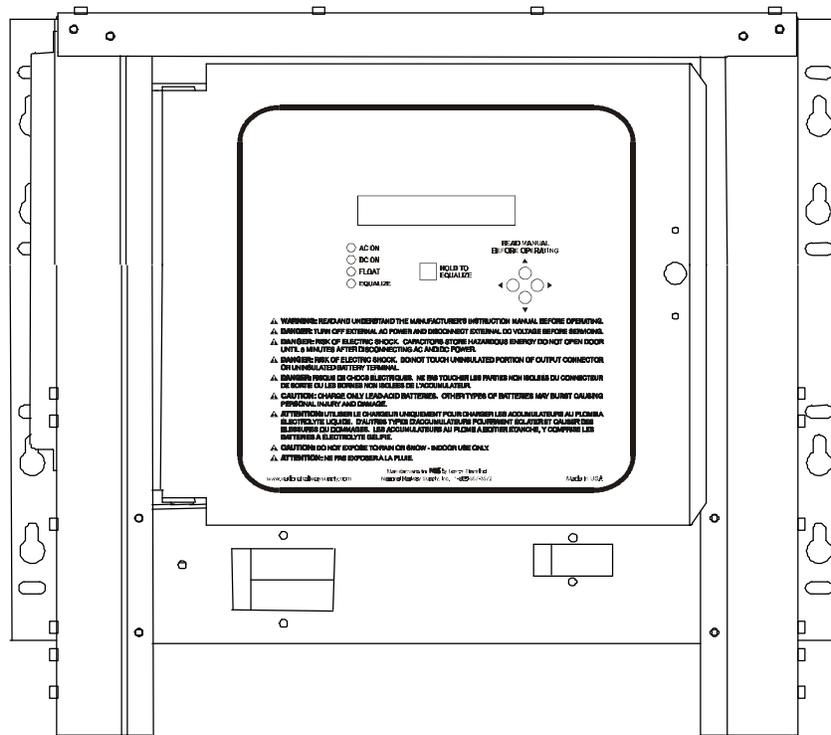


## Important Safety, Installation, Operation and Maintenance Instructions





## HOW TO READ THE MODEL NUMBER

The model number describes the options on the charger. Write the model number from the charger ratings specification label in the spaces provided below. The descriptions shown below will confirm your charger's configuration. If the charger options are changed in the field, please make sure to tag the charger with a detailed description of the changes.

Ordering Code									
	A	B	C	D	E	F	G	H	I
Example	EC	48-	06	E	240	1	2	1	4
Your Code	EC			E					

	Description	Code	Feature
A		EC	EC Series
B	Nominal DC Output Voltage	24-	24 Vdc
		48-	48 Vdc
		130-	130 Vdc
C	Nominal DC Output Current	06	6 Adc
		12	12 Adc
		20	20 Adc
		25	25 Adc
		50	50 Adc
D	Filtering	E	Filtered/Eliminator (std.)
E	AC Input Voltage	120	120 Vac, 50/60 Hz
		208	208 Vac, 50/60 Hz
		240	240 Vac, 50/60 Hz
F	Alarms	0	None
		1	Alarm Board/Individual Form C Contacts/Relays
G	Remote Control/Sensing	0	None
		1	Remote Temp Comp Cable/Sensor (10 ft.)
		2	Remote Temp Comp Cable/Sensor (25 ft.)
		3	Remote Voltage Sensing Leads (30 ft.)
		4	Options 1 & 3
		5	Options 2 & 3
H	Lighting Arrestor	0	None
		1	Included
I	Other Options	0	None
		1	Lockable Door (2 keys)
		2	NEMA 3R (Outdoor)
		3	NEMA 12 (Indoor)
		4	19" Relay Rack Mounting Brackets
		5	23" Relay Rack Mounting Brackets
		6	Options 1 & 4
		7	Options 1 & 5

**SAVE THIS MANUAL:** Keep it in a location where it is available to anyone who may operate or service the charger.

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## **IMPORTANT SAFETY INSTRUCTIONS**

1. **SAVE THESE INSTRUCTIONS** – This manual contains important safety and operating instructions.
2. Before using battery charger, read all instructions and cautionary markings on battery charger, battery, and product using battery.



**LOOK FOR THIS SYMBOL TO POINT OUT SAFETY PRECAUTIONS. IT MEANS: *BE ALERT—YOUR SAFETY IS INVOLVED.* IF YOU DO NOT FOLLOW THESE SAFETY INSTRUCTIONS, INJURY OR PROPERTY DAMAGE CAN OCCUR.**

3. **⚠ CAUTION:** This charger is factory set to charge only lead-acid type rechargeable batteries. Other types of batteries may burst causing personal injury and damage. Before charging any other type of rechargeable battery, change the charger settings as recommended by that battery manufacturer.
4. **⚠ DANGER:** TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, CAREFULLY READ AND FOLLOW THESE IMPORTANT SAFETY AND OPERATING INSTRUCTIONS BEFORE INSTALLING OR OPERATING THE CHARGER.
5. **⚠ INSTRUCTIONS IMPORTANTES CONCERNANT LA SECURITÉ.**
6. **⚠ DANGER:** RISK OF ELECTRIC SHOCK. CAPACITORS STORE HAZARDOUS ENERGY. DO NOT OPEN DOOR OR REMOVE PANELS UNTIL 5 MINUTES AFTER DISCONNECTING ALL AC AND DC SUPPLY. THE CAPACITORS WILL HOLD A CHARGE FOR UP TO 5 MINUTES AND CAN CAUSE A SHOCK EVEN IF THE POWER HAS BEEN DISCONNECTED.
7. **⚠ DANGER:** TURN OFF EXTERNAL AC POWER AND DISCONNECT EXTERNAL DC VOLTAGE BEFORE SERVICING CHARGER OR BEFORE CONNECTING OR DISCONNECTING THE BATTERY TO PREVENT ARCING OR BURNING.
8. **⚠ DANGER:** RISK OF ELECTRIC SHOCK. DO NOT TOUCH UNINSULATED ELECTRICAL PARTS, EITHER AC OR DC, WHILE THE POWER IS CONNECTED.
9. **⚠ DANGER:** RISQUE DE CHOCS ÉLECTRIQUES. NE PAS TOUCHER LES PARTIES NON ISOLÉES DU CONNECTEUR DE SORTI OU LES BORNES NON ISOLÉES DE L'ACCUMULATEUR.
10. **⚠ DANGER:** TO PREVENT ELECTRICAL SHOCK, DO NOT TOUCH EITHER AC OR DC UNINSULATED PARTS. MAKE SURE ALL ELECTRICAL CONNECTORS ARE IN GOOD WORKING CONDITION. DO NOT USE CONNECTORS THAT ARE CRACKED, CORRODED OR DO NOT MAKE ADEQUATE ELECTRICAL CONTACT. USE OF A DAMAGED OR DEFECTIVE CONNECTOR MAY RESULT IN A RISK OF OVERHEATING OR ELECTRIC SHOCK.
11. **⚠ WARNING:** HAZARD OF ELECTRIC SHOCK.

- 
12. Lead-acid batteries generate explosive gases. To prevent arcing or burning near batteries, do not disconnect DC charging cord from batteries when the charger is operating. Switch the AC breaker and the DC breaker to the “off” position before disconnecting the DC output cord from the batteries. Keep sparks, flame, and smoking materials away from batteries.
  13. Always shield eyes when working near batteries. Do not put wrenches or other metal objects across battery terminal or battery top. Arcing or explosion of the battery can result.
  14. Batteries produce hydrogen gas, which can explode if ignited. Never smoke, use an open flame, or create sparks near the battery. Ventilate the area when the battery is charging in an enclosed place.
  15. Lead-acid batteries contain sulfuric acid, which may cause burns. Do not get acid in eyes, on skin, or clothing. If contact with the eyes occurs, flush immediately with clean water for 15 minutes and obtain medical attention.
  16. Only qualified personnel should program or service this equipment.
  17. De-energize all AC and DC power connections before servicing this unit. If injury does occur, apply standard treatment for electric shock and, if necessary, consult with a physician.
  18.  **CAUTION: FOR INDOOR USE ONLY. THIS CHARGER IS NOT DESIGNED FOR OUTDOOR USE. DO NOT EXPOSE THE CHARGER TO RAIN OR SNOW.**
  19.  **ATTENTION: NE PAS EXPOSER À LA PLUIE.**
  20.  **ATTENTION: UTILISER POUR CHARGER UNIQUEMENT LES ACCUMULATEURS AU PLOMB À ELECTROLYTE LIQUIDE. D'AUTRES TYPES D'ACCUMULATEURS POURRAIENT ÉCLATER ET CAUSER DES BLESSURES OU DOMMAGES. LES ACCUMULATEURS AU PLOMB À BOÎTIER ÉTANCHE, Y COMPRISE LES BATTERIES À ÉLECTROLYTE GÉLIFIÉ.**
  21. This charger is factory set to charge lead-acid batteries.
  22. Do not operate the charger if it has received a sharp blow, been dropped, or otherwise damaged. Have a factory authorized service technician examine and repair as needed.
  23. Do not disassemble the charger. Have the charger examined by a factory authorized service technician. Incorrect re-assembly of the charger may result in an explosion, electric shock, or fire.
  24. Make sure the battery system has the properly rated voltage for this charging system.

**SAVE THESE INSTRUCTIONS**

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## 1. INTRODUCTION

This single-phase battery charger is convection cooled, microprocessor controlled, and SCR regulated. The charger has an “I-E” profile, which is high rate constant current (start region), and constant voltage (plateau region). The plateau region is defined by one voltage point (knee) where the start region changes into the plateau region. This plateau voltage point is called the “Float Voltage” and it is factory set at 2.25 volts per cell for charging lead acid batteries.

The charger has an equalize feature used to perform an equalize charge of the battery. An equalize charge is periodically used to change the voltage set point above the normal float voltage. This increases the gassing to mix the electrolyte in a battery and charge all of the cells to a uniform level. The equalize charge voltage is factory set to 2.32 volts per cell. Contact your battery manufacturer’s authorized service technician for information on how often your batteries should be equalized.

**⚠CAUTION: This charger is factory set to charge only lead-acid type rechargeable batteries. Other types of batteries may burst causing personal injury and damage. Before charging any other type of rechargeable battery, change the charger settings as recommended by that battery manufacturer.**

The charger settings can be changed by following the instructions in SECTION 11, “CONTROL BOARD OPERATION”, of this manual.

## 2. RECEIVING CHARGER

Unpack the charger and examine it for possible shipping damage. If any damage is found, report it immediately as a claim to the carrier.

## 3. STORING CHARGER

When the charger is stored prior to being installed and powered up, it should be stored upright, bolted to the shipping pallet, and covered by the plastic wrap and shipping carton it was shipped in. This will help protect it from dust and abrasion. It should be stored in an area where it is not likely to be damaged. Do not stack anything on top of the charger.

It must be stored indoors in a clean and dry environment where the temperatures will not exceed a range of 32° F to 120°F (0°C to 49°C).

The charger should not be stored more than two years before it is powered up. If the charger capacitors are not powered up, they will lose their effectiveness over time and may need to be replaced.

## 4. LOCATION FOR CHARGER INSTALLATION

**⚠WARNING: DO NOT INSTALL THE CHARGER ON OR NEAR COMBUSTIBLES OR EXPLOSIVES. INSTALL THE CHARGER ON A FIRE RESISTANT FOUNDATION OF STONE, BRICK, CONCRETE OR GROUNDED METAL.**

The charger should be located in a clean, cool, dry and well-ventilated area. To permit ample airflow for convection cooling, allow 4” (102mm) minimum clearance on both the right and left sides of the charger. Allow more space for cooling and convenience of service and maintenance if possible. Do not obstruct the airflow space provided behind and underneath the charger.

Allow 36” (914mm) minimum clear space in front of the charger for ease of operation, maintenance and service.

**⚠WARNING: DO NOT INSTALL THE CHARGER ABOVE OR NEAR THE BATTERIES.** The batteries give off hydrogen gas, which rises upward and can be explosive and also produce acid fumes, which may harm the charger.

Do not install the charger in an area where conditions may be below freezing, above 105° Fahrenheit (40°C) or above 95% relative humidity. These extreme temperatures will reduce the current capacity and possibly the

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service life of the charger. If the charger is to be operated at any of these temperature extremes, contact the manufacturer to verify it will withstand these conditions, and perform at the needed capacity.

The overall outer dimensions of the S1, S2, and S3 charger enclosures are shown in FIGURE 4.0.

Enclosure sizes	Overall height in modular units	Overall height in inches (mm)	Overall width in inches (mm)	Overall depth in inches (mm)
S1	10 U*	17.50 (445)	19.00 (483)	16.75 (425)
S2	15 U*	26.25 (667)	19.00 (483)	16.75 (425)
S3	20 U*	35.00 (889)	19.00 (483)	16.75 (425)

**\*A modular unit (U) is 1.75" (44mm) as defined by the ELECTRONIC INDUSTRIES ASSOCIATION (EIA).**

\*\* Overall width is from the outer edges of mounting flanges, to correspond to a 19" (483mm) rack width.

## **5. INSTALLATION OF CHARGER**

Proper installation is important to achieve good charger performance and to prevent damage to the charger and batteries.

The S1, S2, and S3 enclosure sizes of the charger can be mounted on a shelf, countertop, floor, wall, or relay rack.

Be sure to plan a clear routing for the conduit connections prior to mounting the charger. Looking at the front of the charger, the conduit knockouts are provided on the right side, left side and bottom of the enclosure. See SECTION 6.3. The AC input connections should enter at the left and the DC output connections at the right. The alarm relay wiring, sensor wiring, and remote control wiring should enter at the right side through a separate conduit knockout from the DC connections. The AC and DC wiring should be separated from each other and from the other optional types of wiring, this is a UL requirement.

### **5.1 SHELF, COUNTERTOP OR FLOOR MOUNTING**

The S1, S2 and S3 cabinets of the charger are shipped standard with a kit to install four cushioned feet. These are designed to prevent marring of the mounting surface and to absorb vibration. The kit can be found inside the charger cabinet in a small plastic bag. The kit consists of four round black rubber feet and four mounting screws.

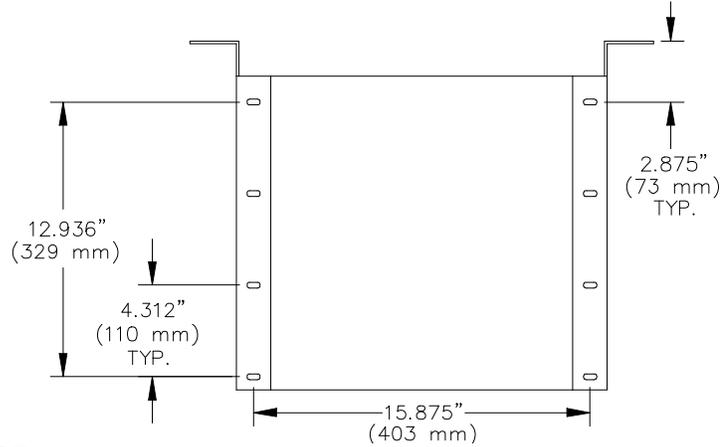
To install the feet, carefully lay the charger on its back onto a protective surface such as the shipping carton collapsed flat. The four small .16" (4mm) diameter mounting holes can be found on the bottom surface of the charger legs near the four corners of the charger. Place the mounting screw through the recessed end of the foot. The screw head will be within the recess and the screw point will engage into the mounting hole in the bottom of the charger. The screw is self-threading into the mounting hole. Tighten each screw until it is snug but do not over compress the rubber.

Now, the charger can be rotated back to its upright position standing on the rubber feet. Be careful to lift (do not slide) the charger into position.

Next, to avoid placing strain on the conduit and wiring, anchor the charger so it does not become displaced. This can be done in either of two ways. The charger can be bolted down to the horizontal-mounting surface that it is resting on or it can be bolted to the wall behind it.

To bolt to the horizontal mounting surface, the mounting bolts will attach through the four ½" (13mm) diameter mounting bolt holes in the bottom surface of the charger legs that are nearest the corners of the charger. The charger itself can be used as a template to mark the locations of the holes to be made in the mounting surface or the bottom mounting hole dimensions in FIGURE 5.1 can be used to measure the locations of the mounting bolt holes.

**FIGURE 5.1: BOTTOM MOUNTING HOLE DIMENSIONS**

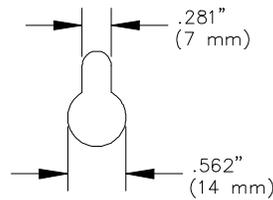


**5.2 WALL MOUNTING**

The S1, S2 and S3 cabinets have built-in wall mounting flanges at the rear. When these flanges are mounted flush against the wall, they provide for a clear airflow space at the rear of the charger. This space should not be reduced or obstructed in any way.

The mounting flanges each have a series of keyhole slots. These are designed to conveniently engage a 1/4\" (6mm) diameter bolt. The mounting flange bolt hole patterns are shown in FIGURES 5.2-1 and 5.2-2.

**FIGURE 5.2-1: KEYHOLE DIMENSIONS**



**FIGURE 5.2-2: CHARGER WALL MOUNTING HOLES**

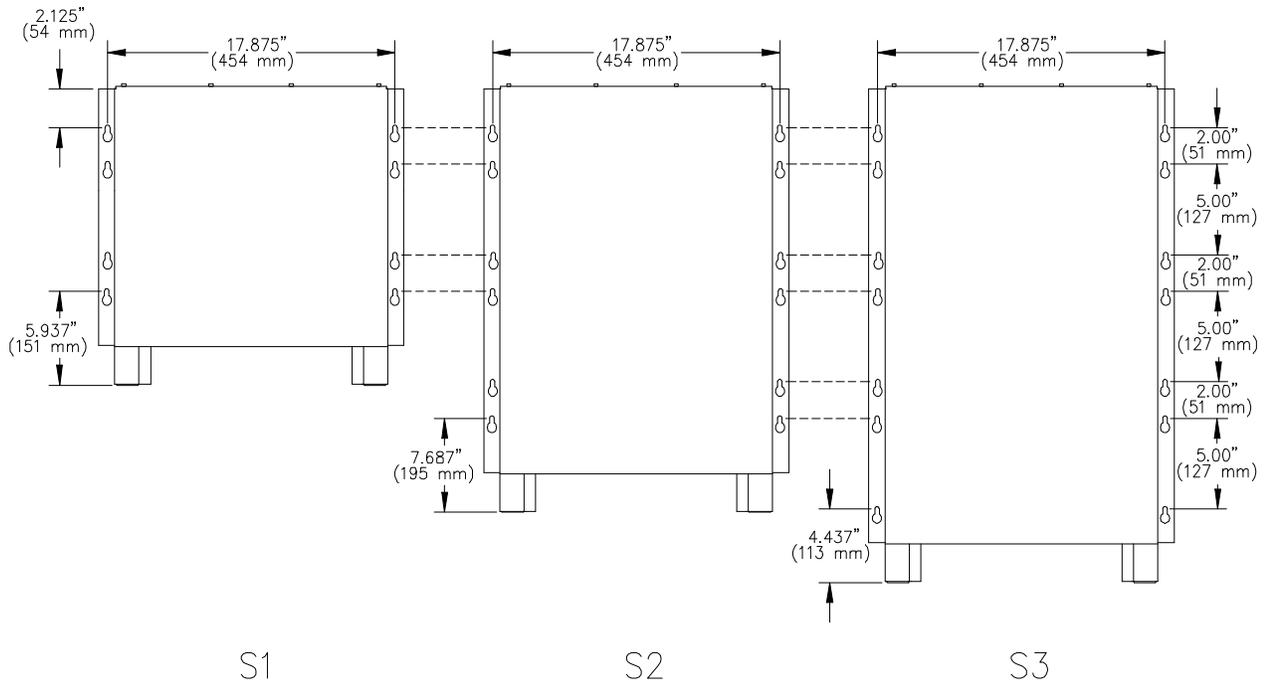


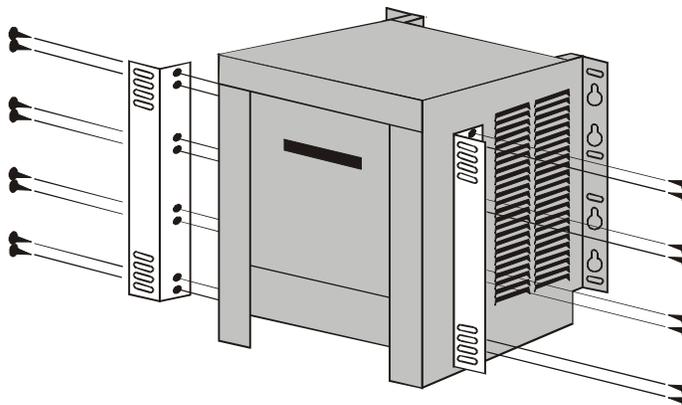
FIGURE 5.2-3: WALL ANCHOR DESIGN LOADS TABLE			
Charger Type	Enclosure size	Charger weight lbs. (Kg)	Design load lbs. (Kg)
24VDC 6A	S1	70 (32)	350 (159)
24VDC 12A	S1	75 (34)	375 (170)
24VDC 18A	S1	85 (39)	425 (193)
24VDC 20A	S1	85 (39)	425 (193)
24VDC 25A	S1	90 (41)	450 (204)
24VDC 50A	S3	190 (86)	950 (432)
48VDC 6A	S1	75 (34)	375 (170)
48VDC 12A	S1	90 (41)	450 (204)
48VDC 18A	S1	110 (50)	550 (249)
48VDC 20A	S1	110 (50)	550 (249)
48VDC 25A	S1	115 (52)	575 (261)
48VDC 50A	S3	222 (100)	1110 (500)
130VDC 6A	S1	100 (45)	500 (227)
130VDC 12A	S1	130 (59)	650 (295)
130VDC 18A	S2	175 (79)	875 (397)
130VDC 20A	S2	175 (79)	875 (397)
130VDC 25A	S2	190 (86)	950 (432)
130VDC 50A	S3	340 (154)	1700 (771)

FIGURE 5.2-3 shows the weight that the set of mounting bolts and their anchoring structure must withstand for the various charger types. The “DESIGN LOAD” shows the “CHARGER WEIGHT” times a safety factor of five (5). Be certain that both the mounting structure and the bolts will, at a minimum, support the “DESIGN LOAD”. Drywall or plaster will not be strong enough on its own, without proper structural reinforcement.

