



Filtered Battery Charger / DC Power Supply



Installation & Operation Manual

ECU Case Size E1

12V/6-50A

24V/6-50A

48V/6-35A

120V/6-16A

240V/6A

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Installation or service questions?
Call SENS at 1.800.742.2326 (303.678.7500)
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1 IMPORTANT SAFETY INSTRUCTIONS FOR INSTALLER AND OPERATOR

WARNING:

HEATSINKS AND OTHER METALLIC SURFACES WITHIN THE CHARGER MAY BE ENERGIZED AT HIGH VOLTAGE POTENTIALS, WHICH CAN BE LETHAL. DO NOT TOUCH EXPOSED METAL SURFACES WITHIN THE CHARGER WHILE INPUT POWER IS APPLIED.

WARNING:

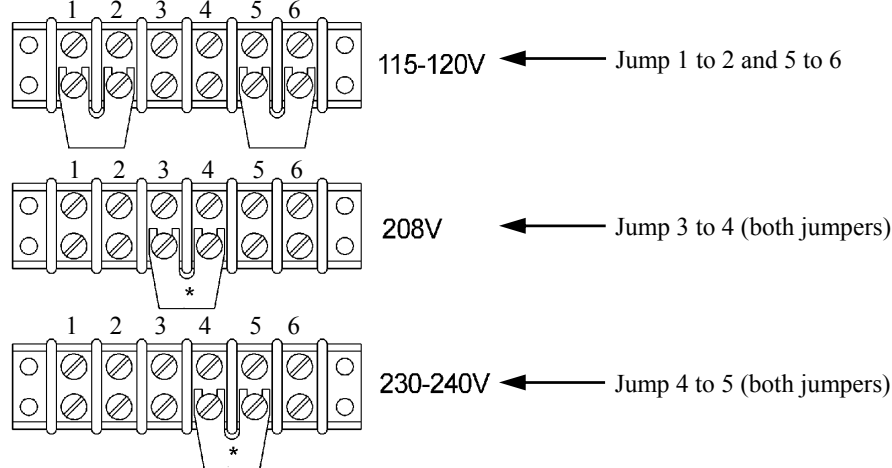
WORKING IN THE VICINITY OF A LEAD-ACID OR NICKEL-CADMIUM BATTERY IS DANGEROUS. STORAGE BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL BATTERY OPERATION. IT IS OF UTMOST IMPORTANCE THAT BEFORE USING YOUR CHARGER, YOU READ THIS MANUAL AND FOLLOW THE INSTRUCTIONS EXACTLY.

- A. **SAVE THESE INSTRUCTIONS.**
- B. **DO NOT EXPOSE CHARGER TO RAIN OR SNOW.**
- C. **GROUNDING INSTRUCTIONS** - This battery charger should be connected to a grounded metal permanent wiring system, or an equipment-grounding conductor should be run with circuit conductors and connected to equipment-grounding terminal or lead on battery charger. Connections to the battery charger should comply with all local codes and ordinances.
- D. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
- E. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; shut off power at the branch circuit protectors and have the unit serviced or replaced by qualified personnel
- F. To reduce risk of electric shock, disconnect the branch circuit feeding the charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.
- G. **ONLY TRAINED AND QUALIFIED PERSONNEL MAY INSTALL AND SERVICE THIS UNIT.**
- H. **Use this charger for charging LEAD-ACID or LIQUID ELECTROLYTE NICKEL-CADMIUM batteries only.** Do not use this battery charger for charging dry cells, alkaline, lithium, nickel-metal-hydride, or sealed nickel-cadmium batteries that are commonly used with home appliances. These batteries may burst and cause injuries to persons and damage to property.
- I. **NEVER** charge a frozen battery.
- J. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of any equipment you intend to use in the vicinity of a battery. Review cautionary markings on these products.
- K. Use of an attachment not recommended or sold by SENS may result in a risk of fire, electric shock, or injury to persons.
- L. Notice to users in the European Union: Declaration of Conformity limits the use of chargers to non-public power grids.

2 QUICK INSTALLATION GUIDE

- A. Remove the charger from the packaging and inspect for damage. See **Paragraph 5.1** for information on moving and lifting the charger. Notify SENS immediately (**1-800-742-2326**) if damage from shipping is evident.
- B. For mounting options (wall or rack) , see **Paragraph 5.2**.
- C. Select models include a 3-way input voltage selection jumper. Ensure the jumpers are in the correct position as shown below:

VOLTAGE SELECT JUMPER SETTINGS



* BOTH JUMPERS IN SAME POSITION

- D. Connect AC wires—**Ensure that the AC input supply is de-energized and the charger AC input circuit breaker is opened.** Wire the AC input circuit to the empty lugs of the AC input breaker. Connect the earthed conductor of the AC input circuit to the grounding lug inside the charger. See **TABLE 2** for AC input breaker wire size. See **wiring diagrams FIG 2** and **FIG 3**.
- E. Connect DC wires—**Ensure that any battery disconnect device in the system, if used, is opened** (batteries disconnected from DC bus), and that the **DC output breaker in the charger is opened.** Connect the DC output wires to the load side of the DC output breaker, **observing the correct polarity** as labeled on the charger next to the output breaker. Make sure small signal leads also attached to the breaker remain connected. See **TABLE 3** for DC output breaker wire sizes. See **wiring diagrams FIG 2** and **FIG 3**.

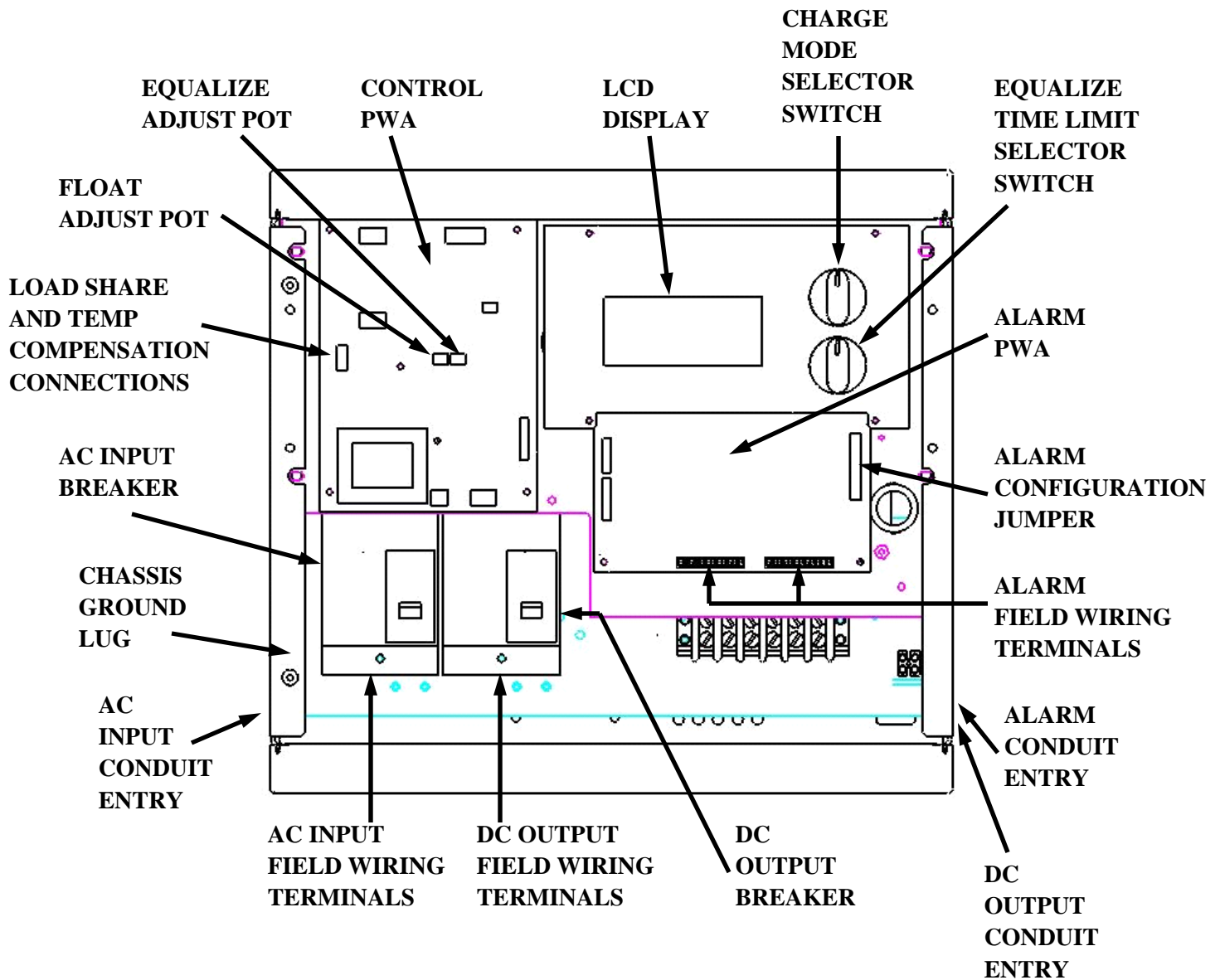
NOTE:

If a shrill tone is heard when connecting to the DC output breaker, or when closing the battery disconnect, the polarity of the battery connection to the output breaker is incorrect and must be remedied.

- F. Connect optional alarm wires—Alarm wiring enters the charger on the right side towards the top of the enclosure. Knock out the appropriate conduit opening and connect alarm wiring, taking care to route the wiring through appropriate cable guides provided within the charger. See **FIG 2**, **FIG 4** and **FIG 5** for alarm wiring terminal block and cable guide locations. See **TABLE 4** for alarm wiring connection locations.

- G. Connect optional remote temperature sensor and load share wires—Remote temperature sensor and load share connections enter the charger on the right side towards the top of the enclosure. Knock out the appropriate conduit opening and connect the remote temperature sensor or load share wire. See **FIG 2** and **FIG 6** for remote temperature sensor and load share terminal block location.
- H. Energize the AC input supply—**With the charger input AC and output DC breakers still opened**, energize the AC input supply, and check the voltage at the line side of the input AC breaker, making sure it is the correct value for the charger.
- I. Verify battery voltage—**With the charger input AC and output DC breakers still opened**, close any system battery disconnect, if used, and measure the battery voltage at the battery side of the charger DC output circuit breaker, making sure it is the correct value. If a shrill tone is heard at this time, the polarity of the battery connection to the charger is incorrect. See **TABLE 5** for typical values of open circuit battery voltage for most common battery configurations.
- J. Apply AC voltage—**With the DC output circuit breaker still opened**, and the front panel **CHARGE MODE** selector switch set to the 'FLOAT' position (see **FIG 8** for CHARGE MODE selector switch and Section 8.1 for description of available charging modes) and with a DMM connected to the charger side of the DC output circuit breaker, close the charger AC input circuit breaker. The charger output should slowly ramp up and settle to its regulated float voltage level within 10 seconds.
- K. Close the DC output breaker—Depending on the state of charge of the batteries and the load on the DC bus, the charger may go into current limit at this time, in which case the output voltage as displayed on the LCD and the DMM will be reduced as the charger operates in constant current mode. Eventually as the battery is charged, the charging current demand should taper to a value below the current limit set point of the charger, and the charger should revert to constant voltage output, regulating the DC bus at the float level.
- L. If Automatic or Equalize charging modes are desired set the **CHARGE MODE** selector switch and the **EQUALIZE TIME LIMIT** selector switch to the desired settings (see **FIG 8** for CHARGE MODE selector switch and EQUALIZE TIME LIMIT selector switch, Section 8.1 for description of available charging modes and Section 8.2 for description of equalize time limit).

Figure 1: ECU battery charger controls and indicators



3 PERFORMANCE SPECIFICATIONS

AC Input

Standard input, 60 Hz rating	< 3,500 W output: Field selectable 120/208/240 VAC, single phase ≥ 3,500 W output: 240 VAC, 60 Hz, single phase
Optional inputs, 60 Hz	240, 480, 575 VAC, 60 Hz
Standard input, 50/60 Hz rating	< 3,500 W output: Field selectable 120/208/240 VAC ≥ 3,500 W output: 230 VAC, 50/60 Hz
Optional input, 50/60 Hz	400 VAC, 50/60 Hz
Input voltage selection	Field accessible terminal block
Voltage tolerance	60 Hz: -12%, +6% per NEMA PE-5. 50 Hz: ±10%
Efficiency	>90%, (120-volt units)
Input protection	2-pole circuit breaker, inrush limiter, soft start, transient suppression

Charger Output

Nominal voltage ratings	12, 24, 48, 110, 120, 220 or 240 volts
Line and load regulation	±0.5%
Current limit	105% typical, adjustable to from 60% to 110%
Charge characteristic	Constant voltage, current limited, multi- rate
Charge mode control	User selectable float, timed equalize or automatic equalize modes
Standard output filtering	12, 24, 48V: 30 mV rms on battery 4 times AH of charger's amp rating; 100 mV rms without battery
Optional output filtering	110, 120, 220, 240V: 1% rms on battery; 2% w/o battery
Dynamic response	110, 120, 220, 240V: 30 mV rms on battery; 100 mV rms w/o battery On battery, output voltage remains within 5% of initial voltage on step load current change 20% to 100% and 100% to 20%. Recovery to within 1% of steady state voltage within 200 milliseconds.
Battery eliminator operation	Stable operation without battery. Battery advised for constant power loads
Temperature compensation	Enable or disable. Remote sensor optional. Two slope programs
Reverse polarity protection	Audible warning, internal diode, DC circuit breaker
Parallel operation	Active load share
Output protection	Current limit, 2-pole circuit breaker, transient voltage suppression

Environmental

Operating temperature	-40C to +60C, with full output available to +50C (+40C for 100 and 150A units)
Over temperature protection	Gradual current reduction to maintain safe power device temperature. Current limit drops to zero amps at about 90C ambient.
Humidity	5% to 95%, non-condensing
Seismic compliance	Tested compliant to UBC Seismic Zone 4
Transient, RF, ESD immunity	To ANSI/IEEE C62.41, Cat. B; ANSI C37.90a; EN50082-2 heavy industrial

Agency Compliance

Safety Agency marking	C-UL listed to UL 1012; CSA standard 22.2 no. 107.2-M89
EMI	CE: 50/60 Hz units DOC to EN 60335
Other	FCC Part 15 Class A; EN 50081-2 NFPA-110 compliant alarm system NFPA-70 compliant

Mechanical/Construction

Printed circuit card	Surface mount technology, conformal coated
Housing	CR steel, cleaned and finished with electrostatically applied and baked polyester compound. Standard wall/rack mounting brackets
Electrical connections	Compression terminals
Cooling	<i>Dual Path</i> convection cooling delivers unheated air to life-critical parts

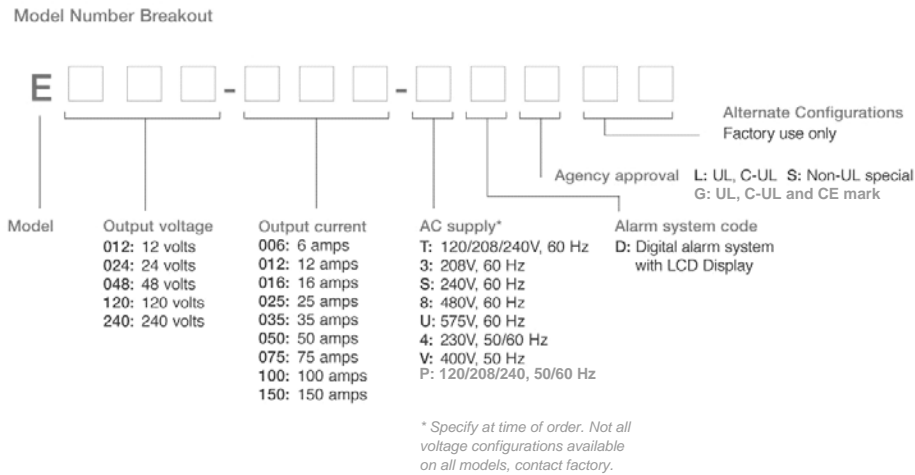
Housing Dimensions

See drawings at back of manual for details on mounting configurations.

Optional features

Input	Optional input voltages as listed under AC Input above
High Interrupt AC breaker	25 or 65 KAIC available in most units
Mounting	Floor mount brackets for housing size 2
Remote temp comp sensor	Recommended where battery & charger are in different locations
Drip shield	Protects from dripping water to IP22
Outdoor cabinet	Allows placement of charger and/or battery nearly anywhere

4 MODEL NUMBER CONFIGURATION



5 MECHANICAL INSTALLATION

5.1 Lifting

The charger is designed to be lifted from the bottom by pallet jack or lift truck.

5.2 Charger Mounting Options

The charger is designed to accommodate mounting on a wall or in a 19-inch rack.

The charger is shipped on its back with the mounting flanges in the wall-mount position. For rack mounting, place the charger in a vertical position, then unbolt and reverse the mounting flanges. See drawings at back of manual for details on mounting configurations.

CAUTION:

When changing the angles from wall mount (the standard shipping configuration) to rack mount, you **MUST** either stand the charger up vertically, or otherwise remove the charger's weight from the rack angles when removing the rack angle bolts. If you do not, the bolts in heavy chargers may strip on their way out.

5.3 Ventilation

The charger is designed to be convection cooled. Recommended clearances around the unit for proper cooling are 6 inches on the top and 4 inches on the bottom.

5.4 Environmental Considerations

The charger should be installed in a sheltered area, protected from rain and snow.

The suggested operating temperature range is -40°C to $+50^{\circ}\text{C}$, but the charger will continue to operate outside of this range. The charger is rated for -40°C for black/cold start, therefore, due to component heating the charger will operate at a lower ambient temperature. The charger thermal limiter will reduce output current to prevent over-heating in higher temperature installations.

