# How I built up my ACL Strobes

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This document will attempt to show how I built and wired my ACL (aka the TPR1 Strobe) which was originally discussed HERE and there was subsequent very large group buy for the boards, components, LEDs and covers. The strobes are quite small and have surface mount components for most of the build (except for the transistor driver and LED).

I started building mine with solder paste and a soldering iron with a small tip but moved on to using a Black&Decker toaster oven with a SparkFun Reflow Oven controller. This makes the process go much quicker although using a soldering iron is not much slower once you get the hang of it. The oven controller kept a very concise heating flow but since it has no method of cooling, it tends to have a very slow ramp down. I worked around this by opening the door a bit after the flow had completed.


*Illustration 1: Black&Decker Toaster Oven being controlled by SparkFun controller*

I only used the oven on the front side of the strobe and completed the back by hand and of course the transistor and LED had to be hand soldered. I used a component bender on it's side to bend the LED leads at a sharp right angle so that they would sit flat from the strobe. Always test the LEDs prior to installation as I found some that were opposite polarity from others. Do not trust the longer lead, the package flat or whatever mechanism that is used – get a 3032 watch battery and test the LEDs – always! The positive (anode) lead goes into the left lead as shown in the picture below. Note also that the current is set by the resistor (it is blue in the picture) next to the NUD constant current driver chip. I used 100mA LEDs for most of my strobes.

