

Page 1 of 6

# AURORA® PHOTOVOLTAIC INVERTERS

October 16, 2012

**Application Note:** 

# <u>Voltage and Temperature Derating for Isolated</u> <u>String Inverter Installations at Altitudes above</u> <u>6600 Feet</u>



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Page **3** of **6** 

- **1. Purpose:** This document provides guidelines for derating input voltage and operating temperature ratings for Power–One's Aurora isolated string photovoltaic inverters.
- **2. Target Audience:** This document is intended for qualified inverter installation planners and designers.
- **3. Validity:** The guidelines herein apply to Power-One Aurora family isolated string inverters; residential products UNO-2.0-I, UNO-2.5-I, PVI-3.8-I, PVI-4.6-I and commercial products PVI-10.0-I and PVI-12.0-I.

<b>1.</b> <i>пррисавие рі байсь</i> јог <i>с</i> их				
	UNO-2.0-I	UNO-2.5-I		
	PVI-3.8-I	PVI-4.6-I		
	PVI-10.0-I	PVI-12.0-I		

# Table 1: Applicable products for this technical note

# **BACKGROUND INFORMATION**

Air pressure decreases as altitude above sea level increases. The reduced air density results in less effective heat dispersal, hence the need to reduce rated operating temperatures. The dielectric strength of air also drops as the air pressure drops, necessitating a reduction in rated operating voltages so to avoid electric arcs in high voltage circuits.

Standard design guidelines cover normal operation up to 6600 feet (2000 meters) elevation. Guidelines given below will aid the designer in planning installations above 6600 feet. These are not hard and fast rules, but guidelines to aid the designer.

The derating curves in the following sections have been validated by Power-One for the string inverters listed in Table 1. The installation planner may contact Power-One for information on other applications.

### **TEMPERATURE DERATING:**

The Y-axis of the graph below (Figure 1) is the normalized temperature derating. The inverter's rated maximum ambient temperature applies up to altitudes of 6600 feet (2000m). Between 6600 and 10,000 feet, the ambient temperature for the inverter must be decreased by the corresponding fraction shown on the Y-axis of the graph below.

These derating guidelines are applicable to both indoor and outdoor applications. The installation designer should consider the site layout, wind, typical maximum temperatures, and other environmental parameters in determining if less derating is acceptable. For example, a windy outdoor location may be designed differently from an indoor application.





#### Figure 1 Normalized temperature derating with altitude

### EXAMPLE - TEMPERATURE DERATING CALCULATION FOR A PVI-12.0-I-OUTD-US installed at 7500 feet:

The maximum rated ambient temperature, for full power operation at sea level, from the Aurora PVI-12.0-I series datasheet, is 113°F (45°C).

The normalized temperature derating factor, from the graph in Figure 1, at an altitude of 7500 feet is ~0.945.

The maximum full-power ambient temperature for operation at 7500 feet would be  $113^{\circ}F * 0.945 = 107^{\circ}F - OR - 45^{\circ}C * 0.945 = 42.5^{\circ}C.$ 



Page 5 of 6

## **VOLTAGE DERATING**

The dielectric strength of air decreases with altitude, so the maximum DC input inverter voltage must be decreased at high altitudes to avoid unwanted electrical arcs. Figure 2 shows the normalized voltage derating factor with increased altitude.



Figure 2 Normalized voltage derating factor vs. altitude (feet)

# EXAMPLE #1 – DC INPUT VOLTAGE DERATING FOR AN AURORA PVI-12.0-I-OUTD-US INSTALLED AT 9000 FEET:

The absolute maximum full-power DC input voltage rating, from the Aurora PVI-12.0-I series datasheet, is 520Vdc at sea level. From Figure 2, the voltage derating factor at 9000 feet is ~0.90.

For an installation at 9000 feet elevation, the designer must confirm the PV array output to the inverter will not exceed 520Vdc \* 0.9 = 468Vdc.

Note that PV panel voltage drops with increased temperature, and maximum insolation may occur during periods of higher temperature: During periods of maximum ambient temperature, a PV voltage less than the Voc rating will be seen at the panel terminals, so the system designer may find the maximum voltage seen at the inverter input is somewhat less than the panels' rated open circuit voltage.

Note also that the AC output voltage does not require altitude derating; the circuitry is very different and covers higher altitudes.





# EXAMPLE #2 – DC INPUT VOLTAGE DERATING FOR AN AURORA PVI-3.8-I-OUTD-US INSTALLED AT 7500 FEET:

The absolute maximum full-power DC input voltage rating, from the Aurora PVI-3.8-I series datasheet, is 520Vdc at sea level. From Figure 2, the voltage derating factor at an elevation of 7500 feet is ~0.963.

For an installation at 7500 feet, the designer must confirm the PV array output to the inverter will not exceed 520Vdc \* 0.963 = 501Vdc.

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