SC-2030 Solar Charge Controller
Technical Manual

12-24 V systems, 30Amps max. Revised 06/15/2017

1. Description of the SC-2030 Solar Charger

What a solar charge controller does: The purpose of a solar charge controller is to regulate the power from a set of solar panels to provide proper charging to your batteries—not over or under charging them.

The SC-2030 Solar Charger is a precision, high efficiency PWM (pulse width modulated) Solar Array Battery Charge Controller. The objective of this design is to maximize the life of your batteries by allowing the flexibility to adjust solar charging closely according to the way your battery manufacturer has specified.

High performance depends on being connected to a TM-2030 TriMetric Battery System Monitor. With this combination you get both high performance monitoring and charging of your battery system.

- For 12 or 24 V battery systems: AGM, Gel or Liquid Electrolyte batteries.
- Up to 30 amps maximum solar current. It will reduce output sufficient to protect charger if the solar output is greater. Four 135 watt solar panels for 12V systems (eight at 24V) can be accommodated. It's also possible to simultaneously use other chargers of the same batteries with additional solar panels.
- Optional Temperature compensation. For this, order the TS-2 Bogart Engineering temperature sensor.

- ●Recommended for use with "12V" or 24V solar panels. (see below on page 2 **Where this controller is not recommended**)
- ●Eight adjustable parameters to allow charging closely according to the way the battery manufacturer specifies. Technical details are shown on graphs on pages 14 and 15.
- ●If the TriMetric TM-2030 is disconnected from the SC-2030, it will do a much less flexible, but minimal, level of charge regulation without receiving information from the TM-2030. See p.11, Table 3.
- ●Recently (TM-2030 version 2.2 and higher) a manual equalization option has been added. See section 6.6.

In addition, it has two advantages not usually offered in solar controllers to better preserve the capacity of your battery system.:

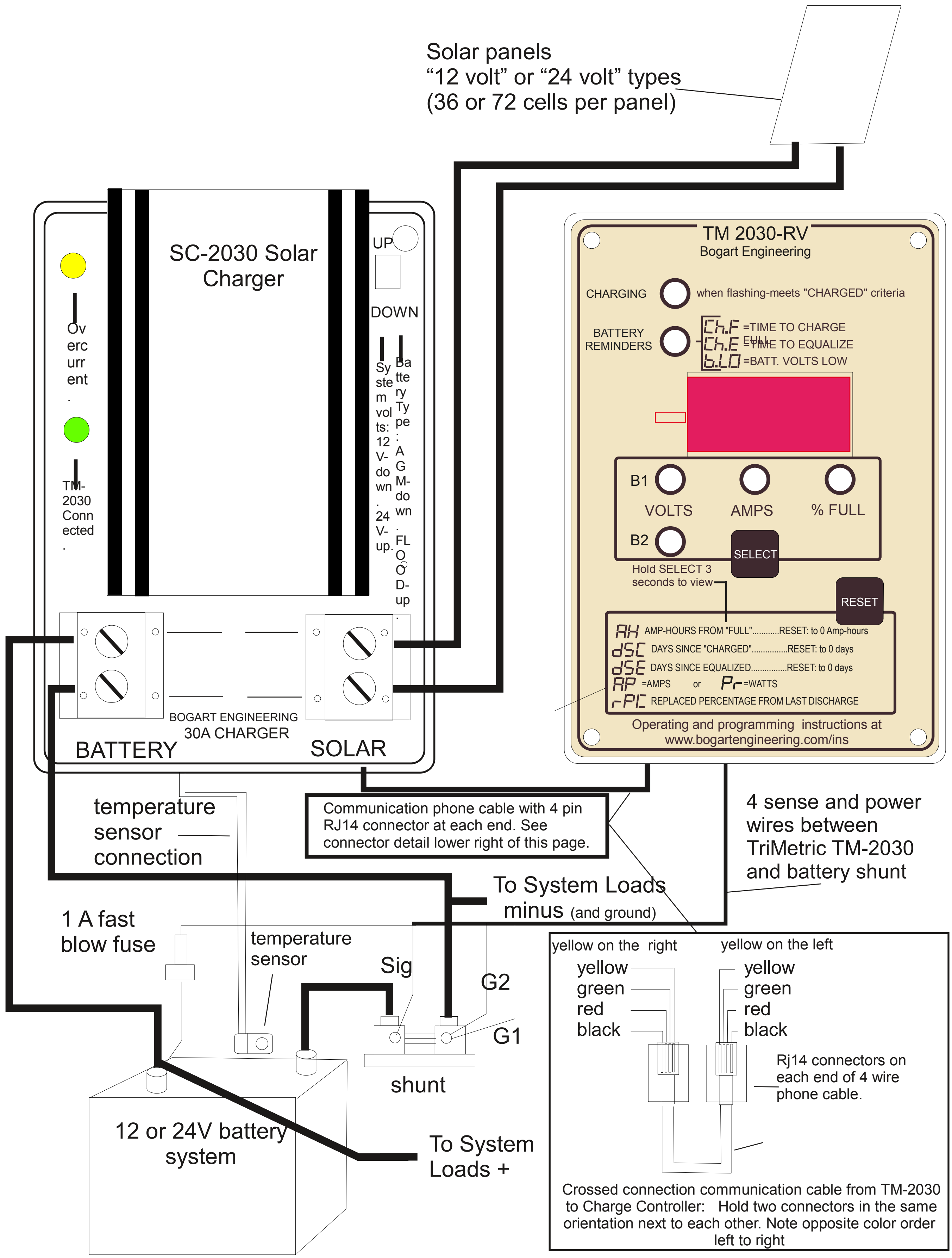
1. **Amp hour counting:** Many battery companies recommend that when batteries are recharged they should be overcharged, so that 104 to 120 percent of the charge that was previously removed should be replaced before going into "float". Most controllers don't measure this. When connected with the TriMetric, this controller measures the amp hours used, and allows you to specify the correct amount of amp hour overcharge when recharging. The more usual benefit of this is to insure that batteries are not **under**charged. However it is also beneficial to prevent **over**charging, in situations where solar panels are charging a lot during successive days but where very little battery discharge is occurring in the evenings.
2. **Finish current charging:** After the batteries are mostly charged, this controller has an optional "fourth" stage that is beneficial for liquid electrolyte lead acid batteries, and this is also sometimes recommended for some AGM types. This stage allows the voltage to go unusually high while it regulates the current to a specified level, to safely get more charge into the batteries. This helps to maintain the capacity of the batteries, which often begins to degrade with solar charged batteries because they don't get sufficiently charged.

Where this controller is NOT recommended: For 12V systems for best efficiency this "PWM type" charger requires what are often called "12 volt" solar panels that have 36 cells per panel. Or, with 24V systems you should use "12 volt" or "24 volt" solar panels with 36, or 72 cells per panel. Many solar panels manufactured recently are mainly intended for "on grid" application that have 60, 80, or other number of cells—that have voltages that don't well match 12V or 24V battery systems These panels are not suitable for high efficiency battery charging with a PWM controller such as this one. For good efficiency, they will require a more sophisticated controller with "MPPT" (Maximum power point tracking) capability.

Many people believe that MPPT type chargers are always better than PWM chargers: We have compared at least one commonly used MPPT charger with the SC-2030 and found that under very ordinary conditions the SC-2030 delivered **more** charge to the batteries. We measured this when the ambient temperature was 70 F degrees in full sun, and when the proper panels matched to the batteries were being used and when charging over 13.0 volts (the most common charging range with lead acid batteries.)

The SC-2030 is a "PWM" (Pulse width modulated) type that is simpler and less costly than a "MPPT" (Maximum Power Point Tracking) type charger. As said, the SC-2030 can give even better performance under some common situations. MPPT technology can give some advantage when temperatures are low, and it is **necessary** for good power transfer when panel voltage is much higher than the battery system voltage. With the SC-2030 (or other PWM charger), you may be able to get more total performance at the same cost by purchasing another properly matched solar panel instead of a more expensive MPPT solar charger.

A common mistake for evaluating MPPT performance is to compare their (lower) solar input current with (higher) output battery current, and thinking this additional current is solely due to the MPPT charger. This is incorrect, and will give an exaggerated impression of its advantage. A comparison must be done by changing to the PWM controller and then comparing battery currents.



