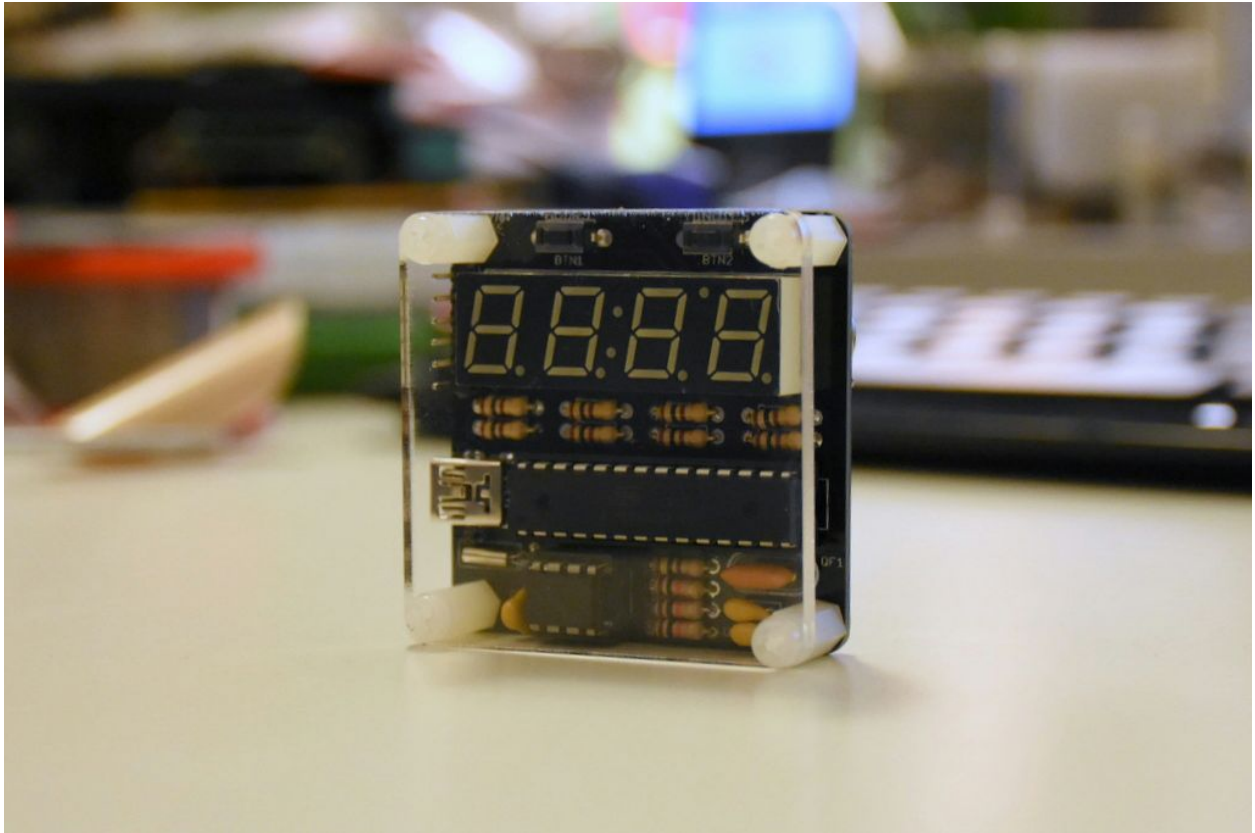


Arduino Clock

Assembly Instructions



Specifications

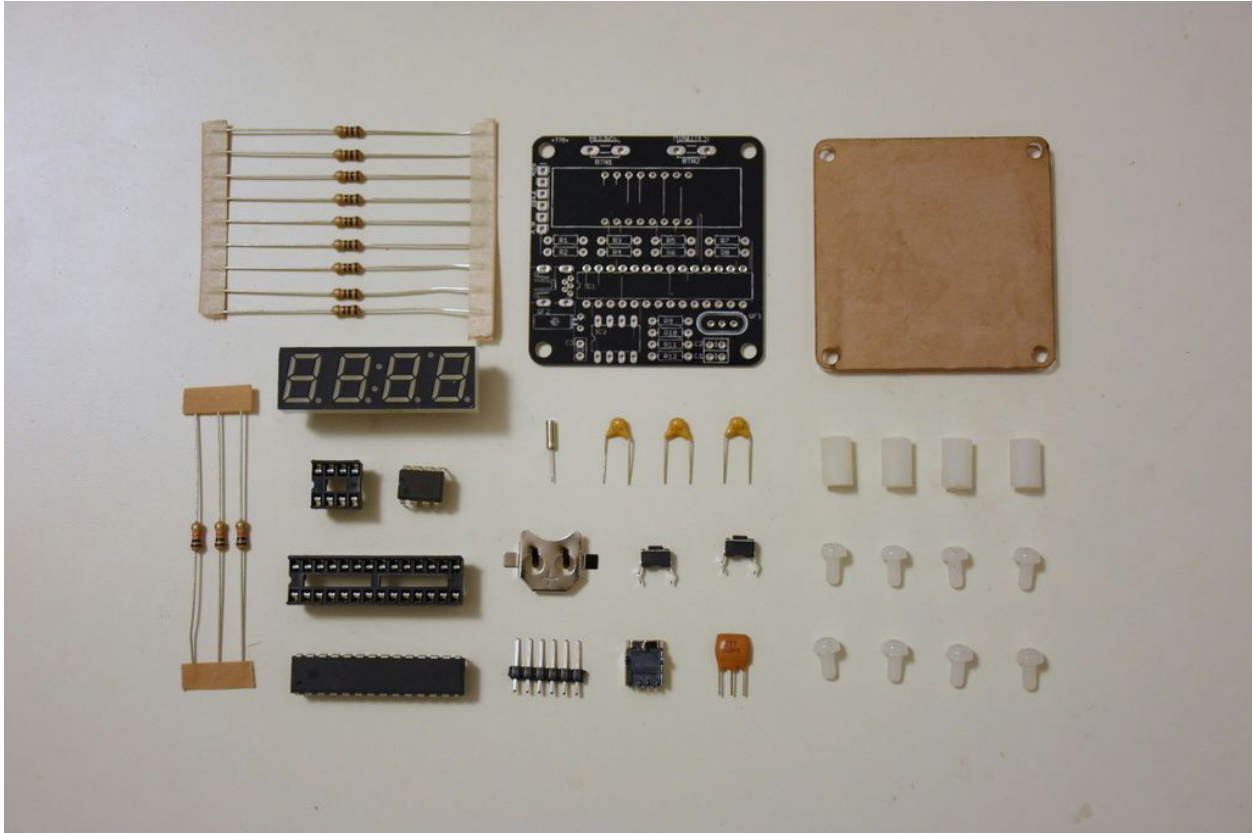
- 4 character 7-segment LED display
- ATMEGA328P with Arduino boot-loader
- 5V operation @ 16Mhz
- DS1307 battery backed clock
- 2x buttons to update minutes and seconds
- Mini USB power connector
- FTDI programming port

Parts List

Part #	Qty	Value	Device	Parts
1	9	82r	Resistor	R1, R2, R3, R4, R5, R6, R7, R8, R9
2	3	10K	Resistor	R10, R11, R12
3	3	0.1uf	Capacitor	C1, C2, C3
4	1	DIL28	28 pin IC socket	IC1
5	1	ATMEGA328P	Processor	IC1
6	1	DIL8	8 pin IC socket	IC2
7	1	DS1307	Calendar chip	IC2
8	1	16Mhz	Processor crystal	QF1
9	1	32.768khz	Calendar crystal	QF2
10	1	7SEG-4DIGIT	7 segment LED	LED1
11	1	CR1220	Battery clip	BATT
12	1	CR1220	3V battery	BATT
13	1	USB	Mini USB socket	X1
14	1	FTDI	Pin header	CN4
15	1	HOURS	Button	BTN1
16	1	MINUTES	Button	BTN2
17	1	n/a	PCB	Clock2.1
18	1	n/a	Acrylic front plate	n/a
19	4	n/a	Acrylic pillars	n/a
20	8	n/a	Acrylic screws	n/a
21	1	n/a	Mini USB cable	n/a

Parts

The kit is supplied with everything you will need to make your Arduino clock.



