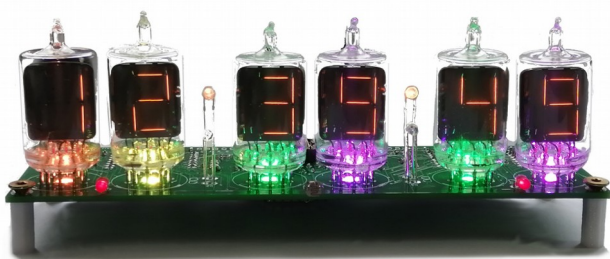


# Numitron Clock

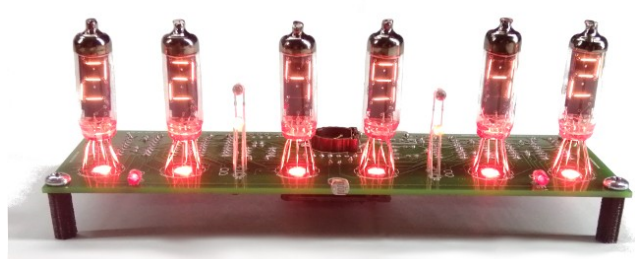
## Firmware V6

### Operating Instructions

Supported Models:



DA-2000 Clock



IV-9 Clock

## About this document

This is the user instruction manual for the Nixie Clocks shown on the first page

- DA2000 Numitron Clock V1
- IV-9 Numitron Clock V1

If you want to have the construction manual to guide you through the process of building the clock, please find the appropriate manual at:

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

There should have been an exact link to the clock manuals on the packing slip you received in the package.

**Please read this manual carefully before trying to set the clock up: It is a complicated device and you will save yourself frustration if you have a good overview of what the clock can do before you start!**

## 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.

<https://www.nixieclock.biz/Store.html>

There is also a forum for the clocks, where you can find many answers to questions and contact others who are also using the clocks at:

<http://bit.ly/2Ec0OvW>

Which should redirect you to the much longer:

<https://www.tubeclockdb.com/forum/wemos-nixie-clock-support-forum>

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## Description

The Wemos Nixie Clock is a beautiful mix of old and new, resulting in a high accuracy, low power clock which will be a talking point in your home.

The clock has the following features:

- Latest technology, highly reliable and accurate.
- Tried and tested design, with many hundreds of clocks sold.
- Based on the Wemos micro-controller with inbuilt WiFi
- Low power consumption.
- Long tube life:
  - Configurable blanking and a motion detector makes sure that the tubes will stay healthy for many years with no intervention from you. Numitrons are already long life tubes, and therefore you can expect many years of use from this clock.
  - Filament pre-heat: the filaments are run with a very low intensity to ensure that thermal shock when turning a segment on cannot destroy the tube
- All settings are stored in non-volatile memory. Once they are set, they are remembered forever, or until you change them again.
- RGB back lighting allows you to set the the color of the back lighting to practically any color you desire.
- Ambient light sensing, with automatic tube dimming, which sets the tube and LED brightness according to the light conditions. This also increases tube life.
- Absolutely silent operation. Some Nixie clocks emit an irritating “buzz” or “hiss” which is especially annoying if you keep the clock in a bedroom.
- Automatic week day or weekend blanking, extends the life of tubes even further
- Automatic time of day blanking, can blank between a start hour and an end hour, on week days, weekends or every day
- Extremely accurate timekeeping using Internet based atomic time sources:
  - The time never drifts, is always right to within 1 second.
  - Automatically compensates for Daylight Savings Time changes, leap years and seconds.
  - Has a local RTC back up chip to keep time if the Internet is not available
- The controller can be programmed without removing it from the board, using “OTA” (Over the Air) updates
- Has support for a motion sensor

## General

The clock has different modes of operation, which you select using the push button.

### First Start Mode

When you start the clock up the very first time, it will start in “First Start Mode”. This mode is intended to simplify the set up of the hardware. It cycles through the digits `00:00:00` - `99:99:99` and cycles through colours on the NeoPixels. This allows you to check that all digits on all tubes are working correctly and that the LEDs can show all hues correctly.

The clock will stay in this mode until you exit it, no matter how many times you power up the clock. Once you have exited first start mode, it will not be used again, unless you completely reset the clock using a “Factory Reset”.

### Exit First Start mode

Once you have mounted the tubes and are happy that they are working well, you can exit “First Start Mode”. To do this, you must have a push button attached to the clock, even temporarily.

**To EXIT First Start Mode, press the push button when the display shows “88:88:88”, and the clock will go to normal time keeping mode!**

### Exit First Start mode with no tubes

When you want to exit First Start Mode, but don't have any tubes installed, you can use the separator and status LEDs to see when the exit time has arrived. They all light up simultaneously when “88:88:88” is shown.

**Holding the button down for a complete cycle until all “8”s is shown will also work.**

### Time Keeping (“Clock”) Mode

After the first start, each time you start up the unit, the clock will go into normal clock mode and will display the time. In normal clock mode, the time will be displayed.

### Factory Reset

If you want to go back to first start or calibration mode, you can perform a factory reset on the clock. To do this, hold down the button **as soon as you see the second yellow back light LED while you power on**. This will reset all settings and start up the clock in First Start Mode again.

The clock will restart after 1 second and clear the settings.

## Power on diagnostics

Every time you power the clock up, it will go through a self check routine to check the most important parts of the circuitry. Behind each digit there is a LED, which tells you the status on start up. Each of the LEDs can have one of three colours, in general “Yellow” means “Checking”, “Green” means the test has passed. Red or Blue have different meanings depending on the LED.

The Numitron displays will also give you information about the current test phase.

The meanings of the different LEDs and colours are:

LED	Colour	Meaning	Numitron
10s Hours	Green	Clock startup up correctly and LED communication is working	“StArt ”
Hours	Yellow	Checking the local file system for configuration information	“SPIFFS”
	Green	Correctly read the existing configuration information from SPIFFS	
	Blue	No existing configuration information was found: reset everything back to factory status (happens on first start, or after a factory reset)	
	Red	Could not mount the SPIFFS storage. This indicates that there has been an error during the flashing of the controller and that no SPIFFS space has been allocated. If this happens, please contact us.	
10s Minutes	Yellow	Trying to connect to a WiFi network	“nEt_UP”
	Green	Connected to a previously entered WiFi network	
	Blue	The previously configured WiFi network was not found OR there was no previously configured WiFi network. Enter Access Point mode	
	Red	Could not connect to the configured network	
Minutes	Yellow	Attempting to recover the time from NTP	“ntP_UP”
	Green	NTP update received correctly	
	Red	NTP Update was not received within a reasonable time	
10s Seconds	Green	A Real Time Clock (“RTC”) module was found	“rtC_UP”
	Red	The RTC module was not found or is faulty	
Seconds	Green	The clock is running in normal mode	“ALL_On”
	Blue	The clock is running in “debug” mode and provides diagnostic information on the serial output	

## Using the clock button

Normally the clock is in "Time Display Mode", which will show the time. If you press the button for differing lengths, different things will happen.

