Warm Tube Clock

Assembly Instructions for the “IN-16 Nixie shield”

Introduction

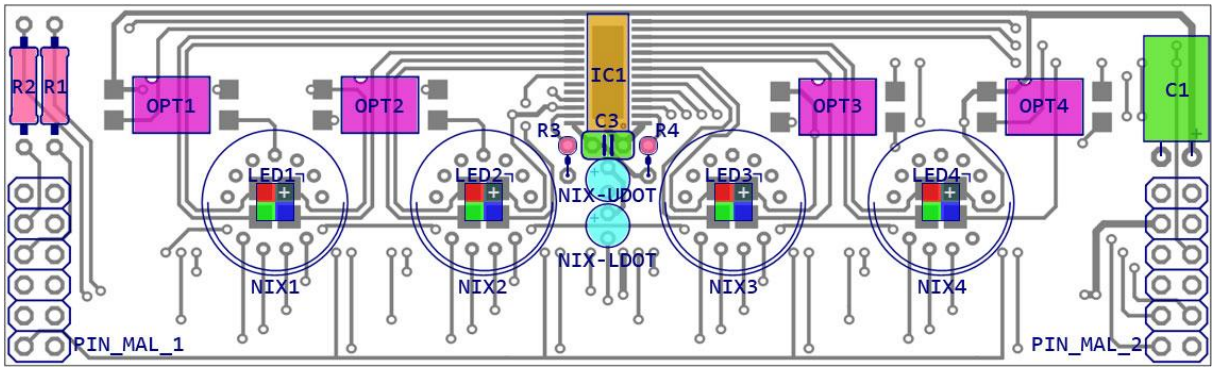
Congratulations on your purchase of OSH Nixie Tube Clock. In this document you will see all steps you need to follow in order to successfully assemble the “IN-16 Nixie shield” of this device.

Before we start, please make sure that you have all required parts that come for the “IN-16 Nixie shield”:

Qty	Value	Device	Parts
2	2x6 MALE PIN HEADER	PINHD-2X6	PIN_MAL_1, PIN_MAL_2
1	3k9	R-EU_0204/2V	R3
1	10k	R-EU_0204/2V	R4
1	10nF	C-EU025-024X044	C3
1	47uF/16V	CPOL-EU-HORI	C1
1	100nF-1uF	C-EUC0805	C2
2	910k	R-EU_0207/10	R1, R2
4	IN-16 NIXIE TUBE	IN-16-X-NEW-NODOT	NIX1, NIX2, NIX3, NIX4
4	LED 1210 COMM ANODE	LED-TRICOLOR	LED1, LED2, LED3, LED4
2	NIXIE-DOT	NIXIE-DOT	NIX-LDOT, NIX-UDOT
1	TLC59401	TLC59401	IC1
4	TLP627 SMD	TLP627V1	OPT1, OPT2, OPT3, OPT4

List of all parts for the “IN-16 Nixie shield” board

All parts should be assembled in correct order, starting from SMD components to low profile components and finally to high profile ones. Component locations are not marked on PCB because a “clean look” of the shield is very important. So, component (Part) locations are in the following image and their values are in the above table.



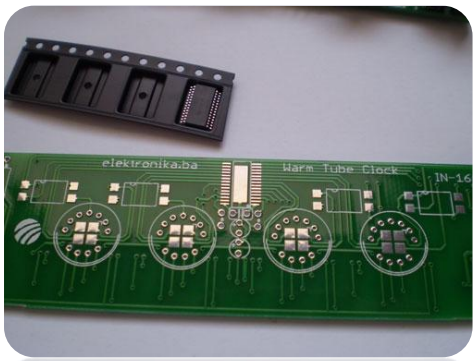
Note: The assembly of this shield PCB implies that you have already successfully assembled the “main board” of the Warm Tube Clock.

Assembly

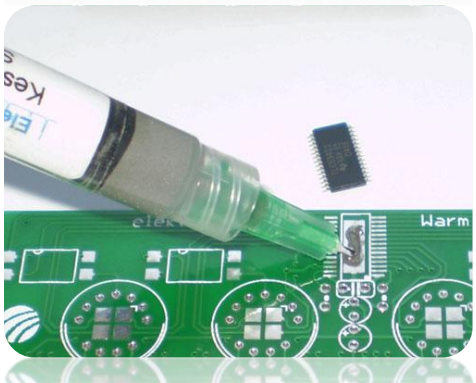
Heat up your soldering iron, take a deep breath and go for it. The assembly of this PCB is easier than “main board” PCB since it has very small component count but requires a steady hand. Also, take your time when soldering the Nixie tubes because you wouldn’t want to solder them crooked.

