

  
**MAC**

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Throughout this manual look for this symbol **!**. It means **BE ALERT - YOUR SAFETY IS INVOLVED**. If you do not follow these safety instructions, personal injury or property damage can occur.

# MAC BATTERY CHARGERS

## 1 Features

- Microprocessor based control
- Auto start/stop
- LED charge mode indicators
- SCR output control
- Battery Type Select
- UL, CUL, CE Available
- Dual AC Input (Export)
- Lightning/surge protection
- Reverse polarity protection
- AC Protection
- DC Protection
- Current limiting
- Full Charge Sentry (Domestic)
- 50/60 HZ (Export)

## 2 Introduction

The MAC SCR series of battery chargers were designed especially for lead acid batteries used in demanding deep cycle applications. Its overall simplicity, method of operation and trouble-free performance makes the SCR charger attractive to every type of equipment user. To operate, after the charger is connected to AC power, the user simply plugs the DC cord into the battery to activate the unit. That's all there is to it. The charger not only immediately starts charging the battery, but also monitors the battery condition determining the proper charge requirements and the correct finish before automatically terminating the charge when the battery is fully charged.

## 3 Installation

### Initial Installation

**!** **CAUTION:** To reduce the risk of fire and to ensure proper operation, this charger should be used only on dedicated circuits provided with a minimum of 15 to 20 amps per charger, depending on the charger data plate requirements, and should be protected by proper circuit breakers or fuses, in accordance with National Electrical Code, ANSI/NFPA 70, and all local codes and ordinances.

Do not operate this charger with an extension cord. Locate cord so that it will not be stepped on, tripped over, or otherwise subjected to damage or stress.

Do not operate this charger if it has been subject to abuse, damage or improper maintenance.

Provide adequate ventilation for the batteries and charger. The convection-cooled design requires an unobstructed flow of cooling air for proper operation. Keep all charger ventilation openings at least two (2) inches (5cm) away from walls and other objects. Do not allow clothing, blankets, or other material to cover the charger.

! **WARNING:** Chargers can ignite flammable materials and vapors. **Do not use near fuels, grain dust, solvents, or other flammables.**

! **WARNING:** To reduce the risk of an electric shock, keep the charger dry. **Do not expose it to rain.** For storage, keep the charger in a building.

## Grounding Instructions

! **WARNING** - Improper connection of the equipment-grounding conductor can result in a risk of an electric shock.

This battery charger must be grounded to reduce the risk of electric shock. The charger is equipped with an electric cord having an equipment-grounding conductor. This plug must be connected to an appropriate receptacle that is properly installed and grounded in accordance with the National Electrical Code and all local codes and ordinances.

The conductor with insulation having an outer surface that is green, with or without yellow stripes, is the equipment-grounding conductor. If charger is to be used in other parts of the world other than USA, check local codes. If repair or replacement of the electric cord or plug is necessary, do not connect the equipment-grounding connector to a live terminal.

**Installation - IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS!**

! **DANGER** - To reduce the risk of fire or electric shock, carefully follow these instructions.

**! CAUTION** - The dual AC input charger may be equipped with an AC voltage select switch located on the front of the unit which will allow you to connect the charger to one of two AC supply voltages. You must be absolutely sure that the switch matches the supply voltage to which the charger will be connected.

In most cases, chargers having an external AC voltage select switch will also have a detachable power supply cord. This cord/plug assembly must match the wall receptacle to which it will be connected. If the detachable power cord is not proper for your application *DO NOT* modify. You must secure the cord that is required or call the factory for guidance. Some models may be equipped with a fixed power cord.

Installation of a charger consists of providing a proper AC power source and selecting a proper location. Even though the charger is portable, a permanent location for operation is strongly recommended. The permanent location must have enough room to bring in equipment for charging.

