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Gear hobs — Accuracy requirements

Fraises-mères — Exigences d'exactitude



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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.

ISO 4468 was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 1, *Nomenclature and wormgearing*.

This second edition cancels and replaces the first edition (ISO 4468:1982), which has been technically revised.

Gear hobs — Accuracy requirements

1 Scope

This International Standard specifies requirements for the accuracy of general-purpose hobs of 0,5 module to 40 module.

These hobs are intended for producing gears which conform to ISO 53 and ISO 54.

This International Standard applies to hobs for spur and helical gears. It applies to solid (monobloc) and inserted blade hobs.

The elemental features of hobs are graded according to accuracy, as follows:

- Grade 4A;
- Grade 3A;
- Grade 2A;
- Grade A;
- Grade B;
- Grade C;
- Grade D.

Grade 4A is the highest order of precision.

In addition to the elemental tests for hobs, this International Standard gives permitted tolerances for composite tests that are taken along the cutting edges on the line of action. The two groups of tests are not equivalent and one shall choose between one or the other. If there was no previous agreement, the hob is regarded as belonging to the precision class specified if it satisfies one or the other of the two methods of inspection.

NOTE The tolerances in this International Standard were determined for gear hobs whose dimensions conform to ISO 2490, but with certain precautions they can be applied to hobs not specified in this International Standard.

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 53, *Cylindrical gears for general and heavy engineering — Standard basic rack tooth profile*

ISO 54, *Cylindrical gears for general engineering and for heavy engineering — Modules*

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 1122-1, *Vocabulary of gear terms — Part 1: Definitions related to geometry*

ISO 2490, *Solid (monobloc) gear hobs with tenon drive or axial keyway, 0,5 to 40 module — Nominal dimensions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1122-1 and the following apply.

- 3.1 radial runout of hub diameter**
total deviation in radial distance of the hub periphery from the axis
- 3.2 axial runout of hub face**
total axial deviation of the hub face from a true plane of rotation
- 3.3 radial runout of tips of teeth**
total deviation in the radial distance from the axis to the tips of the hob teeth
- 3.4 straightness and radial alignment over cutting depth**
angular relationship between the tooth face and a radial line intersecting the tooth face at the hob outside diameter, measured in a plane perpendicular to the axis
- 3.5 adjacent spacing of cutting face of gashes**
maximum deviation between any two consecutive cutting face measurements
- 3.6 total spacing of cutting face of gashes**
maximum deviation between any two cutting face measurements
- 3.7 gash lead deviation per 100 mm**
maximum deviation as the probe contacts the tooth faces within axial region of the gash
- 3.8 tooth profile deviation**
maximum deviation of that portion of the hob tooth that generates an unmodified involute profile
- 3.8.1 tooth profile deviation when line of action test is used**
maximum deviation of that portion of the hob tooth that generates an unmodified involute profile when the line of action test is used

NOTE Test 8A is used for tooth profile deviation when the line of action test is used.

3.9**tooth thickness**

normal tooth thickness difference of actual and reference datum at the reference cylinder

NOTE Negative only.

3.9.1**addendum**

difference of addendum values related to designed normal tooth thickness observed during testing

NOTE Positive only. Test 9A is used for addendum.

3.9.2**tooth thickness difference along one gash**

difference between maximum and minimum nominal tooth thickness along one gash at the reference cylinder

NOTE Test 9B is used for tooth thickness difference along one gash. This test is only valid for quality Grades 4A, 3A and 2A.

3.10**lead deviation on adjacent teeth**

maximum lead deviation between any two consecutive teeth

3.11**lead deviation in one axial pitch**

maximum deviation between any two teeth within any group of consecutive teeth contained in one axial pitch; the number of teeth in one axial pitch is the number of teeth encountered by the measurement probe as it moves parallel to the reference axis during lead testing for a distance of one axial pitch of the hob

NOTE The number of teeth is determined by the number of gashes, the number of threads and, in the case of helical gash hobs, the gash lead.

3.11.1**lead deviation in one axial pitch when line of action test is used**

maximum deviation between any two teeth within any group of consecutive teeth contained in one axial pitch when the line of action test is used

NOTE Test 11A is used for lead deviation in one axial pitch when the line of action test is used.

3.12**lead deviation in three axial pitches**

maximum lead deviation between any two teeth contained in three axial pitches; the number of teeth in three axial pitches is that number of teeth encountered by the measurement probe as it moves parallel to the reference axis during lead testing for a distance of three axial pitches of the hob

NOTE The number of teeth is determined by the number of gashes, the number of threads and, in the case of helical gash hobs, the gash lead.

3.12.1**lead deviation in three axial pitches when line of action test is used**

maximum lead deviation between any two teeth contained in three axial pitches when the line of action test is used

NOTE Test 12A is used for lead deviation in three axial pitches when the line of action test is used.

3.13

adjacent deviation along line of action

maximum deviation between any two consecutive teeth of a given line of action test

NOTE 1 Adjacent hob line of action allowable deviation can be applied to adjacent line of action test results in those cases where the hob has been specified to be manufactured with involute helicoid geometry.

NOTE 2 Adjacent deviation along the line of action is measured at the cutting edge.

3.14

total deviation along line of action

total maximum deviation between any two teeth of a given line of action test

NOTE 1 Total hob line of action allowable deviation can be applied to total line of action test results in those cases where the hob has been specified to be manufactured with involute helicoid geometry.

NOTE 2 Total deviation along the line of action is measured at the cutting edge.

3.15

axial pitch deviation from thread to thread

maximum axial pitch deviation between any two consecutive teeth contained within two gashes

NOTE 1 For an odd number of threads, the angle between the gashes is approximately 90°. For an even number of threads, it is approximately 120°.

NOTE 2 The minimum requirement is to inspect the number of axial pitches equal to the number of threads.