Wiring for TriMetric TM2030 and charge controller--not showing circuit breakers to battery or solar panels

Figure 1

2. Technical Specifications:

Regulation type..PWM
Solar panel open-circuit voltage..................55V maximum
Solar panel nominal voltage.......................12V - 24V, matched to the battery voltage: Vpp about 16-18+Volts for 12-24V systems, Vpp about 32-36+ for 24V systems
Nominal Battery voltage............................12V - 24V
Required operational current.....................While sun shining: 25mA. Solar dark: 1mA max
Maximum Battery voltage............ ....35V
Battery type..AGM, Gel, or flooded lead-acid
Solar-panel peak current..........................Max 31A for full efficiency. May be safely used with panels up to 45A, however charging current will be reduced to protect charger.
MINIMUM in/out power efficiency at 30A: ...97.5% (12V systems) 98.5% (24 V systems)
MINIMUM in/out power efficiency at 15A: ...99%
Battery capacity...10 to 10,000 amp hours
Terminal block wire gauge.....................Up to 6 AWG. (Larger stranded cables you can remove some strands to fit)
Charging profiles....................................Three stages and optional fourth stage
Ambient temperature................................0 ºF to +140 ºF (−18 ºC to +60 ºC)
Dimensions... in.: 3 width X 4 1/4 length X 2 3/4 depth; cm: 7.6 width X 10.8 length X 7 depth

3. General Solar Charging system suggestions and considerations

Balancing batteries with solar: If you intend to charge your batteries mainly or only by solar panels, it's recommended by many battery companies to properly balance the battery storage capacity with adequate solar. Too much battery for solar energy provided can result in undercharging that can reduce battery performance and life. Peak solar panel currents of from 1/10 to 1/4 of the battery "C/20" ampere hour value are often recommended. For example, solar panels that deliver up to 24 Amps could be optimally paired with a battery of 100 to 240 amp-hour capacity system. Otherwise you might want to provide an additional source such as generator or grid tied charger to insure that your batteries frequently get a full charge.

Solar as excellent adjunct to generator charging: A generator can put a lot of energy into the batteries in a relatively short time when they are not too close to being fully charged. As they become more fully charged, batteries gradually accept energy at a lower rate—So charging them to full requires more hours than is usually desirable to run a generator. Even if you don’t plan to use only solar for charging, solar panels are well suited to deliver the last 20% of charge—which would otherwise require long generator times running inefficiently at a low charging rate. This will enhance your battery life and reduce generator wear.

You can use other chargers along with this one: If other chargers are also used with your system, they can be compatible with this system. It is important that the charging current from these shows on the TM-2030 amps display— (see section 4.1.5 below) then the system will properly account for the charging of these others. If you have another solar controller it should have a separate set of panels from which it is charging—you should not attempt to have the same set of panels go to two different controllers.

4. Installation of the SC-2030: Explained in five sections:

4.1 Planning the installation
4.2 Verifying that TM-2030 reads volts and amps correctly
4.3 Tools and hardware required
4.4 Installing SC-2030 and connecting solar panels, Batteries, Temperature sensor
4.5 Verifying operation and installing correct charging profiles

4.1. Planning the installation

Installation must be performed by a person knowledgeable of proper electrical wiring, best practices, safety and applicable electrical codes. If you do not meet these qualifications, please ask someone qualified to perform, supervise, or inspect the installation.

4.1.1 Normal configuration—Paired with a TM-2030 For best performance, the SC-2030 should be paired with a TM-2030 (TriMetric) monitor. The charge controller and the monitor are connected together using a low-cost telephone wire, which can be over 100 ft. long.

4.1.2 Minimal configuration—Standalone. Without the TM-2030, the SC-2030 Solar Charge Controller can perform only basic charge regulation. There are two jumper selected parameters located on the SC-2030 that are then used to regulate the charging: The system voltage can be set to 12 or 24V. The battery type can be designated "AGM" or "liquid electrolyte." These determine the charging only when the TM-2030 is not connected—otherwise they are ignored. In this case, there is an "absorb" stage set to 14.6 or 29.2 volts (for 12 or 24V liquid electrolyte systems) or 14.3 or 28.6 (for AGM systems) which runs for two hours, followed by a float stage of 13.2 or 26.4 volts.

4.1.3 Temperature Compensation: The optional temperature sensor is recommended especially when using AGM or Gel batteries, unless the batteries are kept at a fairly constant ambient temperature.

4.1.4 Review wiring diagram on page 3.

4.1.5 Can more than one charge controller be used?: If the TM-2030 and SC-2030 are connected together, other charge controllers may be added for additional charging current, while still retaining most of the benefits gained by using this paired system. They must be connected so the TM-2030 "sees" this current when they are charging. Also, though all chargers go to the same battery set, the solar panels should be segregated into groups—with each group being controlled by only one charger.

4.1.5 Locating TM-2030 monitor and SC-2030 charger. The TM-2030 is usually placed somewhere with access in the living area to allow easy viewing and control of the SC-2030. Four small wires usually 22 or 24 gauge connect the TM-2030 to the batteries and required shunt. In addition a four wire telephone cable will need to be installed that sends control information from TM-2030 to SC-2030. These wires can be at least 100 feet long (30 meters). The SC-2030 will usually be located in the wire path from panels to batteries to minimize wire length from panels to batteries. Unless the SC-2030 will be used without the TM-2030, it is not required that the SC-2030 be located right near the batteries.

TABLE 1: Required minimum copper wire size for 3% loss.
One way total length from solar panels to SC-2030 plus SC-2030 to batteries

		Length for 12V systems: For 24V systems double all distances											
Maximum amps from panels→		**5 Amps**		**10 Amps**		**15 Amps**		**20 Amps**		**25 Amps**		**30 Amps**	
Wire gauge (AWG)	**Diameter (mm)**	**(ft)**	**(m)**	**(ft)**	**(m)**	**(ft)**	**(m)**	**(ft)**	**(m)**	**(ft)**	**(m)**	**(ft)**	**(m)**
2*	6.544	230	70	115	35	76	23	57	17	46	14	38	11
4*	5.189	144	44	72	22	48	14	36	11	28	8	24	7
6	4.115	91	27	45	13	30	9	22	6	18	5	15	4
8	3.264	57	17	28	8	19	5	14	4	11	3	9	2
10	2.588	36	10	18	5	12	3	9	2	7	2	**	
12	2.053	22	6	11	3	7	2	**		**		**	

*This wire gauge exceeds the terminal block's maximum wire size and requires adapting.

** Not recommended

4.1.6 Determine wire size required from solar panels to charger and batteries from Table 1 above. Wire size from solar panels to SC-2030 and from SC-2030 to batteries must be much larger for low voltage systems compared to 120V house wiring to minimize power loss. The required size depends on (1) total maximum amps to be delivered by the panels, (2) the system volts (12 or 24), and (3) the wire length. The recommended maximum lengths assume a 3% maximum power loss using copper wire in a 12V system. Doubling lengths will increase loss to 6%. However for 24V system double all lengths for 3% loss. All wiring must meet applicable electrical code requirements with respect to maximum current versus gauge. With less than 3% power loss, this is normally not a problem.

4.1.7 Install TM-2030 monitor if not already installed according to "Installer's instructions for TM-2030"

4.2. Verifying that TM-2030 reads volts and amps correctly

Proper charging depends critically on accuracy of TM-2030 voltage and current (amps) readings.

Check volts: For accurate battery-voltage control, the TriMetric's voltage-measurement wire (called "B1" in TriMetric wiring diagram) must be connected directly, or close to the battery's positive terminal.

Check amps on the AMPS TriMetric display:

- Under zero-current conditions when all loads and charging sources are off, the TriMetric's ampere indicator must show 0.0A, or ±0.1A at most when using the standard 500A/50mV shunt. When using the less common 100A/100mV shunt, the zero-current value should be between minus 0.02-0.04A —which represents the current drawn by the TriMetric.
- The discharge current should be measured reasonably. For instance, a 12V, 12W light bulb connected to a 12V battery should display approximately −1A. This assumes no charging is going on, since the amps display shows charge minus discharge. The formula for Amps =Watts ÷ System Volts (12V or 24V).
- Verify that ALL charging sources should be shown as positive amps on the TriMetric TM-2030 when charging. All loads on the batteries should show as negative values when they are operating. Related to this:
- **The following is worth checking, because this mistake is so common:** Check to make sure that nothing except battery negative (no loads or charging sources or grounds) is connected to the battery negative side of the shunt—as illustrated in figure 1 of the TM-2030 INSTALLATION INSTRUCTIONS.

