SLOVENSKI STANDARD
SIST EN 13477-2:2011

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SIST EN 13477-2:2001

Neporušitveno preskušanje - Akustična emisija - Določevanje značilnosti opreme - 2. del: Preverjanje lastnosti delovanja

Non destructive testing acoustic emission - Equipment Characterisation - Part 2: Verification of operating characteristic

Zerstörungsfreie Prüfung - Schallemissionsprüfung - Gerätecharakterisierung - Teil 2: Überprüfung der Betriebskenngrößen

Essais non destructifs, émission acoustique - Caractérisation de l'équipement - Partie 2: Vérifications des caractéristiques de fonctionnement

Ta slovenski standard je istoveten z: EN 13477-2:2010

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

SIST EN 13477-2:2011 **en,fr,de**

EUROPEAN STANDARD

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Supersedes EN 13477-2:2001

English Version

Non-destructive testing - Acoustic emission - Equipment characterisation - Part 2: Verification of operating characteristic

Essais non destructifs, émission acoustique - Caractérisation de l'équipement - Partie 2: Vérifications des caractéristiques de fonctionnement

Zerstörungsfreie Prüfung - Schallemissionsprüfung - Gerätecharakterisierung - Teil 2: Überprüfung der Betriebskenngrößen

This European Standard was approved by CEN on 30 July 2010.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 13477-2:2010) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2011, and conflicting national standards shall be withdrawn at the latest by March 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13477-2:2001.

EN 13477 consists of the following parts under the general title *Non-destructive testing — Acoustic emission — Equipment characterisation*:

— *Part 1: Equipment description*;

— *Part 2: Verification of operating characteristic*.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This part of the standard specifies methods for routine verification of the performance of AE equipment comprising one or more sensing channels. It is intended for use by operators of the equipment under laboratory conditions. Verification of the measurement characteristics is recommended after purchase of equipment, modifications, use under extraordinary conditions, or if one suspects a malfunction. The procedures described in this European Standard do not exclude other qualified methods, e.g. verification in the frequency domain.

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.

EN 1330-1:1998, *Non destructive testing — Terminology — Part 1: List of general terms*

EN 1330-2:1998, *Non destructive testing — Terminology — Part 2: Terms common to the non-destructive testing methods*

EN 1330-9:2009, *Non-destructive testing — Terminology — Part 9: Terms used in acoustic emission testing*

EN 13477-1:2001, *Non-destructive testing — Acoustic emission — Equipment characterisation — Part 1: Equipment description*

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1330-1:1998, EN 1330-2:1998, EN 1330-9:2009 and IEC 60050 (all parts) and the following apply.

3.1
AE signal processor
part of an AE channel for the conversion of the output of the preamplifier to digital signal parameters

NOTE The AE signal processor may include additional support functions, e.g. preamplifier power supply, test pulse control, transient recorder, and more.

3.2
arbitrary function generator (AFG)
electronic device for generating a programmable test signal (burst)

3.3
DC calibrator
electronic device for generating an adjustable or programmable DC voltage of appropriate accuracy for stimulating an external parametric input

4 Required test equipment

4.1 List of required equipment

The following minimum test equipment is required:

a) test body;

b) shielding test plate;

c) Hsu-Nielsen source, for sensor sensitivity verification;

d) sweep function/variable pulse generator (if function not included in f));

e) multimeter, e.g. for DC voltage and DC current measurement;

f) test signal generator, e.g. AE calibrator or arbitrary function generator (AFG);

g) variable attenuator, graduated in decibels, can be part of the test signal generator;

h) DC-calibrator, for external parameter stimulation;

i) DC-power-supply, for preamplifier supply, with a proper circuit to decouple and terminate the AE signal, if the power is fed-in over the signal wire;

j) RMS voltmeter, with known or settable time constant or time window;

k) dual channel storage oscilloscope, for preamplifier verification, peak noise measurement and identification of any artefacts on the AE signal.

NOTE Items i) to k) can be substituted by a verified AE signal processor comprising peak amplitude and RMS measurement.

The inaccuracy of the test signal generator shall be significantly lower than the acceptable inaccuracies given in this standard and summarized in Table 3. Less accurate test signal generators can be used, if the inaccuracy of each pattern is measured and considered during verification.

The reproducibility of the DC calibrator output shall be significantly lower than the acceptable inaccuracy of the external parameter verification. The inaccuracy of the DC calibrator at the used measurement levels shall be obtained and considered during verification (see Clause 8).

All electric/electronic test items shall be calibrated to ensure traceability to SI units.

4.2 Test signal waveforms

The following types of test signals shall be used to verify the operating characteristics of the AE measurement system:

4.2.1 Continuous sine wave

This type of test signal shall be used to verify the frequency response and gain of the preamplifier and the continuous signal level accuracy of the AE signal processor.

