

OPERATING INSTRUCTIONS

BATTERY MANAGEMENT / ENERGY MEASURING SHUNT SHX



The SHX shunt can be used in 2 operating modes either as a battery management shunt or as a current measurement shunt in the energy monitor. The operating mode is switched via the system monitor.

It records all charging and discharging currents and the voltage of the battery. In battery management mode SHX-C, it is able to calculate the battery state after an initial synchronisation. The battery is constantly monitored for full charge, a critical state of charge and complete discharge. In the SHX-L current measurement shunt mode, the current flow from energy sources such as alternators, solar cells, ... or consumers can be recorded and displayed on the DC energy side of the system monitor. Furthermore, the energy yield or consumption can be queried. The connection to the philippi P-BUS is made via an M12 T-connector.



The software version of the PSM2 must be at least 5K or higher.
(PSM1: software version 20A or higher).

Please carry out a corresponding software update of the PSM in advance.

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1 General information

1.1 Purpose of use

The battery management shunts SHX can only be operated in connection with the P-BUS on extra-low voltage DC 8-60V. They are designed for use on yachts or in motorhomes and may only be operated in enclosed spaces protected from rain, moisture, dust and condensation. Never use the battery management shunts SHX in places where there is a risk of explosion due to gas or dust. The battery management shunts SHC are not suitable for outdoor installation.

1.2 Scope of delivery

- Battery Management Shunt SHX
- Plug-in terminal 4pin.
- Fuse holder ASH1 with fuse FSS 1A
- These operating instructions (The document is available in colour on our website www.philippi-online.de available for download).

Optional accessories (not included in the scope of delivery):

- Temperature sensor Temp-BT

Order no.: 0 5900 3000

1.3 Warranty

Warranty is granted for a period of two years from the date of purchase. Defects due to Material or manufacturing defects will be repaired free of charge if:

- the device is sent to the manufacturer free of charge.
- the proof of purchase is enclosed
- the device has been handled and used as intended.
- no foreign spare parts have been installed or interventions have been made.

The warranty does not cover damage caused by:



- overvoltage at the inputs or connection with reversed polarity
- liquids running into the unit or oxidation caused by condensation
- lightning strike

Follow-up costs and natural wear and tear are not covered by the warranty.

When asserting claims under guarantee and warranty, a detailed description of the defect is essential. Detailed information facilitates and accelerates processing. Please understand that we cannot accept shipments that are sent to us freight collect.

1.4 Disclaimer

Compliance with the operating instructions as well as the conditions and methods during installation, operation, use and maintenance of the battery management shunt SHX cannot be monitored by philippi elektrische systeme gmbh. Therefore, we do not accept any responsibility or liability for losses, damages or costs resulting from incorrect installation and improper operation.

1.5 Quality assurance

During production and assembly, the units undergo several checks and tests. Fabrication, inspections and tests are carried out according to established protocols. Each SHX has its own serial number. Therefore, never remove the type plate. The assembly and testing of all SHC shunts is carried out entirely in our factory in Remseck am Neckar.

2 Safety instructions



- No modifications may be made to the unit, otherwise the CE mark
- The SHX may only be connected by qualified electricians.
- Disconnect the battery leads before connecting the SHX.
- Ensure that the polarity of the batteries is correct!
- This appliance is not intended for use by children.

This installation and operating manual is part of the component delivery. It must be kept in a safe place - important for later maintenance work - and passed on to any subsequent owners of the meter.

3. Assembly and installation

3.1 Connection

Mount the shunt SHX in a protected, dry place as close as possible to the battery. The shunt must be connected in the **MINUS path** of the battery.

The following connection options are available on the shunt SHX at the 4-pin connector:

1: Battery measuring lead (+1):and at the same time power supply for shunt

This cable is absolutely necessary for the function of the shunt and should only be disconnected in winter storage to enable a complete recording of the battery capacity. Due to the very low current consumption, the shunt does not place any additional load on the battery.

