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Safety Precautions

Do not power on the clock when tubes are damaged or missing. Use the power supply that came with the clock, or use a power supply that's compliant with the technical specifications of the clock. Do not expose the clock to rain or moisture. Do not put the clock in direct sunlight for prolonged periods. Do not expose the clock to high temperatures. Do not cover the clock.

Power off the clock before cleaning. Always clean the clock with a dry or very slightly damp cloth. Do not use any alcohol or other organic solvents. Be careful when touching the tubes. The clock must be completely dry when powered on. Do not subject the clock to mechanical shocks and avoid any mechanical shock to the tubes.

Keep the clock out of reach of children (and cats... :)

Features

- Support for a wide range of nixie tubes.
- Configurable for 6 or 7 nixie tubes.
- Backlight featuring per-tube individually controllable RGB LEDs.
- Backlight for enclosure featuring discrete RGB LEDs.
- 12-hour and 24-hour time formats.
- Gregorian calendar with 200-year date range from January 1st of 1900 to December 31st of 2099.
- Day-month-year, month-day-year and year-month-day date formats.
- Acquire time and date through Network Time Protocol (NTP) over WiFi.
- Four programmable time zones.
- Built-in buzzer.
- Single-button user control.
- Alarm function with four programmable alarm times.
- Support for temperature sensors.
- Support for relative humidity sensors.
- Support for barometric pressure sensor.
- Support for CO2 sensor.
- Settings are stored in persistent memory.
- USB-to-serial interface for use with serial terminal software.

Power

The clock requires a 9V 1A power supply. The DC power jack is 2.1mm x 5.5mm. The polarity is positive on the inside, negative on the outside.



Connect the power supply to power on the clock. Disconnect the clock from the power supply to power off. Note that there's no ON/OFF switch.

Button

The button on the rear of the clock is the main control for manual user-interaction with the clock.

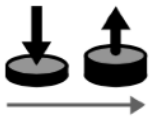
There are a number of ways to control the button:



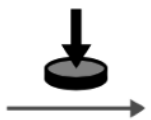
Press the button.



Release the button.



Click the button. Swiftly press and release the button. A click of the button is typically used for navigating the quick menu and the configuration menu.



Hold the button. Push without releasing. Holding the button is typically used for changing values in the quick menu and the configuration menu.

Nixie Tubes

The clock displays information on its tubes: time, date, temperature, etc. The actual output depends on the number of tubes. The clock comes in two configurations: 6 tubes and 7 tubes.



Displaying time on 6 Nixie tubes



Displaying time on 7 Nixie tubes

The brightness of the Nixie tubes is determined by a dimming value. The dimming value ranges from zero to eight. The higher the value, the brighter the tubes, the highest value being full brightness and zero means the tubes are turned off. The dimming value of the tubes can be set for normal mode and sleep mode.

The brightness of the neon lights is also determined by a dimming value along the same lines as those used for the nixies. The dimming value of the neon lights can also be set for normal mode and sleep mode.

HINT! If you turn on the clock for the first time or after a long period of inactivity, some tubes may glow erratically or not glow at all. If this is the case, please do not panic, as this behavior is normal for some types of Nixie tubes. If you keep the clock running for a couple of minutes, the tubes will revert to their normal operation.

Settings

The clock stores settings in persistent memory. All settings are stored in the settings file. The settings file is loaded each time the clock powers on or resets.

The command interface implements a set of commands for controlling all settings of the clock. The command interface is not discussed in this manual.

You can change various settings in the quick menu and the configuration menu. Any changes made will be saved to the settings file in persistent memory as soon as the clock leaves the quick menu or the configuration menu.

Setting Up WiFi

The clock uses the built-in WiFi interface to access the Internet and fetch the time and date. This section explains how to setup the clock to join your local WiFi network. This is similar to setting up a smartphone or laptop as a client of your local WiFi network.

First of all, enable the access point of the clock.



Power on the clock while pressing the button. Wait until the clock beeps twice. The access point is now enabled.

Summary of the set-up steps:

- Let your WiFi-enabled device join the network of the clock.
- Browse to the web portal of the clock.
- Enter SSID and password of your local WiFi network.
- Let the clock join your local WiFi network.

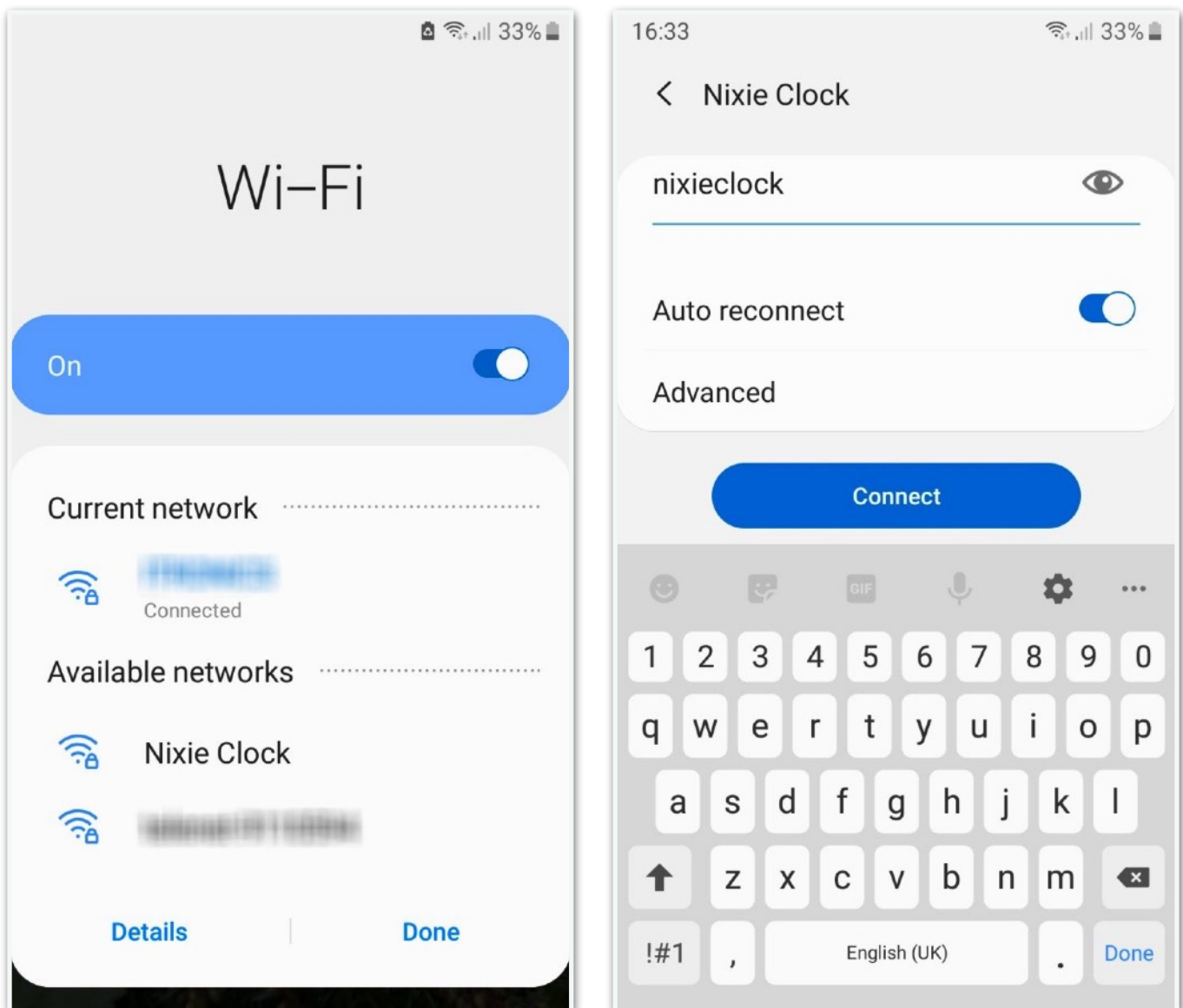
You will need a WiFi-enabled device to set up the clock. You can use your smartphone or laptop. The following example screenshots were taken on a smartphone with Android, but setup will be similar on other types of smartphone.

