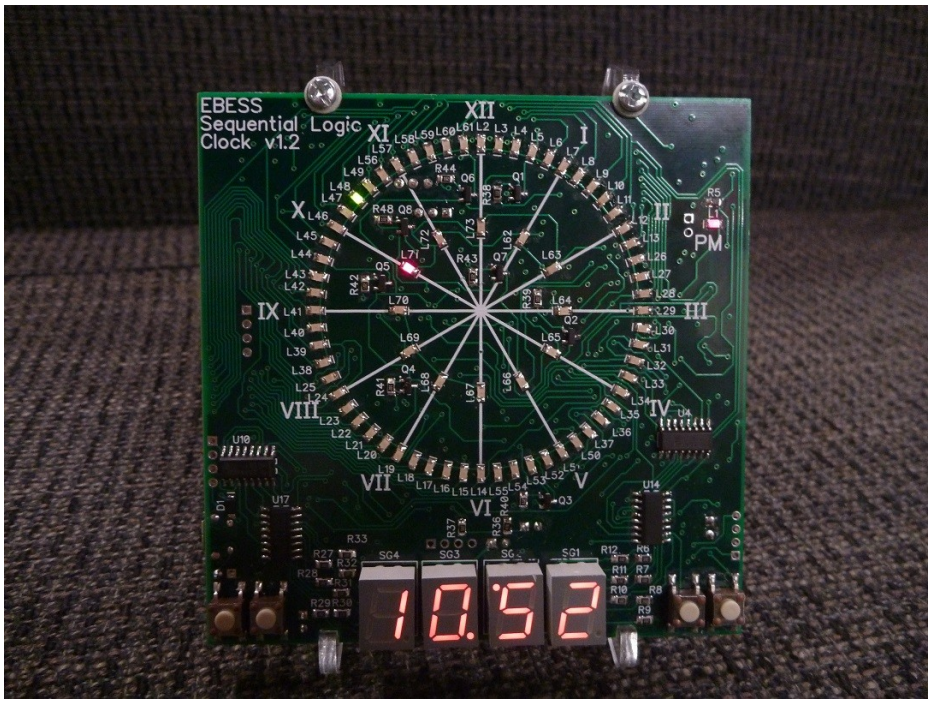
Sequential Logic Clock Kit

Build your own clock that operates only on 74 series logic and a 555 timer! This kit is a bit more challenging, but there's plenty of room for customisation when you're done.

2016

ELECTRICALLY BASED ENGINEERING

STUDENT SOCIETY



EBESS Kit
Sequential Logic Clock
2016
Rev0.2

Introduction

What is this?

This is a sequential logic clock. That simply means that instead of having a microcontroller or some intelligent control system driving this clock and its display, the whole device is run by 74 series logic chips. You may have learnt about the 74 series family in CSSE2010, or in your own studies. Basically, they're integrated circuits (IC) that provide basic logic functionality, such as AND, OR, NOT, etc gates. There are also slightly more advanced 74 series ICs that provide functionality such as counters, decoders, and binary-coded decimal to seven segment display converters, which have been used here as well.

Apologies in advance for the rough nature of this assembly guide and its lack of detail. I'm a bit under the gun with things, and don't have the time to complete a detailed guide with theory notes at the moment. As soon as my thesis is submitted in November (or if I get time before then), I'll get the fully fledged guide done and put it up on the EBESS website. What is presented below should be sufficient for you to assemble your clock and get it all up and running. In the meantime, if you want to do some reading on your own, the concepts that will be covered in the guide include: binary-coded decimal, how 555 timers work, some background and information on 74 series chips, and also the seven segment displays.

*****Given that this guide is in a rough state, my key advice is to ensure that you very carefully look at the footprints on the PCB when you're soldering, and that you have the correct orientation for the component.*****

******ALSO: When soldering your LEDs, the green and red LEDs have opposite anodes and cathodes, despite their packages looking identical. Ensure that you use the diode test on a multimeter to check the orientation of your LEDs before soldering them (just check one red and one green, as it will be the same for each colour). You don't want to have to de-solder a bunch of LEDs later because you got them the wrong way around!*******

All surface mount resistors and ICs should have legible values/names written on them.

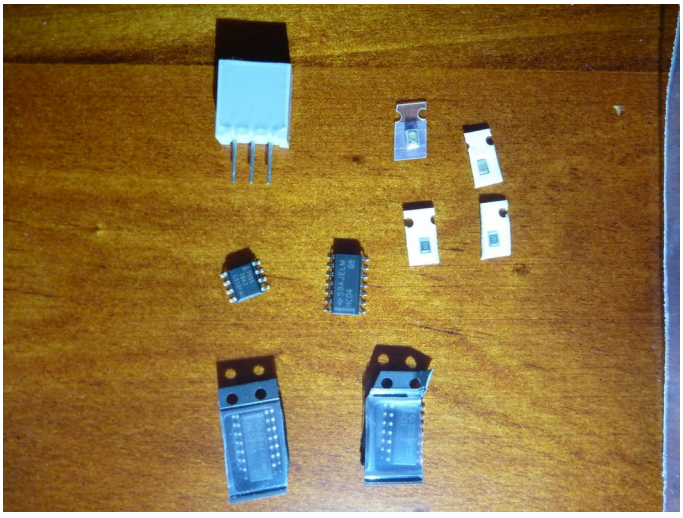
Good luck!

