MicroGenius®2

Genset, Marine & Stationary Battery Charger

Installation & Operation Manual

180W: 12V, 10A; 24V, 6A
300W: 12V, 12A; 24V, 10A
450W: 12/24V, 15A
500W: 36/48V, 6A
600W: 12/24V, 20A
750W: 12/24V, 25A; 36/48V, 12A; 120V, 6A

SENS Part Number: 101324
Document Revision: T
DCN Number: 108417
Date: February 20, 2024

PATENTED US 9,270,140; 9,385,556; 9,413,186; 9,509,164; 9,466,995; 9,948,125

Installation or service questions?
Call SENS between 8 a.m. and 5 p.m. (Mountain Time), Monday through Friday, or visit our website.

SENS®
STORED ENERGY SYSTEMS
1840 Industrial Circle
Longmont, CO 80501
Phone: 303.678.7500
800.742.2326
Fax: 303.678.7504
Email: service@sens-usa.com
Web: www.sens-usa.com

TABLE OF CONTENTS

1 IMPORTANT SAFETY INSTRUCTIONS/INSTRUCTIONS IMPORTANTES CONCERNANT LA SÉCURITÉ

1.1. **SAVE THESE INSTRUCTIONS –** This manual contains important safety and operating instructions for MicroGenius® 2 battery chargers.

Conserver ces instructions. Ce manuel contient des instructions importantes concernant la sécurité et le fonctionnement.

1.2. Do not expose open-frame charger to rain or snow.

1.3. Use of an attachment not recommended or sold by the battery charger manufacturer may result in a risk of fire, electric shock, or injury to persons.

1.4. **This charger is intended for commercial and industrial use.** ONLY TRAINED AND QUALIFIED PERSONNEL MAY INSTALL AND SERVICE THIS UNIT.

1.5. To reduce risk of damage to electric plug and cord (if optional power cord is included), pull by plug rather than cord when disconnecting charger.

1.6. Do not operate charger with damaged cord or plug – replace the cord or plug immediately.

1.7. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; shut off power at the branch circuit protectors and have the unit serviced or replaced by qualified personnel.

1.8. To reduce risk of electric shock, disconnect the branch circuit feeding the charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.

1.9. External connections to charger shall comply with the United States Coast Guard electrical regulations (33CFR183 SUB PART I) when installed in a maritime application.

1.10. **WARNING – RISK OF EXPLOSIVE GASES**

1.10.1. WORKING IN THE VICINITY OF A LEAD-ACID OR NICKEL-CADMIUM BATTERY IS DANGEROUS. STORAGE BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL BATTERY OPERATION. FOR THIS REASON, IT IS OF UTMOST IMPORTANCE THAT YOU READ THIS MANUAL AND FOLLOW THE INSTRUCTIONS EACH TIME YOU USE THE CHARGER.

IL EST DANGEREUX DE TRAVAILLER A PROXIMITÉ D'UNE BATTERIE AU PLOMB. LES BATTERIES PRODUISENT DES GAZ EXPLOSIFS EN SERVICE NORMAL. IL EST AUSSI IMPORTANT DE TOUJOURS RELIRE LES INSTRUCTIONS AVANT D'UTILISER LE CHARGEUR ET DE LES SUIVRE À LA LETTRE.

1.10.2. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of any equipment you intend to use in the vicinity of a battery. Review cautionary markings on these products and on the engine.

Pour réduire le risque d'explosion, lire ces instructions et celles qui figurent sur la batterie.

1.11. **PERSONAL PRECAUTIONS**

1.11.1. Someone should be within range of your voice or close enough to come to your aid when you work near a storage battery.

1.11.2. Have plenty of fresh water and soap nearby in case battery electrolyte contacts skin, clothing, or eyes.

1.11.3. Wear complete eye protection and clothing protection. Avoid touching eyes while working near a storage battery.

1.11.4. If battery electrolyte contacts skin or clothing, wash immediately with soap and water. If electrolyte enters eye, immediately flood the eye with running cold water for at least 10 minutes and get medical attention immediately.

1.11.5. **NEVER** smoke or allow a spark or flame in vicinity of battery or engine.

Ne jamais fumer près de la batterie ou du moteur et éviter toute étincelle ou flamme nue à proximité de ces derniers.

1.11.6. Be extra cautious to reduce risk of dropping a metal tool onto the battery. It might spark or short circuit the battery or another electrical part that may cause explosion. Using insulated tools reduces this risk but will not eliminate it.

1.11.7. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a storage battery. A storage battery can produce a short circuit current high enough to weld a ring or the like to metal, causing a severe burn.

1.11.8. **When charging batteries, charge LEAD-ACID or LIQUID ELECTROLYTE NICKEL-CADMIUM batteries only.** Charger certified for fire pump and emergency generator applications at 200 Ampere hours. Do not use this battery charger to supply power to an extra-low voltage electrical system or to charge any type of non-rechargeable, dry cell, alkaline, lithium, nickel-metal-hydride, or sealed nickel-cadmium batteries that are commonly used with home appliances. These batteries may burst and cause injuries to persons and damage to property.

1.11.9. **NEVER** charge a frozen battery.

Ne jamais charger une batterie gelée.

1.11.10. The charger contains a DC output fuse for *internal* fault protection, but this will not protect the DC wiring from fault currents available *from the battery*. Consult national and local ordinances to determine if additional battery fault protection is necessary in your installation.

1.12. Preparing Battery For Charge

1.12.1. Be sure area around battery is well ventilated while battery is being charged.

1.12.2. Ensure battery terminals are clean and properly tightened. Be careful to keep corrosion from coming in contact with eyes.

1.12.3. Add distilled water in each cell until battery acid reaches level specified by battery manufacturer. Do not overfill. For a battery without removable cell caps, such as valve regulated lead acid batteries, carefully follow manufacturer's recharging instructions.

1.12.4. Study all battery manufacturer specific precautions such as removing or not removing cell caps while charging and recommended rate of charge. The recommended charge current range must include the rated output current of the charger.

Prendre connaissance des mesures de précaution spécifiées par le fabricant de la batterie, p. ex., vérifier s'il faut enlever les bouchons des cellules lors du chargement de la batterie, et les taux de chargement recommandés.

1.13. Charger Location

1.13.1. Locate the charger as far away from the battery as DC cables permit.

Placer le chargeur aussi loin de la batterie que les cables c.c. le permettent.

1.13.2. Never place the charger directly above or below the battery being charged; gases from the battery will corrode and damage charger.

Ne jamais placer le chargeur directement sous la batterie à charger ou au-dessus de cette dernière. Les gaz ou les fluides qui s'échappent de la batterie peuvent entraîner la corrosion du chargeur ou l'endommager.

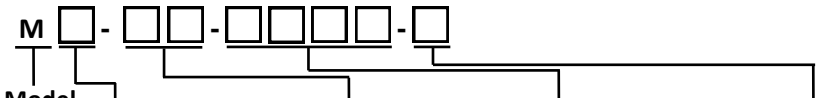
1.13.3. Never allow battery acid to drip on charger when reading electrolyte specific gravity or filling battery.

1.13.4. Do not operate charger in a closed-in area or restrict ventilation in any way.

Ne pas faire fonctionner le chargeur dans un espace clos et/ou ne pas gêner la ventilation.

1.13.5. Do not set anything on top of the charger.

2 MODEL NUMBER BREAKOUT



Power
1: 180W, enclosed
3: 300W, enclosed
4: 450W, enclosed
5: 500W, enclosed
6: 600W, enclosed
7: 750W, enclosed
F: 180W, open-frame
G: 300W, open-frame
H: 450W, open-frame
L: 750W, open-frame

Output Voltage
22: 12/24 Volts
34: 36/48 Volts
20: 120 Volts

Output Current
1006: 10/6A @ 12/24V (180W only)
1210: 12/10A @ 12/24V (300W only)
1515: 15A @ 12/24V (450W only)
2020: 20A @ 12/24V (600W only)
2525: 25A @ 12/24V (750W only)
0606: 6A @ 36/48V (500W only)
1212: 12A @ 36/48V (750W only)
0006: 6A @ 120V (750W only)

Alarms/Communications*
A: base model; includes J-1939 & Modbus RS-485
D: base model + LCD + 5 Form C alarm relays
E: base model + LCD + 2 Form C alarm relays
F: base model + LCD + 5 Form C alarm relays + keypad
G: base model + LCD + 5 Form C alarm relays + keypad + Modbus TCP/IP

*LCD, Form C alarm relays and keypad not available on open-frame charger. Remote accessory with these options available as a separate line item for open-frame chargers and option A enclosed chargers.

3 PERFORMANCE SPECIFICATIONS

MicroGenius® 2 is a switchmode, regulated, filtered, microprocessor-controlled, current limited battery charger designed for heavy-duty industrial service. Chargers may be configured for three primary applications: 1) quick recharge and long-life maintenance of engine start batteries, 2) DC power supply and battery charging for marine environments, and 3) DC power and standby battery charging for industrial control and safety systems. The charger is provided as 180W, 300W, 450W, 500W, 600W or 750W models and in either fully enclosed or open-frame enclosures. Models exist for 12/24V, 36/48V or 120V output voltage and every model includes J1939 and Modbus RS-485 communications. Optional features include alarm relays, easily readable alpha-numeric display, keypad and Modbus TCP/IP. Charger specifications are detailed in the table below, see following sections for installation and operation instructions.

Table 1 – Specifications

AC Input	Voltage, Frequency	90-265 single-phase VAC, 47-63 Hz DC voltage applied at AC terminals: 100-375 VDC, 0Hz (≥500W models only, output limited to 2/3 rated power)
	Current (maximum)	180W: 2.0 Amps
		300W: 3.3 Amps
		450W: 4.0 Amps
		500W: 4.4 Amps
		600W: 6.8 Amps
		750W: 8.5 Amps
	Protection	Supplementary overcurrent protection fuse (non-replaceable); transient protected to EN61000-4-5 level 4
	Efficiency	Up to 95%; meets CA Energy Commission (CEC) Title 20 Appliance Efficiency Regulations; standby AC draw <3W for 180-450W and <7W for 500-750W
	Power factor	>.95 typical at maximum rated load current and boost charge voltage
DC output	Voltage	12/24V nominal; field selectable; adjustable from 8-34V; unit powers down below 8VDC if AC voltage is not applied.
		36/48V nominal; field selectable; adjustable from 10-68V; unit powers down below 10VDC if AC voltage is not applied.
		120V nominal; adjustable from 60-160V; unit powers down below 60VDC if AC voltage is not applied.

	Current	180W: 10A at 12V nominal and 6A at 24V nominal, 180W maximum
		300W: 12A at 12V nominal and 10A at 24V nominal, 300W maximum
		450W: 15A at 12/24V nominal, 450W maximum (12A max below 170VAC input voltage in 24V configuration)
		500W: 6A at 36/48V nominal, 500W maximum
		600W: 20A at 12/24V nominal, 600W maximum
		750W: 25A at 12/24V nominal, 750W maximum 12.5A at 36/48V nominal, 750W maximum 6A at 120V nominal with UL approval, 5.7A at 120V with CSA approval, 750W maximum
	Soft start	Charger gradually increases current with a maximum of 5 seconds to full-required output
	Charging modes	Float voltage, boost voltage; two additional HELIX charging voltages in flooded lead-acid battery program
	DC power supply operation	Delivers fast-responding, stable, well-filtered DC without battery
	Factory adjustment	All charger adjustments factory set to customer specifications; field reconfigurable
	Field voltage adjustment	3 manually selectable voltage settings (120VDC model excluded); Infinite adjustment within specifications using optional keypad or SENS Setup Utility
	Current limit	100% current capability subject to temperature limits and AC voltage limits on 450W; field adjustable
	Charging characteristic	Constant voltage, current limited; patented Dynamic Boost control
	Line/load regulation	±0.5%
	Output ripple	<30mVrms with or without battery
	Battery temperature compensation	On-board sensor controls changes in output voltage when temperature is between 0°C and +40°C at a default rate of – 0.18% per degree C; optional remote battery temperature probe (SENS p/n 209481)
	Output protection	Current limit, supplementary overcurrent protection fuse (non-replaceable), transient protected
	Overvoltage protection	Self-resetting and selective
	Dead battery charge	Starts into and recharges zero-volt battery without user intervention (auto starts excludes 120V models)
	Parallel/Load Share operation	Two or more load-sharing chargers operate with all modes synchronized for increased current or fault tolerance, requires load share accessory kit (SENS p/n 209069)
	Load Dump protection	Output voltage over-shoot is limited to 15% to prevent damage to connected devices if battery is disconnected while charger is operating
	Output Blocking protection	Prevents sparking during battery connection when battery is first connected to charger; serves as an "OR" diode to isolate a non-functioning charger from others in a redundant charger configuration
Adjustment & Controls	Charge mode control	Fully automatic patented Dynamic Boost system. Fully automatic patented HELIX system for flooded lead-acid starting batteries that reduces power use and extends battery life.
	Internal adjustments	Nominal voltage range; battery type program; fine voltage setting
	Battery type programs	Flooded lead-acid, AGM, NiZn, NaCl (salt), NiCd, VRLA, ultracapacitor

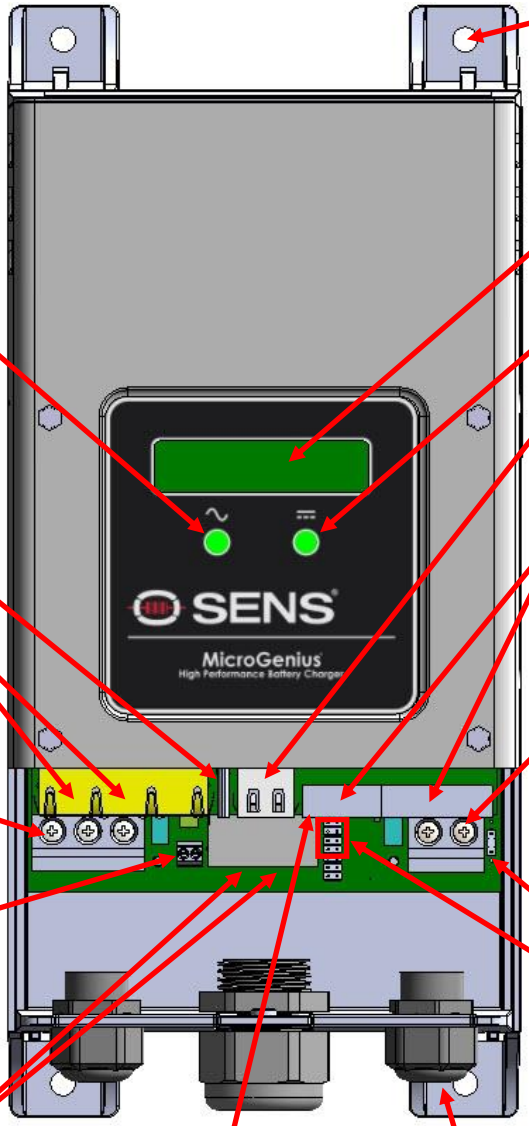
<table>
<tr><td></td><td>Computer adjustment</td><td>Change or customize settings from computer using SENS Setup Utility and on-board USB connection. Connect legacy units (on-board USB not included) using computer to charger cable provided in SENS Setup Utility kit, SENS p/n 209254. SENS Setup Utility software available at www.sens-usa.com.</td></tr>
<tr><td></td><td>Keypad adjustment</td><td>Enable or change all settings from front panel (requires optional keypad)</td></tr>
<tr><td rowspan="4">Status display</td><td>LEDs</td><td>Dual multi-color front panel status LEDs</td></tr>
<tr><td>Digital metering</td><td>DC voltmeter accurate to ±1%; DC ammeter to ±1% (meters require optional display or network connection to a compatible device with a display). AC input voltage is for reference only. If AC waveform is not sinusoidal or is distorted the AC voltage will not be reported accurately.</td></tr>
<tr><td>Status messages</td><td>20-character display of status and alarm messages (requires optional display or network connection to a compatible device with a display)</td></tr>
<tr><td>Quiescent draw</td><td>Max quiescent draw with AC disconnected:
<table>
<tr><th>Output Voltage</th><th>No Display</th><th>With Display</th></tr>
<tr><td>12/24VDC, ≤450W</td><td>0.4W</td><td>0.6W</td></tr>
<tr><td>12-48VDC, >450W</td><td>1W</td><td>2W</td></tr>
<tr><td>120VDC</td><td>2W</td><td>3W</td></tr>
</table></td></tr>
<tr><td rowspan="4">Alarms</td><td>Alarms</td><td>Factory set and field reconfigurable.</td></tr>
<tr><td>Output via network</td><td>Alarms available via either J1939 or Modbus ports. Alarm indication delayed by configured alarm delay value.</td></tr>
<tr><td>Form C contacts</td><td>Two or five Form C contacts, each rated 30VDC/VAC, 2A resistive, assignable at factory or by using SENS Setup Utility. Alarm indication delayed by configured alarm delay value.</td></tr>
<tr><td>Alarm Delay</td><td>30 seconds by default, programmable between 5 to 60 seconds using keypad or SENS Setup Utility. Alarm indication delayed for communications ports and relay contacts; LED indication not delayed.</td></tr>
<tr><td rowspan="4">Networking</td><td>J1939 communications</td><td>CAN 2.0 extended ID on RJ-45 port</td></tr>
<tr><td>Modbus communications</td><td>Modbus RS-485 on RJ-45 port</td></tr>
<tr><td>SENSbus</td><td>Proprietary bus for connection of paralleled chargers and SENS accessories</td></tr>
<tr><td>USB</td><td>USB-C connectivity via SENS Setup Utility (standard with option LCD)</td></tr>
<tr><td rowspan="8">Environ-mental</td><td rowspan="5">Operating temperature</td><td>180W, enclosed: -40°C to +70°C; meets full specification from -40°C to +55°C</td></tr>
<tr><td>180W, open-frame: -40°C to +70°C; meets full specification from -40°C to +60°C</td></tr>
<tr><td>300W, 500W, 600W, 750W: -40°C to +70°C; meets full specification from -40°C to +50°C</td></tr>
<tr><td>450W: -40°C to +70°C; meets full specification from -40°C to +40°C</td></tr>
<tr><td>LCD: display may be unreadable and life reduced above 65°C</td></tr>
<tr><td>Cooling</td><td>Natural convection cooled</td></tr>
<tr><td>Storage temperature</td><td>-40°C to +85°C</td></tr>
<tr><td>Cold Start</td><td>Cold starts down to -40°C. Requires approximately five seconds additional time to start at temperatures below -20°C.</td></tr>
<tr><td>Humidity</td><td>5% to 95%, non-condensing</td></tr>
</table>

	Water ingress	Enclosed Models: NEMA2/IP22; NEMA3R/IP34; UL Rainproof
	Vibration	Swept Sine (EN60068-2-6): 4G, 18-500 Hz, 3 primary axes
		Random: 20-500Hz, .01G^2/Hz
	Shock	EN 60068-2-27 (15G)
	Electrical transient	ANSI/IEEE C62.41 and EN 61000-4-12 on power terminals
Abuse protection	Reverse polarity	Charger self-protects without fuse clearing; indication via LED and optional LCD; charger recovers automatically after removal of the fault condition
	Wrong voltage battery	Charger-battery voltage mismatch shuts down charger after 5 minutes; indication via LED and optional LCD
	Overvoltage shutdown	Selective; shutdown only operates if charger causes the overvoltage condition. Overvoltage caused by an external voltage source does not shut down the charger.
	Over temperature protection	Gradual output power reduction if heatsink temperature becomes excessive
Regulatory compliance	North America	C-UL-US Listed (enclosed chassis): • CSA 22.2, No. 107.2 • UL 1236, File E109740 for category BBGQ • UL 1236, File EX6409 for categories BBHH, BBJY and QWIR; certified to UL 1236 supplements SB (marine), SC (fire pump) and SE (emergency generator); 180W set for 12VDC and 300-450W models only
		C-UL-US Recognized (open-frame chassis): • CSA 22.2, No. 107.2 • UL 1236, File E109740 for category BBGQ2 • UL 1236, File EX6409 for categories BBHH2, BBJY2 and QWIR2; certified to UL 1236 supplements SC (fire pump) and SE (emergency generator); 180W set for 12VDC and 300-450W models only
		NFPA-70; NFPA-110 when annunciating to the genset control panel the charger's output voltage & current, and alarm status via J1939, or when equipped with optional alarm relays
		FCC: Part 15, Class B for home or commercial use and ICES-003 (Canada), ≥ 500W models Class A. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
		Seismic: rigid and non-structure wall mount; max S_{DS} of 2.5G; IBC 2000-2022; California BC 2007-2022
		American Bureau of Shipping: Type Approved
		California Energy Commission: Title 20 Appliance Efficiency Regulations
	European Union (CE)	EMC: 2014/30/EU, UK 2016 EN 61000-6-4 (Emissions – Class B, ≥ 500W models Class A) CISPR 11 EN 61000-6-2 (Immunity – Industrial Environments) EN 61000-4-2 Electro Static Discharge 4 kV contact, 8 kV air EN 61000-4-3 Radiated Immunity – at 10V/m

		EN 61000-4-4 Electrical Fast Transients – 2kV AC, 1kV I/O EN 61000-4-5 Surge Immunity – 2 kV cm, 1 kV diff EN 61000-4-6 Conducted power line immunity – 10 V r.m.s. EN 61000-4-8 Power frequency magnetic field testing – 30 A/m EN 61000-4-11 Voltage dips and interruptions – per the standard
		LVD: 2014/35/EU, UK 2016 EN 60335-1 & EN 60335-2-29
		RoHS: 2015/863, UK 2012 EN 63000
		WEEE: 2012/19/EU This charger is considered electrical and electronic equipment (EEE) for non-household use and should be recycled accordingly. Do not dispose as unsorted municipal waste. See SENS website (www.sens-usa.com) for information on how to properly recycle.
Construction	Housing/configuration	Enclosed chassis: die-cast aluminum heatsink base with stainless steel covers and fasteners; includes two ½ inch conduit openings and one ¾ inch conduit opening
		Open-frame chassis: aluminum heatsink base and cover
	Dimensions	See drawings and dimensions at back of manual
	Weight	Enclosed: 6.0lbs (2.7kg) for 12/24V and ≤15A, 7.2lbs (3.3kg) max
		Open-frame: 3.2lbs (1.5kg) for 12/24V and ≤15A, 4lbs (1.8kg) max
	Connections	AC and DC terminal blocks: 20 to 10 AWG solid copper; 20 to 6 AWG stranded copper
		J-1939 and Modbus-485: RJ-45
		Computer with SENS Setup Utility: USB
		Form C alarms terminal block plug: 28 to 16 AWG

4 SYSTEM OVERVIEW

Fully enclosed model with optional alarm/communications circuit board shown. Refer to the nameplate label or the label on the inside lower cover for factory configured output and alarm relay assignments.



