

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)

ICS 17.220.20; 29.080.01; 29.240.01

National foreword

This British Standard is the UK implementation of EN 61557-12:2008. It is identical to IEC 61557-12:2007.

The UK participation in its preparation was entrusted to Technical Committee PEL/85, Measuring equipment for electrical and electromagnetic quantities.

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

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**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 61557-12:2007)**

Sécurité électrique dans les réseaux
de distribution basse tension
de 1 000 V c.a. et 1 500 V c.c. -
Dispositifs de contrôle, de mesure ou
de surveillance de mesures de protection -
Partie 12: Dispositifs de mesure et
de surveillance des performances (PMD)
(CEI 61557-12:2007)

Elektrische Sicherheit
in Niederspannungsnetzen
bis AC 1 000 V und DC 1 500 V -
Geräte zum Prüfen, Messen oder
Überwachen von Schutzmaßnahmen -
Teil 12: Kombinierte Geräte zur Messung
und Überwachung des Betriebsverhaltens
(IEC 61557-12:2007)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 85/311/FDIS, future edition 1 of IEC 61557-12, prepared by IEC TC 85, Measuring equipment for electrical and electromagnetic quantities, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61557-12 on 2008-04-01.

This standard is to be used in conjunction with EN 61557-1:2007 (unless otherwise specified).

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with the EN have to be withdrawn (dow) 2011-04-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 2004/108/EC. See Annex ZZ.

Annexes ZA and ZZ have been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61557-12:2007 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

As a complement to protection measures, it becomes more and more necessary to measure different electrical parameters, in order to monitor the required performances in energy distribution systems due to:

- installation standards evolutions, for instance over current detection is now a new requirement for the neutral conductor due to harmonic content;
- technological evolutions (electronic loads, electronic measuring methods, etc.);
- end-users needs (cost saving, compliance with aspects of building regulations, etc..);
- safety and continuity of service;
- sustainable development requirements where energy measurement for instance is recognised as an essential element of energy management, part of the overall drive to reduce carbon emissions and to improve the commercial efficiency of manufacturing, commercial organisations and public services.

The devices on the current market have different characteristics, which need a common system of references. Therefore there is a need for a new standard in order to facilitate the choices of the end-users in terms of performance, safety, interpretation of the indications, etc. This standard provides a basis by which such devices can be specified and described, and their performance evaluated.

**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)

1 Scope

This part of IEC 61557 specifies requirements for combined performance measuring and monitoring devices that measure and monitor the electrical parameters within electrical distribution systems. These requirements also define the performance, in single and three-phase a.c. or d.c. systems having rated voltages up to 1 000 V a.c. or up to 1 500 V d.c.

These devices are fixed installed or portable. They are intended to be used indoors and/or outdoors. This standard is not applicable for:

- electricity metering equipment that complies with IEC 62053-21, IEC 62053-22 and IEC 62053-23. Nevertheless, uncertainties defined in this standard for active and reactive energy measurement are derived from those defined in the IEC 62053 standards series.
- simple remote relays or simple monitoring relays.

This standard is intended to be used in conjunction with IEC 61557-1 (unless otherwise specified), which specifies the general requirements for measuring and monitoring equipment, as required in IEC 60364-6.

The standard does not include the measurement and monitoring of electrical parameters defined in Parts 2 to 9 of IEC 61557 or in IEC 62020.

Combined performance measuring and monitoring devices (PMD), as defined in this standard, give additional safety information, which aids the verification of the installation and enhances the performance of the distribution systems. For instance, those devices help to check if the level of harmonics is still compliant with the wiring systems as required in IEC 60364-5-52.

The combined performance measuring and monitoring devices (PMD) for electrical parameters described in this standard are used for general industrial and commercial applications. A PMD-A is a specific PMD complying with requirements of IEC 61000-4-30 class A, which may be used in "power quality assessment" applications.

NOTE 1 Generally such types of devices are used in the following applications or for the following general needs:

- energy management inside the installation;
- monitoring and/or measurement of electrical parameters that may be required or usual;
- measurement and/or monitoring of the quality of energy.

NOTE 2 A measuring and monitoring device of electrical parameters usually consists of several functional modules. All or some of the functional modules are combined in one device. Examples of functional modules are mentioned below:

- measurement and indication of several electrical parameters simultaneously;

- energy measurement and/or monitoring, and also sometimes compliance with aspects of building regulations;
- alarms functions;
- power quality (harmonics, over/undervoltages, voltage dips and swells, etc).

