Empowering the Solar Future

Manual

# AC•THOR / AC•THOR 9s: Operation Manual up to FW a0022702

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1. Assembly

Before placing into operation it is essential to read the assembly instructions provided with the device.

2. Commissioning

A quick-start guide is enclosed with the unit, in which each step of the initial commissioning is explained in detail. These instructions can also be found **here**

2.1. Select language

Use the left and right arrow keys to see more options.

## 2.2. Select operating mode

See chapter headed "Operating modes".
The selection can also be changed at a later date.

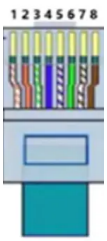
## 2.3. Possible Controls

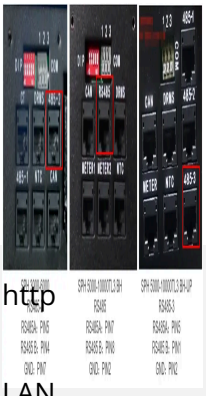
**my-PV WiFi Meter**
Instructions can be found **here**

**Compatible manufacturers**
Instructions can be found **here**

Further preset controls (without separate instructions) are listed here:

| | |
|---|---|
| **Signalsource** | my-PV Power Meter Direkt |
| **Hardware Interface** | Direct connection<br>(RJ45, cross-over network cable) |
| **Comments** | Connection to the my-PV Power Meter is established directly without a network. A crossover network cable must be used for this type of connection!<br><br>**The my-PV Power Meter was replaced by the my-PV WiFi Meter in 2022. No direct connection is possible with the my-PV WiFi Meter!** |
| **Signalsource** | my-PV API |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | For control via the Internet.<br>See chapter "Special setting possibilities in the Web-Interface". |
| **Signalsource** | my-PV WiFi Meter (Modbus RTU) |
| **Hardware Interface** | Modbus RTU<br>(RS485, A B GND) |
| **Comments** | **Connection possible from WiFi meter serial number: 230505XXXX!**<br><br>To use the my-PV Cloud, it is recommended to also integrate the AC-THOR into the network! |
| **Signalsource** | Adjustable Modbus TCP (Sunspec etc) |

| | |
|---|---|
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | Cannot be selected on the display, configuration is done in the web interface. See chapter "Special setting possibilities in the Web-Interface". |
| **Signalsource** | Janitza UMG604 Manual |
| **Hardware Interface** | Network<br>(RJ45, Ethernet) |
| **Comments** | Approved for type UMG 604 / UMG 604-Pro |
| **Signalsource** | Carlo Gavazzi EM24 Manual |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | Approved for meter type EM24 with Modbus TCP. |
| **Signalsource** | Carlo Gavazzi EM500 (Modbus RTU) |
| **Hardware Interface** | Modbus RTU<br>(RS485, A B GND) |
| **Comments** | Approved for meter type EM530-EM540 |
| **Signalsource** | Frequency |
| **Hardware Interface** | Mains connection |
| **Comments** | See chapter 7 Frequency control. |
| **Signalsource** | Growatt (Modbus RTU) |
| **Hardware Interface** | Modbus RTU<br>(RS485, A B GND)<br> |

| | |
|---|---|
| **Comments** | The control signal is received via Modbus RTU (RS485, A B GND)! Connection diagram according to chapter 9.<br><br>When controlling via Modbus RTU, the operating mode M7 cannot be used!<br><br> |
| **Signalsource** | http |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | Note: Inverters that are not SPH**-UP** may need to be updated to the latest firmware version to communicate via RS485, according to Growatt. To do this, send the Growatt serial number and a short explanation to service.de@growatt.com.<br>For control by freely programmable energy management or smart home systems, a description of the open protocols Modbus TCP and http is available in a separate document. The connection to the signal source is made via LAN. The description can be found **here** or at www.my-pv.com/en/info/downloads/ with the search term "Controls". |
| **Signalsource** | IME Conto D4 Modbus MID (Modbus RTU) |
| **Hardware Interface** | Modbus RTU<br>(RS485, A B GND) |
| **Comments** | The control signal is received via Modbus RTU (RS485, A B GND)!<br>Connection diagram according to chapter 9.<br><br>When controlling via Modbus RTU, the operating mode M7 cannot be used!<br><br>Tested by my-PV with IME Conto D4 Modbus MID. |
| **Signalsource** | MEC electronics Manual |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | Approved for meter type MECmeter. |
| **Signalsource** | Modbus TCP |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |

| | |
|---|---|
| **Comments** | For control by freely programmable energy management or smart home systems, a description of the open protocols Modbus TCP and http is available in a separate document. The connection to the signal source is made via LAN. The description can be found **here** or at www.my-pv.com/en/info/downloads/ with the search term "Controls". |
| **Signalsource** | QCELLS (Modbus RTU) |
| **Hardware Interface** | Modbus RTU<br>(RS485, A B GND) |
| **Comments** | The control signal is received via Modbus RTU (RS485, A B GND)!<br>Connection diagram according to chapter 9.<br><br>When controlling via Modbus RTU, the operating mode M7 cannot be used!<br><br>Tested by my-PV with Q.VOLT HYB-G3 5.0 kW 1P, baud rate 115200.<br><br>According to information from Q CELLS, the devices in the Q.VOLT HYB-G3 series support RTU communication.<br><br>The correct communication connection to the Q.VOLT HYB-G3 inverter can be found in the Q CELLS manual. |
| **Signalsource** | RCT Power Manual |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | - |
| **Signalsource** | Slave |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | Cannot be selected manually. See chapter “Multi units” |
| **Signalsource** | Steca Auto |
| **Hardware Interface** | LAN<br>(RJ45, Ethernet) |
| **Comments** | - |

### ⚠ Attention

When controlled by an inverter, a feed-in meter is required in the system. The query of the inverter otherwise provides no data.

### ⚠ Attention

We ask for your understanding that we cannot do any binding support for third-party products. For questions about third-party products, please contact the technical support of the respective company.

### ⚠ Attention

Not every signal source is approved for hybrid systems with battery storage. If necessary, please contact the technical support of my-PV.

### ⚠ Attention

Operation with battery may require additional control parameters. In this case, please contact the technical support of my-PV.

2.4. Digital Temperature sensor assignment and activation

A number is assigned to the sensor in the order in which it is selected. The selection can be deselected by tapping on the key once more.

To assign a sensor to the respective entry in the list, the serial numbers can be identified on a label attached to the sensor wire.

**TIP**

As the measuring value of the sensor is already shown in the selection list, an assignment can alternatively also be made by simply altering the temperature on the sensor.

**TIP**

The use of a sensor is not necessary if the optional boost backup or the legionella programme are not used and the heat generator is switched off by a thermostat!

2.5. Save the settings

By saving the settings the commissioning for the use of excess power is finished. Additional functions, such as the optional boost backup, must be set separately.

3. Controls and displays

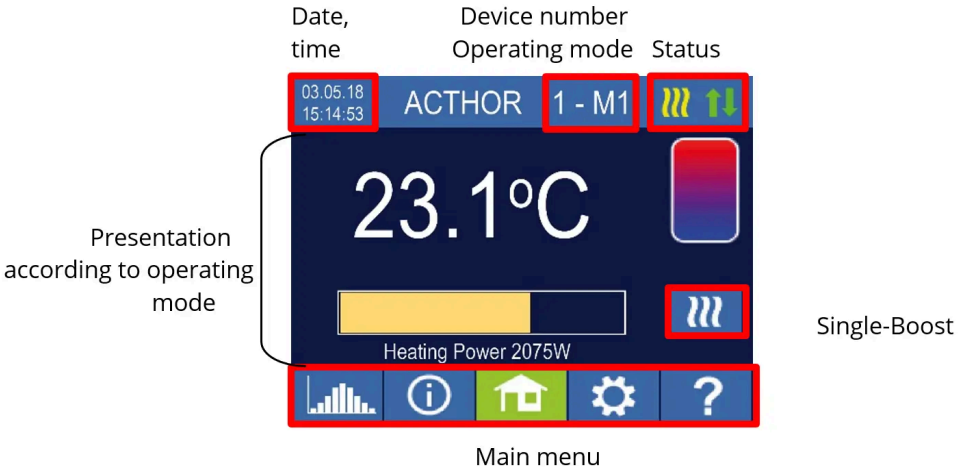
3.1. Homescreen



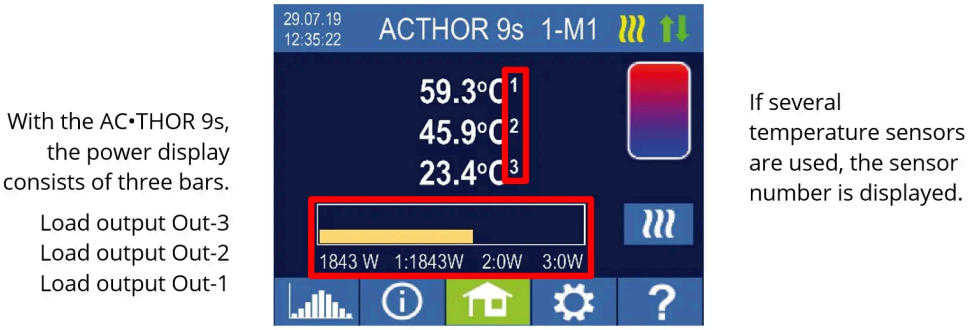
The "Home" button always returns you to the home screen. The upper bar shows the current date, time, the unit number und the operating mode (mode M1 – Mx). On the right, symbols show the unit's current status.

The contents of the home screen vary according to the operating mode and shows how much power the AC•THOR is currently feeding into the load. Depending on how many, if any, digital temperature sensors are defined, the measured values are also shown.

Homescreen AC•THOR:




Homescreen AC•THOR 9s:






The button "Single boost" only appears in hot water operating modes if the function for ensuring a minimum temperature is activated. Actuating the button starts a once-only boost backup mode. This can also be deactivated while it is in operation.
If the boost backup is actuated automatically based on the day of the week, time of day or temperature, it cannot be deactivated by using the button.

| | |
|---|---|
| **Status symbol** |  |
| | Lights up = set temperature reached |
| **Status symbol** |  |
| | Flashes = stand-by, waits for excess |
| **Status symbol** |  |
| | Lights up = heats with PV excess. Flashes = boost backup mode |

| | |
|---|---|
| **Status symbol** |  |
| | Lights up = no control signal |
| **Status symbol** |  |
| | Lights up = physical connection to the RJ45 network connection is intact |
| **Status symbol** |  |
| | Lights up = no intact physical connection to the RJ45 network connection |
| **Status symbol** |  |
| | Block active |

3.2. Status information on the display



The data of all variables relevant to the operation are shown in a list.

Output: shows the current output of the AC•THOR power unit.

Meter: shows the current data for the meter at the measuring point. A positive value shows drawing from the grid, a negative value, feeding into the grid.

PV: If a corresponding measuring point has been set in the Web-Interface under Setup, the value of the PV power is available here. See Measurement Settings.

Load: shows the nominal power of the load (at 230 V) which is currently being supplied by the AC•THOR output unit. This value can be determined from an output of 500 W.
With AC•THOR 9s, the load status (0 or 1) at the three outputs is displayed at this point.
If "none" or "0" is displayed even though a load is connected, the cause may be a thermostat that has been switched off or a safety temperature limiter that has been triggered.

Temperature 1: Current data probe 1

Temperature 2: Current data probe 2

Temperature 3: Current data probe 3

Temperature 4: Current data probe 4

IP: shows the current IP address of the AC•THOR.

Ctrl IP: shows the current IP address of the signal source. Shown in addition in the line below is the designation of the signal source and the current measured value. A positive value shows drawing from the grid, a negative value, feeding into the grid.

Status: Shows the unit's current status. See chapter "Status codes".
For AC•THOR 9s the number consists of two parts. On the left the status code of power unit AC•THOR 9s, on the right the status code of power unit AC•THOR.

Grid voltage: shows the current input voltage at the AC•THOR (only with AC•THOR)

Grid power: shows the current input power at the am AC•THOR (only with AC•THOR)

Output voltage: shows the current output voltage of the AC•THOR (only with AC•THOR)

Power 1: Power at output Out-1 (only with AC•THOR 9s)

Power 2: Power at output Out-2 (only with AC•THOR 9s)

Power 3: Power at output Out-3 (only with AC•THOR 9s)

Frequency: shows the current grid frequency.

Temperature output unit: shows the current temperature of the AC•THOR power electronics.

Fan: shows the current speed setting of the internal fan.

Serial number: shows the unit serial number.

MAC address: shows the MAC address of the unit.

Version: shows the current firmware version of the unit.

Version power stage: shows the current firmware version of the AC•THOR output unit.
For AC•THOR 9s the firmware version of the PS consists of two parts.
pXXX: Power stage AC•THOR
sXXX: Power stage AC•THOR 9s

Device number: shows the unit number set. This is also visible on the home screen.

Operating mode: shows the operating mode set (M1 – Mx). This is also visible on the home screen.

Latest firmware: shows the latest firmware version, or "current" is displayed.

Update status: Ok, loading (number of files), or waiting for installation

Output unit update status: Ok, loading, or waiting for installation

Cloud Status: Regardless of whether the cloud mode is active or not, it is displayed whether the server of the my-PV cloud is reachable. If the info "99, Timeout" is displayed at this point, please send the 16-digit serial number to support@my-pv.com.

Ethernet (E) Firmware: Shows the status of the update progress when a new version is loaded.

Power stage (P) Firmware: Shows the status of the update progress when a new version is loaded.

Power stage 9s (S) Firmware: Shows the status of the update progress when a new version is loaded.

Relay status: shows the current status of the switch output (0 or 1).
For AC•THOR 9s this number has four digits. The first digit shows the status of the switch output (0 or 1), the second digit whether Out-3 is switched (0 or 1), the third digit whether Out-2 is switched (0 or 1) and the fourth digit shows the output that is currently supplied by the power stage (1, 2 or 3).

### 3.3. Settings



See chapter "General settings" for general unit settings, also chapter "Operating modes" for settings specific to the respective operating mode.

### 3.4. Help



After activation, brief information on the current view appears on the display. In the web interface the button leads to the online Operation Manual which corresponds to the firmware version installed.

### ⚠ Attention

You will find wiring diagrams for the respective operating modes and for wiring three-phase heating elements in the assembly instructions supplied with the AC•THOR, as well as in the latest version at any time on www.my-pv.com.

## 4.1. M1: Hot water

AC•THOR: Hot water with a single-phase immersion heater

AC•THOR 9s: Hot water with a three-phase immersion heater or with 3 single-phase immersion heaters

### TIP for AC•THOR

A single-phase heating element does not necessarily have to have 3kW power. Of course, smaller outputs such as 2kW are also possible!

### TIP for AC•THOR 9s

A three-phase heating element does not necessarily have to have 9kW power.
Smaller outputs such as 4.5kW, 6kW or 7.5kW are also possible!
Likewise, three single-phase elements can have a power of less than 3kW!

### 4.1.1. Explanation

In this operating mode, an electric heating element is supplied linearly with excess PV energy. It can be fitted with a bimetal thermostat to switch off when the temperature for which it is set is reached. Otherwise the digital my-PV temperature sensor is to be used.

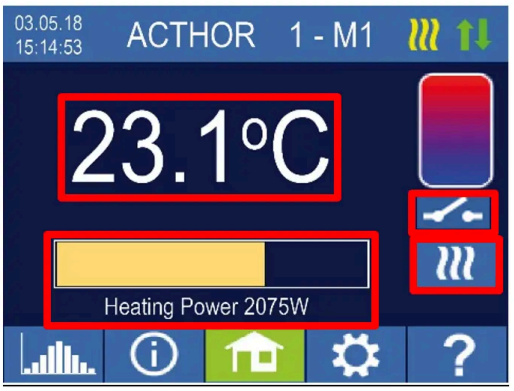
### ⚠ Attention

With AC•THOR 9s in operation with three single-phase heating elements, bimetal thermostats must be present on all three immersion heaters!

Optionally, the AC•THOR can also take over guaranteeing the hot water temperature. For this, the digital my-PV temperature sensor is to be used.

### ⚠ Attention

The digital my-PV temperature sensor is in all cases to be installed in the storage tank above the heating element to provide a reliable reading!




Homescreen

* In operating mode M1 the status of the relay is displayed if the setting "Activate relay when heating" is switched on. See chapter "Special setting options on the web interface".

