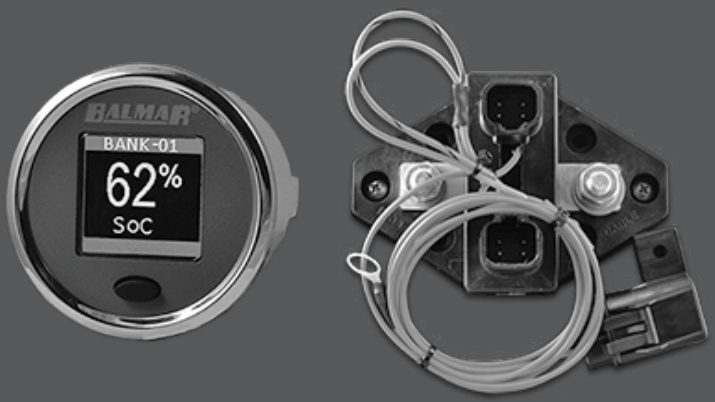
BALMAR®
DC CHARGING SOLUTIONS

SG200

BATTERY MONITOR

Installation & Operation Manual



SUP-0250 REV D.

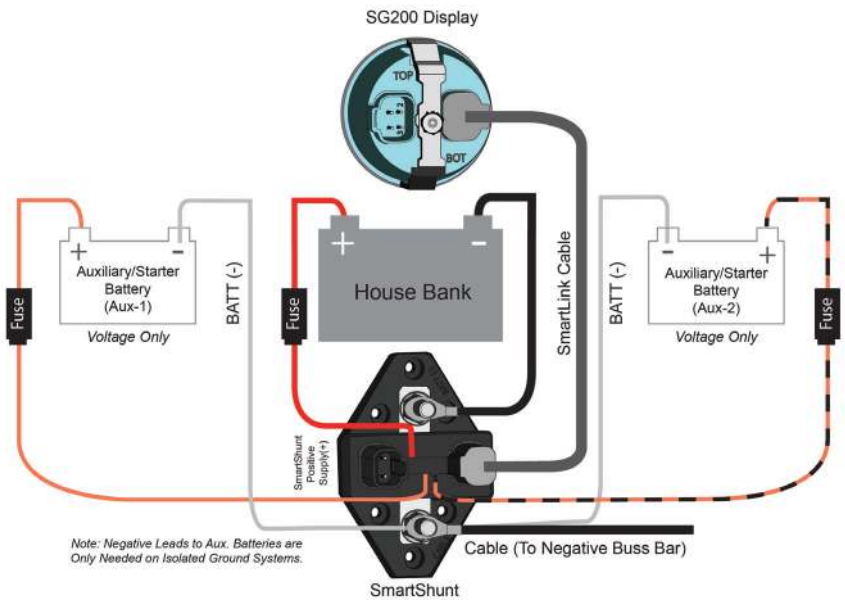
Table of Contents

Safety Precautions

1. Take time to read the manual. Equipment damage and possible injuries may result from an incomplete understanding of the installation and operation of the SG200 Battery Monitor. If you are unfamiliar with marine electrical systems, consult with a qualified marine electrician.
2. Always disconnect your battery banks and ensure that switches are “OFF” prior to installing the SmartShunt. No current should be flowing when the SmartShunt is installed!
3. Remove all metal jewelry while working on your electrical system, to avoid any completing a circuit with these items, especially bracelets, rings or handing necklaces.
4. Wear ANSI-approved safety eye-wear and protective gear.
5. DO NOT attempt to modify the SmartShunt or Display. Modifications could result in damage to your charging system and will void your warranty.
6. DO NOT attempt installation while using alcohol or medication that could impair your judgment or reaction time.
7. Always use the right tool for the job. Improper tool use may damage the shunt, gauge or your vessel, and could result in personal injury.
8. If installing in an engine compartment with a gasoline engine, proper ventilation practices must be used to ensure no explosive gases exist before installation.
9. If installing a compartment with batteries, the compartment must be properly ventilated to ensure no build-up of explosive gases prior to installation.

Installation Overview

CAUTION & WARNING: Batteries are hazardous devices. Please follow battery manufacturer's recommendations for health and safety. Use only the appropriate tools in conjunction with manufacturer's instructions. Isolate both battery and AC power supplies before attempting installation.



CAUTION & WARNING: The Installation Overview does not refer to each and every Caution & Warning Statement in this manual. Be sure to observe safe working practices at all times. Refer to the full manual if you are unsure of any practices that may damage the SG200 Battery Monitor unit, your system wiring or health.

The SG200 is designed to monitor a battery or battery bank which is used in deep cycling applications. It relies on the battery being discharged and then charged to learn the battery's characteristics. This learning process may never occur on a start-only battery, since it is never cycled. However, The SG200 does have two additional leads to connect to starting batteries to read voltage only.

NOTE: If a SG200 is used to monitor a starting-only bank using the cable posts, and not the voltage-only leads, then an accurate state of health may not be determined or maintained.

The diagram above shows a typical installation with one house battery bank, and two auxiliary or engine start batteries.
If multiple displays or shunts are being installed, they may simply be daisy-chained with additional SmartLink communication cables.
Negative leads from auxiliary batteries to the shunt are not needed in a common-ground installation.