MOUNTING:

Mount enclosed chassis charger vertically

Mount open-frame charger in any orientation

AC STATUS LED

OPTIONAL USB PORT:

Connect computer with SENS Setup Utility

OPTIONAL DUAL RJ-45 PORT:

Connect J1939/Modbus RS-485 cable if alarm/comms PCA is included

AC INPUT TERMINALS:

20–10 AWG (0.5–6 mm^2) solid
20–6 AWG (0.5–13.5 mm^2) stranded

Tighten to 10.5 In-Lb (1.2 Nm)

REMOTE TEMPERATURE SENSOR TERMINALS:

28–16 AWG (0.08–1.5 mm^2)

Tighten connections to 2.0 In-Lb (0.22 Nm)

MAIN PCA DUAL RJ-45 PORT:

Connect J1939/Modbus RS-485 cable to main PCA unless optional alarm/comms PCA is included

Always connect load share or remote accessory cable to main PCA

Connect computer with SENS Setup Utility using SENSbus Adapter to configure 120VDC models without alarms/comms PCA

MAIN PCA J1939 ADDR JUMPERS:

Select Charger 1 or 2 on main PCA unless optional alarm/comms PCA is included, use SENS Setup Utility to configure on alarms/comms PCA

MOUNTING FASTENERS:

Use four ¼ inch (M6) screws to mount enclosed and open-frame chargers, fasteners supplied by installer

OPTIONAL LCD:

Status and alarms

DC STATUS LED

OPTIONAL MODBUS TCP/IP PORT:

Connect Modbus TCP/IP

OPTIONAL ALARM TERMINAL BLOCKS:

28–16 AWG (0.08–1.5 mm^2)

Tighten connections to 2.0 In-Lb (0.22 Nm)

DC OUTPUT TERMINALS:

20–10 AWG (0.5–6 mm^2) solid
20–6AWG (0.5–13.5 mm^2) stranded

Tighten to 10.5 In-Lb (1.2 Nm)

GROUND FAULT JUMPER

OUTPUT JUMPERS:

Leave in Factory Configuration (3 jumpers in FLOAT)

Move only if system voltage or battery type change from original factory configuration

Jumpers removed for adjustable keypad or Program Mode
Jumpers not present on 120VDC models, use SENS Setup Utility to configure

CONDUIT OR CORD BUSHINGS:

Customer supplied

5 MOUNTING INSTRUCTIONS

INSTALLATION OF THE UNIT MUST COMPLY WITH LOCAL ELECTRICAL CODES AND OTHER APPLICABLE INSTALLATION CODES AND BE MADE ACCORDING TO THE INSTALLATION INSTRUCTIONS AND ALL APPLICABLE SAFETY REGULATIONS.

Printed circuit boards contain static sensitive components. Damage can occur even when static levels are too low to produce a noticeable discharge shock. To avoid static discharge damage, handle the charger by the chassis only. Remove the cover only when access is essential for installation and service, replace it promptly when finished.

5.1. Mounting Location

The charger is provided in two different chassis options, fully enclosed or open-frame. See diagrams at back of manual for mounting information.

5.1.1. Enclosed Chassis

5.1.1.1. The fully enclosed charger is rated IP22 and is approved as “rainproof” by UL. It can withstand dripping liquid but may require additional protection from spraying, splashing, or blowing liquid.

5.1.1.2. The charger will operate at full specification when located where temperatures are within the ranges specified in Table 1. Output power is gradually reduced at higher temperatures.

5.1.1.3. Mount charger vertically to ensure adequate ventilation.

5.1.1.4. Leave clear space for ventilation all around the enclosed unit: at least 6 inches (15 cm) at the top; at least 4 inches (10.16 cm) at the bottom; at least 0.5 inches (1.27 cm) on each side. Operating temperature ranges stated above assume clearances shown in diagram below.

5.1.1.5. Mount to a wall or other vertical support. The mounting surface must safely support the weight of the charger and the fixed wiring. The weight of the enclosed charger is 6 pounds (2.7 Kg) for 12/24VDC at ≤15A and 7.2lbs (3.3kg) for remaining models.

5.1.2. Open-frame Chassis

5.1.2.1. The open-frame chassis charger is designed for installation inside a customer-provided enclosure, protected from rain, snow and blowing or dripping liquid.

5.1.2.2. Heat sink the charger to a metal surface that is not subject to heating from another source. Base plate temperature should not exceed 83°C measured at top front of base plate when charger is operating at full current load and maximum ambient temperature.

5.1.2.3. The charger will operate at full specification when located where temperatures are within the ranges specified in Table 1. Output power is gradually reduced at higher temperatures.

5.1.2.4. Mount charger in any orientation.

5.1.2.5. The mounting surface must safely support the weight of the charger and the fixed wiring. The weight of the open-frame charger is 3.2 pounds (1.5 kg) for 12/24V at ≤15A and 4 pounds (1.8 kg) for remaining models.

5.1.3. Allow sufficient room for routing the fixed wiring to the charger. All wires enter the charger from the bottom. See diagrams at back of manual for further information.

5.1.4. Do not mount the charger above any heat generating equipment.

5.2. Mounting Instructions

5.2.1. Drill four mounting holes using the mounting template provided with the charger.
IMPORTANT: Protect charger from all drill shavings!

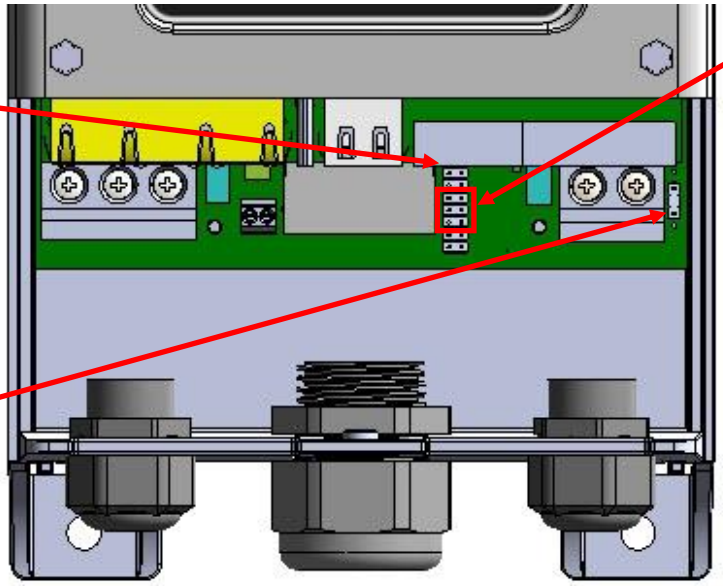
5.2.2. Mount the charger before connecting AC, DC, communications and alarm wiring to ensure un-obstructed access to mounting holes.

5.2.3. Mount the charger using four ¼ inch (M6) screws with standard flat washers. Mounting hardware is not included with the charger and must be provided by the installer.

6 CHARGER SETUP

IMPORTANT! The charger is configured at the factory and typically requires no adjustments before operating. Leave the jumpers in the three FLOAT positions to operate the charger using settings configured at the factory per customer order. Refer to the label on the inside lower cover for factory configured output and alarm relay assignments (see Figure 3). If the system voltage or battery type is different than the factory configuration, or if other custom settings are required, the charger may be reconfigured using the jumpers, the optional front panel keypad, or by software programming using the SENS Setup Utility.

Figure 1 – Jumper Settings
(fully enclosed model with optional alarm/communications circuit board shown)



6.1. Factory Jumper Configuration (excludes 120V models)

The charger is shipped from the factory with three jumpers in the three FLOAT positions on the main circuit board for 12-48VDC models without the optional keypad. Jumpers are not present on 120VDC models; use the optional keypad or SENS Setup Utility (connect using USB if alarms/coms circuit board is included or the SENSbus Adapter if not) to configure instead. Jumpers in the three FLOAT positions indicate the charger is operating using settings configured at the factory per customer order. Refer to the label on the inside lower cover for factory configured output and alarm relay assignments (see Figure 3). Leave jumpers in the factory configuration unless system voltage or battery type changes.

Figure 2 – Factory Configuration

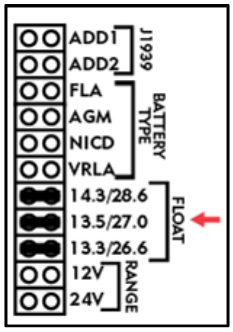
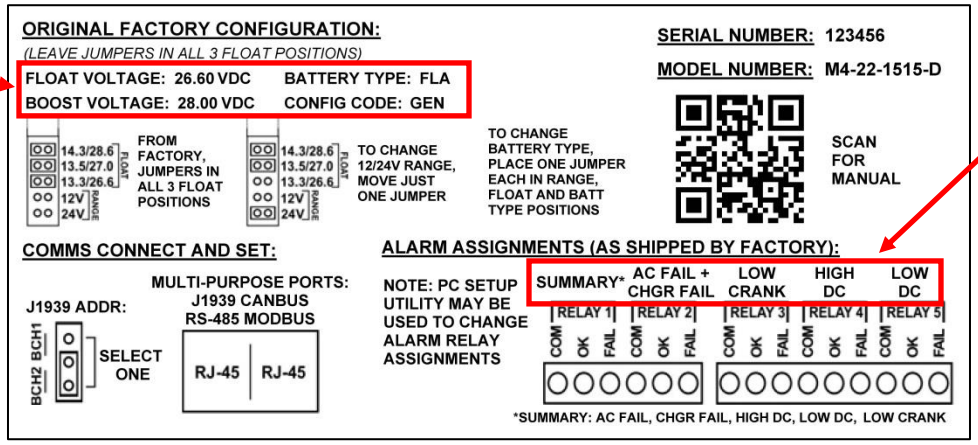


Figure 3 – Configuration Label (on inside lower cover)

View output voltage, battery type and configuration code set at the factory

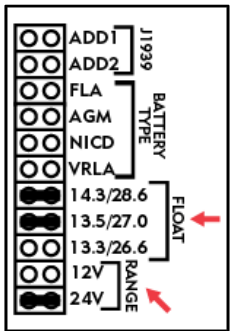


View alarm relay assignments set at the factory

6.1.1. Changing Voltage Range Using Factory Jumpers Mode

Use the voltage range jumper to select output voltage on dual-voltage models (e.g. select 12V or 24V). Set the RANGE jumper to nominal battery voltage. Selections may be indicated by "LO" and "HI" or actual voltages. "LO" indicates the lower nominal voltage (e.g. 12V on 12/24V models and 36V on 36/48V models) and "HI" indicates the higher nominal voltage (e.g. 24V on 12/24V models and 48V on 36/48V models) for dual voltage models. The voltage range may be changed without changing factory settings by moving any one of the three FLOAT jumpers to the appropriate RANGE position. Leave the other two jumpers in the FLOAT positions. In this configuration the charging algorithm, output settings and alarm relay assignments remain as originally configured at the factory but all setpoints are doubled/halved accordingly. Replacing the jumpers in the three FLOAT positions will return the charger to the original factory configuration.

Figure 4 – Change System Voltage



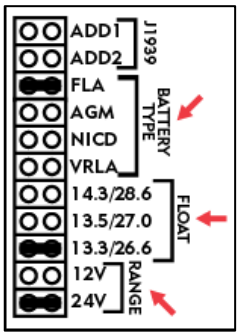
6.1.2. Changing Battery Type Using Jumpers

If battery type changes from original factory configuration, the Standard Jumper Configuration must be used (see section 6.2).

6.2. Standard Jumper Configuration (excludes 120V models)

If battery type changes from the original factory configuration all jumpers must be moved into the standard jumper configuration - one jumper each in BATTERY TYPE, FLOAT and RANGE positions. In this configuration the alarm relay assignments remain as originally configured at the factory. Replacing the jumpers in the three FLOAT positions will return the charger to the original factory configuration. Jumpers are not present on 120VDC models; use the SENS Setup Utility to configure instead.

Figure 5 – Standard Jumper Configuration



6.2.1. Battery Type Jumper

Set the BATTERY TYPE jumper appropriate for the battery type used.

Table 2 – Charging Algorithms by Battery Type

Battery Type	Charging Algorithm		
	Float Mode	Dynamic Boost Mode	HELIX Mode
FLA	✓	✓	✓
AGM	✓	✓	
NICD	✓	✓	
VRLA	✓		

6.2.1.1. FLA

This setting is ideal for flooded lead-acid batteries used in engine starting applications. Set the BATTERY TYPE jumper to FLA when using flooded lead-acid batteries. The charging algorithm for flooded lead-acid batteries includes Float mode (see section 10.2), Dynamic Boost™ mode (see section 10.3) and HELIX mode (see section 10.4).

6.2.1.2. AGM

The term, “AGM” in this manual and for the MicroGenius charger refers to AGM type batteries that are employed in engine starting applications. For AGM type batteries employed in non-engine starting applications please see “VRLA” in section 6.2.1.4 below. Set the BATTERY TYPE jumper to AGM when using engine starting AGM batteries. The charging algorithm for absorbed glass mat batteries includes Float mode (see section 10.2) and Dynamic Boost™ mode (see section 10.3).

6.2.1.3. NICD

Set the BATTERY TYPE jumper to NICD when using nickel-cadmium batteries. The charging algorithm for nickel-cadmium batteries includes Float mode (see section 10.2) and Dynamic Boost™ mode (see section 10.3). Nickel-cadmium batteries are used in all applications.

6.2.1.4. VRLA

The “VRLA” battery profile includes all valve regulated batteries, including AGM types, which are employed in non-engine starting applications. For AGM batteries employed in engine starting applications please see “AGM” in section 6.2.1.2 above. Set the BATTERY TYPE jumper to VRLA when using valve-regulated lead-acid batteries, of which AGM is a subset. The charging algorithm for valve-regulated lead-acid batteries includes Float mode only (see section 10.2).

6.2.1.5. Ultracapacitors

Place one jumper each in the AGM and NICD battery type positions and leave one jumper in the RANGE position if charging ultracapacitors rather than batteries (see section 10.5). Ultracapacitor charging is available only on 12V and 24V models.

6.2.2. Float Voltage Jumpers

When the charger is in Float mode the output voltage is maintained at the float voltage setting. If adjustment from the factory set float voltage is necessary, move the FLOAT output voltage jumper to the setting that is closest to the battery manufacturer's recommended 25°C (77°F) float voltage. Incorrect charge voltage can undercharge or accelerate generation of explosive gases, increasing the risk of fire or explosion. Selections may be indicated by "LO," "MED" and "HI" or actual voltages.

Jumper options:

Indication	Output Voltage	Number of Cells and Battery Type
HI	14.3/28.6V	10 or 20 cell nickel cadmium at 1.43V/cell
	42.9/57.2V	30 or 40 cell nickel cadmium at 1.43V/cell
MED	13.5/27.0V	6 or 12 cell (VRLA, AGM or high capacity) lead-acid at 2.25V/cell
		19 cell nickel cadmium at 1.42V/cell
	40.5/54.0V	18 or 24 cell (VRLA, AGM or high capacity) lead-acid at 2.25V/cell
		38 cell nickel cadmium at 1.42V/cell
LO	13.3/26.6V	6 or 12 cell (flooded) lead-acid at 2.22V/cell
		19 cell nickel cadmium at 1.40V/cell
	40.0/53.3V	18 or 24 cell (flooded) lead-acid at 2.22V/cell
		38 cell nickel cadmium at 1.40V/cell

The FLOAT output voltage setting is not used for charging ultracapacitors (see section 6.4 for ultracapacitor setup).

6.2.3. Range Jumper

Set the RANGE jumper to nominal battery voltage. Selections may be indicated by "LO" and "HI" or actual voltages. "LO" indicates the lower nominal voltage (e.g. 12V on 12/24V models and 36V on 36/48V models) and "HI" indicates the higher nominal voltage (e.g. 24V on 12/24V models and 48V on 36/48V models) for dual voltage models.

6.3. Keypad Configuration—*Optional*

Charger adjustment may also be made using the optional keypad. The keypad is either integral to the charger or located remotely from the charger and connected with a network cable. See section 7.11 for more information on the Remote Alarm/Communications Panel Accessory. Chargers including a keypad are supplied without jumpers and are configured per customer order at the factory. Jumpers must not be present to allow adjustment using the keypad. See section 10.9 for additional details on keypad navigation.

6.3.1. Security Code Protection

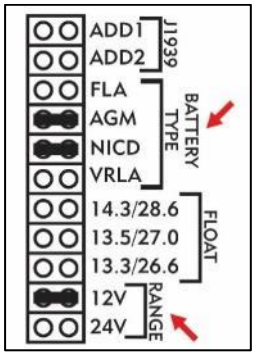
Chargers with the optional keypad may be security code protected to ensure only authorized personnel may adjust charger settings. The default security code is 000000 meaning security code is not enabled. Change the security code to a unique value by scrolling to the "Service Tools" menu and then the "Change Security Code" option. See section 10.9 for further keypad information.

6.4. Ultracapacitor Mode Setup

Ultracapacitor mode is used to charge ultracapacitors rather than batteries. Ultracapacitor mode is available only on 12V and 24V models. Place a jumper in one RANGE position and jumpers in both the AGM and NICD battery type positions (no jumpers are placed in the FLOAT settings) to enable operation with ultracapacitors.

WARNING:
ULTRACAPACITORS ACCEPT AND DISCHARGE CURRENT RAPIDLY. NEVER ATTEMPT TO JUMP OR CONNECT A BATTERY TO AN ULTRACAPACITOR.

Figure 6 – Ultracapcitor Mode Jumper Configuration



6.5. Program Mode

Removing all jumpers from the BATTERY TYPE, FLOAT and RANGE positions enables Program Mode. In Program Mode the charger output is determined by values programmed in the charger using the SENS Setup Utility (see section 10.10). If the charger has not been specially programmed, removing all jumpers will result in an error state and the charger will not produce output. If the charger includes the optional keypad removing the jumpers is required to adjust settings and will not result in an error state (see section 6.3).

6.6. Load Share Charger Setup

Multiple chargers may be connected in parallel to provide charger redundancy and increased charging current. Connection of a load sharing accessory between up to 30 chargers (see section 7.10) automatically initiates load sharing. Load sharing is essential to synchronizing operation of the Dynamic Boost and HELIX modes and helps ensure that current is shared within ±10% between chargers. Remove the ADD jumper, if present, from the main circuit board of any charger connected to load share (see Figure 8). Chargers intended for load sharing must be configured with the same output settings in order to load share. See section 10.12 for further information.

6.6.1. Load Share Termination

For proper load share operation, a 120-ohm terminator is required at the ends of the bus. Figure 9 below shows an example of how to terminate the network. The charger is not equipped with terminators. Termination may be provided as part of the network cabling or 120-ohm termination plugs for the RJ-45 communications connector on the charger are available to order separately (SENS p/n 803707).

6.7. SAE J1939 Communications Setup (CANbus) (excludes 120V models)

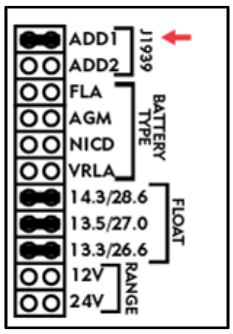
Every charger includes SAE J1939 (CANbus) communications. The J1939 interface provides a highly reliable, low-cost method of delivering to the genset controller all information that NFPA 110 requires the battery charger to deliver. This eliminates the need for a volt/amp display and alarm relays in the charger. To be operational, the genset controller must support the charger's J1939 connection. Contact your genset supplier to determine if your genset supports a J1939-connected charger. See section 7.7 for J1939 wiring and section 11 for further information on J1939 operation and registers.

6.7.1. Battery Charger J1939 Address Configuration

When the optional alarm/communications circuit board is included, the J1939 address should be configured using the SENS Setup Utility or via the optional keypad. For legacy units, the J1939 address may also be configured using the address jumper on the board (see Figure 7) For all other models, configure the address jumper on the main circuit board (see Figure 8). J1939 supports two chargers per network cable. Set the address jumper to position 1 for main charger or position 2 for auxiliary charger. The jumper is set to position 1 by default.

Figure 7 – Optional Circuit Board J1939 Battery Charger (BCH) Jumper

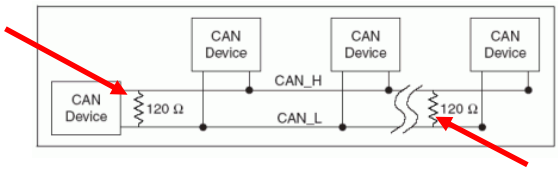
Figure 8 – Main Circuit Board J1939 ADD Jumper



6.7.2. Termination

For proper J1939 operation, a 120-ohm terminator is required at the ends of the J1939 bus. If multiple devices are on the bus, only the devices on the ends of the network bus need termination resistors. Figure 9 shows an example of how to terminate the network. The charger is not equipped with terminators. Termination may be provided as part of the network cabling or 120-ohm termination plugs for the RJ-45 communications connector on the charger are available to order separately (SENS p/n 803707).

Figure 9 – J1939 Termination



6.8. Modbus Communications Setup

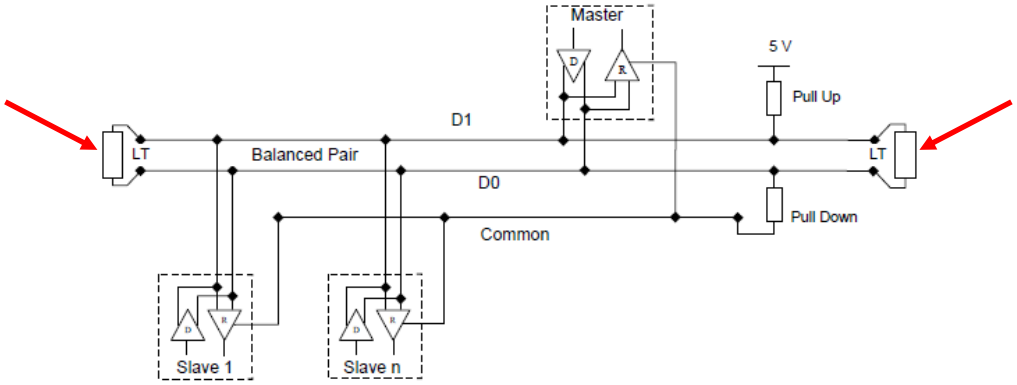
Every charger includes Modbus RS-485 communications. Modbus is an application layer messaging protocol used for client/server communication and is implemented according to specifications provided by Modbus Organization (http://www.modbus.org/specs.php). Modbus communications settings must be configured using the optional keypad or SENS Setup Utility prior to initiating. See section 7.7 for Modbus wiring and section 12 for further information on Modbus operation and configuration.

6.8.1. Termination

For proper Modbus RS-485 operation, a 120-ohm terminator is required at the ends of the RS-485 bus. If multiple devices are on the bus, only the devices on the ends of the network bus need termination resistors. Figure 10 shows an example of how to terminate the network. The charger is not equipped with terminators. Termination may be provided as part of the network cabling or

120-ohm termination plugs for the RJ-45 communications connector on the charger are available to order separately (SENS 803707).

Figure 10 – Modbus Termination



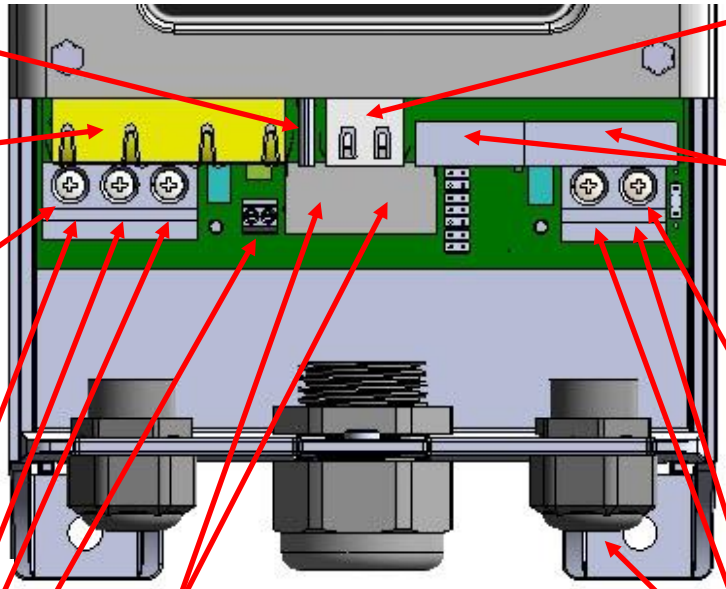
LT = Line Termination 120-ohm resistor

7 WIRING

All wiring must comply with applicable codes and local ordinances.

