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# Electricity metering equipment (a.c.) —

Part 3: Particular requirements —  
Static meters for active energy (class  
indexes A, B and C)

The European Standard EN 50470-3:2006 has the status of a  
British Standard

ICS 91.140.50





## National foreword

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EUROPEAN STANDARD

**EN 50470-3**

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English version

**Electricity metering equipment (a.c.)  
Part 3: Particular requirements -  
Static meters for active energy  
(class indexes A, B and C)**

Équipement de comptage  
d'électricité (c.a.)  
Partie 3: Prescriptions particulières -  
Compteurs statiques d'énergie active  
(classes de précision A, B et C)

Wechselstrom-Elektrizitätszähler  
Teil 3: Besondere Anforderungen -  
Elektronische Wirkverbrauchszähler  
der Genauigkeitsklassen A, B und C

This European Standard was approved by CENELEC on 2006-05-01. 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.

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**CENELEC**

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

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

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## Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 13, Equipment for electrical energy measurement and load control.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50470-3 on 2006-05-01.

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) 2007-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2009-05-01

This EN 50470-3 is related to:

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

The structure of the standards is similar, modifications in this European Standard are provided in the perspective of compliance with the Essential Requirements of the Directive 2004/22/EC on Measuring Instruments (MID).

This standard is to be used with EN 50470-1:2006, *Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C)*.

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 2004/22/EC. See Annex ZZ.

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## 1 Scope

This European Standard applies to newly manufactured static watt-hour meters intended for residential, commercial and light industrial use, of class indexes A, B and C, for the measurement of alternating current electrical active energy in 50 Hz networks. It specifies particular requirements and type test methods.

It applies to static watt-hour meters for indoor and outdoor application, consisting of a measuring element and register(s) enclosed together in a meter case. It also applies to operation indicator(s) and test output(s).

If the meter has (a) measuring element(s) for more than one type of energy (multi-energy meters), or when other functional elements, like maximum demand indicators, electronic tariff registers, time switches, ripple control receivers, data communication interfaces etc. are enclosed in the meter case (multi-function meters) then this standard applies only for the active energy metering part.

This standard distinguishes between:

- meters of class indexes A, B and C;
- direct connected and transformer operated meters;
- meters for use in networks equipped with or without earth fault neutralizers.

It does not apply to:

- watt-hour meters where the voltage across the connection terminals exceeds 600 V (line-to-line voltage for meters for polyphase systems);
- portable meters;
- reference meters.

Methods for acceptance testing are covered by the IEC 62058 series of standards <sup>1)</sup>.

The dependability aspect is covered by the documents of the IEC 62059 series.

## 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.

| Publication | Year | Title  |
|-------------|------|--|
| EN 50470-1  | 2006 | <i>Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C)</i> |
| EN 62059-41 | 2006 | <i>Electricity metering equipment – Dependability – Part 41: Reliability prediction (IEC 62059-41:2006)</i>  |

## 3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in EN 50470-1 apply.

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<sup>1)</sup> At draft stage.

#### 4 Standard electrical values

The values given in EN 50470-1 apply.

#### 5 Mechanical requirements

The requirements given in EN 50470-1 apply.

#### 6 Climatic conditions

The conditions given in EN 50470-1 apply.

#### 7 Electrical requirements

In addition to the electrical requirements in EN 50470-1, meters shall fulfil the following requirements.

##### 7.1 Power consumption

###### 7.1.1 Measurement method

The power consumption in the voltage and current circuits shall be determined at reference conditions given in 8.7.1 by any suitable method. The overall maximum error of the measurement of the power consumption shall not exceed 5 %.

###### 7.1.2 Voltage circuits

The active and apparent power loss in each voltage circuit of a meter at reference voltage, reference temperature and reference frequency shall not exceed the values shown in Table 1.

**Table 1 – Power consumption in voltage circuits**

| Meters<br>(single- and polyphase)   | Power supply<br>connected to the<br>voltage circuits | Power supply not<br>connected to the voltage<br>circuits |
|---|--|--|
| Power consumption in voltage circuit  | 2 W and 10 VA  | 0,5 VA   |
| Power consumption of auxiliary power<br>supply  | --   | 10 VA  |
| NOTE 1 In order to match voltage transformers to meters, the meter manufacturer should state the power factor of the burden (for transformer operated meters only).   |  |  |
| NOTE 2 The above figures are mean values. Switching power supplies with peak power values in excess of these specified values are permitted, but it should be ensured that the rating of associated voltage transformers is adequate. |  |  |
| NOTE 3 For multifunctional meters see EN 62053-61.  |  |  |

###### 7.1.3 Current circuits

The apparent power taken by each current circuit of a meter at reference current, reference frequency and reference temperature shall not exceed the values shown in Table 2.

**Table 2 – Power consumption in current circuits**

| Meters,<br>(single- and polyphase) | Test current          | Class index |        |        |
|------------------------------------|-----------------------|-------------|--------|--------|
|                                    |                       | A           | B      | C      |
| Direct connected                   | $I_{ref} = 10 I_{tr}$ | 2,5 VA      | 4,0 VA | 4,0 VA |
| Transformer operated               | $I_n$                 | 1,0 VA      | 1,0 VA | 1,0 VA |

NOTE In order to match current transformers to meters, the meter manufacturer should state the power factor of the burden (for transformer operated meters only).

**7.2 AC voltage test**

The a.c. voltage test shall be carried out in accordance with Table 3.

The test voltage shall be substantially sinusoidal, having a frequency between 45 Hz and 65 Hz, and applied for 1 min. The power source shall be capable of supplying at least 500 VA.

For the tests relative to earth, the auxiliary circuits with reference voltage equal to or below 40 V shall be connected to earth.

All tests shall be carried out with the case closed and the cover and terminal cover(s) in place.

During this test no flashover, disruptive discharge or puncture shall occur.

**Table 3 – AC voltage tests**

| Test | Applicable to                 | Test voltage<br>r.m.s. | Points of application of the test voltage  |
|------|-------------------------------|------------------------|--|
| A    | Protective class I<br>meters  | 2 kV                   | a) Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth. |
|      |                               | 2 kV                   | b) Between circuits not intended to be connected together in service.  |
| B    | Protective class II<br>meters | 4 kV                   | a) Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth. |
|      |                               | 2 kV                   | b) Between circuits not intended to be connected together in service.  |

**8 Accuracy requirements and tests**

**8.1 Limits of percentage error due to variation of the load**

When the meter is under reference conditions given in 8.7.1, and the current and the power factor are varied, the percentage errors shall not exceed the limits specified for the relevant class indexes in Table 4 and Table 5.

If the meter is designed for the measurement of energy in both directions, the values in Table 4 and Table 5 shall apply for each direction.

**Table 4 – Percentage error limits at reference conditions  
(single-phase meters and polyphase meters with balanced loads)**

| Value of current<br>for direct connected or transformer<br>operated meters | Power factor          | Percentage error limits<br>for meters of class index |       |       |
|--|-----------------------|--|-------|-------|
|  |                       | A  | B     | C     |
| $I_{\min} \leq I < I_{tr}$   | 1                     | ± 2,5  | ± 1,5 | ± 1,0 |
| $I_{tr} \leq I \leq I_{\max}$  | 0,5 ind...1...cap 0,8 | ± 2,0  | ± 1,0 | ± 0,5 |

NOTE For the relationships  $I_{\min} / I_{tr}$  and  $I_{\max} / I_{tr}$  see EN 50470-1, Table 3.

**Table 5 – Percentage error limits at reference conditions  
(polyphase meters carrying a single-phase load,  
but with balanced polyphase voltages applied to voltage circuits)**

| Value of current<br>for direct connected or transformer<br>operated meters | Power factor | Percentage error limits<br>for meters of class index |       |       |
|--|--------------|--|-------|-------|
|  |              | A  | B     | C     |
| $I_{tr} \leq I \leq I_{\max}$  | 0,5 ind...1  | ± 3,0  | ± 2,0 | ± 1,0 |

NOTE For the relationship  $I_{\max} / I_{tr}$  see EN 50470-1, Table 3.

The difference between the percentage error when the meter is carrying a single-phase load and a balanced polyphase load at  $I_{ref}$  and unity power factor shall not exceed 2,5 %, 1,5 % and 1 % for class indexes A, B and C respectively.

## 8.2 Repeatability

The application of the same measurand under the same conditions of measurement shall result in the close agreement of successive measurements. The repeatability at any test point given in Table 13 shall be better than  $1/10^{th}$  of the limit of percentage error at reference conditions. The manufacturer shall state the necessary number of pulses.

## 8.3 Limits of additional percentage error due to influence quantities

When the current and the power factor are held constant at a point within their respective specified measuring ranges, and any single influence quantity is taken from its reference value and varied within its specified operating range, with the meter otherwise operated at reference conditions as specified in 8.7.1, the additional percentage error shall not exceed the limits specified for the relevant class indexes given in Table 6 and Table 7.

Concerning additional percentage error due to temperature variation, the requirements for each sub-range within the full temperature range specified by the manufacturer apply.

NOTE For example, if the manufacturer specifies that the meter is intended for the temperature range -10 °C to + 40 °C, then the requirements for the sub-ranges 5 °C to 30 °C, -10 °C to 5 °C and 30 °C to 40 °C apply.

**Table 6 – Limits of additional percentage error due to influence quantities (single-phase meters and polyphase meters with balanced loads)**

| Influence quantity        | Value of current for direct connected or transformer operated meters | Power factor     | Limits of additional percentage error for meters of class index |       |       |
|---------------------------|--|------------------|---|-------|-------|
|                           |  |                  | A   | B     | C     |
| Temperature variation     |  |                  |   |       |       |
| 5 °C to 30 °C             | $I_{min} \leq I \leq I_{max}$  | 1                | ± 1,8   | ± 0,9 | ± 0,5 |
|                           | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 2,7   | ± 1,3 | ± 0,9 |
| -10 °C to 5 °C            | $I_{min} \leq I \leq I_{max}$  | 1                | ± 3,3   | ± 1,6 | ± 1,0 |
|                           | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 4,9   | ± 2,3 | ± 1,6 |
| 30 °C to 40 °C            | $I_{min} \leq I \leq I_{max}$  | 1                | ± 4,8   | ± 2,4 | ± 1,4 |
|                           | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 7,2   | ± 3,4 | ± 2,4 |
| -25 °C to -10 °C          | $I_{min} \leq I \leq I_{max}$  | 1                | ± 6,3   | ± 3,1 | ± 1,9 |
|                           | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 9,4   | ± 4,4 | ± 3,1 |
| 40 °C to 55 °C            | $I_{min} \leq I \leq I_{max}$  | 1                | ± 1,0   | ± 0,7 | ± 0,2 |
|                           |  |                  |   |       |       |
| Voltage variation ± 10 %  | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 1,5   | ± 1,0 | ± 0,4 |
|                           | $I_{min} \leq I \leq I_{max}$  | 1                | ± 0,8   | ± 0,5 | ± 0,2 |
| Frequency variation ± 2 % | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind, 0,8 cap | ± 1,0   | ± 0,7 | ± 0,2 |

NOTE For the relationships  $I_{min} / I_{tr}$  and  $I_{max} / I_{tr}$  see EN 50470-1, Table 3.

