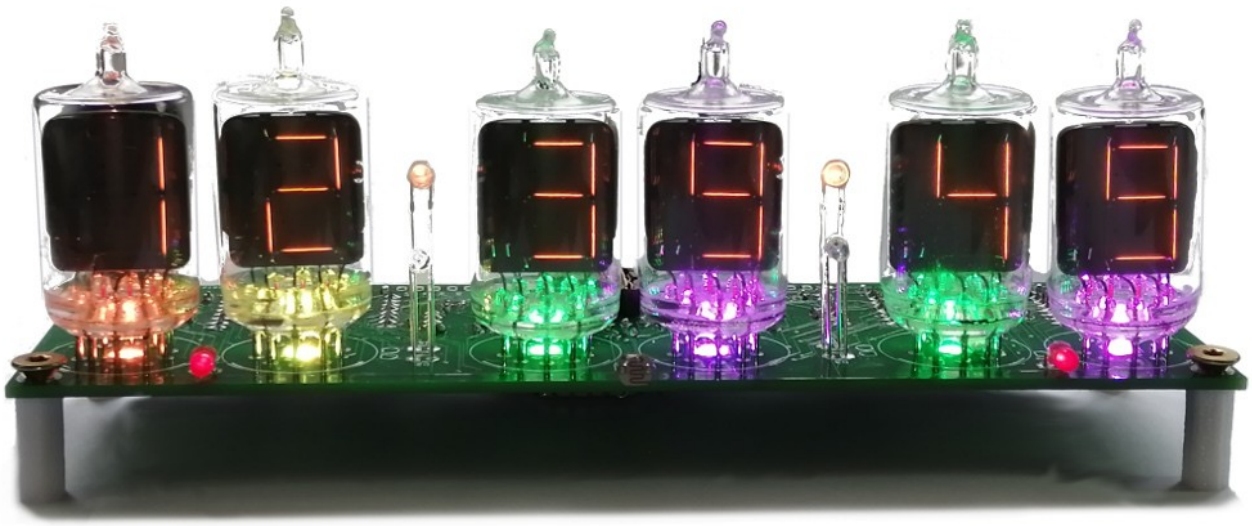
DA2000 6-Digit Numitron Clock "Revision 1.02"

Construction Manual



Index

Table of Contents

About this document

This is the construction manual for the 6-Digit Numitron Clock with DA-2000 tubes, based around the ESP8266, using an Wemos-D1 mini R2. It covers how to build the clock shown above.

If you want to have the user operating manual, please find the appropriate version matching the firmware you are using (the clock will tell you on startup, and it should be marked on the packing slip you received) at:

https://www.nixieclock.biz/Manuals.html

Look for the document called “DA2000 6-Digit Numitron Clock User Manual Vxx”, where “xx” is the version you are using.

Contact Information

If you want to get in contact with us, please email to:

nixie@protonmail.ch

We'll usually get back to you right away. We can help you with kits or construction.

We also offer discounts for direct purchases, we save the Ebay fees, and share this with you.

http://www.nixieclock.biz/Store.html

Troubleshooting

If everything does not work as you expect, please carefully look at the tests in the construction steps, and the troubleshooting tips.

At the end of the manual, there is a troubleshooting section, which goes through some of the common problems.

There is also a forum where many problems have already been dealt with at:

http://bit.ly/2Ec0OvW
(redirects to https://www.tubeclockdb.com/forum/wemos-nixie-clock-support-forum)

You can also find other helpful people here!

Component Identification

Sometimes it is hard to tell one component from another. Please see the “Component Identification” manual to help you tell one component from another. You can get this document here:

