

SPECIALTY CONCEPTS Mark III/15

(SC3/15)

**Photovoltaic Battery Charge Controller
Installation & Operation Manual**

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GENERAL DESCRIPTION

The Specialty Concepts Mark III/15 (SC3/15) is a battery charge controller and system monitoring unit designed for use in mobile or stationary photovoltaic (PV) energy systems. This controller is designed to be used with standard lead acid batteries that are normally supplied for use in stand alone or mobile applications.

The SC3/15 uses a solid state pulse-type charge controller to safely reach and maintain a full state of charge for the battery. A blocking diode is provided to eliminate losses through the solar panels (array) at night. This unit includes a battery voltage meter, a solar charge current meter and a fuse to provide over-current and reverse polarity protection. A "CHARGING" light indicates battery status. This model is available for 12 volt systems with charging currents up to 15 amps. The SC3/15 can be mounted flush or an additional knockout box (4x7 BOX) can be purchased for wall mounting.

SPECIFICATIONS

SC3/15 FEATURES

CHARGE REGULATION

- 15 amp charge current, 12 volt
- Switching shunt, pulse charging
- Adjustable charging set-points
- Temperature compensation (option)

LOW VOLTAGE LOAD DISCONNECT (LVD) (option)

- 10 amp LVD Relay

MONITORING

- Battery voltage meter with colored scale
- Solar panel current meter
- "CHARGING" light

DESIGN FEATURES

- 100% solid state charge control
- Designed for rugged mobile use
- Over-current protection - Battery fuse
- Reverse leakage protection - Blocking diode
- Reverse polarity protection
- Lightning protection
- Input noise suppression
- Low power consumption

MOUNTING OPTIONS

- Flush mount
- Knock-out box available for wall mounting (4x7 BOX accessory)

RELATED SYSTEM EQUIPMENT

The SC3/15 is an integral part of a solar electric power system that includes a PV solar array, a battery and a load. These items should be installed in accordance with the National Electrical Code, and with the instructions provided by the equipment supplier.

SOLAR ARRAY PANELS: The SC3/15 is compatible with all makes and models of PV panels, provided the open circuit voltage (Voc) does not exceed 26 volts (the sum of the Voc of all modules in series) and the short circuit current (Isc) of the array does not exceed 15 amps (the sum of the short circuit currents (Isc) of all the modules in parallel).

BATTERIES: The SC3/15 provides the proper charging of standard lead-acid batteries that are normally used in recreational vehicles, boats, and remote stand alone systems. These include wet cell batteries (with filler caps) and the sealed, maintenance-free batteries. A battery disconnect switch should be installed on the Battery (+) run to the controller. This will allow a safe way to disconnect the battery during installation.

TWO-BATTERY SYSTEMS & SYSTEMS WITH BATTERY ISOLATORS : If solar charging of two separate batteries is desired, a switch can be installed to allow manual selection of one battery or the other. In installations that use a diode battery isolator with two batteries, the SC3/15 can be connected to one of the outputs from the isolator, or at one of the batteries itself to charge that battery only. Do not connect the SC3/15 to the input of the isolator, the SC3/15 will not operate properly when charging batteries through a diode.

LOADS: System loads such as lights, radios and DC/AC inverters must be 12 volts DC (unless an inverter is being used). The loads should be fused as recommended and connected directly to the battery or to a load center/circuit breaker box. See the diagrams in the "INSTALLATION" section. See "*OPTIONS*" section for information on the *Low-voltage Load Disconnect option*.

OTHER CHARGING SOURCES: The SC3/15 can be used only as a photovoltaic (solar) charge controller. **DO NOT** use the SC3/15 to regulate other power sources , such as a hydro or wind generator/alternator or an AC battery charger. This could result in damage to the SC3/15 and/or the generating equipment

The SC3/15 **CAN** remain connected to a battery that is also being charged by an another source (alternator, battery charger, etc.) without damage to the SC3/15 or to the solar panels. Connect all other charging sources, with their own charge regulation devices, directly to the battery. No isolation diode or transfer switch is required. NOTE: Some battery chargers or converters powered by 110 volt sources are not properly regulated and can overcharge batteries if left unattended.

INSTALLATION

WARNINGS / CAUTIONS

WARNING: Electricity, even low voltage electricity, can be dangerous. Installation should be performed by a licensed electrical contractor or other qualified personnel only. The requirements of the U.S. National Electrical Code should be followed.

WARNING: Follow all safety precautions of the battery manufacturer. Proper ventilation must be provided for the batteries. Most batteries produce hydrogen gas when charging, which is extremely explosive. Provide adequate battery ventilation. **DO NOT** expose the battery to open flame, matches, cigarettes or sparks.

WARNING: Install properly DC rated, high interrupt, current limiting, over-current protection and disconnect equipment between the SC3/15 and the battery. Suitable fused disconnect switches are low cost and provide protection from fire and damage due to over-current. Refer to the current National Electrical Code or your local alternative energy vendor for recommendations.

CAUTION: DO NOT exceed the maximum array open circuit voltage (Voc) of 26 volts. This is the sum of the Voc of all modules in series.

CAUTION: DO NOT exceed the maximum current rating of the SC3/15 of 15 amps. This is the sum of the short circuit currents (Isc) of all the modules in parallel.

CAUTION: DO NOT reverse battery "PLUS" and "MINUS" connections to the SC3/15. Reverse polarity or accidental contact to the battery in reverse polarity will cause the fuse to blow, and may damage the unit.

CAUTION: DO NOT connect the array directly to the battery when the array is connected to the SC3/15 at the same time. This will cause damage to the SC3/15 when the battery reaches full charge voltage.

CAUTION: DO NOT wire the SC3/15 in such a way that it can be connected to an alternator (or other charging source) while the battery is disconnected, even if momentarily. Other charging sources should have independent connections to the battery.

INSTALLATION INSTRUCTIONS:

1. MOUNTING CONSIDERATIONS: - The SC3/15 is designed to be mounted flush against a wall. It can be mounted onto a wall by adding the optional knockout box (4x7 BOX). Flush mounting or wall mounting require different installation and mounting considerations.

FLUSH MOUNT: The flush mounted unit requires a rectangular cut-out in the mounting surface with sufficient space (2-3 inches) immediately behind to accommodate the controller. Electrical connection is made to the back of the controller via wires.

