High Ambient Temperatures and Enphase Microinverters

Overview

Enphase® Microinverters have been engineered, and tested to function in the harshest environments expected in a PV installation. The racking systems recommended in our Racking Compatibility document (http://www.enphase.com/support/downloads) keep microinverters shielded from direct exposure to the elements and provide necessary clearance for airflow. However, you must consider the presence of high ambient temperatures when designing any solar array. Following the recommendations in this document will help you to ensure best performance.

Exposing Enphase Microinverters to ambient temperatures outside the acceptable ranges listed on the data sheet and installation manual (http://www.enphase.com/support/downloads) can affect both microinverter function and long-term reliability. This said, Enphase has conducted studies to demonstrate that installation practices such as providing airflow and maintaining minimum clearances as recommended in the installation manual will mitigate the effects of high rooftop temperatures.

This technical brief illustrates the effect that high ambient temperatures have on the internal temperatures reported by the microinverters. Data was gathered from more than 550 systems installed in hot or high irradiance locations across the US, including Phoenix, AZ; Honolulu, HI; Petaluma, CA; Santa Rosa, CA; and Denver, CO.

Findings

Of the internal temperature data gathered from over 75,000 Enphase Microinverters in five of the hottest locations across the US, no microinverters reported a maximum lifetime operating temperature that was outside of the ranges listed on the microinverter data sheet (-40°C to +85°C / -40°F to +185°F). There were only two systems out of all the systems included in the report where the internal operating temperature was reported near the maximum allowable temperature of 185°F (85°C), but temperatures never exceeded this upper limit. These two systems were in Phoenix, AZ and Santa Rosa, CA.

In 2012 there were many days in the test locations where ambient temperatures were recorded well above 100°F (38°C). In fact, July of 2012 was the hottest month on record in US history. Despite the two rare occurrences listed above, the average maximum temperature of all microinverters installed in these areas was still relatively low. The maximum recorded internal operating temperature at one site mentioned in Phoenix, AZ was 183°F (84°C). However, the average of all maximum operating temperatures across all installations in Phoenix, AZ was only 149°F (65°C). In Santa Rosa, one system recorded internal temperatures of 181°F (83°C), but the average of all max temperatures in that area was only 135°F (57°C). This indicates that site design is the most important factor influencing the maximum temperature the system experiences.

Figure 1 below shows a monitoring screen capture of an M215 Microinverter™ located in the middle of a five by five module array in Phoenix, AZ. The temperature and production information displayed is from August 8, 2012, which, according to information available, was the hottest day recorded in Phoenix, AZ during 2012. Temperatures on this day were recorded up to 115°F (46°C). The maximum temperature recorded by this microinverter on August 8, 2012 was 133°F (56°C), just 18°F (10°C) higher than the ambient temperature recorded by weather stations in the area. This microinverter temperature is below the 149°F (65°C) average max temperature recorded across all the Phoenix microinverters included in the report, but does illustrate that proper installations techniques will keep the microinverter operating temperature and ambient temperature under the array well within the allowable range.

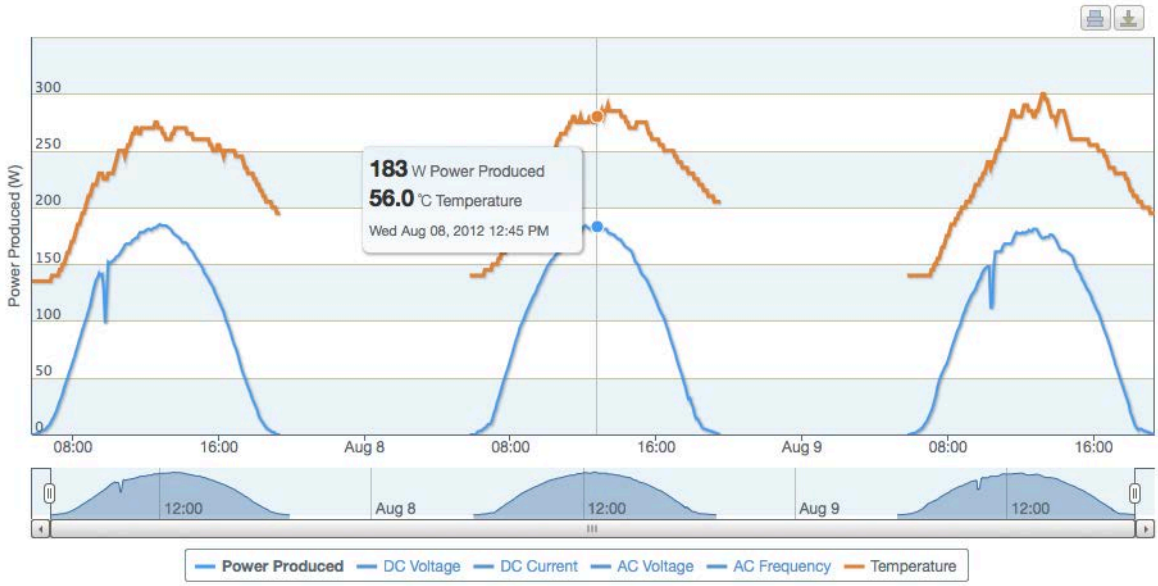

Figure 1: Enphase M215 Microinverter temperature data (8/8/12)

Best Practices

- Follow all recommended installation practices listed in the installation manual (http://www.enphase.com/support/downloads).
- Use approved racking solutions, and follows the installation procedures listed in the Racking Compatibility document (http://www.enphase.com/support/downloads).
- Do not mount the microinverter in a location that allows long-term exposure to direct sunlight. (That is, the PV module should cover the microinverter.)
- Allow a minimum of 1.9 cm (0.75 inches) between the roof and the bottom of the microinverter. Also allow at least 1.3 cm (0.50 inches) between the back of the PV module and the top of the microinverter.
- Ensure that it is possible for air to circulate under the array.
- If using a Built-in PV (BIPV) solution, ensure that the BIPV system is properly ventilated.

Conclusion

Although it is possible for a microinverter to be exposed to temperatures outside of the recommended range, this is a rare occurrence, and is usually the result of the installation practices that do not follow the above guidelines. Even when Enphase Microinverters have been installed in the hottest locations within the US, none of those studied were found to have exceeded the internal operating temperature in their lifetime, nor were failure rates higher for these areas. Enphase Microinverters are engineered to be robust and are thoroughly tested to ensure they are able to function without issue across all expected temperature ranges.

In instances where microinverters were found to be operating near the upper temperature limit, other Enphase Microinverters installed nearby at neighboring systems were reporting internal temperatures that were nearly 50 percent lower. The large discrepancy between internal temperatures of microinverters installed within the same area indicates that the temperature recorded by the microinverter correlates more to installation practice rather than to increases in ambient temperature.

Enphase Microinverters are capable of being installed under modules in the hottest locations across the US. The best practices listed above can further the success of an installation as well as ensure that the production and reliability of an Enphase Microinverter installation is not compromised.