BRITISH STANDARD

BS EN 61557-12:2008

# 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



British Standards

# 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.

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

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2008



**ISISBN 978 0 580 56285 3**

**Amendments/corrigenda issued since publication**

| Date | Comments |
| --- | --- |
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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 61557-12

May 2008

ICS 17.220.20; 29.080.01; 29.240.01

English version

# 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)

This European Standard was approved by CENELEC on 2008-04-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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**



Ref. No. EN 61557-12:2008 E

# 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).

The following dates were fixed:

| | | |
|---|---|---|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2009-01-01 |
| – latest date by which the national standards conflicting 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.

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# 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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CONTENTS

# 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 ±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 ±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 $U_{pg\ dip}$ (line p to line g) and $V_{p\ dip}$ (line p to neutral) |
| $U_{swl}$ | voltage swells including $U_{pg\ swl}$ (line p to line g) and $V_{p\ swl}$ (line p to neutral) |
| $U_{tr}$ | transients overvoltage including $U_{pg\ tr}$ (line p to line g) and $V_{p\ tr}$ (line p to neutral) |
| $U_{int}$ | voltage Interruption including $U_{pg\ int}$ (line p to line g) and $V_{p\ int}$ (line p to neutral) |
| $U_{nb}$ | voltage Unbalance phase and amplitude including $V_{p\ nb}$ (line p to neutral) |
| $U_{nba}$ | voltage Unbalance amplitude including $V_{p\ nba}$ (line p to neutral) |
| $U_h$ | voltage harmonics including $U_{pg\ h}$ (line p to line g) and $V_{p\ h}$ (line p to neutral) |
| $THD_u$ | total harmonic distortion voltage related to fundamental |
| $THD\text{-}R_u$ | 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 |
| $THD\text{-}R_i$ | 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.

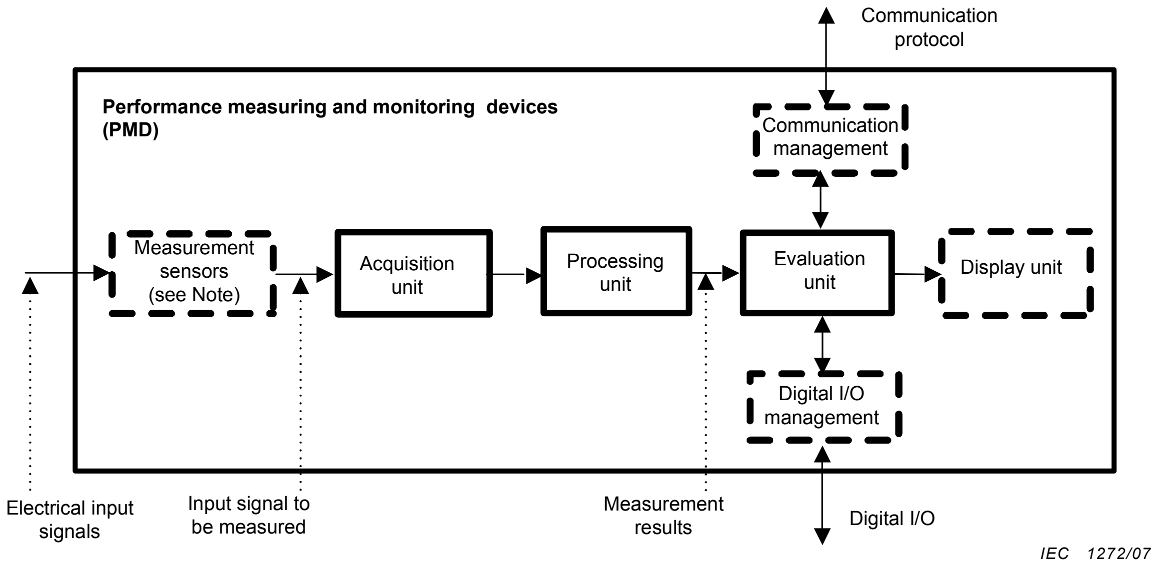



**Figure 1 – PMD generic measurement chain**

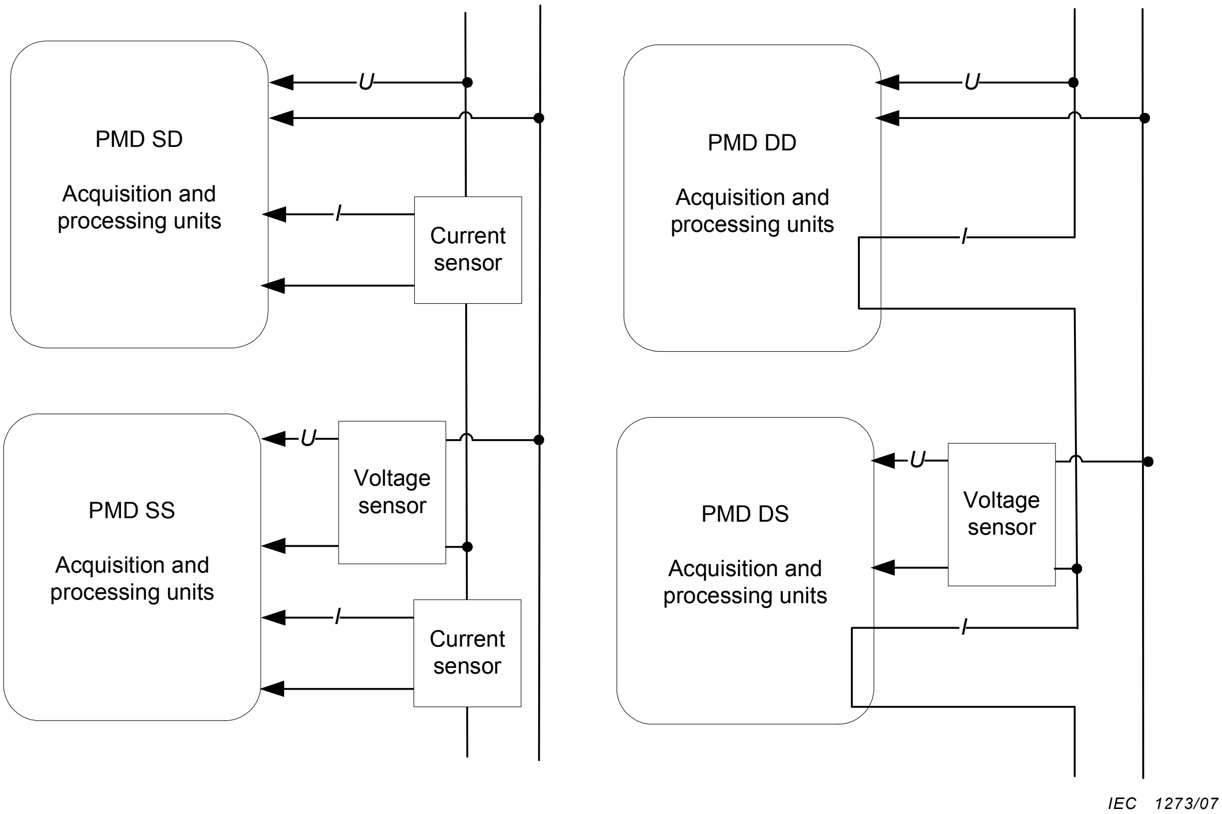
NOTE It is not necessary that the parts in the dotted lines shown in Figure 1 be included in the PMD.

### 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) |




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 |

#### 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.<br>≤ 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 for30 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.

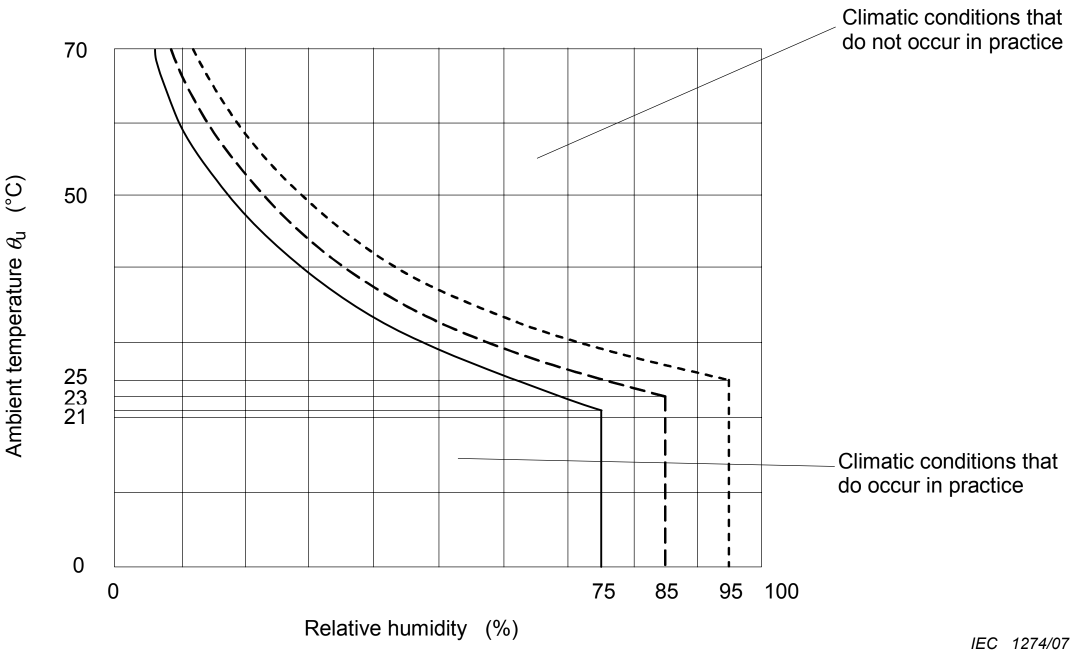



**Figure 3 – Relationship between ambient air temperature and relative humidity**

### 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 %$U_n$

#### 4.7.1.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 8:

**Table 8 – Intrinsic uncertainty table for active power and active energy measurement**

| Specified measuring range | | Power factor [d] | Intrinsic uncertainty limits for PMD of function performance class $C$ [a b c] | | Unit |
|---|---|---|---|---|---|
| Value of current for Direct connected PMD Dx | Value of current for Sensor operated PMD Sx | | for $C < 1$ | for $C \geq 1$ | |
| $2\ \%I_b \leq I < 10\ \%I_b$ | $1\ \%I_n \leq I < 5\ \%I_n$ | 1 | $\pm 2,0 \times C$ | No requirement | % |
| $5\ \%I_b \leq I < 10\ \%I_b$ | $2\ \%I_n \leq I < 5\ \%I_n$ | 1 | No requirement | $\pm(1,0 \times C + 0,5)$ | % |
| $10\ \%I_b \leq I \leq I_{max}$ | $5\ \%I_n \leq I \leq I_{max}$ | 1 | $\pm 1,0 \times C$ | $\pm 1,0 \times C$ | % |
| $5\ \%I_b \leq I < 20\ \%I_b$ | $2\ \%I_n \leq I < 10\ \%I_n$ | 0,5 inductive<br>0,8 capacitive | $\pm(1,7 \times C + 0,15)$<br>$\pm(1,7 \times C + 0,15)$ | No requirement<br>No requirement | % |
| $10\ \%I_b \leq I < 20\ \%I_b$ | $5\ \%I_n \leq I < 10\ \%I_n$ | 0,5 inductive<br>0,8 capacitive | No requirement<br>No requirement | $\pm(1,0 \times C + 0,5)$<br>$\pm(1,0 \times C + 0,5)$ | % |
| $20\ \%I_b \leq I \leq I_{max}$ | $10\ \%I_n \leq I \leq I_{max}$ | 0,5 inductive<br>0,8 capacitive | $\pm(1,0 \times C + 0,1)$<br>$\pm(1,0 \times C + 0,1)$ | $\pm 1,0 \times C$<br>$\pm 1,0 \times C$ | % |

[a] The permitted values for active energy function performance class C are: 0,2 – 0,5 – 1 – 2, the permitted values for active power funtion performance class C are: 0,1 – 0,2 – 0,5 – 1 – 2 – 2,5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor or voltage sensor are given in Annex D.

[c] For active energy measurement class 1 and 2 of this standard, the uncertainty limits of classes 1 and 2 defined in Table 6 of IEC 62053-21 can be used as well as the uncertainty limits given in this table. For active energy measurement class 0,2 and 0,5 of this standard, the uncertainty limits of class 0,2S and 0,5S defined in Table 4 of IEC 62053-22 can be used as well as the uncertainty limits given in this table.

[d] In reference conditions, signals are sinusoidal, so in this case power factor = cos φ.

#### 4.7.1.4 Limits of variations due to influence quantities

The additional variations due to influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in the Table 9:

**Table 9 – Influence quantities for active power and active energy measurement**

| Influence quantities | | Specified measuring range [e] | | Power factor [j] | Temperature coefficient for PMD of function performance class $C$ [a b] | | Unit |
|---|---|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **Value of current for Direct connected PMD Dx** [f] | **Value of current for Sensor operated PMD Sx** [f] | | **for $C$ < 1** | **for C ≥ 1** | |
| Ambient temperature | according to rated operating range of Table 5 & Table 6 | 10 %$I_b \le I \le I_{max}$ | 5 %$I_n \le I \le I_{max}$ | 1 | 0,05 x $C$ | 0,05 x C | % / K |
| | | 20 %$I_b \le I \le I_{max}$ | 10 %$I_n \le I \le I_{max}$ | 0,5 inductive | 0,1 x $C$ | 0,07 x C | % / K |
| | | | | | **Limits of variation for PMD of function performance class $C$** [a b] | | |
| | | | | | **for $C$ < 1** | **for $C$ ≥ 1** | |
| Auxiliary power supply voltage [l] | rated voltage ±15 % | 10 %$I_b$ | 10 %$I_n$ | 1 | 0,1 x $C$ | 0,1 x $C$ | % |
| Voltage | 80 %$U_n < U <$ 120 %$U_n$ | 5 %$I_b \le I \le I_{max}$ | 2 %$I_n \le I \le I_{max}$ | 1 | 0,3 x $C$ + 0,04 | 0,3 x $C$ + 0,4 | % |
| | | 10 %$I_b \le I \le I_{max}$ | 5 %$I_n \le I \le I_{max}$ | 0,5 inductive | 0,6 x $C$ + 0,08 | 0,5 x $C$ + 0,5 | |
| Frequency | rated frequency ±2 % | 5 %$I_b \le I \le I_{max}$ | 2 %$I_n \le I \le I_{max}$ | 1 | 0,3 x $C$ + 0,04 | 0,3 x $C$ + 0,2 | % |
| | | 10 %$I_b \le$ I $\le I_{max}$ | 5 %$I_n \le I \le I_{max}$ | 0,5 inductive | 0,3 x $C$ + 0,04 | 0,3 x $C$ + 0,4 | |
| Reversed phase sequence | --- | 10 %$I_b$ | 10 %$I_n$ | 1 | 0,15 x $C$ + 0,02 | 1,5 | % |
| Voltage unbalance | 0 to 10 % | $I_b$ | $I_n$ | 1 | 1,5 x $C$ + 0,2 | 2,0 x $C$ | % |
| Phase missing [f] | one or 2 phases missing | $I_b$ | $I_n$ | 1 | 2,0 x $C$ | 2,0 x $C$ | % |
| Harmonic components in the current and voltage circuits | voltage, 5th harmonic: 10 %<br>current, 5th harmonic: 40 % | 50 %$I_{max}$ | 50 %$I_{max}$ | 1 | 0,4 x $C$ + 0,3 | 0,2 x $C$ + 0,6 | % |

