INTERNATIONAL STANDARD

ISO 4759-1

Second edition
2000-11-15

Tolerances for fasteners —

Part 1: Bolts, screws, studs and nuts — Product grades A, B and C

Tolérances des éléments de fixation —

Partie 1: Vis, goujons et écrous — Grades A, B et C

Reference number
ISO 4759-1:2000(E)

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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 3.

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 part of ISO 4759 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4759-1 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 7, *Reference Standards for fasteners (mainly covering terminology, dimensioning, sizes and tolerancing)*.

This second edition cancels and replaces the first edition (ISO 4759-1:1978), which has been technically revised.

ISO 4759 consists of the following parts, under the general title *Tolerances for fasteners*:

— *Part 1: Bolts, screws, studs and nuts — Product grades A, B and C*

— *Part 3: Plain washers for bolts, screws ans nuts — Product grades A and C*

Annexes A to C of this part of ISO 4759 are for information only.

Tolerances for fasteners —

Part 1:
Bolts, screws, studs and nuts — Product grades A, B and C

1 Scope

This part of ISO 4759 specifies a selection of tolerances for bolts, screws, studs and nuts with ISO metric threads and with product grades A, B and C and for tapping screws with product grade A.

NOTE The product grades refer to the size of the tolerances where grade A is the most precise and grade C is the least precise.

The tolerances, except tolerances for threads, are selected from the system of limits and fits specified in ISO 286-1 and ISO 286-2. The tolerances for metric threads are taken from the series of tolerance classes specified in ISO 965-3. The tolerances for tapping screw threads are covered in ISO 1478.

The tolerances of form and position are specified and indicated in accordance with ISO 1101, ISO 8015 and ISO 2692.

The tolerances specified in this part of ISO 4759 apply to fasteners prior to coating unless otherwise specified. See also ISO 4042.

Deviations from the tolerances specified in this part of ISO 4759 are only permitted in product standards where there are valid technical reasons. In cases where there is a difference between the tolerance requirements in this part of ISO 4759 and the product standard, the product standard takes precedence.

It is recommended that these tolerances also be used for non-standard fasteners.

Dimensions and tolerances given in this part of ISO 4759 are in millimetres.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 4759. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 4759 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 225:1983, *Fasteners — Bolts, screws, studs and nuts — Symbols and designation of dimensions.*

ISO 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 885:2000, *General purpose bolts and screws — Metric series — Radii under the head.*

ISO 965-3:1998, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads.*

ISO 1101:2000, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out.*

ISO 1478:1999, *Tapping screws thread.*

ISO 1479:1983, *Hexagon head tapping screws.*

ISO 2692:1988, *Technical drawings — Geometrical tolerancing — Maximum material principle.*

ISO 4032:1999, *Hexagon nuts, style 1 — Product grades A and B.*

ISO 4042:1999, *Fasteners — Electroplated coatings.*

ISO 4757:1983, *Cross recesses for screws.*

ISO 7053:1992, *Hexagon washer head tapping screws.*

ISO 7721:1983, *Countersunk head screws — Head configuration and gauging.*

ISO 8015:1985, *Technical drawings — Fundamental tolerancing principle.*

ISO 10509:1992, *Hexagon flange head tapping screws.*

ISO 10642:1997, *Hexagon socket countersunk head screws.*

ISO 10664:1999, *Hexalobular internal driving feature for bolts and screws.*

3 Tolerances for metric bolts, screws and studs

3.1 Dimensional tolerances

Symbols and designations of dimensions are specified in ISO 225.

<table>
<tr><th rowspan="2">Feature</th><th colspan="3">Tolerance for product grades</th><th rowspan="2">Notes</th></tr>
<tr><th>A</th><th>B</th><th>C</th></tr>
<tr><td>3.1.1 Tolerance level

Shank and bearing surface
Other features</td><td>

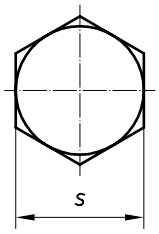
close
close</td><td>

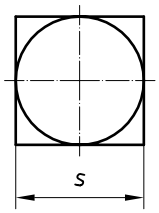
close
wide</td><td>

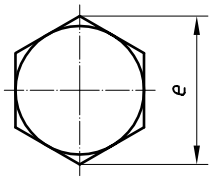
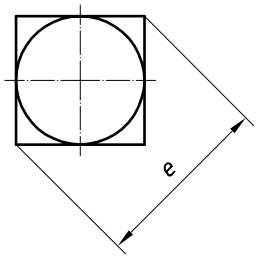
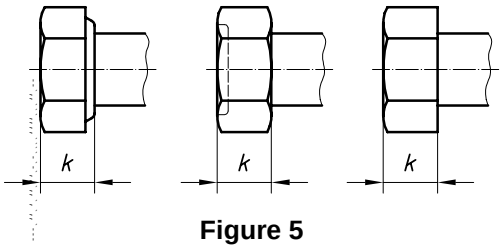
wide
wide</td><td></td></tr>
<tr><td>3.1.2 External thread</td><td colspan="2">6g</td><td>6g</td><td>8g
(but 6g for property class 8.8 and higher)</td><td>For certain products and coatings, other tolerance classes for threads may be specified in the relevant product and coating standards.</td></tr>
<tr><td>3.1.3 Driving features

3.1.3.1 External

3.1.3.1.1 Width across flats

 
Figure 1

 
Figure 2</td><td colspan="2"><table><tr><th>s</th><th>Tolerance</th></tr><tr><td>⩽ 30</td><td>h13</td></tr><tr><td>> 30</td><td>h14</td></tr></table></td><td colspan="2"><table><tr><th>s</th><th>Tolerance</th></tr><tr><td>⩽ 18</td><td>h14</td></tr><tr><td>> 18 ⩽ 60</td><td>h15</td></tr><tr><td>> 60 ⩽ 180</td><td>h16</td></tr><tr><td>> 180</td><td>h17</td></tr></table></td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Feature</th><th colspan="3">Tolerance for product grades</th><th rowspan="2">Notes</th></tr>
<tr><th>A</th><th>B</th><th>C</th></tr>
<tr><td>3.1.3.1.2 Width across corners
 
Figure 3</td><td colspan="3">$e_{min} = 1{,}13\ s_{min}$
$e_{min} = 1{,}12\ s_{min}$ for bolts and screws with flange and other cold forged heads without trimming operation</td><td></td></tr>
<tr><td> 
Figure 4</td><td colspan="3">$e_{min} = 1{,}3\ s_{min}$</td><td></td></tr>
<tr><td>3.1.3.1.3 Height of head
 
Figure 5</td><td>js14</td><td>js15</td><td>k | Tolerance
< 10 | js16
⩾ 10 | js17</td><td></td></tr>
</table>

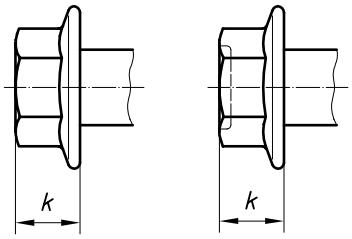
<table>
<tr><th>Feature</th><th>Tolerance for product grades
A | B | C</th><th>Notes</th></tr>
<tr><td> 

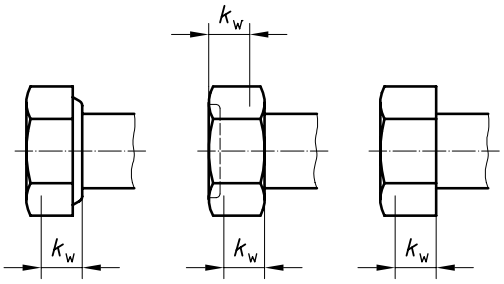
Figure 6</td><td>For hexagon bolts and screws with flange, k is defined only as a maximum</td><td></td></tr>
<tr><td>3.1.3.1.4 Wrenching height
 

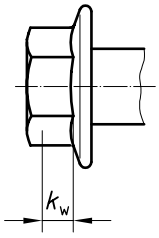
Figure 7</td><td>$k_w{}^a{}_{min} = 0{,}7\ k_{min}$</td><td>$k_w$ defines the length over which e_{min} applies but excluding any chamfer, washer face or radius specified in the appropriate product standard.
The formulae for $k_{w\,min}$ only apply to the products illustrated.
[a] The symbol k_w replaces the previously used k'.
[b] For gauging, see annex A of the product standards</td></tr>
<tr><td> 

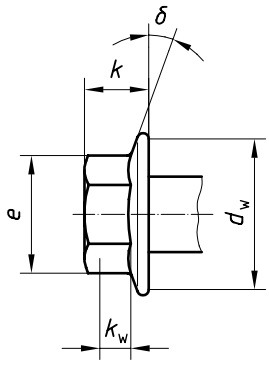
Figure 8</td><td>$k_{w\,min}^{\ b} = 0{,}7\left[(k_{max} - IT15) - \left(x + \frac{d_{w\ min} - e_{min}}{2}\tan\delta_{max}\right)\right]$
x is the greater of $c_{min} \times 1{,}25$ or $c_{min} + 0{,}4$
δ is the flange angle
Dimensions $k_w{}^a$, k, d_w, e and δ are in accordance with ISO 225.
 

Figure 8 a)</td><td></td></tr>
</table>

<table>
<tr><th rowspan="2">Feature</th><th colspan="3">Tolerance for product grades</th><th rowspan="2">Notes</th></tr>
<tr><th colspan="2">A</th><th>B</th><th>C</th></tr>
<tr><td>3.1.3.2 Internal

3.1.3.2.1 Hexagon sockets

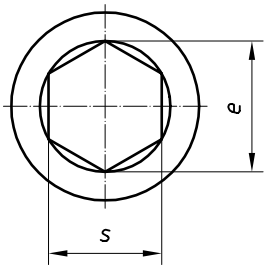
 

Figure 9</td><td colspan="2">$e_{min} = 1{,}14\ s_{min}$

s — Tolerance
0,7 — EF8
0,9 — JS9
1,3 — K9
1,5; 2; 2,5; 3 — D11
4 — E11
5; 6; 8; 10; 12; 14 — E12
> 14 — D12</td><td>—</td><td>—</td><td></td></tr>
<tr><td>3.1.3.2.2 Slots