2 Normative references

The following referenced documents are indispensable for the application 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 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-30, *Environmental testing – Part 2-30 – Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60364-6, *Low-voltage electrical installations – Part 6: Verification*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-15, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications*

IEC 61000-4-30:2003, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control, and laboratory use*

IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61326-1:2005, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61557-1:2007, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 1: General requirements*

IEC 62053-21:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62053-22:2003, *Electricity metering equipment (a.c.) – Particular Requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

IEC 62053-23:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)*

IEC 62053-31:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61557-1, unless otherwise specified in this standard, and the following terms and definitions apply.

3.1 General definitions

3.1.1

performance measuring and monitoring device

PMD

combination in one or more devices of several functional modules dedicated to measuring and monitoring electrical parameters in energy distribution systems or electrical installations. A PMD can be used in connection with sensors (see 4.3)

A PMD that complies with class B as defined in IEC 61000-4-30 is also covered by this definition.

NOTE 1 Under the generic term “monitoring” are also included functions of recording, alarm management etc.

NOTE 2 These devices may include power quality functions.

3.1.2

PMD-A

PMD in which all power quality assessment functions comply with measurement methods and performance requirements according to class A of IEC 61000-4-30 and with complementary requirements (safety, EMC, temperature range, complementary influence quantities, ...) of this standard

NOTE If this device is used for checking the compliance to the connection agreement with a network operator, it should be installed at the interface point between the installation and the network.

3.1.3

power quality assessment functions

power quality functions whose measurement methods are defined in IEC 61000-4-30

3.1.4

specified external sensor

sensor that is chosen in such a way that, connected to a PMD without sensors, the system performance class complies with 4.4.2

3.1.5

current sensor

CS

electrical, magnetic, optical or other device intended to transmit a signal corresponding to the current flowing through the primary circuit of this device

NOTE A current transformer (CT) is in general a magnetic current sensor.

3.1.6

compliance voltage

value of the voltage that can be developed at the output of a current generator while conforming to the requirement of the uncertainty specification for that output

NOTE This definition applies to current analogue output signals.

3.1.7 **voltage sensor** **VS**

electrical, magnetic, optical or other device intended to transmit a signal corresponding to the voltage across the primary terminals of this device

NOTE A voltage transformer (VT) is in general a magnetic voltage sensor.

3.1.8 **self-powered PMD**

equipment able to work without an auxiliary power supply

NOTE 1 Self powered PMD have no provision for power supply terminals.

NOTE 2 Self powered PMD includes equipment powered from measurement inputs, internal batteries, or other internal power sources (internal photo-voltaic sources, etc.).

3.1.9 **auxiliary power supply**

external power supply, either a.c. or d.c. that powers the PMD through dedicated terminals separated from the measurement inputs of the PMD

3.2 Definitions related to uncertainty and performance

3.2.1 **reference conditions**

appropriate set of specified values and/or ranges of values of influence quantities under which the smallest permissible uncertainties of a measuring instrument are specified

NOTE The ranges specified for the reference conditions, called reference ranges, are not wider, and are usually narrower, than the ranges specified for the rated operating conditions.

[IEC 60359, definition 3.3.10]

3.2.2 **intrinsic uncertainty**

uncertainty of a measuring instrument when used under reference conditions. In this standard, it is a percentage of the measured value defined in its rated range and with the other influence quantities under reference conditions, unless otherwise stated

[IEC 60359, definition 3.2.10, modified]

3.2.3 **influence quantity**

quantity which is not the subject of the measurement and whose change affects the relationship between the indication and the result of the measurement

NOTE 1 Influence quantities can originate from the measured system, the measuring equipment or the environment [IEV].

NOTE 2 As the calibration diagram depends on the influence quantities, in order to assign the result of a measurement it is necessary to know whether the relevant influence quantities lie within the specified range [IEV].

[IEC 60359, definition 3.1.14 modified]

3.2.4 **variation (due to a single influence quantity)**

difference between the value measured under reference conditions and any value measured within the influence range

NOTE The other performance characteristics and the other influence quantities should stay within the ranges specified for the reference conditions.

3.2.5**(rated) operating conditions**

set of conditions that must be fulfilled during the measurement in order that a calibration diagram may be valid

NOTE Beside the specified measuring range and rated operating ranges for the influence quantities, the conditions may include specified ranges for other performance characteristics and other indications that cannot be expressed as ranges of quantities.