Other items needed

You will also need a few other items, if you don't have these at home, you can come into Cambridge Hackspace and borrow ours.

- Soldering iron
- Solder
- Screwdriver
- Wire cutters
- Multimeter
- 5v FTDI Programmer
- Computer for programming
- Power supply from old phone or tablet with USB power out (optional)

SOLDERING

IS A REALLY USEFUL SKILL.

IT IS ALSO WAY EASY!

*REALLY, IT IS!
YOU'LL SEE.*

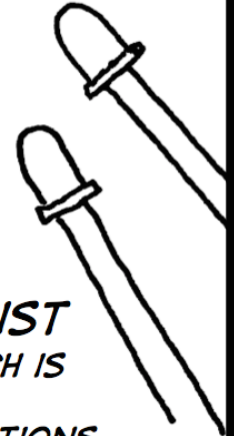
SOLDERING IS ALSO LOTS OF FUN!



IF YOU KNOW HOW TO SOLDER, YOU CAN MAKE JUST ABOUT ANYTHING WITH ELECTRONICS, WHICH IS JUST TOO COOL!

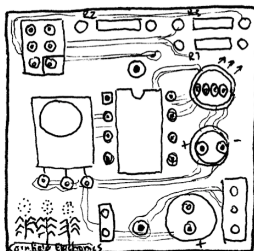
THERE ARE MANY WAYS TO MAKE GOOD SOLDER CONNECTIONS. I'M GOING TO EXPLAIN HOW I DO IT.

LET'S GET STARTED!



THERE ARE MANY WAYS TO CONNECT ELECTRONIC PARTS TOGETHER, BUT PERHAPS THE EASIEST WAY IS WITH A

PRINTED CIRCUIT BOARD

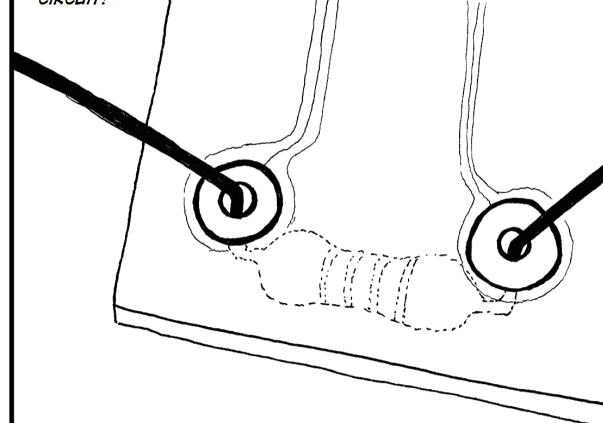


PCB OR
JUST
"THE
BOARD"

THE PCB MAKES IT EASY BECAUSE IT HAS PADS FOR EACH PART.

IF YOU LOOK CAREFULLY AT THE PCB, YOU WILL SEE LINES CONNECTING PADS TOGETHER WITH OTHER PADS - THESE LINES ARE CALLED TRACES.

MOST PADS HAVE A HOLE IN THE MIDDLE - THIS IS WHERE THE LEAD POKES THROUGH AND MAKES A CONNECTION TO THE CIRCUIT!



SO, TO SOLDER IN THE RESISTOR, YOU START BY FINDING THE CORRECT VALUE OF RESISTANCE FROM THE PROJECT'S DOCUMENTATION.

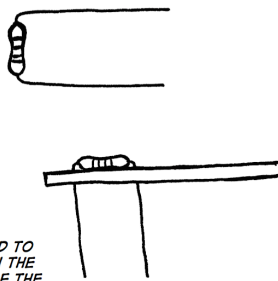
THEN BEND THE TWO LEADS OF THE RESISTOR DOWN THE WIDTH OF THE PART, LIKE THIS:

THEN PLACE THE TWO LEADS THROUGH THE TWO PADS ON THE PCB FOR THIS RESISTOR.

YOU PUSH THE RESISTOR'S LEADS THROUGH THE PADS UNTIL THE PART RESTS FLAT ON THE PCB

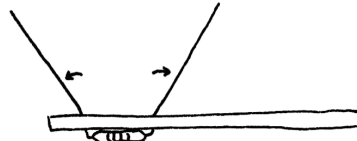
(SOMETIMES YOU MAY NEED TO WIGGLE AND TUG GENTLY ON THE LEADS FROM THE BOTTOM OF THE PCB TO DO THIS).

FOR MOST PCBs, ALL OF THE PARTS ARE PLACED THROUGH THE PADS ON THE PRINTED SIDE OF THE PCB (WHICH WE'LL CALL THE TOP OF THE BOARD), AND WE'LL SOLDER ALL OF THE PADS ON THE BOTTOM OF THE BOARD.



THEN YOU TURN THE PCB OVER SO WE CAN SOLDER THE TWO PADS.

AS YOU TURN THE PCB OVER, YOU WILL NEED TO HOLD THE RESISTOR WITH YOUR FINGER SO IT DOESN'T FALL OUT OF THE BOARD.

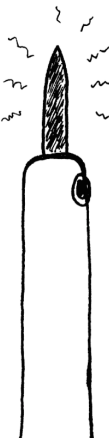


THEN YOU BEND THE LEADS OF THE RESISTOR OUTWARDS AT ABOUT 45 DEGREES SO THE PART WON'T FALL OUT WHILE WE SOLDER IT IN PLACE.

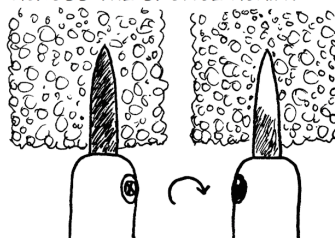
GOT IT? GREAT!

AS I SAID EARLIER, SOLDERING IRONS GET HOT ENOUGH TO MELT METAL. THAT MEANS THAT THE TIPS GET HOT ENOUGH TO OXIDIZE QUICKLY, WHICH BASICALLY MEANS THAT THEY GET DIRTY JUST SITTING IN THE AIR!

THE OXIDES ARE AN INSULATOR FOR HEAT, SO WE WANT TO CLEAN THEM OFF THE TIP BEFORE EACH SOLDER CONNECTION SO THE HEAT FLOWS NICELY AND WE CAN MAKE GOOD SOLDER CONNECTIONS.



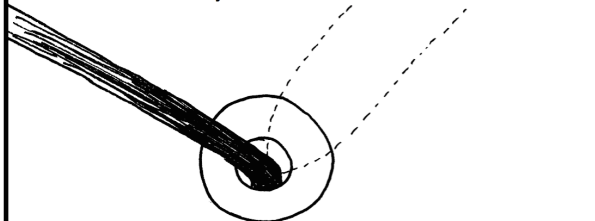
THIS IS WHY WE HAVE A WET SPONGE: TO CLEAN THE OXIDES OFF THE TIP. JUST SCRAPE THE TIP ACROSS THE SPONGE GENTLY, THEN ROTATE THE IRON AND SCRAPE GENTLY ACROSS THE SPONGE AGAIN.



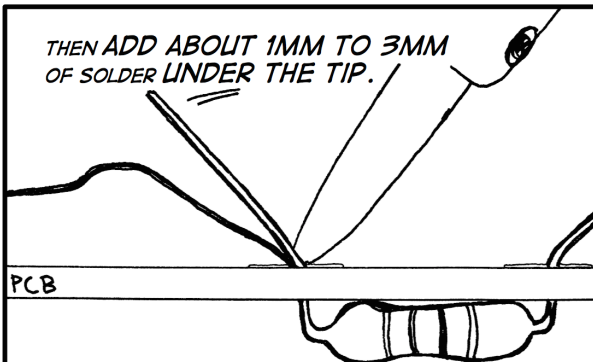
THIS SHOULD MAKE THE TIP SILVERY AND SOMEWHAT SHINY - READY TO SOLDER. REMEMBER TO CLEAN THE TIP LIKE THIS BEFORE EACH CONNECTION YOU MAKE - THE TIPS OXIDIZE QUICKLY!

