



# X-90 Solar V3-AUX

Patent pending

## Portable Fast-Charge Solar Battery Charger

### Features

- ◆ Maximum Power Point Tracking
  - Up to 30% more power
- ◆ Universal Charging Algorithm
  - Identifies chemistry automatically
- ◆ Fully protected 12V/8A auxiliary output
- ◆ No User Input Required
- ◆ Fully Ruggedized Design
- ◆ Field Replaceable Sense Pins
- ◆ Fully Protected, including Reverse Polarity, Over Temperature, and Active Current Limiting, and MIL-810F Compliant
- ◆ Integrated "Time Until Charged/Discharged" Calculator
  - An LED bar will indicate the time until charged or discharged based on the energy source, auxiliary load, and battery state of charge.
- ◆ 12V or 24V Solar Panel Input - No Minimum/Maximum Solar Panel Wattage
- ◆ Polarized SAE plug to connect to solar panel or source
- ◆ Available extension input cable for use with other solar panels or DC sources
- ◆ Available "Y" adapter, to parallel multiple solar panels for maximum charge speed
- ◆ Compatible with "Smart X-90" adapters, allowing expanded operation with numerous batteries and adapters
- ◆ Emergency regulated 14.4V Aux output when there is no battery connected
- ◆ Auto dimming LED indicators reduce the LED brightness when there is no input power



Supported batteries	Chemistry
BB/UBI-2590/U	Li-Ion
BB-590/U	NiCd
BB-390B/U	NiMH
UBBL09	Li-Ion
UBBL36	Li-Ion
X-90 Smart Adapter	Numerous

### Description

The X-90 Solar Charger is a portable solar battery charger capable of charging a wide array of typical portable rechargeable batteries. The charger features advanced digital control, which enables automatic battery detection, maximum power point tracking (MPPT) of the solar panel, and value-added features such as an unregulated 12V output, a "time until charged/discharged" calculator, and the ability to use "X-90 Smart Adapters" for charging numerous other types of batteries. The charger is able to operate from any solar panel configuration with  $V_{\text{open circuit}} < 60\text{V}$ . The charger directly plugs onto the top of the supported batteries, and the only wiring needed is the connection to the solar panel or DC source using a polarized SAE plug. The advanced charge controller minimizes charge time by charging two battery strings simultaneously, while monitoring critical parameters to ensure safety and reliability. The implementation of high-speed MPPT delivers maximum charging current, even in low light or poor weather conditions. The simple LED interface informs the user when the batteries have been completely charged, and if there are any fault conditions.



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## Absolute Maximum Ratings

	Parameters	Max.	Units
V <sub>in</sub>	Input Voltage	65	V
V <sub>batt</sub> / V <sub>aux</sub> (3)	Battery / Auxiliary Output Voltage	20	V
I <sub>batt</sub>	Battery Charging Current (Total)	8	A
I <sub>aux</sub> (3)	Auxiliary Current	16	A
T <sub>A</sub>	Ambient Operating Temperature	60	°C
T <sub>STG</sub>	Storage Temperature	85	°C