**Table 7 – Limits of additional percentage error due to influence quantities (polyphase meters carrying a single phase load, but with balanced polyphase voltages applied to voltage circuits)**

| Influence quantity        | Value of current for direct connected or transformer operated meters | Power factor | Limits of additional percentage error for meters of class index |       |       |
|---------------------------|--|--------------|---|-------|-------|
|                           |  |              | A   | B     | C     |
| Temperature variation     |  |              |   |       |       |
| 5 °C to 30 °C             | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 1,8   | ± 0,9 | ± 0,5 |
|                           |  | 0,5 ind      | ± 2,7   | ± 1,3 | ± 0,9 |
| -10 °C to 5 °C            | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 3,3   | ± 1,6 | ± 1,0 |
|                           |  | 0,5 ind      | ± 4,9   | ± 2,3 | ± 1,6 |
| 30 °C to 40 °C            | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 4,8   | ± 2,4 | ± 1,4 |
|                           |  | 0,5 ind      | ± 7,2   | ± 3,4 | ± 2,4 |
| -25 °C to -10 °C          | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 6,3   | ± 3,1 | ± 1,9 |
|                           |  | 0,5 ind      | ± 9,4   | ± 4,4 | ± 3,1 |
| 40 °C to 55 °C            | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 1,5   | ± 1,0 | ± 0,3 |
|                           |  | 0,5 ind      | ± 2,0   | ± 1,5 | ± 0,5 |
| Voltage variation ± 10 %  | $I_{tr} \leq I \leq I_{max}$   | 1            | ± 1,0   | ± 0,7 | ± 0,3 |
|                           |  | 0,5 ind      | ± 1,3   | ± 1,0 | ± 0,3 |
| Frequency variation ± 2 % | $I_{tr} \leq I \leq I_{max}$   | 0,5 ind      | ± 1,3   | ± 1,0 | ± 0,3 |

NOTE For the relationship  $I_{max} / I_{tr}$  see EN 50470-1, Table 3.

**8.4 Maximum permissible error (MPE)**

In addition to the requirements of 8.1 and 8.3, the composite error of the meter shall not exceed the values given in Table 8.

When the operating range of the meter covers more than one temperature range, then the respective requirements for each temperature range apply.

The composite error at a certain load shall be calculated from the following formula:

$$e_c = \sqrt{e^2(I, \cos\phi) + \delta^2(T / I, \cos\phi) + \delta^2(U / I, \cos\phi) + \delta^2(f / I, \cos\phi)}$$

where

$e(I, \cos\phi)$  = the intrinsic error of the meter at a certain load;

$\delta(T / I, \cos\phi)$  = the additional percentage error due to the variation of the temperature at the same load;

$\delta(U / I, \cos\phi)$  = the additional percentage error due to the variation of the voltage at the same load;

$\delta(f / I, \cos\phi)$  = the additional percentage error due to the variation of the frequency at the same load.

See also 8.7.6.

**Table 8 – Maximum permissible error (MPE)**

| Value of current  | Power factor   | Operating temperature range          |   |   |                                  |   |   |                                    |   |   |   |   |   |
|---|----------------|--------------------------------------|---|---|----------------------------------|---|---|------------------------------------|---|---|---|---|---|
|   |                | 5 °C to 30 °C                        |   |   | -10 °C to 5 °C or 30 °C to 40 °C |   |   | -40 °C to -25 °C or 55 °C to 70 °C |   |   |   |   |   |
|   |                | -25 °C to -10 °C or 40 °C to 55 °C   |   |   |                                  |   |   |                                    |   |   |   |   |   |
|   |                | Meter class index                    |   |   |                                  |   |   |                                    |   |   |   |   |   |
|   |                | A                                    | B | C | A                                | B | C | A                                  | B | C | A | B | C |
| <b>Single-phase meter; polyphase meter with balanced loads</b>  |                |                                      |   |   |                                  |   |   |                                    |   |   |   |   |   |
| $I_{min} \leq I < I_{tr}$   | 1              | ±                                    | ± | ± | ±                                | ± | ± | ±                                  | ± | ± | ± | ± | ± |
|   |                | 3,52,01,05,02,51,37,03,51,79,04,02,0 |   |   |                                  |   |   |                                    |   |   |   |   |   |
| $I_{tr} \leq I \leq I_{max}$  | 0,5 ind...1... | ±                                    | ± | ± | ±                                | ± | ± | ±                                  | ± | ± | ± | ± | ± |
|   | 0,8 cap        | 3,52,00,74,52,51,07,03,51,39,04,01,5 |   |   |                                  |   |   |                                    |   |   |   |   |   |
| <b>Polyphase meter carrying a single-phase load, but with balanced voltage supplied to the voltage circuits</b> |                |                                      |   |   |                                  |   |   |                                    |   |   |   |   |   |
| $I_{tr} \leq I \leq I_{max}$  | 0,5 ind...1    | ±                                    | ± | ± | ±                                | ± | ± | ±                                  | ± | ± | ± | ± | ± |
|   |                | 4,02,51,05,03,01,37,04,01,79,04,52,0 |   |   |                                  |   |   |                                    |   |   |   |   |   |

**8.5 Effect of disturbances of long duration**

When the meter is otherwise operated at reference conditions, the additional percentage error due to disturbances of long duration, when applied one by one, shall not exceed the critical change values specified in Table 9.

For testing, see 8.7.7.

**Table 9 – Effect of disturbances of long duration – Critical change values**

| Disturbance   | Value                                      | Value of current (balanced unless otherwise stated) |                                 | Power factor | Critical change value for meters of class index, % |                        |                        |
|---|--|---|---------------------------------|--------------|--|------------------------|------------------------|
|   |  | For direct connected meters                         | For transformer operated meters |              | A  | B                      | C                      |
| Severe voltage variation                                | $0,8 U_n \leq U < 0,9 U_n$                 | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 3,0$  | $\pm 2,1$              | $\pm 0,6$              |
|   | $1,1 U_n < U \leq 1,15 U_n$                |   |                                 | 0,5 ind      | $\pm 4,5$  | $\pm 3,0$              | $\pm 1,2$              |
|   | $U < 0,8 U_n$                              |   |                                 | 1 and        |  |                        |                        |
| Reversed phase sequence                                 | Any two phases interchanged                | $I_{tr}$  | $0,1 I_n$                       | 1            | $\pm 1,5$  | $\pm 1,5$              | $\pm 0,3$              |
| Voltage unbalance                                       | One or two phases interrupted <sup>a</sup> | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 4,0$  | $\pm 2,0$              | $\pm 1,0$              |
| Self-heating  |  | $I_{max}$   | $I_{max}$                       | 1<br>0,5 ind | $\pm 1,0$<br>$\pm 1,5$                             | $\pm 0,7$<br>$\pm 1,0$ | $\pm 0,2$<br>$\pm 0,2$ |
| Earth fault <sup>b</sup>                                | $1,9 U_n$ on two lines                     | -   | $0,5 I_n$                       | 1            | $\pm 1,0$  | $\pm 0,7$              | $\pm 0,3$              |
| Harmonic components in the current and voltage circuits | 10 % $U$ ,<br>40 % $I$                     | $0,5 \sqrt{I_{max}}$                                | $0,5 I_{max}$                   | 1            | $\pm 1,0$  | $\pm 0,8$              | $\pm 0,5$              |
| DC and even harmonics in the a.c. current circuit       | 5 <sup>th</sup> harmonic                   | $I$   |                                 | 1            | $\pm 6,0$  | $\pm 3,0$              | $\pm 1,5$              |
| Sub-harmonics in the a.c. current circuit               |  | $5 I_{tr}$  | $0,5 I_n$                       | 1            | $\pm 6,0$  | $\pm 3,0$              | $\pm 1,5$              |
| Continuous magnetic fields of external origin           | 1 000 Ampere-turns                         | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 3,0$  | $\pm 2,0$              | $\pm 1,0$              |
| Power frequency magnetic fields of external origin      | 0,5 mT                                     | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 3,0$  | $\pm 2,0$              | $\pm 1,0$              |
| Radiated RF electromagnetic fields                      | 10 V/m                                     | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 3,0$  | $\pm 2,0$              | $\pm 1,0$              |
| Operation of auxiliary devices                          | Most unfavourable condition                | $I_{min}$   | $I_{min}$                       | 1            | $\pm 1,0$  | $\pm 0,5$              | $\pm 0,1$              |
| Electrical fast transient/burst                         | 4 kV (2 kV)                                | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 6,0$  | $\pm 4,0$              | $\pm 2,0$              |
| Conducted disturbances induced by RF fields             | 10 V                                       | $10 I_{tr}$   | $I_n$                           | 1            | $\pm 3,0$  | $\pm 2,0$              | $\pm 1,0$              |
| Damped oscillatory                                      |  |   |                                 |              |  |                        |                        |

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waves<sup>d</sup>

2,5 kV / 1 kV

-

/

n

1

± 3,0

± 2,0

± 1,0

- a Polyphase meters with three measuring elements shall measure and register, within the limits of variation in percentage error shown in this table, if the following phases are interrupted.
- in a three-phase, four wire network one or two phases ;
  - in a three-phase, three-wire network (if the meter is designed for this service) one of the three phases.
- This only covers phase interruptions and does not cover events such as transformer fuse failures.  
In case of polyphase meters with two measuring elements the test does not apply.
- b Only for three-phase four-wire voltage transformer operated meters connected to distribution network equipped with earth fault neutralizers.
- c This requirement does not apply to current transformer operated meters.
- d For voltage transformer operated meters only.

For testing, see 8.7.7.

## 8.6 Short time overcurrents

Short-time overcurrents shall not damage the meter. The meter shall perform correctly when back to its initial working condition and the additional error shall not exceed the critical change value specified in Table 10.

NOTE This requirement does not apply to meters having a contact in the current circuits. For this case, see the appropriate standards.

