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BSI Standards Publication

Electricity metering equipment (a.c.) — Severity levels, immunity requirements and test methods for conducted disturbances in the frequency range 2 kHz — 150 kHz

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Electricity metering equipment (a.c.) - Severity levels, immunity requirements and test methods for conducted disturbances in the frequency range 2 kHz - 150 kHz

Equipement de comptage d'électricité (c.a.) – Niveaux de sévérité, prescriptions d'immunité et méthodes d'essai pour les perturbations conduites dans le domaine de fréquence de 2 kHz à 150 kHz

Wechselstrom-Elektrizitätszähler - Prüfschärfe, Störfestigkeit und Prüfverfahren für leitungsgeführte Störgrößen im Frequenzbereich von 2 kHz bis 150 kHz

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CENELEC

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

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Foreword

This document (CLC/TR 50579:2012) has been prepared by CLC/TC 13 "Equipment for electrical energy measurement and load control".

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Introduction

This Technical Report specifies immunity levels and standard testing procedure for the immunity against symmetric currents in the frequency range from 2 kHz to 150 kHz as an extension of the harmonised standards EN 50470-1 and EN 50470-3 until the basic standards IEC 61000-x-x are in force.

This Technical Report was requested by various approval bodies and utilities as a temporary solution, since accuracy problems with electricity meters were observed in presence of disturbing currents in the frequency range from 2 kHz to 150 kHz. Up to date no standards are available for this frequency range.

The testing against symmetrical currents is not yet a part of the actual basic standards or product standards in EMC. However for some electricity meters an influence of symmetric currents has been shown in various investigations. The source of these currents in a frequency range from 2 kHz to 150 kHz can be a photovoltaic inverter or other switched mode power supplies.

1 Scope

This European Technical Report 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 immunity test for direct connected and transformer connected electricity meters as an extension for EN 50470-1 and EN 50470-3. The tests are designed to achieve immunity against disturbing currents of up to 2 A (2 kHz-30 kHz) and up to 1 A (30 KHz-150 kHz) for direct connected meters and 2 % Imax (2 kHz-30 kHz) and 1 % Imax (30 KHz-150 kHz) for transformer connected meters.

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.

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 Technical Report applies only for the active energy metering part.

This Technical Report distinguishes between:

– meters of class indexes A, B and C;
– direct connected and transformer operated meters;

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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50470-1, *Electricity metering equipment (a.c.) — Part 1: General requirements, tests and test conditions — Metering equipment (class indexes A, B and C)*

EN 50470-3:2006, *Electricity metering equipment (a.c.) — Part 3: Particular requirements — Static meters for active energy (class indexes A, B and C)*

3 Terms and definitions

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

3.1
equipment under test
(EUT)
electricity meter or other instrumentation for the measurement of energy which is tested against the disturbing current described in this Technical Report

3.2
load current
I_{50Hz}
50 Hz current flowing through the current path of the equipment under test. Typically the current is flowing through the live wires LIN to LOUT of the electricity meter

3.3
disturbing current
I_{Dist}
current in the frequency range from 2 kHz to 150 kHz flowing through the current path of an electricity meter or other instrumentation for the measurement of energy

4 General

The test is done with two currents flowing through the electricity meter. One current is the 50 Hz load current I_{50Hz} second is the disturbing current I_{Dist} in the frequency range from 2 kHz to 150 kHz flowing only through the current path of the electricity meter. Both currents I_{50Hz} and I_{Dist} are generated independently from each other.

