



ClockTHREEjr

Assembly Guide and Manual v2.0

ClockTHREEjr.



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Safety Precautions



The assembly of ClockTHREEjr can be dangerous. Lead solder should be handled with care as it is poisonous. Always wash your hands after use.

Soldering irons are hot and can cause a fire if not handled properly. Do not solder around flammable materials.



Never touch the tip of your soldering iron and return the device to its stand when not in use. Do not try to catch a hot soldering iron should you drop it.

Always wear safety glasses when soldering. Solder may splatter as it heats up and we don't want you losing an eye.

Always wait a few minutes for solder to cool before touching it.



Always solder in a well ventilated area. We recommend that you use a fume extractor to avoid breathing toxins. It will also prevent loved ones in the vicinity from complaining about your "stinky hobby."



Electricity is dangerous and can cause serious injury or death if not used properly.

Only use the recommended power options within this manual.

Never solder while electricity is applied to the circuit.

Always remove power from the soldering iron when you leave your workspace.

Introduction

Congratulations on your purchase of the ClockTHREEjr kit! We are extremely fortunate to have hobbyists like yourself joining our family! This is a fairly easy project to assemble and you should be able to complete it over a weekend using only basic electronics skills.

Please read through and understand the entire set of instructions before you get started. It could save you hours of rework and much consternation. We've captured all of the mistakes and blunders made in creating and building the prototypes and tried to foresee problems you may have.

Take your time! Enjoy the build process and take a break when you feel fatigued. You will have this clock for years to come so there are no worries if it takes an extra day to build. If you're not sure about something, please ask questions before doing something regretful. We're here to help!

Tips

You should leave the protective film on the front and rear plates until final assembly. The acrylic plates are delicate and the film is there to protect against scratches and smudging. Always place the plates on a soft, clean surface like a towel when handling after the film is removed.

Please be careful when handling the baffles. They are engineered to provide the most light possible to the face so they are thin and somewhat fragile.

Before you solder the IC sockets check that every leg has come through the PCB. Trust us, you don't want to notice a bent pin after soldering the first twenty.

Some components are polarized and must be oriented correctly to ensure a functional clock. Reversing the orientation can also cause catastrophic damage to your clock, and possible injury, when power is applied. Don't worry, though, as the pictures should help you out tremendously.

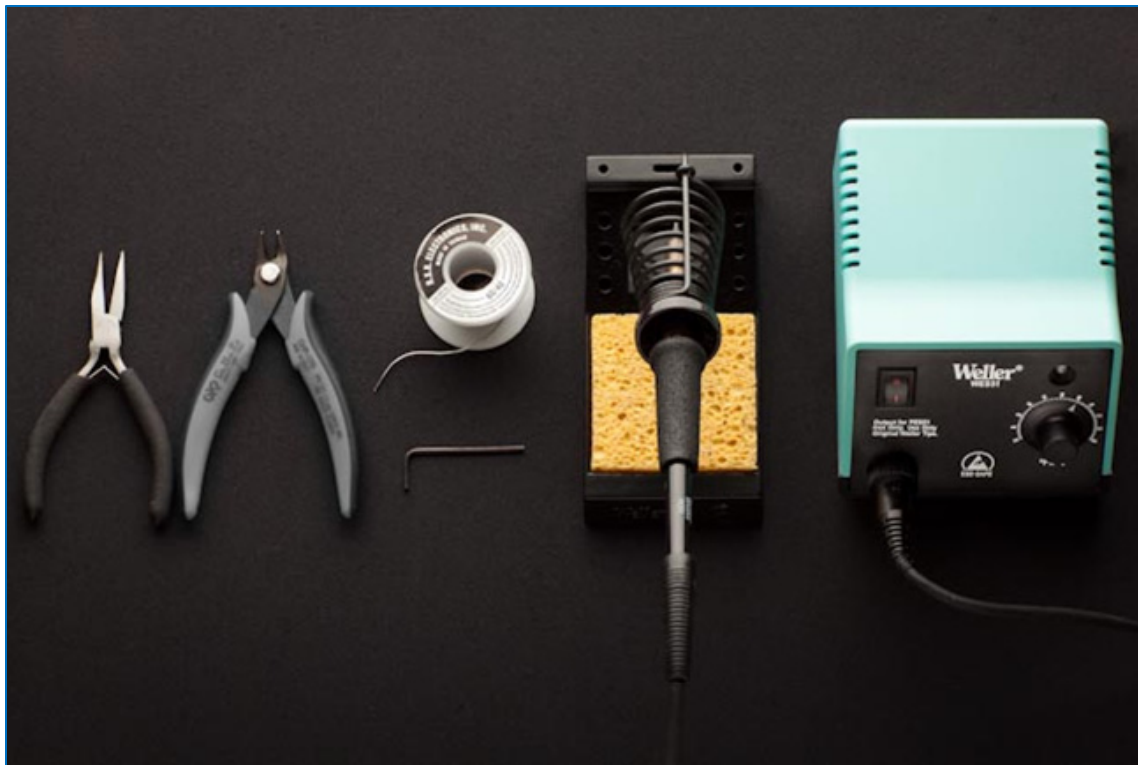
We assume that this is NOT your first soldering project. If it is, we suggest watching some training videos on the internet along with the purchase of a cheap learn-to-solder kit before getting started. A general rule of thumb is to heat the junction for two seconds and then apply a little solder. A little goes a long way and it's easy to add more if needed.

Triple check that your parts are in the correct place with the correct orientation (if applicable). While de-soldering is possible, it is troublesome, time consuming, and risky. Make it a goal that you will not have to de-solder in the course of making this clock.

After each step, evaluate the solder joints from the front and back of the board. On the back, the solder should be shiny and make a volcano shape, as opposed to a dome shape. On the front, you should see that the solder came all the way through the board. If it doesn't look good, try re-heating the joint until the plated-through-hole sucks up the solder. Strange Fact: Solder is attracted to heat and will move towards it, but gravity will usually prevent you from doing anything too interesting.

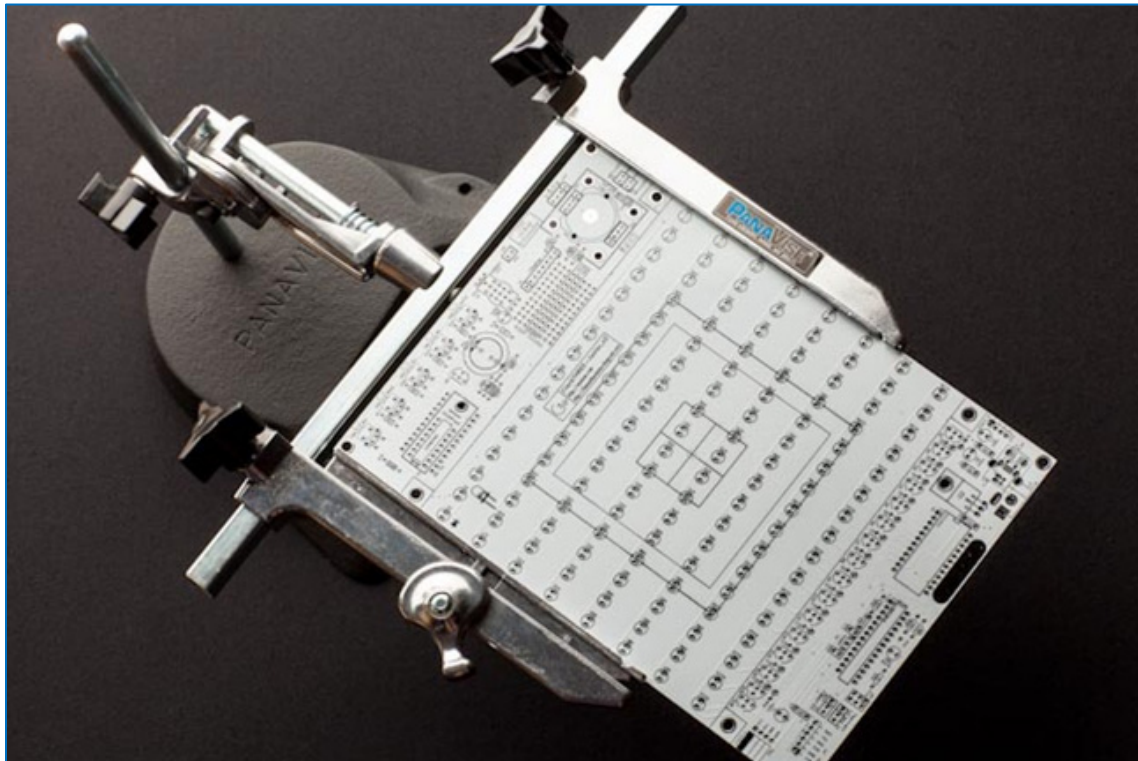
Check that the solder doesn't overlap into the neighboring parts as this will cause a short.

If you do make a mistake, don't panic. Use a solder sucker to remove the solder and pull the piece gingerly while applying heat. If you damage a trace in the process of de-soldering, send a picture of the damaged area and we will help you make the most of the situation. It may be possible to solder a piece of wire around the damage.



Required Tools

1. Needle Nose Pliers
2. Flush or Diagonal Cutters
3. Either 60/40 or 63/37 Rosin Core Lead Solder - .031" Diameter
4. Allen Wrench supplied with Kit
5. Quality Soldering Iron with regular and extra sharp tips



Optional Tools

6. A PanaVise Circuit Board Holder, or similar device, will make your life infinitely easier.

Kit Inventory



BT1 & BATTERY

Battery socket and LR2032
Coin Battery

3003K-ND & P189-ND



C1,C2,C8

100 μ F Capacitors (x3)

P833-ND



C3-7, C9-10

0.1 μ F Capacitors (x7)

399-5863-ND



D1-128, D258, D260

CREE 5mm LED (x130)

C535A-WJN-CU0V0231-ND



J1

USB Mini B Socket

H2960CT-ND



J1 CABLE

USB A to USB Mini B Cable

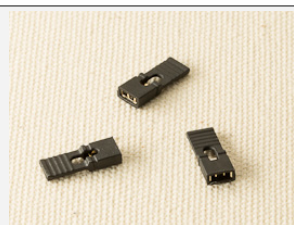
Q365-ND



K1, K2, K4, K5, P7

Header to be clipped into
appropriate sizes

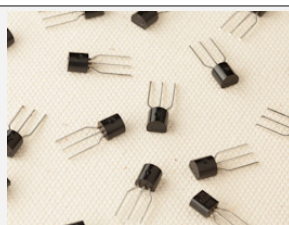
SAM1031-50-ND



JUMPERS

Jumpers for the K headers
(x3)

S9341-ND



Q1-17

Transistors (x17)

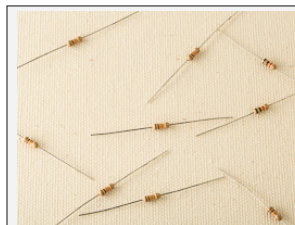
2N5401GOS-ND



R1-R16, R30

100 Ω Resistor (x16)
Brown, Black, Brown, Gold

CF18JT100RCT-ND



R17-19, R22-23, R31, R36-38

10,000 Ω Resistor (x9)
Brown, Black, Orange, Gold

CF18JT10K0CT-ND



R20,R21

4,700 Ω Resistor (x2)
Yellow, Purple, Red, Gold

CF18JT4K70CT-ND

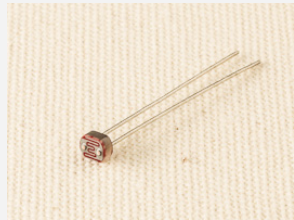
Kit Inventory



R24-26

1,000 Ω Resistor (x3)
Brown, Black, Red, Gold

CF18JT1K00CT-ND



R32

10K-100K Ω Photoconductive
Cell

PDV-P9007-ND



R33, R35

680 Ω Resistor (x2)
Blue, Gray, Brown, Gold

CF18JT680RCT-ND



R34

2,000 Ω Thumbwheel
Potentiometer

3352T-202LF-ND



SP1

Speaker

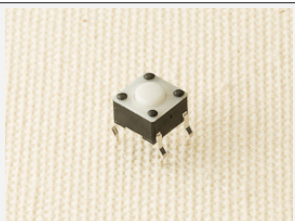
102-1169-ND



SW1, SW2, SW3, SW5

Long button tactile switches

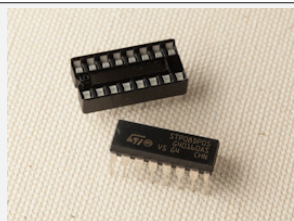
450-1644-ND



SW4

Short button tactile switch

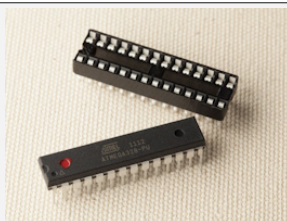
450-1649-ND



U1

16 Pin LED Driver and Socket

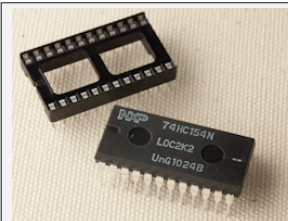
497-6271-5-ND & A100206-ND



U3

28 Pin ATmega328 Controller
and Socket

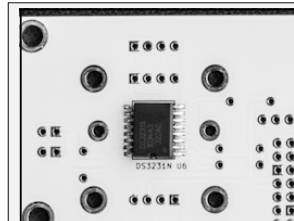
ATMEGA328-PU-ND & A100210_ND



U4

24 Pin IC Decoder/Demux and
Socket

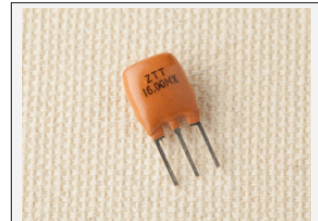
568-1407-5-ND & 3M5479-ND



U6

IC Real Time Clock - Surface
Mount

DS3231S#-ND

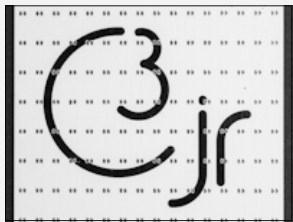


X1

16MHz Resonator with internal
capacitor

X908-ND

Kit Inventory



PCB1

Main Circuit Board

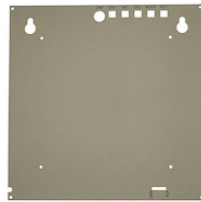
Custom Part



FRONT PLATE

Leave protective film on until
final steps

Custom Part



REAR PLATE

Leave protective film on until
final steps

Custom Part



BAFFLES

x17 Short Baffles
x9 Long Baffles

Custom Part



FRAME HARDWARE

x12 Hex Screws
x8 Nuts
x4 Cylinder Spacers
x4 Square Spacers
Hex Wrench

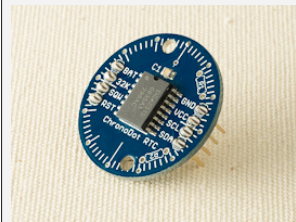
Optional Parts List



C11, C12, X1 ALTERNATE

18pF Caps (x2), 16MHz Crystal instead of Resonator, 3 Pin Socket

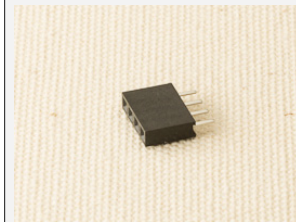
EvilMadScience.com - Search for Kit



CHRONODOT

Real Time Clock Module

Macetech.com - MTRTC001



CD1, CD2, CD3

4 Pin Socket - Used with I2SD (CD2/3) or ChronoDot (CD1/2)

3M9515-ND



FRAME

Ikea Ribba 9"x9" Wooden Frame

Ikea.com - 000.780.51



5V FTDI CABLE

USB A to FTDI Cable for Clock Programming - 5 Volt version

768-1015-ND



FTDI SOFTWARE

Install the Arduino Software on your computer to program the clock

<http://arduino.cc/>



J2

USB B Socket

ED2982-ND



J2 CABLE

USB A to B Cable

AE10620-ND



J3

2.5mm Barrel Socket

CP-002B-ND



J3 POWER

5 Volt Power Supply

T977-P6P-ND



P1

7 Segment 4 Digit Display

Sparkfun.com - COM-09766



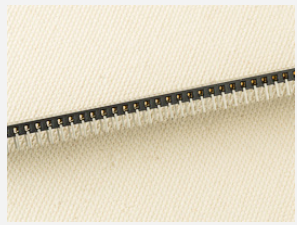
P13

ISP Header 3x2 Pin

SAM1095-36-ND

The Optional Parts List has been included to give our hackers a starting point if they want to go above, and beyond, what we have included with the kit. All items must be purchased separately by the customer. DigiKey.com part numbers have been noted for convenience when possible.