CAUTIONS & WARNING: DO NOT install any of the positive leads without proper fusing!!!

NOTE: The fuse holder is shipped without the fuse installed. Install the fuse AFTER completely connecting all of the wires/cables, and all other installation steps.

The SG200 will scale automatically to the voltage of commonly used battery systems (12v,24v,36v,48v.)

Initial configuration of the SmartShunt consists of setting the following parameters.

1. Battery Chemistry
2. Battery Capacity

For complete instructions, follow the rest of this manual.

Introduction

The SG200 is a battery monitoring system. It's purpose is to provide the user with continuous information on various parameters of a battery or battery-bank, and of direct current (DC) usage in the system.

Specifically, it can show:

Parameter	Unit
Voltage	Volts (V)
State of Charge (SoC)	Percent (%)
State of Health (SoH)	Percent (%)
Current (A)	Amperes (A)
Time Remaining	Hours: Minutes
Voltages for two separate Auxiliary batteries	Volts (V)

What is a battery monitor, and why is it important?

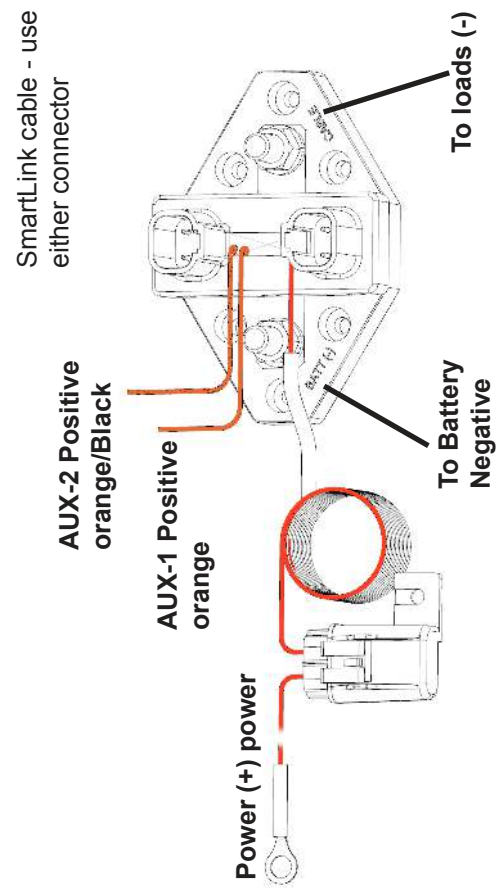
Who would argue that it is not good to know how much power is left in a battery? It is like a fuel gauge, and you would not drive a car or boat without knowing how much fuel is remaining in the tank. Enter the battery monitor. The most important function of a battery monitor is to report the State of Charge of a battery or battery bank. The State of Charge (SoC) is a percentage value showing what percentage of the battery's capacity is remaining.

The SG200 very accurately calculates the State of Charge, and it does so by incorporating a new feature: State of Health (SoH). State of Health is another percentage value, that compares the design capacity of a battery, or the capacity the battery's manufacturer says it should be when new, with it's actual capacity, which degrades over time as a battery ages.

Accurate and continuous measurement of SoC and SoH is a breakthrough in battery monitoring. As the battery ages, the monitor does not get less and less accurate. Instead, the SoC value is always a percentage of the calculated capacity taking into account the aging and other detrimental effects on a battery's capacity.

The SG200 also is unaffected by other issues inherent in all other shunt-based systems, like accuracy drift over multiple partial state of charge cycles. Simply put, traditional shunt-based products need to reach 100% charge each cycle. Inaccuracy is introduced that is multiplied with each additional cycle that does not reach full 100% charge.

For more information about issues that effect battery health and capacity, read the Appendix entitled "Factors Affecting Battery Life"



Installation

Included in the Box

The following parts are included in the standard SG200 System Kit.

(1) SmartShunt, with 60” fused positive-lead wire.
(1) Color Display
(1) Display mounting bracket and nut
(1) 10m SmartLink Cable
(1) SmartLink Deutsch-style connector kit, with a connector and wedgelock.
(1) Fuse for positive wire
(1) This manual

Not Included in the Box

1. Mounting fasteners for the SmartShunt. These should be #8 sized cap-head bolts or screws, depending on the mounting surface.
2. Additional fuse assemblies for the Aux-1 and Aux-2 voltage leads. ABYC rules specify that circuit protection (fuses) should be located within 6” of the power source
3. Additional battery cable.

The SmartShunt should be mounted to a firm surface in a dry location. All cables need to be sized for the maximum current flow. Undersized cables can present a fire hazard and adversely affect the performance of the SmartShunt.

Tools needed:

- 9/16” wrench or socket and wrench.
- Any tools required for owner-supplied mounting fasteners.
- 2.0625”, or 53mm hole saw suitable for the mounting surface, if a suitable a display hole does not already exist.

Installing the SmartShunt and Display

CAUTION: High currents may be carried by the battery cables attached to the SmartShunt. If you are unsure of any part of the installation, refer to a qualified installer for their assistance.