### 5.3 RACK MOUNTING

The S1, S2 and S3 cabinets can be mounted to a standard EIA 19” (483mm) rack system using the fasteners provided by the rack manufacturer. The rear mounting flanges are configured for an EIA 19” (483mm) rack for a forward mounting arrangement. For a recessed mounting arrangement, optional mounting brackets can be attached to the charger sides to fit either an EIA 19” (483mm) or a 23” (584mm) rack. See FIGURE 5.3.

FIGURE 5.3: ATTACHING RACK-MOUNTING BRACKETS



**CAUTION:** TO ENSURE THE STRUCTURAL INTEGRITY OF THE RACK MOUNTING BRACKETS, USE THE SIXTEEN #10 SELF-THREADING SCREWS PROVIDED IN THE KIT. USE EIGHT SCREWS PER BRACKET AND TIGHTEN THEM UNTIL SNUG. DO NOT STRIP THE THREADS.

## 6. AC ELECTRICAL SUPPLY

The charger must be connected to a single-phase power source. All models can operate on an AC power source input frequency of 50 or 60  $\pm$  3% Hertz. Check the label on the front of the charger or contact the manufacturer for proper AC power source. The AC input voltage is pre-wired at the factory to 120, 208 or 240 (+10% / -12%) VAC and should not be changed.

**NOTE: Field alteration of input voltage voids the charger's UL Listing.**

The AC input wiring must be sized and installed in compliance with the National Electric Code and all applicable state and local codes and requirements. A qualified electrician must install the AC input wiring system.

**⚠ CAUTION: TO REDUCE THE RISK OF FIRE, USE ONLY CIRCUITS PROVIDED WITH BRANCH CIRCUIT PROTECTION IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE, ANSI/NFPA 70.**

### 6.1 AC INPUT CONNECTIONS

The standard charger is shipped with conduit knockouts and no AC power supply cord. A qualified electrician must perform this AC input wiring work.

FIGURE 6.1-1: RATINGS AND BREAKERS TABLE								
DC Output					AC Input			
Rated DC Volts	Rated DC Amps	Rms. DC Amps	DC Circuit Breaker Amps	Optional Cable Size AWG	Rated AC Input Volts	Rated AC Amps	AC Frequency Hz	AC Circuit Breaker Amps
24	6	10	15	14	120 only	5	60 or 50	10
24	6	10	15	14	208 only	3	60 or 50	10
24	6	10	15	14	240 only	3	60 or 50	10
24	12	20	30	12	120 only	7	60 or 50	10
24	12	20	30	12	208 only	5	60 or 50	10
24	12	20	30	12	240 only	5	60 or 50	10
24	18	35	40	8	120 only	10	60 or 50	15
24	18	35	40	8	208 only	6	60 or 50	10
24	18	35	40	8	240 only	6	60 or 50	10
24	20	35	40	8	120 only	12	60 or 50	15
24	20	35	40	8	208 only	7	60 or 50	10
24	20	35	40	8	240 only	7	60 or 50	10
24	25	40	60	8	120 only	14	60 or 50	20
24	25	40	60	8	208 only	8	60 or 50	10
24	25	40	60	8	240 only	8	60 or 50	10
24	50	80	90	6	120 only	24	60 or 50	30
24	50	80	90	6	208 only	15	60 or 50	20
24	50	80	90	6	240 only	15	60 or 50	20

**Notes: All input AC circuit breakers are of the "high inrush" type to prevent nuisance tripping during power-up.**  
(Continued on next page)

FIGURE 6.1-1: RATINGS AND BREAKERS TABLE								
DC output					AC input			
Rated DC Volts	Rated DC Amps	Rms. DC Amps	DC Circuit Breaker Amps	Optional Cable Size AWG	Rated AC Input Volts	Rated AC Amps	AC Frequency Hz	AC Circuit Breaker Amps
48	6	10	15	14	120 only	7	60 or 50	10
48	6	10	15	14	208 only	5	60 or 50	10
48	6	10	15	14	240 only	5	60 or 50	10
48	12	20	30	12	120 only	14	60 or 50	20
48	12	20	30	12	208 only	8	60 or 50	15
48	12	20	30	12	240 only	7	60 or 50	10
48	18	35	50	8	120 only	17	60 or 50	30
48	18	35	50	8	208 only	11	60 or 50	15
48	18	35	50	8	240 only	10	60 or 50	15
48	20	35	50	8	120 only	18	60 or 50	30
48	20	35	50	8	208 only	12	60 or 50	15
48	20	35	50	8	240 only	10	60 or 50	15
48	25	40	60	8	120 only	28	60 or 50	30
48	25	40	60	8	208 only	14	60 or 50	20
48	25	40	60	8	240 only	13	60 or 50	20
48	50	80	90	6	120 only	45	60 or 50	60
48	50	80	90	6	208 only	25	60 or 50	40
48	50	80	90	6	240 only	23	60 or 50	40
130	6	10	15	14	120 only	14	60 or 50	20
130	6	10	15	14	208 only	9	60 or 50	15
130	6	10	15	14	240 only	8	60 or 50	15
130	12	20	25	12	120 only	27	60 or 50	40
130	12	20	25	12	208 only	17	60 or 50	30
130	12	20	25	12	240 only	15	60 or 50	25
130	18	35	40	8	120 only	45	60 or 50	60
130	18	35	40	8	208 only	24	60 or 50	40
130	18	35	40	8	240 only	21	60 or 50	30
130	20	35	40	8	120 only	45	60 or 50	60
130	20	35	40	8	208 only	24	60 or 50	40
130	20	35	40	8	240 only	22	60 or 50	30
130	25	40	60	8	120 only	63	60 or 50	70
130	25	40	60	8	208 only	32	60 or 50	40
130	25	40	60	8	240 only	32	60 or 50	40
130	50	80	90	4	208 only	70	60 or 50	90
130	50	80	90	4	240 only	60	60 or 50	70

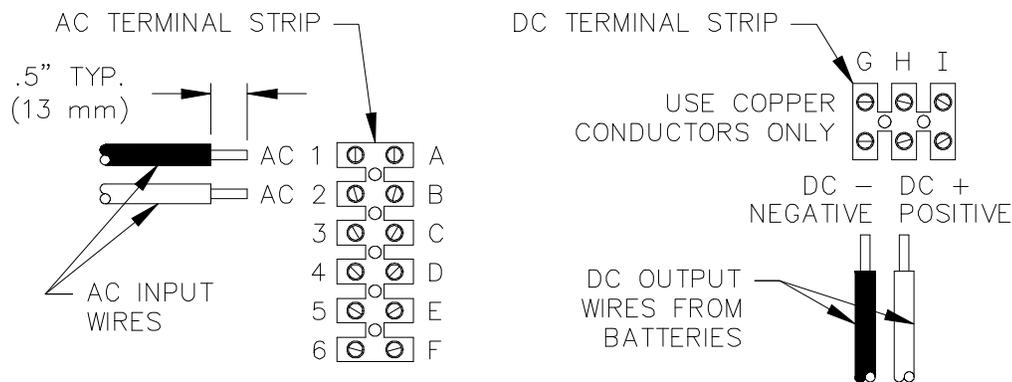
**Notes:** All input AC circuit breakers are of the "high inrush" type to prevent nuisance tripping during power-up.

Wiring and connections must meet the requirements of the National Electric Code, state and local codes and requirements, and the requirements in this manual.

To connect the input AC voltage, route the AC conduit through the appropriate knockout hole. See SECTION 6.3. Route the AC wiring to terminal lugs **AC1** and **AC2** located above the AC breaker as shown in FIGURE 6.1-2. **For proper connection, torque the AC1 and AC2 terminal strip screws to 18 inch pounds (2Nm), and the ground lug screw to 35 inch pounds (4Nm), see FIGURES 6.1-2 and 6.1-3.**

**⚠ WARNING: ALL AC AND DC CIRCUIT BREAKERS MUST BE IN THE “OFF” POSITION WHILE MAKING THE AC AND DC CONNECTIONS TO THE CHARGER.**

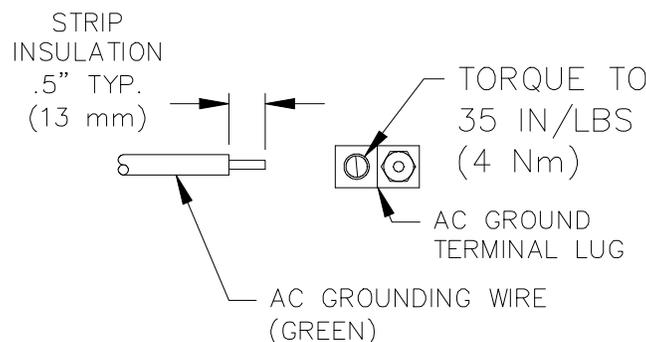
**FIGURE 6.1-2: AC AND DC WIRE HOOK UP**



**⚠ WARNING: IMPROPERLY CONNECTED WIRING CAN CAUSE AN ELECTRICAL FIRE.**

Connect the AC ground to the terminal lug located to the right of the AC breaker on the charger floor as shown in FIGURE 6.1-3. In some models the AC ground lug is above the AC terminal strip on the inner-panel. See SECTION 6.3. For proper connection torque the screw to 35 inch pounds (4Nm).

**FIGURE 6.1-3: GROUND WIRE HOOK UP**  
(Located on charger floor (S1,S2) or above terminal strip (S3))



**⚠ WARNING: DO NOT OPERATE THE CHARGER WITHOUT PROPER GROUNDING. IMPROPER GROUNDING MAY CAUSE AN ELECTRIC SHOCK, WHICH COULD RESULT IN INJURY OR DEATH.**

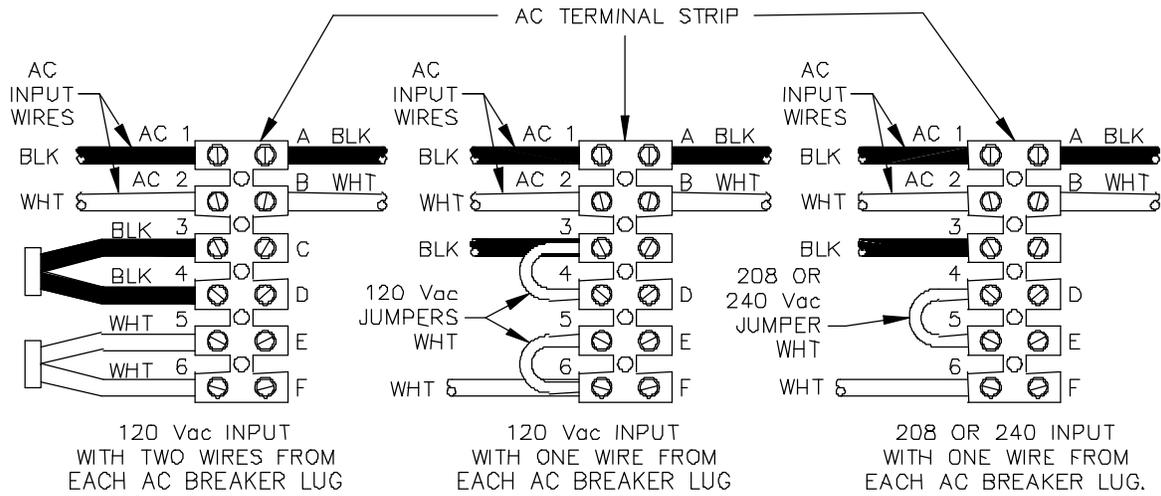
## 6.2 AC VOLTAGE JUMPER SETTINGS

Check the “AC VOLTS” box on the charger rating specification label to determine its AC Voltage setting. The AC Voltage jumper settings and the AC Input Voltage of the charger cannot be changed. See FIGURE 6.2 for AC Voltage Jumper Settings.

**NOTE: Field alteration of AC voltage jumper settings voids charger’s UL listing.**

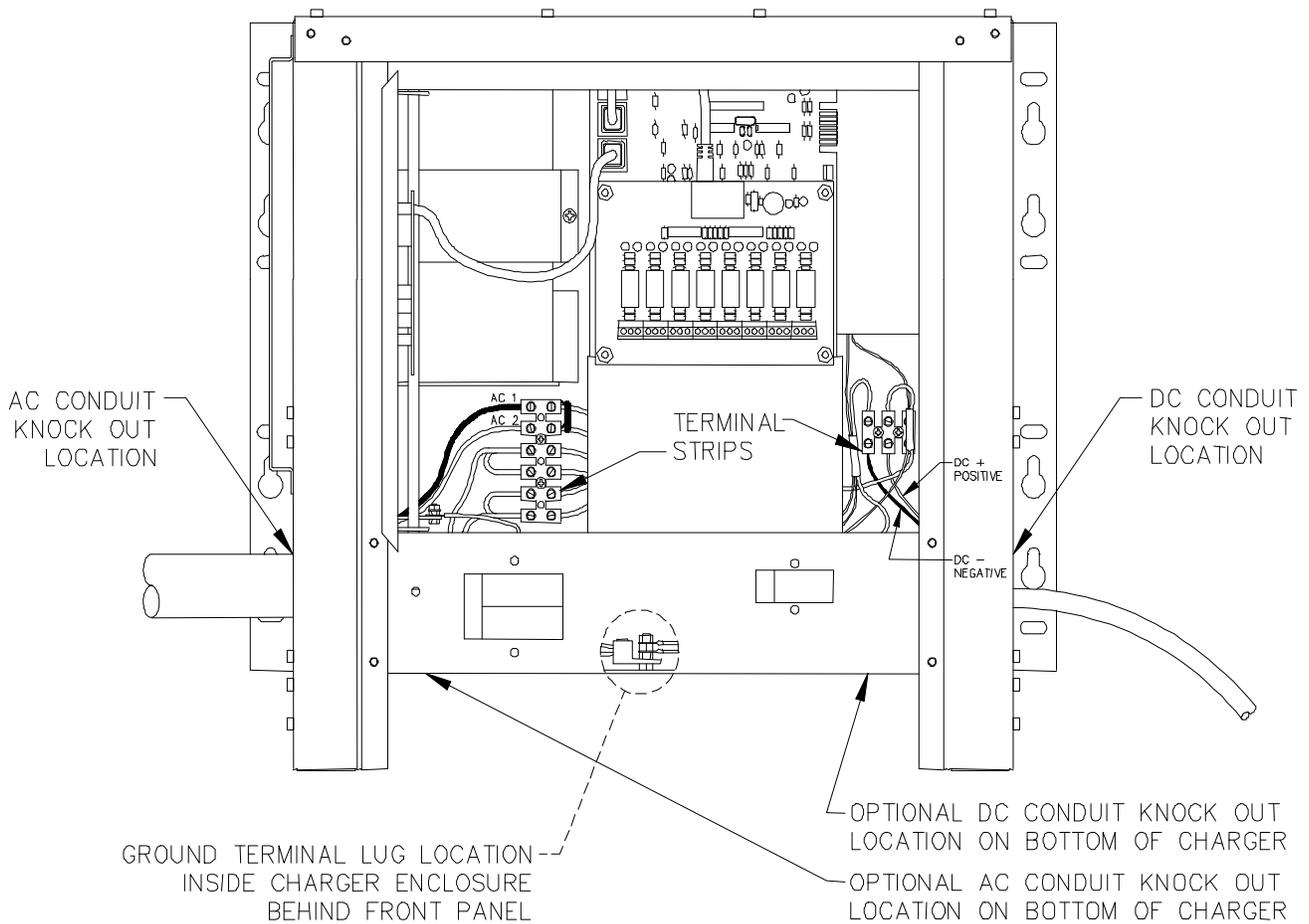
**⚠ WARNING: IMPROPER AC VOLTAGE JUMPER CONNECTION MAY CAUSE SEVERE DAMAGE TO THE CHARGER AND BATTERY.**

