The Bob Boyce Electrolyzer Project

The Electronics

This Group (http://tech.groups.yahoo.com/group/WorkingWatercar/) has been given permission, most graciously, by Mr. Boyce to present a compilation of his project so that it may perhaps be more easily understood and replicated by the general public.

This document will serve as a roadmap, so to speak, for anyone wishing to delve into replicating the Electronics of Bob's project. At the end you will find a parts list. Good Luck!

In order to view and order the "Printed Circuit Board" you will need to download and install the "ExpressPCB" software, which can be done here:

http://www.expresspcb.com/ExpressPCBHtm/Download.htm

It is approximately 9.29Mb and includes both the ExpressPCB and ExpressSCH programs; though you only need the ExpressPCB to order your circuit boards.

The files for the circuit board are in the files section, under "Bob Boyce Project". I have included 2 versions "PWM3e" & "PWM3f". The "3f" version is the latest revision. There is also a parts list, which can be used to buy parts wherever you wish or you can click on the link below and be linked to digikey.com. This was setup by a guy named Terry, here's what he says:

Posted by: "Terry" Terry photographerbyday

Tue Mar 20, 2007 9:23 pm (PST)

Ok Guys...

I went through Bob's list and created a public BOM at DigiKey for all the board components needed to build one board. Just click on the link and place the order with the totals seen. They take into account the minimum lot you can purchase. You don't have to punch them in yourself now.

It will cost you $54.49 plus shipping. Just under $60 total.

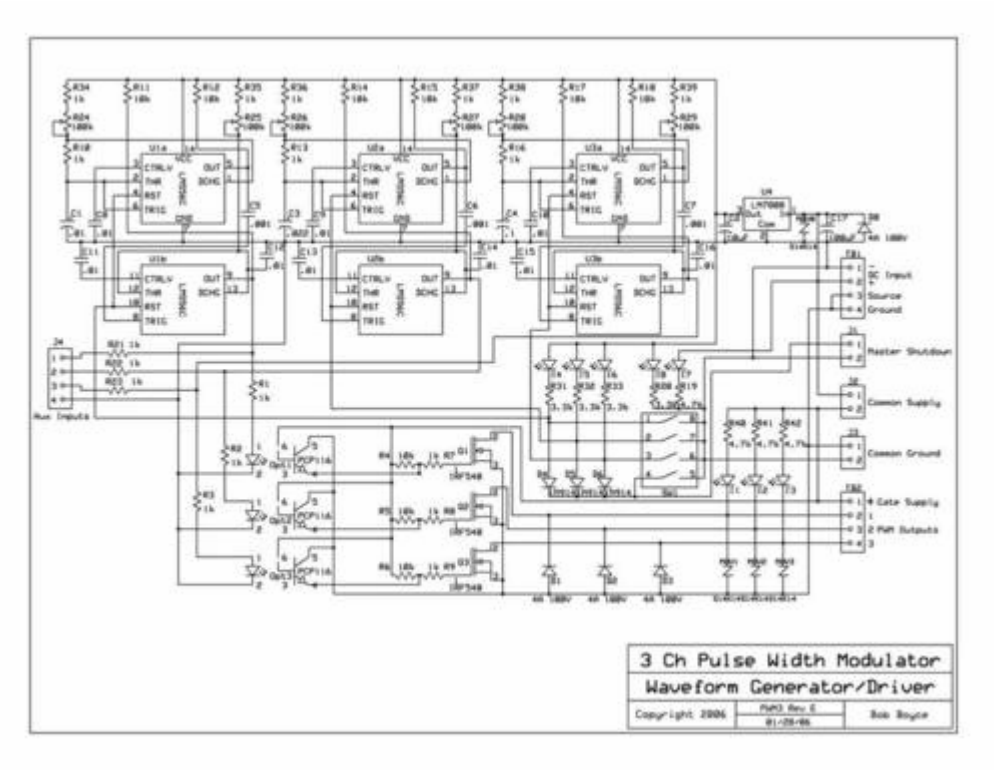
I tried calculating the cost for purchasing enough to build 10 boards and it only saved $4.19 per kit, not worth the hassle, so you can order them yourself.

I did replace one item 3006P-104-ND which has a 5 week lead time because it has lead in it, with the lead free version 3006P-1-104LF-ND.

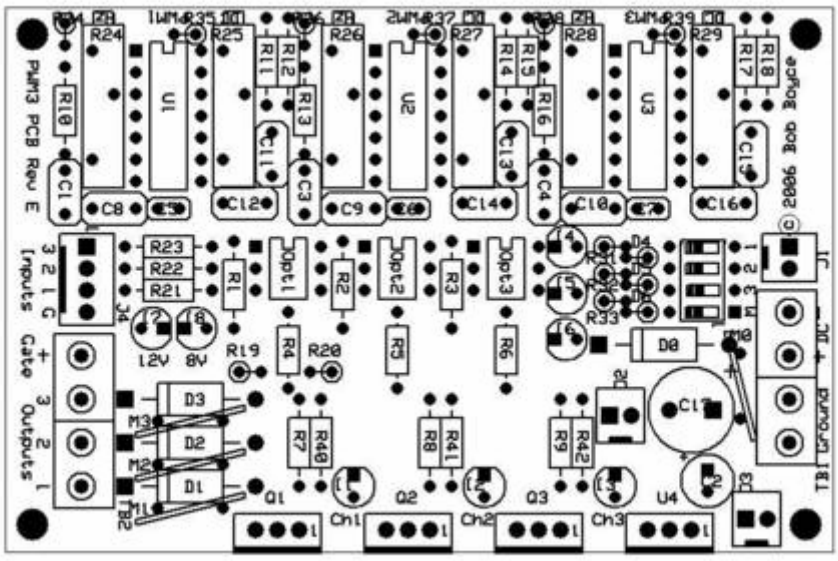
http://sales.digikey.com/scripts/ru.dll?action=pb_view&pb_glue=1014385

Board Construction

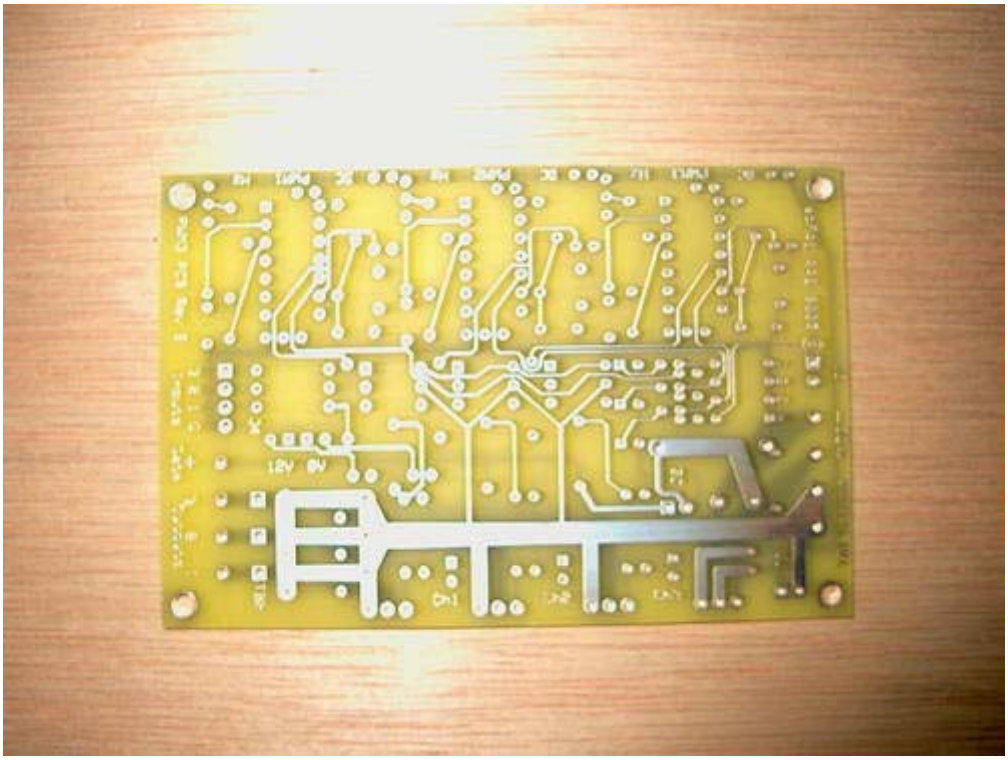
This is a pictorial construction guide for the PWM3e, however as I understand this is "basically the same as the "PWM3f"



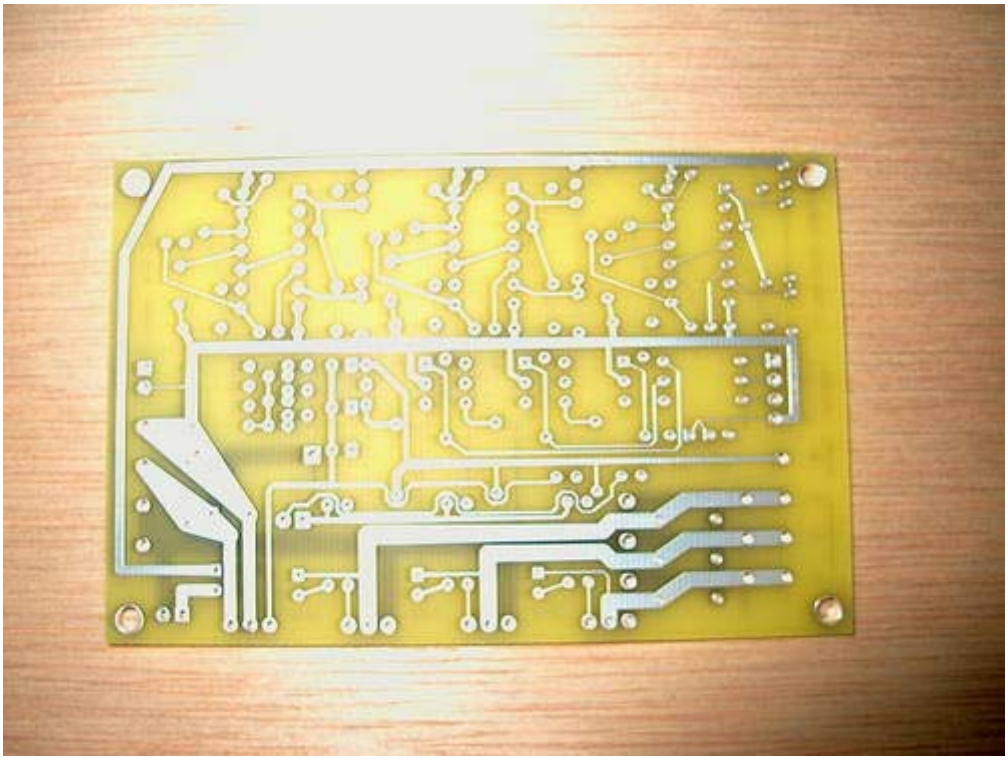
1. Here's a view of the most recent schematic for the PWM3E.



2. Here's a view of the most recent PC board layout of the PWM3E.

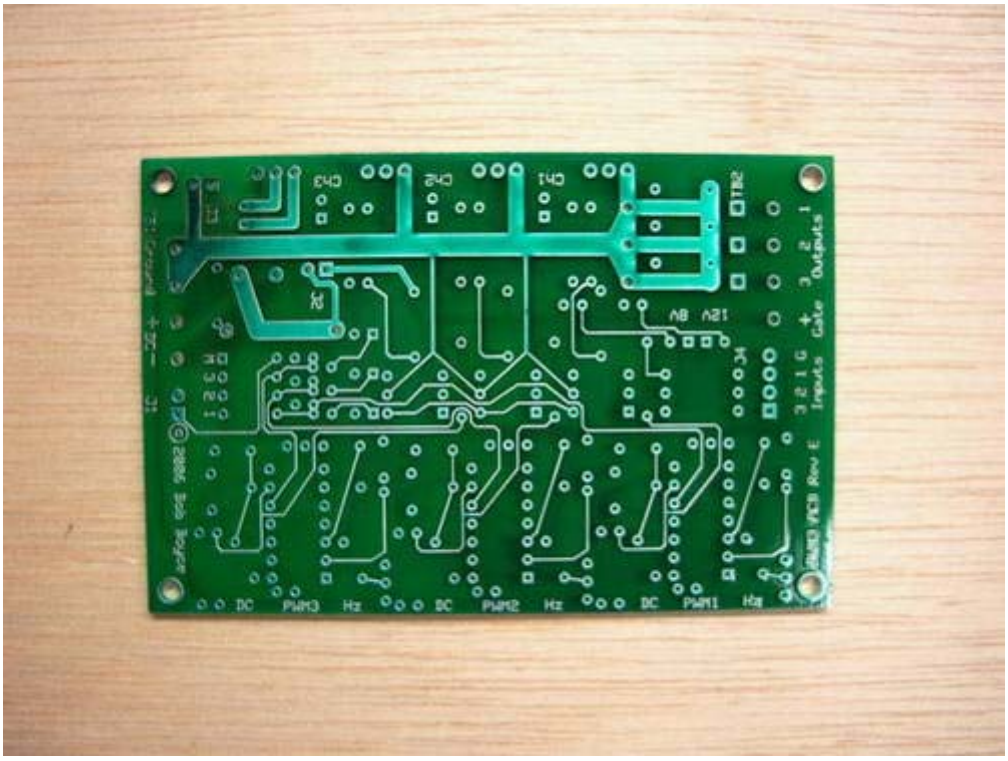


3. Component side view of a bare PWM3E PC board, as it comes from pcbexpress. These boards need to be painted right away to prevent oxidation of the traces (as can be seen in lower right corner of this board), and to protect the traces from corrosion damage.

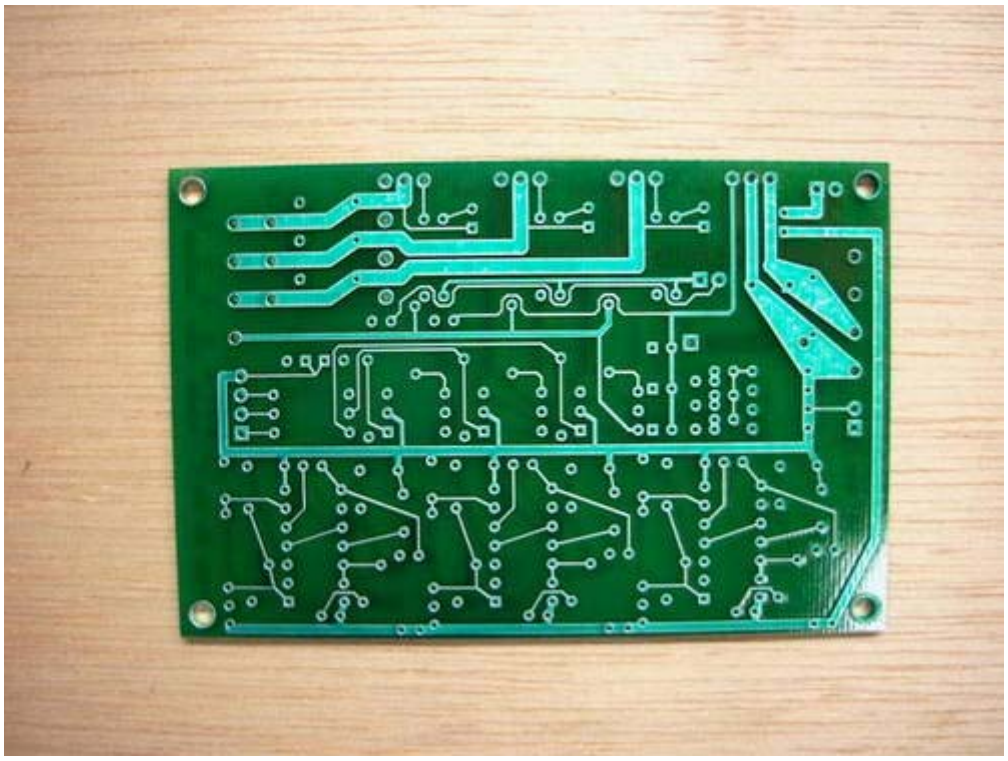


4. Solder side view of a bare PWM3E PC board, as it comes from pcbexpress. These boards need to be painted right away to prevent oxidation of the traces, and to protect the traces from corrosion damage.

