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REDLINE VERSION

Solcellssystem – Prestanda – Del 1: Övervakning

*Photovoltaic system performance –
Part 1: Monitoring*

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Edition 2.0 2021-07
REDLINE VERSION

INTERNATIONAL STANDARD



Photovoltaic system performance – Part 1: Monitoring

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	10
2 Normative references.....	10
3 Terms and definitions	11
4 Monitoring system classification.....	16
5 General	17
5.1 Measurement precision and uncertainty.....	17
5.2 Calibration	17
5.3 Repeated elements	17
5.4 Power consumption.....	17
5.5 Documentation.....	17
5.6 Inspection	18
6 Data acquisition timing and reporting	18
6.1 Samples, records, and reports.....	18
6.2 Timestamps	20
6.3 Parameter names.....	20
7 Measured parameters Required measurements.....	21
8 Irradiance.....	27
8.1 Sensor types.....	31
8.2 General requirements.....	31
8.2.1 Overview	31
8.2.2 Sensor requirements.....	31
8.2.3 Sensor locations	32
8.2.4 Recalibration.....	33
8.2.5 Soiling mitigation	33
8.2.6 Dew and frost mitigation.....	33
8.2.7 Inspection and maintenance.....	34
8.2.8 Sensor alignment.....	34
8.3 Measurements	34
8.3.1 Global horizontal irradiance.....	34
8.3.2 In-plane irradiance	34
8.3.3 In-plane rear-side irradiance.....	35
8.3.4 In-plane rear-side irradiance ratio.....	35
8.3.5 Horizontal albedo.....	35
8.3.6 Direct normal irradiance	35
8.3.7 Diffuse horizontal irradiance.....	35
8.3.8 Spectrally matched irradiance	35
8.3.9 In-plane irradiance for concentrator systems.....	36
8.3.10 Spectral irradiance for concentrator systems	37
8.3.11 Circumsolar ratio measurements for concentrator systems.....	37
8.3.12 Satellite remote sensing of irradiance	38
9 Environmental factors	39
9.1 PV module temperature.....	39
9.2 Ambient air temperature.....	41

9.3	Wind speed and direction	42
9.4	Soiling ratio.....	42
9.5	Rainfall	45
9.6	Snow	45
9.7	Humidity	45
10	Tracker system.....	45
10.1	Single-axis trackers.....	45
10.2	Dual-axis trackers for >20x systems	45
10.2.1	Monitoring.....	45
10.2.2	Pointing error sensor alignment.....	45
11	Electrical measurements.....	46
11.1	Inverter-level measurements	46
11.2	Plant-level measurements	47
12	Data processing and quality check	48
12.1	Daylight hours Night.....	48
12.2	Quality check	48
12.2.1	Removing invalid readings	48
12.2.2	Treatment of missing data	49
13	Calculated parameters.....	49
13.1	Overview.....	49
13.2	Summations	50
13.3	Irradiation	50
13.4	Electrical energy	51
13.4.1	General	51
13.4.2	DC output energy.....	51
13.4.3	AC output energy	51
13.5	Array power rating.....	51
13.5.1	DC power rating.....	51
13.5.2	AC power rating	52
13.6	Yields	52
13.6.1	General	52
13.6.2	PV array energy yield.....	52
13.6.3	Final system yield	52
13.6.4	Reference yield.....	52
13.6.5	Bifacial reference yield	53
13.7	Yield losses	53
13.7.1	General	53
13.7.2	Array capture loss.....	53
13.7.3	Balance of systems (BOS) loss.....	53
13.8	Efficiencies	54
13.8.1	Array (DC) efficiency.....	54
13.8.2	System (AC) efficiency	54
13.8.3	BOS efficiency	54
14	Performance metrics.....	54
14.1	Overview.....	54
14.2	Summations	55
14.3	Performance ratios.....	55
14.3.1	Performance ratio	55