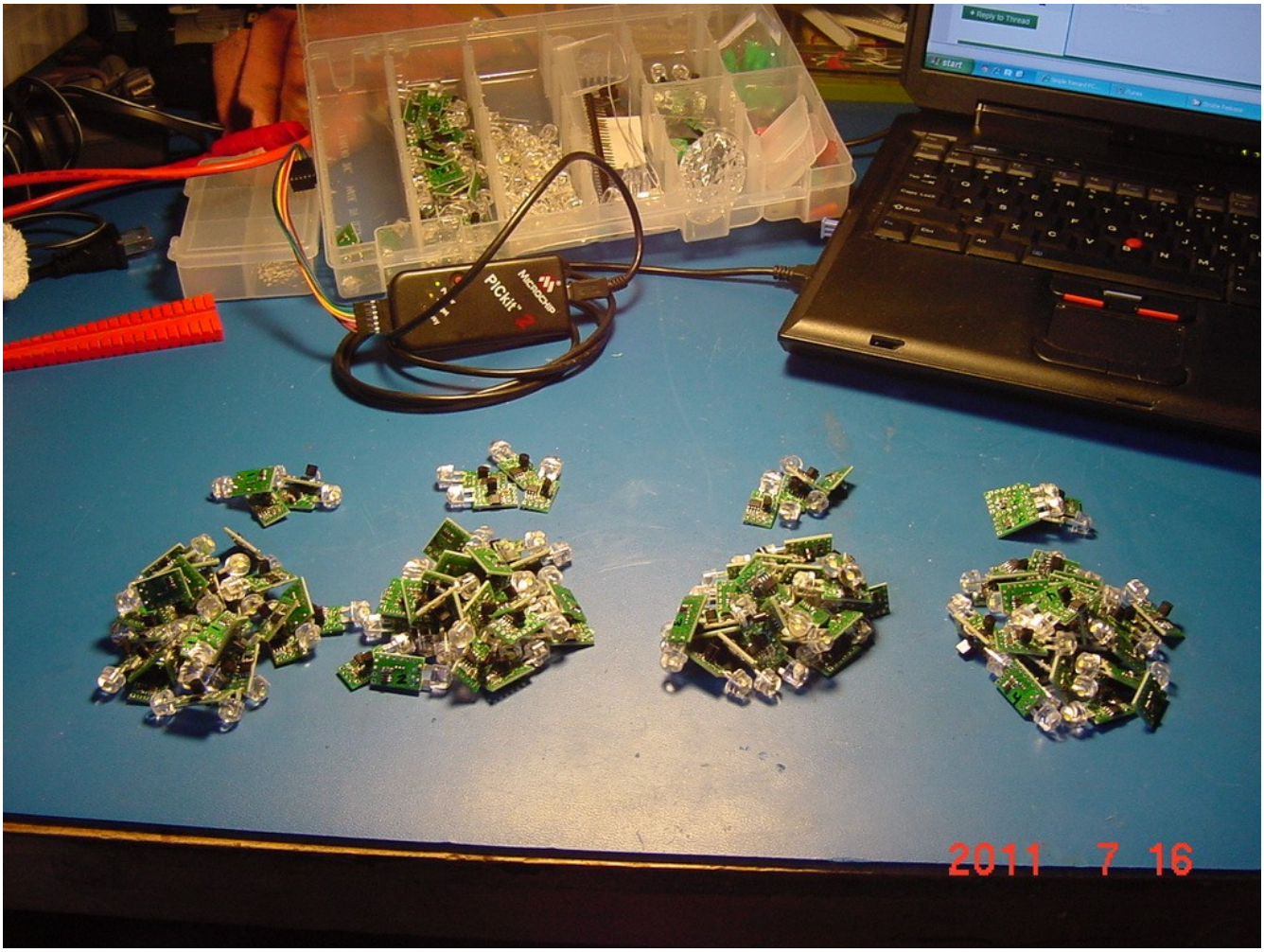

*Illustration 2: 10 ACL Strobes completed with LEDs*

When the boards are completed, it's time to program the PIC (on the underside of the board). To do this, I downloaded the .asm file from ACL and changed the timer settings to create four different .hex file images. This ensured that I got variations in the strobe start time and rates. This is not completely necessary as they will get random quickly but I found it created a good variance. As the strobes do not have pins to insert the PIC programmer, I installed the header pins

into an extension cable I put together. This allows you to insert the pins into the board to complete the programming. I leave the voltage enabled to the output so that after the PIC is programmed, it supplies power to the strobe and you can test the board at the same time. If it doesn't flash/strobe – you've got a problem and there's a 99.9% chance it's solder related so take a closer look at the board.


*Illustration 3: PICkit 2 with extension cable and header pins*

As I indicated earlier, I programmed four different file versions to get a more random look so after going through several boards, you end up with four piles of completed assemblies. Each is marked with a Sharpie to indicate the code version.




After the boards are completed, you need to decide the method of how you will be triggering the PIC to start the strobing sequence. There are essentially two methods – the first uses a separate low power trigger from some type of DC controller and power (5v) is supplied via a separate path. This is known as the three-wire method. The other way is to force the trigger on full-time with a jumper wire and then just turn on/off the supply voltage via a DC controller. This is known as the two-wire method. I personally saw no advantage to either method with the final result, so I went with the two-wire method to save wire.

The next step is to mount the completed/programmed assemblies to the “crystal” covers supplied in the group buy. It's important to note that these have drain holes both in the tip and around the widest point in the middle of the cover. Obviously, we need a way to keep water from leaking from these holes onto the circuit board/LED. I decided it would be too much work to try and seal up the holes in the covers so I went with sealing the LED to the inside of the cover effectively using the LED as a plug.

I used pure aquarium grade silicone sealant to seal the LED (and later the other end of the board). Using the tip provided, I made sure to get a complete ring of

silicone inside the cover, just past the twist-on openings. I then inserted the LED with a twisting/spinning motion to get a good seal and then inserted the board into the small gap from the twist-on opening.

*Illustration 4: 100% Silicone Sealant (DAP brand shown/used)*

After the board was seated, I shot more silicone into the backside opening of the board to make it stick to the cover a bit better and seal off the bottom of the board. I then set these aside for 24 hours to make sure the sealant fully cured. You can seal the top of the board as well if you wish – I didn't bother as I was going for more weather-proof versus water-proof.