**Table 9** *(continued)*

| Influence quantities | | Specified measuring range [e] | | Power factor [j] | Temperature coefficient for PMD of function performance class *C* [a b] | | Unit |
|---|---|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **Value of current for Direct connected PMD Dx** [f] | **Value of current for Sensor operated PMD Sx** [f] | | | | |
| Odd harmonics in the a.c. current circuit | see [g] | 50 %$I_b$ | 50 %$I_n$ | 1 | 3,0 x *C* | 3,0 x *C* | % |
| Sub harmonic in the a.c. current circuit | see [g] | 50 %$I_b$ | 50 %$I_n$ | 1 | 3,0 x *C* | 3,0 x *C* | % |
| Common mode voltage rejection on isolated current inputs [k] | 0 to maximum voltage to earth (depending on measuring category) [i] | 10 %$I_b$ | 5 %$I_n$ | 1 | 1,0 x *C* | 0,5 x *C* | % |
| Permanent a.c. magnetic induction of external origin 0,5 mT [c d h] | see [c] and [d] | $I_b$ | $I_n$ | 1 | 2,0 | 1,0 x *C* + 1,0 | % |
| Electromagnetic RF fields [c d] | see [c] and [d] | $I_b$ | $I_n$ | 1 | 3,4 x *C* + 0,3 | 1,0 x *C* + 1,0 | % |
| Conducted disturbances, induced by radio frequency fields [c d] | see [c] and [d] | $I_b$ | $I_n$ | 1 | 3,4 x *C* + 0,3 | 1,0 x *C* + 1,0 | % |

a The permitted values for active energy function performance class *C* are: 0,2 – 0,5 – 1 – 2, the permitted values for active power function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2 – 2,5

b For active energy measurement class 1 and 2 of this standard, the variation limits of class 1 and 2 defined in Table 8 of IEC 62053-21 can be used as well as the uncertainty limits given in this table. For active energy measurement class 0,2 and 0,5 of this standard, the variation limits of class 0,2 S and 0,5 S defined in Table 6 of IEC 62053-22 can be used as well as the uncertainty limits given in this table.

c EMC levels and test conditions are defined in IEC 61326 standard relating to industrial location.

d The EMC influence quantities are applicable only for energy measurements.

e Currents are balanced unless otherwise specified.

f Not applicable to self powered PMD.

g See clause 6.

h A magnetic induction of external origin of 0,5 mT produced by a current of the same frequency as that of the voltage applied to the PMD and under the most unfavourable conditions of phase and direction shall not cause a variation exceeding the values shown in this table.

i Measuring category is defined in IEC 61010-2-030, for instance 300 V common mode voltage for 300 V cat III.

j In reference conditions, signals are sinusoidal, so in this case power factor = cos φ.

k If current inputs are connected internally or externally to the ground, this requirement is not applicable.

l These limits are settled for a PMD powered by mains supply voltage. In the case of a larger range of the supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

#### 4.7.1.5 Starting and no-load condition

##### 4.7.1.5.1 Start-up of the PMD

See subclause 4.6.

##### 4.7.1.5.2 No load condition (only for energy measurement)

When the voltage is applied with no current flowing in the current circuit, the test output of the PMD shall not produce more than one pulse.

For this test, the current circuit shall be open-circuit and a voltage of 115 % of the rated voltage shall be applied to the voltage circuit.

NOTE In the case of outside shunt, only the input circuit of the PMD shall be opened.

The minimum test period $\Delta t$ shall be:

| PMD types | Minimum test period $\Delta t$ for no load condition | |
|---|---|---|
| | for $C < 1$ | for $C \geq 1$ |
| PMD | $\Delta t = \frac{((100 / C) + 400) \times 10^6}{k \times m \times U_n \times I_{max}}$ min | $\Delta t = \frac{((240 / C) + 360) \times 10^6}{k \times m \times U_n \times I_{max}}$ min |

where

$C$ is the function performance class;

$k$ is the number of pulses emitted by the output device of the PMD per kilowatt-hour (imp/kWh);

$m$ is the number of measuring elements;

$U_n$ is the rated voltage in volts;

$I_{max}$ is the maximum current in amperes.

For transformer-operated PMD with primary or half-primary registers, the constant $k$ shall correspond to the secondary values (voltage and current).

##### 4.7.1.5.3 Starting current

The PMD shall start and continue to register at the starting current values (and in the case of three-phase meters, with balanced load) shown in Table 10.

When starting conditions are met (according to Table 10), intrinsic uncertainty shall be between –40 % and +90 % of measured values.

If the PMD is designed for the measurement of energy in both directions, then this test shall be applied with energy flowing in each direction.

**Table 10 – Starting current for active power and active energy measurement**

| PMD types | Power factor [a] | Starting current for PMD of function performance class *C* | |
|---|---|---|---|
| | | for *C* < 1 | for *C* ≥ 1 |
| PMD Dx | 1 | $2 \times 10^{-3} \times I_b$ | $(C+3) \times 10^{-3} \times I_b$ |
| PMD Sx | 1 | $1 \times 10^{-3} \times I_n$ | $(C+1) \times 10^{-3} \times I_n$ |

[a] In reference conditions, signals are sinusoidal, so in this case power factor = cos φ.

#### 4.7.2 Reactive power ($Q_A$, $Q_V$) and reactive energy ($E_{rA}$, $E_{rV}$) measurements

##### 4.7.2.1 Techniques

See Annex A.

Zero blind measurement is required.

##### 4.7.2.2 Rated range of operation

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

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

##### 4.7.2.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 11:

**Table 11 – Intrinsic uncertainty table for reactive power and reactive energy measurement**

| Specified measuring range | | sin φ (inductive or capacitive) | Intrinsic uncertainty limits for PMD of function performance class *C* [a b c] | | Unit |
|---|---|---|---|---|---|
| value of current for Direct connected PMD Dx | value of current for Sensor operated PMD Sx | | for *C* < 3 | for *C* ≥ 3 | |
| $5\ \%I_b \le I < 10\ \%I_b$ | $2\ \%I_n \le I < 5\ \%I_n$ | 1 | ±1,25 x *C* | ±1,33 x *C* | % |
| $10\ \%I_b \le I \le I_{max}$ | $5\ \%I_n \le I \le I_{max}$ | 1 | ±1,0 x *C* | ±1,0 x *C* | % |
| $10\ \%I_b \le I < 20\ \%I_b$ | $5\ \%I_n \le I < 10\ \%I_n$ | 0,5 | ±1,25 x *C* | ±1,33 x *C* | % |
| $20\ \%I_b \le I \le I_{max}$ | $10\ \%I_n \le I \le I_{max}$ | 0,5 | ±1,0 x *C* | ±1,0 x *C* | % |
| $20\ \%I_b \le I \le I_{max}$ | $10\ \%I_n \le I \le I_{max}$ | 0,25 | ±1,25 x *C* | ±1,33 x *C* | % |

[a] The permitted values for reactive energy function performance class *C* are: 2 – 3; the permitted values for reactive power function performance class C are: 1 – 2 – 3.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor or voltage sensor are given in Annex D.

[c] For reactive energy measurement class 2 and 3 of this standard, the uncertainty limits of class 2 and 3 defined in Table 6 of IEC 62053-23 can be used as well as the uncertainty limits given in this table.

##### 4.7.2.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 12:

**Table 12 – Influence quantities for reactive power and reactive energy measurement**

| Influence quantities | | Specified measuring range [d] | | sin φ (inductive or capacitive) | Temperature coefficient for PMD of function performance class *C* [a e] | | Unit |
|---|---|---|---|---|---|---|---|
| Influence type | Influence range | Value of current for Direct connected PMD Dx | Value of current for Sensor operated PMD Sx | | for $C < 3$ | for $C \geq 3$ | |
| Ambient temperature | According to rated operating range of Table 5 & Table 6 | $10\ \% I_b \leq I \leq I_{max}$ | $5\ \% I_n \leq I \leq I_{max}$ | 1 | $0{,}05 \times C$ | $0{,}05 \times C$ | % / K |
| | | $20\ \% I_b \leq I \leq I_{max}$ | $10\ \% I_n \leq I \leq I_{max}$ | 0,5 | $0{,}075 \times C$ | $0{,}08 \times C$ | % / K |
| | | | | | Limits of variation for PMD of function performance class *C* [a b] | | |
| | | | | | for $C < 3$ | for $C \geq 3$ | |
| Auxiliary power supply voltage [f] | Rated voltage ±15 % | $10\ \% I_b$ | $10\ \% I_n$ | 1 | $0{,}1 \times C$ | $0{,}1 \times C$ | % |
| Voltage | $80\ \% U_n < U < 120\ \% U_n$ | $5\ \% I_b \leq I \leq I_{max}$ | $2\ \% I_n \leq I \leq I_{max}$ | 1 | $0{,}5 \times C$ | $0{,}66 \times C$ | % |
| | | $10\ \% I_b \leq I \leq I_{max}$ | $5\ \% I_n \leq I \leq I_{max}$ | 0,5 inductive | $0{,}75 \times C$ | $1{,}0 \times C$ | % |
| Frequency | Rated frequency | $5\ \% I_b \leq I \leq I_{max}$ | $2\ \% I_n \leq I \leq I_{max}$ | 1 | $1{,}25 \times C$ | 2,5 | % |
| | ±2 % | $10\ \% I_b \leq I \leq I_{max}$ | $5\ \% I_n \leq I \leq I_{max}$ | 0,5 inductive | $1{,}25 \times C$ | 2,5 | |
| Permanent a.c. magnetic induction of external origin 0,5mT [b c] | see [b] and [c] | $I_b$ | $I_n$ | 1 | $1{,}5 \times C$ | 3,0 | % |
| Electromagnetic RF fields [b c] | see [b] and [c] | $I_b$ | $I_n$ | 1 | $1{,}5 \times C$ | 3,0 | % |
| Conducted disturbances, induced by radio frequency fields [b c] | see [b] and [c] | $I_b$ | $I_n$ | 1 | $1{,}5 \times C$ | 3,0 | % |

[a] The permitted values for reactive energy function performance class *C* are: 2 – 3; the permitted values for reactive power function performance class *C* are: 1 – 2 – 3.

[b] EMC levels and test conditions are defined in IEC 61326 standard relating to industrial location.

[c] The EMC influence quantities are applicable only for energy measurements.

[d] Currents are balanced unless otherwise specified.

[e] For reactive energy measurement class 2 and 3 of this standard, the variation limits of class 2 and 3 defined in Table 8 of IEC 62053-23 can be used as well as the uncertainty limits given in this table.

[f] These limits are settled for a PMD powered by mains supply voltage. In the case of a larger range of the supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

#### 4.7.2.5 Starting and no-load condition

##### 4.7.2.5.1 Start-up of the PMD

See subclause 4.6.

##### 4.7.2.5.2 No load condition

When the voltage is applied with no current flowing in the current circuit, the test output of the PMD shall not produce more than one pulse.

For this test, the current circuit shall be open-circuit and a voltage of 115 % of the rated voltage shall be applied to the voltage circuit.

NOTE In case of outside shunt, only the input circuit shall be open circuited.

The minimum test period Δ*t* shall be:

| PMD types | Minimum test period Δ*t* for no load condition | |
|---|---|---|
| | for *C* < 3 | for *C* ≥ 3 |
| PMD | $\Delta t = \frac{((240 / C) + 360) \times 10^6}{k \times m \times U_n \times I_{max}}$ min | $\Delta t = \frac{((1080 / C) - 60) \times 10^6}{k \times m \times U_n \times I_{max}}$ min |

where

*C* is the function performance class;

*k* is the number of pulses emitted by the output device of the PMD per kilovar-hour (imp/kvarh);

*m* is the number of measuring elements;

$U_n$ is the rated voltage in volts;

$I_{max}$ is the maximum current in amperes.

For transformer-operated PMD with primary or half-primary registers, the constant *k* shall correspond to the secondary values (voltage and current).

##### 4.7.2.5.3 Starting current

The PMD shall start and continue to register at the starting current values (and in case of three-phase meters, with balanced load) shown in Table 13.

When starting conditions are met (according to Table 13) intrinsic uncertainty shall be between –40 % and +90 % of measured values.

If the PMD is designed for the measurement of energy in both directions, then this test shall be applied with energy flowing in each direction.

**Table 13 – Starting current for reactive energy measurement**

| PMD types | sin φ (inductive or capacitive) | Starting current for PMD of function performance class *C* for *C* < 3 | for *C* ≥ 3 |
|---|---|---|---|
| PMD Dx | 1 | $(C + 3) \times 10^{-3} \times I_b$ | $(5 \times C - 5) \times 10^{-3} \times I_b$ |
| PMD Sx | 1 | $(C + 1) \times 10^{-3} \times I_n$ | $(2 \times C - 1) \times 10^{-3} \times I_n$ |

### 4.7.3 Apparent power ($S_A$, $S_V$) and apparent energy ($E_{apA}$, $E_{apV}$) measurements

#### 4.7.3.1 Techniques

See Annex A.

Zero blind measurement is required.

#### 4.7.3.2 Rated range of operation

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

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

#### 4.7.3.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed the limits given in Table 14:

**Table 14 – Intrinsic uncertainty table for apparent power and apparent energy measurement**

| Specified measuring range: Value of current for Direct connected PMD Dx | Value of current for Sensor operated PMD Sx | Intrinsic uncertainty limits for PMD of function performance class *C* [a b]: for *C* < 1 | for *C* ≥ 1 | Unit |
|---|---|---|---|---|
| $5\ \%I_b < I \le 10\ \%I_b$ | $2\ \%I_n < I \le 5\ \%I_n$ | $\pm 2,0 \times C$ | $\pm(1,0 \times C + 0,5)$ | % |
| $10\ \%I_b < I \le I_{max}$ | $5\ \%I_n < I \le I_{max}$ | $\pm 1,0 \times C$ | $\pm 1,0 \times C$ | % |

[a] The permitted values for function performance class *C* are: 0,2 – 0,5 – 1 – 2

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor or voltage sensor are given in Annex D.