14.3.2	Temperature-corrected performance ratios	56
14.3.3	Bifacial performance ratios	58
14.4	Performance indices	59
15	Data filtering	59
15.1	Use of available data	59
15.2	Filtering data to specific conditions	59
15.3	Reduced inverter, grid, or load availability	59
Annex A (informative)	Sampling interval	61
A.1	General considerations	61
A.2	Time constants	61
A.3	Aliasing error	61
A.4	Example	62
Annex B (informative)	Module backsheet temperature sensor selection and attachment	63
B.1	Objective	63
B.2	Sensor and material selection	63
B.2.1	Optimal sensor types	63
B.2.2	Optimal tapes	63
B.2.3	Cyanoacrylate adhesives and backsheet integrity	64
B.3	Sensor attachment method	64
B.3.1	Permanent versus temporary	64
B.3.2	Attachment location	64
B.3.3	Sensor attachment Bifacial modules	64
B.3.4	Method	64
Annex C (normative)	Soiling measurement using clean and soiled PV reference device pair	67
C.1	Overview	67
C.2	Equipment	67
C.3	Normalization	67
C.4	Measurement method 1 – max power reduction due to soiling	68
C.5	Measurement method 2 – short-circuit current reduction due to soiling	68
C.6	Non-uniform soiling	68
C.7	Daily average value	69
C.8	Renormalization	69
Annex D (informative)	Derate factors	70
Annex E (normative)	Systems with local loads, storage, or auxiliary sources	72
E.1	System types	72
E.2	Parameters and formulas	74
Bibliography	81
Figure 1	– Possible elements of PV systems	8
Figure 2	– Samples, records and reports	19
Figure B.1	– Sensor attachment, permanent	65
Figure B.2	– Sensor attachment, temporary	65
Figure B.3	– Sensor element wire strain relief	66
Figure E.1	– Energy flow between possible elements of different PV system types	72

Table 1	– Monitoring system classifications and suggested applications	81
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Table 1 – Sampling and recording interval requirements	20
Table 2 – Measured parameters and requirements for each monitoring system class	22
Table 3 – Relation between system size (AC) and number of sensors for specific sensors Multiplier referenced in Table 2	27
Table 4 – Irradiance sensor requirements	32
Table 5 – Sensor choices and requirements for in-plane and global irradiance	
Table 6 – Irradiance sensor alignment accuracy	
Table 7 – Irradiance sensor maintenance requirements	
Table 5 – Inverter-level electrical measurement requirements	46
Table 6 – Plant-level AC electrical output measurement requirements	47
Table 7 – Calculated parameters	50
Table 8 – PV module temperature sensor maintenance requirements	
Table 8 – Performance metrics	55
Table 9 – Ambient air temperature sensor maintenance requirements	
Table 11 – Inverter-level electrical measurement requirements	
Table 12 – Plant-level AC electrical output measurement requirements	
Table 13 – Calculated parameters	
Table 14 – Performance metrics	
Table E.1 – Elements of different PV system types	73
Table E.2 – Parameters and formulas for different system types	74

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC SYSTEM PERFORMANCE –

Part 1: Monitoring

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61724-1:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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

This second edition cancels and replaces the first edition, published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- Monitoring of bifacial systems is introduced.
- Irradiance sensor requirements are updated.
- Soiling measurement is updated based on new technology.
- Class C monitoring systems are eliminated.
- Various requirements, recommendations and explanatory notes are updated.

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

FDIS	Report on voting
82/1904/FDIS	82/1925/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 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.