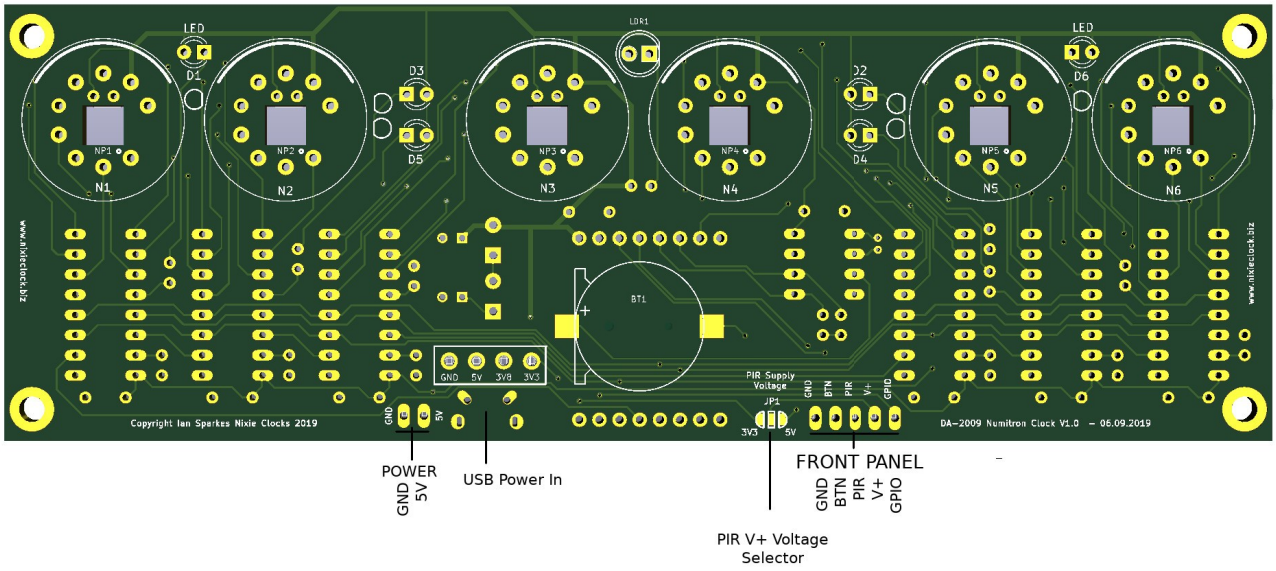
https://www.nixieclock.biz/Manuals.html

Board layout

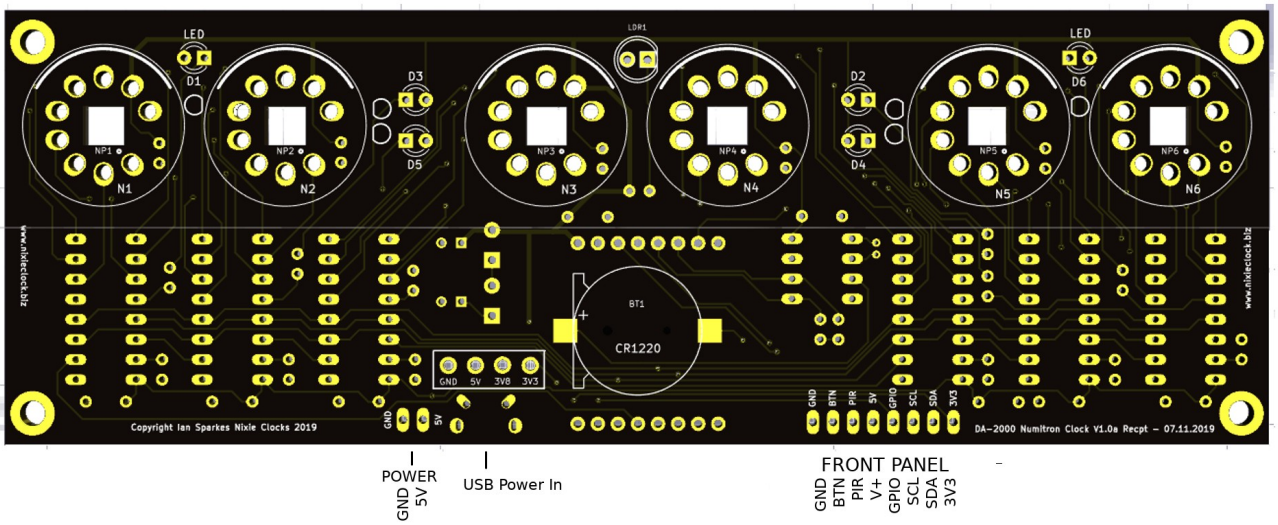
There are several different layouts available, depending on the version you ordered.

For reference, the main board layout is as shown (viewed from the top):

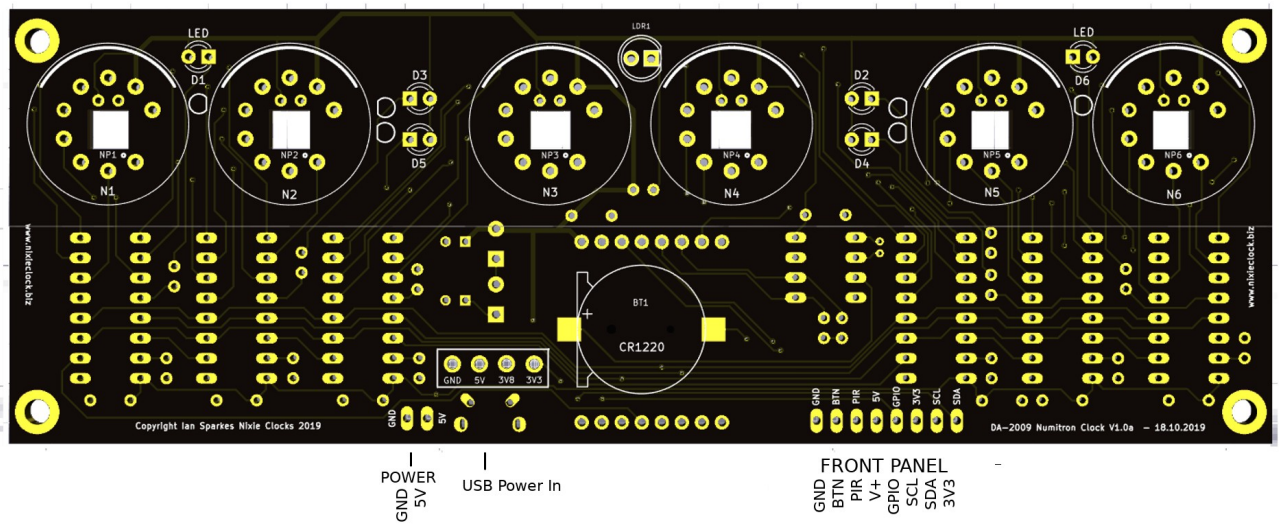
DA2000 Version 1.0, 5-pin header:



