MicroCab 1500

MicroCab 1500 Outdoor Non-Stop DC Power System

Installation & Operation Manual

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1   IMPORTANT SAFETY INSTRUCTIONS FOR THE INSTALLER AND OPERATOR

1.1.   **SAVE THESE INSTRUCTIONS –** This manual contains important safety and operating instructions for the MicroCab 1500.

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

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

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

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

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

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

2   MODEL NUMBER BREAKOUT

MC	2	-	24	-	45	-	3	-	S	30	-	1234	-	1	4	1	4	-	1	0
A	B	-	C	-	D	-	E	-	F	G	-	H	-	I	J	K	L	-	M	N

	Parameter	Code	Value
A	Product Family	MC	MicroCab 1500
B	Cabinet Type	1	Base Cabinet
		2	Expanded Cabinet
C	Voltage	12	12 VDC
		24	24 VDC
		48	48 VDC
D	Output Current	12	12A, 48V only
		15	15A, 12/24V only
		25	25A
		30	30A, 12/24V only
		45	45A, 12/24V only
E	Number of Chargers	1	1X MG2
		2	2X MG2 (N+1 redundancy optional)
		3	3X MG2 (12/24V only, N+1 or N+2 redundancy optional)
F	Battery Type	S	Standard sealed lead acid
		H	High temperature sealed lead acid
G	Battery Capacity	##	System ampacity (Ah / 10)
H	Breaker Slot A	1=10A, 2=20A, 3=30A, 4=40A	
	Breaker Slot B	0=Blank, 1=10A, 2=20A, 3=30A, 4=40A	
	Breaker Slot C	0=Blank, 1=10A, 2=20A, 3=30A, 4=40A	
	Breaker Slot D	0=Blank, 1=10A, 2=20A, 3=30A, 4=40A	
	NOTE: Minimum 1 breaker required. All blank slots are covered with blank panel.		
I	Low Voltage Load Disconnect	0	No LVLD
		1	With LVLD - only available on 12/24V units
J	Battery Thermal Management	0	None
		1	Heaters
		2	Heaters, fans
		3	Heaters, insulation
		4	Heaters, fans, insulation
		5	Fans
		6	Fans, insulation
		7	Insulation
K	Surge Protection	0	Standard AC/DC protection
		1	Supplemental AC/DC protection
L	Mounting	1	Wallmount
		2	Wallmount with toplift
		3	Floormount
		4	Floormount with toplift
M	Communications *Note that Modbus R485 is standard*	0	Standard
		1	Modbus TCP/IP communications
N	Configuration	0	Standard configuration
		X	Factory specified custom configuration

3   PERFORMANCE SPECIFICATIONS

MicroCab 1500 is the newest generation of high reliability outdoor power systems that SENS has been producing for over a quarter-century.

Optimized to power critical industrial and communications loads, SENS' MicroCab 1500 offers multiple technologies that enhance reliability and system uptime, including:
- Patented SENS-designed switchmode power converters specially designed to survive outdoor environments including severe electrical transients and extreme temperatures
- Completely sealed electronics compartment that protects power converters, breakers and other components from environmental attack,
- Generous convection cooling and thermal protection to insure reliable operation in the hottest climates
- Optional high temperature batteries designed for long life in hot climates
- Optional battery heaters and battery system insulation to improve battery performance in cold climates, and improve battery life in hot climates

MicroCab 1500 also includes a comprehensive alarm system with information available via either Form C contacts or native Modbus. In addition to alarms, all operating parameters of MicroCab such as output voltage and current are accessible via network connection.

Performance Specifications

| Type	Specification	Value
AC Input	Voltage, Frequency	90-265 single-phase VAC, 47-63 Hz
	Current	14A maximum for models with 3x 12/24V rectifiers and heaters, 18A maximum for 2x 48V rectifiers and heaters
	Protection	2-pole circuit breaker rated 20A and 5KAIC, soft start, transient protection
	Efficiency	Up to 95%
	Power factor	>.95 typical at maximum rated load current and boost charge voltage
DC Output	Voltage	12V nominal: adjustable from 8-17V 24V nominal: adjustable from 8-34V 48V nominal: adjustable from 10-68V
	Line/load regulation	±0.5%
	Output ripple	<30mVrms with or without battery
	Current	450W: 15A at 12/24V nominal, 450W maximum (12A max below 170VAC input voltage in 24V configuration) 750W: 12A at 48V nominal, 25A at 12/24V nominal, 750W maximum 900W: 30A at 12/24V nominal, 900W maximum (24A max below 170VAC input voltage in 24V configuration) 1350W: 45A at 12/24V nominal, 1350W maximum (36A max below 170VAC input voltage in 24V configuration) 1500W: 25A at 48V nominal, 1500W maximum
	Charging characteristic	Constant voltage, current limited
	DC power supply	Delivers fast-responding, stable, well-filtered DC with or without battery
	Soft start	5 seconds from startup to full-required output
	Current limit	100% current capability subject to temperature limits and AC voltage input; field adjustable

Type	Specification	Value
	Battery temperature compensation	Battery sensor controls changes in output voltage when battery temperature is between 0°C and +40°C at a rate of – 0.18% per degree C
	Output protection	1-pole circuit breakers rated 60A and 10KAIC each for charger and battery disconnect, optional 1-pole load distribution breakers rated 10-40A and 10KAIC, transient protected
	Overvoltage protection	Self-resetting and selective
	Dead battery charge	Starts into and recharges zero-volt battery without user intervention
	Load Dump protection	Output voltage over-shoot is limited to 15% to prevent damage to connected devices if battery is disconnected while charger is operating
	Output Blocking protection	High surge current prevented from flowing to charge output capacitors when charger is connected to battery; serves as an "OR" diode to isolate non-functioning chargers from others in the system
Batteries	Type	VRLA, standard or high temperature
	Number	Up to 2 blocks with base cabinet, up to 4 blocks with expanded cabinet
	System ampacity	Up to 150Ah at 48V, up to 300Ah at 24V, up to 600Ah at 12V
Adjustment & Controls	Factory adjustment	Factory set to customer specifications; field configurable
	Adjustment	Change or customize settings from computer using SENS Setup Utility and on-board USB connection. Connect legacy units that do not include on-board USB using the computer to charger cable provided in SENS Setup Utility kit, SENS p/n 209254. SENS Setup Utility software available at SENS	Download Center.
	Keypad adjustment	Enable or change all settings from front panel
Status display	LEDs	Dual multi-color front panel status LEDs
	Digital metering	DC voltmeter accurate to +1%; DC ammeter to +1%. AC input voltage is for reference only. If AC waveform is not sinusoidal or is distorted the AC voltage will not be reported accurately.
	Status messages	20-character display of status and alarm messages
Alarms	Alarms	Factory set and field reconfigurable. Factory set to: **Major Alarms**: AC Fail, High DC Voltage, Overvoltage Shutdown, Charger Failure, Reverse Polarity, Invalid Settings, Incompatible Battery, Low current, Individual Module Fault, Low Voltage Load Disconnect Active (optional) **Minor Alarms**: Low DC Voltage, Thermal Foldback, SENSbus not Active, Battery on Discharge, DC/AC Surge Replacement (optional) **Summary Alarm**: All major and minor alarms
	Output via network	All alarms available via Modbus. Alarm indication delayed by configured alarm delay value.
	Form C contacts	Three Form C contacts, each rated 30VDC/VAC, 2A resistive, assignable. Alarm indication delayed by configured alarm delay value.
	Alarm Delay	30 seconds by default, programmable between 5 to 60 seconds using keypad or SENS Setup Utility. Alarm indication delayed for communications ports and relay contacts, LED indication not delayed.

| Type	Specification	Value
Networking	Modbus communications	Modbus RS-485 via field wiring terminal block Optional Modbus over TCP/IP
	SENSbus	Proprietary bus for field programming and SENS accessories
	USB	USB-C connectivity via SENS Setup Utility
Environ-mental	Operating temperature	-40C to +70C; meets full specification from -40C to +40C. Heaters and/or insulation are recommended for the batteries in ambient temperatures below 0°C.
	Cooling	Natural convection cooled
	Cold Start	5 second warm-up time required for operation below -20C
	Humidity	5% to 95%, non-condensing
	Water ingress	Charging and electronics panel is IP 66, NEMA 4X. Battery compartment(s) is IP 33, NEMA 3RX. Battery compartment(s) utilize louvers for battery gas ventilation.
	Electrical transient	ANSI/IEEE C62.41 and EN 61000-4-12 on power terminals
Options	Distribution Breakers	1-4 breakers, 10-40A each
	Low Voltage Load Disconnect	Disconnects the batteries from the load at a set voltage. Field reconfigurable.
	Expanded Battery Cabinet	Provides a second battery compartment doubling the battery capacity of the system
	Battery Heater	Keeps batteries above 0°C in ambient temperatures down to -30°C
	Battery Insulation	Thermally insulates batteries in hot and cold environments and allows heaters to keep batteries above 0°C in ambient temperatures down to -40°C
	Battery Fans	Provide forced ventilation to battery compartment(s)
	High Temp Batteries	Provides battery life of 6 years with battery temperatures at 35°C
	Supplemental Surge Protection	Provides supplemental AC and DC surge protection. Surge protective devices are field replaceable.
Abuse protection	Reverse polarity	System self-protects without fuse clearing; indication via LED and LCD; system recovers automatically after removal of the fault condition
	Wrong voltage battery	Charger-battery voltage mismatch shuts down charger(s); indication via LED and LCD
	Overvoltage shutdown	Selective; shutdown only operates if charger causes the overvoltage condition
	Over temperature protection	Gradual output power reduction if heatsink temperature becomes excessive
Regulatory compliance	North America	UL Listed for the United States and Canada: CSA 22.2, No. 107.2; UL 1012 category QQIJ
		Seismic: rigid and non-structure wall mount; max S_{DS} of 2.5G; IBC 2000-2022; California BC 2007-2022
Construction	Housing/configuration	Welded 5052 aluminum, hi-reflective outdoor powder-coated finish
		All hardware is stainless steel
	Dimensions	See drawings
	Weight	Maximum weight of system (excluding batteries) is 105lbs (47.6kg)

4   SYSTEM OVERVIEW

Fully optioned unit with expanded battery compartment shown.

