LCD Shutterglasses

Rainbow Adapter

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For the official kit from

OmberTech

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Introduction

The rainbow adapter for LCD shutterglasses uniquely exploits a refractive effect exhibited in liquid crystal display "elements" when fading out from their opaque state. This allows a rainbow of colours to be viewed surrounding reflective objects.

The following page describes usage of the adapter, then we move on to a step–by–step description of how to construct the adapter kit, as well as modify an unwanted pair of active 3D shutterglasses for use with it. Then finally, we look at exactly what electronics are required in order to put rainbows in your eyes.

Usage

With four AA batteries fitting snugly in the battery holder, a simple flick of the "Power" switch while the "Boost" switch remains off will begin powering the shutterglasses with the alternating drive signal that produces the refractive "rainbow" effect. Within thirty seconds a halo of multicoloured bands should be visible around lights, windows, and white or reflective objects. After about a minute, the effect should have built up fully.

The effect is most visible in more dimly lit areas out of direct sunlight, or outdoors at sunrise or sunset. Hold a piece of white paper in the sunlight shining through a window to see rainbow coloured images of it "floating" above on either side. When outdoors, face away from the sun to view the reflected light to best effect, remember never to look directly at the sun.

When Boost mode is enabled, the drive voltage to the shutterglasses is increased and the effect is made brighter and more vivid. However this may cause instability in the circuit, and in any case the effect will fade and become less defined shortly after this mode is enabled. Turning Boost mode off again returns to regular performance.

Some faint flickering will be visible while the glasses rapidly fade in and out. Take a break if this begins to cause headaches or nausea.

The adapter can connect to most wired 3D shutterglasses designed for use with PC 3D graphics adapters or TVs when they are equipped with a 3.5mm stereo plug. Some models may produce the effect while some may not, the only way to know is to give them a try.

Wireless adapters require modification to connect wires from the adapter circuit directly to the LCD "lens" elements. This is described in the following section.

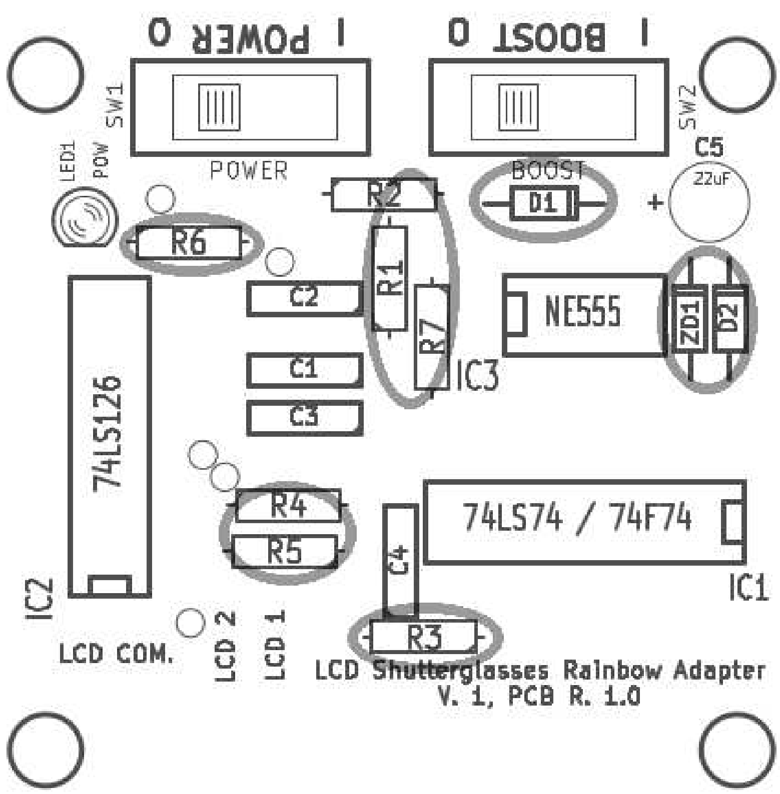
Construction

If you have purchased the rainbow adapter kit from OmberTech, you are likely reading this in the company of an assorted bag of bits (described more exactly in Figure 1) that you hope to turn into the driver for your new rainbow tinted glasses. This chapter will guide you though step–by–step in the fulfillment of this goal. So grab your soldering iron and let's get started!