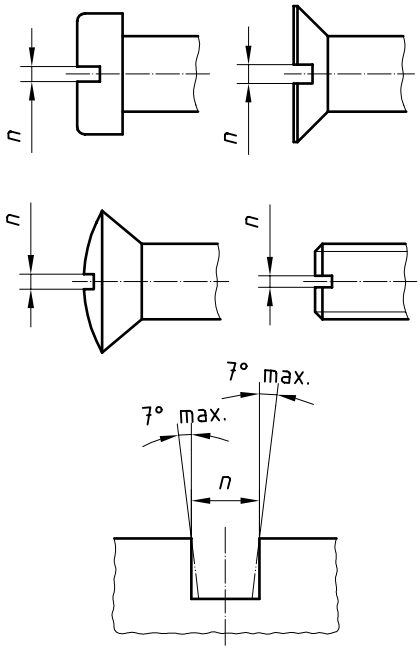
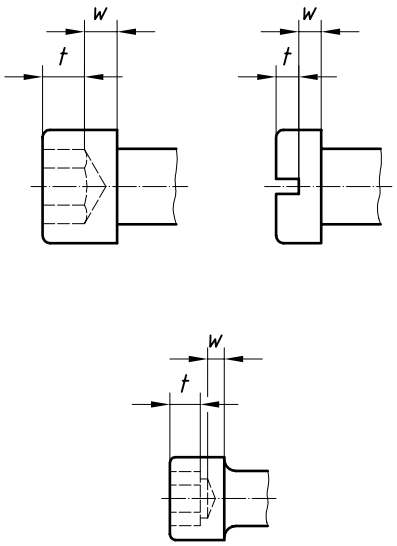
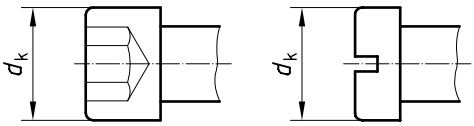
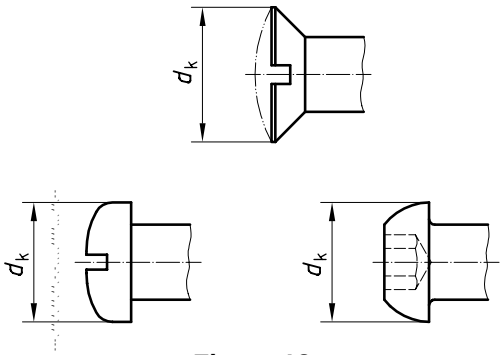
 

Figure 10</td><td colspan="2">n — Tolerance
$\leqslant 1$ — + 0,20 / + 0,06
$> 1 \leqslant 3$ — + 0,31 / + 0,06
$> 3 \leqslant 6$ — + 0,37 / + 0,07</td><td>—</td><td>—</td><td>Tolerance field
C13 for $n \leqslant 1$

C14 for $n > 1$</td></tr>
</table>

Feature	Tolerance for product grades			Notes
	A	B	C	
3.1.3.2.3 Depth of hexagon sockets and slots  **Figure 11**	The depth of hexagon sockets and slots is specified in product standards only as a minimum. It is restricted by the minimum wall thickness *w*.	—	—	For the time being generally applicable tolerances cannot be specified.
3.1.3.2.4 Cross recesses	See ISO 4757 for all dimensions except penetration depths. For penetration depths see appropriate product standard.			
3.1.3.2.5 Hexalobular recesses	See ISO 10664 for all dimensions except penetration depths. For penetration depths see appropriate product standard.			
3.1.4 Other features **3.1.4.1 Head diameter**  **Figure 12**	h13[a]	—	—	[a] ± IT13 for knurled heads
 **Figure 13**	h14	—	—	Combined control of diameter and height for countersunk head screws in accordance with ISO 7721 or ISO 10642.

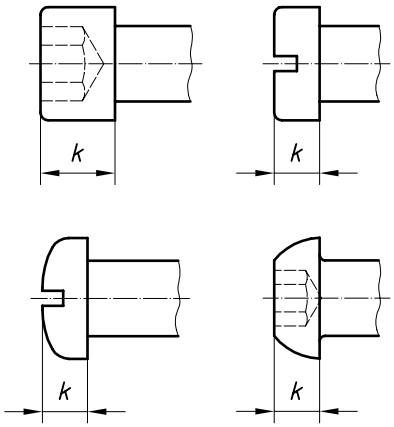
<table>
<tr><th rowspan="2">Feature</th><th colspan="3">Tolerance for product grades</th><th rowspan="2">Notes</th></tr>
<tr><th>A</th><th>B</th><th>C</th></tr>
<tr><td>3.1.4.2 Head height (except for hexagon heads)
 

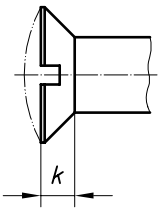
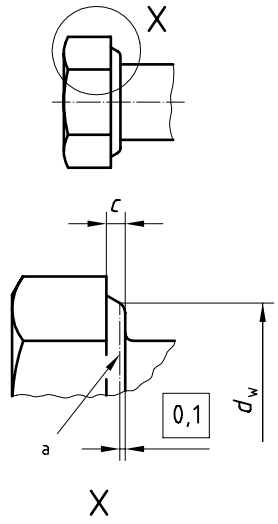
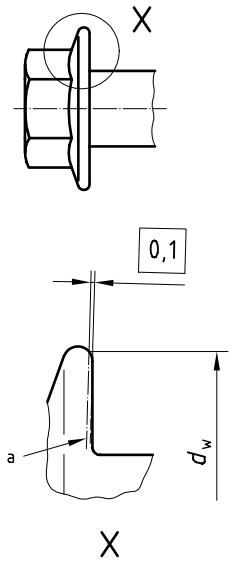
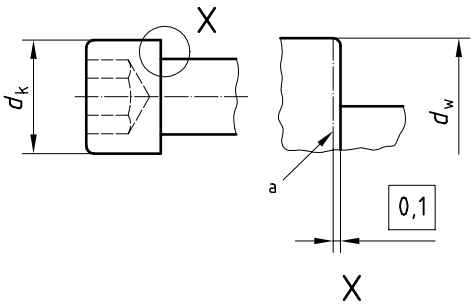
Figure 14</td><td>⩽ M5: h13
> M5: h14</td><td>—</td><td>—</td><td></td></tr>
<tr><td> 

Figure 15</td><td colspan="3">For countersunk head screws k is definied in product standards only as a maximum.</td><td>Combined control of diameter and height for countersunk head screws in accordance with ISO 7721 or ISO 10642.</td></tr>
<tr><td>3.1.4.3 Bearing face diameter and height of washer-faced portion
 

a Reference datum for d_w
Figure 16</td><td colspan="3">$d_{w\,min} = s_{min}$ – IT16 for width across flats < 21 mm
$d_{w\,min} = 0{,}95\ s_{min}$ for width across flats ⩾ 21 mm
$d_{w\,max} = s_{actual}$
<table><tr><th rowspan="2">Thread diameter</th><th colspan="2">c</th></tr><tr><th>min.</th><th>max.</th></tr><tr><td>⩾ 1,6 to 2,5</td><td>0,10</td><td>0,25</td></tr><tr><td>> 2,5 to 4</td><td>0,15</td><td>0,40</td></tr><tr><td>> 4 to 6</td><td>0,15</td><td>0,50</td></tr><tr><td>> 6 to 14</td><td>0,15</td><td>0,60</td></tr><tr><td>> 14 to 36</td><td>0,20</td><td>0,80</td></tr><tr><td>> 36</td><td>0,30</td><td>1,0</td></tr></table></td><td>For product grade C a washer face is not mandatory.</td></tr>
</table>

<table>
<tr><th>Feature</th><th colspan="4">Tolerance for product grades
A | B | C</th><th>Notes</th></tr>
<tr><td> 

a Reference datum for d_w
Figure 17</td><td colspan="4">d_w is defined in product standards only as a minimum.</td><td></td></tr>
<tr><td> 

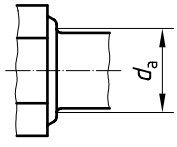
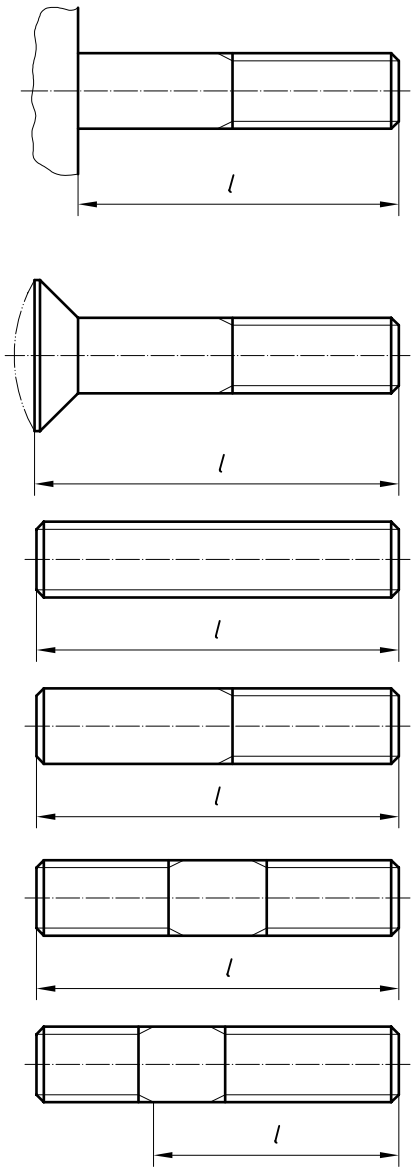
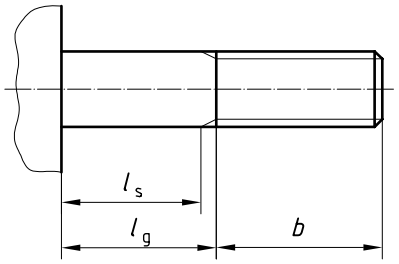
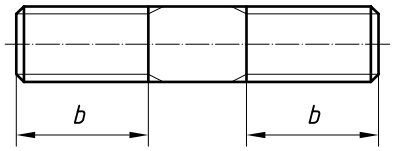
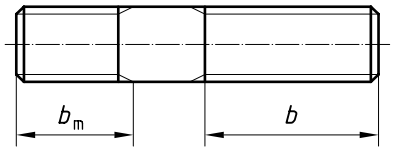
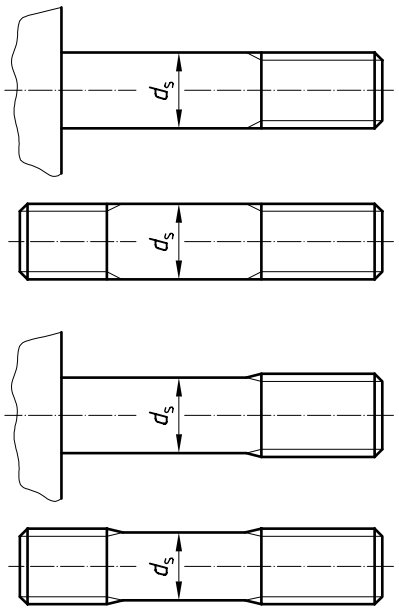
a Reference datum for d_w
Figure 18</td><td colspan="3">
<table>
<tr><th colspan="2">Thread diameter</th><th>d_w</th></tr>
<tr><th>></th><th>⩽</th><th>min.</th></tr>
<tr><td></td><td>2,5</td><td>$d_{k\ min} - 0,14$</td></tr>
<tr><td>2,5</td><td>5</td><td>$d_{k\ min} - 0,25$</td></tr>
<tr><td>5</td><td>10</td><td>$d_{k\ min} - 0,4$</td></tr>
<tr><td>10</td><td>16</td><td>$d_{k\ min} - 0,5$</td></tr>
<tr><td>16</td><td>24</td><td>$d_{k\ min} - 0,8$</td></tr>
<tr><td>24</td><td>36</td><td>$d_{k\ min} - 1$</td></tr>
<tr><td>36</td><td>—</td><td>$d_{k\ min} - 1,2$</td></tr>
</table>
</td><td>For product grade A only</td></tr>
<tr><td> 

