

SPECIALTY CONCEPTS MODEL 2 (SC2)

Photovoltaic Battery Charge Controller Installation And Operation Manual

SPECIALTY CONCEPTS, INC.
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MODELS: SC2-12, SC2-24, SC2-36, SC2-48

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GENERAL DESCRIPTION

The SPECIALTY CONCEPTS CHARGER MODEL 2 (SC2) 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 systems with models for 30 amps of charge current (optional 50 amps available for 12 and 24 volt units).

The SC2 consists of a series-relay battery charge controller in a wall mount chassis and a system status light. The "CHARGE MODE" light indicates the charging condition. The SC2 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 (option), 12 or 24 volt
- Two-step, series charging, 12 and 24 volt
- Single step, series charging, 36 and 48 volt
- Adjustable charging set-points (option)
- Temperature compensation (option)

DESIGN FEATURES

- Reverse polarity protection
- Reverse leakage protection
- Lightning protection
- Input noise suppression
- Remote battery voltage sense

MONITORING

- Charging light
- Analog volt/amp meters (option)

MOUNTING OPTIONS

- Indoor wall mount
- Outdoor enclosure available (accessory)

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

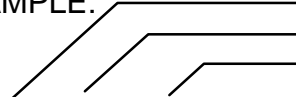
PARAMETERS	UNITS	NOMINAL VOLTAGES			
		12 v	24 v	36 v	48 v
Charge Current, Continuous (1)	(Amps)	30	30	30	30
Charge Current, Max (60 seconds) (2)	(Amps)	39	39	39	39
Load Current, Continuous (3)	(Amps)	30	30	30	30
Load Current, Max (60 seconds) (2)	(Amps)	39	39	39	39
Array Voltage, Max Voc	(Volts)	22	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, Meter, Typ. (7)	(Milliamps)	.5	.5	.5	.5
Voltage Drop, Typ. (Array to Battery)	(Volts @ Max rating)	.15	.15	.15	.15
Full Charge Termination (6)	(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
Float Voltage NA	(Volts)		14.1 ± .2	28.2 ± .4	NA
Float Current, Max	(Amps)	3	1	NA	NA
Temp. Comp. coef. (from 25°C) (8)	(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) Adjustable set-point is available. Refer to table.
- (7) Metering option

FULL CHARGE TERMINATION SET-POINTS				
Controller 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:  Model
Nominal Voltage
Options

SC2 - 12 - AF

MODEL	NOMINAL VOLTAGE	OPTIONS
SC2	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.

RELATED SYSTEM EQUIPMENT

The SC2 charge controller is an integral part of a solar electric power system that includes a PV solar array and a battery. These items should be installed according to the instructions provided by the equipment supplier.

SOLAR ARRAY PANELS: The SC2 is compatible with all makes and models of PV panels, provided the open circuit voltage and the maximum power current of the solar panel does not exceed the maximum open circuit voltage (Array Voltage, Max Voc) and the maximum charge current (Charge Current, Max) specifications for the SC2 being used.

HIGHER CHARGING CURRENTS : For arrays exceeding the maximum power current of the SC2, the array can be divided into smaller parallel sub-arrays. A SC2 can be wired in parallel to each sub-array, provided the sub-arrays do not exceed the rating of the individual SC2.

BATTERIES: The standard SC2 is designed to be used with the most common lead-acid batteries. These are wet cell batteries using pure lead, lead antimony and/or lead calcium grids. The standard charging set-points should be adjusted when using sealed, maintenance free batteries, or vented pocket plate nickel-cadmium batteries. This will maximize performance and battery life. Adjustments in set-points may be made on SC2 models with the Adjustable Set-Point option (option T). For these 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 SC2 load current (*see SPECIFICATION section*) can be connected to the load terminals of the SC2, which provides an additional connection to battery plus and minus for convenience. 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 SC2 to regulate a power source other than a solar panel, such as a hydro or wind generator/alternator or an AC battery charger. This could result in damage to the SC2 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 SC2 and solar panel can remain connected to a battery being charged by other sources, (alternator, battery charger, etc.) without damage to the control or solar panel.