WARNING:
ENSURE THAT AC POWER IS DISCONNECTED AT A CIRCUIT BREAKER OR OTHER SAFETY DISCONNECT BEFORE WIRING THE CHARGER

Figure 11 – Wire Connections
(Fully enclosed model with optional alarm/communications circuit board shown)



OPTIONAL USB PORT:
Connect computer with SENS Setup Utility

OPTIONAL RJ-45 PORT:
Connect J1939/Modbus RS-485 cable if alarm/comms PCA is included

AC INPUT TERMINALS:
20–10 AWG (0.5–6 mm²) solid
20–6AWG (0.5–13.5 mm²) stranded
Tighten to 10.5 In-Lb (1.2 Nm)

AC L1
AC L2/N
GND ⏚

REMOTE TEMPERATURE SENSOR TERMINALS:
28–16 AWG (0.08–1.5 mm²)
Tighten connections to 2.0 In-Lb (0.22 Nm)

MAIN PCA SENSBUS RJ-45 PORT:
Connect J1939/Modbus RS-485 cable to main PCA unless optional alarm/comms PCA is included
Always connect SENS Setup Utility, load share or remote accessory cable to this main PCA connector

OPTIONAL MODBUS TCP/IP PORT:
Connect Modbus TCP/IP

OPTIONAL ALARM TERMINAL BLOCKS:
28–16 AWG (0.08–1.5 mm²)
Tighten connections to 2.0 In-Lb (0.22 Nm)

DC OUTPUT TERMINALS:
20–10 AWG (0.5–6 mm²) solid
20–6AWG (0.5–13.5 mm²) stranded
Tighten to 10.5 In-Lb (1.2 Nm)

DC POS (+)
DC NEG (-)

CONDUIT OR CORD BUSHINGS:
Customer supplied

7.1. Wire Ratings and Sizes

7.1.1. All power conductors should be rated for use at 90°C or higher and 400V or higher. Alarm relay conductors and J1939 data cable should be rated for use at 75°C or higher.

7.1.2. Coordinate the AC input conductor size with the customer-provided branch circuit protection device.

7.1.3. For best performance and recharge time, refer to the following table to determine the appropriate output conductor gauge and length. Use of a remote temperature sensor (SENS p/n 209481, see section 7.6) is highly recommended for best charging performance.

Table 3 – DC Output Cable Size

Charger Rated Output Current (Amps)	Wire Size		Resistance per Foot (mΩ/Ft.)	Maximum Charger to Battery Distance (Ft.)				
	AWG	mm^2		12V	24V	36V	48V	120V
6	14	2.5	2.50		33	49.5	66	165
	12	4.0	1.60		52	78	104	260
	10	6.0	1.00		83	124.5	166	415
	8	10	0.63		132	198	264	660
	6	16	0.40		208	312	416	1040
10	14	2.5	2.50	10	20			
	12	4.0	1.60	16	32			
	10	6.0	1.00	25	50			
	8	10	0.63	40	80			
	6	16	0.40	63	126			
12	14	2.5	2.50	8		24	32	
	12	4.0	1.60	13		39	52	
	10	6.0	1.00	21		63	84	
	8	10	0.63	33		99	132	
	6	16	0.40	52		156	208	
15	14	2.5	2.50	6	12			
	12	4.0	1.60	10	20			
	10	6.0	1.00	17	34			
	8	10	0.63	26	52			
	6	16	0.40	42	84			
20	14	2.5	2.5	5	10			
	12	4	1.6	8	16			
	10	6	1	13	26			
	8	10	0.63	20	40			
	6	16	0.4	31	62			
25	14	2.5	2.5	4	8			
	12	4	1.6	6	12			
	10	6	1	10	20			
	8	10	0.63	16	32			
	6	16	0.4	25	50			

The above lengths consider the resistance of the battery and cables only and do not take into account any additional interconnects. The above lengths are for operation at 25°C/77°F. For high temperature installations (40°C/104°F) increase wire gauge by 10%.

7.1.4. The charger terminal blocks accept the following wire gauge ranges:

- AC input terminal block: 20 – 10 AWG (0.5 – 6 mm^2) solid; 20 – 6 AWG (0.5 – 13.5 mm^2) stranded
- Remote temperature sensor terminal block: 28 – 16 AWG (0.08 – 1.5 mm^2)
- DC output terminal block: 20 – 10 AWG (0.5 – 6 mm^2) solid; 20 – 6 AWG (0.5 – 13.5 mm^2) stranded
- Alarm terminal block: 28 – 16 AWG (0.08 – 1.5 mm^2)

7.2. Grounding Instructions and Connection

7.2.1. Charger must be grounded to reduce risk of electric shock. The charger must be connected to a grounded, metal, permanent wiring system, or an equipment-grounding conductor (earthing conductor) must be run with the circuit conductors and connected to equipment-grounding terminal on charger.

7.2.2. Connect the equipment grounding conductor to the ground position on the AC input terminal block in the charger (see Figure 11). This position is marked with the ground symbol. This should always be the first wire connected and the last wire disconnected.

7.2.3. The charger may be equipped with an optional power cord having an equipment-grounding conductor and a grounding plug. The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes and ordinances.

> **DANGER:**
> **NEVER ALTER AC CORD OR PLUG PROVIDED – IF IT WILL NOT FIT OUTLET, HAVE PROPER OUTLET INSTALLED BY A QUALIFIED ELECTRICIAN. IMPROPER CONNECTION CAN RESULT IN A RISK OF AN ELECTRIC SHOCK.**

7.3. DC Connection

Ensure that any battery disconnect device in the system, if used, is opened (batteries disconnected from DC bus). Connect the DC output conductors to the DC output terminal block in the charger (see Figure 11). Always observe proper polarity of the DC output leads. Always connect the output leads in the following order – charger output to ungrounded battery terminal, followed by charger output to grounded battery terminal. If the battery must be disconnected for service, remove the output wiring in the reverse order. The terminals accept 20 through 10 AWG (0.5 through 6 mm^2) solid copper conductors and 20 through 6 AWG (0.5 through 13.5 mm^2) stranded copper conductors. Tighten connections to 10.5 Lb-In (1.2 Nm) using a Phillips slotted #2 driver. Route DC wiring at least ¼ inch (6 mm) away from AC wiring, alarm wiring, and the circuit board.

> **WARNING:**
> **A MAXIMUM OF 40 VOLTS MAY BE APPLIED AT THE OUTPUT TERMINALS. HIGHER VOLTAGE MAY DAMAGE THE CHARGER.**

7.4. AC Connection

This unit is permanently connected to the AC circuit and to the battery. An external disconnect device must be located in the AC input to the charger. The charger is rated to operate on any AC input within the range of 90-265VAC, 47-63Hz.

Ensure that the AC input supply is de-energized. Connect the AC line, neutral and ground conductors to the AC input terminal block in the charger (see Figure 11). If there is an identified grounded circuit conductor (neutral), attach it to the terminal marked “L2/N.” The terminals accept 20 through 10 AWG (0.5 through 6 mm^2) solid copper conductors and 20 through 6 AWG (0.5 through 13.5 mm^2) stranded copper conductors. Tighten connections to 10.5 Lb-In (1.2 Nm) using a Phillips slotted #2 driver. Route AC wiring at least ¼ inch (6 mm) away from DC wiring, alarm wiring, and the circuit board.

7.5. Alarm Connections—*Optional*

If the optional alarm/communications circuit board is included, connect alarm wiring to the respective terminals on the pluggable terminal block in the charger (see Figure 11 for location in charger and Figure 12 for detail). To make wiring easier, the terminal block unplugs from the header. Pull terminal block straight out from header to remove. Connect wires to terminal block by tightening screws at each position. After wires are connected, plug terminal block securely back into header. Alarm relay assignments are custom configurable. See charger inside cover label for original factory alarm relay assignments. Wire from FAIL or OK to COM depending on whether the alarm should be present on an open or closed circuit (see Table 4-6). Connect alarm terminals only to low voltage, limited energy (“Class

2") circuits. Alarm circuits are rated 2A at 30V AC or DC. The terminals accept 28-16 AWG (0.08-1.5 mm^2) conductors. Tighten connections to 2.0 Lb-In (0.22 Nm) using a small slotted driver. Route alarm wiring at least ¼ inch (6 mm) away from DC wiring, AC wiring, and the circuit board.

Figure 12– Pluggable Terminal Block

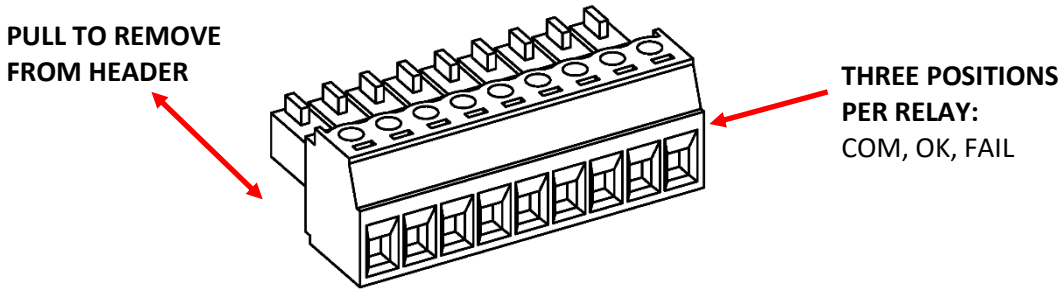


Table 4 – Example Alarm Relay Contact Wiring for Genset Configuration

Wire from COM to OK for alarm present on open circuit or from COM to FAIL for present on closed circuit.

	RELAY 1 Non-latching Coil	**RELAY 2 Non-latching Coil**	**RELAY 3 Latching Coil**	**RELAY 4 Latching Coil**	**RELAY 5 Latching Coil**
Relay Contacts	**AC Fail Alarm**	**Charger Fail Alarms**	**Low Crank Alarm**	**High DC Alarm**	**Low DC Alarm**
Common	COM (TB1-1)	COM (TB1-4)	COM (TB1-7)	COM (TB1-10)	COM (TB1-13)
Open on alarm	OK (TB1-2)	OK (TB1-5)	OK (TB1-8)	OK (TB1-11)	OK (TB1-14)
Close on alarm	FAIL (TB1-3) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-6) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-9)	FAIL (TB1-12)	FAIL (TB1-15)

Table 5 – Example Alarm Relay Contact Wiring for Marine Configuration

Wire from COM to OK for alarm present on open circuit or from COM to FAIL for present on closed circuit.

	RELAY 1 Non-latching Coil	**RELAY 2 Non-latching Coil**	**RELAY 3** Latching Coil	**RELAY 4** Latching Coil	**RELAY 5** Latching Coil
Relay Contacts	**Summary Alarm***	**AC Fail + Charger Fail Alarms**	**Ground Fault Alarm**	**High DC Alarm**	**Low DC Alarm**
Common	COM (TB1-1)	COM (TB1-4)	COM (TB1-7)	COM (TB1-10)	COM (TB1-13)
Open on alarm	OK (TB1-2)	OK (TB1-5)	OK (TB1-8)	OK (TB1-11)	OK (TB1-14)
Close on alarm	FAIL (TB1-3) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-6) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-9)	FAIL (TB1-12)	FAIL (TB1-15)

*Summary alarm includes AC Fail, Charger Fail, Ground Fault, High DC and Low DC alarms.

Table 6 – Example Alarm Relay Contact Wiring for Stationary Power Configuration

Wire from COM to OK for alarm present on open circuit or from COM to FAIL for present on closed circuit.

	RELAY 1 Non-latching Coil	**RELAY 2 Non-latching Coil**	**RELAY 3** Latching Coil	**RELAY 4** Latching Coil	**RELAY 5** Latching Coil
Relay Contacts	**Summary Alarm***	**AC Fail + Charger Fail Alarms**	**Battery Discharging Alarm**	**High DC Alarm**	**Low DC Alarm**
Common	COM (TB1-1)	COM (TB1-4)	COM (TB1-7)	COM (TB1-10)	COM (TB1-13)
Open on alarm	OK (TB1-2)	OK (TB1-5)	OK (TB1-8)	OK (TB1-11)	OK (TB1-14)
Close on alarm	FAIL (TB1-3) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-6) Defaults to FAIL with no AC and DC power (normally closed)	FAIL (TB1-9)	FAIL (TB1-12)	FAIL (TB1-15)

*Summary alarm includes AC Fail, Charger Fail, Battery Discharging, High DC and Low DC alarms.

7.6. Remote Temperature Sensor Connection—*Optional*

The charger includes local temperature compensation using an internal on-board sensor. Alternately, the charger will use remote temperature compensation based on the temperature of the batteries when an optional external sensor is located at the batteries and connected to the main circuit board remote temperature sensor terminal block (see Figure 11). Remote temperature compensation is required for ultracapacitor charging and is highly recommended in all applications. It is most critical in applications where battery and charger are located in different ambient conditions and in NFPA-20 fire pump and NFPA-110 emergency power system installations in order to return 100% of the battery's ampere-hour rating within 24 hours without causing damage to the battery. Chargers connected to load share only require a remote temperature sensor connected to one charger. Temperature compensation is disabled by connecting a short across the remote temperature sensor terminal block on the main circuit board, using the optional keypad or by setting the temperature compensation slope to zero using the SENS Setup Utility. See section 10.11 for further information regarding temperature compensation. A 50-foot remote temperature sensor is available to order separately (SENS p/n 209481).

The remote temperature sensor is not polarized; it does not matter which lead connects to each terminal. Route sensor wiring at least ¼ inch (6 mm) away from DC wiring, AC wiring, and the circuit board. Locate the remote sensor where it will accurately detect the battery temperature by connecting it to a *grounded* battery terminal or the battery case. When securing to the battery case, use an adhesive/glue properly rated for the application material and temperature, such as Super Glue®.

7.7. J1939/Modbus RS-485 Communications Connection

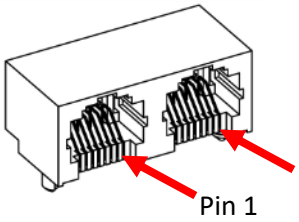
Connect either J1939 or Modbus RS-485 communications using a twisted pair cable at the RJ-45 connector on the optional alarm/communications circuit board if present (see Figure 11 for location in charger and Figure 13 for detail). Connect the communications cable to the main circuit board RJ-45 connector if the optional alarm/communications circuit board is not present. Chargers with only the main circuit board support J1939 or SENSbus devices (load sharing charger or remote accessory) but not both at the same time. If both J1939 and a remote SENSbus accessory or load sharing are desired the optional alarms/communications circuit board must be included.

Two RJ-45 ports are provided on both the main and optional alarms/communications circuit boards (see Figure 13). On each circuit board the ports are in parallel and either port may be used. Use the second

port to connect chargers for load sharing (see section 7.10) or remote accessories (see section 7.11). See Table 7 for connector pinout. An adapter from RJ-45 to an 8-position terminal block may be connected to the RJ-45 connector and is available to order separately (SENS p/n 208026). See section 11 for further information on J1939 operation and section 12.1 for further information on Modbus RS-485 operation and registers.

Communications are non-isolated and referenced to negative battery terminal.

Figure 13 – RJ-45 Connection



TWO PORTS:

Connect J1939 or Modbus RS-485 to one port and load sharing charger or remote accessory to second port

Table 7 – Connector Pinout

Pin #	Purpose
1	J1939 Data High/SENSbus
2	J1939 Data Low/SENSbus
3	No connect pass-through
4	Modbus –D0 (B)
5	Modbus +D1 (A)
6	No connect pass-through
7	Power*
8	Common (referenced to battery negative)

*Main circuit PCA only, used for interconnect between SENS devices

7.8. Modbus TCP/IP Communications Connection—*Optional*

Connect Modbus TCP/IP communications using Cat5 or better ethernet cable at the RJ-45 connector on the optional alarm/communications circuit board if present (see Figure 11).

7.8.1.1. Configure TCP/IP Address

Configure TCP/IP settings using the SENS Setup Utility or the optional keypad (see section 10.9.3). Set the IP address as desired. It may take up to 10 seconds for the network setting changes to apply. A TCP/IP address of 0.0.0.0 implies DHCP (Dynamic) addressing. Adjust the Gateway and Subnet Mask values as required. See section 12.2 for further information on Modbus TCP/IP operation and registers.

7.9. USB Connection—*Optional*

The unit is equipped with a USB-C connector (see Figure 11) for monitoring and configuration via the SENS Setup Utility (see section 10.10).

7.10. Load Share Connection—*Optional*

Multiple chargers may be connected in parallel to provide charger redundancy and increased charging current using a load sharing accessory, available to order separately (SENS p/n 209069). Connect the load sharing accessory from one charger to another using the RJ-45 ports on each charger to automatically initiate load sharing. Two RJ-45 ports are provided on the main circuit board (see Figure 11 for location in charger and Figure 13 for detail). The ports are in parallel and either port may be used for the load share connection. Connect one charger to the “CHARGER 1” port and the other charger to the “CHARGER 2” port on the load sharing accessory using provided network cables. Connect the other

end of the network cables to the SENSbus RJ-45 port on each charger. Leave a factory installed 120-ohm terminator in a SENSbus port on the main circuit board on each charger to ensure a terminator is located at both ends of the communications bus.

7.11. Remote Alarm/Communications Panel Accessory Connection—*Optional*

Connect remote accessories to the charger using a network cable connected to the RJ-45 port on the charger main circuit board. Two RJ-45 ports are provided on the main circuit board (see Figure 11 for location in charger and Figure 13 for detail). Connect a network cable from the remote accessory to one port and a 120-ohm terminator to the second port. Connect the other end of the network cable to the RJ-45 splitter connected to the RJ-45 port on the remote accessory circuit board.

For proper operation, a 120-ohm terminator is required at both ends of the communications bus. Remote accessories are provided with a terminator installed in the 2-position RJ-45 splitter connected to the RJ-45 port located on the remote accessory circuit board. Remove the terminator on the splitter only if the remote accessory is not at the end of the communications bus.

The remote accessory may be connected to multiple chargers. In this case, the remote accessory, chargers or other equipment, such as a genset controller, may be located at the ends of the communications bus. Ensure a terminator is located at both ends of the communications bus.

7.12. Verify Connections

7.12.1. Verify that all connections are secure and in the proper locations. Tighten all unused screws on the terminal blocks to secure them against vibration.

7.12.2. Ensure all wires are routed in a way that the cover or other objects will not pinch or damage them.

8 POWER ON/POWER OFF PROCEDURE

8.1. Connect Battery

Ensure wiring is correctly connected between charger and battery. Close any system battery disconnect, if used, to connect the battery to the charger.

8.2. Apply AC Input Voltage

Verify the AC input is the correct value (90-265 VAC, 47-63 Hz) and apply AC to charger.

Depending on the state of charge of the batteries and the load on the DC bus, the charger may go into current limit at this time, in which case the output voltage will be reduced as the charger operates in constant current mode. Eventually as the battery is charged, the charging current demand should taper to a value below the current limit setpoint of the charger, and the charger should revert to constant voltage output.

8.3. Power Off

Power charger off in any order or remove any jumper (if charger is not in Program Mode) to disable output voltage.

9 ALARMS, LEDS AND DISPLAY

9.1. LED Indicators

The charger is equipped with two LEDs, one for AC status and one for DC status. See further alarm definitions in section 9.5.

Table 8 – LED Definitions

AC LED	DC LED	Meaning
OFF	OFF	AC and DC not applied or charger failed or optional alarm/communications circuit board cannot communicate with main circuit board
*SOLID GREEN	SOLID GREEN	AC good, DC good, in Float Mode
SOLID GREEN	FLASHING GREEN	AC good, in Dynamic Boost Mode
*SOLID GREEN	FLASHING 2X GREEN	AC good, DC in current limit (max charge)
*SOLID GREEN	FLASH LONG-SHORT GREEN	AC good, HELIX Eco-Float mode
*SOLID GREEN	FLASH LONG-2X SHORT GREEN	AC good, HELIX Refresh Charge mode
*SOLID GREEN	FLASH LONG-SHORT YELLOW	AC good, battery commissioning mode active
*SOLID GREEN	FAST FLASHING GREEN	AC good, battery check in progress
*SOLID GREEN	FAST FLASHING YELLOW	AC good, battery check failure
*SOLID GREEN	SOLID RED	AC good, charger fail or overvoltage shutdown (charger disabled)
*SOLID GREEN	FLASHING RED/YELLOW	AC good, reverse polarity detected on output
*SOLID GREEN	SOLID YELLOW	AC good, high or low DC voltage (above/below alarm setpoint)
*SOLID GREEN	FLASHING GREEN/RED	For multi-charger system with optional alarm/communications circuit board only: AC good, system DC output good, some individual charger(s) in alarm state
*SOLID GREEN	FLASHING RED/YELLOW	AC good, incompatible battery error (charger disabled)
*SOLID GREEN	FLASHING YELLOW	AC good, positive/negative ground fault present
*SOLID GREEN	FLASHING GREEN/YELLOW	AC good, output limited by high temperature
*SOLID GREEN	DOUBLE FLASH YELLOW	AC good, load share fail
*SOLID GREEN	DOUBLE FLASH RED	AC good, load sharing DC negative connection open or load sharing charger address fault
SOLID RED	SOLID GREEN	AC fail, DC voltage good
SOLID RED	SOLID YELLOW	AC fail, high or low DC voltage (above/below alarm setpoint)
SOLID RED	SOLID RED	AC fail, charger fail or overvoltage shutdown (charger disabled)
SOLID RED	FLASHING RED/YELLOW	AC fail, incompatible battery error (charger disabled)
SOLID RED	FLASHING YELLOW	AC fail, positive/negative ground fault present
FLASH LONG-2X SHORT YELLOW		SENSbus Inactive
ALTERNATING FLASHING YELLOW		Illegal jumper configuration
ALTERNATING FLASHING RED		Missing or invalid code (boot load required)
ALTERNATING FLASHING GREEN		Charger starting up

*AC LED will flash green when charger is in ultracapacitor mode.

9.2. Individual Alarm Relay Contacts—*Optional*

The optional alarm/communications circuit board offers two or five alarm discrete Form C contacts. The Form C relay contacts change state when alarms are activated (see Tables 4-6). Alarm relay assignments are custom configurable to any of the alarm functions listed in section 9.5. See charger inside cover label for original factory alarm relay assignments. See Tables 4-6 for typical alarm relay assignments.

The relay contacts change state 30 seconds after the onset of a fault or after a programmable time period when the charger is in Program Mode (see section 10.10). See section 9.5 for alarm definitions.

9.3. LCD Panel—*Optional*

If the optional alarm/communications circuit board is included, a two line by twenty-character LCD is present and provides precision digital ammeter and voltmeter as well as information about input, output, charging status and alarms. The voltmeter is accurate to ±1% and the ammeter is accurate to ±1%. The display is readable with or without ambient lighting and operates automatically, requiring no operator intervention.

The LCD is fully operational from -20°C to +40°C. It may temporarily become unreadable below -20°C but should recover as temperature increases. LCD life is reduced with sustained operation above 65°C.

