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TECHNICAL SPECIFICATION

Photovoltaic systems – Power conversion equipment performance – Energy evaluation method

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PHOTOVOLTAIC SYSTEMS – POWER CONVERSION EQUIPMENT PERFORMANCE – ENERGY EVALUATION METHOD

FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

IEC TS 63156, 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:

Draft TS	Report on voting
82/1755/DTS	82/1801A/RVDTS

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.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The performance of a photovoltaic power generation system is influenced by various factors, such as meteorological conditions, installation environment (e.g. shade sources, soiling), design, and so on. The performance of a power conversion equipment is one of the significant indices for evaluating the performance of a PV system. IEC 61683 and IEC 62891 describe procedures for measuring the static (constant) conversion efficiency of power conversion equipment and MPPT efficiency, respectively. However, the standards do not define conversion efficiency under dynamic changes in factors such as meteorological changes, installation environment changes or temporal changes.

The CEC efficiency test protocol and EN 50530 define dynamic performance tests and procedures partially, but do not define a calculation procedure for evaluating the quantity of energy produced by a PV system. IEC TS 61724-3 describes a procedure for measuring and analysing the energy production of a specific photovoltaic system relative to the production expected for the same system from actual weather conditions for a certain period, but does not define the procedure for measuring the performance of power conversion equipment under actual environments.

Since there are areas where meteorological conditions, especially irradiance, change greatly and could affect the performance of power conversion equipment, a performance evaluation method under dynamic conditions needs to be defined. This document describes the procedure for evaluating the dynamic performance and energy production efficiency of power conversion equipment in a particular location using site-specific solar profiles.

PHOTOVOLTAIC SYSTEMS – POWER CONVERSION EQUIPMENT PERFORMANCE – ENERGY EVALUATION METHOD

1 Scope

This document describes the procedure for evaluating the energy conversion performance of stand-alone or grid-connected power conversion equipment (PCE) used in PV systems. This procedure includes the calculation of inverter performance to anticipate the energy yield of PV systems. This evaluation method is based on standard power efficiency calculation procedures for PCE found in IEC 61683 and IEC 62891, but provides additional methods for evaluating the expected overall energy efficiency for a particular location given solar load profiles. This document can be used as the energy evaluation method for PCE in IEC TS 61724-3, which defines a procedure for evaluating a PV system's actual energy production relative to its modeled or expected performance.

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 61683, *Photovoltaic systems – Power conditioners – Procedure for measuring efficiency*

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

IEC 62891, *Maximum power point tracking efficiency of grid connected photovoltaic inverters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 as well as the following 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
irradiance
G
electromagnetic radiated power per unit area

Note 1 to entry: Unit: $W \cdot m^{-2}$.

3.2
in-plane irradiance
G_I
total irradiance on the plane of a PV cell or module

Note 1 to entry: Unit: $W \cdot m^{-2}$.

3.3
rate of change of irradiance
R
change in irradiance amount during 1 s

Note 1 to entry: Unit: $W \cdot m^{-2} \cdot s^{-1}$.

3.4
rated input voltage
$V_{DC,r}$
rated input voltage specified by the manufacturer, to which other data sheet information refers

Note 1 to entry: Unit: V.

3.5
rated input power
$P_{DC,r}$
rated input power of the power conversion equipment, which can be converted under continuous operating conditions

Note 1 to entry: Unit: W.

3.6
rated output voltage
$V_{AC,r}$
utility grid voltage to which other data sheet information refers

Note 1 to entry: Unit: V.

3.7
rated output power
$P_{AC,r}$
active power that the power conversion equipment can output during continuous operation

Note 1 to entry: Unit: W.

3.8
PV simulator MPP-Power
$P_{MPP,PVS}$
MPP power provided by the PV simulator

Note 1 to entry: Unit: W.

3.9
input power
P_{DC}
measured input power of the device under test

Note 1 to entry: Unit: W.

3.10
PV simulator MPP voltage
$V_{MPP,PVS}$
MPP voltage provided by the PV simulator

Note 1 to entry: Unit: V.

3.11
input voltage
V_{DC}
measured input voltage of the device under test

Note 1 to entry: Unit: V.

3.12
PV simulator MPP current
$I_{MPP,PVS}$
MPP current provided by the PV simulator

Note 1 to entry: Unit: A.

3.13
input current
I_{DC}
measured input current of the device under test

Note 1 to entry: Unit: A.

3.14
output power
P_{AC}
measured AC output power of the device under test

Note 1 to entry: Unit: W.

3.15
output voltage
V_{AC}
measured AC voltage of the device under test

Note 1 to entry: Unit: V.

3.16
output current
I_{AC}
measured AC output current of the device under test

Note 1 to entry: Unit: A.

3.17
MPPT efficiency
η_{MPPT}
ratio of the energy drawn by the device under test within a defined measuring period T_M to the energy provided theoretically by the PV simulator at the maximum power point (MPP):

$$\eta_{MPPT} = \frac{\int_0^{T_M} P_{DC}(t)dt}{\int_0^{T_M} P_{MPP}(t)dt} \quad (1)$$

where

η_{MPPT} is MPPT efficiency;

$P_{DC}(t)$ is the instantaneous value of the power drawn by the device under test, in kW;

$P_{MPP}(t)$ is the instantaneous value of the MPP power provided theoretically by the PV simulator, in kW.

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.18
energy conversion efficiency
η_{CONV}
ratio of the energy delivered by the device under test at the AC terminal within a defined measuring period T_M to the energy received by the device under test at the DC terminal:

$$\eta_{CONV} = \frac{\int_0^{T_M} P_{AC}(t)dt}{\int_0^{T_M} P_{DC}(t)dt} \quad (2)$$

where

η_{conv} is the energy conversion efficiency;

$P_{AC}(t)$ is the instantaneous value of the delivered power at the AC terminal of the device under test, in kW;

$P_{DC}(t)$ is the instantaneous value of the received power at the DC terminal of the device under test, in kW.

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.19
total energy conversion efficiency
η_t
product of the energy conversion efficiency and MPPT efficiency:

$$\eta_t = \eta_{CONV} \times \eta_{MPPT} \quad (3)$$

where

η_t is the total energy conversion efficiency.

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.20
weighted static energy conversion efficiency
η_s
efficiency calculated by using a ratio of irradiance and the results of static performance evaluation:

$$\eta_s = F_1\eta_{t1} + F_2\eta_{t2} + \cdots + F_n\eta_{tn} \quad (4)$$

where

$\eta_{t1}, \eta_{t2} \cdots \eta_{tn}$ are the total energy conversion efficiency values at rated power values of IEC 61683 defined;

$F_1, F_2, \cdots F_n$ are the weighting factors of each power level that are defined from the distribution rate of the static state data at the location where the PV system is installed.