INTERNATIONAL STANDARD

ISO 28199-1

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Paints and varnishes — Evaluation of properties of coating systems related to the application process —

Part 1: Relevant vocabulary and preparation of test panels

Peintures et vernis — Évaluation des propriétés des systèmes de revêtement liées au mode d'application —

Partie 1: Vocabulaire pertinent et préparation des panneaux d'essai

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 28199-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

ISO 28199 consists of the following parts, under the general title *Paints and varnishes — Evaluation of properties of coating systems related to the application process*:

— *Part 1: Relevant vocabulary and preparation of test panels*

— *Part 2: Colour stability, process hiding power, re-dissolving, overspray absorption, wetting, surface texture and mottling*

— *Part 3: Visual assessment of sagging, formation of bubbles, pinholing and hiding power*

Introduction

In many areas (e.g. car manufacture, industrial coatings, coatings for plastics) the coating materials used are adapted to the specific application equipment and technologies of the particular user. A coating material is, therefore, to be understood as a semi-manufactured product that only receives its final form in combination with the specific application conditions. The adaptation to the application conditions is therefore decisive for the quality of the coated product.

The test methods specified in ISO 28199 are based on studies by a Working Group of the European Council for Automotive R&D (EUCAR).

They may be used for evaluation of coating materials in research, development and production with regard to their suitability and safety for industrial processes, and error analysis. The properties of coating materials and coatings to be evaluated depend on the film thickness, so a coating system of increasing thickness is applied to a test panel under defined conditions.

The following characteristics are measured (in this part of ISO 28199):

— film thickness in accordance with ISO 2808;

— surface texture;

— colour in accordance with ISO 7724 (all parts).

In combination with visual assessment, the following properties are determined:

— colour stability, process hiding power, re-dissolving, overspray absorption, wetting, surface texture and mottling (ISO 28199-2);

— tendency toward sagging, formation of bubbles, pinholing and hiding power (ISO 28199-3).

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the locally related measurements used in Version A in Clauses 8 and 9.

ISO takes no position concerning the evidence, validity and scope of this patent right.

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Paints and varnishes — Evaluation of properties of coating systems related to the application process —

Part 1:
Relevant vocabulary and preparation of test panels

1 Scope

This part of ISO 28199 defines terms relating to the evaluation of coating materials in research, development and production with regard to their suitability and safety for industrial processes and error analysis.

This part of ISO 28199 specifies methods for the preparation of test panels and the subsequent measurement of film thickness, colour and surface texture.

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.

ISO 1513, *Paints and varnishes — Examination and preparation of samples for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 7724-1, *Paints and varnishes — Colorimetry — Part 1: Principles*

ISO 7724-2, *Paints and varnishes — Colorimetry — Part 2: Colour measurement*

ISO 7724-3, *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

ISO 28199-2, *Paints and varnishes — Evaluation of properties of coating systems related to the application process — Part 2: Colour stability, process hiding power, re-dissolving, overspray absorption, wetting, surface texture and mottling*

ISO 28199-3, *Paints and varnishes — Evaluation of properties of coating systems related to the application process — Part 3: Visual assessment of sagging, formation of bubbles, pinholing and hiding power*

3 Terms and definitions

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

3.1
bubble
closed or already burst blister in a layer, arising when solvents or cleavage products evaporate too rapidly

NOTE If bubbles are caused by the process control and/or the formulation components, the viscosity of the paint film has increased too rapidly during the drying phase so that solvents/reaction products still in the paint film have built up at the polymer paint skin which forms, usually resulting in closed blisters and sometimes resulting in burst blisters.

3.2
bubble formation limit
first appearance of continuous bubbles in the measuring area

NOTE A single bubble does not define the bubble formation limit. Bubbles at the edge of the measuring area and in the perforated area of the panel (see Figure 2) should not be taken into account.

3.3
colour stability
non-variability, or variability within agreed tolerances, of colour despite variation of influencing factors

NOTE Examples of influencing factors are thickness and application method.

3.4
cratering
formation in a film of small circular depressions that persist after drying

[ISO 4618:2006]

NOTE 1 Craters can extend as far as the next lower layer.

NOTE 2 Craters are caused by local inhomogeneities in the surface tension of the coating, most frequently due to incompatible contamination substances on the substrate, in the applied coating material or in the form of foreign particles or small oil drops.

3.5
locally related measurements
measurements of film thickness and optical surface property which are taken at the same point, i.e. within a radius of < 10 mm

3.6
locally unrelated measurements
measurements of film thickness and optical surface property which are not taken at the same point, i.e. within a radius of $\geqslant 10$ mm

3.7
minimum film-build
lowest thickness at which a coating material forms a continuous film on a substrate

3.8
mottling
non-uniform appearance of a film caused by presence of irregularly shaped, randomly distributed areas on the surface that vary in colour and/or gloss

[ISO 4618:2006]

3.9
overspray absorption
ability of a coating material already applied to absorb dried overspray particles of the same coating material resulting from a subsequent application

NOTE Evidence of poor overspray absorption is shown, for example, by raised surface texture and low colour stability as well as mottling.