Always set the charger on a flat hard surface to insure proper air circulation under and around it. The area must be well ventilated, because explosive hydrogen gas is generated while charging the batteries. Exercise caution to avoid possible open flame or electrical sparks near the operation. For general safety, do not place the charger on the floor. Make sure that the AC line cord and DC output cables do not obstruct traffic.

## 4 Pre-operating Procedure

**! CAUTION** - Impurities in tap water will damage battery plates.

If you have a wet battery system, check fluid level in each cell and, if necessary, add enough filtered or distilled water to cover the battery plates, but do not allow fluid to rise into the cell filler necks. **IF LOW, ALWAYS FILL CELL, ONLY TO PROPER LEVEL, AFTER CHARGE CYCLE. SEE BATTERY INSTRUCTIONS.** SVR Battery systems are sealed and should not be opened. The addition of water is not required.

**! WARNING** - Hydrogen gas, formed while charging, is explosive. Avoid open flame or electrical spark near battery. To avoid accumulation of gas, be sure batteries are charged in a well-ventilated area.

**! DANGER** - Visually and manually inspect to verify the DC output cord set, plug and battery charging receptacle are in good working condition before each and every use and do not use the charger if:

1. The DC charging receptacle does not grip the DC output plug tightly, is loose or does not make a good electrical connection.
2. The DC output plug and/or charging receptacle feel hotter than normal.
3. The DC output plug pins or receptacle contacts are bent, corroded or are dark or bluish in appearance.
4. The DC output plug, cords, receptacle or equipment charging wiring are cut, worn, broken, or have any exposed conductors.
5. The DC output plug, cords, charger or receptacles are damaged or distressed in any way.

Using the charger with any of the above symptoms could result in a fire, property damage, or personal injury.

Have your distributor, dealer or other qualified service technician repair or replace worn or damaged parts immediately. Repairs should not be attempted by people who are not qualified.

Check that there is no open flame or electrical spark in the area.

**!** **CAUTION** - Improper AC power can damage the charger. Consult data plate on the charger to verify AC input power requirements. Note CAUTION in Installation Section.

## 5 Theory of Operation

The control circuit monitors battery voltage and charging current. A microprocessor and silicon controlled rectifiers (SCR's) are employed to realize a modified 2-step-E-I or 3-step I-E-I charge profile.

**1] CONSTANT START CURRENT** - Charge current to the batteries is maintained at a constant value during initial charge stage to ensure capacity is rapidly returned to discharged batteries until battery voltage per cell reaches a specified level.

**2] CONSTANT VOLTAGE** - To rapidly charge the batteries without exposing them to both high current and high voltage, the battery voltage is maintained at a steady voltage while being charged with decreasing current.

**3] CONSTANT FINISH CURRENT** - To fully charge the batteries while avoiding damage to the batteries, a lower constant current is delivered to the batteries. Charge is terminated when battery is fully charged. During the charging process, the rate of voltage rise over time is constantly monitored. As long as the voltage rises faster than pre-established parameters, the control circuit will keep the charger on until finishing the 3-step I-E-I charge cycle. Otherwise, the charge cycle will be terminated. A 16 to 20 hour backup timer is also programmed into the microprocessor. This will terminate the charge cycle in 16 to 20 hours in the event that a normal shutoff does not occur.

Your charger may incorporate a different charge profile than explained above. If you wish further information on your specific charger you can call the factory. Please have nameplate data information available.

## 6 Normal Operation

**! WARNING** - FOR DUAL VOLTAGE MODELS MAKE SURE TO MOVE VOLTAGE SELECTION SWITCH TO PROPER POSITION TO MATCH AC SUPPLY VOLTAGE.

**! WARNING** - To reduce the risk of an electric shock, connect only to a properly grounded single-phase (3 wire) outlet. Refer to grounding instructions.

1. For dual AC voltage chargers set switch to match AC supply voltage.
2. Plug AC cord into grounded receptacle.
3. Plug DC cord into battery receptacle.
4. All LED's will flash.
5. Charge will begin after a few seconds.
6. **WARNING:** This charger may be provided with a manual selectable charge profile that allows for proper charging of:

(W) = Wet gassing lead acid batteries

or

(S) = Sealed valve regulated (SVR), gelled/agm type lead acid batteries.