System Overview
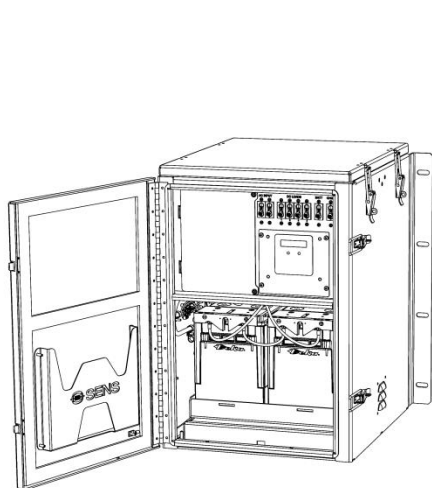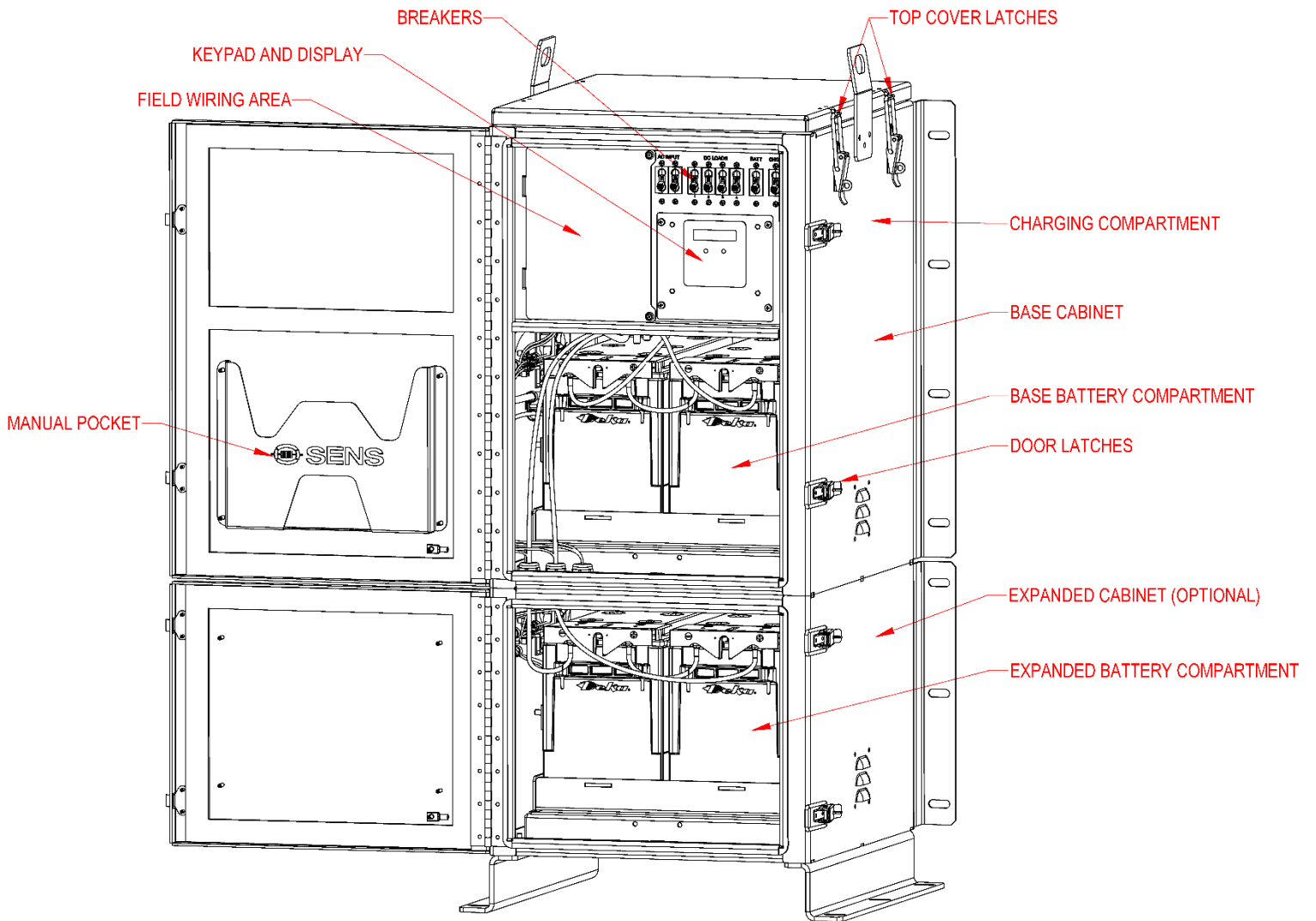
Base Cabinet
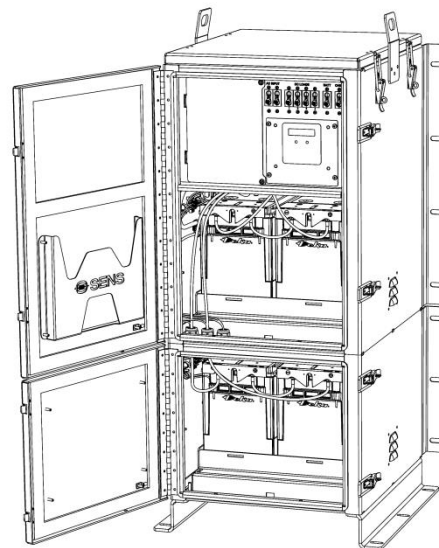
Expanded Cabinet

5   MOUNTING INSTRUCTIONS

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

WARNING: ONLY QUALIFIED PERSONNEL SHOULD INSTALL, OPERATE, AND SERVICE THIS EQUIPMENT.
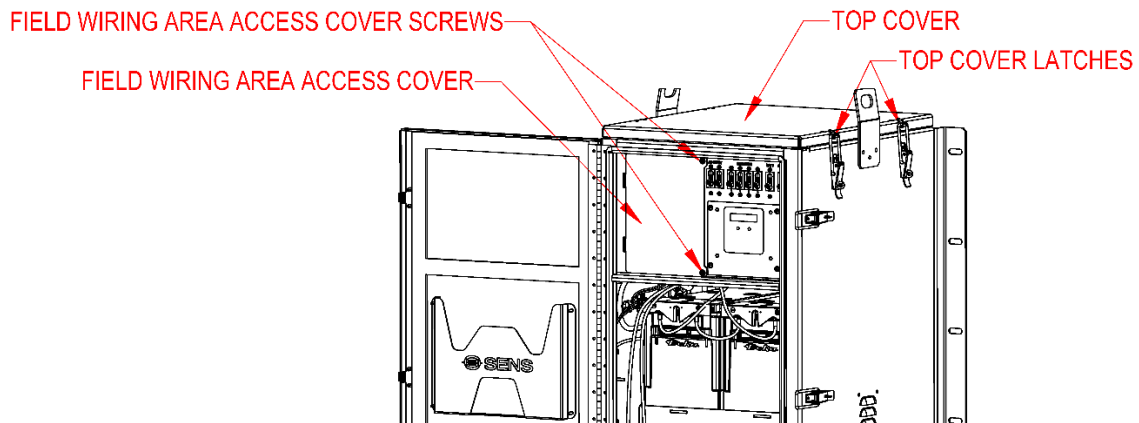
5.1. Installation Location and Handling

The MicroCab 1500 system is shipped in a wooden crate. Although the final installed system is intended for outdoor applications, the crated system must be shipped and stored in an area protected from water exposure. Do not remove the system or batteries from the packaging crate until the system is transported to the installation location.

Locate the system in an environment within the specified operating temperature range given in the Performance Specifications table. The system is designed to be wall, floor, or pole mounted. Each system is shipped with wall-mount brackets. The wall-mount brackets are also used for pole mounted systems. These brackets can be inverted if needed to move the mounting slots inside the width of the enclosure for pole mounting. For pole mounted systems, use customer-supplied structural materials to secure the enclosure around pole. Floor-mount brackets are optional. If mounting with floor-mount brackets, wall-mount bracket may be removed from the cabinet. Mounting slots are provided to accommodate 3/8 inch anchoring bolts/studs. Ensure that all mounting slots are used when mounting the system. A convection ventilation clearance of 4 inches is recommended on the sides and 12 inches on the top of the system. Refer to DIA\00641 (at back of manual) for mounting details.

6   WIRING

All wiring and wiring terminals are to be installed in accordance with the applicable electrical codes. The field wiring area is accessed by opening the system door and removing the field wiring area cover. Remove the two screws as shown in the figure below. For additional access, the top cover can also be removed by unfastening the four cover latches as shown in the figure below. For outdoor applications, ensure that all enclosure conduit fittings are liquid tight. Use conduit entry holes as shown in the Conduit Entry figure. Do not remove factory installed conductors.

Access Covers

FIELD WIRING AREA ACCESS COVER SCREWS — TOP COVER — TOP COVER LATCHES — FIELD WIRING AREA ACCESS COVER

Conduit Entry

AC INPUT
DC OUTPUT(S)
COMMUNICATIONS
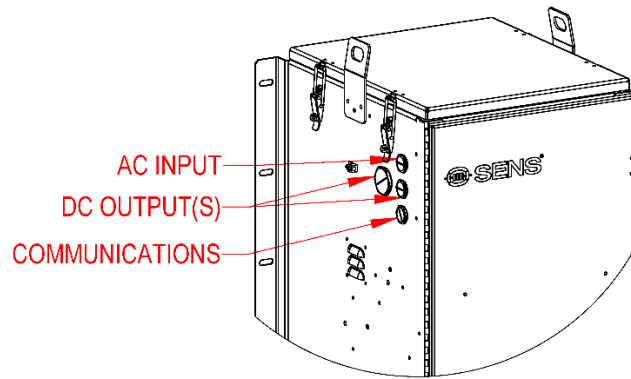
Note: 3x 1 inch and 1x 1.5 inch conduit entry openings provided.

Field Wiring

MODBUS TERMINAL BLOCK
HEATER VOLTAGE SELECTOR SWITCH
SENS BUS RJ45 PORT
ALARM TERMINAL BLOCK
AC INPUT TERMINAL BLOCK
DC OUTPUT TERMINAL BLOCK

SENS BUS   MODBUS RS-485

AC INPUT   DC LOADS   BATT   CHGR

L
L/N
INPUT VOLTAGE

LOAD 1
SPARE
SPARE
SPARE
SPARE
SPARE

LOAD 2
FAIL
OK
COM

LOAD 3
FAIL
OK
COM

USB PORT (PANEL SIDE)
MODBUS TCP/IP RJ45 PORT (PANEL SIDE)
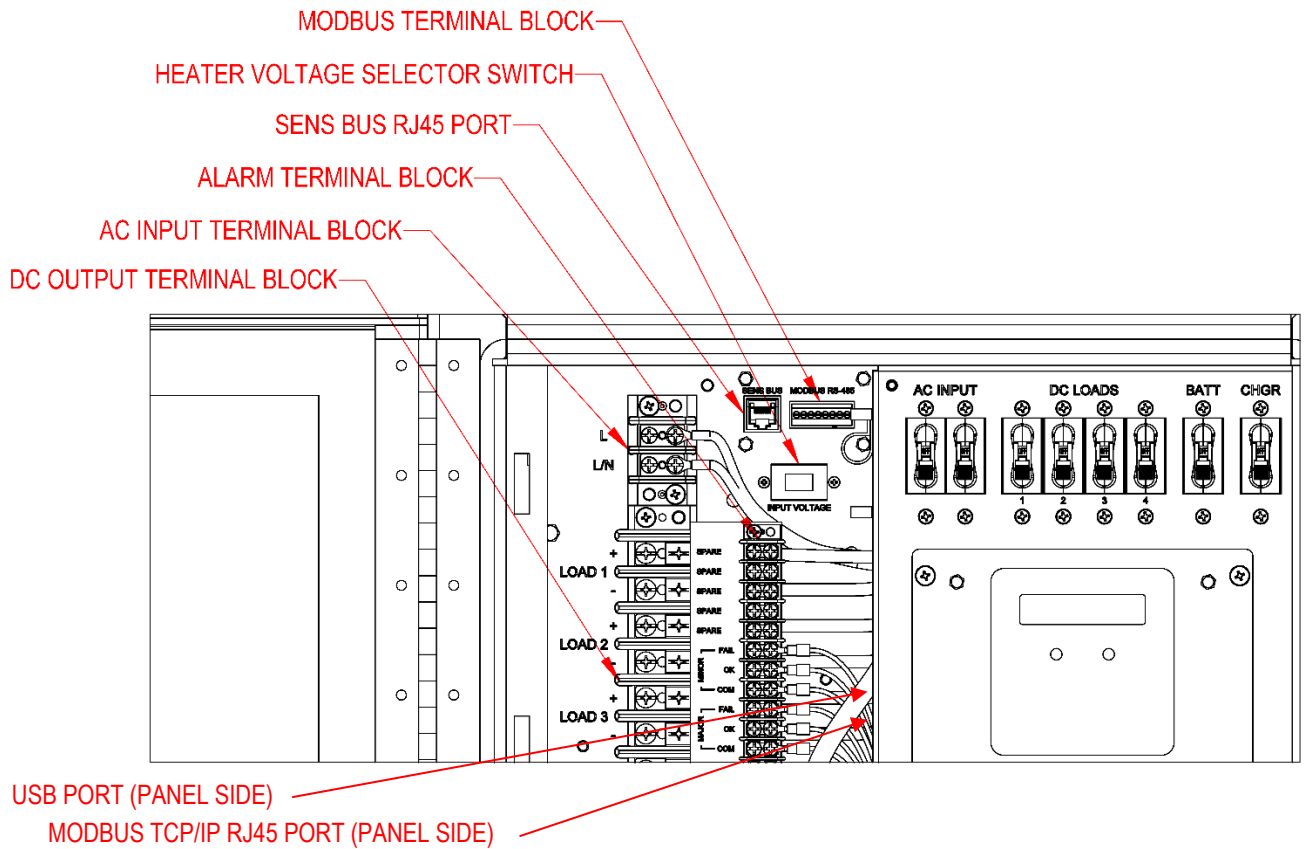
CAUTION - SWITCH ALL BREAKERS (AC, CHARGER, DISTRIBUTION, AND BATTERY STRING) TO OFF BEFORE INSTALLING FIELD WIRING

6.1. Input Wiring

Connect AC input wiring to input terminal block. Route L and L/N wires through (2) factory-installed cable clamps. Terminal block accepts 14-10AWG ring lug terminals. Torque terminals to 16lb-in.