This kit doesn't use any CMOS devices, so no special static precautions are required when handling the components.

Part	QTY	Identifiers	Marking
100nF MKT Cap.	3	C1, C2, C3	104J100
4.7uF Electrolytic Cap.	1	C4	4.7uF
22uF Electrolytic Cap.	1	C5	22uF
1N4148 Silicon Diode	2	D1, D2	1N4148
4.7V Zener Diode	1	ZD1	TZX 4V7 C
3mm LED	1	LED1	
74LS74 Flip−Flop IC	1	IC1	SN74LS74AN
74LS126 3−State Buffer IC	1	IC2	SN74LS126AN
555 Timer IC	1	IC3	SE555P
47ohm Resistor	1	R7	Yel, Ppl, Blk
1.2Kohm Resistor	1	R3	Brn, Red, Red
2.2Kohm Resistor	2	R4, R5	Red, Red, Blk, Brn (Green body)
3.3Kohm Resistor	1	R6	Ong, Ong, Red
56Kohm Resistor	1	R2	Grn, Blu, Blk, Red, Brn (Green body)
100Kohm Resistor	1	R1	Brn, Blk, Yel
DPDT PCB−Mount Switch	2	SW1, SW2	
3−Way Ribbon Cable	1		
4xAA Battery Holder	1		
50x50mm Circuit Board	1		V. 1, PCB R. 1.0

Table 1, Parts List.

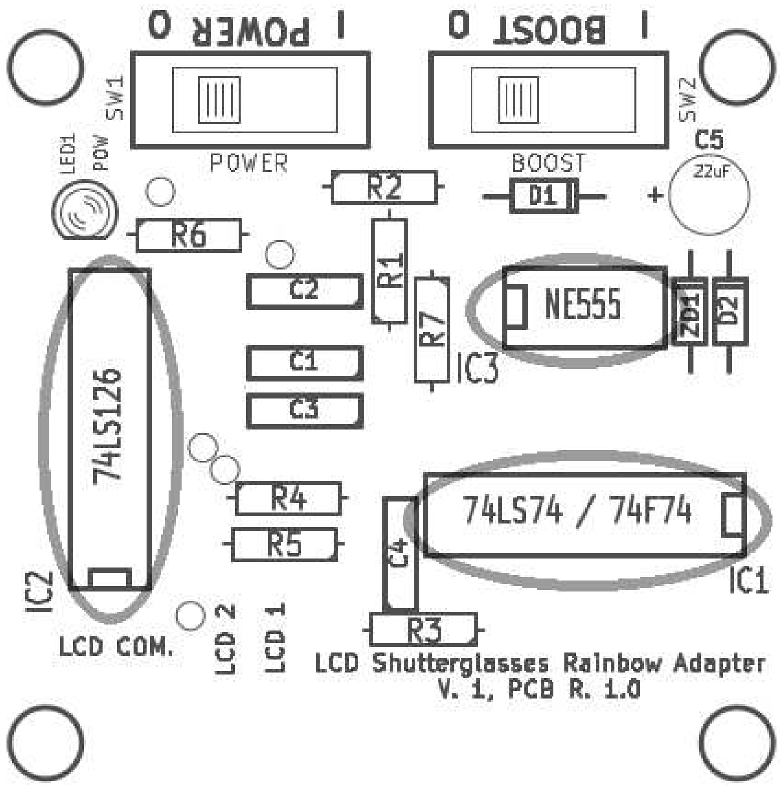


Resistors and Diodes: R1 – R7, 1N4148 x2 (D1 – D2), 4V7 x1 (ZD1)

We begin with the resistors and diodes. Resistor values are shown in Table 2 below. Ensure that the black band at the end of the diodes matches the corresponding mark on the silkscreen image.