**FIGURE 6.2: AC VOLTAGE JUMPER POSITIONS**



### 6.3 AC AND DC CONNECTION LOCATIONS

**FIGURE 6.3-1: S1 ENCLOSURE**



**FIGURE 6.3-2: S2 ENCLOSURE**

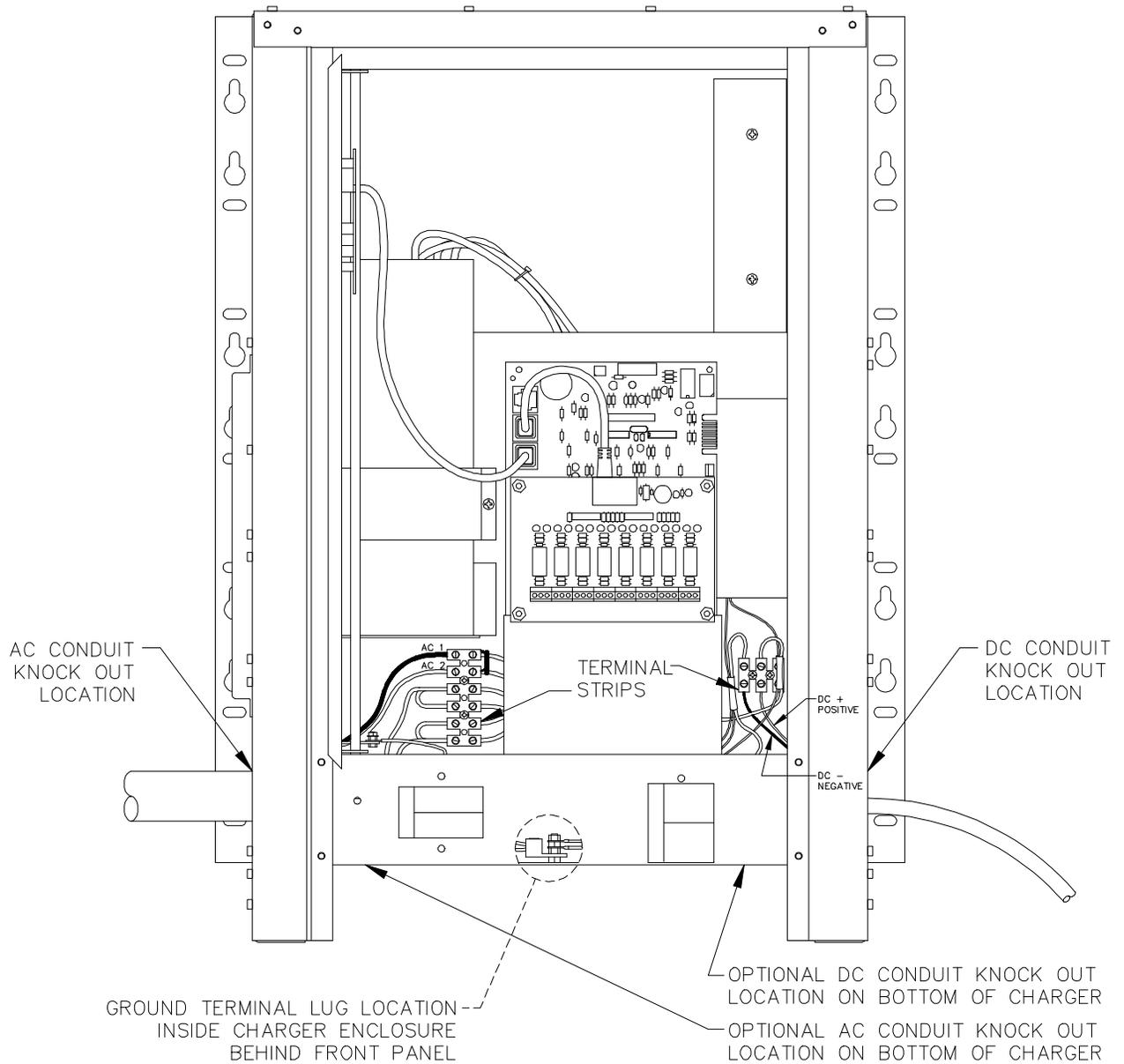
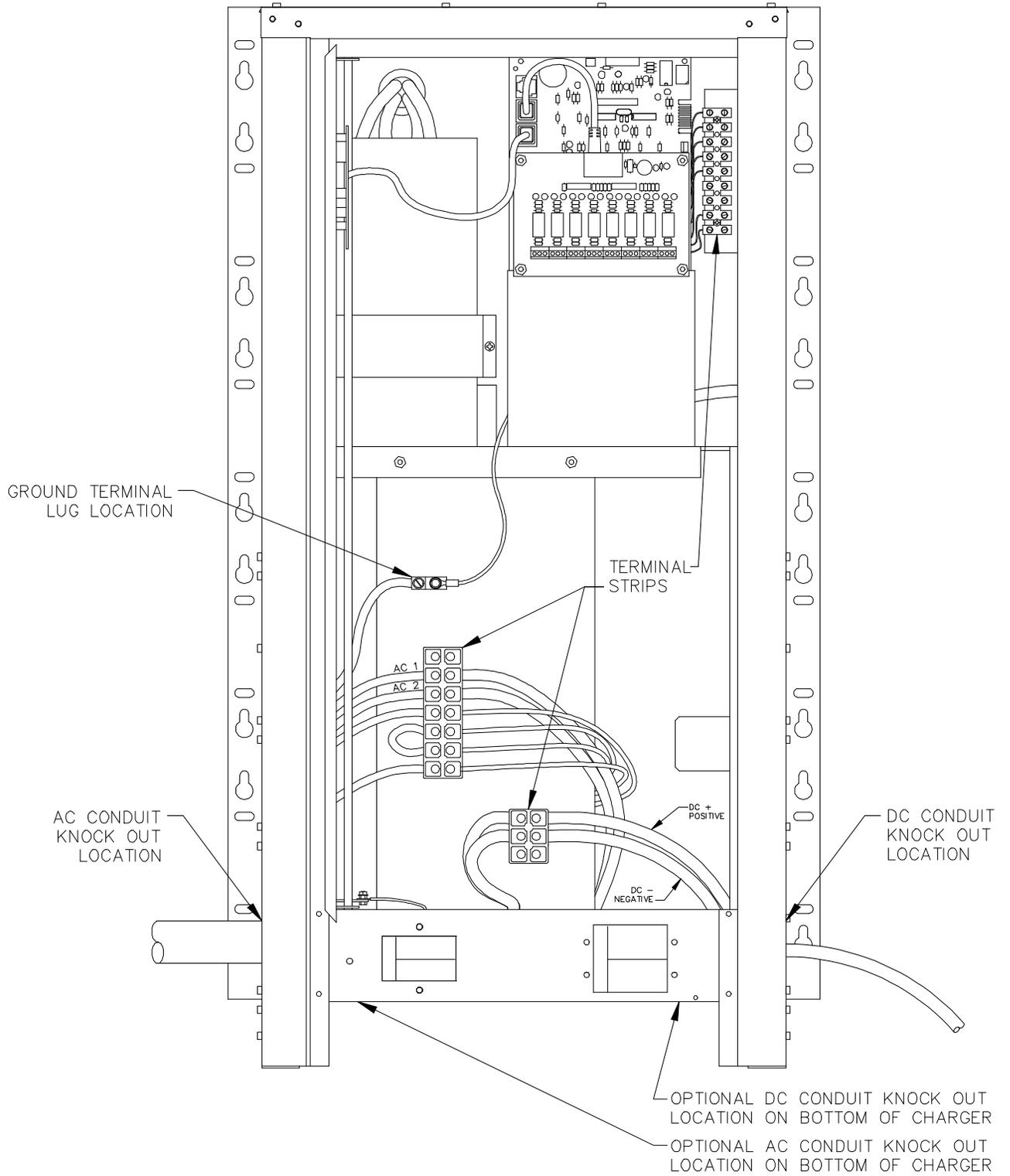


FIGURE 6.3-3: S3 ENCLOSURE



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## 7. DC OUTPUT

It is recommended that a DC disconnect switch or circuit breaker be used between the charger and the DC bus. This device should have lockout capability to allow the charger to be disconnected from the DC bus when connecting the charger during installation and maintenance.

### 7.1 DC OUTPUT CONNECTIONS

The standard charger is shipped with conduit knockouts and no DC output cable. Determine which charger knockout to route the DC output cable through. See Section 6.3. Make sure to keep the DC output cable isolated from the AC input cables and any other optional wiring.

To help in determining the proper size of cable to use for the DC output, FIGURE 7.1 lists the DC voltage drop per one foot (305mm) of cable for the various Rated DC currents of the chargers and various wire sizes. Take the appropriate number from FIGURE 7.1, and multiply it by the cable length needed to get the approximate voltage drop from the charger to the battery or DC bus. FIGURE 7.1 values are approximate values, the exact value can be measured after installation.

NOTE: If the total voltage drop of the DC output cable is greater than 1% of the charger voltage ( 0.24 VDC for a 24 VDC system, 0.48 VDC for a 48 VDC system, 1.3 VDC for a 130 VDC system) it is recommended that the optional Remote DC Voltage Sensing cable be used.

To connect the DC output cable, route the conduit through the appropriate knockout hole. Route the DC positive wire to terminal lug labeled **DC POSITIVE** and the DC negative wire to terminal lug labeled **DC NEGATIVE** located above the DC breaker as shown in FIGURE 6.1-2. **For proper connection, torque the terminal strip screws to 18 inch pounds (2Nm).** The charger will not operate in a reversed polarity condition. The DC output circuit breaker is used to protect the silicon-controlled rectifiers (SCRs).

**NOTE: DC circuit breaker may trip when switched on until capacitors are charged.**

FIGURE 7.1: VOLTAGE DROP PER 1 FT (305mm) OF WIRE TABLE						
For stranded copper wire at 68°F (20°C)						
WIRE SIZE (AWG.)	RATED DC CURRENT, AMPERES					
	6A	12A	18A	20A	25A	50A
16	0.0450	0.0900	0.1440	-	-	-
14	0.0270	0.0540	0.0864	0.0945	-	-
12	0.0180	0.0360	0.0576	0.0630	0.0720	-
10	0.0110	0.0220	0.0352	0.0385	0.0440	0.0880
8	0.0070	0.0140	0.0224	0.0245	0.0280	0.0560
6	0.0045	0.0090	0.0144	0.0158	0.0180	0.0360
4	0.0025	0.0050	0.0080	0.0088	0.0100	0.0200
2	0.0018	0.0036	0.0058	0.0063	0.0072	0.0144
1	0.0015	0.0030	0.0048	0.0053	0.0060	0.0120
0	0.0011	0.0022	0.0035	0.0039	0.0044	0.0088

## 8. REMOTE AND ALARM I/O RELAY OPTIONS

The Remote option allows the charger to be controlled and monitored remotely. The ALARM I/O relay board allows the user to connect other devices to it to monitor various faults. The following sections go over function and installation of these optional parts.

### 8.1 REMOTE DC VOLTAGE SENSING

This option will compensate for the voltage drop across the DC output cable due to the resistance and current flowing through it. The remote voltage sensing cable can measure the DC voltage of batteries or DC bus up to 30 ft. (9m) with the standard cable length. This can be extended with a longer cable. This gives the charger display a more accurate voltage display. In order for the charger to function, the connection to the DC bus must be secure and reliable.

If the charger was shipped from the factory with the optional Remote Voltage Sensing cable, it will have the sensing wires installed into the correct terminal strip and have the resistors moved to the correct location. If this option is added later, installation instructions on how to wire it will be included.

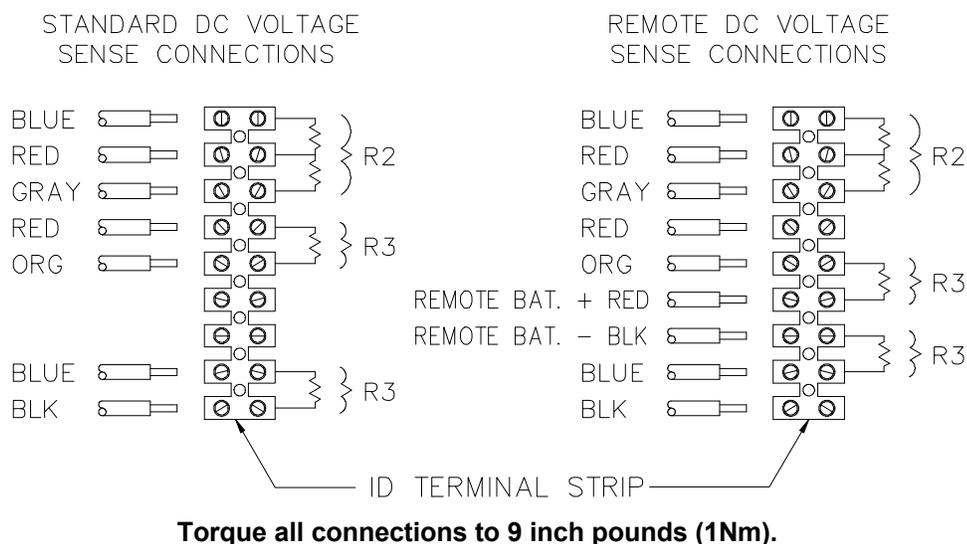
### 8.1.1 WIRING THE REMOTE DC VOLTAGE CABLE

With both AC and DC de-energized follow the procedure below:

1. Place the RED and BLACK wires that are coiled up inside the charger through one of the spare knockouts provided on the DC side of the enclosure. See SECTION 6.3. Do not place in the same knockout as either the AC input or DC output wiring. Protect the wires to ensure the sharp edges of the opening will not damage the wire. It is recommended to place a fuse in-line with the cable near the battery connection in case the wires would get shorted together.
2. Securely connect the RED wire to the POSITIVE of the battery or DC bus.
3. Securely connect the BLACK wire to the NEGATIVE of the battery or DC bus.
4. Wire tie the cables so they can not be pulled loose.
5. After the charger is fully installed, connect the DC bus to the charger. Verify the voltage on the display corresponds to the actual battery voltage. If so, the charger is ready for service.

For wiring diagram of this option, see FIGURE 8.1.1.

**FIGURE 8.1.1: CHARGER VOLTAGE SENSING WIRING DIAGRAM**



### 8.1.2 REMOVING REMOTE VOLTAGE SENSING CABLE

When removing Remote Voltage Sensing Cable both AC and DC will need to be de-energized. Reference FIGURE 8.1.1 for proper placement of wires and R3 resistors.

## 8.2 REMOTE TEMPERATURE SENSING CABLE

This option will allow the charger to adjust the charging voltage to compensate for the temperature of the batteries. The temperature of the battery will be closely monitored by the sensor and the float and equalize voltages will be adjusted accordingly. The remote temperature sensing cable has a temperature sensor that needs to be mounted to the battery post for accurate battery temperature sensing.

Temperature compensation is based on a reference temperature of 77°F (25°C). The Temperature compensation factor is - 2.5 mV (millivolts) per Cell per Degree F (- 4.5 mV per cell per Degree C). The compensation factor is NEGATIVE because of the inverse relationship between the temperature and the voltage (i.e. as the temperature increases the voltage should decrease).

---

**Note:** When the remote temperature sensing cable is not installed, charging voltages can be adjusted to compensate based on the internal temperature sensor, which is inside each charger on the SCR driver board.

### **8.2.1 REMOTE TEMPERATURE SENSING CABLE INSTALLATION**

A charger shipped from the factory will not have this option connected and temperature compensation will be disabled. With both AC and DC de-energized, follow the procedure below:

1. The remote temperature sensing cable will be in the charger's shipping carton. Carefully unpack the cable from its bag and inspect for any cuts in the cable.
2. Place the 3-pin connector of the cable through one of the spare knockouts provided on the DC side of the enclosure. See SECTION 6.3. Do not place in the same knockout as either the AC input or DC output wiring. Protect the wire to prevent damage from the sharp edges of the opening.
3. Connect the 3-pin connector to JP5. Secure the cable to prevent it from being pulled loose. See FIGURE 10.1.
4. Secure the other end of the cable to a negative battery terminal post in the center of the battery set.
5. After the installation is finished, connect DC voltage and verify that the display temperature corresponds to the temperature of the battery. To view the external temperature, refer to SECTION 11.3.8 of the manual.
6. Enable the Temperature Compensation by going to DC Settings then go to Temperature Compensation. Default is disabled. Enable it to External (EX) by pressing right twice, refer to SECTION 11.3.3 of the manual.
7. The charger is ready for service if the charger display shows the proper battery temperature.

### **8.2.2 REMOVING TEMPERATURE SENSING CABLE**

With both AC and DC de-energized, remove connector from JP5. The charger will automatically detect that there is no external temperature cable and return to temperature compensation disabled.

## **8.3 OPTIONAL REMOTE CONTROL PANEL**

This option will allow the charger to be controlled remotely from a distance of up to 50-ft. (15m); without this option the charger would be controlled from the front door panel. Only one control panel can be connected at a time. The Remote Control Panel is shipped with a 50-ft. (15m) communication cable with plug-in connectors. The Remote Control Panel can be mounted to a 19-in. (483mm) relay rack or wall mounted.

### **8.3.1 REMOTE CONTROL PANEL INSTALLATION**

With both AC and DC de-energized, follow the procedure below:

1. If the Remote Control Panel was ordered with the charger as an option, it will be found packed inside of the carton shipped with the charger. If it was ordered separately as a service part kit, it will be packaged in its own carton. In either case, carefully unpack the control panel assembly and inspect for any cuts in the cable or other damage.
2. It will be necessary to connect the remote control panel printed circuit board to the SCR driver printed circuit board in the charger. If the remote control panel was ordered as a service part option and the charger has a control board on the door then the Control printed circuit board on the door will have to be disconnected before installing the Remote Control Panel. Only one control printed circuit board can be electrically connected to the SCR Driver board at a time.
3. Determine where and how the Remote Control Panel will be mounted. The Control Panel is shipped from the factory with the communication cable entering the bottom of the case. If preferred by the installer, the cable can be changed to enter the back of the case.
4. To change where the cable enters, remove the four nuts on the case cover to open the case. Disconnect the cable from the control board, being careful to squeeze the retaining latch on the cable connector before pulling on the connector. If the latch has been properly released, the connector will easily slide out of the socket. Carefully pull the cord and connector out

- 
- through the hole in the bottom of the cover. Reinstall the cable through the backside of the larger hole in the back panel of the case. Reconnect the cable to either one of the connector sockets on the control printed circuit board. Re-assemble the Remote Control Panel.
  5. Carefully route the 50 ft. (15m) long communication cable to the charger making sure it is protected from being pulled out of the Remote Control Panel or pinched.
  6. Place the cable through one of the spare knockouts provided on the DC side of the enclosure. See SECTION 6.3. Do not place in the same knockout as either the AC input or DC output wiring. Protect the cable to ensure that the sharp edges of the knockout opening will not damage the cable. Any excess communication cable can be coiled up and wire tied out of the way.
  7. The communication cable can be connected into any of the three RJ1, RJ2 or RJ3 connector sockets on the charger SCR driver board. Do not connect more than one control board to the SCR Driver board at the same time.
  8. Reconnect the charger to either AC or DC and then verify that the Remote Control Panel is functioning properly, (refer to SECTION 11). If both charger and remote control panel are operating normally, they are ready for service.

**Important:** Proprietary communication protocol is used with the charger and control panel. Equipment damage will occur if they are connected to Ethernet or any other network device or port.

## 8.4 ALARM I/O RELAY BOARD OUTPUT

The optional ALARM I/O Relay board allows the user the use of “NO” (normally open) or “NC” (normally closed) contacts with reference to “C” (common) to be connected to other equipment for fault detection. The one GREEN LED and seven RED LEDs are used to signify when each individual relay coil has been energized. The ALARM I/O Relay board receives its signal to energize the relays from the Charger Control board.

### 8.4.1 ALARM I/O RELAY BOARD OPERATION

The GREEN LED (DS1) and J1 contacts are used to indicate the Auxiliary Summary Alarm fault status. (See FIGURE 8.4.4-2) The GREEN LED will illuminate if the charger detects no faults. Thirty seconds after any of the monitored faults have occurred, the J1 relay coil will be de-energized and the GREEN LED will go off.

**C=COMMON**

**NC=NORMALLY CLOSED**

**NO=NORMALLY OPEN**

The J1 terminal block contacts on the ALARM I/O relay board will switch at the same time as the Summary Alarm terminal block contacts on the SCR Driver Board. With no faults the relay will be energized and there will be continuity from “C” to “NC” and no continuity from “C” to “NO” on J1. With a fault the relay coil will be de-energized and there will be continuity from “C” to “NO” and no continuity from “C” to “NC”.

The seven RED LEDs and the J2 through J8 terminal block contacts on the ALARM I/O board are used to indicate the seven individual fault conditions. Each relay will be energized and its corresponding LED will illuminate when the SCR Driver board detects that fault. When there are no faults, the relays will be de-energized and there will be continuity from “C” to “NC” and there will be no continuity from “C” to “NO” on J2 through J8. With a fault, the appropriate relay coil will be energized and there will be continuity from “C” to “NO” and no continuity from “C” to “NC”. The appropriate LEDs will illuminate with each fault. See SECTION 11.3.4 for information on setting up the charger faults. The ALARM I/O relay board terminal blocks and LED indicated fault functions are shown in FIGURE 8.4.4-2.

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## 8.4.2 ALARM I/O FIELD INSTALLATION INSTRUCTIONS

The installation kit will come with the following components:

Qty.	Part #	Description
1	22845-XX*	ALARM I/O Relay Board
1	31666	1 ft. (305mm) Communication cable
1	33456	Wiring Shield
4	32678	Spacers
4	03237	Nuts, 6-32

\* - XX-Multiple options available, see SECTION 17 for proper option number.

Follow the instructions below to install the ALARM I/O Relay Board into the charger:

1. De-energize both AC and DC power from the charger.
2. To see how the ALARM I/O Relay board mounts to the SCR Driver Board and the cable hookup, see FIGURE 8.4.4-1. (All RJ45 connector Sockets are in parallel, so it will work with the cable in any location.)
3. Install the four nylon spacers into the SCR Driver board on the inner panel of the charger.
4. Put the wiring shield on the bottom two nylon spacers.
5. Mount the ALARM I/O Relay board on the four nylon spacers as shown.
6. Install the four nuts on the nylon spacers and tighten. (Do not over-tighten nuts or the nylon spacers will strip.)
7. Connect the communication cable from the SCR Driver board RJ45 connector socket to the ALARM I/O Relay board RJ45 connector socket.
8. Fold the wiring shield under the front of the charger base edge by the circuit breaker if possible.

