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**Metallic materials — Sheet and strip  
— Earing test**

*Matériaux métalliques — Tôles et bandes — Essai de corne*

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## Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

This second edition cancels and replaces the first edition (ISO 11531:1994), of which it constitutes a minor revision.

# Metallic materials — Sheet and strip — Earing test

## 1 Scope

This International Standard specifies a method for determining the ear height of metal sheet and strip of nominal thickness from 0,1 mm to 3 mm after deep drawing.

## 2 Symbols and their meanings

The meanings of the symbols used in the earing test are given in [Table 1](#) and illustrated in [Figures 1](#) and [2](#).

**Table 1 — Symbols**

| Symbol             | Meaning                                                           | Units         |
|--------------------|-------------------------------------------------------------------|---------------|
| $a$                | Thickness of test piece                                           | mm            |
| $d_1$              | Diameter of punch                                                 | mm            |
| $R_1$              | Corner radius of punch                                            | mm            |
| $d_2$              | Inside diameter of die                                            | mm            |
| $R_2$              | Inside corner radius of die                                       | mm            |
| $d_b$              | Diameter of circular blank                                        | mm            |
| $h_t$              | Distance between outside bottom of cup and any ear peak           | mm            |
| $h_v$              | Distance between outside bottom of cup and any ear valley         | mm            |
| $h_{t,max}$        | Maximum value of $h_t$                                            | mm            |
| $h_{v,min}$        | Minimum value of $h_v$                                            | mm            |
| $\bar{h}_t$        | Mean value of $h_t$                                               | mm            |
| $\bar{h}_v$        | Mean value of $h_v$                                               | mm            |
| $\bar{h}_e$        | Mean ear height                                                   | mm            |
| $h_{e,max}$        | Maximum ear height                                                | mm            |
| $N_{ear\ peaks}$   | Number of ear peaks                                               | —             |
| $N_{ear\ valleys}$ | Number of ear valleys                                             | —             |
| $Z$                | Ear height expressed as a percentage                              | %             |
| $R_a$              | Surface roughness parameter: arithmetic mean deviation of profile | $\mu\text{m}$ |

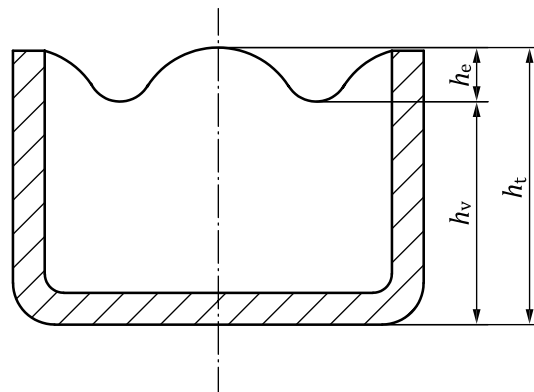
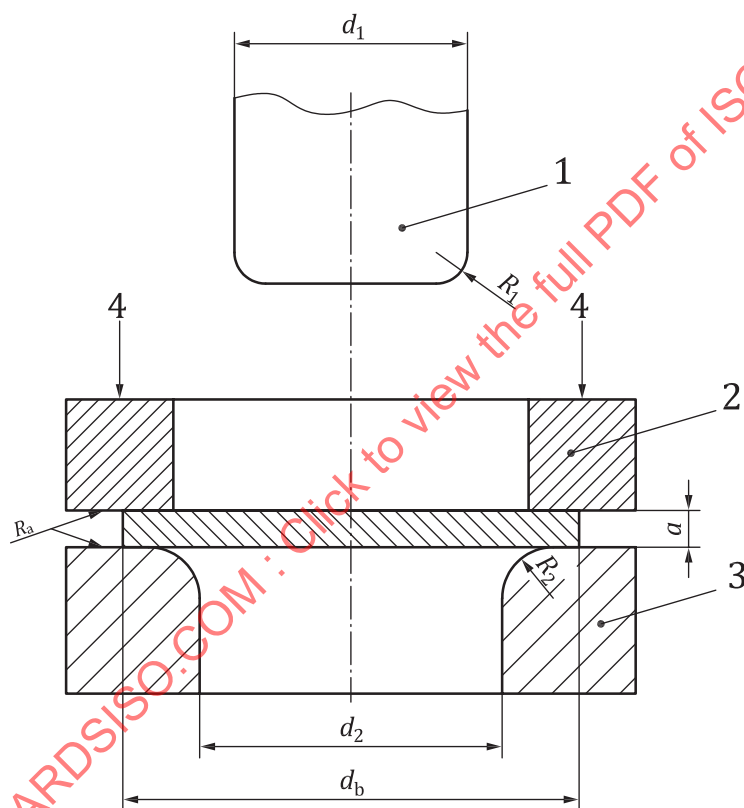


Figure 1 — Schematic section of cup



**Key**

- 1 punch
- 2 blankholder
- 3 die
- 4 direction of blankholder force

Figure 2 — Schematic diagram of test equipment

### 3 Principle

Cylindrical cups are drawn from circular blanks taken from metal sheets or strips, and the height of any earring produced by this process is measured.