Table 1: Absolute Maximum Ratings

## Recommended Operating Conditions

	Parameters	Min.	Typ.	Max.	Units	Conditions
V <sub>in</sub>	12V PV Panel Voltage	V <sub>batt</sub> +1V	20	28	V	T <sub>panel</sub> =25°C
	24V PV Panel Voltage	V <sub>batt</sub> +1V	40	56	V	T <sub>panel</sub> =25°C
	DC Input Voltage	20	-	60	V	
V <sub>batt</sub>	Battery Voltage	10	-	20	V	
V <sub>aux</sub> (3)	Auxiliary Voltage	V <sub>batt</sub> -0.9V	-	V <sub>batt</sub> -0.2V	V	I <sub>aux</sub> =(0.8)A with battery without battery
		-	14.4V	-		
I <sub>batt</sub>	Battery Charging Current (Total)	0	-	8	A	
I <sub>aux</sub> (3)	Auxiliary Current	0	-	8	A	Continuous
				16		
P <sub>i</sub>	Input Power	-	-	140	W	
P <sub>batt</sub>	Battery Charging Power	0	-	132	W	V <sub>batt</sub> =16.5V, I <sub>batt</sub> =8A (1)
P <sub>aux</sub> (3)	Auxiliary Power	-	-	120	W	Continuous, V <sub>aux</sub> =15V
				240		Peak, w/ battery only, V <sub>aux</sub> =15V
I <sub>s</sub>	Self Consumption	-	0.8	-	W	V <sub>in</sub> =20V (5)
		-	1.2	-		V <sub>in</sub> =40V (5)
		-	0.45	-		V <sub>bat</sub> =15V, No V <sub>in</sub> (2)
η	Efficiency: Input to Battery	-	97.5	-	%	V <sub>in</sub> =20V, V <sub>batt</sub> =15V, I <sub>o</sub> =4A
		-	96.2	-		V <sub>in</sub> =40V, V <sub>batt</sub> =15V, I <sub>o</sub> =4A
		-	96.0	-		V <sub>in</sub> =40V, V <sub>batt</sub> =15V, I <sub>o</sub> =8A (1)
	Efficiency: Battery to Auxiliary	-	94.75	-		V <sub>batt</sub> =16V, V <sub>aux</sub> =15.5V, I <sub>aux</sub> =4A
		-	93.6	-		V <sub>batt</sub> =15V, V <sub>aux</sub> =14.1V, I <sub>aux</sub> =8A
		-	93.1	-		V <sub>in</sub> =20V, V <sub>aux</sub> =14.4V, I <sub>aux</sub> =4A
	Efficiency: Input to Auxiliary (5)	-	92.9	-		V <sub>in</sub> =30V, V <sub>aux</sub> =14.4V, I <sub>aux</sub> =4A
		-	91.0	-		V <sub>in</sub> =30V, V <sub>aux</sub> =14.4V, I <sub>aux</sub> =8A
T <sub>A</sub>	Ambient Operating Temperature	- 30	-	60	°C	
T <sub>STG</sub>	Storage Temperature	- 50	-	85	°C	
T <sub>LIM</sub>	Internal Temperature Limiting Protection	-	110	-	°C	Auxiliary port turns off and battery charge power reduces to maintain temperature limit (4)

Table 2: Electrical Characteristics

### Notes:

- (1) Charging a BB-2590/U Li-Ion battery with the rated maximum charging current
- (2) Total self consumption current taken from battery without input power
- (3) Auxiliary output is currently only enabled for Li-Ion chemistry batteries
- (4) External case temperature can become very hot in certain high load conditions, use caution when handling
- (5) No battery connected, X-90 is running to supply 14.4V on the auxiliary output



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## X-90 V3-AUX Label



## LED Status Information

Fault	Status	85% Charged	Aux Enabled	Meaning	Action to take
Red	Green	Green	Green		
Off	Off	Off	Off	Ready to connect	Connect battery
Off	Blinking <sup>(2)</sup>	Off	-	Charging	-
		On <sup>(1)</sup>		Charging, battery is 85% full <sup>(1)</sup>	<b>Optional:</b> Disconnect battery and connect a lower charged battery. In the time it takes to charge the last 15%, the first 50% of an empty battery could be charged. <sup>(1)</sup>
Off	On	On	-	Finished charging	Disconnect battery
On/ Blinking	-	-	-	Fault, converter not running	Check connections, make sure that operation of converter is within the maximum ratings
-	-	-	On	Aux output is enabled	An auxiliary load can be applied if desired
			Off	Aux output is disabled	The type of battery is not supported for auxiliary output or it has been disabled because of over-current or over-temperature
			Blinking	Aux output is close to maximum current or temperature rating	Reduce the load on the auxiliary port to keep it from turning off

Table 3: LED status information

### Notes:

<sup>(1)</sup> Only applies when charging Li-Ion

<sup>(2)</sup> Blinking speed changes based on charging current: ~ (0.5 to 20) blinks/sec for a total charge current of (0 to 8) A



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## Solar Maximum Power Point Tracking

The X-90 Solar Charger uses an advanced proprietary solar charge control algorithm which is capable of extracting the maximum possible energy from the solar source, and charging Li-Ion, NiMH, and NiCd at the fastest possible rate. ApECOR's universal MPPT algorithm is international patent pending, and is the only solar charge algorithm in the world capable of MPPT fast-charging nickel based batteries. The included algorithm can safely charge NiMH and NiCd at a rate up to 1C. The digital control algorithms are extremely tolerant of solar variation, and can operate down to only 5W of input power. The algorithms will not be disrupted by fluctuations of solar energy, or even if the charge cycle persists through the night.

