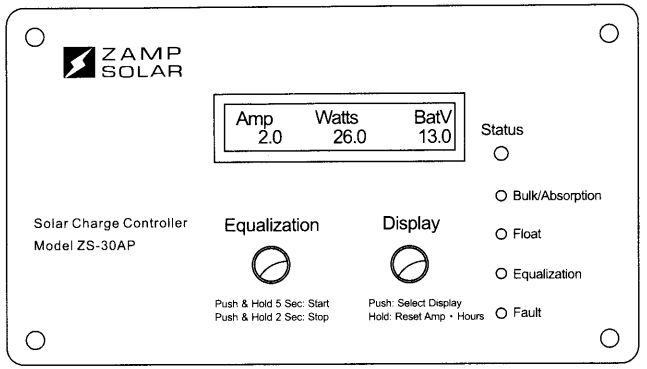
ZAMP SOLAR

User's Manual



Solar charge controller
Model ZS-30AP

General

ZS-30AP is designed for flush mounting on a wall / panel. The controls and indications are built on the Front Panel face plate that has 4 countersunk holes for flush mounting (Fig. 1). All the electronics, DIP switches for settings, terminal strip for connections for the PV Array and the Battery and terminal for the optional Battery Temperature Sensor (BTS) are mounted on a PCB that is in turn mounted at the back of the face plate (Fig. 2). For flush mounting on the wall / panel, a suitable cutout is required to be made in the wall / panel to accommodate the PCB at the back of the unit. As the components at the back of the unit will be hidden and protected behind the wall / panel, the components at the back of the unit are exposed and do not have a protective cover.
PLEASE HANDLE THE UNIT CAREFULLY TO PREVENT ANY DAMAGE TO THE EXPOSED COMPONENTS AT THE BACK OF THE UNIT.

NOTE: As the unit will be connected to 12 V / 24 V Nominal Solar Array / battery system, there is no likelihood of electrical shock.

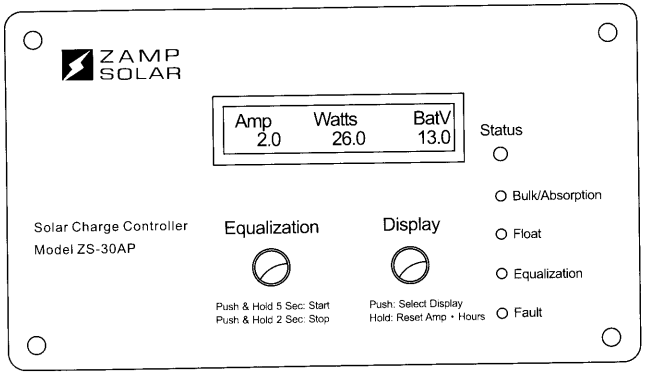
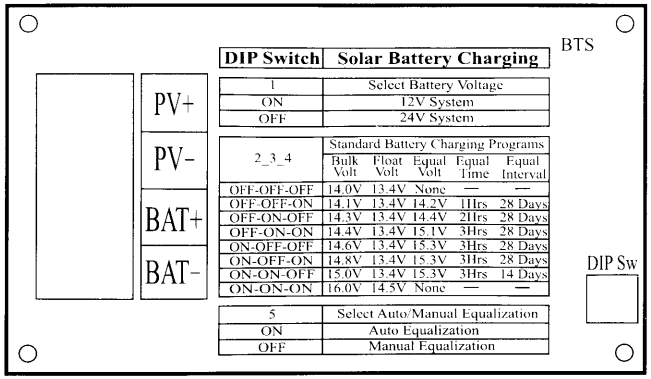


