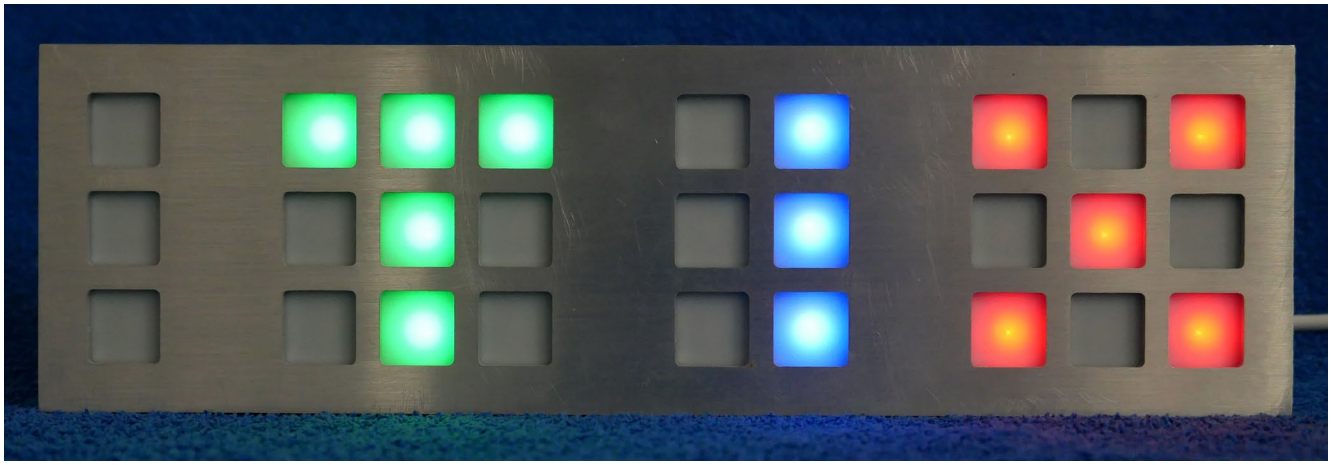
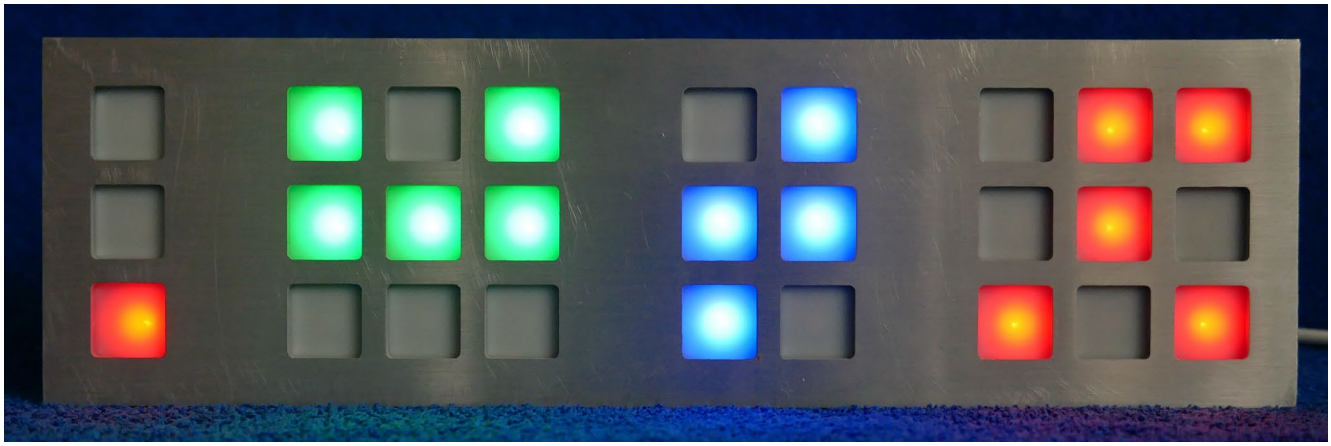
# TIX Clock

## Instructions for the new circuit board





**Version 1.1.2**

Date: 3.3.2025

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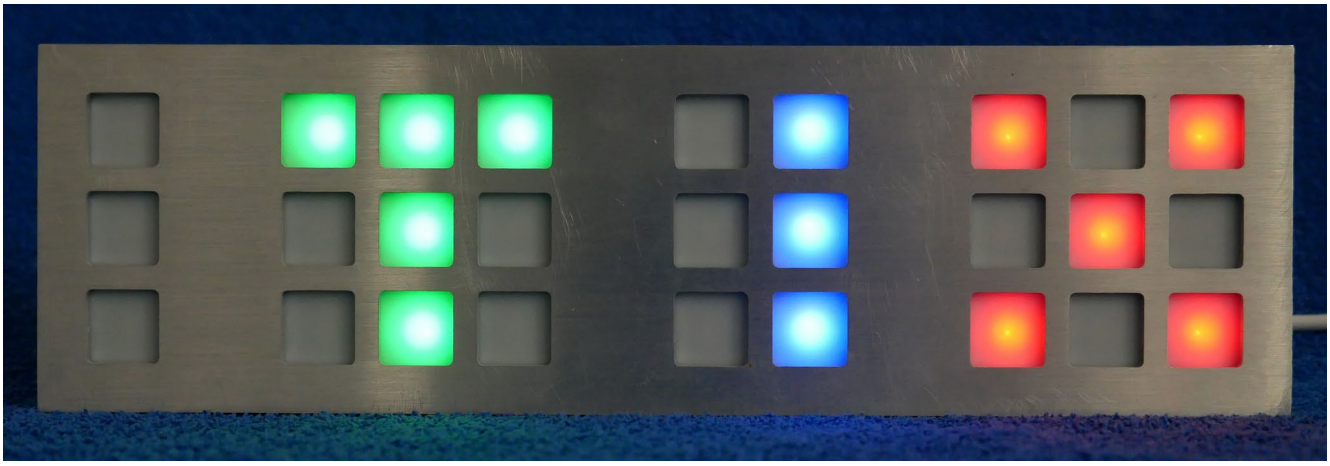
# 1. Introduction

The TIX Clock was developed by James Scott Thompson and manufactured by the company Cube Root (USA) in the period 2005 - 2014. The TIX trademark was registered in 2005 by Cube Root Labs (CUBE ROOT LABS, 464 Jersey Street, San Francisco CA 94114). The inventor James Scott Thompson died in 2007. The company Cube Root had applied for the patent for the watch on 26.1.2006. Patent US7333398B2 was granted on 26.7.2007 (US7333398B2 as PDF). On 23.3.2020, the patent protection expired because the patent fees were no longer paid.

This manual describes the conversion and configuration of the new board for the TIX Clock.



In 2024, I developed a new board for the TIX Clock with some additional features:

- Display:
  - Time (hour, minutes)
  - Date (month, day)
  - Temperature
  - Relative humidity
  - VOC (air quality)
- LEDs with RGBW (red, green, blue, white)
- Colors of the LEDs can be configured as desired
- Brightness of the LEDs manually or automatically with light sensor
- Night shutdown with defined dark period
- Time synchronization over the Internet (NTP, requires Wi-Fi)
- Configuration via integrated web server
- Sensors for temperature, relative humidity, and air quality (MQTT Publisher)
- Change of the display (see above) via MQTT command
- Update Firmware via Internet (OTA = over the air update)
- Power supply via USB-A (2 A, 5V DC, USB cable included, USB power adapter not included)

The files for this project are licensed under the "GNU General Public License v3.0" (Link) freely available. Further informations can be found in the chapter "Programming".

The latest instructions and firmware can be downloaded here:

https://www.beathis.ch/tix/tix.html

# 2. Modes

## 2.1 «SOLO» - Operation without Internet time synchronization

The TIX Clock only uses the internal timer. A time deviation after a certain time cannot be ruled out. The time is entered via the TIX Clock web interface (see «Mode «Solo»»).

In this mode, the WLAN access point switches off automatically after 5 minutes without access. It can be reactivated by pressing one of the buttons on the back of the TIX Clock. The LED in the upper left corner flashes green as long as the Wi-Fi is activated.

The functionality for sending the sensor data via MQTT is not available in this mode.

## 2.2 «Internet/NTP» - Operation with Internet time synchronization

The TIX Clock is connected to a WLAN and thus also to the Internet. The TIX Clock always synchronizes the time around 0400.

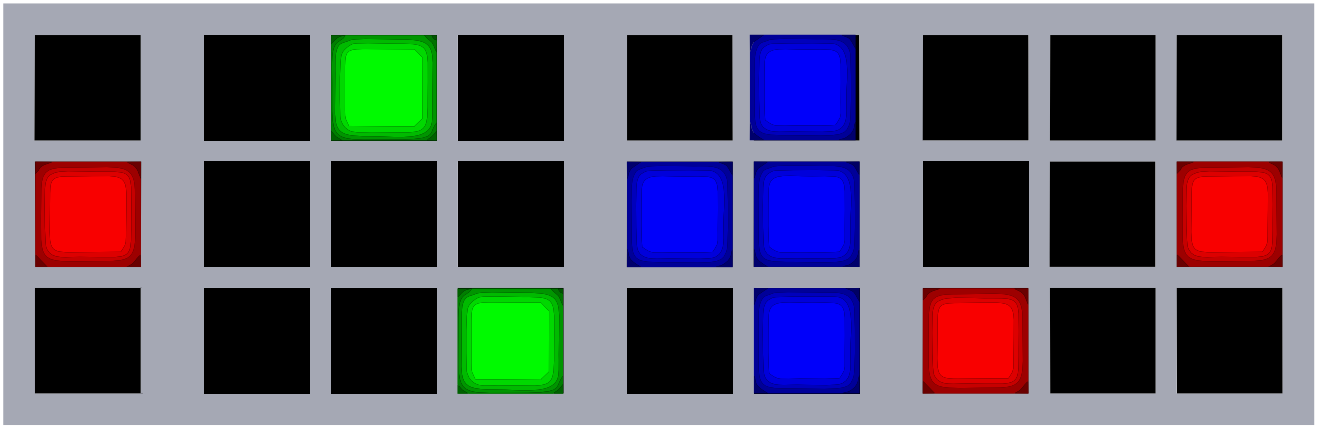
If MQTT mode is activated, the WLAN remains permanently activated. If MQTT mode is disabled, the Wi-Fi will automatically turn off after 5 minutes without user interaction. The Wi-Fi can be reactivated by pressing one of the buttons on the back of the TIX Clock. The LED in the upper left corner flashes green as long as the Wi-Fi is activated. The Wi-Fi can also remain permanently activated via a setting.

# 3. Display

The TIX Clock supports the following displays.

## 3.1 Time

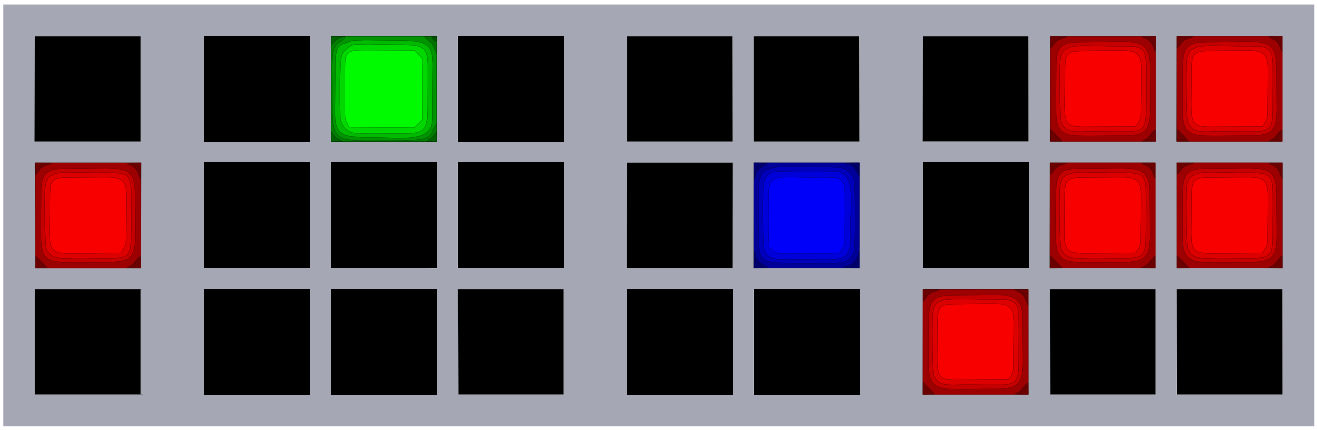
The following illustration shows the time **12:42**.



| 10th hour | 1th hour | 10th minute | 1th minute |
|---|---|---|---|
| **1** | **2** | **4** | **2** |

## 3.2 Date

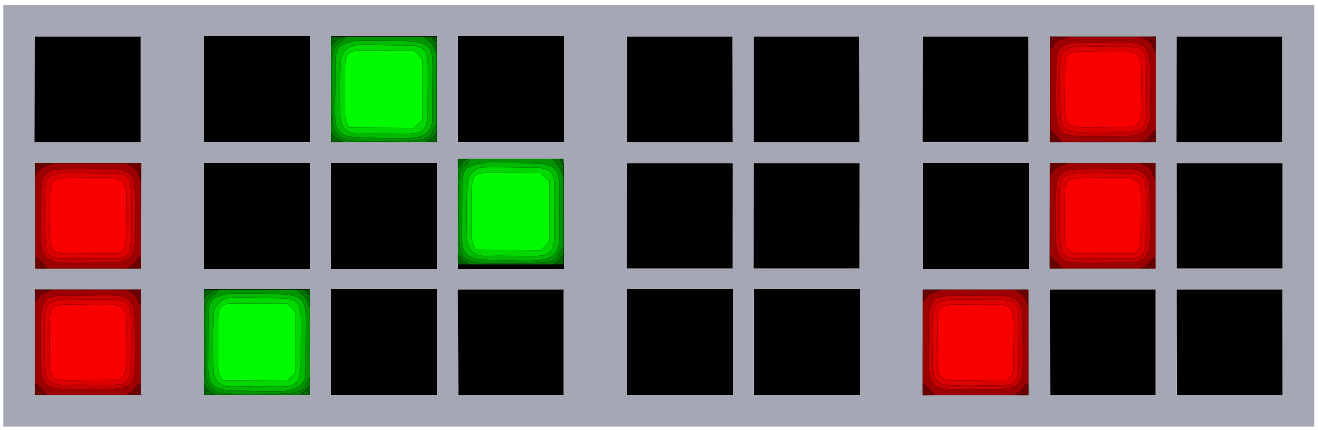
The following illustration shows the date **15.November (15.11.)**.



| 10th month | 1th month | 10th day | 1th day |
|---|---|---|---|
| **1** | **1** | **1** | **5** |

### 3.3 Temperature

The following diagram shows the temperature **23.3°C**.