## 8.4.3 WIRING THE ALARM I/O BOARD TO EXTERNAL CIRCUITS

1. Route the wiring for your external circuits into the charger through one of the spare conduit knockouts on the DC side of the enclosure. See SECTION 6.3. Make sure to isolate this wiring from the charger AC input and DC output power wiring. The wiring shield is to help isolate these wires from the other wires. Do not place in the same knockout as either the AC input or DC output wiring.
2. Use #26-14 AWG wire stripped 0.25 in. (6mm) on the end going into the Individual Alarm Terminal Blocks. Torque all connections to 5 inch pounds (.6Nm). All terminal blocks are labeled in the non-alarm or fault condition.
3. Make sure to observe the Alarm Relay Contact Rating on FIGURE 8.4.4-2 when wiring into external circuits.
4. Secure all wires with a strain relief in the conduit knockout so they will not to be pulled out of unit. Protect the wires to ensure the sharp edges of the opening will not damage the wire.
5. Return power to the charger.

## 8.4.4 TESTING THE ALARM I/O RELAY BOARD AND EXTERNAL CIRCUITS

1. It is recommended that a test be performed after installation to make sure everything works as intended.
2. Go into the TECH MENU on the charger control board by pressing the RIGHT ARROW, then LEFT ARROW buttons, and repeat this sequence 4 times while in the default display mode, then enter the TECH MENU code which is set to "0001". (For additional information on the TECH MENU see SECTION 12.2.)
3. The first display in the TECH MENU is the control board version and date.
4. Press the DOWN ARROW button and you can get to the following menus: **Relay Start, LEDs are off, and Disp (Display voltage mode)**.
5. Go to the Relay Start Menu. This menu will only be available if the charger has an optional ALARM I/O Relay Board that is functioning.
6. Press the RIGHT ARROW button at the "Relay Start" display. The ALARM I/O Relay Board LEDs and Relay Contacts will go through a test cycle to verify they are working properly.
7. If you press the RIGHT ARROW button while the display shows "Relay Stop", the test will stop.
8. You can restart the test anytime the display shows "Relay Start".
9. To exit the TECH MENU, press the LEFT ARROW button.
10. The charger is ready for service if all of these tests verify that it functions properly.



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## 9. CHARGER START UP SEQUENCE

When all connections are made with the proper wire size, location and torque value, the charger is ready for power up. Use the following steps to start up the charger.

### 9.1 CHECK DISPLAY AND LEDS

Switch the charger AC and DC breakers "OFF", and disconnect the charger from the battery. Then, reconnect the DC battery bus voltage to the charger. The Display and LEDs on the front of the charger should power up and display the DC voltage that the charger senses on the DC terminal strip. If the display does not show the proper DC voltages, disconnect charger from the DC battery bus and verify connections and polarity again. (The charger requires at least 17 volts DC for the display to power up in the 24 and 48-volt DC chargers and at least 100 volts DC in the 130-volt DC chargers.) If the Display or LEDs do not power up correctly, even though connections were verified to be correct, see the Troubleshooting section. Note: The back light of the LCD display will not be illuminated while the AC breaker is off.

### 9.2 CHARGER SETTINGS

If the charger senses the proper voltage, you can go into the charger menus and customize the charger settings. At this time, the summary alarm buzzer may sound because of various fault codes. If necessary, disable the alarm buzzer or the fault condition while customizing the charger settings and then enable them after the charger setup is complete.

### 9.3 AC & DC POWER UP

Disconnect the charger from the DC battery bus again with the switch or breaker. Apply the proper AC voltage to the Charger AC terminal strip. Turn the AC Breaker "ON". The charger Display should power up with the display back light on, the "AC ON" LED should illuminate, now turn the DC breaker "ON". The charger will power up and slowly charge up the capacitor(s) in the charger to the proper float voltage. The "DC ON" LED will illuminate.

### 9.4 RECONNECT DC & RE-CHECK

Connect the charger to the DC battery bus again with the switch or breaker. The charger will start charging the battery at the appropriate voltage and current if everything is functioning properly. If you experience any problems, go to the Troubleshooting section.

## 10. CIRCUIT BOARDS

The standard circuit boards are the SCR Driver Board and the Control Board. The optional circuit board is the ALARM I/O Relay Board. Each of these three boards can be used universally in all charger models.

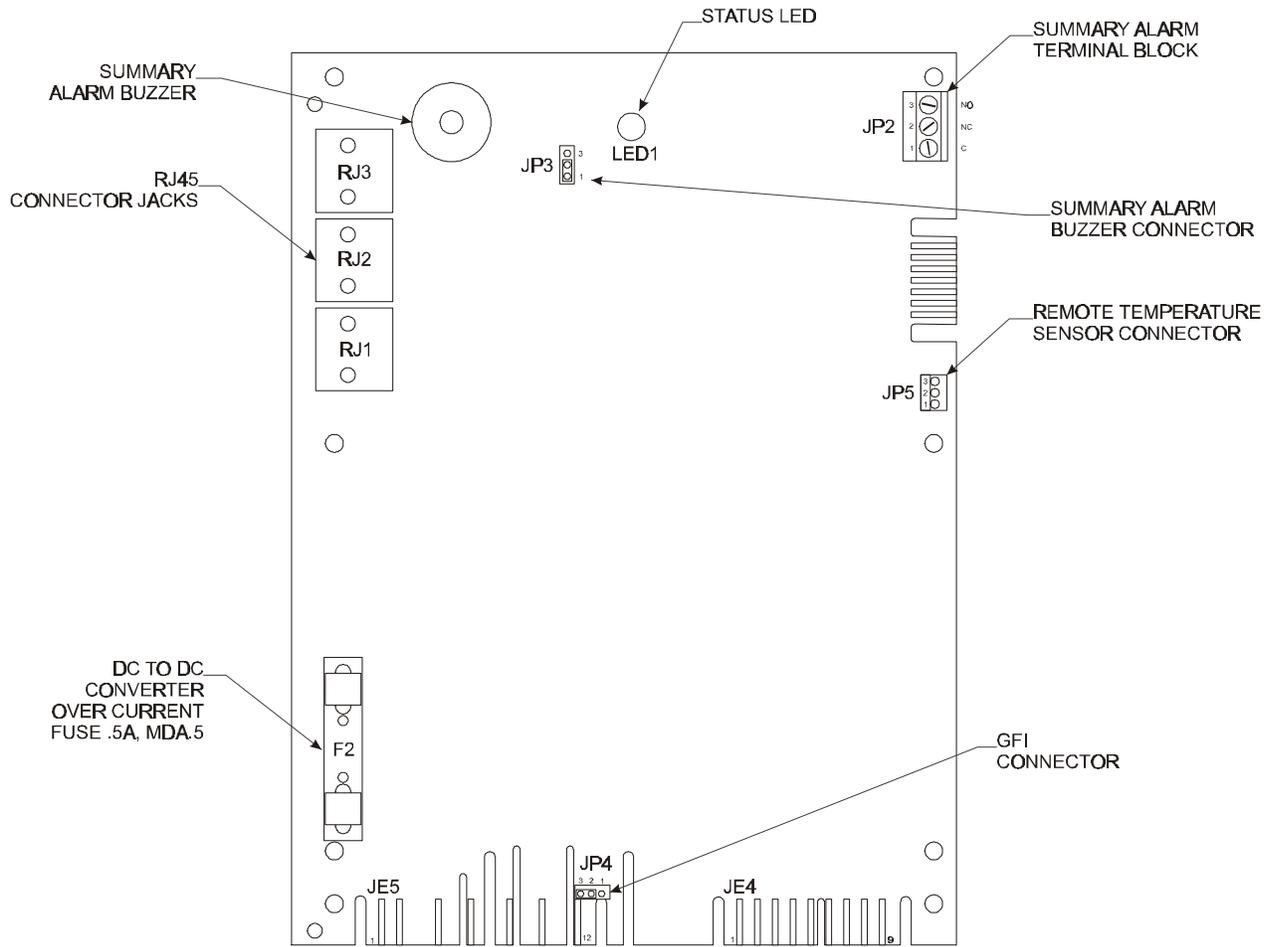
All three boards have RJ45 connector sockets to allow them to be easily connected or disconnected from each other for service or to allow the use of an optional Remote Control Panel. The RJ45 connector sockets are all connected in parallel so the cables can be plugged into any of the RJ45 receptacles on each board.

### 10.1 SCR DRIVER BOARD

The SCR Driver Board stores all of the important variables for the charger except for the time of an equalize cycle. It determines what model the charger is, monitors the charger system for faults, and sends information to the control board. It also provides the SCR gate drive pulses to control the charger output and the proper supply voltages for the other two boards.

The following features are found on the SCR Driver Board. See FIGURE 10.1 for location of components.

**FIGURE 10.1: SCR DRIVER BOARD**



### 10.1.1 BACKUP CHARGER POWER

The SCR Driver Board is normally powered from the AC input power. However, if AC input power is not present the SCR Driver Board will automatically switch to be powered from the DC batteries as a backup power source. The SCR Driver Board includes a DC-to-DC converter that allows the wide range of DC Battery voltage supplies to be converted to a usable 12 volt DC source. The DC-to-DC converter has a fuse (F2) for over-current protection. This allows the charger to monitor the charger information and provide the power supplies to the other circuit boards.

**NOTE: It will not charge the batteries until AC power has returned.**

### 10.1.2 SUMMARY ALARM BUZZER AND RELAY CONTACT CONNECTIONS

The Summary Alarm and Relay Contact Connections provide the user with two ways to monitor for faults. See the Alarm Settings menu section for alarm setting information.

The Summary alarm buzzer and contacts will be enabled 30 seconds after the board detects a fault code, reference FIGURE 10.1. Removing the **JP3** jumper connector from pins 1 and 2 of the **JP3** connector can disable the summary alarm buzzer. When the jumper is connecting pins 1 and 2 (bottom two pins) the summary alarm buzzer is enabled. Removing the jumper from pins 1 and 2 disables the alarm buzzer. The jumper can be stored by installing it on pins 2 and 3 (top two pins). Removing the fault code or disarming the fault code from the charger can be done from the Alarm Settings Menu.

The Summary Relay coil will also be de-energized after the board detects a fault for 30 seconds. This will change the Relay Contact Connections on the **JP2** terminal strip. With a fault the relay coil will be de-energized and there will be continuity from “**C**” (common) to “**NO**” (normally open) and no continuity from “**C**” to “**NC**” (normally closed). With no faults the relay will be energized and there will be continuity from “**C**” (common) to “**NC**” (normally closed) and no continuity from “**C**” to “**NO**” (normally open) on the **JP2**.

External wiring can be connected to the JP2 terminal block connections for external fault detection. See SECTION 19 for information about the Alarm relay contact ratings.

### 10.1.3 GFI JUMPER

The GFI (Ground Fault Indicator) Jumper can be used to Enable (pins 2-3 of JP4) or Disable the GFI faults. To disable the GFI, remove the Jumper from pins 2 and 3 of JP4 on the bottom edge of the board. See the Alarm Settings menu SECTION, 11.3.4, for GFI setting information.

### 10.1.4 INTERNAL TEMPERATURE SENSOR

The Internal Temperature Sensor is located on the SCR Driver Board. It can be used for monitoring the Charger temperature and also can be used for charger controlled temperature compensation. See the DC Settings/Temp Comp SECTION, 11.3.3, for more information.

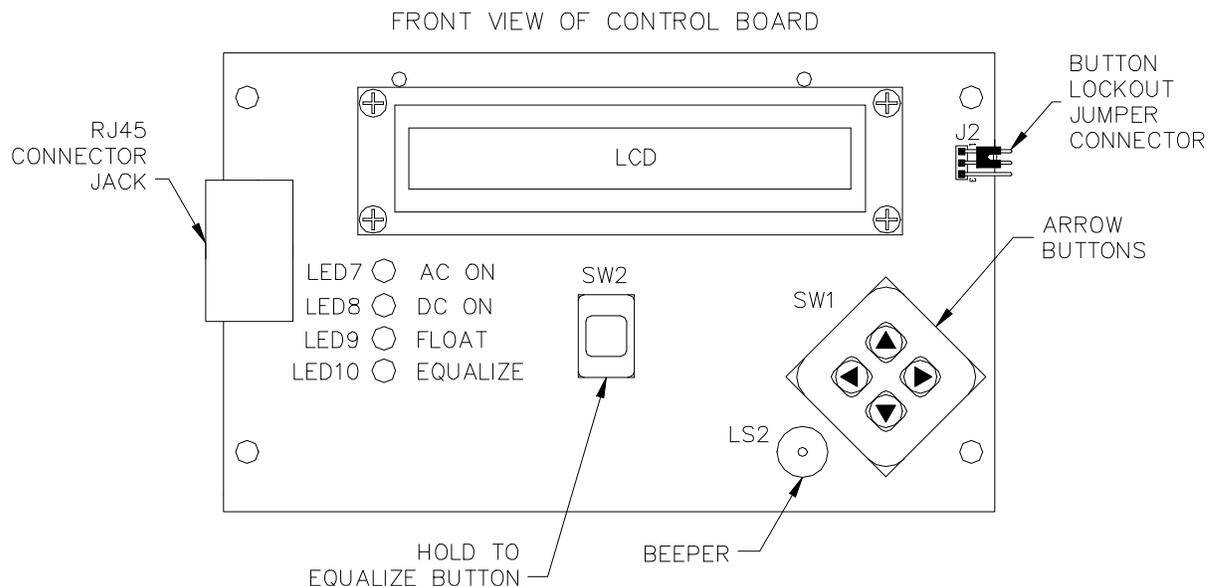
### 10.1.5 OPTIONAL REMOTE TEMPERATURE SENSOR CONNECTOR

The Optional Remote Temperature Connector is located on the SCR Driver Board. It allows the optional Remote Temperature Sensor to be used to monitor battery temperature. It can also be used for charger controlled temperature compensation based on the battery temperature. This is the preferred method of temperature compensation because the battery voltage is adjusted based on the battery temperature. See the DC Settings/Temp Comp SECTION, 11.3.3, for more information.

## 10.2 CONTROL BOARD FEATURES

The charger control board has a 16-character alpha numeric Liquid Crystal Display (LCD), 5 Push Buttons, 4 Light Emitting Diodes (LED's), a button lockout jumper connector, and a beeper. These features allow the operator to view the status of the charger functions and to change the charger settings. Their operation is described in the following sections. See FIGURE 10.2 for Control Board layout information.

**FIGURE 10.2: CONTROL BOARD**



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### 10.2.1 LIQUID CRYSTAL DISPLAY (LCD)

This is used to display DC Voltage and DC Current, fault identification, charger status information and menu information.

### 10.2.2 “HOLD TO EQUALIZE” BUTTON (LARGE SQUARE BUTTON)

This is used to change from FLOAT mode to a manually started EQUALIZE mode. To manually activate an EQUALIZE mode, push and hold about 6 seconds until the EQUALIZE LED illuminates. The same button can be used to manually stop an equalize cycle and return to FLOAT mode.

### 10.2.3 ARROW BUTTONS

The four Arrow buttons allow the user to go **UP**, **DOWN**, **LEFT**, and **RIGHT** in the menus. They are used to view and change the different menus, display modes, and set point values.

### 10.2.4 GREEN “AC ON” LED

This LED will be illuminated whenever the charger has AC input power connected to it and the AC circuit breaker is closed, (in the ON position).

### 10.2.5 GREEN “DC ON” LED

This LED will be illuminated whenever the DC circuit breaker is closed, (in the ON position) and the charger detects DC voltage. This voltage can be the charger capacitor or battery voltage.

### 10.2.6 YELLOW “FLOAT” LED

This LED will be illuminated whenever the charger has AC or DC voltage and it is in the FLOAT mode.

### 10.2.7 RED “EQUALIZE” LED

This LED will be illuminated whenever the charger has AC or DC voltage and it is in an EQUALIZE mode.

### 10.2.8 BUTTON LOCKOUT JUMPER CONNECTOR

This allows the buttons to be locked out for security purposes. The connector is located on the top left edge of the control circuit board when looking at the back of the board. The buttons enabled jumper position is located on the top two pins (pins 1-2) of the **J2** connector. If the jumper is removed or put on the bottom two pins of **J2** (pins 2-3) of the connector, the buttons will be disabled and not allow any changes. (Shown in FIGURE 10.2)

### 10.2.9 BEEPER

This is designed to beep each time a button is pushed, signifying a button press except when the button lockout feature is being used. It also beeps when the charger changes charging modes, and beeps a tune on control board initialization.

## 11. CONTROL BOARD OPERATION

The Control Board operation will be explained in the following sections. These sections will explain the various display modes, how to view or change information, and menu descriptions.

### 11.1 DEFAULT DISPLAY MODES

The charger's “DC Voltage and DC Current” values are continuously displayed when there are no fault codes and the charger is in FLOAT mode.

If there are faults, the display will toggle between the “DC Voltage and DC Current” and the Fault codes.

If in Manual/Manual Equalize mode and an Equalize Charge is started, the display will toggle between the “DC Voltage and DC Current”, any Fault Codes, and “Manual EqLz” (manual equalize cycle).

In any other equalize mode, the display will toggle between the “DC Voltage and DC Current”, any Fault Codes, and the number of hours left of the equalize charge.

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If the user is in any menu for longer than 60 seconds without pressing a button, the display mode will return to the default display mode.

## 11.2 HOW TO VIEW OR CHANGE INFORMATION

The user can view and change charger settings easily. By using the UP ARROW or DOWN ARROW buttons, the user can view the different charger information and menus that allow the user to change the charger profile. In most cases there will be an '→' to show that a value can be changed after the menu description. The exception to this is the "Time" menu.

By pressing the DOWN ARROW button you can see the following menus or information:

Fault Codes, DC Settings, Alarm Settings, EqLz Settings, Hrs Run, InTemp, ExTemp (if unit has optional Remote Temperature Probe), Time of Day, Pause Time and Next EqLz Time. All of these will be explained in SECTION 11.3.

When the display has an '→' after the menu description, the user can press the RIGHT ARROW button to get into that menu or toggle between menu choices. The UP and DOWN ARROW buttons allow values to be changed. After making the changes to the values that are underlined or a cursor is present, the user must SAVE the change by pressing the RIGHT ARROW button until you get the '→' again. In most cases if the user backs out of changing a value by pressing the LEFT ARROW button, the value will NOT be saved. The value will take affect only when the user presses the RIGHT ARROW button at the last changeable value.

### **Example 1 – Changing Float Settings:**

Example 1 explains how to change the Float settings for the charger

Press the DOWN ARROW button until you get to the following.

**"DC Settings   Ⓜ"**

Press the RIGHT ARROW button and it will show you the charger type. Press the DOWN ARROW button to get the following.

**"Float 2.25V/CⓂ"**

Press the RIGHT ARROW button to get the following.

**"Float 2.25V/C"**

Notice the arrow is gone and the 2 is underlined or the cursor is under it. The user can change the value of the digit above the cursor by pressing the up and down arrow buttons. The up button increases to the next higher digit and the down button decreases. Press the UP ARROW button to get the following.

**"Float 2.35V/C"**

Pressing the RIGHT ARROW button will move the cursor to the right to get the following.

**"Float 2.35V/C"**

The cursor has moved and again the value can be changed by pressing the up or down arrow button. Press the DOWN ARROW button to get the following.

**"Float 2.30V/C"**

When the cursor is under the farthest right digit, if the user presses the RIGHT ARROW button, the value shown will be saved and take affect. Press the RIGHT ARROW button to get the following.

---

**“Float 2.30V/C®”**

However, if the user pressed the LEFT ARROW button twice instead of the RIGHT ARROW button the value will revert to the value before being changed like the following.

**“Float 2.25V/C®”**

### **Example 2 - Arming and Disarming Faults:**

Example 2 explains how to toggle between arming and disarming fault codes and between many other modes.

Press the DOWN ARROW button until you get the following.

**“Alarm Settings ®”**

Press the RIGHT ARROW button and it will show you the following.

**“AC Hi Armed®”**

Press the RIGHT ARROW button and it will show you the following.