3.16

axial pitch deviation in any three axial pitches over all threads

maximum axial pitch deviation over any three adjacent teeth contained within two gashes

NOTE 1 For an odd number of threads, the angle between the gashes is approximately 90°. For an even number of threads, it is approximately 120°.

NOTE 2 The minimum requirement is to inspect the number of axial pitches equal to the number of threads.

4 Accuracy requirements

Hobs shall conform to the requirements of Tables 2 and 4, as appropriate.

When prior agreement between the hob manufacturer and purchaser specifies measurement of hobs, the manufacturer should select:

- the measurement method to be used from among the applicable methods described in this International Standard and summarized in Table 1;
- the piece of measurement equipment to be used by the selected measurement method, provided it is in proper calibration;
- the individual teeth to be measured, as long as they are approximately equally spaced.

No particular method of measurement or documentation is considered mandatory. When applications require measurements beyond those recommended in this International Standard, it is recommended to negotiate special measurement methods prior to manufacturing the hob.

Table 1 — Reference for measurement methods

Test method definition	Test description	Test number ^a	
		Elemental test	Composite test ^b
3.1	Radial runout of hub diameter	1	1
3.2	Axial runout of hub face	2	2
3.3	Radial runout of tips of teeth	3	3
3.4	Straightness and radial alignment over cutting depth	4	4
3.5	Adjacent spacing of cutting face of gashes	5	5
3.6	Total spacing of cutting face of gashes	6	6
3.7	Gash lead deviation per 100 mm	7	7
3.8	Tooth profile deviation	8	8A
3.9	Tooth thickness	9 or 9A and 9B	9 or 9A and 9B
3.10	Lead deviation on adjacent teeth	10	10
3.11	Lead deviation in one axial pitch	11	11A
3.12	Lead deviation in three axial pitches	12	12A
3.13	Adjacent deviation along line of action (measured at the cutting edge)	— ^c	13
3.14	Total deviation along line of action (measured at the cutting edge)	— ^c	14
3.15	Axial pitch deviation from thread to thread	15	15
3.16	Axial pitch deviation in any three axial pitches over all threads	16	16
^a See Clause 5. ^b Select the composite test when the line of action test is used. ^c Test does not apply to the elemental method.			

5 Derivation of allowable values

5.1 General

Test 7 does not conform to a datum value and is not among the statements in Clause 5 concerning grade relationships.

With the exception of Test 7, the datum from which all the values in Table 6 are derived is the value of 45 µm Test 14 Grade A modules 16 to 25.

5.2 Tests 1-7

For tests 1 to 7, use Equation (1):

$$\text{Calculated value} = 45 K_e K_m K_g \quad (1)$$

K_t is not used.

5.3 Tests 9, 11, 11A, 12, 12A

For tests 9, 11, 11A, 12, 12A, use Equation (2):

$$\text{Calculated value} = 45 K_e K_m K_g K_t \quad (2)$$

where

K_e is the ratio for test element (see Table 3);

K_m is the ratio for division of module (see Table 4);

K_g is the ratio for grade (see Table 3);

K_t is the ratio for number of threads (see Table 5).

5.4 Test 9B

Test 9B is only valid for quality Grades 4A, 3A and 2A.

5.5 Tests 8, 8A, 9B, 10, 13, 14, 15 and 16

Tests 8, 8A, 9B, 10, 13, 14, 15 and 16 are only valid for the following:

- a) 1-thread, all Module ranges;
- b) 2-threads, Module range $0,5 \leq m \leq 16$;
- c) 3- and 4-threads, Module range $0,5 \leq m \leq 6$;
- d) 5-, 6- and 7-threads, Module range $0,5 \leq m \leq 3,5$.

The value of the allowable deviations has been rounded to the nearest whole value after calculation. The minimum value of allowable deviations is 2 μm .

Standard bores shall be finished straight and parallel within the tolerances given in Table 2 for 75 % of each bearing length for Grades 4A, 3A, 2A, A and B hobs and 50 % for Grades C and D hobs.

A reference mandrel of nominal bore diameter shall pass through the bore as a check of alignment.

The tolerances on bore diameter are specified in Table 2.

Table 2 — Tolerance on bores

Grade of hob	Tolerance ^a									
	Datum diameter									
	mm									
	8	10	13	22	27	32	40	50	60	80
4A	H3									
3A	H3			H4						
2A										
A	H4			H5						
B	H5									
C	H6									
D										
^a In accordance with ISO 286-2.										

Table 3 — Ratio for test element and grade

Test number	Ratio of test element K_e	Ratio of grade K_g						
		4A	3A	2A	A	B	C	D
1	0,3	0,35	0,5	0,71	1	1,6	1,6	2,11
2	0,25							
3	1,6							
4	1,25					1,8	1,8	2,38
5	1,4							
6	2,6							
7	No relationship to test 14							
8	0,5	0,71	0,71	1	1,25	2,31		
8A	0,85							
9	1,5							
9A	As by Table 4	0,71	0,71	1	2	2	2,54	
9B	0,8	0,35	0,5	0,71	—	—	—	—
10	0,4							
11	0,7							
11A	0,8							
12	1,3							
12A	1,8				1	2	4	5,28
13	0,4							
14	1							
15	0,45							
16	0,8							

Table 4 — Ratio for division of module

Module range m	Ratio for module range K_m	Multiplication factor
$0,5 \leq m \leq 1$	0,33	1
$1 < m \leq 2$	0,33	
$2 < m \leq 3,5$	0,41	1,25
$3,5 < m \leq 6,0$	0,51	1,25
$6,0 < m \leq 10$	0,64	1,25
$10 < m \leq 16$	0,8	1,25
$16 < m \leq 25$	1	1,32
$25 < m \leq 40$	1,32	

Table 5 — Ratio for number of threads

Number of threads	Ratio for number of threads K_t	Multiplication factor
1	1	1,25
2	1,25	
3, 4	1,56	1,25
5, 6, 7	1,95	

