STEVENS
MEASUREMENTS TO MIND

Quick Start Instructions For

SOLO

Power Management System

DESCRIPTION

Stevens SOLO is much more than just a solar charge controller and regulator. It is an intelligent power management system. SOLO performs the features of a **charge controller,** a **power monitor,** SDI-12 **bus activity monitor,** and a **remote power controller** all in a single compact package.

The goal of SOLO is to keep your remote data collection platform operating smoothly year after year while avoiding data outages and costly site visits.

CHARGE CONTROLLER

Stevens SOLO features a float charger that can be used with PV arrays or power supplies having power ratings as high as 40 watts (or larger under controlled conditions).

Battery temperature is sensed by a sensor installed at the terminal labeled "Temp Sensor" on the controller. The float level of the SOLO changes by approximately – 23 millivolt per degree C, colder temperatures causing a higher float level. If the battery is located far from SOLO or in an area with differing temperature, it is recommended to place the temperature sensor on the battery and extend using standard low voltage wire.

The float threshold of SOLO is adjustable via an adjustment screw located on the top of SOLO labeled "Float Adjust". The 20 degree C float threshold may be set to any level between 11 and 16 volts. The charge controller will charge a fully discharged battery at the full current output of the solar panel and will automatically taper the charging current to zero as the terminal voltage of the battery approaches the float level of the charger. The charger then supplies whatever trickle current is required by the battery to maintain the battery at the float level, assuming sufficient sunlight. Any additional current, due to the load on the battery, is automatically supplied as needed, so long as there is sufficient sunlight to produce the current.

An LED indicator located on the top of the unit and labeled "Charge" indicates when the charger is charging or holding the battery at the float level. The main purpose of this LED is to give an indication that the charger and solar panel are functional. The LED is powered from the solar panel, and will not be illuminated if there is no sunlight. A dimly lit LED will occur with low sunlight levels insufficient for battery charging.

POWER MONITOR

Using SDI-12 commands, SOLO can be treated like a sensor, making measurements of Solar panel voltage, Battery voltage, and Load current. Both instantaneous and averaged measurements can be made. Measurement averaging sample rate and time period are adjustable with extended SDI-12 commands (see Appendix, SOLO SDI-12 Extended Commands for details).

> To request measurement data using the SDI-12 protocol send aM! (where a is the address, default 0). SOLO responds with a0006 to indicate 6 parameters of data are available. These 6 parameters are Instantaneous Load Current, Instantaneous Input Voltage, Instantaneous Battery Voltage, Average Load Current, Average Input Voltage and Average Battery Voltage. Current is measured in amperes, voltage is measured in volts. All measurement are fixed point with two digits to the left of the decimal and 4 to the right. Instantaneous Measurements are returned in response to the command aD0!. Average measurements are returned in response to the commands aD1!. A typical response to aDn! is in the format:

a+CC.cccc+VV.vvvv+VV.vvvv (e.g. `0+01.2714+12.9881+11.2222`) where the first parameter is Load Current, the second is Input Voltage and the third is Battery Voltage.

POWER MANAGER

Power cycling is often the main solution to a troubled data collection station. SOLO allows for this to happen remotely and/or automatically, eliminating costly and unnecessary trips to the remote site. Load power can be turned off and on using a set of SDI-12 extended commands. A power cycle (with programmable delays) can also be initiated with a manual button on the side of SOLO or with a pulse input at the "Pulse In" terminal block. Both these inputs have the delay and off-time controlled by the relevant SDI-12 commands.

Additionally, SOLO can be used as an **SDI-12 bus activity monitor**. An extended command sets the 'watchdog' timeout period. If SOLO does not detect SDI-12 bus activity before the timer expires, then load power will be cycled. In this way, SOLO can automatically monitor whether your logger is issuing commands to your SDI-12 sensors. If the logger ceases to issue commands, for instance due to a software crash, then SOLO will automatically restart the system.

See Appendix: SDI-12 Extended Commands for all commands relating to power management.

WIRING

Refer to the nameplate label on the top of the unit for proper wiring. Terminal connections may be made to the solar panel, battery and load in any sequence. Be careful to connect the polarity correctly. Reverse connection of the solar panel and battery will not cause damage. Reverse connection to the load, however could damage the load equipment depending on what it is.

SPECIFICATIONS

Maximum input voltage: Not to exceed 28 volts including transients and spikes.

Maximum charging current and/or power dissipation: Typically 4 amps. The controller will conservatively handle currents to 10 amps so long as the power dissipated by the controller doesn't exceed approximately 15 watts for longer than 5 seconds (SOLO would in this case need to be properly heatsinked). For example, assume SOLO is driven by a solar panel or power supply that is supplying 4 amps at a terminal voltage of 16 volts. Assume also that the battery terminal voltage is 13 volts. The power dissipated by the controller may be calculated as follows:

$$P = (16 - 13)(4) = 12 \text{watts}$$

Higher charging currents can be handled if the input voltage is closer to the charging voltage. The maximum allowable solar panel or power supply terminal voltage for a given charging current can be calculated as follows:

$$V = (15/ I) = V_{bat}$$

where: **V** = Maximum allowable terminal voltage of solar panel or power supply. (In no case should V be allowed to exceed 28 volts).