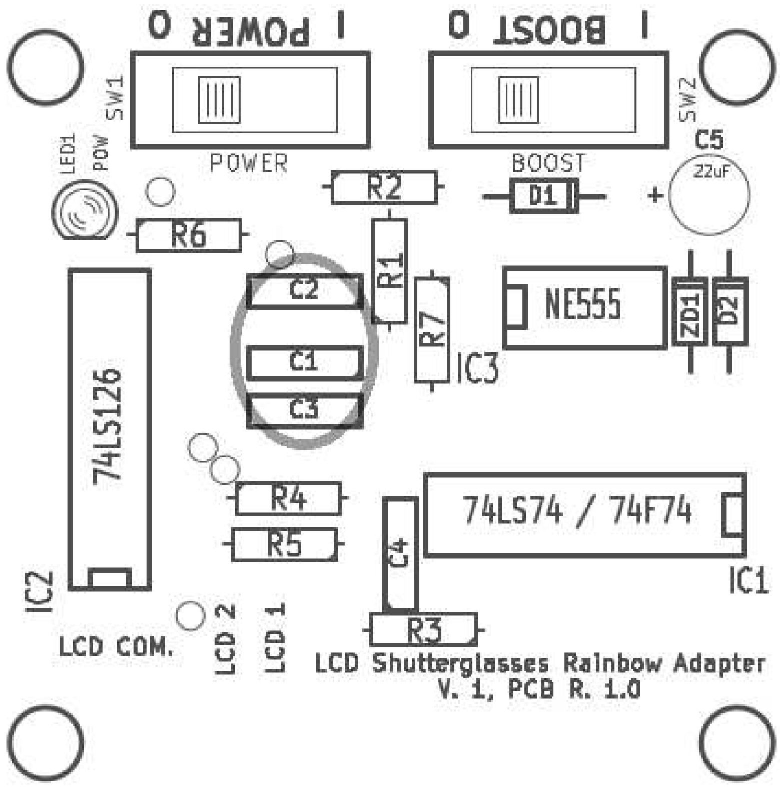
Identifier	Value	Marking
R1	100K	Brn, Blk, Yel
R2	56K	Grn, Blu, Blk, Red, Brn (Green body)
R3	1K2	Brn, Red, Red
R4, R5	2K2	Red, Red, Blk, Brn (Green body)
R6	3K3	Ong, Ong, Red
R7	47R	Yel, Ppl, Blk

Table 2, Resistor Values.