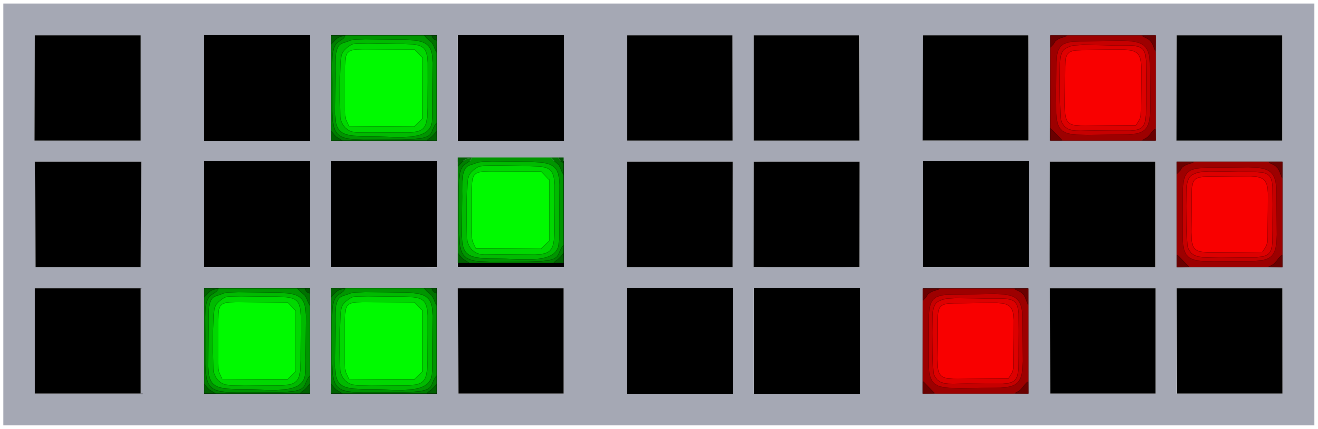


| 10th | 1th | empty | 1.Decimal |
|---|---|---|---|
| 2 | 3 | | 3 |

Note: The temperature is measured inside the TIX Clock and is slightly higher than the room temperature outside the case.

### 3.4 Relative humidity

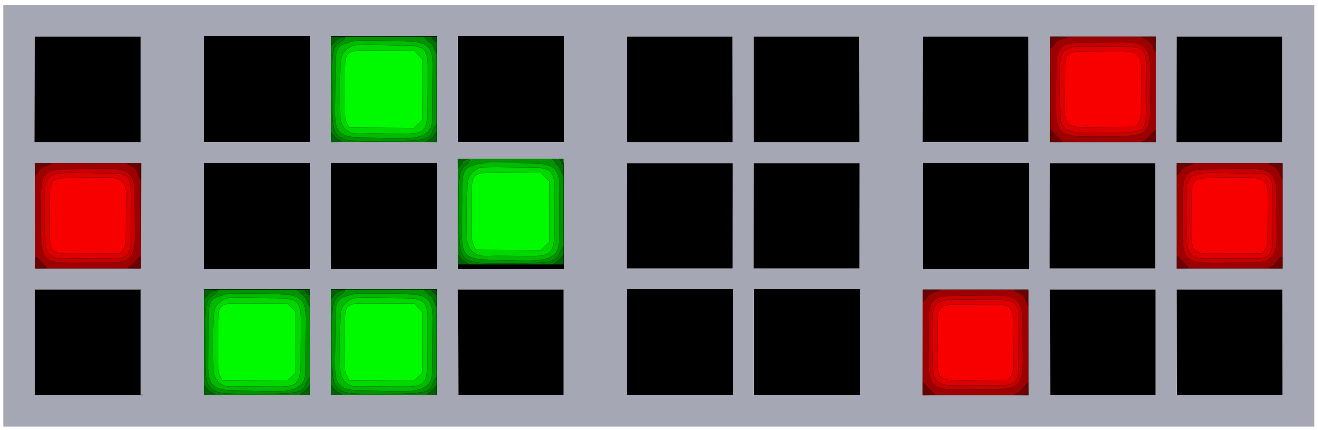
The following diagram shows the relative humidity 43%.



| 100th | 10th | empty | 1th |
|---|---|---|---|
| | 4 | | 3 |

### 3.5 VOC (Air quality)

The following illustration shows the air quality VOC **143**.




Further information on the VOC can be found here: «VOC (Air quality)»

# 4. Scope of delivery

The scope of delivery consists of:


- TIX Clock new circuit board
- Cable for power supply (USB-A to 5.5mm round plug)
- Brightness sensor with cable

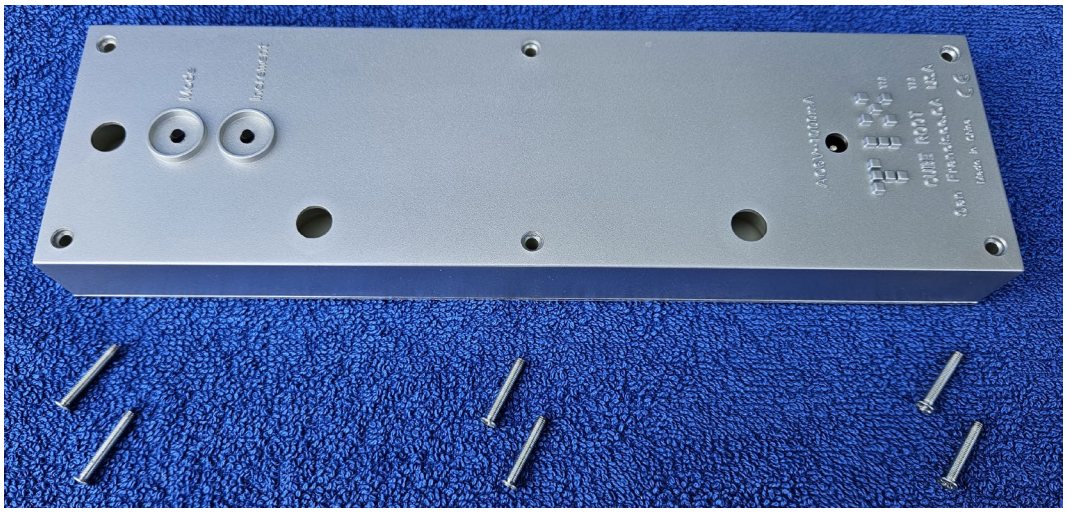
# 5. Modification of the TIX Clock

The instructions in this chapter must be followed exactly. The conversion is at your own risk.

## 5.1 Opening the TIX Clock

1. Disconnect the TIX Clock from the power supply.
2. Place the front of the TIX Clock on a soft cloth.

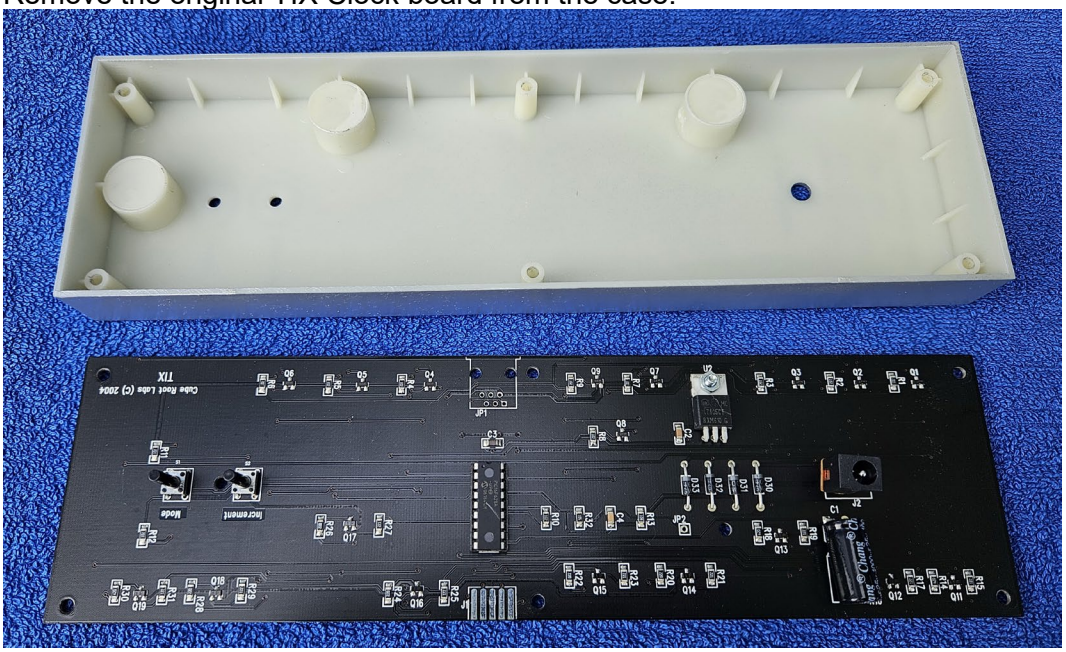
3. Loosen and remove the 6 screws on the back.



4. Carefully separate the front from the plastic case.

Note: The front "sticks" possibly. something on the board. Separate carefully.

5. Remove the original TIX Clock board from the case.



Note: The original TIX clock board and the original power supply are no longer required. Disposal in accordance with national requirements.

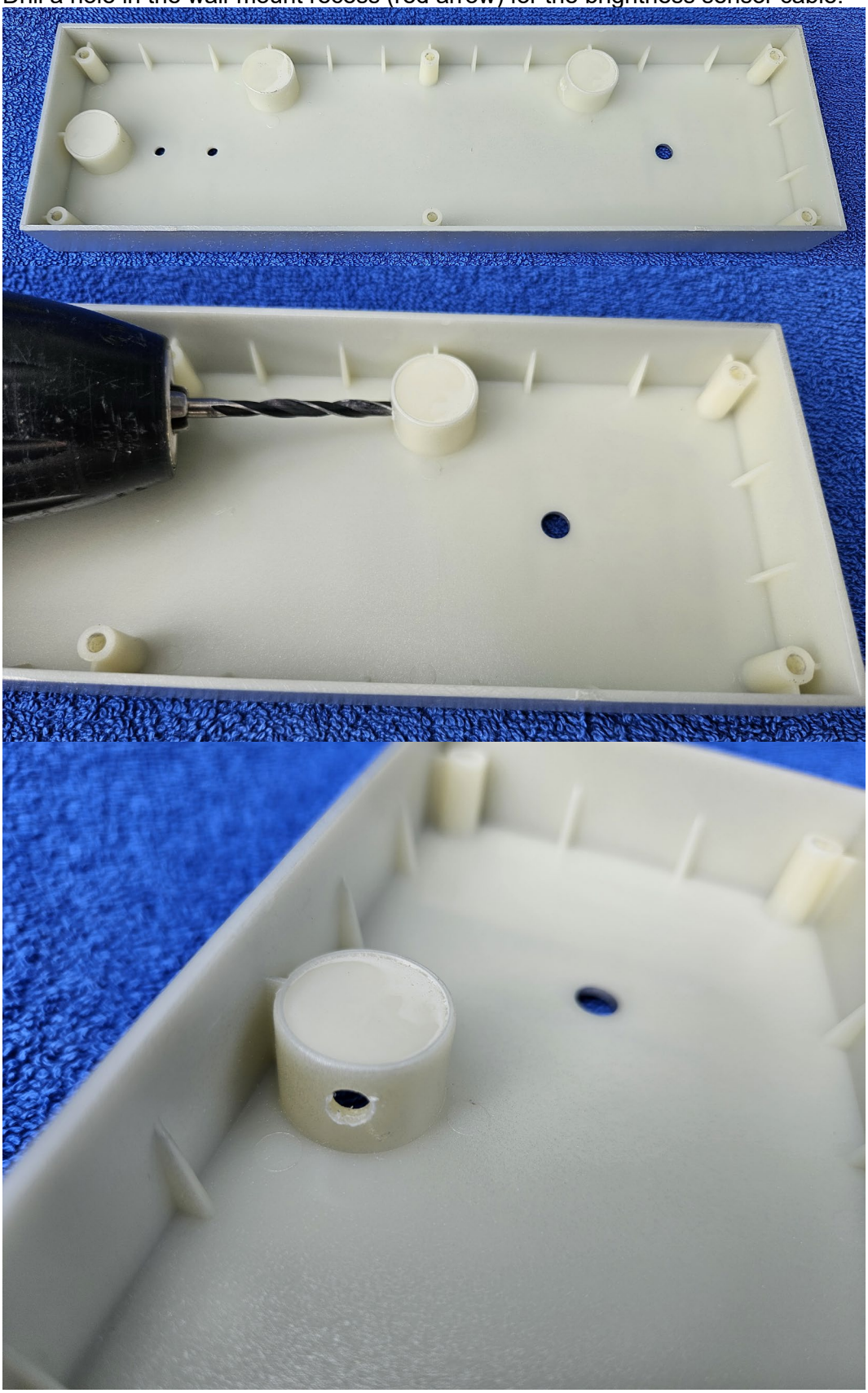
## 5.2 Adjustments to the housing

The following adjustments must be made to housings:

- Carefully enlarge the holes for the 2 buttons with a 4mm drill (possibly 4.5mm).

