Wirewound	Dale	Mouser	\$1.35	1	\$1.35
R4	71-RS01A4R000FE12	Res. 4R0, 1W, 1%, RS1A1 Wirewound	Dale	Mouser	\$1.04	1	\$1.04
R5,10,12,14,26,31,34,39	4.75KXBK-ND	Res. 4K75, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	8	\$0.78
R6	71-RN55D-F-4.99	Res. 4R99, 1/4W, 1%, MF, RN55	Dale	Mouser	\$0.99	1	\$0.99
R7	49.9XBK-ND	Res. 49R9, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R8,9	100XBK-ND	Res. 100R, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	2	\$0.20
R11,13,19,21,22	1.00KXBK-ND	Res. 1K, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	5	\$0.49
R15	475XBK-ND	Res. 475R, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R16	681XBK-ND	Res. 681R, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R17,18,20,27,30,35,38	10.0KXBK-ND	Res. 10K, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	7	\$0.69
R23	475KXBK-ND	Res. 475K, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	1	\$0.10
R24	Not Used	Res. Select, Depends on Motor Current	Yageo	Digikey	\$0.10	0	\$0.00
R25,32,33,40	2.49KXBK-ND	Res. 2K49, 1/4W, 1%, MF, MF25	Yageo	Digikey	\$0.10	4	\$0.39
R28,29,36,37	20.0KXBK-ND	Res. 20K	Yageo	Digikey	\$0.10	4	\$0.39
POTENTIOMETERS & SWITCHES							
VR1	594-64W503	Pot. 50K, 3.8", Vertical, Linear, 25T	Spectrol	Mouser	\$1.95	1	\$1.95
VR2,3	3006P-502LF-ND	Pot. 5K, 3/4" Horizontal, 25T	Bourns	Mouser	\$1.23	2	\$2.46
VR4,5	91A1A-B24-B13L-ND	Pot. 5K, 12mm,1T, 500mW, Cond Plastic	Bourns	Digikey	\$4.75	2	\$9.50
SW1	360-1836-ND	Switch, DPDT, On-On Vert-Right Angle	NKK	Digikey	\$7.60	1	\$7.60
SW2,3	360-1792-ND	Switch, SPDT, On-On Vert-Right Angle	NKK	Digikey	\$5.35	2	\$10.70
SW4,5	CT2068-ND	8 DIP sw.,206 series,top slide	CTS	Digikey	\$0.65	2	\$1.30
SW & Led Battery Status Indicator							
R51,54,55	1.00KXBK-ND	Res. 1K, MF, 1%	Panasonic	Digikey	\$0.10	3	\$0.29
R52	332XBK-ND	Res. 332, MF, 1%	Panasonic	Digikey	\$0.10	1	\$0.10
R53	2.21KXBK-ND	Res. 2K21, MF, 1%	Panasonic	Digikey	\$0.10	1	\$0.10