I = Charging current

$\mathbf{V_{bat}}$ = terminal voltage of battery

As an example, 7.5 amps of charging current can be handled by SOLO if the solar panel or power supply terminal voltage doesn't exceed:

$$V = (15/7.5) + V_{bat} = 2 + V_{bat}$$

Solar Panel Wattage: typically 40 Watts

Current consumption: 4-7mA, unloaded. The LED requires approximately 3 ma, however this current is supplied from the solar panel.

Temperature compensation: Approximately –23 millivolt/degree C.

Operating Temperature: -50 degree C to +55 degree C.

Storage Temperature: -55 degree C to +85 degree C.

ADJUSTING FLOAT THRESHOLD

This procedure assumes that the magnitude of the desired float level has been determined for the corresponding temperature of the temperature sensor. The float voltage can be determined as follows:

$$V_{float} = V_{20} + (20 - T_s)(.0234)$$

where: V_{20} = The specified float voltage for the battery at 20 degrees C.

T_s = actual ambient temperature of the temperature sensor in degrees C.

Step 1 Disconnect the battery from the battery leads of SOLO.

Step 2 Connect a voltmeter across the battery leads of SOLO.

Step 3 If the adjustment is being made in the field, be sure that the solar panel is producing adequate voltage, (several volts higher than the float level desired for the battery). If the adjustment is being made in the shop, connect a power supply to the solar input terminals, (DO NOT SET THE POWER SUPPLY OUTPUT HIGHER THAN 28 VOLTS OR YOU MAY DAMAGE SOLO).

Step 4 Adjust the screwdriver adjustment control on the top of SOLO until the voltmeter reads the desired float voltage.

Step 5 Remove the voltmeter and re-connect the battery to the battery terminals.

NOTES

If SOLO is used as a float regulator in conjunction with a power supply, be sure that the maximum output voltage from the supply never exceeds 28 volts. If the power supply is unfiltered, then the peaks of the rectified cycles must not exceed 28 volts. Keep in mind that a dc meter generally gives a reading that represents the average of the waveform, not the peak value. An oscilloscope should be used to accurately determine the peak value of the output waveform of a non-filtered power supply. Allow a 20% or more margin for high power line voltage.

There is no current limiting in SOLO, so be careful not to short the BATTERY leads when SOLO is being powered by a power supply. Shorting the battery leads from SOLO will reflect the short back onto the power supply, and may damage the power supply and/or SOLO. SOLO WILL NOT be damaged by shorts on the battery leads when supplied by a solar panel.

DO NOT CHANGE THE BATTERY CHEMISTRY FLOAT LEVEL (USING THE SDI-12 EXTENDED COMMAND SHOWN BELOW) WHEN UNIT IS CONNECTED TO A BATTERY. Also, changing battery chemistry will require a readjustment of the float voltage level. SOLO settings default for use with standard lead-acid type batteries. An SDI-12 extended command can be issued to SOLO to change internal settings when using Gel-Cell type batteries.

Setting the proper float level for the particular type of battery will optimize the charging voltage over temperature and extend the life of the battery

Appendix: SDI-12 Extended Commands for SOLO:

a = SDI-12 device address

= a 3-digit number value

aXJ0! - Switch OFF load

aXJ1! - Switch ON load

aXJR! - Initiate power cycle NOTE: aM9! will also initiate a power cycle. This is provided as a convenience for data loggers that do not support extended commands.

aXJD###! - Set off-time in seconds [001 to 255]. Must enter all 3 digits.
Note: Entering aXJD! restores default value (10 seconds of off-time)

aXJZ###! - Set restart delay time in minutes [000 to 255]. Must enter all 3 digits
Note: Entering aXJZ! restores default value (0, turn-off delay disabled).

aXJW###! - Set SDI-12 bus monitor watchdog timeout in minutes [000 to 255]. Must enter all 3 digits
Note: Entering aXJW! restores default value of (0, disable SDI-12 bus monitor).

aXJT###! - Set the Time between measurements in seconds used for historical averaging [001 to 120]. Must enter all 3 digits.
Note: Entering aXJT! restores default value of 1 second.

aXJM###! - Set the number of sample measurements used in historical averaging [002 to 030].
Note: Entering aXJM! restores default value of 002.

aXJB[L or G]! - Set the battery type ["L"= lead acid "G" = Gel Cell]. Default is "L".

aXFR!- Display all programmable values
Response is of the form:

aXFR:S=s,A=a,D=ddd,Z=zzz,W=www,T=ttt,M=mmm,B=b

where:
s - 0 flash has been erased, 1 flash has been programmed
a - SDI address
ddd – power cycle off-time (in seconds)
zzz – power cycle delay time (in minutes)
www – SDI-12 bus monitor watchdog timeout period (in minutes)
ttt - time between sensor measurements (in seconds)
mmm - measurement samples to be averaged
b - battery chemistry, G for gel cell, L for lead acid