[IEC 60359, definition 3.3.13]

3.2.6**operating uncertainty**

uncertainty under the rated operating conditions

NOTE The operating instrumental uncertainty, like the intrinsic one, is not evaluated by the user of the instrument, but is stated by its manufacturer or calibrator. The statement may be expressed by means of an algebraic relation involving the intrinsic instrumental uncertainty and the values of one or several influence quantities, but such a relation is just a convenient means of expressing a set of operating instrumental uncertainties under different operating conditions, not a functional relation to be used for evaluating the propagation of uncertainty inside the instrument.

[IEC 60359, definition 3.2.11, modified]

3.2.7**overall system uncertainty**

uncertainty including the instrumental uncertainty of several separated instruments (sensors, wires, measuring instrument, etc.) under the rated operating conditions

3.2.8**function performance class**

performance of a single function without external sensors, expressed as a percentage and depending on function intrinsic uncertainty and on variations due to influence quantities

NOTE In this standard, C stands for function performance class.

3.2.9**system performance class**

performance of a single function including specified external sensors expressed as a percentage and depending on function intrinsic uncertainty and on variations due to influence quantities

NOTE In this standard, C stands also for system performance class.

3.2.10**rated frequency**

f_n

value of the frequency in accordance with which the relevant performance of the PMD is fixed

NOTE f_n stands for nominal frequency in IEC 61557-1.

3.2.11**rated current**

I_n

value of current in accordance with which the relevant performance of an PMD operated by an external current sensor (PMD Sx) is fixed

[IEV 314-07-02, modified]

NOTE I_n stands for nominal current in IEC 61557-1.

3.2.12

basic current

I_b

value of current in accordance with which the relevant performance of a direct connected PMD (PMD Dx) is fixed

[IEC 62052-11, definition 3.5.1.2, modified]

3.2.13

starting current

I_{st}

lowest value of the current at which the PMD starts and continues to register

[IEC 62052-11, definition 3.5.1.1, modified]

3.2.14

maximum current

I_{max}

highest value of current at which the PMD meets the uncertainty requirements of this standard

[IEC 62052-11, definition 3.5.2, modified]

3.2.15

rated voltage

U_n

value of the voltage in accordance with which the relevant performances of the PMD are fixed. Depending on the distribution system and its connection to the PMD, this voltage can be either the phase to phase voltage or the phase to neutral voltage

NOTE U_n stands for nominal voltage in IEC 61557-1.

3.2.16

nominal voltage

U_{nom}

a suitable approximate value of voltage used to designate or identify a system

[IEV 601-01-21]

3.2.17

minimum voltage

U_{min}

lowest value of voltage at which the PMD meets the uncertainty requirements of this standard

3.2.18

maximum voltage

U_{max}

highest value of voltage at which the PMD meets the uncertainty requirements of this standard

3.2.19

declared input voltage

U_{din}

value obtained from the declared supply voltage by a transducer ratio

[IEC 61000-4-30, definition 3.2]

**3.2.20
residual voltage**

U_{resid}
minimum value of U recorded during a voltage dip or interruption

NOTE The residual voltage is expressed as a value in volts, or as a percentage or per unit value of the rated voltage.

[IEC 61000-4-30, definition 3.25, modified]

**3.2.21
demand value**

average value of a quantity over a specified period of time

**3.2.22
peak demand value**

highest demand value (positive or negative) since the beginning of the measurement or the last reset

**3.2.23
thermal demand**

emulation of a thermal demand meter that provides an exponentially time lagged demand, given a constant load, the indication reading 90% of the actual demand in a specified time

NOTE Time is specified by manufacturer, usually 15 min.

**3.2.24
three-phase average value**

in a three- or four-wire system, the arithmetical average of each phase value

**3.2.25
maximum value**

highest value measured or calculated since the beginning of the measurement or the last reset

**3.2.26
minimum value**

lowest value measured or calculated since the beginning of the measurement or last reset

**3.2.27
interval**

period of time used by the PMD to integrate r.m.s. or instantaneous values in order to calculate demand values

3.3 Definitions related to electric phenomena**3.3.1
phase current**

I

value of the current flowing in each phase of an electrical distribution system

**3.3.2
neutral current**

I_N

value of neutral current of an electrical distribution system

3.3.3

**phase to phase voltage
line to line voltage**

U

the voltage between phases

[IEV 601-01-29]

3.3.4

**phase to neutral voltage
line to neutral voltage**

V

voltage between a phase in a polyphase system and the neutral point

[IEV 601-01-30]

3.3.5

frequency

f

value of measured frequencies in an electrical distribution system

3.3.6

power factor

PF

under periodic conditions, ratio of the absolute value of the active power to the apparent power

NOTE This power factor is not the displacement power factor.

