

Instruments and software used for measurement in high-voltage impulse tests —

Part 1: Requirements for instruments

The European Standard EN 61083-1:2001 has the status of a
British Standard

ICS 17.220.20

National foreword

This British Standard is the official English language version of EN 61083-1:2001. It is identical with IEC 61083-1:2001. It supersedes BS EN 61083-1:1993 which will be withdrawn on 2004-03-01.

The UK participation in its preparation was entrusted to Technical Committee PEL/42, Testing techniques for high voltages and currents, which has the responsibility to:

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**Instruments and software used for measurement
in high-voltage impulse tests
Part 1: Requirements for instruments
(IEC 61083-1:2001)**

Appareils et logiciels utilisés pour les
mesures pendant les essais de choc
à haute tension
Partie 1: Prescriptions pour les appareils
(CEI 61083-1:2001)

Messgeräte und Software bei
Stoßspannungs- und Stoßstromprüfungen
Teil 1: Anforderungen an Messgeräte
(IEC 61083-1:2001)

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Foreword

The text of document 42/164/FDIS, future edition 2 of IEC 61083-1, prepared by IEC TC 42, High-voltage testing techniques, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61083-1 on 2001-03-01.

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Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, C and ZA are normative and annex D is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61083-1:2001 was approved by CENELEC as a European Standard without any modification.

CONTENTS

	Page
FOREWORD.....	2
1 General.....	5
1.1 Scope.....	5
1.2 Normative references.....	5
1.3 Terms and definitions.....	6
1.3.1 General definitions.....	6
1.3.2 Definitions specific for digital recorders and analogue oscilloscopes.....	7
1.3.3 Definitions specific for digital recorders.....	7
1.4 Operating conditions.....	9
1.5 Calibration and test methods.....	9
1.5.1 Impulse calibration.....	9
1.5.2 Step calibration.....	10
1.5.3 Constancy of scale factor within time interval.....	11
1.5.4 Time base.....	11
1.5.5 Rise time.....	11
1.5.6 Voltage deflection characteristic of analogue oscilloscopes.....	11
1.5.7 Determination of static differential and integral non-linearities.....	12
1.5.8 Differential non-linearity under dynamic conditions.....	12
1.5.9 Internal noise level.....	12
1.5.10 Interference.....	12
1.6 Input impedance.....	13
2 Digital recorders for impulse tests.....	13
2.1 Requirements for impulse measurements.....	13
2.1.1 Requirements for digital recorders used in approved measuring systems.....	13
2.1.2 Individual requirements.....	13
2.1.3 Requirements for digital recorders used in reference measuring systems.....	15
2.1.4 Tests.....	15
2.1.5 Record of performance.....	17
3 Analogue oscilloscopes for impulse tests.....	18
3.1 Requirements for impulse requirements.....	18
3.1.1 Requirements for analogue oscilloscopes used in approved measuring systems.....	18
3.1.2 Individual requirements.....	18
3.1.3 Tests.....	19
3.1.4 Record of performance.....	20
4 Peak voltmeters for impulse tests.....	21
4.1 Requirements for impulse measurements.....	21
4.1.1 General requirements for peak voltmeters.....	21
4.1.2 Individual requirements.....	21
4.1.3 Tests.....	22
4.1.4 Record of performance.....	23

Annex A (normative) Procedure for determination of non-linearities of a digital recorder.....	27
Annex B (normative) Electromagnetic interference in high-voltage laboratories.....	30
Annex C (normative) Calibration method for analogue oscilloscopes — Separate calibration of voltage and time.....	33
Annex D (informative) Analysis of impulse waveform.....	34
Annex ZA (normative) Normative references to international publications with their corresponding European publications.....	35
Figure 1 — Integral non-linearity $s(k)$ at code k	24
Figure 2 — Differential non-linearity $d(k)$ and code bin width $w(k)$ under d.c. conditions.....	24
Figure 3 — Calibration by comparison.....	25
Figure 4 — Separate calibration of voltage and time.....	25
Figure 5 — Step calibration.....	26
Figure A.1 — Determination of non-linearities.....	29
Figure B.1 — Current injection into the shield of the cable.....	32
Figure B.2 — Application of electric and magnetic fields.....	32
Table 1— Operating conditions.....	9
Table 2 — Requirements for reference impulse generators.....	10
Table 3 — Tests required for digital recorders.....	16
Table 4 — Tests required for analogue oscilloscopes.....	19
Table 5 — Tests required for peak voltmeters.....	22

INSTRUMENTS AND SOFTWARE USED FOR MEASUREMENT IN HIGH-VOLTAGE IMPULSE TESTS –

Part 1: Requirements for instruments

1 General

1.1 Scope

This part of IEC 61083 is applicable to **digital recorders**, including digital oscilloscopes, **analogue oscilloscopes** and **peak voltmeters** used for measurements during tests with high impulse voltages and high impulse currents. It specifies the measuring characteristics and calibrations required to meet the measuring uncertainties and procedures specified in IEC 60060-2.