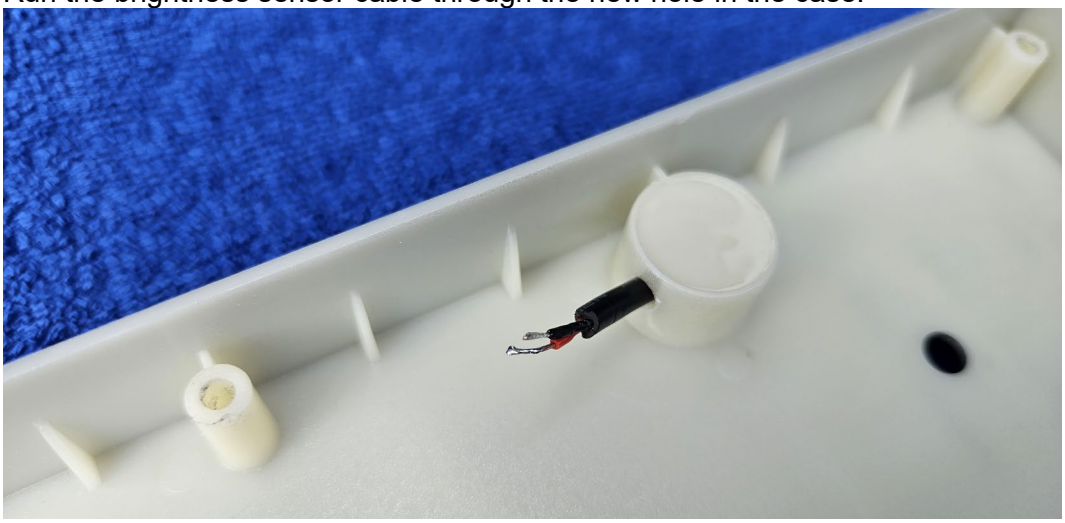

The buttons must not jam and a cracking sound must be audible when pressed.

- Drill a hole in the wall-mount recess (red arrow) for the brightness sensor cable.

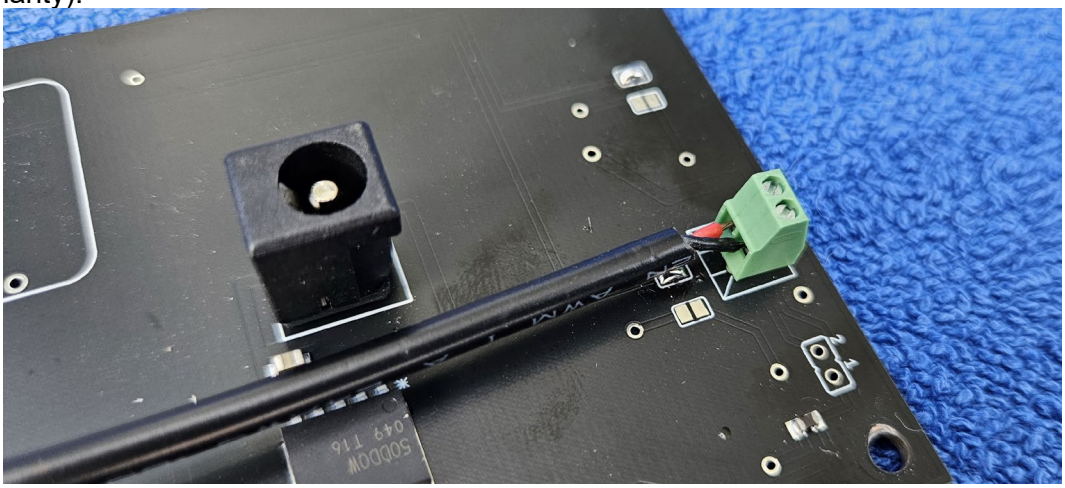


## 5.3 Assembly

1. Run the brightness sensor cable through the new hole in the case.



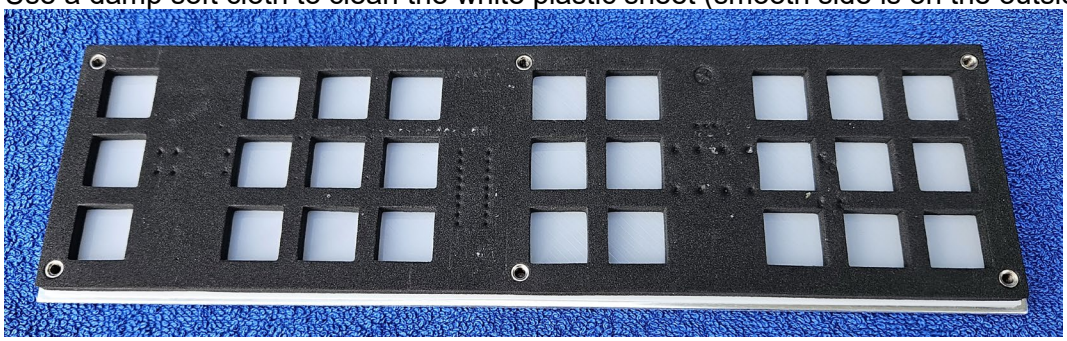
2. Connect the cable to the jack on the board. The two wires can be connected as desired (no polarity).

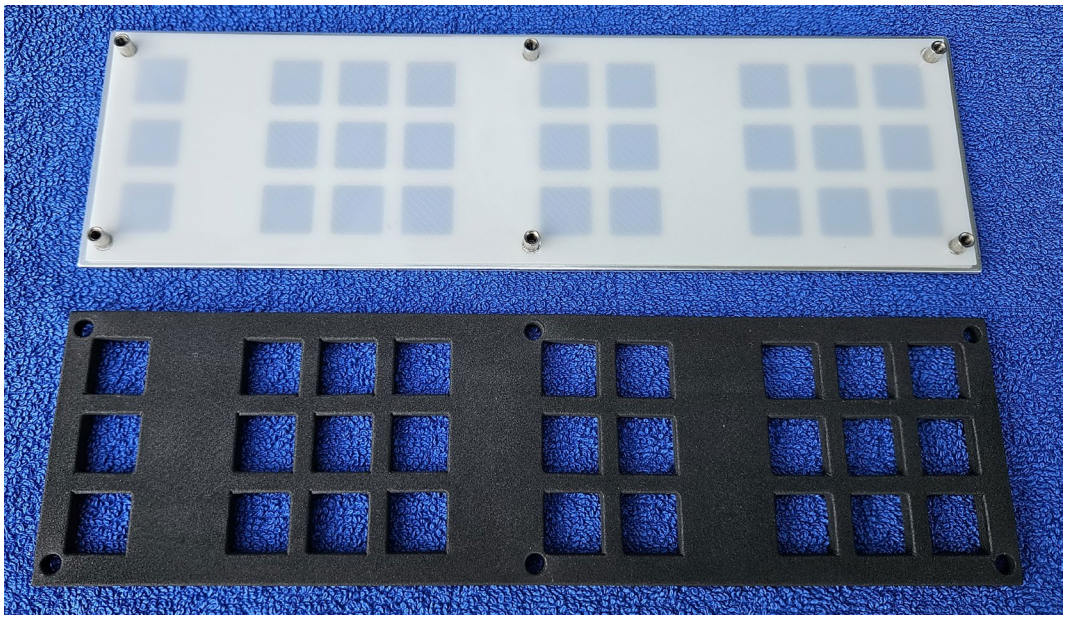


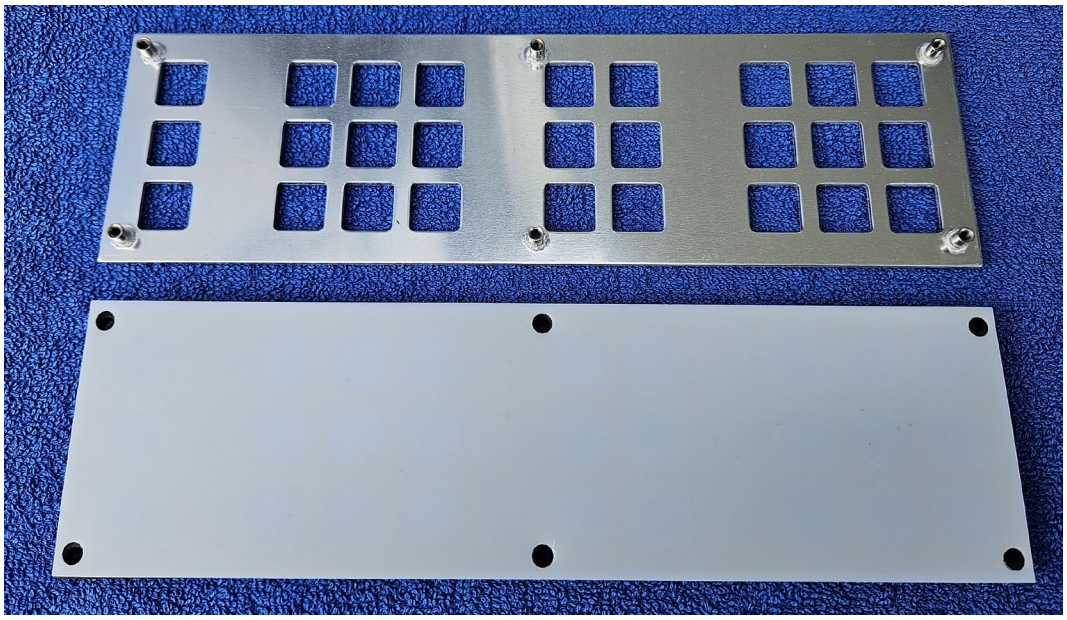
3. Carefully place the new board in the case. Make sure that the board is correctly aligned in the case. The cable from the brightness sensor must not be pinched.


The buttons must not jam and a cracking sound must be audible when pressed.

4. Use a damp soft cloth to clean the white plastic sheet (smooth side is on the outside).

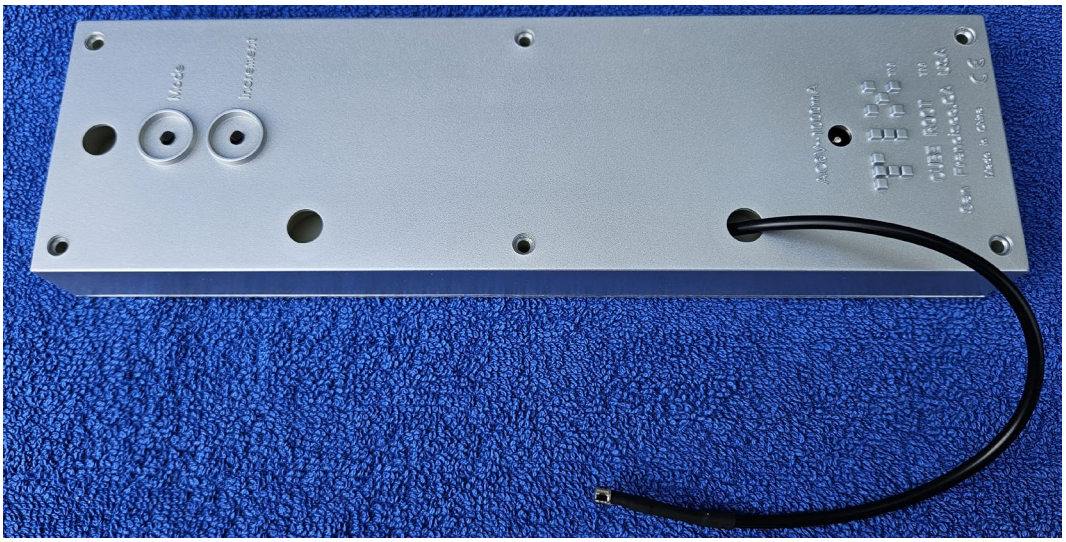




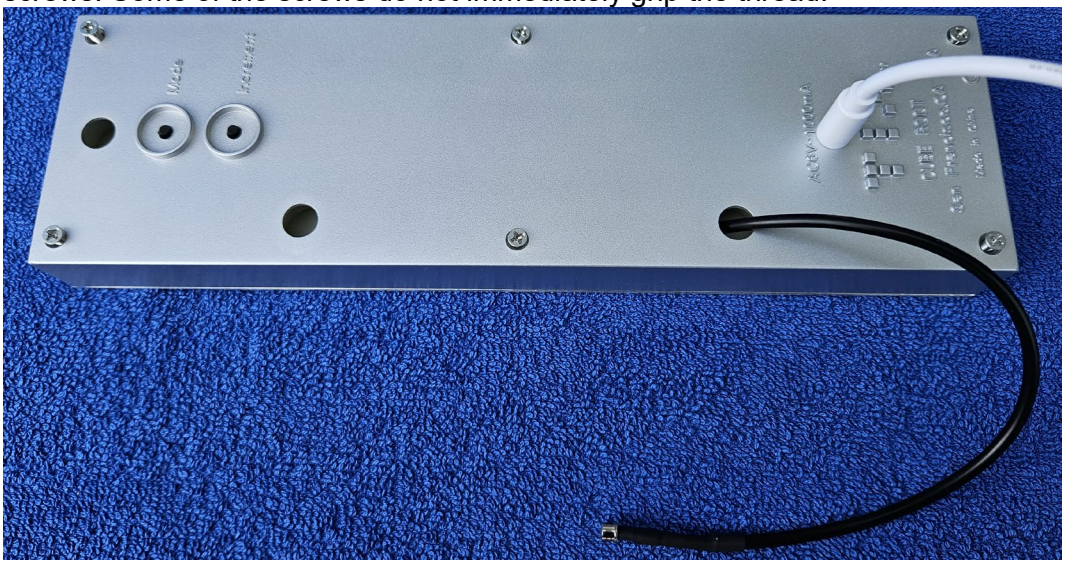


5. Reassemble the front.
6. Place the front on top of the case.

7. Turn the case over.




8. Plug in the new power cable and insert all 6 screws into the holes in the case. Screw in all the screws. Some of the screws do not immediately grip the thread.