**"Short Press"** (less than 1 second): A temporary display will be shown for 5 seconds. This is useful if you want to know the date, for example. The options here are given in the section "Temporary Display Mode"

**"Medium Press"** (more than 1 second): If you are in settings mode, the clock will go move to the next configuration. If you are not in settings mode, a medium press does not do anything.

**"Long Press"** (more than 2 seconds): The clock will go into "Setting Mode" to allow you to change settings. If you are connected to a network, you can change settings using a browser which is much easier.

**Note: To exit "Setting Mode" do another "Long Press".**

Nowadays, setting up the clock using the button is not really necessary. Please use the Web Interface for all settings of the clock.

## Temporary Display Mode

Normally, the clock will show the time. To show additional information press the button with a “short” press. Each press cycles through the following information. After 5 seconds, the display will revert to the normal time display.

Note that some of the options are not shown under all circumstances. For example, if you are not connected to a WiFi access point, the IP address will not be shown.

Mode	Description	Values
Date	<b>Date.</b> The current date will be shown in the date format you selected.	Example 19:09:06
LDR	<b>Ambient Light Reading.</b> This shows the current ambient light reading from the LDR (light dependent resistor). It is a normalized value, and goes between 100 (dark) to 999 (bright). This controls the dimming of the tubes.	Example 01:00:00 100: darkest 999: brightest
Version	Display the version number. The format will be “00:VV:vv”, where major version is “VV”, minor version is “vv”.	Example 00:00:01
IP Address part 1	If you have WiFi connected, this will show the first two digits of the 4 digit IP address. Usually this address starts with “192.168”. If you are on a cable network, it might start with “10.10”.  <b>Note:</b> The IP address is skipped if you do not have a WiFi connection.	Example: 19:21:68 = “192.168”
IP Address part 2	The second digit of the 4 digit IP address.  <b>Note:</b> The IP address is skipped if you do not have a WiFi connection.  You can enter the whole value into your browser to connect to the module. You must remove any leading “0” from the value. If you receive “192.168.001.106”, you must enter this as “192.168.1.106” into your browser address bar. Do not include the leading zeros on any part of the address.	Example: 00:11:06 = “1.106”
Display Speed	This shows the number of impressions per second, which is the refresh rate of the display. It varies a little based on the exact workload, but is usually about 90 impressions per second.	Example: 00:00:90
ESPID	This shows the ESP ID of the clock, which can be used to reach the clock web interface using mDNS. To reach the clock web interface once the clock has started, use this number in your browser, putting the number you receive in the URL line of your browser like this:  http://esp_<ESPID>.local  In the example value given, this will be  http://esp_43391b.local	Example: 43:E9:1b



## Status LEDs

There are two status LEDs, one on the left of the “10X Hours” digit, and one on the right of the “1X Seconds” digit. You can configure these to tell you about the current clock status.

By default, (or after a factory reset) the status LEDs will have the following meanings:

Status LED	Default Meaning
Left Status LED	<b>NTP Time valid.</b> We recently got an NTP update and the clock is still using it.
Right Status LED	<b>WiFi connected.</b> If the clock is connected to the WiFi network, this LED will light.

## Alternative Status LED meanings

You can change the meaning of the Status LEDs in the clock configuration page. The other options for the Status LEDs are:

Mode	Description
WiFi	<b>WiFi connected.</b> If the clock is connected to the WiFi network, this LED will light.
NTP	<b>NTP Time valid.</b> We recently got an NTP update and the clock is still using it. We assume that the NTP time is valid for twice the update time. If the update time is 2 hours, the NTP time is considered valid for 4 hours, even if network connectivity is interrupted.
PIR	<b>No motion detected.</b> The PIR or microwave sensor has detected that no one is in the vicinity of the clock. <b>Note:</b> This value is also shown on the blue LED on the ESP module.
AM/PM	<b>AM/PM Mode.</b> Lights when the clock is showing a time in the afternoon (PM).
On	<b>On.</b> On all the time.
Off	<b>Off.</b> Off all the time.

## Setting Mode

Usually you will want to set the clock up using the browser interface, because it is much easier to understand and quicker that way.

To enter setting mode, press the button for more than 1 second (“Medium press”).

Each Medium press of more than 1 second will move the setting mode onto the next. When you finish the setting modes, the clock returns to normal time display mode.

**To exit** the setting mode before going through all the options, press the button for more than 2 seconds (“Long press”). Another way of exiting is to cycle through all of the setting options, after which you will return to time mode.

To change a setting, press the button for less than one second, and then release it (“Short press”).

Mode	Description	Values
	<p><b>Time mode.</b> This is the normal mode and displays the time. It is the normal start up mode of the clock. If you do nothing. The clock is in this mode.</p> <p>In this mode a short press cycles through the values given in “Time Display Mode”, but always returns to the standard time display after 5 seconds.</p>	
<b>Time and Date Settings</b>		
<p><b>Note that the Time and Date settings will not be shown if WiFi is active!</b> There is no need to set the time manually in this case. If you have no active WiFi connection, you can set the time. However, as soon as WiFi is active, the time will be set according to the Internet NTP servers.</p>		
	<p><b>Set Hours.</b> Each short press will advance the hour. The hours roll over back to zero after reaching 12 or 24 (depending on the 12/24 hours mode).</p>	
	<p><b>Set minutes.</b> Each short press will advance the minute. The minutes roll over back to 0 after reaching 59 minutes. Each time you set the minute, the seconds is reset to 0.</p>	
	<p><b>Reset seconds.</b> Each short press will reset the seconds to 0, without changing the hours or minutes.</p>	
	<p><b>Set Day.</b> Each short press will advance the day. The day roll over back to one after reaching the maximum number of days in the month.</p>	
	<p><b>Set Month.</b> Each short press will advance the month. The month roll over back to zero after reaching 12.</p>	
	<p><b>Set Year.</b> Each short press will advance the year. The year roll over back to 2015 after reaching 2099.</p>	

