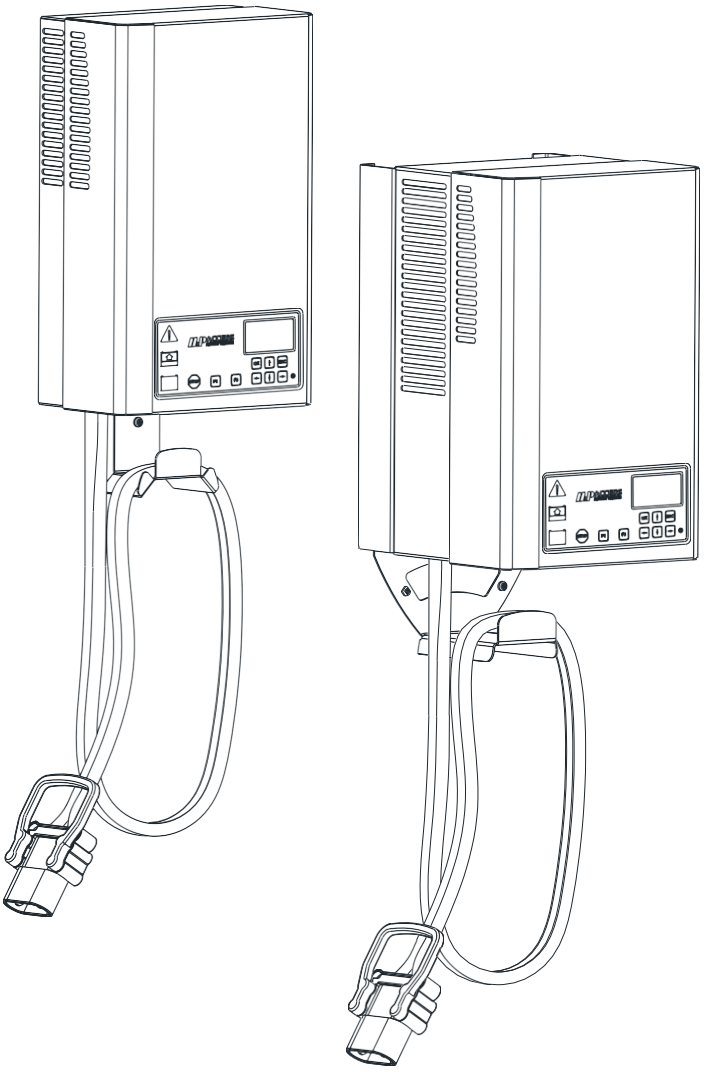
SBS MicroSMART



Battery charger **Technical handbook** **English**

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1. Foreword

The intention with this document is to describe all features and functions in the SBS MicroSMART battery charger.

This document is intended for use as training and reference material by personnel with general knowledge about SBS battery chargers.

In this document charger menu items are written in *Italic* and charger panel buttons are written in **bold**.

Due to continuous development of SBS MicroSMART functionality the availability of features mentioned in this handbook can vary between charger software versions.

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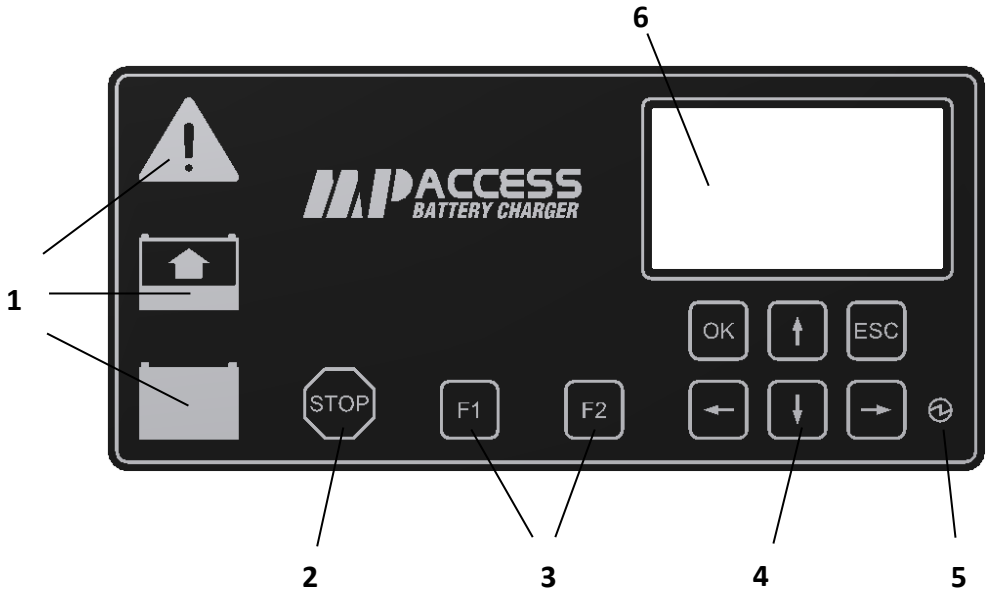
2. Table of contents

3. Charger panel



3.1. Status indicators

The combinations of the status indicators during charging can be defined in the charging curve. Therefore these indicators can show combinations of light that differ from below depending on the actual charging curve. Please refer to the charging curve definition for exact information about the status indicators during charging.

Red constant light	An alarm is active.
Red fast flashing light	Software malfunction.
Yellow constant light	A battery is connected to the charger and a charge is in progress.
Yellow flashing light	A battery is connected to the charger but charging is restricted. The restriction can be due to settings in the *Time restrictions, Remote in* function or a BMU initialization is ongoing.
Green constant light	A battery is connected to the charger and the charging process is completed.
Green flashing light	The charging process has been manually stopped. Press ESC to resume charging.
Green constant light and yellow flashing light.	Equalize charging in progress.

Green flashing light and yellow flashing light.	Watering in progress. Watering can be active without this indication.
Green, yellow and red flashing light	An indication request has been sent from the PC-software SBS MicroSMART Service tool.
Green, yellow, red, F1, F2, blue constant light	Charger is in boot loader mode. Wait until charger automatically restarts.

3.2. STOP button

The STOP button stops the ongoing charging or prevents next charging to start. To resume charging the ESC button must be pressed.

If external *CAN* control is activated the STOP button overrides the external control and stops the power module until the ESC button is pressed.

3.3. F1 and F2 button

The functionality of **F1** and **F2** buttons can be configured in the menu system. If a configured function is active the button will show yellow light.

3.4. Keyboard

The keyboard consists of six buttons for navigating the menu system:

OK: Enter the menu system or selected menu, confirm and edited values.

ESC: Exit present menu, cancel edit, resume charging.

Arrow up: Go up one step, increase/toggle values during editing.

Arrow down: Go down one step, decrease/toggle values during editing.

Arrow left: Previous menu page, change selected digit during edit.

Arrow right: Next menu page, change selected digit during edit.

3.5. Mains indicator

A constant blue light indicates that mains supply is connected.

3.6. Display

In the display charger status, parameters, and information can be viewed and edited. The display lights up when a button is pressed, a battery is connected to the charger or a battery is disconnected from the charger. In the display menu, the *Backlight* time can be edited together with display *Contrast*.

3.7. Shortcuts

F1 + **F2** pressed at mains supply power on.	The entire flash memory is cleared including all configured parameters, calibration values and statistical data. The charger must be configured prior to use after this shortcut has been used. **Warning!** The synchronization between the PC-software SBS MicroSMART Service tool and the charger will be lost. All data stored in the SBS MicroSMART Service tool that is related to the present charger should be cleared.
OK + **ESC** pressed at mains supply power on.	The charger is configured with *Default settings*. The *Default settings* can be set or reset in the *Factory settings* menu.
Arrow down pressed for two seconds.	If the charger is connected to a radio network *Join enable* is activated. If the charger is not connected to a radio network but the radio *Function* is set to *Enabled,* the charger tries to connect to a network. If *Network Settings* are set to Auto the charger will try to join any network where *Join enable* is activated. If *Network Settings* are set to *User def.* the charger will only try to join the specified network.

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4. General functionality

4.1. Battery detection

When a battery is connected to the charger the charging process is started automatically. After the battery has been connected there is a short delay of approximately 2 seconds before the charging process starts. If the battery is disconnected and reconnected again the delay is approximately 10 seconds after the battery is disconnected until the charging process starts again.

The measured battery voltage at which the charger considers a battery to be connected or disconnected is defined by the charging curve and the *Cells* parameters. Normally the battery is considered to have been connected if the measured battery voltage is greater than 1,05 V * *Cells* or lower than 2,65 V * *Cells.* The battery is considered to have been disconnected if the measured battery voltage is lower than 1,0 V * *Cells* or higher than 2,9 V * *Cells.*

4.2. BMU communication

If charging parameters *Source* is set to *BMU* or *Dual* the charger will try to contact the BMU when it senses a battery voltage greater than 5 V. The charger shows the display text *BMU init* and sends current pulses with information about PAN-ID, channel and charger node address on the battery cables. The BMU reads the information and, if not connected to the received network, the BMU tries to join any node with *Join enable* set within the network.

If the charger fails to contact the BMU with current pulses and is set to *Source BMU* it tries with a second method, alternating current levels. 3 current levels, 4seconds each, are set by the charger which thereafter sends a broadcast message with information about the levels set. The BMU that has detected the correct levels answer the charger and the handshaking is ready. Please note that for this second method to work, the charger and BMU needs to be connected to the same network. If the second method fails as well, a BMU init alarm is shown in the charger display and charging is not started.

If the charger fails to contact the BMU with current pulses and is set to *Source Dual,* it will start *Charging init*. In *Charging init* the charger checks the battery voltage towards the set *Cells* parameter. When the voltage changes less than 10 mV/cell/minute and is within 1.9 to 2.3 VPC, charging will start according to charger set *Charging param*. If the voltage changes less than 10 mV/cell/minute and is below 1.9 VPC or above 2.3 VPC an alarm for low or high battery voltage is raised. The *Dual* function cannot feel the difference between 72 and 80 V batteries. If the *Dual* function is used in a fleet with batteries of same voltage, the batteries with highest rated capacity should be equipped with BMU and the lower capacity entered in *Charging param*.

When the BMU connected to the charger it sends it’s charging parameters and the charger starts charging. After this handshaking, the BMU and charger communicates once every minute, sharing battery temperature, current, voltage, water and equalize information. When the battery is disconnected and end of charge message is sent from charger to BMU with information about performed charging phases etc. that can be read in the BMU historical log.

If the charger and BMU can't communicate during charging the parameters last received by the charger is used.

4.3. Automatic cable Ri calculation

If the BMU with software 11612008 revision 5 or greater is used together with a SBS MicroSMART battery charger with software type 11613004 an automatic cable Ri calculation can be activated.

The resistance in the charger cables causes the voltage between battery and charger to differ depending on actual charging current. If the automatic cable Ri calculation is activated the charger will once every minute during charging when current is greater than half the rated current compare BMU measured battery voltage with charger measured voltage. The difference between these voltages is then used to calculate the cable Ri. The calculated cable Ri can be seen in the SBS MicroSMART battery charger display under *Charging status* → *Charging param* → *Cable Ri.*

Automatic cable Ri calculation is activated by setting the *DC cable Ri* to 0 in BMU configuration.

5. Menu system

5.1. Structure

The menu system is intended to be an easy to use user interface for viewing status and information and edit parameters.

The keyboard is used to navigate through the menu system, see section 3.4.

See also appendix 3 for overview of the structure.

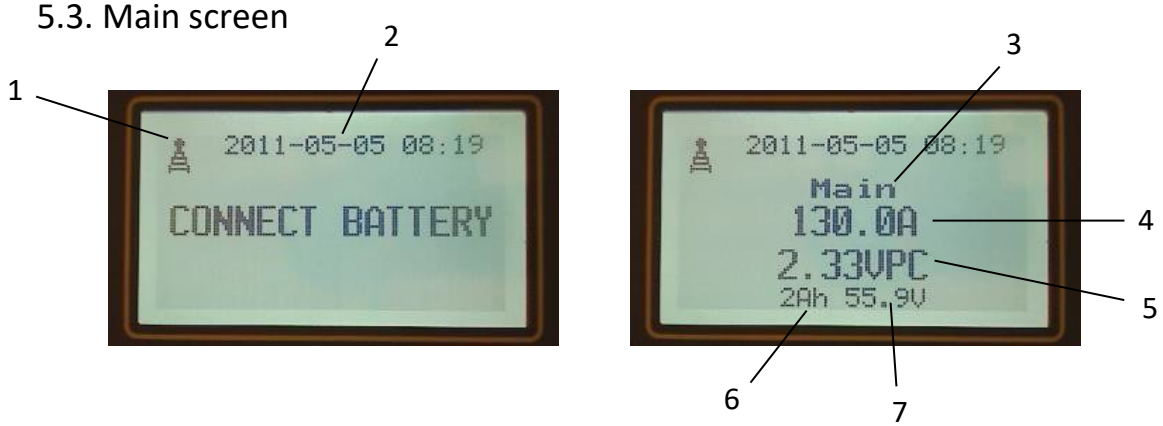
5.2. Access levels

All information and parameters in the menu system can be viewed without pin code but to edit three access levels are used. Access level one does not require any pin code and is used for editing *Display Backlight* and similar basic parameters. The second and third access level requires a pin code and the menu system informs the user when a pin code is needed and which access level that is required.

The pin codes for access level two and three can be changed by using the PC-software SBS MicroSMART Service tool.

When the *Display Backlight* is switched off, any access level entered will be lost.

5.3. Main screen



1. Radio function activated. When data is send through radio additional “waves” are shown on top of the symbol.
2. Date and time.
3. Charging phase.
4. Actual battery charging current. If a *Base load* is configured this charging current will be measured charging current – *Base load*.
5. Actual battery charging cell voltage. If a *Cable Ri* is defined this voltage will be (measured charging voltage – *Cable Ri**measured battery charging current)/*Cells*.
6. Charged ampere hours (Ah) since start of charge cycle.
7. Actual battery charging voltage. This voltage is equal to Actual battery charging cell voltage**Cells*.

When configured as CAN controlled *BMS ctrl* or *Slave* the main screen text will be different. Please refer to section CAN.

5.3.1. Battery status

The battery status menu is visible when a BMU is connected to the charger and shows information about the connected BMU. The information is updated once every minute during charging.