Step 1

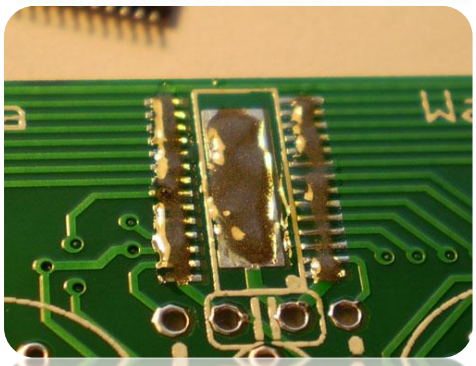
First you need to solder the TLC59401 SMD IC (IC1). This IC should have came already soldered on your shield PCB so you can skip this step, or read it FYI and see how easy it is to solder complicated SMD parts at home.



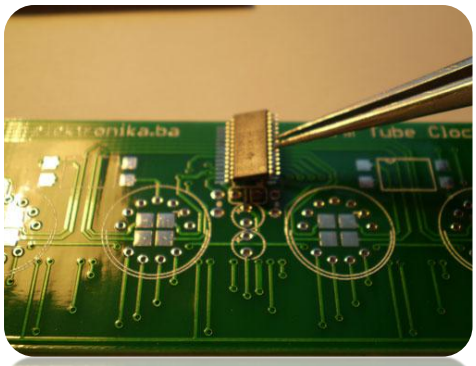
1. Make sure the PCB pad where IC goes is clean from grease. Rub it with some alcohol just in case.



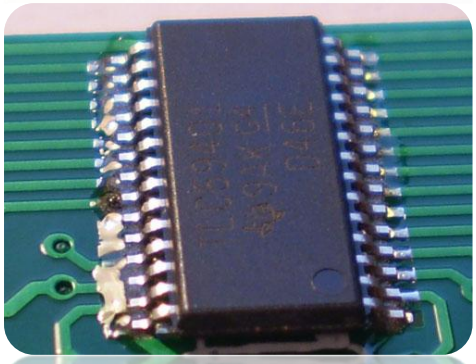
2. Apply some amount of liquid solder paste. I can’t give you the exact amount of solder paste to use, as this comes with experience and pure sense.
Just put the amount you think that will be enough to solder the entire bottom pad of the TLC59401 IC and not too much to make a problem.



3. As you can see, it doesn’t look pretty and it doesn’t have to! You can also put some solder paste on the pin’s locations so you don’t have to use a soldering iron after “hot-plating” the IC. You will see what “hot-plating” is later on.



4. Now, using your tweezers gently place the component in its position. Push it all the way to the PCB so it kind of “glues” itself. Make sure it is centred and placed correctly!

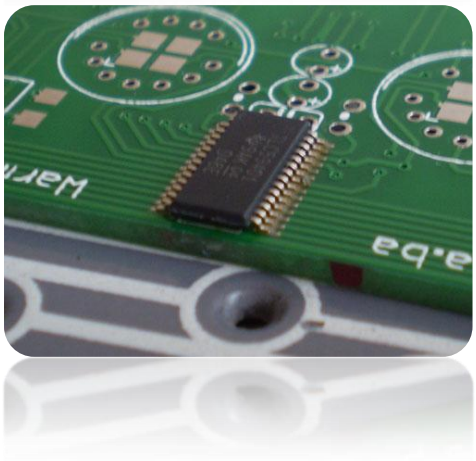


5. It looks something like this before “hot-plating”.

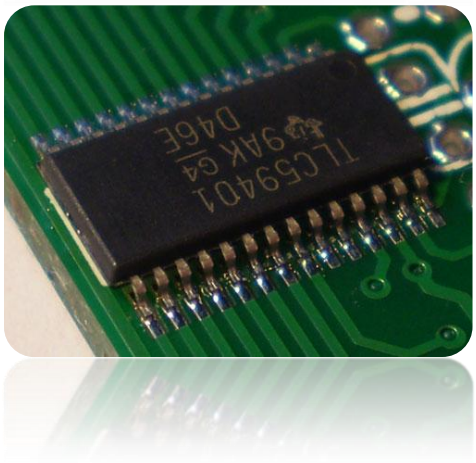
6. Now, find your favourite “hot-plate”. As you can see, I am using a clothing iron! It works excellent.

