Emonio P3

User Manual

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Firmware version 3.0.24

berliner energieinstitut

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1. Introduction and usage

Thank you for choosing the Emonio P3 !

This product allows you to measure and record the energy consumption of electrical devices and systems quickly, easily and accurately.

The Internet site of the company B.E.I. - Berliner Energieinstitut GmbH (https://my.emonio.de) offers the ability to record the measurement data historically, to combine several devices or to generate mathematical and statistical analyses.

The Emonio P3 is suitable to:

- Measure and display the electrical quantities in the range of over-voltage Category III
- Measuring three voltages to neutral
- Measuring three currents by means of split-core transformer or Rogowski coil
- Measuring the active, apparent and reactive power of three one-phase consumers or one three-phase consumer
- Measuring the grid frequency
- Determination of the power factor
- Recording the measured data in the internal memory
- Transmitting the data via WiFi to an energy management system

The instrument may not be operated while being open. Measurements in damp areas or under adverse environmental conditions (wet or high humidity, dust, combustible gases, vapours or solvents) are not permitted. Other adverse conditions are thunderstorms or storm conditions such as strong electrostatic fields, etc.

Using the device under circumstances as described above, may cause damage to the measuring instrument, there is also the risk of short circuit, fire or electric shock.

For measuring only test leads and accessories that are tailored to the specifications of the instrument (minimum: CAT III, 600V) are to be used.

The meter must not be modified. The safety instructions must be observed!

2. Safety

Symbols used:

Symbol	Description	Symbol	Description
	Warning of dangerous voltage. Risk of electric shock !		Warning, danger !
	Complies with EU directives.		Double or reinforced insulation
	Do not dispose in household trash.		Reboot, activate Access Point (AP)
	WiFi		Operating condition
	Alternating current		Fuse

Please read the entire manual before using the device, it contains important informations about the correct and safe operation. Damage to property or personal injury caused by improper handling or failure to observe these safety instructions will void the warranty / guarantee and there is no liability. For further damages we do not accept liability!

The Emonio may only be connected by a specialist. Consult a professional if you have any doubt about operation, safety or connection of the device. The security of the system in which the meter is integrated, is under the responsibility of the installer. Measuring instruments and accessories are not toys and must be kept out of childrens' reach.

Use only with accessories certified for over-voltage category III, 600V. The use of fully insulated accessories, guarded against accidental contact are absolutely necessary for connection to the neutral conductor! If the neutral line is disconnected from the supply during operation, the full supply voltage of the phase A (10) will be on the neutral line (9). The use of a magnetic probe tip or other not fully insulated accessories on the neutral line (9) is a great danger!

In commercial institutions, the accident prevention regulations of the professional association for electrical systems and equipment must be observed.

The voltage between the three phases (10), (11) and (12) and the neutral line (9) must not exceed 264V ~. The voltage between the three phases (10), (11) and (12) must not exceed 440V ~.

The voltage at the current inputs (5), (6) and (7) must not exceed 1V ~.

Be especially careful when connecting the test leads. The touch of electric lines is dangerous!

Before each use the meter and all peripheral components (test leads, test adapters, power converters) should be checked for damage. Do not attempt any measurements if the protecting insulation is defective (torn or demolished). Do not use the meter immediately prior to, during or after a thunderstorm (lightning / over-voltage). Make sure that during the measurement hands, shoes, clothing, the floor, switches and switching components are dry.

Avoid operation in the immediate vicinity of strong magnetic or electric fields and transmitting antennas or RF generators because the measured values can be falsified.

Never immediately turn on the meter when it was moved from a cold to a warm room. The resulting condensation could destroy the device under certain circumstances. Allow the unit to reach room temperature slowly.

If it is suspected that safe operation of the instrument is no longer possible, the device must be taken out of service and secured against inadvertent operation. It can be assumed that safe operation is no longer possible if:

- apparatus comprising visible damage
- the device no longer works
- It was stored under unfavourable conditions for a longer period
- stress caused by transport

Exercise extreme caution when fitting the current transformers and measuring lines (5 to 7 and 9 to 12). There is a risk of electric shock ! Use of protective equipment (eg.: insulating gloves, shoes, goggles, etc.) to prevent electric shocks and arcs is strongly advised.

In schools and training centres, hobby and self-help workshops, handling of measuring instruments must be supervised by trained personnel.

If possible try to avoid working alone so that assistance can be made in case of emergency.

3. Product description

The Emonio measures current and voltage values by means of the connected current transformer and test leads. The consumed active, apparent and reactive power is calculated and transmitted every second via WiFi to the measuring platform [=> 9]. There, the data is stored and can be analysed, combined, averaged and graphically displayed using different dashboards.

Alternatively (in the absence of an Internet connection) the data will be stored as a CSV-file in the built-in 1MB large Flash memory for later processing. A separate SD-card adapter is available for purchase to increase the data storage capacity to many GB. If installed, measurements of up to one year at one-second precision are possible.

The interaction with the meter takes place predominantly via WiFi and web browser.

3.1. What's included

- Measurement device “Emonio P3”
- Four measuring lines (blue, brown, black, grey) 0.75m or 1m, min. CAT III, 600V
- Three split-core current transformers: YHDC, type: SCT-010 with +/- 0.33V output*
- Three magnetic test tips 6.6mm, black: Electro PJP, type: 606MG6,6-IEC3IV-0
- One alligator clip, blue: Cliff FCR7943, CAT III, 600V
- Magnetic foil on Backside (for mounting on e.g. the door of a distribution board)
- 3mm grommet
- User manual
- Transport case

* Alternatively the device can be ordered with split-core transformers for 200A or 600A or with Rogowski coils for 100A, 250A, 500A, 1000A or 3000A.

3.2. Operating elements

1. Button ‘activate AP / factory reset’	9. Test lead for neutral line
2. Status-LED ‘Power’	10. Test lead for Phase A
3. Status-LED ‘WiFi’	11. Test lead for Phase B
4. Status-LED ‘Error’	12. Test lead for Phase C
5. Current input for Phase A	13. Device-ID
6. Current input for Phase B	
7. Current input for Phase C	
8. Grommet for mounting	

3.3. Status LEDs

Power LED (green) (2)	Significance
off	Not connected to power (Neutral line and Phase A) or internal fuse triggered.
fast flashing (3x / sec.)	Initial configuration.
on, occulting every two seconds	Status: ok. Normal operation.
rapid flickering	Factory Reset was performed, button can now be released. Device will reboot.

WiFi LED (yellow) (3)	Significance
off	WLAN, AccessPoint inactive.
on	AccessPoint is active.
short flash (e.g.: 1x / sec.)	WLAN-connection active, data is successfully transmitted. The frequency of the flashes shows the data transmission. This is to be configured in Setup/Telemetry.
fast blinking (3x / sec.)	No WiFi connection possible (wrong SSID, password or the chosen WiFi network cannot be reached)
slow blinking (1x / sec.)	WiFi connection successful, but no connection to telemetry server (wrong server-URL, password, port, etc.)

Error LED (red) (4)	Significance
off	No error. Normal operation.
fast blinking (3x / sec.)	General error. See website for details.
slow blinking (1x / sec.)	Warning. For details see website. Or (temporary): firmware is being installed right now.

3.4. Button

Button WiFi reset(1)	Function
short press (< 1 sec)	Start internal Access Point (AP)
hold for > 8 seconds	Reset configuration to factory defaults (As soon as the green LED flickers, the button can be released. The factory reset has been executed and the device will restart.) Counter values and CSV-files will **not** be deleted ! After reset to factory defaults, the Emonio has to be reconfigured and an admin-name and password has to be set ! The following settings will be reset: • device_name = emonio-xxxxxx • admin_name = • admin_pass = • wifi_enabled = 1 • wifi_ssid = none • ap_enabled = 0 • ap_mode = 0 • ap_addr = 10.1.1.1 • ntp_enabled = 1 • update_enabled = 1 • update_auto = 0 • update_url =http://update.emonio.de/update.php • update_pass = xxxxxxxx • update_interval = 24 • logger_enabled = 0 • logger_channels = 5 • mdns_enabled = 1 • webserver_enabled = 1 • websocket_enabled = 1 • telnet_enabled = 0 • gpio_enabled = 1 • ade_enabled = 1 • dht_enabled = 0 • bme_enabled = 1 • ds18_enabled = 1

3.5. Site requirements

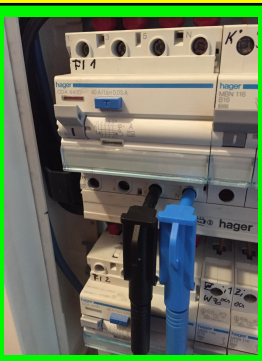
This instrument has been designed for use indoors. Operation is safe under the following ambient conditions: max. 2000m above sea level, ambient temperature of 5° C to 40° C, maximum relative humidity of 80%. Max. variation of the supply voltage of +/- 10%. The installation site should be clean and free of dust.

3.6. Connection to power supply

The power supply of the measuring device is established using measuring lines (9) and (10). It is recommended to always connect the neutral line (9) first and remove last.

3.7. Installation with residual-current devices

The cables for the phase A (10) and neutral conductor (9) provide current to the integrated power supply. These connections must be made on the same side of the RCD, otherwise the RCD will be activated!

		
Magnetic test tip	wrong	correct

3.8. Disposal

Electronic devices are hazardous waste and do not belong to the household waste. If the device is at the end of its service life, please dispose of it in accordance with the statutory regulations at the communal collection points.