6 ELECTRICAL INSTALLATION

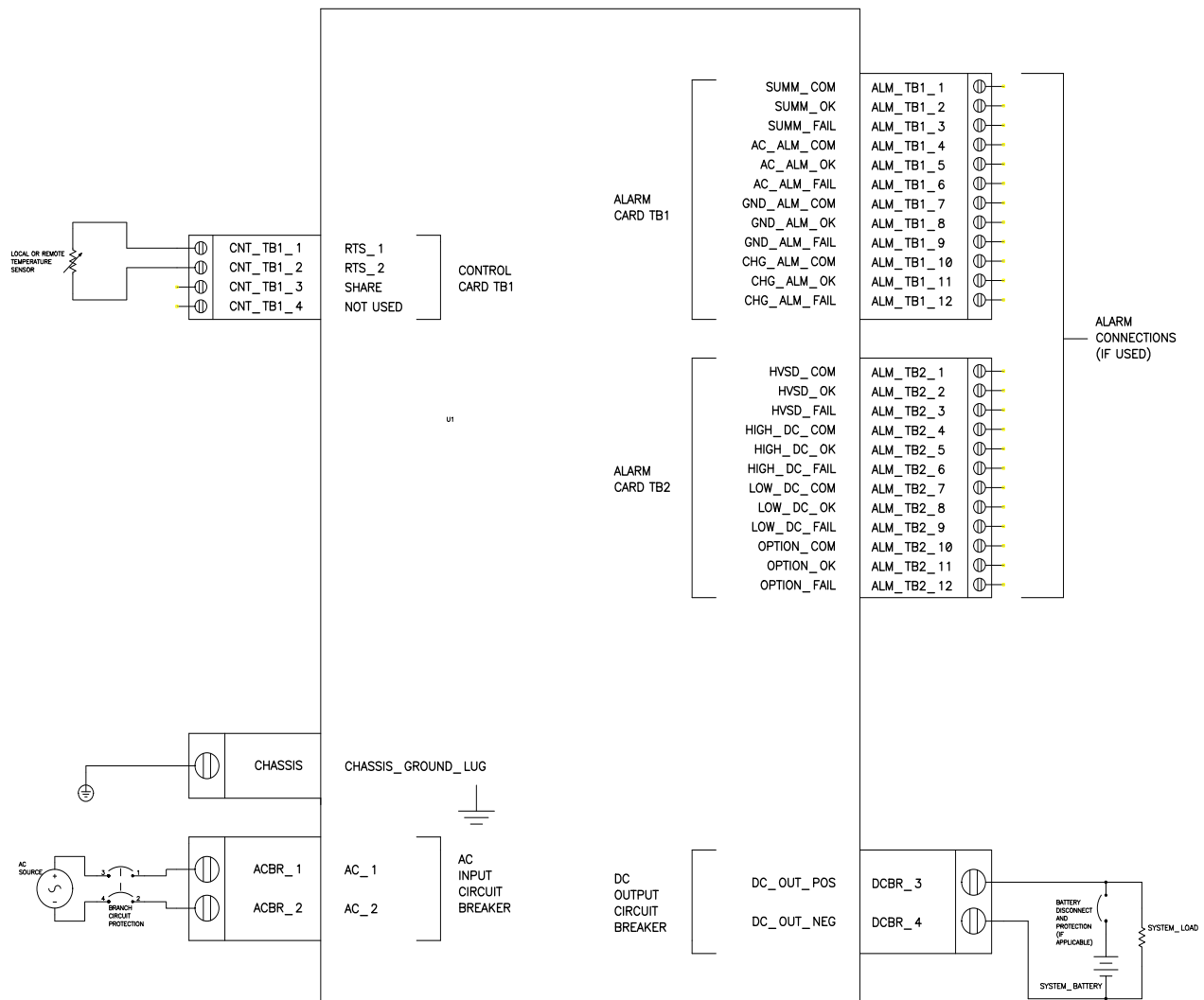
WARNING:
BEFORE ELECTRICAL INSTALLATION, ENSURE THE FOLLOWING:

- A. AC MAINS SUPPLY CIRCUIT IS DE-ENERGIZED.**
- B. AC INPUT BREAKER ON THE CHARGER IS OPENED**
- C. DC OUTPUT BREAKER ON THE CHARGER IS OPENED**
- D. BATTERY DISCONNECT, IF USED, IS OPENED (BATTERY REMOVED FROM DC BUS).**

See wiring diagram in **FIG 2**. This diagram reflects charger setup for a typical installation only. For applications not covered in the diagram, please consult the factory.

See drawings at back of manual for quick reference installation information.

Figure 2: Typical wiring diagram for ECU battery chargers



6.1 AC Input Connections

The battery charger is permanently connected to an appropriately rated single phase, grounded AC mains circuit, as shown in **FIG 3**. Wiring used must be sized appropriately for the charger input current and must be selected to meet any applicable local codes (please see **TABLE 1** for charger circuit breaker ratings and **TABLE 2** for wire gauges). Connect to the line side of the input circuit breaker and ground lug via conduit knockout openings on the lower left side of the charger enclosure. The earthed conductor of the AC mains circuit must be connected to the charger-grounding terminal.

Figure 3: Input and output circuit breaker wiring locations (circuit breaker appearance may vary depending on model)

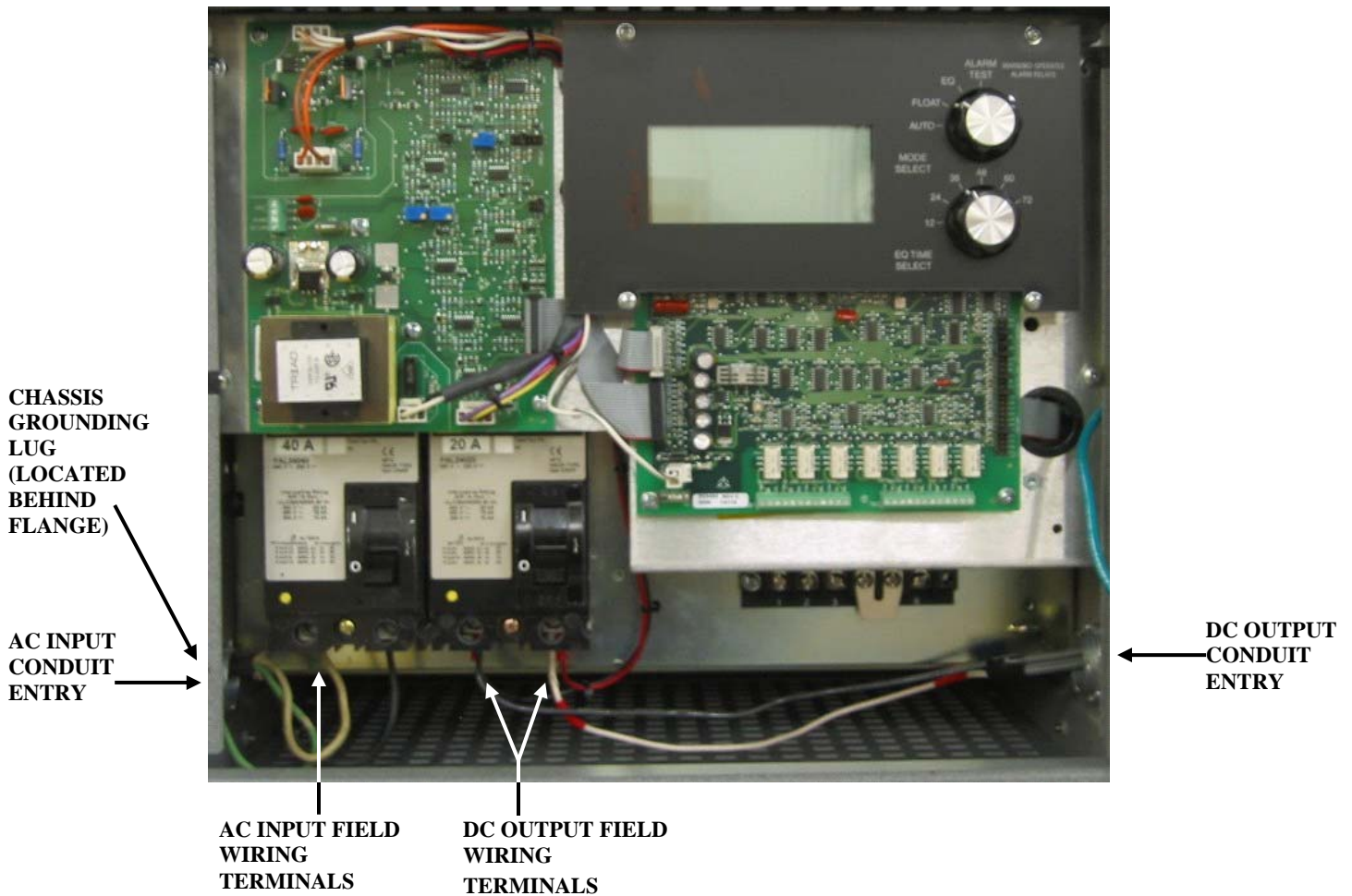


Table 1: AC Input Current and AC/DC Circuit Breaker Current Ratings

Charger Model	Rated AC Input Current				Charger Input Breaker Current Ratings					Output Breaker Current Ratings
	480V 60Hz (8)	120/208/240V 50/60Hz (P), 60Hz (T)	575V 60Hz (U)	400V 50/60Hz (V)	480V 60Hz (8)	120/208/240V 50/60Hz (P)	120/208/240V 60Hz (T)	575V 60Hz (U)	400V 50/60Hz (V)	
E012-006	0.4	1.5/0.8/0.7	0.3	0.4	15	15	10	15	15	10
E012-012	0.7	3.0/1.6/1.5	0.6	0.9	15	15	10	15	15	15
E012-016	1.0	3.9/2.2/2.0	0.8	1.2	15	15	10	15	15	20
E012-025	1.5	6.2/3.4/3.1	1.3	1.8	15	15	10	15	15	35
E012-035	2.1	8.7/4.8/4.3	1.8	2.5	15	15	15	15	15	45
E012-050	3.0	12.5/6.9/6.2	2.5	3.7	15	15	15	15	15	70
E024-006	0.7	2.8/1.6/1.4	0.6	0.8	15	15	10	15	15	10
E024-012	1.4	5.6/3.1/2.8	1.1	1.6	15	15	10	15	15	15
E024-016	1.8	7.4/4.1/3.7	1.5	2.2	15	15	15	15	15	20
E024-025	2.8	11.5/6.4/5.8	2.4	3.4	15	15	15	15	15	35
E024-035	3.9	16.2/8.9/8.1	3.3	4.7	15	20	20	15	15	45
E024-050	5.6	23/13/12	4.7	6.7	15	30	30	15	15	70
E048-006	1.2	5.1/2.8/2.6	1.0	1.5	15	15	10	15	15	10
E048-012	2.5	10.2/5.7/5.1	2.1	3.0	15	15	15	15	15	15
E048-016	3.3	13.5/7.5/6.8	2.8	4.0	15	20	20	15	15	20
E048-025	5.1	21/12/10	4.2	6.1	15	30	30	15	15	35
E048-035	7.2	29/16/15	6.0	8.6	15	30	30	15	15	45
E120-006	3.0	12.3/6.8/6.2	2.5	3.6	15	15	15	15	15	15
E120-012	5.9	24/13/12	5.0	7.1	15	30	30	15	15	15
E120-016	7.8	32/18/16	6.5	9.3	15	40	40	15	15	20
E240-006	5.9	24/13/12	4.9	7.0	15	30	30	15	15	15

Table 2: AC Input Wire Gauge Ratings

Rated Charger Input	Wire Gauge	
	Min	Max
≤ 240 VAC, ≤ 24A	# 14 Cu or Al	#2 Cu or Al
≤ 240 VAC, 60 Hz, > 24A	# 14 Cu or Al	#2 Cu or Al
≤ 240 VAC, 50/60 Hz, > 24A	# 14 Cu, #12 Al	# 1/0 Cu or Al
> 240 VAC (All)	# 14 Cu, #12 Al	#2 Cu, #4 Al

NOTE:

Table 2 represents only the physical capabilities of the terminals. In addition to the physical limitations, conductors must be electrically adequate per local electrical safety regulations (such as the National Electrical Code®).

6.2 DC Output Connections

WARNING:

OBSERVE PROPER POLARITY WHEN CONNECTING THE BATTERY CIRCUIT TO THE CHARGER. FAILURE TO DO SO COULD RESULT IN EXPLOSION AND DAMAGE TO THE BATTERY CHARGER. SHOULD THE BATTERY CONNECTIONS BE REVERSED, A SHRILL TONE WILL BE HEARD. IF THIS TONE IS HEARD, RECHECK BATTERY AND SENSE LEAD CONNECTIONS TO OUTPUT BREAKER FOR PROPER POLARITY.

The battery charger is permanently connected to the battery and DC load circuit, as shown in **FIG 3**. Wiring used must be sized appropriately for the charger output current and must be selected to meet any applicable local codes (please see **TABLE 1** for circuit breaker ratings and **TABLE 3** for wire gauges). Connection is made to the load side of the output circuit breaker via conduit knockout openings on the right side towards the bottom of the charger enclosure. Proper polarity for connection to the circuit breaker is as marked on the chassis of the battery charger next to the output circuit breaker.

CAUTION:

Small sense leads are connected to the load (output) side of the DC output circuit breaker. These must remain connected with the proper polarity after installation of the output power DC wiring or the charger will not function properly.

NOTE:

Either positive or negative charger output may be connected to chassis ground. If this is done, the ground fault alarm must be disabled (see 5D below).

Table 3: DC Output Wire Gauge Ratings

Rated Charger Output		Wire Gauge	
Volts	Current	Min	Max
12V - 48V	≤ 50A	# 14 Cu or Al	# 2 Cu or Al
120V & 240V	≤ 16A	# 14 Cu, #12 Al	# 4 Cu or Al
	≥ 25A	# 14 Cu, #12 Al	# 1/0 Cu or Al

NOTE:

Table 3 represents only the physical capabilities of the terminals. In addition to the physical limitations, conductors must be electrically adequate per local electrical safety regulations (such as the National Electrical Code®).

6.3 Alarm Wiring

WARNING:
CONNECT ALARM TERMINALS ONLY TO LIMITED ENERGY (“CLASS 2” or “CLASS 3”) CIRCUITS. ALARM CIRCUITS ARE RATED 26V AT 2.0A AND 125V AT 0.25A (RESISTIVE) MAXIMUM.

Connect alarm wiring to the alarm terminal blocks (TB1 and TB2) on the alarm printed wiring assembly as shown in **FIG 4** and **FIG 5**. See **TABLE 4** for alarm pin designations. The alarm wires should be connected from COM to either FAIL or OK.

Conduit knockouts are provided on the right side towards the bottom of the charger for alarm wires. Wire gauge between 16 and 28AWG may be used for the alarm connection wires. Route alarm wires through cable guides provided, as shown in **FIG 4**. Make sure to keep alarm wiring at least 6 mm (1/4 inch) away from any PWA and any other wiring in the unit.

