

WATROUTER MX - USER MANUAL

FOR MODELS:

WATROUTER MX (WRMX 01/08/17 AND WT 02/10)
WATROUTER MX 100A (WRMX 01/08/17 A WT 03/11)

HOW TO FIT AND SETUP THE DEVICE

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GENERAL INFORMATION

WATTrouter Mx is a programmable controller to optimize self-consumption of energy produced by photovoltaic or wind power plant (hereinafter referred to as PV-plant). It is a smart home energy management system. After correct installation and configuration, the controller perfectly optimizes self-consumption of energy produced by your PV-plant. WATTrouter Mx consists of a current sensing module and the regulator itself.

WATTrouter Mx has the following features:

- Three-phase indirect current measurement.
- Single phase detection of voltage necessary to determine the power direction in phase L1, for other phases it is determined by software.
- Evaluation of active power outputs in individual phases, necessary to determine the surplus of produced electric power.
- Regulation based on the sum of power outputs (summary surplus) from all three phases or based on surplus in each phase.
- Switching for up to 8 outputs (2 relays and 6 external solid state relays SSR) based on configured priorities.
- Optimal use of surplus energy produced by PV-plant on SSR outputs through the application of proportional synchronous regulation of resistive loads, compliant to European standards EN 61000-3-2 and EN 61000-3-3. This regulation modulates connected load's power exactly according to the available surplus energy.
- Very short average dynamic response of the controller (up to 10 s)
- Optional CombiWATT function used for switching loads under a combined mode where energy is taken both from PV-plant and public grid (especially suitable for water heating and also for swimming pool filtering system).
- Input for low tariff signal (nightly low price electricity) for CombiWATT. This is for households where double tariff rates will apply.
- 4 multi-purpose ANDI inputs for connection of external current transformers, impulse outputs of external energy meters, and analog temperature sensors of type NTC or PT1000.
- DQ input to connect up to 4 digital temperature sensors of type DS18x20.
- Separated current sensing module and regulator for easy installation into existing household wiring.
- WATTconfig software designed for Microsoft Windows, Linux and MAC OS X, provides comfortable controller configuration and monitoring via USB, Ethernet or RS485 interfaces.
- Integrated web interface allows comfortable controller configuration and monitoring using regular Internet browser.
- Real-time module backed with a lithium battery for advanced management of outputs and CombiWATT function.
- S-Connect protocol for sharing devices over existing network or wireless infrastructure.
- Daily, weekly, monthly and annual statistics.
- Integrated MicroSD card.

- Firmware update.

DESCRIPTION OF BASIC FUNCTION

The current sensing module measures electric current in real time and on all phases. The regulator evaluates the measured electric currents and if it determines the available surplus energy produced by the PV-plant, it will switch on connected loads according to adjustable priorities, while constantly trying to maintain zero energy flow through the current sensing module, the so called "virtual zero" (the sum of active power outputs on all three phases = 0) or optionally, on each phase separately, so called "phase zero".

Switching according to priorities is done in the following way:

By default (during night), all loads are turned off. If surplus energy generated by PV-plant is determined in the morning, the output with the first (highest) priority is switched on.

The switching time is different according to selected output function.

- SSR/PWM outputs (proportional outputs) are switched on almost immediately after surplus energy is detected and the controller is gradually (synchronous control or PWM modulation) maintaining "virtual zero" or "phase zero", according to the control settings.
- Relay outputs are switched on only if the surplus energy exceeds the preset load's nominal power. Alternatively, relay outputs may be operated in "prepend" mode if there is sufficient power at any proportional output with nearest higher priority. This allows for maximum utilization of the produced surplus power even for relay outputs - refer to the "Prepend before SSRs" function.

When load with 1st priority is switched on (for proportional output it means switching on the maximum power), the system waits until the power output of PV-plant increases again (beginning of dawn). If electric production is determined even when this load is switched on, load with second priority in the same mode is switched on as well.

If the power output of PV-plant is still increasing, additional connected loads are switched on in the same mode.

If the power output of the PV-plant decreases, or if another load - not connected to the WATTrouter device is switched on, the switched (active) outputs are disconnected - again according to preset priorities but in reverse order (the load with lower priority is disconnected first).

For relay outputs there may be set a minimum switching time. If, simultaneously with a relay output the proportional output with higher priority is switched on, and the available surplus energy is reduced, then this proportional output will reduce the power output of the of the load (even down to zero) in order to maintain virtual zero or phase zero on the current sensing module, if possible.

Except for the situation specified in the paragraph above, the controller never violates the established priorities.

The above specified principle applies only to standard connection of the current sensing module, connected right behind the facility's main energy meter, so the WATTrouter device uses only the actual PV-plant surpluses (recommended settings). However, WATTrouter controller is versatile device and can be connected according to your needs. For example, you can place the current sensing module just next to the PV inverter and then you can maintain the virtual or phase zero on that line.

The above specified basic control mode may be combined with another mode of output switching, provided that low tariff signal (double tariff rate) is available (CombiWATT mode), or with switching based on preset time conditions (time schedules).



This device is not designed for precise active power measurement (it is not a replacement for a wattmeter or electricity meter). Active power is measured with sufficient precision in order to maintain all control functions.

PACKAGING CONTENTS

Contents of packaging:

1 WATTrouter Mx regulator

1 WATTrouter Mx current sensing module

1 USB cable

1 short manual with links to this manual, software and firmware updates.

SAFETY WARNING

When you receive your package, inspect the packaging unit for damages. After opening your package, inspect the regulator and the current sensing module for damages. Do not fit the regulator or the current sensing module if you see signs of mechanical damages!



Always have the regulator and the current sensing module fitted by a person with the necessary electrical qualification. It is necessary that you read this manual thoroughly and observe all safety warnings and requirements specified herein.



The regulator and the current sensing module must be fitted in a dry room without excessive dust level. The room must be protected from direct sunlight and the ambient temperature must be maintained within the range mentioned in chapter Technical specifications. Do not place the regulator or other electronic components of this system near flammable objects!



When power SSRs are connected to SSR outputs, it is absolutely necessary to fit these into a distribution box equipped with adequate heat dissipation system (with ventilation grid or vents)!



Make sure that unauthorized persons, mainly children, cannot access the location where the controller is fitted. There is a serious risk of electric shock!



Only connect outputs of the controller to electrical loads which have been designed for this operation mode and for which the manufacturer does not explicitly prohibit connection via switching element!



The manufacturer is not liable for any damages occurred due to improper fitting or operation of the device! The owner is fully responsible for operation of the entire system.

FITTING THE DEVICE

WATTrouter Mx regulator may be fitted in a regular distribution board onto a 35 mm DIN rail or attached to a wall using 2 screws with round or countersink head and with diameter up to 6 mm.

WATTrouter Mx current sensing module may be fitted in a regular distribution board onto a 35 mm DIN rail.

Measuring inputs of the current sensing module may be connected as single, double, or triple-phase connections.

The recommended maximum distance of the current sensing module and the regulator is 2 meters. Bigger distance is acceptable, but it will slightly affect the measuring accuracy.

If CYKY or other thick and hard cables cannot pass through current transformers easily, use flexible cables to extend the existing connections. When fitting the current sensing module do not press hard on it. You may damage the module.

Tip: Individual phase wires may pass through the current sensing module from either direction. The direction of currents may be configured in the control software.

To connect power supply to the regulator (L1 and N) use wires with a minimum cross-section of 0.5 mm², for example CYKY 1.5.

To connect loads to the relay outputs use wires with adequate cross-section corresponding with the power ratings of the connected loads.

To connect loads to the power SSRs again use wires with adequate cross-section corresponding with the power ratings of the connected loads.

To interconnect the current sensing module and regulator (inputs Y and ILx) use 4-wire cable with cross-section from 0.5 to 1.5 mm². If these wires are longer than 2m or are placed in a cable tray together with other power cables/wires, we recommend using a shielded cable. Similar recommendation applies for connecting external current transformers to the ANDI inputs.

To interconnect power SSR control inputs and/or 0-10VDC control signals with SSR outputs use wires with cross-section from 0.5 to 1.5 mm². If these wires are longer than 2m or are placed in a cable tray together with other power cables/wires, we recommend using a shielded cable.

To interconnect S0 impulse signals from external energy meters with ANDI inputs use 2-wire cable with cross-section from 0.5 to 1.5 mm², connected between GND and respective ANDI terminal. If these wires are longer than 2m or are placed in a cable tray together with other power cables/wires, we recommend using a shielded cable.

To interconnect analog temperature sensors with ANDI inputs use 2-wire shielded cable with cross-section from 0.5 to 1 mm², connected between GND and respective ANDI terminal.

To interconnect digital temperature sensors of type DS18x20 to DQ bus use 3-wire shielded cable with cross-section from 0.5 to 1 mm², connected between GND (ground), +5V (power supply) and DQ terminal (data bus). When connecting other sensors to the DQ data bus always connect shielding. Total length of the bus including all branches should not exceed 50m.

Connect shielding of all shielded cables to the GND terminal as close as possible to the regulator.

If you use shielded cables then use for each type of signal a standalone shielded cable, i.e. do not mix signals from analog and digital sensors in one cable, especially when making the cables longer. There might be crosstalk which will decrease measurement accuracy.

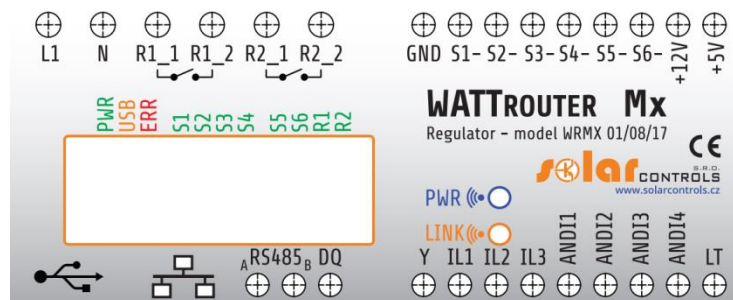


Figure 1: Connector and LED description (top view).

Regulator terminals - description:

Top left terminal block (**this only accepts voltage from public grid!**):

- L1 – regulator power supply and voltage detection L1, 230VAC/50Hz (must always be connected)
- N – neutral wire (must always be connected)
- R1_1 – relay output 1 – terminal 1
- R1_2 – relay output 1 – terminal 2
- R2_1 – relay output 2 – terminal 1
- R2_2 – relay output 2 – terminal 2

Top right pluggable terminal block:

- GND – signal ground
- S1- – external output for SSR 1 – negative electrode (open collector)
- S2- – external output for SSR 2 – negative electrode (open collector)
- S3- – external output for SSR 3 – negative electrode (open collector)
- S4- – external output for SSR 4 – negative electrode (Sallen-Key filter)
- S5- – external output for SSR 5 – negative electrode (Sallen-Key filter)
- S6- – external output for SSR 6 – negative electrode (Sallen-Key filter)
- +12V – external SSR outputs – common positive electrode (+12V with respect to GND)
- +5V – power supply for digital temperature sensors DS18x20 (+5V with respect to GND)

Left bottom communication connectors:

- USB – USB interface connector (USB B)
- LAN – Ethernet interface connector (RJ45, 10/100 Mbit/s)

Left bottom pluggable terminal block:

- RS485 A – non-inverting RS485 line
- RS485 B – inverting RS485 line
- DQ – data bus for digital temperature sensors of type DS18x20

Right bottom pluggable terminal block:

- Y – common wire coming from the current sensing module (must always be connected)
- IL1 – electric current measuring input L1 from the current sensing module (must always be connected)
- IL2 – electric current measuring input L2 from the current sensing module
- IL3 – electric current measuring input L3 from the current sensing module
- ANDI1 – multi-purpose ANDI 1 input
- ANDI2 – multi-purpose ANDI 2 input
- ANDI3 – multi-purpose ANDI 3 input
- ANDI4 – multi-purpose ANDI 4 input
- LT – low tariff signal detection (0V or +5V)

LED description:

- PWR – regulator power on light (green)

- USB – communication light - USB interface (yellow)
- ERR – error status light (red)
- S1– external output for SSR 1 - activity indication light
- S2– external output for SSR 2 - activity indication light
- S3– external output for SSR 3 - activity indication light
- S4– external output for SSR 4 - activity indication light
- S5– external output for SSR 5 - activity indication light
- S6– external output for SSR 6 - activity indication light
- R1– relay output No. 1 - activity indication light
- R2– relay output No. 2 - activity indication light
- RJ45 connector – Ethernet connection indication light (left yellow LED – carrier frequency, right green LED - connection speed)
- Wireless PWR – SC-Gateway power LED (optional accessories)
- Wireless LINK – SC-Gateway link LED (optional accessories)

Other connectors:

- Micro SD – slot with integrated MicroSD card

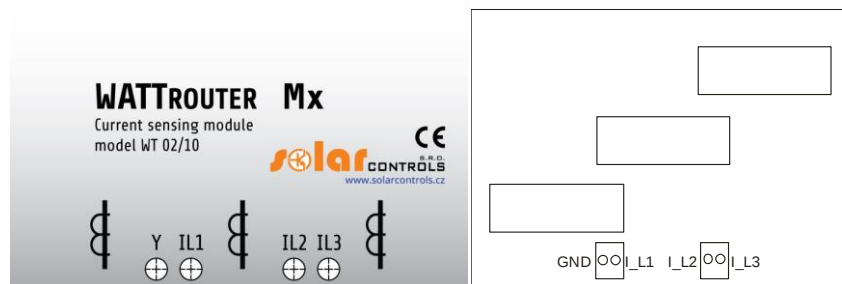


Figure 2: Connection terminals of current sensing module WT 02/10 (for WATTrouter Mx) and WT 03/11 for WATTrouter Mx 100A. The GND terminal of the WT 03/11 module must be connected to the Y terminal of the controller.

Current sensing module terminal description (the terminals are described directly on the motherboard of the Mx 100A module):

- Y – common wire (must always be connected), on the WT 03/11 module it is marked as GND.
- I_L1 – current measuring output L1 (must be always connected)
- I_L2 – current measuring output L2
- I_L3 – current measuring output L3

Connect the controller according to sample connection diagrams shown on figures below. If you observe basic principles, connections may be combined in various ways. You may connect any number of loads to any outputs; in certain cases you may remove certain phase cable from the measuring, etc.

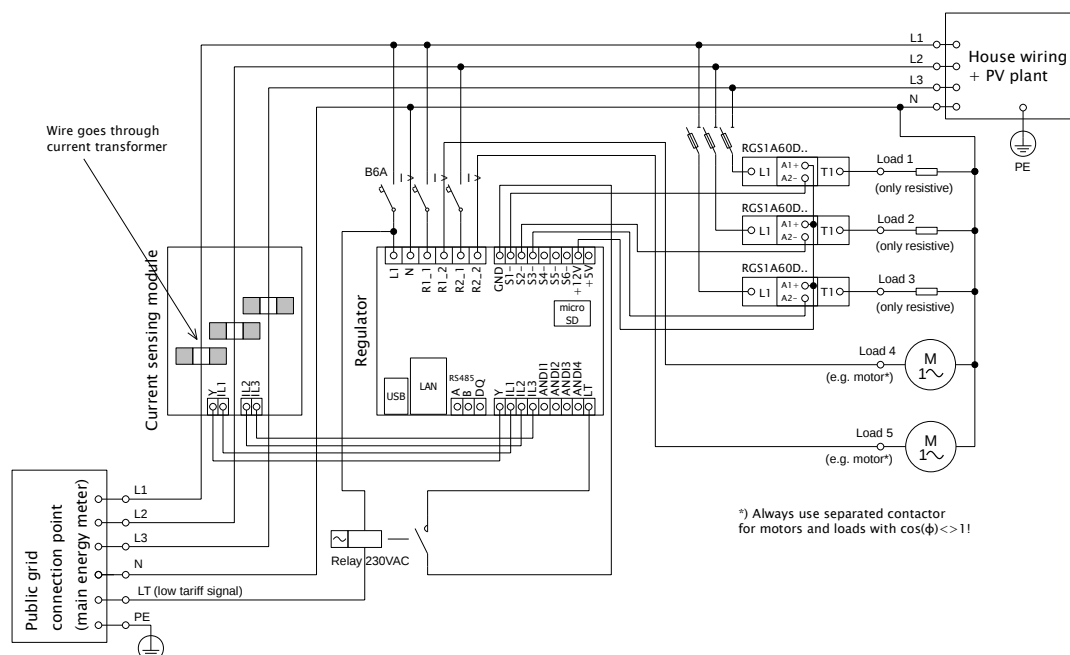


Figure 3: Three-phase connection with low tariff signal circuit for CombiWATT mode, or time schedules. Current sensing module is placed at the facility's supply cable coming from the distribution box where main energy meter is located. The connected loads use only real surpluses produced by PV-plant. 5 loads are connected, 3 of them through the recommended SSRs, RGS1A series manufactured by Carlo Gavazzi.

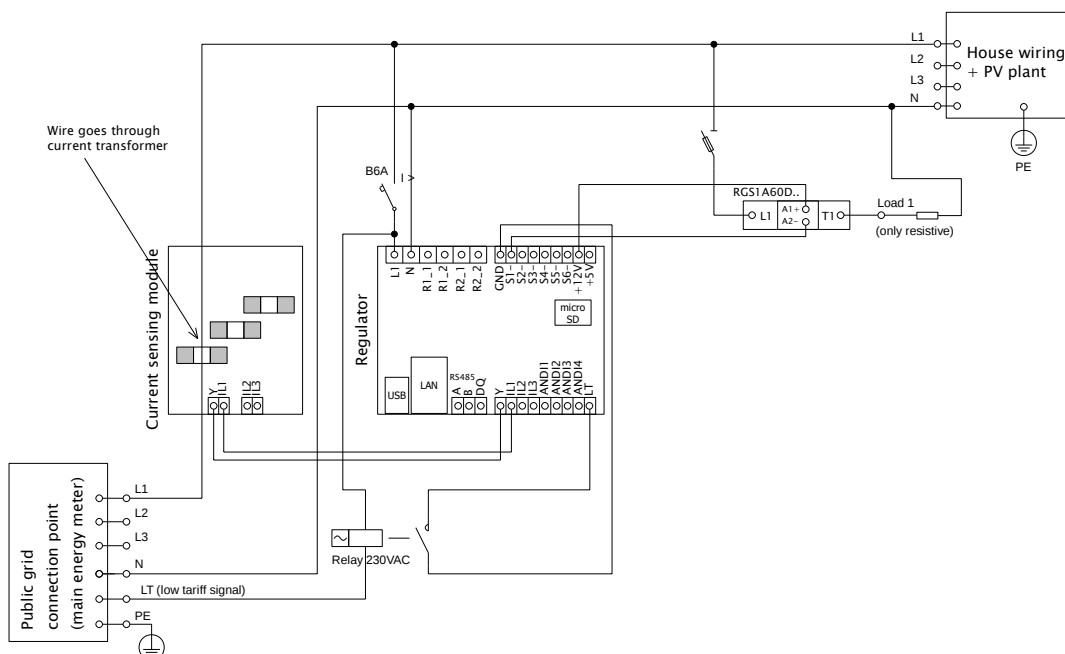


Figure 4: Single-phase connection with optional low tariff signal circuit for CombiWATT mode, or time schedules. Current sensing module is placed at the facility's supply cable coming from the distribution box where main energy meter is located. The connected loads use only real surpluses produced by PV-plant. Only 1 load is connected through the recommended SSR, RGS1A series manufactured by Carlo Gavazzi.

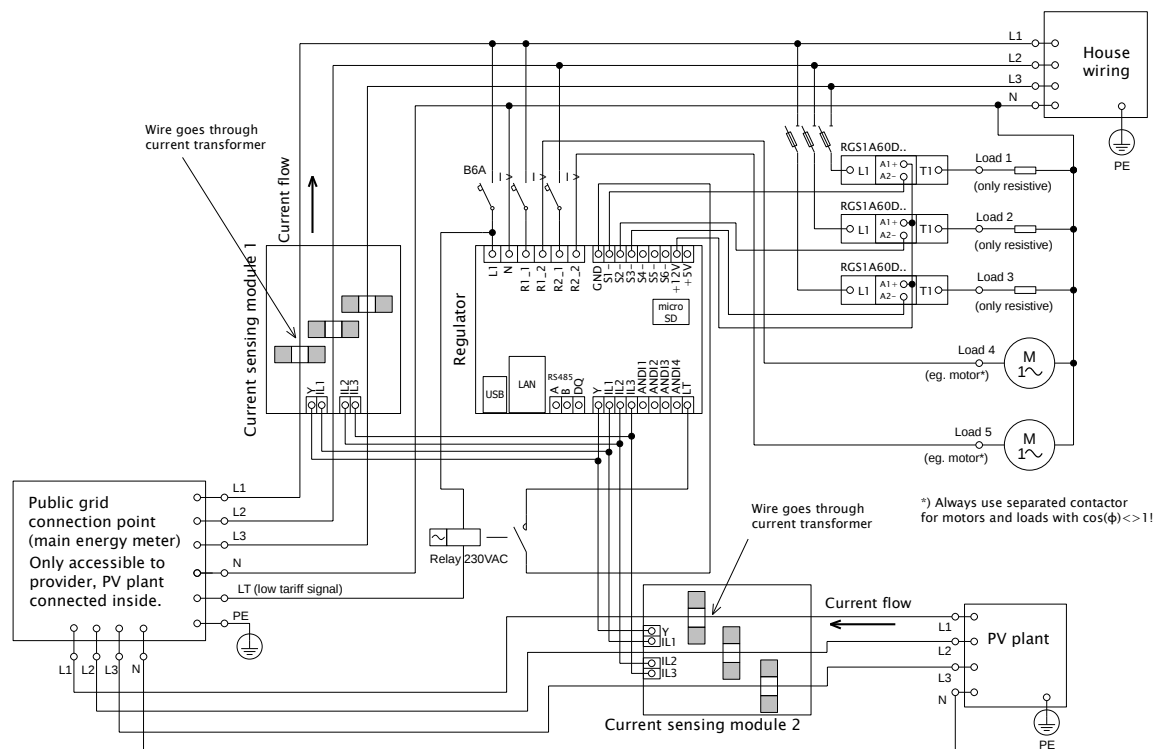


Figure 5: Three-phase connection with 2 current sensing modules and with low tariff signal circuit for CombiWATT mode, or time schedules. This connection is necessary if the PV-plant output is connected directly to a sealed distribution box, accessible only to the electricity provider. This may be the case for PV-plants made originally only for feed-in tariff, without self-consumption possibility. Current sensing module 1 is connected to the household wiring branch; current sensing module 2 is connected to PV-plant branch. The accuracy of measurement is reduced down to $\pm 10\%$ in this connection because of the finite impedance of current transformer secondary winding. **Caution: Current flow through current sensing modules must always be subtracted in this connection (marked with arrows on the picture). The same phase sequence must be observed in the regulator and in both current sensing modules!**

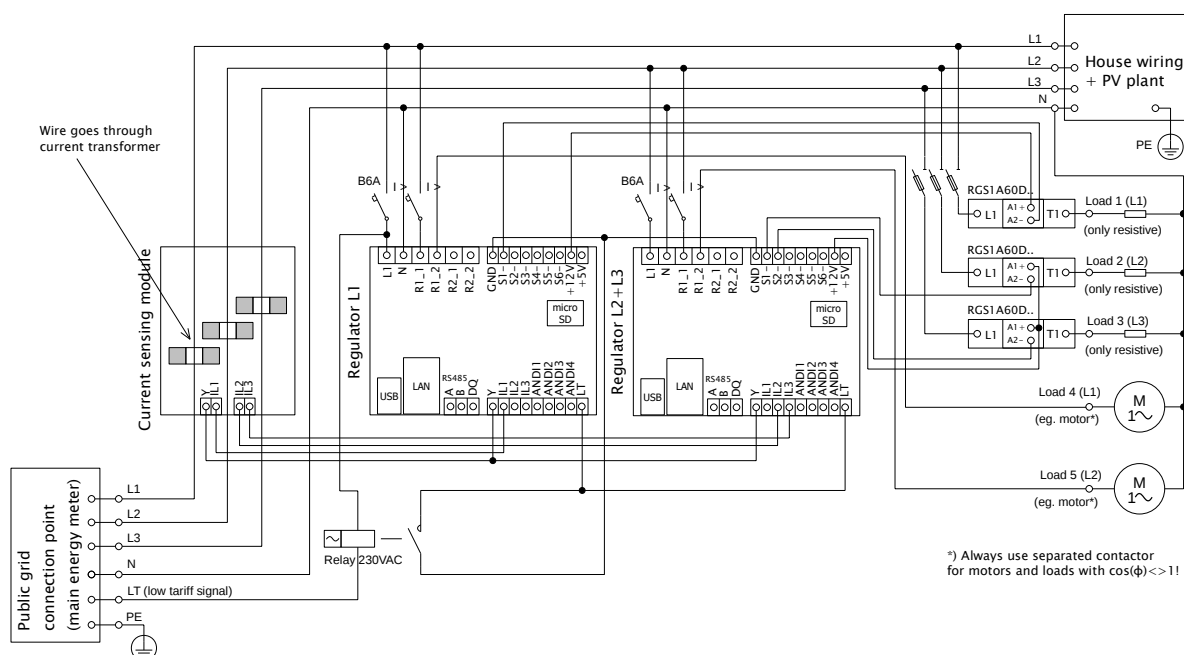


Figure 6: Three-phase connection of WATTrouter Mx with 2 regulators and with low tariff signal circuit for CombiWATT mode, or time schedules. Using this connection you may extend the number of outputs up to 16. Current sensing module is placed at the facility's supply cable coming from the distribution box where main energy meter is located. Connected loads use only the actual surpluses

produced by PV-plant. To make things simple, again only 5 loads are connected, but you may use all 16 outputs. Similarly, you may also connect 3 regulators to 1 current sensing module. In such scenario, each regulator works on one phase and you will get 24 outputs.

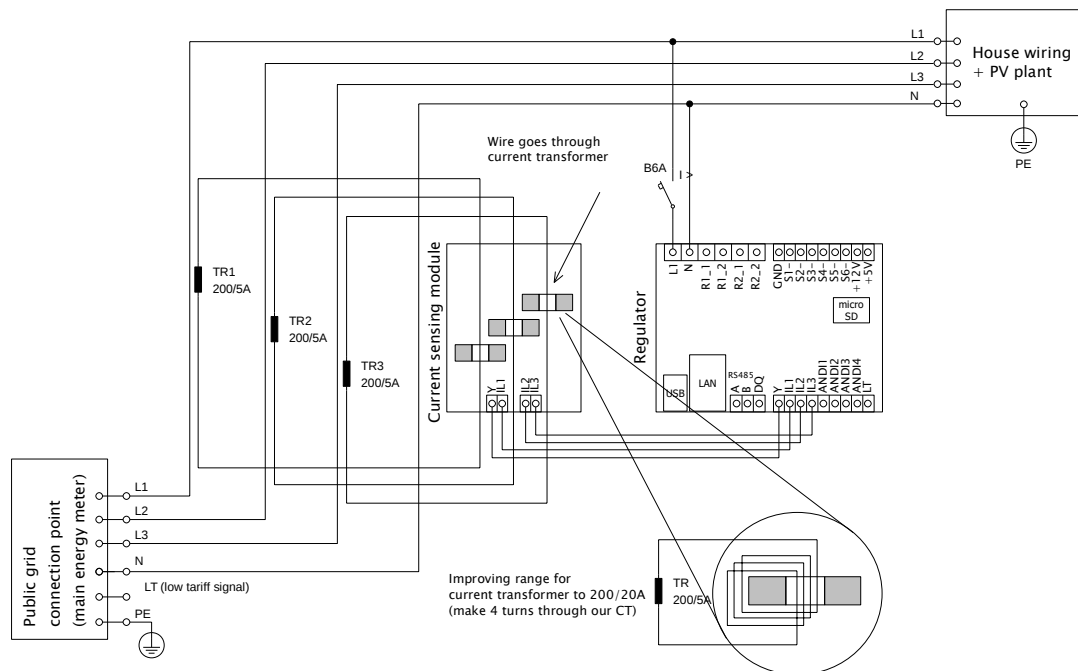


Figure 7: Increasing of current measurement range of the device for facilities where main circuit breaker is larger than 3x40A. Transformers 200/5A, or even 400/5A may be used, based on the main circuit breaker value. Secondary coil of current transformers is shorted through the current sensing module (the secondary circuit passes through measuring transformers in the current sensing module). Additional increase of current measurement range may be done if you take the secondary circuit of the current transformer and make several turns through the measuring transformer in the current sensing module (for transformers 200/5A, the best option is to make 4 turns in order to reach optimum transfer ratio 200/20A). For this purpose we recommend using lines, which are not overrated for the nominal secondary current, just to be able to make more turns through the hole of measuring transformer. When connected through external current transformers, the conversion ratio must be set correctly in the control software - see the item Conversion ratio of external CT's in the main window of the WATTconfig software.

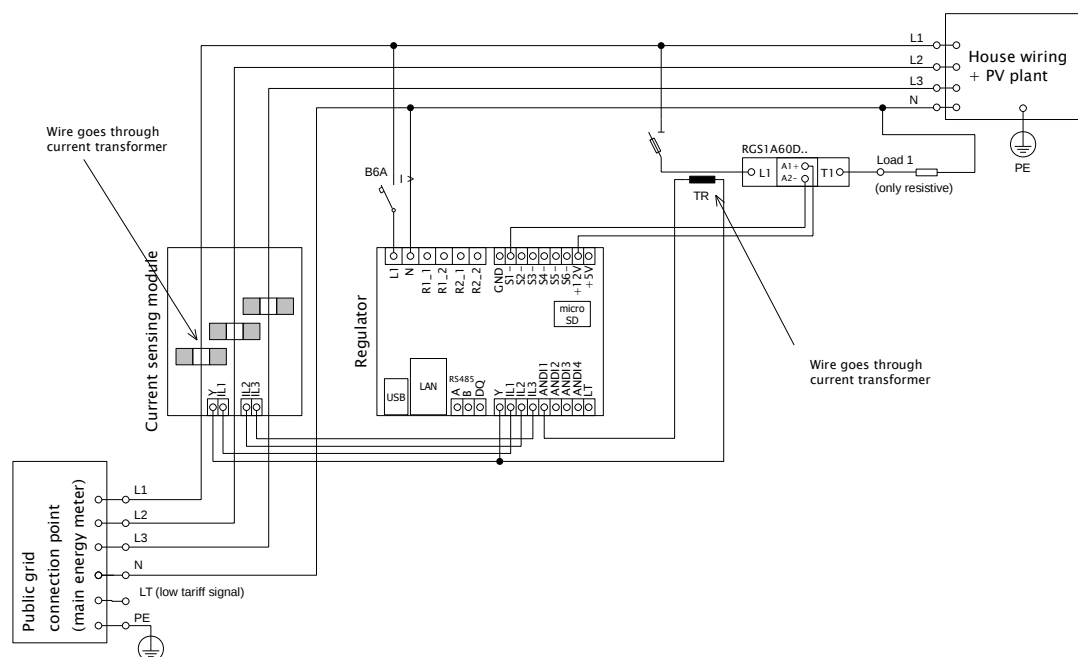


Figure 8: Connection of an external current transformer (marked as TR, this may be another current sensing module or other compatible current transformer) to measure the current flow through the appliance. The secondary transformer circuit is connected between the Y terminal and any ANDIx input, which must be configured correctly in WATTconfig. In this example, ANDI1 function must be set to power measurement and the Measurement Source option must be set to SSR1. It is also possible to use an external impulse output meter and connect this output to the ANDI input, which must then be set to the S0 pulse counter function.

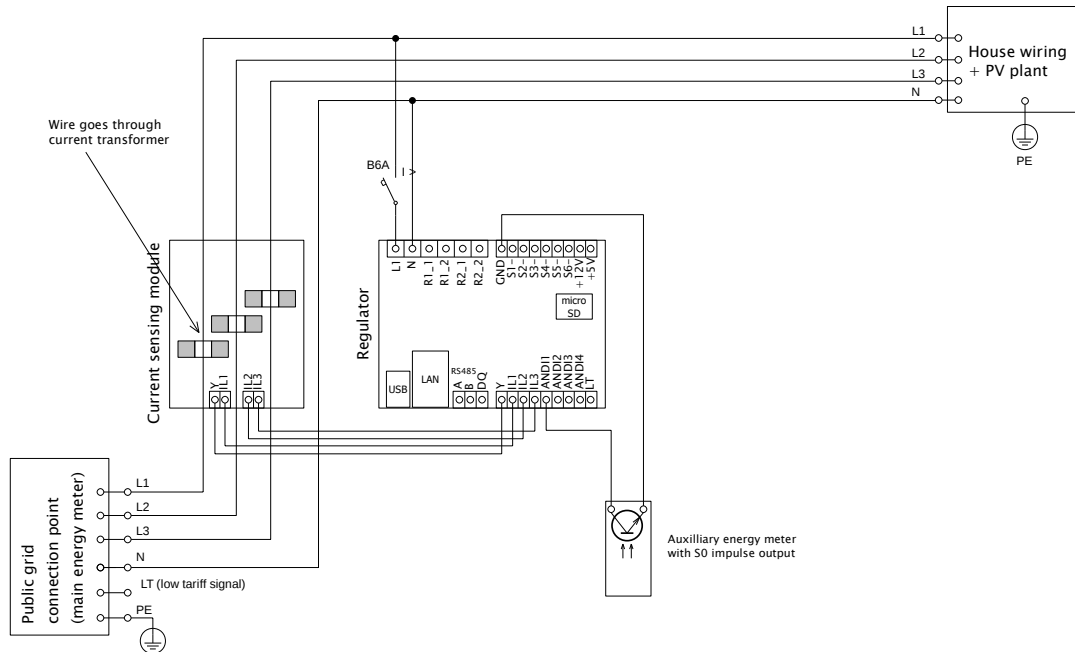


Figure 9: Connection of external meter with S0 impulse output. The meter can measure, for example, the energy produced from the PV plant. The S0 output of the meter is connected between the GND terminal and the ANDIx input, which must be further configured correctly in WATTconfig. In this example, the ANDI1 input must be set to the S0 pulse counter function, and the Measurement Source option must be set to one of the Lx items if the meter measures the PV power produced.

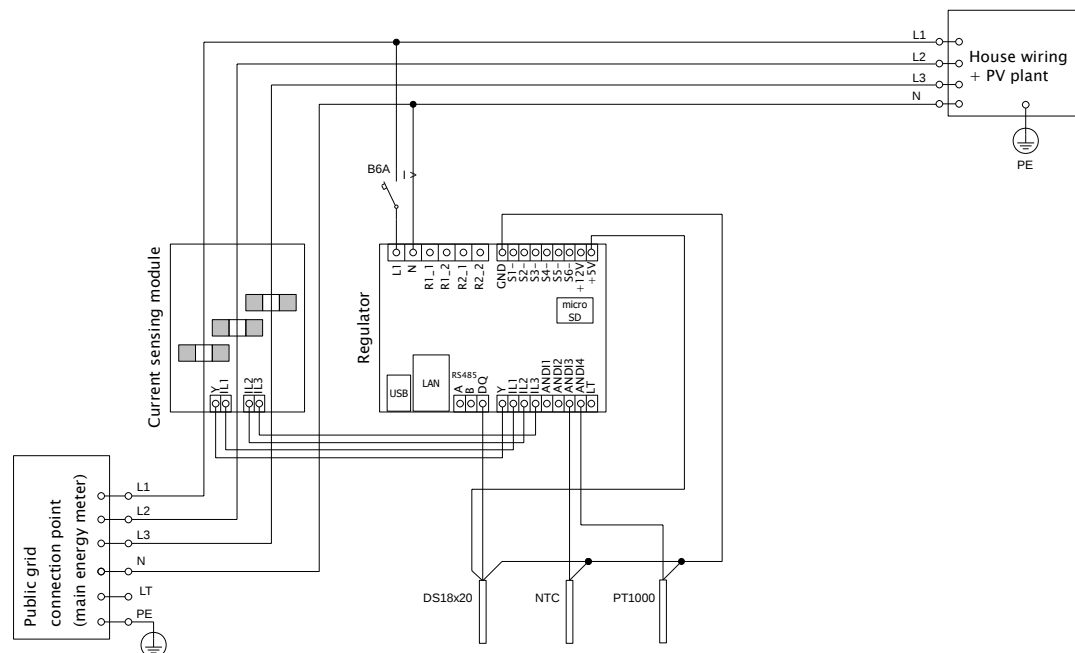


Figure 10: Connection of supported types of temperature sensors to the regulator. The DS18x20 digital sensors are connected three-wire to the GND, DQ and +5V terminals, analog sensors are connected two-wire between the GND terminals and the corresponding ANDIx input, which must be correctly configured in WATTconfig. In this example, ANDI3 must be set to NTC and ANDI4 to PT1000.