Mode	Description	Values
<b>Basic Settings</b>		
"--:--:07" seconds flashing	<b>12 or 24 hour time.</b> The hours are displayed in 12 or 24 hour mode.	"1" = 12 hour "0" = 24 hour default: 0
"--:--:08" seconds flashing	<b>Blank leading "0".</b> Blank out the leading "0" from single digit hours.	"1" = blank "0" = don't blank default: 0
"--:--:09" seconds flashing	<b>Date format.</b> Set the format that the date is displayed in.	"0" = YY.MM.DD "1" = MM.DD.YY "2" = DD.MM.YY default: 2
"--:--:10" seconds flashing	<b>Display blanking.</b> To preserve the tubes, you can set the display to be blanked.  Options: <ul style="list-style-type: none"> <li>"0" = "never": Don't use blanking.</li> <li>"1" = "Weekends": Blank at weekends.</li> <li>"2" = "Week days": Blank on week days.</li> <li>"3" = "Always": Always use blanking.</li> <li>"4" = "Hours": Blanks between the start and end hour every day.</li> <li>"5" = "Hours or weekends": This blanks all day during the weekends and between the start and end hour every other day.</li> <li>"6" = "Hours or week days": This blanks all day during the week days and between the start and end hour every other day.</li> <li>"7" = "Hours on weekends": This blanks between the start and end hour on weekends.</li> <li>"8" = "Hours on week days": This blanks between the start and end hour on week days.</li> </ul>	"0" = Don't blank "1" = Weekends "2" = Week days "3" = Always "4" = Hours "5" = H <b>or</b> weekends "6" = H <b>or</b> week days "7" = H <b>on</b> weekends "8" = H <b>on</b> week days default: 0
"--:--:11" seconds flashing	<b>Blanking Hour Start.</b> Hour blanking will start at this hour, on the days set by the Display Blanking Mode. <b>If the display blanking mode does not use hours, this setting is not shown.</b>	Default: 00
"--:--:12" seconds flashing	<b>Blanking Hour End.</b> Hour blanking will end at this hour, on the days set by the Display Blanking Mode. <b>If the display blanking mode does not use hours, this setting is not shown.</b>	Default: 07

Mode	Description	Values
<b>Special Effects Settings</b>		
"--:--:13" seconds flashing	<b>Use LDR.</b> If you disable the LDR, the tubes will always work at maximum brightness.	"1" = enable "0" = disable default: 1
GUI only	<b>Min Dim.</b> This is the minimum value of the tube brightness. The higher this number, the brighter the tubes will be when the clock is fully dimmed.	100 = minimum 800 = max default: 400
GUI only	<b>LDR Threshold.</b> This is the value at which the LDR will detect full brightness. The higher this number, the quicker the sensor will detect full brightness.	0 = minimum 500 = maximum default: 200
GUI only	<b>LDR Sensitivity.</b> This is how quickly the LDR changes the tube brightness. The higher the sensitivity, the quicker the tube brightness changes compared to the LDR reading.	100 = minimum 400 = maximum default: 300
"--:--:14" seconds flashing	<b>Blank Mode.</b> You can set the tubes, the LEDs or both the tubes and the LEDs to be blanked when in blanking mode.	"0" = tubes "1" = LEDs "2" = tubes and LEDs default: 2
"--:--:15" seconds flashing	<b>Slots Mode.</b> You can have the date shown automatically once per minute for about 5 seconds.	"1" = enable "0" = disable default: 1
"--:--:16" seconds flashing	<b>Separator Mode.</b> The allows you to set the separator flash mode.	"0" = "railroad" "1" = "slow blink" "2" = "fast blink" "3" = "double blink" "4" = "always on" "5" = "always off" default: 0
<b>PIR Settings</b>		
"--:--:17" seconds flashing	<b>PIR Timeout Longer.</b> You can set the amount of time that the clock will wait before blanking the display, in seconds.	Default: 300 Max: 3600 Min: 60
"--:--:18" seconds flashing	<b>PIR Timeout Shorter.</b> You can set the amount of time that the clock will wait before blanking the display, in seconds.	
<b>Back Light Settings</b>		

Mode	Description	Values
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:19"</div> <small>seconds flashing</small>	<p><b>Back Light Mode.</b> This sets the mode of the back light.</p> <p>"Fixed" mode will show the back light color according to the Red, Green and Blue channel intensities.</p> <p>"Pulse" will make the intensity of the back light "pulse", brightening for a second and then darkening for a second, but always respecting the relative intensities set by the Red, Green and Blue channel intensities.</p> <p>"Cycle" fades the back lighting randomly, and does not use the Red, Green and Blue channel intensities. These settings will be skipped if cycle mode is selected.</p> <p>Options "0", "1" and "2", do not dim with the bulbs. Options "3", "4" and "5" do.</p>	<p>"0" = Fixed  "1" = Pulse  "2" = Cycle  "3" = Fixed/Dim  "4" = Pulse/Dim  "5" = Cycle/Dim  default: 0</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:20"</div> <small>seconds flashing</small>	<p><b>Red Channel Intensity.</b> Sets the maximum intensity of the red channel back light. This will be dimmed according to the display dimming.</p> <p>If you are in cycle mode, this setting will be skipped.</p>	<p>Default: 15  Max: 15  Min: 0</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:21"</div> <small>seconds flashing</small>	<p><b>Green Channel Intensity.</b> Sets the maximum intensity of the green channel back light. This will be dimmed according to the display dimming.</p> <p>If you are in cycle mode, this setting will be skipped.</p>	<p>Default: 15  Max: 15  Min: 0</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:22"</div> <small>seconds flashing</small>	<p><b>Blue Channel Intensity.</b> Sets the maximum intensity of the blue channel back light. This will be dimmed according to the display dimming.</p> <p>If you are in cycle mode, this setting will be skipped.</p>	<p>Default: 15  Max: 15  Min: 0</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:23"</div> <small>seconds flashing</small>	<p><b>Cycle Speed.</b> If you are in cycle mode, this controls the speed at which the colors cycle. The higher the number, the slower the colors will change.</p> <p>If you are <b>not</b> in cycle mode, this setting will be skipped.</p>	<p>Default: 10  Max: 64  Min: 4</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:24"</div> <small>seconds flashing</small>	<p><b>Increase Minimum dim.</b> This setting allows you to increase the minimum brightness you want to have when the clock is fully dimmed.</p>	<p>Default: 500  Max: 1000  Min: 250</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:25"</div> <small>seconds flashing</small>	<p><b>Decrease Minimum dim.</b> This setting allows you to decrease the minimum brightness you want to have when the clock is fully dimmed.</p>	<p>Default: 500  Max: 1000  Min: 250</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content;">"--:--:26"</div> <small>seconds flashing</small>	<p><b>PIR Pullup.</b> Use the internal pull-up resistor. Normally you will not have to change this setting, but in the case that your motion detector does not work correctly, you can set this.</p>	<p>"1" = enable  "0" = disable  default: 1</p>

Mode	Description	Values
<div style="border: 1px solid black; padding: 2px; display: inline-block;">"--:--:27"</div> <small>seconds flashing</small>	<p><b>Digit Preheat.</b> This setting keeps the filaments warm when they are not in use, to prevent a thermal shock when they are turned on. This extends the life of the filaments in the tube.</p>	<p>"1" = very strong  "2" = string  "3" = weak  "4" = very weak  "5" = off  default: 3</p>
<div style="border: 1px solid black; padding: 2px; display: inline-block;">"--:--:28"</div> <small>seconds flashing</small>	<p><b>Clock version.</b> Show the clock software version.</p>	
<p><b>Digit Test.</b> Will roll through all digits on all locations to check that the display is healthy.</p>		

# Setting Up the WiFi

This step sets up the clocks access to your WiFi and lets it start up and show a display. To complete this step you should have the display board finished and installed on the clock.