7. Turn it around and secure it in place!

8. Place the PCB onto the “hot-plate” and turn it ON to pre-heat. Don’t turn the “hop-plate” to maximum temperature just yet. First put it to half, wait a minute, and then turn it up to the maximum. The maximum temperature for a clothing iron is around 210 degrees Celsius which is just enough to get the job done.



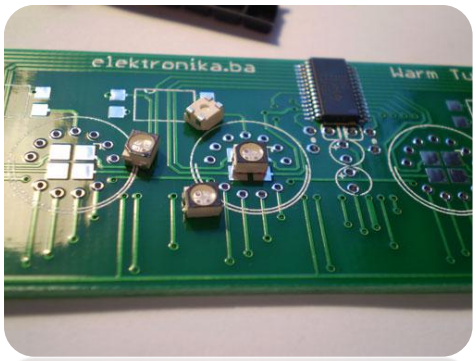
9. Now, what you can (should be able to) see in this picture is that the soldering paste we previously applied is slightly starting to melt and liquefy. It might also start to smoke a bit (depends on the type of your liquid solder) – so don’t worry that is normal.
The end of the soldering process is when the solder paste fully melts, just like in the following picture.



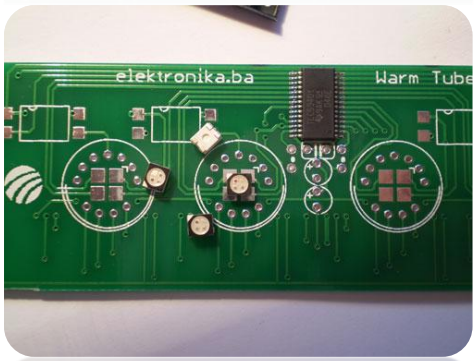
10. Now it is time to remove the PCB from the “hot-plate”. I usually don’t leave it there until it cools down totally, so after turning the “hot-plate” off I wait about half a minute and remove the PCB with hands, but very slowly, and place it on the desk to cool down.
Now it is time to inspect the solder-work. If the pins don’t look like they have enough solder on them, feel free to fix the work with your soldering iron. If there are short-circuits between pins – fix with soldering iron!
The “hot-plate” kind of soldering is required because the TLC59401 has a bottom GND pad that **needs** to be soldered and this is the only way to do it (actually you could also do this with the hot-air soldering station).

Step 2

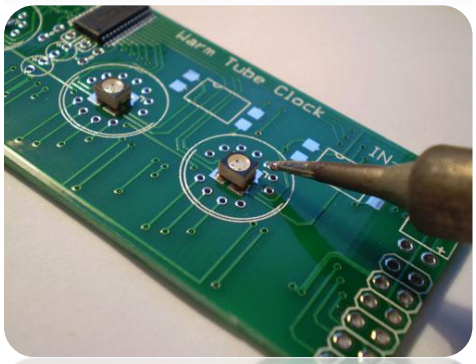
Now we need to solder the RGB LEDs LED1, LED2, LED3 and LED4. We could have done it at the same time, together with TLC59401, but since it already came soldered on the PCB we have to do it with the soldering iron.



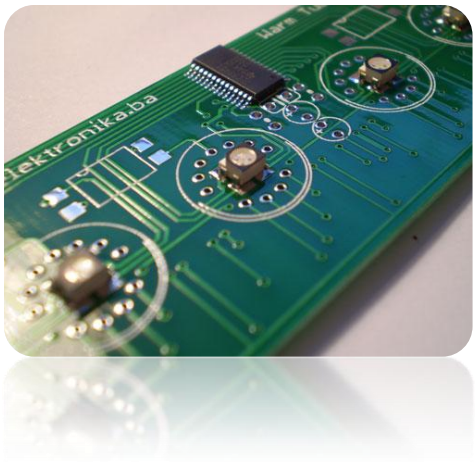
1. The LEDs are not that small, so soldering should take a minute or two.



2. Place the LED in the position but keep in mind about its common Anode pin. The common Anode is marked on the PCB as you can see – the upper right corner has a white mark. The first pin on this RGB LED is actually a Cathode of the RED LED-part, so by following the IC marking convention the common Anode is the fourth pin of this RGB LED.