Verify charge profile setting after charge begins. A flashing incomplete LED prior to the 80% LED coming in indicates a (S) sealed valve regulated profile has been selected. If not flashing, charger is in a (W) wet charging profile.

**! CAUTION:** Improper profile setting may damage the batteries. To change setting remove cover and follow instructions in charger.

7. When batteries are fully charged, only the Green LED "Charge Complete" should be illuminated.

**! WARNING** - Do not disconnect the DC output cord from the battery receptacle when the charger is on. The resulting arcing and burning of the plug and receptacle could cause the batteries to explode. If the charger must be stopped, first press the stop button, if provided, or disconnect the AC power supply cord from its outlet, then disconnect the charger DC output plug from the battery receptacle.

## LED INDICATORS

### Normal Charge Sequence-

1- During the initial constant current stage, both the Yellow LED "Charger On" and the Red LED "Incomplete" will illuminate. A flashing Red LED "Incomplete" prior to the Yellow LED "80% Charge" coming on indicates a (S) Sealed Valve Regulated profile has been selected. NOTE - Early models did not incorporate this flashing LED feature.

2- When battery voltages reach 2.35 to 2.38 volts/cell, the Yellow LED "80% Charge" will illuminate.

3- When a charge cycle is terminated both the Yellow LED "80% Charge" and the Yellow LED "Charger On" will turn off. The Green LED "Complete" will then illuminate.

O	GREEN	"CHARGE COMPLETE"
O	YELLOW	"80% CHARGE"
O	RED	"INCOMPLETE" flashes in SVR mode
O	YELLOW	"CHARGER ON"
O	RED	"ABNORMAL CYCLE"

### Abnormal Charge Sequence

1- If a charge cycle does not finish in 16 to 20 hours, only the Red LED "Abnormal Cycle" lights up. All other LED's turn off.

2- If shorted battery cells are detected during a charge cycle, the Red LED "Abnormal Cycle" will flash in a pattern of being on for 2 seconds and off for 1 second.

3- If batteries are disconnected from the charger during a charge cycle, the Yellow LED "Charger On" will turn off. The charger will also shut off.

4a- On most models, if AC power is lost during a charge cycle, the Yellow LED "Charger On" will turn off and the Red LED "Abnormal Cycle" will turn on. The battery status LED (either Yellow "80% Charge" or Red "Incomplete") will remain on. The Yellow LED "Charger On" will come back on and the Red LED "Abnormal Cycle" will turn off upon resumption of AC power.

4b- On models that are AC powered only, if AC power is lost during a charge cycle, the charger will turn off and all LED's will go out. Upon resumption of AC power, charger will go through self-diagnostic test (LED's flash) and charge cycle will restart.

5- In the event of output over-current, the Yellow LED "Charger On" will turn off and the Red LED "Abnormal Cycle" will flash. The battery status LED (either Yellow "80% Charge" or Red "Incomplete") will remain on.

## 7 Full Charge Sentry (FCS)

This feature was developed to maintain batteries in a charged state while they are left in storage. FCS will be found on most MAC SCR Domestic chargers. This feature is not incorporated into the Export Dual AC Voltage models. The FCS feature will be activated upon satisfaction of the following four conditions:

1. Charger is connected to the battery and AC power.
2. Battery voltage reached 2.50 volts per cell at the end of the last charge cycle.
3. Battery has been in storage for at least 14 days since the last complete charge cycle.
4. Battery voltage falls below 2.05 volts per cell.

If these conditions are met, the charger will automatically maintain the battery as required.

**NOTE:** A charger with FCS should not be used in applications where the charger's DC output is permanently connected to the battery. The Export charger should be selected for these applications.

To verify that your charger has the FCS feature, simply connect the DC output to the battery without plugging in the AC. The LED's on the front of the charger will flash through the self-diagnostic sequence if the unit has FCS.