WALL MOUNT: The wall mounted unit (SC3/15 with the 4x7 BOX) is installed onto a wall surface via four mounting screws. Electrical connections are made through knockouts in the box to the wires on the back of the controller.

2. ACQUIRE TOOLS AND MATERIALS

TOOLS AND MATERIALS NEEDED:

FLUSH MOUNT:

Slotted screwdriver

Wire cutter/strippers

Drill with 3/32" and 3/8" bits

Keyhole saw or saber saw

Pencil, scratch awl or other marker

Soldering iron and solder (if available)

Electrical tape

Wire of sufficient gauge to run from the panels, to the SC3/15, and to the battery (See **INSTALLATION INSTRUCTIONS: SELECT WIRE \ WIRE SIZE**)

Mounting fasteners of appropriate type for wall material (3/4 - #6 screws provided)

Included are wire nuts, four 3/4 - #6 screws and washers and a spare fuse (15 amp AGC).

WALL MOUNT (SC3/15 with 4X7 BOX):

Slotted screwdriver

Wire cutter/strippers

Pencil, scratch awl or other marker

Soldering iron, solder (if available)

Electrical tape

Wire of sufficient gauge to run from the panels, to the SC3/15, and to the battery (See **INSTALLATION INSTRUCTIONS: SELECT WIRE \ WIRE SIZE**)

Mounting fasteners of appropriate type to mount the box to the wall

1/2 inch Romex strain relief clamps

Included are wire nuts, four 3/4 - #6 screws and washers and a spare fuse (15 amp AGC).

3. LOCATION: - The SC3/15 should be mounted where it can be easily seen and reached to take the best advantage of the metering. Carefully consider how the wires are to be run from the solar panel to the controller, and from the controller to the battery. The SC3/15 should be mounted as close to the battery as possible, and should be mounted on a vertical surface to aid in cooling.

FLUSH MOUNT: The SC3/15 is designed to be recessed into the side of a cabinet or wall where the wiring can be accessed from the back. Allow 2 - 3 inches behind the unit.

WALL MOUNT: The SC3/15 with 4x7 BOX is designed to be mounted on the surface of a cabinet or wall. Wiring can be run down the wall or through a hole in the wall directly below the controller.

4. PROTECTION REQUIREMENTS: - The unit should be mounted indoors, out of the weather, unless a weatherproof enclosure is used. Avoid mounting in direct sunlight or in a hot environment. Basically, do not mount anywhere you would not put a TV or stereo.

5. PREPARE THE LOCATION PRIOR TO WIRING:

FLUSH MOUNT: Use the template provided to position and mark the cut-out and the four mounting holes. Make the cut-out using a key hole or jig saw. Start by drilling holes in the corners, then saw between the holes.

WALL MOUNT: Mount the knock-out box to the wall using suitable fasteners.

6. COMPLETE THE INSTALLATION OF PANEL, BATTERIES AND LOAD: - Follow the manufacturer's instructions for mounting and wiring the solar panel, batteries and the load. Install with the correct series-parallel configuration to insure proper system voltage and current.

7. SELECT WIRE:

WIRE TYPE: - It is recommended that stranded wire rather than solid wire be used whenever possible, because stranded wire does not fatigue and cause loose connections over time as easily as solid wire does.

WIRE SIZE: - Wire should be sized of sufficient gauge to safely handle the rated current of the system and to limit voltage drop. The wiring used within the controller is of sufficient gauge to handle the currents carried, and these wires are short enough that voltage drops are not a concern, but larger gauge may be appropriate for runs to the array or battery.

Approximate Wire Size: (for 10 foot total length: panels to batteries)

<u># Solar Panels (50 watt)</u>	<u>Minimum Wire Gauge</u>
1	# 14
2	# 12
3 - 6	# 10

INSTALLATION INSTRUCTIONS (continued)

8. REMOVE POWER FROM BATTERY / PANELS: - Disconnect power from the batteries and panels prior to running the wires to the controller.

9. RUN SYSTEM WIRING: - After disconnecting the power sources, run the wires from the battery and solar panel to the location selected for the controller.

WALL MOUNT: Run the array and battery wires into the box through the knockouts, using a 1/2 inch Romex cable clamp for strain relief.

10. NOTE WIRE POLARITY: - Make sure to correctly mark the polarity of the wires using colored wires or tags. Incorrect polarity may blow the front panel fuse or damage the SC3/15. Some vehicles or solar kits use black and white wires for connection to the battery. These kits will label the white wire as battery negative and the black wire as battery positive. Black and red wiring systems will label the black wire as negative and the red wire as positive. When these systems interconnect, the black wire does not connect to the black wire. **CAREFULLY NOTE BATTERY POLARITY AND WIRE COLORS!**

11. SC3/15 CONNECTION: - Wire the SC3/15 according to **Figure 1**. (*Units with Option-E should refer to **Figure 2** and the **OPTIONS** section*). When possible, solder the wires before installing the wire nuts, then wrap the wire nuts and wires with electrical tape.

12. INSTALL OPTIONS: - If included

TEMPERATURE COMPENSATION (OPTION A): - Refer to **OPTIONS** section.

WALL MOUNT: Run the temperature compensation cable through the holes in the knock-out box.

LOW-VOLTAGE DISCONNECT (OPTION-E): - Refer to **Figure 2** to complete the load connection for low-voltage load disconnect. Refer to **OPTIONS** section.

13. SC3/15 MOUNTING: - Mount the SC3/15 to the wall or box front using the four screws provided or other suitable fasteners. Slip the washers (supplied) over the screws so the washers are between the back of SC3/15 and the wall (or box). This provides an air gap for added cooling. **INSTALLATION OF THESE WASHERS IS REQUIRED FOR PROPER COOLING DURING OPERATION.**

14. INSTALL FUSING AS NEEDED: - Add circuit protection where needed. A 15 amp fuse and disconnect switch should be installed on the Battery (+) run of the SC3/15.

15. RECONNECT BATTERY AND ARRAY POWER

16. OPERATION: - Operation of the charge controller is now fully automatic. If the battery voltage is below the Full Charge Termination set-point (14.4 volts) and power is available from the array, the SC3/15 should start up in the full-charge mode.

During operation, it is normal for the unit to feel warm.