Optional Parts List



P41

4 Pin 90° Socket to Connect
Multiple Boards (STACK-L)

SAM1009-50-ND



P42

4 Pin 90° Header to Connect
Multiple Boards (STACK-R)

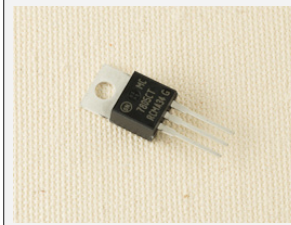
SAM1043-50-ND



SW1,SW2,SW3,SW4,SW5

Right Angle Switch for Top
Access

450-1657-ND

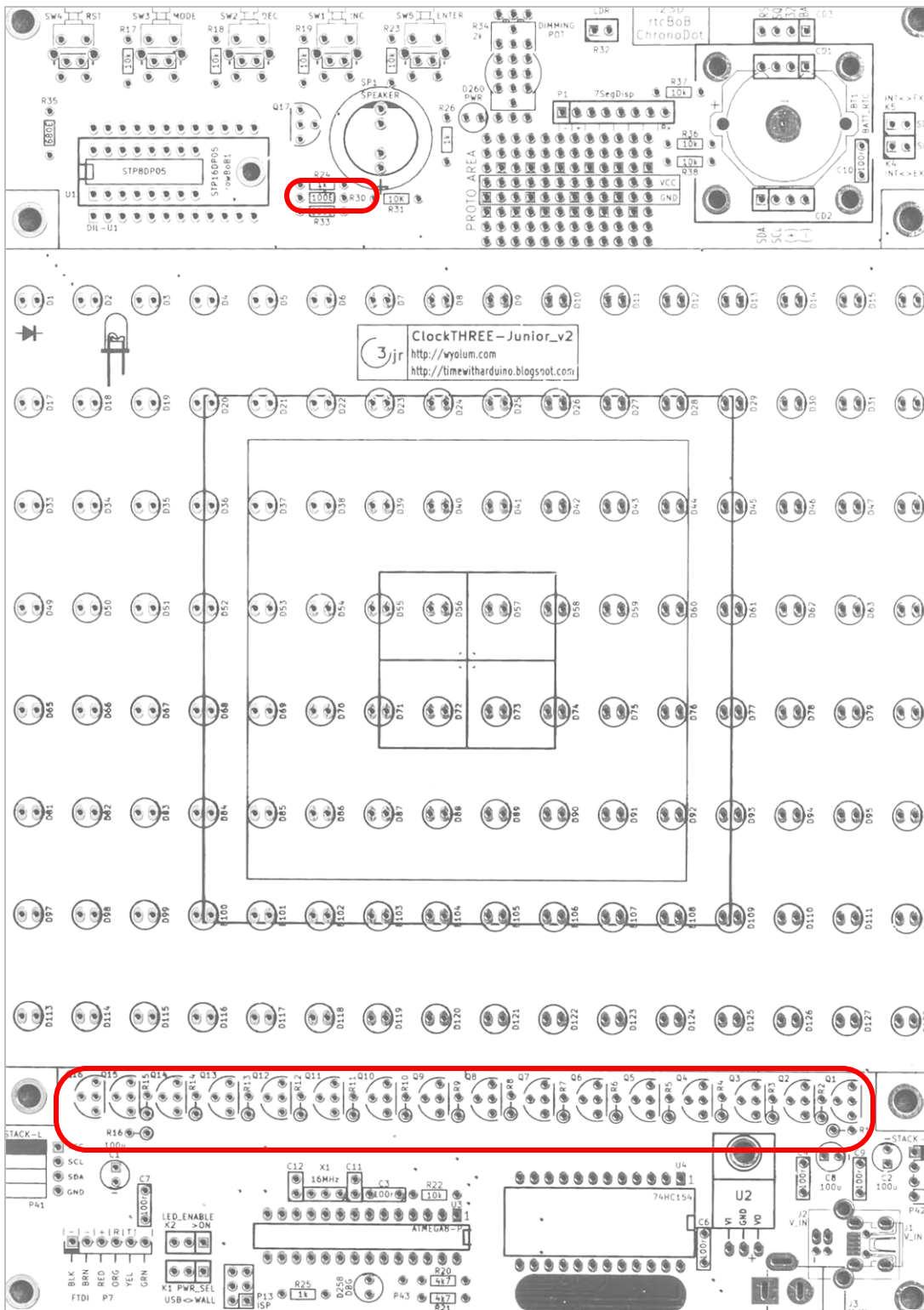


U2

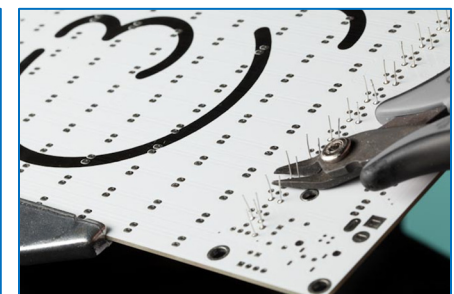
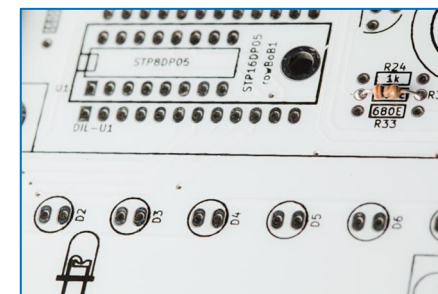
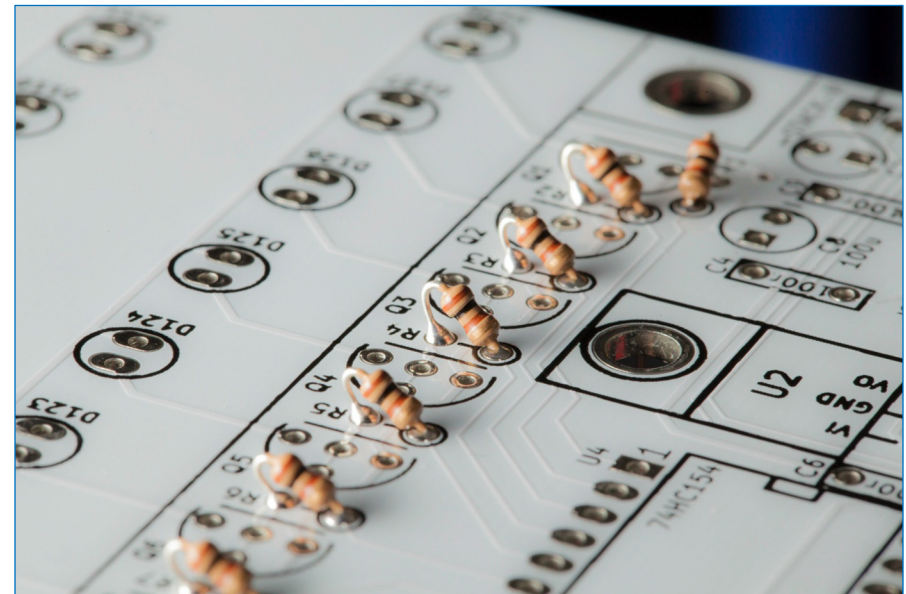
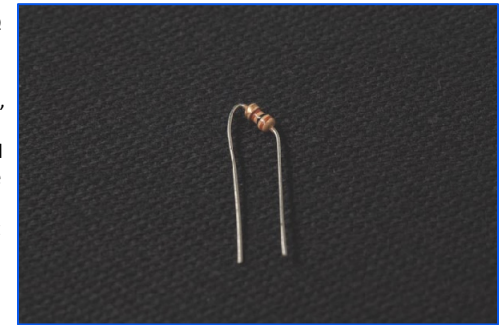
5v Regulator

MC7805CTGOS-ND

The Optional Parts List has been included to give our hackers a starting point if they want to go above, and beyond, what we have included with the kit. All items must be purchased separately by the customer. DigiKey.com part numbers have been noted for convenience when possible.



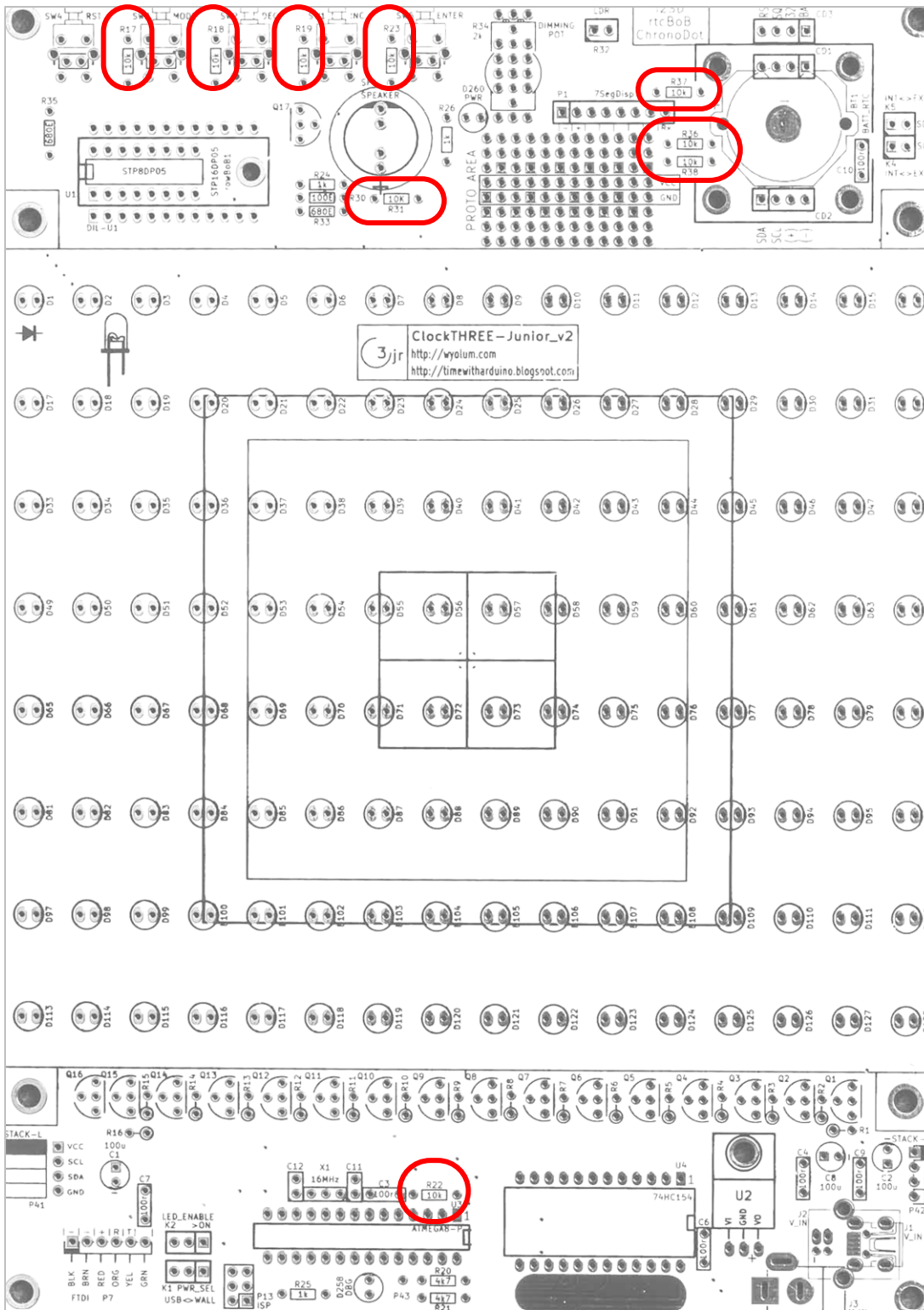
Start your assembly process with the 100 Ω Resistors (**Brown-Black-Brown-Gold**) located at **R1 - R16** and **R30**. The polarity (orientation) does not matter with resistors, but you will need to bend these in the manner shown so that they fit on the board properly in a vertical fashion. These are the only resistors that need to be installed vertically. To solder, you may bend leads at 45° angles, on the underside, so that they stay in place when you flip the board over.



