

# INTERNATIONAL STANDARD

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BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

**Electromagnetic compatibility (EMC) –  
Part 4-19: Testing and measurement techniques – Test for immunity to  
conducted, differential mode disturbances and signalling in the frequency range  
2 kHz to 150 kHz at a.c. power ports**

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**Compatibilité électromagnétique (CEM) –  
Partie 4-19: Techniques d'essai et de mesure – Essai pour l'immunité aux  
perturbations conduites en mode différentiel et à la signalisation dans la gamme  
de fréquences de 2 kHz à 150 kHz, aux accès de puissance à courant alternatif**



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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	8
3.1 Terms and definitions.....	8
3.2 Abbreviations.....	9
4 General .....	9
5 Test levels and wave profiles in the frequency range 2 kHz to 150 kHz .....	10
5.1 Test levels for differential voltage testing .....	10
5.1.1 General .....	10
5.1.2 Test wave profile with CW pulses with pause.....	11
5.1.3 Test wave profile with rectangularly modulated pulses.....	12
5.2 Test levels for differential current testing .....	12
5.2.1 General .....	12
5.2.2 Test wave profile with CW pulses with pause.....	13
5.2.3 Test wave profile with rectangularly modulated pulses.....	13
6 Test equipment.....	13
6.1 Test generators .....	13
6.1.1 General .....	13
6.1.2 Characteristics and performance of the generator for the differential voltage test.....	14
6.1.3 Characteristics and performance of the generator for the differential current test.....	14
6.2 Verification of the characteristics of the test generators .....	15
6.2.1 General .....	15
6.2.2 Verification of the generators.....	15
6.2.3 Verification of the coupling/decoupling network .....	16
7 Test setups.....	17
7.1 Test setup for differential mode voltage testing.....	17
7.2 Test setup for differential mode current test.....	18
8 Test procedure .....	18
8.1 General.....	18
8.2 Laboratory reference conditions .....	19
8.2.1 Climatic conditions .....	19
8.2.2 Electromagnetic conditions.....	19
8.3 Execution of the test .....	19
9 Evaluation of test results .....	19
10 Test report.....	20
Annex A (informative) Interference sources, victims and effects.....	21
Annex B (informative) Selection of test levels .....	25
Annex C (informative) Testing electricity meters guideline .....	27
C.1 Example of the basic structure of a test generator for differential current testing.....	27
C.2 Example of a test circuit.....	28

C.3 Example of a realized setup including schematics .....	29
Annex D (informative) Test wave profiles .....	30
Bibliography .....	31
Figure 1 – Frequency vs. amplitude profile for differential voltage testing .....	11
Figure 2 – Test wave profile with CW pulses with pause .....	12
Figure 3 – Test wave profile with rectangularly modulated pulses for differential voltage testing .....	12
Figure 4 – Example of a simplified circuit diagram with the major elements of the differential voltage test generator .....	14
Figure 5 – Test setup for verification of the CDN in a 10 $\Omega$ measurement system .....	16
Figure 6 – Limit for the damping characteristics measured in a 10 $\Omega$ measurement system .....	17
Figure 7 – Example of test setup for differential mode voltage testing with auxiliary equipment .....	17
Figure 8 – Example of test setup for differential mode current testing .....	18
Figure A.1 – Standards dealing with voltage levels due to non-intentional emissions in the frequency range 2 kHz to 150 kHz .....	23
Figure A.2 – Standards dealing with voltage levels due to intentional emissions in the frequency range 2 kHz to 150 kHz .....	24
Figure C.1 – Simplified circuit of a differential current test generator .....	27
Figure C.2 – Example of a test circuit .....	28
Figure C.3 – Example for a realized test set up .....	29
Table 1 – Test levels in the 2 kHz to 150 kHz frequency range for differential voltage testing .....	10
Table 2 – Test levels in the 2 kHz to 150 kHz frequency range for differential current testing .....	13

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 4-19: Testing and measurement techniques – Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at a.c. power ports**

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International Standard IEC 61000-4-19 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-19 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The text of this standard is based on the following documents:

FDIS	Report on voting
77A/845/FDIS	77A/854/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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## INTRODUCTION

