BS EN 13100-4:2012

BSI Standards Publication

Non destructive testing of welded joints of thermoplastics semifinished products

Part 4: High voltage testing

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Non destructive testing of welded joints of thermoplastics semifinished products - Part 4: High voltage testing

Essais non destructifs des assemblages soudés sur produits semi-finis en thermoplastiques - Partie 4 : Essais à haute tension

Zerstörungsfreie Prüfung von Schweißverbindungen thermoplastischer Kunstoffe - Teil 4: Hochspannungsprüfung

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Foreword

This document (EN 13100-4:2012) has been prepared by Technical Committee CEN/TC 249 “Platics”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

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This document is composed of the following parts:

— EN 13100-1, *Non destructive testing of welded joints of thermoplastics semi-finished products — Part 1: Visual examination*;

— EN 13100-2, *Non-destructive testing of welded joints in thermoplastics semi-finished products — Part 2: X-ray radiographic testing*;

— EN 13100-3, *Non destructive testing of welded joints in thermoplastics semi-finished products — Part 3: Ultrasonic testing*;

— EN 13100-4, *Non destructive testing of welded joints of thermoplastics semifinished products — Part 4: High voltage testing*.

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1 Scope

This European Standard specifies the equipment and methods for the high voltage testing of butt or overlap welded joints in thermoplastic sheets for locating through-thickness defects only. It applies to new unused constructions only.

2 Terms and definitions

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

2.1
dielectric strength
maximum voltage a material of unit thickness can withstand continuously without failure

3 Symbols and designations

Symbols and designations are given in Table 1.

Table 1 — Symbols and designations

Symbol	Designation	Unit
D_s	Dielectric strength	Vmm^{-1}
V_B	Breakdown voltage	V
d_t	Distance from test electrode to conductor	mm
V_I	Initial test voltage	V
V_A	Actual voltage used for the test	V
V_o	Voltage which causes a spark at a hole in the plastic sheet	V

4 Principle of the test

A high voltage is applied to one side of the joint to be tested using a suitable electrode, the other side of the material needs to be in contact with a conductive substrate which in some cases will need a connection back to the test equipment.

The test shall be carried out with a voltage high enough to jump the gap between the test electrode and a conductor. A defect is indicated by a spark discharge and, depending on the equipment used, a simultaneous optical and / or acoustic signal.

The health and safety aspects (e.g. electric shocks, risks of explosions in flammable atmosphere) together with the environmental impacts (e.g. electromagnetic disturbances) shall be thoroughly considered before operating the equipment.

NOTE Moisture in concrete can make it sufficiently conductive to allow high voltage testing to be used.

5 Equipment types

5.1 General

There are three types of high voltage tester available. The most appropriate type to be used will depend on the type of tests to be carried out and customer requirements.

5.2 High frequency spark tester

5.2.1 Principle

This equipment generates a high frequency AC voltage of up to 100 kV. It is normally mains powered. The output is low power and normally un-stabilised. The output voltage is adjusted by spark length. Defects are normally indicated by visual spark only.

5.2.2 Advantages

— No connection to the substrate required as long as it is metal and has an area 1 000 times larger than the test electrode.

— Higher output voltages, allowing thicker material or longer overlap joints to be tested.

5.2.3 Limitations

— No output voltage meter.

— Fault identified by visual spark only.

— AC mains powered.

5.3 DC Holiday detector

5.3.1 Principle

This equipment generates a DC high voltage of up to 50 kV. It can be mains or battery powered. The output is low power and normally stabilised. The output voltage is indicated on a meter either in the unit or external to it. Defects are indicated by the activation of an optical and/or acoustic signal as well as a visual spark.

5.3.2 Advantages

— The test voltage can be set accurately.

— Can be used on concrete substrates.

5.3.3 Limitations

— Connection to substrate required.

— Can be affected by moisture on the surface of the thermoplastic sheet.