Fig. 1. Front Panel of ZS-30AP



DIP Switch	Solar Battery Charging				
1	Select Battery Voltage				
ON	12V System				
OFF	24V System				
2_3_4	Standard Battery Charging Programs				
	Bulk Volt	Float Volt	Equal Volt	Equal Time	Equal Interval
OFF-OFF-OFF	14.0V	13.4V	None	—	—
OFF-OFF-ON	14.1V	13.4V	14.2V	1Hrs	28 Days
OFF-ON-OFF	14.3V	13.4V	14.4V	2Hrs	28 Days
OFF-ON-ON	14.4V	13.4V	15.1V	3Hrs	28 Days
ON-OFF-OFF	14.6V	13.4V	15.3V	3Hrs	28 Days
ON-OFF-ON	14.8V	13.4V	15.3V	3Hrs	28 Days
ON-ON-OFF	15.0V	13.4V	15.3V	3Hrs	14 Days
ON-ON-ON	16.0V	14.5V	None	—	—
5	Select Auto/Manual Equalization				
ON	Auto Equalization				
OFF	Manual Equalization				

Fig. 2. Back view of ZS-30AP

Controls & Indications

The description and the functions of the controls and indications are given below:

Front Panel

Charge Status LED Indications

LED STATE	INDICATION	
Blinking Green	Charging is in the state of Bulk or Absorption depending upon the number of blinks as follows:	
	For 12 V Battery	For 24 V Battery
- 1 Green Blink	> 0.75 V below Absorption Voltage setting	> 1.5 V below Absorption voltage setting
- 2 Green Blinks	0.75 V below Absorption Voltage setting	1.5 V below Absorption Voltage setting
- 3 Green Blinks	0.5 V below Absorption Voltage setting	1.0 V below Absorption Voltage setting
- 4 Green Blinks	0.25 V below Absorption Voltage setting	0.5 V below Absorption Voltage setting
- 5 Green Blinks	At Absorption Voltage setting	At Absorption Voltage setting
Solid Green	Charging is in the state of Float	

Solid Orange	Charging is in the state of Equalization
Solid Red	Charging is in the state of fault: Over current or low DC voltage or operating temp below 0°C (32°F)
Blinking Red	Charging is in the state of fault: Over Temperature

Push Buttons

BUTTONS	ACTION
Display Reset Amp-Hours	Push to change the display as in Fig. 3. Push and hold to reset Amp-Hours.
Equalization Start/Stop	When DIP Switch 5 is set at OFF, hold Restart/Stop Equalization for 5 sec to manually start equalization. Press it for 2 sec to stop equalization.

LCD Display

The LCD Display is a 2 Line, 16 character display. The Push Switch marked "PUSH Select Display" and "HOLD Reset Amp Hours" is used to manipulate the LCD functions. Every time the Push Switch is pressed momentarily, the screen display scrolls. The scrolling sequence is shown in Fig. 5.3. Please note that the 7 screens are sequential & are displayed in a continuous loop: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 1 - 2 - 3 and so on.