**Table 10 – Effect of short time overcurrents – Critical change value**

| Meters for                             | Value of current (balanced) |       | Power factor | Critical change value for meters of class index, % |           |           |
|--|-----------------------------|-------|--------------|--|-----------|-----------|
|  |                             |       |              | A  | B         | C         |
| Direct connection                      | $10 I_{tr}$                 | -     | 1            | $\pm 1,5$  | $\pm 1,5$ | $\pm 1,5$ |
| Connection through current transformer | -                           | $I_n$ | 1            | $\pm 1,5$  | $\pm 1,5$ | $\pm 1,5$ |

For testing, see 8.7.8.

## 8.7 Performing the tests

### 8.7.1 Accuracy test conditions

To test the accuracy requirements, the following test conditions shall be maintained:

- the meter shall be tested in its case with the cover in position; all parts intended to be earthed shall be earthed;
- before any test is made, the circuits shall have been energized for a time sufficient to reach thermal stability;
- in addition, for polyphase meters:
  - the phase sequence shall be as marked on the diagram of connections;
  - the voltages and currents shall be substantially balanced (see Table 11).

**Table 11 – Voltage and current balance**

| Condition   | Tolerance  |
|---|------------|
| Each of the voltages between phase and neutral and between any two phases shall not differ from the average corresponding voltage by more than                                    | $\pm 1 \%$ |
| Each of the currents in the conductors shall not differ from the average current by more than   | $\pm 2 \%$ |
| The phase displacements of each of these currents from the corresponding phase-to-neutral voltage, irrespective of the phase angle, shall not differ from each other by more than | $2^\circ$  |

- the reference conditions are given in Table 12;
- for requirements regarding test stations, see IEC/TR 60736.

**Table 12 – Reference conditions**

| Influence quantity  | Reference value                                 | Permissible tolerances for meters of class index                                |         |         |
|---|---|---|---------|---------|
|   |   | A   | B       | C       |
| Ambient temperature   | Reference temperature or, in its absence, 23 °C | ± 2 °C  | ± 2 °C  | ± 2 °C  |
| Voltage   | Reference voltage                               | + 1,0 %   | + 1,0 % | + 1,0 % |
| Frequency   | Reference frequency                             | + 0,5 %   | + 0,3 % | + 0,3 % |
| Phase sequence  | L1 – L2 – L3                                    | --  | --      | --      |
| Voltage unbalance   | All phases connected                            | --  | --      | --      |
| Wave-form   | Sinusoidal voltages and currents                | Distortion factor less than:  |         |         |
|   |   | 3 %   | 2 %     | 2 %     |
| Continuous magnetic field of external origin  | Equal to zero                                   | --  | --      | --      |
| Power frequency magnetic field of external origin   | Equal to zero                                   | Induction value which causes a variation of error not greater than <sup>b</sup> |         |         |
|   |   | ± 0,3 %   | ± 0,2 % | ± 0,1 % |
| Electromagnetic RF field, 30 kHz to 2 GHz   | Equal to zero                                   | < 1 V/m   | < 1 V/m | < 1 V/m |
| Operation of auxiliary devices  | No operation of auxiliary devices               | --  | --      | --      |
| Conducted disturbances, induced by RF fields, 150 kHz to 80 MHz   | Equal to zero                                   | < 1 V   | < 1 V   | < 1 V   |
| <p><sup>a</sup> If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter determined for the temperature ranges <math>T_{ref} + 10\text{ °C}</math> and <math>T_{ref} - 10\text{ °C}</math> respectively.</p> <p><sup>b</sup> The test consists of:</p> <ul style="list-style-type: none"> <li>- for a single-phase meter, determining the errors first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two errors is the value of the variation of error. Because of the unknown phase of the external field, the test should be made at <math>I_{tr}</math> at unity power factor and at <math>2 I_{tr}</math> at 0,5 power factor;</li> <li>- for a three-phase meter, making three measurements at <math>I_{tr}</math> at unity power factor, after each of which the connection to the current circuits and to the voltage circuits are changed over 120° while the phase sequence is not altered. The greatest difference between each of the errors so determined and their average value is the value of the variation of error.</li> </ul> |   |   |         |         |

**8.7.2 Accuracy tests at reference conditions**

The accuracy test at reference conditions shall be performed at least at the test points shown in Table 13 and it shall be verified that the requirements of 8.1 are met.

In case of polyphase meters, tests shall be performed with balanced three-phase voltage and with balanced three-phase or single-phase load as indicated. For testing with single-phase load, the test current shall be applied to each measuring element in sequence.

**Table 13 – Test points determining the intrinsic error and the additional percentage error due to influence quantities**

| Value of current for meters for |                        | Meter / Load |                | Power factor        |
|---------------------------------|------------------------|--------------|----------------|---------------------|
| Direct connection               | Transformer connection |              |                |                     |
| $I_{\min}$                      | $I_{\min}$             | 1-P          | 3-P balanced   | 1                   |
| $I_{tr}$                        | $I_{tr}$               | 1-P          | 3-P balanced   | 0,5 ind, 1, 0,8 cap |
| $I_{tr}$                        | $I_{tr}$               | -            | 3-P unbalanced | 1 and 0,5 ind       |
| $10 I_{tr}$                     | $I_n$                  | 1-P          | 3-P balanced   | 0,5 ind, 1, 0,8 cap |
| $10 I_{tr}$                     | $I_n$                  | -            | 3-P unbalanced | 1 and 0,5 ind       |
| $I_{\max}$                      | $I_{\max}$             | 1-P          | 3-P balanced   | 0,5 ind, 1, 0,8 cap |
| $I_{\max}$                      | $I_{\max}$             | -            | 3-P unbalanced | 1 and 0,5 ind       |

NOTE "1-P" means single-phase meter. "3-P balanced" means polyphase meter with balanced load. "3-P unbalanced" means polyphase meter carrying a single-phase load, but with balanced polyphase voltages applied to voltage circuits.

### 8.7.3 Interpretation of accuracy test results

Certain test results may fall outside the percentage limits indicated in Table 4 and Table 5, owing to uncertainties involved in the measurement process. However, if by one displacement of the zero line parallel to itself by no more than the limits indicated in Table 14, all the test results are brought within the limits, it shall be considered that the requirements set in those tables are met.

**Table 14 – Interpretation of test results**

|   | Meters of class index |       |       |
|---|-----------------------|-------|-------|
|   | A                     | B     | C     |
| Permissible displacement of the zero line (%) | ± 1,0                 | ± 0,5 | ± 0,2 |

### 8.7.4 Repeatability

To verify that the requirement of 8.2 is met, at each test point shown in Table 13 at least three measurements shall be done.

### 8.7.5 Test of effects of influence quantities

#### 8.7.5.1 General

The additional percentage error due to influence quantities shall be determined for each influence quantity one by one, at the test points specified in Table 13, with all other influence quantities kept at their reference values (see Table 12).

#### 8.7.5.2 Temperature variation

The additional percentage error due to temperature variation shall be determined for each sub-range within the temperature range selected by the manufacturer.

NOTE If the variation of error is known to be a monotonic function of the temperature, it is sufficient to perform the test at the extremes of each sub-range.

It shall be verified that the requirements of Table 6 and Table 7 for each relevant temperature range are met.

### 8.7.5.3 Voltage variation

The additional percentage error due to voltage variation shall be determined and it shall be verified that the requirements of Table 6 and Table 7 are met.

If the meter has more than one reference voltage, the test shall be repeated for each value of  $U_n$ .

NOTE If the variation of error is known to be a monotonic function of the voltage, it is satisfactory to perform the test at the extremes of the voltage range(s).

### 8.7.5.4 Frequency variation

The additional percentage error due to frequency variation shall be determined and it shall be verified that the requirements of Table 6 and Table 7 are met.

NOTE If the variation of error is known to be a monotonic function of the frequency, it is satisfactory to perform the test at the extremes of the frequency range.

### 8.7.6 Calculation of the composite error

The composite error shall be calculated using the formula given in 8.4. For each test point, the intrinsic error and the largest corresponding values of additional percentage errors due to the variation of the respective influence quantities within their specified operating range shall be taken into account.

An example is shown in Annex A.

### 8.7.7 Test of effects of disturbances of long duration

#### 8.7.7.1 General

The effect of disturbances of long duration shall be determined for each disturbance one by one, at the test points shown in Table 9, while otherwise the meter is under reference conditions as specified in 8.7.1.

#### 8.7.7.2 Severe voltage variation

The additional percentage error due to severe voltage variation shall be determined and it shall be verified that it does not exceed the critical change value specified in Table 9.

If the meter has more than one reference voltage, the test shall be repeated for each value of  $U_n$ .

NOTE If the variation of error is known to be a monotonic function of the voltage, it is satisfactory to perform the test at the extremes of the voltage range(s).

#### 8.7.7.3 Reversed phase sequence

This requirement applies only for three-phase meters. The test shall be performed first interchanging L1 and L2 then L1 and L3. It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

#### 8.7.7.4 Voltage unbalance

This requirement applies only for poly-phase meters with three measuring elements.

The test shall be performed by interrupting each phase one by one or any two phases, as applicable.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

### 8.7.7.5 Self-heating

The test shall be carried out as follows: After the voltage circuits have been energized at reference voltage for at least 1 h for meters of class index A and 2 h for class index B and C, without any current in the current circuits, the maximum current shall be applied to the current circuits.

The percentage error of the meter shall be measured immediately after the current is applied and then at intervals short enough to allow a correct drawing to be made of the curve of error variation as a function of time. The test shall be carried out for at least 1 h, and in any event until the variation of error during 20 min does not exceed 10 % of limits of percentage error at reference conditions. With minimum interruptions for changing the measurement point, the percentage error of the meter shall be measured at power factor = 1 and power factor = 0,5 inductive.

The cable to be used for energizing the meter shall have a length of 1 m and a cross-section to ensure that the current density is between 3,2 A/mm<sup>2</sup> and 4 A/mm<sup>2</sup>. If this would result in a cable with a cross section of less than 1,5 mm<sup>2</sup>, then a cable with a cross section of 1,5 mm<sup>2</sup> shall be used.

It shall be verified that the variation in percentage error does not exceed the critical change value specified in Table 9.

### 8.7.7.6 Earth fault

This test applies only for three-phase four-wire voltage transformer operated meters, connected to distribution networks which are equipped with earth fault neutralizers or in which the star point is isolated (in the case of an earth fault and with 10 % overvoltage, the line-to-earth voltages of the two lines which are not affected by the earth fault will rise to 1,9 times the nominal voltage).