## 8 Troubleshooting

**TO BE ABLE TO USE THE TROUBLE SHOOTING GUIDE SAFELY AND EFFECTIVELY IT IS IMPORTANT TO READ THIS GUIDE COMPLETELY BEFORE BEGINNING ANY TESTS.**

**! CAUTION** - DO NOT DISASSEMBLE THE CHARGER. TAKE IT TO A QUALIFIED SERVICE TECHNICIAN WHEN SERVICE OR REPAIR IS REQUIRED. Modifying this charger for use other than that for which it was intended, repairs by persons not qualified or not using original equipment replacement parts will void the manufacturer's warranty and liability. Incorrect assembly may result in a risk of electric shock or fire. The following procedures are intended only to determine if a malfunction may exist in the charger.

**! DANGER** - Hazard of Electric Shock! To reduce the risk of electric shock, always disconnect both electrical cords, first from the AC outlet and then from the charger receptacle before attempting any maintenance, cleaning, repairs or service to the charger.

**! WARNING** - Do not operate the charger if it is malfunctioning. Personal injury or property damage could result.

Equipment Required:

Analog or digital multi-meter with alligator clip test leads

**! WARNING** - Use insulated test leads so your hands are never inside the charger with either AC plugged in or DC plug connected to receptacle. Always unplug both AC and DC, then move alligator clips to desired positions. Then plug in appropriate AC or DC connector as instructed in the following checkout procedures.

# GENERAL SERVICE PROCEDURES

Refer to quick check guide first before working on charger or removing cover. The obvious is often missed.

If unable to diagnose from quick check, unplug AC and DC connectors, and remove cover. Carefully inspect for damaged, discolored components and loose or discolored wiring. If unable to spot problem, proceed to DC Circuit Checkout Procedure.

## Quick Check Guide

Charger does not come on - no transformer hum with charger unplugged:

- check AC voltage to charger
- check circuit breaker
- check for continuity through DC fuse
- check DC plug and receptacle for good connection
- check for loose component/wire connections

<u>PROBLEM</u>	<u>THIS MEANS</u>	<u>YOU SHOULD</u>
AC circuit breaker trips	Abnormal voltage or current spikes	Reset
	AC voltage switch in wrong position or wrong supply voltage	Correct switch
AC circuit breaker trips after reset	Possible wrong circuit breaker or transformer or SCR	Have qualified service technician inspect.
DC fuse/breaker blows	SCR short, circuit board malfunction	Same as above

**PROBLEM****THIS MEANS****YOU SHOULD**

Charger will not turn on:  
No LED self test or all  
keep flashing

No AC power

Check charger  
circuit breaker LEDs  
and supply voltage  
wall breaker

Poor DC connection

Check connection  
from charger to  
battery

Battery voltage less  
than 1.25 VPC

Check battery  
voltage

Charger will not turn on  
LED self test OK

No AC power

Check charger  
circuit breaker  
and supply  
voltage wall  
breaker

Charger will not turn on  
LED self test is partially OK

Circuit board may  
have failed. SCR  
failed

Have qualified  
service technician  
inspect

Charger will not shut off

Circuit board may  
have failed. SCR  
short

Same as above

LED's show abnormal

Refer to pages 8-9  
LED Indicators -  
Abnormal Charge  
Sequence

# DC CIRCUIT CHECKOUT PROCEDURE

**!** **CAUTION:** No AC power should be applied to charger during DC circuit checkout procedure.

Charger needs battery voltage to turn on. Set meter to read DC voltage.

