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Aerospace — MJ threads — Gauging

Aéronautique et espace — Filetage MJ — Vérification par calibres



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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).

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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 20, *Aircraft and space vehicles*, Subcommittee SC 4, *Aerospace fastener systems*.

This second edition cancels and replaces the first edition (ISO 10959:2000), which has been technically revised.

Introduction

The purpose of this International Standard, which differs from ISO 1502, is to take into account the basic characteristics of the ISO MJ threads (restricted form variation and increased root radius of the external thread) as well as the specific tolerances and to standardize the gauging principles for ISO MJ threads, intended for products for aerospace applications.

Aerospace — MJ threads — Gauging

1 Scope

This International Standard contains information for the gauging of ISO MJ threads in accordance with ISO 5855-1, ISO 5855-2, and ISO 5855-3.

Other methods of ensuring that the product is within the specified limits may be used provided correlation with the specified gauges is established [see 8.2, e)].

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 1, *Geometrical Product Specifications (GPS) — Standard reference temperature for geometrical product specification and verification*

ISO 1502:1996, *ISO general-purpose metric screw threads — Gauges and gauging*

ISO 5408, *Screw threads — Vocabulary*

ISO 5855-1, *Aerospace — MJ threads — Part 1: General requirements*

ISO 5855-2, *Aerospace — MJ threads — Part 2: Limit dimensions for bolts and nuts*

ISO 5855-3, *Aerospace — MJ threads — Part 3: Limit dimensions for fittings for fluid systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5408 and the following apply.

3.1

best wire size

cylinder or sphere which has a radius so that it will contact the thread flanks at the pitch cylinder intersection

Note 1 to entry: The radius of the best wire or sphere is theoretically equal to $0,288\ 68\ P$.

3.2

indicating gauge

device having contacts which will precisely compare the size of a work piece thread to a setting standard of known dimensions

Note 1 to entry: The value for the indicated characteristic thus established is the dimensional value attributed to the work piece. An indicating gauge may have contacts designed to measure any thread characteristic. This International Standard specifies the characteristics and designs for ISO MJ threads.

3.3

simple pitch diameter

diameter of an imaginary cylinder intersecting an actual thread over the width of one groove where that width is equal to one half of the basic pitch

3.4

virtual pitch diameter

pitch diameter of the smallest (for external threads) or largest (for internal threads) perfect thread form with GO gauge profile which can engage the product threads for a distance equal to the GO gauge thread engagement

4 Types of gauges

4.1 Gauges and setting plugs for external product threads

	Gauge type	Reference
a)	GO screw ring gauges	6.1.2
b)	Setting plug for adjustable GO screw ring and indicating thread gauges	7.1
c)	Virtual pitch diameter indicating thread gauges	6.1.1
d)	Simple pitch diameter indicating thread gauges	6.1.3
e)	Flat contact gauges for major diameter	6.1.4
f)	Point contact indicating thread gauges for minor diameter	6.1.5
g)	Optical comparator for root radius and minor diameter	6.1.6

4.2 Gauges for internal product threads

	Gauge type	Reference
a)	GO screw plug gauges	6.2.1
b)	NOT GO screw plug gauges	6.2.2
c)	Plain gauges for minor diameter (plug gauge)	6.2.3
d)	GO full form screw plug gauges	6.2.3.2
e)	Virtual pitch diameter indicating thread gauges	6.2.4
f)	Simple pitch diameter indicating thread gauges	6.2.5

5 Reference temperature

In accordance with ISO 1, the dimensions of the gauge and the product shall be checked at the temperature of 20 °C.

If the product and the gauge have the same coefficients of linear expansion, the temperature may deviate from 20 °C, provided the temperature of the product and the gauge are the same.

If the product and the gauge have different coefficients of linear expansion, the temperature of both, at the time of gauging, shall be

- a) 20 °C ± 2 °C for sizes MJ24 and smaller, and
- b) 20 °C ± 1 °C for larger threads.

6 Function, design, and use of gauges

6.1 Gauges for external threads

6.1.1 Virtual pitch diameter indicating thread gauges

6.1.1.1 It measures, on two or three segments or rolls, the maximum material virtual pitch diameter, taking into account variations of form such as pitch variation, helix and flank variations, roundness, and taper which produces an enlargement of the virtual pitch diameter. In addition, virtual pitch diameter control ensures the flank angle contact is sufficient to ensure that the root radius does not exceed the maximum limit. Measurement of virtual pitch diameter with indicating gauges shall be obtained to calculate virtual-minus-simple pitch-diameter differential unless the simple pitch diameter limits, gauged in accordance with the measurements given in [6.1.3](#), are within the limits defined by the maximum pitch diameter and the form variation limits in ISO 5855-1.

6.1.1.2 Indicating gauges have two or three contacts at 180° or 120° respectively. Gauges with segments or rolls are designed with the length of the GO virtual maximum material gauging elements equal to the GO ring gauge length (see [Table 1](#)). For configuration and profile requirements, see [Figure 1](#).

6.1.1.3 The minor diameter of the GO virtual maximum material thread segments and the diameter of the circle surrounded by the roll cluster of GO virtual maximum material rolls shall be equal to the pitch diameter of the product minus $0,375 H$, less the T_{PL} , minus tolerance when assembled in the gauge frame, where T_{PL} is specified in ISO 1502. This corresponds to a flat width of $0,3125 P$ on the minor crest for the thread. The crest shall be flat in an axial plane and parallel to the axis of the segments or rolls.

6.1.1.4 The major diameter of the GO virtual maximum material segments and the root of the GO virtual maximum material rolls shall be cleared beyond a $0,125 P$ flat, either by an extension of the flanks of the thread toward a sharp vee or by an undercut no greater than $0,125 P$ maximum width and approximately central. The root clearance shall be such that the major diameter of the full form section of the thread setting plug gauge is cleared after the assembled gauge has been properly set to size. Optional clearance specifications given in ISO 1502 may be used.

6.1.1.5 The simple pitch diameter cylinder axis of threaded segments and rolls shall be straight within the diameter tolerance zone equal to T_{PL} as specified in ISO 1502. The segment or roll thread profile, lead, pitch, and the half-angle variations shall be within the limits specified in ISO 1502.

6.1.2 Solid or adjustable GO screw ring gauges

To ensure the ease of assembly of product threads and conformance to the maximum material virtual pitch diameter limits, GO screw ring gauges with thread form as shown in [Figure 1](#) and setting gauges in accordance with the details described in [6.1](#) may be used. Solid GO screw ring gauges shall not be permitted to exceed the product thread dimensional limits. The gauge thickness/length shall be standardized as shown in [Table 1](#). The gauge tolerances, W_{GO} , shall be in accordance with ISO 1502.