Figure 4: Alarm contact terminal blocks and alarm wire routing guides

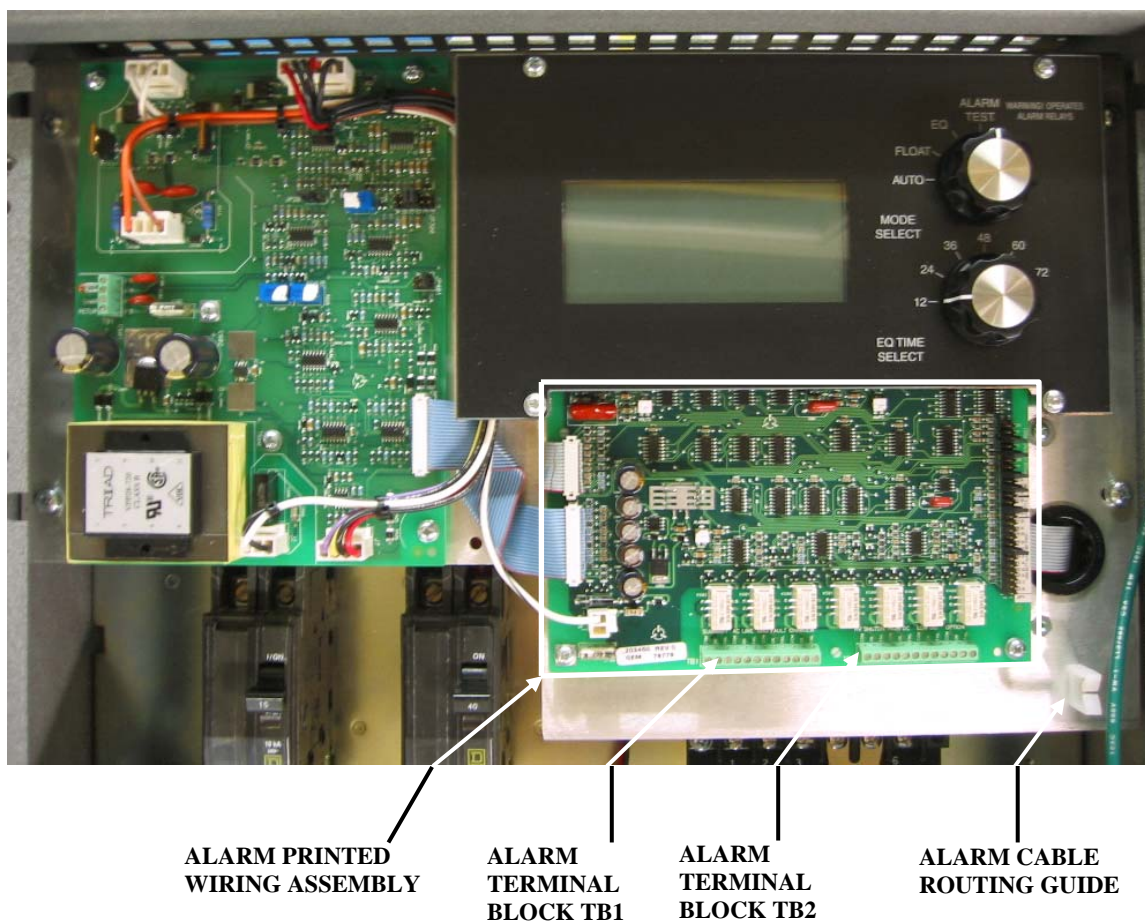


Figure 5: Alarm terminal block wiring locations

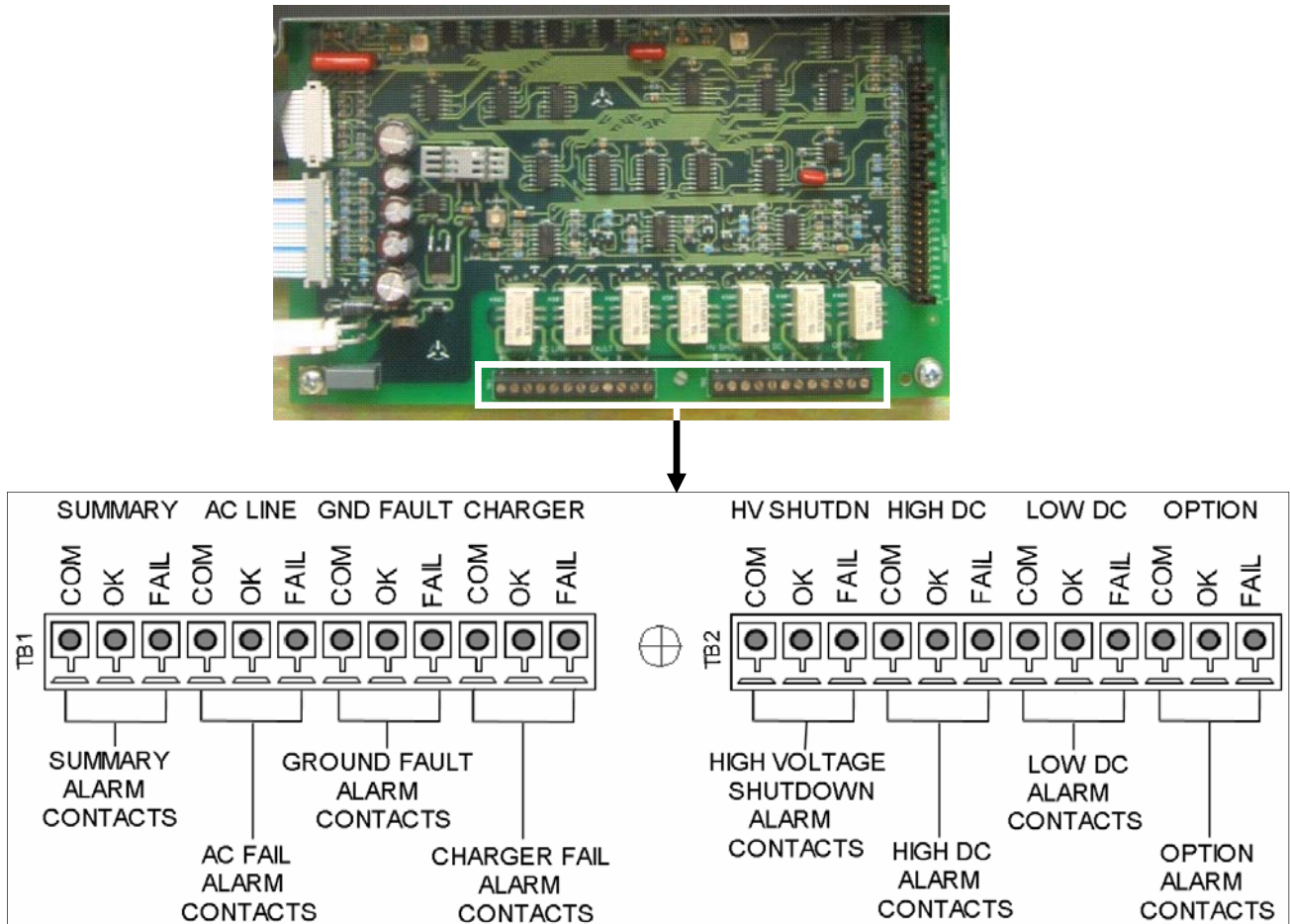


Table 4: Alarm terminal block contact designations

RELAY CONTACTS	ALARM FUNCTION							
	SUMMARY	AC FAIL	GROUND FAULT	CHARGER FAIL	HIGH VOLTAGE SHUTDOWN	HIGH DC	LOW DC	OPTION
COMMON	TB1-1 COM	TB1-4 COM	TB1-7 COM	TB1-10 COM	TB2-1 COM	TB2-4 COM	TB2-7 COM	TB2-10 COM
OPEN ON ALARM	TB1-2 OK	TB1-5 OK	TB1-8 OK Defaults to OK with no battery	TB1-11 OK Defaults to OK with no AC input	TB2-2 OK Defaults to OK with no AC input	TB2-5 OK Defaults to OK with no AC input	TB2-8 OK	TB2-11 OK
CLOSE ON ALARM	TB1-3 FAIL Defaults to FAIL with no AC input	TB1-6 FAIL Defaults to FAIL with no AC input	TB1-9 FAIL	TB1-12 FAIL	TB2-3 FAIL	TB2-6 FAIL	TB2-9 FAIL Defaults to FAIL with no battery	TB2-12 FAIL Defaults to FAIL with no battery

6.4 Battery Temperature Compensation Sensor Connections

WARNING:

REMOTE TEMPERATURE SENSOR LEADS ARE AT BATTERY POTENTIAL. THE SAME CARE SHOULD BE TAKEN WHEN ROUTING THIS WIRE AS WOULD BE TAKEN WITH THE DC OUTPUT WIRING OF THE CHARGER. USE ONLY REMOTE SENSORS PROVIDED BY THE FACTORY.

Connect a factory supplied remote or local temperature sensor to provide temperature compensated charging to terminal block TB1, positions 1 and 2 on the control PWA, as shown in **FIG 6**. The temperature sensor is not polarity sensitive, so it does not matter what lead connects to positions 1 or 2. Conduit knockouts are provided on the left side towards the top of the enclosure for remote sensor wires. Sensor wires should be run as directly as possible from the PWA to the conduit opening.

NOTE:

When temperature compensation is active, the DC output voltage is temperature compensated, however alarm threshold levels (HVSD, High Voltage and Low Voltage) are not.

Figure 6: Load share and temperature sensor terminal block on control printed wiring assembly

LOAD SHARE AND
REMOTE TEMPERATURE
SENSOR TERMINAL
BLOCK TB1



6.5 Dual Charger Setup

For a dual charger system in which equal current sharing of the load is desired, a single wire is connected between the two chargers to force load current sharing. A typical setup with two parallel chargers is shown in **FIG 7**. The current share wire is connected to terminal block TB1, position 3 on the control PWA, as shown in **FIG 6**. Use wire gauge between 18 and 22AWG for this connection. Conduit knockouts are provided on the left side towards the top of the enclosure for the share wire. The current share wire should be run as directly as possible from the PWA to the conduit opening.

WARNING:

THE CURRENT SHARE WIRE IS AT BATTERY POTENTIAL. THE SAME CARE SHOULD BE TAKEN WHEN ROUTING THIS WIRE AS WOULD BE TAKEN WITH THE DC OUTPUT WIRING OF THE CHARGER. WIRE USED FOR THIS CONNECTION MUST BE OF THE APPROPRIATE CLASS FOR THE APPLICATION.

NOTE:

The two chargers must be in the same charge mode (FLOAT or EQUALIZE) for load share to operate.

NOTE:

For load sharing to operate properly, it is necessary for the output voltages of the 2 parallel chargers to be within 2% of each other.

6.6 Battery Eliminator Operation

The charger is designed to operate in a stable fashion when driving DC loads either with or without a battery connected. When the charger is operated without a battery connected it is being used as a power supply. This is otherwise known as Battery Eliminator operation.

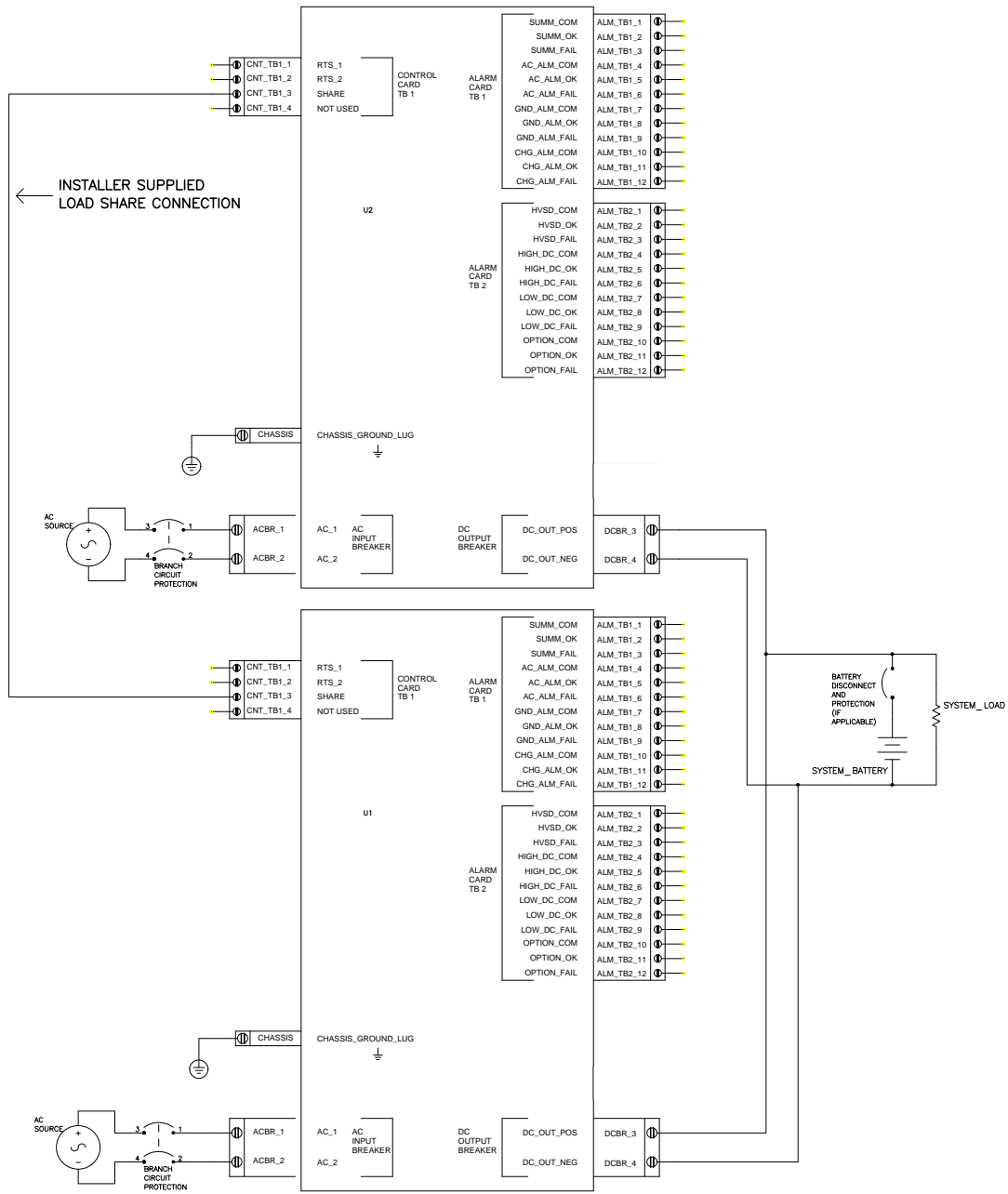
Unless otherwise specified at the time of order, the Float voltage of a charger ordered as a power supply will be set to the nominal rating of the charger. For example, if the charger is rated for 24VDC output it is configured to output 24V.

Boost mode is only required to properly recharge batteries. When used as a power supply the charger should not go into Boost mode, but should remain in Float mode. **This requires the Mode Select Switch on the front of the charger to always remain in the Float position.**

Temperature compensation is only appropriate when recharging batteries. When used as a power supply the charger output voltage should not be temperature compensated. **The charger should not have a thermistor (local temperature sensor) installed at Terminal Block TB1.**

It is possible to disconnect the battery (for test or replacement purposes) while leaving the charger powered on without interrupting the load. If the battery is disconnected from the system the normal transient voltage response will occur - output voltage remains within 5% of initial voltage when subjected to load current changes between 20% to 100% and 100% to 20% of full rated load current. Recovery to within 1% of steady state voltage within 200 milliseconds.

Figure 7: Dual charger in load share configuration



7 POWER ON/POWER OFF

7.1 Verify Input AC Supply

With the input AC and output DC breakers open, connect a portable voltmeter to the line side of the input AC breaker on the charger. Energize the AC supply and verify it is within acceptable range.

7.2 Verify Battery Voltage

With the input AC and output DC breakers open, connect a portable voltmeter to the load side of the DC breaker and verify that the open circuit battery voltage is within acceptable range (see **TABLE 5** below).

Table 5: Typical open circuit battery voltages for lead acid batteries

Number of Cells	6	12	24	55	60	110	120
Nominal Charger Output Voltage	12	24	48	110	120	220	240
Open Circuit Voltage	12.0-12.9	24.0-25.8	48.0-51.6	110-118	120-129	220-237	240-258

7.3 Verify Charger Output

Connect a portable voltmeter to the line side of the charger DC output circuit breaker. With the front panel CHARGE MODE selector switch in the FLOAT position (see **FIG 8** for CHARGE MODE selector switch and Section 8.1 for description of available charging modes) and with the charger DC output circuit breaker still open, close the charger AC input circuit breaker and verify that charger output comes up to its nominal float setting. It should take less than 10 seconds for the charger output to reach its final value.

NOTE:

With the DC output breaker open and input AC applied, the 'CHARGE FAIL' indicator on the front panel LCD will flash, and 30 seconds later, the 'CHARGE FAIL' relay contacts will change state. This is a normal alarm function indicating an open output breaker.

7.4 Begin Charging

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

7.5 Power Off

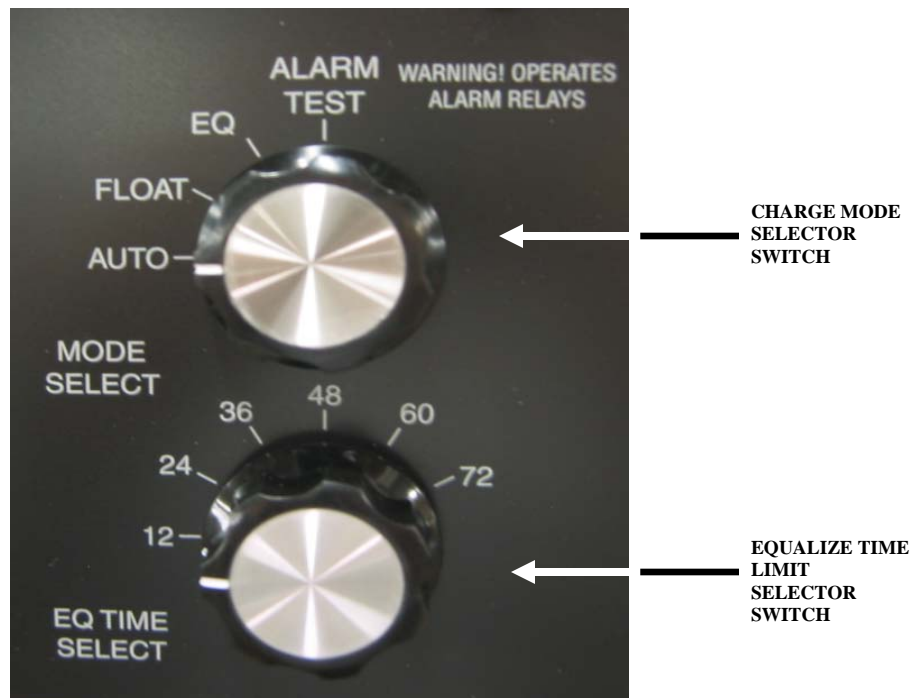
Power off the charger by opening the AC and DC breakers, in any order.

8 FRONT PANEL CONTROLS

8.1 Charge Mode Select

The charging mode of the battery charger is controlled via the front panel CHARGE MODE rotary switch, as shown in **FIG 8**. The charger may be operated in any one of three modes, FLOAT, EQUALIZE or AUTOMATIC.

Figure 8: Charge mode and equalize time limit selector switches



8.1.1 Float mode

The float mode is used to maintain the battery in its fully charged state, and is the normal setting for all batteries and the preferred setting at all times for Valve Regulated Lead Acid (VRLA) batteries. With the charger in the FLOAT setting, the output voltage is maintained at the float voltage setting.

8.1.2 Equalize mode

The equalize mode is used to ensure that all battery cells in a battery string are charged to the same level, and also used when faster charging of the batteries is desired, such as recovery from a power failure. The output voltage of the charger is typically a few percent higher in equalize mode. With the charger in the EQUALIZE setting, the output voltage is maintained at the equalize voltage until the equalize time period (see Section 8.2) has expired, or the FLOAT setting is selected manually with the rotary switch. If the charger is switched from EQUALIZE to FLOAT, then back to EQUALIZE, this resets the equalize time period.

8.1.3 Automatic Mode

The automatic mode provides a battery interactive automatic equalize cycle in which the charger measures the output current to determine state of charge of the battery. With the charger in the AUTOMATIC setting, when the output current of the charger exceeds 95% (+/- 5%) of its full rated value, the charger enters equalize mode. As the output current tapers off to less than 70% (+/- 5%) of the rated output current, the charger reverts to float mode. When in equalize mode, the charger will also revert to float mode when the equalize time period (see Section 8.2) has expired. If the charger is switched from AUTOMATIC to FLOAT, then back to AUTOMATIC, this resets the equalize time period. A typical automatic charge sequence is shown in **FIG 9**.

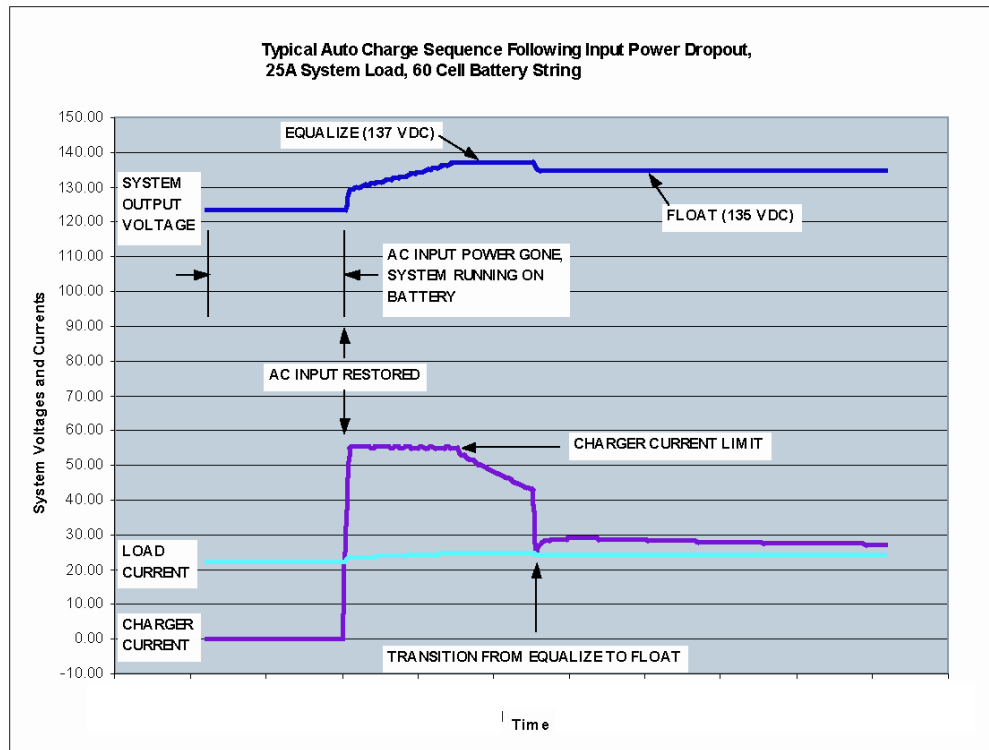
CAUTION:

Always read and follow battery manufacturer's recommendations regarding float and equalize charge settings.

CAUTION:

For systems with a large amount of continuous DC load (load separate from battery charging current) the AUTOMATIC setting may force the charger into equalize charging mode for longer than is required by the battery, possibly causing excessive charging of the battery. This should be taken into account in the design of the system and in the choice of charge mode setting.

