SPECIALTY CONCEPTS MODEL 1

(SC1)

Photovoltaic Battery Charge Controller
Installation and Operation Manual

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GENERAL DESCRIPTION

The SPECIALTY CONCEPTS CHARGER MODEL 1 (SC1) is a versatile, industrial quality charge controller for the efficient use of photovoltaic energy and the protection of expensive batteries. It is available for 12, 24, 36, and 48 volt negative ground systems with models for 30 amps of charge current (optional 50 amps available) .

The SC1 consists of a series-relay battery charge controller in a wall mount chassis with low voltage load disconnect, a load circuit breaker, and system status lights. The lights indicate "CHARGE MODE" and "LOAD DISCONNECTED" conditions. The SC1 is housed in an anodized aluminum chassis and has a terminal block that accepts up to 10 gauge wire. A terminal adapter kit is included to increase wire size to #6.

FEATURES

CHARGE REGULATION
- 30 amp charge current, 12, 24, 36 or 48 volt
- 50 amp charge current (optional), 12 or 24 volt
- Two-step, series charging, 12,24 v
- Single step, series charging, 36,48 v
- Adjustable charging set-points (option)
- Temperature compensation (option)

LOW-VOLTAGE LOAD DISCONNECT (LVD)
- 30 amp LVD, 12 volt
- 20 amp LVD, 24 volt
- 15 amp LVD, 36 and 48 volt
- Adjustable disconnect set-points
- Manual override switch

DESIGN FEATURES
- Maximum array usage
- Over-current protection - load circuit breaker
- Reverse polarity protection
- Reverse leakage protection
- Lightning protection
- Input noise suppression
- Remote battery voltage sense

MONITORING and MOUNTING
- “CHARGE MODE” light
- ”LOAD DISCONNECTED” light
- Analog volt/amp meters (option)
- Indoor wall mount
- Outdoor enclosure (accessory)

S P E C I F I C A T I O N S

PARAMETERS	UNITS	NOMINAL VOLTAGES			
		12 v	24 v	36 v	48 v
Charge Current, Continuous (1)	(Amps)	30	30	30	30
Charge Current, Max (60 seconds) (2)	(Amps)	39	39	39	39
Load Current, Continuous (3)	(Amps)	30	20	15	15
Load Current, Max (60 seconds) (2)	(Amps)	39	26	20	20
Array Voltage, Max Voc	(Volts)	22	44	66	88
Operating Voltage @ Battery, Minimum	(Volts)	8.5	17.0	25.5	34.0
Quiescent Current (4)	(Milliamps)	10	10	10	10
Current Consumption, Charging (5)	(Milliamps)	160	160	80	80
Current Consumption, Load Disconnected (6)	(Milliamps)	140	100	70	70
Current Consumption, Metering, Typ. (7)	(Milliamps)	. 5	.5	.5	.5
Voltage Drop, Typ. (Array to Battery)	(Volts @ Max rating)	.15	.15	.15	.15
Voltage Drop, Typ. (Battery to Load)	(Volts @ Max rating)	.40	.40	.40	.40
Full Charge Termination (8)	(Volts)	14.8 ± .2	29.6 ± .4	44.4 ± .6	59.2 ± .8
Full Charge Resumption	(Volts)	12.8 ± .2	25.6 ± .4	38.4 ± .6	51.2 ± .8
Load Disconnect (9)	(Volts)	11.5 ± .2	23.0 ± .4	34.5 ± .6	46.0 ± .8
Load Disconnect Adjustment Range	(Volts)	11.0 to 12.0	22.0 to 24.0	33.0 to 36.0	44.0 to 48.0
Load Reconnect	(Volts)	13.0 ± .3	26.0 ± .6	39.0 ± .9	52.0 ± 1.2
Float Voltage	(Volts)	14.1 ± .2	28.2 ± .4	NA	NA
Float Current, Max	(Amps)	3	1	NA	NA
Temp. Compensation coef. (from 25°C) (10)	(Volts/°C)	-.03	-.06	-.09	-.12
Operating Temp. Range	(°C)	0 to 50	0 to 50	0 to 50	0 to 50
Storage Temp. Range	(°C)	-55 to 85	-55 to 85	-55 to 85	-55 to 85

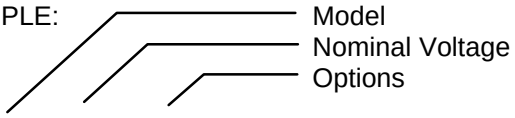
Notes:
(1) 50 amp option available.
(2) Carry only, Non-switching
(3) Non-inductive.
(4) Both relays unenergized, red L.E.D.s off, typical value.
(5) Charge relay energized, red L.E.D. on, typical value.
(6) LVD relay energized, red L.E.D. on, typical value.
(7) Metering option
(8) Adjustable set-point is available. Refer to table.

FULL CHARGE TERMINATION SET- POINTS (OPTION)

Control Voltage	SWITCH POSITIONS A	B	C	D
12	15.3	14.8	14.3	13.8
24	30.6	29.6	28.6	27.6
36	45.9	44.4	42.9	41.4
48	61.2	59.2	57.2	55.2

P A R T N U M B E R I N G K E Y

EXAMPLE:



SC1 - 12 - AF

MODEL	NOMINAL VOLTAGE	OPTIONS
SC1	12	A - Remote Temperature Compensation
	24	F - Volt Meter / Amp Meter
	36	P - 50 Amp charge current (12 & 24 volt)
	48	T - Adjustable Full Charge Termination Set-point

ACCESSORIES

INDOOR ENCLOSURE (NEMA 13)
OUTDOOR ENCLOSURE (NEMA 4X)

Specifications and product availability subject to change without notice.