[IEV 131-11-46, modified]

3.3.7

amplitude of harmonic current

I_h

value of the amplitude of the current at harmonic frequencies in the spectrum obtained from a Fourier transform of a time function

3.3.8

amplitude of harmonic voltage

U_h

value of the amplitude of the voltage at harmonic frequencies in the spectrum obtained from a Fourier transform of a time function

3.3.9

stationary harmonics (voltage and current)

harmonic content of the signal with the amplitude variation of each harmonic component remaining constant within $\pm 0,1$ % of the amplitude of the fundamental

3.3.10

quasi-stationary harmonics (voltage and current)

harmonic content of the signal with the amplitude variation of each harmonic component of each contiguous 10/12 cycles window remaining within $\pm 0,1$ % of the fundamental

3.3.11

sub-harmonics (voltage and current)

interharmonic component of harmonic order lower than one

NOTE In this standard sub-harmonic components are restricted to ranks being reciprocal of integers.

[IEV 551-20-10, modified]

3.3.12**flicker**

impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[IEV 161-08-13]

3.3.13**voltage dip**

temporary reduction of the voltage at a point in the electrical distribution system below a defined threshold

NOTE 1 Interruptions are a special case of a voltage dip. Post-processing may be used to distinguish between voltage dips and interruptions.

NOTE 2 In some areas of the world a voltage dip is referred to as sag. The two terms are considered interchangeable; however, this standard will only use the term voltage dip.

[IEC 61000-4-30, definition 3.30, modified]

3.3.14**voltage swell**

temporary increase of the voltage at a point in the electrical distribution system above a defined threshold

[IEC 61000-4-30, definition 3.31, modified]

3.3.15**voltage interruption**

reduction of the voltage at a point in the electrical distribution system below a defined interruption threshold

3.3.16**amplitude and phase unbalanced voltage**

condition in a three-phase system in which the r.m.s. values of the line voltages (fundamental component), or the phase angles between consecutive line voltages, are not all equal

NOTE 1 The degree of the inequality is usually expressed as the ratios of the negative-sequence and zero-sequence components to the positive-sequence component.

NOTE 2 In this standard, voltage unbalance is considered in relation to three-phase systems.

[IEV 161-08-09, modified]

3.3.17**amplitude unbalanced voltage**

condition in a three-phase system in which the r.m.s. values of the line voltages (fundamental component) are not all equal. Relative phase between the line voltages is not taken into account.

NOTE In this standard, voltage unbalance is considered in relation to three-phase systems.

[IEV 161-08-09, modified]

3.3.18**transient overvoltage**

short-duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped.

[IEV 604-03-13]

NOTE 1 Transient overvoltages may be immediately followed by temporary overvoltages. In such cases the two overvoltages are considered as separate events.

NOTE 2 IEC 60071-1 defines three types of transient overvoltages, namely slow-front overvoltages, fast-front overvoltages and very fast-front overvoltages according to their time to peak, tail or total duration, and possible superimposed oscillations.

3.3.19

mains signalling voltage

signals transmitted by energy suppliers on public networks for network management purposes, such as the control of some categories of load.

NOTE Technically, mains signalling is a source of interharmonics voltages. In this case, however, the signal voltage is intentionally impressed on a selected part of the supply system. The voltage and frequency of the emitted signal are pre-determined, and the signal is transmitted at particular times.

3.4 Definitions related to measurement techniques

3.4.1

zero blind measurement

measurement technique where the measurement is performed continuously. For digital techniques and for a given sampling rate, no sample shall be missing in the measurement processing.

NOTE When zero blind measurement techniques are used, no assumption is made regarding the stability of the signal, in opposition with non-zero blind measurement techniques, where the signal is considered to be stable during the time where no measurement is done.