Start the clock and wait for the LED behind the “1 X Minutes” digit to turn blue. This means that the clock has gone into “Access Mode”. It will remain in “Access Mode” at least 60 seconds.



The clock will stay in “access mode” for longer than 60 seconds if any device is connected to it.  
If you want to skip over the WiFi set up, you need to make sure that no devices are connected to it.

When the clock is in “Access Mode”, you are able to connect to it with any computer, tablet or phone. Search for a new WiFi network called “ESPClock”. When you connect to it, you will be asked to enter the password:

This access point has the credentials:

Credential	Value
SSID	ESPClock
Password	SetMeUp!

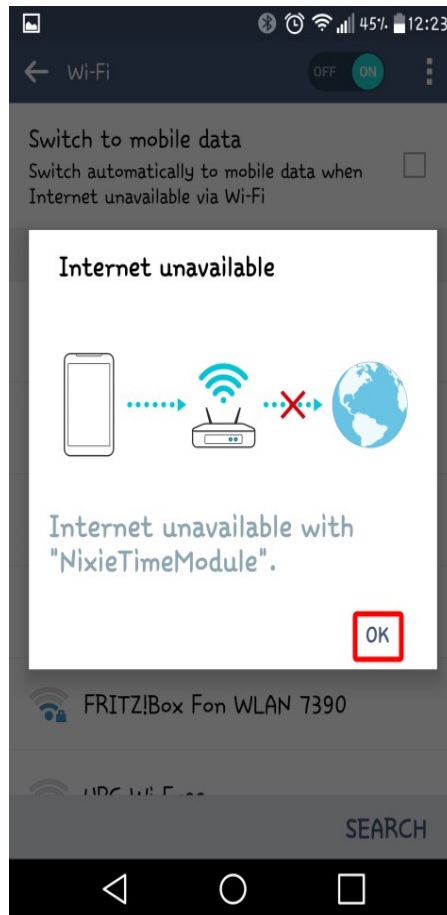
**Note:** The password is case sensitive!



After a few seconds, you should be taken to the captive portal of the module:

On some phones or tablets, you may get the message that “Internet is not available”, or that you have to “Sign in to the network”. Accept these messages if they appear, at which point you

should see that the landing page appears as shown above.



When you see the landing page, press the “Configure WiFi” button, and you should see a list of available WiFi networks (it might take a few seconds to come up if you have many networks in your area).

Select the network you want and enter the password for it.

**Note:** The network you are using and the password for it will be remembered in your module, and it will try to reconnect to the same network.

If for any reason the module can no longer find the network (for example, you have changed network or moved the clock), it will revert to set up mode when you re-power the clock.

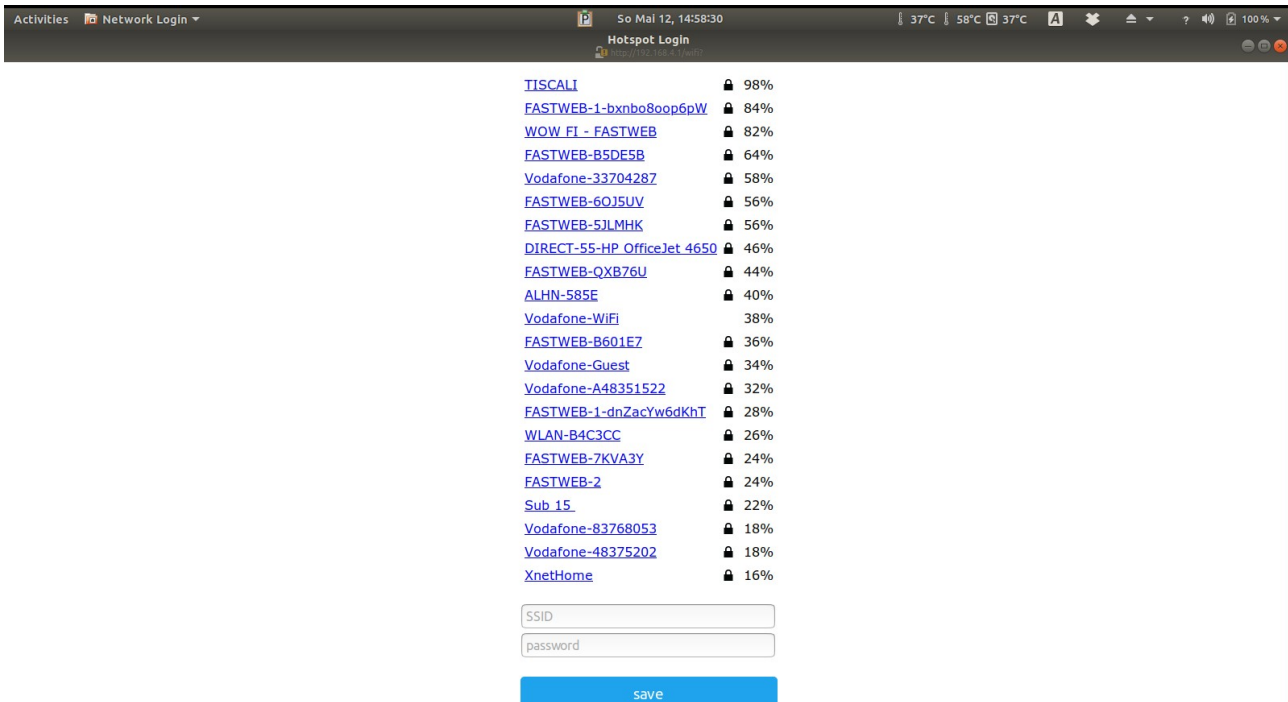
**Note:** If you want to continue to use the same network, just leave the clock as it is: It will reconnect automatically when the network becomes available once more.

**Note:** If for any reason you are not asked to go to the captive portal, and you are sure that you are connected, you can also try going to <http://192.168.4.1> instead. Some older browsers are not able to detect the redirect.

When you have entered the information, the page should close and you will get a message saying that the information has been saved.



If you have the module connected to the clock, you should get a time update after a maximum of two minutes. The module will disconnect you from it.



**Note:** The time you get will be the time in Central Europe by default! Don't worry, you can change this right away!

See the section about "setting the time" for more information.

## How to access the module after WiFi set up

Once the module is set up, you will need to log into it to configure the time server and set the configuration of the clock. The module has an in-built web server, and you can configure it (and your clock) using a browser.

