adafruit learning system

TIMESQUARE Watch Kit

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Overview

Show up stylish AND on time to any event with this awesome looking DIY watch. We have a few watch kits here at Adafruit but we finally have one that looks good and fits well, even for ladies and kids and others with smaller wrists and hands. Its got a 8x8 bit matrix display and a repurposed silicone watch band for a professional look.

64 LEDs light up to tell you the time in a variety of ways. Built into the kit are 3 different watch 'faces' - a scrolling marquee with time and date, a binary watch display (for geeks, robots and binary fans), and a moon phase display (for beach-combers, werewolves). There's also a built in battery meter so you can check your battery life. Want to make your own watch? Easy! The microcontroller is an Arduino-compatible, all you need is an FTDI Friend and the Arduino IDE and you can design your own watch faces and upload them to the TIMESQUARE. (http://adafru.it/aT9)

Engineered for greatness by PaintYourDragon, this watch squeezes over 1000 full time displays out of a coin battery, and a 1+ year 'resting' lifetime, so you can use this as a day-to-day time keeper.

This watch comes with a ultra bright red LED matrix and a black silicone watch band that fits all wrists from children to adult.

This is a DIY kit, and requires some basic soldering/assembly to put together. It is a beginner kit, so

this is a fine project to use in learning how to solder. Tools are not included, you'll need a soldering iron, solder and diagonal cutters as a minimum. Check the tutorial page for details on what tools and steps are required to assemble. (http://adafru.it/aTa) Take about 1-2 hours to put together. Build it in the afternoon and you'll be done in time to hit the clubs in the evening.

Tools List

Tutorials

- Learn how to solder with tons of tutorials! (http://adafru.it/aTk) (http://adafru.it/aOm)
- Don't forget to learn how to use your multimeter too! (http://adafru.it/aOy)

Tools

There are a few tools that are required for assembly. None of these tools are included. If you don't have them, now would be a good time to borrow or purchase them. They are very very handy whenever assembling/fixing/modifying electronic devices! I provide links to buy them, but of course, you should get them where ever is most convenient/inexpensive. Many of these parts are available in a place like Radio Shack or other (higher quality) DIY electronics stores.

Soldering iron

Any entry level 'all-in-one' soldering iron that you might find at your local hardware store should work. As with most things in life, you get what you pay for.

Upgrading to a higher end soldering iron setup, like the Hakko FX-888 that we stock in our store (http://adafru.it/180), will make soldering fun and easy.

Do not use a "ColdHeat" soldering iron! They are not suitable for delicate electronics work and can damage the kit (see here (http://adafru.it/aOo)).

Click here to buy our entry level adjustable 30W 110V soldering iron. (http://adafru.it/180)

Click here to upgrade to a Genuine Hakko FX-888 adjustable temperature soldering iron. (http://adafru.it/303)

Solder

You will want rosin core, 60/40 solder. Good solder is a good thing. Bad solder leads to bridging and cold solder joints which can be tough to find.

Click here to buy a spool of leaded solder (recommended for beginners). (http://adafru.it/145)

Click here to buy a spool of lead-free solder. (http://adafru.it/734)

Multimeter

You will need a good quality basic multimeter that can measure voltage and continuity.

Click here to buy a basic multimeter. (http://adafru.it/71)

Click here to buy a top of the line multimeter. (http://adafru.it/308)

Click here to buy a pocket multimeter. (http://adafru.it/850)

Flush Diagonal Cutters

You will need flush diagonal cutters to trim the wires and leads off of components once you have soldered them in place.

Click here to buy our favorite cutters. (http://adafru.it/152)

Solder Sucker

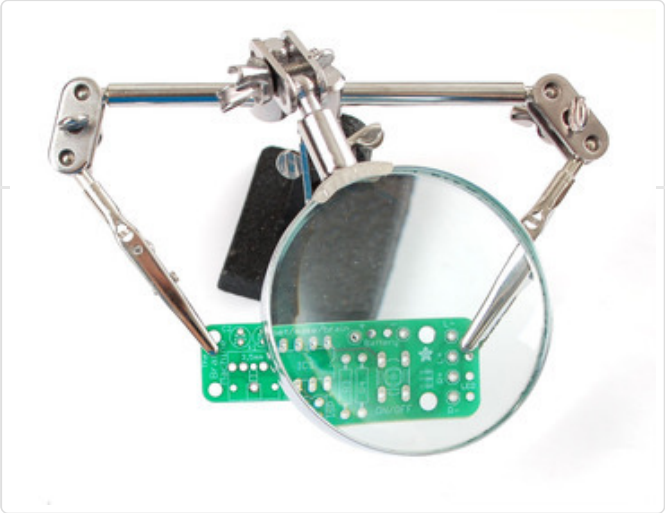
Strangely enough, that's the technical term for this desoldering vacuum tool. Useful in cleaning up mistakes, every electrical engineer has one of these on their desk.

Click here to buy a one. (http://adafru.it/148)

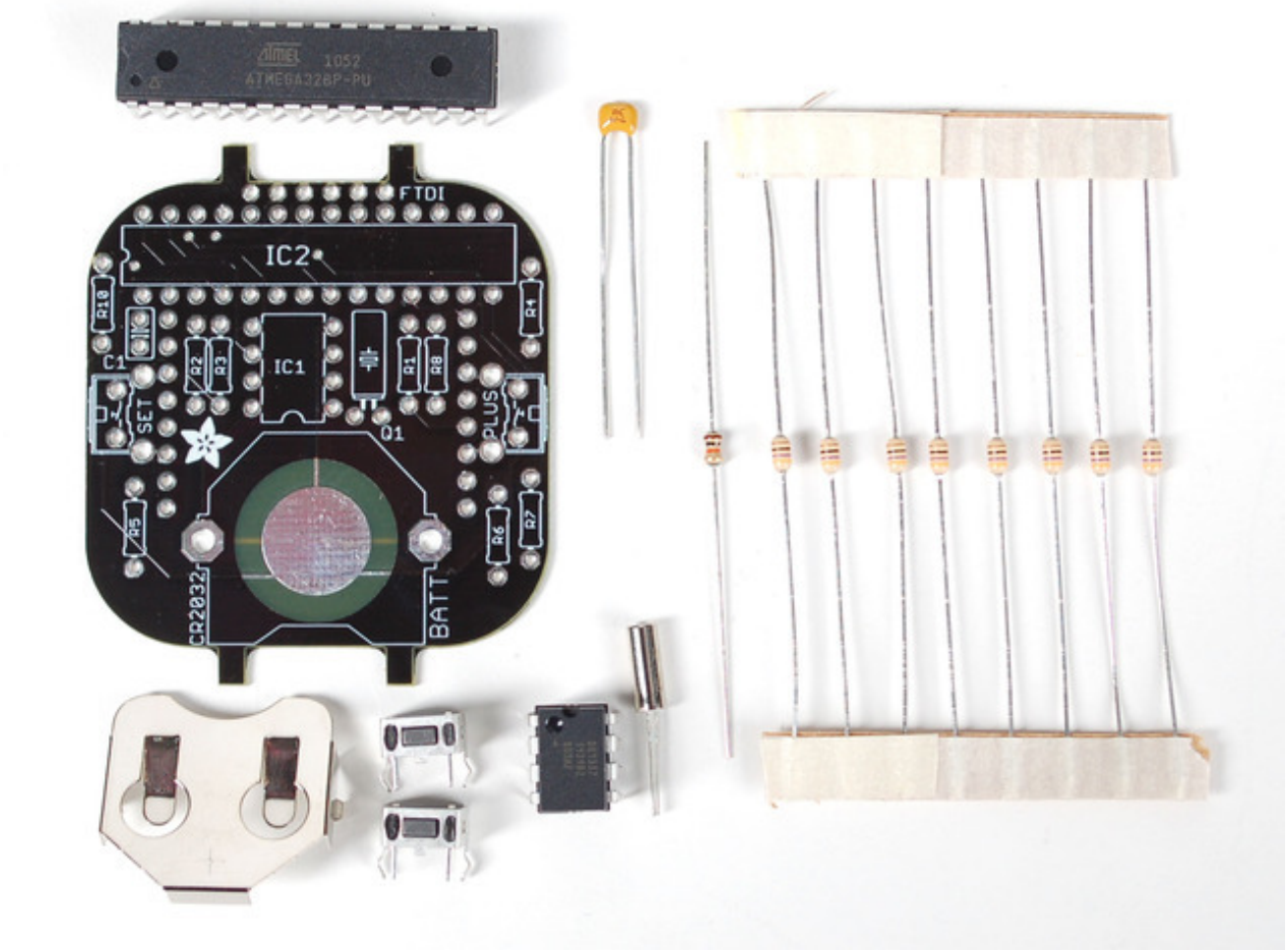
Helping Third Hand With Magnifier

Not *absolutely* necessary but will make things go much much faster, and it will make soldering much easier.