CAUTION - Heater Voltage Selection

If the system includes heaters, the input voltage switch must be set to match the AC input voltage. For 100-186VAC, use the 120 setting. For 187-240VAC, use the 240VAC setting. See the Field Wiring figure for switch location.

6.2. Earth Ground Wiring

Connect AC input ground and the field ground conductor to the earth ground lug. The lug accepts Class B and C wire size 14-2/0AWG and Class G-K wire size 14-1/0AWG. Tighten connections as described in table below.

Ground Lug Tightening Torque

Wire Size (Class B&C)	Wire Size (Class G-K)	Tightening Torque
	1-1/0	75lb-in (8.5 Nm)
	4-1	55lb-in (6.2 Nm)
3-2/0	8-4	50lb-in (5.6 Nm)
6-4	10-8	45lb-in (5.1 Nm)
8	14-10	40lb-in (4.5 Nm)
14-10	N/A	35lb-in (4.0 Nm)

6.3. Output Wiring

Connect DC output wiring to output terminal block. Each output terminal is numbered the same as its output breaker. Terminal block accepts 14-6AWG ring lug terminals. Torque terminals to 20lb-in.

Electric Load Limitation: The maximum simultaneous sum of all load outputs must not exceed 50A.

6.4. Communications Wiring

6.4.1. Alarm Wiring

6.4.1.1. Connect alarm wiring to alarm terminal block. The terminal block accepts 22-14AWG solid conductors, or 22-14AWG stranded conductors terminated in Listed ring lug terminals for #6 hardware. Torque terminals to 9lb-in.

6.4.2. Modbus RS-485 Wiring

6.4.2.1. Connect Modbus wiring to Modbus terminal block. Modbus communications settings must be configured using the keypad or SENS Setup Utility prior to initiating. See section 10 for further information on Modbus operation and configuration.

6.4.2.2. The Modbus terminal block is a pluggable connector. The terminal block accepts 24-16AWG wire. Torque wires to 2.0lb-in. Route Modbus wiring through factory-installed cable clamp. See the figure below and the Modbus pinout table for connections:
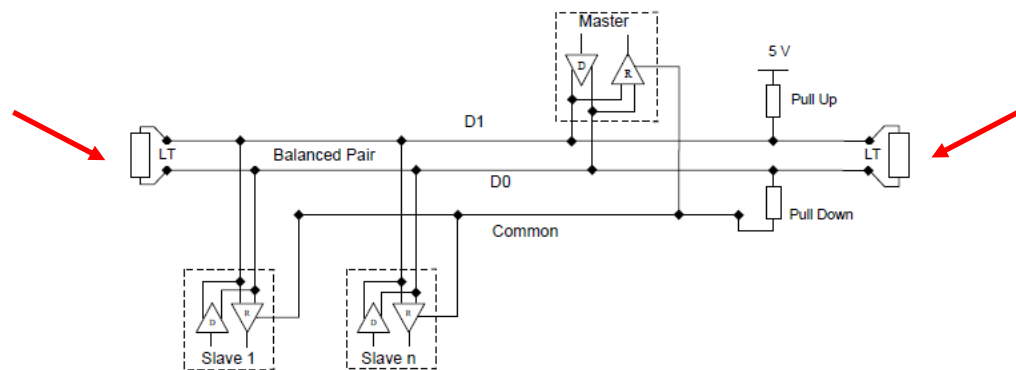
Modbus connector

PIN 1
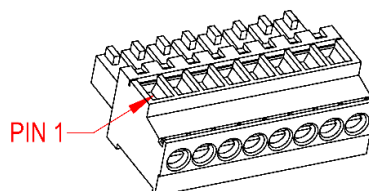
Modbus pinout

Pin	Function
1	RS485-IN D0
2	RS485-IN D1
3	Common
4	Shield
5	RS485-OUT D0
6	RS485-OUT D1
7	Common
8	Shield

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

Modbus Termination

LT = Line Termination 120-ohm resistor

6.4.3. Modbus TCP/IP Wiring—*Optional*

Connect Modbus TCP/IP communications using Cat5 or better ethernet cable at the RJ45 connector on the side panel (see Field Wiring diagram). See section 6.4.3.2 for connection on legacy units.

6.4.3.1. Configure TCP/IP Address

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

6.4.3.2. Modbus TCP/IP and USB Wiring—*Legacy*

Legacy units include optional connections for TCP/IP Modbus (RJ45) and SENSbus USB (microUSB). Connect to the RJ45 port for Modbus communications. Connect to the USB port using the SENS Setup Utility (PC utility only, no SENSbus Adapter necessary) to configure the system. These connections are shown in the figure below.

Note - connect the SENS Setup Utility using the optional USB port when it is included rather than directly to the SENSbus RJ45 connector (see section 6.4.4.1 below for further info).

Optional TCP/IP Modbus and SENSbus USB
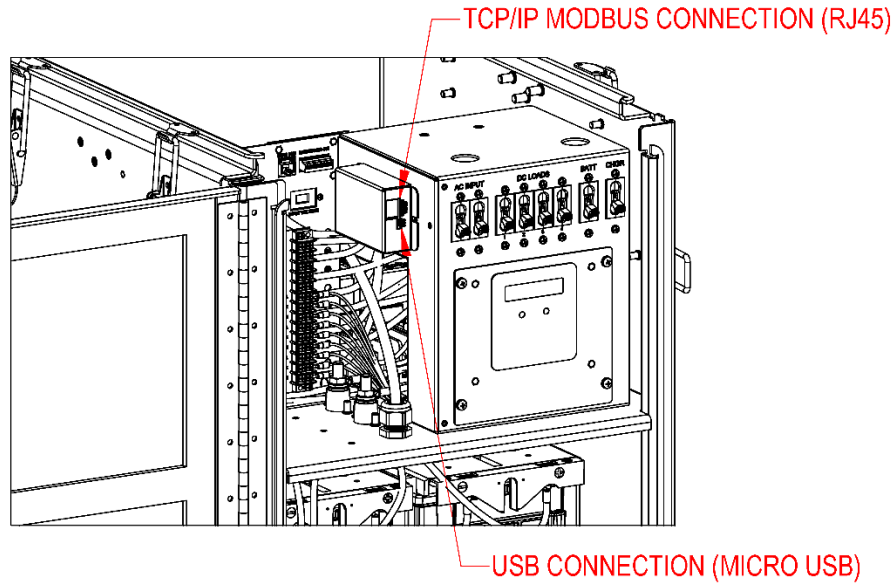
6.4.4. **USB Connection for SENS Setup Utility**

The unit is equipped with a USB-C connector (see Field Wiring diagram) for monitoring and configuration via the SENS Setup Utility (see section 9.7).

6.4.4.1. SENS Setup Utility Connection—*Legacy*

Connect the SENS Setup Utility to legacy units using the SENSbus Adapter (shipped with SENS Setup Utility kit p/n 209254) or the optional microUSB connector (see section 6.4.3.2). Connect the SENSbus Adapter to the SENSbus port in the field wiring area with the provided network cable. See the figure below for connections.

Note - connect the SENS Setup Utility using the optional USB port when it is included rather than the SENSbus port (see section 6.4.3.2).

SENSbus Connection

6.5. Battery Installation

WARNING:

BATTERY POWER SYSTEMS PROVIDE ELECTRICAL VOLTAGE AND AMPERAGE LEVELS THAT ARE CONSIDERED ELECTRICAL HAZARDS. ONLY QUALIFIED PERSONNEL SHOULD INSTALL, OPERATE, AND SERVICE THIS EQUIPMENT. USE APPROPRIATE INSTALLATION METHODS INCLUDING USING ONLY INSULATED TOOLS. REMOVE ALL JEWELRY AND WATCHES BEFORE INSTALLATION.

ENSURE THAT ALL BATTERY CABLE TERMINALS ARE INSULATED FROM THE SYSTEM ASSEMBLY PRIOR TO POWERING CHARGER OR CONNECTING BATTERIES.

SWITCH ALL BREAKERS (INPUT, CHARGER, BATTERY, OUTPUTS) TO OFF BEFORE INSTALLING BATTERIES. TREAT THE BATTERY SYSTEM WITH GREAT CAUTION, AS IT IS CAPABLE OF DELIVERING LARGE SHORT CIRCUIT CURRENT AND DOES <u>NOT</u> HAVE AN "OFF" SWITCH.

Batteries are shipped on the pallet base of the crate and must be installed in the system cabinet in the field. Before unpacking the battery blocks, note the system voltage from the MicroCab system label. Each battery shelf is intended to contain a single unique battery string. Each string has the same voltage as the system voltage. When multiple shelves are present, each battery string (one per shelf) is factory connected in parallel at the feed-through posts. The battery string cables connecting the feed-through posts to batteries are factory installed and are to be terminated to the batteries in the field. The interconnect cables/bus bars required to connect the batteries in a battery string are included in the battery cabinets.

6.5.1. Battery Installation and Wiring Steps

1. See the <u>Battery Wiring</u> diagram for example battery installations.

2. Place batteries on shelve(s), ensuring proper placement to achieve system voltage (each battery shelf contains a unique battery string). Shelves are connected in parallel by the factory wiring.

3. The battery shelves are provided with slots for use with the supplied battery securing straps. Secure batteries in seismically-active areas, and where compliance with IBC seismic codes is required.

    CAUTION: IF MULTIPLE BATTERY STRINGS ARE PRESENT, ALL THE WIRES ARE LIVE. ENSURE PROPER INSULATION OF ALL CABLE TERMINALS.

4. Connect the factory supplied positive wire in the main battery compartment to the positive terminal of the first battery in the main compartment. If the system has an expansion battery compartment, connect the factory supplied positive wire in the expansion battery compartment to the positive terminal of the first battery in the expansion compartment.

5. Connect the remote temperature sensor ring lug terminal to one of the negative battery posts in the base battery compartment.

6. Connect the negative wires to the negative terminal of the last battery. If the system has multiple battery strings, connect the other negative wires.

7. Connect batteries together using the interconnect cables/bus bars supplied. Verify all battery connections for proper order and terminal polarity, per the <u>Battery Wiring</u> diagram.