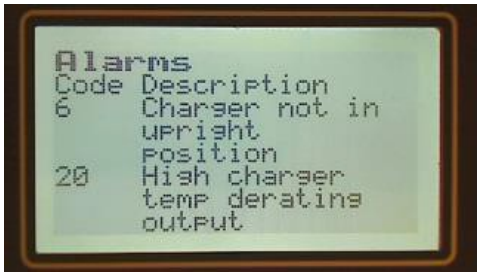
B-ID	Battery numeric identifier, configured in BMU.
Tag	Battery alphanumeric identifier, configured in BMU.
SOC	Current battery state of charge calculated by the BMU.
Battery temp	Battery temperature measured by the BMU.

5.3.2. Charging status

The charging status menu is shown when a battery is connected to the charger. Charging status shows information about the ongoing battery charge.

Start date	Date when the battery was connected to the charger.
Start time	Time when the battery was connected to the charger.
Start VPC	Actual battery voltage per cell when the battery was connected to the charger. Measured before start of charge.
End VPC	Actual battery voltage per cell when the charging main stage was completed. Measured prior to main charge end. This value will show N/A until the main stage is completed. If the battery is disconnected prior to completion of the main stage *End VPC* will be the battery voltage per cell 5 seconds before the battery was disconnected.
Charged Ah	Charged Ah since battery connected to the charger.
Charged Ah (%)	Charged Ah in main stage in percent of configured battery *Capacity*. For a cycle log to be stored this value must be greater than 2.

5.3.2.1. Alarms



In the alarms view any alarm that occurs during the ongoing charge is shown. If no alarms present, this menu cannot be entered.

5.3.2.2. Charging param

In the *Charging param* menu the charging parameters being used in the ongoing charge can be seen, these parameters are stored when a battery is connected. If parameters in the *Service Charging param* menu are altered during an ongoing charge those parameters will be used after the battery is disconnected and reconnected again.

Source	The source of the charging parameters. The possible values are: • *User def*. • *BMU*. • *Dual*. • *Multi.* A detailed description of *Source* is found in *Service Charging param* section.
B-ID	Battery monitoring unit id, if present.
Curve	Name of the charging curve being used.
Capacity	Battery capacity being used (in ampere hours).
Cells	Number of cells being used.
Cable Ri	Battery cable resistance being used.
Base load	Base load being present in the charging circuit during charging.

5.3.2.3. Momentary data

Momentary data shows actual measured values in the charger.

Phase	Current charging phase.
P (W)	Power delivered from the charger. This indicates the total power and is only equal to *U(VPC)*I(A)* if *Cable Ri* and *Base load* is set to zero.

U (VPC)	Actual charging cell voltage. If a *Cable Ri* is defined this voltage will be (measured charging voltage – *Cable Ri**measured charging current)/*Cells*.
I (A)	Actual charging current. If a *Base load* is configured this charging current will be measured charging current – base load.
Charger temp (ºC)	Charger heat sink temperature. When this temperature reaches approximately 70ºC the charger starts to reduce the current to prevent overheating.
PCB temp (ºC)	Charger board temperature.
Limiter	The regulator parameter that is limiting the battery current regulation. Possible values are: • *Iset*, Charging algorithm set value for current. • *Uset*, Charging algorithm set value for voltage. • *Ths*, Power unit heat sink temperature. • *Pset,* Charging algorithm set value for power. • *IdcLimit.* Configured DC current limit. • *IacLimit,* Configured AC current limit. • *PacLimit,* Configured AC power/current limit. • *PmaxEngine,* Power limit defined in power unit.

5.4. Statistics

In the statistics menu cycle logs and charger operation information can be read. The statistical information can be cleared in the *Factory settings* menu.

5.4.1. Charging cycles

5.4.1.1. Cycles summary

In this menu, a summary of all performed charging cycles are shown. The cycles are divided into different percentage of charged ampere hours in main stage in percent of configured battery capacity.

The charged ampere hours in main stage indicates the battery state of charge when the battery was connected to the charger.

5.4.1.2. Cycle log

The cycle log shows data stored during the previous charging cycles. Description of the data can be read under *Charging status*. The latest cycle is automatically selected when entering this menu. To select another cycle, press **OK** and select *Cycle no* by arrow up or arrow down on the keyboard.

A large amount of additional data is also stored with each *Cycle log*, and can be accessed by using the PC-software SBS MicroSMART Service tool.

5.4.2. Charger

Run time (h)	Total time in operation since reset of statistic information. The time is calculated when the power unit is active.
Charged Ah	Totally charged ampere hours since last reset of statistic information.
Charged kWh	Totally charged kilo watt hours since last reset of statistic information.
AC OVP	Number of mains over voltage protection (*OVP*) activations. The *OVP* is counting if a main over voltages is detected during charging.

5.5. Service

The service menu is used to edit or view parameters stored in the charger.

5.5.1. Charger info

HW S/N	Production serial number of the control board. This number can also be read on the control board sticker.
Main FW type	Part number of the main microprocessor firmware.
Main FW ver	Version of the main microprocessor firmware.
Radio FW type	Part number of the radio microprocessor firmware.
Radio FW ver	Version of the radio microprocessor firmware.

5.5.2. Charging param

In the *Charging param* menu parameters used for charging can be edited.

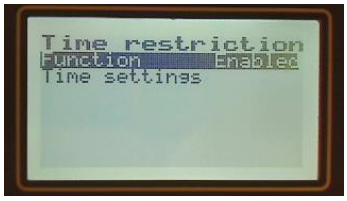
If *Source* is set to *BMU* and a BMU is connected to the charger, the parameters uploaded from BMU are shown. If these parameters are edited while the BMU is connected new parameters will be written to the BMU when **Esc** is pressed.

Source	The source of the charging parameters. The possible values are: • *User def*, user defined parameters in the service menu. • *BMU*, parameters will be uploaded from the separate product Battery Monitoring Unit. When battery connected, the charger will try to communicate with the BMU. This is done in two steps BMU Init 1 and BMU Init 2. BMU Init 1 takes up to 15 seconds. If BMU Init 1 fails BMU Init 2 will start. BMU Init2 can take up to 50 seconds. If BMU Init 2 fails a *BMU Init fail* alarm will be shown and charging stopped.

	If the communication between charger and BMU fails during charging the latest received BMU information (SOC, Battery temperature, alarm etc.) are used for charging. A new radio communication attempt is made once every minute. See the BMU communication chapter for more information. • *Dual*, attempt will be made to upload parameters from BMU (BMU Init 1 only), if no BMU present normal charging will start according to parameters set from menu. See the BMU communication chapter for more information. • *Multi*, attempt will be made to upload parameters from BMU (BMU Init 1 only), if no BMU present charger will determine the nominal battery voltage and set charging parameters thereafter. The charging parameters to be used are set from charger *Charging param* sub menues *Battery 6 cells, Battery 12 cells*, *Battery 18 cells*, *Battery 24 cells* or *Battery 40 cells*. When battery voltage is determined two conditions must be fulfilled. First of all, the voltage must be stable, delta voltage must be below 10mV/cell/minute. Secondly the measured battery voltage must be within 1.9VPC and 2.3VPC of any of the nominal voltages supported. The charger will not start until the two conditions are fulfilled. This can take some minutes depending on the state of the battery. If measured battery voltage is not within limits of any of the nominal voltages supported the charger will not start charging and display battery error (Code 8).
Curve	Name of the charging curve.
Capacity	Battery capacity in ampere hours. Minimum allowed capacity is 1 Ah and maximum allowed capacity is 9999 Ah.
Cells	2V battery cell count. Minimum allowed cell count is 1 and maximum is 999.
Cable Ri	Battery cable resistance, 0–99 mΩ. Set according to below if original 3 m DC harness is used. SBS MicroSMART 24/60 10 mΩ SBS MicroSMART 24/80 7 mΩ SBS MicroSMART 24/100 5 mΩ SBS MicroSMART 24/100 5 mΩ SBS MicroSMART 24/150 4 mΩ SBS MicroSMART 24/120 4 mΩ SBS MicroSMART 24/300 2 mΩ SBS MicroSMART 36/40 10 mΩ SBS MicroSMART 36/60 10 mΩ SBS MicroSMART 36/80 7 mΩ SBS MicroSMART 36/100 5 mΩ SBS MicroSMART 36/130 4 mΩ

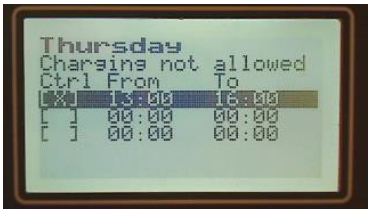
	SBS MicroSMART 36/150	4	mΩ
	SBS MicroSMART 36/300	2	mΩ
	SBS MicroSMART 48/60	10	mΩ
	SBS MicroSMART 48/60	10	mΩ
	SBS MicroSMART 48/80	7	mΩ
	SBS MicroSMART 48/100	5	mΩ
	SBS MicroSMART 48/130	4	mΩ
	SBS MicroSMART 48/200	2	mΩ
	SBS MicroSMART 48/260	2	mΩ
	SBS MicroSMART 72/40	10	mΩ
	SBS MicroSMART 72/60	10	mΩ
	SBS MicroSMART 72/80	7	mΩ
	SBS MicroSMART 72/100	5	mΩ
	SBS MicroSMART 72/120	4	mΩ
	SBS MicroSMART 72/160	2	mΩ
	SBS MicroSMART 80/40	10	mΩ
	SBS MicroSMART 80/60	10	mΩ
	SBS MicroSMART 80/80	7	mΩ
	SBS MicroSMART 80/100	5	mΩ
	SBS MicroSMART 80/120	4	mΩ
	SBS MicroSMART 80/160	2	mΩ
Base load	Base load being present in the charging circuit during charging. 0-65535 mA.		
Battery temp	Fixed battery temperature to be used when no BMU is connected to the charger. Please note that this parameter is not stored in the historical log.		
Curve param	This sub-menu is only visible if *Curve param* setting have been activated and the selected *Curve* supports editable parameters. If these conditions are fulfilled pre-defined parameters in the selected Curve can be modified according to customer needs.		

5.5.3. Time restrictions



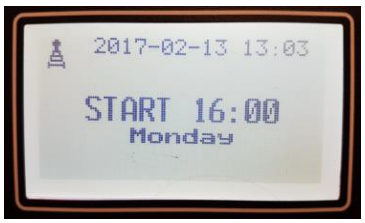
The time restrictions function can be used to restrict charging at certain times. When this function is set to *Enabled* charging is restricted according to the time settings.

5.5.3.1. Time settings



Time settings are set by first selecting the weekday on which charging should be restricted. For each weekday three restrictions can be set. *Ctrl* should be set to X to activate the restriction and then the start time, *From*, and end time, *To*.

When a time restriction is active charging can be resumed/started by pressing the **ESC** button.



5.5.4. Extra charge

To enable an additional charge for example before Monday morning after a weekend of rest the *Extra charge* function can be used. This function restarts the charging cycle automatically on the configured weekday and time. The *Extra charge* function has the same effect as if the battery was manually disconnected and reconnected again.

Status	Indicates if the ongoing charging cycle is trigged by the *Extra charge* function. On=trigged by the Extra charge function.
Week day	The day of the week when the *Extra charge* will be activated.
Time	Time on the *Week day* when the *Extra charge* function will restart the charging cycle.

5.5.5. Equalize

The *Equalize* function enables equalize charging upon different decision criteria. The function can be set to *Cyclic* or *Weekday*.

When *Cyclic* is selected an equalize charge will be performed with *Interval* number of cycles of 2 % or more of the battery capacity charged in main phase between. *Cycles to next* indicate how many cycles are left until next equalize charge. I.e. if *Interval* is set to 1 an equalize charge will be performed every other cycle.

When *Weekday* is selected all charges ongoing the configured weekday will run an equalize charge.

This function tells the charging curve to run an equalize charge. If and when equalize charging is performed is defined in the charging curve, normally when the battery is fully charged.

Please note that if *Charging param* is set to *BMU* and *Equalize* is activated in BMU the charger parameters will be disabled because then *Equalize* is scheduled in the BMU.

5.5.6. BBC, Best Battery Choice

This function is only visible in the menu system if the charger is connected to a radio network. The *BBC* function is intended for battery prioritizing. If a group of chargers are connected to the same radio network, the *BBC* function is active and if they have the same *Group ID,* only one of the chargers will light up green and indicate ready at a time. The decision criteria for the best battery are longest time in best charging stage. In this way the batteries are being used more evenly which causes reduced temperatures and longer rest periods between cycles. This will also make sure that the battery can deliver up to its full potential when actually being used.

If a charging related alarm occurs in the charger being BBC it will no longer be BBC.

Time between BBC messages	60 s
Time to BBC can set first time (battery connected)	90-270 s
Time between BBC is set and green lamp is lit (if ready)	10 s

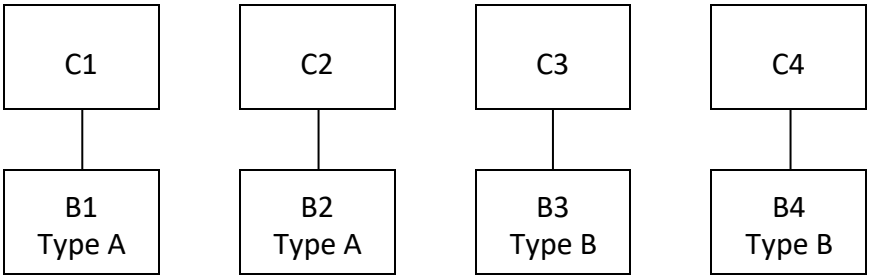
To activate *BBC* set the *Function* to *Enabled* and the *Group ID* to any number between 0 and 127. All chargers in the same group/queue shall have the same *Group ID*. Please note that *Group ID* above 127 is not allowed to be used.

When the *BBC* function is active the main screen will only show *Charging* or *Ready*.

To view details about the ongoing charge please see the *Charging status* section.
Information is also available in the *BBC View* application, installed together with the PC-software SBS MicroSMART Service tool.
See also the tutorial *Activate a BBC system* for more information.

5.5.6.1. An example of how BBC can be used

Imagine that we have eight different batteries, four of type A and four of type B. We also have four chargers marked C1-C4. Four of the batteries are being used in the production and four are currently being charged marked B1-B4, below.



In order for BBC to work properly all batteries (i.e. chargers) of a certain type should all have the same *Group ID.* For more information on how to change the *Group ID* of a charger see the tutorial Activate a BBC system.

Now imagine that a battery is empty and a new of type A is needed. B1 have been charged a longer time and therefore have spent more time in the best charging stage. Because C1 and C2 are connected to each other via a radio network and have the same *Group ID*, the charger C1 will light up green and indicate that B1 is the BBC (best battery choice).