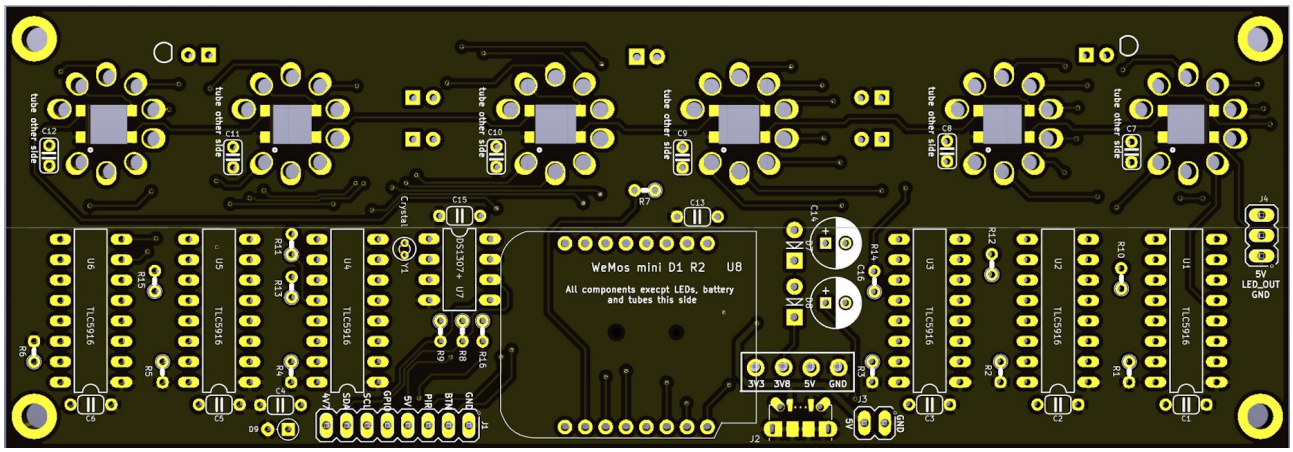
DA2000 Version 1.0, 8-pin header, Pin receptacles:



DA2000 Version 1.0, 8-pin header, Pin receptacles:



Back of the board:



The connections are:

Connector	Description
Power	External power should be applied to the board with this connector. A 5V DC input source can be used, as long as at least 1A is available from the input. The input must be regulated. **GND:** The negative side of the input supply **5V:** The positive side of the input supply, with a voltage of 5V DC.
USB Power In	A standard USB “B” charger can be used to run this board. A charger suitable for a smart phone is ideal.
Front Panel	These are the controls that go on the front panel: The input button and a PIR or microwave motion sensor can be used. **GND:** The “ground”. One lead of the button and one lead of the motion detector are connected to this. **BTN:** The other lead of the button is connected to this input **PIR:** The output pin of the PIR or microwave detector is connected to this pin. **V+:** voltage output to drive a PIR or microwave module. The voltage at this pin is user selectable to 5V or 3V3 using the solder jumper JP1. **GPIO:** A GPIO (General Purpose Input/Output) pin. Currently there is no specified use for this pin, and it is reserved for future expansion. **SCL:** The SCL line of a 3V3 compatible I2C interface. **SDA:** The SDA line of a 3V3 compatible I2C interface. **3V3:** The 3V3 line of a 3V3 compatible I2C interface. **4V7:** Stabilised 4V7 used for driving a microwave detector.

Construction

Preparation

You should have a small tipped soldering iron, some thin (< 1mm) solder, and electronic side cutters.

There are a few SMD components to install, to mount these, thinner solder (<= 0.6mm) and some electronic tweezers are recommended.

Kit Contents

When you unpack the kit, you should find the following contents as listed in the BOM (Bill of Materials). It is best to check the contents before you start, and notify me straight away if you are missing any components.

Please see the appendix to help you identify individual components.

USB connector

Parts List:

J2	USB B connector
J3	2 pin header (see note)

Note!

If you bought the board with the USB connector pre-mounted, you can skip this step!

