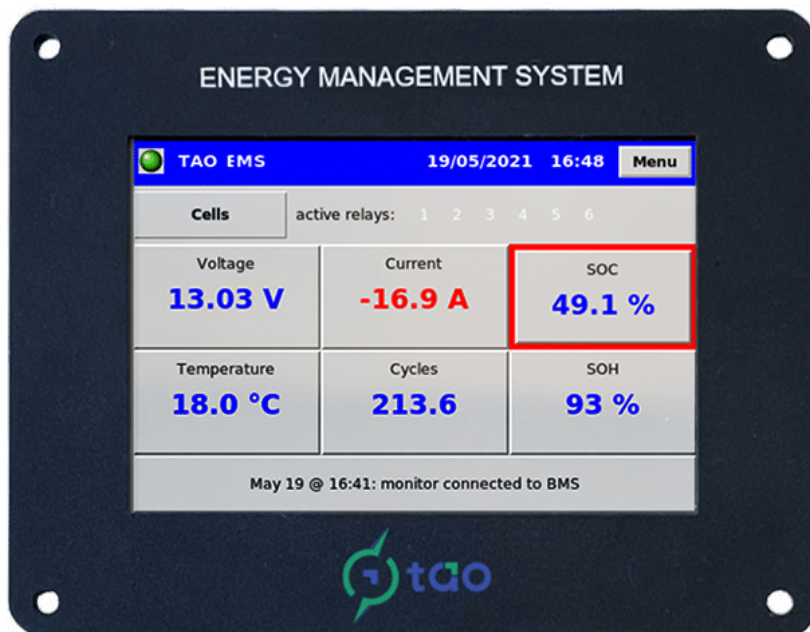




Energy Management System Installation and User Manual Monitor

Revision A.01 January 2024



TAO Performance limited

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1. ABOUT THIS MANUAL

To understand this manual it is important to first read the manual for the TAO EMS.







Who should read this manual?

This manual has been written with a number of public in mind:

- prospective buyer, to understand the capabilities of the EMS Monitor
- qualified installer, to understand specific procedures and safety guidelines
- end user, to learn how to best use the EMS Monitor and program it to meet specific needs

Pictograms

Throughout this document, the pictograms below are used to underline points or important notions

	Important information
	Good to know - trick
	Risk
	Action to be avoided
	Mandatory action
	Sensitive or difficult procedure requiring special care

Manual revisions

Revision	Date	Description
A.03	11/02/2022	firmware v1.02.04 - added charge profile, fix WiFi connection bug
A.02	1/12/2021	Monitor enclosure redesign + firmware v2.02.01
A.01	19/08/2021	First release (firmware v1.05.00)
A.00	09/06/2021	Pre-release complete version (Monitor firmware v1.00.01)

2. OVERVIEW

2.1 What is the TAO EMS Monitor?

TAO Monitor is a 5A touchscreen connected to the TAO EMS to:

- display battery and cell measures + state of relays outputs
- display voltage, current, temperature and SOC history
- display the last 100 events
- access to all EMS data and functions via Wi-Fi
- view live and historical data on Internet (Cloud)
- command external equipment via CAN interface

The EMS Monitor includes a UPS (Uninterruptible Power Supply) powered by an external battery (not included)

2.2 Package content

The TAO EMS monitor package includes:

- EMS monitor touchscreen with stylus
- power supply cable with jack (12-24V)
- UPS backup battery holder
- 10 meters cable to connect to the TAO EMS
- "RJ11" coupler connector

What else you will need:

- the USB cable that ships with the TAO EMS (the cable used to connect a computer)
- a lithium battery for power supply backup
 battery type: Li-ion 18650
 size: 18.5 mm diameter x 65 to 68 mm long
 nominal / charge voltage: 3.7V / 4.2V
 capacity: >= 3000 mAh

2.3 Specifications

EMS Monitor

Description	Value
Power supply	9 V to 30 V
Screen size	3.5 inch
Touchscreen type	resistive
UPS (uninterruptible power supply)	rechargeable lithium battery

3. SAFETY INSTRUCTIONS

Read the safety and installation instructions before installing and using the product. The equipment should be used for the designated application only and should be installed by a qualified electrician.

WARNING: DANGER OF ELECTRICAL SHOCK



Always disconnect the power supply and the UPS battery before performing maintenance. (follow proper shutdown procedure)

The product is used in combination with a permanent energy source (battery). Even if the equipment is switched off, an electrical voltage can occur at the input and/or output terminals

Do not open the enclosure

NO INTERNAL USER-SERVICEABLE PARTS



All maintenance should be performed by qualified personnel

Do not put the product into operation unless the enclosure is properly closed

INSTALLATION

Read the installation instructions before commencing installation activities

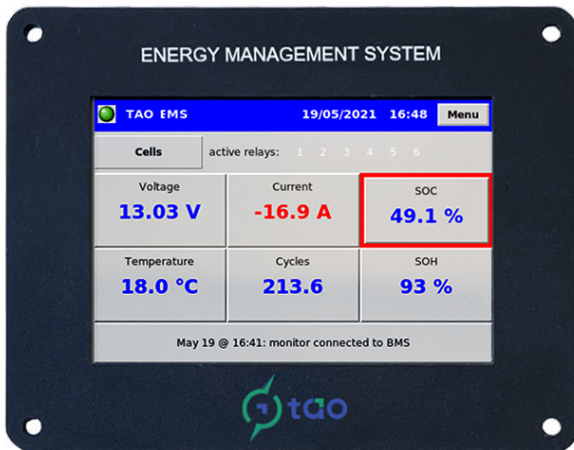
Installation must be in accordance with the local applicable regulations



Ensure that the power supply circuit is protected with a 5 A fuse or circuit breaker

Ensure that the equipment is used under the correct operating conditions (do not operate it in a wet or dusty environment)

