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TECHNICAL SPECIFICATION

Photovoltaic system performance – Part 2: Capacity evaluation method

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61724-2, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/1101/DTS	82/1159/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61724 series, published under the general title *Photovoltaic system performance*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The performance of a PV system is dependent on the weather, seasonal effects, and other intermittent issues, so measurement of the performance of a PV system is expected to give variable results. IEC 62446-1, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1 Grid connected – Documentation, commissioning tests and inspection*, describes a procedure for ensuring that the plant is constructed correctly, but does not attempt to verify that the output of the plant meets the design specifications. IEC 61724-1[1], *Photovoltaic system performance – Part 1: Monitoring*, defines the performance data that may be collected, but does not define how to analyze that data in comparison to predicted performance. ASTM E2848-13 *Standard test method for reporting photovoltaic non-concentrator system performance* describes a method for determining the power output of a photovoltaic system based on a regression. IEC TS 61724-3 *Photovoltaic system performance – Part 3: Energy evaluation method* describes a one-year test that evaluates performance over the full range of operating conditions and is the preferred method for evaluating system performance. However, it is essential that plant performance can also be quantified with a shorter test, even if there can be higher uncertainty associated with that test. This document is designed to complete an evaluation in a short time as a complement to IEC TS 61724-3. As a capacity test, it measures power (not energy) at a specified set of reference conditions (which can differ from standard test conditions that have been designed to facilitate indoor measurements). The method in IEC TS 61724-2 is a non-regression-based method for determining power output.

This method uses the design parameters of the plant to quantify a correction factor for comparing the plant's measured performance to the performance targeted under reference conditions. In other words, the measured performance, adjusted by the correction factor, is then compared with the target plant performance to identify whether the plant operates above or below expectations at the target reference conditions.

Multiple aspects of PV system quality are dependent on both the weather and the system's quality, so it is essential to have a clear understanding of the system being tested. For example, the module temperature is primarily a function of irradiance, ambient temperature, and wind speed, all of which are weather effects that can be difficult to simulate precisely. However, the module-mounting configuration also affects the module temperature, and the mounting is an aspect of the system that is being tested. This document presents a process for test development and clarifies how measurement choices can affect the outcome of the test so that users can benefit from streamlined test design with consistent definitions, while still allowing flexibility in the application of the test so as to accommodate as many unique installations as possible.

It is to be noted that when the output of a PV system exceeds the capability of the inverter, the output of the system is defined more by the inverter operation than by the PV modules. In this case, the measurement of the capacity of the plant to generate electricity is complicated by the need to differentiate situations in which the inverter is saturated and when the output of the PV system reflects the module performance. For PV plants with high DC-to-AC power ratios, the operation of the plant can reflect the capability of the inverters for the majority of the day, with the capability of the DC array only being measurable for a short time in the morning and in the evening. In this case, it can be necessary to disconnect parts of the DC array to reduce the DC-to-AC power ratio during the measurement period.

IEC TS 61724-2 is applicable to times when the system is fully available.

Methods presented in this document can be used in place of ASTM E2848-13 to determine photovoltaic system performance.

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[1] Under preparation. Stage at time of publication: IEC/FDIS 61724-1:2016

PHOTOVOLTAIC SYSTEM PERFORMANCE –

Part 2: Capacity evaluation method

1 Scope

This part of IEC 61724 defines a procedure for measuring and analyzing the power production of a specific photovoltaic system with the goal of evaluating the quality of the PV system performance. The test is intended to be applied during a relatively short time period (a few relatively sunny days).

In this procedure, actual photovoltaic system power produced is measured and compared to the power expected for the observed weather based on the design parameters of the system. The expected power under reference and measured conditions are typically derived from the design parameters that were used to derive the performance target for the plant as agreed to prior to the commencement of the test. For cases when a power model was not developed during the plant design, a simple model that increases transparency is presented in the annexes as a possible approach.

The intent of this document is to specify a framework procedure for comparing the measured power produced against the expected power from a PV system on relatively sunny days. This test procedure is intended for application to grid-connected photovoltaic systems that include at least one inverter and the associated hardware.

The performance of the system is quantified both during times when the inverters are maximum-power-point tracking and during times when the system power is limited by the output capability of the inverter or interconnection limit, reducing the system output relative to what it would have been with an inverter with generation freely following irradiance, if this condition is relevant.

This procedure can be applied to any PV system, including concentrator photovoltaic systems, using the irradiance (direct or global) that is relevant to the performance of the system.

This test procedure was designed and drafted with a primary goal of facilitating the documentation of a performance target, but it can also be used to verify a model, track performance (e.g., degradation) of a system over the course of multiple years, or to document system quality for any other purpose. The terminology has not been generalized to apply to all of these situations, but the intent is to create a methodology that can be used whenever the goal is to verify system performance at a specific reference condition chosen to be a frequently observed condition. A more complete evaluation of plant performance can be accomplished by using the complementary Technical Specification IEC TS 61724-3, *Photovoltaic system performance – Part 3: Energy evaluation method*.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61724-1[2], *Photovoltaic system performance – Part 1: Monitoring*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

ISO/IEC Guide 98-1, *Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement*

ASME, *Performance Test Code 19.1*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61724-1, IEC TS 61836, the ASME Performance Test Code 19.1 and the following and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
constrained operation
operation of a plant in a condition when all inverters are limited by the capability of the inverters (otherwise referred to as inverter saturation) rather than by the output from the PV array, as is observed for a system with high DC rating relative to the AC rating and when the irradiance is high

3.2
correction factor
ratio of the power expected for the reference conditions to the power expected for the measured conditions

3.3
curtailed operation
output of the inverter(s) is limited due to external reasons such as inability of the local grid to receive the power or contractual agreement

3.4
expected power
power generation of a PV system that is expected for actual weather data collected at the site during operation of the system based on the design parameters of the system

3.5
measured power
electric power that is generated by the PV system

Note 1 to entry: See also 3.14 to define the location of measurement.

3.6
model
simulation model used to calculate the predicted or expected PV power generation based on the design parameters of the system

[2] Under preparation. Stage at time of publication: IEC/FDIS 61724-1:2016.