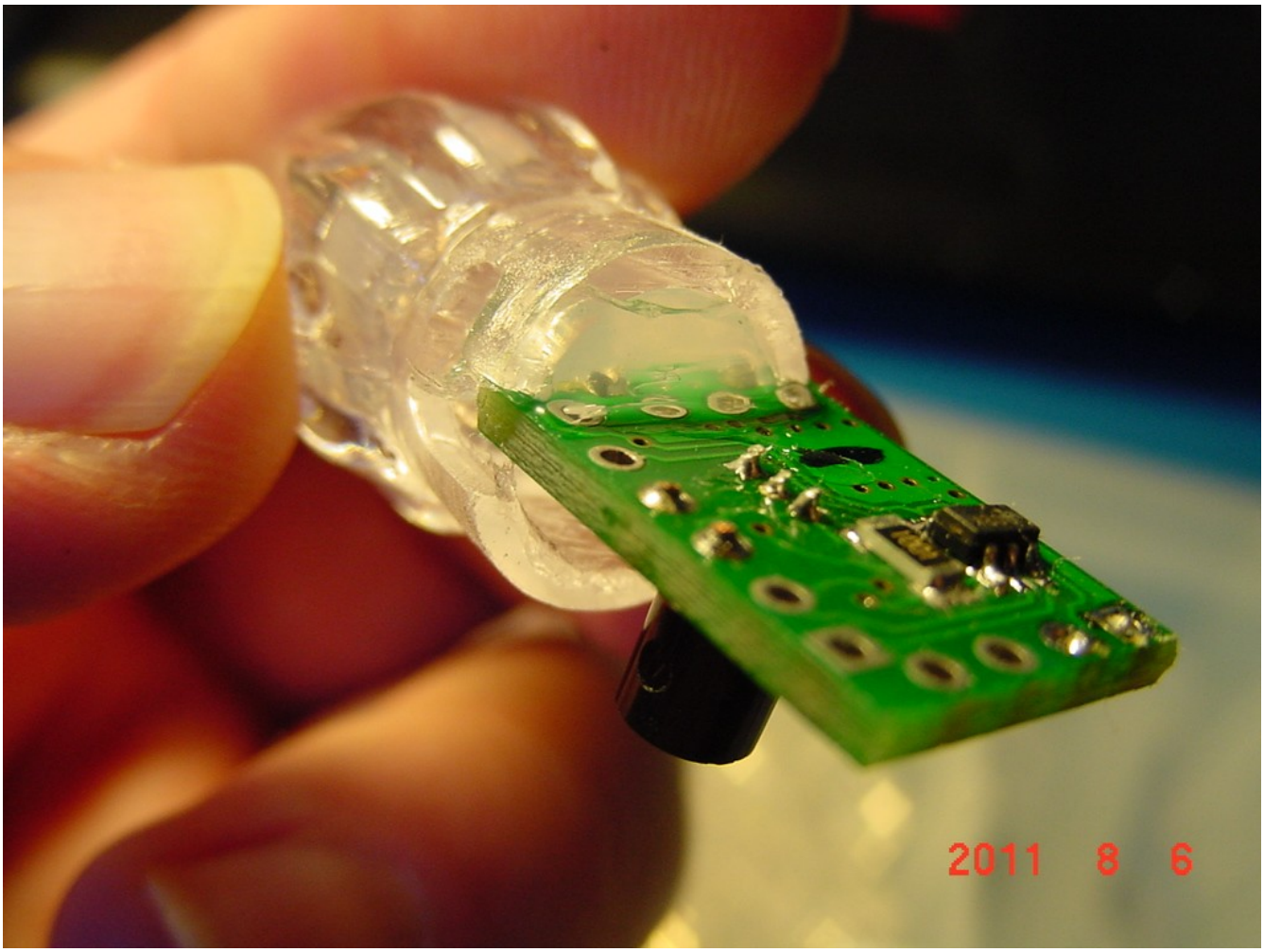


*Illustration 5: Board inserted into twist-lock opening and back side of board fully sealed to cover*

Between each of these operations I usually retested the boards as I went to ensure everything was still working. You don't want to waste your time getting it completely wired up only to find it's dead and having to redo something.

Now it's time to start wiring these guys up. I used a simple set of small clamps to hold the board while soldering on the wires. Before soldering the wires, I installed a 1-1/2” section of white 12mm or 1/2” shrink tubing over each pair of Cat5 wire pairs. BE SURE TO DO THIS BEFORE SOLDERING THE WIRES!!! You will come up with new curse words if you don't remember this step since you'll have to redo your soldering...

*Illustration 6: Two clamps on a spool of wire served as my board holder*

It is VERY important that you untwist the wires at least an inch back when soldering them to the board. If you don't do this, the heat from soldering will melt the wires together and you'll end up with a short! You can re-twist them after soldering if you wish. After soldering the wires on, I tied them into a knot which will serve as a simple strain relief. My thought process was that for simple wire tugs the knot will be tried to be pulled through a blob of dried silicone (not easy to do) before the wires would be ripped from the board. Obviously if you're rougher with these, you'll break them – it's only 24 gauge wire after all...