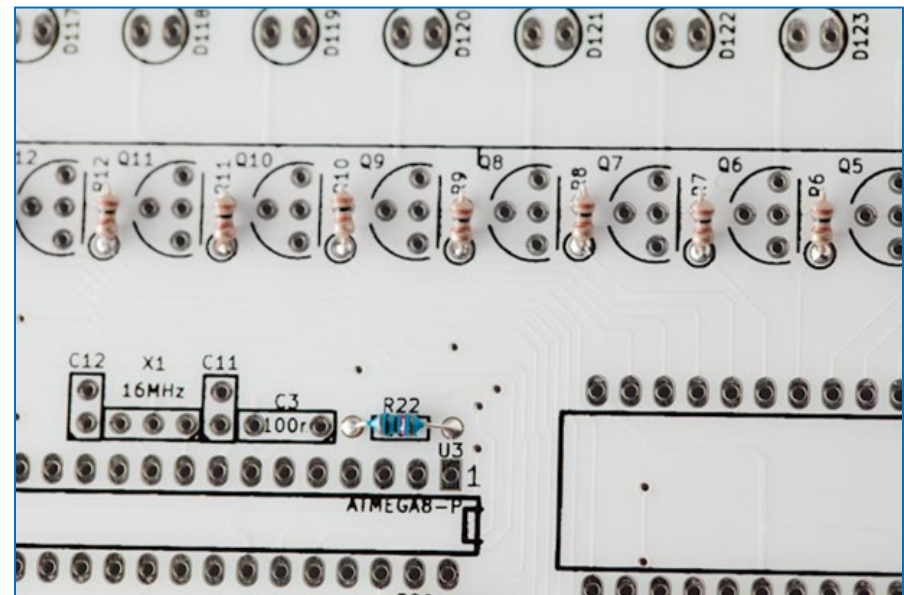
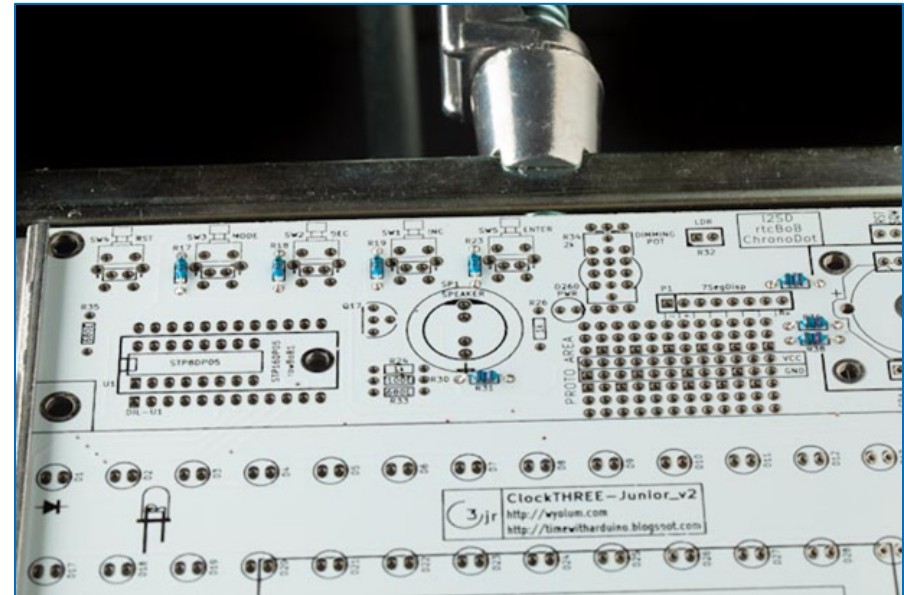
Follow these steps to build your clock!

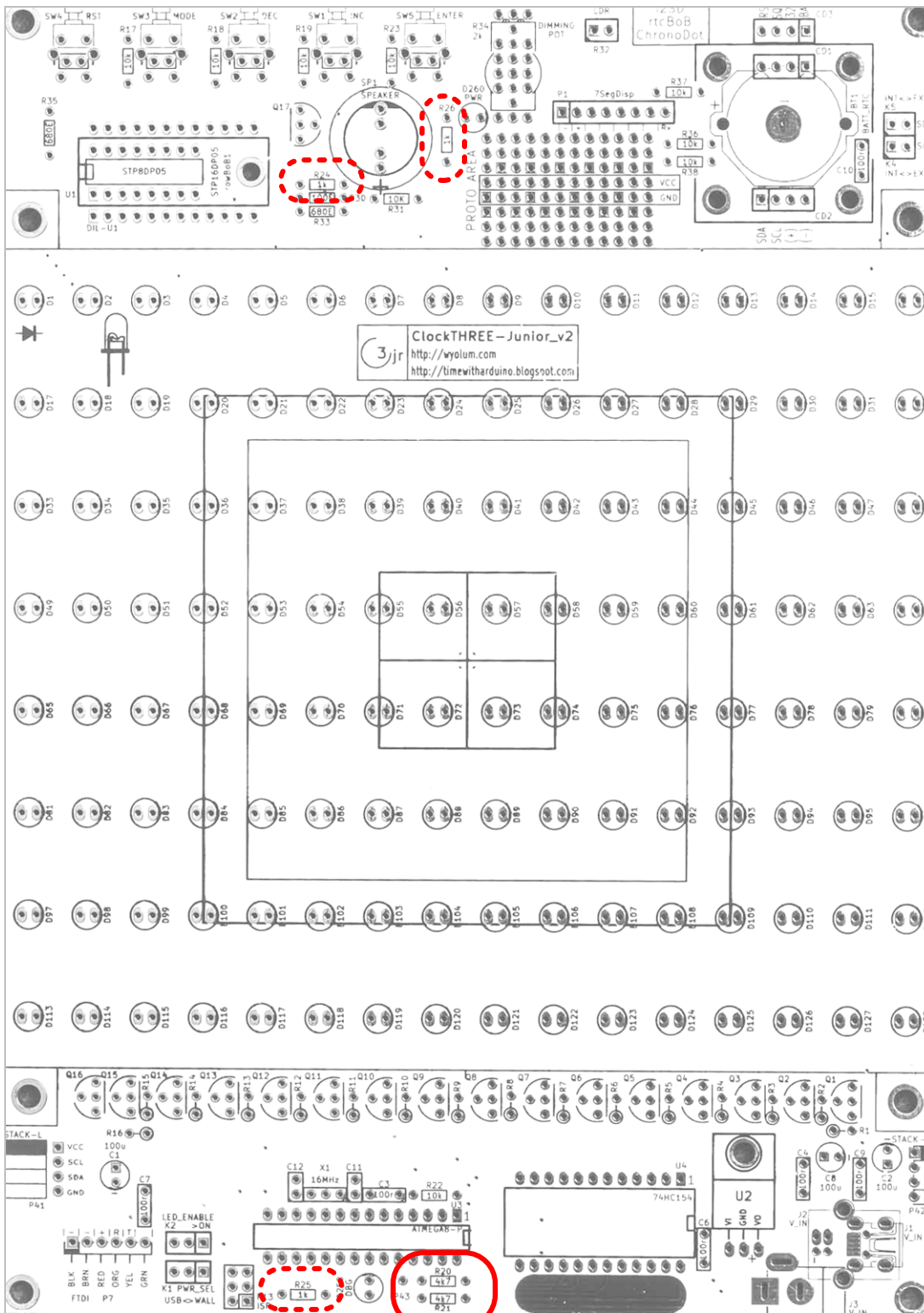
Step 1

100 Ω Resistors

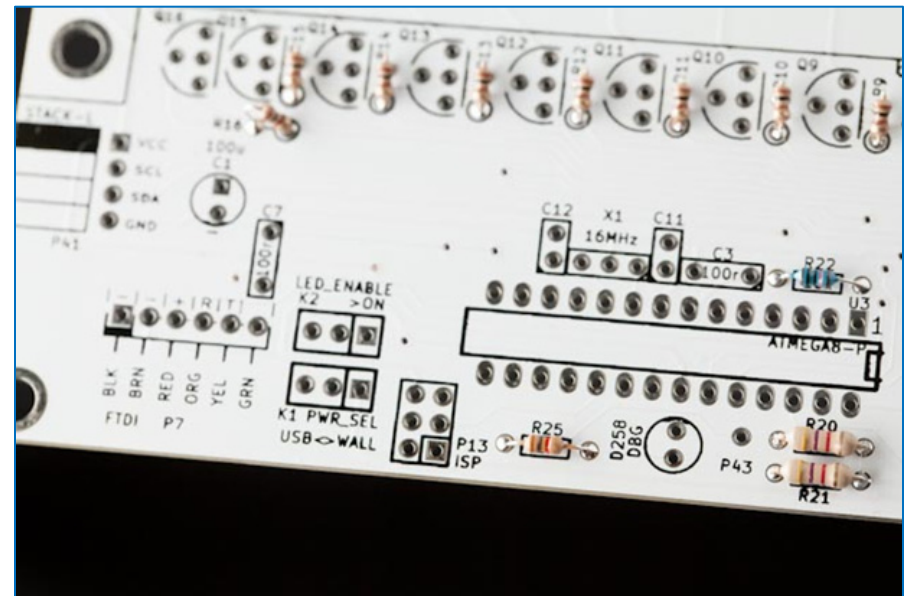
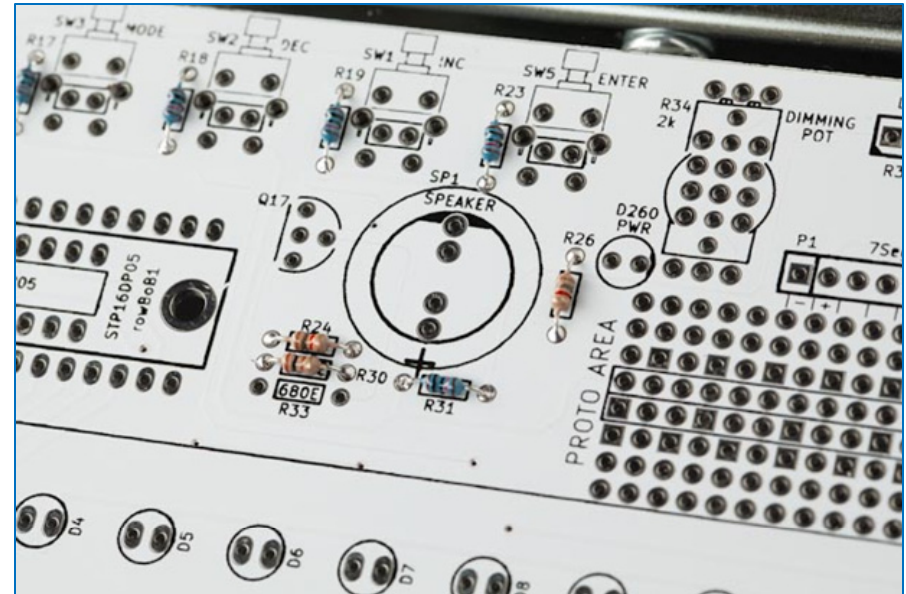


Now we move on to the 10,000 Ω Resistors (Brown-Black-Orange-Gold) located at R17, R18, R19, R22, R23, R31, R36, R37, and R38. While the photo shows resistors with a blue surface color, you will likely receive brown. These are some spares that were lying around waiting on a fun project!

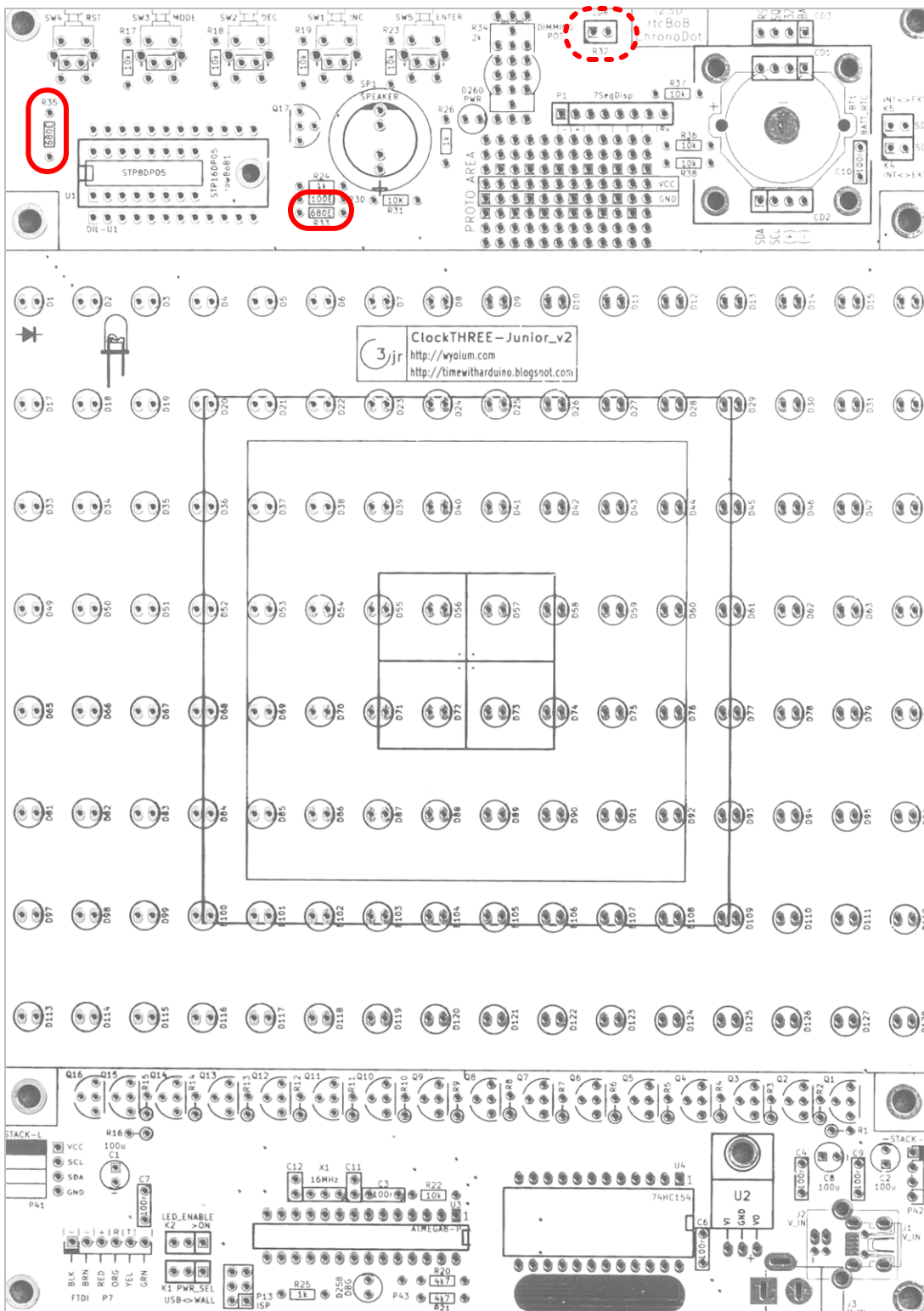




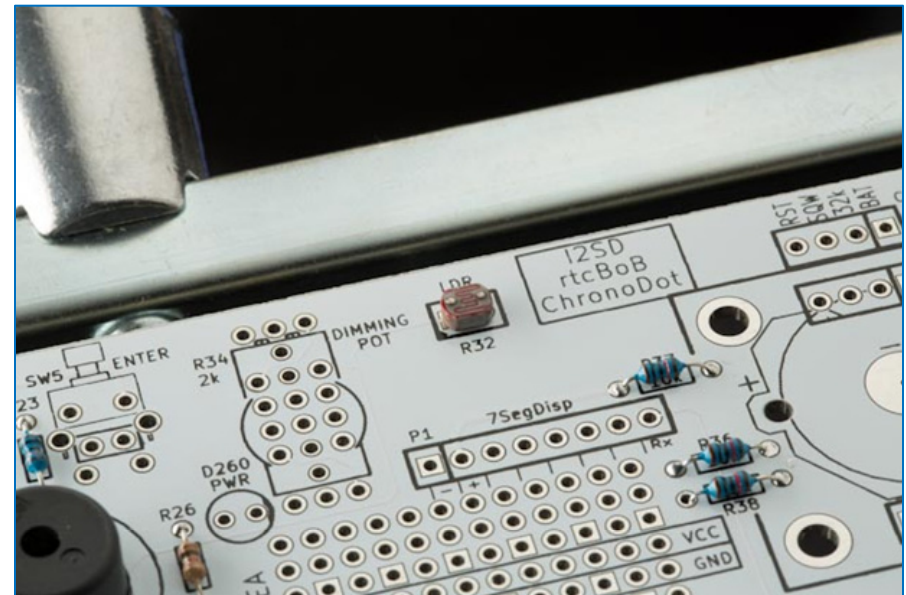
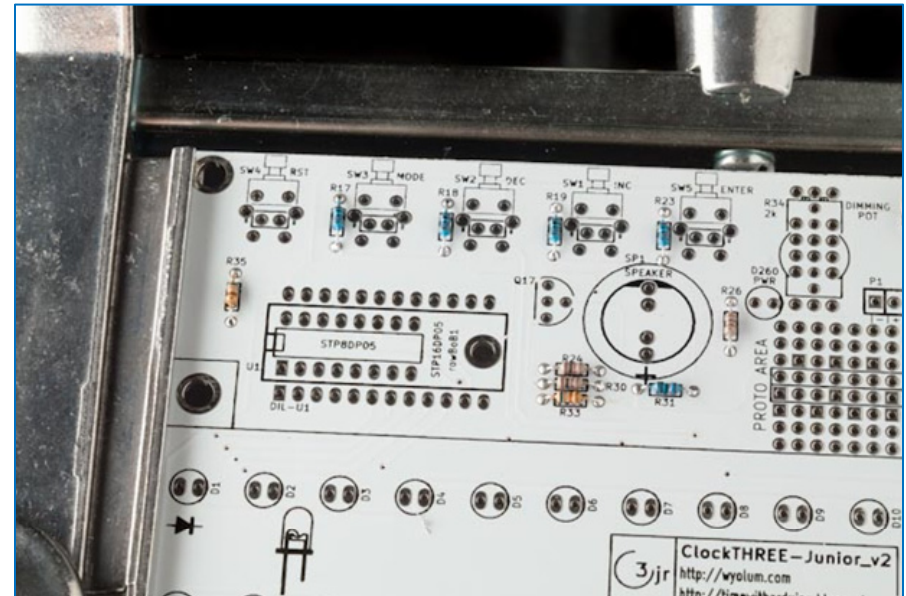
Next are the 4,700 Ω Resistors (Yellow-Violet-Red-Gold) located at R20 and R21 followed by the 1,000 Ω Resistors (Brown-Black-Red-Gold) at R24, R25, and R26.