Although the SmartShunt uses watertight connectors for the SmartLink cable, the overall design is not waterproof. The SmartShunt must be installed in a dry location. The Display is IP65 rated from the front when installed properly, but is NOT watertight from the rear to allow for condensation to exit the Display.

NOTE: Should the LCD need cleaning, it can be done with water and a clean cloth. No chemicals of any type should be used

The SmartShunt is installed in-line with the negative battery cable of the battery system or bank that you wish to monitor. If you are designing a new system, refer to a wire size chart to determine the correct size cable to use in the installation. The cables should be sized for the lowest percentage voltage drop that is practical, and should not exceed 3%.

NOTE: Do not install any positive voltage-carrying wires to the SmartShunt studs - ONLY negative cables. The SmartShunt will not work on the positive side of an installation.

The SmartShunt should be located as close to the battery as possible, preferably within a few feet (1 meter). The SG200 uses the SmartShunt to measure current, or how many amperes are going into or out of the battery. Because of this, you must ensure that no loads (like a bilge pump) or sources (like an inverter) are connected directly to the battery. ALL loads and sources MUST terminate their negative connection at or before the “CABLE” end of the SmartShunt. If there are multiple connections to be made, a buss bar can be installed directly prior to the SmartShunt.

NOTE: If you have a shore-power charger, inverter or inverter-charger, they may have both a Positive and Negative cable directly connected to the battery. The positive cable can stay, but the negative cable must be moved to a position at or before the “CABLE” stud on the SmartShunt.

NOTE: The SG200 needs to be powered continuously to correctly function. While disconnecting for an extended layup period is advisable, disconnecting over short periods of time between usage will lead to incorrect SoC and SoH readings.

Installation Steps

NOTE: The purpose of this manual is to enable the installer to install SG200 in a manner that permits it to operate as designed. This manual is not intended to educate the installer on the regulatory requirements of any particular type of installation. The manufacturer, supplier, dealer and/or their agents cannot know what the final installation will be and therefore cannot know what the regulatory requirements of such installation may be.

1. Determine a mounting location and mount the SmartShunt. The surface should be flat. Do not install the SmartShunt on a curved surface. Note that the cable connection bolts are not insulated on the underside of the SmartShunt and therefore cannot be mounted onto a conductive surface.
2. Remove all loads and charging sources from the battery before any other steps are taken. This often is accomplished by turning off a battery switch. If there are loads or chargers directly attached to the battery, they should be disconnected as well.
3. Connect the negative cables to both sides of the studs, as shown below.

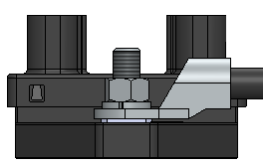
NOTE: In a simple installation, the battery Negative (-) cable is removed from the battery, and connected to the “CABLE” end of the shunt. Then a new, short cable is installed from the “BATT” (-) stud to the battery.

4. Re-install the lock washers and nuts on the shunt, the battery cable lug goes first, then the washer, and then the nut.

NOTE: DO NOT PLACE ANYTHING between the battery lug and the face of the shunt. Do not use nylock nuts in place of the lock-nut and washer.

5. Connect the 60” Power lead to the battery POSITIVE+ terminal. DO NOT EXTEND the wire from the fuse to the fuse holder, this must be kept short for safety reasons.

NOTE: The fuse holder is shipped without the fuse installed. Install the fuse AFTER completely connecting all of the wires/cables and all other installation steps.



6. Connect the voltage sense leads to the auxiliary batteries. AUX-1 is a solid orange wire, and AUX-2 is orange/black. Each AUX lead needs to be fused within 6” of the battery. Fuses MUST BE INSTALLED FOR THESE WIRES, and are not included. The wires do not carry any current, so the fuse should be sized for the wire gauge and length. If you need to extend the wire, do so with at least 18ga wire.
7. If the auxiliary batteries being monitored do not share a common ground with the main battery bank connected to the shunt, a negative lead must be wired from the auxiliary battery’s NEGATIVE post to the “CABLE” post on the shunt.
8. Determine the mounting location of the Display. The Display is weather-tight from the front, but not the rear. Do not install the display where the rear of the unit is exposed to water. The cutout hole is 2.0625in in diameter. The maximum depth of surface that is supported is 1/2 inch. Once the hole is cut, remove the nut, washer and mounting brace, insert the display from the front and then replace the brace. Tighten the nut by hand, and then 1/2 turn or so. If it is being mounted in a plastic dash, do not over-tighten the nut or you could risk cracking the dash.
9. Run the SmartLink Cable from the SmartShunt to the Display. Since one end has the Deutsch connector pre-terminated, and the other does not, it may be better to start from one end or the other, depending on the installation. Make sure that there is chafe protection if the cable passes through bulkheads. The cable should be supported every 18 inches.
10. Install the Deutsch-style connector onto the pins of the SmartLink Cable. See the following section that illustrates this procedure.

NOTE: DO NOT insert pins before reading these instructions entirely.

