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Interested committees:

Title: BS EN 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)

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



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SECRETARIAT:

China

SECRETARY:

Ms Guiju HAN

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 13, TC 38, TC 66

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

Electricity transmission and distribution

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TITLE:

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)

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CONTENTS

1	CONTENTS	1
2	FOREWORD	7
3	INTRODUCTION	9
4	1 Scope	10
5	2 Normative references	11
6	3 Terms, definitions and notations	12
7	3.1 General definitions	12
8	3.3 Definitions related to electric phenomena	19
9	3.4 Definitions related to measurement techniques	21
10	3.5 Notations	22
11	3.5.1 Functions	22
12	3.5.2 Symbols and abbreviations	24
13	4 Requirements	24
14	4.1 General requirements	24
15	4.2 PMD general architecture	25
16	4.3 Classification of PMD	25
17	4.3.1 Classification of PMD-AC	25
18	4.4 Structure of PMD	26
19	4.4.1 Structure of PMD related to transducers	26
20	4.4.2 Requirements for self-powered PMD	27
21	4.5 List of applicable performance classes	27
22	4.6 Operating and reference conditions for PMD	28
23	4.6.1 Reference conditions	28
24	4.6.2 Rated operating conditions	29
25	4.7 Start-up conditions	31
26	4.8 Requirements for PMD functions	31
27	4.8.1 General requirements	31
28	4.8.2 Active power (P) and active energy (E_a) measurements	32
29	4.8.3 Reactive power (Q_A , Q_V) and reactive energy (E_{rA} , E_{rV}) measurements for AC systems	40
30	4.8.4 Apparent power (S_A , S_V) and apparent energy (E_{apA} , E_{apV}) measurements for PMD-AC	45
31	4.8.5 Frequency (f) measurements for PMD-AC	48
32	4.8.6 RMS phase current (I) and neutral current (I_N , I_{Nc}) measurements for PMD-AC	49
33	4.8.7 RMS voltage (U) measurements for PMD-AC	53
34	4.8.8 Power factor (PF_A , PF_V) measurements	55
35	4.8.9 Short term flicker (P_{st}) and long term flicker (P_{lt}) measurements	55
36	4.8.10 Voltage dip (U_{dip}) and voltage swell (U_{swl}) measurements	56
37	4.8.11 Voltage interruption (U_{int}) measurements	61
38	4.8.12 Transient overvoltage (U_{tr}) measurements	62
39	4.8.13 Voltage unbalance (U_{nb} , U_{nba}) measurements	62
40	4.8.14 Voltage harmonics (U_h) and voltage THD (THD_U and $THD-R_U$) measurements for PMD-AC	63

46	4.8.15	Current unbalance (I_{nb} , I_{nba}) measurements	64
47	4.8.16	Current harmonics (I_h) and current THD (THD_i and $THD-R_i$)	
48		measurements for PMD-AC	65
49	4.8.17	Minimum, maximum, peak, three-phases average and demand	
50		measurements	66
51	4.9	General mechanical requirements	66
52	4.9.1	Vibration requirements	66
53	4.9.2	IP requirements	66
54	4.10	Safety requirements	67
55	4.10.1	Protection against electrical hazards	67
56	4.10.2	Protection against mechanical hazards	68
57	4.10.3	Protection against other hazards	68
58	4.11	EMC requirements	68
59	4.11.1	Immunity	68
60	4.11.2	Emission	68
61	4.12	Inputs and/or outputs	68
62	4.12.1	General	68
63	4.12.2	Analog outputs	68
64	4.12.3	Pulse outputs	69
65	4.12.4	Control outputs	69
66	4.12.5	Analog inputs	69
67	4.12.6	Pulse and control inputs	70
68	5	Marking and operating instructions	70
69	5.1	General	70
70	5.2	Marking	70
71	5.3	Operating, installation and maintenance instructions	70
72	5.3.1	General	70
73	5.3.2	General characteristics	70
74	5.3.3	Essential characteristics	71
75	6	Tests	72
76	6.1	General	72
77	Annex A (informative)	Metering, measuring and monitoring applications	73
78	A.1	Applications on demand side and supply side	73
79	A.2	Link between applications, devices and standards	73
80	Annex B (informative)	Definitions of electrical parameters	75
81	B.1	General	75
82	B.2	Definitions in the presence of a neutral	75
83	B.3	Power measurement in three-phase three-wire AC systems using the two-	
84		wattmeter method	79
85	B.3.1	General	79
86	B.3.2	Total active power	80
87	B.3.3	Total vector reactive power using quadrature phase shift definition	80
88	B.3.4	Total vector reactive power using Budeanu's definition	81
89	B.4	Additional relationships in case of sinusoidal voltage	81
90	Annex C (informative)	Convention about the sign of the power factor	82
91	C.1	General	82
92	C.2	Convention for power factor (consumer perspective)	82
93	C.3	Convention for power factor (producer reference frame)	83