8. Torque all battery cables and connections as specified on the battery label.

9. Verify proper battery connection by measuring the battery voltage at the red and black feed through posts in the shelf of the main cabinet.

10. For seismic approved units, secure batteries to battery shelves using provided battery straps.
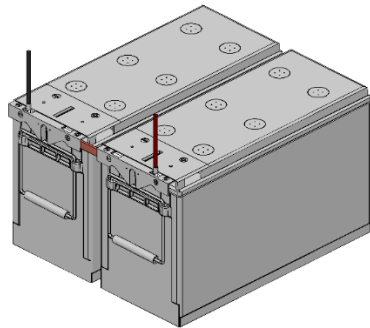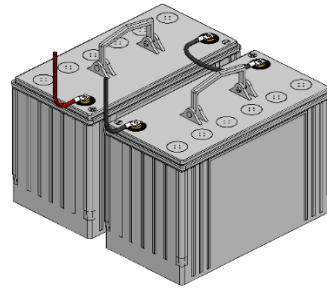
Battery Wiring
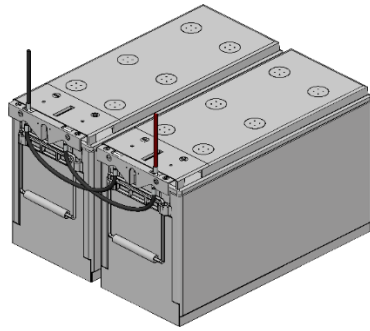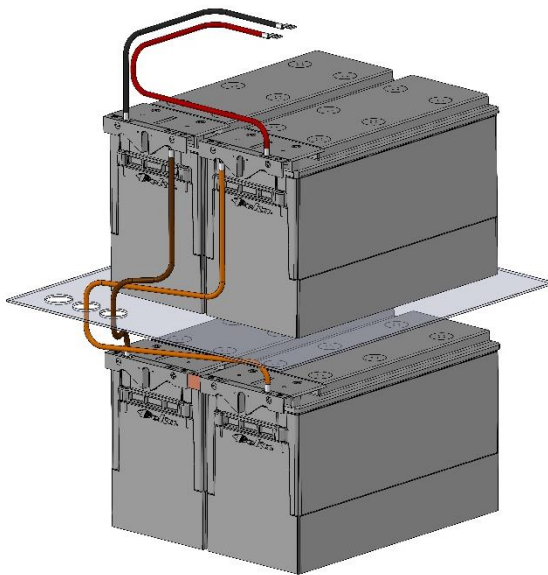
12V FRONT TERMINAL CONNECTION
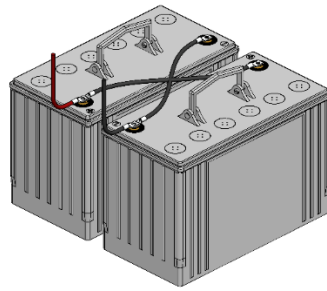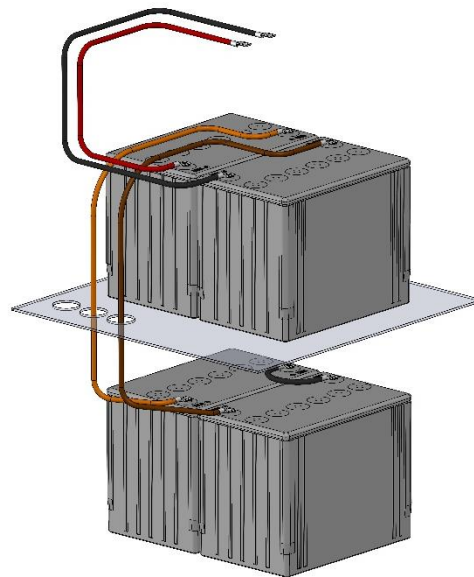
12V TOP TERMINAL CONNECTION

24V FRONT TERMINAL CONNECTION

24V TOP TERMINAL CONNECTION

48V FRONT TERMINAL CONNECTION

48V TOP TERMINAL CONNECTION

6.6. Verify Connections

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

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

7   POWER ON/POWER OFF PROCEDURE

7.1. Apply AC Input Voltage

Verify the AC input is the correct value (90-265 VAC, 47-63 Hz) and apply AC to charger. Switch the AC BREAKER to ON. The charging system is now energized. The CHGR breaker controls the charging output to the main output bus. The BATT breaker controls the battery connection to the main output bus. Switch both the CHGR and BATT breakers to ON.

Depending on the state of charge of the batteries and the load on the DC bus, the charger may go into current limit at this time. As the battery is charged, the charging current demand will taper to a value below the current limit setpoint of the charger, and the charger will revert to constant voltage output.

7.2. Power Off

Power system off in any order by turning the breakers OFF. Note that system is energized from both the AC input source and the internal DC battery source.

8   ALARMS, LEDS AND DISPLAY

8.1. LED Indicators

The system is equipped with two LEDs, one for AC status and one for DC status. These are visible on the front keypad display. To view the alarm status of the individual MG2 chargers, remove the top cover access panel. See further alarm definitions in section 8.6.

<div align="center">

LED Definitions

</div>

AC LED	DC LED	Meaning
OFF	OFF	AC and DC not applied or charger failed or optional alarm/communications circuit board cannot communicate with main circuit board
SOLID GREEN	SOLID GREEN	AC good, DC good, in Float Mode
SOLID GREEN	FLASHING 2X GREEN	AC good, DC in current limit (max charge)
SOLID GREEN	FAST FLASHING GREEN	AC good, battery check in progress
SOLID GREEN	SOLID RED	AC good, charger fail or overvoltage shutdown (charger disabled)
SOLID GREEN	FLASHING RED/YELLOW	AC good, reverse polarity detected on output
SOLID GREEN	SOLID YELLOW	AC good, high or low battery voltage (above/below alarm setpoint)
SOLID GREEN	FLASHING GREEN/RED	AC good, system DC output good, some individual charger(s) in alarm state
SOLID GREEN	FLASHING RED/YELLOW	AC good, incompatible battery (charger disabled)
SOLID GREEN	FLASHING GREEN/YELLOW	AC good, output limited by high temperature
SOLID GREEN	DOUBLE FLASH YELLOW	AC good, load share fail
SOLID GREEN	DOUBLE FLASH RED	AC good, load sharing DC negative connection open or load sharing charger address fault
SOLID RED	SOLID GREEN	AC fail, battery voltage good

AC LED	DC LED	Meaning
SOLID RED	SOLID YELLOW	AC fail, high or low battery voltage (above/below alarm setpoint)
SOLID RED	SOLID RED	AC fail, charger fail or overvoltage shutdown (charger disabled)
SOLID RED	FLASHING RED/YELLOW	AC fail, incompatible battery (charger disabled)
FLASH LONG-2X SHORT YELLOW		SENSbus Inactive
ALTERNATING FLASHING RED		Missing or invalid code (boot load required)
ALTERNATING FLASHING GREEN		Charger starting up

8.2. Individual Alarm Relay Contacts

The system includes three discrete Form C contacts. The Form C relay contacts change state when alarms are activated (see section 8.4). Alarm relay assignments are custom configurable to any of the alarm functions listed in section 8.4 using the SENS Setup Utility.

8.3. LCD Panel

A two line by twenty-character LCD is present and provides precision digital ammeter and voltmeter as well as information about input, output, charging status and alarms. The DC voltmeter is accurate to $\pm$1% and the ammeter is accurate to $\pm$1%. The display is readable with or without ambient lighting and operates automatically, requiring no operator intervention.

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

8.4. Alarm Assignment

There are three output alarms on the MicroCab System. The table below shows the default factory alarm assignment. The alarms assignments can be changed using the SENS Setup Utility (see <u>section 9.7</u>).

Default Alarm Assignment

Alarm Relay	Alarm
Major Alarm	AC Fail
	High DC Voltage
	Overvoltage Shutdown
	Charger Failure
	Reverse Polarity
	Invalid Settings
	Incompatible Battery
	Low current
	Internal module fault
	LVLD Active
Minor Alarm	Low DC Voltage
	Thermal Foldback
	SENSbus Inactive
	Battery Discharging
	Replace DC/AC Surge Suppressor
	Load Share Fail
	All Major and Minor Alarms

8.5. Latched Alarms

All alarm messages displayed on the front panel LCD are latching. Alarm relay configurations created using the SENS Setup Utility may be configured as latching if desired. Once an alarm condition no longer exists, the alarm message will no longer display in the main/home screen but will remain under the "Latched Alarms" menu. Clear latched alarms using the optional keypad under the "Latched Alarms" menu (see section 9.5.3), using the SENS Setup Utility or by cycling power.

8.6. Alarm Definitions

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

8.6.1. AC Line Failure

Indicates AC input voltage is not applied or is outside of allowed 90-265 VAC range. Activates solid red AC LED. LCD indicates AC FAIL and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.2. High DC Voltage

Indicates DC output voltage is above factory alarm setpoint (see the Default Factory Settings table). Activates solid yellow DC LED. LCD indicates HIGH DC and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.3. Overvoltage Shutdown

Indicates that the charger has executed a high voltage shutdown and DC output voltage is above factory alarm setpoint (see the Default Factory Settings table). The charger disables itself whenever excessive output voltage occurs while the charger is delivering current. The overvoltage shutdown system is protected against nuisance trips and will not execute if the high voltage condition is caused by an external source. Activates solid red DC LED. LCD indicates OVERVOLT FAULT and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.4. Charger Failure

Indicates the charger is not able to provide the current demanded by the battery and/or load or is providing more current than the charger's control system is commanding. The most likely cause is a charger internal component failure. This alarm does not occur during AC power failures. Activates solid red DC LED. LCD indicates CHARGER FAIL and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.5. Reverse Polarity

Indicates a battery is connected backwards. Charger output is disabled until the condition is corrected. Activates flashing red/yellow DC LED. LCD indicates REVERSE POLARITY and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.6. Incompatible Battery

Indicates charger is connected to an incompatible battery (e.g. a 12V battery is connected to a 24V charger). The charger operates for approximately 5 minutes while observing behavior of the DC voltage. If DC voltage behavior is normal the charger will continue charging. If DC voltage behavior is abnormal, as is typical with a battery voltage mismatch, the charger will shut down and lock off after approximately five minutes. Activates flashing yellow DC LED. LCD indicates INCOMPATIBLE BATTERY and the alarm relay contacts to which this alarm is mapped change to Fail state after delay. After correcting mismatched condition, remove and replace any jumper on the main circuit board or AC power to reset the charger and begin operation.

8.6.7. Low Current

Indicates current drawn from the charger is below factory alarm setpoint. This alarm is NOT intended to indicate failure of the rectifier/charger system. Purpose of the alarm is to detect whether load current drops below some user-adjustable threshold, such as a when a load suffers a failure and no longer draws current. The MicroCab system is shipped with the low current alarm disabled. LCD indicates LOW CURRENT and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.8. LVLD Active

Indicates that optional Low Voltage Load Disconnect (LVLD) is active, and that the load has been disconnected from the battery. Activates solid yellow DC LED. LCD indicates END OF DISCHARGE and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.9. Low DC Voltage

Indicates battery has discharged and DC output voltage is below factory alarm setpoint (see the Default Factory Settings table). Activates solid yellow DC LED. LCD indicates LOW DC and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.10. Thermal Fold Back

Indicates charger output is reduced to protect the charger from over-heating damage. The charger will not be able to produce full output until the ambient temperature drops. LCD indicates THERMAL FOLD BACK and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.11. SENSbus Inactive

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

8.6.12. Battery Discharging

Indicates battery is beginning to discharge and DC output voltage is below factory alarm setpoint (see the Default Factory Settings table). Alarm setpoint must be set higher than LOW DC alarm. Activates solid yellow DC LED. LCD indicates BATTERY DISCHARGING and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.13. DC/AC Surge Replacement

Indicates that the optional supplemental surge protectors need to be replaced. Consult SENS for replacement modules. LCD indicates SURGE ARRESTOR FAULT and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.14. No Remote Temp Sense

Indicates disabled or failed remote temperature sensor. LCD indicates NO BATT TEMP SENSOR and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.15. Current Limiting

Indicates the charger is operating at maximum allowable output, either the maximum current setting or maximum power output (whichever occurs first). LCD indicates CURRENT LIMIT and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.16. Charger Module Fault

Indicates one or more individual charger(s) are in an alarm state. Activates flashing green/red DC LED. LCD indicates INDIVIDUAL CHARGER and the alarm relay contacts to which this alarm is mapped change to Fail state after delay.