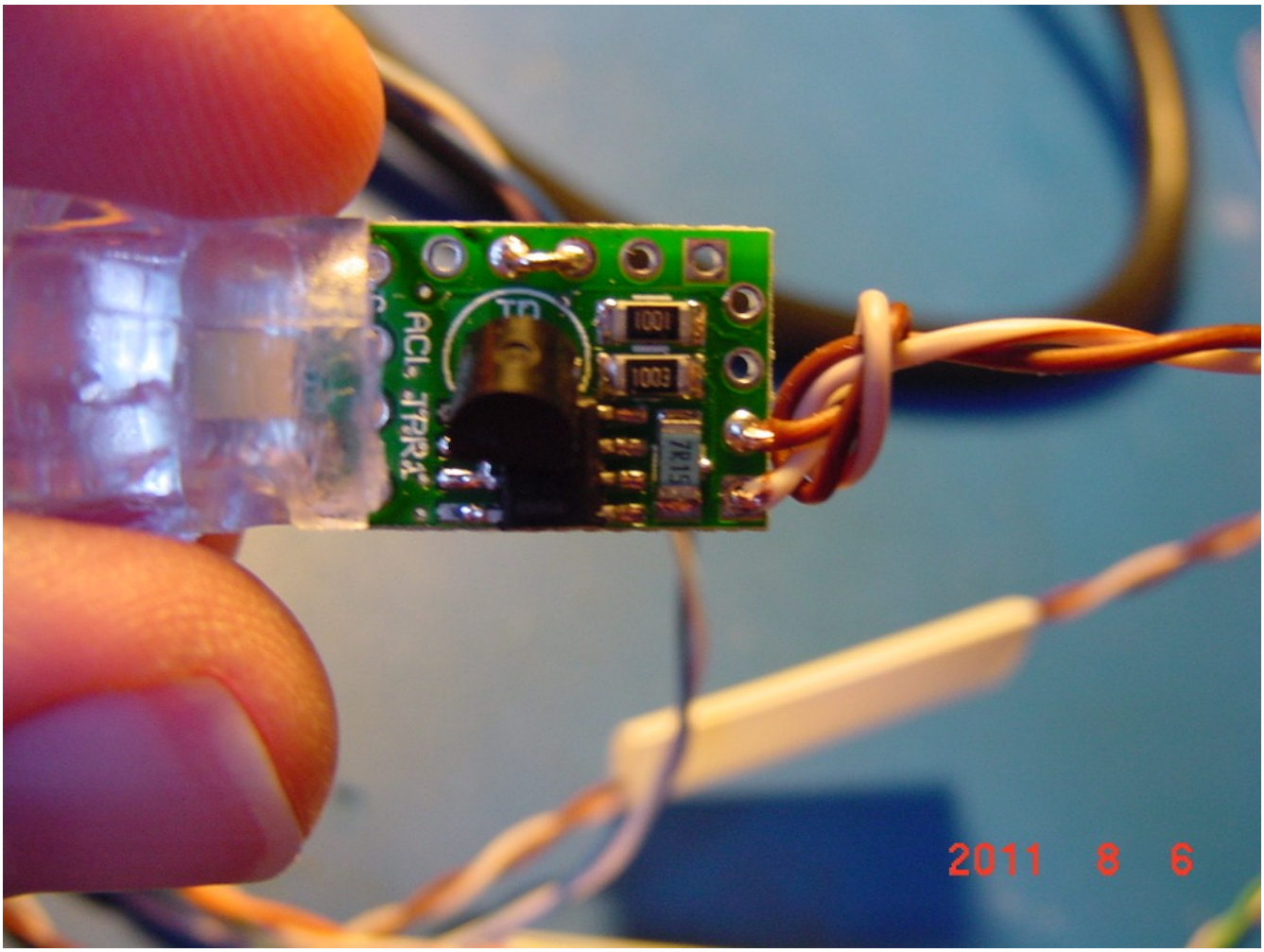


*Illustration 7: Completed wiring with knot in wire for strain relief*

My wiring scheme is to use the four pairs of the Cat5 for four strobes which will all be connected together onto a single channel of my Ren48LSD. In other words, one RJ45 port will drive sixteen strobes in all or up to 192 from one Ren48LSD controller.

