
**Graphic technology — Method for
radius determination of printing
cylinders**

*Technologie graphique — Méthode de mesure du rayon de cylindres
d'impression*

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Published in Switzerland

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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.

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).

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 130, *Graphic technology*.

Introduction

Although the external radius of the cylinders used in offset presses is fixed by the design of the printing press, there are applications in flexography and gravure printing where the diameter of individual cylinders is critical for the final result and has to be determined. This International Standard provides a recommended device and procedure to accomplish such measurements.

The body of this International Standard describes the operational principles and general requirements, including all relevant parameters necessary for the functional design. Different areas of application are covered in different annexes. For each particular application, a normative annex contains the set of critical parameters and a corresponding informative annex contains a set of technical drawings to be utilized in the creation of a suitable device. Functional variables are defined in the body of this International Standard and the aims and tolerances for each targeted application are given in the applicable normative annex.

Standard hand-held micrometers have traditionally been used for checking and determining the radius of printing cylinders. Because the micrometer positioning on a cylinder surface is normally carried out by a human operator, problems with poor repeatability, low precision, and weak reliability of the measurements have been reported. The test method and subsequent device(s) described in the present International Standard represent a cost-efficient, reliable, and operator-independent means of determining the radius of printing cylinders.

The normative annex included in this International Standard defines a particular methodology for measuring the external radius of flexographic printing sleeves and the informative annex provides guidance for the physical design of the instrument.

Sleeves are the structural, mechanical, and dimensional base of a printing forme for different web printing methods. Flexographic printing plates are assembled/mounted on the surface of a sleeve to create a printing forme. Dimensional variations of a sleeve radius can lead to length variations of the printed matter that can have a direct impact on the final appearance of prints. Dimensional variations of a sleeve radius can also have an impact on other functional properties (e.g. in the case of packaging).

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Graphic technology — Method for radius determination of printing cylinders

1 Scope

This International Standard defines a method for measuring the external radius of printing cylinders, specifies critical parameters and operational instructions and provides recommendations for instrument design.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1101:2004, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 6507-1:2004, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 12637-1, *Graphic technology — Vocabulary — Part 1: Fundamental terms*

3 Terms, definitions, and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12637-1 and the following apply.

3.1.1

flexographic printing

forme-based process/method using flexible relief formes where the raised inked areas reproduce images onto a substrate using low viscosity inks

3.1.2

sleeve

seamless tube used to fasten printing plates to rapidly change printing forme on a press

3.1.3

mandrel

cylindrical shaft equipped with a mechanism that allows a sleeve to be securely attached

3.1.4

repeat

circumference of the external surface of a printing forme when installed for printing

Note 1 to entry: Sleeves are commonly designated by their repeat.

3.1.5

printing cylinder

rotating carrying component of a printing forme structure

Note 1 to entry: A printing cylinder can either be a sleeve on a mandrel or a solid cylinder.

3.2 Symbols

For the purposes of this document, the following symbols apply.