94	Annex D (normative) Definitions of minimum, maximum, peak and demand values	85
95	D.1 Demand quantities	85
96	D.1.1 General	85
97	D.1.2 Power demand.....	85
98	D.1.3 Current demand.....	85
99	D.1.4 Thermal current demand (or bi-metal current demand).....	85
100	D.1.5 Specified intervals for demand calculation	85
101	D.2 Peak demand quantities.....	86
102	D.3 Three-phase average quantities	86
103	D.4 Maximum and minimum quantities	86
104	Annex E (informative) Intrinsic uncertainty and operating uncertainty	87
105	E.1 General.....	87
106	E.2 Operating uncertainty calculation	87
107	Annex F (informative) Recommended transducer classes for the different kinds of	
108	PMD	89
109	F.1 General considerations	89
110	F.2 Specific case of an active power and energy measurement, achieved by a	
111	PMD associated with an external current transducer or/and a voltage	
112	transducer	89
113	F.3 List of functions affected by uncertainty of external transducers	89
114	Annex G (normative) Requirements for power metering and monitoring function (PMF)	
115	and additional requirements for equipment embedding power metering and	
116	monitoring function (EPMF)	91
117	G.1 Scope	91
118	G.2 Normative references.....	91
119	G.3 Terms, definitions and notations	92
120	G.4 Requirements for PMF and additional requirements for EPMF	92
121	G.4.1 General requirements	92
122	G.4.2 EPMF general architecture	93
123	G.4.3 Classification of PMF	93
124	G.4.4 Structure of EPMF	94
125	G.4.5 List of applicable performance classes for PMF	94
126	G.4.6 Operating and reference conditions	94
127	G.4.7 Start-up conditions for EPMF	95
128	G.4.8 Requirements for PMF	95
129	G.4.9 General mechanical requirements.....	95
130	G.4.10 Safety requirements.....	95
131	G.4.11 EMC requirements	95
132	G.4.12 Inputs and/or outputs	95
133	G.5 Marking and operating instructions.....	96
134	G.5.1 General	96
135	G.5.2 Marking	96
136	G.5.3 Operating, installation and maintenance instructions	96
137	G.6 Tests	97
138	G.6.1 General	97
139	G.6.2 Type tests of EPMF	97
140	G.6.3 Routine tests of EPMF	99
141	Bibliography.....	100

143	Figure 1 – PMD generic measurement chain	25
144	Figure 2 – Description of different types of PMD	27
145	Figure 3 – Relationship between ambient air temperature and relative humidity	31
146	Figure A.1 – Simplified overview of measurement applications on supply side and	
147	demand side	73
148	Figure B.1 – Arithmetic and vector apparent powers in AC systems sinusoidal situation	79
149	Figure B.2 – Three-phase circuit without neutral	80
150	Figure C.1 – Formatting of power factor with a consumer perspective	82
151	Figure C.2 – Convention for power factor with a producer perspective	83
152	Figure D.1 – Thermal current demand	85
153	Figure D.2 – Fixed block interval	86
154	Figure D.3 – Sliding block interval	86
155	Figure E.1 – Different kinds of uncertainties	87
156	Figure E.2 – Flowchart for the determination of the operating uncertainty	88
157	Figure G.1 – Example of architecture of EPMF	93
158		
159	Table 1 – Functional classification of PMD-AC with minimal required functions	25
160	Table 2 – Structure of PMD	26
161	Table 3 – List of functions and applicable performance classes for PMD	27
162	Table 4 – Reference conditions for testing	29
163	Table 5 – Rated operating temperatures for portable equipment	29
164	Table 6 – Rated operating temperatures for fixed installed equipment	30
165	Table 7 – Humidity and altitude operating conditions	30
166	Table 8 – Nominal voltages	32
167	Table 9 – Acceptable error limits (AEL) for active power and active energy	
168	measurement for PMD-AC	33
169	Table 10 – Influence quantities for active power and active energy measurement for	
170	PMD-AC of classes > 0,5	33
171	Table 11 – Influence quantities for active power and active energy measurement for	
172	PMD-AC of classes ≤ 0,5	36
173	Table 12 – Minimum test period	39
174	Table 13 – Starting current for active power and active energy measurement	40
175	Table 14 – Acceptable error limits (AEL) for reactive power and reactive energy	
176	measurement for PMD-AC	41
177	Table 15 – Influence quantities for reactive power and reactive energy measurement	41
178	Table 16 – Minimum test period	45
179	Table 17 – Starting current for reactive energy measurement	45
180	Table 18 – Acceptable error limits (AEL) for apparent power and apparent energy	
181	measurement	46
182	Table 19 – Influence quantities for apparent power and apparent energy measurement	47
183	Table 20 – Acceptable error limits (AEL) for frequency measurement	48
184	Table 21 – Influence quantities for frequency measurement	49
185	Table 22 – Rated range of operation for phase current measurement	49
186	Table 23 – Rated range of operation for neutral current (calculated or measured)	50
187	Table 24 – Acceptable error limits (AEL) for phase current	

188	Table 25 – Acceptable error limits (AEL) for neutral current measurement	50
189	Table 26 – Acceptable error limits (AEL) for neutral current calculation.....	51
190	Table 27 – Influence quantities for phase current and neutral current measurement	52
191	Table 28 – Rated range of operation for RMS voltage measurement	53
192	Table 29 – Acceptable error limits (AEL) for RMS voltage measurement	53
193	Table 30 – Influence quantities for RMS voltage measurement	54
194	Table 31 – Acceptable error limits (AEL) for power factor measurement	55
195	Table 32 – Acceptable error limits (AEL) for flicker measurement	56
196	Table 33 – Rated range of operation for voltage dips and swells measurement.....	58
197	Table 34 – Acceptable error limits (AEL) for voltage dips and swells measurement.....	59
198	Table 35 – Influence quantities for dips and swells measurement	60
199	Table 36 – Acceptable error limits for voltage interruption measurement.....	62
200	Table 37 – Acceptable error limits for transient overvoltage measurement	62
201	Table 38 – Acceptable error limits (AEL) for voltage unbalance measurement	63
202	Table 39 – Rated range of operation for voltage harmonics measurement	63
203	Table 40 – Acceptable error limits (AEL) for voltage harmonics measurement	64
204	Table 41 – Acceptable error limits (AEL) for voltage THD_U or $THD-R_U$ measurement.....	64
205	Table 42 – Acceptable error limits (AEL) for current unbalance measurement	65
206	Table 43 – Rated range of operation for current harmonics measurement	65
207	Table 44 – Acceptable error limits (AEL) for current harmonics measurement	65
208	Table 45 – Acceptable error limits (AEL) for current THD_i and $THD-R_i$ measurement	66
209	Table 46 – Minimum IP requirements for PMD	67
210	Table 47 – PMD specification form.....	71
211	Table 48 – Characteristics specification template.....	72
212	Table A.1 – Main measurement applications	74
213	Table B.1 – Definition of symbols.....	75
214	Table B.2 – Calculation definitions for AC systems electrical parameters	76
215	Table C.1 – Conventions for the sign of Power factor with a Consumer perspective	83
216	Table C.2 – Conventions for the sign of power factor with a producer perspective	84
217	Table F.1 – PMD SD associated with current transducer or PMD DS associated with	
218	voltage transducer or PMD SS associated with voltage and current transducers	89
219	Table F.2 – List of functions affected by uncertainty of external transducers	90
220	Table G.1 – Equipment list.....	92
221	Table G.2 – Functional classification of PMF with minimal required functions	93
222	Table G.3 – Structure of EPMF	94
223	Table G.4 – Value of current according to the type of EPMF	95
224	Table G.5 – EPMF specification form	96