4.3 Tools and hardware required

- Drill with bits of suitable sizes for entry of telephone cable and/or Temperature sensor into SC-2030 plastic enclosure
- Medium Phillips screwdriver for the large green terminal blocks connecting wire to panels and batteries.
- Small Phillips screwdriver for four screws holding front plate enclosure
- Wire cutters, wire strippers, and a lug crimper for the battery wire, the solar panel wire, etc.
- SC-2030 charge controller
- TM-2030 (TriMetric) battery monitor with sensing and power wires (assuming the TM-2030 will be connected)
  - If TM-2030 is not yet installed, it will require an electrical shunt: 500A/50mV or 100A/100mV size. see TM-2030 installation instructions.
- Mounting hardware for the above, if required
- Wire of suitable size and length (as determined in section 4.1.6) from panels to SC-2030 and SC-2030 to batteries
- Common four wire conductor "telephone cable" up to 100 ft. long—to go from SC-2030 to TM-2030. This is the common 4 wire telephone extension cable with RJ11 connectors sold in different lengths at hardware or other stores in the telephone accessories section. The wiring must be crossed (crossover) between the two connectors, as shown in the lower right-hand corner of Figure 1 on page 3. This is usually the way they are manufactured—but check.
- Temperature sensor (optional but recommended unless batteries will remain at same temperature)

4.4 Installing the SC-2030, connecting solar panels, batteries, and Temperature sensor

Plan to mount the SC-2030 in a well-ventilated and shaded area to prevent overheating, and protected from direct rainfall. The heat sink can get hot during charging; therefore, the charge controller must be installed beyond the reach of animals and young children. The black heat sink fins should be vertical—not horizontal, which means the printing of "SOLAR" or "BATTERY" will be right side up or upside down (not sideways).

4.4.1 Run wires (size determined as described section 4.1.6) from solar panels to location for SC-2030, and from batteries to SC-2030 location with enough extra length to easily connect to large green terminal blocks. Carefully mark on the ends of the wire which are positive and which are negative—both to batteries and to solar panels.

4.4.2 If communication (phone) cable has RJ14 connectors attached at both ends, check that connectors are "crossed" as shown in figure 1. Run phone cable from TM-2030 to SC-2030 location with sufficient length. If you have a RJ14 crimp tool and correct RJ14 connector, to avoid drilling a larger hole you could pass wire through a small drilled hole through TM-2030 enclosure then use crimp tool to install connector (carefully observing polarity Fig 1). Don't yet connect the communication cable to the TM-2030 (unless connectors at each end are attached and you don't intend to put them on or change them later.)

4.4.3 Remove front panel and circuit board from SC-2030 enclosure by removing 4 screws and put it aside. Drill one or more holes in the SC-2030 enclosure to allow the communication cable and the temperature sensor wire (if used) to pass through in a location suitable to the positioning of the controller, wires and the rest of the system. The temperature sense connector requires a 5/16 diameter hole to pass through. For the communication cable, as described in 4.4.2 you could pass the wire through the hole and attach the connector similarly to 4.4.2 if you have the appropriate connector and crimping tool. Reminder: be sure the connectors are attached "crossed" as shown figure 1.

4.4.4 Mount the enclosure on vertical surface so the heat sink fins go up and down. Use two screws on flanges, or you may drill your own holes internally and use those.

4.4.5 Connect the temperature sensor connector (if used) and the communication cable to the two connectors on the back of the SC-2030 (inside the box). Place the circuit board back onto the enclosure board and secure with four screws.

4.4.6 Place the temperature sensor (if used) near the batteries. The hole in the sensor could be connected to a battery terminal—but this is not necessary for it to measure temperature.

For safety, turn off power from batteries and solar panels before doing next step

4.4.7 Connect the wires from batteries and the solar panel wires to the controller. **For the following steps, refer to wiring diagram, Figure 1 on page 3. For safety, turn all switches and circuit breakers off while making the connections. While voltages in a 12V or 24V solar system are generally considered safe from electrical shock, amperages can be very high and can create powerful arcs if accidentally shorted, or when connections are made or unmade.**

a. Connect the SC-2030 minus wire to the batteries. Observe in figure 1 (page 3) how the SHUNT is connected to the batteries. The shunt has two large bolt terminals. One is connected to the battery negative terminal—the other side is connected to the loads in your system. The wire from the SC-2030 “BATTERY minus” terminal (large green) must go to the LOAD side of the shunt. Avoid a common mistake of connecting this directly to the negative post of the battery. If you make this mistake the solar current will not register as “amps” on your TM-2030, and charging will not be correctly controlled by the TM-2030.

b. Connect the wire from the battery + terminal to large green connector on the SC-2030 marked BATTERY +.

c. Connect two solar panel wires to the two large green terminals on the SC-2030 identified on the SC-2030 as “SOLAR” . Be sure to observe correct polarity: + from panels to terminal marked SOLAR +, and minus to terminal marked SOLAR “ —“.

4.4.8 Connect communication connector at TM-2030 end if not already connected.

4.4.9 Verify all wiring and polarities (plus and minus not reversed). Then close the switches or circuit breakers.

4.5 Verifying SC-2030 operation and programming charging parameters.

NOTE: References to “P” numbers such as P4, P16, etc. refer to user programmable values explained on page 12.

●When solar is shining on the panels with more than 0.5 amps the amber light on the SC-2030 should be ON. When flashing every half second, it is in over current protection and charger is limiting current to a safe value for charging.

4.5.1 If the SC-2030 is connected to a TM-2030 while sun is shining on panels: Check the green light on the SC-2030 Solar Charge Controller. If the two units are communicating it should be ON most of the time—but possibly occasionally blink off. If the green LED is off or mostly off, except for occasional blinks on, check the communication cable again, check that the TriMetric is powered and operating properly, and also verify that the phone cable contacts are crossed as shown in the lower right-hand corner of Figure 1. Also, there must be at least a small amount of solar current coming from the solar panels.

4.5.2 If the SC-2030 is operating without the TriMetric: If at least a little solar energy is coming in, the amber light will be on, but the green LED will be **usually off**—but every 10 seconds or so will blink on to indicate the charge state as indicated in next section **4.5.3**.

4.5.3 The flashing green light on the SC-2030 will tell you what charging state the SC-2030 is: The following sequence will be repeated every 10 seconds or so:

●Flashing once, the charger is in the first stage or “bulk” charging.
●Flashing twice, charging at the absorb voltage
●Flashing 3 times indicates floating mode.
●Flashing 4 times: in higher voltage “finish,” limited current charging. (With TM-2030 connected only)
●Flashing 5 times: at maximum voltage “finish,” limited current charging. (With TM-2030 connected only)
●Flashing 6 times: Was in float, now discharging but still at least 98% full. (With TM-2030 connected only)
●Flashing zero times: Discharging and less than 98% full (With TM-2030 connected only)

4.5.4 L**ast important step: Programming the SC-2030 for your battery system when TM-2030 is connected.**

Easy way: Most people will choose the easy way to enter this data. This method automatically enters 8 charging parameters to control the charging, and also provides proper monitoring in most cases. This requires the following three steps:

STEP 1. Find the "charging profile number" from the table below depending on the type of batteries and system voltage you have, 12 or 24 volts. If yours is not on the chart, and you have liquid electrolyte batteries (with caps on top for watering) you could start with "Generic" profile 1 or 2. If you have AGM batteries, start with profile 9 or 10. (See "Concorde" on chart)

continued next page

After determining profile number, use Program P22 (of the TM2030) to enter data as described (in detail) here.

a. Press "SELECT" and hold it down until "P1" appears in display. Release.
b. Press SELECT repeatedly to get to "P7" (to select operational level).
c. Press SELECT and RESET together, momentarily, to get 3 lights to flash.
d. Use RESET to change display until operational level "L3" shows.
e. Press SELECT repeatedly to get to program "P22".
f. Press SELECT and RESET together, momentarily to get 3 lights to flash.
g. Use RESET to enter profile number that you got from table 2 below into display.
h. Press SELECT once, to get out of program mode—but remaining in P22 with profile number showing.
I. **Hold RESET down—watch as number go 5,4,3,2,1,0. Profile not entered until numbers stop changing.**

STEP 2. Determine the battery system capacity, in amp hours. To determine the system capacity you need to know the capacity of each **battery** in amp hours—then multiply by the number of series strings in your system. The 20-hour value specified for capacity is appropriate. The default value automatically entered by step 1 is for 220 amp hours. **If your system capacity is not between 200-240 amp hours, change value by entering the correct value into program P3 in the TM-2030**. **Always do this *after* step 1 or this data will get overwritten. To program P3: similar to steps a - d. above, except go to P3 instead of P7. For exact instructions, see Section 5.**

STEP 3: In many RV's or other installations, while charging the voltage to items connected to the battery may exceed the maximum safe limit under cold conditions. **Although this may not provide ideal battery care, you may adjust P8 to the maximum allowed charging voltage**. This will override any other programmed settings. **Early units do not have this option. Call Bogart Engineering for upgrade.**

For experts that want to customize the charging: Enter a profile number that is close to what you want. (see Table 4, below on page 16). This overwrites all values. Then you may individually modify any of the eight parameters according to your liking. Section 6.3, below, describes the function of each of these eight parameters.