This part

- defines the terms specifically related to **digital recorders**, **analogue oscilloscopes** and **peak voltmeters**,
- specifies the necessary requirements for such instruments to ensure their compliance with the requirements for high-voltage and for high-current impulse tests, and
- establishes the tests and procedures necessary to demonstrate their compliance.

Only **digital recorders** that permit access to **raw data** from permanent or temporary storage are covered by this standard. The **raw data**, with relevant scaling information, may be

- printed graphically, or
- stored in digital format.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61083. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61083 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2:1994, *High-voltage test techniques – Part 2: Measuring systems*
Amendment 1 (1996)

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test*. Basic EMC Publication

1.3 Terms and definitions

For the purposes of this part of IEC 61083, the following terms and definitions apply.

1.3.1 General definitions

1.3.1.1

digital recorder

instrument, including a digital oscilloscope, which can make a temporary digital record of a high-voltage or high-current impulse, that can be converted into a permanent record. The digital record can be displayed in the form of an analogue graph

NOTE The waveform may be displayed on a screen, plotted or printed. This process may change the appearance of the waveform due to the processing involved.

1.3.1.2

analogue oscilloscope

instrument, which can make a temporary analogue record of a scaled high-voltage or high-current impulse, that can be converted into a permanent record. The permanent record can be displayed in the form of a graph or photograph of the screen of the oscilloscope

1.3.1.3

peak voltmeter

instrument, which can measure the peak value of a scaled high-voltage or high-current impulse without short-duration overshoot or high-frequency oscillation (see clause 4)

1.3.1.4

warm-up time

time interval from when the instrument is first switched on to when the instrument meets operational requirements

1.3.1.5

operating range

range of input voltage for which the instrument can be used within the uncertainty limits given in this standard

1.3.1.6

output of an instrument

1.3.1.6.1

output of a digital recorder

numerical value recorded by a **digital recorder** at a specific instant

1.3.1.6.2

output of an analogue oscilloscope

deflection of the trace of an **analogue oscilloscope** at a specific instant

1.3.1.6.3

output of a peak voltmeter

display of a **peak voltmeter**

1.3.1.7

offset

output of an instrument for zero input

1.3.1.8

full-scale deflection

minimum input voltage, which produces the nominal maximum output of the instrument in the specified range

1.3.1.9

non-linearity of amplitude

deviation of the actual **output of an instrument** from the nominal value, which is determined by dividing the input voltage by the **scale factor**

NOTE The static non-linearity for a d.c. input voltage may be different from the non-linearity under dynamic condition.

1.3.1.10

scale factor

factor by which the output corrected for **offset** is multiplied in order to determine the measured value of the input quantity. The **scale factor** includes the ratio of any built-in or external attenuator and is determined by calibration

1.3.1.10.1

static scale factor

scale factor for a direct voltage input

1.3.1.10.2

impulse scale factor

scale factor for an input representing the shape of the relevant impulse

1.3.2 Definitions specific for digital recorders and analogue oscilloscopes

1.3.2.1

rise time

time interval within which the response to an applied step passes from 10 % to 90 % of its steady-state amplitude

1.3.2.2

time-scale factor

factor by which the interval measured from the record is multiplied in order to determine the value of that time interval

1.3.2.3

non-linearity of time base

variation of the **time-scale factors** measured in different parts of the trace or digital record from their mean value

1.3.3 Definitions specific for digital recorders

1.3.3.1

rated resolution r

rated resolution is expressed by the reciprocal of two to the power of the rated number of bits N of the A/D converter, namely $r = 2^{-N}$

1.3.3.2

sampling rate

number of samples taken per unit of time

NOTE The sampling time interval is the reciprocal of the **sampling rate**.

1.3.3.3**record length**

duration of the record expressed either in a time unit or as the total number of samples

1.3.3.4**raw data**

original record of sampled and quantized information obtained when a **digital recorder** converts an analogue signal into a digital form

The correction of the output for **offset** to give a zero-based record is permitted, as is multiplying the record by a constant **scale factor**. Records processed in this way are still considered as **raw data**

NOTE 1 This information may be made available in binary, octal, hexadecimal or decimal form.

NOTE 2 The scaling information relevant to the digital record should also be stored.

1.3.3.5**processed data**

data obtained by any processing (other than correction for **offset** and/or multiplying by a constant **scale factor**) of the **raw data**

NOTE **Digital recorders**, which do not allow access to the **raw data**, are not covered by this standard.

1.3.3.6**base line**

value of the output of the recorder during the initial flat part of the record of the impulse. It is the mean of at least 20 samples in the initial flat part of the record

1.3.3.7**quantization characteristic**

characteristic showing the relationship between the output of the **digital recorder** and the direct voltage on the input which produces this output (see figure 1)

NOTE The average slope of the **quantization characteristic** is equal to the reciprocal of the **static scale factor**.

1.3.3.8**code k**

integer used to identify a digital level

1.3.3.9**code bin width $w(k)$**

range of input voltage allocated to **code k** (see figure 2)

1.3.3.10**average code bin width w_0**

product of the **full-scale deflection** and the **rated resolution** (see figure 2)

NOTE The **average code bin width** is approximately equal to the **static scale factor**.

