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ISO metric trapezoidal screw threads — Tolerances

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National foreword

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ISO metric trapezoidal screw threads — Tolerances

Filetages métriques trapézoïdaux ISO — Tolérances

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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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 1, *Screw threads*.

This third edition cancels and replaces the second edition (ISO 2903:1993), Clauses 1, 13 and 14, and Table 7 of which have been technically revised (now Clauses 1, 11 and 12, and Table 5).

ISO metric trapezoidal screw threads — Tolerances

1 Scope

This document specifies a tolerance system for metric trapezoidal screw threads in accordance with ISO 2902. The tolerances refer to the design profile in accordance with ISO 2901.

The tolerance system does not apply to trapezoidal screw threads with special requirements on axial displacement, for example, machine tool lead and feed screws and nuts.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 965-1, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 2901, *ISO metric trapezoidal screw threads — Basic and design profiles*

ISO 2902, *ISO metric trapezoidal screw threads — General plan*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Symbols

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

D_4	basic major diameter of internal thread
D	nominal diameter (internal thread)
D_2	basic pitch diameter of internal thread
D_1	basic minor diameter of internal thread
d	basic major diameter of external thread (nominal diameter)
d_2	basic pitch diameter of external thread
d_3	basic minor diameter of external thread
P	pitch
Ph	lead

N	designation for normal group of thread engagement
L	designation for long group of thread engagement
T	tolerance
T_{D2}, T_{D1}, T_d, T_{d2}, T_{d3}	tolerances for D_2, D_1, d, d_2 and d_3, respectively (no tolerance for D_4)
EI, ei	lower limit deviations
ES, es	upper limit deviations

5 Tolerance system

The system is based on the tolerance system for ISO general-purpose metric screw threads of ISO 965-1.

6 Tolerance positions

The following tolerance positions are standardized for the pitch diameters.

— For internal threads: H with zero fundamental deviation (*EI*). See Figure 1.

— For external threads: c and e with negative fundamental deviation (*es*). See Figure 2.

The tolerance position for the minor diameter (D_1) and the major diameter (D_4) of the internal threads is always H, i.e. with zero fundamental deviation (*EI*).

The tolerance position for the major diameter (d) and minor diameter (d_3) of the external threads is in all cases h, i.e. with zero fundamental deviation (*es*), and it is independent of the tolerance positions of the pitch diameter.

The fundamental deviations for the pitch diameters of internal and external threads are given in Table 1.