3.10
pinholing
presence of small holes in a film resembling those made by a pin

[ISO 4618:2006]

NOTE Pinholes can be caused by gas inclusions in the base coat which burst after the application of the clear coat and leave a hole both in the clear coat and base coat. They are often the result of inappropriate process parameters. Pinholes are often confused with craters.

3.11
pinholing limit
first appearance of pinholing in the measuring area

NOTE A single pinhole does not define the pinholing limit. Pinholes at the edge of the measuring area and in the perforated area of the panel (see Figure 2) should not be taken into account.

3.12
process hiding power
minimum thickness above which the complete coating system in combination with the colour of the substrate (e.g. the colour of the priming coat) provides colour stability and represents the lower limit of the film thickness range of the serial coating plant

NOTE See also “hiding power”, defined in ISO 4618:2006 as “ability of a coating material or a coating to obliterate the colour or the differences in colour of a substrate”.

3.13
re-dissolving
mutual effect of an already applied coating material on a subsequently applied coating material, in which the solvent of the later coating interacts with the already dried previous coating

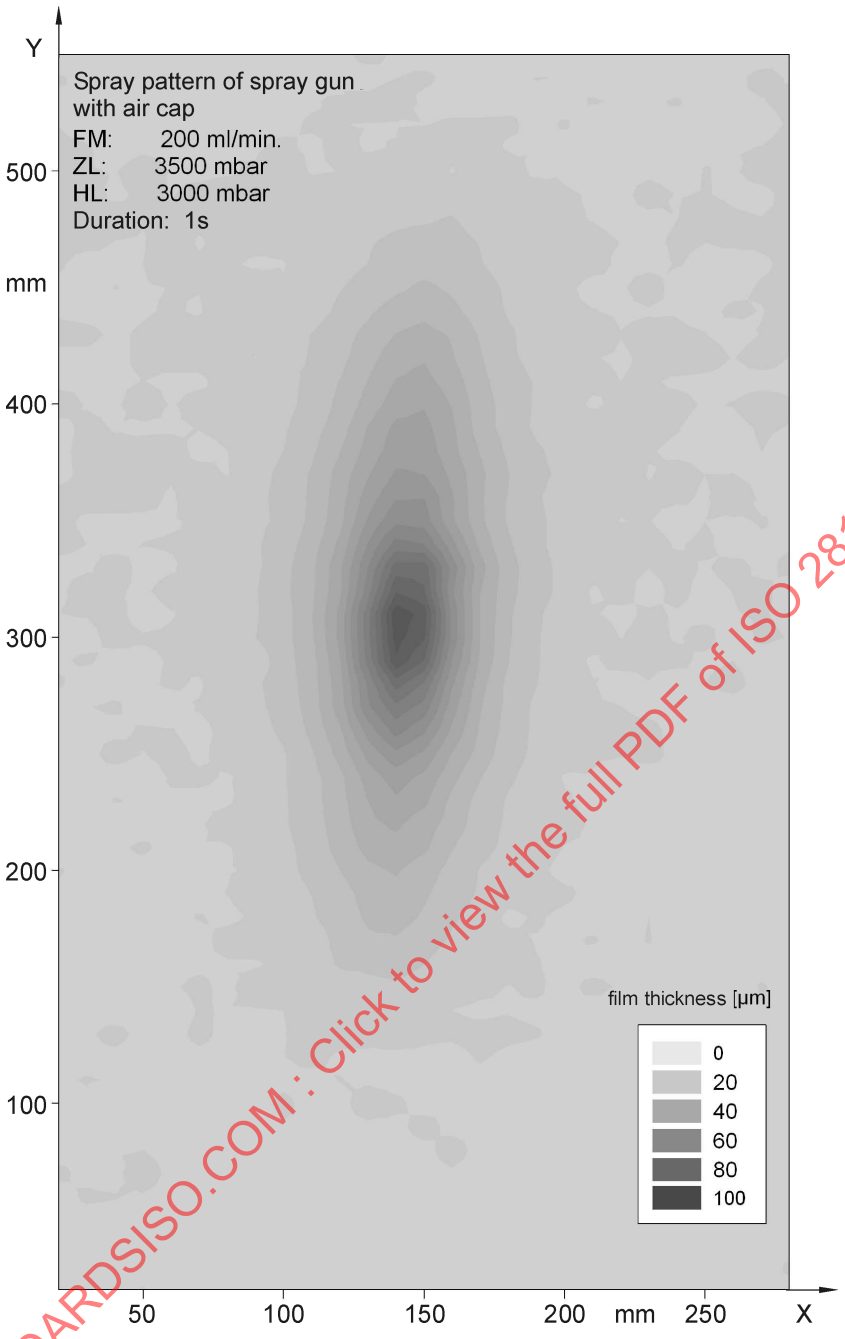
NOTE The interaction could be evidenced by a change in colour.