Figure 9: Typical automatic charge sequence



8.1.4 Alarm Test

The ALARM TEST function on the CHARGE MODE selector switch activates all display characters on the LCD display and also activates all alarm contacts about 30 seconds after entering TEST mode.

8.2 Equalize Time Select

A time limit is put on the equalize portion of the charge cycle when in AUTOMATIC or EQUALIZE mode to avoid overcharging and possible damage to the battery. The EQUALIZE TIME SELECT rotary switch, shown in **FIG 8**, allows this time limit to be varied. When the CHARGE MODE selector switch is set to AUTOMATIC and the charger is in equalize mode, or the CHARGE MODE selector switch is set to EQUALIZE, the equalize cycle is time limited to 12, 24, 36, 48, 60 or 72 hours, as determined by the EQUALIZE TIME SELECT rotary switch setting. The equalize timer is reset if the charger is switched from AUTOMATIC or EQUALIZE charge mode to FLOAT charge mode, then back to AUTOMATIC or EQUALIZE charge mode. If an AC fail alarm occurs, the equalize timer is reset.

9 DISPLAY AND ALARMS

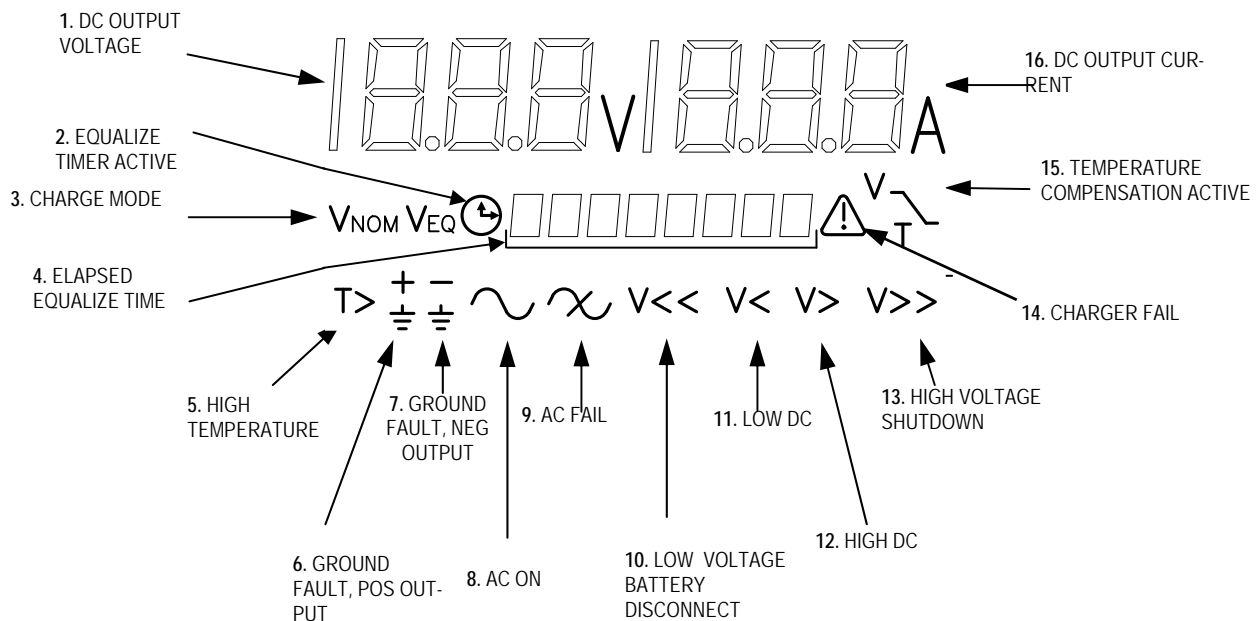
9.1 Display and Alarm Description

The front panel LCD provides visual indication of DC output voltage and current, as well as status of the input AC source, the charging mode (FLOAT or EQUALIZE), equalize time elapsed, indication of temperature compensation, and status of all alarms. The display, along with a description of the symbols, is shown below in **FIG 10**.

NOTE:

With no AC mains supply present and with a battery connected to the output of the charger, and with the DC output breaker closed, the display will operate. Battery voltage and alarm status will be displayed (AC FAIL alarm should be flashing). With the system in this condition, the charger draws 100mA maximum from the battery.

Figure 10: LCD display



1. **DC OUTPUT VOLTAGE** - A 3-½-digit display indicates DC output voltage. The display is accurate to within $\pm 1\%$.
2. **EQUALIZE TIMER ACTIVE** - A 'clock' symbol indicates an equalize charge cycle has begun and is being timed. The symbol flashes on and off when the charger is in equalize mode or has timed out and reverted to float mode.
3. **CHARGE MODE** - Charge mode is indicated by either VNOM (for FLOAT) or VEQ (for EQUALIZE).
4. **ELAPSED EQUALIZE TIME** - An eight segment display indicates time that has elapsed in the equalize cycle. Each individual segment turns black when 1/8 of the total equalized time has elapsed. When all 8 segments are black, the equalize cycle has timed out and the charger has reverted to the float charging mode.
5. **HIGH TEMPERATURE** - This symbol flashes on and off indicating that the charger's internal temperature protection circuitry is active and reducing the charger output current.
6. **GROUND FAULT, POS OUTPUT** - A ground fault from the chassis of the charger to the positive output is indicated when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a ground fault, where a fault can be indicated by either a contact closure or contact open. The ground fault relay contacts change state 30 seconds after the onset of the fault. Typical current threshold is ± 1.2 mA at nominal output voltage.
7. **GROUND FAULT, NEG OUTPUT** - A ground fault from the chassis of the charger to the negative output is indicated when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a ground fault, where a fault can be indicated by either a contact closure or contact open. The ground fault relay contacts change state 30 seconds after the onset of the fault. Typical current threshold is ± 1.2 mA at nominal output voltage.

NOTE:

For systems in which the output is normally grounded to the equipment chassis, the ground fault indicator and alarm can be disabled. See Section 10.2.3.

8. **AC ON** - Indicates AC input power is present.
9. **AC FAIL** - Indicates AC input voltage is low (less than approximately 70% of the nominal nameplate rating) or missing when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a loss of input AC power, where a fault can be indicated by either a contact closure or contact open. The AC fail relay contacts change state 30 seconds after the onset of the fault.
10. **LOW VOLTAGE BATTERY DISCONNECT** - When this symbol flashes on and off this indicates DC output voltage is below the programmed Low Voltage Load Disconnect threshold. Low Voltage Battery Disconnect power contactor is an optional feature. See Section 10.2.5 for more information.
11. **LOW DC** - Indicates DC output voltage is below a programmed level when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a Low DC alarm, where a fault can be indicated by either a contact closure or contact open. The Low DC relay contacts change state 30 seconds after the onset of the fault.
12. **HIGH DC** - Indicates DC output voltage is above a programmed level when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a High DC alarm, where a fault can be indicated by either a contact closure or contact open. The High DC relay contacts change state 30 seconds after the onset of the fault.
13. **HIGH VOLTAGE SHUTDOWN** - Indicates that the charger has executed a high voltage shutdown when this symbol flashes on and off. A set of form C relay contacts is provided to indicate a high voltage shutdown has occurred, where a fault can be indicated by either a contact closure or contact open. The high voltage shut down relay contacts change state 30 seconds after the onset of the fault.
14. **CHARGER FAIL** - Indicates the charger is not providing the current demanded by the load when this symbol flashes on and off. An open DC output circuit breaker will also activate this alarm. A set of form C relay contacts is provided to indicate a Charger Fail has occurred, where a fault can be indicated by either a contact closure or contact open. The Charger Fail relay contacts change state 30 seconds after the onset of the fault.
15. **TEMPERATURE COMPENSATION ACTIVE** - Indicates the output is temperature compensated via either remote or local temperature sensor.
16. **DC OUTPUT CURRENT** - A 3-½-digit display indicates DC output current. The display is accurate to within $\pm 1\%$.

9.2 Option Alarm Contacts

The charger provides an 'OPTION' set of form C relay contacts, which may be programmed to indicate either a Low Battery Load Disconnect at a programmed level (see 10 above), or that the charger's internal temperature protection is active (see 5 above). Please consult the factory on the application of the 'OPTION' relay contacts.

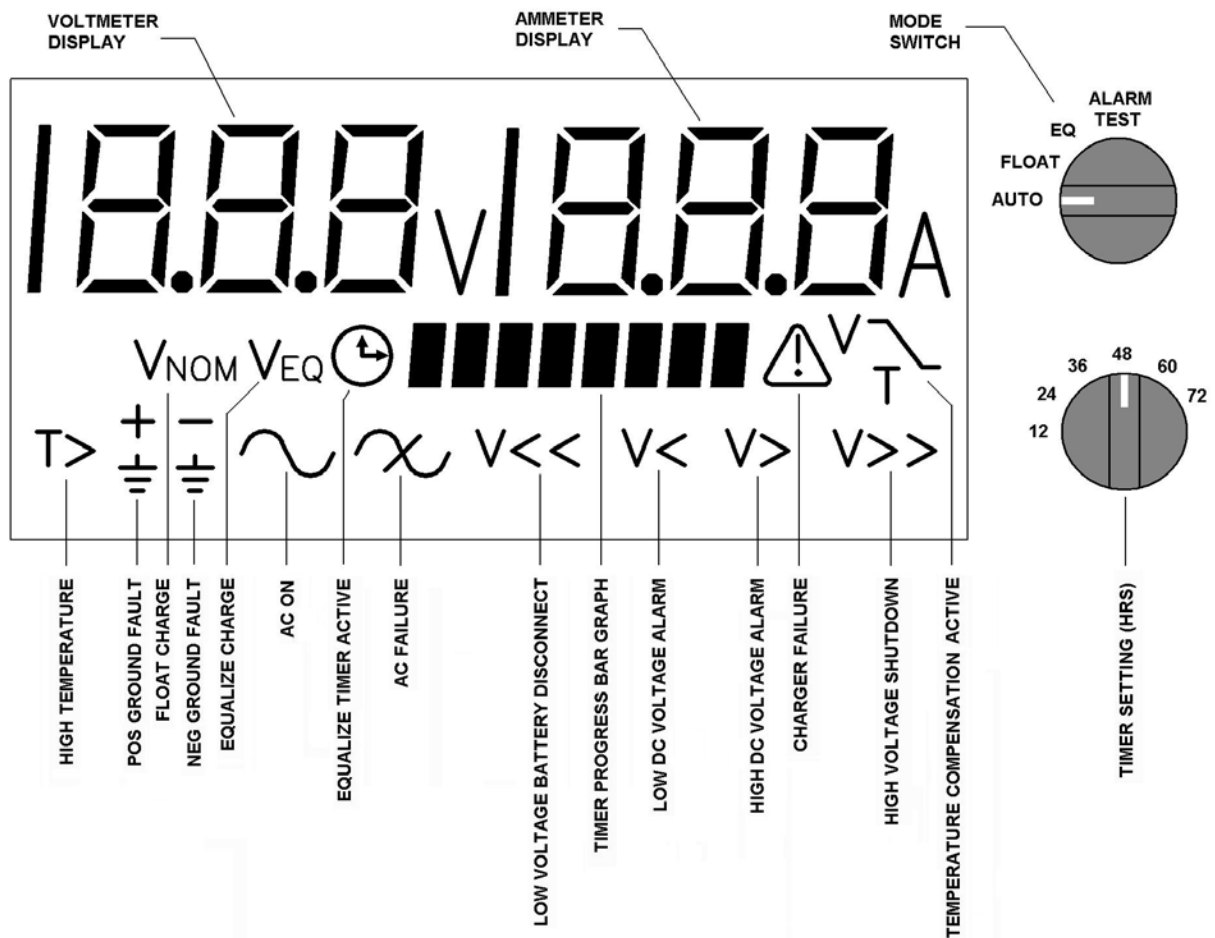
9.3 Summary Alarm Contacts

The charger provides a 'SUMMARY' set of form C relay contacts, which change state if any other of the alarm relays is activated. The 'SUMMARY' set of form C contacts allows the user to monitor all alarm relays at once with one set of contacts.

9.4 Display Tutorial

9.4.1 Display Contents

ECU chargers have a liquid crystal display panel, replacing the mechanical meters and LED indicators used in older model chargers. The drawing below identifies the display panel functions and the operator panel controls.

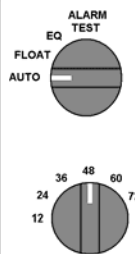
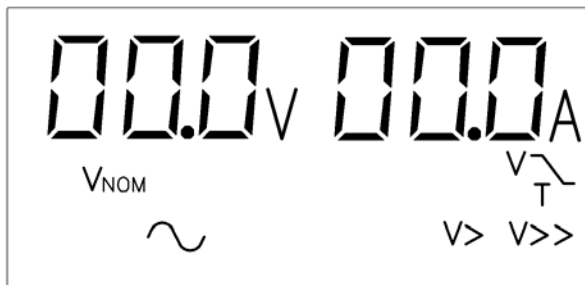


9.4.2 General

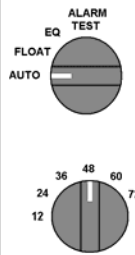
This tutorial shows typical display indications for the various operating modes and other features included in the ECU charger. It will follow typical operation from power on through a recharge cycle, showing the alarm functions and special operating modes of the charger. The voltage and current displays are typical for a 120V 50A charger connected to a 60 cell lead-acid battery. Except for the voltage and current displays, operation is identical for all ECU chargers.

9.4.3 Power On

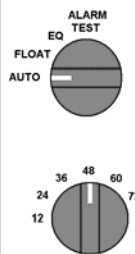
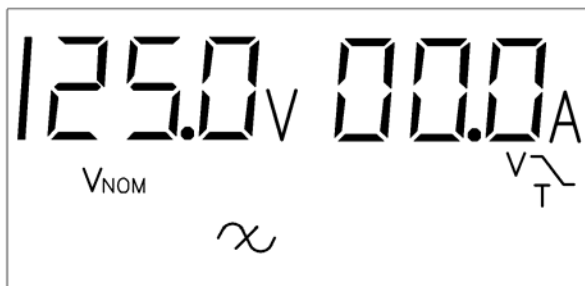
The display will operate from either AC line or DC battery power. If either source of power is present, the display will begin operating. At power-on, the voltmeter and ammeter will work immediately. The high voltage warning (V>) and high voltage shutdown (V>>) indicators will blink for approximately 10 seconds while the charger power on; this is a normal consequence of the peak-memory circuit in those detectors.



When AC power is applied first (AC breaker closed with DC breaker open), the charger output starts at 0V. The AC logo is on, showing that sufficient AC power is reaching the charger circuits. The temperature compensation logo is on, showing that a temperature sensor is connected and functional.



The voltage will gradually increase, following the "soft start" profile. Current will be low, sufficient for the output discharge resistors ("bleeders") and power for the alarm and display circuits. The Charger Fail logo (!) is on, indicating that the charger is not recharging the battery (because the output circuit breaker is open).



When battery power is applied first (DC breaker closed with AC breaker open), the voltmeter will show the battery open-circuit voltage. The ammeter reads zero, because the charger's power stage is not delivering any output. The AC Fail logo will flash, indicating that sufficient AC power is not reaching the charger circuits.

9.4.4 Recharge Sequence



When AC power is present and both the AC and DC circuit breakers are closed, the recharge cycle begins. If the battery is not at full charge, the charger begins bulk charging at maximum output current. The display ammeter shows the present charger output voltage and current. The output is at current limit, because the battery voltage has not yet risen to the charger's set-point. If the mode switch is set to "Auto" or "Eq", the "Veq" setting logo will be on and the timer logo will flash. If the mode switch is set to "float", the "Vnom" setting logo will be on and the timer logo will be off.



When the battery voltage reaches the charger output setting, output stabilizes at the equalize voltage setting in Auto and Eq mode, or at the float voltage setting in Float mode. The output current will taper off as the battery completes charging.

In Auto and Eq modes, eight timer progress bars indicate the elapsed recharge time. For example, with a 48 hour timer setting each bar represents six hours since the beginning of the recharge cycle.



In Auto mode, the charger operates at the high setting until the output current drops below 75% of the maximum rating. Then the charger enters float mode. The "Vnom" logo is on, showing the charger is at nominal output voltage. The timer logo and timer progress bars are off. The timer resets for the next automatic recharge cycle.



If the timer expires, the charger returns to float mode (regardless of output current, if in "Auto" mode). The "Vnom" logo is on, the timer logo flashes, and all eight timer progress bars are on. This shows the recharge cycle has timed out. The Eq and Auto modes are disabled until the timer is reset, either by AC fail alarm or by setting the mode switch to Float.

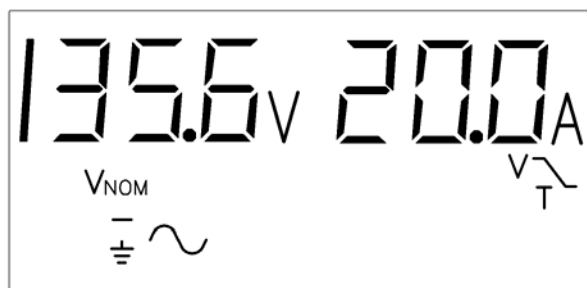
9.4.5 Status and Alarm Indications



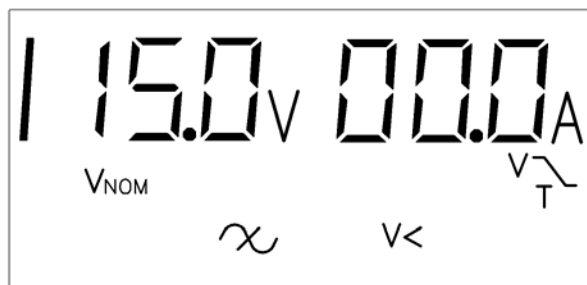
If a temperature sensor is not connected to the charger's control board or if the sensor leads are shorted, **temperature compensation** is automatically disabled. The temperature compensation logo will be off. The charger reverts to a default setting corresponding to 25C. In all other respects, the charger functions normally. There is no alarm relay associated with temperature compensation.



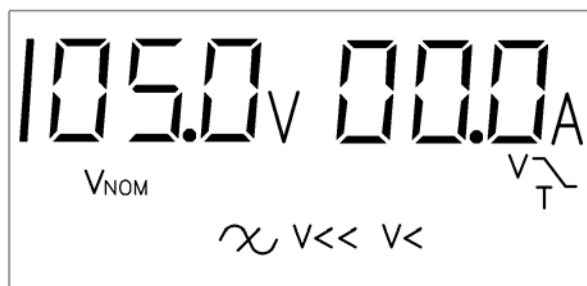
The charger includes a **ground-fault** detector, which may be enabled for applications where neither output terminal is a grounded conductor. The ground fault alarms operate when chassis ground potential is close to or exceeds the voltage at either output terminal. The positive or negative ground fault logo will flash, corresponding to the faulted output terminal.