Figure 19</td><td colspan="4">d_a for products without undercut is specified in ISO 885.</td><td>d_a for undercut products, see the appropriate product standard.</td></tr>
</table>

Feature	Tolerance for product grades			Notes
	A	B	C	
3.1.4.4 Length  **Figure 20**	js15	js17	$l \leqslant 150$: js17 $l > 150$: ± IT17	

Feature	Tolerance for product grades			Notes
	A	B	C	
3.1.4.5 Thread length **Bolt**  	b^{+2P}_{0}	b^{+2P}_{0}	b^{+2P}_{0}	P is the pitch of thread. l_s is the minimum length of the unthreaded (plain) shank. l_g is the maximum length of the unthreaded shank (thread run-out included) and is therefore the minimum clamping length. Tolerance + 2 P related to dimension b applies only where l_s and l_g are not specified in the product standard. b_m refers to metal end of studs only.
Tie rod  	b^{+2P}_{0}	b^{+2P}_{0}	b^{+2P}_{0}	
Stud  	b^{+2P}_{0} b_m js16	b^{+2P}_{0} b_m js17	b^{+2P}_{0} b_m js17	
Figure 21				
3.1.4.6 Shank diameter  	h13	h14	± IT 15	The tolerance is not applicable in the areas of the underhead fillet and thread run-out.
	Reduced shank diameter ≈ pitch diameter			
Figure 22				

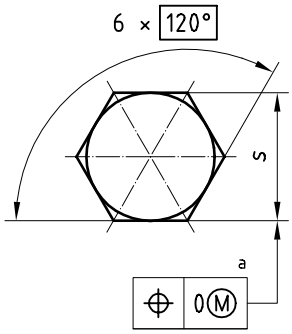
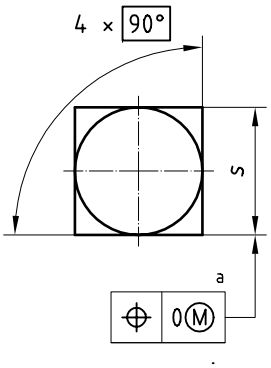
3.2 Geometrical tolerances

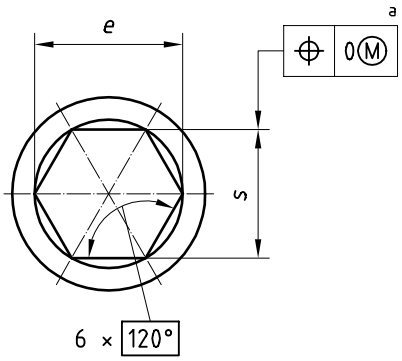
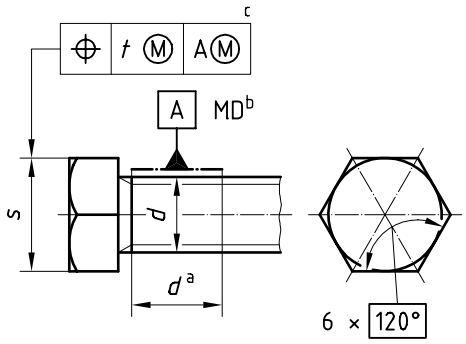
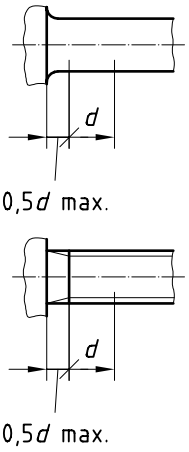
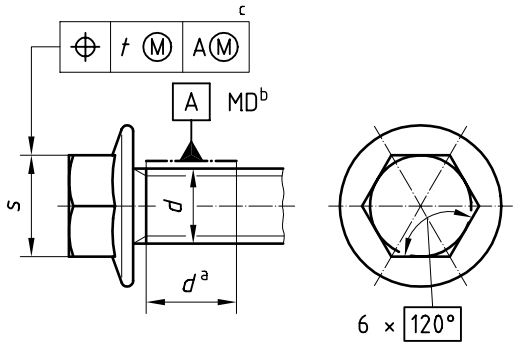
In accordance with ISO 1101 and ISO 2692 the tolerances specified in Figures 23 to 57 do not necessarily imply the use of any particular method of production, measurement or gauging.

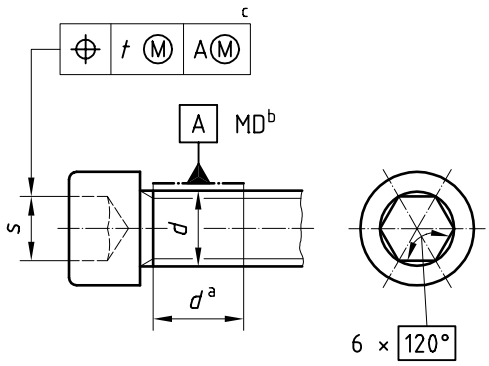
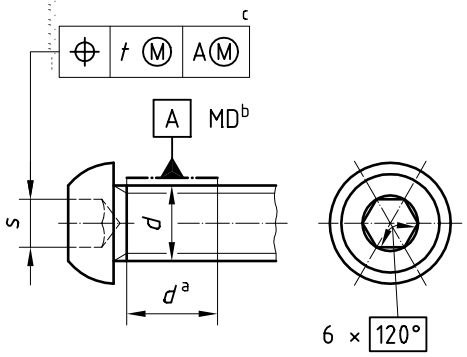
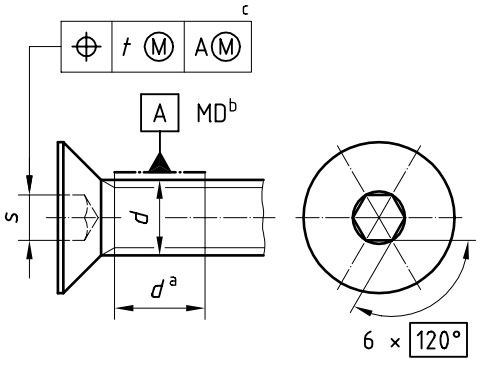
When the pitch diameter axis is specified as the datum and the coaxiality deviation of the major diameter axis relative to the pitch diameter axis is negligible, e.g. normally with rolled threads, the major diameter axis may be taken as the datum.

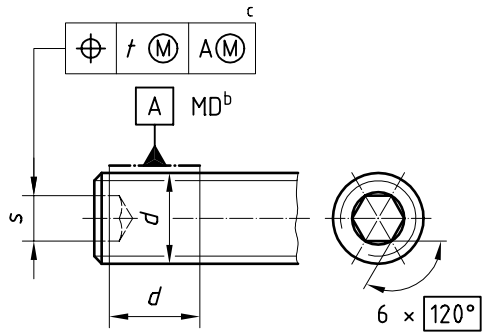
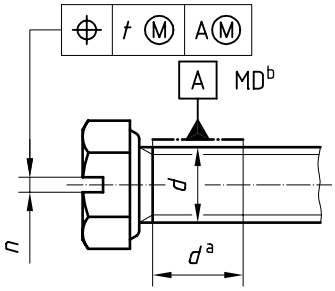
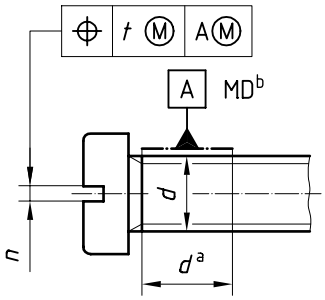
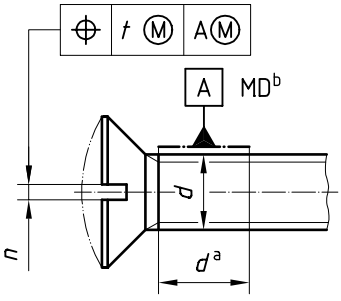
According to ISO 1101 when the datum is the thread axis the letters MD indicate that the datum reference is the major diameter axis.

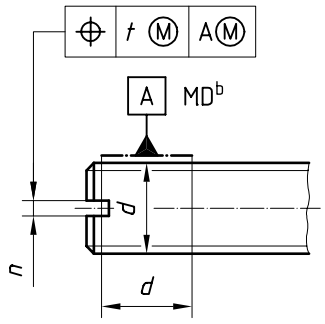
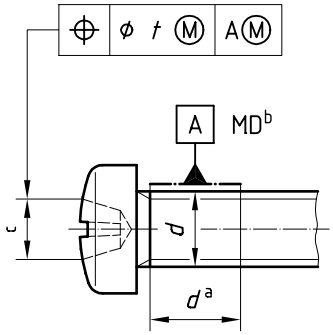
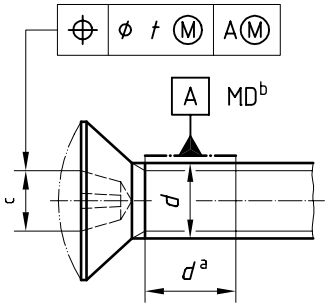
The maximum material principle in accordance with ISO 2692 is used.

