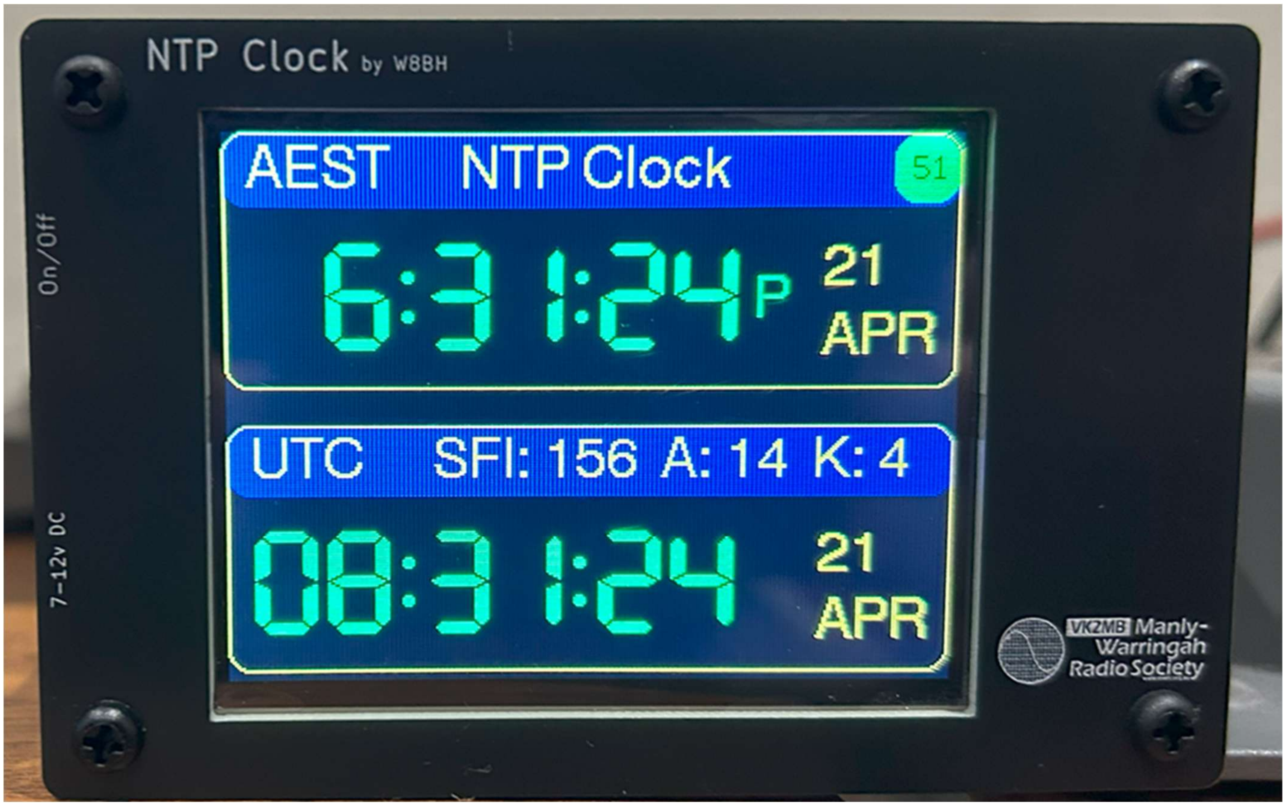
NTP Clock Kit



By Richard VK2ARH

The NTP Clock Kit Build Notes, Documentation and firmware for this kit can be downloaded from:

https://github.com/VK2ARH/NTP-Clock/tree/main

Bill of Materials – NTP Clock

Part	Qty
Main Board	1
Top Cover	1
Bottom Cover	1
2.8" LCD Display	1
Wemos D1 Mini	1
SPST Slide Switch	1
100nF MLCC Capacitor	1
10k Resistor	1
40 Pin Female Header	1
40 Pin Male Header	1
USB Socket - Power Only	1
Spacer 16mm M-F	4
Spacer 15mm F-F	4
Plastic Bags	2
Screws 6mm	8
Additional Optional Parts	
WEMOS Li Battery Shield	1
LDR GL5516	1
LM2956 Power Module	1
6mm x 6mm push button switch	4
5.5mm x 2.1 mm Socket	1
5.5mm x 2.1 mm Plug	1
Battery JST Header	1

These notes are not intended to be a detailed construction manual but are supplied to direct the NTP Clock builders to the relevant documentation and provide additional information to support the NTP Clock build by the Manly Warringah Radio Society (MWRS).