R E L A T E D S Y S T E M E Q U I P M E N T

The SC1 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 SC1 is compatible with all makes and models of PV panels. The open circuit voltage of the array should not exceed the maximum open circuit voltage of the SC1*(See SPECIFICATIONS: "Array Voltage, Max Voc")* and the maximum power current of the panels should not exceed 30 amps (or 50 amps with P-Option).

HIGHER CHARGING CURRENTS: For arrays exceeding the maximum power current of the SC1, the array can be divided into smaller parallel sub-arrays. A SC1 can be wired in parallel to each sub-array, provided the sub-arrays do not exceed the rating of the individual SC1.

BATTERIES: The standard SC1 is designed to be used with the most common lead-acid batteries. These are wet cell batteries using pure lead, lead antinomy and/or lead calcium grids. Adjustments in voltage set-points may be made on SC1 models with the adjustable set-point option (Option T). For sealed, maintenance free batteries, or vented pocket plate nickel-cadmium batteries, the charging set-points should be adjusted to maximize performance and battery life. For sealed, maintenance free batteries or nickel cadmium batteries, consult the battery manufacturer for recommended set-points and refer to Table 1 (*OPTIONS section*) for appropriate settings.

LOADS: The load is considered the item or equipment that the PV system is powering. System loads such as lights, radios, DC/AC inverters, etc. must be rated for the proper DC input voltage. DC loads not exceeding the rated SC1 load current *(See SPECIFICATIONS "Load Current, Continuous")* can be connected to the load terminals of the SC1 and they will automatically be disconnected in the event of a low-voltage condition. Higher current, or inductive loads such as pumps, motors or inverters should be connected directly to the battery, using properly rated over-current protection devices (fuses or circuit breakers).

OTHER CHARGING SOURCES: Do not use the SC1 to regulate a power source other than a photovoltaic array, such as a hydro or wind generator/alternator or an AC battery charger. This could result in damage to the SC1 and/or the generating equipment. Connect other charging sources with their own regulation devices directly to the battery, using properly rated over-current protection devices.

The SC1 and solar panel can remain connected to a battery being charged by other sources, (alternator, battery charger, etc.) without damage to the controller or solar panel.

I N S T A L L A T I O N

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 vented batteries. Most vented batteries produce hydrogen gas when charging, which is extremely explosive. 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 SC1 and the battery. Suitable fused disconnect switches are low cost and provide protection from fire and damage due to over-current. Refer to the National Electrical Code or your local alternative energy vendor for recommendations.

CAUTION: DO NOT subject the controller to voltages greater than the "Array Voltage, Max Voc" as stated in the SC1 specifications. This is the open circuit voltage (Voc) of the solar panel, or the sum of the open circuit voltages of all modules connected in series.

CAUTION: DO NOT exceed the maximum current rating ("Charge Current, Max") of 30 amps (or 50 amps with P-Option). This is the sum of the maximum power currents of all the modules in parallel.

CAUTION: On higher voltage units (36, 48 volt), exercise extreme care during installation. These voltages can be extremely dangerous in that they can create large arcs, which can burn or cause other injuries.

INSTALLATION INSTRUCTIONS:

1. LOCATION: - A suitable location must be found for mounting the SC1. The unit should be mounted on a vertical surface and be as close as possible to the batteries to avoid errors in battery voltage reading. DO NOT block the ventilation holes on the top and bottom of the SC1. On units with temperature compensation (Option A), the sensor wire is 10 feet long and should reach the battery bank if possible. *For installation details on temperature compensation, refer to OPTIONS section.*

2. PROTECTION REQUIREMENTS: - The unit should not be placed in direct sunlight or close to any heat generating source to avoid extreme temperature increases. It must receive adequate protection from rain, dust and insects. The SC1 is NOT designed to be mounted outdoors or in high humidity environments unless protected by a suitable enclosure.

3. MOUNTING: - Secure the SC1 to the selected location using the four mounting holes on the chassis and proper fasteners.

4. COMPLETE THE INSTALLATION OF THE PANELS, BATTERIES AND LOAD: - Follow the manufacturer's instructions for mounting and wiring the solar panel, batteries and the load.

5. 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: - The SC1 terminal block accepts bare wire up to 10 AWG. (The 50 amp model accepts up to 6 AWG). Wire should be sized of sufficient gauge to safely handle the rated current of the system and to limit voltage drop. Consult wire sizing tables and local alternative energy system suppliers for information on wire sizing.

6. REMOVE POWER FROM BATTERY / PANELS: - Disconnect power from the batteries and panels prior to running the wires to the SC1 to prevent accidental damage or bodily harm.

7. SET CIRCUIT BREAKER TO "OFF": - Make sure the load circuit breaker on the SC1 is "OFF".

8. RUN SYSTEM WIRING: - After disconnecting the power sources, refer to wiring diagram (FIGURE 1) and run the system wiring to the location of the SC1. The wires should reach the location of the SC1 with a little extra for strain relief loops.

9. NOTE WIRE POLARITY: - Insure that the polarity of the wires is correctly marked, using colored wires or tags. Incorrect polarity should not damage the SC1, but incorrect operation would result.