For a test under a simulated earth fault condition in one of the three lines, all voltages are increased to 1,1 times the nominal voltages during 4 h. The neutral terminal of the meter under test is disconnected from the ground terminal of the meter test equipment (MTE) and is connected to the MTE's line terminal at which the earth fault has to be simulated (see Annex B). In this way the two voltage terminals of the meter under test, which are not affected by the earth fault are connected to 1,9 times the nominal phase voltages. For this test, the current circuits are set to 50 % of rated current  $I_n$ , power factor 1 and symmetrical load. After the test, the meter shall show no damage and shall operate correctly.

After the application of the simulated earth fault condition, the meter shall be allowed to return to the initial temperature then an accuracy test shall be performed. It shall be verified that the variation in percentage error does not exceed the critical change value specified in Table 9.

### 8.7.7.7 Accuracy in the presence of harmonics

The test shall be performed under the following conditions:

- fundamental frequency current:  $I_1 = 0,5 I_{max}$ ;
- fundamental frequency voltage:  $U_1 = U_n$ ; –
- fundamental frequency power factor: 1;
- content of 5<sup>th</sup> harmonic voltage:  $U_5 = 10\%$  of  $U_n$ ;
- content of 5<sup>th</sup> harmonic current:  $I_5 = 40\%$  of fundamental current;
- harmonic power factor: 1;
- fundamental and harmonic voltages are in phase, at positive zero crossing.

5<sup>th</sup> harmonic is  $P_5 = 0,1 U_1 \times 0,4 I_1 = 0,04 P_1$  or total active

Resulting harmonic power due to the 5  
power = 1,04  $P_1$  (fundamental + harmonics).

It shall be verified that additional percentage error does not exceed the critical change value specified in Table 9.

**8.7.7.8 Influence of d.c. and even harmonics in the a.c. current circuit**

NOTE This test is applicable to direct connected meters only.

The tests of the influence of direct current and even harmonics shall be made with the circuit shown in Figure C.1, or with other equipment able to generate the required waveforms, and the current waveforms as shown in Figure C.2.

The distortion factor of the voltage shall be less than 1 %.

The value of the current (before applying the distortion) shall be  $\frac{I_{max}}{\sqrt{2}}$ , at unity power factor.

The additional percentage error when the meter is subjected to the test waveform compared to the percentage error when it is subjected to the reference waveform shall not exceed the critical change value given in Table 9.

**8.7.7.9 Odd harmonics and sub-harmonics in the a.c. current circuit**

The tests of the influence of odd harmonics and sub-harmonics shall be made with the circuit shown in Figure C.4 or with other equipment able to generate the required waveforms, and the current waveforms as shown in Figure C.5 and Figure C.7 respectively.

The distortion factor of the voltage shall be less than 1 %.

The additional percentage error when the meter is subjected to the test waveform compared to the percentage error when it is subjected to the reference waveform shall not exceed the critical change value given in Table 9.

**8.7.7.10 Immunity to continuous magnetic fields of external origin**

The test procedure is described in EN 50470-1, Subclause 7.4.11.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

**8.7.7.11 Immunity to power frequency magnetic fields of external origin**

The test procedure is described in EN 50470-1, Subclause 7.4.12.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

**8.7.7.12 Immunity to radiated RF electromagnetic fields**

The test procedure is described in EN 50470-1, Subclause 7.4.6.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

**8.7.7.13 Operation of auxiliary devices**

This test applies to meters with auxiliary devices enclosed in the meter case. Such devices may not be operating or actuated continuously.

NOTE An example is an electromagnet of a multi rate register.

It shall be verified that due to the operation or actuation of such auxiliary devices, the additional percentage error does not exceed the critical change value specified in Table 9.

When such auxiliary devices are actuated by an external device, the auxiliary circuits shall preferably be marked to indicate the correct method of its connection. If these connections are made by means of plugs and sockets, they should be irreversible.

The test shall be performed with the connections specified by the manufacturer. In the absence of such markings or irreversible connections, the test shall be performed with the connections giving the most unfavourable condition.

#### **8.7.7.14 Immunity to electrical fast transients/bursts**

The test procedure is described in EN 50470-1, Subclause 7.4.7.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

#### **8.7.7.15 Immunity to conducted disturbances, induced by RF fields**

The test procedure is described in EN 50470-1, Subclause 7.4.8.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

#### **8.7.7.16 Immunity to damped oscillatory waves**

NOTE This test is applicable to voltage transformer connected meters only.

The test procedure is described in EN 50470-1, Subclause 7.4.10.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

#### **8.7.8 Short time overcurrents**

The test circuit shall be practically non-inductive and the test shall be performed for polyphase meters phase-by-phase.

##### **a) Meter for direct connection:**

The meter shall be able to carry a short-time overcurrent of  $30 I_{\max}$  with a relative tolerance of + 0 % to - 10 % for one half-cycle at rated frequency.

##### **b) Meter for connection through current transformer:**

The meter shall be able to carry for 0,5 s a current equal to  $20 I_{\max}$  with a relative tolerance of + 0 % to - 10 %.

After the application of the short time overcurrent, the meter shall be allowed to return to the initial temperature with the voltage circuit(s) energized (about 1 h) then an accuracy test shall be performed. It shall be verified that the requirements of 8.6 are met.

### 8.7.9 Test of starting and no-load condition

#### 8.7.9.1 General test conditions

For these tests, the conditions and the values of the influence quantities shall be as stated in 8.7.1 except for any changes specified below.

#### 8.7.9.2 Initial start-up of the meter

The meter shall be functional within 5 s after the rated voltage is applied to the meter terminals.

#### 8.7.9.3 Test of no-load condition

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

For this test the current circuit shall be open circuit and a voltage of 115 % of the reference voltage shall be applied to the voltage circuits.

The minimum test period  $\Delta t$  shall be

$$\Delta t \geq \frac{240 \cdot 10^3}{k \cdot m \cdot U_{test} \cdot I_{st}} \text{ min}$$

where

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

NOTE For transformer-operated meters with primary or half-primary registers, the constant k shall correspond to the secondary values (voltage and currents).

m is the number of measuring elements;

$U_{test}$  is the test voltage in volts; its value shall be 1,15  $U_n$ ;

$I_{st}$  is the starting current.

#### 8.7.9.4 Starting

The meter shall start and continue to register at the starting current values (and in case of polyphase meters, with balanced load) shown in Table 15.

If the meter is designed for the measurement of energy in both directions, then the fulfilment of this requirement shall be verified with energy flowing in each direction.

**Table 15 – Starting current**

| Meters for                              | Meters of class index |               |               | Power factor |
|---|-----------------------|---------------|---------------|--------------|
|   | A                     | B             | C             |              |
| Direct connection                       | 0,05 $I_{tr}$         | 0,04 $I_{tr}$ | 0,04 $I_{tr}$ | 1            |
| Connection through current transformers | 0,06 $I_{tr}$         | 0,04 $I_{tr}$ | 0,02 $I_{tr}$ | 1            |

### 8.7.10 Meter constant

The relation between the test output and the indication of the register shall comply with the marking on the name-plate. The difference of the percentage error determined from the test output and by reading the register shall be less than  $1/10^{\text{th}}$  of the limit of percentage error at reference conditions.

NOTE This applies at a single test current.

This shall be verified by measuring a sufficient amount of energy, and observing the test output and reading the display.

## 9 Durability

The meter shall be designed to maintain an adequate stability of its metrological characteristics over a period estimated by the manufacturer, provided that it is properly installed, maintained and used according to the manufacturer's instruction when in the environmental conditions for which it is intended.

Conformity to this requirement shall be verified by the examination of test results and/or design documentation provided by the manufacturer.

These may include the following as appropriate:

- field test results of meter types of similar design;

NOTE 1 IEC/TR 62059-21 provides guidance for collecting dependability data from the field.

- laboratory test results of key parts and assemblies determining the long term stability of the meter and/or of complete meters;

NOTE 2 The test method should be described by the manufacturer and should be based – as far as possible – on internationally accepted standards and generally accepted methods.

- any specifications and calculations of the long term stability of such parts and assemblies;
- any operating principles used to maintain and improve long term stability;
- any manufacturing processes applied to ensure and improve long term stability;
- any methods to indicate if long term stability is affected.

## 10 Reliability

The meter shall be designed to operate reliably. It shall be designed to reduce as far as possible the effects of any fault that would lead to an inaccurate measurement result, unless such a defect is obvious.

Conformity to this requirement shall be verified by the examination of test results and/or design documentation provided by the manufacturer.

These may include the following as appropriate:

- field test results of meter types of similar design;

NOTE 1 IEC/TR 62059-21 provides guidance for collecting dependability data from the field.

- laboratory reliability test results of key components and/or complete meters;

NOTE 2 IEC 62059-31 provides a method for accelerated reliability testing. Any other test methods should be described by the manufacturer and should be based – as far as possible – on internationally accepted standards and generally accepted methods.

- reliability prediction calculations based on EN 62059-41;

- any methods applied to reduce the effect of eventual faults occurring on the accuracy of the measurement and/or integrity of data;

NOTE 3 The effect of any faults may be reduced by applying redundant designs. However, this, due to higher number of parts, may lead to higher unreliability. Therefore, the use of redundant designs should be left to the judgement of the manufacturer.

- any method used to indicate if measurement accuracy is affected and/or integrity of data is lost.

## 11 Requirements concerning the software and protection against corruption

### 11.1 General

In addition to the requirements of EN 50470-1, Subclause 5.2.1, the following requirements apply to metering equipment, in which metrologically relevant functions are realised partly by software.

### 11.2 Identification of functions implemented in software

The functions implemented in software shall be unambiguously identified and their operation adequately documented by the manufacturer.

NOTE Metrologically relevant functions implemented in software may include, but not limited to:

- the conditioning and processing of the input signals;
- compensation of the effect of influence quantities;
- the generation, storage and display of the measurement results;
- controlling the starting and running with no load;
- the setting and changing of metrologically relevant parameters;
- the control of operation indicator(s) and the test output(s);
- recovery from fault conditions;
- tariff control.

Metrologically not relevant functions may include:

- remote data exchange;
- control outputs.

### 11.3 Identification and protection of software

Software identification shall be easily provided. The manufacturer shall ensure that the version of metrologically relevant software of the meter used in serial production is identical with the version included in the type approval confirmation. The software shall be protected against any accidental or intentional changes. Evidence of any intervention shall be available for a reasonable period of time.