Main Documentation

This project is drawn from the NTP clock developed by Bruce Hall W6BH and a wealth of information relating to this project can be found on his website : http://w8bh.net/

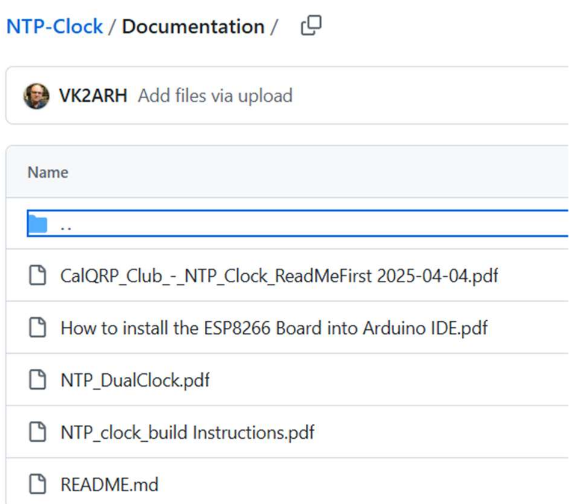
Bruce Halls documentation specific to his original project consists of the following:

- ✓ **NTP_DualClock.pdf** – Provides the background to the operation and programming of the firmware for the NTP Clock
- ✓ **NTP_clock_build Instructions**.pdf – A detailed construction manual of how to build the NTP clock using Bruce's original PCB provided for the project.

These documents together with a range of additional information including the Gerber Files for PCB production used in this project and the modified software can be found at my GitHub site:

https://github.com/VK2ARH/NTP-Clock/tree/main

The following documents (in addition to this one) can be found in the documents folder on the GitHuib site:



CalQRP_Club_-_NTP_Clock_ReadMeFirst 2025-04-04.pdf

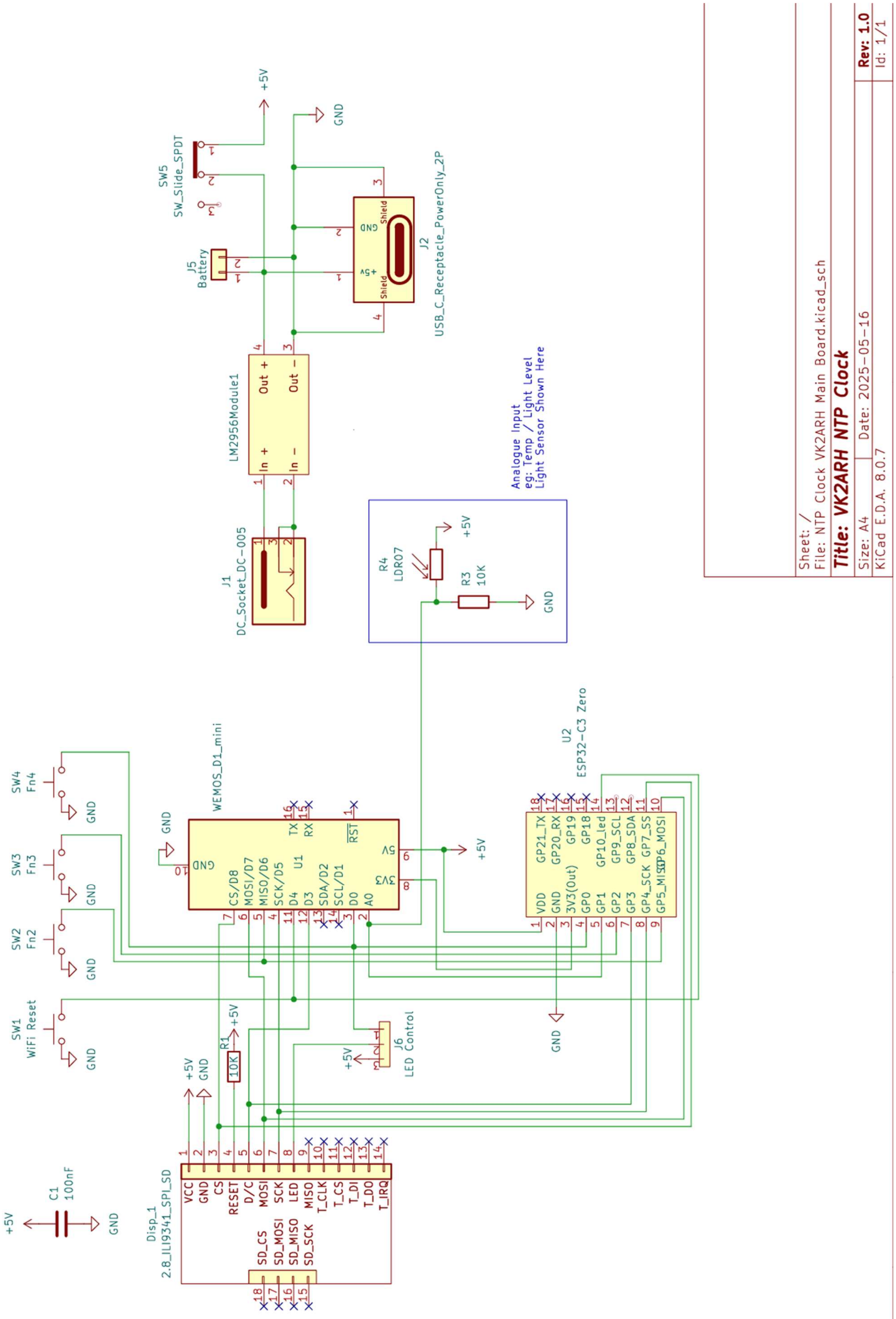
This document provides a series of guidelines provided to the California QRP Club who built the project in April 25 using Bruce Hall's original project PCB's. These guidelines relate to configuring the timezone for the USA, so read how to configure the Australian Time Zones later in this document.