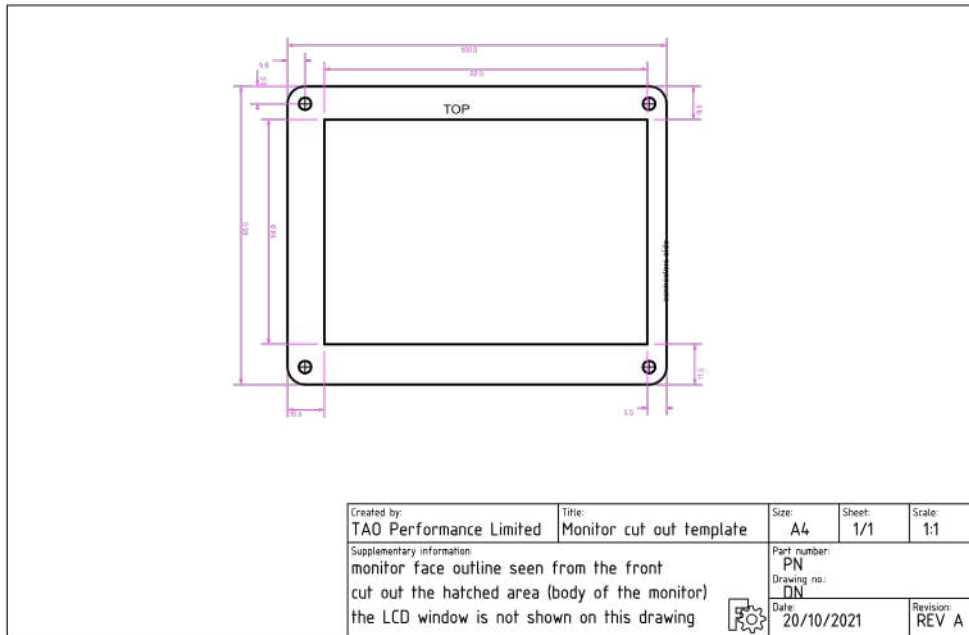
4. INSTALLATION OF THE EMS MONITOR



Identify a suitable bulkhead where an opening can be cut out to insert the EMS Monitor:

- Bulkhead maximum thickness: 14 mm
- Size of the opening: 64 x 92 mm
- Size required on the front: 85 x 108 mm
- Size of the battery holder: 20 x 80 mm (can be attached at the back of the bulkhead with a screw or on the side of the Monitor with double sided tape)
- Length of battery connection wire: 100 mm
- Leave enough space on the rear side of the bulkhead so that the cables can be easily inserted and are not bent. When looking at the Monitor from the front all the connectors are on the right side.
- be sure you can access the power switch situated at the rear ()

Cut-out an opening in the bulkhead



- Download the template from the TAO Performance website.

Attach the EMS Monitor to the bulkhead

- Insert the Monitor in the opening with the cable connectors on the right side
- Attach the Monitor to the bulkhead with four screws (wood screws provided)

Attach the battery holder at the back of the bulkhead

- Position the battery holder so that the wire can be plugged into the Monitor
- Secure the battery holder with screws or double sided tape

5. MONITOR CONNECTIONS



5.1 Power connection

- Use the supplied cable equipped with a jack
- Connect the power cable to a suitable power source that is protected with a 5A fuse (red wire is positive)

5.2 EMS connection

- Run the supplied 10 meters cable from the EMS to the Monitor
- Connect the "RJ11" connector on one end to the EMS (top port marked "PC / Monitor")
- Connect the supplied "RJ11" coupler connector at the other end of the cable
- Connect the USB PC / Monitor cable (supplied with the EMS) to the "RJ11" coupler connector
- Connect the other end (the USB connector) to the Monitor as shown on the picture

5.3 CAN bus connection

- The CAN bus uses only two wires: "High" and "Low"
- Follow the topology recommendations from your main CAN bus backbone supplier / designer to extend out the "High" and "Low" wires
- Each end of the CAN bus must have a termination resistance. If your CAN bus topology calls for the connection to the Monitor to be terminated with a resistance, insert the jumper next to the CAN connector (if no termination resistance is required, remove that jumper)
- Strip and insert the "Low" CAN bus wire on the left side of the CAN terminal (marked "L")
- Strip and insert the "High" CAN bus wire on the right side of the CAN terminal (marked "H")

5.4 UPS backup battery connection



- Insert the battery in the battery holder



Insert the battery with correct polarity

Follow the diagram and the + sign at the bottom of the battery holder

- Insert the battery wire connector as shown on the picture - the connector can only be inserted in one way (the red wire is on the left side)



Cable stress relief


To avoid accidental disconnections, you must install cable stress relief for all the cables

6. TURNING THE MONITOR ON AND OFF



The memory card must be inserted in the Monitor and should NEVER be removed (slot at the top of the picture)

The Power button () is recessed to avoid accidental press. Use the provided stylus to press the button




The Monitor is a mini computer and like a computer...

ITS MEMORY WILL BE CORRUPTED IF THE POWER AND
THE BATTERY ARE DISCONNECTED WHILE IT IS RUNNING

THE MONITOR MAY NOT START AGAIN
Read further for the proper shutdown procedure

6.1 Powering ON

- The power connector must be connected and supply a voltage between 9 and 28 volt
- The UPS backup must be installed and connected to the Monitor




BE SURE TO INSERT THE BATTERY THE RIGHT WAY
the battery positive (+) must be on the holder side marked (+)
(+) - red wire
the battery negative (-) must be on the holder side marked (-)
) - black wire

INSERTING THE BATTERY THE WRONG WAY
WILL DAMAGE THE MONITOR

- Press the Power switch briefly to turn ON the Monitor: The Power LED (red LED on the side of the Monitor opposite the cables) comes on and the boot sequence is initiated (about 3 minutes)


6.2 Screen calibration



If the touchscreen is not properly calibrated
the touch commands may not work as expected

If you have difficulties with the touchscreen response, run the
calibration process by selecting the menu option: *Maintenance -*
> Screen calibration

The Monitor will reboot and you will be presented with a calibration screen.
With the stylus press each of the four cross-hair as instructed on the screen.
When completed the Monitor will restart



Calibration timeout


the calibration screen times out after 30 seconds of inactivity...
and the boot sequence continues without screen calibration.

In that case you need to restart the calibration procedure

6.3 Set date and time

Refer to the appropriate section of the manual Date & Time

6.4 Monitor shutdown



There are two ways to shut down the Monitor in an orderly
fashion

**NOT FOLLOWING ONE OF THESE PROCEDURES
CAN CORRUPT THE MONITOR MEMORY
AND YOU MAY NEED TO REPLACE THE MEMORY CARD**

Software shutdown

Select the menu option *Power -> Shutdown* to initiate an orderly shutdown procedure.

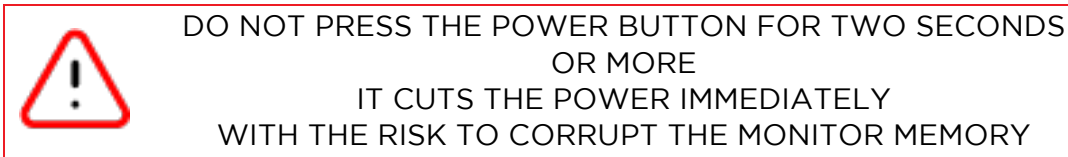
Wait for the red Power led to be OFF before disconnecting the power cable and the backup battery.

Hardware 'soft' shutdown

You can use this procedure in case the screen is not responsive.

Press the Power button () briefly to instruct the Monitor to shut down. Then wait for the Power led to be OFF (may take up to 15 seconds)

Note: Depending on the Monitor activity when the Power button () is pressed, it may need to be pressed for up to one second for the Monitor to register the command. So if the Power led does not go OFF after 15 seconds, press the Power button () again for up to one second.