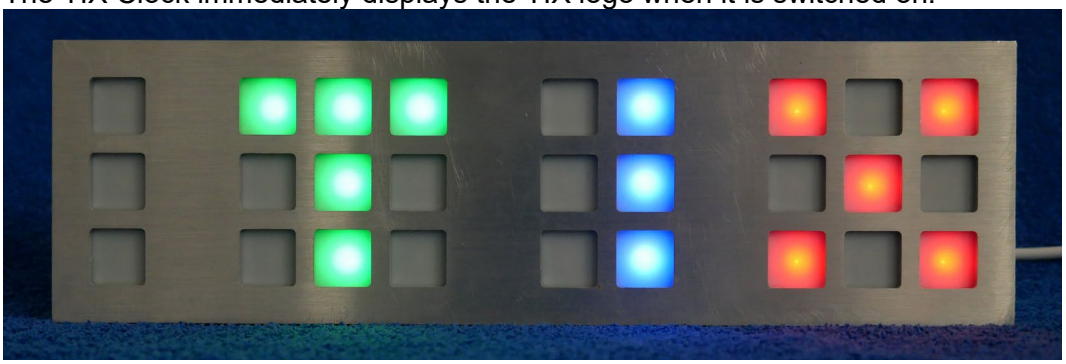

Note: The two buttons must have a clear pressure point when pressed (crack). If this is not the case, disassemble the TIX Clock again and enlarge holes for the buttons in the case with a fine file or a larger drill.

9. Gently push the brightness sensor cable back into the case up to the desired length.

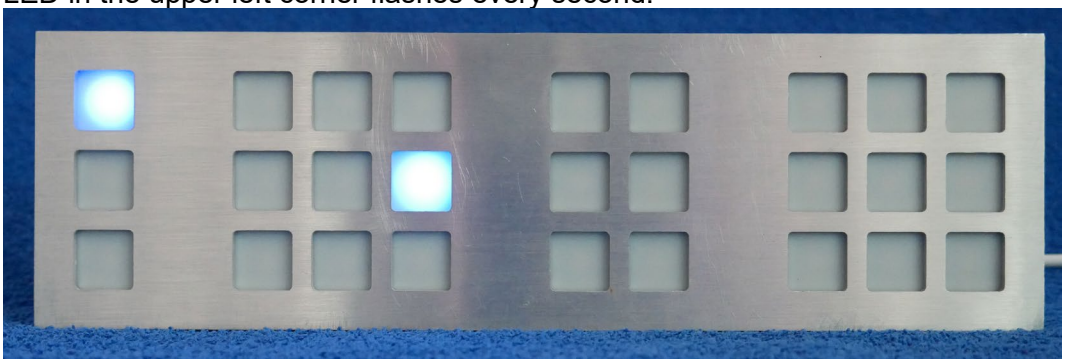

10. The conversion is now complete.

# 6. First commissioning

1. Plug the power cable into the housing of the TIX Clock.
2. Connect the power cable to the USB power adapter (not included).
3. The TIX Clock immediately displays the TIX logo when it is switched on.



4. After a few seconds, the clock starts and shows a first time. The TIX clock starts at 01:00. The LED in the upper left corner flashes every second.



5. Connect to the TIX Clock's "TIX" Wi-Fi access point. (see «Mode «Solo»»)
6. Configure the TIX Clock according to your ideas (details see «**Fehler! Verweisquelle konnte nicht gefunden werden.**»).

# 7. Keys

There are 2 buttons on the back of the TIX Clock:

| | |
|---|---|
| Key MODE | Button on the left of the image, closer to the edge of the case |
| Key INC | Button on the right of the image, closer to the center of the case |

The buttons have the following functions:

| | | |
|---|---|---|
| When switching on | MODE and INC | When turning on, press and hold both ⇨ Reset Operating Mode, see «Reset TIX Clock». |
| Night mode active | MODE or INC | LEDs are turned on for 5 minutes |
| «SOLO» | MODE or INC | WLAN Access-Point activated |
| «Network/NTP» | MODE or INC | Wi-Fi is enabled when MQTT is disabled |
| WLAN active | MODE | Increase brightness (manual mode only) |
| WLAN active | INC | Reduce brightness (manual mode only) |

# 8. Settings

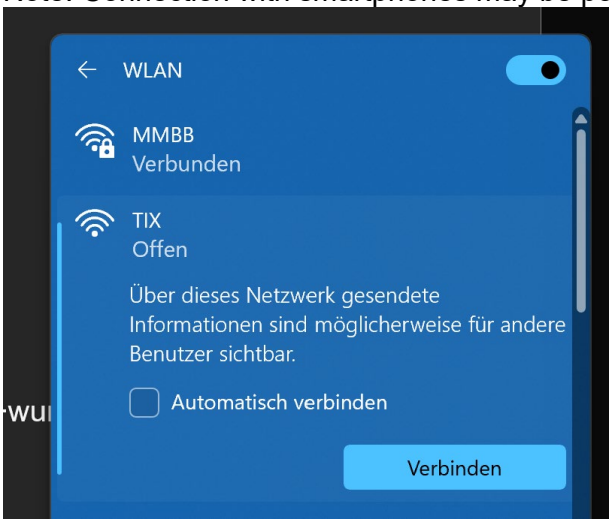
## 8.1 TIX Clock website

The settings of the TIX Clock are made via a website in the TIX Clock. The access to the website depends on the set operating mode (see «Modes»).

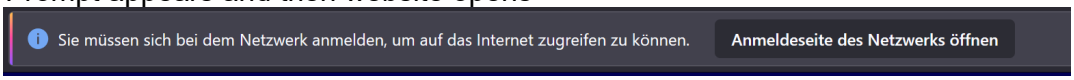
IMPORTANT: The web server in the TIX Clock is not very fast. The loading times of the pages can sometimes be a little longer. If no website is displayed, the TIX Clock must be restarted (unplug the USB cable and plug it back in).

### 8.1.1 Mode «Solo»

1. Press a button on the back of the TIX Clock.
2. The WLAN access point is activated. The LED in the upper left corner flashes green.
3. Connect the device (tablet, notebook, smartphone) to the "TIX" access point
   Note: Connection with smartphones may be possible. Can cause problems.




4. Depending on the device:
   - Website opens automatically
   - Prompt appears and then website opens



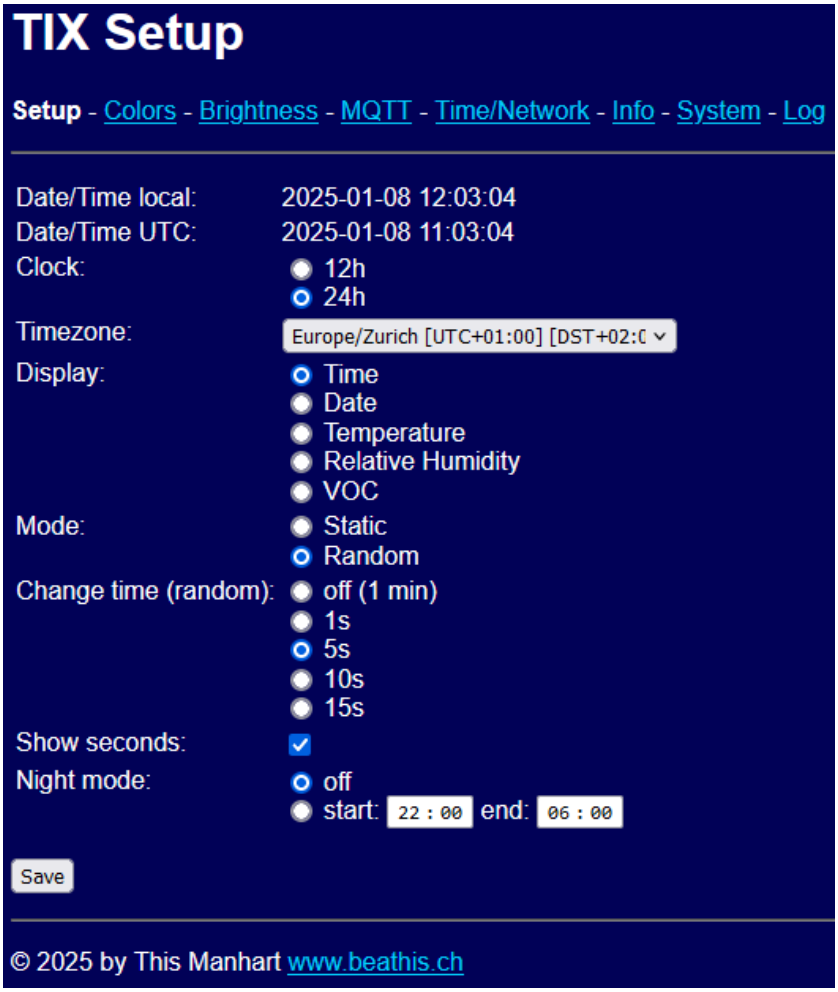

   - Website open manually with the link http://192.168.4.1

### 8.1.2 Mode «Internet/NTP»

1. Call the website using the IP address you set earlier.

## 8.2 TIX Setup

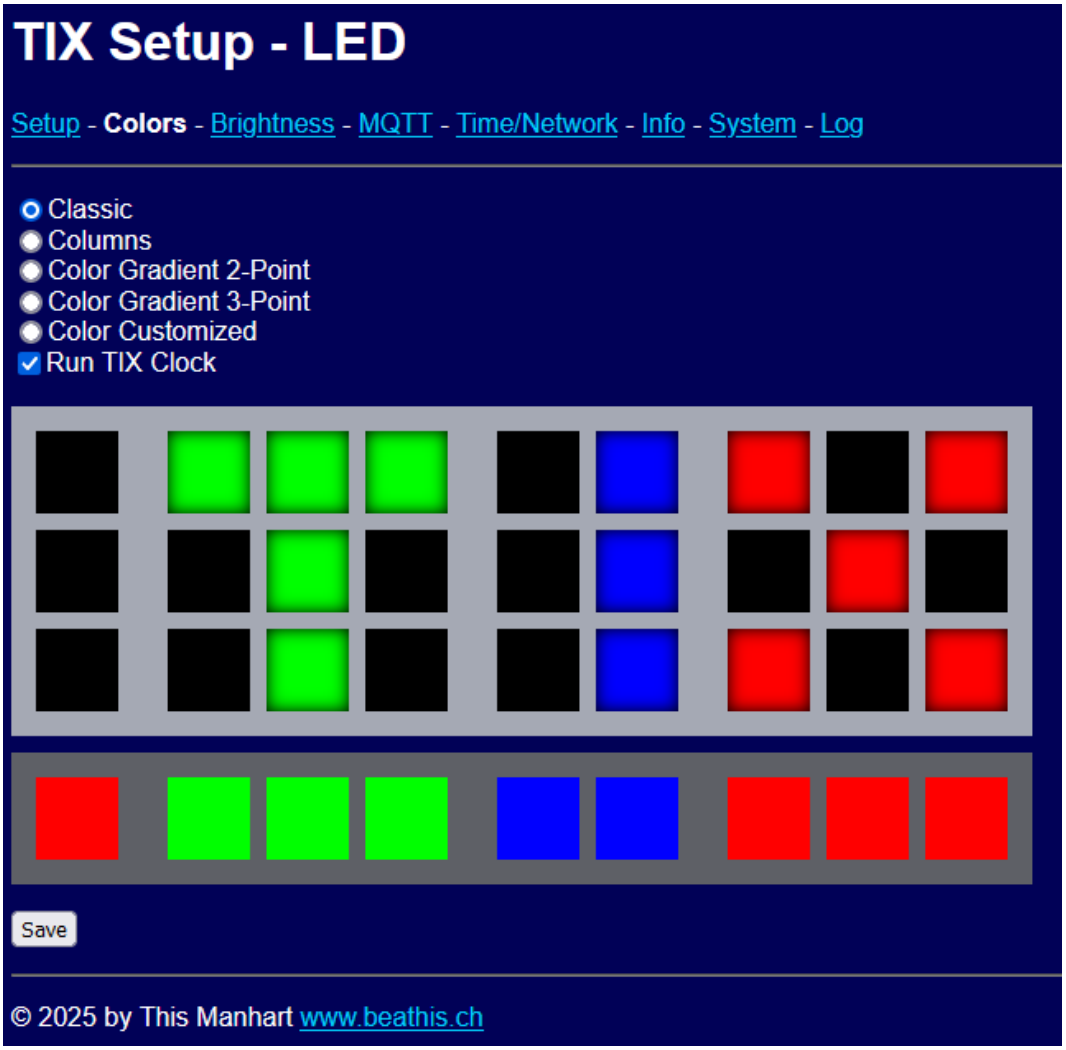
The TIX Clock home page displays the settings of the clock.




| | |
|---|---|
| Date/Time local | |
| Date/Time UTC | |
| Clock | Switching 12h/24h display |
| Timezone | Time zone |
| Display | ○ Time (hours, minutes)<br>○ Date (month, day)<br>○ Temperature<br>○ Relative humidity<br>○ VOC (Air quality) |
| Mode | Static = LEDs do not change<br>Random = LEDs change (see next parameter) |
| Change time | Time in which the LEDs change |
| Show seconds | LED on the top left flashes every second |
| Night mode | off = Mode disabled<br>on = Time window when the LEDs are switched off<br>Button MODE or INC activated LED for 5 minutes when night mode is activated |