Assembly Instructions

Let’s have a quick look at all the parts we have in the bags. You should open your box to find a single large bag with several smaller bags inside.

You should find 11 smaller bags, 1 PCB, 1 3xAA battery pack, and 3 pieces of acrylic. In the following section, you’re going to be shown all of the parts in the bags, along with their part designators (R1, L45, U17, etc). With this information, you should be able to solder up the PCB, paying attention to the orientation of component footprints on the board. Since this is a bit more of an advanced kit, there isn’t going to be too much detail in this assembly section. Having the parts and their designators should be enough for you to be able to assemble the kit.

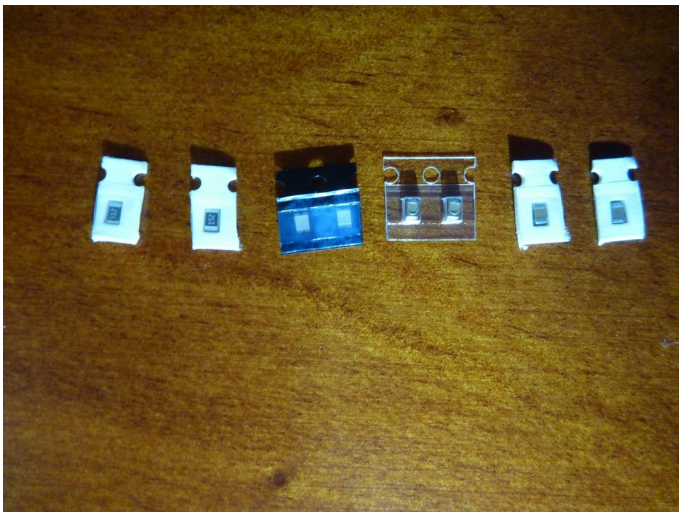
Bag 1



Here we have:

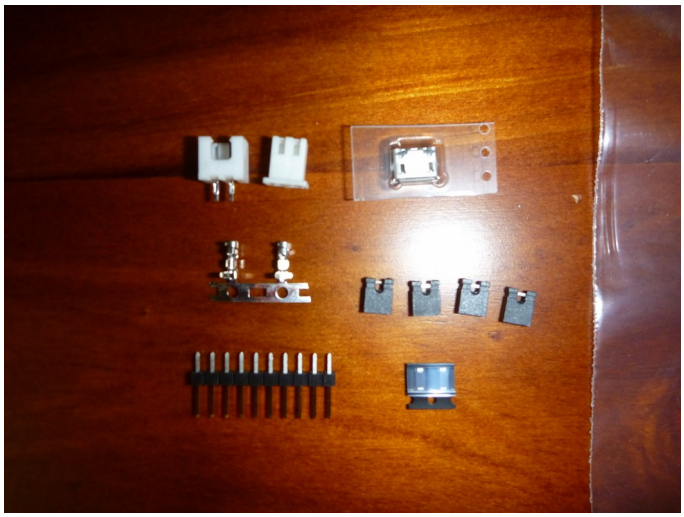
1. Top left grey component – 1x 200kΩ trimpot – TR1
2. Capacitor in white packaging– 1x 10nF capacitor – C1
3. Capacitor in clear packaging – 1x 10µF capacitor – C2
4. White packaging – 1x 33kΩ resistor – R1
5. White packaging – 1x 5.1kΩ resistor – R2
6. 8-SOIC IC – 1x ICM7555IBAZ – U1 (555 timer)
7. 14-SOIC IC – 1x SN74HC21 – U2
8. 14-SOIC IC - SN74HC590 - U3
9. 14-SOIC IC - SN74HC04 - U18

Bag 2



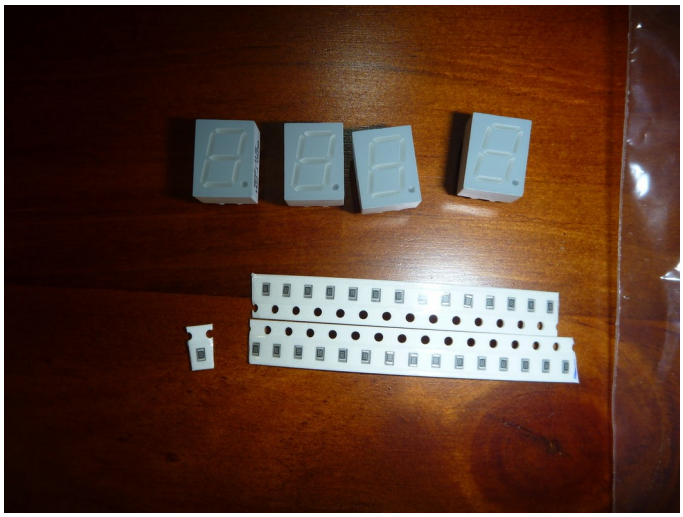
1. 1x 5.1kΩ resistor – R47
2. 1x 1.5kΩ resistor – R5
3. 2x red LEDs – L1, L74
4. 1x 100nF capacitor (white packaging with no black mark on back)– C3
5. 2x 1uF capacitor (clear packaging) – C4, C6
6. 1x 1nF capacitor (black mark on back of packaging) – C5