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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)****FOREWORD**

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International Standard IEC 61557-12 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This third edition cancels and replaces the second edition published in 2018. This edition constitutes a technical revision.

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

- a) PMD for DC systems (PMD-DC) has been added in IEC 61557-12-1.
- b) Ib has been replaced with In; Ib is no longer used when referencing direct connected PMD.

c) Tables for active power and energy and Tables for reactive power and energy have been replaced by Tables of Annex I Amendment 1:2021.

The text of this International Standard is based on the following documents:

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 61557 series, published under the general title *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*, 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.

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INTRODUCTION

Energy distribution systems need to guarantee energy efficiency, availability, and network performances to address the following challenges:

- meet sustainable development requirements, where energy measurement is necessary to identify sources of energy savings, and to improve the energy performance of manufacturing, commercial organizations and public services;
- adjust technological evolutions (electronic loads, electronic measuring methods, etc.);
- address end-users needs (cost saving, compliance with aspects of building regulations, etc.) regarding electrical energy management as well as other energies, or fluids. Other functionalities involving several non-electrical parameters are often needed in parallel;
- ensure safety and continuity of service;
- adjust evolution of installation standards;
- meet the need of new applications for DC systems (Photovoltaic, Electrical vehicle, DC distribution, ...).

Monitoring electrical quantities in internal networks allows to address these challenges.

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

In order to fulfil the requirements of the energy efficiency project, many PMD measuring electrical parameters can also collect data (water, air, gas, temperature...) coming from other sensors or meters inside building or plant areas. In order to be able to transmit all these data to a supervision software it will be relevant to equip the PMD with a communication bus. The supervision software will then manage all the collected data in order to monitor them and produce useful reports for energy usage and consumption analysis.

PMD allow to implement energy data collection plan as requested for the energy management system required by ISO 50001 or can be used during energy audit as defined in ISO 50002. They are recommended in Electrical Energy Efficiency Management Systems (EEMS) for monitoring an installation complying with IEC 60364-8-1 for the efficient use of electricity and for prosumer's installations (AC and DC parts) complying with IEC 60364-8-82.

**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)

1 Scope

This part of IEC 61557 specifies requirements for power metering and monitoring devices (PMD) that measure and monitor the electrical quantities within electrical distribution systems, and optionally other external signals. These requirements also define the performance of PMD in single- and three-phase AC or DC systems having rated voltages up to 1 000 V AC or up to 1 500 V DC.

These devices are fixed or portable. They are intended to be used indoors and/or outdoors.

Power metering and monitoring devices (PMD), as defined in this document, give additional safety information, which aids the verification of the installation and enhances the performance of the distribution systems.

Additionally, this document specifies requirements for measurement functions dedicated to metering and monitoring of electrical parameters called power metering and monitoring function (PMF) which can be embedded in equipment (EPMF) that is not classified as PMD and for which the main function is not power metering and monitoring.

Requirements for power metering and monitoring function (PMF) and additional requirements for equipment embedding power metering and monitoring function (EPMF) are described in Annex G.

The power metering and monitoring devices (PMD) for electrical parameters described in this document are used for general industrial and commercial applications.

The power metering and monitoring devices (PMD) can be associated with sensing devices such as but not limited to instruments transformers compliant to IEC 61869 set of standards or with transducers compliant to IEC 60688.

This document does not address functional safety and cyber security aspects.

This document is not applicable for:

- electricity metering equipment that complies with IEC 62053-21, IEC 62053-22, IEC 62053-23 and IEC 62053-24. Nevertheless, uncertainties defined in this document for active and reactive energy measurement are derived from those defined in IEC 62053 (all parts);
- the measurement and monitoring of electrical parameters defined in IEC 61557-2 to IEC 61557-9 and IEC 61557-13 or in IEC 62020;
- power quality instrument (PQI) according to IEC 62586 (all parts);
- devices covered by IEC 60051 (all parts) (direct acting analogue electrical measuring instrument).

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

- 376 – energy management inside the installation, such as facilitating the implementation of documents such as
- 377 ISO 50001 and IEC 60364-8-1;
- 378 – monitoring and/or measurement of electrical parameters;
- 379 – measurement and/or monitoring of the quality of energy inside commercial/industrial installations.

380 NOTE 2 A measuring and monitoring device of electrical parameters usually consists of several functional

381 modules. All or some of the functional modules are combined in one device. Examples of functional modules are:

- 382 – measurement and monitoring of several electrical parameters simultaneously;
- 383 – energy measurement and/or monitoring, as well as sometimes compliance with aspects of building regulations;
- 384 – alarms functions;
- 385 – demand side quality (current and voltage harmonics, over/under voltages, voltage dips and swells, etc.).

386 NOTE 3 PMD are historically called power meter, power monitor, power monitor device, power energy monitoring

387 device, power analyser, multifunction meter, measuring multifunction equipment, energy meters.

