SuperTorque 8ZR

Integrated Engine Starting System

Super High-Performance Battery + Integrated Charger System

Installation & Operation Manual

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This product is covered by one or more patents:
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Installation or service questions?
Call SENS between 8 a.m. and 5 p.m. (Mountain Time), Monday through Friday, or visit our website.

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1 IMPORTANT SAFETY INSTRUCTIONS FOR INSTALLER AND OPERATOR

1.1. **SAVE THESE INSTRUCTIONS –** This manual contains important safety and operating instructions for SuperTorque 8ZR integrated engine starting systems.

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

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

1.3. **This genset starting system is intended for commercial and industrial use.** ONLY TRAINED AND QUALIFIED PERSONNEL MAY INSTALL AND SERVICE THIS UNIT.

1.4. Do not operate integrated engine starting system if it has received a sharp blow, been dropped, been inverted, or otherwise damaged in any way; shut off power at the branch circuit protectors, open battery disconnects, and have the system serviced or replaced by qualified personnel.

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

1.6. **WARNING – RISK OF FIRE, EXPLOSION OR BURNS**

1.6.1. **WORKING IN THE VICINITY OF A NICKEL-ZINC BATTERY IS DANGEROUS. BATTERY INCLUDES ALKALINE ELECTROLYTES. 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 GENSET STARTING SYSTEM.**

1.6.2. Do not disassemble battery, heat above 75°C, incinerate, puncture or impact.

Mise en garde : Risque d'incendie, d'explosion ou de brûlures. Ne pas démonter, chauffer à plus de 75°C (ou °F) ou incinérer.

1.6.3. 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.

1.6.4. Ensure battery spill control procedures exist in accordance with building, fire and installation codes.

1.7. **PERSONAL PRECAUTIONS**

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

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

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

1.7.4. 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.

1.7.5. **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.

1.7.6. 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.

1.7.7. 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.

1.7.8. **NEVER** charge a frozen battery.

Ne jamais charger une batterie gelée.

1.7.9. The charging circuit 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.

1.7.10. Calculate arc flash for each module per NPFA 70e, annex D, method D.5, using bolted fault current (IBF) 5400A (80Ah) / 6200A (90Ah), 1/2 bolted fault current 2700A/3100A, protective device clearing time (max arcing time) 2s, max system voltage 30.4V, working distance 45.5cm and no protective device.

1.8. **Preparing Battery For Charge**

1.8.1. Storage - recharge every 6 months or when open circuit battery voltage drops below 13.5VDC (12V nominal systems) or 27.0VDC (24V nominal systems).

1.8.2. Ensure area around battery is well ventilated and in accordance with local fire and installation codes while battery is being charged.

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

1.8.4. Do not operate integrated engine starting system with damaged cables. Defective cables must be replaced before operation.

1.8.5. Verify that all cables are properly secured and connected.

1.9. **Installation**

1.9.1. Limited to indoor use: IP2X

1.9.2. Charging temperature: 0°C to 45°C

1.9.3. Do not tip, keep system level.

1.9.4. Do not set anything on top of system.

1.9.5. Engine controller high DC alarm voltage threshold must be set to 16/32V.

1.9.6. Unit shall be installed in accordance with Article 480 or 706 of NFPA 70 or Section 64 of CSA C22.1.

1.10. **Service**

1.10.1. Do not open 8Z battery modules, not field serviceable.

2 MODEL NUMBER BREAKOUT

8	R	-	A	1	-	L	A	-	3	3	1	-	0	0	A	-	2
1	**2**	**-**	**4**	**5**	**-**	**7**	**8**	**-**	**10**	**11**	**12**	**-**	**14**	**15**	**16**	**-**	**18**

	Parameter	Code	Value
1-2	Product Family	8R	SuperTorque 8Z rack
4	DC Output Voltage & Capacity	0	No batteries
		A	24V 80 Ah
5	Charging Current	1	15 A
7	Termination Panel	0	None
		S	AC/Coms Only
		L	AC/Coms/DC (includes DC disconnects)
8	Control and Communication	A	LCD, keypad, (5) form-C relays, USB-C, RS-485 and TCP/IP Modbus (Accessory board)
10	# of 8Z SuperTorque Modules	0	None
		1	1 8Z module
		2	2 8Z modules
		3	3 8Z modules
		4	4 8Z modules
11	Rack Layout	1	1H x 1W
		2	2H x 1W
		3	3H x 1W
		A	1H x 2W
		B	2H x 2W
12	Banks (max of 3 8Zs per bank)	0	No panel/wiring
		1	1 output bank
		2	2 output banks
		3	3 output banks
14	DC Isolation (only available with two banks)	0	No isolation
		A	BCS – Battery Control System
		B	BBS – Best Battery Selector
		C	BCS and BBS
15	Battery Monitoring	0	No battery monitoring
16	Configuration	A	Standard configuration
18	Starter Cables (positive and negative, include 3/8 lug on rack side, 1/2 lug on starter side)	0	No starter cables
		1	6ft long
		2	10ft long
		3	15ft long

3 PERFORMANCE SPECIFICATIONS

SuperTorque 8ZR is an integrated engine starting system including high-performance 8Z NiZn battery and charger modules, controls, communications, and user-interface in one package, specially targeted for long-life and high reliability.

Multiple output banks are independently controlled and wired as separate outputs. Five standard Form C contact alarms per output bank are factory set and field reconfigurable, with indication via communication port, front panel LCD and assignable alarm relays. Keypad control and data communications including serial and Ethernet Modbus. Specifications are detailed in the table below, see following sections for installation and operation instructions.

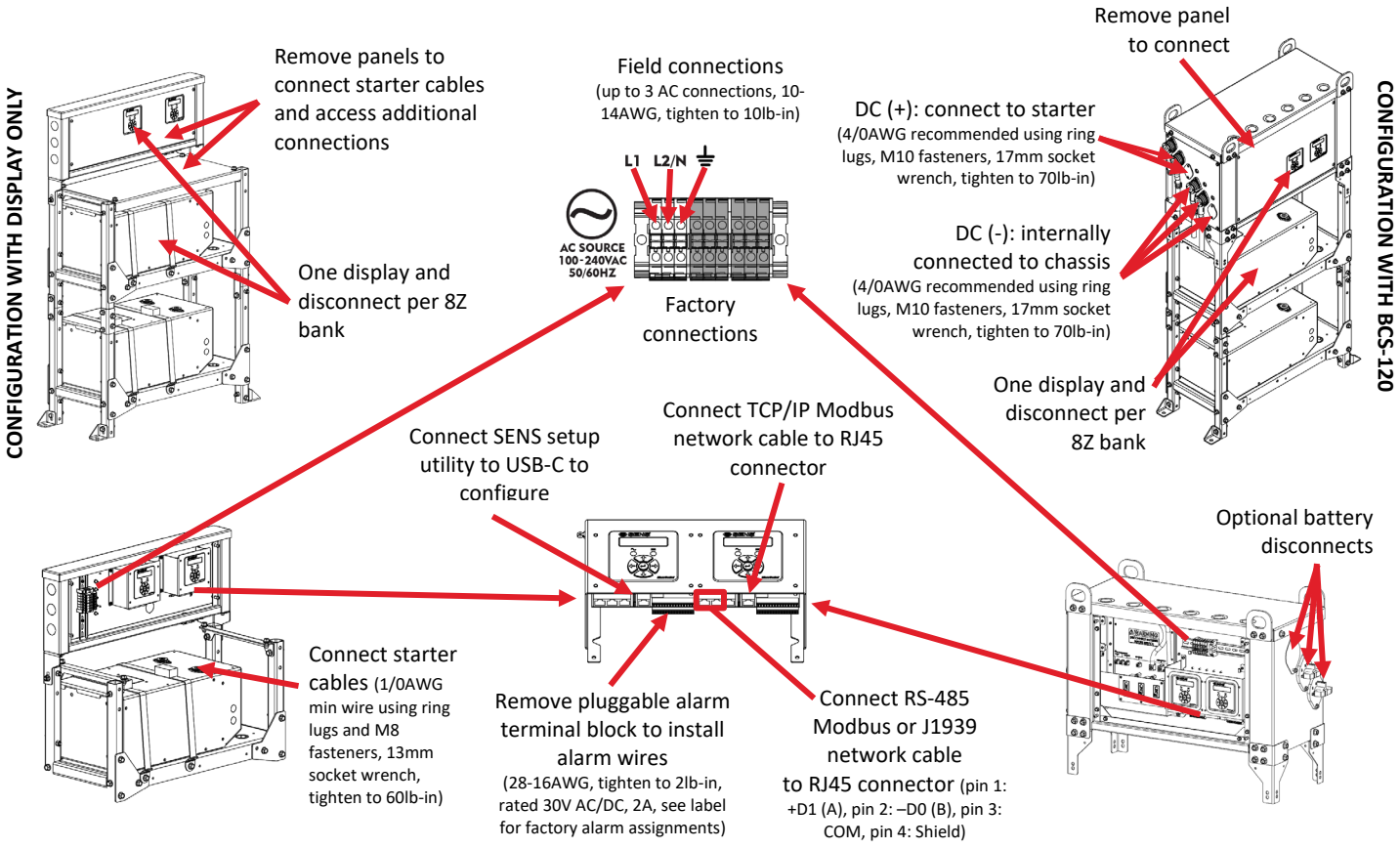
System Parameters	8Z modules	1 – 4 8Z modules per system					
	8Z configuration	8ZR can be configured with 1, 2 or 3 isolated DC output banks, maximum of 3 8Z modules per output bank					
	DC disconnects	DC disconnects standard, 1 disconnect per output bank					
	Best battery selector	Optional internal BBS-4800, couples 2 isolated output banks for a single redundant starting output					
	Battery control system	Optional internal BCS-120, couples 2 isolated output banks for a single redundant engine control power output and couples the engine DC alternator output to 2 isolated output banks					
	Rack configuration (8Z layout, height by width)	1H x 1W, 2H x 1W, 3H x 1W, 1H x 2W, 2H x 2W					
	Rack-to-engine DC cables	Optional, 6ft, 10ft, and 15ft lengths. 4/0AWG cables with 1/2in lugs on starter side					
AC Input (per 8Z module)	VAC, Hz	90-265VAC single-phase, 47-63Hz, 1 AC input per output bank					
	Current (max)	12VDC: 3A 24VDC: 4A					
	Power factor & efficiency	PF >.95 typical; efficiency to 93%; meets CEC Title 20 Efficiency Regulations; standby AC draw < 3W					
DC Output Bank Ratings		# of 8z per Bank	Recharge Current[1] (0°C to 45°C)	Capacity (80/90Ahr)	Discharge 15s on, 15s off (-40°C – 40°C)	Incident Energy[2] (80/90Ahr)	Bolted Fault/Short Circuit Current[3] (80/90Ahr)
	Ratings per bank without optional BBS	1	15A	80/90Ahr	800A	0.79/0.91 cal/cm^2	5400/6200A
		2	30A	160/180Ahr	1600A	1.58/1.82 cal/cm^2	10800/12400A
		3	45A	240/270Ahr	2400A	2.37/2.73 cal/cm^2	16200/18600A
	Ratings per bank with optional BBS	1	15A	80/90Ahr	800A	1.58/1.82 cal/cm^2	10800/12400A
		2	30A	160/180Ahr	1600A	3.16/3.64 cal/cm^2	21600/24800A
		[1]Calculated using NFPA 70E, Annex D, Method D.5 [2]Battery voltage: 13V (12V systems) / 26V (24V systems) nominal, 15.2V/30.4V max [3]1/2 bolted fault current is the bolted fault current divided by 2					
Engine Starting Performance	Typical cranking current per 8Z module	2,700 amps at breakaway while maintaining battery terminal voltage above 12.0 volts (24V model). Rolling current is typically ~30% of breakaway (locked rotor) current.					
	Engine displacement	Configurable for engines up to 110 liters					
	Typical crank cycles	Minimum of 6x 15s crank sequences, per NFPA 110 standard					