Bag 3



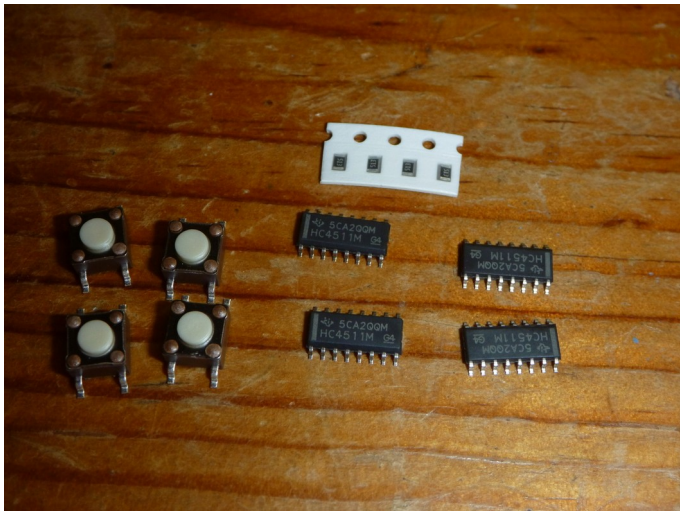
1. 1x Micro USB-B socket – U23
2. 1x Male two pin JST board connector – BAT1
3. 1x Female two pin JST wire connector
4. 2x JST crimps (these are to be crimped on to the battery pack wires, which may be easier if you cut off the ends of the wires and strip them back slightly)
5. 10x Header pins for J5-J8 (you will need to snip off the appropriate amount of pins for each jumper)
6. 4x Jumper shunts (put these on J5-J7, and on J8, put it on the left and centre pin to use the 555 clock source)
7. 2x Schottky Diode – D1, D2

Bag 4



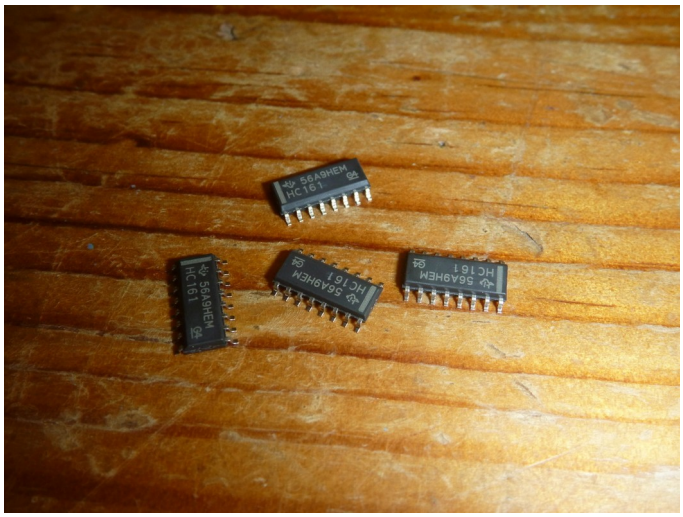
1. 4x Seven segment displays – SG1...SG4
2. 30x 1kΩ – R6...R33, R45, R46

Bag 5



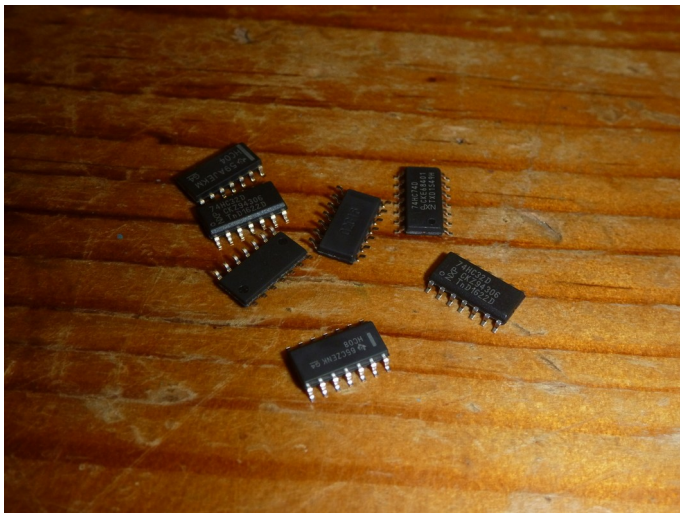
1. 4x 51kΩ resistors – R3, R4, R34, R35
2. 4x Buttons – B1...B4
3. 4x CD74HC4511 – U14...U17