When the battery has been switched, the procedure starts over. B2 will have spent more time in a better charging stage than the empty battery and will now be the BBC for that group of batteries.

Remember that the decision criteria for which is the best battery among batteries with the same *Group ID* is longest time in best charging stage, which means that a battery doesn't need to be fully charged to be the Best Battery Choice (BBC).

5.5.7. I/O control

With this function events in the charger can be trigged by external functions or control external functions.

To activate and run this function an I/O board must be connected to the battery charger. There are two different I/O boards available. Multi I/O board and single I/O board. The multi I/O board consists of all functions in the single I/O board together with additional relay outputs, inputs and air pressure sensor. The single I/O board is connected through the six-pin connector on the Access control board and the multi I/O board is connected through the eight pin connector on the Access control board.

5.5.7.1. Remote Input

Remote input is activated when connected to battery minus and has the following selections.

Disabled	The remote input is not activated.

Start/Stop	Charging will be restricted until the *Remote input* is activated and stopped when *Remote input* is deactivated. Charging is restricted within approximately 20ms from deactivation, unless for the *Extra inputs* where charging is restricted within approximately 1s.
Stop	The charging process is Stopped and can be resumed by pressing Esc.
High/Low	This option is only available for Extra inputs. If selected: current is limited to 500mA if input is deactivated. If input is activated operation will proceed as normal.

5.5.7.2. Remote output

If multi I/O board is used this input is related to connector J19. The RE5x and $\overline{\text{RE5}}$ are connected when the output is not activated and RE5x and RE5 are connected when the output is activated.

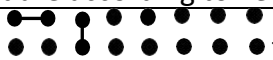
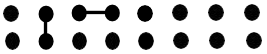
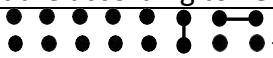
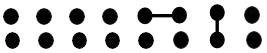
The remote output has the following selections.

Disabled	The remote output is not activated.
Alarm	The remote output is activated when an alarm occurs, i.e. when the red indicator on the charger is activated.
Phase	The remote output is activated when the configured charging phase is entered. The available selections are: • Pre • Main • Additional • Maintenance/Ready • Equalize Ready is a flag defined in the charging curve and can be active in several phases. Normally ready is activated when the green light is lit and the charger enters the Maintenance phase and is kept active when the Equalize phase is entered.
BBC	The remote output is activated when the charger is set to be the best battery of choice. There are two configurable options: • BBC The charger can be set to the best battery of choice even if the ongoing charging isn't ready. E.g. the remote output can be activated in pre-, main, additional, maintenance or equalize charging phase. • BBC & Ready The remote output will only be activated if both BBC and charging is in Ready phase.
Water	The remote output is activated when the Water flag is set in the charging curve. Please see the charging curve definition for details when and how this flag is set.

Air pump	The remote output is activated when the Air-pump flag is set in the charging curve. Please see the charging curve definition for details when and how this flag is set. When the *Air pump* is activated, air pump pressure monitoring is also activated. If the pressure is to low (<3 kPa) or high (>12 kPa) an alarm is trigged. The following settings can be made from sub menu: • Pump on(min) • Pump cycle(min)

5.5.7.3. Extra inputs

The *Extra inputs* menu contains the additional inputs available when using the multi I/O board. If a board is connected available inputs are shown in the menu as:

IN1A	The input is activated when IN1 on the multi I/O board is connected to battery minus. Available selections for this input are according to *Remote input*.
IN2A	If jumpers on J8 are mounted as  then the input is activated when IN2 on the multi I/O board is connected to battery minus. If jumpers on J8 are mounted as  then the input is activated when IN2 on the multi I/O board is supplied with min 3 mA current. **WARNING!** The current must not exceed 10 mA/15 V. Available selections for this input are according to *Remote input*
IN3A	If jumpers on J8 are mounted as  then the input is activated when IN3 on the multi I/O board is connected to battery minus. If jumpers on J8 are mounted as  then the input is activated when IN3 on the multi I/O board is supplied with 3 mA current. **WARNING!** The current must not exceed 10 mA/15 V. Available selections for this input are according to *Remote input*
IN4A	The input is activated when IN4 on the multi I/O board is connected to battery minus. Available selections for this input are according to *Remote input*

5.5.7.4. Extra outputs

The *Extra outputs* menu contains the additional outputs available when using the multi I/O board. If a board is connected available inputs are shown in the menu as:

RE1A	This output is connected to RE1 on the multi I/O board. On J5 the RE1x and $\overline{\text{RE1}}$ are connected when the output is not activated and RE1x and RE1 are connected when the output is activated. Available selections for this output are according to *Remote output*.
RE2A	This output is connected to RE2 on the multi I/O board. On J16 the RE2x and RE2 are connected when the output is not activated and RE2x and RE2 are connected when the output is activated. Available selections for this output are according to *Remote output*.
RE3A	This output is connected to RE3 on the multi I/O board. On J17 the RE3x and RE3 are connected when the output is not activated and RE3x and RE3 are connected when the output is activated. Available selections for this output are according to *Remote output*.
RE4A	This output is connected to RE4 on the multi I/O board. On J18 the RE4x and $\overline{\text{RE4}}$ are connected when the output is not activated and RE4x and RE4 are connected when the output is activated. Available selections for this output are according to *Remote output*.

5.5.8. Parallel control

This function is only visible in the menu system if function *CAN* is set to *Master* or *BMS ctrl*.

The *Parallel control* function can be used to combine several chargers into a high-power cluster. Up to five chargers can be connected through CAN-bus.

The Parallel control function has the following selections:

Function	Activates/deactivates the *Parallel control* function.
Charger select	Selection of the charger to be used in the *Parallel control* cluster.

Chargers on the CAN-bus becomes visible in the *Charger select* menu if they are connected on the CAN network, the *Master* is in *CAN Operational state* and they send heart beats and have serial number available for read out.

Ctrl	An X indicates that the charger should be used in the parallel control. Please note that the *Master* is shown in the list and must be selected as well. If not selected the *Master* will only control the *Slaves* and not use its own power unit.
S/N	Serial number of the charger on the CAN-bus.
Status	A ? indicates that the charger is available on the network but not selected. A ! indicates that the charger has been selected but cannot be found on the CAN bus.

5.5.9. F1 and F2 button

The **F1** and **F2** buttons are intended to be used as a short cut to functions commonly used. The function connected to the button is activated with one push and deactivated with a second push. When activated the button lights up yellow.

The **F1** and **F2** have the following selections.

Disabled	No function connected to the button.
Equalize	The button will trigger equalize charging. This function tells the charging curve to run an equalize charge. If and when the actual equalize charge is performed is defined in the charging curve, normally when the battery is fully charged. Please note that the button can be pressed at any time even if no battery is connected. When the battery is connected the equalize charge will be trigged. This function enables equalize charging no matter the settings in the *Equalize* function. When **F1** or **F2** are configured as *Equalize,* scheduling of Equalize in BMU can be overridden by pressing the **F1** or **F2** button to enable or disable *Equalize* for the current charging cycle.
Remote out	The button controls the remote output. Please note that this setting overrides all other functions using the remote out. If the *F1* or *F2* button is set to *Remote out* and not activated no other functions can activate the remote output. If the

	F1 or *F2* button is set to *Remote out* and activated no other functions can deactivate the remote output.

5.5.10. Date and time

The date and time function is used to set the charger internal real time clock and calendar. The date and time format has three possible options.

ISO/JIS	YYYY-MM-DD HH:MM, 24 hour
EUR	MM.DD.YYYY HH.MM, 24 hour
USA	MM/DD/YYY HH:MM, 12 hour

5.5.11. Display

In the *Display* menu contrast and backlight time can be adjusted. The backlight time determines how long time after a button has been pressed the backlight should be activated.

Please note that the intensity of the indicators (LED) in the charging panel can be adjusted via the PC-software SBS MicroSMART Service tool.

5.5.12. Radio

In the *Radio* menu, the radio function can be configured. The menu changes appearance depending on whether the charger is connected to a radio network or not.

If *Network settings* is set to *Default* the charger is always connected to a network pre-defined from production. The default network will be "started" every time the charger power up. In most cases, there is no need to make any changes.
The following menu is shown:

Function	Activates/deactivates the radio function. If the charger is connected to a default network and *Disabled* is selected the network will be left. When Enabled is selected the default network will be "joined" again.
Status	Determines if the charger is connected to a radio network. The charger is not accessible through radio until the status says *Connected*.
Network settings	Defines the parameters when starting or joining a network. If set to *User def* or *Auto* the charger will automatically leave the default

	network once *network settings* menu is left. If set to *Default* the charger will automatically "join" the default network once *Network settings* menu is left.
Network info	Information about the radio network, please see below for details.

If *Network settings* is set to *User def* or *Auto* the following applies:

If not connected to a network the following menu is shown.

Function	Activates/deactivates the radio function. If the charger is connected to a network and *Disabled* is selected the network will be left and the charger network address lost. When *Function* is set to enabled the radio parameters can be set in *Network settings*.
Status	Determines if the charger is connected to a radio network. The charger is not accessible through radio until the status says *Connected*.
Network settings	Defines the parameters when starting or joining a network. See below for details.
Start network	Start a new network based on the parameters set in *Network settings.* Please note that *Start network* will fail if there are any other networks on the same *Channel* and with the same *PAN-ID* within hearing distance.
Join network	Join an existing network. This function scans all 16 channels for existing network with *Join enable* activated. If any such network is found a join is automatically performed. Possible reasons for a *Join network* fail can be the following. • No network with *Join enable* activated found within hearing distance. • The node with *Join enable* activated has no remaining network addresses to share.

If connected to a network the following menu is shown.

Function	Activates/deactivates the radio function. If the charger is connected to a network and *Disabled* is selected the network will be left and the charger radio network address lost.
Status	Determines if the charger is connected to a radio network. The charger is not accessible through radio until the status says *Connected*.
Network settings	Defines the parameters when starting or joining a network. See below for details.
Network info	Information about the radio network, please see below for details.
Join enable	When *Join enable* is activated another node can join the network. *Join enable* will be reset automatically.
Leave network	Leaves the present network.

5.5.12.1. Network settings

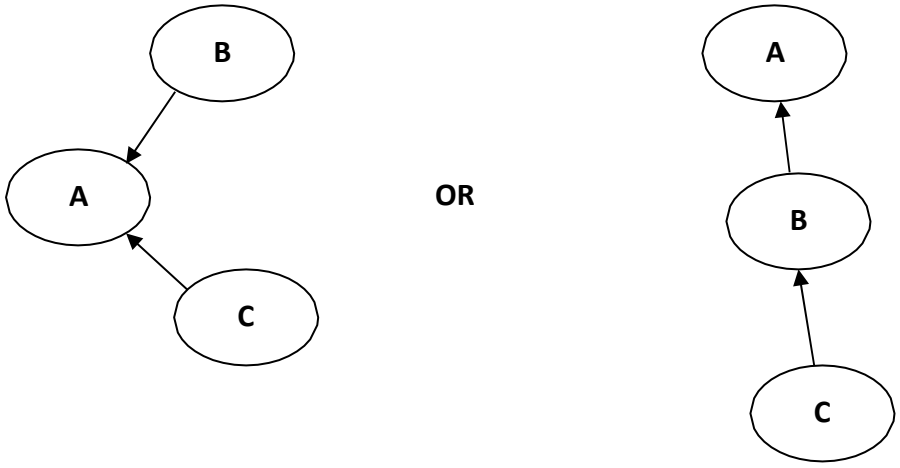
Settings	*User def* means that the settings configured in the menu is used to start a new network. *Auto* means that an available channel and *PAN-ID* is selected automatically. *Default* means that the charger is always connected to a network pre-defined from production.
Charger ID	The configurable identification of the charger. Can be set to any numeric value between 0 and 4294967236.
Channel	Determines which channel to use between 11 and 26. The channels are evenly distributed between 2,405 GHz 2,480 GHz with 5 MHz channel separation.
PAN ID	Private Area Network identifier. The name of the radio network. There can be several networks on the same channel with different *PAN ID:s*. Possible values between 0 and 65535.
Routing	Determines if routing and broadcasting should be *Enabled* or *Disabled* in the radio communication.

5.5.12.2. Network info

Charger ID	The configured identification of the charger.
Channel	Network radio channel, 11 to 26. The channels are evenly distributed between 2.405 GHz 2.480 GHz with 5 MHz channel separation.

PAN ID	Private Area Network identifier, the name of the radio network. There can be several networks on the same channel with different *PAN ID:s*.
Node ID	Charger radio network address. Is used for communication within the network.
Signal strength	Indicates the quality of the radio link to surrounding nodes on the same network (*Channel* and *PAN-ID*). Level 4 can only be obtained if multiple nodes are within range.
Address pool	Number of available radio network addresses to share. When a charger is joining a radio network 10%, minimum 10 and maximum 400 of the available addresses are shared, i.e. the *Address pool* will be reduced when other chargers joins. If this number is 0 no other nodes can Join the charger.

With a radio network, multiple chargers can be connected and communicate with each other wirelessly. Here follows an example of how this could work in reality. Imagine that node A, B and C wants to communicate with each other via a radio network. One of the nodes has to start the network. Let's assume node A starts the network. Node B can now join the network if A allows it (*Join enable*). Node C can of course also join the network, either by connecting to B or by connecting to A. The three nodes are now connected wirelessly.



If another node wants to join the network, it can connect to any of the three nodes already connected to the network. However, note that it is always preferable to connect to the node that started the network (in this case node A). If node A for some reason disappears node B and C will still be able to communicate. The network is with other words still fully functional even if a node is removed.

See the tutorials Start a new radio network and Connect to an existing network for more information about how a network could be configured with different chargers and BMU:s.

The radio used to connect the chargers operates on the 2,4 GHz license free frequency band. By altering which channel the network should use the frequency the network should operate on can be altered. There are 16 different channels, all evenly distributed between 2,405 GHz

and 2,480 GHz with 5MHz channel separation and a bandwidth of 2MHz. The available are numbered from 11 to 26.

The different units are connected in a mesh network which automatically finds and selects suitable paths for communication via other units in the network.

The access system uses the same radio transmitter in all units which makes it possible for all different units (charger, BMU, computer etc.) to communicate with each other.

The network has a range of up to 100 meters in free range and approximately 10-20 meters in an office.

5.5.13. CAN

The CAN bus functionality makes it possible for the chargers to be externally controlled or combined into *Parallel control* clusters where several chargers charge the same battery.

To activate and run this function an I/O board must be connected to the battery charger. On the I/O board a CAN termination, 120 Ω, can be turned on or off with a jumper. The CAN pins are galvanic isolated from battery and mains with configuration according to appendix 1.