Step 3
4700 Ω and 1000 Ω Resistors

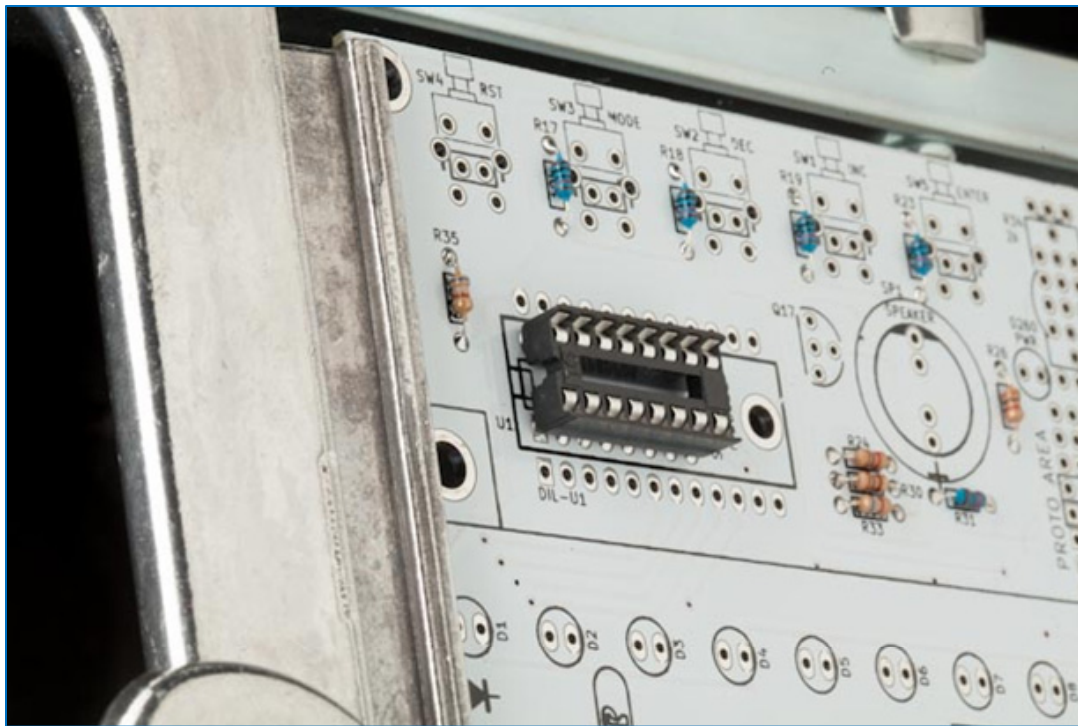


We finish up the Resistors with two 680 Ω (**Blue-Grey-Brown-Gold**) located at **R33** and **R35** along with the **LDR** (Light Dependent Resistor) at **R32**. While the LDR comes with the kit, it is not functional at this time and may (or may not) be supported in future software releases. We really just wanted to give Makers something to tinker with.



Step 4

680 Ω and LDR Resistors

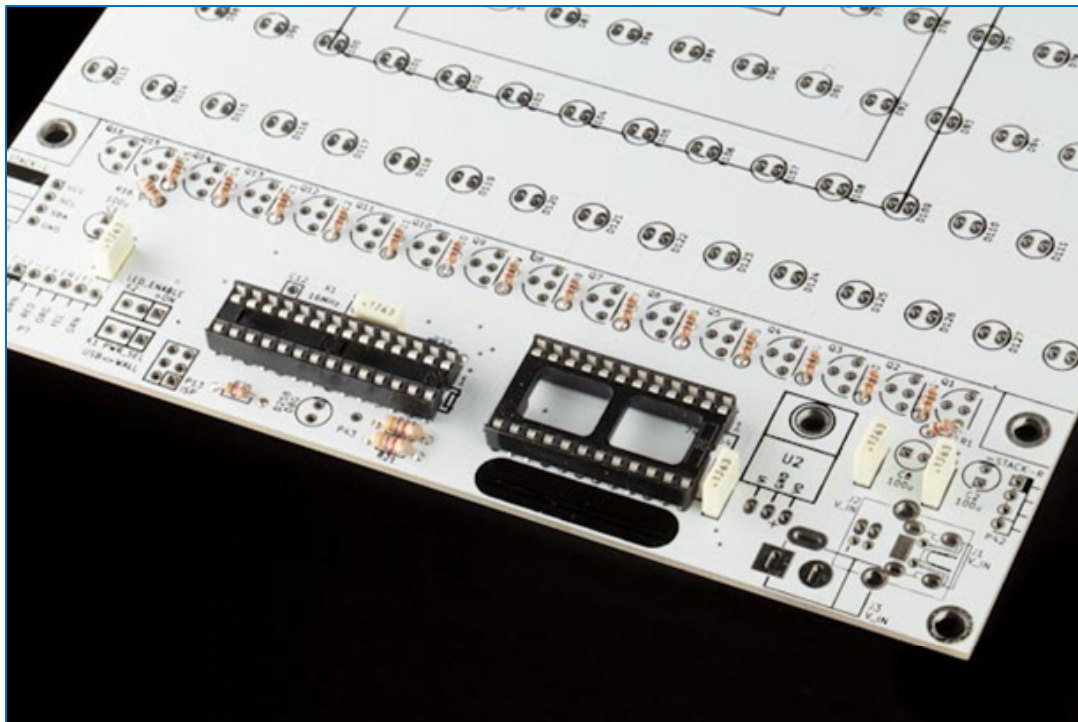


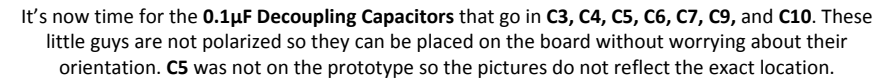
The IC (Integrated Circuit) Sockets are next in the assembly process. The chips and sockets are polarized – Please make sure to align them correctly with the legends on the board indicating indentation positions. If you happen to solder one of the sockets in backwards, don't fret... just make sure to plug the chip in with the notch in the correct position.

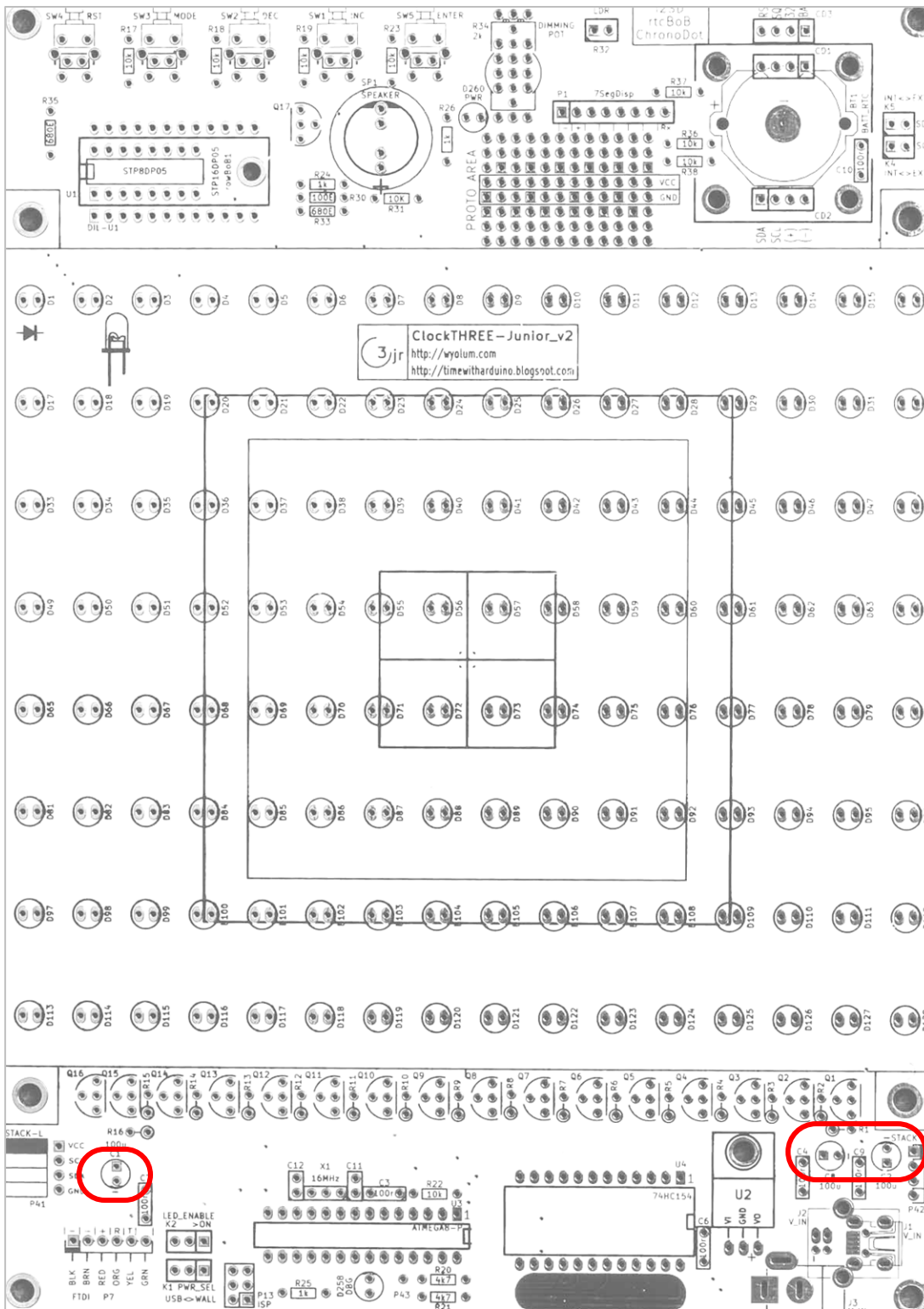
U1 – 16 Pin for Row Driver **STP8DP05**
U3 – 28 Pin for **ATMega328** Processor
U4 – 24 Pin for Column Driver **74HC154**

You may find it easier to solder the sockets after applying tape to hold them in place.

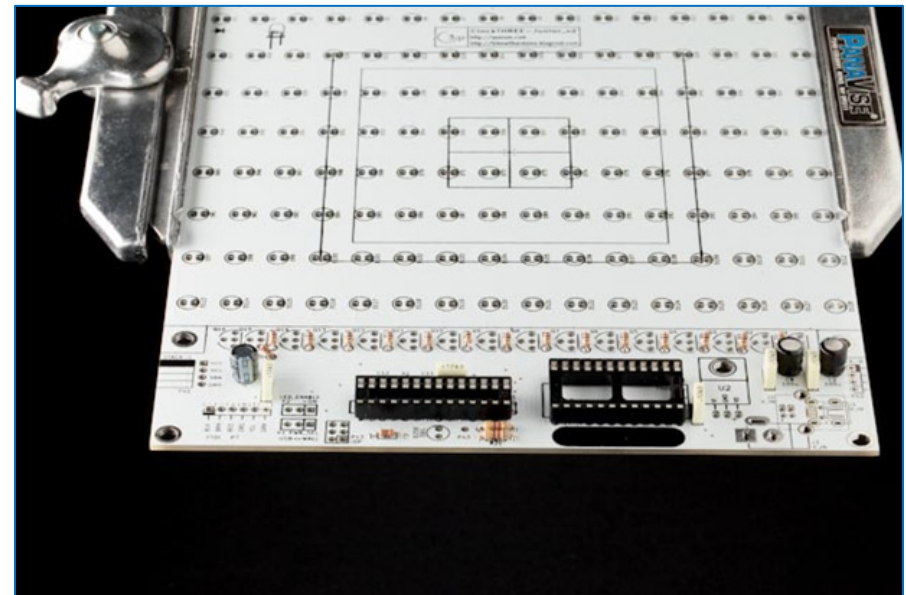
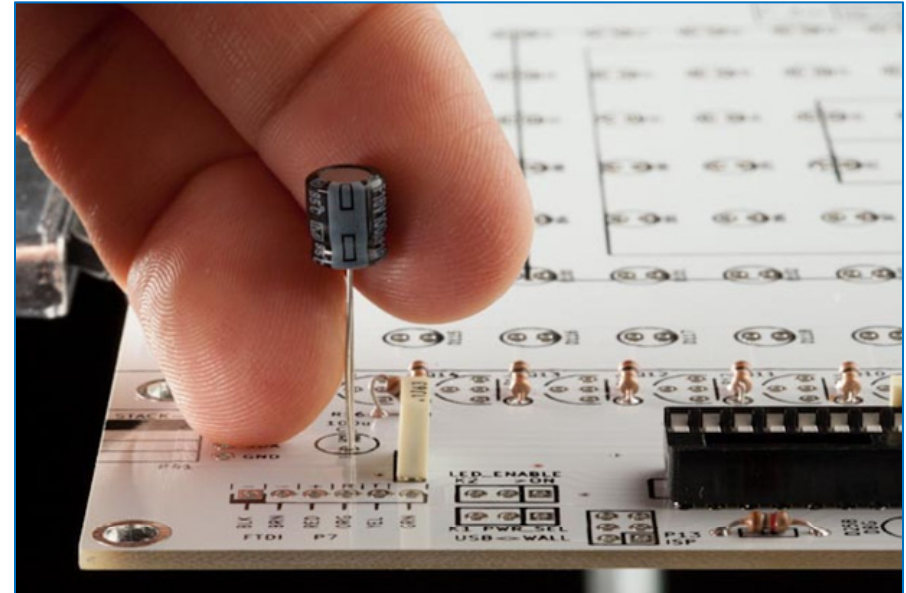
Note: Do not install the IC's into their sockets right away. It's far safer to wait until we're ready to test the board, towards the end of this manual, due to the risk of ESD (Electrostatic Discharge).