9.4. Latched Alarms

All alarm messages displayed on the front panel LCD are latching. Alarm relay configurations created using the SENS Setup Utility may be configured as latching if desired. Once an alarm condition no longer exists, the alarm message will no longer display in the main/home screen but will remain under the "Latched Alarms" menu. Clear latched alarms using the optional keypad under the "Latched Alarms" menu (see section 10.9.3), using the SENS Setup Utility or by cycling power.

9.5. Alarm Definitions

See Table 8 for a description of LED indicator activity. Unless noted otherwise, the following alarms are displayed on the optional LCD panel if it is included.

9.5.1. AC Line Failure

Indicates AC input voltage is not applied or is outside of allowed 90-265 VAC range. Activates solid red AC LED. Optional alarm/communications circuit board AC FAIL relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.2. High DC Voltage

Indicates DC output voltage is above factory alarm setpoint (see Table 9), standard jumper configuration setpoint (see Table 10), or the programmed level if the charger is in Program Mode. Activates solid yellow DC LED. Optional alarm/communications circuit board HIGH DC relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

Table 9 – Factory Configuration High DC Setpoints

Configuration Code*	Battery Type	High DC Setpoint (V / Cell)
GEN	AGM	2.667
	FLA	2.667
	NICD	1.600
	HCB	2.667
	Ultracapacitor	17.00/28.00V
MAR	VRLA	2.440
	AGM/FLA	2.470
	NCD	1.600
NGN	VRLA	2.440
	AGM/FLA	2.470
	NCD	1.600
PSP	N/A	2.200

*Configuration Code displayed on charger label.

Table 10 – Standard Jumper Configuration High DC Setpoints

Battery Range	Jumper	High DC Setpoint
12-48V	Any FLOAT position	2.667VPC
	Ultracap Mode	17.00/28.00V

9.5.3. Battery Discharging

Indicates battery is beginning to discharge and DC output voltage is below factory alarm setpoint (see Table 13), standard jumper configuration setpoint (see Table 14), or the programmed level if the charger is in Program Mode. Alarm setpoint must be set higher than LOW DC alarm. Activates solid yellow DC LED. Optional alarm/communications circuit board BATTERY DISCHARGING relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

Table 13 – Factory Jumper Configuration Battery Discharging Setpoints

Configuration Code*	Battery Type	Battery Discharging Setpoint (V / Cell)
GEN	AGM	2.083
	FLA	2.083
	NICD	2.083
	HCB	2.083
	Ultracapacitor	14.40/24.00V
MAR	VRLA	2.000
	AGM/FLA	2.000
	NCD	2.000
NGN	VRLA	2.000
	AGM/FLA	2.000
	NCD	2.000
PSP	N/A	1.700

*Configuration Code displayed on charger label.

Table 14 – Standard Jumper Configuration Battery Discharging Setpoints

Battery Range	Jumper	Battery Discharging Setpoint
12-48V	Any FLOAT position	2.083VPC
	Ultracap Mode	12.00/24.00V

9.5.4. Low DC Voltage

Indicates battery has discharged and DC output voltage is below factory alarm setpoint (see Table 11), standard jumper configuration setpoint (see Table 12), or the programmed level if the charger is in Program Mode. Activates solid yellow DC LED. Optional alarm/communications circuit board LOW DC relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

Table 11 – Factory Jumper Configuration Low DC Setpoints

Configuration Code*	Battery Type	Low DC Setpoint (V / Cell)
GEN	AGM	2.017
	FLA	2.017
	NICD	2.017
	HCB	2.017
	Ultracapacitor	13.00/22.40V
MAR	VRLA	1.833
	AGM/FLA	1.833
	NCD	1.833
NGN	VRLA	1.833
	AGM/FLA	1.833
	NCD	1.833
PSP	N/A	1.700

*Configuration Code displayed on charger label.

Table 12 – Standard Jumper Configuration Low DC Setpoints

Battery Range	Jumper	Low DC Setpoint
12-48V	Any FLOAT position	2.017VPC
	Ultracap Mode	13.00/22.40V

9.5.5. Battery End of Discharge

Indicates DC output voltage is below factory alarm setpoint (see Table 15), standard jumper configuration setpoint (see Table 16), or the programmed level if the charger is in Program Mode. This alarm is intended only for longer discharge rates (i.e. not engine starting applications) and indicates the normal end-of-discharge voltage for a lead-acid battery. Alarm setpoint must be set lower than LOW DC and BATTERY DISCHARGING alarms. Activates solid yellow DC LED. Optional alarm/communications circuit board BATTERY END OF DISCHARGE relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

Table 15 – Factory Jumper Configuration Battery End of Discharge Setpoints

Configuration Code*	Battery Type	Battery End of Discharge Setpoint (V / Cell)
GEN	AGM	1.750
	FLA	1.750
	NICD	1.750
	HCB	1.750
	Ultracapacitor	10.50/21.00V
MAR	VRLA	1.750
	AGM/FLA	1.750
	NCD	1.750
NGN	VRLA	1.750
	AGM/FLA	1.750
	NCD	1.750
PSP	N/A	1.700

*Configuration Code displayed on charger label.

Table 16 – Standard Jumper Configuration Battery End of Discharge Setpoints

Battery Range	Jumper	Battery End of Discharge Setpoint
12-48V	Any FLOAT position	1.750VPC
	Ultracap Mode	10.50/21.00V

9.5.6. Charger Failure

Indicates the charger is not able to provide the current demanded by the battery and/or load or is providing more current than the charger's control system is commanding. This is typically caused by a charger internal component failure. This alarm does not occur during AC power failures. Activates solid red DC LED. Optional alarm/communications circuit board CHARGER FAIL relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.7. Overvoltage Shutdown

Indicates that the charger has executed a high voltage shutdown and DC output voltage is above factory alarm setpoint (see Table 17), standard jumper configuration setpoint (see Table 18), or the programmed level if the charger is in Program Mode. The charger disables itself whenever excessive output voltage occurs while the charger is delivering current. The overvoltage shutdown system is protected against nuisance trips and will not execute if the high voltage condition is caused by an external source. Activates solid red DC LED. Optional alarm/communications circuit

board OVERVOLTAGE SHUTDOWN relay contacts change to Fail state after delay when alarm is assigned to relay contacts. Reset the charger by removing and replacing any jumper on the circuit board to clear the alarm.

Table 17 – Factory Jumper Configuration Overvoltage Shutdown Setpoints

Configuration Code*	Battery Type	Overvoltage Shutdown Setpoint (V / Cell)
GEN	AGM	2.833
	FLA	2.833
	NICD	2.833
	HCB	2.833
	Ultracapacitor	17.60/29.20V
MAR	VRLA	2.530
	AGM/FLA	2.568
	NCD	2.833
NGN	VRLA	2.530
	AGM/FLA	2.568
	NCD	2.833
PSP	N/A	2.200

*Configuration Code displayed on charger label.

Table 18 – Standard Jumper Configuration Overvoltage Shutdown Setpoints

Battery Range	Jumper	Overvoltage Shutdown Setpoint
12-48V	Any FLOAT position	2.833VPC
	Ultracap Mode	17.00/34.00V

9.5.8. Reverse Polarity

Indicates a battery is connected backwards. Charger output is disabled until the condition is corrected. Activates flashing red/yellow DC LED. Optional alarm/communications circuit board REVERSE POLARITY relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.9. Low Cranking Voltage

Indicates the battery voltage is likely to be inadequate to provide engine-cranking capability. Using the Factory default settings, alarm indicates that DC output voltage during a prior cranking event dropped below 50% of the nominal DC output voltage rating (e.g. 6V for a 12V system). **This alarm is latching and must be manually reset by disconnecting both AC and DC power or using optional keypad**. Chargers intended for marine and standby power applications are shipped with the low cranking voltage alarm disabled. Optional alarm/communications circuit board LOW CRANK relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.10. Incompatible Battery

Indicates charger is connected to an incompatible battery (e.g. a 12V battery is connected to a 24V charger). The charger operates for approximately 5 minutes while observing behavior of the DC voltage. If DC voltage behavior is normal the charger will continue charging. If DC voltage

behavior is abnormal, as is typical with a battery voltage mismatch, the charger will shut down and lock off after approximately five minutes. Activates flashing red/yellow DC LED. Optional alarm/communications circuit board INCOMPATIBLE BATTERY relay contacts change to Fail state after delay when alarm is assigned to relay contacts. After correcting mismatched condition, remove and replace any jumper on the main circuit board or cycle power to reset the charger and begin operation. See section 10.6 for charging a very low or zero-volt battery.

9.5.11. Invalid Settings

Indicates main circuit board output voltage jumpers (see Figure 1) are not valid. Charger output is disabled until the condition is corrected. If the charger is programmed to use custom settings it will enter Program Mode when all jumpers are removed. The invalid jumper alarm will not be active in this case but will be active if no jumpers are installed and the charger has not been programmed. Activates alternating flashing yellow AC and DC LEDs. Optional alarm/communications circuit board INVALID SETTINGS relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.12. SENSbus Inactive

Indicates the charger cannot communicate using SENSbus when load sharing and/or remote accessories are connected. Activates flashing long then 2x short yellow AC and DC LEDs. Optional alarm/communications circuit board SENSBUS INACTIVE relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.13. Thermal Fold Back

Indicates charger output is reduced to protect the charger from over-heating damage. The charger will not be able to produce full output until the ambient temperature is lowered. Optional alarm/communications circuit board THERMAL FOLD BACK relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.14. No Remote Temp Sense

Indicates disabled or failed remote temperature sensor. Optional alarm/communications circuit board NO BATT TEMP SENSOR relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.15. Current Limiting

Indicates the charger is operating at maximum allowable output, either the maximum current setting or maximum power output (whichever occurs first). Optional alarm/communications circuit board CURRENT LIMIT relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.16. Ground Fault

Indicates a short circuit or high impedance leakage current (greater than 500uA) exists from the charger positive or negative output to ground. To disable the alarm, remove the ground fault jumper from the main circuit board (see Figure 1). Chargers intended for genset applications are shipped with the ground fault alarm disabled via software (even though ground fault jumper is still in place on the main circuit board). Chargers intended for Marine and stationary power applications are shipped with ground fault enabled. When multiple chargers are operated in parallel and the ground fault alarm is desired, physically remove the ground fault jumper on all but one charger (see Figure 1). Activates flashing yellow DC LED. Optional alarm/communications circuit board GROUND FAULT relay contacts change to Fail state after delay when alarm is assigned to relay contacts. Using the optional keypad, navigate to the “DC Meters” menu to view detected ground fault voltage and current.

The RJ-45 port used for communications is not isolated from the charger output. Non-isolated communications equipment/adapters connected to the RJ-45 port may cause a ground fault alarm.

9.5.17. Low Current

Indicates current drawn from the charger is below factory alarm setpoint. Chargers are shipped with the low current alarm disabled. Optional alarm/communications circuit board LOW CURRENT relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.18. Load Share Fail

Indicates that chargers connected for load sharing are not sharing the current load. Activates double flashing yellow DC LED. Optional alarm/communications circuit board LOAD SHARE FAIL relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.19. AutoBoost Lockout Active

Indicates the Boost mode time limit has expired and charger has returned to Float mode. Boost mode is disabled until the time limit is reset. The Boost time limit is reset if charger power is cycled, charger is reset by removing and replacing jumpers or an engine crank is detected. The Boost time limit is set to 24 hours by default.

9.5.20. DC Negative Open

Indicates an open DC negative output connection when chargers are load sharing. Tighten or make connection to remove alarm. Activates double flashing red DC LED. Optional alarm/communications circuit board DC NEGATIVE OPEN relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.21. Address Fault

Indicates an address fault when more than 30 chargers are connected to load share. Activates double flashing red DC LED. Alarm is not displayed on the optional LCD and cannot be assigned to relay contacts.

9.5.22. Charger Module Fault

Only applicable to multi-charger systems with an optional remote alarm/communications panel accessory. Indicates one or more individual charger(s) are in an alarm state. Activates flashing green/red DC LED. Optional alarm/communications circuit board INDIVIDUAL CHARGER relay contacts change to Fail state after delay when alarm is assigned to relay contacts.

9.5.1. DC Below Startup Voltage

Indicates battery voltage is below the factory Startup Voltage setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. When this alarm is assigned to a relay contact DC BELOW STARTUP VOLTAGE will cause the assigned relay to change to the Failed state after the time delay.

9.5.2. Battery Check

Indicates battery has failed the most recent battery check. This is a latching alarm. This alarm is cleared by passing a new battery check or by manual reset. When this alarm is assigned to a relay contact BATTERY CHECK will cause the assigned relay to change to the Failed state after the time delay.

9.5.3. Thermal Fault

Indicates charger has faulted because it over heated and thermal fold-back has reached zero watts. Charger output has been disabled. Cycle AC and DC power for re-initiation. When this alarm is assigned to a relay contact THERMAL FAULT will cause the assigned relay to change to the Failed state after the time delay.

9.5.4. High Battery Temperature

Indicates battery temperature is above the High Battery Temperature setpoint. This alarm is only available when a remote battery temperature sensor is installed. When this alarm is assigned to a relay contact HIGH BATTERY TEMPERATURE will cause the assigned relay to change to the Failed state after the time delay.

9.5.5. High Battery Temperature Shutdown

Indicates battery temperature is above the High Battery Temperature Shutdown setpoint and that the charger has shut off as a safety concern. This alarm is only available when a remote battery temperature sensor is installed. When this alarm is assigned to a relay contact HIGH BATTERY TEMPERATURE SHUTDOWN will cause the assigned relay to change to the Failed state after the time delay.

9.5.6. Charger Low Temperature

Indicates charger is currently below its rated temperature. Output may be derated. When this alarm is assigned to a relay contact CHARGER LOW TEMPERATURE will cause the assigned relay to change to the Failed state after the time delay.

9.5.7. Battery Low Temperature

Indicates battery temperature is below the Low Battery Temperature setpoint. This alarm is only available when a remote battery temperature sensor is installed. When this alarm is assigned to a relay contact BATTERY LOW TEMPERATURE will cause the assigned relay to change to the Failed state after the time delay.

9.5.8. AC Voltage Over Maximum

Indicates AC Voltage has gone above maximum allowed by the charger. This alarm has a delay of 3 seconds. Output has been disabled. Activates solid red AC LED. When this alarm is assigned to a relay contact AC VOLTAGE OVER MAXIMUM will cause the assigned relay to change to the Failed state after the time delay.

9.5.9. AC Voltage Low

Indicates AC Voltage has gone below AC Min Voltage alarm setpoint. Activates solid yellow AC LED. When this alarm is assigned to a relay contact AC VOLTAGE LOW will cause the assigned relay to change to the Failed state after the time delay.

9.5.10. AC Frequency Out of Range

Indicates AC Frequency is above the AC High Frequency or below the AC Low Frequency alarm setpoint. Activates solid yellow AC LED. When this alarm is assigned to a relay contact AC FREQUENCY OUT OF RANGE will cause the assigned relay to change to the Failed state after the time delay.

9.5.11. AC Voltage High

Indicates AC Voltage is above the AC Max Voltage alarm setpoint. Activates solid yellow AC LED. When this alarm is assigned to a relay contact AC VOLTAGE HIGH will cause the assigned relay to change to the Failed state after the time delay.

9.5.12. TCP/IP Error

Indicates a setup error on the Modbus TCP/IP device on the optional communications circuit board. Re-apply network settings using the front panel keypad by re-entering the IP address and then pressing the Enter (center arrow) key.

10 OPERATION

10.1. Charging Algorithms

The charger uses charging algorithms appropriate for different battery types. The charging algorithm for each battery type includes various combinations of Float mode, Dynamic Boost™ mode, and HELIX mode, as described in Table 19. See following sections for descriptions of each charging mode.

Table 19 – Charging Algorithms

Battery Type	Charging Algorithm		
	Float Mode	Dynamic Boost Mode	HELIX Mode
FLA for Genset	✓	✓	✓
FLA	✓	✓	
AGM	✓	✓	
NICD	✓	✓	
VRLA	✓		

10.1.1. Recharging Batteries

After a battery has been discharged, the charger will enter Dynamic Boost mode if this mode is enabled (see section 10.3). The charger's output voltage setpoint during Dynamic Boost mode increases to the boost voltage value (see section 10.3). If the battery is deeply discharged, DC voltage will remain below the boost voltage setpoint until the charger's output current drops below its rated maximum. Charging in boost mode continues until the Dynamic Boost control system ends boost mode or the boost time limit expires (boost time limit set to 24 hours by default). After operating in boost mode the charger switches to Float mode. If the charger is configured for flooded lead-acid batteries the charger will engage HELIX mode after operating in Float for a short time.

10.2. Float Mode

Float mode is used to maintain stationary batteries and AGM starting batteries in a fully charged state. When the charger is in Float mode the output voltage is maintained at the float voltage setting. See the charger nameplate label or the inside cover label for original factory configuration float value. Float voltage matches jumper value if jumpers are in standard jumper configuration.

Table 20– Factory Jumper Configuration Float Voltage Settings

Configuration Code*	Battery Type	Float Voltage (V / Cell)
GEN	AGM	2.270
	FLA	2.218
	NICD	1.430
	HCB	2.230
	Ultracapacitor	15.00/25.40V
FHP	FLA	2.218
MAR	VRLA	2.270
	AGM/FLA	2.218
	NCD	1.430
NGN	VRLA	2.270
	AGM/FLA	2.218
	NCD	1.430
PSP	N/A	2.000

*Configuration Code displayed on charger label.

Table 21 – Standard Jumper Configuration Float Voltage Settings

Battery Range	Float Jumper	Float Voltage (V)
12V	LO or 13.3/26.6	13.3/26.6/40.0/53.3
	MED or 13.5/27.0	13.5/27.0/40.5/54.0
	HI or 14.3/28.6	14.3/28.6/42.9/57.2

10.3. Dynamic Boost™ Mode

Dynamic Boost mode utilizes a higher voltage charge to quickly recharge batteries and ensure that all battery cells in a battery string are charged to the same level. Dynamic Boost mode automatically adjusts how long the charger remains in boost mode every recharge cycle. Dynamic Boost automatically adjusts for differing battery sizes, depths of discharge, varying load, battery age and other variables. Dynamic Boost mode safely maximizes recharge performance while cutting risks of both overcharging and undercharging associated with manual or automatic boost timers or earlier generation automatic boost control systems.

Dynamic Boost is automatically used by the charger depending on battery type selected. See the nameplate label or the charger inside cover label for original factory configuration boost value. Flooded lead-acid, absorbed glass mat (AGM) and nickel-cadmium batteries are automatically charged using Dynamic Boost mode when the battery requires it. Charging in boost mode continues until the Dynamic Boost control system ends boost mode or the boost time limit expires. The boost time limit is set to 24 hours by default. Since boost charging is discouraged by most manufacturers of valve-regulated lead-acid (VRLA) batteries used in stationary applications Dynamic Boost mode is disabled when the charger battery type is VRLA. Boost is also disabled when the battery type is set to ultracapacitor.

Relatively high boost voltages are appropriate in applications where rapid charge recovery is essential or required for strict NFPA-20 fire pump or NFPA-110 emergency power system installations. Order chargers from the factory configured for fire pump/emergency power system installations or configure the charger appropriately using the optional keypad or SENS Setup Utility. Use of the optional remote temperature compensation probe is highly recommended to maximize charging performance and optimize battery life.

Table 22 – Factory Jumper Configuration Boost Voltage Settings

Configuration Code*	Battery Type	Boost Voltage (V / Cell)
GEN	AGM	2.387
	FLA	2.363
	NICD	1.520
	HCB	2.400
	Ultracapacitor	Disabled
FHP	FLA	2.617
MAR	VRLA	Disabled
	AGM/FLA	2.300
	NCD	1.520
NGN	VRLA	Disabled
	AGM/FLA	2.300
	NCD	1.520
PSP	N/A	Disabled

*Configuration Code displayed on charger label.

Table 23 – Standard Jumper Configuration Boost Voltage Settings

Battery Range	Float Jumper	Battery Type	Boost Voltage (V / Cell)
12V	LO or 13.3/26.6	FLA	2.363
		AGM	2.333
		NICD	1.400
		VRLA	Disabled
	MED or 13.5/27.0	FLA	2.400
		AGM	2.367
		NICD	1.420
		VRLA	Disabled
	HI or 14.3/28.6	FLA	2.533
		AGM	2.533
		NICD	1.520
		VRLA	Disabled

10.4. HELIX Mode

HELIX (High Efficiency, LIfe-eXtending) mode significantly increases the life of flooded lead-acid starting batteries. Battery engineers confirm that continuous flooded SLI (starting batteries) are all designed for vehicle use where they are NOT continuously float charged. Continuous float charging flooded SLI batteries causes these batteries' polyethylene battery separators to oxidize much sooner than would occur in vehicles, where charging is intermittent. Premature separator failure in turn causes earlier failure of the battery than would occur in a vehicle application. Because HELIX allows battery separators to last their entire design life, HELIX also substantially reduces the risk of catastrophic failure of flooded lead-acid batteries.

HELIX is only active when the charger is set at the factory for flooded lead-acid battery type with configuration code "GEN" (see inside cover label for configuration code) or when set for flooded lead-acid battery type using the Standard Jumper Configuration (see section 6.2). HELIX operates automatically and no configuration is required by the operator. HELIX mode can be disabled using the optional keypad, the SENS Setup Utility, or by selecting a different battery type using the charger jumpers.

HELIX mode adds two DC output voltage settings to the traditional Boost and Float voltages. These are called Eco-Float and Refresh. The Eco-Float voltage is just above battery open circuit voltage, below traditional float. Refresh voltage is approximately halfway between Float and Boost voltage.

When HELIX is operating, the charger spends more than 90% of its operating hours in the Eco-Float mode. In this mode the charger uses less energy and substantially reduces the rate at which water is lost from the battery. If there are no power outages or other battery discharge events the charger periodically transitions from Eco-Float mode to Refresh mode to ensure that the battery remains fully charged. After operating in Refresh mode the charger reverts to Eco-Float mode.

10.5. Ultracapacitor Mode

Ultracapacitor mode is used to charge ultracapacitors rather than batteries. Ultracapacitor mode is available only on 12V and 24V models. The AC LED will flash green to indicate ultracapacitor mode. The charger output voltage in ultracapacitor mode is 15V for 12V ultracapacitors and 25.4V for 24V ultracapacitors. Dynamic Boost mode is disabled for operation with ultracapacitors.

10.6. Charging Low or Zero-volt Batteries

The charger will initially charge/commission zero-volt or fully discharged batteries without special user intervention. The charger will charge for approximately 5 minutes to determine if the battery voltage will begin to rise. If the voltage rises properly the charger will continue to charge the battery normally using standard output settings (see section 10.7 if alternate output settings are required). If the voltage does not rise appropriately within 5 minutes the charger will shut down. This shut down prevents long-term overcharge in the event of a mismatched battery (e.g. a 12V battery connected to a 24V system). After correcting a mismatched condition, cycle AC and DC power or remove and replace any jumper on the main circuit board to reset the charger and begin operation.

10.7. Commissioning Batteries

Initially charge/commission zero charge batteries with configurable output voltage and current by activating Commissioning Mode from the optional keypad or by using the SENS Setup Utility with the charger in Program Mode. When using the keypad, navigate to the “Battery Set-up” menu to enable commissioning and configure commissioning voltage, current and duration. When using Program Mode and the SENS Setup Utility (because the charger is not equipped with the optional keypad), see section 10.10 and the SENS Setup Utility user manual. Commissioning is not available for VRLA, AGM, power supply and ultracapacitor battery types. During commissioning the Over Voltage Shutdown alarm occurs at approximately 102% of the commissioning charge voltage and temperature compensation is not active. After commissioning completes, the charger will automatically revert to the settings configured for normal charging, including temperature compensation and Over Voltage Shutdown alarm.