UNITS WITH OPTION E (LVD): - *Resetting the LVD circuit to activate the loads immediately after installation.* On initial installation, the SC3/15 with LVD (Option-E) will start out with the load disconnected (relay energized mode). The battery voltage has to rise to the reset voltage (about 13.0 volts) to connect the loads. The loads can be immediately activated if the array is connected to the controller and is producing at least 17 volts open circuit, and the battery voltage is above 11.5 volts. By disconnecting and then reconnecting the battery positive, the load should go on.

17. CHECK FOR VOLTAGE DROP (OPTIONAL): - Once the system is installed and operational, a check on the connections is recommended. A poor connection will result in a voltage loss that will cause the batteries to be under-charged and/or result in excessive heat generated at the location of poor connection (wire connection or terminal block). A poor connection to the battery will also distort the battery voltage reading and cause the charging to stop too soon. To check the connections, a voltage multi-meter is required and the SC3/15 must be charging with maximum expected charge current.

Battery Connection: - First, note the voltage at the battery terminals. Select the positive and negative terminals that are used for the SC3/15 connection. Then note the voltage at the SC3/15 wires for battery(+)(red) and battery(-)(black). Ideally, the difference in voltage should be no more than $\frac{1}{4}$ volt.

Array Connection: - Next, note the voltage at the panel. Select the positive and negative wires that are used for the SC3/15 connection. Then note the voltage at the SC3/15 wires for array(+)(yellow) and array (-)(black). Ideally, the difference should also be no more than $\frac{1}{4}$ volt.

If the voltage drop is more, suspect crimp connections that have not been soldered, in-line fuses or fuse holders, or loose terminals. If no location of voltage drop is found, consider using larger wires (or double up the wires) for your run.

FIGURE 1 SC3/15 CONTROLLER

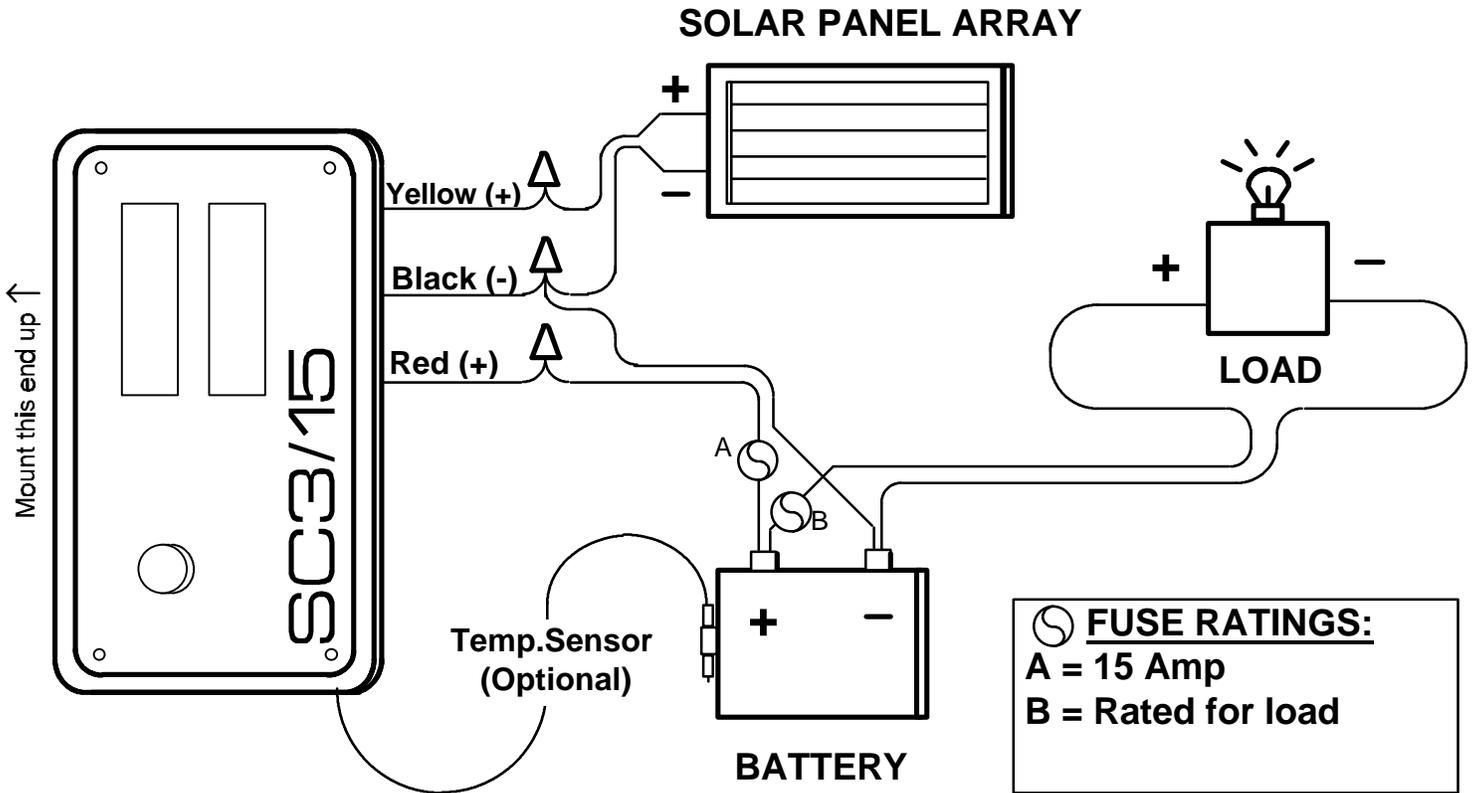
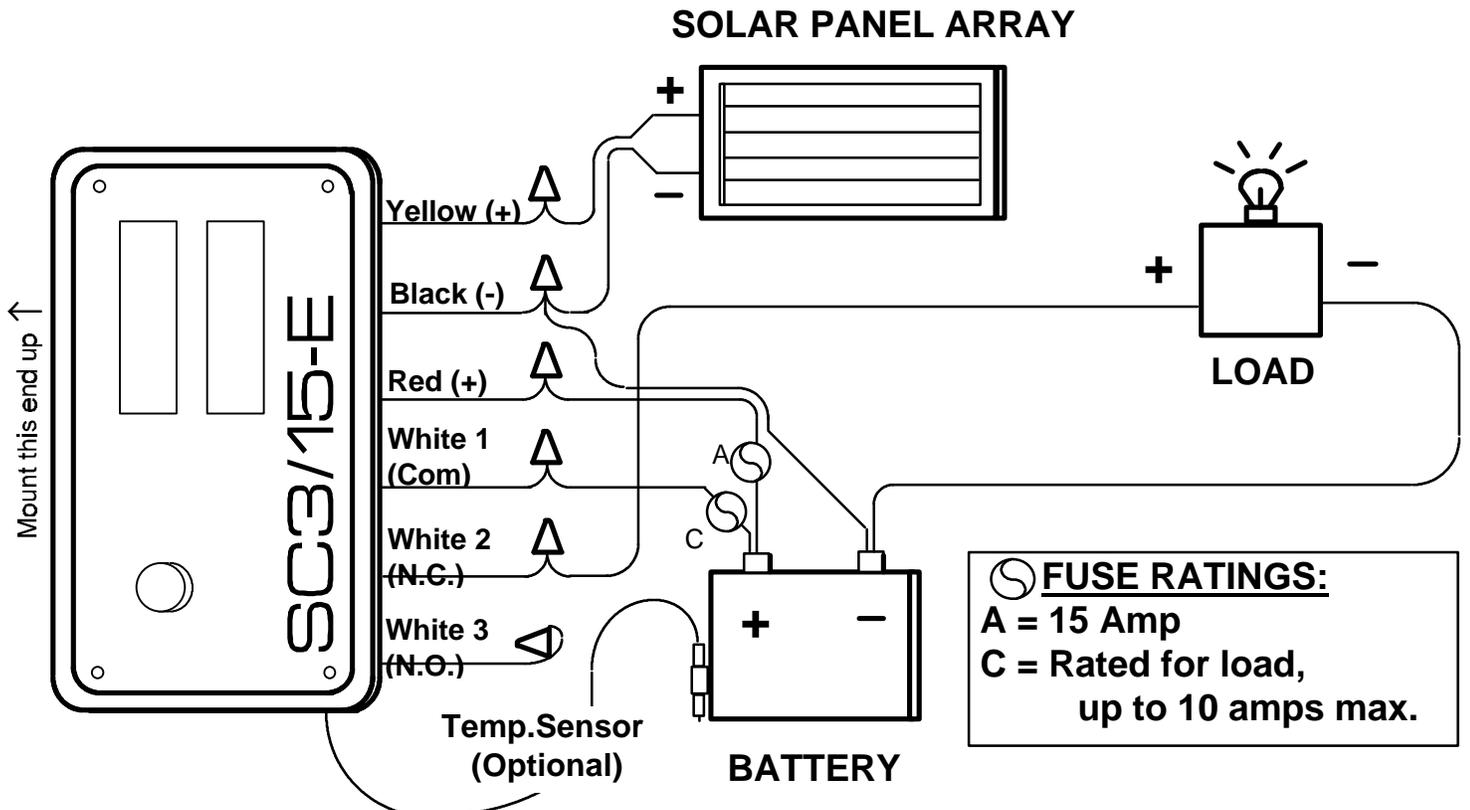