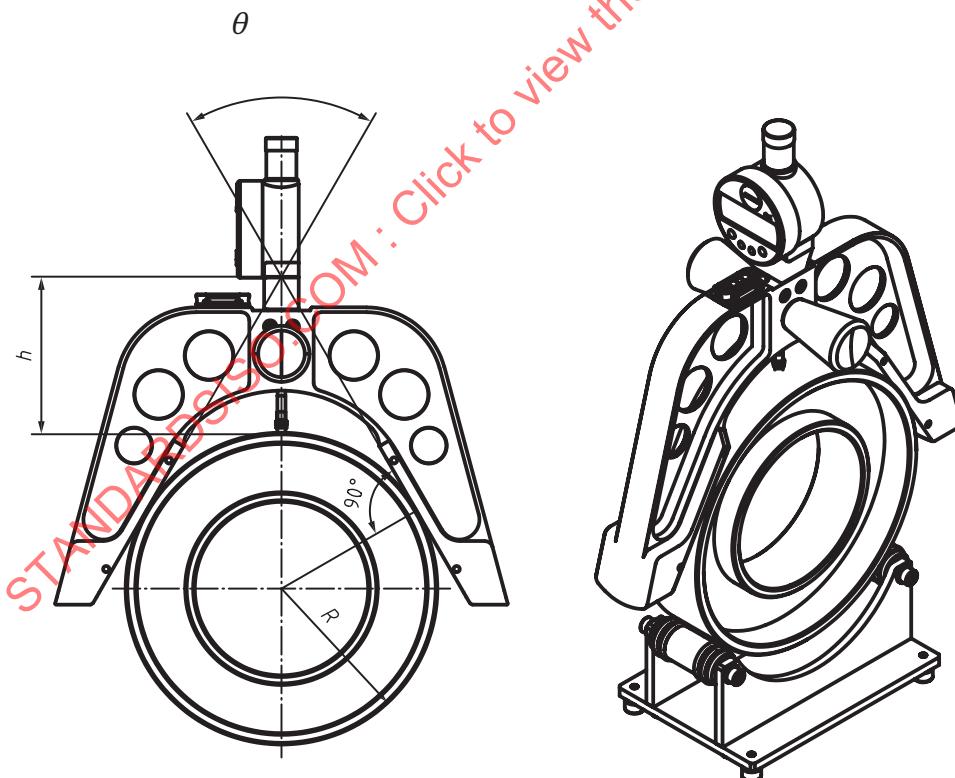
α thermal expansion coefficient (K^{-1})

4 Measurement device

4.1 Principle

The measuring device is formed by a mechanical frame supporting two flat surfaces arranged at a precise angle, as illustrated in [Figure 1](#). A standard high-precision indicator (micrometer) is mounted at the intersection of the two planes created by the previously defined surfaces, as shown in [Figure 1](#).

The device positioning on a cylinder surface is an action physically independent of the measuring using a dedicated frame for positioning. The cylinder radius, R , in contact with the measuring tool surface is always at a right angle to the plane. This geometric arrangement allows for the measurement to always be performed perpendicularly to the tangent of the cylinder surface.



Key

- η frame angle
- R radius of the cylinder
- h measured distance

Figure 1 — Operational principle and 3D rendering (example of a device with a 60° angle)

When the device is correctly calibrated, the measured distance, h , is a measure of the cylinder radius and can be converted using a suitable formula based on the frame angle. In practice, the measured distance, h , can be used to estimate the cylinder radius since the equality is only true if the cylinder is perfectly round. This feature makes the device sensitive to the cylinder shape, allowing for capture of deviations from a perfect round. For measurement of out-of-roundness, it is recommended to take at least three measurements, rotating the cylinder by 60° between measurements.

4.2 Apparatus

[Table 1](#) defines the critical parameters necessary for the construction of an apparatus. Aims and tolerances for specific applications are provided in the annexes.

NOTE 1 It is intended that future editions of this International Standard will contain specific applications beyond that included in [Annex A](#).

Table 1 — Critical parameters

Parameter	Unit
Frame angle	°
Thermal expansion coefficient, α	K ⁻¹
Total weight of assembled apparatus	kg
Total width of the frame active surfaces	mm
Edge radius of the frame active surfaces	mm
Position of the apparatus centre of mass ^a	mm
Indicator spindle movement range	mm
Calibration tool (ring) diameter	mm
^a Located along the spindle axis, distance measured from the top of the frame.	

[Annex A](#) provides information for measurement of mid-web flexographic sleeves.

NOTE 2 [Annex A](#) lists the critical parameters for a particular application, measuring mid-web flexography sleeves having a repeat between 490 mm (radius of 77,986 mm) and 740 mm (radius of 117,775 mm).

The device shall contain a mechanism capable of assuring that, during operation, both contact lines generated between the printing cylinder surface and the frame surfaces are parallel to the cylinder longitudinal central axis to ensure a correct reading of the distance. The same or a complementary mechanism shall be capable of assuring the correct operational positioning of the indicator spindle axis during operation.

NOTE 3 A possible implementation is the usage of a mechanism (e.g. by means of a spirit level or an electronic measure) assuring that the frame is horizontal, and therefore also indirectly assuring that the spindle axis is vertical, during operation while in contact with a cylinder.