4.2.2 Triangular modulated sine wave

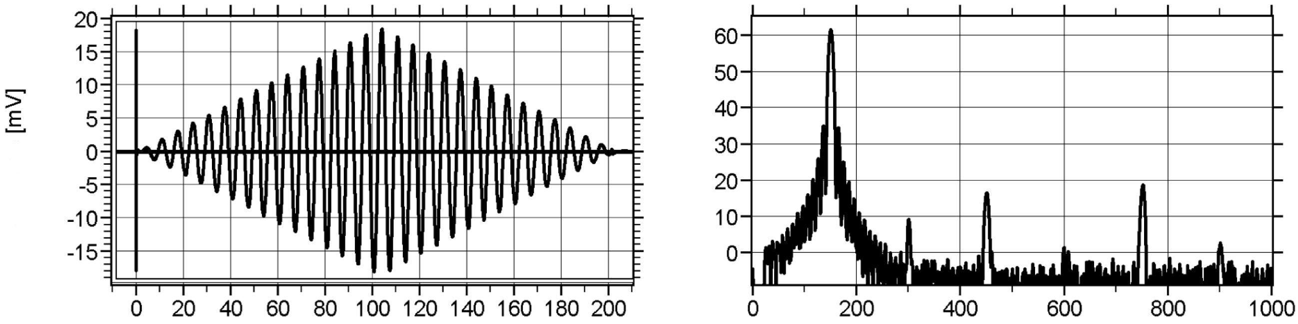
This type of wave simulates an AE burst signal, see Figure 1. It is defined by the following characteristics:

— A = amplitude;

— R = rise-time;

— D = duration;

— f = carrier frequency.



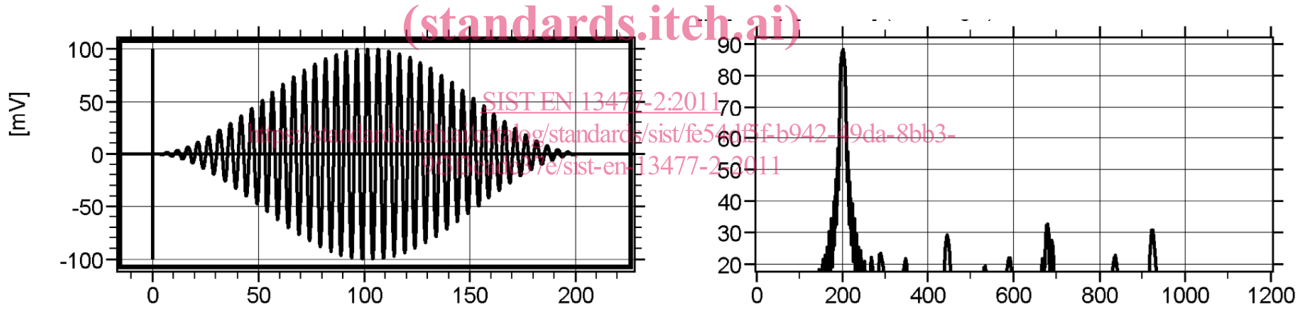
Key
[mV] amplitude

Figure 1 — Triangular modulated sine wave in time (left) and frequency (right) domain

The measured rise time may be shorter than the visible rise time of the test signal because rise time measurement starts at the time of the first threshold crossing. Table 1 shows the dependency of this threshold crossing delay on the difference between maximum amplitude and threshold setting in an AE channel.

4.2.3 Sine²-modulated sine wave

A sine²-modulated signal (see Figure 2) can be used as an alternative to a triangular modulated sine wave. Due to its smooth begin, peak and end, its spectrum is very pure and the influence of filter overshoot and filter ring down behaviour is reduced. This signal can be used to obtain the frequency response of the bandpass of a preamplifier or AE signal processor by burst peak amplitude measurement.



Key
[mV] amplitude

Figure 2 — Sine²-modulated sine wave in time (left) and frequency domain (right)

NOTE The shown signal corresponds to the following function:

$$U[N] = U_P \times \sin(N \times 2 \times \pi / SpSW) \times \sin^2(N \times \pi / (SpSW \times SWpB)) \quad (1)$$

$$N = 0 \text{ to } (\mathrm{SpSW} \times \mathrm{SWpB}) \text{, in integer steps} \quad (2)$$

where

N = number of each sample in time order;

$SpSW$ = Samples per sine wave (48 in Figure 2);

$SWpB$ = Sine waves per burst (41 in Figure 2);

$U[N]$ = Voltage of sample N;

U_P = Peak amplitude (100 mV in Figure 2) of simulated burst.