TABLE 2: Find P22 profile number for your battery type and system voltage

Manufacturer	Models	System Voltage	System capacity	Profile number. Enter in P22 (Table 4, p16, has profile definitions)
"Generic" wet cell batteries		**12**	220	1
		24	220	2
Concorde	Lifeline AGM Sun-Xtender AGM	**12**	220	9
		24	220	10
Crown	All wet cell	**12**	220	5
		24	220	6
Deka	Monobloc example 8C11	**12**	220	11
		24	220	12
GNB /Excide	Absolyte AGM	**12**	220	15
		24	220	16
Interstate	All wet cell. Example: GC2 types	**12**	220	13
		24	220	14
Trojan	All liquid 6 V types ExampleT-105	**12**	220	3
		24	220	4
US Battery	All liquid 6V types: example T-105	**12**	220	7
		24	220	8
Generic 12V without higher volt	Wet Cell Generic	**12**	220	17

finish charge (see page 16)	AGM Generic	**12**	220	18

5. Useful Information for everyday users

See also the Trimetric Installation guide and TriMetric Technical Manual for more information

5.2 A useful display item for seeing if your batteries are being properly charged

If you partially drain your batteries on a daily basis, we suggest understanding the new display function on the TM-2030 called "**Replaced Percentage from Last Discharge**" This is listed as a secondary display shown near the bottom of the TM-2030 front panel, identified as **"rPC"**. **This will be of lesser significance when your batteries are charged and on "float" most of the time—when this may go to high values**. Many battery companies recommend that when recharging your batteries that you completely replace the amount of charge most recently discharged by your batteries, plus add an additional percentage. This depth of discharge is recorded by the TM-2030 during the previous discharge. For "wet cell" lead acid batteries it is often recommended that 110-120% be replaced. For AGM type (sealed) batteries 104-108% is often suggested. At the end of a day of solar charging, the **"rPC"** ("replaced percentage") display will tell you how much you have replaced. This level of charge may not happen every day—however if less than the ideal is achieved for a day or two, it would be good to go even higher on subsequent days if possible. Soon after you start discharging your batteries again this will read 0%—to anticipate the next day's recharge.

New with Version 2.2 of the TM-2030 monitor With this version, it is possible when viewing "**rPC**" function, to push and hold the RESET button to momentarily observe the previous depth of discharge in amp hours upon which the **rPC** percentage is based. This is useful, because if this discharge was small compared with your battery capacity, a large value of **rPC** should be of much less, if any concern.

5.3 A useful display item to see if you have extra solar power in the afternoon

When charging with solar, often in the afternoon the batteries will begin to accept less solar energy—and as a result this energy may be wasted although it could be used for some extra loads, such as a dishwasher or vacuum. With the TM-2030 connected, there is a "secondary display" item that is not shown on the front panel called **"UPr"** (Unused power) which displays this. If most of the solar power is now surplus (because the batteries are getting well charged), **"YES"** will show on the display. If a lesser amount, the display will indicate the approximate number of watts that are being wasted. Refer to the **Quick Reference Guide**, section 2.1 Also listed there is information about observing solar amps (**"SOL"**) and battery temperature (**ºC**).

5.4 For information about the meaning of the LED lights on the SC-2030 charger

Refer to section 4 of the "**Quick** Reference **Guide**" referred to above. Section 6 in this **SC-2030 User's Manual** describes in detail the meaning of the various charging modes referred to there.

5.5 There are two different standards you can select to define a "full charge."

The highest (more stringent) standard is selected by using TM-2030 program P7 to choose **L4** instead of **L1, L2,** or **L3** which use a lower standard, which requires only that the battery voltage exceed the value in P1, and that the charging amps be less than P2. The L4 level requires that in addition either the required "absorb time" or "percent overcharge" be achieved, such that the "float" state has been reached. This establishes a better, but more difficult, level to reach. Refer to the **TM-2030 User's Instructions**, section 6.2 for details.

5.6 Using History Data to diagnose system problems

The TM-2030 (TriMetric) makes history data available when the user level P7 has been set to "L2," "L3," or "L4" in programming code "P7." History is recorded daily for the past five days or the last five charge cycles, depending on the parameter. This data can be used to diagnose some system problems. Please refer to the **TM-2030 User's Instructions,** section 6.3 for instructions on interpreting this data.

6. Technical information for interested and advanced users

6.1 Charging lead acid batteries—basic information

Charging a battery is very different than loading a tank with gasoline. First, when filling a tank it is very clear when the tank is full, and trying to overfill simply results in gasoline being spilled without any damage to the tank. Second, using up the gasoline until the tank is completely empty may be inconvenient, but again that does not damage the tank, even if the tank remains empty for a long time. Thirdly, filling the tank slowly or fast, whether the weather is hot or cold, or whether one is starting from a nearly-empty or nearly-full tank, does not affect the eventual amount of gasoline in the tank. Finally, a fuel tank's capacity does not vary over time.

None of these analogies apply to batteries. Lead-acid batteries can accept higher charge currents when they are nearly empty, but must be charged more slowly when they are nearly full because then they will not readily accept the charge. Batteries need to be frequently fully charged. If a battery is allowed to operate consistently at a low charge level, its capacity to hold charge decreases over time. This means that a battery needs to be fully charged every now and then for the proper maintenance of its capacity. In solar applications, this sometimes cannot be achieved in the course of a single day, depending on sunshine and energy usage.

Sometimes a generator is used instead of sunlight to charge the battery at a high current for one or two hours each day. This can easily shorten the life of lead-acid batteries, which cannot get fully charged in two hours even with a very powerful generator. If only charged with very high currents over a short time, a battery's charge capacity will decline over time. A "hybrid" generator-solar system would be preferable with a strategy of using the generator to provide a fast charge early in the morning, when the battery is at its lowest charge level, and stop when the battery can no longer accept high charging currents. By the time the sun is high enough, the solar panel can take over the charging at a lower current for the following six to nine hours. Alternatively, a surplus of solar panels can accomplish something similar, but that means the peak solar power in the afternoon, when batteries are accepting less current, may not be used. To overcome this, plan to use heavier loads, such as laundry, dish washing or well pumping, during the mid afternoon, when batteries accept less solar energy.

6.2 Specifically how solar chargers, including the SC-2030 charge batteries

The following charging description applies when the SC-2030 Solar charger is connected with the TM-2030. If for some reason the TM-2030 is not connected, it uses a basic charging procedure, to be described in section 6.3.

This discussion refers to 12V systems—for 24V systems multiply voltages by two.

To charge batteries, a charger supplies electrical energy to the battery with a certain "voltage." "Volts" is a measure of how hard the charger is attempting to push the energy (electrons) into the battery. The battery always tends to resist the tendency to push the electrons in—the voltage of the charger must be high enough to overcome the resisting force of the battery. This is a little like pushing water into a pipe which is under pressure—enough force must be provided to push it in or it will not go. The "current" or "amperes" is a measure of how much (charge) energy is actually flowing in. The actual flow ("amps" or amperes) depends on two factors: how hard the charger is pushing (voltage) and how much the battery is resisting.

When batteries are at a lower state of charge they do not push back very hard, and the battery will easily absorb all the charge (amperes) that the charger can supply. This is called the "bulk" stage of charging, and the "voltage" from the charger during charging will be below 14 volts or so. This is when most of the charge can go into the battery, and is the simplest part of the charging process; usually the batteries will be able to absorb all the energy the charger is capable of delivering.

When the batteries reach about 85% full, the job of the charger gets more difficult. The batteries begin to resist more, and absorb amps at a lower rate, meaning that it takes a longer time to do the rest of the charging. One might say, "why bother, then to go beyond 85% full? Wouldn't this make the job easy on the charger? Just always operate the batteries from 55%-85% charged." Well, yes it would, but the reason this is not a satisfactory strategy for lead acid batteries is that if you don't fully charge them regularly, it makes it harder in the future to charge them as much. It is remarkable how often even authoritative sources on lead acid battery charging repeat the phrase that "lead acid batteries do not have memory." Lead acid batteries DO have a memory—if you do not fully charge them, they will remember that, and if this is repeated often their capacity will gradually "walk down" as is correctly described in charging information from the Concorde battery company.