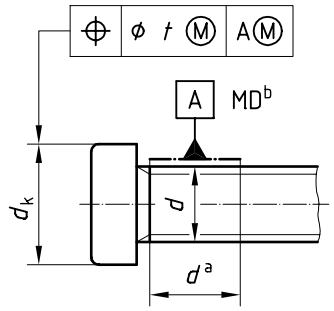
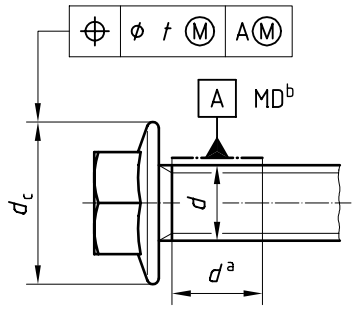
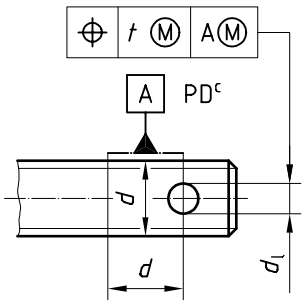
Feature	Tolerance *t* for product grades			Notes
	A	B	C	
3.2.1 Driving feature **3.2.1.1 Tolerances of form** **3.2.1.1.1 External**  a 3 × simultaneously. **Figure 23**  a 2 × simultaneously. **Figure 24**				

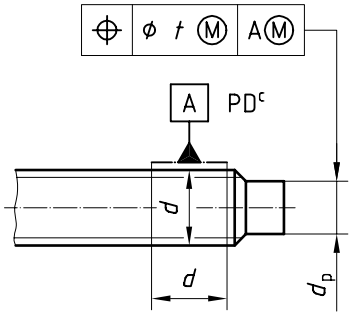
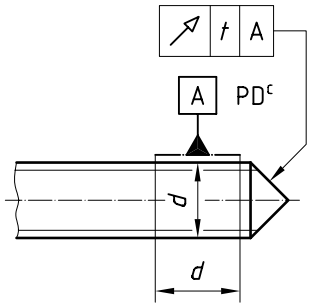
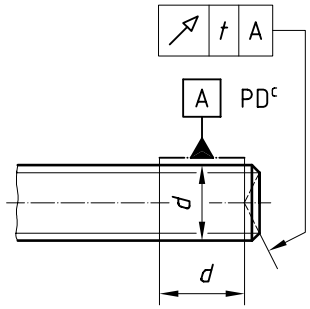
Feature	Tolerance *t* for product grades			Tolerance *t* based on dimensions	Notes
	A	B	C		
3.2.1.1.2 Internal  a 3 × simultaneously. **Figure 25**					
3.2.1.2 Tolerances of position   	2 IT13	2 IT14	2 IT15	*s*	
a The datum A shall be as close to the head as possible but within 0,5*d* distance of the head and shall be either wholly plain or wholly threaded but shall not include the thread run-out or underhead fillet. b MD means that tolerance applies in relation to the axis of the cylinder derived from the major thread diameter. c 3 × simultaneously. **Figure 26**					
 a, b, c See Figure 26. **Figure 27**	2 IT13	2 IT14	—	*s*	

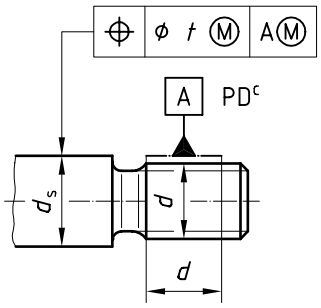
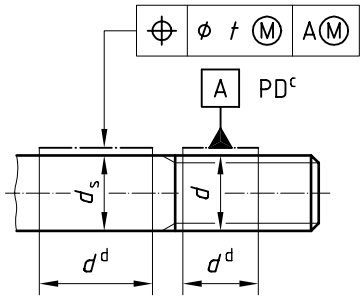
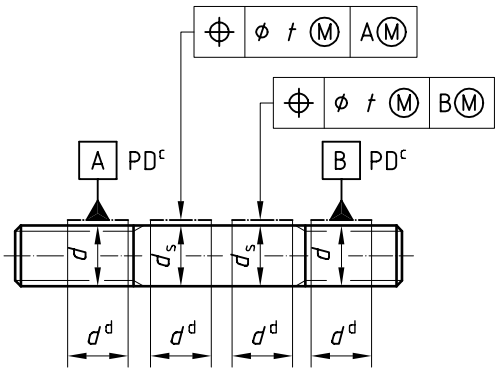
Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
 a, b, c See Figure 26 **Figure 28**	2 IT13	—	—	d	
 a, b, c See Figure 26. **Figure 29**	2 IT13	—	—	d	
 a, b, c See Figure 26. **Figure 30**	2 IT13	—	—	d	

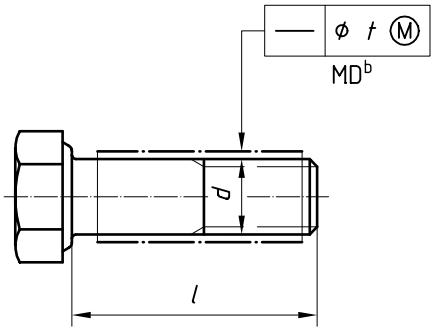
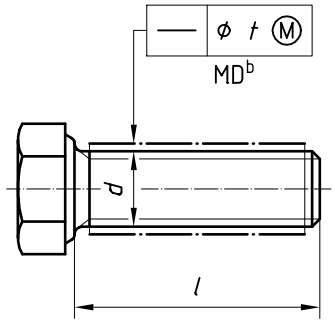
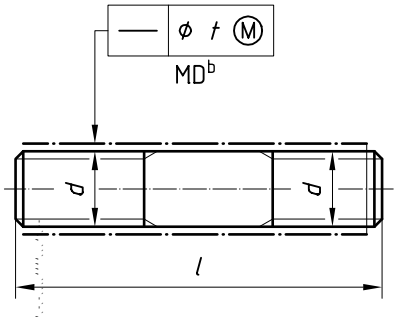
Feature	Tolerance *t* for product grades			Tolerance *t* based on dimensions	Notes
	A	B	C		
 b, c See Figure 26. **Figure 31**	2 IT12	—	—	*d*	
 a, b See Figure 26 **Figure 32**	2 IT12	2 IT13	2 IT14	*d*	
 a, b See Figure 26. **Figure 33**	2 IT12	2 IT13	2 IT14	*d*	
 a, b See Figure 26. **Figure 34**	2 IT12	2 IT13	2 IT14	*d*	

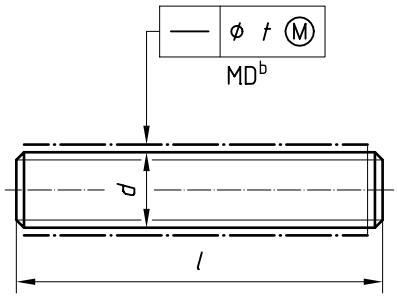
Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
	2 IT12	—	—	d	
b See Figure 26.					
Figure 35					
	2 IT13	—	—	d	
a, b See Figure 26.					
c For referee purposes coaxiality of cross recess shall be assessed by means of a penetration gauge point in accordance with ISO 4757.					
Figure 36					
	2 IT13	—	—	d	
a, b See Figure 26.					
c See Figure 36.					
Figure 37					

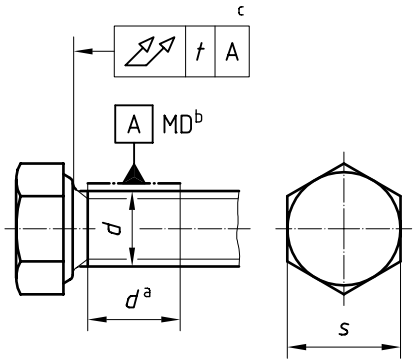
Feature	Tolerance *t* for product grades			Tolerance *t* based on dimensions	Notes
	A	B	C		
3.2.2 Other features					
3.2.2.1 Tolerances of position and run-out					
	2 IT13	2 IT14	2 IT15	d_k	
a, b See Figure 26.					
Figure 38					
	2 IT13	2 IT14	—	d_c	
a, b See Figure 26.					
Figure 39					
	2 IT13	2 IT14	2 IT15	d	
c PD means that the tolerance applies in relation to the axis derived from the pitch diameter.					
Figure 40					

Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
	IT13 [d] 2 IT13 [e]	—	—	d	[d] For set screws. [e] For all other products.
[c] See Figure 40.					
Figure 41					
	IT13	—	—	d	
[c] See Figure 40.					
Figure 42					
	IT13	—	—	d	
[c] See Figure 40.					
Figure 43					

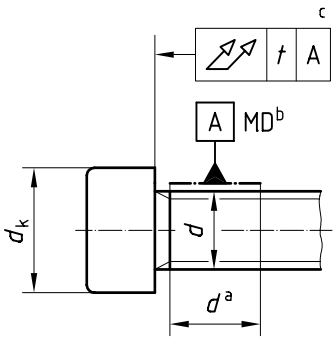
Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
	2 IT13	2 IT14	2 IT15	d	
c See Figure 40.					
Figure 44					
	IT13	IT14	IT15	d	
c See Figure 40.					
d The gauge datum feature A shall be as close to the respective part of the shank as possible but shall avoid the thread run-out.					
Figure 45					
	IT13	IT14	—	d	
c See Figure 40.					
d The gauge datum features A and B shall be as close to the respective part of the shank as possible but shall avoid the thread run-out.					
Figure 46					

Feature		Tolerance t for product grades			Tolerance t based on dimensions	Notes
		A	B	C		
3.2.2.2 Tolerances of straightness	d			$d \leqslant 8$: $t = 2(0{,}002l + 0{,}05)$ $d > 8$: $t = 2(0{,}002\,5l + 0{,}05)$		
	$\leqslant 8$	$t = 0{,}002l + 0{,}05$				
	> 8	$t = 0{,}002\,5l + 0{,}05$				
b See Figure 26.						
Figure 47						
	d			$d \leqslant 8$: $t = 2(0{,}002l + 0{,}05)$ $d > 8$: $t = 2(0{,}002\,5l + 0{,}05)$		
	$\leqslant 8$	$t = 0{,}002l + 0{,}05$				
	> 8	$t = 0{,}002\,5l + 0{,}05$				
b See Figure 26.						
Figure 48						
	d			—		
	$\leqslant 8$	$t = 0{,}002l + 0{,}05$				
	> 8	$t = 0{,}002\,5l + 0{,}05$				
b See Figure 26.						
Figure 49						

<table>
<tr><th rowspan="2">Feature</th><th colspan="3">Tolerance t for product grades</th><th rowspan="2">Tolerance t based on dimension d</th><th rowspan="2">Notes</th></tr>
<tr><th>A</th><th>B</th><th>C</th></tr>
<tr><td> 

b See Figure 26.
Figure 50</td><td colspan="2"></td><td>$d \leqslant 8$: $t = 2(0{,}002l + 0{,}05)$
$d > 8$: $t = 2(0{,}002\,5l + 0{,}05)$</td><td></td><td></td></tr>
<tr><td>3.2.2.3 Tolerance of total run-out
 

a, b See Figure 26.
c Up to 0,8s diameter only.
Figure 51</td><td colspan="2">0,04</td><td rowspan="8">—</td><td>1,6</td><td rowspan="8">For product grades A and B tolerance t is calculated as follows:
$\leqslant$ M 39:
$t = 1{,}2\ d \cdot \tan 1°$
> M 39:
$t = 1{,}2\ d \cdot \tan 0{,}5°$