** Single-Boost. Starts a once-only boost backup mode (button only appears if boost backup is activated)

**TIP**

With the hot water boost backup, limit the use of grid power by avoiding the switch-off at maximum temperature. To do this, set the value higher than the cut out temperature on the immersion heating element thermostat and site the digital temperature sensor between the immersion heating element and the top edge of the storage tank. In this way, in boost backup mode only the volume above the sensor will be heated to the minimum temperature, while when there is excess PV, the entire contents above the immersion heating element will be heated.

4.1.2. Specific settings for operating mode M1

**Hot water 1 temperatures**

Adjustable is the maximum permitted temperature to be reached at the digital my-PV temperature sensor (factory setting = 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

**Attention**

If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup is shown "On" in the window on the right (factory setting "Off") or the relay output has been selected, a minimum temperature can then be set (factory setting 50 °C).

Automatic temperature boost backup "On":
The AC•THOR can ensure a minimum temperature at the digital my-PV temperature sensor through the immersion heating element connected. This is supplied with maximum power. This may result in power being drawn from the mains or a battery being discharged!

Relay output:
Alternatively, the minimum temperature can be maintained by enabling an external heat source. Enablement is by means of a potential-free contact. For details of wiring the potential-free contacts, please refer to the assembly instructions in the chapter "Connections".

This option is not available if the “Activate relay when heating” function is activated in the web interface.

**Hot water 1 min switching times**

This setting can be selected when the temperature boost backup is "On" under "Hot water 1 temperatures", or when the relay output has been selected.

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

**TIP**

Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

**Attention**

Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

**Attention**

If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the temperature boost backup is "On" under "Hot water 1 temperatures", or when the relay output has been selected.

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Legionella program**

For ensuring drinking water hygiene, a period can be specified by the end of which a set minimum temperature must again be reached after the last time it was reached. The number of days in this period can be set between 1 and 14. A time at which the legionella program is to start can also be specified. Factory settings are number of days 7, starting time 8 pm, temperature is 60 °C, the legionella program is "Off".
The immersion heating element is supplied with maximum power.

**Load priority (only with AC•THOR 9s)**

Defines the sequence in which the three load outputs are controlled.

Out 1-2-3: Standard, for a three-phase immersion heater.

Out 3-2-1: For stratified charging with three single-phase immersion heater.

> ⚠ **Attention**
>
> For Out 3-2-1, it is essential to observe the order of the load outputs according to the wiring diagram!

**Boost output (only with AC•THOR 9s)**

If boost backup is activated for AC•THOR 9s, it is possible to specify which load outputs are to be used for this purpose. All three outputs are activated at the factory.

> 💡 **TIP**
>
> If, for example, 3 single-phase heating elements are used, it may only be necessary to use the boost function on the top heating element. This keeps storage capacities free for excess energy, which can significantly improve the degree of self-sufficiency!

**TIP**

If not all three outputs of a three-phase heating element are used for boosting, control power is still available in case of excess energy!

4.1.3. digital Temperature sensors (only with AC•THOR 9s)

Optionally, three digital temperature sensors can also be used in the operation of three single-phase heating elements. The assignment must be made vice versa to the load outputs.

Note: One digital temperature sensor is always enclosed with the AC•THOR, other sensors must be purchased separately.

| | |
|---|---|
| **Load output / heater** | Out-3 / Top |
| **Sensor number** | 1 |
| **Load output / heater** | Out-2 / Center |
| **Sensor number** | 2 |
| **Load output / heater** | Out-1 / Bottom |
| **Sensor number** | 3 |

Excess power control and boost backup are then carried out individually for each heating element; the settings in " Hot water 1 temperatures" affect all three elements. If only one sensor is used, this only switches off the upper heating element, the other heating elements must be controlled via thermostats.

4.2. M2: Hot water stratified charging

AC•THOR: Hot water with two single-phase immersion heaters

### 4.2.1. Explanation

In a water tank in this operating mode, two immersion heating elements are supplied successively and linearly with excess PV power. The upper element has priority. The aim is to reach the desired temperature at the tapping point as quickly as possible before further excess power heats up the remaining contents of the tank.

As soon as the upper immersion heating element reaches the target temperature the lower heater will be supplied. If no digital my-PV temperature sensor is used, the switch-over takes place via the thermostats of the heating elements, the AC•THOR then regularly checks whether the upper heating element is available again. If the digital my-PV temperature sensor is used, the changeover takes place when the temperature at the sensor reaches the set maximum value.

> ⚠ **Attention**
>
> Both heating elements must be equipped with a bimetal thermostat to switch off when the set temperature is reached!

With AC•THOR, the switchover between the single-phase heating elements takes place directly via the integrated relay (see wiring diagram). With the AC•THOR 9s, the relay operates a three-pole NC contact and a three-pole NO contact (see wiring diagram), which then switch over the three-phase heating elements.

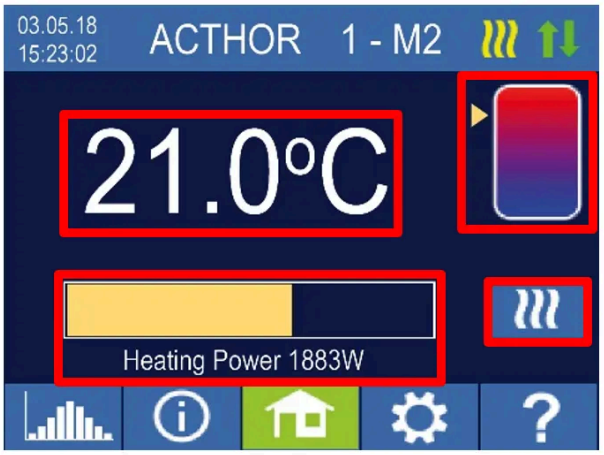
> **TIP**
>
> It is also possible to control two immersion heating element s in separate tanks. The "upper" heater would then for instance be located in a drinking water tank, the "lower" heater in a buffer tank alongside it. However, the digital temperature sensor is absolutely necessary and must be fitted above the "upper" heating element!

Optionally, the AC•THOR can also take over the boost backup of the hot water temperature at the upper immersion heater. For this, the digital my-PV temperature sensor is to be used.

> ⚠ **Attention**
>
> The digital my-PV temperature sensor must in any event be installed in the hot water tank above the upper heater to provide a reliable reading!

Data my-PV temperature sensor

Current power output




Homescreen

An arrow shows which heater is currently being supplied.
(upper or lower)

Single-Boost
Starts a once-only boost backup mode
(button only appears if boost backup is activated)

4.2.2. Specific settings for operating mode M2

**Hot water 1 temperatures**

Adjustable is the maximum permitted temperature to be reached at the digital my-PV temperature sensor (factory setting = 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

> ⚠ **Attention**
>
> If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup is shown "On" in the window on the right (factory setting "Off"), a minimum temperature can then be set (factory setting 50 °C).

Automatic temperature boost backup "On":
The AC•THOR can ensure a minimum temperature at the digital my-PV temperature sensor with the upper heater. This is supplied with maximum power. This may result in power being drawn from the mains or a battery being discharged!

**Hot water 1 min switching times**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

**TIP**

Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

**Attention**

Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

**Attention**

If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Legionella program**

For ensuring drinking water hygiene, a period can be specified by the end of which a set minimum temperature must again be reached after the last time it was reached. The number of days in this period can be set between 1 and 14. A time at which the legionella

program is to start can also be specified. Factory settings are number of days 7, starting time 8 pm, temperature is 60 °C, the legionella program is "Off".
The upper immersion heating element is here supplied with maximum power.

**Boost output (only with AC•THOR 9s)**

If boost backup is activated for AC•THOR 9s, it is possible to specify which load outputs are to be used for this purpose. All three outputs are activated at the factory.

TIP

If not all three outputs of a three-phase heating element are used for boosting, control power is still available in case of excess energy!

4.3. M3: Hot water 6 kW/18kW

AC•THOR: Hot water 6kW
AC•THOR 9s: Hot water 18kW

**The AC•THOR 9s assumes two three-phase loads, three single-phase loads are not permitted in this operating mode!**

TIP

In this operating mode, it is strongly recommended that both the AC•THOR control and the power measurement at the switched load are carried out with a my-PV Meter!

4.3.1. Explanation

In this operating mode, two heating elements are supplied with excess PV power in a water storage tank. One of them be regulated continuously variable, the other cuts in as soon as sufficient surplus PV is available. When this occurs, the first heater starts again from 0 with the power regulation. The total range of regulation is thus extended.

The digital my-PV temperature sensor is to be used.

**There are two operating modes:**

A fixed threshold value can be set from which the second load is switched on.

However, switching only actually takes place when the surplus or the power input is 10% higher than the set threshold value. There is also a delay of a few seconds before switching to ensure that stable conditions prevail.

This threshold value is set in the web interface. See chapter "Special setting options in the web interface".

### ⚠ Attention

The relay is switched on for the first time when a surplus level of 3kW for the AC•THOR or 9kW for the AC•THOR 9s is exceeded!

Alternatively, a my-PV Meter can be used to measure the power of the switched load. See chapter "Load measurement at relays with my-PV Meter (recommended)".

### ⚠ Attention

The power switched at the relay must not be greater than the power that can be controlled by the AC•THOR. Otherwise, unstable control behavior would be expected. Error 106 is displayed!

### ⚠ Attention

Third party control types may not be able to command the power up to 6kW / 18 kW!

### ⚠ Attention

If no my-PV Meter is used for power measurement at the switched load, the power display of the AC•THOR and the energy recording of the data logger cannot take this consumption into account!

### ⚠ Attention

The following applies to external control via "Modbus TCP", "http" or "SMA Home Manager" (not "SMA Direct Meter Communication"): An AC•THOR without an available load at the controllable output cannot be externally controlled in M3 operating mode. Since the load at the relay is not controllable, an unstable control behavior would be expected! This also applies if a my-PV Meter is used for power measurement at the switched load!

### ⚠ Attention

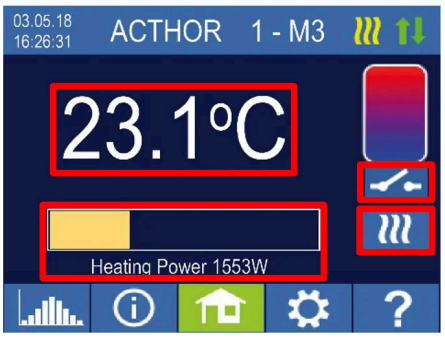
Multiple units (multi-mode): A slave without an available load at the controllable output cannot be controlled in the M3 operating mode in multi-mode. Since the load at the relay is not controllable, an unstable control behavior would be expected!
This also applies if a my-PV Meter is used for power measurement at the switched load!

### ⚠ Attention

The following applies to frequency control: This operating mode is not suitable for off-grid systems. my-PV recommends using several AC•THORs instead to increase the control range!

Optionally, the AC•THOR can also take over boost backup of the hot water temperature. This can be done either with both heating elements or only with the switched heating element.

> ⚠ **Attention**
>
> The digital my-PV temperature sensor must in any event be installed in the hot water tank above the upper heater to provide a reliable reading!




Data my-PV temperature sensor

Current power output

Relay state

Single-Boost
Starts a once-only boost backup mode
(button only appears if boost backup is activated)

Homescreen

The power display is automatically scaled by the additional power.

4.3.2. Load measurement on relays with my-PV Meter (recommended)

If a my-PV Meter is used for power measurement at the switched load, then the consumption is also shown in the power display and taken into account in the energy recording of the data logger.

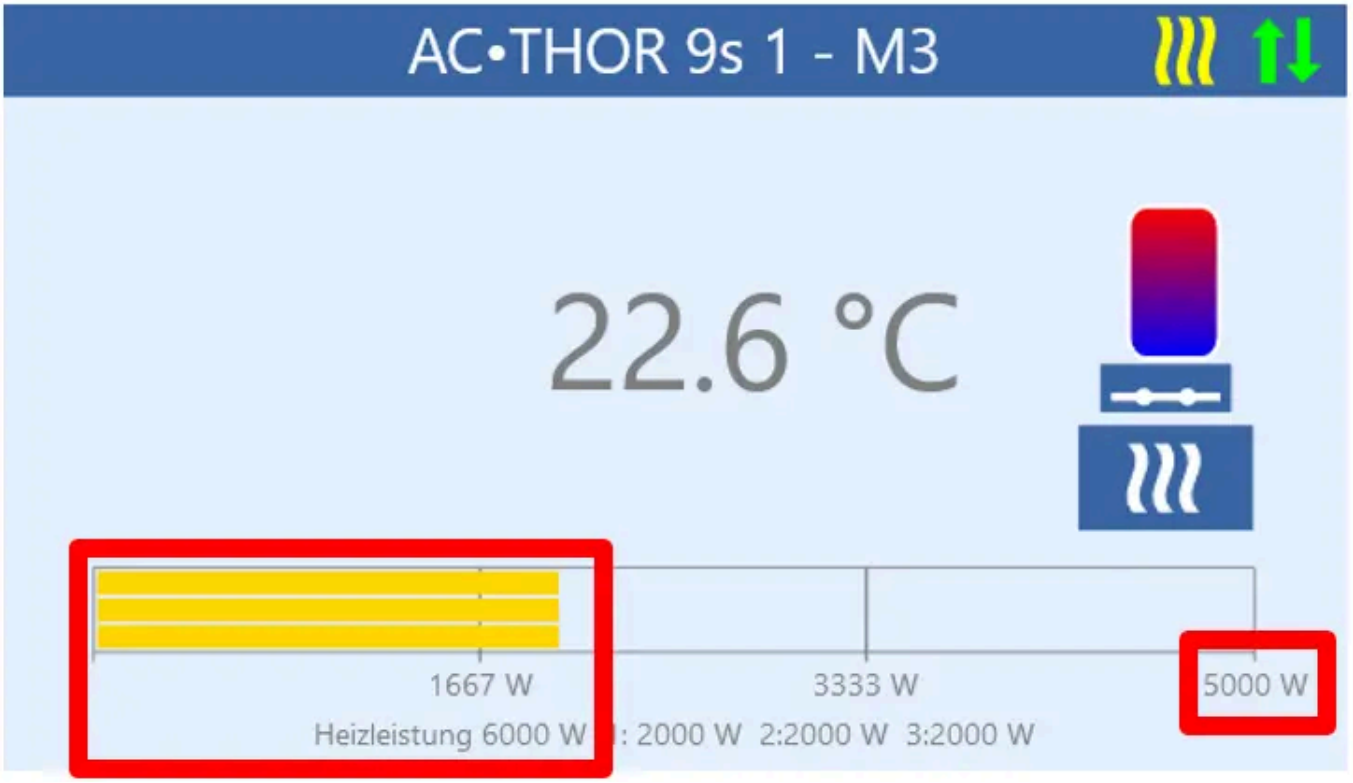
The configuration is done in the web interface. See chapter "Special setting options in the web interface".

**Scaling of the power display:**

- With the AC•THOR to 3,000 watts + power measurement at the relay
- With AC•THOR 9s to 3,000 watts + power measurement at the relay / 3

A three-phase load is assumed at the relay (see wiring diagram).

**Example AC•THOR 9s:**
The power of the switched load was measured at 6,000 watts, the relay is switched. The three 3kW bars are each extended by 2kW (6kW/3).




Homescreen AC•THOR 9s in the web interface

### ⚠ Attention

When measuring the load on relays with a my-PV Meter, it is essential to follow the corresponding wiring diagram!

### ⚠ Attention

The relay is switched on for the first time when a surplus level of 3kW is exceeded with the AC•THOR or 9kW with the AC•THOR 9s. As soon as a measured value of the load is available, it is taken into account as a switching threshold in further operation!

### ⚠ Attention

If the nominal power at the switched load is reduced at a later point in time (e.g. due to a modification of the system), the switching threshold must be changed once to "Load on relay". Afterwards, the setting can be changed back to "Load measurement at relay with my-PV Meter". See chapter "Special setting options in the web interface".

4.3.3. Specific settings for operating mode M3

**Hot water 1 temperatures**

Adjustable is the maximum permitted temperature to be reached at the digital my-PV temperature sensor (factory setting = 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

### ⚠ Attention

If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup is shown "On" in the window on the right (factory setting "Off"), a minimum temperature can then be set (factory setting 50 °C).

Automatic temperature boost backup "On":
With both immersion heaters, the AC•THOR can assure a minimum temperature at the digital my-PV temperature sensor. These are supplied with maximum power. This may result in power being drawn from the mains or a battery being discharged!