6.1.3 Simple pitch diameter indicating thread gauges

The simple pitch diameter indicating gauge with cone and vee rolls or segments or rolls with the best wire size radius allows to ensure that the pitch diameter is greater than the minimum limit. The indicators are set to the GO threaded setting plug gauge. Readings indicate the position of the pitch diameter and the minimum measurement shall be no less than the minimum pitch diameter limit. The minimum measured pitch diameter shall be within the ISO 5855-1 form variation limit compared to the virtual pitch diameter measurement in accordance with the differential value given in [6.1.1](#).

The simple pitch diameter contacts have cone and vee rolls or segments which contact the product pitch cylinder. Other designs have two or three rolls with radii on annular ribs on rolls made to best

wire size. The product thread contacts is restricted to 1,5 pitch lengths. See [Figures 2](#) and [3](#) for design and contact form.

6.1.4 Major diameter gauges

The maximum limit of the major diameter may be checked with a plain ring gauge, a plain GO calliper, or plain diameter measuring device (see [Figure 4](#)). The minimum limit of the major diameter shall be measured with a plain diameter measuring device set to a plain diameter plug with H_P tolerance in accordance with ISO 1502. Plain micrometer calliper may be used to measure the major diameter and may have standard gauge block settings.

6.1.5 Minor diameter gauges

It shall be set to the plain minor diameter setting plug with H_P tolerance, in accordance with ISO 1502. See [Figure 5](#) for design and contact form.

6.1.6 Optical comparator checks

The optical comparator shall be used to verify the root radius by comparing the shadow contour to the radius charts. The minor diameter may also be measured with an optical comparator using appropriate measuring techniques.

6.2 Gauging for internal threads

6.2.1 GO screw plug gauges

To ensure ease of assembly of threads and conformance to the maximum material virtual pitch and major diameter limits, GO screw plug gauges specified in ISO 1502 or the full form GO screw plug gauge in accordance with the details described in [6.2.3.2](#) shall be used.

6.2.2 NOT GO screw plug gauges

To check that the minimum virtual pitch diameter is not greater than the maximum limit, NOT GO screw plug gauges specified in ISO 1502 shall be used.

6.2.3 Minor diameter gauges

6.2.3.1 The minimum minor diameter may be evaluated by a plain cylindrical GO plug gauge per ISO 1502 or a GO full form screw plug gauge in accordance with the details described in [6.2.3.2](#). The maximum minor diameter may be checked with a plain cylindrical NOT GO plug per ISO 1502. The diameters of the plain plugs shall be based on the minimum minor diameter specified in ISO 5855-1, ISO 5855-2, or ISO 5855-3 with gauge tolerance, H_1 , specified in ISO 1502. Internal micrometer callipers may be used to measure the minor diameter.

6.2.3.2 The GO full form screw plug gauge shall be a modified GO screw plug gauge specified in ISO 1502 with a controlled root radius on the gauge, see [Figure 6](#), equal to the maximum external thread root radius specified in ISO 5855-1, ISO 5855-2, or ISO 5855-3 with a radius tolerance in accordance with the values given in [Table 2](#).

6.2.4 Virtual pitch diameter indicating thread gauges

6.2.4.1 It measures, on two or three segments or rolls, the maximum material virtual pitch diameter taking into account variations of form such as pitch variation, helix and flank variations, roundness, and taper which produces a decrease in the virtual pitch diameter. The virtual pitch diameter shall be measured using indicating gauges to calculate the virtual-minus-simple pitch-diameter differential

unless the simple pitch diameter limits are within the limits defined by the minimum pitch diameter and the form variation limits in ISO 5855-1, ISO 5855-2, and ISO 5855-3.

6.2.4.2 Indicating gauges have two or three contacts at 180° or 120° respectively. Gauges with segments or rolls are designed with the length of the GO virtual maximum material gauging elements equal to the GO plug gauge length equal to nine pitches (P) or the basic major diameter of the thread, whichever is the smallest. For configuration and profile requirements, see [Figure 7](#).

6.2.5 Simple pitch diameter indicating thread gauges

The simple pitch diameter indicating thread gauge with cone and vee rolls or segments or rolls with the best wire size radius allows to ensure that the pitch diameter is not greater than the maximum limit. The indicators are set to the GO threaded ring gauge. Readings indicate the position of the pitch diameter and the maximum measurement shall be no greater than the maximum pitch diameter limit. The maximum measured pitch diameter shall be within the ISO 5855-1, ISO 5855-2, and ISO 5855-3 form variation limit compared to the virtual pitch diameter measurement made in accordance with the details given in [6.2.4.1](#).

The simple pitch diameter contacts have cone and vee rolls or segments which contact the product pitch cylinder. Other designs have two or three rolls with radii on annular ribs on rolls made to best wire size. The product thread contacts is restricted to 1,5 pitch lengths. See [Figures 7, 8, and 9](#) for design and contact form.

7 Setting gauges

7.1 The virtual pitch diameter indicating gauge is set to the threaded setting plug whose average simple pitch diameter, see [Figure 10](#), is below basic size by the value m specified in ISO 1502:1996, Table 4. The m factor adjusts the size of the setting plug so as to correct for the potential diametrical equivalents of the average variation which would be expected in the pitch and flank angles of the plug for adjustable GO screw ring gauges.

7.2 Set and check the GO screw ring gauge as specified in ISO 1502. Check the GO screw plug gauge as specified in ISO 1502.

7.3 Set the simple pitch diameter indicating gauge to the calibrated or marked pitch diameter setting plug gauge. These gauges are the same setting gauges as described in [7.1](#) to permit differential measurement calculations.

7.4 Set the major and minor diameter indicating gauges to their respective plain setting plugs. The diameter of these plain setting plugs shall be made to the maximum dimension with a negative tolerance of H_p in accordance with ISO 1502, see [Figures 11 and 12](#). The micrometer callipers may have standard gauge block settings.

8 Gauging of threads

8.1 Gauges with a wear allowance, such as permitted in ISO 1502, which allows gauges to exceed the maximum or minimum limits of the product thread, are not permitted for MJ threads.

A product thread characteristic is acceptable when any appropriate standardized gauge can be assembled. The manufacturer is responsible for ensuring that, whatever the case, the means ultimately ensures characteristics in accordance with the envelope requirements (see [Annex A](#)).

8.2 External threads shall be as follows.

- a) Check the virtual pitch diameter by measurement using either an indicating gauge or an assembly with a GO threaded ring gauge.
- b) Measure the simple pitch diameter with an indicating gauge.
- c) Compare the difference between the virtual and simple pitch diameter measurements to evaluate the cumulative effect of variations defined in ISO 5855-1.
- d) Evaluate the thread minor and major diameters and root contour.
- e) Normally, the use of more than one gauge option is not required. A product thread characteristic is accepted if it satisfies any one appropriate standard gauge. However, if there is a conflict between gauges for the product external thread maximum material limit, the product thread shall be accepted as long as the thread satisfies the GO threaded ring gauge. Wear check plugs shall not exceed the basic profile.