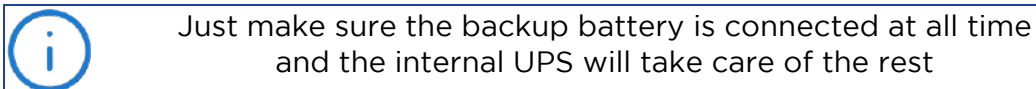
6.5 UPS operation

Once powered up, the Monitor should never be shutdown.

The Uninterruptible Power Supply (UPS) will keep the Monitor running between 30 minutes and one hour in case the power is lost (may happen during maintenance operations or if the power cable is disconnected from the Monitor)

When the voltage of the backup battery becomes too low, the Monitor will shut down properly.

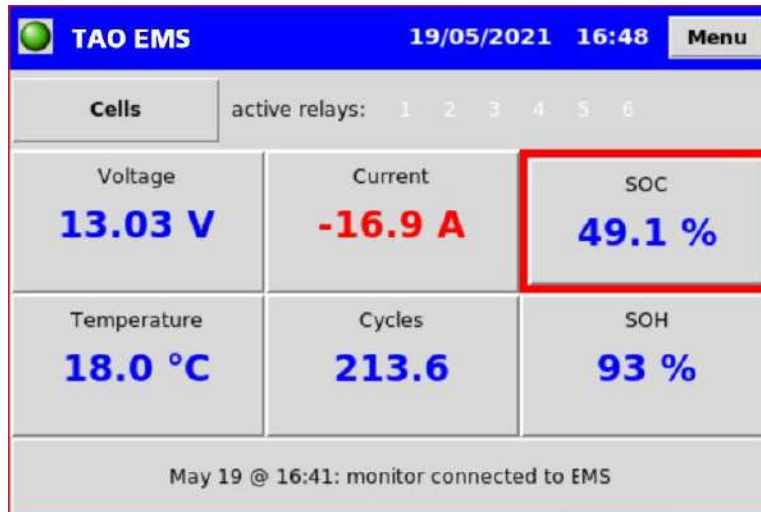
As soon as the power is reconnected to the monitor, the Monitor starts recharging the backup battery



7. THE MONITOR SCREENS AND OPTIONS

7.1 Home screen

This is the base screen that is displayed when the Monitor is powered up. This is also the screen displayed when you exit from a menu or other screens:



Active relays: the relays that are currently active will be shown in black

SOC: the SOC value has a coloured border based on the age of the last full charge:

- yellow: last full charge older than 21 days
- orange: last full charge older than 28 days
- red: last full charge older than 35 days - or no full charge since the EMS has been turned ON

The bottom section of the screen shows the last recorded event

Screen buttons:

- Press the "cells" button to display the voltage, temperature and resistance for each cell
- Press the "Current" button to toggle between Amps and Watts
- Press the "SOC" button to cycle the display:
SOC% -- Ah left in the battery -- Ah used
- Press the "SOH" button to cycle the display:
SOH% -- battery calculated capacity -- max cell resistance -- battery resistance
- Press the bottom section of the screen to list the last 50 events

Cells

Exit	Voltage	Temperature	Resistance
Battery	13.013 V	18.0 °C	1.05 mOhm
Range	0.002 V	0.0 °C	0.07 mOhm
cell 1	3.254 V	18.0 °C	0.23 mOhm
cell 2	3.254 V	18.0 °C	0.27 mOhm
cell 3	3.252 V	18.0 °C	0.25 mOhm
cell 4	3.253 V	18.0 °C	0.30 mOhm

This screen can also be accessed by selecting *Menu -> Cell measures*

Events log

Exit	Events log
	May 19 @ 14:47 monitor application closed by user
	May 18 @ 16:31 cell resistance update
	May 14 @ 12:08 balance: charge 4 - discharge 1
	May 13 @ 09:26 monitor connected to EMS
	May 13 @ 09:26 monitor switched ON
	May 13 @ 09:26 CANBUS not active
	May 12 @ 18:59 monitor connected to EMS
	May 12 @ 18:59 monitor switched ON

This screen can also be accessed by selecting *Menu -> Events log*

You can browse through the last 100 events. Use the web dashboard for more history

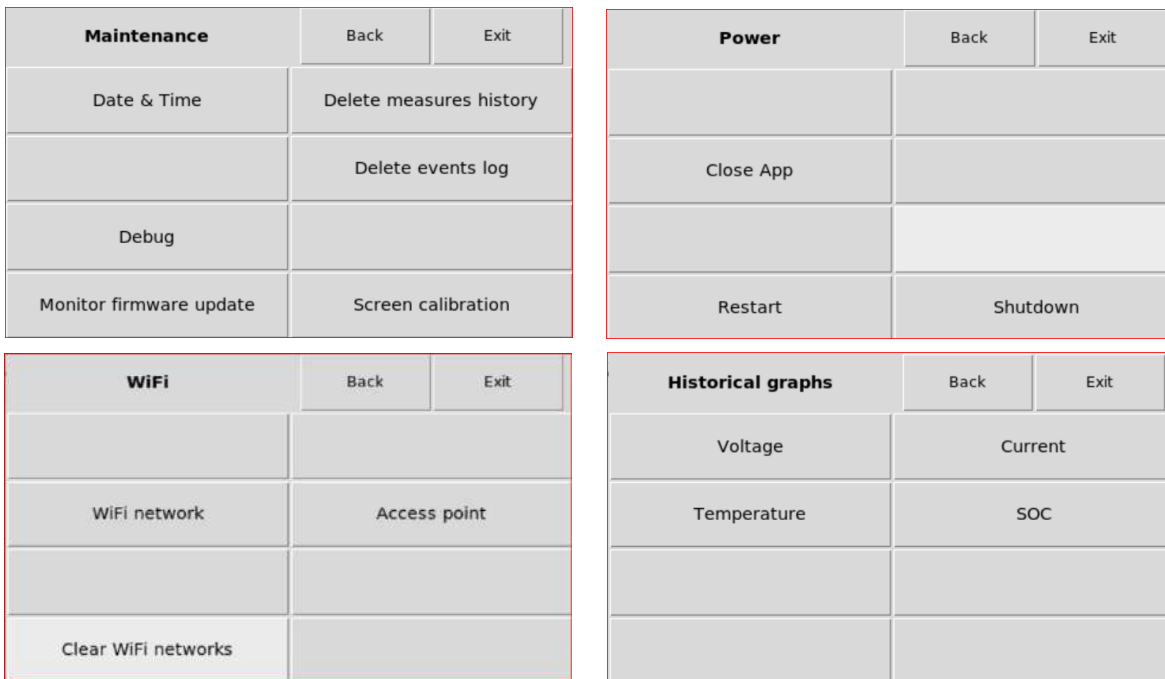
7.2 Navigation and touchscreen operation

Menu system

To access the menu system, press the "Menu" button on the top right of the screen. the main menu is displayed:

Main Menu	Back	Exit
Maintenance	Cell measures	
WiFi	Events log	
Charge profiles	Historical graphs	
Power	About	

The following menus can be accessed from the main menu:



Back go to previous menu

Exit return to Home screen

In this document, the selection of a menu item is indicated as follows:

Menu -> Maintenance -> Date & Time

Keyboard

When you need to enter text, you are presented with a keyboard:



Use the stylus to press on the keys.