Relay output:
Alternatively, the minimum temperature can also be maintained only by the switched heating element on the relay. This may result in power being drawn from the mains or a battery being discharged!

**TIP**

The "Relay" backup mode has the advantage that the lower storage area remains "free" for PV surplus and less energy tends to be required for temperature backup.

**Hot water 1 min switching times**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

**TIP**

Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

**Attention**

Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

**Attention**

If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Legionella program**

For ensuring drinking water hygiene, a period can be specified by the end of which a set minimum temperature must again be reached after the last time it was reached. The number of days in this period can be set between 1 and 14. A time at which the legionella program is to start can also be specified. Factory settings are number of days 7, starting time 8 pm, temperature is 60 °C, the legionella program is "Off".
The immersion heaters are supplied with maximum power.

### 4.4. M4: Hot water + Heat pump

AC•THOR: Hot water with a single-phase immersion heater
AC•THOR 9s: Hot water with a three-phase immersion heater

#### 4.4.1. Explanation

In this operating mode the electric immersion heating element of a heat pump is linearly supplied with excess PV power. This can be equipped with a bimetal thermostat to switch off when the set temperature is reached. Otherwise the digital my-PV temperature sensor must be used.

> ⚠ **Attention**
>
> The digital my-PV temperature sensor must in any event be installed in the hot water tank above the upper heater to provide a reliable reading!

On exceeding a given excess power threshold, operation of the heating pump will be enabled. This threshold can be set. Similarly a minimum time for which this threshold must be exceeded. At the same time as the heat-pump is working, the additional excess power can be passed by the AC•THOR to the immersion heating element . This is activated in the factory settings.

After the defined excess power threshold has been exceeded for a specified time (t P>), the heat-pump starts for the minimum operating time (t run). This may also result in power being drawn from the grid!

When the minimum operating time has expired, the heat-pump remains enabled, provided there is still excess PV power available and the target temperature at the digital my-PV

temperature sensor is not yet reached. If this now causes a fall in the excess PV power, the heat-pump will only be disabled after 60 seconds.

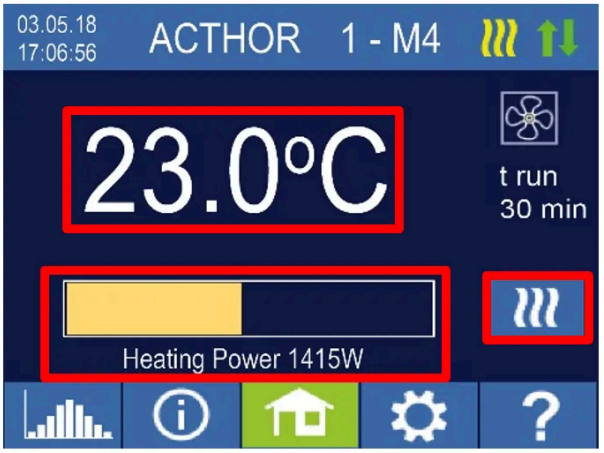
Once the heat-pump is disabled, it will not be reactivated for a period which can be set (t wait).

Optionally, the AC•THOR can also take over guaranteeing the hot water temperature. This is carried out by enabling the heat-pump, when the immersion heating element will continue to be linearly supplied with excess.

> ⚠ **Attention**
>
> The target temperature of the heat-pump control is not to be set lower than the AC•THOR minimum temperature, as this could then no longer be guaranteed!

Data my-PV temperature sensor

Current power output




Homescreen

Time period and time counter value of the HP control

Single-Boost
Starts a once-only boost backup mode
(Button appears only when the relay output is activated)

4.4.2. Specific settings for operating mode M4

**Hot water 1 temperatures**

Adjustable is the maximum permitted temperature to be reached at the digital my-PV temperature sensor (factory setting = 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

### ⚠ Attention

If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup with relay output has been selected, a minimum temperature can then be set (factory setting 50 °C).

Relay output:
The AC•THOR can also maintain the minimum temperature at the digital my-PV temperature sensor by enabling the heat-pump.

**Hot water 1 min switching times**

This setting can be selected when the relay output is selected under "Hot water 1 temperatures".

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

### TIP

Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

### ⚠ Attention

Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

> ⚠ **Attention**
>
> If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the relay output is selected under "Hot water 1 temperatures".

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Legionella program**

For ensuring drinking water hygiene, a period can be specified by the end of which a set minimum temperature must again be reached after the last time it was reached. The number of days in this period can be set between 1 and 14. A time at which the legionella program is to start can also be specified. Factory settings are number of days 7, starting time 8 pm, temperature is 60 °C, the legionella program is "Off".
This enables the heat-pump and the immersion heating element remains in "excess" operation.

**Relay thresholds**

As switching threshold for a heat-pump, any output between 0 and 9,999 W can be set. Factory setting is 500 W. An alteration to this output threshold only becomes effective after the end of the current control cycle or after the AC•THOR is restarted.

Optionally, simultaneous control of the AC•THOR load output can be deactivated on the right of the screen.

**Relay delay**

A period in minutes is laid down (t P>), during which the switching threshold above must at least be exceeded before the heat-pump is enabled. The factory setting suggests 15 minutes. After this, a minimum operating period (t run) and a minimum pause duration (t wait) can be set for the heat-pump. Factory settings suggest 30 minutes for both these values

4.5. M5: Hot water + Space heating

AC•THOR: Hot water + one heating zone
AC•THOR 9s: Hot water + two heating zones

### ⚠ Note for AC•THOR 9s as of Ethernet firmware version a0020806

Compared to previous versions, there is now the following advantage: If a minimum temperature must be ensured with maximum power at room heating 1 (output Out-1), then the AC•THOR 9s can still control power at outputs Out-2 (room heating 2) or Out-3 (hot water) during this time, provided the target temperature has not yet been reached at these and there is still surplus.

From version a0020806 onwards, a 2-pole changeover contact must be provided in the installation for this purpose, which is actuated by the potential-free contact of the AC•THOR 9s. For wiring details, please refer to the installation instructions enclosed with the unit. You can also find the latest information at any time at **www.my-pv.com**.

Note: A firmware update does not change the previous operating mode of already installed

#### 4.5.1. Explanation

This operating mode is intended for buildings with hot water and space heating by electricity. Electrical heat sources are supplied with PV surplus one after the other linearly with power. The immersion heating element for the hot water supply takes priority. As soon as the hot water target temperature at the respective digital my-PV temperature sensor is reached, next the electric space heating is supplied until here too the target value at the digital my-PV temperature sensor is reached.

Optionally, the AC•THOR can also take over guaranteeing the hot water temperature.

Two digital my-PV temperature sensors are required for AC•THOR!
Three digital my-PV temperature sensors are required for AC•THOR 9s!
Note: One digital temperature sensor is always included with the AC•THOR, other sensors must be purchased separately.

### ⚠ Attention

The first digital my-PV temperature sensor is in any case to be sited over the heater in the hot water tank to provide a reliable reading!

### ⚠ Attention

For controlling the space heating, the respective digital my-PV temperature sensor is to be installed in a suitable place to provide a reliable reading!

### TIP

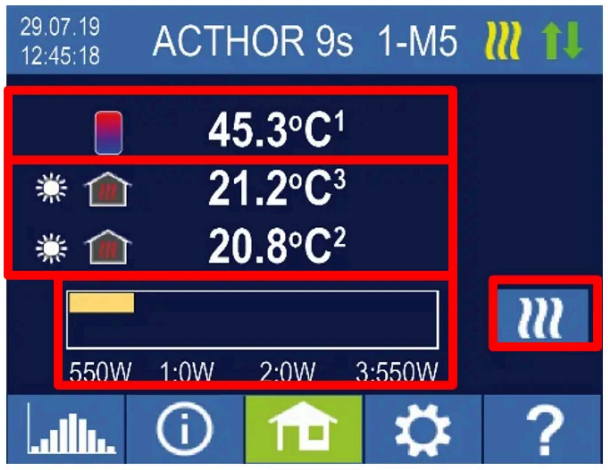
When specifying room temperatures, to avoid using power from the public grid the minimum values for day and night should be set correspondingly low. See explanation "SH 1 temperatures".

Data my-PV temperature sensors

Water temperature

Room temperature 2
Room temperature 1
(sun = daytime operation)

Current power output




Single-Boost
Starts a once-only hot water boost backup (button only appears if boost backup is activated)

Homescreen

On the display a sun or moon symbol shows which time period is currently controlling the room temperature. Different minimum temperatures can be specified for day and night.

4.5.2. Specific settings for operating mode M5

**Hot water 1 temperatures**

The maximum temperature permitted to be reached at digital my-PV temperature sensor 1 can be adjusted (factory setting 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

> ⚠ **Attention**
>
> If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup is shown "On" in the window on the right (factory setting "Off"), a minimum temperature can then be set (factory setting 50 °C).

Automatic temperature boost backup "On":
The AC•THOR can ensure a minimum temperature at the digital my-PV temperature sensor through the immersion heating element connected. This is supplied with maximum power. This may result in power being drawn from the mains or a battery being discharged!

**Hot water 1 min switching times**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

> **TIP**
>
> Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

> ⚠ **Attention**
>
> Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

> ⚠ **Attention**
>
> If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the temperature boost backup is "On" under Hot water 1 temperatures".

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Legionella program**

For ensuring drinking water hygiene, a period can be specified by the end of which a set minimum temperature must again be reached after the last time it was reached. The number of days in this period can be set between 1 and 14. A time at which the legionella program is to start can also be specified. Factory settings are number of days 7, starting time 8 pm, temperature is 60 °C, the legionella program is "Off".
The immersion heating element is supplied with maximum power.

**SH 1 temperatures (with AC•THOR 9s SH 1 und SH 2)**

The maximum room temperature permitted to be reached at digital my-PV temperature sensor 2 or 3 (sensor 1 is for hot water) can be adjusted (factory setting 22 °C), as are the minimum temperatures which should be maintained in the day and night periods (factory setting 20 °C in each case).

**SH 1 Switching times (with AC•THOR 9s SH 1 und SH 2)**

Start and finish of the night period can both be adjusted with hours and minutes. The factory setting suggests the period between 10 pm and 5 am. This setting can be selected as desired for all days of the week with corresponding selection of the button alongside the time (MON-SUN, MON-FRI, SAT-SUN).

#### 4.5.3. Digital temperature sensors

**Sensor assignment AC•THOR:**

| | |
|---|---|
| **Application** | Hot water |
| **Sensor number** | 1 |
| **Application** | Space heating |
| **Sensor number** | 2 |

**Sensor assignment AC•THOR 9s:**

Excess power control and boost backup are then carried out individually for each load output.

| | |
|---|---|
| **Load output / Application** | Out-3 / Hot water |
| **Sensor numb** | 1 |
| **Load output / Application** | Out-2 / Space heating 2 |
| **Sensor numb** | 3 |
| **Load output / Application** | Out-1 / Space heating 1 |
| **Sensor numb** | 2 |

### 4.6. M6: Space heating

AC•THOR: One heating zone
AC•THOR 9s: Three heating zones

#### 4.6.1. Explanation

In this operating mode an electric space heating is supplied linearly with excess PV power.

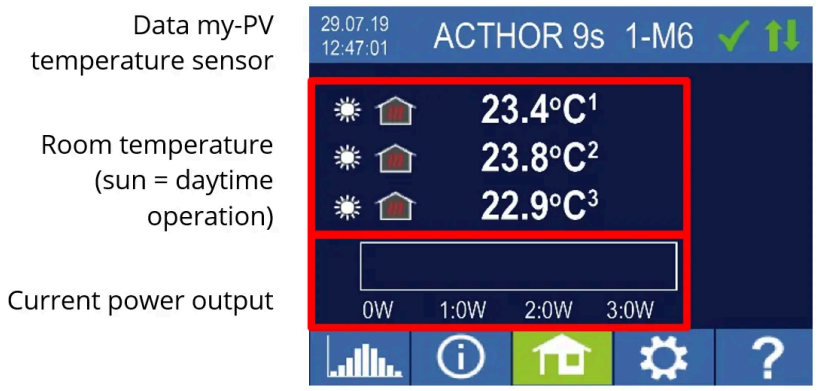
One digital my-PV temperature sensors are required for AC•THOR!
Three digital my-PV temperature sensors are required for AC•THOR 9s!
Note: One digital temperature sensor is always included with the AC•THOR, other sensors must be purchased separately.

### ⚠ Attention

To control the space heating, the respective digital my-PV temperature sensor is to be installed in a suitable location to provide a reliable reading!

### TIP

When specifying room temperatures, to avoid using power from the public grid the minimum values for day and night should be set correspondingly low. See explanation "SH 1 temperatures".



Homescreen

On the display a sun or moon symbol shows in which time period the room temperature control is currently operating. Different minimum temperatures can be specified for day and night.

4.6.2. Specific settings for operating mode M6

**SH 1 temperatures (with AC•THOR 9s SH 1, SH 2 and SH 3)**

The maximum room temperature permitted to be reached at the digital my-PV temperature sensors can be adjusted (factory setting 22 °C), as are the minimum temperatures which should be maintained in the day and night periods (factory setting 20 °C in each case).

**SH 1 Switching times (with AC•THOR 9s SH 1, SH 2 and SH 3)**

Start and finish of the night period can both be adjusted with hours and minutes. The factory setting suggests the period between 10 pm and 5 am. This setting can be selected as desired for all days of the week with corresponding selection of the button alongside the time (MON-SUN, MON-FRI, SAT-SUN).

4.6.3. Digital temperature sensors

**Sensor assignment AC•THOR:**

| | |
|---|---|
| **Application** | Space heating |
| **Sensor number** | 1 |

**Sensor assignment AC•THOR 9s:**

Excess power control and boost backup are then carried out individually for each load output.

| | |
|---|---|
| **Load output / Application** | Out-3 / Space heating 3 |
| **Sensor numb** | 3 |
| **Load output / Application** | Out-2 / Space heating 2 |
| **Sensor numb** | 2 |
| **Load output / Application** | Out-1 / Space heating 1 |
| **Sensor numb** | 1 |

4.7. M7: Hot water + PWM

AC•THOR: Hot water with a single-phase immersion heater
AC•THOR 9s: Hot water with a three-phase immersion heater

> ⚠ **Attention**
>
> When controlling via Modbus RTU, the operating mode M7 cannot be used!

4.7.1. Explanation

In this operating mode, an electric heating element is supplied linearly with excess PV energy. In addition, the AC•THOR can send out a temperature-dependent PWM signal. This can control the speed of a pump.

This function was tested by my-PV with the pump types **Wilo Para PWM1 and PWM2** and **Wilo Varios PICO-STG**. For PWM2, the setting command xxx.xxx.xxx.xxx.xxx/setup.jsn?pwmt=2 must be entered in the URL of the webinterface. For other pumps, the function cannot be certified.

> ⚠ **Attention**
>
> In this operating mode, two digital my-PV temperature sensors are required!

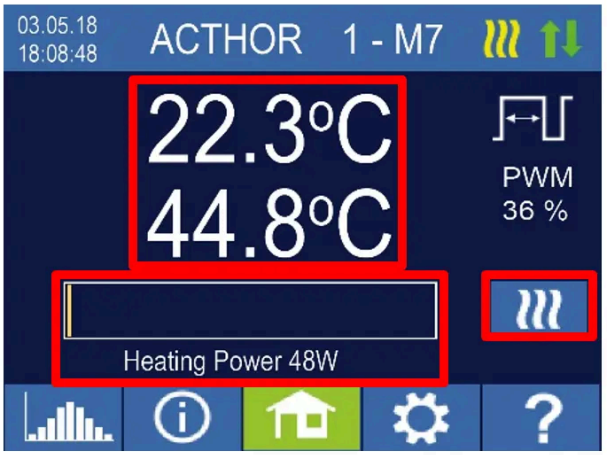
The output of the PWM signal starts when the target temperature + hysteresis is reached at sensor 2. The signal becomes stronger the further the target temperature + hysteresis is exceeded.

Optionally, the AC•THOR can also take over guaranteeing the hot water temperature. For this, a third digital my-PV temperature sensor is to be used.

Note: A digital temperature sensor is always included with the AC•THOR, other sensors must be purchased separately.

Data my-PV temperature sensors

Current power output




Homescreen

Status PWM Output signal

Single-Boost
Starts a once-only boost backup mode
(button only appears if boost backup is activated)

4.7.2. Specific settings for operating mode M7

**Hot water 1 temperatures**

Adjustable is the maximum permitted temperature to be reached at the digital my-PV temperature sensor (factory setting = 60 °C). This has nothing to do with a bimetal thermostat which may be installed!