The CAN functionality has the following selections:

Disabled	CAN bus turned off. When turning off the CAN bus the *Parallel control* function is automatically set to *Disabled*.
Slave	The charger works as a *Slave* or *BMS ctrl* controlled slave in a *Parallel control* cluster and gets all its reference values through the CAN bus. In each Parallel control cluster, there must be one *Master* or *BMS ctrl* and up to five *Slaves*. No charger statistics is stored. No battery charging related functions are functional. The main screen shows CAN CONTROLLED SLAVE. Depending on the power unit settings a minimum voltage may be needed to start the charger.
Master	The charger works as a master in a *Parallel control* cluster and controls none or several *Slaves*. Reference values are read from the charging algorithm and charging related functions are fully functional. In each Parallel control cluster, there must be one *Master* or *BMS ctrl* and up to five *Slaves*.

	Please note that the *Parallel control* function must be activated and chargers selected, see chapter on *Parallel control* in this document.
BMS ctrl	The charger works as an externally controlled master in a *Parallel control* CAN network, controls none or several *Slave* and gets all its reference values through the CAN bus. External control according to CAN BMS control protocol 3914008. In each Parallel control cluster, there must be one *Master* or *BMS ctrl* and up to five *Slaves*. No charger statistics is stored. No battery charging related functions are functional. Depending on the power unit settings a minimum voltage may be needed to start the charger. Please note that the *Parallel control* function must be activated, chargers selected and set to *Operational*, see chapter on *Parallel control* in this document.
Status	Reference values are read from the charging algorithm and charging related functions are fully functional except for *Parallel control* which is not applicable. The idea is to use this mode when charger status via CAN-bus is needed. It is also possible to restrict charging via a CAN SDO message. This requires that *I/O control->Remote input->function* is set to *Start/Stop.* For detailed description see: CAN Status protocol 3914008.

The following menu items availability is depending on the *CAN Function* selection.

State	Node CAN state *Auto ID, Pre-Op* or *Operational*. *Boot,* available for *BMS ctrl*. If the charger remains in this state, the CAN bus is not connected or faulty. *Auto ID,* available for *Slave* and *Master*. The charger is automatically searching for an available *Node ID*. If the CAN bus is not connected or faulty the charger will remain in this state. *Pre-Op,* the charger is waiting for a network management message. *Operational*, the charger is ready for operation.
Node ID	Node CAN-bus identification. Can be *Auto* or *Set.* If auto the *Node ID* is set automatically and if any conflict appears the ID will change. The ID might also change between charger startups. If *Set* the *Node ID* is fixed to the configured value. Allowed values 1 to 127.
Node list	A list of available nodes on the CAN bus and their *State*. Please note that the nodes must be set to *Master* or *BMS ctrl* to have this menu available. The node must also be *Operational* to show any nodes in the list. All nodes sending heartbeats on the CAN-bus will be present in the list.

5.5.14. Calibration

In this menu, the difference between charger measured and actual current and voltage can be compensated. When changing *Power unit* under *Factory settings* the *Calibration* parameters are cleared.

U measured (V)	The measured battery voltage. Calibration of the battery voltage shall be performed with zero battery current. This can be achieved by connecting the battery and then press the STOP button. Please note that a calibration value that differs more than 15 % from starting value will be ignored.
I measured	The measured battery current. Calibration of the battery current shall be performed with a high battery current. Please note that a calibration value that differs more than 15 % from starting value will be ignored.

5.5.15. Factory settings

Power unit	See appendix 5 for available power units. The power unit number determines scaling factors, error detection, power curve etc. and it is therefore very important to have the correct power unit set. The different power units have the following voltage/current limits set: **24V, 3-phase:** 10 % of rated current between 0 and 11.0 V 100 % of rated current between 11.0 and 29.4 V 92 % of rated current @ 31.7 V 25 % of rated current @ 33.8 V 0 % of rated current above 33.8 V **36V, 3-phase:** 10 % of rated current between 0 and 21.8 V 100 % of rated current between 21.8 and 43.8 V 92 % of rated current @ 47.3 V 25 % of rated current @ 50.6 V 0 % of rated current above 50.6 V **48V, 3-phase:** 10 % of rated current between 0 and 21.8 V 100 % of rated current between 21.8 and 58.2 V 92 % of rated current @ 62.9 V 25 % of rated current @ 67.4 V 0 % of rated current above 67.4 V **80V, 3-phase:** 10 % of rated current between 0 and 21.8 V 100 % of rated current between 21.8 and 96.6 V 92 % of rated current @ 104.3 V 25 % of rated current @ 112.2 V 0 % of rated current above 112.2 V

	<u>24V/120A, 1-phase:</u> 0 % of rated current between 0 and 6.0 V 10 % of rated current between 6 and 12.0 V 100 % of rated current between 12.0 and 23.0 V 88 % of rated current @ 28.5 V 0 % of rated current above 35 V **<u>36V/80A, 1-phase:</u>** 0 % of rated current between 0 and 6.0 V 10 % of rated current between 6 and 9.0 V 100 % of rated current between 9.0 and 43.6 V 92 % of rated current @ 47.0 V 0 % of rated current above 50.5 V **<u>48V/60A, 1-phase:</u>** 0 % of rated current between 0 and 6.0 V 10 % of rated current between 6 and 12.0 V 100 % of rated current between 12.0 and 49.0 V 67 % of rated current @ 62.0 V 42 % of rated current @ 67.3 V 0 % of rated current above 67.3 V The battery voltage must exceed 6V for the charger to start.
Idc max (A)	Maximum allowed battery current. The battery current is also limited by the power unit settings, and the maximum allowed mains AC power and AC current. Please note that limits on time or charged capacity in charging cycles is changed In parallel control this setting affects the individual charger only.
Iac max (A)	Maximum allowed mains current. In parallel control this setting affects the individual charger only.
Pac max (W)	Maximum allowed mains power. In parallel control this setting affects the individual charger only.

5.5.15.1. Default settings

The *Default settings* are used to set or reset parameters to previously stored values. During production settings are stored in a separate memory for future reset. Use *Store* to save all parameters currently set in the charger to the default settings memory. Use *Restore* to copy all parameters in the default settings memory to the charger parameters.

Always disconnect the battery prior to a *Default settings Reset*, if this is not done the ongoing charge will be reset and not stored in the historical log.

5.5.15.2. Clear statistics

Clears all statistical data stored in the charger.

5.5.16. Advanced

5.5.16.1. Force start

Force start forces the charger to start charging even if no battery is detected. When *Force start* is enabled a battery voltage of 1.5 VPC is simulated. The current levels are determined by the charging curve.

If the voltage rises above 1.5 VPC within 30 seconds *Force start* is disabled. After 30 seconds, *Force start* is disabled and charging continues according to charging curve if the battery voltage is above the battery detection threshold. If the voltage is below battery detection threshold the charger enters idle state.

5.5.16.2. Instant log

The *Instant log* is used for storing battery voltage, battery current, charger temperature, charger board temperature and alarms with a configured period. The *Instant log Period* can be set between 0 and 65535 seconds. If set to 0 the logging is turned off.

If *Period* is set to a value greater than 0 and then set to 0 the logs are not cleared but logging is turned off. If *Period* is set to a value greater than 0 all instant logs are cleared and logging turned on.

Instant logs can be read out by using the PC-software SBS MicroSMART Service tool.

5.5.16.3. Power group

Defines the *Power group* the charger belongs to, 0 to 999. *Power group* is used together with the *Mains Power Limit* function in the PC-software SBS MicroSMART Service tool.

5.5.16.4. CEC mode

If enabled limitations according to CEC (California Energy Commission) will be applied. This includes:

- Limitations to capacity and cell parameters setting depending on engine code selected.
- Only a few charging curves are allowed
- No maintenance charging pulses.

5.5.16.5. Curve parameters

If enabled charging curves with “user parameters” can be edited. A *Curve parameters* sub-menu will appear in the *Charging param* menu for these curves.

5.6. Log out/Log in

Used to log in to or log out from the menu system. Log out is automatically trigged after the *Display Backlight* time.

5.7. Language

The *Language* menu is always in English no matter the menu language set.

The Language selection affects the menu languages and in some cases the charger functionality. When language set to USA the following options are activated:

- Display backlight is lit continuously during charging and turned off in maintenance.
- Temperature values are shown in Fahrenheit.
- *F1 button* is locked to *Equalize.*
- *F2 button* is renamed to *Fn button*

6. Charging curves

Identity	Display text (max 8 characters)	Description
1	1.10-06	Free ventilated lead acid. I1 20 % C5, U1 2.4 VPC, I2 5 % C5, U2 2.8 VPC, pulsed maintenance charging. Manual Equalize 5 % C5, 2.8 VPC 2 h + 10 min water + 1 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 2.5 h charging min time.
2	2.10-04	Free ventilated lead acid with ionic mixing. I1 20 % C5, U1 2.4-2.8 VPC, I2 5 % C5, U2 2.8 VPC, pulsed maintenance charging. Manual Equalize 5 % C5, 2.8 VPC 2 h + 10 min water + 1 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 1 h charging min time.
3	3.20-09	Valve regulated lead acid. I1 14 % C5, U1 2.35 VPC, I2 1.2 % C5, U2 2.8 VPC, I3 0.6 % C5, U3 2.8 VPC. Manual Equalize 0.6 % C5, 2.8 VPC 30 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 2 h charging min time. It's recommended to activate Equalize once per week when using 3.20-09.
4	4.CFLA-01	Free ventilated lead acid. I1 16.3 % C5, U1 2.4 VPC, I2 4.7 % C5, U2 2.8 VPC pulsed maintenance charging. Manual Equalize 4.7 % C5, 2.8 VPC 3 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 3 minutes charging min time.
5	5.CIMX-01	Free ventilated lead acid with ionic mixing. I1 16.3 % C5, U1 2.4-2.8 VPC, I2 4.7 % C5, U2 2.8 VPC, pulsed maintenance charging. Manual Equalize 4.7 % C5, 2.8 VPC 3 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 2 h charging min time.
6	6.OP25-01	Free ventilated lead acid. I1 25 % C5, U1 2.4 VPC, I2 5 % C5, U2 2.7 VPC, pulsed maintenance charging. Manual Equalize 5 % C5, 2.7 VPC, 3h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 2.5h main charging min time. Plus, extra protection functions and du/dt termination function.
7	7.OP30-01	As 6.OP25-01 with I1 30 % C5.
8	8.OP35-01	As 6.OP25-01 with I1 35 % C5.
9	9.OP40-01	As 6.OP25-01 with I1 40 % C5.

10	10.LiFePO4	Lithium iron phosphate. I1 300 % C5, U1 3.65VPC. Ready when I < 5 % C5.
11	11.FCIUI	As 1.10-06 with I1 40 % C5. Manual equalize 2h + 10 min water + 4h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 40º-65ºC. 3 minutes charging min time.
12	12.FCIU	As 1.10-06 with I1 40 % C5 no I2 phase. Manual equalize I2 + 2h + 10 min water + 4h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 40º-65ºC. 3 minutes charging min time.
13	13.CFLA-02	As CFLA-01 with min charging time 1 h + 1 min.
16	16.10-05	Free ventilated lead acid. I1 20 % C5, U1 2.4 VPC, I2 5 % C5, U2 2.8 VPC, I3 0.8 % C5, U3 2.26 VPC. Manual Equalize 5 % C5, 2.8 VPC 2 h + 10 min water + 1 h. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 2.5 h charging min time.
20	20.23-03	Evolution curve. For detailed information contact Enersys (ref: CDC-Evo 05).
21	21.10-16	As 16.10-05 with U3 2.8 VPC.
22	22.10-99	As 2.10-04 but with 15 % additional charge.
23	23.OP25-02	As 4.CFLA-01 with I1 25% C5 and 15 second charging min time.
24	24.OP30-02	As 4.CFLA-01 with I1 30% C5 and 15 second charging min time.
25	25.OP35-02	As 4.CFLA-01 with I1 35% C5 and 15 second charging min time.
26	26.OP40-02	As 4.CFLA-01 with I1 40% C5 and 15 second charging min time.
27	27.OP45-01	As 6.OP25-01 with I1 45 % C5.
28	28.10-98	As 16.10-05 but with U2 2.5 VPC, U1 max time = 3h and I2 max time = 4h.
29	29.FCI25-01	As 23.OP25-02. Only I1 phase unless manual equalize then UI, I2, EQU is done as well.
30	30.Lion-01	Litium ion. I1 200 % C5. ReguOn = 2.0VPC ReguOff = 4.5 VPC.
31	31.10-97	As 1.10-06 but with 3-minute total min time.
32	32.10-96	As 2.10-04 but with 3-minute total min time.
34	34.SC03-01	Shop charging curve. I1 5%, U1 2.8VPC. Max 3h or 15% then goto Ready.
35	35.SC06-01	Shop charging curve. I1 5%, U1 2.8VPC. Max 6h or 30% then goto Ready.

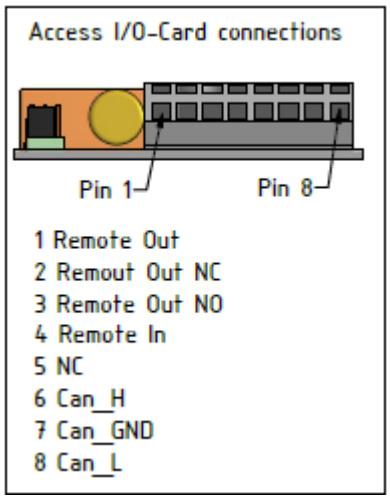
36	36.SC12-01	Shop charging curve. I1 5%, U1 2.8VPC. Max 12h or 60% then goto Ready.
37	37.SC24-01	Shop charging curve. I1 5%, U1 2.8VPC. Max 24h or 120% then goto Ready.
38	38.OP25-03	As 4.CFLA-01 with I1 25% C5, U2 2.58VPC and 2,5h charging min time. No temperature compensation in U2 and forward.
39	39.LK70-01	Lithium iron phosphate with user parameters. I0, I1, U1 and I2 phases. Default parameter values are I0 173% C5, I1 173% C5, I2 0% C5, U0 3.58VPC, U1 3.58VPC, U2 3.0VPC.
40	40.LiIon-IU-01	Lithium-ion. I1 10 % C5, U1 0.5V/Cell.
41	41.10-18	Free ventilated lead acid with ionic mixing and du/dt termination. I1 20 % C5, U1 2.4-2.8 VPC, I2 7 % C5, U2 2.8 VPC, pulsed maintenance charging, automatic equalize after 16h. Equalize: 5 % C5, 2.8 VPC 2 h + 10 min water + 1 h. Manual equalize (if activated after automatic): 5 % C5, 2.8 VPC 10min. U temp comp 3 mVPC, neutral 30ºC. I temp comp 45º-60ºC. 1h15min charging min time.
43	43.OPXX-01	As 6.OP25-01 with user parameters, extra protection functions and du/dt termination function. Default values are set as 6.OP25-01.
44	44.LiIUI	Charging curve for Lithium battery with user parameters. Default I1 100% C5, U1 3.72VPC, I2 10% C5, U2 3.72VPC. I1U1 Time max 1h, I2U2 Time max 5h. See document 03015033 for detailed description.
46	46.10-95	As 41.10-18 but with 3-minute total min time.
47	47.FVLA	Free ventilated lead acid curve based on LK10-06 with user parameters. See document 03015036 for detailed description.
48	48.70-02	Charging curve for Lithium battery with user parameters. Default I1 50% C5, U1 3.65VPC, I2 5% C5, U2 3.65VPC. I/O control for Main and Equalize charge.
49	49.10-20	Free ventilated lead acid. Charging curve based on 1.10-06 with air pump functionality for acid circulation.