<<<: to erase the last character

shift: to change the keyboard to upper case letters

OK: to return to the screen you came from



WiFi	Back	Exit
WiFi network	Access point	
Clear WiFi networks		

Overview

The EMS Monitor has the ability to either connect to an existing Wi-Fi network or create its own network (Access Point)

When the EMS Monitor is first switched ON or if there is no known Wi-Fi network within reach the Wi-Fi Access Point is activated
 The default Access Point name is "TAO_BMS" and the password is "taobms01"

When the EMS is powered-up it searches for known Wi-Fi networks and connects to the network with the strongest signal. If it does not find any, or cannot connect, the Access Point is activated.

Access Point



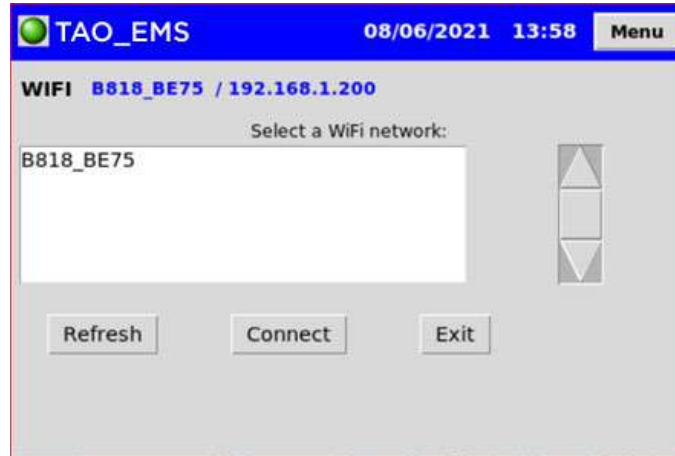
Select *Menu -> Wi-Fi -> Access point* to open the "Access Point" setup and activation

If the Access Point is active, the Monitor IP address is displayed

Button	Action
SSID - Edit	change Access Point SSID (the name of the WiFi network)
Password - Edit	change the WiFi network password
Start	disconnect from WiFi network (if connected) and activate the Access Point
Stop	turns OFF the Access Point

Connect to a WiFi network

Select *Menu -> WiFi -> WiFi network* to open the WiFi setup and connection screen:



If the Monitor is already connected to a WiFi network, the network SSID (name) is displayed in the screen header, followed by the IP address that has been allocated to the Monitor (example: B818_BE75 / 192.168.1.200)

Press "Refresh" to initiate a new search for available networks

To connect to a network:

1. press on the desired network to highlight it
2. press "Connect"

If the Monitor has already connected to that network, it will try to connect again using the saved password

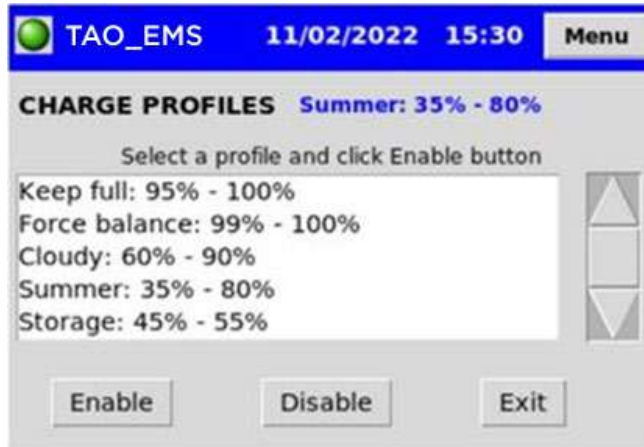
If this is the first connection to that network or the password has changed, you will be asked to enter the network password

Clear WiFi networks

Select *Menu -> Wi-Fi -> Clear Wi-Fi networks* to forget all the networks the Monitor has been connected to in the past. You will be asked to enter the password if you want to connect again to any network.

You need to do that if you have two known networks in your area, but want the Monitor to connect automatically to the weakest one.

7.4 Charge Profiles



This screen allows you to select a charge profile that will be used by the "Charge Cycle Management (CCM)" feature of the EMS.

You can have preset charge profiles with minimum and maximum SOC to disable and re-enable the chargers (see Charge Cycle Management section in the EMS manual).

The charge profiles are set using the Monitor Web Application

The currently selected charge profile is displayed in the heading

Select a charge profile and click "Enable"

Click "Disable" to stop the Charge Cycle Management

note: from EMS firmware v1.30, the charge is automatically enabled in case a low voltage or a low SOC trigger is activated

7.5 Power menu

Power	Back	Exit
Close App		
Restart	Shutdown	



The "Close App" option should not be used unless instructed by TAO Performance support. Selecting this option is recorded in the events log and voids any warranty.

Shutdown

After confirmation the Monitor will initiate a shutdown procedure and will then turn OFF the power supply

If the Monitor is not used for a while, disconnect the Power cord and the backup battery

To restart the Monitor, press briefly on the Power button () at the rear of the Monitor.

Restart

This option shuts down the Monitor then restarts a boot sequence.

7.6 Maintenance menu

Maintenance	Back	Exit
Date & Time	Delete measures history	
	Delete events log	
Debug		
Monitor firmware update	Screen calibration	

Date & Time

TAO EMS 19/05/2021 16:57 Menu

DATE & TIME

Time zone: Pacific/Auckland [Change]

year: 2021 month: 5 day: 19 hour: 16 minute: 57

[Set] [Exit]

First select your time zone in the list

Then press the UP and DOWN arrows to set the date and the time

Press "Set" to record the new data and time

Debug

Debug	Back	Exit
Exceptions		
Updates		

Exceptions: this option opens a screen listing error messages and exceptions recorded by the EMS

Updates: this option opens a screen with a report on last firmware update process

Monitor firmware update

Select this option to update the Monitor firmware.



The Monitor must be connected to a WIFI network with Internet access

After downloading the update, the Monitor will restart

Delete measure history



All the historical measures will be deleted
This operation cannot be undone

Delete events log



All the event log records will be deleted
This operation cannot be undone

Screen calibration

Select this option if the touchscreen does not register your touch commands accurately.