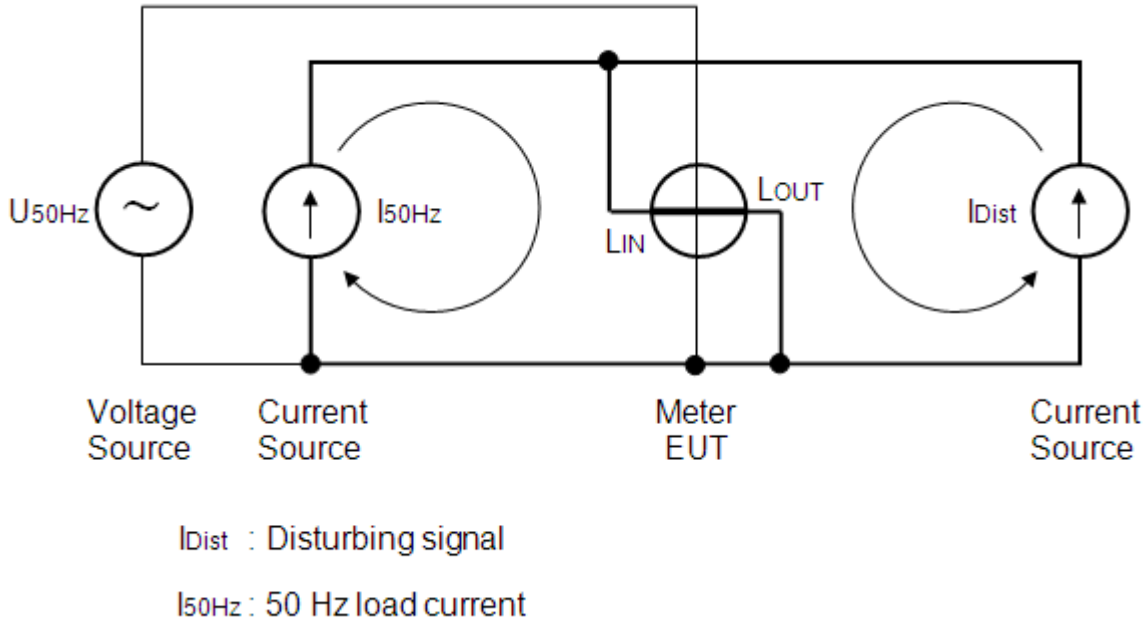


Figure 1 — Simplified diagram of the currents flowing through the current path of the electricity meter

The method to generate the current flowing through the current path of the electricity meter is not given as specification or requirement in detail by this Technical Report. The important parameter is the level of the disturbing current flowing through the current path of the electricity meter. The method to generate both the disturbing current and the 50 Hz load current is not of interest for the result of the test.

5 Test equipment

5.1 Test generator for the disturbing current

5.1.1 General

The test generator includes all equipment necessary to generate the disturbing signal. The disturbing signal is the current through the current path of the EUT. The test generator shall meet the following minimum specifications:

Table 1 — Specifications of the test generator

Parameter	Specification
Frequency range of the disturbing signal:	2 kHz – 150 kHz
Generated wave shape:	Sine wave, unmodulated
Maximum THD of the generated disturbing signal at maximum level:	< 5 %
Output level:	Sufficiently high to generate selected test level
Tolerance of the disturbing signal (current) during the test:	± 5 %
Dwell time:	The dwell time shall be long enough to allow a stable accuracy measurement
Maximum frequency step during the test:	1 %

The generator shall be able to perform frequency steps with variable step size. The step size for the testing shall not be higher than 1 % of the preceding frequency value. Before changing to the next frequency the generator shall reduce the level of the disturbing current in order to avoid that the level of the disturbing current at the new frequency is higher than the test level. The reduction shall be high enough to avoid disturbing currents higher than the test level selected at the new frequency.

The test level (disturbing current) shall be generated with a tolerance of ± 5 % of the selected level.

5.1.2 Example of a test generator for the disturbing current

The basic structure of a test generator is given in Figure 2.