3.14
sagging
downward movement of a coating material during drying in a vertical or an inclined position that results in irregularities in the dry coat

[ISO 4618:2006]

3.15
static spray pattern
distribution of the coating material after spray application using defined parameters, with both coated object and spray application system at rest

NOTE See Figure 1.



Key

X width of the test panel

Y length of the test panel

Figure 1 — Static spray pattern

3.16
surface texture
visual appearance and visible texture in the surface

NOTE The surface texture depends on the topographic characterization, the observation distance and the image clarity of the surface. In the case of the so-called “orange peel” texture which can occur with automotive paints, the range of the wavelength of the surface waviness is between 0,1 mm and 30 mm. Typically, two ranges are used in this part of ISO 28199:

a) short-wavelength range: 0,3 mm to 1,2 mm;

b) long-wavelength range: 1,2 mm to 12 mm.

The surface texture is, for example, influenced by the levelling (as defined in ISO 4618) of the still-liquid coating as well as the substrate.

3.17
wetting
complete coverage of a substrate by a coating material

4 Principle

The coating material to be tested is applied to a test panel in the form of a wedge. Various optical properties are measured by an appropriate procedure dependent on the film thickness.

5 Apparatus

Ordinary laboratory apparatus and the following.

5.1 Programmable automatic painting machine, used to coat the specified test panels according to the procedure and accuracy specified in this part of ISO 28199.

In order to achieve this, at least the following features of the machine shall be separately adjustable or changeable:

— spray gun;

— fan air (pressure- or volume-controlled);

— atomizer air (pressure- or volume-controlled);

— flow rate;

— distance to the object;

— feed speed of atomizer;

— pitch between traverses of machine.

The quality of the film thickness profiles (wedge-shaped or constant) produced has a decisive influence on the reproducibility and repeatability of the results obtained when using this procedure, and the application parameters should therefore be as close as possible to those of the process to be simulated.

NOTE 1 Examples of suitable application parameters are given in Annex A, Table A.1.

Unless otherwise agreed, the wedge-shaped coating shall be applied in two spraying stages using identical application parameters.

NOTE 2 The wedge can be produced either purely pneumatically or with pneumatic-electrostatic support.

5.2 Data-recording device(s).

The data-recording device(s) shall be suitable for the reproducible determination of the following characteristics for the coated test panels, using a set measurement pattern chosen in accordance with 9.4.1:

— film thickness;

— surface texture;

— colour.

It is preferable that an automatic system be used for recording the measured data.

6 Calibration

Calibrate the measuring instruments and the data-recording device(s) in accordance with the specifications of the manufacturer.

7 Sampling

Take a representative sample of the product to be investigated, in accordance with ISO 15528.

Examine and prepare each sample for testing, in accordance with ISO 1513.

8 Test panels

8.1 Substrate

Unless otherwise agreed, use either:

a) Version A: perforated panel (see Figure 2) of dimensions 300 mm × 570 mm × 0,75 mm;

NOTE The perforation is needed for the determination of sagging only.

or

b) Version B: panel (see Figure 2) of dimensions 200 mm × 500 mm × 0,75 mm.

For testing the surface texture, only metal panels of defined surface profile (roughness) as agreed between interested parties shall be used.