LCD Display Screens

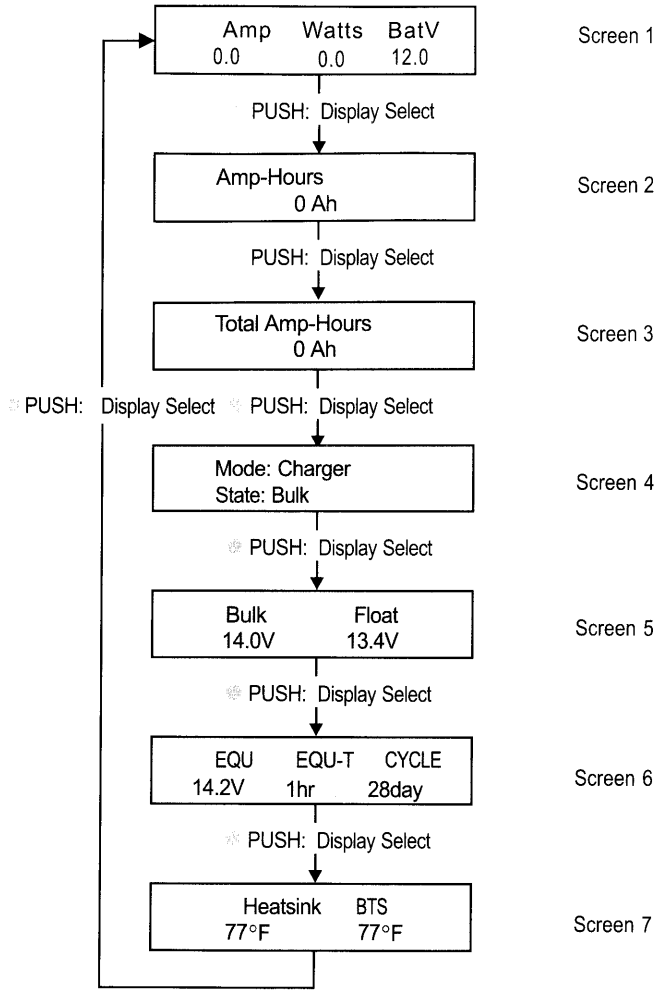


Fig. 3. LCD Display Flow

The details of information provided in the LCD screens are given below:

Screen 1

- Shows the solar array current / charging current in Amperes (Amp), battery voltage in V (BatV) and the power delivered by the solar array / fed to the batteries in Watts (Watts). The value of Watts = the charging current in Amperes (Amp) x Battery Voltage in V (BatV).

Screen 2

- It is a resettable counter that displays the Ampere Hours (Amp-Hours) of energy (in Ah) delivered by the solar panel into the batteries with effect from the time the solar panel has been connected or with effect from a desired starting / reference point after the counter is set to 0. ***The counter can be set to zero with the help of the Push Button marked "Reset Amp-Hours" (Push and hold the Push Button till the counter resets to 0).*** For example, due to its 75% to 85 % efficiency, a lead acid battery requires up to around 130% of Amp-Hour energy as compared to its rated Amp-Hour capacity to recharge fully. Hence, during start of recharging of say a fully discharged 100 AH battery, the Amp-Hours counter can be set to 0. As 130 Amp-Hour of energy will be required to re-charge a fully discharged 100 AH battery, a healthy battery is likely to be fully recharged when the Amp-Hour counter approaches 130 Amp-Hours.

Screen 3

- Counts the total running Ampere Hours (Amp-Hours) of energy (in Ah) delivered by the solar panel into the batteries. ***This will only reset if the battery connection is removed.***

Screen 4

- Shows the charging Mode in progress: Bulk or Absorption or Equalization or Float.

Screen 5

- Shows the Bulk (Absorption) and Float voltages that have been set for the desired battery type / charging algorithm corresponding to one of the 8 options that can be selected with the help of DIP Switches 2, 3, 4 (Table 3).

Screen 6

- Displays the Equalization Voltage (EQU, in Volts), Equalization Time (EQU-T, in Hours) and Equalization Cycle (CYCLE, in days). These parameters are automatically set once a particular battery type / charging algorithm corresponding to one of the 8 options has been selected using DIP Switches 2,3,4 (Table 3).

Screen 7

- Displays the heat sink temperature (Heatsink) in °F (the metal plate of the front panel acts as the heat sink). It also displays the temperature of the battery in °F when the optional Battery Temperature Sensor (BTS) is used.

NOTE: The battery temperature can not be displayed below 32° F. If the battery temperature falls below 32° F, the display will read "- - - ° F".

Fault Messages

The LCD displays might have the following fault messages when ZS-30AP stops operating.

DISPLAy	DESCRIPTION	CAUSE OF FAULT
Alarm: OC Over Current	Over Current	The current exceeds 15% of the rated current
Alarm: OT	Heat Sink over temperature	Heat sink temperature exceeds 194°F.
Alarm: CPF04 DC / DC Low Volt	Low Battery voltage < 9V for 12V Battery < 18V for 24V Battery	1. Batteries are discharged below the minimum acceptable level, or 2. DIP Switch 1 is set for 24V battery but the battery is 12V.
Alarm: CPF09 Heat Sink SR Open	Low operating	Operating temperature of the unit is below the specified limit of 32°F.
Battery Temperature Sensor (BTS) displays: - - - °F	Battery temperature is below 32°F	1. Lower limit of temperature compensation is 32°F. 2. Negative values can not be displayed.

