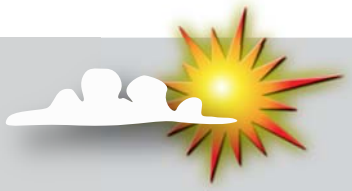

MidNite Solar Inc
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Why HyperVOC

The main question asked regarding MPPT solar controllers is "How many panels can I hook up in series?" Since we designed the OutBack MX60 a decade ago, we have answered this question thousands of times!

This is the scenario:

Consumer:
I have a 150V MPPT controller. How many panels can I put in series. I plan on using a panel with a VOC of 44.3V.

Technician:
How cold does it get where you live?

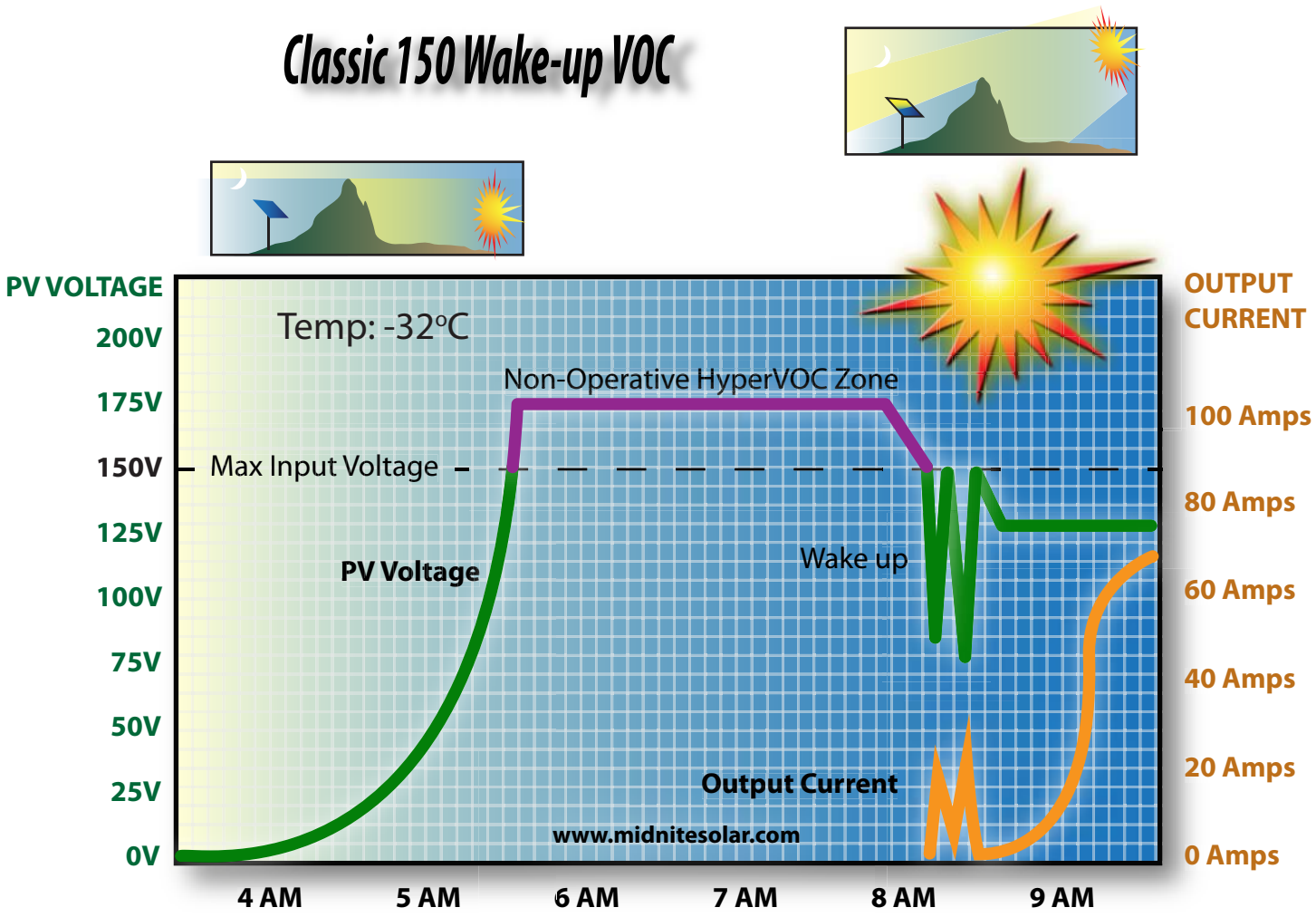
Consumer:
I live in Alberta, Canada. It gets mighty cold up here, Aye, -32^{0}C in winter.

