Technical Bulletin #100214

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Affected Products: All Solar Boost™ charge controllers

Purpose: Guidelines for PV Module selection

Background:

PV modules are available in a variety of voltage, current and power ratings. For safety, charge controller reliability and proper battery charging, PV modules must be properly matched to the charge controller and battery. This technical bulletin clarifies key PV module specifications and provides guidelines for proper PV module selection. Note that modules must be properly sized for both current and voltage.

➢ **WARNING:** To reduce the risk of fire or personal injury photovoltaic charge controllers must be installed in accordance with National Electrical Code (NEC), ANSI/NFPA 70. This technical bulletin serves as an application guide only and is not intended to identify all installation and safety requirements for a photovoltaic electric system. For the purpose of PV module selection, use only the PV module manufacturers published specifications conducted at Standard Test Conditions (STC) per ASTM E1036. This specifies a 25°C cell temperature and illumination of 1kW/m^2 at a spectral distribution of AM 1.5 (ASTM E892 global spectral irradiance).

PV Modules:

PV modules are essentially energy converters which convert light into electricity. Because the voltage, current and power produced by a given PV module varies widely based on actual operating conditions, a set of test conditions commonly referred to as ***Standard Test Conditions*** or ***STC*** has been developed to rate modules in a meaningful and consistent manner. STC ratings not only provide a fair means to compare one manufacturers modules against another, most importantly STC ratings provide standardized performance data against which actual real world performance can be predicted.

Key PV module specifications;

P_{MAX}	Maximum power in watts ($P_{MAX} = V_{MP} \times I_{MP}$)
V_{OC}	Open circuit voltage (maximum voltage with module output open circuit)
V_{MP}	Voltage at which module produces greatest power (also called Operating Voltage)
I_{MP}	Current at which module produces greatest power (also called Operating Current)
I_{SC}	Short circuit current (maximum current with output shorted)

It is important to note that STC ratings are not "maximum" or "optimal" ratings, and that voltage, current and power will be higher or lower based on actual operating conditions. Conditions can be present where V_{OC} and I_{SC} can approach 1.25 times STC ratings which is why NEC and our recommendations call for 1.25 voltage and current derating. While voltage and current can spike to nearly 1.25 times STC ratings, in typical steady state real world operation I_{MP} is commonly only about 70 – 80% of I_{MP} at STC.

Solar Boost charge controllers will provide the best MPPT current boost performance if all PV modules are identical. If module types are mixed, do not put dissimilar modules in series. Dissimilar modules in parallel should have V_{MP} values within ≈0.5V or better for 12V modules, and be of the same basic cell technology or have a similar temperature coefficient of V_{MP} so the V_{MP} of the various modules will tend to track each other as operating conditions change. If module types are very different consider using a separate charge controller for each module type to obtain the best MPPT current boost performance.

PV Module Voltage Sizing:

➡ Maximum V_{OC} Limit:

Do not connect a total PV Module V_{OC} at STC greater than the controller's maximum PV voltage rating divided by 1.25. This is because real world operating conditions can and will be present where V_{OC} will exceed the published STC value. The industry standard 1.25 derating factor is specified by NEC to prevent the controller from becoming damaged due to excess PV voltage. Application of PV voltage in excess of the maximum PV voltage specification will damage the charge controller and void the limited warranty.

➡ Minimum V_{MP} Limit:

A typical 12V nominal PV module has V_{MP} and V_{OC} ratings of about 17.0V and 22.0V respectively at STC. This seemingly high voltage at STC is designed in by PV module manufacturers because real world operating conditions can and will be present where V_{MP} will decrease at higher temperatures to the point that the module voltage is barely high enough to charge a 12V battery. To obtain good charge performance a rule of thumb is to not attach a PV module of less than 16.5V V_{MP} to charge a 12V battery. PV modules with higher V_{MP} in the range of 17.5V – 18.5V will provide improved MPPT[①] and battery charge performance. These numbers should be ratioed up by 2X or 4X for 24V or 48V batteries.

Using the table below for the particular charge controller and battery voltage, select PV modules that have both; 1) Total series V_{OC} at STC not greater than the "Max. Applied PV V_{OC} @ STC" value, and 2) Total V_{MP} value within the "Recommended range of V_{MP} at STC".