How to install the ESP8266 Board into Arduino IDE.pdf

The title is self explanatory. You will be uploading the firmware for this project to a WEMOS D1 mini microcontroller, and this document shows you how to set up the Arduino IDE environment to work with this board.

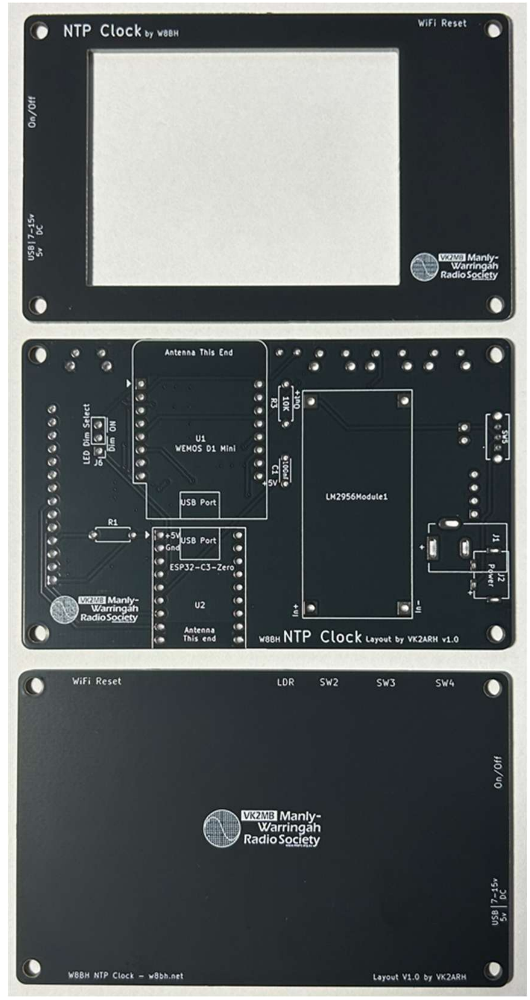
This document provides additional information specific to the MWRS NTP Clock kit and should be read in conjunction with the documents detailed above. The latest version of this document (MWRS NTP Clock Build Notes) can also be found in the NTP-Clock document sub folder at my GitHub site listed above.

MWRS NTP Clock Schematic



MWRS PCB’s

The MWRS project provides all the necessary hardware to build a fully functional version of the NTP clock powered by a USB-c power supply, or an external DC power source ranging from 7-15v via a 5.5mm x 2.1mm DC plug. The DC power source uses an onboard buck converter to reduce the supply voltage to 5V for the microprocessor and enables the NTP Clock to be powered directly from a traditional 13.8v shack power supply or use portable with a LiFePO4 or car battery power source.