## Time Until Charged/Discharged Indicator

The X-90 Solar Charger has the capability to simultaneously harvest energy from a solar or DC source, charge the connected battery, and provide a protected auxiliary output. This in effect can allow the system to become an uninterruptable power supply (UPS), which can provide the auxiliary power until the battery is fully discharged. Depending on the balance of power, in some cases the battery will be generally charging, while in other cases the battery will be discharging. For example, if the auxiliary load is on average 50W, but the available solar energy is only 30W, there will be a 20W deficit, which must be supplied by the battery. The X-90 V3 AUX will estimate the current battery state of charge (SOC) and based on the current conditions calculate how much time it will take for the battery to become completely charged or discharged, depending on the balance of power. This is then indicated by the 10-segment LED bar below the label.

## Typical Charging Times

Battery	Chemistry	Capacity (Ah)	Max Charge Current	Solar Panel (Watts)	Typical Full Charge Time (Hours)
BB-2590	Li-Ion	14.4	4A/String <sup>(1)</sup>	62	4.5 (3 hrs 85%)
				124	2.65 (1.75 hrs 85%)
				DC Source	2.5 (1.5 hrs 85%)
BB-390	NiMH	9.8	2A/String	62	3
BB-590	NiCd	4.8	2A/String	62	1.5
UBBL09	Li-Ion	18.4	4A/String	62	5.25
				124	3.25
				DC Source	3
UBBL36	Li-Ion	8.7	4A	62	2.75 (2 hrs 85%)

Table 4: Typical Charging Times

### Notes:

<sup>(1)</sup> Only applies when charging certain BB-2590 type batteries. Depending on the design limitations imposed by various manufacturers, the X-90 will automatically charge some BB-2590 type batteries at 3.2A per string.



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## Dimensions and Weight

	Parameters	Typ.	Units
L	Length	119.0	mm
		4.687	inch
W	Width	69.5	mm
		2.737	inch
H	Height	41.8	mm
		1.645	inch
W	Weight	0.44	kg
		0.965	lbs