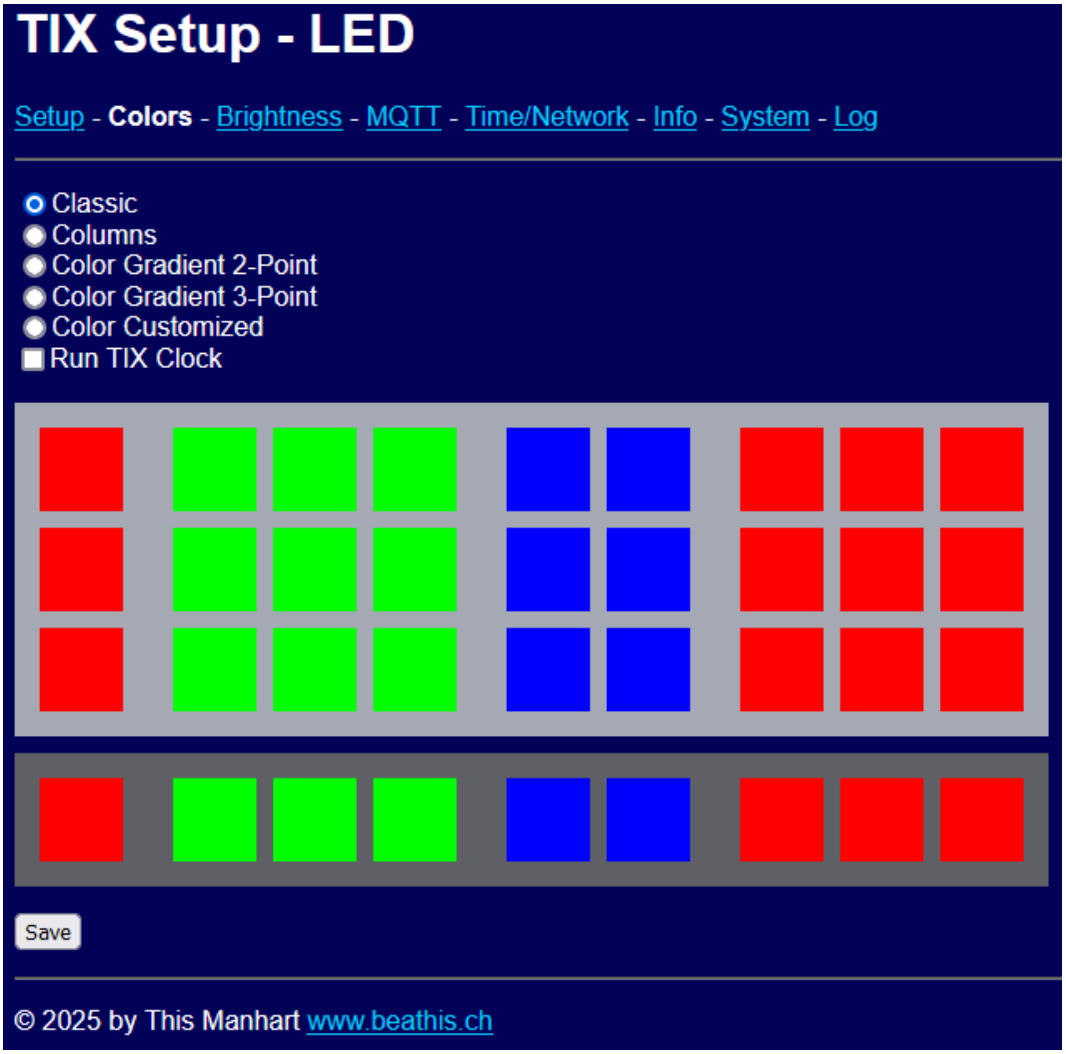
## 8.3 Colors

The colors of the LEDs can be adjusted individually. The colors are displayed in the best possible way as on the TIX Clock. The randomly switched on LEDs do not correspond to the LEDs on the TIX Clock.




| | |
|---|---|
| Classic | Colors like the original TIX Clock. |
| Columns | A color can be set for each column<br>Click on LED below the TIX clock. |
| Color Gradient 2-Point | Gradient between 2 points in the color spectrum<br>Click on the 2 colors below the TIX Clock. |
| Color Gradient 3-Point | Gradient between 3 points in the color spectrum<br>Click on the 3 colors below the TIX Clock. |
| Color Customized | The color can be defined individually for each LED.<br>Click directly on the desired LED. |

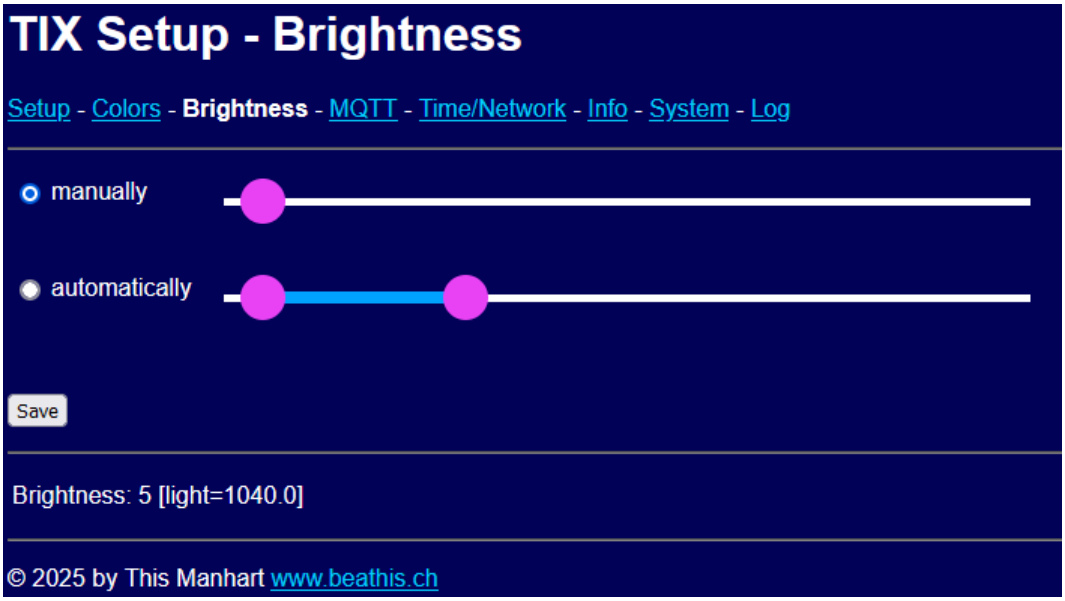
For easier display of the colors, the "Run TIX Clock" mode can be switched off. In this special mode, all LEDs are switched on.




This mode remains activated until the "Run TIX Clock" option is reactivated or the menu is exited.

## 8.4 Brightness

The brightness of the LEDs can be adjusted in 2 ways.




| | | |
|---|---|---|
| manually | manuell | The LEDs shine in the desired brightness. |
| automatically | automatisch | The brightness automatically adjusts in the set range with the help of the brightness sensor. |

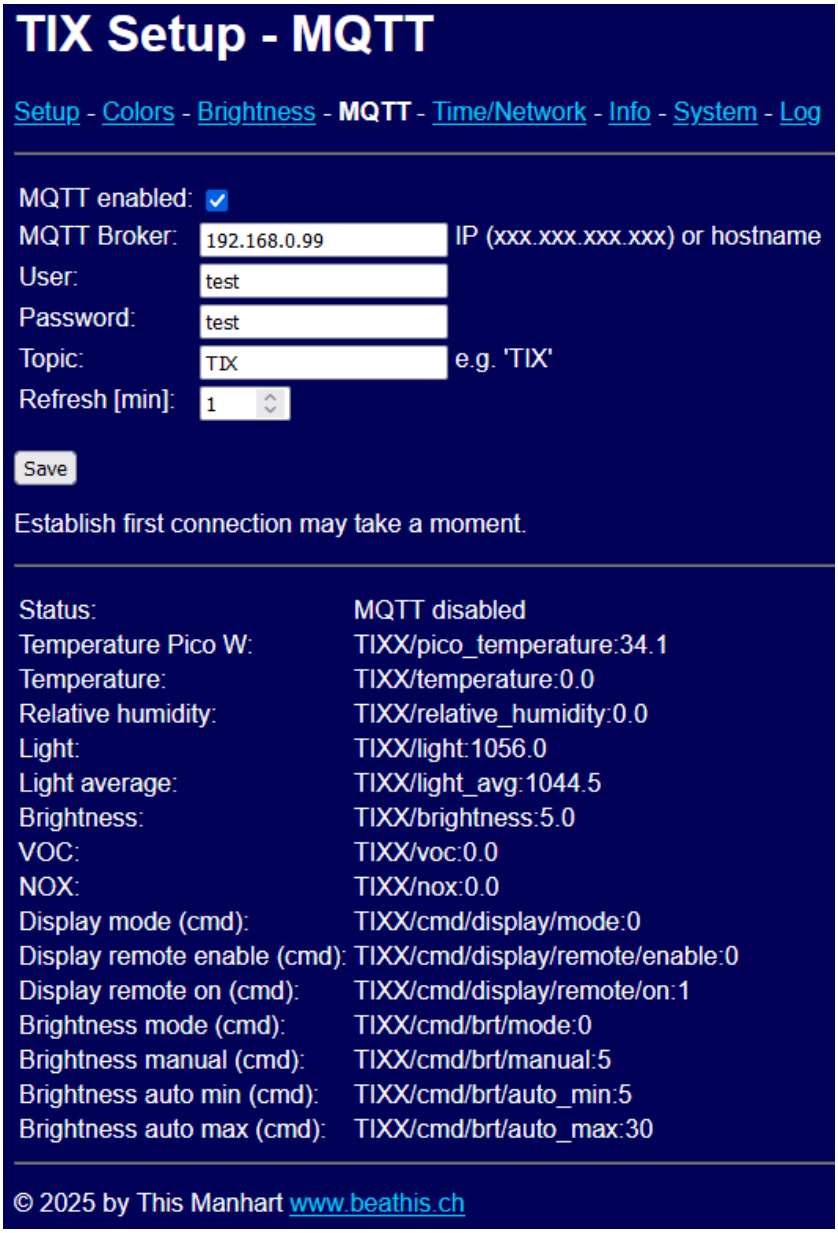
The brightness is set in the range 0 to 100. The current value is shown below (brightness).

Note: The colors are sometimes not reproduced correctly at brightness values below 5.

## 8.5 MQTT

The TIX Clock can send the sensor data to an MQTT broker. The TIX Clock can also receive commands via MQTT. This MQTT mode can only be used in the "Internet/NTP" mode.

When this mode is enabled, the Wi-Fi will not turn off.




| | |
|---|---|
| MQTT enabled | Enables the sending of data |
| MQTT Broker | IP address or hostname of the MQTT broker |
| User | Username of the account on the MQTT broker |
| Password | Password of the account on the MQTT broker |
| Topic | Top level of data |
| Refresh | Frequency of sending data in minutes |

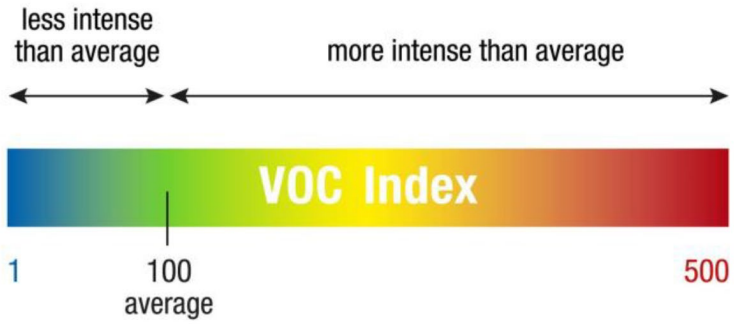
Below the settings, the status and the transmitted data are displayed.

### 8.5.1 Air quality

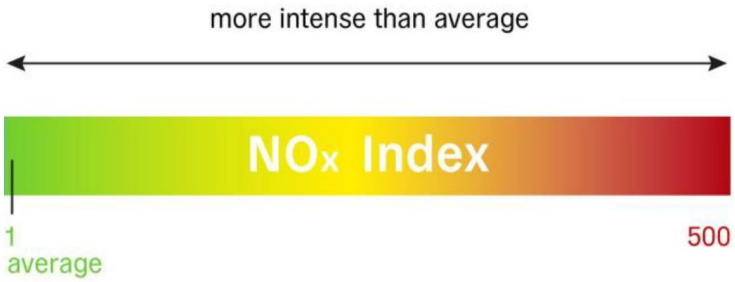
The TIX Clock is equipped with the SGP41-D-R4 sensor from Sensirion AG. It determines 2 values regarding air quality.

- VOC: Volatile Organic Compounds
  (gaseous and vaporous substances of organic origin in the air)
- NOx: Nitrogen oxides

The VOC Index 100 corresponds to the mean value of the gas composition of the last 24 hours. Values greater than 100 correspond to a deterioration of the gas composition. Values less than 100 correspond to an improvement.




The average value for NOx is 1. If the value is greater than 1, nitrogen oxides are present.



### 8.5.2 Commands

MQTT can be used to change selected settings of the TIX Clock.

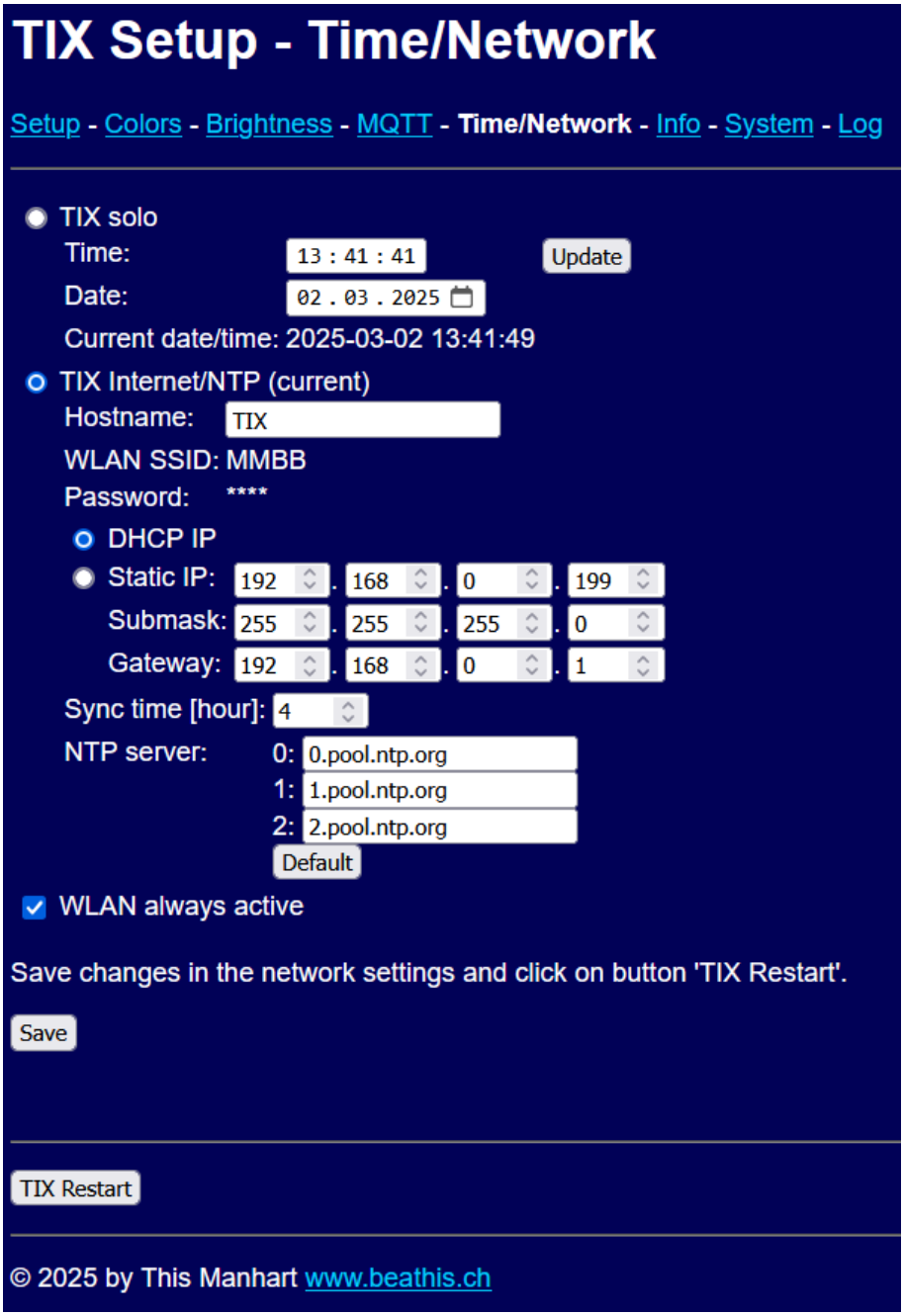
| | |
|---|---|
| Display mode (cmd): | TIXX/cmd/display/mode:0 |
| Display remote enable (cmd): | TIXX/cmd/display/remote/enable:0 |
| Display remote on (cmd): | TIXX/cmd/display/remote/on:1 |
| Brightness mode (cmd): | TIXX/cmd/brt/mode:0 |
| Brightness manual (cmd): | TIXX/cmd/brt/manual:1 |
| Brightness auto min (cmd): | TIXX/cmd/brt/auto_min:5 |
| Brightness auto max (cmd): | TIXX/cmd/brt/auto_max:30 |