This is the hardest part of the build. Soldering with surface mount component is quite tricky and requires a very light touch. If you are worried about it, it is possible to get the board with the SMD components pre-mounted and tested.

Spread a small amount of solder paste under the connector and in the mounting holes and put the connector in place. Turn the board over and solder the mounting holes, adding solder to fill them up and fix the connector in place. Add pressure to the connector to make sure that it is close to the board surface while you are soldering it.

Once the connector is physically connected, turn the board over and **carefully** solder the tiny wires with a heat gun or small tipped soldering iron.

Notes:

- There is an alternative power supply to the board possible via J3. If you do not want to use a USB power supply, mount J3 and use that to supply the power instead.

Test Step

Once the connector is mounted, test between the GND and 5V test points to see if there is continuity between the over rails. **If there is**, you must check for solder bridges! Do not move on until you have cleared the short circuit.

Note that solder paste is conductive even before being soldered, and therefore will seem short until you have finished soldering.

Test Step

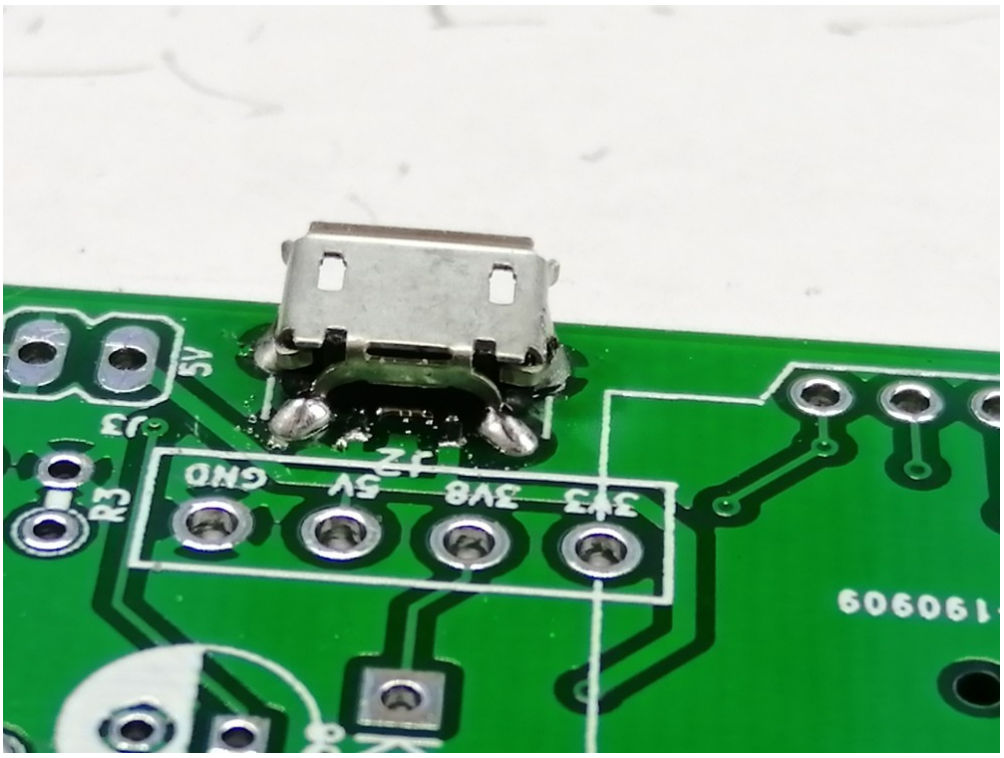
Once you have performed the continuity check, put power into the board via a USB power supply and check that you can read 5V between the GND and 5V test points. **If there is not 5V**, you must check for incomplete solder connections on the right most pin of the 5 tiny pins!

If you want to watch a video of this build step, please see the associated video at:

YouTube: https://youtu.be/Kmx90PTDylM

BitChute: https://www.bitchute.com/video/2ZtHA3Cn6v61/

After soldering, the socket should look like this:



Back lights circuit

Parts List:

NP1 - NP6	WS2812B
C7 - C12	100nF 0805 or 2.54mm

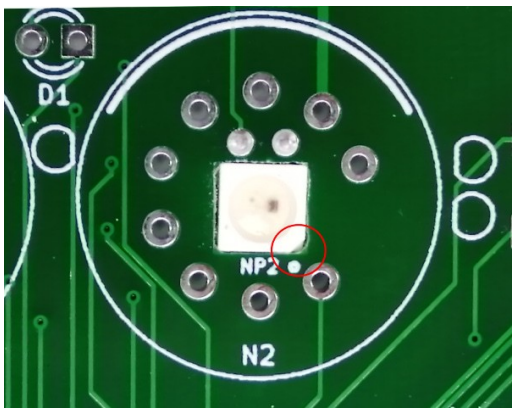
Note!