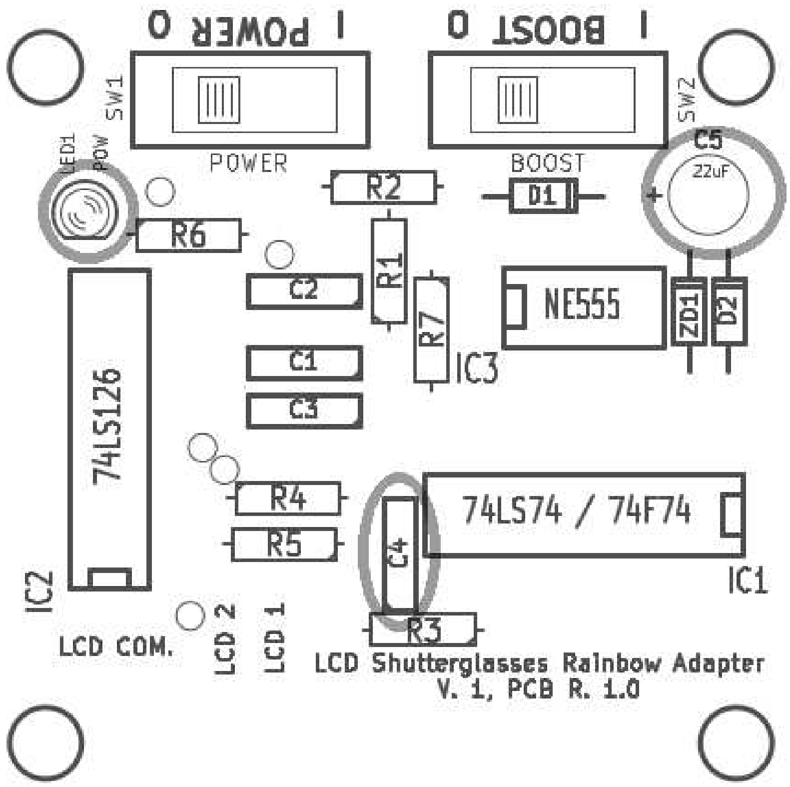
Integrated Circuits: IC1 – IC3

The ICs are now soldered into place, watching that the notch or round mark on the their top matches the mark on the silkscreen image.



MKT Capacitors: 100nF x3 (C1 – C3)

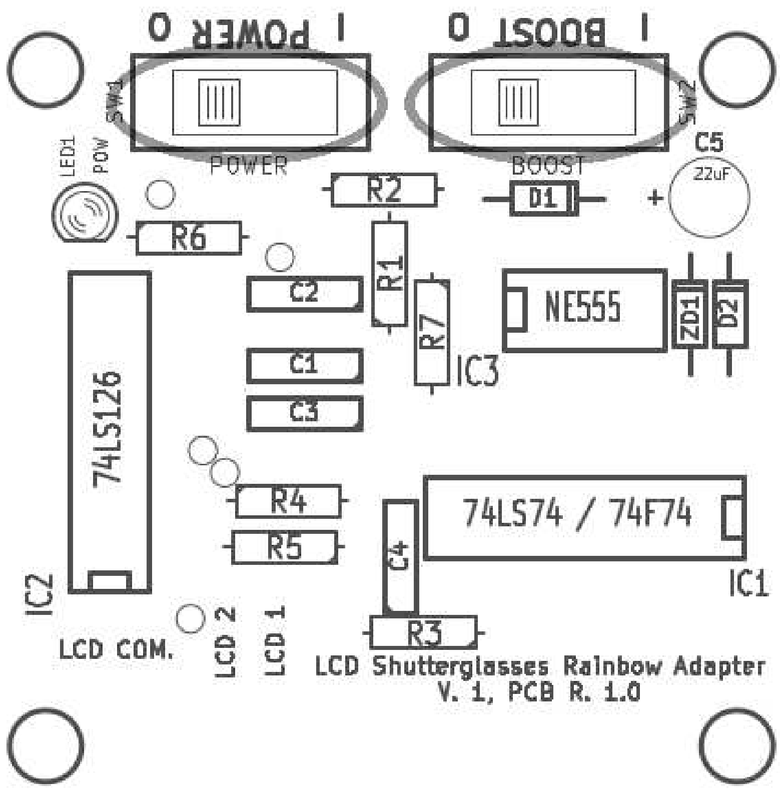
These little grey blocks of capacitance are all lined up in the middle of the board, time to plop them on.



Electrolytic Capacitors and LED: 4.7uF x1 (C4), 22uF x1 (C5), 3mm LED x1 (LED1)