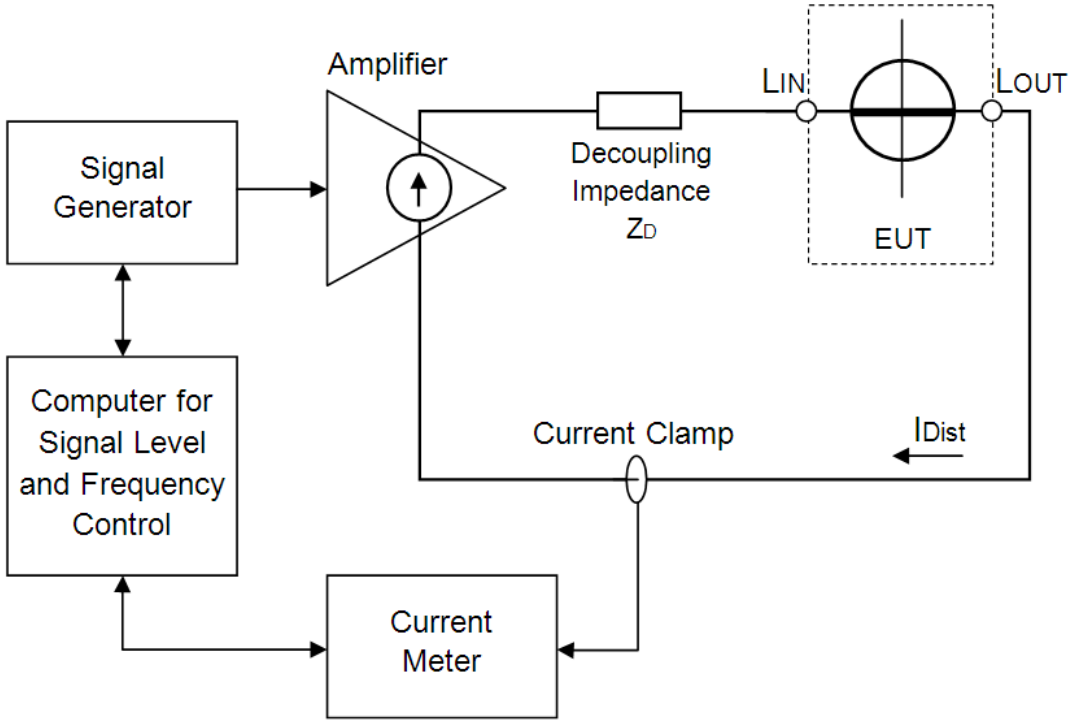


Figure 2 — Simplified circuit of a test generator

It is important that the test generator impedance (internal impedance of the amplifier plus decoupling impedance Z_D) is at least 100 times higher than the impedance of the EUT (Electricity Meter).

NOTE Such a current clamp might also be used during a calibration cycle to generate a calibration file (transducer) done without 50 Hz-current flowing, but with the meter connected.

5.2 Generator for 50 Hz current and voltage

5.2.1 General

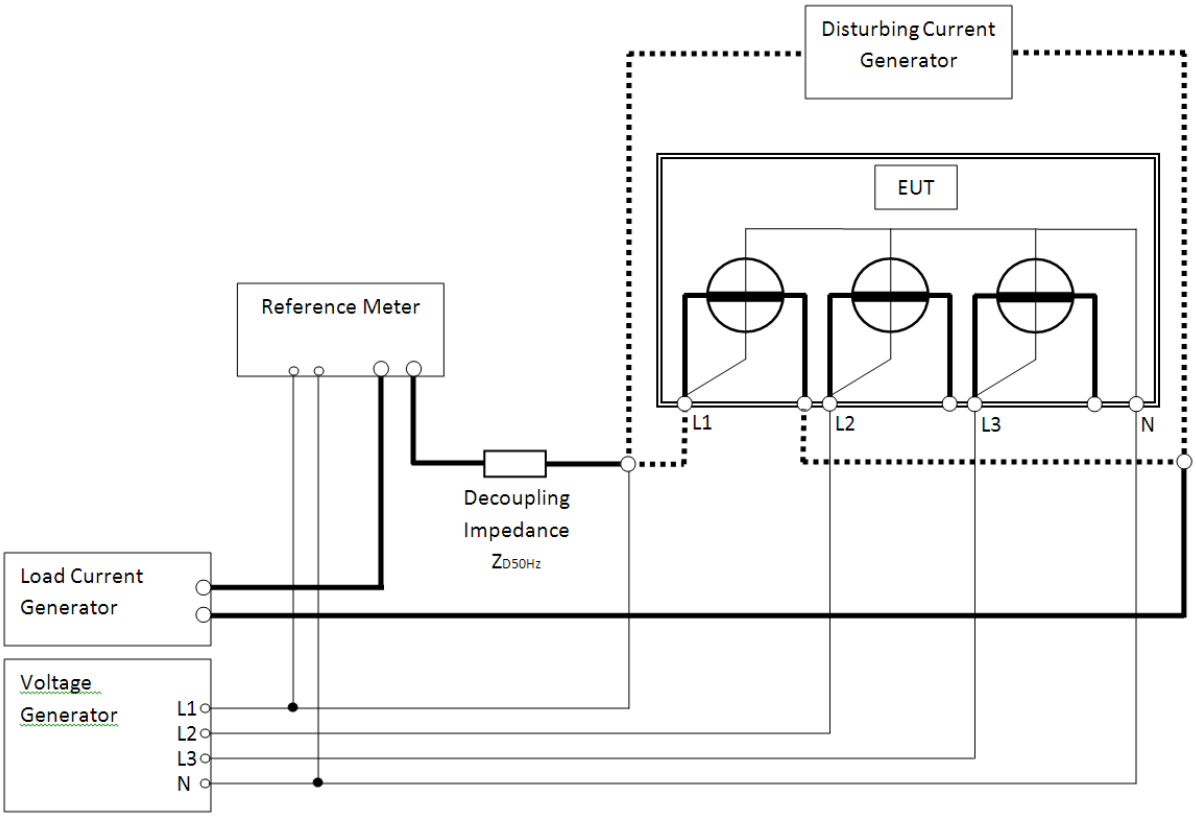
The meter shall be loaded with active power during the test.