	Redundancy	Optional, achieved via: • N+1 – an extra 8Z module for the output bank • N+1 or N+N – multiple isolated output banks • N+N – integrated Best Battery Selector
Internal Nickel Zinc Battery System	Volts	24VDC nominal, 28.4VDC float voltage, 30.4VDC boost voltage, 31.5VDC maximum DC voltage Note – this system charges at similar voltage levels as NiCd, ensure engine high voltage DC alarm is set at 32VDC
	Battery capacity	80Ah per 8Z module
	Output banks	Up to 3 separate output banks, each bank requires same number of 8Z modules. Each bank includes independent display and status.
	Recharge rate	12-15A per 8Z module. Maximum recharge time 8hrs.
	Battery temp. compensation	Standard
	Battery charging	Patented factory programmed NiZn charging
Status Display	Metering & status display	One display with AC and DC LEDs per output bank. Battery voltage accurate to +1%; charger current to +1%; 20-character display of status & alarms.
	Quiescent draw per 8Z module	237mA at 12VDC or 123mA at 24VDC max quiescent draw with AC disconnected and module not in “Sleep” mode
Alarms	Alarms	Factory set, field reconfigurable. Alarm functions announced on the J1939 and Modbus ports and on the LCD. Any one of 20+ alarms or any combination of alarms is assignable to any Form C contact.
	Alarms: Form C contacts	Five Form C contacts per output bank, each rated 30V, 2A resistive, assignable
Networking	J1939 communications	CAN 2.0 extended ID on RJ45 port
	Modbus communications	Modbus RS-485 or TCP/IP on RJ45 port
	SENSbus	Proprietary bus for connection of paralleled units and SENS accessories
	USB	USB-C connectivity via SENS Setup Utility
Environmental	Operating temperature	-10°C to +55°C; charging 0°C to +45°C; storage -20°C to +60°C
	Humidity	5% to 95%, non-condensing
	Altitude	Full specification 0 to 13,000 ft (0 to 4000 m)
	Ingress protection	IP2X, NEMA 1
	Vibration & shock resistance	Vib: Swept Sine (EN60068-2-6): 4G, 18-500 Hz, 3 axes. Random: 20-500Hz, .01G2/Hz. Shock: EN 60068-2-27 (15G)
	Electrical transient	ANSI/IEEE C62.41 & EN 61000-4-12 on power terminals
Abuse Protection	Overvoltage shutdown	Selective; shutdown only operates if the overvoltage condition is caused by the internal charger itself
	Overtemperature protection	Gradual output power reduction if 8Z charging module temperature becomes excessive; recovery is automatic
Regulatory Compliance	North America	C-UL Listed for US & Canada, UL file MH66088. UL tested to +40°C.
		NFPA-70
		FCC Part 15, Class B
		Seismic: Rigid & non-isolated floor mount; max S_{DS} of 2.5G, z/h = 0, Ip = 1.5. IBC 2000-2021, Calif. BC 2007-2021

	European Union (CE), United Kingdom (UKCA)	EMC: 2014/30/EU, UK 2016 (EN 61000-6-2 & EN 61000-6-4)
		LVD/Safety: 2014/35/EU, UK 2016 (EN 60335-1 & EN 60335-2-29)
		RoHS: 2015/863, UK 2012 (EN 63000)
		Battery Directive: 2006/66/EC
Construction	Housing/configuration	Floor-mounted steel rack with powder coated finish
Connections	AC	14-10AWG terminal blocks
	Engine starter	M10 threaded insert for positive and negative, standard. M8 without standard termination panel.
	BCS-120	1/0-8AWG terminal blocks for alternator and engine panel connections
	Alarms & comms	J1939 and Modbus TCP/IP: RJ45; Modbus RS-485 and Form C alarms: 28-16AWG terminal blocks

4 SYSTEM OVERVIEW

4.1. Physical Overview



4.2. Functional Overview

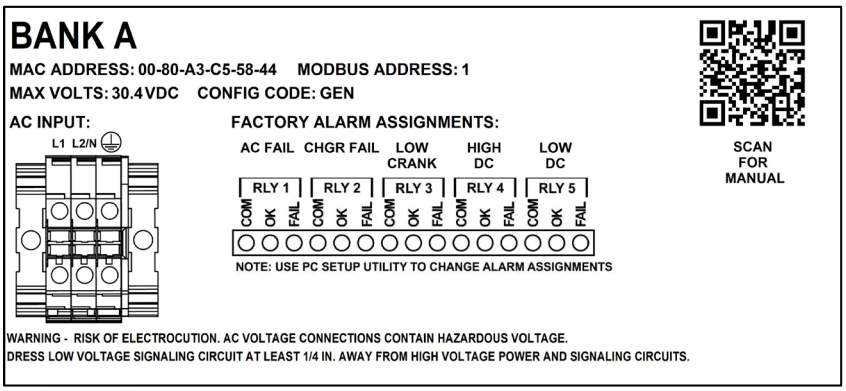
4.2.1. Configuration

Each SuperTorque 8ZR comes configured from the factory and requires no output adjustments. Configuration details are provided on the configuration label(s). These values are assigned according to the profile configuration selected during the customer order.

Each output bank includes independent control of communications, settings and alarms. Adjustments to communications settings and other configurable settings can be made using the

front panel keypad or the SENS Setup Utility software. Connect a computer with the SENS Setup Utility to the system via USB-C.

Example Configuration Label



4.2.2. Standard Items

4.2.2.1. One front panel LCD with keypad control per output bank.

4.2.2.2. Five Form C alarm relay contacts per output bank

4.2.2.3. USB-C

4.2.2.4. SENSbus communications

4.2.2.5. Modbus (TCP/IP and RS-485) communications

4.2.2.6. J1939 communications

4.2.3. Factory Optional Items

4.2.3.1. DC disconnects

4.2.3.2. BCS - Battery Control System

4.2.3.3. BBS - Best Battery Selector

4.2.3.4. Starter cables – positive and negative cables with 3/8 inch lug on rack side and 1/2 inch lug on starter side. Options for 6 feet, 10 feet and 15 feet long. Includes one set per output bank unless BBS is specified.

5 MOUNTING INSTRUCTIONS

INSTALLATION OF THE SYSTEM 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 system by the chassis only.

5.1. Mounting

See diagrams below for dimensions and mounting information.

5.1.1. Unit rated IP2X.

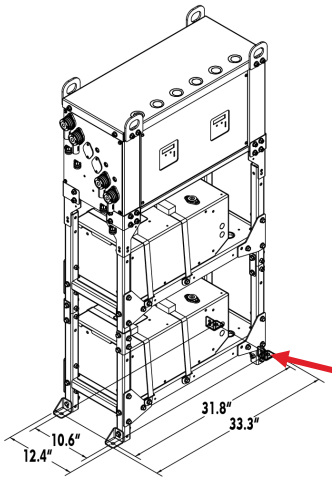
5.1.2. Operate system at -10°C to +55°C (14°F to +131°F). Do not operate outside of 0°C to 50°C (32°F to 122°F) for more than 10% of operating life.

5.1.3. Mounting surface must safely support the weight of the rack unit and the fixed wiring. The 8ZR rack system (including bars and shelf) weighs 95-729 lbs. Lift the system using a lifting device.

5.1.4. Use a spreader bar to evenly distribute weight when transporting using top-lift connections.

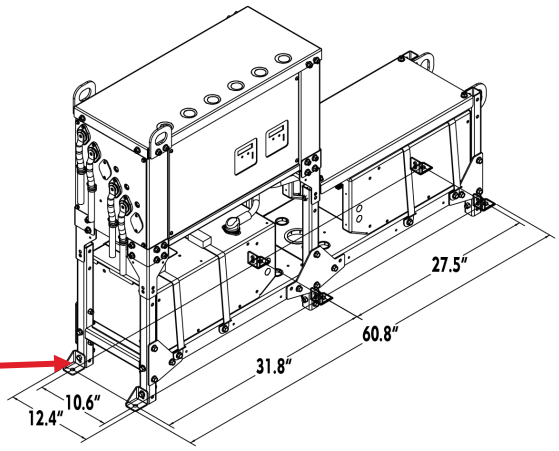
5.1.5. System is installed with rigid floor mounting; install using 1/2-inch fasteners (provided by installer).

CONFIGURATION WITH DISPLAY ONLY



Note: common configurations shown. Multiple options available.

Mounting holes sized for 1/2 inch hardware



CONFIGURATION WITH BCS-120

5.1.6. Allow sufficient room for routing the fixed wiring to the system. Alarm and communications field connections may enter the optional termination panel using conduit knockouts.

6 SETUP AND WIRING

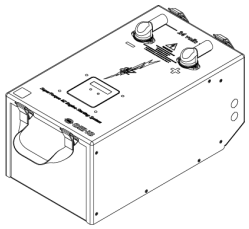
IMPORTANT! Charge for 8 hours minimum prior to placing into service. Do not leave AC disconnected. To avoid battery damage, do not drain battery below 11.2VDC (12V nominal systems) or 22.4VDC (24V nominal systems). Storage - recharge every 6 months or when open circuit battery voltage drops below 13.5VDC (12V nominal systems) or 27.0VDC (24V nominal systems).