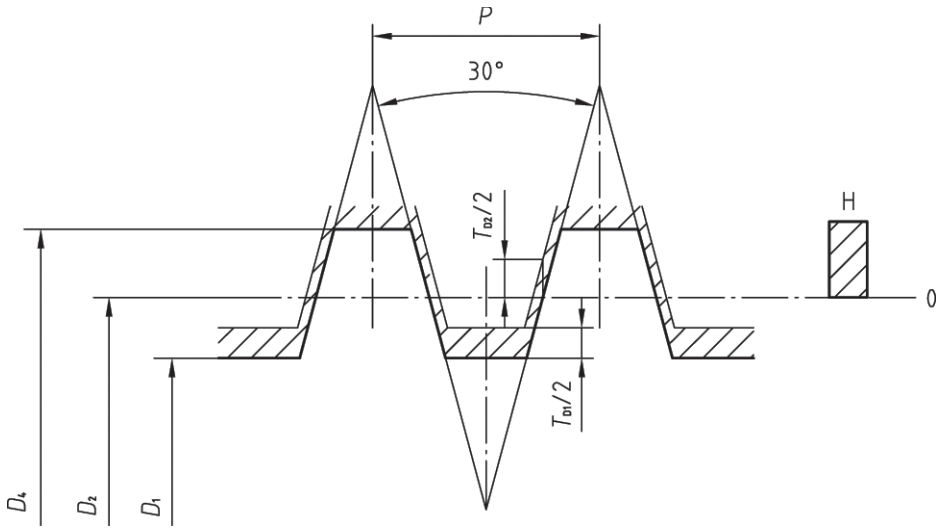

Figure 1 — Internal threads with tolerance position H

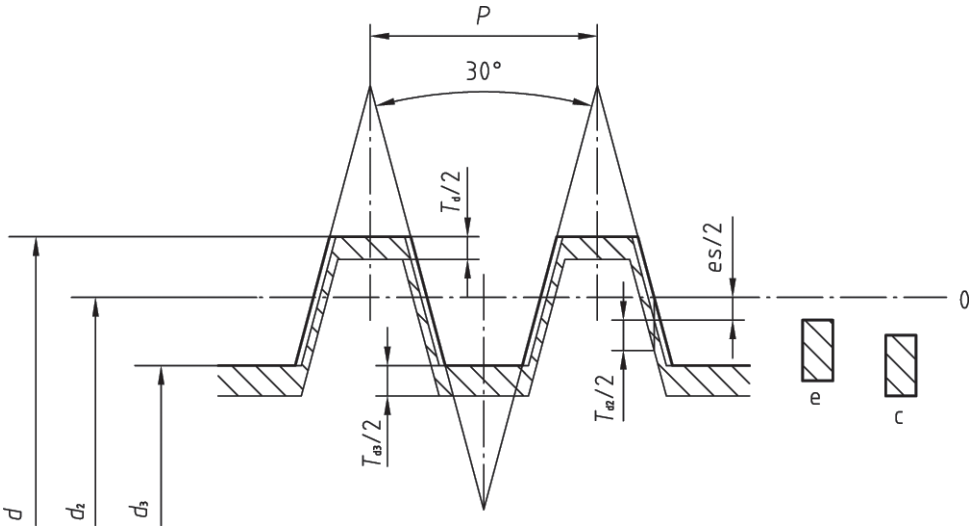

Figure 2 — External threads with tolerance positions c and e for the pitch diameter

Table 1 — Fundamental deviations for the pitch diameters of internal and external threads

Pitch *P*	Fundamental deviations		
	Internal threads D_2	External threads d_2	
	H *EI*	c *es*	e *es*
mm	µm	µm	µm
1,5	0	−140	−67
2	0	−150	−71
3	0	−170	−85
4	0	−190	−95
5	0	−212	−106
6	0	−236	−118
7	0	−250	−125
8	0	−265	−132
9	0	−280	−140
10	0	−300	−150
12	0	−335	−160
14	0	−355	−180
16	0	−375	−190
18	0	−400	−200
20	0	−425	−212
22	0	−450	−224
24	0	−475	−236
28	0	−500	−250
32	0	−530	−265
36	0	−560	−280
40	0	−600	−300
44	0	−630	−315

7 Tolerance grades

The tolerance grades for the following screw thread diameters are standardized.

	Tolerance grades		
Minor diameter of internal threads, D_1		4	
Major diameter of external threads, d		4	
Pitch diameter of internal threads, D_2	7	8	9
Pitch diameter of external threads, d_2	7	8	9
Minor diameter of external threads, d_3	7	8	9

The tolerance grade for the minor diameter (d_3) of the external thread is always the same as for the pitch diameter (d_2). However, the values for T_{d3} and T_{d2} are not the same for a same grade.

The minor diameter tolerances of internal thread (T_{D1}) are given in Table 2.

The major diameter tolerances of external thread (T_d) are given in Table 3.

Table 2 — Minor diameter tolerances of internal threads (T_{D1})

Pitch P	**Tolerance grade 4**
mm	µm
1,5	190
2	236
3	315
4	375
5	450
6	500
7	560
8	630
9	670
10	710
12	800
14	900
16	1 000
18	1 120
20	1 180
22	1 250
24	1 320
28	1 500
32	1 600
36	1 800
40	1 900
44	2 000

Table 3 — Major diameter tolerances of external threads (T_d)

Pitch *P*	**Tolerance grade 4**
mm	µm
1,5	150
2	180
3	236
4	300
5	335
6	375
7	425
8	450
9	500
10	530
12	600
14	670
16	710
18	800
20	850
22	900
24	950
28	1 060
32	1 120
36	1 250
40	1 320
44	1 400

The pitch diameter tolerances of internal thread (T_{D2}) are given in Table 4.