FIGURE 2 SC3/15 CONTROLLER with OPTION E (LVD)



O P E R A T I O N

The charge regulation aspects of the SC3/15 are completely automatic. No user interface is required after installation. This controller will regulate the charging of batteries during conditions of heavy usage, or when left unattended for long periods of time.

SWITCHING SHUNT, PULSE CHARGE REGULATION: When in the charge mode, the SC3/15 allows maximum available array current, to flow into the battery through a blocking diode, lighting the "CHARGING" light. As the battery charges, the voltage will rise slowly until it reaches about 14.5 volts. At this point, the "CHARGING" light goes out and battery charging stops. When charging stops the battery voltage will fall, and when the battery voltage drops to 13.0 volts, the SC3/15 will resume charging.

A TYPICAL DAY: A typical daily cycle will be as follows. As the charging starts for the day and battery state of charge is low, charging will be continuous and the "CHARGING" light will be on all the time. As the battery charges up, current will pass into the battery for awhile and eventually stop. Later, charging will resume and the system will continue this cycle throughout the day. During the course of the day, the duration of the charging period of each cycle will get shorter (cycling on for shorter periods and staying off longer). When the battery is close to full charge, it will pulse current into the battery to achieve and maintain full charge. This pulse charging is indicated by the "CHARGING" light occasionally turning on and off.

B A T T E R Y F U S E

BATTERY FUSE - A battery fuse is included for the SC3/15. This will protect the controller from over-current from the solar panels, reverse polarity from the batteries and a short circuit in the system. Fuse type: 15 AMP AGC.

MONITORING

The system operation can be monitored by the meters and "CHARGING" light.

"CHARGING" LIGHT: The "CHARGING" light will be on when the battery is charging. When the battery is at a low state of charge, the light will be on continuously during the day. When the battery charges up, the light will go out for awhile (until the voltage drops a little) and then will be on again. When the battery is close to full charge, the light will be on for short periods of time, and off for longer.

The charging light will be on when there is voltage from the solar panel and the battery can use more charging. This could result in the "CHARGING" light being on when the panels are in very low light conditions, such as the moon and street lights.

METERS: These meters have an accuracy of 5% of full scale, which means the voltage reading may be off by .75 volts, and the current by .75 amps. These meters are intended only as an **INDICATION** of system condition, like a gas gauge on a car, and **NOT** as an accurate measurement. For more precise measurements, a separate meter with higher accuracy is advisable.

"BATTERY" METER: This meter reads battery voltage. The battery voltage is a general indication of battery condition, or capacity.

GREEN: The battery is charged or in good condition.

YELLOW: Usage should be more conservative.

RED: Usage should be limited and other sources of charging used if available.

"PANEL" METER: This meter indicates the amount of current the solar panel is generating. Consult the panel supplier or literature for rated output to see what the output should be for the total number of panels in the system under ideal conditions. Ideal conditions are a bright sunny day, the panel aimed right at the sun and no shadows or dirt on the panel. Any current generated by the solar panels will be used first to operate any loads that are on, and any left over will go into the battery for charging. The current meter can be used to optimize the array tilt angle by moving the array (if possible) and noting when current is maximum.

SC3/15 STATUS

<u>BATTERY</u> <u>METER</u>	<u>PANEL</u> <u>METER</u>	<u>CHARGE</u> <u>LIGHT</u>	<u>OTHER</u>	<u>STATUS</u>
9.5-11.5 volts	1-15 amps	ON	Daytime	Battery is low and is charging. Reduce usage and charge from other source if possible.
9.5-11.5 volts	No amps	OFF	Night	Battery is low. Reduce usage and charge from other source if possible.
12-14.5 volts	1-15 amps	ON	Daytime	OK - Battery charging
13-14.5 volts	No amps	OFF		OK -Charging stopped. Battery at or near full charge
11.5-14.5 volts	No amps	OFF	Night	OK

OPTIONS

Options can not be added to finished units.