| Command | Value |
|---|---|
| /cmd/display/mode | 0 Time (hours, minutes)<br>1 Date (month, day)<br>2 Temperature<br>3 Relative humidity<br>4 VOC (Air quality) |
| /cmd/display/remote/enable | 0 Control via MQTT off *<br>1 Control via MQTT on |
| /cmd/display/remote/on | 0 LED off<br>1 LED on * |
| /cmd/brt/mode | 0 Manual<br>1 Automatic |
| /cmd/brt/manual | Manual brightness value |
| /cmd/brt/auto_min | Minimum brightness value automatic |
| /cmd/brt/auto_max | Maximum brightness value automatic |

* Default settings after switching on the TIX Clock

## 8.6 Time/Network

This page defines the operating mode of the TIX Clock and the network parameters.



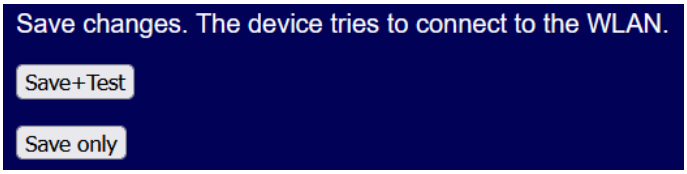

The current mode of the TIX Clock is marked with "current". If this mode is not changed, the current settings can be saved with "Save". The settings are only activated with a restart (see «Restart TIX Clock»).

The Wi-Fi remains permanently switched on if the "Wi-Fi always active" switch is switched on.

If the mode is changed, the following buttons are displayed:

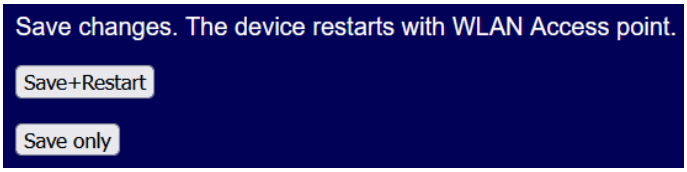
**Mode «TIX solo»**

With "Save+Test", the TIX Clock tries to establish the connection to the WLAN and determine the IP address of the TIX Clock. With "Save only", only the settings are saved. Further information see «TIX Internet/NTP».




**Mode «TIX Internet/NTP»**

With "Save+Restart", the TIX Clock switches to the "TIX solo" mode. With "Save only", only the settings are saved.




Note: Currently, the TIX Clock does not support calling up the website in the WLAN via the host name (limitation Micropython).

### 8.6.1 TIX solo

In this mode, the TIX Clock is not connected to the Internet. The time must be re-entered on this page after each restart.

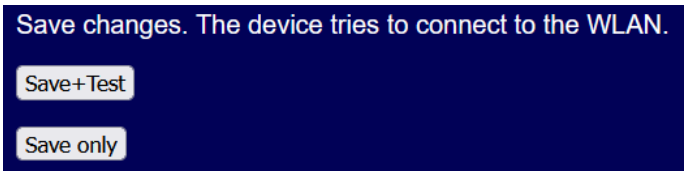
| | |
|---|---|
| Time | Time |
| Date | Date |

By clicking on the "Update" button, the date/time is stored in the TIX Clock.

### 8.6.2 TIX Internet/NTP

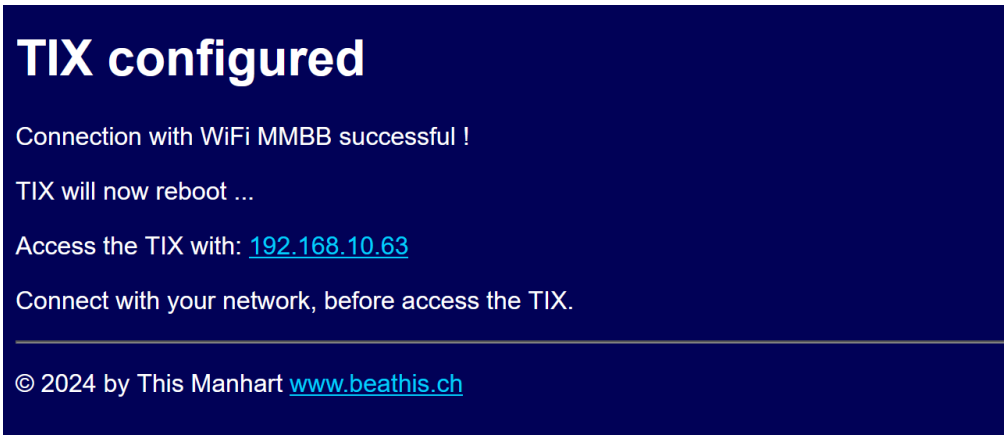
| | | |
|---|---|---|
| Hostname | Hostname | Name of the TIX Clock on the net |
| WLAN | WLAN | Select Wi-Fi |
| Password | Passwort | Password of the WLAN |
| DHCP IP | DHCP IP | The TIX Clock is assigned an IP |
| Static IP | Statische IP | Static IP in the network |
| Submask | Submaske | Submask to static IP |
| Gateway | Gateway | Gateway to Static IP |
| Sync time [hour] | Zeitpunkt Abgleich [Stunde] | Time (full hour) for time synchronization and testing of new firmware (OTA) |
| NTP server | NTP Server | 3 Addresses for Time Synchronization (NTP) Default ⇨ Standard NTP Server |

By clicking on the "Save+Test" button, the TIX Clock tries to log in to the WLAN:




This process takes a few seconds !

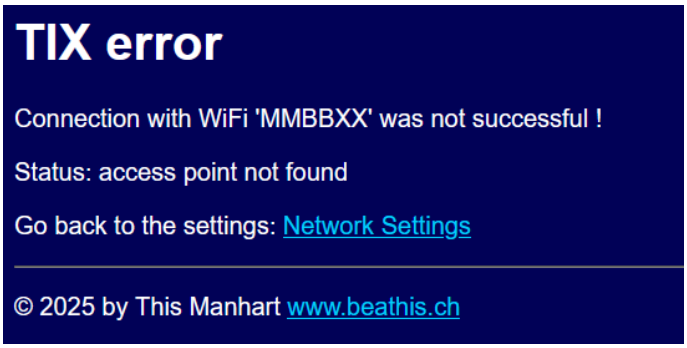
If signing in to Wi-Fi worked, you'll see the following page:




Connect the PC to the original Wi-Fi network and click the link with the IP address. The TIX Clock website opens.

IMPORTANT: Write down this IP address for later access to the website. (Save favorite)

If there is an error, the corresponding error is displayed.

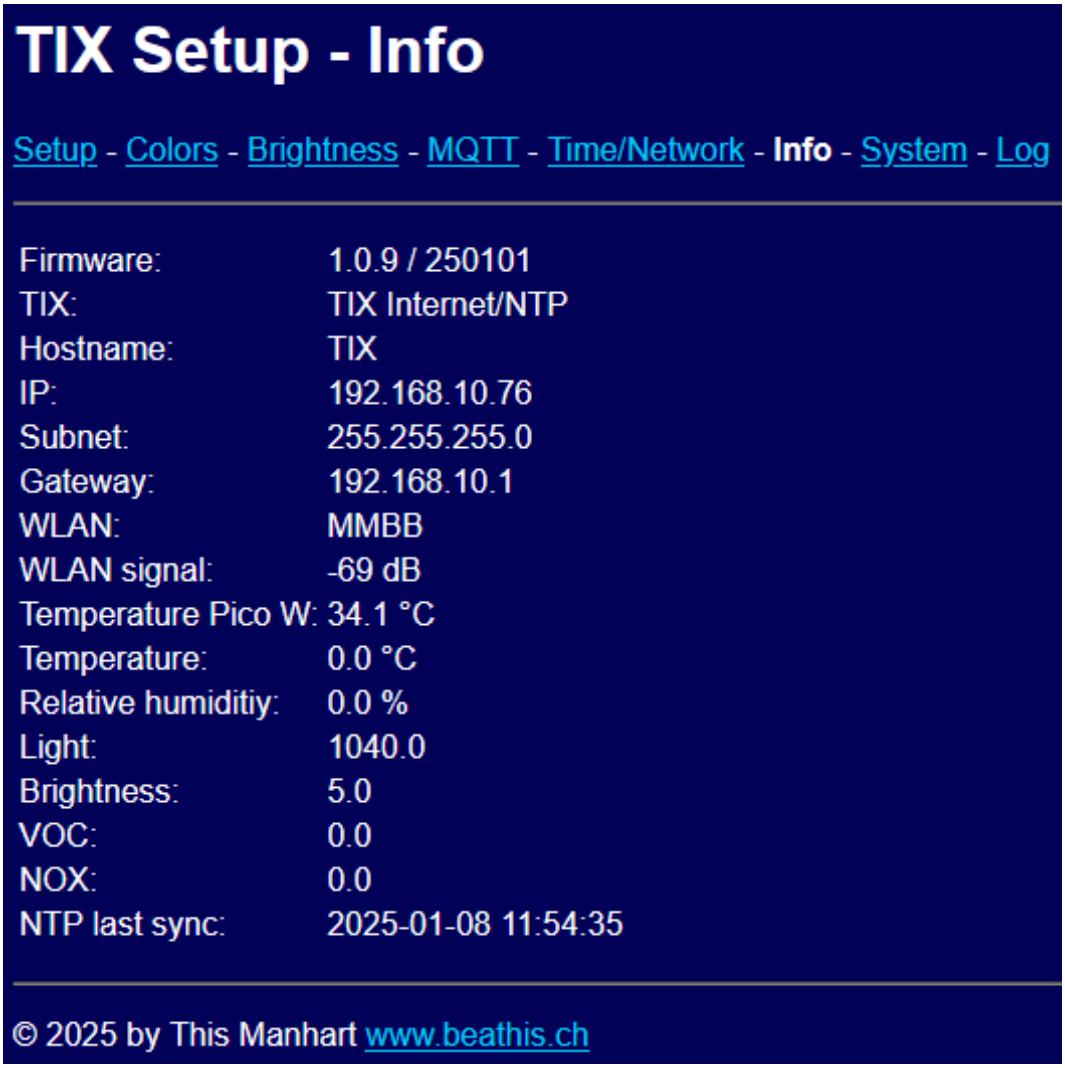



### 8.6.3 Restart TIX Clock

The TIX can be restarted with the "Restart" button.

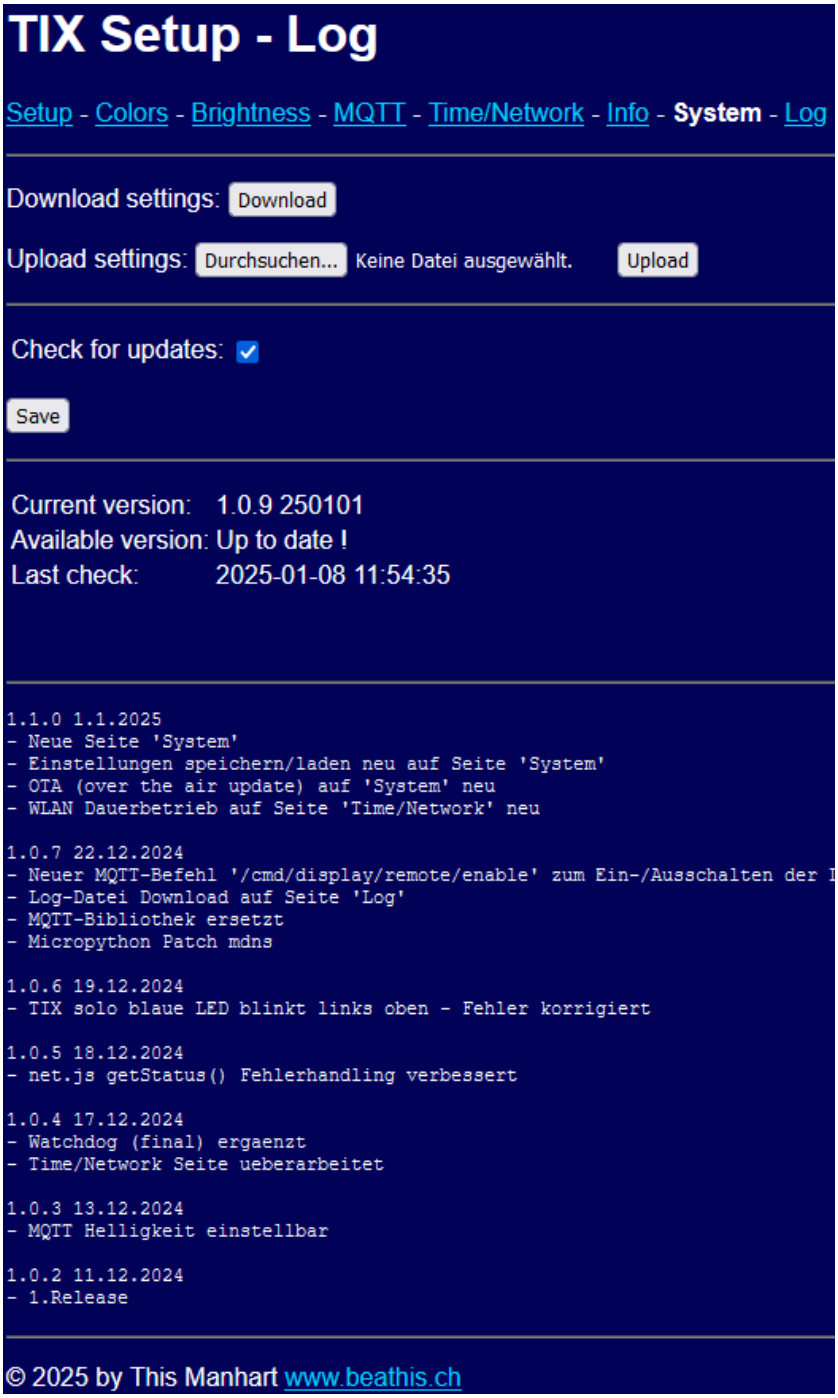
## 8.7 Info

The info page shows the settings and sensor values of the TIX Clock.