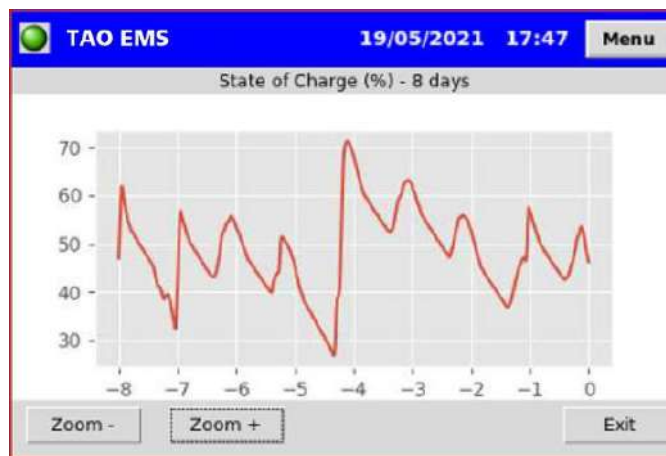
The Monitor restarts then runs a calibration procedure.

With the stylus press each of the four cross-hair as instructed on the screen

Historical graphs

You can view a graph with historical data for battery voltage, battery temperature, current and state of charge

Historical graphs	Back	Exit
Voltage	Current	
Temperature	SOC	



Press "Zoom +" and "Zoom-" to change the time scale from 3 hours up to 32 day
Use the web dashboard for more history and details

8. MONITOR WEB APPLICATION

8.1 Connect to the Monitor with Wi-Fi



To remotely access the Monitor
it must be connected to a WiFi network
or its Access Point must be activated
Refer to the WiFi section for more details

1. Take note of the Monitor IP address:
 - if connected to a Wi-Fi network, select *Menu -> Wi-Fi -> Wi-Fi network* to display the IP address of the Monitor - the IP address is in the format 999.999.999.999
 - if the Monitor Access Point is activated, the Monitor IP address is: 192.168.100.1
2. Connect your device (computer, phone, tablet) to the same WiFi network as the Monitor
3. On the device, open a web browser
4. In the address bar of the browser enter: `http://999.999.999.999:5000`
where "999.999.999.999" is the IP address noted at step 1 or 2
5. For easy future access, you may want to save that address as a favourite in your browser



If connecting to an existing WiFi network
you should contact the network administrator
to set a fixed IP address for the Monitor

8.2 Application overview

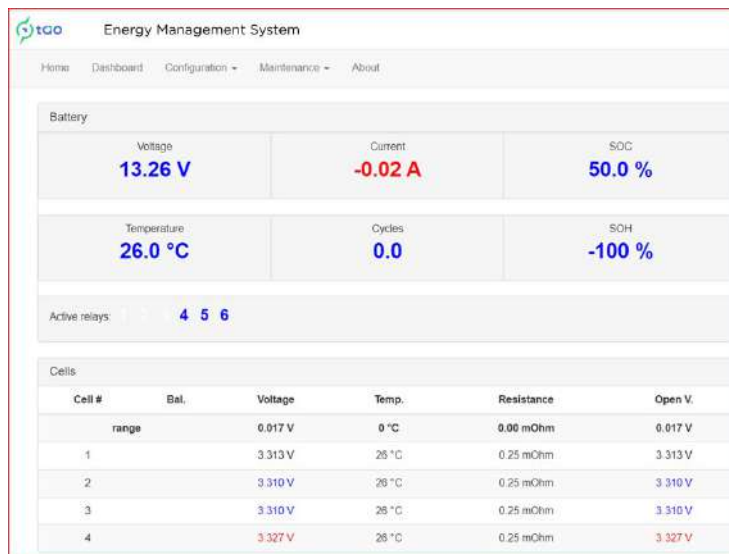
Most options and screens are similar to those found in the EMS Config desktop application Please refer to the EMS user manual for more details

This section only explains additional functionalities

The new sections are:

- Monitor configuration
- CAN bus configuration
- Export historical data
- Dashboard

Cell open voltage (Open V.): this is the cell measured voltage



compensated with the drop of voltage due to the cell resistance and the current

$$\text{Open V.} = (\text{Cell voltage}) - (\text{cell resistance}) \times (\text{current})$$

8.3 Monitor configuration

Select *Configuration* -> *Monitor configuration*

The 'Monitor configuration' screen is divided into two main sections:

- General:** Contains 'Time to sleep' (set to 3 minutes) and 'LCD sleep version' (set to 2).
- Relay output names:** Lists six outputs with their respective names: Output 1 (Pre-charge), Output 2 (empty), Output 3 (empty), Output 4 (Loads), Output 5 (Chargers), and Output 6 (Battery).

General

Time to sleep:

- the screen backlight is turned off after that time of inactivity
- enter 0 keeps the screen ON all the time = does not go to sleep

LCD sleep version:

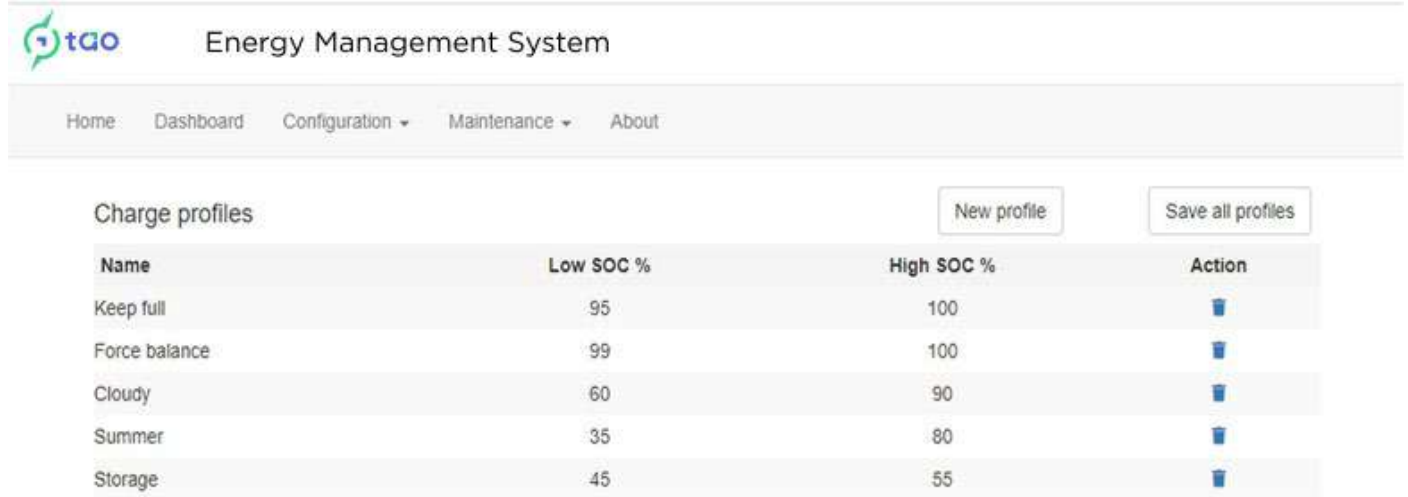
- this is a hardware related setup and should not be changed

Relay output names

For each relay output you can enter a name that will be used in the event log instead of the output number

8.4 Charge Profiles

Select *Configuration-> Monitor configuration*



The screenshot shows the TAO Energy Management System interface. The navigation menu includes Home, Dashboard, Configuration, Maintenance, and About. The main content area is titled 'Charge profiles' and contains a table with the following data:

Name	Low SOC %	High SOC %	Action
Keep full	95	100	
Force balance	99	100	
Cloudy	60	90	
Summer	35	80	
Storage	45	55	

Buttons for 'New profile' and 'Save all profiles' are located at the top right of the table area.