IEC 61000 is published in separate parts, according to the following structure:

### **Part 1: General**

General considerations (introduction, fundamental principles)  
Definitions, terminology

### **Part 2: Environment**

Description of the environment  
Classification of the environment  
Compatibility levels

### **Part 3: Limits**

Emission limits  
Immunity limits (in so far as they do not fall under the responsibility of the product committees)

### **Part 4: Testing and measurement techniques**

Measurement techniques  
Testing techniques

### **Part 5: Installation and mitigation guidelines**

Installation guidelines  
Mitigation methods and devices

### **Part 6: Generic standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts, published either as international standards or as technical specifications or technical reports, some of which have already been published as sections. Others are published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

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## ELECTROMAGNETIC COMPATIBILITY (EMC) –

### Part 4-19: Testing and measurement techniques – Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at a.c. power ports

#### 1 Scope

This part of IEC 61000 relates to the immunity requirements and test methods for electrical and electronic equipment to conducted, differential mode disturbances and signalling in the range 2 kHz up to 150 kHz at a.c. power ports.

The object of this standard is to establish a common and reproducible basis for testing electrical and electronic equipment with the application of differential mode disturbances and signalling to a.c. power ports. This standard defines:

- test waveforms;
- range of test levels;
- test equipment;
- test setup;
- test procedures;
- verification procedures.

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These tests are intended to demonstrate the immunity of electrical and electronic equipment operating at a mains supply voltage up to 280 V (from phase to neutral or phase to earth, if no neutral is used) and a frequency of 50 Hz or 60 Hz when subjected to conducted, differential mode disturbances such as those originating from power electronics and power line communication systems (PLC).

NOTE In some countries, the maximum voltage can be as much as 350 V from phase to neutral.

The immunity to harmonics and interharmonics, including mains signalling, on a.c. power ports up to 2 kHz in differential mode is covered by IEC 61000-4-13.

Emissions in the frequency range 2 kHz to 150 kHz often have both differential mode and common mode components. This standard provides immunity tests only for differential mode disturbances and signalling. It is recommended to perform common mode tests as well, which are covered by IEC 61000-4-16.

#### 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.

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*  
Amendment 1:2009

IEC 61000-4-16:1998, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in*

*the frequency range 0 Hz to 150 kHz*  
 Amendment 1:2001  
 Amendment 2:2009

### 3 Terms and definitions

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

NOTE The terms apply to the restricted field of conducted, differential mode disturbances and signalling in the range of 2 kHz up to 150 kHz (not all of these definitions are included in IEC 60050-161).

#### 3.1 Terms and definitions

##### 3.1.1

##### **auxiliary equipment**

##### **AE**

equipment that is necessary for setting up all functions and assessing the correct performance (operation) of the EUT (equipment under test) during the test

##### 3.1.2

##### **port**

particular interface of the specified equipment with the external electromagnetic environment

##### 3.1.3

##### **a.c. power port**

port of connection to power supply networks

##### 3.1.4

##### **coupling**

interaction between circuits transferring energy from one circuit to another

##### 3.1.5

##### **coupling network**

electrical circuit for the purpose of transferring energy from one circuit to another

##### 3.1.6

##### **immunity (to a disturbance)**

ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-20]

##### 3.1.7

##### **differential mode voltage**

##### **symmetrical voltage**

voltage between any two of a specified set of active conductors

[SOURCE: IEC 60050-161:1990, 161-04-08]

##### 3.1.8

##### **differential mode current**

##### **$I_{Diff}$**

in a two-conductor cable, or for two particular conductors in a multi-conductor cable, half the magnitude of the difference of the phasors representing the currents in each conductor

[SOURCE: IEC 60050-161:1990, 161-04-38]

### 3.1.9 load current

#### $I_{Load}$

for the EUT which has a dedicated a.c. current measurement port, this is the current at power frequency flowing through the current path of the EUT, e.g. in an electricity meter, typically the load current  $I_{Load}$  is flowing through the live wires  $L_{IN}$  to  $L_{OUT}$  of the meter

### 3.2 Abbreviations

BB	Broadband
CDN	Coupling/decoupling network
CW	Continuous wave
EUT	Equipment under test
LV	Low voltage
MV	Medium voltage
NB	Narrowband
PLC	Power line communications

## 4 General

Conducted, differential mode disturbances and signalling in the frequency range 2 kHz up to 150 kHz may influence the performance of equipment and systems installed in all electromagnetic environments. Therefore in this frequency range, differential mode disturbances and signalling are to be taken into account.