8.3 Internal threads shall be evaluated as follows.

- a) Check the maximum material limit of the virtual pitch diameter, as well as the minimum major diameter with a GO screw plug gauge in accordance with ISO 1502. A full form screw plug gauge may be used for this check.
- b) Measure the virtual pitch diameter with an indicating gauge. This requirement is optional for thread sizes less than 5 mm.
- c) Check the minimum material pitch diameter with a NOT GO screw plug gauge. Measuring the simple pitch diameter with an indicating gauge is, except for thread sizes less than 5 mm, also required.
- d) Check the minimum minor diameter with either a GO plain plug gauge or GO full form screw plug gauge. Use a NOT GO plain plug gauge to check the maximum minor diameter.

Table 1 — GO gauge thickness (length)

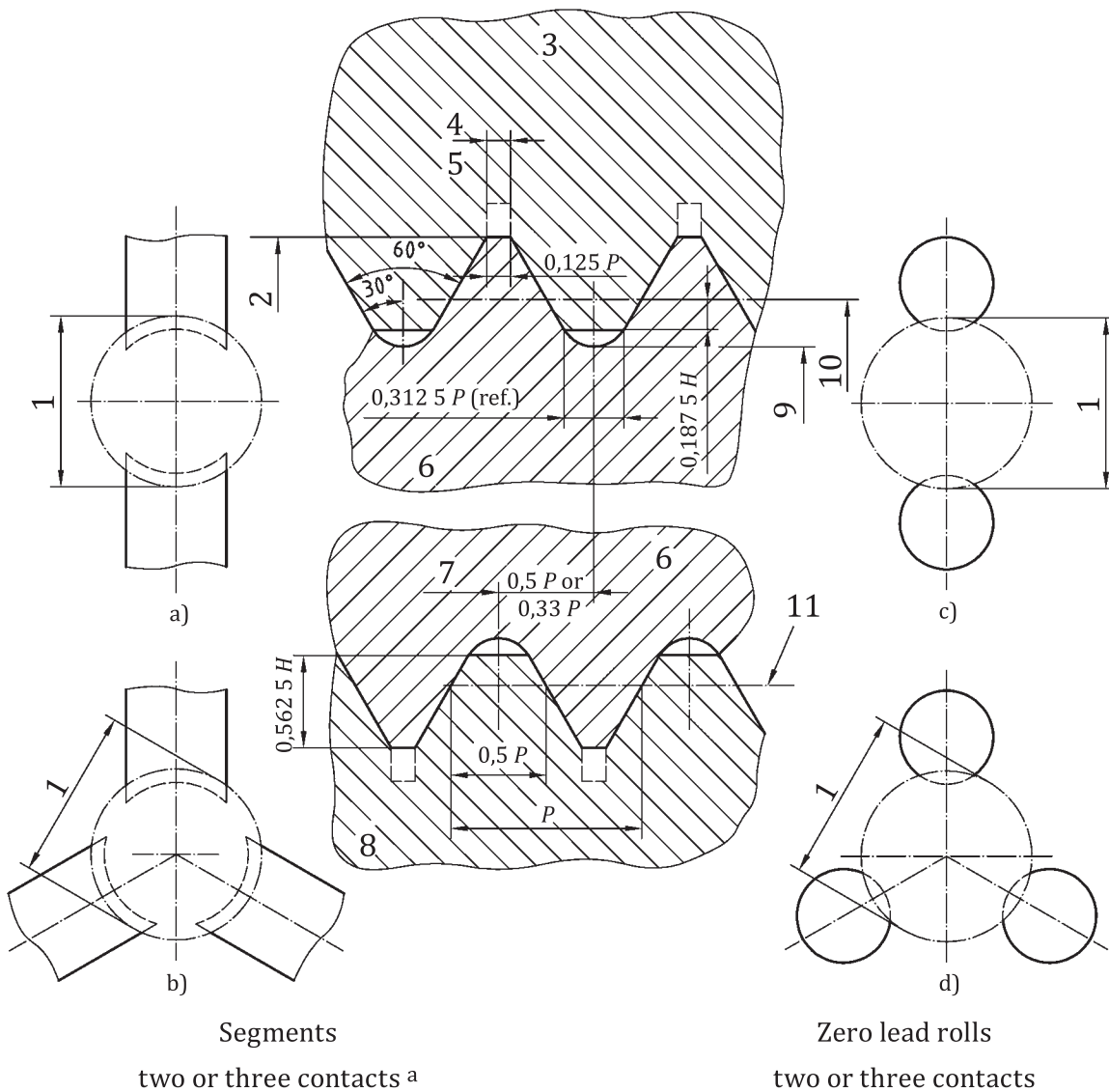
Thread size	Gauge length ^a mm	Thread size	Gauge length ^a mm
MJ1,6 × 0,35	1,60	MJ14 × 1,5	13,5
MJ2 × 0,4	2,00	MJ16 × 1,5	13,5
MJ2,5 × 0,45	2,50	MJ18 × 1,5	
MJ3 × 0,5	3,00	MJ20 × 1,5	
MJ3,5 × 0,6	3,50	MJ22 × 1,5	18,0
MJ4 × 0,7	4,00	MJ24 × 2	
MJ5 × 0,8	5,00	MJ27 × 2	
MJ6 × 1	6,00	MJ30 × 2	
MJ7 × 1	7,00	MJ33 × 2	
MJ8 × 1	8,00	MJ36 × 2	
MJ10 × 1,25	10,00	MJ39 × 2	
MJ12 × 1,25	11,25		

^a Gauge thickness: for diameter/pitch combinations not listed in [Table 1](#), the gauge thickness is equal to nine pitches (*P*) or the basic major diameter (*D*, *d*) of the thread, whichever is the smallest.

Table 2 — Tolerance for GO full form screw plug gauge

Nominal thread pitch	Radius tolerance^a + μm	Nominal thread pitch	Radius tolerance^a + μm
0,35	6	0,70	13
0,40	7	0,80	14
0,45	8	1,00	18
0,50	9	1,25	23
0,60	11	1,50 to 2,00	25