► Step 1

You'll find a sticker on the bottom of the clock. On the sticker, you'll find the SSID and the password of your clock's access point. Use this information to connect your WiFi-enabled device to the network of the clock.

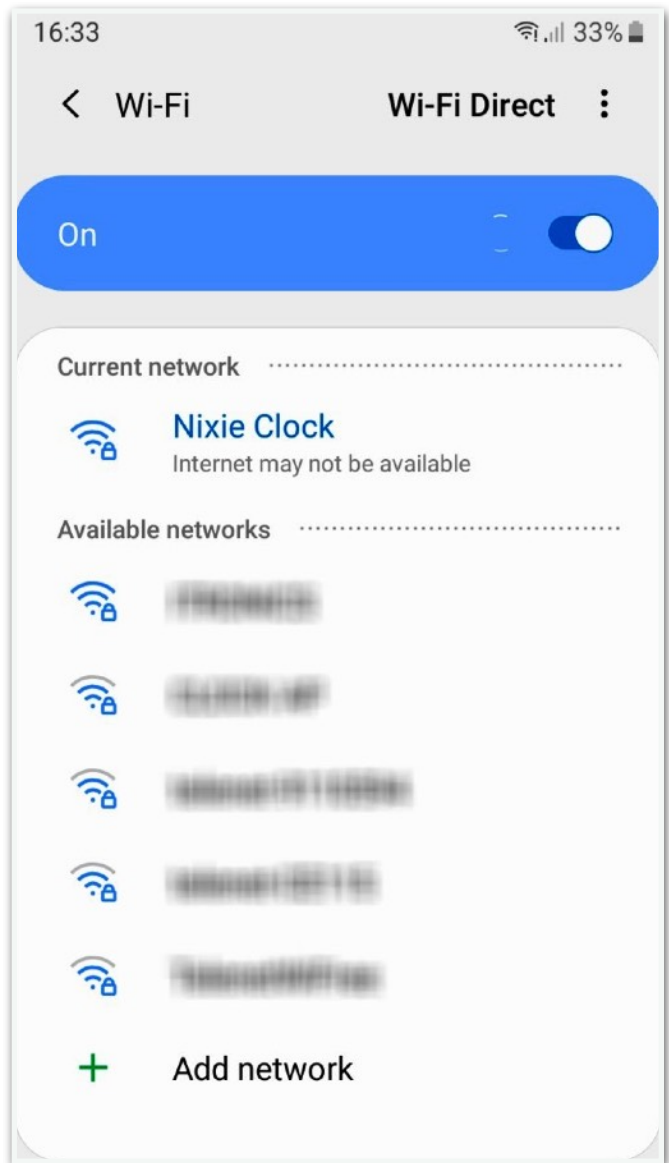
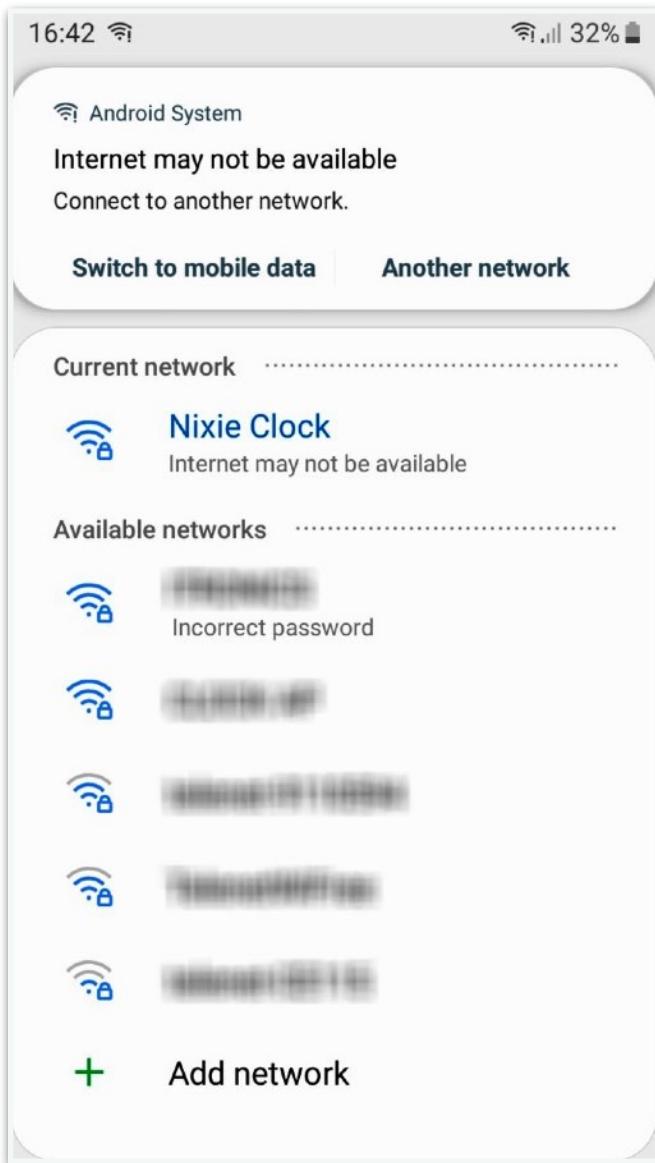
Depending on the capabilities of your WiFi-enabled device, you can scan the QR code on the sticker and let your device join the network of the clock instantly.