4.3 Material

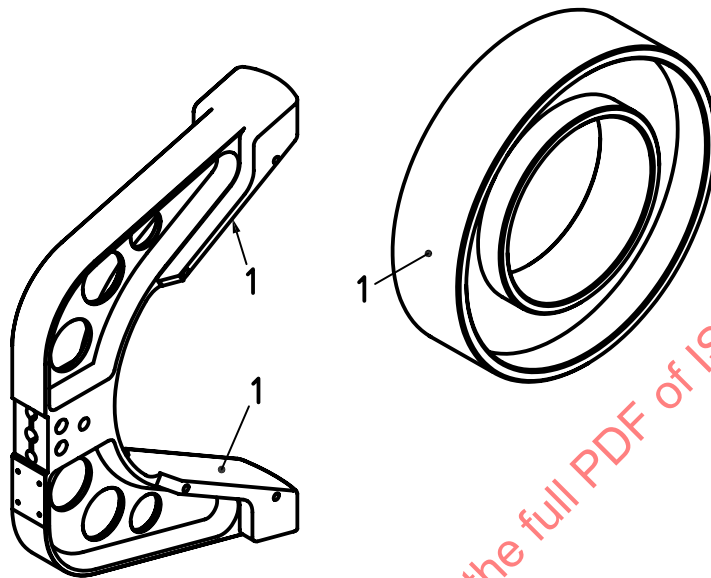
The apparatus frame and calibration tool shall be constructed in a material resistant to minor shocks resulting from normal manual handling. The material shall have an α equal or less than the value specified in [Annex A](#). Handles made from a non-thermal conducting material shall be assembled to the frame in order to minimize temperature increase resulting from hand contact.

The total weight of the assembled apparatus including frame, handles, indicator, rods, and eventual extender shall be inside the aim and tolerances specified in the applicable normative annex. Defining a mass tolerance improves inter-instrument repeatability, specifically when measuring cylinders with a surface of compressible nature.

All active surfaces shall be surface-finished in order to attain a roughness value (Ra) of at least 0,8 µm defined according to ISO 4287.

To increase abrasion and corrosion protection, all active surfaces shall be coated using a material having a Vickers Pyramid Number (HV) equal or higher than 1100HV30 according to ISO 6507-1:2004. Active surfaces are identified in [Figure 2](#). The required protection can be achieved by any means of surface treatment deposition and material choice. The treatment shall not compromise dimensional tolerances or roughness specifications.

NOTE 15 µm of chemical nickel plating (electroless nickel plating) is an example of a suitable surface treatment.



Key

1 active surfaces

Figure 2 — Active surfaces identification of frame and calibration tool

4.4 Dimensions of critical functional parts

The two identical flat active surfaces of the mechanical frame which are in contact with the cylinder during measurement shall have a width and edge radius as specified in [Annex A](#). The specified total width dimension includes the width of the contact line and the two-edge radius. Their length shall be sufficient to ensure a correct physical contact between the device active surface and the cylinder, in this way covering the complete range of specified radius.

The indicator shall be mounted in a position assuring the spindle axis absolute symmetry in relation to the frame.

The assembled apparatus centre of mass shall be located along the spindle axis at a position specified in [Annex A](#).

4.5 Indicator

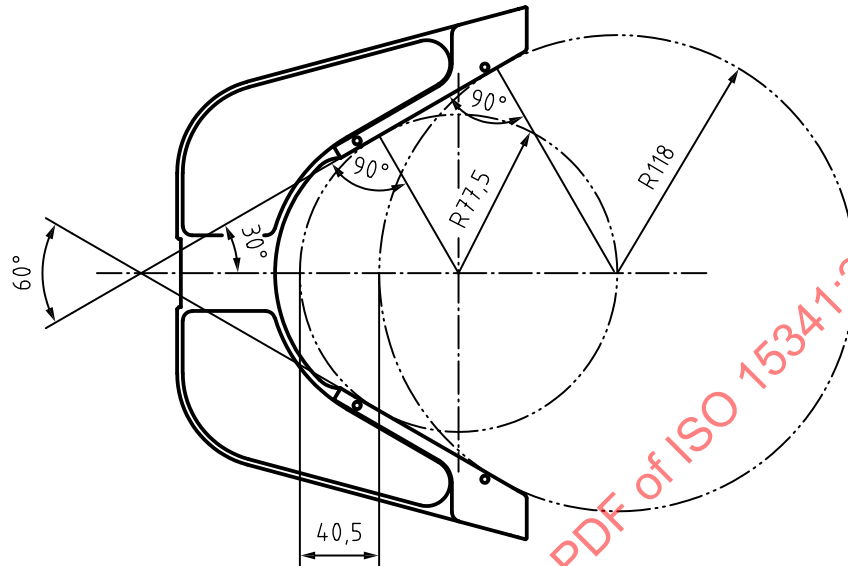
The indicator shall be mounted following the manufacturer's instructions in order not to interfere with performance.