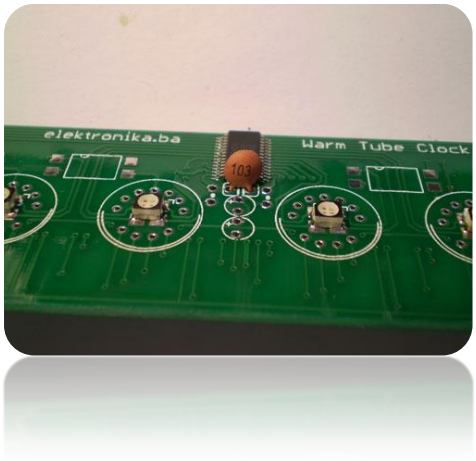
3. After placing the LED in its position, you can hold it in place using tweezers while firstly soldering it's any pin ("tacking" it actually). After "tacking" it into place with some solder, you can solder the remaining pins and then go back to solder the "tacked" pin. While soldering these LEDs, you actually don't need to touch the LED with the soldering iron. It is enough to touch the PCB under the LED's pin and it will solder it.



4. Your finished work should look like this.

Step 3

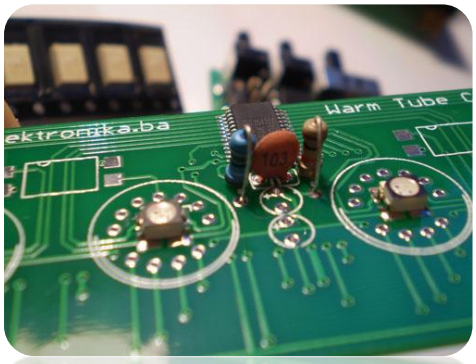
Now find the “103” C3 capacitor (10nF = 0.01uF). It is used to filter voltage spikes for the TLC59401 IC. It must run flawlessly since every flicker will be visible on the Nixie tubes.



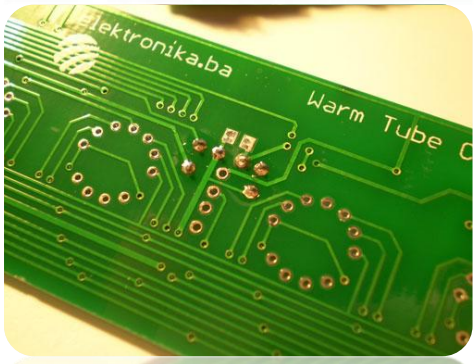
1. Place it and solder it – piece of cake.

Step 4

Now locate the resistors R3 and R4: 3k9 (3.9k) and 10k, respectively. The 3k9 resistor defines the current that will be provided to the RGB LEDs (and also to the opto-couplers) – for more information about this LED current, see the TLC59401 datasheet. The 10k resistor is simply a pull-up resistor for the BLANK line of the TLC59401 IC. It is there to make sure all LEDs are turned off in case Atmel AVR doesn't have the correct firmware loaded.



1. Put them in place and solder them. Left one is the 3k9, the right one is the 10k.

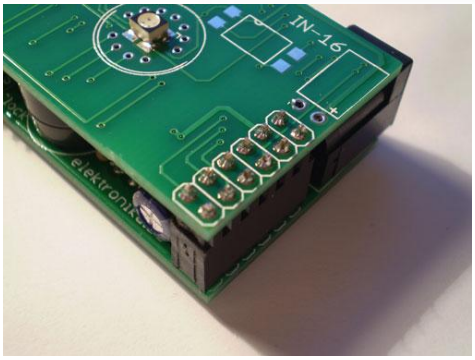


2. So it looks like this from the bottom view.

Step 5

Now locate the “2x6” male pin headers: PIN_MAL_1 and PIN_MAL2. These connect the “main board” and the “shield board”, so make sure they get soldered correctly.

1. Put these into the female pin headers on the “main board”, all the way in. Now place the shield board on top of the “main board” like in the picture. This way you will know that it will fits perfectly!



2. Push it all the way down while soldering, so it doesn’t “float”! Simply solder both connectors while the PCB is on top of the “main board” like in the picture.

Step 6

Now that we have all required parts soldered for TLC59401 to operate, we can test it to see if it works. This is the first time we can verify our TLC59401 SMD soldering work!

1. Make sure your desk is clean of all wires and solder remains, and plug in the DC supply to the “main board” and the LEDs should start blinking in blue after few seconds!

WARNING!

When you now connect the DC power supply, the booster circuit will generate around 200V DC. Don’t touch any part of the device, including the upper shield PCB!