4. Connection of the CTs and voltage probes

In order to obtain correct power values, the voltage lines and current transformers must always be connected to the same phase. E.g. voltage sample for phase A (10) is connected to the same line as the current transformer for phase A (5).

The voltage line for the neutral conductor (9) must always be connected to the neutral conductor, never to one of the three phases!

Please follow the safety instructions in [=>] Chapter 2!

4.1. Three phase measurement

In three phase operation, the current transformers for phases A, B and C and the measuring lines for the phases A, B, C and the neutral line are connected.

4.2. Measuring single phase loads

If one or multiple individual, single-phase loads are to be measured, the current transformers for the phases A (5), B (6) and C (7) can be connected to any location in the fuse box to each of the three phases. The three voltage samples (10-12) have to be attached to the corresponding phases.

Please always observe [=>] Chapter 2 of the safety instructions!

It is also possible to measure only one single-phase load. In order to ensure the internal power supply of the measuring instrument the voltage sample A (10) and the associated current transformer A (5) are to be used.

5. Access to device and initial configuration

5.1. Basic information on WiFi usage

All measuring devices of the type Emonio P3 have the option to use two wireless connections simultaneously. To distinguish these, one is called the Access Point (AP). This network is activated by pressing the button on the side of the device. By default it is active for a period of ten minutes and turned off again when the device is restarted.

Since this network is not encrypted, its use is only recommended for initial configuration and possibly sporadic retrieval of the measured values or CSV files. A permanent operation of the AP is not recommended. See also chapter [=> 10.2].

The second wireless connection of the Emonio is used to establish a permanent connection to an existing wireless network. Usually all communication with the instrument should take place over this connection.

5.2. Device ID

Each meter of type Emonio P3 is uniquely identified by the device ID. Initially, this corresponds to the pattern "emonio-xxxxxx" where "xxxxxx" is a random hexadecimal string that is unique for each meter.

The factory-set device ID of your meter is printed on the front side (13). Eg: "emonio-a4ce8d"

The name of the device can be changed to a value such as "generator_4" or "cold_storage", as described further below in the chapter configuration. The device_name can be changed at any time and is also reflected in the name of the .csv file and the mDNS name. A reset to factory defaults will restore the original device_id as printed on the front of the Emonio.

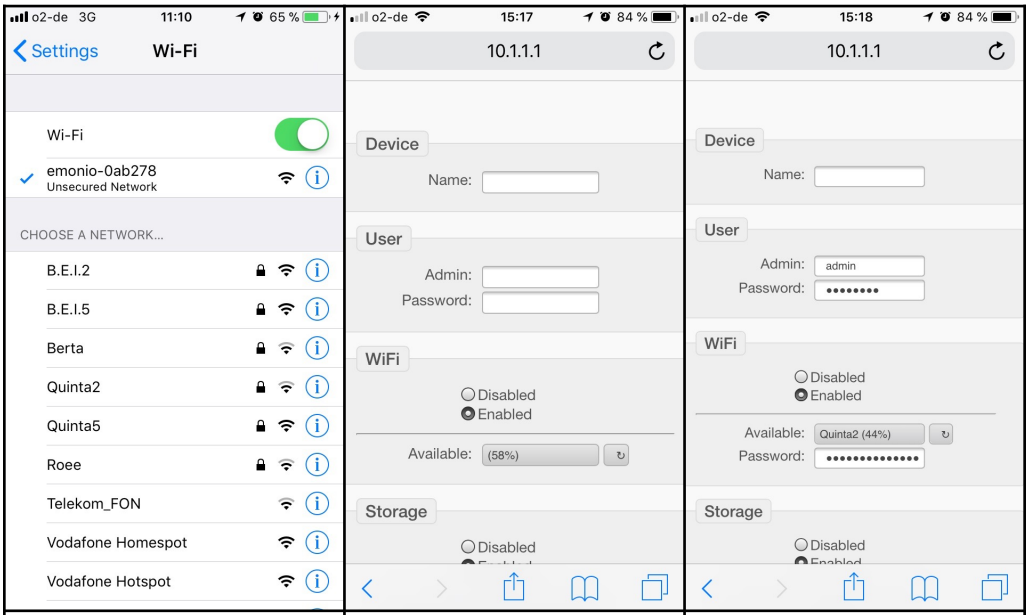
5.3. Initial configuration

To configure the device or to put into operation the connection of the power supply via the neutral line (9) and phase A (10) is the only thing required. The green LED should turn on and start flashing after a few seconds. This displays either normal operation or, if necessary, the initial configuration.

If the device was reset to factory settings, an initial configuration is necessary. This is indicated by rapid flashing of the green LED. An unconfigured device has no Internet connection configured, so access to the meter is only possible via the access point. The Access Point (AP) is turned on by pressing the button (1) and its activity is indicated by continuous illumination of the WiFi-LED (3). Once this is done, you can use a computer or mobile phone to connect with this WiFi network. The name of the wireless network corresponding to the device ID (13), which is printed on the front side.

Once the initial configuration has been performed and a user name and password for the admin account were set, all the functions of the instrument are available.

1. Enable access point by briefly pressing the button (1).



2. Select WiFi network.	3. Navigate to the site http://10.1.1.1 via web browser.	4. Admin account and WiFi is configured. -> Save & Restart.

6. Operation

When the initial configuration is done, the Emonio begins to transmit or record measurement data after only about 30 seconds.

There are the following two modes of operation:

- **Offline-operation** (Recording the measurement data in the internal flash memory)
  Select this operation mode if no wireless network is available or transfer of data using WiFi is not desired or useful. All data will be stored internally in a CSV-file.
- **Online-operation** (Transmitting the measurement data to an energy management system, for example: https://my.emonio.de by means of WiFi network)
  The optional smaller intervals of an online measurement allow a closer examination of the energy data and provide customers and energy consultants or technicians with access to live data while the energy monitoring is executed.
  In additional the recording of CSV files in the internal memory is possible.

6.1. Access via AP (internal Access Point)

If no wireless network is available or if the Emonio has not been configured accordingly, access to the instrument can only take place via the integrated access point. Switch it on for a (default) period of the minutes by pressing the button (1). The activity is indicated by continuous illumination of the WiFi LED (2). Connect directly to the wireless network of the meter. The name of the wireless network corresponds to the device ID (13), which is printed on the front side. You can access the Emonio via a web browser by using the address: http://10.1.1.1

6.2. Access via WiFi (with configured Internet connection)

If you have already configured an Internet connection for your meter and are using your laptop or mobile device in the same (wireless) network, you can access the device via the mDNS name. This is composed of the device ID [=> 5.2] and the postfix .local together.

For example: http://emonio-a4ce8d.local or http://motor_4.local or http://solar_input.local

6.3. Access via Telnet

You can communicate with your meter using Telnet to enjoy the speed and convenience of the command line. A list of all commands can be found in the chapter [=> 11.1]. However, the Telnet protocol provides no encryption, so it is recommended to only be used via a secure wireless network or an additional VPN.

6.4. Admin- and User-account

The unit offers two different accounts:

- The admin account has read and write permissions.
- The user account only has read permissions.

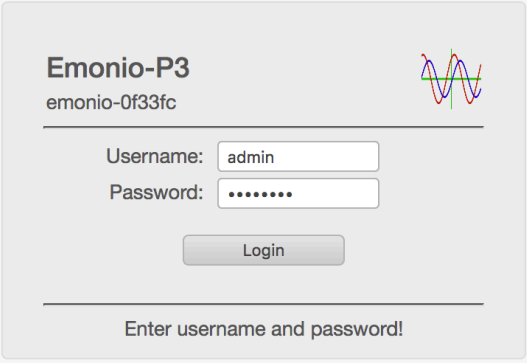
The 'user' account offers all the options to display data, meter readings and to retrieve the .csv file, but all functionality to change values or settings does not exist. This also applies to the available commands on the command line. This user account should be used to provide an employee access to the data without exposing them to the danger that settings could be inadvertently changed or data to be erased.
To enable this user account, a user name must be entered. The account name and password can be freely selected.

6.5. Login

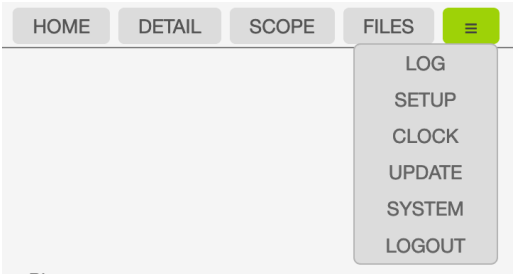
Connected via local WiFi network, point your web browser to: e.g.: http://emonio-0f33fc.local

or

Connected to the access point of the Emonio, use web address: http://10.1.1.1

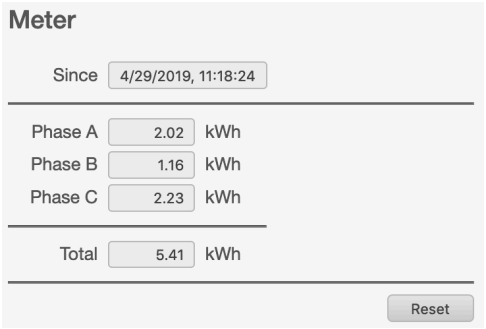
	You will be asked for a valid login to the Emonio. Here you use the credentials that you specified during the initial startup.

