

ISSUE: [March 2014](#)

## ***Do You Know The ABCs Of Inverter Testing?***

*by Fred Zhu, Inverters and Product Safety, TÜV Rheinland, Pleasanton, Calif.*

After the recent economic slowdown during which some medium-sized inverter manufacturers went out of business, new companies have begun to enter this market. In part, the growth has been due to the introduction of new technology and designs to meet the changed market needs. These include (among many) higher dc input voltage, dc-side arc fault protection and interruption, and transformer-less inverters for better power conversion efficiency.

As tech innovations are taking over the market, the need for testing services for these products—often to differing standards of import markets—has increased as well. Yet, many manufacturers are unsure what exactly the requirements are and what happens during testing. This knowledge gap may be especially detrimental if an inverter design needs to be changed in the late stages of the development process because of the need to comply with a certain standard requirement. This article offers answers to some of the most often asked questions about inverter testing.

## ***Do testing requirements differ vastly for inverters sold in various countries?***

Product safety requirements for various countries are very similar, though governed by different standard systems: UL 1741 and CSA C22.2 No. 107.1 in North America and IEC 62109-1 and IEC 62109-2 in Europe and Asia. However, the differences are significant in the grid-connection requirements. Inverter manufacturers have to design different versions of the control system—both software and hardware—for inverters intended for different countries.

## ***What are the main testing requirements and standards for inverters in the U.S. and Canada?***

In the U.S., the testing requirements for inverters are specified in the UL-1741 standard, which calls out IEEE 1547 and IEEE 1547.1 for the grid connection and protection requirements. Canada requires inverters to meet the requirements of CSA C22.2 No. 107.1. Fortunately, with some minor documentation differences, most of the Canadian tests are similar to the U.S. tests, allowing testing providers to combine tests for the two markets and save costs for manufacturers.

## ***What is the standards governing body for inverters?***

In the U.S., it is the ANSI/UL/IEEE organizations; in Canada, it is the CSA; and internationally, it is the IEC.

## ***What actually happens during the inverter testing? Are there different types of tests?***

Inverter tests can be divided into three broad groups: (1) safety testing including temperature, spacing, insulation and abnormal conditions; (2) inverter output quality such as harmonics and synchronization; and (3) response to abnormal grid conditions such as abnormal voltage, abnormal frequency, lost phase and anti-islanding.

## ***Do you test inverters at factories and/or already installed? If so, describe the differences in testing and requirements.***

Type tests for certification purposes can be done either in an inverter testing lab (see the figure) or at a manufacturer's facility, especially for inverters rated at power levels of 100 kW and higher. The requirements for testing in a lab and onsite are the same, and so are the testing procedures. The only difference when testing

at a manufacturer's facility is that a third-party engineer does not operate the testing equipment but checks the set-up, ensures conditions per applied standards and collects and verifies the data during a witness test.



*Figure. An inverter undergoing anti-islanding testing in TÜV Rheinland's inverter testing lab in Pleasanton, Calif.*

### ***How reliable are inverters and how does one test for reliability?***

There are many factors influencing the reliability of inverters, and testing methods vary depending on the inverter's purpose. Usually, an installer will be more confident about the testing data performed and reported by an independent, third-party testing lab as opposed to the data reported by the manufacturer.

### ***Are internal tests done by manufacturers reliable?***

Yes, provided the manufacturer kept a detailed record of testing conditions, methods, and the original testing data to make the repeat testing possible. This is necessary because manufacturers often declare their warranties based on their internal reliability testing data.

### ***What are the documentation requirements for inverters?***

The documentation requirements for inverters are similar to those of other major electrical products: the nameplate; the warning; user, installation and service manuals, just to name a few, per requirements of the applied standard.

***What do design engineers need to think about in terms of compliance while designing the product—both for domestic and foreign markets?***

Design engineers are advised to read the standards for the targeted countries to ensure that their products comply with, for instance, the spacing and grounding requirements; that they specify correct cable sizes for various internal and external connections; and select proper safety-related components. If the task seems too daunting, engineers can consult a testing lab that offers this type of pre-certificate services. Such consultation services pay off in saved time and costs associated with re-design and repeated testing should an inverter need a modification due to an incompliance issue discovered during testing.

***What innovations do you see coming down the road to improve inverter performance and reliability?***

At the moment, good performance and long, reliable service life depend on the quality of key components and application of a quality control system in the production line, as well as professional installations.

***How does one find a testing company for inverters?***

In the U.S., manufacturers can check the OSHA-NRTL list: <https://www.osha.gov/dts/otpc/nrtl/tuv.html>.

***What certifications should an inverter testing lab have?***

In the U.S., an inverter test lab needs to be featured in the OSHA-NRTL list. Other countries have similar accreditation requirements.

***How long does it take to get back to a client with a quote?***

A lab would normally get back to a client within a week; some labs are striving to respond within 48 hours.

***How long does it take to test an inverter?***

From six weeks to three months, depending on the inverter's power level.

***What are the labeling requirements for inverters in the U.S.? Does the lab need to look at labeling as well?***

For the U.S., detailed labeling requirements are listed in clause 62-63 of UL 1741. A testing engineer will normally check compliance item by item per applied standards.

**About The Author**



*Fred Zhu has more than 17 years of experience in the regulatory compliance industry including five years of inverter and converter testing for products marketed in the U.S.A., Canada, and Europe. He is based in the Pleasanton, Calif. office of [TÜV Rheinland](#), which operates a unique network of nine testing laboratories for various power-level inverters located in the U.S.A., Australia, Germany, Greater China (Shanghai and Taiwan), Hungary, India, Italy and Japan. Contact Zhu at [zzhu@us.tuv.com](mailto:zzhu@us.tuv.com) or (925) 918-5123.*

For further reading on inverter development, see the [How2Power Design Guide](#), select the Advanced Search option, go to Search by Design Guide Category and select "DC-AC Inverters" in the Power Supply Function category.