388 NOTE 4 Metering, measuring and monitoring applications are explained in Annex A.

389 2 Normative references

390 The following documents are referred to in the text in such a way that some or all of their

391 content constitutes requirements of this document. For dated references, only the edition

392 cited applies. For undated references, the latest edition of the referenced document (including

393 any amendments) applies.

394 IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

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

396 IEC 60068-2-30, *Environmental testing – Part 2-30 – Tests – Test Db: Damp heat, cyclic*

397 *(12 h + 12 h cycle)*

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

399 IEC 61000-4-8, *Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques*

400 *- Power frequency magnetic field immunity test*

401 IEC 61000-4-19, *Electromagnetic compatibility (EMC) - Part 4-19: Testing and measurement*

402 *techniques - Test for immunity to conducted, differential mode disturbances and signalling in*

403 *the frequency range 2 kHz to 150 kHz at a.c. power ports*

404 IEC 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and*

405 *measurement techniques – Power quality measurement methods*

406 IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control,*

407 *and laboratory use – Part 1: General requirements*

408 IEC 61010-1:2010/AMD1:2016

409 IEC 61010-2-030:2017, *Safety requirements for electrical equipment for measurement, control,*

410 *and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits*

411 IEC 61326-1:2020, *Electrical equipment for measurement, control and laboratory use – EMC*

412 *requirements – Part 1: General requirements*

413 IEC 62053-31:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 31:*

414 *Pulse output devices for electromechanical and electronic meters (two wires only)*

3 Terms, definitions and notations

For the purposes of this document, the following terms, definitions and notations apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 General definitions

3.1.1 power metering and monitoring device for AC systems PMD-AC

combination in one or more devices of several functional modules dedicated to metering and monitoring electrical parameters in AC energy distribution systems or electrical installations, used for applications such as energy efficiency, power monitoring and network performance

Note 1 to entry: Under the generic term “monitoring” are also included functions of recording, alarm management, etc.

Note 2 to entry: These devices may include demand side quality functions for monitoring inside commercial/industrial installations.

Note 3 to entry: This note applies to the French language only.

3.1.2 alternating current system AC system electrical system fed by alternating voltage

[SOURCE: IEC 60050-601:1985, 601-01-03]

3.1.3 active power

under periodic conditions, mean value, taken over one period T , of the instantaneous power P

$$P = \frac{1}{T} \int_0^T p dt$$

[SOURCE: IEC 60050-131:2013, 131-11-42]

3.1.4 active energy

integral of the active power as defined in 3.1.3

3.1.5 apparent power

product of the rms voltage U between the terminals of a two-terminal element or two-terminal circuit and the rms electric current I in the element or circuit

$$S = U \times I$$

Note 1 to entry: Under sinusoidal conditions, the apparent power is the modulus of the complex power $\underline{S}$, thus $S = |\underline{S}|$.

Note 2 to entry: The coherent SI unit for apparent power is voltampere, VA.

[SOURCE: IEC 60050-131:2013, 131-11-41]

3.1.6

apparent energy

integral of the apparent power as defined 3.1.5

Note 1 to entry: The unit for apparent power is voltampere hour, VAh.

3.1.7

reactive power

reactive power at any single sinusoidal frequency component of a periodic signal in a single-phase circuit is defined as the product of the RMS values of current and voltage and the sine of the phase angle between them, where the phase angle is the angle of the voltage signal vector with respect to the current signal vector

Note 1 to entry: In IEC 62053-24 metering standard for reactive energy the reactive power and energy are defined for fundamental frequency only.

Note 2 to entry: The algorithm used for the calculation of reactive power is not specified, however the meter is expected to meet requirements of the relevant accuracy class standard.

Note 3 to entry: The coherent SI unit for reactive power is voltampere, VA. The special name var and its symbol var are also used.

[SOURCE: IEC 62052-11:2020 modified]

3.1.8

reactive energy

integral of the reactive power as defined in 3.1.7

Note 1 to entry: The unit for reactive energy is var hour, varh.

3.1.9

power quality assessment function

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

3.1.10

supply side

part of the grid where electric energy is generated, transmitted and distributed to end-use customers through the public supply network

Note 1 to entry: This definition encompasses micro-grids, decentralised generators or renewable energy generators.

3.1.11

demand side

part of the grid where electric energy is consumed by end-use customers within their electric distribution system

3.1.12

point of common coupling

PCC

point of a power supply network, electrically nearest to a particular load, at which other loads are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct customer's installations.

Note 2 to entry: In some applications, the term "point of common coupling" is restricted to public networks.

[SOURCE: IEC 60050-161:1990, 161-07-15]

3.1.13**power quality**

characteristics of the electric current, voltage and frequencies at a given point in an electric power system, evaluated against a set of reference technical parameters

Note 1 to entry: These parameters might, in some cases, relate to the compatibility between electricity supplied in an electric power system and the loads connected to that electric power system

[SOURCE: IEC 60050-617:2009, 617-01-05]

3.1.14**dedicated external transducer**

proprietary external transducer able to operate only with a range of PMD specified by the manufacturer

3.1.15**current transducer****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 1 to entry: A current transformer (CT) is in general a magnetic current transducer.

Note 2 to entry: This note applies to the French language only.

3.1.16**compliance voltage**

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

Note 1 to entry: This definition applies to current analog output signals.

3.1.17**voltage transducer****VS**

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

Note 1 to entry: A voltage transformer (VT) is in general a magnetic voltage transducer.

Note 2 to entry: This note applies to the French language only.

3.1.18**self-powered PMD**

equipment where measuring terminals are also used for power supply

3.1.19**auxiliary power supply**

external power supply, either AC or DC, that powers the PMD through dedicated terminals separated from the measurement inputs of the PMD

3.1.20**transformer operated PMD**

PMD intended to be connected to the circuit(s) being measured via external instrument transformer(s)

Note 1 to entry: Transformer operated PMD corresponds to PMD Sx or PMD xS in this document.