IF THE TIP IS NICE AND SILVERY AND SHINY, YOU CAN MAKE GOOD CONNECTIONS.

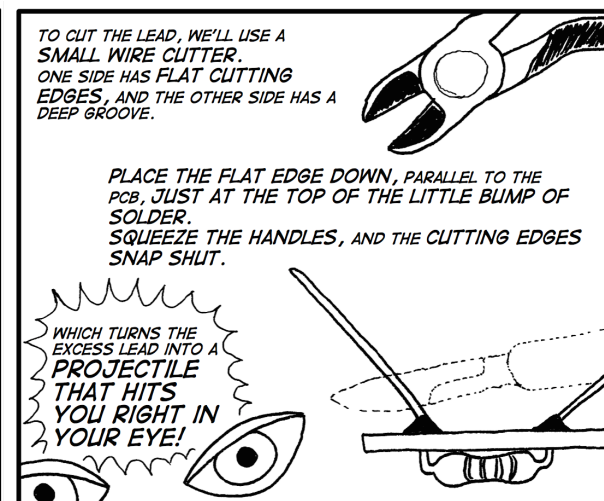
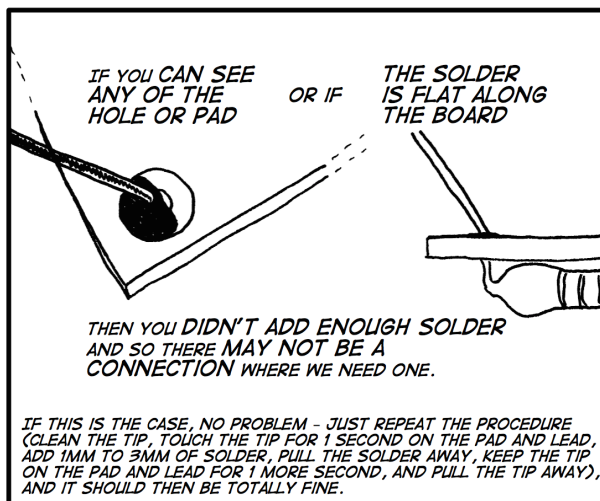
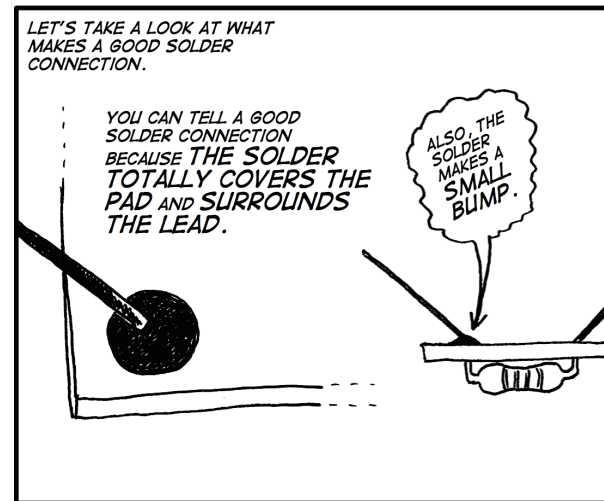
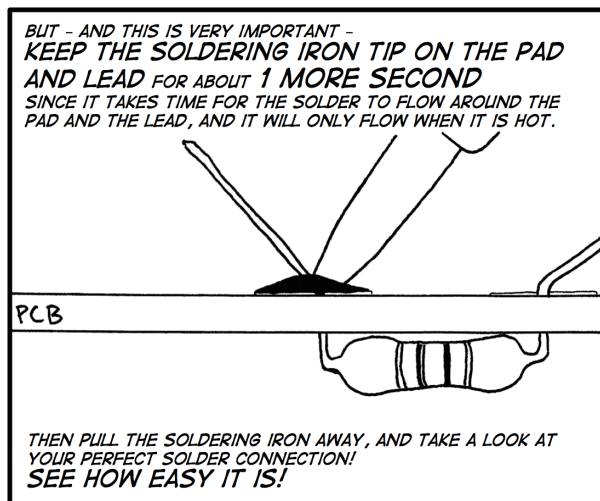
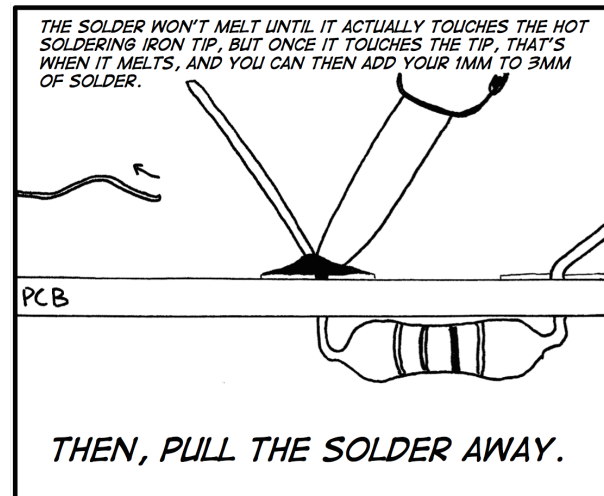
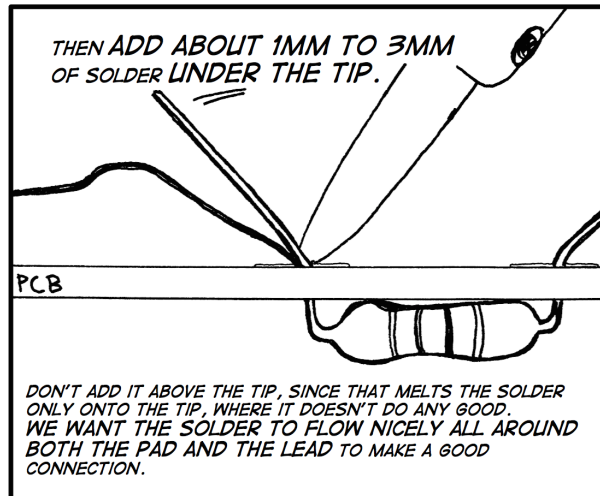
TOUCH THE CLEANED TIP TO BOTH THE PAD AND THE LEAD OF THE PART YOU WANT TO SOLDER. KEEP IT THERE FOR ABOUT 1 SECOND, SO EVERYTHING HEATS UP NICELY.



THEN ADD ABOUT 1MM TO 3MM OF SOLDER UNDER THE TIP.



DON'T ADD IT ABOVE THE TIP, SINCE THAT MELTS THE SOLDER ONLY ONTO THE TIP, WHERE IT DOESN'T DO ANY GOOD. WE WANT THE SOLDER TO FLOW NICELY ALL AROUND BOTH THE PAD AND THE LEAD TO MAKE A GOOD CONNECTION.



Assembly

We'll start with the shortest components first, building up to the taller ones. We do this so that the short ones don't fall out when you're soldering the tall ones.

This will become clear as you start to solder, especially if you forget a short one, and have to go back to add it in later.

For each component look for the part number on the table, and match it up with the part number on the board.

Below you can see that we are using part QF2, so look for that marking on the PCB.