10. COMPLETE ARRAY AND BATTERY CONNECTIONS: - Connections to the SC1 terminal block should be made with just the bare wire (not crimped spade or ring lugs unless the lugs are crimped AND soldered)

11. COMPLETE LOAD CONNECTIONS: - Refer to wiring diagram (FIGURE 1). DC loads not exceeding the rated SC1 load current (see specification section “Load Current, Continuous”) can be connected to the load terminals of the SC1 and they will automatically be disconnected in the event of a low-voltage condition. Higher current, or inductive loads such as pumps, motors or inverters should be connected directly to the battery, using properly rated over-current protection devices (fuses or circuit breakers).

12. BATTERY VOLTAGE SENSE CONNECTIONS: - The factory has installed two jumpers onto the terminal block. They connect the "BATTERY VOLTAGE SENSE" (positive and negative) terminal to their respective "BATTERY" terminals. These jumpers should remain in place if the SC1 is located within 5-10 feet of the batteries and if large enough wire is used to minimize voltage drops to less than 2%.

If the SC1 is at a greater distance from the batteries and/or if the voltage drop in the battery wires exceeds 2%, then the jumpers should be removed and replaced with another circuit running directly to the battery terminals. This is a low current, voltage sensing circuit that can be wired in 16 AWG wire. Proper over-current protection should be added on the positive side. This connection will allow the SC1 to accurately measure battery voltage.

13. INSTALL FUSING AS NEEDED: - Add circuit protection where needed. A 30 amp fuse (or 50 amp with Option P) should be installed on the Battery (+) run of the SC1. Fusing is also advised for the battery voltage sense connection, if included. The load is already protected by the built-in circuit breaker of the SC1.

14. ATTACH TEMPERATURE COMPENSATION CABLE (OPTION A): - If included**.** *See Temperature Compensation section*

15. MAKE NEEDED ADJUSTMENTS TO VOLTAGE SET-POINT (OPTION T): - If included. *See Setting/Adjustments section*

16. RECONNECT BATTERY AND ARRAY POWER - Reconnect both power sources, then position the load circuit breaker on.

POWER CONNECT SEQUENCE

It is recommended that the power is supplied to the system using this sequence. Some of the circuits within the SC1 must be reset to their "start state" and this is automatically accomplished if the power is supplied in this order. If the order is not followed, a period of up to 24 hours may have to elapse before the electronics are fully reset.

Step 1	**Battery (-) *(terminal # 7):***	To Battery (-)
Step 2	**Battery (+)*(# 2):***	To Battery (+)
Step 3	**Solar Panel (-)*(# 6):***	To Solar Panel Array (-)
Step 4	**Solar Panel (+)*(# 3):***	To Solar Panel Array (+)

Optional *(see "COMPLETE LOAD CONNECTION" above)*

Step 5	**Load (-)*(# 5):***	To Load (-)
Step 6	**Load (+)*(# 4):***	To Load (+)

If Needed *(see "BATTERY VOLTAGE SENSE CONNECTIONS" above)*

Step 7	**Battery Voltage Sense(-) *(# 8):***	To Battery (-). *(Remove #7-#8 jumper)*
Step 8	**Battery Voltage Sense(+)*(# 1):***	To Battery (+) *(Remove #1-#2 jumper)*

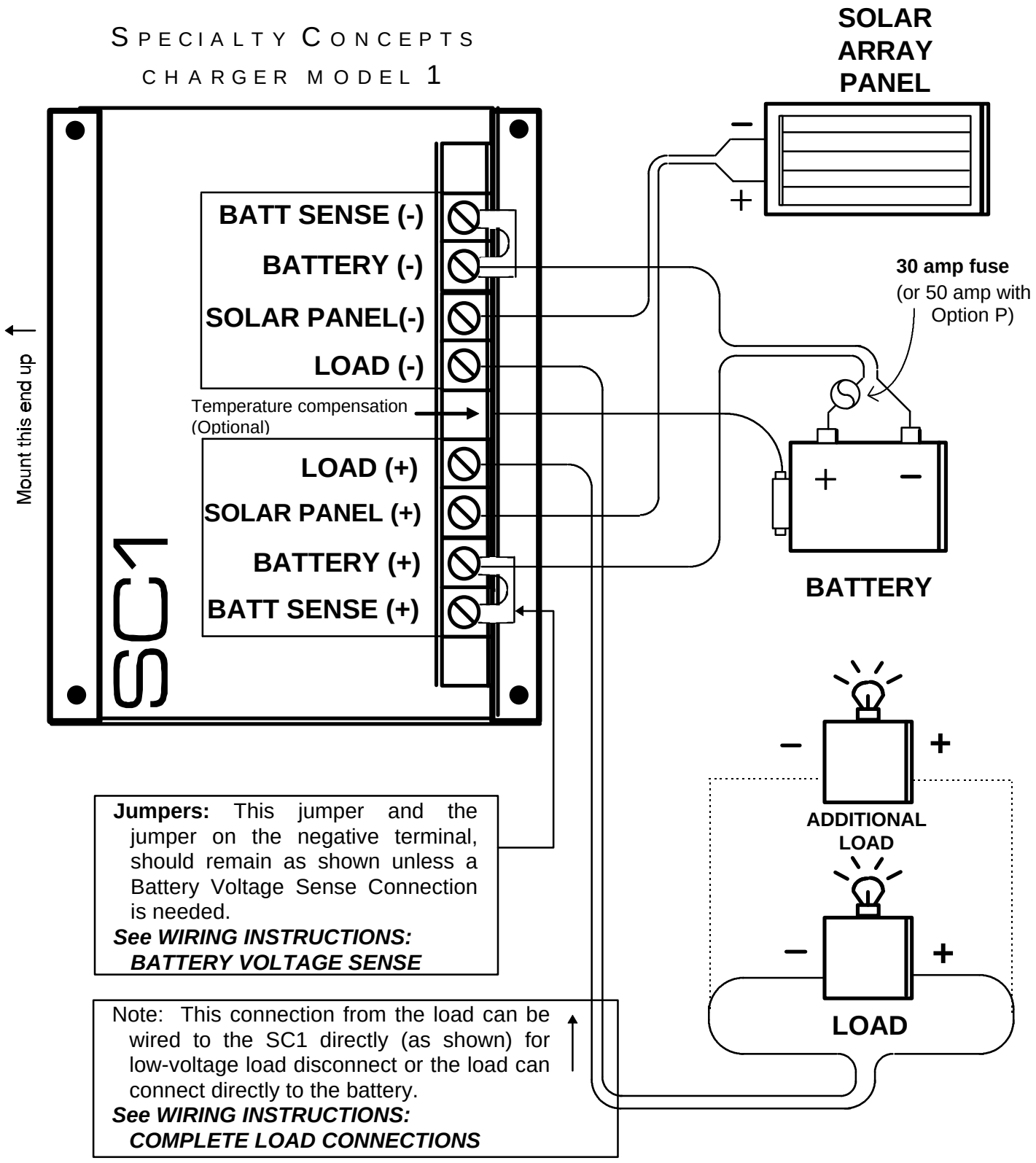
17. OPERATION: - Operation of the charge controller is now fully automatic. If the battery voltage is below the Full Charge Termination set-point (*see SPECIFICATIONS*) and power is available from the array and the Power Connect Sequence (above) was followed, the SC1 should start up in the full-charge mode. If the battery voltage is above the Load Disconnect voltage, the loads connected to the LOAD terminals should go on.