For product grade C tolerance t is twice as much.</td></tr>
<tr><td>2</td></tr>
<tr><td rowspan="6">0,08</td><td>2,5</td></tr>
<tr><td>3</td></tr>
<tr><td>3,5</td></tr>
<tr><td>4</td></tr>
<tr><td rowspan="3">0,15</td><td rowspan="3">0,3</td><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td> 

a, b See Figure 26.
c Up to 0,8 d_k diameter only.
Figure 52</td><td colspan="2">0,17</td><td>0,34</td><td>8</td><td></td></tr>
<tr><td colspan="2">0,21</td><td>0,42</td><td>10</td><td></td></tr>
<tr><td colspan="2">0,25</td><td>0,50</td><td>12</td><td></td></tr>
<tr><td colspan="2">0,29</td><td>0,58</td><td>14</td><td></td></tr>
<tr><td colspan="2">0,34</td><td>0,68</td><td>16</td><td></td></tr>
<tr><td colspan="2">0,38</td><td>0,76</td><td>18</td><td></td></tr>
<tr><td colspan="2">0,42</td><td>0,84</td><td>20</td><td></td></tr>
<tr><td colspan="2">0,46</td><td>0,92</td><td>22</td><td></td></tr>
<tr><td colspan="2">0,50</td><td>1,00</td><td>24</td><td></td></tr>
<tr><td colspan="2">0,57</td><td>1,14</td><td>27</td><td></td></tr>
<tr><td colspan="2">0,63</td><td>1,26</td><td>30</td><td></td></tr>
<tr><td colspan="2">0,69</td><td>1,38</td><td>33</td><td></td></tr>
<tr><td colspan="2">0,76</td><td>1,52</td><td>36</td><td></td></tr>
<tr><td colspan="2">0,82</td><td>1,64</td><td>39</td><td></td></tr>
<tr><td colspan="2">0,44</td><td>0,88</td><td>42</td><td></td></tr>
<tr><td colspan="2">0,47</td><td>0,94</td><td>45</td><td></td></tr>
<tr><td colspan="2">0,50</td><td>1</td><td>48</td><td></td></tr>
<tr><td colspan="2">0,55</td><td>1,1</td><td>52</td><td></td></tr>
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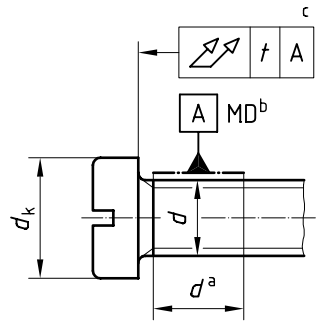
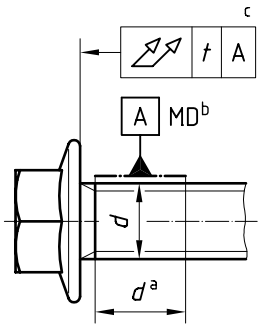


a, b See Figure 26.

c Up to 0,8 d_k diameter only.

Figure 53

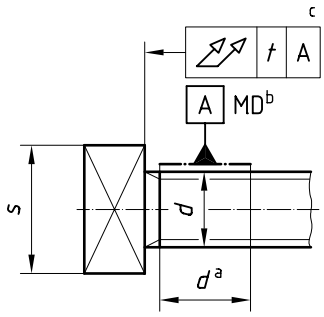
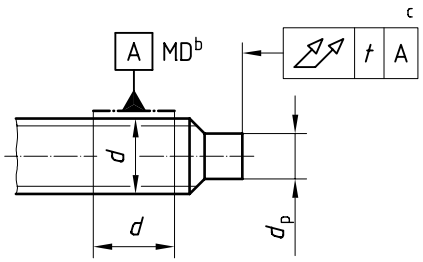


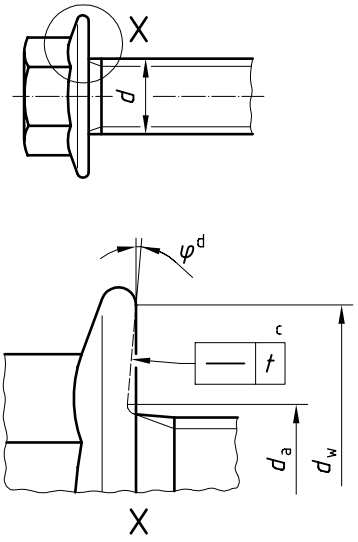
a, b See Figure 26.

c Line of highest points on any radial line.

Figure 54

Feature	Tolerance t for product grades			Tolerance t based on dimension d	Notes
	A	B	C		
	0,04		—	1,6	See Figures 51 and 52 In case of flange bolts, tolerances apply to type F and type U.
				2	
	0,08		0,3	2,5	
				3	
				3,5	
				4	
	0,15			5	
				6	
				7	
	0,17		0,34	8	
	0,21		0,42	10	
	0,25		0,50	12	
	0,29		0,58	14	
	0,34		0,68	16	
	0,38		0,76	18	
	0,42		0,84	20	
	0,46		0,92	22	
	0,50		1,00	24	
	0,57		1,14	27	
	0,63		1,26	30	
	0,69		1,38	33	
	0,76		1,52	36	
	0,82		1,64	39	
	0,44		0,88	42	
	0,47		0,94	45	
	0,50		1	48	
	0,55		1,1	52	

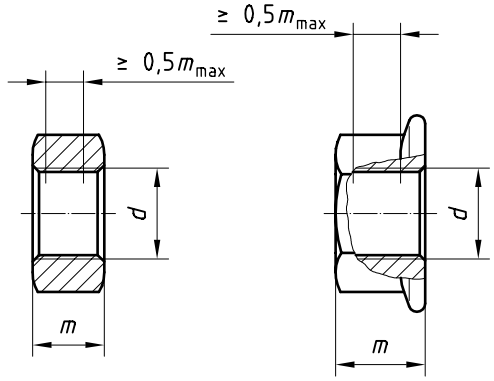
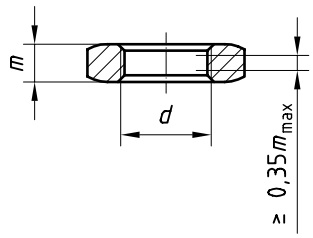
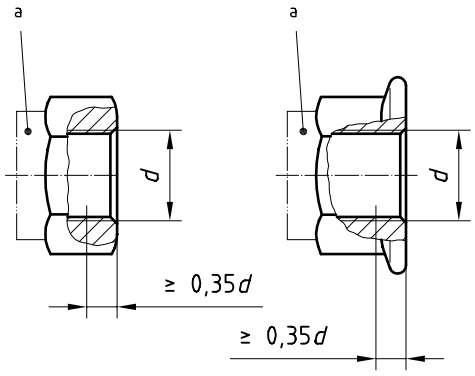
Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
 a, b See Figure 26. c See Figure 51. **Figure 55**	For t see Figures 51 to 54			Basis for t see Figures 51 to 54	
 a, b See Figure 26. c Up to ∅ 0,8d_p only **Figure 56**					For dog points only, not for pilot points

Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
3.2.2.4 Permissible deviation from the form of bearing face  c radial lines between $d_{a\,max}$ and $d_{w\,min}$. d According to product standard. **Figure 57**	0,005 d			d	

4 Tolerances for metric nuts

4.1 Dimensional tolerances

NOTE Symbols and designations of dimensions are specified in ISO 225.

Feature	Tolerance for product grades			Notes
	A	B	C	
4.1.1 Tolerance level				
Bearing surface	close	close	wide	
Other features	close	wide	wide	
4.1.2 Internal thread	6H	6H	7H	For certain products and coatings, other tolerance classes may be specified in the relevant product and coating standards.
	For all nuts of heights $m \geqslant 0{,}8d$ the minor diameter shall be within the specified tolerances for a minimum of 0,5 m_{max} (only for sizes $\geqslant$ M3).			
	For all nuts of heights $0{,}5d \leqslant m < 0{,}8d$ the minor diameter shall be within the specified tolerances for a minimum of 0,35 m_{max}			
	For prevailing torque type nuts the minor diameter may exceed the specified tolerance for a maximum height of 0,35d from the non-restricted end which does not contain the prevailing torque feature.			
a Profile varies for different types of prevailing torque type nuts.				
Figure 58				

<table>
<tr><th rowspan="2">Feature</th><th colspan="4">Tolerance for product grades</th><th rowspan="2">Notes</th></tr>
<tr><th colspan="2">A</th><th>B</th><th>C</th></tr>
<tr><td>4.1.3 Driving features

4.1.3.1 Width across flats

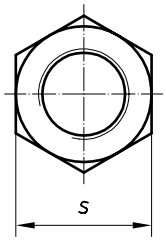
 

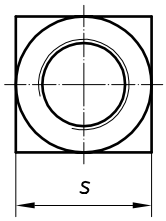
Figure 59</td><td>s</td><td>Toler-ance</td><td>s</td><td>Tolerance</td><td></td></tr>
<tr><td></td><td>$\leqslant$ 30
> 30</td><td>h13
h14</td><td>$\leqslant$ 18
> 18 $\leqslant$ 60
> 60 $\leqslant$ 180
> 180</td><td>h14
h15
h16
h17</td><td></td></tr>
<tr><td> 

Figure 60</td><td colspan="2">See figure 59</td><td colspan="2">See figure 59</td><td></td></tr>
<tr><td>4.1.3.2 Width across corners