7. Alarms

Code	Alarm text	Description	Recommended actions
1	Low battery voltage	Battery voltage below low limit. Defined by charging curve.	Check battery for damages cells. Check charging parameter cell count.
2	High battery voltage	Battery voltage above charging algorithm high limit. Defined in charging curve.	Check charging parameter C*ells*.
3	Time limit exceeded	Time limit defined in charging curve exceeded.	Check battery for damaged cells.
4	Ah limit exceeded	Ah limit defined in charging curve exceeded.	Check battery for damaged cells. Check charging parameter *Capacity*
5	Invalid charging parameters.	Charging parameters not set correctly in charger.	Check charging parameters in menu.
6	Charger not in upright position	Charger is not in upright position.	Place the charger in vertical position.
7	High battery voltage power unit shut off	Battery voltage above charger high limit. Defined in charging curve.	Check battery voltage. Check charging parameter C*ells*.
8	Battery error	General battery charging error.	Check battery. Check charging curve specification for error details.
9	Low air pump pressure	The monitored air pump pressure is below 3 kPa.	Check air pump installation for leaks.
10	High air pump pressure	The monitored air pump pressure is above 12 kPa.	Check air pump installation for blockings.
17	Mains feed phase error	A phase is missing from mains supply. The charger has been restarted more than three times within a time period.	Check mains supply fuses. If the failure cause is restored the alarm will reset automatically. Wait 1 minute for the alarm to reset.
18	Regulator error	Error in power unit control. Current has been below 1 A for one minute and set current is greater than 1 A. Error is triggered the third time this happens during one charging cycle.	Check secondary side fuse. Make sure power unit parameter is according to used power unit.
19	Low charger temp	Heat sink temperature is below low limit.	Place the charger in heated environment.
20	High charger temp, derating output	Heat sink temperature is above high limit. This alarm is trigged when the temperature reaches the derate end threshold and is kept active until the derate start threshold is reached.	Check cooling fans.
21	Low board temp	This error code is not used.	This error code is not used.

22	High board temp	This error code is not used.	This error code is not used.
23	High charger temp power unit shut off	Hardware temperature protection (pin 14 on power unit interface) active.	Check cooling fans.
24	CAN timeout	Expected CAN bus messages where not received. Alarm is not triggered when the nodes are in Pre-operational state.	Check in Parallel control menu that all chargers selected are ok (no !). Check CAN-bus harness. Set the nodes in Pre-operational before disconnecting external control.
25	Slave Mains feed phase error	Alarm from CAN-bus Slave.	Check slave according to code 17.
26	Slave Regulator error	Alarm from CAN-bus Slave.	Check slave according to code 18.
27	Slave Low charger temp	Alarm from CAN-bus Slave.	Check slave according to code 19.
28	Salve High charger temp, derating output	Alarm from CAN-bus Slave.	Check slave according to code 20.
31	Slave High charger temp power unit shut off	Alarm from CAN-bus Slave.	Check slave according to code 21.
32	CAN Slave timeout	Alarm from CAN-bus Slave. Measured voltage between chargers in a *Parallel control* cluster differs more than 6 V. Chargers that measure a voltage 6 V below the highest measured voltage is considered to be faulty and therefore disconnected.	Check slave according to code 24. Check DC harness, fuse and calibration on connected chargers.
101	High battery temperature	The battery temperature measured by BMU is above alarm threshold level.	-
102	Low electrolyte level	The BMU is sensing a low electrolyte level.	Top up the battery with distilled water.
103	Battery voltage not in balance	The BMU voltage balance sensor is above alarm threshold level.	Check for damages cells on battery. Run an equalize charge.
-	Invalid charging parameters from BMU	Charging parameters loaded from BMU is not valid.	Check that the charging curve identity specified in BMU is present in charger. Check that Cell count parameter in BMU is ≥ 6.
-	Radio gateway error	The main controller can't communicate with the radio gateway.	Restart charger. Contact service.

8. Appendix 1, I/O board connections



For multi I/O board connections, please refer to text printed on the board itself.

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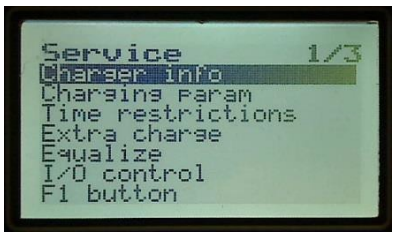
9. Appendix 2, Tutorials

9.1. Enter the service menu

1. While in the main menu press **OK**. The main menu is the following menu.

2. Put the marker on *Service* by using the up or down arrow. Press **OK**.

3. The *Service* menu is now shown.



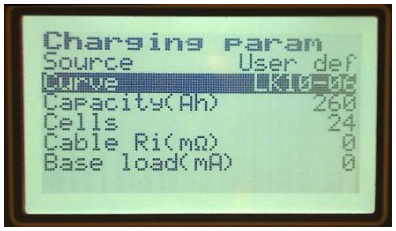
4. Done!

9.2. Edit parameters

To edit parameters that require an access level the PIN-code need to be entered. See also Access level clause in menu system chapter.

1. Go to the service menu according to the tutorial Enter the service menu. Put the marker on the field *Charging param* and press **OK**

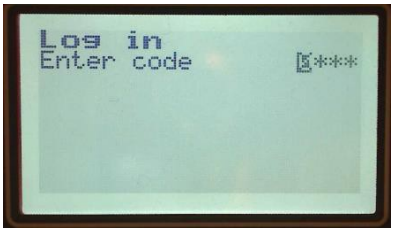
2. Locate the parameter to edit.



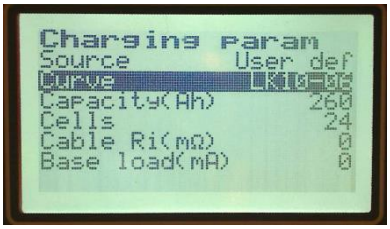
3. Press **OK**, the following menu is shown.

4. Press **OK**, the following menu is shown.

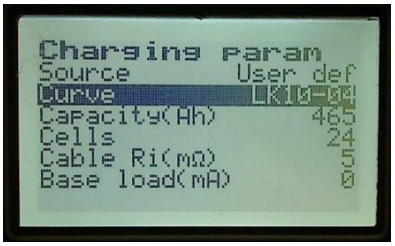
5. Press **OK** and enter the correct Access level 1 or 2 PIN-code using arrow up, down, left and right. Press **OK** when all the four digits of the PIN-code are entered. Note that your level 2 PIN-code will work both when level 1 and level 2 access is required.



6. The original parameter menu is shown again.



7. Press **OK** and edit the parameter using arrow up, down, left and right. Press **OK** to confirm the value.



8. Press **ESC** until the main screen is shown.

9. Done!

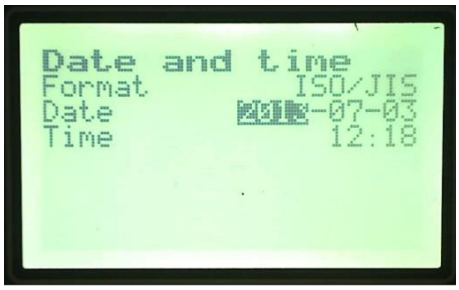
9.3. Set date and time

When installing a new charger or if the control board has been replaced with a new one it might be necessary for the user to adjust the date and time to match reality. Because the internal clock of the charger is used to keep track of for example scheduled charging it is important that it is correctly adjusted. Here follows a tutorial for how to set the time and date on the charger. Note that to edit time and date no pin-code is required.

1. While in the service menu put the marker on *Date and time* and press **OK.** The following menu will be shown.

   There are three different formats for how the time and date should be entered. See *5.5.10 Date and time* for more information.

2. To change the date put the marker on *Date* and press **OK**. Select the desired values for year, month and date by using up, down, left and right arrows. Press **OK** to confirm.



3. To adjust the time just follow the same procedure. Put the marker on *Time* and press **OK.** Select the correct values for hours and minutes using the up, down, left and right arrows. Press **OK** to confirm when ready. Note that the time and date here was set using the format ISO/JIS.

4. Press **ESC** until the main menu is shown. The new date and time can be seen at the top of the screen.

9.4. Start a new radio network

As discussed in *5.5.12 Radio* a radio network allows the chargers to communicate with each other wirelessly. However, in order for this to work one of the chargers or BMU: s has to start the network and allow other chargers or BMU: s to connect to it. So to emphasize: A radio network can be established by letting one charger start the network and let other chargers or BMU: s join this network.

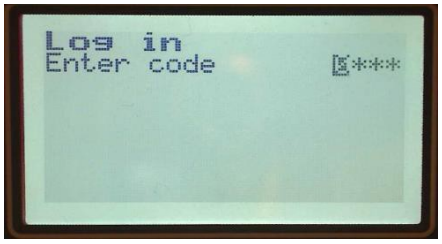
Setting up a new radio network will require an access level which means that a pin code need to be entered to gain access to all network configurations. Here is a step by step tutorial on how to start and configure a radio network.

1. Go to the service menu according to the tutorial Enter the service menu. Put the marker on the field *Radio* and press **OK**.

2. When not connected to any existing network you will see the following menu.

3. To be able to configure the network, the field *Function* must be set to *Enabled.* To do this put the marker on *Function* and press **OK.** The following menu will be shown. Press **OK** to log in.

4. Press **OK** and enter the correct Access level 1 or 2 PIN-code using arrow up, down, left and right. Press **OK** when all the four digits of the PIN-code are entered. Note that your level 2 PIN-code will work both when level 1 or level 2 access is required.



5. The original radio menu will now be shown again.

6. Put the marker on *Function* and press **OK.** Set the *Function* field to *Enabled* by using the up or down arrow. Press **OK** to confirm your choice. After the choice has been confirmed the following menu is shown.

7. By entering the field *Network settings* it is possible to select if the settings should be *Auto* or *User def. User def* allows the user to manually select which channel and PAN-ID the network should have. With settings set to *Auto* this is selected automatically. Note that it is impossible to start a network with a specific channel number if there is another radio network with the same channel number within hearing distance.

   Press *ESC* to return to the *Radio* window.

8. To set up a new network simple put the marker on the field *Start network* and press **OK.** The following screen will be shown if the network was started successfully.

9. When the network is up and running the following menu will be shown.

10. It is always preferable to check which channel number and PAN-ID the network got if it was started using *Auto* settings. To do this, put the marker on *Network info* and press **OK**. Here you can also see the *Signal strength* of the network. Note that if no other nodes are connected to the network the *Signal strength* will always show 0.

11. Press **ESC** until the main screen is shown. The radio mast in the top left corner of the main screen indicates that the radio function is active.

12. Done!

9.5. Connect to an existing network

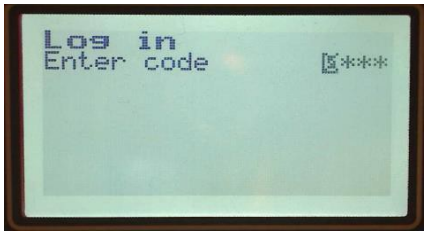
1. In order to be able to find and connect to an existing network, a device that is already connected to the network has to be set to *Join enable*. To do this on a charger which is already connected to the network put the marker on the field *Join enable* and press OK. Another option is to press **Arrow down** for 3 seconds when display is stand by in main window. See *3.7 Shortcuts* for more information. The following menu will be shown when the network is free for other devices to join.

2. On a device which would like to connect to the network go to the service menu according to the tutorial Enter the service menu. Put the marker on the field *Radio* and press **OK**.

3. When not connected to any network the following menu is shown.

4. Set the field *Function* to *Enabled* by putting the marker on the field *Function* and press **OK**. The following menu is shown. Press **OK** to log in.

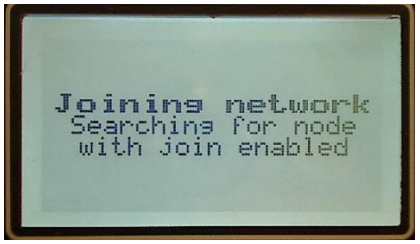
5. Press **OK** and enter the correct Access level 1 or 2 PIN-code using arrow up, down, left and right. Press **OK** when all the four digits of the PIN-code are entered. Note that your level 2 PIN-code will work both when level 1 or level 2 access is required.



6. The original *Radio* window is shown again. Change *Function* to *Enabled* by marking the field *Function*, press **OK** and change the option by using the up or down arrow. Press **OK** to confirm.

7. If the network settings are set to *User def* you will only search for a network with the channel number and PAN-ID specified in *Network settings.* To avoid this enter the field *Network settings* and make sure the field *Settings* is set to *Auto*, as shown in this picture. Press **ESC** to return to the *Radio* window.

8. Put the marker on the field *Join network* and press **OK.** There are a number of reasons to why a device might not be able to join the network. See *Join network* under *Radio* for more information. The following menu is shown when the device is searching for a radio network within hearing distance.



9. The following menu is shown when a network has been found.

Note that it is always preferable to connect to the device that originally started the network to prevent the network from running out of addresses. See Address pool under *5.5.12.2 Network info* for more information.