## 4 Test equipment

**4.1** The general arrangement of the test equipment is given in [Figure 2](#). The punch shall be capable of moving along the central axis of the die and blankholder and the blank. The equipment shall be such that ironing of ears due to the blankholder force and/or due to insufficient clearance between the punch and die is avoided and such that the cup can be removed without damaging the ears.

**4.2** The machine shall be capable of controlling the speed of drawing and the blankholder force.

**4.3** The machine shall be equipped with a device for positioning the blank concentrically with the central axis of the machine.

The blank-positioning device is not required if the blank is produced as part of the cup-forming process.

**4.4** The dimensions of the punch and die shall be chosen as a function of the sheet thickness in accordance with [Table 2](#), unless otherwise specified in the product standard or by agreement.

The punch and die dimension combinations given in [Table 2](#) are general and may not be ideal for all materials due to the influence of the clearance between the punch and die. It is recommended that the product standard specify the combinations required for each product.

**4.5** The die, the blankholder and the punch shall be sufficiently rigid so as not to deform appreciably during the test. The Vickers hardness of the working surfaces of the die, the blankholder and the punch shall be at least 750 HV 30. The surfaces (of the die, the blankholder and the punch) which contact the test piece shall be polished. The roughness value  $R_a$  of the surfaces shall be in accordance with [Table 2](#).

**Table 2 — Punch and die dimensions**

| Thickness of test piece | Inside diameter of die |                | Inside radius of die |                | Surface roughness |
|-------------------------|------------------------|----------------|----------------------|----------------|-------------------|
| $a$                     | $d_2$                  |                | $R_2$                |                | (maximum)         |
|                         | for $d_1 = 33$         | for $d_1 = 50$ | for $d_1 = 33$       | for $d_1 = 50$ | $R_a$             |
| mm                      | mm                     | mm             | mm                   | mm             | $\mu\text{m}$     |
| $0,1 < a \leq 0,2$      | 33,44                  | 50,44          | $2,0_{-0,2}^0$       | $2,5_{-0,2}^0$ | 0,1               |
| $0,2 < a \leq 0,4$      | 33,88                  | 50,88          | $2,5_0^{+0,2}$       | $3,0_0^{+0,2}$ | 0,1               |
| $0,4 < a \leq 0,8$      | 34,76                  | 51,76          | $3,5_0^{+0,2}$       | $4,5 \pm 0,1$  | 0,8               |
| $0,8 < a \leq 1,6$      | 36,52                  | 53,52          | $5,0_0^{+0,2}$       | $6,5 \pm 0,1$  | 0,8               |
| $1,6 < a \leq 3,0$      | 39,60                  | 56,60          | $7,0_0^{+0,2}$       | $9,0_{-0,2}^0$ | 1,6               |

Punch radius  $R_1$  will be  $3,3 \text{ mm} \pm 0,05 \text{ mm}$  for punch diameter of 33 mm, and  $5,0 \text{ mm} \pm 0,05 \text{ mm}$  for punch diameter 50 mm.

## 5 Test piece

**5.1** Circular blanks are used as test pieces. The drawing ratio, i.e. the ratio of blank diameter to punch diameter, shall be as large as possible without any risk of tearing at the bottom of the cup. For a test series or comparative tests, the same drawing ratio shall be the same in all cases. A drawing ratio of 1,8 has been found satisfactory.

5.2 The test piece shall be free of burrs on the edges which would interfere with the test.

5.3 Before testing, the test piece shall not be subjected to any hammering or hot or cold working.

## 6 Procedure

6.1 In general, the test shall be carried out at ambient temperature within the limits of 10 °C and 35 °C.

Tests performed under controlled conditions shall be carried out at a temperature of 23 °C ± 5 °C.

6.2 Determine the thickness of the test piece to the nearest 0,01 mm and select the appropriate punch and die in accordance with 4.4.

6.3 Before testing, coat the two faces of the test piece lightly and uniformly with lubricant as specified in the relevant standard or by agreement. The lubricant will depend on the nature of the material.

6.4 Position the blank concentrically between the blankholder and the die. Apply the blankholder force that is just sufficient to prevent wrinkling of the flange.

NOTE If it is not known what blankholder force is required to achieve this, it will have to be found by trial and error. The following values are provided for guidance for the first attempt:

| Diameter of punch | Aluminium | Steel   |
|-------------------|-----------|---------|
| 33 mm             | 1 000 N   | 2 000 N |
| 50 mm             | 2 000 N   | 4 000 N |

(See also 4.1.)

6.5 Bring the punch into contact with the test piece and form the cup without a flange.

6.6 All non-concentric cups and those having irregular deformations or other faults shall be rejected.

6.7 Measure the height of each ear peak  $h_t$  and each ear valley  $h_v$  on the cup with an accuracy of ± 0,05 mm.

6.8 Record the orientation of the ears with respect to the direction of rolling of the sheet.