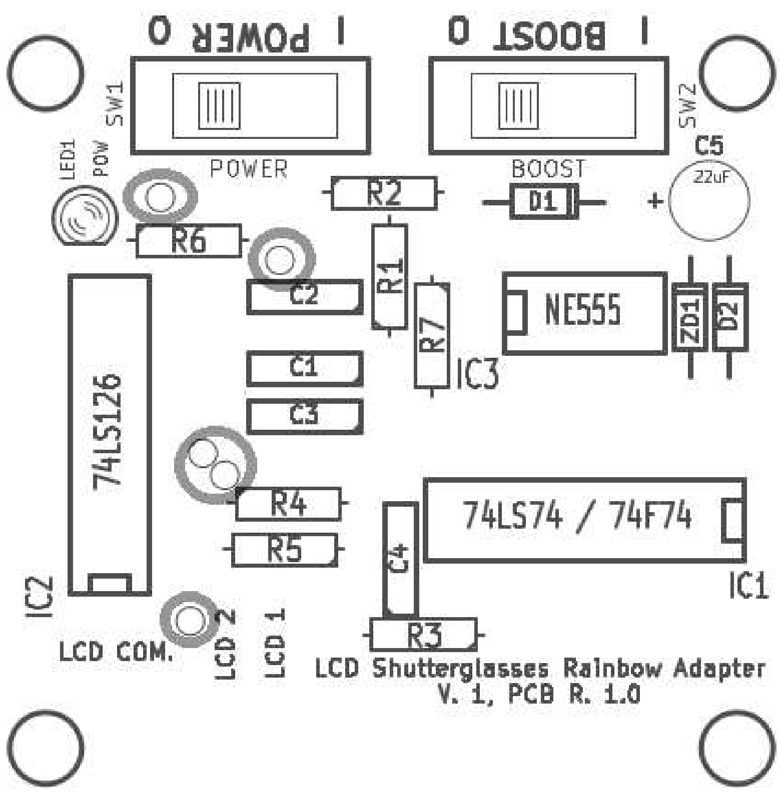
The remaining capacitors and the power LED now get their turn. There's no mark indicating the orientation of C4 on the silkscreen, but it should be orientated with the negative side (marked by the stripe and the shorter lead) closest to the center of the board. C5 is orientated with negative facing outwards from the board, as indicated by the little "+" symbol on the silkscreen. Also watch that the notch on the body of the LED (and the shorter lead) match the image on the silkscreen.

C4 can be bent down over R4 and R5 before soldering, and the same done to C5 on top of ZD1 and D2. If using the optional second board mounted above for protection, bend the LED sideways as well so that it sticks out the side and is visible when everything is assembled.



Switches: SW1 – SW2

The only components missing from the board should now be the switches. Try to get the "legs" of the switches resting flat against the board so that minimal stress is put on the connections during use, and also to make sure that they don't end up too high if you're using the optional second board for protection.



Wires:

Wire connections are brought in from the top of the board and fed through holes in order to prevent strain from twisting at the solder joints. The grey three−way ribbon cable for connecting with the glasses is parted and the individual wires can be pulled through the holes with their insulation using pliers. The Power wires from the battery holder turned out to be a little thick for this, so only the core wires may fit through the holes, stripped of their insulation.

Once through to the solder side of the board, the wires are soldered to the long pads described by writing on the silkscreen or copper layer. The "LCD COM." pad is broken into two, and the wire must be soldered over both of these pads.

If you're using wired glasses with the adapter, you can solder a 3.5mm socket onto the end of the ribbon cable to connect with the plug from the glasses. Make sure to connect the "LCD COM." wire with the base of the 3.5mm plug, and the LCD 1/2 wires to either the middle or the tip with no preference to which.

Final Checks:

With the circuit board completed, now is the time to check over your work for any of those pesky components that like to hop into the wrong position, or spin themselves the wrong way round, while you're not looking. While you're there, check the bottom of the board for any missed or bridged solder joints.

Enclosure Assembly:

If you're happy with the board on its own, or you have your own case, you can now start using your wired glasses with the rainbow adapter, or move over to the section on modifying wireless glasses to connect them to it.

If you bought the optional second board to mount above the adapter circuitry for protection, now you can install it using the nuts, bolts, and plastic spacers supplied.

The outer screw holes in the battery holder are aligned with the holes at the switch end of the adapter board, and the bolts run through from the battery compartment side. Drop the spacers onto the bolts and do the same with the bolts at the other end before installing the second board with the notched end above the switches to allow easy access. Add the nuts to the end of the bolts and tighten the bolts with a flat head screwdriver while gripping the nuts with pliers. Additional protection might be achieved by wrapping the sides in electrical tape, while making sure to leave the power LED visible.