10. When connected to a network press ESC until the main screen is shown.

9.6. Activate a BBC system

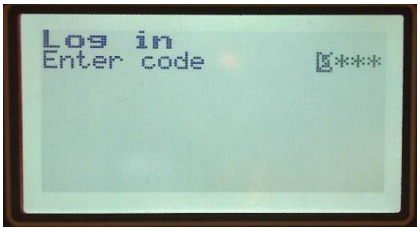
1. Before start setting up your BBC system it is always important to think through how you should administrate the battery park, which type of chargers should be included in which group and what numbers the different groups should be assigned. In order for the BBC system to work satisfactory all chargers of a certain type, for example chargers which are designed to charge 48 V batteries should all have the same *Group ID*. See *5.5.6. BBC* for more information.

2. Go to the service menu according to the tutorial Enter the service menu. Put the marker on the field *BBC* and press **OK**. Note that the function *BBC* only is visible in the service menu if the charger is connected to a radio network.

3. When no BBC function is activated the following menu is shown.

4. Set the field *Function* to *Enabled* by putting the marker on the field *Function* and press **OK**. The following menu is shown. Press **OK** to log in.

5. Press **OK** and enter the correct Access level 1 or 2 PIN-code using arrow up, down, left and right. Press **OK** when all the four digits of the PIN-code are entered. Note that your level 2 PIN-code will work both when level 1 and level 2 access is required.



6. The *BBC* window will now be shown again.

7. Put the marker on *Function* and press **OK.** You should now be able to change the field *Function* to *Enabled* by using the up or down arrow. Press **OK** to confirm your choice. The following menu is now shown.

8. Choose which *Group ID* number the charger should have by marking the field *Group ID,* press **OK** and switch number by using arrow up, down, left and right. Press **OK** to confirm your choice. For more information on how to use Group numbers see the example under 5.5.6. BBC.

9. Press **ESC** until the main screen is shown.

9.7. Calibrate the charger

By calibrating the charger, it is possible to compensate for the difference between the chargers measured values and the actual values you get when measuring on the battery.

1. Go the service menu according to the tutorial Enter the service menu. Put the marker on *Calibration* and press **OK.** The following menu is shown.

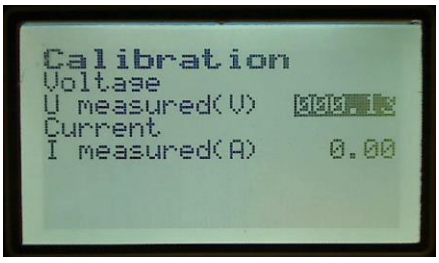
2. Measure the battery voltage. Note that this should be done with zero charging current. This can be achieved by connecting the battery and then push the **STOP** button.

3. Put the marker on the field *U measured* and press **OK.** Note that a level 2 access PIN-code is required to change this value. The following menu is shown.

4. Press **OK** and enter the correct level 2 access PIN-code by using arrow up, down, left and right. Press **OK** when all four digits are entered.

5. The original *Calibration* menu is now shown again.

6. Put the marker on *U measured* and press **OK**. The following menu is now shown.



7. You should now be able to change *U measured* to the actual value you got when measuring on the battery by using arrow up and down. Press **OK** to confirm the value.

8. To calibrate the current, *I measured* follow the same procedure. First measure the current being charged to the battery, however note that calibration of the current should be performed with as high battery current as possible. In the calibration menu put the marker on *I measured* and press **OK**. If necessary, enter the level 2 access PIN-code. The following menu is shown.

It should now be possible to change to value for *I measured* to the value you got when measuring on the battery by using the up and down arrows. Press **OK** to confirm when ready. Note that the calibration is preferably done when the charging current is fairly constant.

9.8. Start with a new control board

When a charger is being started for the first time after a full reset or after replacement of the control board there are some options the user has to enter before it is possible to start charging a battery. This is a result of that no configured parameters are stored in the flash memory. Here follows a tutorial of how to start charging a battery when all parameters and options are set to default values.

1. To avoid usage with settings which are not intended for the present charger and battery it is recommended to first completely erase the flash memory by pressing and hold **F1 + F2** at mains supply power on. See *3.7 Shortcuts* for more information. When the memory has been erased most of the parameters are set to zero and others have adopted default values. Furthermore, all functions are disabled. This means that if for example the function Extra charge was activated before clearing the memory it will now be disabled.

   Here you can see the *Charging param* menu when the flash memory has been cleared.

2. In order to be able to start charging a battery it is necessary to edit the factory settings which will have adopted default values according to the picture below. Go to the service menu according to the tutorial *Enter the service menu*. Put the marker on *Factory settings* and press **OK**. The following menu is shown.

Change the values of *Power unit* and *Idc max* according to the sticker on the charger. See *5.5.15 Factory settings* for more information. Note that the values for *Iac* and *Pac* seen here are default values. This means that if the current for example will have an amplitude of more than 16 A it is necessary to change this value. To change the parameters, follow the tutorial *Edit parameters.* In the picture below *Iac* has been changed to 32 A and Pac to 20000 W.

Press ESC to return to the service menu.

3. You are also going to be required to adjust the parameters found under *Charging param* in the service menu. While in the service menu put the marker on *Charging param* and press **OK**. The following menu is now shown.

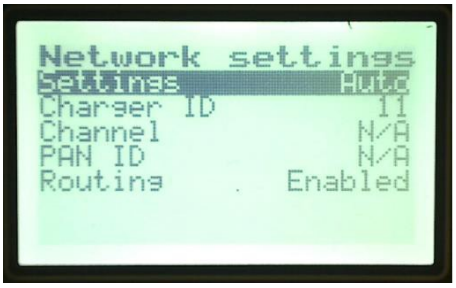
Here it is possible to change options regarding how the charge should be carried out. See *5.5.2 Charging param* for more information. Change the options in the *Charging param* menu to be suitable for the type of battery being used. To change a value put the marker on the parameter you would like to change and follow the tutorial *Edit parameter* in order to change it. Press **ESC** to return to the service menu.

4. The next step is to calibrate the charger. While in the service menu put the marker on *Calibration* and press **OK.** See the tutorial *Calibrate the charger* for more information.

5. Make sure the *Charger ID* is the same as the serial number of the charger which can be found on a sticker at the bottom of the charger. To edit the *Charger ID* go to the Radio menu found under Service. The following menu is shown.

To enter the network settings menu put the marker on *Network settings* and press **OK**. Note that the field *Function* has to be set to *Enabled* in order to change any parameters in the Radio menu. For more information, see the tutorials *Start a new radio network* and *Connect to an existing radio network*.

When entering the network settings menu, the following menu is shown. To change any of the parameters follow the tutorial Edit parameters.



6. If the control board is a new one, it might be necessary to adjust the date and time to match reality. This could be accomplished by following the tutorial *Set date and time*.

7. Press ESC until the main menu is shown.

8. You should now be able to use your charger normally.

9.9. Restore a forgotten PIN-code

We all know how easy it might be to forget a password. This tutorial will show how to restore your level 1 and 2 access PIN-codes in case they are forgotten.

1. At mains supply power on press and hold **OK**+**ESC.** This will configure the charger with default settings. This means that your level 1 and 2 access PIN-codes will be reset to their default values.
2. Note that if you can't remember your default PIN-codes the only option is to erase the memory as mentioned in the tutorial *Start with a new control board*. This will reset the PIN-codes according to the factory settings.

9.10. Store and restore default settings

If some settings in the charger are frequently used it can be advantageous to store these as the default settings. In case some parameters then are changed it is very easy to restore the default values. Here follows a tutorial for how to store and restore default settings.

1. The default settings can be stored by going to the *Service menu→Factory settings→Default settings* and click on *store* as shown in the picture below.

3. If necessary, enter the level 2 pin-code and press **OK.** The following menu will be shown.

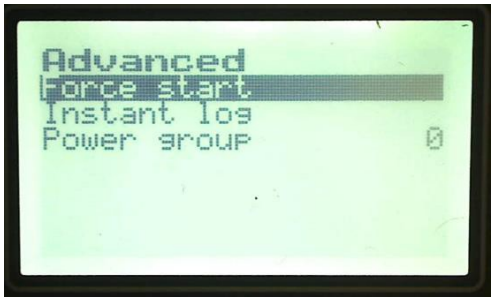
4. Choose *Confirm* to make the current settings your default settings.

5. In case you want to restore the default settings put instead the marker on *Restore* and press **OK.** Choose *Confirm* to restore the default settings.

9.11. Activate instant log

In order for the charger to upload any data to the instant log found in the SBS MicroSMART Service tool this function has to be activated on the charger. In the instant log the user can find historical information regarding for example DC voltage, DC current and board temperature. This information is being sampled with a specific sample interval specified by the user on the charger. Here follows a tutorial for how to activate the instant log and select the sample interval on the charger.

1. While in the service menu put the marker on *Advanced* and press **OK**. The following menu is shown.

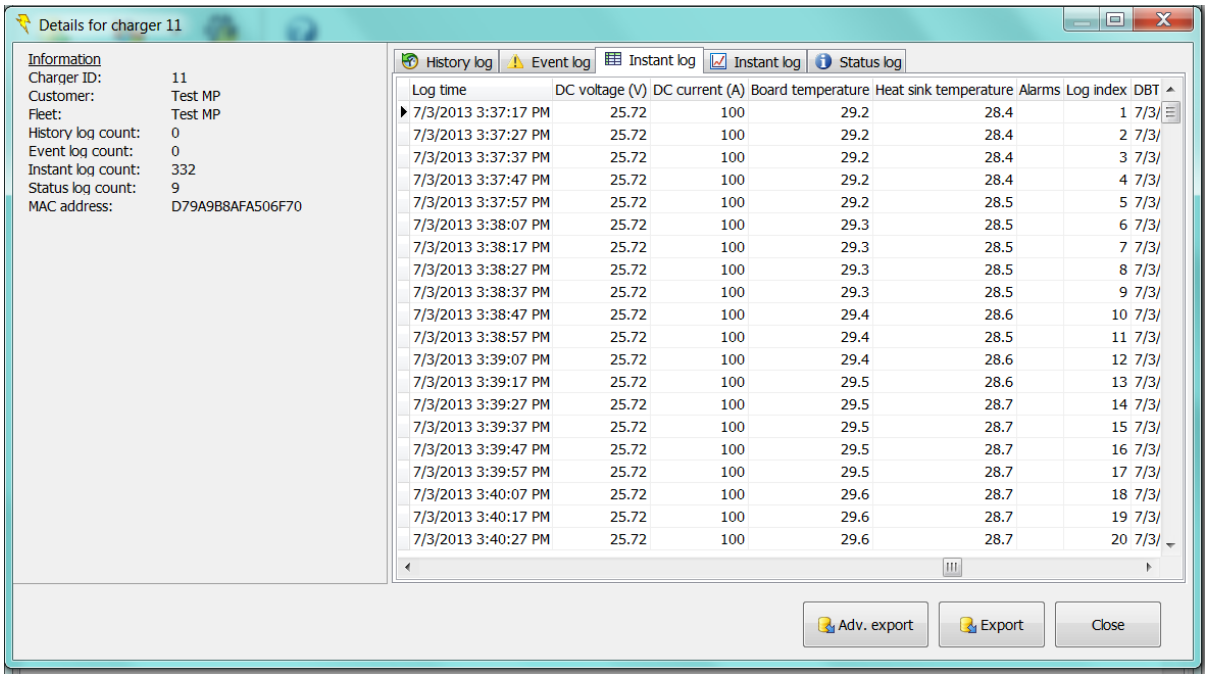


2. Put the marker on *Instant log* and press **OK.** The following menu is shown. Note that when the sample period as in this case is set to zero no instant log will be stored.

3. To edit the sample period put the marker on *Period* and press **OK.** If necessary enter the level 2 pin-code and choose the desired sample period using the up, down, left and right arrow. Press **OK** to confirm when ready. See the tutorial *Edit parameters* for more information.

4. Press **ESC** until the main menu is shown.

5. The values can now be imported to the instant log in the SBS MicroSMART service tool. See the *SBS MicroSMART Applications User manual* for more information.

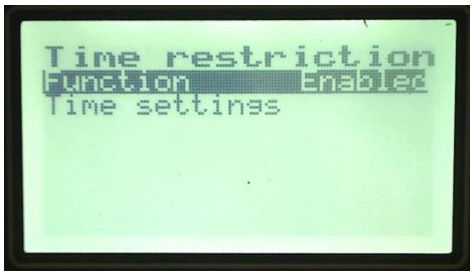


9.12. Activate time restricted charge

This function makes it possible to in advance enter when charging should be forbidden. This could for example prevent charging at certain times during the day when the fees for electricity are especially high. For more information, see *5.5.3 Time restrictions*. This is a tutorial for how to activate time restricted charge.

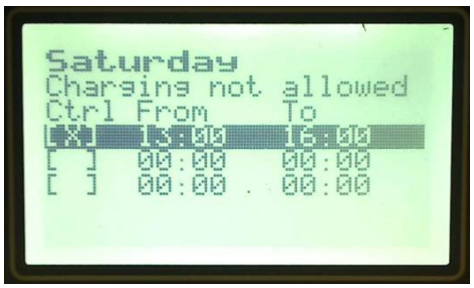
1. While in the service menu select *Time restrictions.* The following menu isshown.

2. Set the field *Function* to *Enabled*. See the tutorial *Edit parameters* for more information.



3. Put the marker on *Time settings* and press **OK**. Select then the weekday for which charging should be restricted. Confirm by pressing **OK.** The following menu is shown.

4. Select a row and press **OK.** To activate restricted charge the column *Ctrl* should be marked with a X. Then choose between which times charging should be prohibited. Confirm with **OK** when ready. In this example charging will not be able to take place on Saturday between 13.00 and 16.00. Note that it is possible to have a maximum of 3 time intervals per day when charging will be forbidden.

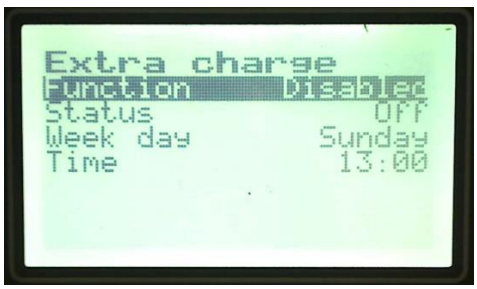


5. Press **ESC** until the main menu is shown.
6. Below is a picture of the main screen during a time when charging is prohibited.

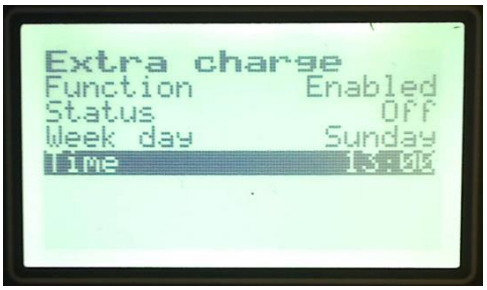
9.13. Activate an extra charge

To make sure the battery really is fully charged when needed the most, an extra charge can be carried out prior to use. See *5.5.4 Extra charge* for more information.