2: Voltage (+2) second battery group OR partial voltage of a 24V battery

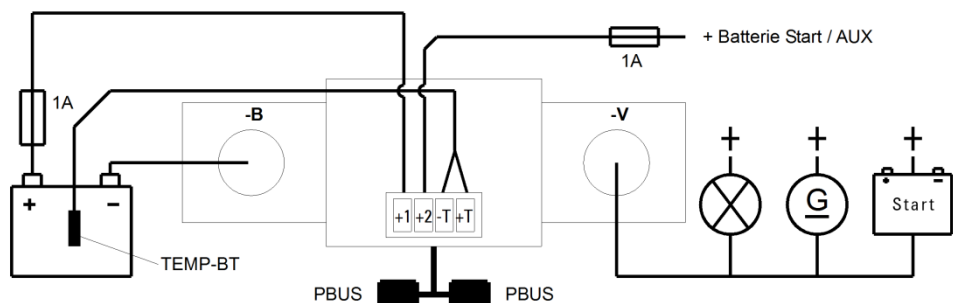
- a) Optional connection of a voltage measurement of a second battery group (starter battery), this is then displayed as a second battery group on the PSM.

- b) Partial voltage of a 24V battery group for monitoring the uniform state of charge of batteries connected in series. The battery group is displayed in red if half the partial voltage of a series-connected 24V battery deviates from the total voltage by more than 2%. In this case, the batteries must be checked for cell shortage or unequal state of charge.

3: T-: Minus temperature sensor (black wire) T+: Plus temperature sensor (blue wire)

Optional temperature sensor (Temp-BT, order no.: 059003000) for recording the battery temperature. The temperature sensor should be fixed to the outside of the battery housing. The temperature sensor has no active influence on the capacity calculation or charging, but is only used for information.

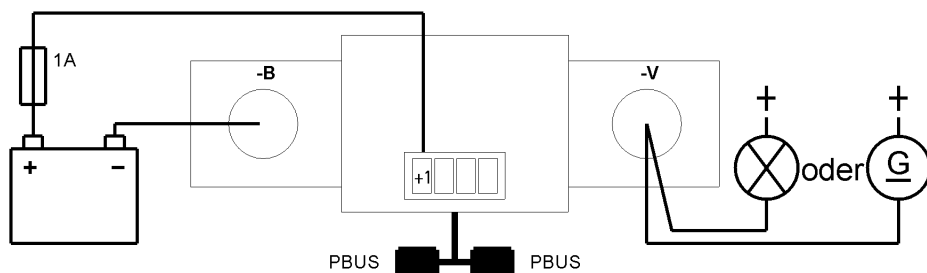
Connection Mode Battery Management SHX-C :



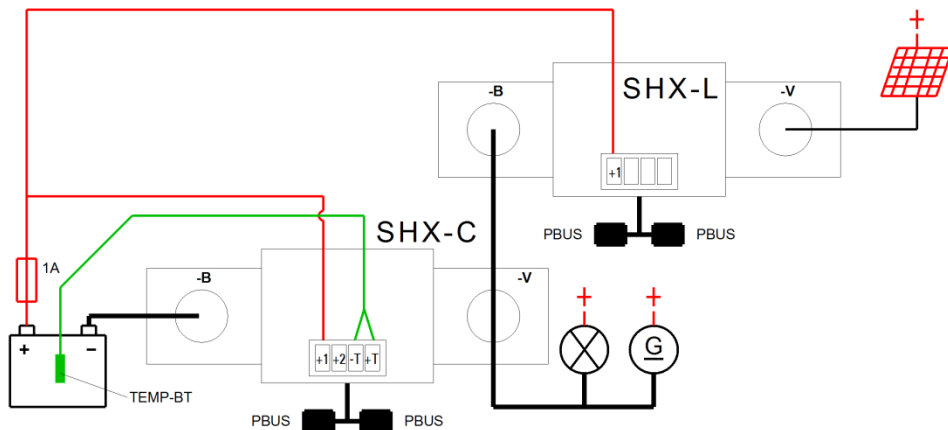
Monitored battery group

Consumers, charging sources, starter batteries

Connection mode energy/current measurement SHX-L :



If, for example, an SHX-L is installed to measure the solar current and an SHX-C, they are connected as follows:



The LED integrated in the shunt SHX indicates the operating status:

Rapid flashing	during firmware update of the shunt SHX
Flashing every 1 sec.	Normal operation
Flashing every 5 sec.	Sleep mode (power saving mode) when the system monitor is off.

