



BSI Standards Publication

Photovoltaic system performance

Part 1: Monitoring (IEC 61724-1:2017)

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National foreword

This British Standard is the UK implementation of EN 61724-1:2017. It is identical to IEC 61724-1:2017. Together with PD IEC/TS 61724-2:2016 and PD IEC/TS 61724-3:2016 it supersedes BS EN 61724:1998, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/82, Photovoltaic Energy Systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 89972 0

ICS 27.160

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2018.

Amendments/corrigenda issued since publication

Date	Text affected
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EUROPÄISCHE NORM

May 2017

ICS 27.180

Supersedes EN 61724:1998 (partially)

English Version

Photovoltaic system performance - Part 1: Monitoring (IEC 61724-1:2017)

Performance d'un système photovoltaïque - Partie 1:
Surveillance
(IEC 61724-1:2017)

Betriebsverhalten von Photovoltaik-Systemen - Teil 1:
Überwachung
(IEC 61724-1:2017)

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The text of document 82/1215/FDIS, future edition 1 of IEC 61724-1, prepared by IEC/TC 82 "Solar photovoltaic energy systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61724-1:2017.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2018-01-07
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2020-04-07

This document supersedes EN 61724:1998 (partially).

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Endorsement notice

The text of the International Standard IEC 61724-1:2017 was approved by CENELEC as a European Standard without any modification.

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-131	-	International Electrotechnical Vocabulary (IEV) -- Part 131: Circuit theory	-	-
IEC 60904-2	-	Photovoltaic devices - Part 2: Requirements for photovoltaic reference devices	EN 60904-2	-
IEC 60904-3	-	Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data	EN 60904-3	-
IEC 60904-5	-	Photovoltaic devices -- Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method	EN 60904-5	-
IEC 60904-10	-	Photovoltaic devices -- Part 10: Methods of EN 60904-10 linearity measurement	EN 60904-10	-
IEC 61557-12	-	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures -- Part 12: Performance measuring and monitoring devices (PMD)	EN 61557-12	-
IEC 62053-21	-	Electricity metering equipment (a.c.) - Particular requirements -- Part 21: Static meters for active energy (classes 1 and 2)	EN 62053-21	-
IEC 62053-22	-	Electricity metering equipment (a.c.) - Particular requirements -- Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)	EN 62053-22	-
IEC 62670-3	-		EN 62670-3	-
IEC 62817	2014	Solar trackers for photovoltaic systems - Design qualification	EN 62817	2015
ISO 9060	-	Solar energy; specification and classification of instruments for measuring hemispherical solar and direct solar radiation	-	-
ISO 9488	-	Solar energy - Vocabulary	EN ISO 9488	-
ISO 9846	-	Solar energy -- Calibration of a pyranometer using a pyrliometer	-	-
ISO 9847	-	Solar energy - Calibration of field pyranometers by comparison to a reference pyranometer	-	-
IEC/TS 61836	-	Solar photovoltaic energy systems - Terms, definitions and symbols	CLC/TS 61836	-
ISO/IEC Guide 98-1	-	Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement	-	-

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		Guide to the expression of uncertainty in measurement (GUM:1995)		
ASTM G 183	-	Standard Practice for Field Use of Pyranometers, Pyrhemimeters and UV Radiometers	-	-
WMO No 8	-	Guide to meteorological instruments and methods of observation	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC SYSTEM PERFORMANCE –

Part 1: Monitoring

FOREWORD

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International Standard IEC 61724-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This first edition cancels and replaces the first edition of IEC 61724, published in 1998. This edition constitutes a technical revision.

This edition (in conjunction with IEC TS 61724-2:2016 and IEC TS 61724-3:2016) includes the following significant technical changes with respect to IEC 61724:

- a) IEC 61724 is now written with multiple parts. This document is IEC 61724-1, addressing PV system monitoring. IEC TS 61724-2 and IEC TS 61724-3 address performance analysis based on the monitoring data.
- b) Three classes of monitoring systems are defined corresponding to different levels of accuracy and different intended applications.
- c) Required measurements for each class of monitoring system are stated, along with the required number and accuracy of sensors.

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- d) Options for satellite-based irradiance measurement are provided.
- e) Soiling measurement is introduced.
- f) New performance metrics are introduced, including temperature compensated performance ratios and others.
- g) Numerous recommendations and explanatory notes are included.

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

FDIS	Report on voting
82/1215/FDIS	82/1248/RVD

Full information on the voting for the approval of this International Standard 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 document will remain unchanged until the stability date indicated on the IEC website under "<http://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.