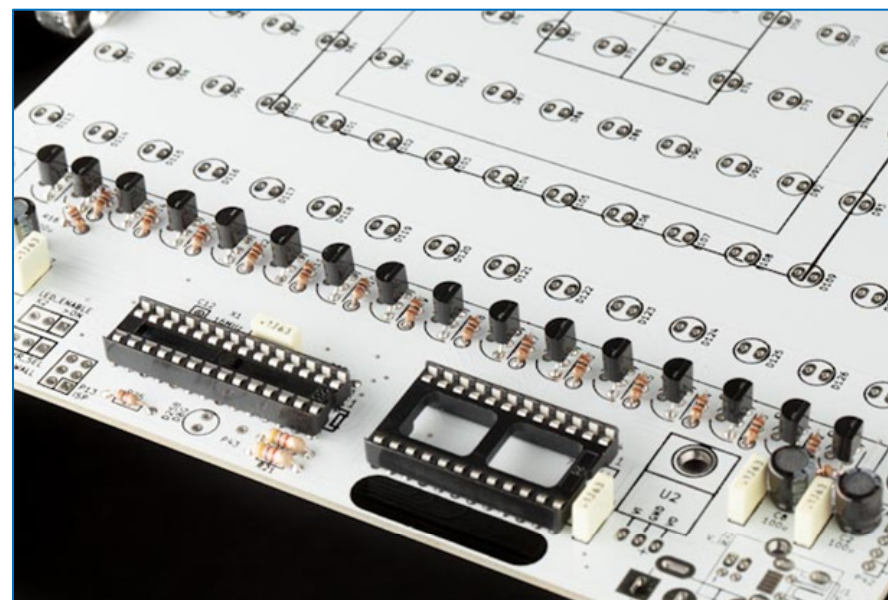
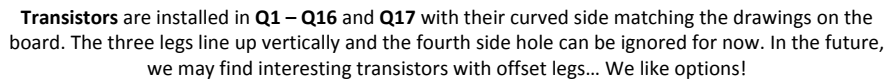




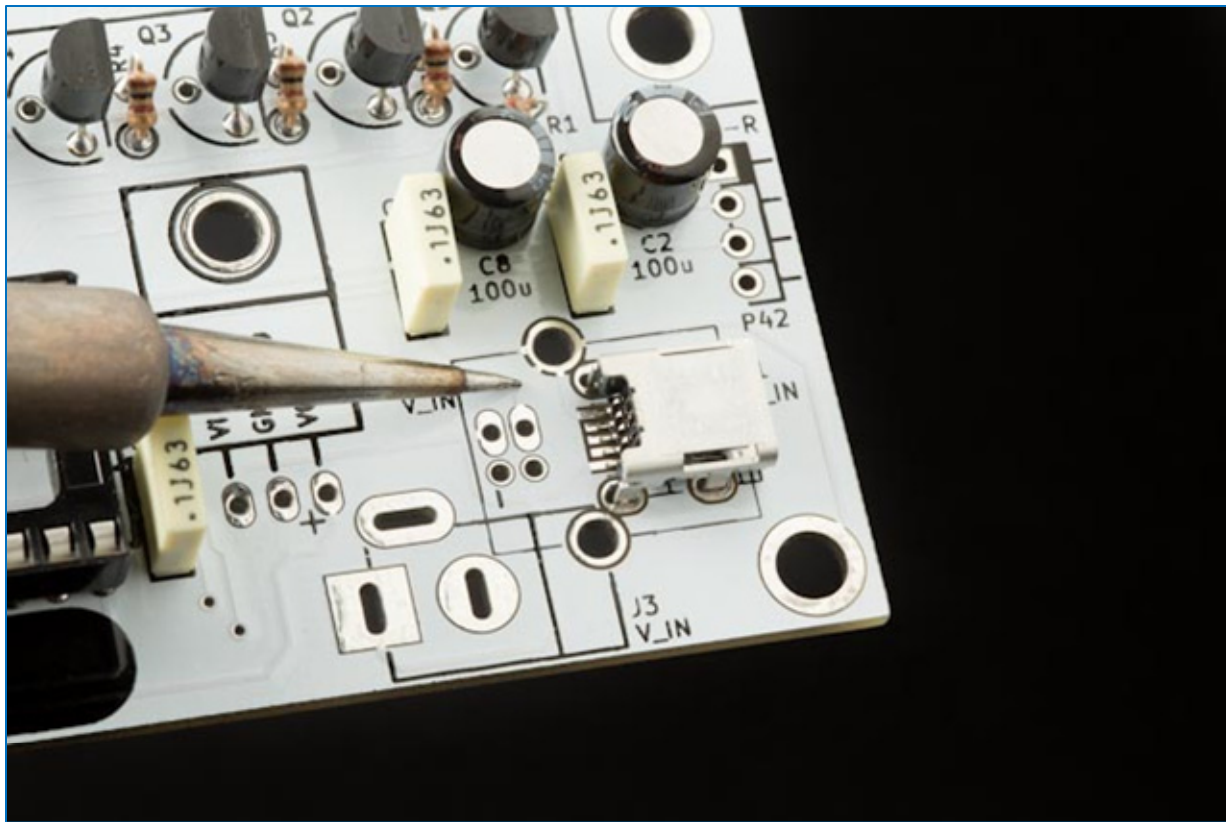
The **100µF Capacitors** located at **C1, C2, and C8** are the last to be installed. These are polarized so the board has been marked with a symbol (-) on the negative side. The negative side of the Capacitors is easy to discern by the stripe. The positive lead is also longer than the negative to help out even more.



Step 7
100µF Capacitors



Transistors



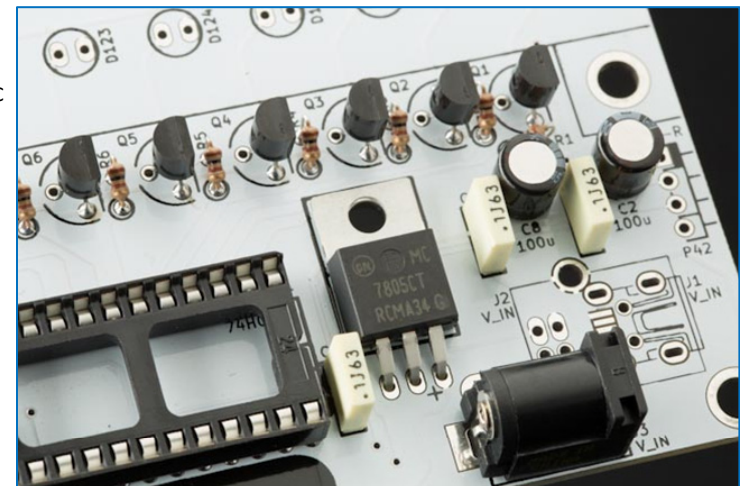
Next, we'll give our clock a **Power Source**. The kit will include **J1**, a **Mini USB socket**, that needs to be carefully soldered onto the board. We suggest using the sharpest possible tip for your iron due to the delicacy of the surface mount connection.

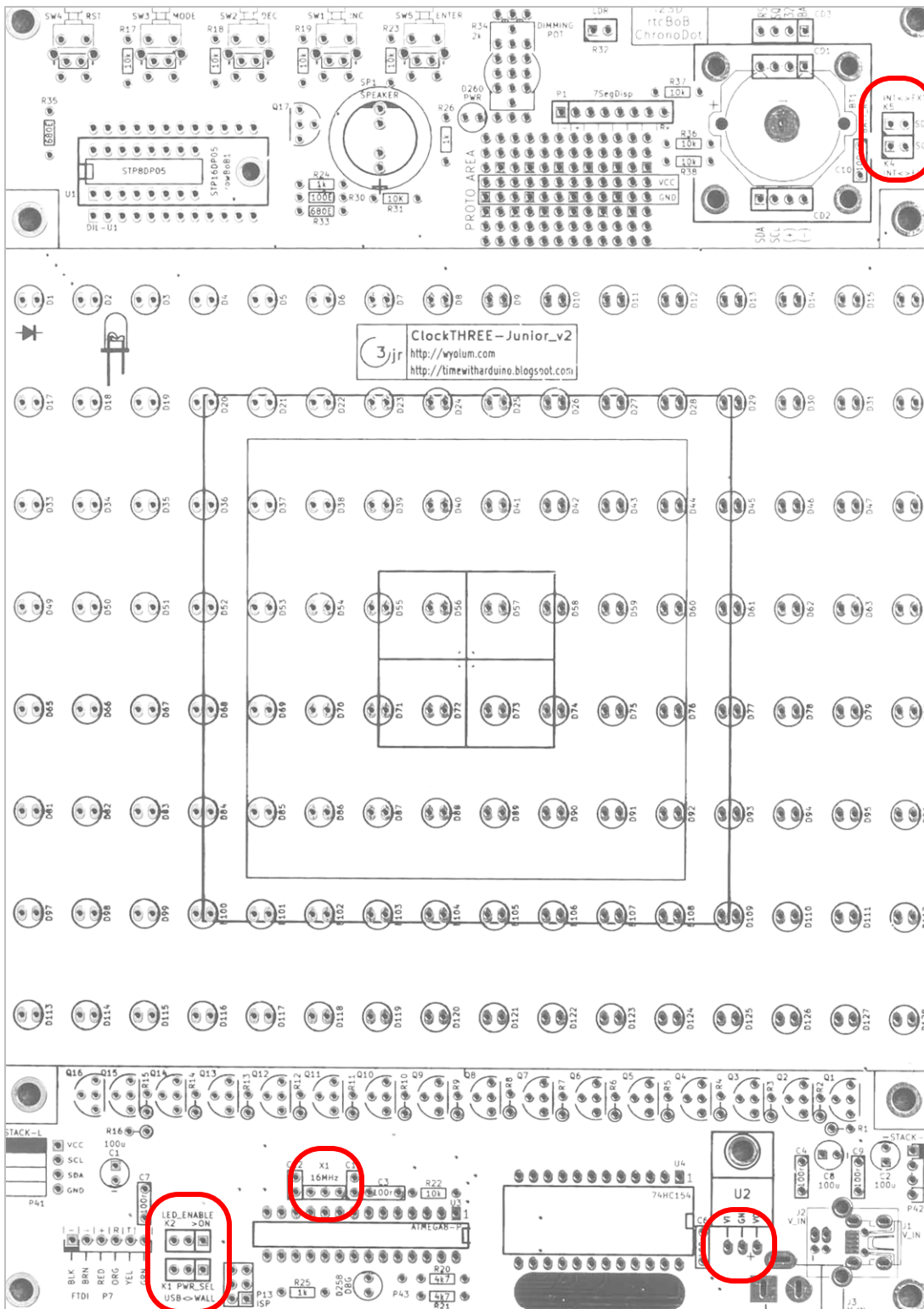
If you choose to purchase a **J2 (USB B socket)** from the optional parts list, you would place it on the board in the orientation shown below.



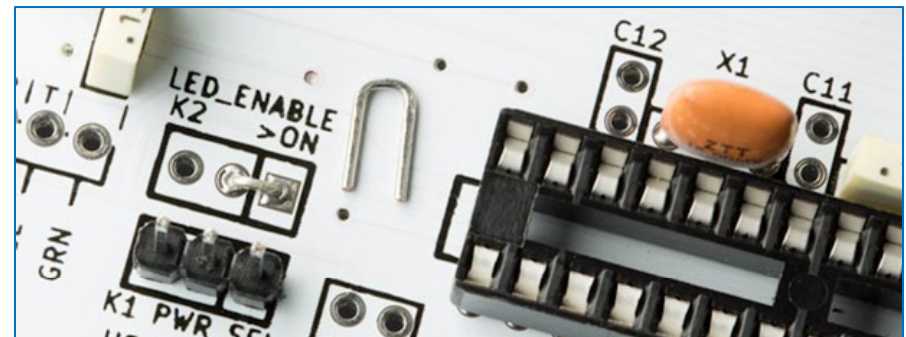
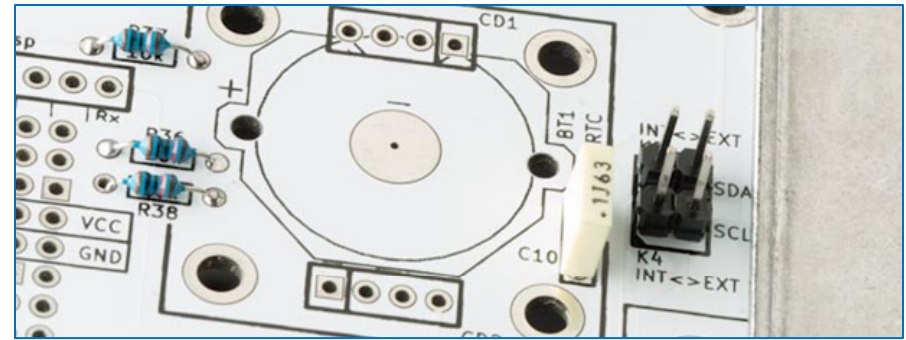
The last power option available to you is through a standard DC power supply. You can purchase **J3** (the **2.5mm Barrel Socket**) separately from the optional parts list along with a 5v power supply.

We highly recommend that you also install **U2 (5v Regulator)** when using **J3** to prevent the destruction of your board. With the 5v Regulator, we recommend using a 9v – 12v power supply... a lower voltage won't power the board... a higher voltage isn't recommended unless heat sinks are used (Don't start any fires!). The 5v Regulator will help to ensure that your clock doesn't go boom if you accidentally plug in the wrong wall wart.