Pick one up here. (http://adafru.it/291)



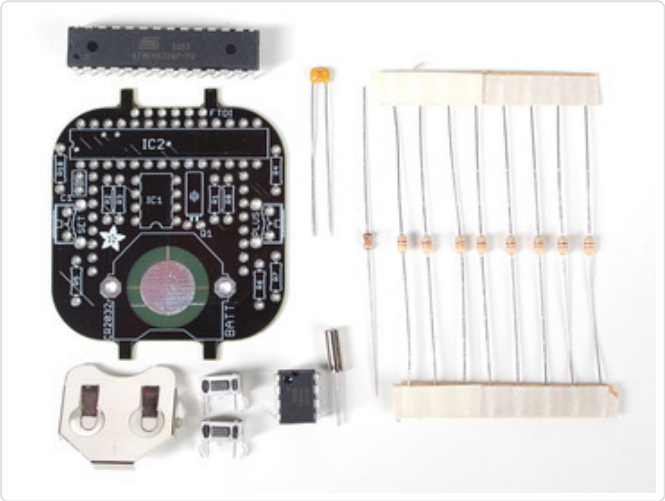
Parts List



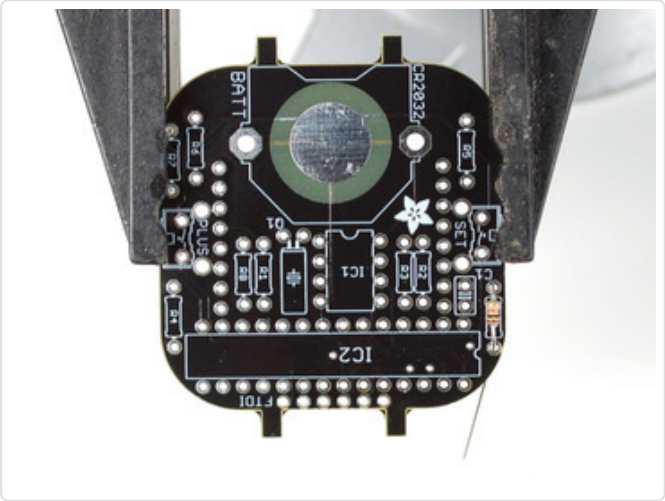
- TIMESQUARE PCB - half thickness black PCB
- ATMEGA328P - preprogrammed microcontroller
- DS1337 - 8 pin real time clock chip
- 32.768KHz Crystal - thin silver cylinder
- Right angle buttons - two for either side
- 20mm coin battery holder
- 0.1uF ceramic capacitor - yellow blobby
- 1 x 10K resistor - brown black orange gold
- 8 x 47 ohm resistor - yellow violet black gold
- 1.5" 8x8 matrix (not shown)

- Silicone rubber watch band
- Clear plastic cutout back
- CR2032 Coin cell battery (battery not included as of October 22nd, 2015)

Kit Assembly

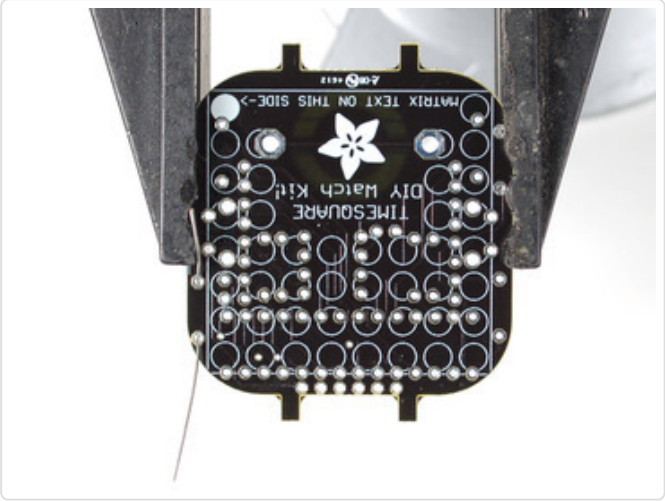


First up, check that you have all the electronic parts laid out on your table and ready for soldering!

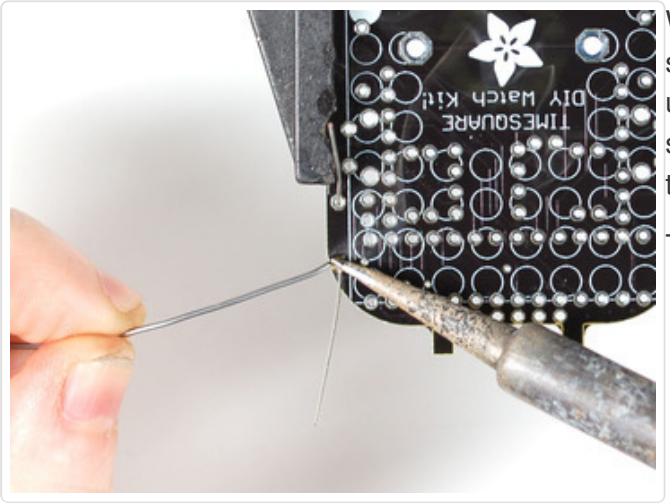


Start by placing the PCB in a vise to keep it steady. We'll be soldering parts on TOP, where the silkscreen shows the component placing. The first part we'll place is the 10K resistor. This resistor is marked **brown black orange gold**. (It's also the only single resistor of that color)

Bend the resistor into a staple and slip the wire leads into the two holes so that the resistor covers the outline labeled **R10** in the bottom right corner shown here

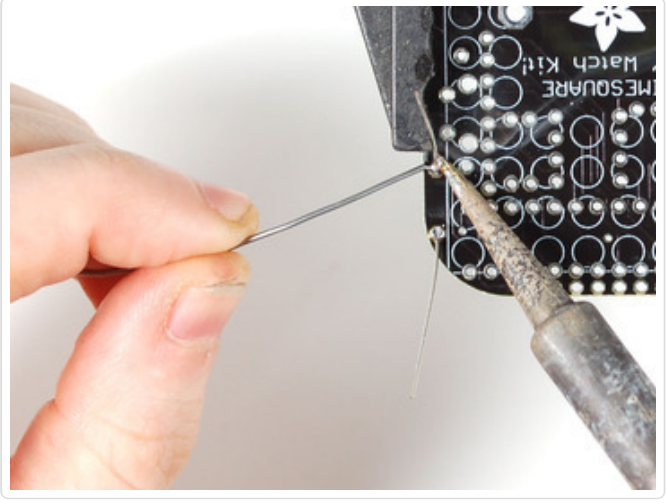


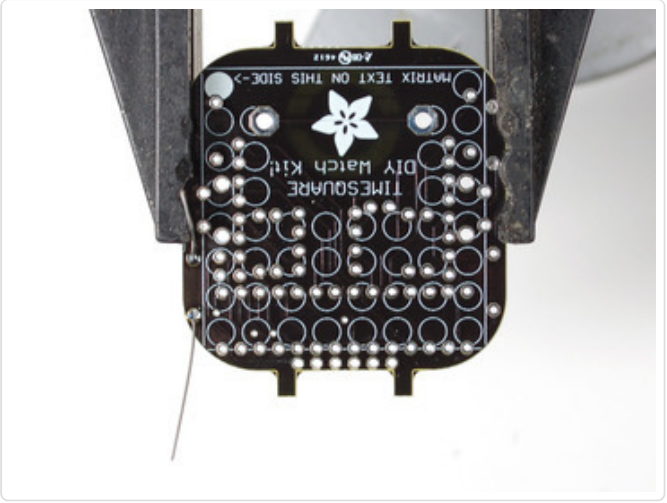
Bend the wire leads out so the resistor sits flat against the PCB. Then you can flip it over and it wont fall out!



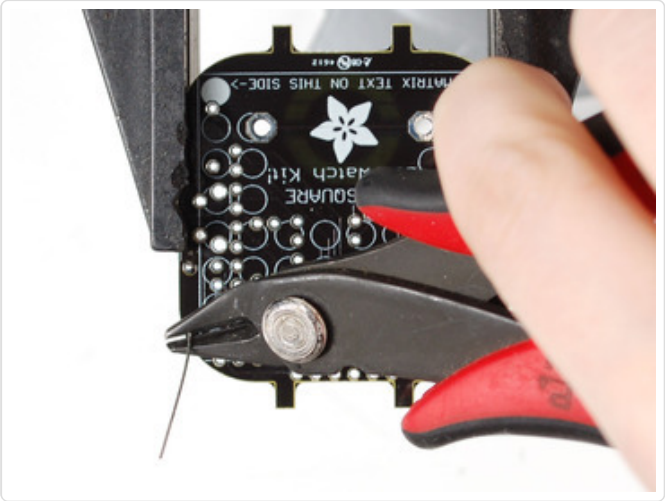
With your soldering iron heated up and ready, solder in both leads of the resistor. To do this, heat up the round ring pad and the wire lead at the same time for 2 or 3 seconds, then dip the end of the solder into the heated joint to melt it in.

Then remove the solder and the soldering iron.

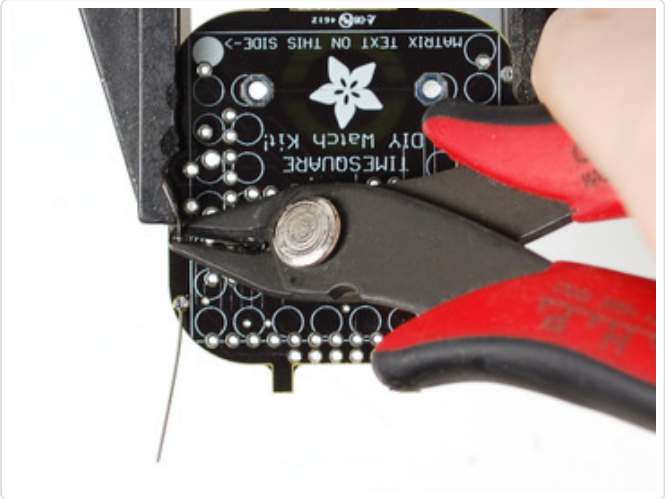




Once the soldering is complete, we can clean up by clipping the leads of the resistor. This keeps them



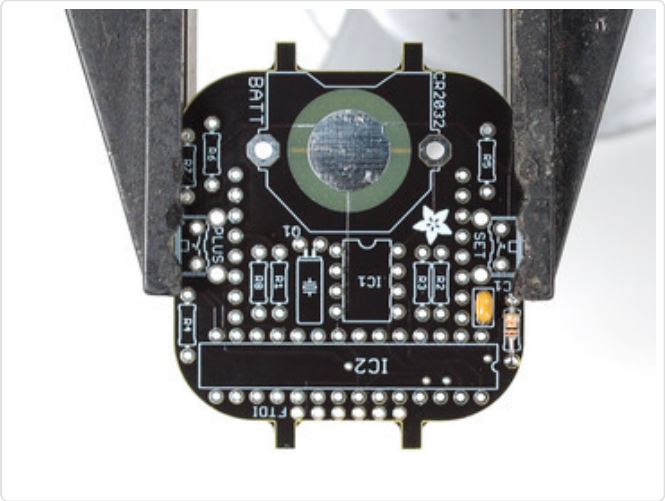
from shorting to something else. Use diagonal or flush cutters to clip the wires right above where the solder joint ends.