3.1.21**primary register**

register of an instrument transformer-operated meter which takes into account the ratios of all the transformers (voltage and current transformers) to which the meter is connected

Note 1 to entry: The value of the energy on the primary side of the transformers is obtainable from the direct reading of the register.

[SOURCE IEC 62053-52:2005, 3.4]

3.1.22**half-primary register**

register of an instrument transformer-operated meter which takes into account either the ratio(s) of the current transformer(s) or the ratio(s) of the voltage transformer(s), but not both

Note 1 to entry: The value of the energy on the primary side of the transformer(s) is obtainable from the reading of the register multiplied by an appropriate factor.

[SOURCE IEC 62053-52:2005, 3.5]

3.1.23**power metering and monitoring function****PMF**

measurement function dedicated to metering and monitoring electrical parameters within electrical distribution systems embedded in an equipment that is not a PMD and complies to another IEC product standard

3.1.24**equipment embedding PMF****EPMF**

equipment or arrangement of equipment embedding PMF whose main function is not metering and monitoring of electrical parameters

Note 1 to entry: Such equipment are uninterruptible power systems (UPS), static transfer systems (STS), circuit breakers, transfer switching equipment (TSE), switches, disconnectors, switch-disconnectors, fuse-combination units, programmable controllers (PLC), inverter for use in photovoltaic power systems, adjustable speed electrical power drive systems, protection relay, residual current devices (RCDs, RCBOs), residual current monitoring devices (RCM), load-shedding equipment (LSE), Bi-directional grid connected power converters.

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 1 to entry: 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.

[SOURCE: IEC 60359:2001, 3.3.10]

3.2.2**measurand**

quantity subjected to measurement, evaluated in the state assumed by the measured system during the measurement itself

[SOURCE: IEC 60359:2001, 3.1.1, modified – the notes have been removed.]

3.2.3**measurement uncertainty
uncertainty of measurement
uncertainty**

non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

[SOURCE: ISO/IEC GUIDE 99:2007, 2.26, modified – the notes have been removed.]

3.2.4**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 to entry: Influence quantities can originate from the measured system, the measuring equipment or the environment [IEV].

Note 2 to entry: 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].

[SOURCE: IEC 60359:2001, 3.1.14, modified – note 3 has been removed.]

3.2.5**rated operating conditions**

set of conditions that must be fulfilled during the measurement

[SOURCE: IEC 60359:2001, 3.3.13, modified and note has been removed]

3.2.6**function performance class**

number accounting for the performance of a single function

Note 1 to entry: In this document, *C* stands for the numerical value of the function performance class (for instance *C* = 0,2).

Note 2 to entry: In IEC 62053-2x series for electricity metering equipment, performance class is called accuracy class.

3.2.7**rated value**

value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08]

3.2.8**nominal value**

value of a quantity used to designate and identify a component, device, equipment, or system

Note 1 to entry: The nominal value is generally a rounded value

[SOURCE: IEC 60050-151:2001, 151-16-09]

3.2.9**rated frequency**

f_n

value of the frequency at which the specification of the PMD is defined

3.2.10**basic current** I_b

value of the current at which the specification of a direct connected PMD (PMD Dx) is defined

3.2.11**rated current** I_n

value of the current at which the specification of a PMD operated by an external current transducer (PMD Sx) or a direct connected PMD (PMD Dx) is defined

Note 1 to entry: in previous editions of this standard, "I_b" was used for direct connected PMD instead of "I_n". Abbreviation I_b can be used instead as it was the case IEC 61557-12:2018.

3.2.12**starting current** I_{st}

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

[SOURCE: IEC 62052-11:2003, 3.5.1.1, modified – "meter" has been replaced by "PMD".]

3.2.13**maximum current** I_{max}

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

3.2.14**rated voltage** U_n

value of the voltage in accordance with which the relevant performances of the PMD are fixed

Note 1 to entry: 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.

3.2.15**nominal voltage** U_{nom}

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

[SOURCE: IEC 60050-601:1985, 601-01-21]

3.2.16**minimum voltage** U_{min}

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

3.2.17**maximum voltage** U_{max}

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

3.2.18**residual voltage** U_{res} minimum value of U recorded during a voltage dip or interruption

Note 1 to entry: The residual voltage is expressed as a value in volts, or as a percentage or a fraction of the rated voltage.

3.2.19**declared input voltage** U_{din}

value obtained from the declared supply voltage by a transducer ratio

[SOURCE: IEC 61000-4-30:2015, 3.2]

3.2.20**sliding reference voltage** U_{sr}

voltage magnitude averaged over one minute, representing the voltage preceding a voltage dip or swell

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 1 to entry: The time is specified by the manufacturer, usually 15 min.

3.2.24**three-phase average value**

in a three- or four-wire system, the arithmetical average of all 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 RMS or instantaneous values in order to calculate demand values

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

value of the current flowing in each phase of an AC system

3.3.2**neutral current** I_N

value of neutral current of an AC electrical distribution system

3.3.3**phase to phase voltage****line to line voltage** U

voltage between phases in an AC system

[SOURCE: IEC 60050-601:1985, 601-01-29 modified]

3.3.4**phase to neutral voltage****line to neutral voltage** V

voltage between a phase and the neutral point in an AC system

[SOURCE: IEC 60050-601:1985, 601-01-30 modified]

3.3.5**frequency** f

value of measured frequency in an electrical distribution system

3.3.6**power factor** PF

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

Note 1 to entry: This power factor is not the displacement power factor. Both are not equal in presence of harmonics.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-131:2002 131-11-46, modified – the formula in the definition has not been included, note 1 has been changed and a note 2 has been added.]

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 in which the amplitude variation of each harmonic for contiguous 10 (50 Hz systems) or 12 (60 Hz systems) cycles remains within $\pm 0,1$ % of the amplitude of the fundamental

3.3.11**sub-harmonics**

<voltage and current> interharmonic component of harmonic order lower than one

Note 1 to entry: In this document, sub-harmonic components are restricted to ranks being reciprocal of integers.