Table 6 — Accuracy requirements

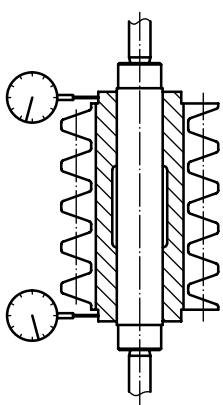
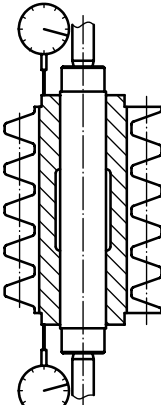
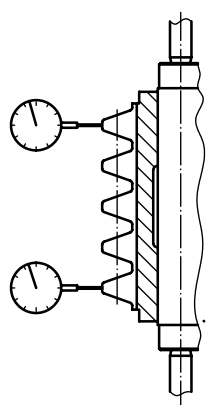
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade	4A	3A	2A	A	B	C	D
1	Hub diameter		Radial runout	$0,5 \leq m \leq 1$	2	2	3	4	7	7	9	
				$1 < m \leq 2$	2	2	3	4	7	7	9	
				$2 < m \leq 3,5$	2	3	4	6	9	9	12	
				$3,5 < m \leq 6,0$	2	3	5	7	11	11	15	
				$6,0 < m \leq 10$	3	4	6	9	14	14	18	
				$10 < m \leq 16$	4	5	8	11	17	17	23	
				$16 < m \leq 25$	5	7	10	14	22	22	28	
				$25 < m \leq 40$	6	9	13	18	29	29	38	
				$0,5 \leq m \leq 1$	2	2	3	4	6	6	8	
				$1 < m \leq 2$	2	2	3	4	6	6	8	
2	Hub face		Axial runout	$2 < m \leq 3,5$	2	2	3	5	7	7	10	
				$3,5 < m \leq 6,0$	2	3	4	6	9	9	12	
				$6,0 < m \leq 10$	3	4	5	7	12	12	15	
				$10 < m \leq 16$	3	5	6	9	14	14	19	
				$16 < m \leq 25$	4	6	8	11	18	18	24	
				$25 < m \leq 40$	5	7	11	15	24	24	31	
				$0,5 \leq m \leq 1$	8	12	17	24	43	43	113	
				$1 < m \leq 2$	8	12	17	24	43	43	113	
				$2 < m \leq 3,5$	10	15	21	30	53	53	140	
				$3,5 < m \leq 6,0$	13	18	26	37	66	66	174	
3	Outside diameter		Radial runout of tips of teeth	$6,0 < m \leq 10$	16	23	33	46	83	166	219	
				$10 < m \leq 16$	20	29	41	58	104	207	274	
				$16 < m \leq 25$	25	36	51	72	130	259	342	
				$25 < m \leq 40$	33	48	67	95	171	342	451	

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade							
					4A	3A	2A	A	B	C	D	
4	Cutting face of gashes		Straightness and radial alignment over cutting depth	$0,5 < m \leq 1$	6	9	13	19	33	44	44	
				$1 < m \leq 2$	6	9	13	19	33	44	44	
				$2 < m \leq 3,5$	8	12	16	23	42	55	68	
				$3,5 < m \leq 6,0$	10	14	20	29	52	68	86	
				$6,0 < m \leq 10$	13	18	26	36	65	86	107	
5	Cutting face of gashes		Adjacent spacing	$0,5 < m \leq 1$	7	10	15	21	37	49		
				$1 < m \leq 2$	7	10	15	21	37	49		
				$2 < m \leq 3,5$	9	13	18	26	46	61	76	
				$3,5 < m \leq 6,0$	11	16	23	32	58	76	96	
				$6,0 < m \leq 10$	14	20	29	40	73	96	120	
6	Cutting face of gashes		Total spacing	$0,5 < m \leq 1$	18	25	36	50	91	120		
				$1 < m \leq 2$	22	32	45	63	113	150		
				$2 < m \leq 3,5$	29	42	59	83	150	198		
				$3,5 < m \leq 6,0$	33	47	66	94	168	223		
				$6,0 < m \leq 10$	41	59	83	117	211	278		

NOTE The numbers 1, 2, 3, etc. refer to the cutting teeth on the hob.

NOTE The numbers 1, 2, 3, etc. refer to the cutting teeth on the hob.

Table 6 — Accuracy requirements (continued)

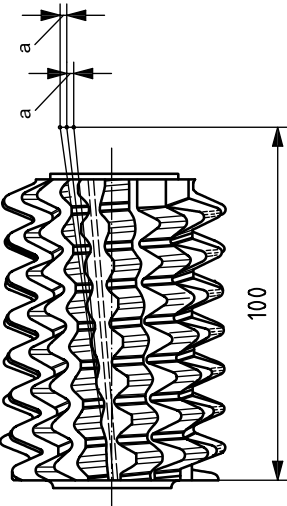
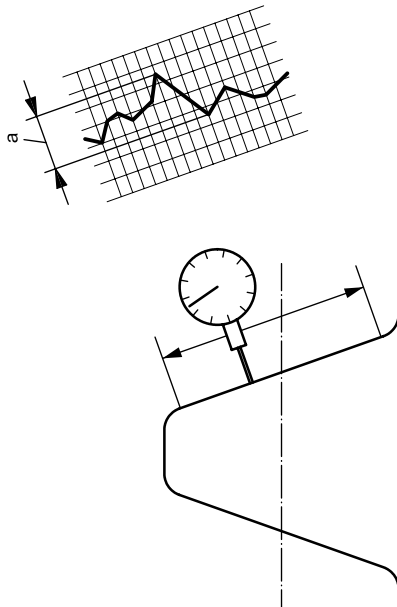
Test No.	Element	Drawing	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
					4A	3A	2A	A	B	C	D
7	Cutting face of gashes	<p>(See the end of Table 6 for the key to the drawings.)</p> 	Gash lead deviation per 100 mm	$0,5 \leq m \leq 40$	28	40	57	80	100	114	185