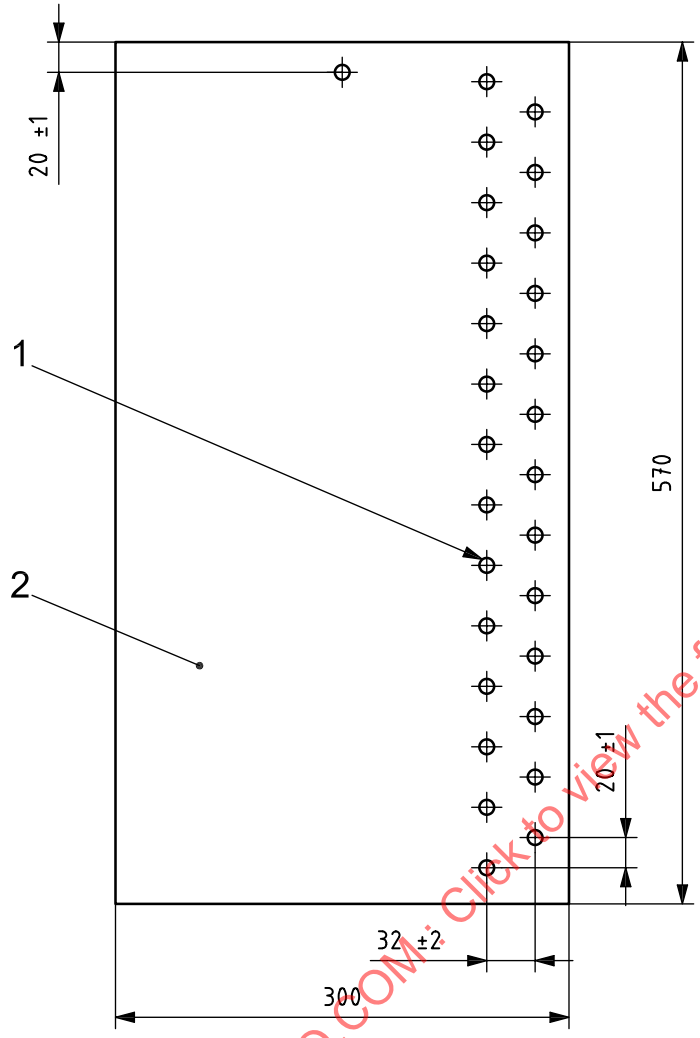
8.2 Preparation of the test panel

Ensure the test panel is free from foreign matter. Prepare the test panel for coating in accordance with one of the examples given in Figure 2.

Dimensions in millimetres

Example 1 (Version A)

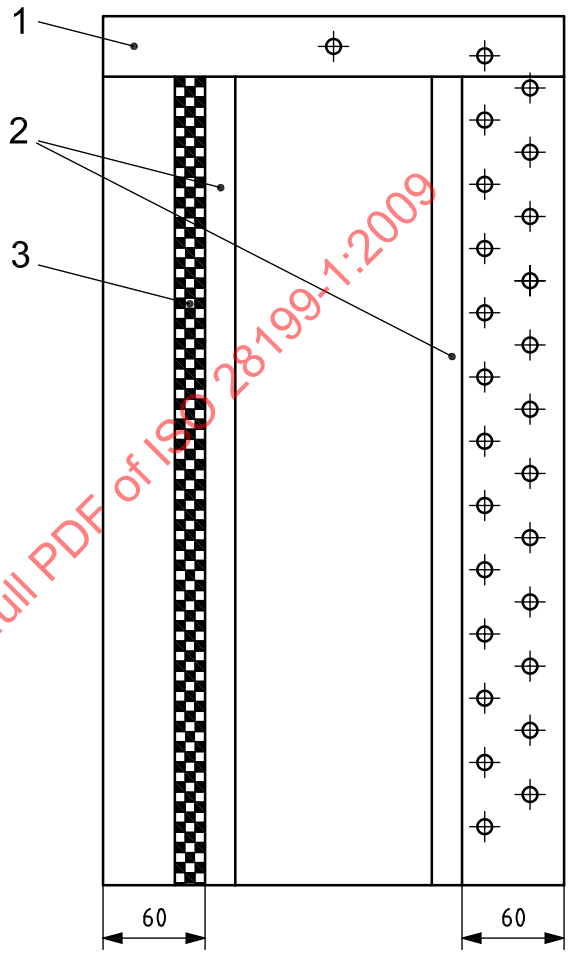
Test panel before masking



Key

1 holes of diameter 7 mm
2 coil-coated metal panel

Test panel after masking



Key

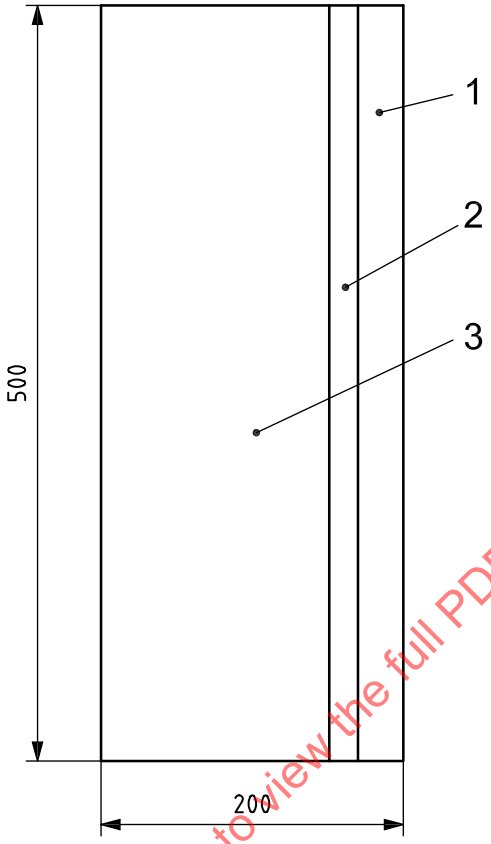
1 adhesive tape, width ~ 30 mm (reference strip 1)
2 adhesive tape, width ~ 19 mm (reference strip 2)
3 contrast strip, width 20 mm (black/white strip)

Figure 2 — Examples of test panels

Dimensions in millimetres

Example 2 (Version B)

Test panel after masking



Key

1 adhesive tape, width ~ 30 mm (reference strip 1)

2 adhesive tape, width ~ 19 mm (reference strip 2)

3 surfacer-coated metal panel

Figure 2 (*continued*)

8.3 Coating of the test panel

8.3.1 General

The parameters for the application of the coating materials to be tested (air temperature and humidity, flash-off and drying/curing times, drying/curing temperatures) are directly related to the coating process to be simulated. Further parameters (atomizer type, air cap, fan air, atomizer air and flow rates) shall be established by trial in order to simulate the industrial process as closely as possible.