Table 5: X-90 Dimensions and Weight

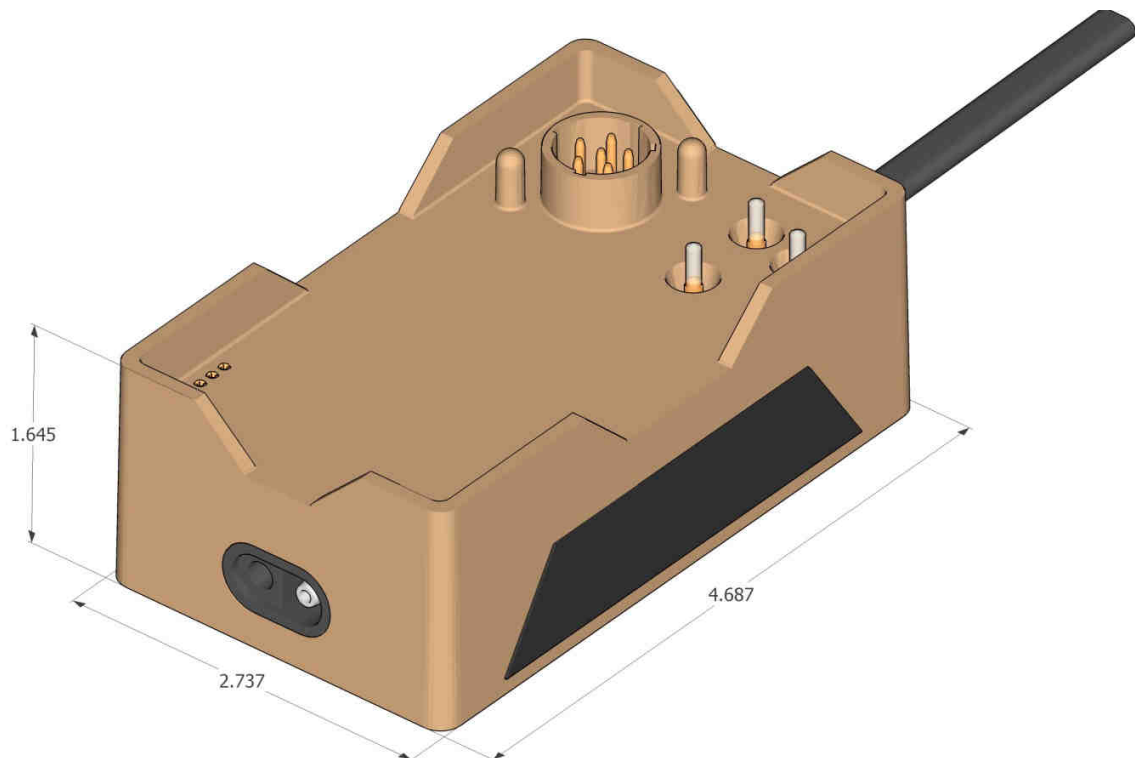


Figure 1: X-90 Dimensions (inches)



## Application Examples



Figure 2: X-90 charging a BB-2590/U using the Global Solar P3-62W/24V panel



Figure 3: X-90 Charging a BB-2590/U from a DC Source, with a 12V CLA adapter output

## Application Examples (Continued)



Figure 4: X-90 Powering a RCR-123A LiFePO4 battery charger



Figure 5: X-90 Charging a BB-2590/U with an extension cable, auxiliary output powering a PRC-148/152 battery eliminator adapter



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## **Recommended Sources**

Use only “12V” or “24V” PV Arrays, you can use 2 in parallel with “Y” connector, for improved charge speed.

### **Solar Panels - Global Solar Energy, Inc.**

- P3 - 124W/12V, P3-124W/24V - Optimal for BB-2590 charging
- P3 - 62W/12V, P3 - 62W/24V
- P3 - 30W/12V, P3 - 30W/24V

### **Other Solar Panels**

- Open circuit voltage must be less than 60V
- Maximum power point voltage should be greater than 17V for optimal operation, although the X-90 will still work with a lower  $V_{mpp}$  rated panel
- There is no wattage restriction, but the X-90 will not be able to utilize more than 140W

### **DC Sources**

- 20 - 60V DC, 140W minimum power capability

## **Recommended Batteries**

### UltraLife Batteries

- UBBL02 (UBI-2590), UBBL10 (UBI-2590 SMB<sub>us</sub>), UBBL09 (UBI-2590 12V/24V), UBBL36 (1/2 UBI-2590), UBBL13 (UBI-2590 HC)

### Mathews Associates, Inc.

- BB-2590/U, BB-390A/U, BB-590/U

### Bren-Tronics

- BB-2590/U, BB-390B/U, BB-590/U

### Patco Electroncis, Inc.

- BB-2590/U

## **Available X-90 Smart Adapters**

The X-90 V3 includes the capability to use adapter cables connected to the 6-pin XX90 barrel connector to allow the charging of numerous other batteries and accessories. The adapters communicate with the X-90 V3 to indicate the type of adapter connected, so as to allow the X-90 to implement the proper charge algorithm. ApECOR has the capability to provide specific charging solutions for nearly all battery types, please contact us at [ask@apecor.com](mailto:ask@apecor.com) to request specific charging capability.





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## Warranty Statement

The X-90 Solar Charger is warranted to be free from defects in material and workmanship for a period of TWO (2) years from the date of shipment to the original end user. ApECOR will, at its option, repair or replace any such defective products.

### Claim Procedure

- Before requesting warranty service, check the User Manual to be certain that there is a problem with the controller. Contact ApECOR to request Returned Material Authorization (RMA). Return the defective product to your authorized ApECOR distributor with shipping charges prepaid. Provide proof of date and place of purchase.
- To obtain service under this warranty, the returned products must include the model, serial number and detailed reason for the failure, the module type, solar panel size, type of batteries. This information is critical to a rapid disposition of your warranty claim.
- ApECOR will pay the return shipping charges if the repairs are covered by the warranty.

### Warranty Exclusions and Limitations

This warranty does not apply under the following conditions:

- Damage by accident, negligence, abuse or improper use.
- PV or load currents exceeding the ratings of the product.
- Unauthorized product modification or attempted repair.
- Damage occurring during shipment.

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