Modifying Wireless Shutterglasses:

Results with different models of shutterglasses have been mixed. While the old PC wired glasses optionally offered for sale with the adapters, and a pair of HiSense brand wireless glasses for 3D TVs from 2011 have worked, a pair of SamSung 3D TV glasses from 2013 failed to work with the adapter. Although these latter glasses briefly showed the effect while unplugging them from the circuit, no timing arrangement in the circuit has succeeded in making it visible for any length of time. In the end it just comes down to "try it and see".

To attempt such a try, the first step is to break into the circuitry that controls the LCD "lenses" and cut the connections before wiring them directly to the adapter. The following pictures show disassembling the Hisense brand glasses, model FPS3D02.

First remove any screws that are present. Look around the hinges.

Next the plastic clips that hold the glasses together will have to be prised apart. Use a flat head screwdriver to slip into the gap and lever the front apart from the back. The strength of the clips can vary and it may be impossible to separate the halves without damaging the plastic, but try hard to avoid putting pressure on the glass it can easily crack.

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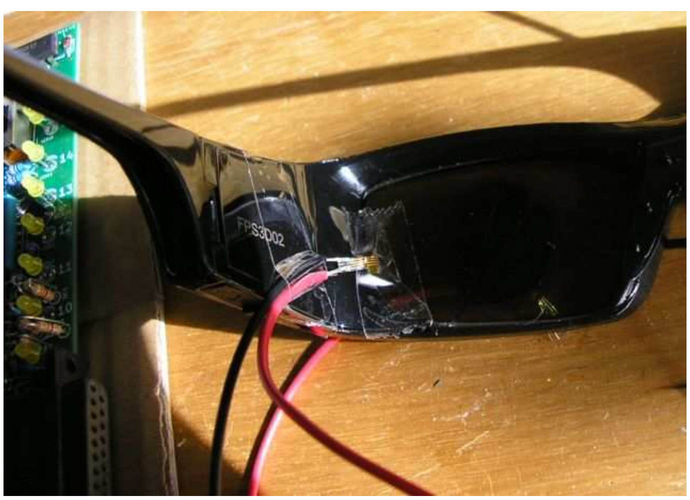
The middle is the most difficult part.

Once inside, the lenses on modern glasses seem often to be connected using a flexible PCB. On the SamSung glasses it was easy to solder the wires onto the solder pads connecting the lenses to the flex, then the control board was cut off to prevent it interfering. On the HiSense glasses, the wires had to be carefully soldered to the contacts at the end of the flex where it was meant to fit into a connector on the control board.

SamSung Glasses



Hisense Glasses

Remember that the LCD 1/2 wires can be interchanged, but the LCD

COM. wire must be the one that connects to both of the lenses. Polarity is not important.

Once all the wiring is done, the case can be pressed back as well as is possible (it may need to be glued if the wire pushes the halves too far apart, or the clips have all broken). Then the screws are put back, and with a bit of luck you can put the glasses on and let them bring some brand new colour into your world.

Theory

LCD Elements:
The "lenses" in the LCD Shutterglasses are equivalent to single pixels in a monochrome Liquid Crystal Display, or single elements of a 7−segment numeric display. The "D" in "LCD Shutterglasses" is therefore out of place because there is nothing that can really be displayed by glasses with lenses that in normal use can only be transparent or opaque.

From an electrical perspective the elements themselves act as capacitors. When charged, the Liquid Crystal molecules align to straighten out a twist in their structure that otherwise rotates the polarisation of light passing through. By placing polarising filters either side of the crystals, when the polarisation of the light is opposite to the outer filter, no light can get through at all. Depending on the filter this can happen in either the charged or discharged state of the LCD element. Most commonly it is in the charged state, so when a signal is applied the element becomes opaque.

It would seem that this signal might simply be a fixed voltage difference, but to complicate matters LCD elements perform best and live longest when the polarity of their charge is constantly changed. The signal therefore needs to be rapidly alternating from High to Low in opposite states across the LCD element's two electrical connections. Then it appears opaque until the element is shorted so that it can allow light to pass through once more.