If you bought the board with the LEDs pre-mounted, you can skip this step. The soldering with surface mount components is not very difficult, but if you are worried about it, it is possible to get the board with the components pre-mounted and tested.

Mount the NeoPixel LEDs and capacitors, making sure you mount the LEDs in the right orientation.

Notes:

- The NeoPixel LEDs should be mounted from the reverse side of the board. If they are a tight fit, enlarge the holes slightly using a jeweller's square file until they fit into the holes without having to force them.
- The LEDs have to be mounted with the tiny notch on the LED matching the cut off corner of the silk screen (see the picture below – the red lines mark the notch and the cut off corner)
- The WS2812B are easily damaged by heat. Please solder them rapidly. A spare is in the parts, just in case.
-

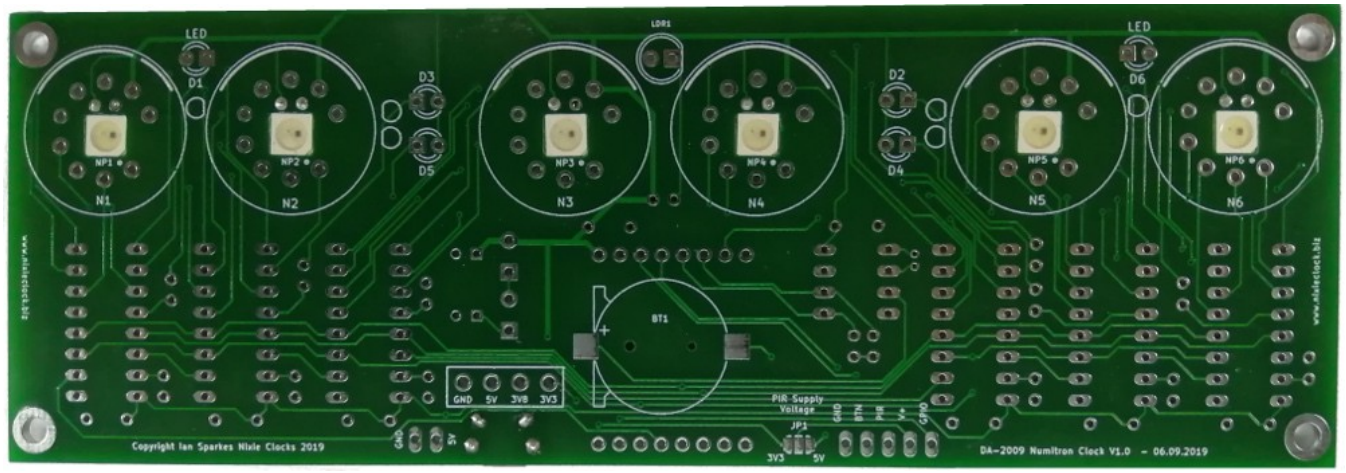


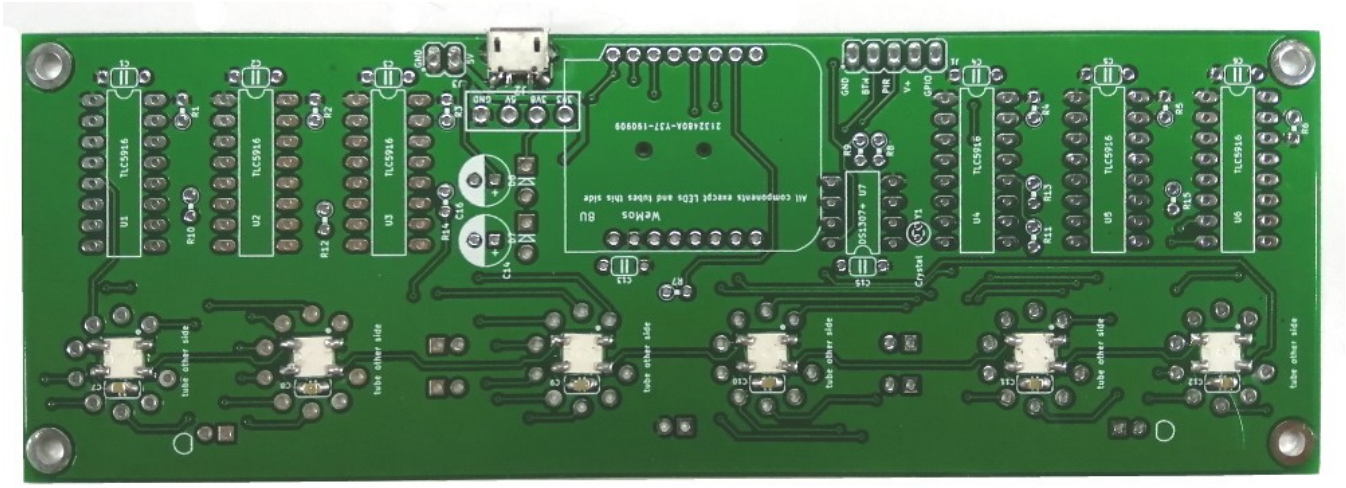
If you want to watch a video of this build step, please see the associated video at:

YouTube: https://youtu.be/9Uc2u4l3340

BitChute: https://www.bitchute.com/video/1UVB6teyw5VB/

After you have installed the components, your board should look like this:





Wemos controller

Parts List:

J3	01 x 02 male header
U8	Wemos D1 R2 Mini
C13	100nF
C14	220uF 10V

This part of the circuit mounts the controller and checks that it drives the NeoPixels. If you received the kit with the components from the previous steps already mounted, this step is the first one you need to do.