The system is configured at the factory and requires no adjustments before operating. Refer to system labels for alarm relay assignments. Communications settings are configured using the front panel keypad or the SENS Setup Utility. Each output bank includes independent control of communications, settings and alarms.

6.1. Wire Ratings

All wiring must comply with applicable codes and local ordinances. All power conductors should be rated for use at 90°C or higher and 600V or higher. Alarm relay conductors and communications data cable should be rated for use at 75°C or higher.

CAUTION: VOLTAGE ALWAYS PRESENT ON BATTERY TERMINALS!



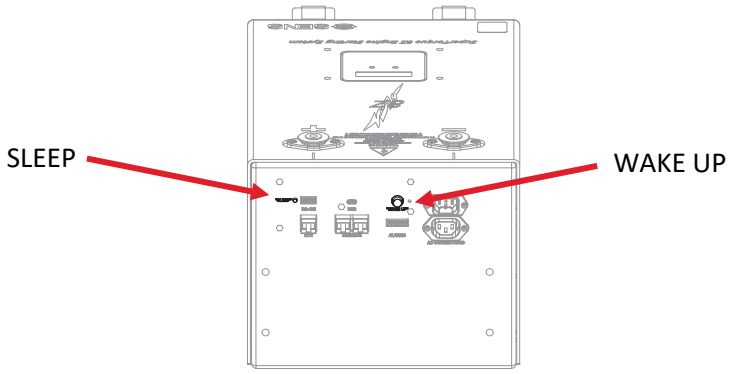
6.2. Grounding Instructions

System must be grounded via grounded AC input connection to reduce risk of electric shock. The system must be connected to a grounded, metal, permanent wiring system, or an equipment-grounding conductor (earthing conductor) must be run with the circuit conductors.

6.3. Sleep and Wake Up Buttons

To prevent battery discharge when AC power is not connected, press “SLEEP” button on each 8Z module to turn off display and communications (system shipped from factory in SLEEP mode). If AC voltage is going to be disconnected for an extended period of time, press the "SLEEP" button to put the 8Z to sleep and disconnect the 8Z from DC loads and engine. System will not go into SLEEP mode when powered by AC. Press “WAKE UP” button to turn display and communications on when AC power is not connected. The internal battery is always connected to the DC output terminals and will always be available to start an engine when the display and communications are powered off.

WARNING:
PRESSING “WAKE UP” BUTTON WITHOUT AC CONNECTED WILL CAUSE BATTERY DISCHARGE, CONNECT AC POWER AS SOON AS POSSIBLE!

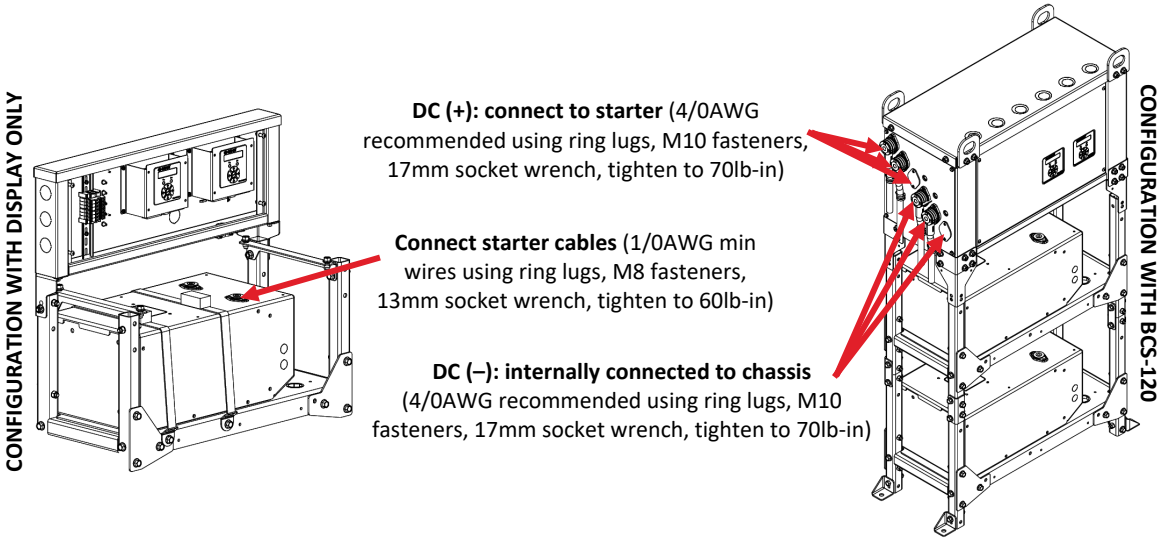


6.4. DC Connection

Connect 4/0AWG minimum DC output conductors to the DC output terminals on the system using ring lugs and M8/M10 fasteners. Display only systems, termination panel not included, require the DC wires connected directly to the 8Z module terminals. On systems where the terminal panel is present, connect the DC wires directly to the output terminals on the termination panel. Separate connections exist for each output bank. Always observe proper polarity of the DC output leads. Tighten connections to 60/70lb-in using a 13/17mm socket wrench. Do not rely on threads for electrical connection; ensure connection to terminal surface. Route DC wiring at least ¼ inch (6 mm) away from AC and alarm wiring.

See engine manufacturer recommendation for DC output conductor gauge and length between the 8ZR system and the engine starter / DC bus.

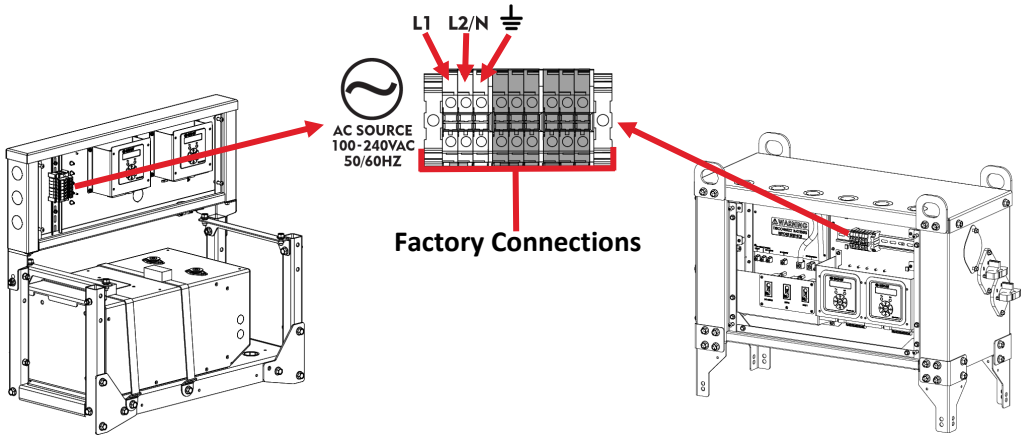
WARNING:
BATTERY TERMINALS MUST BE COVERED
TO PROTECT AGAINST ELECTRICAL SHOCK!



6.5. AC Connection

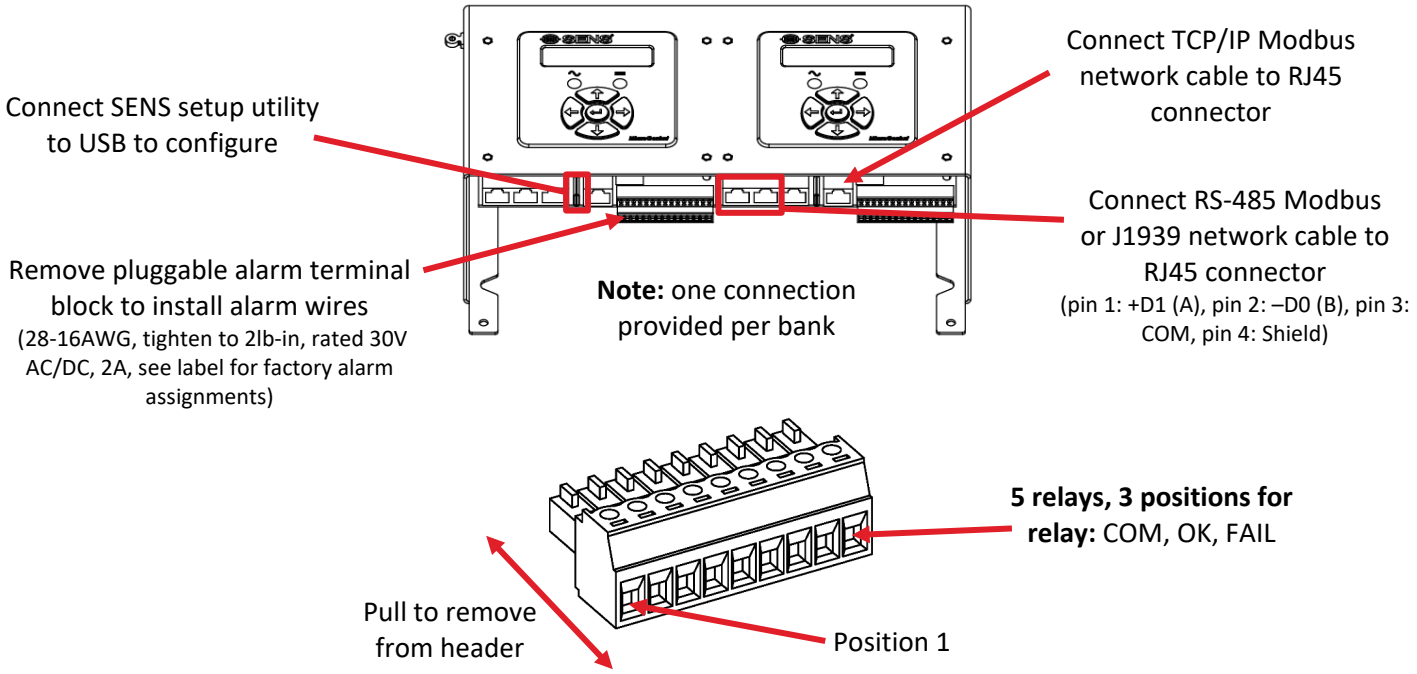
AC input voltage rated 100-240VAC, 50/60Hz. Connect 14-10AWG wire to terminal blocks, tighten to 10lb-in. Separate connections exist for each output bank. Use UL recognized wire rated ≥90C. UL Listed Branch Circuit protection ≤20A required. Route AC wiring at least ¼ inch (6 mm) away from DC and alarm wiring.