3.5 Notations

3.5.1 Functions

Symbol	Function
P	total active power
E_a	total active energy
Q_A / Q_V	total reactive power arithmetic / total reactive power vector
E_{rA} / E_{rV}	total reactive energy arithmetic / total reactive energy vector
S_A / S_V	total apparent power arithmetic / total apparent power vector
E_{apA} / E_{apV}	total apparent energy arithmetic / total apparent energy vector
f	frequency
I	phase current including I_p (current on Line p)
I_N / I_{Nc}	measured neutral current / calculated neutral current
U	voltage including U_{pg} (line p to line g voltage) and V_p (line p to neutral voltage)
U_{din}	declared input voltage [IEC 61000-4-30]
PF_A / PF_V	power factor arithmetic / power factor vector
	NOTE $PF_V = \cos(\varphi)$ when no harmonics are present
P_{st} / P_{lt}	short term flicker / long term flicker
U_{dip}	voltage dips including $U_{pg \text{ dip}}$ (line p to line g) and $V_{p \text{ dip}}$ (line p to neutral)
U_{swl}	voltage swells including $U_{pg \text{ swl}}$ (line p to line g) and $V_{p \text{ swl}}$ (line p to neutral)
U_{tr}	transients overvoltage including $U_{pg \text{ tr}}$ (line p to line g) and $V_{p \text{ tr}}$ (line p to neutral)
U_{int}	voltage Interruption including $U_{pg \text{ int}}$ (line p to line g) and $V_{p \text{ int}}$ (line p to neutral)
U_{nb}	voltage Unbalance phase and amplitude including $V_{p \text{ nb}}$ (line p to neutral)
U_{nba}	voltage Unbalance amplitude including $V_{p \text{ nba}}$ (line p to neutral)
U_h	voltage harmonics including $U_{pg \text{ h}}$ (line p to line g) and $V_{p \text{ h}}$ (line p to neutral)
THD_u	total harmonic distortion voltage related to fundamental
$THD-R_u$	total harmonic distortion voltage related to r.m.s. value

I_h	current harmonics including $I_{p\ h}$ (harmonics on line p)
THD_i	total harmonic current related to fundamental
$THD-R_i$	total harmonic current related to r.m.s. value
Msv	mains signalling voltage

3.5.2 Symbols and abbreviations

$\%U_n$	percentage of U_n
$\%I_n$	percentage of I_n
$\%I_b$	percentage of I_b

3.5.3 Indices

a	active
r	reactive
ap	apparent
n	rated
b	basic
nom	nominal
N	neutral
c	calculated
h	harmonic
i	current
u	voltage
dip	dips
swl	swells
tr	transient
int	interruption
nb	unbalance
nba	amplitude unbalance
A	arithmetic
V	vectorial
min	minimum value
max	maximum value
avg	average value
peak	peak value
resid	residual

4 Requirements

4.1 General requirements

The following requirements as well as those given in IEC 61557-1 shall apply unless otherwise specified hereafter.

For safety requirements, IEC 61010-1, applicable parts of IEC 61010 and additional requirements specified hereafter shall apply.

For electromagnetic compatibility (EMC) requirements, IEC 61326-1 shall apply unless otherwise specified hereafter. For immunity, Table 2 of IEC 61326-1 (Immunity test requirements for equipment intended for use in industrial locations) shall apply. For emission either class A or class B limits as defined in IEC 61326-1 shall apply.