R56	47.5KXBK-ND	Res. 47K5, MF, 1%	Panasonic	Digikey	\$0.10	1	\$0.10
D51	1N5237B-TP	1N5237B, Zener Diode, 8.2V, 1/2W		Digikey	\$0.08	1	\$0.08
D52,58	1N4148-TP	1N4148, Small Signal Diode		Digikey	\$0.05	2	\$0.11
D53,57	Not Used	1N4148, Small Signal Diode		Digikey	\$0.05	0	\$0.00
D54	160-1142-ND	Led, Green, 3MM HI-EFF DIFFUSED		Digikey	\$0.19	1	\$0.19
D55	1N4731A-TP	1N4731A, Zener Diode, 4.3V, 1W		Digikey	\$0.08	1	\$0.08
D56	1N4741A-TP	1N4741A, Zener Diode, 11V, 1W		Digikey	\$0.08	1	\$0.08
D59	160-1145-ND	Led, Yellow, 3MM HI-EFF DIFFUSED		Digikey	\$0.19	1	\$0.19
D60	1N5245B-TP	1N5245B, Zener Diode, 15V, 1/2W		Digikey	\$0.08	1	\$0.08
D61	160-1139-ND	Led, Red, 3MM HI-EFF DIFFUSED		Digikey	\$0.19	1	\$0.19
D62	160-1600-ND	LED - Blue T1(3MM) POWER Indicator		Digikey	\$0.50	1	\$0.50
HARDWARE & MISC							
TRANSFORMERS							
T1	TE70033-ND	Transformer, Output: 15VAC Serie @ 0.466A		Digikey	\$14.83	1	\$14.83
CONNECTORS							
J1 (Battery)	31-157-0	Conn. 2.1MM DC POWER JACK 2A, Panel	Mode	e-sonic	\$1.55	1	\$1.55
J1a	31-121-0	Conn. 2.1MM DC POWER PLUG SHORT	Mode	e-sonic	\$0.72	1	\$0.72
J2 (Motor)	25-732-0	Conn. Mike 2 pins connector, Panel Mount	Mode	e-sonic	\$1.92	1	\$1.92
J2a	25-722-0	Conn. Mike 2 pins Male (For cable)	Mode	e-sonic	\$1.92	1	\$1.92
J3	Q210-ND	AC Input Conn.		Digikey	\$1.00	1	\$1.00
X1L,N	A29938CT-ND	Stack-On, PCB mount connector		Digikey	\$0.06	2	\$0.11
X2,3	281-1421-ND	Conn. 2 pins, Screw Terminal, 5MM	Weidmuller	Digikey	\$0.75	2	\$1.50
FUSES & etc.							
Fuse Socket	96F8317	5x20mm PCB mount fuseholder	Schurter	Newark	\$1.02	2	\$2.04
F1,2	F2416-ND	0.5A, 250V IEC SLO 5X20MM (GDC 500ma)		Digikey	\$0.82	2	\$1.64
HARDWARE & MISC							
JP2	93K5737	Header, 3 pins, gold		Newark	\$0.10	1	\$0.10
	97F9686	Header Jumper, 2 pins, long		Newark	\$0.14	1	\$0.14
	BER110-ND	HEATPAD TO-220 .009" SP600		Digikey	\$0.73	2	\$1.46
	BER120-ND	HEATPAD TO-247 .009" SP600		Digikey	\$1.36	1	\$1.36
	ED58083-ND	IC Socket, DIP8, gold plated		Digikey	\$0.77	3	\$2.31