#### 4.7.3.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 15:

**Table 15 – Influence quantities for apparent power and apparent energy measurement**

| Influence quantities | | Specified measuring range [d] | | Power factor [e] | Temperature coefficient for PMD of function performance class *C* [a] | | Unit |
|---|---|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **Value of current for Direct connected PMD Dx** | **Value of current for Sensor operated PMD Sx** | | **for $C < 1$** | **for $C \geq 1$** | |
| Ambient temperature | According to rated operating range of Table 5 and Table 6 | $10\ \% I_b \leq I \leq I_{max}$ | $5\ \% I_n \leq I \leq I_{max}$ | 1 | $0{,}05 \times C$ | $0{,}05 \times C$ | % / K |
| | | | | | **Limits of variation for PMD of function performance class *C* [a b]** | | |
| | | | | | **for $C < 1$** | **for $C \geq 1$** | |
| Auxiliary power supply voltage [f] | Rated voltage ±15 % | $10\ \% I_b$ | $10\ \% I_n$ | 1 | $0{,}1 \times C$ | $0{,}1 \times C$ | % |
| Voltage | $80\ \% U_n < U < 120\ \% U_n$ | $5\ \% I_b \leq I \leq I_{max}$<br>$10\ \% I_b \leq I \leq I_{max}$ | $2\ \% I_n \leq I \leq I_{max}$<br>$5\ \% I_n \leq I \leq I_{max}$ | 1<br>0,5 inductive | $0{,}3 \times C + 0{,}04$<br>$0{,}6 \times C + 0{,}08$ | $0{,}3 \times C + 0{,}4$<br>$0{,}5 \times C + 0{,}5$ | % |
| Continuous magnetic induction of external origin 0,5mT [c d] | see [c] and [d] | $I_b$ | $I_n$ | 1 | 2,0 | $1{,}0 \times C + 1{,}0$ | % |
| Electromagnetic RF fields [c d] | see [c] and [d] | $I_b$ | $I_n$ | 1 | $3{,}4 \times C + 0{,}3$ | $1{,}0 \times C + 1{,}0$ | % |
| Conducted disturbances, induced by radio frequency fields [c d] | see [c] and [d] | $I_b$ | $I_n$ | 1 | $3{,}4 \times C + 0{,}3$ | $1{,}0 \times C + 1{,}0$ | % |

[a] The permitted values for function performance class *C* are: 0,2 – 0,5 – 1 – 2.

[b] EMC levels and test conditions are defined in IEC 61326 standard relating to industrial location.

[c] The EMC influence quantities are applicable only for energy measurements.

[d] Currents are balanced unless otherwise specified.

[e] In reference conditions, signals are sinusoidal, so in this case power factor = cos φ.

[f] These limits are settled for a PMD powered by mains supply voltage. In the case of a larger range of the supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

### 4.7.4 Frequency (*f*) measurements

#### 4.7.4.1 Techniques

Zero blind measurement is not required.

#### 4.7.4.2 Rated range of operation

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

– Voltage: 50 %$U_n$ to $U_{max}$; or
– Current: for PMD Dx: 20 %$I_b$ to $I_{max}$, for PMD Sx: 10 %$I_n$ to $I_{max}$

NOTE Frequency is usually measured from voltage function of PMD; current rated range of operation has to be considered only if this function does not exist in the PMD.

#### 4.7.4.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 16:

**Table 16 – Intrinsic uncertainty table for frequency measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| 45 Hz to 55 Hz or 55 Hz to 65 Hz | ±1,0 × *C* | % |

[a] The permitted values for function performance class *C* are: 0,02 – 0,05 – 0,1 – 0,2 – 0,5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external CS or VS are given in Annex D.

#### 4.7.4.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 17:

**Table 17 – Influence quantities for frequency measurement**

| Influence quantities | | Temperature coefficient for PMD of function performance class *C* [a] | Unit |
|---|---|---|---|
| Influence type | Influence range or influence level | | |
| Ambient temperature | According to rated operating range of Table 5 and Table 6 | 0,1 × *C* | % / K |
| | | **Limits of variation for PMD of function performance class *C* [a]** | |
| Voltage | 50 %$U_n$ to $U_{max}$ | 0,2 × *C* | % |
| Harmonics in the voltage circuits [b] | 3rd harmonic 10 %<br>5th harmonic 12 %<br>7th harmonic 10 %<br>9th harmonic 3 %<br>11th harmonic 7 %<br>13th harmonic 6 %<br>15th harmonic 1 % | 0,2 × *C* | % |

[a] The permitted values for function performance class *C* are: 0,02 – 0,05 – 0,1 – 0,2 – 0,5

[b] All harmonics components have the same relative phase, but in opposite phase referred to the fundamental.

#### 4.7.5 R.m.s. phase current ($I$) and neutral current ($I_N$, $I_{Nc}$) measurements

##### 4.7.5.1 Techniques

See Annex A.

Zero blind measurement is not required.

##### 4.7.5.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated ranges given in Table 18 and Table 19:

###### 4.7.5.2.1 Rated range of operation for phase current

**Table 18 – Rated range of operation for phase current measurement**

| PMD types | Specified measuring range | Minimum bandwidth (harmonic) | Crest factor |
|---|---|---|---|
| PMD Sx | 10 %$I_n$ to 120 %$I_n$ | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 2 |
| PMD Dx | 20 %$I_b$ to $I_{max}$ | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 2 |

###### 4.7.5.2.2 Rated range of operation for measured neutral current (with a sensor) and calculated neutral current (from phase currents)

**Table 19 – Rated range of operation for neutral current measurement**

| PMD types | Specified measuring range | Minimum bandwidth (harmonic) | Crest factor |
|---|---|---|---|
| PMD Sx | 10 %$I_n$ to 120 %$I_n$ | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 2 |
| PMD Dx | 20 %$I_b$ to $I_{max}$ | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 2 |

NOTE The nominal current of the neutral current sensor may be different from the one for phase current sensor.

##### 4.7.5.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 20, Table 21 and Table 22.

#### 4.7.5.3.1 Intrinsic uncertainty table for phase current

**Table 20 – Intrinsic uncertainty table for phase current**

| Specified measuring range | | Intrinsic uncertainty limits for PMD of function performance class *C* [a b] | Unit |
|---|---|---|---|
| value of current for Direct connected PMD Dx | value of current for Sensor operated PMD Sx | | |
| 20 %$I_b \leq I \leq I_{max}$ | 10 %$I_n \leq I \leq I_{max}$ | ±1,0 x *C* | % |

[a] The permitted values for function performance class *C* are: 0,05 – 0,1 – 0,2 – 0,5 – 1 – 2.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor are given in Annex D.

#### 4.7.5.3.2 Intrinsic uncertainty table for measured neutral current (with a sensor)

**Table 21 – Intrinsic uncertainty table for neutral current measurement**

| Specified measuring range | | Intrinsic uncertainty limits for PMD of function performance class *C* [a b] | Unit |
|---|---|---|---|
| value of current for Direct connected PMD Dx | value of current for Sensor operated PMD Sx | | |
| 20 %$I_b \leq I_N \leq I_{max}$ | 10 %$I_n \leq I_N \leq I_{max}$ | ±1,0 × *C* | % |

[a] The permitted values for function performance class *C* are: 0,2 – 0,5 – 1 – 2.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor are given in Annex D.

#### 4.7.5.3.3 Intrinsic uncertainty table for calculated neutral current (from phase currents)

**Table 22 – Intrinsic uncertainty table for neutral current calculation**

| Specified measuring range | | Intrinsic uncertainty limits for PMD of function performance class *C* [a b d] | Unit |
|---|---|---|---|
| value of current for Direct connected PMD Dx | value of current for Sensor operated PMD Sx | | |
| 20 %$I_b \leq I_p$ [c] $\leq I_{max}$ | 10 %$I_n \leq I_p$ [c] $\leq I_{max}$ | ±1,0 × *C* | %I [c] |

[a] The permitted values for function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor are given in Annex D.

[c] Uncertainty shall be expressed as a percentage of the phase current, whose current is the largest.

[d] Performance class *C* refers to Phase current performance class.

#### 4.7.5.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 23:

**Table 23 – Influence quantities for phase current and neutral current measurement**

| Influence quantities | | Specified measuring range [b] | | Temperature coefficient for PMD of function performance class *C* [a] | Unit |
|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **For current Direct connected PMD Dx** | **For current Sensor operated PMD Sx** | | |
| Ambient temperature | According to rated operating range of Table 5 and Table 6 | 20 % $I_b \le I \le I_{max}$ | 10 % $I_n \le I \le I_{max}$ | 0,05 × *C* | % / K |
| | | | | **Limits of variation for PMD of function performance class *C* [a]** | |
| Auxiliary power supply voltage [c] | Rated voltage ±15 % | 20 % $I_b$ | 10 % $I_n$ | 0,1 × *C* | % |

[a] The permitted values for function performance class *C* for measured neutral current are: 0,2 – 0,5 – 1 – 2 The permitted values for function performance class *C* for calculated neutral current are: 0,1 – 0,2 – 0,5 – 1 – 2.

[b] Influence quantities for phase current are defined with balanced currents in three-phase distribution system.

[c] These limits are settled for a PMD powered by mains supply voltage. In the case of a larger range of the supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

### 4.7.6 R.m.s. voltage (*U*) measurements

#### 4.7.6.1 Technique

See Annex A.

Zero blind measurement is not required.

#### 4.7.6.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated ranges given in Table 24:

**Table 24 – Rated range of operation for r.m.s. voltage measurement**

| PMD types | Specified measuring range | Minimum bandwidth (harmonic) | Crest factor |
|---|---|---|---|
| PMD xS | 20 %$U_n$ to 120 %$U_n$<br>see NOTE | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 1,5 |
| PMD xD | As specified by manufacturer | 45 Hz to 15 times rated frequency or<br>d.c. and 45 Hz to 15 times rated frequency | 1,5 |
| NOTE Between 20% of $U_n$ and 50% of $U_n$, PMD using frequency detection circuits not operating in all the rated range can measure voltage with the last consistent measured value of frequency. | | | |

#### 4.7.6.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 25:

**Table 25 – Intrinsic uncertainty table for r.m.s. voltage measurement**

| Specified measuring range | | Intrinsic uncertainty limits for PMD of function performance class *C* [a b] | Unit |
|---|---|---|---|
| Value of voltage for Direct connected PMD xD | Value of voltage for Sensor operated PMD xS | | |
| $U_{min} \leq U \leq U_{max}$ [c] | $U_{min} \leq U \leq U_{max}$ [c] | ±1,0 × *C* | % |

[a] The permitted values for function performance class *C* are: 0,05 – 0,1 – 0,2 – 0,5 – 1 – 2

[b] The permitted values and formula to calculate the system performance class of a PMD with an external CS or VS are given in Annex D.

[c] Manufacturer can define $U_{max}$ and $U_{min}$, taking into account minimum measuring range of Table 24.

#### 4.7.6.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 26:

**Table 26 – Influence quantities for r.m.s. voltage measurement**

| Influence quantities | | Specified measuring range [b] | | Temperature coefficient for PMD of function performance class *C* [a] | Unit |
|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **value of voltage for Direct connected PMD xD** | **value of voltage for Sensor operated PMD xS** | | |
| Ambient temperature | According to rated operating range of Table 5 and Table 6 | $U_{min} \le U \le U_{max}$ | $U_{min} \le U \le U_{max}$ | $0,05 \times C$ | % / K |
| | | | | **Limits of variation for PMD of function performance class *C* [a]** | |
| Auxiliary power supply voltage [c] | Rated voltage ±15 % | $U_{min} \le U \le U_{max}$ | $U_{min} \le U \le U_{max}$ | $0,1 \times C$ | % |

[a] The permitted values for function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2.

[b] Manufacturer can define $U_{max}$ and $U_{min}$, taking into account specified measuring range of Table 24.

[c] These limits are settled for a PMD powered by mains supply voltage. In the case of a large dynamic supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

#### 4.7.7 Power factor ($PF_A$, $PF_V$) measurements

##### 4.7.7.1 Techniques

See Annex A.

##### 4.7.7.2 Rated range of operation

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

– Voltage: 50 % $U_n$ to $U_{max}$ or;

– Current: for PMD Dx: 20 % $I_b$ to $I_{max}$

for PMD Sx: 10 % $I_n$ to $I_{max}$

##### 4.7.7.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 27:

**Table 27 – Intrinsic uncertainty table for power factor measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| From 0,5 inductive to 0,8 capacitive | ±0,1 × *C* | [c] |

[a] The permitted values for function performance class *C* are: 0,5 – 1 – 2 – 5 – 10.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor or voltage sensor are given in Annex D.

[c] No units.

##### 4.7.7.4 Limits of variation due to influence quantities

The additional variations from intrinsic uncertainties shall be calculated according to Table 9 and Table 15 for power factor 1 and 0,5 inductive, within the rated ranges of operation, taking into account the worst case combination of uncertainties.

#### 4.7.8 Short term flicker ($P_{st}$) and long term flicker ($P_{lt}$) measurements

##### 4.7.8.1 Techniques

See IEC 61000-4-15.

##### 4.7.8.2 Rated range of operation

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

– Voltage: 80 % $U_n$ to $U_{max}$

##### 4.7.8.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 28:

**Table 28 – Intrinsic uncertainty table for flicker measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] | Unit |
|---|---|---|
| From 0,4 to 2 | ±1,0 × *C* | % |

[a] The permitted values for function performance class *C* are: 0,5 – 1 – 2 – 5 – 10.

### 4.7.9 Voltage dip ($U_{dip}$) and voltage swell ($U_{swl}$) measurements

#### 4.7.9.1 Techniques

See Annex A. Zero blind measurement is required.

Requirements in 5.4 of IEC 61000-4-30 apply, with the following modifications:

– in this part, either a fixed reference voltage or a sliding reference voltage with a one-minute time constant first order filter are required as threshold value for voltage dips or voltage swells detection;

– in this part, a synchronisation on zero crossing of voltage fundamental is not required.

#### 4.7.9.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated ranges given in Table 29:

**Table 29 – Rated range of operation for voltage dips and swells measurement**

| PMD types | Minimum threshold range settable for voltage dip | Minimum threshold range settable for voltage swell |
|---|---|---|
| PMD xS | From 5 %$U_n$ to 100 %$U_n$ | from 100 %$U_n$ to 120 %$U_n$ |
| PMD xD | As specified by manufacturer | as specified by manufacturer |

Minimum detectable duration shall be equal at least to one period of the measured voltage.

#### 4.7.9.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 30:

**Table 30 – Intrinsic uncertainty table for voltage dips and swells measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a b c] | Unit |
|---|---|---|
| Dips, residual voltage and swells overvoltage | ±1,0 × *C* | %$U_n$ |
| Dips duration and swells duration | One period at the network frequency | ms [d] |

[a] The permitted values for function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external voltage sensor are given in Annex D.

[c] The uncertainty of a dip or swell duration is equal to the dip or swell commencement uncertainty (half a cycle) plus the dip or swell conclusion uncertainty (half a cycle).

[d] This is a fixed uncertainty.

#### 4.7.9.4 Limits of variation due to influence quantities

The additional variations due to change of influence quantities with respect to reference conditions as given in 4.5.1, shall not exceed the limits for the relevant performance class given in Table 31:

**Table 31 – Influence quantities for dips and swells measurement**

| Influence quantities | | Specified measuring range [b] | | Temperature coefficient for PMD of function performance class *C* [a] | Unit |
|---|---|---|---|---|---|
| **Influence type** | **Influence range** | **value of voltage for Direct connected PMD xD** | **value of voltage for Sensor operated PMD xS** | | |
| Ambient temperature | according to rated operating range of Table 5 and Table 6 | $U_{min} \leq U \leq U_{max}$ | $U_{min} \leq U \leq U_{max}$ | 0,05 × *C* | % / K |
| | | | | **Limits of variation for PMD of function performance class *C* [a]** | |
| Auxiliary power supply voltage [c] | rated voltage ±15 % | $U_{min} \leq U \leq U_{max}$ | $U_{min} \leq U \leq U_{max}$ | 0,1 × *C* | $\%U_n$ |
| Frequency | rated frequency ±10 % | $U_{min} \leq U \leq U_{max}$ | $U_{min} \leq U \leq U_{max}$ | 0,5 × *C* | $\%U_n$ |

a The permitted values for function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2.

b Manufacturer can define $U_{max}$ and $U_{min}$, taking into account minimum measuring range of Table 29.

c These limits are settled for a PMD powered by mains supply voltage. In the case of a larger range of the supply voltage a.c or d.c., tests shall be done at least at lower input value and upper input value of this range. In any case, PMD shall comply with the requirement for all the specified supply voltage ranges.