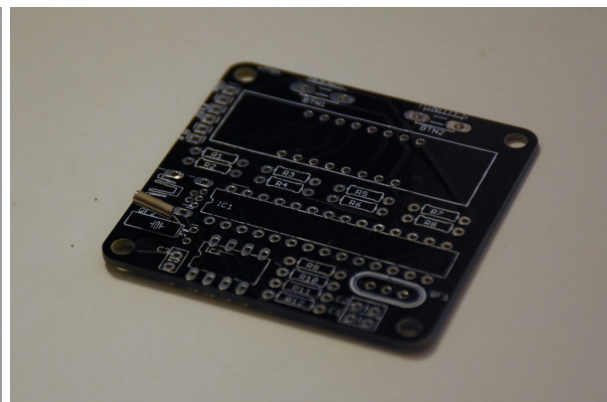
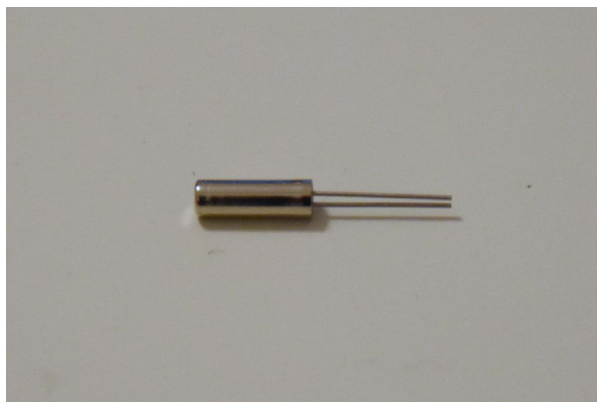
When a component has multiple pins, it's a good idea to start by soldering just 2 of those pins first, checking that everything looks good on the front before proceeding. If you notice that the component is on at an angle, or not flush against the back of the PCB, then you can adjust easily before soldering the rest of the pins.

Let's get started!

Calendar crystal

Part #	Qty	Value	Device	Parts
9	1	32.768khz	Calendar crystal	QF2

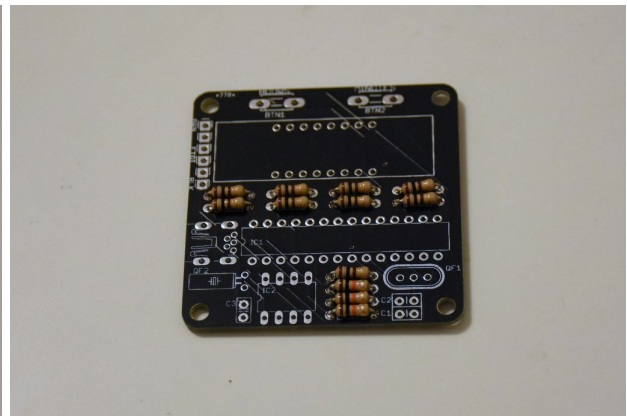
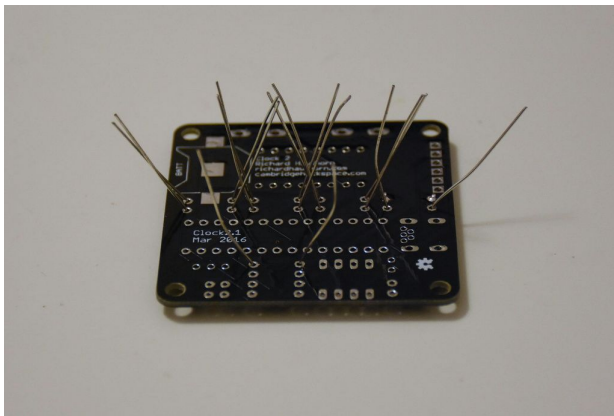
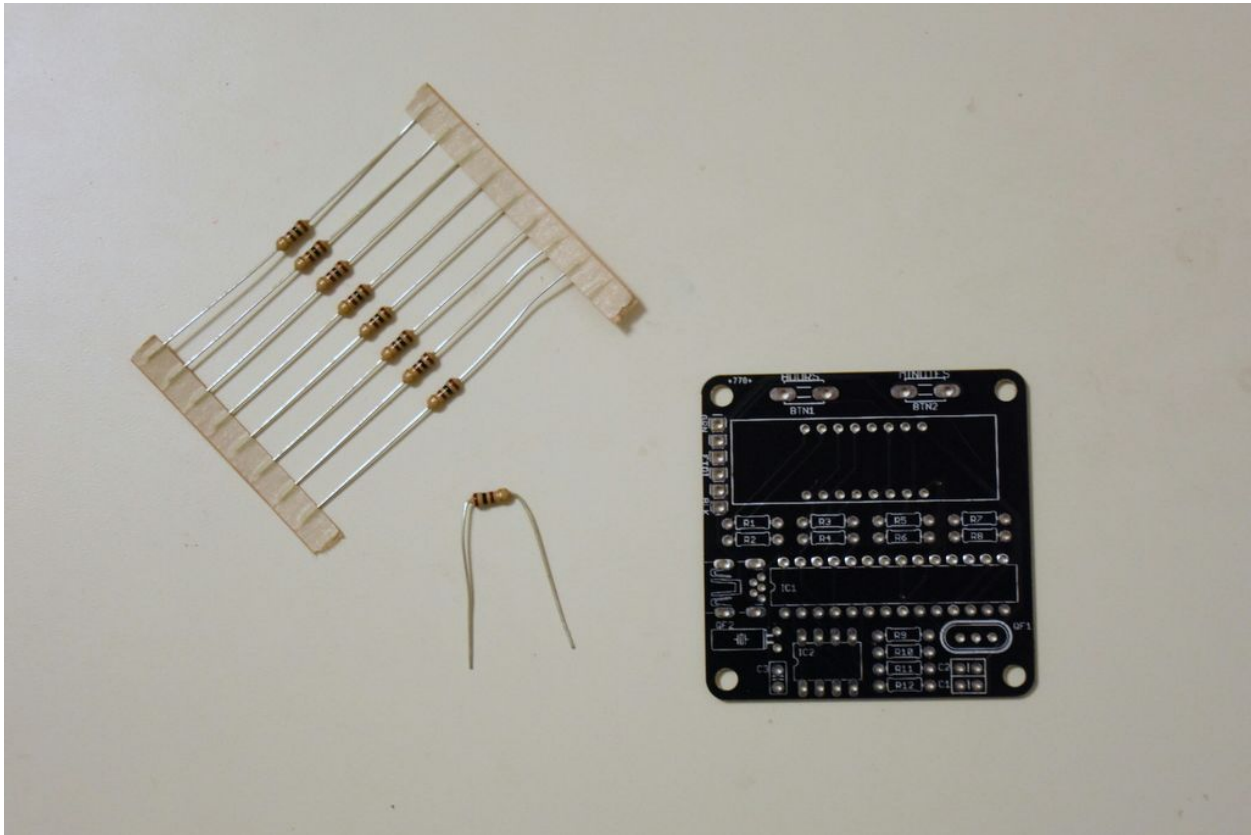
As the calendar crystal is the shortest component we'll start with it.