Reference test conditions according to EN 50470-3:2006, 8.7.1, Table 12 apply.

A polyphase meter is connected to a balanced voltage system with single phase load. If the meter metrology design is identical in all three phases, testing of one phase is sufficient; otherwise each phase shall be tested one by one.

NOTE If a meter is specified for more than one reference voltage, the test at one reference voltage is deemed to be sufficient.

5.2.2 Example for a testing circuit



Key

Z_{D50Hz}: 1 Ohm

Figure 3 — Test circuit

NOTE 1 The value for Z_{D50Hz} yields a sufficiently small error influence of the disturbing current when the impedance of the current path of the meter (including all connection impedances) is 10 mOhm or less. In this case a 50 Hz current of 10 A yields to a power dissipation of 100 W at a purely ohmic resistor. If a non-ohmic resistor is used it should be ensured, that the cos φ >0,9 condition is met.

NOTE 2 It should be ensured that the 50 Hz current flowing through the disturbing current generator does not disturb the disturbing current generator.

6 Test sequence

a) Start frequency is set in the signal generator. Then the level of the generator output is increased in small steps from zero (or near zero) until the selected test level is achieved. At each level step the actual disturbing current I_{Dist} is measured by the current meter and compared with the wanted test level. When the test level is achieved within the given tolerance (see specification) the selected measuring period is started.

b) Before the next frequency (actual frequency increased by 1 %) is selected, the disturbing signal level is reduced by a sufficient value to avoid a disturbing signal level higher than the selected test level for the next frequency.

c) Then steps are repeated until the stop frequency is reached.

7 Performance criteria — Performance criteria for electricity meter as described in EN 50470-1 and EN 50470-3

The maximum allowed additional percentage error is given in Table 2 for direct connected meters and in Table 3 for transformer connected meters.

Table 2 — Maximum allowed additional percentage error depending on the accuracy class for direct connected meters

Frequency range	Value of disturbing current	50 Hz current	50 Hz: cos φ	Maximum allowed additional percentage error for electricity meters of class		
				A	B	C
2 kHz to 30 kHz	2 A	I_{ref}	>0,9	± 6 %	± 4 %	± 2 %
30 kHz to 150 kHz	1 A	I_{ref}	>0,9	± 6 %	± 4 %	± 2 %
At the transition frequency of the frequency range the higher test level applies.						