Test these chosen parameters using a static spray pattern.

The desired film thickness should preferably be achieved by controlling the feed speed of the atomizer.

Coat the test panel in accordance with the procedure in 8.3.2 or 8.3.3.

8.3.2 Version A (perforated panel)

Apply a 30 mm wide strip of adhesive tape on the test panel at the upper edge (Figure 2, example 1, reference strip 1). Keep this in place until the final coat has been applied.

Apply two 19 mm wide adhesive tapes parallel to the longer side of the test panel (Figure 2, example 1, reference strip 2).

Apply the base coat.

Pull off the two 19 mm wide adhesive tapes (reference strip 2).

Apply the clear coat.

Pull off the 30 mm wide adhesive tape (reference strip 1).

Allow each coat to dry/cure in accordance with the time specified by the manufacturer for the individual product.

8.3.3 Version B (non-perforated panel)

8.3.3.1 Version B1 with reference strip

Apply on the right side of the test panel a 30 mm wide strip of adhesive tape (Figure 2, example 2, reference strip 1) and a 19 mm wide strip of adhesive tape (Figure 2, example 2, reference strip 2).

Apply the base coat and then pull off the 19 mm wide adhesive tape (reference strip 2).

Apply the clear coat and then pull off the 30 mm wide adhesive tape (reference strip 1).

Allow each coat to dry/cure in accordance with the time specified by the manufacturer for the individual product.

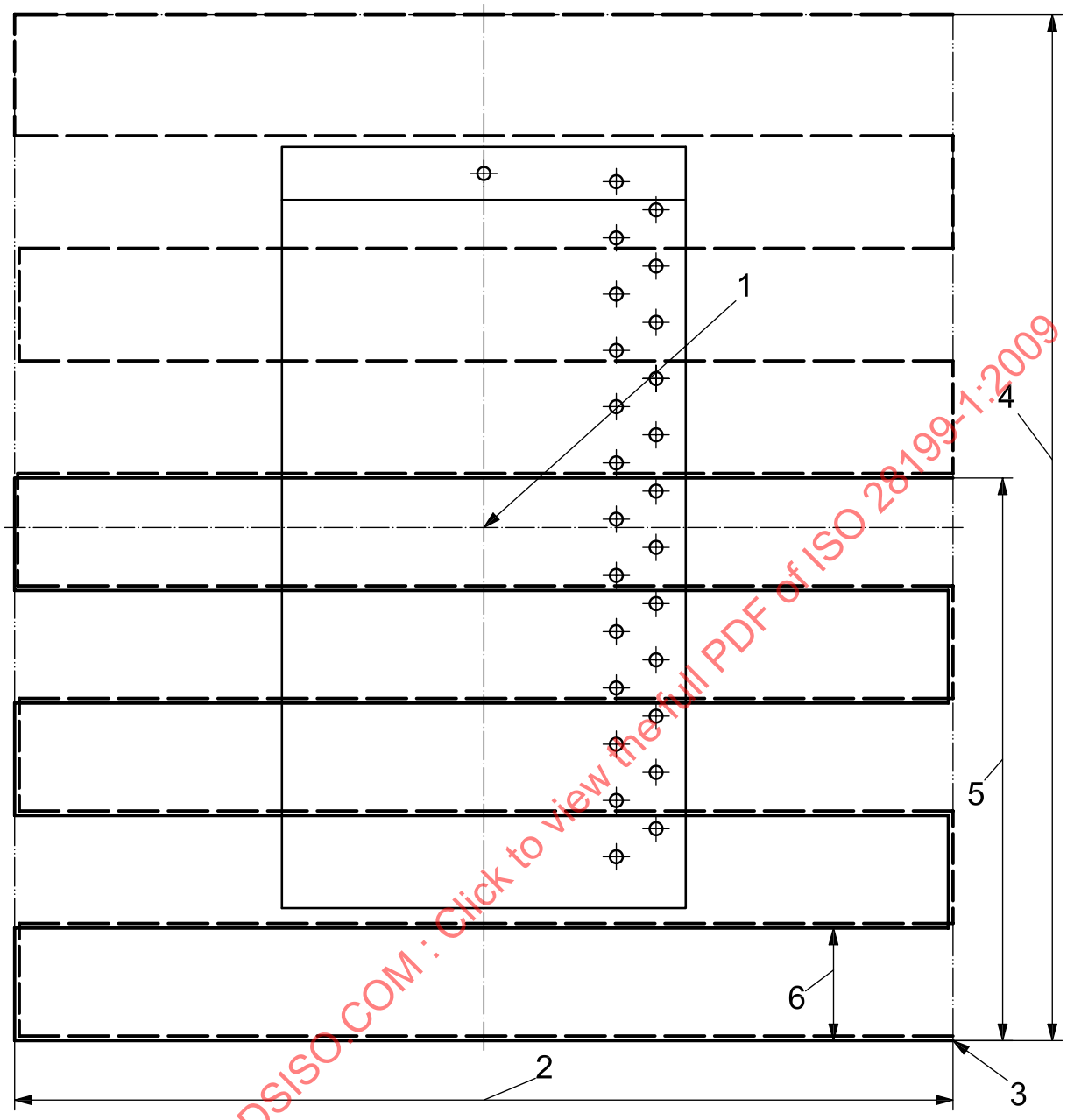
8.3.3.2 Version B2 without reference strip