The indicator shall have a precision of at least 0,001 mm, an accuracy of at least 0,003 mm, and a measuring force less than 1,8 N. The valid operating temperature shall be between 10 °C and 40 °C.

The indicator measuring tip shall be flat with a round section, made of hard metal, and have a diameter of 6,5 mm.

The indicator spindle movement shall have a range as specified in [Annex A](#). Extenders to the measuring tip can be used. The range shall be such to cover the complete range of specified radius, as exemplified in [Figure 3](#).

NOTE Informative suggestions regarding the choice of suitable components are made in [Annex B](#).



NOTE An example of a device covering a repeat range between 490 mm and 740 mm, corresponding to a radius between 77,986 mm and 117,775 mm.

Figure 3 — Indicator range

4.6 Calibration tool

A calibration tool with an external surface diameter corresponding approximately to the middle of the measurement range covered by the device shall be used, unless determined by a specific application and, in that situation, the calibration tool diameter can differ. An example of specific application is the particular case where only a subset of the device range of specified radius is used in practice. The calibration tool surface is considered an active surface and shall be constructed and surface finished in accordance with instructions provided in [4.3](#). Furthermore, the calibration tool surface shall have a roundness of 0,003 mm and shall not exceed 0,008 mm, according to ISO 1101:2004.

The external diameter of the calibration tool shall be measured with a precision of at least 0,001 mm and the resulting measure indicated.

5 Test procedure

5.1 Calibration

The device shall be calibrated

- prior to use for a series of measurements,
- every time the indicator is powered on,
- if the ambient temperature varies more than $\pm 4^\circ\text{C}$ since the last calibration, and
- every 30 min when in use.

The calibration tool and the measuring apparatus shall be exposed to the same environment where the measurements shall be performed and be allowed sufficient time to reach thermal equilibrium.

The calibration tool shall be carefully secured on a flat surface and its active surface shall be clean and free from dust. A scratched, dented, or damaged surface invalidates the tool.

The calibration tool radius (for calibration purposes the radius is half of the diameter) shall be used as reference for the indicator. The measured radius is the quantity measured by the indicator, including conversion using a suitable formula based on the frame angle (comprising the sign, positive for larger diameters and negative for smaller diameters) added to the calibration tool radius. If the indicator has the possibility of storing a preset value, the calibration tool radius can be stored and the final result directly presented.

5.2 General measurement conditions

For a measurement to be valid the temperature shall be between 10 °C and 40 °C. During a measurement or between the calibration and a measurement, the temperature shall not vary more than ± 4 °C.

NOTE The nominal measurement and printing environment is 20 °C.

5.3 Preliminary preparation

The printing cylinder shall be mounted on a compatible mandrel or support in a way that does not compromise its dimensional stability. The printing cylinder shall rest during a time period equal or superior to the one prescribed by the manufacturer. This rest time is necessary for achieving dimensional stability.

Before any measurement is performed, the printing cylinder surface shall be clean and free of any particles, debris, or damage to the surface.

5.4 Measurement

The measurement is performed by placing the device, previously calibrated, in contact with the surface of a printing cylinder and directly reading the result on the indicator. The radius is calculated using a suitable formula based on the frame angle. No direct or indirect force shall be applied. The device shall rest on its own weight. During measurement, there shall be no movement between the device and the printing cylinder. The angle formed between the spindle axis and the perpendicular line to the reference plane (measured surface) shall be less than $\pm 1^\circ$.

The radius shall be reported in millimetres to three decimal places.