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade							
					4A	3A	2A	A	B	C	D	
8	Tooth		Tooth profile 1-thread	$0,5 \leq m \leq 1$	3	4	5	7	15	30	39	
				$1 < m \leq 2$	3	4	5	7	15	30	39	
				$2 < m \leq 3,5$	3	5	7	9	18	37	49	
				$3,5 < m \leq 6,0$	4	6	8	11	23	46	61	
				$6,0 < m \leq 10$	5	7	10	14	29	58	76	
				$10 < m \leq 16$	6	9	13	18	36	72	95	
				$16 < m \leq 25$	8	11	16	23	45	90	119	
				$25 < m \leq 40$	10	15	21	30	59	119	157	
			2-threads	$0,5 \leq m \leq 1$	3	5	7	9	19	37	49	
				$1 < m \leq 2$	3	5	7	9	19	37	49	
				$2 < m \leq 3,5$	4	6	8	12	23	46	61	
				$3,5 < m \leq 6,0$	5	7	10	14	29	57	76	
				$6,0 < m \leq 10$	6	9	13	18	36	72	95	
				$10 < m \leq 16$	8	11	16	23	45	90	119	
				$16 < m \leq 25$	—	—	—	—	—	—	—	
				$25 < m \leq 40$	—	—	—	—	—	—	—	
3-, 4-threads	$0,5 \leq m \leq 1$	4	6	8	12	23	46	61				
	$1 < m \leq 2$	4	6	8	12	23	46	61				
	$2 < m \leq 3,5$	5	7	10	14	29	58	76				
	$3,5 < m \leq 6,0$	6	9	13	18	36	72	95				
	$6,0 < m \leq 10$	—	—	—	—	—	—	—				
	$10 < m \leq 16$	—	—	—	—	—	—	—				
	$16 < m \leq 25$	—	—	—	—	—	—	—				
	$25 < m \leq 40$	—	—	—	—	—	—	—				

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Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade							
					4A	3A	2A	A	B	C	D	
8			5-, 6-, 7-threads	0,5 ≤ m ≤ 1	5	7	10	14	29	58	76	
				1 < m ≤ 2	5	7	10	14	29	58	76	
				2 < m ≤ 3,5	6	9	13	18	36	72	95	
				3,5 < m ≤ 6,0	—	—	—	—	—	—	—	
				6,0 < m ≤ 10	—	—	—	—	—	—	—	
				10 < m ≤ 16	—	—	—	—	—	—	—	
				16 < m ≤ 25	—	—	—	—	—	—	—	
				25 < m ≤ 40	—	—	—	—	—	—	—	

Table 6 — Accuracy requirements (continued)

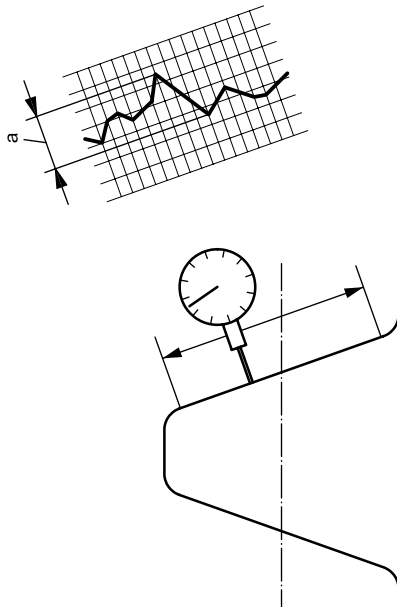
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade	4A	3A	2A	A	B	C	D
8A	Tooth		Tooth profile (when line of action test is used)	0,5 < m ≤ 1	4	6	9	13	25	50	67	
				1 < m ≤ 2	4	6	9	13	25	50	67	
				2 < m ≤ 3,5	5	8	11	16	31	63	83	
				3,5 < m ≤ 6,0	7	10	14	20	39	78	103	
				6,0 < m ≤ 10	9	12	17	24	49	98	129	
				10 < m ≤ 16	11	15	22	31	61	112	162	
				16 < m ≤ 25	13	19	27	38	77	153	202	
				25 < m ≤ 40	18	25	36	50	101	202	267	
			1-thread	0,5 < m ≤ 1	6	8	11	16	32	63	83	
				1 < m ≤ 2	6	8	11	16	32	63	83	
				2 < m ≤ 3,5	7	10	14	20	39	78	104	
				3,5 < m ≤ 6,0	9	12	17	24	49	98	129	
				6,0 < m ≤ 10	11	15	22	31	61	122	162	
				10 < m ≤ 16	13	19	27	38	77	153	202	
				16 < m ≤ 25	—	—	—	—	—	—	—	
				25 < m ≤ 40	—	—	—	—	—	—	—	
2-threads	0,5 < m ≤ 1	7	10	14	20	39	79	104				
	1 < m ≤ 2	7	10	14	20	39	79	104				
	2 < m ≤ 3,5	9	12	17	24	49	98	129				
	3,5 < m ≤ 6,0	11	15	22	31	61	122	162				
	6,0 < m ≤ 10	11	15	22	31	61	122	162				
	10 < m ≤ 16	13	19	27	38	77	153	202				
	16 < m ≤ 25	—	—	—	—	—	—	—				
	25 < m ≤ 40	—	—	—	—	—	—	—				
3-, 4-threads	0,5 < m ≤ 1	7	10	14	20	39	79	104				
	1 < m ≤ 2	7	10	14	20	39	79	104				
	2 < m ≤ 3,5	9	12	17	24	49	98	129				
	3,5 < m ≤ 6,0	11	15	22	30	61	122	161				
	6,0 < m ≤ 10	—	—	—	—	—	—	—				
	10 < m ≤ 16	—	—	—	—	—	—	—				
	16 < m ≤ 25	—	—	—	—	—	—	—				
	25 < m ≤ 40	—	—	—	—	—	—	—				