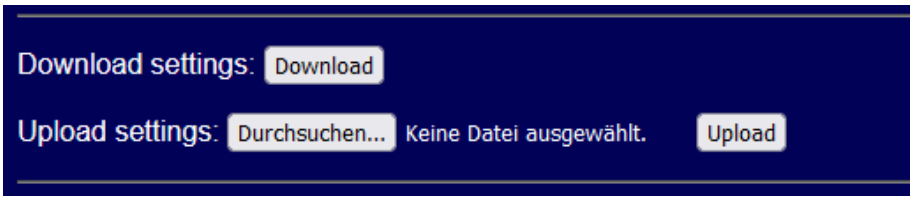
## 8.8 System

On the "System" page, the settings of the TIX Clock can be saved and restored. Furthermore, information about a newly available software version is displayed and the update can be executed.



### 8.8.1 Saving TIX Clock Settings

The current settings of the TIX Clock can be downloaded. Click on the "Download" button.

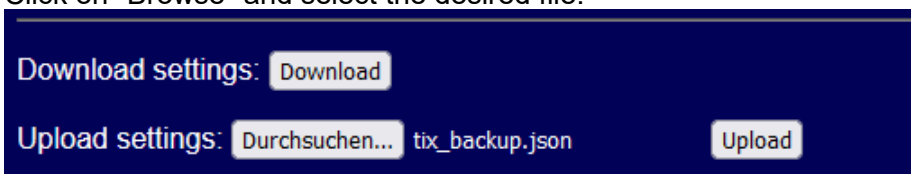



The file «tix_backup.json» will be downloaded.

### 8.8.2 Loading TIX Clock Settings

Previously saved settings can be loaded back into the TIX Clock.

1. Click on "Browse" and select the desired file.



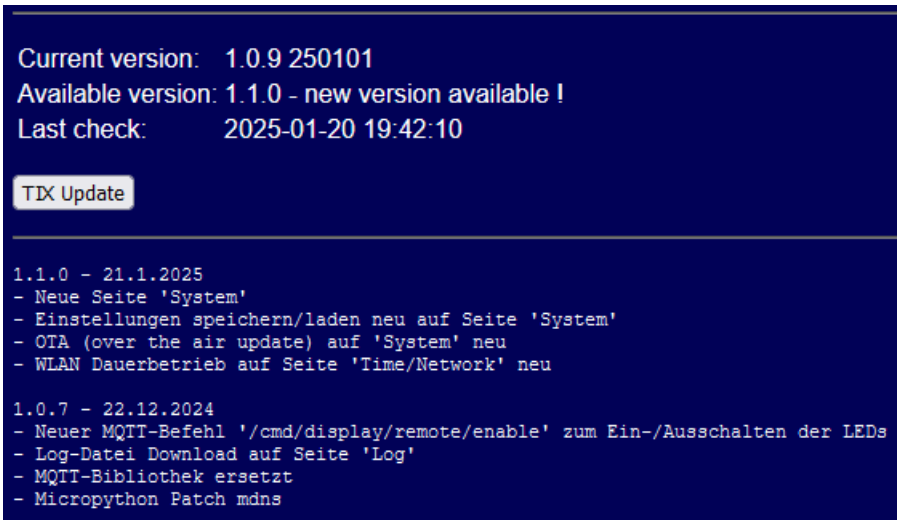

2. Click on "Upload".
3. The TIX Clock restarts with the settings.

Note: All settings will be overwritten, including the settings for the network (WLAN).

### 8.8.3 Update software

The TIX Clock checks whether new software is available when it is switched on and daily at about 0400. If so, it will be downloaded and ready for an update of the TIX Clock software.

The following information is displayed on the "System" page:




| | | |
|---|---|---|
| Current version | Aktuelle Version | Current software version with date |
| Available version | Verfügbare Version | New version, if available or "up to date" |
| Last check: | Letzte Kontrolle | Date/Time of Last Inspection |

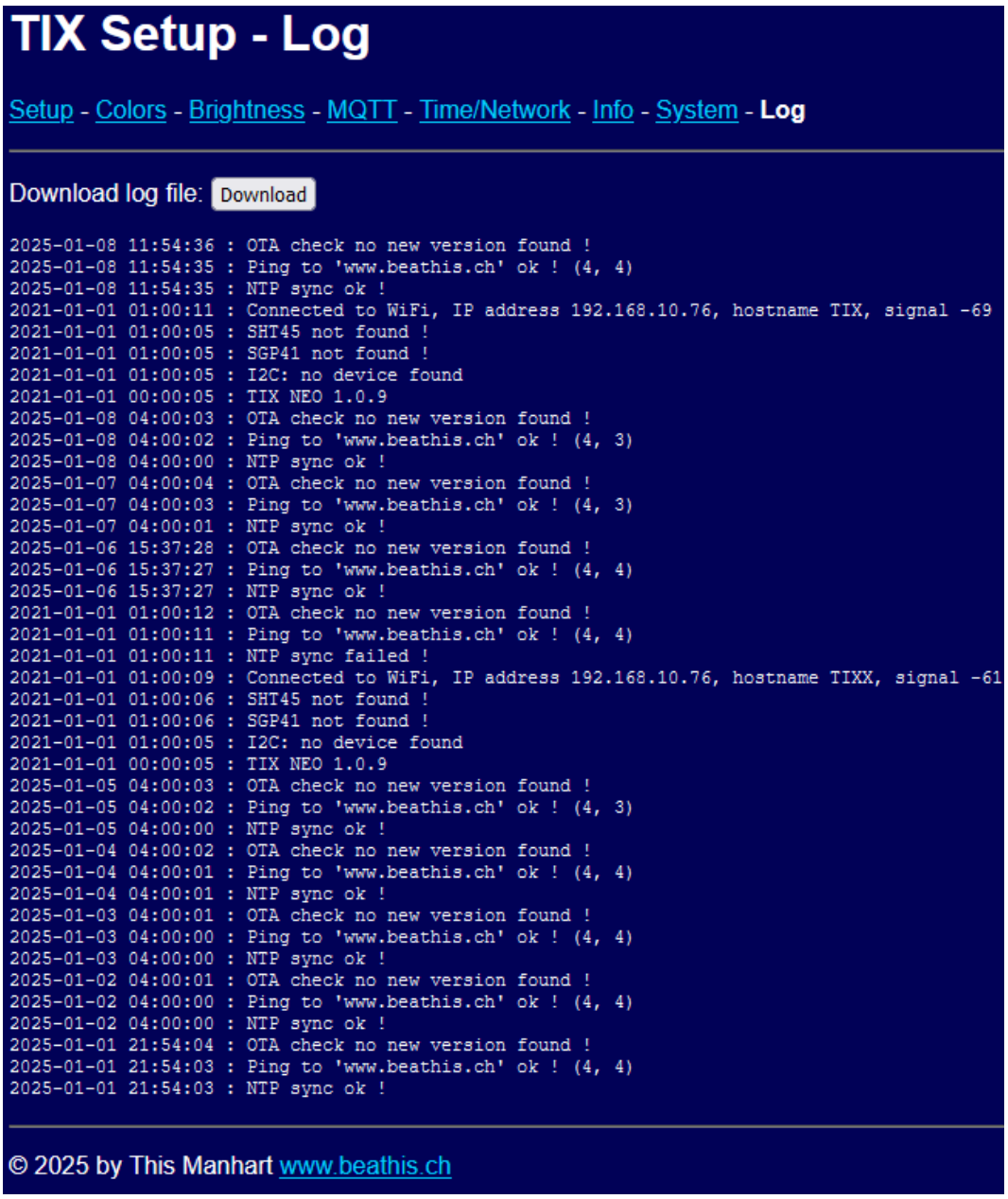
In the lower part, the adjustments in the software versions are displayed. If a new version is available, the corresponding adjustments are already displayed.

The "Update" button installs the new software and restarts the TIX Clock. The process takes 1-2 minutes. The current settings will be retained.

If the update does not work, i.e. the TIX clock does not work correctly after the restart, a firmware update must be carried out (see «Firmware-Update»).

## 8.9 Log

The "Log" page displays the latest entries in the internal log file.

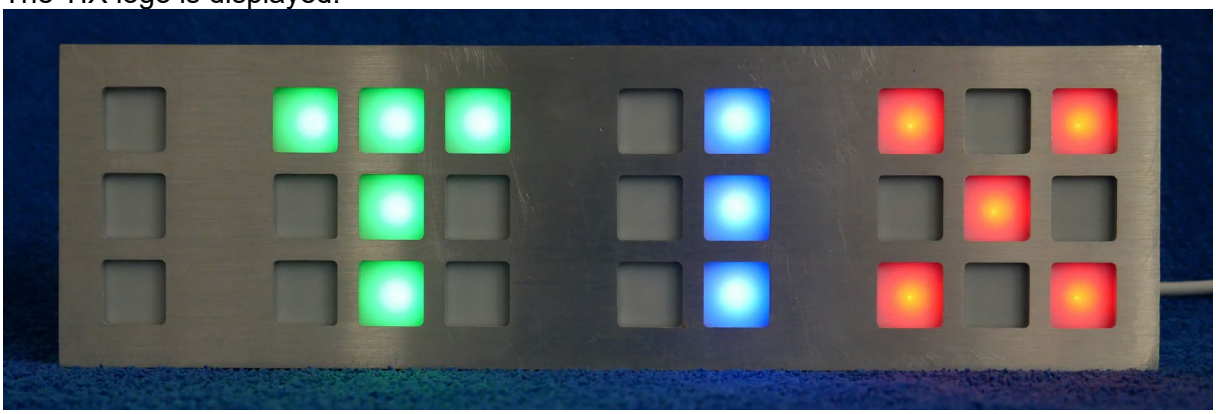



The "Download" button can be used to download the «tix_log.txt" file.

# 9. Reset TIX Clock

In case of problems, the TIX Clock must be reset so that the TIX Clock website can be accessed again via a WLAN access point.

1. Unplug the power cable.
2. Press both buttons on the back of the TIX Clock.
3. Plug in the power cable.
4. The TIX logo is displayed.



5. Wait for the logo to disappear and the time to appear.
6. Release both buttons.
7. Continue as in «First commissioning».

# 10. Error handling

## 10.1 Mode «Internet/NTP» - wrong time

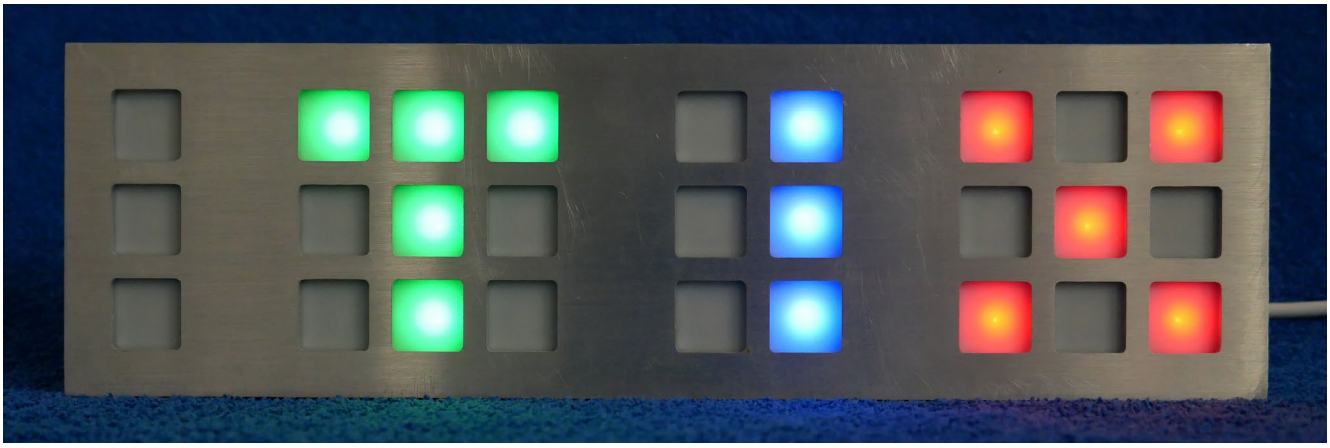
The TIX Clock displays the wrong time in the "Internet/NTP" operating mode.

The LED in the upper left corner gives an indication of the possible problem in this operating mode:

| | |
|---|---|
| LED red | Wi-Fi not connected<br>⇨ Restart TIX Clock (unplug and plug in USB cable)<br>⇨ see «Reset TIX Clock» |
| LED blue | Time synchronization with Internet not possible<br>⇨ check if internet connection is ok<br>⇨ Restart TIX Clock (unplug and plug in USB cable) |

## 10.2 TIX Clock does not show a TIX logo when turned on

When the TIX Clock is switched on, the TIX logo is displayed.