This version shall be used when the film thicknesses of the cathodic electrodeposition coat, surfacer, base coat and clear coat are measured after each application. In this case, the individual coats shall be dried/cured or stoved prior to measurement.

A coating system generally consists of several layers (e.g. base coat and clear coat), of which one shall be applied as a wedge. The other layer(s) shall be applied with constant thickness.

Apply the paint wedge in accordance with Figure 3, using two overlapping spraying stages. The first spraying stage shall end at the point where the test panel is fully coated, and the second shall end just beyond the middle of the test panel.

Carry out the coating procedure so that the film thickness on the test panel increases from the top towards the bottom. Then fix the test panels in a defined position so that reproducible coating wedges are obtained.



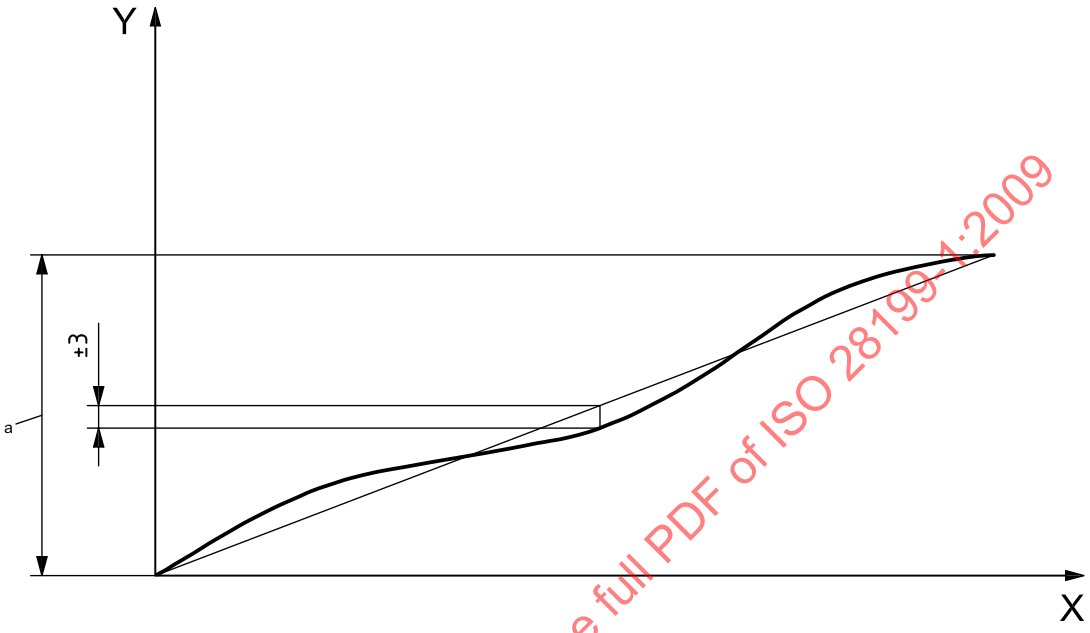
Key

1 midpoint of test panel/area sprayed
2 width of area sprayed
3 starting point of first and second spraying stages (first stage: dashed line, second stage: continuous line)
4 height of area sprayed at first spraying stage
5 height of area sprayed at second spraying stage
6 pitch between horizontal traverses of painting machine

Figure 3 — Spraying parameters

8.4 Film thickness

The thickness of the paint wedge shall begin at 0 µm, and shall increase continuously, with variations ⩽ (± 3) µm, up to 7 µm to 13 µm more than the upper film thickness limit indicated in the product specification (see Figure 4).



Key

X measuring range, cm

Y film thickness, µm

a Upper limit of film thickness +7 µm to 13 µm.

Figure 4 — Film thickness of the paint wedge

Apply all coats vertically. Flashing-off as well as drying/curing of the wedge-shaped layer shall also take place vertically, while the constant-thickness layer(s) shall be horizontal during the final flashing-off and drying/curing.

9 Procedure

9.1 Conditioning the test panels

Unless otherwise agreed, condition the test panels before testing at (23 ± 2) °C (standard temperature in accordance with ISO 3270) for at least 16 h.