**Note:** The web interface only starts to be available when the clock is running in normal time mode. **It is not available in "Test Mode"!**

## Accessing the clock using mDNS

The clock registers on your network with a unique address. You can use a browser to directly access the clock if you know the address. The address of a clock never changes.

If you don't know the address of the clock, you can get it from in these ways:

- read it from the display of the clock by using the "temporary display", by pressing the button with short presses until you see the "ESPID".
- From the packing slip we sent with the clock.
- From the summary page as "Clock Name".

If you know the ESP ID you can access the clock directly using the address in your browser:

`http://esp_xxxxxx.local`

The “xxxxxx” is the ESP\_ID and is made up of the last 6 places of the MAC address.

## Reading the IP from the clock display

The clock will receive an IP address from your router, and you need to know the address in order to log into the module. The easiest way to find the IP address is to wait for the time update to the clock. When this happens, the WiFi module sends the address you need to the clock, and you can read the address from the clock display.

See your user manual for details of how to access the address and read it. The short version is that you can short press the clock button and read the address as it is shown. On 6-Digit clocks you will see something like “19:21:68”, then “00:10:47”, this means 192.168.1.47. On 4-Digit clocks you will see the same address as “1:92”, “1:68”, “0:01” and “0:47” (the address is shown as 4 parts instead of 2).

## Reading the IP Address from your router

The other alternative is to look on your WiFi router to see the address the module has been given. You should find an entry in the “connected devices” list which starts with “ESP\_” with some numbers and letters after it. This is the module, and the IP address assigned will be shown there.

Remember the IP address, or write it down. You will need it to access the module.

## Common address ranges - Cable networks

**Note:** If you are on a cable network, it is usual that you will get an address starting with “10” instead of “192.168” (such as “10.10.34.134”). Just follow the same steps but substitute the address you received.

When you have found the address of the WiFi module, you can log into it using any browser. In the example below, the address I saw on a 6-Digit clock was “19:21:68” then “00:10:84”.

This equates to 192.168.1.84 as shown below:

### Current Status

Name	Value
WLAN IP	192.168.1.84
WLAN MAC	84:F3:EB:5A:47:DD
WLAN SSID	TISCALI
NTP Pool	pool.ntp.org
TZ	CET-1CEST,M3.5.0,M10.5.0/3
Last NTP time	2019,5,25,16,11,29
Uptime	26 s
Last time update	17 s ago
Time before next update	2 h 44 s
Version	1

## Setting the time

In order to make the time as flexible as possible, you have to enter a cryptic looking string into the “Time Zone String” setting on the time configuration page. For central Europe, (the default setting) this string is:

“CET-1CEST,M3.5.0,M10.5.0/3”

and it means that there is daylight savings time for this time zone, and that it changes on the the 3<sup>rd</sup> month on the last Sunday (“M3.5.0”) and changes back on the 10<sup>th</sup> Month on the last Sunday (“M10.5.0/3”) at 3am.

The most common codes are shown at the end of this section.

Enter this in the page “Configure Time Server”, and press “Set”.

4 Digit Nixie Clock Summary Configure Time Server Configure clock settings Utility

Select time server

NTP Pool	<input type="text" value="pool.ntp.org"/>
Update interval:	<input type="text" value="9876"/>
Time Zone String	<input type="text" value="CET-1CEST,M3.5.0,M10.5.0/3"/>

## Some common time zone strings

Here is a short list of some common time zone strings. It is not a full list! (A full list can be found at: [https://github.com/nayarsystems/posix\\_tz\\_db/blob/master/zones.csv](https://github.com/nayarsystems/posix_tz_db/blob/master/zones.csv))

Area	Value
United Kingdom	GMT0BST,M3.5.0/1,M10.5.0
Central Europe	CET-1CEST,M3.5.0,M10.5.0/3
US Mountain	MST7MDT,M3.2.0,M11.1.0
US Central	CST6CDT,M3.2.0,M11.1.0
US Eastern	EST5EDT,M3.2.0,M11.1.0
US Pacific	PST8PDT,M3.2.0,M11.1.0
Australia East	AEST-10AEDT,M10.1.0,M4.1.0/3
Australia West	AWST-8
Eastern Europe	EET-2EEST,M3.5.0/3,M10.5.0/4
Ireland	IST-1GMT0,M10.5.0,M3.5.0/1

# Web Interface

## Menu bar

The menu bar allows you to select the page you are interested in:



The options are:

Page	Description
Summary	<b>Summary Information.</b> This page provides information about the current status of the clock. It is not password protected.
Time Server	<b>Time Server configuration.</b> This page lets you set important information about the way the time is retrieved from the internet. This page is password protected.
Clock settings	<b>Clock general settings.</b> This page lets you set up the clock features. This page is password protected.
Utility	<b>Utility functions.</b> This page lets you perform additional utility functions. This page is password protected.

## Clock summary page

When you log into the clock's web interface, you will usually arrive on the summary page. This shows an overview of the most important or interesting information about the clock.

### Current Status

Name	Value
WLAN IP	192.168.1.84
WLAN MAC	84:F3:EB:5A:47:DD
WLAN SSID	TISCALI
NTP Pool	pool.ntp.org
TZ	CET-1CEST,M3.5.0,M10.5.0/3
Last NTP time	2019,5,25,16,11,29
Uptime	26 s
Last time update	17 s ago
Time before next update	2 h 44 s
Version	1

Option	Description
WLAN IP	This is the IP address under which the clock is available in your WiFi network.

Option	Description
WIFI MAC	This is the MAC address (unique hardware identifier) of the module in your network. You can use this if you have trouble finding the module in your router.
WLAN SSID	This is the WiFi name that you have connected to.
NTP pool	This is the NTP (Network Time Protocol) pool you are using to recover the current time from.
TZ	This is the Posix Time Zone setting you are using. This string tells the clock what time offset from Greenwich Mean Time to use and how to deal with Daylight Savings Time.
Last NTP Time	This was the time that was recovered from the NTP server the last time that it was requested. <b>Note:</b> This time stays fixed until the next update.
Uptime	How long the clock has been running. This will reset ever 50 days or so. (A so called "rollover").
Last time update	How long ago the time was last recovered from the NTP server.
Time before next update	How long until the next time update is expected from the NTP server.
Version	The firmware version.

The next section deals with the information about peripherals the clock has and how these affect the current status.

#### Clock information

Name	Value
LDR Value	999
Digit brightness %	100.00
Motion Sensor	Not installed
Time Source	NTP
Display Time	2019:5:25 16:11:46
Real Time Clock	Not installed
Impressions/Sec	250
Total Clock On Hrs	0 s
Total Tube On Hrs	0 s

Option	Description
LDR value	The current value read by the LDR ambient light sensor. This goes between 100 (dark) and 999 (bright).
Digit brightness %	As a result of the LDR value and the configuration option "Use LDR", this is the bightness of the display digits expressed as a percentage of full brightness.