Table 1. Fault Messages.

Back of the Unit

The back of the unit (Fig 2) has the following input / output connections and DIP Switches for various settings.

NAME	DESCRIPTION
PV+	Connecting terminal for Solar Array Positive
PV	Connecting terminal for Solar Array Negative
Battery +	Connecting terminal for Battery cable Positive
Battery	Connecting terminal for Battery cable Negative
DIP Switch 1	ON*Selection of battery voltage for 12V system
	OFFSelection of battery voltage for 24V system
DIP Switch 2,3, 4	Battery charge control mode: Battery charging algorithm
DIP Switch 5	ONSelection of Auto Equalization
	OFF*Selection of Manual Equalization
BTS	Battery Temperature Sensor for temperature compensation

***NOTE: Factory preset condition**

Table 2. Control Terminal Connection (At the back of the unit).

Dip Switch Settings

Five DIP Switches permit the following parameters to be adjusted at the installation site:

NAME		DESCRIPTION
DIP Switch 1	ON*	Selection of battery voltage for 12V system
	OFF	Selection of battery voltage for 24V system
DIP Switch 2,3, 4	Battery charge control mode: Battery charging algorithm (see Table 3)	
DIP Switch 5	ON	Selection of Auto Equalization
	OFF*	Selection of Manual Equalization

***NOTE: Factory preset condition**

Battery Charging Notes

The ZS-30AP manages many different charging conditions and system configurations. Some useful functions to know are given below.

Solar Overload: Enhanced radiation or "edge of cloud effect" conditions can generate more current than the controller's rating. The unit will reduce this overload up to 130% of rated current by regulating the current to safe levels. If the current from the solar array exceeds 150%, the controller will interrupt charging.

Battery Types: The ZS-30AP's standard battery charging programs are suitable for a wide range of Lead-Acid battery types. These standard programs are select by DIP Switch 2~4. There is also one program for Ni-Cd battery (see Table 3).

Standard Battery Charging Programs

The ZS-30AP provides 8 standard battery charging algorithms (programs) that are selected with DIP Switches 2, 3, 4. These standard algorithms are suitable for Lead-Acid batteries ranging from sealed (Gel, AGM, maintenance free) to flooded to L-16 cells and Ni-Cd etc.

Table 3 below summarizes the major parameters of the standard charging algorithms. ***Note that all the voltages are for 12V systems. For 24 V system, multiply the voltages by 2.***

- Consult the battery manufacturer / battery specifications & select the appropriate Algorithm.
- The unit is preset for Battery Type 1 (off-off-off) for a sealed / VRLA battery.
- For a generic non-sealed / vented / flooded / well cell Lead Acid battery, choose Battery Type 4.

Note: 1. All voltage values are at 77 °F.
2. All the voltages given in the Table are for 12V Battery System.
For 24V Battery Systems multiply the voltage values by 2.

	A	B	C	D	E	F
DIP Switches (2-3-4)	Battery Type	PWM Absorption Voltage	Float Voltage	Equalize Voltage	Equalize Time (hours)	Equalize Interval (days)
Off-Off-Off (Factory Preset)	1 - Sealed	14.0	13.0	None	-	-
Off-Off-On	2 - Sealed	14.1	13.4	14.2	1	28
Off-On-Off	3 - Sealed	14.3	13.4	14.4	2	28
Off-On-On	4 - Flooded	14.4	13.4	15.1	3	28
On-Off-Off	5 - Flooded	14.6	13.4	15.3	3	28
On-Off-On	6 - Flooded	14.8	13.4	15.3	3	28
On-On-Off	7 - L - 16	15.0	13.4	15.3	3	14
On-On-On	8 - Ni - Cd	16.0	14.5	None	-	-

Table 3. **Standard Battery Charging Programs**

A. ***Battery Type*** These are generic Lead-Acid wet cell (Lead Antimony, Lead Calcium), sealed AGM, sealed Gel Cell and Ni-Cd battery types.