Technician:
The panels will output higher voltages in cold weather. The NEC says you must multiply the VOC of your solar panel by the correction factor based on your coldest conditions. In your case the correction factor is 1.23. Let's see what happens when we apply the 1.23 correction factor to 2 and 3 panels in series. Two in series looks like this: 44.3V x 2 x 1.23 = 108.98V. Three in series looks like this: 43.3 x 3 x 1.23 = 163.46V.

On a normal 150V controller you can put 2 panels in series. The highest voltage the controller will see is 108.98V. That is below the 150V max input voltage. If you put 3 panels in series on a standard 150V controller, it will see up to 163.46V on a cold morning. I suggest you read the directions and warranty information on your controller. Go to the section of the instructions for your normal (other than MidNite) controller that deals with PV input voltage. It will read something like this regarding voltages above 150V. "Voltage above 150VDC will cause the controller to explode into a huge ball of flames leaving a smoldering crater. This condition is not covered under warranty."

I might have paraphrased a bit but you get the message, they do not want you going over 150VDC on the input. Here is a little known fact about PV output voltage and charge controllers.

Classic 150 Wake-up VOC



On cold mornings the PV panels will put out full voltage even before you can see the sun. Ambient light may not have much current behind it but it does have voltage exceeding the possible voltage limits that destroy the controller. The fact that there is no power behind the output voltage means that the controller will not be able to turn on and drag the panels down from VOC to max power voltage.

The controller requires a few watts of power coming in from the PV panels to overcome its internal power requirements. While the controller is waiting for enough power to wake up, the PV array is at its highest output voltage. This is very dangerous if the maximum operating voltage is exceeded.

The MidNite Solar controller gives you bonus headroom for those cold mornings that would potentially destroy any other controller. We have advised thousands of customers to play it safe in conditions like our example above. MidNite has a unique characteristic of the circuitry that allows it to go beyond the maximum operating voltage for these conditions, it's called HyperVOC.

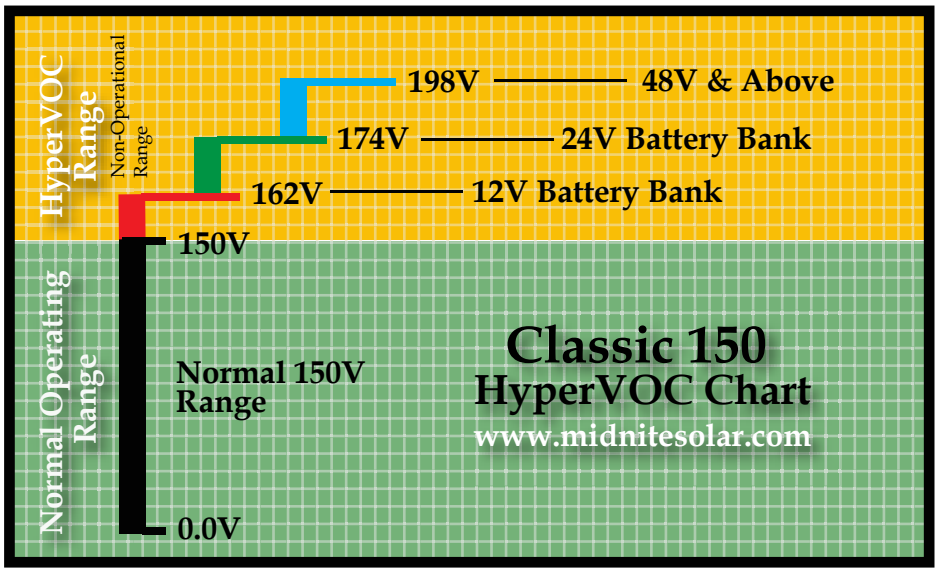
Do not abuse the HyperVOC zone though. For example, let's take a 150V Classic configured with 4 modules in series that have 36.9 VOC, 4 x 36.9 = 147.6. In Alberta with a -32^{0}C temperature, the max VOC will reach 181.54. This is well within the HyperVOC zone on a 48V battery bank.