**“AC Hi Disarmed®”**

The “AC Hi” alarm is now disarmed and will not be an active fault code. Press the RIGHT ARROW button again and it will show you the following.

**“AC Hi Armed®”**

By pressing the RIGHT ARROW button in these types of menus you can see and change the different charger profiles.

Press the UP or DOWN ARROW buttons when you have the selection you want and this will change to a different Alarm setting.

By pressing the LEFT ARROW button you can get back to the following.

**“Alarm Settings ®”**

By pressing the LEFT ARROW button again you get back to the default menu.

Most of the Control Panel menus use one of the two example methods to make changes. The exception to this is the GFI set point menu, which will be explained in SECTION 11.3.4.

## **11.3 CHARGER INFORMATION AND MENU DESCRIPTIONS**

### **11.3.1 DC VOLTAGE AND DC CURRENT**

The Default Display is the DC Voltage and DC Current. It is updated every second. The last character of the display changes every second to show the display is updating. Display Example: (26.50V 20.00A –)

### **11.3.2 FAULT CODES AND FAULT LEDS**

The display will show “No Faults” unless a fault has occurred. The following fault codes are displayed on the display: Hi DC, Lo DC, EOD, GFI +, GFI - , Hi AC, Lo AC, HiLoc, and LoLoc. The “AC ON” and “DC ON” LEDs can also be used as fault indicators.

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The SCR Driver Board in the charger has a Summary alarm and Relay contact that indicates when any fault has occurred. The fault has to be active for 30 seconds before the summary alarm and contact are activated.

The optional ALARM I/O Relay Board has LEDs and Relay contacts that can be used to indicate the following fault codes: EOD, GFI (positive or negative), DC Fail, Lo DC, Hi DC, Lo AC, and Hi AC. This board also has a Summary alarm and Relay contact, which indicates when any fault has occurred. The fault has to be active for 30 seconds before the summary alarm and contact are active.

**FAULT CODE DEFINITIONS:**

**Hi DC**

This stands for High DC voltage. This fault occurs when the charger detects a DC voltage higher than the value in the DC Hi set point location in the Alarm Settings menu.

**Lo DC**

This stands for Low DC voltage. This fault occurs when the charger detects a DC voltage lower than the value in the DC Lo set point location in the Alarm Settings menu.

**EOD**

This stands for End of Discharge voltage. This fault occurs when the charger detects a DC voltage lower than the value in the EOD set point location in the Alarm Settings menu.

**GFI +**

This stands for Ground Fault Indicator to the Positive Battery Terminal. This fault occurs when the charger detects a leakage current from the battery positive to the charger ground of more than the threshold value. The threshold value is set with a 10K-ohm resistor at the factory. The GFI set points are set in the Alarm Settings menu.

**GFI –**

This stands for Ground Fault Indicator to the Negative Battery Terminal. This fault occurs when the charger detects a leakage current from the battery negative to the charger ground of more than the threshold value. The threshold value is set with a 10K-ohm resistor at the factory. The GFI set points are set in the Alarm Settings menu.

**HiLoc**

This stands for High DC output voltage lockout. This fault occurs when the charger DC output voltage exceeds the value in the HiLoc set point location in the Alarm Settings menu for more than one minute or if the DC voltage varies above this value more than about three times in a minute. This fault will lockout and not allow the charger to charge the batteries until the AC input voltage is cycled off and then back on. Switching the AC breaker off and then on can do this.

The optional ALARM I/O Relay Board will indicate the “HiLoc” fault by actuating the “DC Hi” contacts and LED if the “DC Hi” alarm is armed.

**LoLoc**

This stands for Low DC output voltage lockout. This fault occurs approximately 3 minutes after the charger detects the DC output voltage drop below approximately 0.2 volts per cell or a near short. This fault will lockout or not allow the charger to charge the batteries until the AC input voltage is cycled off then back on or the battery voltage the charger detects increases above this value.

**Hi AC**

This stands for High AC input voltage. The charger AC input voltage being higher than the nominal AC input voltage for the charger by approximately 10% or more causes this fault.

**Lo AC**

This stands for Low AC input voltage. The charger AC input voltage being lower than the charger nominal input voltage by approximately 10% or more causes this fault. An AC input voltage

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supply loss or an open charger AC input breaker will also cause it. AC Power loss, or an open charger AC breaker is also displayed with the green “AC ON” LED being off.

#### **DCFail**

This stands for DC voltage failure. This fault is caused by the DC output circuit breaker being open (in the OFF position), or the charger detects no DC voltage. This fault will not be displayed on the display, but it will cause the “DC ON” LED to be off. The optional ALARM I/O Relay Board LED and contact for this fault will be active if this fault detector is armed along with the summary alarm and contacts on the SCR Driver Board.

The **Hi DC**, **Lo DC**, **EOD**, **GFI +**, and **GFI -** faults can be armed or disarmed in the Alarm Settings menu and the alarm set points can be set at the point the user wants them to become faults. The optional ALARM I/O Relay Board LED and contact for these faults will be active if this fault is armed along with the summary alarm and contacts on the SCR Driver Board. They will be explained further in the Alarm Settings section.

The **Hi AC** and **Lo AC** can be armed or disarmed in the Alarm Settings menu, but the user cannot change the values. The optional ALARM I/O Relay Board LED and contact for these faults will be active if this fault is armed along with the summary alarm and contacts on the SCR Driver Board.

### **11.3.3 DC SETTINGS**

The DC Settings menu has the following menus: Charger type, Float, EqLz, Amps, Offset, and Temp Comp. These allow the user to view and make changes to the charger profile. They will be explained in the following sections.

#### **Charger Type**

The first display after you press the RIGHT ARROW button gives you the charger type information. Example: “12Cells 20A” (Factory set at Cells and DC amps).

#### **BY PRESSING THE UP OR DOWN ARROW BUTTONS YOU CAN VIEW AND CHANGE THE FOLLOWING:**

##### **Float**

Sets the float voltage for charging of the batteries. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 2.25 V/C with a range of 2.0 to 2.5 V/C)

##### **EqLz (Equalize)**

Sets the equalize voltage for charging the batteries during an Equalize cycle. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 2.32 V/C with a range of 2.0 to 2.5 V/C)

##### **Amps**

Sets the Current limit that the charger delivers to the batteries. (Factory setting same as charge DC ampere Rating with maximum current range of 110% of this value.)

##### **Offset**

Sets the voltage offset or voltage compensation for the cable's voltage drop due to the cable's resistance between the charger and the battery. The cable's voltage drop can be found two ways. Voltage offset should only be used when the cable's drop difference causes problems. The two methods are listed below:

- Read the display voltage at the rated DC output current then subtract the battery voltage measured at the batteries. Both of these readings should be done at the rated DC output current of the charger.
- Find the resistance of the cable and multiply that by the DC output current rating of the charger.

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Enter the measured or calculated value as the Offset set point. (Factory setting of 0.00V with a maximum of 2.50V)

### Temp Comp

Sets the type of temperature compensation that adjusts the output voltage of the charger depending on the temperature. The choices are:

- “Dis” for disabled or no temperature compensation
- “In” for internal temperature compensation based on the temperature sensor on the SCR Driver Board
- “Ex” for external or remote temperature compensation based on the Optional Remote Temperature Sensor. The “Ex” in this submenu only shows, if the Remote Temperature Sensor is plugged into JP5 on the SCR Driver board.

Temperature compensation is based on a reference temperature of 77°F (25°C). The Temperature compensation factor is - 2.5 mV (millivolts) per Cell per Degree F (- 4.5 mV per cell per Degree C). The compensation factor is NEGATIVE because of the inverse relationship between the temperature and the voltage (i.e. as the temperature increases the voltage should decrease).

See the **InTemp** or **ExTemp** menu section for the temperature that the charger uses to determine the float or equalize voltage after temperature compensation. This value is used for the calculation.

### The equivalent equation for the compensated voltage is:

$$V - ((- 0.0025 * k) * (77°F - t)) = V_{\text{comp}} \text{ for Fahrenheit}$$
$$V - ((- 0.0045 * k) * (25°C - t)) = V_{\text{comp}} \text{ for Celsius}$$

- V - is the nominal Float or Equalize voltage of the battery at 77°F (25°C)
- t - is the temperature in °F or °C according to the temperature sensor being used for compensation
- k – is the number of cells.
- Vcomp - will be the new float or equalize voltage for the charger

#### Example 1:

If a 60-cell battery is charging with a Float voltage of 2.25 volts per cell or 135 volts, and the temperature increases to 95°F, then the output float voltage decreases to 132.3 volts.

$$(2.25 * 60) - ((- 0.0025 * 60) * (77°F - 95°F)) = 132.3 \text{ volts}$$

#### Example 2:

If a 24-cell battery is charging with an Equalize voltage of 2.32 volts per cell or 55.68 volts, and the temperature decreases to 20°C, then the output equalize voltage increases to 56.22 volts.

$$(2.32 * 24) - ((- 0.0045 * 24) * (25°C - 20°C)) = 56.22 \text{ volts}$$

The Battery Charger will switch back to “Dis” or no temperature compensation if the temperature sensor detects 32 °F (0°C) or has been disconnected.

## 11.3.4 ALARM SETTINGS

The Alarm Settings menu allows the user to have the following fault conditions armed (enabled) or disarmed (disabled) and allow the alarm to be turned on or not because of that fault condition. It also allows the user to change some of the factory default values to user-desired values.

Disarming the fault will mask it out of the Fault menu and will cause the summary alarm to not turn on because of it. If the optional ALARM I/O Relay board is equipped the fault will not be displayed on it either. All faults are factory set to be armed or enabled.

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**AC Hi Armed or Disarmed**

“AC Hi” stands for AC voltage input high. This fault occurs if the AC input voltage is higher than the nominal AC input voltage for the charger by approximately 10% or more. This menu allows the user to arm or disarm the “Hi AC” fault code and optional ALARM I/O Relay board contacts.

**AC Lo Armed or Disarmed**

“AC Lo” stands for AC voltage input low. This fault occurs if the AC input voltage is lower than the nominal AC input voltage for the charger by approximately 10% or more. This menu allows the user to arm or disarm the “Lo AC” fault code and optional ALARM I/O Relay board contacts.

**DC Hi Armed or Disarmed**

“DC Hi” stands for DC voltage output high. This fault occurs if the DC output voltage is higher than the value set in the “DC Hi set point” menu. This menu allows the user to arm or disarm the “Hi DC” fault code and optional ALARM I/O Relay board contacts.

**DC Lo Armed or Disarmed**

“DC Lo” stands for DC voltage output low. This fault occurs if the DC output voltage is lower than the value set in the “DC Lo set point” menu. This menu allows the user to arm or disarm the “Lo DC” fault code and optional ALARM I/O Relay board contacts.

**DCFail Armed or Disarmed**

“DCFail” stands for DC voltage failure. This fault is caused by the DC output circuit breaker being open or in the OFF position or the charger detecting no DC voltage. This menu allows the user to arm or disarm the “DCFail” fault code on the optional ALARM I/O Relay board contacts. The “DCFail” fault does not show as a fault on the Control Board display. The “DC ON” LED will go off even with the fault disarmed. This fault is included in the summary alarm and contacts on the SCR Driver board if it is armed.

**GFI Armed or Disarmed**

“GFI” stands for Ground Fault Indicator. This fault occurs when the charger detects a leakage current from the battery negative or positive to the charger ground of more than the threshold value. The threshold value is factory set with a 10K-ohm resistor. This menu allows the user to arm or disarm the “GFI” fault codes and the optional ALARM I/O Relay board contacts. The two faults that are displayed are the “GFI –” and “GFI +”. The GFI set points are also set in the Alarm Settings menu.

**EOD Armed or Disarmed**

“EOD” stands for End of Discharge voltage. This fault occurs when the charger detects a DC voltage lower than the value in the “EOD set point” menu. This menu allows the user to arm or disarm the “EOD” fault code and optional ALARM I/O Relay board contacts.

**DC Hi 2.50V/C**

This is the “DC Hi” set point menu. The user can set the value that the charger will give the “Hi DC” fault. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 2.50V/C with a range of 1.00 to 2.70V/C)

**HiLoc 2.50V/C**

This is the “HiLoc” set point menu. The user can set the value that activates the “HiLoc” fault. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 2.50V/C with an adjustable range of 1.00 to 2.70V/C)

**DC Lo 2.10V/C**

This is the “DC Lo” set point menu. The user can set the value that the charger will give the “Lo DC” fault. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 2.10V/C with a range of 1.00 to 2.50V/C)

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### **EOD 1.70V/C**

This is the “EOD” set point menu. The user can set the value that the charger will give the “EOD” fault. This is factory set at voltage per cell but can be changed to voltage (of the entire battery set). (Factory set @ 1.70V/C with a range of 1.00 to 2.00V/C)

### **Set GFI Open**

This is the Ground Fault Indicator (GFI) set point menu. The user can set the leakage current threshold value with a resistor. This sets the value that will cause the charger to give the “GFI +” or “GFI –“ faults. (Factory set with a 10k-ohm resistor).

To set the “GFI” set points, do the following:

- 1) Determine what value of resistance the set point will be changed to and have a resistor of that value available with leads ready to use. (Charger factory set with a 10k-ohm resistor)
- 2) When the display reads “**Set GFI Open**” and there is no resistor on Positive or Negative battery to Chassis Ground, press the **RIGHT ARROW** button.
- 3) The display reads “**Set GFI Pos**”. Place the resistor between Battery Positive and Chassis Ground and wait 5 seconds, then press the **RIGHT ARROW** button.
- 4) The display reads “**Set GFI Neg**”. Place the resistor between Battery Negative and Chassis Ground and wait 5 seconds, then press the **RIGHT ARROW** button.
- 5) The display should have “**Set GFI Open**” on it.
  - A) If it does, remove the resistor from the Battery Negative, then press **LEFT ARROW** button.
  - B) If it reads, “**GFI Set Fault**”, there is a problem. Repeat steps 1 through 5.
- 6) The display reads “**Alarm Settings**”. Press the **LEFT ARROW** button again to get to the default display menu.

This resistance is the set point for the “GFI” fault. The fault will have a resistance window that will trigger the fault. To test the fault, you may need a resistance less than the set point value.

## **11.3.5 EQLZ SETTINGS (EQUALIZE SETTINGS)**

The Equalize Settings menu allows the user to set up the length of time an equalize cycle is active, the interval or time between equalize cycles, the type of equalize mode, and the charge mode that the charger starts in. The menus are explained in the following sections.

### **Eqlz Time (Equalize Time)**

This menu sets the amount of time the Equalize mode of charging is set to run before it will return to float mode automatically. This time will be shown on the Default display as “Hrs Left” and count down until the Equalize charge returns to float charge. (Factory set @ 1hr with a range of 1 to 255hrs)

### **Eqlz Int (Equalize Interval)**

This menu sets the interval between Automatic equalizing charges. The charger will start counting down when the equalizing mode Auto/Auto is selected. (Factory set @ 1Day with a range of 1 to 180 Days)

### **Mode (Equalize Mode)**

This menu allows the user to choose one of the three Equalize mode selections explained in the following sections. (Factory set at Manual/Automatic.)

#### **1) Man/Man (Manual/Manual)**

In this mode the user must press and hold the “HOLD TO EQUALIZE” button to manually start an Equalize charge mode. The default display will show, “Manual Eqlz”. To stop the equalize charge mode the user must press and hold the “HOLD TO EQUALIZE” button until it stops and returns to Float Mode.

#### **2) Man/Auto (Manual/Automatic)**

In this mode the user must press and hold the “HOLD TO EQUALIZE” button to manually start an Equalize charge mode. The charger will charge in the Equalize mode for the amount of time in the Equalize Time menu, then automatically return to the FLOAT mode. The

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default display will show, “Hrs Left” and count down until the Equalize charge shuts off and the charger returns to Float Mode.

### **3) Auto/Auto (Automatic/Automatic)**

In this mode the charger will automatically start an Equalize charge mode, and stop and return to Float mode using the Equalize Interval and Equalize time values. The default display will show, “Hrs Left” and count down until the Equalize charge shuts off and the charger returns to Float Mode.

#### **Start in Float or Eqlz**

This menu allows the user to choose what mode to start charging in after the AC power is applied. If the charger is set in Auto/Auto Equalize mode, the user can select to start in Float charge mode or Equalize charge mode. (Factory set at Start in Float)

### **11.3.6 HRS RUN (HOURS RUN)**

This menu displays the total time the SCR Driver Board has run in hours and minutes.

### **11.3.7 INTEMP (INTERNAL TEMPERATURE)**

This menu displays the temperature inside the case on the SCR Driver Board. The factory default value is in degrees Celsius, but can be toggled or changed to degrees Fahrenheit. This value can be used for internal temperature compensation calculations.

### **11.3.8 EXTEMP (EXTERNAL TEMPERATURE)**

This menu is only displayed if the optional remote temperature sensor is plugged into JP5 on the SCR Driver Board. The factory default value is in degrees Celsius, but can be toggled or changed to degrees Fahrenheit. This value can be used for External temperature compensation calculations.

### **11.3.9 CURRENT TIME**

This menu allows the user to set the day of the week and time. To set the time, Press the RIGHT ARROW button to get the “→”, then set the day of the week and the time the same way you set other menu values.

**The time needs to be reset every time the AC and DC power are both lost.**

### **11.3.10 PAUSE (CHARGER PAUSE)**

This menu allows the user to prevent the charger from charging the batteries for up to 60 minutes after AC power has been restored or applied. (Factory set at 00 minutes)

### **11.3.11 NEXT EQLZ (NEXT EQUALIZE CYCLE)**

This menu will display the number of days and the hundredths of a day until the next equalize charge will start, if the Equalize Mode is Auto/Auto. This menu will display “0.00” if the Equalize Mode is not Auto/Auto.

## **12. SPECIAL MENUS**

The following two menus allow the user to change the security level of the charger and also to make some special technician level changes and tests.

### **12.1 SECURITY MENU**

The Security Menu is reached by pressing the RIGHT ARROW then the LEFT ARROW 4 times in the default display, then entering the code which is set to “1234”. The three options in the security menu are listed below. Exiting the Security menu is accomplished by pressing the LEFT ARROW button.

**Lo:** The user can change and view any menu

**Med:** The user can only view any menu

**Hi:** The user can not view or change any menu

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## 12.2 TECH MENU

The Tech Menu is reached by pressing the RIGHT ARROW then the LEFT ARROW 4 times in the default display, then entering the code which is set to "0001".

The first display in the Tech menu is the Control board version and date. Exiting the Tech Menu is accomplished by pressing the LEFT ARROW button.

Press the DOWN ARROW button and you can get to the following menus.

### 12.2.1 RELAY START

This menu will only be available, if the charger has an optional ALARM I/O Relay Board. If the user presses the RIGHT ARROW button at the "Relay Start" display, the ALARM I/O Relay Board LEDs and Relay contacts can be tested to verify they are working properly.

### 12.2.2 LEDS ARE OFF

This menu allows the user to test the four LEDs on the Control Board to verify they are functioning properly. In the Tech Menu, all LEDs are turned off. Press the RIGHT ARROW button and the display will toggle between "LEDS are off" and "LEDS are on", the LEDs should turn on and off accordingly.

### 12.2.3 DISP (DISPLAY VOLTAGE MODE)

This menu allows the user to change how the voltages in the menu are displayed, and in the 130 Volt DC chargers it allows the user to change the number of cells the charger is setup to charge.