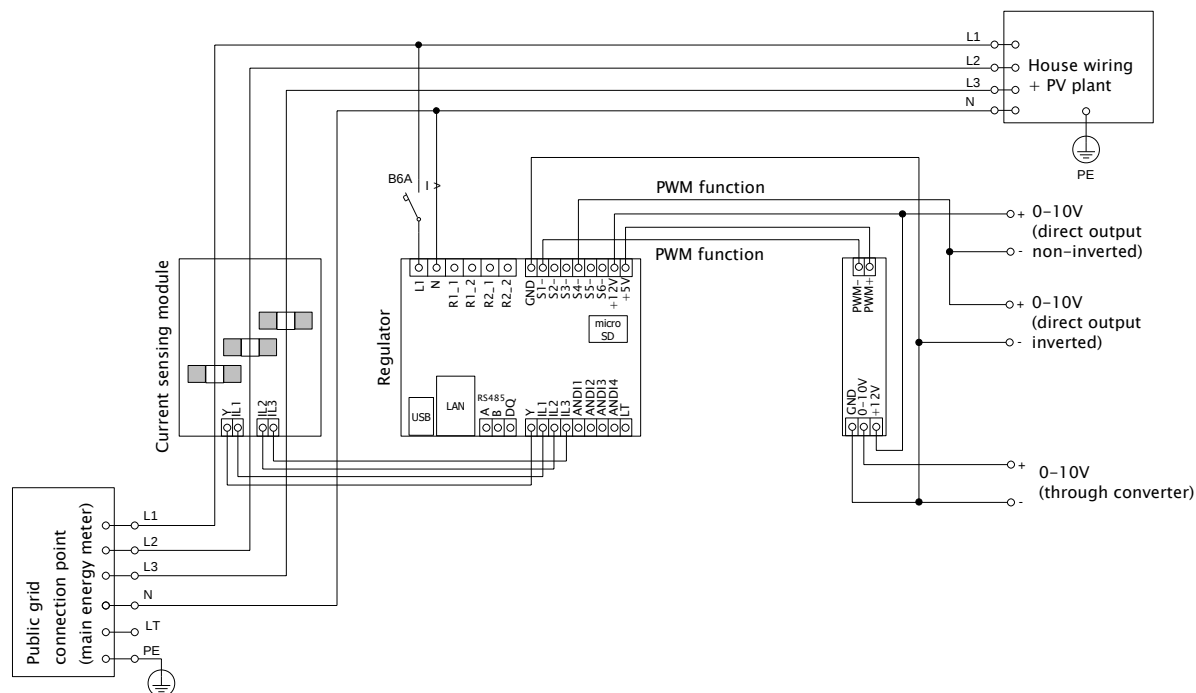


Figure 11: Example for 0-10V signal output from the regulator. The corresponding SSR outputs must be set to the PWM function, and the desired PWM modulation frequency must be set. The outputs SSR 4 to 6 generate the desired signal directly (but the signal may have a significant output ripple at slow PWM modulation), the output voltage further depends on the “inverted” option for given output. SSR outputs 1 to 3 generate only PWM, so you must use external PWM/0-10V converter to get the desired signal. In the picture, the PWM/0-10V converter is powered from the controller, but it can of course be powered from external source (e.g. from controlled device), which then guarantees galvanic (optical) isolation between the controller and controlled device (in case the used PWM/0-10V converter has optically isolated input and output).

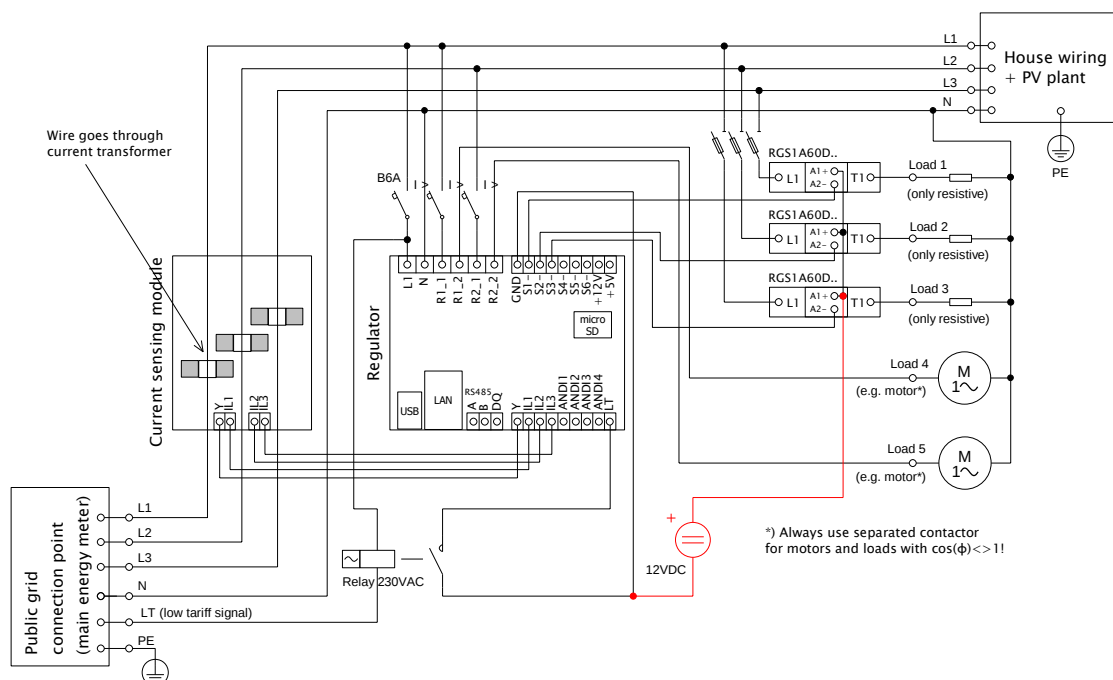


Figure 12: Connection of positive SSR anodes (typically A1+) to an external DC source +12V when the internal power supply of the controller is heavily loaded. SSR control circuit can be normally powered by +12V or +5V terminals. We recommend the +12V (must be used if the control voltage >5V is required). However, using the two built-in relays, the voltage at the +12V terminal can drop to +8V and will not fully drive the SSR 4 to SSR 6 outputs in the PWM / 0-10V function, and some of the built-in relays does not need to be

switched on. In this case, connect all SSRs to an external power source as shown in the figure. Firmware since version 1.5 already checks the voltage drop at + 12V terminal and also enables software optimization of the built-in relay consumption. For details, see chapter Measured parameters and statuses and chapter Other settings tab.



The controller may be connected only to 230VAC, 50 Hz public electric grids. Regulator must be protected with a circuit breaker - recommended rating is B6A - and connected loads must also be adequately protected! Installation may only be done when the facility's main circuit breaker is turned off!



Upon completion of the installation process make sure to check thoroughly the connection of the regulator and the current sensing module. Also check connection of all pluggable terminal blocks, where **NO** power grid voltage or voltage outside of tolerances specified in the chapter Technical specifications may be connected! **NO** other than resistive (heating) loads may be connected to power SSRs! Regular relays **CANNOT** be connected to SSR outputs! It is prohibited to connect loads with higher than the maximum allowed nominal power! If you fail to observe these rules it is almost guaranteed that you will damage the regulator and lose your warranty!



For the correct operation of the controller, it is absolutely necessary to ensure proper phasing of the measured currents with the internal voltage detector. This can be done by selecting the appropriate phase in the Input Settings tab. It is strongly recommended to connect the controller so that the phase conductor fed to terminal L1 corresponds to the phase conductor wired through the measuring transformer corresponding to the IL1 input, which will allow the measurement to match the default settings of the controller (and therefore the same as required for older models). The IL2 and IL3 current inputs can be connected arbitrarily, the respective phases for these inputs must be set up correctly in the WATTconfig control software.



We strongly advise you to protect your loads connected to the power SSRs with fuses suitable for protection of semiconductors, rather than regular circuit breakers. Please note that SSRs damaged by overcurrent or short-circuit most likely cannot be claimed under warranty. Make sure that solid state relays are correctly connected, as required by their user manual.



No electronic devices (various measuring and protective elements, such as sub-meters and residual current circuit breakers) may be installed between the SSRs and the appliance, since they may be damaged by impulse power! Always install these devices on the line between the fuse and the solid-state relay where constant power is available.



If your facility is located in an area with higher risk of overvoltage spikes due to atmospheric discharge (lightning), we strongly recommend fitting a suitable overvoltage/lightning protection between the distribution box with the main energy meter and the current sensing module!



If any sensors are connected to the ANDI multi-purpose inputs, it is imperative to properly configure their function, otherwise these and/or even the ILx inputs may not work properly!



The current sensing module supplied with the WATTrouter Mx controller is fully compatible with the current sensing module supplied with older types of WATTrouter CWx, WATTrouter CWx SSR, WATTrouter ECO, WATTrouter M and vice versa. The current sensing module installed with these controllers can be used with the WATTrouter Mx controller (and vice versa). **However, please note: The terminal marked GND for these older measuring modules must be connected to the Y terminal of the Mx controller, not to the GND terminal!**



If the regulator is constantly connected to PC via USB interface (mostly if long cable is used), we strongly recommend using an USB isolator!

Note: It is allowed to connect only pure resistive loads to power SSRs. These loads cannot be fitted with own electronic control system nor with built-in motors (e.g. fans - see the note below). These loads may only have regular mechanically controlled thermostats and indication LEDs or neon lamps. Almost any regularly produced boilers, immersion heaters, infra radiators, heating floor pads, motor-free dryers (infra dryer), oil heaters, cartridge heaters in a solar tanks, etc. may be used.

Note: Each SSR output is capable of providing power to heating loads with built-in fan for longer time (such as hair dryer, heat radiator). These loads are fitted with a built-in thermal protection, which, if synchronous SSR control mode is used for that load, will disconnect the load for low power of SSR output (in this scenario, the built-in fan's power is not sufficient to cool down the heating element of the load). Therefore, consider fitting these loads to SSR outputs carefully.

Note: Heating loads connected via residual-current circuit breaker may be connected to SSR outputs.

Note: Heating loads with nominal power up to 2 kW may be connected to relay outputs directly, without using external contactor.

Carefully examine connection of the controller and then turn off all circuit breakers and deactivate fuse switches for connected loads. Then turn on the main circuit breaker and the regulator circuit breaker (L1 power supply). The LED PWR lights up (power on indication). If the light is off, or if it does not shine permanently, or if the LED ERR starts to flash (error status), proceed according to instructions specified in the Troubleshooting chapter. In default status no output is active and therefore, no load will be turned on.

Now the controller is fitted and ready for configuration.

INSERTING THE SC-GATEWAY OR SC-ROUTER MODULE

The SC-Gateway module is an optional accessory that provides wireless communication with wireless end-points. Insert the module to sockets in the regulator according to the images below. Before insertion you must lift the regulator cover with a small screwdriver or similar tool.



Make sure the regulator is turned off before inserting the module!



Keep the proper orientation of the module. Reverse orientation can damage the module!
Insert the module gently, without unusual force!

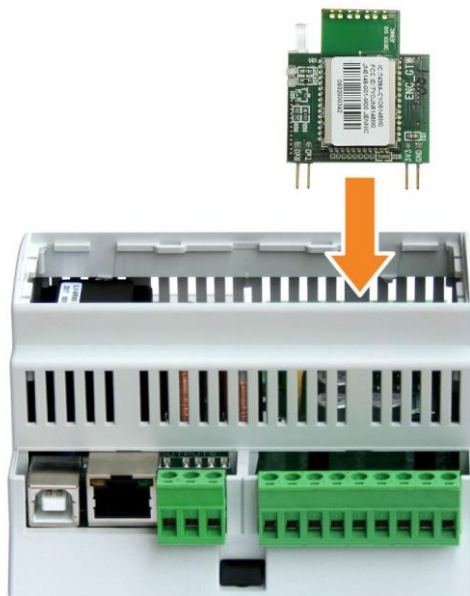


Figure 13: Insert the module to sockets on regulator mainboard, use vertical movement as the arrow indicates.



Figure 14: Resulting position of the module inside the regulator.

After regulator power on, the blue LED on the module must indicate the module initialization sequence, refer to chapter LED Statuses. In case that does not happen, refer to chapter Troubleshooting.

DEVICE CONFIGURATION

You will need notebook or regular PC (placed closely enough to the regulator) with USB interface (hereinafter referred to as a computer only). The controller is configured using the WATTconfig Mx control software. The installation package for this software is available on manufacturer's web pages. Before installing the WATTconfig Mx control software you need to install the driver for USB interface.



In order to connect to the USB interface, it is necessary - due to safety reasons - to turn off the entire distribution box before manipulation.

Tip: After you configure Ethernet network connection you may perform all settings including firmware update over the Ethernet interface. You do not need to use the USB interface at all, provided that the parameters of the connected LAN are the same as the default controller parameters (see below), and if there is no conflict between IP addresses or conflict between physical MAC addresses.

Tip: The controller can be monitored and configured via the RS485 interface using the WATTconfig Mx software. An appropriate USB/RS485 converter is required to connect to this interface using a PC. The RS485 interface is reserved for various other protocols (such as MODBUS RTU) which might be implemented in future.

If you cannot continue with the settings (due to any reasons), proceed according to instructions specified in the Troubleshooting chapter.

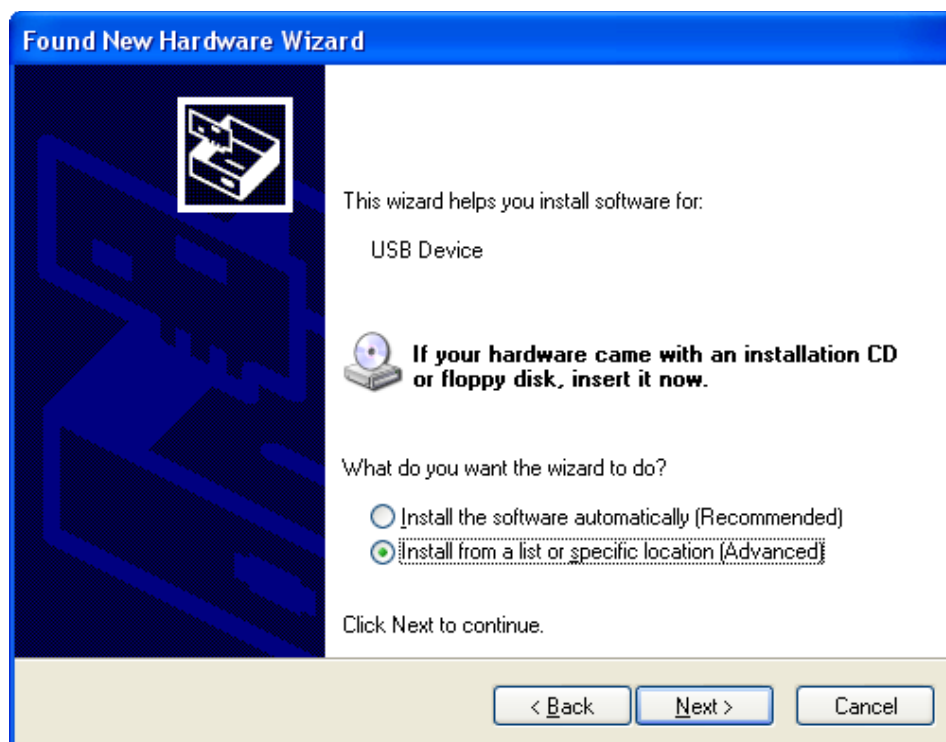
USB DRIVER INSTALLATION

The installation procedure is described for Windows XP, English locale. The procedure is similar for newer systems, or it is much simpler. Newer operating systems (Windows, Linux and MAC OS) usually have these drivers pre-installed; hence you can skip following sections.

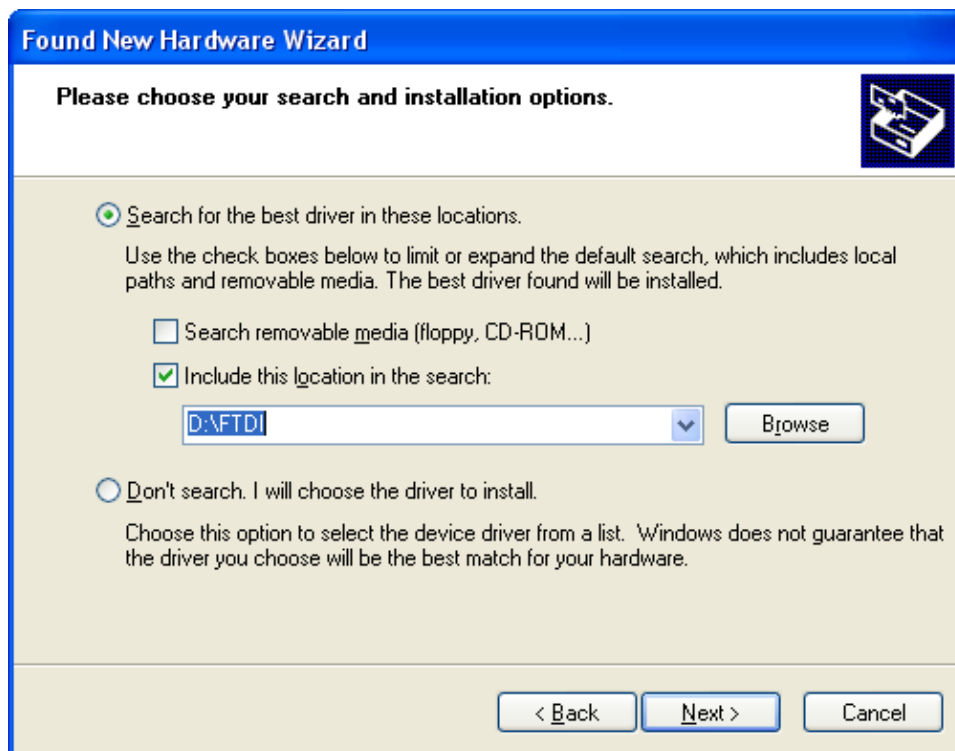
1. Insert the attached USB cable to the USB connector of the regulator and then to the computer.
2. Turn on the controller. The green LED PWR must light up (power on indication). Also the yellow LED USB light will or should flash briefly (communication process indication) as the USB device will start to register in your computer.
3. After a moment, following window must appear confirming that a new device was found:



4. Select: No, not this time. In the following window select: Install from a list or specific location (Advanced).



5. Select the path to the driver file:



6. The driver has been installed successfully, if this window appears:



7. During the installation there might appear a warning about an invalid digital driver signature. Just ignore it. The device is registered in your system device manager as USB serial converter (menu Universal Serial Bus Controllers)
8. You must perform the same installation process for the second USB serial port device.

WATTCONFIG MX CONTROL SOFTWARE INSTALLATION

1. Turn on the PC.
2. Run WATTconfig_Mx_Setup_x86_64.exe.
3. Follow the on-screen instructions.

SETTING UP MAIN FUNCTION

1. Click on START button in your PC and run the WATTconfig Mx control software. The system will display the main software window.
2. Make sure that the controller is turned on and connected to your computer. Make sure that USB interface driver is correctly installed.
3. Select USB interface connection mode (field next to the "Connect" button).
4. Select correct port for connection. This can be done in the dropdown menu Port in USB/COM driver configuration window, which will show up by clicking on button Configure connection.
5. Click the "Connect" button. The controller should be now connected and the connection indicator (a stripe) should be displayed in green. If it is not, and the system displays an error message, wait until the USB driver is ready for use in your PC, or inspect the settings in the USB driver configuration window. You may display the window by pressing the Configure button.
6. After establishing successful communication, you should be able to see the current measured values (power outputs on individual phases, etc.). No outputs should be active ("unused" priority). Also no time schedules should be used.
7. Now you can configure measuring inputs. This can be done on the "Input settings" tab. First, you set the phase sequence and then the direction of current flows through the current sensing module.
 - a. **Setting up phase sequence:** Turn off the PV-plant and turn on a resistive load on each phase which will be involved in the measuring process. The system will display measured active power on each individual phase. For now, you may ignore the signs of the measured power values. Now, in the Phase field select corresponding phase, based on the actual status recognized by the controller, and press Write button. The configuration will be saved in the controller. If the output values measured on individual phases differ too much from the reality, change the phase for given input and again press the Write button. Repeat these steps for all 3 inputs IL1, IL2 and IL3 until all measured powers are displayed correctly.
 - b. **Setting up the direction of current flows through the current sensing module:** As specified in the previous steps, leave loads on measured phases switched on. When the PV-plant is turned off, **all measured power output values must be smaller than 0 or equal to 0**. If any of the measured power outputs is positive it means that the phase wire is passing through the current sensing module in a reverse direction. Use the Current orientation field for the relevant phase, select the reversed option and press the Write button. The configuration will be saved in the controller. Now, all measured power outputs must be ≤ 0 . Turn the PV-plant on and turn off all loads. **Now, measured outputs must be positive (≥ 0)**. If they are not, or if the measured values do not correspond with nominal power ratings of the connected loads, or if they do not correspond with the power output of the PV-plant, you have either still connected another loads (which you don't know about, such as various loads in stand-by mode, etc.), or the phase sequence in voltage or in current inputs does not match, or you may have a defect in household wiring. **In any case, make sure to inspect the entire electric wiring.**
 - c. You can verify the correctness of measurement input configuration by using the chart "Input checking oscilloscope". This chart shows measured current waveforms in selected phase,

values are given in units of the built-in A/D-converter (digits), these are not normalized to amps due to performance. This feature should only aid the fitter when configuring the measuring inputs. **Always verify with a resistive (heat) load only, so that the phase shift between voltage and current is zero ($\cos(\varphi) = 1$)!** Moreover, in order to verify the measuring inputs the amplitude of current half-wave should always be greater than 1000 digits (to be sure about the correctness of the settings).

Note: During normal operation there may be shown even "exotic" waveforms. Be sure this is the real current flowing through the phase wire, a superposition of currents flowing through the connected appliances which are not always sinusoidal or their power factor varies from one.

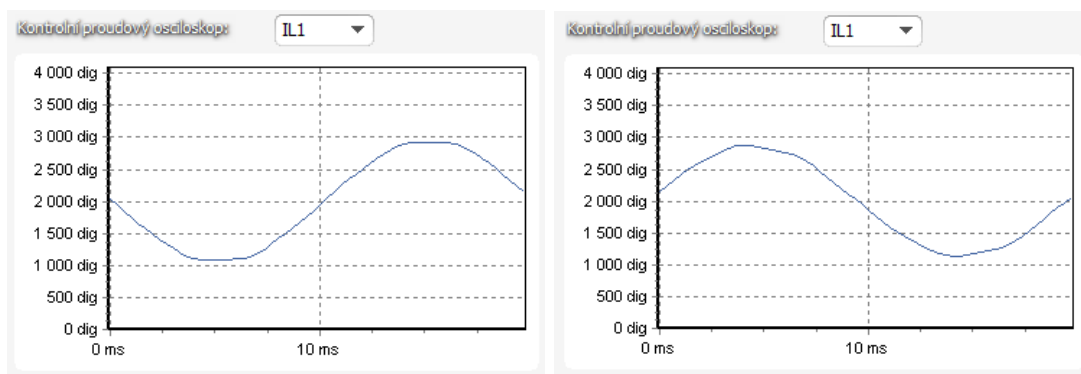


Figure15: Input is fitted correctly - sine wave of the current flowing through a resistive (heat) load is in phase with the voltage. WATTrouter shows negative values on selected phase (consumption). Left image appears when there is normal (default) current flow direction, right image appears for opposite direction. Note: The PV-inverter throughput appears exactly as the opposite, because the current is anti-phased with the voltage. If the inverter performs power factor compensation you can observe corresponding phase shifts.

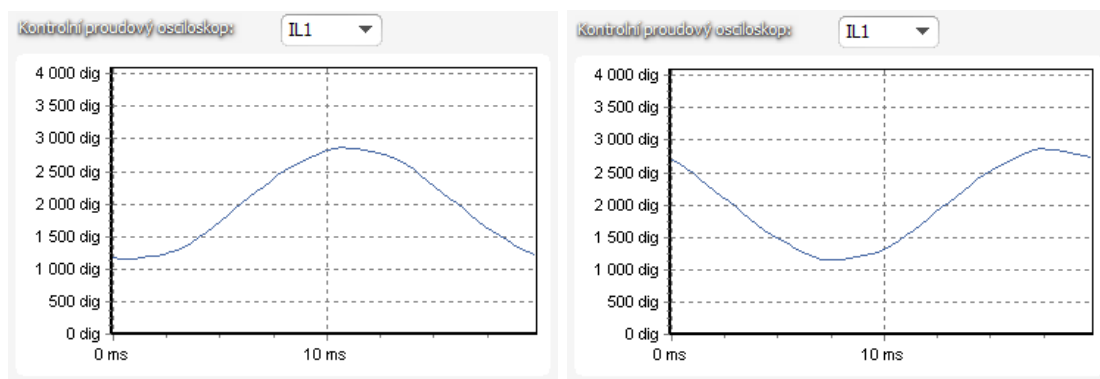


Figure 16: Input is fitted incorrectly - sine wave of the current flowing through a resistive (heat) load is not in phase with the voltage and either precedes (image left) or lags behind (image right) the voltage by 1/3 of mains half-wave. Measuring inputs are fitted incorrectly and you need to select correct option in the Phase field for respective input.

8. After a successful setup of measuring inputs you may begin to test outputs. This can be done on the "Output settings" tab. Each connected load must be tested separately. Turn on circuit breaker or activate fuse switch for the first output, and press the TEST button for the corresponding output. The load should switch on. When the load is switched on, the active power drawn by connected load must be detected by the current sensing module on the relevant phase.
9. After you have successfully tested all outputs, you may begin to configure the control mode in the Control settings field. This can be done on the "Other settings" tab. Set this mode either to "sum of all phases" or to "each phase independently", based on the configuration of your 4-quadrant energy meter. If you are not sure how your energy meter is configured, please contact your electricity

provider or use the "each phase independently"-mode, which works for any configuration of the energy meter.

In order to use the "each phase independently"-mode, it is necessary to select correct phase for each output, i.e. phase where the corresponding load is really connected. Controller will then try to maintain zero energy flow in each phase ("phase zero"). You may check correct phase assignment again through the TEST button. Within a short time after pressing the button the active power drawn by connected load must be detected by the current sensing module on relevant phase.

As far as your energy meter is configured to evaluate sum of powers in all phases, you may use the mode "sum of all phases". Here the controller will try to maintain virtual zero energy flow. This means that for output switching it takes the sum of measured powers from all 3 phases ("virtual zero"). Here you may try experimenting with both methods, but it is recommended to use "sum of all phases"-mode, because it is more effective for the user.

10. After a correct setup of the control mode, you may start to assign priorities and power ratings for individual outputs. This can be done on the "Output settings" tab. Select priorities of individual loads. The switching process based on priorities may be described as follows:

By default (during night), all loads are turned off. If PV-plant production (available surplus energy) is determined in the morning, the output with the first (highest) priority is switched on. The switching time is different for proportional outputs (their function equals to proportional or PWM) and relay outputs. Proportional outputs are switched on almost immediately (this is the proportional switching), but relay outputs are switched on only if the available surplus energy exceeds the value specified in the Connected power field (there is also a different solution available – see the "Prepend before SSRs" function). When the load is switched on (for proportional output it means the load is switched to the value specified in the Maximum power field), the system waits until the power output of PV-plant increases again (sunrise). If additional available surplus energy is determined when the load with first priority is switched on, then load with second priority is switched on in the same mode. The same applies to all outputs. If the available surplus energy decreases, or if another load in the household is switched on, active outputs are disconnected according to preset priorities but in reverse order (first, the load with the lowest priority gets disconnected).

The value in the "Connected power" field should be equal to the power rating of the connected load. For relay output it must be higher or equal to the power rating of the load, otherwise the controller will not operate correctly, and the load will be repeatedly turned on and off. For proportional output this value only configures the control dynamics, but it should be also equal to the actual power rating of the load.

The fields On-delay time and Off-delay time for relay outputs specify the time delay to switch the relay on or off after a condition has been detected to do so. This feature is necessary for loads which cannot be switched on frequently.

Set outputs according to the connected loads and based on your priorities and then press the Write button. The configuration will be saved in the controller. Now the main function of the controller should be configured.

11. Test the main function of the controller, or possibly, modify priorities for outputs and power settings of connected loads.

SETTING UP COMBIWATT MODE

After you have successfully tested the main function, you may start to configure CombiWATT mode, provided a low tariff signal is connected to the controller (it may be used even if single tariff rate is present – see notes

below). This can be done on the "Output settings" tab. CombiWATT mode provides constant daily energy supply to the connected loads. This mode is indispensable if you need to heat up water but also e. g. if you use a swimming pool filtering system during cloudy days or when your PV-plant is temporarily out of order. In CombiWATT mode, energy is taken both from PV-plant and from public grid.

Determine the optimal value of energy in kWh for the connected load (for example for a boiler or immersion heater), which you plan to supply the load with every day. For example, for a boiler it is suitable to determine the value of electric energy based on the average consumption of hot water. Usually, electric energy necessary

$$E[kWh] = \frac{c_v * V[l] * \Delta T[K]}{3600000}$$

to increase the temperature of hot water by 40°C equals to: . If you enter it into the formula you will get: $E[kWh] = 0.0464 * V[l]$. For a 180 liter boiler it will be 8.36 kWh. We recommend to increase this value by the daily heat loss of the boiler and also to modify (reduce) the value based on the actual average consumption of hot water.

Note: If you are heating water for example, the controller does not "know" how hot the water in the boiler is and therefore, the assumed values of the supplied electric energy may be higher than the actual delivered energy (the boiler thermostat may shut it off at any time). If you want to count only real supplied energy to the boiler then connect additional measurement for it according to Figure 8.

Mark the CombiWATT field for the relevant output (output must be activated, which means that the output must be assigned with the relevant priority), enter the established value of the daily electric energy in kWh and press the Write button. The configuration will be saved in the controller.

The CombiWATT mode is activated only if ALL the following conditions are met:

- The output is activated (priority has been assigned to the output - that means the output is not in the "not used" status).
- PV-plant does not produce electric power (active powers at all measured phases are <= (less or equal to the) CombiWATT production limit field).
- During the day, PV-plant did not supply the load with the required amount of energy, that is, the field "Supplied energy" is lower than the value specified in the "CombiWATT [kWh]" field for the relevant output.
- Low tariff signal has been detected (the info LED "low tariff" is red). Energy from public grid is always consumed in CombiWATT only if low tariff is present. See note below to learn how to configure this mode if you don't have double tariff rate.
- The "Time to activate CombiWATT"-field shows zero.

The CombiWATT mode is deactivated if some of the following conditions will apply:

- The value in the field "Supplied energy" reached the "CombiWATT [kWh]" value for the relevant output.
- PV production has been detected at some of the measured phases (active power at some measured phase is > (greater than the) CombiWATT production limit field).
- The low tariff signal is turned off.

Reset of energy counters (that is reset of values in the fields "Supplied energy")

- At sunrise. Counters are reset to zero at sunrise time, which is automatically calculated by the controller.
- At fixed time. Counters are reset to zero at a preset time.

More information about counter reset processing is available in the chapter Description of WATTconfig Mx items.

Note: For boilers/immersion heaters or any other hot water tanks the CombiWATT mode "does not care" during what time of the day the water is heated and used. The CombiWATT function only supplies the preset minimum daily power to the boiler and thus making sure that there is enough hot water when the recommended configuration is used. In cases when even under the recommended configuration hot water is not available in required amount, we recommend to gradually increase the daily energy limit ("CombiWATT [kWh]") for example, by 1 kWh, in order to make sure that hot water is available and at the same time that not too much energy is consumed from public grid. This is recommended mostly for households where consumption of hot water is high at the evening. Here it may come to the situation where water is sufficiently heated during the present day by the PV-plant, but the next day the plant is not capable of providing the necessary amount of energy (cloudy weather). The CombiWATT mode may also be aided by enforcing the relevant output with a time schedule. Based on user preferences, time schedules may even completely replace the CombiWATT mode. For more information see chapter Setting up time schedules.

If you do not have low tariff signal available (either you don't have double tariff rate or the signal cannot be utilized) but you still want to use the CombiWATT mode, connect the GND terminal to the LT terminal. In such scenario, the low tariff signal will be active at all times and the CombiWATT mode will be activated after production of PV-plant comes to an end (after sundown).

SETTING UP TIME SCHEDULES

Up to 4 independent time intervals may be set for each individual output. During these time intervals the relevant output may be forced to be switched on, or the switching process may be prohibited (restricted). The enforcing/restricting process may be further conditioned by the presence of the low tariff signal and / or by the status of daily energy counters for the relevant output ("Supplied energy"-fields) or temperature conditions.

The actual configuration of time schedules is done on the "Time schedules" tab. For more set up information, see the chapter Description of WATTconfig Mx items, Time schedules tab.

ANDI INPUT CONFIGURATION

The controller has 4 multi-purpose ANDI inputs to connect:

1. WATTrouter-compatible external current transformers (e.g. another current sensing module or other compatible current measuring transformers). These can measure powers exactly as ILx inputs;
2. External meters with impulse output S0, which meets the parameters specified in the technical specification and its output signal provides information about the measured electrical energy;
3. Analog temperature sensors of NTC type;
4. Analog temperature sensors type PT1000.
5. (since firmware version 2.0) Binary inputs.

ANDI inputs are not required to be used. They play an auxiliary role and provide additional information to the controller. For more information, see chapter Description of WATTconfig Mx items, Input settings tab.

WIRELESS COMUNICATION SETTINGS

Note: This function is accessible, once SC-Gateway module is inserted.

WATTrouter Mx optionally integrates wirelessly controlled devices which can be purchased as accessories. Wireless connection solution can be applied in buildings, where installation of wire connections between controller and devices would be too difficult.

Attention: Before ordering this accessory function, assure that wireless devices will be accessible by the controller. The accessible distance is based on construction of the building and it is possible to extend this range by repeaters. Further information can be obtained from technical support.

This function requires SC-Gateway module which needs to be inserted into the regulator. To install this SC-Gateway module, refer to the SC-Gateway user manual. It is also necessary to buy at least one wireless peripheral (wireless socket or another controller equipped with the SC-Router module).

As of firmware version 2.0, the wireless communication settings are part of the S-Connect protocol. For more detailed information on wireless communication settings, see chapter S-Connect protocol settings.

S-CONNECT PROTOCOL SETTINGS

The device supports the S-Connect device sharing protocol since firmware version 2.0. For more detailed information on setting up this communication, see chapters Description of the S-Connect protocol and S-Connect tab.

FINISHING THE CONFIGURATION

After setting up the controller according to previous chapters the controller is fully configured. You may save the preset configuration by pressing the Save button or you may load it at any time by pressing the Open button. This way you may create several different configurations and monitor them for some time and determine which one provides better utilization of energy self-consumption in your facility or household.