10.8. Battery Check

Run a Battery Check test to determine if a battery can support a load. Battery Check will reduce charger output voltage to a configurable backstop level to permit the battery to support the load. Activate a Battery Check using the optional keypad. Navigate to the “Battery Check” menu to enable a Battery Check and configure battery check minimum voltage and duration. Upon completion of the test, the LCD will display whether the test passed or failed for ten seconds or until the “Enter” key is pressed. If the audible alarm is enabled, a single beep occurs when the battery check results are displayed. Schedule a Battery Check to run automatically by setting the Scheduled Battery Check interval in the “Battery Check” menu. An in-progress Battery Check activates a fast flashing green DC LED. Battery Check failure activates a fast flashing yellow DC LED. Optional alarm/communications circuit board BATTERY CHECK relay contacts change to Fail state after delay when alarm is assigned to relay contacts. Clear a failed Battery Check alarm using the keypad by scrolling to the “Alarms & Settings” menu then selecting the “Battery Check” option and pressing the UP arrow.

When chargers are connected to load share, initiating a battery check on one charger will automatically initiate a simultaneous battery check on connected charger(s).

IMPORTANT: A load less than 3% of the charger maximum current rating may cause inaccurate battery check results. If the system load is typically lower than 3% disable the Scheduled Battery Check feature. Battery Check will not indicate whether a battery is healthy enough to start a generator or engage switchgear relays for chargers in typical genset or switch gear applications without a continuous current load.

10.9. Keypad Operation

Chargers and accessories equipped with the optional front panel keypad provide the ability to adjust charger settings without the SENS Setup Utility.

10.9.1. Security Code Protection

Chargers with the optional keypad are security code protected to ensure only authorized personnel may adjust charger settings. The default security code is 000000 meaning security code is not enabled. Change the security code to a unique value by scrolling to the “Service

Tools" menu and then the "Change Security Code" option. Contact SENS Customer Service if a custom password is lost or forgotten (800-742-2326 or www.sens-usa.com).

10.9.2. Menu Navigation

Use the keypad to scroll through settings to view and adjust. The keypad provides X-Y navigation with main fields up and down, and details within each field left and right (see Figure 14). Press the up and down arrow keys to scroll through main menu options. Press the left and right arrow keys to scroll through data available within each menu. Value adjustments are made with the up and down arrow keys. Press center Enter key to return to main fields. Press center Enter key twice to return to Home screen.

Figure 14 – Menu Navigation

Step 1	⇧ or ⇩ for main fields
Step 2	⇦ or ⇨ for details within each main field
Step 3	⇧ or ⇩ to adjust values
Step 4	↵ to return to main fields
Step 5	↵ to return to Home screen

10.9.3. Menu Options

Input, output, temperature and alarm status are displayed on the front panel LCD by default. Press the UP or DOWN arrow to access additional menus as described below. If an option described below is not displayed it is likely because the option or an associated parameter is not set to active or the "UI Access Control" is set to a restricted state. Absolute maximum voltage limits apply to all output and alarm settings. A message is displayed indicating an adjustment is limited due to settings conflict.

Menus *(Press arrows to scroll through menu options)*		**Configurable/Viewable** *(Press left/right arrows to scroll through menus, press up/down arrows to configure values)*	**Parameter Descriptions**
Main Menu ⇕	**Sub Menu** ⇕ ⇔		
Browse Status		Scroll left/right to view basic meters and alarms	
Latched Alarms		Clear All Latched Alarms	Clear status of all latched alarms.
DC	Meters	DC Output *(voltage)*	DC output voltage and current
		DC Output *(power)*	DC output watts and % of rated output being provided
		Battery Temp.	Temperature at battery if a remote temperature sensor is connected
		Ambient Temp.	Temperature inside charger
		GF voltage	Ground Fault voltage detected by charger and indication of whether on positive or negative battery terminal
		GF Current	Ground Fault current detected by charger and indication of whether on positive or negative battery terminal

	Basic Settings	Battery Select Type	Select type of battery to be charged - flooded lead-acid, AGM, nickel-cadmium VRLA, power supply.
		Battery Select Number of Cells	Adjust number of series cells in battery string
		Float Voltage	Adjust output Float voltage, must be greater than 60% of Boost setting
		Boost Voltage	Adjust output Boost voltage from, must be same or greater than Float setting, must not be greater than 166% of Float setting
		HELIX-EcoFloat	Enable or disable HELIX mode
		Current Limit	System current limit setting. Set to “No Limit Set” for full current capacity. Set a value in amps to limit available current. It is sometimes necessary to limit maximum charging current to the battery.
		Temp. comp./°C	Adjust temperature compensation slope from 0 to -0.30%V/°C
	Boost Settings	Boost Voltage	Adjust output Boost voltage from, must be same or greater than Float setting, must not be greater than 166% of Float setting
		Auto Boost Delay	Adjust amount of time from 0 to 5 minutes to delay before entering Boost mode after power is cycled or battery type is changed. Delay affects all outputs for multiple output models.
		Auto-Boost	Enable or disable Dynamic Boost mode
		Auto Boost Limit	Adjust the maximum amount of time charger will be in Dynamic Boost mode from 1 to 255 hours. The Boost time limit is reset if charger power is cycled or an engine crank is detected.
		Boost Duration	Adjust amount of time charger will be in scheduled periodic Boost mode from 1 to 255 hours. The Boost timer is reset if charger power is cycled
		Scheduled Boost	Adjust amount of time between periodic scheduled Boost events from 1 to 180 days. Set to OFF to disable.
		Run Timed Boost	Start or stop a manual Boost cycle. Will operate in Boost mode until the Boost Duration expires.
		Next Scheduled Boost	View time until next scheduled Boost
	Battery Check	Battery Check	Start or stop a manual Battery Check.
		Clear Failure Battery Check	Press UP arrow to reset/clear Battery Check alarm on selected output
		Batt Check Time	Adjust amount of time to run Battery Check from 1 to 60 minutes

		Batt Check Vmin	Adjust minimum voltage allowed during Battery Check test, must be greater than End-of-Discharge voltage and less than 98% Float voltage
		Sched Batt Check	Adjust amount of time between scheduled Battery Check tests from 1 to 90 days
		Next Sched Batt Check	View time until next scheduled Battery Check test
	Alarms	Relay Delay Time DC	Adjust amount of time to delay activation of alarm relays after a DC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Ground Fault Alarm	Enable/disable or adjust setpoint to trigger positive or negative Ground Fault alarm.
		Low Crank	Adjust setpoint to trigger Low Crank alarm from 6V to 98% of Float, must be at least 2% less than Float setting
		Clear Failure Low Crank	Press UP arrow to reset/clear Low Cranking alarm on selected output
		End Discharge	Adjust setpoint to trigger Battery End-of-Discharge alarm, must be less than Low DC setting
		Low DC Voltage	Adjust setpoint to trigger Low DC voltage alarm, must be greater than End Discharge setting and less than Battery Discharging setting
		Batt Discharging	Adjust setpoint to trigger Battery Discharging alarm, must be between Low DC setting and 98% of Float setting or Eco-Float setting when HELIX is active
		High DC Voltage	Adjust setpoint to trigger High DC voltage alarm, must be greater than Boost by 2% of Float setting, must be less than 40% higher than Boost setting
		Overvolt Fault	Adjust setpoint to trigger Over Voltage Shutdown alarm, must be greater than High DC setting
		Low Current	Adjust setpoint to trigger Low Current alarm from 0% to 50% of nominal current
		High Batt Temp	Adjust setpoint to trigger High Battery Temperature alarm
		Hi BatTmp Shtdwn	Adjust setpoint to trigger High Battery Temperature Shutdown alarm
		Low Batt Temp	Adjust setpoint to trigger Low Battery Temperature alarm
		Battery Room Temp	Adjust setpoint to trigger High Battery Room Temperature alarm

	Startup Voltage	DC Start Volts	Adjust DC Startup Voltage. Set to zero to start into zero-volt battery automatically.
		Force Startup	Enables charger to attempt to charge a battery with a voltage below the DC Startup Voltage. Only enables startup on selected output.
	Commission	Batt Commission *(voltage)*	Adjust battery commissioning output voltage must be greater than or equal to Float voltage
		Batt Commission *(current)*	Adjust battery commissioning output current from 5% to 100% of nominal current rating
		Batt Commission *(duration)*	Adjust battery commissioning hours from 1 to 120 hours
		Batt Commission *(enable)*	Start or stop commissioning cycle. Charger will deliver commissioning voltage and current until commissioning hours expire.
	Advanced Settings	Restore Factory Default Settings DC	Press UP arrow to restore settings to factory configuration
		DC Output #A	Enable/disable Output A (enabled from factory)
		DC Output #B	Enable/disable Output B for multiple output units
		DC Output #C	Enable/disable Output C for multiple output units
		DC Output #D	Enable/disable Output D for multiple output units
AC	Meters	AC Input	AC input voltage and frequency
		AC Reference Meters	Press UP arrow to enable displaying AC meter values in the Browse Status menu area
	Basic Settings	Number of Phases	Set to 1 for single-phase or 3 for three-phase input voltage
		Nominal Volts AC	Set nominal input voltage for charger model. Must match hardware jumper/terminal block on inside of charger when jumper exists.
	Alarms	Relay Delay Time AC	Adjust amount of time to delay activation of alarm relays after an AC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Max Voltage	Adjust setpoint to trigger AC Voltage High alarm
		Min Voltage	Adjust setpoint to trigger AC Voltage Low alarm
		High Freq	Adjust setpoint to trigger AC Frequency Out of Range alarm
		Low Freq	Adjust setpoint to trigger AC Frequency Out of Range alarm
	Advanced Settings	Restore Factory Default Settings AC	Press UP arrow to restore settings to factory configuration

		AC Input #A	Enable for S2/S4 units
		AC Input #B	Disable for S2/S4 units
User Access		UI Access Control	Select allowed user interface access. Access options include read-only/monitor viewing or full access adjustments for advanced users.
		Change Security Code	Change security code to desired 6 digits. The default security code is 000000 (disabled). Upon entering a security code, the display will automatically prompt user for the code to access protected menus. Menus are protected depending on configured level of access (see UI Access Control definitions above).
		Relock Access	Exit Service Mode and relock access
Service Tools	Output	Force DC Startup All	Enables charger to attempt to charge a battery with a voltage below the DC Startup Voltage. Enables startup on all outputs.
	Alarms	Clear Failures All	Press UP arrow to reset/clear failures on all outputs
		Clear Failure Low Crank	Press UP arrow to reset/clear Low Cranking alarm on all outputs
		Clear Failure Battery Check	Press UP arrow to reset/clear Battery Check alarm on all outputs
	Display	Display Type	Set to "Unit Display" to display single unit values or set to "System Display" to display system (for a system with multiple chargers) values on the unit LCD
		LCD Brightness	Adjust LCD brightness from 0 – 100%
		Display Test	Press UP arrow to set all LCD segments black and DOWN arrow to clear all LCD segments
	Alarm Test	Relay Test	Press UP arrow to set all alarm relays and DOWN arrow to clear all relays
		Simulate Alarms	Simulate/set alarms for testing purposes. Set AC Fail, High DC, Low DC, Charger Fail and Over Voltage Shutdown alarms true. Alarm state times out after 5 minutes.
	Advanced	Soft Reset All Devices	Press UP arrow to reset all devices in the unit/system
		Full Reboot Protocol Board	Press UP arrow to reboot protocol communications device
		Repository Config	Set to Stable
		Minimum System Number of Chargers	Enable or disable whether alarm is indicated or not. Alarm active when the number of charger modules active on SENSbus is less than the minimum charger count for the system. Disabled by default, meaning no alarm. See Error Code 301

			for further details.
		Minimum Unit Number of Chargers	Enable or disable whether alarm is indicated or not. Alarm active when the number of charger modules active on SENSbus is less than the minimum charger count for the unit. Disabled by default, meaning no alarm. See Error Code 301 for further details.
Communica-tions	TCP/IP Settings	TCP-IP Address	Set TCP-IP Address
		TCP-IP Gateway	Set TCP-IP Gateway
		TCP-IP Subnet Mask	Set TCP-IP Subnet Mask
		Hardware Mask	Reads Hardware Address (MAC address of the unit)
	SENSnet	SENSnet Mode	Enable or disable SENSnet Mode. When disabled the charger will not communicate via IP address. Enabled by default.
	Modbus RS485	Modbus Configuration	Select RTU or set to OFF to disable Modbus communications. Only one RS-485 communications protocol is allowed at a time.
		Modbus Configuration Address	Adjust Modbus slave address from 1 to 255. Set to OFF to disable Modbus communications.
		Modbus Configuration Parity Bit	Set Modbus parity to none, even or odd
		Modbus Configuration Baud Rate	Adjust Modbus baud rate, 230.4 Kbps maximum
		Modbus Configuration Write	Enable or disable write access via Modbus
	Modbus TCP	Modbus Configuration	Enable or disable Modbus TCP-IP
		Modbus Configuration Address	Adjust Modbus slave address from 1 to 255. Set to OFF to disable Modbus communications.
		Modbus Configuration Write	Enable or disable write access via Modbus
		Modbus Configuration Max Connections	Set number of clients allowed to connect at once
	DNP3 RS485	DNP3 Configuration	Enable or disable DNP3 RS-485. Only one RS-485 communications protocol is allowed at a time.
		Source Addr	Set DNP3 source address
		Dest Addr	Set DNP3 destination address
		Parity Bit	Set DNP3 parity to none, even or odd
		Baud Rate	Adjust DNP3 baud rate, 230.4 Kbps maximum
		Conf File	Set to factory default DNP3 configuration or select one of two custom configurations. Use SENS DNP3 Config Tool to generate custom configuration file.
	DNP3 TCP	DNP3 Configuration	Enable or disable DNP3 TCP-IP

		Port	Set DNP3 port
		Source Addr	Set DNP3 source address
		Dest Addr	Set DNP3 destination address
		Conf File	Set to factory default DNP3 configuration or select one of two custom configurations. Use SENS DNP3 Config Tool to generate custom configuration file.
	J1939	J1939 Configuration BCH1 Output	Assign charger output for J1939 battery charger address to 1
		J1939 Configuration BCH2 Output	Assign charger output for J1939 battery charger address 2
		J1939 Configuration Veh Sys Instance	Adjust J1939 Vehicle System Instance from 0 to 15
		J1939 Configuration Funct Instance	Adjust J1939 Function Instance from 0 to 31
		J1939 Configuration ECU Instance	Adjust J1939 ECU Instance from 0 to 7
		J1939 Configuration Extended Status	Enable or disable receiving extended J1939 data
	User CAN	User CAN Mode	Enable or disable User CAN Mode
Alarm Relays		Relay Delay Time AC	Adjust amount of time to delay activation of alarm relays after an AC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Relay Delay Time DC	Adjust amount of time to delay activation of alarm relays after a DC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Relay Test	Press UP arrow to set all alarm relays and DOWN arrow to clear all relays
Unit Information		Serial No.	Charger serial number
		Display Revision	Software revision currently loaded on alarms/comms circuit board
		Copyright	SENS copyright year
		Charger Revision	Software revision currently loaded on charging devices. Press UP arrow to identify device by temporarily flashing LEDs.

10.10. SENS Setup Utility and Program Mode

Use the SENS Setup Utility to program the charger with custom settings. Remove all jumpers (on models including jumpers) to enable Program Mode. If the charger has not been specially programmed, removing all jumpers will result in an INVALID SETTINGS error state and the charger will not produce output. Custom configuration is typically completed by OEMs, qualified dealers/distributors, and packagers. Use the setup utility to update firmware on all devices and configure select settings including alarm relay assignments. Download the SENS Setup Utility software at sens-usa.com/support/download-center/.

10.10.1. Connect SENS Setup Utility

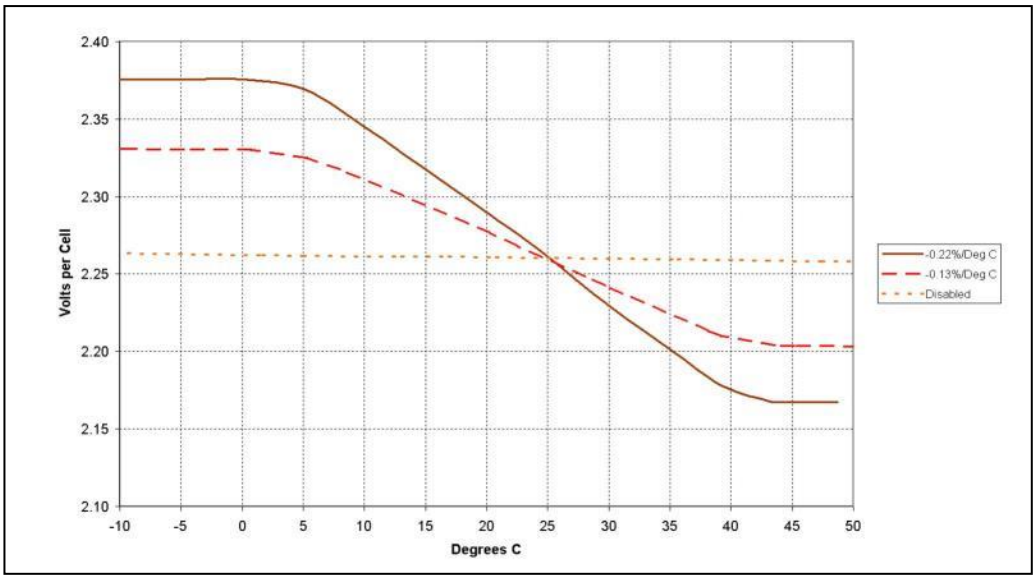
Communication between a computer and the charger/system using the SENS Setup Utility requires connection via USB-C (see section 7.8) on models including the optional alarm/communications circuit board or connection of the SENSbus Adapter (shipped with SENS Setup Utility kit p/n 209254). If connecting the SENSbus Adapter, connect the provided USB cable from the USB port on a PC to the SENSbus Adapter port labeled “USB.” Connect the provided network cable from the SENSbus Adapter RJ-45 port labeled “SENSbus” to the RJ-45 port on the charger main circuit board. Two RJ-45 ports are provided on the main circuit board (see Figure 11 for location in charger and Figure 13 for detail). The ports are in parallel and either port may be used for the SENSbus Adapter connection. See the SENS Setup Utility user manual for information on configuring the charger.

10.11. Temperature Compensation

The charger is temperature compensated to match the negative temperature coefficient of the battery. When temperature compensation is active, the output voltage will increase slightly as temperature decreases, decrease as temperature increases, and is clamped at 0°C (32°F) and +50°C (122°F) to protect against extremely high or low output voltage (see Figure 15).

The charger automatically includes local temperature compensation using an internal on-board sensor. Remote temperature compensation is enabled when an optional external sensor is located at the batteries (see section 7.6 for connections). Remote temperature compensation is required for ultracapacitor charging and should be used in applications where battery and charger are located in different ambient conditions. Chargers connected to load share only require a remote temperature sensor connected to one charger. Temperature Compensation is set to a slope of -0.18% per °C by default for operation with batteries. The temperature Compensation slope for ultracapacitors is set by the factory and is not adjustable. Temperature compensation is disabled by connecting a short across the remote temperature sensor terminal block on the main circuit board, using the optional keypad or by setting the temperature compensation slope to zero using the SENS Setup Utility. If the optional LCD is included, the temperature present at a sensor (local or remote) is displayed. Actual battery temperature is only displayed if the optional remote temperature sensor is connected to the charger and placed at the batteries.

Figure 15 – Example Temperature Compensation Curves



10.12. Load Share Charger Operation

Multiple chargers may be connected in parallel to provide charger redundancy and increased charging current. Up to 30 chargers may be connected in parallel for load sharing. Load sharing chargers are fault tolerant; one charger failure will not cause failures in paralleled chargers.

10.12.1. Load Sharing and Synchronization

Connection of a network cable between chargers using RJ-45 connectors (see section 7.10) automatically initiates load sharing synchronization of operating modes. Chargers will share the current load within ±10%. Remove the ADD jumper from the main circuit board of any charger connected to load share (see Figure 8). For proper load share operation, a 120-ohm terminator is required at the ends of the bus. Chargers intended for load sharing must be configured with the same output settings in order to load share properly. A charger in a multi-charger load sharing system with different output settings will not load share properly. The LOAD SHARE FAIL alarm will occur any time a charger is unable to load share. If a charger in a multi-charger load sharing system fails or is disconnected the remaining chargers will still load share and ignore the faulted charger. Each load sharing charger will alarm independently using individually configured alarm setpoints.

If the optional alarm/communications circuit board is included the output voltage and current of the individual charger will be shown on the LCD. If an optional remote alarm/communications panel accessory (not included internal to charger) is connected it will display only the system output voltage and current. An alarm/communications circuit board that is configured for an individual charger can be set to show system information by using the SENS Setup Utility.

Chargers connected in parallel without the load sharing network cable will operate but without synchronization. Current is not shared between chargers, Boost and HELIX modes are not synchronized and the system voltage is not displayed on the optional LCD. The chargers must be set for the same voltage range and Float voltage. When load sharing is disabled boost mode should be disabled on all but one charger to avoid conflicts between chargers. As a result, redundancy of Boost output voltage is not included when load sharing is not employed.

10.13. Remote Alarm/Communications Panel Accessory

The optional remote alarm/communications panel accessory provides the ability to adjust and communicate with multiple chargers using one external device. Connection of a network cable

between the accessory and charger(s) using RJ-45 connectors (see section 7.11) automatically initiates communication. For proper operation, a 120-ohm terminator is required at the ends of the bus. Adjust configuration and view status using the front panel keypad and display. See section 10.9 for keypad operation.

11 J1939 COMMUNICATIONS

See data messages below for read-only information available using J1939. Each charger automatically broadcasts a data message once per second after it has joined the J1939 network. Charger operation parameters may not be configured using J1939 communications.

In most cases, charger default J1939 settings are sufficient to automatically begin using J1939 communications after connecting the charger to the network. Use the SENS Setup Utility to adjust J1939 settings (e.g. baud rate, vehicle system instance, etc.) if required.

11.1. J1939 Data Messages

J1939 Data	Bits	Details
Battery Charger State	0-3	0 = OFF, 1 = boost charge, 2 = float charge, 13 = battery failure/too hot/cold to charge, 14 = charger failure, 15 = no status available
AC Power Line State	4-5	0 = AC OFF, 1 = AC ON, 2 = sensing error, does not indicate power out of specification, 3 = no status available
Thermal Limit Alarm*	6-7	0 = OK, 1 = Fail, 2 = sensor failure, 3 = no status available
Output Voltage	8-23	0 to 3212.75V in 0.05V increments, 0xFFFF = data not available, 0xFEFF = hardware error
Output Current	24-39	-1600.00 to +1612.75A in 0.05A increments, 0xFFFF = data not available, 0xFEFF = hardware error
High DC Voltage Alarm*	42-43	0 = OK, 1 = Fail, 2 = sensor failure, 3 = no status available
Low DC Voltage Alarm*	44-45	0 = OK, 1 = Fail, 2 = sensor failure, 3 = no status available
Low Cranking Voltage Alarm*	46-47	0 = OK, 1 = Fail, 2 = sensor failure, 3 = no status available
Invalid Settings Alarm*	48-49	0 = OK, 1 = Fail, 2 = sensor failure, 3 = no status available

**Optional*, must enable SENS data extensions using SENS Setup Utility

12 MODBUS COMMUNICATIONS

Modbus is an application layer messaging protocol used for client/server communication and is implemented according to specifications provided by Modbus Organization (http://www.modbus.org/specs.php).