The pitch diameter tolerances of external thread (T_{d2}) are given in Table 5.

Table 4 — Pitch diameter tolerances of internal thread (T_{D2})

Basic major diameter *D*		**Pitch** *P*	**Tolerance grade**		
over	up to and incl.		7	8	9
mm	mm	mm	µm	µm	µm
5,6	11,2	1,5	224	280	355
		2	250	315	400
		3	280	355	450
11,2	22,4	2	265	335	425
		3	300	375	475
		4	355	450	560
		5	375	475	600
		8	475	600	750

Table 4 *(continued)*

Basic major diameter *D*		**Pitch** *P*	**Tolerance grade**		
over	up to and incl.		7	8	9
mm	mm	mm	µm	µm	µm
22,4	45	3	335	425	530
		5	400	500	630
		6	450	560	710
		7	475	600	750
		8	500	630	800
		10	530	670	850
		12	560	710	900
45	90	3	355	450	560
		4	400	500	630
		8	530	670	850
		9	560	710	900
		10	560	710	900
		12	630	800	1 000
		14	670	850	1 060
		16	710	900	1 120
		18	750	950	1 180
90	180	4	425	530	670
		6	500	630	800
		8	560	710	900
		12	670	850	1 060
		14	710	900	1 120
		16	750	950	1 180
		18	800	1 000	1 250
		20	800	1 000	1 250
		22	850	1 060	1 320
		24	900	1 120	1 400
		28	950	1 180	1 500
180	355	8	600	750	950
		12	710	900	1 120
		18	850	1 060	1 320
		20	900	1 120	1 400
		22	900	1 120	1 400
		24	950	1 180	1 500
		32	1 060	1 320	1 700
		36	1 120	1 400	1 800
		40	1 120	1 400	1 800
		44	1 250	1 500	1 900

Table 5 — Pitch diameter tolerances of external thread (T_{d2})

Basic major diameter *d*		**Pitch** *P*	**Tolerance grade**		
over	up to and incl.		7	8	9
mm	mm	mm	µm	µm	µm
5,6	11,2	1,5	170	212	265
		2	190	236	300
		3	212	265	335
11,2	22,4	2	200	250	315
		3	224	280	355
		4	265	335	425
		5	280	355	450
		8	355	450	560
22,4	45	3	250	315	400
		5	300	375	475
		6	335	425	530
		7	355	450	560
		8	375	475	600
		10	400	500	630
		12	425	530	670
45	90	3	265	335	425
		4	300	375	475
		8	400	500	630
		9	425	530	670
		10	425	530	670
		12	475	600	750
		14	500	630	800
		16	530	670	850
		18	560	710	900
90	180	4	315	400	500
		6	375	475	600
		8	425	530	670
		12	500	630	800
		14	530	670	850
		16	560	710	900
		18	600	750	950
		20	600	750	950
		22	630	800	1 000
		24	670	850	1 060
		28	710	900	1 120

Table 5 *(continued)*

Basic major diameter *d*		**Pitch** *P*	**Tolerance grade**		
over	up to and incl.		7	8	9
mm	mm	mm	µm	µm	µm
180	355	8	450	560	710
		12	530	670	850
		18	630	800	1 000
		20	670	850	1 060
		22	670	850	1 060
		24	710	900	1 120
		32	800	1 000	1 250
		36	850	1 060	1 320
		40	850	1 060	1 320
		44	900	1 120	1 400

The minor diameter tolerances of external thread (T_{d3}) are given in Table 6.

Table 6 — Minor diameter tolerances of external thread (T_{d3})

Basic major diameter *d*		**Pitch** *P*	**Tolerance position c of the pitch diameter**			**Tolerance position e of the pitch diameter**		
			Tolerance grade			Tolerance grade		
over	up to and incl.		7	8	9	7	8	9
mm	mm	mm	µm	µm	µm	µm	µm	µm
5,6	11,2	1,5	352	405	471	279	332	398
		2	388	445	525	309	366	446
		3	435	501	589	350	416	504
11,2	22,4	2	400	462	544	321	383	465
		3	450	520	614	365	435	529
		4	521	609	690	426	514	595
		5	562	656	775	456	550	669
		8	709	828	965	576	695	832
22,4	45	3	482	564	670	397	479	585
		5	587	681	806	481	575	700
		6	655	767	899	537	649	781
		7	694	813	950	569	688	825
		8	734	859	1 015	601	726	882
		10	800	925	1 087	650	775	937
		12	866	998	1 223	691	823	1 048