After you have completed the settings using the USB port then in case of manipulating within the distribution box turn off entire distribution box, remove the USB cable and turn on the distribution box again.

Tip: In order to maintain continuous monitoring the controller can be kept connected either via USB or Ethernet. If you want to use permanent USB connection, then it is recommended using a suitable USB isolator or USB connection extender via Ethernet. To use permanent Ethernet connection you may connect the network cable directly to your network router or switch.

DESCRIPTION OF WATTCONFIG MX ITEMS

This chapter contains a list of all items available in the WATTconfig control software and explains their meaning. Or you may use the controller web interface, where the items have identical names and meanings.

MAIN WINDOW

The main window displays all basic measured values and statuses. The controller can be configured using configuration tabs.

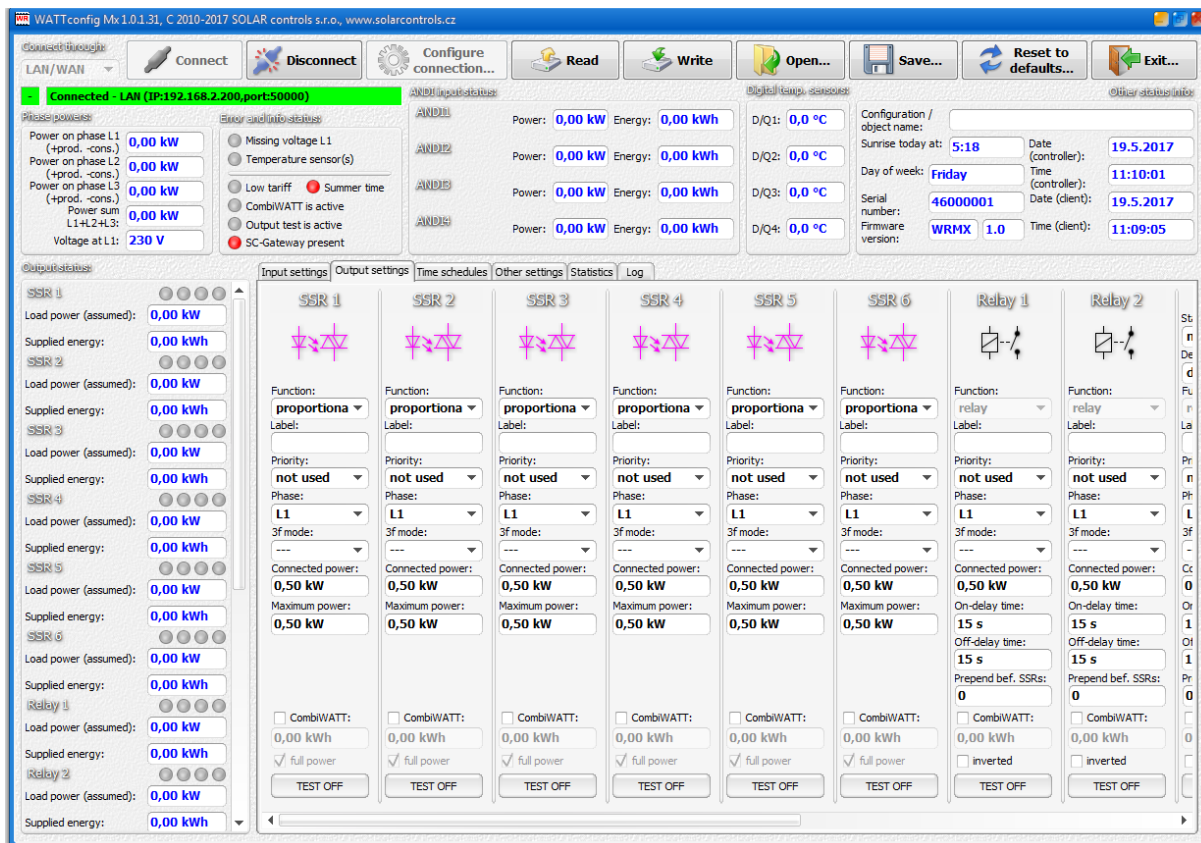


Figure 17: Main window of WATTconfig software.

MEASURED PARAMETERS AND STATUSES

Measured values:

- Power on ph. Lx - the actual value of the active power measured on the relevant phase wire. Positive value means production (PV-plant supplies power to the grid); negative value means that power is being drawn from the grid.
- Power sum L1+L2+L3 – sum of active power outputs in all three phases.
- Actual power offset – (since firmware version 2.3) displays the current value of the power offset used for output switching. The value is given either by the standard setting of the Power offset item on the Other settings tab, or by the Priority power offset register accessible via the MODBUS protocol.
- Voltage at L1 – voltage on phase L1 which powers up the regulator. This voltage value is used to more accurately calculate the power output than for the older WATTrouter models where the voltage was not measured and a constant value of 230V was assumed. It is also used for calculating the powers on other phases where a similar voltage value is assumed.

Error and info status (gray in inactive status, red in active status):

- Missing voltage L1 – failure of the synchronization circuit that detects the voltage at L1 terminal. This is a hardware failure of the regulator and it must be replaced or repaired. This fault blocks the power measurement and the active functions of the controller (output switching).
- Wrong voltage value L1 - grid voltage is too low (<200VAC) or high (> 260VAC). Firmware since version 1.5 signals this fault separately from the previous general state "Missing voltage L1". The controller will remain functional in this malfunction state, only indicating the problem. Instead of the measured voltage value, a fixed voltage of 230VAC is assumed (as for previous models CWx, M, ECO). If the voltage at terminal L1 is within the specified limits, it is a circuit failure that measures the voltage, and replacement or repair of the controller is recommended. This fault does not block any functions of the controller.
- Temperature sensor(s) – somewhere in time schedules temperature conditions are defined according to a temperature sensor (ANDI or DQ input) but this sensor does not work. Change the time schedule configuration or fix the problem with the sensor. This fault blocks the active functions of the controller (output switching).
- DC source overload - Voltage level at terminal + 12V drops below + 9V relative to GND. This malfunction can occur when the internal DC voltage source is heavily loaded. The firmware since version 1.5 checks this and eventually signals this failure. This malfunction lasts for the duration of the cause and for a further 60s afterwards. Typically, this failure occurs when all 8 internal outputs are used or there is overload on the + 12V or + 5V terminals may (there can be for example a malfunction of some digital sensor if powered from + 5V terminal). Please check that the + 12V or + 5V terminals are not overloaded. When the two internal relays are occupied, connect the control circuits of all used SSRs to an external source (see Figure 12). You can also enable the Optimize internal relay consumption feature (see chapter Other settings tab) which might help to reduce the power consumption of internal relays. This fault blocks the active functions of the controller (output switching).
- SD card error - (since firmware version 2.0) this error is reported if the built-in SD card does not initialize successfully or if the data is not successfully written to the SD card. To eliminate this error, first restart the controller. If this does not help, then carefully remove the SD card and test its functionality, e.g. in a mobile phone or card reader, and if the card does not work, replace it with the same type (for this, it is necessary to disassemble the controller and open the SD card slot by pushing

cover of the slot towards the backup battery, so this can only be done if the controller is no longer under warranty). If this does not help either, then repair or replacement of the regulator is necessary. This fault does not block any functions of the controller.

- S-Connect: device error - (since firmware version 2.0) this error is reported if any device mapped in the S-Connect tab is not functional or the station that provides it is not connected. Which device is affected can be determined by the Ping [ms] value and the device activity indicator on the S-Connect tab. This fault does not block any functions of the controller, except for functions that depend on faulty shared devices.
- Low tariff – if the low tariff signal is detected the red light comes on, otherwise it is grayed.
- Summer time - informs the user that the summer time mode is active. Summer time starts at 2:00 CET, on the last Sunday in March and ends at 3:00 CEST, on the last Sunday in October. If the option "Use summer time" is not marked on the "Other settings" tab, the indicator remains inactive.
- Output test is active – informs the user about a status when some of the outputs have been activated by the TEST button. Output tests done via LAN interface are protected from unauthorized access or intervention.
- CombiWATT is active – informs the user that CombiWATT mode is active. This indicator is active if the condition necessary to run CombiWATT is valid, if the low tariff is active and if the CombiWATT function has been configured for some output.
- Cloud service is active - (since firmware version 2.4) informs the user about an active connection to the selected cloud service. The indicator is active if the cloud service responds to the corresponding controller requests and therefore the "Successful exchanges" counter increases in the Cloud services window.
- SC-Gateway/SC-Router present – informs the user about the presence of the SC-Gateway or SC-Router module in the controller.

In case of an error that blocks active functions of the controller, all outputs turn off and any control functions are stalled.

Output statuses:

- Load power - the power drawn by the load connected to the relevant output. It is either:
 - a. Estimated power based on the output settings and may not correspond with the actual power output of the load, or:
 - b. Measured power using an external current transformer connected to the corresponding ANDI input or shared RP input when S-Connect protocol is activated. If the output is switched on by the controller, but the assigned ANDI/RP input does not measure any output (for example, the appliance is disconnected by its internal thermostat), the item flashes.
- Supplied energy - daily energy counters counting power already supplied to the relevant output. It is either:
 - a. Estimated energy supplied to the load, which is based on the output settings and may not correspond with the actual amount of the power supplied to the load, or:
 - b. Measured energy using an external current transformer connected to the corresponding ANDI input or shared RP input when S-Connect protocol is activated.

These energy counters inform CombiWATT mode or the corresponding time schedule about the energy already delivered to the load and at the same time, they also inform the user about the amount of delivered energy. Counters are reset to zero based on the configuration of "CombiWATT - Energy counter reset"-field in the Other settings tab.

Note: In case ad a) the WATTrouter device does not "know" the status of the load and therefore, counters may also show much higher energy values than those actually delivered to the load (for example, if the boiler is heated up during the day and turned off by the thermostat).

- Status output indicators - inform the user about the reason for switching, or possibly about the reason for output restriction. There are 4 indicators:
 - a) Blue - it is displayed only if the output is switched on due to basic control process according to the available surplus energy from PV-plant. This indicator also signals possible off-delay time for the relay output (after being enforced by time schedule or CombiWATT mode).
 - b) Violet - it is displayed only if the output is switched on by the CombiWATT mode.
 - c) Green - it is displayed only if switching is enforced by time schedule.
 - d) Red - it is displayed if the output is restricted by time schedule or consumption watchdog, or by a remote device via the S-Connect protocol.
 - e) Green - (since firmware version 2.0) is displayed when the output is forced to be switched on by a remote device via the S-Connect protocol, or when the output is forced to be switched on during duplication from another relay output.

ANDI input status:

- Power- displays electric power which is measured either with an:
 - a. External current transformer when the ANDI function is set to power measurement or with an:
 - b. External meter with S0 impulse input when the ANDI function is set to S0 pulse counter. The

value is calculated using the following formula:
$$P[\text{kW}] = \frac{3600}{t_p[\text{s}] \cdot \text{Imp}_{\text{kWh}}}$$

Where:

P – final power (this field)

t_p – period of impulses

Imp_{kWh} – number of impulses per kWh (see FB input settings)

The measurement dynamics depends on the impulse frequency. It may be very small for small measured powers. The maximum measurable period of impulses is set to 15 seconds (at 1000 impulses per kWh it corresponds to a power value of 0.24 kW). If the measured power is lower, zero is displayed.

- Energy – displays electric energy counted either with an:
 - a. External current transformer when the ANDI function is set to power measurement or with an:
 - b. External meter with S0 impulse input when the ANDI function is set to S0 pulse counter. The

value is calculated using the following formula:
$$E[\text{kWh}] = E_p[\text{kWh}] + \frac{\text{Imp}}{\text{Imp}_{\text{kWh}}}$$

Where:

E – final energy (this field)

E_p – initial energy at the input (see FB input settings)

Imp – number of impulses registered by FB input since the moment the impulses were connected to this FB input. These counter values are not displayed.

Imp_{kWh} – number of impulses per kWh (see FB input settings)

Impulses are counted only if the controller is operating. It is only an auxiliary and informative feature of the controller. Counted impulses are saved in the internal EEPROM memory every hour. In case of a short time power supply failure these values should not be very different from the actual reality. More frequent impulse saving is not possible due to technical reasons. If these values do not correspond with the value shown on the display of the connected energy meter, modify the field "Energy offset" to match the value of the energy meter, check the "Reset energy"-field and press the Write button.

- Temperature – displays the temperature measured by the corresponding ANDI input when the ANDI function is set to NTC or PT1000. Invalid temperature displays as X.X.
- Status - (since firmware version 2.0) displays the binary status of the ANDI input when ANDI function is set to binary input.

Digital temperature sensors:

- Temperature – displays the temperature measured by the corresponding sensor. Invalid temperature displays as X.X.

Other statuses:

- Configuration/object name - it is used to set label to the facility or the current configuration. Text may contain maximum of 16 characters in ASCII encoding.
- Sunrise today – it displays time of sunrise for today. This time is calculated directly in the controller based on the actual calendar date and the actual geographic location of the facility/building (see "Geographic location" on the "Other settings" tab). The calculated time is converted to the current local time based on configuration of the "Use summer time" and "Time zone" settings. The official sunrise zenith is considered, i.e. 90° 50'. Sunrise time is used to reset energy counters ("Supplied energy"-fields) in the main window, provided that the applicable mode in the field "CombiWATT – Energy counter reset" is selected, and also since firmware version 2.2 to start or end the time schedule.
- Sunset today – (since firmware version 2.2) it displays time of sunset for today. This time is calculated directly in the controller based on the current calendar date and the current location of the facility/building (see "Geographic location" on the "Other settings" tab). The calculated time is converted to the current local time based on configuration of the "Use summer time" and "Time zone" settings. The official sunset zenith is considered, i.e. 90°50'. The sunset time is used to start or end the time schedule.
- Day of week – shows the current day of week, which is obtained from the controller date.
- Serial number- displays serial number and it is unique for each regulator.
- Firmware version – displays actual regulator firmware version.
- Date (regulator) – it indicates the real time running inside the regulator (date part).

- Time (regulator) – it indicates the real time running inside the regulator (time part).

Note: Regulator real time is backed up with a built-in lithium battery, so it runs even if the regulator power supply is turned off.

- Date (client) – it displays the real-time running on the PC (date part).
- Time (client) – it displays the real-time running on the PC (time part).
- Spot price – (since firmware version 2.3) displays the current price of electricity on the spot market, according to which the behavior of time schedules can be configured. The controller does not determine this price alone, but it must be provided to it by an external device via the MODBUS protocol. This external device will usually be the SpotProcessor module (this module is applicable only in CZ, however). Invalid price is displayed as X.XX text.

INPUT SETTINGS TAB

In this tab you may set measuring inputs, multi-purpose ANDI inputs and configure digital temperature sensors.

Note: The ANDI multi-purpose inputs are an extension of FB input functionality from older WATTrouter models that only worked as SO pulse counter.

Common settings for Measurement input settings and ANDI input settings:

- Label – used to assign a label for the relevant input. Label may contain a maximum of 16 characters in ASCII encoding. For ILx inputs it cannot be modified.
- Function – is used to select proper function for the input. For ILx inputs it cannot be modified. The ANDI inputs may perform following functions:
 - a. Power measurement – default function. Connect WATTrouter-compatible external current transformers (e.g. another current sensing module or other compatible current measuring transformers). Do not overload the ANDI inputs with bigger primary currents than 15A (which corresponds to secondary current 15mA);
 - b. SO pulse counter – connect impulse output SO of an external meter, which meets the parameters specified in the technical specification and its output signal provides information about the measured electrical energy;
 - c. NTC – connect analog temperature sensors of NTC type;
 - d. PT1000 - connect analog temperature sensors type PT1000.
 - e. Binary input - (since firmware version 2.0) a voltage-free switch (ANDI to GND) is connected to the input, the input then signals "0" in the case of an open switch and "1" in the case of a closed switch.
- Current orientation - it is used to change the sign of measured powers, if the current sensing module is fitted in inverted position, or in cases for example, when it is desirable to pass the wire through the module in inverted direction.
- Phase - it is used to set the physical phase to given input when its function is set to power measurement. Assign the phase so that the measured currents are in phase with voltage. Check the assignment using a control oscilloscope and a purely resistive (thermal) load on the given phase.

Note: The Phase parameter replaces the "Phase Order Setting" menu from older WATTrouter models and allows you to set any phasing for all inputs with the power measurement function.

- Ratio for external CTs - set this ratio only if you use additional external current transformers (CTs), whose secondary coils are shorted with a wire passing through measuring coils of the current sensing module, as specified on figure 7. If you use standard connection for WATTrouter device that is, the facility or household supply wire is passing directly through measuring coils as specified on figure 3, then this ratio should be 1:1 (however, this ratio can also be used to calibrate current measurement even in the case of standard wiring without external measuring transformers). External current transformers can extend the measuring range of the controller up to any value, depending on the conversion rate of the external current transformer.

Example: Let us say you want to use WATTrouter Mx in a facility where the main circuit breaker is rated up to 3x400A. In this case you have to buy external current transformers with ratio 400A:5A. Connect/short-cut their secondary terminals using a wire, and at the same time, pass it through measuring coils of the current sensing module (see Figure 7). Now set the conversion rate to 400:5.

However, in order to use the full range of the built-in A/D converter, it is recommended to make 4 turns around the measuring coils to get optimum conversion rate of 400A:20A. Then, set the conversion rate to 400:20.

Note: Use only external CTs for large facilities and large PV-plant power outputs. If you are using a high conversion rate of external CTs, you have to take into account that (relatively) small power outputs (in the example describing the optimized conversion rate 400A:20A, the limit represents approximately 100 W per phase) are below the resolution capacity of the measuring inputs and therefore, these power values will not be measured and equal to zero.

- Voltage for calculation – (since firmware version 1.6) use this to configure voltage source for power calculations:
 - a. measured at L1 (default setting like in all older firmware versions)
 - b. fixed 230 VAC
 - c. RV1 etc. (voltage taken from another voltage meter via the S-CONNECT protocol, since firmware version 2.3)

The controller does not physically measure voltages at L2 or L3. If the voltage on these phases is roughly different from L1, we recommend using a fixed value of 230 VAC for these phases or, since firmware version 2.3, a measured value from another voltage meter via the S-CONNECT protocol. It is also possible to ignore the measured voltage value at L1 and use a fixed value everywhere, which is the same setting as for all older WATTrouter models.

Note: If the measurement a) or c) fails, the fixed value of 230 VAC is always used for the calculation.

ANDI input settings:

- Measurement source – as of firmware version 2.0, this item is replaced by the more general items Measured by input (see chapter Output settings tab) and Input settings for statistics (see chapter Other settings tab), which better correspond to the advanced options when using the S-Connect protocol.
- Energy offset - this field can be used to set initial values of measured energies. If the values of measured energies do not match the display on the connected energy meter (for example), put the value of the energy shown on the display into this column and reset impulse counters to zero by marking the option "Reset energy".
- Reset energy - used to reset energy counters to zero.

- Number of impulses per one kWh – this column is used to set the number of impulses per one kWh, when the ANDI input function is set to S0 pulse counter. Set the value according to the label or manual of the connected energy meter, inverter or according to another compatible measuring instrument. It is recommended to use highest possible amount of impulses per kWh to get better resolution for the power fields in the “ANDI input status” group.

Input checking oscilloscope:

This graph is primarily used to check the correctness of ILx metering inputs settings and/or ANDI inputs settings when their function is set to power measurement. However, it can also be used to check ANDI input configuration for other selected functions. From the drop-down menu, select the input you want to check and follow the chart.

The oscilloscope will always display the events at the analog inputs of the WATTrouter microprocessor, which will vary according to the assigned input function:

- a. Power measurement - one whole period of measured current is displayed, the value for zero measured power should be around 2000 digits. For more information about this view, see chapter Setting up main function.
- b. S0 pulse counter - logic 1 (about 4000 digits) will be displayed for pulse delay or logic 0 (about 10 digits) for the active pulse from the meter.
- c. NTC, PT1000 - the analog value measured by the sensor or amplified by the built-in programmable amplifier is displayed, which is further processed by the microprocessor for the temperature readout.
- d. Binary input - (since firmware version 2.0) the inverse status of the switch is displayed, ie about 4000 digits for logic 0 in the case of a switched off switch or about 10 digits for logic 1 in the case of a closed switch.



In case of connection of external current transformers, S0 pulse outputs or temperature sensors to the ANDI multipurpose inputs, it is imperative to correctly configure their function or otherwise even the ILx inputs may not work properly! You will see this as wrong diagram in the input checking oscilloscope.

Digital temperature sensors:

- Sensor type – select the type of connected digital sensors. All sensors must be of the same type.
- Search for digital temperature sensors - starts searching for digital sensors connected to the DQ bus. If all connected sensors do not appear after performing this function, make sure that the data bus connection is correctly wired and that the shielding is also connected and working. Frequent errors in communicating with sensors occur especially at longer distances and incorrect shielding. The feature is password protected against unauthorized access.
- Labels – used to assign a label for the relevant input. Label may contain a maximum of 16 characters in ASCII encoding.

OUTPUT SETTINGS TAB

On this tab you may set basic parameters for outputs and setup the CombiWATT mode for outputs.

- Station – as of firmware version 2.0, this entry is no more available and is replaced by the device mapping on the S-Connect tab.
- Device index – as of firmware version 2.0, this entry is no more available and is replaced by the device mapping on the S-Connect tab.
- Function - used to set the functionality of the corresponding output:

- a. Relay - the output will operate in On/Off mode (as a relay).
- b. Proportional - (only for SSR outputs or when S-Connect protocol is activated, also for supported RO outputs) the output will operate in proportional control mode, by modulating connected load's power according to the available surplus energy.



This mode is only for controlling the output of resistive (thermal) appliances and requires the connection of external power semiconductor relays (SSRs)! This mode can further increase the flicker (fast changes in mains voltage or fast flashing of light bulbs and fluorescent lamps). Before connecting the appliance to this mode, read the flicker recommendations in the Frequently Asked Questions section of the manufacturer's website.

- c. PWM – (only for SSR outputs or when S-Connect protocol is activated, also for supported RO outputs) the output will operate in proportional control mode, by modulating connected load's power according to the available surplus energy, but the output signal will be PWM, see technical specification for PWM parameters.



Caution: The purpose of this mode is only to control the instantaneous power of external devices which allow this and have corresponding input (such as some battery chargers and heating pumps). This mode cannot be used if external solid state relays (SSRs) are connected to the SSR outputs!

Note: If the Function field is disabled then either there is only one function possible (function that is shown) or (since firmware version 2.0) the function is set remotely by S-Connect protocol.

- Label – used to assign a label for the relevant output. Label may contain a maximum of 16 characters in ASCII encoding.
- Priority – it is used to set priority for the relevant output. First priority is the highest; the eighth priority is the lowest (in case activated S-Connect it is possible to configure up to 16 priorities). "Not used" means that the output is not activated. Output with higher priority will switch on "sooner" and will switch off "later" (see the chapter Setting up main function). If you are using the "Sum of all phases" control mode, you cannot select the same priority for two or more outputs (except for the "not used" status). In the "Each phase independently" control mode this settings must be applied to each phase. From the first (the highest) priority all the way down to the lowest priority. No gaps are allowed in the priority settings, that is, you cannot set only the 1st priority and the 3rd priority, without setting the 2nd priority as well. WATTconfig inspects priority and phase settings before writing them into the controller.
- Phase – if using the "Each phase independently" control mode you have to set the phase wire for each output where the relevant load is connected to. The setting must correspond with the reality. Use the TEST button to verify that.

Note: The output phases may not correspond to the physical phase settings for the ILx inputs or ANDI inputs. The reason is that for the inputs physical phase is assigned according to the actual connection of the current sensing module and for the outputs logical phase in relation to the inputs ILx.

- 3f mode –when using the "Each phase independently" control mode you can set special method of surplus energy calculation to switch on or off this output. These special methods can be used only for symmetrical three-phase loads (such as 3-phase heating elements, 3-phase heat pumps and others), which have to be connected on 3-phase line. Connect those loads only via external 3-phase contactor or 3-phase power SSR or, if you have 3-phase inverter heat pump, use corresponding control module which can directly control the power of this heat pump.

The phase entry for the output in 3f mode indicates a *reference phase*, which is used only for assigning the output to the priority chain for that phase.

Put one third of nominal input power of the load to the Connected Power field and set phase and priority according to your preferences (the Phase field only serves here as reference parameter to include this output into correct priority chain). Following special methods of energy surplus calculation are available:

- a. Min (L1, L2, L3) – output will be switched on behalf on a minimum surplus energy from all 3 phases
- b. Avg (L1, L2, L3) – output will be switched on behalf on average surplus energy from all 3 phases
- c. Max (L1, L2, L3) – output will be switched on behalf on a maximum surplus energy from all 3 phases

Within the assignment of one phase there can be combined single-phase and three-phase loads at different outputs. Use this function with extreme caution and only if it is not actually possible to split given three-phase load to 3 single-phase loads (e.g. as the aforementioned 3-phase heating element).

Since firmware version 1.6, this mode has changed:

- The output in 3f mode no longer blocks the switching of the lower priority outputs on the reference phase if there is enough surplus energy at that phase to switch them.
- Also, if there is enough surplus energy on the reference phase and there are lower priorities switched on at that phase, and the available surplus energy on other phases decreases, it does not remain permanently (incorrectly) switched on, but adjusts (regulates) its excitation according to the requirement from all 3 phases.
- Connected power - it specifies the active power rating of connected load. If power rating is specified in VA and the power factor $\cos(\Phi)$ is specified, you may determine the active power rating using $P[W] = S[VA] \cdot \cos(\Phi)$ formula. The connected power value should be equal to the power rating of connected load for proportional or PWM function, and must be higher or equal for relay function.
- Maximum power – this value applies only for proportional outputs. It determines the maximum allowed power applicable for the connected load. In many cases this value is equal to the connected power value, but for example, due to limited SSR cooling possibility or due to saving the surplus energy for additional outputs, you may decrease this value. The value in the "Load power"-field may be slightly lower than the selected maximum power value, even if the output is fully excited and maximum power is reached (if this power is assumed and not measured by an ANDI input). The reason is that outputs with proportional function do not switch on fully proportionally but only "quasi-proportionally", which means, only in certain switching levels.



Always keep the value equal to the Connected power value in cases where the output is set to the proportional function, causing an increased flicker (fast changes in mains voltage or rapid flashing of light bulbs and fluorescent lamps). The output will always be permanently switched on when fully excited. See the flicker recommendation in the Frequently Asked Questions section of the manufacturer's website.

- Prepend before SSRs – allows prepending the relay output before specified number of proportional outputs. Fill in 1 if you want a relay with lower priority to switch on when load power on nearest higher priority proportional output reaches the relay's Connected power value. Fill in 2 if you want this relay to be switched on when sum of load powers on nearest 2 higher priority proportional outputs

reaches the relay's Connected power value. The function works similar for higher values. This function will violate the preset order of priorities. However, it allows using almost all available surplus energy even if heating elements are connected to relay outputs. For example, if you are using a three-phase heating element.

Example 1: heating element 3x2 kW connected and configured in the following way:

- 1st heating coil connected to SSR No. 1, 1st priority, connected power 2 kW, maximum power 2 kW
- 2nd heating coil connected to relay No. 1, 2nd priority, connected power 2 kW, prepend value = 1
- 3rd heating coil connected to relay No. 2, 3rd priority, connected power 2 kW, prepend value = 1

If the SSR No. 1 is fully switched and consumes 2 kW of surplus energy and the amount of surplus energy further increases, then the relay No. 1 will switch on and SSR No. 1 will automatically reduce its power. If the surplus energy increases by additional 2 kW so that the SSR No. 1 is fully switched again, then the relay No. 2 will be switched and SSR No. 1 will again automatically reduce the power output. If the power output continues increasing, additional outputs with lower priorities will be connected. Similarly, outputs will disconnect when the PV-plant power generation will decrease.

Note: To make sure that the function works correctly, all 3 heating coils must be active (heated) at the same time or inactive (disconnected by the thermostat). The algorithm will not work correctly if heating coil No. 1 is disconnected by the thermostat and the other two heating coils will continue producing heat. In this scenario, the relay will be continuously connected and disconnected because the controller is trying to keep "virtual zero" or "phase zero", depending on control mode, and is not able to determine from phase wire measurements that heating coil No. 1 is disconnected. However, if we arrange that the real output power of the 1st heating coil connected to SSR No. 1 will be measured with some ANDI input, then the function will work properly even if the heating coils have independent thermostats.

Note: In order to ensure correct function of the algorithm it is necessary that the SSR output - to which the heating coil No. 1 is connected, is assigned with the higher priority than the relay No.1 with the 2nd heating coil. If the coil No. 1 connected to a SSR output has lower power rating than the other two remaining heating coils, then the relays will connect only after the overall power (power drawn by the first coil + surplus energy) exceeds the value of "Connected power" field set for relay No. 1. In this case, the part of surplus energy will be still delivered to public grid as in the case of the default function of WATTrouter controller, without prepend mode.

Example 2: A boiler and 2 other heating elements:

- the boiler connected to SSR No. 1, 1st priority, connected power 2 kW, maximum power 2 kW,
- 1st heating coil connected to SSR No. 2, 2nd priority, connected power 2 kW, maximum power 2 kW,
- 2nd heating coil connected to relay No. 1, 3rd priority, connected power 2 kW,
 - a) Prepend value set to **0**: In this case the 2nd coil will never be prepended and after 4kW surplus is reached and consumed by boiler and 1st coil the controller will wait until the available surplus is 6kW. Then it connects 2nd coil. In the meantime surplus flows to public grid.
 - b) Prepend value set to **1**: In order to prioritize the 2nd coil, we will take into account only the load power of the 1st coil, which means that the boiler will always have first priority. So after PV-surplus reaches 4 kW the 2nd coil will be connected (prepended) before the 1st coil.
 - c) Prepend value set to **2 and higher**: In order to prioritize the 2nd coil, we will take into account the sum of load powers of the boiler and 1st coil. So after surplus reaches 2 kW the 2nd coil will be connected (prepended) before boiler and 1st coil.

Note: The Prepend function does not affect relay output priorities. For example, if the relay 2 is set to the nearest lower priority than the relay 1 but has a higher Prepend value than the relay 1, the relay 2 will not be prepended before the relay 1. Therefore, in this case, higher Prepend value for relay 2 than for relay 1 is not meaningful, so don't set it.

- Minimum power – for proportional outputs when PWM function is used this value gives the minimum power for the connected load. The output will not be activated unless available surplus energy exceeds this threshold. Nonzero value can be useful e.g. for proportional control of inverter air conditioner or heating pump. These devices usually don't run with less than 1/3 of nominal power. For more information about controlling air conditioners or heating pumps proportionally see manufacturer's web site.
- @ – (since firmware version 2.2) for proportional outputs when PWM function is used, it allows you to enter the output excitation level corresponding to the item Minimum power. The excitation level is entered as a percentage of the full cycle of the PWM signal or full voltage range 0-10V. Up to and including firmware version 2.1, the level was fixed at 10%/1V.

Example: Let's have a heat pump, controlled by the external 0-10V signal, connected to the SSR output with the PWM function set. The smallest pump power is 1kW, which corresponds to a voltage of 3V. The highest pump power is 3kW, which corresponds to a voltage of 10V. The pump switches off at a voltage of <0.5V. Then we set Connected power=3kW, Minimum power=1kW and item @=30%. PWM-range remains full 0-100%. The controller will then switch this pump in the range of 1kW to 3kW, which corresponds to 3V to 10V. If it needs to be turned off, the controller will set it to 0V.

- PWM-I – for proportional outputs when PWM function is used then this value is equal to the I-component value of the PID-regulator assigned to this output. The value can be selected between 1 and 1000. Select value according to the dynamics of the connected system (battery charger, heating pump etc.). Start with a small value (1 to 10) and gradually increase the value if the system dynamics is slow. For values less than 100 the dynamics is rather slow so that the system allows switching outputs with lower priorities, to cover available surplus energy. If the Minimum power field is nonzero the control will start after 3 minutes. In the meantime minimum power is held – aimed for softstart of air conditioners or heating pumps.



Caution: In case of a too big PWM-I value the system may become unstable and this status may damage the connected device, when there is no built-in protection in the device!

- PWM range – (since firmware version 1.6) these values can be used to limit physical PWM or 0-10V output to given subrange. For example, if we need a signal that is 1-10V (1V corresponds to zero power, 10V corresponds to full power) then we set 10-100%. Similarly if we need a signal that is 2-5V (2V corresponds to zero power, 5V corresponds to full power) then we set 20-50%. The output within this range is linear and even for the smallest possible subrange (10% of the full range, so eg. 10-20% ie. 1-2V) is fine enough and has minimum resolution of 100 levels (for smallest subrange of 1V it means the resolution is 10mV).
- On-delay time – this value applies only for relay outputs. This delay time runs from the moment a condition has been detected to switch the relay output on. By this condition we mean that the corresponding energy surplus exceeds the limit set by the "Connected power" field, which is further increased by internal fixed hysteresis of 0.1 kW. After the on-delay time elapses the relay is really switched on. It is recommended to use the default value, or to slightly increase it if the relevant load cannot be switched on frequently. The value may be decreased down to 2s. However, such small delay

time may sometimes cause false load switching. Therefore, we recommend decreasing the value only in certain cases and after proper testing. This time delay is not active in CombiWATT and TEST mode.

- Off-delay time - this value applies only for relay or PWM outputs. For relay outputs this delay time runs from the moment a condition has been detected to switch the relay output off. After the time elapses the relay is really switched off. This feature is necessary for loads which cannot be switched on frequently. The value may be reduced down to 2s. This time delay is not active in CombiWATT and TEST mode. Here it is assumed that the low tariff activity time is always sufficiently long in case of double tariff rates.

For proportional outputs when PWM function and nonzero minimum power is used this value gives the switch off delay for case air conditioner or heating pump is connected to this output and controlled by PWM mode. If there is not enough surplus energy to run the device anymore the device will continue to run at minimum power for specified amount of time. The delay in this case cannot be set to less than 3 minutes.

- Duplicate to - (since firmware version 2.0) allows you to duplicate the relay output switching to another relay output that is selected in this field.

Example: Consider a three-phase pool heater operated in the control mode of each phase separately. Here we need to ensure the operation of the pool water circulation pump when switching on the pool heating in any phase. We will use 3 relay outputs in the first priority on each phase, where the circulation pump is connected to the relay output on phase L1. We will also use 3 SSR outputs in the second priority on each phase, which proportionally switch the individual heating coils of the pool heating. Duplication ensures switching of the relay output on L1 even in case there is no PV surplus on L1, but it is on L2 or L3.

Note: When you select an output that has no relay function set, duplication does not apply.

- Measured by input - (since firmware version 2.0) assigns the respective output for measuring the power of the connected appliance. Any ANDI input and, if the S-Connect protocol is activated, remote RP measurement input can be set. In older firmware versions, it was only possible to select ANDI inputs for measuring the appliance power, in the Measurement source field corresponding to the ANDI input.

Note: When upgrading the firmware from an older version, the controller will try to convert the original ANDI input settings (Measurement source settings) to this item.

- CombiWATT – activates the CombiWATT mode for the relevant output (output must be activated, i.e. have assigned a valid priority). Enter the required amount of energy power, which must be supplied to the corresponding load every day.
- Watch consumption – (since firmware version 2.2) mark this field if you want to restrict this output by the consumption watchdog, upon meeting the other conditions for its restriction.
- Full power – mark this field if you want to switch the proportional output in CombiWATT or TEST mode at full power, regardless of the Maximum power setting ("Maximum power"-field). In this way you may eliminate the occurrence of disturbing flicker effect (fast changes in mains voltage or rapid flashing of light bulbs and fluorescent lamps) when CombiWATT or TEST is active. If you don't check this field the specified maximum power for the load is used in CombiWATT or TEST mode.
- Inverted – this checkbox applies only for relay or PWM outputs. When checked, the selected output will be switched on in inactive status and switched off in active status. Since firmware version 1.6 this inversion is active in all cases (independent from priority assignment or even the TEST status). There is

only one exception when a failure is detected. In this case the inverted relay output will remain physically turned off.