12.1. Modbus RS-485—*Optional*

Serial Modbus communications over RS-485 using RTU mode requires configuration using the SENS Setup Utility or the optional keypad. Configure Modbus slave address, baud rate, parity and enable/disable Modbus write access as desired. See section 7.7 for connection and termination requirements.

Modbus RS-485 Default Settings

Setting	Value
Configuration	RTU
Baud Rate	19200
Data Bits	8
Parity	Even
Stop Bits	1
Slave Address	10

12.2. Modbus TCP/IP—*Optional*

Modbus communications over TCP/IP is optional and requires configuration using the SENS Setup Utility or the keypad (see section 10.9.3). Adjust IP address as desired. It may take up to 10 seconds for the network setting changes to apply. A TCP/IP address of 0.0.0.0 implies DHCP (Dynamic) addressing. Adjust the Gateway and Subnet Mask values as required. Configure Modbus slave address and enable/disable Modbus write access as desired. See section 7.8 for connection information.

TCP/IP Modbus Default Settings

Setting	Value
IP Address	0.0.0.0 DHCP/AUTO
Subnet Mask	N/A
Gateway	N/A
Port Number	502
Modbus Slave Address	10

12.3. Modbus Holding Registers

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
0	0x000	1	0x001	System Serial Number	Serial Number of System the device was built into and shipped part of	Num	1
2	0x002	3	0x003	Program Revision	Version of the main program	Num	1
4	0x004	5	0x005	Bootloader Version	Version of bootloader	Num	1
6	0x006	7	0x007	Type	Device type	Enum	1
8	0x008	9	0x009	Serial	Serial Number of the Device	Num	1
10	0x00A	11	0x00B	Build Date	Year (16bit), month(8bit), day(8bit)	Num	1
12	0x00C	13	0x00D	Model Num 1_4	Model number character	bit	1
14	0x00E	15	0x00F	Model Num 5_8	Model number character	bit	1
16	0x010	17	0x011	Model Num 9_12	Model number character	bit	1
18	0x012	19	0x013	Model Num 13_16	Model number character	bit	1
20	0x014	21	0x015	Model Num 17_20	Model number character	bit	1
22	0x016	23	0x017	Model Num 21_24	Model number character	bit	1
24	0x018	25	0x019	Model Num 25_28	Model number character	bit	1

Address High		Address Low		Name	Description	Units	Scale
26	0x01A	27	0x01B	Model Num 29_32	Model number character	bit	1
36	0x024	37	0x025	Number of Cranks Detected	Number of times the crank logger has been tripped. Available on charger only.	Num	1
38	0x026	39	0x027	Number of Cranks Under Threshold	Number of times the crank logger has detected a bad battery. Available on charger only.	Num	1
42	0x02A	43	0x02B	Basic Charging Alarms	Charging Alarm status bits (see section 12.3)	Bitfield	1
44	0x02C	45	0x02D	Charging Status	Charging Status bits (see section 12.4)	Bitfield	1
46	0x02E	47	0x02F	Charging Alarms Extended	Charging Alarm Extended status bits (see section 12.5)	Bitfield	1
48	0x030	49	0x031	Charging AC Alarms	Charging AC Alarm status bits (see section 12.6)	Bitfield	1
62	0x03E	63	0x03F	Uptime Counter Value	Charger uptime counter value	Sec	1
68	0x044	69	0x045	Default Output Batt Voltage	Voltage currently being supplied by the charger to the battery	V	32768
70	0x046	71	0x047	Default Output Current	Current currently being supplied by the charger to the battery	A	32768
72	0x048	73	0x049	Default Output Power	Power currently being supplied by the charger	W	32768
74	0x04A	75	0x04B	Default Output Factory Float Setting	Float Cell Voltage set at Factory	V/cell	32768
76	0x04C	77	0x04D	Default Output Factory Boost Setting	Boost Cell Voltage set at Factory	V/cell	32768
78	0x04E	79	0x04F	Default Output Remote Temp	Remote temp sense temperature in 0.0°C	°C	32768
80	0x050	81	0x051	Default Output Internal Temp	Ambient air temperature near charger input connectors (tp 1)	°C	32768
82	0x052	83	0x053	Default Output Boost Elapsed Time	Boost time	Sec	1
84	0x054	85	0x055	Default Output Periodic Boost Countdown	Time until next Boost	Sec	1
86	0x056	87	0x057	Default Output AC Line Frequency	AC Line Frequency	Hz	10
88	0x058	89	0x059	Default Output AC Line Voltage 1	AC Line 1 Voltage	V	32768
90	0x05A	91	0x05B	Default Output AC Line Current 1	AC Line 1 Current (not applicable to single phase chargers)	A	32768
92	0x05C	93	0x05D	Default Output AC Line Voltage 2	AC Line 2 Voltage (not applicable to single phase chargers)	V	32768
94	0x05E	95	0x05F	Default Output AC Line Current 2	AC Line 2 Current (not applicable to single phase chargers)	A	32768
96	0x060	97	0x061	Default Output AC Line Voltage 3	AC Line 3 Voltage (not applicable to single phase chargers)	V	32768
98	0x062	99	0x063	Default Output AC Line Current 3	AC Line 3 Current (not applicable to single phase chargers)	A	32768
100	0x064	101	0x065	Default Output Battery Check Time Elapsed	Battery Check time elapsed	Sec	1
102	0x066	103	0x067	Default Output Battery Check Due	Time until next Battery Check	Sec	1
104	0x068	105	0x069	Default Output Number of Chargers	Number of chargers detected on SENSbus, 0 - 30	Num	1

Address High		Address Low		Name	Description	Units	Scale
128	0x080	129	0x081	Default Output Maximum Power	Maximum rated power	V/Cell	32768
130	0x082	131	0x083	Default Output Maximum Voltage	Maximum rated voltage in x.xx V	V/Cell	32768
132	0x084	133	0x085	Default Output Maximum Current	Maximum rated current in x.xx A	A	32768
134	0x086	135	0x087	Default Output Program Float Setting	Float Cell Voltage used in Program Mode	V/Cell	32768
136	0x088	137	0x089	Default Output Program Boost Setting	Boost Cell Voltage used in Program Mode	V/Cell	32768
138	0x08A	139	0x08B	Default Output Program Mode	Mode callouts for Program Mode setting (battery type… etc.)	Custom	1
140	0x08C	141	0x08D	Default Output Program Cell Count	Number of cells set in Program Mode	Cells	32768
142	0x08E	143	0x08F	Default Output Program Temp comp slope	In 0.xx°C per output volt x -1	°C/V	32768
144	0x090	145	0x091	Default Output Low DC Program	Alarm setpoint for low DC (used for Program Mode setting)	V/Cell	32768
146	0x092	147	0x093	Default Output Low Crank Program	Alarm setpoint for low Crank (used for Program Mode setting)	V/Cell	32768
148	0x094	149	0x095	Default Output Low Current Program	Alarm setpoint for low Current (used for Program Mode setting)	A	32768
152	0x098	153	0x099	Default Output High DC Program	Alarm setpoint for high DC (used for Program Mode setting)	V/Cell	32768
154	0x09A	155	0x09B	Default Output OVSD Program	Alarm setpoint for OVSD (used for Program Mode setting)	V/Cell	32768
156	0x09C	157	0x09D	Default Output Batt Discharge Program	Alarm setpoint for Batt Discharge (used for Program Mode setting)	V/Cell	32768
158	0x09E	159	0x09F	Default Output Batt End Discharge Program	Alarm setpoint for End Discharge (used for Program Mode setting)	V/Cell	32768
160	0x0A0	161	0x0A1	Default Output Program Boost Time Limit	Boost time limit (used for Program Mode setting)	Hr	3600
162	0x0A2	163	0x0A3	Default Output Current Limit Setting	Current Limit setpoint in % of output current as a 10 bit value	% Rated A	32768
164	0x0A4	165	0x0A5	Default Output Helix Float Time	Helix Float Time	Hr	3600
166	0x0A6	167	0x0A7	Default Output Helix Refresh Time	Helix Refresh Time	Hr	3600
168	0x0A8	169	0x0A9	Default Output Helix Eco Time	Helix Eco Time	Hr	3600
170	0x0AA	171	0x0AB	Default Output Periodic Boost Time	Interval between scheduled Periodic Boost	Days	86400
172	0x0AC	173	0x0AD	Default Output Battery Check Voltage Setting	Battery check failure threshold	V/Cell	32768
174	0x0AE	175	0x0AF	Default Output Battery Check Interval	Interval between scheduled automatic battery checks	Days	86400
176	0x0B0	177	0x0B1	Default Output Battery Check Duration	Duration of battery check	Min	60
178	0x0B2	179	0x0B3	Default Output Commissioning VPC	Commissioning VPC	V/Cell	32768
180	0x0B4	181	0x0B5	Default Output Commissioning Duration	Commissioning Duration	Hr	3600
182	0x0B6	183	0x0B7	Default Output Commissioning A	Commissioning Amps	A	32768

Address High		Address Low		Name	Description	Units	Scale
184	0x0B8	185	0x0B9	Default Output Rated Power	Output Rated Power	W	32768
186	0x0BA	187	0x0BB	Default Output Rated Current	Output Rated Current	A	32768
188	0x0BC	189	0x0BD	Default Output Periodic Boost Duration	Periodic Boost Duration	Bits	3600
190	0x0BE	191	0x0BF	Default Output Min Allowed Voltage Setting	Min Allowed Voltage Setting	V/Cell	32768

12.4. Alarm Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Alarm AC Fail	Charger does not have usable AC input
1	0x01	Alarm High DC	Charger output exceeds alarm threshold
2	0x02	Alarm Low DC	Charger output below alarm threshold
3	0x03	Alarm Charger Fail	Charger not operating because of an internal failure
4	0x04	Alarm Over Voltage Shutdown	Charger disabled by selective overvoltage shutdown
5	0x05	Alarm Reverse Polarity	Charger disabled because battery polarity is reversed
6	0x06	Alarm Low Cranking	Low cranking voltage event has been detected
7	0x07	Alarm Incompatible Battery	Charger disabled because it does not match battery (12V vs. 24V)
8	0x08	Alarm Invalid Settings	Charger disabled because jumper setting is not correct
9	0x09	Unused	Unused
10	0x0A	Alarm Thermal Foldback	Available output is reduced because of high temperature
11	0x0B	Alarm No Temperature Probe	Battery temperature probe is not connected
12	0x0C	Alarm Current Limiting	Operating in current limit mode (below output voltage set point)
13	0x0D	Alarm Ground Fault Positive	Ground fault alarm enabled and positive ground detected
14	0x0E	Alarm Low Current	Low current alarm enabled and output below alarm threshold
15	0x0F	Alarm Load Share Fault	Charger fails to provide its share of the output current
16	0x10	AutoBoost Lockout Active	Boost mode time limit has expired and charger has returned to Float mode. Boost mode is disabled until the time limit is reset. The Boost time limit is reset when power is cycled.
17	0x11	Unused	Unused
18	0x12	Alarm SENSbus Inactive	Display board is not receiving any charger data
19	0x13	Alarm Battery On Discharge	Battery in range where discharge occurs (below open circuit voltage)
20	0x14	Alarm Battery End Discharge	Battery voltage below safe discharge range threshold
21	0x15	Alarm Ground Fault Negative	Ground fault alarm enabled and negative ground detected
22	0x16	Alarm DC Negative Open	Charger disabled because common negative lead is open
23	0x17	DC Below Startup Voltage	Battery voltage is below the Startup Voltage setpoint. Unit output voltage is disabled. Forced startup feature overrides.
24	0x18	Unused	Unused
25	0x19	Alarm Load Disconnect	Load relay open: set at "end discharge", clear when not "on discharge"
26	0x1A	Alarm Individual Unit Fault	Alarm flag 32-54 active for one, but not all, chargers in any Output
27	0x1B	Alarm Battery Check	Battery check failed

12.5. Status Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Output Idle	Charging status - Output Idle
1	0x01	Slave Mode	Charging status - Slave Mode
2	0x02	Helix Float Charge	Charging status - Helix Float
3	0x03	Float Charge	Charging status - Float Charge
4	0x04	Helix Refresh Charge	Charging status - Helix Refresh Charge
5	0x05	Auto Boost Charge	Charging status - Auto Boost Charge
6	0x06	Periodic Boost Charge	Charging status - Periodic Boost Charge
7	0x07	Battery Check Active	Charging status - Battery Check Active
8	0x08	Commission Charge	Charging status - Commission Charge
9	0x09	High Charger Current	Output current is more than rated current.
10	0x0A	Unused	Unused
11	0x0B	Unused	Unused
12	0x0C	Using Battery Temperature	Charger reading battery temperature and is compensating the voltage.
13	0x0D	UltraCap Mode Active	Charger is set to charge an Ultra Capacitor.
14	0x0E	Battery Check Passed	Battery Check test successfully passed

12.6. Extended Status Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Check Filter	Module has experienced a thermal roll back which can be caused by a clogged input air filter.
1	0x01	Thermal Fault	Module has faulted because it over-heated and thermal fold-back has reached zero watts. Module output has been disabled.
2	0x02	High Battery Temperature	Battery temperature is above the High Battery Temperature alarm setpoint.
3	0x03	High Battery Temperature Shutdown	Battery temperature is high enough that the unit has shut off for safety precautions. Only available when a remote battery temperature sensor is installed with the optional remote battery monitor.
4	0x04	High AC Ripple Detected on Output	Charger's output ripple is above High AC Ripple Detection alarm setpoint.
5	0x05	DC Output Open	Charger has detected that the output is not connected to anything.
6	0x06	Charger Low Temperature	Unit ambient temperature is below its rated ambient temperature, unit output may be derated.
7	0x07	Battery Low Temperature	Battery temperature is below Battery Low Temperature alarm setpoint. Only available when a remote battery temperature sensor is installed with the optional remote battery monitor.

12.7. Charging AC Alarms Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Unused	Unused
1	0x01	AC Phase Missing	An AC phase is missing or out of range. Only available in a 3-phase capable device.
2	0x02	AC Voltage Over Maximum	AC Voltage has gone above max AC voltage allowed by the charger on any phase. NOTE: This alarm has a delay of 3 seconds. Output has been disabled.
3	0x03	AC Voltage Low	AC Voltage has gone below AC Min Voltage alarm setpoint.
4	0x04	AC Frequency Out Of Range	AC Frequency is outside of the AC High Frequency and AC Low Frequency alarm setpoints.
5	0x05	AC Voltage High	AC Voltage is above the AC Max Voltage alarm setpoint.

12.8. Writable Control Flags (Coils) – *available with optional alarm/communications circuit board*

Single coil writes: 0xFF00 for ON, 0x0000 for OFF

Multiple coil writes: 1 for ON, 0 for OFF

Address		Description	Details
Decimal	Hex		
0	0x000	Start/stop manual boost, Default Output	ON to start, OFF to stop
1	0x001	Reset periodic boost charge schedule	ON to reset schedule, OFF is no-op
2	0x002	Start/stop battery check, Default Output	ON to start, OFF to stop
3	0x003	Reset periodic battery check schedule	ON to reset schedule, OFF is no-op
4	0x004	Clear battery check failure, Default Output	ON to reset alarm, OFF is no-op
5	0x005	Clear low cranking failure, Default Output	ON to reset alarm, OFF is no-op
6	0x006	Force DC Startup, Default Output	ON to force DC Startup, OFF is no-op
7	0x007	Reset latched alarms, Default Output	ON to Reset Latched Alarms, OFF is no-op

13 TROUBLESHOOTING/ERROR CODES

13.1. Configuration Error Codes

Error codes are displayed on front panel LCD.

Error	Scope	Description	Corrective Action
101	Charger Module	**Invalid charger position jumper setting** for a charger module used in a multi-module unit. Jumpers must identify the module position: either no jumper (position 0) or a single jumper in positions 1 - 9. Not compatible with jumper-selected output settings for stand-alone chargers.	- When a charger contains multiple charger modules, each module in that unit must be set to a different position number. Install one jumper per module to select module positions 1 - 9, or no jumper to select position 0. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set Output" setting in the "Other Settings" menu or the setup utility to assign all modules to the “Default” DC output.
102	Stand-alone Charger	**Simultaneous use of output jumper settings and keypad control** on a charger not used as a module. The keypad is enabled while the charger output is controlled by its jumper settings. Output can be either keypad controlled or jumper-selected, but not both simultaneously. Chargers not used as modules do not use jumpers to identify their installation positions.	- To operate under keypad control, remove all charger output setting jumpers. - To disable keypad control, Change the "UI Access Level" setting in the "Service Tools" menu to "Monitor Only." For factory default settings install jumpers on the charger in all three Float Voltage positions or two float settings plus one Range jumper. For other standard settings install three jumpers on the charger to select the Battery Type, Float Voltage, and Range for your battery.
103	Stand-alone Charger	**Inconsistent jumper settings** for chargers not used as modules. When multiple stand-alone chargers operate in parallel using output jumper settings, all the chargers must have identical settings. This prevents unexpected output settings changes if the master charger (the charger with the lowest power board serial number) loses SENSbus data communication for any reason.	- For factory default settings install jumpers on the charger in all three Float Voltage positions or two float settings plus one Range jumper of every charger. - For other standard settings, install three jumpers on each charger to select the Battery Type, Float Voltage and Range, using settings appropriate for your battery. All chargers must use the same settings. - For keypad control (programmed settings), remove all output setting jumpers from all the chargers.
104	Charger Module	**Invalid output configuration**. Charger modules must be set to a valid output: either output A through D for use in multiple output units or 0 for use in single output units. Combining charger modules configured for use in single output units with those configured for multiple output units in the same unit (or system) is **not** supported.	- If necessary, enable the output using the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility. - To select a different output, reassign the module to match its actual output connection using the "Set DC Output" setting in the "Other Settings" menu or by using the setup utility. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to assign all modules to the “Default” DC output.
105	Charger Module	**Duplicate charger location** settings within a unit with multiple charger modules, not using the default output. Every charger module must have a unique location setting. Duplication is allowed for modules in different units, *i.e.* with different "Unit Serial Numbers". Modules using the “default” output do not use charger positions.	- Use a different position number (jumper setting) for each module in a multi-module unit. See Error Code 101 for more detail. - When replacing a charger in a multi-module unit, set the replacement charger for the same position as the module being removed. - To prevent confusion, the position jumper settings should agree with the position markings on labels, internal wiring, *etc.* (so the displayed module ID number will match its physical and electrical position).
201	Charger (or system)	**No charger modules assigned** to output. Every enabled charger output must have at least one module assigned to it. When none is found, it is	- Check for a module that has failed (indicated by its LED status). - Check for disconnected or damaged SENSbus data

Error	Scope	Description	Corrective Action
		presumed that a module has failed, has lost SENSbus data communication, or has an incorrect output setting.	cables. - If the output is not to be used, disable it by using the keypad "DC Output #" setting in the "Other Settings" menu or the setup utility.
202	Charger (or system)	**Too few charger modules operating**. The combined output rating of all modules operating on this charger output is less than the rated output. This can occur because a module has failed, has an open AC input or DC output connection, has lost SENSbus data communication, or is configured for the wrong output.	- Use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to verify all chargers output settings. Each module must be set for the output corresponding to its electrical DC output connection. - If necessary, install additional modules to meet the required output rating (plus the additional modules needed for "N+1" or "N+2" redundant operation). - Verify that each output is assigned enough modules to meet the required DC output rating (plus any extra modules needed to provide "N+1" or "N+2" redundant operation). - Check for a module that has failed (indicated by its LED status). - Check for disconnected or damaged SENSbus data cables. - Check for miswired, disconnected, or damaged input and output connections.
203	Charger (or system)	**Charger Module assigned to a disabled output**. All modules must either be set for single output operation (0, Default output) or to a valid output that is enabled in this unit or system.	- To use this output, enable it using the keypad “DC Output #" selection in the "Other Settings" menu or the setup utility. Verify that the DC outputs of all modules assigned to each output are electrically connected to that output. - To select a different output, reassign the module to match its actual output connection using the "Set DC Output" setting in the "Other Settings" menu or by using the setup utility. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to assign all chargers to the “Default” DC output.