Note!

If you are **confident** in your electronic skills, you can mount the controller without using the female header strips. If you decide to do this, be aware that problem solving later might be more difficult.

If you mount the controller without the headers, make sure that the clearance between the USB connector on the Wemos board and the tracks on the PCB is sufficient!

Put the parts on the board in the marked locations in the order they appear on the list.

Notes:

- C14 must go the right way round. The negative side is marked with a stripe. (See hint).
- U8 comes with header strips, which are optional. If you mount the Wemos on the header strips, it will stand quite a long way from the board. If you mount the Wemos without the headers, of course it will not be possible to remove it afterwards.

Test Step

Once all the components are on the board, hook up the power. If you have a lab bench power supply, use this for the first power up, with the current limited to 200mA.

Check that the NeoPixels start to light up in the test sequence. Note that the entire test sequence will take more than a minute to complete.

See the user manual for information about the test sequence.

Hint: The 220 uF capacitor

The electrolytic capacitor has a stripe on it to denote the **negative** side of the capacitor. The positive side of the capacitor (which goes into the “+” on the board) is the other one!

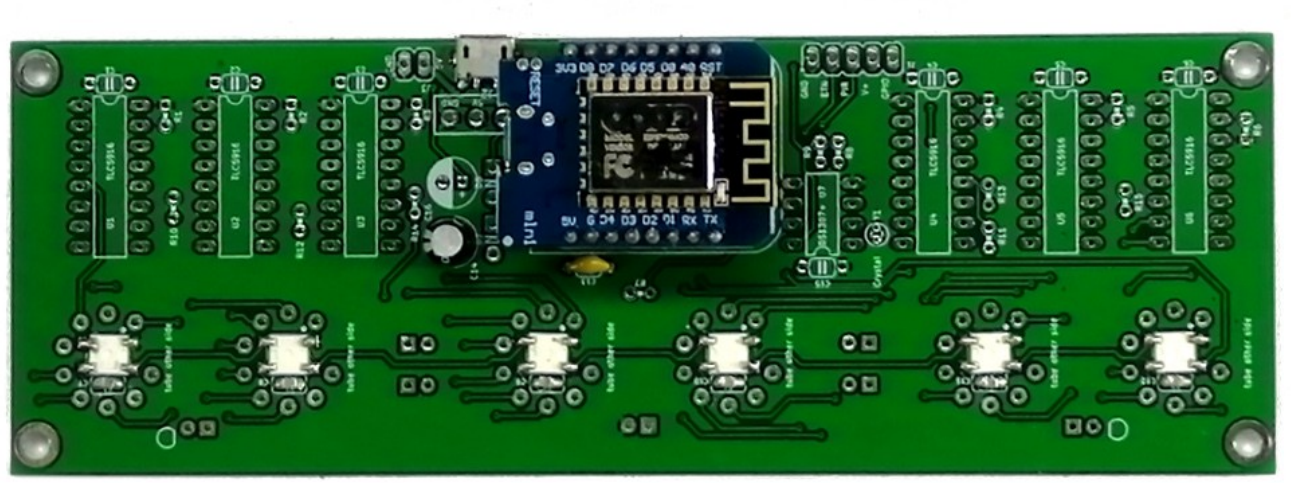
220uF capacitor “stripe”

If you want to watch a video of this build step, please see the associated video at:

YouTube: https://youtu.be/5bswdQ6vPZo

BitChute: https://www.bitchute.com/video/nAZvyUY74KCK/

At the end of the low voltage circuit build, your board should look like this:



Tube drivers

Parts List:

U1 - U6	TLC5916N
C1 - C6	100nF 5.08mm
R1 - R6	910R
DIP16	16-pin DIP sockets
D7, D8	1N4007
C16	220uF 10V

This step builds the main drivers for the tubes. These are 6 identical circuits, one for each tube. The supply for the drivers is derived from the 5V supply by using a diode dropper (D7, D8) to provide an intermediate supply voltage, which means that the logic signals provided by the Wemos (3V3 outputs) are compatible to the drivers.

