IEC 62891

Edition 1.0 2020-07

INTERNATIONAL STANDARD

colour inside

Maximum power point tracking efficiency of grid connected photovoltaic inverters

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-8470-4

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
3.1 Inverter input (PV generator) 6
3.2 Inverter output (grid) 7
3.3 Measured quantities 7
3.4 Calculated quantities 8
4 MPPT efficiencies 9
4.1 General description 9
4.2 Test set-up 10
4.3 Static MPPT efficiency 11
4.3.1 Test conditions 11
4.3.2 Measurement procedure 12
4.3.3 Evaluation – Calculation of static MPPT efficiency 13
4.4 Test conditions for dynamic MPPT efficiency 13
4.4.1 Dynamic MPPT efficiency 13
4.4.2 Measurement procedure 14
4.4.3 Evaluation – Calculation of the dynamic MPPT efficiency 14
5 Calculation of the overall efficiency 15
Annex A (normative) Requirements on the measuring apparatus 16
A.1 PV generator simulator 16
A.1.1 General 16
A.1.2 Requirements on the static characteristic 16
A.1.3 Requirement on the transient stability 17
A.1.4 Requirements on the dynamic characteristic 17
A.1.5 Requirements on electrical characteristic 17
A.1.6 Calibration – Uncertainty 17
A.2 AC power supply 17
Annex B (normative) Test conditions for dynamic MPPT efficiency 18
B.1 Test profiles 18
B.2 Test sequence with ramps 10 % – 50 % G_{STC} (See Table B.1) 20
B.3 Test sequence with ramps 30 % – 100 % G_{STC} (See Table B.2) 21
B.4 Start-up and shut-down test with slow ramps (See Table B.3 and Figure B.3) 21
B.5 Total test duration 22
Annex C (normative) Models of current/voltage characteristic of PV generator 23
C.1 PV generator model for MPPT performance tests 23
C.2 Alternative PV generator model for MPPT performance tests 27
Annex D (normative) Efficiency weighting factors 29
D.1 European efficiency 29
D.2 CEC efficiency 29
Annex E (normative) Specification of the static MPPT and conversion efficiency in terms of normalised rated AC power 30
E.1 General 30
E.2 Re-normalisation of output power P_{AC} to the rated output power $P_{AC,r}$ 30

E.3 Representation of the conversion efficiency in terms of normalised rated output power 30
E.4 Interpolation on normative nodes 31
E.5 Result 33
Bibliography 34

Figure 1 – Example test set-up for MPPT efficiency measurements 11
Figure B.1 – Test sequence for fluctuations between small and medium irradiation intensities 18
Figure B.2 – Test sequence for fluctuations between medium and high irradiation intensities 19
Figure B.3 – Test sequence for the start-up and shut-down test of grid connected inverters 22
Figure C.1 – Irradiation-dependent V-I- and V-P characteristic of a c-Si PV generator 25
Figure C.2 – Irradiation-dependent V-I- and V-P characteristic of a thin-film PV generator 26

Table 1 – Test specifications for static MPPT efficiency 12
Table A.1 – General requirements on the simulated I/V characteristic of the PV generator 16
Table B.1 – Dynamic MPPT-Test 10 % → 50 % G_{STC} (valid for the evaluation of $\eta_{MPPTdyn}$) 20
Table B.2 – Dynamic MPPT-Test 30 % → 100 % G_{STC} (valid for the evaluation of $\eta_{MPPTdyn}$) 21
Table B.3 – Dynamic MPPT- Slow Ramp 1 % → 10 % G_{STC} (valid for the evaluation of $\eta_{MPPTdyn}$) 21
Table C.1 – Technology-dependent parameters 24
Table C.2 – MPP-values obtained with the cSi PV model 25
Table C.3 – MPP-values obtained with the TF-PV mode 27
Table D.1 – Weighting factors and partial MPP power levels for the calculation of the European efficiency 29
Table D.2 – Weighting factors and partial MPP power levels for the calculation of the CEC efficiency (California Energy Commission) 29
Table E.1 – Measured quantities at the conversion efficiency test 30
Table E.2 – Conversion efficiency in term of rated AC power 31
Table E.3 – Allowed limits for the nodes of the normalised AC power 31
Table E.4 – Sought values by means of interpolation 32
Table E.5 – Interpolated conversion efficiencies 33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

MAXIMUM POWER POINT TRACKING EFFICIENCY OF GRID CONNECTED PHOTOVOLTAIC INVERTERS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62891 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/1723/FDIS	82/1736/RVD

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

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

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

MAXIMUM POWER POINT TRACKING EFFICIENCY OF GRID CONNECTED PHOTOVOLTAIC INVERTERS

1 Scope

This document provides a procedure for the measurement of the efficiency of the maximum power point tracking (MPPT) of inverters used in grid-connected photovoltaic (PV) systems. Both the static and dynamic MPPT efficiency are considered. Based on the static MPPT efficiency calculated in this document and steady state conversion efficiency determined in IEC 61683 the overall efficiency can be calculated.

The dynamic MPPT efficiency is indicated separately.

NOTE This document addresses PV inverters connected to an AC grid. However, this procedure may also be used for other power conversion devices with MPPT functionality used in PV systems, such as charge controllers or optimizers.

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*

EN 50160, *Voltage characteristics of electricity supplied by public distribution networks*