Field Connections
(up to 3 AC connections, 14-10AWG, tighten to 10lb-in)



6.6. Alarm Connections

See label(s) on system for original factory alarm relay assignments. Alarm relay assignments are custom configurable using the SENS Setup Utility. Alarm circuits are rated 2A at 30V AC or DC. Connect alarm wiring to the respective terminals on the pluggable terminal block on the alarm/communications circuit board for each output bank. To make wiring easier, the terminal block unplugs from its header. Pull terminal block straight out (down) 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. Wire from FAIL or OK to COM depending on whether the alarm should be present on an open or closed circuit. Connect alarm terminals only to low voltage, limited energy ("Class 2") circuits. The terminals accept 28-16AWG (0.08-1.5 mm^2) conductors. Tighten connections to 2.0lb-in (0.22 Nm) using a small slotted driver. Route alarm wiring at least ¼ inch (6 mm) away from DC and AC wiring.



Alarm Relay Connections

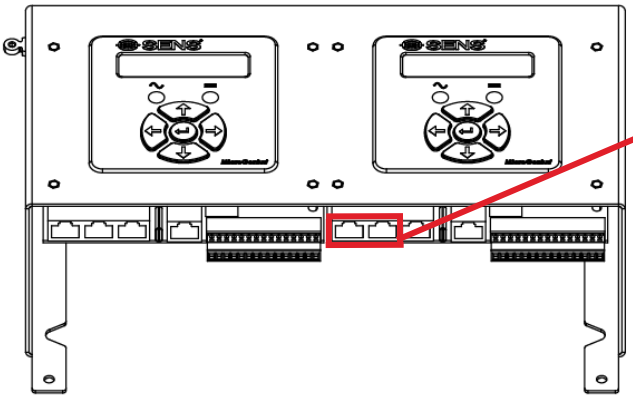
Wire from COM to OK for alarm present on open circuit or from COM to FAIL for present on closed circuit.

	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)

6.7. J1939/Modbus RS-485 Connection

The system is equipped with RJ45 ports for J1939 or Modbus RS-485 using RTU mode communications. Separate connections exist for each output bank. Two RJ45 ports are provided per output bank. The ports are in parallel and either port may be used. See connector pinout below for more detail. An adapter from RJ45 to an 8-position terminal block may be connected to the RJ45 connector (included from factory). Connect either J1939 or Modbus RS-485 communications using a twisted pair cable at the RJ45 connector. Route alarm wiring at least ¼ inch (6 mm) away from DC wiring, AC wiring and low voltage wiring.

Note: one connection provided per bank

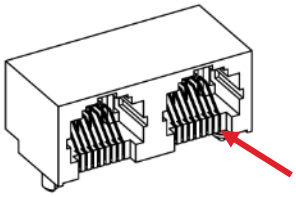


Connect RS-485 Modbus or J1939 network cable to RJ45 connector

RJ45 Connection

Two ports:

Connect J1939 or Modbus RS-485 to one port

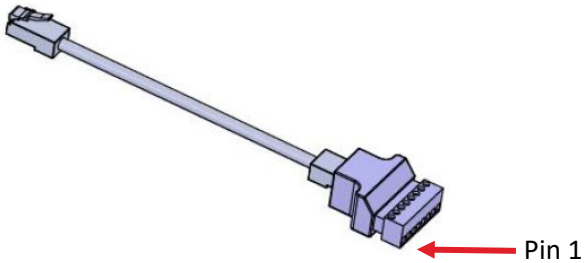


Connector Pinout

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

RJ45 to Terminal Block Adapter — *Optional*



6.7.1. SAE J1939 (CANbus)

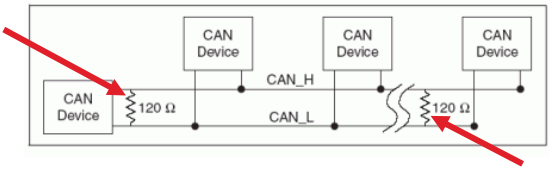
The J1939 interface provides a highly reliable, low-cost method of delivering to the genset controller all information that NFPA 110 requires a charging system to deliver. To be operational, the genset controller must support the system J1939 connection. J1939 communications are disabled by default and until the BCH address is configured (see below). See section 11 for further information on J1939 operation and registers.

6.7.1.1. J1939 Address (BCH)

Configure the J1939 address using the SENS Setup Utility or front panel keypad (J9139 communications are disabled until this address is configured). J1939 supports two units per network cable. Set to address 1 for main unit or address 2 for auxiliary unit. The system is set to address 1 by default.

6.7.1.2. 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. The system is not equipped with terminators. Termination may be provided as part of the network cabling or 120-ohm termination plugs for the RJ45 communications connector on the system are available to order separately (SENS p/n 803707). Use a splitter as needed in the RJ45 port on the system to connect both the network cable and terminator. Below figure shows an example of how to terminate the network.

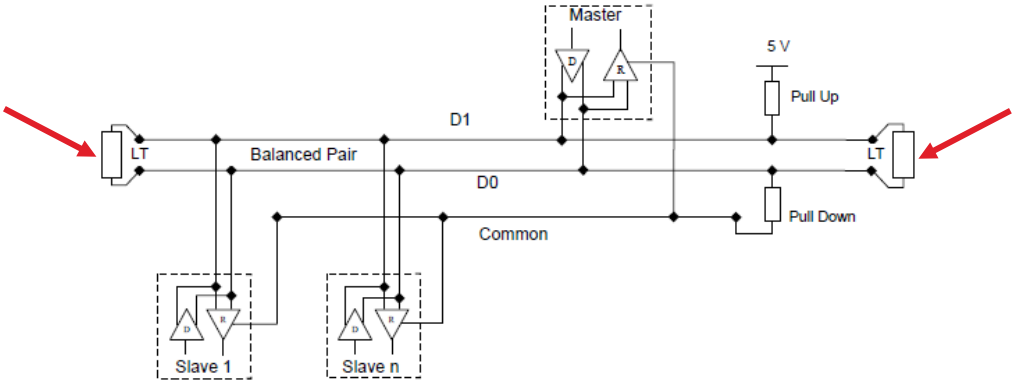


6.7.2. Modbus RS-485

See section 12 for further information on Modbus RS-485 using RTU mode operation and registers.

6.7.2.1. Termination

For proper 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. Termination may be provided as part of the network cabling or 120-ohm termination plugs for the RJ45 communications connector on the systems are available to order separately (SENS p/n 803707). SENS units are server devices. Pull-up and pull-down resistors are optional per Modbus specifications. Below figure shows an example of how to terminate the network.



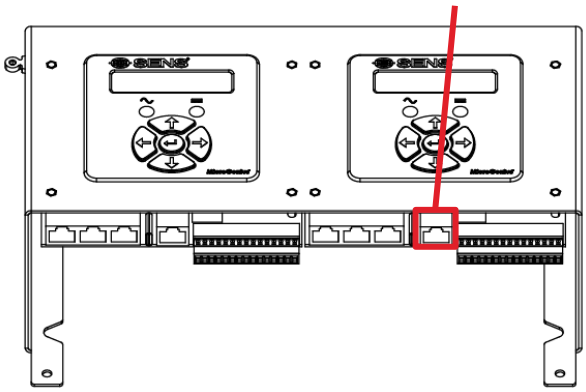
LT = Line Termination 120-ohm resistor

6.8. Ethernet Modbus TCP/IP

The system is equipped with RJ45 ports for Ethernet Modbus TCP/IP communications. Separate connections exist for each output bank. Connect Cat5 or better ethernet cable to provide a 10/100 ethernet connection.

Connect TCP/IP Modbus network cable to RJ45 connector

Note: one connection provided per bank



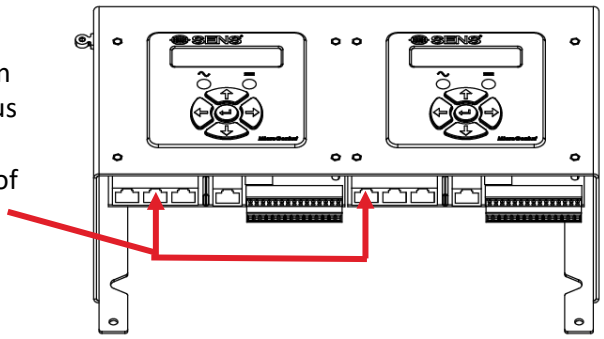
6.8.1.1. Configure TCP/IP Address

Configure TCP/IP settings using the SENS Setup Utility or the keypad (see section 9.6.3). 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. The displayed Hardware Address is the MAC address corresponding to the Ethernet interface. This value is not adjustable. See section 12 for further information on Modbus TCP/IP operation and registers.

6.8.1.2. Modbus TCP/IP to RS-485 Gateway

Each output bank includes one alarm/communications circuit board with independent Modbus communications and IP addresses. If one connection (one IP address) is preferred to poll Mobus data from multiple output banks, enable the Modbus TCP/IP to RS-485 gateway. Using the keypad, navigate to the “Communications” menu and either “TCP Modbus” or “RS485 Modbus” and then enable the “Modbus TCP-RS485 Gateway.” Connect a network cable between the alarm/communications circuit boards on each output bank using the Modbus RS-485 ports (cable installed by default at SENS factory). For proper operation, a 120-ohm terminator is required at the ends of the RS-485 connection (see section 6.7.2.1 for further details). Polling data using Modbus TCP/IP from any of the alarm/communications circuit board ethernet connections will then include data from all output banks.

Connect cable between output banks at Modbus RS-485 connectors. Terminate at the ends of the RS-485 bus.