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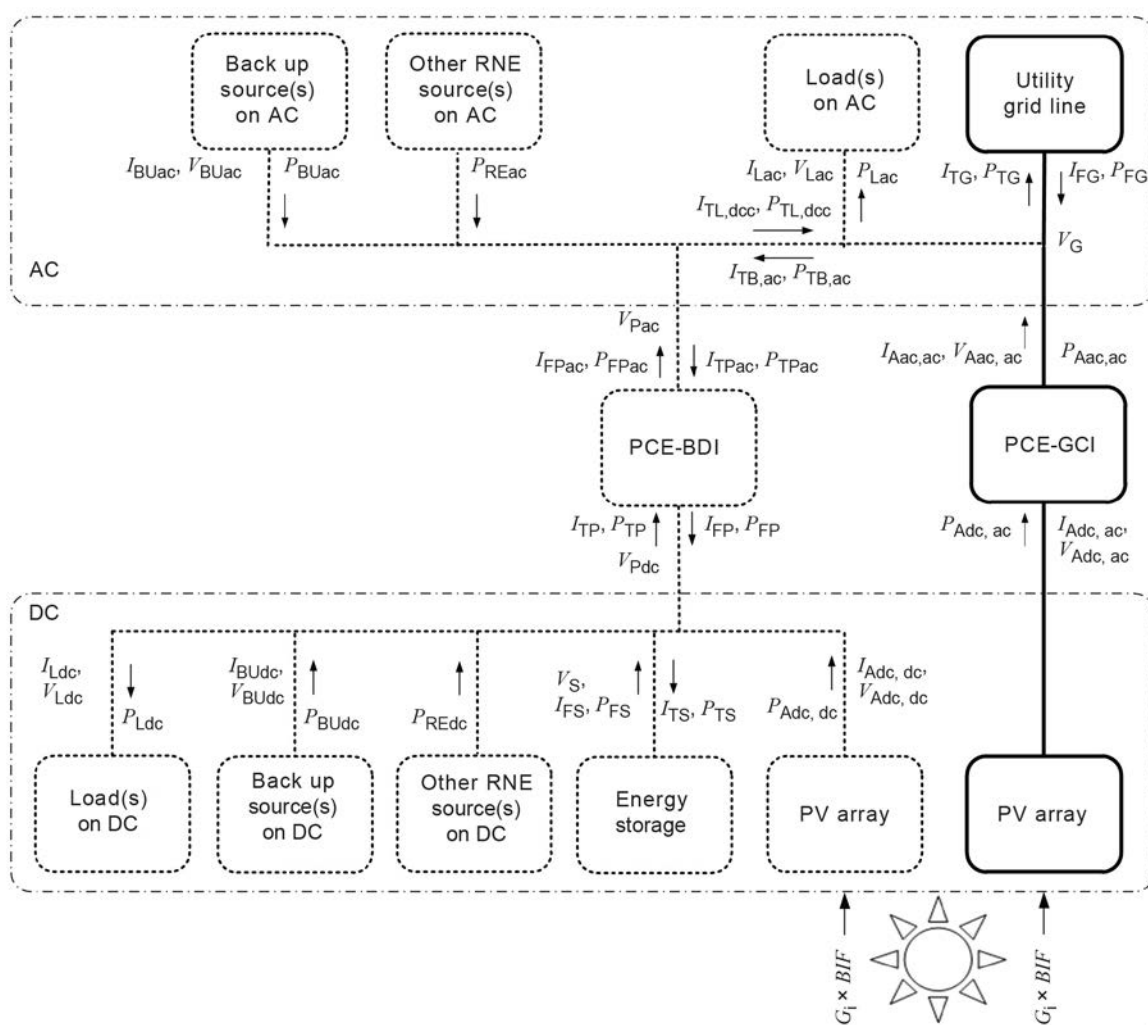
INTRODUCTION

This document 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 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 E includes some details for systems with additional components.

The PV array may include both fixed-axis and ~~tracking~~ tracker systems and both flat-plate and concentrator systems. ~~Module-level electronics, if present, may be a component of the monitoring system.~~



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~~ could 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.~~

comparing performance to design expectations and guarantees as well as detecting and localizing faults.

~~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.~~

For detecting and localizing faults there ~~may~~ should 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 terminology, equipment, and methods 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.~~ It also 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 (IEV) – 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 60904-7, *Photovoltaic devices – Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices*

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

IEC 61215 (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

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

IEC TS 61724-2, *Photovoltaic system performance – Part 2: Capacity evaluation method*

IEC TS 61724-3, *Photovoltaic system performance – Part 3: Energy evaluation method*

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

~~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 – Particular requirements – Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)*

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 9060:2018, *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*~~

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Solcellssystem – Prestanda – Del 1: Övervakning

*Photovoltaic system performance –
Part 1: Monitoring*

Som svensk standard gäller europastandarden EN IEC 61724-1:2021. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61724-1:2021.

Nationellt förord

Europastandarden EN IEC 61724-1:2021

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61724-1, Second edition, 2021 - Photovoltaic system performance - Part 1: Monitoring**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61724-1, utgåva 1, 2017, gäller ej fr o m 2024-08-25.

Standarder underlättar utvecklingen och höjer elsäkerheten

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SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

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Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

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English Version

**Photovoltaic system performance - Part 1: Monitoring
(IEC 61724-1:2021)**

Performances des systèmes photovoltaïques - Partie 1:
Surveillance
(IEC 61724-1:2021)

Betriebsverhalten von Photovoltaik-Systemen - Teil 1:
Überwachung
(IEC 61724-1:2021)

This European Standard was approved by CENELEC on 2021-08-25. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 82/1904/FDIS, future edition 2 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 IEC 61724-1:2021.