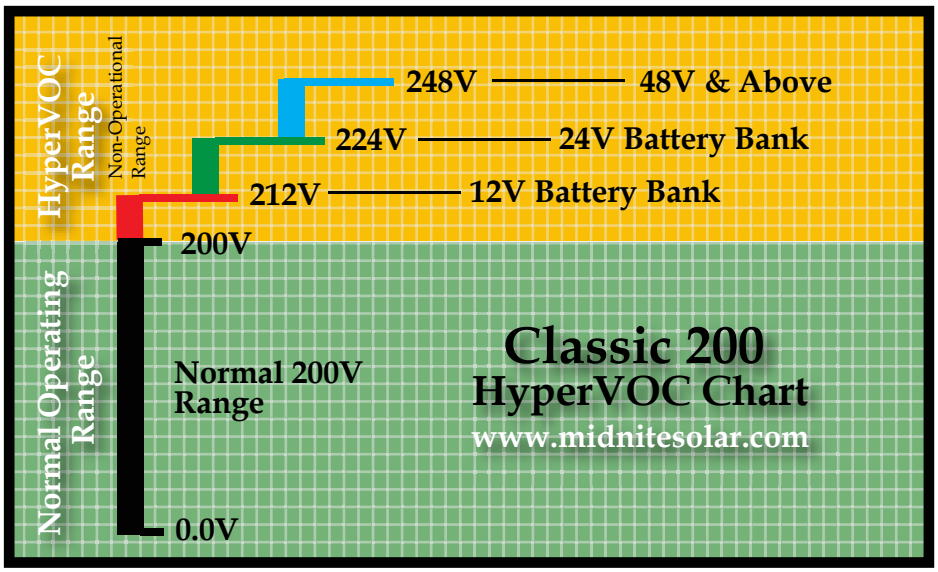
You would think that this is a well-designed system, WRONG! This configuration will be safe from exploding into a ball of flames, but the VOC is so high, chances are the panels may not warm up enough during the day to drop below 150V. Remember the Classic will not turn on when the PV input voltage is above 150V. Since the nominal 25°C VOC was already 147.6V, you can see it won't take much cold weather to go over 150V. Heck you probably wouldn't even need a sweater, but your system will not be charging due to cold temperature.

The charts below display the upper maximum HyperVOC limit based on the nominal battery bank voltage.

Important: HyperVOC is the maximum input voltage plus nominal battery voltage. The maximum nominal battery bank voltage allowable is 48V, even if the battery bank being used is higher than 48V.

HyperVOC Charts for the Classics 150 and 200





HyperVOC Charts for the Classics 250

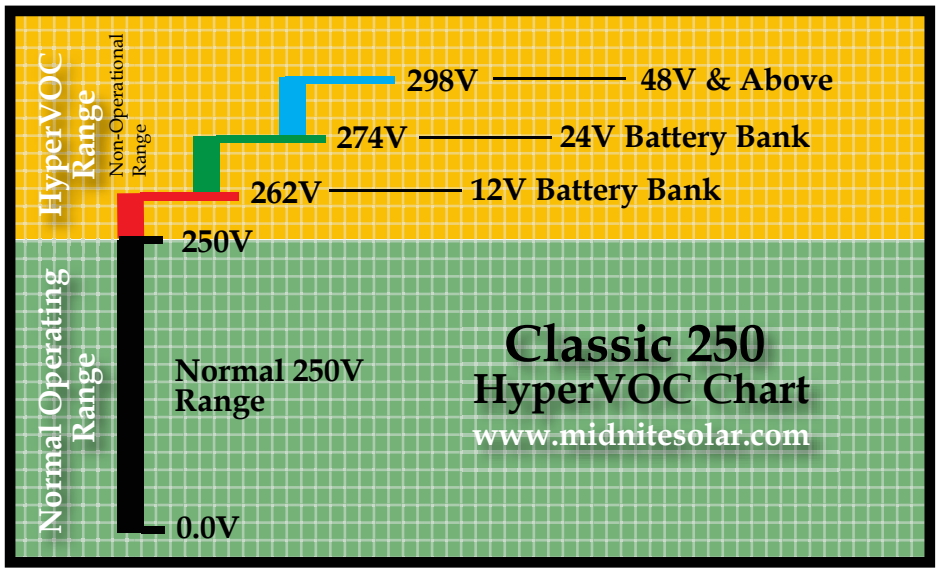


Table 690.7 Voltage Correction Factors for Crystalline and Multicrystalline Silicon Modules

Correction Factors for Ambient Temperatures Below 25°C (77°F). (Multiply the rated open circuit voltage by the appropriate correction factor showen below.)

Ambient Temp (°C)	Factor	Ambient Temp (°F)
24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
-1 to -5	1.12	31 to 23
-6 to -10	1.14	22 to 14
-11 to -15	1.16	13 to 5
-16 to -20	1.18	4 to -4
-21 to -25	1.20	-5 to -13
-26 to -30	1.21	-14 to -22
-31 to -35	1.23	-23 to 31
-36 to -40	1.25	-32 to -40

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