This presents a challenge to solar charging— because the solar day starts to end as the batteries become more resistant. This can result in a battery that is not fully charged when the day ends. It is frequently observed that batteries being charged only by solar tend to lose capacity to hold energy— described as batteries becoming "sulfated". This conveys the fact that the lead sulfate, which is the byproduct of discharging gets more difficult to convert back to fully charged lead and sulfuric acid if it sits around too long before recharging.

To continue the charging story, once the batteries become more resistant to charging—when the charger rises to 14.4 volts, (at 77 degrees F or 25 degrees C) liquid electrolyte batteries will begin to "gas" which means that although part of the energy is still doing some slower charging, part of the charger energy is breaking down the electrolyte in the battery into oxygen and hydrogen gases—and in addition a higher amount of the energy begins to go into heating the battery instead of the desirable conversion of the chemical charging. Although the gassing does waste some energy, this turns out to be desirable in liquid electrolyte batteries because the gas bubbles stir up the electrolyte which otherwise can stratify—because without the stirring the heavier acid can sink to the bottom while weaker acid goes to the top causing unequal charging at the top and bottom. In AGM batteries, the design is different, so gassing typically doesn't occur, which makes them a little more efficient.

Good solar chargers will then go into what is often called "absorb" stage—where the charger holds the voltage just above the gassing point (voltage ideally temperature compensated). The batteries then absorb gradually less and less energy as they further charge. Most manufactured solar chargers maintain the "absorb" voltage for a set amount of time—perhaps one to four hours before they go into the "float" voltage of about 13.2 volts. Often the better chargers allow you to set the exact absorption voltage, the holding time, and the exact float voltage. The float voltage is a maintenance voltage which is intended to be the ideal voltage to keep a battery at minimum wear for the longest time once it's fully charged.

Although just maintaining the "absorb" voltage for a fixed time is not a bad way to decide when to go into "float", many battery companies suggest that it is better to monitor the amount of current (amperes) going into the battery during this time and then go into float based on this. There are three variations on this method:

(1) Charge above the gassing voltage until the amperes drop to a sufficiently low value, say an "ampere" value that is 1% or 0.5% of the amp hour "capacity" of the batteries.

(2) Charge until the value of amps into the batteries stops decreasing for a specified period of time—and stays at this constant value for perhaps a couple of hours.

(3) Charge until the charger has replaced a specified percentage of charge amp hours that was last removed from the batteries during its last discharge cycle.

These options are unusual with most solar chargers, but the first or third is possible with the SC-2030 solar charger when used with the TM-2030 monitor. The TM-2030 measures the previous amount of discharge (typically the night before), then when recharging requires returning 105-120% of that amount, adjustable by the user. The problem for many chargers is that they do not measure or know the exact value of amperes or amp hours going into the batteries. They may measure the amps from the charger going into the battery and loads together, but they don't know what percentage of this is going into the battery compared to the loads, so these methods of observing battery amps are not available.

By returning a constant additional percentage, excess charge that is returned depends on the amount that was previously removed. This has the effect that the "absorb" time is not always the same, but is adjusted to the previous day's usage to avoid overcharge or undercharge. Undercharge is more common in many systems, but in applications where solar charging goes on for days when very little drain occurs on the batteries, such as for RV's stored in the sun, or occasionally used cabins, measuring amp hours can avoid overcharge.

An additional method the SC-2030 uses to get in sufficient charge is that it has an (optional) finish charge stage to try to increase the intake of current into the battery by boosting the voltage when the current has declined to a safe enough value. This is explicitly recommended by some battery companies for liquid electrolyte batteries and recently even AGM types—but usually not gel batteries.). If the SC-2030 is programmed to do this, after the charging current decreases to a safe value while in "absorption" state the SC-2030 then increases voltage (while regulating current) to attempt to put more charge at the end when the battery is becoming extra resistant so as to attain the specified overcharge amount. The overcharge percentage, maximum voltage, and maximum permitted current are all values that can be programmed into the TM-2030.

The effect of temperature on charging: The ideal temperature for a lead acid battery is often considered to be about 25 degrees C (77 degrees F). When batteries are cold, the charging process is slower, so they take longer to charge. The gassing voltage of the battery increases with lower temperature—and therefore the recommended "absorption" voltage should rise as temperature goes below the usual reference temperature of 25 degrees C (77 degrees F). If the battery temperature varies much, the charger should have the capability to adjust its voltage to temperature, especially for sealed AGM or gel types.

6.3 Description and graph of exact SC-2030 charging profiles

Standalone operation-without the TM-2030: With the TM-2030 not connected, there are only two charging selections available (by two jumpers you set on the SC-2030 circuit board.) They allow choice for "AGM or liquid electrolyte" and "12 or 24V" system. These are intended to be for "backup" charging if for any reason the TM-2030 is not connected. When the TM-2030 is connected, these values are ignored.

Continued next page

The chart below shows the voltages used depending on how the jumpers have been set. It begins charging at maximum solar current until it reaches the limiting "absorb" voltage shown. After that it charges for an absorb time of two hours. Then it regulates at the float voltage shown.

Table 3: Shows "absorb volts" and "float volts" for jumper settings –TM-2030 not connected

SC-2030 Battery type jumper setting	System Voltage jumper setting	Absorb voltage (temperature compensated to 25º C if sensor is connected)	Float voltage (after 2 hours at Absorb)
Liquid electrolyte	**12V**	14.7V	13.2V
Gel or AGM	**12V**	14.2V	13.2V
Liquid electrolyte	**24V**	29V	26.4V
Gel or AGM	**24V**	28.4V	26.4V

6.4 Two Graphs of charging profiles for SC-2030 when TM-2030 is connected

The first profile (page 14, figure 2) is more typical of most good solar chargers. However the SC-2030 has an additional unusual option of setting a "percentage of overcharge" value compared to last discharge from 100 to 120%.

The second profile (page 15, figure 3) adds a higher voltage "finishing absorb," current limited charging stage, to safely more fully charge batteries as they become more resistant to charging, originally intended for lead acid liquid electrolyte (wet cell) types—but now some companies are recommending this for AGM batteries too .

Each profile shows **the program values** that you use with the TM-2030 to adjust the charging; these are identified by the "**P1, P2**, etc which identify values that you enter using theTM-2030.

Important note about settings for P2 and P21. These are percent settings that refer to the percentage of the value programmed into P3. For example, for P2 the "amps" set point equals the value in P2 (in percent) times the P3 value. Similarly, P21 (max Amps finish value) is also referenced as a percent of the P3 setting.

The P8 "high voltage limit" setting is not installed by the install profile. Some systems (often in RV's) don't allow battery voltage as high as typically recommended for properly charging batteries. *If you must impose a maximum voltage* limit, use program P8 to set voltage from exceeding this value, even during low temperature--although this could compromise ideal charging. To disable, place it to a voltage that your system will never reach, such as 65.0V.

The P22 "battery **install profile" setting automatically writes 8 values shown below (EXCEPT P8) as shown in Table 4 below. Always enter P22 first**. After that any other values may be changed individually if desired. If you find a profile set that has most of the values you want, first enter that profile, then change the ones that you want to be different. Presently there are 18 profiles available. We may add more in the future in later revisions of the TM-2030.

If you wish to use a "conventional" type charge profile, typical of most controllers manufactured today, this may be easily accomplished by setting program **P21** to "OFF", as described near the top of page 14. Or use profiles **17** or **18** when entering a charging profile in **P22**. All of the profiles, except P17 and P18 have an extra "higher voltage finish charge" to give a more thorough charge, which is recommended by many battery companies, including some manufacturers of AGM type batteries.

P1: Absorb volts: When charging begins, the maximum solar current is sent to the batteries until this voltage is reached. Then the charger limits voltage to this value. (10.0-65.0)

P2: Charged setpoint. The "amps charged setpoint" is equal to **P2**, expressed as a percentage from 0.0-10.0%, times **P3** (battery capacity). When battery voltage is equal or greater than **P1**, (when the TM-2030 is in Levels 1-3) and the amps drops to P2 times P3, the batteries are signaled as "charged." (In Level 4, the standard is much higher: batteries must go into float mode before they are signaled as "charged".)