This function in case of a relay output can be useful when you want to avoid delivering surplus energy to public grid. Here, typically, one relay output is set as inverted and assigned to last priority. And it is used to block the inverter. If there is inconsumable surplus energy (typically in hot summer) this relay output disconnects the inverter for some time (given by Off-Delay time). After this time the inverter starts again. To block the inverter it is recommended to use analog inputs of the inverter (for inverters which support power reduction). In this configuration the inverter will be disconnected from grid on each WATTrouter failure or when WATTrouter itself gets disconnected from grid.

In case of the output with PWM function, the output duty cycle of the PWM signal is inverted (outputs SSR1 to SSR3), respectively. The output voltage of the analog outputs (outputs SSR4 to SSR6) is inverted, here the 0-10V signal is assumed to be connected between the GND terminal and the corresponding output terminal.

Attention: *As of firmware version 2.0, the output can also be switched on by an external station when the S-Connect protocol is activated. In this case, the inversion does not apply! If you want the output to be inverse and you also want to switch it externally, you must also set the inversion of the corresponding remote output on the external station (however, not all stations support this).*

- TEST – it is used to test the relevant output and load. If you press the TEST button then the corresponding output is forced to switch on, independent from its current configuration. If the output is inverted then since firmware version 1.6 the test mode is also inverted, i.e. it switches off. The behavior of all other control functions depends on the “Output test blocks control” option state as described in chapter Other settings tab.

TIME SCHEDULES TAB

On this tab you may set time schedules for individual outputs.

Up to 4 independent time intervals may be set for each individual output. During these time intervals the relevant output may be forced to be switched on, or the switching process may be restricted. Enforcing or restricting may be further conditioned by the binary input status and / or by the status of daily energy counter for the relevant output (field "Supplied energy"), or with temperature conditions.

You may use time schedules to create more complex configurations for outputs, based on user preferences. You may also use time schedules to add or possibly replace the built-in CombiWATT mode.



Time schedules operate independently of the basic regulation mode. If used inappropriately, time schedules may worsen the energy efficiency of your facility. Setting up time schedules depends entirely on your creativity and provides a wide range of different combinations. Only advanced users should use time schedules and only after they have been thoroughly familiarized with the applicable functionalities of this device!

Description of a time schedule option:

- Time schedule mode:
 - a) Not used – time schedule is not active.
 - b) Restricted – the output will be restricted during the interval specified in the "From - To" field. If the "From" time is larger than the "To" time, the restrictions or limitations are valid from the "From" time to midnight and on the next following day from midnight to the "To" time.
Restriction applies to all activities of this output and has the highest priority. During the time

interval neither basic regulation - based on the surplus energy - nor the CombiWATT mode will work. Neither any other time schedule set to enforced mode will work. Output restriction does not prevent outputs with lower priorities from working regularly.

- c) Enforced - the output will be enforced/switched-on during the time specified in the "From – To" interval. If the "From" time is larger than the "To" time, the enforcement is valid from the "From" time to midnight and on the next following day from midnight to the "To" time. **Enforcement has the second highest priority** and it may be disabled only with another time schedule set to the restricted mode at the same time. During the preset time interval the output enforcement deactivates the basic regulation mode based on surplus energy (only if the Power field is set to 100%). However, it does not affect conditions for the activation of CombiWATT mode, which then can run simultaneously with the enforcement mode. Output enforcement does not prevent outputs with lower priorities from working regularly.
- Activity indicator – (since firmware version 2.3) shows the activity of the time schedule. These indicators are useful if you use multiple schedules for a single output.
- From – time when time schedule begins. Since firmware version 2.2, the following times can be set:
 - a) Time – the entered time is used
 - b) SR – sunrise time is used
 - c) SS – sunset time is used
- To – time when time schedule ends. Since firmware version 2.2, the following times can be set:
 - a) Time – the entered time is used
 - b) SR – sunrise time is used
 - c) SS – sunset time is used
- Power – it can be configured for proportional outputs (if the function is proportional or PWM). This field can be used here to enforce or restrict the output power as a percentage of the connected power. Thus, the output can be switched proportionally even when switched by the time schedule. Since firmware version 2.2, the Power item behaves differently depending on the time schedule mode and the Minimum power value for the PWM function. Conversion tables of the Power item to resulting PWM signal, or voltage 0-10V, follow. These conversion tables apply in the case of full PWM range (PWM Range item) and no output inversion:
 - a) Enforced mode:

Power [%]	Smallest PWM duty cycle [%]	Lowest voltage [V]
0	Cannot configure	Cannot configure
1	1	0,1
10	10	1
20	20	2
...		
90	90	9
100 (fully enforced)	100	10

Important: If the PWM output function is selected, a non-zero Minimum power is set, and the Power item is lower than what would correspond to the percentage excitation in the @ field, the output will not be forced. This serves as protection against powering the connected appliance outside the specified operating range.

Note: If in the Enforced mode the output power is set to be lower than 100%, then such enforcement does not deactivate the basic regulation mode according to excess energy. So if the output is forced to e.g. 50% and there is a surplus energy available to switch it to 75%, the output will switch to 75% power.

- b) Restricted mode:

Power [%]	Biggest PWM duty cycle [%]	Highest voltage [V]
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0 (fully restricted)	0	0
1	1	0,1
10	10	1
20	20	2
...		
90	90	9
100	Cannot configure	Cannot configure

Important: If the PWM output function is selected, a non-zero Minimum power is set, and the Power item is lower than what would correspond to the percentage excitation in the @ field, the output will be fully restricted. This serves as protection against powering the connected appliance outside the specified operating range.

Note: If in the Restricted mode the output power is set to be higher than 0%, then such restriction does neither deactivate the basic regulation mode according to excess energy nor the enforced time schedule. So if the output is restricted to e.g. 50% and there is a surplus energy available to switch it to 25%, the output will switch to 25% power.



In the Enforced mode, always keep the Power value equal to 100% in cases where the output is set to the proportional function, causing an increased flicker (fast changes in mains voltage or rapid flashing of light bulbs and fluorescent lamps). The output will always be permanently switched on when fully excited. A similar recommendation also applies to the Restricted mode, where the Power value should always be equal to 0%. See the flicker recommendation in the Frequently Asked Questions section of the manufacturer's website.

- M to S – shortcuts for weekdays. The time schedule will be active only on checked days.
- LT – this checkbox is not available since firmware version 2.2. It has been replaced by the more general Binary Input condition.
- Binary input – (since firmware version 2.2) if you mark this field, the time schedule activity additionally depends on the state of the binary input. The function is different depending on the time schedule mode:
 - a) Restricted mode – the output will be restricted only if a binary input is selected and it is switched off when the ON condition is set or switched on when the OFF condition is set.
 - b) Enforced mode – the output will be enforced only if a binary input is selected and it is switched on when the ON condition is set or switched off when the OFF condition is set.
- Energy – if you mark this field, the time schedule activity additionally depends on the status of the daily energy counter of the relevant output (the "Supplied energy" fields). Again the function differs based on the time schedule mode:
 - a) Restricted mode – the output will be restricted only if the daily energy counter exceeds the value specified in the Limit field.
 - b) Enforced mode – the output will be enforced only if the daily energy counter did not yet reach the value specified in the Limit field.
- Temperature – if you mark this field, the time schedule activity additionally depends on the temperature measured by the specified sensor. It is possible to select any D/Q or ANDI input, or in case of activating the S-Connect protocol, also any RT remote input. There are 2 types of temperature conditions and they always use temperature hysteresis which can be configured on the Other settings tab:
 - a) Less than – the output will be enforced / restricted only if the temperature is less than the assigned limit.

- b) Greater than – the output will be enforced / restricted only if the temperature is greater than the assigned limit.

Important: If the ANDI temperature input is selected for the Temperature field, or RT input, which is not configured for temperature measurement, or the selected temperature sensor is not functional, then the temperature condition is not used and a temperature sensor fault is emitted. Up to and including firmware version 1.7, this malfunction blocked the switching of all outputs. As of firmware version 2.0, this fault no longer blocks the switching of all outputs, but only the relevant time schedule. If the schedule is set to Restricted mode, then it will remain running for safety reasons, i.e. as if the temperature condition had not been set at all. If the time schedule is set to Enforced mode, then it will not run at all.

- Spot price – (since firmware version 2.3) if you mark this field, the time schedule activity additionally depends on the current price of electricity on the spot market. 2 conditions can be set:
 - a) Less than – output is forced/restricted only if the price is less than set.
 - b) Greater than – output is forced/restricted only if the price is greater than set.

Important: The time schedule won't work if the spot price is invalid!

Tip: Time schedules may also be set for an output which does not have any assigned priority. These outputs may be used for example, as time switch clock etc. Labels and "Connected power" field may be configured for these outputs using the Output settings tab. "Connected power" field of such output is then used to update the daily energy counter.

Note: The conditions described above combine with logic AND within one time schedule. If you need to create a logic OR combination, you need to add a second time schedule with the same time range and another condition. For example, if the schedule should restrict the output function in case where the energy counter exceeds the 5 kWh limit AND the temperature at the assigned input exceeds 60 °C, just use one time schedule where both conditions are set. If this should limit the output function in case where the energy counter exceeds the 5 kWh limit OR the temperature at the assigned input exceeds 60 °C, it will be necessary to use 2 time schedules with the same time limits but each set for a different additional condition.

Note: Impact-free transition to the basic regulation mode: If the condition necessary for the enforcement of a relay output no longer exists, a basic 10s delay is set for this output. This delay is used to ensure impact-free transition to the basic regulation mode. Similar method is also used for proportional outputs. User-defined off-delay time is not used here.

For more practical samples demonstrating configuration of time schedules, see the chapter Configuration examples.

OTHER SETTINGS TAB

On this tab you may configure general control settings and other advanced device settings.

Control settings:

- Control mode - it is used to set the basic control mode:
 - a. Each phase independently - the controller will control outputs according to measured active power on each phase wire separately. In this mode it is necessary to correctly set phases for all active outputs. They must correspond with the phase wire where the load is connected to.
 - b. Sum of all phases - the controller will control all outputs according to the sum of measured active powers from all three phases. In this mode it is not necessary to set phases for individual outputs as this does not matter.

- **Power offset** – this field specifies the difference between the actual sum of measured powers in 3 phases L1+L2+L3 and the value used for the control purposes. For example, if the actual sum of measured powers L1+L2+L3 equals to +500W and the power offset equals to -100W, the controller will use the value of 400W to determine the conditions for output switching. Above terms apply for the "sum of all phases" control mode. For the "each phase independently" control mode this power offset value applies for each phase independently. The lower (more negative) the power offset is, the more power consumption from grid is avoided in transitional statuses as well as in stable statuses where the proportional outputs pass only small amount of power to the load. Transitional statuses are usually identified by 4-quadrant energy meters as "movement around zero", where production and consumption indicators change irregularly and fast. Negative power offset avoid showing up the consumption indicator, but during normal and stable control statuses some surplus energy flows unused into public grid. If you use standard connection and configuration, then it is not recommended to use positive offset.
- **PWM frequency** - set the desired frequency for outputs with PWM function. This frequency is always the same for all outputs (and cannot be set differently by hardware). If the slow rate is set, the analog outputs SSR4 to SSR6 will have a significant output ripple. Therefore, if the SSR1 to SSR3 outputs are to be set at a slow frequency and the SSR4 to SSR6 outputs must have a small ripple, then this ripple must be eliminated by an additional RC filter.
- **Voltage calibration** - it is used to calibrate the voltage measured at the L1 phase. If the measured voltage differs from the reality by more than about 3V you can calibrate it by specifying the multiplier and the divider in the same way as for the External MT conversion ratio, see chapter Input settings tab. For example, a 100:99 calibration increases the measured value by about 2 V, whereas a 99:100 calibration will decrease it.



By entering incorrect values, the voltage value may go beyond the specified limits (200V to 260V) and the Missing voltage L1 error is emitted!

- **Internal DC source** - informs about the voltage value of the internal DC source of the controller. This value is used to check for eventual overloading of the internal power supply, which may lead to the "DC source overload" fault. See chapter Measured parameters and statuses for details.
- **Optimize internal relay consumption** - this feature tries to optimize the consumption of the built-in relays to decrease the probability that "DC source overload" fault is raised when the two relays are switched on. The feature is active only when both relays are switched on. For details about this fault state, see chapter Measured parameters and statuses. Before activating this function, it is recommended to reduce the DC source load on the + 12V and + 5V terminals, i.e. connect the control circuit of all used SSRs to an external power supply (see Figure 12) when the two internal relays are active.
- **Output test blocks control** - (since firmware version 1.6) this function is used to set the output behavior in TEST mode. If this option is checked, the test mode behaves as in all older firmware versions and thus activating any output to the TEST mode completely stops the control. If this option is unchecked, the TEST mode does not block the control of other outputs that are not in the TEST mode.
- **Output test timeout** - (since firmware version 1.6) this item is used to limit the duration of the TEST mode activity. If the entry is zero, the TEST mode is unlimited and behaves as in all older firmware versions. If the item is non-zero, the TEST mode will be limited to the specified time. The value is the same for all outputs. This new function can be used, for example, to temporarily switch an output in

manual mode, if it is necessary to quickly force a certain output to switch on for a limited period of time.

Network configuration:

- Controller IP address – IP address saved/stored in the controller. The controller uses this address to "listen" to all UDP and TCP/IP (HTTP) incoming requests.
- Subnet mask – a network mask to which the controller is connected.
- Default router IP address – we recommend using IP address of your router. Requests outside of the local network, except the DNS server, are directed to this address.
- DNS server IP address - (since firmware version 1.6) enter the IP address of your preferred DNS server.
- Controller MAC address – physical (MAC) address of the controller. Change this address only if there is a conflict between physical addresses in your local network. As of firmware version 2.1, it is not possible to change the first 3 bytes of the address (vendor identification).
- UDP port – port used by the controller to listen to UDP requests.
- HTTP port – port used by the controller to listen to HTTP requests.
- DHCP mode - (since firmware version 1.6) selects the mode of automatic configuration of network connection via DHCP:
 - a) none – DHCP is inactive, entire network settings have to be input manually as in case of all older firmware versions.
 - b) DNS – DHCP is only used to obtain the IP address of the DNS server (the device will use only the DHCP inform request or the DHCP discover request).
 - c) all – DHCP is used for complete network setup. Note that in this mode the IP address of the controller can be changed at any time, which may lead to loss of its accessibility e.g. from the Internet (NAT routing stops working). Recommended only for experienced users!



The network configuration will become effective after you reset the controller (see option "Reset unit on config. write").

Date and time settings:

- Synchronize date and time with the client - check this field if you want to synchronize the controller date and time with the actual time running in your PC. The date and time will be synchronized when the configuration is subsequently written.
- Synchronize date and time with time server - check this box if you want the controller to synchronize the date and time once a week with the time server on the Internet. In order for synchronization to work, the controller must be connected to the Internet, a valid time server IP address must be set and the default gateway IP address must also be set correctly. The moment of synchronization is calculated from the serial number of the controller and is different for each controller.



In order for the time server synchronization function to work, the controller must be connected to the Internet, the time server IP address or its domain name must be valid and the default gateway IP address must be set correctly!

- Time server (hostname) - time Server domain name. Here changes were made since firmware version 1.5:

Firmware since version 1.5: The time server name is stored directly in the controller and its IP is obtained automatically using the newly implemented DNS protocol. Then, the IP address of the time server is ignored. The default and recommended name is pool.ntp.org, which is a service that automatically assigns the IP address of a particular time server, based on the load of individual time servers and other criteria. You can use the "Test time server and get it's IP" button to verify the functionality of the server.

Firmware up to version 1.5: The controller does not save the time server domain name and it only appears in WATTconfig. Find the closest time server from available resources on the Internet, enter its domain name and press the "Test Time Server and Find IP" button.

- Time server IP address - time server IP address stored in the controller. Here changes were made since firmware version 1.5:

Firmware since version 1.5: The IP address of the time server does not need to be set and detected, just use a valid time server domain name. However, in case the IP of a time server cannot be found from its name, an attempt will be made to contact the time server specified by this IP. Therefore, it is possible to use this field as a backup solution to the specified domain name.

Firmware up to version 1.5: Set this IP either manually, or enter the time server domain name in the Time server (hostname) box, then press the "Test Time Server and Find IP" button.

- Use summer time - check this field if you want the controller to perform automatic switching between summer and winter time. Based on EU recommendations only summertime is supported, which starts at 2:00 CET on the last Sunday in March and ends at 3:00 CEST on the last Sunday in October. The summertime information is used to automatically modify the current time as well as the calculated sunrise time.
- Time zone - specify the time zone based on your country. The default value uses Central European time. This value is only used to modify the calculated sunrise time. Time zones outside of multiples of full hours are not supported.
- Test time server and get its IP - press to test the time server and determine its IP address. The IP address is written to the controller when the configuration is next written. Since firmware version 1.5 there is no need to use this feature, IP is detected primarily from the specified domain name.
- Synchronize time now! - press this button to instantly synchronize the time in the controller (without requiring configuration writing). If the Synchronize date and time with the client check box is checked, the time is set equal to PC time, otherwise the time server synchronization is performed (if properly configured, otherwise nothing will be done).

CombiWATT settings:

- CombiWATT delay time – specifies the time delay from the moment where PV-plant production is not detected anymore (after sunset) until CombiWATT can become active. It is recommended to increase the setting if you are frequently using electrical loads (other loads than those connected to the controller), which consume entire surplus energy of the PV-plant for long time. In this case, the controller cannot recognize that PV-plant production is not yet over.
- Time to activate CombiWATT – it displays the remaining time before activation of the CombiWATT mode. The value is equal to the "CombiWATT delay time" parameter, provided that some surplus

energy is still detected. If the value equals to zero and low tariff signal is detected at the same time, the system activates the CombiWATT mode for corresponding outputs.

- CombiWATT production limit – small amount of active production or surplus energy (single units or tens of Watts) may be detected for facilities with significant capacity loads (blocking capacitors, UPS stations, large number of switching sources, etc.), even though the inverter does not work. The cause may be even the inverter itself. In this case, the controller displays small amounts of positive active power in either phase wire. Reason for this is significant reactive power, which is drawn by those devices and measured by WATTrouter near the "recognition line" between production and consumption. Also watt meters produced by different manufacturers behave in similar way. This item partially tries to resolve this issue by setting additional offset valid for each phase wire.

For example, if the production limit equals to 0.05 kW, CombiWATT mode will already be initiated (provided that also other requirements for the initiation of this mode are met), even if the surplus falls below 0.05 kilowatt in each phase.

- CombiWATT – Energy counter reset – this field is used to reset energy counters, i.e. the "Supplied energy" fields in the main window. You have two options:
 - a) At sunrise: counters are reset if the time equals the sunrise time valid for this day.
 - b) At fixed time: counters are reset if the time is the same as the time set in the field called "Fixed time for energy reset".
- Fixed time of energy reset – it specifies a fixed time for energy counter reset mode according to fixed time (the previous paragraph, mode b).

Low tariff:

- Input - low tariff - (since firmware version 2.0) allows you to enter an input for low tariff signaling. You can enter the LT input (which was previously the only possible input for this signal), any ANDI input (which must be configured as a binary input) and any RI logic input when activating the S-Connect protocol (this can transfer low tariff information from any remote station).

RS485 (since firmware version 2.0):

- Protocol – select the protocol that will be used for communication via the RS485 line. These protocols are supported:
 - a) WATTconfig – non-public protocol, through which the controller communicates with WATTconfig. There can be only 1 controller on the RS485 line.
 - b) MODBUS RTU slave – MODBUS protocol. See chapter Description of the MODBUS protocol.
- Baud rate – (since firmware version 2.1) select baud rate for MODBUS RTU slave protocol. Other parameters are always 8N1, ie. 8 data bits, no parity and 1 stop bit.
- MODBUS slave address – enter the controller address for the MODBUS RTU slave protocol. The controller only answers those requests of the MODBUS RTU master that will be equipped with this address.

Geographic location:

- Latitude - enter the latitude (in degrees) here. The value is used to calculate the sunrise time and therefore, values specified in degrees are precise enough.
- Longitude - enter the longitude (in degrees) here. The value is used to calculate the sunrise time and therefore, values specified in degrees are precise enough.

Tip: By changing the longitude you may modify the sunrise time in order to reset energy counters according to your preferences, for example, based on how large area is covered by shadow, etc. If you are not sure, do not modify these values. The default geographic location is set to Central Europe (CZ).

Other settings:

- Temperature hysteresis - (since firmware version 2.3) set the temperature hysteresis value that will be used for the temperature conditions in the time schedules. Default value is 1°C (fixed hysteresis used in older versions).
- Consumption watchdog - (since firmware version 2.2) enter the value of the main circuit breaker in amperes if you need to ensure that the consumption on some phase does not exceed the limit of the main circuit breaker and it does not disconnect. If you have a three-phase circuit breaker (eg 3x25A), set the limit in one phase (ie 25A). When the consumption limit is exceeded, the controller disconnects the currently switched outputs.

Note: If the value of the main circuit breaker exceeds the measured range (e.g. a 25A circuit breaker used in a standard variant with a measuring range of 20A), you must set a limit for the consumption watchdog at most equal to the measuring range (e.g. 20A). Although the controller will measure larger currents inaccurately, it will measure higher values and the consumption watchdog will therefore work.

The consumption watchdog only works in the following cases:

- a) The configured limit in A is non-zero (positive).
- b) The control mode of each phase independently is set, so that the controller knows to which phase the given output is connected.

If a greater consumption is detected for a given phase than corresponds to the set limit in A, the controller gradually disconnects all currently connected outputs, if their disconnection makes sense.

The following conditions apply to output disconnection:

- a) The output is switched on.
- b) The checkbox "watch consumption" is marked for this output.
- c) The current power of the connected load (assumed or measured) is sufficient so that after disconnecting the output, the consumption on the given phase is less than the specified limit in A.
- d) If the current power of the connected load (assumed or measured) is not sufficient so that after disconnecting the output, the consumption on the given phase is less than the specified limit in A, then the given output is disconnected only when the options for disconnecting outputs ad c) have been exhausted.

The output is completely disconnected in 3s from the evaluation of all these conditions.

The following conditions apply to the reactivation of the output:

- a) The output is disconnected by the consumption watchdog.
- b) The current consumption per phase is low enough so that when the output is reconnected to any power level of the connected load, the consumption per phase is less than the specified limit in A.

The output will be reconnected in 60s from the evaluation of all these conditions.

If the output is disconnected by the consumption watchdog, this is indicated by a red indicator, as well as in the case of time schedule restrictions.

Note: If the output is set to three-phase mode (min., avg. or max.), then it means that a symmetrical three-phase consumer is connected. The latter can increase consumption both on its reference phase (that is, the phase that is set for it) and on other phases. As part of the calculations of the conditions for disconnecting this output, the maximum consumption on all phases is taken, not just the consumption on the reference phase.

Note: The regulator selects the appropriate output to disconnect exclusively according to the currently measured or expected power of the connected appliance. The priorities assigned to the outputs for the purpose of regulation according to PV surpluses do not play a role.

- Default tab - set the tab you wish to appear when you launch the WATTconfig program or web interface. For WATTconfig software this setting is stored on PC hard drive, the same settings in the web interface is stored directly in the controller.
- Default statistics tab - (since firmware version 1.6) set the subtab on Statistics tab you wish to appear when you launch the WATTconfig program or web interface. For WATTconfig software this setting is stored on PC hard drive, the same settings in the web interface is stored directly in the controller.
- Sort outputs by phase and priority - (since firmware version 2.3) check this field to sort outputs by phase and priority. This ordering may simplify the configuration of the device outputs in some situations. E.g. when activating the S-CONNECT protocol, when only logical RO outputs are used. The outputs will be sorted in the Output settings and Time schedules tabs, as well as in the Output status table.
- Reset unit on config. write - check this field if you want to restart the controller after each configuration was written. Controller reset is necessary to change the network settings.
- Language - select the language which you want the WATTconfig software to use after restart. The Custom item may be used for any other, still not supported language. If you want to use this option, you have to manually translate strings in the *custom.xml* file into the language you want to use.

Authorization settings:

- Require better HTTP security – check this to disallow passing plain text username and password in HTTP/XML requests (see chapter Description of web interface and XML communication). If checked the authorization will be made using a hash (XML node <sig> replaces here the nodes <UN> and <UP>) and username/ password cannot be changed using web interface anymore (nodes <UNn> and <UNp> cannot be used). If you use a superior system to modify the device configuration this option must be left unchecked because you will not be able to generate the hash there.
- New username - write a new username to authorize writing data to the controller via Ethernet interface.
- New password - write a new password to authorize writing data to the controller via Ethernet interface.

Note: New login data is written to the controller and can only be used after the configuration is written to the controller. WATTconfig will automatically change the previously saved login so you do not have to re-enter it later.

Wireless stations table:

As of firmware version 2.0, the wireless communication settings are part of the S-Connect protocol. For more detailed information on wireless communication settings, see the chapter S-Connect tab.

Note: When upgrading the firmware from an older version, the controller will try to convert the original settings of the wireless station table to the S-Connect station table, including the original settings of the remote WLS outputs.

Input settings for statistics:

As of firmware version 2.0, the source inputs for calculating data on the Statistics tab can be set more precisely. In older firmware versions, it was only possible to select ANDI inputs for measuring or capturing photovoltaic production, in the Measurement source field corresponding to the ANDI input. In newer versions, it is already possible to select inputs both for determining the production of photovoltaics and for determining (measuring) consumption and surpluses, for all 3 phases.

For any phase and any category (consumption, surplus and PV production) it is now possible to select any input that measures or captures information about the instantaneous active power. If the S-Connect protocol is activated, logic RP inputs can also be selected, which can provide active power information from remote stations.

- Consumption - the power measured by the assigned input is registered in the Cons. NT or Cons. LT fields of the relevant phase, according to the validity of the low tariff. If the assigned input is the same as the input in the Surplus column for the given phase, then only negative values are registered.
- Surplus - the power measured by the assigned input is registered in the Surplus field of the respective phase. If the assigned input is the same as the input in the Consumption column for the given phase, then only positive values are registered.
- Production - the power measured by the assigned input is registered in the Production field of the relevant phase.

As of firmware version 2.1, it is also possible to create a sum of up to 3 source inputs for each category and phase.

If the same input is assigned to several phases in a given category, then the measured power is divided evenly by the number of these phases.

Example: If the ANDI1 input is assigned to the Production field on all phases, then this means that the power of the three-phase PV-inverter is determined by this input, and this power is evenly divided into three phases.

By default, the IL1-3 inputs are set to detect consumption and surpluses, as was the case in older firmware versions, and the production inputs are unoccupied.

Note: When upgrading the firmware from an older version, the controller will try to convert the original ANDI input settings (Measurement source settings) to the Production items.

Firmware update:

- Update firmware button - allows you to update firmware of this product. You can find firmware updates in the Download section at the manufacturer's website. If there is an update available you may download it and install it. The progress of the update process is indicated on screen and it takes (based on your connection type and speed) between 20 to 60 seconds. Firmware update via LAN interface is protected from unauthorized access or intervention.



Update of original firmware is completely safe. The system fully and thoroughly inspects the integrity of the update file, as well as the integrity of data after downloading. In case of a power failure during the update, you may download the firmware again at any time after your power is restored. If possible, download your firmware via USB or ONLY from your local network (should an error occur during the download, the controller remembers the original network setting only for about 2 minutes). Should you experience an unsuccessful firmware update repeatedly, you may file a claim pursuant to valid trade terms and conditions. It is strictly prohibited to modify the downloaded file in any way. If you modify the downloaded file and even if the system inspected the integrity, you may still damage your product and lose your warranty!

Cloud services:

Cloud services button – opens a dialog box where XML based data exchange in web client mode can be configured for supported cloud services. This feature is available since firmware version 1.5. See chapter Cloud services.

S-CONNECT TAB

As of firmware version 2.0, the S-Connect protocol can be configured on this tab.

For more information on the S-Connect protocol itself, see chapter S-Connect protocol settings.

- Communication mode - selects the protocol mode for this unit:
 - a) Turned off - the protocol is not used. If the protocol is switched off from the previous active state, its entire configuration (station table and device mapping) is deleted and the data exchange with the unit is terminated.
 - b) Access Point (AP) - the unit acts as an access point that controls the operation of remote stations and their pairing.
 - c) Station (STA) - the unit acts as a station that responds to access point messages.

Note: If the S-Connect protocol is activated (ie AP or STA modes), then the configuration options of logic devices are displayed in the control interface of the device.

Note: If the SC-Gateway module is inserted in the device, the communication mode is automatically set to access point (AP). If the SC-Router module is inserted in the device, the communication mode is automatically set to the station (STA). Therefore, when inserting these modules, the S-Connect protocol cannot be switched off or set to another mode.

Note: Activating the S-Connect protocol does not block other functions of the device, as was the case when the SC-Router module was inserted in older firmware versions. It is thus solely the user's choice which functions of the device to use. If the device is only used as a station for expanding the number of outputs, it is recommended not to activate local control functions, which themselves affect the switching of outputs, unless the user has a good reason to do so.

- Autodetect new stations – (since firmware version 2.3) this option affects the station pairing on the Ethernet line:
 - a) Automatic detection (default behavior, option is checked) – new stations will be paired automatically according to the UDP or ARP broadcast messages.
 - b) Manual detection (option is not checked) – new stations must be paired manually by pressing the Manually detect station button.
- Delete ignored stations – when checked, this will clear all stations that were previously rejected by the user, ie the request to pair them was rejected (Ignore button). This option will allow you to re-pair previously rejected stations. The option is only enabled if some previously rejected stations are stored in the controller. For this option to be effective, the configuration must be written to the controller.
- Detect station manually – (since firmware version 2.3) – in manual pairing mode, press this button and then enter the IP where a new station is available. The controller will try to find the station. The detection may take longer time depending on the type of station (usually 2-60s).

Remote station table:

This table shows the essential data of the paired stations. The number of table rows varies depending on the communication mode. In the case of an access point, the table has 6 rows, so a maximum of 6 remote stations can be added. In the case of a station, the table has only 1 row, which is reserved for access point information.

- Type – indicates the type of station, which can be:

- a) Not used – the table row is not used
- b) Ethernet – (AP only) the station communicates via a computer network (Ethernet or WIFI)
- c) Tasmota HTTP – (AP only, since firmware version 2.3) the station equipped with the Tasmota firmware communicates via a computer network (Ethernet or WIFI)
- d) Shelly HTTP – (AP only, since firmware version 2.3) the station equipped with the Shelly firmware communicates via a computer network (Ethernet or WIFI)
- e) Wireless – (AP only) the station communicates wirelessly via the embedded SC-Gateway
- f) Access point – (STA only) this is the access point
- MAC address – the MAC address of the station is displayed in this field. For stations communicating via Ethernet this is the Ethernet MAC address (last 6 bytes, the first 2 bytes are zero), for stations communicating via the SC-Gateway wireless interface this is the wireless MAC address (8 bytes).
- Name – in this field you can name the station. If the name is not filled in by the user, it is pre-filled in from the station identification data if these are transmitted via the S-Connect protocol (for stations communicating via Ethernet, the station name is transmitted, for wireless sockets it is not transmitted).
- Configuration name – this field displays the name of the station's configuration, if this information is supported by the station and has been filled in.
- Serial Number – this field displays the station's serial number, if supported by the station.
- IP Address – (Ethernet only) this field displays the IP address that is currently assigned to the station.
- LQI – this field displays information about the signal quality of the station's connection. For stations communicating via Ethernet, 100% is always displayed because this physical layer does not communicate the relevant data. For stations communicating via WIFI, the RSSI parameter converted to percentage value is displayed. For stations communicating via the SC-Gateway wireless interface, the signal quality between the station and the nearest access point is displayed (this is either the SC-Gateway or the nearest signal repeater).
- Message counter – this field shows the number of messages that have been sent to the respective station. If the number of messages exceeds 2^{32} , the messages are counted again from zero.
- Ping – this field displays the station response in milliseconds. The term response refers to the actual response of the station from the moment a message is sent to the station to the receipt of the response, increased by a pause in the communication which is inserted by the access point. Communication pauses are necessary to maintain communication stability and to optimize the use (non-overloading) of the controller's network interface.

Note: The access point operates all stations of the same type cyclically. The response thus increases in proportion to the increasing number of stations of the same type in the station table. For example, if all 6 stations are occupied and all are of the same type (eg Ethernet), then the response will usually be 6 times longer than the response of one station (if we consider a similar response for all stations). If a station is unavailable, then the station response increases by a preset response timeout.

- Station status indicator – is displayed in green when the station is connected.
- Clear entry button – removes the station, ie cancels the pairing. For the change to take effect, it is necessary to write the configuration to the controller.

Device mapping table:

In this table, the source devices of the station are assigned to the destination (logic) device of the controller. Each line defines one usable device. New mapping can be added by pressing the Add entry button. A maximum of 32 devices can be mapped in total.

- Station – in this field the remote station is selected from the station table.

- Device type – in this field the device type is selected. Since firmware version 2.3, the number of published source devices of a certain type is indicated in parentheses. If no number and brackets are displayed, then the remote station does not publish any source devices of this type.
- Source device – the source device is selected in this field. If the source device cannot be selected, then the station either does not publish any physical device for the type, or a map of available devices has not yet been retrieved from the station. The source devices are generally named with identical names as the respective inputs and outputs of the station.
- Direction – this field displays the direction of data flow between the source and destination devices. For input devices (binary input, temperature, power) the data is transferred from the source to the destination, for output devices (output) it is the other way around. For memory cells, the direction depends on what value is stored in it.
- Destination device – in this field the destination device is selected. If the destination device cannot be selected, then the controller (local unit) does not publish any logic device for that type. The destination (logic) devices are the following:
 - a) RI - remote binary input
 - b) RT - remote temperature input
 - c) RP - remote power meter
 - d) RO - remote output
 - e) RV – remote voltage meter (since firmware version 2.3)
 - f) M - memory cell
- Label – this field displays the label of the source device. These labels are also transmitted via the S-Connect protocol, with the exception of its wireless version (through SC-Gateway).

Note: The label can be filled in for the RO logic outputs in the output settings table in the same way as for the SSR outputs and relays. If the name is not filled in by the user, it is pre-filled with this source device label.

- Value – this field displays the current value of the source device that is transmitted via the S-Connect protocol. The value is displayed in the given units; the excitation in percent is displayed for the outputs.
- Ping – this field displays the response of the source device in milliseconds. The term response here means the cumulative response on the entire communication path from source to destination. If the source-destination communication does not take place via memory cells, but directly, the response of the device is equal to the response of the station. If memory cell communication is involved, then the device response is the sum of the responses of all participating stations.
- Device status indicator – is displayed in green when the device is connected and working.
- Clear entry button – removes the device, ie cancels the mapping. For the change to take effect, it is necessary to write the configuration to the controller.

If an invalid or duplicate mapping is stored by the user, then the controller will delete it itself after writing the configuration. Invalid mapping is that one where some data is not selected correctly. Duplicate mapping is that one where the same source output is used in 2 or more mappings or the same destination device is used in 2 or more mappings.