Notes:

- C16 must go the right way round. The negative side is marked with a stripe. (See hint).
- D7 and D8 must go the right way round. The white stripe on the body must go into the hole with the square outline.
- Put the sockets in with the notch facing the notch marked on the silk screen. When you put the drivers into the sockets, align the notch on the chip with the notch on the board and the socket.
- Make even more sure that the chip goes into the sockets the right way round. The chip also has a notch, and this should match up with the notch on the socket **and** on the board.

Test Step

Once you have populated the components, power on the circuit and test the voltages at the 3V8 and 5V test points.

You should be able to read the expected voltages. It is not important if the 3V8 test point shows a voltage that is not exactly 3V8. It should be between 3V6 and 4V2.

Test Step

Once you have populated the components, you can attempt the first test with the tubes.

The DA-2000 tubes should fit snugly into the locations on the board. You can place them temporarily in place, and they should fit without falling out.

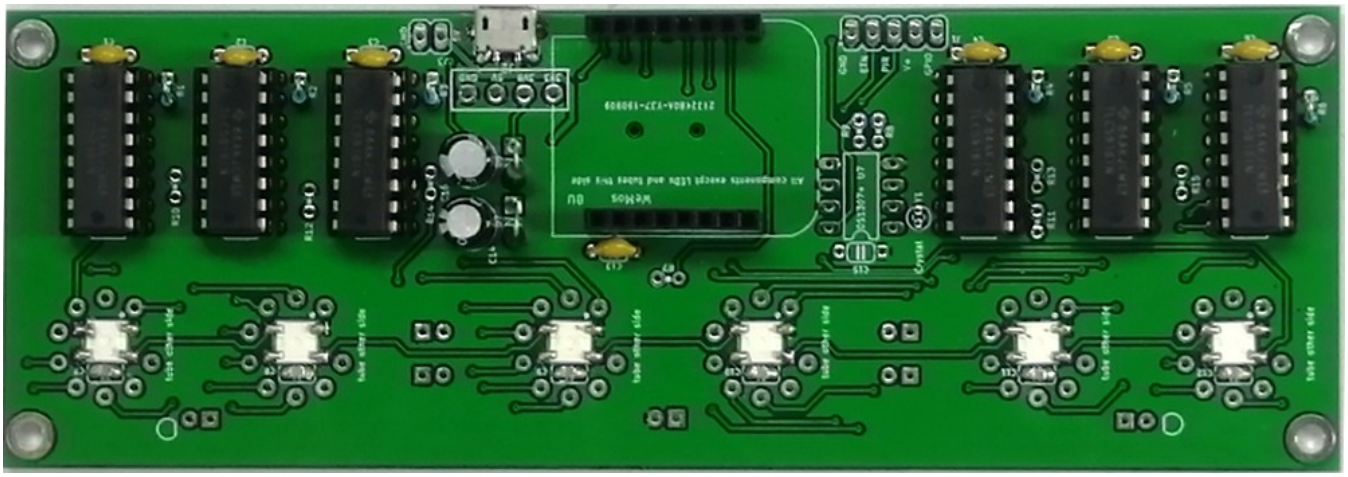
Power on the board and wait for the startup sequence to finish. After this, you should see the tubes counting from 0 to 9 repeatedly.

If you want to watch a video of this build step, please see the associated video at:

Bitchute: https://www.bitchute.com/video/npGOxvD75jzp/

YouTube: https://youtu.be/BYvxTW3qgBo

After you have mounted the components, the board should look like this:



LED Separators and indicators

There are different types of board, but each of them is identical apart from the type of tubes that are installed.

This step installs the separators, the indicator LEDs and the LDR.

Between the seconds and minutes tubes, and the minutes and hours tubes there are “separator” LEDs. There are also two “status” LEDs which can be used to convey information about the clock.

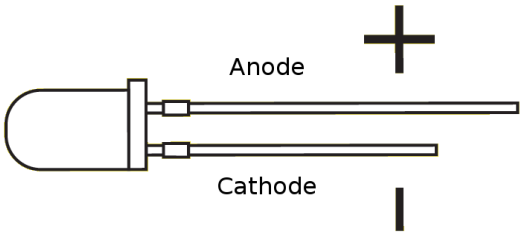
Parts List:

R10 – R15	4k7
D1, D6	3mm Red LED
D2 - D5	3mm Orange LED

Notes:

- The Red LEDs D1 and D6 are the indicator LEDs, and should be mounted facing forwards with a slight bend in the leads.
- The Orange LEDs are mounted with the head bent to face forwards, one above the other.
- be careful to get the LEDs the right way round. The silk screen shows you the side with the “flat” on it. (See hint below).
- Some LEDs do not have an easy to identify flat on the side of them. In this case, the **short** lead is the one that has the flat on it. (See hint below).
- Bend the head of the orange LEDs over so that they shine forwards between the tubes.
- It does not matter which way round the PDR is mounted, it is not polarised.

The LED should look something like this:



Test Step

Plug the display board into the main board and power up the circuit again. This time let the startup sequence complete. Please see the section on “Setting the WiFi information” for details of how to log into the clock and set it up.