[SOURCE: IEC 60050-551:2001, 551-20-10, modified – the term has been changed from "sub-harmonic component" to "sub-harmonics" and the domain has been indicated.]

3.3.12**flicker**

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

[SOURCE: IEC 60050-161:1990, 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 to entry: Interruptions are a special case of a voltage dip. Post-processing may be used to distinguish between voltage dips and interruptions.

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

3.3.14**voltage swell**

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

3.3.15**RMS voltage refreshed each half-cycle**

$U_{\text{rms}(1/2)}$

value of the RMS voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle

Note 1 to entry: This technique is independent for each channel and will produce RMS values at successive times on different channels for polyphase systems

Note 2 to entry: This RMS voltage value may be a phase to phase value or a phase to neutral value.

3.3.16**RMS voltage refreshed each cycle**

$U_{\text{rms}(1)}$

value of the RMS voltage measured over 1 cycle and refreshed each cycle

Note 1 to entry: In contrast to $U_{\text{rms}(1/2)}$, this technique does not define when a cycle commences.

797 Note 2 to entry: This RMS voltage value can be a phase to phase value or a phase to neutral value.

798 3.3.17

799 voltage interruption

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

802 3.3.18

803 amplitude and phase voltage unbalance

804 condition in a three-phase system in which the RMS values of the line voltages (fundamental
805 component), or the phase angles between consecutive line voltages, are not all equal

806 Note 1 to entry: The degree of the inequality is usually expressed as the ratios of the negative-sequence and
807 zero-sequence components to the positive-sequence component.

808 Note 2 to entry: In this document, voltage unbalance is considered in relation to three-phase systems.

809 3.3.19

810 amplitude voltage unbalance

811 condition in an AC three-phase system in which the RMS values of the line voltages
812 (fundamental component) are not all equal.

813 Note 1 to entry: The relative phase between the line voltages is not taken into account.

814 Note 2 to entry: In this document, voltage unbalance is considered in relation to three-phase systems.

815 3.3.20

816 transient overvoltage

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

819 Note 1 to entry: Transient overvoltages may be immediately followed by temporary overvoltages. In such cases
820 the two overvoltages are considered as separate events.

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

824 [SOURCE: IEC 60050-604:2016, 604-03-14]

825 3.3.21

826 crest factor

827 peak to RMS ratio.

828 3.4 Definitions related to measurement techniques

829 3.4.1

830 measurement window

831 interval during which a single measurement is performed, expressed in seconds or in number
832 of fundamental cycles

833 Note 1 to entry: Depending on the measurement technique the duration of the measurement window may be fixed
834 or variable.

835 3.4.2

836 gapless measurement

837 measurement technique where the measurement is performed continuously without gap, that
838 is, using contiguous measurement windows

839 Note 1 to entry: For digital techniques and for a given sampling rate, no sample is missing in the measurement
840 processing.

Note 2 to entry: When gapless measurement techniques are used, no assumption is made regarding the stability of the signal, as opposed to non-gapless 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	AC	Function
P	x	AC active power
E_a	x	AC active energy
Q_A / Q_V	x	total reactive power arithmetic / total reactive power vector
E_{rA} / E_{rV}	x	total reactive energy arithmetic / total reactive energy vector
S_A / S_V	x	total apparent power arithmetic / total apparent power vector
E_{apA} / E_{apV}	x	total apparent energy arithmetic / total apparent energy vector
F	x	frequency
I	x	AC phase current (I_p : current on line p)
I_N / I_{Nc}	x	measured neutral current / calculated neutral current
U	x	AC line to line voltage (U_{pg} : line p to line g)
V	x	line to neutral voltage (V_p : line p to neutral)
PF_A / PF_V	x	arithmetic power factor / vector power factor NOTE $PF_V = \cos(\varphi)$ when no harmonics are present
P_{st} / P_{lt}	x	short term flicker / long term flicker
U_{dip}	x	AC voltage dips line to line ($U_{pg \text{ dip}}$: line p to line g)
V_{dip}	x	AC voltage dips line to neutral ($V_{p \text{ dip}}$: line p to neutral)
U_{swl}	x	AC voltage swells line to line ($U_{pg \text{ swl}}$: line p to line g)
V_{swl}	x	AC voltage swells line to neutral ($V_{p \text{ swl}}$: line p to neutral)
U_{tr}	x	AC transients overvoltage line to line ($U_{pg \text{ tr}}$: line p to line g)
V_{tr}	x	AC transients overvoltage line to neutral ($V_{p \text{ tr}}$: line p to neutral)
U_{int}	x	AC voltage Interruption line to line ($U_{pg \text{ int}}$: line p to line g)
V_{int}	x	AC voltage interruption line to neutral ($V_{p \text{ int}}$: line p to neutral)

U_{nb}	x	AC amplitude and phase voltage unbalance line to line ($U_{pg\ nb}$: line p to line g)
V_{nb}	x	AC amplitude and phase voltage unbalance line to neutral ($V_{p\ nb}$: line p to neutral)
I_{nb}	x	current unbalance phase and amplitude
U_{nba}	x	AC amplitude voltage unbalance line to line ($U_{pg\ nba}$: line p to line g)
V_{nba}	x	AC amplitude voltage unbalance line to neutral ($V_{p\ nba}$: line p to neutral)
I_{nba}	x	current unbalance amplitude
U_h	x	voltage harmonics line to line ($U_{pg\ h}$: line p to line g)
V_h	x	voltage harmonics line to neutral ($V_{p\ h}$: line p to neutral)
THD_u	x	total harmonic distortion voltage line to line related to fundamental
$THD-R_u$	x	total harmonic distortion voltage line to line related to RMS value
THD_v	x	total harmonic distortion voltage line to neutral related to fundamental
$THD-R_v$	x	total harmonic distortion voltage line to neutral related to RMS value
$THD-R$	x	total harmonic current related to RMS value