<u>ACTION</u>	<u>MEASURE</u>	<u>IF</u>	<u>THEN</u>
Step 1 - Attach positive and negative test leads of meter to appropriate battery system receptacle - (positive to positive and negative to negative). Measure voltage.	Measure Voltage 1.70vpc-2.16vpc	No	Check wiring
Step 2 - Remove the charger cover. Step 3 - Place negative test lead of meter where negative (black) DC cable connects to the shunt. Place positive test lead of meter where positive (white or red) DC cable connects to DC circuit breaker or fuse. Step 4 - Plug DC connector into receptacle. Measure voltage and unplug.	Measure Voltage 1.70vpc-2.16vpc	No	Check DC plug or connection to receptacle
Step 5 - Keep negative test lead as located in Step 3. Move positive test lead to other side of the circuit breaker or fuse. Step 6 - Plug DC connector into receptacle. Measure voltage and unplug.	Measure Voltage 1.70vpc-2.16vpc	No	Replace circuit breaker or fuse
Step 7a - Keep negative test lead as located in Step 3. Move positive test lead to the longer stem (cathode) of one SCR. Step 7b - Plug DC connector into receptacle. Measure and unplug. Step 8a - Keep negative test lead as located in Step 3. Move positive test lead to the longer stem (cathode) of the other SCR. Step 8b - Plug DC connector into receptacle. Measure voltage and unplug.	Measure Voltage 1.70vpc-2.16vpc	No	Check connections from SCR to circuit breaker or fuse

**ACTION****MEASURE****IF****THEN**

Step 9 - Keep negative test lead as located in Step 3. Place positive test lead on #6 pin of the white 17-pin J1 connector on circuit board. Note that #1 pin of J1 connector starts on the other end of the circuit board across from the green LED.

Measure Voltage  
1.70vpc-2.16vpc

No

Check connection from circuit breaker or fuse to #6 pin of J1 connector on the circuit board.

Step 10 - Plug DC connector into receptacle. Measure voltage and unplug.

Step 11 - keep negative test lead as located in Step 3. Place positive test lead on #16 on J1 connector.

Measure Voltage  
1.70vpc-2.16vpc

No

Check connection from circuit breaker or fuse to #16 pin of J1 connector on circuit board.

Step 12 - Plug DC connector into receptacle, measure voltage and unplug.

Step 13 - Keep positive test lead located in Step 11. Move negative test lead to #5 pin of J1 connector on the circuit board.

Measure Voltage  
1.70vpc-2.16vpc

No

Check connection from shunt or fuse to #5 pin of J1 connector on the circuit board.

Step 14 - Plug DC connector into receptacle. Measure voltage and unplug.

# AC CIRCUIT CHECKOUT PROCEDURE FOR SINGLE INPUT VOLTAGE CHARGERS

Check for proper input voltage to primary of transformer. Set meter to read AC voltage.

<u>ACTION</u>	<u>MEASURE</u>	<u>IF</u>	<u>THEN</u>
Step 1 - Place AC voltage test leads of meter at wall receptacle.	Measure voltage 100-130 volts AC	No	Check wall breaker or fuse.
Step 2 - Remove cover. Step 3 - Place one meter test lead on the varistor leg that connects to white wire of AC cord. Place the other test lead on the charger circuit breaker terminal that is connected to black wire of AC cord. Step 4 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 100-130 volts AC	No	Replace AC cord.
Step 5 - Keep connection at varistor leg as in Step 3. Move circuit breaker connection to the other terminal of circuit breaker. Step 6 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 100-130 volts AC	No	Replace circuit breaker.
Step 7 - Plug DC connector into receptacle.	All LED's will flash through the self diagnostic sequence	No	Perform DC circuit checkout procedure.
Step 8 - Place meter test leads on terminals A & B of relay. Step 9 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 90-130 volts AC	No	Check wire harness of #4 pin connector on circuit board. If O.K. replace circuit board and retest.
Step 10 - Place on meter test lead at varistor leg as in Step 3. Place the other meter test lead at "NO" terminal of relay. Step 11 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 90-130 volts AC	No	Replace relay.

# AC CIRCUIT CHECKOUT PROCEDURE

## FOR DUAL INPUT VOLTAGE CHARGERS

Check for proper input voltage to primary of transformer. Set meter to read AC voltage.