> ⚠ **Attention**
>
> If the cut out temperature of an immersion heating element with a bimetal thermostat is set too low, the AC•THOR may possibly be unable to reach the desired temperature!

If the optional automatic temperature boost backup is shown "On" in the window on the right (factory setting "Off") or the relay output has been selected, a minimum temperature can then be set (factory setting 50 °C).

Automatic temperature boost backup "On":
The AC•THOR can ensure a minimum temperature at the digital my-PV temperature sensor through the immersion heating element connected. This is supplied with maximum power. This may result in power being drawn from the mains or a battery being discharged!

Relay output:
Alternatively, the minimum temperature can be maintained by enabling an external heat source. Enablement is by means of a potential-free contact. For details of wiring the potential-free contacts, please refer to the assembly instructions in the chapter "Connections".

### TIP for AC•THOR (not AC•THOR 9s):

If as an external heat source a second immersion heating element (maximum 3 kW) is used, it can be suitably connected up for 6 kW operation. This differs from the 6 kW operating mode in that here the second immersion heating element is only used for temperature boost backup and not as an extension to the normal control range!

**Hot water 1 min switching times**

This setting can be selected when the temperature boost backup is "On" under "Hot water 1 temperatures", or when the relay output has been selected.

There are two time windows available to maintain the minimum temperature on the digital my-PV temperature sensor. Start and finish can each be defined at full hours. Factory settings suggest switching times of 5 to 11 pm and 5 to 7 am.

### TIP

Restrict the times when the minimum temperature has to be maintained to mornings and evenings, to increase your own PV consumption through the day!

### ⚠ Attention

Start hour and stop hour refer to the same calendar day. If a time window is defined over midnight, hot water backup will not start!

### ⚠ Attention

If the adjusted start-hour is after the stop-hour, hot water backup will not start!

**Hot water 1 min weekdays**

This setting can be selected when the temperature boost backup is "On" under "Hot water 1 temperatures", or when the relay output has been selected.

You can select the weekdays on which the minimum temperature has to be maintained. In the factory settings, all weekdays are activated.

**Boost output (only with AC•THOR 9s)**

If boost backup is activated for AC•THOR 9s, it is possible to specify which load outputs are to be used for this purpose. All three outputs are activated at the factory.

**TIP**

If not all three outputs of a three-phase heating element are used for boosting, control power is still available in case of excess energy!

4.8. M8: Frequency mode

**⚠ From Ethernet firmware version a0020400 applies**

The frequency mode is no longer a separate operating mode. Instead, frequency control is selectable as a signal source. This means that the operating modes M1 to M7 can now be used in AC off-grid systems.

A firmware update on a unit in "M8 frequency mode" automatically switches it to the operating mode "M1 hot water" and "frequency" is set as the signal source.

For more information, see chapter 7 Frequency control.

5. General settings

For settings specific to the different operating modes, please see the chapter "Operating modes". Under the settings these are accessed on the first sheet "Setup 1/X“ and some of them on sheet two, "Setup 2/X".

Time zone: The time zone can be set for the time. In addition, summer time is activated for Europe.

Date: The date can be entered in the format dd.mm.yy.

Time: The time can be entered in the format hh:mm:ss.

NTP server: (NTP = Network Time Protocol) As long as the router provides an Internet, the AC•THOR draws its time information automatically from the Internet. However, the respective time zone is not specified. NTP-Timeserver-address can be changed if necessary. The factory setting is 131.130.251.107.

> ⚠ **Attention**
>
> With a direct connection from the AC•THOR to the my-PV power meter, there is no Internet connection. Hence the time cannot be taken!

IP DHCP/static: As standard, DHCP is activated, i.e., the unit will get an IP address from the router to which it is connected. This only works when the router is configured as a DHCP server. If no DHCP server is active in the grid or if a static assignment is required, a fixed IP address is needed.

> ⚠ **Attention**
>
> The settings have to fit with the router, otherwise the device become invisible in the network!

IP address: can only be set when "Static IP" has been selected and there is no direct connection to the my-PV power meter.

Subnet mask: can only be set when "Static IP" has been selected and there is no direct connection to the my-PV power meter.

Gateway address: can only be set when "Static IP" has been selected and there is no direct connection to the my-PV power meter.

DNS server: can only be set when "Static IP" has been selected and there is no direct connection to the my-PV power meter.

Display duration: the number of seconds elapsing until the display is turned off can be set. A value between "10" and "250" seconds can be entered.

Display brightness: brightness of the display can be adjusted in ten steps.

Logo brightness: brightness of the illuminated AC•THOR logo on the unit can be adjusted in ten steps. "0" indicates that the logo will not be turned off

Control: In this section the choice of the signal source for the AC•THOR is made. See chapter "Commissioning".

Ctrl IP: The IP address of the signal source can be selected manually. Fr example, this is necessary when there are several compatible sources in the network and a special one of them should be chosen as the control system.

Control target value: here the set value of the power at the metering point is specified. A negative value means feed-in. The factory pre-set of the set-point is -50 W. This parameter can be freely chosen in a range between -9999 and +9999 W.

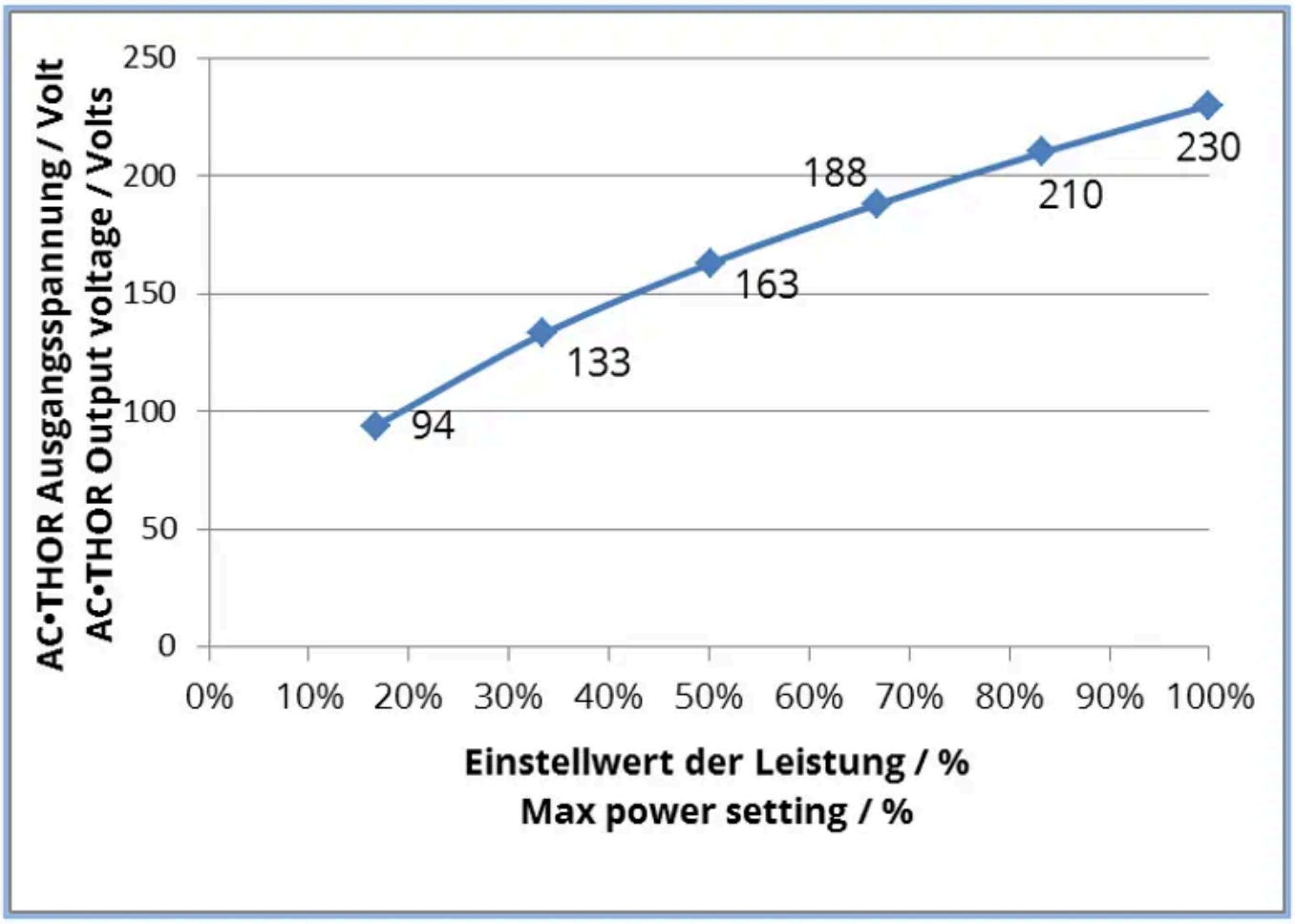
Sensors: Here the digital temperature sensor is selected for the operating mode. See chapter "Commissioning".

Operating mode: Detailed description will be found in the chapter "Operating modes".

Language: Apart from German, the following languages can be selected: English, French and Spanish.

Unit number: Shows the set unit number. This can also be seen on the Home screen.

Maximum power: This setting limits the output voltage of the AC•THOR. This results in a reduction factor of the nominal power of the load, i. the actual maximum output power depends on the rated power of the load. The maximum output voltage as a function of the parameter results from the following characteristic curve:




The value can be set on the display between 17 – 100 percent.

### ⚠ Attention

This setting is not taken into account in M3 operating mode.

### ⚠ Attention

Adjustment is generally only required if the rated load power is bigger than the power available for the AC•THOR.
(protection, inverter power in frequency mode)

Access level (only until Firmware-Version a0010103): according to user level (1 – 3), different setting possibilities are enabled on the AC•THOR. In level 3 all settings are enabled. As factory setting, this level is active. It is possible to restrict the setting options enabled.

Level 2 offers slightly restricted setting possibilities for experienced users. Some examples of settings which cannot be altered are those for communication, operating mode, basic settings, sensor assignment and control settings.

In level 1 the setting possibilities are limited to temperature specifications and switching times for space heating (only relevant in operating modes M5 and M6), as well as the brightness and duration of the display settings and brightness of the AC•THOR logo.

A password is required to be able to return to a higher level. The password for level 2 is "1970", that for level 3, "1965".

Power timeout: With this setting, the timeout of the AC•THOR (power timeout) can be set for several control types.

Hysteresis: switch hysteresis can be set for hot water and room heating. This does not cause too high a target temperature! After reaching the target temperature, the value is allowed to fall by the set amount before the heating process is restarted.

Hot water maximum temperature (factory setting 3.0 °C)
Hot water minimum temperature (factory setting 3.0 °C)
Space heating maximum temperature (factory setting 0.5 °C)
Space heating minimum temperature (factory setting 0.5 °C)

Check new firmware:

> ⚠ **Attention**
>
> Internet access is required!

Start check for new updates manually. When a new version is available, it will be stored on the SD card. This procedure takes several minutes. The AC•THOR will operate normally during this period.

*Start firmware update:* if a newer software version is present on the SD card, the update can be started manually. After the update, the unit will be restarted automatically.

*Start power firmware update:* if a newer output unit software version is present on the SD card, the update can be started manually. After the update, the unit will be restarted automatically. With AC•THOR 9s the update for both power stages is started.

Factory settings:
*Factory settings:* tapping on the menu point resets the AC•THOR to its factory settings. This will cause all altered settings in the unit to be deleted!
**CAUTION! No security confirmation is requested!**

*Debug mode:* To analyse control problems, the debug mode can be activated in coordination with support@my-pv.com.

Cloud Mode / Cloud Connection:

If desired, the settings of the AC•THOR can also be accessed from outside the local network. For this purpose, it is necessary to register the device with serial number and device key in the my-PV data cloud: **https://live.my-pv.com/**

Open the website and log in or register as a new user. When you register for the first time, you will receive an email with a confirmation link. If the email does not appear in your inbox, it may be in the spam folder.

**TIP**

If you already have a user profile from previous versions of the my-PV data cloud, it will still be valid in the new cloud. In addition, you automatically have full access to all devices that you have already integrated previously.

The serial number and the device key can be found under Settings - Cloud Connection

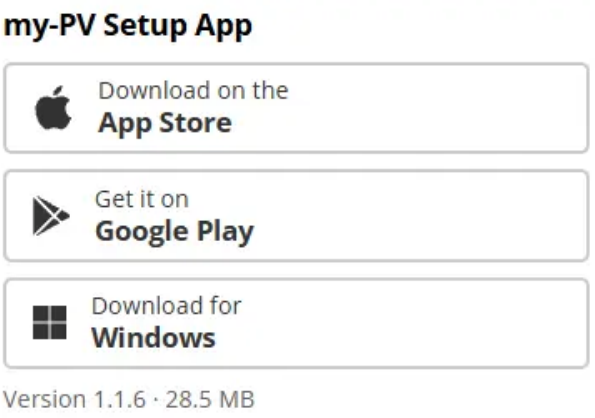
If the cloud mode is also activated, an overview of the recorded operating data is also available after connecting the device to the my-PV data cloud.

Activate the data transfer under Cloud mode.

**Privacy:** Information on the privacy regulations can be found at www.my-pv.com.

## 6. Local web interface in the my-PV Setup app

The local web interface is available in the my-PV Setup app. The app is available to download for Windows, iOS and Android from our website. You will find the link at the very bottom of the page in the footer.




The connection to the device is established exclusively within the local network. Remote access is only possible via the my-PV Cloud.

### ⚠ Attention

The local web interface within the app should be distinguished from the my-PV Cloud. The web interface is primarily used to set up the device, whilst the Cloud offers significantly more functions.

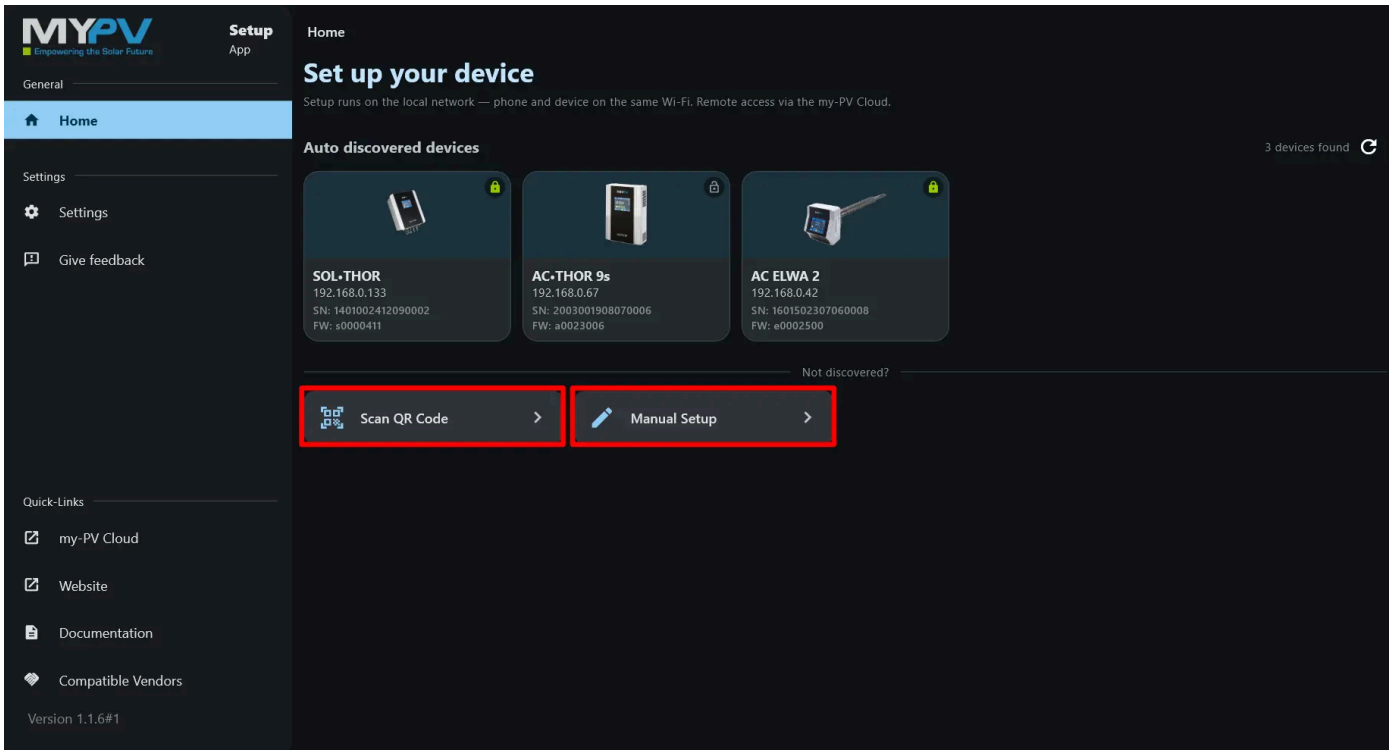
Further information on the my-PV Cloud: **https://live.my-pv.com/**