If you don't see this logo, check:

- Connector of the power cable fully plugged into the TIX Clock housing
- Power cable connected to USB power supply and plugged it into a socket
- USB power supply delivers at least 2A at 5V DC

## 10.3 TIX Clock dark

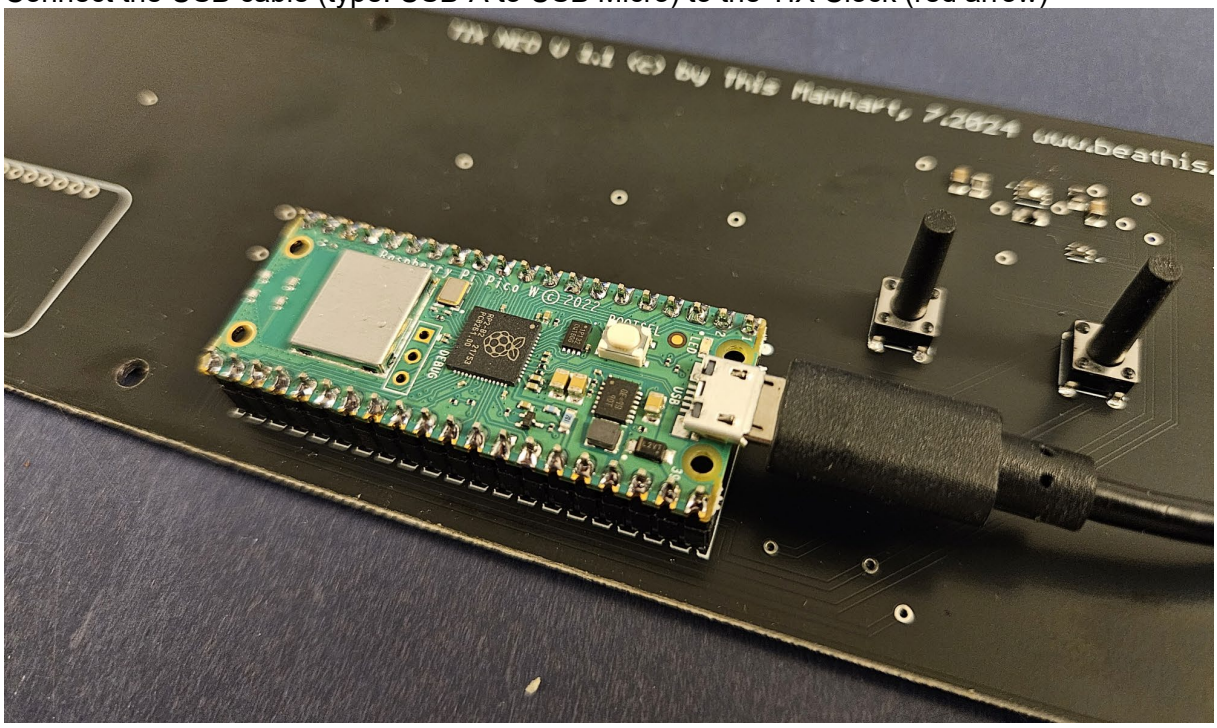
If no LEDs on the TIX Clock are lit, night mode is probably active. Press one of the two buttons on the back. The LEDs will then be activated for 5 minutes.

# 11. Firmware-Update

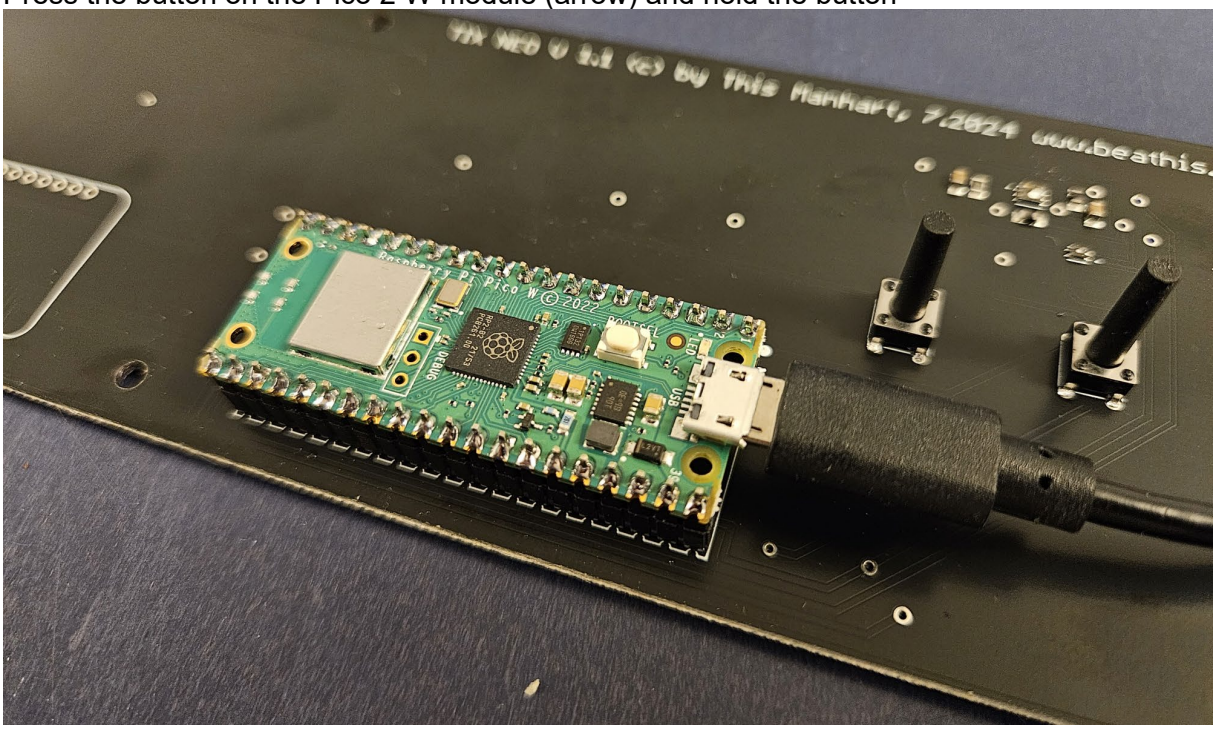
Below is how to update the firmware of the TIX Clock. The firmware is provided as a so-called UF2 file. This file contains the Micropython operating system and the complete TIX Clock software.

It is recommended to back up the current settings before updating (see page 29). After the update, these settings can be loaded back into the TIX Clock (see page 30).

1. Save the current settings (see «Saving TIX Clock Settings»)
2. Download the latest firmware of the TIX Clock from the website (Link)
3. Unzip UF2 file on PC
4. Open TIX Clock (see «Opening the TIX Clock»)
   **NOTE: The power supply cable of the TIX Clock must not be connected !**
5. Connect the USB cable (type: USB-A to USB Micro) to the TIX Clock (red arrow)



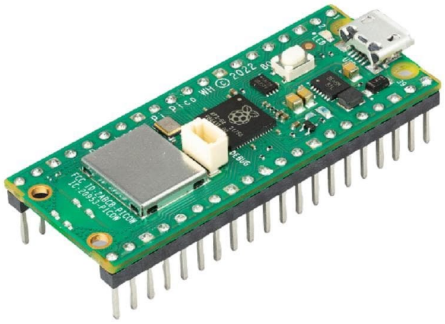
6. Press the button on the Pico 2 W module (arrow) and hold the button




7. Connect the USB cable to the PC
8. Release the button on the Pico 2 W module
9. A new drive appears in the PC
10. Copy the UF2 file to this new drive
11. After the copying process, the drive will disappear and the TIX Clock will restart
12. Disconnect the USB cable from the TIX Clock and PC
13. Continue as in «First commissioning»
14. Restore settings (see «Loading TIX Clock Settings»)

# 12. Programming

The software in the TIX Clock runs on a Raspberry Pico 2 W module.



The module is plugged into the board of the TIX Clock and can be removed if necessary.

The software consists of the following 2 components:

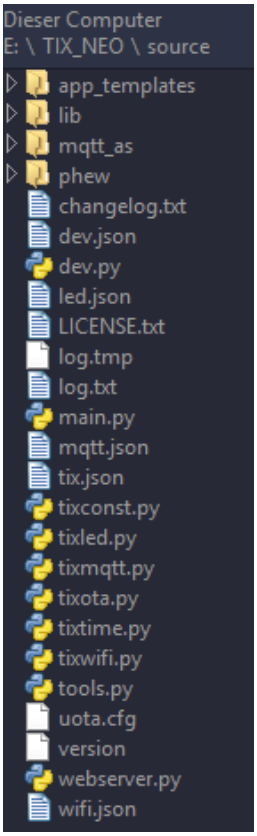
| | |
|---|---|
| Software | Programming language: Micropython (19.1.2025 Version: 1.25.0-pre) |
| Web-Interface | Programming languages: HTML, Javascript |

For programming, the Pico 2 W module is connected directly to the PC via a USB cable. The TIX Clock USB cable for power supply must NOT be connected at the same time (see Seite 35).

With the Thonny software (Link) programming is carried out.

## 12.1 Software-Structure

The software in the TIX Clock is structured as follows:




Main Program File: main.py

Directories:

- \ : Main
- \app_templates : Web-Interface
- \lib : Micropython Libraries
- \mqtt_as : MQTT-Library
- \phew : Micropython Webserver

File extensions:

- py : Micropython file
- json : Setting data
- txt : Log-file, Changelog
- tmp : temporary file
- html : HTML file
- css : HTML formatting
- js : Javascript file
- png : Image file
- cfg : Configuration OTA

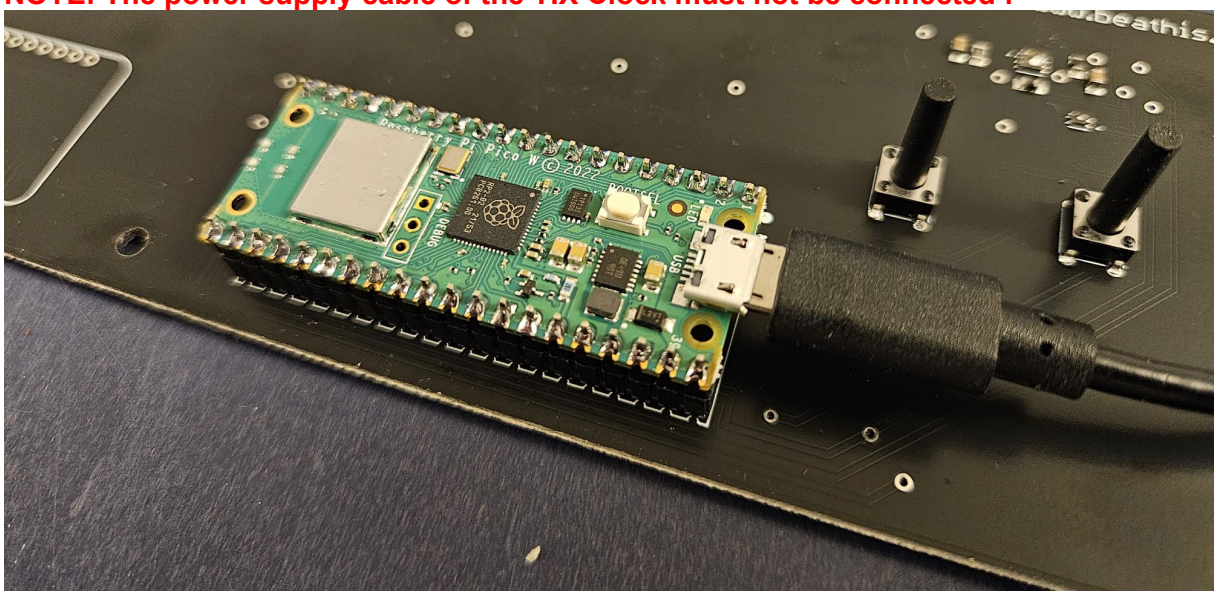
## 12.2 Preparations

1. Installing software Thonny
2. Download the latest TIX Clock software and unpack it into a directory

## 12.3 Programming

During programming, the files on the Pico 2 W module are processed directly. It is strongly recommended to upload these files to your PC regularly (right mouse button on file bottom left, command "Upload").

1. Connect TIX Clock to PC via USB cable
   **NOTE: The power supply cable of the TIX Clock must not be connected !**



2. Launch software Thonny
3. Select connection (COMx) correctly in the bottom right
4. Stop-Symbol anklicken
5. The TIX clock stops and the contents of the Pico 2 W module are displayed in the bottom left corner *
6. Open the file «main.py»
7. Open the desired file and make the adjustments
8. Save the file
9. Switch back to the file «main.py»
10. Click on the "Run current script" icon
11. The TIX clock starts and outputs become visible in the console

* The software uses the watchdog of the Pico 2 W. This must be switched off during programming. To do this, open the "tixconst.py" file on the Pico 2 W and change the code according to the screenshot below.

```
#final = const(True)
final = const(False)
```

Stop the Pico 2 W again and save this file immediately. Now the watchdog should no longer be active.

# 13. Specifications

| | |
|---|---|
| Input voltage | 5V – 25V DC |
| Electricity consumption | Power supply 5V DC<br>• WLAN on, all LED white, brightness max: 637mA (3.1W)<br>• WLAN on, all LED off 64mA (0.3W)<br>• WLAN off, all LED off 35mA (0.1W) |
| Power supply connection | Jack plug 5.5mm (outside) / 2.5mm (inside) |
| Power supply cable | Jack plug to USB-A |
| USB Power Supply Requirement | 5V 2A DC |
| Microcontroller | Raspberry Pico 2 W |
| LED | SKC6812RGBW-NW-B from OPSCO Optoelectronics |
| Sensor Brightness | NSL-5110 from Advanced Photonix |
| Sensor temperature/humidity | SHT45-AD1F-R2 from Sensirion AG |
| Air quality sensor | SGP41-D-R4 from Sensirion AG |
| WLAN | 2.4 GHZ 802.11n, too 802.11b and 11g<br>Encryption: WPA2 |

# 14. Support

Technical support is only available by email.

**tix@beathis.ch**