13.2. Troubleshooting

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
OFF	OFF	Both AC and DC LEDs are off on models without accessory display board	1. Proper AC or DC voltages not applied 2. Main power board frozen 3. Main power board failure	1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 265VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminal block (J800) and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve issue, remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve issue, a main power board failure is the likely cause. Replace charger.
OFF	OFF	Both AC and DC LEDs are off and display is off	1. Proper AC or DC voltages not applied 2. Frozen accessory display board or main power board 3. Main power board to accessory display board cable is incorrectly installed 4. Main power board to accessory board cable failure or poor connection 5. Main power board failure 6. Accessory display board failure	1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminal block (J800) and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve issue, remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve issue, determine if main power board AC and DC LEDs are on (any color). If main power board LEDs are off, remove cable between accessory display board and main power board. If main power board LEDs remain off, a main power board failure is the likely cause. Replace charger. If main power board LEDs are on, proceed to step 4. 4. If step 3 doesn't resolve issue, check that the main power board to accessory display board cable is correctly installed between main power board J900 and accessory display board J1, and that both ends of the cable are fully inserted. 5. If step 4 doesn't resolve issue, unplug the main power board to accessory display board cable and, using an ohmmeter, check for continuity across the cable on each pin of the cable (cable is a straight pass through). If an open connection is found, replace cable (208117). If cable ohms out ok, a failed accessory display board is the likely cause. Replace accessory display board.
OFF	OFF	Both AC and DC LEDs are off and display is on	1. Charger communication terminator is missing 2. Failed main power board 3. Jumper installed in address 1 or address 2 header on main power board 4. Main power board to accessory display board cable failure 5. Failed accessory display board	1. Verify that a terminator is installed in port 1 or 2 of main power board J901. If terminator is missing, install missing terminator. 2. If terminator is installed, disconnect one end of the main power board to accessory display board cable. Verify that main power board AC and DC LEDs are on (any color). If main power board LEDs remain off, replace charger, main power board has most likely failed. 3. If power board LEDs are on, make sure there are no jumpers installed in Address 1 or Address 2 on main power board header JP900. Remove any address jumpers. 4. If step 3 doesn't resolve issue, unplug the main power board to accessory display board cable and, using an ohmmeter, check for continuity across the cable on each pin of the cable (cable is a straight pass through). If an open connection is found, replace cable (208117). If cable ohms out ok, a failed accessory display board is the likely cause. Replace accessory display board.
*SOLID GREEN	FLASH LONG-SHORT GREEN	AC LED is green, DC LED flashes Long-Short green, and output voltage is lower than expected	1. Charger is in HELIX Eco-Float mode	1. Output voltage is automatically lowered to extend battery life in the HELIX Eco-Float mode. Charger will automatically refresh the battery as required and no action is needed (this is normal operation). If a customer wishes to disable HELIX mode, use a

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
				battery type other than FLA, disable it using the Setup Utility, or disable it via the option keypad.
*SOLID GREEN	FLASH LONG-SHORT-SHORT GREEN	AC LED is green, DC LED flashes Long-Short-Short green, and output voltage is higher than expected float voltage	1. Charger is in HELIX REFRESH mode	1. Charger will automatically refresh the battery as required and no action is needed (this is normal operation). If a customer wishes to disable HELIX mode, use a battery type other than FLA, disable it using the Setup Utility, or disable it via the option keypad.
*SOLID GREEN	FLASH or SOLID GREEN	Unable to Communicate using J1939 on models without accessory display board	1. Address jumper is not installed or is installed in the wrong position 2. No communication bus termination installed 3. Wiring is incorrect 4. Unsupported or incorrect J1939 command 5. Cannot find an available address on the network	1. Verify that a jumper is installed in Address 1 or Address 2 (depending on selected address) on main power board header JP900. Correct address jumper if missing, incorrect address, or if multiple addresses are selected. 2. If step 1 doesn't address the issue, verify that a terminator is installed in port 1 or 2 of main power board J901. If terminator is missing, install missing terminator. (Note that a terminator is not required if the charger is not at the end of the communication bus). 3. If a terminator is correctly installed, verify that cabling is correct and the J1939 Data High goes to pin 1 of J901 and that J1939 Data Low goes to pin 2 of J901. 4. If step 3 didn't resolve the issue, verify that requested command is supported by SENS charger per J1939 table in charger manual. 5. If the steps above didn't resolve the issue, check for address conflicts on the network
*SOLID GREEN	FLASH or SOLID GREEN	Unable to Communicate using J1939 on models with accessory display board	1. Address jumper is not installed or is installed in the wrong position 2. No communication bus termination installed 3. Communication cable is plugged into the wrong charger port 4. Wiring is incorrect 5. Unsupported or incorrect J1939 command 6. Incorrect address or address conflict	1. Verify that a jumper is installed in Battery Charger (BCH) 1 or Battery Charger (BCH) 2 (depending on selected address) on accessory display board header JP2. Correct address jumper if missing or incorrect address. 2. If a terminator is correctly installed, verify that a terminator is installed in port 1 or 2 of accessory display board J2. If terminator is missing, install missing terminator. (Note that a terminator is not required if the charger is not at the end of the communication bus). 3. If step 3 didn't resolve the issue, verify that communication cable is connected to port 1 or port 2 of J2 on the accessory display board. Correct cabling as required. 4. If communication cable is connected correctly, verify that cabling is correct and the J1939 Data High goes to pin 1 of J2 and that J1939 Data Low goes to pin 2 of J2. 5. If cable wiring is correct, verify that requested command is supported by SENS charger per J1939 table in charger manual. 6. Check for address conflicts on the network
*SOLID GREEN	FLASH or SOLID GREEN	Basic J1939 communications work but SENS extended commands don't work	1. SENS extended J1939 commands are not enabled	1. Enable SENS extended J1939 commands using setup utility
*SOLID GREEN	FLASH or SOLID GREEN	Unable to Communicate using MODBUS on models without accessory display board	1. No communication bus termination installed 2. Wiring is incorrect 3. Incorrect MODBUS settings (baud rate, type (RTU or ASCII), address)	1. Verify that a terminator is installed in port 1 or 2 of main power board J901. If terminator is missing, install missing terminator. (Note that a terminator is not required if the charger is not at the end of the communication bus). 2. If a terminator is installed, verify that cabling is correct and that Modbus +D1 (A) goes to pin 5 of J900 and that Modbus –D0 (B) goes to pin 4 of J900. 3. If cable wiring is correct, verify that charger and application MODBUS settings are as required. Adjust settings using setup utility as required.
*SOLID	FLASH or	Unable to Communicate	1. No communication bus	1. Verify that a terminator is installed in port 1 or 2 of

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
GREEN	SOLID GREEN	using MODBUS on models with accessory display board	termination installed 2. Communication cable is plugged into the wrong charger port 3. Wiring is incorrect 4. Incorrect MODBUS settings (baud rate, type (RTU or ASCII), address)	accessory display board J2. If terminator is missing, install missing terminator. (Note that a terminator is not required if the charger is not at the end of the communication bus). 2. If terminator is installed, verify that communication cable is connected to port 1 or port 2 of J2 on the accessory display board. Correct cabling as required. 3. If cable is connected correctly, verify that cabling is correct and that Modbus +D1 (A) goes to pin 5 of J2 and that Modbus –D0 (B) goes to pin 4 of J2. 4. If cable wiring is correct, verify that charger and application MODBUS settings are as required. Adjust settings using setup utility as required.
*SOLID GREEN	SOLID RED	AC good, charger fail or overvoltage shutdown	1. Charger has experienced an unexpected fault 2. Programmed setting are incorrect (OVSD set too low) 3. Power board failure	1. Remove both AC and DC power for 1 minute, then reapply power. 2. If fault remains, check overvoltage shutdown settings and again remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve issue, a main power board failure is the likely cause. Replace charger.
*SOLID GREEN	FLASHING RED/YELLOW	Charger's output is not enabled	1. A battery is connected to the charger output with reverse polarity	1. Correct DC polarity applied to main power board DC output terminal block (J800).
*SOLID GREEN	SOLID YELLOW	AC good, high battery voltage	1. Alarm setpoint incorrect for application 2. DC voltage is high due to an external source such as an alternator	1. Check that charger battery settings and alarms are set appropriately for the application and battery under charge. 2. If settings and alarms are correct, check and correct battery / load voltage (consider battery surface charge, alternator, and any connected equipment).
*SOLID GREEN	SOLID YELLOW	AC good, low battery voltage	1. Alarm setpoint incorrect for application 2. Battery discharged or defective	1. Check that charger battery settings and alarms are set appropriately for the application and battery under charge. 2. If settings and alarms are correct, check and correct battery / load voltage (consider loads and any connected equipment).
*SOLID GREEN	FLASHING GREEN/ RED	AC good, system DC output good, some individual charger(s) in alarm state (For multi-charger system with optional accessory display circuit board only)	1. One or more system chargers has an alarm.	1. Troubleshoot issue using fault code from individual chargers.
*SOLID GREEN	FLASHING YELLOW	AC good, low incompatible battery error (charger disabled)	1. Voltage range improperly set	1. Check that charger voltage range is set correctly for the battery. After making any correction to the range setting, remove both AC and DC power for 1 minute, then reapply power.
*SOLID GREEN	FLASHING GREEN/YELLOW	AC good, output power limited	1. Charger power is reduced to protect charger due to high temperatures	1. Reduce operating environment temperature. Charger will automatically increase power as temperature is lowered.
*SOLID GREEN	DOUBLE FLASH YELLOW	AC good, load share fail	1. Charger output settings do not match between chargers	1. Check that individual charger settings are identical. Adjust as required. After making any adjustments, unplug and re-plug SENSbus cable from charger.
*SOLID GREEN	DOUBLE FLASH RED	AC good, output disabled	1. Negative DC connection is broken to one of the chargers 2. Too many devices on the SENSbus network	1. Check that the negative DC connection at main power board J800 is made and that connection is tight. 2. If step 1 doesn't resolve issue, look for break in the DC ground cable. 3. If steps 1 and 2 don't resolve the issue, ensure that less than 30 devices are on the SENSbus. 4. If none of the above steps resolved the issue, a failed accessory display board is likely, replace accessory display board.
SOLID RED	SOLID GREEN	AC fail, battery voltage good	1. Proper AC voltages or frequency not applied 2. Power board failure	1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz. Correct charger AC input voltage as required

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
				2. If step 1 doesn't resolve issue, a main power board failure is the likely cause. Replace charger.
SOLID RED	SOLID YELLOW	AC fail, high battery voltage	1. Proper AC voltages or frequency not applied 2. Main power board Failure And 3. Alarm setpoint incorrect for application 4. DC voltage is high due to an external source such as an alternator	AC LED 1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz or that > 8VDC is present at DC output terminal block (J800) and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve RED AC light, remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, a main power board failure is the likely cause. Replace charger. DC LED 4. Check that charger battery settings and alarms are set appropriately for the application and battery under charge. 5. If settings and alarms are correct, check and correct battery / load voltage (consider battery surface charge, alternator, and any connected equipment).
SOLID RED	SOLID YELLOW	AC fail, low battery voltage	1. Proper AC voltages or frequency not applied 2. Main power board Failure And 3. Alarm setpoint incorrect for application 4. Battery discharged or defective	AC LED 1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz or that > 8VDC is present at J800 and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve RED AC light, remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, a power board failure is the likely cause. Replace charger. DC LED 4. Check that charger battery settings and alarms are set appropriately for the application and battery under charge. 5. If settings and alarms are correct, check and correct battery / load voltage (consider loads and any connected equipment). 6. If fault remains after the above steps, check battery health. Replace battery if weak.
SOLID RED	SOLID RED	AC fail, charger fail or overvoltage shutdown	1. Charger is in a fault state 2. Charger failure	AC LED 1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz or that > 8VDC is present at J800 and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve RED AC light, remove both AC and DC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, a power board failure is the likely cause. Replace charger. DC LED 4. Remove AC and DC power from charger for 1 minute before reapplying power. Ensure AC voltage and/or DC voltage is within specified operating limits of the charger. 5. If fault remains, check overvoltage shutdown settings and again remove both AC and DC power for 1 minute, then reapply power. 6. If steps 1 and 2 don't resolve issue, a power board

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
				failure is the likely cause. Replace charger.
SOLID RED	FLASHING YELLOW	AC fail, low incompatible battery error	1. Proper AC voltages or frequency not applied 2. Main power board Failure And 3. Voltage range improperly set	AC LED 1. Using a voltmeter, check that AC input voltage and frequency at AC input terminal block (J100) are in the range 80VAC – 264VAC / 47Hz – 63Hz or that > 8VDC is present at J800 and that the DC polarity is correct. Correct charger AC input and DC output voltage as required. 2. If step 1 doesn't resolve RED AC light, remove both AC and DC power for 1 minute and then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, a main power board failure is the likely cause. Replace charger. DC LED 4. Check that charger voltage range is set correctly for the battery. After making any correction to the range setting, remove both AC and DC power for 1 minute, then reapply power
ALTERNATING FLASHING YELLOW		No output	1. Illegal jumper or program configuration	1. If in factory mode, make sure all three float positions have a jumper or that 2 of 3 float positions have a jumper and that the third jumper is placed in the 12 or 24 volt range position. Remove any addition battery type or range jumpers. 2. If using standard jumper configuration, ensure a single jumper is placed in battery type, float, and range. 3. If in program mode, ensure that charger has been programmed to desired settings (program mode is set from the factory to have no output).
ALTERNATING FLASHING RED		No output	1. Missing or invalid code (boot load required)	1. Update charger firmware using setup utility. 2. If step 1 doesn't resolve issue or setup utility is not available, replace charger
ALTERNATING FLASHING GREEN		For chargers with optional alarm/communications circuit board only: Starting-up	1. Charger is still powering-on 2. Failed accessory display board	1. Remove both AC and DC power for 1 minute and then reapply power. Allow charger at least 1 minute to fully boot. 2. If step 1 doesn't resolve issue, an accessory display board failure is the likely cause. Replace accessory display board.

*AC LED will flash green when charger is in ultracapacitor mode.

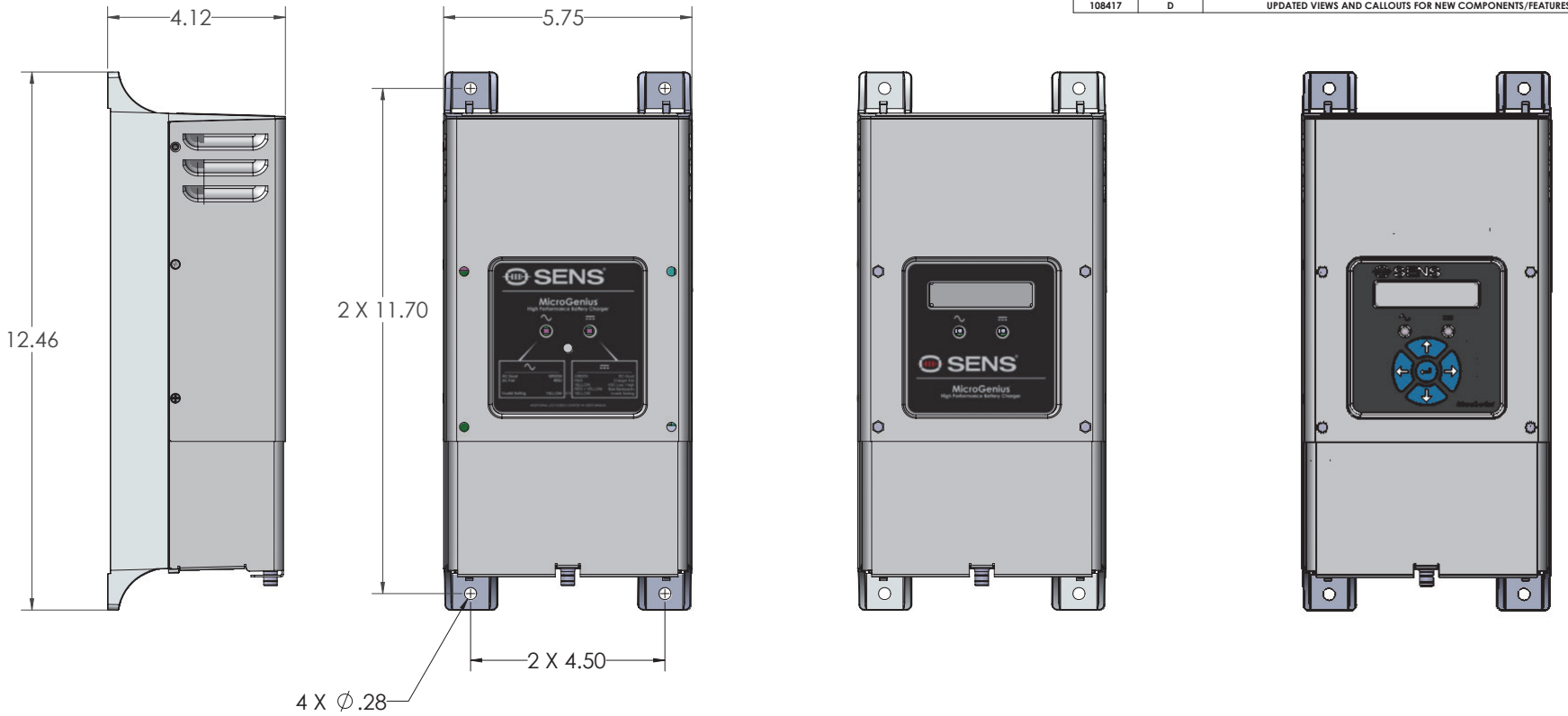
14 GLOSSARY

Original Factory Configuration	Configuration set at the factory. Charger operates using settings configured at the factory per customer order. Indicated by three jumpers in the three FLOAT jumper positions on the main circuit board.
Standard Jumper Configuration	Charger operates according to main circuit board jumpers rather than original factory configuration. Indicated by one jumper each in BATTERY TYPE, FLOAT and RANGE positions.
Battery Type	Indicates the type of battery being charged. Battery type is selected when ordering charger for original factory configuration or by jumper position if using standard jumper configuration.
Range	RANGE is a jumper position on the main circuit board set when using standard jumper configuration. Indicates system DC output voltage.
Program Mode	In Program Mode, charger output is determined by values programmed in the charger using computer to charger cable (SENSbus adapter) and SENS Setup Utility Kit (SENS p/n 209254 plus SENS software available at www.sens-usa.com). Removing all jumpers from the BATTERY TYPE, FLOAT and RANGE positions enables Program Mode.
Float Voltage	Float output voltage is used to maintain batteries in a fully charged state and prevents a fully charged battery from becoming overcharged.
Boost Voltage	“Boost” describes an elevated output voltage employed to accelerate the recharge of a battery that is periodically discharged. The voltage employed to boost charge batteries is typically the same as that employed to “equalize” cells of a battery on long-term float charge. The terms “Boost” and “Equalize” are often used interchangeably. SENS’ convention is to employ the term “Boost” when referring to both the fast recharge function and the cell equalization function described under the definition of “Equalize Voltage”.
Equalize Voltage	“Equalize” describes an elevated voltage typically employed to reset the series-connected cells of a battery such that cell voltages and capacities more nearly match each other. Equalize charging is employed to improve the performance

	and life of an already charged battery that is primarily charged using Float voltage. SENS' convention is to employ the term "Boost" to mean both this cell equalization function and the fast battery recharge function.
Configuration Code	Indicates charger output voltage configuration. Configuration code is included on nameplate label on open-frame chargers and on inside cover label on enclosed chargers.
SAE J1939 (CANbus)	J1939 is a communications protocol provided by SAE International and used in the commercial vehicle area for communication between the charger and genset controller.
Modbus	Modbus is an application layer messaging protocol provided by Modbus Organization and used for client/server communication. Modbus is provided over RS-485 in RTU mode or over TCP/IP as an option.

ENCLOSED CHARGER

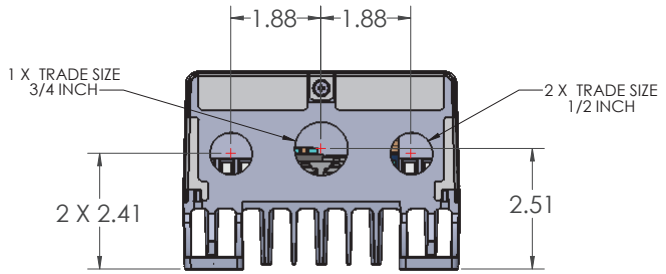
REVISIONS				
DCN	REV	DESCRIPTION	DATE	APPROVED
107038	A	INITIAL RELEASE	6/23/2016	JWF
107141	B	UPDATE VIEWS AND MOUNTING DIMENSIONS	10/31/2016	JWF
107158	C	UPDATE VIEWS AND CALLOUTS	12/19/2016	JWF
108417	D	UPDATED VIEWS AND CALLOUTS FOR NEW COMPONENTS/FEATURES	8/22/2023	MBH



FRONT VIEW NO DISPLAY

FRONT VIEW WITH OPTIONAL DISPLAY

FRONT VIEW WITH OPTIONAL DISPLAY AND OPTIONAL KEYPAD



SENS
STORED ENERGY SYSTEMS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN **INCHES**
DEFAULT TOLERANCES:

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	JWF	2/7/2014
CHECKED		

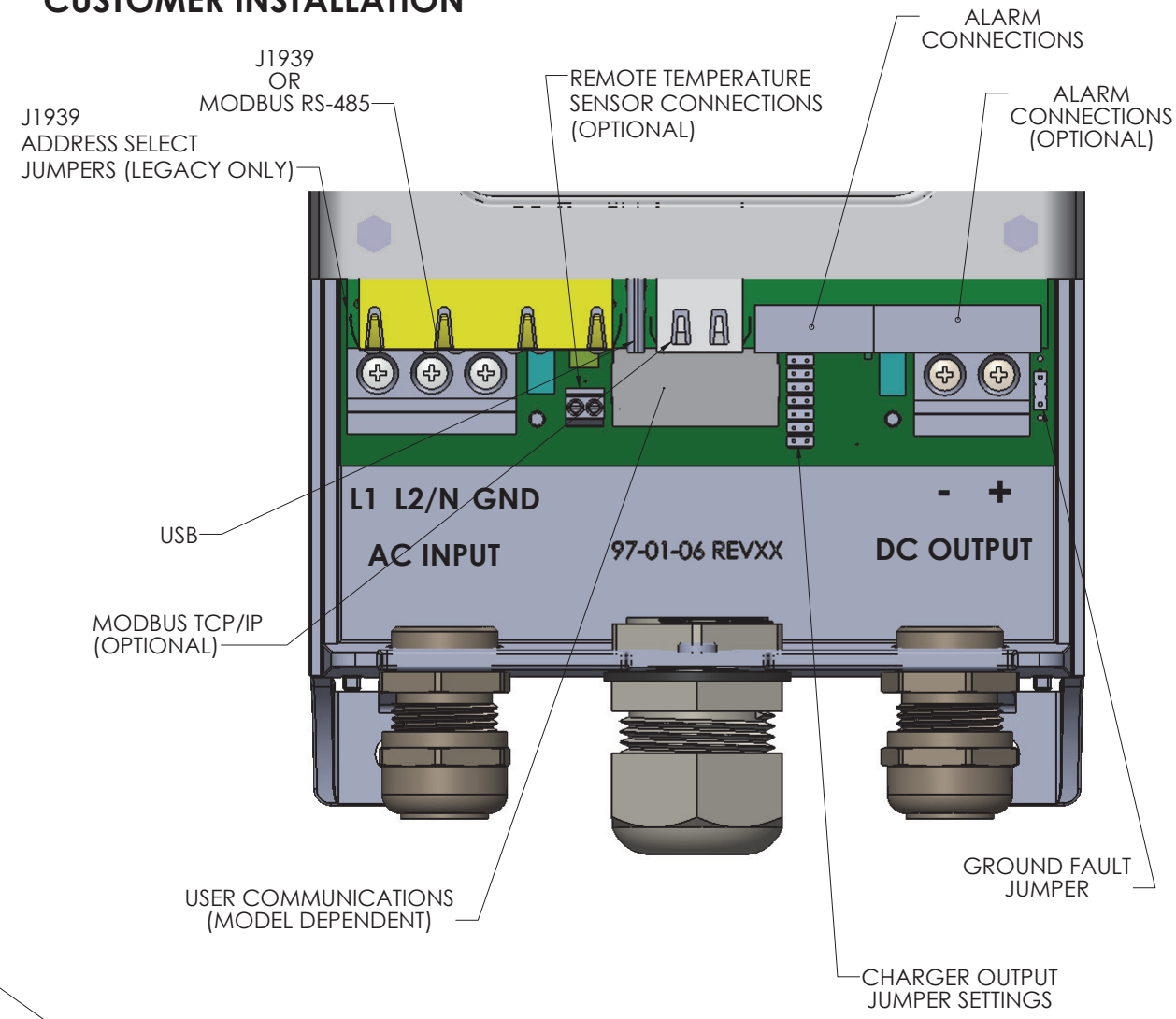
THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

DESCRIPTION: 2DCAD,MG2,ENCLOSED,STANDARD

SIZE: C | DOCUMENT NUMBER: 2DCAD-MG2-STD-ENC | REV: D

REVISIONS				
DCN	REV	DESCRIPTION	DATE	APPROVED
--	--	See sheet 1.	--	--

ENCLOSED CHARGER CUSTOMER INSTALLATION



NOTES:

1. INSTALL ENCLOSED CHARGER USING CUSTOMER SUPPLIED 1/4 MAX MOUNTING HARDWARE.
2. PROVIDE ADEQUATE CLEARANCE AROUND THE CHARGER FOR VENTILATION. MINIMUM CLEARANCES ARE: 0.5 INCHES FOR EACH SIDE, 4 INCHES AT BOTTOM SURFACE AND 6 INCHES ABOVE THE TOP SURFACE.
3. CHARGER MUST BE MOUNTED VERTICALLY FOR ADEQUATE VENTILATION.