### TIP

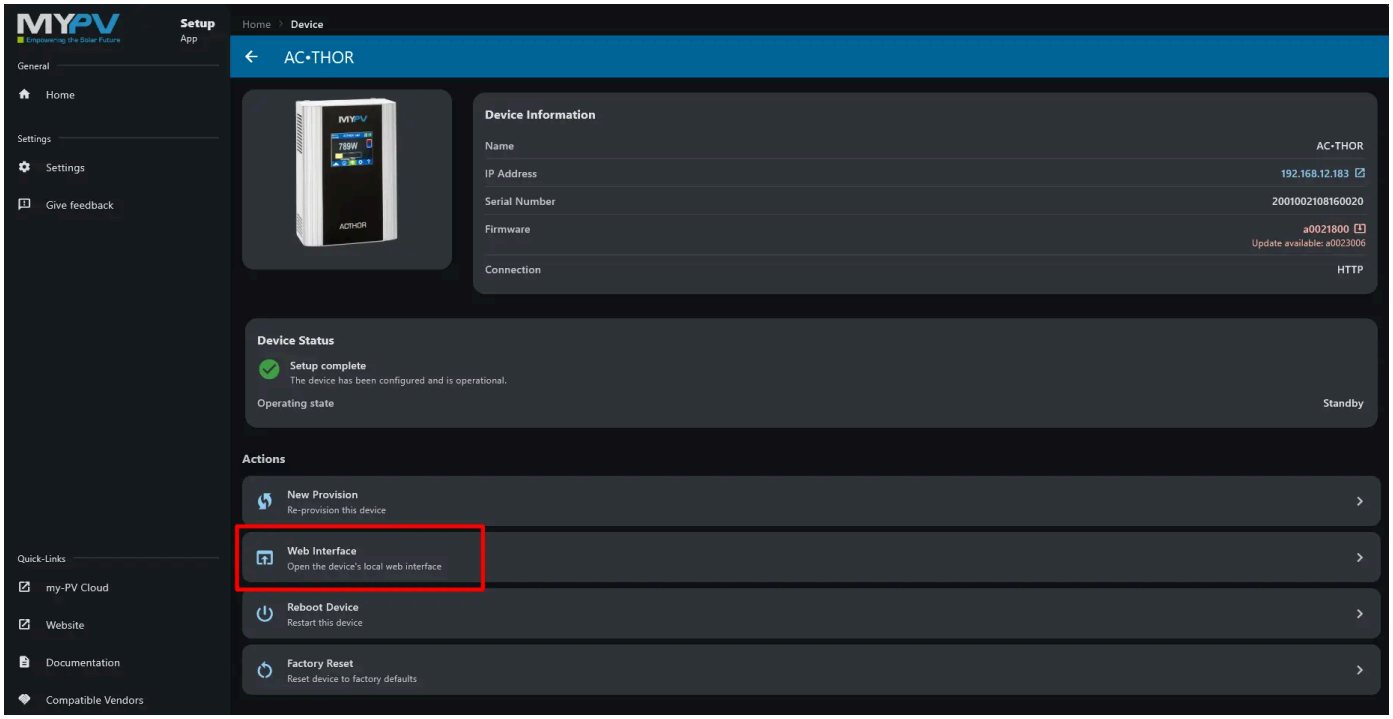
The web interface allows you to configure additional settings that are not available on the AC•THOR display.

### 6.1. Searching for devices on the same network

If the connected device is on the same network as the mobile device or computer, the app will search for it automatically. Alternatively, it can be added by scanning a QR code or via ‘Manual setup’.




Once the desired device has been found, it can be selected and, in the next step, the web interface can be opened.

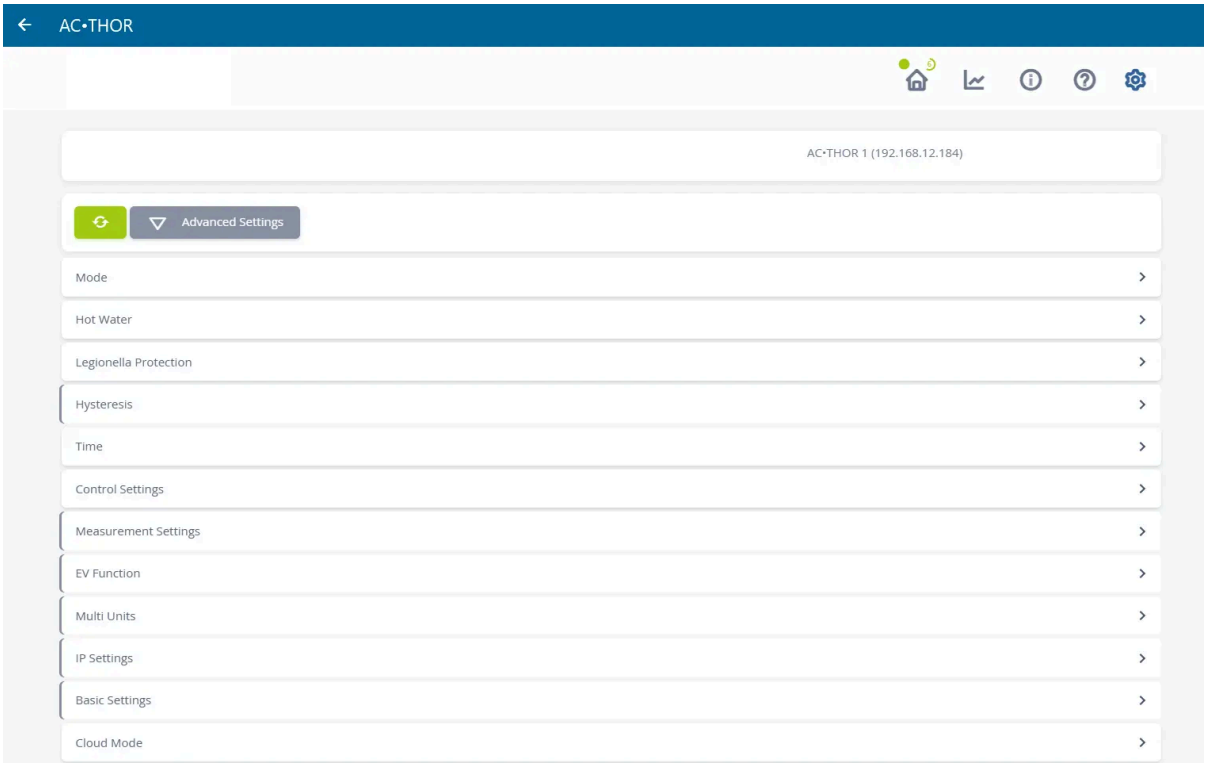



## 6.2. Settings

The setting possibilities in the web browser are more extensive than those on the AC•THOR display. See next section " Special setting possibilities in the Web-Interface".

An explanation of the other general unit settings is included in the chapter "General settings".

An explanation of the other specific unit settings for the different operating modes is included in the chapter "Operating modes".




The choice of setting options varies depending on the operating mode.

## 6.3. Special setting possibilities in the Web-Interface

The following unit settings are only possible in the web interface and cannot be carried out on the AC•THOR display.

### 6.3.1. Special settings for operating mode M1

The following parameters can be set on the web interface in operating mode M1 (3,5 kW).




**Activate relay when heating:** If this option is "On", the relay is switched on for at least 120 seconds when heat is emitted. The relay can thus be used as a potential-free signal transmitter.

It can also be used to switch smaller circulation pumps with outputs of up to approx. 50 Watts.

### ⚠ Attention

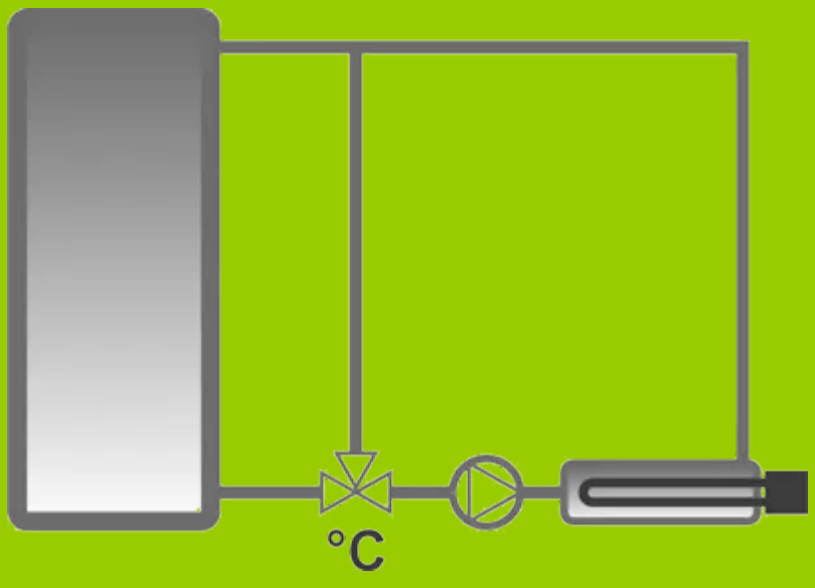
The boost backup mode “Relay” is then not available!

### ⚠ Attention

Unstable control behavior may occur when switching higher outputs or with external control via "Modbus TCP", "http" or "SMA Home Manager"!

### TIP

If the heating element is not installed directly in the thermal store, but in a hydraulic bypass, and if the heat is to be introduced by the circulation pump, any turbulence of the thermal layers in the store could be prevented by a mixing valve installed in between.

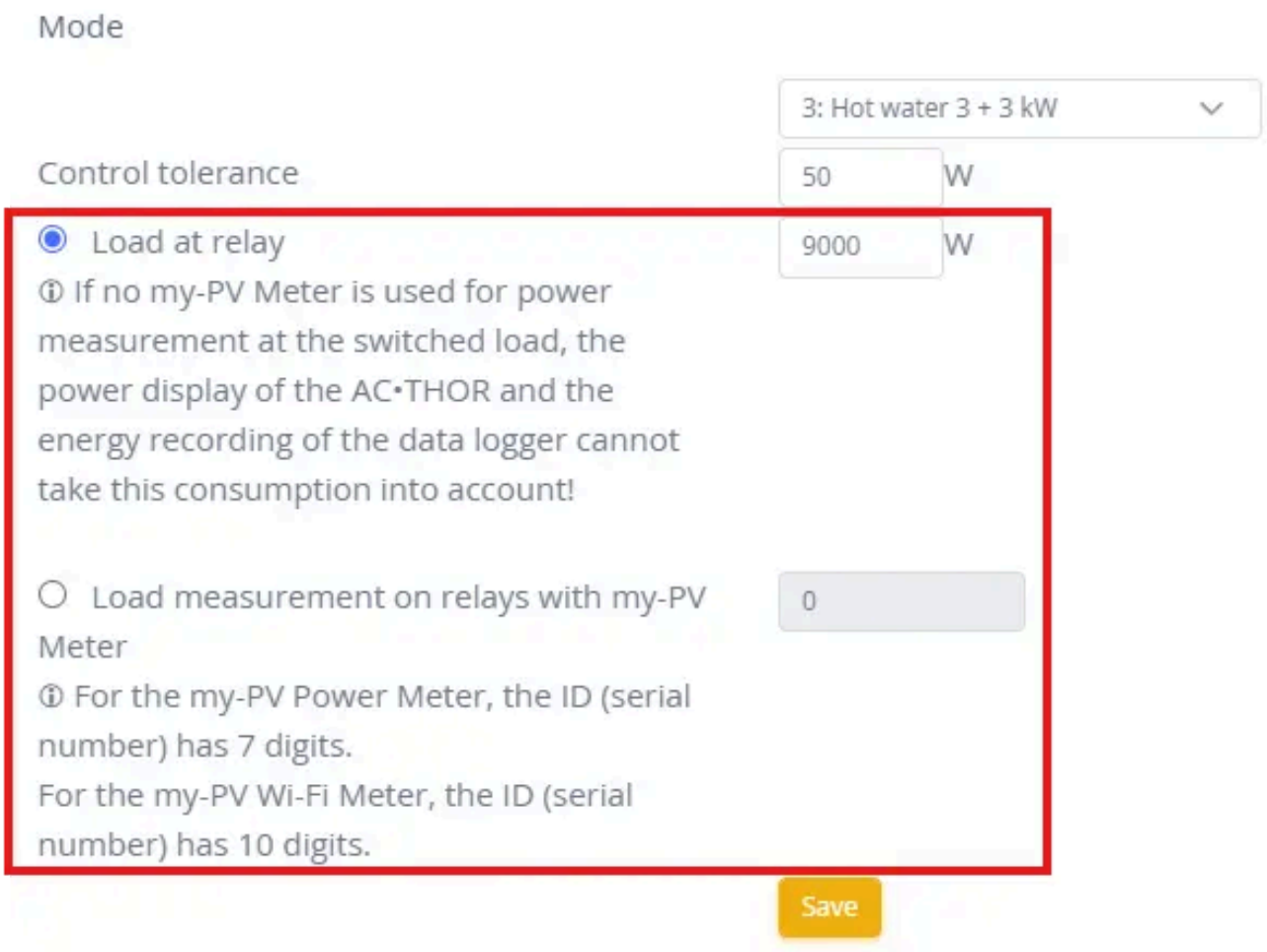


**TIP**

Alternatively, the M7 operating mode of the AC-THOR offers a further option for loading large thermal stores with a circulation pump.

6.3.2. Special settings for operating mode M3 (6kW/18 kW)

The following parameters can be set on the web interface in operating mode M3 (6kW/18 kW).




**Control tolerance:** This value defines the reaction sensitivity of the AC•THOR relay to changes in the power input. The second heating rod is switched by the relay.

**Load at relay:** The control range of the AC•THOR is extended by this adjustable threshold value. When the threshold value is reached, the load on the relay is switched on and the AC•THOR starts controlling again from 0 watts at the controlled load.

**Load measurement on relay with my-PV Meter:** As an alternative to the static definition of the load at the relay, it can also be measured with a my-PV Meter. To do this, enter the device ID of the my-PV Meter. This can be found on the device.

**TIP**

If the AC•THOR control is also carried out with a my-PV Meter (recommended), a static IP address should be assigned for it and the control type "my-PV Meter Manual" should be selected. Otherwise, the AC•THOR could confuse the signal source!