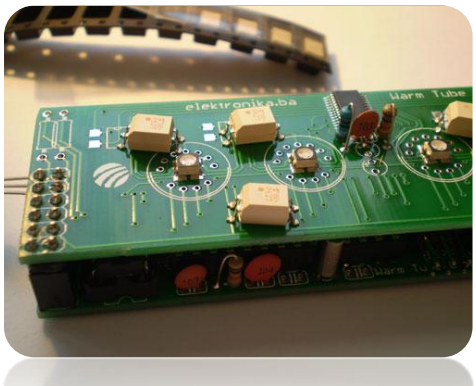
Now, disconnect the DC power supply, wait a minute for the high voltage capacitor to empty, and continue soldering.

But what if it doesn’t work properly?

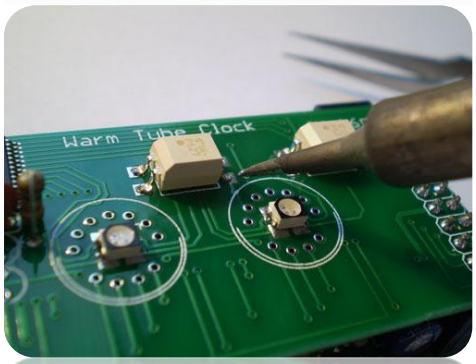
1. Turn off the DC power supply
2. Make sure you have Atmel AVR placed in its socket on the “main board”
3. Make sure your Atmel AVR has a valid firmware programmed for the Warm Tube Clock with IN-16 Nixie shield
4. Take your soldering iron and re-solder all pins of TLC59401 IC. Yes, they are tiny but soldering these pins is really no problem if you use a good soldering flux. That way the solder will stay only on the pins of TLC59401 making sure they got soldered. Make sure there are no short-circuits among pins!
5. If after the step 2. didn’t help solve the problem, you really need to use the hot-air station to re-solder the bottom GND pad of the TLC59401 since clearly your “hot-plate” method didn’t go as planned.
6. If the LEDs do blink, but not in blue colour – it seems that your LEDs are not the same as ones I used, so you will need to edit the Warm Tube Clock *wt.h* file a bit, and recompile the firmware.

Step 7

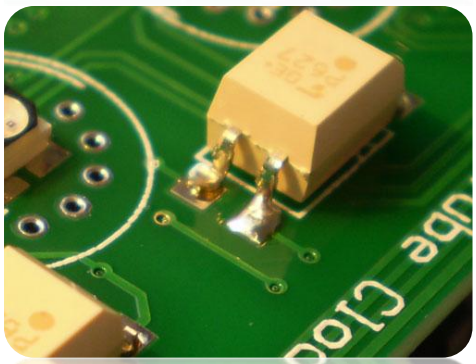
Get all four of TLP627 SMD opto-couplers: OPT1, OPT2, OPT3 and OPT4.



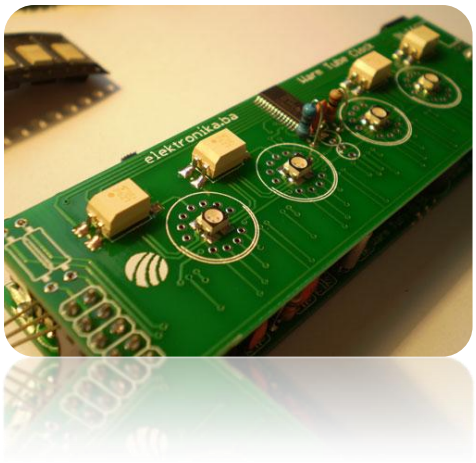
1. Even though these are SMD, they are pretty big and easy to solder.



2. Place them correctly and in proper orientation and while holding with tweezers, solder (“tack”) just one pin of each opto-coupler to hold them in place.



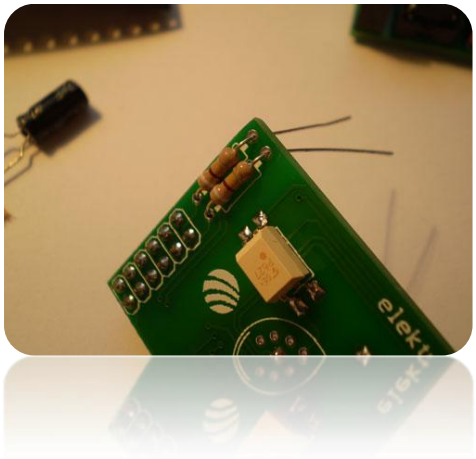
3. So that it looks like this for each opto-coupler.