3.2 Selection of SHX-C / SHX-L operating mode

The SHX shunt can be used in 2 operating modes either as a battery management shunt (SHX-C) or as a current measurement shunt (SHX-L) in the energy monitor. In the delivery state, the battery management shunt (SHX-C) operating mode is set.



The operating mode is switched via the system monitor in the menu item (unit info):
Settings/Devices/Battery/SHX-C or Settings/Devices/Energy/SHX-L:

In the unit info, in addition to updating the firmware of the shunt, this can be changed by pressing the " SET SHX 300-L" or "SHX 300-C" button in the respective other operating mode.
After pressing the button, the setup PIN must be entered to confirm the change. The system monitor is then restarted so that the shunt can be recognised in its new operating mode and can be re-registered via the menu item Settings/P-BUS "Register devices".

4. Setting on the system monitor SHX-C mode

For proper function, the following data must be set during commissioning:

- Nominal capacity of the battery (1-9999Ah) (Chap . 5.3)
- Nominal voltage [12, 24 V] of the battery group (chap. 5.4)

If the battery was not fully charged at that time, this is mandatory to synchronise the display with the battery charge level.

A setup is available for each SHX-C shunt connected.



For optimal function, the following data can also be set:

- Alarm capacity is preset to 50%. (chap. 4.4)
- Battery type [GEL, NASS, AGM, Lithium, INDIV] (chap. 4.8).
- Capacity threshold for generator start (chap. 4.6)
- Capacity threshold for generator stop (chap. 4.7)
- Ah Efficiency (CEF) Default setting is 95%. (chap. 4.9)

- Peukert exponent, default 1.27 (chap. 4.10)
- Cycle depth. Starter batteries 10-20%, GEL batteries 50% (chap. 4.11).
- Alarm threshold (Alarm U) for U2. Default setting 11.5 V. (chap. 4.16)

4.1 Designation

This name is shown in the battery symbol of the display and is used for easier assignment.

4.2 Nominal capacity

The nominal capacity of the battery (1-9999Ah) is set here. To obtain a meaningful accuracy of the remaining time function as well as the percentage charge display, the capacity of the installed battery must be set.

Please note that the battery capacity should only be adjusted when the batteries are 100% charged, as this procedure sets the capacity indicator to 100% and all internal counters to 0.

If the battery was not fully charged at that time, this is mandatory to synchronise the display with the battery charge level.

4.3 Rated voltage

Please set the nominal voltage [12, 24, 36, 48V] of the battery group so that the capacity calculation can be done properly.

4.4 Alarm capacity

The system monitor generates an alarm (battery appears red) when the battery falls below the set capacity threshold.

The alarm for the alarm capacity is preset to 50%. For an average application, this value is normally fine; however, the alarm can be adjusted according to the application's requirements.

4.5 Device info

The type of hardware (e.g. Shunt SHX 300C), its software version (1) and the serial number of the unit are displayed.

4.6 Generator On

Capacity threshold for generator start at a relay module CMR4. See also chap. 6.5

4.7 Generator Off

Capacity threshold for generator stop on a relay module CMR4. See also chap. 6.5

4.8 Battery type

For optimal adjustment of the parameter for "battery empty" detection, the battery type used [GEL, NASS, AGM, Lithium, INDIV] must be entered.

4.9 Ah Efficiency (CEF)

Every battery has an Ah efficiency. This means that more ampere-hours must be loaded into the battery than can be removed. The efficiencies of lead batteries are between 80% and 95%. If the CEF deteriorates below 70% during operation, this basically means that the battery has reached the end of its life and needs to be replaced. The factory default setting is 95%. The CEF is automatically adjusted during operation by means of a sliding average over the last 4 cycles.