B. ***Voltage*** This is the PWM Absorption Stage with constant voltage charging. The "PWM Absorption voltage" is the maximum battery voltage that will be held constant. As the battery becomes more charged, the charging current tapers off until the battery is fully charged.

C. ***Float Voltage*** When the battery is fully charged, the charging voltage will be reduced to 13.4 volts for all battery types. It will be 14.5V for Ni-Cd.

D. ***Equalization Voltage*** During an equalization cycle, the charging voltage will be held constant at this voltage.

E. ***Equalization Time*** The charging at the selected equalization voltage will continue for this number of hours.

F. ***Equalization Interval*** Equalizations are typically done once a month. Most of the cycles are 28 days so the equalization will begin on the same day of the month.
Each new cycle will be reset as the equalization starts so that a setting day period will be maintained.

Equalization Procedure

Standard Equalization Programs

Both automatic and manual equalizations can be performed using the standard charging programs.

Manual Equalization

The ZS-30AP is shipped with the DIP Switch 5 set for manual equalization only.
This is to avoid an unexpected or unwanted automatic equalization. In the Manual Mode, the push button marked "Equalization" is used to both start and stop a manual equalization. ***Hold the push button down for 5 seconds to start and 2 seconds to stop an equalization (depending on whether an equalization is in progress or not).***
There are no limits to how many times the push button can be used to start and stop equalizations. Equalizations will be terminated automatically as per the charging program selected if the push button is not used to manually stop the equalization.

Automatic Equalization

If the equalization DIP Switch 5 is moved to the ON position, the equalizations will begin automatically as per the charging program selected. Other than starting, the automatic and manual equalizations are the same and follow the standard charging program selected. The push button can be used to start and stop equalizations in both the manual and automatic mode.

Typical Equalization

The automatic equalizations will occur at the selected charging program from DIP Switch 2~4. When equalization begins (Auto or Manual), the battery charging voltage increases up to the Equalization Voltage **Veq**. The battery will remain at **Veq** for the time specified in the selected charging program.

The equalization process will continue until the voltage has been held above the bulk (Absorption) setting for a cumulative period of one, two or three hours. A second manual equalization cycle can be started with the push button, if needed.

If the equalization cannot be completed in one day, it will continue the next day or days until finished.

Temperature Compensated Battery Charging

An optional Battery Temperature Sensor (BTS) is available for temperature compensated battery charging.

The BTS consists of a temperature sensing probe that is installed on the side of battery. The temperature of the battery post reflects the approximate temperature of the electrolyte. A 20 ft wire connects the temperature sensing probe to the, housing marked BTS at the back of the unit (Fig. 2).

As the battery gets warmer, the gassing increases. As the battery gets colder, it becomes more resistant to charging. Depending on how much the battery electrolyte temperature varies, it is important to adjust the charging for temperature changes.

Various voltage set points given in the specifications are indicated at a reference temperature of 77 °F.

It is recommended that the optional Battery Temperature Sensor (BTS) may be used if the battery electrolyte temperature (measured at the + terminal stud) varies more than 9 °F to 18 °F from the reference temperature of 77 °F.

There are three battery charging parameters that are affected by temperature:

PWM Absorption

This is the most important part of charging that is affected by temperature because the charging may go into PWM absorption almost every day. If the battery temperature is colder, the charging will begin to regulate too soon and the battery may not be recharged with a limited solar resource. If the battery temperature rises, the battery may heat and gas too much.

Equalization

A colder battery will lose part of the benefit of the equalization. A warmer battery may heat and gas too much.

Float

Float is less affected by temperature changes, but it may also undercharge or gas too much depending on how much the temperature changes.