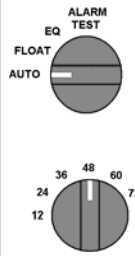
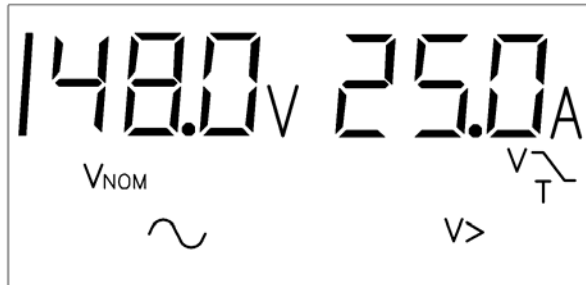
When the output is connected to a grounded system, the ground fault alarms should be disabled as described in Section 10.2.3. The alarm logos and the ground fault alarm relay will not operate when the alarms are disabled.



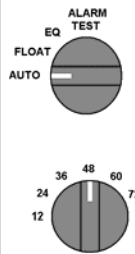
There are two low voltage alarm settings. The first setting normally is a warning level, showing the battery has discharged to a low state of charge. The **low voltage alarm** logo flashes, and the low voltage alarm relay will operate after a 30 second delay.



The second low voltage setting indicates that the battery has reached the minimum acceptable discharge voltage. The **low voltage battery disconnect** logo flashes. If the optional alarm relay is set to LVBD (low voltage battery disconnect) mode, it will operate after a 30 second time delay. This may be used to shut down the system load, protecting the battery from damage caused by excessively deep discharge.

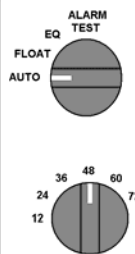


The **high voltage alarm** logo flashes when the output voltage is above the warning threshold. The threshold is selected by a jumper on the alarm card. The high voltage alarm has a ten second hold, providing a memory for short term deviations. If the alarm persists for 30 seconds, the high voltage alarm relay operates.

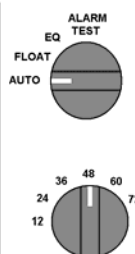


The charger disables output power whenever the output voltage exceeds the **high voltage shutdown** threshold. The threshold is fixed at 2% above the high voltage alarm threshold. The charger will cycle on and off as voltage varies above and below the threshold until latch-off occurs, as described below.

The high voltage shutdown logo will flash. This has a ten second hold, providing a memory for short term events. If the alarm persists for 30 seconds, the HVSD (high voltage shutdown) relay operates.

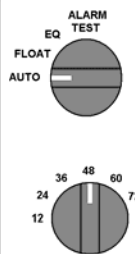


If the High Voltage Shutdown Latching is enabled by a jumper on the alarm card, the charger will lock off when the HVSD relay operates. It then remains off until AC power is disabled long enough to operate the AC Fail alarm relay, which resets the latched HVSD condition. If latching is disabled, the voltage limit cycle continues until the cause of the high voltage fault has been corrected.



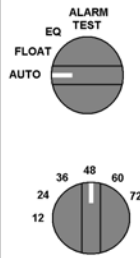
If internal temperatures reach the maximum safe level, the current limit decreases to prevent over heating. The **high temperature alarm** logo flashes. If the option alarm relay is configured for high temperature alarm, the relay operates after 30 seconds delay.

Charger operation will continue, but with reduced maximum output current as shown in the upper drawing. The amount of reduction varies to maintain safe internal temperatures.



If the load current is less than the current limit (as adjusted for temperature), the output voltage remains regulated as shown in the lower drawing.

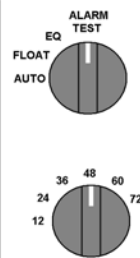
The alarm remains active until internal temperatures return to normal. High temperature alarm usually indicates restricted ventilation, high ambient temperature, or influence of external heat sources.



The **Charger Fail Alarm** indicates that the charger is not meeting the appropriate output demand. This occurs when output voltage is below the regulated set point and, at the same time, output current is less than 20% of the charger's rating. The charger fail logo flashes, and the charger fail alarm relay operates after 30 seconds delay.

Charger fail indicates the output circuit breaker is open or an internal component failure has occurred.

9.4.6 Special Modes



Setting the mode switch to "Alarm Test" turns on all the display logos. Those that normally flash will do so. The charger remains in float mode, and the ammeter and volt-meter continue to operate normally. If the mode switch remains in the test position for longer than the alarm relay delays (approximately 30 seconds), all relays except HVSD and LVBD will operate. HVSD and LVBD do not operate, to prevent accidentally shutting down the charger or disabling power to a critical load.

10 SETTINGS AND ADJUSTMENTS

10.1 Typical Battery Settings

Factory settings for float and equalize voltages and alarm settings for the most common battery configurations are shown for reference in **Tables 6, 7** and **8**. See the test data sheet provided with your charger for actual values. Please see **FIG 14** for a graphical representation of float and equalize voltage and alarm threshold settings for a typical installation.

Table 6: Non-temperature compensated factory charger output DC voltage and alarm threshold settings for typical VRLA batteries

Setting	Volts per Cell	12V, 6 Cells	24V, 12 Cells	48V, 24 Cells	110V, 55 Cells	120V, 60 Cells	220V, 110 Cells	240V, 120 Cells
Float Voltage	2.27	13.62	27.24	54.48	124.9	136.2	249.7	272.4
Equalize Voltage	2.27	13.62	27.24	54.48	124.9	136.2	249.7	272.4
Low Voltage Disconnect Threshold	1.75	10.50	21.00	42.00	96.25	105.0	192.5	210.0
Low DC Alarm Threshold	1.92	11.52	23.04	46.08	105.6	115.2	211.2	230.4
High DC Alarm Threshold	2.51	15.06	30.12	60.24	138.1	150.6	276.1	301.2
High Voltage Shutdown Threshold	2.57	15.42	30.84	61.68	141.4	154.2	282.7	308.4

Table 7: Non-temperature compensated factory charger output DC voltage and alarm threshold settings for flooded lead acid batteries

Setting	Volts per Cell	12V, 6 Cells	24V, 12 Cells	48V, 24 Cells	110V, 55 Cells	120V, 60 Cells	220V, 110 Cells	240V, 120 Cells
Float Voltage	2.27	13.62	27.24	54.48	124.9	136.2	249.7	272.4
Equalize Voltage	2.45	14.70	29.40	58.80	134.8	147.0	269.5	294.0
Low Voltage Disconnect Threshold	1.75	10.50	21.00	42.00	96.25	105.0	192.5	210.0
Low DC Alarm Threshold	1.92	11.52	23.04	46.08	105.6	115.2	211.2	230.4
High DC Alarm Threshold	2.61	15.66	31.32	62.64	143.6	156.6	287.1	313.2
High Voltage Shutdown Threshold	2.67	16.02	32.04	64.08	146.9	160.2	293.7	320.4

Table 8: Non-temperature compensated factory charger output DC voltage and alarm threshold settings for NICAD batteries (based on 1.43V per cell for float, and 1.55V per cell for equalize)

Setting	9 Cells	10 Cells	19 Cells	20 Cells	37 Cells	38 Cells	92 Cells	93 Cells	184 Cells	186 Cells
Float Voltage	12.87	14.30	27.17	28.60	52.91	54.34	131.6	133.00	263.1	266.0
Equalize Voltage	13.95	15.50	29.45	31.00	57.35	58.90	142.6	144.2	285.2	288.3
Low Voltage Disconnect Threshold	10.35	11.50	21.85	23.00	42.55	43.70	105.8	107.0	211.6	213.9
Low DC Alarm Threshold	10.80	12.00	22.80	24.00	44.40	45.60	110.4	111.6	220.8	223.2
High DC Alarm Threshold	14.85	16.50	31.35	33.00	61.05	62.70	151.8	153.5	303.6	306.9
High Voltage Shutdown Threshold	15.21	16.90	32.11	33.80	62.53	64.22	155.5	157.2	311.0	314.3

9.2 Field Adjustable Charger Settings

WARNING:

CHARGER CONTROL CIRCUITS ARE AT BATTERY POTENTIAL AND CAN BE HAZARDOUS IF TOUCHED. ONLY INSULATED TOOLS SHOULD BE USED WHILE WORKING ON A CHARGER THAT IS POWERED UP. AVOID TOUCHING ANY CIRCUIT OR ANY BARE METAL IN THE CHARGER.

CAUTION:

Do not tamper with charger adjustments unless authorized by the factory. Any charger adjustment not authorized by the factory completely voids the product warranty.

The charger output voltage and alarm thresholds and configurations are normally preset at the factory for a given battery configuration. Should the application require different settings, these can be accommodated in the field after consulting with the factory. Charger adjustments that may be made in the field include the following:

ADJUSTMENT	METHOD
Float Voltage	Float adjust potentiometer on control PWA (FIG 11)
Equalize Voltage	Equalize adjust potentiometer on control PWA (FIG 11)
Ground Fault Enable/Disable	Configuration Jumper Strip on Alarm PWA (FIG 12)
Low Voltage Battery Disconnect	Configuration Jumper Strip on Alarm PWA (FIG 12)
Low Battery Alarm Threshold	Configuration Jumper Strip on Alarm PWA (FIG 12)
High Battery Alarm Threshold	Configuration Jumper Strip on Alarm PWA (FIG 12)
High Voltage Shutdown Mode	Configuration Jumper Strip on Alarm PWA (FIG 12)
Option Alarm Relay Contacts	Configuration Jumper Strip on Alarm PWA (FIG 12)
Temperature Compensation Curve	Temperature compensation jumper on control PWA (FIG 14)

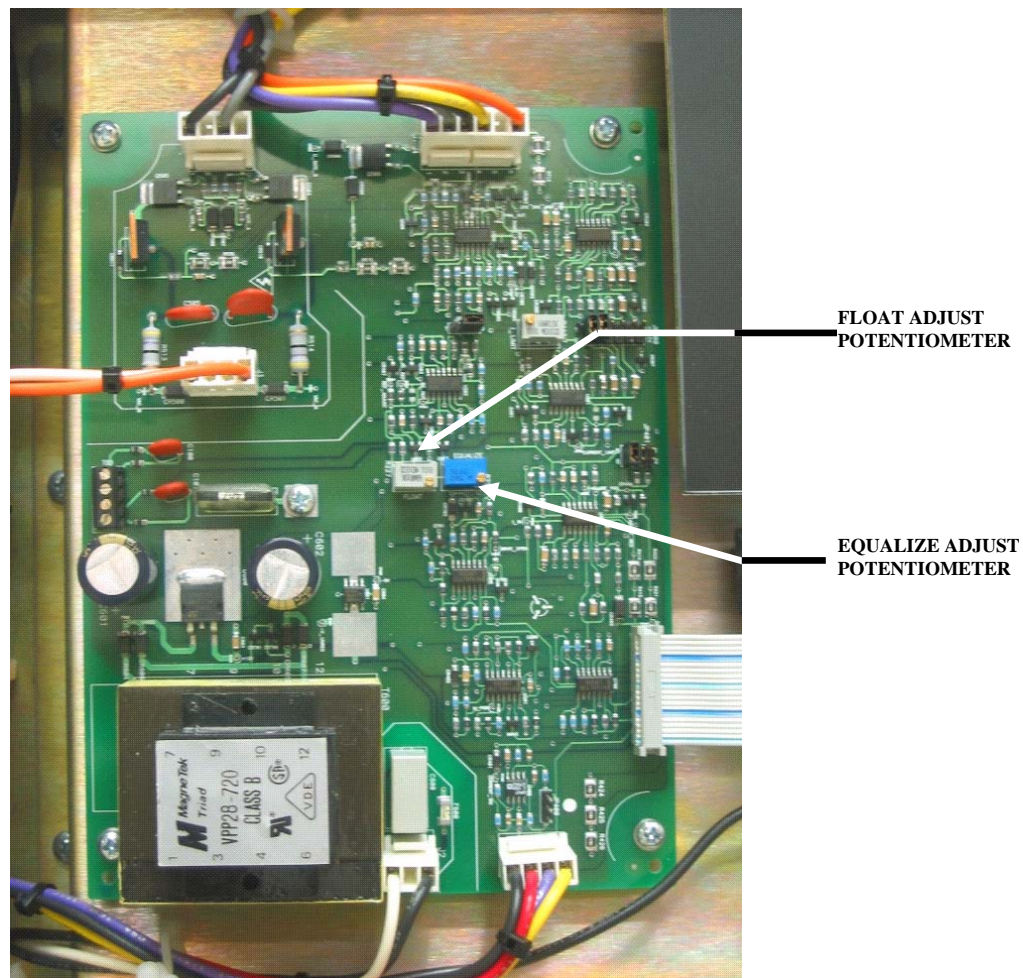
10.2.1 Float Voltage Setting

The float voltage setting of the charger may be adjusted with the float voltage adjust potentiometer on the control PWA (please see **FIG 11**). Make output voltage adjustments using a precision voltmeter connected directly to the charger DC output breaker with the output breaker closed and with the charger front panel CHARGE MODE selector switch set to the FLOAT position. Clockwise rotation of the potentiometer increases the output voltage, counterclockwise rotation decreases the output voltage. If the charger DC output is connected to batteries, allow time for the voltage to settle after adjustment.

10.2.2 Equalize Voltage Setting

The equalize voltage setting of the charger may be adjusted with the equalize voltage adjust potentiometer on the control PWA (please see **FIG 11**). Make output voltage adjustments using a precision voltmeter connected directly to the charger DC output breaker with the output breaker closed and with the charger front panel CHARGE MODE selector switch set to the EQUALIZE position. Clockwise rotation of the potentiometer increases the output voltage, counterclockwise rotation decreases the output voltage. If the charger DC output is connected to batteries, allow time for the voltage to settle after adjustment.

Figure 11: Control printed wiring assembly with float and equalize adjust potentiometers



10.2.3 Ground Fault Enable/Disable

It may be necessary in systems that connect either the positive or negative DC output terminal to earth ground to disable the ground fault alarm provided by the charger. To enable/disable the ground fault alarm utilize the configuration jumper strip located on the right edge of the alarm PWA (see **FIG 12**) and the connector found at J5 on the V/I board (see **FIG 13**). Two positions on the jumper strip program the ground fault alarm to be either enabled or disabled. The two positions, 'ON' and 'OFF', are adjacent to the bracketed letters GRND towards the top of the jumper strip (pins 45-48). To enable the ground fault alarm, a jumper plug should be in place at the 'ON' position and the connector at J5 on the V/I board must be installed. To disable the ground fault alarm, a jumper plug should be in place at the 'OFF' position and the connector must be removed from J5 on the V/I board.

Figure 12: Configuration jumper strip on alarm printed wiring assembly

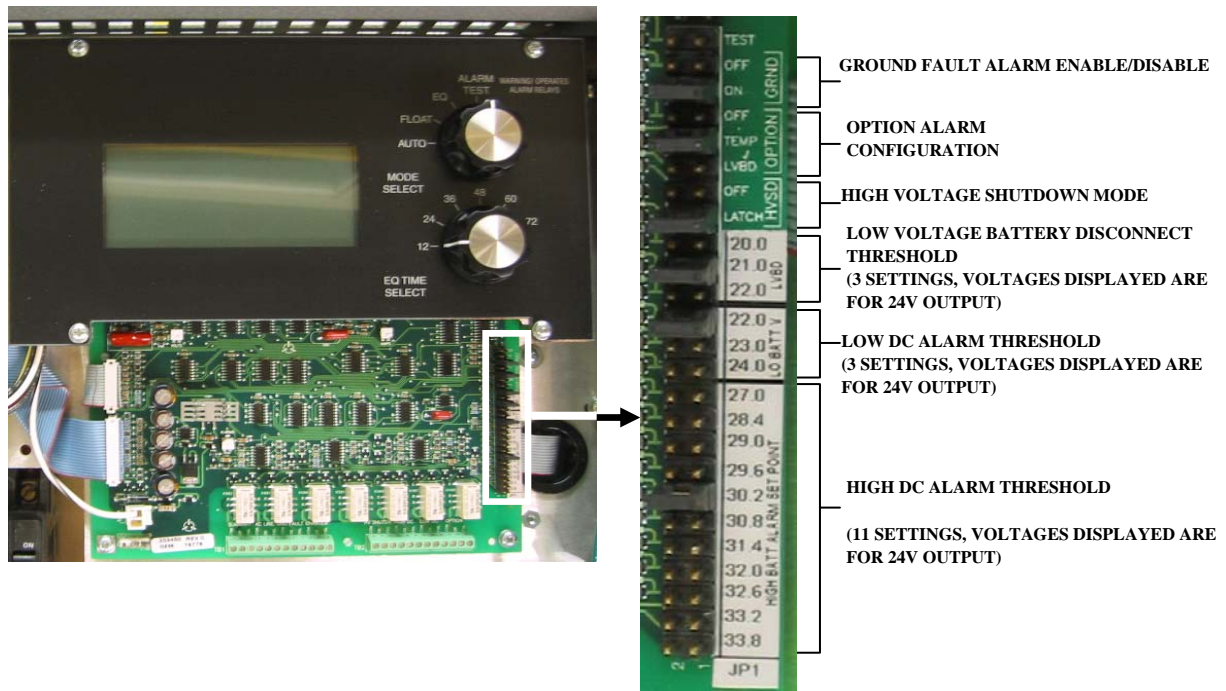
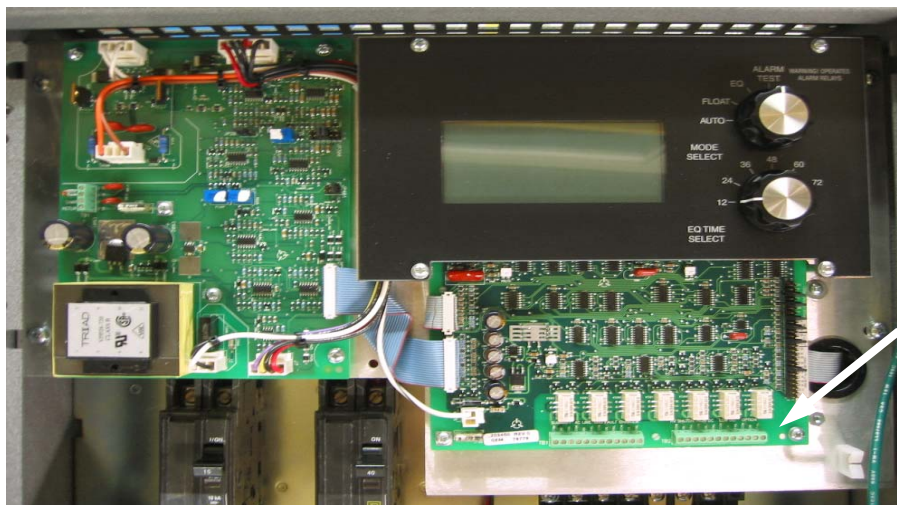


Figure 13: V/I board connector to enable/disable Ground Fault alarm



The V/I board is mounted underneath the panel shown in Figure 13. **Connector J5** is located on the V/I board directly beneath the corner of the alarm board as indicated by the arrow shown here. The connector is the bottom right most connector (underneath the panel) when facing the charger as shown here.