Table 6 *(continued)*

Basic major diameter *d*		**Pitch** *P*	**Tolerance position c of the pitch diameter**			**Tolerance position e of the pitch diameter**		
			Tolerance grade			Tolerance grade		
over	up to and incl.		7	8	9	7	8	9
mm	mm	mm	µm	µm	µm	µm	µm	µm
45	90	3	501	589	701	416	504	616
		4	565	659	784	470	564	689
		8	765	890	1 052	632	757	919
		9	811	943	1 118	671	803	978
		10	831	963	1 138	681	813	988
		12	929	1 085	1 273	754	910	1 098
		14	970	1 142	1 355	805	967	1 180
		16	1 038	1 213	1 438	853	1 028	1 253
		18	1 100	1 288	1 525	900	1 088	1 320
90	180	4	584	690	815	489	595	720
		6	705	830	986	587	712	868
		8	796	928	1 103	663	795	970
		12	960	1 122	1 335	785	947	1 160
		14	1 018	1 193	1 418	843	1 018	1 243
		16	1 075	1 263	1 500	890	1 078	1 315
		18	1 150	1 338	1 588	950	1 138	1 388
		20	1 175	1 363	1 613	962	1 150	1 400
		22	1 232	1 450	1 700	1 011	1 224	1 474
		24	1 313	1 538	1 800	1 074	1 299	1 561
		28	1 388	1 625	1 900	1 138	1 375	1 650
180	355	8	828	965	1 153	695	832	1 020
		12	998	1 173	1 398	823	998	1 223
		18	1 187	1 400	1 650	987	1 200	1 450
		20	1 263	1 488	1 750	1 050	1 275	1 537
		22	1 288	1 513	1 775	1 062	1 287	1 549
		24	1 363	1 600	1 875	1 124	1 361	1 636
		32	1 530	1 780	2 092	1 265	1 515	1 827
		36	1 623	1 885	2 210	1 343	1 605	1 930
		40	1 663	1 925	2 250	1 363	1 625	1 950
		44	1 755	2 030	2 380	1 440	1 715	2 065

8 Length groups of thread engagement

The lengths of thread engagement are classified into one of the two groups, normal (N) or long (L), in accordance with Table 7.

Table 7 — Length groups of thread engagement

Dimensions in millimetres

Basic major diameter *D, d*		**Pitch** *P*	**Length groups of thread engagement**		
			N		L
over	up to and incl.		over	up to and incl.	over
5,6	11,2	1,5	5	15	15
		2	6	19	19
		3	10	28	28
11,2	22,4	2	8	24	24
		3	11	32	32
		4	15	43	43
		5	18	53	53
		8	30	85	85
22,4	45	3	12	36	36
		5	21	63	63
		6	25	75	75
		7	30	85	85
		8	34	100	100
		10	42	125	125
		12	50	150	150
45	90	3	15	45	45
		4	19	56	56
		8	38	118	118
		9	43	132	132
		10	50	140	140
		12	60	170	170
		14	67	200	200
		16	75	236	236
		18	85	265	265
90	180	4	24	71	71
		6	36	106	106
		8	45	132	132
		12	67	200	200
		14	75	236	236
		16	90	265	265
		18	100	300	300
		20	112	335	335
		22	118	355	355
		24	132	400	400
		28	150	450	450

Table 7 — *(continued)*

Dimensions in millimetres

Basic major diameter *D, d*		**Pitch** *P*	**Length groups of thread engagement**		
			N		L
over	up to and incl.		over	up to and incl.	over
180	355	8	50	150	150
		12	75	224	224
		18	112	335	335
		20	125	375	375
		22	140	425	425
		24	150	450	450
		32	200	600	600
		36	224	670	670
		40	250	750	750
		44	280	850	850

9 Recommended tolerance classes

In order to reduce the number of gauges and tools, the tolerance classes should preferably be chosen from Tables 8 and 9.