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade							
					4A	3A	2A	A	B	C	D	
8A			5-, 6-, 7-threads	0,5 ≤ m ≤ 1	9	12	17	25	49	98	130	
				1 < m ≤ 2	9	12	17	25	49	98	130	
				2 < m ≤ 3,5	11	15	22	31	61	122	161	
				3,5 < m ≤ 6,0	—	—	—	—	—	—	—	
				6,0 < m ≤ 10	—	—	—	—	—	—	—	
				10 < m ≤ 16	—	—	—	—	—	—	—	
				16 < m ≤ 25	—	—	—	—	—	—	—	
				25 < m ≤ 40	—	—	—	—	—	—	—	

Table 6 — Accuracy requirements (continued)

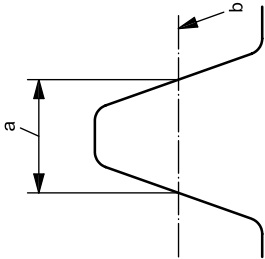
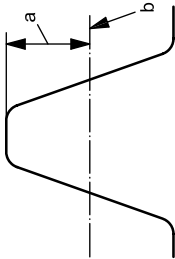
Test No.	Element	Drawing	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
				mm	4A	3A	2A	A	B	C	D
9	Tooth	<p>(See the end of Table 6 for the key to the drawings.)</p> 	Normal tooth thickness (negative only)	$0,5 \leq m \leq 1$	16	16	22	22	45	45	57
				$1 < m \leq 2$	16	16	22	22	45	45	57
				$2 < m \leq 3,5$	20	20	28	28	55	55	70
				$3,5 < m \leq 6,0$	24	24	34	34	69	69	87
				$6,0 < m \leq 10$	31	31	43	43	86	86	110
				$10 < m \leq 16$	38	38	54	54	108	108	137
9A	Tooth		Addendum (positive only)	$0,5 \leq m \leq 1$	63	63	89	89	178	178	226
				$1 < m \leq 2$	48	48	68	68	135	135	171
				$2 < m \leq 3,5$	63	63	89	89	178	178	226
				$3,5 < m \leq 6,0$	89	89	115	115	235	235	295
				$6,0 < m \leq 10$	115	115	155	155	315	315	395
				$10 < m \leq 16$	145	145	195	195	395	395	495
				Deviations from test 9 divided by $2 \cdot \tan$ (pressure angle)							

Table 6 — Accuracy requirements (continued)

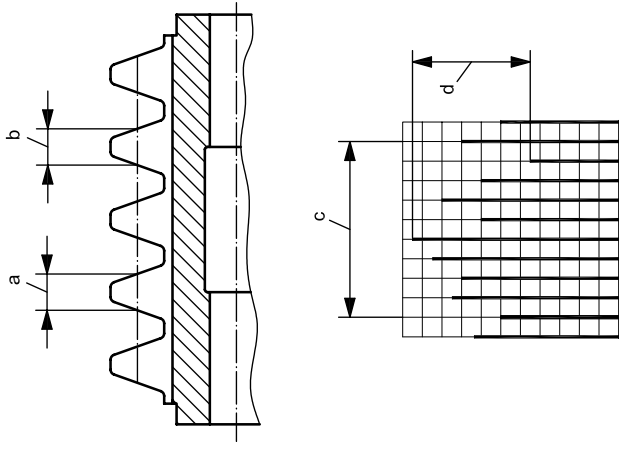
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm					
					4A	3A	2A	A	B	C
9B	Tooth		<p>Difference between maximum and minimum normal tooth thickness along one gash</p> <p>1-thread</p> <p>2-threads</p> <p>3-, 4-threads</p>	0,5 ≤ m ≤ 1	4	6	8	Test 9B is only valid for quality grade 4A, 3A and 2A.		
				1 < m ≤ 2	4	6	8			
				2 < m ≤ 3,5	5	7	10			
				3,5 < m ≤ 6,0	6	9	13			
				6,0 < m ≤ 10	8	12	16			
				10 < m ≤ 16	10	14	20			
				16 < m ≤ 25	13	18	26			
				25 < m ≤ 40	17	24	34			
				0,5 ≤ m ≤ 1	5	7	11			
				1 < m ≤ 2	5	7	11			
				2 < m ≤ 3,5	6	9	13			
				3,5 < m ≤ 6,0	8	11	16			
				6,0 < m ≤ 10	10	14	20			
				10 < m ≤ 16	13	18	26			
				16 < m ≤ 25	—	—	—			
				25 < m ≤ 40	—	—	—			
0,5 ≤ m ≤ 1	6	9	13							
1 < m ≤ 2	6	9	13							
2 < m ≤ 3,5	8	12	16							
3,5 < m ≤ 6,0	10	14	20							
6,0 < m ≤ 10	—	—	—							
10 < m ≤ 16	—	—	—							
16 < m ≤ 25	—	—	—							
25 < m ≤ 40	—	—	—							

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
					4A	3A	2A	A	B	C	D
9B			5-, 6-, 7-threads	0,5 ≤ m ≤ 1	8	12	16				
				1 < m ≤ 2	8	12	16				
				2 < m ≤ 3,5	10	14	20				
				3,5 < m ≤ 6,0	—	—	—				
				6,0 < m ≤ 10	—	—	—				
				10 < m ≤ 16	—	—	—				
				16 < m ≤ 25	—	—	—				
				25 < m ≤ 40	—	—	—				