4.10 Peukert Factor

The capacity of lead-acid batteries is usually specified for a 20-hour discharge. This means, for example, that a 100 ampere-hour battery can deliver 5 amps for 20 hours before the battery is empty. If the discharge current is higher, for example 10 amps, the battery is not able to deliver the full 100 ampere hours. In this case, the battery voltage drops below the lower limit of 10.8 V for 12V batteries before the battery has delivered its rated capacity.

This relationship can be captured mathematically with the Peukert equation.

In the residual time function, this equation is used to adjust the residual time at high discharge rates. Under normal circumstances, the Peukert exponent does not need to be changed.

Usually, the Peukert exponent is set to 1.27 for lead batteries, if no deviating values are available, and to 1.02 for lithium systems.



4.11 Cycle depth

The cycle depth indicates the % value by which a battery must be discharged and charged for a charge cycle to be counted. For starter batteries a value between 10-20% should be set and for GEL batteries up to 50% can be set. The value represents the cycle stability of the battery, i.e. how much the battery can be discharged without reducing its life.

4.12 Charging cycles

A cycle is counted when the battery has been discharged by the capacity set in the cycle depth (5.11) and then recharged.

With the number of cycles, you will be able to estimate the life of your battery. Standard starter batteries have a life span of 30-50 cycles, whereas cycle batteries can be expected to last up to 300 cycles if a modern charger is used. These values can only be achieved with proper care and deteriorate rapidly if not handled properly.

4.13 Deep discharges

Each complete discharge to the lower voltage limit (approx. 11V) is considered a deep discharge. Deep discharges should be avoided at all costs, as they damage the battery and a premature loss of capacity and reduction in service life is to be expected with most battery types. Should a deep discharge nevertheless occur, the battery must be recharged immediately to avoid further damage.

4.14 Average depth of discharge

The average depth of discharge indicates the average residual capacity value to which the battery group has been discharged in the past 10 cycles. From this, the cycle stress of the battery can be read and a conclusion drawn about the battery life.

4.15 Resetting the counters for charge cycles, number of deep discharges and average depth of discharge

If a new battery set is inserted, the number of cycles and the number of deep discharges must be set to zero. To do this, press the respective button and after entering the PIN (PIN default 1234), the counter is reset.

4.16 AlarmU (only with simple voltage measurement, 2nd battery)

If a voltage >1V is present at the SHX-C shunt at the terminal for the second battery voltage, this is reported as another battery. An alarm threshold (alarm U) can be defined for this voltage monitoring / battery.

The default setting for the alarm threshold is 11.5 volts and the alarm triggering is delayed. If the battery is heavily loaded, the voltage alarm can be set somewhat lower, for example to 10.8 volts. If battery groups with higher nominal voltages (e.g. 24 V) are connected, the thresholds must be adjusted accordingly.



5. setting on the system monitor SHX-L mode

To identify the shunt on the DC power side, only the designation must be set.

5.1 Designation

This name is shown in the energy symbol of the display and is used to assign the shunt to the measured current. Current sources such as solar, wind, hydrogenerator, fuel cell... are shown in the upper part of the display. Current sinks (consumers) in the lower part.

If the designation "Not active" is selected, this shunt is not displayed in the energy monitor.



5.2 Identification

The type of hardware (shunt SHX-L 300), its software version (V01) and the serial number of the unit are displayed.

5.3 Reset capacity counter

Reset the counter of the charged or discharged Ah. To do this, press the respective button and after entering the PIN (PIN default 1234), the counter is reset.