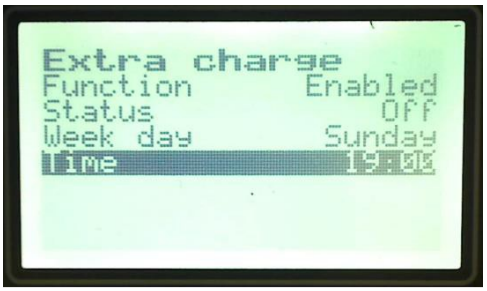
1. While in the service menu put the marker on *Extra charge* and press **OK**. The following menu is shown.



2. Set the field Function to Enabled. See the tutorial *Edit parameters* for more information.



3. It is now possible to edit at which time and weekday the charging should be started by choosing the parameter to change and press **OK**. Use the up, down, left and right arrows to choose the desired value and confirm with **OK** when ready. Note that in this example an extra charge will take place on Sunday 19.00.

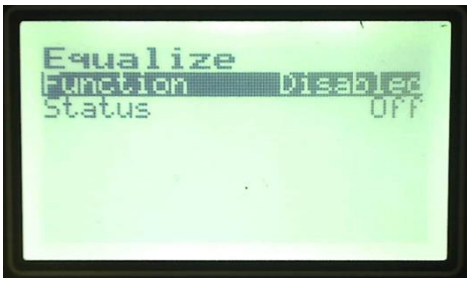


4. Press **ESC** until the main menu is shown.

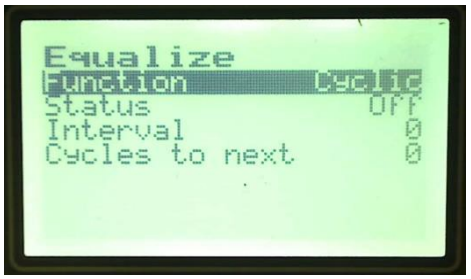
9.14. Activate an equalize charge

To assure that all cells in the battery are equally charged it is preferable to every now and then execute an equalize charge. See *5.5.5 Equalize* for more information.

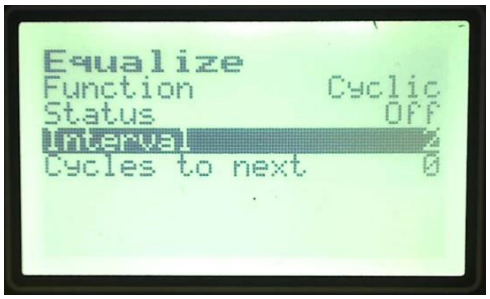
1. Go to the service menu and select *Equalize*. The following menu is shown.



2. Set the field *Function* to either *Cyclic* or *Weekday*. If *Cyclic* is chosen, the following menu is shown.



3. With the parameter *Interval* it is possible to define with which interval equalize charge should be carried out. To edit the parameter put the marker on *Interval* and press **OK**. Select the desired value with up, down, left and right arrows. Confirm with **OK** when ready. Note that in this example equalize charge will be executed every third cycle because the value on *Interval* is set to 2. In this menu it is also possible to see how many charging cycles remains before an equalize charge will occur. In this case an equalize charge will be executed the next charge because the value on *Cycles to next* is 0.

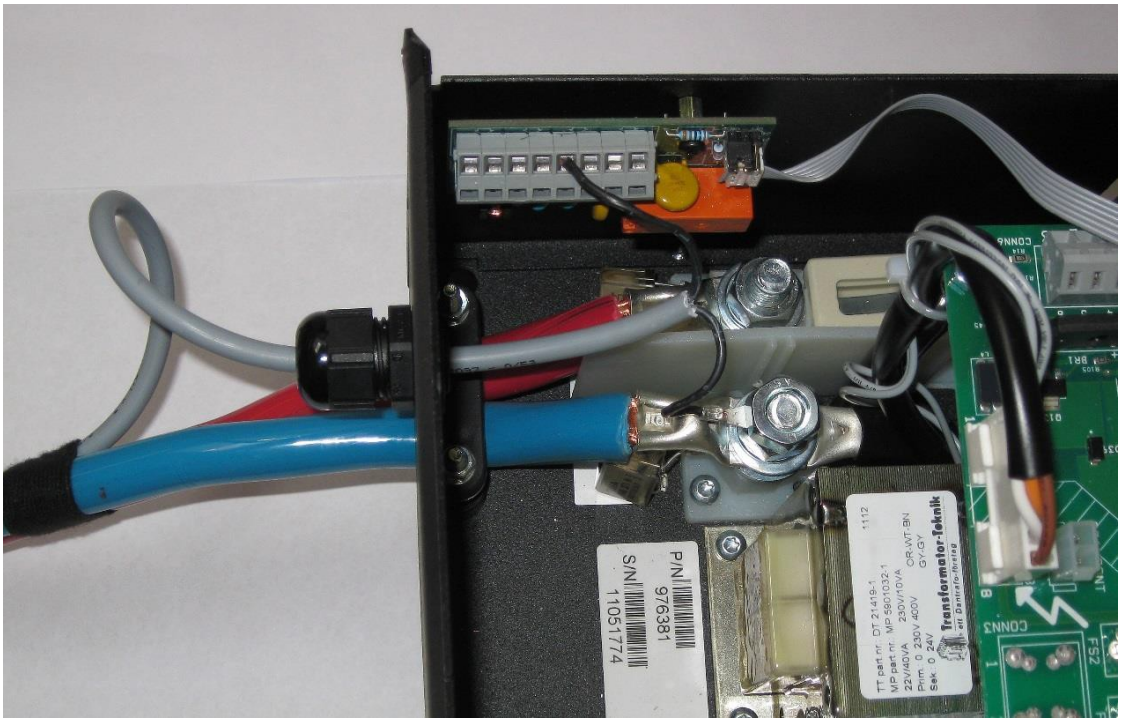


4. Another option is to select *Weekday* in the field *Function.* Equalize charge will now be done on every charge started on the specified day, in this case a Saturday.

5. Press **ESC** until the main menu is shown.

9.15. Activate Remote in Start/Stop

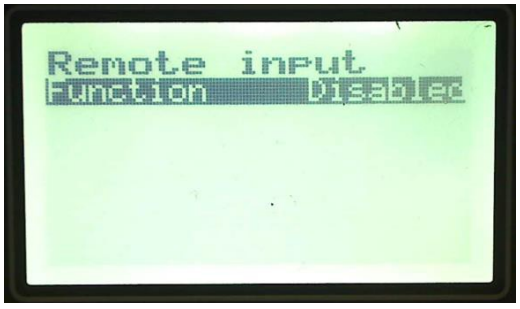
With I/O control means that the charger can be set either to be controlled by external functions (Remote input) or to control external functions (Remote out). See *5.5.7 I/O control* for more information. The remote input is activated when connected to the battery minus i.e. when the charger is connected with the connector to the battery. See the pictures below for a better understanding. The remote input connection is placed on Pin 4 on the I/O board in the bottom left corner and can via the red and black connections on the glove be connected to battery minus. This cabling can be installed during the manufacturing process if requested upon order.



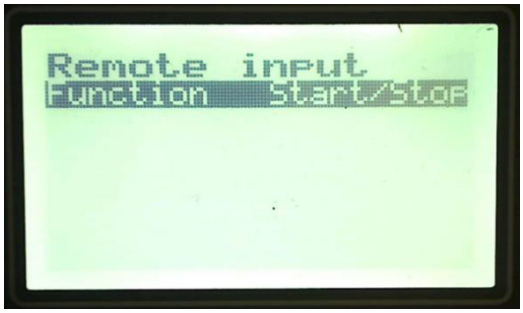
The remote input function can be set to a state called *Start/Stop* where charging only can occur when remote input is activated i.e. connected to battery minus. This function makes it possible to activate and deactivate charging simply by connect respectively disconnect the charger from the battery. Here follows a tutorial for how this function can be activated.

1. While in the service menu put the marker on *I/O control* and press **OK**. The following menu is shown.

2. Select *Remote input* and press **OK.**



3. Put the marker on the field *Function* and press **OK**. If necessary, enter the level 1 pin-code and select *Start/Stop.* See the tutorial *Edit parameters* for more information.



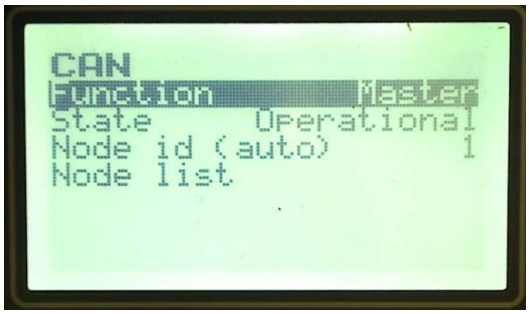
4. Press **ESC** until the main menu is shown. Note that charging now only can be carried out when remote input is connected to battery minus. If the battery is disconnected from the charger during ongoing charge the following message will appear and one of the status indicators will be flashing yellow. Note that charging is terminated within approximately 20 ms from the point when the charger and battery are disconnected from each other. Charging can be resumed by connecting the charger to the battery again.

9.16. Activate parallel control

The parallel control function offers the opportunity for several chargers to cooperate in order to charge the battery with a higher charging current and thereby faster. This can be useful in situations where a fast charge of the battery is essential. This function is designed to primarily work with chargers of the same type for example 48/80. See *5.5.13 CAN* for more information. Note that one of the chargers has to act as a master and control the other chargers (slaves) in the cluster. How the charging process will be carried out will be determined entirely by the master and the slaves will comply with the charging parameters set by the master. The different chargers in the cluster are connected to each other via the CAN connections on the I/O Board, CAN High to CAN High and so forth. See *Appendix 1 I/O Board connections* for more information regarding which PINs to use. Here follows a tutorial for how to activate parallel control.

1. While in the service menu put the marker on *CAN* and press **OK**. The following menu is shown.

2. Set the field *Function* to *Master*. See the tutorial *Edit parameters* for more information.



3. On another charger in the cluster follow the same procedure but set instead the field *Function* to *Slave*.

4. On the charger which is set to *Master* a new menu has appeared in the service menu. Put the marker on *Parallel control* and press **OK**. The following menu is shown.

5. Set the field *Function* to *Enabled.*

6. Enter the menu *Charger select*. Here it is possible to choose which chargers should be a part of the cluster by making sure the charger is marked with an X in the column *Ctrl*. In the column *S/N* the serial numbers of the present chargers are viewed. Note that also the charger which acts as master has to be selected.

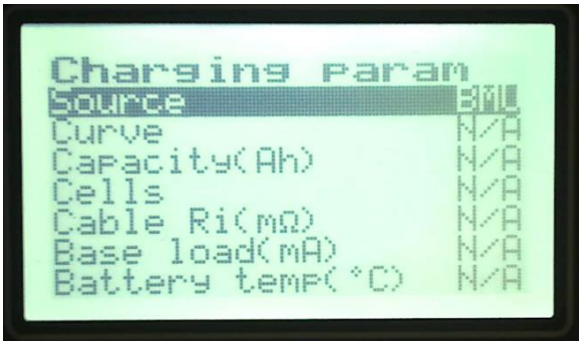
7. Press **ESC** until the main menu is shown. The chargers will now work together in order to be able to charge the battery even faster. How the charge is carried out is controlled entirely by the master. Below you can see the main screen of a charger which acts as a slave in the cluster. Note that a cluster can have of maximum of 5 slaves and 1 master.

In order for the parallel control function to work it is important that all chargers in the cluster have their secondary cable connected to the battery.

9.17. Activate BMU controlled charge

If desired by the user, the charging can also be carried out according to charging parameters set by a BMU (Battery monitoring unit). The BMU has to be mounted on the battery and correctly configured. The charging parameters in the BMU are editable via the SBS MicroSMART service tool. See *SBS MicroSMART Applications User manual* for more information. Note that in order for the BMU to be able to control the charging process the BMU and the charger has to be on the same network.

1. In the service menu enter the menu *Charging param*. In the field *Source* choose *BMU*. Press **OK** to confirm.

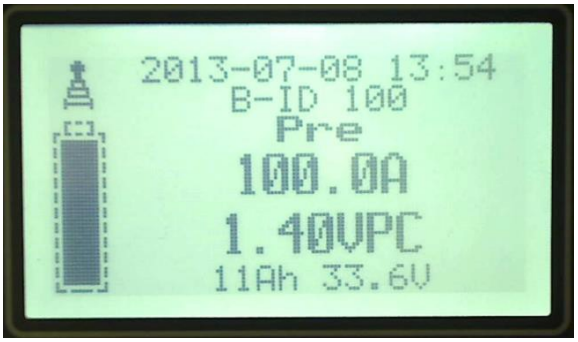


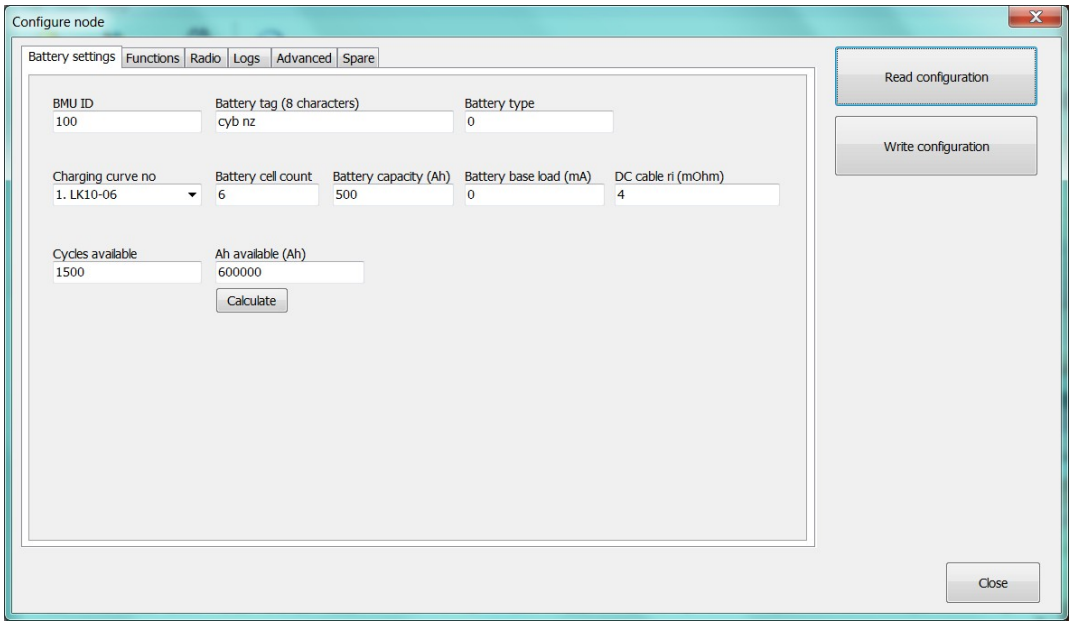
Press **ESC** to return to the main menu when ready.