OPTION A - Temperature Compensation:

DESCRIPTION: On units equipped with temperature compensation, a small sensor on a ten foot cable is wired into the controller to adjust the charging thresholds according to battery temperature. The rate of compensation is $-5\text{mv}/^{\circ}\text{C}$ per battery cell in series from 25°C . (See **TABLE 1** below)

WHEN NEEDED: Temperature compensation is recommended for stand alone systems with sealed batteries, or for systems that have no regular charging source other than PV **AND** where prolonged temperature extremes will be experienced during periods of charging. Temperature extremes would be when the battery will be exposed to average temperatures below 50°F (10°C) or above 90°F (32°C). Systems with other sources of charging, (alternators on RVs) or applications where the battery is on maintenance charge, normally do not need this option.

CAUTION: SENSOR CABLE: If the sensor is damaged or the cable is cut, the controller will no longer function.

INSTALLATION INSTRUCTIONS

Provision must be made to attach the sensor unit to the battery. This must be done properly to insure that accurate temperature readings are made. It is important that ambient temperature not influence the sensor. To minimize this, attach the sensor to the battery as follows:

- 1. RUN SENSOR TO BATTERIES:** Run the sensor to the batteries, taking care to prevent damage to the actual sensor itself. When pulling the sensor through conduit, do not pull on the rubber-coated sensor, but instead on the gray cable just behind the sensor. Do not force the sensor. The sensor itself is made of glass, but it is encased in an aluminum tube, then coated with plastic. If the tube should pull off of the glass sensor, and if the sensor is not damaged, the tube can be slipped back over the sensor.
- 2. ATTACH SENSOR:** Use the adhesive sided foam pad (included) to cover the sensor (the plastic coated unit at the end of the cable) and attach it to the side of the battery approximately half-way up the side of the battery. Choose a battery that is shielded from drafts or sunlight by other batteries or by the battery shelter. **DO NOT** immerse the sensor directly in the battery's electrolyte. Temperature compensation of charging voltage is now automatic.

TABLE 1 : Voltage set-points by temperature.

Temperature compensation coefficient is: $-.03$ volts / $^{\circ}\text{C}$ from 25°C .

SC3/15	TEMPERATURE $^{\circ}\text{C}$ ($^{\circ}\text{F}$)						
<u>VOLTAGE</u>	<u>0 (32)$^{\circ}$</u>	<u>10 (50)$^{\circ}$</u>	<u>20 (68)$^{\circ}$</u>	<u>25 (77)$^{\circ}$</u>	<u>30 (86)$^{\circ}$</u>	<u>40 (104)$^{\circ}$</u>	<u>50 (122)$^{\circ}$</u>
12 VOLT	15.15	14.85	14.55	14.40	14.25	13.95	13.65

OPTION E - Low-Voltage Load Disconnect (LVD) \ Generator Start:

This option provides a relay that can be used as a switch to automatically disconnect loads or start a standby generator at a low-voltage condition of the battery. Connection to the N/O, Common and N/C connections is via three wires. The relay activates at about 11.5 volts and de-activates at about 13.0 volts. For generator start function, the generator must be equipped with a two wire auto-start feature.

Low-Voltage Load Disconnect: - To use this option, choose the white wire labeled "1" (common) and connect it to the battery (+) and connect the white wire labeled "2" (normally closed) to the Load (+). Connect the load (-) to battery (-) terminal. The white wire labeled "3" (normally open) is not used. Be sure to insulate the end of the wire, as it will be "hot". (See *wiring diagram*, **FIGURE 2** and **INSTALLATION INSTRUCTIONS - #16. OPERATION**)

Generator Start: - To use this option, choose the white wires labeled "1" (common) and "3" (normally open) and connect them to the generator auto-start circuit. The generator and loads would connect directly to the battery. The white wire labeled "2" (normally closed) is not used

TROUBLE SHOOTING

The following section can assist in the troubleshooting of a solar system. Please review the section below titled "**HELP NOTES**" which lists some common situations with a solar system. Within this section, you may be asked to perform a test using a voltage multi-meter to assist with the diagnosis.

- **SC3/15 Charge Controller:** - If a possible problem is suspected based on the observations of the SC3/15 controller, refer to the chart titled **SC3/15 PROBLEMS** and the "SC3/15 Note" for each condition on the following pages.
- **Battery:** - If you feel your batteries are not being adequately charged or are consistently being over-charged, refer to the section **BATTERY PROBLEMS**.
- **Solar Panels:** - If you feel that the solar panels are not performing adequately, refer to the section **SOLAR PANEL PROBLEMS**.

HELP NOTES: *(Normal Conditions and Common Problems)*

NORMAL CONDITIONS:

1. **NORMAL OPERATION: CHARGING / NOT CHARGING** - Depending on your system, the SC3/15 may go for long periods of constant charging or long periods with no charging. The SC3/15 is designed to prevent over-charging of the battery. It does this by stopping the charging at about 14.4 volts. It will then turn the solar panel off. Charging will resume when the battery voltage drops to about 13.05 volts. If the battery is fully charged, additional charging may not be needed. If the charge current is not strong enough to over-charge the battery, the controller may not turn the panel charging off.
2. **BATTERY WATER LOSS** - Vented batteries will need some water from time to time in the natural course of events. Minor water loss is not a problem; just top up the level when needed. Excessive water loss (a quart or more in a period of a month) may indicate a more serious problem.
3. **BATTERY GASSING** - In vented batteries, some gassing is good. Gassing stirs up the battery acid and allows the battery to fully charge. A little bubbling in the batteries is not necessarily a problem. See **BATTERY WATER LOSS** above.
4. **TEMPERATURE** - Temperature can affect the performance of batteries. They will tend to over-charge easier when hot, and will have a lower state of charge when cold.
5. **METER ACCURACY** - The meters on the SC3/15 are intended to be an indication of system performance, like a gas gauge in a car. They are not intended for exact measurements. The meters can be off by as much as 3/4 volt or 3/4 amp.