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. It is recommended that the requirements of all applicable local electrical codes (or U.S. National Electrical Code in the absence of local codes) be followed.

WARNING: Follow all safety precautions of the battery manufacturer and the National Electrical Code. 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 SC2 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 subject the regulator to voltages greater than the "Array Voltage, Max Voc" as stated in the SC2 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 the SC2 regulator as stated in the specifications. 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 SC2. 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 SC2. On units with the temperature compensation option, 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 bugs. The SC2 is NOT designed to be mounted outdoors or in high humidity environments unless protected by a suitable enclosure.
- 3. MOUNT THE SC2:** - Secure the SC2 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 SC2 terminal block accepts bare wire up to 10 AWG, with a terminal adapters included for 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 SC2 to prevent accidental damage or bodily harm.
- 7. RUN SYSTEM WIRING:** - After disconnecting the power sources, refer to wiring diagram (FIGURE 1) and run the system wiring to the location of the SC2. The wires should reach the location of the SC2 with a little extra for strain relief loops.
- 8. NOTE WIRE POLARITY:** - Insure that the polarity of the wires is correctly marked, using colored wires or tags. Incorrect polarity should not damage the SC2, but incorrect operation would result.
- 9. COMPLETE ARRAY AND BATTERY CONNECTIONS:** - Connections to the SC2 terminal block should be made with just the bare wire (not crimped spade or ring lugs unless the lugs are crimped AND soldered).
- 10. COMPLETE LOAD CONNECTIONS:** - DC loads not exceeding 30 amps can be connected to the load terminals of the SC2. 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).

11. 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 SC2 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 SC2 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 SC2 to accurately measure battery voltage.

12. INSTALL FUSING AS NEEDED: - Add circuit protection where needed. A 30 amp fuse (or 50 amp with P-Option) should be installed on the Battery (+) run of the SC2.

13. INSTALL TEMPERATURE COMPENSATION (option A): - If included. *Refer to OPTIONS section below.*

14. MAKE ADJUSTMENT TO VOLTAGE SET-POINT (option T): - If included and if needed. *Refer to OPTIONS section below.*

15. RECONNECT BATTERY AND ARRAY POWER

POWER CONNECT SEQUENCE

It is recommended that the power is supplied to the system using this sequence. Some of the circuits within the SC2 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 | Array (-)(# 6): | To Solar Panel Array (-) |
| Step 4 | Array (+)(# 3): | To Solar Panel Array (+) |

Optional (see "COMPLETE LOAD CONNECTIONS" above)