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) 2022-05-25
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-08-25

This document supersedes EN 61724-1:2017 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61724-1:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60904-3 NOTE Harmonized as EN IEC 60904-3

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where 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 60904-5	-	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 60904-7	-	Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices	EN IEC 60904-7	-
IEC 61215	series	Terrestrial photovoltaic (PV) modules Design qualification and type approval	EN IEC 61215	series
IEC 61557-12	-	Electrical safety in low voltage distribution-systems up to 1 000 V AC and 1 500 V DC - Equipment for testing, measuring or monitoring of protective measures - Part 12: Power metering and monitoring devices (PMD)		-
IEC/TS 61724-2		Photovoltaic system performance - Part 2: Capacity evaluation method		
IEC/TS 61724-3		Photovoltaic system performance - Part 3: Energy evaluation method		
IEC/TS 61836		Solar photovoltaic energy systems - Terms, definitions and symbols		-
IEC 62053-22	-	Electricity metering equipment - Part 22: requirements - Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)	EN IEC 62053-22	-

EN IEC 61724-1:2021 (E)

IEC 62670-3	-	Photovoltaic concentrators (CPV) –EN 62670-3 Performance testing - Part 3: Performance measurements and power rating	-
IEC 62817	2014	Photovoltaic systems - Design qualification of solar trackers	EN 62817 2015
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	2018	Solar energy - Specification and classification of instruments for measuring hemispherical solar and direct solar radiation	
ISO 9488		Solar energy - Vocabulary	EN ISO 9488



IEC 61724-1

Edition 2.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**Performances des systèmes photovoltaïques –
Partie 1: Surveillance**

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CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	10
2 Normative references.....	10
3 Terms and definitions	11
4 Monitoring system classification	15
5 General	16
5.1 Measurement precision and uncertainty	16
5.2 Calibration	16
5.3 Repeated elements	16
5.4 Power consumption	16
5.5 Documentation	16
5.6 Inspection	16
6 Data acquisition timing and reporting	16
6.1 Samples, records, and reports	16
6.2 Timestamps	18
6.3 Parameter names.....	18
7 Required measurements	18
8 Irradiance.....	23
8.1 Sensor types.....	23
8.2 General requirements.....	23
8.2.1 Overview	23
8.2.2 Sensor requirements.....	23
8.2.3 Sensor locations	24
8.2.4 Recalibration.....	25
8.2.5 Soiling mitigation	25
8.2.6 Dew and frost mitigation.....	25
8.2.7 Inspection and maintenance	26
8.2.8 Sensor alignment	26
8.3 Measurements	26
8.3.1 Global horizontal irradiance.....	26
8.3.2 In-plane irradiance	26
8.3.3 In-plane rear-side irradiance.....	27
8.3.4 In-plane rear-side irradiance ratio.....	27
8.3.5 Horizontal albedo.....	27
8.3.6 Direct normal irradiance	27
8.3.7 Diffuse horizontal irradiance	27
8.3.8 Spectrally matched irradiance	27
8.3.9 In-plane irradiance for concentrator systems.....	28
8.3.10 Spectral irradiance for concentrator systems	29
8.3.11 Circumsolar measurements for concentrator systems.....	29
8.3.12 Satellite remote sensing of irradiance	30
9 Environmental factors	31
9.1 PV module temperature.....	31
9.2 Ambient air temperature	31

9.3	Wind speed and direction	32
9.4	Soiling ratio.....	32
9.5	Rainfall	33
9.6	Snow	33
9.7	Humidity	33
10	Tracker system.....	33
10.1	Single-axis trackers.....	33
10.2	Dual-axis trackers	33
10.2.1	Monitoring.....	33
10.2.2	Pointing error sensor alignment.....	33
11	Electrical measurements.....	34
11.1	Inverter-level measurements	34
11.2	Plant-level measurements	34
12	Data processing and quality check	35
12.1	Night.....	35
12.2	Quality check	35
12.2.1	Removing invalid readings	35
12.2.2	Treatment of missing data	35
13	Calculated parameters.....	36
13.1	Overview.....	36
13.2	Summations	36
13.3	Irradiation	36
13.4	Electrical energy	37
13.4.1	General	37
13.4.2	DC output energy.....	37
13.4.3	AC output energy	37
13.5	Array power rating.....	37
13.5.1	DC power rating.....	37
13.5.2	AC power rating	38
13.6	Yields	38
13.6.1	General	38
13.6.2	PV array energy yield.....	38
13.6.3	Final system yield	38
13.6.4	Reference yield.....	39
13.6.5	Bifacial reference yield.....	39
13.7	Yield losses	39
13.7.1	General	39
13.7.2	Array capture loss.....	39
13.7.3	Balance of systems (BOS) loss.....	40
13.8	Efficiencies	40
13.8.1	Array (DC) efficiency.....	40
13.8.2	System (AC) efficiency	40
13.8.3	BOS efficiency	40
14	Performance metrics.....	41
14.1	Overview.....	41
14.2	Summations	41
14.3	Performance ratios.....	41
14.3.1	Performance ratio	41