#### 4.7.10 Transients overvoltage ($U_{tr}$) measurements

##### 4.7.10.1 Techniques

See Annex A of IEC 61000-4-30.

Zero blind measurement is required.

Reference waveform: 1,2/50 μs as defined in IEC 61000-4-5

##### 4.7.10.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated ranges given in Table 32.

##### 4.7.10.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 32:

**Table 32 – Intrinsic uncertainty table for transient overvoltage measurement**

| Specified measuring range for PMD of function performance class *C* | Intrinsic uncertainty limits for PMD | Resolution for duration measurement [b] |
|---|---|---|
| 0 to $U_{tr}$ [a] | ±3,0 % x $U_{tr}$ | 5 μs |

[a] The recommended values for the specified measuring range are 6 kV – 4 kV – 2,5 kV – 1,5 kV – 0,8 kV.

[b] Duration measurement is optional. If it is provided, it shall be made at 50 % of the peak value of the transient.

#### 4.7.11 Voltage interruption ($U_{int}$) measurements

##### 4.7.11.1 Techniques

See Annex A.

Zero blind measurement is required.

Subclause 5.4 of IEC 61000-4-30 applies excepted that, in this part, a synchronisation on zero crossing of voltage fundamental is not required.

NOTE This measurement is possible only if the neutral wire is connected to the PMD.

##### 4.7.11.2 Rated range of operation

The manufacturer shall choose at least one value for the threshold of voltage interruption detection included in the range 1 % to 5 % of $U_n$.

Minimum detectable duration shall be equal at least to one period of the measured voltage.

##### 4.7.11.3 Intrinsic uncertainty table

The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 33:

**Table 33 – Intrinsic uncertainty table for voltage interruption measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| Interruptions from 0 % to 5 % of $U_n$ | ±1,0 × *C* | $\%U_n$ |
| Interruption duration | Less than two periods at the network frequency | ms [c] |

[a] The permitted values for function performance class *C* are: 0,1 – 0,2 – 0,5 – 1 – 2.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external voltage sensor are given in Annex D.

[c] This is a fixed uncertainty.

### 4.7.12 Voltage unbalance ($U_{nb}$, $U_{nba}$) measurements

#### 4.7.12.1 Techniques

Zero blind measurement is not required.

According to manufacturer specification, one of the following functions shall be implemented:

- amplitude voltage unbalance ($U_{nba}$): see Annex A
- amplitude and phase voltage unbalance ($U_{nb}$): see IEC 61000-4-30

#### 4.7.12.2 Rated range of operation

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

– between 80 % and 120 % of $U_n$

#### 4.7.12.3 Intrinsic uncertainty table

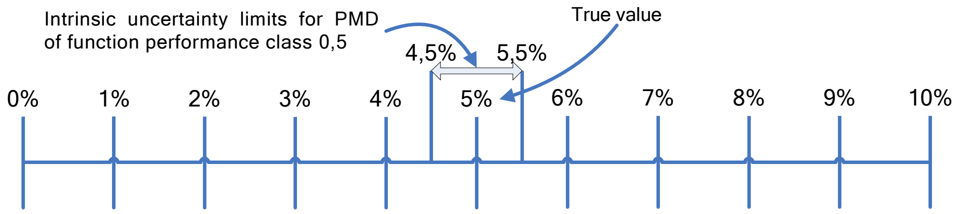
The intrinsic uncertainty under reference conditions shall not exceed limits given in Table 34:

**Table 34 – Intrinsic uncertainty table for voltage unbalance measurement**

| Indicated range of $U_{nb}$ or $U_{nba}$ | Intrinsic uncertainty limits for PMD of function performance class *C* [a] | Resolution | Unit |
|---|---|---|---|
| 0 % to 10 % | ±1 × *C* [b] | ±0,1 | % |

[a] The permitted values for function performance class *C* are: 0,2 – 0,5 – 1.

[b] The diagram below shows an example of uncertainty limits for class 0,5:



### 4.7.13 Voltage harmonics ($U_h$) and voltage THD ($THD_u$ and $THD\text{-}R_u$) measurements

#### 4.7.13.1 Techniques

Manufacturer shall specify sampling frequency, number of ranks, windows and filtering methods, aggregation method.

NOTE 1 IEC 61000-4-7 compliance is not mandatory.

Zero blind measurement is not required.

NOTE 2 When zero blind measurement is not implemented, only stationary and quasi-stationary harmonics can be measured.

#### 4.7.13.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated range given in Table 35:

**Table 35 – Rated range of operation for voltage harmonics measurement**

| PMD types | Minimum bandwidth | Fundamental frequency range |
|---|---|---|
| PMD | 15 times rated frequency | 45 Hz to 65 Hz |

#### 4.7.13.3 Intrinsic uncertainty table

The uncertainty indicated in Table 36 and Table 37 applies for a single tone stationary harmonic signal over the whole working conditions.

**Table 36 – Intrinsic uncertainty table for voltage harmonics measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| $U_h > 3 \times U_n \times C / 100$ | ±5,0 | $\%U_h$ |
| $U_h \leq 3 \times U_n \times C / 100$ | $\pm 0{,}15 \times C$ | $\%U_n$ |

[a] The permitted values for function performance class *C* are: 1 – 2 – 5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external voltage sensor are given in Annex D.

**Table 37 – Intrinsic uncertainty table for voltage $THD_u$ or $THD\text{-}R_u$ measurement**

| Specified measuring range for voltage THD | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| 0 % to 20 % | $\pm 0{,}3 \times C$ [c] | point [c] |

[a] The permitted values for function performance class *C* are: 1 – 2 – 5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external voltage sensor are given in Annex D.

[c] 0,3 x *C* is a constant uncertainty. For example with 10 % of THD, if *C* = 1, the measured value may be between 9,7 and 10,3.

### 4.7.14 Current harmonics ($I_h$) and current THD ($THD_i$ and $THD\text{-}R_i$) measurements

#### 4.7.14.1 Techniques

According to manufacturer specification: sampling frequency, number of ranks, windows and filtering methods, aggregation method.

Zero blind measurement is not required.

NOTE When zero blind measurement is not implemented, only stationary and quasi-stationary harmonics can be measured.

#### 4.7.14.2 Rated range of operation

The intrinsic uncertainty requirements shall apply within the rated range given in Table 38:

**Table 38 – Rated range of operation for current harmonics measurement**

| PMD types | Minimum bandwidth | Fundamental frequency range |
|---|---|---|
| PMD | 15 times rated frequency | 45 Hz to 65 Hz |

#### 4.7.14.3 Intrinsic uncertainty table

The uncertainty indicated in Table 39 and Table 40 apply for a single tone stationary harmonic signal over the whole working condition.

**Table 39 – Intrinsic uncertainty table for current harmonics measurement**

| PMD types | Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a b] | Unit |
|---|---|---|---|
| PMD-Sx | $I_h > 10 \times I_n \times C / 100$ | ±5,0 | $\% I_h$ |
| | $I_h \leq 10 \times I_n \times C / 100$ | $\pm 0{,}5 \times C$ | $\% I_n$ |
| PMD-Dx | $I_h > 10 \times I_b \times C / 100$ | ±5,0 | $\% I_h$ |
| | $I_h \leq 10 \times I_b \times C / 100$ | $\pm 0{,}5 \times C$ | $\% I_b$ |

[a] The permitted values for function performance class *C* are: 1 – 2 – 5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor are given in Annex D.

**Table 40 – Intrinsic uncertainty table for current $THD_i$ and $THD\text{-}R_i$ measurement**

| Specified measuring range | Intrinsic uncertainty limits for PMD of function performance class *C* [a] [b] | Unit |
|---|---|---|
| 0 % to 100 % | ±0,3 × *C* [c] | point [c] |
| 100 % to 200 % | ±0,3 × *C* × *THD* / 100 [d] | point [c] |

[a] The permitted values for function performance class *C* are: 1 – 2 – 5.

[b] The permitted values and formula to calculate the system performance class of a PMD with an external current sensor are given in Annex D.

[c] 0,3 x *C* is an absolute uncertainty. For example with 10 % of THD, if *C* = 1, the measured value may be between 9,7 and 10,3.

[d] *THD* is the measured value of current THD expressed in %.

#### 4.7.15 Minimum, maximum, peak, three-phases average and demand measurements

##### 4.7.15.1 Rated range of operation

Manufacturer shall specify rated range of operation.

##### 4.7.15.2 Intrinsic uncertainty table

Uncertainty on these values (minimum, maximum, …) shall be the same as those from the corresponding measurements used to calculate these values.

For instance, a PMD claiming a class *C* performance on power measurement shall have to comply with the same performance class *C* for the power demand measurement if any.

Calculation methods are specified in Annex B.

### 4.8 Requirements for PMD-A functions

Measuring uncertainties, measuring methods, measuring ranges, testing methods shall comply with IEC 61000-4-30 class A, and the complementary characteristics given in Table 41 below.

Depending on the purpose of the measurement, all or a subset of the functions listed in Table 41 shall be measured.

NOTE For contractual applications, all functions listed in Table 41 may be necessary.

Any "power quality assessment function" of a PMD-A shall comply with the measurement methods and measurement uncertainty defined for class A in IEC 61000-4-30.

Each function shall comply with IEC 61000-4-30 within operating conditions specified in 4.5.2 of this standard.

For PMD-A, the maximum variation caused by change of ambient temperature within the specified temperature operating range according to 4.5 shall not exceed 1,0 x measuring uncertainty as specified in IEC 61000-4-30. Manufacturers shall specify the variation as required in Note 2, subclause 4.1 of IEC 61000-4-30.

**Table 41 – Complementary characteristics of PMD-A**

| Function | Other complementary characteristics |
|---|---|
| $f$ | Range of operation: 50 % $U_{din}$ to $U_{max}$ or 1 % $U_{din}$ to $U_{max}$ if dips and swells are in concern.<br>See Note. |
| $U$ | No complementary characteristics. |
| $P_{st}$, $P_{lt}$ | No complementary characteristics. |
| $U_{dip}$ | Threshold settable from 50 % to 120 % of $U_{din}$;<br>Hysteresis: 2 % of $U_{din}$ |
| $U_{swl}$ | Threshold settable from 50 % to 120 % of $U_{din}$;<br>Hysteresis: 2 % of $U_{din}$ |
| $U_{int}$ | Threshold settable from 0,5 % to 10 % of $U_{din}$;<br>Duration measurement uncertainty < 2 cycles |
| $U_{nb}$ | Limit settable from 0 % to 5 %;<br>Resolution: 0,05 % minimum |
| $U_h$ | Requirement is to measure up to 50$^{th}$ rank, consequently minimum frequency bandwidth shall be at least 51 times the rated frequency. |
| $I_h$ | No complementary characteristics. |
| $Msv$ | Threshold settable from 0,1 % to 10 % of $U_{din}$ |
| NOTE Between 1% of $U_{din}$ and 50% of $U_{din}$, PMD using frequency detection circuits can measure voltage with the last consistent measured value of frequency. | |

### 4.9 General mechanical requirements

#### 4.9.1 Vibration requirements

Requirements for portable equipment are described in IEC 61557-1. For fixed installed equipment the requirement is as below:

- amplitude: 0,35 mm;
- frequency: 25 Hz;
- duration: 20 min in each 3 directions;
- PMD under test must be powered on.

The PMD functions shall remain in their specifications during the test.

#### 4.9.2 IP requirements

Manufacturer shall document equipment IP according to IEC 60529. The minimum requirements are given in Table 42, which specifies minimum IP requirements for the different kind of housings of PMD:

**Table 42 – Minimum IP requirements for PMD**

| Kind of PMD | Front panel | Housing, except front panel |
|---|---|---|
| Fixed installed PMD<br>→ panel mounted devices. | IP 40 | IP 2X |
| Fixed installed PMD<br>→ modular devices snapped on DIN rails within distribution panel. | IP 40 | IP 2X |
| Fixed installed PMD<br>→ housing devices snapped on DIN rails within distribution panel. | IP 2X | IP 2X |
| Portable PMD | IP 40 | IP 40 |

### 4.10 Safety requirements

PMD shall comply with safety requirements of IEC 61010, and in addition with the requirements of the following subclauses.

NOTE 1 Class II requirement as stated in IEC 61557-1 is not mandatory.

NOTE 2 Protection classes are defined in IEC 61140.

#### 4.10.1 Clearances and creepage distances

Clearances and creepage distances shall be selected at least in accordance with:

– pollution degree 2;
– measurement category III for measuring input circuits;
– overvoltage category III for mains circuits.

NOTE 1 Measurement category is defined in IEC 61010-2-030.

NOTE 2 For portable equipment, overvoltage category II is acceptable only for mains circuits powered from socket outlets.

#### 4.10.2 Connection of a fixed installed PMD with a current transformer

When a hazardous situation can be the result of an unintended disconnection of a current transformer from its PMD, connections of the current inputs shall be designed in such a way to prevent open circuit condition. This condition may be achieved either by removable auto short-circuiting connectors or screwable connectors or fixed connections or external protective devices, or protective devices integrated in the current transformer.

#### 4.10.3 Connection of a PMD with a high voltage sensor

The connection of a PMD xS or a PMD xD with external high voltage sensors (e.g. for systems with rated voltages higher than 1 000 V a.c. and 1 500 V d.c.) is allowed, provided that design features of such sensors prevent any hazards.

#### 4.10.4 Accessible parts

Requirements for accessible parts as defined in IEC 61010 apply.

Circuits intended to be connected to an external accessible circuit shall be considered as accessible conductive parts, e.g. communication circuits.

A communication port that may be connected to a data system shall also be considered as an accessible conductive part.

These accessible conductive parts require protection against single fault condition.

NOTE Basic insulation is not a sufficient protection against single fault condition. Examples of relevant insulation is double insulation or reinforced insulation, etc., see IEC 61010.

#### 4.10.5 Hazardous live parts

In a distribution system, neutral conductor shall be considered as a hazardous live part.

### 4.11 Analog outputs

#### 4.11.1 General requirements

The global uncertainty of each analogue output representing a measured parameter shall be in the uncertainty limits specified for the measurement of that parameter in Clause 4 unless otherwise specified.

NOTE 1 For testing of analog outputs, see 6.1.11. For a PMD fitted with analog outputs the requirements specified in 4.11.5 shall apply.

NOTE 2 The current analog output signal should be 4 mA to 20 mA, but 0 mA to 20 mA is also possible.

NOTE 3 The preferred voltage output signal is 0 V to 10 V. Voltages 0 V to ±1 V and 0 V to -10 V are also possible.

#### 4.11.2 Compliance voltage

Current output signals shall have a compliance voltage of at least 10 V. The actual compliance voltage shall be specified in the accompanying documentation (see 5.2).

When tested in accordance with the compliance voltage tests of 6.1.11.2 the uncertainty of the analog output shall not exceed $(2 \times C)$ % of full scale for a PMD with an analog output of performance class $C$.

#### 4.11.3 Analog output ripple content

When tested in accordance with 6.1.11.3 the maximum ripple content in the output signal for an output of performance class $C$ shall not exceed $(2 \times C)$ % of full scale of the maximum specified output signal.