Resistors

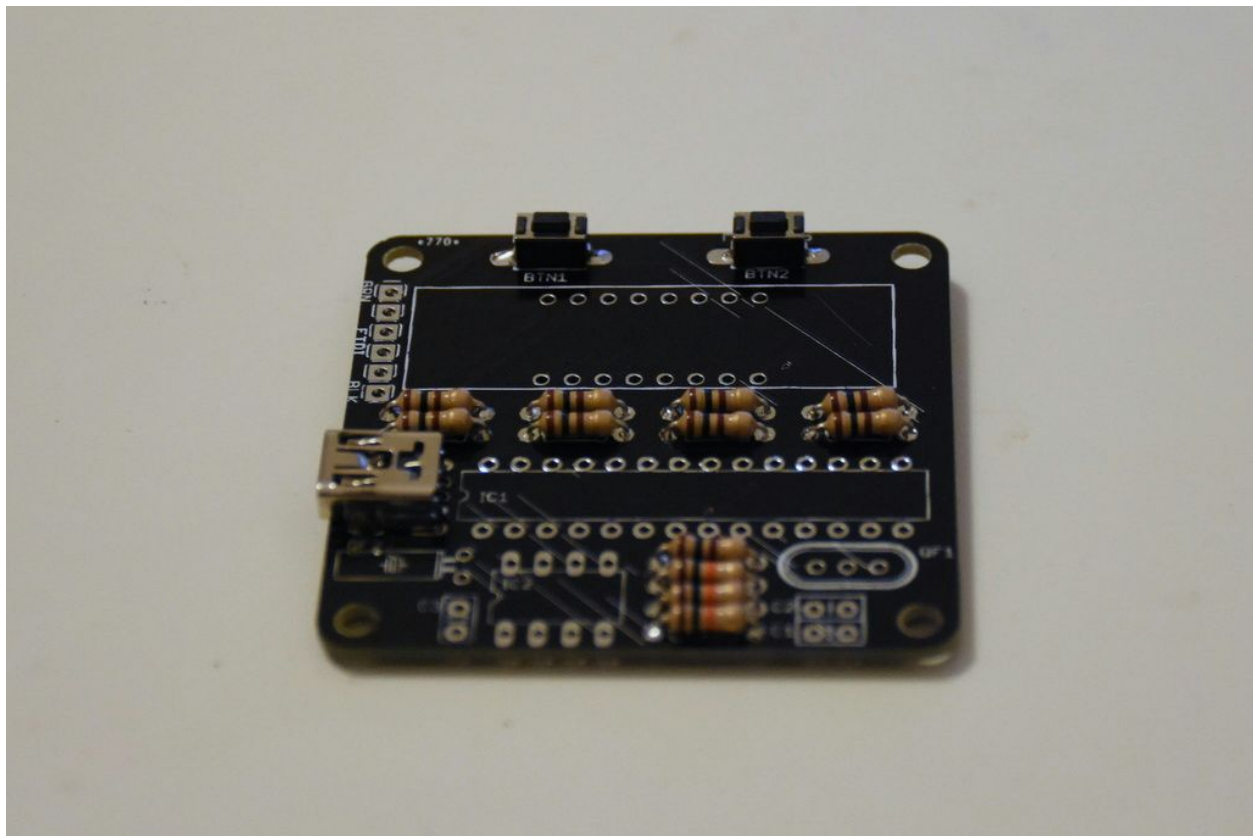
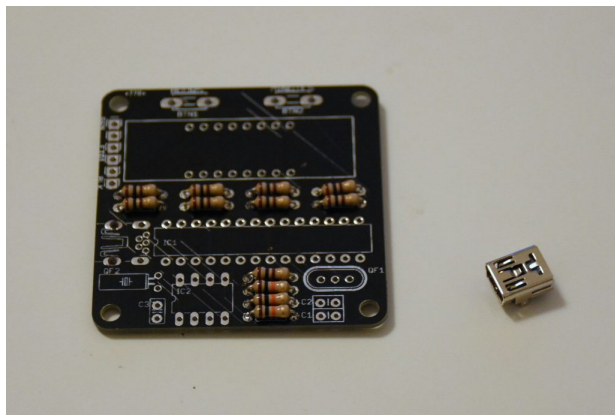
Part #	Qty	Value	Device	Parts
1	9	82r (grey red black)	Resistor	R1, R2, R3, R4, R5, R6, R7, R8, R9
2	3	10K (brown black orange)	Resistor	R10, R11, R12

It doesn't matter which way around these go. (see appendix for resistor colour codes)



USB Connector + Buttons

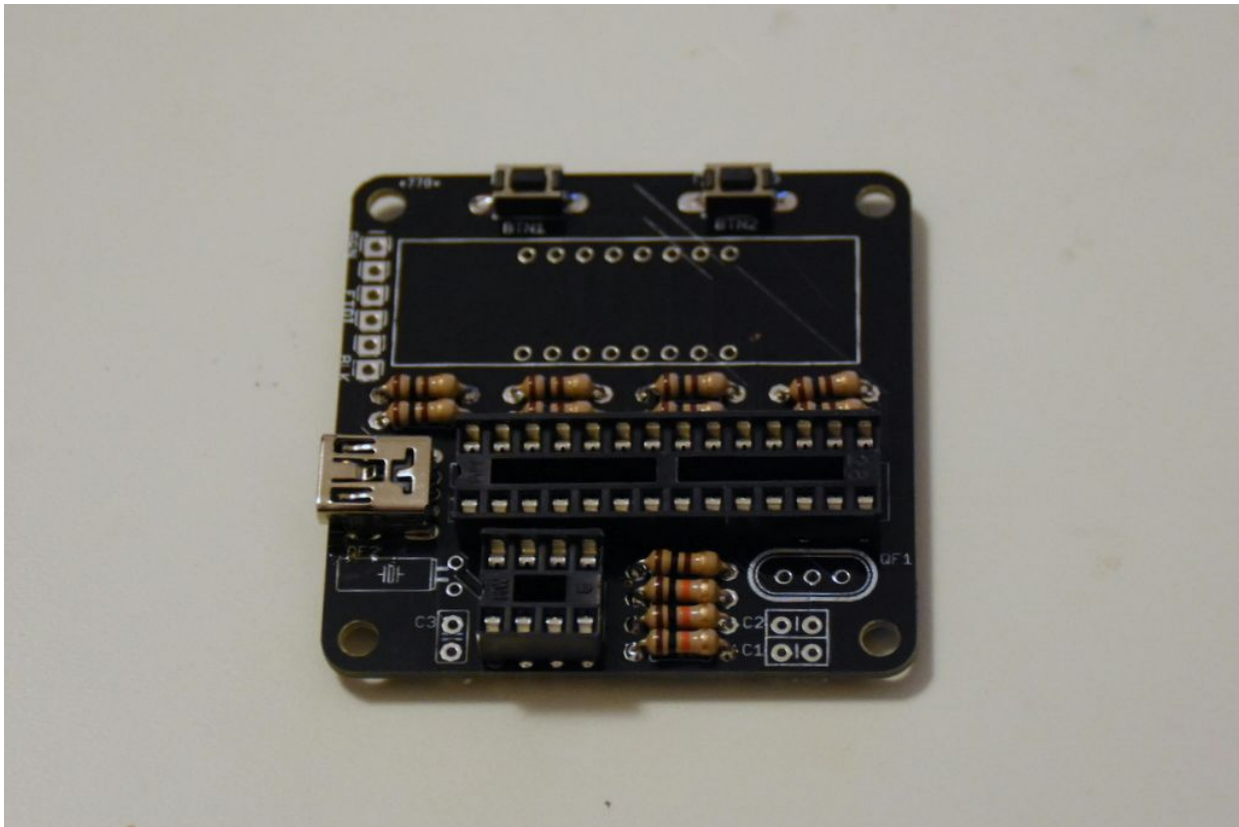
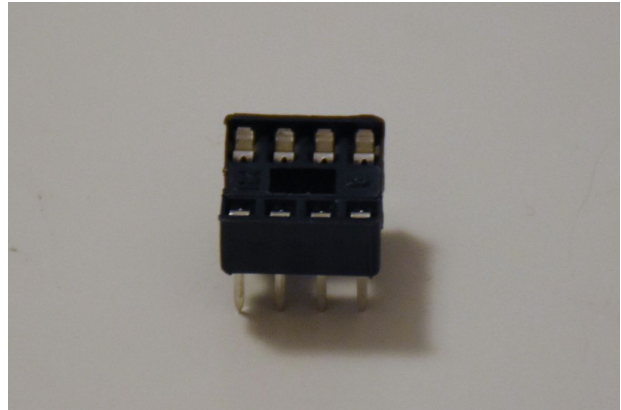
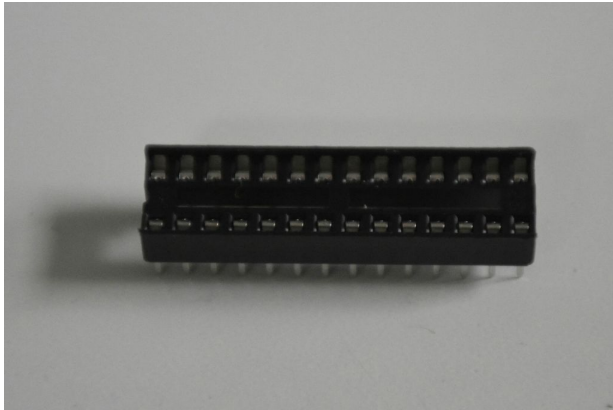
Part #	Qty	Value	Device	Parts
13	1	USB	Mini USB socket	X1
15	1	HOURS	Button	BTN1
16	1	MINUTES	Button	BTN2