6.6. Menu



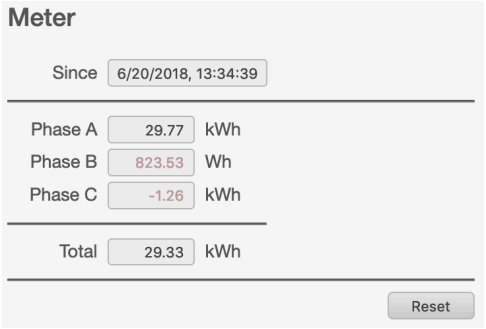
After logging in you are on the home page ("HOME") of the instrument. The various sub-pages are accessed through the menu at the top.

6.7. Home / meter function (“HOME”)



On the home page ('Home') of the Emonio you see the energy consumption since the last reset of the counters.

The counter values are set to zero by clicking on 'Reset', after an additional security pop-up ("Are you sure ...") is confirmed.

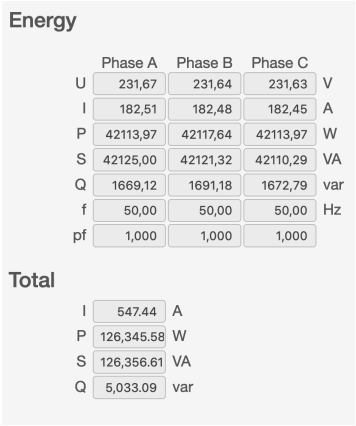


If the supply voltage for a phase is less than 48V, it is displayed with **less contrast**.

Energy data for such 'inactive' phases is not transmitted via Telemetry.

The left picture shows an Emonio in single-phase operation (measurement of a single consumer with 240V).

6.8. Detailed Measurements (“DETAIL”)



All electrical values can be found on the page "Detail".

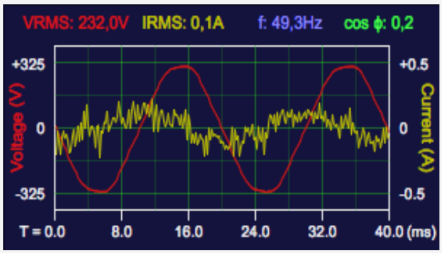
The following specifics are displayed on this page:

- Voltage U in volts
- Current I in amperes
- Power P in Watts
- Apparent power S in volt ampere
- Reactive power in volt-ampere reactive
- Frequency f in Hertz
- Power factor (pf)

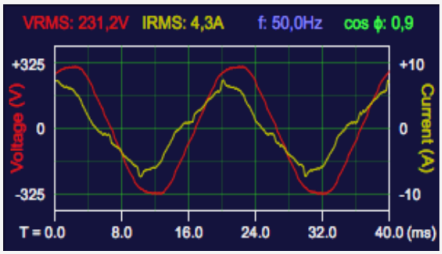
Total will show the sum of all three phases.

6.9. Oscilloscope (“SCOPE”)

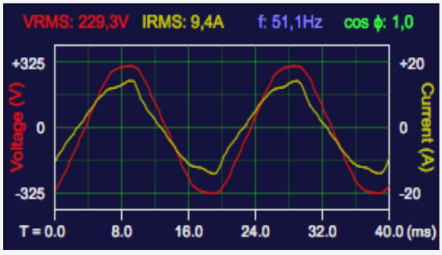
Phase A



Phase B



Phase C



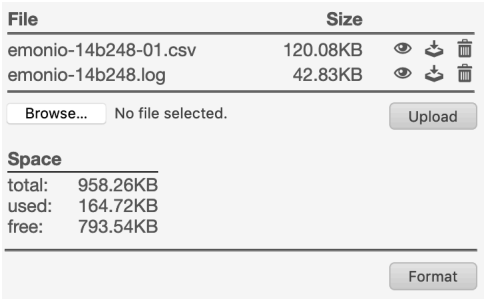
The exact graph of current and voltage and the current measured values of voltage, current, frequency and power factor are indicated on the page "SCOPE".

This view is also very well suited to verify the phase angles or the proper connection of the voltage samples to a three-phase connection: The voltage curves in a right-handed three-phase electric circuit start for phase A at the zero point, for phase B at the voltage maximum and Phase C at the voltage minimum.

The display areas for voltage are: 60, 170, 325, 400 V (peak)

For current these are: 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 3000A (peak)

6.10. Internal storage (“FILES”)

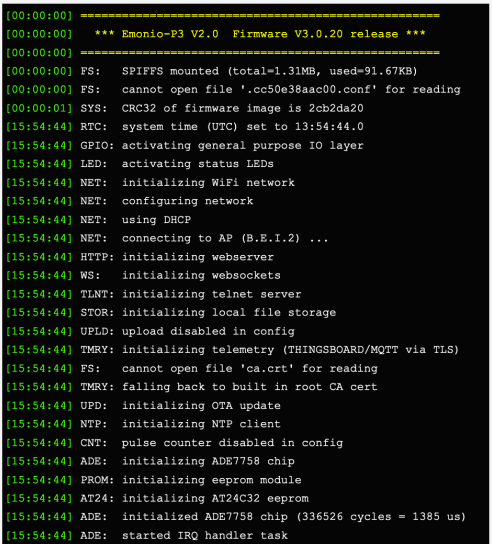


If the local storage of measured data is activated, values are stored in an CSV-file. The file is named after the device [=> 5.2] and can be displayed directly in the web browser, downloaded or deleted.

Furthermore, an optional log file shows the detailed activities of the unit.

An optional TLS root certificate to be used with a different telemetry server can be uploaded here. [=> 8.5].

6.11. Logfile (“LOG”)



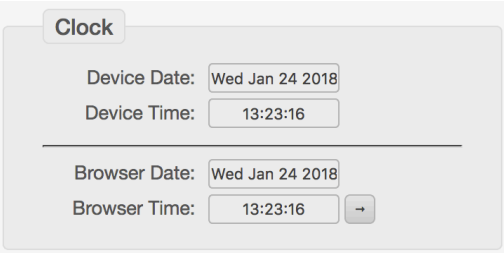
If logging is enabled, the last lines of the log file are displayed on this page. Here you will find detailed information on the inner workings of the Emonio and are able to diagnose potential faults. For example, problems with the network connection, the telemetry server or the like.

The log file is being truncated every now and then so to not exceed a maximum size of ~40kB.

6.12. Configuration (“SETUP”)

This will be thoroughly discussed in [->] Chapter 7.

6.13. Real time clock (“CLOCK”)

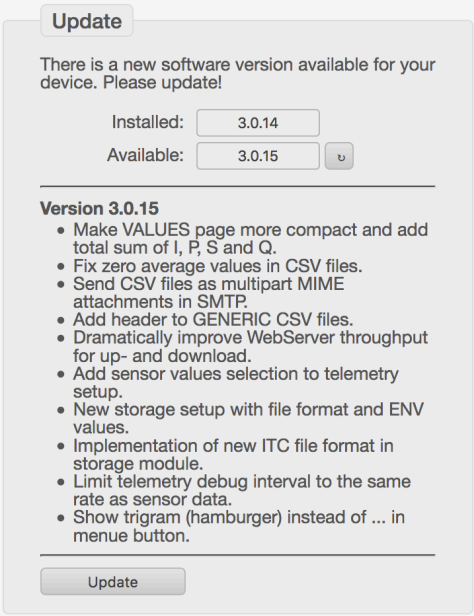


The 'Clock' page allows you to synchronise the built-in battery-backed real time clock with the time on your computer. Click on the small arrow in the lower right corner and the time of the Emonio will match up with your web browser.

An exact time is important for the proper recording of CSV files!

If the Emonio is connected to the Internet, the internal clock is synchronised automatically with an Internet time server every three hours.
[=>8.9]

6.14. Software update (“UPDATE”)

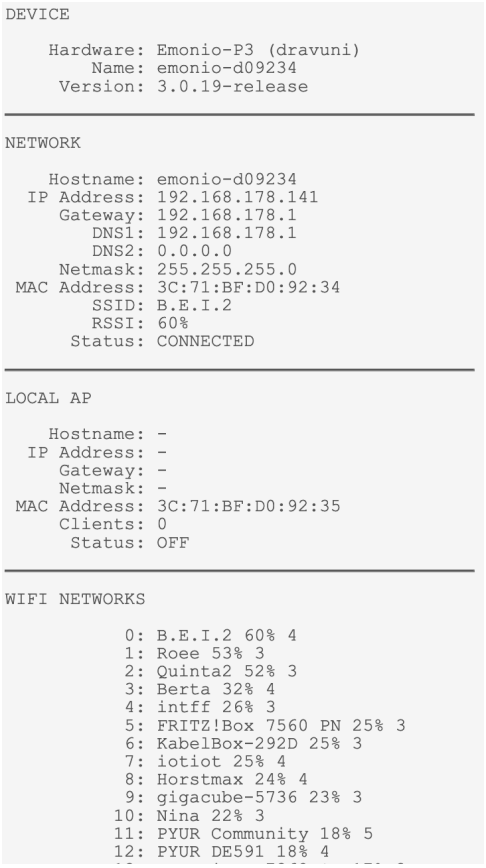


Your meter has the possibility to update its own operating system ("firmware") over the Internet.

By default, the device will search once a day for an update. Should newer firmware be available, this is indicated here. The update is initiated by clicking on the appropriate button and usually takes about two minutes.

It is **highly recommended** to keep the meter updated to the latest version, as we are constantly adding new features and errors of previous firmware versions are eliminated.

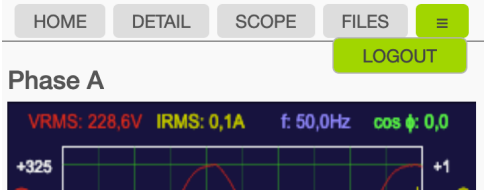
6.15. System information und Reboot (“SYSTEM”)



On the 'SYSTEM' page you will see information about the hardware and software of the device as well as the configuration of the wireless connection ('Network') and the access point ('Local AP').