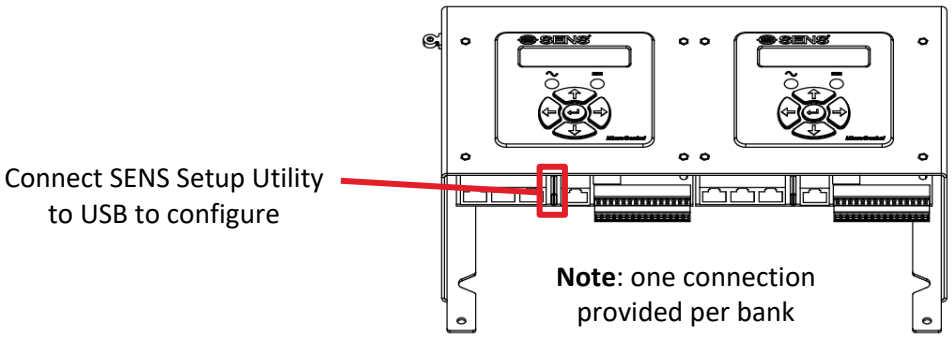


6.9. SENSbus Connection

SENSbus is a unique protocol used to communicate and load share between SENS products; however, this connection is not intended for use on the SuperTorque 8ZR. Each output bank is independently wired, assigned unique output channels and will continue to operate independently even if SENSbus is connected between output banks. SENSbus may be connected between output banks to configure all devices and channels at the same time using the SENS Setup Utility but is not intended to be connected permanently.

6.10. USB Connection

The system is equipped with USB-C connectors for monitoring and configuration via the SENS Setup Utility. Separate connections exist for each output bank. Connect to and configure each output bank separately.



6.11. Verify Connections

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

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

7 START-UP PROCEDURE

7.1. Connect DC Output

Connect DC wires from 8ZR system to engine starter / DC bus (see section 6.4). The system is configured at the factory and requires no adjustments before operating.

7.2. Apply AC Power

Connect AC power to 8ZR system to start charging internal batteries (see section 6.5). Charge for 8 hours minimum prior to placing into service.

Depending on the battery state of charge, the system may go into current limit upon initial AC connection. In this case, the output voltage will be reduced as the internal charger operates in constant current mode. As the battery is charged, the charging current demand will taper to a value below the current limit setpoint and the internal charger will revert to constant voltage output. Operation will continue in boost mode for a variable time ranging from a few minutes to several hours depending on state of charge of the batteries.

WARNING:
DO NOT LEAVE AC DISCONNECTED.
TO AVOID BATTERY DAMAGE, DO NOT DRAIN BATTERY BELOW 11.2VDC (12V NOMINAL SYSTEMS) OR 22.4VDC (24V NOMINAL SYSTEMS).

7.3. Connect Alarms and Communications

Connect alarm and communications wiring (see section 6.7). Refer to system labels for alarm relay assignments. Review and adjust alarm relay assignments and communications settings using the front panel keypad or the SENS Setup Utility. See section 9.6 for additional details on keypad navigation.

8 ALARMS, LEDS AND DISPLAY

8.1. LED Indicators

The system is equipped with two LEDs per output bank, one for AC status and one for DC status. See further alarm definitions in section 8.5. LEDs and the front panel LCD indicate active alarm(s).

AC LED	DC LED	Meaning
OFF	OFF	AC and DC not applied, system failed or alarm/communications circuit board cannot communicate with system
SOLID GREEN	SOLID GREEN	AC good, DC good, in Float Mode
SOLID GREEN	FLASHING GREEN	AC good, in Boost Mode
SOLID GREEN	FLASHING 2X GREEN	AC good, DC in current limit (constant current operation)
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	SOLID YELLOW	AC good, high or low DC voltage (above/below alarm setpoint)
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 YELLOW	SOLID GREEN	AC voltage/frequency out of range or AC phase missing, DC voltage good
SOLID RED	SOLID GREEN	AC fail or over max voltage, 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 YELLOW	AC fail, positive/negative ground fault present
FLASH LONG-2X SHORT YELLOW		SENSbus Inactive
ALTERNATING FLASHING YELLOW		Invalid Settings
ALTERNATING FLASHING RED		Missing or invalid code (boot load required)
ALTERNATING FLASHING GREEN		System starting up

8.2. Individual Alarm Relay Contacts

The system includes five alarm discrete Form C contacts per output bank. The Form C relay contacts change state when alarms are activated. Alarm relay assignments are custom configurable to any of the alarm functions listed in section 8.5. See system labels for original factory alarm relay assignments. The relays can be configured to be latching or non-latching with adjustable delays using the SENS Setup Utility.

By default, the relay contacts change state 30 seconds after the onset of a fault. The relay delay is

configurable using the front panel keypad (see section 9.6) or the SENS Setup Utility. See section 8.5 for alarm definitions.

8.3. LCD Panel

One two-line by twenty-character LCD is included per output bank and provides precision digital ammeter and voltmeter as well as information about input, output, charging status and alarms. The DC 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 +50°C. It may temporarily become unreadable below -20°C but should recover as temperature increases.

8.4. 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 keypad under the "Latched Alarms" menu (see section 9.6.3), using the SENS Setup Utility or by cycling power.

8.5. Alarm Definitions

See section 8.1 for a description of LED indicator activity. Unless noted otherwise, the following alarms are displayed on the LCD panel.

8.5.1. AC Line Failure

Indicates AC input voltage is not detected or is outside of the allowed 90-265VAC range. Activates solid red AC LED. When this alarm is assigned to a relay contact AC LINE FAIL will cause the assigned relay to change to the Failed state after the time delay.

8.5.2. High DC Voltage

Indicates DC output voltage is above the High DC Voltage factory alarm setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. Alarm setpoint is factory configured to 15.6VDC for 12V or 31.2VDC for 24V units. Activates solid yellow DC LED. When this alarm is assigned to a relay contact HIGH DC VOLTAGE will cause the assigned relay to change to the Failed state after the time delay.

8.5.3. Battery on Discharge

Indicates battery is beginning to discharge and DC output voltage is below Battery Discharge Voltage factory alarm setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. Alarm setpoint is factory configured to 13.4VDC for 12V or 26.8VDC for 24V units. The BATTERY DISCHARGING alarm is the first to trigger of three low output voltage alarms and is followed by LOW DC and then END OF DISCHARGE. Alarm setpoint must be set higher than LOW DC and END OF DISCHARGE alarms. Activates solid yellow DC LED. When this alarm is assigned to a relay contact BATTERY DISCHARGING will cause the assigned relay to change to the Failed state after the time delay.

8.5.4. Low DC Voltage

Indicates battery has discharged and DC output voltage is below Low DC Voltage factory alarm setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. Alarm setpoint is factory configured to 13.0VDC for 12V or 26.0VDC for 24V units. Alarm setpoint must be set lower than BATTERY DISCHARGING and higher than END OF DISCHARGE alarms. Activates solid yellow DC LED. When this alarm is assigned to a relay contact LOW DC VOLTAGE will cause the assigned relay to change to the Failed state after the time delay.

8.5.5. Battery End of Discharge

Indicates DC output voltage is below Battery End Discharge factory alarm setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. Alarm setpoint is

factory configured to 10.0VDC for 12V or 20.0VDC for 24V units. Alarm setpoint must be set lower than LOW DC and BATTERY DISCHARGING alarms. Activates solid yellow DC LED. When this alarm is assigned to a relay contact BATTERY END OF DISCHARGE will cause the assigned relay to change to the Failed state after the time delay.

8.5.6. Charger Failure
Indicates the internal charger has failed. Charger is not able to provide the current demanded by the battery and/or load or is providing more current than the control system is commanding. This alarm is typically caused by an internal component failure. This alarm does not occur during AC power failures. Activates solid red DC LED. When this alarm is assigned to a relay contact CHARGER FAIL will cause the assigned relay to change to the Failed state after the time delay.

8.5.7. Over Voltage Shutdown
Indicates the internal charger has executed a high voltage shutdown and DC output voltage is above Over Voltage Shutdown factory alarm setpoint or the configured level if setpoint is adjusted using keypad or SENS Setup Utility. Alarm setpoint is factory configured to 16.0VDC for 12V or 32.0VDC for 24V units. The charger disables itself whenever excessive output voltage occurs while 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 including a parallel connected charger of any type. Activates solid red DC LED. When this alarm is assigned to a relay contact OVERVOLTAGE SHUTDOWN will cause the assigned relay to change to the Failed state after the time delay.

8.5.8. Low Cranking Voltage
Indicates the battery voltage is likely to be inadequate to provide engine-cranking capability. Indicates that DC output voltage during a prior cranking event dropped below the Low Cranking Voltage setpoint. **This alarm is latching and must be manually reset using the front panel keypad or the SENS Setup Utility**. Low Cranking Voltage indication is disabled by default from the factory. When this alarm is assigned to a relay contact LOW CRANK will cause the assigned relay to change to the Failed state after the time delay.

8.5.9. Invalid Settings
Indicates settings are not valid. Output is disabled until the condition is corrected. The invalid setting is indicated on the LCD. Activates alternating flashing yellow AC and DC LEDs. When this alarm is assigned to a relay contact INVALID SETTINGS will cause the assigned relay to change to the Failed state after the time delay.

8.5.10. SENSbus Inactive
Indicates the system is not communicating on SENSbus either when load sharing and/or remote accessories are connected. Activates flashing long then 2x short yellow AC and DC LEDs. When this alarm is assigned to a relay contact SENSBUS INACTIVE will cause the assigned relay to change to the Failed state after the time delay.

8.5.11. Thermal Fold Back
Indicates output power has been reduced to protect from over-heating. The system will not be able to produce full output until the ambient temperature is lowered. When this alarm is assigned to a relay contact THERMAL FOLDBACK will cause the assigned relay to change to the Failed state after the time delay.

8.5.12. Current Limiting
Indicates the system is operating at maximum allowable output, either the maximum current setting or maximum power output (whichever occurs first). Activates flashing green DC LED. When this alarm is assigned to a relay contact CURRENT LIMITING will cause the assigned relay to change to the Failed state after the time delay.

8.5.13. Ground Fault Positive
Indicates a short circuit or high impedance leakage current exists from the positive output to ground. Ground fault indication is disabled by default from the factory. Activates flashing yellow DC LED. When this alarm is assigned to a relay contact GROUND FAULT POSITIVE will cause the assigned relay to change to the Failed state after the time delay. Using the keypad, navigate to the “DC Meters” menu to view detected ground fault voltage and current.

8.5.14. Ground Fault Negative
Indicates a short circuit or high impedance leakage current exists from the negative output to ground. Ground fault indication is disabled by default from the factory. Activates flashing yellow DC LED. When this alarm is assigned to a relay contact GROUND FAULT NEGATIVE will cause the assigned relay to change to the Failed state after the time delay. Using the keypad, navigate to the “DC Meters” menu to view detected ground fault voltage and current.