Bag 6



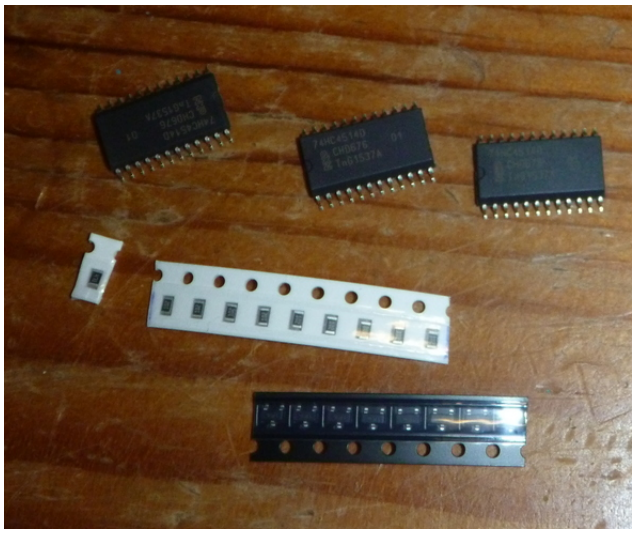
1. 4x SN74HC161 – U4, U7, U8, U10

Bag 7



1. 1x SN74HC04 – U5
2. 2x SN74HC08 – U6, U12
3. 2x 74HC32 – U9, U19
4. 1x 74HC11 – U11
5. 1x 74HC74 – U13

Bag 8



1. 3x 74HC4514 – U20, U21, U22
2. 9x 1kΩ resistors – R37...R44, R48
3. 1x 470Ω resistor – R36
4. 8x 2N3904 transistors – Q1...Q8

Bag 9

1. 12x Red LEDs – L62...L73

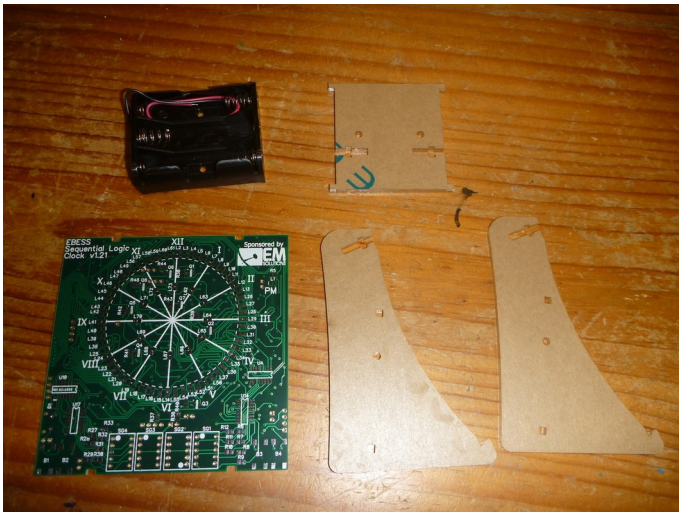
Bag 10

1. 60x Green LEDs – L2...L61

Bag 11

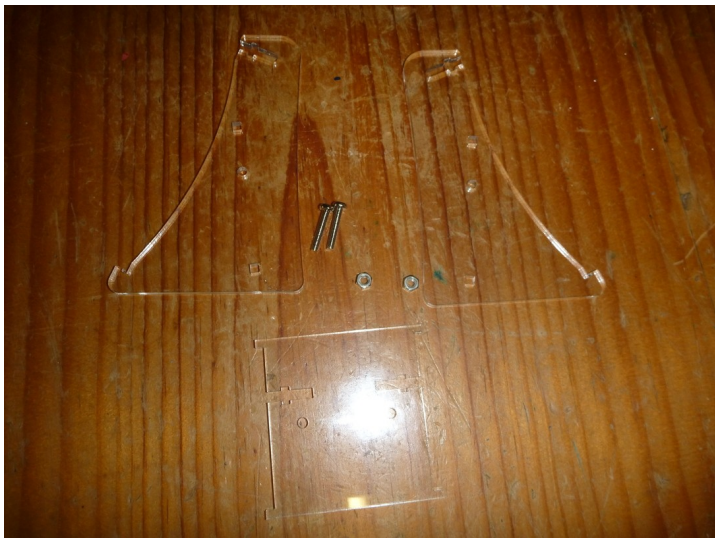
1. 6x M3 Hex nuts
2. 4x 16mm M3 bolts
3. 2x 10mm countersunk M3 bolts
4. 2x M3 washers