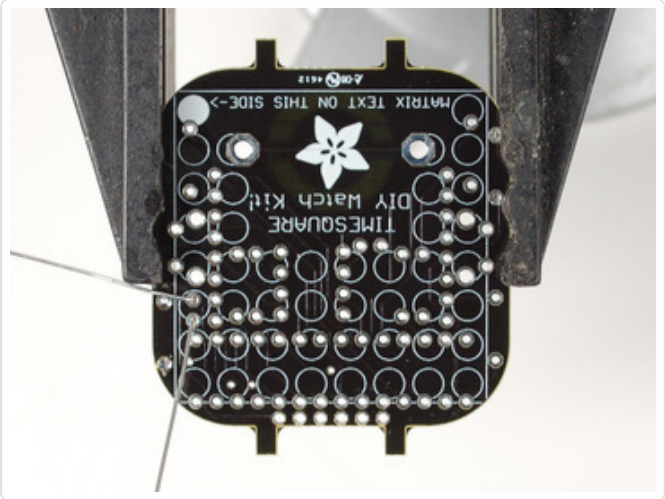


Next we'll solder in the yellow blobby 0.1uF capacitor. This capacitor is part of the reset circuitry as well, and is used to help reset the chip when we want to reprogram it.

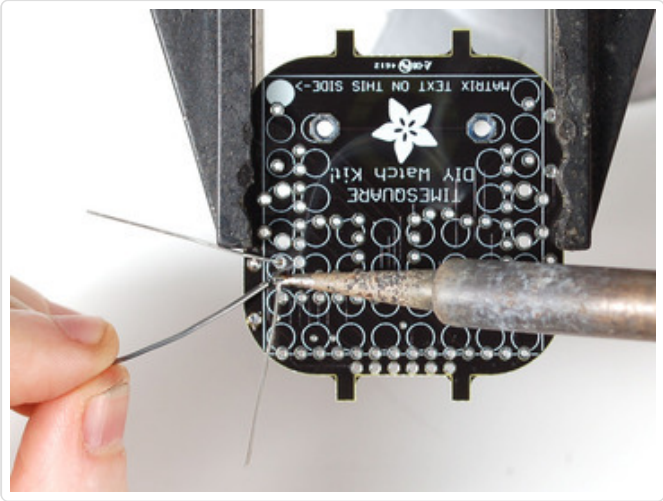
Ceramic capacitors, like resistors, are not directional. So put it in any way it fits, next to the **R10** resistor, so its surrounded by the **C1** outline

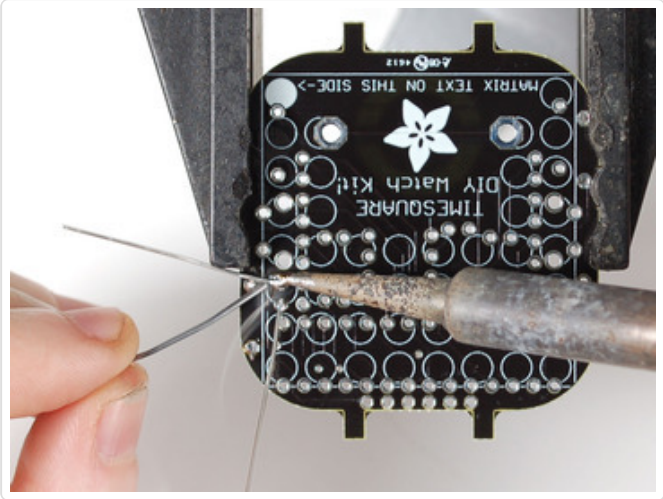
Then bend the leads and flip over the board.





Solder in the capacitor's two legs just like you did with the resistor

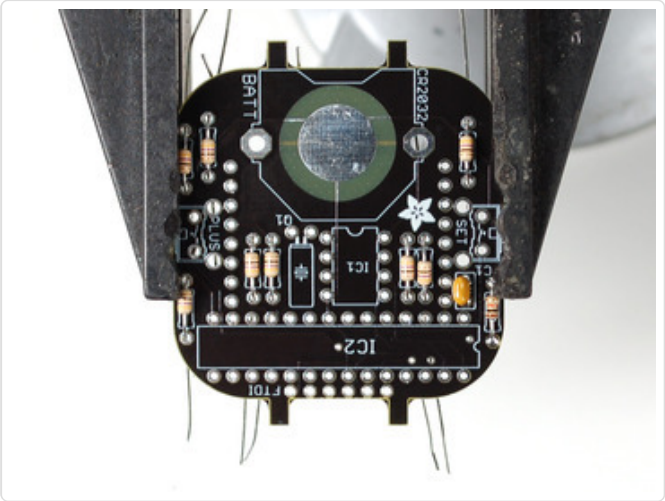


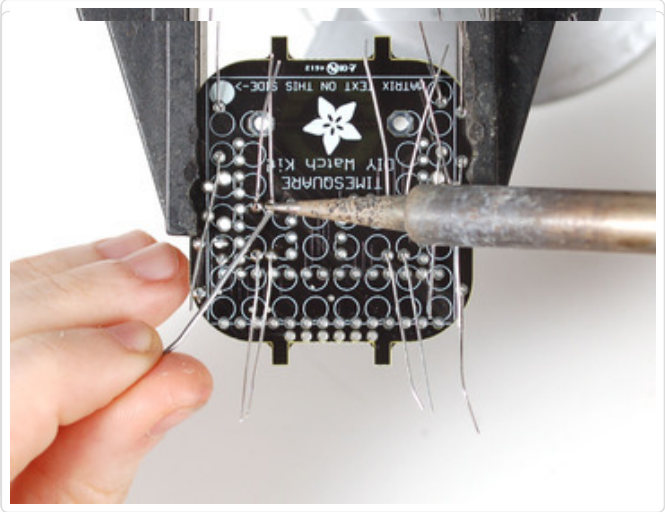


You did great with the first two parts, now we will solder in the remaining resistors **R1-R8** . These resistors are the LED 'choke' resistors - they keep the LED matrix's light even and avoids having too much current draw that would kill the battery off!

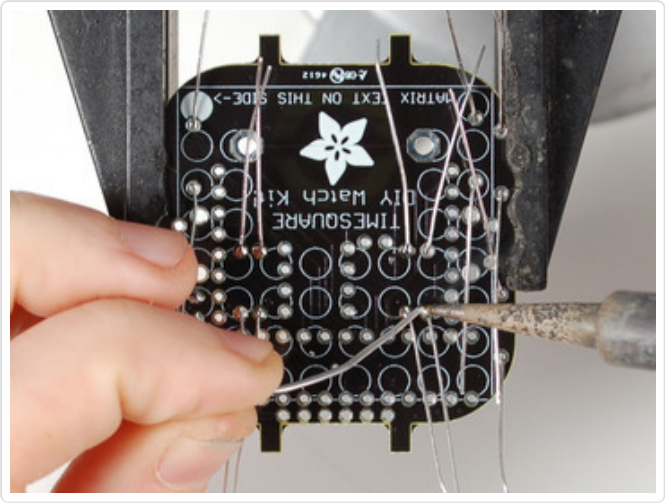
All the resistors are the same 47 ohm value - **Yellow Violet Black Gold**

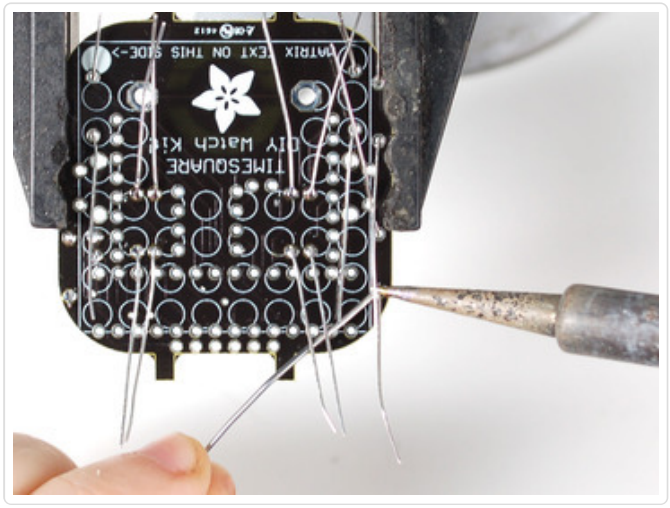
Here we placed and soldered all 8 at once but you can go one at a time if you want to take it a little slower!