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

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

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

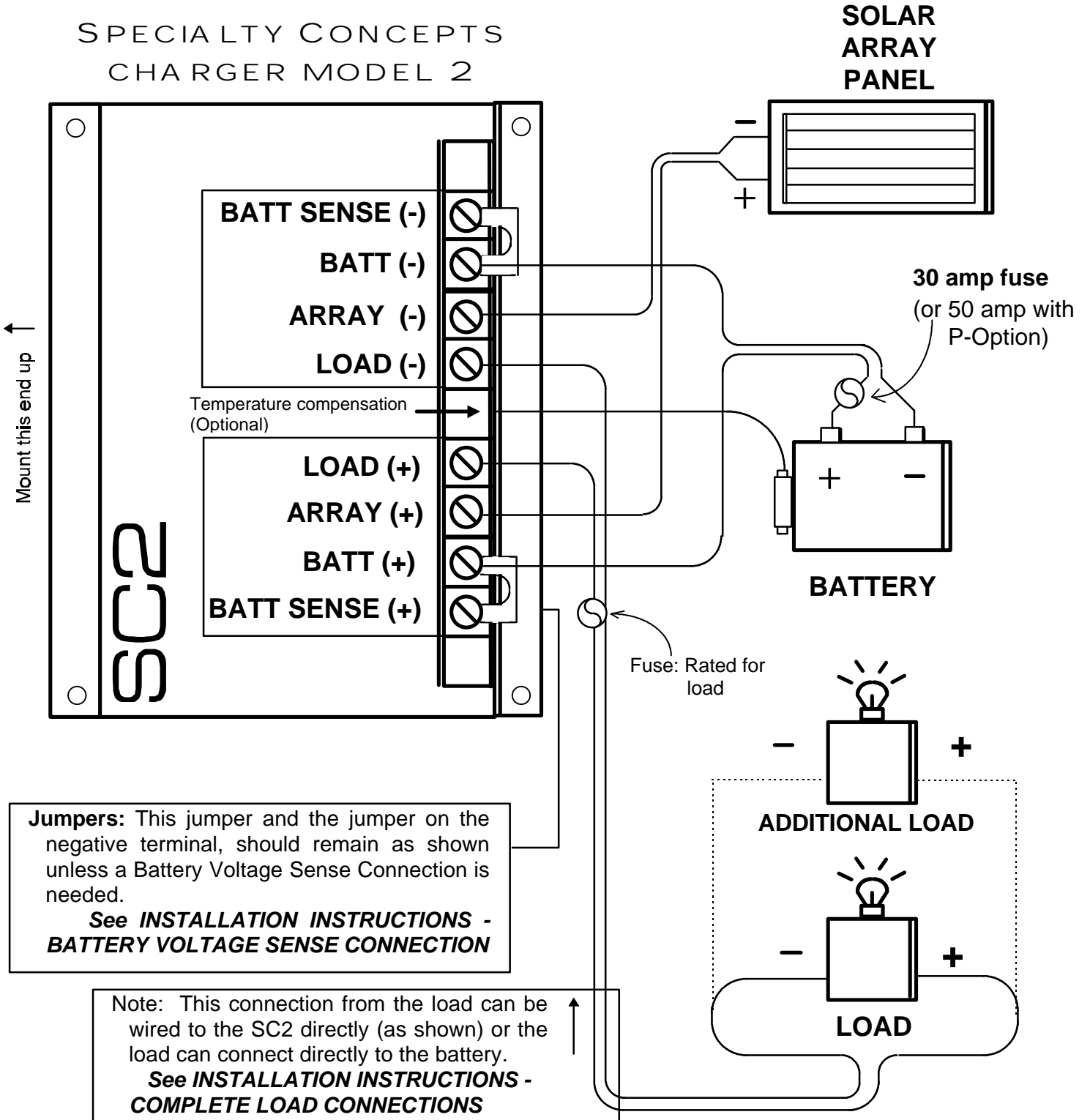
16. OPERATION: - Operation of the charge controller is now fully automatic. If the battery voltage is below the Full Charge Termination Set-point (see *SPECIFICATIONS*) and power is available from the array and the Power Connect Sequence (above) was followed, the SC2 should start up charging.

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.

17. 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 SC2 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 SC2 connection. Then note the voltage at the SC2 terminals for BATT (+) and BATT (-). The difference in voltage should be no more than $\frac{1}{4}$ volt for a 12 volt system ($\frac{1}{2}$ volt for 24 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 2



OPERATION

The SC2 uses a two-step control circuit to regulate the charging of storage batteries by monitoring battery and array voltage. The charge regulator is fully automatic, and there are no user adjustment or operations to perform. If the controller is supplied with the adjustable set-point option (T option), the charge termination set-point may be adjusted.

REVERSE CURRENT PROTECTION - The SC2 is designed to minimize losses from the battery at night. About 12 hours after sunrise the charging relay will open (stop charging), and stay open if the battery stays above the reconnect threshold. If the battery goes below the threshold and voltage is still available from the array, the relay will re-close (resume charging), and open again every 2 hours to determine if power is still available for charging. When no charge is available (night time) the relay will remain open until sunrise. This guarantees that the relay will be open every night, preventing reverse leakage current without cycling the relay during the high current part of the day or using an inefficient blocking diode.