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m mm	Allowable deviation μm Grade							
					4A	3A	2A	A	B	C	D	
10	Thread lead		Lead deviation on adjacent teeth	0,5 ≤ m ≤ 1	2	3	4	6	12	24	31	
				1 < m ≤ 2	2	3	4	6	12	24	31	
				2 < m ≤ 3,5	3	4	5	7	15	30	39	
				3,5 < m ≤ 6,0	3	5	7	9	18	37	48	
			6,0 < m ≤ 10	4	6	8	12	23	46	61		
			10 < m ≤ 16	5	7	10	14	29	58	76		
			16 < m ≤ 25	6	9	13	18	36	72	95		
			25 < m ≤ 40	8	12	17	24	48	95	125		
			0,5 ≤ m ≤ 1	3	4	5	7	15	30	39		
			1 < m ≤ 2	3	4	5	7	15	30	39		
			2 < m ≤ 3,5	3	5	7	9	18	37	49		
			3,5 < m ≤ 6,0	4	6	8	11	23	46	61		
			6,0 < m ≤ 10	5	7	10	14	29	58	76		
			10 < m ≤ 16	6	9	13	18	36	72	95		
			16 < m ≤ 25	—	—	—	—	—	—	—		
			25 < m ≤ 40	—	—	—	—	—	—	—		
0,5 ≤ m ≤ 1	3	5	7	9	19	37	49					
1 < m ≤ 2	3	5	7	9	19	37	49					
2 < m ≤ 3,5	4	6	8	12	23	46	61					
3,5 < m ≤ 6,0	5	7	10	14	29	57	76					
6,0 < m ≤ 10	—	—	—	—	—	—	—					
10 < m ≤ 16	—	—	—	—	—	—	—					
16 < m ≤ 25	—	—	—	—	—	—	—					
25 < m ≤ 40	—	—	—	—	—	—	—					

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
				mm	4A	3A	2A	A	B	C	D
10				$0,5 \leq m \leq 1$	4	6	8	12	23	46	61
				$1 < m \leq 2$	4	6	8	12	23	46	61
				$2 < m \leq 3,5$	5	7	10	14	29	58	76
				$3,5 < m \leq 6,0$	—	—	—	—	—	—	—
				$6,0 < m \leq 10$	—	—	—	—	—	—	—
				$10 < m \leq 16$	—	—	—	—	—	—	—
				$16 < m \leq 25$	—	—	—	—	—	—	—
			$25 < m \leq 40$	—	—	—	—	—	—	—	
			5-, 6-, 7-threads								

Table 6 — Accuracy requirements (continued)

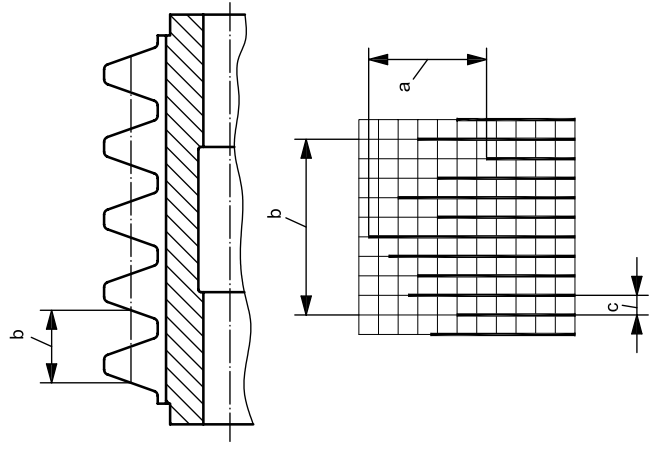
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m mm	Allowable deviation μm Grade							
					4A	3A	2A	A	B	C	D	
11	Thread lead		Lead deviation in one axial pitch 1- to 7-threads	$0,5 \leq m \leq 1$	4	5	7	10	21	42	55	
				$1 < m \leq 2$	4	5	7	10	21	42	55	
				$2 < m \leq 3,5$	5	6	9	13	26	52	68	
				$3,5 < m \leq 6,0$	6	8	11	16	32	64	85	
				$6,0 < m \leq 10$	7	10	14	20	40	81	106	
				$10 < m \leq 16$	9	13	18	25	50	101	133	
				$16 < m \leq 25$	11	16	22	32	63	126	166	
				$25 < m \leq 40$	15	21	30	42	83	166	220	

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m mm	Allowable deviation μm Grade						
					4A	3A	2A	A	B	C	D
11A	Thread lead		Lead deviation in one axial pitch (when line of action test is used) 1- to 7-threads	0,5 ≤ m ≤ 1	4	6	8	12	24	48	63
				1 < m ≤ 2	4	6	8	12	24	48	63
				2 < m ≤ 3,5	5	7	10	15	30	59	78
				3,5 < m ≤ 6,0	6	9	13	18	37	73	97
				6,0 < m ≤ 10	8	12	16	23	46	92	122
				10 < m ≤ 16	10	14	20	29	58	115	152
				16 < m ≤ 25	13	18	26	36	72	144	190
				25 < m ≤ 40	17	24	34	48	95	190	251

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade	4A	3A	2A	A	B	C	D
12	Thread lead		Lead deviation in three axial pitches	$0,5 \leq m \leq 1$	7	10	14	19	39	77	102	
				$1 < m \leq 2$	7	10	14	19	39	77	102	
				$2 < m \leq 3,5$	8	12	17	24	48	96	127	
				$3,5 < m \leq 6,0$	10	15	21	30	60	119	158	
				$6,0 < m \leq 10$	13	19	27	37	75	150	198	
				$10 < m \leq 16$	16	23	33	47	94	187	247	
				$16 < m \leq 25$	20	29	42	59	117	234	309	
				$25 < m \leq 40$	27	39	55	77	154	309	408	

Table 6 — Accuracy requirements (continued)