5.4 Pulsed Holiday detector

5.4.1 Principle

This equipment generates a pulsed DC high voltage of up to 50 kV. The pulse rate can be from 30 to 10 000 pulses per second depending on the manufacturer. Pulsed units tend to have higher power output than spark testers or DC holiday detectors. The output voltage can be verified using a crest reading voltmeter. Imperfections are indicated by the activation of an optical and/or acoustic signal as well as a visual spark.

5.4.2 Advantages

— Can work in the presence of a small amount of moisture on the surface.

5.4.3 Limitations

— Connection to substrate required.

— Output voltage harder to verify (special meter required).

— Lower speed of testing dependent on pulse rate.

6 Determination of test voltage

6.1 General

This section is for testers that can be set to a known voltage.

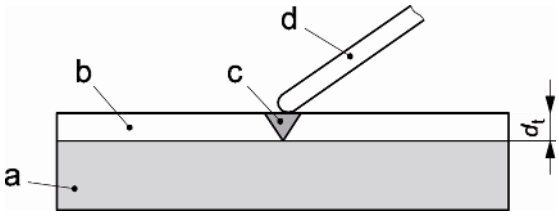
6.2 Butt joints

6.2.1 Test arrangement

For butt joints in thermoplastic sheets with a thickness in the range 1 mm to 30 mm (see Figure 1), the initial test voltage, V_I, is given by:

$$V_I = 250\ (1000\ d_t)^{½} \quad (1)$$

Providing the test electrode is in contact with the upper surface of the sheet and the conductive substrate is in contact with the lower surface of the sheet, d_t is equal to the sheet thickness.



Key

a substrate
b plastic sheet
c weld
d electrode

Figure 1 — Butt joint

However, depending on the dielectric strength of the sheet, V_I can damage the material. The breakdown voltage, V_B, is given by:

$$V_B = D_s\, d_t \quad (2)$$

The value of the breakdown voltage, V_B, for each sheet shall be calculated from Formula (2) using the value of D_s provided by the sheet manufacturer.

If $V_I < V_B$, then the actual test voltage to be used, V_A, shall be equal to V_I.

If $V_I > V_B$, then experimental trials, as described in 6.2.2, shall be carried out to determine V_A.

If the dielectric strength is not known, the output voltage of the tester shall be set to 1.3 V_I. The test electrode shall then be placed on an unwelded test piece of the same material in which the welds are to be examined and the voltage shall be applied for a duration of 1 min. If no fault is made in the sheet then V_A shall be equal to V_I. If the material fails then further experimental trials, as described in 6.2.2, shall be carried out to determine V_A.

6.2.2 Determination of V_A if $V_I > V_B$

A 1 mm diameter perpendicular hole shall be made in an unwelded test piece of the same material in which the welds are to be examined, using a clean drill. The minimum distance from the hole to the edge of the test piece shall be five times the sheet thickness. With the electrode over the hole, the voltage shall be increased until a spark jumps the gap. This voltage, V_o, shall be noted.

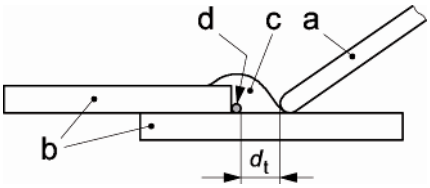
Further holes shall be made in the test piece at an angle of 45°. The minimum distance between holes and also between any hole and the edge of the test piece shall again be five times the sheet thickness. The test voltage shall then be increased to $(V_B+V_o)/2$ and, if all of the holes are detected, this shall be used as V_A.

If any of the holes are not detected, the test voltage shall be increased by 10 % and the tests shall be repeated using new holes. Test holes shall only be used once.

6.3 Overlap joints

In overlap joints the distance from the test electrode to the substrate, d_t, can be many times the thickness of the material and the test voltage required could therefore cause the material to break down.

To minimise the test voltage required, a thin un-insulated wire should be placed as close as possible to the inside of the weld. See Figure 2.