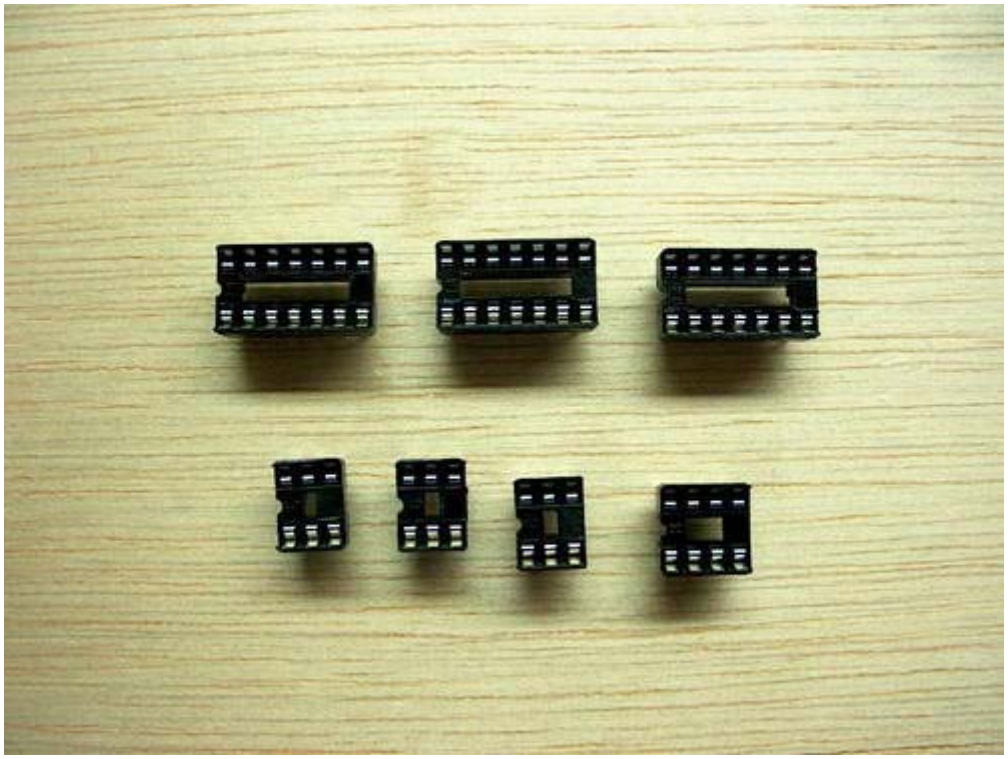
5. Only use Testors 1601 Transparent Candy Emerald Green for this. Other types of paint may contain conductive additives that can affect operation of the circuit.



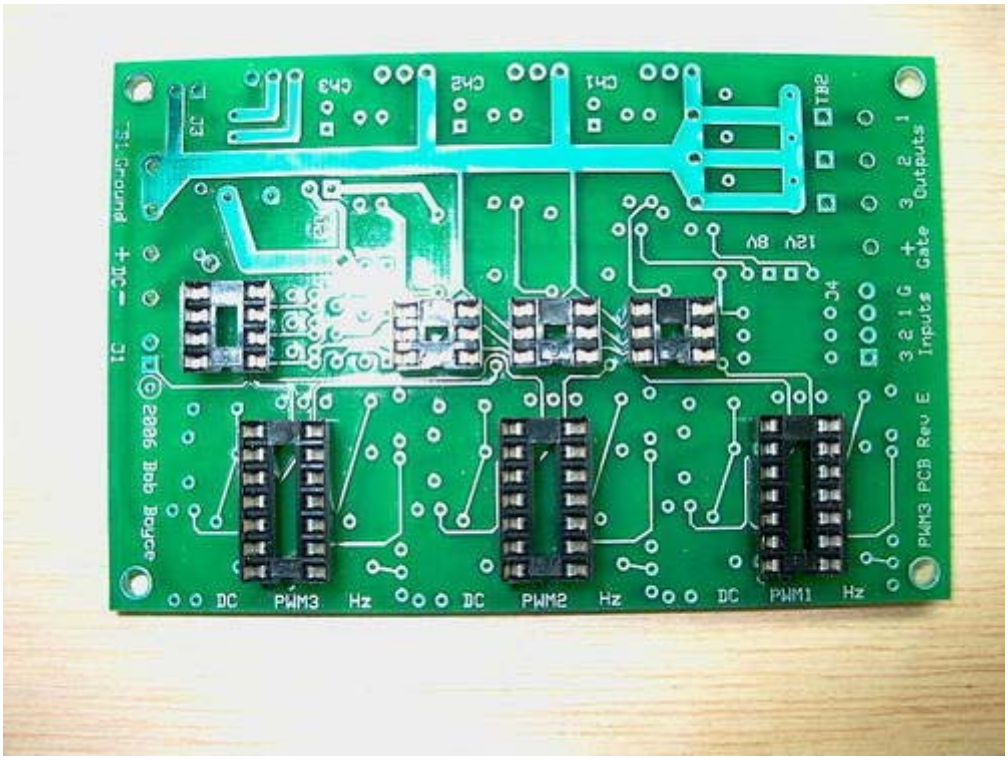
6. Component side view of the painted PWM3E PC board.



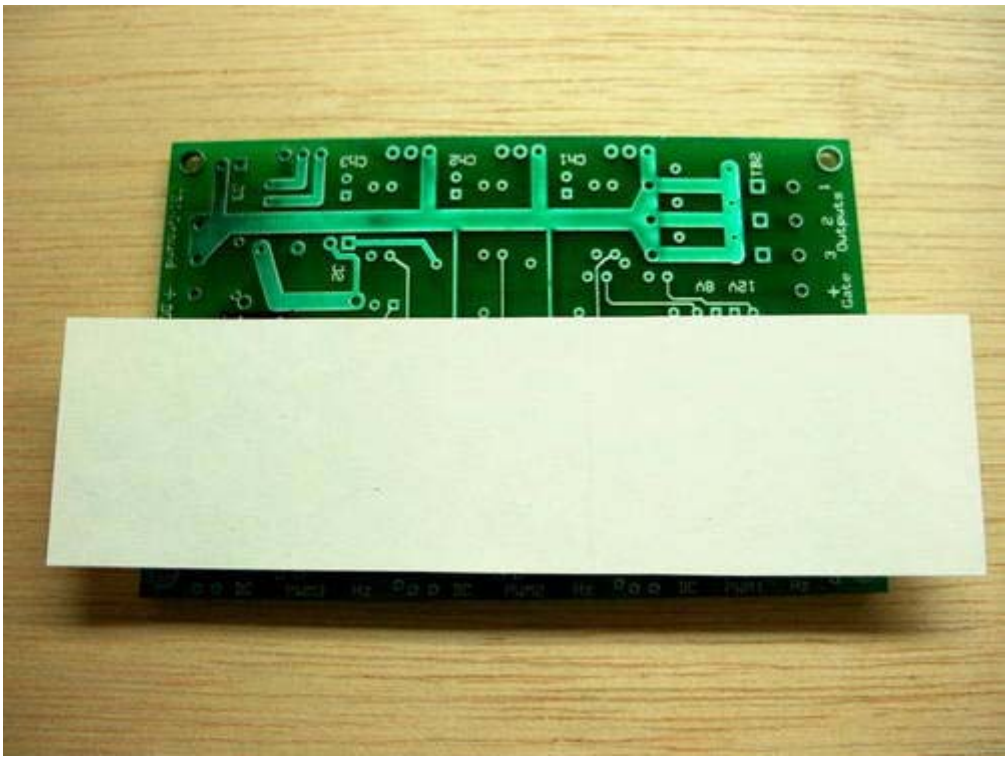
7. Solder side view of the painted PWM3E PC board



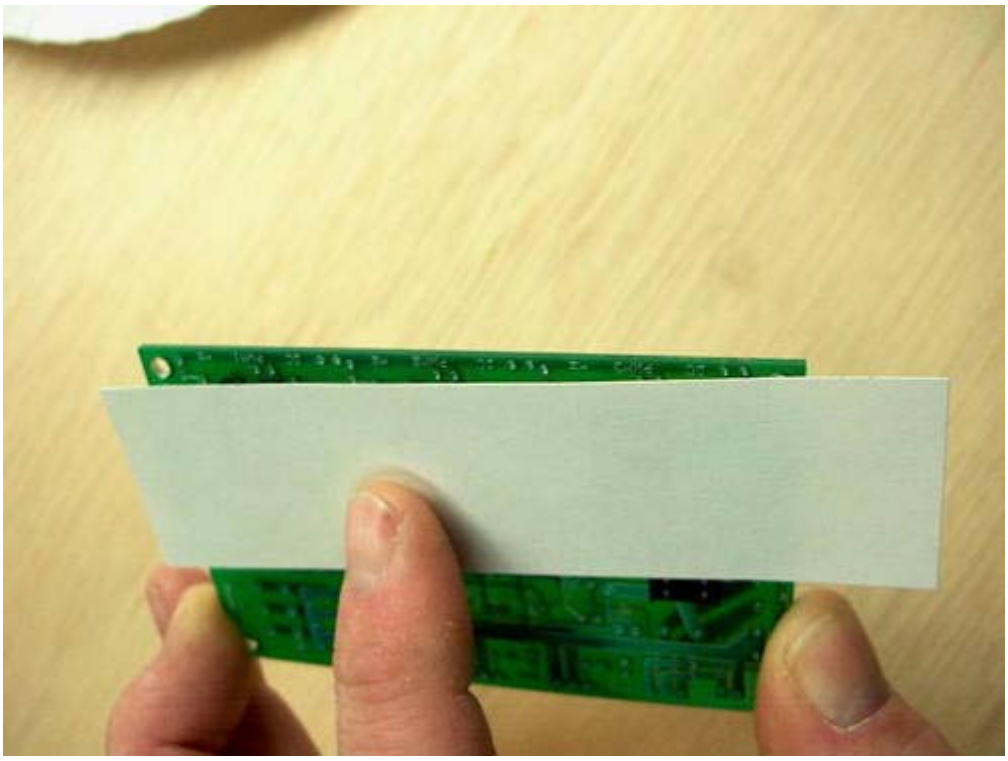
8. These are the IC sockets I will be mounting to the PC board. The three with 14 pins are for the 556 timer chips, the one with 8 pins is for the DIP switch (they do sometimes go bad), and the three with 6 pins are for the digital optocouplers.



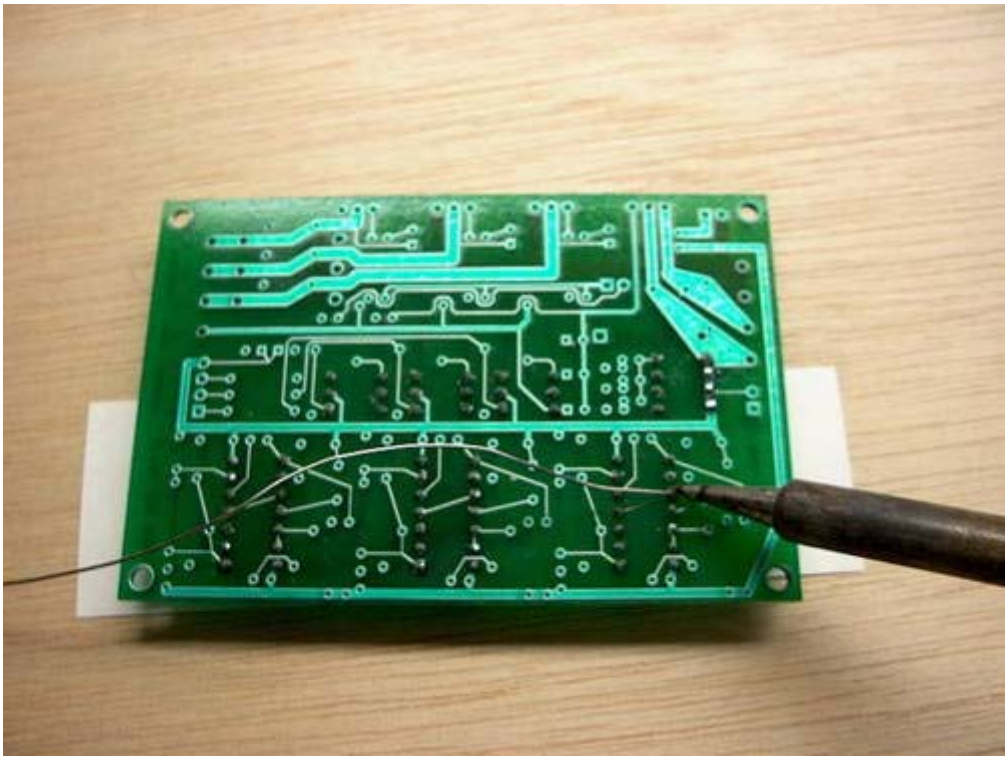
9. The sockets are laid into place. The pin 1 notches are all facing the edge of the board that borders the 556 chips



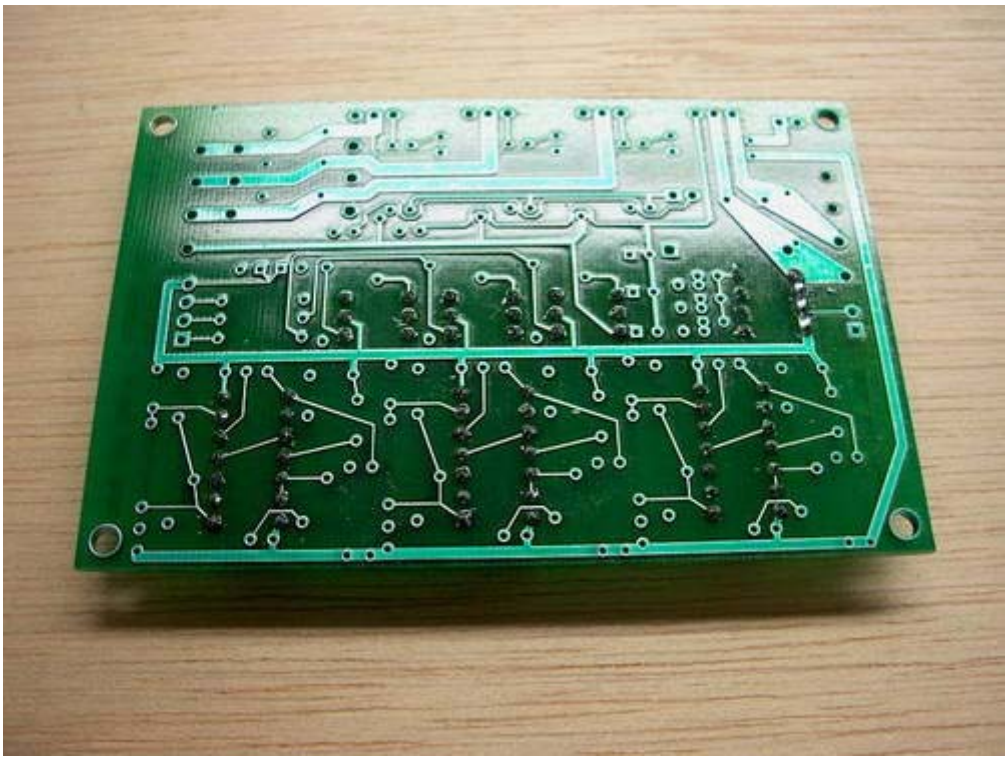
10. A piece of stiff paper is laid over the IC sockets.