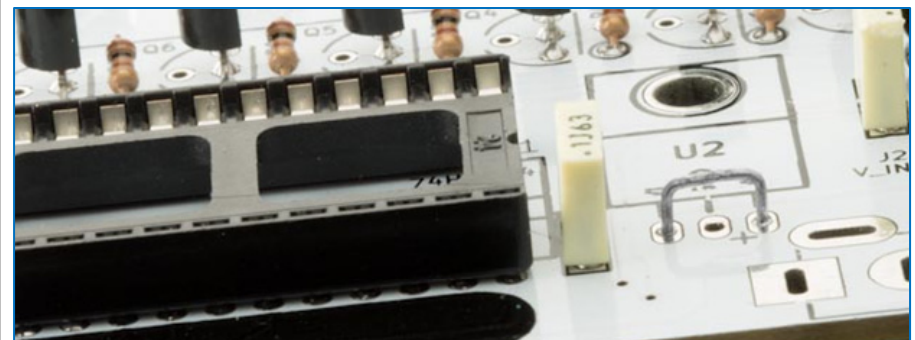


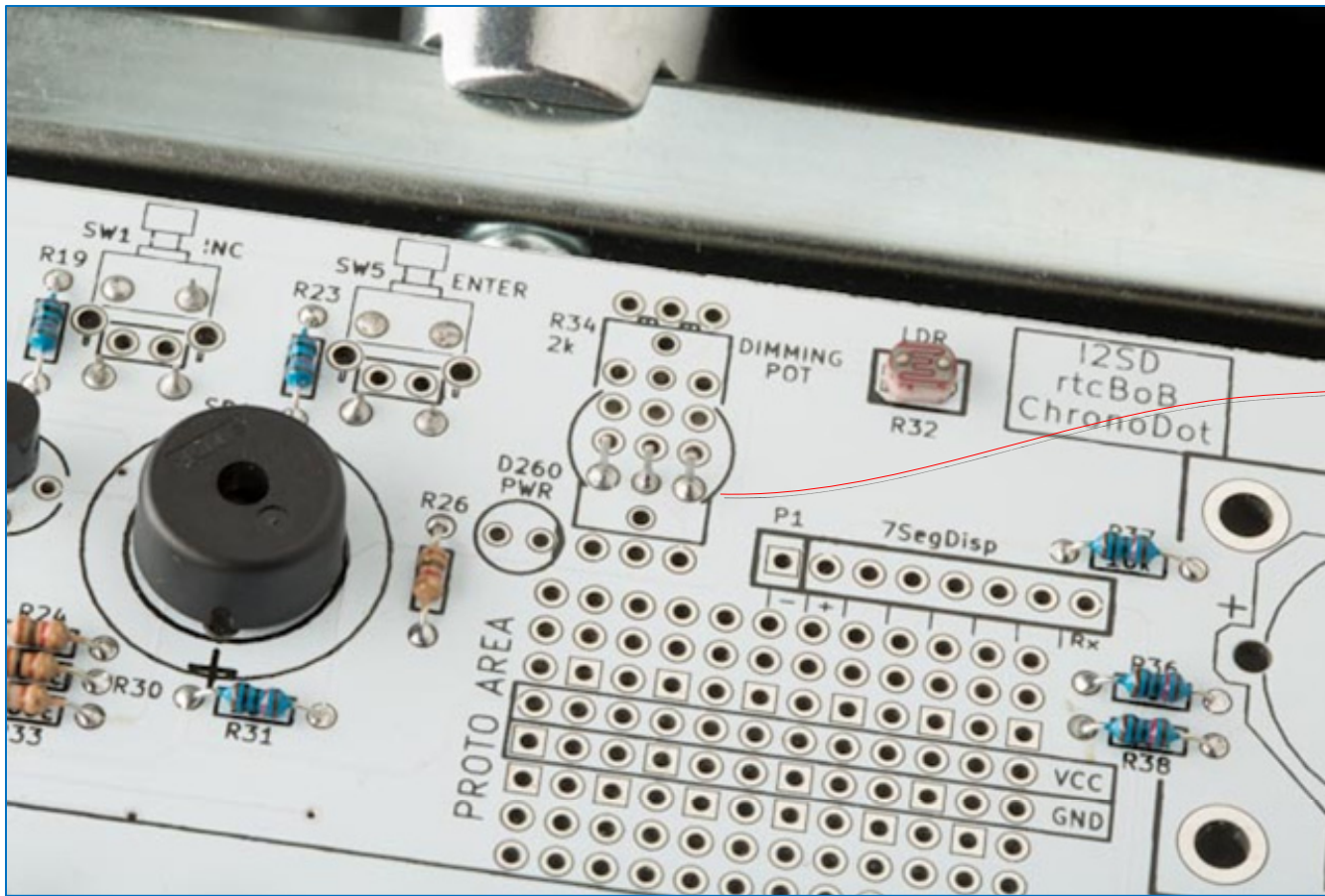


The jumpers are next in line for installation. You may receive many male header pins on a strip, or you may get the header pins already broken up in 3's and 2's. **K1** requires a **3 Pin Male Header** with a **Jumper** to switch between getting power from the options (J1, J2, or J3) on the bottom right side of the board (Wall)... or getting power from the FTDI connection (P7) on the bottom left side of the board (USB). For **K2**, solder in a wire to create a permanent link – see photo... any wire will do. **K4** and **K5** each require a **2 Pin Male Header** and both need a **Jumper** with the stock kit. If you decide to use a different RTC, like the I2SD, rtcBoB, or ChronoDot, you would remove the jumpers. While here, please solder on the 16MHz **Resonator** - **X1**. It's not polarized and can go in either way.

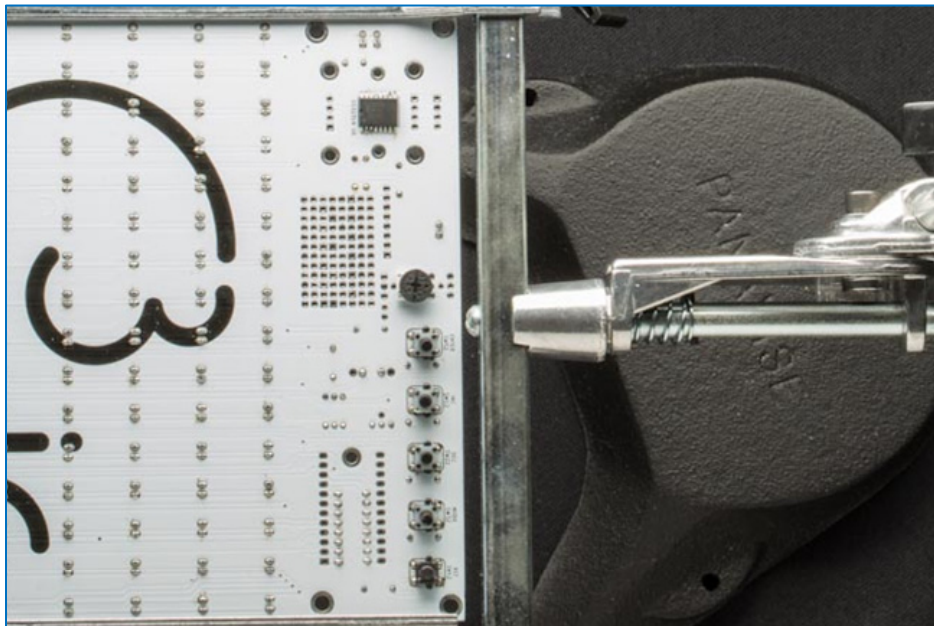
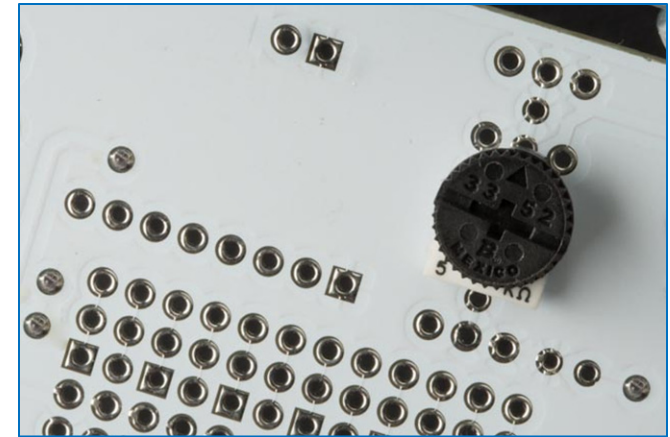


The last jumper is permanent like K2. **U2** requires a **Jumper** between VO and VI unless you install the 5v Regulator... in which case, the Jumper would not be needed. Once again, you may use some scrap wire, or even a heavy staple, as the jumper.





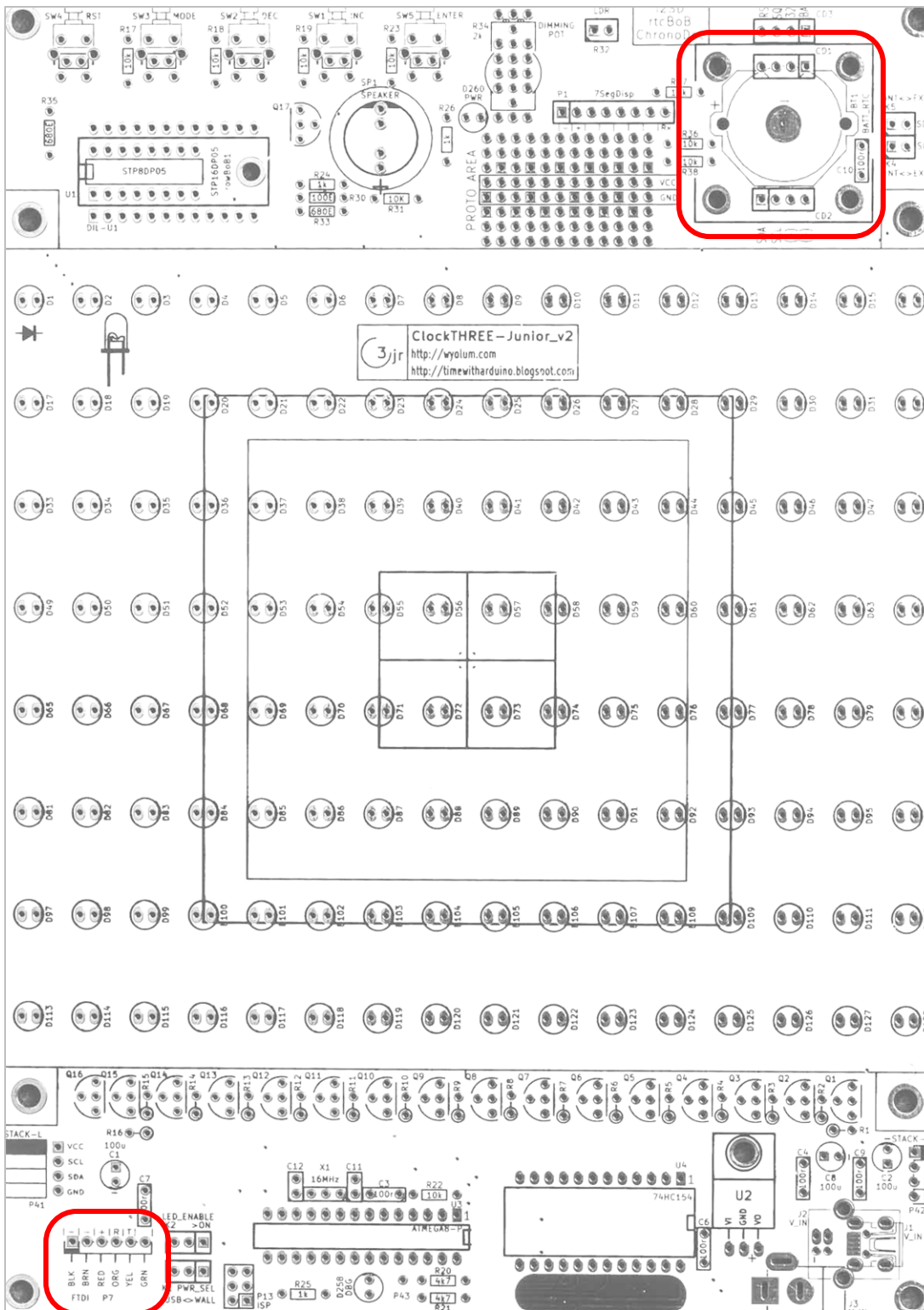
Start this step by soldering in the **Speaker** at **SP1**. Polarity is shown on the board in case you want to upgrade your horn, but it's not important with the kit speaker. Next is the **Thumb Wheel Potentiometer**, which controls the LED brightness, at **R34**, and this part goes on the back side of the board. Make sure you line the holes up just like the photo to the left.



Just past the Potentiometer, on the back of the board, are places for all of the **Switches**. **SW1, SW2, SW3** and **SW5** have longer buttons and the **SW4** Reset Switch has the shorter button. These switches will pop into the board when you press on them, which keeps them in place for soldering.

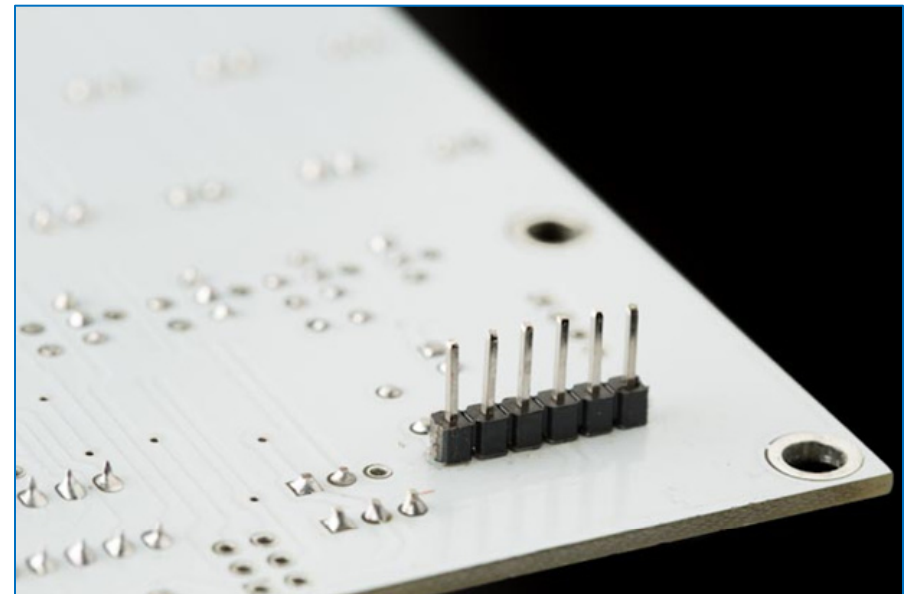
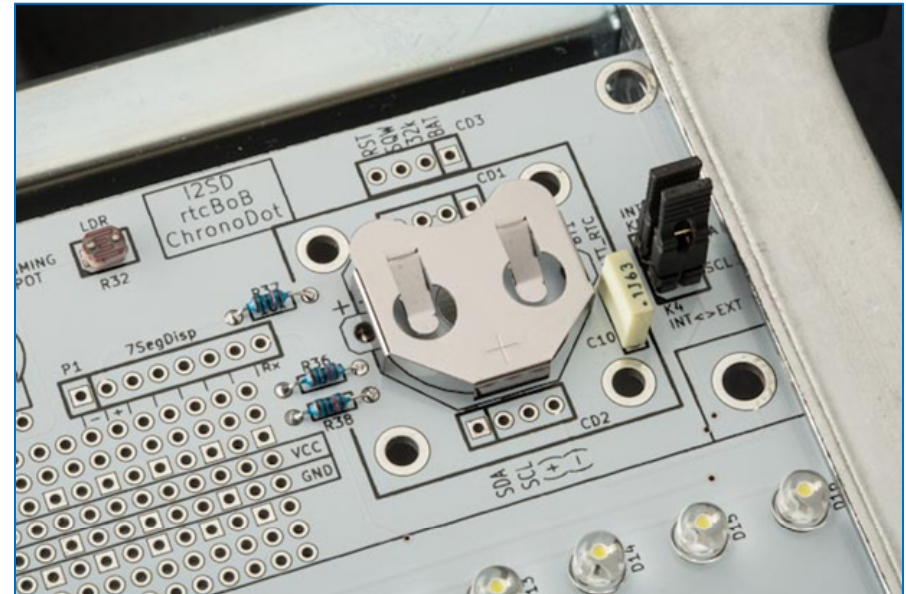
Step 11