In the screenshots below, the SSID is "Nixie Clock" and the password is "nixieclock". The device uses this information to connect to the clock.



After the device has joined the network of the clock, it may tell you that the Internet connection may not be available. This is normal since the clock only offers the basic

infrastructure for hosting the web portal, while a modern WiFi-enabled device expects a bit more support from the Internet connection.



► Step 2

Open the web browser on your device to browse for the web portal.

The URL of the web portal is:

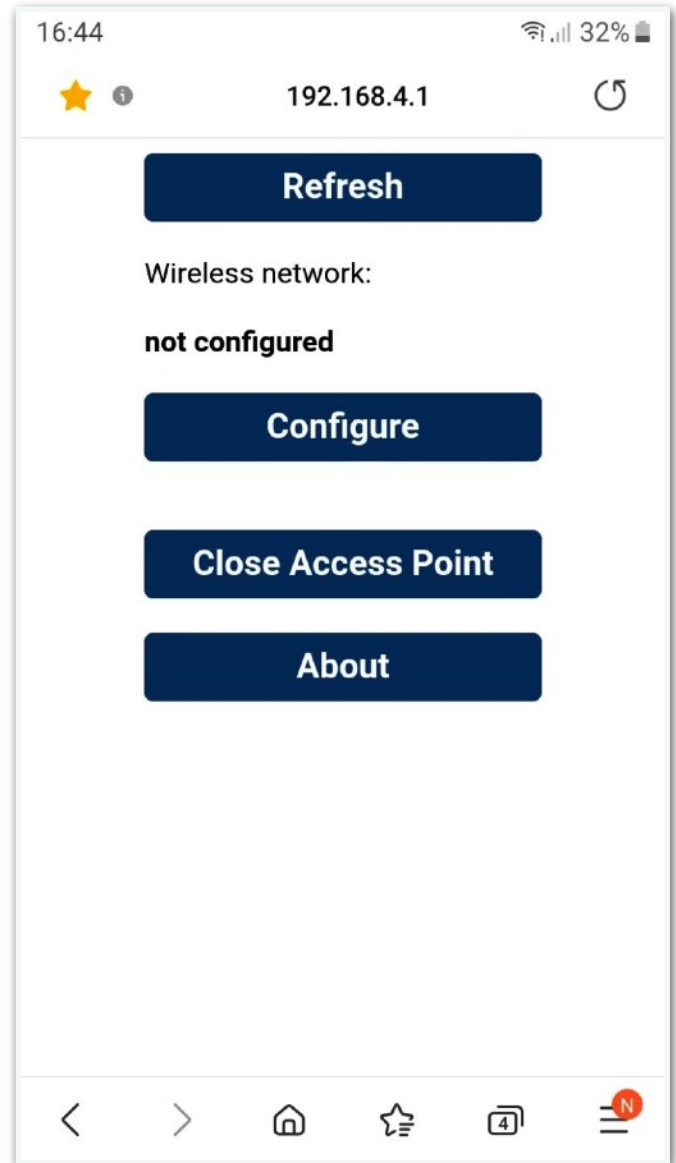
192.168.4.1

This URL will bring you to the home page of the web portal.

The “Refresh” button reloads the home page.