PROBLEM CONDITIONS:

6. **SYSTEM IS NOT SIZED CORRECTLY** - The solar system batteries will tend to be under-charged if the solar panel array is too small, or if the battery bank is too small, or if the usage is too high.
7. **PROBLEMS WITH SOLAR PANELS** - Solar panel output is dependent upon the amount of sun-energy reaching the panel. This can be seriously affected by panel angle of orientation, minor shading, high level haze (barely visible) and dust on the panel. At the time of installation, a solar array can have an incorrect series-parallel configuration for the proper system voltage and current. A panel can also become less productive or defective over time. **TEST:** Disconnect the array(+) connection on the SC3/15, and measure the voltage directly at the array using the positive and negative wires. In sunny conditions, this should be 18-24 volts. A lower voltage could indicate a problem with the solar panels.
8. **PROBLEMS WITH THE BATTERIES** - At the time of installation, a battery bank can have an incorrect series-parallel configuration for the proper system voltage and current. When batteries get old and start to fail, they do not accept charge current or deliver load current very well, and begin to act like a very small battery. A small amount of charging will cause the voltage to rise quickly, and any discharge will make the voltage fall rapidly. Another condition, a shorted battery cell, can cause the system to charge continuously without any appreciable increase in overall battery voltage. The cells that are not shorted will tend to gas heavily. If the condition of the battery is suspect, a battery capacity test is recommended.

HELP NOTES: (Continued)

9. **BAD CONNECTION: PANEL** - The panel connection to the controller may be weak or completely out. This may include problems with the connections at the SC3/15 (yellow wire and black wire), both panel connections (“+” or “-”) or fuses and unsoldered crimp connectors in these lines. Also, wire that is too small for the length of the run may cause a voltage drop. (See **INSTALLATION INSTRUCTIONS**, step #17. **CHECK FOR VOLTAGE DROP.**)
10. **BAD CONNECTION: BATTERIES** - The SC3/15 needs to read an accurate battery voltage to regulate the charging correctly. The battery connection to the controller may be weak or completely out. Connection problems can be with a blown or defective fuse, a bad fuse holder, the connections at the SC3/15 (red wire and black wire), both battery terminals (“+” or “-”) or fuses and unsoldered crimp connectors in these lines. Also, wire that is too small for the length of the run may cause a voltage drop. (See **INSTALLATION INSTRUCTIONS**, step #17. **CHECK FOR VOLTAGE DROP.**)
11. **CONTROLLER FUSE BLOWN** - The fuse on the front panel of the controller can be blown and need replacing. Replacement is a 15 amp AGC fuse. Before replacing a blown fuse, locate and correct the cause. Possible causes for blown fuses:
 - 1) Reverse battery connection
 - 2) Incorrect connection
 - 3) Array current is over 15 amps
12. **INCORRECT CALIBRATION** - The SC3/15 may be functional but the calibration of the voltage set-point may be off. Rarely would the factory setting stray much unless there was a manual adjustment to the backside components. All adjustments should be performed at the factory.
13. **SYSTEM NOISE** - The SC3/15 can be subjected to electrical noise from a converter or inverter. This will cause the meter readings to be erratic and the light to turn on and off. If the SC3/15 is connected to the converter, or to a buss that is connected to a converter, try connecting the SC3/15 directly to the battery instead.

Fuse Removal Test

This test temporarily removes the battery connection to the SC3/15. By noting the reaction on the SC3/15's volt-meter, one can receive additional information about the workings of your system.

Requirements: - Perform this test at mid-day on a day with good sun. The battery voltage must be over 10 volts.

- First, observe "BATTERY VOLTAGE" reading.
- Remove the fuse, observe the "BATTERY VOLTAGE" reading again. (When the fuse is removed, it is normal for the “CHARGING” light to go on and to hear a faint buzzing).
- Note the new reading and any changes and refer to the sections below.
- Remember to replace the fuse after testing.

VOLT METER MOVES TO EXTREME LEFT (“9” ON METER) - If the meter drops to “9” on meter, this means that the array panel is bad or disconnected or the SC3/15 is defective.

METER STAYS THE SAME - If the meter stays the same, that means that the controller is not connected to the battery.

THE METER MOVES TO THE RIGHT - This is the correct reaction and suggests the unit is working properly. If it appears that the battery is overcharging, check the voltage directly at the battery with a volt-meter. A battery voltage of over 14.7 volts would indicate the controller was defective or out of calibration.

SC3/15 PROBLEMS: - Refer to this chart and the **SC3/15 PROBLEM NOTES** (next page) to help diagnose potential problems based on the SC3/15 readings

<u>CASE</u>	<u>BATTERY METER</u>	<u>PANEL METER</u>	<u>CHARGE LIGHT</u>	<u>OTHER</u>	<u>SC3/15 NOTE</u> (Next page)
1 →	No Volts (9 on meter)			Day/Night	See Note 1 (next page)
2 →	No Volts (9 on meter)			Night only	See Note 2
3 →	Voltage 9-12	No amps	OFF	Day time	See Note 3
4 →	Voltage 14.7 - 15.0				See Note 4
5 →	Voltage meter less than actual battery voltage				See Note 5
6 →	Voltage meter higher than actual battery voltage				See Note 6
7 →	Voltage reading erratic				See Note 7
8 →		No amps	ON	Day time	See Note 8
9 →		Turns OFF (too soon)		Day time	See Note 9
10 →			ON - at night		See Note 10
11 →		Panel meter moving rapidly	Charge light may also be going on and off rapidly		See Note 11
12 →		Current meter less than expected panel current			See Note 12
13 →			Changing to ON or OFF	Front fuse being touched or taken out	See Note 13
14 →				SC3/15 buzzing	See Note 14
15 →				SC3/15 hot	See Note 15

SC3/15 PROBLEM NOTES (from SC3/15 PROBLEMS chart)

SC3/15 Note 1 - During the day, no voltage on the voltage meter would suggest one of the following:

- A bad connection exists to both the battery and the solar panel (perhaps the black wire of the SC3/15). (See **BAD CONNECTION: PANEL** (*Help Note #9*) and **BAD CONNECTION: BATTERY** (*Help Note #10*))
- The SC3/15 is defective.

SC3/15 Note 2 - At night only, no voltage on the voltage meter would suggest one of the following:

- The battery may not be connected. (See **BAD CONNECTION: BATTERY** (*Help Note #10*)).
- A blocking diode or diode isolator exists in the battery connection (red wire line). If there is a blocking diode, remove it. If there is a diode isolator, modify the system so the SC3/15 charges only one battery bank.
- The SC3/15 is defective.