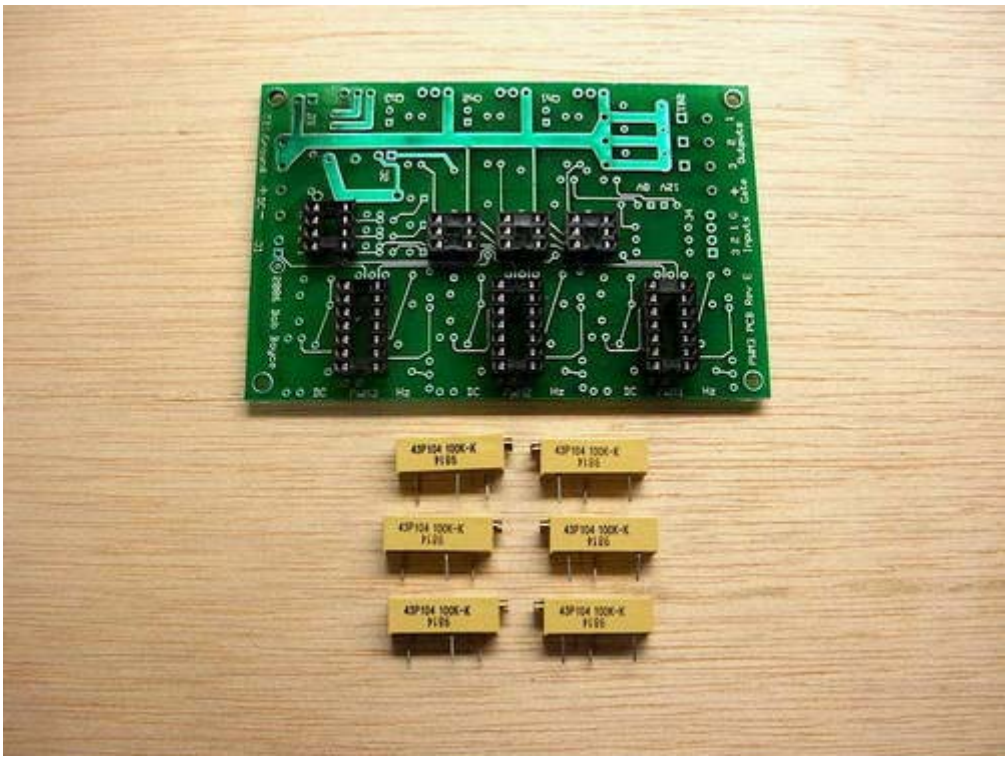
11. Holding the paper in place keeps the IC sockets from falling out when the PC board is turned over.



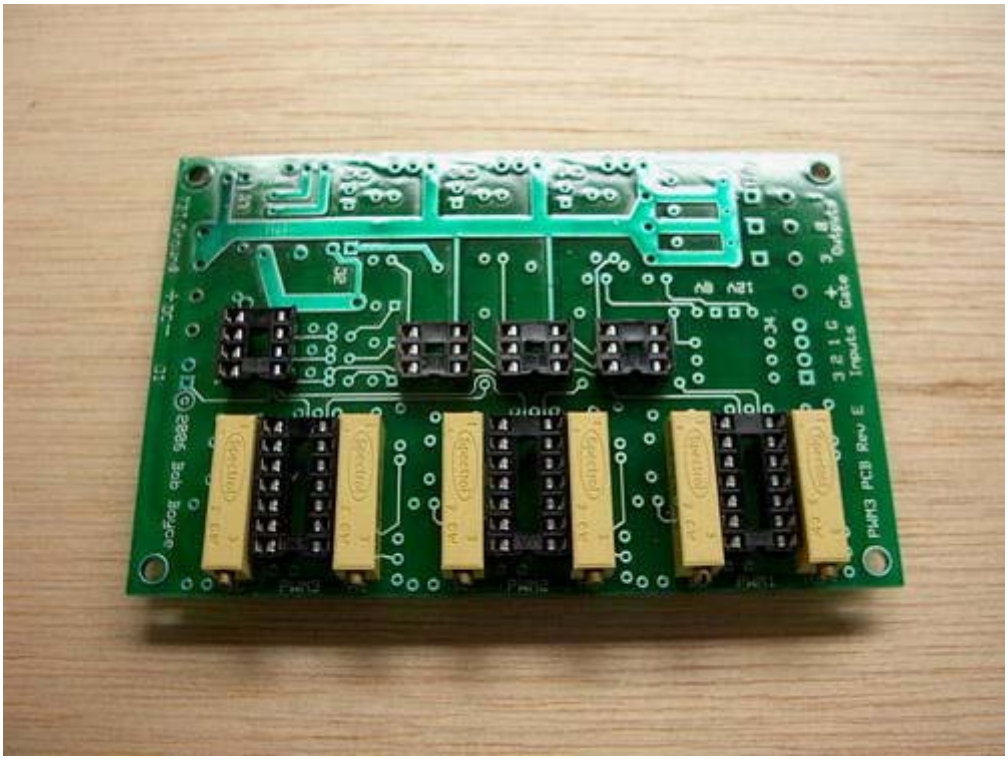
12. All of the pins of the IC sockets are soldered to their pads on the PC board.



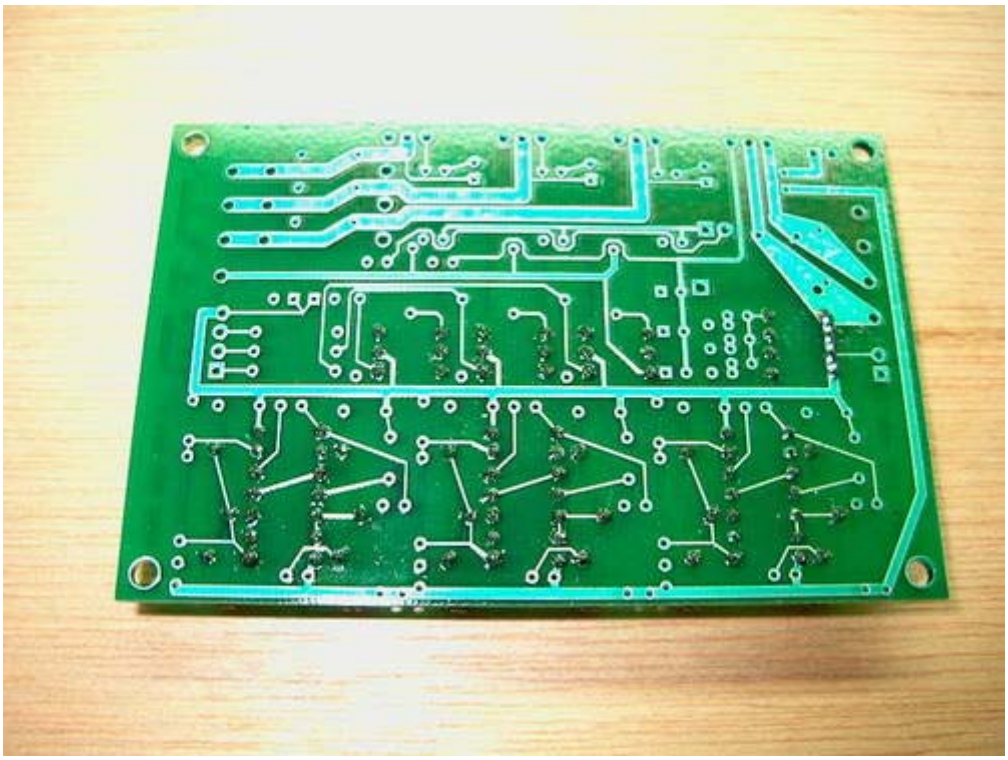
13. All of the IC sockets have been soldered in.



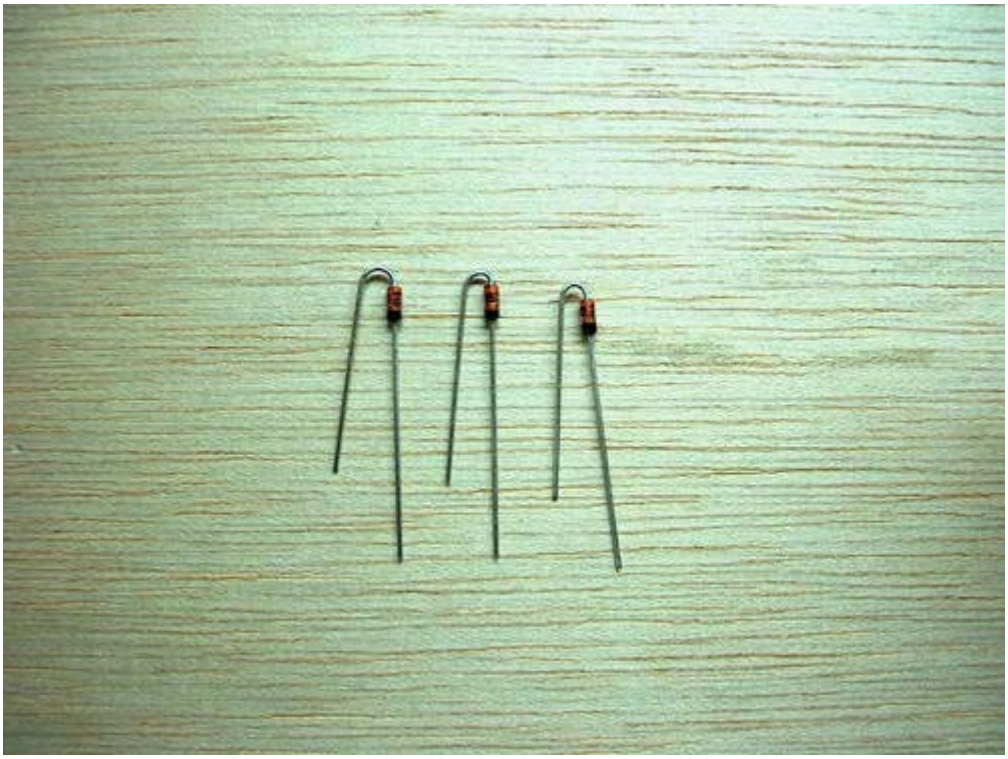
14. These are the 100K multi-turn cermet trimmers that I use. They are a little more expensive than the normal potentiometers of the same size and shape, but they are of higher quality.



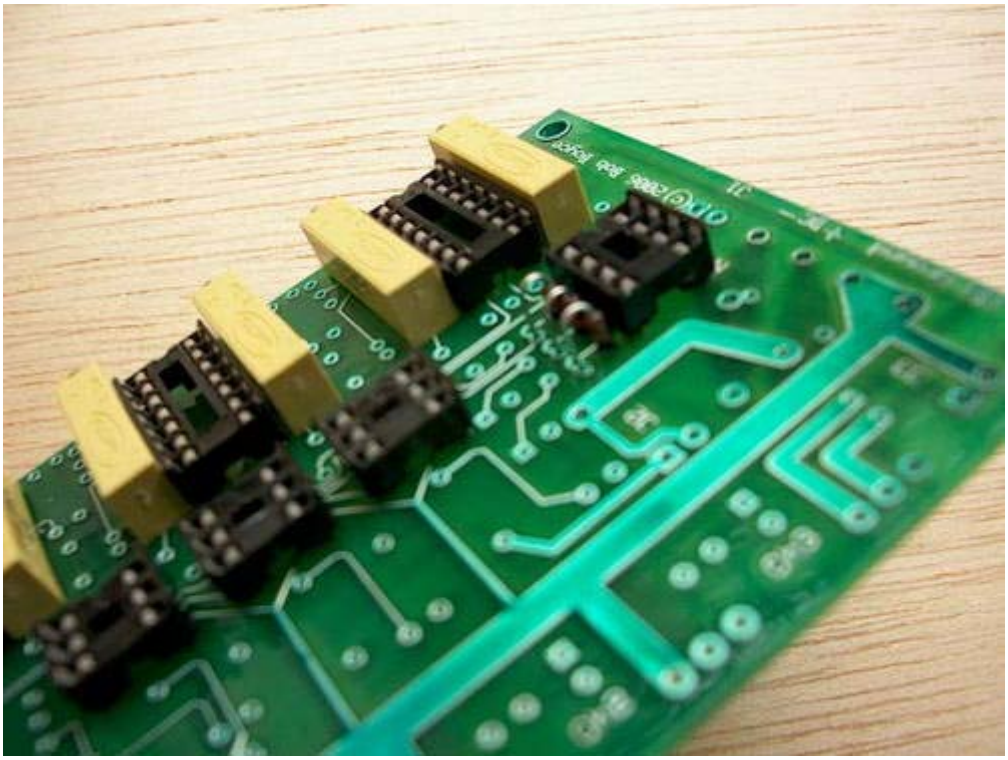
15. The cermet trimmers are inserted. They fit a bit snugger in the holes so they pretty much stay put when the PC board is turned over for soldering.



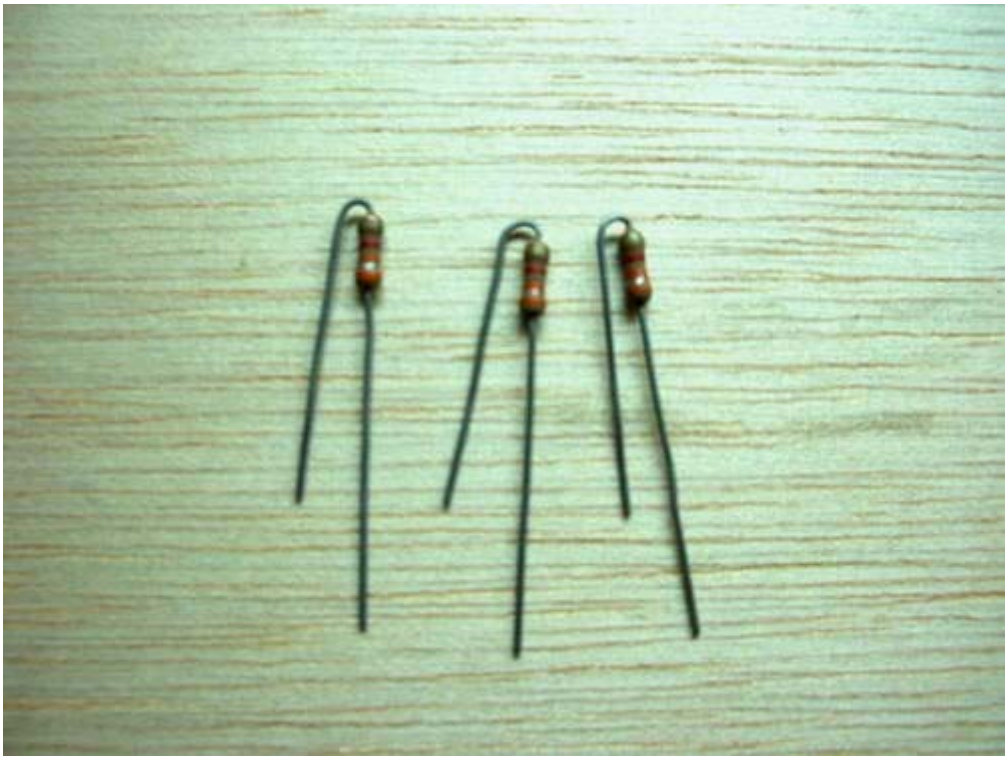
16. The cermet trimmers are soldered in place, and the excess lead lengths are clipped off.



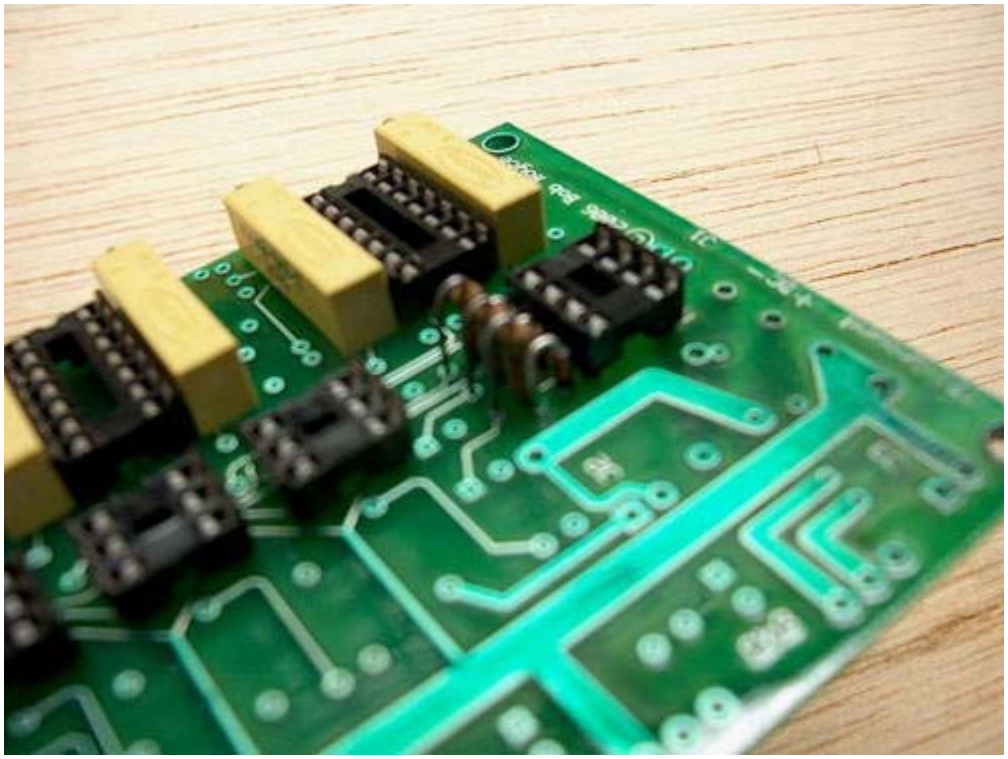
17. These are three 1N914 diodes. Note the position of the black band, and bend the lead at the other end over and down fairly close to the body of the diode as shown.