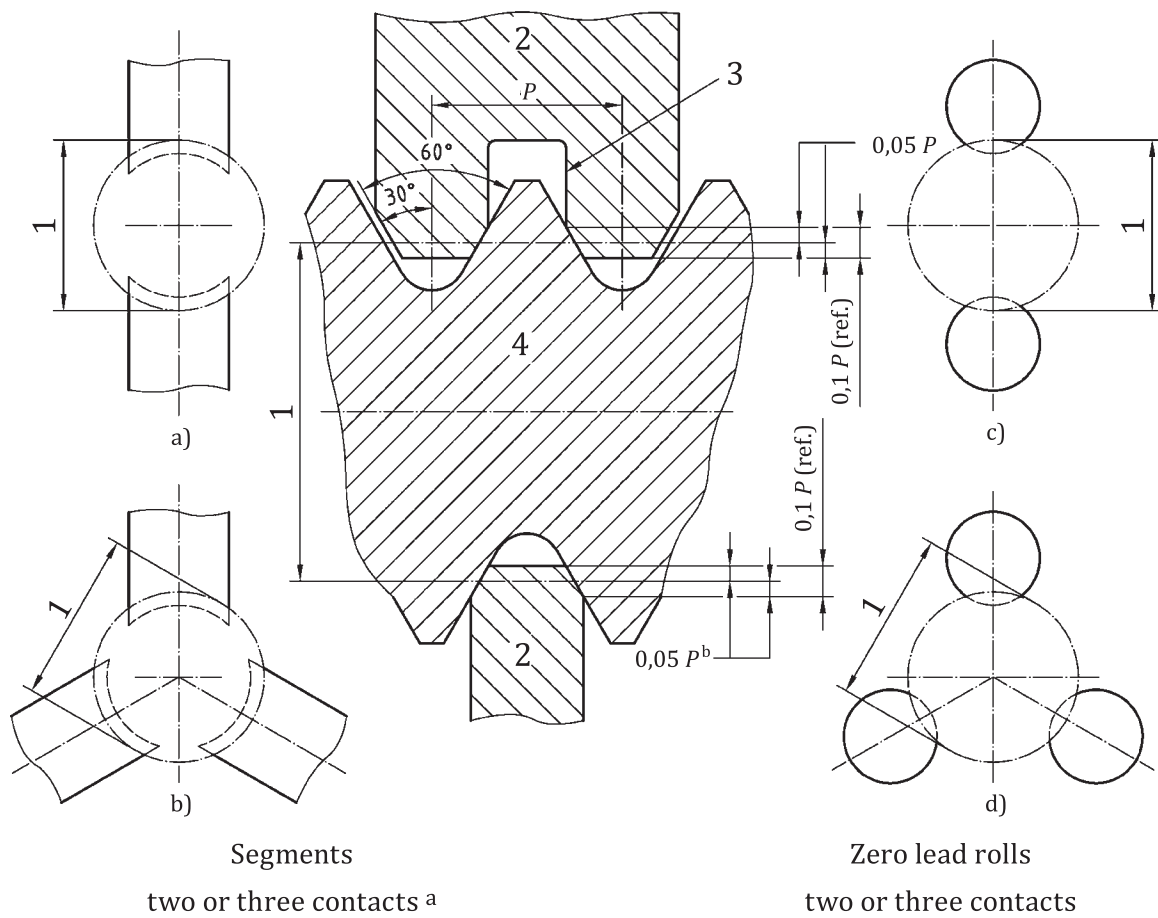
^a Gauge thickness: for thread pitches not listed in [Table 2](#), the radius tolerance shall be based on 0,5 of the root radius (*R*) tolerance for the external thread.



Key

- 1 pitch diameter
- 2 maximum major diameter of product external thread
- 3 gauge thread form
- 4 clear $0,125 P$ when not undercut
- 5 form of relief optional — width approximately central when undercut
- 6 maximum product external thread
- 7 for two or three contacts respectively
- 8 form of segment or roll
- 9 maximum minor diameter of product external thread
- 10 maximum pitch diameter of product external thread
- 11 pitch cylinder
- a The total segment contact to be a minimum of 25 % of circumference.

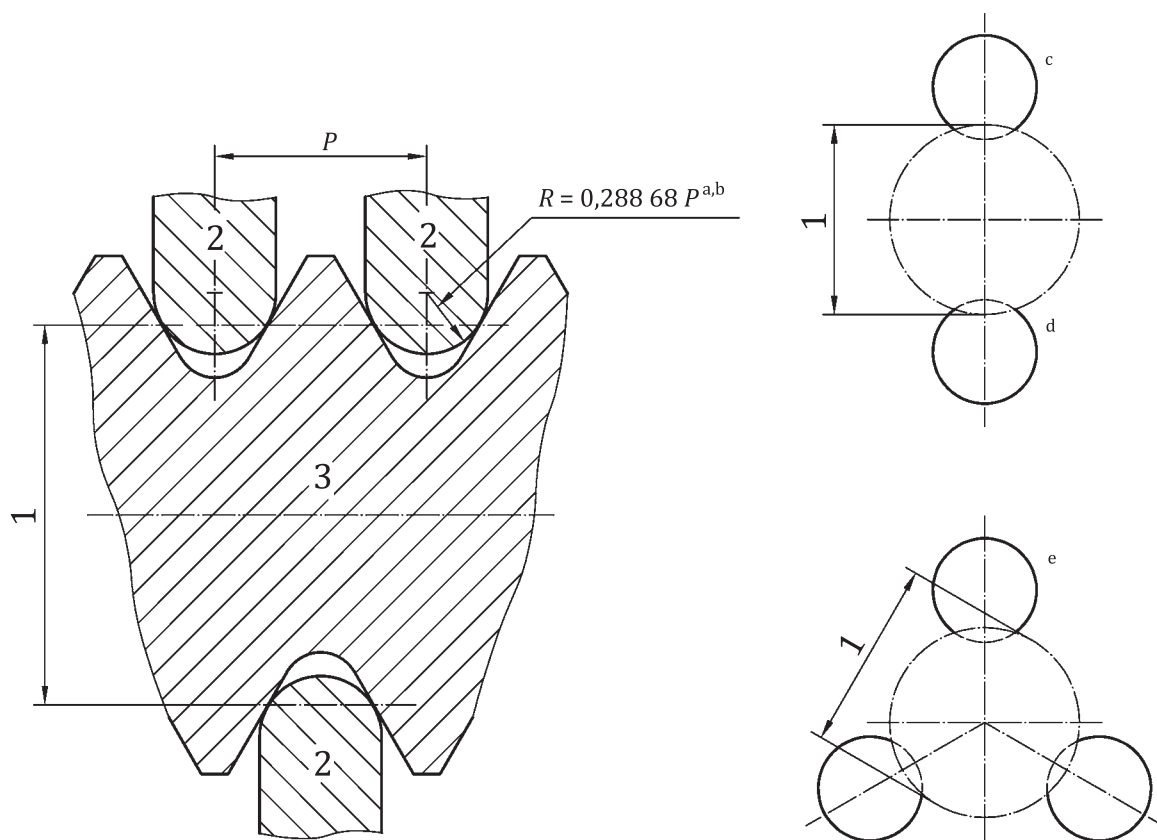
Figure 1 — Virtual pitch diameter indicating thread gauges for external threads



Key

- 1 pitch diameter
- 2 gauging element
- 3 form of relief optional
- 4 external thread
- ^a The total segment contact to be a minimum of 25 % of circumference.