In this circuit we add one more input state for this capacitive LCD element, which discharges it slowly so that it fades out rather than being shorted out and made immediately transparent. A possible explanation for the resulting effect is that the slow discharge results in the liquid crystal molecules lingering in a partially twisted state, thereby partially rotating the polarisation of the light traveling through. The wavelength of the light influences the degree of rotation that takes place, so the different colours of light become visible in bands, as in a rainbow.

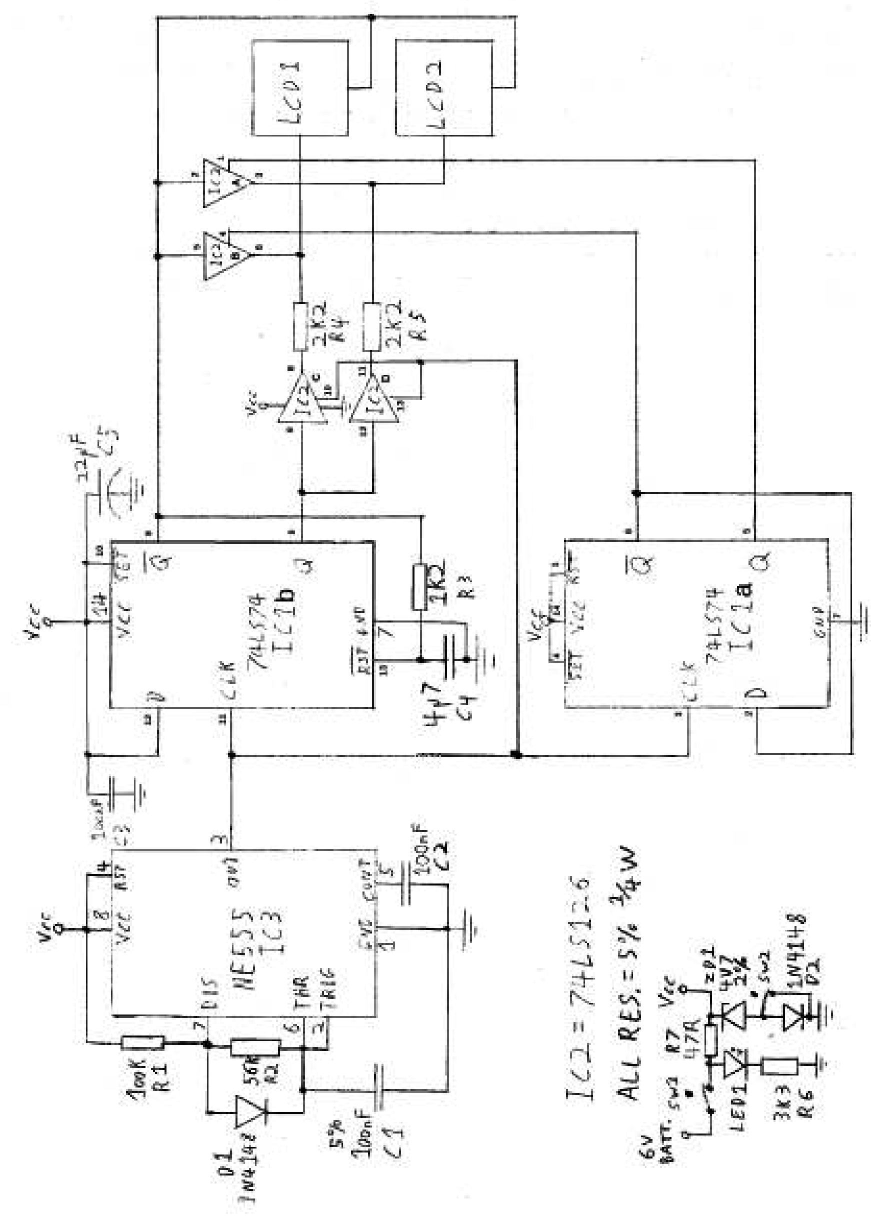


Figure 1, Schematic.