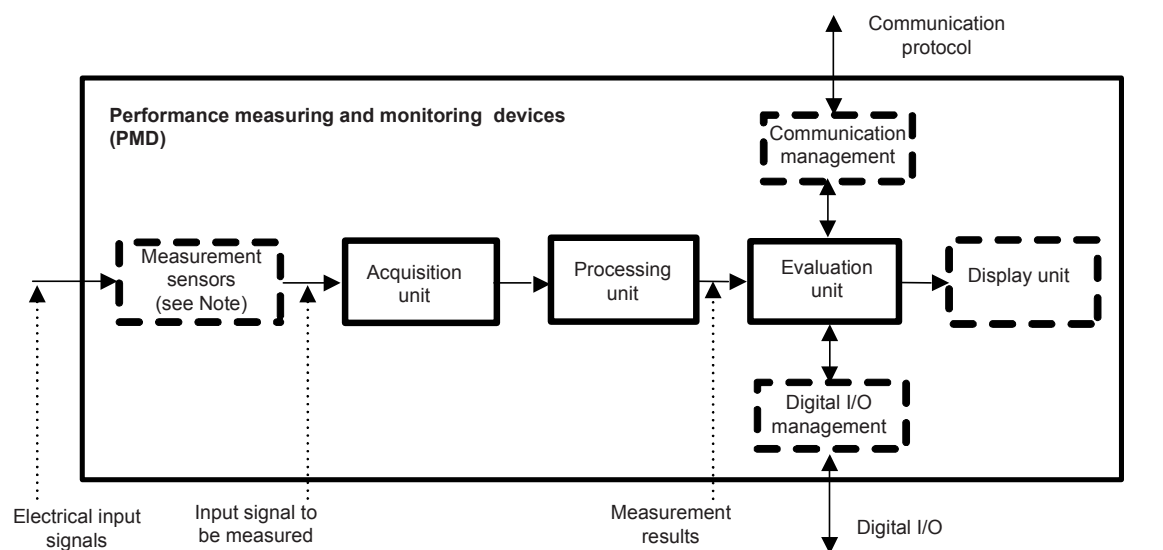
NOTE Guidance for requirements applicable to PMD-A or/and PMD is given in Annex E.

4.2 PMD general architecture

Organisation of the measurement chain: the electrical quantity to be measured may be either directly accessible, as it is generally the case in low-voltage systems, or accessible via measurement sensors like voltage sensors (VS) or current sensors (CS).

Figure 1 below shows the common organisation of a PMD.

In some cases when a PMD does not include the sensors, their associated uncertainties are not considered. When a PMD includes the sensors, their associated uncertainties are considered.



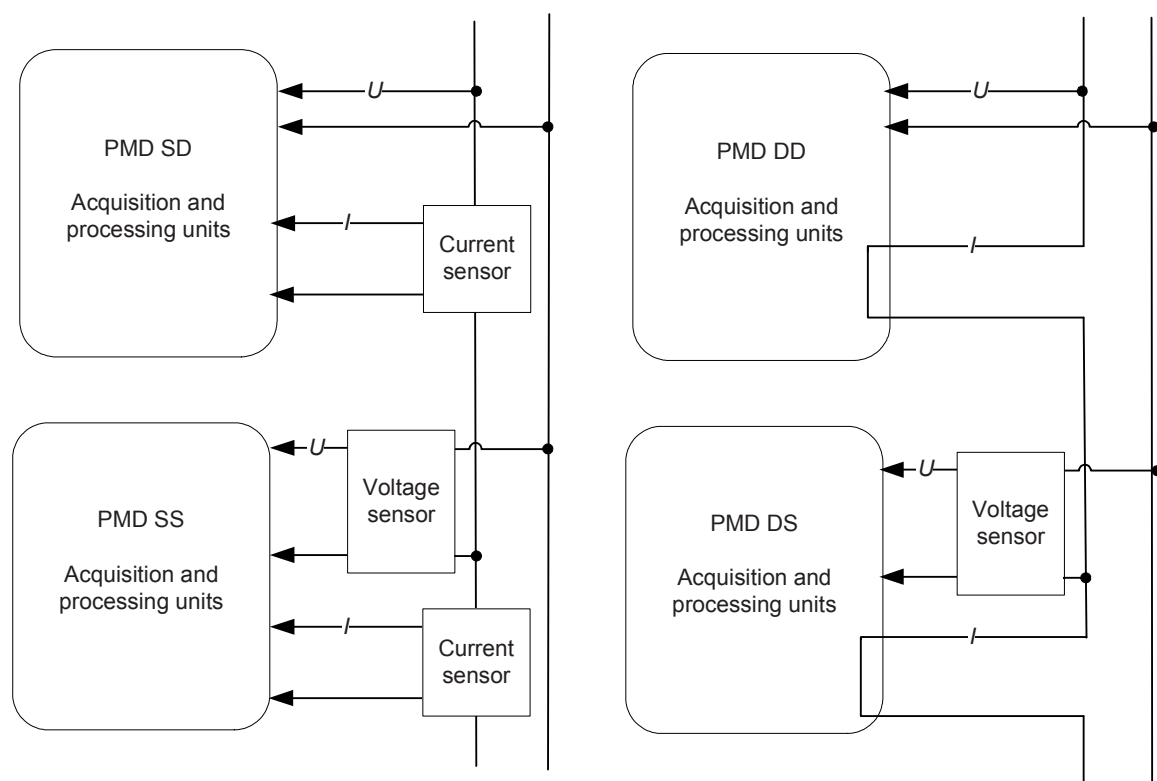
NOTE It is not necessary that the parts in the dotted lines shown in Figure 1 be included in the PMD.