The unit can be restarted by clicking on the 'reboot' button at the bottom of the page.

6.16. Logout (“LOGOUT”)



To end the session, or to register with another user, click the menu item 'LOGOUT'.

After ten minutes of inactivity, the session is terminated automatically.

The adjacent menu to the left shows the limited functionality of the user account.

7. Configuration ("SETUP")

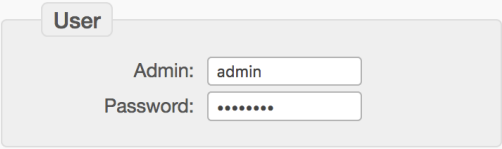
To perform successful measurements it is useful and in parts necessary to make certain settings on the device. The following section describes all settings of the 'SETUP' page in detail.

All these settings can also be changed on the command line, you will find an overview of the necessary commands for this purpose in the appendix.

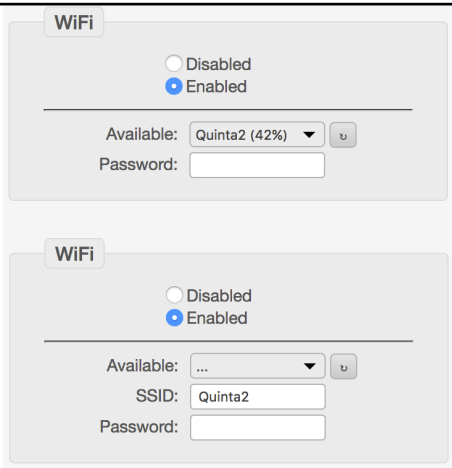
7.1. Device name (“Device”)

	By default, this field is blank and the meter uses the factory-set name 'emonio-xxxxxx'. The value of this field will affect the mDNS name of the device and the name of the .csv and .log file. Furthermore, this name can also be part of the values transmitted over the Internet and for example be used in your energy management software. In the attached example shown, the name was changed to UV_2a. This meter is now to be found on the network using the name 'uv_2a' or via the URL http://uv_2a.local .

7.2. Admin account (“User”)

	Here username and password can be set for the 'Admin' account. In the extended configuration a non-privileged 'user' account can also be configured. [=> 8.1]

7.3. WiFi configuration (“WiFi”)

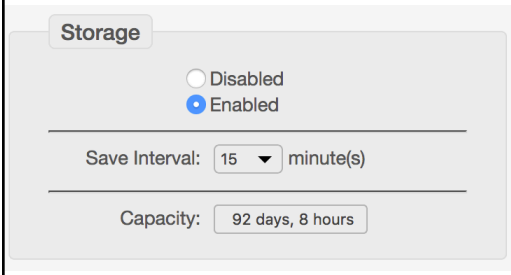


If measurement data is to be transmitted by means of WiFi, an existing connection can be configured here. To do this, select the desired network (SSID) from the list and enter the appropriate password. The percentage next to the SSID indicates the strength of the WiFi signal.

Use the button on the side to refresh the network list.

A non-existent or hidden network can be configured by selecting the three points ("...") at the bottom of the list and then enter the appropriate SSID in the new field.

7.4. Local recording of measurement values (“Storage”)



The recording of the measured values in the local flash memory is enabled by default.

The quarter-hour average values of U, I, P are written for each of the three phases in a single CSV file. Each line will start with a Unix timestamp and the date and time in human readable format.

An approximate estimation of the maximum recording time will be shown in the field 'Capacity'.

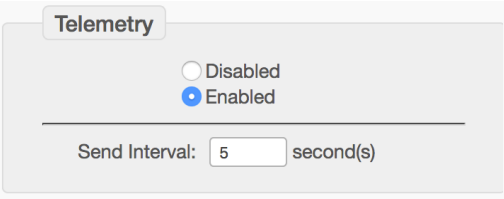
7.4.1. Description of CSV-file contents

All electrical values found in the CSV file are root mean square values, averaged over the measurement period. If for example the storage interval is set to one minute, the result is an arithmetic average of the 14.000 samples per second x 60 seconds.

Following you find all columns that can be configured. Depending on the selected values to be stored [=> 8.5], not all columns have to be present. There can be additional columns at the end with environment values of optional sensors (temperature, humidity, CO2, counter, ...)

- **timestamp**: Unix-timestamp (seconds since 1.1.1970).
  This field is used to exchange time information between IT systems.
- **localtime**: Date/time in user configurable format [=> 8.5]
- **vrms**: Voltage in Volt, arithmetic mean of the three phases.
- **irms**: Current in Ampere, sum of all three phases.
- **watt**: Active power in Watt, sum of all three phases.
  If the phase angle between voltage and current of one phase is > 90°, the sign will be negative.
- **var**: Reactive power in var, sum of all three phases.
- **va**: Apparent power in VA, sum of all three phases.
- **freq**: Frequency in Herz, arithmetic mean of the three phases.
- **kwh**: Elektrical work in kWh, since resetting the counters [=> 6.7], sum of all three phases.
- **pf**: Power factor (cos Phi), arithmetic mean of the three phases.
- **connected_a**: Indicator for activity of this phase (A).
  1 = Phase A was active (meaning > 48V) during the whole measurement interval.
  0 = Phase was inactive (meaning < 48V) during the whole measurement interval.
  vrms_a: Voltage in Volt, Phase A
- ...
- **pf_c**: Power factor (cos Phi), Phase C

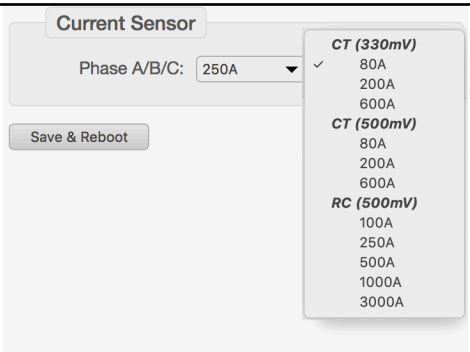
7.5. Transmitting of measurement values (“Telemetry”)



By default each Emonio is equipped with valid settings for the secure transmission of measured values to the analysis portal of the Berliner Energieinstitut on https://my.emonio.de .

Authentication is performed via token.

7.6. Current sensors (“Current Sensor”)

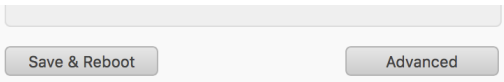


It is indispensable to correctly configure the connected current sensors.

The selection menu shows the available sizes and will configure all three current inputs to the appropriate value.

To configure different sensors to the individual inputs or to invert power values, use the Advanced configuration (next chapter).

7.7. Saving the settings (“Save & Apply/Reboot”)



To activate the new settings, click the 'Save & Apply' or 'Save & Restart' button at the bottom of the setup page.

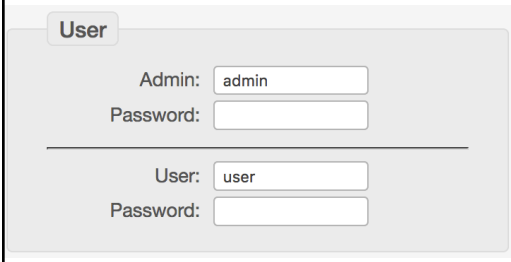
If one of the following settings: Device, User or WiFi has been changed, the device will need to do a quick reboot to apply the changes.

8. Advanced Configuration (“Advanced Setup”)

Settings not frequently used can be found in the expanded configuration. This can be accessed via the button 'Advanced' at the bottom of the Setup page.

We will show some of the advanced settings in detail.

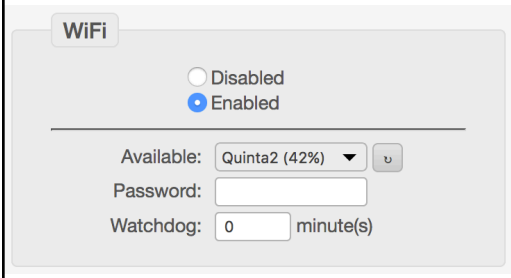
8.1. Unprivileged User



If you need an additional account to access the Emonio with limited user rights, it can be defined here.

The 'User' can only read but not change any settings or delete data.

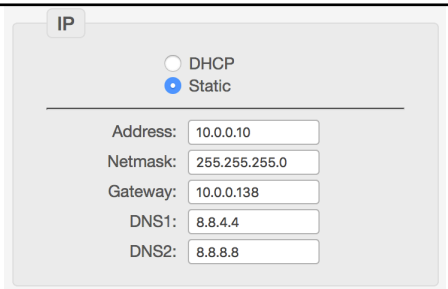
8.2. WiFi-Watchdog (WiFi)



In special cases it may be useful to activate the 'WiFi Watchdog'. If it is not possible to connect to the Internet, the Emonio will reboot after the time set here, and then try again to connect to the selected WiFi.

Using this setting should not be necessary and the use is not recommended as continuous restarts can distort the measurements in case of a permanent error in the network!