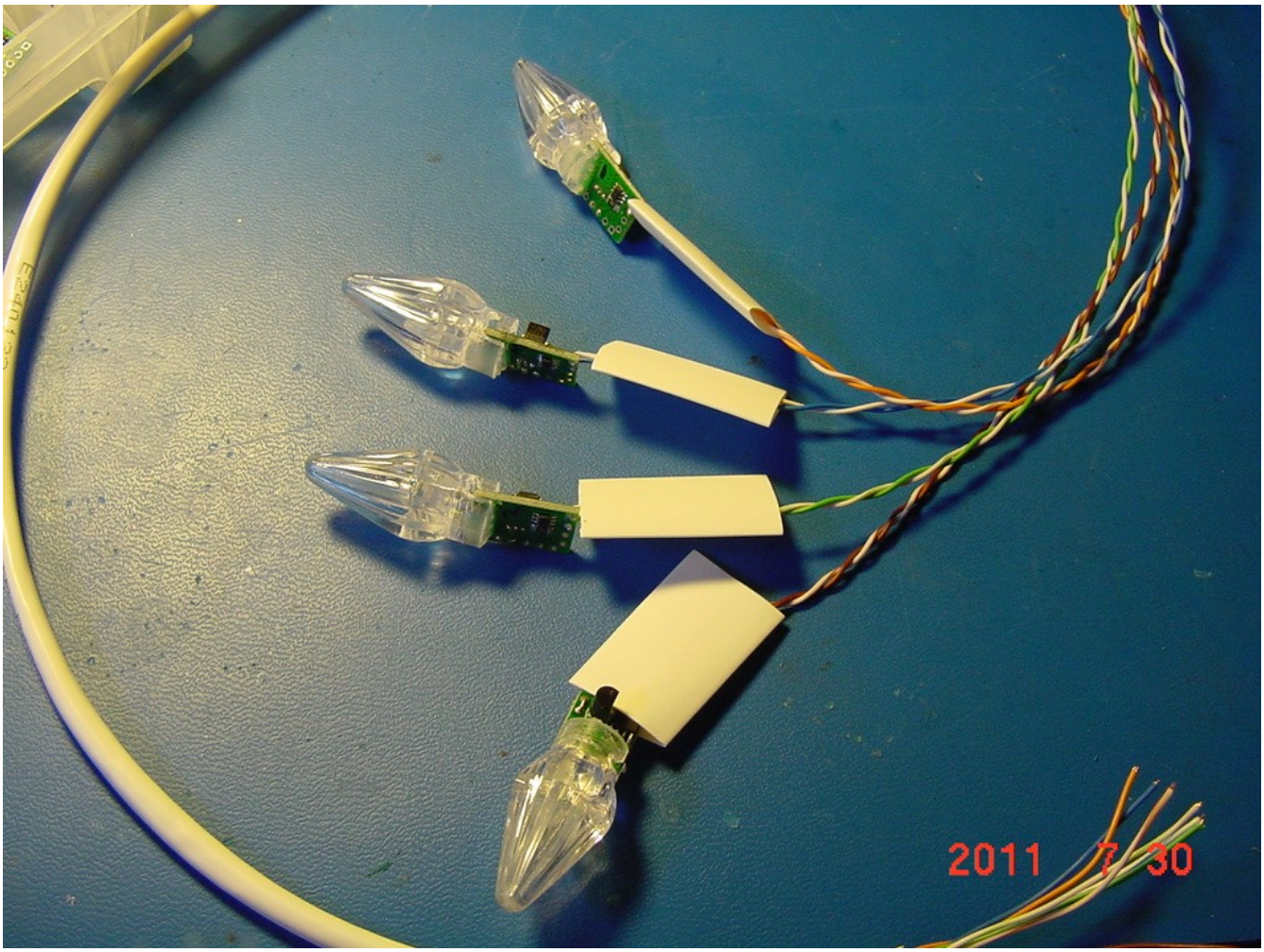


*Illustration 8: Wiring complete for four strobes which will be connected together*

Now it's time to seal these up once and for all. The first step is to slide the shrink tubing up the wire (you didn't forget did you?), over the board and onto the cover. I used my reflow rework station that I got off eBay earlier this year to shrink the tubing. This worked very well as it's much more directional than the larger heat guns.

*Illustration 9: Reflow rework station with 3/16" tip installed*

Push the tubing as far up the cover as you can.