1.3.3.11**integral non-linearity $s(k)$**

difference between corresponding points on the measured **quantization characteristic** and on the ideal **quantization characteristic** that is based on the **static scale factor** (see figure 1)

1.3.3.12

differential non-linearity $d(k)$

difference between a measured **code bin width** and the **average code bin width** divided by the **average code bin width** (see figure 2):

$$d(k) = \frac{w(k) - w_0}{w_0}$$

1.4 Operating conditions

The range of operating conditions given in table 1 are those under which the instrument shall operate and meet the accuracy requirements specified for the instrument.

Table 1 – Operating conditions

Condition	Range
Environment	
Ambient temperature	5 °C to 40 °C
Ambient relative humidity (non-condensing)	10 % to 90 %
Mains supply	
Supply voltage	Rated voltage ± 10 % (r.m.s.) Rated voltage ± 12 % (a.c. peak)
Supply frequency	Rated frequency ± 5 %

Any exceptions to the values given in table 1 shall be explicitly and clearly stated in the record of performance with an indication that they are exceptions.

1.5 Calibration and test methods

1.5.1 Impulse calibration

Impulse calibration is the reference method to establish the **impulse scale factor** of approved **digital recorders**, **analogue oscilloscopes** and **peak voltmeters**. It is also the reference method to check the time parameter determination from the records of **digital recorders** and **analogue oscilloscopes**. Requirements on reference calibration impulses for calibrating instruments used in approved measuring systems are given in table 2. The waveshapes are chosen from table 2 according to the type and polarity of the high voltage or current impulses to be measured. The peak value and time parameters of the applied calibration impulses shall be within the limits given in table 2, and the actual values shall be entered in the record of performance.

The polarity of the calibration impulses shall be that of the impulse to be measured. The output corresponding to the calibration impulse shall be evaluated for at least 10 impulses. The maximum deviation of the output peak values from their mean value shall be less than 1 % of the mean value. The **impulse scale factor** is the quotient of the input peak value and the mean peak value of the outputs.

The time parameters of at least 10 impulses shall be evaluated. The maximum deviation of each time parameter shall be less than 2 % of the mean value.

This impulse calibration shall be made on each range of use for tests. Care should be taken to avoid overloading the devices with low input impedance.

NOTE A **digital recorder** can be calibrated for an exponential current impulse using the full lightning impulse of a reference impulse generator, and switching impulse for 10/350 impulse current (the 10/350 μs impulse current is under consideration for inclusion in the future revision of the IEC 60060 series).

Table 2 – Requirements for reference impulse generators

Impulse type	Parameter being measured	Value	Uncertainty ¹⁾ %	Short-term stability ²⁾ %
Full and standard chopped lightning impulse	Time-to-half value	55 μs to 65 μs	≤ 2	$\leq 0,2$
	Front time	0,8 μs to 0,9 μs	≤ 2	$\leq 0,5$
	Peak voltage	Within operating range	$\leq 0,7$	$\leq 0,2$
Front chopped lightning impulse	Time-to-chopping	0,45 μs to 0,55 μs	≤ 2	≤ 1
	Peak voltage	Within operating range	≤ 1	$\leq 0,2$
Switching impulse	Time-to-peak	15 μs to 300 μs	≤ 2	$\leq 0,2$
	Time-to-half value	2 600 μs to 4 200 μs	≤ 2	$\leq 0,2$
	Peak voltage	Within operating range	$\leq 0,7$	$\leq 0,2$
Rectangular impulse	Duration	0,5 ms to 3,5 ms	≤ 2	$\leq 0,5$
	Peak value	Within operating range	≤ 2	≤ 1
¹⁾ The uncertainty is determined in accordance with annex H of IEC 60060-2 by a traceable calibration where the mean of a sequence of at least 10 impulses is evaluated.				
²⁾ The short-term stability is the standard deviation of a sequence of at least 10 impulses.				

1.5.2 Step calibration

A direct voltage V_{CAL} , which is known to within 0,1 % and within the **operating range** of the instrument, is applied to the input and then short-circuited to ground by an appropriate switching device, preferably based on a mercury-wetted relay. The resultant transition to zero level is recorded as the output $O(t)$ (an example is shown in figure 5) and evaluated within the time interval specified in 1.5.3. Several records of the response may be averaged to reduce the random noise. The deviation of the sample values $O(t)$ from their mean O_s shall be within the limits specified for the **scale factor** when t ranges within the time interval given in 1.5.3. At least 10 records of steps shall be evaluated in this manner. The deviation of each of the 10 O_s values from their overall mean, O_{sm} , shall also be within the limits specified for the **scale factor**. The **impulse scale factor** is the quotient of the input voltage V_{CAL} and O_{sm} . The **rise time** of the step shall be less than 10 % of the lower limit of the time interval specified in 1.5.3.

This voltage calibration shall be made in each range of use for tests. Care should be taken to avoid overloading of recorders with low input impedance.

This test shall be done using both polarities. If the **scale factors** determined agree to within ± 1 %, then this method is valid. If not, impulse calibration according to 1.5.1 of appropriate polarity shall be used.