8.3. Network settings (IP)

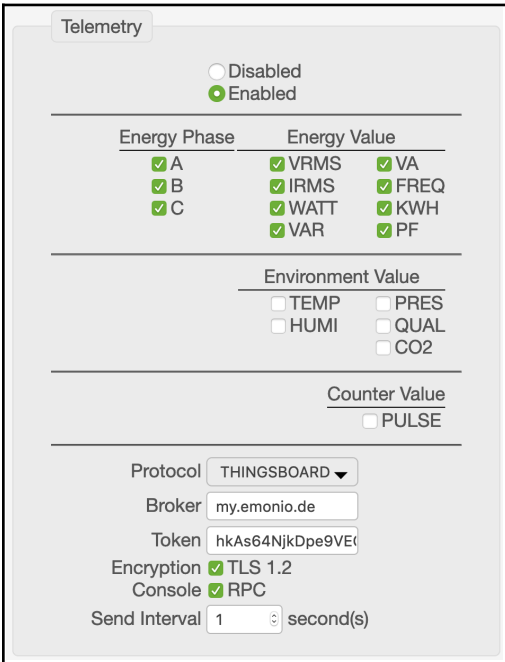


If it is necessary to manually configure the TCP / IP settings for the wireless connection, the automatic DHCP configuration can be deactivated here to enter all values manually.

8.4. Transmitting the measurement values ("Telemetry")

To send the measurement data as well as monitor the status of the Emonio, there are several communication protocols based on MQTT and HTTP that can be used. The data is transmitted in JSON or XML format and encrypted using TLS. By default the Emonio is equipped with the root certificate of LetsEncrypt.org. If an alternative certificate is required, this can be stored in the flash memory via file upload [=> 6.10].

8.4.1. Thingsboard



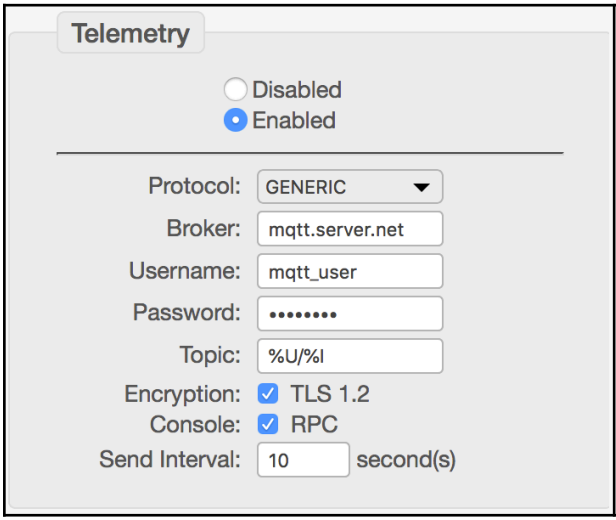
In the advanced view you can control in detail the parameters that are sent over the network.

By default every Emonio will have valid settings and an authentication token to use https://my.emonio.de.

Encryption of the data during transport (TLS) is enabled by default.

The Emonio can be remote controlled using RPC (if enabled). For a detailed explanation of these possibilities, see [=> 9.3] and [=>11.3].

8.4.2. MQTT/Generic



If you want to use your own MQTT broker (e.g.: Mosquitto) you'll find all necessary settings in the protocol 'Generic'.

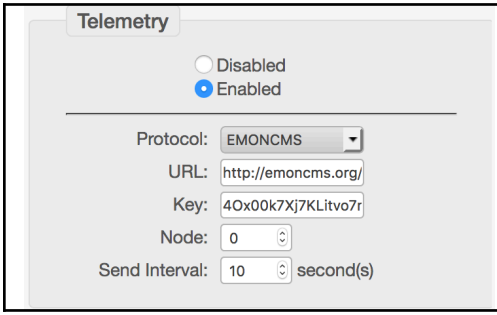
Besides the standard settings of server (broker), user, password, there are several place markers that can be used for topic:

%U for username

%I for device_id

%N for device_name

8.4.3. EmonCMS

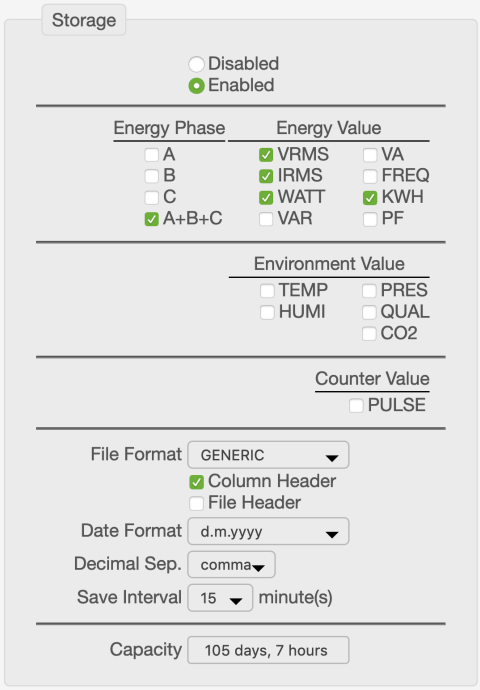


You can register for an account on https://emoncms.org or download the software to your own server. To use this protocol you need the correct URL that is:

http://emoncms.org/input/post

The authentication is based on a token that has to be generated on the server and saved in the 'key' field.

8.5. Local recording of measurement values (Storage)



Here you can configure in detail which values should be saved in your CSV file.

To save space, the separate recording of the three phases can be deactivated and the sum/ average of all three selected instead (as seen in the picture => "A+B+C").

You can choose between the standard CSV-format with separate columns for each value and the “ITC”-format. The latter will write one value per row and use OBIS-codes to describe the measurements taken.

The Environment- and Counter Values are reserved for optional sensors that will be available as add-ons in the future.

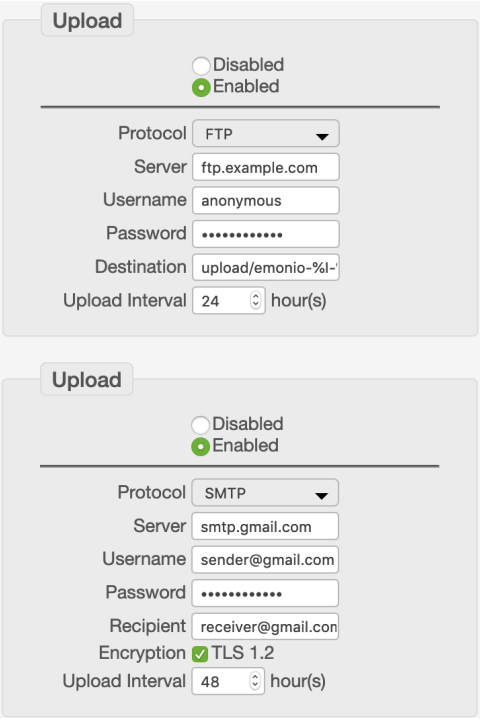
'Column header' will add a header line to the file which designates the values. The 'File Header' will add three additional lines to the top of the file showing the Device-ID, Device-name and CSV-Version. These can be used to ease later, automated processing of the file.

To ease further processing of the CSV file, the format of the date as well as the decimal seperator can be set here.

The save (write) interval can be chosen between one second and one hour.

Capacity will show an estimation of the recording time with the currently configured settings.

8.6. Automatic file transfer (Upload)



Locally stored CSV-files can be periodically uploaded to a remote location. To do so you can use FTP, SMTP or HTTP upload protocols.

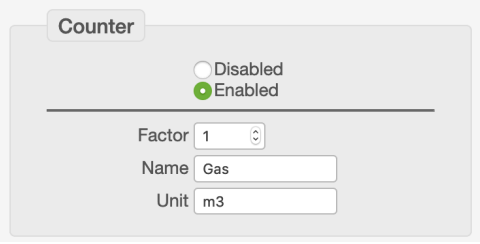
When configured correctly, the files will be uploaded and upon success are **deleted** from the device.

The following place markers can be used for the destination:

- %U: upload_user
- %I: device_id
- %N: device_name
- %T: date/time-stamp

To use SMTP upload you need access to an email account like Gmail or the like. The files will be sent as a MIME-encoded attachment. Only SMTP servers that support TLS can be used. STARTTLS (like it's being used on outlook.com) is not an option at the moment. By default SMTP will try to use port 465. Specific port numbers may be used by adding *:port* to the server name.

8.7. Pulse counter (Counter)

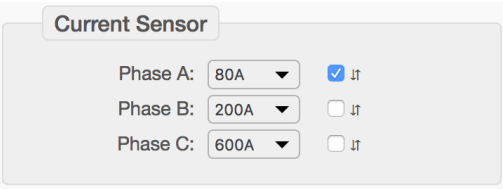


If the Emonio is equipped with the optional 'X1' extension, an additional pulse counter may be configured.

Specify a factor, name and unit for the pulse counter and these values will be transmitted with the other telemetry values.

If activated, the pulse counter will also be shown on the 'HOME' page of the Emonio.

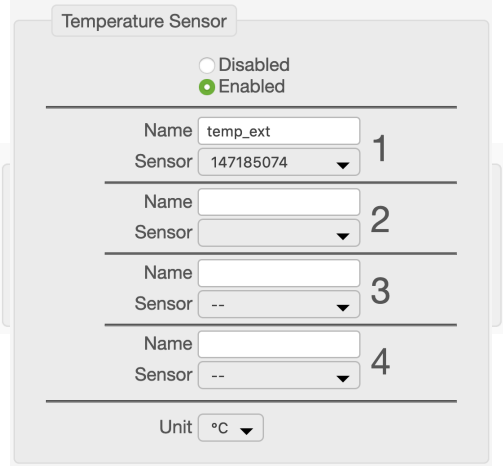
8.8. Current sensors



When using advanced setup you can configure different values for each individual current input.

In addition you have the option to 'virtually reverse' the sensor. In case a sensor was mounted the wrong way around you can turn it here and do not have to physically reinstall it.