8.6.1. DC Below Startup Voltage

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

8.6.2. Battery Check

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

8.6.3. Thermal Fault

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

8.6.4. High Battery Temperature

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

8.6.5. High Battery Temperature Shutdown

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

8.6.6. Charger Low Temperature

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

8.6.7. Battery Low Temperature

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

8.6.8. AC Voltage Over Maximum

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

8.6.9. AC Voltage Low

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

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

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

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

9   OPERATION

9.1. Charging Operation
9.1.1. Battery Types
The system is factory set to use charging algorithms for the VRLA battery type. The VRLA charging algorithm maintains stationary batteries in a fully charged state when AC power to the system is available.

Because the system employs rectifier/chargers that can be employed to charge other types of storage devices such as flooded lead-acid and nickel cadmium batteries and ultracapacitors, it is possible to select charging algorithms other than "VRLA" using the keypad. Do <u>not</u> change the battery type from VRLA battery settings or activate the Dynamic Boost or HELIX charging modes unless you receive specific instruction to do so from SENS' service department.

9.1.2. Charging Low or Zero-volt Batteries
The rectifier/charger system will initially charge/commission zero-volt or fully discharged batteries without special user intervention. The charger system will charge for approximately 5 minutes to determine if the battery voltage will begin to rise. If the voltage rises properly the charger system will continue to charge the battery normally. If the voltage does not rise appropriately within 5 minutes the charger system will shut down. This shut down prevents long-term overcharge in the event of a mismatched battery (e.g. a 12V battery connected to a 24V system). After correcting a mismatched condition, cycle AC and DC power.

9.2. Load Distribution
The DC output of both the charging system and the batteries are tied to the main DC bus. During normal operation (AC power present), the MicroCab will supply the external loads. When there is an AC power failure, the batteries will power the external loads. Since the battery is connected in parallel with the charger/rectifier output bus there is no active switching and thus no interruption of DC when charger output either stops or resumes. There are four DC output positions, with each output connected through its breaker. A breaker must be ordered with the system for each desired output position.

9.3. Low Voltage Load Disconnect (optional)
The Low Voltage Load Disconnect (LVLD) disconnects the loads from the batteries at the End of Discharge DC voltage (see the table below) keeping the batteries from draining completely and extends battery life. The load is reconnected when the battery voltage reaches the Battery Discharging Alarm level. In applications where the absolute longest run time is more valuable than a long-lived battery life the LVLD should not be used.

9.4. Factory Default Settings

The table below shows the MicroCab system default factory settings. These settings can be changed using the keypad or the SENS Setup Utility.

Default Factory Settings

Setting	Factory Setting (12V / 24V / 48V)
Float Voltage	13.5V / 27.0V / 54.0V
End of Discharge (LVLD disconnect threshold)	10.5V / 21.0V / 42.0V
Battery Discharging Alarm (LVLD reconnect threshold)	12.9V / 25.8V / 51.8 V
Overvoltage Shutdown	17.004V / 34.008V / 68.016V
Temperature Compensation	-0.18%/°C
High DC Voltage Alarm	14.64V / 29.28V / 58.56V
Low DC Voltage Alarm	10.98V / 21.96V / 43.92V
Low Current Alarm	5%
Current Limit Alarm	100%

9.5. Keypad Operation

The front panel keypad provides the ability to adjust charger settings without the SENS Setup Utility.

9.5.1. Security Code Protection

The keypad is security code protected to ensure only authorized personnel adjust system settings. The default security code is 000000 meaning security code is not enabled. Change the security code to a unique value by scrolling to the "Service Tools" menu and then the "Change Security Code" option. Contact SENS Customer Service if a custom password is lost or forgotten (800-742-2326 or SENS | Service and Technical Support).

9.5.2. Menu Navigation

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

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

9.5.3. Menu Options

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

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

Menus (Press arrows to scroll through menu options)		Configurable/Viewable (Press left/right arrows to scroll through menus, press up/down arrows to configure values)	Parameter Descriptions
Main Menu ⇕ ⇔	Sub Menu ⇕ ⇔		
Browse Status		Scroll left/right to view basic meters and alarms	
Latched Alarms		Clear All Latched Alarms	Clear status of all latched alarms.
DC	Meters	DC Output (voltage)	DC output voltage and current
		DC Output (power)	DC output watts and % of rated output being provided
		Battery Temp.	Temperature at battery if a remote temperature sensor is connected
		Ambient Temp.	Temperature inside charger
		GF voltage	Ground Fault voltage detected by charger and indication of whether on positive or negative battery terminal
		GF Current	Ground Fault current detected by charger and indication of whether on positive or negative battery terminal
		Last Crank	Rolling crank voltage and temperature detected during last engine crank
	Basic Settings	Battery Select Type	Select type of battery to be charged - flooded lead-acid, AGM, nickel-cadmium VRLA, power supply.
		Battery Select Number of Cells	Adjust number of series cells in battery string
		Float Voltage	Adjust output Float voltage, must be greater than 60% of Boost setting
		Boost Voltage	Adjust output Boost voltage from, must be same or greater than Float setting, must not be greater than 166% of Float setting
		HELIX-EcoFloat	Enable or disable HELIX mode
		Current Limit	System current limit setting. Set to "No Limit Set" for full current capacity. Set a value in amps to limit available current. It is sometimes necessary to limit maximum charging current to the battery.
		Temp. comp./°C	Adjust temperature compensation slope from 0 to -0.30%V/°C
	Boost Settings	Boost Voltage	Adjust output Boost voltage from, must be same or greater than Float setting, must not be greater than 166% of Float setting

		Auto Boost Delay	Adjust amount of time from 0 to 5 minutes to delay before entering Boost mode after power is cycled or battery type is changed. Delay affects all outputs for multiple output models.
		Auto-Boost	Enable or disable Dynamic Boost mode
		Auto Boost Limit	Adjust the maximum amount of time charger will be in Dynamic Boost mode from 1 to 255 hours. The Boost time limit is reset if charger power is cycled or an engine crank is detected.
		Boost Duration	Adjust amount of time charger will be in scheduled periodic Boost mode from 1 to 255 hours. The Boost timer is reset if charger power is cycled
		Scheduled Boost	Adjust amount of time between periodic scheduled Boost events from 1 to 180 days. Set to OFF to disable.
		Run Timed Boost	Start or stop a manual Boost cycle. Will operate in Boost mode until the Boost Duration expires.
		Next Scheduled Boost	View time until next scheduled Boost
	Battery Check	Battery Check	Start or stop a manual Battery Check.
		Clear Failure Battery Check	Press UP arrow to reset/clear Battery Check alarm on selected output
		Batt Check Time	Adjust amount of time to run Battery Check from 1 to 60 minutes
		Batt Check Vmin	Adjust minimum voltage allowed during Battery Check test, must be greater than End-of-Discharge voltage and less than 98% Float voltage
		Sched Batt Check	Adjust amount of time between scheduled Battery Check tests from 1 to 90 days
		Next Sched Batt Check	View time until next scheduled Battery Check test
	Alarms	Relay Delay Time DC	Adjust amount of time to delay activation of alarm relays after a DC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Ground Fault Alarm	Enable or disable ground fault alarm. Disable for MicroCab units; output is always grounded.
		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	Disabled for MicroCab units
		DC Output #B	Disabled for MicroCab units

		DC Output #C	Disabled for MicroCab units
		DC Output #D	Disabled for MicroCab units
AC	Meters	AC Input	AC input voltage and frequency
		AC Reference Meters	Press UP arrow to enable displaying AC meter values in the Browse Status menu area
	Basic Settings	Number of Phases	Set to 1 for single-phase or 3 for three-phase input voltage
		Nominal Volts AC	Set nominal input voltage for charger model. Must match hardware jumper/terminal block on inside of charger when jumper exists.
	Alarms	Relay Delay Time AC	Adjust amount of time to delay activation of alarm relays after an AC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Max Voltage	Adjust setpoint to trigger AC Voltage High alarm
		Min Voltage	Adjust setpoint to trigger AC Voltage Low alarm
		High Freq	Adjust setpoint to trigger AC Frequency Out of Range alarm
		Low Freq	Adjust setpoint to trigger AC Frequency Out of Range alarm
	Advanced Settings	Restore Factory Default Settings AC	Press UP arrow to restore settings to factory configuration
		AC Input #A	Enable for S2/S4 units
		AC Input #B	Disable for S2/S4 units
User Access		UI Access Control	Select allowed user interface access. Access options include read-only/monitor viewing or full access adjustments for advanced users.
		Change Security Code	Change security code to desired 6 digits. The default security code is 000000 (disabled). Upon entering a security code, the display will automatically prompt user for the code to access protected menus. Menus are protected depending on configured level of access (see UI Access Control definitions above).
		Relock Access	Exit Service Mode and relock access
Service Tools	Output	Force DC Startup All	Enables charger to attempt to charge a battery with a voltage below the DC Startup Voltage. Enables startup on all outputs.
	Alarms	Clear Failures All	Press UP arrow to reset/clear failures on all outputs
		Clear Failure Low Crank	Press UP arrow to reset/clear Low Cranking alarm on all outputs

		Clear Failure Battery Check	Press UP arrow to reset/clear Battery Check alarm on all outputs
	Alarm Test	Relay Test	Press UP arrow to set all alarm relays and DOWN arrow to clear all relays
		Check Vent Fan	Press UP arrow to run vent fan and DOWN arrow to stop vent fan
		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 unit values or set to "System Display" to display system (for a system with multiple chargers) values on the unit LCD
		LCD Brightness	Adjust LCD brightness from 0 – 100%
		Display Test	Press UP arrow to set all LCD segments black and DOWN arrow to clear all LCD segments
	Advanced	Soft Reset All Devices	Press UP arrow to reset all devices in the unit/system
		Full Reboot Protocol Board	Press UP arrow to reboot protocol communications device
		Repository Config	Set to Stable
		Minimum System Number of Chargers	Enable or disable whether alarm is indicated or not. Alarm active when the number of charger modules active on SENSbus is less than the minimum charger count for the system. Disabled by default, meaning no alarm. See Error Code 301 for further details.
		Minimum Unit Number of Chargers	Enable or disable whether alarm is indicated or not. Alarm active when the number of charger modules active on SENSbus is less than the minimum charger count for the unit. Disabled by default, meaning no alarm. See Error Code 301 for further details.
Communica-tions	TCP/IP Settings	TCP-IP Address	Set TCP-IP Address
		TCP-IP Gateway	Set TCP-IP Gateway
		TCP-IP Subnet Mask	Set TCP-IP Subnet Mask
		Hardware Mask	Reads Hardware Address (MAC address of the unit)
	SENSnet	SENSnet Mode	Enable or disable SENSnet Mode. When disabled the charger will not communicate via IP address. Enabled by default.