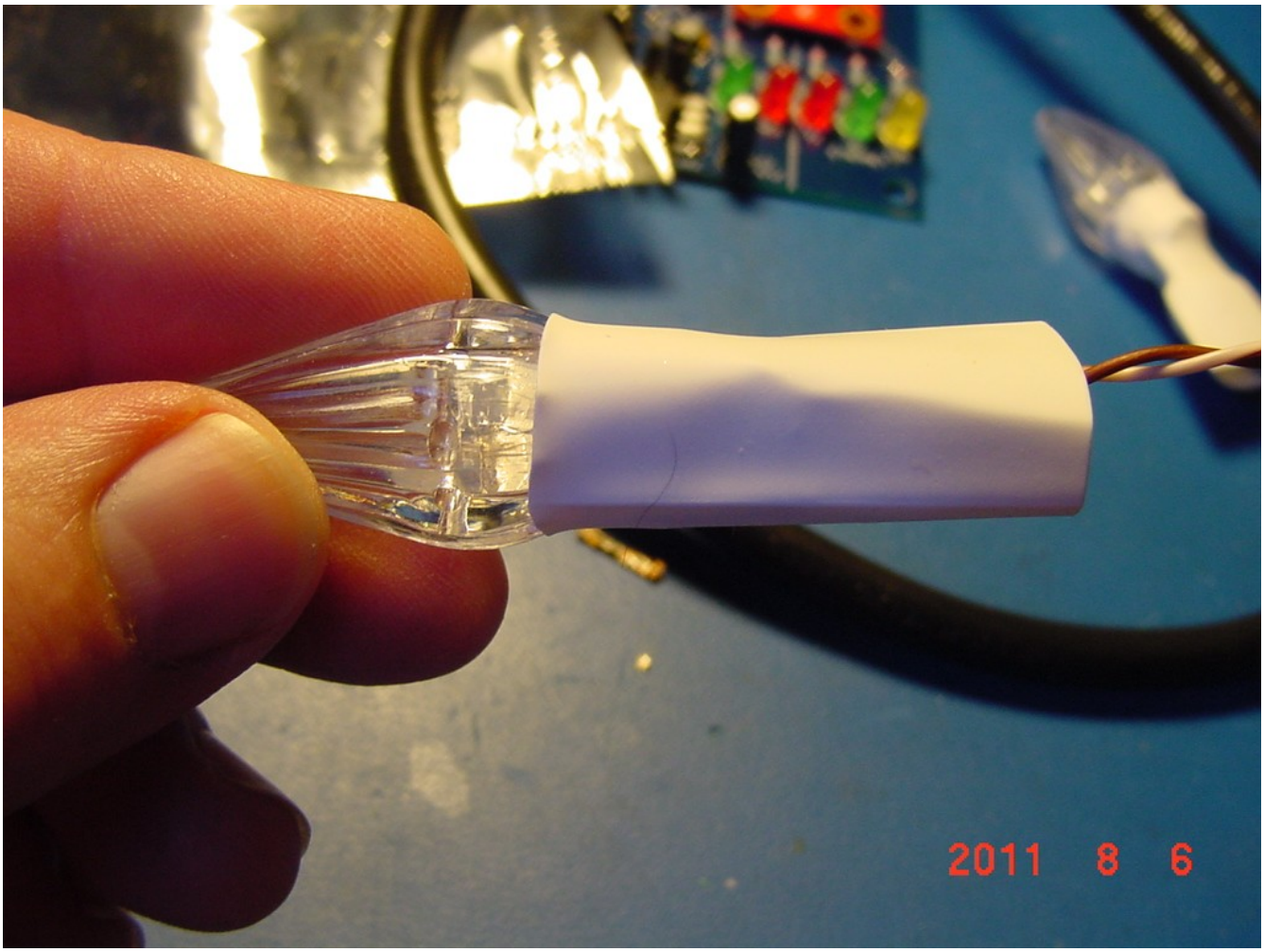


*Illustration 10: Shrink tubing onto cover*

The first step is to shrink the tubing onto the cover and down to nearly the end of the board. Do NOT shrink it completely or you'll have to start over – or at least it will be much hard to complete the sealing process!

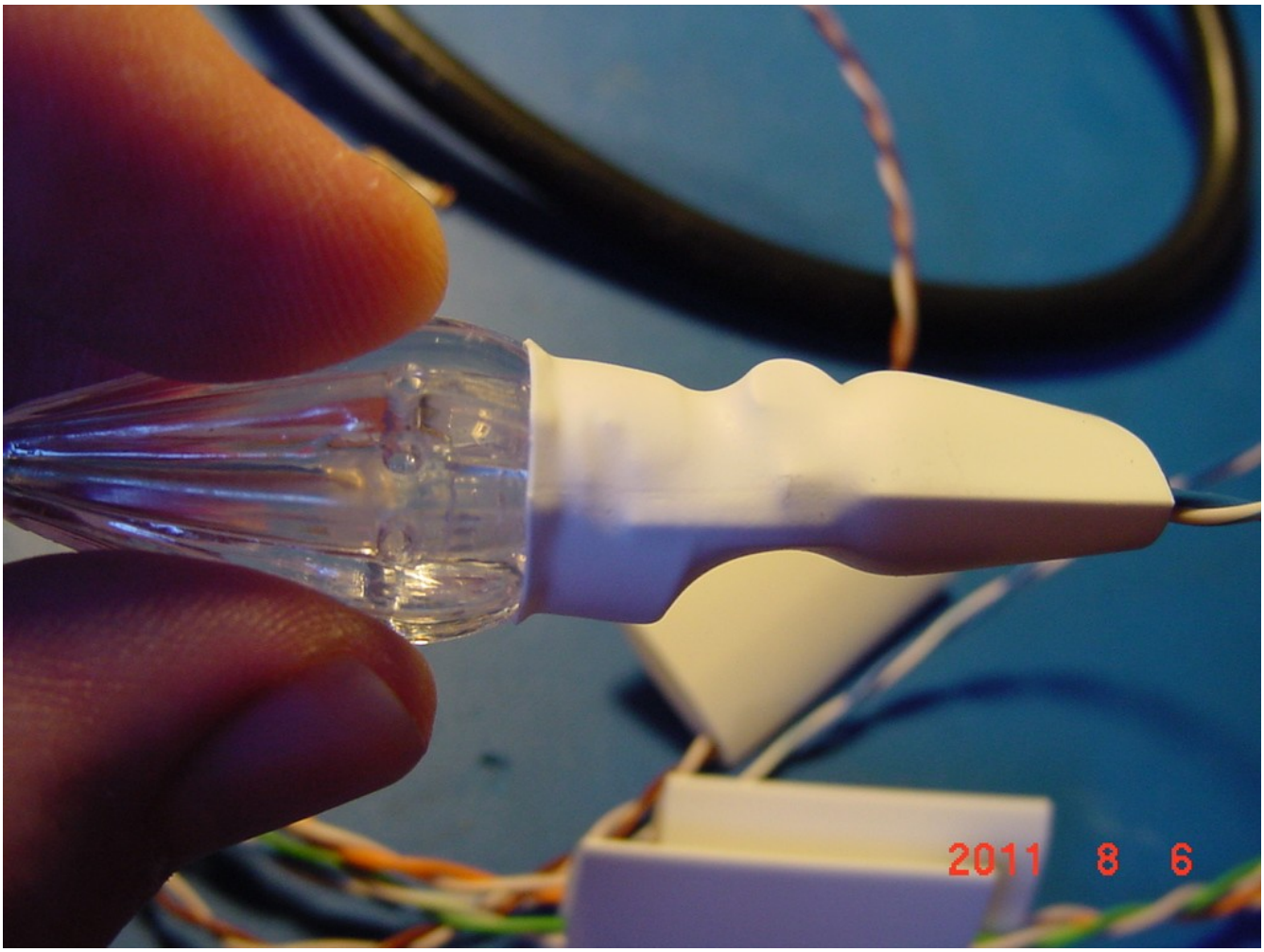


*Illustration 11: Here the tubing is only partially shrunk - the wire end is still not shrunk*