Click on the "New profile" button to add a line

To edit a profile, click on the field to edit

To delete a profile, click on the trash can in the "Action" column

Click the "Save all profiles" before leaving the screen

9. CAN BUS INTERFACE

A CAN bus (Controller Area Network) is a message-based communications protocol. It is used extensively in automotive, marine, aviation, medical, industrial... and many other equipment.

The EMS Monitor provides integrated support for many CAN compatible equipment including chargers, regulators, controllers, displays and more. This means that the TAO EMS Monitor can communicate directly with these equipments in order to provide them with useful real-time information such as battery voltage, current, limits, temperatures, state of charge, trigger & relays status... This information can be used by the equipment to make decisions regarding their operation.

Disclaimer:

The following information is provided as a guide to integrate the EMS Monitor with CAN compatible equipment. It is the user's responsibility to verify all aspects of the end application and the suitability of the CAN integration.

CAN bus integration is an advanced feature and requires a reasonable understanding of the CAN protocol, a good knowledge of the equipment to integrate with (or detailed specifications from the manufacturer), and eventually some debugging tools to monitor the CAN traffic.

We provides sample messages for informational purposes only and is not responsible for changes in specifications made by the manufacturer of external equipment. For more details consult the specifications provided with the CAN compatible equipment you want to connect to.

The EMS Monitor CAN bus adapter has been created to comply with the Society of Automotive Engineers (SAE) standard SAE J1939. This is the same standard on which is based the NMEA2000 protocol (registered trademark of National Marine Electronics Association), RV-c used in recreational vehicles, Open System Energy use in many DC installations, and more. The EMS Monitor makes no claim of the correctness, compatibility, nor support for any standard.

TAO EMS Monitor has been designed with flexibility in mind so that it should be possible to adapt to the changes in external equipment specifications and required messages as long as they are within the SAE J1939 standard. But there is no warranty in that area.

Each CAN message sent by TAO EMS Monitor is defined by an identifier (CAN ID), contains specific information and is broadcasted at a set frequency.

The identifier for CAN messages is configurable to match the requirements of the equipment on the CAN bus. TAO EMS Monitor CAN Protocol works using both standard 11-bit identifiers or extended 29-bit identifiers, that can be configured for each message.

Each message can include up to 8 bytes of data. Each data element can be a character, a number or the real-time value of a field provided by the EMS (voltage, temperature, current, SOC, SOH, trigger status, relay output status...)



These concepts are quite technical and require some understanding of data structure and CAN protocol
If you post the CAN protocol requirements of your equipment on the TAO Performance Forum we will give you some guidance on the way to structure the CAN messages in the TAO EMS Monitor

Multiple batteries in parallel

In case there are multiple batteries in parallel, each being monitored by a EMS, the different EMS's can communicate together with proprietary messages so that only consolidated data is sent to the outside world on the CAN bus.

One EMS is setup as the Master, and all the other EMS are Slaves:

- the Master is set with a EMS instance = "0"
- each Slave is set with a different EMS instance from 1 to 10

Each Slave is setup to only send the "Slave EMS" proprietary messages per the image below:

CAN messages								backup	restore	save
Group	Send	Ext.	ID / PGN	Description	Bytes	Freq.	Action			
Slave BMS ▾			(hex)			(ms)				
Slave BMS	✓	✓	EF00	01: voltage, current	8	500				
Slave BMS	✓	✓	EF00	02: soc, temperature, power	8	500				
Slave BMS	✓	✓	EF00	03: capacity, soh	8	500				
Slave BMS	✓	✓	EF00	04: charge voltage, current	6	500				
Slave BMS	✓	✓	EF00	05: charge voltage & current	6	500				
Slave BMS	<input checked="" type="checkbox"/>	✓	EF00	06: triggers & outputs	7	500				

DO NOT CHANGE THE DEFINITION OF THESE MESSAGES

The Master EMS collects and consolidates the information from all the Slaves EMS's

The Master EMS sends the consolidated data to external equipment:

- average voltage, temperature, SOC
- sum of current/power in or out of the battery, nominal and calculated capacities, charge/discharge current limits
- minimum SOH, charge voltage limit
- maximum discharge voltage limit
- triggers that are activated by any EMS (OR function)
- relay outputs that are activated by all the EMS's (AND function)

9.1 CAN parameters

Enable CAN messages:

- whether or not you want the Monitor to send CAN messages via the CAN bus connector

CAN bus bit rate:

- set it at the same rate as the CAN bus you connect to (refer to the documentation of the equipment you want to send messages to)

Preferred address:

- this is the SAE J1939 address you want to set for the TAO EMS on the CAN network. The default should work in most situations, but you need to check the specifications of other equipment to see if they have specific requirements for the address range to use for a EMS.
- in case of address conflict on the CAN bus, the EMS Monitor will try other addresses until it finds one that is available

Battery instance:

- if there are multiple independent batteries and EMS in your installation, this is the reference of the battery being monitored
- this is a field that is required by some equipment and can be used as part of messages (refer to the specification and message definition of other equipment)
- leave the battery instance to "1" if there is only one battery

EMS instance:

- if there are multiple batteries in parallel, each monitored by a EMS, the EMS Master is instance "0", and the EMS Slaves must each have a different instance form "1" to "10"
- if there is only one battery and one EMS, leave the EMS instance = "0"

Mini time between messages:

- To avoid the saturation of the CAN bus, there must be a minimum time delay between messages. 50ms is generally suitable, but in case of CAN bus is busy you may have to increase that value (to be done by a professional who understands the specifics of your CAN network)

9.2 CAN bus messages



















Select *Configuration -> CAN bus messages* to define and select the CAN messages that are sent out

You can define as many messages as you want and only the messages that are enabled will be sent at the defined frequency

CAN messages are grouped by user defined categories (by default groups correspond to equipment manufacturers or protocols)