During float charging (12 or 24 volt units) it is normal for the unit to feel warm. This is due to power dissipation of the voltage regulated float circuit.

18. CHECK FOR VOLTAGE DROP (OPTIONAL): - Once the system is installed and operational, a check on the battery connection is recommended. A poor battery 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 voltage multi-meter is required and the SC1 must be in Full Charge mode with maximum expected charge current.

First, note the voltage at the battery terminals. Select the positive and negative terminals that are used for the SC1 connection. Then note the voltage at the SC1 terminals labeled "BATT (+)" and "BATT (-)". The difference in voltage should be no more than ¼ volt (for a 12 volt system). If the voltage drop is more, suspect crimp connections that have not been soldered or loose terminals. If no location of voltage drop is found, consider using larger wires for your run or run a separate wire for the Battery Sense connection. See "BATTERY VOLTAGE SENSE CONNECTION" (above).

FIGURE 1
SPECIALTY CONCEPTS CHARGE CONTROLLER MODEL 1



S E T T I N G S / A D J U S T M E N T S

FULL CHARGE VOLTAGE ADJUSTMENT (Option T) : If the controller is supplied with this option, the charge termination voltage set-point may be adjusted. *Refer to the OPTIONS section ("OPTION T").*

LOW-VOLTAGE LOAD DISCONNECT (LVD) SETTINGS: The Load Disconnect and Reconnect set-points are factory set as listed in the specifications section, and are adjustable.

NO LVD: - For an override of the load disconnect function, push the switch up. No load disconnect will occur with the switch in the "NO LVD" position.

AUTO LVD: - When the "Load Disconnect" switch is in the "AUTO" position, the load control circuit will operate automatically. Refer to the "OPERATION: LOW-VOLTAGE DISCONNECT" section for a description of this operation. If a load disconnect occurs, the loads will be automatically reconnected when the batteries charge up to the Load Reconnect voltage, or they can be reconnected manually with the "Load Disconnect" switch.

MANUAL RESET: - For a temporary reset, push the switch down. The battery voltage must remain above the Load Disconnect voltage for the load to stay connected after reset.

ADJUSTING LVD SET-POINTS : To alter the voltage at which the load disconnect and reconnect occur, turn the adjustment pot on the front of the unit labeled "LOAD DISCONNECT ADJUST" clockwise to decrease and counter-clockwise to increase *(for the range of adjustment, refer to the specifications section: "Load Disconnect Adjustment Range*"). Both set-points will change, with the span value fixed.

CAUTION : When adjusting this controller, it is important to use the proper size screwdriver. Do not force the adjustment beyond the end stops, it will damage the controller.

If problems develop, refer to the "TROUBLE SHOOTING" section of this book.

O P E R A T I O N

CHARGE REGULATION (12 and 24 volt units): The two-step control circuit regulates the charging of storage batteries by monitoring battery and solar panel voltage. **STEP 1: CONSTANT CURRENT (FULL) CHARGE MODE**: At sunrise, the charging relay energizes and closes, connecting the solar panel directly to the battery and lighting the "CHARGE MODE" light. The battery will accept as much current as the solar panel will provide, and battery voltage will rise. **STEP 2: CONSTANT VOLTAGE (FLOAT) CHARGE MODE**: When the battery reaches the full charge termination voltage, the charging relay will open and the "CHARGE MODE" light will go out. At this point the float controller takes over to keep the battery below the float voltage and supply limited current (maximum float current). As the battery approaches the float voltage, the current will taper off, eventually falling to the battery's maintenance current.

