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IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems

Sponsor

IEEE Standards Coordinating Committee 21
on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage

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IEEE-SA Standards Board

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Abstract: This recommended practice contains guidance regarding equipment and functions necessary to ensure compatible operation of photovoltaic (PV) systems that are connected in parallel with the electric utility. This includes factors relating to personel safety, equipment protection, power quality, and utility system operation. This recommended practice also contains information regarding islanding of PV systems when the utility is not connected to control voltage and frequency, as well as techniques to avoid islanding of distributed resources.
Keywords: islanding, nonislanding inverter, photovoltaic, utility interconnection

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Introduction

[This introduction is not a part of IEEE Std 929-2000, IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems.]

This revision of IEEE Std 929 is in response to the maturation of the photovoltaic industry. That maturation has identified the critical need to have the interconnection of photovoltaic (PV) systems to the utility grid be covered under a comprehensive document that includes specific recommendations rather than general guidance. The intent of this document is to define the technical requirements of PV system interconnection in a manner that can be adopted as a PV system technical interconnection standard by individual utilities. This document also includes several annexes for tutorial and clarification purposes.

A significant effort has been made to coordinate this document with Underwriters Laboratories in the production of UL 1741, a test procedure that can be performed by an independent body to verify that an inverter intended for use with a utility-interconnected PV system meets the recommendations described in this recommended practice. The safety test procedure put forth by the Underwriters Laboratories will, among other things, test the inverter for proper response, as detailed in this recommended practice (including Annex A), to loss of utility or “out of bounds” utility conditions. One aspect of this testing is to ascertain that the inverter will not operate as a utility-independent island.

Participants

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IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems

1. Overview

This recommended practice contains guidance regarding equipment and functions necessary to ensure compatible operation of photovoltaic (PV) systems that are connected in parallel with the electric utility. This guidance includes factors relating to personnel safety, equipment protection, power quality, and utility system operation.

The document also includes seven annexes

— Annex A, Minimum test procedure for a nonislanding PV inverter
— Annex B, PV inverters and the utility interface
— Annex C, Disconnect switches and utility procedures
— Annex D, Islanding as it applies to PV systems
— Annex E, The PV inverter under utility fault conditions
— Annex F, Dedicated distribution transformers
— Annex G, Bibliography

1.1 Scope

This recommended practice applies to utility-interconnected PV power systems operating in parallel with the utility and utilizing static (solid-state) inverters for the conversion of direct current (dc) to alternating current (ac). (This recommended practice does not apply to systems utilizing rotating inverters.)

This recommended practice describes specific recommendations for “small” systems, rated at 10 kW or less, such as may be utilized on individual residences. These recommendations will provide greater standardization for these smaller systems, thereby reducing the engineering and design burden on both the PV system installer and the interconnecting utility.

“Intermediate” applications, ranging from over 10 kW up to 500 kW, follow the same general guidelines as small systems. Options to have adjustable setpoints or other custom features may be required by the inter-

connecting utility, depending on the impact of the PV system on the portion of the utility system to which it is interconnected.

“Large” systems, greater than 500 kW, may combine various standardized features as well as custom requirements, depending on the impact of the PV system on the portion of the utility system to which it is interconnected. A greater degree of custom engineering of the utility interface is to be expected as the size of the PV system grows in relation to utility system capacity.

1.2 Purpose

This recommended practice will provide value to a wide spectrum of personnel involved with utility-interconnected PV systems, including utility engineers, PV system designers and installers, and PV system owners. The standardized interconnection recommendations included in this recommended practice will minimize custom engineering of many aspects of the interconnection. This document is focused on providing recommended practice for utility interconnection of PV systems in a manner that will allow the PV systems to perform as expected and be installed at a reasonable cost while not compromising safety or operational issues.

Small utility-interconnected PV systems should use standardized, listed inverters (listed to test standards, such as UL 1741-1999[1], which include the testing requirements described in Annex A). The listing process assures that the inverter incorporates fixed voltage and frequency trip settings and incorporates an integral anti-islanding scheme. It is the intent of this recommended practice that small systems designed and installed in accordance with this document and other applicable standards, such as the National Electrical Code® (NEC®) (NFPA 70-1999), will require no additional protection equipment.

2. References

This recommended practice shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

Accredited Standards Committee C2-1997, National Electrical Safety Code® (NESC®).[2]

ANSI C84.1-1995, American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60 Hertz).[3]

IEEE Std 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

NFPA 70-1999, National Electrical Code® (NEC®).[4]

UL 1741–1999, Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems.[5]

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[1]Information on references can be found in Clause 2.

[2]The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[3]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[4]NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

[5]UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (http://global.ihs.com/).