#### 4.11.4 Analog output response time

The response time of the analog output, in accordance with 6.1.11.4, for both increasing and decreasing inputs if different, shall be specified in the accompanying documentation (see 5.2).

#### 4.11.5 Limiting value of the analog output signal

The output signal shall be limited to a maximum of twice the rated maximum output signal. For bipolar outputs, this shall apply in both directions.

When tested in accordance with 6.1.11.5 when the measurement is not between the lower and upper values represented by the maximum and minimum output signals, the meter shall not, under any conditions of operation except loss of auxiliary power, produce an output having a value between its maximum and minimum output signals.

#### 4.11.6 Pulse outputs

For those outputs, subclause 4.1 of IEC 62053-31 (functional requirements) shall apply.

## 5 Marking and operating instructions

Marking and operating instructions shall comply with IEC 61010 and IEC 61557-1, unless otherwise specified in this standard.

### 5.1 Marking

Marking requirements as defined in IEC 61010 shall apply. In addition, but not in contradiction, the following markings shall be clearly readable and indelible:

- wiring diagrams or Symbol 14 according to IEC 61010-1;
- if necessary, also inside the device, serial number, year of manufacturing or type designation.

### 5.2 Operating and installation instructions

Operating instructions defined in IEC 61010 shall apply. In addition, but not in contradiction, the following requirements apply:

#### 5.2.1 General characteristics

The following characteristics shall be documented:

- calibration period, if a calibration is necessary;
- the rated voltage in one of the following forms:
  - the number of active conductors of the connecting system if more than one, and the applicable voltage at the PMD terminals of the voltage circuit(s);
  - the nominal voltage of the system or the secondary voltage of the instrument transformer to which the PMD is intended to be connected;
- for direct connected PMD, the basic current ($I_b$) and the maximum current ($I_{max}$) expressed. For example: 10-40 A or 10(40) A for a PMD having a basic current of 10 A and a maximum current of 40 A;
- for current transformer-operated PMD, the rated secondary current ($I_n$) of the transformer(s) and the maximum secondary current ($I_{max}$) of the transformer which the PMD should be connected to. For example: /5 (6,5) A.
- for sensor-operated PMD, the main characteristics of the corresponding PMD input. For example: 1 V / 1 000 A;
- the rated frequency or frequency range in Hz;
- for energy measurement, the meter constant if any;
- start-up time, if it is longer than 15 s.

### 5.2.2 Essential characteristics

#### 5.2.2.1 Characteristics of PMD

Characteristics of the PMD shall be specified in a table as specified in Table 43 with the following items:

a) power quality assessment function (if any);

b) classification of PMD according to 4.3;

c) temperature according to 4.5.2.1 and 4.5.2.2;

d) humidity and altitude conditions according to 4.5.2.3;

e) active power or active energy function (if existing) performance class according to 4.7.1.

The sequence of function symbols shall be the following:

**Table 43 – PMD specification form**

| Type of characteristic | Examples of possible characteristic value | Other complementary characteristics |
|---|---|---|
| Power quality assessment function (if any) | -A or blank | |
| Classification of PMD according to 4.3 | SD or DS or DD or SS | |
| Temperature | K40 or K55 or K70 or Kx | |
| Humidity + altitude | Blank or extended values | |
| Active power or active energy function (if function available) performance class | 0,1 or 0,2 or 0,5 or 1 or 2 | |

NOTE It is strongly recommended that all items be listed, and only existing ones be specified.

#### 5.2.2.2 Characteristics of functions

Characteristics of functions of the PMD shall be specified in a table as specified in Table 44 with the following items:

a) function symbols as defined in Table 44;

b) function performance class according to this standard;

c) measuring range for the specified performance class;

d) other complementary characteristics.

The sequence of function symbols shall be the following:

**Table 44 – Characteristics specification template**

| function symbols | Function performance class according to IEC 61557-12 | Measuring range | Other complementary characteristics |
|---|---|---|---|
| $P$ | | | |
| $Q_A$, $Q_V$ | | | |
| $S_A$, $S_V$ | | | |
| $E_a$ | | | |
| $E_{rA}$, $E_{rV}$ | | | |
| $E_{apA}$, $E_{apV}$ | | | |
| $f$ | | | |
| $I$ | | | |
| $I_N$, $I_{Nc}$ | | | |
| $U$ | | | |
| $PF_A$, $PF_V$ | | | |
| $P_{st}$, $P_{lt}$ | | | |
| $U_{dip}$ | | | |
| $U_{swl}$ | | | |
| $U_{tr}$ | | | |
| $U_{int}$ | | | |
| $U_{nba}$ | | | |
| $U_{nb}$ | | | |
| $U_h$ | | | |
| $THD_u$ | | | |
| $THD\text{-}R_u$ | | | |
| $I_h$ | | | |
| $THD_i$ | | | |
| $THD\text{-}R_i$ | | | |
| $Msv$ | | | |

NOTE It is strongly recommended that all functions be listed, and only existing ones be specified.

### 5.2.2.3 Characteristics of "Power quality assessment functions"

Characteristics of the "power quality assessment functions" of the PMD shall be specified in a table as specified in Table 45 with the following items:

a) function symbols as defined in Table 45;

b) function performance class according to this standard;

c) measuring range for the specified performance class;

d) other complementary characteristics;

e) measurement method class according to IEC 61000-4-30.

The sequence of function symbols shall be the following:

**Table 45 – Characteristics specification template**

| function symbols | Function performance class according to IEC 61557-12 | Measuring range | Other complementary characteristics | Class acc. to IEC 61000-4-30 if any |
|---|---|---|---|---|
| $f$ | | | | |
| $I$ | | | | |
| $I_N$, $I_{Nc}$ | | | | |
| $U$ | | | | |
| $P_{st}$, $P_{lt}$ | | | | |
| $U_{dip}$ | | | | |
| $U_{swl}$ | | | | |
| $U_{int}$ | | | | |
| $U_{nba}$ | | | | |
| $U_{nb}$ | | | | |
| $U_h$ | | | | |
| $I_h$ | | | | |
| *Msv* | | | | |

NOTE It is strongly recommended that all functions be listed, and only existing ones be specified.

### 5.2.3 Safety characteristics

#### 5.2.3.1 Insulation between circuits

For safety reasons, accessible parts shall be defined and documented.

Manufacturer shall state the type of insulation according to IEC 61010 used between each independent circuit (e.g. basic insulation, double or reinforced insulation, etc. )

## 6 Tests

Measuring equipment shall be tested in accordance with IEC 61557-1 unless otherwise specified.

All tests shall be carried out under reference conditions unless otherwise specified. The reference conditions are stated in 4.5.1 of this standard.

### 6.1 Type tests of PMD

Type tests shall be executed to check the compliance with the requirements of 4.7, 4.6 and 4.5. For some of them, tests of the influence quantities on several functions can be combined if applicable (e.g. test of influence of temperature done on active power measurement can be done at the same time as those of voltage and current).

### 6.1.1 Test of temperature influence

The temperature coefficient shall be determined for the whole operating range. The operating temperature range shall be divided into 20 K wide ranges. The temperature coefficient shall then be determined for each of these ranges, by taking measurements 10 K above and 10 K below the middle of the range. During the test, the temperature shall be in no case outside the specified operating temperature range.

The indicated temperature coefficient shall be the greatest one.

### 6.1.2 Active power

#### 6.1.2.1 Influence of harmonics in current and voltage circuits

Test conditions shall be:

- fundamental frequency current: $I_1$ = 50 % of $I_{max}$;
- fundamental frequency voltage: $U_1 = U_n$;
- fundamental frequency power factor: 1;
- content of 5th harmonic voltage: $U_5$ = 10 % of $U_n$;
- content of 5th harmonic current: $I_5$= 40 % of $I_1$;
- harmonic power factor: 1;
- fundamental and harmonic voltages are in phase, at positive zero crossing;
- the total active power is $1,04 \times P_1 = 1,04 \times U_1 \times I_1$.

#### 6.1.2.2 Influence of odd harmonics in the current circuit

The peak value of the test waveform shall be equal to $\sqrt{2} \times I_b$ or to $\sqrt{2} \times I_n$.

The following current test waveform shall be generated:

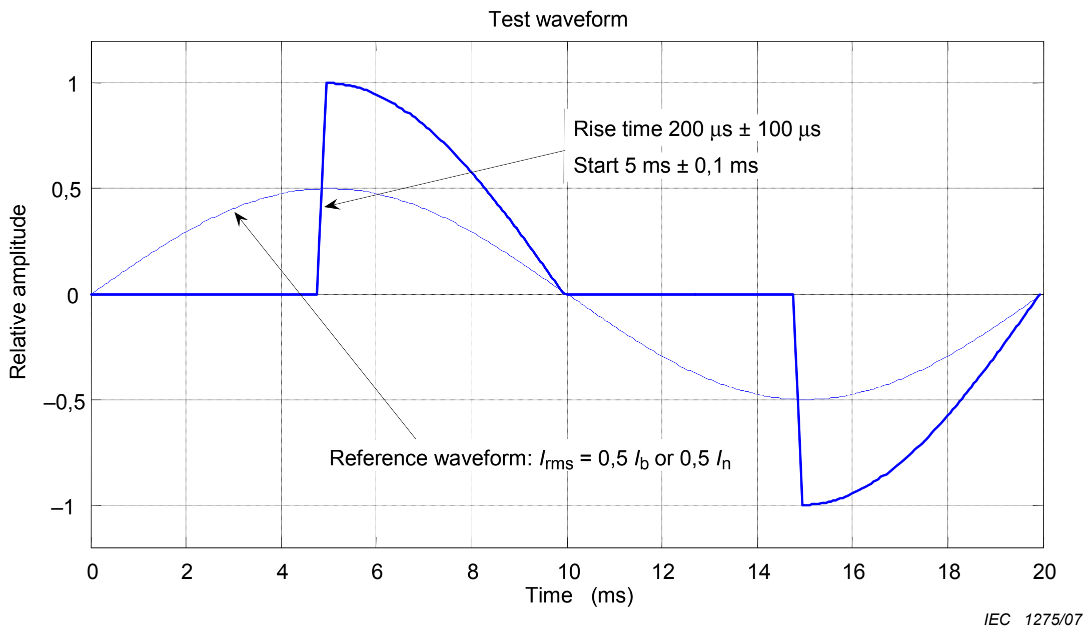



**Figure 4 – Waveform for odd harmonics influence test on active power measurement**

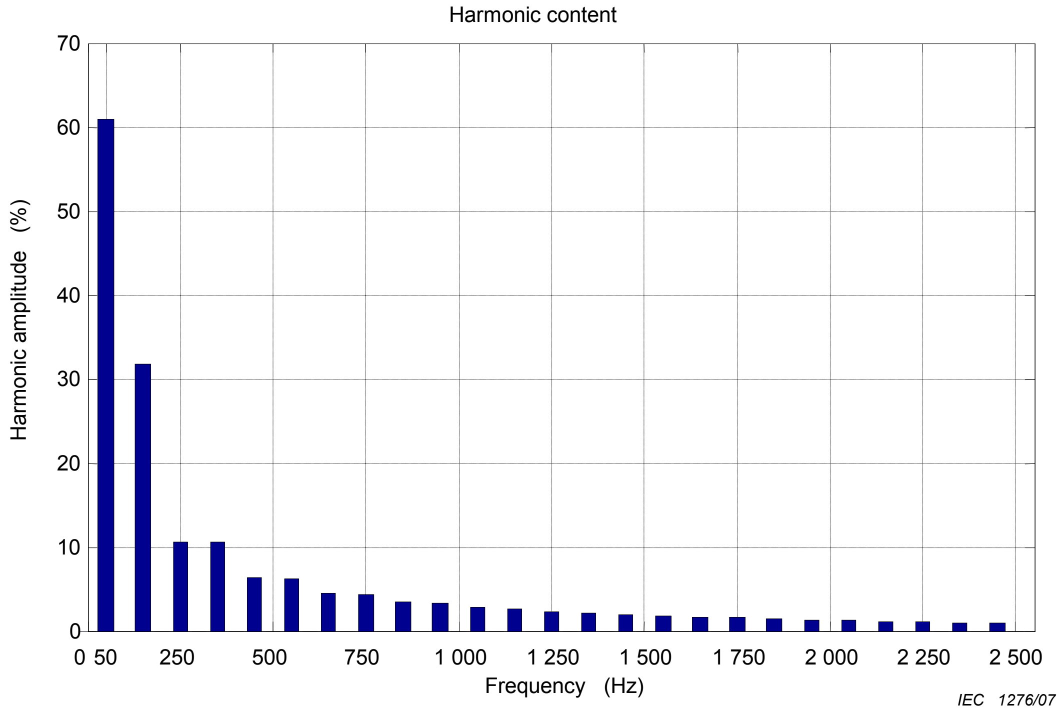



**Figure 5 – Spectral content for odd harmonics influence test on active power measurement**

NOTE 1 The reference waveform and the distorted waveform result in the same active power or active energy.

NOTE 2 The curve, diagram and values are given at 50 Hz. For other frequencies, they must be adapted accordingly.

### 6.1.2.3 Influence of sub-harmonics

The peak value shall be equal to $\sqrt{2} \times I_b$ or to $\sqrt{2} \times I_n$. Cycle of the signal is made of 2 full waves followed by 2 non-signal periods.