11. Connect the Smartlink Cable to both the Display and the SmartShunt. You can connect to either connector on each device. Press the connector into the receptacle until it snaps into place.
12. Insert the included fuse into the fuse holder. At this point the Display will power up, and be operational in a few seconds.

NOTE: You may add a new device at any time. However, you MUST remove and re-apply power to the entire network for the new device to be recognized.

Installing the Deutsch-Style Connector

The receptacles for the connector come pre-terminated onto each wire. They must be installed into the connector as shown below.

1. Slide the heat shrink tubing over the bare wires.
2. Slowly push the receptacle into the appropriate hole, until a clicking sound is heard. Even though the holes look too small to accept the sockets they will fit, with the material expanding to form a seal around the sockets.

Position	Color
1	Green
2	White
3	Red
4	Black

3. Inspect the receptacle from the face of the connector. The receptacles should be flush with the face of the connector

4. Install the wedgelock into the face of the connector. It will click into place.
5. Heat up the heat shrink tubing to lock it into place. The tubing is not needed for water tightness, but does provide chafe protection to the exposed wires.

When the wedgelock is in place, you should just be able to see the ends of the receptacles through the wedgelock. You can refer to the factory-installed connector for guidance.

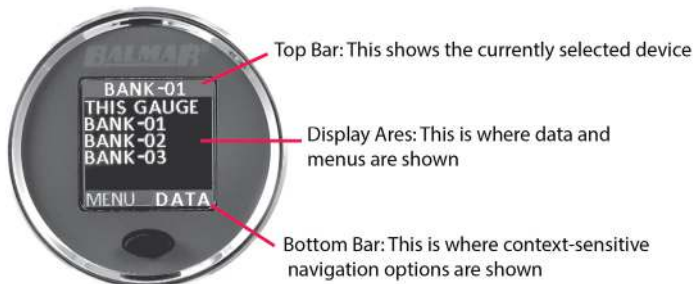
NOTE: When initially inserting the connector into the SmartShunt receptacle a light application of grease to the connector's rubber seal will reduce the force needed for insertion.

Adding an Additional Device to the SmartLink Network

You may add additional Displays and/or SmartShunts to the SmartLink Network, up to total of 32 devices. Most SmartLink devices have two connectors available to allow you to extend the network in either direction. The network design is a simple, point-to-point network. Do not create a loop

SG200 Layout and Operation

The SG200 has three main data display areas, as shown below.



Single Button Operation

The SG200 has a single button for ease of operation. A button press can be:

1. Short Press
2. Long Press (release as soon as screen flashes)
3. Extra-Long Press (about three seconds until checkerboard pattern shows: performs a network reset)

Short presses take you from one item on the screen to another. For instance, if the screen is showing Voltage, a single short press will change the screen to show Current in amperes.

A long press is used to make a selection or enable the editing of a value. As soon as you see flashing on the screen, you have made a long press and cab release your finger.

EXAMPLE: If you are looking at a list of devices on the SmartLink network, you can use short presses to move from one device to the next. When you have the desired device highlighted, a long press will select the device, and show the real-time data for that device. Similarly, if you are again back at the list of devices, and use short presses to highlight “Setup”, a single, long press will take you to the setup menu for the selected device.

The extra-long press will reset the SmartLink network, which may be helpful after software updates, in lieu of removing and replacing the fuse.

Bluetooth Gateway

The SG2-0300 Bluetooth gateway is a useful addition to the SmartLink network. It can be used to both monitor and configure SmartLink devices through an APP on both Apple and Android smartphones and tablets.
The Gateway also allows for periodic upgrading of devices, as new features or improvements are rolled out.

NOTE: There are differences in the functionality available when using the SmartShunt with the color display, or directly to the Balmar APP.

NOTE: When using the APP to upgrade SmartLink devices, always start with upgrading the Bluetooth Gateway itself, if it has an upgrade available.

Real-Time Data

Once a SmartShunt is selected, the SG200 will display the Real-Time Data for that SmartShunt. Selecting a different SmartShunt will allow you to view the data from that SmartShunt and battery-bank. You will see the SmartShunt bank selected on the top bar of the SG200 screen.

Real-Time Data parameters

Parameter	Unit	Note
Voltage	**Volts (V)**	**Voltage of the Battery Bank**
State of Charge (SoC)	**Percent (%)**	**SoC is a percentage of the actual full-charge capacity of the battery, NOT the design capacity Also, See the section “Initial Accuracy”**
State of Health (SoH)	**Percent (%)**	**SoH is the battery’s existing, or actual aged capacity compared to the initial design capacity.**
Current	**Amps (A)**	**Shows the NET of simultaneous charge, minus any discharge.**
Time Remaining	**Hours: Minutes**	**Shows time remaining until battery is 50% (20% for $LiFePO_4$) discharged when the battery is discharging. When charging, shows the time until charge completion. .**
Voltages for two separate Auxiliary batteries	**Volts (V)**	**Typical usage would be the starter battery for one or two engines, or a single engine and generator.**

NOTE: If left on any MENU screen, the Display will revert to Real-Time Data after a time.