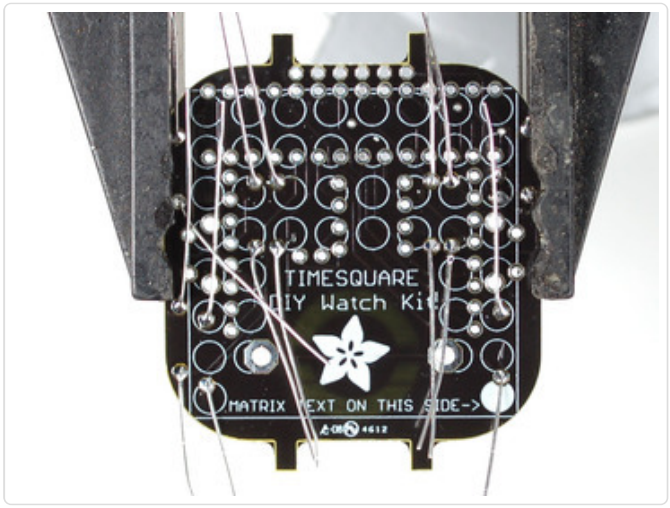




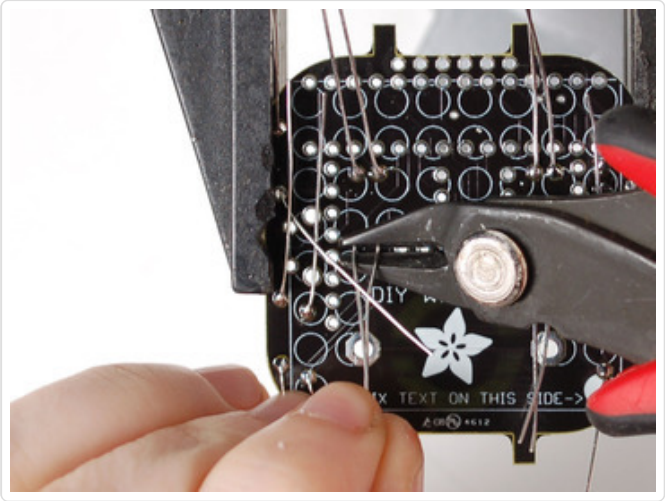
Solder in all the resistors, either one at a time or all 8 at once! Make sure you don't forget any solder points, though.

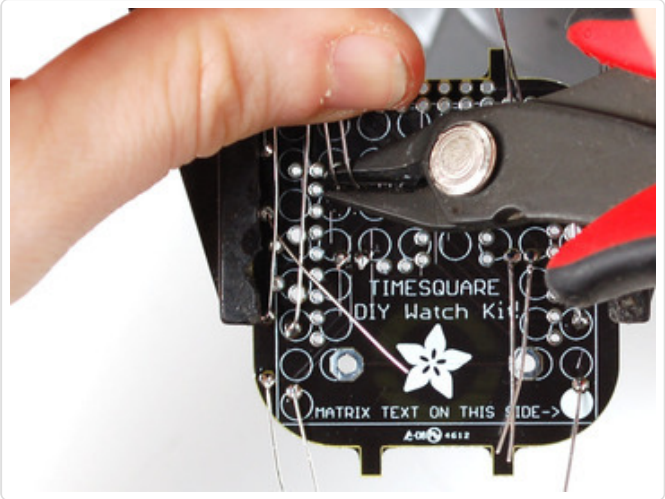


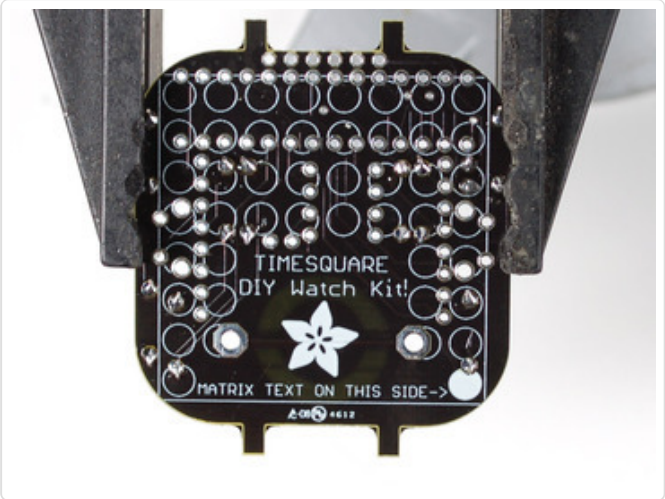




Next clip all the leads!




TIMESQUARE
DIY Watch Kit!
MATRIX TEXT ON THIS SIDE->


TIMESQUARE
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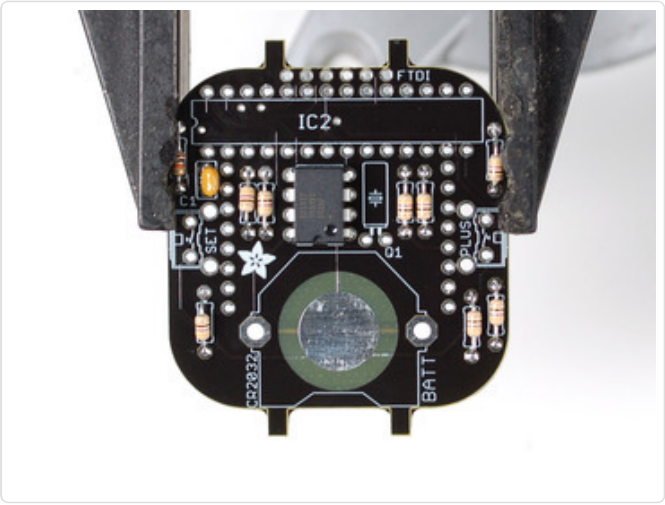
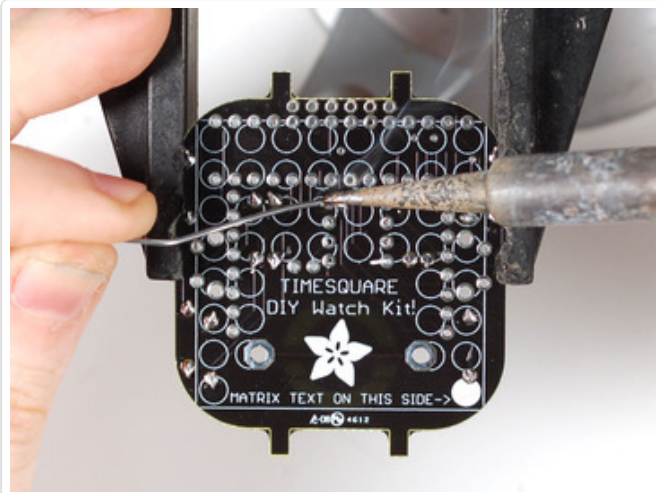


Next up we will put in the first chip. This chip has 8 legs and has the label **DS1337** on top. Make sure you've got the right label on the chip.

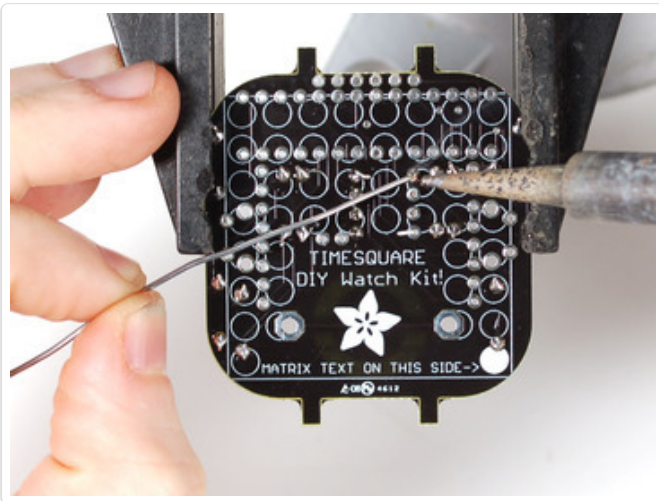
This chip is the "real time clock" - the timekeeper. It is a ultra-lo-power circuit, whose only task is to keep track of the time, so its pretty good at it. It's possible to have the main microcontroller chip (the next one we'll do) keep track of the time, but its not as good at it (both in terms of power and precision) so we splurged on having a seperate RTC

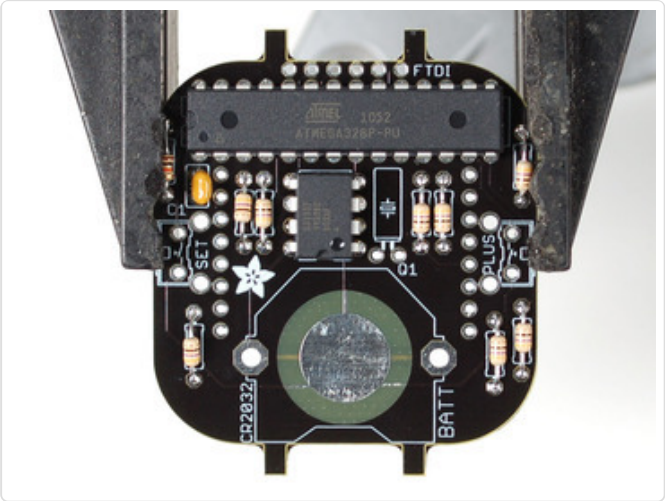
The important thing about chips is that they are not like resistors and capacitors in that they **can't** be placed 'either way'. It **must** be placed the right way or the chip wont work. Look for the end of the chip with a notch and a dot. These must match up the silkscreened image on the PCB so make sure the notches line up.



Solder all eight pins of the RTC

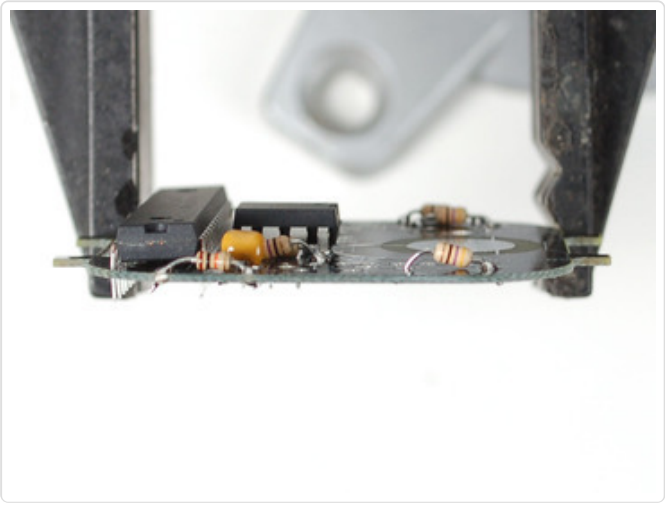
No need to clip them after they're done





Next we'll do the big microcontroller chip. This chip is the brains, it does all of the displaying and button handling. Most of the time its 'sleeping' and when you press a button it wakes up and shows the time. It has a lot of pins because the matrix requires 16 pins to draw, and then you need some more pins for buttons, the RTC chip, reprogramming, etc.