Figure 2 — Simple pitch diameter indicating thread gauges with cone and vee for external threads



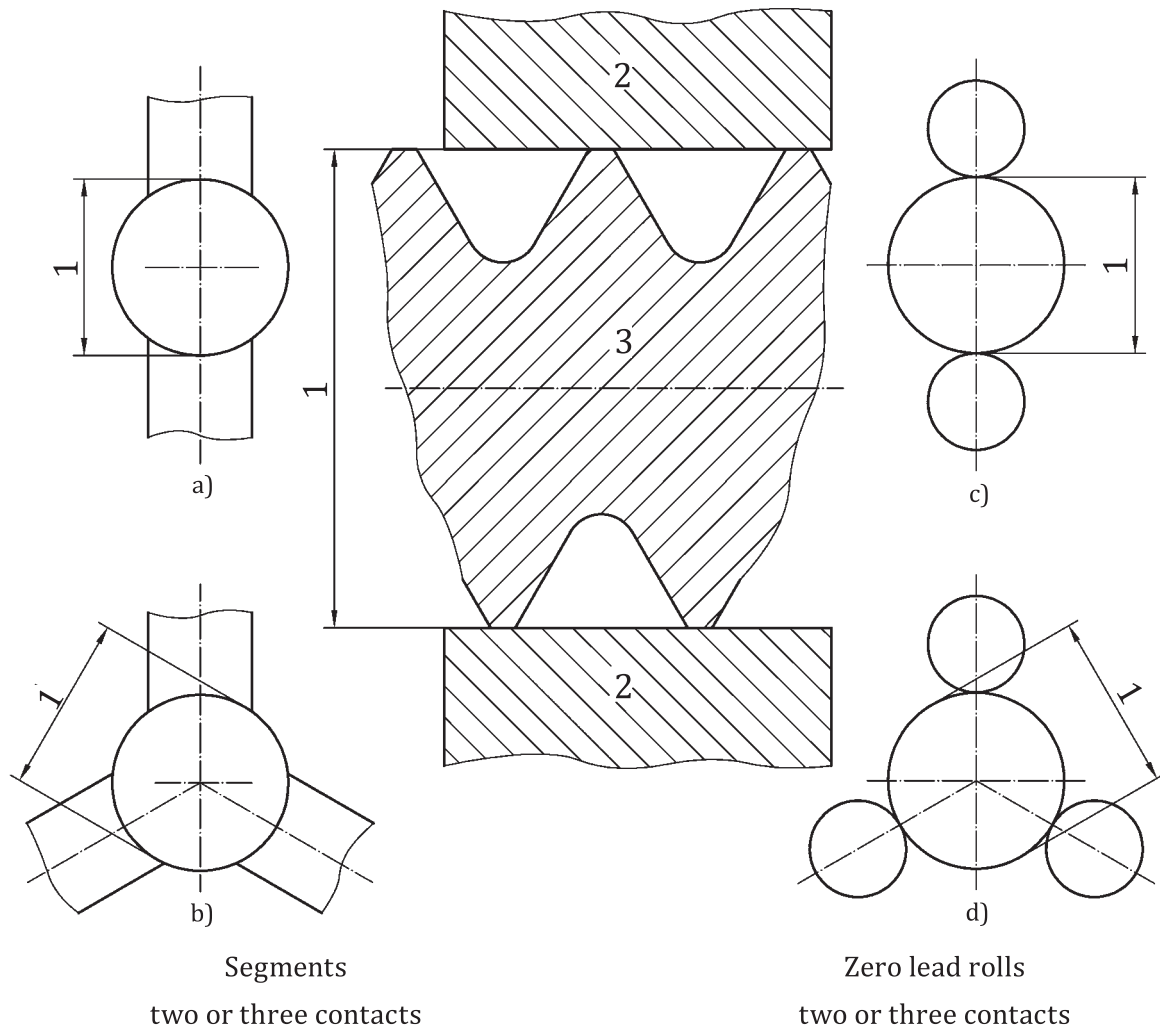
Zero lead rolls
two or three contacts

Key

- 1 pitch diameter
- 2 roll
- 3 external thread
- c Two ribs on top roll.
- d One rib on bottom roll.
- e One rib on each roll, one-third pitch apart.

NOTE Best wire size radius = $0,288\ 68\ P$.

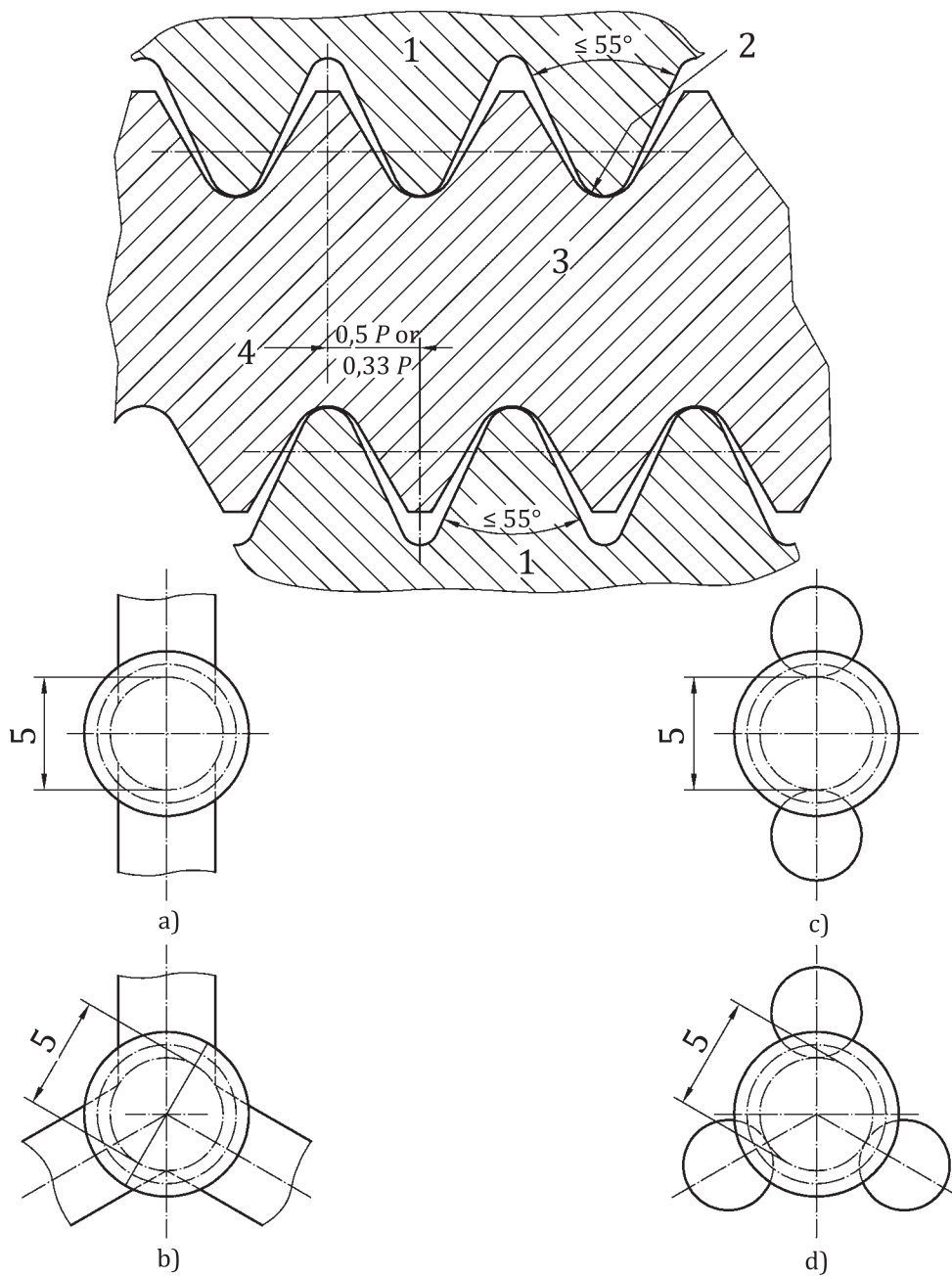
Figure 3 — Simple pitch diameter indicating thread gauges with radius roll for external threads