Additional hardware is supplied to support further experimentation with hardware/software but is not essential for the operation of the NTP clock. This hardware includes:

- Four push button switches to support further enhancement of the clock function via software development.
- A light dependent resistor (LDR) and associated resistor to adjust the brightness of the display based on the level of the ambient light falling on the NTP clock**, if the code is developed** to support this function.
- The PCB has been modified to support the ESP32-C2 Zero microprocessor if the builder wishes to port the firmware to that processor and undertake firmware development that exceeds the capabilities of the D1 Mini.
- The kit also includes a WEMOS D1 Mini Battery shield if you wish to use it to provide battery backup (UPS type support) for the project during power outages. However, the builder should note that without additional modifications (hacks) to the main PCB and its components – the NTP Clock’s power On/Off switch will not switch off the battery shield, and the NTP clock will continue to operate until such time as the backup battery has been discharged.

The use of the WEMOS D1 Mini Battery Shield in this project is not covered in these notes and additional guidance and notes may be issued later. If you wish to go ahead and use the shield, please do so using your own knowledge and understanding of how to incorporate it safely into the project.

The kit includes a top and bottom PCB cover which enables the NTP clock to be mounted in a free-standing housing, without the need for further mounting in an enclosure. Simon VK2YU has developed a 3D printed enclosure for those who wish to use that type of enclosure.

Software

The Original NTP Clock software has been enhanced in the following ways:

- Robert Kincaid AI6P added solar indices to the UTC display header. These are updated approximately every 30 minutes with data pulled down from an internet-based solar weather server.
- Simon VK2YU added WiFi Manager to better manage Wi-Fi connections and allow screen-based input from your cell phone rather than hard coding the wifi credentials into the NTP Clock firmware.
- The software will need to be configured with your callsign (or any other header you wish to display) and the local time zone if you wish to operate the clock in any location other that Australian Eastern Standard Time (Sydney).
- Details of how to change the code to support other time zones can be found in the CalQRP_Club-NTP Clock_ReadMeFirst 2025-04-04.pdf document and a full list of global time zone ‘code string’ can be found here:

https://github.com/nayarsystems/posix_tz_db/blob/master/zones.csv

Building the MWRS NTP Clock

The kit takes approximately one hour to assemble

There are two decisions to be made when first building the kit.

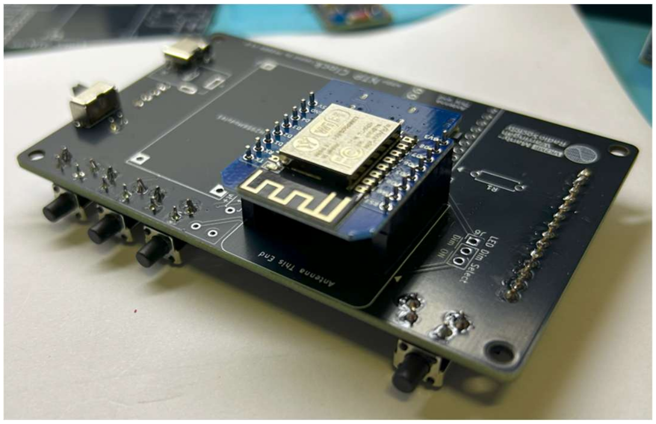
Decision 1 – How do I want to power the NTP Clock

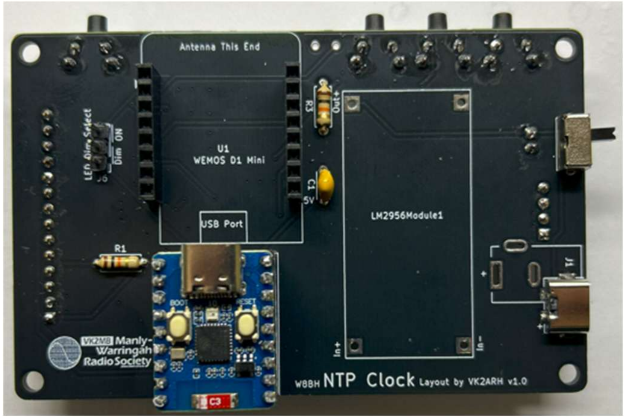
- **5v USB supply** – Build the NTP Clock using the USB-C port and do not install the buck converter power supply module; or
- **7-15v DC** – Build the NTP Clock and install the LM2956 Power Module and the 5.5mm x 2.1mm DC Jack.