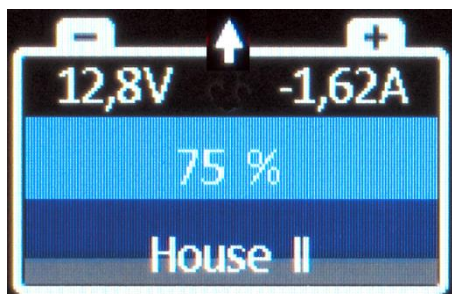
6. operation mode SHX-C

The shunt provides the following data to the P-BUS for display in SHX-C mode:

- Charge/discharge current, battery voltage, current capacity in % or Ah
- Estimated time remaining until capacity alarm
- Expected charging time in charging mode
- Battery temperature via ext. sensor (Temp-BT)
- Capacity / "Battery 20%" / "Battery empty" / "Overvoltage" alarm
- Number of cycles , Deep discharges and the average depth of discharge

On the PSM, the determined battery data is displayed as follows:

Battery voltage Charge/discharge current



Light blue: usable capacity up to the set capacity alarm

Dark blue: the theoretically available capacity until the battery is completely discharged.

Grey: unusable capacity

A minus sign in front of the ampere value means that the battery is being discharged. If the value is positive, the battery is being charged.

The message "Not synchronised" appears when the Shunt SHX-C is restarted and the capacity value displayed does not yet correspond to the true capacity level. Then the battery group connected to the Shunt SHX-C must be fully charged with a charger so that the capacity display can synchronise with the battery. The message then goes out automatically.

If the battery capacity falls below the set threshold, a warning message appears in the display. The remaining capacity is shown in orange and the battery symbol is shown in red.

6.1 Full charge detection

A battery is classified as fully charged (100%) when the following conditions are fulfilled depending on the battery type [GEL, NASS, AGM, Lithium, INDIV].

e.g. for lead acid batteries:

- 1) the charging voltage is maintained (13.4 V) **and**
- 2) the charging current has dropped below 2% of the set battery capacity **and**
- 3) the charged capacity is greater than the previous withdrawn capacity.

or

- 1) the charging voltage is maintained (14.0 V) and
- 2) the charging current has dropped below 1% of the set battery capacity.

If the parameters are met for 3 minutes, the value for the current capacity is reset to 100%. For the other battery types, values adapted to the battery chemistry apply.

6.2 Detection of the non-usable part of the battery capacity

If the battery voltage drops below certain voltage thresholds prematurely depending on the load, the state of charge is automatically set to 20 % or to 0% if the battery is completely discharged.

If possible, the unavailable capacity (difference between nominal capacity and withdrawn capacity) is determined and shown as a grey area.

This grey area can be used as an indicator of battery ageing for normal discharges smaller than C10 (current smaller than nominal capacity/10).

In the case of high current loads in the range greater than C5 (e.g. electric boats (current greater than nominal capacity/5)), this is to be taken as an indicator of the usual reduced capacity at high loads.

The detection of the unavailable capacity is only possible if the battery is discharged up to the first discharge limit (depending on battery type & load, below approx. battery voltage < 11.5 V).

If the battery is never discharged to this first discharge limit, this detection cannot take place and a 100% intact battery is assumed.

We therefore recommend that this is done once a year at the start of the season to determine the performance of the battery system.

See the note in chapter 8c.

6.3 Remaining time calculation

The remaining time is the time that the main battery can still be used with the current power consumption until the capacity alarm is reached.

During charging, the expected charging time is displayed until the batteries are charged to approx. 95 %. The maximum value during a discharge process is 99.9 hours (> 4 days). The remaining time is automatically corrected taking into account the Peukert - function.

6.4 Calculating the current state of charge

During charging, the Ah efficiency of the battery (C.E.F.) is automatically taken into account in the capacity calculation. In doing so, the charging current is evaluated with the C.E.F. value (in %).

6.5 Control of an external generator

To control a generator depending on the battery capacity, the system monitor PSM2 can be used in conjunction with a relay module CMR4

The generator start contact is controlled by all SHX-C battery management shunts connected in the system. For this purpose, the generator start/stop values must be adjusted in the battery setup (see also under 4.6 and 4.7).