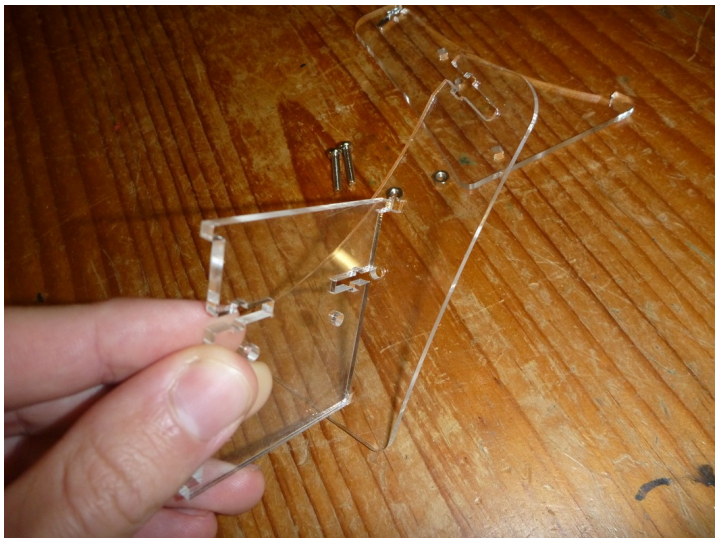
Loose parts

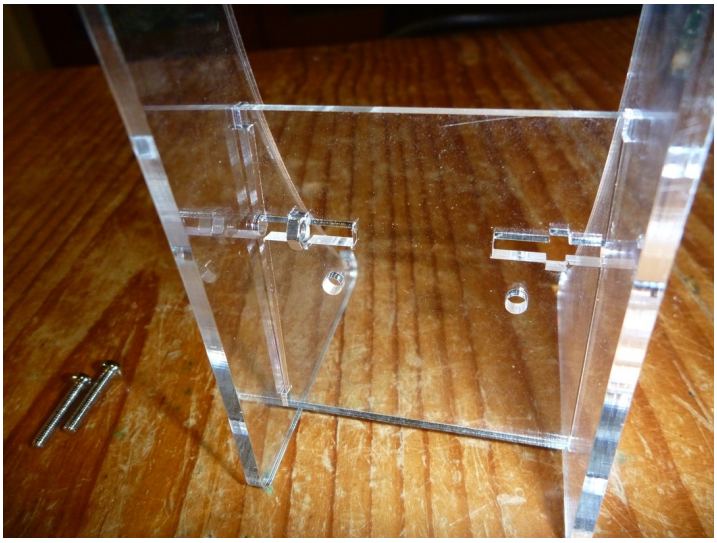


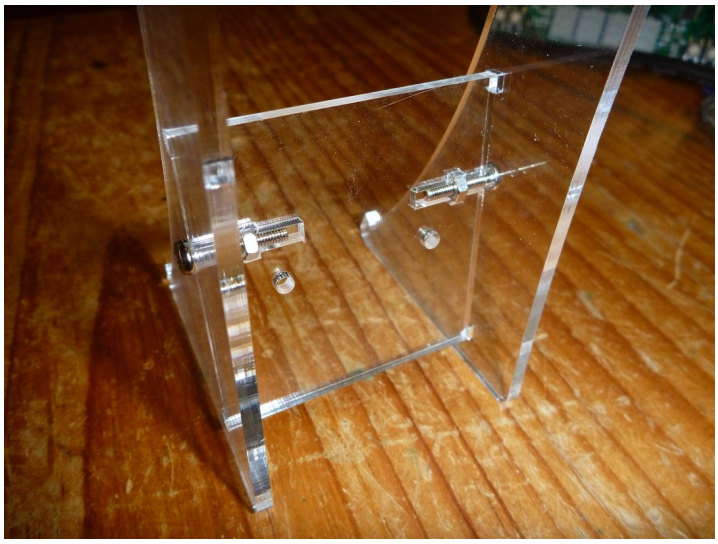
1. 1x PCB
2. 1x Battery pack
3. 2x Acrylic side pieces
4. 1x Acrylic back piece