MONITORING

CHARGE MODE LIGHT OFF (NIGHT TIME): All indicator lights will be off during periods when no charging current is available (outside darkness). At night, the charging relay will be opened, preventing reverse leakage current.

CHARGE MODE LIGHT ON: The "CHARGE MODE" light will be on when the controller is in the full charge (constant current) mode. This mode is the primary charging step. In this mode, the charging relay is closed, connecting the solar panel directly to the battery. Generally, this light should go on in the morning at sunrise. All available output from the panels is channeled into the battery bank. This light should stay on during daylight hours until the batteries have been charged and the battery voltage has reached the "Full Charge Termination" set-point. The light may go on again if the battery drops below the reconnect voltage ("Full Charge Resumption") 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.

CHARGE MODE LIGHT OFF (DAY TIME) (12 & 24 v units): The "CHARGE MODE" light will go off when the controller is in the float mode. This is the secondary charging step. This happens once the batteries have been charged and the battery voltage has reached the Full Charge Termination set-point and voltage is still available from the array. Upon full-charge termination, the voltage will generally instantly drop down below the "Float Voltage" set-point.

When the battery voltage is lower than the "Float Voltage" level, the control will supply the batteries a small amount of current ("Float Current") in order for the batteries to reach and maintain full charge. The level of float current is usually not sufficient to maintain the battery voltage all the way up to the float voltage, and the battery will hover around 13.0-13.6 volts (or 26.0 - 27.2)

During float charging, it is normal for the unit to feel warm. This is due to power dissipation of the voltage regulated float circuit.

OPTIONS

NOTE : 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:

DESCRIPTION: - On units equipped with temperature compensation, a small sensor on a ten foot cable is wired into the control 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 .

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 control 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 coated 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 accept up to 6 AWG wire. Load ratings and other specifications remain as stated in the specifications.

OPTION T - ADJUSTABLE FULL CHARGE TERMINATION SET-POINT:

DESCRIPTION: - This option allows for the adjustment of the high voltage charge termination set-point on an SC2 equipped with this option. All other set-points remain fixed, and as stated in the specifications section. No field calibration is required because the set-points are switch selected. There are four set-point positions, with values ($\pm 2\%$) corresponding to the following table :

<u>TABLE 1</u>	<u>CONTROLLER</u>	<u>SWITCH POSITION</u>			
	<u>VOLTAGE</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
	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 control 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 control, 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

TROUBLE SHOOTING: GENERAL NOTES

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 regulator 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 broken 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 colored scale volt meters that the SC2 with F options are equipped with are 5% accurate (about .5 volt in a 12 volt system) and are 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 regulator and the battery by measuring voltage at the battery and at the regulator 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 broken 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 THE 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 a 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 at 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

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 solar panel (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.

TROUBLE SHOOTING: SYSTEM

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

<u>CASE</u>	<u>BATTERY</u>	<u>SEE NOTE(S)</u>
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).
- **Regulator Problem:** The SC3/30 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 SC3/30 is set to. *Refer to SETTINGS / ADJUSTMENTS Section.*
- **Other Charging Sources:** Another charging source could be the cause. If the SC3/30 “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.**
- **SC3/30 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.

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 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 SC3/30 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.

FIELD TEST PROCEDURE: SC2

The following procedure provides a basic field test to check the operation of a SC2.

Test equipment required: digital multimeter.

Conditions: Sunny or bright overcast if possible

This procedure assumes that the system panels and battery are installed and operational, or at least capable of generating close to the system nominal voltage. Open circuit voltage required from the panels for these tests is at least 11.0 volts for a 12 volt system (22.0 volts for a 24 volt system). Systems should be equipped with disconnects or switches to facilitate connecting and disconnecting components without hazard. If connecting and disconnecting the batteries and solar panel as instructed in this procedure without approved disconnects, care should be taken since arcing can occur. On bright days, it may be advisable to partially cover the solar panel to reduce 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.