CHARGE REGULATION (36 and 48 volt units): The operation of a 36 and 48 volts unit is identical with the exception that no float circuit is included.

MAXIMUM SOLAR PANEL USAGE : If a load is applied when the controller is in the float mode, the controller will supply up to its maximum float current to maintain the battery charge. If the load is less than the maximum float current the batteries will still be receiving a net charge from the float controller. If the load current is more, the battery will supply what the float controller cannot and the battery voltage will fall. When it falls below the full charge resumption voltage, the charging relay will re-close, re-initiating the full charge mode. This insures that if a large load is applied during the day, maximum use will be made of the power available from the solar panel.

LOW-VOLTAGE DISCONNECT : The low-voltage disconnect (LVD) of the SC1 prevents damage from deep discharge of the batteries by automatically disconnecting the loads. The disconnect threshold is load current compensated by a factor of 10 mv/amp, and a minimum time of 3 seconds is applied to prevent false disconnect. When a disconnect occurs, the load relay is energized and opens, and a red "LOAD DISCONNECTED" light, visible on the front panel, will light to indicate that the loads have been disconnected. Normal battery charging will continue. When the battery voltage rises to the reconnect threshold, the loads will automatically be reconnected to the battery and the red light will go off. The LVD function has a reset/disable switch and user adjustable set-points.

Note: The amount of time required to recharge the battery sufficiently to reconnect the loads depends upon the battery size, solar panel current and weather conditions. In some cases, it can take several days or longer. The loads can be manually reset prior to the reconnect voltage by pressing the "MANUAL RESET" switch.

REVERSE CURRENT PROTECTION : The SC1 uses a timing circuit to disconnect the solar panel from the battery at night, preventing reverse leakage current loses through the solar panel. About 12 hours after sunrise the charging relay will open. If the battery is below the reconnect threshold and voltage is still available from the solar panel, the relay will re-close and continue charging. It will open again about every 2 hours thereafter to determine if power is still available for charging. The relay will stay open after the 12 hour period if the battery is above the reconnect threshold or if there is no power available from the solar panel. This results in the relay being open every night. Note: The relay may be closed ("CHARGE MODE" light on) for a few hours in the evening after the sun has gone down.

M O N I T O R I N G

“CHARGE MODE” LIGHT: The "CHARGE MODE" light will be on when the controller is in the full charge mode. In this mode, the charging relay is closed, connecting the solar panel directly to the battery. This light should go on first thing in the morning. When the battery reaches the "Full Charge Termination" set-point, the SC1 will switch from Full-Charge mode to Float-Charge mode and the CHARGE MODE light will go out. The light may go on again if the battery drops below the reconnect voltage and the controller goes into the full charge mode again. It is not uncommon for the light to remain on, for several hours after dark. *Refer to the operation section for details on controller operation.*

“LOAD DISCONNECTED” LIGHT: When the "LOAD DISCONNECTED " light is on, the Low-voltage Load Disconnect (LVD) circuit is activated and any DC loads connected to the "LOAD" terminals will be disconnected. This occurs at the LVD set-point voltage. The light will go out when the voltage rises above the reconnect voltage and the load is reconnected automatically, or if the reset switch is pushed to LVD "MANUAL RESET" or "NO LVD". *Refer to the operation section for details on LVD operation.*

C I R C U I T B R E A K E R

“LOAD CIRCUIT BREAKER” - A load circuit breaker is included with the SC1. This provides over-current protection for the load circuit (SC1 and load connections) and provides protection from a short circuit at the load. This also can be used as an on/off switch for the load.

O P T I O N S

The following are the options available with the SC1. Options cannot be added to units after production. Some of the features and functions described in this manual are not included on all of the units. Check the model number and voltage/current ratings of your unit and compare with the specifications and option descriptions to determine what your particular model's capabilities are.

OPTION A - TEMPERATURE COMPENSATION

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.

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 -5mv/°C per battery cell in series from 25° C.

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 (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, it will be severely damaged. Temperature compensation of charging voltage is now automatic.

OPTION F - VOLT / AMP METERS

These meters monitor the battery voltage and charging current of the system. The battery voltage meter is an expanded scale meter with red, yellow and green indication of state of charge. These are 5% meters and are intended to give an indication of system status, but are not designed to give highly accurate readings of voltage and current. The Specialty Concepts Digital Monitor (DM3) is available if higher accuracy is required.

OPTION P - 50 AMP CHARGE CURRENT

This option provides 50 amps of charging current capabilities. The terminal accepts up to 6 AWG wire. Load ratings and other specifications remain as stated in the "SPECIFICATIONS" section.

OPTION T - ADJUSTABLE FULL CHARGE TERMINATION SET-POINT

This option allows for the adjustment of the high voltage charge termination set-point on SC1's equipped with this option. All other set-points remain fixed and as stated in the "SPECIFICATIONS " section.

Four different voltage set-points are available when using the selection switch. See Table 1

TABLE 1: VOLTAGE SET-POINT SELECTION **(values ± 2%)**

CONTROLLER VOLTAGE	SWITCH POSITION A	B	C	D
12 VOLT	15.3	14.8	14.3	13.8
24 VOLT	30.6	29.6	28.6	27.6
36 VOLT	45.9	44.4	42.9	41.4
48 VOLT	61.2	59.2	57.2	55.2

The controller is factory set at position B. To change the set-point, locate the adjustment switch. The switch is located on the bottom or top of the controller in one of the vent slots, and can be identified by the label. Using a slotted screwdriver, turn the switch until the slot is pointing at the desired position.