4.3 Classification of PMD

PMD either can have an internal sensor, or may need an external sensor, as shown in Figure 2. Depending on these characteristics, PMD can be split in 4 categories as defined in Table 1.

Table 1 – Classification of PMD

		Current measurement	
		Sensor operated PMD (current sensors out of PMD) → PMD Sx	Direct connected PMD (current sensors in PMD) → PMD Dx
Voltage measurement	Direct connected PMD (voltage sensors in PMD) → PMD xD	PMD SD (Semi-direct insertion)	PMD DD (Direct insertion)
	Sensor operated PMD (voltage sensors out of PMD) → PMD xS	PMD SS (Indirect insertion)	PMD DS (Semi-direct insertion)



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NOTE A PMD specified as a PMD Dx (respectively PMD xD) can sometimes under certain conditions be used as a PMD Sx (respectively PMD xS) when used with external sensors provided that it complies with both requirements of PMD Sx and Dx (respectively PMD xS and xD).

Figure 2 – Description of different types of PMD

4.4 List of applicable performance classes

4.4.1 List of applicable function performance classes for PMD without external sensors

Table 2 specifies the list of allowed performance classes for a PMD without external sensors:

Table 2 – List of applicable function performance classes
for PMD without external sensors

0,02	0,05	0,1	0,2	0,5	1	1,5	2	2,5	3	5	10	20
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4.4.2 List of applicable system performance classes for PMD with external sensors

Table 3 specifies the list of allowed performance classes for a system including a PMD and its external sensors:

Table 3 – List of applicable system performance classes for PMD with external sensors

0,02	0,05	0,1	0,2	0,5	1	1,5	2	2,5	3	5	10	20
------	------	-----	-----	-----	---	-----	---	-----	---	---	----	----

It is not allowed to specify a system performance class without specified external sensors.

The requirements for the system performance for a PMD with a specified external sensor are the same as for a direct connected PMD.

NOTE When a PMD Sx or a PMD xS is used with specified external sensors, the system performance class is based on the measured intrinsic uncertainty.

When the sensors are not specified, the system performance class is equal to the uncertainty calculated according to Annex D.

4.5 Operating and reference conditions for PMD

4.5.1 Reference conditions

Table 4 gives the reference conditions for testing:

Table 4 – Reference conditions for testing

Conditions	Reference conditions
Operating temperature	23 °C ± 2 °C or otherwise specified by manufacturer
Relative humidity	40 % to 60 % RH
Auxiliary supply voltage	Rated power supply voltage ±1 %
Phases	Three phases available ^a
Voltages unbalance	≤ 0,1 % ^a
External continuous magnetic field	≤ 40 A/m d.c. ≤ 3 A/m ac at 50/60 Hz
D.c. component on voltage and current	None
Waveform	Sinusoidal
Frequency	Rated frequency (50 Hz or 60 Hz) ±0,2 % ^b
^a Required only in the case of three-phase systems.	
^b PMD should use the standard rated frequencies of 50 Hz or 60 Hz, where possible, although other rated frequencies, or rated frequency ranges, including d.c., may be specified.	

4.5.2 Rated operating conditions

The tables below give the conditions in which functions shall be performed according to their specifications.

4.5.2.1 Rated temperature operating conditions for portable equipment

Table 5 gives the rated operating temperature for portable PMD:

Table 5 – Rated operating temperatures for portable equipment

	K40 temperature class of PMD
Rated operating range (with specified uncertainty)	0 °C to +40 °C
Limit range of operation (no hardware failures)	–10 °C to +55 °C
Limit range for storage and shipping	–25 °C to +70 °C

4.5.2.2 Rated temperature operating conditions for fixed installed equipment

Table 6 gives the rated operating temperature for fixed installed PMD:

Table 6 – Rated operating temperatures for fixed installed equipment

	K55 temperature class of PMD	K70 temperature class of PMD	Kx^b temperature class of PMD
Rated operating range (with specified uncertainty)	–5 °C to +55 °C	–25 °C to +70 °C	Above +70 °C and/or under –25 °C ^a
Limit range of operation (no hardware failures)	–5 °C to +55 °C	–25 °C to +70 °C	Above +70 °C and/or under –25 °C ^a
Limit range for storage and shipping	–25 °C to +70 °C	–40 °C to +85 °C	Acc. to manufacturer specification ^a
^a Limits are to be defined by manufacturer according to the application.			
^b Kx stands for extended conditions.			