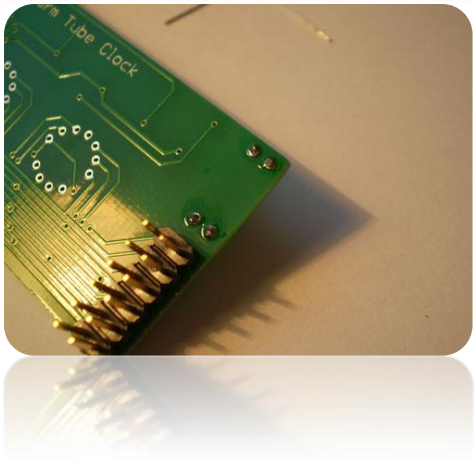
4. Now solder all pins of every opto-coupler to complete the work.

Step 8

Now get the remaining two 910k resistors: R1 and R2. These will provide GND to two Nixie dots from two NPN high-voltage transistors from the “main board”.



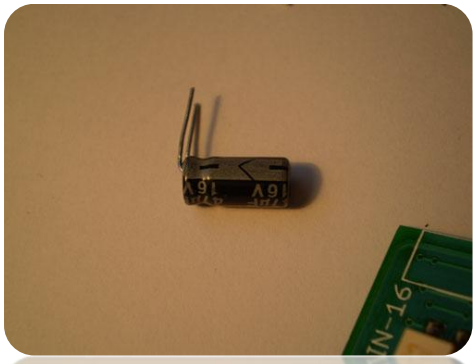
1. Place them in their corresponding locations.



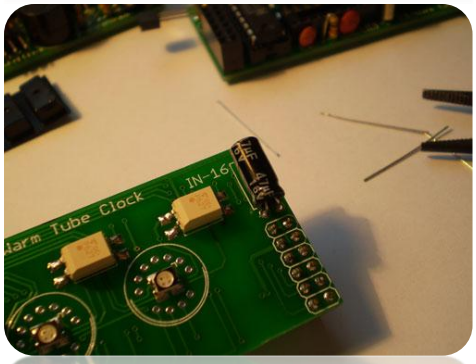
2. Turn the PCB around and solder them.

Step 9

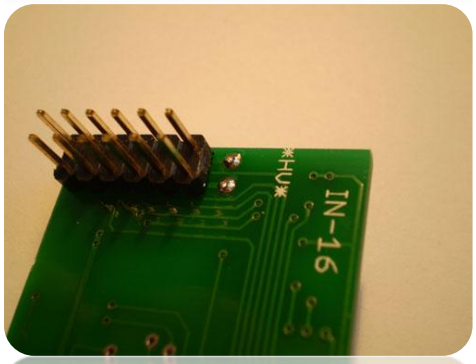
Now take the 47uF electrolytic capacitor C1. It is used as a power storage capacitor for the LEDs and the TLC59401.



1. Bend it like in the picture.



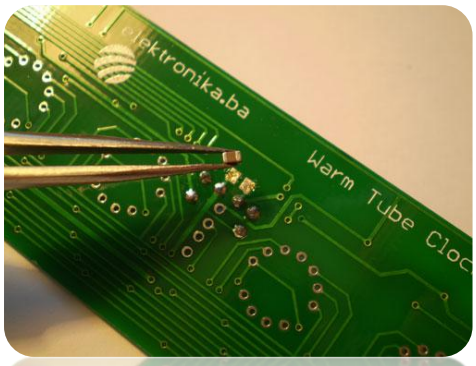
2. Place it in its corresponding location.



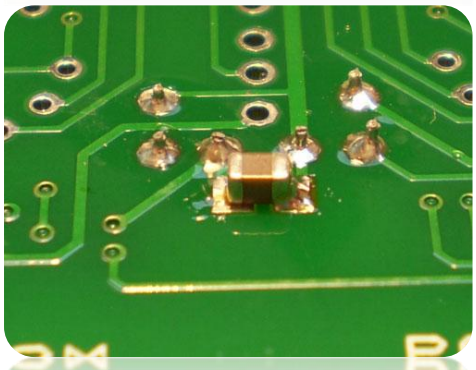
3. Now, turn the PCB around and solder it.