IC Sockets

Part #	Qty	Value	Device	Parts
4	1	DIL28	28 pin IC socket	IC1
6	1	DIL8	8 pin IC socket	IC2

Make sure you have these the right way around, look for the notch in the end of the socket, and match that up with the notch on the PCB. (see appendix for pinout details)

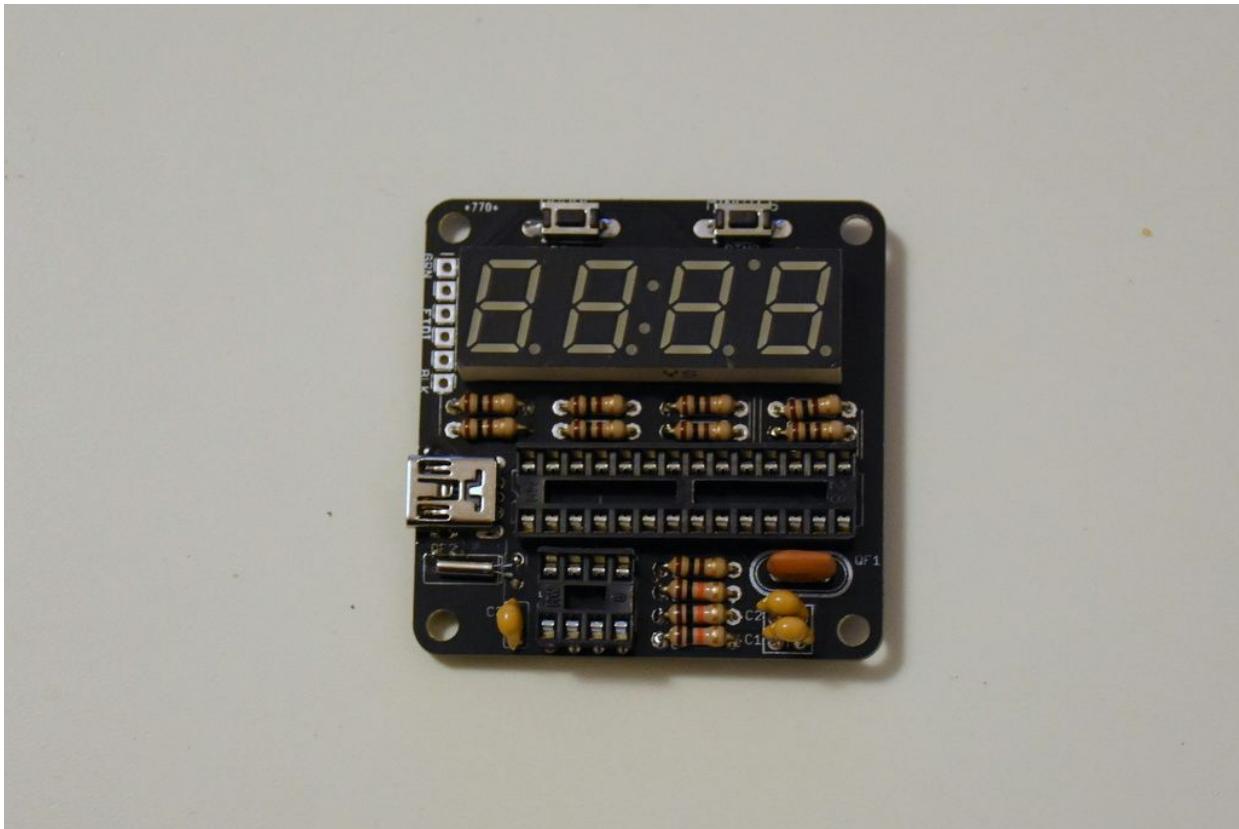
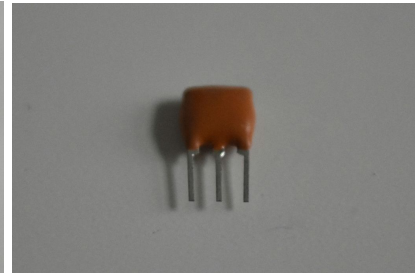
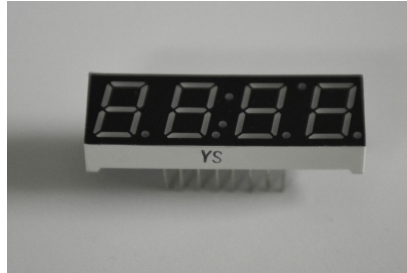


Capacitors + LED screen + Processor crystal

Part #	Qty	Value	Device	Parts
3	3	0.1uf	Capacitor	C1, C2, C3
8	1	16Mhz	Processor crystal	QF1
10	1	7SEG-4DIGIT	7 segment LED	LED1

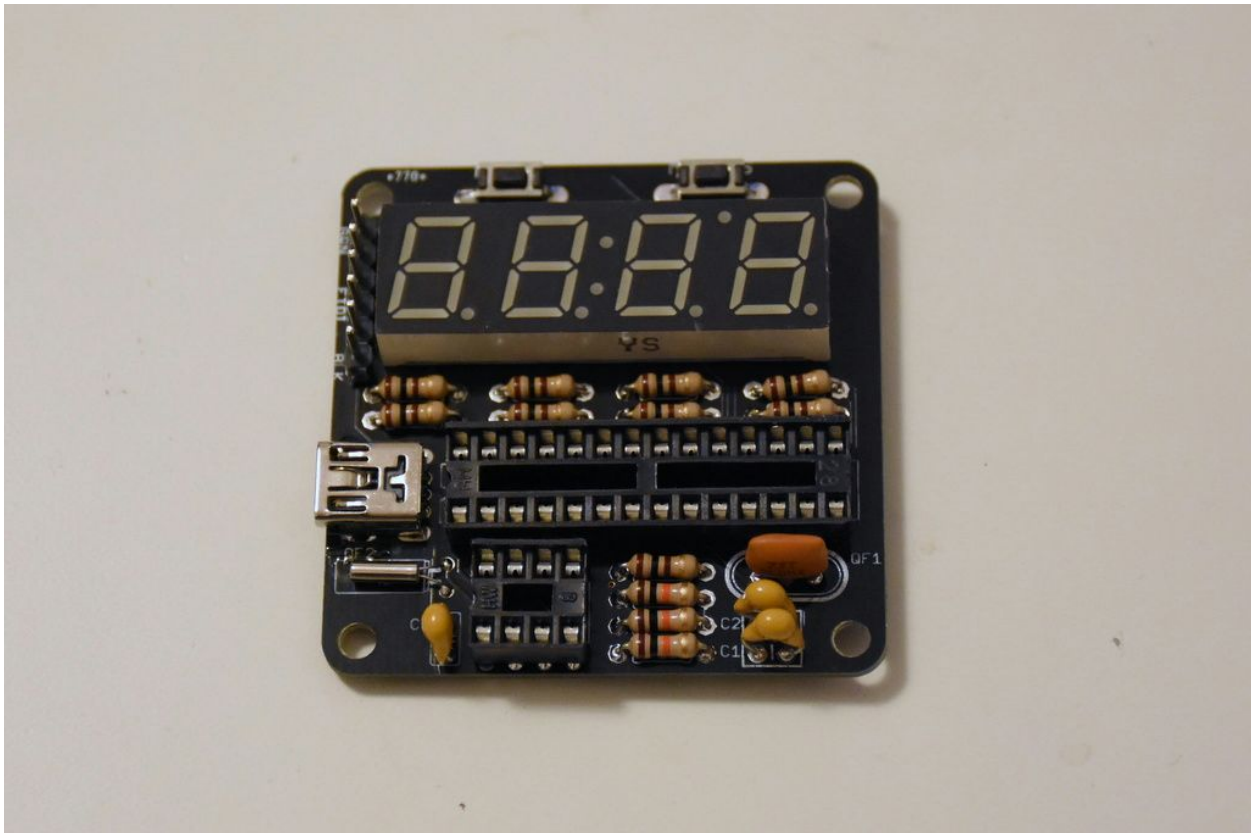
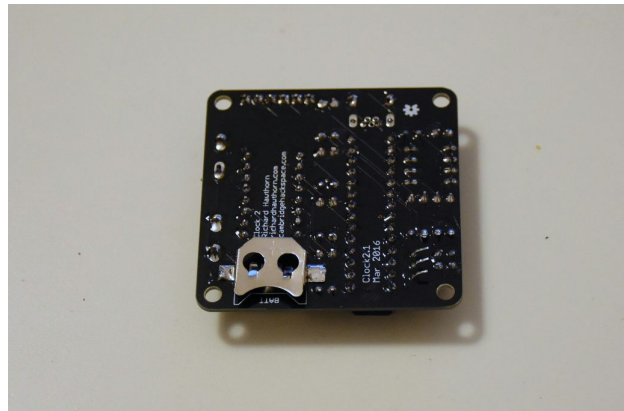
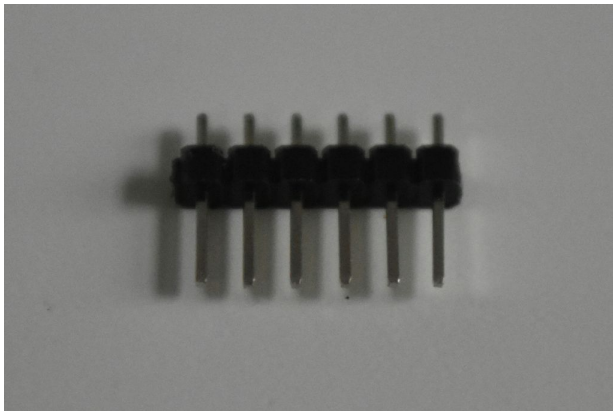
It's really important you put the LED screen in the correct way. Make sure the 4 decimal places are at the bottom of the screen, as shown below.