Speaker, Potentiometer, and Switches



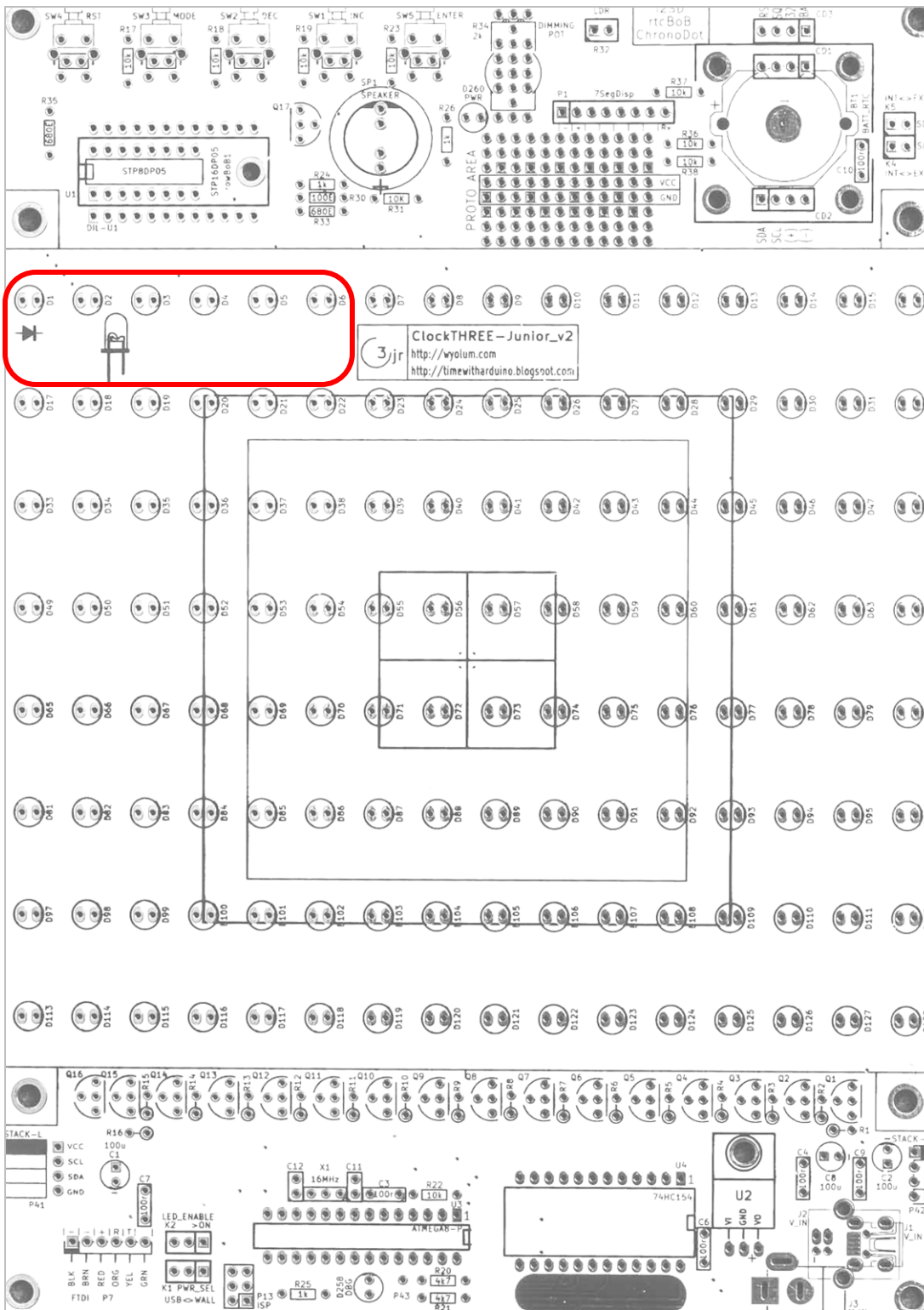
The kit comes with a DS3231 Real Time Clock (RTC) located on the back side of the board at U6. Since it is a little tricky to solder, we've taken care of that for you. The DS3231 does need the **Coin Battery** and **Battery Socket** located at BT1, so please solder that in now. You may want to give the socket a little extra solder for strength, but do not solder, or heat, any part of the battery.

The 6 Pin **FTDI Header** at P7 rounds out this step and it is mounted on the back of the board just like the switches. This will allow a connection to your computer to program the board, should you want to explore.



Step 12

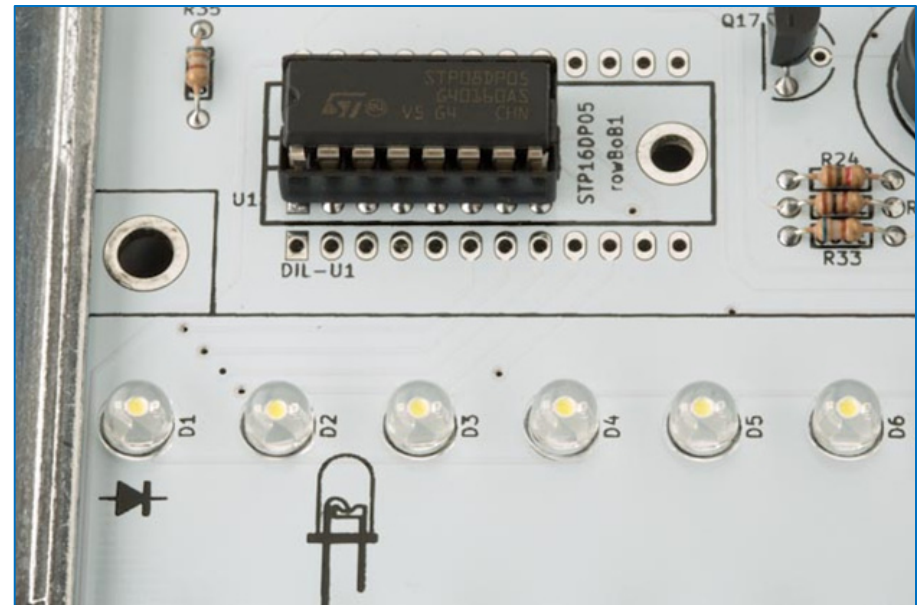
Battery and FTDI Connection



We're almost to the finish line, but first we need to test out the environment before we solder in a bunch of LED's. Let's do a "Smoke Test" by only soldering in the first 6 LED's at **D1 – D6**. These 5mm Cree LED's have a long positive lead which goes into the left hole as the drawing on the board points out. When you've finished with these 6 LED's, go ahead and carefully plug in the chips at **U1, U3**, and **U4** making sure the notch on the end is in the correct orientation. If the legs don't line up vertically in the socket, try rolling the chip slowly on a flat surface to bend all of the legs together at once so that they straighten out. Always take your time with IC's as they are easy to mangle... and not easy to replace.

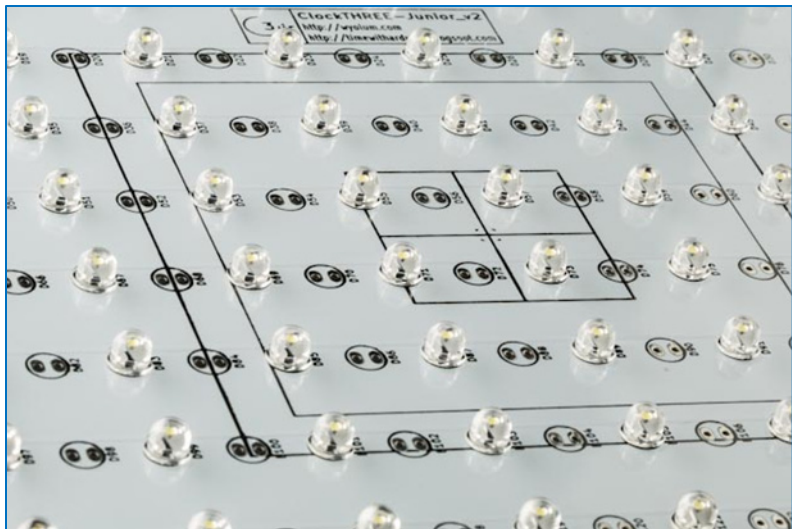
Also make sure that you have placed a plastic jumper on the header at K1 to select "WALL" and that you have soldered the permanent wire at K2 to enable the "ON" position. Once you have double checked everything, take a deep breath and power up the board! Depending on your language, some of the lights will come on (English – D1, D2, D4, and D5). If everything worked out, take a moment to smile and give yourself a big pat on the back!

If the LED's aren't happy, don't worry! Shoot an email to << info@wyolum.com >> before soldering the rest of the LED array. We can help!



Step 13

Smoke Test!



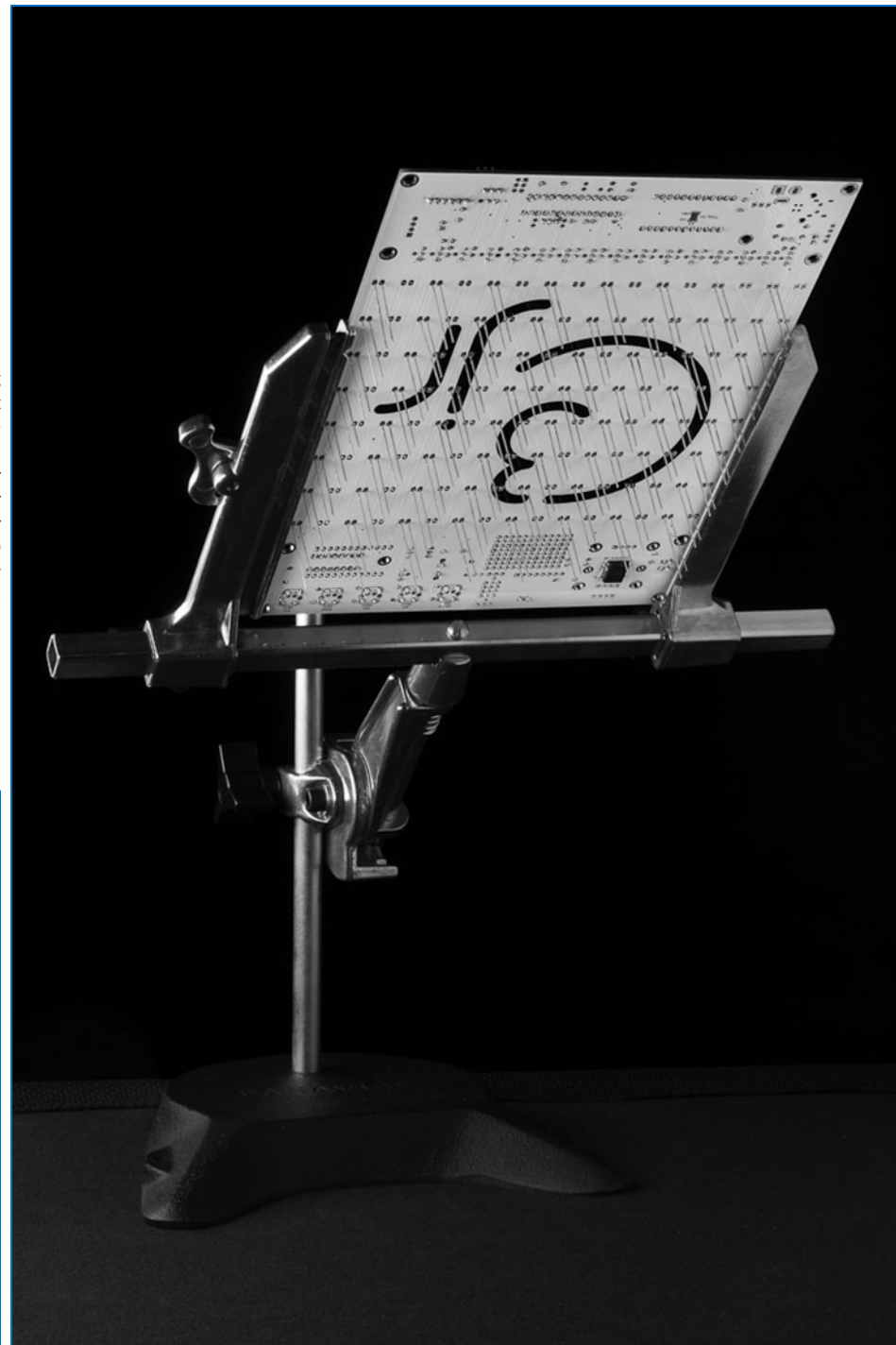
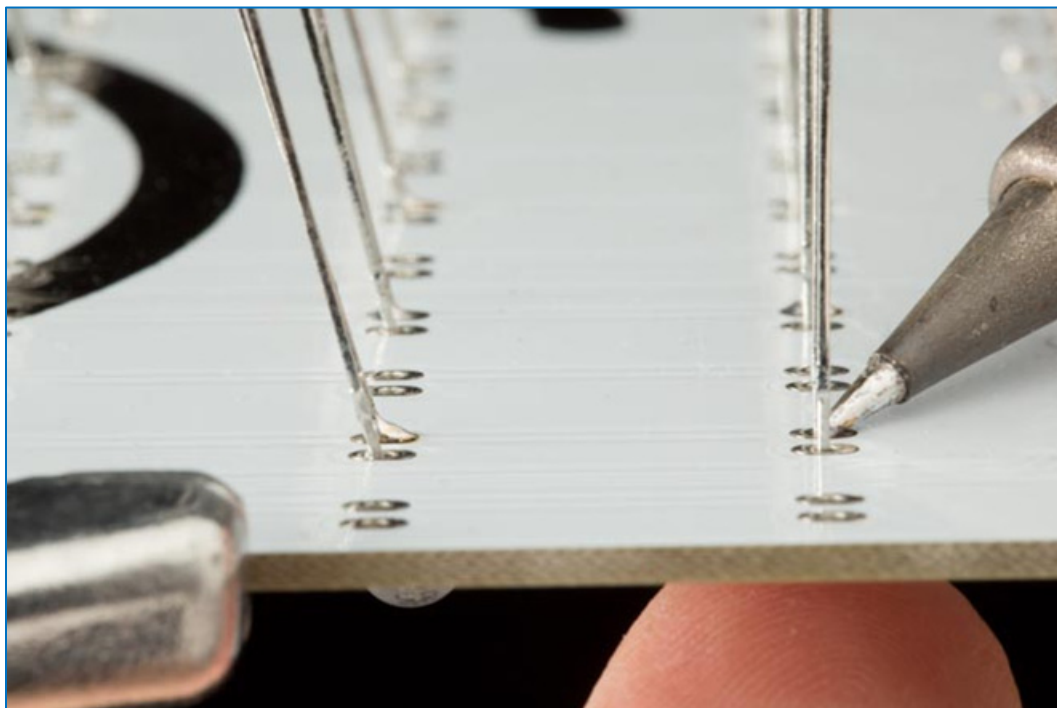
You're probably trying to figure out how to solder on the rest of the LED's in the shortest amount of time. We've found the fastest way to install the LED's is with this two step process:

1. Solder every other row simultaneously as a group
2. Solder in the rest.

The challenge is doing the job without bending the leads since that can turn into spaghetti. Adjust your board to a 45° angle (or higher) and only solder in one leg of each LED to keep them stable for the flip.