The number of measurements and respective position both across and around the printing cylinder shall be previously agreed and communicated between the provider and the receiver. Any supplementary calculation (e.g. mean, range, or standard deviation) of all or parts of the acquired measurements shall be previously agreed and communicated between the provider and the receiver.

NOTE Printing cylinder areas with visible surface perturbations (i.e. scratches, cracks, or cuts) can affect the quality of the measurements.

6 Test reporting

6.1 Required information

The test report shall include at least the following information:

- a) a reference to this International Standard, i.e. ISO 15341:2014;
- b) details of the measured printing cylinder (including when available, the name of the manufacturer, the reference/type of printing cylinder, and the serial number);
- c) rest time on the mandrel/support before measuring;

- d) number of valid performed measurements;
- e) approximate location of each of the performed measurements in relation to the printing cylinder;
- f) measurement results of each measured location;
- g) details of any deviations from this International Standard.

6.2 Optional information

The test report may include the following information:

- a) eventual supplementary calculations (clearly identified);
- b) ambient temperature during measurement;
- c) operator identifier;
- d) name and address of the test facility;
- e) date of the tests;
- f) manufacturer of the measurement device.

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Annex A (normative)

Device for measuring mid-web flexography sleeves

A.1 General

One common and demanding application for the type of measurement devices described in this International Standard is the measurement of sleeves used in flexographic printing. This Annex specifies the values and tolerances for the critical dimensions associated with measuring mid-web flexographic sleeves with a repeat between 490 mm (radius 77,986 mm) and 740 mm (radius 117,775 mm). [Annex B](#) shows technical drawings of a specific implementation of such a device.

[Table A.1](#) contains the aims and tolerances of the critical parameters necessary for designing a device for measuring flexographic printing sleeves having a repeat between 490 mm (radius 77,986 mm) and 740 mm (radius 117,775 mm).

Table A.1 — List of critical parameters

Parameter	Unit	Aim	Tolerance
Frame angle	°	60	± 0,005
Thermal expansion coefficient ^a , α	K ⁻¹	$\leq 1,15 \times 10^{-5}$	-
Total weight of assembled apparatus	kg	2,60	± 0,20
Total width of the frame active surfaces	mm	45	± 0,3
Edge radius of the frame active surfaces	mm	2	-
Position of the apparatus centre of mass ^b	mm	≥ 103,3	-
Indicator spindle movement range	mm	> 40,5	-
Calibration tool (ring) diameter	mm	194 ^c	± 0,003
^a Stainless steel SS 2172 is an example of a material suitable for the frame construction. ^b Located along the spindle axis, distance measured from top of the frame. ^c Typical value for the specified sleeve radius range; depending on the specific application, other values are possible. See 4.6 .			

A.2 Formula for converting the measured distance in the cylinder radius for an apparatus with a frame angle of 60°

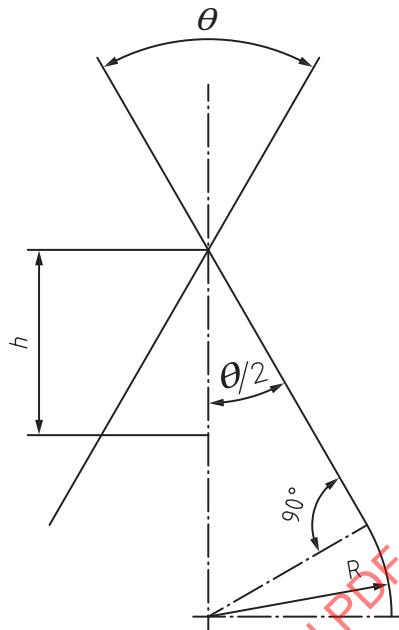
$$R = \sin\left(\frac{\eta}{2}\right) \cdot (h + R) \quad (\text{A.1})$$

$$R = \frac{\left[h \cdot \sin\left(\frac{\eta}{2}\right) \right]}{\left[1 - \sin\left(\frac{\eta}{2}\right) \right]}$$

For a frame with an angle of 60°, the measured distance, h , is equal to the cylinder radius, R .

A.3 General principle for an apparatus with a frame angle of η

Figure A.1 illustrates the principle for an apparatus with a frame angle of η .