The factory default mode for this is to show the set point values as volts per cell. (Example: Float 2.25 v/c)

In the 130-Volt Chargers, this menu allows the user to change the charger's number of cells to 57, 58, 59 or the default value of 60. (Example: 57Cells)

If the Display Voltage mode is changed to "Volts", all values shown on the display as volts per cell will now be shown as total voltage. (Example: Float 27.00V)

## 13. CHARGER CONTROL BOARD QUICK GUIDE

### USER MENUS:

DC Voltage & DC Current -----	" 24.00V 25.00A "
Faults -----	"Lo DC Lo AC GFI+ "
DC Settings-----	"DC Settings →"
Voltage and Current Rating -----	" 12Cells 25A "
Float Volts per Cell-----	"Float 2.25V/C→"
Float Volts Tenths-----	"Float 2.25V/C "
Float Volts Hundredths-----	"Float 2.25V/C "
Equalize Volts per Cell -----	"Eqlz 2.32V/C→"
Equalize Volts Tenths -----	"Eqlz 2.32V/C "
Equalize Volts Hundredths -----	"Eqlz 2.32V/C "
Amps-----	"Amps 25.00→"
Amps Ones -----	"Amps 25.00 "
Amps Tenths -----	"Amps 25.00 "
Voltage Offset-----	"Offset 0.00V→"
Offset Tenths-----	"Offset 0.00V "
Offset Hundredths-----	"Offset 0.00V "
Temperature Compensation Disabled -----	"Temp Comp: Dis→"
Internal Temp Sensor -----	"Temp Comp: In→"
Optional External Temp Sensor -----	"Temp Comp: Ex→"
Alarm Settings -----	"Alarm Settings →"
AC High Armed or Disarmed-----	"AC Hi Armed→"
-----	"AC Hi Disarmed→"

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AC Low Armed or Disarmed -----	“AC Lo Armed→”
-----	“AC Lo Disarmed→”
DC High Armed or Disarmed-----	“DC Hi Armed→”
-----	“DC Hi Disarmed→”
DC Low Armed or Disarmed -----	“DC Lo Armed→”
-----	“DC Lo Disarmed→”
DC Failure Armed or Disarmed-----	“DCFail Armed→”
-----	“DCFail Disarmed→”
Ground Fault Indicator -----	“GFI Armed→”
Armed or Disarmed -----	“GFI Disarmed→”
End of Discharge -----	“EOD Armed→”
Armed or Disarmed -----	“EOD Disarmed→”
DC High Volts per Cell Set point -----	“DC Hi 2.50V/C→”
DC High Set point Tenths -----	“DC Hi 2.50V/C ”
DC High Set point Hundredths -----	“DC Hi 2.50V/C ”
High DC Lockout Volts per Cell Set point -----	“HiLoc 2.50V/C→”
High DC Lockout Volts Set point Tenths -----	“HiLoc 2.50V/C ”
High DC Lockout Volts Set point Hundredths -----	“HiLoc 2.50V/C “
DC Low Volts per Cell Set point-----	“DC Lo 2.10V/C→”
DC Low Volts Set point Tenths-----	“DC Lo 2.10V/C ”
DC Low Volts Set point Hundredths-----	“DC Lo 2.10V/C ”
End of Discharge Volts/Cell Set point-----	“EOD 1.70V/C→”
EOD Volts Set point Tenths-----	“EOD 1.70V/C ”
EOD Volts Set point Hundredths-----	“EOD 1.70V/C ”
Ground Fault Indicator Set point -----	“Set GFI Open →”
GFI Positive Set point -----	“Set GFI Pos →”
GFI Negative Set point -----	“Set GFI Neg →”
<b>Equalize Settings</b> -----	“Eqlz Settings →”
Equalize Time-----	“Eqlz Time 1hr→”
Equalize Hours of Ones-----	“Eqlz Time 2hr ”
Equalize Hours of Tens -----	“Eqlz Time 10hr ”
Equalize Interval-----	“Eqlz Int 1Days→”
Interval Days of Ones-----	“Eqlz Int 1Days ”
Interval Days of Tens-----	“Eqlz Int 11Days ”
Change Equalize Mode	
Manual Start/Manual Stop Eqlz -----	“Mode: Man/Man →”
Manual Start/Automatic Stop Eqlz-----	“Mode: Man/Auto →”
Automatic Start/Automatic Stop Eqlz-----	“Mode:Auto/Auto →”
Select Start in Float or Equalize mode-----	“Start in Float →”
-----	“Start in Eqlz →”
<b>Hours Run</b> -----	“Hrs Run 12:34”
<b>Internal Charger Temperature in °C or °F</b> -----	“InTemp 29.00°C→”
-----	“InTemp 84.20°F→”
<b>Optional External Temperature in °C or °F</b> -----	“ExTemp 29.00°C→”
-----	“ExTemp 84.20°F→”
<b>Time</b> -----	“Mon 06:00:00 AM ”
Set Time -----	“Time Mon 06:00A→”
Change Weekday -----	“TIME: Mon 06:00A”
Change Hours -----	“TIME: Mon 06:00A”
Change Mins -----	“TIME: Mon 06:00A”
Change AM/PM-----	“TIME: Mon 06:00A”
<b>Charger Pause</b> -----	“Pause 00 mins→”
Charger Pause in minutes of Tens -----	“Pause 10 mins “
Charger Pause in minutes of Ones-----	“Pause 10 mins “
<b>Days Till Next Eqlz</b> -----	“Next Eqlz 0.00”
<b>TECH MENUS:</b>	
<b>Control Board Version</b> -----	“Prod ?? MM/DD/YY”
<b>Optional ALARM I/O Relay Test Start</b> -----	“Relay Start →”
<b>Optional ALARM I/O Relay Test Stop</b> -----	“Relay Stop →”
<b>LED Test</b> -----	“ LEDs are off →”
-----	“ LEDs are on →”

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**Display Voltage Mode**

**Voltage Reference is in Cells** -----“Disp 12Cells→”

**Voltage Reference is in Total Volts**-----“Disp Volts→”

**130 Volt Only Voltage Reference is in Cells** -----“Disp 57Cells→”

(The 130 Volt Charger has a cell range of 57 to 60 cells)

**SECURITY MENU:**

**Security Level Low**-----“Security: Lo →”

**Security Level Medium**-----“Security: Med →”

**Security Level High**-----“Security: Hi →”

## 14. MAINTENANCE

Maintenance should be performed on the battery/charging system as often as necessary, depending on conditions, or at least every six months.

**⚠WARNING: DISCONNECT BOTH AC AND DC POWER FROM THE CHARGER BEFORE ENTERING THE ENCLOSURE. CONTACT WITH LIVE COMPONENTS WITHIN THE CHARGER COULD CAUSE ELECTRICAL SHOCK, SERIOUS INJURY, OR DEATH.**

**⚠CAUTION: KEEP CHARGER CLEAN AND DRY, INSIDE AND OUT. FAILURE TO DO SO MAY CAUSE DAMAGE OR FAILURE OF CHARGER.**

### 14.1 FUNCTIONAL TESTS

1. Check that the display and buttons are working properly. See SECTION 11 of the manual for more information.
2. Measure the output voltage at the charger and battery. If the voltage difference is larger than expected, make sure the cables are in good condition and the connections are tight. Reference SECTION 7.1 and FIGURE 7.1.
3. Compare the measured voltage at the charger with the charger display voltage to insure the charger calibration is proper.
4. If the optional Remote DC voltage Sensor cable is used, the charger display voltage should read very close to the voltage measurement taken manually at the battery.
5. Check the temperature display to see if the values are close to the temperature as manually measured. If the optional Remote Temperature Compensation cable is used, verify it is working properly.
6. Check the charger settings listed below to ensure they are correct and were not inadvertently changed.
  - a) Cell count in charger type
  - b) Amps in charger type
  - c) Float voltage setting
  - d) Equalize voltage setting
  - e) Amps setting
  - f) Alarm settings
  - g) Equalize settings
  - h) Any other charger settings that may be used to customize the charger.
  - i) If the optional ALARM I/O relay board is used, verify it is working properly. See SECTION 8.4 in manual.

### 14.2 PHYSICAL CLEANING

The charger itself requires little maintenance. However, elements such as dust, debris, and moisture, can adversely affect the charger. These elements should be kept away from the charger. If they do come in contact with the charger, they must be removed. Dust, debris, or moisture will shorten the working life of the charger, if they are allowed to build up.

The ventilation slots and louvers in the enclosure should be kept clean and free of obstruction of airflow. All the components within the charger should be kept clean and free of contamination build up.

The working components of the charger are cooled by natural convection. If dust and debris are allowed to build up, they will restrict airflow and cause these components to overheat.

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Moisture may cause electrical shorting and/or corrosion. It may also combine with dust and debris making them more difficult to remove. Do not use liquids to clean the working components of the charger as they may damage them. Compressed air should be used to clean dust and debris from the charger and its components

It may be necessary to remove the top panel and/or a side panel from the charger enclosure to allow access to the internal parts for cleaning.

Always be careful not to bump the wiring or components. This could cause loose connections or failures.

### **14.3 CHECK AREA AROUND CHARGER**

The area around the charger must remain clean, cool, dry, and well ventilated. Check for obstructions to airflow, clearances, or other violations of the requirements in SECTION 4 of this manual on "LOCATION FOR CHARGER INSTALLATION".

### **14.4 VISUAL INSPECTION**

Check the charger for any physical failures, such as loose contacts or hardware, excess wear, or damage. Darkened or hot terminals should be tightened or replaced.

### **14.5 BATTERY CONDITION**

Batteries must be well maintained for the charging system to operate properly. Follow the battery manufacturer's instructions for battery maintenance. Check for loose connections or corrosion. Periodic cleaning and watering of non-sealed batteries is very important. Logging the water usage of non-sealed batteries is useful. As a battery ages it will use more water and increase in float current.

**⚠ CAUTION: CHECK THE DC CONNECTIONS FROM THE CHARGER TO THE BATTERY AND MAKE SURE THEY ARE TIGHT AND CLEAN. TIGHTEN AND/OR CLEAN IF NEEDED. FAILURE TO DO SO COULD CAUSE MALFUNCTION, FIRE, OR EXPLOSION.**

DC connections may become corroded over time. If the connections become corroded, they should be cleaned as recommended by the battery manufacturer.

After the connections are cleaned, a battery connection treatment should be applied to help prevent corrosion from reoccurring. Contact the battery manufacturer for their recommendations.

## **15. SERVICING THE CHARGER**

The battery chargers are fully tested and calibrated with factory default values. If properly installed and set up, the charger should require very little attention.

The manual has a Troubleshooting Guide with a section on interpreting fault codes and LEDs and for help in repairing most of the problems that may occur. If the symptom does not appear in the guide or the repair does not work, consult your sales or service representative to arrange for on site or factory service.

If a problem does occur, the following steps should help the user or technician find the problem and determine what is necessary to correct it and return the charger to service:

- 1) Make note of any information about the Charging System (Charger, Battery, Battery Bus or Wiring, AC Power Supply and other equipment hooked to the Charger). Write down the symptoms, such as, condition of the batteries, what does the charger display show for voltage, current and fault codes, condition of the charger circuit breakers, condition of any other circuit breakers or fuses in the charging system. If possible, measure the DC voltage at the battery, DC voltage at the charger, DC current from the charger, AC input voltage, and AC input current. Open the AC and DC breakers to prevent equipment damage or personal injury.
- 2) If the Control Board is working, check the Control Board for Fault Codes and verify proper LEDs are on. The charger will show fault codes that can be used to help diagnose problems with the battery charging

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system. See SECTION 15.1 for help solving Fault Code problems or improper LED function before continuing.

- 3) If there are no fault codes, the AC and DC circuit breakers are on, and the charger is not functioning properly; a complete power reboot may be required. This should only be done once and if the charger does not return to normal operation, continue to the next step.

To do a complete power reboot, remove AC power by shutting off the charger AC breaker or AC power at the source. Disconnect the battery voltage from the charger. With the charger DC breaker closed, let the capacitor(s) in the charger discharge. The charger has a bleed resistor on the output, but to discharge the capacitors faster an additional resistor may be used. Verify capacitors are discharged with a voltmeter. The charger display and LEDs should all go off. Reapply Battery DC voltage. Using the charger control board, verify charger settings are correct. Reapply AC power to the charger. This will return the charger to normal operation, if there is no other internal component failure.

## 15.1 TROUBLESHOOTING

**⚠ WARNING: USE EXTREME CAUTION WHEN WORKING INSIDE THE CHARGER OR WITH THE CHARGING SYSTEM. DO NOT ATTEMPT TO WORK INSIDE THE CHARGER UNLESS YOU ARE A QUALIFIED TECHNICIAN OR ELECTRICIAN. HIGH VOLTAGES APPEAR AT SEVERAL POINTS INSIDE THE BATTERY CHARGER. DISCONNECT AND LOCK OUT BOTH AC AND DC POWER FROM THE CHARGER AND MAKE SURE CAPACITORS IN CHARGER ARE DISCHARGED BEFORE REMOVING ANY COMPONENT. CONTACT WITH LIVE COMPONENTS WITHIN THE CHARGER COULD CAUSE ELECTRICAL SHOCK, SERIOUS INJURY, OR DEATH.**

CONTROL BOARD OR DISPLAY SYMPTOMS		
Symptom	Possible Cause	Recommended Action
1) Control board display or LED problems.	Defective A2 control board or CC1 cable.	If the charger is charging properly but the A2 control board has a problem, then check the CC1 cable connections then replace the A2 control board. The charger will charge properly without the A2 control board connected. If the charger is not charging properly go to that symptom section.
2) Control board display blank.	Bad CC1 cable or connection.	The control board receives power and information from the SCR driver board. Check the CC1 cable connections between the two boards.
	No DC voltage to SCR driver board .	If charger has proper DC voltage at the TS3 DC output terminal strip and the control board display is blank, the charger will need to be de-energized and the following items checked. F2 fuse (see FIGURE 10.1) on the SCR driver board, JE5-1 and JE5-6 wiring to TS3 terminal strip, and, if applicable, the ZD1 zener diode on the 130 VDC output chargers.
3) Back light not on display.	Bad control board.	The control board display back light will not illuminate without good AC voltage to the SCR driver board. If the "AC ON" LED is illuminated on the control board, then replace the control board.
	Bad CC1 cable or connection.	The control board receives power and information from the SCR driver board. Check the CC1 cable connections between the two boards.
4) Buttons not functioning.	Buttons locked out .	Check button lockout jumper (J2) position. See FIGURE 10.2 and SECTION 10.2.8.
5) Wrong display voltage.	Bad R3 resistors or bad connections.	De-energize the charger and disconnect JE4 and JE5 cable edge connectors from the A1 SCR Driver board. Measure the resistance from the charger TS3 DC Output Terminal Strip charger positive and negative to the JE5 pin 2 orange and JE5 pin 4 blue wires. See FIGURE 15.4 for the proper resistance values. With CB2 DC circuit breaker in the ON position measure the resistance from the charger positive to JE4 pins 5 for near zero ohms. If any of these measurements are bad, find the problem and fix it.
	Bad A1 SCR Driver board	If no problem is found, reconnect the cables and restart the charger and verify problem still exists. Replace the A1 SCR Driver board if problem still exists.
6) Wrong display current.	Problem with charger ID circuit or SCR driver board.	Go to the DC settings menu (SECTION 11.3.3) and check for proper charger type. See SECTION 15.4, Charger ID Testing SECTION, of manual. Verify values and all connections to the SCR driver board. If all connections and values are good, replace the SCR driver board
7) Wrong charger type (ID).	Problem with charger ID circuit or SCR driver board.	See SECTION 15.4, Charger ID Testing SECTION, of manual. Verify values and all connections to the SCR driver board. If all connections and values are good, replace the SCR driver board.

## CHARGER OUTPUT SYMPTOMS

Symptom	Possible Cause	Recommended Action
<b>8)</b> No charger DC current.	Defective A1 SCR Driver board	Verify both AC and DC breakers are ON. Verify AC and DC LEDs are on and the display shows proper voltage. See other symptom if any of these are not proper. Otherwise replace SCR driver board A1.
	Bad connection or open SCR's.	If the SCR driver board is good, check the internal charger connections or check for an open SCR1. See SECTION 15.2.2 for procedure to determine if the charger has an open SCR1.
<b>9)</b> Charger output current wrong.	Bad S1 shunt	Check S1 shunt connections, and make sure shunt not damaged. JE4-3 and JE4-7 wires provide the SCR driver board output current sensing.
	Defective A1 SCR Driver board	A defective A1 SCR Driver board will not control the SCR firing pulses properly. This could over charge the battery or allow the DC voltage to go too high. Disconnect JE4 control cable from the SCR Driver board. With the charger wired for normal operation, re energize the charger. If there is output current, then the SCR may be bad. See Charger output uncontrollable symptom (#10).
<b>10)</b> Charger output uncontrollable.	Leaky or full-on SCR1	A leaky or full-on SCR1 will not allow the SCR Driver Board to control the charger voltage or current. Disconnect both of the Brown SCR1 gate wires at the SCR's. Restart the charger. If there is any measurable DC current, then at least one of the SCR's is defective. It is recommended that both be replaced.
	Defective A1 SCR Driver board	If no problem is found, reconnect the cables, restart the charger, and verify if the problem still exists. Replace the A1 SCR Driver board if the problem still exists.
<b>11)</b> DC Breaker CB2 (trips) OFF after a few minutes.	Charger output current wrong	Turn the DC breaker back on and make note of the charger current on the display. If output current on the display is wrong, go to that symptom (#9).
	Bad connection or part in DC output circuit.	If output current on display is proper and the DC breaker still trips OFF, de-energize the charger and check for a bad connection or part between the DC terminal strip and the shunt causing the DC breaker to trip OFF. High DCrms current or high temperature will cause the breaker to trip OFF.
	Bad DC breaker CB2.	If no other problem is found, replace the DC breaker CB2.
<b>12)</b> DC Breaker CB2 (trips) OFF immediately.	Wrong DC output wiring	Turn the CB1 AC breaker off. Verify the DC output wiring is correct.
	Shorted SCR1 Rectifier	Try to reset the CB2 DC breaker with AC breaker OFF. If it trips again, there is a defective component in the output of the charger. See SECTION 15.2.1 of the manual on SCR1 shorted or leaky to determine if you have a defective SCR1.
	Shorted component in the output circuit.	With charger completely de-energized, measure the resistance from charger positive to negative. It should start low and rise above 1K ohm because of the capacitor in the charger. If the resistance is lower than 1K ohm, disconnect JE4 and JE5 cables from the SCR driver board. Disconnect necessary parts to isolate them.

## INPUT BREAKER SYMPTOMS

Symptom	Possible Cause	Recommended Action
<b>13)</b> AC supply breaker or CB1 AC breaker (trips) OFF immediately after reset, and the CB2 DC breaker remains ON.	Defective AC input wiring or wrong voltage.	Check AC input wiring, jumper connections (W1) and AC input voltage to make sure they are proper for the charger label and AC circuit breaker. See FIGURE 6.2 for proper jumper connections. See FIGURE 6.1-1 for Charger Ratings and Breaker sizes. Make sure all TS2 Input Terminal Strip and CB1 AC Breaker connections are tight. Verify T1 wires 1- 4 are in proper location. See Charger schematic.
	Defective input voltage protection device.	Verify V2 Input Surge Suppressor MOV or optional Lightning Arrester are not shorted or defective. Disconnect parts from circuit and retest.
	Defective T1 transformer.	With DC breaker CB2 OFF, disconnect Transformer T1 Secondary wires from Anode A of both the SCR1's. See FIGURE 15.2.2-1 or FIGURE 15.2.2-2 for SCR anode connections. Make sure wires are not touching anything. Reapply AC power, Turn ON AC circuit breaker. If CB1 breaker trips again you need to replace the transformer. If CB1 does not trip, you will need to measure transformer T1 voltages with a multimeter. See SECTION 15.3 for instructions. If transformer measures bad, replace it.
<b>14)</b> AC supply breaker or CB1 AC breaker (trips) OFF a few minutes after reset, and the CB2 DC breaker remains ON.	Defective AC input wiring or wrong voltage.	Check AC input wiring, jumper connections (W1) and AC input voltage to make sure they are proper for the charger label and AC circuit breaker. See FIGURE 6.2 for proper jumper connections. See FIGURE 6.1-1 for Charger Ratings and Breaker sizes. Make sure all TS2 Input Terminal Strip and CB1 AC Breaker connections are tight. Verify T1 wires 1-4 are in proper location. See Charger schematic.
	Open SCR1.	If the AC current draw is higher than expected, check the charger DC output current on the charger display. If DC output current is OK and the AC current draw is high, the charger may have only one SCR1 working. See SECTION 15.2.2 for procedure to determine if the charger has an open SCR1.
	Defective CB1 breaker.	If the AC current draw is less than the AC current rating (found in FIGURE 6.1-1 or on the ratings decal on the lower front of the charger) but the AC breaker is tripping, then the AC breaker may need to be replaced.
	Open wire to SCR Gate .	If both SCR1s appear to be OK, verify brown JE4-1 and JE4-2 wires are good.
	SCR1 not controllable	If DC output current is higher than the charger is setup for in the maximum DC amps setting you may have an uncontrollable SCR1. See DC Settings and charger label for maximum output current. Change DC amps setting to a lower value using the Control board buttons. If the DC amps on the display do not drop you may have a shorted or leaky SCR1. See SECTION 15.2.1 for procedure to determine if the charger has a shorted or leaky SCR1.
	Defective A1 SCR Driver Board	If both SCR1s appear to be OK, replace A1 SCR Driver Board with a different board.