Open up the wire end of the tubing and squeeze in a shot of silicone sealant. Make sure it touches all the sides of the tubing and around the knot of wire but there is no need to fill in the entire gap on the PCB itself.

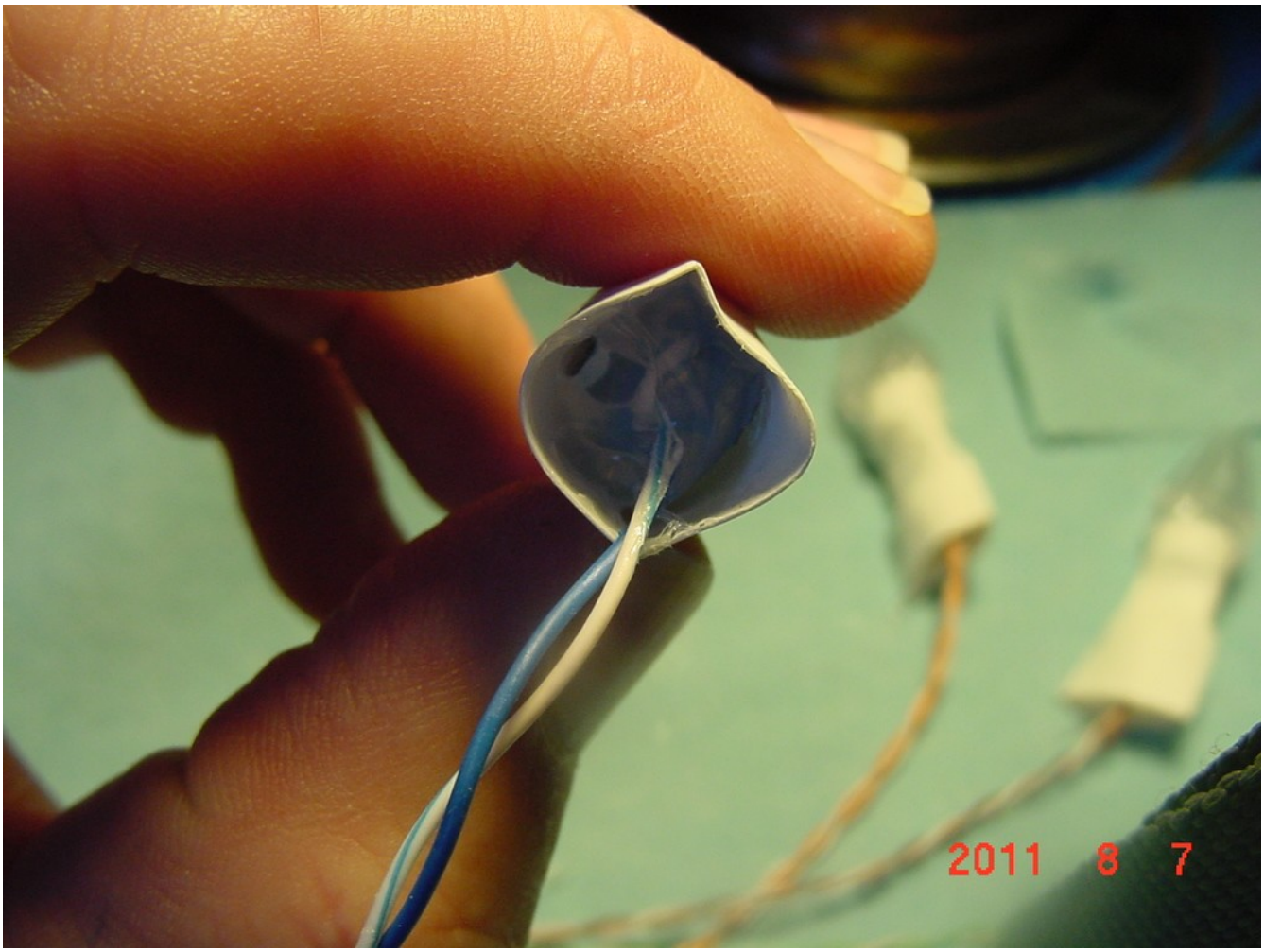


*Illustration 12: After you do a few you will get an idea of how much silicone to use*

I then used my rework station again to shrink the rest of the tubing. I made sure to go from the middle of the board and worked my out to the wires so that the bulk of the excess silicone pushed its way out the top.. You can leave it this way if you have space to leave these out to cure. I didn't want a big mess so I used some paper shop towels to wipe the excess from the openings.