Communication mode:
☐ Clear ignored stations

Remote station table

Type	MAC address	Name	Config. name	Serial number	IP address	LQI [%]	Msg. count	Ping [ms]	
ethernet	0.0.232.233.142.32.0.3	Heating Control	Test. config.	48000003	192.168.2.62	100	5226	90	
ethernet	0.0.232.233.142.128.4.137	WATTrouter Mx		00000000	0.0.0.0	0	0	0	
wireless	0.21.141.0.0.23.104.168	Socket		00000000	0.0.0.0	37	388	1090	
unused	0.0.0.0.0.0.0.0			00000000	0.0.0.0	0	0	0	
unused	0.0.0.0.0.0.0.0			00000000	0.0.0.0	0	0	0	
unused	0.0.0.0.0.0.0.0			00000000	0.0.0.0	0	0	0	

Device mapping table

Station	Dev. type	Src.device	Dir.	Dest.device	Label	Value	Ping [ms]	
Station 3 (Socket)	output	R1	←	RO2		0 %	1090	
Station 1 (Heating Control)	temperature	T1	→	RT1	Test temperature	24.4 °C	90	
Station 1 (Heating Control)	output	Re1	←	RO1	Test output	100 %	90	

Figure 18: Example of access point configuration. 3 stations are paired, one of which (WATTrouter Mx in the 2nd position in the station table) is disconnected. The device table maps 3 devices, 2 logic outputs RO1, RO2 and one logic temperature input RT1.

Important information for input mapping

If the device is not functional, or the corresponding mapping has been disconnected or canceled, then the default values are used for the respective input logic devices. They are:

- RI - logic 0 is used, ie input is disconnected.
- RT - temperature 0 °C is used.
- RP - power 0W is used.
- RV – voltage 0V is used.

Important information for output mapping

For output logic devices, the physical outputs of the source (remote) station are mapped to the logic outputs of the destination (local) station. The destination outputs are abbreviated RO (previously these outputs were intended for wireless communication only and were abbreviated WLS). Within the SOLAR controls s.r.o. product range they can have different types and can have different functions assigned to them.

The supported output types in the current version of the S-Connect protocol are as follows:

- Relay - the output is an electromechanical relay. An example is the relay output of any wattrouter.
- PWM - semiconductor output that allows relay switching or pulse width modulation. An example is the Ext output of the Heating Control controller.
- SPC - semiconductor output that allows relay switching or zero switch proportional control. An example is the triac output of the Wattrouter M controller.
- PWM_SPC - semiconductor output that allows relay switching, zero switch proportional control and pulse width modulation. An example is the SSR output of any wattrouter.

The output type is transmitted by the S-Connect protocol from the source (physical) to the destination (logic) device and can be used by the local unit to determine the compatibility of the given control algorithm with the respective output type.

Caution: *Not all devices support all types of outputs! For example, the Wattrouter Mx does not support the SPC type because it does not have built-in triacs like the Wattrouter M. In contrast, the Heating Control controller does not support SPC and PWM_SPC outputs because it does not contain algorithms for proportional control. It is necessary to keep this in mind when expanding the number of outputs and selecting the appropriate expansion unit!*

The Wattrouter Mx controller fully distinguishes the output types and does not allow the user to activate such control algorithms that would not respect this. Wattrouter Mx also checks the validity of the received values for switching its outputs. If the received value for the relay output is different from the off and on state, the relay switches in slow pulse width modulation mode with a period of 10 minutes.

The supported output functions in the current version of the S-Connect protocol are as follows:

- a) Relay - the output can only be switched off or on.
- b) SPC - the output performs zero switch proportional control.
- c) PWM - the output switches in pulse width modulation mode.

The output function is transmitted by the S-Connect protocol from the destination (logic) device to the source (physical) device, and the source unit can use it to determine the switching algorithm of the output if the output allows multiple algorithms.

Example 1: *The source and destination units are both Wattrouter Mx. The source unit only provides output expansion for the destination unit, which provides basic control of PV excess energy. The source wattrouter uses the S-Connect protocol to inform the destination wattrouter that it has an SSR1 output, which is of the PWM_SPC type, thus enabling 3 algorithms for switching. The user maps this output in the destination wattrouter to the logic output RO1 and all 3 functions (relay, continuous control, PWM) are displayed in the Function field of RO1. The user selects the function, eg proportional control. The function is transferred back to the source device via the S-Connect protocol, which will then switch the SSR1 output in proportional control mode.*

Example 2: *The source unit is Heating Control; the destination unit is Wattrouter Mx. The source unit only provides output expansion for the destination unit, which provides basic control of PV excess energy. The source wattrouter uses the S-Connect protocol to inform the target that it has an Ext1 output, which is of the PWM type, so it allows only 2 algorithms for switching (relay or PWM). The user maps this output in the destination wattrouter to the logic output RO1 and only 2 functions (relay and PWM) are displayed in the Function field of RO1. The user selects the function, eg PWM. The function is transmitted back via the S-Connect protocol to the source device, which then switches the Ext1 output in pulse width modulation mode.*

STATISTICS TAB

This tab displays daily, weekly, monthly and annual statistics on production, consumption and surplus (excess) energy. Statistics can be exported to *.csv files if desirable.

Note: *The controller stores basic statistics into the internal EEPROM memory and more detailed statistics on the SD card. These more detailed statistics cannot be displayed in WATTconfig or in a web interface, but can be imported from the SD card to a computer as a *.csv file, which can be opened, for example, in MS Excel.*



Through the current sensing module it is only possible to measure consumption and surplus data using IL1-3 signals. In order to display data on production and self consumption, it is necessary to add photovoltaic power measurements. As of firmware version 2.0, this means setting the

appropriate input carrying active power information in the Production field in the Input settings for statistics on the Other settings tab. It is possible to use any ANDI input or, when activating the S-Connect protocol, a remote RP input. It is necessary to connect pulse output from an external electricity meter, which measures the power and energy from the inverter, to the appropriate ANDI/RP input. Or to measure the power directly by connecting an external current transformer to the ANDI/RP input. Alternatively, connect inverter directly to the respective input when the inverter is equipped with a compatible impulse output.

Values are approximate! The device does not know the exact values from utility/billing meters!



Daily statistics are reset every time just after midnight, i.e. at 0:00 A.M. At the same time, daily values from the just finished day are moved into history. When you change the date in the controller you may cause irreversible deletion of stored history!

Real time chart (since firmware version 1.6):

Up to 7 rows can be selected in this line chart, which can display power or temperature curves. You can select a time base of acquiring values from 1 second to 10 minutes. The maximum number of points on the time axis of the chart is 144 (when selecting a ten-minute period it corresponds to 1 day). The chart data are not stored in a non-volatile EEPROM, and therefore after a reset, or if there is a power failure, the data is deleted. The data will also be erased each time you reconfigure this chart.

- Time base - configure the period of reading values into the chart.
- Series 1-7 - dropdown menus configure the input or output to be loaded into the corresponding chart series. As of firmware version 2.0, if the S-Connect protocol is activated, any logic input or output that contains power or temperature data can also be displayed in the chart.
- Export - exports chart data to a *.csv file that can be opened e.g. in MS-Excel.

Daily statistics:

- Show for day –select the date for which to view daily statistics. You can display them for current date and last 31 days.
- Phase Lx–displays information about the surplus (excess) energy, normal and low price energy tariff as well as (optionally) PV-production, when counted with an ANDI input, in the current or selected day.
- Total L1+L2+L3 – displays summary data from all three phases. The calculation of these data depends on the selected control mode -the "Control mode" field on the Other settings tab:
 - a. Each phase independently – summary data are simply the sum of the fields from all 3 phases
 - b. Sum of all phases – summary data are updated continuously from immediate results. **In this control mode summary data are not the simple sum of the displayed values in each phase** (in one phase the surplus energy may cover consumption in different phase, etc.).
- Daily output status- displays the assumed or really measured amount of energy supplied to each load in the current or selected day. **Since the statistics are reset every time just after midnight, these values will not correspond with the values in the fields "Supplied energy"**(reset of those fields is generally done at different time).
- Daily ANDI input status- displays the measured energy at corresponding ANDI input in the current or selected day. In brackets on the right, the configured measurement source is also displayed. If ANDI input is configured to measure temperature, the item always remains zero. Temperatures are not counted in stats.
- Read from SD card – use this button to read more detailed statistics from the built-in SD card. These statistics will be saved to a *.csv file which you can load e.g. in MS Excel.
- Erase internal stats – use this button to delete all statistics stored in the built-in EEPROM memory. Confirmation dialog will be shown first.
- Erase SD card stats – use this button to delete all statistics stored in the built-in SD card. Confirmation dialog will be shown first.

- Charts – they show a graphical interpretation of the daily statistics on production and consumption. Charts in each phase indicate the part of corresponding summary data (pie slice or part of the bar). The self-consumption value is calculated from this formula: $\text{self-consumption} = \text{production} - \text{surplus energy}$. Self-consumption values are not available unless the displayed production value is bigger than measured surplus energy value.

Note: For very small energy values (typically immediately after resetting statistics after midnight) internal rounding to 0.01kWh is significant for displaying the charts. In these cases, pie charts may not be displayed absolutely correctly.

Weekly statistics:

- Chart - shows the 5 main summary data (production, surplus energy, self-consumption, consumption in normal and low tariff) in bars for the last 7 days. Double click on the bar to view the day in the daily statistics.

Monthly statistics:

- Production chart - displays summary data on production (production + surplus energy) in the last 31 days. Double click on the bar to view the day in the daily statistics.
- Consumption Chart - displays summary data on consumption (self-consumption, consumption in normal and low tariff) in the last 31 days. Double click on the bar to view the day in the daily statistics.
- Export - exports monthly statistics to a *.csv file that can be opened e.g. in MS-Excel.
- Import - imports monthly statistics from the *.csv file. The file must contain monthly statistics stored in WATTconfig Mx, M, or ECO. This feature can transfer statistics from another device. The daily input and output states are not imported. This import only replaces internal statistics and does not affect data stored on the SD card.

Annual (yearly) statistics:

- Production chart – displays summary data on production (production + surplus energy) in the last 12 months.
- Consumption Chart – displays summary data on consumption (self-consumption, consumption in normal and low tariff) in the last 12 months.
- Export - exports annual statistics to a *.csv file that can be opened e.g. in MS-Excel. Exports data for last 24 months.
- Import - imports annual statistics from the *.csv file. The file must contain annual statistics stored in WATTconfig Mx, M, or ECO. This feature can transfer statistics from another device. This import only replaces internal statistics and does not affect data stored on the SD card.

Note: Actual day will take effect in the annual history (current month) after moving into history (after midnight).

All time statistics:

- Counted from date – this is the day where counting all time statistics started from.
- Phase Lx – displays information about the surplus (excess) energy, normal and low price energy tariff as well as (optionally) PV-production, when counted with an ANDI input, in the current or selected day.
- Total L1+L2+L3 – displays summary data from all three phases. The calculation of these data depends on the selected control mode - the "Control mode" field on the Other settings tab:
 - c. Each phase independently – summary data are simply the sum of the fields from all 3 phases
 - d. Sum of all phases – summary data are updated continuously from immediate results. **In this control mode summary data are not the simple sum of the displayed values in each phase** (in one phase the surplus energy may cover consumption in different phase, etc.).
- Charts – they show a graphical interpretation of the daily statistics on production and consumption. Charts in each phase indicate the part of corresponding summary data (pie slice or part of the bar). The self-consumption value is calculated from this formula: $\text{self-consumption} = \text{production} - \text{surplus energy}$. Self-consumption values are not available unless the displayed production value is bigger than measured surplus energy value.

Note: All time statistics may not match the summarized values in annual statistics as this feature was first added in firmware version 1.5. All time statistics are not retrospectively deducted from annual statistics when updating to version 1.5.

Statistics on SD card

Data is saved to the SD card after the end of the previous day (after midnight). The daily record of the day just passed is saved. If the names of inputs and outputs are changed during the past day, a new line with column labels is also saved.

The data is saved in the stats.csv file in the root directory of the SD card. The file can be loaded with the Read from SD card function and deleted with the Erase SD card stats function (buttons on the Day tab).

The structure of the data in the file is as follows:

- Date – date (day)
- L1surp. - excess L1
- L1consHT – high price tariff consumption L1
- L1consLT – low price tariff consumption L1
- L1Prod. – production L1
- L2surp. - excess L2
- L2consHT – high price tariff consumption L2
- L2consLT – low price tariff consumption L2
- L2Prod. – production L2
- L3surp. - excess L3
- L3consHT – high price tariff consumption L3
- L3consLT – low price tariff consumption L3
- L3Prod. – production L3
- Surp. – excess L1+L2+L3
- ConsHT – high price tariff consumption L1+L2+L3
- ConsLT – low price tariff L1+L2+L3
- Prod. – production L1+L2+L3
- SSR1 – RO8 – daily statuses of internal outputs SSR1-Relay2 and remote outputs RO (original name WLS until firmware version 1.7)
- ANDI1 – ANDI4 – daily states of ANDI inputs

Note: Decimal numbers are stored on the SD card with a decimal point. When processing in the localized spreadsheet (e.g. MS Excel), it is usually necessary to import the file (Import data from text function) and choose the correct decimal place separator (the value separator is a semicolon, the decimal place separator is a period). So it is not enough to just open the file, because then the decimal numbers will be loaded incorrectly. Also see the spreadsheet help.

LOG TAB

This tab displays error and warning log. For example, the system displays detected communication errors. Since firmware version 1.5, there is also a listing of up to 20 error messages stored in the controller from the latest to the oldest. This error list is stored in the nonvolatile memory (EEPROM) so that it remains saved in the controller in case of a power failure.

- Clear error list - press this button to clear the error list in the controller.
- Save error list - press this button to save the error list to a CSV file on your PC hard drive.
- Clear log – use this button to clear log contents.
- Save log – use this button to save the log as text file on your PC hard drive.
- Write detailed communication info - check this option to see more detailed information about communicating with the controller, for example for diagnostics. Additional information may help the technical support to detect possible problems in connection configuration etc.

OPTIONS AND BUTTONS

Main window buttons:

- Connect through – this option allows you to connect via USB/RS485 or LAN.
- Connect – connects your computer to the controller and loads configuration from the controller just after successful connection has been established.
- Disconnect - disconnects your computer from the controller.
- Configure connection - the software displays a window where you may configure active connection.
- Read – reads configuration from the controller.
- Write – writes (downloads) configuration to the controller and optionally resets the controller. Configuration download via LAN interface is protected from unauthorized access or intervention.
- Open - loads configuration from PC hard drive.
- Save - saves configuration to PC hard drive.
- Reset to defaults – loads default configuration settings in WATTconfig (you have to write it then to the controller).
- Exit - exits WATTconfig software.

USB/COM DRIVER CONFIGURATION WINDOW

In this dialog box you may specify connection parameters for the USB or RS485 interfaces.

Port settings:

- Port – if the driver is properly installed and the controller is connected to the computer, the appropriate COMx port can be found in the pop-up menu. If multiple or none ports are shown make sure that the USB serial port or your RS485 converter driver installation in Device Manager is correct. Here, you can also find out which port is used for communication. The communication parameters are fixed: 115200 Bd, 8N1.

Timeouts:

- Default read timeout – maximum time necessary to receive response from the controller. Modify the value (increase) only if you experience communication problems.

Buttons:

- Default – sets default communication parameters.
- OK, Cancel – standard confirmation and cancellation of the dialog box.

LAN/UDP DRIVER CONFIGURATION WINDOW

In this dialog box you may specify Ethernet interface parameters and UDP protocol settings.

UDP protocol settings:

- Select profile - it is used to select connection profile. Connection profiles are used to quickly configure connection settings. They are useful e. g. for connections from local and public networks where you must switch between two IP addresses. New profile may be created by pressing the "New" button. The new profile stores the current IP address and UDP port settings. Created profiles may be deleted by the Delete button.
- IP address (IPv4) – IP address used to access the controller. You may specify the controller IP address in your local network, or if you use suitable NAT settings for your router you may also specify the global Internet address of your router. Before you changing the IP address, you have to change the IP address settings directly in the controller - see the "Other settings" tab.
- UDP port – UDP port used to access the controller. The default value is 50000.

Note: If you cannot establish communication via Ethernet, connect via USB and check the current LAN settings in the controller.

Timeouts:

- Default read timeout – maximum time necessary to receive response from the controller. Modify the value (increase) only if you experience communication problems.
- Communication delay after reset – if you are connected via LAN the "reestablishment" of the connection after the controller reset may take longer than if you are connected via USB or RS485. Modify the value (increase) only if you experience communication problems after controller reset (typically, after you loaded new firmware to your controller).

CLOUD SERVICES WINDOW

In this window, you can set options related to data exchange functionality in web client mode for cloud services as described below. This feature is available since firmware version 1.5.

In this mode, the controller periodically sends the specified data record to the specified server using the HTTP protocol. Data can be processed by any user script on the server. The advantage of this communication is that the controller works as a regular web browser and does not require a fixed IP address as in the case of standard access to the controller from the Internet.

Feature configuration:

The data has the format described in chapter Data record for web client based XML exchange.

- Cloud service provider - select a cloud service provider. One of the following options can be selected:
 - a. None – the controller will not send any data.
 - b. XML exchange based on the web client – the controller will send the data specified in chapter Data record for web client based XML exchange.
 - c. Sophistio Cloud – (since firmware version 2.4) the controller will send data for the cloud service Sophistio.com. After selecting this service, the program will pre-fill the other fields in this window with data valid for the Sophistio.com cloud service.
- Server hostname – enter domain name of the server accepting data.
- Script URL – enter script URL on this server.
- Identification token – enter the security identifier/key assigned by the relevant cloud service for this device. Copy the data from the user interface of the respective cloud service. If you cannot write in this field, identification is not supported by the device or the given cloud service.
- Write access enabled - check this box if you want the cloud service to be able to change the configuration of the device remotely. If this box cannot be checked, data writing is not supported by the device or the given cloud service.
- HTTP port – enter a port where the server listens to these HTTP requests.
- Sending period - specify the periodicity of the transmitted data. Can be set from 1 s to 86400 s (1 day). Some cloud services may change this item themselves.
- Successful exchanges – can be used to check the connection and functionality of this feature. This counter is incremented after each successful data exchange.
- Error code – this code is useful for diagnostics of the connection and the functionality of sending data to the server. A zero will be displayed if the data link is functional. In other cases, contact the technical support of the respective cloud service.

LED STATUSES

The following table shows possible controller statuses indicated by built-in LEDs.

LED	Status	Note
LED PWR (green)	On	The controller is switched on and no output is active.
	Flashes	The controller is switched on and some outputs are active.
	Flashes quickly	The controller is switched on and boot mode is active.
	Off	The controller is without power supply or there is a failure.
LED COM (yellow)	Off	Communication with computer via USB was not established.
	Stays on or flashes quickly	Communication with computer via USB was established.
LED ERR (red)	Off	No error status detected.
	Flashes regularly in the following way: short- short- short	Missing voltage L1 error. Proceed according to instructions specified in the chapter Measured parameters and statuses.
	Flashes regularly in the following way: short- long- short	Wrong voltage value at L1. Proceed according to instructions specified in the chapter Measured parameters and statuses.
	Flashes regularly in the following way: short- short- long	Temperature sensor(s) error. Proceed according to instructions specified in the chapter Measured parameters and statuses.
	Flashes regularly in the following way: long- long- short	DC source overload. Proceed according to instructions specified in the chapter Measured parameters and statuses.
	Flashes regularly in the following way: long- short- long	SD card error. Proceed according to instructions specified in the chapter Measured parameters and statuses.
	Flashes regularly in the following way: long- short- short	S-Connect: device error. Proceed according to instructions specified in the chapter Measured parameters and statuses.
LED OUT	Off	The relevant output is not active.
	On or flashes quickly	The output is active (switched on)
LED on LAN connector - right green	Off	No Ethernet signal detected.
	On	Ethernet signal detected.
	Flashes	Data transfer active
LED on LAN connector - left yellow	Off	Data rate is 10 Mbit/s.
	On	Data rate is 100 Mbit/s.
LED PWR (blue) under the lid of regulator.	Off	SC-Gateway module is not powered or module error.
	Flashes quickly	SC-Gateway module is being initialized after power on.
	Flashes slowly	SC-Gateway module has been

		initialized and running.
LED PWR (blue) under the lid of regulator.	Off	SC-Gateway module is not powered or module error.
	Flashes quickly	SC-Gateway module is being initialized after power on.
	Flashes slowly	SC-Gateway module has been initialized and running.
LED LINK (yellow) under the lid of regulator.	Off	No wireless communication.
	On or flashes quickly	Indicates wireless communication.

CONFIGURATION EXAMPLES

The examples below only illustrate the possible use of the device; in most cases it may be necessary to adjust the settings.

The examples were created in version 1.0 of the software. In newer versions there may be other advanced options to further increase the efficiency of the system.

EXAMPLE NO. 1 – ONE LOAD ONLY

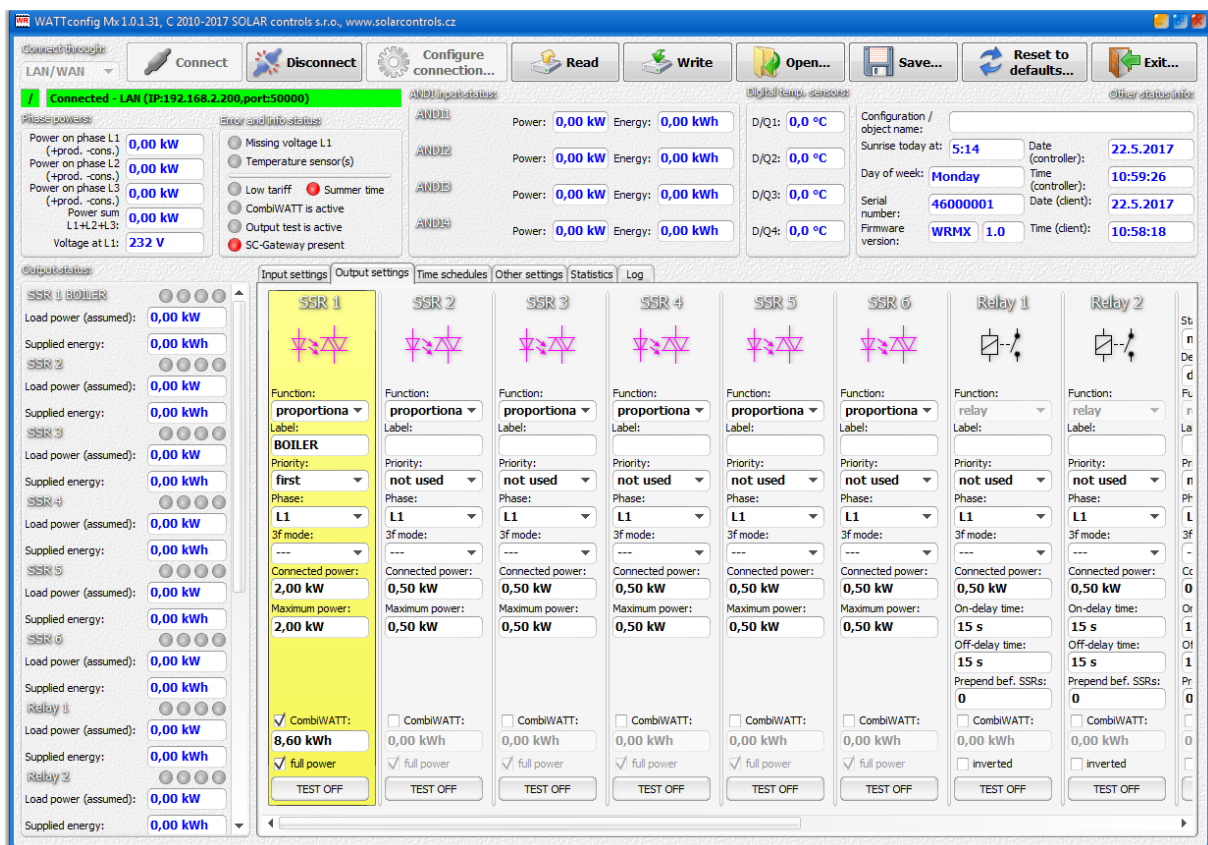
Boiler with nominal power rating of 2 kW, 200l of water, average cold water temperature at the input is 12 °C, hot water target temperature 50 °C, average daily water consumption is 160 l. The daily amount of electric power necessary to heat up the entire boiler (without taking into account heat losses) is:

$$E = \frac{c_v * V[l] * \Delta T[K]}{3600000} = \frac{4180 * 200 * 38}{3600000} = 8.82 \text{ kWh}$$

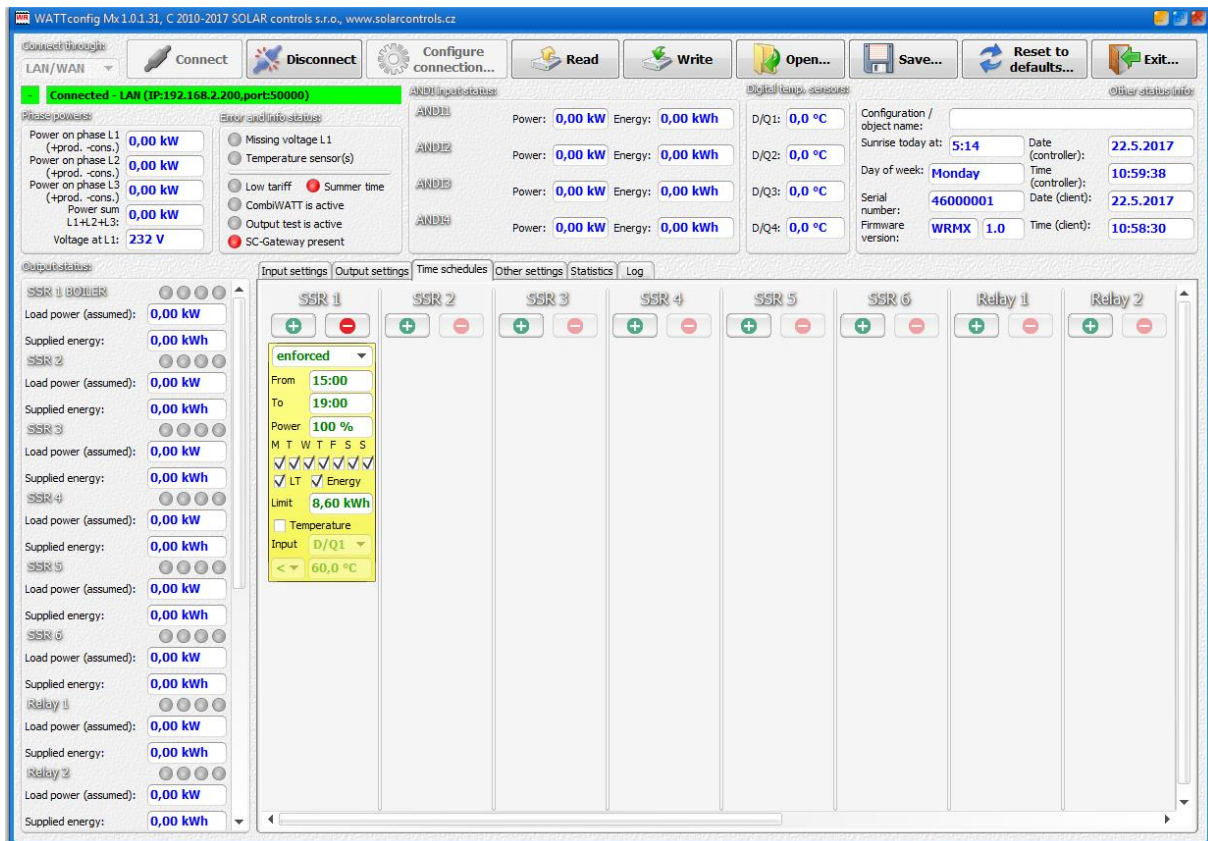
Average daily losses of boilers with these parameters represent approximately 1.5 kWh. If you use 160 l of hot water and you take into account heat losses, the daily supply of electric power is approximately 8.6 kWh.

Boiler is connected to SSR output No. 1, WATTrouter device uses low tariff signal and the boiler operates under CombiWATT mode.

With the "Each phase separately"-control mode set, in this configuration with one appliance connected to L1 we cannot use surpluses in phases L2 and L3. In the "Sum of all phases"-control mode, it is irrelevant to which phase wire the boiler is connected and the Phase fields cannot be changed. The "Sum of all phases"-control mode is better, but your 4-quadrant meter must allow it.



The time schedule is configured for the boiler between 15:00 and 19:00. It becomes active only if the low tariff is available and, moreover, until the supplied energy to the boiler did not exceed the specified limit. This allows you to heat up water for evening use, provided that during morning and afternoon hours the boiler was not sufficiently heated up by power supplied by the PV-plant. If low tariff is not active from 15:00 to 19:00, the basic control mode according to available surplus energy continues even during this time period.



EXAMPLE NO. 2 – 6 LOADS, CONTROL MODE = SUM OF ALL PHASES

The same boiler as specified in example No. 1, swimming pool filtering pump and 6 kW instantaneous water heating for the swimming pool (pump and three-phase heating element). Recommended peak power output of the PV-plant is more than 8 kWp.

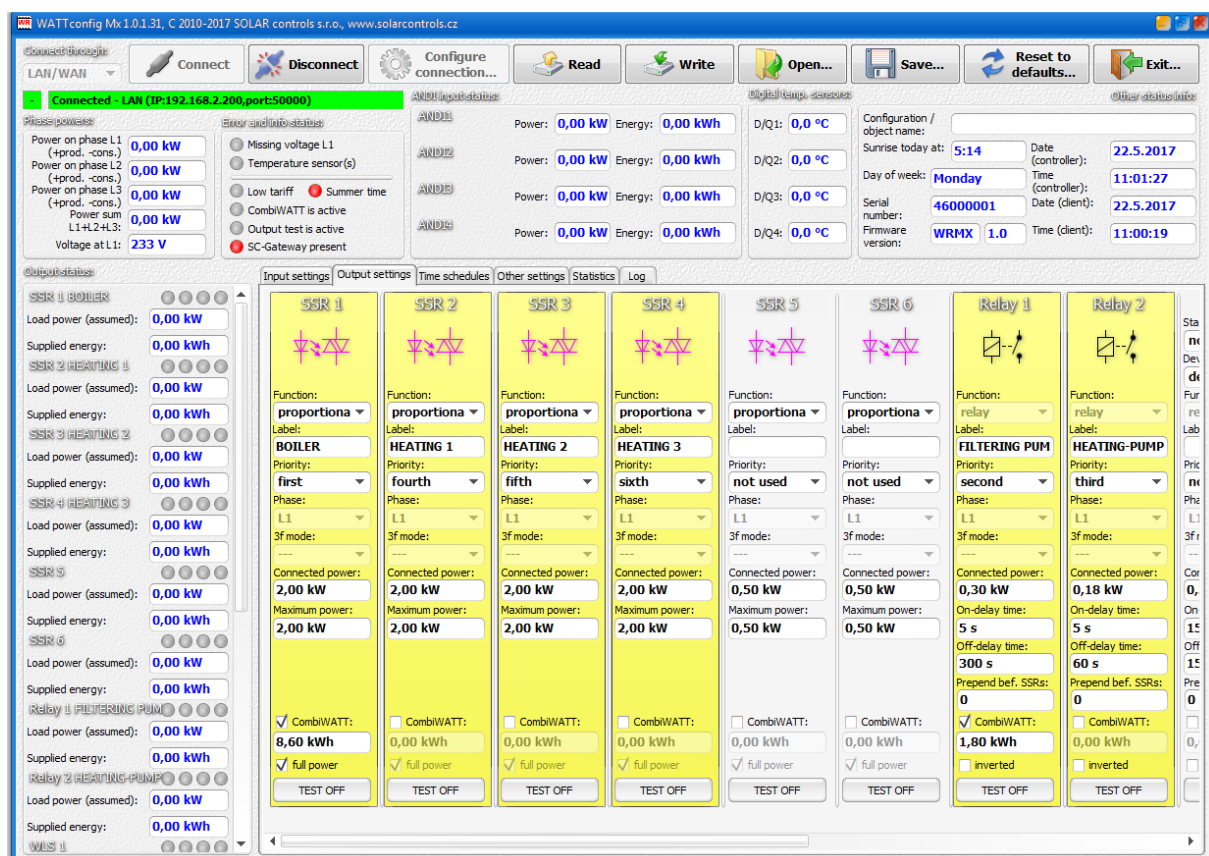
Boiler heating process has 1st priority (SSR1 No. 1). Requirements are the same as in example No. 1.

Filtering pump has 2nd priority (relay No. 1), nominal motor rating 0.3 kW (value in VA is usually not specified here), and it must run exactly for 6 hours per day and the minimum switching time is 5 minutes. The daily amount of required power for this motor is 1.8 kWh. If there is not sufficient amount of sunshine available, the system will switch back to the low tariff. The motor should not be running at night between 23:00 and 5:00 - not to disturb people during night (this also depends on the local low tariff time schedule so that the motor can get a chance to run). If the boiler is large enough and does not often turn off by thermostat, we can set the "Prepend before SSR" condition to 1 for the filtering pump to make better use of surpluses.

Heating pump has 3rd priority (relay No. 2), power output 0.16 kW and it must always run if the heating element of the pool heating is on. The typical off delay time for the pump is 1 minute. We only want to turn the swimming pool heating when there is surplus energy available. Make sure swimming pool heating is fitted with a thermal protection!

Heating elements are connected to the remaining outputs with lower priorities (SSR outputs).

We recommend using separate contactors for motors, but due to their low power consumption rate it is not really necessary. WATTrouter device uses low tariff signal and the boiler and swimming pool filtration motors operate under CombiWATT mode.