8.9. Temperature Sensors



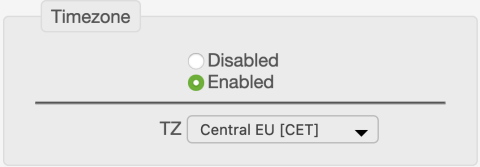
Only recently there is the option of adding an additional port to the Emonio P3 to connect up to four DS18x temperature sensors.

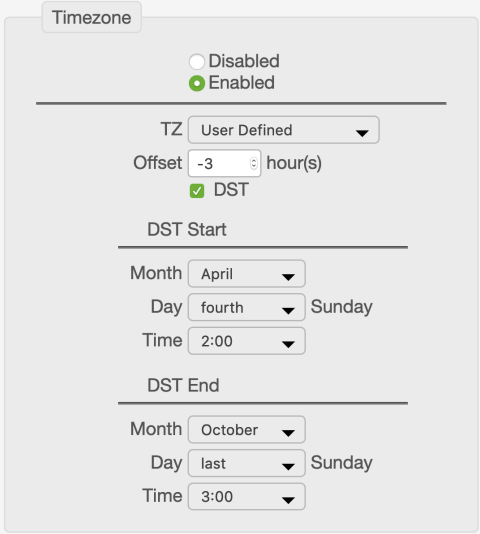
These sensors are identified by their sensor ID and can be given a name using this configuration dialog.

The additional columns in the CSV file and the additional fields in the MQTT data are named according to the values you add here.

Additionally there is the possibility to select the unit from °C, K oder F.

8.10. Timezone





The local timezone is important for a correct recording of the time (in the CSV files) and (if applicable) the switching to/from daylight saving time (DST).

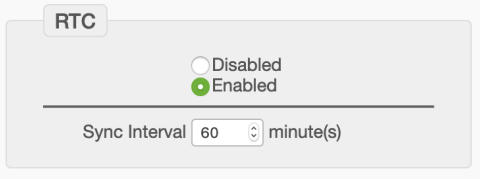
Some of the more important or common timezones are preconfigured and can be selected directly from the menu.

If your timezone is not in the menu, please select 'User Defined' and konfigure all relevant parameters as follows:

Most important is the offset from UTC (previously also known as GMT).

If your timezone needs the swithing to/from daylight saving time, the exact date and time for these changes can bne configured here.

8.11. Real Time Clock (RTC)

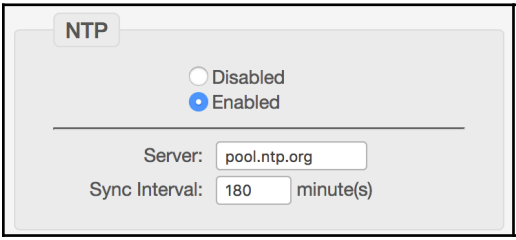


The Emonio is equipped with a battery buffered high precision DS3231 real time clock module.

The internal CPU-clock is synchronised with the RTC in the given interval.

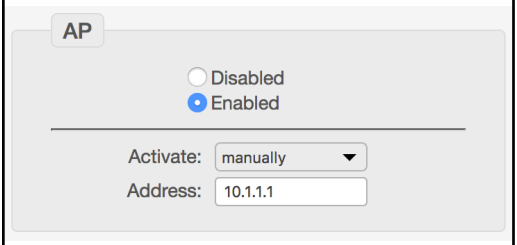
The included battery is rechargeable and should keep the time for at least one year.

8.12. Time synchronisation (NTP)



If the Emonio has a working Internet connection, it will synchronise its internal clock using Network Time Protocol (NTP) in the given interval.

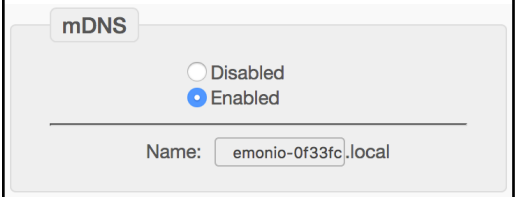
8.13. AccessPoint (AP)



The Access Point (AP) usually is manually activated and will turn off by itself after 10 minutes.

Here you can either disable it completely or activate it permanently. Also you can choose a different IP-address for the AP.

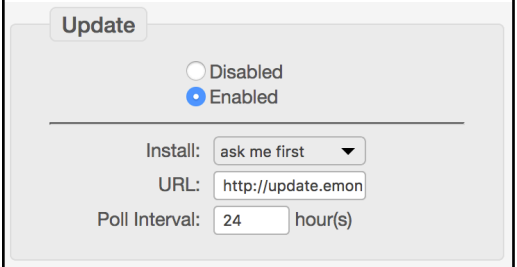
8.14. Name resolution (mDNS)



mDNS or Multicast-DNS enables you to find and access the Emonio without knowing it's IP address.

The mDNS-name is inherited from the device-name [=> 7.1].

8.15. Firmware update (Update)

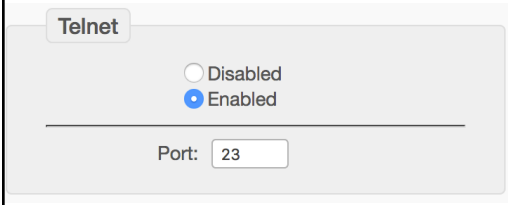


By default the Emonio will look for updated firmware once a day. If new software is found, the user will be redirected to the update page once after login.

The update is installed after user confirmation (by default) but can be set to run completely unattended if preferred.

It is highly recommended to always use the latest firmware available!

8.16. Telnet (Telnet)

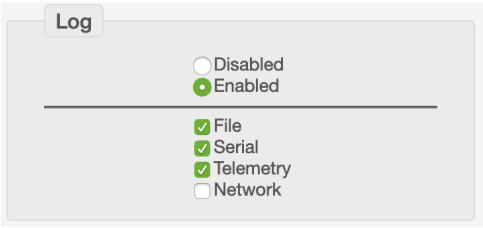


Access via Telnet can be enabled here.

By default the port 23 is used but this can of course be changed.

For a detailed description of the command line, please see chapter [=> 11].

8.17. Logging (Log)



To find the reason for errors or unusual behaviour, logging can be activated.

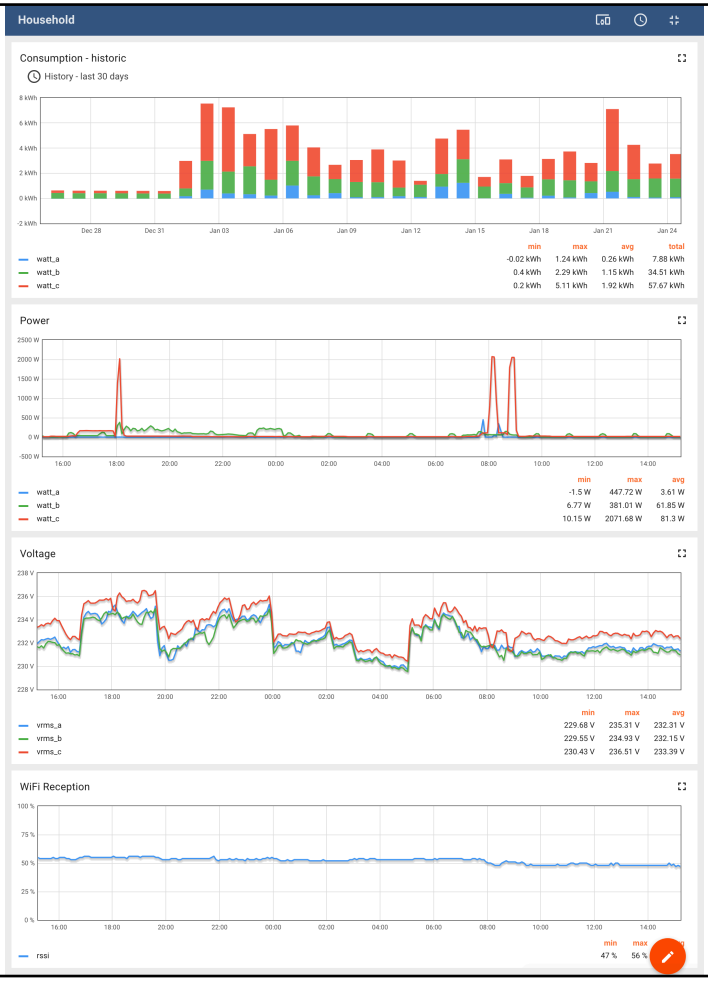
Individual log lines will be written for every system event. These can be stored on the device in a file, broadcasted via UDP, port 49152 to a log server or transmitted via MQTT to the Telemetry server.

9. Telemetry data on the Internet

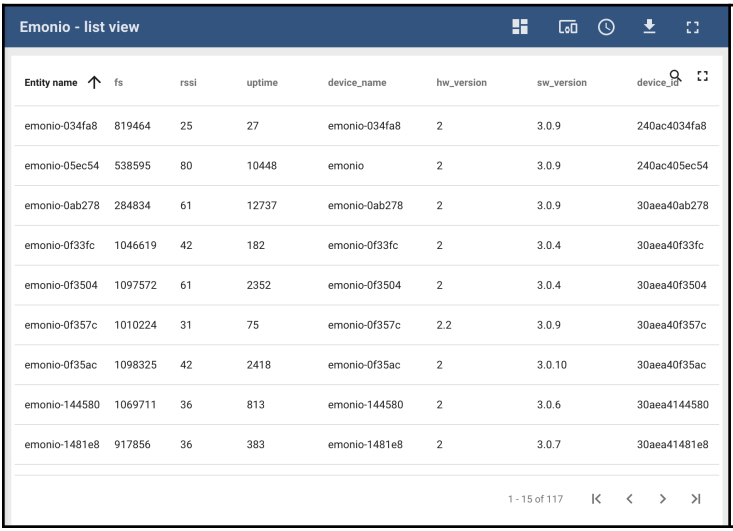
If the Emonio is configured with a working Internet connection, it will send the measurement data every second to the internet site: https://my.emonio.de . Here all telemetry data is recorded in a database and can be processed and visualised using different techniques.