8.5.15. Low Current
Indicates current from the charger is below the Low Current Alarm setpoint. The low current alarm is disabled by default from the factory. When this alarm is assigned to a relay contact LOW CURRENT will cause the assigned relay to change to the Failed state after the time delay.

8.5.16. Load Share Fail
Indicates that systems connected for load sharing are not sharing the current load. Activates double flashing yellow DC LED. When this alarm is assigned to a relay contact LOAD SHARE FAIL will cause the assigned relay to change to the Failed state after the time delay.

8.5.17. AutoBoost Lockout Active
Indicates the Boost mode time limit has expired and system has returned to Float mode. Boost mode is disabled until the time limit is reset. The Boost time limit is reset if system power is cycled. The Boost time limit is set to 12 hours by default. When this alarm is assigned to a relay contact AUTOBOOST LOCKOUT ACTIVE will cause the assigned relay to change to the Failed state after the time delay.

8.5.18. **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.

8.5.19. Thermal Fault
Indicates charger has faulted because it over heated and thermal fold-back has reached zero watts. Charger output has been disabled. Recycle AC and DC power for re-initiation. The issue is likely environmental. 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.

8.5.20. High Battery Temperature
Indicates battery temperature is above the High Battery Temperature setpoint. 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.

8.5.21. High Battery Temperature Shutdown
Indicates battery temperature is high enough that the charger has shut off as a safety concern. 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.

8.5.22. High Battery Room Temperature
Indicates battery room temperature is above the High Battery Room Temperature setpoint. When this alarm is assigned to a relay contact HIGH BATTERY ROOM TEMPERATURE will cause the assigned relay to change to the Failed state after the time delay.

8.5.23. 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.

8.5.24. Battery Low Temperature
Indicates battery temperature is below the Low Battery Temperature setpoint. 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.

8.5.25. AC Voltage Over Maximum
Indicates AC Voltage has gone above maximum allowed by the system. 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.

8.5.26. 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.

8.5.27. AC Frequency Out of Range
Indicates AC Frequency is outside of the AC High Frequency and AC Low Frequency alarm setpoints. 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.

8.5.28. 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 OPERATION

IMPORTANT! Adjustments of most settings are prohibited and protected by security code to ensure proper operation. Settings that are adjustable include communications (TCP/IP, MODBUS, J1939), alarm assignments, alarm delays, and AC alarm setpoints. Contact SENS Customer Service for more information regarding setting adjustments (800-742-2326 or SENS | Service and Technical Support).

9.1. Charging Algorithms

The system uses charging algorithms appropriate for Nickel-Zinc battery types, which includes Float mode and Dynamic Boost™ mode. See following sections for descriptions of each charging mode.

9.1.1. Recharging Batteries

After a battery has been discharged, the internal charger will enter Dynamic Boost mode. The charger's output voltage setpoint during Dynamic Boost mode increases to the boost voltage value (see section 9.3). 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 12 hours by default). After operating in boost mode the charger switches to Float mode (see section 9.2). Note: After several high current discharges, battery temperature may exceed allowed charging temperature. Recharge will automatically initiate after battery temperature is lowered.

9.2. Float Mode

Float mode is used to maintain batteries in a charged state. When the system is in Float mode the output voltage is maintained at the float voltage setting. Float voltage is factory configured to 14.2VDC for 12V or 28.4VDC for 24V units.

9.3. Dynamic Boost™ Mode

Dynamic Boost is an advanced method of boost charging that automatically computes during each recharge the optimal time for the charger to remain at the boost voltage, before transitioning back to the float charge mode. Dynamic Boost automatically adjusts for 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 system. Boost voltage is factory configured to 15.2VDC for 12V or 30.4VDC for 24V units. 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 12 hours by default.

9.4. 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 keypad or SENS Setup Utility. Using the 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. 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 systems are connected to load share, initiating a battery check on one system will automatically initiate a simultaneous battery check on connected system(s).

IMPORTANT: A load less than 3% of the charger output 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.

9.5. Restore Factory Defaults

Restore factory defaults using the front panel keypad or the SENS Setup Utility. Values that will revert to original factory settings include:

- Battery type
- Cell count
- Float Voltage
- Boost Voltage
- Battery Discharge Voltage
- Low DC Voltage
- Battery End of Discharge Voltage
- High DC Voltage
- Battery Check Voltage
- Over Voltage Shutdown
- Temperature Compensation Slope
- Auto Boost Time Limit
- Periodic Scheduled Boost Interval
- Periodic Scheduled Boost Duration
- Low Current Alarm
- Battery Check Interval
- Battery Check Duration
- Commissioning Time
- Commissioning Charge Voltage
- Commissioning Current

9.6. Keypad Operation

The front panel keypad (one included for each output bank) provides the ability to adjust system settings.

9.6.1. Security Code Protection

Systems are security code protected from the factory to ensure only authorized personnel may adjust settings. Adjustments of most settings are prohibited to ensure proper operation. Settings that are adjustable include communications (TCP/IP, MODBUS, J1939), Battery Check (start/stop, duration, interval), alarm delays, AC alarm setpoints and Low Current alarm setpoint. Contact SENS Customer Service for more information regarding setting adjustments (800-742-2326 or SENS | Service and Technical Support).

9.6.2. 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. 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. Values are saved to nonvolatile memory. Press center Enter key to return to main fields. Press center Enter key twice to return to Home screen.

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

9.6.3. 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. Absolute maximum voltage limits apply to all output and alarm settings. A message is displayed indicating an adjustment is limited due to settings conflict.

IMPORTANT! Adjustments of most settings are prohibited to ensure proper operation (see section 9.6.1).

Main Menus *(Press arrows to scroll through menu options)* **Main Menu** ⇕ ⇔ **Sub Menu** ⇕ ⇔		**Configurable/Viewable** *(Press left/right arrows to scroll through menus, press up/down arrows to configure values)*	**Parameter Descriptions**
Browse Status		Scroll left/right to view basic meters and alarms	
Latched Status		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	Set to NiZn for 8Z modules, not adjustable
		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	Disable for 8Z modules
		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 for 8Z modules
		DC Output #B	Disable for 8Z modules
		DC Output #C	Disable for 8Z modules
		DC Output #D	Disable for 8Z modules
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 8Z modules
		AC Input #B	Disable for 8Z modules
User Access		UI Access Control	Select allowed user interface access. Adjustments of most settings are prohibited and security code protected to ensure proper operation.
		Change Security Code	Systems are security code protected from the factory to ensure only authorized personnel may adjust settings. Adjustments of most settings are prohibited to ensure proper operation. Contact SENS Customer Service for more information regarding setting adjustments (800-742-2326 or www.sens-usa.com).
		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
	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.
	Display	Display Type	Set to "Unit Display" to display single system values or set to "System Display" to display system (for a system with multiple chargers) values on the system 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
	Advanced	Soft Reset All Devices	Press UP arrow to reset all devices in the unit/system
		Repository Config	Set to Stable

		Minimum System Number of Chargers	Not applicable to 8Z modules
		Minimum Unit Number of Chargers	Not applicable to 8Z modules
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 system)
	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 server 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-RS485 Gateway	Enable or disable Modbus TCP/IP to RS-485 gateway
	Modbus TCP	Modbus Configuration	Enable or disable Modbus TCP-IP
		Modbus Configuration Address	Adjust Modbus server 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
		Modbus TCP-RS485 Gateway	Enable or disable Modbus TCP/IP to RS-485 gateway
	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
System 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

9.7. Configuration and Monitoring with SENS Setup Utility

The SENS Setup Utility is used to monitor, configure, and troubleshoot SENS systems. Download the SENS Setup Utility software at SENS | Download Center. Use the setup utility to update firmware on all devices and configure select settings including alarm relay assignments. Communication between a computer and the system using the SENS Setup Utility requires connection via USB-C (see section 6.11). Connect to and configure each output bank separately. See the SENS Setup Utility user manual for further details.

9.8. Temperature Compensation

The system is temperature compensated to match the negative temperature coefficient of the internal battery. With temperature compensation active, the output voltage will increase slightly as temperature decreases, decrease as temperature increases, and is clamped at 0°C (32°F) and +40°C (122°F) to protect against extremely high or low output voltage.

10 SERVICE AND MAINTENANCE

10.1. Recommended Annual Maintenance

Check all field wiring connections for electrical and mechanical integrity. Verify no corrosion or loose hardware is present.

10.2. Service

Do not open the 8Z module, field repair is not recommended. Contact SENS Customer Service for more information (800-742-2326 or www.sens-usa.com).

11 J1939 COMMUNICATIONS

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

J1939 communications are disabled by default and until the BCH address is configured (see section 6.9.2). In most cases, the remaining default J1939 settings are sufficient to automatically begin using J1939 communications after connecting the system to the network. Use the SENS Setup Utility to adjust J1939 settings 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. TCP/IP Modbus

Modbus communications over TCP/IP requires configuration using the SENS Setup Utility or the keypad (see section 9.6.3). 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 server address and enable/disable Modbus write access as desired. The displayed Hardware Address is the MAC address corresponding to the Ethernet interface. This value is not adjustable. See section 6.9.1 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 Server Address	10

12.1.1. Modbus TCP/IP to RS-485 Gateway

Each output bank includes one alarm/communications circuit board with independent Modbus communications and IP addresses. If one connection (one IP address) is preferred to poll Mobus data from multiple output banks, enable the Modbus TCP/IP to RS-485 gateway. Using the keypad, navigate to the “Communications” menu and either “TCP Modbus” or “RS485 Modbus” and then enable the “Modbus TCP-RS485 Gateway.” Connect a network cable between the alarm/communications circuit boards on each output bank using the Modbus RS-485 ports (cable installed by default at SENS factory). For proper operation, a 120-ohm terminator is required at the ends of the RS-485 connection. Polling data using Modbus TCP/IP from any of the alarm/communications circuit board ethernet connections will then include data from all output banks. See section 6.8.1.2 for further details.

12.2. Modbus RS-485

Serial Modbus communications over RS-485 using RTU mode may be configured using the keypad or SENS Setup Utility prior to executing communications. Configure Modbus server address, baud rate, parity and enable/disable Modbus write access as desired. See section 6.8 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
Server Address	10

12.3. Modbus Holding Registers

The 8ZR system includes an extensive array of Modbus registers. These Modbus registers are organized using 32-bit big-endian. The registers are zero-indexed, meaning the first register is index zero as opposed

to index 1. Some Modbus polling utilities may be one-indexed or default to little-endian and as such may need to be adjusted. To verify, poll register 9 as a 32-bit value and verify the first 6-digits match the serial number shown on the product label. If they don't match, adjust the offset (zero or one), change the endianness (sometimes referred to as swapping the registers) or both. Note that registers that do not have a scaling factor of one must be divided by the scaling factor to obtain the decimal/floating point representation.