10.2.4 Option Alarm Configuration

The charger has an additional set of relay alarm contacts which may be programmed for three different functions, low voltage battery disconnect (Section 10.2.5), over temperature protection (Section 9.1, number 5), or off. In the first case, low voltage battery disconnect, the relay is programmed to change state if the low voltage battery disconnect threshold is reached. In the second case, the relay is programmed to change state if the charger internal over temperature protection circuit is activated. In the third case, the contacts are not used. Programming of the option alarm relay contacts may be done using the configuration jumper strip on the alarm printed wiring assembly (see **FIG 12**). Three jumper positions, OFF, TEMP and LVBD are located adjacent to the bracketed letters OPTION on the jumper strip (pins 39-44). Place a jumper plug on the desired pins.

10.2.5 Low Voltage Battery Disconnect

The low voltage battery disconnect function monitors the output of the charger and once a preprogrammed threshold has been exceeded can change the state of the 'OPTION' relay contacts. An external contactor can be supplied and connected to the relay by the user to disconnect the battery from the load when the state of the contact changes due to low battery voltage (a prolonged AC power outage has occurred). The OPTION alarm relay contacts may also be used as a second low voltage battery alarm (in addition to the LOW DC alarm). The Low Voltage Battery Disconnect threshold may be adjusted using the configuration jumper strip on the alarm PWA (see **FIG 12**). Three jumper positions program the low voltage battery disconnect threshold to three discrete levels, as shown on the alarm card and in **TABLE 9**. The three low voltage battery disconnect programming positions are adjacent to the bracketed letters LVBD (pins 29-34). a jumper on the position corresponding to the desired low voltage battery disconnect threshold.

Table 9: Low Voltage Battery Disconnect Thresholds

CHARGER OUTPUT VOLTAGE	LOW VOLTAGE BATTERY DISCONNECT THRESHOLD # 1	LOW VOLTAGE BATTERY DISCONNECT THRESHOLD # 2	LOW VOLTAGE BATTERY DISCONNECT THRESHOLD # 3
12	10.0	10.5	11.0
24	20.0	21.0	22.0
48	40.0	42.0	44.0
110	92.0	96.0	101
120	100	105	110
220	183	193	202
240	200	210	220

10.2.6 Low DC Alarm Threshold

The charger low DC alarm threshold may be adjusted using the configuration jumper strip on the alarm printed wiring assembly (see **FIG 12**). Three jumper positions program the low DC alarm threshold as shown in **TABLE 10**. The three low DC alarm programming positions are adjacent to the bracketed letters LO BATT (pins 23-28). Place a jumper on the position corresponding to the desired low DC alarm threshold.

Table 10: Low DC Alarm Thresholds

CHARGER OUTPUT VOLTAGE	LOW DC ALARM THRESHOLD # 1	LOW DC ALARM THRESHOLD # 2	LOW DC ALARM THRESHOLD # 3
12	11.0	11.5	12.0
24	22.0	23.0	24.0
48	43.9	46.0	48.0
110	101	105	110
120	110	115	120
220	201	211	220
240	220	230	240

10.2.7 High DC Alarm Threshold

The charger high DC alarm threshold may be adjusted using the configuration jumper strip on the alarm printed wiring assembly (see **FIG 12**). Eleven jumper positions program the high DC alarm threshold as shown in **TABLE 11**. The eleven high DC alarm programming positions are adjacent to the bracketed letters HIGH BATT (pins 1-22). Place a jumper on the position corresponding to the desired high DC alarm threshold.

NOTE:

The high DC alarm threshold must be set well above the adjusted equalize voltage (a minimum of 5% is recommended) to avoid false alarms and false high voltage shutdowns. **TABLES 12, 13** and **14** show typical High DC alarm threshold settings for a given range of equalize voltage settings, for both temperature compensated and non-temperature compensated charger configurations.

Table 11: High DC Alarm Threshold Settings

NOMINAL CHARGER OUTPUT VOLTAGE	HIGH DC JUMPER POSITION*										
	1	2	3	4	5	6	7	8	9	10	11
12	13.5	14.2	14.5	14.8	15.1	15.4	15.7	16.0	16.3	16.6	16.9
24	27.0	28.4	29.0	29.6	30.2	30.8	31.4	32.0	32.6	33.2	33.8
48	54.1	56.8	58.0	59.2	60.4	61.6	62.8	64.0	65.2	66.4	67.6
110	124	130	133	136	138	141	144	147	149	152	155
120	135	142	145	148	151	154	157	160	163	166	169
220	248	260	266	271	277	282	288	293	299	304	310
240	270	284	290	296	302	308	314	320	326	332	338

*Reference label on charger inside door for jumper positions.

10.2.8 High Voltage Shutdown Mode

The charger disables itself whenever the output voltage exceeds the high voltage shutdown threshold. The threshold is fixed at 4% above the high voltage alarm threshold (See Section 10.2.7). The charger high voltage shutdown alarm mode may be adjusted using the configuration jumper strip on the alarm printed wiring assembly (see **FIG 12**). High voltage shutdown cannot be disabled. If not desired, set the High DC alarm threshold higher (see Section 10.2.7). Two positions on the jumper strip program how high voltage shutdown behaves. The two positions, 'LATCH' and 'OFF', are adjacent to the bracketed letters HVSD towards the top of the jumper strip (pins 35-38). When high voltage shutdown occurs, the charger will cycle on and off as voltage varies above and below the threshold. If the high voltage condition persists for 30 seconds, the high voltage shutdown relay operates. At this time, if the jumper was placed in the 'OFF' position the charger will continue to cycle on and off until the cause of the high voltage fault has been corrected. If the jumper was placed in the 'LATCH' position the charger will lock off when the high voltage shutdown relay operates. It then remains off until AC power is disabled long enough to operate the AC Fail alarm relay, which resets the latched condition.

10.2.9 Temperature Compensation

Temperature compensation of the charger output voltage may be implemented by connecting either a local or remote temperature sensor, both of which are supplied by the factory, to terminal block TB1 on the control printed wiring assembly. The temperature compensation is active between 0 and 40° C (see **FIG 15**). The temperature compensation curve is selectable to either $-0.22\%/deg\ C$ or $-0.13\%/deg\ C$ via jumper JP201 on the control printed wiring assembly, per **FIG 14**.

NOTE:

Connection of a remote temperature sensor automatically enables temperature compensation. If a sensor is not connected, temperature compensation is not active.

Figure 14: Temperature compensation curve programming jumper

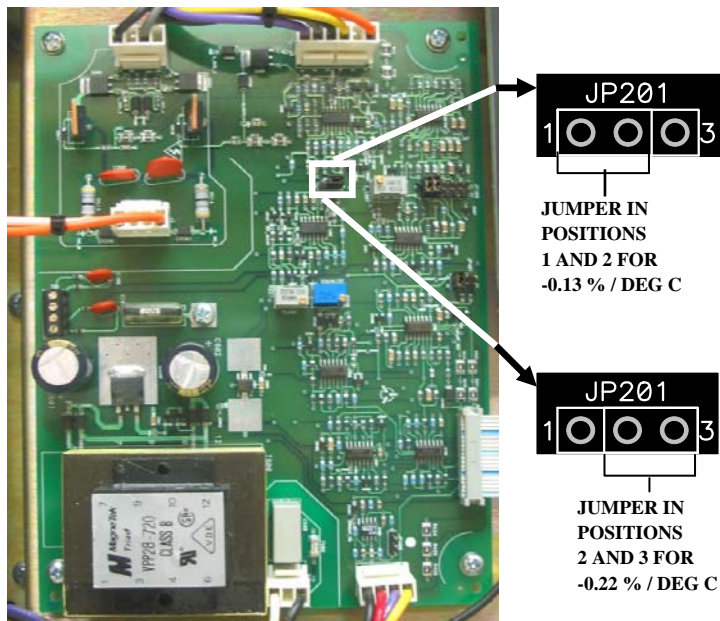


Figure 15: Temperature compensation curves

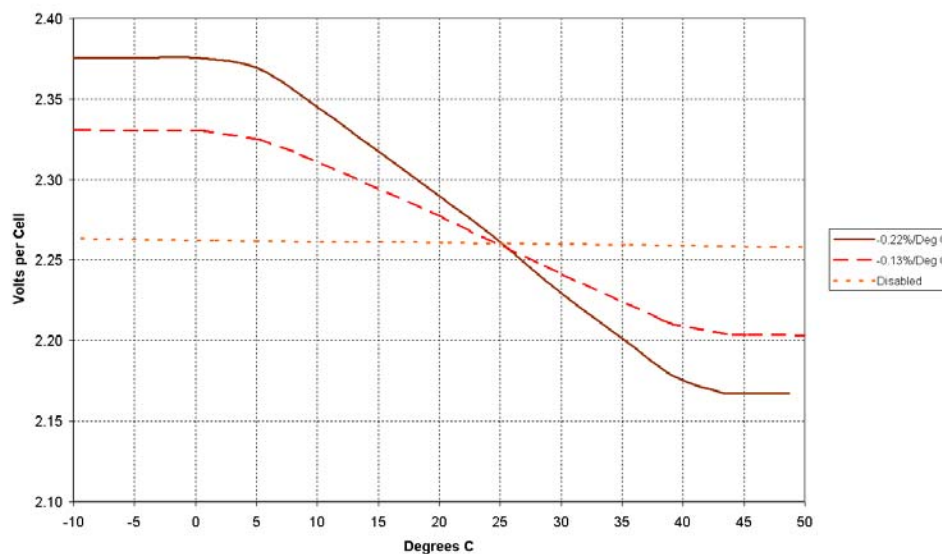


Table 12: Typical High DC alarm settings for equalize voltage setting ranges, for non-temperature compensated applications

Equalize Voltage Range for Lead-Acid Batteries								High DC Jumper Setting*
Volts Per Cell	6 Cells	12 Cells	24 Cells	55 Cells	60 Cells	110 Cells	120 Cells	
2.133-2.246	12.80-13.48	25.60-26.95	51.20-53.90	117.3-123.5	128.00-134.76	234.6-247.1	256.0-269.5	2
2.247-2.300	13.48-13.80	26.96-27.60	53.93-55.20	123.6-126.5	134.82-138.00	247.2-253.0	269.6-276.0	3
2.301-2.343	13.81-14.06	27.61-28.12	55.22-56.23	126.6-128.9	138.06-140.58	253.1-257.7	276.1-281.2	4
2.344-2.400	14.06-14.40	28.13-28.80	56.26-57.60	128.9-132.0	140.64-144.00	257.8-264.0	281.3-288.0	5
2.401-2.438	14.41-14.63	28.81-29.26	57.62-58.51	132.1-134.1	144.06-146.28	264.1-268.2	288.1-292.6	6
2.439-2.476	14.63-14.86	29.27-29.71	58.54-59.42	134.1-136.2	146.34-148.56	268.3-272.4	292.7-297.1	7
2.477-2.533	14.86-15.20	29.72-30.40	59.45-60.79	136.2-139.3	148.62-151.98	272.5-278.6	297.2-304.0	8
2.534-2.590	15.20-15.54	30.41-31.09	60.82-62.17	139.4-142.5	152.04-155.43	278.7-284.9	304.1-310.9	9
2.591-2.628	15.55-15.77	31.09-31.54	62.18-63.09	142.5-144.5	155.46-157.71	285.0-289.1	310.9-315.4	10
2.629-2.686	15.77-16.12	31.55-32.23	63.10-64.46	144.6-147.7	157.74-161.16	289.2-295.5	315.5-322.3	11

*Reference label on charger inside door for jumper positions.

Table 13: Typical High DC alarm settings for equalize voltage setting ranges, for temperature compensated applications with -0.13% / deg C temperature coefficient

Equalize Voltage Range for Lead Acid Batteries @ 20 deg C								High DC Jumper Setting*
Volts Per Cell	6 Cells	12 Cells	24 Cells	55 Cells	60 Cells	110 Cells	120 Cells	
2.188-2.304	13.13-13.82	26.26-27.65	52.51-55.30	120.3-126.7	131.3-138.2	240.7-253.4	262.6-276.5	4
2.305-2.360	13.83-14.16	27.66-28.32	55.32-56.64	126.8-129.8	138.3-141.6	253.6-259.60	276.6-283.2	5
2.361-2.404	14.17-14.42	28.33-28.85	56.66-57.70	129.9-132.2	141.7-144.2	259.7-264.4	283.3-288.5	6
2.405-2.462	14.43-14.40	28.86-28.80	57.72-57.60	132.3-135.4	144.3-144.0	264.6-270.8	288.6-295.4	7
2.463-2.501	14.78-15.01	29.56-30.01	59.11-60.02	135.5-137.6	147.8-150.1	270.9-275.1	295.6-300.1	8
2.502-2.540	15.01-15.24	30.02-30.48	60.05-60.96	137.6-139.7	150.1-152.4	275.2-279.4	300.2-304.8	9
2.541-2.599	15.25-15.59	30.49-31.19	60.98-62.38	139.8-142.5	152.5-155.9	279.5-285.9	304.9-311.9	10
2.600-2.657	15.60-16.05	31.20-32.10	62.40-64.20	143.0-146.1	156.0-160.5	286.0-292.3	312.0-321.0	11
2.658-2.696	NOT RECOMMENDED**							
2.697-2.756	NOT RECOMMENDED**							

*Reference label on charger inside door for jumper positions.

**Output adjustments this high with this temperature compensation are not recommended due to collision with High DC alarm set point.

Table 14: Typical High DC alarm settings for equalize voltage setting ranges, for temperature compensated applications with -0.22% / deg C temperature coefficient

Equalize Voltage Range for Lead Acid Batteries @ 20 deg C								High DC Jumper Setting*
Volts Per Cell	6 Cells	12 Cells	24 Cells	55 Cells	60 Cells	110 Cells	120 Cells	
2.227-2.345	13.36-14.07	26.72-28.14	53.45-56.28	122.5-129.0	133.6-140.7	245.0-258.0	267.2-281.4	5
2.346-2.401	14.08-14.41	28.15-28.81	56.30-57.62	129.0-132.1	140.8-144.0	258.1-264.1	281.5-288.1	6
2.402-2.446	14.41-14.68	28.82-29.35	57.65-58.70	132.1-134.5	144.1-146.8	264.2-269.1	288.2-293.5	7
2.447-2.506	14.68-15.04	29.36-30.07	58.73-60.14	134.6-137.8	146.8-150.4	269.2-275.7	293.6-300.7	8
2.507-2.545	15.04-15.27	30.08-30.54	60.17-61.08	137.9-140.0	150.4-152.7	275.8-280.0	300.8-305.4	9
2.546-2.585	15.28-15.51	30.55-31.02	61.10-62.04	140.0-142.2	152.8-155.1	280.1-284.4	305.5-310.2	10
2.586-2.644	15.52-15.86	31.03-31.73	62.06-63.46	142.2-145.4	155.2-158.6	284.5-290.8	310.3-317.3	11
2.645-2.704	NOT RECOMMENDED**							
2.705-2.744	NOT RECOMMENDED**							
2.745-2.804	NOT RECOMMENDED**							

*Reference label on charger inside door for jumper positions.

**Output adjustments this high with this temperature compensation are not recommended due to collision with High DC alarm set point.

11 MAINTENANCE AND TROUBLESHOOTING

WARNING:
CHARGER CONTROL CIRCUITS ARE AT BATTERY POTENTIAL AND CAN BE HAZARDOUS IF TOUCHED. ONLY INSULATED TOOLS SHOULD BE USED WHILE WORKING ON A CHARGER THAT IS POWERED UP. AVOID TOUCHING ANY CIRCUIT OR ANY BARE METAL.

If you suspect there is a problem with the charger, the following should be done immediately:

- A. Disconnect AC mains supply.
- B. Open both AC input and DC output circuit breakers.
- C. Open the front door of the charger and inspect the interior for loose objects.
- D. Examine connector locations on printed wiring assemblies for loose or un-plugged connectors.
- E. Reconnect AC mains supply.
- F. Check AC input voltage on line side of input breaker with DMM and verify it is in the proper range.
- G. Check wiring to DC output breaker and verify proper polarity of output connections. Also verify small terminals connected to load side of DC output breaker are still connected.

If none of these inspections yield a solution, consult **FIGS 16-22** for additional troubleshooting tips.