SET-POINT RECOMMENDATIONS:

POSITION A: NiCad batteries or for occasional equalization charging

POSITION B: Wet cell lead acid batteries

POSITION C: Sealed maintenance free batteries (heavy use)

POSITION D: Sealed maintenance free batteries (float applications)

Contact the battery manufacturer for recommended settings

T R O U B L E S H O O T I N G : G E N E R A L N O T E S

IF THE CONTROLLER IS NEWLY INSTALLED, CHECK THESE THINGS FIRST:

1) Re-check system wiring to insure proper installation and polarity .
2) Check all system fuses and circuit breakers. Before replacing a blown fuse, locate and correct the cause.
3) Check to be sure that there is a connection (voltage input) to the "BATTERY VOLTAGE SENSE" terminals from the battery. This would be either a factory installed jumper strip on the controller terminal block from the "BATTERY VOLTAGE SENSE" terminals to the "BATTERY" terminals, or a connection from the sense terminals directly to the battery itself.
4) Check to see that modules and batteries are in the correct series-parallel configuration for proper system voltage and current.
5) Review controller specifications relating to solar panel output, load ratings and system sizing to insure that ratings are not exceeded.
6) Review the controller specifications relating to operation and set-points, particularly the charge termination and reconnect voltage set-points. If possible, check this with the operation of the controller, monitoring the battery voltage with a multi-meter.
7) Some types of loads (fluorescent lights, inverters) can generate electronic "noise" that sometimes interferes with the operation of the controller. Check to see if strange behavior can be traced to operation of a certain appliance.
8) If the unit is equipped with temperature compensation, inspect the temperature sensor and sensor wire. Check for a broker sensor or a cut or frayed sensor wire.
9) If possible, perform the "FIELD TEST PROCEDURE" and /or "BENCH TEST PROCEDURE" that follows.
10) The SC1 with Option F are equipped with a colored scale volt meter. This meter is 5% accurate (about .5 volt in a 12 volt system) and is designed to give a general state of charge, not to determine voltages accurately.

IF THE CONTROLLER HAS BEEN INSTALLED AND WORKING PROPERLY FOR AWHILE, CHECK THESE THINGS FIRST:

11) Check all system fuses and circuit breakers. Before replacing a blown fuse, locate and correct the cause.
12) Confirm that all connections are clean and tight. Particularly check crimp connections that have been crimped but not soldered as these connections tend to deteriorate over time.
13) Some types of loads (fluorescent lights, inverters) can generate electronic "noise" that sometimes interferes with the operation of the controller. Check to see if strange behavior can be traced to operation of a certain appliance.
14) If you have an accurate digital volt meter, check for voltage drop between the controller and the battery by measuring voltage at the battery and at the controller when maximum charging is occurring. Drops often occur through old fuses, fuse holders or circuit breaker boxes and at loose or corroded connections.
15) High voltage from nearby lightning strikes or unregulated charging sources can damage the controller. The built-in lightning protection provides substantial protection, but it is sometimes overwhelmed.
16) If the unit is equipped with temperature compensation, inspect the temperature sensor and sensor wire. Check for a broker sensor or a cut or frayed sensor wire.
17) Check output from the solar panel, and that it is not partially shaded or dirty.
18) If possible, perform the "FIELD TEST PROCEDURE" and /or "BENCH TEST PROCEDURE" that follows.

PROBLEM DESCRIPTIONS

BATTERY UNDER CHARGED

CONTROLLER NOT CHARGING AT ALL, ALWAYS IN FLOAT MODE ("CHARGE MODE" LIGHT OFF)

Check to see that the controller is receiving voltage (at least about nominal system voltage) from the battery and the solar panels. If it is, momentarily disconnect the panels, using an solar panel disconnect switch if available, then reconnect. The controller should reset into the full charge mode ("CHARGE MODE" light on). If it does not reset, the controller may be defective.

See General Note #8 above. A damaged sensor or wire will cause the controller to malfunction.

CONTROLLER STOPS CHARGING TOO SOON, AT TOO LOW A VOLTAGE

See General Note #6 above: Try to monitor the voltage at the "BATTERY VOLTAGE SENSE" terminals when the controller actually switches. Most often, when a controller is operational, it is switching the correct voltage. If the battery is not reaching the charge termination set-point voltage before the controller switches, it is usually an error in the voltage that the controller is sensing, not a controller failure.

See General Notes #12 and #14 above: A poor connection between the battery and the controller results in a voltage drop during charging periods (larger drop for higher current) that disappears when charging stops. This voltage drop results in a higher voltage being sensed at the controller than is actually at the battery.

CONTROLLER CLICKS AND CHATTERS, PARTICULARLY IN THE MORNING AND EVENING

See General Notes #12 and #14 above: Check the connection to the battery. A poor connection at the battery will cause the relay to chatter under low light conditions and the controller to remain in float mode during full sun.