After you flip the board over, heat up the leg you soldered and use your finger to push each LED flush against the board so that the legs point straight up. Once you have them all straightened out, it's just a matter of soldering in the other leg and cleaning up the original if needed. You might be surprised at how quickly this can flow once you get the hang of it!

Applying too much heat may cook your LED's (and your finger!) so try to use as little as possible.

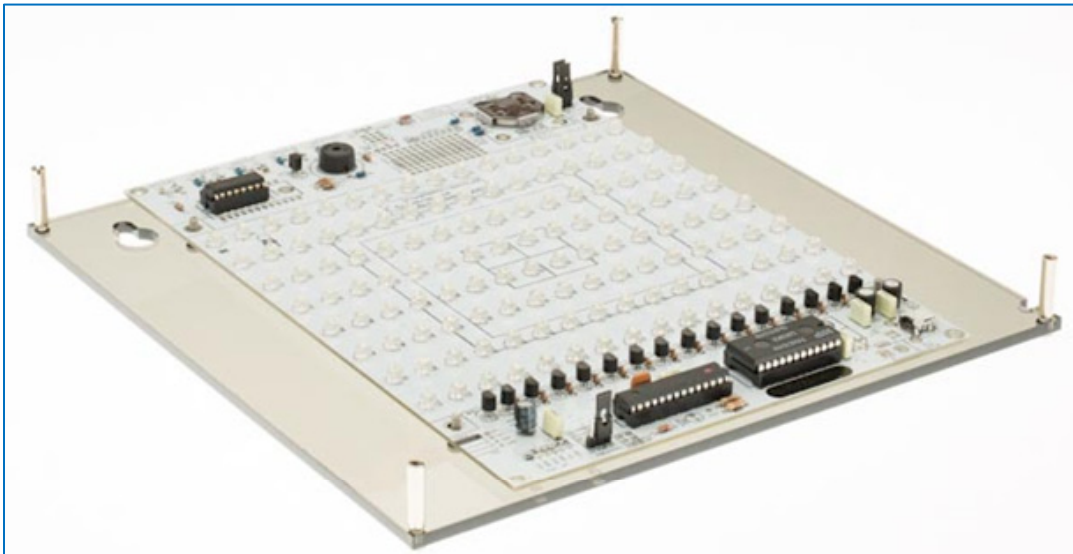




We're ready to start making this project look more like a clock! We'll start assembling the enclosure by removing the protective peel from the rear plate. Be very careful to place the front and back plates down on a clean, soft surface to prevent scratches. Start by installing the four corner screws and shafts that will later be used to mount the front plate. Then insert the four inner screws and nuts used to secure the board.

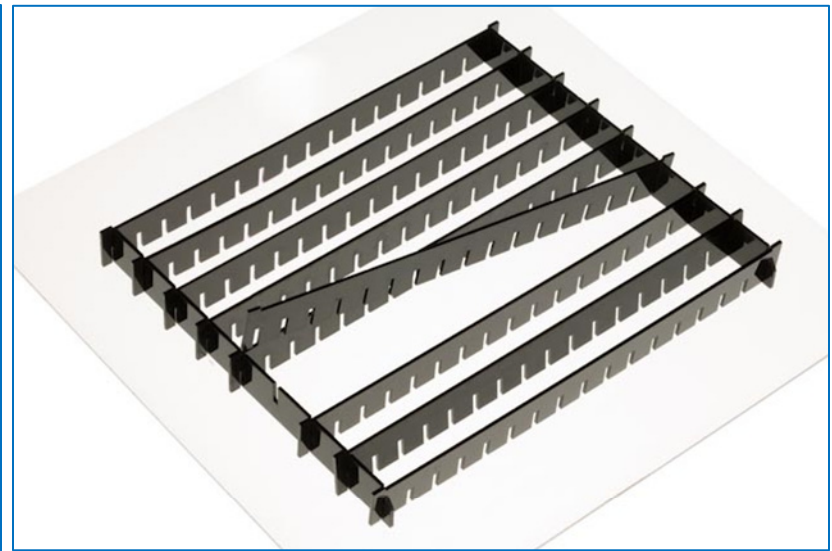
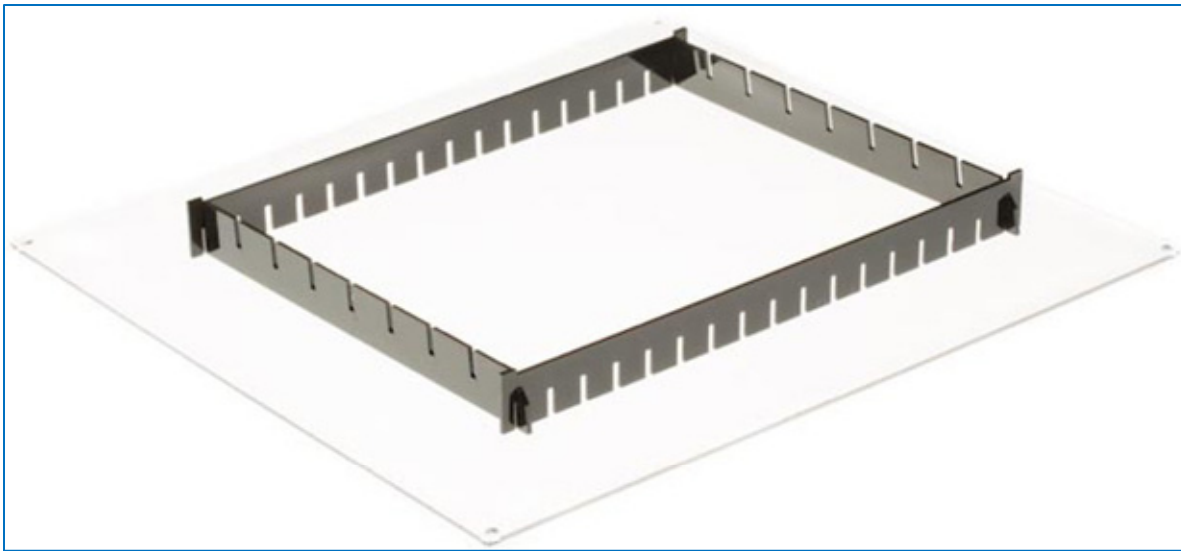
Line up the board with the four inner screws and lay it down so that it's flush with the hardware and oriented properly. The buttons and FTDI connection will need to fall into place with the cutouts on the rear plate.

Secure the board with the four square spacers and four nuts. The spacers will help keep the baffle grid in place later on.



Step 15

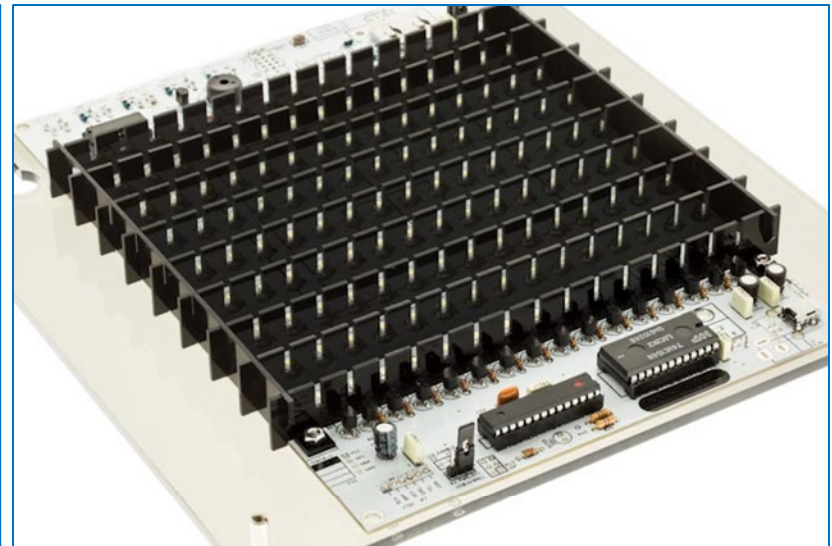
Enclosure



The baffles may seem like a bit of a puzzle, but hopefully these tips will help. First, take two short pieces (slots up) and two long pieces (slots down) and make a square on a flat surface that you'll be able to flip over later. You may consider using a piece of cardboard or large book as your surface.

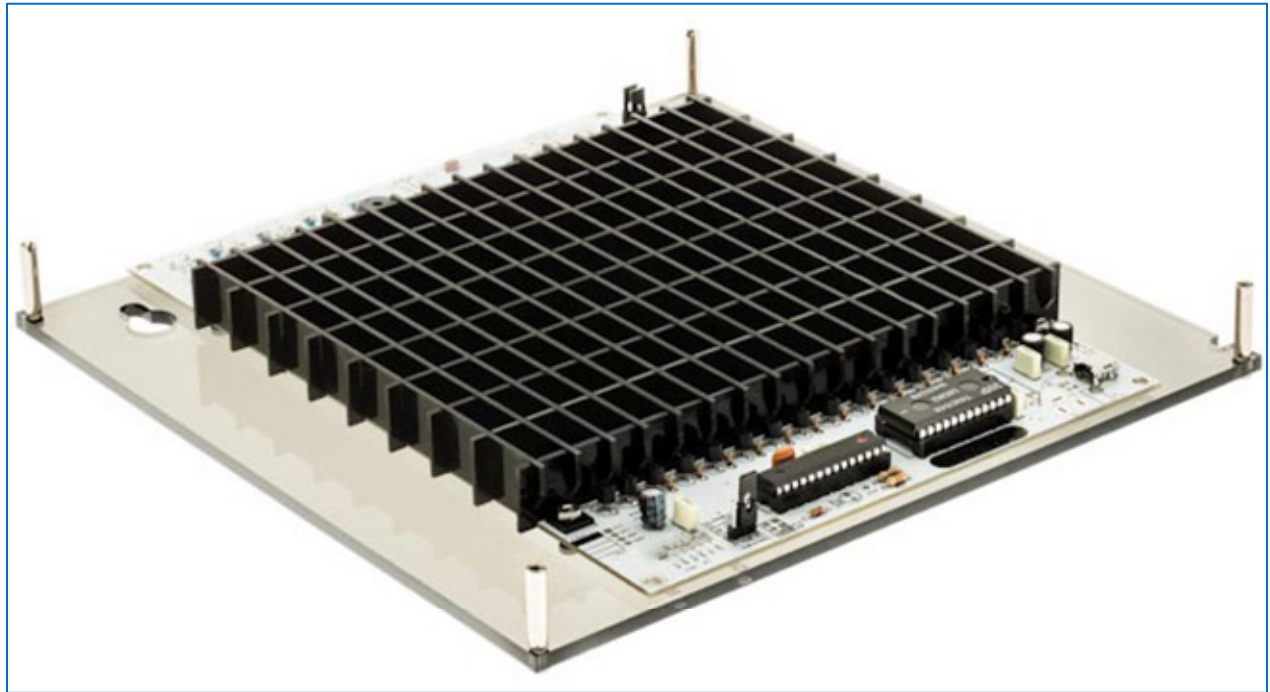
Next, fill in the rows of long pieces using your two short pieces as columns.

Finally, orient the back plate so that the four square spacers line up at the top and bottom of the grid and lay it down. When you're sure that everything is lined up and fitted, carefully flip everything over so that the back plate is once again on your clean, soft surface.



If you find an easier way to do this, please let us know!

Now place the rest of your short pieces onto the grid.



Locate the top plate and carefully remove the protective peel. Place the plate face down on your clean, soft surface to prevent scratches. Center the sheet of paper vellum so that it covers all of the letters and secure it with some tape. This sheet will help to soften and spread the light. If you prefer a softer look, you can layer tracing or parchment (baking) paper until you get the results you're looking for.

You're almost done!

Ensure that the PWR SEL jumper is in the correct position (Left = FTDI Cable | Right = USB Cable) and mount the front plate to the rear plate.

Great Job! Your clock is complete!

Power ClockTHREEjr up and admire your hard work!



Using ClockTHREEjr

Buttons and Dimmer

You'll find five buttons on the back plate that are used to control your clock along with a thumb wheel to adjust the brightness.

<RST> Reset. The Reset button can be used to restore function if the clock should become unresponsive. It's the same theory as rebooting your computer with [CTRL] + [ALT] + [DEL].

<MODE> Mode brings up the clock menu and is usually the first thing you'll press. The word clock on the face will be replaced with large characters. You can switch between the options (Currently "S" and "N") with the <INC> and <DEC> buttons. Pressing the <ENTER> button chooses a mode to go into.

The "S" mode is used for setting the date and time. Once you enter the mode, you'll see an alternating "Y", which stands for year, followed by a two digit number flashing continuously. Pressing <INC> or <DEC> will change the two digit year back and forth. Pressing <MODE> acknowledges any changes made and circles through all of the other time settings. Year/Month/Day/Hour/Minute are all represented by their flashing first letter. Press <ENTER> when you are happy with the changes to drop back into normal mode.

The "N" mode is the normal mode for telling time. This option is available to back out of the menu prior to entering a mode. We may include more modes in the future, so this was included as a way to back out of the menu.

<INC> Increment Up. When pressed in the menu, or a mode, this button will switch to the next possibility. When pressed by itself, the clock displays seconds on the clock face. Press any button to switch back to the normal clock mode.

<DEC> Decrement Down. When pressed in the menu, or a mode, this button will switch to the previous possibility. When pressed by itself, the clock will display the temperature in Celsius or Fahrenheit. You can switch between the formats by pressing the <INC> key. Press any button other than <INC> to switch back to the normal clock mode.

<ENTER> Enter. This button is used to lock in your selection.

Programming the ATmega328

ClockTHREEjr comes with a pre-programmed processor, so the clock is ready to use once plugged in. From time to time, we may release a revision to the clocks code which can be programmed into the ATmega328 via an FTDI cable (sold separately) using the free Arduino Software as your deployment tool. If you're not familiar with Arduino, now would be a great time to get involved with this very user friendly device and create some projects of your own. It's incredibly simple, has a huge community to help with your questions, and the knowledge gained will help you to understand the methods for updating your ATmega328's code.

Once you get a handle on the Arduino software, use the "Arduino Duemilanove w/ ATmega328" board setting to program the clock and make sure that you select the right serial port for your cable.

As always, if you have any questions for the WyoLum team, please feel free to contact us in our forums or through the support email address <info@wyolum.com>.

Links

Wyolum: <http://www.wyolum.com>

Support & Discussion: <http://wyolum.com/forum/index.php>

WiseTime with Arduino: <http://timewitharduino.blogspot.com>

C3Jr Project Repository: <http://code.google.com/p/clockthree>

DigiKey Electronics Parts: <http://www.digikey.com>

PanaVise Circuit Board Holder at Electronix Express: http://www.elexp.com/pro_v333.htm

Weller WES51 Soldering Station & Tips at Electronix Express: http://www.elexp.com/sdr_es51.htm

Chronodot at Adafruit: <http://www.adafruit.com/products/255>

7-Segment Serial Display at Sparkfun: <http://www.sparkfun.com/products/9766>

Arduino: <http://arduino.cc>

Seeed Studio: <http://www.seeedstudio.com/depot>

Creative Commons: <http://creativecommons.org/licenses>

Open Source Hardware (OSHW): <http://freedomdefined.org/OSHW>

OSHW Logo: <http://oshwlogo.com>

Open Hardware Summit: <http://www.openhardwaresummit.org>