Key

- 1 major diameter
- 2 plain gauge contact
- 3 external thread

Figure 4 — Major diameter indicating plain gauges for external threads



Segments

two or three contacts

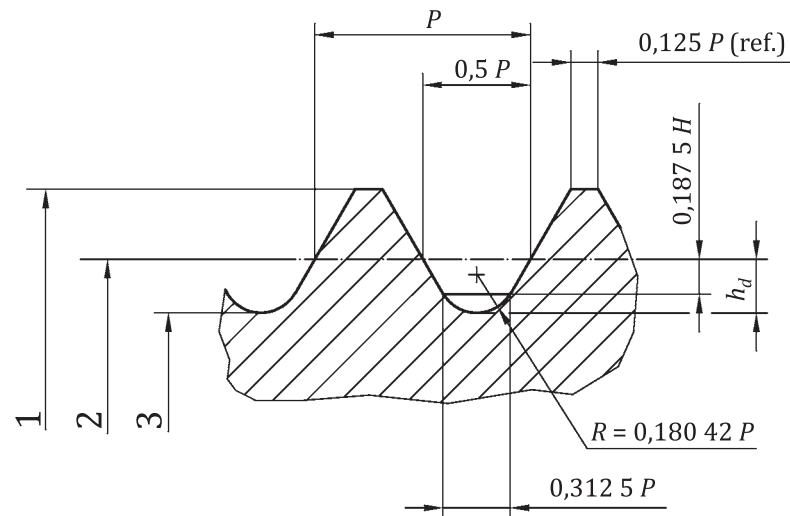
Zero lead rolls

two or three contacts

Key

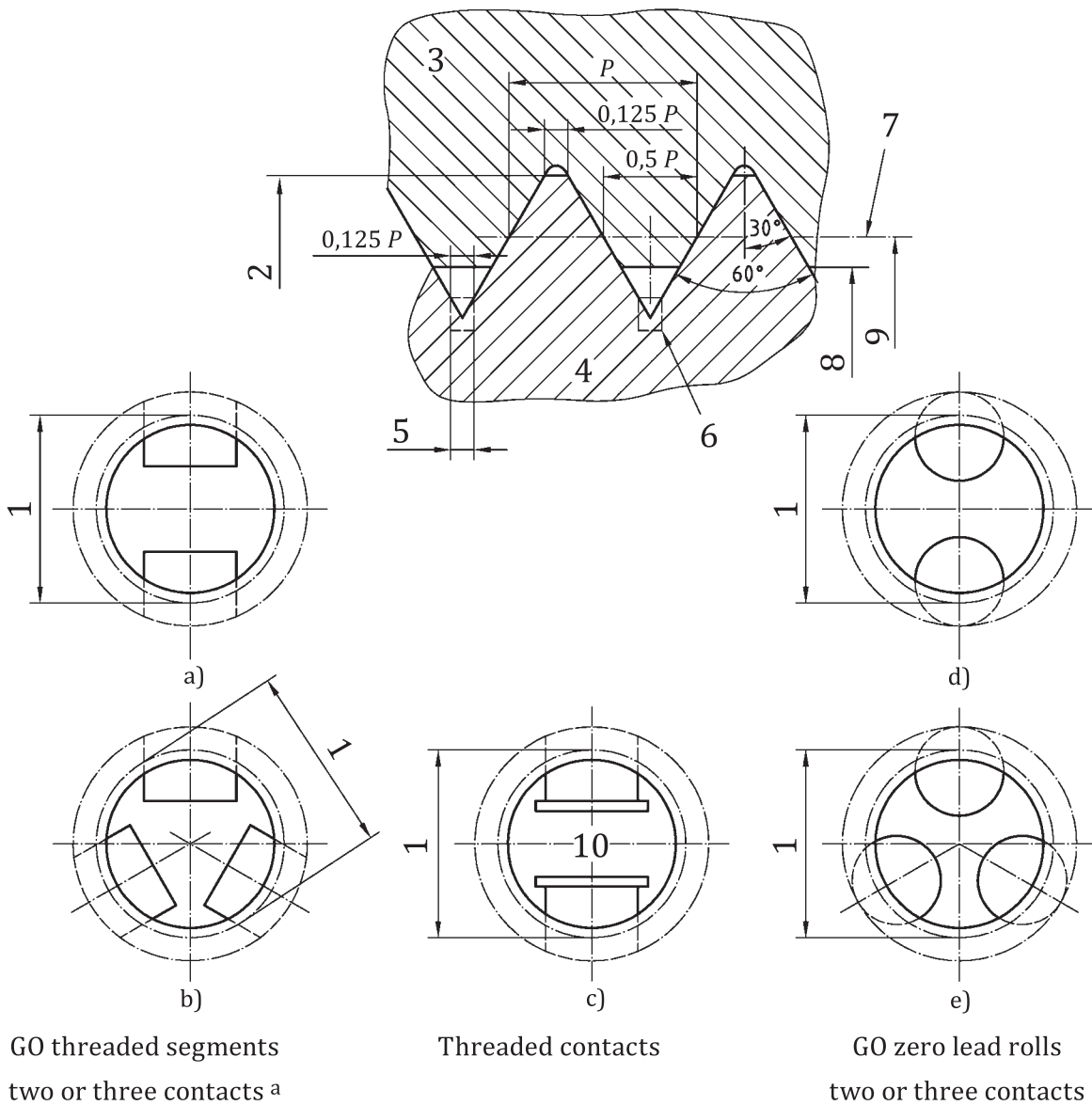
- 1 three thread segments or rolls
- 2 radius not to exceed root radius of part
- 3 external thread
- 4 for two or three contacts respectively
- 5 minor diameter