The tolerance class should be selected according to the tolerance quality (medium and coarse) and the length group of thread engagement (N and L).

The following general rules can be formulated for the choice of tolerance quality.

— Medium: for general use.

— Coarse: for cases where manufacturing difficulties can arise.

If the actual length of thread engagement is unknown, group N is recommended.

Table 8 — Recommended tolerance classes for the pitch diameter of internal threads

Tolerance quality	**Length groups of thread engagement**	
	N	**L**
Medium	7H	8H
Coarse	8H	9H

Table 9 — Recommended tolerance classes for the pitch diameter of external threads

Tolerance quality	**Length groups of thread engagement**	
	N	**L**
Medium	7e	8e
Coarse	8c	9c

10 Multiple-start threads

With the same pitch, the tolerances for multiple-start threads are the same as for single-start threads, with the exception of the pitch diameter tolerances which are enlarged.

For multiple-start threads, the tolerance values for pitch diameter (T_{D2} and T_{d2}), specified in Tables 4 and 5, shall be multiplied by a factor according to Table 10.

Table 10 — Factors for multiple-start threads

Number of starts	2	3	4	5 and larger
Factor	1,12	1,25	1,4	1,6

11 Formulae

11.1 General

The values for pitch and crest diameter tolerances and for fundamental deviations have been calculated by the formulae and then rounded off to the nearest value in the R40 series of preferred numbers.

The calculated values for the minor diameter tolerances, T_{d3}, have not been rounded.

In order to reproduce a smooth progression, the rules of rounding off are not always used.

When the tolerance values calculated by the formulae are different from the values specified by the tolerance tables, the values in the tolerance tables shall be used.

11.2 Fundamental deviations

The fundamental deviations for threads are calculated as given by Formulae (1) to (6):

$$EI_H = 0 \tag{1}$$

$$es_h = 0 \tag{2}$$

$$es_e = -(50 + 11P) \tag{3}$$

NOTE 1 This is applicable to threads with $P \leq 3$ mm.

$$es_e = -47{,}49\ P^{0,5} \tag{4}$$

NOTE 2 This is applicable to threads with $P \geq 4$ mm.

$$es_c = -(125 + 11P) \tag{5}$$

NOTE 3 This is applicable to threads with $P \leq 2$ mm.

$$es_c = -(5 + 94{,}12\ P^{0,5}) \tag{6}$$

NOTE 4 This is applicable to threads with $P \geq 3$ mm.

where

EI and es are expressed in micrometres;

P is expressed in millimetres.

11.3 Crest diameter tolerances

11.3.1 Tolerances for major diameter of external thread (T_d)

The tolerances for grade 4 are calculated as given by Formula (7):

$$T_d = 0{,}63\ (180\ P^{2/3} - 3{,}15/P^{0{,}5}) \quad (7)$$

where

T_d is expressed in micrometres;

P is expressed in millimetres.

11.3.2 Tolerances for minor diameter of internal thread (T_{D1})

The tolerances for grade 4 are calculated as given by Formula (8):

$$T_{D1} = 0{,}63\ (230\ P^{0{,}7}) \quad (8)$$

where

T_{D1} is expressed in micrometres;

P is expressed in millimetres.

11.4 Pitch diameter tolerances

11.4.1 Tolerances for pitch diameter of external thread (T_{d2})

The tolerances for grades 7, 8 and 9 are calculated as given by Formulae (9) to (11):

$$T_{d2}\ (7) = 1{,}25\ (90\ P^{0{,}4}\ d^{0{,}1}) \quad (9)$$

$$T_{d2}\ (8) = 1{,}6\ (90\ P^{0{,}4}\ d^{0{,}1}) \quad (10)$$

$$T_{d2}\ (9) = 2\ (90\ P^{0{,}4}\ d^{0{,}1}) \quad (11)$$

where

T_{d2} is expressed in micrometres;

P and d are expressed in millimetres;

d is equal to the geometrical mean value of the diameter range limits.