CONTROLLER NOT CHARGING, "CHARGING" LIGHT DIM, BATTERY VOLTAGE VERY LOW

See LVD trouble shooting section (“LOAD DISCONNECT CIRCUIT NOT OPERATING CORRECTLY”) . If the LVD circuit is not operating, the battery can be discharged to a very low voltage. If the battery is extremely low, there might not be enough voltage to operate the controller. The charging relay requires a minimum operating voltage to engage and allow charging. If the battery is down to 9 volts or lower on a 12 volt system, (17 on a 24 volt) connect the battery directly to the array (or use an auxiliary charging source) until sufficient charging has occurred to increase the voltage. Note: Battery life depends on the number, time and the depth of the discharges. Severe battery damage can result when batteries are deeply discharged and not recharged immediately.

"CHARGE MODE" LIGHT ON AT NIGHT

Review the "REVERSE CURRENT PROTECTION" and "CONNECTION SEQUENCE" sections of this manual. The reverse leakage timer may cause the "CHARGE MODE" light

to be on for a few hours each evening. Also, the light will stay on during the night of the first day of installation or if the solar panel has been manually disconnected that day. If the light stays on all night every night, the timer may be defective.

BATTERY OVERCHARGING

CONTROLLER ALWAYS IN FULL CHARGE ("CHARGE MODE" LIGHT ON)

See General Note #6 above: The battery may not be reaching the charge termination set-point.

See General Note #3 above: No voltage at the BATTERY VOLTAGE SENSE terminals tells the controller that the battery voltage is low and needs to be charged more. Install a connection from battery to "BATTERY VOLTAGE SENSE" terminals to resolve..

See General Note #8 above: A damaged temperature sensor or wire will cause the controller to malfunction and requires immediate replacement.

CONTROLLER NOT IN CHARGE MODE ("CHARGE MODE" LIGHT OFF)

Disconnect solar panel, then reconnect. Listen for relay to click and for “CHARGE MODE" light to come back on. If the light goes on but you hear no click, the relay or controller may be defective.

Check for other charging sources that are not properly regulated, causing the battery to overcharge.

LOAD DISCONNECT CIRCUIT NOT OPERATING CORRECTLY

LOADS ALWAYS DISCONNECTED, LVD LIGHT ON, EVEN WHEN BATTERY VOLTAGE IS HIGH

See General Note #6 above: No voltage at the BATTERY VOLTAGE SENSE terminals tells the controller that the battery voltage is low and loads need to be disconnected. Install a connection from the battery to "BATTERY VOLTAGE SENSE" terminals to resolve.

LOADS DISCONNECTED TOO SOON OR NOT RECONNECTING

See General Note #6 above: The battery may not be reaching the reconnect voltage set-point.

See General Note #12 and #14 above: A poor connection between the controller and the battery results in a voltage drop when heavy loads are turned on that disappears when the loads are turned off. The heavier the loads are, the larger the voltage drop will be. This voltage drop results in the controller seeing a lower voltage than what the battery voltage actually is.

LOADS NOT DISCONNECTING ON LOW VOLTAGE, LVD LIGHT OFF

Check the position of the "LVD" switch. If the switch is in the "NO LVD" position the load will not be disconnected.

LOADS ALWAYS DISCONNECTED, LVD LIGHT OFF, BATTERY VOLTAGE IS HIGH

Check the load circuit breaker on the front of the controller. If the breaker is tripped, the load will not operate.

T R O U B L E S H O O T I N G : B A T T E R I E S

Refer to this section to help diagnose potential problems based on battery observations.

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

Battery Note 1 - **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. Check the "BATTERY VOLTAGE" reading. Normal battery voltage for a wet cell battery can be up to 14.8 volts (12v system).
- **Controller Problem:** The SC1 could be defective. Refer to the field test procedure.
- **Battery Type:** The batteries may be a type that require a lower full-charge voltage than what the SC1 is set to. *Refer to SETTINGS / ADJUSTMENTS Section.*
- **Other Charging Sources**: Another charging source could be the cause. If the SC1 "CHARGING" light is off and the "ARRAY CURRENT" reading is 0, then the solar system is off and overcharging can be from another source. Some 110 volt battery chargers are not well regulated and could over-charge batteries if left unattended.
- **A Hot Battery** - Hot temperatures can affect the battery charging, a hot location for batteries will tend to over-charge the batteries.

Battery Note 2 - **BATTERY UNDER-CHARGED:** If the battery voltage is low and they are not able to be charged sufficiently, consider one of the following problems:

- **Solar Panels Problem** - Panel may be dirty, not aligned or other problem.
- **Bad Connection to the Solar Panel.**
- **SC1 Controller Problem**. - Refer to the FIELD TEST PROCEDURE
- **A Bad Battery -** The batteries may be going bad**.** TEST**:** If the battery is going bad, a little charging or discharging will cause a large change in the battery voltage.
- **A Cold Battery** - Cold temperatures can affect the battery charging. 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.

TROUBLE SHOOTING: SOLAR PANELS

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 load current as presented in their specifications. To reach this level assumes that all conditions are ideal. If the panel performance as measured at the panel inputs on the SC1 controller is much lower, consider the following potential problems.

- **Solar Panels Problem** - Panels may be dirty, not aligned or other problem. TEST: Monitor the "ARRAY CURRENT" reading before and after cleaning of the solar panels and orientation. Locate panel where no shadows will cross it.
- **Bad Connection to the Solar Panel**. TEST: Measure the voltage up at the solar panel, and then down at the battery itself during a sunny period of maximum charging. These voltage readings should not be more than 1 to 1.5 volts different. More than that would indicate a bad connection or other voltage drop in the system. Suspect crimp connections that have not been soldered.
- **Solar Panels may be defective** - TEST: Disconnect the array by switching the array circuit breaker off, and measure the solar array voltage between the array(+) and the array(-). In sunny conditions, this should be 18-24 volts (in a 12 volt system). A lower value could indicate problems with the solar panel.