Option	Description
Motion sensor	If no motion sensor is installed, this value remains "Not installed". If a motion sensor is installed, this will show how long ago motion was last detected, and if the display is blanked.
Time source	Either "NTP", "RTC" or "internal". The value will show NTP is an update was received in the recent past and if we are still using the value of the NTP time update. This will stay on "NTP" all the while we are in a valid reading, and for the same time afterwards. If you set the "update interval" to 2 hours, the clock will continue to report NTP as being the time source for 2 hours after the reading has expired.
Display time	This is the time that the clock is currently showing on the display.
Real time clock	This will either show "Not installed" if no RTC was found, or the current internal time reported by the RTC. Normally this should be close (maximum a few seconds difference) to the display time.
Impressions/sec	The display update frequency. Normally this should be around 250 per second.
Total Clock On Hours	The total accumulated time the clock has been switched on. This is saved into flash memory once per day at midnight. It does not get forgotten.
Total Tube On Hours	The total accumulated time the tubes have been on. If you have configured tube blanking or have a motion sensor installed, this will be smaller (sometimes considerably smaller) than the clock "on" time.

#### ESP8266 information

Name	Value
Sketch size	425168
Free sketch size	2719744
Sketch hash	8278dcc0e8f63186ade39499c0219e59
Free heap	30240
Boot version	31
CPU Frequency (MHz)	160
Flash speed (MHz)	40
SDK version	2.2.1(cfd48f3)
Chip ID	5a47dd
Flash Chip ID	164068
Flash size	4194304

Option	Description
Sketch Size	The size (in bytes) of the currently loaded firmware.
Free Sketch Size	How much free space is left in the flash memory. If this is more than the "Sketch Size", the OTA (Over the air) update option will be available.
Sketch Hash	The MD5 checksum of the firmware. This is useful when handling firmware problems, because it tells us exactly which build version you have.

Option	Description
Free Heap	The amount of volatile memory still available.
Boot Version	The boot loader version.
CPU Frequency	The speed of the CPU. This is usually 160MHz.
Flash Frequency	The speed of the communication to the flash memory. This is usually 40MHz.
SDK Version	The version of the manufacturer's software development kit.
Chip ID	Identifies the exact version of the main processor.
Flash Chip ID	Identifies the exact version/manufacturer of the flash memory.
Flash size	How big the flash memory is.



## Time server options page

This page allows you to set how the time is retrieved from the internet and interpreted. This page may be protected by a password if this is configured. Please see the section on “Password Protection” for more information.

Option	Description
NTP Pool	<p>This is the “NTP Pool” you want to use for getting the time. It is recommended that you should use a pool close to you, but in practice, this does not matter very much. You can use the standard pool “pool.ntp.org” if you don’t have a preference for this.</p> <p>A NTP Pool is a group of servers which work together to handle the many requests which arrive.</p>
NTP Update Interval	<p>This is how often the time should be recovered from the NTP pool. Usually there is no real benefit to setting this value too low, because it is used only to make small corrections to the time held by the clock over a long period.</p> <p>The configuration parameter is variable from 60 seconds (once per minute) to 86400 (once per day). It is best to choose a value that is not a multiple of 60 seconds, so that the load on the NTP pool is spread out.</p>
Time Zone String	<p>This tells the clock how to interpret the UTC/GMT time from the NTP pool. It describes the usual offset from UTC, if there is Daylight Savings Time and when the DST should be applied.</p>

Note that settings are only applied when you press the “Set” button.

## Clock Settings Page

The clock settings page lets you set up the clock. The options are those presented in the section “Setting Mode”. For full details of the options, please see that section.

Note that settings are only applied when you press the “Set” button.

## Utilities Page

The utilities page lets you access functions which are not usually necessary for normal operation of the clock.

Care should be taken when using these options. If you are not sure what you want to do, don’t play around with these options. They can cause you to lose your settings, or potentially make the clock no longer work properly.

Option	Description
Restart WiFi Module	<p>This will cause the clock to restart. Settings are not changed.</p>
Clear WiFi and restart Module	<p>This will cause the saved WiFi settings to be cleared, and then the clock will restart to let you enter new WiFi settings. Note that after doing this, the clock will of course not connect to your network any more, and instead will go into “Access Point” mode.</p>

Option	Description
Update Firmware	This will allow you to upload new firmware for the clock. You can select the firmware file to upload and it will be loaded and installed. Please make sure you are using a firmware which is suitable for the clock, otherwise it will stop working.
Force Update from NTP now	This will cause the clock to access the NTP pool immediately and get the current time, ignoring the "NTP Update Interval".
Perform Factory Reset	This will cause the clock to forget all settings and go into the state it was in when it was first programmed.

# Password Protection

## Configuration settings

By default, the configuration options are password protected. You can change the username and password, or turn off the protection if you want to.

By default the configuration protection settings are:

<b>Username</b>	admin
<b>Password</b>	setup

## OTA Update settings

The “Over The Air” update settings are:

<b>Username</b>	admin
<b>Password</b>	update

## Forgotten or Lost settings

If you forget or lose the settings, you will have to factory reset the controller. Please see the section about “Factory Reset”. After a Factory Reset, the values will be the ones you see above.

## Display Blanking Mode

### If you have a motion detector installed

If you have a motion detector installed (either a PIR or a microwave detector), the standard display blanking will be turned off and only the detector will be used for blanking the display, using the "PIR Timeout" value to determine how long to leave the display on.

If you have a motion detector, you can skip the rest of this section.

### Time based display blanking

During display blanking mode the tubes will be off depending on the display blanking settings. You can choose if you want to blank the LEDs, the tubes, or both the LEDs and the tubes.

You can configure the display to blank at weekends, during week days, always or never (the default). Also you are able to define hours during which to blank. For example I have a setting saying that the clock is blanked on weekdays between 7am and 4 pm, while I am out at work. At weekends, the display runs all the time.

### Blanking override

Sometimes you will want to override the blanking, for example normally you have a clock at home that blanks during the day while you are at work, but on a holiday you are at home. In this case it is possible to temporarily override the blanking.

Press the button ("short press") while the clock is blanked, and the display will come on again for a few seconds, and then return to blanking mode.

If you press the button multiple times within 5 seconds, the blanking will stay off for longer periods:

- 1 Press: 10 seconds
- 2 Presses: 1 hour
- 3 Presses: 4 hours

# Time Handling

## Time provider priorities

The clock has three time providers:

- NTP time provider
- RTC time provider
- Internal time provider

The clock will always try to use the time provider furthest up the list, because each time you drop down to a lower priority time provider, features are lost.