IC sockets and diode (mount diode proud of board)

small signal transistors

connectors

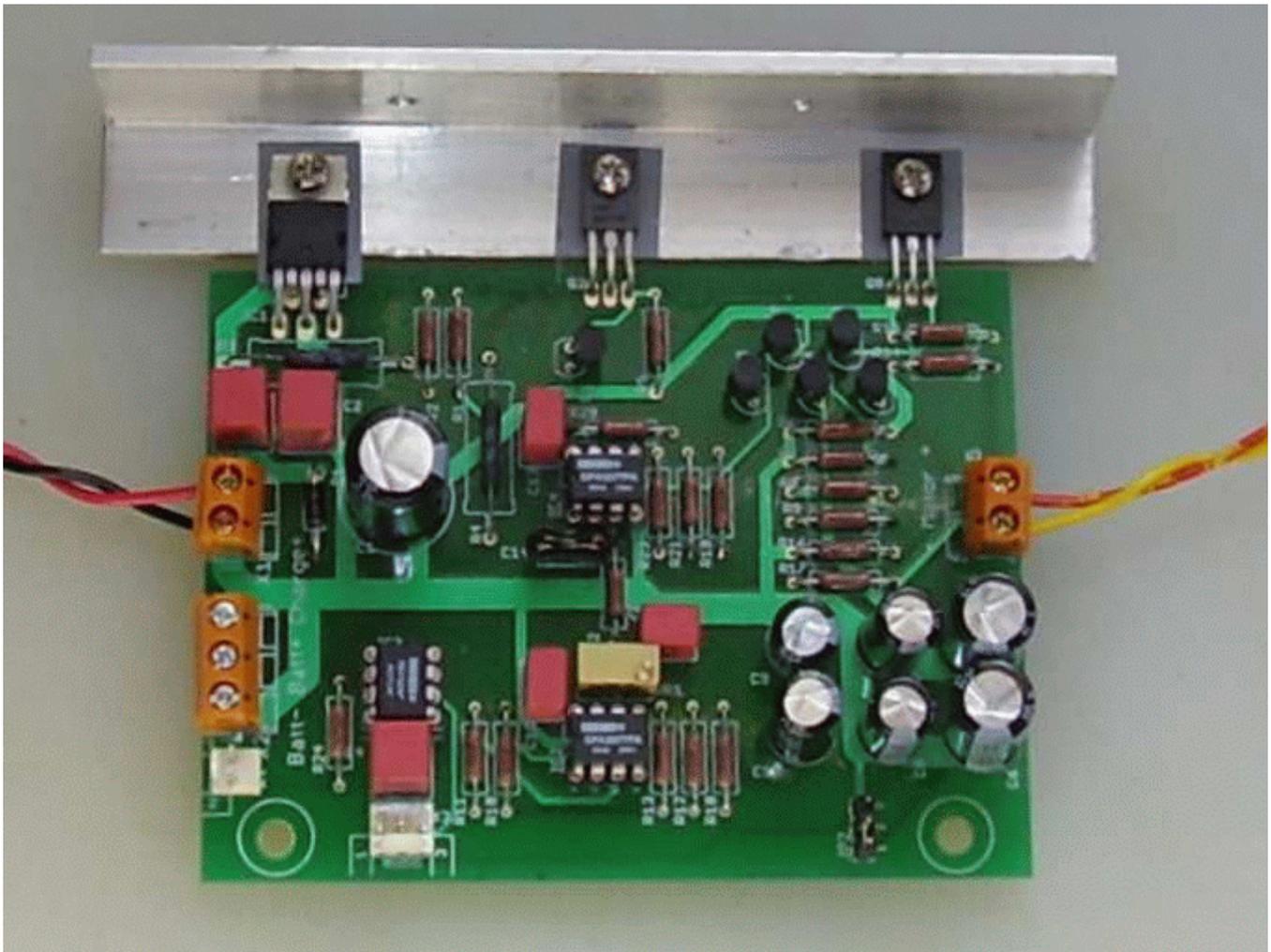
small capacitors

large capacitors.

The pads for the resistors are quite small so you will need good soldering technique to get a reliable joint - keep the tip clean, heat the lead and the pad with iron, touch the solder to the pad so it wicks into the joint.

I recommend attaching the L200C and the two larger transistors to an angle bracket (I used a 125mm length of 20mm x 25mm aluminium angle 3mm thick) before they are soldered to the board. Drill three holes in line 10mm in from the angle edge with centres spaced at 1.5" (my apologies for the mixture of units but the board software I used defaults to inch)

Tap these holes for the hardware in use (I use 3mm ISO screws). Attach the transistors and the L200C to this and bend the transistor leads so they are in line with the inner set of leads on the L200C. Insert all the leads through the PCB holes and solder.



Board and heatsink connection.