WATTrouter Mx 1.0.1.31, C 2010-2017 SOLAR controls s.r.o., www.solarcontrols.cz

Connected - LAN (IP:192.168.2.200, port:50000)

Configuration / object name:
 Sunrise today at: 5:14
 Date (controller): 22.5.2017
 Day of week: Monday
 Time (controller): 11:01:27
 Serial number: 46000001
 Date (client): 22.5.2017
 Firmware version: WRMX 1.0
 Time (client): 11:00:19

Power: 0,00 kW Energy: 0,00 kWh D/Q1: 0,0 °C
 Power: 0,00 kW Energy: 0,00 kWh D/Q2: 0,0 °C
 Power: 0,00 kW Energy: 0,00 kWh D/Q3: 0,0 °C
 Power: 0,00 kW Energy: 0,00 kWh D/Q4: 0,0 °C

SSR 1 BOILER
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 SSR 2 HEATING 1
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 SSR 3 HEATING 2
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 SSR 4 HEATING 3
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 SSR 5
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 SSR 6
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 Relay 1 FILTERING PUMP
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh
 Relay 2 HEATING-PUMP
 Load power (assumed): 0,00 kW
 Supplied energy: 0,00 kWh

Function: proportiona
 Label: BOILER
 Priority: first
 Phase: L1
 3f mode:
 Connected power: 2,00 kW
 Maximum power: 2,00 kW
 CombiWATT:
 8,60 kWh
 full power
 TEST OFF

Function: proportiona
 Label: HEATING 1
 Priority: fourth
 Phase: L1
 3f mode:
 Connected power: 2,00 kW
 Maximum power: 2,00 kW
 CombiWATT:
 0,00 kWh
 full power
 TEST OFF

Function: proportiona
 Label: HEATING 2
 Priority: fifth
 Phase: L1
 3f mode:
 Connected power: 2,00 kW
 Maximum power: 2,00 kW
 CombiWATT:
 0,00 kWh
 full power
 TEST OFF

Function: proportiona
 Label: HEATING 3
 Priority: sixth
 Phase: L1
 3f mode:
 Connected power: 2,00 kW
 Maximum power: 2,00 kW
 CombiWATT:
 0,00 kWh
 full power
 TEST OFF

Function: proportiona
 Label:
 Priority: not used
 Phase: L1
 3f mode:
 Connected power: 0,50 kW
 Maximum power: 0,50 kW
 CombiWATT:
 0,00 kWh
 full power
 TEST OFF

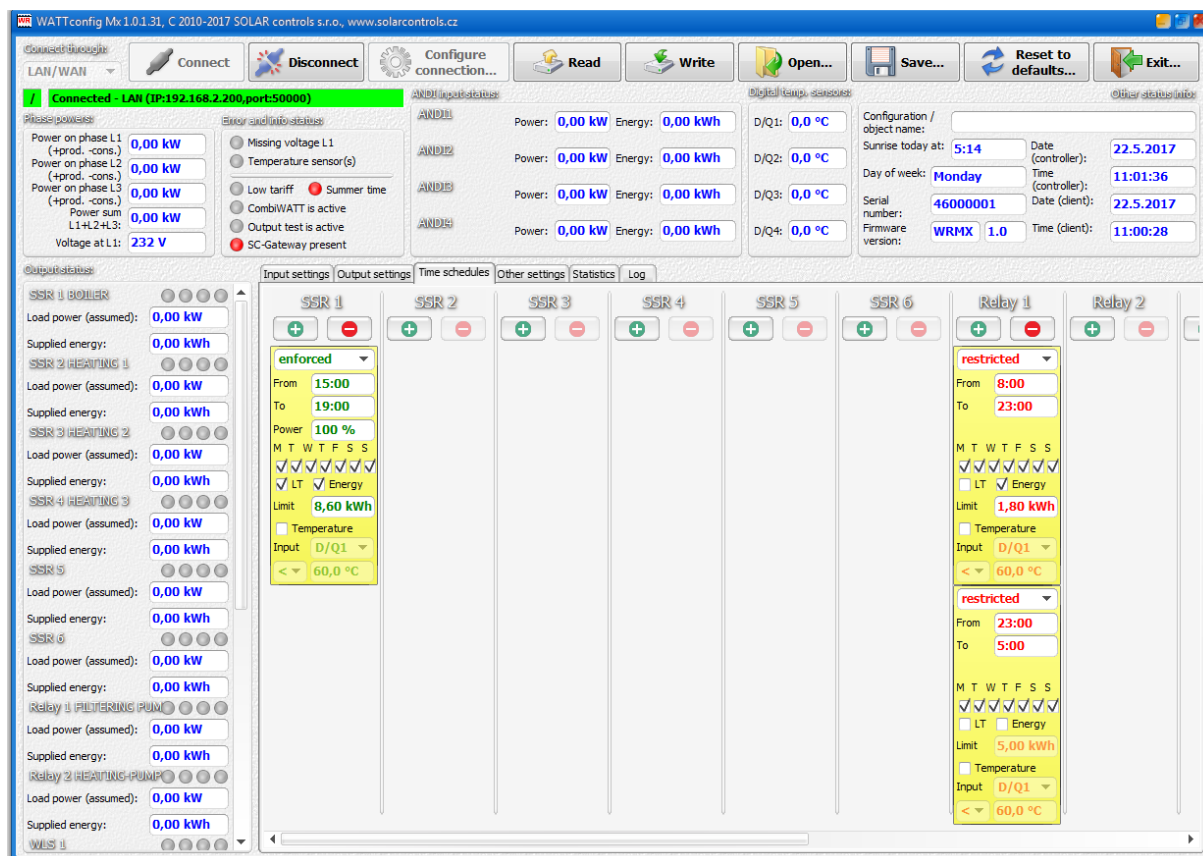
Function: proportiona
 Label:
 Priority: not used
 Phase: L1
 3f mode:
 Connected power: 0,50 kW
 Maximum power: 0,50 kW
 CombiWATT:
 0,00 kWh
 full power
 TEST OFF

Function: relay
 Label: FILTERING PUMP
 Priority: second
 Phase: L1
 3f mode:
 Connected power: 0,30 kW
 On-delay time: 5 s
 Off-delay time: 300 s
 Prepend bef. SSRs: 0
 CombiWATT:
 1,80 kWh
 inverted
 TEST OFF

Function: relay
 Label: HEATING-PUMP
 Priority: third
 Phase: L1
 3f mode:
 Connected power: 0,18 kW
 On-delay time: 5 s
 Off-delay time: 60 s
 Prepend bef. SSRs: 0
 CombiWATT:
 0,00 kWh
 inverted
 TEST OFF

Time schedule for boiler is set the same as in example No. 1.

Two time schedules are assigned for pool filtering pump. The first of them describes restriction of the output during "daytime" between 8:00 and 23:00. This restriction ensures the motor runs approximately 6 hours (1,8kWh / 0,3kW) and therefore, it applies only if the output energy counter (field Supplied energy) exceeds 1.8 kWh. The second time schedule restricts operation of the motor between 23:00 and 5:00 without any special requirements or conditions. The necessary prerequisite for correct application of these two time schedules is correct configuration of daily energy counter reset. As reset mode there must be selected "at sunrise" or "at fixed time". The fixed time for second case should be selected in the morning before 8:00.



EXAMPLE NO. 3 – 7 LOADS, CONTROL MODE = EACH PHASE INDEPENDENTLY

Loads specified in example No. 2 but more complex connection. Control mode is set for each phase independently. In this example, it is necessary to distribute the appliances as uniformly as possible to the individual phases, which is more complex and rarely can be done optimally.

Connect the following to L1 phase:

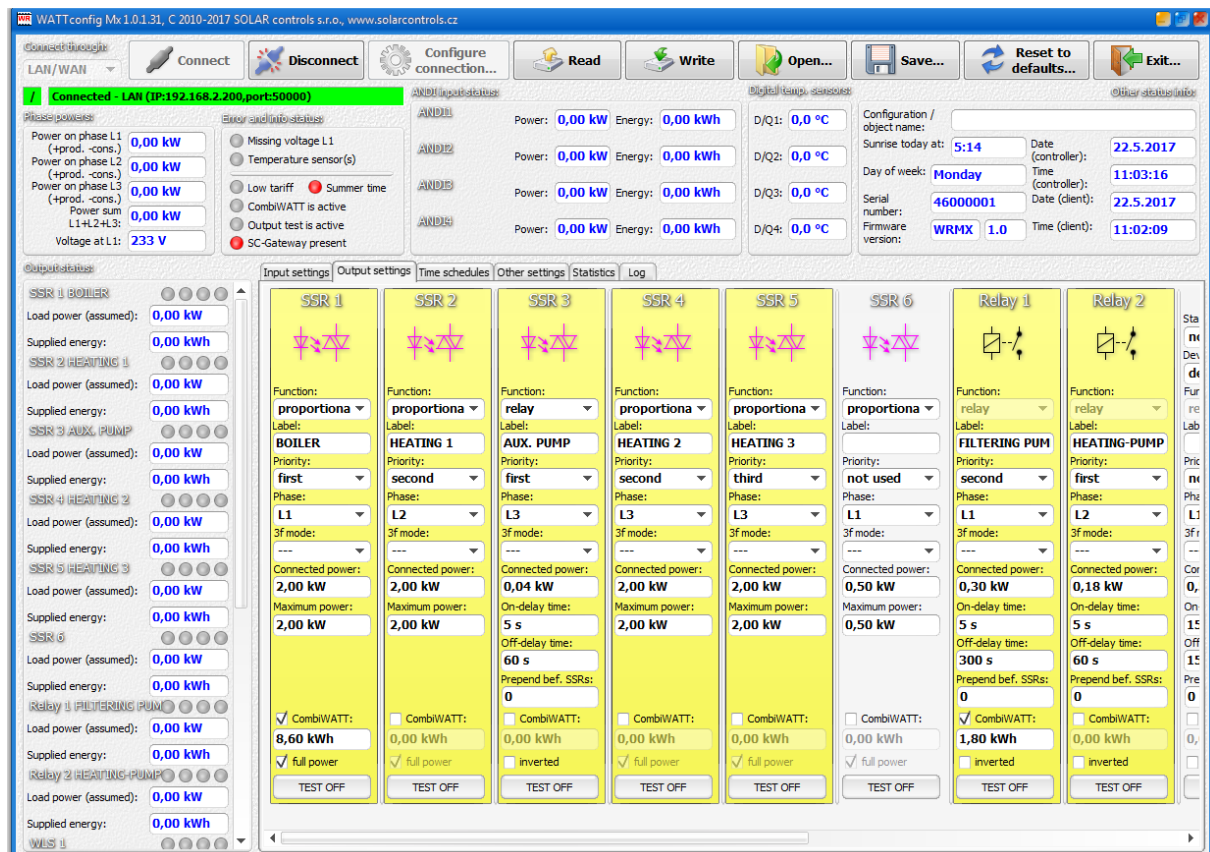
- boiler has 1st priority (SSR No. 1). Requirements are the same as in example No. 1.
- pool filtering pump has 2nd priority (relay No. 1). Requirements are the same as in example No. 2. Again we can set the "Prepend before SSR" condition to make better use of PV-surpluses.

Connect the following to L2 phase:

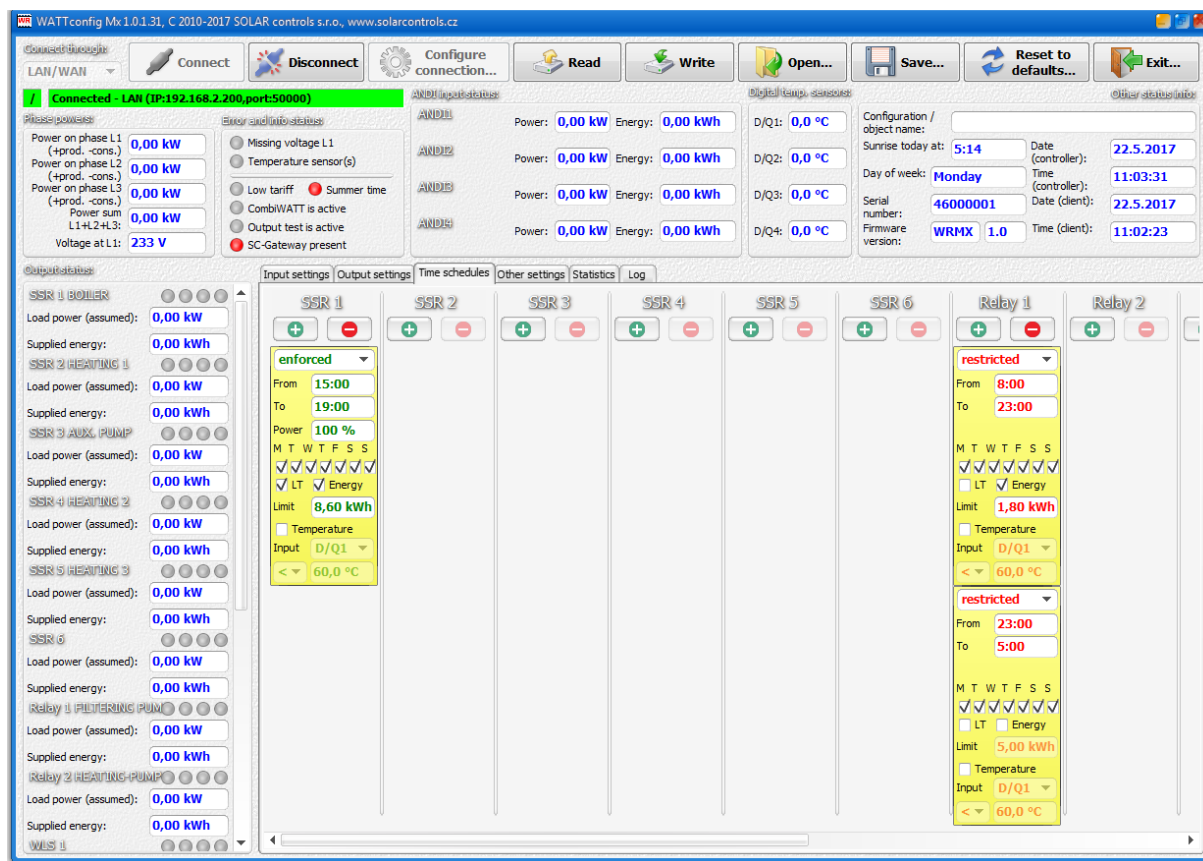
- heating pump has 1st priority (relay No. 2). Requirements are the same as in example No. 2.
- 1st heating coil with 2nd priority (SSR No. 2).

Connect the following to L3 phase:

- auxiliary contact with 1st priority (SSR No. 5 operating as a relay), will also turn on the heating pump connected actually to phase L2 (here, a small amount of power may be drawn from the public grid at phase L2, but in order to prevent it we would have to use two circulation pumps).
- 2nd heating coil with 2nd priority (SSR No. 3).
- optionally also the 3rd heating coil in the 3rd priority (SSR No. 4), however, only if the assumed PV-power at this stage is enough and it pays to buy another SSR.



Time schedules are the same as in example No. 2.



The screenshot displays the WATTrouter Mx configuration software interface. The top bar shows the connection status as 'Connected - LAN (IP:192.168.2.200, port:50000)'. The main interface is divided into several sections:

- Phase power:** Displays power on phase L1, L2, and L3, all at 0,00 kW. The voltage at L1 is 233 V.
- Error and info status:** Includes checkboxes for 'Missing voltage L1', 'Temperature sensor(s)', 'Low tariff', 'Summer time', 'CombiWATT is active', 'Output test is active', and 'SC-Gateway present'.
- Configuration / object name:** Shows settings for 'Sunrise today at: 5:14', 'Date (controller): 22.5.2017', 'Day of week: Monday', 'Time (controller): 11:03:31', 'Serial number: 46000001', 'Date (client): 22.5.2017', 'Firmware version: WRMX 1.0', and 'Time (client): 11:02:23'.
- Output devices:** Lists various devices including SSR 1 BOILER, SSR 2 HEATING 1, SSR 3 AUX. PUMP, SSR 4 HEATING 2, SSR 5 HEATING 3, SSR 6, Relay 1 FILTERING PUMP, and Relay 2 HEATING-PUMP. Each device shows its load power (assumed) and supplied energy (0,00 kWh).
- Time schedules:** A tabbed interface showing schedules for SSR 1, SSR 2, SSR 3, SSR 4, SSR 5, SSR 6, Relay 1, and Relay 2. The 'enforced' schedule for SSR 1 is highlighted, showing a time range from 15:00 to 19:00, power limit of 100%, and energy limit of 8,60 kWh. The 'restricted' schedule for Relay 1 is also shown, with a time range from 8:00 to 23:00, power limit of 1,80 kWh, and energy limit of 5,00 kWh.

EXAMPLE NO. 4 – 5 LOADS, CONTROL MODE = EACH PHASE INDEPENDENTLY

Boiler and pool filtering system specified in example No. 2 plus 2 resistive electric heaters and a heating pump used to heat the swimming pool. Everything in more complex connection plus control mode set for each phase separately.

Each electric heater draws 2 kW and should be powered only with the PV-surplus energy, independently of the house hold primary heating system. These heaters must be deactivated at summer time - either through built in thermostats, by deactivating fuse switches for respective outputs or by deactivating them in the software.

The heating pump draws power of 1.3 kW and it is powered only with the PV-surplus energy, or manually, independently of the WATTrouter device.

Connect the following to L1 phase:

- boiler has 1st priority (SSR No. 1). Requirements are the same as in example No. 1.
- pool filtering pump has 2nd priority (relay No. 1). Requirements are the same as in example No. 2.

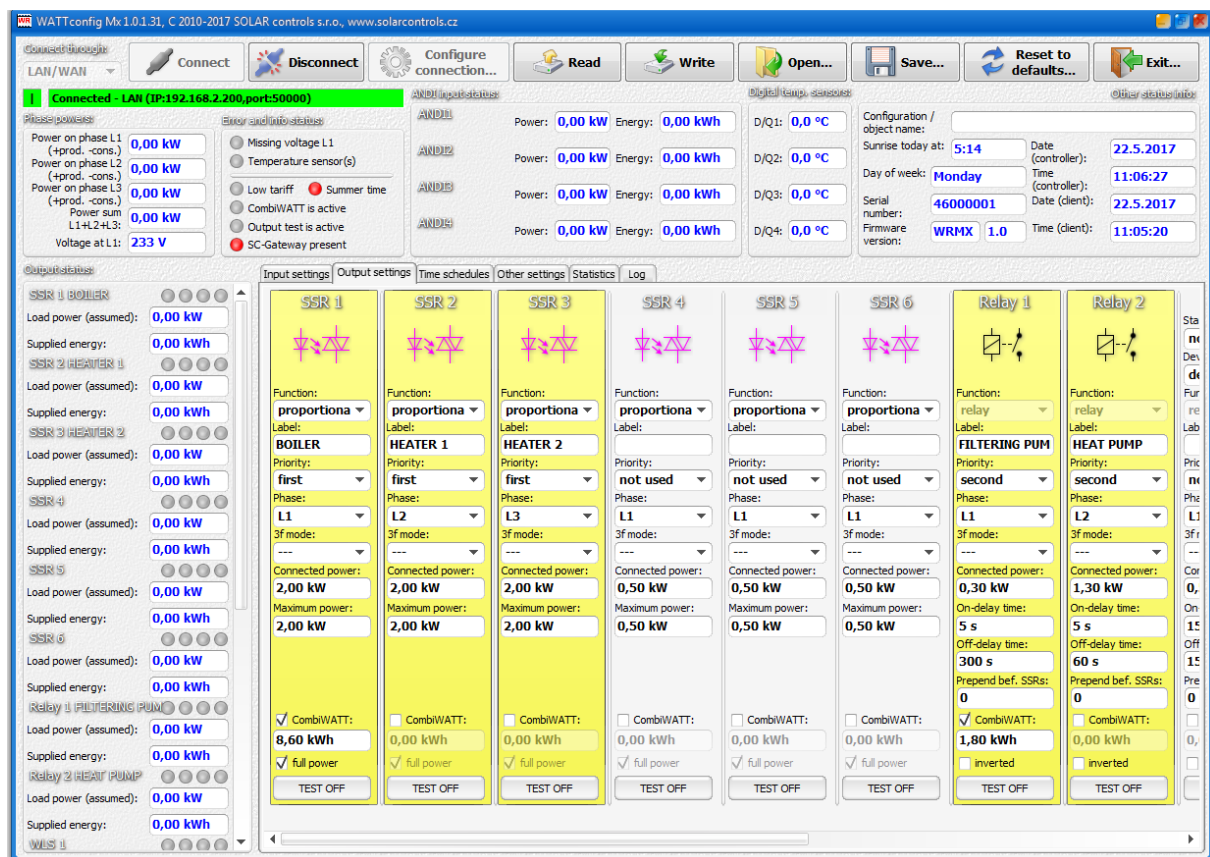
Connect the following to L2 phase:

- 1st electric heater with 1st priority (SSR No. 2).
- heating pump with 2nd priority (relay No. 2).

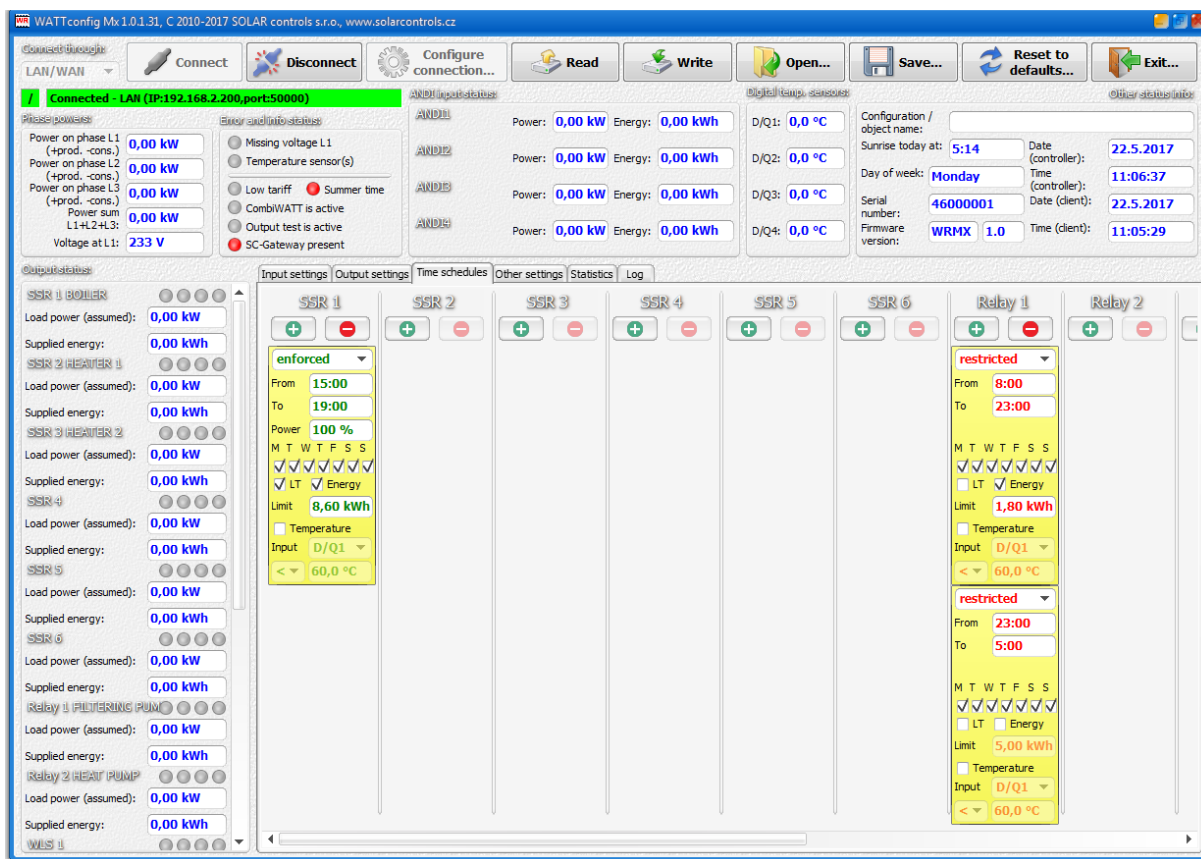
Connect the following to L3 phase:

- 2nd electric heater with 1st priority (SSR 3).

You may activate the "Prepend before SSR" function for relay outputs, in order to better use the PV-surplus energy at L2, when the heating pump and electric heater operate at the same time.



Time schedules are the same as in example No. 2.



The screenshot displays the WATTrouter Mx configuration software interface. The top bar shows the connection status as 'Connected - LAN (IP:192.168.2.200, port:50000)'. The main interface is divided into several sections:

- Phase powers:** Shows power on phase L1, L2, and L3, all at 0,00 kW. Voltage at L1 is 233 V.
- Error and info status:** Includes checkboxes for Missing voltage L1, Temperature sensor(s), Low tariff, Summer time, CombiWATT is active, Output test is active, and SC-Gateway present.
- ANDI input status:** Shows power and energy for four ANDI inputs, all at 0,00 kW and 0,00 kWh.
- Digital temp. sensors:** Shows D/Q1, D/Q2, D/Q3, and D/Q4, all at 0,0 °C.
- Configuration / object name:** Includes fields for Sunrise today at (5:14), Date (controller) (22.5.2017), Day of week (Monday), Time (controller) (11:06:37), Serial number (46000001), Date (client) (22.5.2017), Firmware version (WRMX 1.0), and Time (client) (11:05:29).
- Output status:** Lists SSR 1 BOILER, SSR 2 HEATER 1, SSR 3 HEATER 2, SSR 4, SSR 5, and SSR 6, all with load power and supplied energy at 0,00 kW.
- Relay 1 FILTERING PUMP and Relay 2 HEAT PUMP:** Both show load power and supplied energy at 0,00 kW.
- Time schedules:** The 'enforced' schedule for SSR 1 is set from 15:00 to 19:00 with a power limit of 100% and a limit of 8,60 kWh. The 'restricted' schedule for Relay 1 is set from 8:00 to 23:00 with a power limit of 1,80 kWh. The 'restricted' schedule for Relay 2 is set from 23:00 to 5:00 with a power limit of 5,00 kWh.

ETHERNET NETWORK CONFIGURATION

WATTrouter Mx allows monitoring and configuration via Ethernet socket. In order to establish the communication you must correctly configure network connection.



Always entrust the configuration of the network and Internet access to the controller to a person with the necessary technical skills. Problems associated with network settings, except for demonstrable malfunctions of the regulator network interface, are not included in the manufacturer's technical support policy and cannot be claimed.

It is recommended to perform controller network settings via USB interface (when you connect via Ethernet and change network parameters you will probably always lose connection).

In order to successfully set network parameters you must know parameters of your local network. It is necessary to know the following parameters:

- IP address of your router or another access point to your local network (if it is installed),
- Free range of IP addresses, which means that you need to know what addresses do not belong to the range of dynamically assigned addresses, provided that your DHCP server is on and also what addresses are not static addresses of other devices in your local network.
- Local network mask used by all devices connected to your local network.

LOCAL NETWORK CONNECTION SETTINGS

Network connection is configured in the "Other settings" tab, group "Network settings".

Default device settings are:

- IP address: **192.168.2.200**
- Subnet mask: **255.255.255.0**
- Default gateway: **192.168.2.1**
- MAC address: **232.233.142.128.(SN1).(SN2)**, hexadecimal **E8:E9:8E:80:(SN1):(SN2)**
- UDP port: **50000**
- HTTP port: **80**

SN1 is serial number (high byte) and SN2 is serial number (low byte).

In case the connection parameters will be configured by a DHCP server (since firmware version 3.0), the parameters IP address, Mask and Default gateway are not set, as they are assigned to the controller automatically.



Network configuration changes will become effective only after you reset the controller (see option "Reset unit on config. write").

- **IP address:** enter the IP address where controller will be accessible. Make sure that the address does not collide with other devices in your local network. For example, if the IP address of your router is **192.168.2.1**, set it to **192.168.2.10**, provided that this address is not already used by other device in your local network and also provided that this address does not belong to the range of dynamically assigned DHCP server addresses in your local network (DHCP server is usually active in your router).
- **Mask:** enter the mask of your local network. In majority of cases the value is **255.255.255.0**.
- **Default gateway:** set IP address of network device where the controller will try to send requests outside of your local network. In majority of cases it is the IP address of your router. In this case the address is **192.168.2.1**. If you do not have such device, enter another IP address not used in your local network. In this case, requests directed outside of your local network will not be acknowledged.

- **Controller MAC address:** enter the physical/MAC address of your controller. Change this value only if there is another device with the same MAC address in your local network.
***Note:** WATTrouter Mx devices do not have their own IP address range registered within the IEEE, because network communication is only additional feature and not the main function of the device. If you change MAC address you must respect specific requirements applicable to these addresses!*
- **UDP port:** enter the value of the UDP port where the controller will listen to incoming UDP requests from WATTconfig software. Change this value only if there are several UDP servers in your local network sharing the same UDP port, or if you want to increase protection against unauthorized access to your network. If you change UDP port in the controller it is also necessary to change the UDP port settings in the LAN/UDP driver configuration dialog.
- **HTTP port:** enter the HTTP port value where your controller will listen to incoming HTTP requests - that is requests from web browser. Change this value only if there are several web servers in your local network (which will be accessible from the Internet), or if you want to increase protection against unauthorized access to your network.

SETTING UP INTERNET ACCESS

In order to connect to the Internet we recommend you to have an active global static IP address. If you have only dynamically assigned IP address, you may see its value in your router info page. Dynamic IP address may also be used, but depending on your Internet connection provider, this address may vary more or less frequently. If your controller is not accessible from the Internet, always check the WAN configuration in your router first.

The controller may be accessed from the Internet only through routers or other access points which support the NAT (Native Address Translation) function or other similar function, which is used to translate global IP addresses and ports into local network IP addresses/ports.

The following text describes a sample Internet connection configuration, using a regular broadband router Edimax BR-6204Wg-M. See the below:

- On the **NAT Settings** tab check the field **Enable NAT module function**, and press **Apply** and then **Continue**.
- On the **Port forwarding** tab check **Enable Port Forwarding**, fill out the NAT table for as seen on the picture and check **Apply** and then again **Apply**, which will save the settings in the router and your router will restart.

NO.	Private IP	Type	Port Range	Comment	Select
1	192.168.2.200	TCP	80	WATTrouter HTTP	☐
2	192.168.2.200	UDP	50000	WATTrouter UDP	☐

NAT configuration is similar for other routers.

If your global address (static or the currently used dynamic address) is **80.200.50.6**, then in order to access your controller from the Internet via HTTP protocol, enter the following address into your web browser (we recommend creating a bookmark in your browser):

<http://80.200.50.6/>

In order to access your controller from the Internet via WATTconfig, enter the same IP address into the LAN/UDP driver configuration window, here **80.200.50.6**.

If you experience conflict between HTTP ports, provided you have several web servers in your local network which you want to be accessible from the Internet, it is necessary to select different HTTP port in the controller, for example widely used alternate port No. 8080, instead of the standard port No. 80. To access the controller then just enter the following address into your internet browser:

http://80.200.50.6:8080/

DESCRIPTION OF WEB INTERFACE AND XML COMMUNICATION

WATTrouter Mx devices can be monitored and configured using regular Internet browsers. Web interface can be used only if the controller is connected via Ethernet.

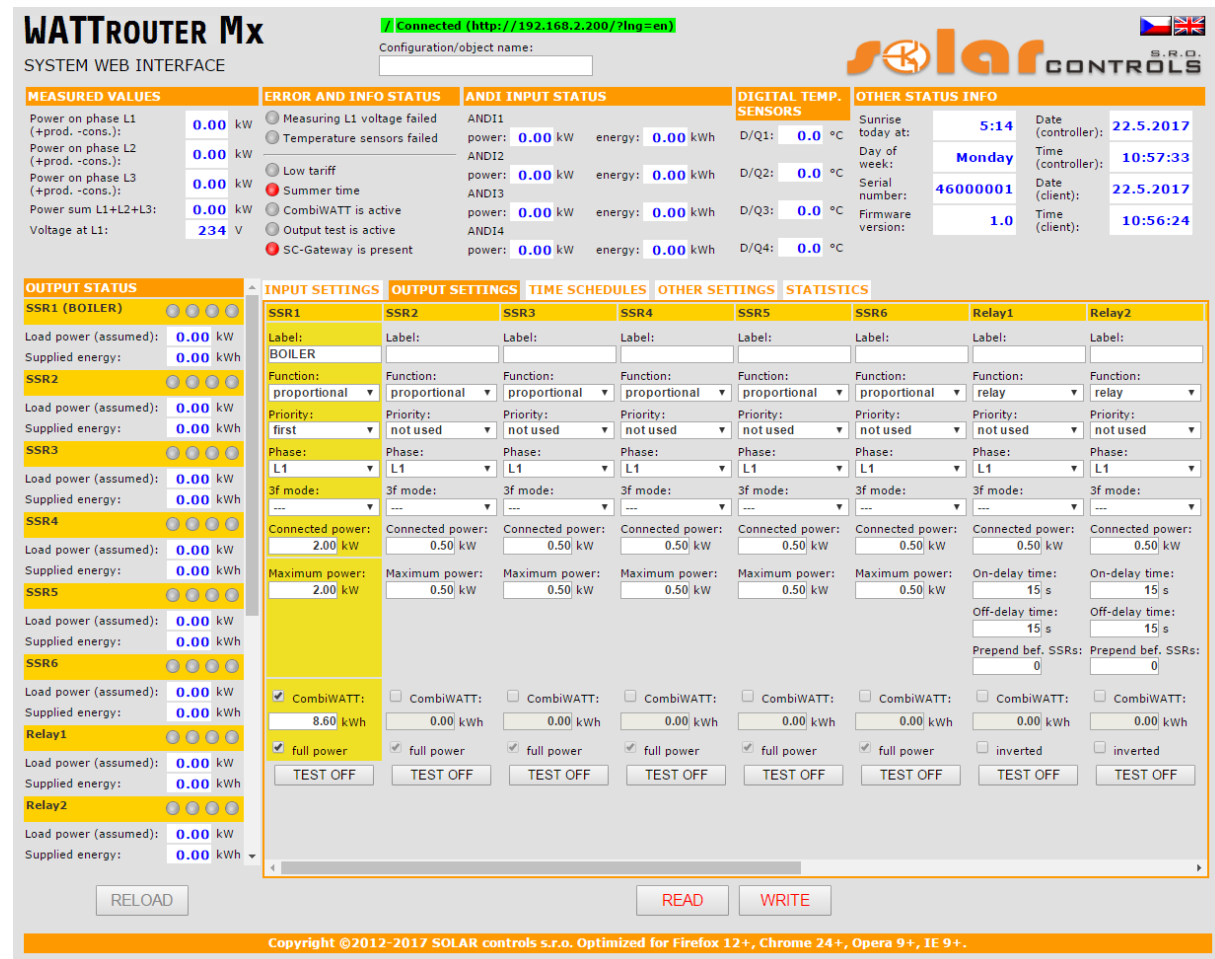


Figure19: Device web interface.

Using the web interface you may monitor and configure all controller parameters as if you would do using the WATTconfig software, except for input checking oscilloscope, time server testing, statistic export/import, firmware upgrade and web client data exchange settings.

Web interface is implemented in your Internet browser by using AJAX/XML technology and therefore, you have to allow JavaScript.

Monitoring the controller activity and configuring it may also be implemented into any superior control system capable to send or parse XML data. However, the implementation requires certain knowledge of HTTP protocols and XML files.

Authorization to write a new configuration was not designed using common HTTP authentication, but instead of it the login data is embedded into each configuration write request. This mechanism simplifies the implementation on the superior control system side where using HTTP authentication could be problematic.