- 1) Start with the solar panel and battery connected to the controller, with any loads disconnected or off.
- 2) If the controller is in the float charge mode ("CHARGE MODE" light off), disconnect the "SOLAR PANEL (+)" and reconnect after waiting a few moments. The controller should go immediately into full charge mode ("CHARGE MODE" light on). If after disconnecting and reconnecting solar panel(+), and battery and solar panel voltage are at least 11 volts (or 22 volts) and the controller stays in float mode, the controller may be defective.
- 3) Once the controller is in the full charge mode, check continuity through the charging relay. Do this by setting the multi meter to resistance and measuring between "SOLAR PANEL (+)" and "BATTERY(+)" terminals on the controller. Reading should be 0.
- 4) If the controller is in the full charge mode, or you have just completed step 3, disconnect "BATTERY(+)". The controller should switch to float mode. If the controller does not switch to float mode, and battery is at least 11 volts (or 22 volts) and the solar panel is at least at 15 volts (or 30 volts), the controller may be defective. Controllers rated at 36 and 48 volts will oscillate (rapidly switch on and off).
- 5) Once in float mode, with the battery (+) disconnected, measure the voltage across "BATTERY (+)" and "BATTERY (-)" on the controller terminal strip. For 12 and 24 volt controllers, this should be about the float voltage. For 36 and 48 volt controllers, this should read 0 and the relay will oscillate (rapidly switch on and off).
- 6) With battery and solar panel connected, disconnect the "BATTERY VOLTAGE SENSE (+)" (removing the jumper). This should switch the light on.

BENCH TEST PROCEDURE: SC2

The following procedure provides a basic bench test to check the operation and calibration of a SC2.

Equipment required: digital multimeter

0-30 volt 500 ma power supply (for 12 and 24 volt controllers)

0-60 volt 500 ma power supply (for 36 and 48 volt controllers)

- 1) Connect the power supply negative to the controller "BATTERY NEGATIVE (-)" terminal. Connect the power supply (+) to the controller "BATTERY POSITIVE (+)" terminal and to the controller "SOLAR PANEL (+)" terminal. Make sure that there is a jumper between "BATTERY VOLTAGE SENSE (+)" and "BATTERY (+)" and between "BATTERY VOLTAGE SENSE (-)" and "BATTERY (-)" terminals on the controller.
- 2) Set the power supply to the nominal system voltage.
- 3) If the controller is in the float charge mode (CHARGE MODE light off), disconnect the "SOLAR PANEL (+)" and reconnect after waiting a few moments. The controller should go immediately into full charge mode (CHARGE MODE light on). If after disconnecting and reconnecting solar panel (+), and the controller stays in float mode, the controller may be defective.
- 4) Once the controller is in the full charge mode, disconnect the solar panel positive and check continuity through the charging relay. Do this by setting the multi meter to resistance and measuring between "SOLAR PANEL (+)" and "BATTERY (+)" terminals on the controller. Reading should be 0.
- 5) If the controller is in the full charge mode, or you have just completed step 3, reconnect "SOLAR PANEL (+)" and disconnect "BATTERY (+)". Set the power supply voltage to 18 volts for 12 volt system (36 volts for a 24 volt system) The controller should switch to float mode. If the controller does not switch to float mode the controller may be defective.
- 6) Once in float mode, with the battery (+) disconnected, measure the voltage across "BATTERY (+)" and "BATTERY (-)" on the controller terminal strip. For 12 and 24 volt controllers, this should be about the float voltage. For 36 and 48 volt controllers, this should read 0 and the relay will oscillate.
- 7) With "BATTERY (+)" and "SOLAR PANEL (+)" connected to the power supply, remove the jumper between "BATTERY VOLTAGE SENSE (+)" and "BATTERY (+)". This should switch the controller into full charge mode ("CHARGE MODE" light on). Reconnect the "BATTERY VOLTAGE SENSE(+)" to "BATTERY (+)".
- 8) Verify the set-points by changing the power supply voltage up and down and observing the activation

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