Key

- η frame angle
- R radius of the cylinder
- h measured distance

NOTE A specific implementation of the present application can be constructed according to the drawings of [Annex B](#).

Figure A.1 — Schematic principle for an apparatus with a η frame angle

Annex B (informative)

Device for measuring mid-web flexography sleeves — Technical drawings

This Annex provides drawings for an actual implementation of [Annex A](#). These drawings are provided without any restriction and can be freely used for actual construction of a device or as an aid to understanding the principle involved.

The technical drawings in [Figures B.1, B.2, B.3, B.4, B.5, B.6, B.7, and B.8](#) provide guidance and assist with the creation of a suitable device for measuring flexographic printing sleeves having a repeat between 490 mm (radius 77,986 mm) and 740 mm (radius 117,775 mm) defined according to [Annex A](#).

The measurement device can be fabricated according to the drawings and specifications. Construction can be made according to the specified dimension tolerances.

[Table B.1](#) lists the measurement device drawings for the convenience of users. [Tables B.2](#) and [B.3](#) list the parts' composition of the assembled drawings.

Table B.1 — Drawings list

Description		Drawing Reference	
		Number	Name
Assembled			
	Measurement device	S1	V-tool
	Calibration tool support	S2	Cradle
Components			
	Device frame	1	Frame
	Spirit level cap	2	Cap level vial
	Calibration tool (ring)	3	Calibration ring 194 mm
	Calibration ring support — bottom plate	4	Bottom plate
	Calibration ring support — side plates	5	Gable
	Calibration ring support — shafts	6	Shaft