## CHARGER FAULT CODE SYMPTOMS

Symptom	Possible Cause	Recommended Action
<b>15)</b> Lo DC fault code or output voltage low.	DC breaker OFF or no DC voltage at the charger.	Check to see if the CB2 DC breaker is OFF or tripped open. If OFF, go to that symptom (#11 or #12). If DC breaker is ON, verify that the Green "DC ON" LED is on? If not, go to the "DC ON" LED off symptom (#21).
	Battery is discharged.	After an AC power failure, battery discharge, or for any other reason, it may take a few hours for the charger to charge the batteries above the DC Lo set point value (SECTION 11.3.4).
	Wrong Display voltage.	If the breaker and LED are both on, then measure the DC voltage at the charger. It should be close to what is displayed on the control board display. If not, the charger has an internal component failure. See wrong display voltage symptom (#5).
	The value in the DC Lo set point is too high.	If the display voltage is correct, calculate the volts per cell value, then verify that the Float voltage setting (SECTION 11.3.3) is higher than the DC Lo set point (SECTION 11.3.4). If the charger was in Equalize Mode, verify that the Equalize voltage setting (SECTION 11.3.3) is higher than the DC Lo set point. If the charger is setup to do Temperature Compensation (SECTION 11.3.3), verify that the calculated voltage after temperature compensation is higher than the DC Lo set point. Hot temperatures will decrease the battery charger voltage if using Temperature compensation. Adjust DC Lo set point in the alarm setting's menu accordingly.
	Bad A1 SCR driver board.	If voltages are correct, calculate the volts per cell value. If the value calculated is higher than the DC Lo value in the Alarm Setting's menu, then power the charger down completely and then power it back up. If the fault code returns, replace the A1 SCR Drive Board.
	Charger type and battery type not matched.	If value is lower, then verify that the battery type and voltage is proper for the charger type on the charger label. Verify charger type in DC setting's menu (SECTION 11.3.3) is proper. See wrong charger type symptom (#7), if control board shows wrong charger type.
	No charger output current or current too low.	If the voltage is rising, the fault should clear after the voltage gets above the set point. If the voltage is dropping, then the charger is either not providing enough DC output current or none at all. Check the DC amps setting in the DC setting's menu (SECTION 11.3.3) and raise the value, if necessary. If the display shows no DC current, then go to the "No charger DC current" symptom (#8).
<b>16)</b> EOD fault code.		See the Lo DC symptom (#15), because it is similar. Check EOD set point values (SECTION 11.3.4) instead of DC Lo set point values.
<b>17)</b> LoLoc fault code.	Bad battery or bad connections.	Check battery voltage and connections. Switch the CB1 AC breaker OFF, then ON. The Charger should start charging the battery and bring the voltage up. See Lo DC symptom (#15) if charger does not begin to charge. This fault occurs about 3 minutes after the charger shows the DC output voltage drop below about 0.2 volts per cell or a near short. This fault will lockout or not allow the charger to charge the batteries until the AC input voltage is cycled off then back on or the battery voltage of the charger shows increases above this value.

## CHARGER FAULT CODE SYMPTOMS (CONTINUED)

Symptom	Possible Cause	Recommended Action
<b>18)</b> DC Fail fault code.	DC breaker OFF or no DC voltage at the charger.	Check the CB2 DC breaker, it has probably tripped or is OFF. If it is not off, the charger is not detecting voltage at the output. This fault will not be displayed on the display, but it will cause the "DC ON" LED to be off. Go to the "DC ON" LED off symptom (#21).
<b>19)</b> Hi AC fault code.	High AC input voltage.	Measure the charger AC input voltage. If it is higher than the nominal AC input voltage for the charger by approximately 10% or more, this is normal.
	Bad T1 transformer supply to board.	If the AC input voltage that is measured is not high and there is still a FAULT, check the AC voltage across wires JE4 pins 5 and 6. See SECTION 15.3 on transformer testing.
	Bad A1 SCR Driver Board	If transformer and AC supply voltages are good, then do a complete power reboot of the charger. If fault remains replace the board.
<b>20)</b> Lo AC fault code.	Low AC input voltage.	Measure the charger AC input voltage. If it is lower than the nominal AC input voltage for the charger by approximately 12% or more, this fault is normal. An AC input power loss or an AC breaker in the OFF position will also cause this symptom. If the charger has an AC power loss, or an AC breaker in the OFF position, the green "AC ON" LED will be off.
	Bad T1 transformer supply to board.	If the AC input voltage that is measured is not low and you still have this FAULT, you will need to check the AC voltage across wires JE4 pins 5 and 6. See SECTION 15.3 on transformer testing.
	Bad A1 SCR Driver Board.	If the transformer and AC supply voltages are good, then do a complete power reboot of the charger. If fault remains, replace the board.
<b>21)</b> "DC ON" LED off.	DC breaker (CB2) off	This LED will light whenever the DC circuit breaker is ON and the charger detects DC voltage. This voltage can be the charger capacitor or battery voltage. Verify breaker is ON.
	Bad A2 control board or CC1 cable.	If the charger has output current, you have a defective control board A2 or communication cable CC1 connection.
	Bad DC breaker sense connection.	If the charger does not have output current, the control board shows a voltage on the display, the breaker is ON, and the LED is not illuminated, there may be a bad connection. First, de-energize the charger and next check the wire connections on JE5 pins 8 and 10.
<b>22)</b> "AC ON" LED off.	AC breaker (CB1) off or No AC input voltage.	If the AC breaker is off, this is expected. If the breaker is ON, verify voltage on the TS2 AC input terminal strip at locations "C" and "D" where the charger transformer T1 connects. Continue to the next step if there is AC voltage at the T1 primary wires.
	Bad A2 control board or CC1 cable.	If the Status LED on the SCR driver board is illuminated (see FIGURE 10.1), check the cable CC1 connections to the control board and check the control board. Replace if defective.

## CHARGER FAULT CODE SYMPTOMS (CONTINUED)

Symptom	Possible Cause	Recommended Action
<b>23)</b> Hi DC fault code or charger output voltage high.	Charger output uncontrollable.	Make note of charger DC voltage and current, turn OFF CB2 DC breaker to turn off the charger output current. Battery voltage should drop and the fault code should go off. Go to DC settings/amps (SECTION 11.3.3) and set the amps down to "0". Turn ON CB2 DC breaker. If you have output current, then go to the charger output uncontrollable symptom (#10). If no current, proceed to next possible cause.
	Wrong display voltage.	Measure the DC voltage at the charger. It should be close to what is displayed on the control board display. If not, the charger has an internal component failure. See "Wrong display voltage" symptom (#5).
	The value in the DC Hi set point is too low.	If the display voltage is correct, calculate the volts per cell value, then verify that the Float voltage setting (SECTION 11.3.3) is lower than the DC Hi set point (SECTION 11.3.4). If the charger is in Equalize Mode, verify that the Equalize voltage setting (SECTION 11.3.3) is lower than the DC Hi set point. Is the charger setup to do Temperature Compensation (SECTION 11.3.3)? If it is, verify that the voltage after temperature compensation as calculated, is lower than the DC Hi set point. Cold temperatures will increase the battery charger voltage if using temperature compensation. Adjust DC Hi set point in the alarm setting's menu accordingly.
	Bad A1 SCR Driver Board.	If voltages are correct, calculate the volts per cell value. If the calculated value is lower than the DC Hi value in the Alarm Settings menu, then power the charger completely down and then power it back up. If problem symptom returns, then replace the A1 SCR Driver Board.
	Charger type and Battery type not matched.	If the calculated volts per cell value is higher, then verify that the battery type and voltage are both correct for the charger type indicated on the charger label. Verify that the charger type in the DC settings menu (SECTION 11.3.3) is correct. If the charger type is not correct for the size of battery set, then it should be replaced with a correctly rated charger.
<b>24)</b> HiLoc fault code.		This fault occurs when the charger DC output voltage exceeds the value in the HiLoc set point location in the Alarm Setting's menu (SECTION 11.3.4) for more than one minute or if the DC voltage varies above this value more than about three times in a minute. This fault will lockout and not allow the charger to charge the batteries until the AC input voltage is cycled off then back on. See "Hi DC" symptom (#23) for recommended action.
<b>25)</b> GFI + or GFI - fault code.	Ground fault on external DC bus.	Disconnect the charger from the battery and DC bus, then check the battery and DC bus for a ground fault.
	GFI alarm needs calibration.	Calibrate the GFI threshold value. See SECTION 11.3.4 and go to "Set GFI Open".
	Defective wiring in the charger.	Disconnect the charger from the battery or DC bus. With charger de-energized, measure with an ohmmeter from charger ground to both the positive and negative DC output connections. The resistance should be about 300k ohms on both. If significantly less, disconnect the A1 SCR Driver board JE4 and JE5 cables and measure the resistance between charger ground to both the positive and negative DC output connections. Both should be open. If not, check for evidence of damage or wires touching metal.
	Defective A1 SCR Driver Board.	Restart the charger. If unable to find GFI cause but the fault code returns, replace the A1 SCR Driver board.

---

## 15.2 TESTING SCRs

While troubleshooting, it may be necessary to determine if you have a defective SCR1 in the charger. The following sections assist in this task.

### 15.2.1 SCR1 SHORTED OR LEAKY

If an SCR1 is suspected of being faulty, it may be checked for a shorted or leakage condition with an ohmmeter. With the AC and DC voltages removed and properly de-energized and locked out from the charger, remove the secondary (SEC) transformer leads and disconnect the "G" or gate wires from the SCR1s on the charger.

On the SCR1s, as in FIGURE 15.2.2-1, you can remove the wire on the terminal labeled "A" for anode. The "K" or cathodes of the two SCR1s then go to the shunt. The "G" or Gate is the smaller terminal with brown wires going to it. These are electrically isolated TO-239 package SCRs with quick disconnect connections.

On the SCR1s, as in FIGURE 15.2.2-2, you will remove the wire attached to the heat sink plate and disconnect the gate wires. These are electrically non-isolated TO-94 package SCRs with a ½-20 STUD for mounting. The mounting stud is the "A" or anode of the SCR, which is mounted to the heat sink plate. The "K" or cathodes of the two SCR1s are hooked together and then mounted on the shunt with a red wire.

An ohmmeter reading between each SCR anode and cathode (which is connected to the shunt) should show an open circuit for both polarities of the meter. If continuity is shown, the SCR is shorted or leaky and should be replaced.

An ohmmeter reading between each SCR anode and gate should show an open circuit for both polarities of the meter. If continuity is shown and the anode to gate is shorted, the SCR should be replaced. If SCR is replaced, the SCR Driver board may also need to be replaced.

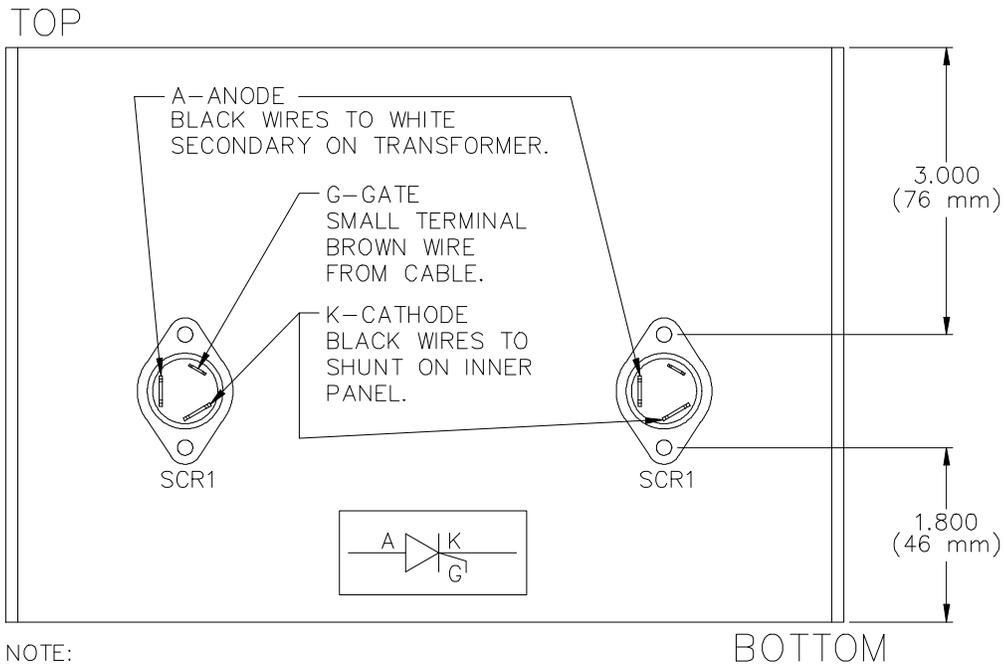
### 15.2.2 SCR1 OPEN

If the ohmmeter indicates an "OPEN" circuit, the SCR may have to be checked on some type of SCR tester to determine if it is OK or an "OPEN" circuit.

Another way to determine if the SCR1 is open, is to use a clamp-on ammeter on either the wire going to the anode or cathode while the charger is running with a small load on it. This needs to be done using caution as to not touch anything that has voltage on it. On the SCR1s, as in FIGURE 15.2.2-2, the heat sinks will have a dangerous voltage on them when the charger is running. Both SCR1s should have about the same current reading. If one has no current flow, then it may be open. Before replacing the SCR1, switch the two brown "G" or gate wires to see if the working and non-working SCRs switch.

If not able to use another method to find out if the SCR1 is working, the SCR temperatures may help determine which SCR is working and which is not. Make sure to disconnect all power before touching anything.

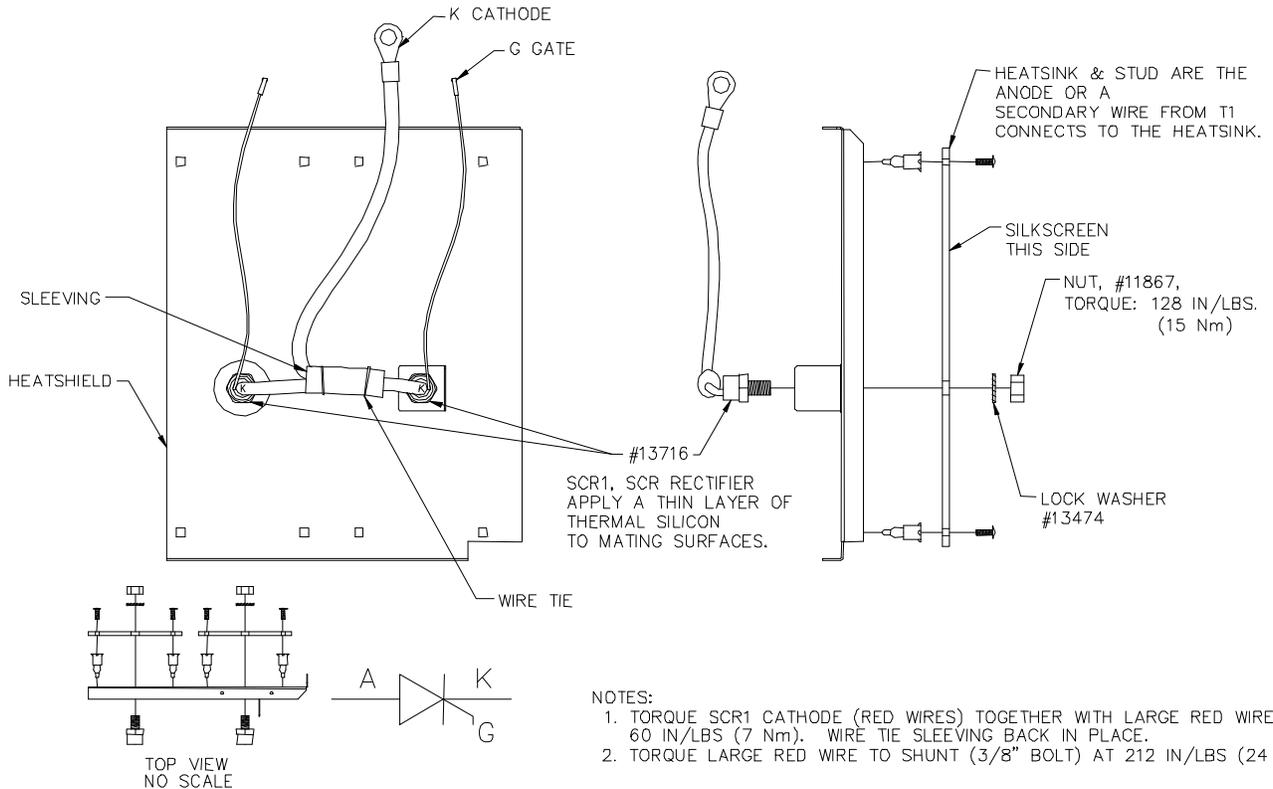
**FIGURE 15.2.2-1: SCR1 TERMINAL DIAGRAM**



NOTE:

1. THE SMALL TERMINALS 3/16 QD IS THE SCR GATE
2. MAKE SURE HEATSINK IS MOUNTED IN CHARGER W/ SCR'S CLOSER TO BOTTOM OF CHARGER
3. MAKE SURE TRANSFORMER WIRES ARE HOOKED TO ANODE ON SCR

**FIGURE 15.2.2-2: SCR1 TERMINAL DIAGRAM FOR 50A CHARGER**



### 15.3 TRANSFORMER TESTING

If the transformer is suspected of being faulty, a voltage check of the transformer should be made. The battery should be disconnected and capacitors in the charger de-energized. With the A1 SCR Driver board cables disconnected and the secondary wires that go to the SCRs disconnected, the voltages can be measured. Connect the charger to the nominal AC voltage source of the charger. The voltages on the transformers should be close to those found in FIGURE 15.3. Use a True RMS meter when taking the AC voltage measurements.

FIGURE 15.3: TRANSFORMER AC VOLTAGES TABLE			
Charger Type	AC Input Voltage	Secondary AC Voltage measured	Wires 5-7 AC Voltage measured
24 VDC 6A	120 or 240	64	27
24 VDC 6A	208	64	27
24 VDC 12A	120 or 240	67	27
24 VDC 12A	208	67	27
24 VDC 18A	120 or 240	66	27
24 VDC 18A	208	66	27
24 VDC 20A	120 or 240	66	27
24 VDC 20A	208	66	27
24 VDC 25A	120 or 240	64	26
24 VDC 25A	208	64	26
24 VDC 50A	120 or 240	56	27
24 VDC 50A	208	56	27
48 VDC 6A	120 or 240	131	27
48 VDC 6A	208	131	27
48 VDC 12A	120 or 240	129	27
48 VDC 12A	208	129	27
48 VDC 18A	120 or 240	119	27
48 VDC 18A	208	119	27
48 VDC 20A	120 or 240	119	27
48 VDC 20A	208	119	27
48 VDC 25A	120 or 240	118	28
48 VDC 25A	208	118	28
48 VDC 50A	120 or 240	107	26
48 VDC 50A	208	107	26
130 VDC 6A	120 or 240	317	28
130 VDC 6A	208	317	28
130 VDC 12A	120 or 240	312	27
130 VDC 12A	208	271	27
130 VDC 18A	120 or 240	271	27
130 VDC 18A	208	270	27
130 VDC 20A	120 or 240	271	27
130 VDC 20A	208	270	27
130 VDC 25A	120 or 240	311	27
130 VDC 25A	208	252	29
130 VDC 50A	240	277	28
130 VDC 50A	208	277	28

**NOTE:** The measured values should be less than 4 volts higher or lower than the values listed.

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## 15.4 CHARGER ID TESTING

If the charger does not show the proper charger type in the charger menu, then there is possibly a problem with the ID resistors or the SCR Driver Board. Use the charger schematic and FIGURE 15.4 to verify the resistors are good.