SENS
STORED ENERGY SYSTEMS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN **INCHES**
DEFAULT TOLERANCES:
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	JWF	2/7/2014
CHECKED		

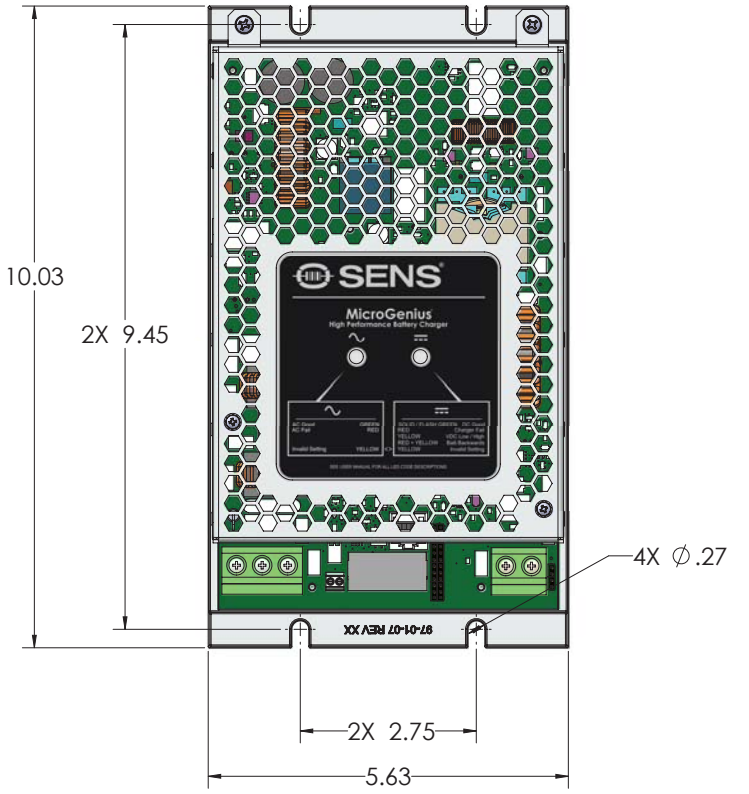
THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

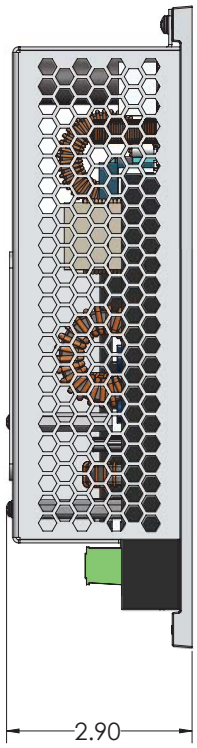
DESCRIPTION: 2DCAD,MG2,ENCLOSED,STANDARD

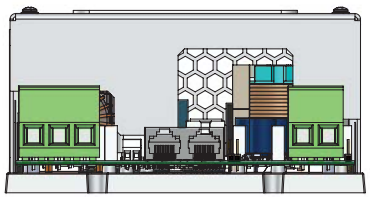
SIZE: C | DOCUMENT NUMBER: 2DCAD-MG2-STD-ENC | REV: D

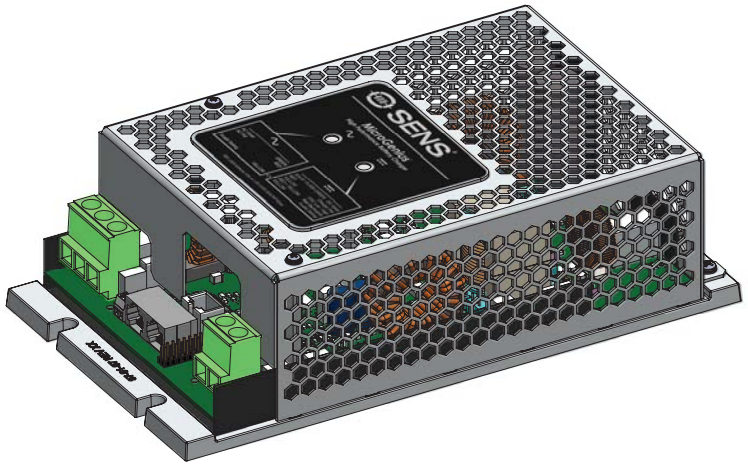
REVISIONS				
DCN	REV	DESCRIPTION	DATE	APPROVED
107158	A	INITIAL RELEASE	12/5/2016	ERS

OPEN FRAME CHARGER









SENS
STORED ENERGY SYSTEMS

PROPRIETARY AND CONFIDENTIAL

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN **INCHES**
DEFAULT TOLERANCES:

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	ERS	12/5/2016
CHECKED		

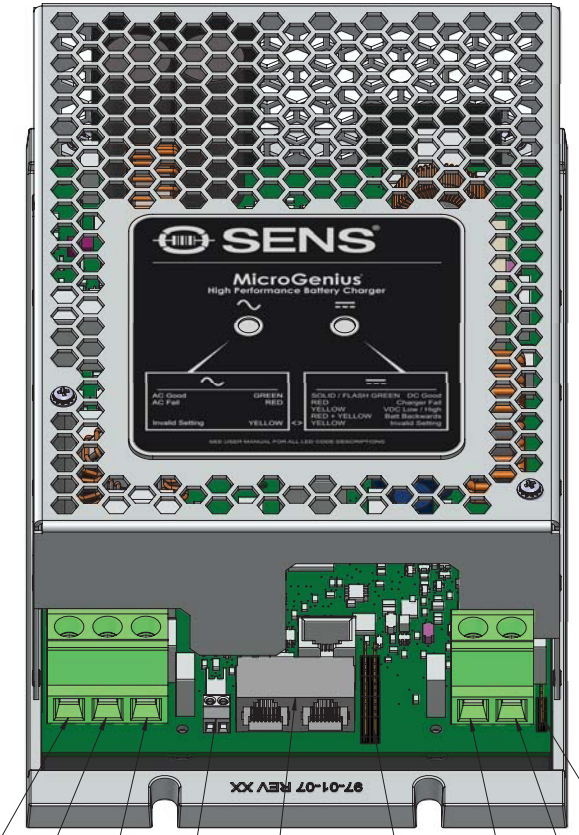
THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

DESCRIPTION: 2DCAD,MG2,OPEN-FRAME,STANDARD

SIZE: C
DOCUMENT NUMBER: 2DCAD-MG2-STD-OPN
REV: A

REVISIONS				
DCN	REV	DESCRIPTION	DATE	APPROVED
--	--	See sheet 1.	--	--

OPEN FRAME CHARGER
CUSTOMER INSTALLATION



AC L1

AC L2/N

GROUND

REMOTE TEMPERATURE SENSE (OPTIONAL)

USER COMMUNICATIONS

GROUND FAULT JUMPER

DC+

DC -

CHARGER OUTPUT JUMPER SETTINGS

NOTES:

1. INSTALL CHARGER USING CUSTOMER SUPPLIED 1/4 MAX MOUNTING HARDWARE.
2. HEAT SINK CHARGER TO A METAL SURFACE

SENS
STORED ENERGY SYSTEMS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN **INCHES**
DEFAULT TOLERANCES:

DO NOT SCALE DRAWING

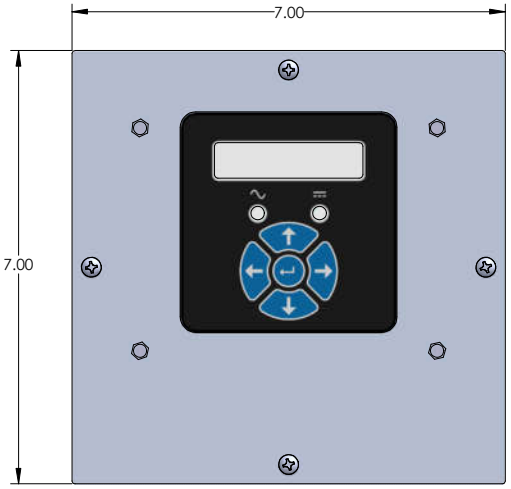
	NAME	DATE
DRAWN	ERS	12/5/2016
CHECKED		

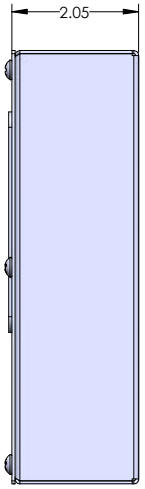
THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

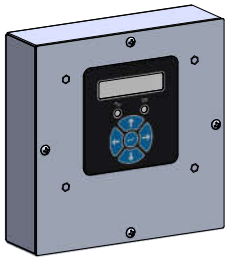
DESCRIPTION: 2DCAD,MG2,OPEN-FRAME,STANDARD

SIZE: C | DOCUMENT NUMBER: 2DCAD-MG2-STD-OPN | REV: A

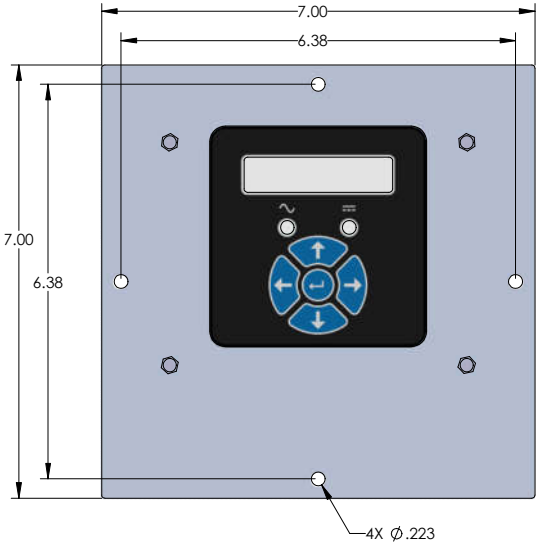
REMOTE PANEL WITH JUNCTION BOX

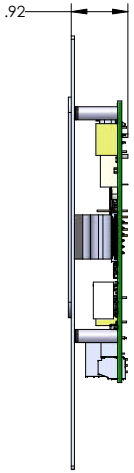


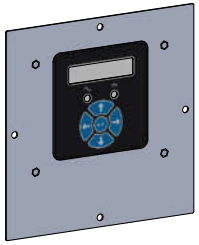


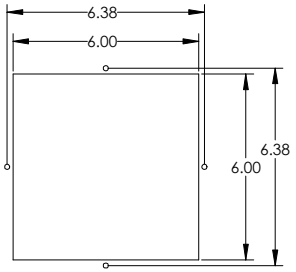


REMOTE PANEL WITHOUT JUNCTION BOX





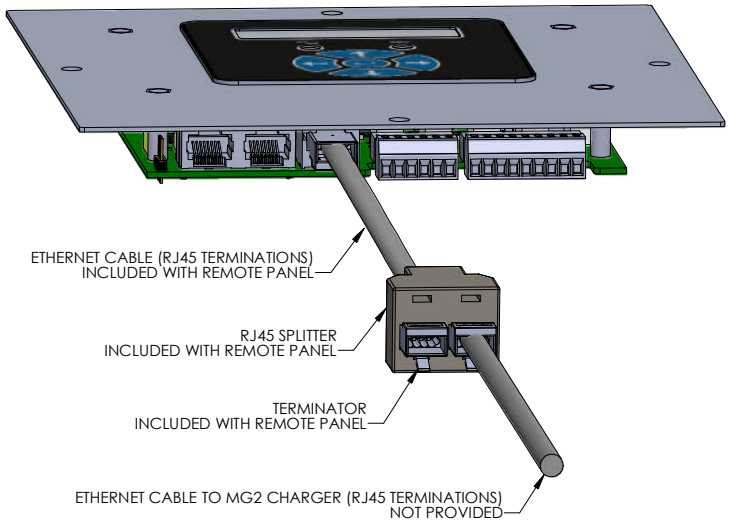




REMOTE PANEL CUTOUT DIMENSIONS

REVISIONS				
DCN	REV	DESCRIPTION	DATE	APPROVED
107320	A	INITIAL RELEASE	7/13/2017	SC
107318	B	NOMENCLATURE UPDATE	8/9/2017	SC
107882	C	DESCRIPTION CHANGE,CLARIFY APPLICATIONS	6/8/2020	ERS

REMOTE PANEL WIRING CONNECTIONS



NOTE - MG2 CHARGER MUST HAVE TERMINATOR INSTALLED.
TERMINATOR IS INCLUDED WITH REMOTE PANEL.

NOTES:
1. THIS PRODUCT IS INTENDED FOR USE WITH SENS MICROGENIUS AND ENERGENIUS PRODUCTS INCLUDING MG2, S2, S4, AND ENERGENIUS DC.

SENS
STORED ENERGY SYSTEMS
1040 INDUSTRIAL CIRCLE
LONGMONT, CO 80501
303-678-7500
WWW.SENS-USA.COM

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN **INCHES**
DEFAULT TOLERANCES:
ANGLES ± 1°
TWO PLACE DECIMAL ± .03
THREE PLACE DECIMAL ± .005
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	ERS	7/13/2017
CHECKED		

THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

DESCRIPTION: 2DCAD,REMOTE PANEL,ACC
SIZE: D
DOCUMENT NUMBER: 2DCAD-MG2-REMOTEPANEL-STD
REV: C
SHEET 1 OF 1

Confirmation of Product Type Approval

Company Name: STORED ENERGY SYSTEMS, LLC

Address: 1840 INDUSTRIAL CIRCLE CO 80501 United States

Product: Battery Charger

Model(s): MicroGenius 2

Endorsements:

Certificate Type	Certificate Number	Issue Date	Expiry Date
Product Design Assessment (PDA)	21-2165921-PDA	01-OCT-2021	30-SEP-2026
Manufacturing Assessment (MA)	23-5820693	15-MAY-2023	30-MAY-2028
Product Quality Assurance (PQA)	NA	NA	NA

Tier
5 - Unit Certification Required

Intended Service
Charging batteries and providing DC power in Marine and Offshore Applications

Description
MicroGenius 2: Switchmode, regulated, filtered, microprocessor-controlled, current limited battery charger designed for heavy-duty industrial service.

Primary application: quick recharge and long-life maintenance of engine start batteries and ultracapacitors.

Refer to the attached sheet for Model Series Designation.

Ratings
Output Voltage: 12 or 24 VDC Nominal;

Output Power: 180 W, 300W, or 450W

Input Voltage: 100-240VAC

Input Frequency: 50/60 Hz;

Operational temperature at full rated output: -40 ºC to +55 ºC for 180W; -40 ºC to +50 ºC for 300W; -40ºC to +40ºC for 450W

Enclosure: IP 22 aluminum/stainless steel enclosure;

Service Restrictions

Unit Certification is not required for this product (ratings less than 25 kW).

If the manufacturer or purchaser requests an ABS Certificate for compliance with a specification or standard, the specification or standard, including inspection standards and tolerances, must be clearly defined.

Not suitable for installation in hazardous areas.

Comments
The Manufacturer has provided a declaration about the control of or the lack of Asbestos in this product.

End-user must use output cables that have sufficient current-carrying capacity as per ABS Marine Vessel Rules 4-8-2/7.7.1.

Notes, Drawings and Documentation
Drawing No. 2016 ABSCert, 2016 ABS MA, Revision: 1, Pages: 1

Drawing No. 2DCad, 2DCad, Revision: 1, Pages: 1

Drawing No. Alarms, ABS alarm reqs, Revision: 1, Pages: 1

Drawing No. Application2016, Type Approval Application 2016, Revision: 1, Pages: 1

Drawing No. Asbestos, Asbestos Cert 2016, Revision: 1, Pages: 1

Drawing No. ComplianceSpec, Compliance Spec, Revision: 1, Pages: 1

Drawing No. DecConf, Declaration of Conformity, Revision: 1, Pages: 1

Drawing No. Discharge , MG2 Discharge Data, Revision: 1, Pages: 1

Drawing No. IP22, IP22 Test, Revision: 1, Pages: 1

Drawing No. ISO, ISO 2021, Revision: 1, Pages: 1

Drawing No. ISO2008, ISO Cert 2008, Revision: 1, Pages: 1

Drawing No. ISO2008Report, ISO Report 2008, Revision: 1, Pages: 1

Drawing No. Model, Model Designation, Revision: 1, Pages: 1

Drawing No. PDA Application, PDA Application, Revision: -, Pages: -

Drawing No. Recharge, MG2 Recharge Data, Revision: 1, Pages: 1

Drawing No. ReversePolarity, Reverse Polarity Test, Revision: 1, Pages: 1

Drawing No. ULAuthorization, UL Authorization, Revision: 1, Pages: 1

Term of Validity
This Product Design Assessment (PDA) Certificate remains valid until 30/Sep/2026 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or previous to the effective date of the ABS Rules and standards applied at the time of PDA issuance. Use of the Product for non-ABS units is subject to agreement between the manufacturer and intended client.

ABS Rules
2021 Rules for Conditions of Classification, Part 1: 1-1-4/7.7, 1-1-A3, 1-1-A4, which covers the following:

2021 Marine Vessel Rules: 4-8-3/1.3, 1.7, 1.11.1, 1.17.1 4-8-1/7.3.3, 4-8-3/5.9

2021 Rules for Conditions of Classification, Part 1 - Offshore Units and Structures: 1-1-4/9.7, 1-1-A2, 1-1-A3, which covers the following:

2021 Mobile Offshore Units Rules: 4-3-1/11, 15, 17.1, 6-1-1/3.7, 6-1-7/9.17

International Standards
CSA 22.2 No. 107.2 (2nd Edition, 2021), Battery Chargers (UL File E109740);

IEC 60529 Degrees of Protection Provided by Enclosures (IP Code), 1989+A1:1999;

BS EN IEC 61000-6-4:2019 Electromagnetic compatibility (EMC). Generic standards;

BS EN 61000-6-2: 2019 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.

EU-MED Standards
NA

National Standards
UL 1236 Battery Chargers for Charging Engine-Starter Batteries, 2015, Edition 8 (UL File E109740 and EX6409).

Government Standards
NA

Other Standards
NA

Corporate ABS Programs
American Bureau of Shipping
Print Date and Time: 05-Jun-2023 3:05

ABS has used due diligence in the preparation of this certificate, and it represents the information on the product in the ABS Records as of the date and time the certificate is printed.

If the Rules and/or standards used in the PDA evaluation are revised or if there is a design modification (whichever occurs first), a PDA revalidation may be necessary.

The continued validity of the MA is dependent on completion of satisfactory audits as required by the ABS Rules. The validity of both PDA and MA entitles the product to receive a **Confirmation of Product Type Approval**.

Acceptance of product is limited to the “Intended Service” details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or prior to the effective date of the ABS Rules and standards applied at the time of PDA issuance. ABS makes no representations regarding Type Approval of the Product for use on vessels, MODUs or facilities built after the date of the ABS Rules used for this evaluation.

Type Approval requires Drawing Assessment, Prototype Testing and assessment of the manufacturer's quality assurance and quality control arrangements. The manufacturer is responsible to maintain compliance with all specifications applicable to the product design assessment. Unless specifically indicated in the description of the product, certification under type approval does not waive requirements for witnessed inspection or additional survey for product use on a vessel, MODU or facility intended to be ABS classed or that is presently in class with ABS.

Due to wide variety of specifications used in the products ABS has evaluated for Type Approval, it is part of our contract that; whether the standard is an ABS Rule or a non-ABS Rule, the Client has full responsibility for continued compliance with the standard.

Questions regarding the validity of ABS Rules or the need for supplemental testing or inspection of such products should, in all cases, be addressed to ABS.

SENS®

Powering Critical Infrastructure

EC Declaration of Conformity

In accordance with EN ISO 17050-1:2004

Manufacturer:	Stored Energy Systems
Manufacture Address:	1840 Industrial Circle Longmont, CO 80501 U.S.A.
Product Type:	MicroGenius 2 Battery Charger
Model Numbers:	MX-YY-YYYY-YY, where X = 1, 3, 4, 5, 6, 7, F, G, H, or L; Y = any digit;
Conformance to Directives:	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast) Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (recast) Commission Delegated Directive (EU) 2015/863 of 31 March 2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council as regards the list of restricted substances.
Harmonized and/or technical specifications applied in full:	Directive 2014/30/EU (EMC) EN 61000-6-2:2019 EN 61000-6-4:2019 Class A – where X = 5, 6, 7, or L Class B – where X = 1, 3, 4, or F, G, H Directive 2014/35/EU (LVD) EN 60335-1:2020 EN 60335-2-29:2021 Directive (EU) 2015/863 (RoHS) EN 63000:2018
Place and date of first issue:	Longmont, CO USA on October 20, 2016

Under the sole responsibility of Stored Energy Systems, the undersigned hereby declares that the equipment specified above conforms to the essential requirements of the above Directive(s) and Standard(s).

Sam Coleman
Compliance Manager
Stored Energy Systems, LLC

April 5, 2023
Date

SENS®

Powering Critical Infrastructure

UKCA Declaration of Conformity

Manufacturer:	Stored Energy Systems
Manufacture Address:	1840 Industrial Circle Longmont, CO 80501 U.S.A.
Product Type:	MicroGenius 2 Battery Charger
Model Numbers:	MX-YY-YYYY-YY, where X = 1, 3, 4, 5, 6, 7, F, G, H, or L; Y = any digit;
Conformance to Directives:	Electromagnetic Compatibility Regulations 2016 Electrical Equipment (Safety) Regulations 2016 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK RoHS)
Harmonized and/or technical specifications applied in full:	UK EMC EN 61000-6-2:2019 EN 61000-6-4:2019 Class A – where X = 5, 6, 7, or L Class B – where X = 1, 3, 4, or F, G, H UK Safety EN 60335-1:2020 EN 60335-2-29:2021 UK RoHS EN 63000:2018
Place and date of first issue:	Longmont, CO USA on April 5, 2023

Under the sole responsibility of Stored Energy Systems, the undersigned hereby declares that the equipment specified above conforms to the essential requirements of the above Regulation(s) and Standard(s).

April 5, 2023
Date

Sam Coleman
Compliance Manager
Stored Energy Systems, LLC

SENS Limited Warranty: NRG and MicroGenius® Battery Chargers

What is covered?
This warranty covers any defect in material and workmanship on NRG and MicroGenius battery chargers manufactured by Stored Energy Systems, a Colorado Limited Liability Company (SENS).

What this warranty does not cover:
This warranty does not cover damages, defects or failures of your equipment resulting from shipping damage, accidents, installation errors, unauthorized adjustment or repair, unauthorized third-party service, failure to follow instructions, misuse, fire, flood, electrical transients, acts of persons not in our control, and acts of God.

For how long:
MicroGenius LE: One year from date of shipment.
MicroGenius 2, S2, NRG: Three (3) years from date of shipment
MicroGenius S4: Five (5) years from date of shipment except for the modules which are covered for three (3) years.

What we will do:
If your battery charger is defective within the warranty period, we will repair it or, at our option, replace it at no charge to you.

If we choose to replace your charger, we may replace it with a new or refurbished one of the same or similar design. The repair or replacement will be warranted for the remainder of the original warranty period. If we determine that your charger cannot be repaired or replaced, we will refund its purchase price to you.

What we ask you to do:
Contact SENS service department to obtain warranty service instructions. To obtain warranty service the product must be returned, freight prepaid, to the factory under a Return Material Authorization (RMA) number provided by SENS. If, in SENS' opinion, the problem can be rectified in the field, SENS may elect to ship replacement parts for customer installation instead of having the product returned to the factory.

Limitation:
This warranty is limited to defects in material or workmanship of the product. It does not cover replacement of consumables such as surge protective devices, unless defective. It does not cover loss of time, inconvenience, property damage or any consequential damages. Repair, replacement or refund of the purchase price of the equipment is your exclusive remedy.

Extended Warranty: NRG and MicroGenius Battery Chargers

Extended Warranty Period
At any time during the standard Limited Warranty period, customer may purchase extended warranty to lengthen the warranty period to 5 or 10 years from date of original shipment. All other terms of SENS Limited Warranty (see above) apply. Extended warranty not available for MicroGenius LE.

5-year extended warranty is included at no extra cost when SENS Commissioning Services are ordered at the time of charger purchase.