14.3.2	Temperature-corrected performance ratios	42
14.3.3	Bifacial performance ratios	44
14.4	Performance indices	44
15	Data filtering	45
15.1	Use of available data	45
15.2	Filtering data to specific conditions	45
15.3	Reduced inverter, grid, or load availability	45
Annex A (informative)	Sampling interval	46
A.1	General considerations	46
A.2	Time constants	46
A.3	Aliasing error	46
A.4	Example	47
Annex B (informative)	Module temperature sensor selection and attachment	48
B.1	Objective	48
B.2	Sensor and material selection	48
B.2.1	Optimal sensor types	48
B.2.2	Optimal tapes	48
B.2.3	Cyanoacrylate adhesives and backsheet integrity	49
B.3	Sensor attachment	49
B.3.1	Permanent versus temporary	49
B.3.2	Attachment location	49
B.3.3	Bifacial modules	49
B.3.4	Method	49
Annex C (normative)	Soiling measurement using clean and soiled PV reference device pair	52
C.1	Overview	52
C.2	Equipment	52
C.3	Normalization	52
C.4	Measurement method 1 – max power reduction due to soiling	53
C.5	Measurement method 2 – short-circuit current reduction due to soiling	53
C.6	Non-uniform soiling	53
C.7	Daily average value	54
C.8	Renormalization	54
Annex D (informative)	Derate factors	55
Annex E (normative)	Systems with local loads, storage, or auxiliary sources	57
E.1	System types	57
E.2	Parameters and formulas	59
Bibliography	66
Figure 1	– Possible elements of PV systems	8
Figure 2	– Samples, records and reports	17
Figure B.1	– Sensor attachment, permanent	50
Figure B.2	– Sensor attachment, temporary	50
Figure B.3	– Sensor element wire strain relief	51
Figure E.1	– Energy flow between possible elements of different PV system types	57
Table 1	– Sampling and recording interval requirements	18

Table 2 – Measured parameters and requirements	20
Table 3 – Multiplier referenced in Table 2	23
Table 4 – Irradiance sensor requirements	24
Table 5 – Inverter-level electrical measurement requirements	34
Table 6 – Plant-level AC electrical output measurement requirements	34
Table 7 – Calculated parameters	36
Table 8 – Performance metrics	41
Table E.1 – Elements of different PV system types	58
Table E.2 – Parameters and formulas for different system types	59

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 second edition cancels and replaces the first edition, published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- Monitoring of bifacial systems is introduced.
- Irradiance sensor requirements are updated.
- Soiling measurement is updated based on new technology.
- Class C monitoring systems are eliminated.
- Various requirements, recommendations and explanatory notes are updated.