<u>ACTION</u>	<u>MEASURE</u>	<u>IF</u>	<u>THEN</u>
Step 1 - Set AC voltage selection switch to proper position. Step 2 - Place AC voltage test leads of meter at wall receptacle.	Measure voltage 100-130 volts AC or 200-260 volts AC	No	Check wall breaker.
Step 3 - Remove charger cover. Step 4 - Place one meter test lead on the IEC320 socket terminal that is connected to a brown wire. Place the other meter test lead on the IEC320 socket terminal that is connected to a blue wire. Step 5 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 100-130 volts AC or 200-260 volts AC	No	Replace AC cord.
Step 6 - Move meter test leads to voltage selection switch terminals where the brown and blue wires are connected. Step 7 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 100-130 volts AC or 200-260 volts AC	No	Check connections from IEC320 socket to voltage selection switch.
Step 8 - Move the meter test lead at the voltage selection switch terminal with a brown wire to the circuit breaker (referred to as the first circuit breaker) terminal that is connected to the voltage selection switch. Leave the other meter test lead as in Step 6. Step 9 - Plug AC cord into wall receptacle. Measure voltage and unplug.	Measure voltage 100-130 volts AC or 200-260 volts AC	No	Check connections from the voltage selection switch to the first circuit breaker.

<u>ACTION</u>	<u>MEASURE</u>	<u>IF</u>	<u>THEN</u>
<p>Step 10 - Move the meter test lead to the other terminal of the first circuit breaker. Leave the other meter test lead as located in Step 6.</p> <p>Step 11 - Plug AC cord into wall receptacle. Measure voltage and unplug.</p>	<p>Measure voltage 100-130 volts AC or 200-260 volts AC</p>	No	<p>Check whether the first circuit breaker popped out. If yes, perform Step 1 and reset the first circuit breaker.</p>
<p>Step 12 - Leave the meter test lead at the first circuit breaker terminal as located in Step 10. Move the other meter test lead to the terminal (that is connected to the voltage selection switch) of the other circuit breaker (referred to as the second circuit breaker).</p> <p>Step 13 - Plug AC cord into wall receptacle. Measure voltage and unplug.</p>	<p>Measure voltage 100-130 volts AC only.</p>	No	<p>Check connections at voltage selection switch and to circuit breaker. If O.K. replace voltage selection switch.</p>
<p>Step 14 - Leave the meter test lead at the first circuit breaker as located in Step 10. Move the other meter test lead to the other terminal of the second circuit breaker.</p> <p>Step 15 - Plug AC cord into wall receptacle. Measure voltage and unplug</p>	<p>Measure voltage 100-130 volts AC only.</p>	No	<p>Check whether circuit breaker popped out. If yes, perform Step 1 and reset the second circuit breaker. If no, replace the second circuit breaker.</p>

## AC CIRCUIT CHECKOUT PROCEDURE SCR CHECKOUT PROCEDURE

Unplug AC plug and DC plug.

Unplug J1 and J2 (If applicable) connector on circuit boards.

1. With VOM set to ohms, place one test lead on heatsink and the other on cathode (long stem). Should read high resistance.
2. With VOM set to ohms, place one test lead on heatsink and the other on gate (short stem). Should read high resistance.
3. With one probe on cathode and one on gate, should read low resistance; reversing probes should read low resistance.