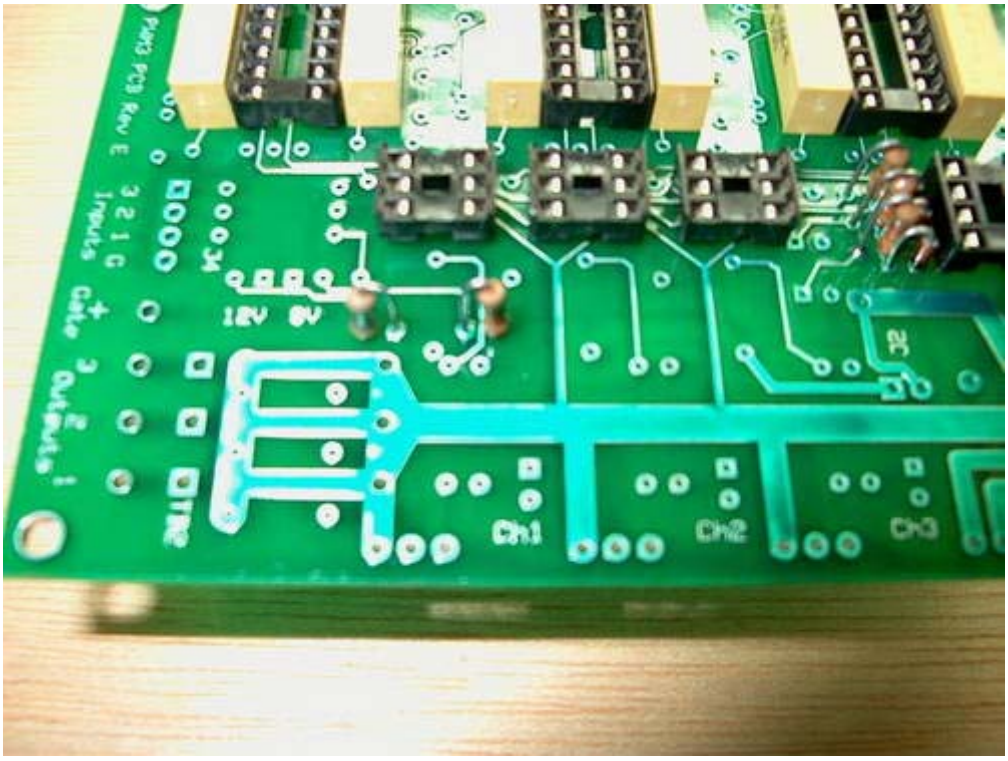
18. The 1N914 diodes are installed in their holes with the body right next to the socket for the DIP switch. This puts the black-banded ends in the holes closest to the DIP switch. I see this photo is a bit out of focus at the diodes, but you can still see them good enough, and also in later pictures.



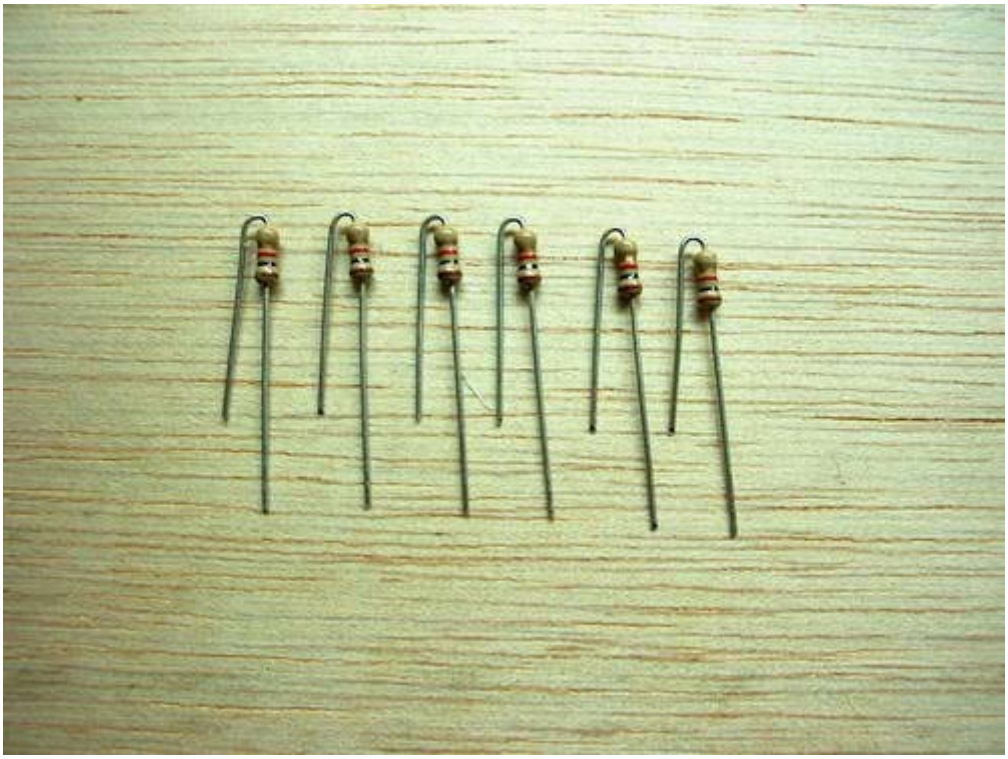
19. These are 3.3k 1/4-watt resistors, and they go in positions R31, R32, and R33. I also prepared another one for R20, and a 4.7k 1/4-watt resistor for R19 in the same manner.



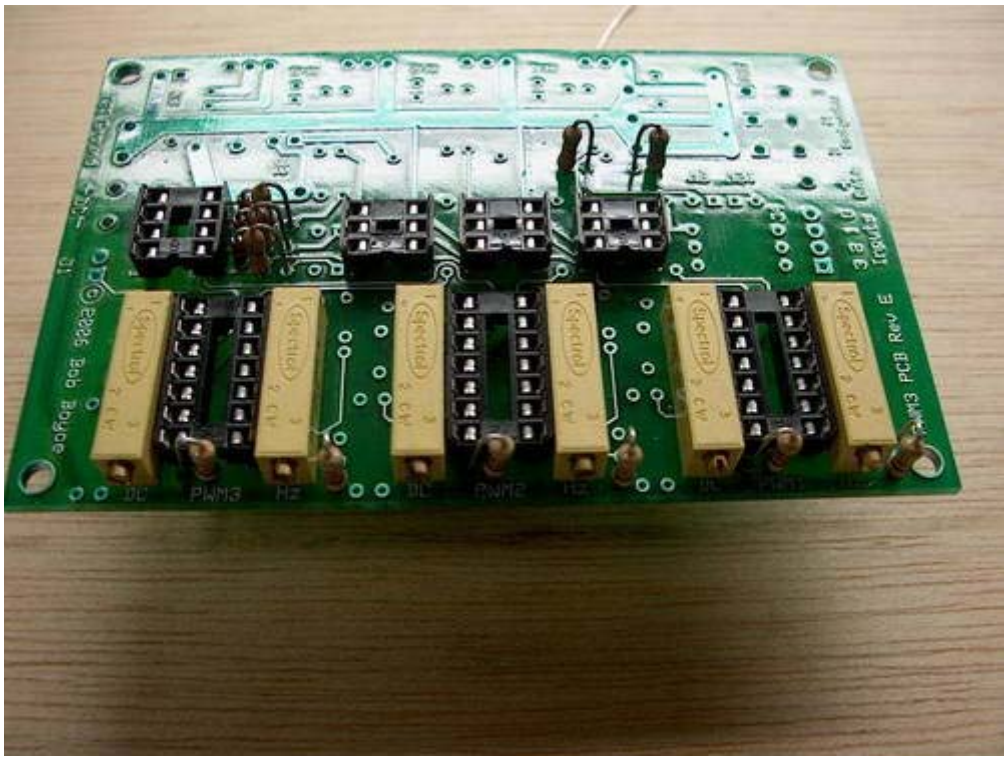
20. R31, R32, and R33 are soldered in place. One end goes next to each top diode lead that is bent over and soldered to the board. Orientation of these resistors does not matter, so I put them in the board in the same orientation as the diodes I had already installed.



21. I installed R19 and R20 at this time as well. Orientation is not important on these, but I did follow the orientation shown on the PC board layout just for convenience.

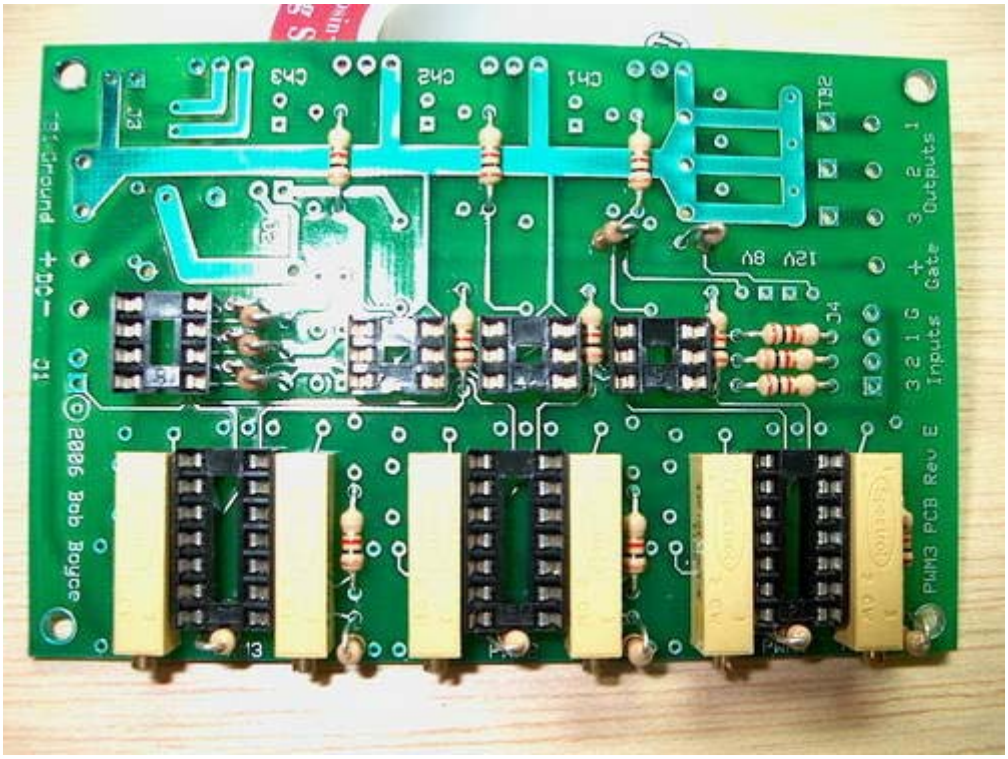


22. These are 1k 1/4 watt resistors that have been lead formed for positions R34, R35, R36, R37, R38, and R39.



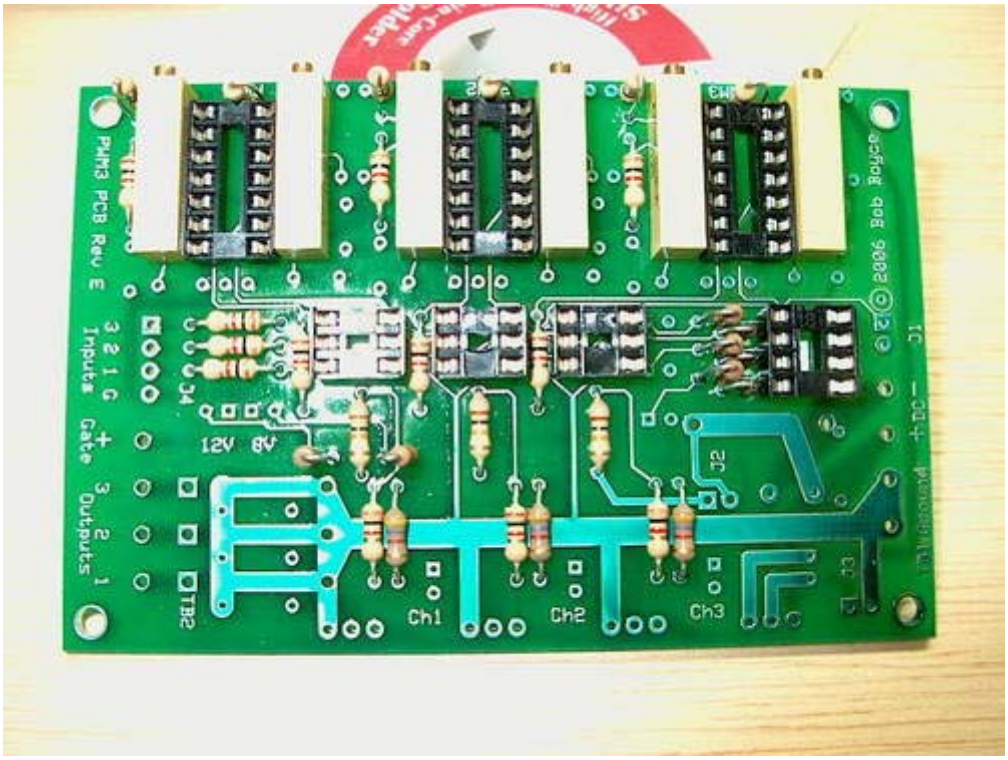
23. Orientation of these resistors is a little important. While they will fit and operate in either direction, I have positioned them so they will interfere less with the insertion of the 556 chips later.

24. Here is an army of 1k 1/4 watt resistors with the leads formed to go into positions R1, R2, R3, R7, R8, R9, R10, R13, R16, R21, R22, and R23.



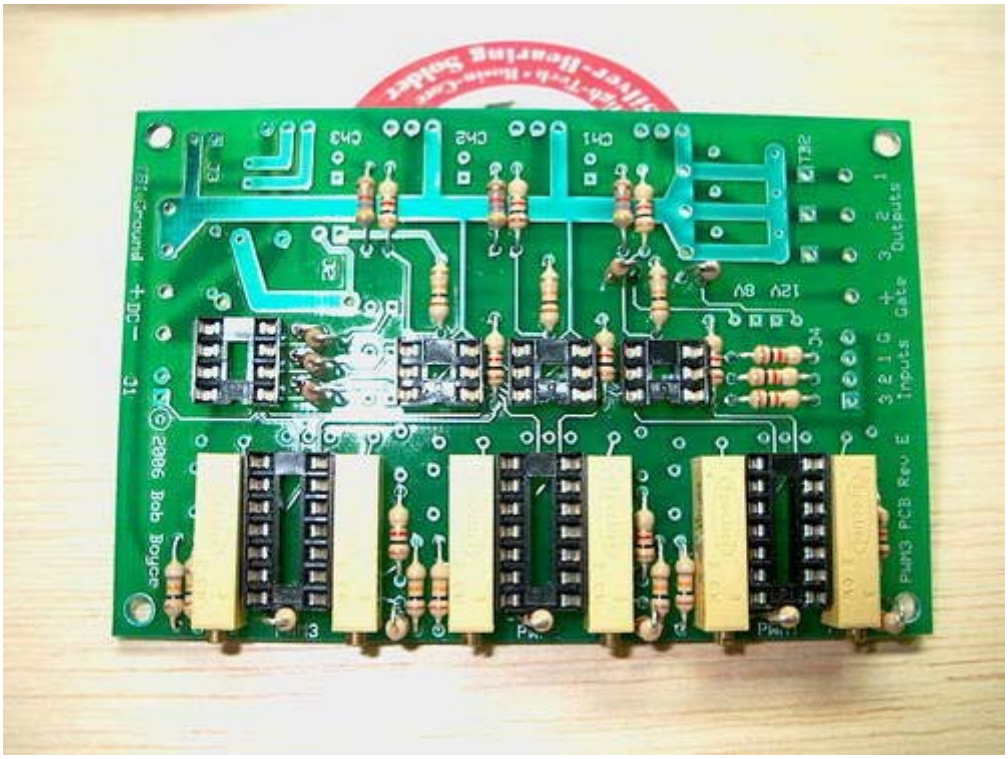
25. This shows R1, R2, R3, R7, R8, R9, R10, R13, R16, R21, R22, and R23 installed. Orientation does not matter on any of these.