The resulting carrier frequency f_c is a function of the sample time interval (t_s):

$$f_c = 1/(t_s \times SpSW) \tag{3}$$

or the time interval (t_s) for a certain carrier frequency is

$$t_s = 1/(f_c \times SpSW) \tag{4}$$

Example in Figure 2: t_s = 1/(200 kHz x 48) = 104.167 ns

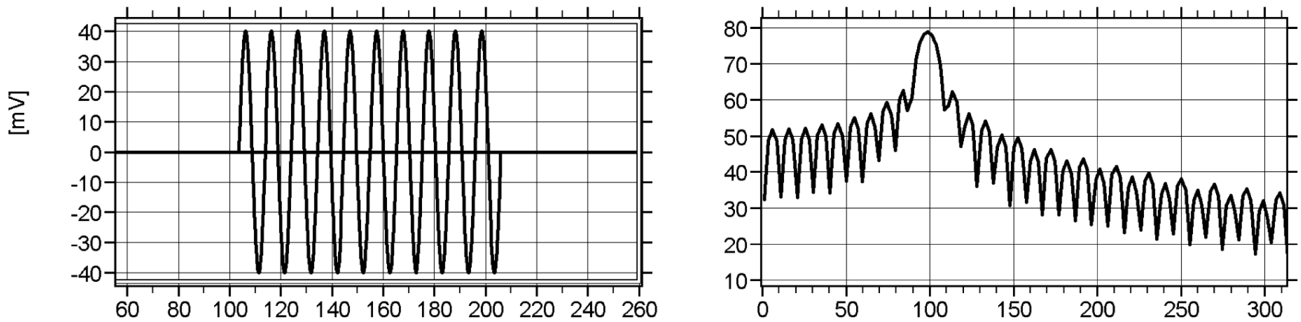
Similar to the triangular modulated sine wave, the rise time measured by an AE signal processor is shorter than the visible rise time of the test signal, because rise time measurement starts at the time of the first threshold crossing. This so-called “first threshold crossing delay” depends on the difference of maximum amplitude and detection threshold in dB and is listed for the two modulated test signals in Table 1.

Table 1 — First threshold crossing delay versus amplitude to threshold ratio for a sin^2 and triangular modulated test signal

Threshold	Sin² modulated first threshold crossing delay % of signal rise time	Triangular modulated first threshold crossing delay % of signal rise time
A – 20 dB	19,7	11,0
A – 25 dB	15,0	6,0
A – 30 dB	12,3	3,5
A – 35 dB	8,3	3,0
A – 40 dB	7,6	1,0

4.2.4 Rectangular modulated sine wave

This type of signal is defined by the characteristics A, D and f, see 4.2.2 and Figure 3.



Key
[mV] amplitude

Figure 3 — Rectangular modulated sine wave in time (left) and frequency domain (right)

4.2.5 Pulse

This test signal shall be used to check the measurement of Δt. It is defined by the characteristics A (amplitude) and D (pulse duration). Figure 4 shows the output of an arbitrary function generator where one sample in a cyclic output buffer was set to 0,8 V, all others to zero. The buffer was output at a sample interval of 50 ns. A pulse duration between 50 ns and 500 ns is recommended. The pulse amplitude shall cause a signal amplitude of about 6 dB above the detection threshold. A much higher amplitude may cause additional threshold crossings by ring down cycles as shown in Figure 5.