As coupling of these disturbances and signalling could be very strong for a.c. power ports but is only relatively weak for all the other ports, the requirements of this standard apply to a.c. power ports only.

The disturbances and signalling are typically generated by:

- power line communication systems;
- power electronic equipment (e.g. power converters, lighting).

Annex A contains information on the interference sources, victims and effects.

Annex D provides the rationale for the test wave profiles and some recommendations for the choice of the tests.

Adequate immunity to these differential mode disturbances and signalling is necessary. To verify such immunity, two tests for voltage and current are defined in this standard, both in the frequency range from 2 kHz to 150 kHz:

- a sweep test performed with CW (continuous wave) pulses with pauses between each pulse;
- a test performed with blocks of rectangularly modulated pulses with four different modulation frequencies.

Typically, voltage tests apply to all equipment, while current tests are intended for equipment with an a.c. current measurement port, such as an electricity meter.

Product committees are free to choose between voltage and current tests, test levels, type of modulation and modulation frequencies.

Nevertheless, it is recommended to perform immunity tests including at least a sweep test performed with CW pulses with pause and another test with rectangularly modulated pulses

with modulation frequencies of 3 Hz and 101 Hz for power frequency at 50 Hz (or 4 Hz and 121 Hz at 60 Hz) which reflect the interference due to inverters and mains communication systems.

NOTE Test levels proposed in Clause 5 may be revised in the future in order to take into account work underway on compatibility levels (IEC 61000-2-2 and IEC 61000-2-12).

## 5 Test levels and wave profiles in the frequency range 2 kHz to 150 kHz

### 5.1 Test levels for differential voltage testing

#### 5.1.1 General

Test levels for differential voltage testing to a.c. power ports in the frequency range from 2 kHz up to 150 kHz are given in Table 1.

A guide for the selection of the test level is given in Annex B.

The level in column 1 of Table 1 makes reference to the environment class (Class 1, Class 2, etc.) defined in Annex B. Table 1 gives the preferred values of test voltage levels for equipment used in the corresponding environment class.

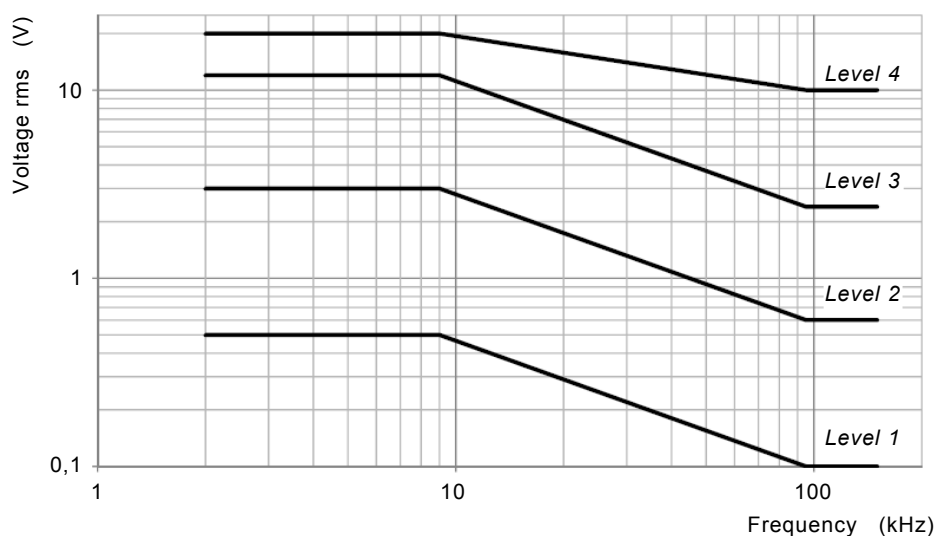
**Table 1 – Test levels in the 2 kHz to 150 kHz frequency range for differential voltage testing**

Level	Open circuit unmodulated test voltage (V (r.m.s.))		
	2 kHz to 9 kHz	9 kHz to 95 kHz	95 kHz to 150 kHz
1	0,5	0,5 to 0,1	0,1
2	3	3 to 0,6	0,6
3	12	12 to 2,4	2,4
4	20	20 to 10	10
X <sup>a</sup>	Special	Special	Special

<sup>a</sup> "X" can be any level, above, below or in between the others. The level shall be specified by the product standard.