26. These are some 4.7k (top) and 10k (bottom) 1/4-watt resistors. Some of the 10k resistors had some lead clipped off to use as jumpers on another project, so I used them here where that missing lead will not affect installation. The 4.7k resistors are for positions R40, R41, and R42. The 10k resistors are for positions R4, R5, and R6.



27. The 4.7k resistors are installed in positions R40, R41, and R42. The 10k resistors are installed in positions R4, R5, and R6.

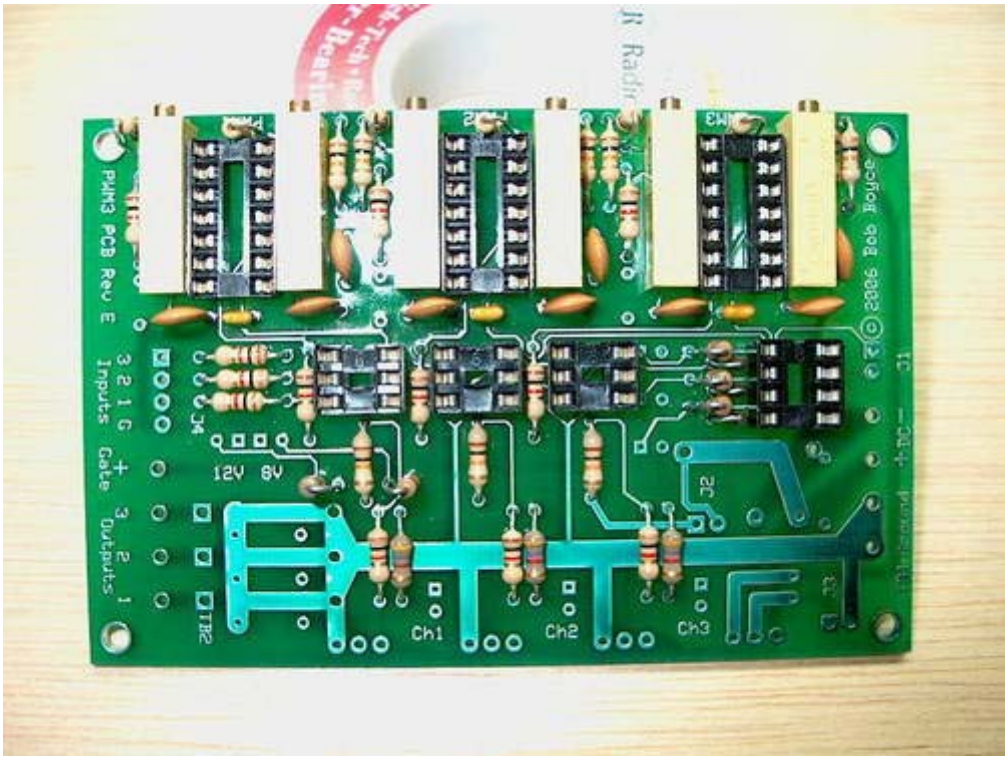
28. A group of six 10k 1/4-watt resistors are formed for positions R11, R12, R14, R15, R17, and R18.



29. These resistors are installed at positions R11, R12, R14, R15, R17, and R18.

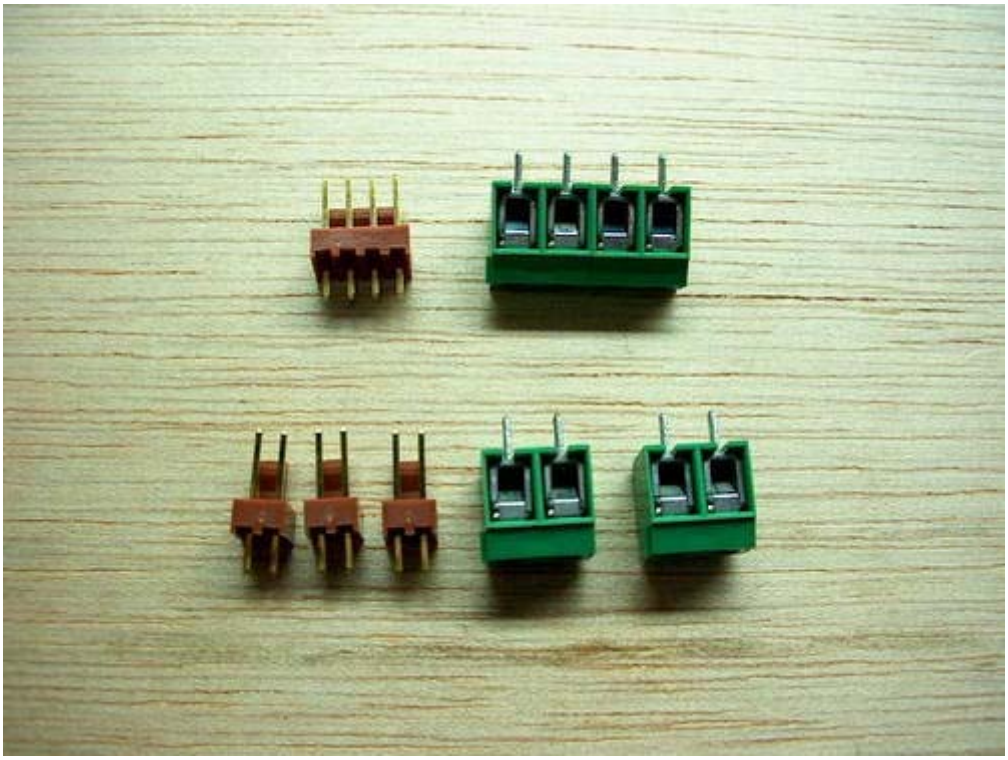
30. The nine capacitors to the left are 0.01 uf 50V ceramic disc, and the three capacitors to the right are 0.001 uf 35V dipped. The 0.01 uf are for positions C8, C9, C10, C11, C12, C13, C14, C15, and C16. The 0.001 uf are for positions C5, C6, and C7.

Please Note: I later replaced C5, C6, and C7 with 0.001 uf 50V ceramic disc capacitors. The dipped capacitors I had initially installed were mismarked, and were actually 0.1 uf 35V rating.

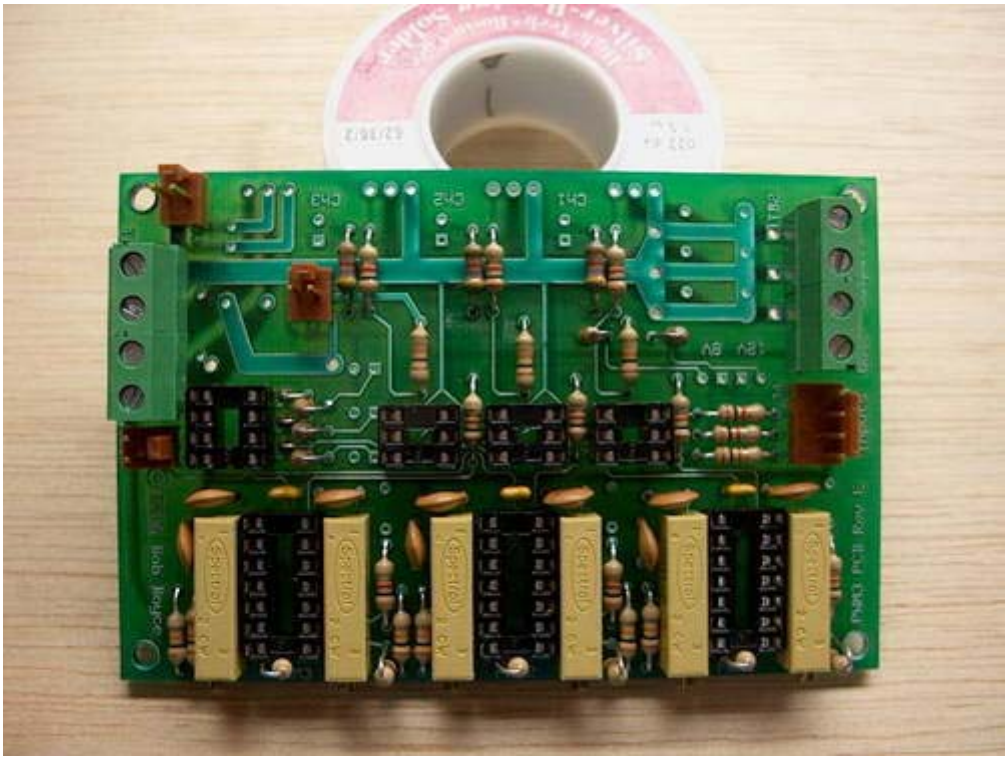


31. The 0.01 uf are installed at positions C8, C9, C10, C11, C12, C13, C14, C15, and C16. The 0.001 uf are installed at positions C5, C6, and C7.

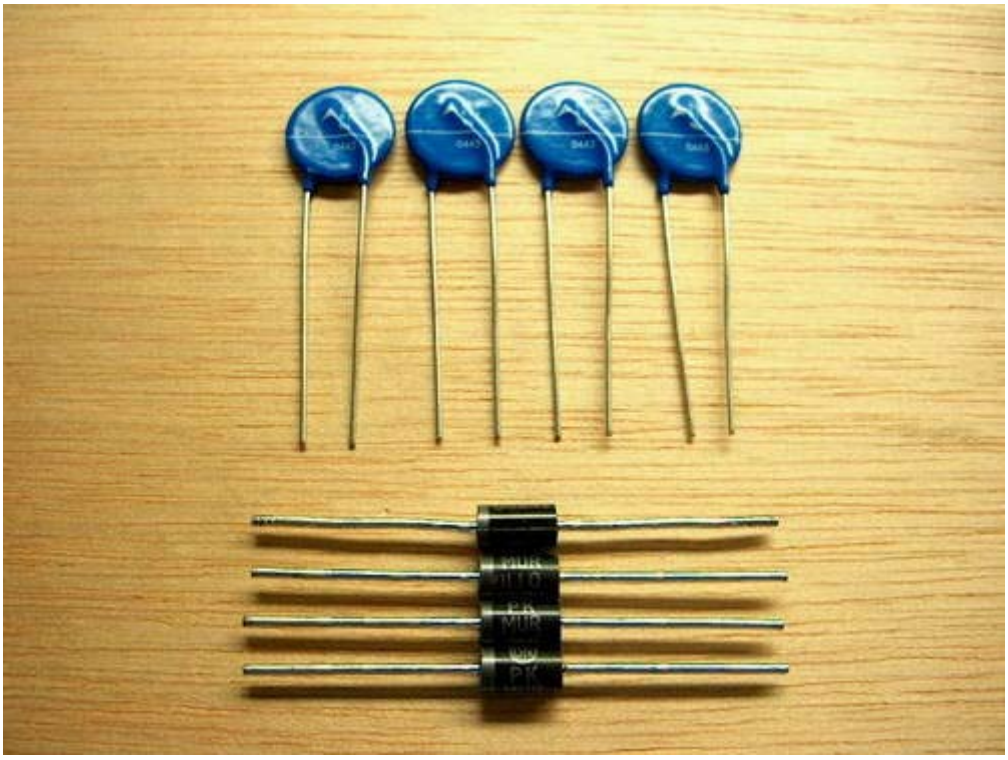
Please Note: I later replaced C5, C6, and C7 with 0.001 uf 50V ceramic disc capacitors. The dipped capacitors I had initially installed were mismarked, and were actually 0.1 uf 35V rating.



32. These are the headers and terminal blocks used on the PC board. The 2 position headers are used at positions J1, J2, and J3. The 4-position header is for position J4. The terminal blocks are for positions TB1 and TB2. I buy these as 2 position terminal blocks, as shown at the bottom right. They assemble together by sliding the tiny triangle tang on one section into the tiny triangle slot of the next section, to form a 4-position terminal as shown on the top right.

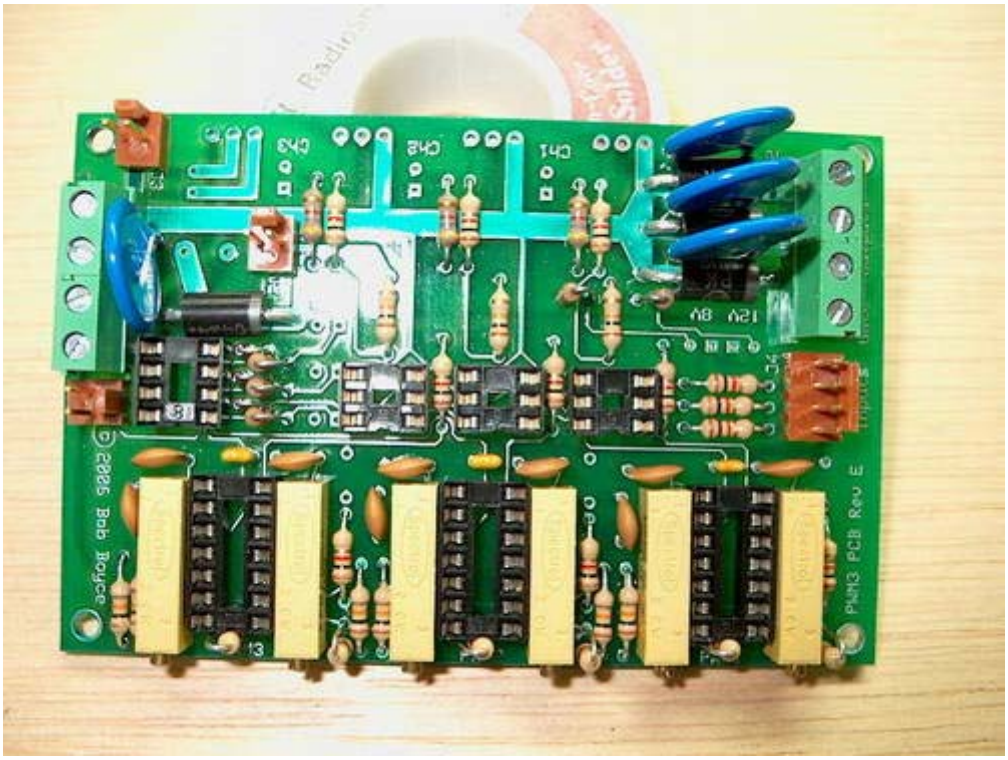


33. The 2 position headers are installed at positions J1, J2, and J3. The 4-position header is installed at position J4. The terminal blocks are installed at positions TB1 and TB2.



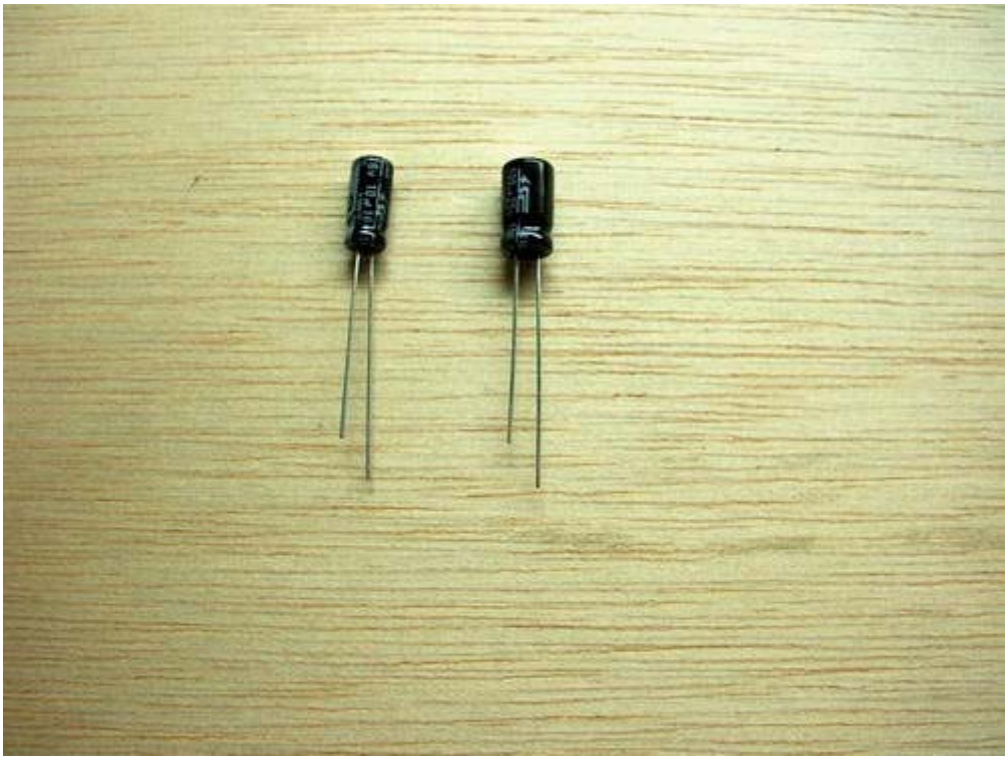
34. The top four are S14K14 MOVs (Metal Oxide Varister), used at positions M0, M1, M2, and M3. The bottom four are MUR410RL Ultra Fast 4 Amp 100V diodes, used at positions D0, D1, D2, and D3. The diode leads are a very snug fit into the holes in the PC board, so they must be formed to fit carefully.