NOTE: The PCB has been designed so that you cannot install both the 5.5mm DC socket and the USB-C Power only socket.

Decision 2 – Do I want to experiment with the NTP clock and its software at a later stage.

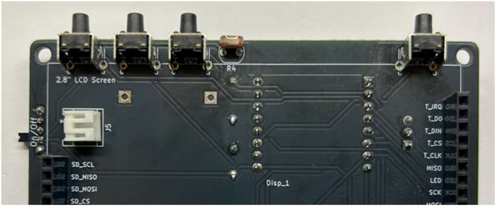
- No – there is no need to install any additional hardware
- Yes – you may wish to install the LDR, the four 6mm x 6mm push button switches, and the pin headers for the ESP32-C3-Zero. NOTE: All these additional components can be soldered to the PCB at a later stage if you later decide to start experimenting with the software and the ESP32. The ESP32-C3-Zero microprocessor is NOT supplied with the Kit.





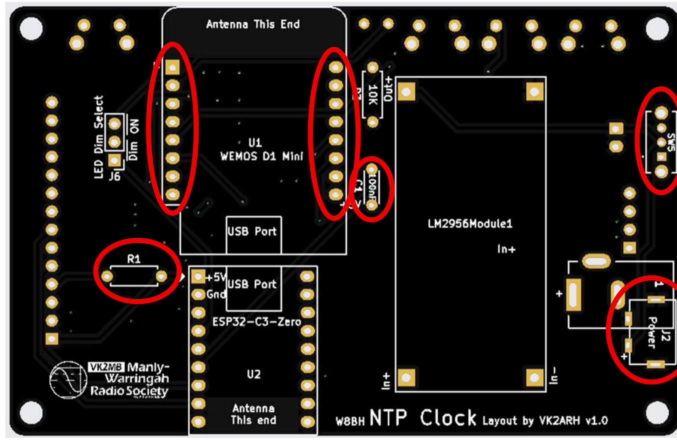
NTP Clock with additional switches installed showing WEMOS D1 Mini on the left, ESP32-C2 Zero on the right when installed to be powered by the USB-C socket.

Photograph below shows the additional switches, LDR and optional JST Power connector installed.



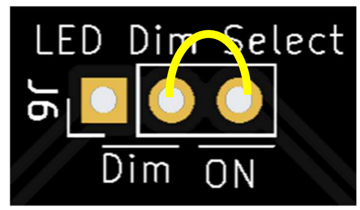
Building the NTP Clock using a 5v USB-C Power Supply

Build the NTP clock using the following components on the main board – it is important that you install the components on the correct side of the PCB:



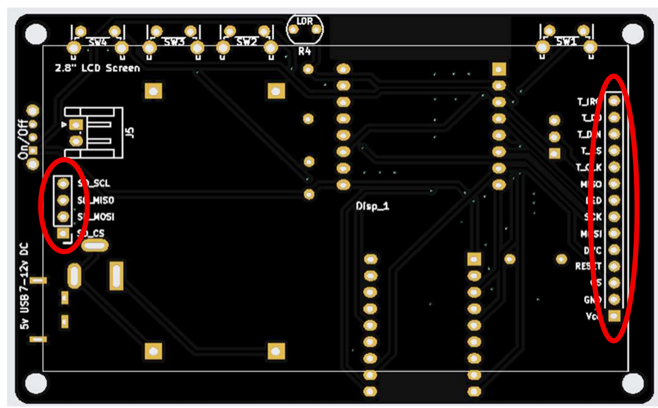
PCB Front (Screen Printed side with the MWRS Logo)

- SPDT Power Switch
- USB-C Power Socket
- R1 10K Resistor
- 2 x 8 Pin Female Headers (supplied with the WEMOS D1)
- C1 – 100nF MLCC Capacitor
- Solder a jumper bridge to J6 effectively hardwiring the LDR dim select option to ON (fully ON, instead of Dim) bypassing any future dimming option using her LDR/resistor combination and a software upgrade. Use a cutoff component lead soldered in a loop so that tt can be easily 'cut' and removed later if required.