F I E L D T E S T P R O C E D U R E : S C 1

Test equipment required: Digital Multimeter
Conditions: Sunny or bright overcast if possible

This procedure assumes that the solar panels are installed and operational and capable of producing at least 17.5 volts open circuit (for a 12 volt system). Proportionately higher for higher voltage systems. Systems should be equipped with disconnects or switches to facilitate connecting and disconnecting the batteries and solar panel as described in this procedure. If performing this procedure without approved disconnects, care should be taken since arcing may occur. On bright days it may be advisable to partially cover the solar panel to reduce the current produced.

Warning: Most batteries produce hydrogen gas when charging, which is extremely explosive. Avoid making sparks in the vicinity of batteries and provide adequate battery ventilation.

All measurements described in this procedure should be made at the controller terminals.

1) Disconnect Load(+), Array(+), Battery(+), and Battery Sense(+)(jumper or wire) from the controller. Secure each wire away from any possible contact with other wires, metal chassis, enclosures etc.

2) Measure the resistance between the Battery(+) and Solar Panel(+) terminals on the controller. It should be open (more than 10M ohm). Turn on load circuit breaker and measure the resistance between Load(+) and Battery(+). It should be less than 1 ohm. Turn off load circuit breaker and re-measure. It should be open.

3) Reconnect the solar panel to the controller. (On 36 volt or 48 volt chargers, briefly connect a jumper wire between Solar Panel(+) and Battery(+). When the charge light comes on, remove the jumper).The charge light should go on, and after a few moments the load disconnected light should come on.

4) Measure the voltage between Solar Panel(+) and Solar Panel(-). It must be at least 17.5 volts for a 12 volt system (proportionately higher for higher voltage systems).

5) Measure the voltage between Battery(+) and Battery(-). It should be the same as the voltage measured in step 4.

6) Turn on load circuit breaker and measure the voltage between Load(+) and Load(-). It should be zero.

7) For 12 volt or 24 volt chargers, go to step 8. For 36 volt or 48 volt chargers, install a jumper wire between Battery(+) and Solar Panel(+) then go to step 8.

8) Install a jumper between Battery(+) and Battery Sense(+). The charge mode light should turn off. Move the LVD switch to manual reset and observe that the load disconnected light turns off. Note: A few seconds after the jumper is installed, the LVD will automatically reset. If this happens before you test the manual reset, remove the jumper, wait for the light to come on, reinstall the jumper and try the switch again.

9) For 12 volt and 24 volt controllers only; Measure the voltage between Battery(+) and Battery(-). It should be approximately equal to the float voltage. *(Refer to the SPECIFICATIONS for actual values.* 10) If the controller fails any of these tests, it is defective. If all tests are passed, the problem is most likely elsewhere in the system.

B E N C H T E S T P R O C E D U R E : S C 1

Test equipment required: Digital Multimeter, Adjustable Power supply

Nominal Voltage	Power Supply Range
12	10-18 Vdc
24	20-36 Vdc
36	30-48 Vdc
48	40-64 Vdc

All measurements described in this procedure should be made at the controller terminals.

1) Make sure that there is a jumper between Battery(+) and Battery Voltage Sense(+) and one between Battery(-) and Battery Voltage Sense(-).
2) Check continuity between Battery(-),Solar Panel(-) and Load(-).
3) Turn off the load circuit breaker and measure the resistance between Load(+) and Battery(+). It should be open (more than 10M ohm). Turn on the load circuit breaker and re-measure. It should be less than 0.2 ohm.
4) Measure the resistance between Solar Panel(+) and Battery(+). It should be open.
5) Set the power supply to the nominal system voltage. Connect the power supply negative to the controller Battery(-) terminal. Connect the power supply positive to the controller Solar Panel(+) terminal. For 36 volt and 48 volt chargers, briefly connect a jumper between Solar Panel(+) and Battery(+). When the charge mode light turns on, remove the jumper.
6) Verify that the charge mode light is on. Measure and note the voltage between Solar Panel(+) and Solar Panel(-).
7) Measure the voltage between Battery(+) and Battery(-). It should be the same as the voltage measured in step 6 to within +/- 0.1 volt. Measure the voltage between Load(+) and Load(-). It should be the same as the voltage measured in step 6 to within +/- 0.1 volt.
8) Install a jumper between Battery(+) and Solar Panel(+).
9) Verify the charge termination and charge resumption set-points by changing the power supply voltage up and down and observing the activation of the “CHARGE MODE” light.
10) Set the LVD switch to AUTO LVD. Verify the load disconnect and load reconnect set-points by changing the power supply voltage up and down and observing the activation of the load disconnected light. There is a time delay on the load disconnect circuit. The set-points must be approached slowly to avoid overshooting. With the controller in the load disconnected mode, press the MANUAL RESET and verify that the light goes off momentarily. Set the LVD switch to NO LVD and verify that the load disconnect does not activate.
11) For 12 and 24 volt controllers only; remove the jumper between Battery(+) and Solar Panel(+). Increase the power supply voltage to 18 volts for a 12 volt system or 36 volts for a 24 volt system. Measure the voltage between Battery(+) and Battery(-). It should be about the float voltage.

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 eyelets, 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 preapproved (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.

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