P3: Total battery system capacity (in amp hours). (10-10,000 amp hours)

P8: Absolute max permitted charging voltage: Default=65.0. Adjust this (if necessary) to limit the maximum charging voltage allowed, for example if temperature compensation raises voltage in cold conditions beyond what is permissible for other devices connected to the battery that can't tolerate the voltage that would otherwise be desirable for proper battery charging. Note that P15 is the **battery limit**. P8 can prevent P15 from being reached.

P14: Limit timer for charging, before going into "Float" described in the profile graphs. (0.0-25.0 hours)

P15: Finish charge (high**) voltage limit**—allowed only after the amps drop below the P21 current limit. (10.0-65.0)

P16: Float voltage (10.0-65.0)

P20: Percent of overcharge before going into "float" (0-20%).

P21: Finish charge **Amps** limit (expressed as a percentage of P3) below which amps must be to rise above P1 voltage to P15 voltage.

P22: The "charge profile" entry program: simultaneously programs all of above eight values based on system voltage and the battery type selection. **See Table 4, page 16 to see the eight values actually programmed for each profile.**

6.5. What determines when SC-2030 goes into float:

these are also shown in graphs on page 14 and 15.

For the "3 state" profile: Timer starts counting with P14 time when goes into "Absorb" state.

The first time after the charger is turned on. Goes into float when (Amps drops below P2*P3) OR (Timer expires.):

After the first time: (Amps drops below P2*P3**) AND (**% overcharge>P20**)} OR** (Timer expires with P14 time.):

For the "4 state" profile: Timer starts counting with P14 time, as shown on 4 state charging profile, page 15.

The first time after the charger is turned on: Goes into float when (Amps drops below P2*P3) OR (Timer expires.):

After the first time: {(Amps drops below P2*P3 at least once during Absorb**) AND (**% overcharge>P20**)} OR** (Timer expires with P14 time.):

6.6. Battery Equalization: how to initiate or terminate the process.

TM-2030 ver. 2.2 or higher. Equalization is a process of overcharging a battery that in the past may have been undercharged. Undercharging can cause "sulfation" of the battery which will cause it to lose some capacity to hold energy. Equalization is an overcharge that can help restore the damage done by under charging. For example, you might want to do this if a reading with a hydrometer of the specific gravity of the battery electrolyte is lower than what the battery manufacturer recommends.

Description of what the SC2030 does (with TM-2030) when equalization is invoked: First, it will attempt to charge the battery until it reaches the "Absorb" voltage that has been set in program P1. Then it stays in "Absorb" until the charging amps drop below 5% of the P3 ("amp hour") programmed value. Next it switches to a "current regulate" stage that limits the current (in amps) to a maximum value of 5% of the P3 programmed value while allowing the voltage to rise no higher than the P15 value. It counts the total time for step 3, and when 2 hours have accumulated it goes into "float", thus terminating the equalization. If the P1, P3 or P15 values are not what you want, temporarily change them during equalization. For longer times, repeat the process. IMPORTANT: If P8 is being used to limit battery voltage, it may nullify the benefit of equalization unless you adjust it higher than the P15 value.

How to initiate or terminate the equalization process: 1. Use the SELECT button to observe the "Days Since Equalize" display. This is one of the "Extra data" items shown at the bottom portion of the front panel label of the TM2030. The display will show "dSE" (Days Since Equalized) alternating with a number of days. 2. Hold the RESET button down for about 5 seconds to reset the Days to 0.0. If they are already 0.0, then this step need not be taken. 3. With 0.0 showing in display, push RESET again for about 5 seconds—it will show "Equ". This initiates the equalization described above. If it is desired to terminate the process, use SELECT to again get to this display, which will be show "Equ" unless the equalization step has ended push the RESET button for 5 or so seconds and it will go to "0.0" thus terminating the equalization. To lengthen the process, you may then restart at any time.

Warranty and customer service

Limited warranty

The SC-2030 Solar Charge Controller is warranted for three years against any manufacturing defect. Any controller not meeting the specification or rated performance shall be replaced or repaired, at Bogart Engineering's discretion, provided it has not been subjected to abuse or misapplication. For warranty service, please email bogart@bogartengineering.com. A return merchandise authorization is required for all merchandise to be returned to Bogart Engineering.

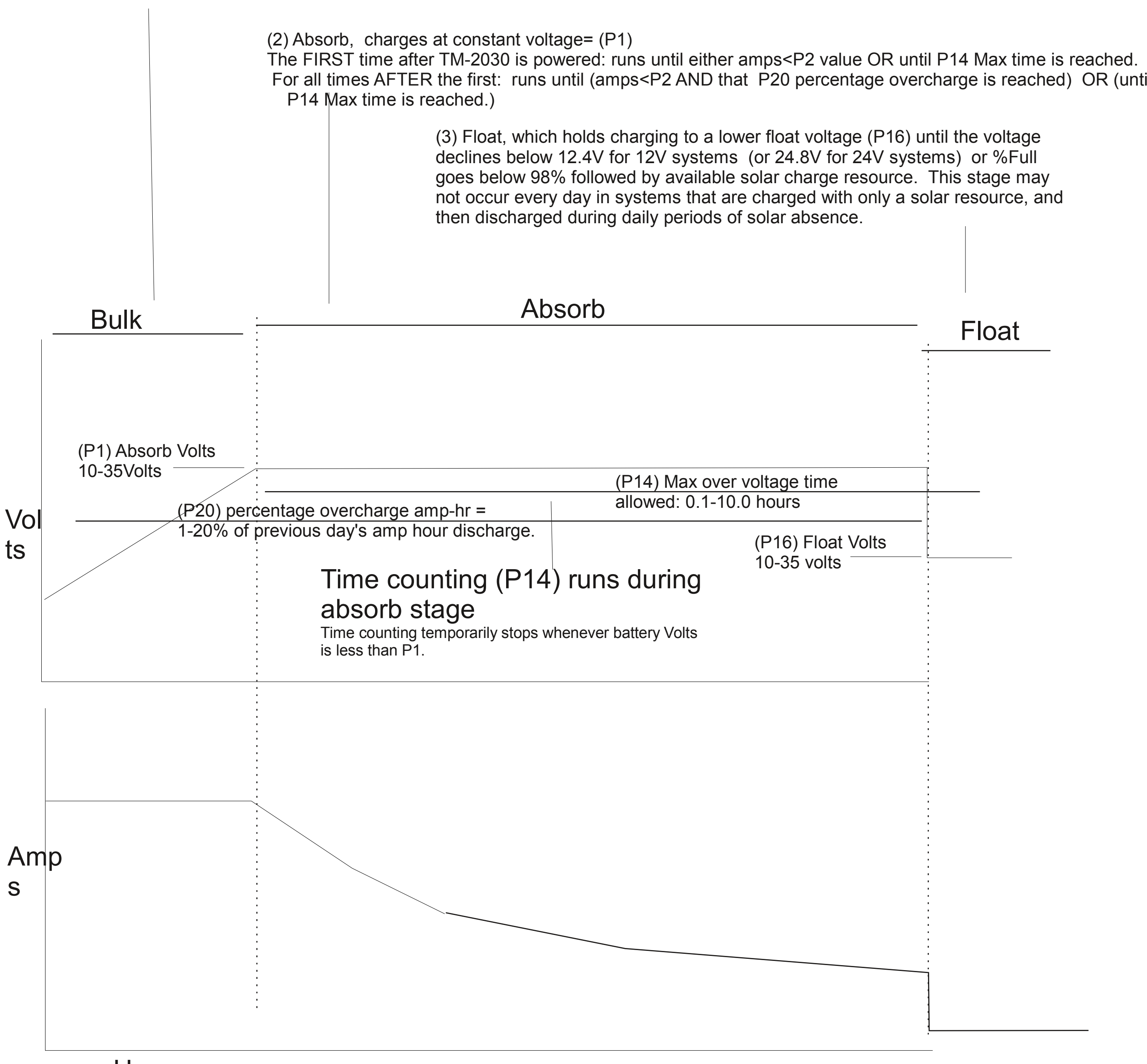
How to obtain customer service

Please review our support page before attempting to contact us. Our distributors are able to answer simple questions about Bogart Engineering products. For technical support, send an email to bogart@bogartengineering and someone will assist you.

www.bogartengineering.com

Three stage charge control: Figure 2. This is closer to how most good conventional controllers charge lead acid batteries--except that this controller also has the capability (if desired) to return a specified number of amp hours to the batteries (compared to the most recent discharge) before going into "float". Also, it has been considered best suited for AGM or Gel type lead acid batteries--however recently some manufacturers are recommending the four stage profile (next page) for AGM type batteries. Liquid electrolyte batteries can usually benefit from four state solar charging (Figure3).