35. The leads on this batch of MOVs are fatter than the last ones I had bought. The holes in the PC board are too small for these leads, so I cut the leads down. The leads for M0 (shown here) were cut down to about 1/4" long, while the leads for M1, M2, and M3 were cut down to about 3/8" long each. Then I used a dremel with a small grinding stone to thin the tips of the leads down so they would fit into the existing PC board holes. I may end up updating the PC board hole sizes to accommodate fatter component leads for these in the future.



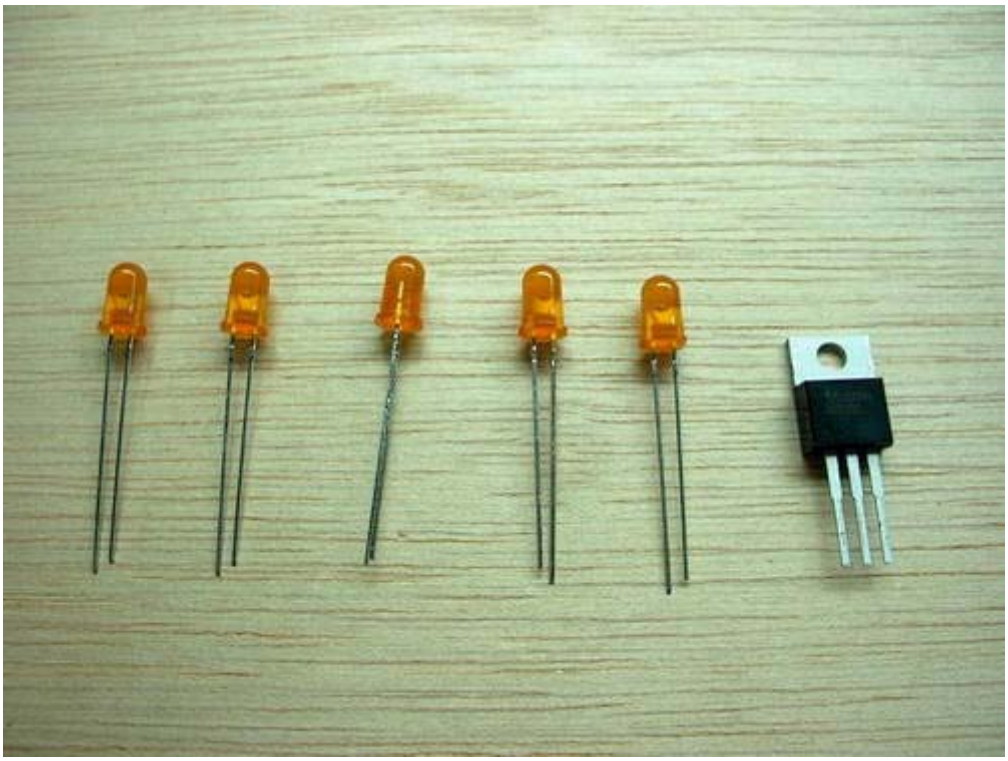
36. I installed the 4 diodes first, at positions D0, D1, D2, and D3. The banded ends of all 4 of these diodes face the TB2 terminal strip, to the right in this picture.

I bent the leads on D3, to move it further away from D2, so that MOV M3 could be installed. Then I bent the leads on D2, to move it away from D1, so that MOV M2 could be installed. Then I installed MOVs M1, and M0. After the MOVs were installed, I bent D2 and D3 back into as close to normal position as they would go.

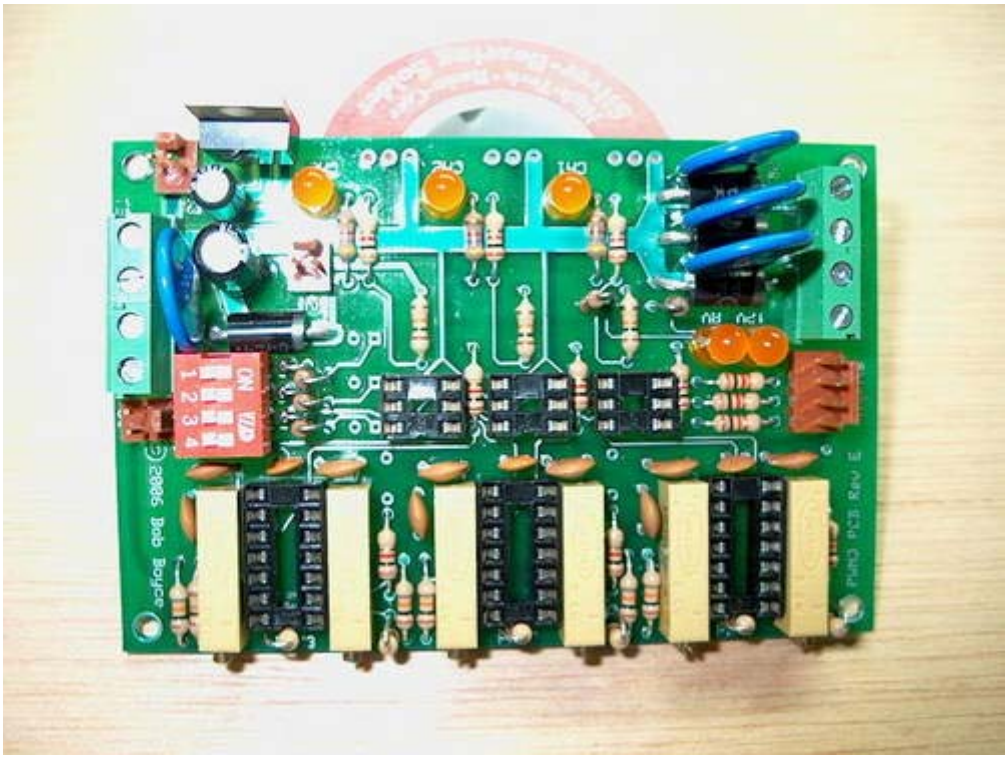


37. These are a 10 uf 16V (left) electrolytic capacitor, and a 100 uf 25V (right) electrolytic capacitor. The 10 uf 16V is used on the 8 VDC rail at position C2, and the 100 uf 25V is used on the input 13.8 VDC rail at position C17.

38. The 10 uf 16V capacitor is installed at position C2, and the 100 uf 25V capacitor is installed at position C17. Both of these are located at the lower right corner of the PC board in this picture.

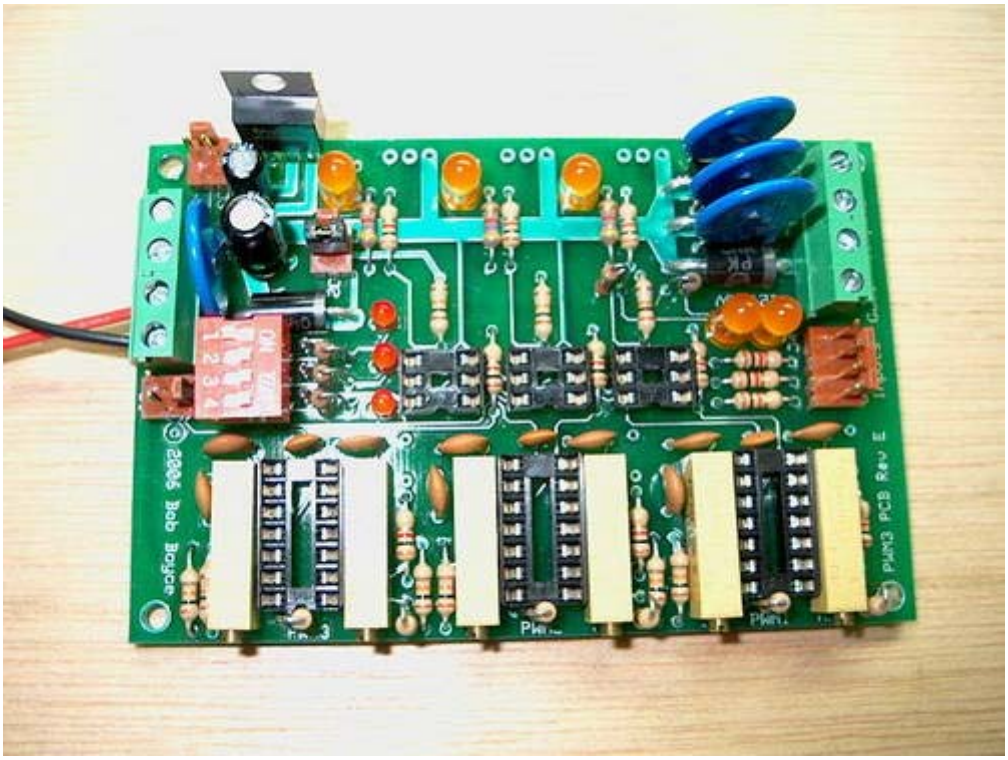


39. These are some amber T1 3/4 size LED indicators that I have a lot of. They are not very bright, but in this case they are only used as indicators so brightness is not important. They will be used in positions I1, I2, I3, I7, and I8. The device on the right is an LM7808 3-terminal 8-volt voltage regulator IC, and it is used in position U4.

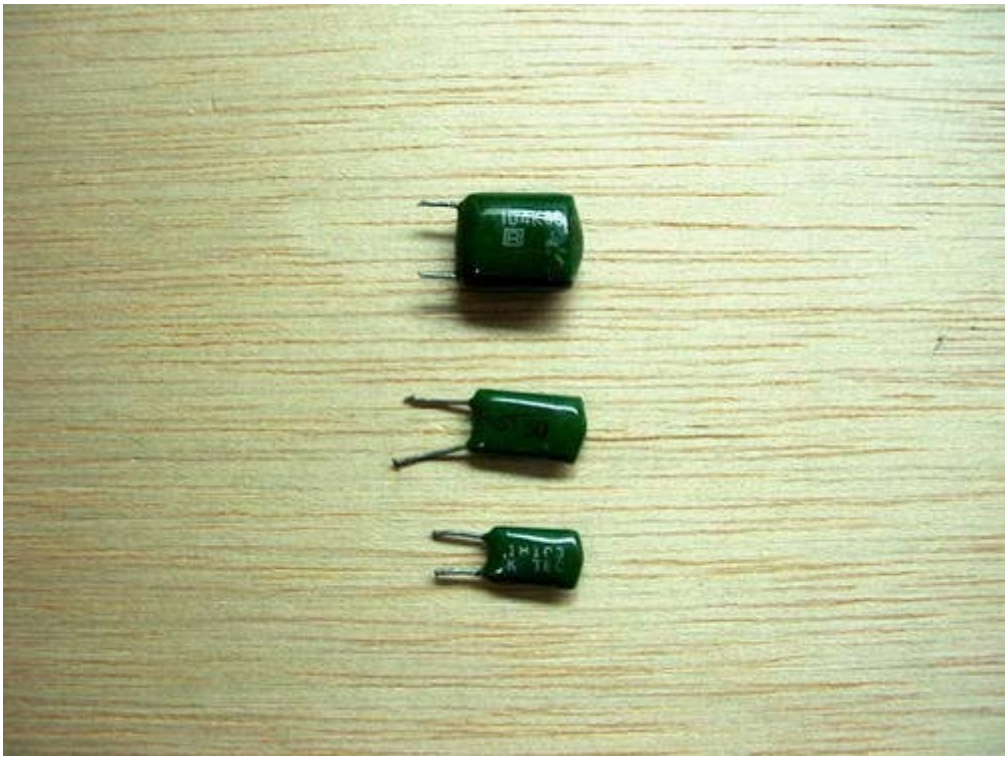


40. The LEDs are installed in positions I1, I2, I3, I7, and I8. The LM7808 is installed in position U4, with the heat sink tab facing the rear edge of the PC board.

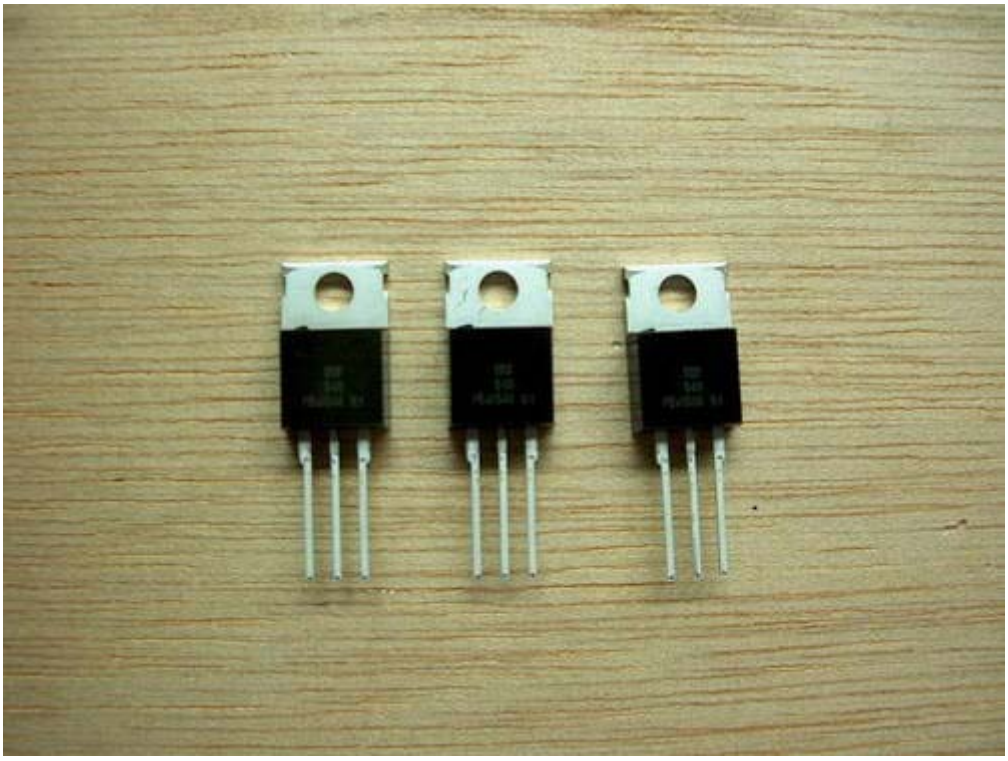
41. These are three T1 sized red LEDs that are used in positions I4, I5, and I6. Any color can be used here, but I chose red because, when lit, they indicate that channel is disabled. These are rated for low power use, and are very bright for their low power consumption.