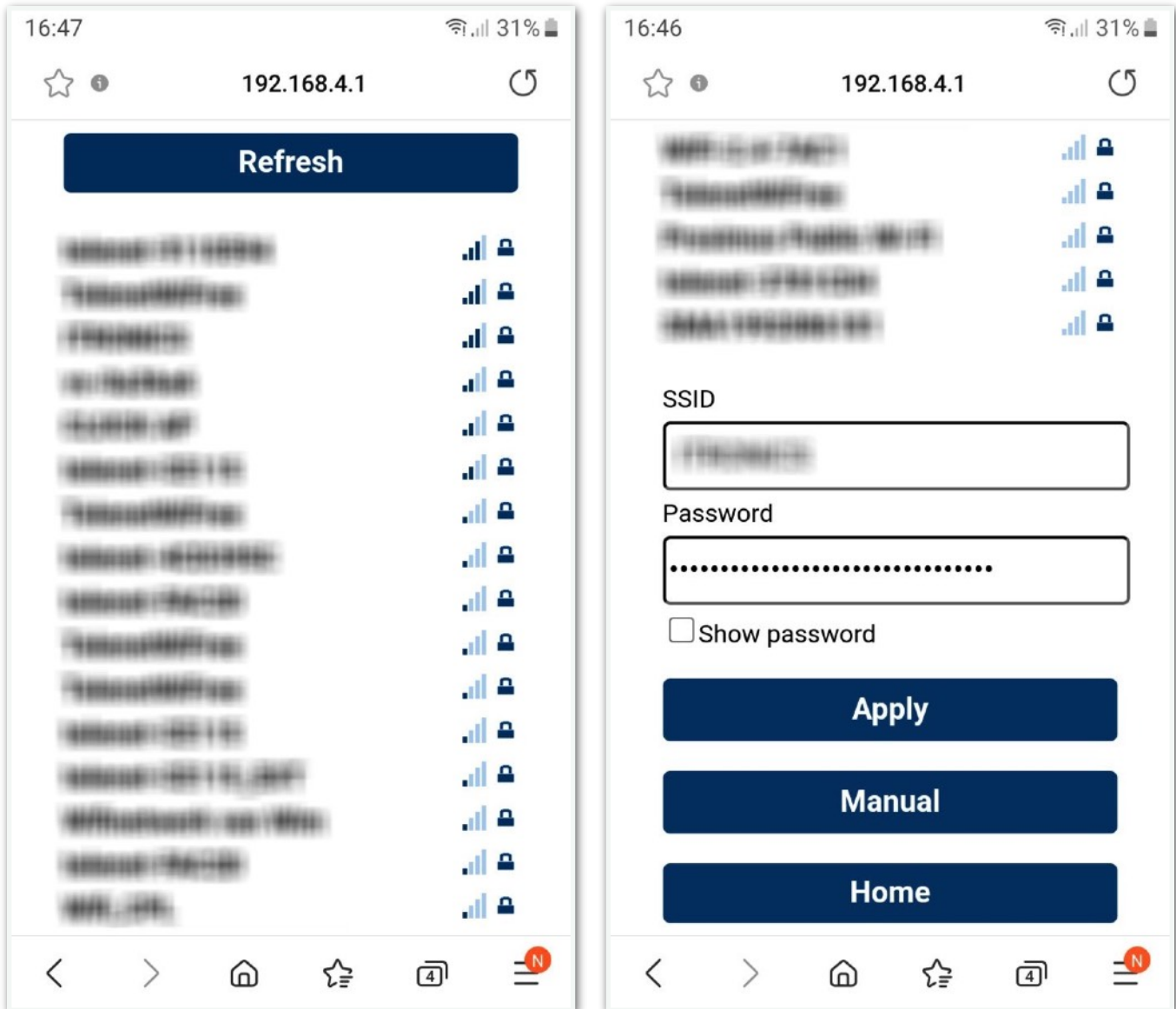
Version information can be found under “About”. Here you can update the firmware as well.

To let the clock join your local WiFi network, click the “Configure” button



► Step 3

The web portal presents a list with all the wireless networks it can find at your location. The icons to the right of each network indicate signal strength and security. Click the “Refresh” button to refresh the list of wireless networks.



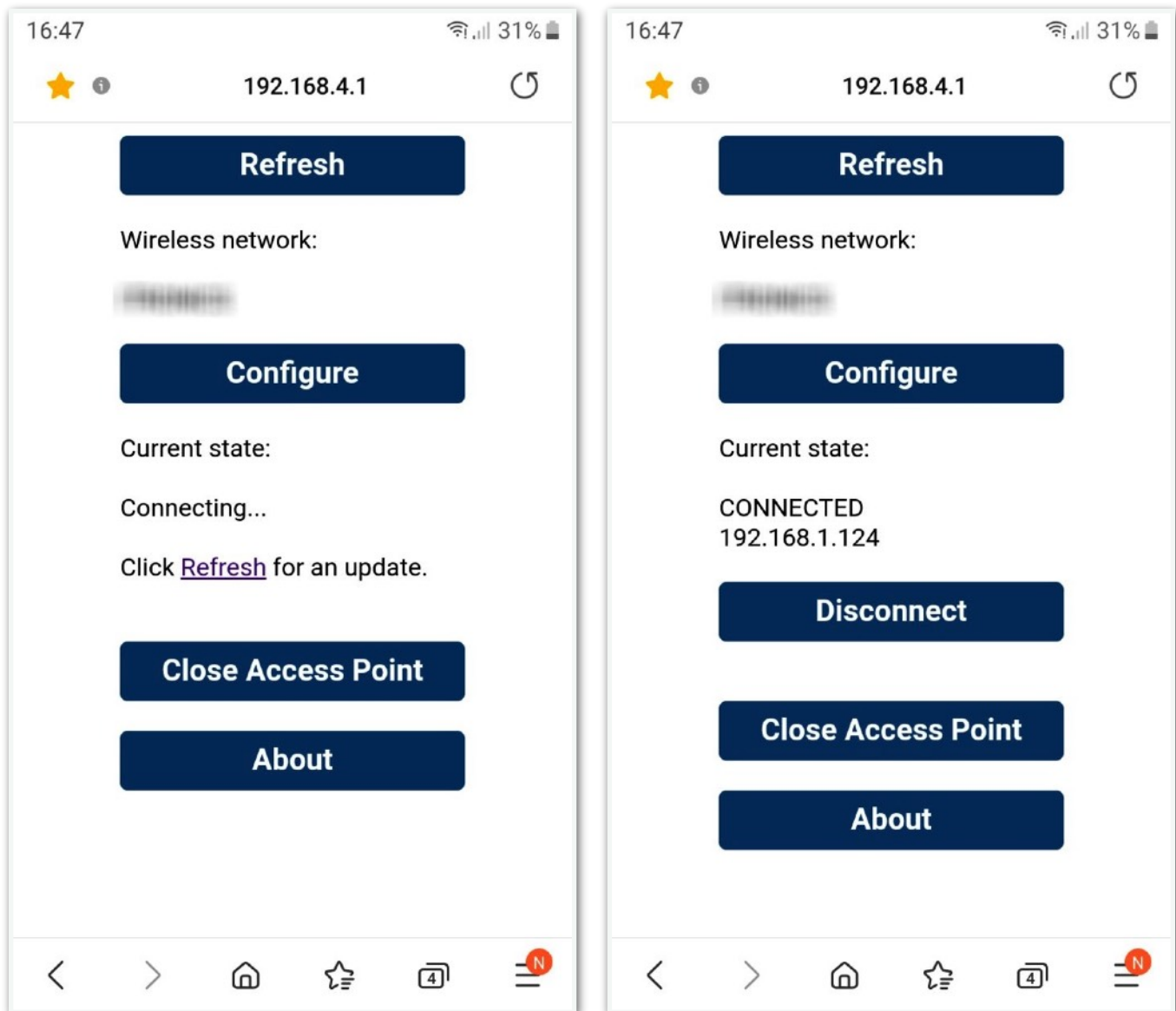
Look for your local WiFi network in the list and click on it. The SSID will be copied into the SSID input field. Enter your password in the “Password” field. Click “Apply” to join your local WiFi network. If your local network doesn’t show up in the list, click “Manual” to enter your network SSID manually in the input field. This may happen if your network is hidden. Clicking “Home” will jump back to the home page without applying any changes.