To select three stage charge control, set program P21 (finish amp value in %) to "OFF." Then for charging, set these program values: P1, Aabsorb volts. P14, max absorb time. P16, float volts and optionally P20 (% overcharge amp hours.)
To properly monitor "percent full", also set these program values: P2: charged setpoint amps (amps =P2% times P3), P3: battery system capacity.

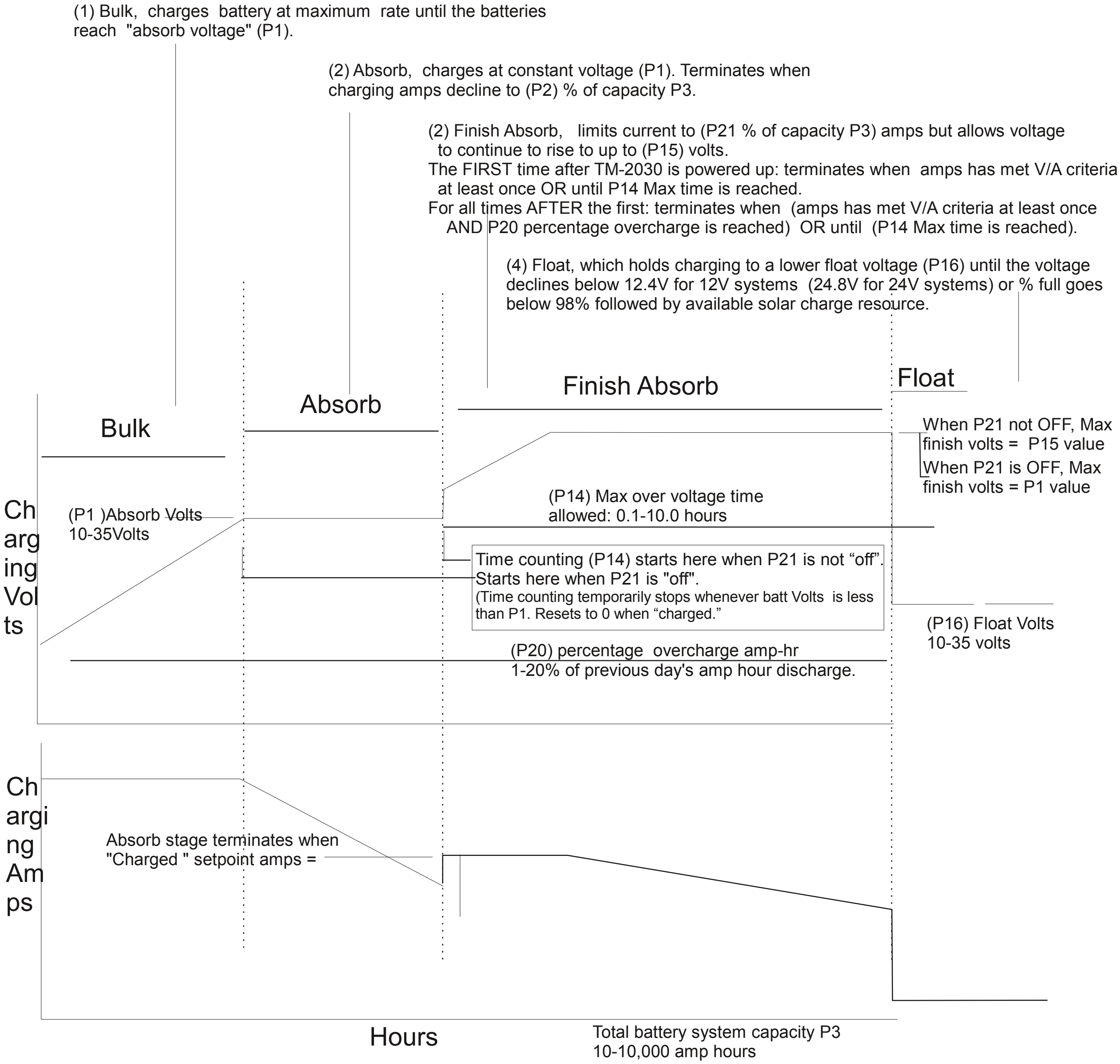


3 state charging profile
(AGM or Gel batteries)
Figure 2

Total battery system capacity P3
10-10,000 amp hours

Four stage charge control: Figure 3. This method has four stages, having an additional final higher voltage "finish absorb" stage, also with optional capability to deliver a measured additional amp hour overcharge (compared with the most recent discharge amount). It is suited to do a more thorough charging of liquid electrolyte lead acid batteries--and recently some companies are also suggesting this for AGM type batteries. This can better maintain their capacity.

To select four stage charge control, program P21 (finish %amp value of P3) must NOT be "OFF." Then for charging, set these program values: P1: Absorb volts. P2: Absorb end amps value. P3: Battery system capacity, amp-hours. P14: Max absorb time. P15: Max finish charge volts, P16: Float volts. P21: Max finish charge amps and optionally P20: % Amp hours overcharge. When these values are properly set, the TriMetric will also correctly measure "% Full"



4 state charging profile

for liquid electrolyte batteries

Figure 3

TABLE 4: Programmed values for each P22 charging profile number. See *NOTE below
All values are normalized to a "capacity" of 220Ahr. After placing a profile in P22, then change the P3 setting to your value unless your system has capacity=220 Amp hr.

Battery type (with total system volts not battery volts**)**	**Profile number P22**	**P1 Absorb V**	**P2 Amps setpt**	**P3 capacity Ahr**	**P14 Time hr**	**P15 high V**	**P16 float V**	**P20 Over charge**	**P21 Finish amps**
"Generic" wet cell (12V)	**1**	14.4V	2.0%	220AH	4.0h	15.7	13.2	10%	3.0%
"Generic" wet cell (24V)	**2**	28.8	2.0%	220AH	4.0h	31.4	26.4	10%	3.0%
Trojan wet cell (12V)	**3**	14.4V	2.0%	220AH	4.0h	16.2V	13.4	10%	3.0%
Trojan wet cell(24V)	**4**	28.8V	2.0%	220AH	4.0h	32.4V	26.8	10%	3.0%
Crown wet cell(12V)	**5**	14.5V	2.0%	220AH	4.0h	15.9	13.5	10%	3.5%
Crown wet cell(24V)	**6**	29.0 V	2.0%	220AH	4.0h	31.8	27.0	10%	3.5%
US Battery(12V)	**7**	14.8V	2.0%	220AH	4.0h	15.5	13.0	15%	3.5%
US Battery(24V)	**8**	29.6 V	2.0%	220AH	4.0h	31.0	26.0	15%	3.5%
Concorde AGM(12V)	**9**	14.3 V	2.0%	220AH	4.0h	16.5	13.3	7%	2.0%
Concorde AGM(24V)	**10**	28.6 V	2.0%	220AH	4.0h	33.0	26.6	7%	2.0%
Deka monobloc(12V) 8A, 8G	**11**	14.2 V	2.0%	220AH	8.0h	14.2	13.5	20%	5.0%
Deka monobloc (24V) 8A, 8G	**12**	28.4 V	2.0%	220AH	8.0h	28.4	27.0	20%	5.0%
Interstate(12V) wet cell	**13**	14.5 V	2.0%	220AH	4.0h	15.3	13.4	15%	4.0%
Interstate(24V) wet cell	**14**	29.0 V	2.0%	220AH	4.0h	30.6	26.8	15%	4.0%
GNB-Absolyte(12V) VRLA	**15**	14.3 V	1.0%	220AH	8.0h	14.3	13.5	7%	2.0%
GNB-Absolyte(24V) VRLA	**16**	28.6 V	1.0%	220AH	8.0h	28.6	27.0	7%	2.0%
Generic-Wet Cell-no hi volt finish	**17**	14.7	2.0%	220AH	0.1h	15.0	13.2	12%	0FF
Generic-AGM-no hi volt finish	**18**	14.3	2.0%	220AH	0.1h	15.0	13.3	7%	0FF

*NOTE: We occasionally update these profiles with what we consider better data, so your unit may not have precisely what's shown. Manufacturers sometimes change their recommendations. And not infrequently some battery companies will have slightly different recommendations on the same web site, depending on which page you look. After loading a profile you may want to check and change any individual program value shown on this table.