9.1. Simple Dashboard

A very simple dashboard showing the consumption of a single three-phase load.

	Energy consumption by day during the last month power used grid voltage WiFi signal

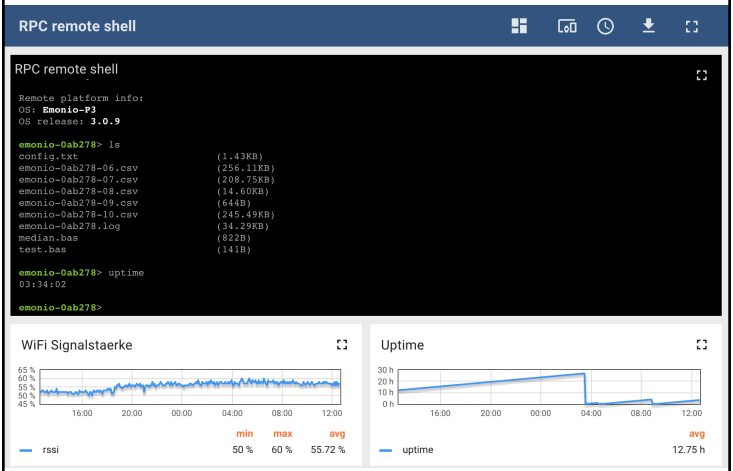
9.2. Showing several devices as list



The dashboard 'List View' shows values of several devices in a table.

You will get to the detailed view [=> 9.1] by clicking on a row.

9.3. RPC remote shell



The RPC console can be used to send single commands to a remotely installed Emonio or to read/change configuration values.

You can find a list of available commands and their limitations in chapter [=> 11.3].

10. Security and data protection

10.1. WiFi Encryption

Please ensure that the data is always sent using encrypted channels. For WiFi we recommend using WPA2 encryption.

10.2. Internal Access Point (AP)

The internal Access Point (AP) of the Emonio P3 does not provide any encryption and should only be used for initial configuration or to quickly access values or download data. The AP is not intended to be used continuously and it is not recommended to enable it permanently*.

If the AP is active, the WiFi-LED (3) will be lit constantly. You can use any WiFi enabled device to connect to the AP's WiFi network and access the Emonios website on http://10.1.1.1.

* An enabled AP will show up as an open WiFi network on all devices that search for it. It might happen that random devices will connect to the AP (because they think there's free WiFi for them). As the AP does NOT provide an Internet connection, these devices will be offline and not receive any notifications, messages or emails. As this scenario is confusing and inconvenient, the AP should stay in its default configuration 'manual' - which will turn it off after 10 minutes of idle time.

10.3. MQTT protocol

The protocol used for sending telemetry data is MQTT in version 3.1.1.

Transmission of MQTT messages is done using TCP on port 1883 or 8883 (with TLS).

All data is JSON formatted and will be sent every second (by default). Here an example of a MQTT message:

```
topic: /benutzername/emonio-0f33fc/values
data:  {
  “ts":1558530515724,
  “device_id":"30aea40f33fc",
  “egy_vrms_a":233.46,
  “egy_irms_a":1.90,
  “egy_watt_a":443.29,
  “egy_var_a":-48.94,
  “egy_va_a”:444.88,
  "egy_pf_a":0.79,
  “egy_freq_a":50.00,
  “egy_kwh_a”:3.231,
  “egy_vrms_b":233.47,
  “egy_irms_b":1.91,
  “egy_watt_b":444.88,
```

```
  “egy_var_b":-51.94,
  “egy_va_b”:446.82,
  "egy_pf_a":0.78,
  “egy_freq_b":50.00,
  “egy_kwh_b”:2.679,
  “egy_vrms_c":233.46,
  “egy_irms_c":1.91,
  “egy_watt_c":446.47,
  “egy_var_c":-47.53,
  “egy_va_c”:448.23,
  "egy_pf_a":0.81,
  “egy_freq_c":50.00,
  “egy_kwh_c”:8.445
}
```

Additionally max. every 60 seconds the following debug data is transmitted:

```
topic: /username/emonio-0f33fc/values:
data: {
  “device_id":"30aea40f33fc",
  “device_name":"emonio-0f33fc",
  “uptime":4149,
  “heap":87784,
  “stack":8228,
  “fs":7546976768,
  “rssi":44,
  “temp_cpu":53.89,
  “temp_ade":35.00,
  "temp_rtc":28.50
}
```

The following data is transmitted once after device startup:

```
topic: /username/emonio-0f33fc/poweron
data:  {
  “device_id":"30aea40f33fc",
  “device_name":"emonio-0f33fc",
  “device":"Emonio-P3",
  “hw_version":"2.0",
  “sw_version":"3.0.19
}
```

By default the Emonio is configured to send telemetry data to the portal of the Berliner Energieinstitut GmbH at https://my.emonio.de. There are several other options for telemetry transmission that can be configured using the setup.

10.4. Data protection

If telemetry is enabled and protocol 'Thingsboard' is selected, the data described in 10.3 will be sent TLS-encrypted to my.emonio.de

The Emonio does not send any data that could be correlated to a person. The identification/relation of the telemetry data is done solely using the configured token. To protect the configured username/ passwords (for SMTP/FTP transfer) from others it is advisable to use TLS encryption or a VPN connection where possible.

All device data is only available to the user owning the device and cannot be seen by other users of the same platform. The collected data is not deleted or truncated automatically. Should you desire to delete data, this can be accomplished using the API of the processing platform on https:// my.emonio.de

The complete privacy policy can be found at: https://emonio.de/index.php/en/privacy-policy .

11. Command line

11.1. Telnet connection

Make sure that Telnet is enabled in Setup and note the port number to be used. [=>8.14]

If the port is left unchanged it will default to 23. The connection can be established using the following command:

```
telnet <device_id>.local
```

or

```
telnet <IP-address>
```

e.g.:

```
telnet emonio-0ab278.local
```

If you did change the port number to a different one, add it to the command as shown here:

```
telnet <device_id>.local <port>
```

11.2. Auto-completion of commands

The command line provides automatic completion for commands, file names and configuration settings. Use the tabulator key to get suggestions for commands. Multiple key presses will cycle through all possible commands/filenames/settings that apply. The auto-completion can be limited by providing the first (known) letters of a command:

Example:

```
'up' + [tabulator] results in: 'uptime'
```

A second key press of the tabulator will give the next command starting with 'up': update.

Another example:

```
'conf wi' + [tabulator] results in: conf wifi_enabled.
```

11.3. List of commands (Admin user)

Following you find a list of commands that can be executed using Telnet and/or MQTT/RPC. Some of these commands need an additional parameter when executed via MQTT/RPC because of technical limitations. These are marked with an asterisk (*).

```
cat <f>       ... print content of file <f>
clear         ... clear screen
conf <k[=v]>  ... get/set value of config key <k> to [v]
counter       ... display current pulse counters
clock         ... get/set system time and/or RTC
cp <f> <n>    ... copy file <f> to new file <n>
date [d]      ... get/set time [YYYY/MM/DD HH:MM:SS]
```

```
  dd            ... dump (parts of) file to disk or console
  df            ... report file system space usage
  dmesg [n]     ... display the last [n] log messages
  export [f]    ... export config to file [f]
  hd <f>        ... print hexdump of file <f>
  help          ... print this info
  import [f]    ... import config from file [f]
  info <i>      ... dump system information <i>
  kill <p>      ... terminate the task with PID <p>
  logout        ... exit shell
  ls            ... list filesystem content
* meter         ... display current meter readings RPC: "meter -o"
  mhz           ... CO2 sensor calibration
  mkfs          ... initialize (format) filesystem
  mv <f> <t>    ... rename file <f> to file <t>
  ps            ... list all currently running tasks
  reboot        ... reboot device
  reset <m>     ... reset module <m> (m=config|meter|counter)
  rm <f>        ... remove file <f> from filesystem
  save          ... save config to EEPROM
  scan          ... scan for available accesspoints
  speed <s>     ... set CPU clock (1=80, 2=160, 3=240 MHz)
  tail <f> <s>  ... cut file <f> from <s> to EOF
* top           ... show system usage statistics RPC: "top -o"
  touch <f> [c] ... create file <f> with content [c]
  update <c>    ... <check|install|rollback|changes> new version
  upload        ... [--to=<user>@<host>] [--file=<file>] [-k]
  uptime        ... get system uptime
```

11.4. List of commands (unprivileged user)

The optional unprivileged user only has a very limited set of commands:

```
  clear         ... clear screen
  counter       ... display current pulse counters
  help          ... print this info
  logout        ... exit shell
* meter         ... display current meter readings RPC: "meter -o"
  reboot        ... reboot device
* top           ... show system usage statistics RPC: "top -o"
  uptime        ... get system uptime
```

11.5. Configuration settings

The following settings can be shown and/or set using the 'conf' command:

```
conf <item>                 Prints the currently configured value for <item>.
conf <item>=<value>         Sets the configuration item to the (new) <value>.
```