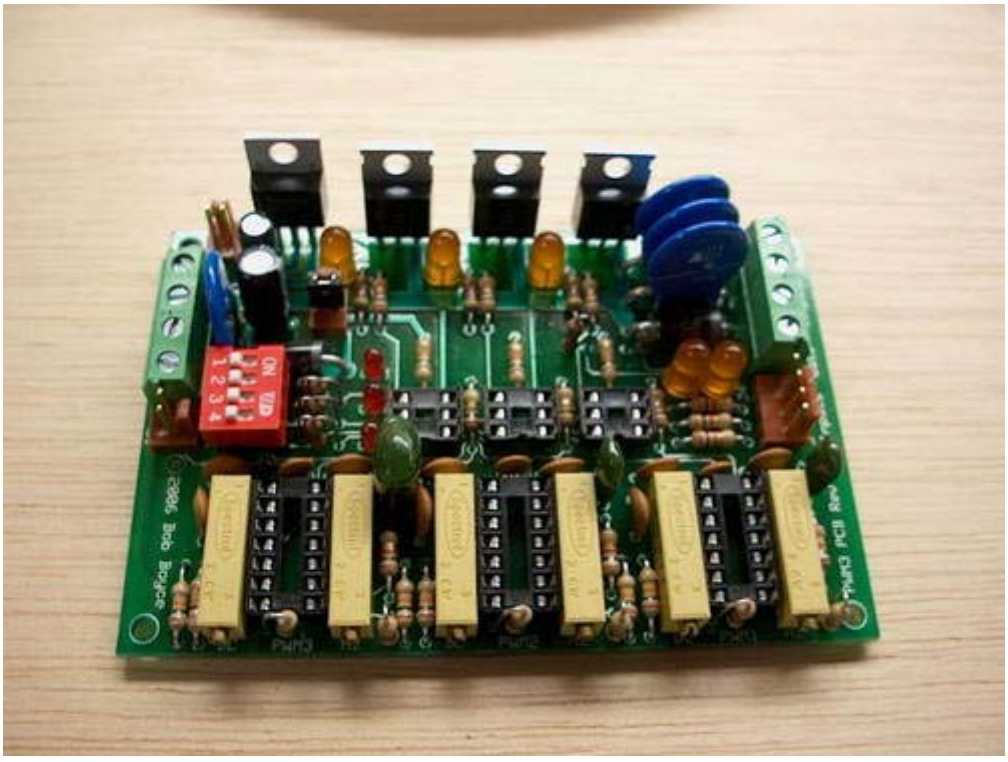
42. The red LEDs are installed at positions I4, I5, and I6. I powered the board with a 9V battery to test the voltage regulator and the LED indicators. They are lit in this picture; however, the flash washed them out so they do not look lit.



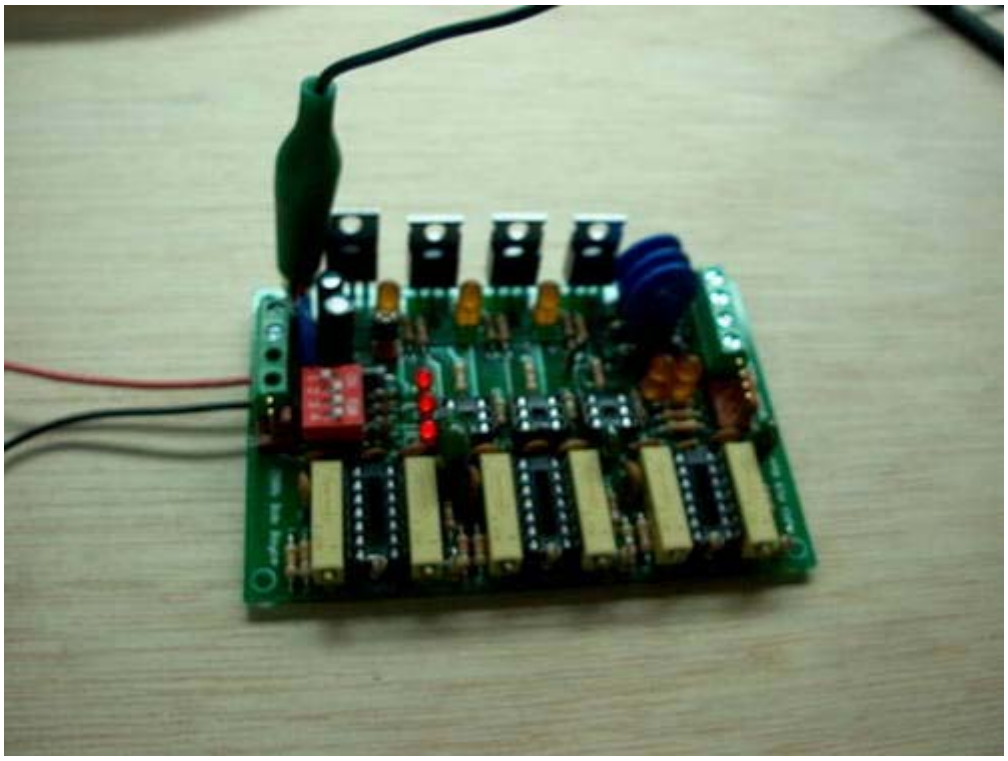
43. These are the precision capacitors I that choose to use for the timing circuits of the 556 dual timer ICs. The smallest one (bottom) is 0.01 uf, and is used in position C1. The medium sized one (middle) is 0.022 uf, and is used in position C3. The largest one (top) is 0.1 uf, and is used in position C4.



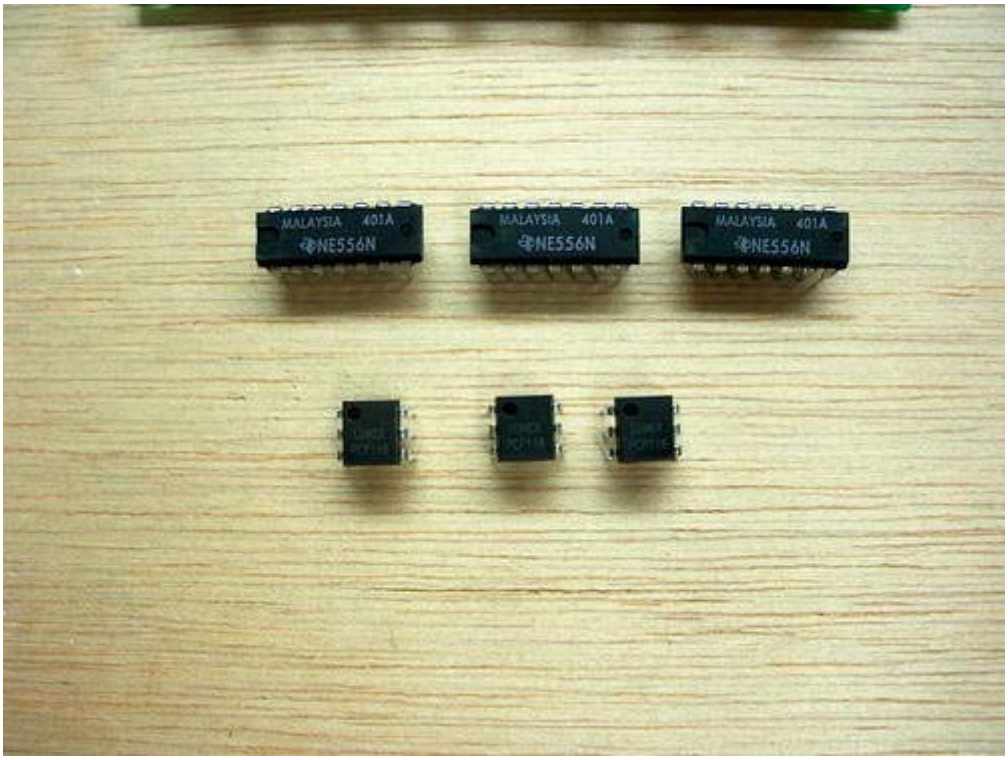
44. These are three IRF540 FET (Field Effect Transistor) devices. These are used in positions Q1, Q2, and Q3. They are oriented so the heat sink tabs face the rear edge of the PC board.



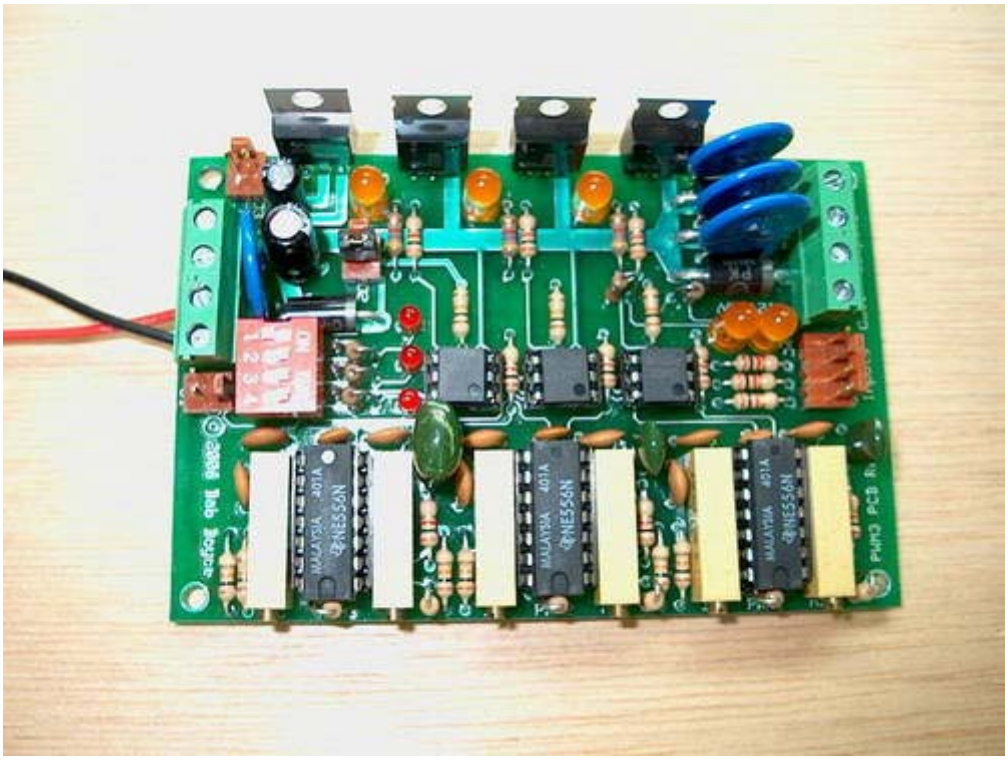
45. The precision capacitors are installed in positions C1, C3, and C4. The FETs are installed in positions Q1, Q2, and Q3.



46. With the camera flash turned off, a power test of the board is made, prior to installing the IC chips. During this test, a jumper-shorting plug is installed on J2 and another jumper shorting plug is installed on J3. I shorted J3 with a cliplead during this test. The DIP switches are set as follows, M off, 3 on, 2 on, and 1 on. When a 9-volt battery is connected, all LEDs should light.



47. These are the ICs I am installing. The top row is Texas Instruments NE556N dual timer ICs, and they plug into the sockets at positions U1, U2, and U3. The bottom row is Lumex OCP-PCP116 digital optocoupler ICs, and they plug into the sockets at positions Opt1, Opt2, and Opt3. Normal opto-isolators cannot handle the frequencies that the timers on this PC board operate at.



48. The ICs are installed. The NE556N dual timer ICs are in the sockets at positions U1, U2, and U3. The PCP116 digital optocoupler ICs are in the sockets at positions Opt1, Opt2, and Opt3. The PC board is now complete and ready to be mounted into a cabinet or box of choice. The regulator U4 does not get very hot, so heat sinking is optional there. The FETs will have to be connected to a large heat sink (with insulated TO-220 mounting hardware) prior to operation.

49. The case material and heat sink material were purchased from sellers on eBay. The heat sink material selected proved to be a good fit for the case material chosen. The case material was shipped from Hong Kong, so it took a while to arrive.

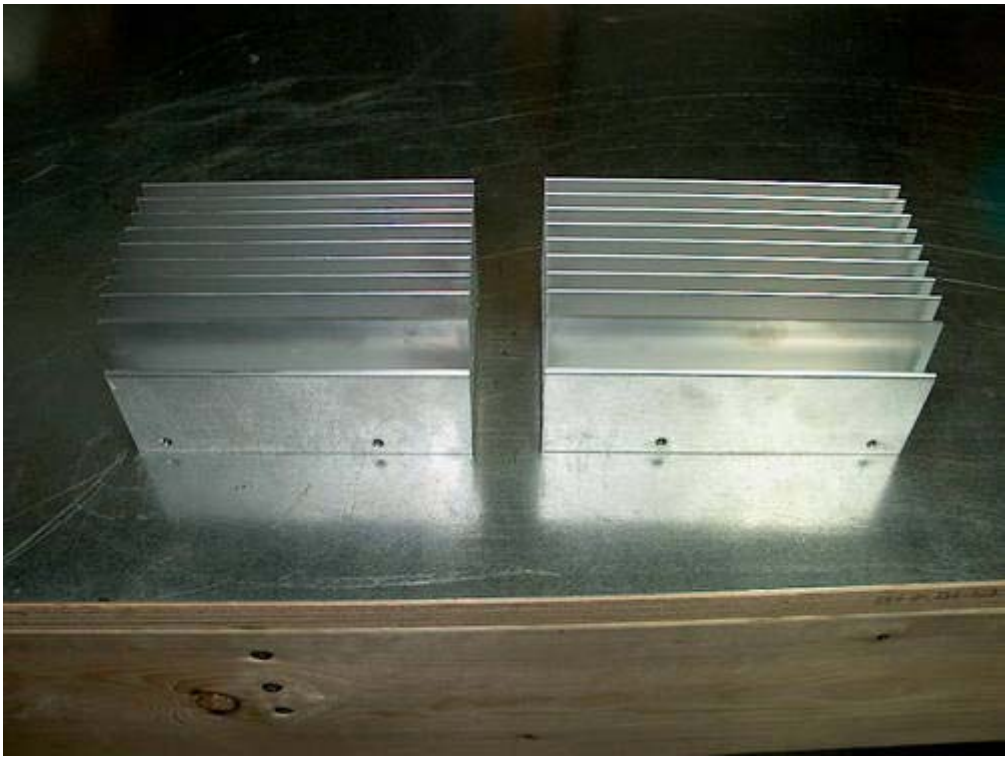
The death of our beloved Gidgie Girl on Jan 26th 2007, had taken a toll on us emotionally. She was an important member of our family, and many times,

she was my only companion while I worked on the shop project. I set up a memorial site in memory of her.

http://www.gidgiegirl.org

On Feb 2nd 2007, I begin work on turning these materials into a suitable case for the PWM3E project.

50. Using my band saw, I cut the heat sink stock down to the width of the case.

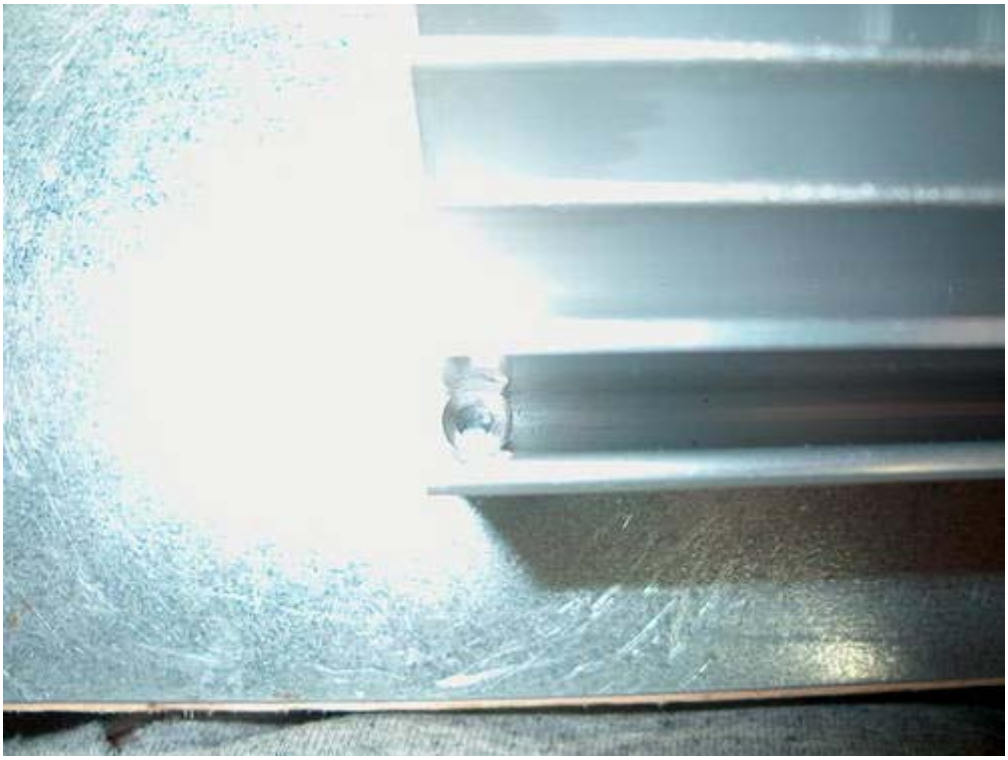


51. This is the cut heat sink after cleaning off the cutting oil and metal debris.

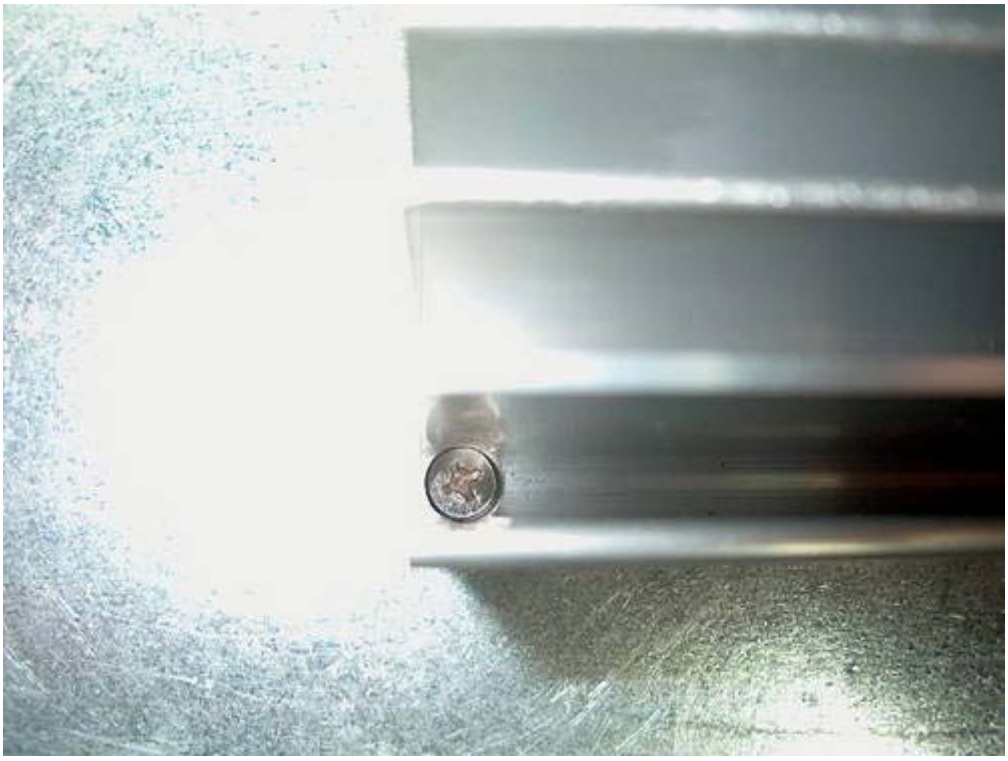
52. This is the case material after cutting on my band saw. I left the front and rear covers attached to hold the case halves in alignment during cutting. I cut off the right hand section 2 9/16" long for use as the case. The PC board is 2 1/2", deep so this allows for a small bit of edge cleaning and squaring to be done if needed.

53. I centered one of the case covers on the heat sink to mark out the locations where the mounting holes are to be drilled.

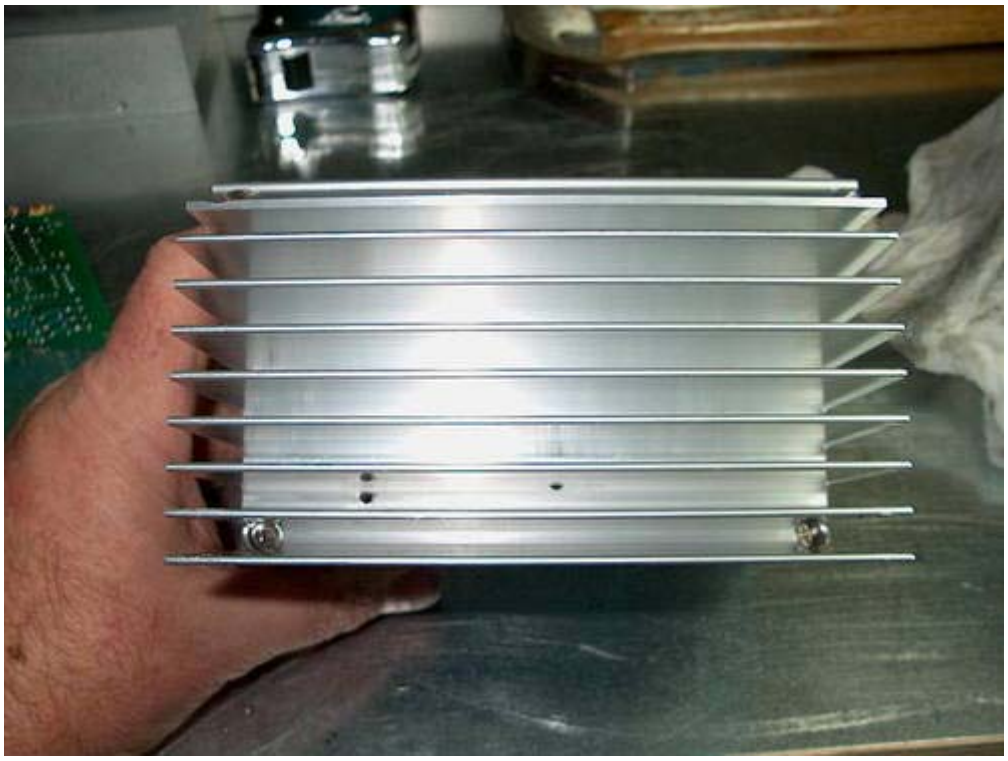
54. The pen left a very good marking of where the mounting holes need to be. I center punched these positions. and drilled the four holes with a 3/16" drill bit. I used my drill press to ensure that the holes would be straight.



55. After drilling the 3/16" mounting holes in the corners, I turn the heat sink over, and drill 3/8" countersink holes in between the heat sink fins, directly over these mounting holes. These are to allow the larger heads of the mounting hardware to fit.



56. The mounting hardware fits perfectly.



57. The heat sink is attached to the case for a test fit. It fits like it was made for it ;-)

58. The heat sink is a very good fit for this case.

59. Plenty of room in this case for the PWM3E PC board.

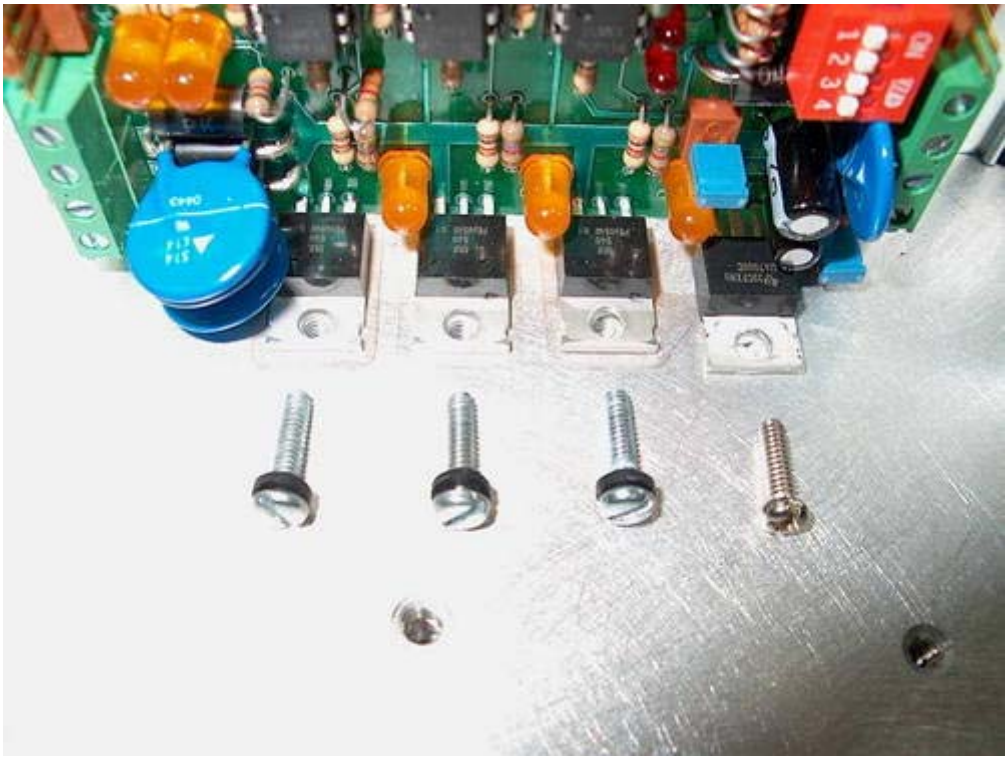
60. Despite a wall mounted propane heater running, and a heat pump with backup electric heat, it has been too cold to work in the shop for a few days. On Feb 5th 2007, in order to get back to work, I had to end up installing a propane fireplace insert. This allowed me to pump out enough heat to overcome the severe cold outside.

These are the insulated mounting hardware kits used for mounting the transistors. The hardware provided in these kits is #4-40. This heat sink is massive, so holes will have to be drilled and tapped in the heat sink to receive the hardware. If the heat sink were not so thick and heavy, then larger holes could be drilled all the way through, and the supplied #4-40 nuts used instead.

61. By mounting the PC board in the lower case with standoffs, I was able to determine exactly where the transistor and regulator mounting holes needed to be. I marked and center punched these locations. Because the 3/32" drill bit was too small to fit the chuck in the drill press, I had to use a hand drill. I tried to drill these four holes as straight as I could by hand.

62. Using a #4-40 tap chucked into a slightly modified needle file holder, I carefully threaded these four holes. This took a very long time to do, as I did not want to break the tap. It is the only one I have of that size. I worked it in a little at a time and removed it often to clean it with a small wire brush, and blow the holes out with compressed air. By hand, I twirled the cutting face of a large bit into the openings to de-burr the holes.

63. Using heat sink grease from Radio Shack, I lightly applied it to the three FETs, the regulator, and to the heat sink at all device locations. I applied the three mica insulators to the heat sink at the FET locations, positioning each insulator screw hole over the respective threaded hole in the heat sink. The regulator does not need an insulator.



64. Each transistor is fastened to the heat sink with a #4-40 machine screw, with an insulated washer fitted. The smaller diameter portion of each washer faces away from each screw head, and goes into the hole on the heat sink tab of each transistor. The regulator gets fastened with an uninsulated #4-40 machine screw.

65. The PC board is mounted and the devices are secured to the heat sink. Further finishing of the case awaits the arrival of a large combination sander. That will be used to better square off the front of the case, prior to fitting the front cover.

And you're finished with the Electronics!
Simple Huh!

"PWM3f Parts List"

ID	Digi-Key Part#	Description
C1	P3913-ND	Capacitor, High Stability, .01uF, 50V, 2%
C2	565-1303-ND	Capacitor, Electrolytic, 10uF, 16V, Radial
C3	P3917-ND	Capacitor, High Stability, .022uF, 50V, 2%
C4	P3921-ND	Capacitor, High Stability, .047uF, 50V, 2%
C5	BC1072CT-ND	Capacitor, Ceramic Disc, .001uF, 50V
C6	BC1072CT-ND	Capacitor, Ceramic Disc, .001uF, 50V
C7	BC1072CT-ND	Capacitor, Ceramic Disc, .001uF, 50V
C8	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C9	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C10	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V

C11	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C12	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C13	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C14	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C15	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C16	BC1078CT-ND	Capacitor, Ceramic Disc, .01uF, 50V
C17	565-1673-ND	Capacitor, Electrolytic, 100uF, 25V, Radial
D0	MUR410RLGOSCT-ND	MUR410RL, Diode, Ultra Fast, 4A, 100V, Axial
D1	MUR410RLGOSCT-ND	MUR410RL, Diode, Ultra Fast, 4A, 100V, Axial
D2	MUR410RLGOSCT-ND	MUR410RL, Diode, Ultra Fast, 4A, 100V, Axial
D3	MUR410RLGOSCT-ND	MUR410RL, Diode, Ultra Fast, 4A, 100V, Axial
D4	1N914-TPCT-ND	1N914 Switching Diode
D5	1N914-TPCT-ND	1N914 Switching Diode
D6	1N914-TPCT-ND	1N914 Switching Diode
I1	67-1058-ND	LED, T1, Amber
I2	67-1058-ND	LED, T1, Amber
I3	67-1058-ND	LED, T1, Amber
I4	67-1064-ND	LED, T1, Red
I5	67-1064-ND	LED, T1, Red
I6	67-1064-ND	LED, T1, Red
I7	67-1070-ND	LED, T1, Green
I8	67-1070-ND	LED, T1, Green
J1	WM8084-ND	Header, .100", 2 Position
J2	WM8084-ND	Header, .100", 2 Position
J3	WM8084-ND	Header, .100", 2 Position
J4	WM8086-ND	Header, .100", 4 Position
M1	495-1450-ND	Metal Oxide Varister - S14K14AUTO
M2	495-1450-ND	Metal Oxide Varister - S14K14AUTO
M3	495-1450-ND	Metal Oxide Varister - S14K14AUTO
M4	495-1450-ND	Metal Oxide Varister - S14K14AUTO
Opt1	67-1566-5-ND	Photocoupler, Single Channel Photo IC, Lumex OCP-PCP116, 6 Pin DIP
Opt2	67-1566-5-ND	Photocoupler, Single Channel Photo IC, Lumex OCP-PCP116, 6 Pin DIP
Opt3	67-1566-5-ND	Photocoupler, Single Channel Photo IC, Lumex OCP-PCP116, 6 Pin DIP
Q1	IRF540ZPBF-ND	IRF540 Diode Protected HEXFET, TO-220
Q2	IRF540ZPBF-ND	IRF540 Diode Protected HEXFET, TO-220
Q3	IRF540ZPBF-ND	IRF540 Diode Protected HEXFET, TO-220
R1	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R2	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R3	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R4	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R5	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R6	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R7	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%

R8	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R9	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R10	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R11	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R12	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R13	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R14	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R15	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R16	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R17	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R18	10KQBK-ND	Resistor, 10k ohm, 1/4W, 5%
R19	4.7KQBK-ND	Resistor, 4.7k ohm, 1/4W, 5%
R20	3.3KQBK-ND	Resistor, 3.3k ohm, 1/4W, 5%
R21	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R22	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R23	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R24	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R25	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R26	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R27	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R28	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R29	3006P-104-ND	Resistor, Potentiometer, 15-turn CERMET, 100k ohm, 3/4W
R31	3.3KQBK-ND	Resistor, 3.3k ohm, 1/4W, 5%
R32	3.3KQBK-ND	Resistor, 3.3k ohm, 1/4W, 5%
R33	3.3KQBK-ND	Resistor, 3.3k ohm, 1/4W, 5%
R34	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R35	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R36	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R37	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R38	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R39	1.0KQBK-ND	Resistor, 1k ohm, 1/4W, 5%
R40	4.7KQBK-ND	Resistor, 4.7k ohm, 1/4W, 5%
R41	4.7KQBK-ND	Resistor, 4.7k ohm, 1/4W, 5%
R42	4.7KQBK-ND	Resistor, 4.7k ohm, 1/4W, 5%
SW1	CT2094LPST-ND	4PST Switch, 8 Pin DIP
TB1	ED1609-ND 2 Required	Terminal Block, .200", 2 position X 2
TB2	ED1609-ND 2 Required	Terminal Block, .200", 2 position X 2
U1	296-6504-5-ND	Texas Instruments NE556N Dual Timer IC, 14 Pin DIP, Must Be From MALAYSIA
U2	296-6504-5-ND	Texas Instruments NE556N Dual Timer IC, 14 Pin DIP
U3	296-6504-5-ND	Texas Instruments NE556N Dual Timer IC, 14 Pin DIP
U4	497-1446-5-ND	7808T or LM7808, Voltage Regulator IC, 3 Terminal, 8V, 1 A, TO-220
Misc	AE8906-ND 3 Required	IC Socket, 6 Pin DIP, Soldertail
Misc	AE8914-ND 3 Required	IC Socket, 14 Pin DIP, Soldertail

Misc	4724K-ND 3 Required	TO-220 Mounting kit X 3 for Q1, Q2, & Q3. Not needed for U4.
Misc	A31697-ND Pack of 10	2-position .100" shunt block for shorting J1, J2, and J3

Functions

J1	External PWM Master Disable, Short to Disable Onboard PWMs 1-3
J2	Single Supply Enable, Short to Tie MOSFET Gate Supply TB3 to +DC
J3	Common Ground Enable, Short to Tie MOSFET Source to -DC
J4	Auxiliary TTL Inputs 1, 2, 3, & Gnd
SW1	1-3 = PWM Channel Disable 4 = PWM Master Disable
TB1	DC Power Input & MOSFET Source Ground
TB2	MOSFET Drain/PWM Outputs & MOSFET Gate Supply Input

Note: Some components are only sold in minimum quantities, or multiples of 5 or 10, so you may need to count the total number of each value required and order accordingly.