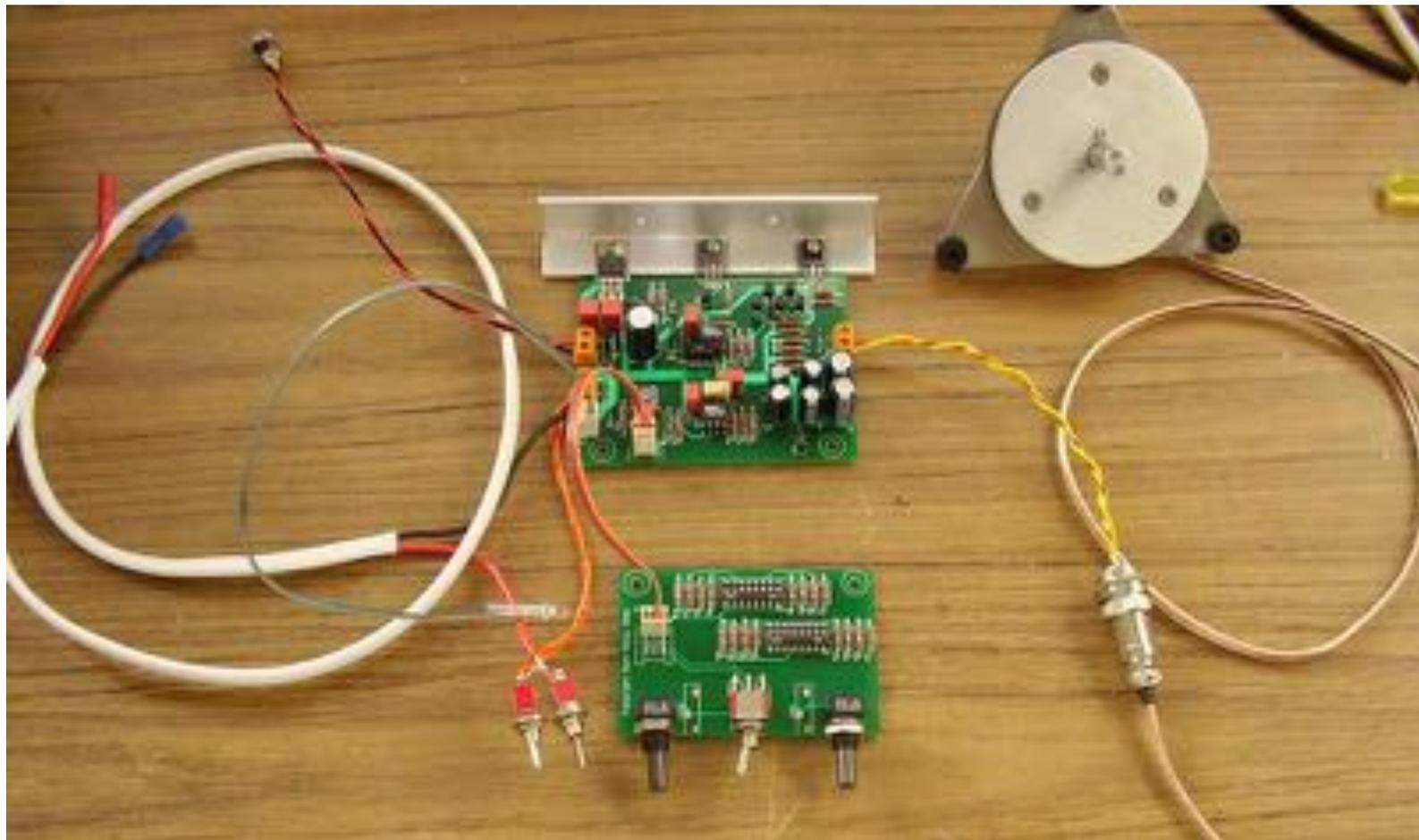
Because the power dissipation in this circuit is so low (less than 3 watts when running without charging) the small piece of aluminium angle as above is all the heatsink it needs. Using the angle as a support on the back panel of the enclosure gives

more than enough heatsinking.

Wiring Up.

NOTE WELL: There is no on board reverse polarity protection. If the circuit is connected to a power source with reversed polarity it will be destroyed. If you can't trust yourself to get it right, install protection diodes at the appropriate terminals. Reversed polarity at the power supply will take out the supply capacitor and the L200C chip. Reversed polarity at the battery will destroy the op-amps, the reference chip, both the power transistors and most likely three of the driver transistors. Don't do it.

The kit does not include wire as the length required depends on enclosure etc.



Built and wired, note this version uses single turn adjustment pots.

The main board and the adjustment board are attached to each other using a three core cable between X3 on the drive board and X6 on the adjustment board. NOTE: due to an error in drafting the three pin connectors should be mounted so that the cable reverses orientation eg pin 1 on one board becomes pin 3 on the other. The plugs use crimp connectors.