Charger Type	V-Rating Resistor	I-Rating Resistor	Bat. Sens. Resistor
24 VDC 6A	2000 $\Omega$	470 $\Omega$	0 $\Omega$ wire
24 VDC 12A	2000 $\Omega$	1000 $\Omega$	0 $\Omega$ wire
24 VDC 18A	2000 $\Omega$	20000 $\Omega$	0 $\Omega$ wire
24 VDC 20A	2000 $\Omega$	2000 $\Omega$	0 $\Omega$ wire
24 VDC 25A	2000 $\Omega$	3300 $\Omega$	0 $\Omega$ wire
24 VDC 50A	2000 $\Omega$	10000 $\Omega$	0 $\Omega$ wire
48 VDC 6A	3300 $\Omega$	470 $\Omega$	95300 $\Omega$
48 VDC 12A	3300 $\Omega$	1000 $\Omega$	95300 $\Omega$
48 VDC 18A	3300 $\Omega$	20000 $\Omega$	95300 $\Omega$
48 VDC 20A	3300 $\Omega$	2000 $\Omega$	95300 $\Omega$
48 VDC 25A	3300 $\Omega$	3300 $\Omega$	95300 $\Omega$
48 VDC 50A	3300 $\Omega$	10000 $\Omega$	95300 $\Omega$
130 VDC 6A	5600 $\Omega$	470 $\Omega$	383000 $\Omega$
130 VDC 12A	5600 $\Omega$	1000 $\Omega$	383000 $\Omega$
130 VDC 18A	5600 $\Omega$	20000 $\Omega$	383000 $\Omega$
130 VDC 20A	5600 $\Omega$	2000 $\Omega$	383000 $\Omega$
130 VDC 25A	5600 $\Omega$	3300 $\Omega$	383000 $\Omega$
130 VDC 50A	5600 $\Omega$	10000 $\Omega$	383000 $\Omega$

**NOTE: V-Rating and I-Rating resistors are 5% tolerance.  
Bat. Sens. Resistors are 0.1% tolerance for proper voltage calibration.**

## 16. ORDERING REPLACEMENT PARTS

When replacing a part or component in the charger, USE ONLY ORIGINAL FACTORY REPLACEMENT PARTS of the correct size and rating.

If replacement parts are needed, please provide the following information for each component:

- Circuit symbol from the schematic diagram if applicable**
- Factory part number and description from the replacement parts**
- Charger Model and serial number from charger label**
- Quantity required**

Contact your sales or service representative to place an order for spare or replacement parts. If part is not listed on the Replacement Parts Tables, contact your sales or service representative for additional parts needed.

## 17. FACTORY REPLACEMENT PARTS

Recommended Spare parts are shown marked with a "Y" in the Rec. Spr. Column.

Miscellaneous Parts for 24 Volt, 48 Volt, and 130 Volt DC Chargers				
Type of Part	Symbol	Description	Factory Part #	Rec. Spr.
Wire	<b>W1</b>	AC Input Jumper ( <b>10 AWG wire</b> )	17869S	
	<b>W1</b>	AC Input Jumper ( <b>6 AWG wire</b> )	33428S	
Varistor	<b>V2</b>	Input Surge Suppressor MOV	11705S	Y
Terminal Strips	<b>TS1</b>	ID Terminal Strip	32446S	
	<b>TS2</b>	AC Input Terminal Strip <b>for less than 50A output</b>	31887S	
	<b>TS2</b>	AC Input Terminal Strip <b>for 50A output</b>	17716S	
	<b>TS3</b>	DC Output Terminal Strip <b>for less than 50A output</b>	31886S	
	<b>TS3</b>	DC Output Terminal Strip <b>for 50A output</b>	23634S	
Cable	<b>CC1</b>	Communication Cable 1ft (305MM)	31666S	Y
Fuse	<b>F2</b>	Fuse, MDA-.5	15762S	Y
Switches	<b>SW1</b>	4 Arrow Push Button Switch	32481S	
	<b>SW2</b>	Single Push Button Switch	32482S	
Display	<b>DS1</b>	LCD Display Assembly	32918S	
Window		Clear Door Window	31453S	
Jumper		Circuit Board Jumper	18682S	Y
Leg		Round Black Rubber Feet	32823S	Y
Spacers		Spacers for Mounting SCR Driver Board	13096S	Y
		Spacers for Mounting Optional ALARM I/O Relay Board	32678S	Y
Nut		# 6-32 Nut for Mounting Optional ALARM I/O Relay Board	03237S	Y

24 Volt DC Chargers Only									
Type of Part	Symbol	Description	Factory Part Numbers						Rec. Spr.
		DC Ampere Rating	6	12	18	20	25	50	
		Cabinet Style	S1	S1	S1	S1	S1	S3	
Trans.	<b>T1</b>	120/240 Vac Transformer	22905S	22915S	23425S	23425S	22425S	23585S	
	<b>T1</b>	208 Vac Transformer	25075S	25085S	25095S	25095S	25105S	23565S	
AC Circuit Breakers	<b>CB1</b>	120 Vac Input Breaker	32658S	32658S	31634S	31634S	31633S	31951S	
	<b>CB1</b>	208 Vac Input Breaker	32658S	32658S	32658S	32658S	32658S	31633S	
	<b>CB1</b>	240 Vac Input Breaker	32658S	32658S	32658S	32658S	32658S	31633S	
DC Circuit Breakers	<b>CB2</b>	DC Breaker	32669S	32659S	32661S	32661S	32671S	32476S	
Unfiltered option	<b>C1</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>D1</b>	Diode Assembly	14786S	14786S	28018S	28018S	28018S	28018S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32092S	32092S	32092S	32092S	32092S	32092S * Note 1	Y
Filtered or Battery Eliminator option	<b>C1</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>C2</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>D1</b>	Diode Assembly	14786S	14786S	28018S	28018S	28018S	28018S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32092S	32092S	32092S	32092S	32092S	32092S * Note 1	Y
	<b>L3</b>	Filter Choke	24265S	24265S	24265S	24265S	24265S	22785S	
Ratings Resistors	<b>R2</b>	Resistor Assembly	32793S	32794S	35077S	32796S	32797S	35056S	
Bat. Sens. Resistors	<b>R3</b>	Resistor Assembly	32343S	32343S	32343S	32343S	32343S	32343S	Y
Rectifiers	<b>SCR1</b>	SCR Rectifiers with Heatsink	31608S	31608S	31608S	31608S	31608S	NA	Y
	<b>SCR1</b>	SCR Rectifiers without Heatsink	NA	NA	NA	NA	NA	13716S * Note 2	Y
Shunt	<b>S1</b>	Shunt Assembly	32921S	32921S	18696S	18696S	18696S	13324S	

Note 1: "The 24 volt 50 amp filtered chargers have two C1 and C2 capacitors and two sets of D1 and V1. The unfiltered 50 A charger has two C1 capacitors and two sets of D1 and V1."

Note 2: "With the 24 volt 50 amp charger it is recommended to replace both SCR's at the same time if one is shorted or open. The #13716S is for only one SCR."

48 Volt DC Chargers Only									
Type of Part	Symbol	Description	Factory Part Numbers						Rec. Spr.
		DC Ampere Rating	6	12	18	20	25	50	
		Cabinet Style	S1	S1	S1	S1	S1	S3	
Trans.	<b>T1</b>	120/240 Vac Transformer	22925S	22435S	23775S	23775S	22445S	23925S	
	<b>T1</b>	208 Vac Transformer	25115S	25125S	25135S	25135S	25145S	23915S	
AC Circuit Breakers	<b>CB1</b>	120 Vac Input Breaker	32658S	31633S	31951S	31951S	31951S	32924S	
	<b>CB1</b>	208 Vac Input Breaker	32658S	31634S	31634S	31634S	31633S	31952S	
	<b>CB1</b>	240 Vac Input Breaker	32658S	32658S	31634S	31634S	31633S	31952S	
DC Circuit Breakers	<b>CB2</b>	DC Breaker	32672S	32662S	32663S	32663S	32673S	32476S	
Unfiltered option	<b>C1</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>D1</b>	Diode Assembly	14786S	14786S	28018S	28018S	28018S	28018S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32092S	32092S	32092S	32092S	32092S	32092S * Note 1	Y
Filtered or Battery Eliminator option	<b>C1</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>C2</b>	Capacitor	32461S	32461S	27843S	27843S	27843S	27843S * Note 1	Y
	<b>D1</b>	Diode Assembly	14786S	14786S	28018S	28018S	28018S	28018S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32092S	32092S	32092S	32092S	32092S	32092S * Note 1	Y
	<b>L3</b>	Filter Choke	24265S	24265S	24265S	24265S	24265S	22785S	
Ratings Resistors	<b>R2</b>	Resistor Assembly	32798S	32799S	35076S	32797S	32801S	34931S	
Bat. Sens. Resistors	<b>R3</b>	Resistor Assembly	32808S	32808S	32808S	32808S	32808S	32808S	Y
Rectifiers	<b>SCR1</b>	SCR Rectifiers with Heatsink	31608S	31608S	31608S	31608S	31608S	NA	Y
	<b>SCR1</b>	SCR Rectifiers without Heatsink	NA	NA	NA	NA	NA	13716S * Note 2	Y
Shunt	<b>S1</b>	Shunt Assembly	32921S	32921S	18696S	18696S	18696S	13324S	

Note 1: "The 48 volt 50 amp filtered chargers have two C1 and C2 capacitors and two sets of D1 and V1. The unfiltered 50 A charger has two C1 capacitors and two sets of D1 and V1."

Note 2: "With the 48 volt 50 amp charger it is recommended to replace both SCR's at the same time if one is shorted or open. The #13716S is for only one SCR."

130 Volt DC Chargers Only									
Type of Part	Symbol	Description	Factory Part Numbers						Rec. Spr.
		DC Ampere Rating	6	12	18	20	25	50	
		Cabinet Style	S1	S1	S1	S1	S1	S3	
Trans.	<b>T1</b>	120/240 Vac Transformer	22935S	22455S	24105S	24105S	22465S	22945S	
	<b>T1</b>	208 Vac Transformer	25155S	24945S	24915S	24915S	24825S	25165S	
AC Circuit Breakers	<b>CB1</b>	120 Vac Input Breaker	31633S	31952S	32924S	32924S	32668S	NA	
	<b>CB1</b>	208 Vac Input Breaker	31634S	31951S	31952S	31952S	31952S	32428S	
	<b>CB1</b>	240 Vac Input Breaker	31634S	31949S	31951S	31951S	31952S	32668S	
DC Circuit Breakers	<b>CB2</b>	DC Breaker	32926S	32664S	23401S	23401S	32792S	32476S	
Unfiltered option	<b>C1</b>	Capacitor	28207S	28207S	23352S	23352S	23352S	23352S * Note 1	Y
	<b>D1</b>	Diode Assembly	28018S	28018S	28018S	23809S	23809S	23809S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32884S	32884S	32884S				Y
Filtered or Battery Eliminator option	<b>C1</b>	Capacitor	28207S	28207S	23352S	23352S	23352S	23352S * Note 1	Y
	<b>C2</b>	Capacitor	28207S	28207S	28207S	28207S	28207S	28207S * Note 1	Y
	<b>D1</b>	Diode Assembly	28018S	28018S	28018S	28018S	28018S	28018S * Note 1	Y
	<b>V1</b>	Varistor-Resistor Assembly	32884S	32884S	32884S	32884S	32884S	32884S * Note 1	Y
	<b>L3</b>	Filter Choke	24275S	24275S	24275S	24275S	24275S	25845S	
	<b>R4</b>	Resistor Assembly	NA	NA	NA	NA	NA	33338S	
Ratings Resistors	<b>R2</b>	Resistor Assembly	32802S	32803S	35077S	32804S	32806S	32807S	
Bat. Sens. Resistors	<b>R3</b>	Resistor Assembly	32809S	32809S	32809S	32809S	32809S	32809S	
Rectifiers	<b>SCR1</b>	SCR Rectifiers with Heatsink	NA	NA	NA	NA	NA	13716S * Note 2	Y
	<b>SCR1</b>	SCR Rectifiers without Heatsink	31608S	31608S	31608S	31608S	31608S	NA	Y
Zener	<b>ZD1</b>	Zener	32371S	32371S	32371S	32371S	32371S	32371S	
Shunt	<b>S1</b>	Shunt Assembly	32921S	32921S	18696S	18696S	18696S	13324S	

Note 1: "The 130 volt 50 amp filtered chargers have two C1 and C2 capacitors and two sets of D1 and V1. The unfiltered 50 A charger has two C1 capacitors and two of the combined diode, varistor, and resistor assemblies."

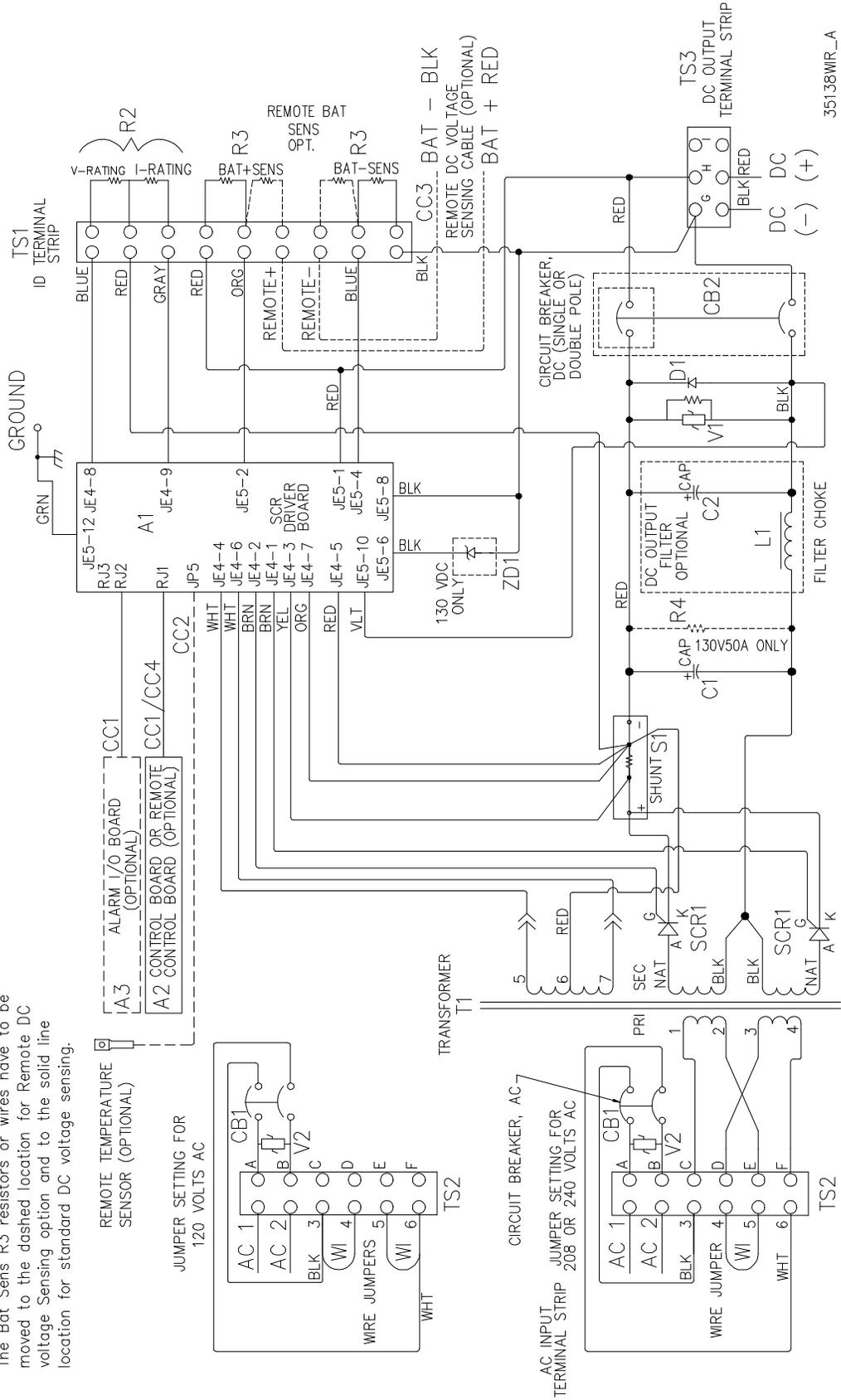
Note 2: "With the 130 volt 50 amp charger it is recommended to replace both SCRs at the same time if one is shorted or open. The #13716S is for only one SCR."

Circuit Boards for 24 Volt, 48 Volt, and 130 Volt DC Chargers						
Type of Part	Symbol	Description	Factory Part Numbers			Rec. Spr.
		Special Treatments	Standard No Coating	Fungus Proofing	Conformal Seal	
Circuit Boards	<b>A1</b>	SCR Driver	22480-00S	22480-01S	22480-02S	Y
	<b>A2</b>	Control or Optional Remote Control	22470-00S	22470-01S	22470-02S	Y
	<b>A3</b>	Optional ALARM I/O Relay	22845-00S	22845-01S	22845-02S	Y

Optional parts				
Type of Part	Symbol	Description	PART #	Rec. Spr
Remote parts	<b>CC2</b>	Remote Temperature Compensation Sensor Cable	32843S	
	<b>CC3</b>	Remote DC Voltage Sensor Cable	33339S	
	<b>CC4</b>	Remote Communication Cable 50ft (15m)	34196S	
		Remote Control Panel Kit (Note 1)	34841S	
Optional Mounting		19" (483mm) Rack Flanges	34829S	
		23" (584mm) Rack Flanges	34832S	
Protection		Input Lightning Arrester	33441S	
Alarm Relays		ALARM I/O Relay Board Installation Kit (Note 1)	33733S	
Note 1: In these optional kits the circuit boards have no special coating on them. If special coatings are needed contact the manufacturer.				

# 18. CHARGER SCHEMATIC

**NOTE:** Items in the dashed boxes or dashed lines are for options or may not be applicable for all models. The Bat Sens R3 resistors or wires have to be moved to the dashed location for Remote DC voltage Sensing option and to the solid line location for standard DC voltage sensing.



35138WR\_A

## 19. CHARGER SPECIFICATIONS

Specification	Conditions	24 Vdc	48 Vdc	130 Vdc
Output Voltage Regulation	Vac + 10%, -12%	± 0.25%		± 0.25%
	0 to 100% load			
	Temp. 32° - 105°F (0 - 40°C)			
	Freq. 50 - 60 Hz ± 3 Hz			
Transient Response	20-100% load charge, with battery connected	Does not exceed ± 6%. Does not activate High Voltage Alarm.		
Output Ripple Voltage (Meets or Exceeds NEMA PE5-1996 Requirements)	Unfiltered on battery	1% V rms		2% V rms
	Filtered on battery	30 mV rms		30 mV rms
	Filtered off battery	30 mV rms		100 mV rms
	Battery eliminator	30 mV rms		100 mV rms
Current Limit	Adjustable	0 to 110%		
Charger Delay	After AC Return	8 Sec. to 60 Mins.		
Soft Start	0 to 100% load	Dynamic Depending on Battery Voltage		
Voltage Adjustment Range	Float	2.00 V/C to 2.50 V/C		
	Equalize	2.00 V/C to 2.50 V/C		
	High DC Voltage alarm	1.00 V/C to 2.70 V/C		
	Low DC Voltage alarm	1.00 V/C to 2.50 V/C		
	End of Discharge Voltage alarm	1.00 V/C to 2.00 V/C		
Voltmeter Range, Vdc		0.40 V/C to 3.00 V/C		
Ammeter Range, Adc	All ratings	0 to 120%		
Reverse Current From Battery	AC input power failure; no options installed	Less than 90 mA		
Audible Noise	Average for 4 sides, 5 feet from charger	Less than 62 dB (A)		
Cooling		Natural Convection		
Ambient Temperature	Operating	32° - 105°F (0 - 40°C)		
Elevation	Without Derating	1000 m (3000 ft)		
Relative Humidity	Non-condensing	0 – 95%		
Alarm Relay Contact Rating	Max. Switching Voltage	150 VDC, 125 VAC		
	Max. Switching Power	30 WDC, 60 VA AC		
	Max. Switching Current	2.0 A		
	Max. Carry Current	2.0 A		

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## NOTES



**SBS**

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