The chip is an **ATMEGA328P** that has been pre-programmed at the Adafruit factory to have an Arduino-compatible bootloader and our default watch display code.



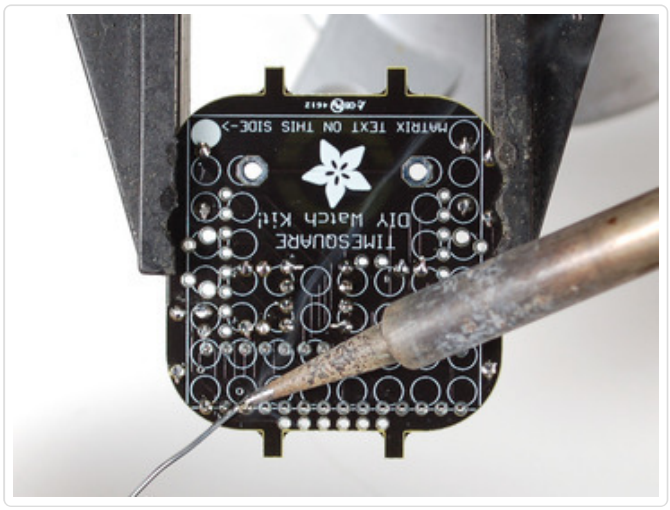
To begin, flatten the pins to make them more parallel || shaped intsead of A shaped. Hold the chip in your hand and press all the pins one side at a time against a flat table.

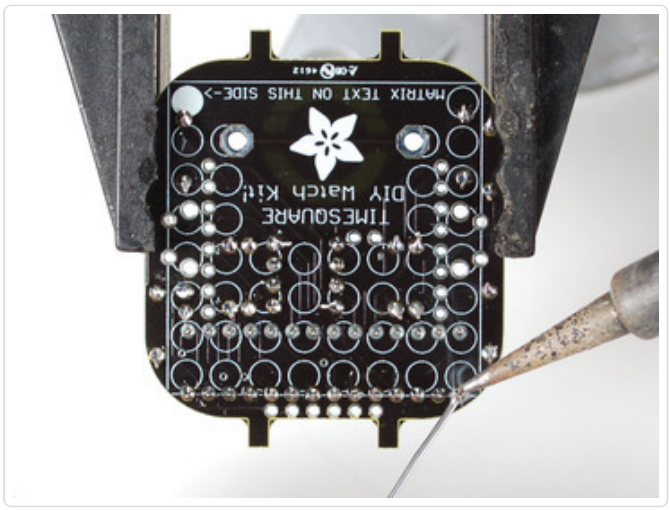
Then when you press it into the holes, make sure each pin has made it into a matching hole, and its sitting flat against the PCB

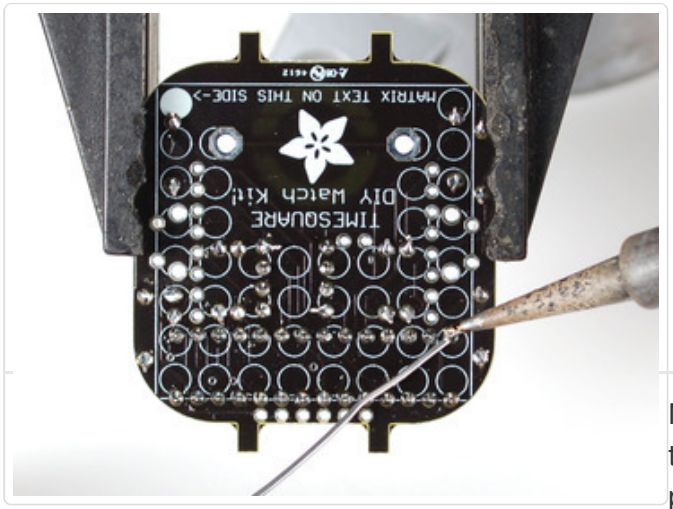
Like the RTC, this chip **must** be put in the right way. The notch on the chip must go on the left side as in these photos. Check twice to make sure you have the chip in right!

Solder all 28 pins!

No need to clip them after they're done

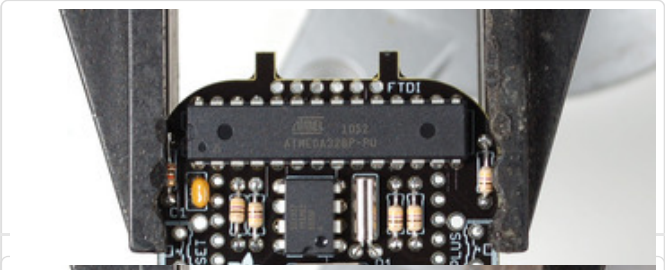






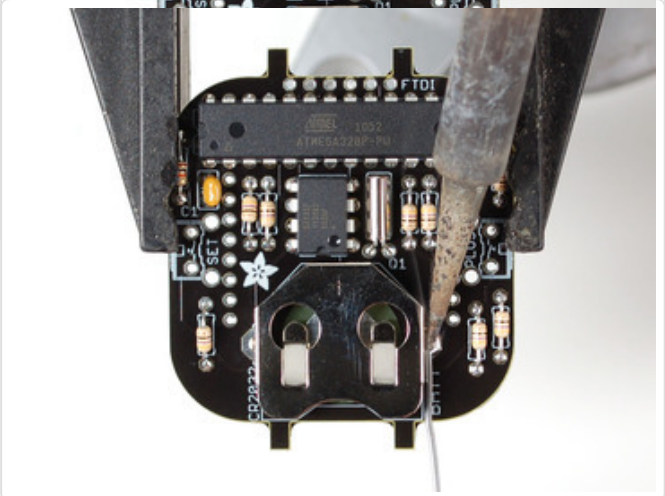
Next we'll place both the battery holder, and the timing crystal. The battery of course is how we power the watch, and this holder keeps it in place. The timing crystal is the "Quartz Crystal" in watches, that keeps time by resonating

The battery holder does have a special way it must go, make sure you can slide the battery in by

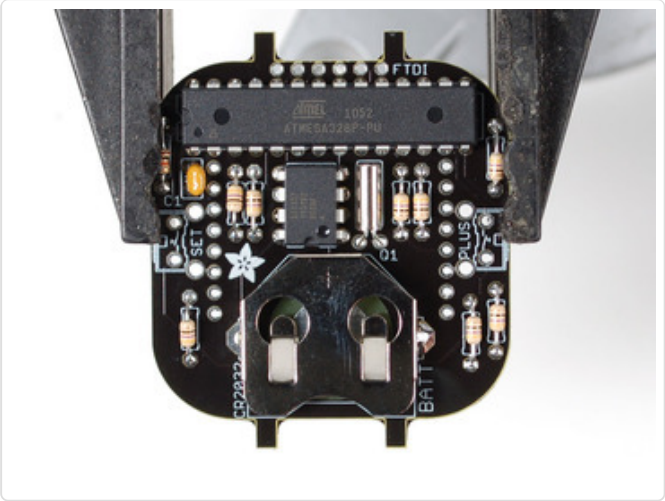


having the open side facing out

The crystal can go in either way, its symmetric, like the resistors

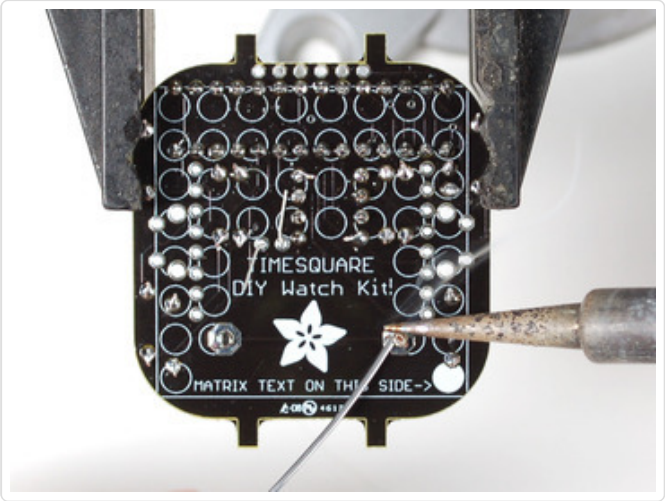


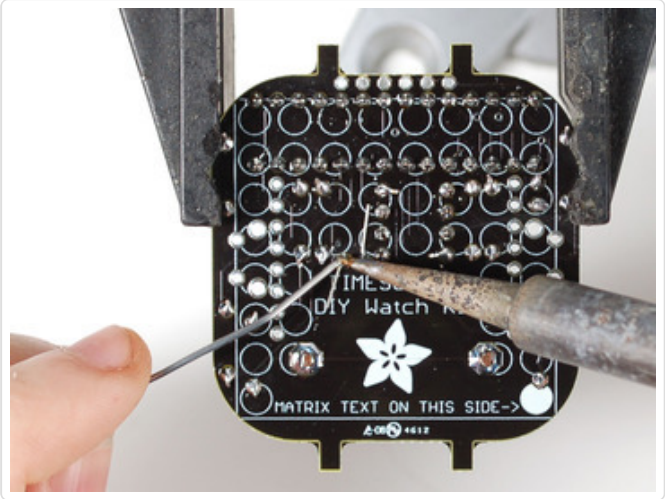
The battery holder will slip out if you flip over the board, so before flipping the board, solder one leg side from the top. The holder is a great heatsink so it may take a little longer than usual to solder in

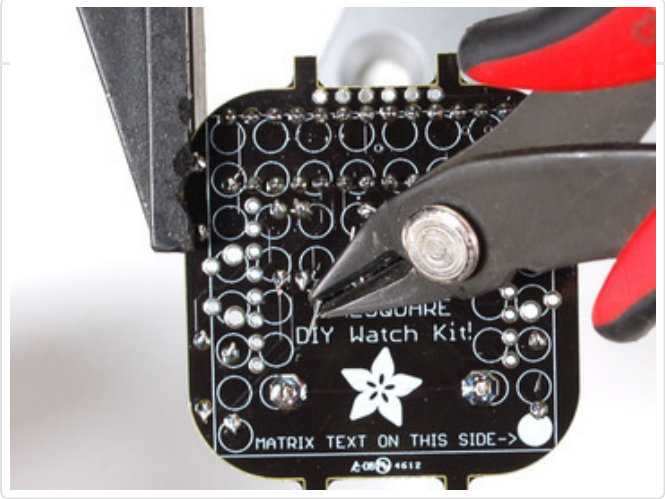


Flip it over and solder in the other battery pin, then go back and do the first one.