Figure 16: Troubleshooting chart for repeated AC breaker trip

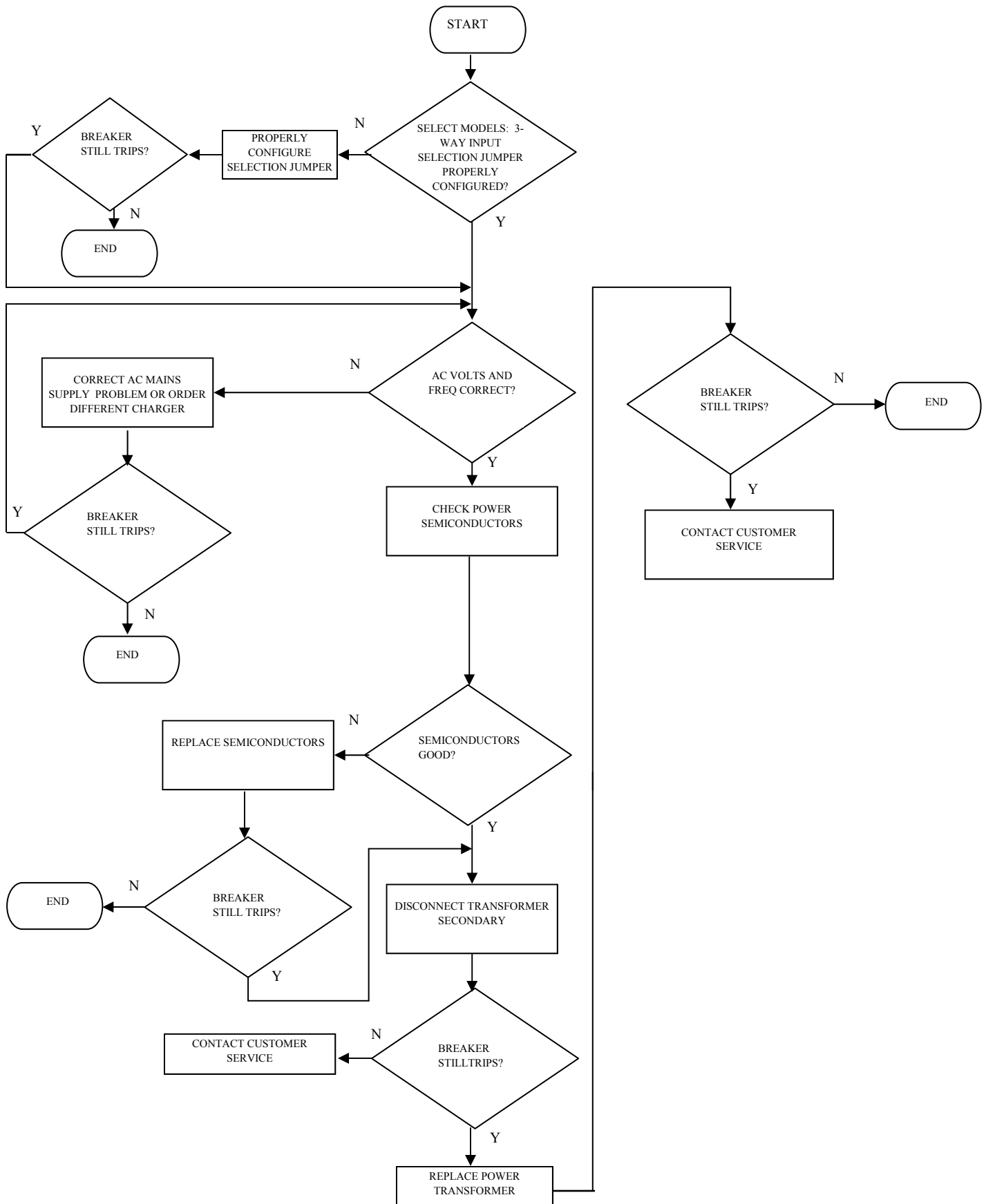


Figure 17: Troubleshooting flowchart for AC fail alarm indication

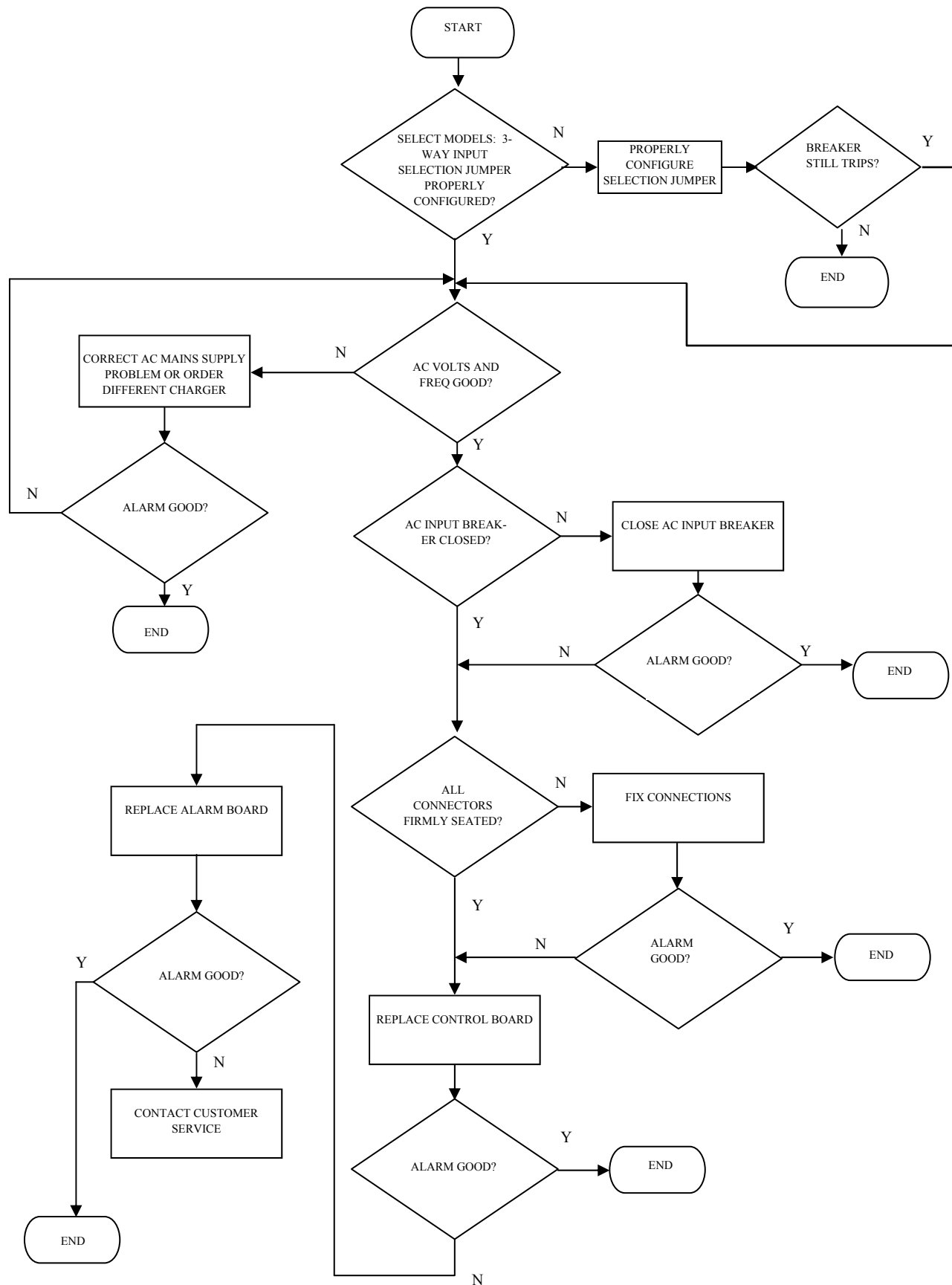


Figure 18: Troubleshooting flowchart for charge fail alarm

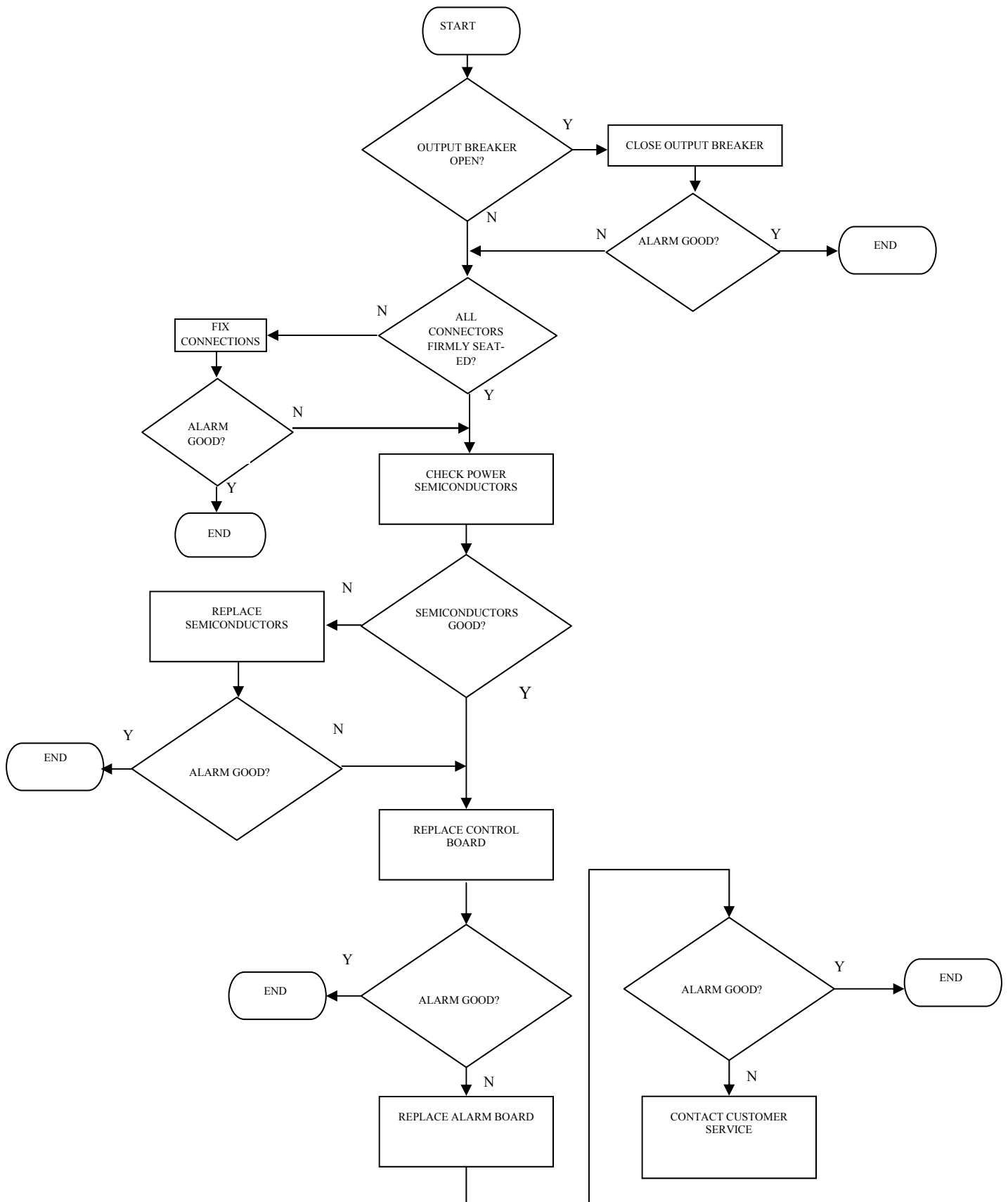


Figure 19: Troubleshooting flowchart for DC output breaker trip

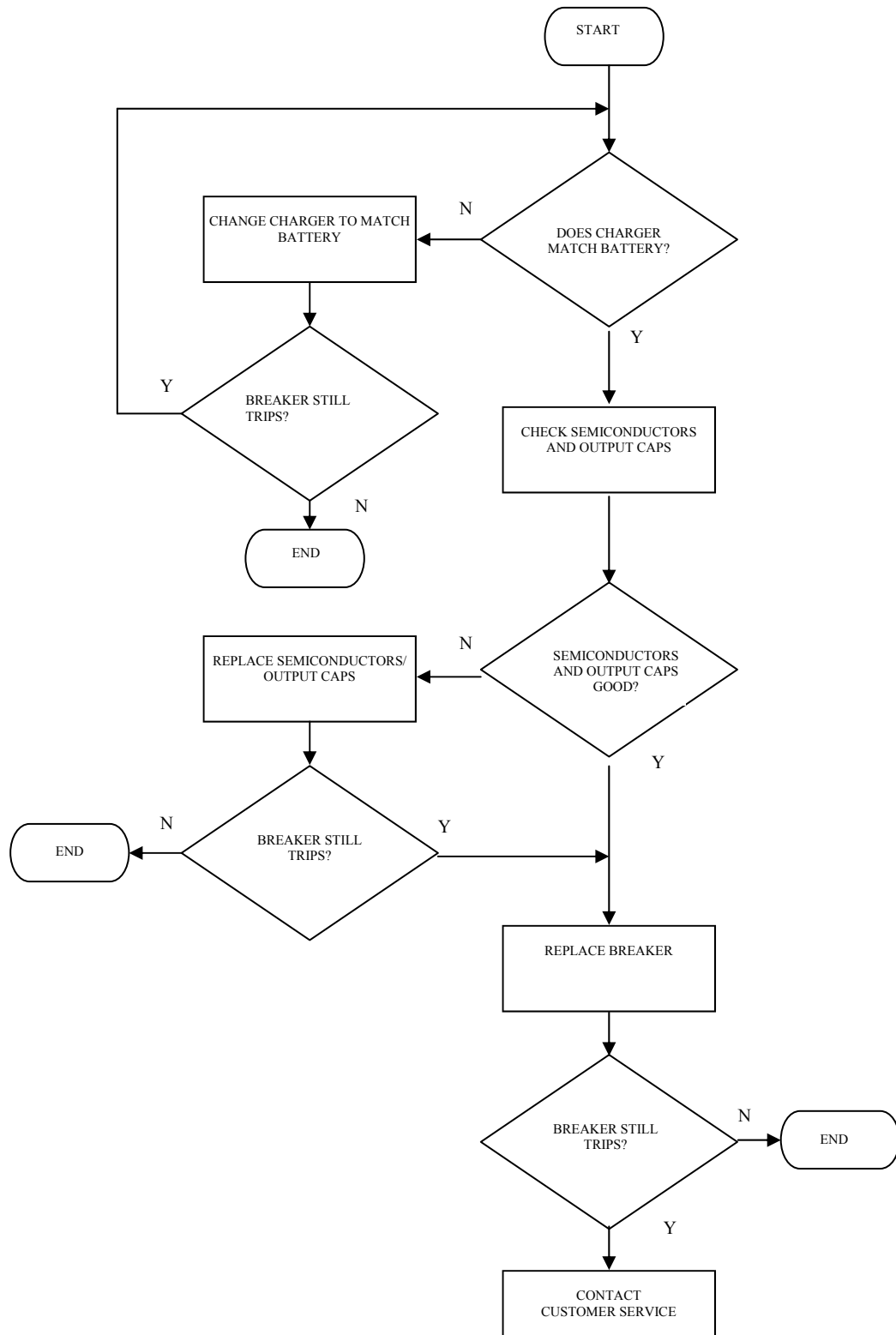


Figure 20: Troubleshooting flowchart for HIGH DC or HVSD alarms

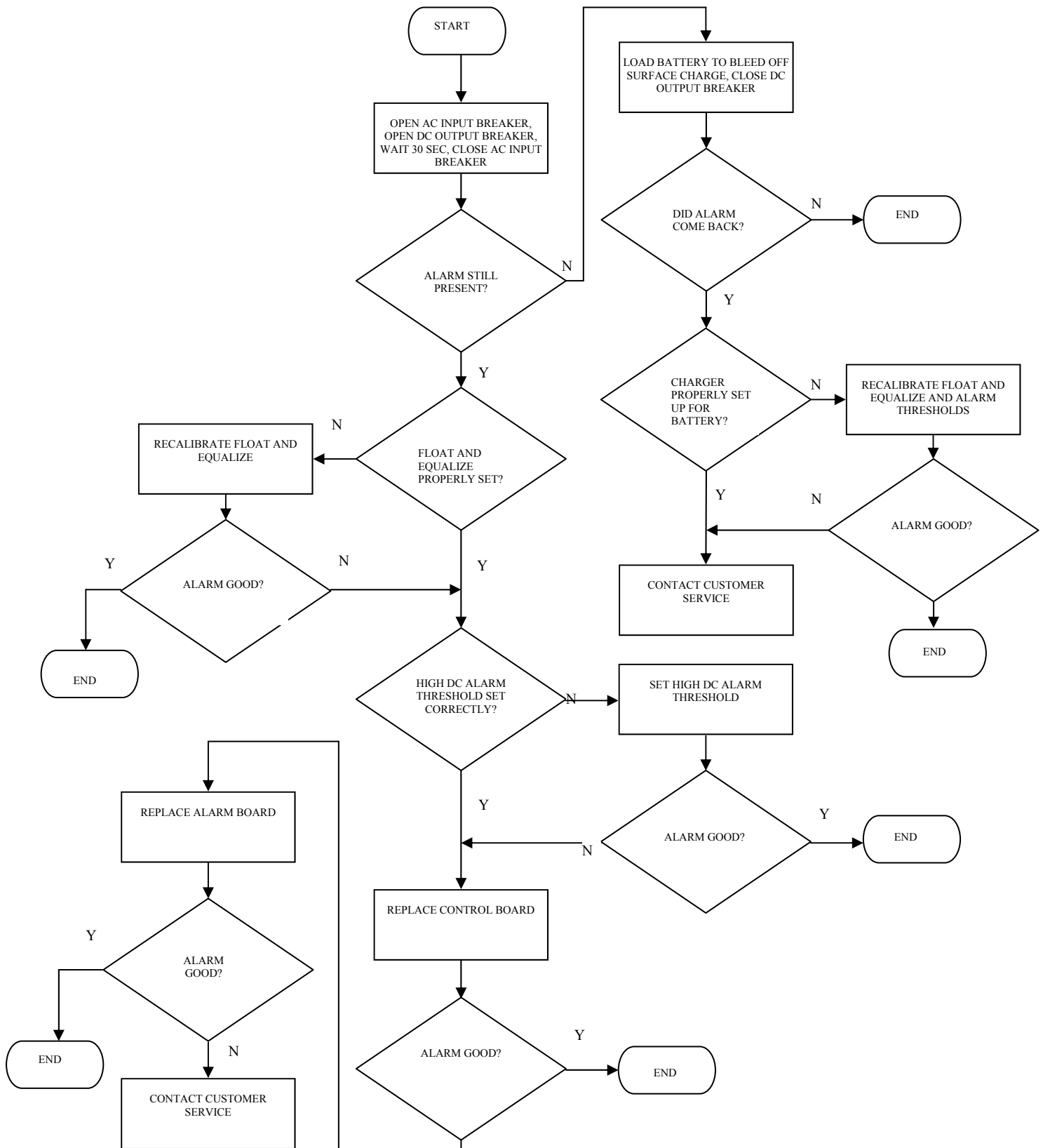


Figure 21: Troubleshooting flowchart for LOW DC alarm

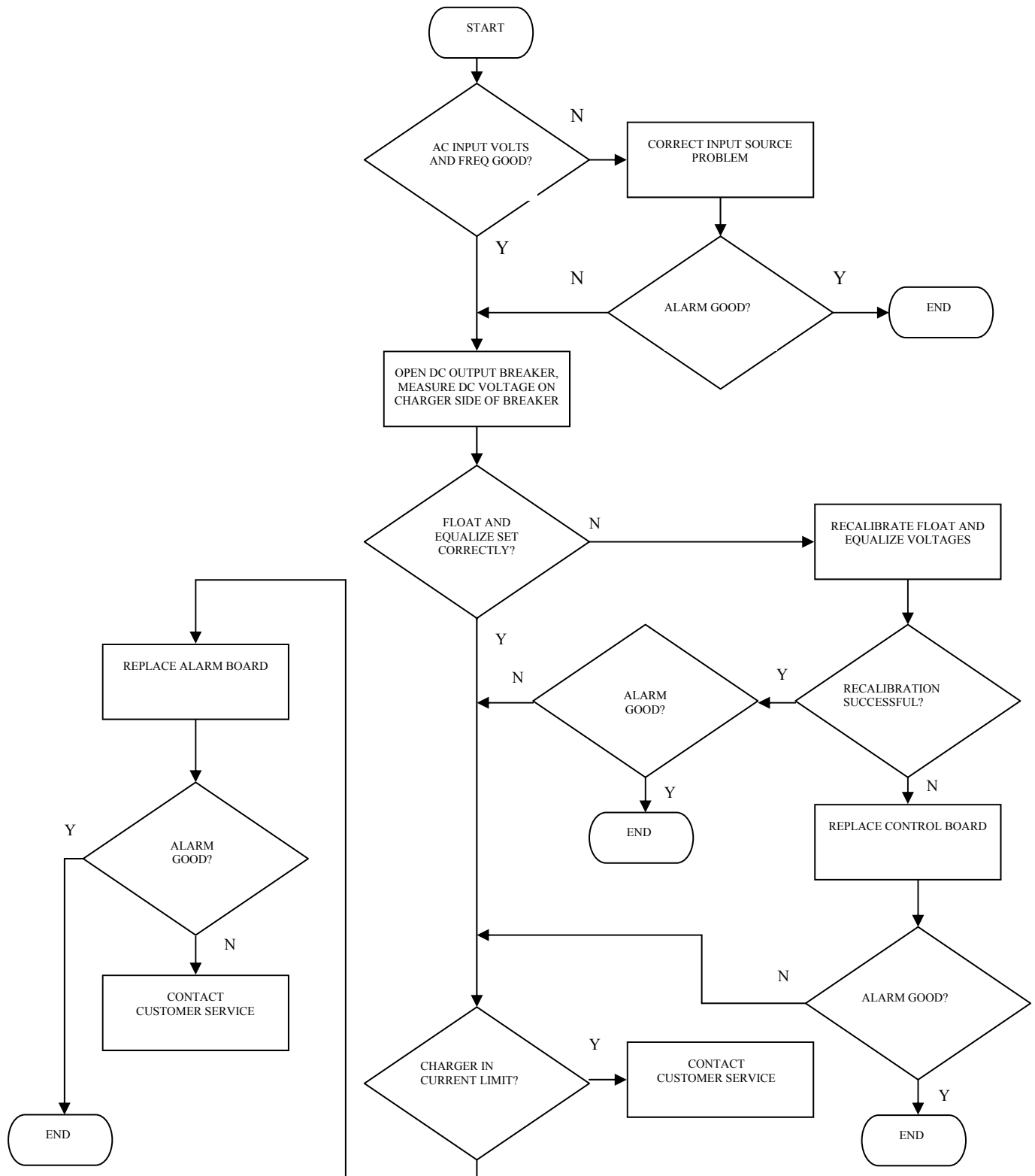
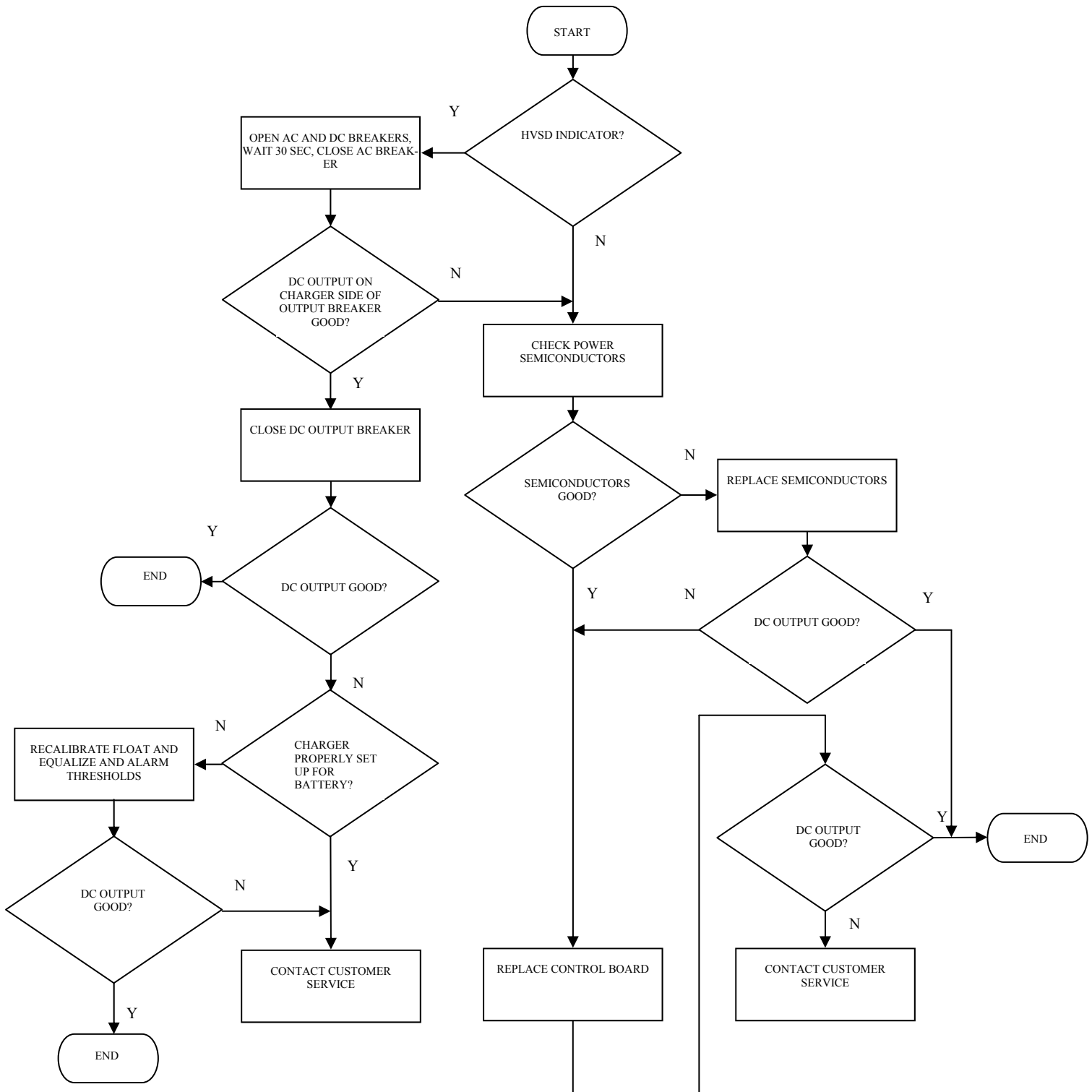


Figure 22: Troubleshooting flowchart for no output

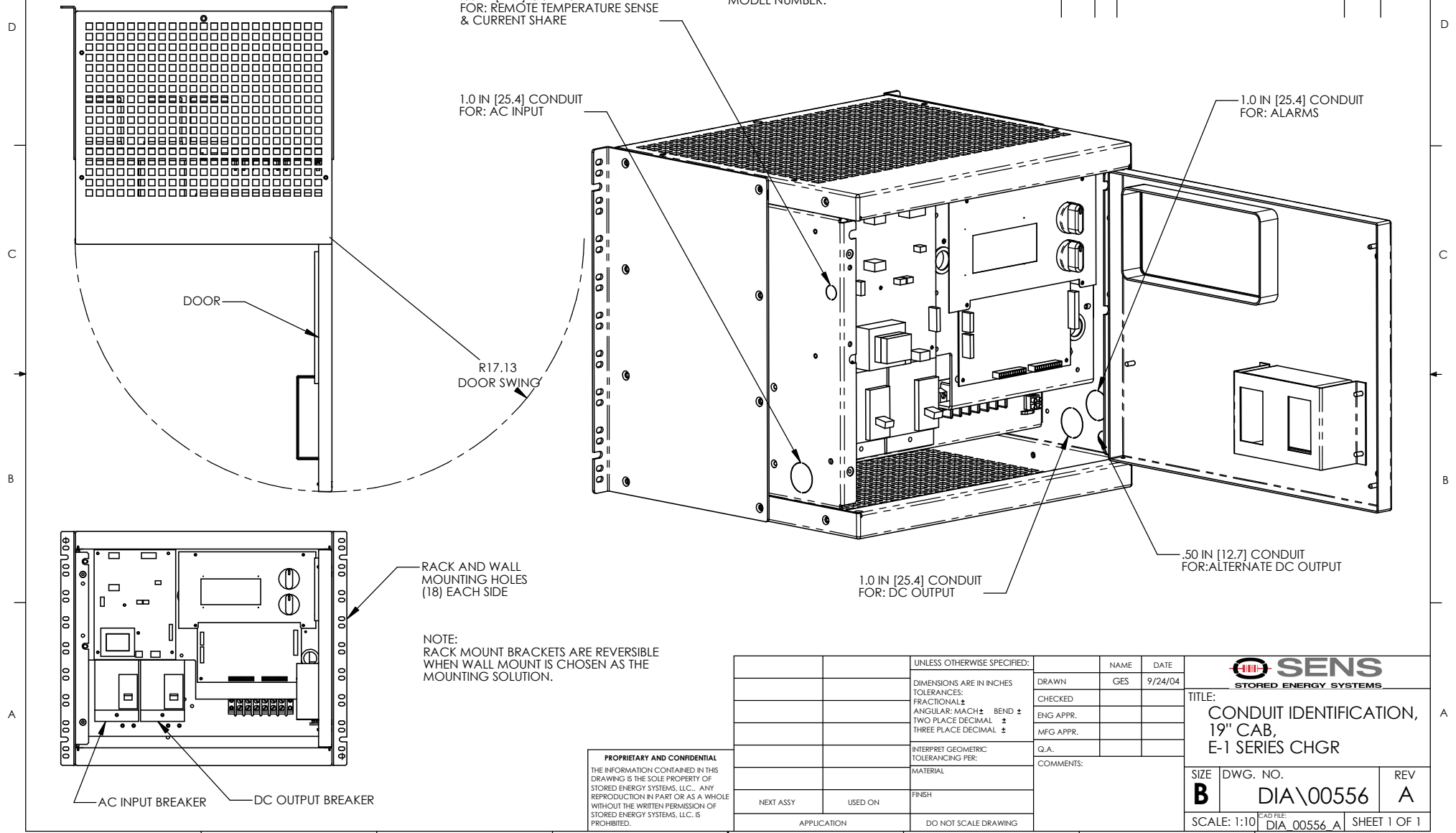


8 7 6 5 4 3 2 1


IMPORTANT INFORMATION

SIZE AND STYLE OF AC AND DC BREAKERS
MAY CHANGE DEPENDING ON CHARGER
MODEL NUMBER.

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
104573	A	PRODUCTION RELEASE	9/24/04	GES



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APPLICATION		DO NOT SCALE DRAWING		

NOTES TO INSTALLER

1. MAKE AC AND DC CONNECTIONS DIRECT TO AC AND DC BREAKERS. LOCATION OF BREAKERS IS SHOWN.
2. MAKE CONNECTIONS TO CHARGER AND TERMINAL BLOCK USING USER GUIDE INSTRUCTIONS.

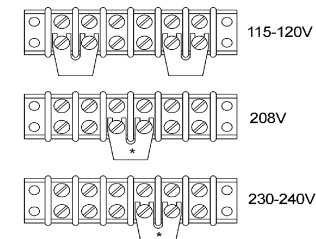
REVISIONS

DCN#	REV.	DESCRIPTION	DATE	APPROVED
104573	A	PRODUCTION RELEASE	9/24/04	GES
104819	B	REMOVED MTG BRKT NOTE	3/10/05	GES
106179	C	REPLACE 40A OUTPUT BRKR W/ 35A	8/20/12	HN

TABLE-1

Charger Model	Input Breaker Current Ratings					Output Breaker Current Ratings
	480V 60Hz	115-120/208/230-240V 50/60Hz	115-120/208/230-240V 60Hz	575V 60Hz	400V 50/60Hz	
E012-006	15	15	10	15	15	10
E012-012	15	15	10	15	15	15
E012-016	15	15	10	15	15	20
E012-025	15	15	10	15	15	20
E012-035	15	15	15	15	15	45
E012-050	15	15	15	15	15	70
E024-006	15	15	10	15	15	10
E024-012	15	15	10	15	15	15
E024-016	15	15	15	15	15	20
E024-025	15	15	15	15	15	20
E024-035	15	20	20	15	15	45
E024-050	15	30	30	15	15	70
E048-006	15	15	10	15	15	10
E048-012	15	15	15	15	15	15
E048-016	15	20	20	15	15	20
E048-025	15	30	30	15	15	20
E048-035	15	30	30	15	15	45
E120-006	15	15	15	15	15	15
E120-012	15	30	30	15	15	15
E120-016	15	40	40	15	15	20
E240-006	15	30	30	15	15	15

VOLTAGE SELECT JUMPER SETTINGS