► Step 4

The web portal jumps back to the home page, where you can check whether the clock has joined your local network.

Usually, the status is "Connecting..." on the first time. Click "Refresh" to repeatedly update the status. Once the status has changed, the connection process has finished.

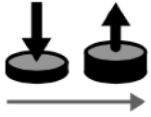
If the status say "CONNECTED", the clock has joined your local network. Your clock has now been set up successfully. You can optionally click "Close Access Point" to prevent further access to web portal.



If connection failed, click "Configure" and try setting up again.

Quick Menu

The quick menu allows you to display the date and to enable and disable the alarm times.



Click the button to enter the quick menu. You can enter the configuration menu when the clock is in normal mode.

The quick menu consists of menu items.

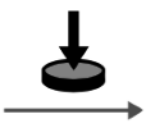


Click the button to rotate through the menu items. The order of the menu items is:

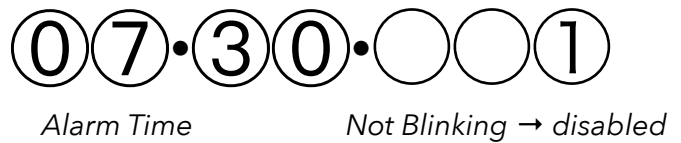
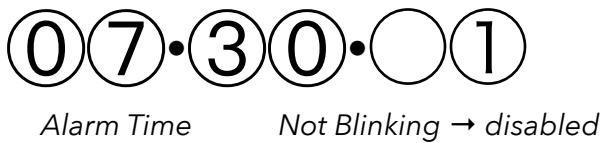
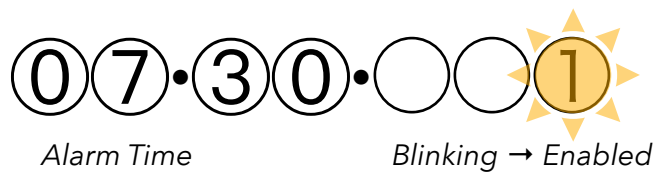
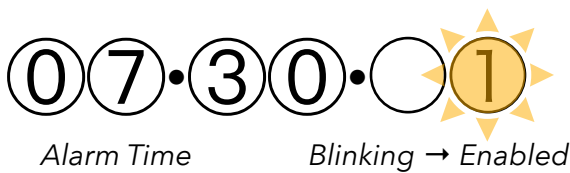


When you enter the quick menu while the date is being displayed, the clock will skip the date and show the next item of the quick menu.

The alarm times can be enabled or disabled in the quick menu.



Hold the button to toggle the enabled settings. If the alarm time number to the right blinks, the alarm time is enabled, if the number doesn't blink, the alarm time is disabled.





To exit the quick menu, release the button and wait for five seconds.

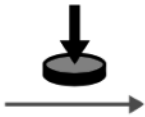
If you changed any settings, the clock will save the settings to persistent memory.



HINT! To enter the quick menu from sleep mode, press the button to wake up the clock, then release the button. Now you can enter the quick menu by clicking the button.

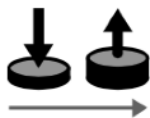
Configuration Menu

The configuration menu offers a convenient way to change common settings with the button.

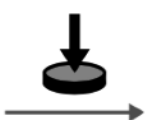


Hold the button to enter the configuration menu. You can enter the configuration menu when the clock is in normal mode.

The configuration menu consists of menu items. Each menu item represents a setting. The clock displays the menu items using a uniform format. The number on the left represents the current item, the number on the right is the current value of that item. The number that blinks is currently selected.



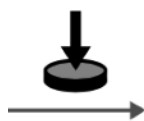
Click the button to toggle the currently selected number. The selection toggles between the item and the value.



Hold the button to advance the currently selected item or value. When you advance the item, the clock will show the next item and its corresponding value. When you advance the value, the clock will cycle through the available values for the currently selected item.



To exit the quick menu, release the button and wait for ten seconds. If you changed any settings, the clock will save the settings to persistent memory.



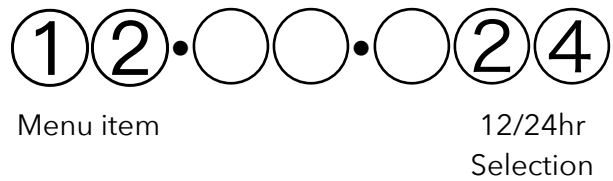
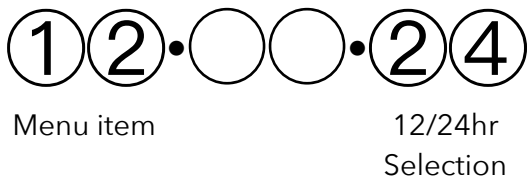
HINT! To enter the configuration menu from sleep mode, press the button to wake up the clock, then release the button. Now you can enter the configuration menu by holding the button.

Time Display

The clock's base function is to display the current local time. If your clock has 7 tubes, it displays tenths of seconds on its seventh tube.



The clock can display time in both 12-hour format and 24-hour format. To change the time format, go to item 12 in the configuration menu:



Date Display

The clock can be programmed to display the local date intermittently. The clock supports three date formats.

①④·③②·②②

Day Month Year

③①·④②·②②

Month Day Year

②②·③①·④②

Year Month Day

①④·③②·②②○

Day Month Year

③①·④②·②②○

Month Day Year

②②·③①·④②○

Year Month Day

To change the date format, go to item 28 in the configuration menu:

②⑧·○ ○·○ ①

Menu item

Selection

0 - YMD

1 - DMY

2 - MDY

②⑧·○ ○·○ ○ ○ ①

Menu item

Selection

0 - YMD

1 - DMY

2 - MDY

Displaying Special Values

Besides displaying the time, the clock can also display so-called special values. These are:

- Date
- Temperature
- Barometric pressure
- Relative humidity
- CO₂ concentration

Except for the date, special values are sensor readings. The clock displays special values at specific time slots during each minute at a fixed rotation of 1 - 3 minutes. A time slot is active for five seconds. There are two such time slots during each minute, at 20 seconds and at 50 seconds.