Also, solder and clip the two crystal pins



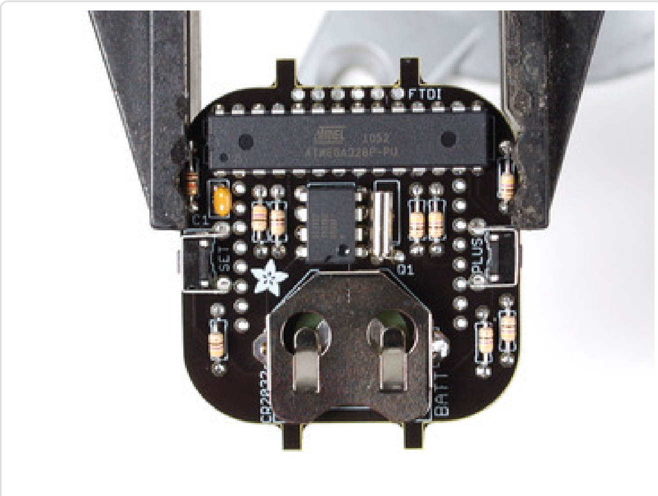


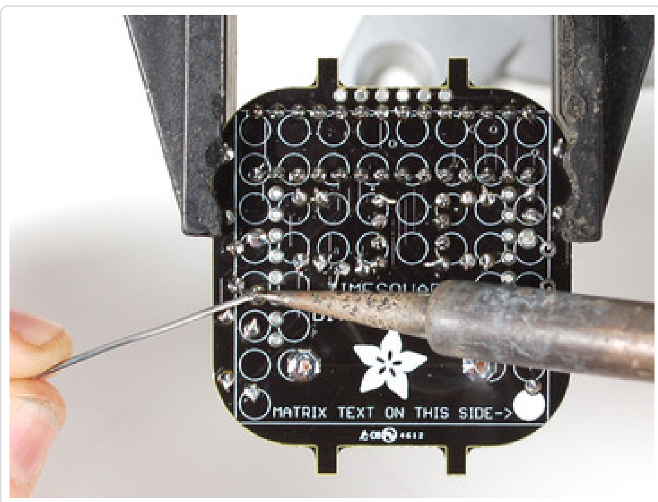


Lastly, place the two interface buttons. You'll use these to set the time, display the time, and change watch faces.

Both go on either side of the board, and they'll snap in.

Then flip the board over and solder in all 4 pins of each



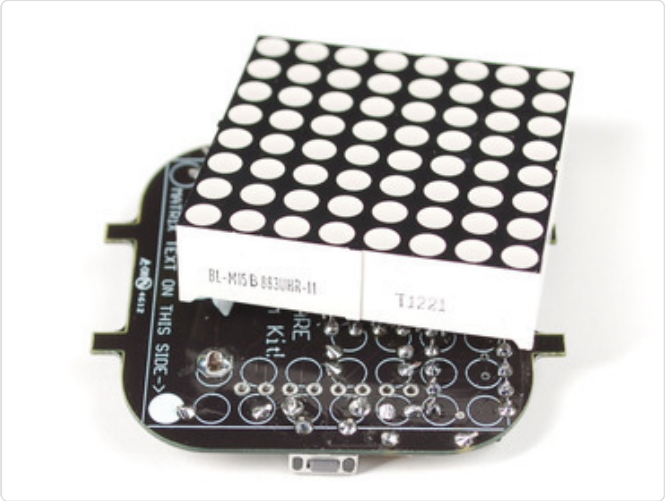


Important! Once you solder the matrix to the board, it is nearly impossible to diagnose or repair any soldering problems. If you have any doubts at all about your solder joints, post some clear photos to the forum now so our engineers can check it over.

Finally, the fun part! The matrix!

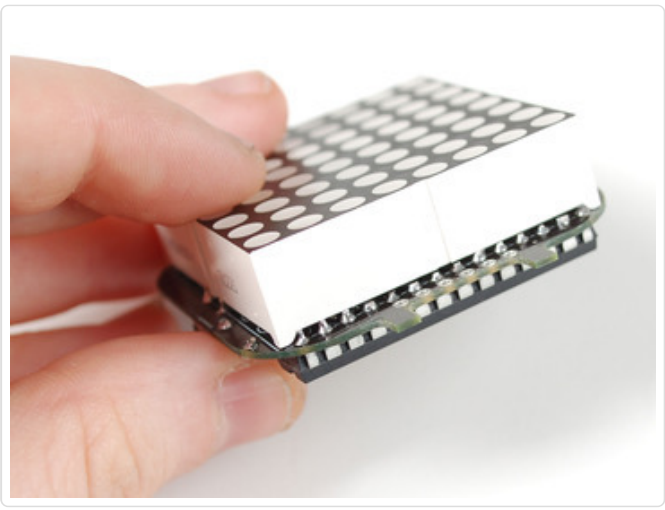
The LED matrix is what you'll be looking at - 64 individual LEDs in a plastic case.

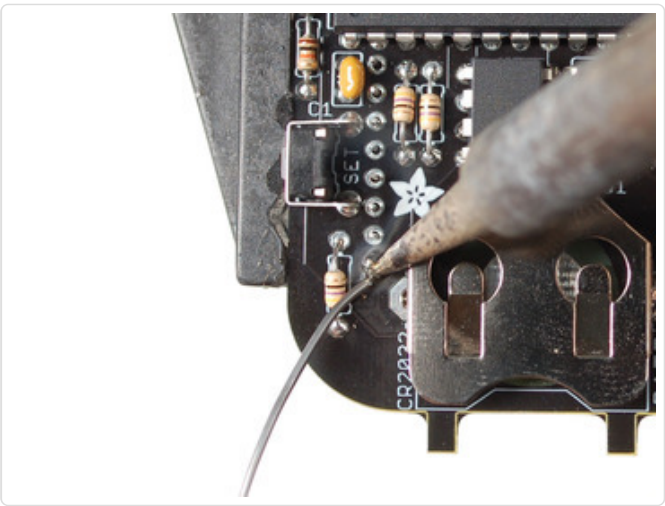
The Matrix is not symetric, it **must** go in the right way on the right side.
Look for the writing on the side of the matrix, this



side must go on the side of the PCB with a dot as you see here. Also the matrix goes on the OPPOSITE side of the other parts!

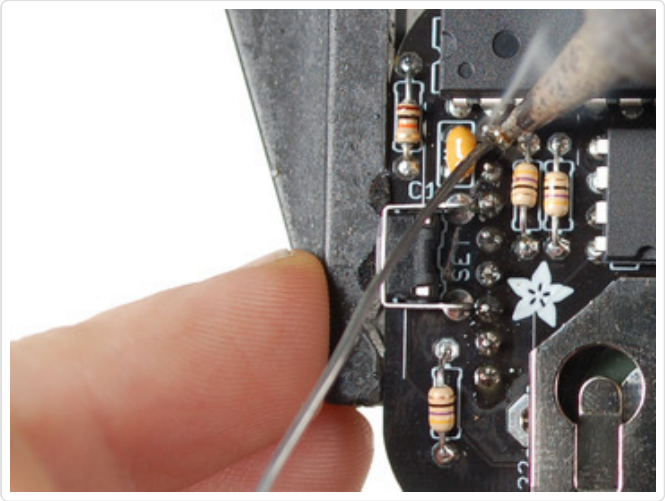
Check that the 28-pin microcontroller pins aren't in the way of the matrix, it should sit nice and flat

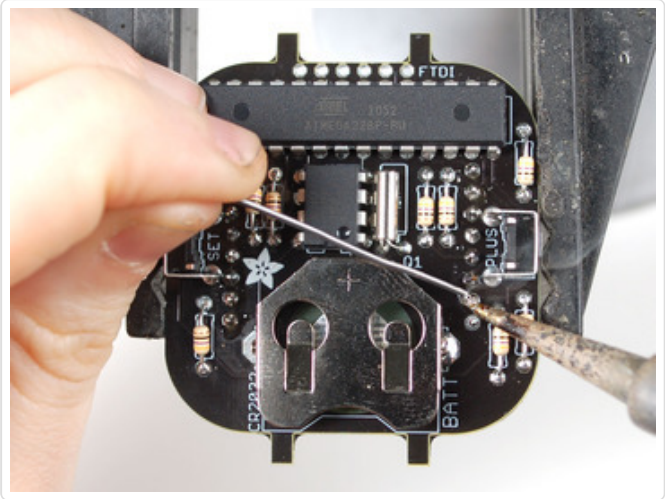


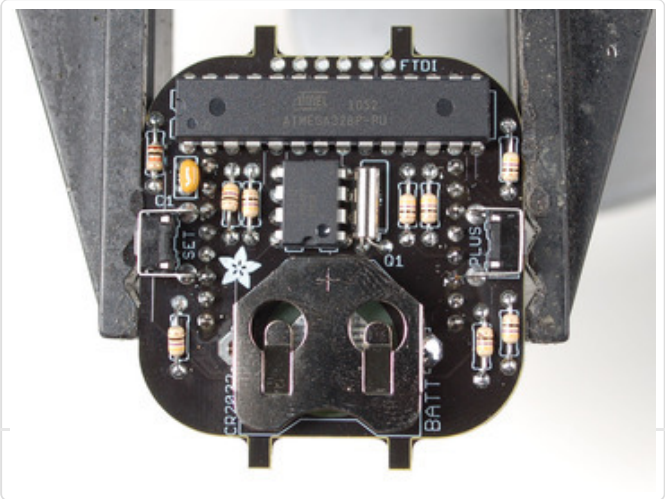


Now solder in all the pins of the matrix, you may have to angle the iron tip a bit to avoid burning other parts

You can clip the leads but you don't have to (they're less long than the height of all the other parts!