11.4.2 Tolerances for pitch diameter of internal thread (T_{D2})

The tolerances for grades 7, 8 and 9 are calculated as given by Formulae (12) to (14):

$$T_{D2}\ (7) = 1{,}7\ (90\ P^{0{,}4}\ d^{0{,}1}) \quad (12)$$

$$T_{D2}\ (8) = 2{,}12\ (90\ P^{0{,}4}\ d^{0{,}1}) \quad (13)$$

$$T_{D2}\ (9) = 2{,}65\ (90\ P^{0,4}\ d^{0,1}) \tag{14}$$

where

T_{D2} is expressed in micrometres;

P and d are expressed in millimetres;

d is equal to the geometrical mean value of the diameter range limits.

11.5 Tolerances for minor diameter of external thread (T_{d3})

The tolerances are obtained from the T_{d2} and es values as given by Formula (15):

$$T_{d3} = 1{,}25\ T_{d2} + |es| \tag{15}$$

where

T_{d2}, T_{d3} and es are expressed in micrometres.

NOTE The tolerance grades for d_2 and d_3 are the same always. See Clause 7.

11.6 Length groups of thread engagement

For the calculation of the limits of the normal length of thread engagements, l_N, the following rules are applied.

$$l_{N\,min} \approx 2{,}24\ P\ d^{0,2} \tag{16}$$

$$l_{N\,max} \approx 6{,}7\ P\ d^{0,2} \tag{17}$$

where

l_N, P and d are expressed in millimetres;

d is equal to the smallest diameter within a certain diameter range of Table 7.

12 Designation

12.1 General

The complete designation for a screw thread comprises a designation for the thread system, the thread size and a designation for the thread tolerance class followed by further individual items, if necessary.

12.2 Designation of single-start threads

A screw thread complying with the requirements of the International Standards for ISO metric trapezoidal screw threads in accordance with ISO 2901, ISO 2902 and this document shall be designated by the letter “Tr” followed by the value of the nominal diameter and of the pitch, expressed in millimetres, and separated by the “×” symbol.

EXAMPLE 1 Tr 40 × 7

The tolerance class designation comprises a tolerance class designation for the pitch diameter only.

There is no need to designate the other diameter tolerances since

— their tolerance position is always the same, h or H,

— only one tolerance grade is established for the minor diameter of internal threads (D_1) and for the major diameter of external threads (d),

— the tolerance grade for the minor diameter of external threads (d_3) is always the same with the pitch diameter (d_2).

Each tolerance class designation consists of

— a figure indicating the tolerance grade of pitch diameter,

— a letter indicating the tolerance position of pitch diameter, uppercase for internal threads, lowercase for external threads.

EXAMPLE 2 External thread

Tr 40 × 7 – 7e

Internal thread

Tr 40 × 7 – 7H

A fit between threaded parts is indicated by the internal thread tolerance class designation followed by the external thread tolerance class designation separated by a forward slash/stroke.

EXAMPLE 3 Tr 40 × 7 – 7H/7e

For the designation of the long length group of thread engagement, the letter L should be added following the tolerance class designation separated by a dash.

EXAMPLE 4 Tr 40 × 7 – 7H – L

The absence of the letter for the length group of thread engagement means that the normal group (N) is specified.

12.3 Designation of multiple-start screw threads

A multiple-start metric screw thread in accordance with this document shall be designated by the letter "Tr" followed by the value of the nominal diameter, the "×" symbol, the value of the lead, the letter "P" and the value of the pitch, a dash and the tolerance class. Nominal diameter, lead and pitch are expressed in millimetres.

EXAMPLE 5 Two-start screw threads

Tr 40 × 14P7 – 7e

Tr 40 × 14P7 – 7H/7e

Tr 40 × 14P7 – 7H/7e – L

12.4 Designation of left-hand threads

When left-hand threads are specified, the letter "LH" shall be added to the end of thread designation separated by a dash.

EXAMPLE 6 Tr 40 × 14P7 – 7e – LH

Tr 40 × 14P7 – 7H/7e – L – LH

Bibliography

[1] ISO 5408, *Screw threads — Vocabulary*

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