The following test waveform shall be generated:

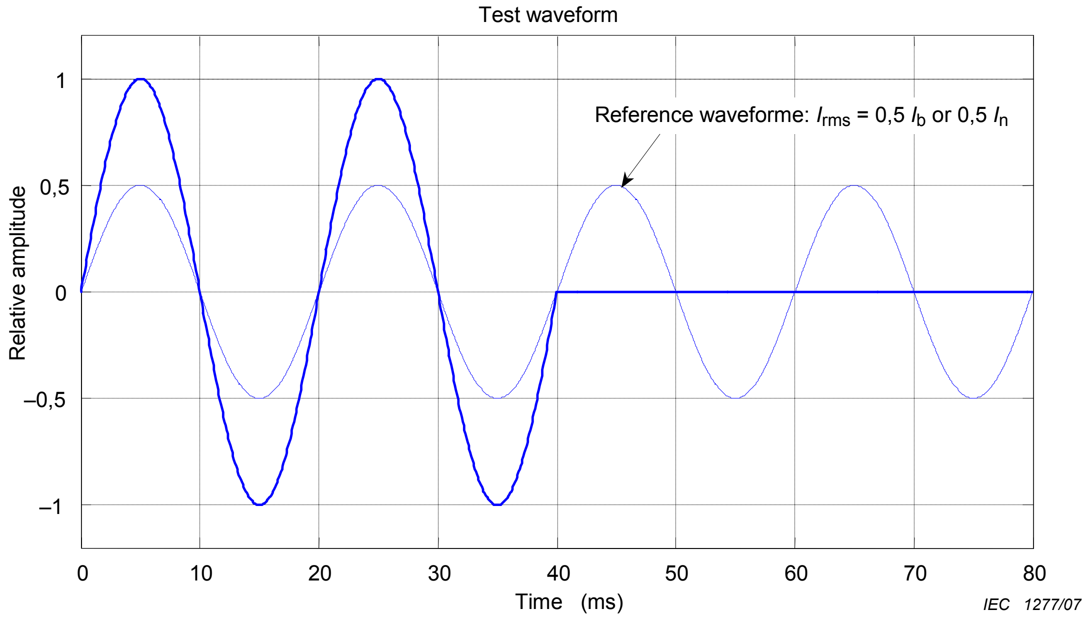



**Figure 6 – Waveform for sub-harmonics influence test on active power measurement**

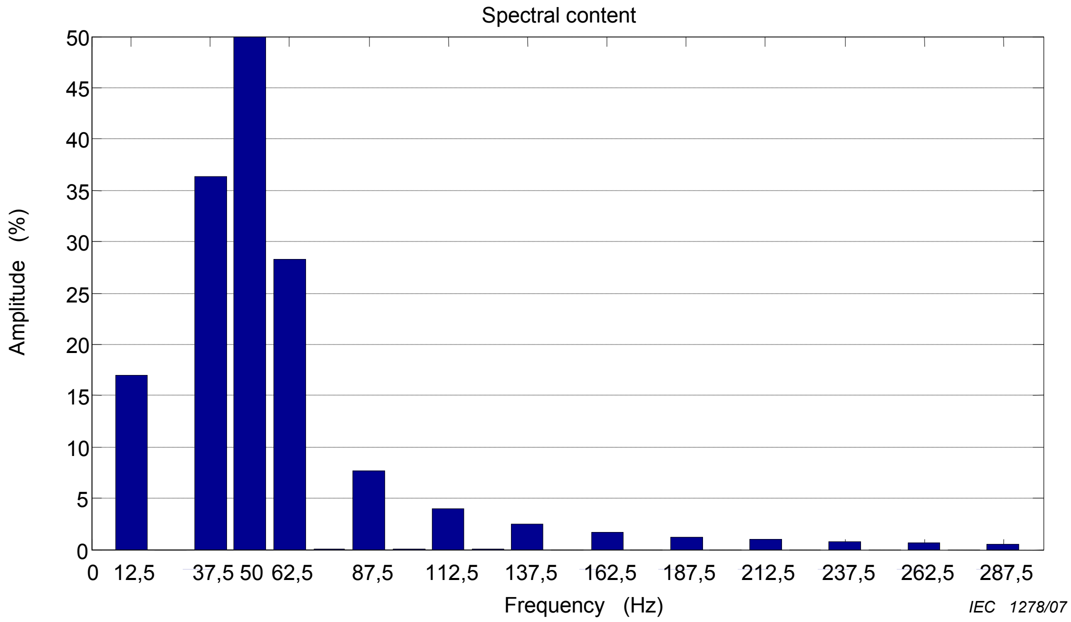



**Figure 7 – Spectral content for sub-harmonics influence test on active power measurement**

NOTE 1 The reference results in the same active power or active energy.

NOTE 2 The curve, diagram and values are given at 50 Hz. For other frequencies, they must be adapted accordingly.

### 6.1.3 Apparent power

Test on apparent power is not mandatory if two at least of the following functions are tested:

– active power;
– reactive power;
– power factor.

### 6.1.4 Power factor

Test on power factor is not mandatory if two at least of the following functions are tested:

– active power;
– reactive power;
– apparent power.

### 6.1.5 Common mode voltage rejection test

For each isolated current input, the following test (as described in Figure 8) shall be made. It consists in calculating the difference between two measurements, P1 without common mode voltage and P2 with a common mode voltage applied between the current inputs and the reference ground.

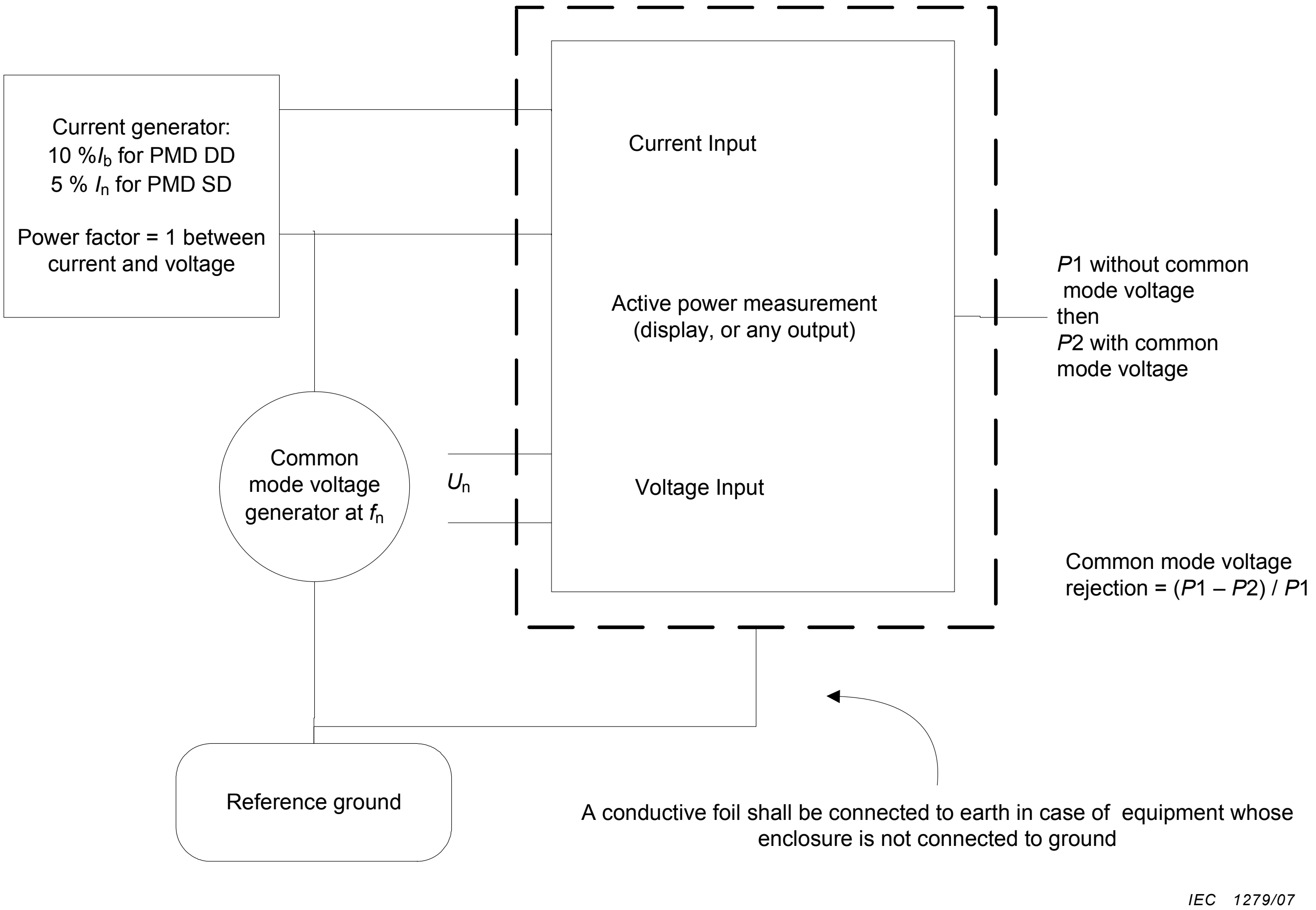



**Figure 8 – Common mode voltage influence testing**

### 6.1.6 Frequency

With the set-up of Table 17, the following waveform is generated:

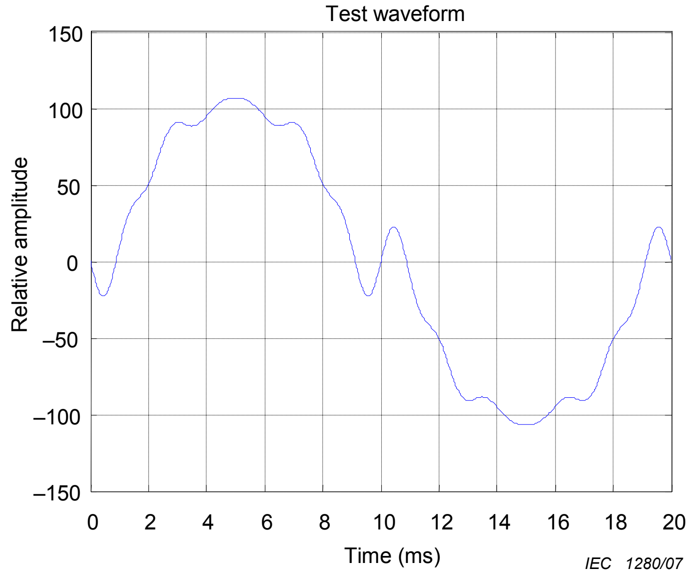



**Figure 9 – Waveform for harmonics influence test on frequency measurement**

NOTE 1 The relative amplitude is expressed in % of fundamental peak value.

NOTE 2 The curve is given at 50 Hz. For other frequencies, it must be adapted accordingly.

### 6.1.7 Measurement of voltage harmonics

The following tests shall be performed at rated voltage $U_n$ at 45 Hz, 50 Hz and 55 Hz for 50 Hz rated frequency, and at 55 Hz, 60 Hz and 65 Hz for 60 Hz rated frequency.

#### 6.1.7.1 Test with a sinusoidal waveform

Test shall be performed with a pure sinusoidal voltage waveform, with frequencies taken from 6.1.7. PMD shall not measure any voltage harmonics component with amplitude above $0{,}0015 \times C \times U_n$ ($C$ is the function performance class).

#### 6.1.7.2 Test with a square waveform

Test shall be performed with a square voltage waveform with frequencies taken from 6.1.7. PMD shall measure the voltage harmonics components within the uncertainty limits defined in Table 36.

The spectral content of the square waveform shall include at least the upper limit of the bandwidth specified in 4.7.13 without alteration.

### 6.1.8 Measurement of current harmonics

The following tests shall be performed at rated current $I_n$ or $I_b$ and at 45 Hz, 50 Hz and 55 Hz for 50 Hz rated frequency, and at 55 Hz, 60 Hz and 65 Hz for 60 Hz rated frequency.

#### 6.1.8.1 Test with a sinusoidal waveform

Test shall be performed with a pure sinusoidal current waveform, with frequencies taken from 6.1.8. PMD shall not measure any current harmonics component with amplitude above 0,005 × *C* x $I_n$ (or $I_b$). (*C* is the function performance class).

#### 6.1.8.2 Test with a square waveform

Test shall be performed with a square current waveform with frequencies taken from 6.1.8. PMD shall measure the current harmonics components within the uncertainty limits defined in Table 39.

The spectral content of the square waveform shall include at least the upper limit of the bandwidth specified in 4.7.14 without alteration.

### 6.1.9 Dips and swells

Tests shall at least be done with rectangular dip or swell modulation and with a dip or swell duration of one full cycle.

Test of the influence quantities can be omitted if this test has been done during the voltage r.m.s. measurements.

### 6.1.10 Voltage interruptions

Tests shall at least be done for a voltage interruption of one full cycle.

### 6.1.11 Outputs tests

#### 6.1.11.1 General

PMD shall be tested under reference conditions.

#### 6.1.11.2 Test of compliance voltage and effect of variation of load.

This test shall only be carried out on PMD with analogue outputs that are a current signal.

Testing shall be carried at the minimum and maximum (low and high) values of the analogue output. At each point the output load resistance shall be set at 10 % and 90 % of its specified maximum value:

– the supply voltage for the analogue output, if supplied from a source external to the PMD, shall be set to its minimum and maximum specified values;
– the supply of the PMD shall be set to its specified minimum and maximum values or in accordance with the rated voltage ±15%.

The worst case maximum and minimum readings at the low and high outputs shall be noted. The percentage uncertainty *E* shall be determined using the following equation:

$$E = \frac{N - W}{U} \times 100$$

where *N* is the rated signal, *W* is the worst case signal and *U* is the output span.

#### 6.1.11.3 Test of ripple content

The ripple content of the analogue output shall be tested at rated minimum and maximum values of the output. The ripple content shall be measured as a peak-to-peak value.

#### 6.1.11.4 Tests of analogue output response time

The response time for an increasing input shall be determined for an input step intended to produce a change in output signal from 0 % to 100 % of the output range as the time for the output to reach 90 % of the output range.

The response time for a decreasing input shall be determined for an input step intended to produce a change in output signal from 100 % to 0 % of the output range as the time for the output to reach 10 % of the output range.

#### 6.1.11.5 Test of limit value of analogue output

The limiting value of the analogue output shall be tested by varying the input parameter between minimum and maximum values. Any programmable features of the output, such as input offset or full-scale value, shall be set so as to provide the maximum overloads.

### 6.1.12 Climatic tests

After an appropriate recovering time after each climatic test, the PMD shall show no damage or change of the information and shall operate within its specifications.

#### 6.1.12.1 Dry heat test

The test shall be carried out according to IEC 60068-2-2, under the following conditions:

– PMD in non-operating condition;
– temperature: +70 °C ±2 °C for K40 PMD and K55 PMD,
  +85 °C ±2 °C for K70 PMD;
– duration of test: 16 h.

#### 6.1.12.2 Cold test

The test shall be carried out according to IEC 60068-2-1, under the following conditions:

– PMD in non-operating condition;
– temperature: –25 °C ±3 °C for K40 PMD and K55 PMD,
  –40 °C ±3 °C for K70 PMD;
– duration of test: 16 h.

#### 6.1.12.3 Damp heat cyclic test

The test shall be carried out according to IEC 60068-2-30, under the following conditions:

– voltage and auxiliary circuits energised with rated voltage;
– without any current in the current circuits;
– variant 1;
– upper temperature: +40 °C ±2 °C for K40 PMD,
  +55 °C ±2 °C for K55 PMD,
  +70 °C ±2 °C for K70 PMD;

- no special precautions shall be taken regarding the removal of surface moisture;
- duration of the test: 6 cycles.

The damp heat test also serves as a corrosion test. The result is judged visually. No trace of corrosion likely to affect the functional properties of the PMD shall be apparent.

#### 6.1.13 EMC tests

The PMD shall be tested in accordance with IEC 61326-1 Table 2 (industrial location).

For EM RF field and conducted RF the following requirements apply:

- auxiliary circuits of PMD shall be energised with the rated voltage;
- PMD shall be tested in their operating conditions with basic current $I_b$, respectively rated current $I_n$, rated voltage, power factor equal to 1 (or equal to 0 for reactive power) whichever is applicable.

Variations due to the EM influence quantities as defined in the previous tables (Limits of variation due to influence quantities) apply.

#### 6.1.14 Start up tests

Starting time of PMD without communication or local user interface shall be tested with the following procedure:

- configure PMD scales to maximum possible values without causing calculation overflows;
- set up kWh/pulse value to the minimum possible value;
- set up optical pick up probe or other pulse pick-up device; a solid state relay or a mechanical relay may be used as the energy pulse output device;
- power down the PMD;
- apply $U_{max}$ and $I_{max}$, PF=1,0 on all voltage and current measurement inputs;
- power up the PMD and measure time from the application of power until the first energy pulse registered by the probe.

### 6.2 Type tests of PMD-A

Tests shall be done according to Clause 6 of IEC 61000-4-30 and if necessary according to this standard.

### 6.3 Routine tests

#### 6.3.1 Protective bonding test

PMD shall be tested in accordance with Annex F of IEC 61010-1.

### 6.3.2 Dielectric strength test

PMD shall be tested in accordance with Annex F of IEC 61010-1.