PCB Rear

- 1 x 14 Pin Female Header
- 1 4 4 Pin Female Header

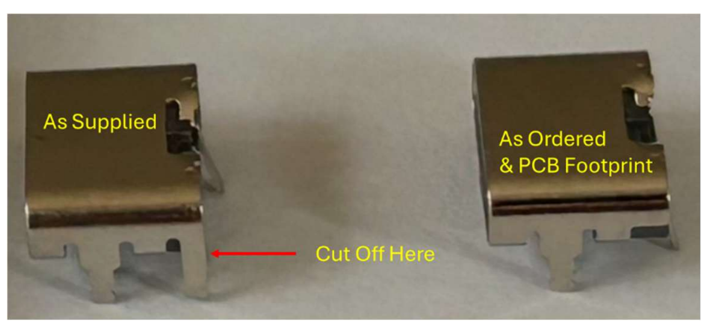


You will need to solder a 4 pin male headers to the 2.8" TFT Display before it is attached to the PCB. Use either a 4 pin male header or snap off a 4 pin header from a longer male pin header strip if one was supplied with your kit.

- The J5 2 pin JST header is for connection of an external 5v power source other than the USB-C. This power source can utilize the JST header socket supplied with the kit or be soldered directly to the pads for the JST Connector depending on your choice.

NOTE: Installing the USB-C Power Socket

The USB-C power sockets supplied for the kit were delivered with a slightly different footprint to the one ordered and designed onto the PCB – The supplied USB-C power socket has two power leads (+5v and GND) **plus four legs** attached to the metal shield of the socket, instead of two as per the PCB footprint. These legs are soldered to the PCB to secure the USB-C socket to the PCB. This is not a 'show stopper' … So read on😊.



Both variants are shown on the right. The easiest way to progress is to cut the 2 additional (rear) legs off the USB-C socket flush with the bottom of the socket. This way they will match the original footprint. Alternatively, you could drill additional small holes into the PCB at the required location, scrape away at the PCB on the rear side to reveal enough of the PCB ground shield to enable you to solder the additional two legs to the PCB. If you do a good job soldering the two-legged connector to the board, this is not necessary. My recommendation – use a fine pair of wire cutters and remove the additional two legs at the rear of the shield as shown in the photograph above.

All the legs (power and shield) on the USB-C connectors are very short and only just protrude through the PCB. Take time using a fine tipped soldering iron, to heat and then flow solder **into** the solder pad so that it bonds with the pad and the USB-C socket legs. Once completed you will have a sound mechanical and electrical connector on your PCB.

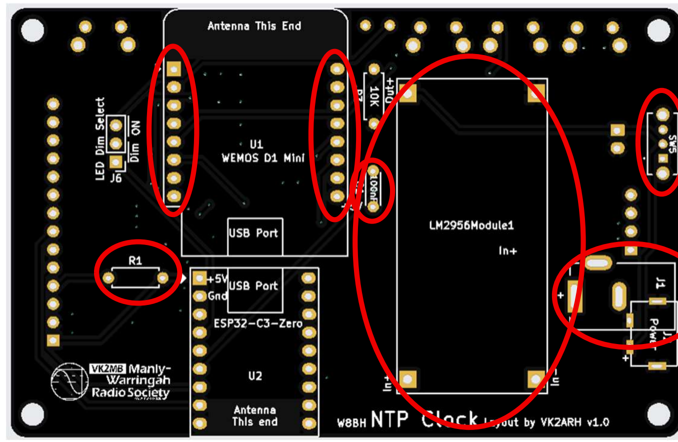
Building the NTP Clock using a 7v-15v DC Power Supply

Follow the same building instructions as per the USB-C power supply for the front and rear of the PCB, BUT do not install the USB-C power only socket.

Install the following components on the PCB's front side:

- LM2965 Power Module using four single header pins, ensure that you align the module in the correct orientation so that the input and output pins match the details provided on the screen print on the PCB.
- 5.5mm x 2.1mm DC Power Socket

Don't forget to install the LED dim select jumper (J6) as per previous discussion for the USB-c powered variant.