BALMAR DC CHARGING SOLUTIONS

Configuring the SG200 for First Use

When the SG200 Display is first powered up, a splash screen is shown. Pressing the button once will take you to either a screen where you can select the device to be monitored (If two SmartShunts are installed, for instance), or directly to the Real-Time Data if the only devices on the network are a single Display and a single SmartShunt. Before the SG200 can be used, you must configure the bank for the correct battery chemistry and the capacity of the battery bank.

Each SmartShunt on a SmartLink Network has it's own menu. If you only have one SmartShunt, it is automatically selected for you. Otherwise, select the SmartShunt that you wish to configure (Using the long-press method) and then select MENU, and then CONFIG. A complete description of the configuration options can be found in the CONFIG section later in this manual.

Initial configuration of the SmartShunt consists of setting the following parameters:

Battery Chemistry
Battery Capacity

The default chemistry is AGM-STD with a capacity of 100Ah.

NOTE: If SoH drops to zero after initially showing a different value, the battery may have a bad cell. If there are multiple batteries installed in a parallel bank, the voltage of each battery should be taken individually using a hand-held meter, as there may be a bad battery in the battery bank.

Initial Accuracy

The SG200 is a self learning product. It continuously monitors the battery bank, and self adjusts over time to improve the accuracy of the two most important parameters, State of Health (SoH) and State of Charge (SoC). On new battery systems, both the State of Health and the State of Charge values may be very close to accurate after the first full charge and a brief relaxation period. This is because the stored characteristics of each battery chemistry is made with healthy batteries. If the batteries are older, it will take a few cycles before these values can be relied upon, and you may see significant changes in these values during this time.

NOTE: The accuracy of the voltage and current measurements are calibrated at the factory and do not change over time.

Display

The Display menu allows for the configuration of the Display's colors, intensity and power usage.

MENU OPTION	DESCRIPTION
INTENSITY	Change the brightness of the color display
THEME	Change the color theme used on the display
PWR SAVE	Choose four power saving combinations of the Color Display, using timeout duration, and whether the Display is dimmed or turned off after timeout
TEST	Run through a test of the Color Display

NOTE: Regardless of the INTENSITY or PWR SAVE options selected, the SG200 Color Display will dim the backlight after 12 hours of non-use to conserve power.

History

The HISTORY sub-menu shows the following

MENU OPTION	DESCRIPTION
VIEW HISTORY	**Displays minimum and maximum values for the following parameters: Voltage, Current, SoC, SoH, Power (Watts)**
VIEW FAULTS	**Displays details on all faults recorded on the device.**
CLR HISTORY	**Reset the min-max values in HISTORY to the current values of those parameters.**

Viewing HISTORY steps the user through the minimum and maximum values recorded of the real-time data parameters. An additional set of values is shown here for POWER, expressed in watts.
When selecting FAULTS, you can select to view either current faults (if the condition leading to a fault is still present) or view information about the last fault of each type, as well as a counter showing how many times that particular fault has been triggered. See faults in FAULTS AND ALERTS for more information on faults.

Config

The CONFIG menu has the options listed below:

CONFIG OPTION	DESCRIPTION
BAT. TYPE	**Select the battery chemistry**
CAPACITY	**Set the battery capacity in Ah**
CHARGING	**Configure charging parameters**
ALERTS	**Configure ALERT thresholds**

BAT TYPE - Selecting the Battery Chemistry

The SG200 uses profiles for each common battery chemistry. It is important to select the chemistry that most closely represents the batteries being monitored. All batteries on the bank being monitored by the SmartShunt should be the same size, age and chemistry. If they are not, the SG200 may not present accurate information.

The currently selected battery type is noted with an asterisk (*) in front of the name. The default is AGM-STD (see the chemistry table). If this is your chemistry and the installation is new, you may either re-select the chemistry, ensuring that the SG200 is starting fresh, or exit back to MENU and move to the next step.

Chemistry Number	Chemistry Name	Description
00	FLOODLA	Flooded (Wet) Lead Acid
01	AGM-STD	AGM (Factory Default)
02	CARB-FOAM	Carbon Foam AGM
03	AGM-TPPL	Thin Plate Pure Lead AGM
04	DUAL-PURP	Dual Purpose Lead Acid
05	LIFEPO4	Lithium Phosphate
06	GEL	GEL

NOTE: Every time a chemistry is selected, all learning is lost, even if you re-select the currently used chemistry. This will mean that the SG200 will need a few charge cycles to obtain peak accuracy.

CAPACITY - Selecting a Battery Design Capacity

Once you select a chemistry, you must specify the capacity of the battery bank. This is the total design capacity of the entire bank, regardless of the battery's condition, or previously measured capacity. Typically the capacity is expressed as the 20-hour discharge rate. This may be written as something like "105Ah/20h" on the battery or battery documentation. If you cannot find an Ah specification for your battery, but it does show a reserve capacity (RC)

refer the Appendix "Converting Reserve Capacity to Amp Hours." CCA or MCCA values are not describing capacity and cannot be used to determine the battery capacity.

EXAMPLE: Consider three Group 31 batteries, each with a design capacity of 100 amp hours. They are connected in parallel to make a 12v, 300Ah bank. The design capacity to be entered is 300. Even if the batteries are older, and they have diminished in capacity, the bank capacity should always be entered as a design capacity.