Each time a time provider is updated, it updates the lower priority providers. That means that each time an NTP update is received, the RTC and internal providers are also updated.

## NTP time provider

The NTP time provider has the advantage that it is always synchronised to a network atomic time source. The maximum deviation from truly correct time is about 1 second, and will never drift more than this. Each time an update is made, the clock corrects itself to the true time.

The NTP time provider also understands Daylight Savings time, and will automatically correct itself to Daylight savings time changes on the next update.

The NTP time provider also restores the time on clock startup and therefore is able to show the correct time, even after the clock has been turned off.

## RTC time provider

The RTC time provider is fairly accurate, but is not as highly accurate as the NTP time provider. It will drift over time, and is not able to track Daylight Savings Time changes.

The RTC time provider does however remember the time if you turn off the clock, and will start again with a correct time if you have fitted a battery.

**Note:** Unfortunately we are not allowed to ship batteries for the battery backup. You will have to locate a battery if you want the RTC time provider to track time while the clock is turned off.

The correct battery is:

**CR1220**

## Internal time provider

The internal time provider is not very accurate, and will drift significantly over time. It does not remember the time while turned off. This is a “last resort” time provider, and should normally not be used.

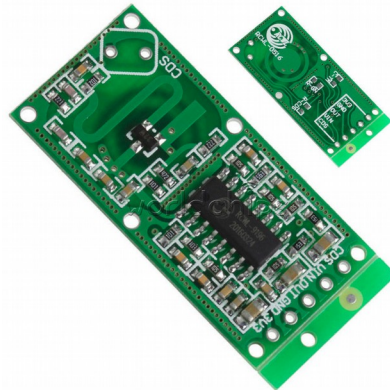


## Adding a motion sensor

One of the best ways for reducing power consumption and extending tube life is to use a motion sensor. This can either be a PIR (recommended: HC-SR505) or a microwave detector (recommended: RCWL-0516, shown on the right).



HC-SR505 PIR



RCWL-0516

You can also use other types of sensor, but it is important that you choose one with a 3.3V output. If you choose one with a 5V output, you could damage your controller.

### Motion sensor automatic detection

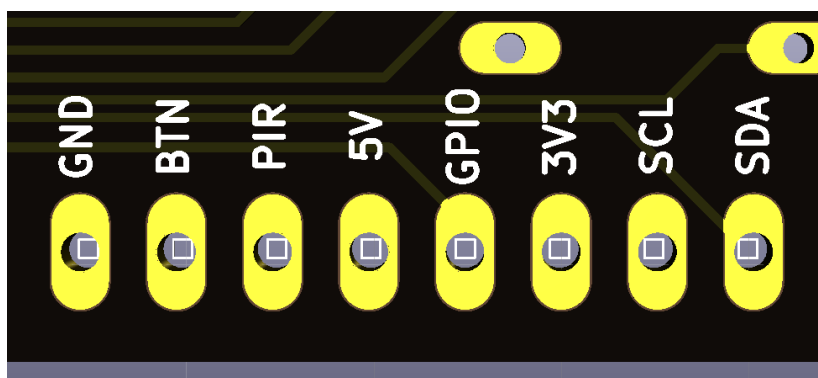
The motion sensor is automatically detected if it is installed, and the default blanking operation is disabled. From the time that the motion sensor is detected, the clock will automatically go into blanking more when the clock detects that no one is there to see the display.

This greatly increases tube life! You can see the effect of blanking by comparing the values of "Total Clock On Hours" and "Total Tube On Hours" on the summary page. For a clock in my bedroom, the on hours is less than 5% of the total on time, therefore increasing the tube life by more than 20 times.

If no motion sensor is detected, the tubes will either be never blanked, or blanked according to the time schedule you have chosen.

### Motion sensor voltage and connection

The motion sensor is attached to the 0.1" header on the back side of the clock. The connector looks like this (older versions have only 4 pins for the Button and Motion detector).



The motion detector needs to be a type that takes a 5V input supply and has a 3V3 compatible output. Although the controller can accept a detector which has a 5V output, it is not recommended to use this type.



## **Factory Reset**

To reset the clock back to initial settings, hold down the button directly after powering on, as soon as you see the second yellow LED come on. The clock will restart and the settings will have been reset.

Everything will be reset back to the factory default state, and the clock will go back to “First Start Mode”.

## External power supply

The power supply must be a 5V supply with a current capacity of at least 1A. A quality USB type charger is ideal.

If you use a low quality or under-rated supply, you will notice that the tube filaments will be unevenly lit, and will flicker. It may also be impossible to get the motion sensor to work reliably.

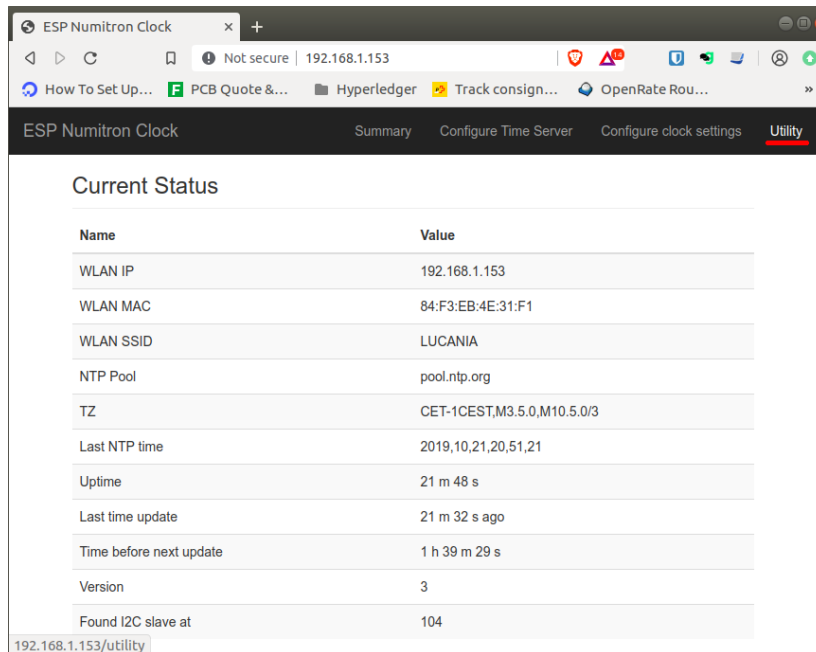
**Do not put more than 5V into the clock.** You will surely damage some components if you do.