In order to monitor and configure your controller you may use following HTTP/XML requests. Description of individual XML data are listed as HTML/XML comments directly embedded in the XML data listings:

1. GET /meas.xml

By sending this HTTP request you will obtain the current measured/status data from the controller (actual measured powers in individual phases and power/energy values for connected loads). Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<meas>
<I1>
  <P>-2.20</P><!-- measured power by IL1 in kW-->
</I1>
<I2>
  <P>1.50</P><!-- measured power by IL2 in kW-->
</I2>
<I3>
  <P>-1.10</P><!-- measured power by IL3 in kW-->
</I3>
<I4><!-- ANDI1 input status-->
  <P>0.50</P><!-- measured power in kW or temperature in °C-->
  <E>1.60</E><!-- energy counted in kWh-->
</I4>
<!-- similarly for remaining inputs ANDI2(I5) to ANDI4(I7)-->
<O1><!-- SSR1 output status-->
  <A>0</A><!-- assigned ANDI/RP input (0=none, 4=ANDI1, 5=ANDI2, etc.)-->
  <P>1.00</P><!-- load power in kW-->
  <E>3.00</E><!-- supplied energy to connected load in kWh-->
  <HN>1</HN><!-- basic control mode: 0=inactive, 1=active-->
  <HC>0</HC><!-- CombiWATT mode: 0=inactive, 1=active -->
  <HE>0</HE><!-- output enforced by time schedule: 0=inactive, 1=active-->
  <HR>0</HR><!-- output restricted by time schedule: 0=inactive, 1=active-->
>
  <HX>0</HX><!-- output switched externally: 0=inactive, 1=active-->
  <TOT>0</TOT><!-- timer status of the relay on-delay timer -->
  <TFT>0</TFT><!-- timer status of the relay off-delay timer -->
  <T>0</T><!-- output test: 0=inactive, 1=active-->
  <EX>0</EX><!-- private auxiliary item-->
  <A1>0</A1><!-- activity of 1st time schedule: 0=inactive, 1=restricted,
2=enforced-->
  <A2>0</A2><!-- activity of 2nd time schedule-->
  <!-- similarly for remaining time schedules-->
</O1>
<!-- similarly for remaining outputs SSR2(O2) to R08(O16)-->
<DQ1>20.0</DQ1><!-- temperature measured by digital temp. sensor D/Q1 in
°C-->
<!-- similarly for remaining sensors DQ2 to DQ4-->
<PPS>-1.80</PPS><!-- sum of measured powers L1+L2+L3 in kW-->
<VAC>230</VAC><!-- voltage at L1 in V-->
<DaR>1.1.2017</DaR><!-- date (controller)-->
<TiR>0:00:00</TiR><!-- time (controller)-->
<CW>7200</CW><!-- time to activate CombiWATT-->
<DC>12.0</DC><!-- internal DC source-->
<FW>1.0</FW><!-- firmware version-->
<SN>46000001</SN><!-- serial number-->
<EL1>0</EL1><!-- 0=no fault, 1=L1 voltage missing error-->
<ELV>0</ELV><!-- 0=no fault, 1=Wrong voltage value L1-->
<ETS>0</ETS><!-- 0=no fault, 1=temperature sensor(s) error-->
<EDC>0</EDC><!-- 0=no fault, 1=DC source overload-->
<ESC>0</ESC><!-- 0=no fault, 1=S-Connect: device failed-->
<ESD>0</ESD><!-- 0=no fault, 1=SD card error-->
<ILT>0</ILT><!-- 0=not present, 1=low tariff active-->
<ICW>0</ICW><!-- 0=not present, 1=CombiWATT active-->
```

```
<ITS>0</ITS><!-- 0=not present, 1=output test active-->
<IDST>0</IDST><!-- 0=not present, 1=summer time-->
<ISC>0</ISC><!-- 0=not inserted, 1=inserted SC-Gateway module, 2=inserted
SC-Router module-->
<SRT>6:00</SRT><!-- sunrise time-->
<SST>18:00</SST><!-- sunset time-->
<DW>1</DW><!-- day of week (0=Monday to 6=Sunday)-->
<SP>91.12</SP><!-- spot price in EUR -->
<DIP>...</DIP><!-- controller IP address (currently configured)-->
<DMS>...</DMS><!-- subnet mask (currently configured)-->
<DDR>...</DDR><!-- default gateway IP address (currently configured)-->
<DDN>...</DDN><!-- DNS server IP address (currently configured)-->
<WV>6</WV><!-- internal version of the corresponding WATTconfig software-->
<CPO>-0.10</CPO><!-- actual power offset in kW --></meas>
```

2. GET /conf.xml

By sending this HTTP request you will obtain the current configuration stored in the controller (input and output settings, etc.). Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<conf>
<DE>My configuration</DE><!-- configuration/object name-->
<I1><!-- IL1 input configuration-->
  <N>IL1</N><!-- input label, for ILx inputs cannot be changed-->
  <F>0</F><!-- input function (0=power meas. to 4=binary input), for ILx
inputs cannot be changed -->
  <Ph>0</Ph><!-- input phase (0=L1 to 2=L3)-->
  <CD>0</CD><!-- current orientation (0=normal, 1=reversed)-->
  <M>1</M><!-- conversion ratio of external CTs - multiplier-->
  <D>1</D><!-- conversion ratio of external CTs - divider-->
  <V>0</V><!-- voltage for calculation (0=measured at L1, 1=fixed)-->
  ..<O>0.00</O><!-- energy offset v kWh, only for ANDI inputs-->
  ..<Pu>1000</Pu><!-- number of impulses per kWh, only for ANDI inputs-->
</I1>
<!-- similarly for remaining inputs IL2(I2) to ANDI4(I7)-->
<O1><!-- SSR1 output configuration-->
  <N>BOILER</N><!-- output label-->
  <F>1</F><!-- output function (0=relay, 1=proportional, 2=PWM)-->
  <Pr>1</Pr><!-- output priority (0=unused to 16=sixteenth)-->
  <Ph>0</Ph><!-- output phase (0=L1 to 2=L3)-->
  <M>0</M><!-- 3f mode (0=none to 3=max(L1,L2,L3))-->
  <Po>2.00</Po><!-- connected output power in kW-->
  <PM>2.00</PM><!-- maximum output power in kW-->
  <PN>0.00</PN><!-- minimum output power in kW, only for PWM function-->
  <PI>500</PI><!-- PWM-I value, only for PWM function-->
  <PRB>0</PRB><!-- PWM range, minimum in %-->
  <PRE>100</PRE><!-- PWM range, maximum in %-->
  <TO>15</TO><!-- on-delay time in s, only for relay function-->
  <TF>15</TF><!-- off-delay time in s, only for relay function-->
  <Du>0</Du><!-- duplicate to (0=not used, 1=SSR1, etc.)-->
  <Q>0</Q><!-- measured by input (0=not used, 1=ANDI1, etc.)-->
  <CE>0.50</CE><!-- energy limit for CombiWATT in kWh-->
  <CF>0</CF><!-- full power for CombiWATT (0=no, 1=yes)-->
  <PR>0</PR><!-- prepend before SSR (0=inactive to 15=max. output count)-->
  <In>0</In><!-- inverted output (0=normal, 1=inverted)-->
  <W>0</W><!-- watch consumption (0=no, 1=yes)-->
  <TS>0</TS><!-- number of displayed time schedules (0=none to 4=all)-->
</O1>
```

```

<!-- similarly for remaining outputs SSR2(O2) to R08(O16)-->
<TS11><!-- 1st time schedule for 1st output (SSR1)-->
  <M>2</M><!-- mode (0=unused, 1=restricted, 2=enforced) + binary input,
energy and temperature flags, day of week flags, details upon request-->
  <N>15:00</N><!-- time From-->
  <F>19:00</F><!-- time To-->
  <P>100</P><!-- power in percent, only for proportional outputs-->
  ..<Li>8.60</Li><!-- energy limit in kWh-->
  ..<TI>0</TI><!-- assigned temperature input (0=none, 1=D/Q1, etc.)-->
  ..<TT>60.0</TT><!-- temperature limit in °C-->
  <B>0</B><!-- assigned Binary input (0=none, 1=LT, etc.)-->
  <S>0</S><!-- spot price limit in whole EUR-->
</TS11>
<!-- similarly for remaining outputs and time schedules (a total of 64 time
schedules)-->
<DQN1>temp. boiler</DQN1><!-- D/Q1 sensor label-->
<!-- similarly for remaining digital temperature sensors-->
<RM>1</RM><!-- control mode (0=each phase independently, 1=sum of all
phases)-->
<PO>-0.10</PO><!-- power offset in kW-->
<PWM>0</PWM><!-- PWM frequency (0=10kHz to 5=200Hz)-->
<VM>1</VM><!-- voltage calibration - multiplier-->
<VD>1</VD><!-- voltage calibration - divisor-->
<URC>0</URC><!--optimize internal relay consumption (0=no, 1=yes)-->
<TB>1</TB><!-- output test blocks control (0=no, 1=yes)-->
<TTL>0</TTL><!-- output test timeout (0=none)-->
<IP>...</IP><!-- controller IP address-->
<MSK>...</MSK><!-- controller subnet mask-->
<DR>...</DR><!-- default gateway IP address-->
<DNS>...</DNS><!-- DNS server IP address-->
<MAC>...</MAC><!-- controller MAC address-->
<HTTP>80</HTTP><!-- HTTP port-->
<UDP>50000</UDP><!-- UDP port-->
<DHCP>1</DHCP><!-- DHCP mode (0=none to 2=all)-->
<CWD>7200.0</CWD><!-- CombiWATT delay in s-->
<CWL>0.02</CWL><!-- CombiWATT production limit in kW-->
<CWR>0</CWR><!-- energy counter reset (0=at sunrise to 1=fixed time)-->
<CWT>6:00</CWT><!-- fixed time for energy counter reset-->
<LA>50</LA><!-- latitude in °-->
<LO>15</LO><!-- longitude in °-->
<STC>0</STC><!-- synchronize date and time with the client (0=inactive,
1=active)-->
<STS>0</STS><!-- synchronize date and time with time server (0=inactive,
1=active)-->
<DST>1</DST><!-- use summer time (0=inactive, 1=active)-->
<TZ>13</TZ><!-- time zone (0=GMT-12 through 25=GMT+14)-->
<TSH>pool.ntp.org</TSH><!-- time server hostname-->
<TSIP>...</TSIP><!-- time server IP address-->
<SO>0</SO><!-- sort outputs by phase and priority (0=no, 1=yes)-->
<DT>0</DT><!-- digital sensor type (0=DS18S20, 1=DS18B20)-->
<TH>1.0</TH><!-- temperature hysteresis in °C-->
<LTI>0</LTI><!-- low tariff input (0=none, 1=LT, etc.)-->
<RSP>0</RSP><!-- RS485 protocol (0=WATTconfig, 1=MODBUS RTU)-->
<RSB>10</RSB><!-- speed (0=1200Bd, 1=2400Bd, etc.)-->
<RSS>1</RSS><!-- MODBUS address-->
<CL>20</CL><!-- consumption watchdog (0=turned off, otherwise current
limit)-->
<DFT>1</DFT><!-- default tab (0=Input settings to 5=Statistics)-->
<DFS>1</DFS><!-- default statistics tab (0=Real time chart to 5=All time)-->
>

```

```
<SC><!-- Configuration of statistics and real time chart -->
  <C1>0</C1><!-- input consumption phase L1 (0=not used, 1=IL1, etc.)-->
  <S1>0</S1><!-- input surplus energy phase L1 (0=not used, 1=IL1, etc.)-->
  <P1>0</P1><!-- input production phase L1 (0=not used, 1=IL1, etc.)-->
  <!-- similarly for remaining phases L2 to L3 -->
  <P>5</P><!-- time base (0=1s to 8=600s)-->
  <L1>1</L1><!-- assignment for series 1 (0=unassigned, 1=IL1, etc.)-->
  <!-- similarly for remaining series-->
</SC>
</conf>
```

3. POST /conf.xml

By sending this HTTP request you will save the configuration in the controller. This configuration has the same format as the GET /conf.xml command, but you must (can) also send additional data. Append the configuration to the POST /conf.xml command and skip 1 empty line, so the request will look like this:

```
POST /conf.xml
<!--Request headers-->
<!--one empty line-->
<conf>
<!--the following shows configuration data structure as in the GET
/conf.xml request-->
<DaC>1.1.2012</DaC><!-- date (client)-->
<TiC>0:00</TiC><!-- time (client)-->
<UN>admin</UN><!-- username for authorization, mandatory item-->
<UP>1234</UP><!-- password for authorization, mandatory item-->
<UNn>home</UNn><!-- new username, only when change is required-->
<UPn>abcd</UPn><!-- new password, only when change is required-->
<RST>1</RST><!-- reset controller, only if required-->
</conf>
```

The controller will reply with the following:

```
<!--Response headers-->
<!--one empty line-->
<conf>
<accept>0</accept><!-- error code: 0-ok, 1-incorrect configuration, 2-
incorrect login (access) data, 3-incorrect new login data, 4-wrong XML file
format, 5-unspecified write error-->
</conf>
```

Note: The write request cannot be sent to the controller too often due to the limited number of available configuration memory write cycles (EEPROM). If you need to change the configuration regularly, this can most often be done once an hour.

Note: Writing partial configuration is possible, eg. writing one time schedule looks like this:

```
POST /conf.xml
<!--Request headers-->
<!--one empty line-->
<conf>
<TS11>
  <M>2</M>
  <N>15:00</N>
  <F>19:00</F>
  <P>100</P>
  <Li>8.60</Li>
  <TI>0</TI>
  <TT>60.0</TT>
</TS11>
```

```
<UN>admin</UN>
<UP>1234</UP>
</conf>
```

4. POST /test.xml

By sending this HTTP request you activate or deactivate test mode for given output(s). Append the data to the POST /test.xml command and skip 1 empty line, so the request will look like this:

```
POST /test.xml
<!--Request headers-->
<!--one empty line-->
<test>
<TST1>1</TST1><!-- activate test mode for SSR1 output (1=activate,
0=deactivate)-->
<!-- similarly for remaining outputs when test mode change is required for
them-->
<UN>admin</UN><!-- username for authorization, mandatory item-->
<UP>1234</UP><!-- password for authorization, mandatory item-->
</test>
```

The controller will reply with the following:

```
<!--Response headers-->
<!--one empty line-->
<test>
<accept>0</accept><!-- error code: 0-ok, 2-incorrect login (access) data,
4-wrong XML file format, 5-unspecified write error-->
</test>
```

5. POST /learn.xml

By sending this HTTP request you activate the search request for any digital temperature sensors connected to the DQ data bus. Append the data to the POST /learn.xml command and skip 1 empty line, so the request will look like this:

```
POST /learn.xml
<!--Request headers-->
<!--one empty line-->
<learn>
<LRN>1</LRN><!-- search for temperature sensors-->
<UN>admin</UN><!-- username for authorization, mandatory item-->
<UP>1234</UP><!-- password for authorization, mandatory item-->
</learn>
```

The controller will reply with the following:

```
<!--Response headers-->
<!--one empty line-->
<learn>
<accept>0</accept><!-- error code: 0-ok, 2-incorrect login (access) data,
4-wrong XML file format, 5-unspecified write error-->
</learn>
```

6. GET /stat_chart.xml

By sending this HTTP request you will obtain the real time chart data from the controller. Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
```

```
<stat_chart>
<DaR>2020-01-01</DaR><!-- date when last acquired-->
<TiR>08:00:00</TiR><!-- time when last acquired-->
<P1>0.50,0.40,...</P1><!-- sequence of values for series 1 - power-->
<T2>20.0,21.0,...</P2><!-- sequence of values for series 1 - temperature-->
<!-- similarly for remaining series (Px=power, Tx=temperature)-->
</stat_chart>
```

7. GET /stat_day.xml?day={index}

By sending this HTTP request you will obtain the daily statistics from the controller. The "index" parameter specifies the selected day (0=today, 1=yesterday to 31=last saved day). Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<stat_day>
<SDD0>2017-07-20</SDD0><!-- date today-->
<SDD{index}>2017-07-17</SDD{index}><!-- date selected day-->
<SDS1>0.00</SDS1><!-- surplus energy phase L1 in kWh-->
<SDH1>0.00</SDH1><!-- consumption normal tariff phase L1 in kWh-->
<SDL1>0.00</SDL1><!-- consumption low tariff phase L1 in kWh-->
<SDP1>0.00</SDP1><!-- production phase L1 in kWh-->
<!-- similarly for remaining phases L2 and L3-->
<SDS4>0.00</SDS4><!-- surplus energy all phases in kWh-->
<SDH4>0.00</SDH4><!-- consumption normal tariff all phases in kWh-->
<SDL4>0.00</SDL4><!-- consumption low tariff all phases in kWh-->
<SDP4>0.00</SDP4><!-- production all phases in kWh-->
<SDO1>0.00</SDO1><!-- daily energy for output 1 in kWh-->
<!-- similarly for remaining outputs SSR2(SDO2) to RO8(SDO16)-->
<SDI1>0.00</SDI1><!-- daily energy for ANDI1 input in kWh-->
<!-- similarly for remaining inputs ANDI2(SDI2) to ANDI4(SDI4)-->
</stat_day>
```

8. GET /stat_week.xml

By sending this HTTP request you will obtain the weekly statistics from the controller. Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<stat_week>
<SWD>2017-07-20</SWD><!-- date today-->
<SWS1>0.00</SWS1><!-- surplus energy all phases in kWh, yesterday-->
<SWH1>0.00</SWH1><!-- consumption normal tariff all phases v kWh,
yesterday-->
<SWL1>0.00</SWL1><!-- consumption low tariff all phases in kWh, yesterday--
>
<SWP1>0.00</SWP1><!-- production all phases in kWh, yesterday-->
<!-- similarly for the 2th to 7th last day-->
</stat_week>
```

9. GET /stat_month.xml

By sending this HTTP request you will obtain the monthly statistics from the controller. Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<stat_month>
<SMD>2017-07-20</SMD><!-- date today-->
<SMS1>0.00</SMS1><!-- surplus energy all phases in kWh, yesterday-->
```

```
<SMH1>0.00</SMH1><!-- consumption normal tariff all phases v kWh,
yesterday-->
<SML1>0.00</SML1><!-- consumption low tariff all phases in kWh, yesterday--
>
<SMP1>0.00</SMP1><!-- production all phases in kWh, yesterday-->
<!-- similarly for the 2th to 31th last day-->
</stat_month>
```

10. GET /stat_year.xml

By sending this HTTP request you will obtain the annual statistics from the controller. Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<stat_year>
<SYD>2017-07-20</SYD><!-- date today-->
<SYS1>0.00</SYS1><!-- surplus energy all phases in kWh, this month-->
<SYH1>0.00</SYH1><!-- consumption normal tariff all phases v kWh, this
month-->
<SYL1>0.00</SYL1><!-- consumption low tariff all phases in kWh, this month-
->
<SYP1>0.00</SYP1><!-- production all phases in kWh, this month-->
<!-- similarly for the 2th to 12th last month-->
</stat_year>
```

11. GET /stat_alltime.xml

By sending this HTTP request you will obtain the all-time statistics from the controller. Structure of returned data:

```
<!--Response headers-->
<!--one empty line-->
<stat_alltime>
<SAD>2017-07-20</SAD><!-- counted from date-->
<SAS1>0.00</SAS1><!-- surplus energy phase L1 in kWh-->
<SAH1>0.00</SAH1><!-- consumption normal tariff phase L1 in kWh-->
<SAL1>0.00</SAL1><!-- consumption low tariff phase L1 in kWh-->
<SAP1>0.00</SAP1><!-- production phase L1 in kWh-->
<!-- similarly for remaining phases L2 and L3-->
<SAS4>0.00</SAS4><!-- surplus energy all phases in kWh-->
<SAH4>0.00</SAH4><!-- consumption normal tariff all phases in kWh-->
<SAL4>0.00</SAL4><!-- consumption low tariff all phases in kWh-->
<SAP4>0.00</SAP4><!-- production all phases in kWh-->
</stat_alltime>
```

In addition to these requests, since firmware version 2.0, there are other non-public HTTP requests for configuring and monitoring the S-Connect protocol.

DATA RECORD FOR WEB CLIENT BASED XML EXCHANGE

The structure of the periodically transmitted XML data record to the server (in the example shown this record is being processed by /index.php on the server):

```
POST /index.php HTTP/1.1
<!--Request headers-->
<!--one empty line-->
<wrnx>
  <meas>
    <DaR>2018-08-20</DaR><!-- date (controller)-->
```

```

<TiR>0:00:00</TiR><!-- time (controller)-->
<SN>46000001</SN><!-- serial number-->
<I1>
  <P>-2.20</P><!-- measured power by IL1 in kW-->
</I1>
<I2>
  <P>1.50</P><!-- measured power by IL2 in kW-->
</I2>
<I3>
  <P>-1.10</P><!-- measured power by IL3 in kW-->
</I3>
<I4><!-- ANDI1 input status-->
  <P>0.50</P><!-- measured power in kW or temperature in °C-->
  <E>1.60</E><!-- energy counted in kWh-->
</I4>
<!-- similarly for remaining inputs ANDI2(I5) to ANDI4(I7)-->
<O1><!-- SSR1 output status-->
  <P>1.00</P><!-- load power in kW-->
  <E>3.00</E><!-- supplied energy to connected load in kWh-->
</O1>
<!-- similarly for remaining outputs SSR2(O2) to R08(O16)-->
<DQ1>20.0</DQ1><!-- temperature measured by dig. sensor D/Q1 in °C-->
<!-- similarly for remaining sensors DQ2 to DQ4-->
<PPS>-1.80</PPS><!-- sum of measured powers L1+L2+L3 in kW-->
<EL1>0</EL1><!-- 0=no fault, 1=L1 voltage missing error-->
<ELV>0</ELV><!-- 0=no fault, 1=Wrong voltage value L1-->
<ETS>0</ETS><!-- 0=no fault, 1=temperature sensor(s) error-->
<EDC>0</EDC><!-- 0=no fault, 1=DC source overload-->
<ILT>0</ILT><!-- 0=not present, 1=low tariff active-->
<ICW>0</ICW><!-- 0=not present, 1=CombiWATT active-->
<ITS>0</ITS><!-- 0=not present, 1=output test active-->
<IDST>0</IDST><!-- 0=not present, 1=summer time-->
<ISC>0</ISC><!-- 0=not inserted, 1=inserted SC-Gateway module-->
</meas>
<current_day>
  <SDD>2018-20-08</SDD><!-- date today-->
  <SDS1>0.00</SDS1><!-- surplus energy phase L1 in kWh-->
  <SDH1>0.00</SDH1><!-- consumption normal tariff phase L1 in kWh-->
  <SDL1>0.00</SDL1><!-- consumption low tariff phase L1 in kWh-->
  <SDP1>0.00</SDP1><!-- production phase L1 in kWh-->
  <!-- similarly for remaining phases L2 and L3-->
  <SDS4>0.00</SDS4><!-- surplus energy all phases in kWh-->
  <SDH4>0.00</SDH4><!-- consumption normal tariff all phases in kWh-->
  <SDL4>0.00</SDL4><!-- consumption low tariff all phases in kWh-->
  <SDP4>0.00</SDP4><!-- production all phases in kWh-->
  <SDO1>0.00</SDO1><!-- daily energy for output 1 in kWh-->
  <!-- similarly for remaining outputs SSR2(SDO2) to R08(SDO16)-->
  <SDI1>0.00</SDI1><!-- daily energy for ANDI1 input in kWh-->
  <!-- similarly for remaining inputs ANDI2(SDI2) to ANDI4(SDI4)-->
</current_day>
<last_day>
  <SDD>2018-19-08</SDD><!-- date yesterday-->
  <SDS1>0.00</SDS1><!-- surplus energy phase L1 in kWh-->
  <SDH1>0.00</SDH1><!-- consumption normal tariff phase L1 in kWh-->
  <SDL1>0.00</SDL1><!-- consumption low tariff phase L1 in kWh-->
  <SDP1>0.00</SDP1><!-- production phase L1 in kWh-->
  <!-- similarly for remaining phases L2 and L3-->
  <SDS4>0.00</SDS4><!-- surplus energy all phases in kWh-->
  <SDH4>0.00</SDH4><!-- consumption normal tariff all phases in kWh-->
  <SDL4>0.00</SDL4><!-- consumption low tariff all phases in kWh-->

```

```

    <SDP4>0.00</SDP4><!-- production all phases in kWh-->
    <SDO1>0.00</SDO1><!-- daily energy for output 1 in kWh-->
    <!-- similarly for remaining outputs SSR2(SDO2) to RO8(SDO16)-->
    <SDI1>0.00</SDI1><!-- daily energy for ANDI1 input in kWh -->
    <!-- similarly for remaining inputs ANDI2(SDI2) to ANDI4(SDI4)-->
  </last_day>
  <all_time><!-- all time statistics-->
    <SAD>2018-08-01</SAD><!-- counted from date-->
    <SAS1>0.00</SAS1><!-- surplus energy phase L1 in kWh-->
    <SAH1>0.00</SAH1><!-- consumption normal tariff phase L1 in kWh-->
    <SAL1>0.00</SAL1><!-- consumption low tariff phase L1 in kWh-->
    <SAP1>0.00</SAP1><!-- production phase L1 in kWh-->
    <!-- similarly for remaining phases L2 and L3-->
    <SAS4>0.00</SAS4><!-- surplus energy all phases in kWh-->
    <SAH4>0.00</SAH4><!-- consumption normal tariff all phases in kWh-->
    <SAL4>0.00</SAL4><!-- consumption low tariff all phases in kWh-->
    <SAP4>0.00</SAP4><!-- production all phases in kWh-->
  </all_time>
</wrmx>

```

The server responds with this message when successfully processed (if this message is received the controller then increments the “Successful exchanges” counter in the Cloud services window):