9.2 Test conditions

The test should preferably be carried out at (23 ± 2) °C (standard temperature in accordance with ISO 3270).

9.3 Number of determinations

Unless otherwise agreed, carry out a single determination.

9.4 Test

9.4.1 Measurement pattern

The measurement pattern shall be chosen so that at least five measurements can be taken at different points on a single film thickness line. At least 20 such lines shall be distributed over the length of the test panel.

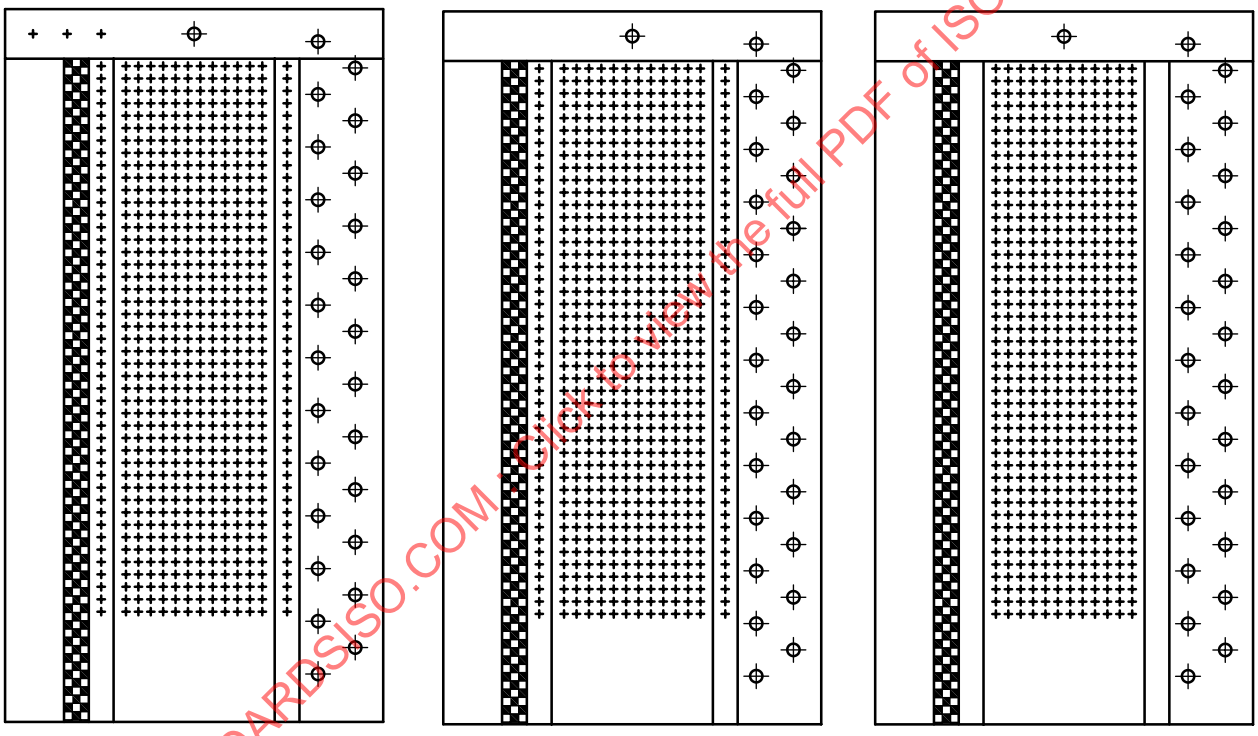
Examples of measurement patterns are given in Figures 5 and 6.

Describe the relationship between the measured film thickness and one or more surface measurement value(s) as one of the following types:

— locally related: i.e. film thickness and surface measurement value taken at the same point;

NOTE This procedure is registered by European Patent No. EP 0 842 414 B1.

— locally unrelated: i.e. film thickness and surface measurement value taken at different, non-overlapping points.



Film thickness measurement (9.4.2) **Colour measurement (9.4.3)** **Texture measurement (9.4.4)**