## 9 CHARGE PROFILE CHANGE PROCEDURE

! **WARNING:** This charger may be provided with a manual selectable charge profile feature that allows for the proper charging of:

(W) = Wet gassing lead acid batteries

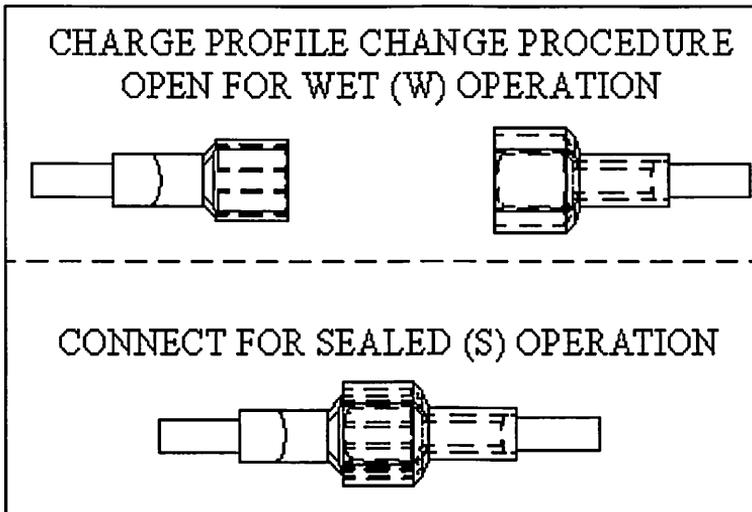
or

(S) = Sealed valve regulated (SVR), gelled/agm type lead acid batteries

Verify charge profile setting after charge begins. A flashing incomplete LED prior to the 80% LED coming on indicates a (S) sealed valve regulated profile has been selected. If not flashing, charger is in a (W) wet charging profile.

**NOTE:** Any chargers having a circuit with date code 9719 or earlier did not incorporate this flashing LED feature.

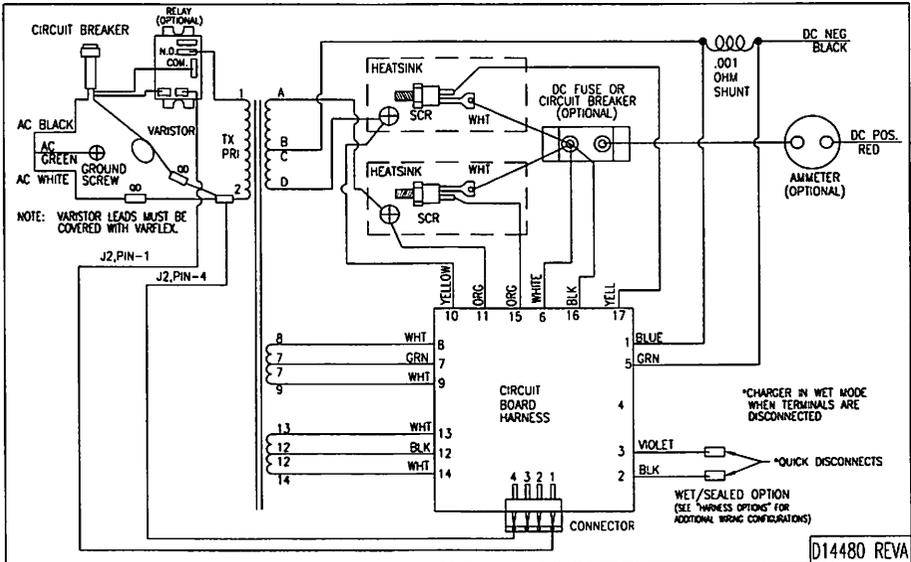
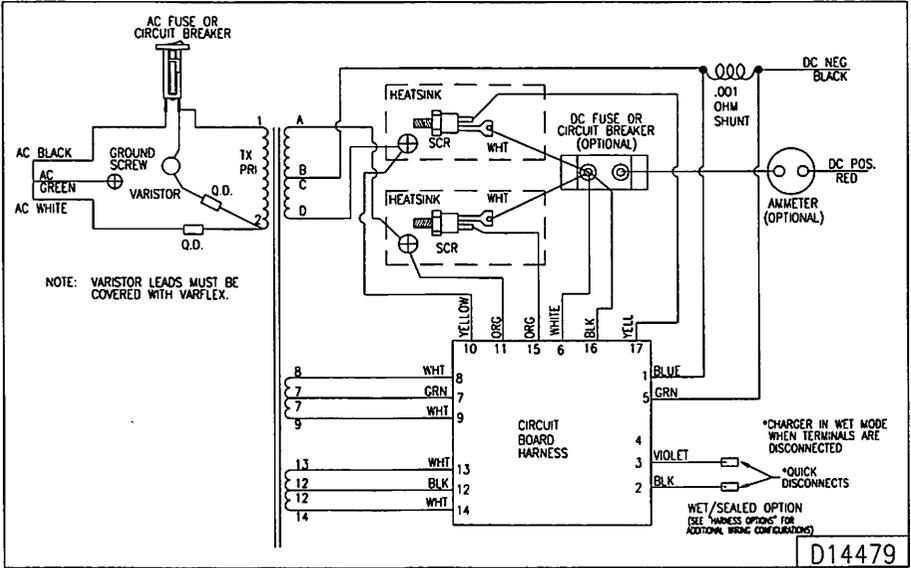
! **CAUTION:** Improper profile setting may damage the batteries. To change setting remove cover and follow instructions in charger.