848

849

850

851 **3.5.2 Symbols and abbreviations**

$\%U_n$	percentage of U_n
$\%I_n$	percentage of I_n
$\%In$	percentage of In
<i>AEI</i>	acceptable error limit
<i>ALV</i>	acceptable limits of variation

852

853 **3.5.3 Indices**

854

Indice	AC	Meaning
AC	x	AC system
a	x	active
r	x	reactive
ap	x	apparent
n	x	rated
nom	x	nominal
p	x	line p
g	x	line g
N	x	Neutral
c	x	calculated
h	x	harmonic
i	x	current
u	x	voltage
dip	x	dips
swl	x	swells
tr	x	transient
int	x	interruption
nb	x	unbalance
nba	x	amplitude unbalance
A	x	arithmetic
V	x	vectorial
min	x	minimum value
max	x	maximum value
avg	x	average value
rms	x	rms value
peak	x	peak value
res	x	residual

855

856 **4 Requirements**857 **4.1 General requirements**

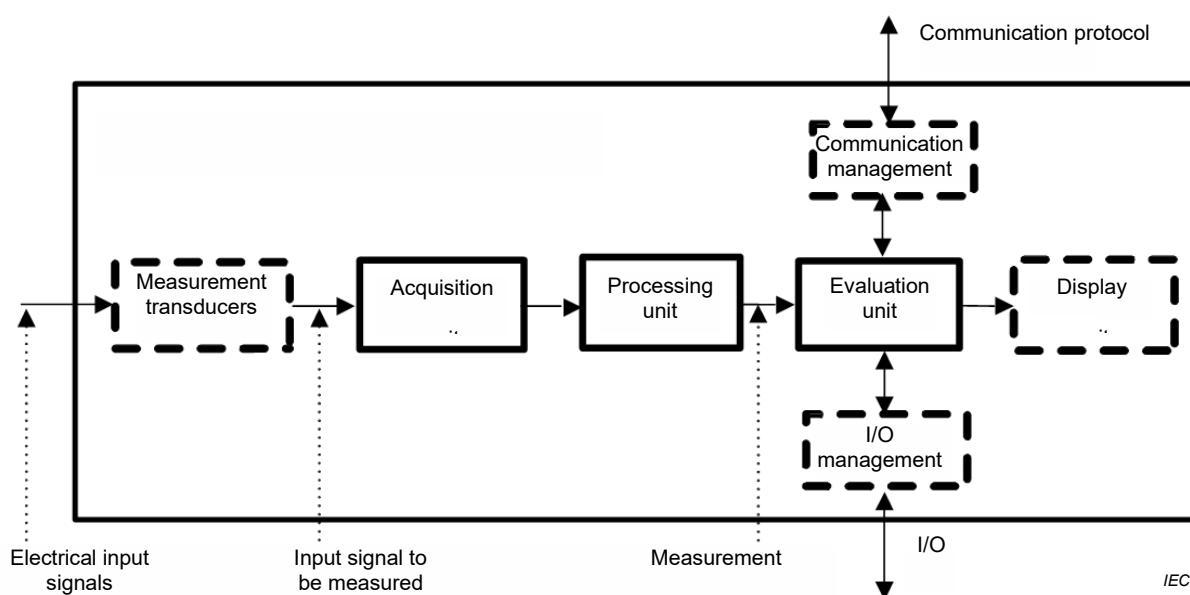
858 The following requirements shall apply unless otherwise specified hereafter.

4.2 PMD general architecture

Organization 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 transducers like voltage transducers (VS) or current transducers (CS).

Figure 1 shows the common organization of a PMD-AC.

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



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

NOTE 2 I/O are analog and/or digital signals with alarms.

Figure 1 – PMD generic measurement chain

4.3 Classification of PMD

4.3.1 Classification of PMD-AC

PMD-AC are classified according to the applications as defined in Table 1.

Table 1 – Functional classification of PMD-AC with minimal required functions

Functionalities symbol ^a	PMD-AC functional classification ^b		
	PMD-AC-I Energy efficiency	PMD-AC-II Basic power monitoring	PMD-AC-III Advanced power monitoring /network performance
P		■	■
Q		■	■
S		■	■
E_a	■	■	■
E_r		■	■
E_{ap}			■

f		■	■
I		■	■
I_N			■
U and/or V		■	■
PF		■	■
THD_U and/or THD_V and/or $THD-R_U$ and/or $THD-R_V$			■
THD_i and/or $THD-R_i$			■
^a Only total quantities are mandatory ^b For PMD other than PMD-AC-I, PMD-AC-II and PMD-AC-III, called PMD-AC-x, other combinations of functions are allowed and shall be specified by the manufacturer.			