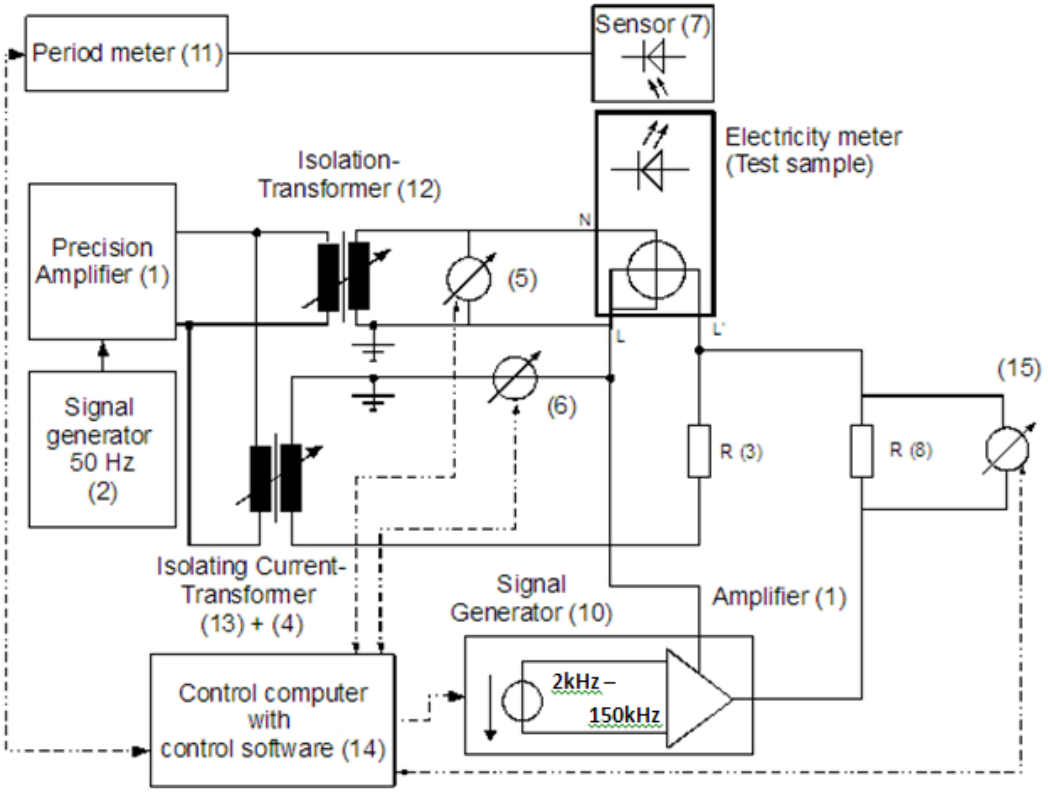
Table 3 — Maximum allowed additional percentage error depending on the accuracy class for transformer connected meters

Frequency range	Value of disturbing current	50 Hz current	50 Hz: cos φ	Maximum allowed additional percentage error for electricity meters of class		
				A	B	C
2 kHz to 30 kHz	2 % * I_{max}	I_{ref}	>0,9	± 6 %	± 4 %	± 2 %
30 kHz to 150 kHz	1 % * I_{max}	I_{ref}	>0,9	± 6 %	± 4 %	± 2 %
At the transition frequency of the frequency range the higher test level applies.						

NOTE EN 60044-1 describes transformers having a measuring range of 0,01 I_n to 1,2 I_n, or of 0,05 I_n to 1,5 I_n, or of 0,05 I_n to 2 I_n and transformers having a measuring range of 0,01 I_n to 1,2 I_n for accuracy classes 0,2S and 0,5S. As the measuring ranges of a meter and its associated transformers have to be matched and as only transformers of classes 0,2S and 0,5S have the accuracy required to operate the meters of this standard, the measuring range of the meter will be 0,01 I_n to 1,2 I_n. The above I_{max} currents should be chosen based on the respective maximum currents of the meters being 120 %, 150 % and 200 % I_n of the meter.

Annex A
(informative)

Example for a realised test set-up — Setup schematic



The dotted lines in the figure are control lines (e.g. RS 232 and IEC-Bus 488)

Figure A.1 — Example for a realized test set-up

The disturbance signal (current) flowing through L to L' is measured by the current meter (15). The software (14) increases the signal generator (10) level from zero to the wanted test level in steps. After each step the disturbance signal level is measured. The signal level is increased until the wanted test level is reached. Then the signal is applied for the selected dwell time (typically 10 s or longer). During the dwell time the 50 Hz voltage (5) and current (6) is measured and the pulse period of the sensor output (7) is measured also. The average of the current, the voltage and the period is then used for the calculation of the additional percentage error.

Special care has been taken with the cabling to avoid current loops generating strong magnetic fields around the cables which might disturb the meter directly via a magnetic field coupling.

The software (14) on the computer controls and regulates the disturbing signal via measuring the disturbing signal (current) (15) and controlling the Amplitude and frequency of the signal-generator (10).

NOTE A small portion of the disturbance signal (current) in this set-up is flowing through the 50 Hz current circuit (4) and not through the EUT. However this portion is very small since the impedance of the current path is very low compared to the resistor in the 50 Hz-Path used for decoupling. This current can be neglected or determined in a pre test and corrected in the calculation or signal generation. Other measures like an inductor as low pass filter in the current path may also be used.

Bibliography

[1] EN 60044-1, *Instrument transformers — Part 1: Current transformers (IEC 60044-1)*

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