Step 10

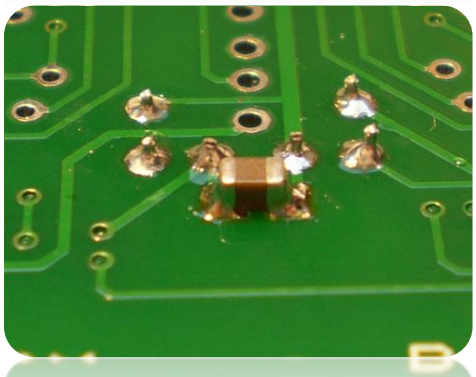
Now, you could skip this step but it is recommended that you do it. Get the 100nF...1uF SMD capacitor C2. It is used to filter out the supply voltage for the TLC59401 IC together with the “103” capacitor C3. Since those RGB LEDs draw pretty much current, it is a good idea to provide the TLC59401 with a stable power source (VCC) as much as possible.



1. You will probably need tweezers for this step.



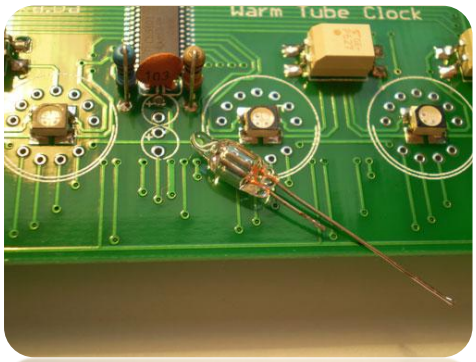
2. While holding it down on the PCB, solder just one side.



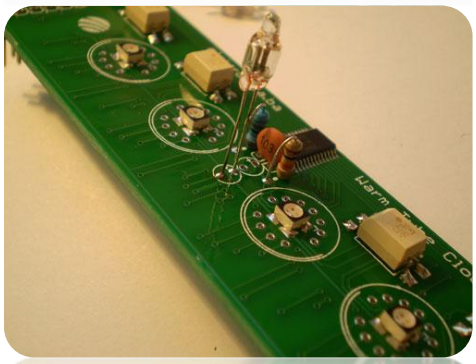
3. The hard part is over, so now solder the other side also and you are done.

Step 11

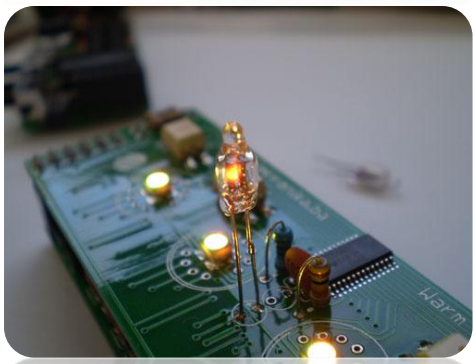
Okay, now it is time to solder some Nixies, the Nixie dots actually – lower dot and the upper dot.



1. This is a Nixie dot. It is actually a neon lamp that lights up when you supply it with more than 100V DC. We will be lighting it up with around 185V so that's why we used those 910k resistors. You can actually increase the value of those resistors to lower the current through these neon lamps even more.
These lamps will glow in redder (more red) colour when you supply it with more current. So for more orange glow increase value of those 910k resistors! You can experiment here...



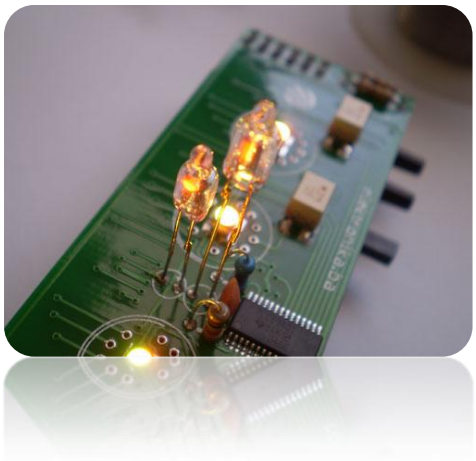
2. For the IN-16 Nixie tube, you should solder the "lower dot" at a distance of **12.65mm** from the PCB. When you solder the IN-16 Nixie tubes, you will see if you need to re-adjust the height of the Nixie dots.
We are soldering these first because it will be harder to solder them later because the IN-16 Nixie tubes will get in our way, and we don't want to damage them!