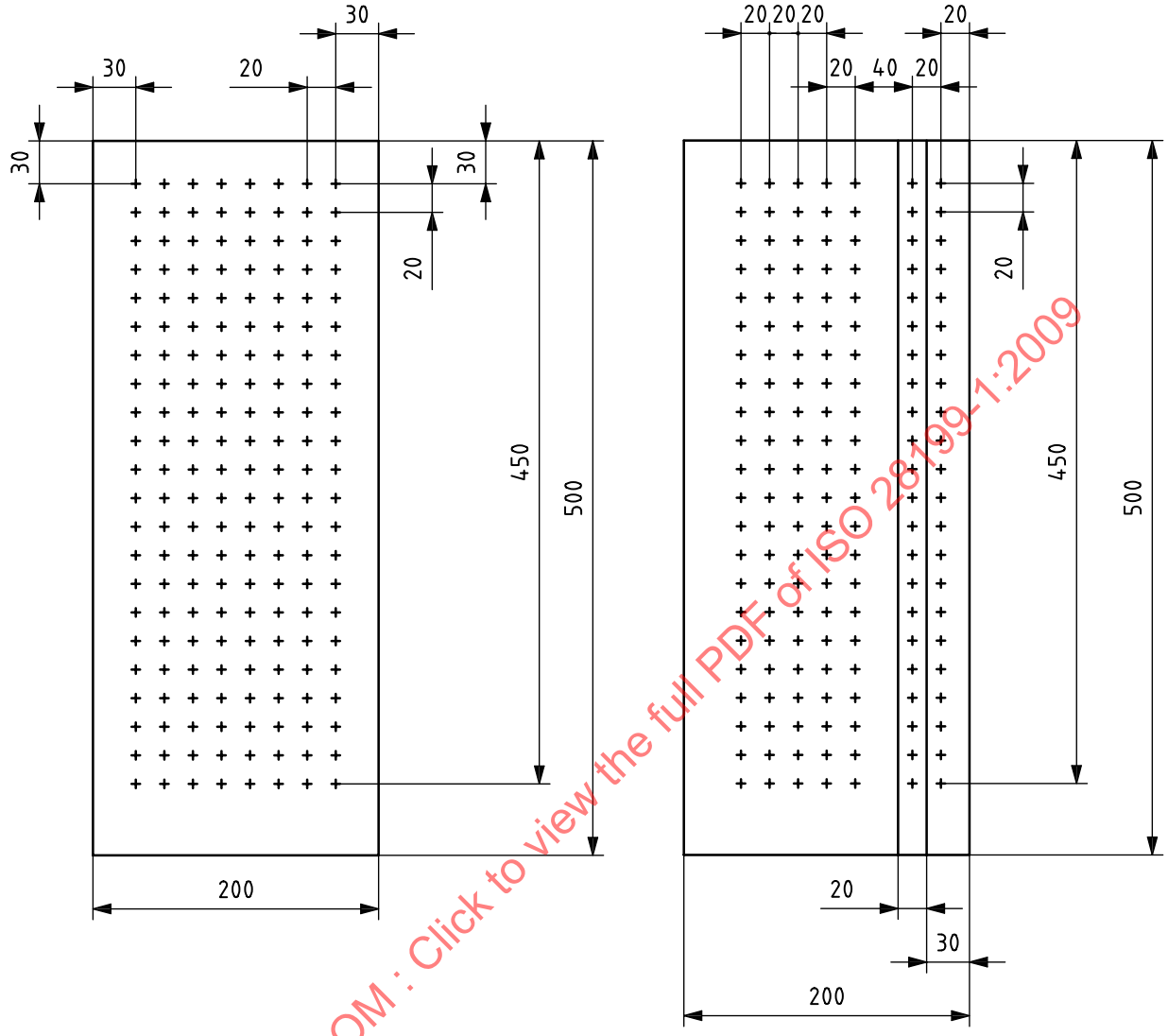
Key

\+ measuring point

⊕ hole (7 mm diameter)

Figure 5 — Measurement pattern for Version A

Dimensions in millimetres



with reference strip (Version B1) **without reference strip (Version B2)**

Key

\+ measuring point

Figure 6 — Measurement pattern for Version B

9.4.2 Film thickness

Measure the film thickness in accordance with one of the procedures given in ISO 2808.

9.4.3 Colour

Measure the colour in accordance with ISO 7724-1, ISO 7724-2 and ISO 7724-3.

Calculate the values of L^*, a^*, b^*, C^*, h^*, for example at angles of 15°, 25°, 45°, 75° and 110°, with standard illuminant D65 and 10° standard colorimetric observer. Depending on colour location, it shall be agreed as to whether L^*, a^*, b^* or L^*, C^*, h^* are used for the subsequent evaluation.

9.4.4 Surface texture

Measure the surface structure by using a laser beam that scans the surface. Using mathematical functions, divide the intensity profile obtained into different ranges: 0,3 mm to 1,2 mm for short wavelengths and 1,2 mm to 12 mm for long wavelengths (see note to 3.16).

10 Evaluation

Evaluate the results of the individual tests in accordance with ISO 28199-2 and ISO 28199-3.

Assess the coating system with regard to process suitability, process safety and an analysis of the relationship between the film thickness and the errors in the measured quantities.

11 Precision

No precision data are currently available.

12 Test report

The test report shall contain at least the following information:

a) all information necessary to identify the coating material tested (manufacturer, product designation, etc.);

b) a reference to this part of ISO 28119 (i.e. ISO 28199-1);

c) the method of application of the test coating to the substrate, including drying/curing conditions for all layers;

d) details of the conditioning of the test panels;

e) the temperature and humidity during the test;

f) the results of the test, expressed in accordance with ISO 28199-2 and ISO 28199-3;

g) any deviations from the test procedure specified;

h) any unusual features (anomalies) observed during the test;

i) the date of the test;

j) the name of the person performing the test.