# WIRING DIAGRAMS

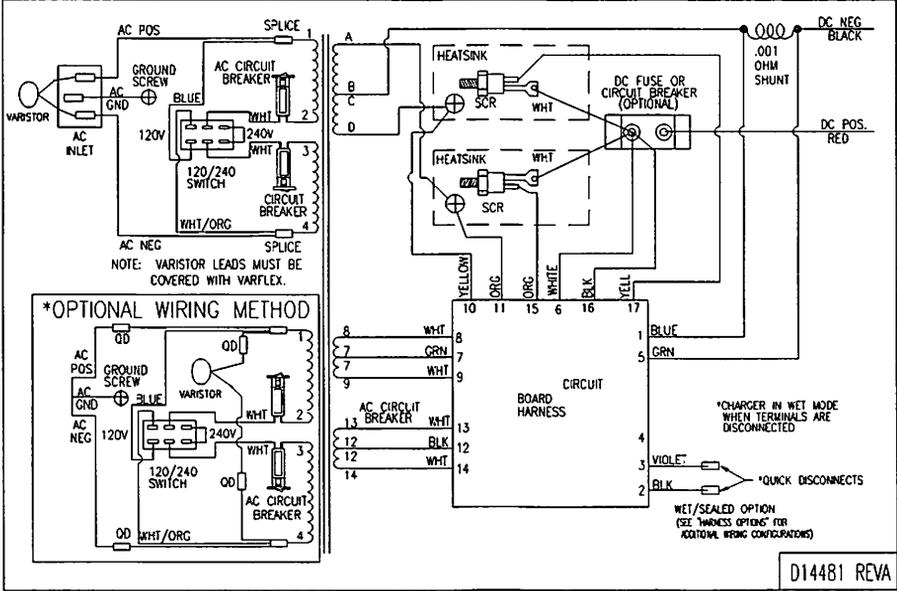
## FOR SINGLE INPUT VOLTAGE CHARGERS

**NOTE:** When ordering parts, give information off the charger data nameplate.

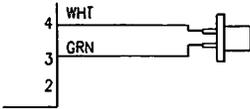


# WIRING DIAGRAMS FOR DUAL AC INPUT CHARGERS

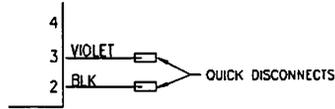
**NOTE:** When ordering parts, give information off the charger data nameplate.



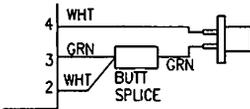
## HARNESS OPTIONS



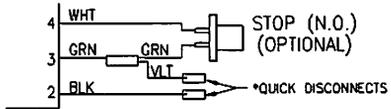
STOP OPTION  
(WET MODE)



WET/SEALED OPTION  
(WET OR SEALED MODE)



STOP OPTION  
(SEALED MODE)



STOP OPTION  
(WET OR SEALED MODE)

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## NOTES