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Solar Boost Controller	Nominal Battery voltage	Absolute Max. PV Input Voltage Spec.[②]	Max. Applied PV V_{OC} @ STC (Max. V_{PV} Spec. ÷1.25)	Recommended range of V_{MP} at STC (At Nominal PV Voltage Shown)				
				12V	18V	24V	36V	48V
SB2000E	12V	30V	24V	16.5 – 18.5V	×	×	×	×
SB2512i	12V	35V	28V	16.5 – 18.5V	×	×	×	×
SB2512iX	12V	35V	28V	16.5 – 18.5V	×	×	×	×
SB3024i -and- SB3024iL	12V	57V	45.6V	16.5 – 18.5V	24.0 – 28.0V	33.0 – 37.0V	×	×
	24V			×	×	33.0 – 37.0V	×	×
SB1524iX	12V	57V	45.6V	16.5 – 18.5V	24.0 – 28.0V	33.0 – 37.0V	×	×
	24V			×	×	33.0 – 37.0V	×	×
SB50	12V	57V	45.6V	16.5 – 18.5V	24.0 – 28.0V[③]	33.0 – 37.0V	×	×
	24V			×	×	33.0 – 37.0V	×	×
SB3048	24V	140V	112V	×	×	33.0 – 37.0V	48.0 – 56.0V[③]	66.0- 80.0V
	48V			×	×	×	×	66.0- 80.0V
SB6024H	12V	140V	112V	×	×	×	48.0 – 56.0V	66.0- 80.0V
	24V			×	×	×	48.0 – 56.0V	66.0- 80.0V

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PV Module Current Sizing:

➡ Maximum I_{SC} Limit:

Do not connect total parallel PV module I_{SC} at STC greater than the controller's maximum output current rating divided by 1.25. This is because real world operating conditions can and will be present where I_{SC} will exceed the published STC value. The industry standard 1.25 derating factor is specified by NEC to prevent the controller from becoming damaged due to excess PV current or power. The industry standard 1.25 derating factor as specified by NEC assumes that battery voltage and PV voltage are the same nominal value.

If nominal PV voltage is greater than nominal battery voltage, I_{SC} must be reduced by the ratio of the nominal voltages such that input power remains constant. Increasing PV voltage does not increase a charge controller's power handling capability. Refer to Technical Bulletin #100210 for more detail regarding I_{SC} limits at higher PV input voltages.

➡ Minimum I_{MP} Limit:

A preferred rule of thumb is that there be at least 3 amps of I_{MP} per 100 amp-hours of battery capacity for proper battery charging. An absolute minimum I_{MP} with no loads is about 1.5 amps per 100 amp-hours of battery capacity.

Using the table below for the particular charge controller, battery voltage and nominal PV module voltage, select the maximum number PV modules that will not exceed "Maximum Short Circuit Current I_{SC} at STC" or "Maximum Applied Total PV Power @ STC".

Solar Boost Controller	Nominal Battery voltage	Maximum Applied Total PV Power @ STC	Max. Controller Output Current Rating	Maximum Short Circuit Current I_{SC} at STC (At Nominal PV Voltage Shown)				
				12V	18V	24V	36V	48V
SB2000E	12V	340W	25A	20.0A	×	×	×	×
SB2512i	12V	340W	25A	20.0A	×	×	×	×
SB2512iX	12V	340W	25A	20.0A	×	×	×	×
SB3024i	12V	400W	30A	24.0A	16.0A	12.0A	×	×
	24V	800W		×	×	24.0A	×	×
④ SB3024iL	12V	540W④	40A ④	32A④	×	×	×	×
	12V	400W	30A	×	16.0A	12.0A	×	×
	24V	800W		×	×	24.0A	×	×
SB1524iX	12V	270W④	20A ④	16A④	×	×	×	×
	12V	200W	15A	×	8.0A	6.0A	×	×
	24V	400W		×	×	12.0A	×	×
SB50	12V	670W	50A	40A	26.7A	20.0A	×	×
	24V	1340W		×	×	40.0A	×	×
SB3048	24V	800W	30A	×	×	24.0A	16.0A	12.0A
	48V	1600W		×	×	×	×	24.0A
SB6024H	12V	800W	60A	×	×	×	16.0	12.0A
	24V	1600W		×	×	×	32.0A	24.0A

① See "What is MPPT" at www.blueskyenergyinc.com .
② The maximum PV input voltage is a hard limit above which the controller will be damaged in a manner not covered by warranty.
③ These modules can be used but a one time special MPPT trim between the high and low ranges is required.
④ Current limit and current rating are are higher when charging a 12V battery from nominal 12V PV modules. If PV V_{OC} ever exceeds 30V (i.e., >12V nominal PV modules) current rating and current limit switch to the lower value until the unit reboots.