List of CAN bus messages

This is the first screen that is displayed. All the CAN messages that are defined in the system are listed:

Group	Send	Ext.	ID / PGN (hex)	Description	Bytes	Freq. (ms)	Action
all							
RV-C	x	✓	1FEA5	DC_SOURCE_STATUS_11	8	500	  
RV-C	x	✓	1FEC7	DC_SOURCE_STATUS_6	8	500	  
RV-C	x	✓	1FEC8	DC_SOURCE_STATUS_5	8	500	  
RV-C	x	✓	1FEC9	DC_SOURCE_STATUS_4	8	500	  
RV-C	x	✓	1FFFB	DC_SOURCE_STATUS_3	8	500	  
RV-C	x	✓	1FFFC	DC_SOURCE_STATUS_2	8	500	  
RV-C	x	✓	1FFFD	DC_SOURCE_STATUS_1	8	500	  
SMA Victron	x	x	351	charge & discharge limits	8	950	  
SMA Victron	x	x	355	soc & soh	6	950	  
SMA Victron	x	x	356	voltage, current & temperature	6	950	  
SMA Victron	x	x	35A	alarms & warnings	8	950	  
SMA Victron	x	x	370	EMS name	7	10000	  
Slave EMS	x	✓	EF00	01. voltage, current	8	500	  
Slave EMS	x	✓	EF00	02. soc, temperature, power	8	500	  
Slave EMS	x	✓	EF00	03. capacity, soh	8	500	  
Slave EMS	x	✓	EF00	04. charge voltage, current	6	500	  
Slave EMS	x	✓	EF00	05. charge voltage & current	6	500	  
Slave EMS	x	✓	EF00	06. triggers & outputs	7	500	  

Under the "Group" heading there is a pull down with the defined groups. Select "all" to see all the messages or select a group to only see the messages from that group.

The "Save" button on this window is the only way to record any changes made to CAN messages

After editing one or more messages you must click the "Save" button to record those changes in the Monitor

The "Confirm" buttons on the edit screens do not save the changes in the Monitor

The columns "Group", "Send", "Ext", "ID/PGN", "Description" and "Freq." can be changed directly on that screen by clicking on the field to change.

To edit the message content, click on

To create a new message, first select a message with similar content and click

To delete a message, click

Do not forget to save the changes before leaving that screen

Group:

- user defined name you can use to group messages

Send:

click on the symbol to switch between values

- send = the message will be sent at the defined frequency
- not used (do not use)
- disabled = the message will not be sent out

Ext:

click on the symbol to switch between values

- use extended 29 bits message identifier
- use standard 11 bits message identifier

- this is the message ID in hexadecimal format
- either 11 bits (standard format) or 29 bits (extended format)
- check the documentation of your CAN compatible equipment to know what message ID it accepts

Description

- this is a note for your own use
- it is not used by the CAN interface

Bytes:

- this is calculated by the system based on message content

Freq:

- the frequency in milliseconds at which to send the selected message

Edit CAN message

This window is opened when you click on the edit button for a CAN message. The selected message's data elements are listed:

Edit CAN message: 0x351 charge & discharge limits ✕

Number of data bytes:

#	bytes	msb	endian	type	value	signed	mult.	div.	
1	2	first	small	field	charge voltage	no	1	1	✎
2	0								
3	2	first	small	field	charge current	no	1	1	✎
4	0								
5	2	first	small	field	discharge current	no	1	1	✎
6	0								
7	2	first	small	field	discharge voltage	no	1	1	✎
8	0								


You can set the number of data bytes to be sent as part of the message (from 1 to 8)

Click the edit button to change the values for the corresponding data element

If a data element uses more than one byte the following bytes are blanked out accordingly

Edit data byte

From the Edit CAN message screen, click the edit button to change the content of that line:



All the required information to define a data element must be provided by the manufacturer of the equipment that will read the message

If in doubt contact this equipment's manufacturer for details

Edit data byte: 5 of message: 1FFFD DC_SOURCE_STATUS_1 ✕

Data type:

Value:

Number of bytes:

Signed: Yes No

Multiply by:

Divide by:

Add:

Endian: Big Small

note: all the lines are not displayed based on the selected "Data type"

Data type:

- Data types can be:
 - field: data element coming from the EMS
 - bits: either a set value (0/1) or the state of a trigger or relay output
 - character: a set character (a-z, A-Z, 0-9)
 - integer: a fixed integer
 - hexadecimal: a fixed hexadecimal value

Value:

- Specify the content of the data element based on the selected "Data type"
- for character: enter a single character
- for integer: enter an integer number
- for hexadecimal: enter a hexadecimal value
- for a field: select the field in the drop down

Number of bytes:

- enter here the number of bytes that will be used by the data element

Signed:

- if the data element is signed, negative values are represented as 2's complement

Multiply by:

- enter a value by which to multiply the data value
- use this to adapt the data element value to the unit expected by the receiving equipment

Divide by:

- enter a value by which to divide the data value
- use this to adapt the data element value to the unit expected by the receiving equipment

Add:

- positive or negative integer that is added to the value after multiplication and division
- use this to adapt the range of values expected by the receiving equipment

Endian:

- if the data element spans multiple bytes, this is the order of the bytes
- it can be Big or Small Endian



After making additions and changes,
do not forget to click the "Save" button
on the list of CAN bus messages window

Available fields:

The available data fields that can be sent by TAO EMS Monitor in a CAN message are:

Field	Description	Unit
battery voltage	0	0
current in/out (signed)	0	0
power in/out unsigned	0	0
battery temperature	0	0
soc	0	0
soh	0	0
max charge voltage	0	0
max charge current	0	0
min discharge voltage	0	0
max discharge current	0	0
nominal battery capacity	0	0
remaining battery capacity	0	0
triggers	0	
outputs	list of relay outputs state (for internal use)	
battery instance	0	

More fields will be added over time to meet the need of different equipment

Let us know if your equipment requires fields that are not in that list

charge / discharge voltage and currents values are defined based on battery state. Refer to CAN charge/discharge limits for details

9.3 CAN charge/discharge limits

Select *Configuration -> CAN charge/discharge limits* to set the voltage and current limits used in the CAN messages:

- charge voltage (max)
- charge current (max)
- discharge voltage (min)
- discharge current (max)

You can set default limits and specific values that will override these defaults when a trigger event is active (read the EMS user manual to understand the triggers concept)

Trigger	Description	CHARGE		DISCHARGE	
		Current (A)	Voltage (V)	Current (A)	Voltage (V)
none	defaults	150	13.80	150	12.50
1	cell voltage > 3.650 V	0	0.00	150	12.50
2	cell voltage < 2.850 V	150	13.80	0	12.50
3	cell temperature > 45 °C	50	13.80	150	12.50
4	cell temperature < 0 °C	0	0.00	100	12.50
5	cell voltage > 3.550 V	20	13.80	150	12.50
6	cell voltage < 2.950 V	150	13.80	20	12.50
7	cell temperature > 40 °C	80	13.80	80	12.50
8	cell temperature < 5 °C	30	13.80	150	12.50
9	cell voltage differential > 0.060 V	50	13.80	50	12.50
10	cell temperature differential > 4 °C	50	13.80	50	12.50
11		0	0.00	0	0.00

When multiple triggers are active only the most restrictive value is retained

The triggers you have set with the *Configuration -> EMS triggers* option are displayed with the corresponding voltage and current limits

Click on the value you want to edit

When done, click "Save" to record the changes in the TAO EMS Monitor

10. HISTORICAL DATA AND DASHBOARDS

Measures and event logs are recorded by TAO EMS Monitor in a time series database. To generate reports, graphs and tables from this historical data we use an open source application called Grafana *.