You should see the tubes light up.

If you want to watch a video of this build step, please see the associated video at:

Bitchute: https://www.bitchute.com/video/wa4tl3BSJ4Rl/

YouTube: https://youtu.be/rvBNCDYdqYE

Start up in Test Mode

Once you have the LEDs and indicators installed, you can power on and perform the start up test. If you have tubes which you can **temporarily** fit, you can fit them now.

Powering on should cause the LEDs to cycle through a series of colours. If you have the tubes fitted, you should see the numbers on the tubes cycling.

See the video for more information.

If you want to watch a video of this build step, please see the associated video at:

Bitchute: https://www.bitchute.com/video/SRBs2YaL3KhP/

YouTube: https://youtu.be/U88nIq4jRgU

LDR and front panel connector

The LDR detects the ambient light conditions and dims the display to match them. This increases the tube life and makes sure that it does not “glare” at night. The front panel connector allows you to connect a push button to the case and attach a motion detector.

Parts List:

R7	10k
LDR1	GL5516
J1	5 pin header / 8 pin header

Notes:

- Mount the LDR either so that it faces forward or upward. If you wish, you can also mount the LDR on the outside of the case using flying leads to the connector.
- Decide if you want to install the header strip, or attach the wires for the button and PIR/ microwave motion detector directly to the board. If you attach the header, you might find the clearance quite tight. Note that you can also trim down the length of the header pins once they are mounted to improve the clearance.
- There are two versions of the board, one with a 5 pin header, one with an 8 pin header. Fit the header that came with your kit. The 8 Pin header additionally has a 3V3 I2C interface.

If you want to watch a video of this build step, please see the associated video at:

YouTube:

BitChute:

RTC circuit

Parts List:

R8, R9	10k
Y1	32.768kHz crystal
BT1	CR1220 battery holder
U7	DS1307+
C15	100nF

Normally you will install the Real Time Clock (RTC) on the board as a back up option for the case that the WiFi time source is not available. For more information about this option, please see the User Manual.

Notes:

- Unfortunately, it is not allowed for us to send lithium batteries to some locations. If you do not receive one, it is because of these regulations. Please source one locally. Sorry about that.

If you want to watch a video of this build step, please see the associated video at:

YouTube:

BitChute:

PIR / Microwave motion detector

Parts List:

PIR	(optional) HC-SR505 PIR module
MW	(optional) RWCL-0516 microwave module

This step attaches an optional PIR detector or microwave motion detector module. This turns the clock off when no one is there to see it, and therefor extends the tube life even more.

Warning!

The PIR input on the Wemos is only 3V3 tolerant. You can damage the Wemos if you use a PIR module or Motion Detector that has a 5V output.

Notes:

- Set the solder jumper JP1 for the voltage that is needed by the module. This is either 5V or 3V3. Both the modules shown below require 5V power input but provide a 3V3 output signal.

HC-SR505 PIR module

RWCL-0516 microwave module

Setting the clock up

Once you have got this far, you have finished the construction of the clock and are ready to set the clock up.

Please see the user manual for full details about how to do this!

The manuals are at:

https://www.nixieclock.biz/Manuals.html

We hope you enjoyed building the clock, and are always interested to hear what you think!

Parts list / BOM

Here is the list of the parts needed for the main board:

DA-2000 Numitron Clock Kit Rev1

Part	Qty	Value	Packed	Mounted
C14,C16	1	Main PCB	☐	
N6,N1,N2,N3,N4,N5	6	DA-2000	☐	
C15,C13,C3,C2,C1,C6,C5,C4	2	100nF 2.54mm	☐	☐
C14,C16	2	220uF 10V	☐	
C7,C8,C9,C10,C11,C12	6	100nF 5.08mm	☐	
U8	1	Wemos D1 R2	☐	
J2	1	USB_B_Micro	☐	☐
NP1,NP2,NP3,NP4,NP5,NP6	1	WS2812B	☐	☐
LDR1	1	GL5516	☐	
D1, D6	2	LED_D3.0mm	☐	
D2,D3,D4,D5	4	LED_D3.0mm	☐	
BT1	1	CR1220 Holder	☐	
R1,R2,R3,R4,R5,R6	6	910R ¼W	☐	
R7,R8,R9	3	10k ¼W	☐	
U1,U2,U3,U4,U5,U6	6	TLC5916	☐	
Y1	1	32.768kHz	☐	
U7	1	DS1307+	☐	
R10,R11,R12,R13,R14,R15	6	4k7 ¼W	☐	
D7,D8	2	1N4007	☐	
J3	1	Header 02X01	☐	
J1	1	Header 05X01	☐	
Socket 16	6	16Pin DIP	☐	
Socket 8	1	8Pin DIP	☐	

Revisions:

V0001: 18May2019: Initial version
V0002: 22Nov2019: Update for page numbers, video links