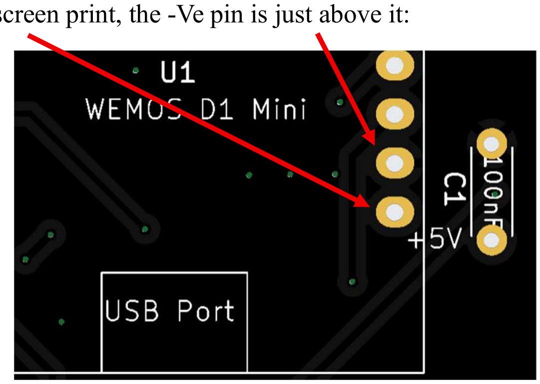
NOTE: Do not install the TFT display or the WEMOS D1 onto your PCB until you have calibrated your LM2965 power module to 5v.

Calibrating the LM2965 Power Module to 5V Output

With the TFT Display and the WEMOS D1 **REMOVED FROM (OR NOT INSTALLED)** on the main PCB, connect a 7v-15v DC supply to the DC Power Socket (Center pin is +ve, shield is -ve). Monitor the output voltage with your multimeter and adjust the multiturn variable resistor until you achieve an output of 5v DC. You may require multiple rotations of the screw before the module's voltage output begins to change.

Once you have set 5v, double check the voltage and polarity being supplied to the WEMOS D1using the following Pins:

The +5v Pin is notated on the PCB screen print, the -Ve pin is just above it:

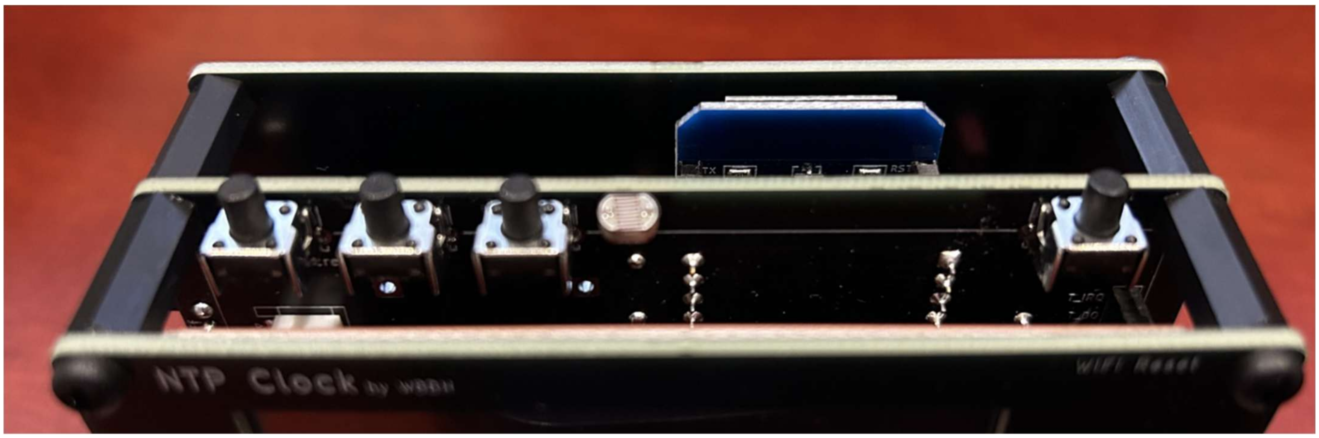


Once built the WEMOS D1 will need to have the software loaded.

Experimenting with the NTP Clock

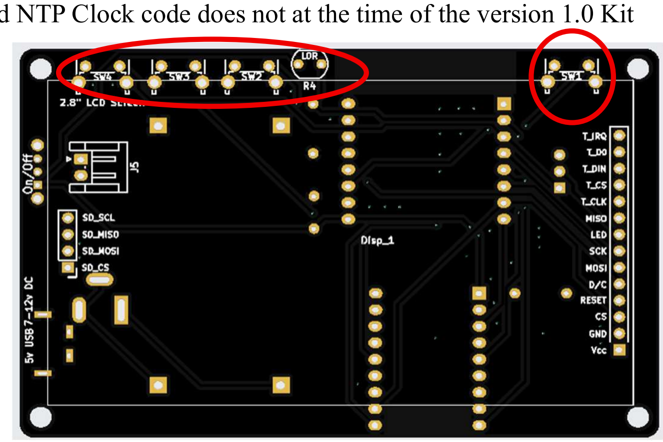
The MWRS board supports a few options for further experimentation and software development of the NTP Clock code. To this end there are options for 4 additional switches which can be utilized by further software development, together with a light dependent resistor and resistor if someone wants to develop the code for dimming the main screen. The installation of these components is optional and the NTP Clock operates effectively without them being installed. The main PCB support the installation of an ESP32-C3-Zero if you want to install that processor to expand options for software development which are beyond the memory and processing capability of the D1 Mini, after porting the D1 code to the ESP32-C3-Zero.