Device name:	ntp_server	storage_seperator	Telnet Server:
device_name	rtc_enabled	storage_interval	telnet_enabled
brand_name	rtc_interval	storage_filesize	telnet_port
model_name	tz_enabled	storage_values	
	tz_id		Logging:
Authentification:	tz_offset	Upload:	logger_enabled
admin_name	tz_dst	upload_enabled	logger_channels
admin_pass		upload_interval	logger_host
user_name	Telemetry:	upload_protocol	logger_port
user_pass	telemetry_enabled	upload_tls	
	telemetry_protocol	upload_url	Software components:
WiFi:	telemetry_url	upload_user	ade_enabled
wifi_enabled	telemetry_user	upload_pass	ble_enabled
wifi_ssid	telemetry_pass	upload_target	bme_enabled
wifi_pass	telemetry_topic	upload_delete	cpu_speed
wifi_power	telemetry_key		dht_enabled
wifi_watchdog	telemetry_node	Counter:	ds18_enabled
	telemetry_rpc	counter_enabled	gpio_enabled
TCP/IP:	telemetry_tls	counter_value	hlw_enabled
ip_static	telemetry_interval	counter_name	mdns_enabled
ip_addr	telemetry_values	counter_unit	mhz_enabled
ip_netmask			prom_enabled
ip_gateway	Firmware update:	Temperature sensors:	rtc_enabled
ip_dns1	update_enabled	ds18_enabled	spp_enabled
ip_dns2	update_auto	ds18_unit	webserver_enabled
	update_url	ds18_name1	websocket_enabled
AccessPoint:	update_pass	ds18_addr1	
ap_enabled	update_interval	ds18_name2	Current sensors:
ap_mode		ds18_addr2	ct_a
ap_addr	Local storage:	ds18_name3	ct_b
	storage_enabled	ds18_addr3	ct_c
Time and date:	storage_format	ds18_name4	ct_invert
ntp_enabled	storage_header	ds18_addr4	
ntp_interval	storage_date		

Attention: if configuration values are changed using the commando line, all changes must be saved using the command 'save'. To activate those changes, the device has to be restarted using 'reboot'.

Specifically coded configuration values:

For most config values applies:

0=off / inactive
1=on / active

Some config values do have more or less complicated bitmasks that are a result of selected checkboxes on the Setup page. (e.g.: telemetry_values or storage_values). These are too complex to address them here and if you are in the process of configuring these via commandline the following approach is suggested: Use a second device to test-configure these values to your liking and copy the resulting value from the commandline to the device that is to be configured.

Some of the more common configuration values are explained here:

storage_interval:

Intervals in minutes can be configured directly:. e.g. 1 = one minute, 15 = 15 minutes

Intervals in seconds: To the possible intervals of 1, 5, 15, 30 seconds you have to add the number 128. to tell the device that these are actually seconds. To set the interval to one second, the config value would be 129. For 15 seconds the value would be 143.

ct_a/b/c:

0 = CT 80A/333mV
1 = CT 200A/333mV
2 = CT 600A/333mV
3 = CT 80A/500mV
4 = CT 200A/500mV
5 = CT 600A/500mV
6 = RC 100A/500mV
7 = RC 250A/500mV
8 = RC 500A/500mV
9 = RC 1000A/500mV
10 = RC 3000A/500mV

ct_invert:

ct_a: ct_invert = 1
ct_b: ct_invert = 2
ct_c: ct_invert = 4
Invert ct_a and ct_b: ct_invert = 3
Invert all three current inputs: ct_invert = 7

cpu_speed:

1 = 80MHz
2 = 160 MHz
3 = 240 MHz (default)

logger_channels:

1 = serial console
2 = network (log-Server)
4 = file (local logfile will be created)
8 = telemetry (loglines will bne transmitted using MQTT)

12. Common errors

12.1. Negative power readings

- If the current sensor is connected to the correct phase:
  - Check the current sensors for correct installation (arrow/label in direction of current flow.)
  - If applicable, turn the current sensor by 180°
  - Invert the current input via Setup => Advanced => Current Sensor [=> 8.9]
- Otherwise see the next point, 12.2:

12.2. Unrealistic power readings

- If the power readings are lower than expected but the apparent power reading shows the expected value, it is very likely that the current sensor is not connected to the correct phase: If voltage line for phase A (10) is connected to phase A but the current sensor for phase A (5) is (by accident) connected to Phase B or C it will result in a much too low and/or negative power reading. You will also notice a power factor that is far from the optimal range (between 0.8 and 1.0). Check the sensor inputs for possible mixups.

12.3. Unrealistic voltage reading

- Check the magnetic test tips or crocodile clamps for bad connections.

12.4. No access via WiFi

- The chosen WiFi network was only briefly available (during configuration) and now cannot be found. Check the available networks with a different device (laptop or smartphone).
- The WiFi password might be wrong.
- Is the device you are using to access the Emonio in the correct WiFi network? It has to be the same network the Emonio is using.
- Did you specify the correct name of the device? (e.g.: http://emonio-xxxxxx.local)
- Did you rename your device and need to input your user-configured name (e.g.: http://generator_4.local?)
- Some router (e.g. Fritz!Box) need a different domain name instead of the .local suffix. For Fritz! box networks try to use the suffix:".fritz.box". (e.g.: http://emonio-xxxxxx.fritz.box)
- Did you use the 'guest network' of your router ? Usually network traffic is not routed between the 'guest network' and the 'normal' WiFi network.

12.5. No data seen on the web interface

- In some cases (commonly after a firmware update) you might notice empty fields where the values of voltage, current, etc. should be shown. This is due to caching problems with the browser.
  Try to force a complete refresh of the website by either manually emptying the cache of the

browser or by using one of the following key combinations to reload the page, ignoring the cache:

- Firefox/Safari:[Shift] + button ‘refresh’
- Google Chrome/IE/Edge/Opera: [Strg] + [F5]

12.6. No function (all LEDs stay off)

- Check for the correct power supply of the device. Important are only the voltage inputs for the Neutral line (9) and Phase 1 (10).
- If the power supply is given and in the correct range it might be that the internal fuse got triggered. This could happen if for example the input of the Neutral line (9) was accidentally connected to a phase and thus the device was powered with 400V instead of 240V. In that case the fuse will break to protect the device from harmful overvoltages.

  The fuse is a special super-fast multimeter-fuse with a greatly enhanced breaking capacity of minimum 30kA. You can find replacement in our webshop at: https://shop.emonio.de

13. Technical specifications

Data acquisition:	14.000 samples/sec.
Operating voltage (between neutral and phase A):	~100-240V 50/60Hz
Input level for current inputs:	±0.125V - ±0.5V
Supply voltage for active current sensors (Rogowski coils):	5V DC, max. 100mA
Power consumption (max/typical):	12.0W / 1.5W
Input voltage for voltage sensors:	240V phase <==> neutral 400V phase <==> phase
Working conditions:	-5°C to 60°C; 85% RH
Weight (without accessories):	215g
Dimensions of housing (w x d x h):	117x85x34mm
Overvoltage category:	CAT III 600V
IP code:	IP40

13.1. Absolute maximum values

These figures represent the maximum input level that the device can withstand without damage. However, correct measurements or normal operation under these conditions is not advisable.

Operating voltage:	~90V-264V
Input level for current sensors:	±6V
Input level for voltage sensors:	275V against neutral 475V phase <==> phase

13.2. Measurement uncertainty

The specified accuracy refers to loads between 2% and 100% of the maximum amperage. All devices are factory calibrated and tested for at least 24h. Only devices which will comply with the tolerances below are shipped.

Voltage:	+/- 1%
Current:	+/- 1%
Power:	+/- 1%
Apparent power:	+/- 1%
Reactive power	+/- 3%

13.3. Manufacturer

B.E.I. - Berliner Energieinstitut GmbH
Zionskirchstr. 13
10119 Berlin, Germany

www.berliner-energieinstitut.de
shop@berliner-energieinstitut.de
+49 30 5228 1575

berliner energieinstitut

CE Declaration of conformity

In accordance with directive 2014/53/EU and 2011/65/EU of the European Parliament and the council of 4/16/2014.

We hereby declare that the designated product below corresponds in its design and construction with the essential health and safety requirements and the directives stated below. Any unauthorised changes to the said product will cause this declaration to lose its validity.

The sole responsibility for issuing this declaration is carried by the manufacturer.

Product model: Emonio P3

Manufacturer: B.E.I. - Berliner Energieinstitut GmbH
Zionskirchstr. 13
D-10119 Berlin

Object of declaration

Compliance with the following guidelines is given:

- Radio Equipment Directive (RED or RTTE) 2014/53/EU from 4/16/2014
- Low Voltage Directive 2014/35/EU from 2/16/2014
- Electromagnetic Compatibility 2014/30/EU from 2/26/2014
- RoHS2 Directive 2011/65/EU from 7/8/2011

Applied harmonised standards and specifications:

- DIN EN 300328:2017-02 - Broadband transmission systems - Data transmission equipment in the 2.4GHz ISM band working and using wide band modulation techniques
- DIN EN 61010-1:2011-07 - Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
- DIN EN 61326-1:2013-07 - Electrical equipment for measurement, control and laboratory use - EMC requirements
- DIN EN 50581:2013-02 - Technical documentation for the assessment of electrical and electronic equipment with regard to the restriction of hazardous substances

Berlin, 1/24/2017
Place and date of issue

David Eitzinger, CEO
Name, position, signature of authorised person