SC3/15 Note 3 - A low voltage condition with no daytime charging would indicate one of the following:

- The panels are not connected (See **BAD CONNECTION: PANEL** (*Help Note #9*))
- The batteries are not connected (See **BAD CONNECTION: BATTERIES** (*Help Note #9*))
- The SC3/15 is defective.

TEST: - Perform the **FUSE REMOVAL TEST** (above). If the voltage drops to zero ("9" on meter), there is either a bad panel connection or the unit is defective. If the volt meter remains unchanged, then the batteries may have a connection problem.

SC3/15 Note 4 - A meter showing high voltage would indicate one of the following:

- The batteries could be charged from another source. If so, add charge regulation to second source.
- The voltage meter reads a little high. See **METER ACCURACY** (*Help Note #5*),
- The battery may not be connected. See **BAD CONNECTION: BATTERY** (*Help Note #10*)
- The voltage set-point is too high (**UNIT OUT OF CALIBRATION** (*Help Note #12*)), or the unit is defective.

TEST: Perform the **FUSE REMOVAL TEST** (above). If the meter remains unchanged, this suggests there is a problem with the battery connection. If the meter goes to the right, and the actual battery voltage does not exceed 14.7 volts, this would indicate that the unit is functional but the volt meter was a little off. If the meter moves to the right and the actual battery voltage exceeds 14.7 volts, this would indicate that the unit is out of calibration or the unit is defective.

SC3/15 Note 5 - A voltage reading that was less than the actual battery voltage would be a result of the meter reading a little low. See **METER ACCURACY** (*Help Note #5*).

SC3/15 Note 6 - A voltage reading that was higher than the actual battery voltage would be a result of one of the following:

- The voltage meter reads a little high. See **METER ACCURACY** (*Help Note #5*),
- A poor battery connection exists. See **BAD CONNECTION: BATTERY** (*Help Note #10*). The battery connection problem would be in the nature of corrosion, or a loose connection.

TEST: Check the system at night or disconnect the array(+)(yellow) wire. If the voltage difference continues, then consider the problem a slightly off meter. If the difference goes away, suspect a bad connection or corrosion in the battery connection.

SC3/15 Note 7 - Erratic voltage readings are caused by **SYSTEM NOISE** (*Help Note #13*)

SC3/15 Note 8 - The panel meter showing no current reading with the “CHARGING” light on would be a result of one of the following:

- Low levels of light to the panels or small panel array (output less than 1 amp)
- The battery may not be connected. See **BAD CONNECTION: BATTERY** (*Help Note #10*).
- A system problem or wiring problem
- The SC3/15 is defective.

TEST: Perform the **FUSE REMOVAL TEST** (above). If the meter moves to the left, suspect a bad connection somewhere or other system problem. If the meter does not move, suspect a problem with the battery connection. If the volt meter moves to the right, then the controller seems to be working OK and the panels are charging a small amount.

SC3/15 Note 9 - A moderate voltage condition where the charging appears to stop too soon (below 14.1 volts at the battery) would indicate one of the following:

- The SC3/15 may have a poor battery connection. Somewhere in the battery connection there could be a voltage drop that would cause the controller to sense a higher battery voltage than what actually exists. See **BAD CONNECTION: BATTERY** (*Help Note #9*)
- The SC3/15 may be out of calibration or defective

TEST: - Try to monitor the voltage at the SC3/15 wires: battery (+)(red) and battery (-)(black) when the controller actually stops charging (“CHARGING” light goes OFF). If the voltage at the unit is about 14.4 volts then assume a voltage drop along the battery connection is causing the problem.

SC3/15 Note 10 - The "CHARGING" light can be on very dimly at night if the panels are under even very low levels of light (moonlight or street lights). If "CHARGING" light is on brightly at night, suspect one of the following:

- The controller is miswired
- A blocking diode exists and is located within the solar panels or in the panel connection. This is not a serious problem, but should be removed if possible.
- The SC3/15 is defective.

TEST: Disconnect the panel(+) (yellow) wire, if the light goes off, then suspect that the panel is receiving enough light for a slight charge or a blocking diode exists in the connection.

SC3/15 Note 11 - The Panel meter and “CHARGING” light moving rapidly would indicate one of the following:

- The condition can occur during normal operation. When the battery is fully charged and there is a load on and the array can provide a lot of charge current, the controller can pulse on and off rapidly. This is not a problem.
- A bad battery (one which is unable to maintain a charge) See **PROBLEMS WITH THE BATTERIES** (*Help Note #8*).
- A poor battery connection exists. See **BAD CONNECTION: BATTERY** (*Help Note #10*).

TEST: Take a voltage reading at the battery with an accurate meter. If the voltage reading stays steady while the meter on the controller is going up and down, then suspect a bad battery connection. If the voltage here also moves up and down rapidly, this may be a normal condition or would suggest the battery bank is bad or too small.

SC3/15 Note 12 - A charging current that is too low would indicate a problem with the Solar Panels. Refer to the **SOLAR PANEL PROBLEMS** section (below)

SC3/15 Note 13 - It is normal for the “CHARGING” light to change when the fuse is touched. The charge control circuit will reset when power is removed. Pushing or removing the front panel fuse will momentarily cause power to be lost to the control circuit, causing it to reset to a charging or a non-charging condition.

SC3/15 Note 14 - The buzzing sound is caused by the controller rapidly switching on and off and is a problem relating to a poor battery connection. See **BAD CONNECTION: BATTERY** (*Help Note #10*).

SC3/15 Note 15 - The SC3/15 may get warm during normal operation. Make sure the unit is protected from direct sunlight and external heat sources. If the unit should get too hot to touch, consider it defective.

BATTERY PROBLEMS: - Refer to this section to help diagnose potential problems based on battery observations.