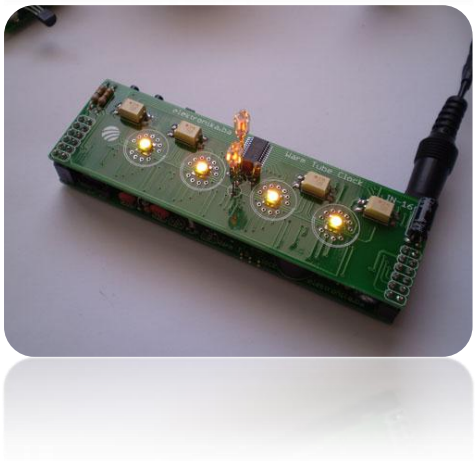
3. After soldering one dot, you probably can't wait to try it out! So, plug in the DC power supply and check it out! It should blink in ½ Hz interval.

WARNING!

When you now connect the DC power supply, the booster circuit will generate around 200V DC. Don't touch any part of the device, including the upper shield PCB and the Nixie dots!



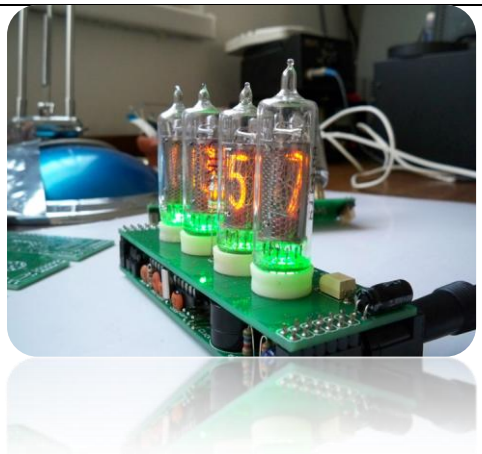
4. Now solder the “upper dot” behind it. It should go around **21.3mm** from the top of the PCB.

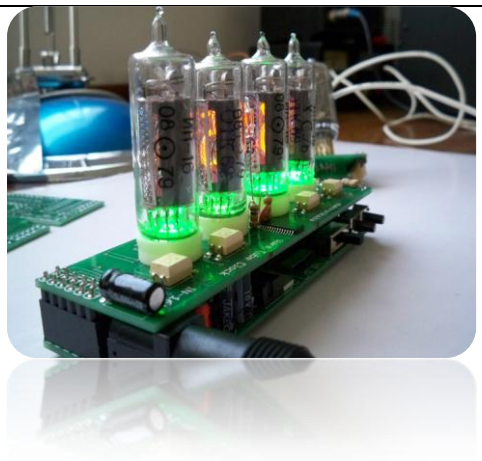


5. Now take a minute to relax, because you must now solder 4 IN-16 Nixie tubes.

Step 12

To solder the IN-16 Nixie tubes, you need some patience. This is a final step, but don't rush it, take your time. If you solder these glass tubes incorrectly or crooked, it is very hard to fix the problem because it is pretty impossible to re-heat all pins of the tube in order to bend or twist it in place.

NO-PICTURE-YET	1. First off, you need to have the Nixie tubes' plastic bottom drilled with a ~4mm drill in centre. This hole will go over the RGB LED so that the LED can shine through this plastic and into the glass tube.
NO-PICTURE-YET	2. Now you need to cut two leads of a Nixie tube. These are for the IN-16's dots. This IN-16 Nixie tube has two dots, one on the left and the other on the right of the digit. Since we are not using these dots and there is no hole on the PCB for them, we must cut them off. We won't cut them all the way to the glass, but only the piece that sticks out of the plastic bottom. This way we can re-use these dots, sometimes in future when and if you ever decide to disassemble the IN-16 Nixie shield PCB. **Be careful not to cut any of the digit-leads of Nixie tube, or the Anode pin! This would render the tube useless and be a terrible waste!**
NO-PICTURE-YET	3. After you clipped of those two unused dot leads, simply put back the plastic bottom under the Nixie, and place it on the PCB through the holes. This step requires a bit of patience so take your time and do it right.
NO-PICTURE-YET	4. After "threading" the leads through the PCB, it is time to do some soldering. First start of by soldering the Anode pin, since it is in the middle. After soldering it, flip back the PCB and straighten the glass tube. After making sure it stands straight, flip the PCB and solder one more pin of your choice. Now flip the PCB back up and see if the tube is straight. If not, you can re-solder that last lead you just soldered and correct the tube. Use this method to solder the remaining leads (pins) of this, and every remaining Nixie tube.
	5. Congratulations, you are all done!



Tests

This assembly requires no further tests. You have tested all your work in the upper assembly steps.