The clock can always display the date. Sensor readings can be displayed when the required sensor is connected to the clock. If a special value can't be displayed, the clock displays the time as if the time slot was not assigned a special value.

Typically, the date is displayed at 50 seconds, and sensor values are displayed at 20 seconds. This is not a restriction though, since any special value can be assigned to any time slot. To assign special values to time slots you have to use the command interface.

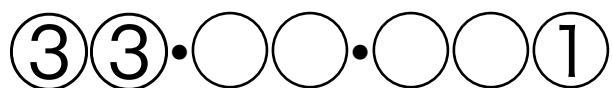
The configuration menu provides two menu items for enabling and disabling special values.

You can enable or disable display of the date in the configuration menu:



Menu item

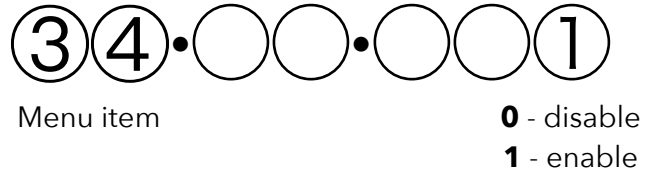
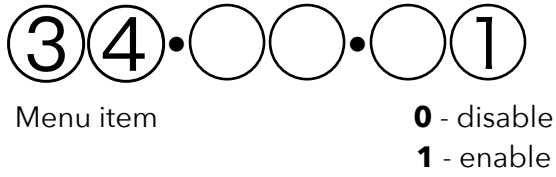
0 - disable
1 - enable



Menu item

0 - disable
1 - enable

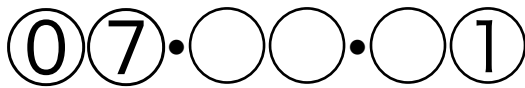
You can enable or disable display of sensor readings in the configuration menu:



Time Zones

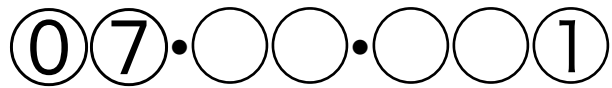
The clock maintains the current time in UTC. The time zone of your location defines your local time, which is shown on the display. A time zone defines the local time by means of an offset from UTC. The clock supports four programmable time zones.

Select the time zone with item 07 in the configuration menu:



Menu item

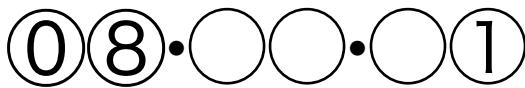
Time Zone
Selection **1 - 4**



Menu item

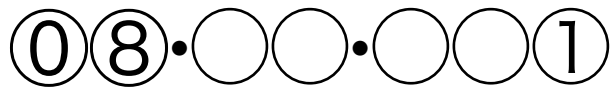
Time Zone
Selection **1 - 4**

In the configuration menu, each time zone can be set as hours relative to the current time. This relative hour has a range of -23 to +23. Note that negative hours are displayed to the left, positive hours are displayed to the right. There are four configuration menu items, one for each time zone.



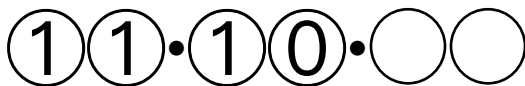
Menu item

Relative hours



Menu item

Relative hours



Menu item

Relative hours



Menu item

Relative hours

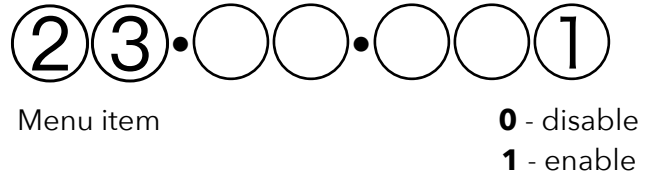
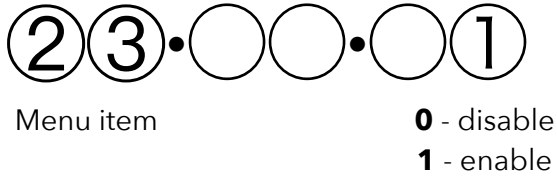
Configuration menu items **08** - Time zone **1** | **09** - Time zone **2** | **10** - Time zone **3** | **11** - Time zone **4**;

Relative hours - Values **23**00 to **01**00 represent the negative hours -23 to -1 respectively. Values 00**00** to 00**23** represent the positive hours 0 to +23 respectively.

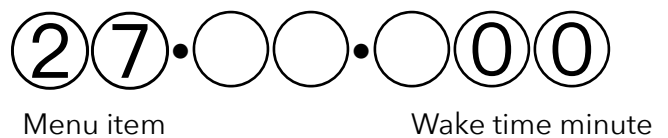
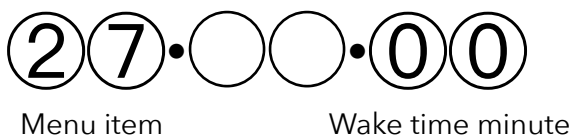
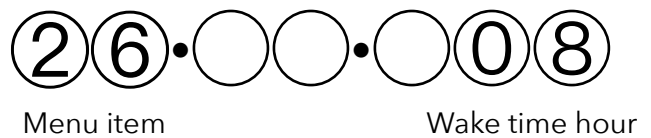
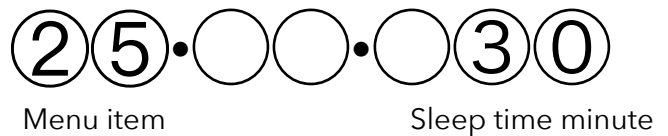
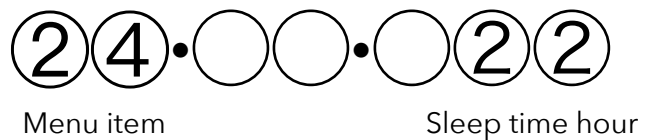
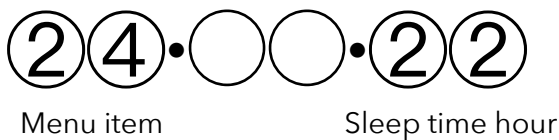
There's always an active time zone. If your local time is the same as UTC, select a time zone with relative hours set to zero.