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

FDIS	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

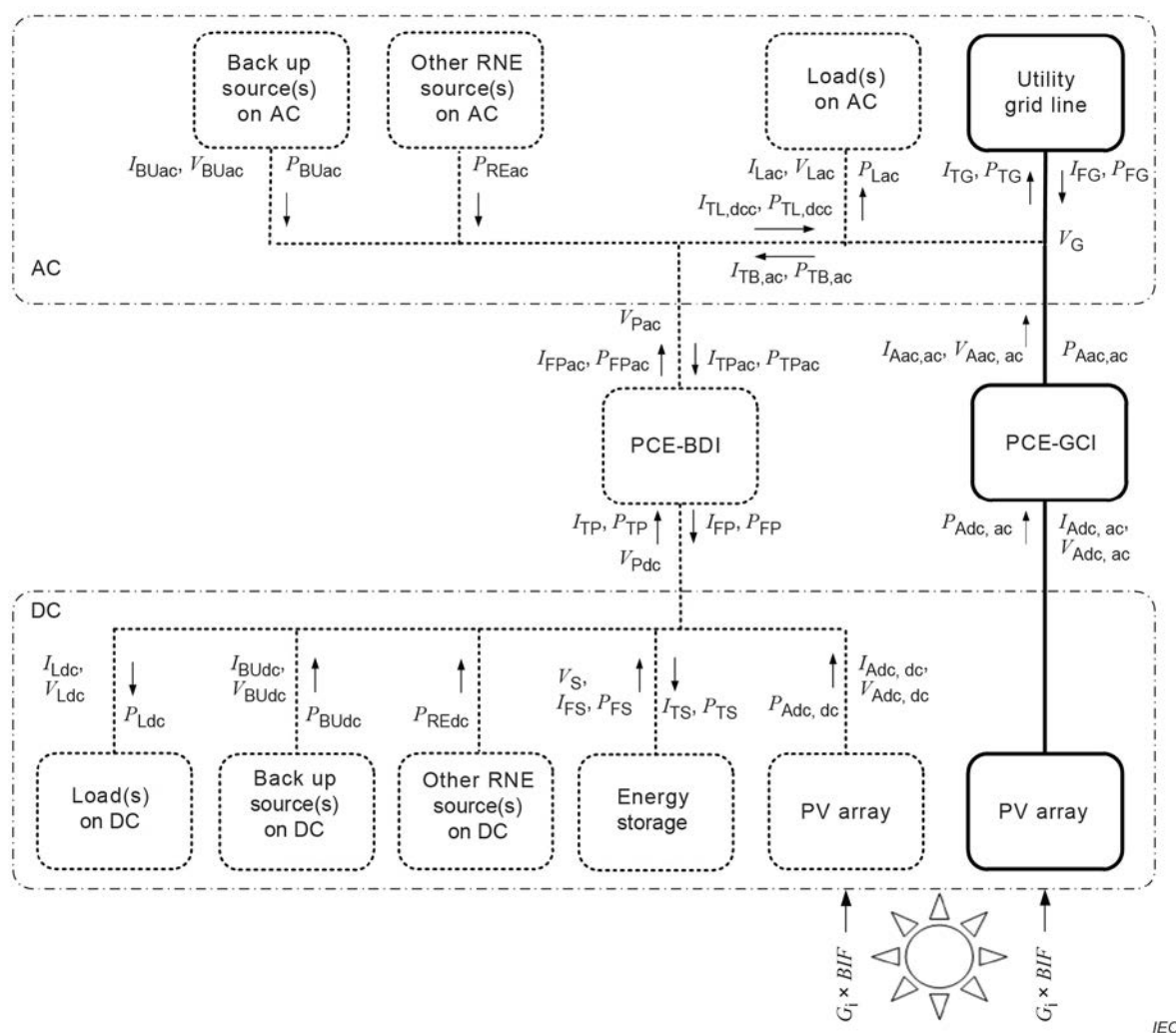
- reconfirmed,
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- amended.

INTRODUCTION

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

Figure 1 illustrates major elements comprising different PV system types. 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 E includes some details for systems with additional components.

The PV array may include both fixed-axis and tracker systems and both flat-plate and concentrator systems.



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 could include comparing performance to design expectations and guarantees as well as detecting and localizing faults.

For comparing performance to design expectations and guarantees, the focus should be on system-level data and consistency between prediction and test methods.

For detecting and localizing faults there should be greater resolution at sub-levels of the system and an emphasis on measurement repeatability and correlation metrics.

The monitoring system should be adapted to the PV system's size and user requirements. In general, larger PV systems should have more monitoring points and higher accuracy sensors than smaller and lower-cost PV systems.

PHOTOVOLTAIC SYSTEM PERFORMANCE –

Part 1: Monitoring

1 Scope

This part of IEC 61724 outlines terminology, equipment, and methods for performance monitoring and analysis of photovoltaic (PV) systems. It also 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 (IEV) – Part 131: Circuit theory*

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

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 60904-7, *Photovoltaic devices – Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices*

IEC 61215 (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

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

IEC TS 61724-2, *Photovoltaic system performance – Part 2: Capacity evaluation method*

IEC TS 61724-3, *Photovoltaic system performance – Part 3: Energy evaluation method*

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

IEC 62053-22, *Electricity metering equipment – Particular requirements – Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)*

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 9060:2018, *Solar energy – Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9488, *Solar energy – Vocabulary*