Generator start: If the battery capacity falls below the set value, the generator start contact becomes active. If several battery management shunts SHX-C are registered in the system, the generator starts as soon as the capacity of one of the battery management shunts falls below the respective set capacity threshold.

Generator stop: if the battery capacity exceeds the set stop value, the generator start contact is deactivated. If several battery management shunts are registered in the system, the generator stops as soon as the capacities of all battery management shunts have risen above the respective set capacity thresholds.

If a battery management shunt is not to be able to start or stop the generator, its capacity thresholds must be set to 0% (start) and 100% (stop).

7. operation mode SHX-L

The system monitor shows the DC energy balance of the on-board system on the DC energy page.

The charging sources are shown in the upper part, the sinks (consumers) and the battery system in the lower part.

In this view, all batteries are combined as one battery to facilitate clarity.

By tapping the source symbols, the current display can be switched to the display of the supplied or consumed ampere hours since the last meter reset. The display automatically switches back to the ampere display after 1 min.



8. tips and tricks

- a) If the message "not synchronised" does not go out despite 100% full charge ($U > 14.0V$ and $I < 2\%$ of the nominal capacity) of the battery, this can be achieved manually by changing the nominal battery capacity by 1 Ah.
Please check that each charging source is correctly recognised. Charging currents are always positive if all consumers are switched off at the same time.
- b) Battery full detection does not work. Please check the charging voltage of your battery charger / solar system or / and set the battery type to WET to work with the lowest possible values.
Please check whether each charging source is detected with the correct current, charging currents are always positive if all consumers are switched off at the same time. This must be checked individually for each charging source. Only the SHX-C shunt with the B- connection may be connected to the negative pole of the battery, nothing else!
- c) **Annual capacity check:** We recommend determining the capacity of the battery system at the start of the season in order to have certainty about the actual available capacity during the season.
To do this, proceed as follows (time requirement 1-2 days!):
 - 1) Fully charge the battery system until the display shows 100% and the "not synchronised" message has disappeared.
 - 2) Switch off all charging devices and discharge the batteries by switching on as many consumers as possible that can be operated without risk (e.g. all lighting, position lights, refrigerator, navigation). By reading the discharge current, the approximate time when the batteries are completely discharged can be determined (rule of thumb: time in hours = half battery capacity / discharge current).
 - 3) Supervised discharge of the battery until the 20% alarm is reached. After the alarm is reached, the display shows the proportion of unusable capacity as a grey area in the lower segment of the battery.
 - 4) Switch off all consumers and immediately charge the battery completely. Never leave the batteries in a discharged state. This can damage the batteries!



ATTENTION: If the 100% charge following the complete discharge is not guaranteed (e.g. due to lack of time), this test must not be carried out!

7. troubleshooting

If the shunt SHX on the PSM2 monitor does not provide any data, check the correct connection to the P-BUS and whether the battery voltage is present at the +1 connection. In addition, the software version of the system monitor must be up to date.

8. Technical data

Supply voltage	DC 8-32 V
Current consumption	20 mA , 5 mA in sleep mode
Shunt0	.1 m Ω
Measuring range U0-35V, resolution 30mV, accuracy 0,25%	
Measuring range U20-35V, resolution 30mV, accuracy 0.25%	
Current carrying capacity SHX 312300A	, 600A 1 min, 1500A 0.5 s
Measuring range I, SHX 312-600 - +600A, resolution 10mV, accuracy 0.5%.	
Measuring range T (ext. probe)	-15 - 60°C, resolution 1K, accuracy 1°C
DimensionsL	118 x W 40 x H 65 mm,
Connections	bolt M8

9. c onfirmation of conformity



This device fulfils the requirements of the EU directives:

2014/30/EG "Elektromagnetische Verträglichkeit"

Interference immunity EN 61000-6-1

Emitted interference EN 61000-6-3

The conformity of the device with the above directive is confirmed by the CE mark.

10. e ntention for disposal



When disposing of this appliance, observe the applicable local regulations and use the collection services/places for waste electrical/electronic equipment.