Sleep Mode

Sleep mode is optional.¹ To enable or disable the sleep function, go to item 23 in the configuration menu:



The clock enters sleep mode at a specific time and wakes up from sleep mode at a specific time. You can program the sleep time and the wake-up time in the configuration menu with items 24 to 27.



¹ Optional, but recommended. Nixie tubes have a finite lifespan depending on the model used. This is usually in the order of years, so turning them off whilst you're asleep will essentially increase your enjoyment of them by *at least* 1/3.

During the period that sleep mode is active, the clock typically dims the tubes and the neon lights, and darkens the backlights. You can adjust the appearance of sleep mode by changing the following items in the configuration menu:

- Item 02 - Animation of the tube back lights.
- Item 05 - Animation of the enclosure back light.
- Item 30 - Dimming level of the tubes.
- Item 32 - Dimming level of the neon lights.

Alarm Mode

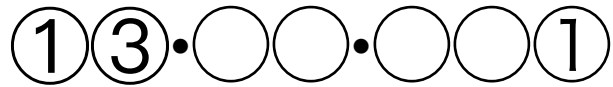
The clock has an alarm function with four programmable alarm times. Each individual alarm time can be enabled and disabled, and the alarm function can be enabled or disabled entirely.

To enable or disable the alarm function, go to item 13 in the configuration menu:



Menu item

0 - disable
1 - enable



Menu item

0 - disable
1 - enable

When the alarm function is enabled and the local time reaches one of the enabled alarm times, the alarm goes into alarm mode.



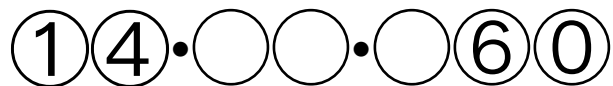
During alarm mode, the buzzer makes a sound and the back lights are highlighted. Alarm mode remains active for a programmable period. Press the button to deactivate the alarm manually.

You can program the alarm period with item 14 in the configuration menu:



Menu item

Alarm period in 15
second increments



Menu item

Alarm period in 15
second increments

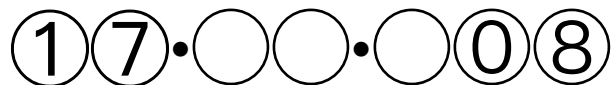
You can program individual alarm times in the configuration menu:



Menu item

Alarm hour

- 15** - Alarm 1 hour
- 17** - Alarm 2 hour
- 19** - Alarm 3 hour
- 21** - Alarm 4 hour



Menu item

Alarm hour

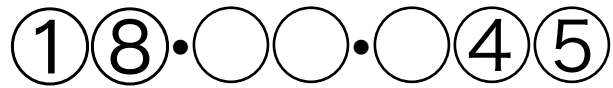
- 15** - Alarm 1 hour
- 17** - Alarm 2 hour
- 19** - Alarm 3 hour
- 21** - Alarm 4 hour



Menu item

Alarm minute

- 16** - Alarm 1 minute
- 18** - Alarm 2 minute
- 20** - Alarm 3 minute
- 22** - Alarm 4 minute

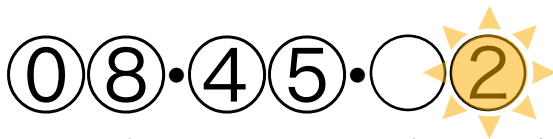


Menu item

Alarm minute

- 16** - Alarm 1 minute
- 18** - Alarm 2 minute
- 20** - Alarm 3 minute
- 22** - Alarm 4 minute

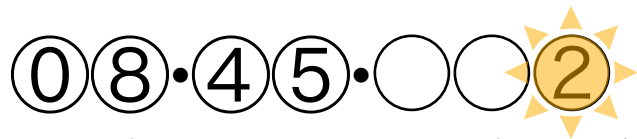
Use the quick menu to enable or disable the individual alarm times:



Alarm time

Alarm number

Blinking - enabled
Not blinking - disabled



Alarm time

Alarm number

Blinking - enabled
Not blinking - disabled

You can adjust the appearance of alarm mode by changing the following items in the configuration menu:

- Item 03 - Animation of the tubes back light.
- Item 06 - Animation of the enclosure back light.

The buzzer sound is different for each alarm time. The buzzer repeatedly beeps once for alarm time 1, twice for alarm time 2, three times for alarm time 3, four times for alarm time 4. When the alarm goes off, you can hear which alarm time triggered the alarm.

Normal Mode

When the clock is not in sleep mode nor alarm mode, normal mode is active.

You can adjust the appearance of normal mode by changing the following items in the configuration menu:

- Item 01 - Animation of the tubes back light.
- Item 04 - Animation of the enclosure back light.
- Item 29 - Dimming level of the tubes.
- Item 31 - Dimming level of the neon lights.

Temperature

The clock can display temperature in degrees Celsius and degrees Fahrenheit.



Degrees Celsius Tenth



Degrees Celsius Tenth



Degrees Fahrenheit Tenth



Degrees Fahrenheit Tenth

Supported temperature sensors:

- Microchip DS18B20.
- Microchip DS18S20.
- Microchip DS1822.
- Microchip DS2438.
- Sensirion SCD-41.
- Bosch BME280.
- Würth Elektronik WSEN-HIDS.

Barometric Pressure

The clock displays barometric pressure in hectopascals (hPa).



Supported barometric pressure sensors:

- Bosch BME280.

Relative Humidity

The clock displays relative humidity in percentages (RH%).



Relative humidity %



Relative humidity %

Supported humidity sensors:

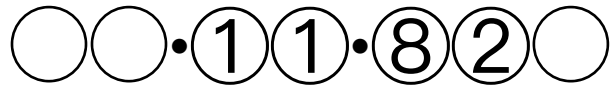
- Sensirion SCD-41.
- Bosch BME280.
- Würth Elektronik WSEN-HIDS.