Figure 5 — Minor diameter indicating thread gauges for external threads

**Key**

- 1 major diameter
- 2 pitch diameter
- 3 minor diameter

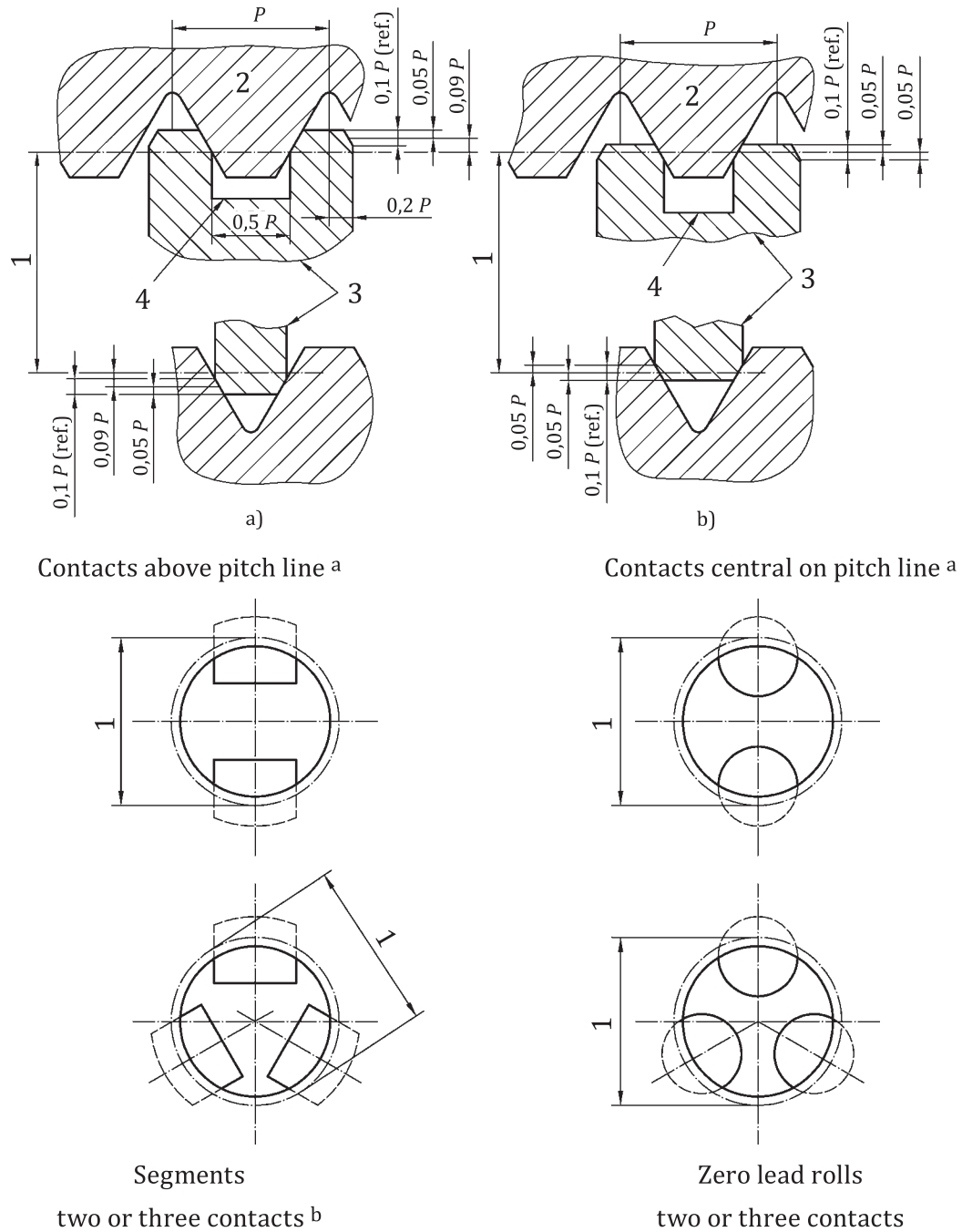
Figure 6 — GO full form screw plug gauges for internal maximum material threads



Key

- 1 pitch diameter
- 2 minimum major diameter of product internal thread
- 3 minimum product internal thread
- 4 gauge thread form
- 5 clear $0,125 P$ when undercut
- 6 form of relief optional - width approximately central when undercut
- 7 pitch cylinder
- 8 minimum minor diameter of product internal thread
- 9 minimum pitch diameter of product internal thread
- 10 fingers
- ^a The total segment contact to be a minimum of 25 % of circumference.

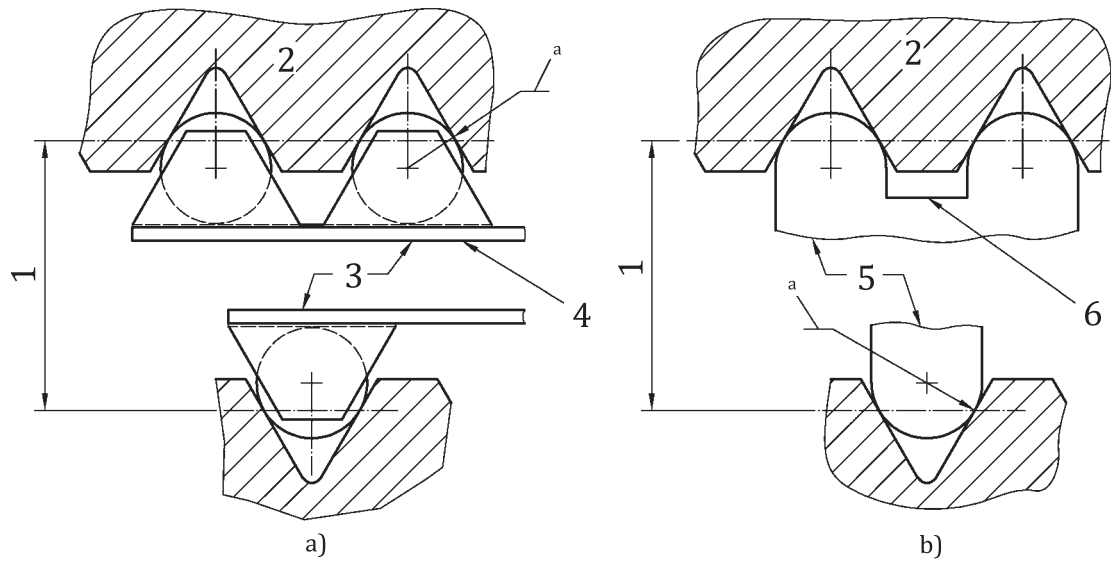
Figure 7 — Virtual pitch diameter indicating thread gauges for internal threads



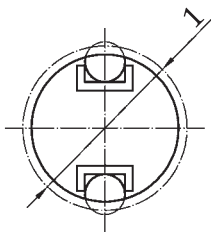
Key

- 1 pitch diameter
- 2 internal thread
- 3 gauging elements
- 4 form of relief optional
- a Alternate designs: contacts in other positions near the pitch cylinder may also be applied.
- b The total segment contact to be a minimum of 25 % of circumference.