NOTE If the software can only be changed after breaking (a) seal(s) or breaking the case, this is considered as an adequate level of protection.

Furthermore, any corruption of the metrologically relevant software shall be easily detectable.

### 11.4 Identification and protection of metrologically relevant parameters

Metrologically relevant parameters shall be identified and protected against any accidental or intentional changes after placing the legal metrology seals.

NOTE 1 Examples of such parameters are calibration constants, meter constant of the test output.

Evidence of any intervention shall be available for a reasonable period of time.

NOTE 2 If the metrologically relevant parameters can only be changed after breaking (a) seal(s) or breaking the case, this is considered as an adequate level of protection.

Furthermore, any corruption of the metrologically relevant parameters shall be easily detectable.

### 11.5 Setting of parameters

If there are parameters, which are allowed to be set in the field, this shall be possible only under adequate protection, using the method specified by the manufacturer.

NOTE 1 Examples are transformer ratios or other data used for matching the meter to installation conditions.

Any admissible changes of such parameters shall be properly traceable.

NOTE 2 One possible solution is the provision of a logbook.

### 11.6 Protection of measurement data

Measurement data shall be protected against any accidental or intentional changes or corruption. Evidence of any such events shall be readily available for a reasonable period of time.

The security system of the meter, providing protection of software, parameters and measurement data – including any hardware and software solutions – shall be adequately documented.

### 11.7 Protection against inadmissible influence by metrologically non-relevant software

If metrologically non-relevant functions implemented by software are present, these shall not inadmissibly influence the correct operation of the metrologically relevant software.

Conformity to these requirements shall be verified by examining the software documentation and, as applicable, using the test methods and tools provided by the manufacturer.

For an intermittent operation of metrologically not relevant software, the requirements of Table 9 for the operation of auxiliary devices also apply.

### 11.8 Protection against inadmissible influence by connecting another device

The metrological characteristics of the meter shall not be influenced in any inadmissible way by the connection to it of another device, by any feature of the connected device itself or by any remote device that communicates with the meter.

The manufacturer shall provide the documentation and tools, which are necessary to verify that these requirements are met. The requirements of Table 9 for operation of auxiliary devices apply.

## Annex A (informative)

### Calculation of the composite error

The following example shows the calculation of the composite error in the presence of influence quantities:

- the intrinsic error of a polyphase meter of class index A, measured at  $I_{tr}$ , balanced load,  $\cos \varphi = 1$  is + 0,7 %;
- at the same load, within the specified operating temperature range of -10 °C to 55 °C, the largest additional error observed in the subrange of -10 °C to 5 °C was at -10 °C, its value is - 1,9 %;
- at the same load, within the specified operating voltage range of 0,9  $U_n$  to 1,1  $U_n$ , the largest additional error observed was at 1,1  $U_n$ , its value is + 0,8 %;
- at the same load, within the specified operating frequency range of 0,98  $f_n$  to 1,02  $f_n$ , the largest additional error observed was at 0,98  $f_n$ , its value is + 0,3 %.

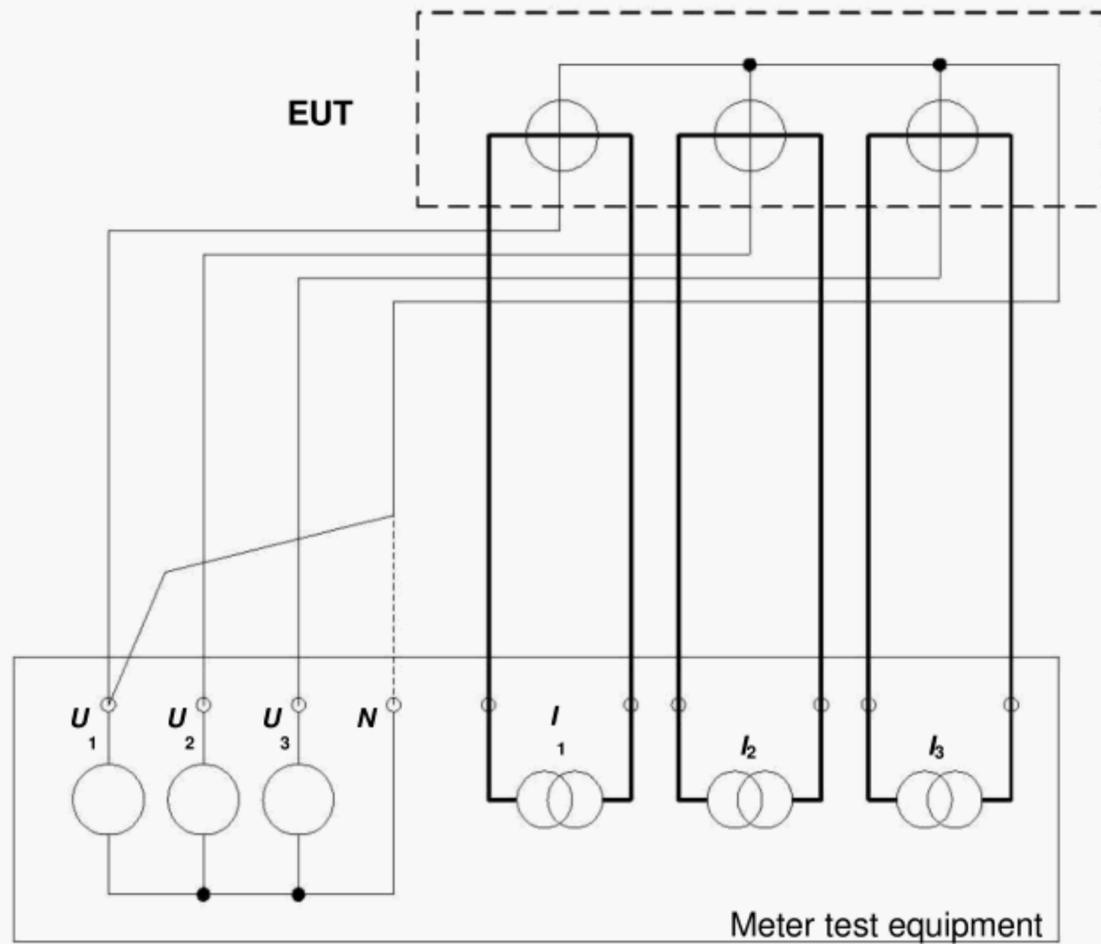
The composite error calculated:

$$e = \sqrt{(+0,7)^2 + (-1,9)^2 + (+0,8)^2 + (+0,3)^2} = \pm 2,2 \%$$

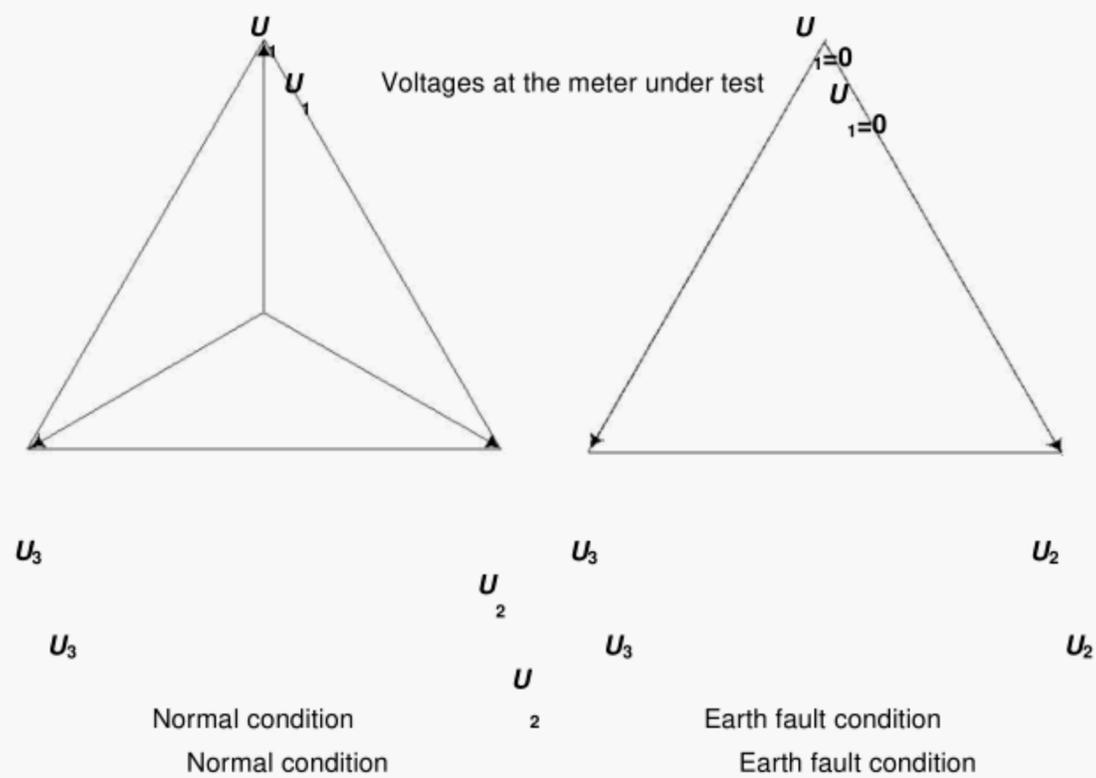
The calculation should be performed for each test point and each temperature sub-range the same way.