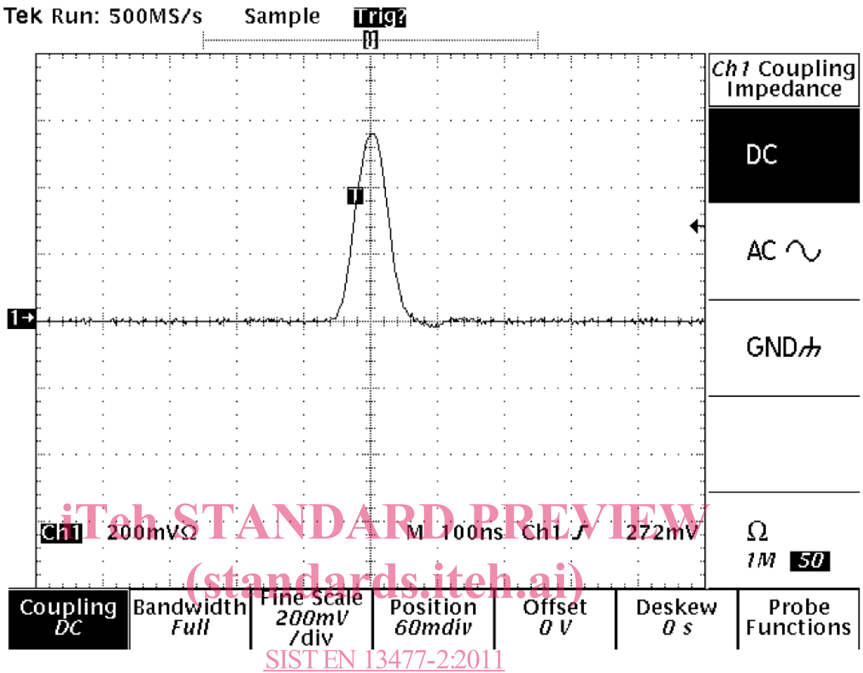
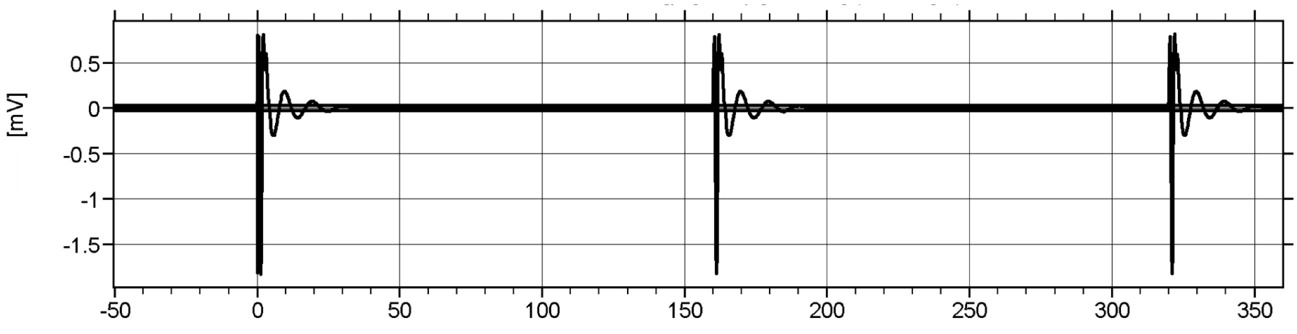


Figure 4 — Pulse

4.2.6 Repetitive signals

This signal is used to verify the signal processing rate. It is a series of pulses as described in 4.2.5. It is defined by A (amplitude), D (pulse duration) and f (repetition frequency), typically 1 Hz – 10 kHz. Figure 5 shows an example with $1/f$ = 160 µs, taken after the band pass filter of an AE signal processor. The maximum reasonable repetition frequency is limited by the ring down effect of the band pass filter, if a pulse causes multiple threshold crossings.



Key

[mV] amplitude

Figure 5 — A series of transient signals (pulses) 160 μs apart behind the band pass

4.3 Test Body

This can take different forms, e.g. a metallic block, or a plate, or an acrylic rod. Once chosen, the dimensions, construction material, Hsu-Nielsen source position, sensor mounting position and usage shall be controlled to ensure reproducibility of results.

The surface in contact with the sensor shall be flat and smooth. The test body shall be isolated acoustically from the work bench to avoid interference from external noise sources.

4.4 Shielding test plate

This is a small flat metallic plate sufficient in size to cover the sensor's sensitive area. The plate shall be connected to a sine wave; therefore, it shall be electrically isolated from earth. Once chosen, the dimension of the plate and the thickness of the non-conductive layer, if applicable, shall be controlled. The test plate shall be given an identifier for use in the verification report. See Figure 6 for the setup.

5 Sensor verification

5.1 General

The following procedure allows rapid comparison of the sensitivity of sensors. The deterioration of the sensors can result from e.g. mechanical shock, exposure to high temperature, high ionizing radiation or a corrosive environment, water ingress, a damaged connector or cable.

5.2 Uses

The specific objectives of the procedure for checking sensors are:

— warning of degrading response or damaged internal shielding;

— determining when a sensor is no longer suitable for use;

— checking sensors that are known to have been exposed to high-risk conditions;

— creating matched sets of sensors to achieve uniform performance;

— verifying sensors quickly and reliably and assisting trouble shooting, when a channel shows a fault.

5.3 Procedure

5.3.1 Preliminary examination

Allow the test body, sensors and couplant to adopt the ambient temperature.

Perform a preliminary examination of the sensor to identify any obvious mechanical damage, paying particular attention to connector and cable, if any.

5.3.2 Sensitivity verification

For the sensitivity verification of a sensor, a verified AE signal processor shall be used. If the sensor does not comprise a preamplifier, a verified reference preamplifier and sensor cable of specified length shall be used. The frequency filters in the preamplifier and AE signal processor shall properly cover the bandwidth of the sensor.