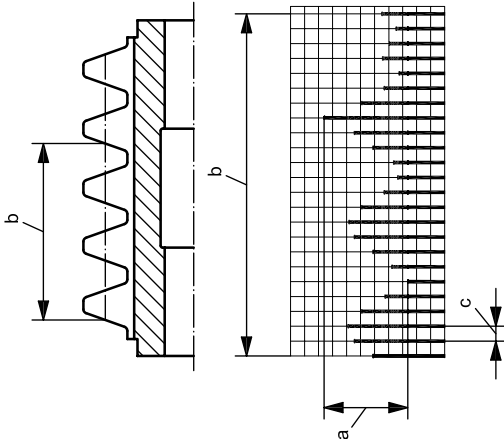
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade	4A	3A	2A	A	B	C	D
12A	Thread lead		Lead deviation in three axial pitches (when line of action test is used)	0,5 ≤ m ≤ 1	9	13	19	27	53	107	141	
				1 < m ≤ 2	9	13	19	27	53	107	141	
				2 < m ≤ 3,5	12	17	24	33	66	133	175	
				3,5 < m ≤ 6,0	14	21	29	41	83	165	218	
				6,0 < m ≤ 10	18	26	37	52	104	207	274	
				10 < m ≤ 16	23	32	46	65	130	259	342	
				16 < m ≤ 25	28	41	58	81	162	324	428	
				25 < m ≤ 40	37	53	76	107	214	428	565	

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade	4A	3A	2A	A	B	C
13	Line of action		Adjacent deviation along line of action (measured at the cutting edge) 1-thread 2-threads 3-, 4-threads	0,5 ≤ m ≤ 1	2	3	4	6	12	24	31
				1 < m ≤ 2	2	3	4	6	12	24	31
				2 < m ≤ 3,5	3	4	5	7	15	30	39
				3,5 < m ≤ 6,0	3	5	7	9	18	37	48
				6,0 < m ≤ 10	4	6	8	12	23	46	61
				10 < m ≤ 16	5	7	10	14	29	58	76
				16 < m ≤ 25	6	9	13	18	36	72	95
				25 < m ≤ 40	8	12	17	24	48	95	125
				0,5 ≤ m ≤ 1	3	4	5	7	15	30	39
				1 < m ≤ 2	3	4	5	7	15	30	39
				2 < m ≤ 3,5	3	5	7	9	18	37	49
				3,5 < m ≤ 6,0	4	6	8	11	23	46	61
				6,0 < m ≤ 10	5	7	10	14	29	58	76
10 < m ≤ 16	6	9	13	18	36	72	95				
16 < m ≤ 25	—	—	—	—	—	—	—				
25 < m ≤ 40	—	—	—	—	—	—	—				
0,5 ≤ m ≤ 1	3	5	7	9	19	37	49				
1 < m ≤ 2	3	5	7	9	19	37	49				
2 < m ≤ 3,5	4	6	8	12	23	46	61				
3,5 < m ≤ 6,0	5	7	10	14	29	57	76				
6,0 < m ≤ 10	—	—	—	—	—	—	—				
10 < m ≤ 16	—	—	—	—	—	—	—				
16 < m ≤ 25	—	—	—	—	—	—	—				
25 < m ≤ 40	—	—	—	—	—	—	—				

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
				mm	4A	3A	2A	A	B	C	D
13				$0,5 \leq m \leq 1$	4	6	8	12	23	46	61
				$1 < m \leq 2$	4	6	8	12	23	46	61
				$2 < m \leq 3,5$	5	7	10	14	29	58	76
				$3,5 < m \leq 6,0$	—	—	—	—	—	—	—
				$6,0 < m \leq 10$	—	—	—	—	—	—	—
				$10 < m \leq 16$	—	—	—	—	—	—	—
				$16 < m \leq 25$	—	—	—	—	—	—	—
			$25 < m \leq 40$	—	—	—	—	—	—	—	
			5-, 6-, 7-threads								

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade	4A	3A	2A	A	B	C
14	Line of action		Total deviation along line of action (Measured at the cutting edge) 1-thread 2-threads 3-, 4-threads	0,5 ≤ m ≤ 1	5	7	11	15	30	59	78
				1 < m ≤ 2	5	7	11	15	30	59	78
				2 < m ≤ 3,5	6	9	13	18	37	74	97
				3,5 < m ≤ 6,0	8	11	16	23	46	92	121
				6,0 < m ≤ 10	10	14	20	29	58	115	152
				10 < m ≤ 16	13	18	26	36	72	144	190
				16 < m ≤ 25	16	23	32	45*	90	180	238
				25 < m ≤ 40	21	30	42	59	119	238	314
				0,5 ≤ m ≤ 1	6	9	13	19	37	74	98
				1 < m ≤ 2	6	9	13	19	37	74	98
				2 < m ≤ 3,5	8	12	16	23	46	92	122
				3,5 < m ≤ 6,0	10	14	20	29	57	115	151
				6,0 < m ≤ 10	13	18	26	36	72	144	190
				10 < m ≤ 16	16	23	32	45	90	180	238
16 < m ≤ 25	—	—	—	—	—	—	—	—			
25 < m ≤ 40	—	—	—	—	—	—	—	—			
0,5 ≤ m ≤ 1	8	12	16	23	46	93	122				
1 < m ≤ 2	8	12	16	23	46	93	122				
2 < m ≤ 3,5	10	14	20	29	58	115	152				
3,5 < m ≤ 6,0	13	18	25	36	72	143	189				
6,0 < m ≤ 10	—	—	—	—	—	—	—				
10 < m ≤ 16	—	—	—	—	—	—	—				
16 < m ≤ 25	—	—	—	—	—	—	—				
25 < m ≤ 40	—	—	—	—	—	—	—				

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m mm	Allowable deviation μm							
					Grade							
					4A	3A	2A	A	B	C	D	
14			5-, 6-, 7-threads	0,5 ≤ m ≤ 1	10	14	21	29	58	116	153	
				1 < m ≤ 2	10	14	21	29	58	116	153	
				2 < m ≤ 3,5	13	18	26	36	72	144	190	
				3,5 < m ≤ 6,0	—	—	—	—	—	—	—	
				6,0 < m ≤ 10	—	—	—	—	—	—	—	
				10 < m ≤ 16	—	—	—	—	—	—	—	
				16 < m ≤ 25	—	—	—	—	—	—	—	
25 < m ≤ 40	—	—	—	—	—	—	—					

* Datum referred to in Clause 5.