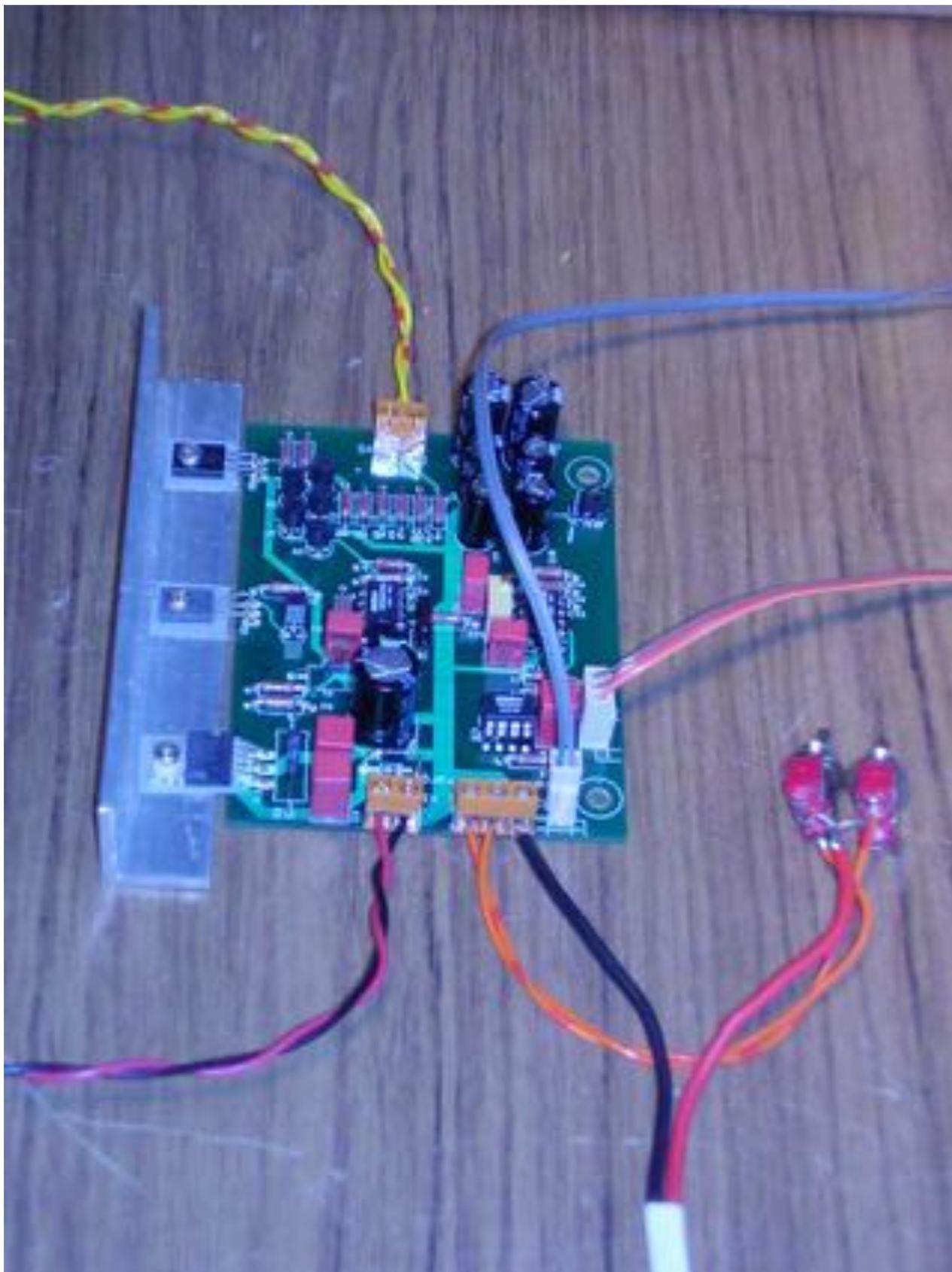
The 2.1mm DC connector is wired to X1 with the positive to the rear terminal (eg closer to the regulator IC) Positive is usually the centre pin but check your power supply BEFORE you power up.

The Batt- terminal at the front of X2 is connected to the negative terminal of the battery. The Batt+ (centre) terminal is taken to a switch. The Charge + (rear) terminal is taken to another switch. The other sides of the two switches are taken to the positive terminal of the battery. I choose to wire the two switches so that "both up" is charge / motor off and "both down" is no charge / motor on. The two switches are independent so that if the supply is switched off for long periods the charge circuit can be disconnected from the battery so that the battery does not drain through the charge circuit (charge off / motor off).