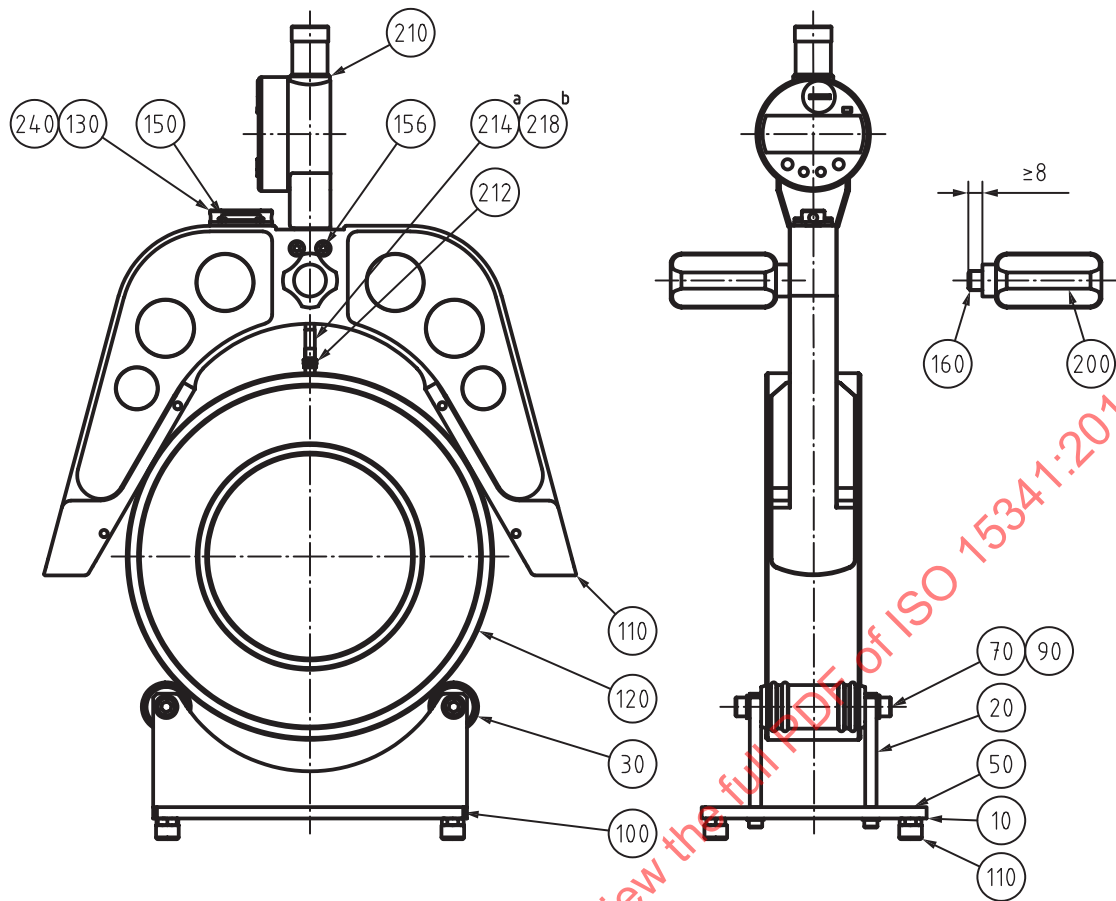
Table B.2 — Parts composing drawing S1

Position	Description	Drawing number	Quantity
100	Cradle	S2	1
110	Frame	1	1
120	Calibration ring	3	1
130	Cap level vial	2	1
150	Screw ISO 4762-M2 × 5-12,9	-	4
155	Screw ISO 4762-M4 × 16-12,9	-	2
160	Screw ISO 4026-P6SS 6 × 16 steel	-	2
200	Handle	-	2
210	Dial indicator	-	1
212	Measuring tip	-	2
214	Extender 35 mm	-	1
216	Extender 15 mm	-	1
240	2 axis spirit level	-	1

NOTE Parts 210, 212, 214, and 216 identify the dial indicator, part 200 identifies the handles, and part 240 the spirit level. They provide an example and can all be substituted by equivalent components.

Table B.3 — Parts composing drawing S2

Position	Description	Drawing number	Quantity
10	Bottom plate	4	1
20	Gable	5	2
30	Shaft	6	2
50	Screw ISO 4026 P6SS 5 × 12 steel	-	4
60	Screw ISO 4762 M4 × 12-12,9	-	4
70	Screw ISO 4762 M6 × 16-12,9	-	4
80	Washer DIN 125A 4,3 fzb	-	4
90	Washer DIN 125A 6,4 fzb	-	4
100	O-ring 19,2 × 3 70 EPDM 281	-	8
110	Foot type NCN Code GG.AU109 Description NCH.11-M4	-	4



Key

- a For diameter > 194 mm ($l = 35$ mm).
- b For diameter < 194 mm ($l = 15$ mm).

NOTE The measurement device is locked with a suitable product.¹⁾

Figure B.1 — Measurement device — S1 V-tool

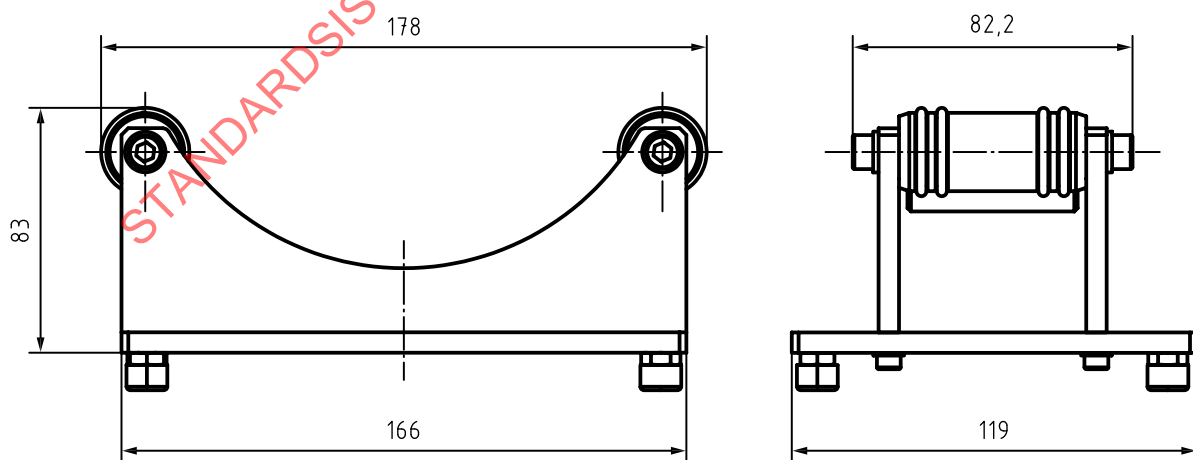


Figure B.2 — Calibration tool support — S2 Cradle

¹⁾ Details of suitable products can be obtained from ISO/TC 130.