Table 6 — Accuracy requirements (continued)

Test No.	Element	Drawing	Object of test	Pitch range module, m	Allowable deviation μm							
					Grade	4A	3A	2A	A	B	C	D
15	Thread spacing	<p>(See the end of Table 6 for the key to the drawings.)</p> <p> $\Delta_1 = P_1 - P_2$ $\Delta_2 = P_2 - P_3$ $\Delta_3 = P_3 - P_4$ $\Delta_n = P_n - P_{n+1}$ Deviation is maximum of all Δ values </p>	Axial pitch deviation from thread to thread	$0,5 < m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	3	4	6	8	17	33	44	
			2-threads	$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	3	4	6	8	17	33	44	
			3-, 4-threads	$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	4	5	7	10	21	42	55	
			5-, 6-, 7-threads	$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	4	5	7	10	21	42	55	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	5	6	9	13	26	52	68	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	6	8	11	16	32	64	85	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	—	—	—	—	—	—	—	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	—	—	—	—	—	—	—	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	5	7	9	13	26	52	69	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	5	7	9	13	26	52	69	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	6	8	11	16	32	65	85	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	—	—	—	—	—	—	—	
				$0,5 \leq m \leq 1$ $1 < m \leq 2$ $2 < m \leq 3,5$ $3,5 < m \leq 6,0$ $6,0 < m \leq 10$ $10 < m \leq 16$ $16 < m \leq 25$ $25 < m \leq 40$	—	—	—	—	—	—	—	

Table 6 — Accuracy requirements (continued)

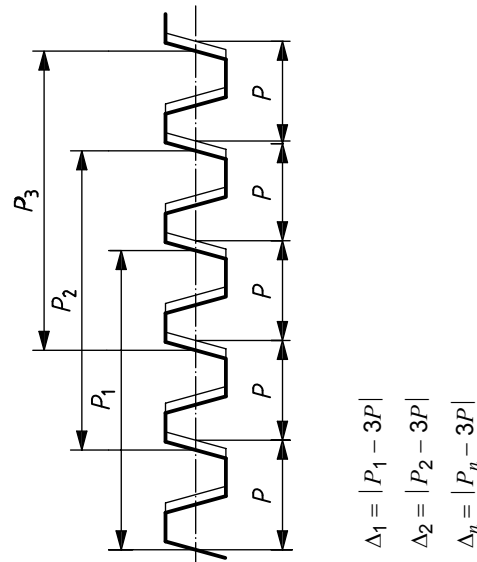
Test No.	Element	Drawing (See the end of Table 6 for the key to the drawings.)	Object of test	Pitch range module, m	Allowable deviation μm						
					Grade						
					4A	3A	2A	A	B	C	D
16	Thread spacing	 $\Delta_1 = P_1 - 3P $ $\Delta_2 = P_2 - 3P $ $\Delta_n = P_n - 3P $ <p>Deviation is maximum of all Δ values</p>	Axial pitch deviation in any three axial pitches over all threads	0,5 ≤ m ≤ 1	5	7	11	15	30	59	78
			1 < m ≤ 2	5	7	11	15	30	59	78	
			2 < m ≤ 3,5	6	9	13	18	37	74	97	
			3,5 < m ≤ 6,0	8	11	16	23	46	92	121	
			6,0 < m ≤ 10	10	14	20	29	58	115	152	
			10 < m ≤ 16	13	18	26	36	72	144	190	
			16 < m ≤ 25	—	—	—	—	—	—	—	
			25 < m ≤ 40	—	—	—	—	—	—	—	
			0,5 ≤ m ≤ 1	6	9	13	19	37	74	98	
			1 < m ≤ 2	6	9	13	19	37	74	98	
			2 < m ≤ 3,5	8	12	16	23	46	92	122	
			3,5 < m ≤ 6,0	10	14	20	29	57	115	151	
			6,0 < m ≤ 10	—	—	—	—	—	—	—	
			10 < m ≤ 16	—	—	—	—	—	—	—	
			16 < m ≤ 25	—	—	—	—	—	—	—	
			25 < m ≤ 40	—	—	—	—	—	—	—	
0,5 ≤ m ≤ 1	8	12	16	23	46	93	122				
1 < m ≤ 2	8	12	16	23	46	93	122				
2 < m ≤ 3,5	10	14	20	29	58	115	152				
3,5 < m ≤ 6,0	—	—	—	—	—	—	—				
6,0 < m ≤ 10	—	—	—	—	—	—	—				
10 < m ≤ 16	—	—	—	—	—	—	—				
16 < m ≤ 25	—	—	—	—	—	—	—				
25 < m ≤ 40	—	—	—	—	—	—	—				
5-, 6-, 7-threads	—	—	—	—	—	—	—				

Table 6 — Accuracy requirements (continued)

Test No.	a	Key			
		b	c	d	
4	deviation	—	—	—	
5	deviation	—	—	—	
6	deviation	—	—	—	
7	deviation	—	—	—	
8	deviation	—	—	—	
8A	deviation	—	—	—	
9	thickness	reference cylinder	—	—	
9A	addendum	reference cylinder	—	—	
9B	thickness max.	thickness min.	one gash	max. difference	
10	deviation	adjacent teeth	—	—	
11	deviation	one axial pitch	one tooth	—	
11A	deviation	one axial pitch	one tooth	—	
12	deviation	three axial pitches	one tooth	—	
12A	deviation	three axial pitches	one tooth	—	
13	deviation	line of action	—	—	
14	total deviation	line of action	active length	—	

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