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Grafana is a very powerful tool and can be complex to master. We have therefore developed a standard dashboard to visualise the live and historical data. This manual only cover the basic navigation to use the standard dashboard.

TAO Performance does not provide support for the Grafana products beyond and above the use of the standard dashboards. Users who want to explore the Grafana capabilities and create their own custom dashboard should use the online help provided by Grafana and its very active community.



If you have specific reporting requirements that may be of interest to the TAO EMS users community, we will work with you do develop a custom dashboard or add the report to the standard dashboard

10.1 Local backup

Select the option *Maintenance -> Export historical data* to export historical data in csv format (comma delimited)

Select the type of export: measures or even log

Select the year to export

The file is generated and downloaded to your computer

10.2 Cloud data backup

When connected to a WiFi network with Internet access, a backup copy of measures and event logs is uploaded to a server run by TAO Performance: the "Cloud".


Cloud data is accesses from the TAO Performance website (<https://tao-perf.com/>) by selecting the "Dashboard" menu.



TAO EMS Monitor must be connected to Internet regularly in order for your historical data to be backed up to the Cloud

Considering that the TAO Monitor is a computer and could, like any other computer, crash or be corrupted, this is a precaution to safeguard your historical data. You have nothing to do and nothing to activate this automatic backup - just connect the TAO EMS Monitor to Internet. If the TAO EMS Monitor has not been connect to the Internet for a while, it may take a few hours for the backup to complete. If Internet connection is lost, the next time Internet connectivity is resumed the backup will restart where it stopped. You can access the Cloud dashboard to see the backed-up data as it builds and validate all your data is on the Cloud.

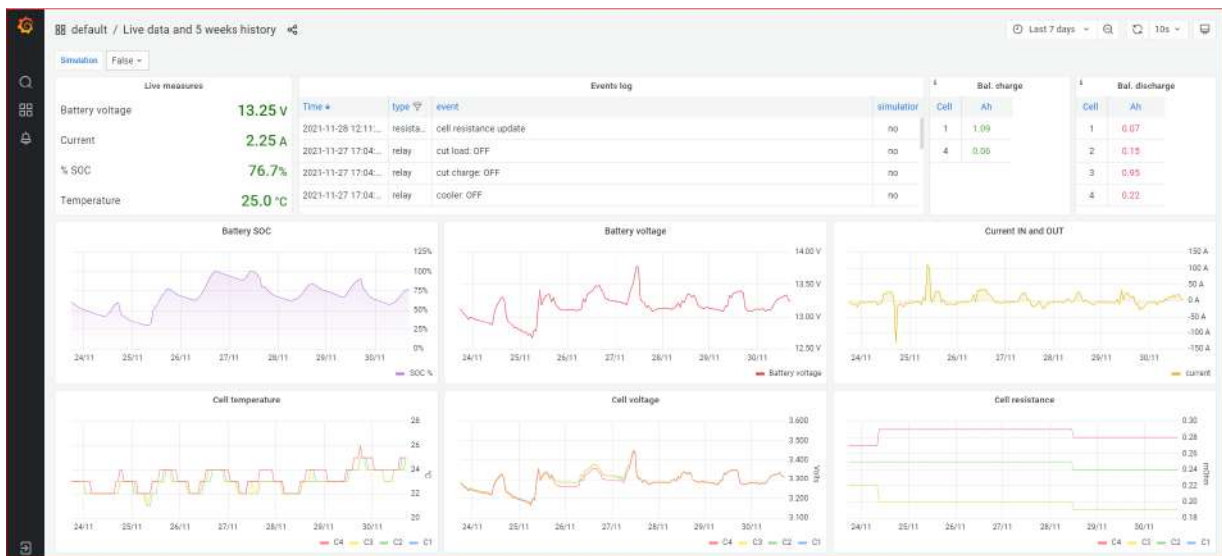
After the backup is up to date and while TAO EMS Monitor is connected to Internet, the TAO EMS Monitor backs up the latest data every 10 seconds.



TAO Performance declines any responsibility
in case of data loss and its consequences.
This applies to data in the TAO EMS Monitor memory or the
Cloud

10.3 Local dashboard

Select *Dashboard* on the top menu to open the dashboard in a new tab:



TAO EMS Monitor records the EMS data every second and keeps that level of details for 30 days. For older data there is one record every 10 seconds with min and max values during that interval.

There are defaults dashboards already created. To select one of them, click the "four squares" in the left column menu, then "Manage", then "Default" directory



To add or edit dashboards

Click the login button at the bottom left of the screen

user: admin / password: taobms

Select the time range for the dashboard

There are two ways to select the time range:

- Click on the "time range" button at the top right corner of the screen (on the picture above it is where you can read "last 7 days"), then either select a preset time range or enter a custom time range
- on any of the graphs use the mouse to select a part of the graph where you want to zoom

View a graph full screen

place the mouse cursor on the heading of the graph and press the 'V' key (or select 'view' from the pull-down menu)


Filter the events log by event type

- First deactivate the automatic refresh by clicking the pull down on the 'refresh' button at the top right corner of the screen (on the picture above it is the button where you can read '10s'), then select 'off'
- Click on the funnel next to the 'type' heading of the 'Events log' table
- Select the event types you want to see

You can modify exiting dashboards, create new ones, import/export dashboard...

10.4 Cloud dashboard

The Cloud dashboard is accessible from the TAO Performance web site by selecting the "Dashboard" menu option



You need to let us know if you wish to access the Cloud dashboard so that we can create an access record for your EMS

Note that the Cloud dashboard is public

Over time we will develop services for those who need their data to be private, want additional functionality or want to develop custom Cloud dashboards...



In the EMS Name drop down, select your EMS to view your dashboard.

Live measures are only available if the EMS Monitor is currently connected to Internet.

All other functionalities are the same as for the local dashboard.

The Cloud dashboard cannot be modified by users.