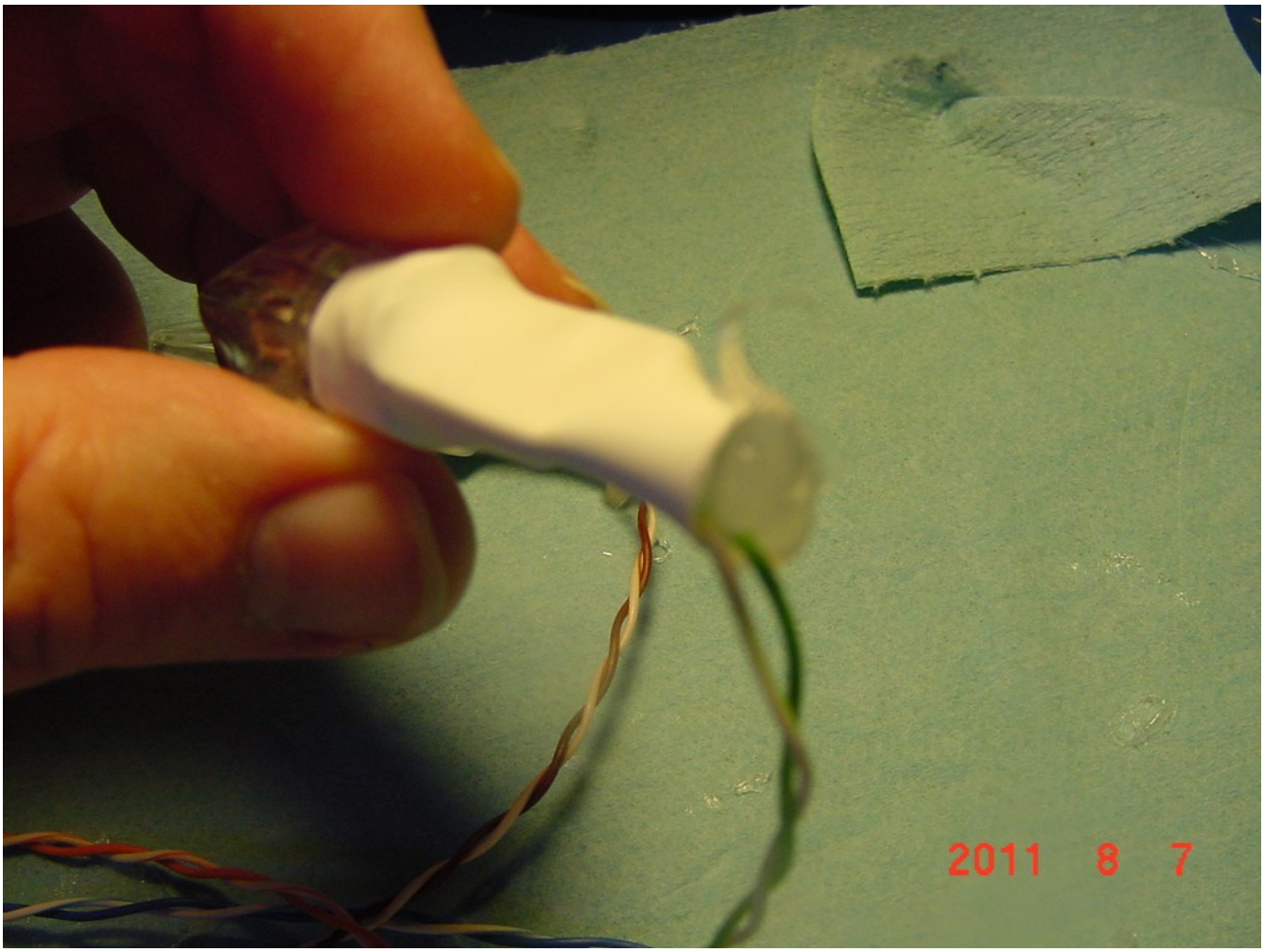


*Illustration 13: Excess silicone being squeezed out after shrinking*

Let these cure for another 24 hours before doing anything more with them.

I then gathered up four completed assemblies as well as 16 foot main Cat5 lead and connected all the like wire colors together. I then soldered and heat-shrunk these connections until I had a complete section with a single Cat5 going back to my Ren48LSD port and the four wires coming out to four pair strands each for a total of sixteen strobes per port. The strobe sub-assemblies used 3 foot sections of cable. I don't have a picture of this quite yet as I still looking at the best method of finishing this part of the wiring. I will update this document with that final step, however the basic heat shrink method worked fine and the harness works and looks great.

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