It doesn't matter which way around the capacitors or crystal go, you may have to bend the legs of the capacitors to fit them into the pcb.



FTDI connector + Battery clip

Part #	Qty	Value	Device	Parts
11	1	CR1220	Battery clip	BATT
14	1	FTDI	Pin header	CN4



Testing

Now is a good time to test your soldering

If you have already added your Arduino and calendar chips, then take them out now.

With your multimeter set to continuity mode, test to make sure you don't have a short on the power line. Try testing the processor pins 7 and 8, they should not be connected.

If you have a short here, or any other unexpected result during this build you will need to investigate further. Check your soldering to make sure pins are not shorted together, make sure all solder joints are clean.

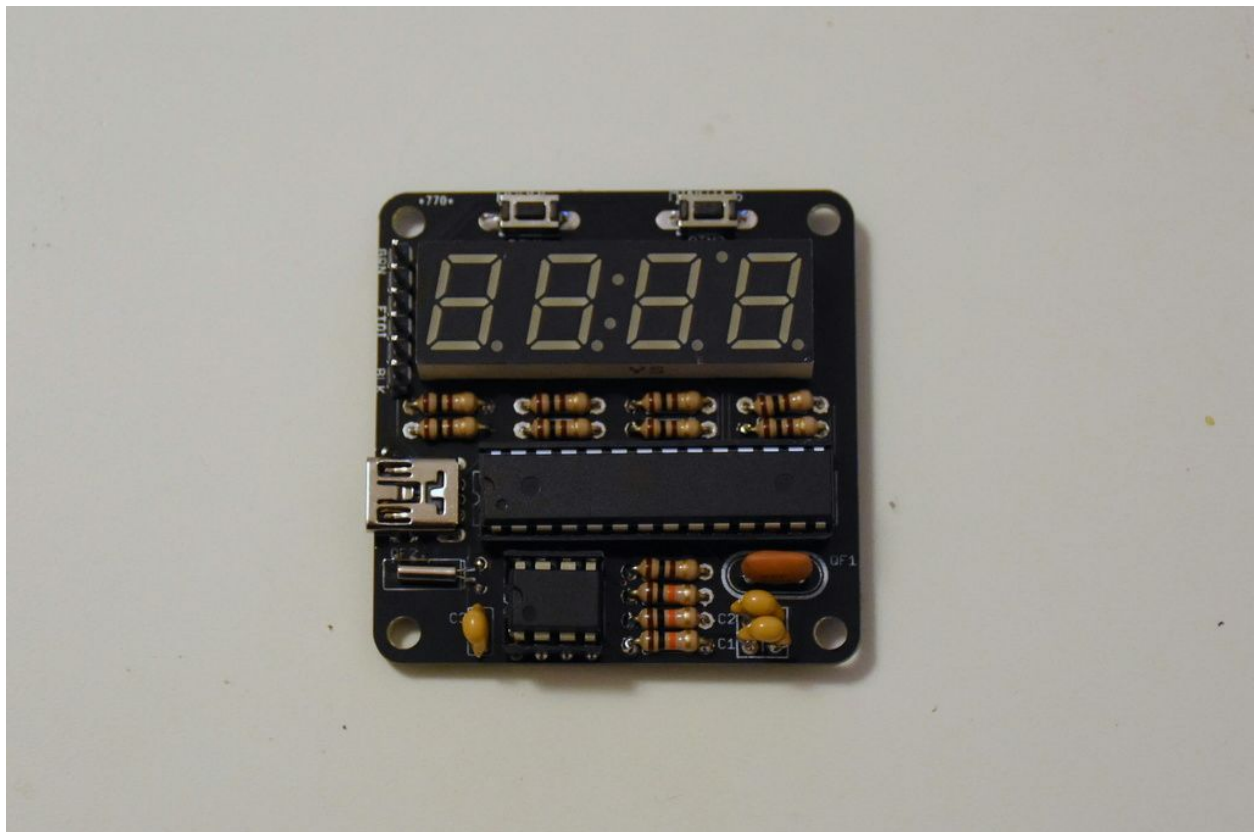
Plug in your USB cable, and check the power on the board, do you get 5v between pins 7 and 8 on the processor?

If you read anything less than 5v, unplug immediately.

If that all looks good then we can add our IC's.

Unplug the USB power connector before proceeding

Make sure the notch on the end of the ICs matches up with the notch on the socket.



Programming

You are now ready to program your device, grab an FTDI programmer, your USB cable and your laptop.

Make sure you have downloaded the Arduino IDE from [arduino.cc](https://www.arduino.cc)

You will also need the RTC library,

Download the library from here, using the 'download zip' button

<https://github.com/adafruit/RTClib>

Unpack the folder, and make sure you remove the '-master' from the folder name

Copy this into your Arduino Library folder, this will probably be located at `arduinofolder/libraries/`

Restart the Arduino IDE

You can now download the clock software here:

<https://github.com/richardhawthorn/Clock1>

When programming set the device as "Arduino UNO"

Connect the FTDI programmer to your clock, make sure that the 'blk' and 'grn' markings match up on the PCB and FTDI programmer.

You can now program the chip.