As shown in Figure 1, where the profile for each of the open circuit test voltage defined in Table 1 in relation to the frequency is given, the test voltage varies with frequency as follows:

- the level is constant from 2 kHz to 9 kHz;
- the logarithm of the level decreases linearly with the logarithm of the frequency from 9 kHz to 95 kHz;
- the level is constant from 95 kHz to 150 kHz.



IEC 1447/14

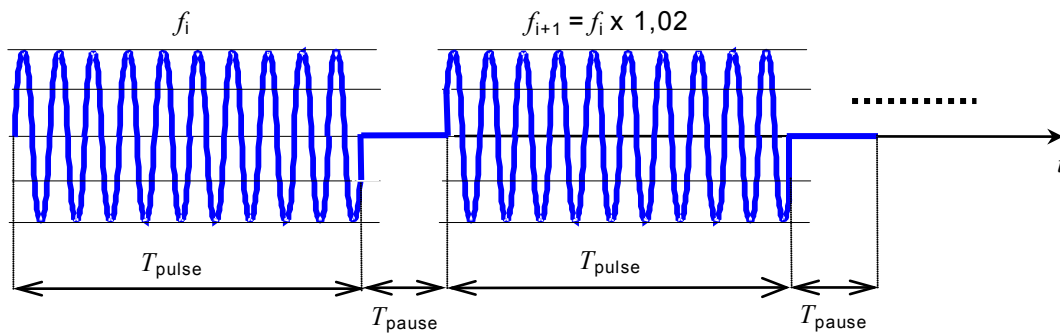
**Figure 1 – Frequency vs. amplitude profile for differential voltage testing**

On the basis of investigations currently available (see Annex A), differential mode tests with two types of modulation are required: one with CW pulses with pauses between each pulse (5.1.2, respectively 5.2.2), and another with blocks of regularly modulated pulses (5.1.3, respectively 5.2.3).

### 5.1.2 Test wave profile with CW pulses with pause

The test is carried out by applying a sequence of pulses of a sinusoidal signal (CW) with an increasing frequency  $f_i$  ranging from 2 kHz to 150 kHz and pauses of a defined duration as follows (see also Figure 2):

- Each CW pulse has a duration (dwell time) of  $T_{\text{pulse}}$ .
- Between each CW pulse the level of the test signal (voltage or current) is zero for a period of  $T_{\text{pause}} = 300$  ms with a tolerance of  $\pm 200$  ms.
- The dwell time  $T_{\text{pulse}}$  shall not be less than the time necessary for the EUT to be exercised and to respond, but shall not be less than 3 s. Product committees may consider requiring longer dwell times.
- The duration of one test cycle for a specific CW test frequency is  $T_{\text{pulse}} + T_{\text{pause}}$ .
- The start frequency of the CW test signal shall be 2 kHz and the frequency of the successive CW test signals shall be increased by 2 % with respect to the previous test frequency:  $f_i = 1,02 f_{i-1}$ .
- The turn-off times at the end of a CW pulse (start of the pause) and the turn-on times at the beginning of a CW pulse (end of the pause) of the test voltages (at frequencies  $f_i, f_{i+1}, \dots$ ) need not be synchronized with the zero crossings of the CW test signal.