Key

a electrode
b plastic sheet
c weld
d wire

Figure 2 — Overlap joint

If the required test voltage is higher than the dielectric strength for the given thickness, check that the material can withstand the higher test voltage, place the test electrode on a sample piece of the material, not a weld and apply the test voltage for 1 min.

If no fault is made in the sample then the test voltage is usable. If the material fails then the maximum distance from the test electrode to the wire must be reduced either by reducing the width of the weld or by changing the material used, and the test voltage recalculated.

7 Test electrode

The test electrode shall be constructed in such a way that it makes contact with the sheet surface without gapping or missing any of the area to be tested.

For recessed or protruding areas, a small (i.e. with a contact area < 1 cm^2) brush electrode should be used.

For overlap joints, a small brush or pointed electrode should be used.

The test electrodes shall be kept in such a mechanical condition as to maintain contact with the sheet surface at all times during the examination.

8 Test procedure

8.1 DC and pulsed holiday detectors

The surface to be tested shall be clean and dry.

The test electrode shall be connected to the high voltage tester in accordance with the manufacturer's instructions.

The high voltage return lead from the detector shall be connected to the substrate or wire and a separate electrical connection shall be made between the substrate and a true earth.

The output voltage of the detector shall be adjusted to the required level, V_A.

To check that the detector is working, the test electrode shall be placed on the substrate; a spark should be seen and the audio / visual alarm should operate.

The test electrode shall be moved without stopping along the weld and in contact with it, at a speed of 40 cm/s maximum, or slower if indicated by the detector manufacturer.

The location of faults shall be visibly marked as they are detected.

All faults detected shall be repaired and the area retested.

8.2 High frequency spark testers

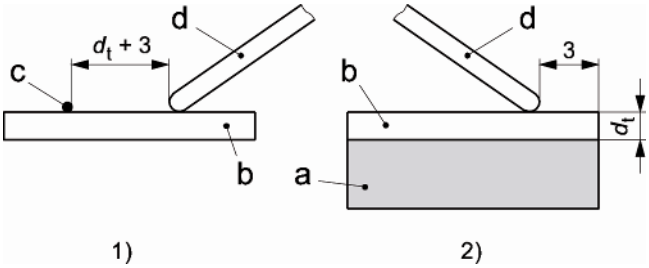
The surface to be tested shall be clean and dry.

The test electrode shall be connected to the spark tester in accordance with the manufacturer's instructions.

If possible, a separate electrical connection should be made between the substrate or wire and a true earth, since this will give a brighter spark.

With the test electrode on the surface, the output of the spark tester shall be adjusted to give a spark length 3 mm longer than the maximum distance expected when testing between the electrode and substrate or wire. See Figure 3.

Dimensions in millimetres



Key

a substrate
b plastic sheet
c wire
d electrode

Figure 3 — Setting of spark testers output for: 1) overlap joint, and 2) butt joint

For butt joints, the test electrode shall be placed on the sheet surface 3 mm from the edge and the output voltage of the spark tester shall be increased until a spark is seen jumping from the electrode to the substrate.

For overlap joints, a wire connected to earth shall be placed onto the sheet surface and the test electrode shall then be placed on the surface 3 mm further away from the wire than the maximum distance expected when testing (i.e. maximum distance expected = 10 mm, place the test electrode 13 mm from the wire).

The test electrode shall be moved without stopping along the weld and in contact with it, at a speed of 20 cm/s maximum, or slower if indicated by the spark tester manufacturer. However if the speed of the electrode is too slow this can result in damage to the material.

Faults are indicated by a brighter spark from the electrode.

The location of faults shall be visibly marked as they are detected. All faults detected shall be repaired and the area retested.

9 Test report

The examination report shall include a reference to this standard and at least the following information:

a) identification of the object under examination;

b) material type;

c) geometry of the weld;

d) material thickness;

e) welding process;

f) type of tester used;

g) description of test electrode(s) used;

h) test voltage(s) or spark length applied;

i) number and location of defects detected;

j) name of the operator;

k) date of test.

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