**Annex B**  
(normative)

**Test circuit diagram for the test of immunity to earth fault**



**Figure B.1 – Circuit to simulate earth fault condition in phase 1**

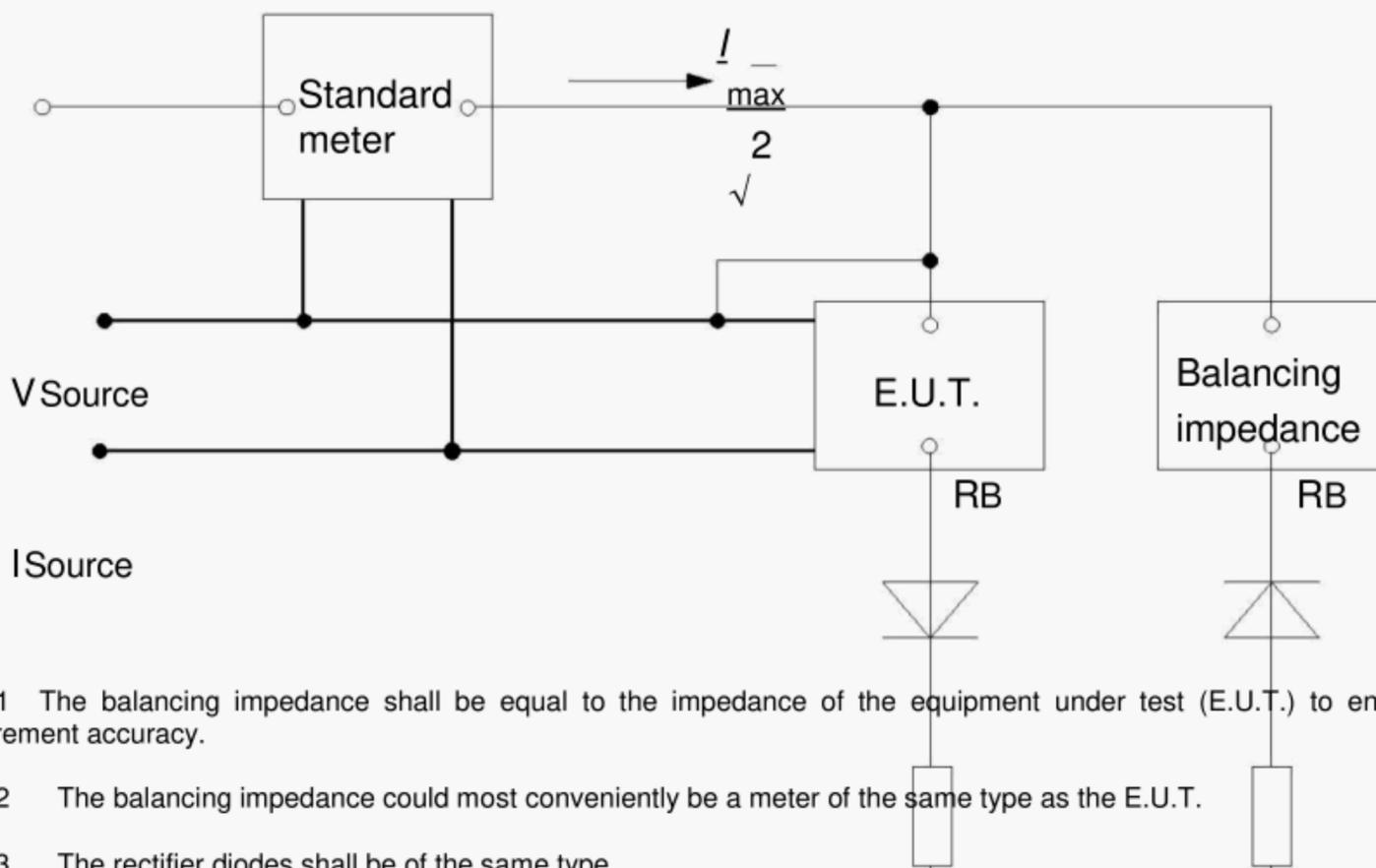


**Figure B.2 – Voltages at the meter under test**

**Annex C**  
(normative)

**Test circuit diagram for d.c., even harmonics, odd harmonics and sub-harmonics**

**C.1 Half-wave rectification (d.c. and even harmonics)**



NOTE 1 The balancing impedance shall be equal to the impedance of the equipment under test (E.U.T.) to ensure the measurement accuracy.

NOTE 2 The balancing impedance could most conveniently be a meter of the same type as the E.U.T.

NOTE 3 The rectifier diodes shall be of the same type.

NOTE 4 The balancing condition can be checked by measuring the DC component of the current in the common line. To improve the balancing condition, additional resistors can be introduced in the test branch and the balancing branch.

**Figure C.1 – Test circuit diagram for half-wave rectification**

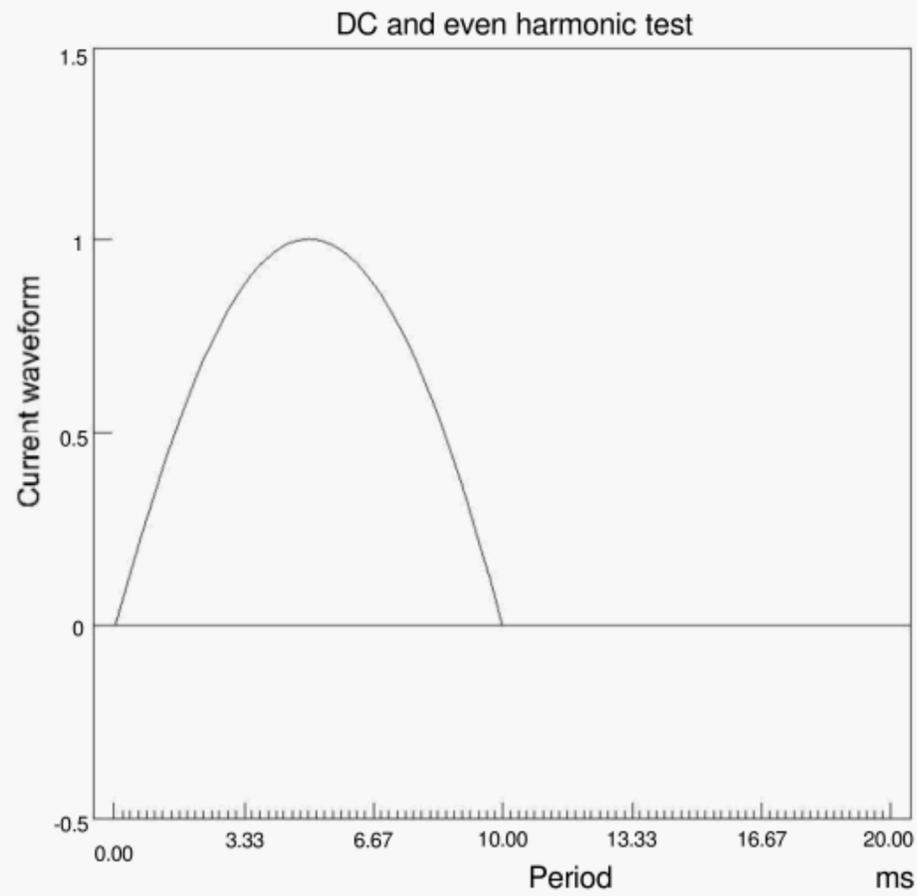


Figure C.2 – Half-wave rectified waveform

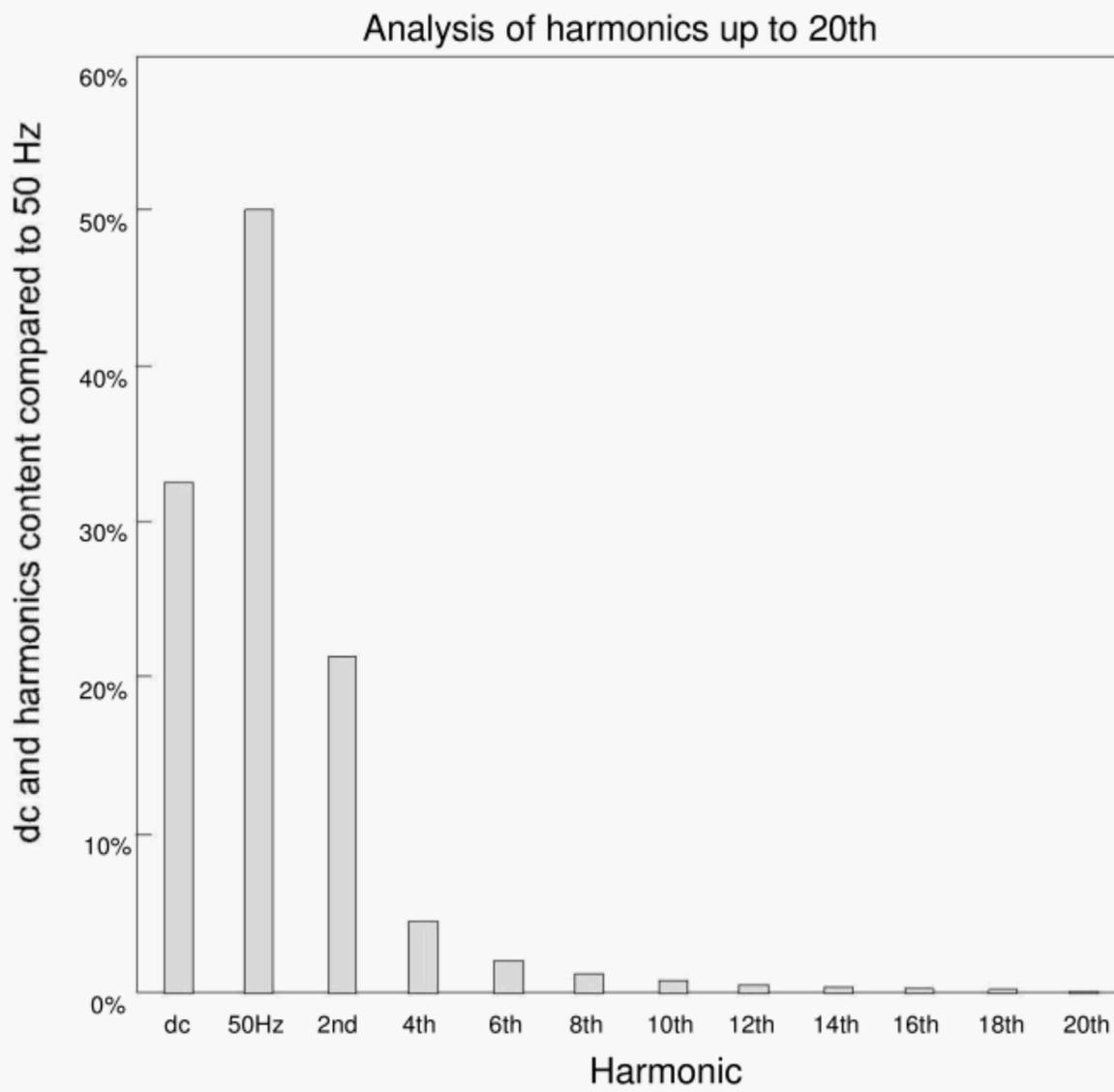
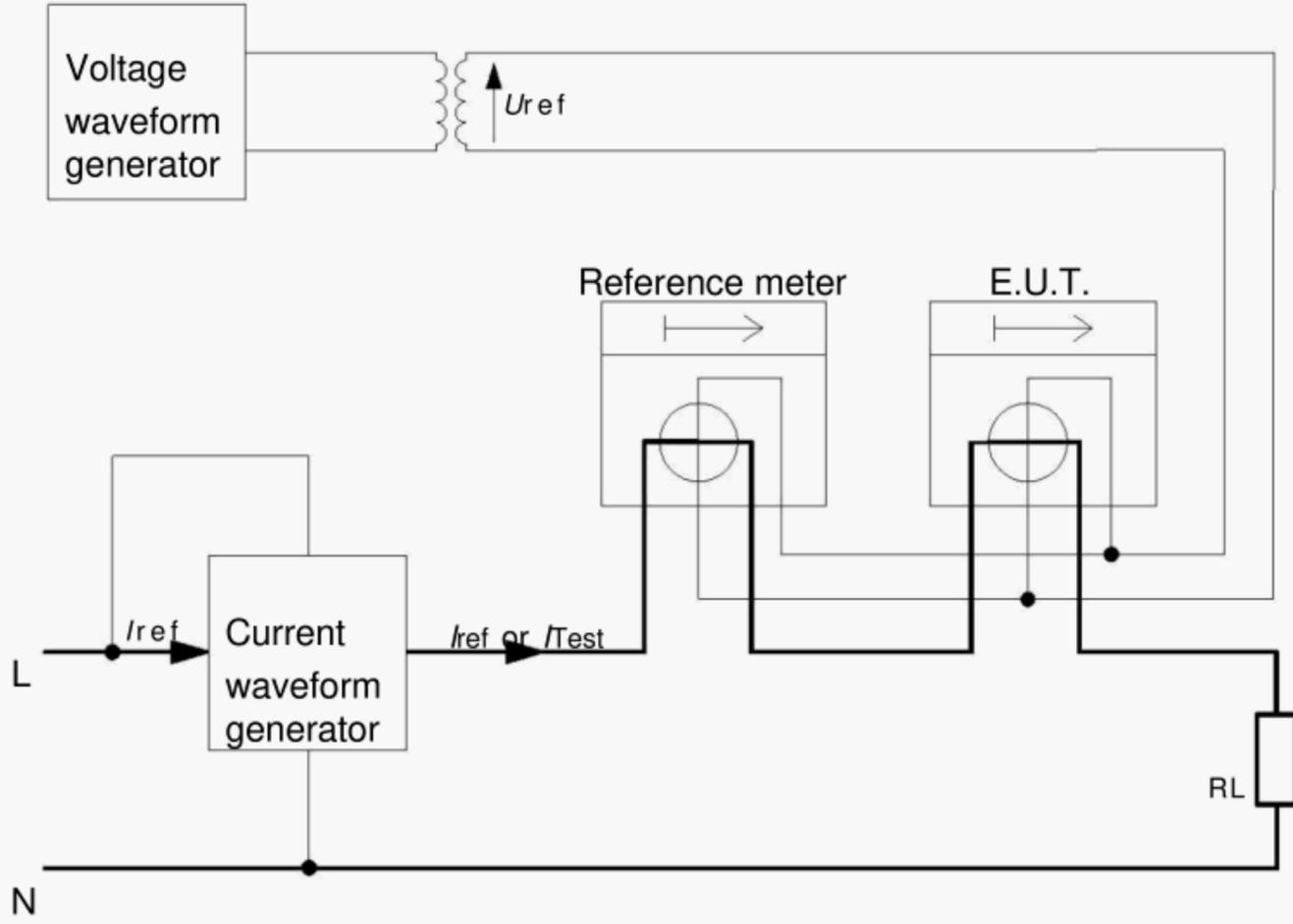