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

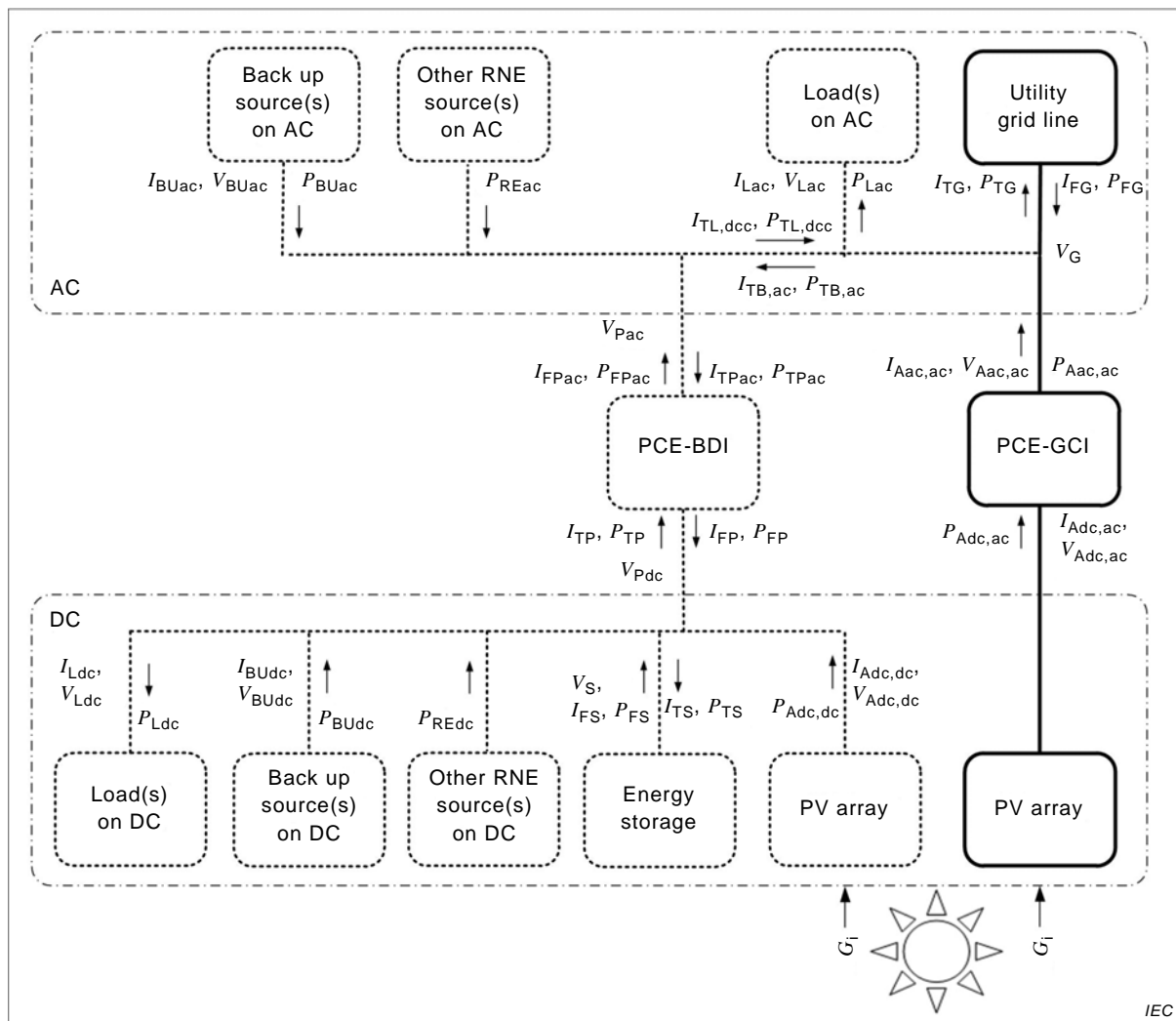
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INTRODUCTION

This International Standard defines classes of photovoltaic (PV) performance monitoring systems and serves as guidance for various monitoring system choices.

Figure 1 illustrates possible major elements comprising different PV system types. The PV array may include both fixed axis and tracking systems and both flat plate and concentrator systems. Module-level electronics, if present, may be a component of the monitoring system.

For simplicity, the main clauses of this document are written for grid-connected systems without local loads, energy storage, or auxiliary sources, as shown by the bold lines in Figure 1. Annex D includes details for systems with additional components.



Key

- RNE renewable energy
- PCE power conditioning equipment
- BDI bi-directional inverter
- GCI grid-connected inverter

Bold lines denote simple grid-connected system without local loads, energy storage, or auxiliary sources.

Figure 1 – Possible elements of PV systems

The purposes of a performance monitoring system are diverse and can include the following:

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- identification of performance trends in an individual PV system;
- localization of potential faults in a PV system;
- comparison of PV system performance to design expectations and guarantees;
- comparison of PV systems of different configurations; and
- comparison of PV systems at different locations.

These diverse purposes give rise to a diverse set of requirements, and different sensors and/or analysis methods may be more or less suited depending on the specific objective. For example, for comparing performance to design expectations and guarantees, the focus should be on system-level data and consistency between prediction and test methods, while for analysing performance trends and localizing faults, there may be a need for greater resolution at sub-levels of the system and an emphasis on measurement repeatability and correlation metrics rather than absolute accuracy.

The monitoring system should be adapted to the PV system's size and user requirements. In general, larger and more expensive PV systems should have more monitoring points and higher accuracy sensors than smaller and lower-cost PV systems. This document defines three classifications of monitoring system with differentiated requirements which are appropriate to a range of purposes.

PHOTOVOLTAIC SYSTEM PERFORMANCE –

Part 1: Monitoring

1 Scope

This part of IEC 61724 outlines equipment, methods, and terminology for performance monitoring and analysis of photovoltaic (PV) systems. It addresses sensors, installation, and accuracy for monitoring equipment in addition to measured parameter data acquisition and quality checks, calculated parameters, and performance metrics. In addition, it serves as a basis for other standards which rely upon the data collected.

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 60050-131, *International Electrotechnical Vocabulary – Part 131: Circuit theory*

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for photovoltaic reference devices*

IEC 60904-3, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

IEC 60904-5, *Photovoltaic devices – Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method*

IEC 60904-10, *Photovoltaic devices – Part 10: Methods of linearity measurement*

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

IEC 61557-12, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 12: Performance measuring and monitoring devices (PMD)*

IEC 62053-21, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62053-22, *Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

IEC 62670-3, *Photovoltaic concentrators (CPV) – Performance testing – Part 3: Performance measurements and power rating*

IEC 62817:2014, *Photovoltaic systems – Design qualification of solar trackers*

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