The following are common registers that are applicable to most applications. Contact SENS for further information if necessary.

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
0	0x000	1	0x001	Unit Serial	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
26	0x01A	27	0x01B	Model Num 29_32	Model number character	bit	1
42	0x02A	43	0x02B	Basic Charging Alarms	Charging Alarm status bits (see section 12.4)	Bitfield	1
44	0x02C	45	0x02D	Charging Status	Charging Status bits (see section 12.5)	Bitfield	1
46	0x02E	47	0x02F	Charging Alarms Extended	Charging Alarm Extended status bits (see section 12.6)	Bitfield	1
48	0x030	49	0x031	Charging AC Alarms	Charging AC Alarm status bits (see section 12.7)	Bitfield	1
50	0x032	51	0x033	Accessory Channel Alarms	Accessory Channel Alarm status bits (see section 12.8)	Bitfield	1
52	0x034	53	0x035	Accessory System Alarms	Accessory System Alarms status bits (see section 12.9)	Bitfield	1
54	0x036	55	0x037	Accessory Assigned Charger Alarms	Accessory Assigned Charger Alarms status bits (see section 12.10)	Bitfield	1
62	0x03E	63	0x03F	Uptime Counter Value	Charger uptime counter value	Sec	1
212	0x0D4	213	0x0D5	Unit Voltage	Voltage currently being supplied by the system to the battery/loads	V	32768
214	0x0D6	215	0x0D7	Unit Current	Current currently being supplied by the system to the battery/loads	A	32768
216	0x0D8	217	0x0D9	Unit Power	Power currently being supplied by the system	W	32768

218	0x0DA	219	0x0DB	Unit Float Voltage	Float Voltage Setting of the system	V/cell	32768
220	0x0DC	221	0x0DD	Unit Boost Voltage	Boost Voltage Setting of the system	V/cell	32768
222	0x0DE	223	0x0DF	Unit Battery Temp	Battery temperature	°C	32768
224	0x0E0	225	0x0E1	Unit Internal temp	Internal temperature of the system	°C	32768
226	0x0E2	227	0x0E3	Unit Boost Timer	Boost timer	Sec	1
228	0x0E4	229	0x0E5	Unit Periodic Boost Countdown	Interval between periodic boost events (0=disabled)	Sec	1
230	0x0E6	231	0x0E7	Unit Line Frequency	AC Line Frequency	Hz	10
232	0x0E8	233	0x0E9	Unit Line Voltage 1	AC Line 1 Voltage	V	32768
234	0x0EA	235	0x0EB	Unit Line Current 1	AC Line 1 Current	A	32768
236	0x0EC	237	0x0ED	Unit Line Voltage 2	AC Line 2 Voltage	V	32768
238	0x0EE	239	0x0EF	Unit Line Current 2	AC Line 2 Current	A	32768
240	0x0F0	241	0x0F1	Unit Line Voltage 3	AC Line 3 Voltage	V	32768
242	0x0F2	243	0x0F3	Unit Line Current 3	AC Line 3 Current	A	32768
244	0x0F4	245	0x0F5	Unit Battery Check Time Elapsed	Timer for Battery Check elapsed time	Sec	1
246	0x0F6	247	0x0F7	Unit Battery Check Due	Time until next Battery Check	Sec	1
248	0x0F8	249	0x0F9	Unit Number of Chargers	Number of modules	Num	1

12.4. Basic Charging Alarms Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	AC Fail	AC input voltage is not detected by the module.
1	0x01	High DC	DC output voltage is above the High DC Voltage alarm setpoint.
2	0x02	Low DC	DC output voltage is below Low DC Voltage alarm setpoint.
3	0x03	Charger Fail	Module has failed. Module is not able to provide the current demanded by the battery and/or load or is providing more current than the system's control system is commanding.
4	0x04	Over Voltage Shutdown	DC output voltage is above Over Voltage Shutdown setpoint and system has executed a high voltage shutdown. This only occurs when the overvoltage is caused by the charger.
5	0x05	Reverse Polarity	Battery is connected backwards. Output is disabled until the condition is corrected.
6	0x06	Unused	Unused
7	0x07	Incompatible Battery	System is connected to an incompatible battery and is unable to bring up the output voltage after a set period of time.
8	0x08	Invalid Settings	Settings are not valid. Output is disabled until the condition is corrected.
9	0x09	Unused	Unused
10	0x0A	Thermal Fold Back	Output power has been reduced to protect from over-heating.
11	0x0B	Temperature Probe Fault	Disabled or failed remote temperature sensor. Temperature compensation is forced OFF when sensor is shorted.
12	0x0C	Current Limiting	Charger is operating at maximum allowable output, either maximum current or maximum power, whichever occurs first.

13	0x0D	Ground Fault Positive	Ground fault current to the positive output terminal is above the Ground Fault Trip sensitivity setpoint.
14	0x0E	Low Current	Output Current is under the Low Current Alarm setpoint.
15	0x0F	Load Share Fault	Modules or chargers connected for load sharing are not sharing the current load.
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	SENS Bus Inactive	Device is not communicating on SENSbus.
19	0x13	Battery On Discharge	Battery is beginning to discharge and DC output voltage is below Batt Discharge Voltage alarm setpoint.
20	0x14	Battery End Discharge	DC output voltage is below Batt End Discharge Voltage alarm setpoint.
21	0x15	Ground Fault Negative	Ground fault current to the negative output terminal is above the Ground Fault Trip sensitivity setpoint.
22	0x16	DC Negative open	Chargers connected in parallel that suffer a loss of high current negative connection may try to route power through the SENSbus cabling. This alarm shows that a charger has detected the issue and has shut itself off. Please check battery terminal connections
23	0x17	DC Below Startup Voltage	Battery voltage is below the Startup Voltage setpoint. System output voltage is disabled. Forced startup feature overrides.
24	0x18	Fan Fail	There is a problem with one or more of the module fans.
27	0x1B	Battery Check	Battery has failed the most recent battery check.

12.5. Charging Status Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Output Idle	Charging status - Output Idle
1	0x01	Follower Mode	Charging status - Follower 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. Charging Alarms Extended 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 system 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	System ambient temperature is below its rated ambient temperature, system 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. Accessory Channel Alarms Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Invalid Settings	Setting for this channel are invalid and must be corrected before settings may be sent to the chargers on this channel.
1	0x01	Low Current Channel	Channel Current is below Low Current alarm setpoint.
2	0x02	Invalid System Config	System configuration settings are invalid.

12.9. Accessory System Alarms Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Invalid System Config	Configuration of system is conflicted. Charger will continue to operate but may not be fully functional until the issue is resolved.
1	0x01	AC1 SPD	The AC supplementary surge protector has expired and needs replacement.
2	0x02	AC1 Breaker	The AC breaker is OPEN or has tripped. Only available with Breaker Status option.
3	0x03	Unused	Unused
4	0x04	Unused	Unused
5	0x05	DC SPD	The DC supplementary surge protector has expired and needs replacement.
6	0x06	DC Breaker	The DC breaker is OPEN or has tripped. Only available with Breaker Status option.
7	0x07	Unused	Unused
8	0x08	Unused	Unused
9	0x09	Unused	Unused
10	0x0A	Unused	Unused
11	0x0B	System Display Board	This device is configured as a system display board. It will present information for the entire system, even if devices are not in its system.
12	0x0C	Unused	Unused
13	0x0D	SENSbus Inactive	No other devices are found on SENSbus.
14	0x0E	Unused	Unused
15	0x0F	Unused	Unused
16	0x10	Unused	Unused
17	0x11	Unused	Unused
18	0x12	No Power Board Data	No module power boards are found on SENSbus.

12.10. Accessory Assigned Channel Alarms Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Invalid Config	The configuration of one or more power modules in the system is invalid.
1	0x01	Individual Module Fault	A power module in the system has faulted.

12.11. Writable Control Flags (Coils) - Single coil writes: 0xFF00 for ON, 0x0000 for OFF

Address		Description	Details
Decimal	Hex		
16	0x010	Start/stop manual boost	ON to start, OFF to stop
17	0x011	Reset periodic boost charge schedule	ON to reset schedule, OFF is no-op
18	0x012	Start/stop battery check	ON to start, OFF to stop
19	0x013	Reset periodic battery	ON to reset schedule, OFF is no-op
20	0x014	Clear battery check failure	ON to reset alarm, OFF is no-op
21	0x015	Not applicable	Not applicable
22	0x016	Force DC Startup	ON to start, OFF to stop
23	0x017	Reset Latched Alarms	ON to reset alarm, 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
104	Charger Module	**Invalid output channel.** Chargers must be set to use a valid output channel setting: use output A for single output systems.	- If necessary, enable the channel using the keypad "DC Output #" selection in the "DC -> Advanced Settings" menu or the setup utility. - To select a different output channel, reassign the charger to match its actual output channel connection using the setup utility.
201	Channel	**No chargers assigned to output channel.** Every enabled output channel must have at least one charger assigned to it. When none is found, it is presumed that a charger has failed, has lost SENSbus data communication, or has an incorrect channel setting.	- Check for a charger that has failed (indicated by its LED status). - Check for disconnected or damaged SENSbus data cables. - If the output channel is not to be used, disable it by using the keypad "DC Output #" setting in the "DC -> Advanced Settings" menu or the setup utility.
202	Channel	**Too few chargers operating.** The combined output rating of all chargers operating on this channel is less than the channel's rated output. This can occur because a charger has failed, has an open AC input or DC output connection, has lost SENSbus data communication, is configured for the wrong output channel, etc.	- Use the "DC Output #" setting in the "DC -> Advanced Settings" menu or the setup utility to verify all chargers' output channel settings. Each charger must be set for the output channel corresponding to its electrical DC output connection. - Use the setup utility to verify the channel DC output current and power ratings. - Check for disconnected or damaged SENSbus data cables. - Check for miswired, disconnected, or damaged input and output connections.
203	Channel	**Charger assigned to a disabled channel.** All chargers must either be set for non-channelized operation (0, Default output) or to a valid output channel that is enabled in this system or system.	- To use this channel, enable it using the keypad "DC Output #" selection in the "DC -> Advanced Settings" menu or the setup utility. Verify that the DC outputs of all chargers assigned to this channel are electrically connected to that output bus.
305	Unit (or System)	**Rogue Module Found.** This can apply to any type of system. It indicates that a charger module was found that has a Unit Serial Number that does not match any display found on the bus. This could happen when adding a module from another system.	Corrective action is to fix Unit Serial Numbers on all chargers/modules and Accessory boards.