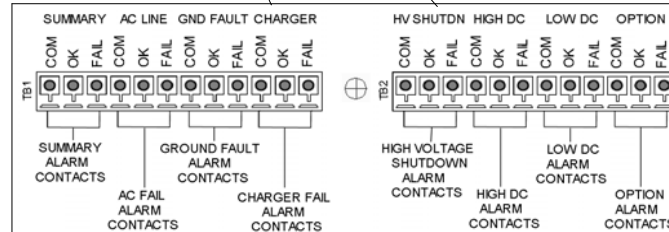
* BOTH JUMPERS IN SAME POSITION

OPTIONAL

AC Input Wire Gauge Ratings		
Rated Charger Input	Wire Gauge	
	Min	Max
≤ 240 VAC, 60 Hz	#14 Cu or Al	#2 Cu or Al
≤ 240 VAC, 50/60 Hz	#14 Cu, #12 Al	#1/0 Cu or Al
> 240 VAC	#14 Cu, #12 Al	#1/0 Cu or Al
All 65 KAIC Breakers (Special Order)	#14 Cu, #12 Al	#1/0 Cu or Al

DC Output Wire Gauge Ratings			
Rated Charger Output	Volts	Current	Wire Gauge
12V - 48V	≤ 50A		#14 Cu or Al
120V & 240V	≤ 16A		#14 Cu, #12 Al
	≥ 25A		#14 Cu, #12 Al

IMPORTANT INFORMATION
SIZE AND STYLE OF AC AND DC BREAKERS MAY CHANGE DEPENDING ON CHARGER MODEL NUMBER.

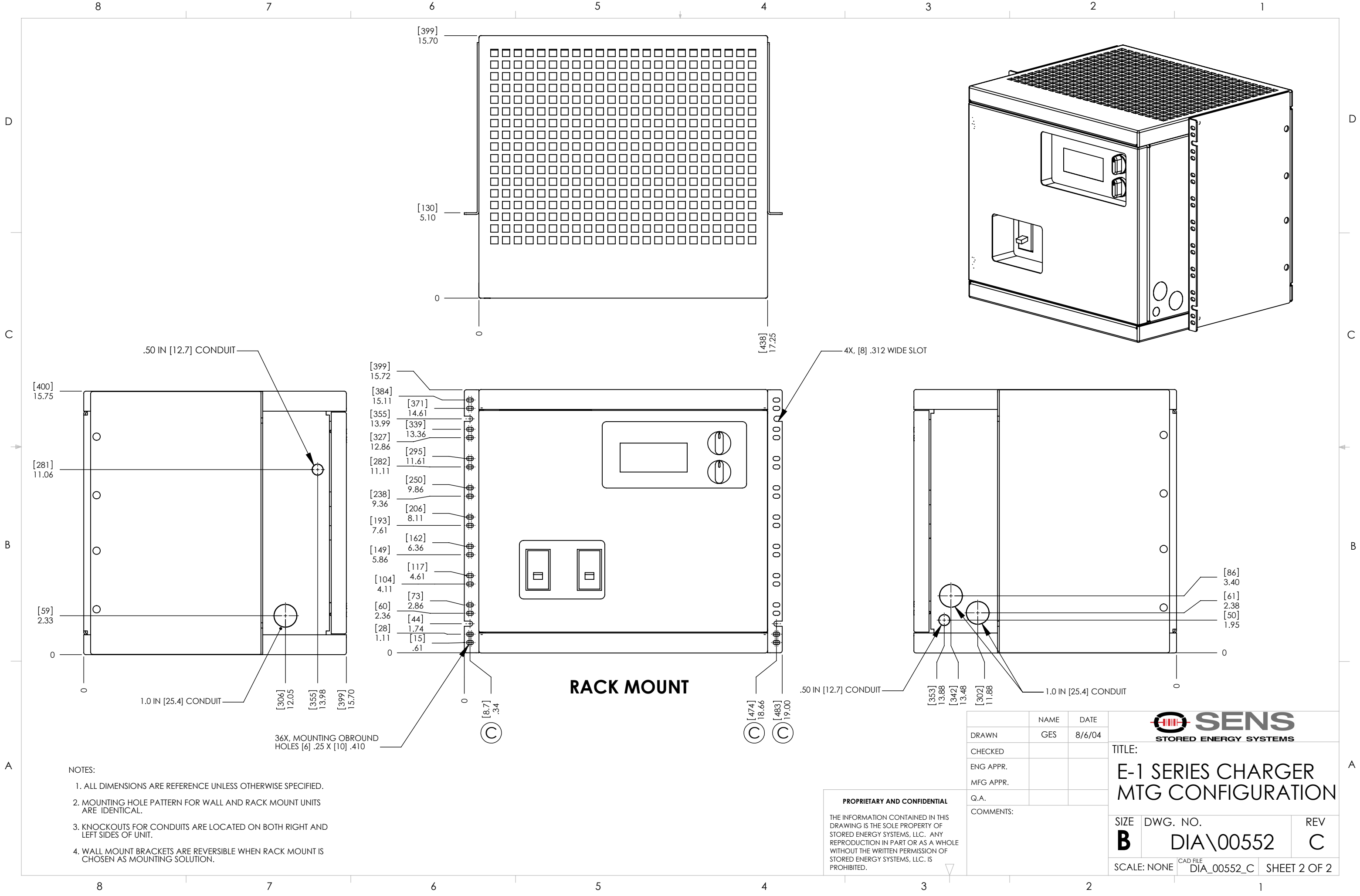


ALARM CONNECTIONS
MAXIMUM WIRE -#16. SEE BODY OF USER GUIDE FOR COMPLETE EXPLANATION OF ALARM FUNCTION AND CONNECTIONS.

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TOLERANCES:		DRAWN	
FRACTIONAL ±		CHECKED	
ANGULAR: MACH ± BEND		ENG APPR.	
TWO PLACE DECIMAL ±		MFG APPR.	
THREE PLACE DECIMAL ±		Q.A.	
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:	
MATERIAL			
FINISH			
NEXT ASSY	USED ON		
APPLICATION		DO NOT SCALE DRAWING	

TITLE:		REV	
ALARM AND CIRCUIT BREAKER CONNECTIONS, 19" CAB, E-1 SERIES CHARGER		C	
SIZE	DWG. NO.		
B	DIA00553		
SCALE: NONE	CAD FILE		
	DIA_00553_B		
SHEET 1 OF 1			





SENS Limited Warranty

Model ECU Chargers & BBS Best Battery Selectors

What is covered?

This warranty covers any defect in material and workmanship on ECU model battery chargers and BBS model best battery selectors manufactured by Stored Energy Systems, a Colorado Limited Liability Company (SENS).

What this warranty does not cover:

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

For how long:

Three years from date of shipment.

What we will do:

If your battery charger or BBS is defective within three years of date of shipment, we will repair it or, at our option, replace it at no charge to you.

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

What we ask you to do:

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

Limitation:

This warranty is limited to defects in material or workmanship of the product. It does not cover loss of time, inconvenience, property damage or any consequential damages. Repair, replacement or refund of the purchase price of the equipment is your exclusive remedy.