Figure C.3 – Informative distribution of half-wave harmonic content (the Fourier analysis is not complete)

**C.2 Phase fired control (odd harmonics)**



NOTE The reference meter shall measure the total active energy (fundamental + harmonics) in the presence of harmonics.

**Figure C.4 – Test circuit diagram (informative)**

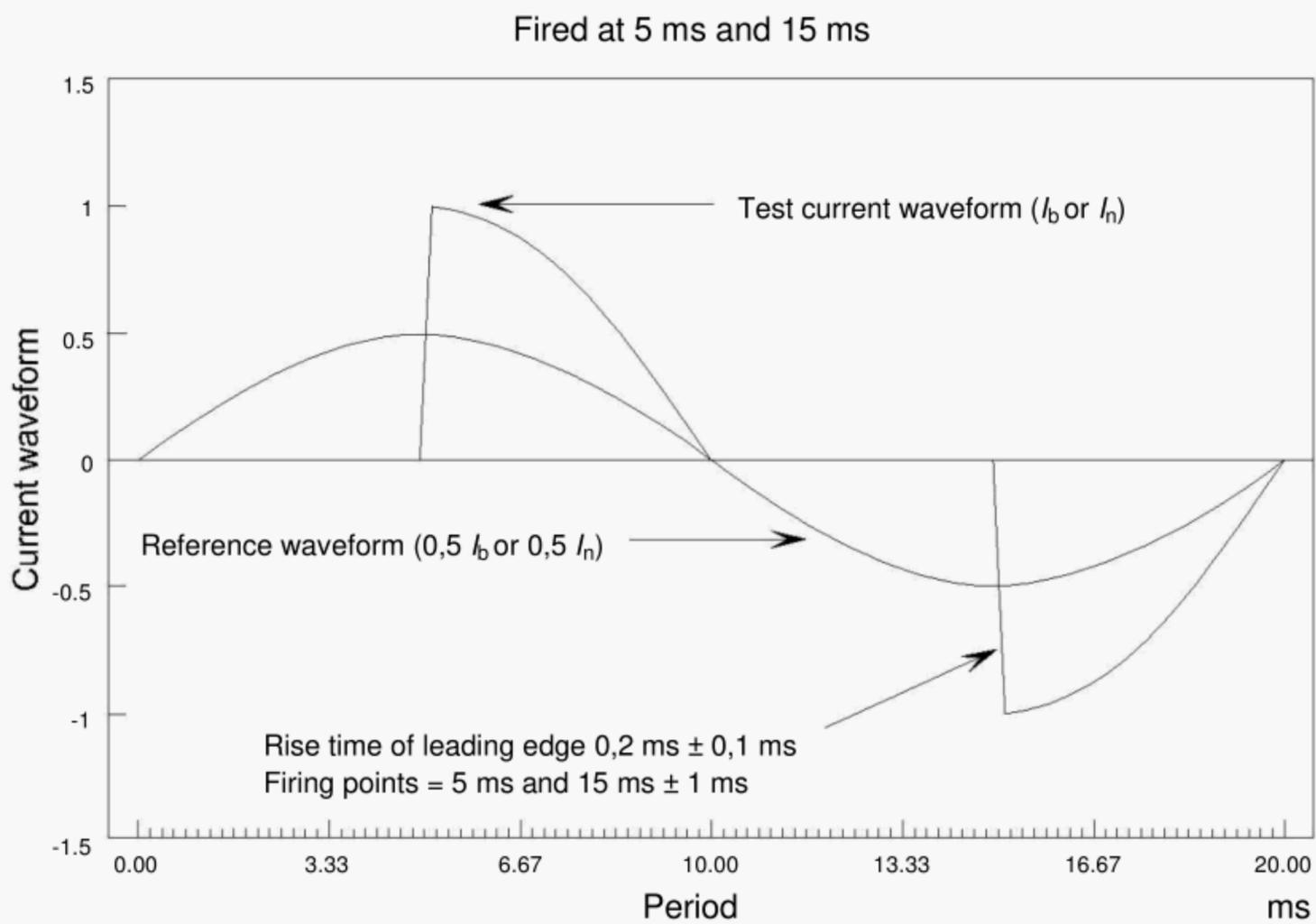


Figure C.5 – Phase fired waveform

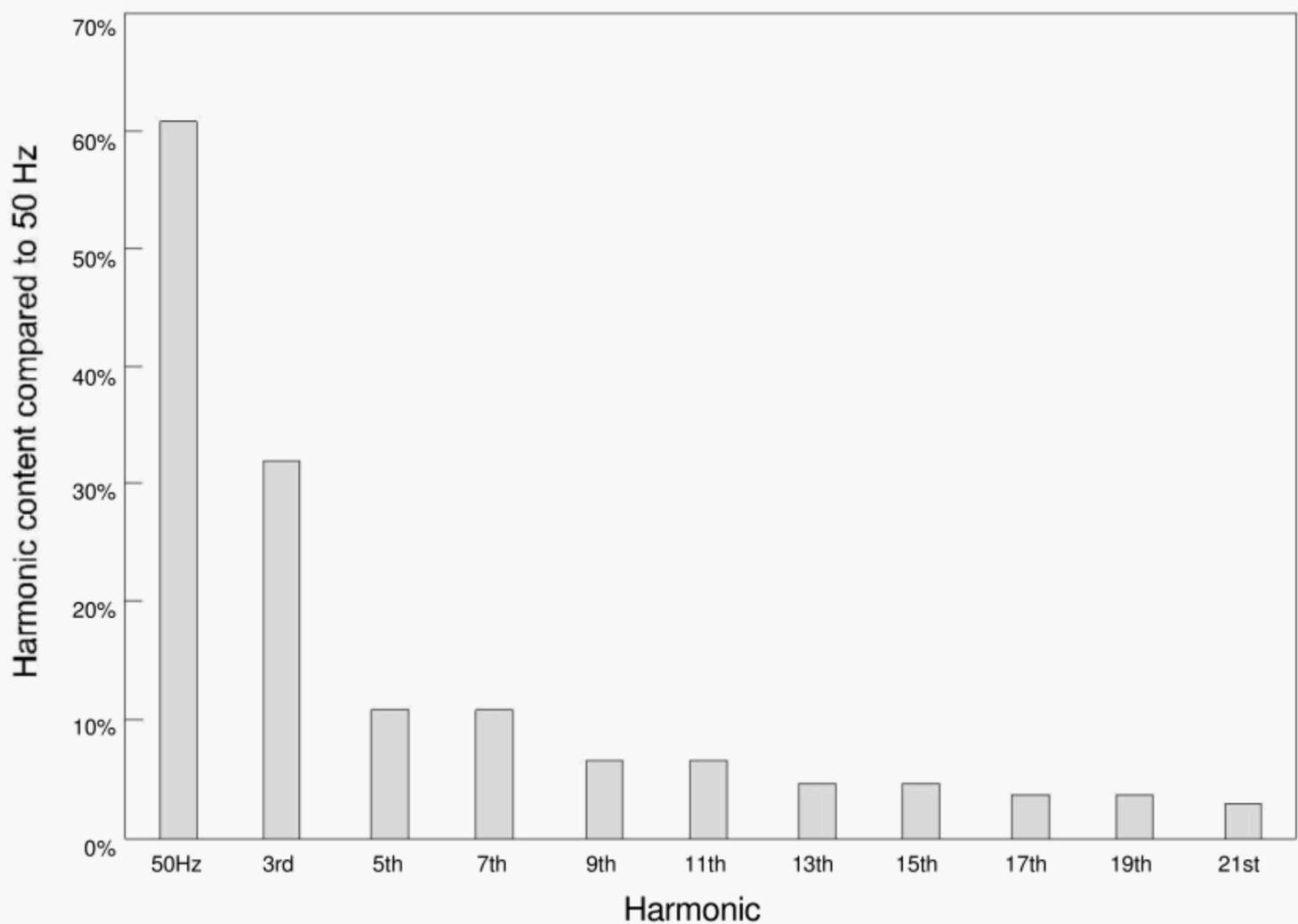
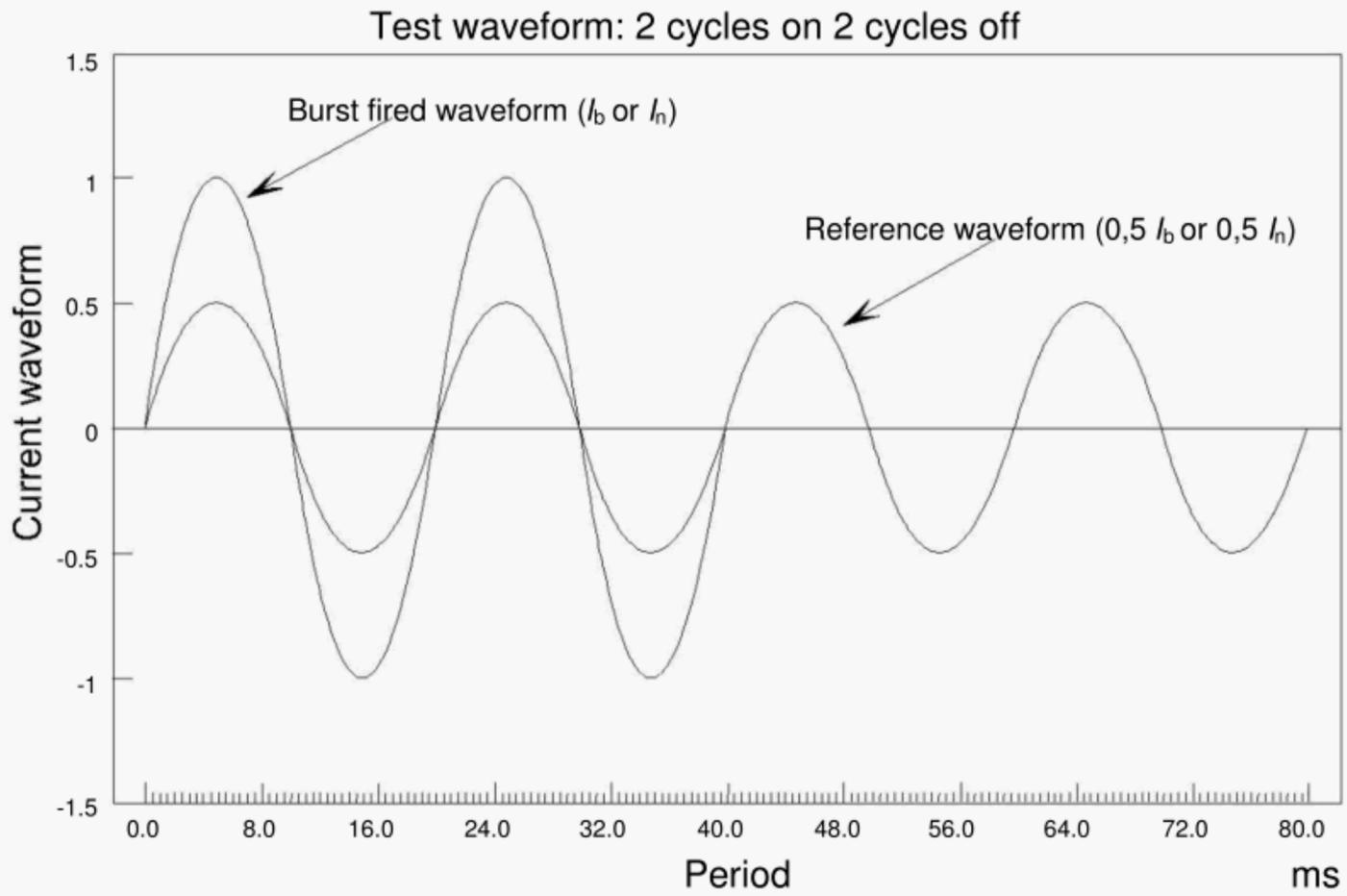


Figure C.6 – Informative distribution of harmonic content of phase fired waveform (the Fourier analysis is not complete)

### C.3 Burst control (sub-harmonics)



Test circuit diagram see Figure C.4.

Figure C.7 – Burst fired waveform

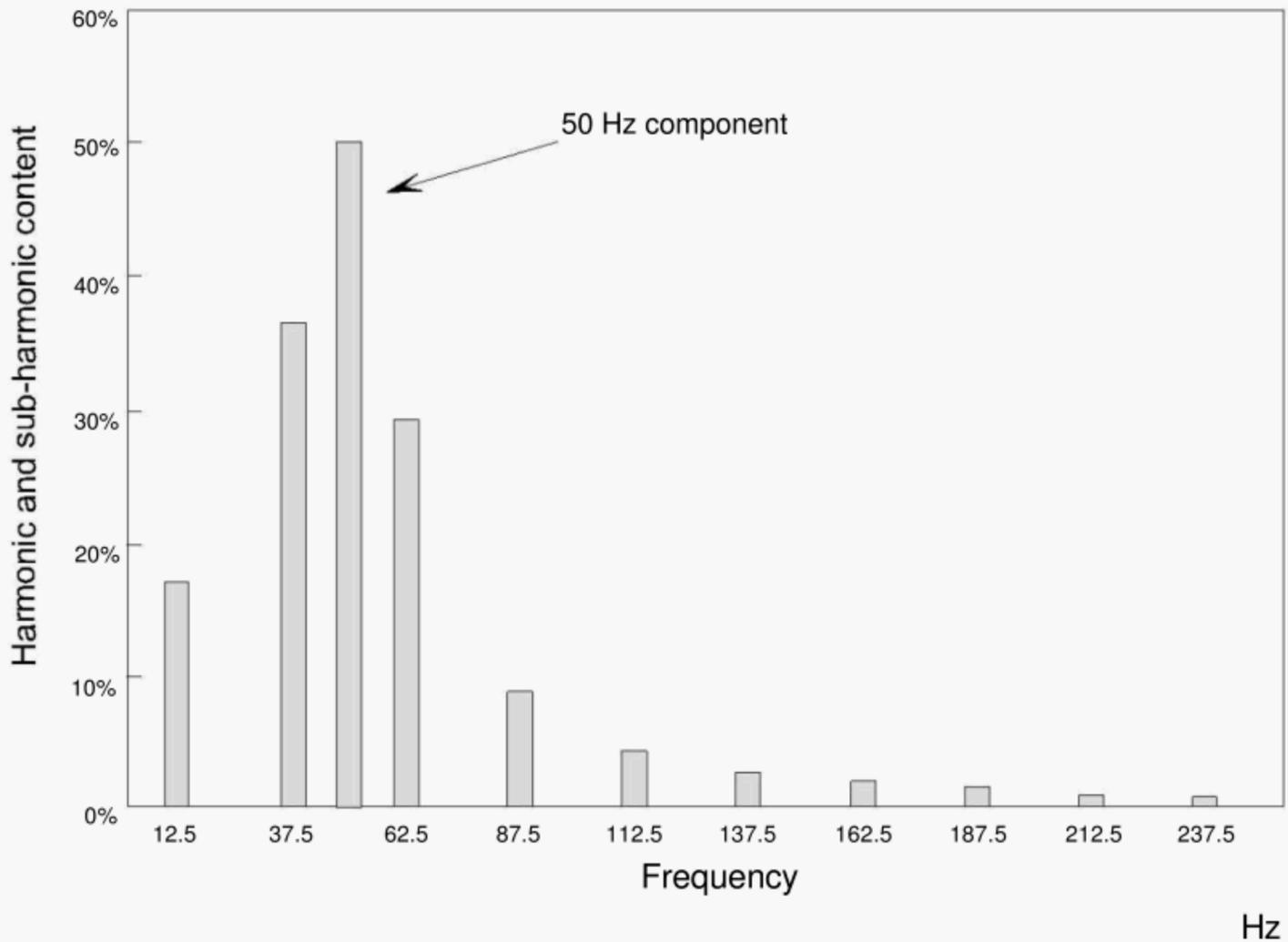


Figure C.8 – Informative distribution of harmonic content of burst fired waveform (the Fourier analysis is not complete)

## **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 and Annex MI-003 of the EC Directive 2004/22/EC of the European Parliament and of the Council on Measuring Instruments.

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.

## Bibliography

| Publication              | Year | Title   |
|--------------------------|------|---|
| EN 62053-21              | 2003 | <i>Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)</i><br>(IEC 62053-21:2003)          |