6.3.3. Legionella boost outputs (only with AC•THOR 9s)

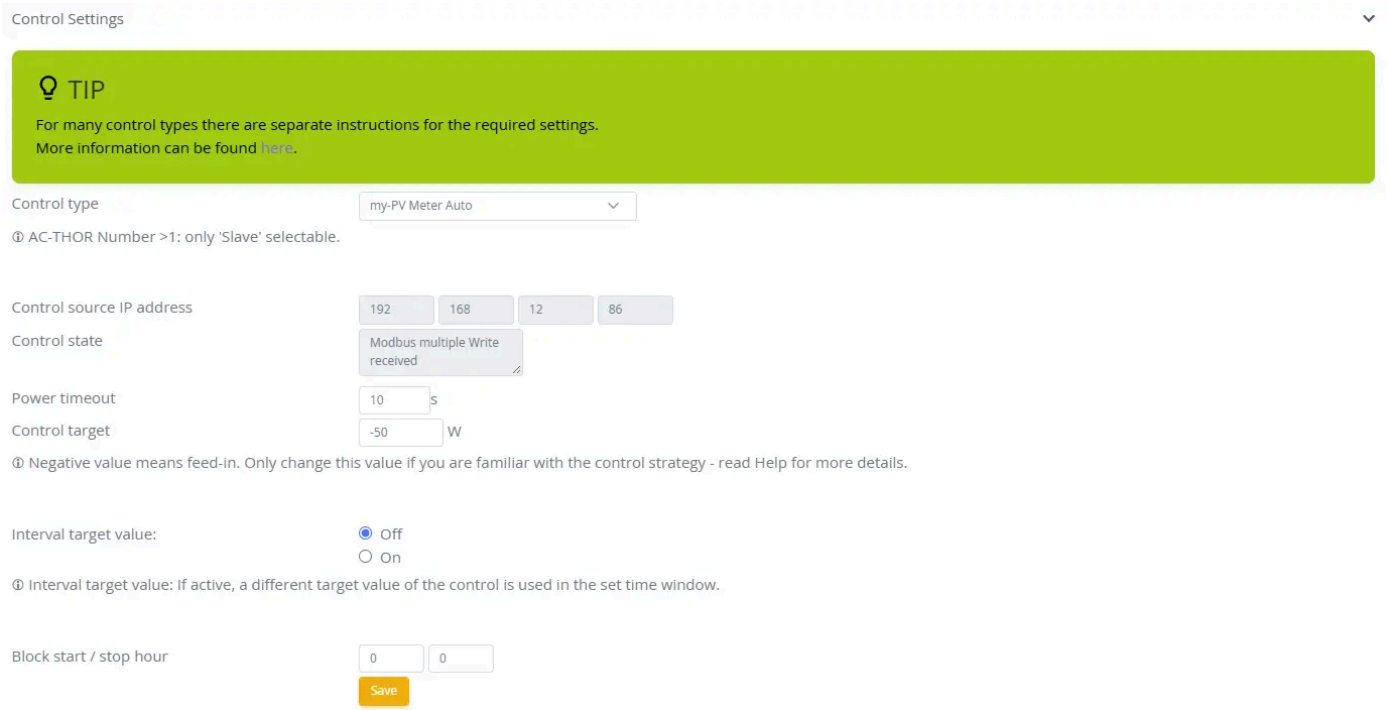
With the AC•THOR 9s, a selection of the load outputs to be used in the Legionella program can be made in the web interface. All three outputs are activated in the factory.



**TIP**

If, for example, 3 single-phase heating elements are used and only one of them is in a drinking water storage tank, then the Legionella programme should only be used on this heating element!

### 6.3.4. Control Settings

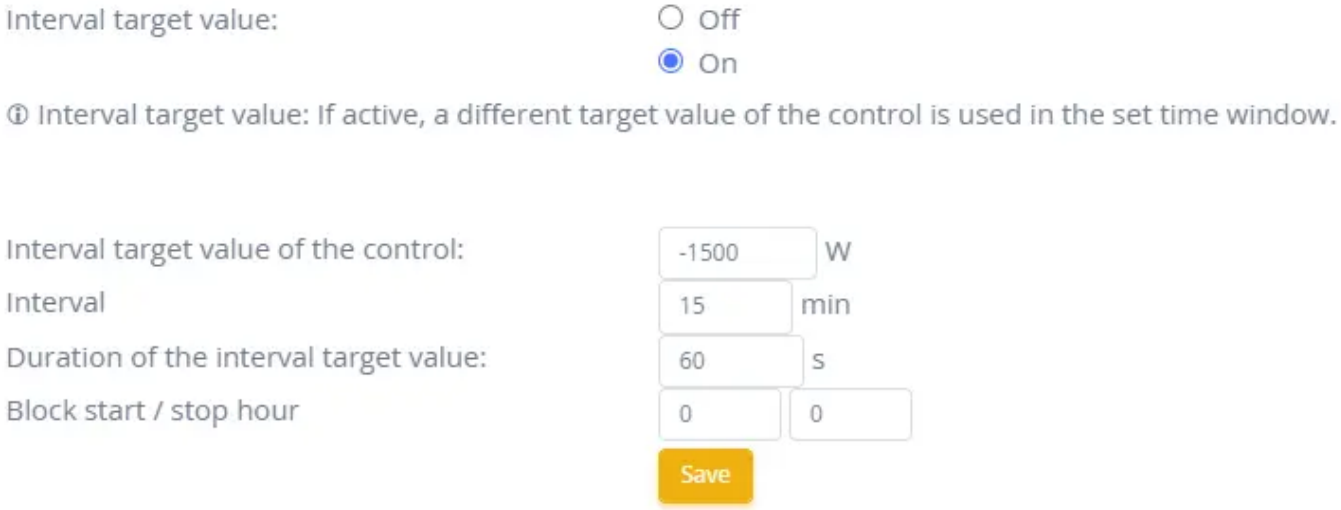



In this section the choice of the signal source for the AC•THOR is made.

**Attention**

A control type can only be selected if the AC•THOR has the factory preset device number 1. See "Basic settings".

The **"Interval target value"** function causes the AC•THOR to automatically change the target value of the control to another adjustable target value for a certain duration in an adjustable time interval. This can ensure that other applications with regulated surplus control are not deprived of surplus energy by the my-PV application.




This includes, for example, charging stations for electric cars that are neither directly nor indirectly connected to my-PV. Therefore, my-PV sets -1500W as the default for the interval target value. This corresponds to the minimum charging power of many electric cars.
A further explanation can be found in the section "Compatibility with charging station without shared energy management" in the chapter "E-car function".

The function „**Block**“ allows to define a time window within AC•THOR must not run. Unlike the two time frames for hot water securing the transition to the following day is possible (Start Hour is higher than Stop Hour). For example, this function can be used to give an existing battery time for charging and to do the water heating subordinate.

The function blocks the surplus control, as well as the optional boost backup via the connected heat generator. It also applies to the switched load in operating mode M3.

The blocking time does not apply to the optional boost backup setting via relay, not to the external load in operating mode M4 and also not to the EV function.

> ⚠ **Attention**
>
> Changes of the time settings are effective within one minute.

With the control modes **"Adjustable Modbus RTU"** and **"Adjustable Modbus TCP"** the AC•THOR receives the power-value in the feed-in point from an inverter or Modbus counter. The required communication registers shall be set according to the manufacturer's description.

### ⚠ Attention

With **"Adjustable Modbus TCP"** the control signal is received via network (RJ45, Ethernet)!

### ⚠ Attention

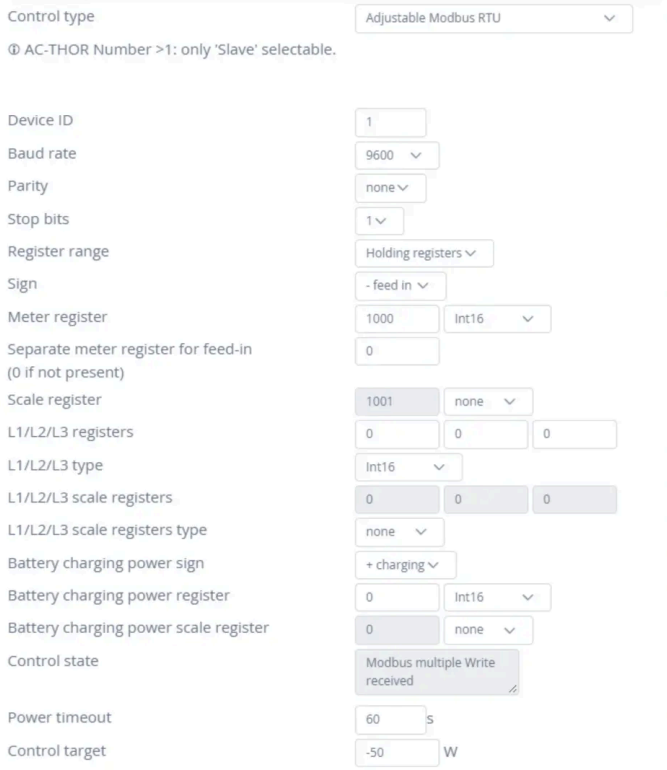
With **"Adjustable Modbus RTU"** the control signal is received via Modbus RTU (RS485, A B GND)! This control system is also configured via the Web-Interface. At least for commissioning, a network access is therefore temporarily necessary, but this can be removed after configuration!

### TIP

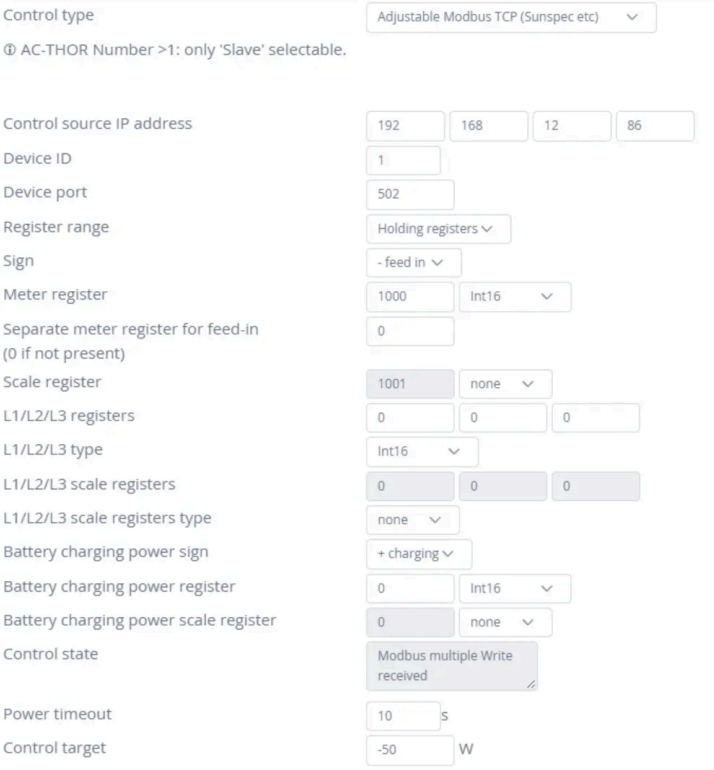
A simple network router is part of the normal tools of a craftsman these days. If you always have your own router with you, you are not dependent on network access at the sight.
An Internet connection is not required.

The Device ID must be set according to the external device.

**Adjustable Modbus RTU**




**Adjustable Modbus TCP**




Description of the data types:

| | |
|---|---|
| Int16 | 16-bit integer value, two's complement representation |
| Int16-nc | 16-bit integer value, magnitude sign representation (1st bit = sign) |
| Int32 | 32-bit integer value, two's complement representation |
| Int32-sw | 32-bit integer value, two's complement representation, swapped words |
| Int32-nc | 32-bit integer value, magnitude sign representation (1st bit = sign) |
| Int32-sw-nc | |

| | |
|---|---|
| | 32-bit integer value, magnitude sign representation (1st bit = sign), swapped words |
| | Float |
| | 32-bit float value |
| | Float-sw |
| | 32-bit float value, swapped words |

### ⚠ Attention

This control types are currently not approved for hybrid systems with battery storage.

### ⚠ Attention

With the settings "Adjustable Modbus TCP (Sunspec etc)", the IP address of the signal source must not change during operation (eg by a DHCP router), otherwise the AC•THOR loses the control signal.

### ⚠ Attention

When controlled by an inverter, a feed-in meter is required in the system. The query of the inverter otherwise provides no data.

### ⚠ Attention

We ask for your understanding that we cannot do any binding support for third-party products. For questions about third-party products, please contact the technical support of the respective company.

### ⚠ Attention

Operation with battery may require additional control parameters. In this case, please contact the technical support of my-PV.

6.3.5. Measurement Settings

As an option, other measurements can be queried in the system in addition to PV excess measurement (see Control Settings) and visualise them on the my-PV cloud. Available variables are Photovoltaic power, Battery power, EV Charging station power and Heat pump power.

### ⚠ Attention

These measured values have no relevance for the regular operation of the my-PV device!

**Detect measuring point with "my-PV Meter"**

If you are using the my-PV Meter to detect these values, you must enter the ID (serial number) of the device. You will find this number on the device.







**Detect measuring point by requesting data from external device ("Adjustable Modbus TCP")**

If the measured values come from an external device like an inverter or Modbus meter, the required communication registers shall be set according to the manufacturer's description.

### ⚠ Attention

Measured value acquisition only works via network, not via Modbus RTU!

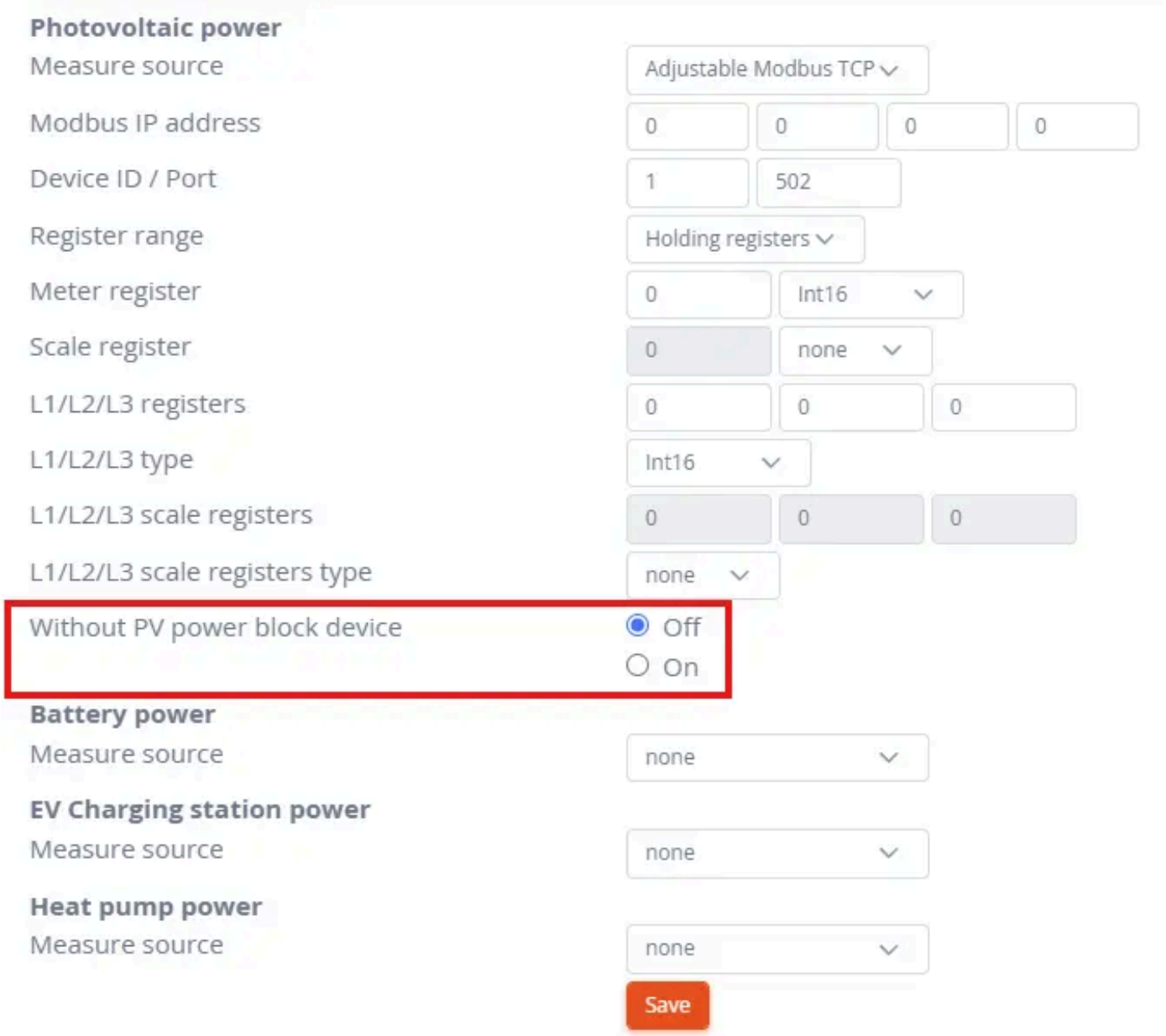
### ⚠ Attention

We ask for your understanding that we cannot do any binding support for third-party products. For questions about third-party products, please contact the technical support of the respective company.