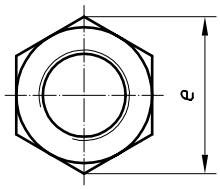
 

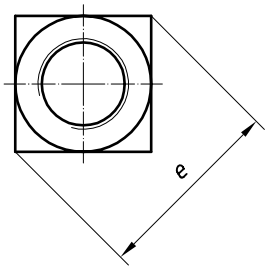
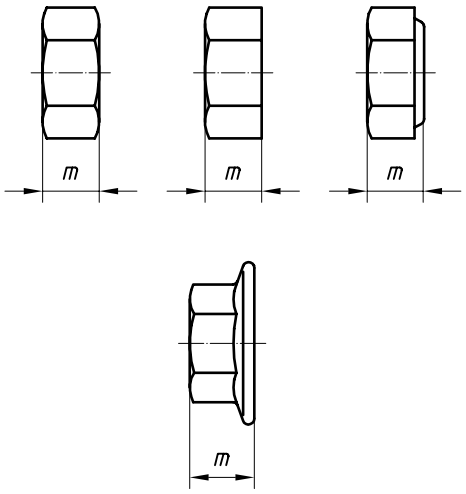
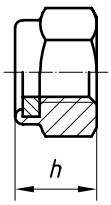
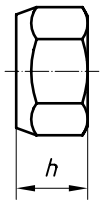
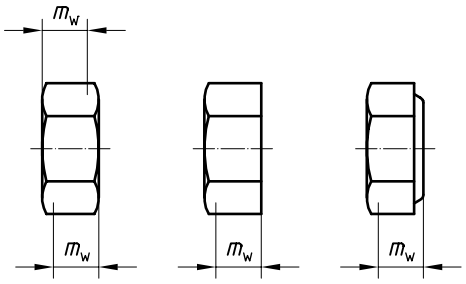
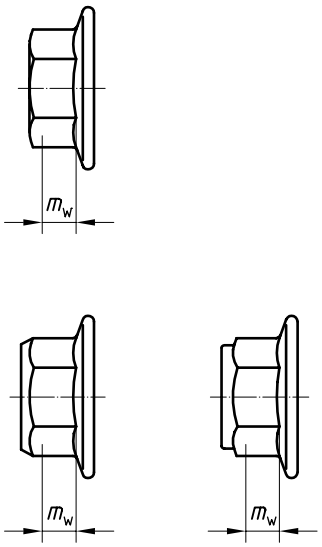
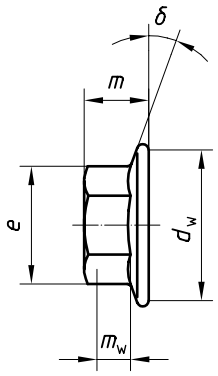
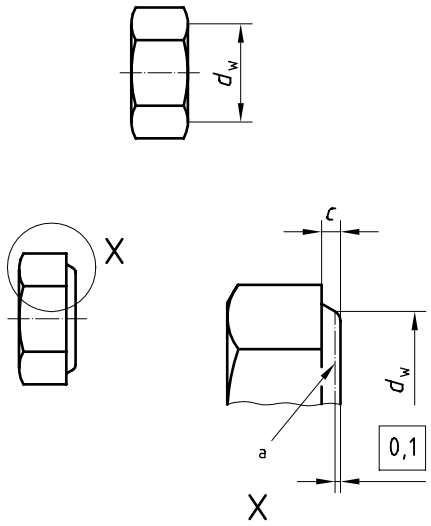
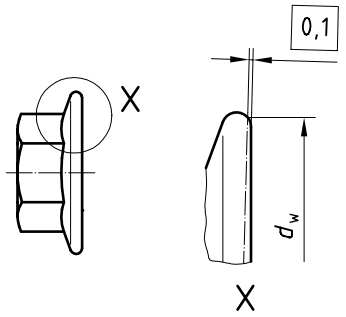
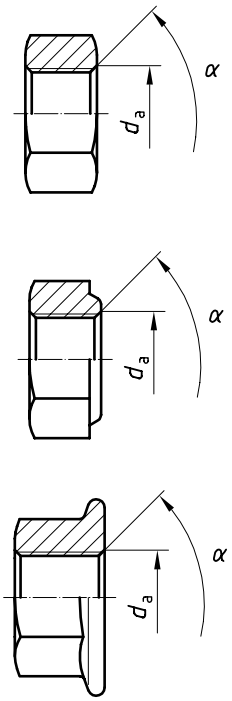
Figure 61</td><td colspan="4">$e_{min} = 1{,}13\ s_{min}$</td><td></td></tr>
<tr><td> 

Figure 62</td><td colspan="4">$e_{min} = 1{,}3\ s_{min}$</td><td></td></tr>
</table>

Feature	Tolerance for product grades A	B	C	Notes
4.1.4 Other features **4.1.4.1 Height of nuts**  **Figure 63**	$d \leqslant 12$ mm: h14 12 mm < $d \leqslant 18$ mm: h15 $d > 18$ mm: h16		h17	For slotted nuts and castle nuts see 4.1.5.1
Prevailing torque type nuts (with non-metallic insert)  Prevailing torque type all metal hexagon nuts  **Figure 64**	Tolerance of h, see product standards			

Feature	Tolerance for product grades A / B / C	Notes
4.1.4.2 Wrenching height  **Figure 65**	$m_{w}{}^{a}{}_{min} = 0{,}8\ m_{min}$	m_w defines the length over which e_{min} applies but excluding any chamfer or washer face specified in the appropriate product standard. The symbol m_w replaces the previously used m'. [a] The formulae for $m_{w\,min}$ only apply to the products illustrated. [b] For gauging, see annex A of the product standards.
 **Figure 66**	$m_{w\,min}^{b} = 0{,}8 \times \left[m_{min} - \left(x + \frac{d_{w\,min} - e_{min}}{2} \tan\delta_{max} \right) \right]$ x is the greater of $c_{min} \times 1{,}25$ or $c_{min} + 0{,}4$ δ is the flange angle Dimensions $m_w{}^a$, m, d_w, e and δ are in accordance with ISO 225. 	

<table>
<tr><th>Feature</th><th colspan="3">Tolerance for product grades
A | B | C</th><th>Notes</th></tr>
<tr><td>4.1.4.3 Bearing face diameter and height of washer-faced portion
 
a Reference datum for d_w
Figure 67</td><td colspan="3">$d_{w\,min} = s_{min}$ – IT16 for width across flats < 21 mm
$d_{w\,min} = 0{,}95\ s_{min}$ for width across flats ⩾ 21 mm
$d_{w\,max} = s_{actual}$
<table><tr><th rowspan="2">Thread diameter</th><th colspan="2">c</th></tr><tr><th>min.</th><th>max.</th></tr><tr><td>⩾ 1,6 to 2,5</td><td>0,10</td><td>0,25</td></tr><tr><td>> 2,5 to 4</td><td>0,15</td><td>0,40</td></tr><tr><td>> 4 to 6</td><td>0,15</td><td>0,50</td></tr><tr><td>> 6 to 14</td><td>0,15</td><td>0,60</td></tr><tr><td>> 14 to 36</td><td>0,2</td><td>0,8</td></tr><tr><td>> 36</td><td>0,3</td><td>1,0</td></tr></table></td><td rowspan="2">Requirements apply to both sides of symmetrical parts.</td></tr>
<tr><td> 
Figure 68</td><td colspan="3">$d_{w\,min}$ for hexagon nuts with flange in accordance with product standards</td></tr>
</table>

<table>
<tr><th>Feature</th><th colspan="3">Tolerance for product grades</th><th>Notes</th></tr>
<tr><th></th><th>A</th><th>B</th><th>C</th><th></th></tr>
<tr><td> 

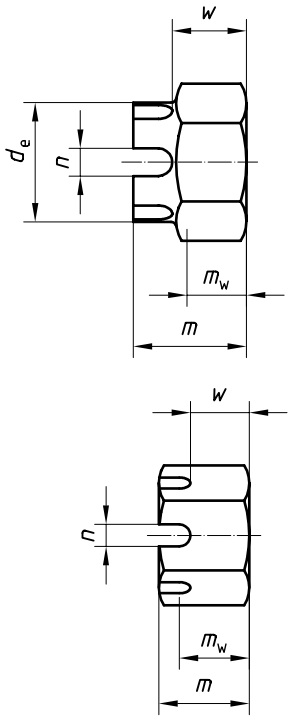
α = 90° to 120°
Figure 69</td><td colspan="2">$d \leqslant$ 5 mm : $d_{a\,max} = 1{,}15d$
5 mm < $d \leqslant$ 8 mm :
$d_{a\,max} = d + 0{,}75$
$d >$ 8 mm: $d_{a\,max} = 1{,}08d$
for all sizes: $d_{a\,min} = d$</td><td></td><td>Requirements apply to both sides of symmetrical parts.</td></tr>
<tr><td>4.1.5 Special products
4.1.5.1 Castle nuts, slotted nuts
 

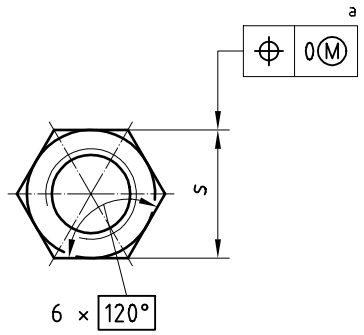
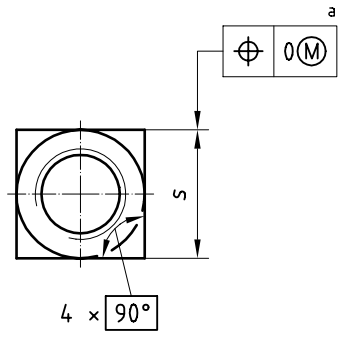
Figure 70</td><td colspan="3"><table>
<tr><td></td><td>A</td><td>B</td><td>C</td></tr>
<tr><td>d_e</td><td>h14</td><td>h15</td><td>h16</td></tr>
<tr><td>m</td><td>h14</td><td>h15</td><td>h17</td></tr>
<tr><td>n</td><td>H14</td><td>H14</td><td>H15</td></tr>
<tr><td>w</td><td>h14</td><td>h15</td><td>h17</td></tr>
<tr><td>m_W</td><td colspan="3">see m_W-values for hexagon nuts style 1 (see ISO 4032)</td></tr>
</table></td><td></td></tr>
</table>

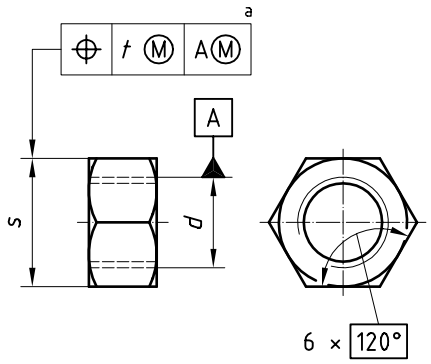
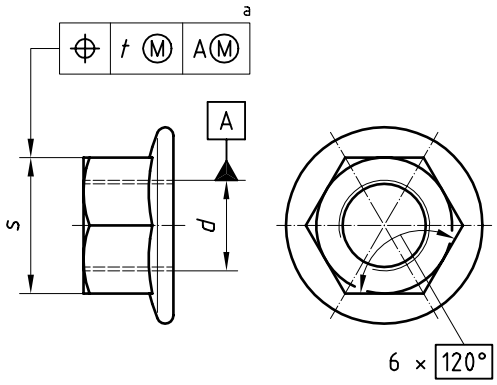
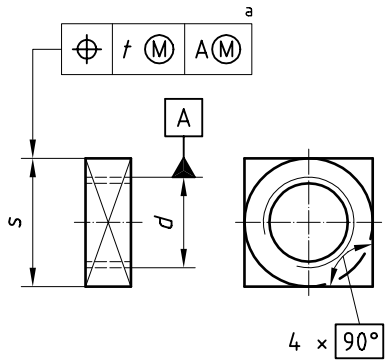
4.2 Geometrical tolerances

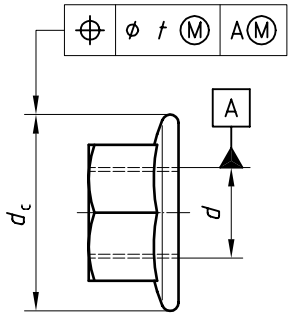
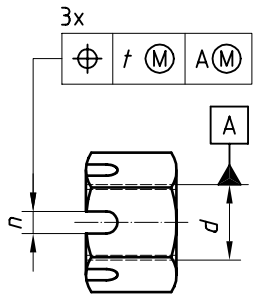
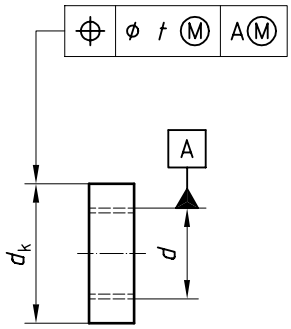
In accordance with ISO 1101 and ISO 2692 the tolerances specified in Figures 71 to 83 do not necessarily imply the use of any particular method of production, measurement or gauging.