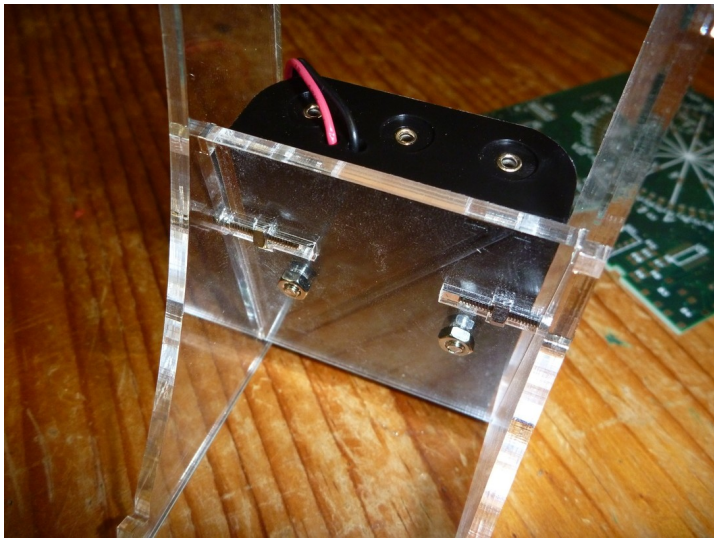
Assembling the acrylic case

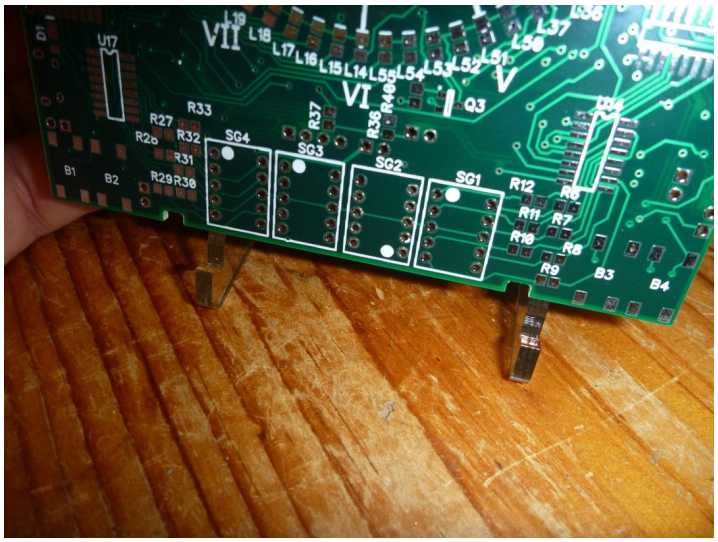


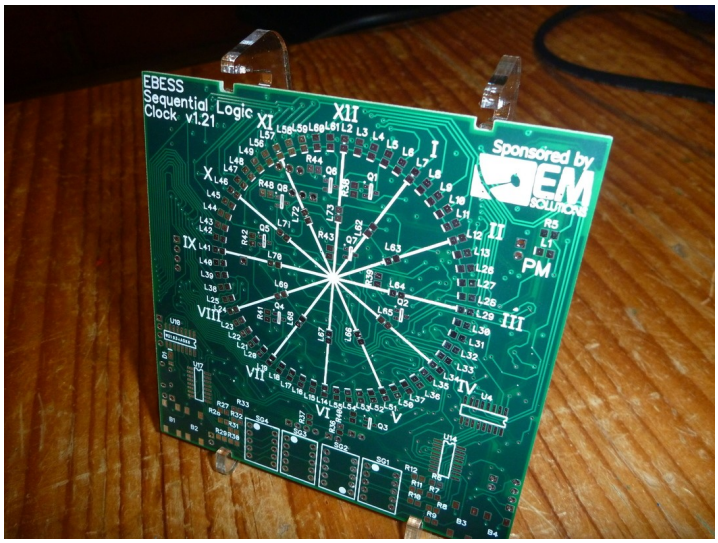


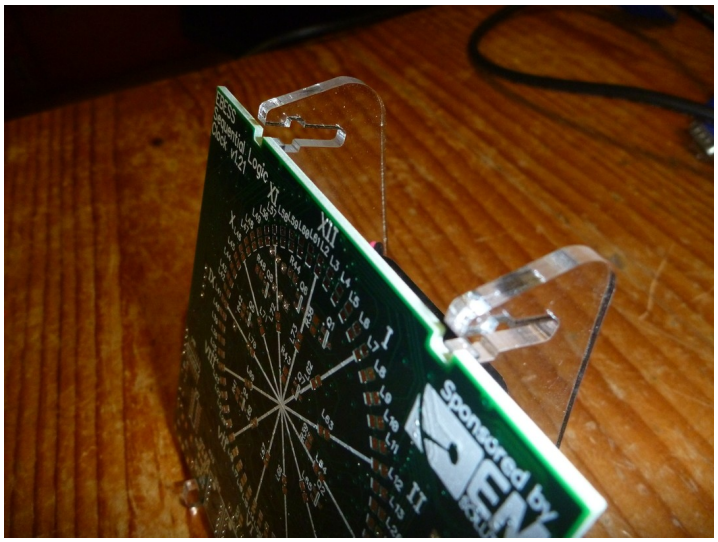







VII
VI
V
U17
R33
R27
R25
R32
R31
R29
R30
SG4
SG3
SG2
SG1
R12
R11
R10
R7
R8
R9
B1
B2
B3
B4
Q3


EBESS
Sequential Logic
Clock v1.21
XII
XI
I
II
III
IV
V
VI
VII
VIII
IX
X
PM
Sponsored by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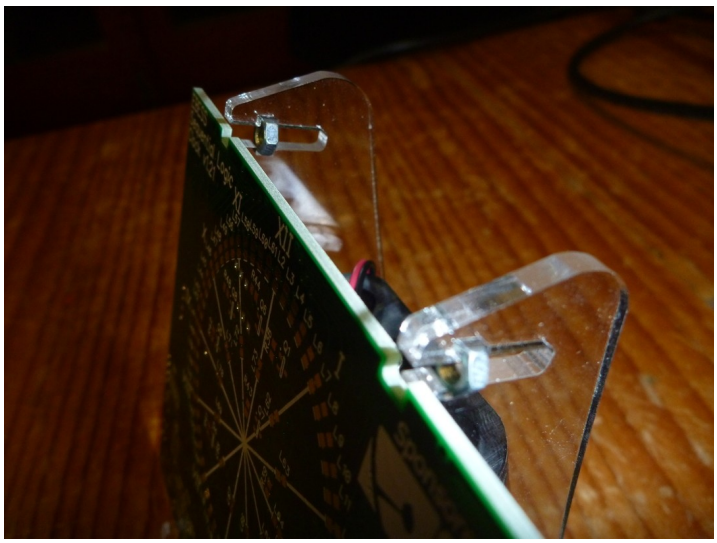