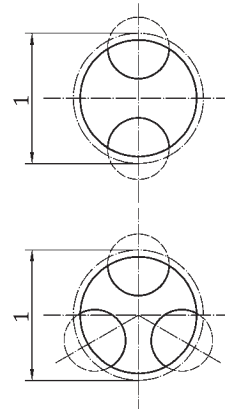
Figure 8 — Simple pitch diameter indicating thread gauges with cone and vee for internal threads



Three roll type: one rib on each roll,
one-third pitch apart
Two roll type: two ribs on one roll,
one rib on other roll, one-half pitch apart



Ball design



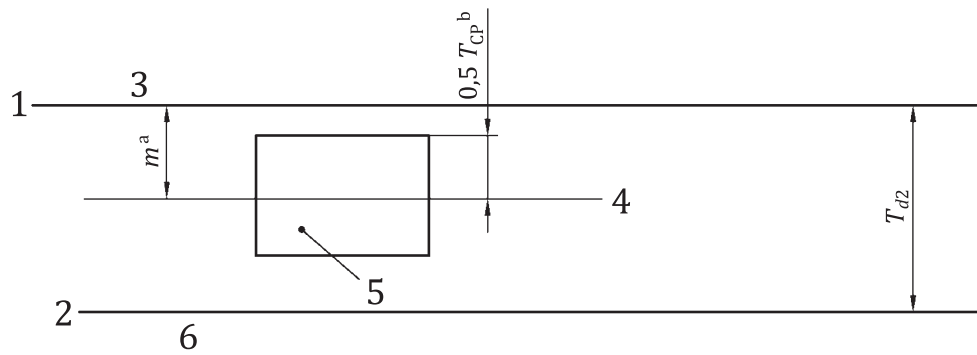
Zero lead rolls
two or three contacts

Key

- 1 pitch diameter
- 2 internal thread
- 3 gauging contacts with best size thread balls
- 4 floating, spaced three pitches apart
- 5 gauging contacts with one-half best size thread-wire diameter
- 6 form of relief optional

NOTE Best wire size radius $R = 0,288\ 68\ P$.

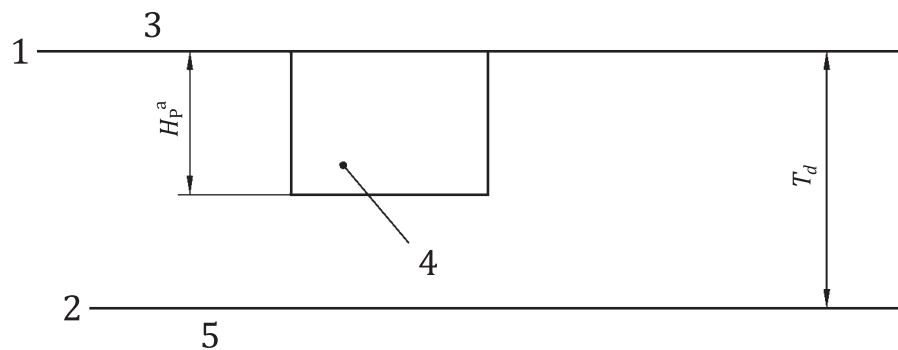
Figure 9 — Simple pitch diameter indicating thread gauges with radius roll for internal threads



Key

- 1 GO
- 2 NOT GO
- 3 maximum pitch diameter, external thread
- 4 average simple pitch diameter
- 5 gauge pitch diameter
- 6 lower limit
- a See ISO 1502.

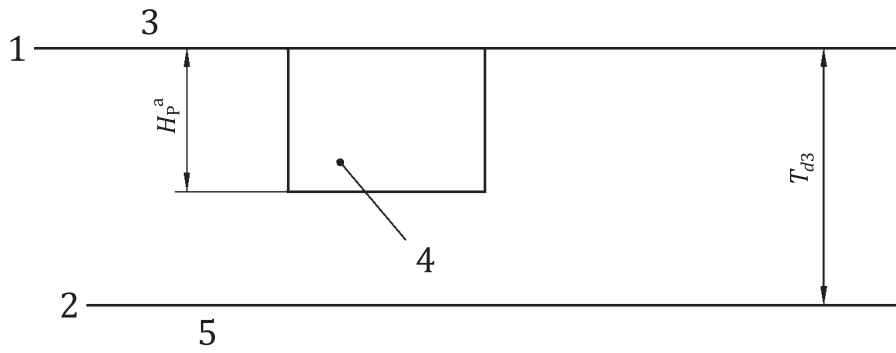
Figure 10 — Tolerance zone for the pitch diameter of GO thread setting plug gauges



Key

- 1 GO
- 2 NOT GO
- 3 maximum major diameter, external thread
- 4 setting plug gauge
- 5 lower limit
- a See ISO 1502.

Figure 11 — Tolerance zone for setting plain plug gauges for major diameter of external threads



Key

- 1 GO
- 2 NOT GO
- 3 maximum minor diameter, external thread
- 4 setting plug gauge
- 5 lower limit
- a See ISO 1502.

Figure 12 — Tolerance zone for setting plain plug gauges for minor diameter of external threads

Annex A (normative)

Prevalence of gauging by GO gauges

A.1 General

This International Standard is a product geometrical specification standard and shall be considered an additional GPS standard (see ISO 14638).

It affects chain link 5 of additional standards relevant to threads.

A.2 Justification of the prevalence of gauging with GO gauges

The present status of thread standards does not allow them to be formally linked to basic geometrical specification standards such as ISO 1101. However, it is possible to apply the principles by taking into account the interpretations in ISO 965-1 and ISO 1502. Indeed, the thread tolerancing and inspection

are equivalent to the envelope requirement \textcircled{E} (see ISO 8015) for the basic tolerance measurements (virtual pitch diameter, simple pitch diameter, and thread crest diameter) and to the independence principle for the other parameters (pitch, angle, etc.).

In the absence of basic geometrical and tolerancing specification standards adapting these principles to helicoid (or helical surface), it may be taken into account that they are used by default in this International Standard. In this case, only the GO screw ring and plug gauges fully achieve the envelope requirement when the measurement is completed by the use of one of the two simple pitch diameter indicating gauges with rolls and by measuring the thread crest diameter. The indicating gauge in [Figure 1](#) may be used to analyse adjustments and developments in manufacturing quality or to make statistics, but it cannot be considered a true virtual pitch diameter gauge achieving the envelope requirement as it raises a problem of the uncertainty of measurements related to the method (see ISO 14253-1) in comparison with the GO screw ring gauge.

Bibliography

- [1] ISO 965-1, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*
- [2] ISO 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*
- [3] ISO 8015, *Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules*
- [4] ISO 14253-1, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformity or nonconformity with specifications*
- [5] ISO 14638, *Geometrical product specifications (GPS) — Matrix model*