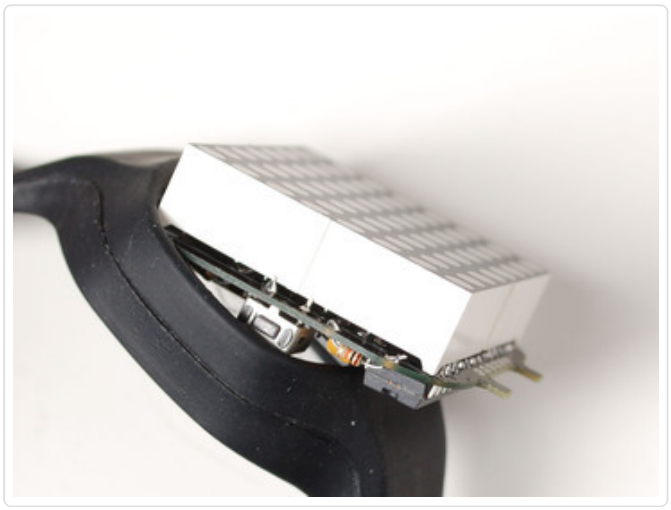


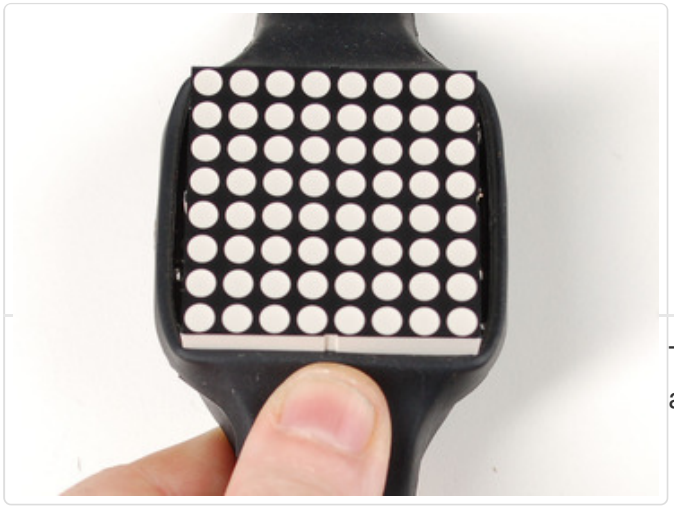
Get the remaining parts out of the kit - a 20mm coin battery, silicone band and optional clear plastic back

Insert a 20mm (CR2032) coin cell battery so that the flat **+** side is facing up and the bumpy side is facing down into the PCB

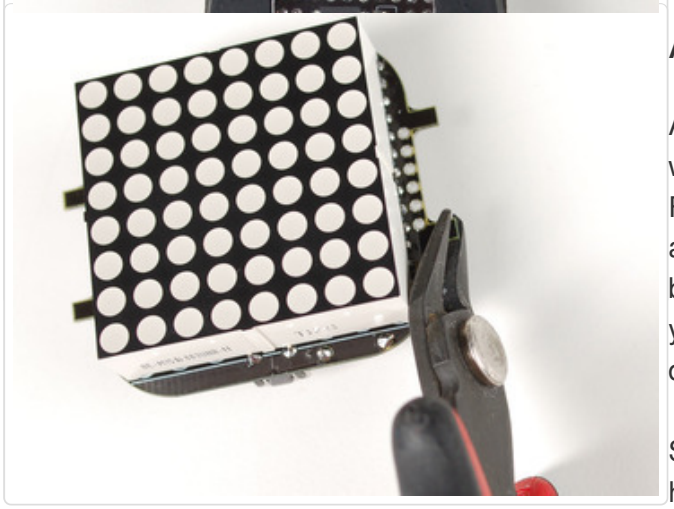
Place the clear back first into the band so it's at the bottom. Then stretch the band and scootch the assembly in, pulling the rubber to fit around!

When you've got it all in, you may need to pull/press the band around the PCB to have the 'nubs' fit into the notches that are molded into the band





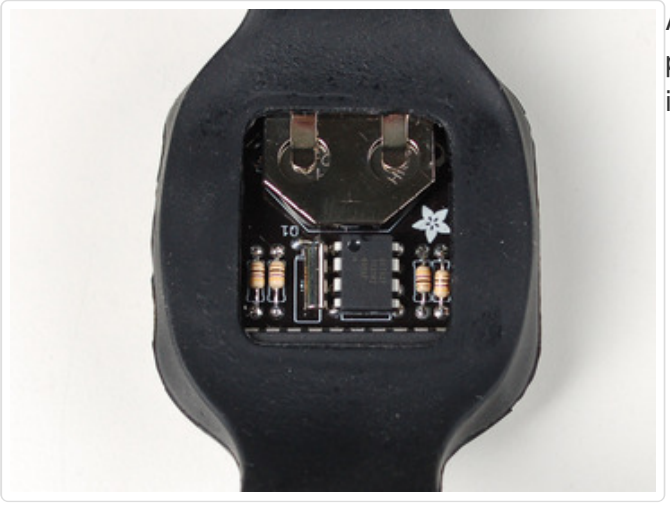
That's it! You can now continue on to set the time and/or adjust your fit



ADJUSTING FIT

After you've assembled your watch there are a few ways to change the fit of the band around the PCB. First is trimming down the nubs on the PCB. These are there to help keep the board inside the rubber band. However, they may be long depending on your wrist size, and band (all the bands are slightly different)

Simply trim them down a millimeter at a time to help avoid them from sticking out too much



Another easy way to adjust the fit is to remove the plastic back - its not essential and for smaller wrists it may make the watch a little bulkier than desired.

OTHER TWEAKS

Kapton tape is a heat-resistant and electrically insulative tape that's used a lot in electronics. This isn't included with the watch, but if you've been in this hobby for a while there's a good chance you already have a roll handy. Wonderful stuff.

One or two layers of Kapton tape applied to the watch face make it less prone to washing out under bright light. The tape's color is similar enough to the red LEDs that they shine through with little difficulty, while most ambient light is blocked.

Rubylith film (from a decent old-school art supply store) would probably work as well, if not better.

Setting the Time

First wake the watch by **tapping** either side button. With the time display active, you can enter time-setting mode by **holding** down **both** side buttons for about two seconds. If using the watch for the first time, or after swapping batteries, it may wake in time-setting mode automatically.

Tap → or ← tap

Hold
→ ←
2 sec

Date and time are set by cycling through each digit. The currently-active digit is shown with a blinking underline cursor. **Tap** the **left** button to advance to the next digit, or **tap** the **right** button to increment the current digit (it will “roll over” to 0 or 1 as needed).

Tap → = Next digit
← Tap = Current digit +1

There are two digits each for the year, month, day, hour and minute, and the watch will briefly display the symbols **Y**, **M**, **D**, etc. when moving from one pair of digits to the next. The high and low digits are set individually…this is different from most digital clocks, we find it faster and less troublesome. The range for each digit varies, and the watch will keep the values in check.

There is no seconds adjustment. Seconds will be reset to zero when exiting time-setting mode.

The last “digit” is a 12- or 24-hour display mode selection. 12/24 currently only affects the marquee mode; the binary display is limited to 12-hour time. Advancing past the 12/24 item will scroll back to the first digit of the year. So if you overshoot a digit you wanted to set, just repeatedly tap the left button until you roll around to it again.

Tap → = Y→Y→M→M→D→D→H→H→M→M→12/24

To exit time-setting mode and return to the last time display mode, **hold** down **both** buttons for two seconds again.

Hold
→ ←
2 sec

Time Display Modes

Tap the right or left side buttons to wake the watch and show the time in the current display mode.

Tap → or ← tap

Hold the left **or** right buttons (not both) for 2 seconds to move back or forward through modes.

Hold → 2 sec or ← hold 2 sec

The sequence of modes is:

Marquee↔Binary↔Moon Phase↔Battery Gauge

Marquee mode

Inspired by the famous Dow Jones news ticker, this scrolls the current time from right to left.

Tap either side button while active to switch the display from time to date. Tap again to show

the time.

Binary mode

Bright dots represent a binary “1,” dimmer dots are “0.” “Off” dots separate the digits.

The hour (1 to 12) is shown as four 2x2 pixel blocks across the top.

Minutes and seconds are 1-pixel blocks, with the high and low digits separated for easier reading (3 bits and 4 bits, respectively).

The display at left shows 4:09 and 12 seconds.

Moon Phase mode

Displays the current phase of the moon.

The resolution is limited somewhat by the screen. It’s generally accurate, but this is not a medical device — do not rely on this data if you are prone to lycanthropy.

Battery Gauge

This displays the *approximate* battery level.

