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**Photovoltaic system performance –
Part 1: Monitoring**

INTERNATIONAL
ELECTROTECHNICAL
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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	10
4 Monitoring system classification	13
5 General	13
5.1 Measurement uncertainty.....	13
5.2 Calibration	14
5.3 Repeated elements.....	14
5.4 Power consumption.....	14
5.5 Documentation.....	14
5.6 Inspection	14
6 Data acquisition timing and reporting.....	15
6.1 Sampling, recording, and reporting	15
6.2 Timestamps	16
7 Measured parameters.....	16
7.1 General requirements	16
7.2 Irradiance	20
7.2.1 On-site irradiance measurement.....	20
7.2.2 Satellite remote sensing of irradiance	25
7.3 Environmental factors	26
7.3.1 PV module temperature	26
7.3.2 Ambient air temperature	27
7.3.3 Wind speed and direction	27
7.3.4 Soiling ratio	28
7.3.5 Rainfall.....	30
7.3.6 Snow	30
7.3.7 Humidity	30
7.4 Tracker system	31
7.4.1 Single-axis trackers	31
7.4.2 Dual-axis trackers for >20x systems	31
7.5 Electrical measurements.....	31
7.6 External system requirements	32
8 Data processing and quality check	32
8.1 Daylight hours.....	32
8.2 Quality check	33
8.2.1 Removing invalid readings.....	33
8.2.2 Treatment of missing data	33
9 Calculated parameters.....	33
9.1 Overview	33
9.2 Summations.....	34
9.3 Irradiation	34
9.4 Electrical energy.....	35
9.4.1 General	35
9.4.2 DC output energy	35

9.4.3	AC output energy.....	35
9.5	Array power rating	35
9.5.1	DC power rating.....	35
9.5.2	AC power rating.....	35
9.6	Yields	35
9.6.1	General	35
9.6.2	PV array energy yield	36
9.6.3	Final system yield.....	36
9.6.4	Reference yield	36
9.7	Yield losses	36
9.7.1	General	36
9.7.2	Array capture loss	36
9.7.3	Balance of systems (BOS) loss.....	36
9.8	Efficiencies	37
9.8.1	Array (DC) efficiency	37
9.8.2	System (AC) efficiency	37
9.8.3	BOS efficiency.....	37
10	Performance metrics.....	37
10.1	Overview	37
10.2	Summations.....	38
10.3	Performance ratios	38
10.3.1	Performance ratio.....	38
10.3.2	Temperature-corrected performance ratios	39
10.4	Performance indices	40
11	Data filtering.....	41
11.1	Use of available data	41
11.2	Filtering data to specific conditions	41
11.3	Reduced inverter, grid, or load availability	41
Annex A (informative)	Sampling interval	42
A.1	General considerations	42
A.2	Time constants	42
A.3	Aliasing error	42
A.4	Example	43
Annex B (informative)	Module backsheet temperature sensor selection and attachment	44
B.1	Objective	44
B.2	Sensor and material selection	44
B.2.1	Optimal sensor types	44
B.2.2	Optimal tapes	44
B.2.3	Cyanoacrylate adhesives and backsheet integrity	44
B.3	Sensor attachment method	45
B.3.1	Permanent versus temporary	45
B.3.2	Attachment location	45
B.3.3	Sensor attachment.....	45
Annex C (informative)	Derate factors	48
Annex D (normative)	Systems with local loads, storage, or auxiliary sources	49
D.1	System types	49
D.2	Parameters and formulas	51

Bibliography.....	57
Figure 1 – Possible elements of PV systems.....	7
Figure 2 – Sampling, recording, and reporting.....	15
Figure B.1 – Sensor attachment, permanent	46
Figure B.2 – Sensor attachment, temporary	46
Figure B.3 – Sensor element wire strain relief.....	46
Figure D.1 – Energy flow between possible elements of different PV system types	49
Table 1 – Monitoring system classifications and suggested applications	13
Table 2 – Sampling and recording interval requirements	16
Table 3 – Measured parameters and requirements for each monitoring system class.....	18
Table 4 – Relation between system size (AC) and number of sensors for specific sensors referenced in Table 3.....	20
Table 5 – Sensor choices and requirements for in-plane and global irradiance	21
Table 6 – Irradiance sensor alignment accuracy	22
Table 7 – Irradiance sensor maintenance requirements	23
Table 8 – PV module temperature sensor maintenance requirements	26
Table 9 – Ambient air temperature sensor maintenance requirements	27
Table 10 – Wind sensor maintenance requirements	28
Table 11 – Inverter-level electrical measurement requirements	32
Table 12 – Plant-level AC electrical output measurement requirements	32
Table 13 – Calculated parameters	34
Table 14 – Performance metrics	38
Table D.1 – Elements of different PV system types.....	50
Table D.2 – Parameters and equations for different system types	51

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.