### 6.3.3 Uncertainty test

Every basic measurement function (e.g. current, voltage, power, etc.), which is accessible to the user, shall be submitted to a routine test.

NOTE It is strongly recommended that the results of this test should be recorded.

# Annex A
(informative)

## Definitions of electrical parameters

This informative annex gives the preferred definition and method for calculating quantities. Manufacturers using other methods will have to specify their own method in technical documentation.

This informative annex cannot be considered as a requirement for PMD-A. See definitions for PMD-A in this standard which refer only to IEC 61000-4-30 concerning measuring aspects.

Table A.1 gives the list of symbols used in this annex. Table A.2 specifies how to calculate parameters.

**Table A.1 – Symbols definition**

| Symbol | Definition |
|---|---|
| $U_{resid}$ | Residual voltage |
| $N$ | Total number of samples by period (period 20 ms for instance) |
| $k$ | Number of sample in the period ($0 \le k < N$) |
| $p$ | Number of phase (*p* = 1, 2 or 3; or *p* = a, b, c; or *p* = r, s, t; or *p* = R, Y, B) [a] |
| $g$ | Number of phase (*g* = 1, 2 or 3; or *g* = a, b, c; or *g* = r, s, t; or *g* = R, Y, B) [a] |
| $i_{p_k}$ | Phase *p* current sampling number *k* |
| $v_{pN_k}$ | Phase *p* to Neutral voltage sampling number *k* |
| $v_{gN_k}$ | Phase *g* to Neutral voltage sampling number *k* |
| $\varphi_p$ | Phase angle between current and voltage for phase *p*, see Figure A.2 |
| $h_i$ | Harmonic component of rank *i* |

[a] *p* and *g* are variable meaning a number of phase.

**Table A.2 – Calculation definitions of electrical parameters, for 3 phase unbalanced system with neutral**

These methods are derived from IEEE Std 1459-2000:

| Item | Definition | Not relevant method |
|---|---|---|
| R.m.s current for phase *p* | $I_p = \sqrt{\dfrac{\sum_{k=0}^{N-1} ip_k^2}{N}}$ | |
| R.m.s neutral current | $I_N = \sqrt{\dfrac{\sum_{k=0}^{N-1} (i1_k + i2_k + i3_k)^2}{N}}$ | Vectorial sum of phase currents. |
| $L_{p\text{-}N}$ r.m.s. voltage | $V_{pN} = \sqrt{\dfrac{\sum_{k=0}^{N-1} vpN_k^2}{N}}$ | |
| $L_p$-$L_g$ r.m.s. voltage | $U_{pg} = \sqrt{\dfrac{\sum_{k=0}^{N-1} (vgN_k - vpN_k)^2}{N}}$ | Vectorial difference of line L voltage and neutral voltage: $U_{pg} = V_{pN} - V_{gN}$ |
| Active power for phase *p* | $P_p = \dfrac{1}{N} \cdot \sum_{k=0}^{N-1} (vpN_k \times ip_k)$ | |
| Apparent power for phase *p* | $S_p = V_{pN} \times I_p$ | |
| Sign of reactive power (*SignQ*) | $SignQ(\varphi_p) = +1 \; if \; \varphi_p \in [0° - 180°]$ [a]<br>$SignQ(\varphi_p) = -1 \; if \; \varphi_p \in [180° - 360°]$ [a] | |
| Reactive power for phase *p* | $Q_p = SignQ(\varphi_p) \times \sqrt{S_p^2 - P_p^2}$ | |
| Total active power | $P = P_1 + P_2 + P_3$ | |
| Total reactive power (vector) | $Q_V = Q_1 + Q_2 + Q_3$ | |
| Total apparent power (vector) | $S_V = \sqrt{P^2 + Q_V^2}$ | |
| Total apparent power (arithmetic) | $S_A = S_1 + S_2 + S_3$ | |
| Total reactive power (arithmetic) [b] | $Q_A = \sqrt{S_A^2 - P^2}$ [b] | |
| Power factor (vector) | $PF_V = \dfrac{P}{S_V}$ | |
| Power factor (arithmetic) | $PF_A = \dfrac{P}{S_A}$ | |

**Table A.2** *(continued)*

| Item | Definition | Not relevant method |
|---|---|---|
| Voltage dips | $U_{dip}(\%) = \frac{U_n - U_{resid}}{U_n}$ | |
| Voltage swells | $U_{swl}(\%) = \frac{U_{resid} - U_n}{U_n}$ | |
| Amplitude voltage unbalance | $U_{nba} = \frac{\max\{\lvert U_{12} - U_{avg}\rvert, \lvert U_{23} - U_{avg}\rvert, \lvert U_{31} - U_{avg}\rvert\}}{U_{avg}}$ where $U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3}$ | |
| Total Harmonic Distortion referring to r.m.s. value (*THD-R*$_u$ for voltage and *THD-R*$_i$ for current). | $THD-R(\%) = \frac{\sqrt{\sum_{i=2} h_i^2}}{\text{rms value}}$ r.m.s. value = $U_{rms}$ for *THD-R*$_u$ $I_{rms}$ for *THD-R*$_i$ | |
| total harmonic distortion referring to fundamental (*THD*$_u$ for voltage and *THD*$_i$ for current). | $THD(\%) = \frac{\sqrt{\sum_{i=2} h_i^2}}{h_1}$ | |
| [a] See Figure A.2. [b] This power is unsigned. | | |

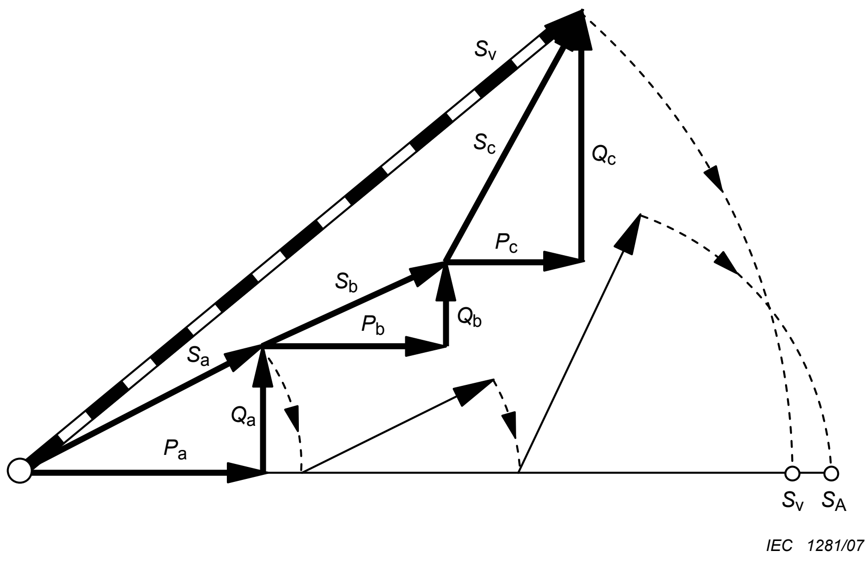
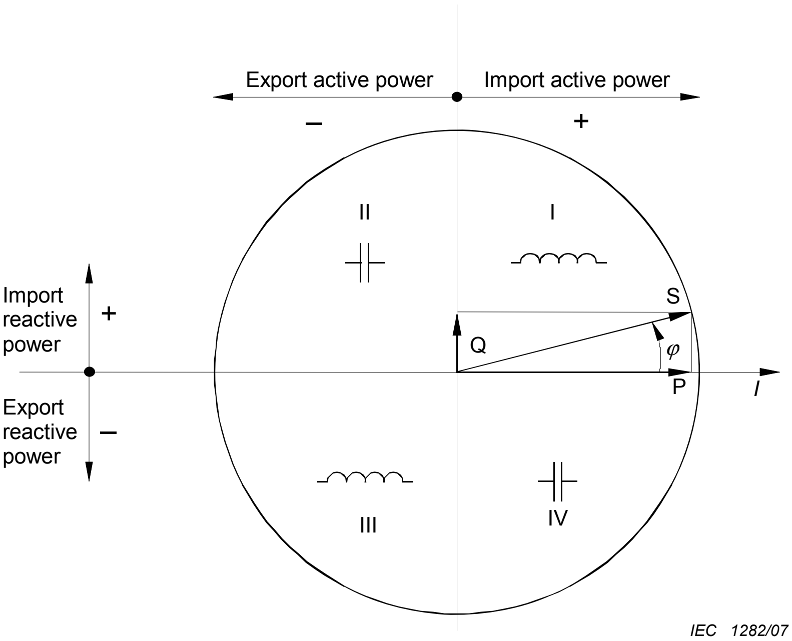



**Figure A.1 – Arithmetic and vector apparent powers in sinusoidal situation**




NOTE 1 Diagram in accordance with clauses 12 and 14 of IEC 60375.

NOTE 2 Reference of this diagram is the current vector (fixed on right-hand line).

NOTE 3 The voltage vector *V* varies its direction according to the phase angle φ.

NOTE 4 The phase angle φ between voltage *V* and current *I* is taken to be positive in the mathematical sense (counter clockwise)

**Figure A.2 – Geometric representation of active and reactive power**

# Annex B
(normative)

# Definitions of minimum, maximum, peak and demand values

## B.1 Demand quantities

A demand is the average value of a quantity over a specified period of time.

### B.1.1 Power demand

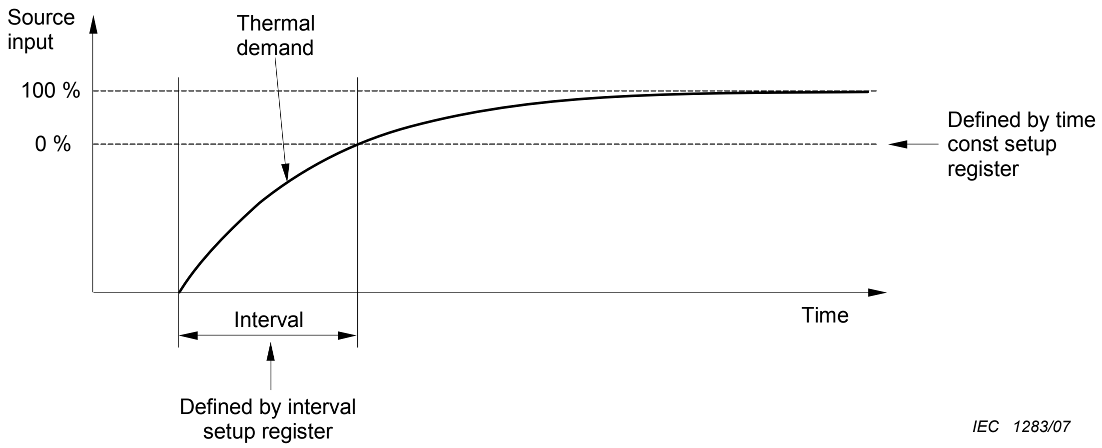
Power demand is calculated using arithmetical integration of power values during a period of time divided by the length of the period. The result is equivalent to the energy accumulated during the period of time divided by the length of the period.

### B.1.2 Current demand

Current demand is calculated using arithmetical integration of the current r.m.s. values during a period of time, divided by the length of the period.

### B.1.3 Thermal current demand (or bi-metal current demand)

Thermal current demand calculates the demand based on a thermal response, which mimics the analog thermal demand meters as described in Figure B.1.



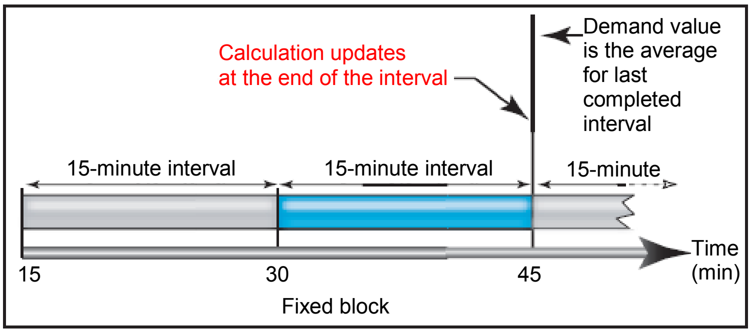

NOTE *n* value usually is 90 %, time interval usually is 15 min.

**Figure B.1 – Thermal current demand**

### B.1.4 Specified intervals for demand calculation

The PMD handle the intervals duration to calculate the demand. PMD can implement several methods:

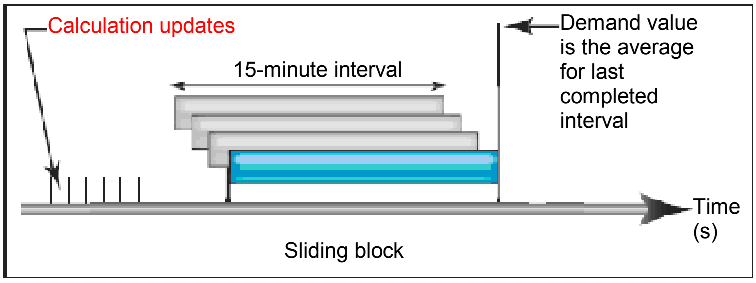
- fixed block interval: the intervals are consecutive; the PMD calculates and updates the demand at the end of each interval;




IEC 1284/07

NOTE 15 min is only an example.

- sliding block interval: the intervals are sliding; the PMD calculates and updates the demand at the sliding speed.




IEC 1285/07

NOTE 15 min is only an example.

### B.2 Peak demand quantities

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

### B.3 Three-phases average quantities

In a three or four wire system, the average value of a quantity is the arithmetical average of each phase value:

Example: 3-phase average line to neutral voltage = (*V1* r.m.s. voltage + *V2* r.m.s. voltage + *V3* r.m.s. voltage) / 3

### B.4 Maximum and minimum quantities

The maximum value of a quantity is the highest value measured or calculated since the beginning of the measurement or the last reset.

The minimum value of a quantity is the lowest value measured or calculated since the beginning of the measurement or the last reset.