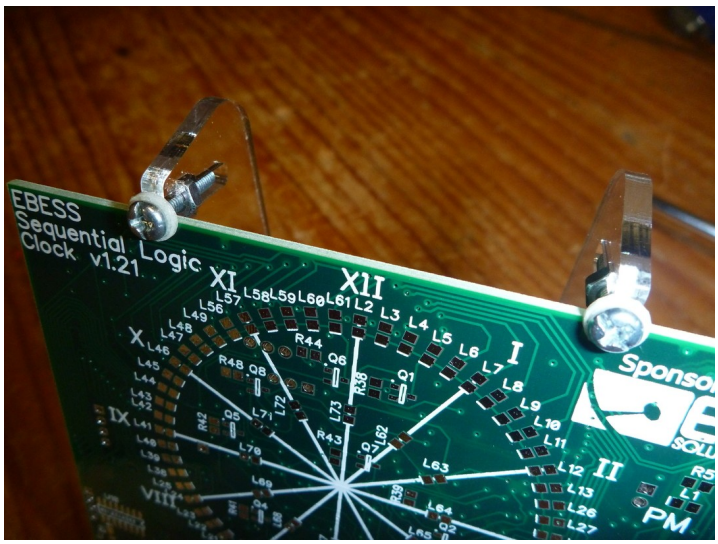
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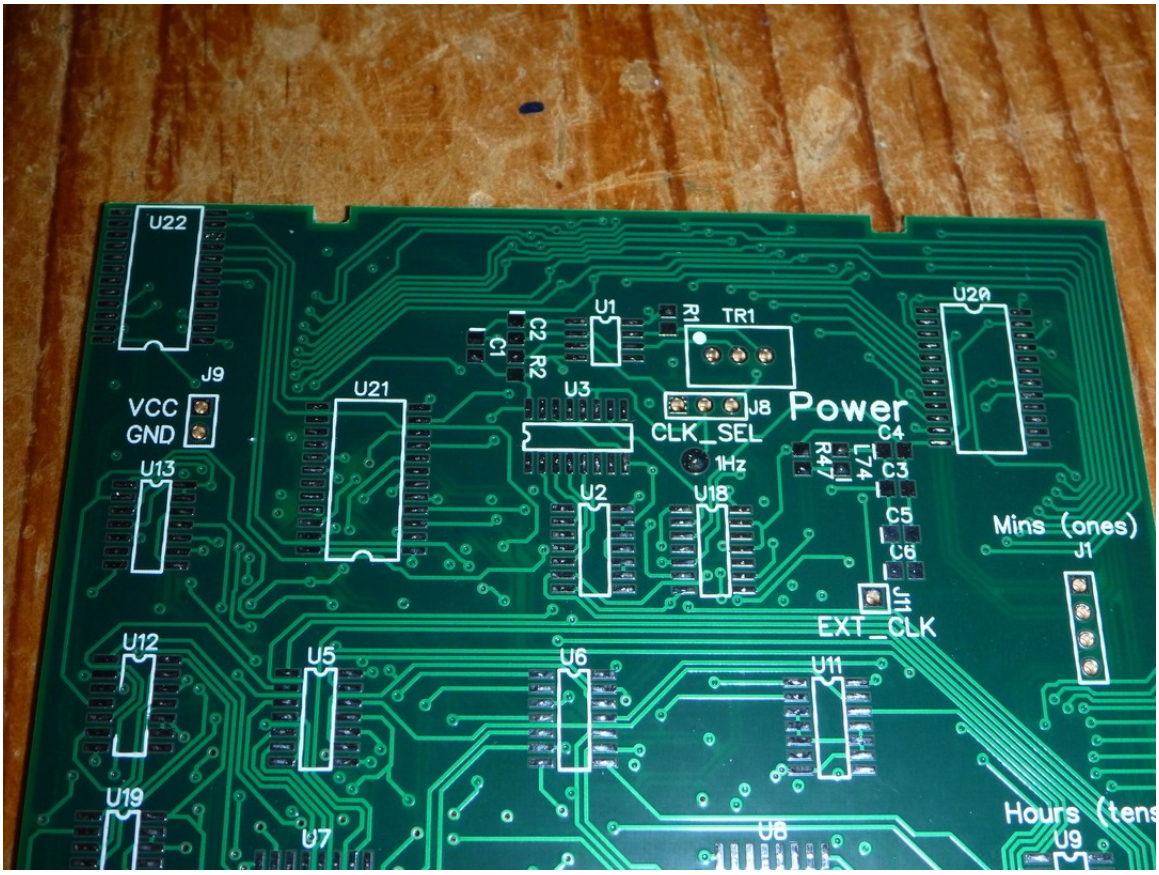
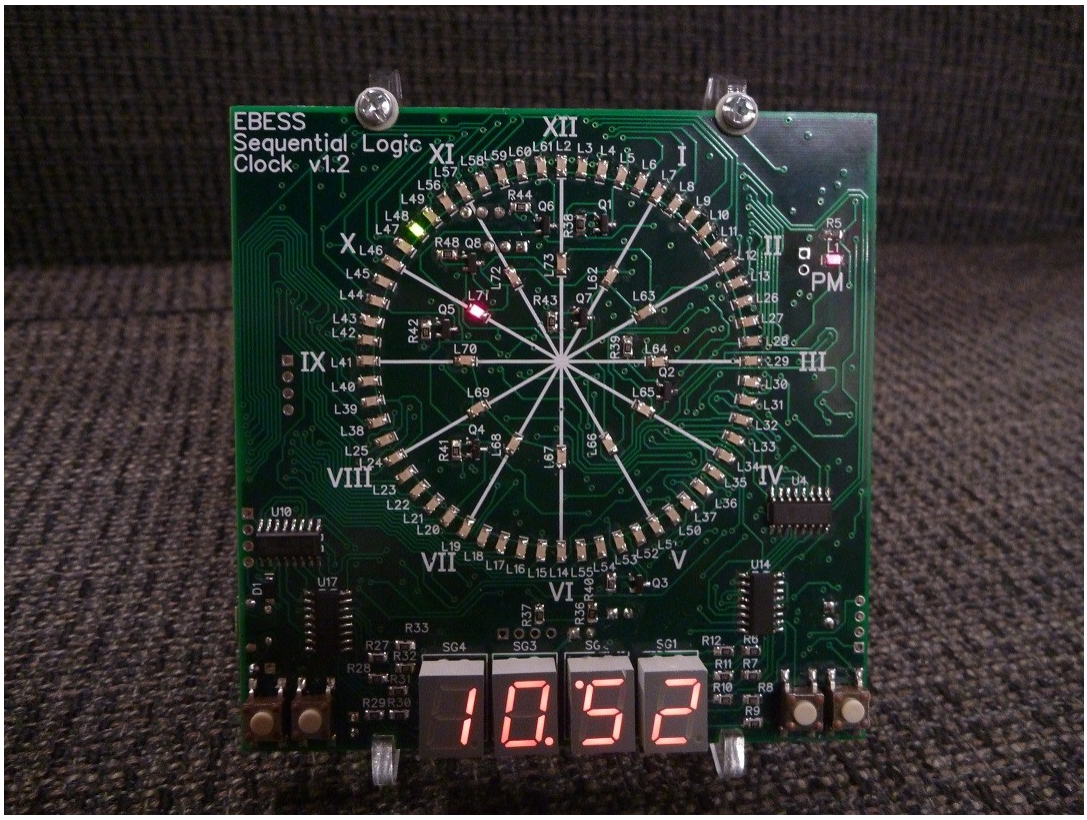
Calibrating the clock



On the back of the PCB, you should notice a 1Hz test point. This is used to calibrate your 555 timer. When everything is soldered, power on your clock, and probe this 1Hz test point. It will likely range somewhere from 0.1Hz to 5Hz initially. To make your clock more accurate, you will need to adjust the trimpot on TR1 and continue to observe the frequency of the square wave at the 1Hz test point on an oscilloscope or whatever you're measuring it with. Turn the trimpot until your frequency is tuned to 1Hz.

Setting the time



In order to set the time, you will need to use the buttons on the front of the PCB. The left button of the left pair of buttons increments the ones place of the minutes, while the right button of the left pair increments the tens place of the minutes. Then the left button of the right pair toggle the PM LED, and the right button of the right pair increments the ones place of the hours. There are two issues to be aware of here:

1. The buttons are not debounced, so you may observe multiple increments in a given press. The best plan to use the buttons is to set your time from the minutes ones place, then the minutes tens place, then the hours, and finally toggle the PM LED on its own.
2. The PM LED cannot be toggled while the hours display reads 12, due to the logic of the circuit.