To set the capacity, use a short press to highlight the digit to be changed. Once it is highlighted, a long press will allow you to edit that digit, then a short press to increment the value up When you have that digit set to the correct number, another long press will exit the edit mode for that digit, and move to the next. Do the same for all digits that need adjusting. When the value is correct, move the highlight to DONE on the bottom menu bar and perform a long press. The design capacity is now saved. If the design capacity is changed at any time, the system resets and any battery learning (described in "Initial Accuracy") is lost.

Note: Do not artificially lower the design capacity to account for a perceived pre-existing loss in capacity. The SG200 relies on the design capacity data being correct.

CHARGING - Charge Termination and Charge Efficiency

The CHARGE VOLTAGE and TAPER CURRENT are used together by the SG200 to determine when charge termination has occurred. This is indicated on the Display when a "+" sign shows on the SoC Display. Charge Termination is defined as when the battery is fully up to 100% of it's present capacity. Each of these values have defaults that are set per chemistry, but can be changed if required.

Selecting the CHARGING menu item brings up a sub menu, where the following options can be set:

NOTE: Each chemistry has default settings for the CHARGE values of CHARGE V and TAPER CURR. In certain circumstances these values may need to be changed when Charge Termination is not being reached. IN ALL OTHER CASES DO NOT CHANGE THESE VALUES. Changing the PEUKERT Value will not effect Charge Termination, only TIME REMAINING Calculations. See Appendix "Changing Charge Terminiation Values" for more information

Menu Option	Description
CHARGE V	**CHARGE VOLTAGE - Used in conjunction with Taper Current to determine when full charge has been reached. The measured voltage when Taper Current is reached must be above the threshold voltage calculated by CHARGE V - 300mv. On most chargers this happens at the end of the absorption stage, before it switches to FLOAT.**
TAPER CURR	**TAPER CURRENT - Used with the Charge Current to determine when a full charge has been reached. This is automatically scaled in relation to the battery bank's design capacity. If modifying, it should be set to slightly higher then the actual taper current (The current seen the absorption sated ends), often about 2-4% of the Full Charge capacity of the battery.**
PEUKERT	**PEUKERT QUOTIENT VALUE - The default value for each chemistry should only be changed if a different value is provided by the battery manufacturer.**

Faults and Alerts

Alerts

Alerts are used to notify the user when a particular threshold on a parameter is passed. For instance, an alert can be set for when the State of Charge exceeds 90%, but also when it drops below 50%. High and low values can be set for most parameters. Alerts can also be disabled entirely. For instance, most users won't need an alert to signify when a low current level is reached. The default for each alert is disabled.

Alerts can be set for the following conditions:

Alerts (User Defined)
Min/Max State of Charge (SoC%)
Min/Max Current (A)
Min/Max State of Health (SoH%)
Min/Max/Voltage (V)
Min/Max Aux-1 & Aux-2 Voltage (V)
Min/Max Mins Left (minutes)

Generally, Alerts are used to notify the user that a certain condition has occurred, and are not only used to signify a problem. For instance, you could set an alert on State of Charge, to let you know when a battery is charged to a specific point, so you can shut down a generator or other charging device.

When an Alert occurs, the screen immediately displays a notification that this has happened. Pressing the button will then show the parameter that is being Alerted, the value reached, as well as the threshold that was set for the value.

To set an alert, ensure you have the correct SmartShunt selected (the device name shows on the top bar) and select ALERTS from the CONFIG menu.

First, select the type of alert you wish to configure, then if you wish to configure for a high or low value. Once selected, you can change the value one digit at a time, using the same method used to configure the battery capacity.

NOTE: When a HIGH value is configured, the parameter must exceed the set value for the ALERT to be triggered. When a LOW value is configured, the parameter must fall below that value for the ALERT to be triggered.

Faults

Faults are triggered when specific values have been passed that may have an impact on safety or the health of the battery. For example. draining a battery down to less than 5% SoC will trigger a fault, as it can adversely affect the life of a battery. Exceeding the safe current carrying ability of the SmartShunt will also trigger a fault. Faults can help a user identify behavior that will shorten the life of a battery. Faults can only be cleared from History with a Factory reset.

The values used to trigger Faults are contained in the Appendix named Fault Thresholds

Fault History is accessed from within the History Sub-menu, see History.

NOTE: The High Voltage Fault threshold for flooded batteries may be higher than a safe voltage for operating electronics and other equipment. This is to allow for the equalization of batteries without triggering a Fault. For this reason, it is important to set and use a High Voltage Alert to let the user know when potentially battery-damaging voltages are sensed.

Comparing Faults and Alerts

Here is a summary of some differences between Faults and Alerts:

1. Alerts are user-configurable; you can enable and disable alerts and change their trigger points.
2. When an alert condition has passed, the alert does as well.
3. Faults are not user configurable.
4. Faults show a time since occurred, duration for the latest fault, and the number of total times that fault has occurred.
5. Faults have history. When a fault is viewed, it is cleared from the screen. The parameters for the last instance of a fault and a counter showing the total times that fault occurred are stored.