The Battery Temperature Sensor (BTS) corrects the three charging set points noted above by the following values (reference temperature is 77 °F):

- 12 volt battery: -0.017 volts per °F.
- 24 volt battery: -0.033 volts per °F.

The temperature sensed by the BTS at the battery is displayed on the LCD screen under the screen display "Heatsink BTS" (see Fig. 3). ***As the LCD display is not capable of displaying negative values, battery temperature below 32 °F will not be displayed. If the battery temperature falls below 32 °F, the display will read --- °F and temperature compensation is disabled.***

Variations in battery electrolyte temperature can affect charging, battery capacity, and battery life. The greater the range of battery temperatures, the greater the impact on the battery. For example, if the battery temperature falls to 50°F, 27°F change in temperature with respective to the reference of 77°F will change the PWM Absorption, equalization and float set points by 0.90 V in a 24 V system and 0.45 V in a 12 V system.

Typical compensation is given in Table 4 below:

BATTERY ELECTROLYTE TEMPERATURE	VOLTAGE COMPENSATION	
	12 VOLT BATTERY	24 VOLT BATTERY
122 °F	-0.75 V	-1.50 V
113 °F	-0.60 V	-1.20 V
104 °F	-0.45 V	-0.90 V
95 °F	-0.30 V	-0.60 V
86 °F	-0.15 V	-0.30 V
77 °F (Reference)	0 V (Reference)	0 V (Reference)
68 °F	+ 0.15 V	+ 0.30 V
59 °F	+ 0.30 V	+ 0.60 V
50 °F	+ 0.45 V	+ 0.90 V
41 °F	+ 0.60 V	+ 1.20 V
32 °F	+ 0.75 V	+ 1.50 V

Table 4 Temperature Compensation

CHARACTERISTICS	SPECIFICATIONS
SYSTEM	
Nominal system voltage	12 VDC or 24 VDC (Selected by DIP Switch)
Current rating	30 A
Set point accuracy	+ / - 200 mV
Minimum voltage to start the micro-controller, activate protections and guide operation	9 VDC for 12 V Battery System 18 VDC for 24 V Battery System
Total self consumption current	100 mA
INPUT SIDE (Solar panel / array)	
Maximum open circuit voltage Voc of the solar panel/array	50 VDC
Maximum operating voltage of the solar panel/array	34 VDC
Maximum short circuit current Isc of the solar panel/array	30 A

BATTERY CHARGING	
Charging algorithm	PWM
Charging stages	Bulk, Absorption, Float, Equalize (Selectable)
Battery Temperature Compensation	With optional Battery Temperature Sensor (BTS), supplied with 20 fts of wire
Voltage coefficient of Temperature change when using optional Battery Temperature Sensor (BTS)	- 5mV / °F / cell (77 °F reference) - 10mV / °F / cell (77 °F reference)
Temperature compensation range	32 °F to 122 °F
PROTECTIONS	
High temp shutdown (Temp of the face plate that is used as a heat sink)	194 °F disconnect solar panel/array 158 °F re-connect solar panel/array
Over current (overload) shut down	45 A
DISPLAY	
LCD	2 lines X 16 characters, alpha numeric
LED	1 LED for status display

CHARACTERISTICS	SPECIFICATIONS
ENVIRONMENTAL	
Ambient temperature	32 °F to 113 °F
Storage temperature	- 67 °F to 185 °F
Humidity	95% Non Condensing
MECHANICAL	
Dimensions (L x W x D)	7.48 x 4.25 x 1.38 inches 190 x 108 x 35 mm
Weight (With gift box)	1.2 lbs / 0.55 kg
Net weight	0.8 lb / 0.36 kg
Enclosure / face plate	Aluminum plate, for indoor use only
ACCESSORIES INCLUDED	
Insulated spade lugs for input / output connections	4 pieces For # 8 stud; AWG 12-10 wire size
Self tapping screws for fixing the face plate	4 pieces 7 x 19, 5/8"; Type 25 point; Flat head; Philips drive

Specifications subject to change without notice