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	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	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
	DNP3 RS485	DNP3 Configuration	Enable or disable DNP3 RS-485. Only one RS-485 communications protocol is allowed at a time.
		Source Addr	Set DNP3 source address
		Dest Addr	Set DNP3 destination address
		Parity Bit	Set DNP3 parity to none, even or odd
		Baud Rate	Adjust DNP3 baud rate, 230.4 Kbps maximum
		Conf File	Set to factory default DNP3 configuration or select one of two custom configurations. Use SENS DNP3 Config Tool to generate custom configuration file.
	DNP3 TCP	DNP3 Configuration	Enable or disable DNP3 TCP-IP
		Port	Set DNP3 port
		Source Addr	Set DNP3 source address
		Dest Addr	Set DNP3 destination address
		Conf File	Set to factory default DNP3 configuration or select one of two custom configurations. Use SENS DNP3 Config Tool to generate custom configuration file.
	J1939	J1939 Configuration BCH1 Output	Assign charger output for J1939 battery charger address to 1
		J1939 Configuration BCH2 Output	Assign charger output for J1939 battery charger address 2
		J1939 Configuration Veh Sys Instance	Adjust J1939 Vehicle System Instance from 0 to 15
		J1939 Configuration Funct Instance	Adjust J1939 Function Instance from 0 to 31

		J1939 Configuration ECU Instance	Adjust J1939 ECU Instance from 0 to 7
		J1939 Configuration Extended Status	Enable or disable receiving extended J1939 data
	User CAN	User CAN Mode	Enable or disable User CAN Mode
Alarm Relays		Relay Delay Time AC	Adjust amount of time to delay activation of alarm relays after an AC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Relay Delay Time DC	Adjust amount of time to delay activation of alarm relays after a DC alarm event takes place from 5 to 60 seconds. Alarm/comms circuit board alarm relay contacts and alarms on communications ports are delayed; LED alarm indication is not delayed.
		Relay Test	Press UP arrow to set all alarm relays and DOWN arrow to clear all relays
Unit Information		Serial No.	Charger serial number
		Display Revision	Software revision currently loaded on alarms/comms circuit board
		Copyright	SENS copyright year
		Charger Revision	Software revision currently loaded on charging devices. Press UP arrow to identify device by temporarily flashing LEDs.

9.6. Battery Check Feature

9.6.1. Activate the Battery Check Feature via the front keypad. Battery Check will reduce charger output voltage to a configurable backstop level to permit the battery to support the load. 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 and status LED 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. An in-progress Battery Check activates a fast flashing green DC LED. Battery Check failure activates a fast flashing yellow DC LED. MAJOR alarm relay contacts change to Fail state after delay. 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.

IMPORTANT: A load less than 3% of the charger's maximum current rating may cause inaccurate battery check results. If the system load is typically lower than 3% disable the periodic automatic battery check feature using the front panel keypad.

9.6.2. Schedule Battery Check to run automatically by enabling Periodic Auto Battery Check via the front panel keypad.

**9.7. Configuration with SENS Setup Utility**

Use the SENS Setup Utility to update firmware on all devices and configure select settings including alarm relay assignments. Download the setup utility software at SENS | Download Center. Communication between a computer and the charger using the SENS Setup Utility requires connection via USB or

connection of the SENSbus Adapter (shipped with SENS Setup Utility kit p/n 209254) for legacy units (see section 6.4.4).

9.8. Temperature Compensation

The charging system is temperature compensated to match the negative temperature coefficient of the battery. When temperature compensation is active, the output voltage will increase slightly as temperature decreases, decrease as temperature increases, and is clamped at 0°C (32°F) and +50°C (122°F) to protect against extremely high or low output voltage (see the figure below). Temperature Compensation is set to a slope of -0.18% per °C by default for operation with batteries.

Example Temperature Compensation Curves
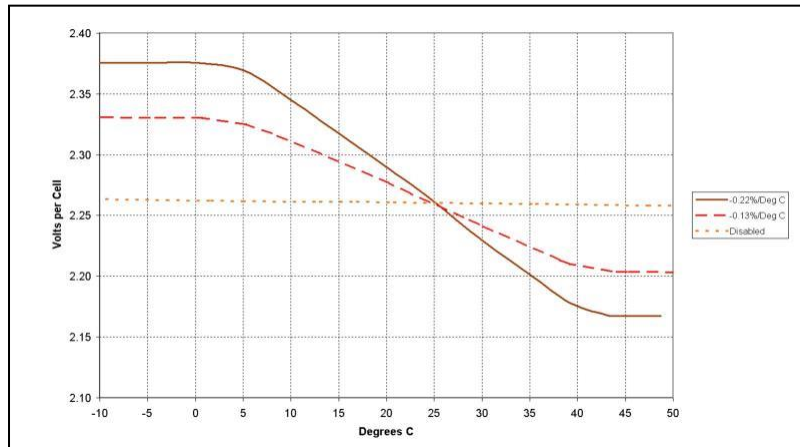
10 MODBUS COMMUNICATIONS

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).

10.1. Modbus RS-485

Serial Modbus communications over RS-485 using RTU mode requires configuration using the SENS Setup Utility or the keypad. Configure Modbus server address, baud rate, parity and enable/disable Modbus write access as desired. See section 6.4.2 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

10.2. Modbus TCP/IP—*Optional*

Modbus communications over TCP/IP is optional and requires configuration using the SENS Setup Utility or the keypad. See section 6.4 for connection information for existing and legacy units. Legacy units must be configured using the Lantronix DeviceInstaller utility (see 10.2.1 section below). 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.

Modbus TCP/IP Default Settings

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

10.2.1. Modbus TCP/IP—*Legacy*

See section 6.4.3 for connections and wiring on legacy units. To configure the TCP/IP settings download and install the DeviceInstaller Software provided by Lantronix Inc. from the URL below: https://www.lantronix.com/products/deviceinstaller/. After installing this software, the search command on the toolbar menu will locate the device. The figure below shows the software screen when the device is located.

Lantronix Device Located
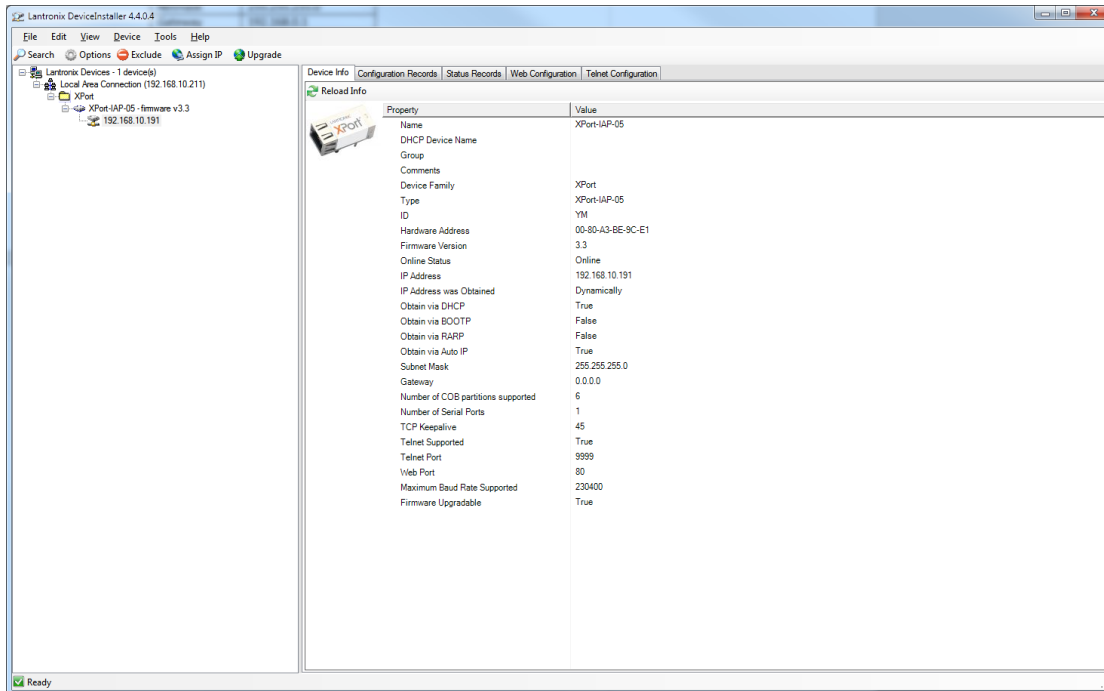
Use the DeviceInstaller software to change the IP Address of the TCP/IP module by using the Assign IP command in the menu toolbar. The software will request the Device Identification (hardware address) of the module. This is located on the MicroCab 1500 system label on the inside of the main cabinet door (See the MAC Address Location figure, Example: 00-80-A3-BE-9C-E1). This identification is unique to each MicroCab 1500 system. Follow the software dialogue to complete the IP address setting setup of the TCP/IP module.

MAC Address Location
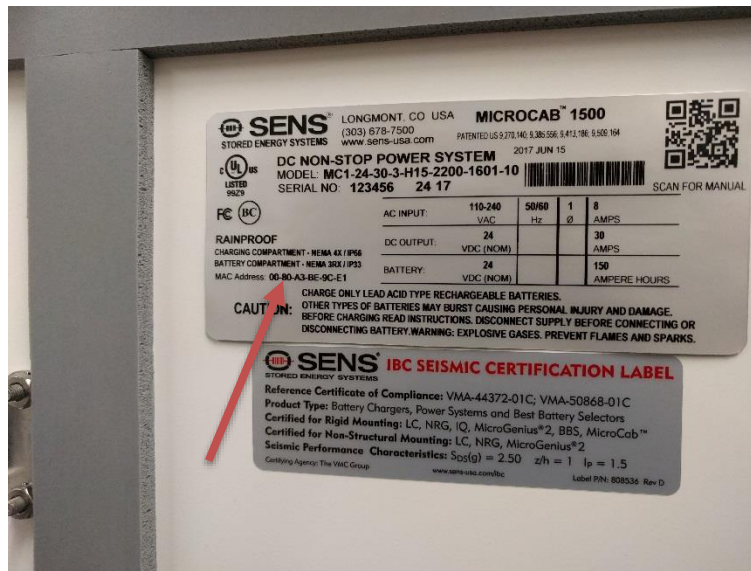
10.3. Modbus Holding Registers

MicroCab 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.