13.2. Troubleshooting

AC LED	DC LED	Symptom	Possible Causes	Recommended Actions
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 charger module 3. Failed accessory display board or charger module	1. Using a voltmeter, check that AC input voltage and frequency are in the range 80VAC – 265VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminals. Correct charger AC input as required. 2. If step 1 doesn't resolve issue, press the "Sleep" button and remove AC power for 1 minute, then reapply power. If steps 1 and 2 don't resolve issue, charger module failure is the likely cause. Replace system.
SOLID GREEN	FLASH or SOLID GREEN	Unable to Communicate using J1939	1. Address is not configured or is configured for the wrong position 2. No communication bus termination installed 3. Communication cable is plugged into the wrong system port 4. Wiring is incorrect 5. Unsupported or incorrect J1939 command 6. Incorrect address or address conflict	1. Verify that Battery Charger (BCH) 1 or Battery Charger (BCH) 2 (depending on selected address) is configured using keypad or setup utility. 2. Verify that both ends of the J1939 bus is terminated. (Note that a terminator is not required if the system is not at the end of the communication bus). 3. Verify that communication cable is connected to the port marked J1939. 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 and that J1939 Data Low goes to pin 2. 5. If cable wiring is correct, verify that requested command is supported by SENS system per J1939 table in 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 keypad or setup utility
SOLID GREEN	FLASH or SOLID GREEN	Unable to Communicate using MODBUS	1. No communication bus termination installed 2. Communication cable is plugged into the wrong system port 3. Wiring is incorrect 4. Incorrect MODBUS	1. Verify that a terminator is installed as directed in the manual (note that a terminator is not required if the system is not at the end of the communication bus). 2. If terminator is installed, verify that communication cable is connected to ports as directed in the manual, in the Modbus connections section. Correct cabling as required.

			settings (baud rate, address)	3. For serial applications, if cable is connected correctly, verify that Modbus +D1 (A) goes to connector position 1 and that Modbus –D0 (B) goes to position 2. 4. If cable wiring is correct, verify that system and application MODBUS settings are as required. Adjust settings using keypad or setup utility as required.
SOLID GREEN	SOLID RED	AC good, charger fail or overvoltage shutdown	1. Charger has experienced an unexpected fault 2. Programmed settings are incorrect (OVSD set too low) 3. Charger module failure	1. Press “Sleep” button and remove AC power for 1 minute, then reapply power. 2. If fault remains, check overvoltage shutdown settings and again remove power for 1 minute, then reapply power. 3. If steps 1 and 2 don’t resolve issue, a charger module failure is the likely cause. Replace system.
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	1. Check that system settings and alarms are set appropriately. 2. If settings and alarms are correct, check and correct high output/load voltage due to any other 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 system settings and alarms are set appropriately. 2. Verify battery is being charged. Measure that output voltage is correct at battery terminals and/or output current is present. If settings and alarms are correct and battery voltage is not improving, likely cause is failed internal battery. Replace system.
SOLID GREEN	FLASHING GREEN/ YELLOW	AC good, output power limited	1. Charger power is reduced to protect system due to high temperatures	1. Reduce operating environment temperature. Unit 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 systems	1. Check that individual system settings are identical. Adjust as required. After making any adjustments, unplug and re-plug load share cable from system.
SOLID GREEN	DOUBLE FLASH RED	AC good, output disabled	1. Too many devices on the SENSbus network	1. Ensure that less than max allowed number of devices is on the SENSbus. 2. If step 1 doesn’t resolve issue, a failed display board is likely. Replace system.
SOLID RED	SOLID GREEN	AC fail, battery voltage good	1. Proper AC voltages or frequency not applied 2. Charger failure	1. Using a voltmeter, check that AC input voltage and frequency are in the range 80VAC – 265VAC / 47Hz – 63Hz. Correct charger AC input voltage as required 2. If step 1 doesn’t resolve issue, a system failure is the likely cause. Replace system.

SOLID RED	SOLID YELLOW	AC fail, high battery voltage	1. Proper AC voltages or frequency not applied 2. Charger 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 are in the range 80VAC – 265VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminals. Correct charger AC input voltage as required. 2. If step 1 doesn't resolve RED AC light, press the "Sleep" button and remove AC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, system failure is the likely cause. Replace system. DC LED 1. Check that system settings and alarms are set appropriately. 2. If settings and alarms are correct, check and correct high output/load voltage due to any other connected equipment.
SOLID RED	SOLID YELLOW	AC fail, low battery voltage	1. Proper AC voltages or frequency not applied 2. Charger 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 are in the range 80VAC – 265VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminals. Correct charger AC input voltage as required. 2. If step 1 doesn't resolve RED AC light, press the "Sleep" button and remove AC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, system failure is the likely cause. Replace system. DC LED 1. Check that system settings and alarms are set appropriately. 2. Verify AC is present and battery is being charged. Measure that output voltage is correct at battery terminals and/or output current is present. If settings and alarms are correct and battery voltage is not improving, likely cause is failed internal battery. Replace system.

SOLID RED	SOLID RED	AC fail, charger fail or overvoltage shutdown	1. Unit is in fault state 2. Programmed settings are incorrect (OVSD set too low) 3. Charger module failure	AC LED 1. Using a voltmeter, check that AC input voltage and frequency are in the range 80VAC – 265VAC / 47Hz – 63Hz or that >8VDC is present at DC output terminals. Correct charger AC input voltage as required. 2. If step 1 doesn't resolve RED AC light, press the "Sleep" button and remove AC power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve RED AC light, system failure is the likely cause. Replace system. DC LED 1. Press "Sleep" button and remove AC power for 1 minute, then reapply power. 2. If fault remains, check overvoltage shutdown settings and again remove power for 1 minute, then reapply power. 3. If steps 1 and 2 don't resolve issue, a charger module failure is the likely cause. Replace system.
ALTERNATING FLASHING YELLOW		No output	1. Illegal configuration	1. Ensure that system has been programmed to desired and allowable settings.
SYNCHRONIZED FLASHING YELLOW		No output	1. Missing /damaged internal device	Unit failure is the likely cause. Replace system.
ALTERNATING FLASHING RED		No output	1. Missing or invalid code (boot load required)	1. Update system firmware using setup utility. 2. If step 1 doesn't resolve issue or setup utility is not available, replace system.
ALTERNATING FLASHING GREEN		Starting-up	1. Unit is still powering-on 2. Failed accessory display board	1. Press the "Sleep" button and remove AC power for 1 minute, then reapply power. Allow system at least 1 minute to fully boot. 2. If step 1 doesn't resolve issue, a display board failure is the likely cause. Replace system.

14 RECYCLING

Contact Stored Energy Systems to recycle SuperTorque 8Z modules. Stored Energy Systems will supply new SuperTorque 8Z units and the old units can be shipped to the appropriate recycling center using a provided prepaid shipping label and packaging. Nickel-zinc batteries are recognized and listed in the Call2Recycle program and may be recycled at more than 50,000 collection sites in North America.

15 GLOSSARY

Original Factory Configuration	Configuration set at the factory and requires no adjustments before operating. Charger operates using settings configured at the factory per customer order. See configuration details on product label.
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 system relay assignment configuration. Configuration code is included on the product label.
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.

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:	SuperTorque 8Z Engine Starting System SuperTorque 8ZR Complete Genset Starting System
Model Numbers:	8Z-XX-X-XX-X-X-X-XX, where X = any digit 8R-YY-YY-YYY-YYY-Y, where 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 IEC 61000-6-2:2019 EN IEC 61000-6-4:2019 – Class B Directive 2014/35/EU (LVD) EN IEC 60335-1:2023+A11:2023 EN IEC 60335-2-29:2021+A1:2021 Directive (EU) 2015/863 (RoHS) EN IEC 63000:2018
Place and date of first issue:	Longmont, CO USA on January 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 Directive(s) and Standard(s).

Jason Hevelone
Compliance
Stored Energy Systems, LLC

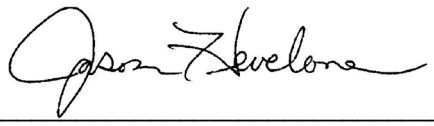
April 30, 2025
Date

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:	SuperTorque 8Z Engine Starting System SuperTorque 8ZR Complete Genset Starting System
Model Numbers:	8Z-XX-X-XX-X-X-X-XX, where X = any digit 8R-YY-YY-YYY-YYY-Y, where 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 IEC 61000-6-2:2019 EN IEC 61000-6-4:2019 – Class B UK Safety EN IEC 60335-1:2023+A11:2023 EN IEC 60335-2-29:2021+A1:2021 UK RoHS EN IEC 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).



Jason Hevelone
Compliance
Stored Energy Systems, LLC

April 30, 2025
Date

SENS
STORED ENERGY SYSTEMS

SENS Limited Warranty: Engine Starting Systems

What is covered?
This warranty covers any defect in material and workmanship on 8Z and 8ZR Engine Starting Systems provided by Stored Energy Systems, a Colorado Limited Liability Company (SENS).

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

For how long:
End Use Within the United States or Canada: 10 years from date of shipment.
Outside of the United States or Canada: Consult Factory for warranty details.

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

If we choose to replace a system component, 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 the system 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 system must be returned, freight prepaid, to the service facility specified by SENS 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 or in advance of returning the system component to the service facility.

Limitation:
This warranty is limited to defects in material or workmanship of the system and its components. 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. No warranty is made or implied for the merchantability or fitness of the system or its components for any particular purpose.

Operating Conditions:
All operating, storage, and maintenance instructions contained in the product's user manual must be followed, including, but not limited to:

Battery Temperature:	Within -10°C to 55°C during all operation. Not outside of 0°C to 50°C for more than 10% of operating life.
Discharge Voltage:	System shall not be discharged below open-cell voltage of 10.5VDC (12V nominal systems) or 21.0VDC (24V nominal systems).
Alternator or External Charge Voltage:	Max 15.0VDC (12V nominal systems) or 30.0VDC (24V nominal systems).
Top-Off Charge:	The system must be connected to 110-240VAC at least every 6 months.
Settings:	Charging voltage and algorithm shall not be changed from factory settings.