Advanced Settings

The advanced menu for any SmartShunt allows the user to perform several levels of reset of SmartLInk devices on the network. An explanation of each of options is in the table below:

Menu Option	Description
RESTART DEV	RESTART DEVICE - Reboots the device (a Display or SmartShunt) that is currently selected (shown at the top of the screen).
RESET NETWORK	RESET NETWORK - Resets the SmartLink network. Learning, chemistry, faults etc. are all retained.
FACTORY RST	FACTORY RESET - Performs a FULL reset of the device. ALL history, including faults, chemistry, capacity, learning etc. is reset. Performing a Factory Reset on device does not perform a reset on any other devices or SmartShunts on the network. A Factory Reset should be performed every time a battery bank is replaced.
XECHO (not shown in screenshot above)	This performs a loopback test from the Display to the device that is currently selected. It is useful for testing the network connectivity between the two devices. If you are getting errors, it typically indicates a bad cable connection. (Note: While you can run a test to the Bluetooth Gateway, it is not a functional test and will give a false result.)

Performing a long press on any of the advanced settings immediately performs that function, except for FACTORY RESET, which has a confirmation step to help avoid false resets.

Specifications

Standard Configuration	1 Bank per SmartShunt Device 2 Start/Auxiliary Voltage Sense Lines (Up to 32 Devices including Displays and SmartShunts can be added to single network.)
Supply Voltage Range	8-60V
MAX Bank Current-Monitored Battery Size	1Ah-1310Ah
Average Supply Current	Display On: 20mA @ 12V Sleep Mode: 10mA @ 12V
SmartShunt Operating Temperature:	-40°C - +85°C (-40°F- +185°F)
SmartShunt Max Current @ 24°C (75°F)	350A Continuous 600A for 10 minutes
Display Values	State of Charge (SoC%) State of Health (SoH%) Voltage (V) Charge/Discharge Current (A) Time Remaining (Hrs, Minutes) History, Faults and Alerts
Communications Cable	4-wire, 22AWG, Shielded 4-pin Deutsch DT Style
Grounding	Negative Battery Connection
Standards Compliance	CE EMC Directive 2014/30/EU RoHS 2 Directive 2011/65/EU

SmartShunt Dimensions	Length: 4.86” (123.7mm) Width: 3.34” (84.8mm) Height 2.01” (50.9mm)
Gauge Minimum Depth (with connector)	2.75 inches, 70mm
Weight	SmartShunt: 0.62 lbs Color Display: 0.16 lbs
Maximum Panel Depth for Gauge Installation	1/2 inch (12.7mm)
Protection Rating	IP65 (Display from Front) IP67 (SmartShunt)

Part Numbers

Part Number	Part Description	Includes
SG200	Battery Monitor Kit, 12V-48V	Standard Unit for Initial Purchase: Includes, Color Display, SmartShunt, SmartLink Com Cable
SG2-0100	SmartShunt SG200, 350A, 12V-48V	Add a SmartShunt for Additional Bank: Includes SmartShunt and SmartLink Com Cable
SG2-0200	Color Display SG200, 2 1/16”	Add a Color Display to an existing SmartLink Network
SG2-0300	Gateway, SG200, Bluetooth®	Optional 39” Bluetooth® Gateway for Smartphone App
SG2-0400	Com Cable, SG200, 10m	Optional SmartLink Com Cable (10 meter) for Longer Cable Runs
SG2-0402	Mounting Plate, SG200	Mounting Adapter from Smartgauge™ to SG200 Display

Appendix

Fault Thresholds

FAULT	Flooded	AGM	TPPL	CARFOAM	LIFEPO4	GEL	Dual Purpose
High Voltage	16.3	15	15	15	14.3	14.4	15
Low Voltage	10.5	10.5	10.5	10.5	13	10.5	10.5
Low SoC	5	5	5	5	5	5	5
Low SoH	20	20	20	20	40	20	20
High Current	351A						

Converting Reserve Capacity to Amp Hours

The following formula converts Reserve capacity, typically expressed in minutes drawing a 25 amp load, to Amp hours at the 20/HR rate.

RC(60)*25/3600
Multiply Reserve Capacity to 60 to convert to seconds
Multiply by 25 to convert to coulombs
Divide by 3600 to convert coulombs to amp/hours

Example:
We have a battery showing reserve minutes of 130
130*60 = 7800
7800 * 25 = 195,000
195,000/ 3600 = 54.16

BALMAR DC CHARGING SOLUTIONS

Factors Affecting Battery Life

State of Health

As batteries age, their overall health diminishes. The biggest sign that a battery's health has declined is seen as reduced capacity. Without the SG200, the easiest way to see if this is happening is to monitor the time it takes a battery to charge using the same charging source. If the time to charge decreases over time, it is because the capacity has diminished. All lead-acid batteries age due to sulfation as well as shedding, where lead falls off of the plates and settles on the bottom of the battery.

There are several factors that affect the health and lifespan of a battery or battery bank. For most lead-acid batteries, the two most important factors affecting lifespan are depth of discharge/cycle count, and the concept of fully charing the battery after each discharge. Each of these effect the mechanical and chemical properties of batteries.