```

<!--Response headers-->
<!--one empty line-->
OK

```

DESCRIPTION OF THE S-CONNECT PROTOCOL

The S-Connect protocol allows you to share devices via any physical network communication layer. The SOLAR controls s.r.o. controllers currently support device sharing via 2 physical layers:

- a) Over the existing network architecture, ie Ethernet or WIFI. This is only possible if the device is connected to an Ethernet network. Therefore, it cannot be used for WATTrouter ECO.
- b) Over the wireless architecture which is created by the SC-Gateway module. This is only possible if a SC-Gateway or SC-Router module is inserted in the device. Therefore, it cannot be used for WATTrouter M and Heating Control.

Attention: In the case of ad a) communication is provided by UDP and TCP protocols. Regarding the requirements for the UDP protocol, see chapter Automatic pairing of stations to the access point. Port 50160 is used for TCP communication. For communication to work, this port must not be blocked on the network. In order for the communication to work without problems, the local network must not be excessively overloaded with other communication, eg by downloading large files, videos, etc.

Attention: Communication in case of ad a) is not secured. It may take place only in the local network or in a network that is sufficiently secured against unauthorized access!

Attention: Communication in case of ad b) only transmits information about the status of the outputs, due to limited data throughput. Therefore, the states of the inputs (binary inputs, temperatures, powers, etc.) and the states of the memory cells are not transmitted!

Note: The S-Connect protocol is not public, so only the principles of the protocol are described, not the protocol itself.

As of firmware version 2.3, the S-CONNECT 2 protocol is implemented, which is fully compatible with the first version of the protocol in terms of data exchange. In addition, the S-CONNECT 2 protocol can respond to a manual station pairing request from the access point.

The term device means hardware device that a controller supports and that holds certain status information, or measure certain physical quantities.

The S-Connect protocol allows you to transfer information from the following devices:

- a) Memory. The memory cell status is transferred. The memory cell can hold any status information described in the following points.
- b) Output. The output excitation data in the range of 0 to 1000 is transmitted, where 0 means the output is switched off and 1000 means the output is fully switched on. In addition, some auxiliary data is transmitted, such as the output hardware type, the assigned output function, or the possible output restriction.
- c) Binary input. Status information 0 (off) or 1 (on).
- d) Temperature. The temperature data is transmitted with a resolution of 0.1 °C.
- e) Power. The instantaneous active power data with a resolution of 1W is transmitted. In addition, some auxiliary data is transmitted, such as the total energy measured by the respective device.
- f) Voltage (since S-CONNECT 2). The electric voltage value with a resolution of 0.1 V is transmitted.
- g) Current (since S-CONNECT 2). The electric current value with a resolution of 1mA is transmitted.
- h) Generic (since S-CONNECT 2). The generic value is transmitted. This device type is intended for other, less frequently used physical quantities.

The S-Connect protocol works based on the access point's communication with remote stations, similar to how computers connect to a WIFI access point. The access point is always 1 device that the user chooses.

The access point controls the communication with remote stations and their pairing. There cannot be 2 access points in one S-Connect network, but there can be several S-Connect networks, ie several access points, within a local Ethernet network.

Example 1: A typical example of an access point is the Watrouter Mx controller, which provides power measurement on phases L1 to L3 and also switches the connected appliances (loads) according to the photovoltaic excess energy. Another Watrouter Mx controller is then connected to it as a remote station, which only serves as an output expansion module. The S-Connect protocol is transmitted via the Ethernet network.

Example 2: Another example of an access point is the Heating Control controller, which controls the building heating. The Watrouter Mx controller then connects to it as a remote station and shares information about the low tariff, temperature data, or excitation of the output needed to optimize the operation of a heat pump according to the photovoltaic excess energy (heat pump that is connected to Heating Control). The S-Connect protocol is transmitted via the Ethernet network.

Example 3: Another example of an access point is again the Watrouter Mx controller, which provides power measurement on phases L1-L3 and switches the connected appliances and at the same time it has the SC-Gateway module installed. A wireless socket is then connected to it as a remote station. The S-Connect protocol is transmitted over the wireless network and replaces the older protocol used in previous firmware versions for this wireless communication.

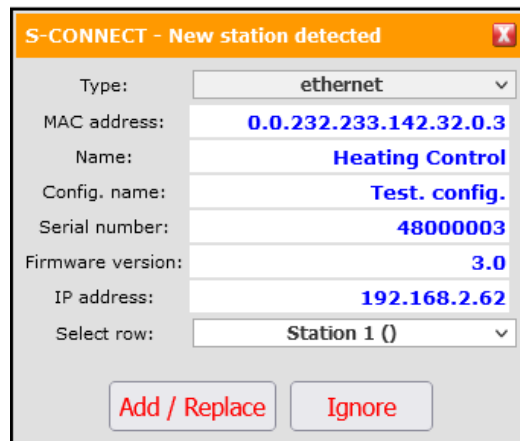
AUTOMATIC PAIRING OF STATIONS TO THE ACCESS POINT

If the station is not connected to an access point, it sends a pairing request. This request is implemented differently depending on the physical layer used:

- a) Ethernet connection (for devices directly supporting S-CONNECT): The station sends a request periodically every 10 s. The station sends a UDP broadcast, which the access point receives if it is connected to the same local network. This UDP broadcast uses IP 255.255.255.255 and port 50161. For the request to arrive, this port must not be blocked on the network and the UDP broadcast function must not be blocked either.
- b) Ethernet connection (for devices that do not support S-CONNECT, connected via a bridge - see chapter Bridges to other protocols): The station sends a request periodically, usually every minute. The station sends an ARP broadcast (ARP announcement), which is received by the access point if it is connected to the same local network.
- c) Wireless connection: The station registers in the wireless network managed by the SC-Gateway module and the request is then sent from the SC-Gateway module to the unit to which the module is connected and which always acts as an access point. The wireless device must be within range of the SC-Gateway for the request to arrive. If the request does not arrive and even after a longer period of time (1 minute or more) and the information below is not displayed, then the station is probably out of range. Then proceed according to chapter Troubleshooting. The request arrives only once, to show the request again station restart is needed (switch it off and on again).

The station pairing request is then displayed to the user in the access point control interface, and the user must decide whether or not to allow the station to pair with the access point.

The pairing request then looks like this:



The dialog box titled "S-CONNECT - New station detected" displays the following information:

Type:	ethernet
MAC address:	0.0.232.233.142.32.0.3
Name:	Heating Control
Config. name:	Test. config.
Serial number:	48000003
Firmware version:	3.0
IP address:	192.168.2.62
Select row:	Station 1 ()

At the bottom, there are two buttons: "Add / Replace" and "Ignore".

Figure 20: A dialog box showing the new station pairing request.

The user can then acknowledge the request and add the station to the specified row of the station table or reject the request, then add the station to the internal list of ignored stations so that the next time the access point ignores its repeated request.

To confirm the pairing or reject the station, it is necessary to write the configuration to the controller.

As soon as a station is added to the station table of the access point, the access point starts communicating with that station immediately.

This is also reflected in the station control interface, where the given access point appears in the first row of the station table.

This completes the pairing.

Note: In the case of ad a), if the connection between the station and the access point is interrupted, the station will start transmitting pairing requests again periodically. This is because the connection may have been lost due to a change in the station's IP address if, for example, the station uses DHCP for IP assignment. The pairing request is therefore also used to communicate the current valid IP address of the station to the access point.

Note: In case of ad a), if there are more access points in one local network, ie more independent S-Connect networks, the pairing request will be displayed in all access points. The user can try to pair the station with multiple access points, but communication can only take place with only one access point at a time, depending on where the first pairing took place. If a station has a specific access point assigned to it, it will refuse to communicate with another access point. Pairings with other access points will be invalid. If a pairing request is displayed at an access point where you do not want to pair the station, the request must be rejected, and the access point will continue to ignore that station.

MANUAL PAIRING OF STATIONS TO THE ACCESS POINT

Since firmware version 2.3, it is also possible to pair individual stations manually on the Ethernet line (in accordance with the S-CONNECT 2 protocol). This form of pairing is only available for stations connected to an Ethernet line and may be necessary if there are too many different stations on the line or the internal table of ignored stations becomes full.

Manual pairing takes place using the UDP protocol on port 50160. This port must not be blocked on the network for the request to arrive.

In manual pairing mode, the IP address of the station is entered and the access point tries to find it on the network. Once the station is found, the pairing process is the same as in automatic pairing mode. For more detailed information on manual pairing, see the S-Connect tab chapter.

The manual pairing mode will only work for stations directly supporting the S-CONNECT 2 protocol, or for stations connected via one of the bridges (see chapter Bridges to other protocols).

CANCEL STATION PAIRING

If the pairing needs to be canceled, this is done in the control interface of the access point and possibly the station.

For an access point, the appropriate command (Clear entry button) removes the stations from the access point station table. This will also delete the station from the access point, end the communication and delete all mapped devices from the device mapping table.

The access point remains assigned in the station control interface. It can either be deleted in the same way or left in case we want to re-pair this station with the same access point later.

DEVICE PAIRING

After pairing the station with the access point, in order to share the device, it is necessary to assign the source (physical) devices of the remote unit to the destination (logic) device of the local unit. This assignment is called mapping and can be done both in the user interface of the access point and at the station.

Source devices can be selected from the device map, which is transmitted by the respective remote unit. The destination devices can be selected from the available logic devices of the local unit.

The mapping is performed in a device mapping table, where each row of the table maps one source device to one destination device. The principle of mapping is best illustrated by the following figure:

S-CONNECT - a device sharing protocol

*) local control

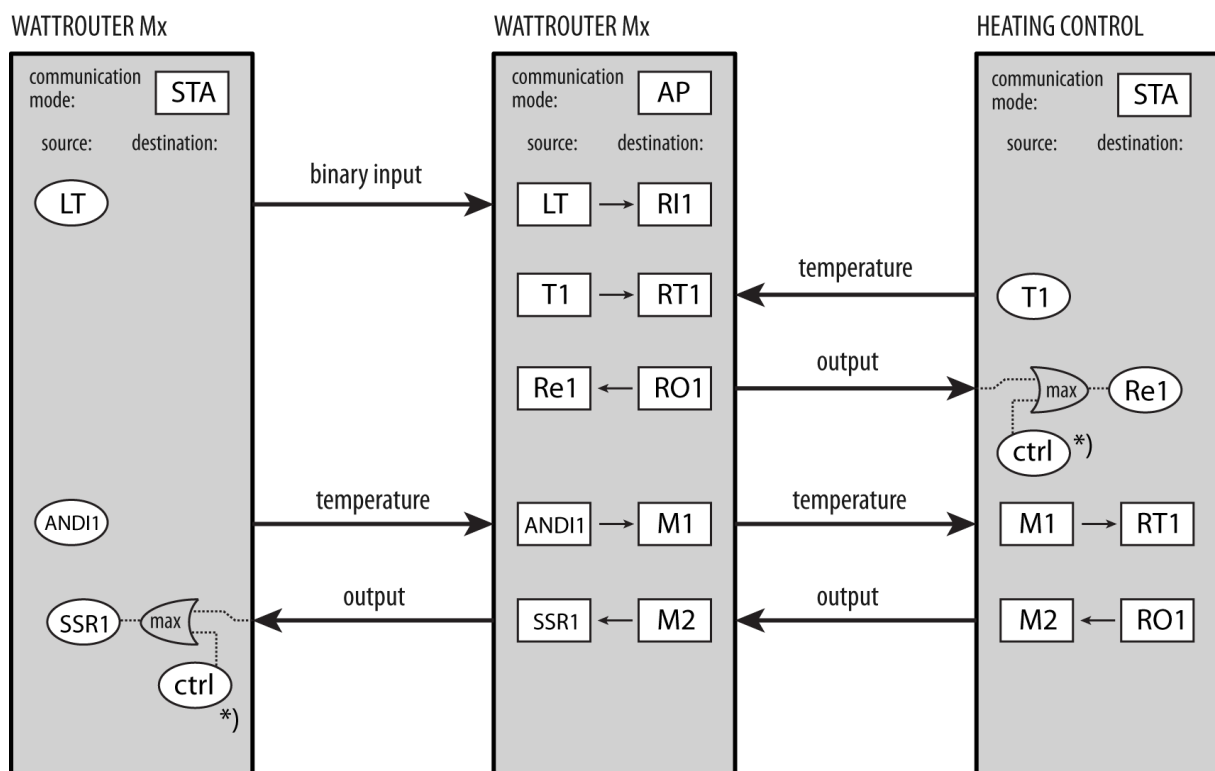


Figure 21: Device sharing in the S-Connect protocol. The communication mode of the given device is marked in the upper part, the relevant mappings of source devices to destination devices are marked in the rectangular fields below. The oval fields indicate the source physical devices available in the device. To excite (switch) the physical outputs, the maximum excitation of the local control of

the given device and the excitation received from the remote station are always used. The figure also shows the sharing of devices between individual stations using the memory cells of the access point.

Only after the mapping is completed, logic (remote) devices can be used in the local unit. These can be selected in various places in the control interface of the local unit as well as their physical devices.

BRIDGES TO OTHER PROTOCOLS

Since firmware version 2.3, simple bridging of the S-CONNECT protocol to other protocols used by IoT device manufacturers is supported. These bridges were created due to the difficult implementation of the S-CONNECT protocol in the firmware of these IoT devices. In the current version, only HTTP converters are supported for devices with Tasmota and Shelly firmware.

BRIDGE TO THE TASMOTA FIRMWARE (HTTP API)

This bridge implements simple communication with a device on the ESP platform that has Tasmota firmware loaded into it. Communication takes place via the HTTP API (HTTP GET request, JSON response). The bridge is primarily intended for WIFI sockets with one relay output and one built-in electricity meter. Since the available input and output physical devices cannot generally be detected from the Tasmota firmware, the bridge will create 3 fixed devices R1, P1 and V1 for subsequent assignment to the device mapping table. The bridge communicates using these commands:

Purpose	HTTP request	Expected response	Notes
Device identification	http://(ip)/cm? cmnd=DeviceName	{"DeviceName": "Tasmota XXX"}	Used to identify the device within station pairing. The DeviceName value must start with Tasmota, so you need to name the station . You can use any text instead of XXX (e.g. Tasmota Home).
Setting safety relay shutdown	http://(ip)/cm? cmnd=PulseTime%20160	Any	It sets the safety relay R1 shutdown to 60 sec as required by S-CONNECT 2.
Turning relay on	http://(ip)/cm? cmnd=Power%20ON	Any	Turns relay R1 on according to the S-CONNECT request.
Turning relay off	http://(ip)/cm? cmnd=Power%20OFF	Any	Turns relay R1 off according to the S-CONNECT request.
Active power measurement	http://(ip)/cm? /cm?cmnd=Status%2010	{..., "Total":2.073, ..., "Power":0.41, ...}	Finds information about the measured active power and total energy for input P1.
Mains voltage measurement	http://(ip)/cm? /cm?cmnd=Status%2010	{..., "Voltage":230, ...}	Finds information about the measured voltage for input V1.
RSSI detection	http://(ip)/cm? /cm?cmnd=Status%2011	{..., "RSSI":86, ...}	Detects WIFI signal strength (RSSI parameter in percentage) for the station's LQI field.

BRIDGE TO THE SHELLY FIRMWARE (HTTP API)

This bridge implements simple communication with a device on the ESP platform that has Shelly firmware loaded into it. Communication takes place via the HTTP API (HTTP GET request, JSON response, API version 2).

The bridge is primarily intended for WIFI sockets with one relay output and one built-in electricity meter. Since the available input and output physical devices cannot generally be detected from the Shelly firmware, the bridge will create 3 fixed devices R1, P1 and V1 for subsequent assignment to the device mapping table. The bridge communicates using these commands:

Purpose	HTTP request	Expected response	Notes
Device identification	http://(ip)/rpc/Shelly.GetDeviceInfo	{"name": "Shelly XXX", ...}	Used to identify the device within station pairing. The name value must start with Shelly, so you need to name the station . You can use any text instead of XXX (e.g. Shelly Home).
Setting safety relay shutdown	http://(ip)/rpc/Switch.SetConfig?id=0&config={"auto_off_delay":60, "auto_off":true}	Any	It sets the safety relay R1 shutdown to 60 sec as required by S-CONNECT 2.
Turning relay on	http://(ip)/rpc/Switch.Set?id=0&on=true	Any	Turns relay R1 on according to the S-CONNECT request.
Turning relay off	http://(ip)/rpc/Switch.Set?id=0&on=false	Any	Turns relay R1 off according to the S-CONNECT request.
Active power measurement	http://(ip)/rpc/Switch.GetStatus?id=0	{..., "apower":0.55, ...}	Finds information about the measured active power for input P1.
Mains voltage measurement	http://(ip)/rpc/Switch.GetStatus?id=0	{..., "voltage":230.5, ...}	Finds information about the measured voltage for input V1.
RSSI detection	http://(ip)/rpc/WiFi.GetStatus	{..., "rssi":-51, ...}	Detects WIFI signal strength (RSSI parameter in percentage) for the station's LQI field.

PROTOCOL LIMITATIONS IN THE WATTROUTER MX

The S-Connect protocol has the following limitations in the device:

- The Ethernet protocol version has no limitations.
- The wireless protocol version only works with the inserted SC-Gateway or SC-Router.
- Only remote outputs can be mapped due to limited data throughput, when using the wireless protocol version. Therefore, the states of the inputs (binary inputs, temperatures, powers) and the states of the memory cells are not transmitted.

The numbers of available logical (remote) devices are:

- 8 memory cells M (M1-M8)
- 8 outputs RO (RO1-RO8)
- 8 temperatures RT (RT1-RT8)
- 8 powers RP (RP1-RP8)
- 4 binary inputs RI (RI1-RI4)

DESCRIPTION OF THE MODBUS PROTOCOL

As of firmware version 2.0, the device supports the MODBUS RTU protocol on the RS485 line and MODBUS TCP on the Ethernet line.

Only the SLAVE (server) version is supported, ie the device answers requests from the parent unit, which is MASTER (client).

The protocol supports only 4 functions, namely:

- Read Holding Registers (03)
- Read Input Registers (04)
- Write Single Register (06)
- Write Multiple Registers (16) – since firmware version 2.2

The slave address is in the range 1-247 and must be set correctly, see chapter Other settings tab.

Attention, a maximum of 32 registers can be read/written with one 03 or 04 or 16 function request!

MODBUS RTU communication parameters on the RS485 line are 8N1, baud rate is selectable.

MODBUS TCP communication parameters on the Ethernet line are: server IP = controller IP, server port = 502.

INPUT REGISTER TABLE

The registers are 16-bit. The data in the registers are stored in Big Endian format. If a 32-bit value is stored, which occupies 2 adjacent registers, then a higher word is stored in the lower register and a lower word in the higher register.

These registers may be read with the function Read Input Registers (04).

Register number	Meaning	Bit width	Unit	Notes
Measured values and states				
0-1	Power on phase L1	32s	Tens of W	
2-3	Power on phase L2	32s	Tens of W	
4-5	Power on phase L3	32s	Tens of W	
6-7	Power sum L1+L2+L3	32s	Tens of W	
8-9	Voltage at L1	32s	V	
10	Error word	16u	-	Meaning of bits: 0 – Missing voltage L1 1 – Temperature sensor(s) 2 – Wrong voltage value L1 3 – DC source overload 4 to 5 – reserved 6 – SD card error 7 – S-Connect: device failed 8 to 15 – reserved
11	Info word	16u	-	Meaning of bits: 0 – Low tariff 1 – CombiWATT is active 2 – Output test is active 3 – Summer time

4 to 15 - reserved				
ANDI inputs				
12-13	Power/ temperature/ stateANDI1	32s	Tens of W/ tenths of °C/ -	Value and unit according to the selected input function
14-15	Energy ANDI1	32s	Tens of Wh	Valid only when the power measurement / pulse counter function is set
16-17	Power/ temperature/ stateANDI2	32s	Tens of W/ tenths of °C/ -	Value and unit according to the selected input function
18-19	Energy ANDI2	32s	Tens of Wh	Valid only when the power measurement / pulse counter function is set
20-21	Power/ temperature/ stateANDI3	32s	Tens of W/ tenths of °C/ -	Value and unit according to the selected input function
22-23	Energy ANDI3	32s	Tens of Wh	Valid only when the power measurement / pulse counter function is set
24-25	Power/ temperature/ stateANDI4	32s	Tens of W/ tenths of °C/ -	Value and unit according to the selected input function
26-27	Energy ANDI4	32s	Tens of Wh	Valid only when the power measurement / pulse counter function is set
Outputs				
28-29	Load power SSR1	32s	Tens of W	
30-31	Supplied energy SSR1	32s	Tens of Wh	
32-33	Load power SSR2	32s	Tens of W	
34-35	Supplied energy SSR2	32s	Tens of Wh	
36-37	Load power SSR3	32s	Tens of W	
38-39	Supplied energy SSR3	32s	Tens of Wh	
40-41	Load power SSR4	32s	Tens of W	
42-43	Supplied energy SSR4	32s	Tens of Wh	
44-45	Load power SSR5	32s	Tens of W	
46-47	Supplied energy SSR5	32s	Tens of Wh	
48-49	Load power SSR6	32s	Tens of W	
50-51	Supplied energy SSR6	32s	Tens of Wh	
52-53	Load power Relé1	32s	Tens of W	
54-55	Supplied energy Relay1	32s	Tens of Wh	
56-57	Load power Relé2	32s	Tens of W	
58-59	Supplied energy Relay2	32s	Tens of Wh	
60-61	Load power RO1	32s	Tens of W	
62-63	Supplied energy RO1	32s	Tens of Wh	
64-65	Load power RO2	32s	Tens of W	

66-67	Supplied energy RO2	32s	Tens of Wh
68-69	Load power RO3	32s	Tens of W
70-71	Supplied energy RO3	32s	Tens of Wh
72-73	Load power RO4	32s	Tens of W
74-75	Supplied energy RO4	32s	Tens of Wh
76-77	Load power RO5	32s	Tens of W
78-79	Supplied energy RO5	32s	Tens of Wh
80-81	Load power RO6	32s	Tens of W
82-83	Supplied energy RO6	32s	Tens of Wh
84-85	Load power RO7	32s	Tens of W
86-87	Supplied energy RO7	32s	Tens of Wh
88-89	Load power RO8	32s	Tens of W
90-91	Supplied energy RO8	32s	Tens of Wh
Statistics current day			
92-93	Cons. HT (total L1+L2+L3)	32s	Tens of Wh
94-95	Cons. LT (total L1+L2+L3)	32s	Tens of Wh
96-97	Surplus (total L1+L2+L3)	32s	Tens of Wh
98-99	Production (total L1+L2+L3)	32s	Tens of Wh
100-101	Cons. HT (L1)	32s	Tens of Wh
102-103	Cons. LT (L1)	32s	Tens of Wh
104-105	Surplus (L1)	32s	Tens of Wh
106-107	Production (L1)	32s	Tens of Wh
108-109	Cons. HT (L2)	32s	Tens of Wh
110-111	Cons. LT (L2)	32s	Tens of Wh
112-113	Surplus (L2)	32s	Tens of Wh
114-115	Production (L2)	32s	Tens of Wh
116-117	Cons. HT (L3)	32s	Tens of Wh
118-119	Cons. LT (L3)	32s	Tens of Wh
120-121	Surplus (L3)	32s	Tens of Wh
122-123	Production (L3)	32s	Tens of Wh
Device type and firmware version (since firmware version 2.2)			
124-125	Device type	32u	- ASCII text „WRMX“
126-127	Firmware version	32u	- ASCII text for firmware version Character meaning: 0 – development version, default is ‘A’ for normal release 1 – bug fix version, default is ‘0’ for normal release 2 – major version, eg. ‘2’ 3 – minor version, eg. ‘2’
128-129	Device option	32u	- ASCII text for device option: a) empty text – 20A option b) text „100A“ – 100A option
Digital temperature sensors (since firmware version 2.2)			
130-131	Temperature D/Q1	32s	Tenths of °C
132-133	Temperature D/Q2	32s	Tenths of °C

134-135	Temperature D/Q3	32s	Tenths of °C
136-137	Temperature D/Q4	32s	Tenths of °C

HOLDING REGISTER TABLE

The registers are 16-bit. The data in the registers are stored in Big Endian format. If a 32-bit value is stored, which occupies 2 adjacent registers, then a higher word is stored in the lower register and a lower word in the higher register.

These registers may be read with the function Read Holding Registers (03) and written with the function Write Single Register (06) or Write Multiple Registers (16).

Register number	Meaning	Bit width	Unit	Notes
Outputs – external switching <i>(does not restrict internal output switching in any way)</i>				
0	Switching level SSR1	16u	-	0 – turned off 1000 – fully turned on
1	Switching level SSR2	16u	-	0 – turned off 1000 – fully turned on
2	Switching level SSR3	16u	-	0 – turned off 1000 – fully turned on
3	Switching level SSR4	16u	-	0 – turned off 1000 – fully turned on
4	Switching level SSR5	16u	-	0 – turned off 1000 – fully turned on
5	Switching level SSR6	16u	-	0 – turned off 1000 – fully turned on
6	Switching level Relay1	16u	-	0 – turned off 1000 – turned on
7	Switching level Relay2	16u	-	0 – turned off 1000 – turned on
Outputs – external restriction (since firmware version 2.2) <i>(restricts internal output switching, does not restrict external switching)</i>				
8	Restriction level SSR1	16u	-	0 – not restricted 1000 – fully restricted
9	Restriction level SSR2	16u	-	0 – not restricted 1000 – fully restricted
10	Restriction level SSR3	16u	-	0 – not restricted 1000 – fully restricted
11	Restriction level SSR4	16u	-	0 – not restricted 1000 – fully restricted
12	Restriction level SSR5	16u	-	0 – not restricted 1000 – fully restricted
13	Restriction level SSR6	16u	-	0 – not restricted 1000 – fully restricted
14	Restriction level Relay1	16u	-	0 – not restricted 1000 – fully restricted

15	Restriction level Relay2	16u	-	0 – not restricted 1000 – fully restricted
Other configuration registers (since firmware version 2.3)				
32	Priority power offset	16u	Tens of W	Value range: -8000 to 1000
33	Reserved	16u	-	Reads as zero, writing does nothing.
34-35	Spot price	32s	Eurocents	Range not given.

Note: For external switching/restriction of outputs, do not write values 1-999 in case of set relay function. For other functions, the selected modulation type (proportional or PWM) is used.

Note: Do not combine external switching on one output via both MODBUS and S-Connect protocols! This may damage the output or the connected load!

Note: When switched/restricted externally, the output keeps the switched/restricted state for only 60 s, then for safety reasons the output will be switched off and its restriction cancelled. If you want to switch/restrict the output in this way for a longer time, you must send message 06/16 repeatedly, with a period of eg 10 s.

Note: The term "priority" in the table of other configuration registers refers to settings that change the behavior of the device, but do not overwrite the basic configuration of the device. By setting this priority register, you can temporarily change the behavior of the device. For security reasons, the priority setting will remain in operation for only 60 seconds, after which the default values will be restored according to the configuration of the device. If you want to keep the priority setting active for a longer time, you have to send the message 06/16 repeatedly, with a period of e.g. 10 s.

TROUBLESHOOTING

The following table shows the most frequent problems and usual solutions:

Problem description	Possible causes	Solution
The controller has been fitted according to the manual but after you switch on the circuit breaker no LED lights up or flashes.	The circuit breaker is on but the supply voltage is missing.	Check or measure whether there is any voltage between terminals L1 and N.
	Regulator failure/defect	Replace the regulator or take it to repair.
The controller has been fitted according to the manual but after you turn on the circuit breaker the green LED quickly flashes, the controller does not work and the WATTconfig software shows BOOT firmware version.	The controller runs in the boot mode without any application firmware	Use the WATTconfig software and load the newest firmware version or load the version you prefer. In this scenario, you have to load the application using USB or RS485 interface, which is not blocked by the controller access authorization.
The controller does not communicate with computer	The regulator has no voltage	Check whether green LED PWR is on and the regulator is powered.
	Computer is not properly connected with the controller	Check the USB/network cable connection, try using different network cable, or try the cable with different device (printer for example). If there is problem with network connection you may have a problem with your router or with other network components. Try to restart your device or try to connect the network cable to another port. Your device may also be incorrectly configured - the same applies to local network configuration settings. Should you experience problems contact a computer or network expert. If there is problem with the USB connection then always try the newest USB driver.
	Computer cannot detect connected controller.	Check USB/network cable connection. When USB device is being registered in your PC, the yellow LED COM must flash temporarily. If your network cable is connected correctly, at least one LED on the regulator network connector must be on.
	USB interface driver was not correctly installed in your computer	Make sure the USB interface driver is correctly installed and Windows device manager detects it as a USB serial converter.
	USB interface driver is not configured properly	Use the USB/COM driver configuration window in WATTconfig and reset all parameters back to default values.

	LAN/UDP interface driver is not configured properly	Use the LAN/UDP driver configuration window in WATTconfig to check the validity of IP address and UDP port. Connect to the controller using USB in order to determine the current network configuration stored in the controller (use the Other settings tab). IP addresses and UDP ports must have the same configuration.
	The Log window records communication errors	A very few communication errors is considered a common status and it depends on the actual load put on the operating system in your computer, the local network, or on the operating system running in the controller. However, if there are many errors inspect the functionality of your PC, or it may also be a conflict at the USB interface in your PC, USB driver may be outdated or your Ethernet may be overloaded or malfunctioning. If you are connected to the Internet, large occurrence of communication errors (packet losses) is considered normal status. With S-Connect communication over Ethernet active, the frequency of these errors increases further.
	Overloaded Ethernet	Your local network or Internet connection is temporarily out of order, overloaded with other transfers, etc. Try to reconnect later or ask a network expert for advice to optimize your connection.
	Regulator failure/defect	Replace the regulator or take it to repair.
	The current sensing module is not connected	Connect the current sensing module according to this manual.
Measured powers on ILx inputs are not displayed or they are displayed incorrectly	Incorrect phase sequence	Make sure that for all ILx inputs the "Phase" field is correctly set. Perform the settings according to chapter Setting up main function and check with Input checking oscilloscope.
	Incorrect current orientation settings	Make sure that for all ILx inputs the "Current orientation" field is correctly set. Perform the settings according to chapter Setting up main function.
	The ANDI inputs are configured incorrectly	Wrong configuration of ANDI inputs can cause incorrect measurement of ILx inputs! Disconnect all CTs or sensors from ANDI inputs and check the ILx function. If everything is OK then again connect the sensors to respective ANDI inputs and select their functions exactly according to

		connected sensors.
	Regulator or current sensing module defect	Replace the regulator and/or current sensing module or take them to repair.
There are suspicious waveforms shown in chart "Input checking oscilloscope"	This is normal	During normal operation there may be shown even "exotic" waveforms. Be sure this is the real current flowing through the phase wire, a superposition of currents flowing through the connected appliances which are not sinusoidal or their power factor varies from one.
Positive measured power value (production) differs too much from the value on the inverter display	There is connected some load, which decreases this value.	No defect
	Inverter shows approximate values, or the status is not stable	No defect
	Incorrect phase sequence or incorrect current orientation settings	Follow the steps specified in the previous troubleshooting item.
Low tariff signal is missing	Low tariff signal is not connected	Connect the low tariff signal to LT terminal. You must connect the signal through an auxiliary relay as specified in this manual.
	Low tariff signal is not active	Wait until the signal is active, or manually test the auxiliary relay by switching it on (some relays have this option).
	Regulator failure/defect	Replace the regulator or take it to repair.
ANDI inputs do not work	Input function set incorrectly	For ANDI inputs it is absolutely necessary to correctly setup input function according to connected input device/sensor.
	Measurement with external current transformers does not work	Connect a compatible external current measuring transformer, such as another current sensing module or other WATTrouter compatible CT. Also check the Phase and Current Orientation settings which should follow the same principles as for the ILx inputs.
	S0 impulse output from external meter/inverter is connected with reverse polarity	Observe polarity of the device output (energy meter, inverter).
	Signal coming from the output is an unsupported impulse signal	Use only device with S0 impulse output whose signal carries information about the measured energy and has a minimum impulse width of 1 ms. Signal parameters are described in chapter Technical specifications.
	Connected analog	Connect only compatible sensors according

	temperature sensor does not work	to chapter Technical specifications. Select ANDI input function that corresponds with the sensor type. Measure the sensor resistance and voltage at the ANDI terminal against the GND terminal. For NTC, the resistance must be about 10 k Ω at 25 °C, the voltage approx. 1.67 V. For PT1000, the resistance of approx. 1100 Ω at 25 °C, voltage approx. 0.35 V.
	Regulator failure/defect	Replace the regulator or take it to repair.
Digital temperature sensors do not work	Incompatible sensor	Use only compatible sensor with original chip inside (DS18B20 or DS18S20).
	Wrong connection	Connect according to the connection information on the sensor. Do not connect sensors where this information is missing. Always connect in 3-wire way (i.e. with power supply)
	DQ data bus too long	Shorten the bus, test the sensors one at a time. If they operate individually but all at a time not, the DQ bus capacity is too high. In this case, you can also try adding a 4k7 resistor between the DQ terminal and the +5V terminal.
	Sensor bad	The sensor may be damaged, measure the sensor power consumption (from terminal +5V) with a milliammeter, the input current should match the sensor specification, i.e. max. 2mA. A faulty sensor sometimes has an increased power consumption and is warming up (this is not a rule). If there are more sensors on the sensor bus, try one at a time and identify the faulty sensor.
	DQ input failure	This is not probable but possible, especially if the sensors work on a different device. Replace the regulator or take it to repair.
The TEST button cannot be used to switch on some of the connected loads	The relevant load is not connected or it is connected incorrectly	Check the connection of the relevant load and switch on the corresponding circuit breaker or fuse switch.
	The load is connected correctly but cannot be switched on	Check whether the load is fitted for example with a thermal protection system or a thermostat, which is currently off.
	Output LED is defect or there is another regulator defect	Replace the regulator or take it to repair.
Outputs do not switch on as they should	Output is not activated	Activate the output by setting the relevant priority.
	PV-plant does not provide	Check whether there is enough surplus

	sufficient power output	energy available in respective phase wire or sum of phases L1 + L2 + L3 is positive, depending on configured control mode.
	Incorrectly set priorities or connected power values	Check the priority settings of your loads and connected power settings according to their power ratings.
	Incorrect settings of some items in the Other settings tab	Check the settings in the Power offset field. Also check the CombiWATT production limit field, which should be low.
You cannot download firmware, even if you try repeatedly	Incorrect or corrupted *.scf file	Load only original firmware for the WATTrouter Mx device.
	Communication errors	Make sure that there are no problems with the connection of the controller to PC, or in the PC alone (viruses etc.).
	Regulator failure/defect	Replace the regulator or take it to repair.
Flashing red LED	The system detected error status	Follow instructions in the LED statuses chapter.
When the available surplus energy is decreased, the SSR output with higher priority is switched off earlier than the relay output with lower priority	This is normal	Relay outputs have always longer delay when in the process of disconnecting. In order to make sure that energy from the power grid is not drawn unnecessarily, all connected proportional outputs with higher priority may be disconnected earlier than the relay outputs with lower priority.
CombiWATT function runs even if PV-plant produces power	This is normal	CombiWATT will be initiated even if during the time specified in the CombiWATT delay time field, no production is detected at any phase wire, which may occur if the PV-plant produces small amount of energy or if loads with large power consumption operate for long time and consume all available surplus energy. If you want to eliminate this behavior, increase the value in the CombiWATT delay time field.
Solid state relay (SSR) does not switch on	SSR is not connected correctly	Check for proper terminal connection and observe polarity of SSR control anodes.
	Incompatible relay	Always use a SSR with zero cross switch and minimum DC control voltage of 4VDC.
	Regulator failure/defect	Replace the regulator or take it to repair.
	SSR failure/defect	Replace the SSR.
Data in statistics don't correspond with reality	This is normal	The data are indicative only; the device does not have accurate data from utility/billing meters. Furthermore, the device may be configured improperly, i.e. does not evaluate the same as your utility meter does.
Statistics suddenly erased	This is normal	There was a date change in the controller or

		power failure during writing the history into EEPROM. Statistics on SD card should be fine.
SC-Gateway or SC-Router module is inserted in the regulator, but neither Link LED nor PWR LED works	Wrong polarity of the module	Remove and insert module once again based on installation manual of the module.
	Regulator or module failure/defect	Replace the module or regulator or take them to repair.
Wireless peripheral can't be registered, even after longer period while connected. Window S-Connect – new station detected is not displayed.	Station out of signal range	Test the wireless peripheral so it is placed temporary closer to the regulator. Once this time it is detected, there is necessary to extend signal range with signal repeater. Consult this problem with technical support.
	Station is incompatible	It is different type of wireless peripheral, which is not compatible with SC-Gateway module.
	Station is defective	Follow the installation manual for the wireless peripheral.
	SC-Gateway module does not react	Reset the controller and wait about 1 minute. Then repeat the network registration procedure.
	SC-Gateway module failure/defective	Replace the module or take it to repair.
Wireless station does not switch or switches incorrectly	Station out of signal range	Test the wireless peripheral so it is placed temporary closer to the regulator. Once this time it is detected, there is necessary to extend signal range with signal repeater. Consult this problem with technical support.
	Station is defective	Follow the station manual
	SC-Gateway module does not react	Reset the controller and wait about 1 minute. Then test the function of the peripheral.
Cannot pair units via Ethernet using the S-Connect protocol	The units do not have S-Connect activated	Activate S-Connect on all units, one unit must be access point (AP) and the other units must be stations (STA).
	The units are not connected to the same local network	Connect all units to the same local network. Note: Pairing requests do not pass from one subnet to another, you must use the same subnet.
	The units have either incorrect network configuration or are disconnected	Make sure all units are accessible on local network (use PING command).
Device responses on the S-Connect tab are very long, change erratically and even	Errors in the Ethernet local network.	The local network is incorrectly configured, there are IP address conflicts. Get your local network up and running.

stations become disconnected.	Local Ethernet network is heavily loaded.	The local network is overloaded, e.g. by downloading movies or due to the operation of other services. Ensure such services do not overload the local network.
	WIFI range problems.	Some WIFI connections are not strong enough and this negatively affects the behavior of the used WIFI router or WIFI bridges. Fix it by using WIFI signal repeaters.
MODBUS RTU protocol does not work on RS485 line	Wrong protocol	Ensure protocol for RS485 is correctly configured, it must be MODBUS RTU slave
	Wrong address	Set address correctly in the MODBUS address field.
	Wrong baud rate	Set baud rate correctly.
	The Master station is not configured properly	Ensure the correct configuration of the Master station, especially do not exceed the maximum number of registers per message (32) and their permitted range.
	The Master station sends messages too often	Ensure that the Master station does not send messages to the controller more often than with a period of 100ms.
MODBUS TCP protocol does not work on Ethernet line	Connection failure	Check the connection of the Ethernet line to the controller.
	Wrong TCP port	Make sure the master polls on the correct port (502).
	The Master station sends messages too often	Ensure that the Master station does not send messages to the controller more often than with a period of 100ms.

MAINTENANCE AND REPAIRS

The WATTrouter Mx devices have been designed as maintenance-free units, provided that they were configured and fitted according to instructions specified in this manual. We recommend inspecting the operation of the entire system at regular intervals (at least once in a month, for example, when inspecting the status of the PV-plant). Focus mainly on the load switching process and heat dissipation.

Should you discover a defect which cannot be repaired according to instructions specified in the Troubleshooting chapter, contact your distributor (applies both to warranty and post warranty repairs).

Defect on current sensing module is very unlikely to occur. In case of a defective regulator, you can send only the regulator for repair or replacement. The current sensing module may still remain fitted without the regulator. Even if electric currents flow through measuring coils, the module will not be damaged.

Never attempt to repair your device by yourself! If you do so, you are putting yourself at risk of electric shock. Further, your entire warranty will be void!

TECHNICAL SPECIFICATIONS

Parameter	Value, notes
Main parameters	
Supply voltage	230 V~, 50 Hz
Power consumption – stand-by mode	<3 VA
Power consumption – 1 relay output	0.4 W
Power consumption – all outputs switched on and loaded with maximum allowable currents	4 W (this value does not include switching losses of connected power SSRs)
Current measuring range	Mx: 0-20 A~ (±5%), 50 Hz (±5 %) Mx 100A: 0-100 A~ (±5 %), 50 Hz (±5 %)
Voltage range	Mx: 230V~ (±5%), 50Hz (±5%)
Maximum steady currents allowed to flow through current sensing module	0-40 A~ (±5 %), 50 Hz (±5 %) Mx 100A: 0-125 A~ (±5 %), 50 Hz (±5 %)
Active power measuring accuracy	2% ± 0,05kW Mx 100A: 2% ± 0,15kW
Output and input parameters	
Power supply terminals L1 and N	230 V~, 50 Hz. L1 = phase wire, N = neutral wire
+12V terminal	+12V with respect to GND. It is used to connect external semiconductor relays (common positive anode) or supply of external PWM/0-10V converters. Max. cons. 60 mA, depending on load, this voltage can drop to 8V.
+5V terminal	+5V with respect to GND. Max. cons. 100 mA. It is used to connect external semiconductor relays (common positive anode) or as power supply for digital temperature sensors DS18x20.
Y terminal	+1,67V with respect to GND. It is a center of a voltage divider for connecting the measuring module or current measuring transformers to the IIX or ANDI inputs. ANDI inputs must have power measurement function.
Relay outputs	230 V~, 50 Hz, max. 10 A, 2300 W (it is recommended to connect load with $\cos(\Phi) \neq 1$ via external contactor) Protection: Regular circuit breaker, type B
SSR outputs - to connect solid state relays SSR (S1-, S2-, S3-, S4-, S5-, S6-)	<+2V or +12V with respect to GND, isolated from power grid supply SSR parameters: control DC min. 4VDC, SSR must switch at zero (zero switch). Protection: based on instructions specified in the SSR relay manual, we recommend semiconductor fuses
SSR outputs – to connect devices with PWM function, direct PWM output (S1-, S2-, S3-)	0V or +12V with respect to GND, isolated from power grid supply Output type: open collector PWM parameters: carrier frequency 200 Hz to 10

	kHz, duty cycle 0-100% in 1% steps Protection: based on connected device instructions
SSR outputs – to connect devices with PWM function, direct output of 0-10VDC signal (S4-, S5-, S6-)	<i>Non-inverted output:</i> +2V to +12V with respect to GND, it means -10V to 0V with respect to +12V terminal. <i>Inverted output:</i> 0V to 10V with respect to GND terminal (after device restart may shortly go up to +12V with respect to GND). Isolated from power grid supply. Output type: Sallen-Key filter. Voltage range: 0-10V in 1% steps. Output ripple: according to preset PWM frequency. Protection: based on connected device instructions
IL1, IL2, IL3 inputs:	Accept only secondary currents from current sensing module or compatible current transformers. Maximum allowed voltage against GND terminal is 5.5 V. Model Mx: max. 40 mA~. Model Mx 100A: max. 125 mA~.
LT input	0 or +5 V with respect to GND, isolated from power grid supply. May be switched using regular relay outputs or optocouplers with open collector, always against GND.
ANDI inputs	Analog inputs. Maximum allowed voltage with respect to GND is + 5.5 V. Isolated from power grid supply. Power measurement function: as inputs IL1 to 3, but approx. 15 mA~. S0 pulse counter function: 0 or +5 V with respect to GND. Minimum pulse and gap width is 1ms. NTC function: Supported is resistive temperature NTC sensor 10k@25°C, $B_{25/85}=3977$, measurement accuracy is $\pm 2^{\circ}\text{C}$. PT1000 function: Supported is platinum temperature PT1000 sensor, 1k@0°C, measurement accuracy is $\pm 5^{\circ}\text{C}$.
DQ terminal	Data bus to connect digital temperature sensors DS18B20 or DS18S20, measurement accuracy is $\pm 0.5^{\circ}\text{C}$.
USB Connection	USB 1.1/ USB 2.0, isolated both from power grid supply and other control parts of the regulator, serial communication parameters: 115200 Bd 8N1.
LAN Connection	10/100 Mbit/s, isolated from power grid supply according to IEEE 802.3
RS485 A and B terminals	RS485, isolated from power grid supply. Serial communication parameters: 115200 Bd 8N1.

Dynamic characteristics	
Active power measuring period (effective values)	typically 600 ms (including averaging of SSRs being switched-on)
Regulation dynamics (full scale) at SSR output with function set to proportional control	typically 3 s (from 0 to 100 % of power output and vice versa)
Relay output on-delay time	Programmable (minimum of 2s)
Relay output off-delay time	Programmable (minimum of 2s)
Other parameters	
Maximum diameter of wires connected to terminals	2.5 mm
Maximum diameter of wires passing through measuring transformers	Mx type: 9 mm (including insulation) Mx 100A type: 14 mm (including insulation)
Distance of the current sensing module and the regulator	<2 m (longer wires are acceptable, but they reduce the accuracy approx. by 0.2% per 2m)
Distance of the regulator and solid state relay	<10 m
Working position	Any
Mounting	Regulator: DIN 35mm or wall mounted using 2 screws with round or sink head and with diameter of up to 6mm. Current sensing module: DIN 35mm or wall mounted using 1 screw with round or sink head and with diameter of up to 6mm.
Overvoltage category	III
Electric strength	4 kV / 1 min (between power supply (L1, N) and pluggable terminals, between power supply and relay outputs R1 and R2, between power supply and communication sockets)
Pollution degree	2
Operational temperature range	-20°C to +40°C
Storage temperature range	-40 °C to +80 °C
Protection (power supply)	B6A
IP code	Regulator and current sensing module: IP 20
Dimensions (WxHxD)	Regulator: 106x110x64mm (6 modules) Current sensing module: Mx type: 70x110x64mm (4 modules) Mx 100A type: 91x90x65mm (5-6M)
Weight	Regulator: 400g Current sensing module: Mx type: 100g Mx 100A type: 250g
Noise level (including power SSRs)	0 dB(A). Passive cooling only, for power SSRs, sufficient heat dissipation is required.
Battery for real time backup	CR2032 lithium, usual lifetime > 6 years
Warranty period	36 months

BATTERY FOR REAL TIME BACKUP

The regulator contains a CR2032 type battery for real time backup. If the controller shows an incorrect date and time after a power failure, then the battery is discharged. The battery can be replaced.

The battery can be of two types (the battery type can be determined by opening the lid of the regulator with a small screwdriver):

- a) Soldered battery to the regulator PCB. This battery usually has a yellow band around the perimeter and contacts for soldering. To replace this battery, it is necessary to disassemble the device and entrust the replacement to an electronics repair service.
- b) Standard battery placed in a case. This battery can be replaced by yourself without having to disassemble the device. Remove the battery with a suitable tool, for example a plastic clamp, after removing the regulator lid. Insert the spare battery in the same way.

Important notice: *It is absolutely necessary to respect the polarity of the battery. If you insert the battery the other way round, the main microprocessor will be damaged! When replacing the battery, do not use metal tools that could short-circuit the battery!*

RECYCLING

After the product life is over the product may be disassembled, recycled or disposed of at a safe dumpsite.

Legal regulations regarding electronic waste treatment have to be observed in respective country.

Before product disposal, remove real time backup battery (if possible).

Do not dispose in regular household waste!

EU DECLARATION OF CONFORMITY



Company:

SOLAR controls s.r.o. (manufacturer name)
Brojova 25, Plzeň, 32600, Czech Republic (manufacturer address)
29109795 (manufacturer id)

Hereby declares that this product:

WATTrouter Mx, WATTrouter Mx 100A (product name)
WRMX 01/08/17 (regulator) and WT 02/10, WT 03/11 (current sensing modules) (type/model)
Designed for to optimize self-consumption of electric power produced by photovoltaic power plant (function)

To which this declaration relates is in conformity with the following directives, standards and other normative documents, provided that it is installed, maintained and used in application for which it was made, in accordance with relevant installation standards and manufacturer's instructions:

Directives:

- LVD Directive 2014/35/EU
- EMC Directive 2014/30/EU

Standards:

- EN 61010-1:2010
- EN 61000-3-2:2006+A1:08+A2:09
- EN 61000-3-3:2008
- EN 61000-3-11:2000
- EN 61000-4-2:2009
- EN 61000-4-4:2012
- EN 61000-4-5:2006
- EN 61000-4-11:2004
- EN 61000-6-3:2007

Year of affixing the CE marking: 2017

Declaration issued:

Plzeň, April 1, 2017

(place and date)

Ing. Tomáš Krýsl, Company Executive

(name, job title and signature of responsible person of the manufacturer)



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