Where the nut thread is used as the datum the pitch diameter shall be the reference diameter.

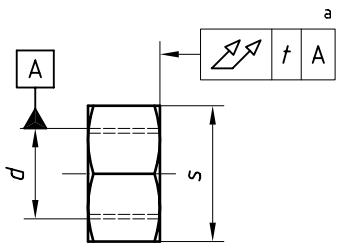
The maximum material principle in accordance with ISO 2692 is used.

Feature	Tolerance *t* for product grades			Notes
	A	B	C	
4.2.1 Driving features				
4.2.1.1 Tolerances of form				
				
a 3 × simultaneously.				
Figure 71				
				
a 2 × simultaneously.				
Figure 72				

Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
4.2.1.2 Tolerances of position  a 3 × simultaneously. **Figure 73**	2 IT13	2 IT14	2 IT15	s	
 a 3 × simultaneously. **Figure 74**	2 IT13	2 IT14	—	s	
 a 2 × simultaneously. **Figure 75**	2 IT13	2 IT14	2 IT15	s	

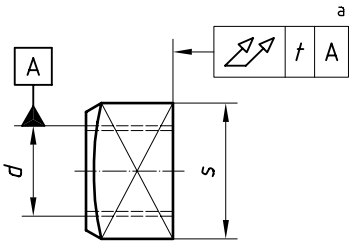
Feature	Tolerance t for product grades			Tolerance t based on dimensions	Notes
	A	B	C		
4.2.2 Other features					
4.2.2.1 Tolerances of position					
 **Figure 76**	2 IT14	2 IT15	—	d_c	
 **Figure 77**	2 IT13	2 IT14	2 IT15	d	
 **Figure 78**	2 IT13	2 IT14	—	d_k	

Feature	Tolerance t for product grades A	B	C	Tolerance t based on dimension d	Notes
4.2.2.2 Tolerance of total run-out	0,04			1,6	For symmetrical parts the perpendicularity requirement shall apply for both faces.
				2	
	0,08		—	2,5	
				3	
				3,5	
				4	
	0,15		0,3	5	
				6	
				7	
	0,17		0,34	8	
	0,21		0,42	10	
	0,25		0,50	12	
	0,29		0,58	14	
	0,34		0,68	16	
	0,38		0,76	18	
	0,42		0,84	20	
	0,46		0,92	22	
	0,50		1	24	
	0,57		1,14	27	
	0,63		1,26	30	
	0,69		1,38	33	
	0,76		1,52	36	
	0,82		1,64	39	
	0,44		0,88	42	
	0,47		0,94	45	
	0,50		1	48	
	0,55		1,1	52	



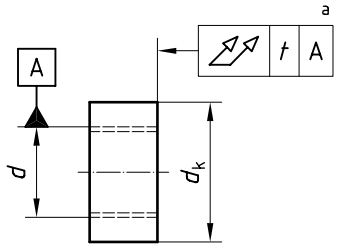
a Up to 0,8s diameter only.

Figure 79



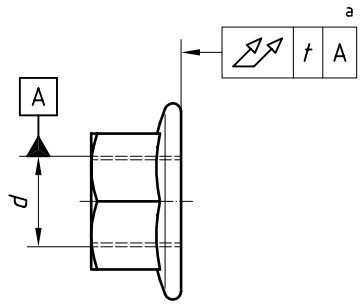
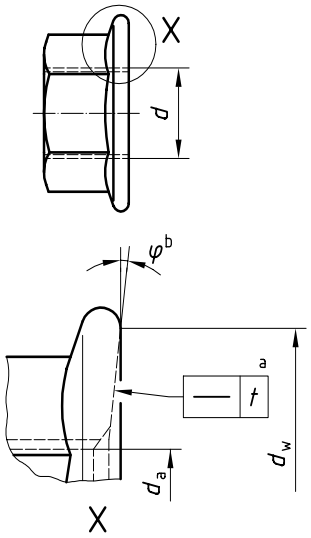
a Up to ∅ 0,8s only.

Figure 80



a Up to ∅ 0,8d_k only.

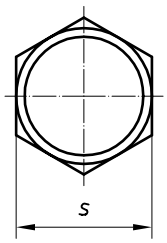
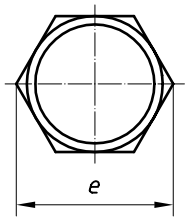
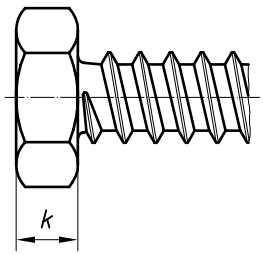
Figure 81

Feature	Tolerance t for product grades			Notes
	A	B	C	
 a Line of highest points on any radial line. **Figure 82**	For t see values for Figures 79, 80 and 81.			
4.2.2.3 Permissible deviation from the shape of bearing face  a Radial lines between $d_{a\,max}$ and $d_{w\,min}$. b According to product standard. **Figure 83**	0,005d			

5 Tolerances for tapping screws

5.1 Dimensional tolerances — Product grade A

Symbols and designations of dimensions are specified in ISO 225.

Feature	Tolerance	Notes
5.1.1 Thread	see ISO 1478	
5.1.2 Driving features **5.1.2.1 External** **5.1.2.1.1 Width across flats**  **Figure 84**	h13	
5.1.2.1.2 Width across corners  **Figure 85**	$e_{min} = 1{,}12\ s_{min}$	
5.1.2.1.3 Height of head  **Figure 86**	For tolerances see ISO 1479	For tapping screws with hexagon flange head and hexagon washer head see ISO 7053 and ISO 10509 respectively.

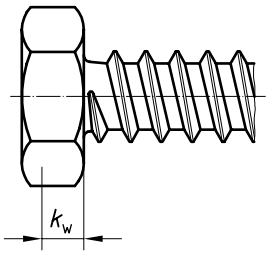
<table>
<tr><th>Feature</th><th>Tolerance</th><th>Notes</th></tr>
<tr><td>5.1.2.1.4 Wrenching height
 

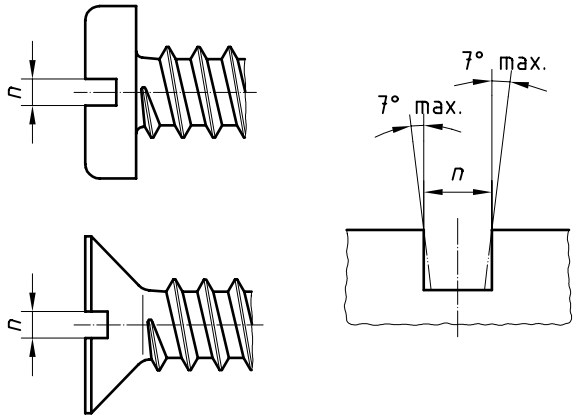
Figure 87</td><td>$k_{w\ min.} = 0{,}7\ k_{min}$</td><td>For tapping screws with hexagon flange head and hexagon washer head see ISO 7053 and ISO 10509 respectively.
The symbol k_w replaces the previously used k'.</td></tr>
<tr><td>5.1.2.2 Internal
5.1.2.2.1 Width of slots
 

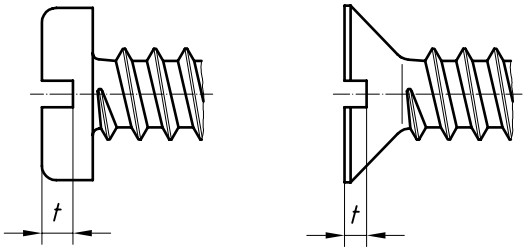
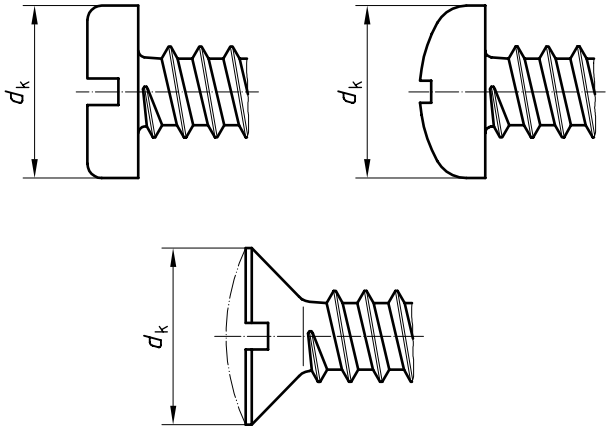
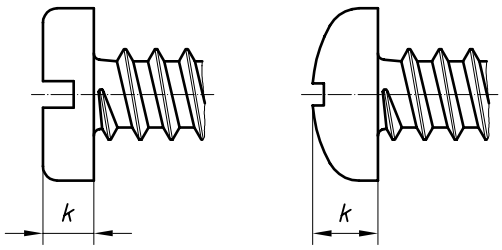
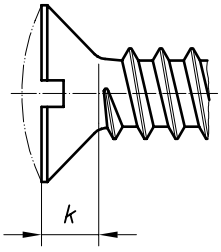
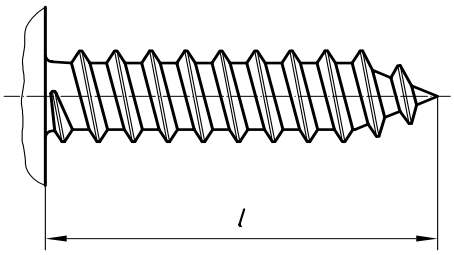
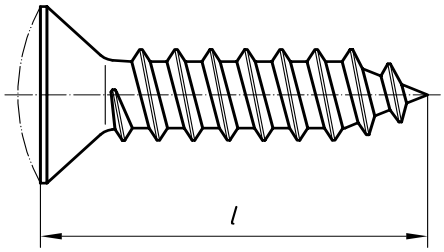
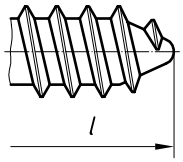
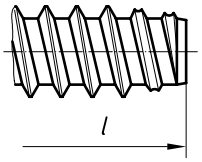
Figure 88</td><td><table><tr><th>n</th><th>Tolerance [a]</th></tr><tr><td>$\leqslant 1$</td><td>+ 0,20
+ 0,06</td></tr><tr><td>$> 1 \leqslant 3$</td><td>+ 0,31
+ 0,06</td></tr><tr><td>$> 3 \leqslant 6$</td><td>+ 0,37
+ 0,07</td></tr></table></td><td>[a] Tolerance field
C13 for $n \leqslant 1$
C14 for $n > 1$</td></tr>
<tr><td>5.1.2.2.2 Depth of slots
 

Figure 89</td><td>The depth of slots is specified in product standards.</td><td></td></tr>
</table>

Feature	Tolerance	Notes
5.1.2.2.3 Cross recesses	See ISO 4757 for all dimensions except penetration depths. For penetration depths see appropriate product standard.	
5.1.2.2.4 Hexalobular recess	See ISO 10664 for all dimensions except penetration depths. For penetration depths see appropriate product standard.	
5.1.3 Other features **5.1.3.1 Head diameters**  **Figure 90**	h14	Combined control of diameter and height for countersunk head screws as specified in ISO 7721.
5.1.3.2 Head height  **Figure 91**	h14	
 **Figure 92**	For countersunk head screws k is defined in product standards only as a maximum.	Combined control of diameter and height for countersunk head screws as specified in ISO 7721.