2. The Charger will now try to establish a connection with the BMU.

3. If the attempt was successful, the following message will appear.

4. The BMU will now control the charging process and charge the battery according to the parameters in the BMU. The charging parameters for the BMU can be edited in the *Configure node* menu in the *SBS MicroSMART service tool*.





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10. Appendix 3, Menu structure

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11. Appendix 4, Statistic logs

The statistic logs are stored in the charger available for read out using the SBS MicroSMART Service tool.

11.1. History log

Charger ID	Charger identifier. Configurable via the charger menu system or *Advanced, Configure charger* in Service tool.
Customer	*Customer* entered at import of data.
Fleet	*Fleet* entered at import of data.
Charge index	The charge index since last *Clear statistics* was performed in the charger.
Charging mode	The source of the charging parameters. The possible values are: • User def, user defined parameters in the service menu. • BM, parameters have been uploaded from the battery monitoring unit. In the charger this is displayed as *Source*.
Charge start time	The date and time when the charge cycle was started, i.e. battery connected. Charger local time.
Charge end time	The date and time when the charge cycle was ended, i.e. battery disconnected. Charger local time.
Charge duration	The difference between *Charge start time* and *Charge end time*. Maximum 99 hours.
Active charge time	Time between *Charge start time* and *Charge end time* when the power unit has been active. Maximum 99 hours.
Totally charged Ah	Ampere hours charged between *Charge start time* and *Charge end time*.
Totally charged Wh	Watt hours charged between *Charge start time* and *Charge end time*.
Charged Ah, main (%)	Ampere hours in percent of capacity charged in main charging phase. Cycles with *Charged Ah, main* below 1 Ah aren't stored as a log.
Start VPC (V)	Actual battery voltage per cell when the battery was connected to the charger. Measured before start of charge.

End VPC (V)	Actual battery voltage per cell when the charging main stage was completed. Measured prior to main charge end. If the battery is disconnected prior to completion of the main stage *End VPC* will be the battery voltage per cell 5 seconds before the battery was disconnected.
Pre charge	*True* indicates that the *Pre charge* phase has been entered. False indicates that the *Pre charge* phase has not been entered.
Main charge	*True* indicates that the *Main charge* phase has been entered. False indicates that the *Main charge* phase has not been entered.
Additional charge	*True* indicates that the *Additional charge* phase has been entered. False indicates that the *Additional charge* phase has not been entered.
Charge ready	*True* indicates that the charging was completed, *Ready* phase has been entered. False indicates that the charging was not completed, i.e. the battery was disconnected prior to the green lamp being lit.
Equalize charge	*True* indicates that the *Equalize charge* phase has been entered. False indicates that the *Equalize charge* phase has not been entered.
Equ time	Time in *Equalize charge* phase. Time is calculated as clock time during *Equalize charge*.
Equ Ah	Ampere hours charged in *Equalize charge* phase.
Equ Wh	Watt hours charged in *Equalize charge* phase.
Battery ID	Identifier of the battery connected to the charger. Only relevant if *Charging mode* set to BM.
Charging curve	Name of the charging curve being used.

Capacity	Battery capacity in ampere hours used in this charging cycle.
Cells	2 V battery cell count used in this charging cycle.
Cable Ri	Battery cable resistance used in this charging cycle.
Base load	Base load being present in the charging circuit during charging used in this charging cycle.
Charger model	The power unit description.
Start heat sink temp	Temperature of the heat sink when battery connected. Measured before start of charging.
End heat sink temp	Temperature of the heat sink when battery disconnected. Measured after disconnection of the battery.
Max heat sink temp	Maximum temperature of the heat sink between *Charge start time* and *Charge end time*.
Alarms	Blank if no alarms present during charge cycle. Text according to alarm description in charger.
Event index start	Index of the *Event log* at start of charging.
Event index end	Index of the *Event log* at end of charging. A difference in *Event index start* and *Event index end* indicates that there have been some errors or other events during the charging cycle. See event log with *Event index* between *Event index start* and *Event index end* for details.
Charge total index	Total charge cycle count since startup. This number can be used as a unique identifier of the charging cycle in case a *Clear statistics* is made in the charger.

11.2. Event log

Event index	Event identifier. If *Clear statistics* is made in the Charger this index starts over on 1.
Event time	Time stamp when the event occurred in the charger. Charger local time.
ID	Event identifier, the following variants exists: 1. Time is set 2. Charge started (not used) 3. Charge ended (not used) 4. Alarm 5. Alarm

	6. Charging parameters changed 7. VCC status 8. Voltage calibration 9. Current calibration 10. Start of radio network 11. Join of radio network 12. Charger start up 13. Settings changed in charger
Information	Information about and data connected to the event.

11.3. Instant log

Charger ID	Charger identifier. Configurable via the charger menu system or Advanced, Configure charger in Service tool.
Log time	Time stamp of the instant log. Charger local time.
DC Voltage (V)	Actual battery charging voltage. If a Cable Ri is defined this voltage will be (measured charging voltage – Cable Ri*measured battery charging current).
DC Current (A)	Actual battery charging current. If a Base load is configured this charging current will be measured charging current – Base load.
Board temperature	Charger control board internal temperature.
Heat sink temperature	Charger heat sink temperature.
Alarms	Blank if no alarms present during charge cycle. Text according to alarm description in charger.
Log index	Total instant log count since startup. This number can be used as a unique identifier of the instant log cycle in case a Clear statistics is made in the charger.

11.4. Status log

All information in the status log is measured momentarily at read out time.

Charger model	The power unit description.
Time	Charger local time.

Charge time total	Total time in operation since reset of statistic information. The time is calculated when the power unit is active.
Charged Ah	Totally charged ampere hours since last reset of statistic information.
Wh (AC)	Totally watt hours drained from mains supply since last *Clear statistics*.
AC OVP	Number of mains over voltage protection activations.
Cycles 2-25 %	Number of charging cycles where 2-25% of battery capacity have been charged in the main charging phase.
Cycles 26-50 %	See above.
Cycles 51-80 %	See above.
Cycles 81-90 %	See above.
Cycles >90 %	See above
Charging mode	The source of the charging parameters. The possible values are: • User def, user defined parameters in the service menu. • BM, parameters have been uploaded from the battery monitoring unit. In the charger this is displayed as *Source*.
Charging curve	Configured name of the charging curve.
Capacity	Battery capacity in ampere hours used in this charging cycle.
Cells	Configured 2 V battery cell count.
Cable Ri	Configured Battery cable resistance.
Base load	Configured base load being present in the charging circuit during charging.
Charging Errors	Bit coded charging errors. • Bit0: Low battery voltage • Bit1: High battery voltage • Bit2: Charge time limit exceeded • Bit3: Charge Ah limit exceeded • Bit4: Incorrect charge curve • Bit5: Tilt sensor error • Bit6: High battery voltage, power unit shut off • Bit7: Battery error • Bit8: High battery temp (BMU) • Bit9: Low electrolyte level (BMU) • Bit10: Battery voltage not in balance (BMU)

Regulator Errors	Bit coded regulator errors. • Bit0: Phase error • Bit1: Regulator error • Bit2: Low heat sink temperature • Bit3: High heat sink temperature • Bit4: Low board temperature • Bit5: High board temperature • Bit6: High trafo temperature • Bit7: CAN timeout • Bit8: Slave Phase error • Bit9: Slave Regulator error • Bit10: Slave Low heat sink temperature • Bit11: Slave High heat sink temperature • Bit12: Slave Low board temperature • Bit13: Slave High board temperature • Bit14: Slave High trafo temperature • Bit15: Slave CAN timeout
Charging status	Bit coded charging status. • Bit0: Mains connected • Bit1: Battery connected • Bit2: BM connected • Bit3: Main charging • Bit4: Additional charging • Bit5: Equalize charging • Bit6: Maintenance charging • Bit7: Charging completed • Bit8: Pause • Bit9: Pre Charging • Bit10: Force start • Bit11: BBC • Bit12: Low battery temp • Bit13: High battery temp • Bit14: Charging restricted
Regulator status	Bit coded regulator status. • Bit0: Voltage error is used • Bit1: Current error is used • Bit2: Power error is used • Bit3: Voltage is near the set value • Bit4: Current is near the set value • Bit5: Power is near the set value • Bit6: Derating output due to temperature • Bit7: Overtemperature, no output • Bit8: Derate Uset because charger can’t deliver output

	• Bit9: Derate Iset because charger can't deliver output • Bit10: Derate Pset because charger can't deliver output • Bit11: Overvoltage • Bit12: Overcurrent • Bit13: Overpower • Bit14: Charger can't deliver rated output • Bit15: Charger can't deliver output
Board temperature	Charger control board internal temperature.
Heat sink temperature	Charger heat sink temperature.
Battery ID	Identifier of the battery connected to the charger. Only relevant if *Charging mode* set to BMU.

11.5. Momentary log

The momentary log is not stored in the charger but can be read out momentarily by the SBS MicroSMART Service tool.

DC Voltage (V)	Actual battery charging voltage. If a *Cable Ri* is defined this voltage will be (measured charging voltage – *Cable Ri**measured battery charging current).
DC Current (A)	Actual battery charging current. If a *Base load* is configured this charging current will be measured charging current – *Base load*.
Board temperature	Charger control board internal temperature.
Heat sink temperature	Charger heat sink temperature.

12. Appendix 5, Power units

12.1. Matrix

Primary voltage	1x230	3x220	3x400	3x440	3x480	3x600
Secondary voltage/current						
24/120	12					
24/130		111	106	106	107	
24/150			7	40		
24/170					30	
24/200			28			
24/300			(21)	60		
24/340			17			
24/400			23			
36/80	11					
36/105		112*	109	109	108	
36/150			16	41		
36/170		33			24	
36/220			58		27	49
36/300				61		
36/340		55			25	
36/420		59			46	52
48/60	13					
48/80		113	105	105	110	
48/100			8	42		
48/130		34	14	43		
48/165			36	65	31	50
48/200			18			
48/260		56	22	62		
48/330			38		47	53
80/60			9	44		
80/80		35	15	45	26	
80/100			37	63	32	51
80/120			19			
80/160		57	20	64	29	
80/200			39		48	54

*36/100.

12.2. Chronological list

Power unit	Description
0	SBS MicroSMART 24/45
1	SBS MicroSMART 24/80
2	SBS MicroSMART 36/22

3	SBS MicroSMART 48/20
7	SBS MicroSMART 24/150
8	SBS MicroSMART 48/100
9	SBS MicroSMART 72-80/60
11	SBS MicroSMART 36/80
12	SBS MicroSMART 24/120 (replaces code 5 from version 4)
13	SBS MicroSMART 48/60 (replaces code 6 from version 4)
14	SBS MicroSMART 48/130
15	SBS MicroSMART 72-80/80
16	SBS MicroSMART 36/150
17	SBS MicroSMART 24/340
18	SBS MicroSMART 48/200
19	SBS MicroSMART 72-80/120
20	SBS MicroSMART 72-80/160
21	SBS MicroSMART 24/300 (Not available)
22	SBS MicroSMART 48/260
23	SBS MicroSMART 24/400
24	SBS MicroSMART 36/170 480 V
25	SBS MicroSMART 36/340 480 V
26	SBS MicroSMART 80/80 480 V
27	SBS MicroSMART 36/220 480 V
28	SBS MicroSMART 24/200 400 V
29	SBS MicroSMART 80/160 480 V
30	SBS MicroSMART 24/170 480 V
31	SBS MicroSMART 48/165 480 V
32	SBS MicroSMART 80/100 480 V
33	SBS MicroSMART 36/170 220 V
34	SBS MicroSMART 48/130 220 V
35	SBS MicroSMART 80/80 220 V
36	SBS MicroSMART 48/165 400 V
37	SBS MicroSMART 80/100 400 V
38	SBS MicroSMART 48/330 400 V
39	SBS MicroSMART 80/200 400 V
40	SBS MicroSMART 24/150 440 V
41	SBS MicroSMART 36/150 440 V
42	SBS MicroSMART 48/100 440 V
43	SBS MicroSMART 48/130 440 V
44	SBS MicroSMART 80/60 440 V
45	SBS MicroSMART 80/80 440 V
46	SBS MicroSMART 36/420 480V
47	SBS MicroSMART 48/330 480V

48	SBS MicroSMART 80/200 480V
49	SBS MicroSMART 36/220 600V
50	SBS MicroSMART 48/165 600V
51	SBS MicroSMART 80/100 600V
52	SBS MicroSMART 36/420 600V
53	SBS MicroSMART 48/330 600V
54	SBS MicroSMART 80/200 600V
55	SBS MicroSMART 36/340 220V
56	SBS MicroSMART 48/260 220V
57	SBS MicroSMART 80/160 220V
58	SBS MicroSMART 36/220 400V
59	SBS MicroSMART 36/420 400V
60	SBS MicroSMART 24/300 440 V
61	SBS MicroSMART 36/300 440 V
62	SBS MicroSMART 48/260 440V
63	SBS MicroSMART 80/100 440 V
64	SBS MicroSMART 80/160 440V
65	SBS MicroSMART 48/165 440 V
100	GTM Access 48/160 (Not available)
101	GTM Access 48/320 (Not available)
102	GTM Access 80/100 (Not available)
103	GTM Access 80/200 (Not available)
104	GTM Access 80/200 (Not available)
105	SBS MicroSMART 48/80 380-440V (Access 50)
106	SBS MicroSMART 24/130 380-440V (Access 50)
107	SBS MicroSMART 24/130 480V (Access 50)
108	SBS MicroSMART 36/105 480V (Access 50)
109	SBS MicroSMART 36/105 380-440V (Access 50)
110	SBS MicroSMART 48/80 480V (Access 50)
111	SBS MicroSMART 24/130 300-240V (Access 50)
112	SBS MicroSMART 36/100 200-240V (Access 50)
113	SBS MicroSMART 48/80 200-240V (Access 50)