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
0	0x000	1	0x001	System Serial Number	Serial Number of System the device was built into and shipped part of	Num	1
2	0x002	3	0x003	Program Revision	Version of the main program	Num	1
4	0x004	5	0x005	Bootloader Version	Version of bootloader	Num	1
6	0x006	7	0x007	Type	Device type	Enum	1
8	0x008	9	0x009	Serial	Serial Number of the Device	Num	1
10	0x00A	11	0x00B	Build Date	Year (16bit), month(8bit), day(8bit)	Num	1
12	0x00C	13	0x00D	Model Num 1_4	Model number character	bit	1
14	0x00E	15	0x00F	Model Num 5_8	Model number character	bit	1
16	0x010	17	0x011	Model Num 9_12	Model number character	bit	1
18	0x012	19	0x013	Model Num 13_16	Model number character	bit	1
20	0x014	21	0x015	Model Num 17_20	Model number character	bit	1
22	0x016	23	0x017	Model Num 21_24	Model number character	bit	1
24	0x018	25	0x019	Model Num 25_28	Model number character	bit	1
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 10.4)	Bitfield	1
44	0x02C	45	0x02D	Charging Status	Charging Status bits (see section 10.5)	Bitfield	1
46	0x02E	47	0x02F	Charging Alarms Extended	Charging Alarm Extended status bits (see section 10.6)	Bitfield	1

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
48	0x030	49	0x031	Charging AC Alarms	Charging AC Alarm status bits (see section 10.7)	Bitfield	1
62	0x03E	63	0x03F	Uptime Counter Value	Charger uptime counter value	Sec	1
68	0x044	69	0x045	Default Output Batt Voltage	Voltage currently being supplied by the charger to the battery	V	32768
70	0x046	71	0x047	Default Output Current	Current currently being supplied by the charger to the battery	A	32768
72	0x048	73	0x049	Default Output Power	Power currently being supplied by the charger	W	32768
74	0x04A	75	0x04B	Default Output Factory Float Setting	Float Cell Voltage set at Factory	V/cell	32768
76	0x04C	77	0x04D	Default Output Factory Boost Setting	Boost Cell Voltage set at Factory	V/cell	32768
78	0x04E	79	0x04F	Default Output Remote Temp	Remote temp sense temperature in 0.0°C	°C	32768
80	0x050	81	0x051	Default Output Internal Temp	Ambient air temperature near charger input connectors (tp 1)	°C	32768
82	0x052	83	0x053	Default Output Boost Elapsed Time	Boost time	Sec	1
84	0x054	85	0x055	Default Output Periodic Boost Countdown	Interval between periodic boost events (0 = disabled)	Sec	1
86	0x056	87	0x057	Default Output AC Line Frequency	AC Line Frequency	Hz	10
88	0x058	89	0x059	Default Output AC Line Voltage 1	AC Line 1 Voltage	V	32768
90	0x05A	91	0x05B	Default Output AC Line Current 1	AC Line 1 Current (not applicable to single phase chargers)	A	32768
92	0x05C	93	0x05D	Default Output AC Line Voltage 2	AC Line 2 Voltage (not applicable to single phase chargers)	V	32768
94	0x05E	95	0x05F	Default Output AC Line Current 2	AC Line 2 Current (not applicable to single phase chargers)	A	32768
96	0x060	97	0x061	Default Output AC Line Voltage 3	AC Line 3 Voltage (not applicable to single phase chargers)	V	32768
98	0x062	99	0x063	Default Output AC Line Current 3	AC Line 3 Current (not applicable to single phase chargers)	A	32768
100	0x064	101	0x065	Default Output Battery Check Time Elapsed	Duration of battery check	Sec	1
102	0x066	103	0x067	Default Output Battery Check Due	Interval between scheduled automatic battery checks	Sec	1
104	0x068	105	0x069	Default Output Number of Chargers	Number of chargers detected on SENSbus, 0 - 30	Num	1
128	0x080	129	0x081	Default Output Maximum Power	Maximum rated power	V/Cell	32768
130	0x082	131	0x083	Default Output Maximum Voltage	Maximum rated voltage in x.xx V	V/Cell	32768
132	0x084	133	0x085	Default Output Maximum Current	Maximum rated current in x.xx A	A	32768
134	0x086	135	0x087	Default Output Program Float Setting	Float Cell Voltage used in Program Mode	V/Cell	32768
136	0x088	137	0x089	Default Output Program Boost Setting	Boost Cell Voltage used in Program Mode	V/Cell	32768

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
138	0x08A	139	0x08B	Default Output Program Mode	Mode callouts for Program Mode setting (battery type… etc.)	Custom	1
140	0x08C	141	0x08D	Default Output Program Cell Count	Number of cells set in Program Mode	Cells	32768
142	0x08E	143	0x08F	Default Output Program Temp comp slope	In 0.xx°C per output volt x -1	°C/V	32768
144	0x090	145	0x091	Default Output Low DC Program	Alarm setpoint for low DC (used for Program Mode setting)	V/Cell	32768
146	0x092	147	0x093	Default Output Low Crank Program	Alarm setpoint for low Crank (used for Program Mode setting)	V/Cell	32768
148	0x094	149	0x095	Default Output Low Current Program	Alarm setpoint for low Current (used for Program Mode setting)	A	32768
152	0x098	153	0x099	Default Output High DC Program	Alarm setpoint for high DC (used for Program Mode setting)	V/Cell	32768
154	0x09A	155	0x09B	Default Output OVSD Program	Alarm setpoint for OVSD (used for Program Mode setting)	V/Cell	32768
156	0x09C	157	0x09D	Default Output Batt Discharge Program	Alarm setpoint for Batt Discharge (used for Program Mode setting)	V/Cell	32768
158	0x09E	159	0x09F	Default Output Batt End Discharge Program	Alarm setpoint for End Discharge (used for Program Mode setting)	V/Cell	32768
160	0x0A0	161	0x0A1	Default Output Program Boost Time Limit	Boost time limit (used for Program Mode setting)	Hr	3600
162	0x0A2	163	0x0A3	Default Output Current Limit Setting	Current Limit setpoint in % of output current as a 10 bit value	% Rated A	32768
164	0x0A4	165	0x0A5	Default Output Helix Float Time	Helix Float Time	Hr	3600
166	0x0A6	167	0x0A7	Default Output Helix Refresh Time	Helix Refresh Time	Hr	3600
168	0x0A8	169	0x0A9	Default Output Helix Eco Time	Helix Eco Time	Hr	3600
170	0x0AA	171	0x0AB	Default Output Periodic Boost Time	Interval between scheduled Periodic Boost	Days	86400
172	0x0AC	173	0x0AD	Default Output Battery Check Voltage Setting	Battery check failure threshold	V/Cell	32768
174	0x0AE	175	0x0AF	Default Output Battery Check Interval	Interval between scheduled automatic battery checks	Days	86400
176	0x0B0	177	0x0B1	Default Output Battery Check Duration	Duration of battery check	Min	60
178	0x0B2	179	0x0B3	Default Output Commissioning VPC	Commissioning VPC	V/Cell	32768
180	0x0B4	181	0x0B5	Default Output Commissioning Duration	Commissioning Duration	Hr	3600
182	0x0B6	183	0x0B7	Default Output Commissioning A	Commissioning Amps	A	32768
184	0x0B8	185	0x0B9	Default Output Rated Power	Output Rated Power	W	32768
186	0x0BA	187	0x0BB	Default Output Rated Current	Output Rated Current	A	32768
188	0x0BC	189	0x0BD	Default Output Periodic Boost Duration	Periodic Boost Duration	Bits	3600

Address High		Address Low		Name	Description	Units	Scale Factor
Decimal	Hex	Decimal	Hex				
190	0x0BE	191	0x0BF	Default Output Min Allowed Voltage Setting	Min Allowed Voltage Setting	V/Cell	32768

10.4. Alarm Bit Definition

Bit Address		Name	Description
Decimal	Hex		
0	0x00	Alarm AC Fail	Charger does not have usable AC input
1	0x01	Alarm High DC	Charger output exceeds alarm threshold
2	0x02	Alarm Low DC	Charger output below alarm threshold
3	0x03	Alarm Charger Fail	Charger not operating because of an internal failure
4	0x04	Alarm Over Voltage Shutdown	Charger disabled by selective overvoltage shutdown
5	0x05	Alarm Reverse Polarity	Charger disabled because battery polarity is reversed
6	0x06	Alarm Low Cranking	Low cranking voltage event has been detected
7	0x07	Alarm Incompatible Battery	Charger disabled because it does not match battery (12V vs. 24V vs. 48V)
8	0x08	Alarm Invalid Settings	Charger disabled because jumper setting is not correct
9	0x09	Unused	Unused
10	0x0A	Alarm Thermal Foldback	Available output is reduced because of high temperature
11	0x0B	Alarm No Temperature Probe	Battery temperature probe is not connected
12	0x0C	Alarm Current Limiting	Operating in current limit mode (below output voltage set point)
13	0x0D	Alarm Ground Fault Positive	Ground fault alarm enabled and positive ground detected
14	0x0E	Alarm Low Current	Low current alarm enabled and output below alarm threshold
15	0x0F	Alarm Load Share Fault	Charger fails to provide its share of the output current
16	0x10	AutoBoost Lockout Active	Boost mode time limit has expired and charger has returned to Float mode. Boost mode is disabled until the time limit is reset. The Boost time limit is reset when power is cycled.
17	0x11	Unused	Unused
18	0x12	Alarm SENSbus Inactive	Display board is not receiving any charger data
19	0x13	Alarm Battery On Discharge	Battery in range where discharge occurs (below open circuit voltage)
20	0x14	Alarm Battery End Discharge	Battery voltage below safe discharge range threshold
21	0x15	Alarm Ground Fault Negative	Ground fault alarm enabled and negative ground detected
22	0x16	Alarm DC Negative Open	Charger disabled because common negative lead is open
23	0x17	DC Below Startup Voltage	Battery voltage is below the Startup Voltage setpoint. Unit output voltage is disabled. Forced startup feature overrides.
24	0x18	Unused	Unused
25	0x19	Alarm Load Disconnect	Load relay open: set at "end discharge", clear when not "on discharge"
26	0x1A	Alarm Individual Unit Fault	Alarm flag 32-54 active for one, but not all, chargers in any Output
27	0x1B	Alarm Battery Check	Battery check failed
28	0x1C	Alarm Circuit Breaker	Circuit breaker monitor contacts are active (if present)
29	0x1D	Alarm Surge Arrestor	Surge arrestor monitor contacts are active (if present)
30	0x1E	Alarm Load Relay Control	Enable load control relay (if present)
31	0x1F	Alarm Vent Fan Control	Enable battery vent fan (if present)

10.5. Status Definition

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

10.6. Extended Status Bit Definition

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

10.7. 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.

10.8. Writable Control Flags (Coils)

Single coil writes: 0xFF00 for ON, 0x0000 for OFF
Multiple coil writes: 1 for ON, 0 for OFF

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

11 MAINTENANCE

11.1. Annual Maintenance

11.1.1. Check all field wiring connections for electrical and mechanical integrity.

11.1.2. Inspect charging compartment for any signs of electrical damage or safety hazards.

11.1.3. Verify that ventilation openings and ventilation opening filters are free from debris.

11.1.4. Ensure cabinet gaskets and conduit bushings are in good working order.

11.2. Regular Maintenance (monthly)

11.2.1. Perform Battery Check. See section 9.6.

11.2.2. Monitor System Status for any alarm codes and warnings.

12 SERVICE

12.1. Battery Replacement
12.1.1.   Warnings
12.1.1.1.   Risk of explosion if batteries are replaced by an incorrect type.