# Updating the Firmware

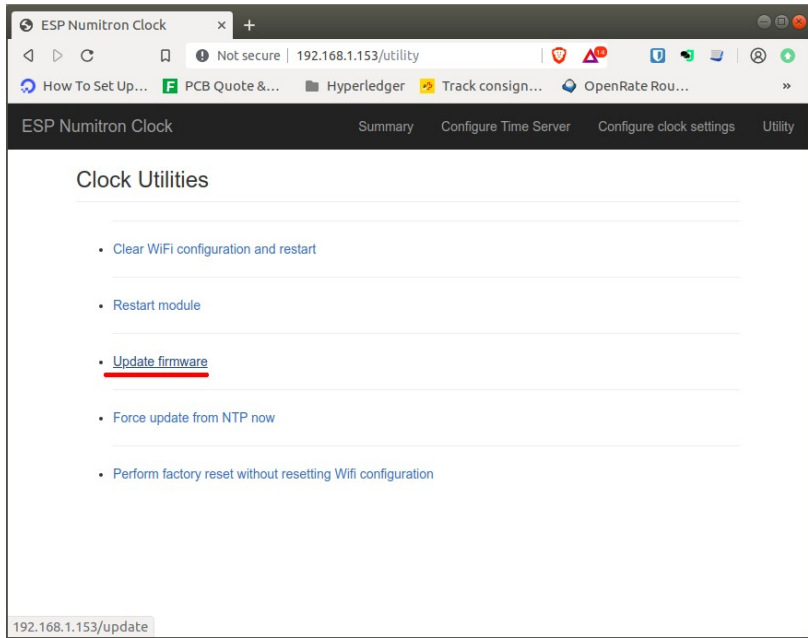
The clock can be updated using a standard browser. This means that you can always get the latest firmware on to clock without any special tools. This is called an “Over The Air” (“OTA”) update.

To perform an update, get the latest firmware from the Nixieclock.biz website. Download the Zip file and unzip it. Inside the Zip file you will find a single firmware file, currently this is called “DA2000-Vx.bin”, where “x” is the version number.

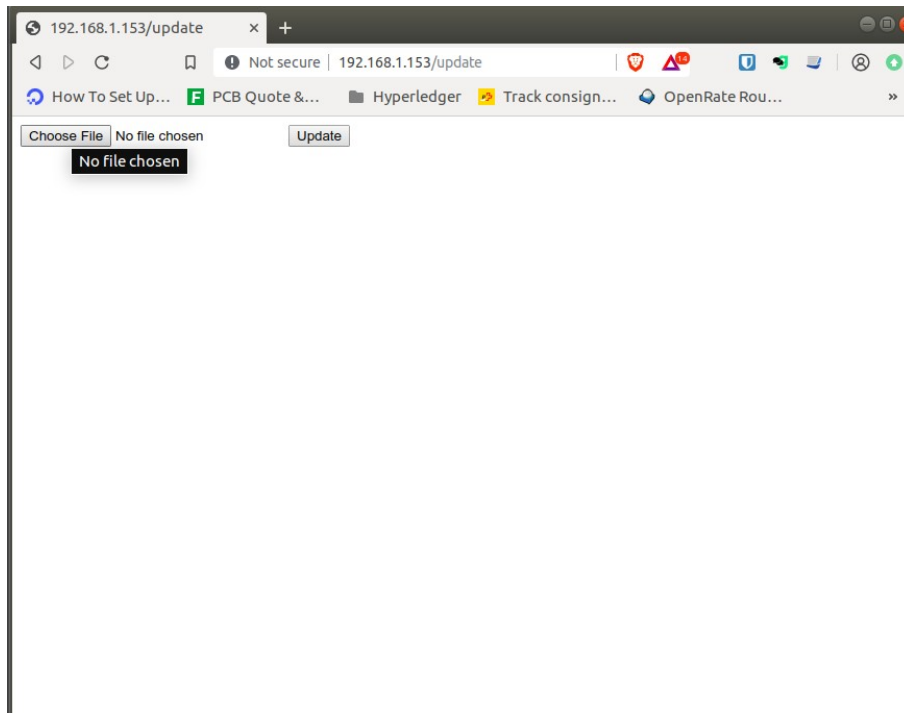
Go to the clock web interface and select the “Utilities” page:



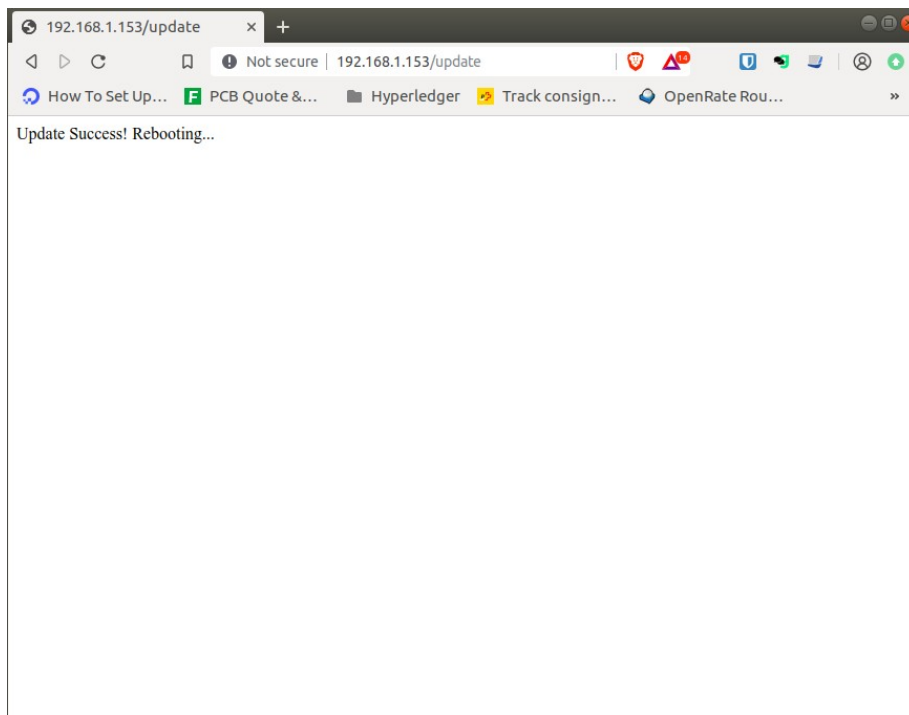
Then you might have to enter the password to get into the configuration (see the section on “Credentials” for the password), after this select the “Update Firmware” link:



Now you can select the file to upload:



and then press the update button. After a few seconds, you should get the confirmation that the file has been uploaded and the clock is rebooting:



That's it!

Revisions:

- V0001: 22Sep2019: Initial version
- V0002: 20Oct2019: Clarified description of first start mode
- V0003: 21Oct2019: Added OTA info and description of mDNS
- V0004: 11Nov2019: No change
- V0005: 22Nov2019: Added information about exit setup mode using LEDs, SPIFFS diagnostic LED
- V0005: 25Feb2020: Preheat settings added
- V0006: 23Oct2020: Update LDR Min/Thrsh/Sens
- V0096: Diags LEDs the wrong way. Thanks Steve!