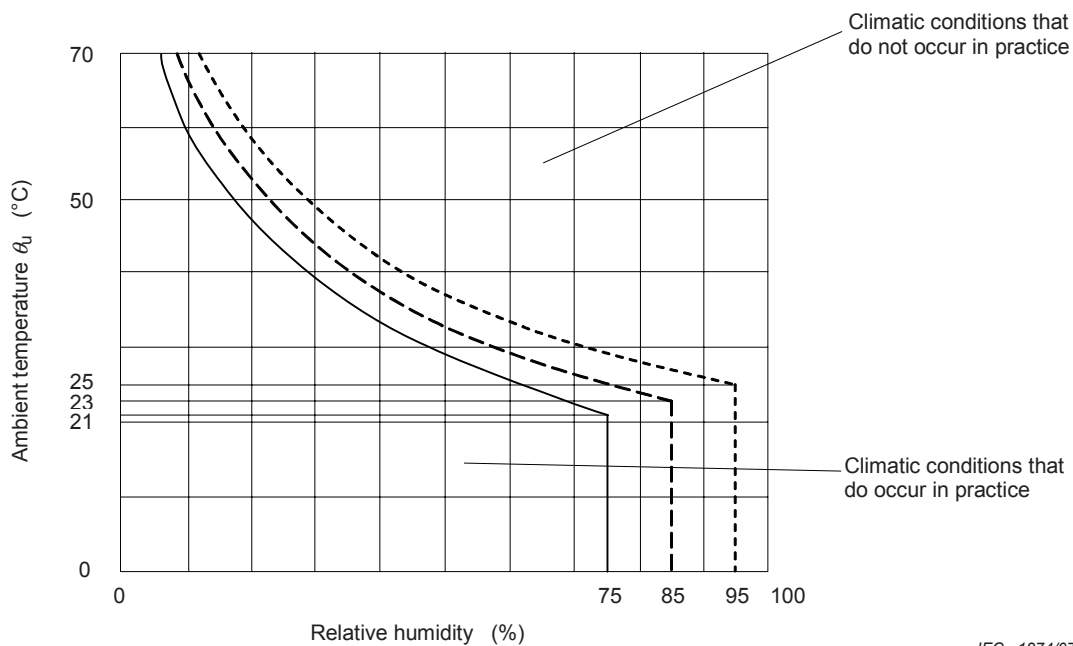
4.5.2.3 Rated humidity and altitude operating conditions

Table 7 gives the rated operating humidity and altitude for portable and fixed installed PMD:

Table 7 – Humidity and altitude operating conditions

	Standard conditions	Extended conditions
Rated operating range (with specified uncertainty)	0 to 75 % RH ^b	0 to above 75 % RH ^{a b}
Limit range of operation for 30 days/year	0 to 90 % RH ^b	0 to above 90 % RH ^{a b}
Limit range for storage and shipping	0 to 90 % RH ^b	0 to above 90 % RH ^{a b}
Altitude	0 to 2 000 m	0 to above 2000 m ^a
^a Limits are to be defined by manufacturer according to the application.		
^b Relative humidity values are specified without condensation.		

The limits of relative humidity as a function of ambient temperature are shown in Figure 3.



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Figure 3 – Relationship between ambient air temperature and relative humidity

4.6 Start-up conditions

Measurement readings shall be available via communications or local user interface 15 s after applying power supply. If the start-up is longer than 15 s, manufacturers shall specify the maximum time until measurement quantities shall be available via communications or local user interface after power supply is applied.

When no communication or local user interface is available, this requirement shall be verified according to the test procedure given in 6.1.14.

4.7 Requirements for PMD functions (except PMD-A)

Subclause 4.7 describes a list of functions. Depending on the purpose of the measurement, all or a subset of the functions listed shall be measured.

All functions implemented in the product and covered by this standard shall comply with the requirements of this standard.

4.7.1 Active power (P) and active energy (E_a) measurements

4.7.1.1 Techniques

See Annex A.

Zero blind measurement is required.

4.7.1.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the following rated range:

$$80 \% U_n < U < 120 \% U_n$$