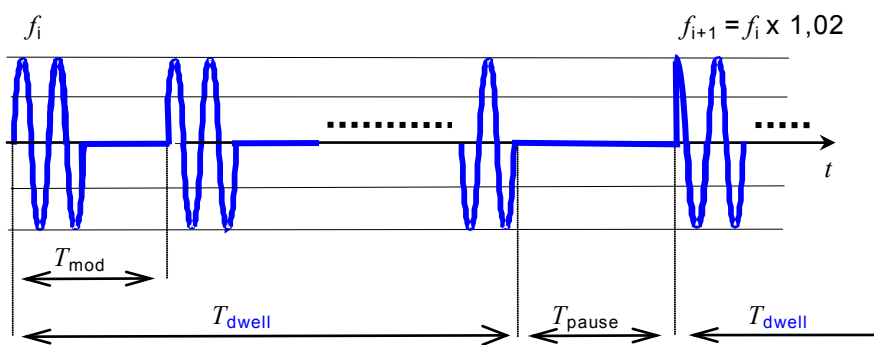
IEC 1448/14

Figure 2 – Test wave profile with CW pulses with pause

5.1.3 Test wave profile with rectangularly modulated pulses

The test is performed by applying a sequence of pulses with an increasing frequency ranging from 2 kHz to 150 kHz that is pulse-modulated with four different modulation frequencies with a duty cycle of 50 % as follows (see also Figure 3):

- The sequence of pulses at frequency  $f_i$  for a chosen modulation frequency has a duration (dwell time) of  $T_{dwell} = 3$  s.
- The start frequency of the pulses shall be 2 kHz and the frequency of the successive sequence of pulses shall be increased by 2% with respect to the previous frequency:  $f_i = 1,02 f_{i-1}$ . Between two dwell times there is a pause of 300 ms with a tolerance of  $\pm 200$  ms. For the four specified tests with rectangularly modulated pulses, the modulation frequencies  $f_{mod}$  depend on the applicable mains power frequency as follows:  
 50 Hz: 3 Hz; 101 Hz; 301 Hz; 601 Hz;  
 60 Hz: 4 Hz; 121 Hz; 361 Hz; 721 Hz.
- The modulation period  $T_{mod}$  for a certain modulation frequency  $f_{mod}$  has the following relation:  $T_{mod} = 1/f_{mod}$
- The turn-off times at the end of a pulse and the turn-on times at the beginning of a pulse need not be synchronized with the zero crossings of the pulses.



IEC 1449/14

Figure 3 – Test wave profile with rectangularly modulated pulses for differential voltage testing

5.2 Test levels for differential current testing

5.2.1 General

Table 2 shows the test levels in the 2 kHz to 150 kHz frequency range for differential current testing.

A guide for the selection of the test level is given in Annex B.

The level in column 1 of Table 2 makes reference to the class environment (Class 1, Class 2, etc.) defined in Annex B. Table 2 gives the preferred values of test current levels for equipment used in the corresponding class environment.

**Table 2 – Test levels in the 2 kHz to 150 kHz frequency range for differential current testing**

Level	Unmodulated current in A (r.m.s.)	
	2 kHz to 30 kHz	30 kHz to 150 kHz
1	1	0,5
2	2	1
3	3	1,5
4	4	2
X <sup>a</sup>	Special	Special

At the transition frequency, the higher level applies.

<sup>a</sup> "X" can be any level, above, below or in between the others. The level shall be specified by the product standard.

Two types of differential current test modulation are defined, one with CW pulses with pauses between each pulse (5.2.2), and another with blocks of rectangularly modulated pulses (5.2.3). Product committees shall define if only one or both modulation types shall be applied.

### 5.2.2 Test wave profile with CW pulses with pause

The same test wave profile as defined for differential voltage testing in 5.1.2 is applicable. Product committees may define frequency step sizes smaller than specified in 5.1.2. As an example, this test profile is applied for electricity meters.

### 5.2.3 Test wave profile with rectangularly modulated pulses

The same test wave profile as defined for differential voltage testing in 5.1.3 is applicable. Product committees may define frequency step sizes smaller than specified in 5.1.3.

## 6 Test equipment

### 6.1 Test generators

#### 6.1.1 General

The features of the test generator for differential voltage testing are given in 6.1.2. The features of the test generator for differential current testing are given in 6.1.3.

All the generators shall have provisions to prevent emissions which, if injected in the power supply network, may influence the test results.

A single electronic a.c. power source for both the differential voltage test and for the differential current test can be used as test generator. For the differential test voltage generator, the values of  $C$  and  $L$  included in Figure 4 are determined by the performance requirements.