12.1.1.2.   Contact your local hazardous waste or recycling center for battery disposal details.

12.1.2.   See [section 6.5](#).

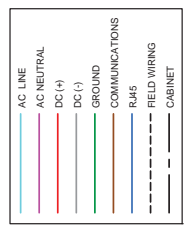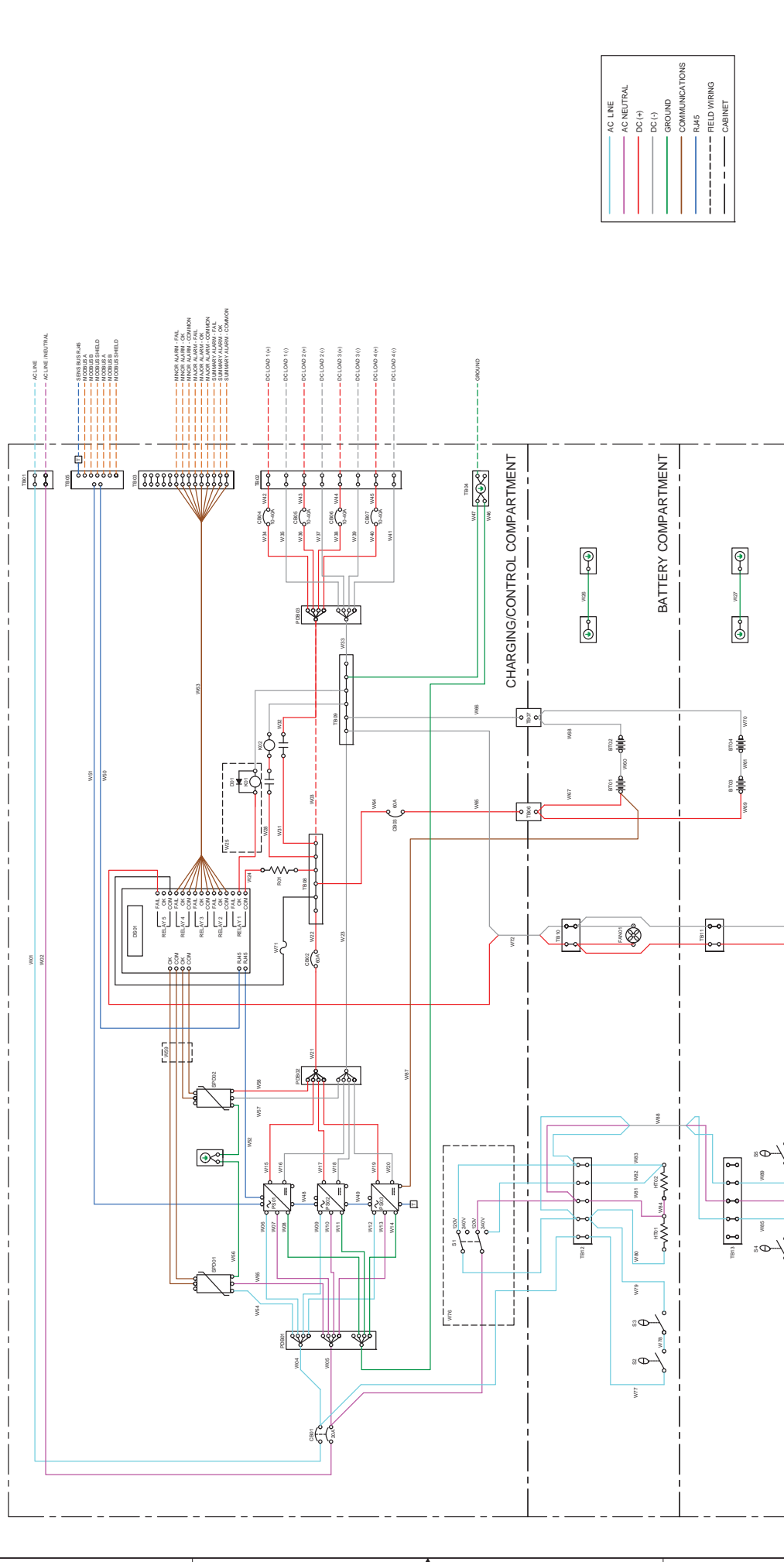## 13 ERROR CODES

13.1. Configuration Error Codes
Error codes are displayed on front panel LCD.

Error	Scope	Description	Corrective Action
101	Charger Module	**Invalid charger position jumper setting** for a charger module used in a multi-module unit. Jumpers must identify the module position: either no jumper (position 0) or a single jumper in positions 1 - 9. Not compatible with jumper-selected output settings for stand-alone chargers.	- When a charger contains multiple charger modules, each module in that unit must be set to a different position number. Install one jumper per module to select module positions 1 - 9, or no jumper to select position 0. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set Output" setting in the "Other Settings" menu or the setup utility to assign all modules to the "Default" DC output.
102	Stand-alone Charger	**Simultaneous use of output jumper settings and keypad control** on a charger not used as a module. The keypad is enabled while the charger output is controlled by its jumper settings. Output can be either keypad controlled or jumper-selected, but not both simultaneously. Chargers not used as modules do not use jumpers to identify their installation positions.	- To operate under keypad control, remove all charger output setting jumpers. - To disable keypad control, Change the "UI Access Level" setting in the "Service Tools" menu to "Monitor Only." For factory default settings install jumpers on the charger in all three Float Voltage positions or two float settings plus one Range jumper. For other standard settings install three jumpers on the charger to select the Battery Type, Float Voltage, and Range for your battery.
103	Stand-alone Charger	**Inconsistent jumper settings** for chargers not used as modules. When multiple stand-alone chargers operate in parallel using output jumper settings, all the chargers must have identical settings. This prevents unexpected output settings changes if the lead charger (the charger with the lowest power board serial number) loses SENSbus data communication for any reason.	- For factory default settings install jumpers on the charger in all three Float Voltage positions or two float settings plus one Range jumper of every charger. - For other standard settings, install three jumpers on each charger to select the Battery Type, Float Voltage and Range, using settings appropriate for your battery. All chargers must use the same settings. - For keypad control (programmed settings), remove all output setting jumpers from all the chargers.
104	Charger Module	**Invalid output configuration**. Charger modules must be set to a valid output: either output A through D for use in multiple output units or 0 for use in single output units. Combining charger modules configured for use in single output units with those configured for multiple output units in the same unit (or system) is **not** supported.	- If necessary, enable the output using the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility. - To select a different output, reassign the module to match its actual output connection using the "Set DC Output" setting in the "Other Settings" menu or by using the setup utility. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to assign all modules to the "Default" DC output.

Error	Scope	Description	Corrective Action
105	Charger Module	**Duplicate charger location** settings within a unit with multiple charger modules, not using the default output. Every charger module must have a unique location setting. Duplication is allowed for modules in different units, *i.e.* with different "Unit Serial Numbers". Modules using the "default" output do not use charger positions.	- Use a different position number (jumper setting) for each module in a multi-module unit. See Error Code 101 for more detail. - When replacing a charger in a multi-module unit, set the replacement charger for the same position as the module being removed. - To prevent confusion, the position jumper settings should agree with the position markings on labels, internal wiring, *etc*. (so the displayed module ID number will match its physical and electrical position).
201	Charger (or system)	**No charger modules assigned** to output. Every enabled charger output must have at least one module assigned to it. When none is found, it is presumed that a module has failed, has lost SENSbus data communication, or has an incorrect output setting.	- Check for a module that has failed (indicated by its LED status). - Check for disconnected or damaged SENSbus data cables. - If the output is not to be used, disable it by using the keypad "DC Output #" setting in the "Other Settings" menu or the setup utility.
202	Charger (or system)	**Too few charger modules operating**. The combined output rating of all modules operating on this charger output is less than the rated output. This can occur because a module has failed, has an open AC input or DC output connection, has lost SENSbus data communication, or is configured for the wrong output.	- Use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to verify all chargers output settings. Each module must be set for the output corresponding to its electrical DC output connection. - If necessary, install additional modules to meet the required output rating (plus the additional modules needed for "N+1" or "N+2" redundant operation). - Verify that each output is assigned enough modules to meet the required DC output rating (plus any extra modules needed to provide "N+1" or "N+2" redundant operation). - Check for a module that has failed (indicated by its LED status). - Check for disconnected or damaged SENSbus data cables. - Check for miswired, disconnected, or damaged input and output connections.
203	Charger (or system)	**Charger Module assigned to a disabled output**. All modules must either be set for single output operation (0, Default output) or to a valid output that is enabled in this unit or system.	- To use this output, enable it using the keypad " DC Output #" selection in the "Other Settings" menu or the setup utility. Verify that the DC outputs of all modules assigned to each output are electrically connected to that output. - To select a different output, reassign the module to match its actual output connection using the "Set DC Output" setting in the "Other Settings" menu or by using the setup utility. - To operate without multiple outputs, use the keypad "DC Output #" selection in the "Other Settings" menu or the setup utility to disable all outputs. Then use the "Set DC Output" setting in the "Other Settings" menu or the setup utility to assign all chargers to the "Default" DC output.

WIRING DIAGRAM
MICROCAB

DRAWING NUMBER
WD\00702

SHEET 1 OF 1

CHARGING/CONTROL COMPARTMENT

BATTERY COMPARTMENT

EXPANSION BATTERY COMPARTMENT

AC LINE
AC NEUTRAL
DC (+)
DC (-)
GROUND
COMMUNICATIONS
RJ45
FIELD WIRING
CABINET

REVISIONS

REV	DESCRIPTION	DCN	DATE	APPROVED
A	INITIAL RELEASE	107259	4/10/2017	SC
B	ADD THERMOSTATS S4 AND S5, NOTATION	107288	6/15/2017	SC

REVISIONS

DCN	REV	DESCRIPTION	DATE	APPROVED
107121	A	INITIAL RELEASE	10/7/2016	SC
107262	B	NOTATION CHANGES	6/15/2017	SC

DETAIL A
MOUNTING SLOT DETAIL
SLOTS FOR 3/8 INCH (M10) HARDWARE

Ø.438
1.188

WALLMOUNT

26.00
BASE CABINET

3.00
0
7.00
14.00
21.00
24.25
30.25
36.25
7X 20.00
EXPANDED CABINET

40.50

23.54
21.80

FLOORMOUNT

43.63
EXPANDED CABINET

29.13
BASE CABINET

1.38
0
9.00
18.00
3X 20.00
21.50
22.04
A

TOPLIFT BRACKETS
PROVIDE A MINIMUM OF 12" CLEARANCE ON THE TOP OF THE SYSTEM FOR TOP COVER ACCESS
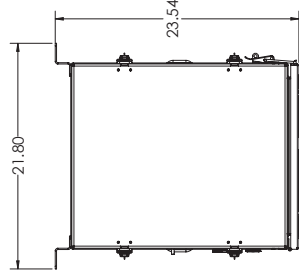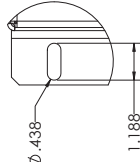FLOORMOUNT BRACKETS
WALLMOUNT BRACKETS

NOTES:
1. WALLMOUNT AND FLOORMOUNT BRACKETS ARE OPTIONAL.
2. WALLMOUNT AND FLOORMOUNT BRACKETS ARE REMOVABLE.
3. TOPLIFT BRACKETS ARE NOT FOR PERMANENT INSTALLATION.
4. THE INSTALLATION OF THIS EQUIPMENT SHALL COMPLY WITH ALL LOCAL AUTHORITY AND APPLICABLE BUILDING CODES.
5. PROVIDE A MINIMUM CLEARANCE OF 12 INCHES ON TOP OF THE CABINET FOR TOP COVER ACCESS.
6. USE ALL PROVIDED MOUNTING SLOTS WHEN INSTALLING EQUIPMENT.
7. HEIGHT AND WEIGHT OF SYSTEM MAY VARY. SEE SPECIFIC SYSTEM DETAILS.

DESCRIPTION
DIAGRAM,MICROCAB,MOUNTING

DOCUMENT NUMBER
DIA\00641

SIZE D
REV B

DRAWN BRS 10/07/2016
THIRD ANGLE PROJECTION
DIMENSIONS & TOLERANCES PER ASME Y14.5 - 2009

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

SENS Limited Warranty: DC Systems

What is covered?
This warranty covers any defect in material and workmanship on PowerCab, PowerCab2, MicroCab, and PowerRack DC Systems provided by Stored Energy Systems, a Colorado Limited Liability Company (SENS).

What this warranty does not cover:
This warranty does not cover damages, defects or failures of 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:
Entire System: for all standard factory configurations, five years from date of shipment for PowerCab2; two years from date of shipment for other DC systems. For non-standard, custom, or special system components, the original manufacturer's warranty will apply.

Embedded battery chargers/rectifiers: five years for IQ models and PowerCab2 models, three years for MicroGenius models.

What we will do:
If your DC 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 component or if necessary, 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.