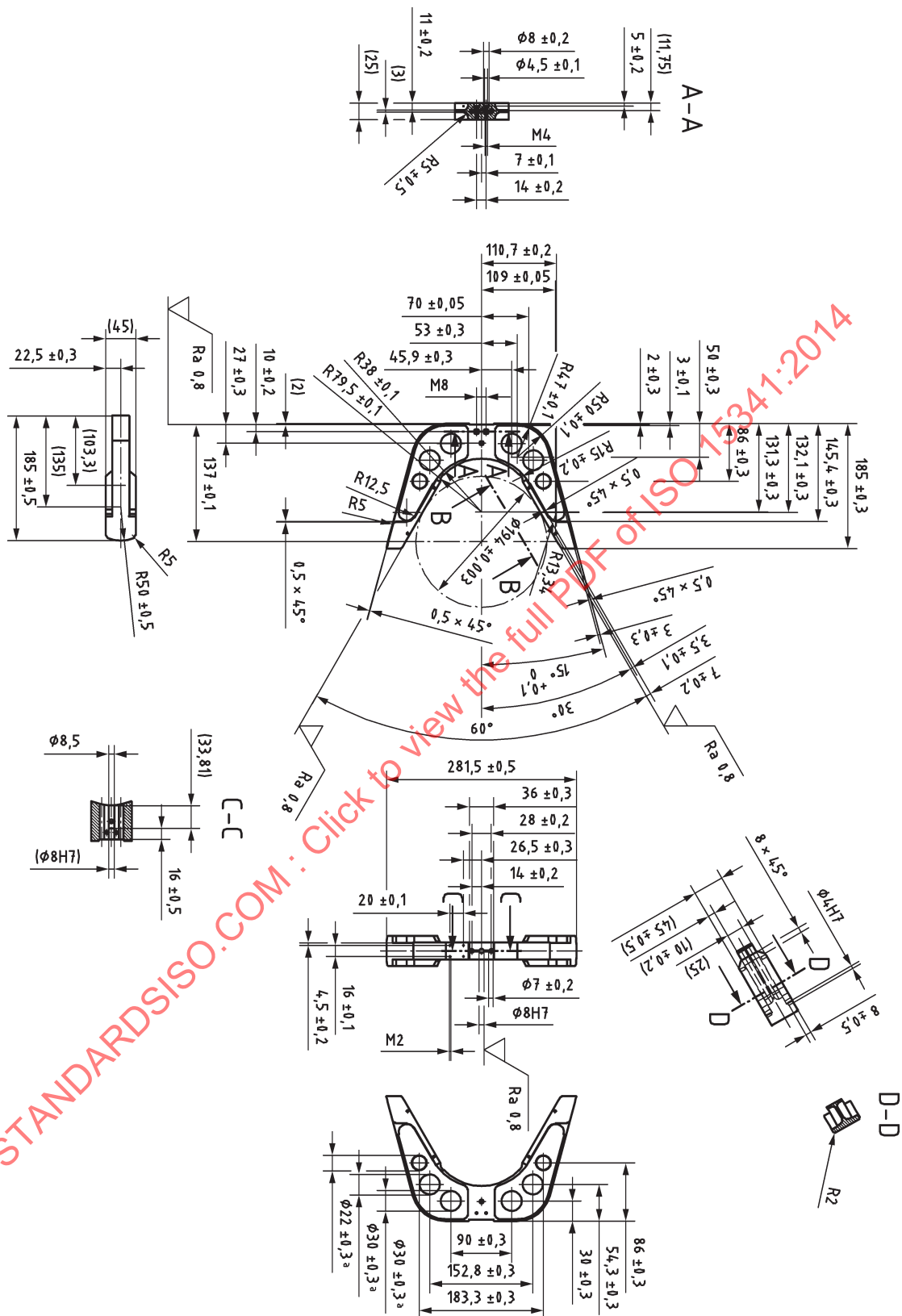


Figure B.3 — Device frame — 1 Frame