- 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.

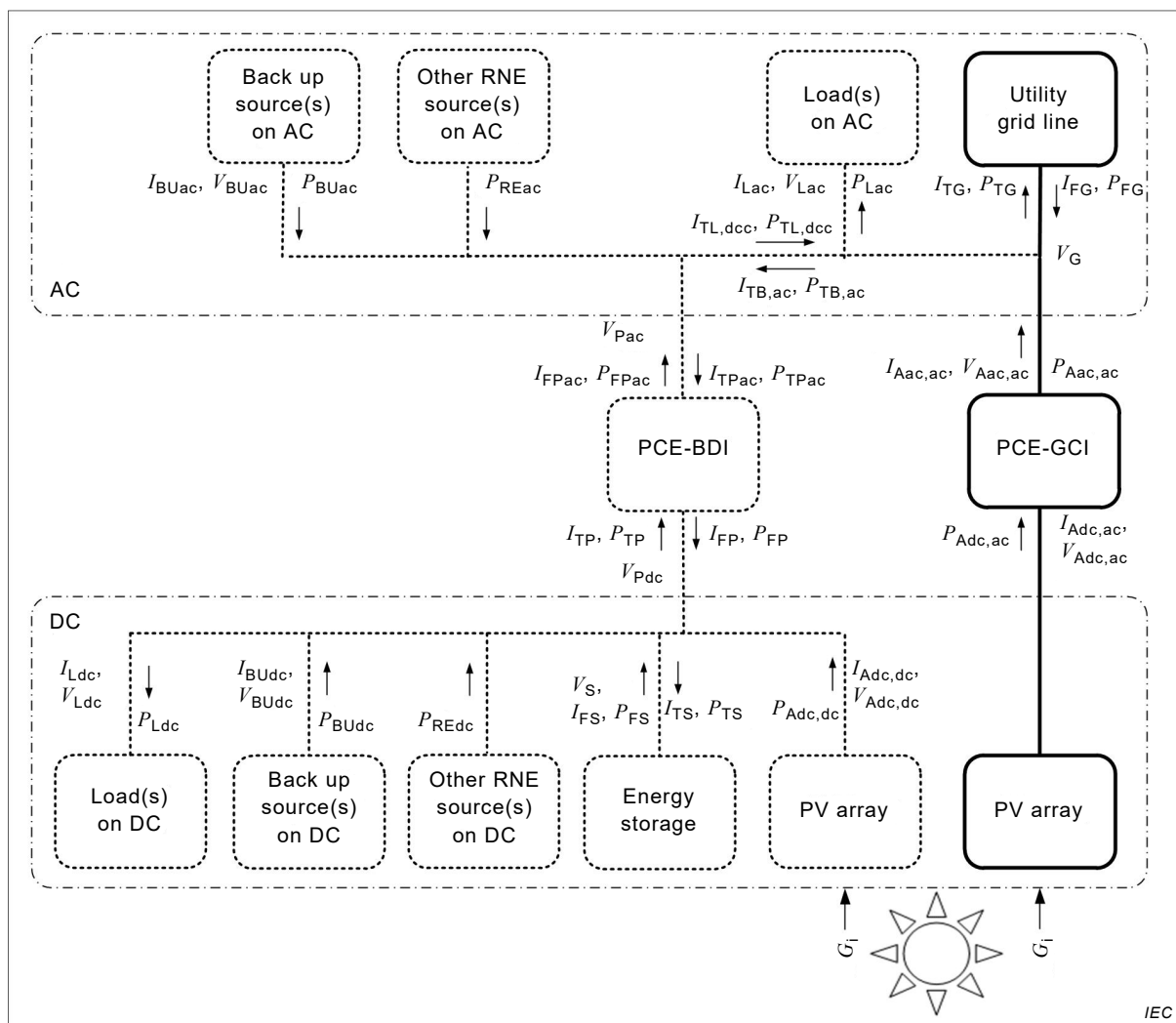
A bilingual version of this publication may be issued at a later date.

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:

- 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*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 9060, *Solar energy – Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9488, *Solar energy – Vocabulary*

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*

WMO No. 8, *Guide to meteorological instruments and methods of observation*

ASTM G183, *Standard Practice for Field Use of Pyranometers, Pyrliometers and UV Radiometers*