Frequent button presses may temporarily lower the battery voltage more than this display indicates. After assembling your watch, you might run through the first battery pretty quickly in your enthusiasm to show everyone. If it seems to have suffered a premature demise, allow the watch to rest for a few hours, or try a fresh battery.

Sometimes the watch display may appear dim or flickery, regardless of the display mode. This happens when the battery voltage runs low. It's normal behavior, an attempt by the watch to preserve battery life. Allow it to rest or replace the battery soon.

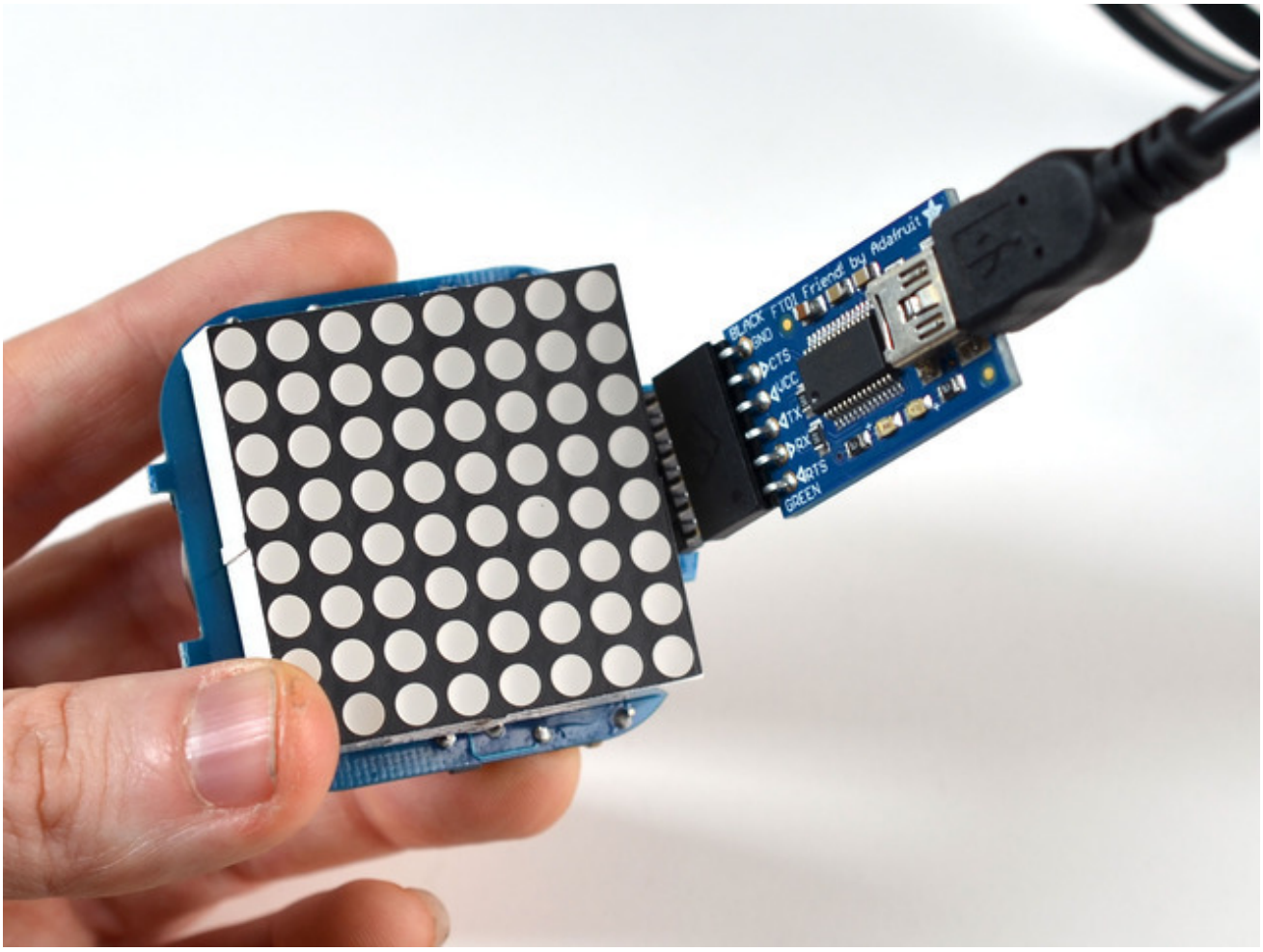
Uploading New Firmware

Now you've had your watch for a few days/weeks/months and you want to come up with your own watch designs. Lucky for you, this watch is designed specifically to be super easy to hack! If you know how to program Arduino, you're basically already there.

You'll need the Arduino IDE, and also some knowledge of how to read and write Arduino code.

To program the watch itself, you'll need an FTDI cable (http://adafru.it/70) or FTDI Friend (http://adafru.it/284). This will connect your computer to the watch. If you're using an FTDI cable or anything other than the Friend, you'll also need some extra long header (http://adafru.it/400) to press-fit.

Simply place a 6-pin extra long header into the FTDI connector and slip the other end into the top of the watch PCB, to match this photo. Be sure to have a battery in the watch, as it does need to be powered while programming!

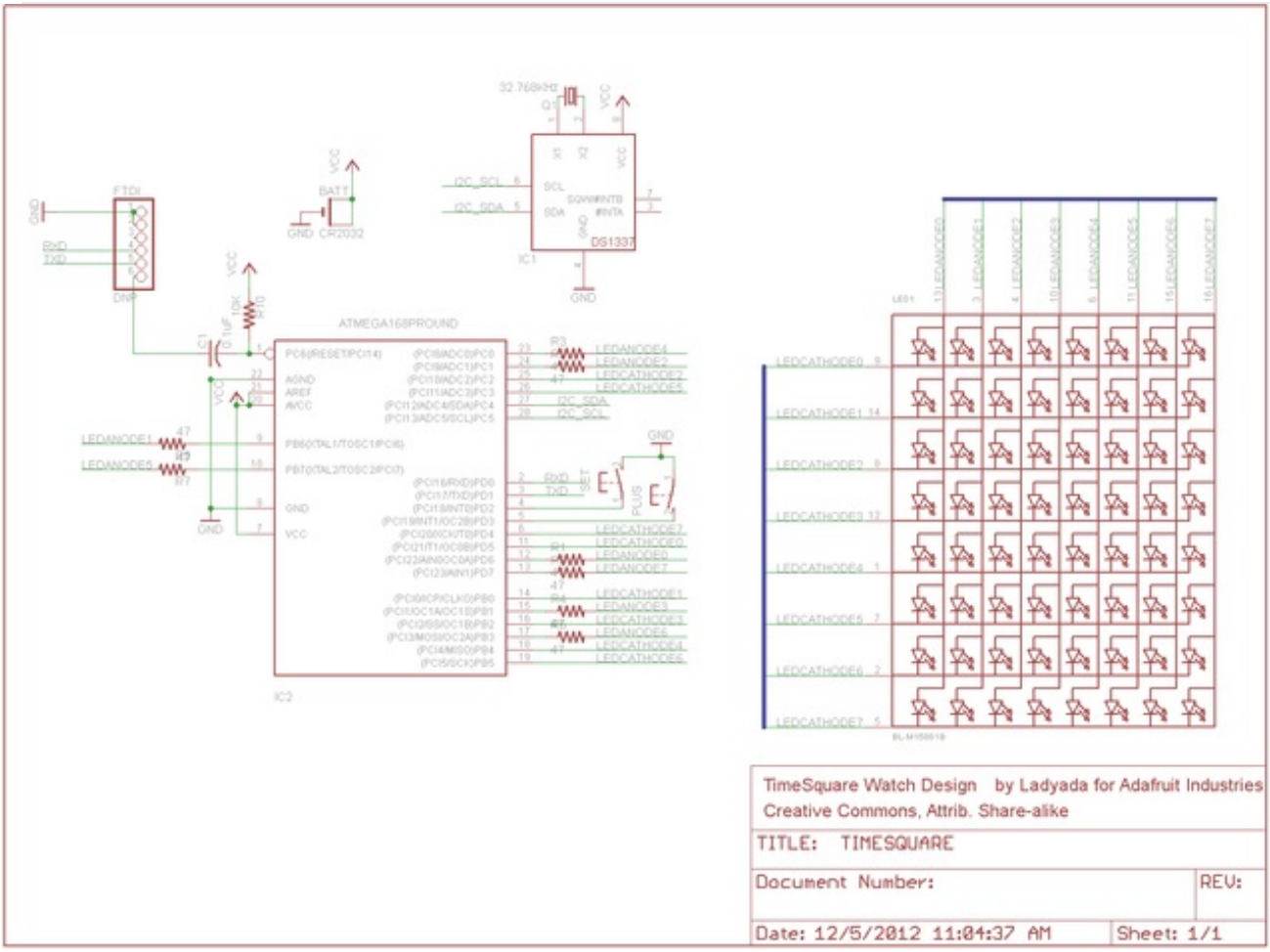


Next, download the TIMESQUARE watch codebase from github. Visit the github page and click on (http://adafru.it/aT8)**DOWNLOAD (http://adafru.it/aT8)** (http://adafru.it/aT8) **(http://adafru.it/aT8)**to download the ZIP file (http://adafru.it/aT8) and uncompress the folder. Rename the folder to **Watch** (check that the renamed folder contains the **Watch**.cpp and **Watch**.h files) and install into the **arduinosketches/libraries** folder. For information how to use and install libraries, see our tutorial (http://adafru.it/aYG)!

Restart the IDE

When programming, select **Lilypad Arduino w/ ATmega328** as the "board" type

Downloads


ATMEGA168PROUND
DS1337
TimeSquare Watch Design by Ladyada for Adafruit Industries
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TITLE: TIMESQUARE
Document Number:
REV:
Date: 12/5/2012 11:04:37 AM
Sheet: 1/1