| | |
|---|---|
| **Setting** | Measure source |

| | |
|---|---|
| **Description** | With "Adjustable Modbus TCP", the control signal is received via the network (RJ45, Ethernet)! |
| **Setting** | Modbus IP address |
| **Description** | Enter the IP address of the device from which you want to retrieve data. |
| **Setting** | Device ID / Port |
| **Description** | Device ID and port must be set according to the external device. This is like a specific apartment in a large building. You tell the system which "door" it should knock on. Example: Device ID 1 and port 502. |
| **Setting** | Register range |
| **Description** | **Holding Registers:** Are intended for storing information that can be changed by a user, such as settings, configurations or process parameters (R/W Read and Write).<br><br>**Input Registers:** Contain data that cannot normally be changed by the user (R/O Read Only). These registers often contain information about the status of a device or process, such as sensor data or status information. |
| **Setting** | Meter register |
| **Description** | The sum register (sum of the power at all three current phases) of the external device is set here.<br><br>⚠<br><br>If relevant for the type of metering point, e.g. for battery storage or bi-directional wallbox, the register must include both directions of energy flow!<br><br>Data type: Specify the format in which the totals register provides data. Description of the data types: |
| **Setting** | Int16<br>Int16-nc<br>Int32<br>Int32-sw<br>Int32-nc<br>Int32-sw-nc<br>Float<br>Float-sw |

| | |
|---|---|
| **Description** | 16-bit integer value, two's complement representation<br>16-bit integer value, magnitude sign representation (1st bit = sign)<br>32-bit integer value, two's complement representation<br>32-bit integer value, two's complement representation, swapped words<br>32-bit integer value, magnitude sign representation (1st bit = sign)<br>32-bit integer value, magnitude sign representation (1st bit = sign), swapped words<br>32-bit float value<br>32-bit float value, swapped words |
| **Setting** | Scale register<br><br>Scale register type |
| **Description** | If scaling of the data from the register is required, you can set this here. You can choose between scaling according to Sunspec, dividing "DIV" or multiplying "MUL". |
| **Setting** | L1/L2/L3 registers<br><br>L1/L2/L3 type<br><br>Scale registers<br><br>Scale register type |
| **Description** | If the manufacturer does not have a total register (sum of the power of all three current phases), the three registers for the individual phases can usually be queried.<br><br>Data type: Specify the format in which the phase registers provide data. Description of the data types above.<br><br>If scaling of the data from the registers is required, you can set this here. You can choose between scaling according to Sunspec, dividing "DIV" or multiplying "MUL". |



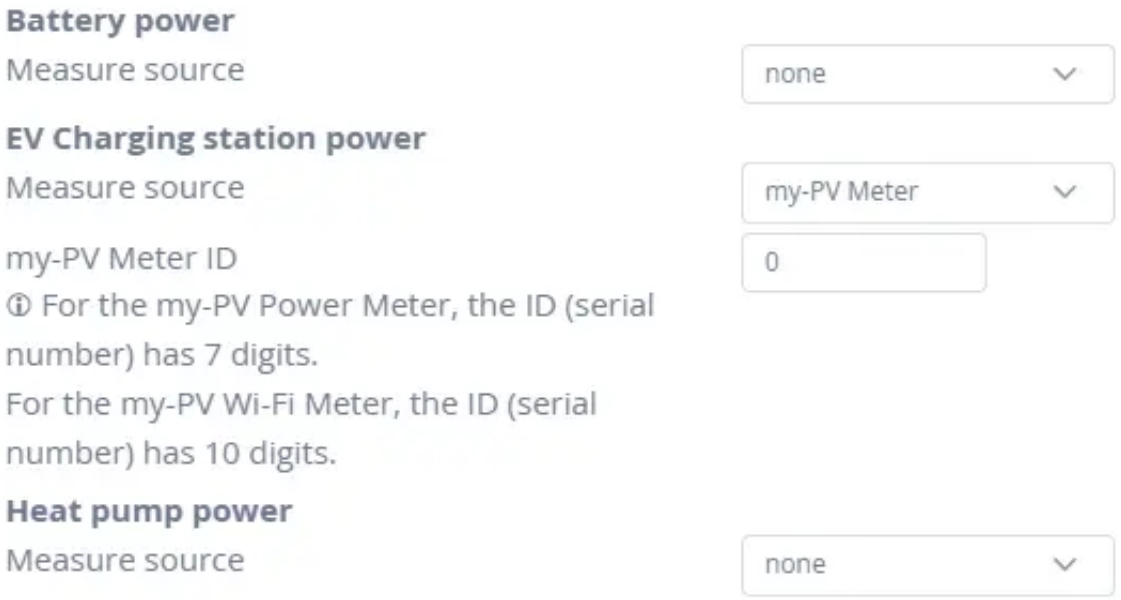

**Photovoltaic power**
At the measuring point "Photovoltaic power" it is possible to block the my-PV device if the inverter does not produce any power. The operation for optional boost-backup is not affected by this.

**Battery power**
With the "Battery power" measuring point, it is also possible to query the SOC (State of Charge) of the battery and the battery status, if this information is provided by the battery.

**EV Charging station power**
At the "EV Charging station power" measuring point, it is also possible to query the SOC (State of Charge) of the vehicle, if this information is provided by the charging station.

If the "Interval target value" control function is used (see chapter "Control settings") and the "EV Charging station power" measuring point is also queried, it is possible to define an additional duration of the interval target value here. The interval target value is thus

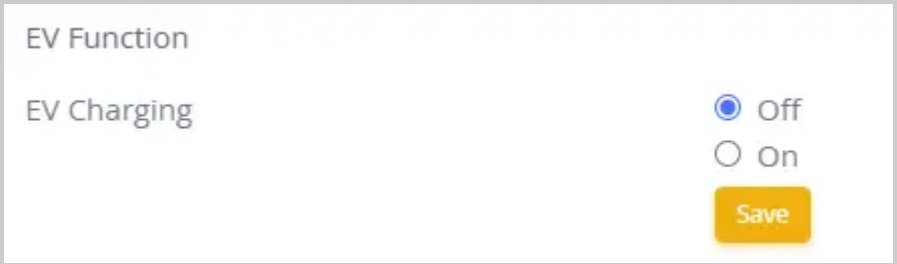
extended by this additional duration, provided the power at the charging station is at least above 500W at the end of the first interval.




The positive effect of this is that the time of the higher target value of the control can be significantly shortened. It is regulated back to the original target value more quickly, which in turn ensures higher self-consumption.

### 6.3.6. EV Function

Although my-PV does not produce charging stations, there are various options for compatibility.

> ⚠ **Attention**
>
> The EV Function is to be used exclusively for direct compatibility!
>
> 
> 

**Direct compatibility with charging station**
Direct compatibility exists if my-PV also performs the energy management of the charging station. However, it should be noted here that the power controllers from my-PV can only modulate the power on electric resistance heaters. This means that they never take over the power modulation of the charging station! However, the energy management system can tell

the charging station how much photovoltaic surplus is available. As soon as the available charging current exceeds the limit of 6 amps, the charging station can adjust the power for vehicle charging accordingly. Although my-PV does not actually consider itself a Smarthome manufacturer, this type of energy management is possible with some types of the Keba brand.
More information on compatible charging stations can be found **here**.

**Indirect compatibility with charging station**
Indirect compatibility already exists when a higher-level energy management system has control over all consumers. For example, if a smarthome is able to control a charging station in addition to providing power to my-PV. In some cases, such systems also allow prioritisation of the different applications. Examples of such indirect compatibility include the SMA Sunny Home Manager, E3DC or Solar-Log. In this case, the my-PV device has nothing to do with the charging station. From my-PV's point of view, the wallbox manufacturer openWB also falls into the category of higher-level energy management, because the entire control and regulation strategy of the consumers is the responsibility of openWB, while the my-PV devices are only given the power output.
With both indirect and direct compatibility, an intelligent system coordinates the heat applications of my-PV and the charging station. There is also a third possibility.

**Compatibility with charging station without common energy management.**
This concerns the case where there are both applications, but they do not interact intelligently with each other through any energy management. This is the case when, for example, an inverter manufacturer can control its own charging station with solar power, but has not implemented the my-PV application as part of the energy management in its control system. In this case, my-PV exists as a separate controller quasi parallel to it and uses the PV surplus according to the power measurement from the house connection. It can happen that the my-PV application does not leave any surplus for the charging pole.
However, the interaction with the charging station is coordinated with the AC ELWA-E from firmware 00205.00 and with the AC-THOR from firmware a0020800. The explanation can be found in the section "Interval target value" in the chapter "Control settings", as well as in the section "EV Charging station power" in the chapter "Measured value settings".

### 6.3.7. Multi units

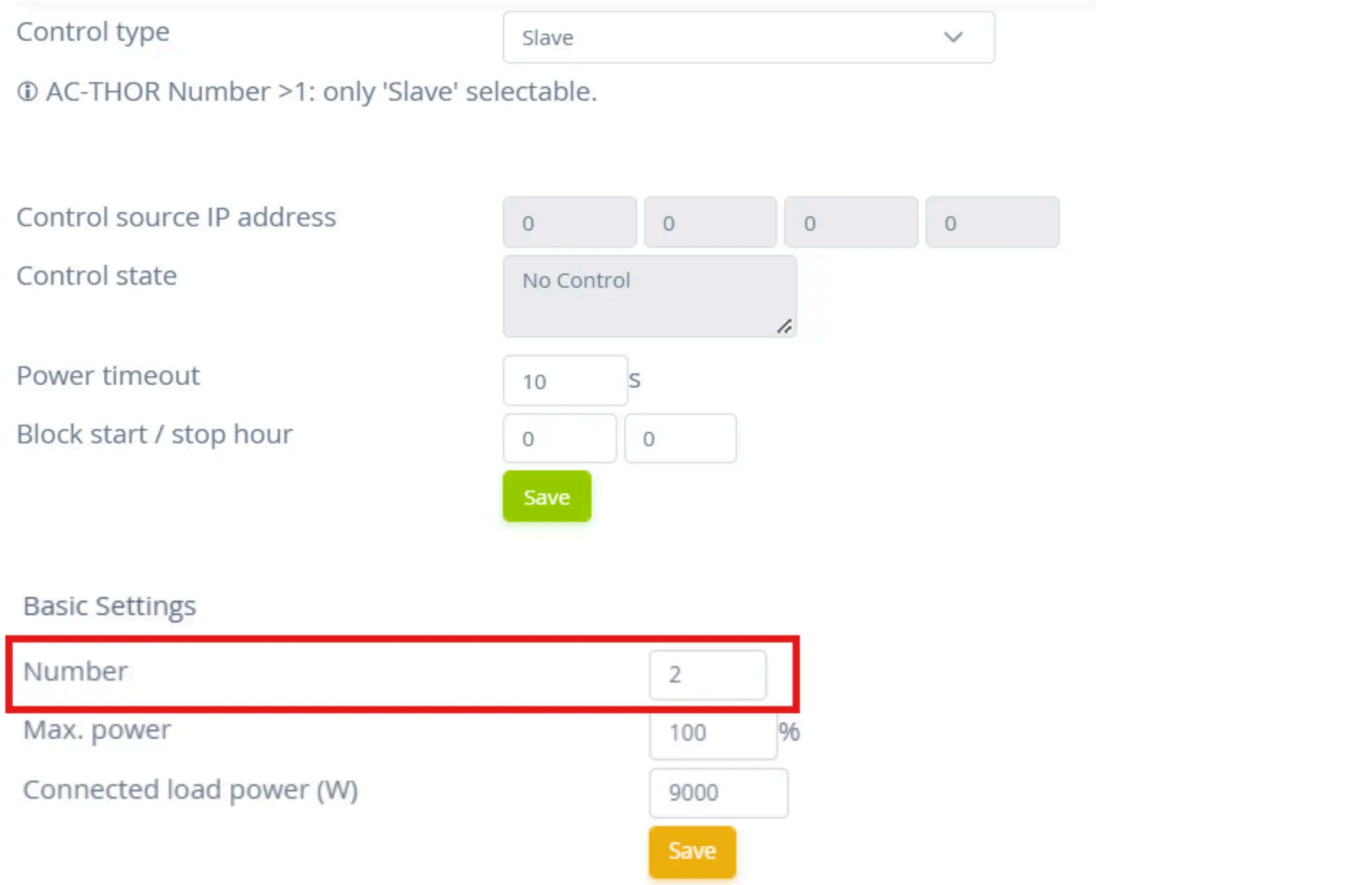
Multiple AC ELWA 2, AC ELWA-E, AC•THOR or AC•THOR 9s can be used in a network.
Operation is based on the master / slave principle.

### ⚠ Attention

When using several units, the following things have to be considered:

- All devices must be connected to the router via network cable.
- Only one master can be assigned to a signal source and vice versa.
- A maximum of 10 slaves are possible per master.
- All slaves in the network must have different device numbers, even if these are assigned to different masters.
- **All devices must be assigned by permanent IP addresses**. This can be done in three ways:
  - In the web interface of the respective device (see IP Settings)
  - On the display of AC•THOR
  - By the router (recommended)

**Settings on Slaves**
For the slaves only the device numbers has to be specified (see Basic Settings). All other settings are only required on the master.




As soon as an assignment has been made, further control settings are no longer possible or required. The IP address field is disabled and “Slave” appears in the Signal source field.

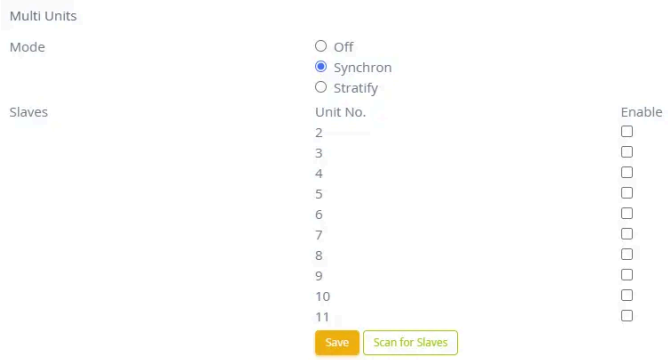
After a device search in the quick selection at the top right, the slave with the set number appears. Switching between the devices is possible here.

**Settings on Master**

Only for devices with number 1 (= master) the following display appears in the setup:




To make the settings for several devices on the master, first choose between **Synchron** and **Stratify**. In the case of synchronous charging, the power is evenly distributed to the master and its slaves. In the case of stratified charge, the devices are controlled one after the other according to their numbers, in each case until the set target temperature is reached.



After selection, please start the "Search for slaves" and activate the desired devices. Then save the setting.

> ⚠ **Attention**
>
> Scanning is performed via UDP port 16124. Firewalls (or specific router settings) may prevent that other units can be found.

#### 6.3.8. API

This menu item only appears in the device settings in the my-PV Cloud, not in the local Web-Interface! For this, it is essential that the device has an active internet connection and “Cloud mode” is activated.

The my-PV API allows current operating data to be queried and setup changes to be made via an internet-based interface (https). Power can be specified for the duration specified in the request.

An access token can be generated in the ‘API’ menu item. In conjunction with the 16-digit serial number of the device, the endpoints of the API can be used with the token. This token is only displayed once in the my-PV Cloud, so please make a note of it. However, you can generate a new token at any time if necessary.

**The detailed documentation of the API (Swagger documentation) is available at: api.my-pv.com**

> ⚠ **Attention**
>
> Local signal sources are overridden with this control. The API control always has priority!

### 6.4. Help



In the web interface the button leads to the online Operation Manual which corresponds to the firmware version installed.

7. Frequency control

7.1. Explanation




With this signal source, an electric heater in an AC off-grid system is linearly supplied with excess PV power. The output of the AC•THOR is specified to the unit by a battery inverter through alteration of the grid frequency via mains connection. Wiring for communication is not required!

As soon as the frequency control is selected as the signal source, the measured value is shown on the display at the bottom right above the help button.

> ⚠ **Attention**
>
> In boost backup mode, the battery must be expected to discharge!

> **TIP**
>
> Using several AC•THORs, each one may specify a different frequency range. This means that prioritisation of several heat generators is possible even without setting the multi-mode!

7.2. Specific settings for Frequency control

**Frequency**

The frequency range in which the adjustable power can be linearly fed can be altered. As lower limit (no power) and upper limit (maximum power) a range between 45 and 65 Hz is available. The factory settings are 50 Hz and 51 Hz. The frequency range must be at least 0.5 Hz!

**Maximum power**

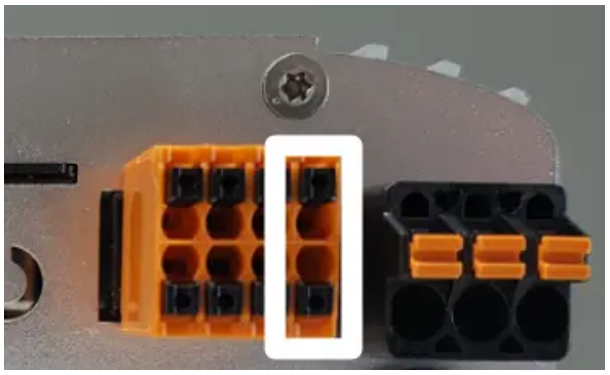
The input of maximum power of the heating load is extremely important for this operating mode. This is why this setting possibility appears here in second place again, in addition to

its normal position in the settings. See "General Settings" for details.

