

# Technical Bulletin

## 5 Steps to Size Controllers for Low PV Panel Temperatures

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Phocos Americas

Winter in the Northern Hemisphere brings a surge in technical support calls related to damaged controllers due to low temperature effects on PV panels. Damage occurs when the cold weather panel voltage increases above the Standard Test Condition (STC) ratings.

Below is a quick, five-step worksheet to size your controller appropriately for low PV cell temperatures. You'll need to have the manufacturer's product specifications for the PV panels and the charge controller to complete the worksheet.

In Step 3, NEC Article 690 Table 690.7(A) *Voltage Correction Factors for Crystalline and Multicrystalline*



**Low temperature effects on PV panels can lead to charge controller damage if the controller is not sized properly.**

*Silicon Module* is the source for the factor of 1.25 used to calculate a worst case panel voltage condition in -40°C weather.

There are other methods and NEC factors that might be applicable, but this is the quickest, easiest check. If you do not know about worst case

ambient temperatures at the install location, then use the worst case 1.25 factor or consult the NEC.

Voltage is only one specification out of many that must be matched between panel arrays and charge controllers. We have provided some important reminders for sizing PWM and MPPT controllers below. Be sure to check that all specifications match within your systems.

The Phocos Technical Department is here to help you select the right charge controller. Please contact us at 520.777.7906 option 2 or email us at [tech.na@phocos.com](mailto:tech.na@phocos.com).

5-Step Worksheet for Sizing Charge Controllers for Minimum PV Panel Temperatures	
<b>Step 1 Panel Voc</b>	Enter panel Voc at STC from your panel datasheet or nameplate here: #1 _____
<b>Step 2 Series String</b>	Enter number of the above panels wired in series here: #2 _____
<b>Step 3 Array Voc @ STC</b>	Multiply #2 by #1: #3 _____
<b>Step 4 Array Voc with Min. Cell Temperature</b>	Multiply #3 by 1.25: #4 _____
<b>Step 5 Controller Check</b>	<p>Is #4 <math>\geq</math> maximum controller solar input voltage specified on the datasheet of your selected controller? #5 _____</p> <p>If #4 is greater or equal to maximum controller solar input voltage, the selected controller is <u>not suitable</u> for the system as designed. Select a controller with a max solar input voltage <math>\geq</math> #4 and/or change system wiring configuration and start over.</p> <p>If #4 is less than maximum controller solar input voltage on the datasheet of your selected controller, it is suitable for the system as designed.</p>



### Important Reminders for Sizing PWM Controllers

<b>PWM Controller Tip 1</b>	<b>PV panel <math>V_{mp}</math> &gt; controller's overvoltage protection level for the battery.</b> The panel voltage at maximum power ( $V_{mp}$ ) should be higher than the controller's overvoltage protection level for the battery. The battery overvoltage protection level is typically 15.5V for 12V systems and 31V for 24V systems.
<b>PWM Controller Tip 2</b>	<b>Pair 12V battery banks with 36 cell panels.</b> 12V battery banks perform best when paired with 36 cell panels. When larger panels such as 60 cell panels are used, the power output will be far less (<50%) than the maximum rating even in full sunlight. This is not recommended.
<b>PWM Controller Tip 3</b>	<b>Pair 24V battery banks with 72 cell panels.</b> 24V battery banks perform best when paired with 72 cell panels or strings of two 36 cell panels in series. When a smaller panel array is used, such as one 60 cell panel, the voltage is typically too low to keep the batteries charged properly, resulting in reduced battery life. When a larger panel array is used, such as two 60 cell panels in series, the power output will be far less than the maximum array rating even in full sunlight. This is not recommended.

### Important Reminders for Sizing MPPT Controllers

<b>MPPT Controller Tip 1</b>	<b>PV panel <math>V_{mp}</math> &gt; controller's minimum solar input voltage.</b> The panel voltage at maximum power ( $V_{mp}$ ) should be higher than the controller's minimum solar input voltage specification. For 12V systems, this is typically 17V. For 24V systems, this is typically 34V.
<b>MPPT Controller Tip 2</b>	<b>Don't pair one 60 cell panel to a 24V battery bank.</b> Using one 60 cell panel to charge a 24V battery bank is not recommended. The $V_{mp}$ is typically too low to charge the batteries sufficiently.

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