The motor is wired to X5, the polarity given will give correct direction for the Maxon motor for a belt system. Wire from X5 to the two pin JDEC microphone socket and from the equivalent plug to the motor will allow the controller to be disconnected when

required. The JDEC connector plug has a fixing screw on top. Remove this screw then remove the plug insert from the body (bayonet release). Solder the motor wires then reconnect. I use heatsink to give the cable clamp some purchase.

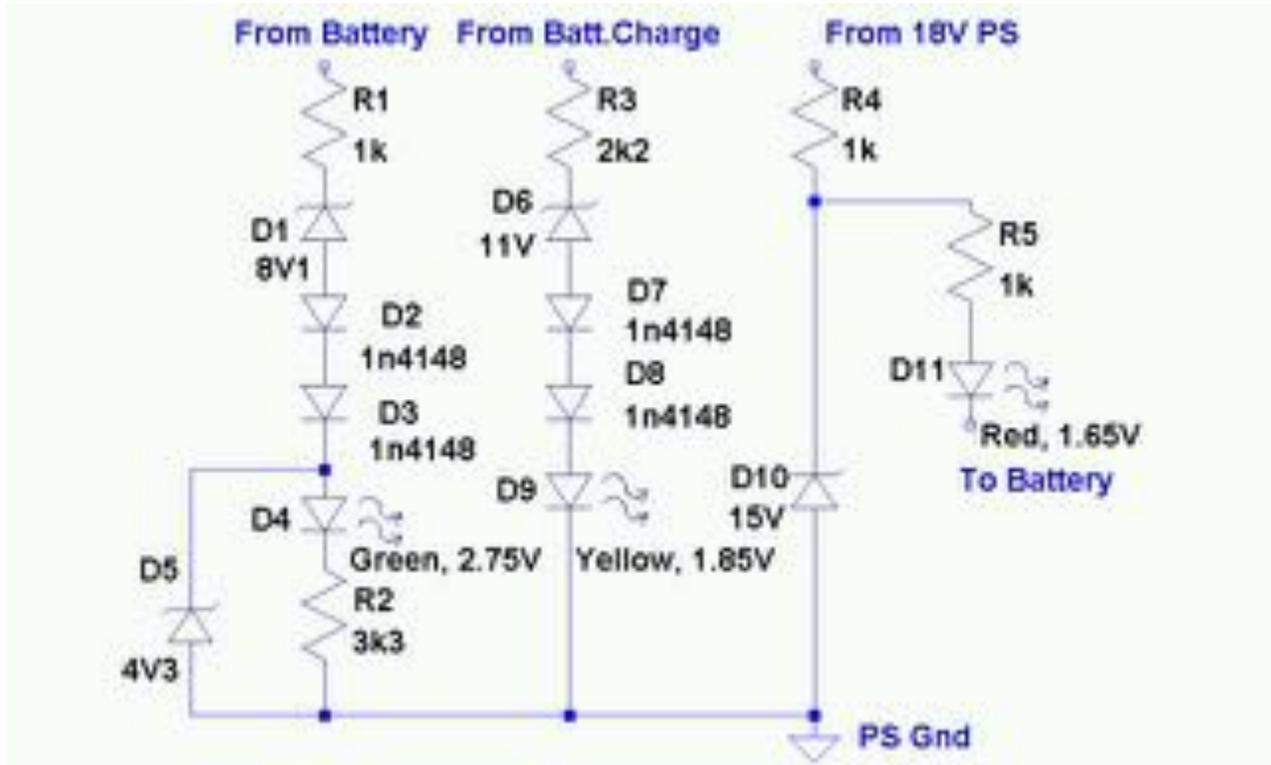
X4 connects the indicator LED, pin 1 to the shorter lead.



Left side showing wiring layout.

Niceties

If you want you can include some charge status LEDs. Here is one scheme:



The red LED indicates current limited charge (CL). The amber LED indicates trickle charge (TC). When the charger is connected to the battery the red LED will light. As the battery voltage comes up to the trickle voltage (13.8V) the red LED will start to fade and the yellow LED will start to glow. When the trickle voltage is reached the red LED will be completely out and the yellow completely on.

The green LED indicates battery OK (> 11.4 volts, dims below 12V). If the blue status LED is on but the green is off or dim the battery needs charging.

I wired the LEDs to the switches for the battery / charger like this: