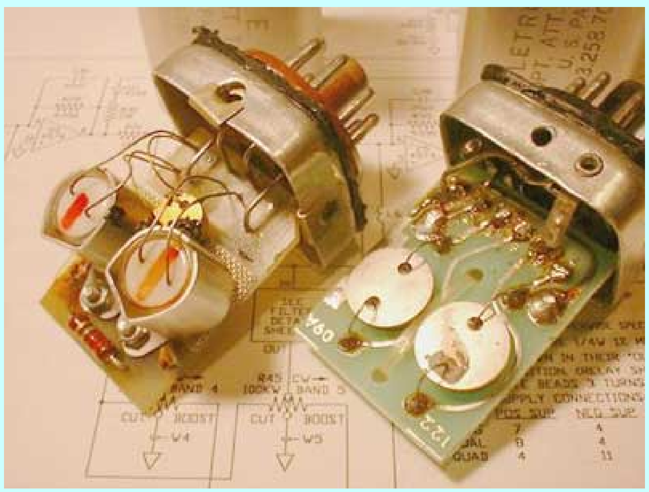
T4 Module

The T4 module is part of the famous LA2a audio compressor. There was the T4a, then the T4b. The module is used to control the level of signals while recording and mixing. The heart of the T4 module is the EL panel, or electro-luminescent panel. This panel emits light into a pair of light dependant resistors, or LDR's. The normal price for a T4 module is around one hundred and sixty dollars. Thus, it is one of the main stumbling blocks to building a DIY compressor for most people.

Here you will find instructions on how to build your own T4 module using the exact same parts as in the original. There are also some links to additional information on the T4.

A manual for the LA2a with much interesting information on the compressor and it's operation, can be found at this link:

Here are a few picturs of someT4 modules. Some of them are older models.



Notice that the module on the left has three LDR cells. One of the big ones is probably for metering, the other two probably have different attack and release characteristics, which affects the compressors characteristics. I have not tried the three cell

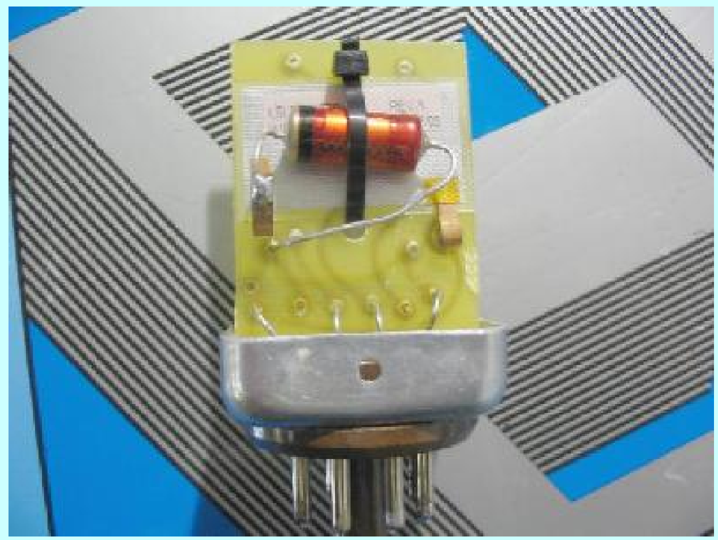
model, but hope to build a similar unit.
Early models had a 2.2 megohm resistor in paralell with the EL panel. Universal Audio now sells the T4b reissue with a 4700 pf cap in series with the EL panel. This makes the compressor follow the bass notes less. You can change the frequency response of the T4 module by changing the value of the capacitor. More capacitance will tend to make the compressor follow the bass notes more while compressing. Less capacitance will mean the compressor follows the upper frequencies more, which will mean less squashing of the dynamics durring compression. You can tweak this value to suit your needs. If you are using the compressor for bass or drums, us a bigger value cap. If using it for guitar or vocals, stick to the stock 4700 pf.

The capacitor might also prolong the life of the EL panel, since it limits the signal going to the panel somewhat.

Clairex cells were used in the earlier units. Now, Silonex is the sole source for cells.

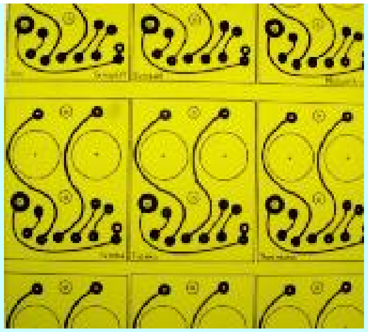
Right: This is probably a UREI module judging from the decal.
Universal Audio now uses a taller can than this.

A couple of custom units for Bluebird!
1950's vintage Wima capacitors.



A more typical unit.
The cap allows the compressor to follow less of the lows and more of the highs.

PC Board



You can download a pdf file of the T4 PC board artwork if you like:
PC Board Artwork
This is a negative image. The printed lies on the sensitized side of the pc board.
The board measures 1 1/4 inces by 1 5/8 inches.
You can get 9 boards on a single sided MG Chemicals 4 by 6 pre-sensitized board. Check the measurements of your artwork. Some printers will change the scale of the artwork slightly.

Relay Housing

I have been taking apart plastic octal base relays and using their housings.

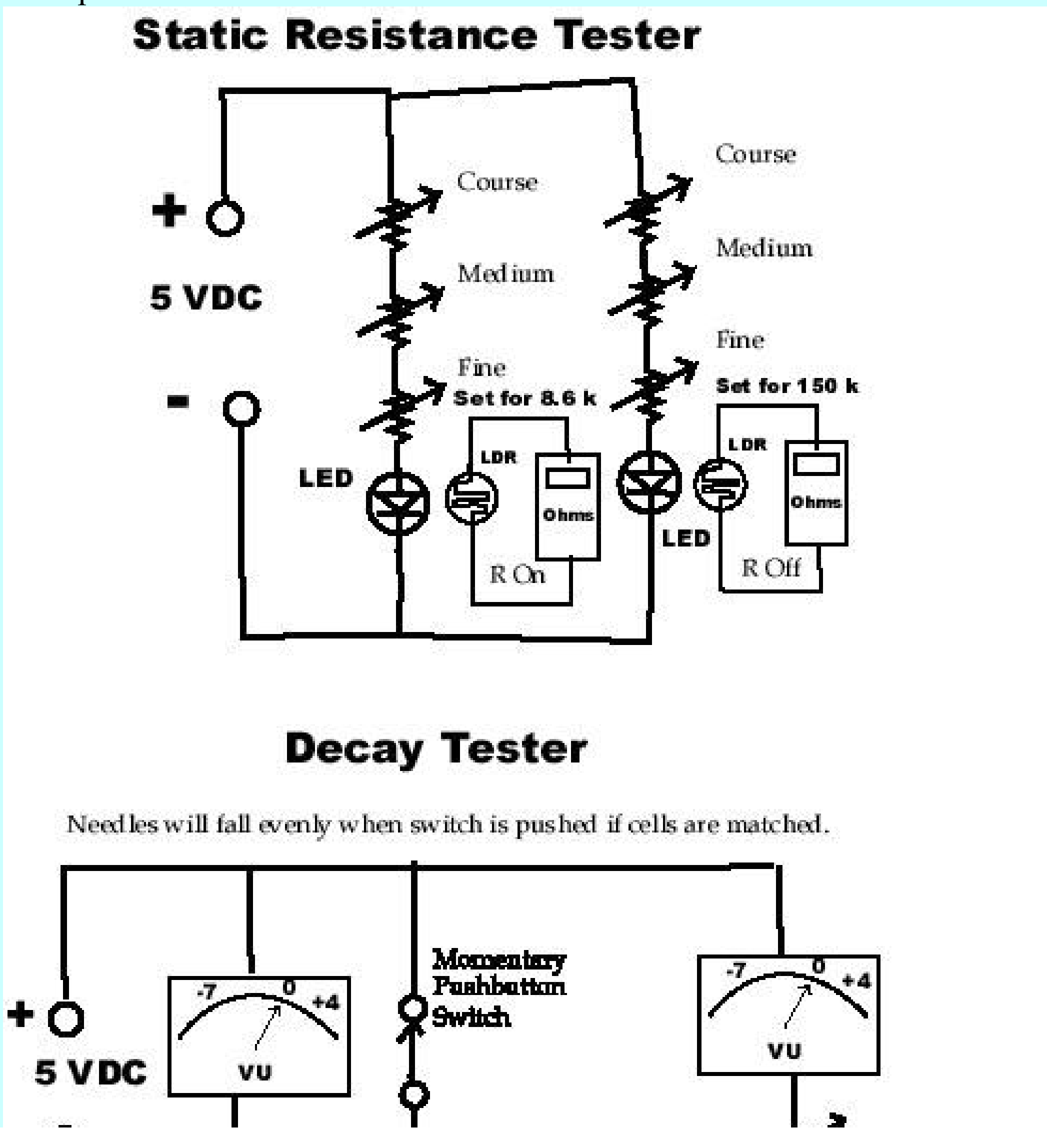
Light Dependent Resistors

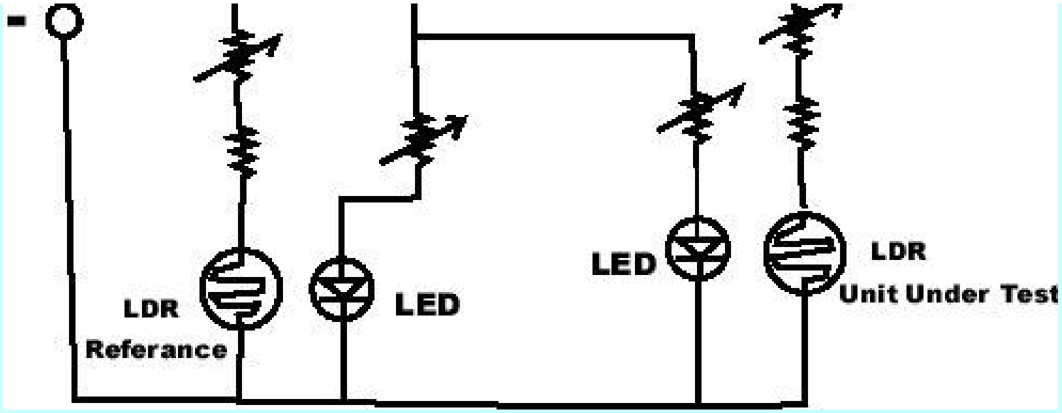
Clairex and Silonex are the only two makers of light dependant resistors for the T4 module that I have used. Clairex no longer sells LDR's, but old stock can still be found. The Clairex p/n is CL5M5L. Cells from Clairex tended to be much less consistant than the Silonex NSL 5910 cells, as far as static resistance is concearned. Clairex was used prior to the Silonex products.

UREI had a spec for cells that is probably used by UA also. Here is an original document that specifies certain parameters for the cells, which were tested on a jig that was probably supplied by UREI:

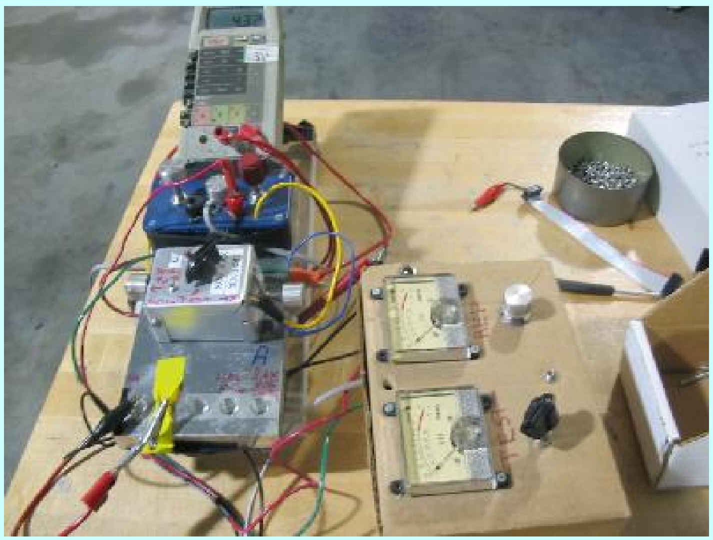
[1604.pdf]

Here is the schematic for the test fixture that I built:
I kept it simple so that anybody could build it. I experimented with precision referances, fet current regulators and voltage regulators, but this system worked the best, as cells change their resistances slightly from day to day. I can dial out ant differences with the potentiometers.





Here is a test fixture I built to match the Light Dependent Resistors:



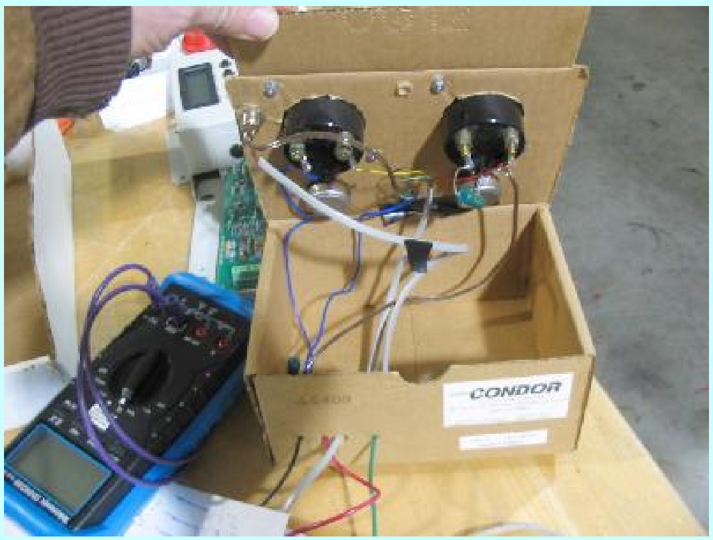
On and Off Resistance jig and decay tester.

Course, medium and fine adjustments for LED light level.

Matching

VU meters for decay testing with zero adjust pots.

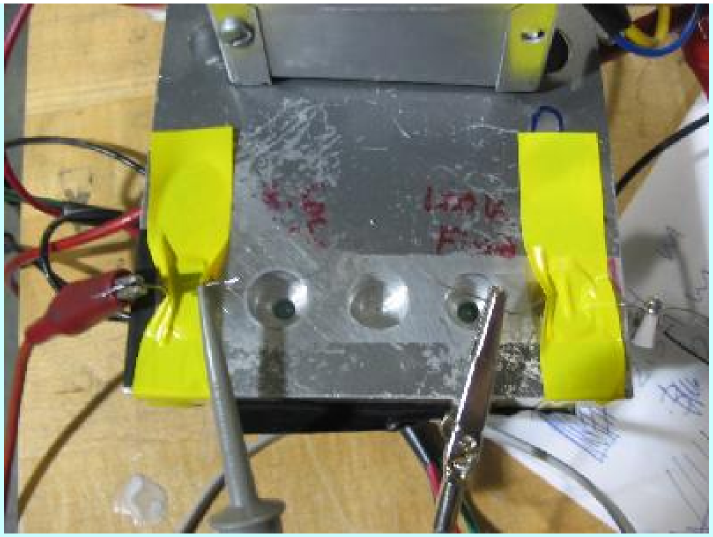
Just a few resistors and pots needed to complete.



Just a two

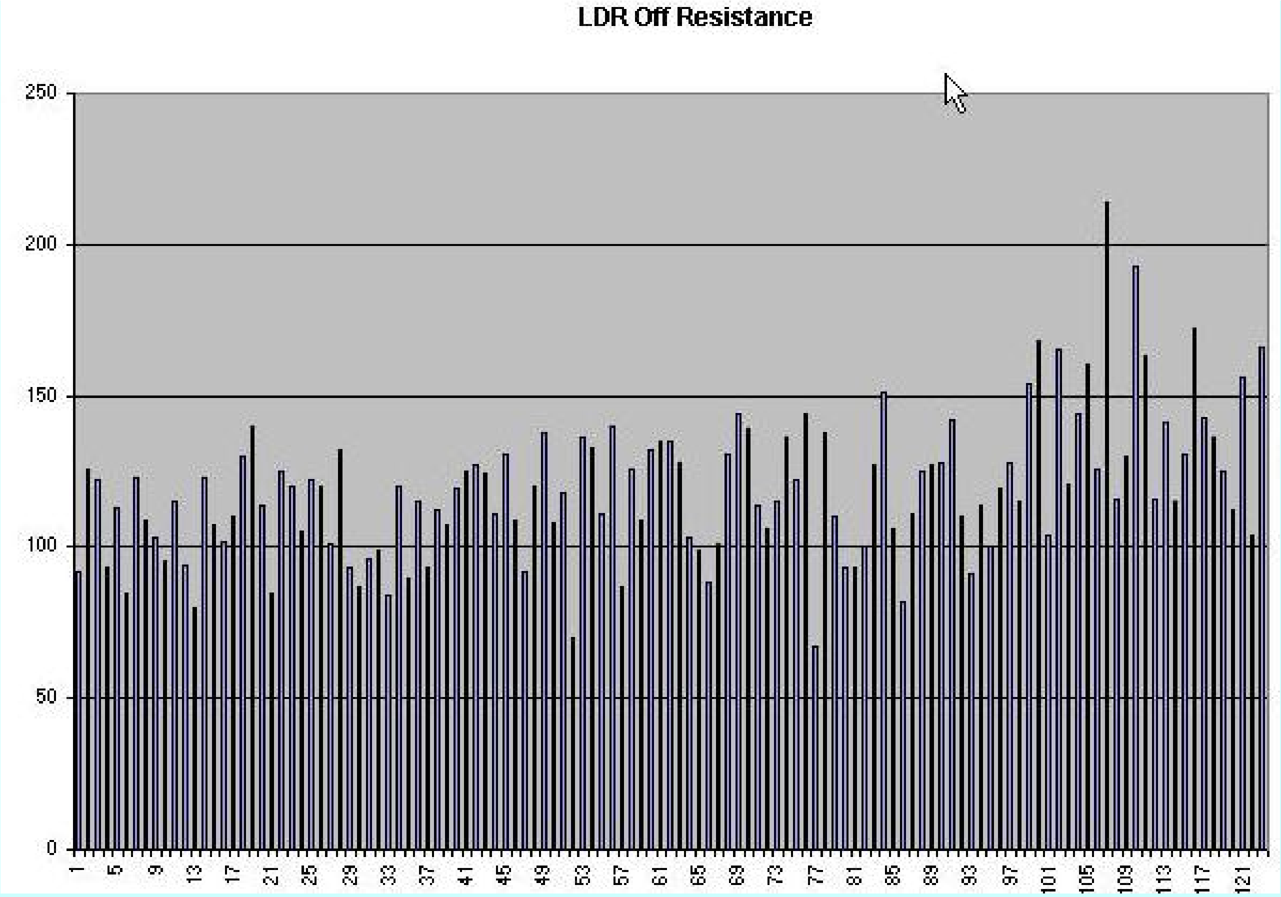
hour project in a cardboard chassis.

Inner two LED's for on and off resistance.
Outer two for decay testing against a referance cell.

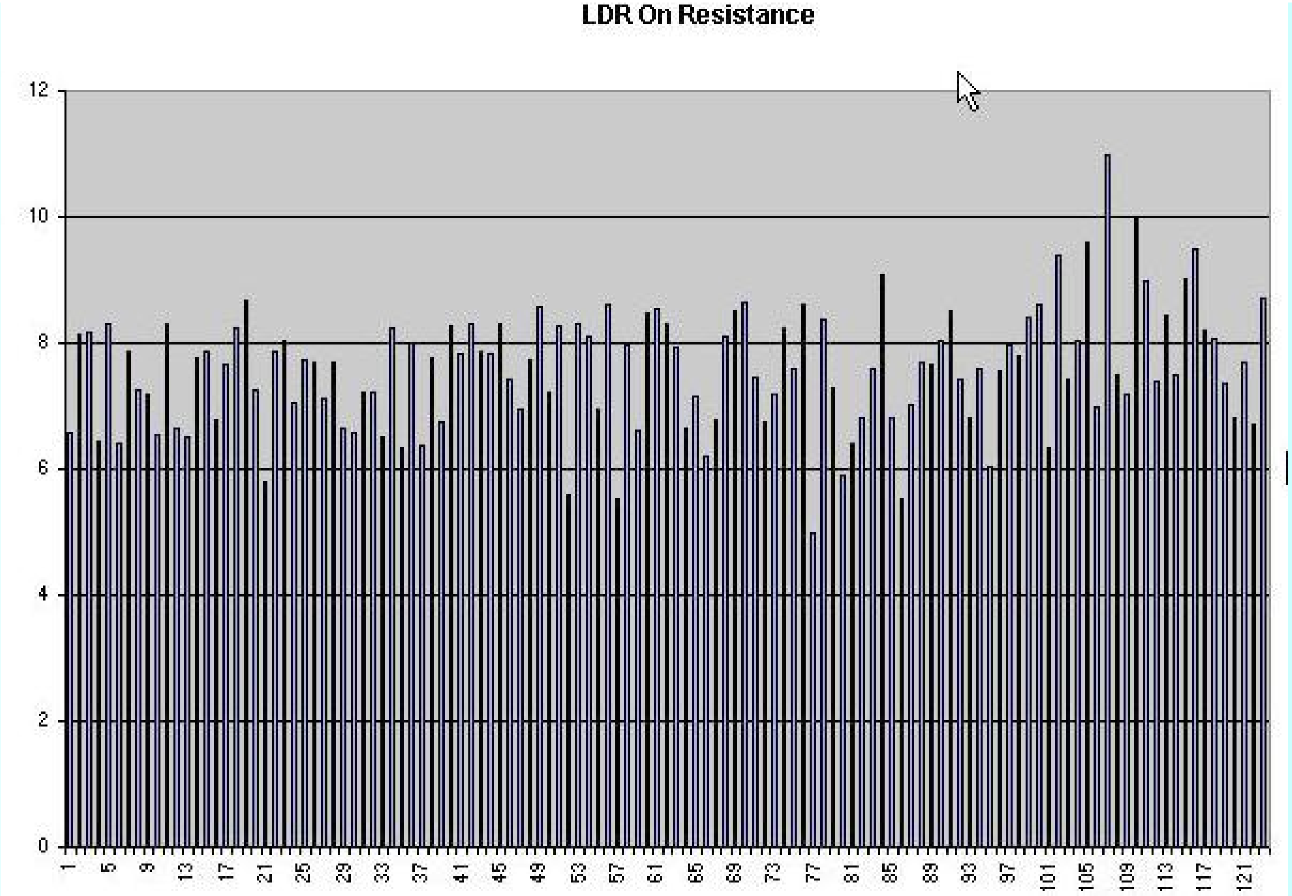


Cells are taped into the cavities for testing.

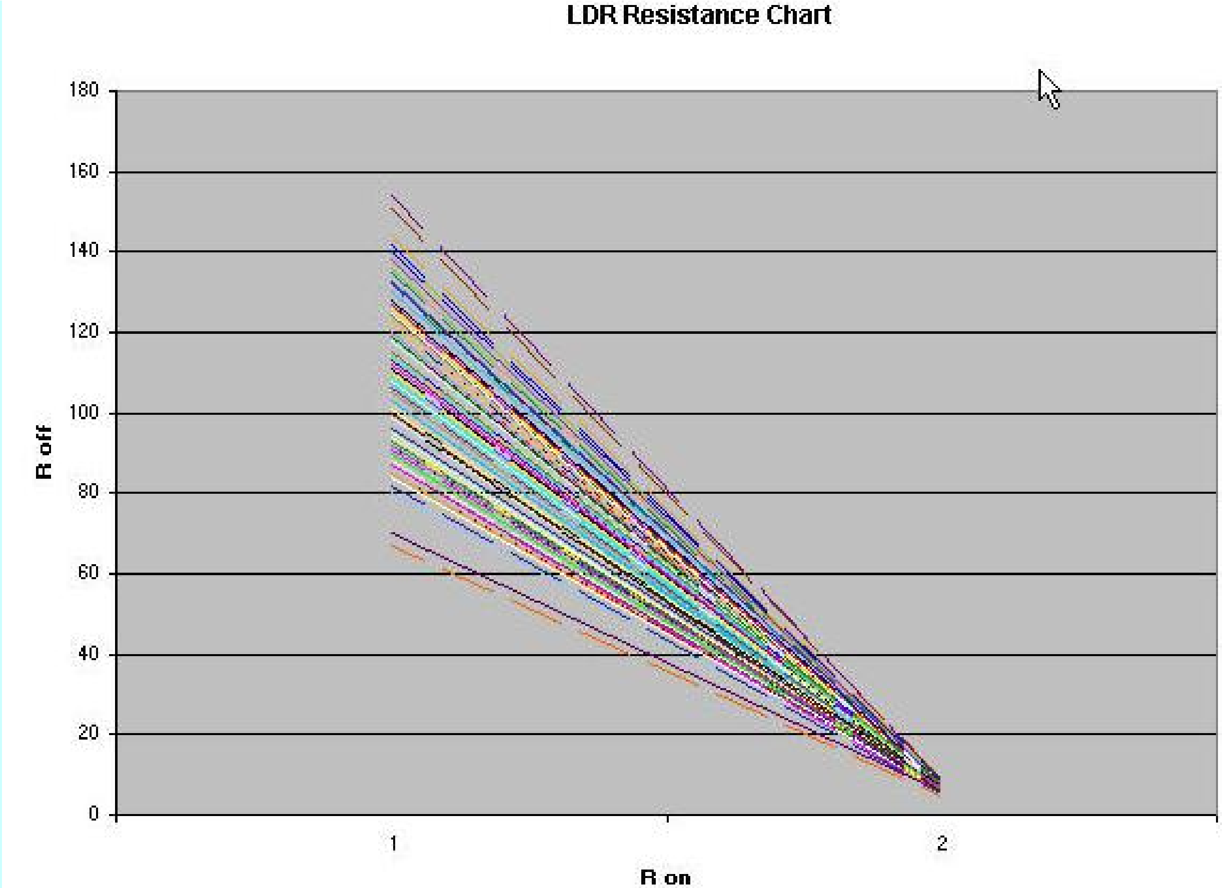
Some Test Results:



This is a chart showing the "off" resistance of 125 LDR's.
You can see there were some real strange ons in there!



This is the same sample group only with a stronger LED intensity used.
Cells over 8.6 k or under about 6.2 k are rejected. Once all the cells are checked, their specs can be entered on a spreadsheet and sorted for matching. Then they are checked for decay times.



This chart shows on and off resistance on the same page. Although the cells may start out at different off resistances, they all converge to nearly the same on resistance. Note that none of the cells cross over each other.

Some notes on cells and my testing procedure:

I have tested about 150 cells so far. I check them for three different parameters, off resistance, on resistance, and decay time.

Test 1: First, the static resistance of the cells are checked using a green LED in a test fixture that is set up to duplicate a low light situation. In this test, cells tend to fall into a range of about 100k to 150k ohms.

Test 2: The second test does the same thing, only a different green LED is used that is set up to get the cell down to the 8.6k ohms range, which is the maximum resistance specified on the 1604 pdf file above. Most cells in this test fall into the 6k to 9 k ohm range.

Test 3: Decay time is checked last, if I get two cells that match up in the above two tests. A referance cell is placed on a test jig that has a green LED . The led is trimmed to make the referance cell read 8.6k ohms. Then the referance cell is then used to calibrate another LED which sits on the same test jig. Both LED's have a momentary switch place in series with their power supply so that I can cut power to both at the same time. The cells are fed a voltage through calibration pots, and then two VU meters. The calibration pots are set to make each cell read 0 VU on their respective meters. Then, power is cut to the LED's and the needle movement of the meters is observed. Most cells, if matched for resistance, will exibit the same exact decay characteristics. . Using this method allows for a much better match, as the cells are watched as they travel through their varius decay times. Short, medium and long decay characteristics can be seen in the same test. The original test procedure only checked the cells for theit quick decay characteristics.

Only about five percent of the cells fail the decay test after being matched for resistance.
A much larger percentage, around twenty-five percent, are rejected due to them falling above the 8.6 k ohm spec, or too far below. I usually set the cutoff point at around 7k ohms. **The lower the resistance, the slower the decay time**. This held true with just about every cell I tested.

Some weird stuff: One cell that I tested had a quicker short decay time, and then a longer decay time than the referance cell .In other words, when I tracked them side by side with the VU meters, the test cell needle fell quicker at first, but then was passed by the slower cell needle after about ten seconds had elasped. This was unheard of in all my other testing. It was probably a cell that fell into the wrong box at the factory! Thus, the need for decay testing. The second weird cell did the opposite. It was slower out of the gate during the test, but then caught up and passed the referance cell. These were the onlty two cells out of 150 that exhibited theses strange characteristics.

Does the decay time make a difference in the sound? Yes! On one ocassion, I forgot to check a matched set of cells for decay time. I had matched them the night before for resistance, but not decay. The next day, I assumed I had done all three tests. When I installed the cells in a T4 module and plugged it in for a listening test, the sound was not quite the same. A subtle difference, but noticiable after careful listening. I pulled both cells back out of the module and tested their decay time. As luck would have it, the cell that was installed in the slot that controls the signal volume had too fast a decay time! After matching up another cell, the module sounded fine.

Does the twin VU meter method really work/ Yes! One time, the black tape that I used to hold down one of the cells to the test fixture came a little bit loose. When I did the decay test, I noted some strange behavior, much like that mentioned above. When I checked the fixture and noticed the loose tape, I realized that the ambient light from outside was upsetting the test! After the cell was retaped, it tested good.

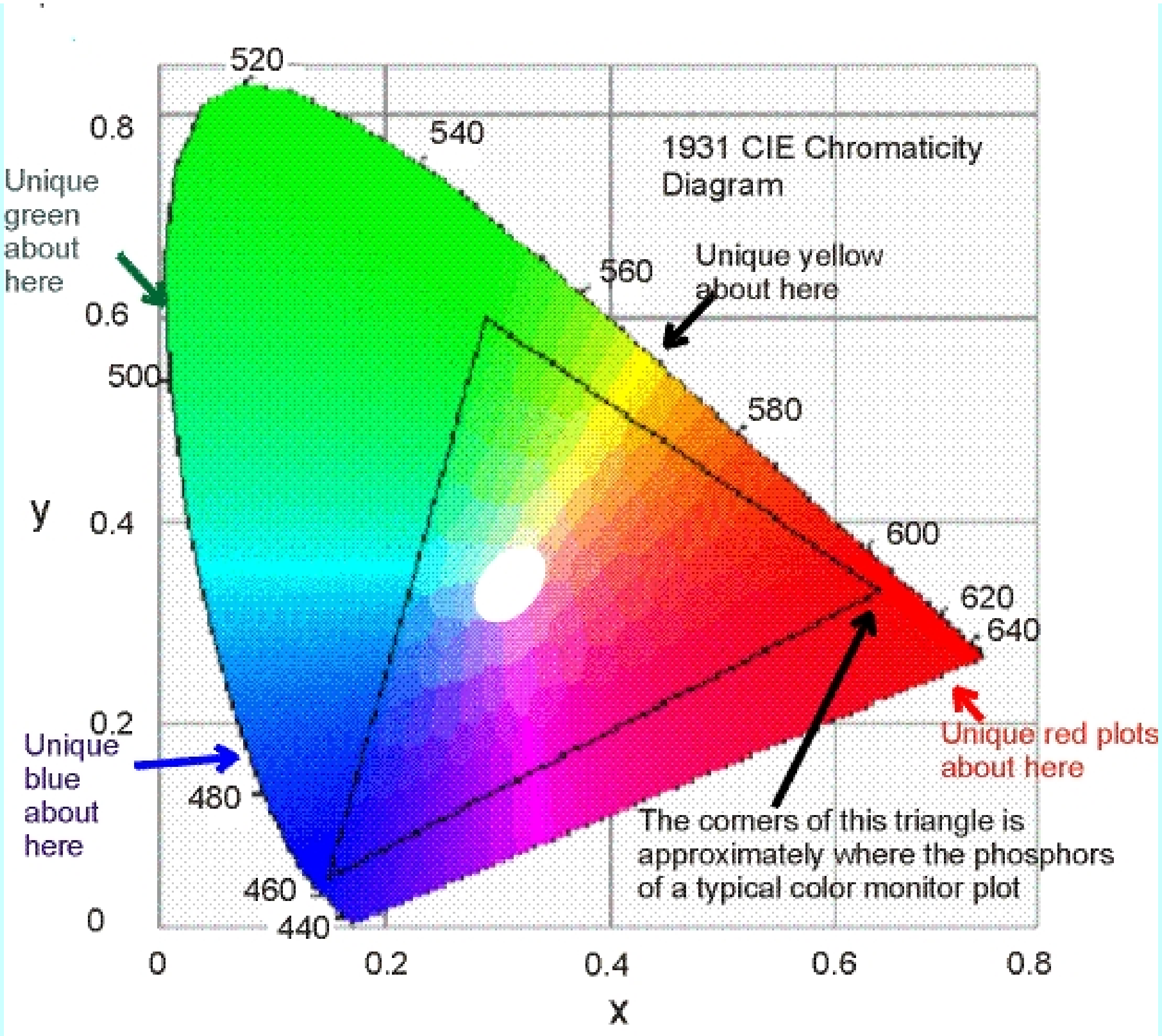
EL Panels

The Electro-luminescent Panel, or EL Panel for short, is sourced from LSI. EL panels are widely used for airplane lighting. They consist of a coating of phosphorus, that when subjected to an electric field, excites electrons from the valence band into higher energy levels. When the electrons return to their normal level, they emit light. Early EL panels were not sealed and therefore were subject to early failure or degeneration due to moisture causing oxidation of the phosphors. Modern panels have a thin layer of clear plastic which seals the panel against this. The panel is the most expensive part of the T4. They go for $27.50 U.S. with a minimum order of $100. The price drops to $22 for quanties of 100.

Here are some specs for the panel:

The PN 37721-1 is the LSI manufacturing PN for PN 95-0015-1. The latter PN (95-0015-1) was assigned to the design when manufactured by our NY facility. All designs of this type were transferred to this NH based facility and issued in-house manufacturing part numbers (PN 37721-1).

Lamp color is aviation green, CIE chromaticity coordinates of X = .205 +/- .030, Y = .485, +/- .030. Initial brightness is 20-26 ftL typically at 115VAC/400Hz. Average time to half-brightness is 1000-1100 hours (again typical performance using operation parameters of 115/400). Lamp uses copper ribbon as termination material. The ribbons are left "flying" as they exit the package material of the lamp.



520
540
560
580
600
620
640
500
480
460
440
0.8
0.6
0.4
0.2
0
y
0
0.2
0.4
0.6
0.8
x
1931 CIE Chromaticity Diagram
Unique green about here
Unique yellow about here
Unique blue about here
Unique red plots about here
The corners of this triangle is approximately where the phosphors of a typical color monitor plot

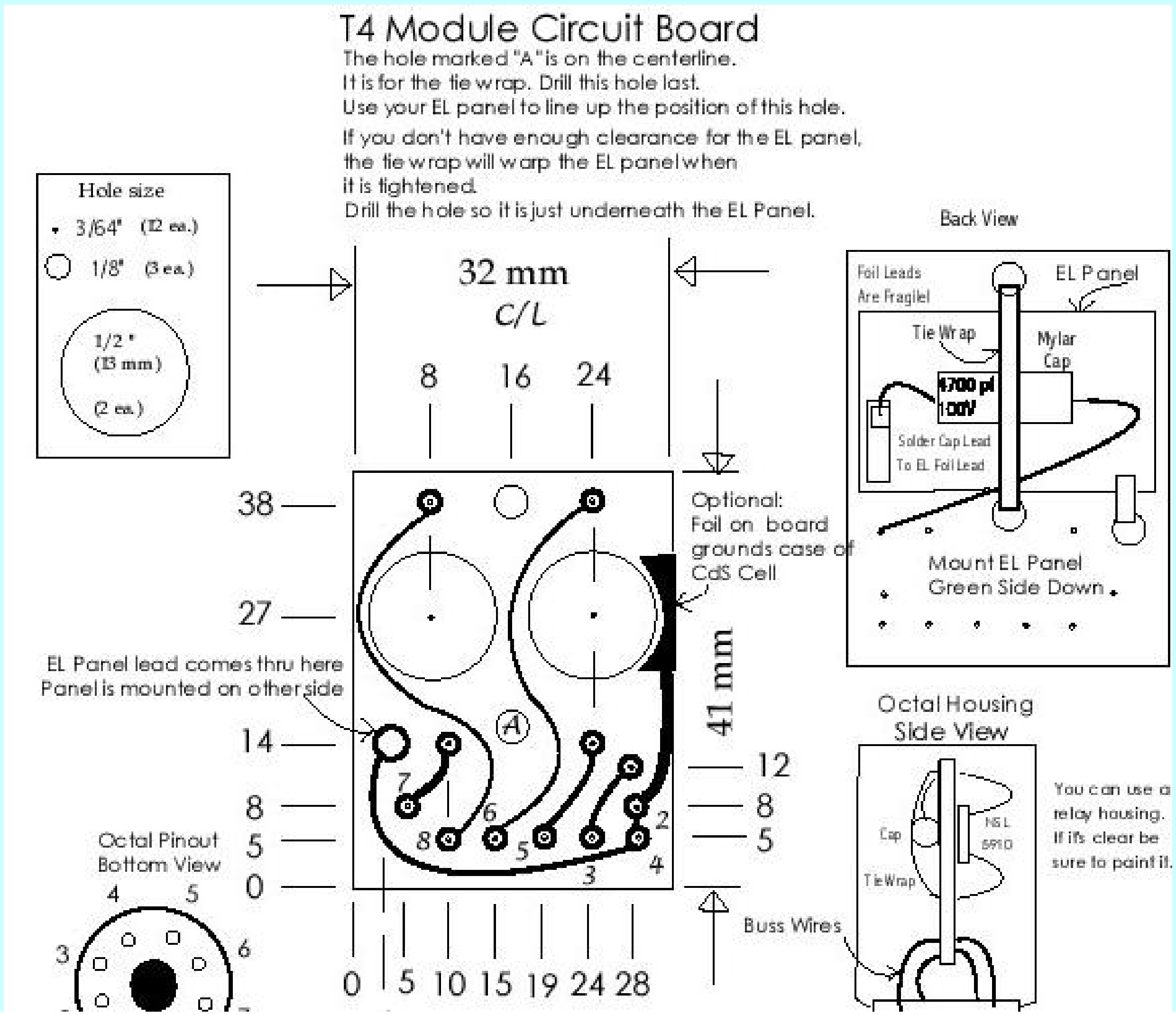
Parts List

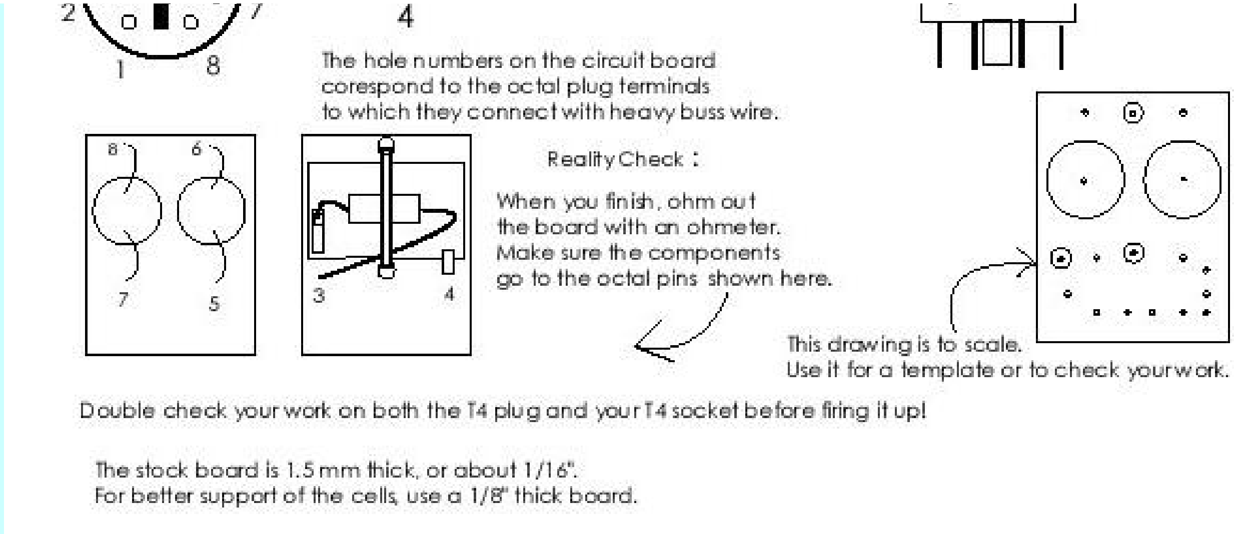
Description	Part number	Vendors	Quanity	Price
EL Panel	LSI p/n 37721-1 Rev. A You must fax in orders with your credit card information attached. There is usually a long lead time for the panel so order ear	Luminescent Systems Inc. LSI 4 Lucent Drive, Lebanon, NH 03766, USA Tel: 603-643-7766, Fax: 603-643-5947, E-Mail: salesnh@lumsys.com In Europe, inquiries for all of LSI's products should be directed to our sales office in Belgium: Van Kerckhovenstraat 110 Bus 204, 2880 Bornem, Belgium Tel: +32 (0)3 890 4740, Fax: +32 (0)3 890 4744, E-Mail: lsi.europe@glo.be	1	$27.50 U.S. (minimum order $100)
Light_Dependent_Resistors	Silonex NSL-5910 Silonex	Allied Electronics Allied	2	$3.00 ea.
Capacitor	4700 pf 100 volts	anybody	1	$1.00 ea.
Tie Wrap	1/8 inch thick	anybody	1	10 cents
PC Board	1.25" x 1.625"	MG Chemicals (DIY)	1	?
Relay Housing	hopefully we will source soon!	?	1	$5 ?

Buss Wire	20 ga.	anybody	24-inches	$1.00

Instructions

For those with ADD (attention deficit disorder), here is a quick version of the instructions.





Here are the new and improved instructions!

Preparing the relay housing

Typical octal relay housing

Prying off the lid with

a small screwdriver.

Got the lid off without breaking it!

Snip all the wires leading to the relay.

Some relays will require the removal of a few rivets.

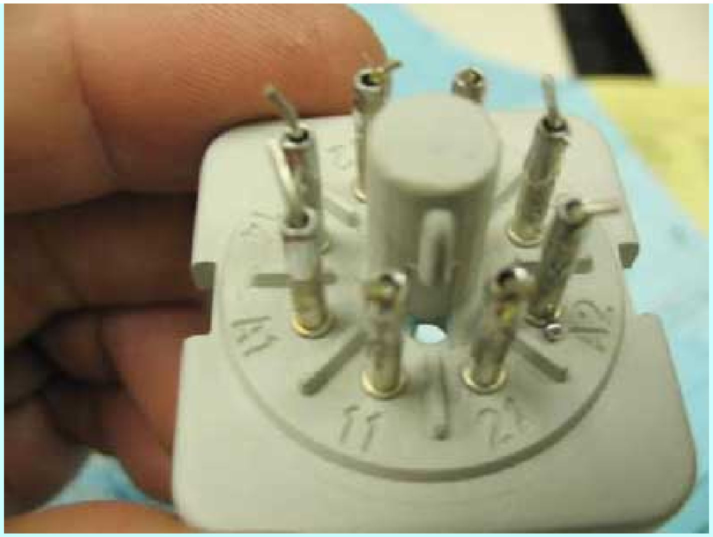
Removing the relay from the housing.

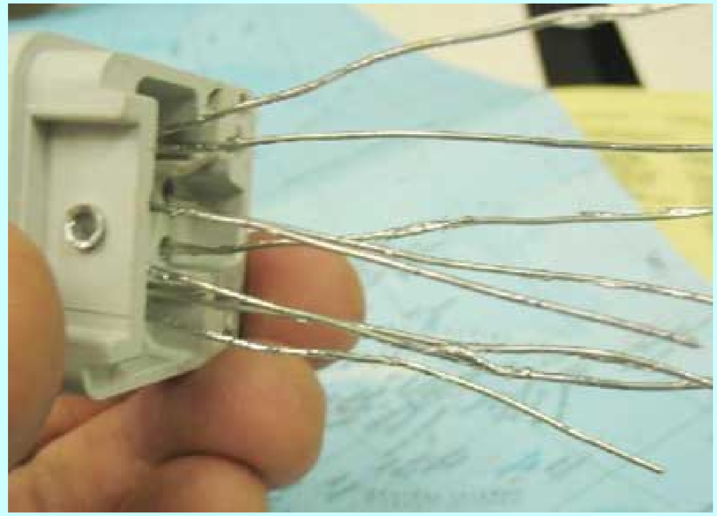
Removing the old relay wires from the octal base.

You will need some 20 gauge buss wire.

Cut 8 pieces of buss wire.
Make each one about 3 inches long just in case!

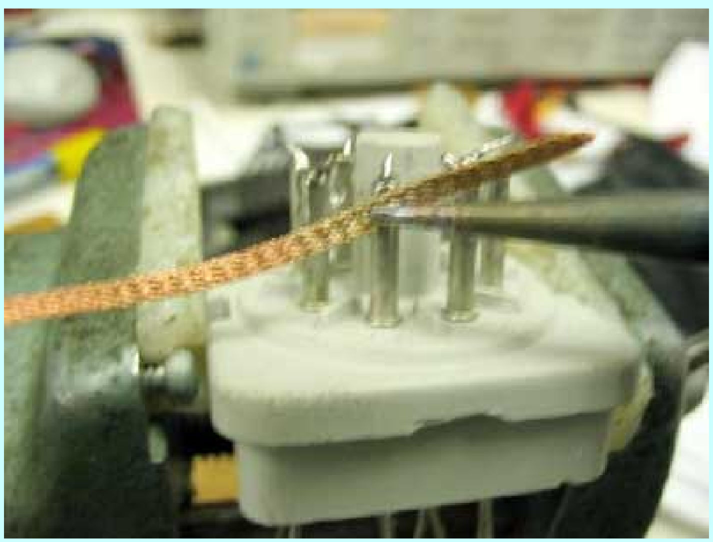
Heat the pin so you can drop the wires in.





Bend the wires just enough so that they don't
fall thru when you solder them.
Heat the pin and wire long enough so that
the solder flows into the pin, not outside of it.

Do not worry about excees solder on the leads.
You can clean them up if they do not go
through the holes in the PC board.



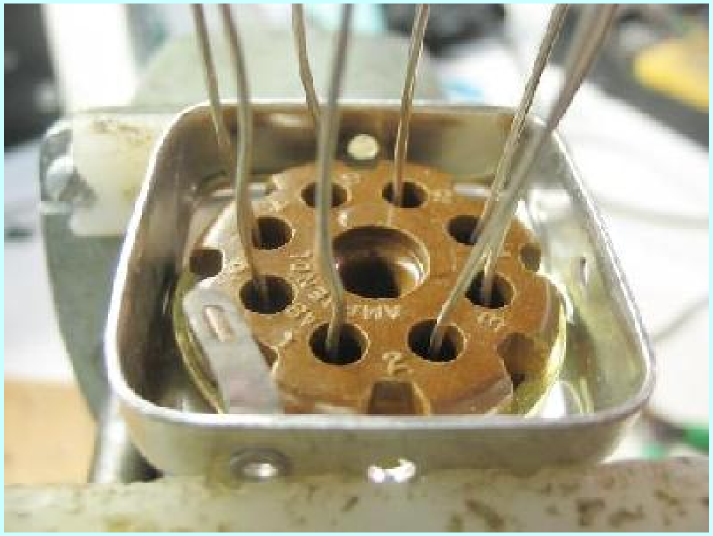
Clean up any excess solder on the pins with solder

File down any rough spots.

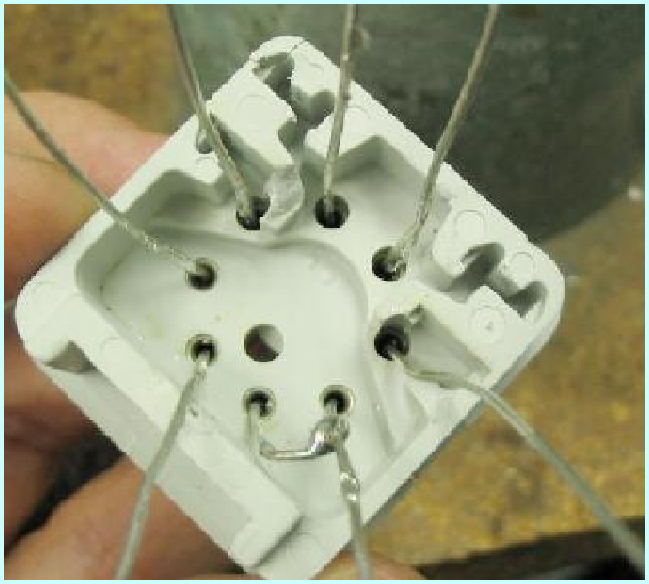
wick or a wet paper towell.
You don't have to get the pins perfectly clean.
Just enough so that they will not stretch out
the octal socket.

Attaching the PC Board

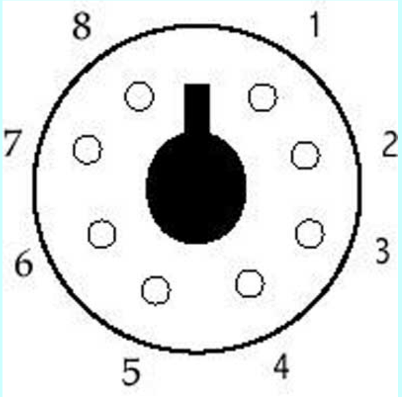
Now we are going to attach the PC board to the octal base. I will show two different bases being wired. The one on the left is a NOS 1950'2 original T4 housing. The one on the right is a plastic relay housing I picked up at the surplus store for $1.98.
I have already wired wire 1 to wire 2 on the plastic base. I will show this in detail on the brown base.



1950's NOS T4 base.



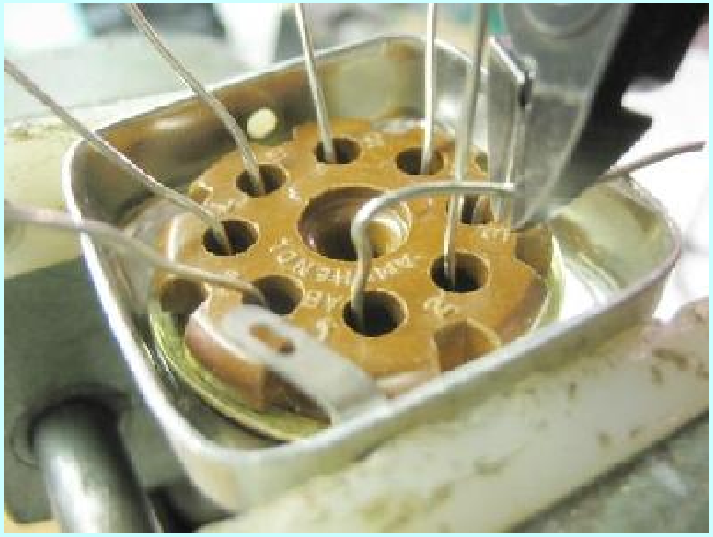
Surplus relay base.



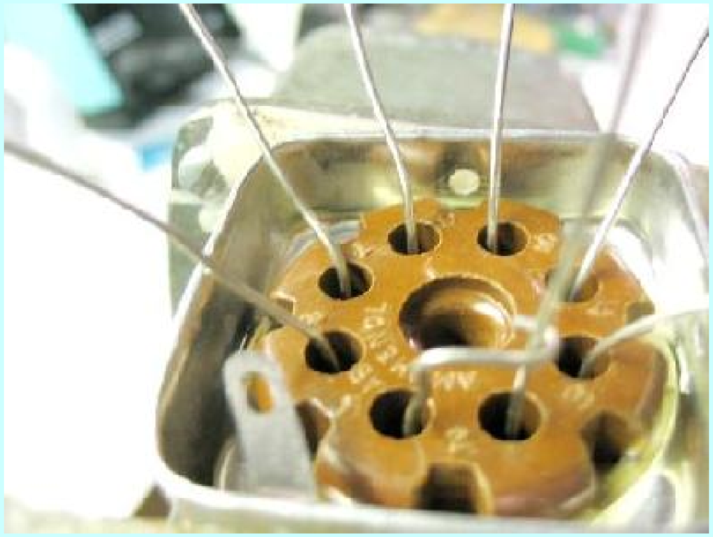
Bottom View
Octal Plug

Locate Pin 1 on the base. Grab the pin 1 wire with some needle nose pliers about one quarter of an inch from the bottom. Use the diagram on the left for referance.

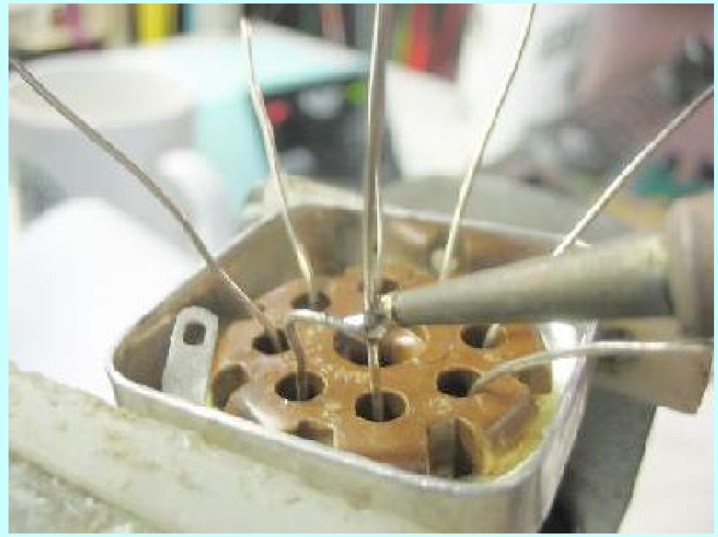
Bend the wire to the right. Make a ninty degree angle.



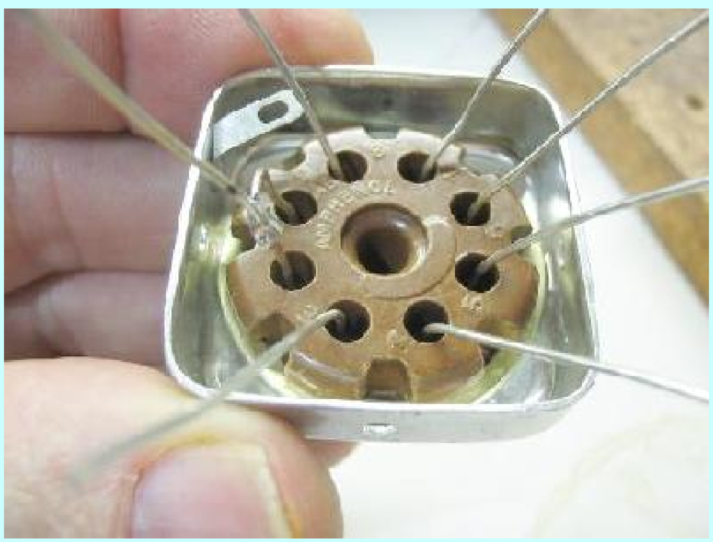
Cut wire one leaving enough wire to loop it around wire two.



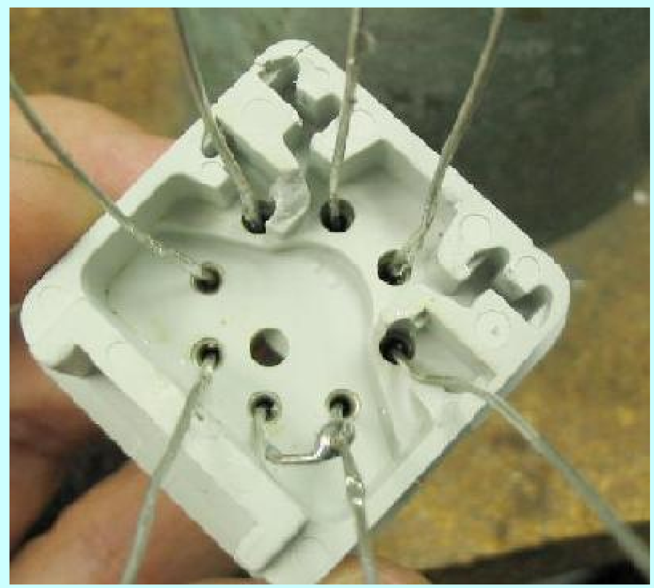
Loop wire one around wire two and crimp it tight.



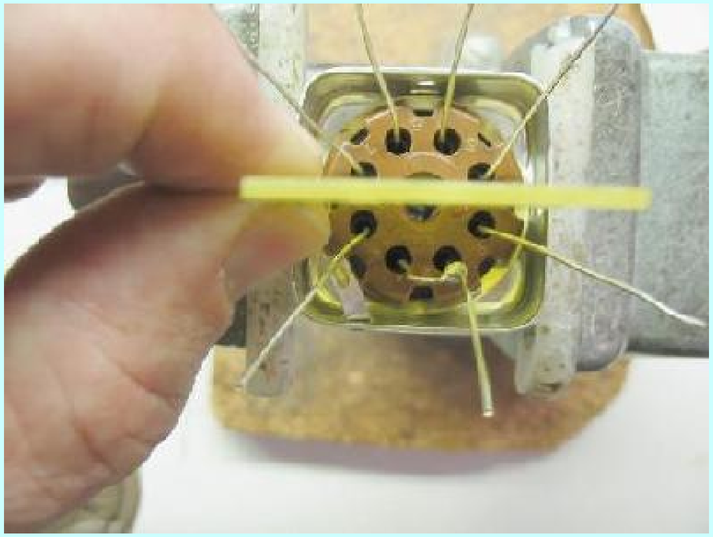
Solder wire 1 to wire 2.



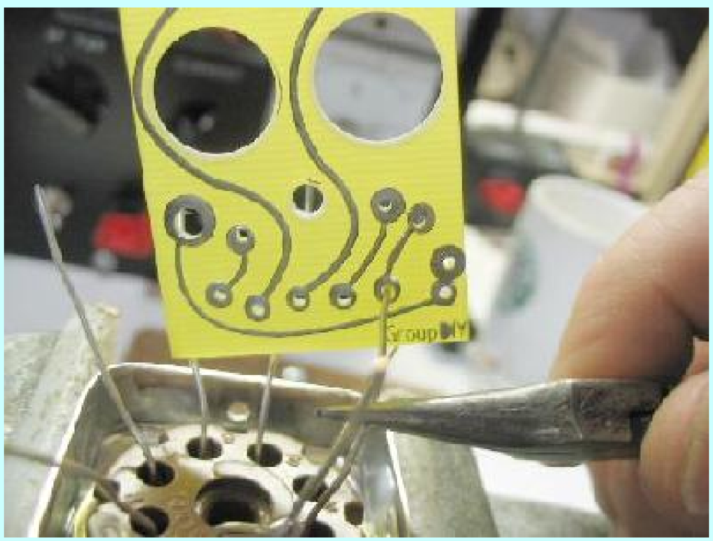
Locate wires 8, 1-2, and 3 and bend them all back away from the center. Do the same with wires 4, 5, 6 and 7.

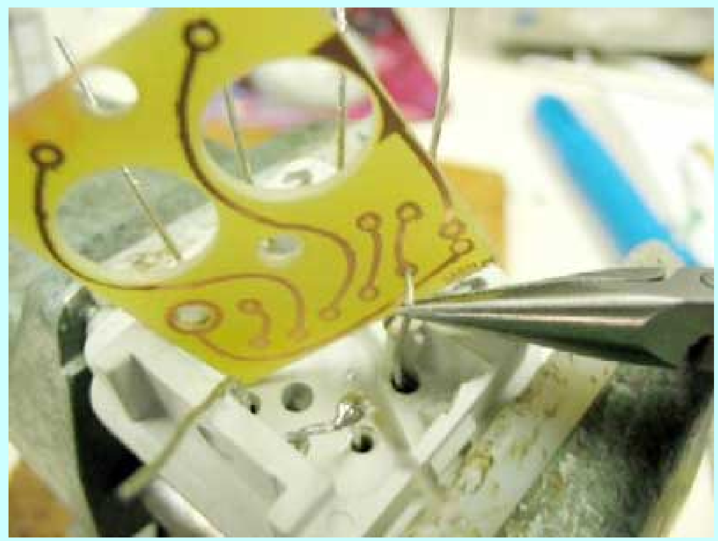


The same thing has been done here.

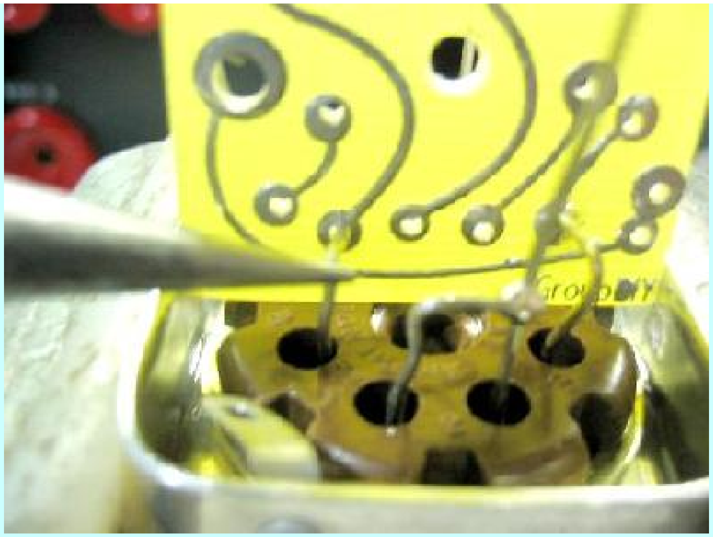


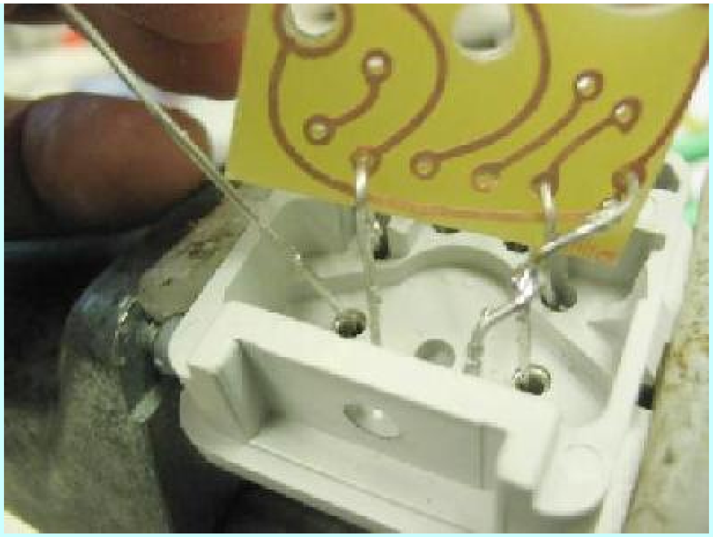
The board goes in the valley created by the seperated wires.
On the plastic version, the board will usually sit at a forty-five degree angle to the base because of the lead orientation..





Locate pin 3 and hook it's wire into the board as shown.

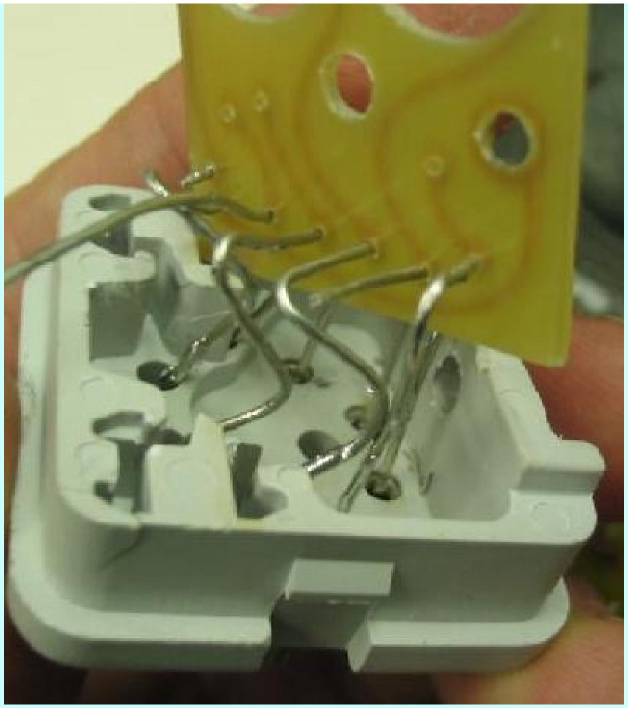




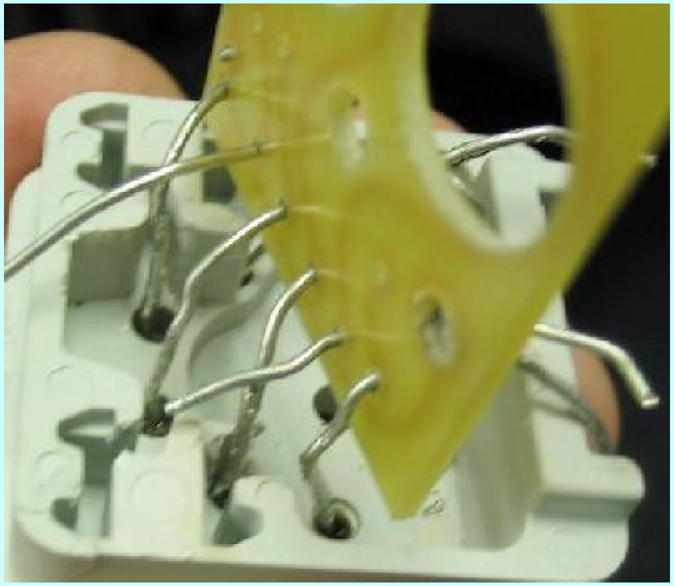
Locate pin 7 and put it's wire into the hole shown.
Pin 1 and two wire has been already placed into it's home on the plastic base.

Turn the module around to fit the rear wires:

Locate pin 7 and put it's wire into the hole as shown.
Working from the back on these views.

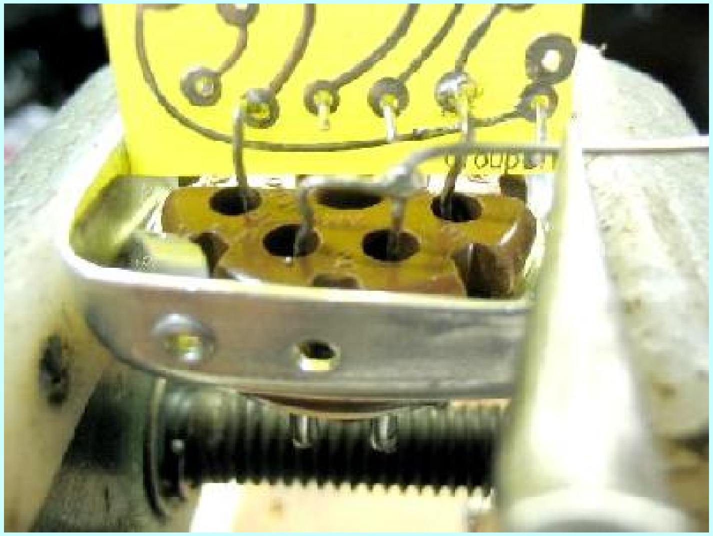


Do not worry if you end up with some bent
buss wires. They can be straightened out later.



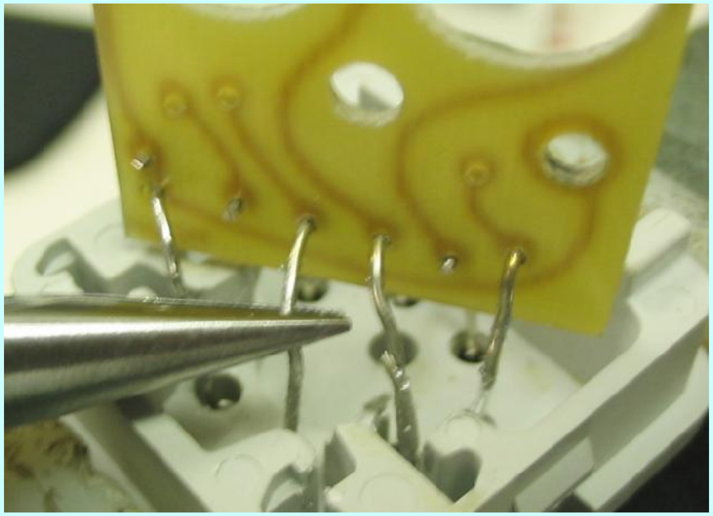
Insert the rest of the buss wires into the backside of the board.

Working on the front of the board again:

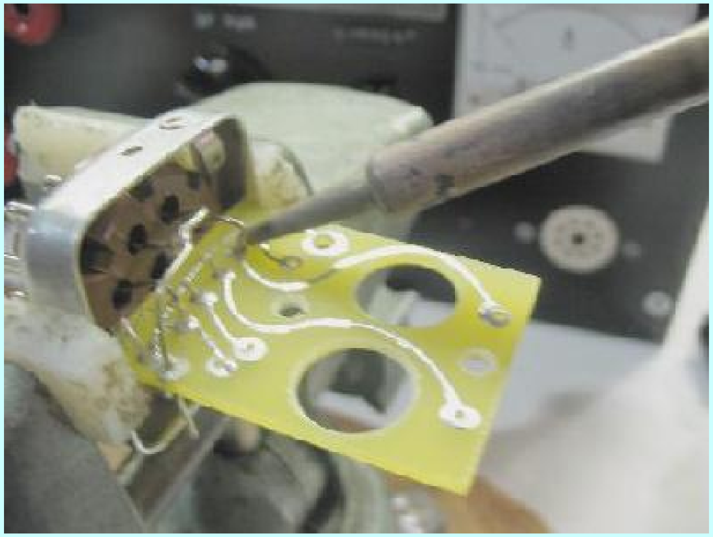


Illustrating the wire 1-2 connection. First, make a right angle to the right with the buss wire. Then, bend the wire toward the top hole of the pc board. This lead shares a connection with wire 4, which comes in from the back and gets inserted into the lower of the two holes.

Showing the routing of the wire 1-2 combination.

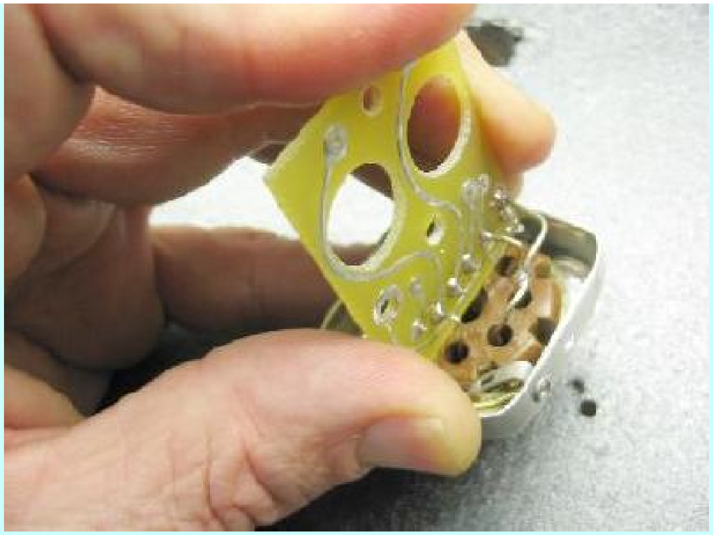


True up any bent wires before soldering. This will keep you from ripping up any PC board pads by bending the wires after they are soldered.



Lay the board on it's side and solder the 7 leads.

Trim the leads but becareful not to cut the wrong ones! It's very easy to do! Trust me!

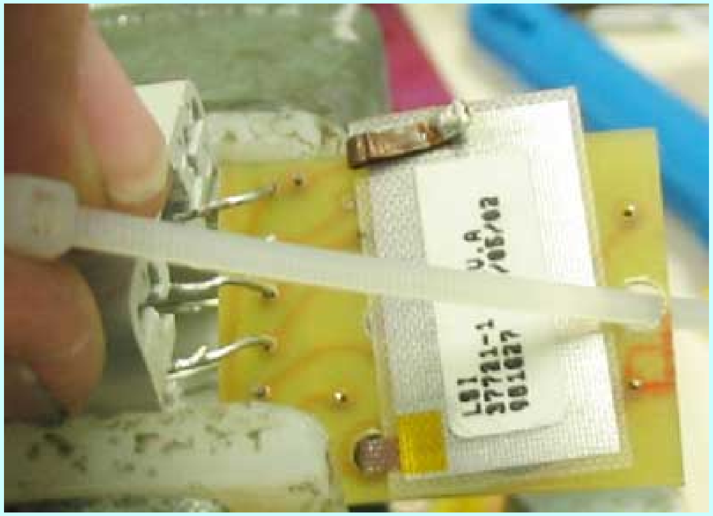


Finally, push the board down on top of the octal plug so you will have enough room for the lid to fit. Center the board between the leads.

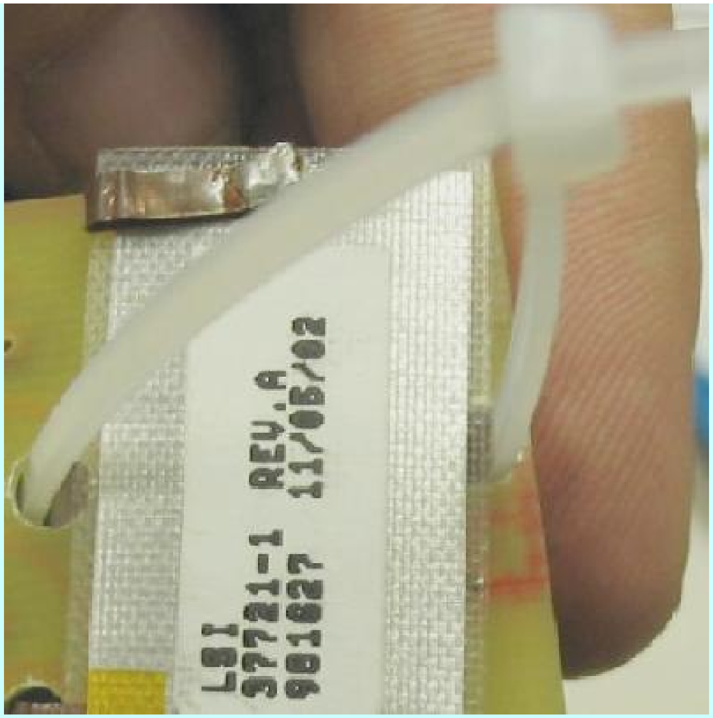
Mounting the Components!

Now comes the fun part! We are almost finished with a geniune T4 module! Take your time so you do not damage any of the components. Try not to drip molten solder onto the EL panel! Cell leads can not be bent back and forth many times before the break off at the metal base of the LDR, so be careful not to overstress them.

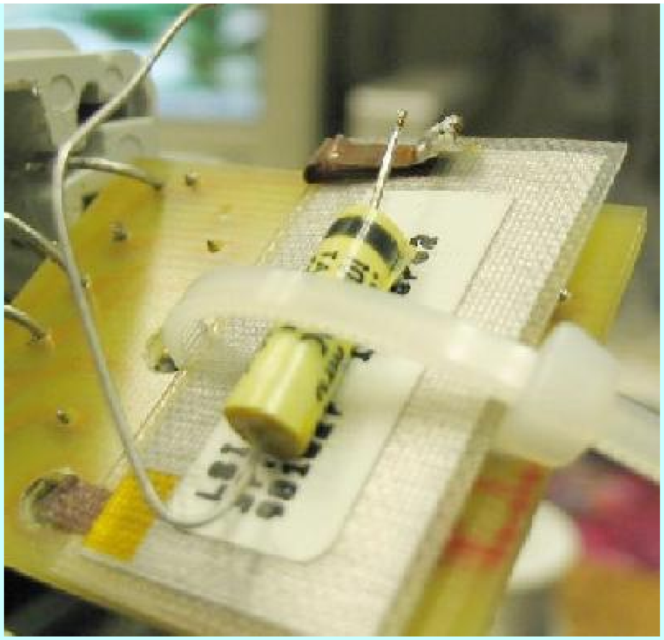
First, we are going to attach the EL Panel and Cap to the board with a tie wrap:

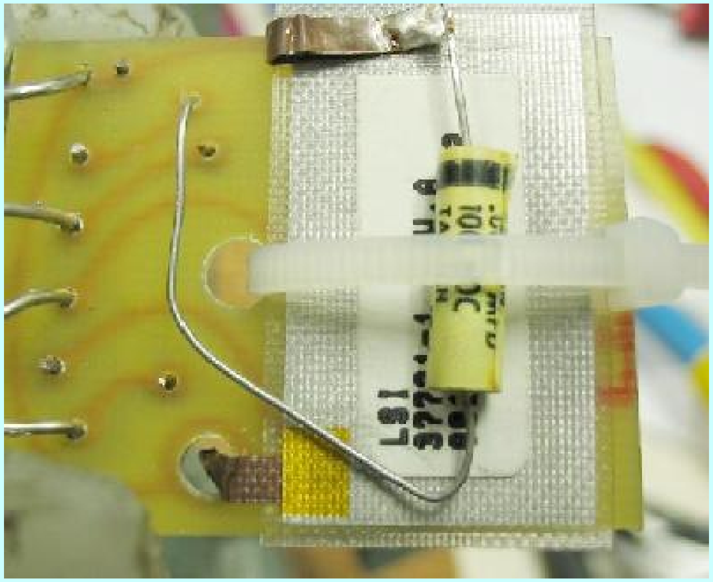


Place the EL panel, green side down, label up, on the side of the PC board that has no traces.



Attach the tie wrap as shown.





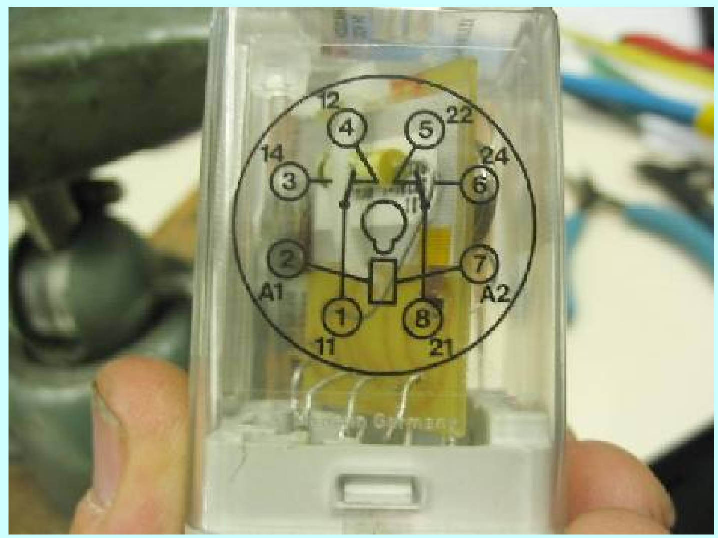
Place the cap on the EL panel and tighten the tie wrap as snug as you can get it. Do not worry about component alignment until after you tighten the wrap all the way. You will still be able to slide things around. Place the cap lead through the hole on the PC board and solder it before soldering the other lead to the EL panel.

The last step! Mounting the LDR cells!

Use a quarter inch drill bit to form the leads. The arc size is important. We want the cells to sit flat on the EL panel.

Insert the leads into the board and solder them while holding the cells flush against the EL panel.   .

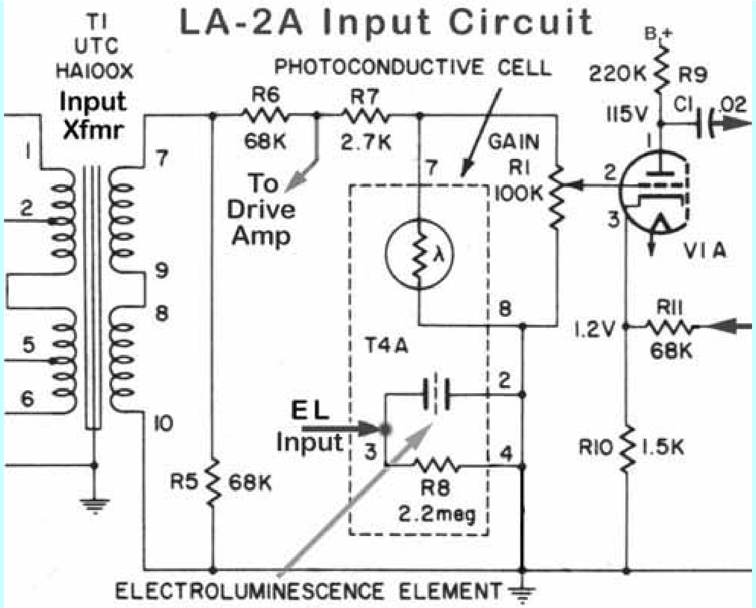
Line up the cells so the sit flat on the EL Panel.

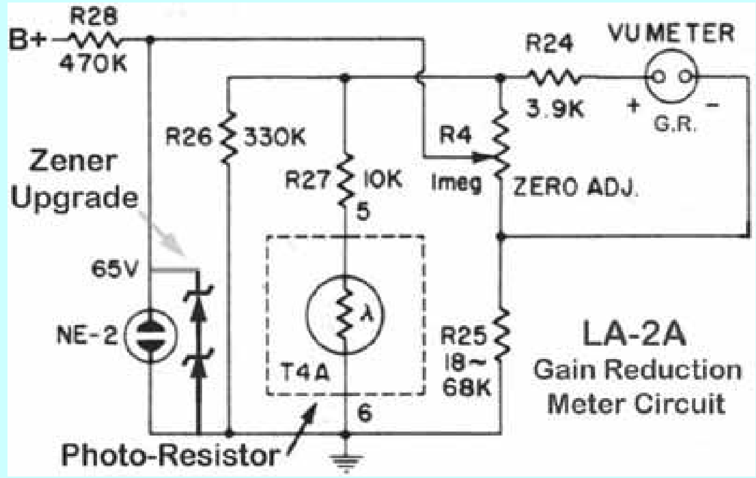


Pop the lid on and your ready to test!

This concludes the instructions for the T4 module.   I hope you have as much fun building T4's as I do!

Here is the T4 schematic for referance. Note that the older model with the 2.2 meg resistor is shown. The cap is not on the schematic. The second diagram is the metering circuit.


LA-2A Input Circuit
T1
UTC
HA100X
Input
Xfmr
PHOTOCONDUCTIVE CELL
R6
68K
R7
2.7K
To
Drive
Amp
GAIN
R1
100K
B+
220K
R9
115V
C1
.02
V1A
T4A
EL
Input
R8
2.2meg
R5
68K
1.2V
R11
68K
R10
1.5K
ELECTROLUMINESCENCE ELEMENT


B+
R28
470K
R24
3.9K
VU METER
G.R.
R26
330K
R27
10K
R4
1meg
ZERO ADJ.
Zener
Upgrade
65V
NE-2
T4A
R25
18~
68K
LA-2A
Gain Reduction
Meter Circuit
Photo-Resistor