CO₂ Concentration

The clock displays CO₂ concentration in parts-per-million (ppm).



Parts per million - (ppm)



Parts per million - (ppm)

Supported carbon dioxide sensors:

- Sensirion SCD-41.

Table of Configuration Menu Settings

Item	Description and values
1	<p style="text-align: center;"><i>Animation of the tubes back light during normal mode:</i></p> <ul style="list-style-type: none"> 1 - Solid red. 2 - Solid cerise. 3 - Solid orange. 4 - Solid yellow. 5 - Solid chartreuse. 6 - Solid spring green. 7 - Solid green. 8 - Solid turquoise. 9 - Solid azure. 10 - Solid cyan. 11 - Solid blue. 12 - Solid purple. 13 - Solid pink. 14 - Solid white. 15 - Solid rainbow colors. 16 - Gradient animation pastel colors single. 17 - Gradient animation pastel colors smooth. 18 - Unique color per digit. 19 - Pendulum animation white on rainbow colors. 20 - Cylon animation white on blue. 21 - KITT animation red dot moving fast. 22 - KITT animation red dot moving slow. 23 - Off.
2	<p style="text-align: center;"><i>Animation of the tubes back light during sleep mode:</i></p> <ul style="list-style-type: none"> 1 - Solid dark red. 2 - Solid dark green. 3 - Solid dark blue. 4 - Solid dark purple. 5 - Solid dark gray. 6 - KITT animation dark red dot moving slow. 7 - Off.
3	<p style="text-align: center;"><i>Animation of the tubes back light during alarm mode:</i></p> <ul style="list-style-type: none"> 1 - Solid red. 2 - Flashing red and blue. 3 - KITT animation red dot moving fast. 4 - Off.

Item	Description and values
4	<p style="text-align: center;"><i>Animation of the enclosure back light during normal mode:</i></p> <p>1 - Solid red. 2 - Solid cerise. 3 - Solid orange. 4 - Solid yellow. 5 - Solid chartreuse. 6 - Solid spring green. 7 - Solid green. 8 - Solid turquoise. 9 - Solid azure. 10 - Solid cyan. 11 - Solid blue. 12 - Solid purple. 13 - Solid pink. 14 - Solid white. 15 - Gradient animation pastel colors. 16 - Gradient animation primary colors. 17 - Gradient animation matrix green. 18 - Gradient animation brown. 19 - Gradient animation cyan and blue. 20 - Gradient animation purple and pink. 21 - Off.</p>
5	<p style="text-align: center;"><i>Animation of the enclosure back light during sleep mode:</i></p> <p>1 - Solid dark red. 2 - Solid dark green. 3 - Solid dark blue. 4 - Solid dark purple. 5 - Solid dark gray. 6 - Off.</p>
6	<p style="text-align: center;"><i>Animation of the enclosure back light during alarm mode:</i></p> <p>1 - Solid red. 2 - Solid blue. 3 - Flashing red and blue. 4 - Off</p>
7	Time zone: 1 to 4 .
8	<p style="text-align: center;"><i>Time zone 1 relative hours:</i></p> <p>2300 to 0100 - negative hours -23 to -1 respectively. 0000 to 0023 - positive hours 0 to +23 respectively.</p>
9	<p style="text-align: center;"><i>Time zone 2 relative hours:</i></p> <p>2300 to 0100 - negative hours -23 to -1 respectively. 0000 to 0023 - positive hours 0 to +23 respectively.</p>

Item	Description and values
10	<p style="text-align: center;"><i>Time zone 3 relative hours:</i></p> 23 00 to 01 00 - negative hours -23 to -1 respectively. 00 00 to 00 23 - positive hours 0 to +23 respectively.
11	<p style="text-align: center;"><i>Time zone 4 relative hours:</i></p> 23 00 to 01 00 - negative hours -23 to -1 respectively. 00 00 to 00 23 - positive hours 0 to +23 respectively.
12	Time format: 12 - 12-hour format, 24 - 24-hour format.
13	Alarm function: 0 - disabled, 1 - enabled.
14	Alarm period: 15, 30, 45, 60, ..., 300 seconds.
15	Alarm time 1, hour: 0 to 23 .
16	Alarm time 1, minute: 0 to 59 .
17	Alarm time 2, hour: 0 to 23 .
18	Alarm time 2, minute: 0 to 59 .
19	Alarm time 3, hour: 0 to 23 .
20	Alarm time 3, minute: 0 to 59 .
21	Alarm time 4, hour: 0 to 23 .
22	Alarm time 4, minute: 0 to 59 .
23	Sleep function: 0 - disabled, 1 - enabled.
24	Sleep time hour: 0 to 23 .
25	Sleep time minute: 0 to 59 .
26	Wake-up time hour: 0 to 23 .
27	Wake-up time minute: 0 to 59 .
28	Date format: 0 - YMD, 1 - DMY, 2 - MDY.
29	<p style="text-align: center;"><i>Dimming level of the tubes during normal mode:</i></p> 0 - Tubes are turned off. 1 to 8 - lowest to full brightness.
30	<p style="text-align: center;"><i>Dimming level of the tubes during sleep mode:</i></p> 0 - Tubes are turned off. 1 to 8 - lowest to full brightness.
31	<p style="text-align: center;"><i>Dimming level of the neon lights during normal mode:</i></p> 0 - Neon lights are turned off. 1 to 8 - lowest to full brightness.

Item	Description and values
32	<p style="text-align: center;"><i>Dimming level of the neon lights during sleep mode:</i></p> <p>0 - Neon lights are turned off. 1 to 8 - lowest to full brightness.</p>
33	Displaying of the date: 0 - disabled, 1 - enabled.
34	Displaying of sensor readings: 0 - disabled, 1 - enabled.
35	Real-time clock year: 0 to 99 meaning 2000 - 2099.
36	Real-time clock month: 1 to 12 .
37	Real-time clock day: 1 to 31 .
38	Real-time clock hour: 0 to 23 .
39	Real-time clock minute: 0 to 59 .
40	<p style="text-align: center;"><i>Real-time clock command. Select a command value and click the button to execute:</i></p> <p>0 - No-operation. 1 - Commit date and time specified in items 35 to 39 to the real- time clock. Note that seconds are set to zero.</p>