Both processors should not be installed at the same time.

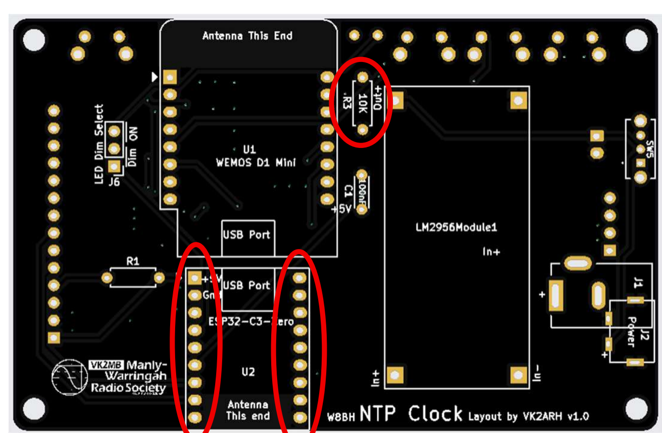


The location of the switches and LDR are shown above. The LDR is installed after bending the leads at right angles before soldering to the board.

The use and function to which the switches and LDR are used (or any other device you solder to the pins) is up to you if you wish to develop code to take advantage of them. The standard NTP Clock code does not at the time of the version 1.0 Kit release include any functionality to use these switches or LDR.



- SW1, SW2, SW3, SW4 and the LDR are installed on the rear of the main PCB as shown on the right:



- The 10K (R3) resistor and the female pin headers for the ESP32-C3 Zero are installed on the front side of the main PCB.

NOTE: The ESP32-C3 Zero is not supplied with the NTP Clock Kit.

Installing and Running the Software

The software to operate the NTP clock needs to be uploaded into the WEMOS D1 Mini after 'personalizing' your installation. By default the MWRS firmware will provide a display as shown below left – with the banner set to "NTP Clock" and the time zone set to Australian Eastern Standard Time (AEST). You can edit the firmware and insert your own callsign as shown in the photo below on the right:

Details of how to modify and install the firmware can be found in the documents listed on P3 of these notes. Read these documents to gain an understanding of the process involved. In short:

- You need to configure the Arduino IDE to program the WEMOS D1 Mini.

  See: How to install the ESP8266 Board into Arduino IDE.pdf

- Download the Simon VK2YU's updated firmware from my GitHub site: https://github.com/VK2ARH/NTP-Clock and load it into the Arduino IDE, make sure you install the libraries identified in lines 36-48 of the code.

  NTP_Dual_Clock_VK2YU_V1.ino

- Modify the entry for the banner eg: insert your callsign at line 50 in the code (eg: replace "NTP Clock" with your callsign).

```
50    #define TITLE          "NTP Clock"
```

- Change the code at line 56 which configures your time zone if you are in any time zone other than Eastern Australia Standard Time (AEST). The character string you need to use for your time zone can be found

```
56    #define TZ_RULE        "AEST-10AEDT,M10.1.0,M4.1.0/3"
```

- Upload the firmware to the D1 Mini.
- Upon first power up, if no WiFi credentials are stored in the D1 mini (or the stored network is not available) you need to enter new Wifi Credentials using the WiFi Manager capability. After about 15-20 seconds, you will be looking at a blank screen on the NTP Clock.
  - Open up your mobile phone and look for a WiFi access point "NTPClockAP" and select Configure WiFi (1)
  - Identify the WiFi network SSID that you wish to connect to by tapping on the listed network (2), then enter the password for that network (3). Hit the SAVE button (4) and restart your NTP Clock. The clock should now connect to your chosen WiFi network and commence operation. The information screen (5) can be displayed by selecting the Info button on the first WiFiManager screen