8. Potential-free input for external control

**Control with 3.3 - 24 V DC voltage from external source**

The AC•THOR can also be operated via an external PWM signal with variable power. The corresponding signal input is located at the 8-pin connector to which the digital temperature sensor is also connected.

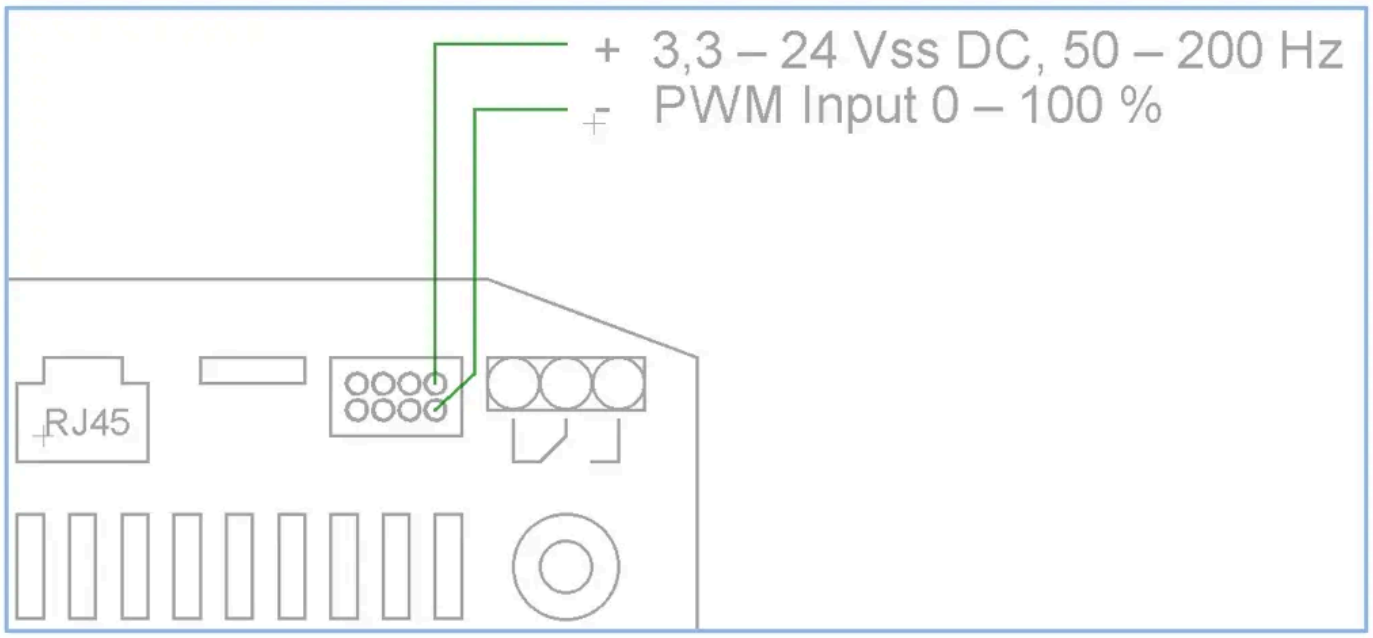


This control is independent of the selected operating mode. If a PWM signal is present, all other control signals that might be available via a network are also overridden. If the boost backup mode is set at the AC•THOR, it remains valid.

> ⚠ **Attention**
>
> When using several AC•THORs, a separate PWM signal is required for each device. Multimode is not possible with this control mode!

As soon as a PWM signal is present, it is displayed in percent on the bottom right of the display above the help button.






### ⚠ Attention

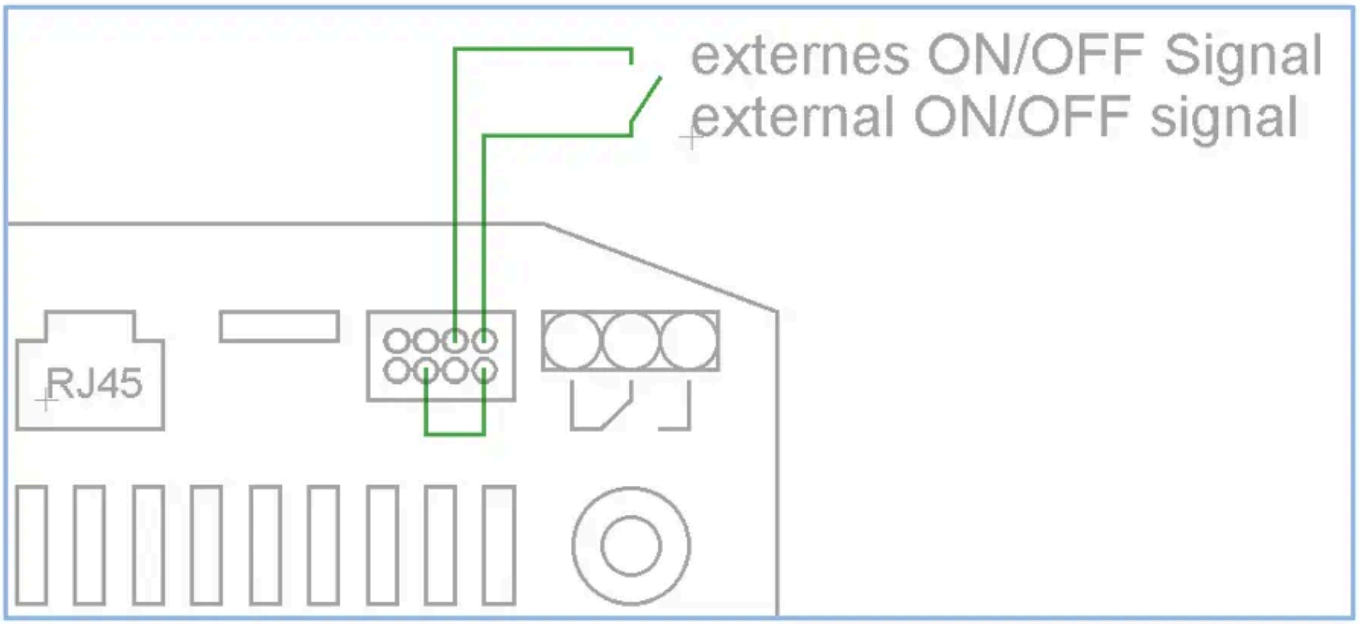
Observe the polarity of the DC voltage!

### ⚠ Attention

Without a digital temperature sensor, the AC•THOR will not switch off. This must then be done by the external signal source or by switching off by thermostat!

**Control by potential-free contact**

The AC•THOR can also be operated rigidly with maximum power via an external signal.




9. Modbus RTU connection for external control

### ⚠ Attention

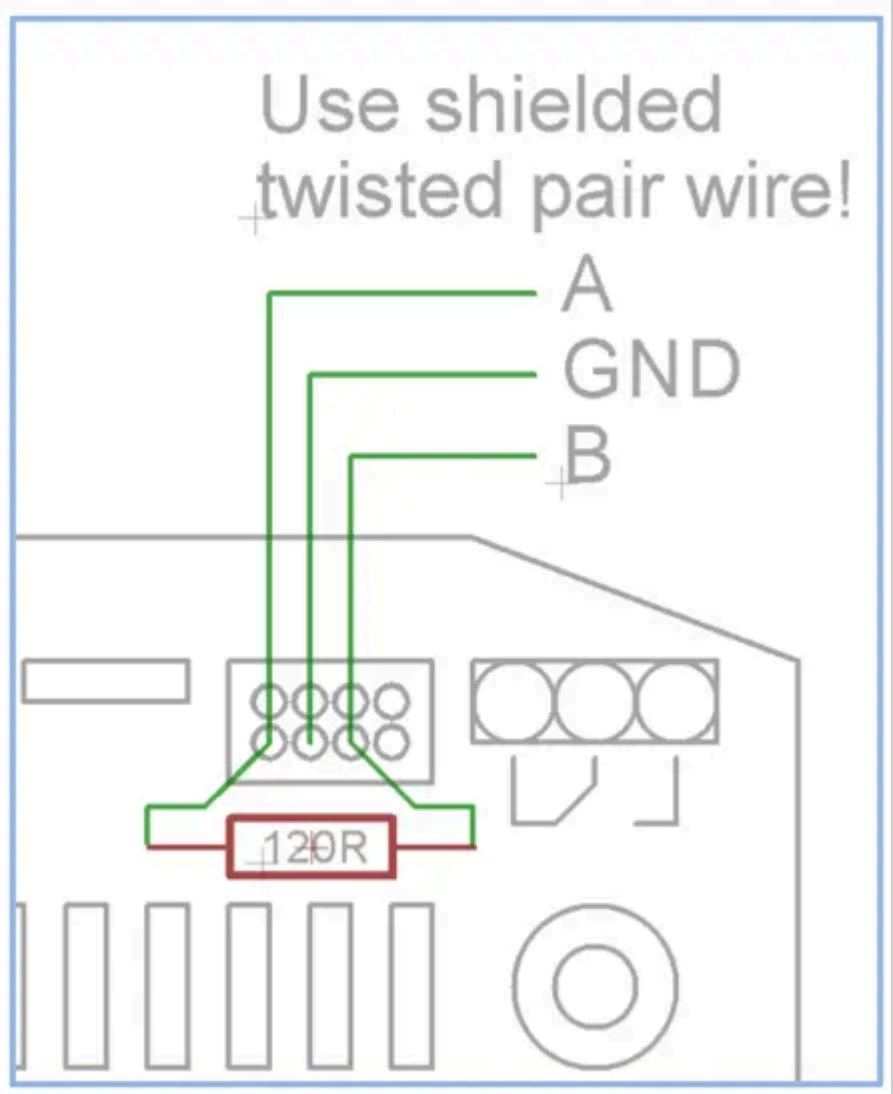
Use shielded twisted pair cable and connect the shield to earth (GND) at one end!

### ⚠ Attention

RTU bus must be equipped with a 120 Ohm termination resistor!
(Not included in the scope of delivery)

### ⚠ Attention

When controlling via Modbus RTU, the operating mode M7 cannot be used!




10. Firmware update

10.1. Update from server

### ⚠ Attention

Internet access is required!

### 10.1.1. Manual Update

Display - Settings - Factory settings:

Check for new firmware: Start check for new updates manually. When a new version is available, it will be stored on the SD card. This procedure takes several minutes. The AC•THOR will operate normally during this period.

Start firmware update: if a newer software version is present on the SD card, the update can be started manually. After the update, the unit will be restarted automatically.

Start power firmware update: if a newer output unit software version is present on the SD card, the update can be started manually. After the update, the unit will be restarted automatically. With AC•THOR 9s the update for both power stages is started.

## 10.2. Update with SD card

This possibility is provided for installations without Internet access. Consultation with our technical support is necessary. To do this, send us the 16-digit serial number to **support@my-pv.com**.

> ⚠ **Attention**
>
> Never remove the SD card while the unit is operational!

> ⚠ **Attention**
>
> Never exchange an SD card between one unit and another! It contains data specific to the serial number of the unit.

# 11. Status codes

**AC•THOR:**

- 0..... Off
- 1-8... Unit start-up
- 9... Operation
- >=200 Fault conditions power stage

**AC•THOR 9s:**

- 0-15 ... internal states for support purposes
- >=200 Error states power stage 9s

12. Digital temperature sensors: Assignment and function (only with AC•THOR 9s)

Sensor assignment:

| **Operation mode** | Load priority |
|---|---|
| **M1** | 1-2-3 |
| **M1** | 3-2-1 |
| **M2** | 1-2-3 |
| **M3** | 1-2-3 |
| **M4** | 1-2-3 |
| **M5** | 3-2-1 |
| **M6** | 3-2-1 |
| **M7** | 1-2-3 |

| **Operation mode** | OUT-3 |
|---|---|
| **M1** | Sensor 1 |
| **M1** | Sensor 1 |
| **M2** | Sensor 1 |
| **M3** | Sensor 1 |
| **M4** | Sensor 1 |

| | |
|---|---|
| **M5** | Sensor 1 HW |
| **M6** | Sensor 3 SH3 |
| **M7** | Sensor 1 |
| **Operation mode** | OUT-2 |
| **M1** | Sensor 1 |
| **M1** | Sensor 2 |
| **M2** | Sensor 1 |
| **M3** | Sensor 1 |
| **M4** | Sensor 1 |
| **M5** | Sensor 3 SH2 |
| **M6** | Sensor 2 SH2 |
| **M7** | Sensor 1 |
| **Operation mode** | OUT-1 |
| **M1** | Sensor 1 |
| **M1** | Sensor 3 |
| **M2** | Sensor 1 |
| **M3** | Sensor 1 |
| **M4** | Sensor 1 |
| **M5** | Sensor 2 SH1 |
| **M6** | Sensor 1 SH1 |

| | |
|---|---|
| **M7** | Sensor 1 |

Sensor function:

| **Operating mode** | Load priority |
|---|---|
| **M1** | 1-2-3 |
| **M1** | 3-2-1 |
| **M2** | 1-2-3 |
| **M3** | 1-2-3 |
| **M4** | 1-2-3 |
| **M5** | 3-2-1 |
| **M6** | 3-2-1 |
| **M7** | 1-2-3 |

| **Operating mode** | Sensor 1 |
|---|---|
| **M1** | Max / Min |
| **M1** | Max / Min |
| **M2** | Switch-over |
| **M3** | Max / Min |
| **M4** | Max / Min |
| **M5** | Max / Min |
| **M6** | Max / Min |

| | |
|---|---|
| **M7** | Max |
| **Operating mode** | Sensor 2 |
| **M1** | none |
| **M1** | Max / Min |
| **M2** | none |
| **M3** | none |
| **M4** | none |
| **M5** | Max / Min |
| **M6** | Max / Min |
| **M7** | PWM |
| **Operating mode** | Sensor 3 |
| **M1** | none |
| **M1** | Max / Min |
| **M2** | none |
| **M3** | none |
| **M4** | none |
| **M5** | Max / Min |
| **M6** | Max / Min |
| **M7** | Min |

13. Fault digital temperature sensors

- 0°: Broken probe
- 85°: Data disruption digital temperature sensor

14. Error messages on the Display

Error messages are only displayed on the home screen of the display. They are not shown in the web interface.

- Error 101
  No phase detected on the middle relay contact
- Error 102
  Temperature sensor 1 required for hot water boost backup Check if the sensor has been activated!
- Error 103
  Temperature sensor 1 required for this operating mode Check if the sensor has been activated!
- Error 104
  Temperature sensor 1 required for space heating Check if the sensor has been activated!
- Error 105
  Temperature sensor 1 required for hot water Check if the sensor has been activated!
- Error 106
  Controllable power < Load at relay
- Error 107
  Temperature sensor 2 required for space heating Check if the sensor has been activated!
- Error 108
  Temperature sensor 2 required for PWM Check if the sensor has been activated!
- Error 109
  Temperature sensor 1 required for legionella protection Check if the sensor has been activated!
- Error 110
  Firmware update unsuccessful communication fault with output unit Restart the unit
- Error 111
  Firmware update unsuccessful Problem with p-file. Switch off the unit. Insert SD card with p-file. See Operating instructions www.my-pv.com Restart the unit
- Error 112
  Temp sensor 3 required for hot water boost backup Check if the sensor has been activated!

- Error 113
  Output unit communication timeout. Restart the unit.
- Error 114
  Output unit stuck in bootloader. Restart the unit.
- Error 115
  Temperature sensors 2+3 required for spaceheating Check if sensors have been activated!
- Error 116
  Powerstage overload. Check installation
- Error 117
  Powerstage overtemperature. Device restarts after cool down.

**The following error codes are only relevant for Tuxhorn tubra eTherm devices**

- Error 118
  No load detected.Check STL.
- Error 119
  Operating pressure <1.2 bar
  Increase operating pressure.

15. Fault signals by the AC•THOR Logo

| | |
|---|---|
| 1x blinking: | SD Card error |
| 2x blinking: | Firmware defective |
| 3x blinking: | Display error |