CASE	BATTERY	SEE NOTE(S)
1 →	Does not fully charge batteries	See Battery Note 1
2 →	Seems to be over-charging	See Battery Note 2

Battery Note 1 - BATTERY UNDER-CHARGED: If the batteries are not able to be charged sufficiently, consider one of the following problems:

- **Solar Panels Problem or Bad Connection-** Panel may be dirty, not aligned or other problem. See *Help Note #7 and #9*
- **SC3/15 Controller Problem** - A problem may exist with the charging input from the controller. This would delete or reduce the daily re-charging of the battery. A problem with the SC3/15 would **not** cause the battery to be drained of voltage. See the **SC3/15 PROBLEM** section.
- **A Bad Battery or Bad Connection-** The batteries or their connection may be going bad. See *Help Note #8 and #10*
- **A Cold Battery** - Cold temperatures can affect the battery charging (see *Help Note #4*). If the battery is cold much of the time, the battery's long-term performance and life may suffer.
- **System not sized correctly** - For too much usage, try charging the battery with another charging source (engine alternator, generator or AC battery charger). If the batteries are OK and hold the charge, an increase in the number batteries and panels may be needed to support the usage. See *Help Note #6*.

Battery Note 2 - BATTERY OVER-CHARGING: If there is evidence that the batteries have been over-charging, consider these points:

- **Normal Battery Condition:** The batteries may not be over-charging but only be experiencing normal water loss and normal levels of gassing. See *Help Notes #2 and #3*
- **A Problem with the Batteries** - The batteries could be configured incorrectly. See *Help Note #8*
- **A Hot Battery** - See **TEMPERATURE** (*Help Note #4*)
- **Non-compatible Batteries:** The batteries may be a type that are not compatible with this system and require a lower full-charge voltage.
- **Other Charging Sources:** Another charging source could be the cause. Some 110 volt battery chargers are not well regulated and could over-charge batteries if left unattended.
- **Controller Problem:** The SC3/15 could be defective. If the charging light is on and the actual battery voltage (measured at the battery) is over 14.7 volts, the controller appears to be defective or out of calibration. See the **SC3/15 PROBLEM** section.

SOLAR PANEL PROBLEMS: - Refer to this section to help diagnose potential problems based on panel performance.

CASE	PANELS	SEE NOTE(S)
1 →	Less charge than expected	See Panel Note 1

Panel Note 1 - The panels should generate a charge close to their rated short circuit current as presented in their specifications. To reach this level assumes that all conditions are ideal. If the panel performance as observed at the SC3/15's "PANEL" meter is much lower, consider the following potential problems.

- **Solar Panels Problem** - Panels may be dirty, not aligned or other problem. See *Help Note #7*. Monitor the "PANEL" meter as the panels are cleaned and oriented. Locate panel where no shadows will cross it.
- **Bad Connection to the Solar Panel or Batteries** - See *Help Notes #9 and #10*. Check for possible voltage drop in the connections. See **INSTALLATION INSTRUCTIONS: step #17. CHECK FOR VOLTAGE DROP.**
- **Solar Panels may be Defective** - Panels can have internal problems that can reduce the charging output. See *Help Note #7*.

TEST: Disconnect the array(+) wire from the yellow wire on the SC3/15, and measure the panel voltage between the array(+) and the array(-) (black wire). In sunny conditions, this should be 18-24 volts. A lower value could indicate problems with the solar panel or panel connection.

LIMITED FIVE YEAR WARRANTY

SPECIALTY CONCEPTS, INC.

1. Specialty Concepts, Inc. warrants all its products for a period of five (5) years from the date of shipment from its factory. This warranty is valid against defects in materials and workmanship for the five (5) year warranty period. It is not valid against defects resulting from, but not limited to:
 - A. Misuse and/or abuse, neglect or accident.
 - B. Exceeding the unit's design limits.
 - C. Improper installation, including, but not limited to, improper environmental protection and improper hook-up.
 - D. Acts of God, including lightning, floods, earthquakes, fire and high winds.
 - E. Damage in handling, including damage encountered during shipment.
2. This warranty shall be considered void if the warranted product is in anyway opened or altered. The warranty will be void if any eyelet, rivets, or other fasteners used to seal the unit are removed or altered, or if the unit's serial number is in any way removed, altered, replaced, defaced or rendered illegible.
3. The five (5) year term of this warranty does not apply to equipment where another manufacturers' warranty is available. An example of such equipment may be, but is not limited to, an electronic enclosure. The time limit for this warranty may be for less than the Specialty Concepts limited warranty. Specialty Concepts will assist the claimant in attempts to seek warranty claims for such equipment, where appropriate.
4. Specialty Concepts cannot assume responsibility for any damages to any system components used in conjunction with Specialty Concepts products nor for claims for personal injury or property damage resulting from the use of Specialty Concepts' products or the improper operation thereof or consequential damages arising from the products or use of the products.
5. Specialty Concepts cannot guaranty compatibility of its products with other components used in conjunction with Specialty Concepts products, including, but not limited to, solar modules, batteries, and system interconnects, and such loads as inverters, transmitters, and other loads which produce "noise" or electromagnetic interference, in excess of the levels to which Specialty Concepts products are compatible.
6. Warranty repair and/or evaluation will be provided only at Chatsworth, California facility of Specialty Concepts. Units for such repair and/or evaluation must be returned freight prepaid to Specialty Concepts with a written description of any apparent defects. Specialty Concepts will not be required at any time to visit the installation site wherein Specialty Concepts' products are subject to warranty repair and/or evaluation.
7. Only Specialty Concepts is authorized to repair any of its products, and they reserve the right to repair or replace any unit returned for warranty repair. The party returning a unit for repair is responsible for proper packaging and for shipping and insurance charges, as well as any other charges encountered, in shipping to and from Specialty Concepts.
8. This warranty supersedes all other warranties and may only be modified by statement in writing, signed by Specialty Concepts.

Warranty terms effective as of April 1, 1993

REPAIR INFORMATION

Directions for returning units needing repair.

1. Write up a note with the following information:
 - Name / Company Name
 - Return Address : (For USA/Canada: UPS Deliverable. Avoid PO Boxes)
 - Daytime Phone
 - Description the failure
 - Specify amount of repair charges pre-approved (we will contact you if repair charges are larger than this amount.)
2. Box up unit with copy of sales receipt (if available).
3. Send by UPS or Parcel Post to :
 - Specialty Concepts, Inc.**
 - Attn : Repair Dept.**
 - 8954 Mason Ave**
 - Chatsworth, CA 91311 USA**

If the Repair is not covered under warranty, the repair charges will not exceed 30% of the value of a new unit. (shipping and handling not included) Domestic charges are collected via UPS-COD .
For non-warranty repairs, repaired portion features an additional one-year warranty.

SPECIALTY CONCEPTS, INC.

8954 MASON AVE., CHATSWORTH, CA 91311 USA

PH: (818) 998-5238, FAX: (818) 998-5253