Sulfation and Shedding

At the mechanical/chemical level, there are two primary conditions that reduce the life, or State of Health of a battery. They are Sulfation and Shedding. Sulfation occurs when lead sulfate, formed naturally during battery use, is converted to a more stable crystal form that covers the negative lead plates in a battery. This happens when a lead acid battery is left in a partially charged state. Different battery manufacturers have devised different methods and chemistries to combat this effect, with varying degrees of success. Sulfation is accelerated by Partial State of Charge (PSOC) cycling and deeply discharging batteries.

Shedding in another naturally occurring phenomenon. During use, lead is shed from the plates and falls to the bottom battery. When enough lead has gathered, a partial-short starts to occur in the battery which will drain the capacity on it own and hasten the battery's demise.

In extreme instances, a battery can suffer a mechanical failure internally and will quickly short a cell with no chance of recovery. When this happens the battery must be replaced. If left in place the other cells can be overcharged,risking excessive heat and fire.

Cycle Life

Batteries are rated to show how many charge/discharge cycles they are able to endure before their health falls to a point where replacement is necessary. This is typically expressed as XX # of cycles to XX% discharge. It means that if you discharge to a lower value each time before re-charging, the total times this is done is lower than if the battery is only discharged a smaller amount each time. Of course, this is in a laboratory setting, as nobody discharges their batteries to a set point each time before re-charging, and many other factors will contribute to how long a battery lasts. For lead acid batteries, these also include:

1. Ambient temperature.
2. If the battery is fully charged after discharge and how much time passes between the two steps.
3. If the battery is actually fully charged, instead of "Almost fully charged"
4. If the battery is over charged, at voltages higher than the manufacturers recommendations

These factors together mean that in real-life applications, most batteries never reach the cycle life proposed by manufacturers.

Partial State of Charge (PSOC) Cycling

All lead-acid batteries benefit from being fully charged back to 100% after each use. PSOC means discharging a battery to some point, and then not fully charging back to 100%, before discharging again. For some users, this is not an issue as their batteries are not often left in a partial state of charge. Boaters using battery powered trolling motors typically charge their batteries fully right after use. For others, perhaps boondocking in an RV or cruising (and anchoring) in a sailboat, this plays an important part in battery usage. Current wisdom says when 24/7 charging is not available for lead acid batteries (including AGM) the best balance between cycle life and maximizing capacity is to discharge the batteries to 50%, and then charge back up to 80%. Then, perhaps once week, charge up to 100%. As batteries close in on around 80% charge, the current they accept diminishes. This means that the time it takes to get the last 20% into a battery can become excessive. This becomes clear when running an engine or generator to charge batteries.

State of Health Calculations

The calculation of State of Health occurs over one or more charge cycles. In this context, the term “Charge Cycle” has a specific meaning:

1. Fully charge the batteries. If you are starting with full batteries, then do a short discharge of a few Ah, and then begin charging.
2. Allow the batteries to rest at the full charge state for a brief moment. At this point, a + sign on the SoC screen should appear, indicating that the SG200 has reached Charge Termination. If this does not happen, either the initial discharge was too short, no rest period happened, or the Charge Parameters have been modified from the defaults and are not allowing charge termination to occur

The State of Health value may adjust during several charge cycles. When the SoH value has stabilized, this can be taken as a sign that the value is correct.

Under certain circumstances, it may be desirable to obtain a SoH value within a single charge cycle. This is usually possible, if the following procedure is strictly followed.

3. Obtain CHARGE TERMINATION as previously outlined
4. Discharge the batteries to 37% SoC or lower
5. Allow the batteries to rest at 37% SoC or lower for at least 65 minutes. Charge the batteries to reach Charge Termination again.
6. Disconnect all loads (Except for the SG200) and allow the batteries to rest for at least 35 minutes.

This process should be considered a shortcut, and not the standard method for obtaining a SoH value. While we have tested this procedure with many batteries, we cannot guarantee that it will work with every installation and battery configuration.

Changing Charge Termination Values

Each battery chemistry has default values for both Charge Voltage and Taper Current. These values should only be changed if:

1. Charge Termination is not occurring.
2. Charge Termination occurs early, meaning that the charging source continues to charge after Charge Termination has been reached, and this “Extra” charging is at least 1% in Ah of the total battery capacity. This should only be considered an issue if the Charge Termination happens with significant charge still occurring afterwards.

In either case consider raising the Taper Current in small increments, the target should be 2-4% of the battery capacity in Ah. It is unlikely that the CHARGE V needs to be changed, but if it does, consider lowering the CHARGE V in small increments. Don’t perform both changes at the same time, try the Taper Current first.

NOTE: $LiFePO_4$ users will often not charge their batteries fully, leaving one or more % of capacity unused. If you do this, you must ensure that you still reach charge termination. If you leave a percentage of the battery uncharged, the SoH will be lowered by that amount. Do not attempt to compensate by artificially lowering the design capacity.

NOTE: Changing these values can completely stop the calculation of SoH if the Charge V is set too high, or Taper Current too low, or both.

NOTES