# Annex C
(informative)

# Intrinsic uncertainty, operating uncertainty, and overall system uncertainty

Figure C.1 below describes different kind of uncertainties:

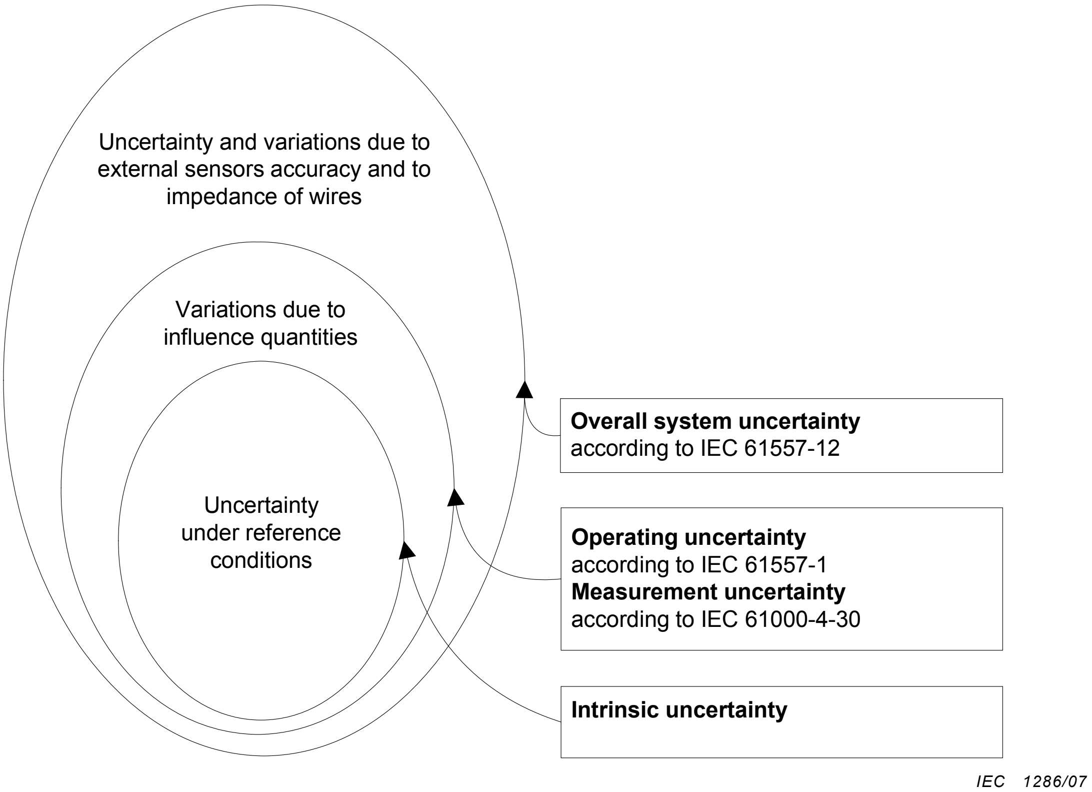



**Figure C.1 – Different kind of uncertainties**

## C.1 Operating uncertainty

Operating uncertainty shall include intrinsic uncertainty (under reference conditions) and variation due to influence quantities.

$$\text{Operating uncertainty} = \left|\text{Intrinsic uncertainty}\right| + 1{,}15 \times \sqrt{\sum_{i=1}^{N} (\text{variation due to influence quantities})^2}$$

with $N$ = number of influence quantities.

## C.2 Overall system uncertainty

Overall system uncertainty shall include operating uncertainty, uncertainty due to impedance of wires and uncertainty due to sensors.

For PMD DD: Overall system uncertainty = operating uncertainty

For PMD xS and PMD Sx: The formula given below is a simplified approach, and applies only to voltage, current, active power and active energy measurements:

$$\text{Overall system uncertainty} = 1{,}15 \times \sqrt{(\text{PMD operating uncertainty})^2 + \sum_{i=1}^{N}(\text{sensoruncertainty} + \text{wirings uncertainty})^2}$$

with $N$ = number of kind of external sensors (voltage or current).

NOTE $N$ = 1 when only a current (or voltage) sensor is used, $N$ = 2 when a current sensor and a voltage sensor are used.

# Annex D
(informative)

# Recommended sensor classes for the different kinds of PMD

## D.1 General considerations

The association of a PMD Sx, PMD xS or PMD SS with external current and/or voltage sensors builds a complete system. The system performance class depends on the sensor class and the PMD performance class (See Clauses D.2 and D.3 for evaluation of the system performance class).

However, this system performance class is only applicable for the range where the sensor intrinsic uncertainty is within the limit of its performance class, and is not equivalent to the performance class of a PMD DD. Current sensors that comply with IEC 60044-1 for example, have only a limited specified range compared to a PMD DD of the same performance class.

Special considerations must be taken for power and energy measurements, because phase error of the sensor affects the measurements for non unity power factor: a phase error of 20 min adds 1 % error for active power measurement at PF = 0,5.

For this reason, if improved performance class is required, it is strongly recommended to use class 0,2S or class 0,5S sensors for power or energy measurement.

## D.2 PMD with external current sensor or voltage sensor

Table D.1 gives some recommendations when associating a PMD with an external sensor.

**Table D.1 – PMD SD associated to current sensor or PMD DS associated to voltage sensor**

| Performance class of the PMD without external sensors | Recommended sensor class to associate to the PMD [b c] | Expected performance class for PMD-Sx or PMD-xS including their external sensors | maximum possible sensor class to associate to the PMD [a] |
|---|---|---|---|
| 0,1 | 0,1 or below | 0,2 | 0,2 |
| 0,2 | 0,2 or below | 0,5 | 0,5 |
| 0,5 | 0,5 or below | 1 | 1 |
| 1 | 1 or below | 2 | 2 |
| 2 | 2 or below | 5 | 5 |
| 5 | 5 or below | 10 | |

[a] This induces an acceptable loss of performance of the system.

[b] For power and energy measurements 0,2 S and 0,5 S class sensors are usually required.

[c] Class sensor refers to classes defined in IEC 60044-1, IEC 60044-2, IEC 60044-7 and IEC 60044-8. When transducers replace sensors, class sensor refers to intrinsic uncertainty of the transducer.

Overall system performance class =

$$1{,}15 x \sqrt{Class(sensor)^2 + \text{Performance class(PMD SS)}^2}$$

NOTE In a three-phase system, the class of the three sensors is equal to the class of one sensor provided that the three sensors have the same class.

The overall system performance class is rounded up to the closest standard default value (see Table D.4).

For example, a class 1 PMD and a class 1 CS will give an overall system performance class equivalent to class 2.

## D.3 PMD with external current sensor and voltage sensor

Table D.2 gives some recommendations when associating a PMD with an external current sensor and an external voltage sensor.

**Table D.2 – PMD SS with current sensor and voltage sensor association**

| Performance class of the PMD without external sensors | Recommended sensor class to associate to the PMD [b c] | Expected performance class for PMD-SS including their external sensors | maximum possible sensor class to associate to the PMD [a] |
|---|---|---|---|
| 0,1 | 0,1 or below | 0,2 | 0,2 |
| 0,2 | 0,2 or below | 0,5 | 0,5 |
| 0,5 | 0,5 or below | 1 | 1 |
| 1 | 1 or below | 2 | 2 |
| 2 | 2 or below | 5 | 5 |
| 5 | 5 or below | 10 | |

a This induces an acceptable loss of performance of the system.

b For power and energy measurements, 0,2 S and 0,5 S class sensors are usually required.

c Class sensor refers to classes defined in IEC 60044-1, IEC 60044-2, IEC 60044-7 and IEC 60044-8. When transducers replace sensors, class sensor refers to intrinsic uncertainty of the transducer.

Overall system performance class =

$$1{,}15 x \sqrt{Class(current\_sensor)^2 + Class(voltage\_sensor)^2 + \text{Performance class(PMD SS)}^2}$$

NOTE In a three-phase system, the class of the three sensors is equal to the class of one sensor provided that the three sensors have the same class.

The system performance class is rounded up to the closest standard default value (see Table D.4).

For example, a class 1 PMD with a class 0,5 CS and a class 0,5 VS will give a system performance class equivalent to class 2.

## D.4 Range of applicable performance classes

Each applicable performance class for each specific function of PMD is given in Clause 0 of this standard.

Table D.3 gives a summary of all applicable performance classes.

**Table D.3 – Range of applicable performance classes for PMD without its associated external sensors**

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

Table D.4 gives the list of applicable performance classes resulting from the calculations given in Clauses D.2 and D.3.

**Table D.4 – Range of applicable performance classes when calculating performance class of PMD with its associated external sensors**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,2 | 0,3 | 0,5 | 0,75 | 1 | 1,5 | 2 | 2,5 | 3 | 5 | 7,5 | 10 | 15 | 20 |

## D.5 List of functions affected by uncertainty of external sensors

Table

D.5 defines the influence of each kind of sensor on each function of a PMD.

**Table D.5 – List of functions affected by uncertainty of external sensors**

| Symbol | Function | Current sensor | Voltage sensor |
|---|---|---|---|
| $P_a$ | Total active power | x | x |
| $Q_A$, $Q_V$ | Total reactive power (arithmetic or vector) | x | x |
| $S_A$, $S_V$ | Total apparent power (arithmetic or vector) | x | x |
| $E_a$ | Total active energy | x | x |
| $E_{rA}$, $E_{rV}$ | Total reactive energy (arithmetic or vector) | x | x |
| $E_{apA}$, $E_{apV}$ | Total apparent energy (arithmetic or vector) | x | x |
| $f$ | Frequency | - | - |
| $I$ | Phase current | x | - |
| $I_N$, $I_{Nc}$ | Neutral current (measured, calculated) | x | - |
| $U$ | Voltage ($L_p$-$L_g$ or $L_p$-N) | - | x |
| $PF_A$, $PF_V$ | Power factor (arithmetic, vector) | x | x |
| $P_{st}$, $P_{lt}$ | Flicker (short term, long term) | - | - |
| $U_{dip}$ | Voltage dips ($L_p$-$L_g$ or $L_p$-N) | - | x |
| $U_{swl}$ | Voltage swells ($L_p$-$L_g$ or $L_p$-N) | - | x |
| $U_{int}$ | Voltage Interruption ($L_p$-$L_g$ or $L_p$-N) | - | x |
| $U_{nba}$ | Voltage Unbalance amplitude ($L_p$-N) | - | x |
| $U_{nb}$ | Voltage Unbalance phase and amplitude ($L_p$-$L_g$ or $L_p$-N) | - | x |
| $U_h$ | Voltage harmonics | - | x |
| $THD_u$, $THD\text{-}R_u$ | Voltage THD (refered to fundamental, refered to r.m.s. value) | - | x |
| $I_h$ | Current harmonics | x | - |
| $THD_i$ $THD\text{-}R_i$ | Current THD (refered to fundamental, refered to r.m.s. value) | x | - |
| $Msv$ | Mains signalling voltage | - | x |
| NOTE "x" means "affects the function", "-" means “does not affect the function” | | | |

# Annex E
(normative)

## Requirements applicable to PMD and to PMD-A

Table E.1 gives a summary of all applicable requirements for each kind of PMD.

**Table E.1 – Requirements applicable to PMD and to PMD-A**

| | **Requirements applicable to PMD including PMD-A** | **Requirements applicable to PMD except PMD-A** | **Requirements applicable to PMD-A only** |
|---|---|---|---|
| Scope | Clause 1 | | |
| Normative references | Clause 2 | | |
| Definitions | Clause 3 | | |
| General requirements | Subclause 4.1<br>Subclause 4.2<br>Subclause 4.3<br>Subclause 4.4<br>Subclause 4.5<br>Subclause 4.6 | | |
| Performance requirements | | Subclause 4.7 | Subclause 4.8 |
| Mechanical requirements | Subclause 4.9 | | |
| Safety requirements | Subclause 4.10 | | |
| Analog outputs | Subclause 4.11 | | |
| Marking and operating instruction | Clause 5 | | |
| Type test | Subclause 6.1.14 | Subclause 6.1 | Subclause 6.2 |
| Climatic tests | Subclause 6.1.12 | | |
| EMC tests | Subclause 6.1.13 | | |
| Routine Test | Subclause 6.3 | | |
| Definitions of electrical parameters | | Annex A | |
| Definitions of minimum, maximum, peak and demand measurements | | Annex B | |
| Intrinsic uncertainty, operating uncertainty, and overall system uncertainty | Annex C | | |
| Recommended sensors classes for the different kind of PMD | Annex D | | |

# Bibliography

IEC 60044-1:1996, *Instrument transformers – Part 1: Current transformers*

NOTE Harmonized as EN 60044-1:1999 (modified).

IEC 60044-2:1997, *Instrument transformers – Part 2: Inductive voltage transformers*

NOTE Harmonized as EN 60044-2:1999 (modified).

IEC 60044-7:1999, *Instrument transformers – Part 7: Electronic voltage transformers*

NOTE Harmonized as EN 60044-7:2000 (not modified).

IEC 60044-8:2002, *Instrument transformers – Part 8: Electronic current transformers*

NOTE Harmonized as EN 60044-8:2002 (not modified).

IEC 60050-131:2002, *International Electrotechnical Vocabulary – Part 131: Circuit theory*

IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

IEC 60050-300:2001, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 60050-551-20: *International Electrotechnical Vocabulary – Part 551-20: Power electronics – Harmonic analysis*

IEC 60050-601:1985, *International Electrotechnical Vocabulary – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60050-604:1987, *International Electrotechnical Vocabulary – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules*

NOTE Harmonized as EN 60071-1:2006 (not modified).

IEC 60359:2001, *Electrical and electronic measurement equipment – Expression of performance*

NOTE Harmonized as EN 60359:2002 (not modified).

IEC 60364-5-52:2001, *Electrical installations of buildings – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

NOTE Harmonized as EN 61000-4-7:2002 (not modified).

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*

NOTE Harmonized as EN 61140:2002 (not modified).

IEC 61010-2-030:___ [1], *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Special requirements for testing and measuring circuits*

IEC 62052-11:2003, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*

NOTE Harmonized as EN 62052-11:2003 (not modified).

IEEE 1459-2000: *IEEE Standard Definitions for the Measurement of Electric Power Quantities Under Sinusoidal, Nonsinusoidal, Balanced, or Unbalanced Conditions*

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[1] In preparation.

## Annex ZA
(normative)

## Normative references to international publications with their corresponding European publications

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.

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

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 60068-2-1 | - [1] | Environmental testing - Part 2-1: Tests - Test A: Cold | EN 60068-2-1 | 2007 [2] |
| IEC 60068-2-2 | - [1] | Environmental testing - Part 2-2: Tests - Test B: Dry heat | EN 60068-2-2 | 2007 [2] |
| IEC 60068-2-30 | - [1] | Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) | EN 60068-2-30 | 2005 [2] |
| IEC 60364-6 (mod) | - [1] | Low voltage electrical installations - Part 6: Verification | HD 60364-6 | 2007 [2] |
| IEC 60529 | - [1] | Degrees of protection provided by enclosures (IP Code) | EN 60529<br>+ corr. May | 1991 [2]<br>1993 |
| IEC 61000-4-5 | - [1] | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test | EN 61000-4-5 | 2006 [2] |
| IEC 61000-4-15 | - [1] | Electromagnetic compatibility (EMC) - Part 4-15: Testing and measurement techniques - Flickermeter - Functional and design specifications | EN 61000-4-15 | 1998 [2] |
| IEC 61000-4-30 | 2003 | Electromagnetic compatibility (EMC) - Part 4-30: Testing and measurement techniques - Power quality measurement methods | EN 61000-4-30 | 2003 |
| IEC 61010 | Series | Safety requirements for electrical equipment for measurement, control, and laboratory use | EN 61010 | Series |
| IEC 61010-1 | 2001 | Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements | EN 61010-1<br>+ corr. June | 2001<br>2002 |
| IEC 61326-1 | 2005 | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements | EN 61326-1 | 2006 |
| IEC 61557-1 | 2007 | 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 1: General requirements | EN 61557-1 | 2007 |

[1] Undated reference.
[2] Valid edition at date of issue.

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 62053-21 | 2003 | Electricity metering equipment (a.c.) - Particular requirements - Part 21: Static meters for active energy (classes 1 and 2) | EN 62053-21 | 2003 |
| 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) | EN 62053-22 | 2003 |
| IEC 62053-23 | 2003 | Electricity metering equipment (a.c.) - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3) | EN 62053-23 | 2003 |
| IEC 62053-31 | 1998 | Electricity metering equipment (a.c.) - Particular requirements - Part 31: Pulse output devices for electromechanical and electronic meters (two wires only) | EN 62053-31 | 1998 |

## Annex ZZ
(informative)

### Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Annex I of the EC Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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