| EN 62053-22              | 2003 | <i>Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)</i><br>(IEC 62053-22:2003)  |
| EN 62053-61              | 1998 | <i>Electricity metering equipment (a.c.) – Particular requirements – Part 61: Power consumption and voltage requirements</i><br>(IEC 62053-61:1998)                 |
| IEC 62058-11             | 1)   | <i>Electricity metering equipment (a.c.) – Acceptance inspection – Part 11: General acceptance inspection methods</i>   |
| IEC 62058-31             | 1)   | <i>Electricity metering equipment (a.c.) – Acceptance inspection – Part 31: Particular requirements for static meters for active energy (classes 0,5S, 1 and 2)</i> |
| IEC 62059-31             | 1)   | <i>Electricity metering equipment – Dependability – Part 31: Accelerated reliability testing</i>  |
| IEC/TR 60736             | 1982 | <i>Testing equipment for electrical energy meters</i>   |
| IEC/TR 62059-11          | 2002 | <i>Electricity metering equipment – Dependability – Part 11: General concepts</i>   |
| IEC/TR 62059-21          | 2002 | <i>Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field</i>  |
| WELMEC Guide 7.2 Issue 1 | 2005 | <i>Software Guide (Measuring Instruments Directive 2004/22/EC)</i>  |

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1) At draft stage.

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