Now is a good time to add in your battery

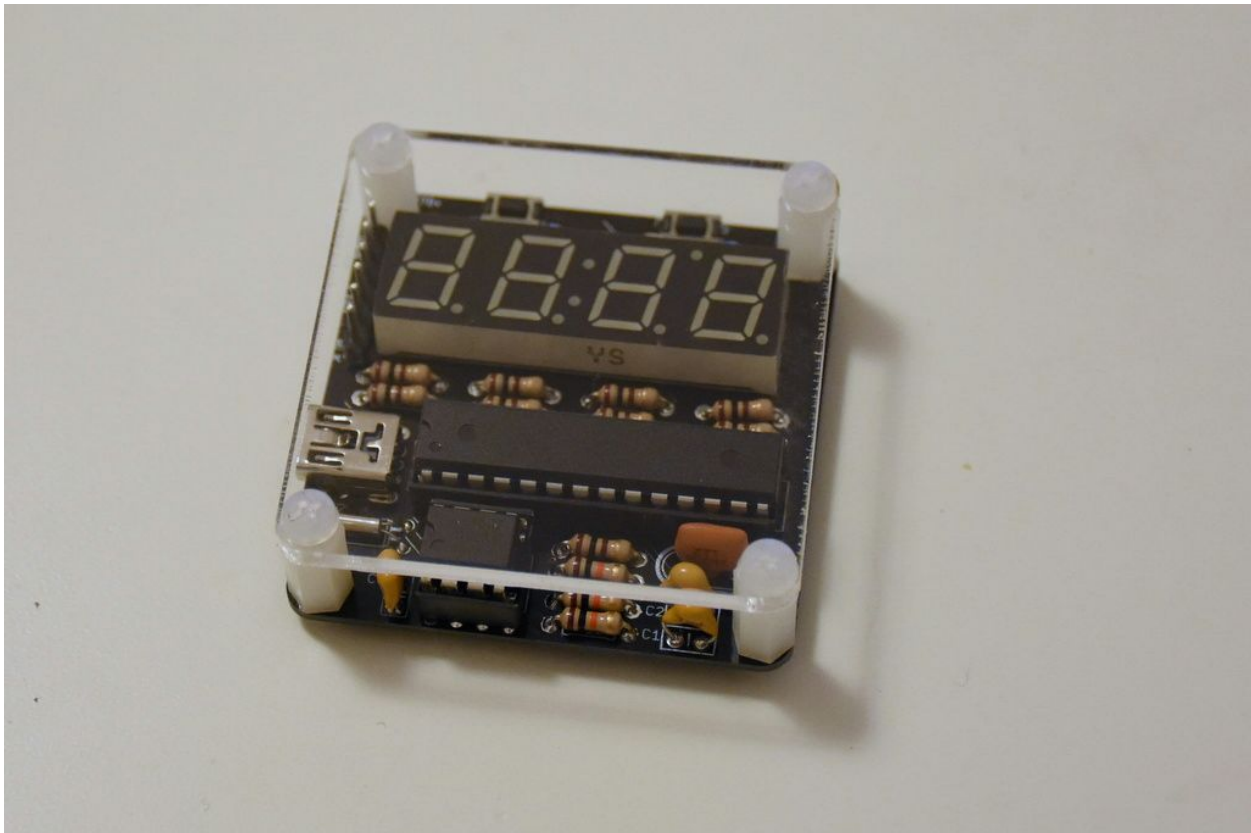
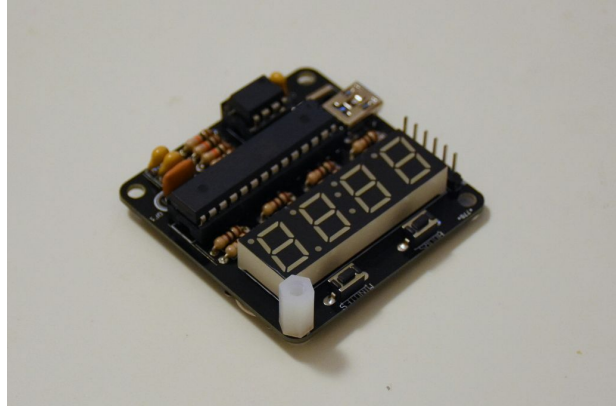
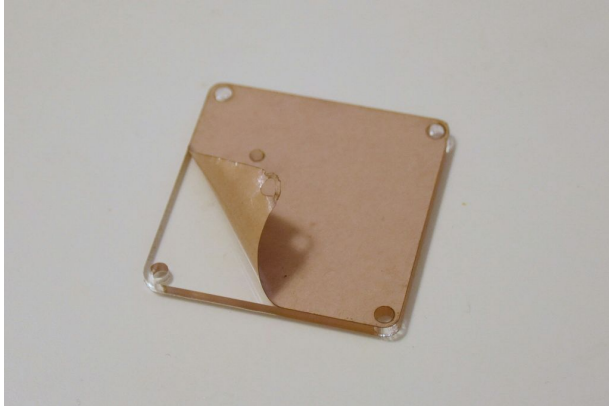
Potential Issues

Problem	Solution
Arduino does not program	Make sure the Arduino is powered correctly when the programmer is connected, check solder joints on the arduino chip. Make sure the FTDI connectors is on the right way.
Not all segments light up	Check your soldering on the Arduino chip and 7 segment screen
Display shows 6500	Make sure the calendar chip is in correctly, and that the battery has been added.

Front Plate

Once you have the software working you can add the front plate.

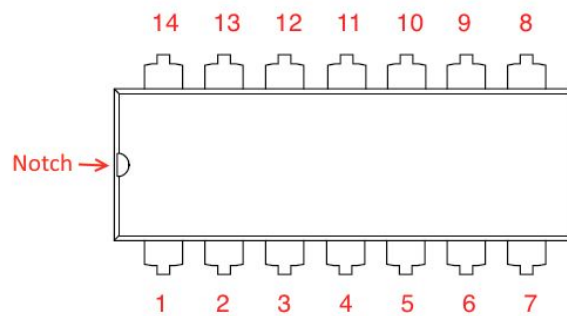
Remove the plastic from the acrylic front plate, and screw it to the pillars. This can then be attached to the PCB using the remaining screws.



Appendix

General component information

You need to make sure you add your ICs in the right way around, they will have a notch at one end, this will let you know which way around they go. You can identify pins by counting anti clockwise from the notch.



Resistor Values

Resistors can be read by looking at their colour code, using the following table.

Colour	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	1 Ω	
Brown	1	1	1	10 Ω	$\pm 1\%$
Red	2	2	2	100 Ω	$\pm 2\%$
Orange	3	3	3	1k Ω	
Yellow	4	4	4	10k Ω	
Green	5	5	5	100k Ω	$\pm 0.5\%$
Blue	6	6	6	1M Ω	$\pm 0.25\%$
Violet	7	7	7	10M Ω	$\pm 0.1\%$
Grey	8	8	8	n/a	$\pm 0.05\%$
White	9	9	9	n/a	
Gold				0.1 Ω	$\pm 5\%$
Silver				0.01 Ω	$\pm 10\%$

Credits

Designed, tested, and documented by Richard Hawthorn

www.richardhawthorn.com

@richardhawthorn

Soldering comics

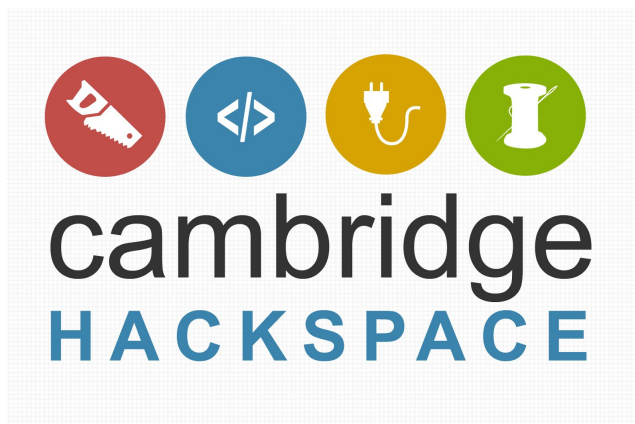
Soldering comic excerpts from Jeff Keyzer - @mightyohm

<http://mightyohm.com/blog/2011/04/soldering-is-easy-comic-book/>

Workshop

Run as a workshop at Cambridge Hackspace

www.cambridgehackspace.com



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