Circuit Description:

IC3 is that old favourite the 555 timer, here configured with D1 ensuring a longer On time than Off time by allowing C1 to bypass R2 when it charges while the output is High.

At the same time as this output is High, IC2c/d (74LS126) are enabled, allowing the non−inverted output of the IC1b (74LS74) Flip−Flop to be applied to R4 and R5. When the clock signal from IC3 goes from Low to High, the Flip−Flop output likewise goes Low to High as well. But at the same time C4 begins to discharge via R3, connected to the Flip−Flop's inverted output, and eventually causes it to reset, bringing the non−inverted output back Low again.

This oscillation alternately charges the active LCD element because the opposite states of the inverted and non−inverted Flip−Flop outputs are applied to it.

Meanwhile, the inactive element is shorted out by either IC2a or IC2b. These force both of the LCD connections to an equal voltage and thereby discharge its capacitance. The active element is alternated on each clock cycle by Flip−Flop IC1a which toggles the Enable inputs of the IC2a/b 3−state buffers.

The connection of the Enable inputs of the other 3−State buffers IC2c/d to the clock signal allows the active LCD element to be discharged slowly for the Low period of the clock waveform (set by R2) when all the buffers on one of its connections are in 3−State mode. This fades out from the charged, opaque, state that it was in during the preceeding High period of the clock waveform. The complete resulting output waveform is shown in Figure 2.

Finally, the effect was found only to work at drive lower voltages to the LCD elements, but with an increased brilliance when the circuit supply voltage was quickly raised from around 4.75V to above 5V, before fading out. The power regulation part of the circuit, shown in the bottom left of the schematic, makes sure that the normal supply voltage is set for optimal performance by using ZD1 to keep it within 2% of 4.7V. SW2 effectively switches a silicon diode in series with ZD1's path to GND, increasing the voltage across it, and therefore the circuit supply voltage, by at most about 0.7V. This provides the "Boost" functionality, but unfortunately also introduced circuit instability with some 74LS74 ICs. The power LED is connected to the unregulated part of the supply to prevent unneeded power dissipation across R7.

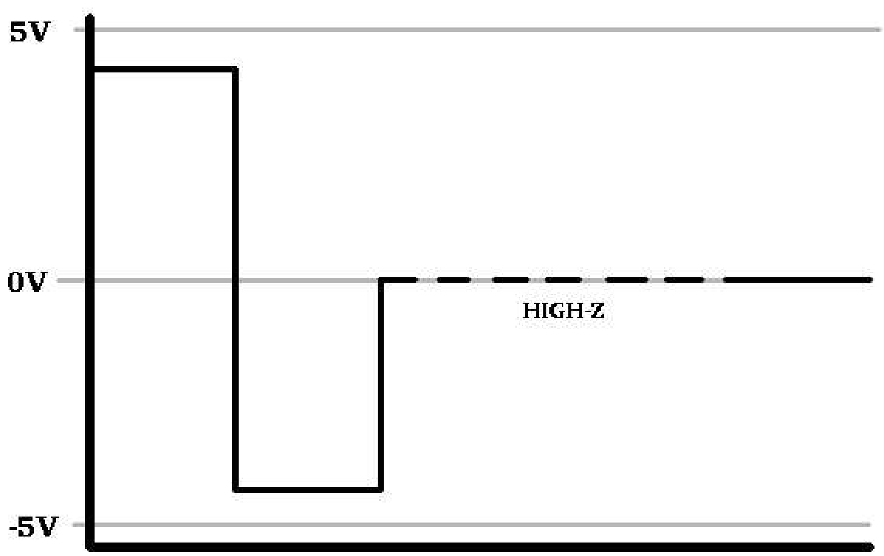


Figure 2, Output Waveform. Shows voltage measured over LCD COM. and either LCD 1 or LCD 2 output, with no LCD element connected. Begins at the rising edge of the clock cycle. The dotted line indicates that both output buffers on the LCD output are in 3−State mode.