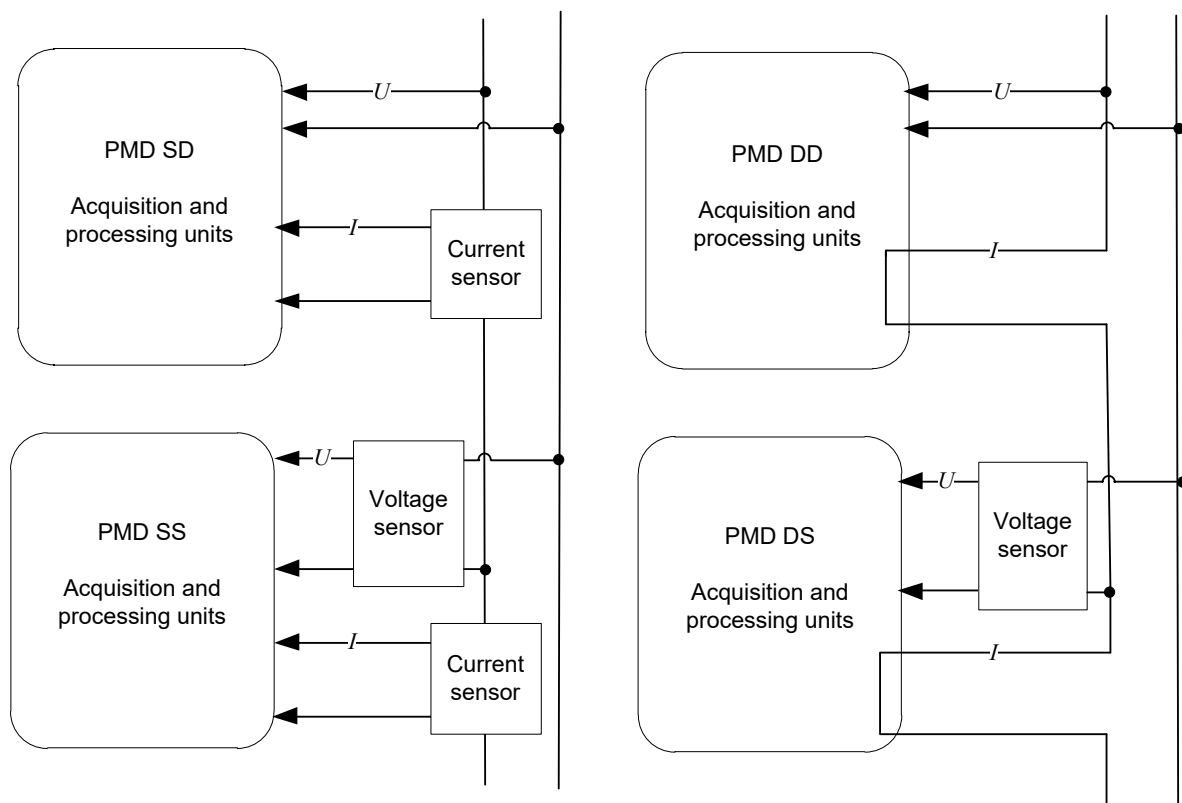
4.4 Structure of PMD

4.4.1 Structure of PMD related to transducers

PMD-AC can have either an internal transducer, or may need an external transducer, as shown in Figure 2. Depending on these characteristics, PMD-AC can be split in four categories as defined in Table 2.

Table 2 – Structure of PMD

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



IEC

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 transducers 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

4.4.2 Requirements for self-powered PMD

Three-phase self-powered PMD shall measure within the specified accuracy limits even in the event one of the three phases or two of the three phases are disconnected.

4.5 List of applicable performance classes

Table 3 specifies the list of functions and allowed performance classes for PMD-AC.

Table 3 – List of functions and applicable performance classes for PMD

Function	PMD-AC Sub clause	Performance class C									
Active energy	4.8.1.6			0,1	0,2	0,5	1	2			
Active power	4.8.1.6			0,1	0,2	0,5	1	2	2,5		
Reactive energy	4.8.3					0,5	1	2		3	
Reactive power	4.8.3					0,5	1	2		3	
Apparent energy	4.8.4				0,2	0,5	1	2			
Apparent power	4.8.4				0,2	0,5	1	2			
Frequency	4.8.5	0,02	0,05	0,1	0,2	0,5					
Phase current	4.8.6		0,05	0,1	0,2	0,5	1	2			

Measured neutral current	4.8.6				0,2	0,5	1	2			
Calculated neutral current	4.8.6			0,1	0,2	0,5	1	2			
Voltage	4.8.7		0,05	0,1	0,2	0,5	1	2			
Power factor	4.8.8					0,5	1	2			5
Flicker	4.8.9										5
Dips and swells measurement	4.8.10					0,5	1	2			
Voltage interruption	4.8.11					0,5	1	2			
Voltage unbalance	4.8.13				0,2	0,5	1				
Voltage harmonics	4.8.14						1	2		3	5
Voltage THD	4.8.14						1	2		3	5
Current unbalance	4.8.14				0,2	0,5	1				
Current harmonics	4.8.16						1	2		3	5
Current THD	4.8.16						1	2		3	5

The requirements for the performance for a PMD associated with a dedicated external transducer are the same as for a direct connected PMD. Each combination of a PMD associated with a dedicated external transducer shall be considered as a PMD DD that needs to comply with the performance requirements of this document.

EXAMPLE If a manufacturer provides three different types of dedicated transducers (for example, a 100 A dedicated CT, a 500 A dedicated CT and a 1 000 A dedicated CT), then the manufacturer would provide three separate performance type test reports (one for the tests related to the PMD associated with the 100 A dedicated transducer, one for the tests related to the PMD associated with the 500 A dedicated transducer and one for the tests related to the PMD associated with the 1 000 A dedicated transducer). The manufacturer shall provide proper justification (e.g. simulation results, existing tests results, design notes, schematics...) for extrapolating performance if some physical tests are not performed.

NOTE Guidance related to the association of a PMD with a transducer is provided in Annex E and Annex F.

4.6 Operating and reference conditions for PMD

4.6.1 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 ^c	Three phases available ^a
Voltages unbalance ^c	≤ 0,1 % ^a
External continuous magnetic field	≤ 40 A/m DC ≤ 3 A/m AC at 50/60 Hz
DC 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 DC, may be specified.	

4.6.2 Rated operating conditions

4.6.2.1 General

Table 5 to Table 7 give the conditions in which functions shall be performed according to their specifications.

4.6.2.2 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

4.6.2.3 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 ^c (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	According to manufacturer's specification ^a
^a Limits are to be defined by the manufacturer according to the application. ^b Kx stands for extended conditions. ^c The operating temperature is the highest temperature of the air in close proximity to the PMD.			

4.6.2.4 Rated humidity and altitude operating conditions

Table 7 gives the rated operating humidity and altitude conditions 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 m to 2 000 m	0 m to above 2 000 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.