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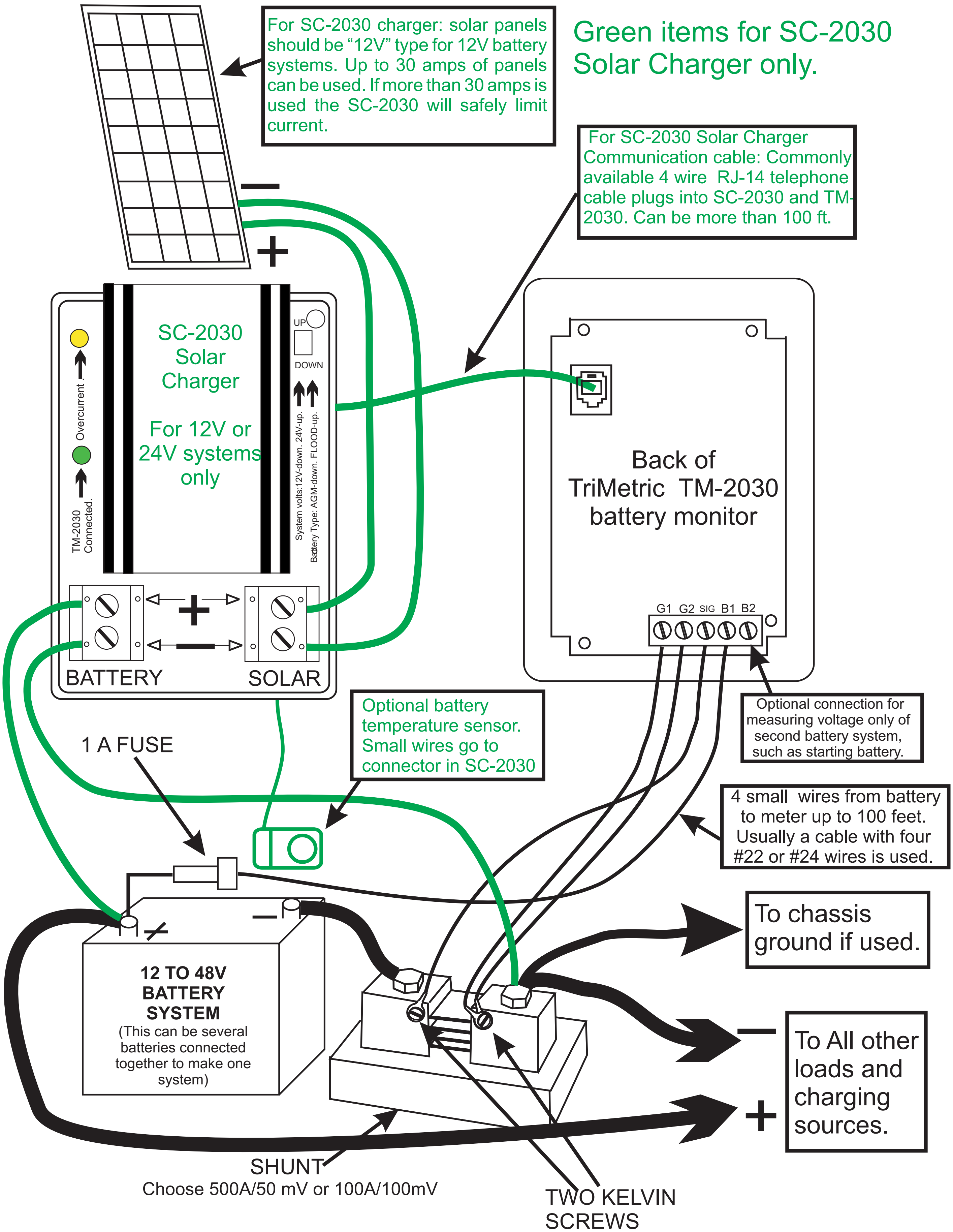
For SC-2030 charger: solar panels should be "12V" type for 12V battery systems. Up to 30 amps of panels can be used. If more than 30 amps is used the SC-2030 will safely limit current.
Green items for SC-2030 Solar Charger only.
For SC-2030 Solar Charger Communication cable: Commonly available 4 wire RJ-14 telephone cable plugs into SC-2030 and TM-2030. Can be more than 100 ft.
SC-2030 Solar Charger
For 12V or 24V systems only
UP
DOWN
System volts: 12V-down. 24V-up.
Battery Type: AGM-down. FLOOD-up.
Overcurrent
TM-2030 Connected.
BATTERY
SOLAR
Back of TriMetric TM-2030 battery monitor
G1 G2 SIG B1 B2
Optional connection for measuring voltage only of second battery system, such as starting battery.
Optional battery temperature sensor. Small wires go to connector in SC-2030
1 A FUSE
4 small wires from battery to meter up to 100 feet. Usually a cable with four #22 or #24 wires is used.
To chassis ground if used.
12 TO 48V BATTERY SYSTEM
(This can be several batteries connected together to make one system)
To All other loads and charging sources.
SHUNT
Choose 500A/50 mV or 100A/100mV
TWO KELVIN SCREWS

Simplified description for installing Bogart Engineering SC-2030 charger and TM-2030 Battery Monitor. Illustration on previous page.

WHAT'S INVOLVED IN INSTALLING THE BOGART ENGINEERING TM-2030 monitor:

This is a brief description. See TM-2030 Installer's instructions for complete description

Additional parts you will need: ●Shunt. ●4 wire cable from battery to meter. ●Short, large cable to go from shunt to battery.

Mounting the Meter: The TM-2030 is usually installed in the living area. Depending on how you want to mount it, two styles of TM-2030 are available which perform identically. The label colors are also different. See the "bogartengineering.com" website: go to "Products", "TriMetric" for photos and further description.

The TM-2030-RV is most popular, and easiest to mount on a wall using two screws. When mounted on a wall it is 5 inches high and 3 inches wide and extends from the wall 1 inch.

The TM-2030-A is easier to mount flush on a wall if this is desired. It has a panel that is 4-1/4 by 4-3/4 inches, and extends 1 inch deep. It is designed to fit into a double gang electrical box of sufficient size, or it can be fastened to a wall with four screws onto a square hole of sufficient size. The panel color is different from the TM-2030-RV.

Installing the shunt: **The shunt is not included with the meter**, and must also be purchased with the meter for about $30. There are two possible choices for shunt, depending on your system size. To decide on which one, look on the Bogart Engineering web site under "Frequently Answered Questions" in the "shunt" section. This enables the TM-2030 to measure the battery current. Size: 1-3/4 x3-1/4 x 2 in high. It is located near the batteries and connects to the TM-2030 with 4 small wires, usually in a plastic jacket.

First remove all connections presently connected to the battery system negative pole.

Connect one end of the shunt to the now bare negative pole of the battery system with a short cable large enough to accommodate the largest current you will have when charging or discharging your batteries

Wires and cables previously connected to the battery negative pole must then be reconnected to the "load" side of the shunt.

Connect four wires from shunt and battery to Meter: Cable consisting of small wires (#22 up to 100 feet long) need to connect from the TriMetric to the shunt and batteries.

WHAT'S INVOLVED IN INSTALLING THE BOGART ENGINEERING SC-2030 Solar Charger: Brief description. Complete description is in the SC-2030 User's Manual

Additional parts you will need: ●Obviously solar panel(s). ●Two wires from panels to charger and 2 wires from charger to batteries. ●Telephone cable (4 wire, RJ-14) for communication from SC-2030 to TM-2030. ●Optional temperature sensor.

The SC-2030 charger is usually located near the batteries, but may be located anywhere between panels and batteries when being controlled by the TM-2030 since it is monitoring the exact battery voltage and can compensate for some voltage drop in the wires.

Usually the solar panels will be installed first. For good efficiency with 12 volt battery set, when used with a PWM type controller, these must be so called "12 volt" panels. These are ones that have a maximum power voltage (Vpp) of about 17 or 18 volts. Two wires of sufficient size must be run that will carry the current from the panels to the batteries. A wire table in the SC-2030 instructions tells proper wire size depending on maximum solar amps and the wire distance from panels to battery.

Install the temperature sensor: For batteries that are not usually at nearly 25° C (77° F), a temperature sensor is advisable for temperature compensation of the voltage. It should be located in a place in the battery compartment that is at the temperature of the batteries. It connects to the SC-2030 Solar Charger at the back of the circuit board. A hole must be drilled in the enclosure at a convenient place in the box to accommodate the small wire.

Install communication wires from SC-2030 charger to TM-2030 Monitor: This is a 4 wire common telephone cable between the TM-2030 and SC-2030. This allows control commands from the TM-2030 and Solar data from the SC-2030. One end plugs into each device. A hole must be drilled in the TM-2030 and SC-2030 cases at suitable location for your situation to accommodate the wire.