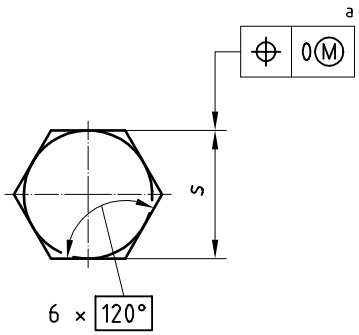
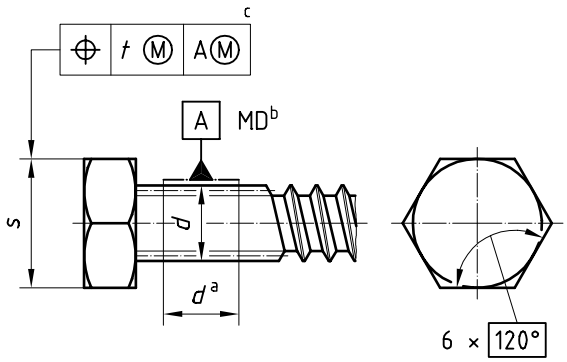
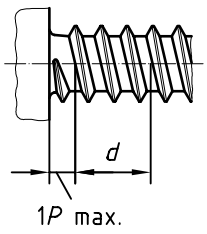
Feature	Tolerance	Notes
5.1.3.3 Length   Type C  Type R  Type F **Figure 93**	**Types C and R** l | Tolerance $\leqslant 25$ | $\pm 0{,}8$ > 25 | $\pm 1{,}3$ **Type F** l | Tolerance $\leqslant 19$ | $^{0}_{-0{,}8}$ $> 19 \leqslant 38$ | $^{0}_{-1{,}3}$ > 38 | $^{0}_{-1{,}5}$	

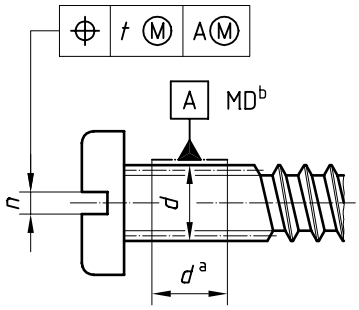
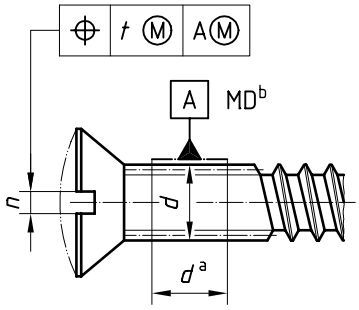
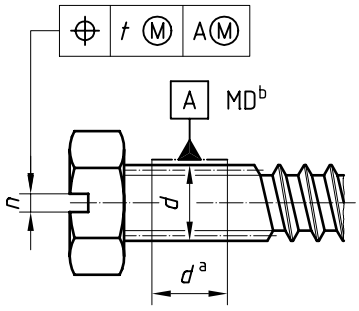
5.2 Geometrical tolerances — Product grade A

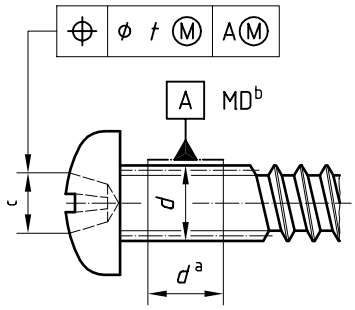
In accordance with ISO 1101 and ISO 2692 the tolerances of form and position indicated in Figures 94 to 104 do not necessarily imply the use of any particular method of production, measurement or gauging.

Where a tapping screw thread is indicated either as the datum or as the toleranced feature the axis shall be determined from the major diameter of the thread.

The maximum material principle in accordance with ISO 2692 is used.

Feature	Tolerance t	Tolerance t based on dimension	Notes
5.2.1 Driving features			
5.2.1.1 Tolerance of form			
			
a 3 × simultaneously.			
Figure 94			
5.2.1.2 Tolerances of position			
	2 IT13	s	
a The datum A shall be as close to the head as possible but within 1 P distance of the head. It shall not include the thread run-out or underhead fillet.			
b MD means that tolerance applies in relation to the axis of the cylinder derived from the major thread diameter according to ISO 1101.			
c 3 × simultaneously.			
Figure 95			

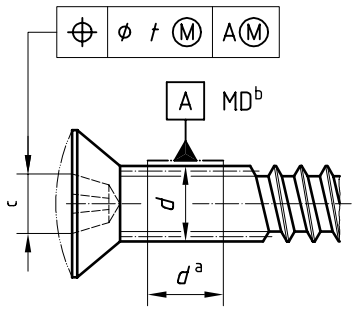
Feature	Tolerance *t*	Tolerance *t* based on dimension	Notes
 a, b See Figure 95. **Figure 96**	2 IT12	*d*	
 a, b See Figure 95. **Figure 97**	2 IT12	*d*	
 a, b See Figure 95. **Figure 98**	2 IT12	*d*	

Feature	Tolerance t	Tolerance t based on dimension	Notes
	2 IT13	d	

a, b See Figure 95.

c For referee purposes assessment of co-axiality of cross recess features shall be by means of a penetration gauge point in accordance with ISO 4757.

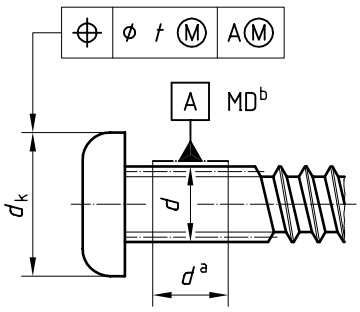
Figure 99

	2 IT13	d	

a, b See Figure 95.

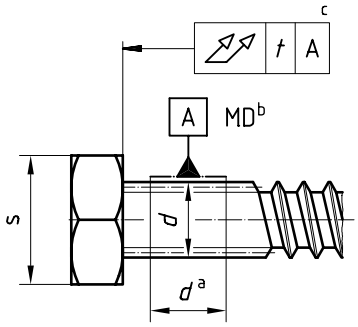
c See Figure 99.

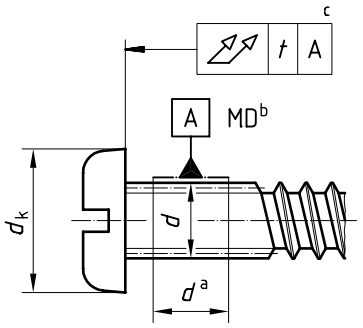
Figure 100

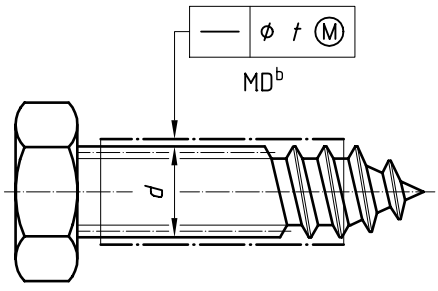
5.2.2 Other features **5.2.2.1 Tolerance of position** 	2 IT13	d_k	

a, b See Figure 95.

Figure 101

<table>
<tr><th>Feature</th><th>Tolerance t</th><th>Tolerance t based on dimension</th><th>Notes</th></tr>
<tr><td>5.2.2.2 Total run-out
 

a, b See Figure 95.
c Up to 0,8s diameter only.
Figure 102
 

a, b See Figure 95.
c up to 0,8 d_k diameter only.
Figure 103</td><td><table><tr><th>d</th><th>t</th></tr><tr><td>ST2,2</td><td>0,08</td></tr><tr><td>ST2,9</td><td>0,16</td></tr><tr><td>ST3,5</td><td>0,16</td></tr><tr><td>ST4,2</td><td>0,16</td></tr><tr><td>ST4,8</td><td>0,3</td></tr><tr><td>ST5,5</td><td>0,3</td></tr><tr><td>ST6,3</td><td>0,3</td></tr><tr><td>ST8</td><td>0,34</td></tr><tr><td>ST9,5</td><td>0,42</td></tr></table></td><td>d
d</td><td>Tolerance t calculated as follows:
$t \approx 1{,}2\ d \times \tan 2°$</td></tr>
<tr><td>5.2.2.3 Straightness
 

b See Figure 95.
Figure 104</td><td>$t = 0{,}003l + 0{,}05$</td><td>—</td><td>for $l \leqslant 20d$</td></tr>
</table>

Annex A
(informative)

Tolerances

Numerical values of IT tolerance grades are given in Table A.1 and the limit deviations for shafts and for holes are given in Tables A.2 and A.3 respectively. These tolerances are taken from ISO 286-1 and ISO 286-2.

Table A.1 — Numerical values of standard tolerance grades IT for basic sizes up to 500 mm

Nominal dimension		Standard tolerance grades					
>	⩽	IT12	IT13	IT14	IT15	IT16	IT17
		Tolerances					
	3	0,1	0,14	0,25	0,4	0,6	1
3	6	0,12	0,18	0,3	0,48	0,75	1,2
6	10	0,15	0,22	0,36	0,58	0,9	1,5
10	18	0,18	0,27	0,43	0,7	1,1	1,8
18	30	0,21	0,33	0,52	0,84	1,3	2,1
30	50	0,25	0,39	0,62	1	1,6	2,5
50	80	0,3	0,46	0,74	1,2	1,9	3
80	120	0,35	0,54	0,87	1,4	2,2	3,5
120	180	0,4	0,63	1	1,6	2,5	4
180	250	0,46	0,72	1,15	1,85	2,9	4,6
250	315	0,52	0,81	1,3	2,1	3,2	5,2
315	400	0,57	0,89	1,4	2,3	3,6	5,7
400	500	0,63	0,97	1,55	2,5	4	6,3

Table A.2 — Limit deviations for shafts

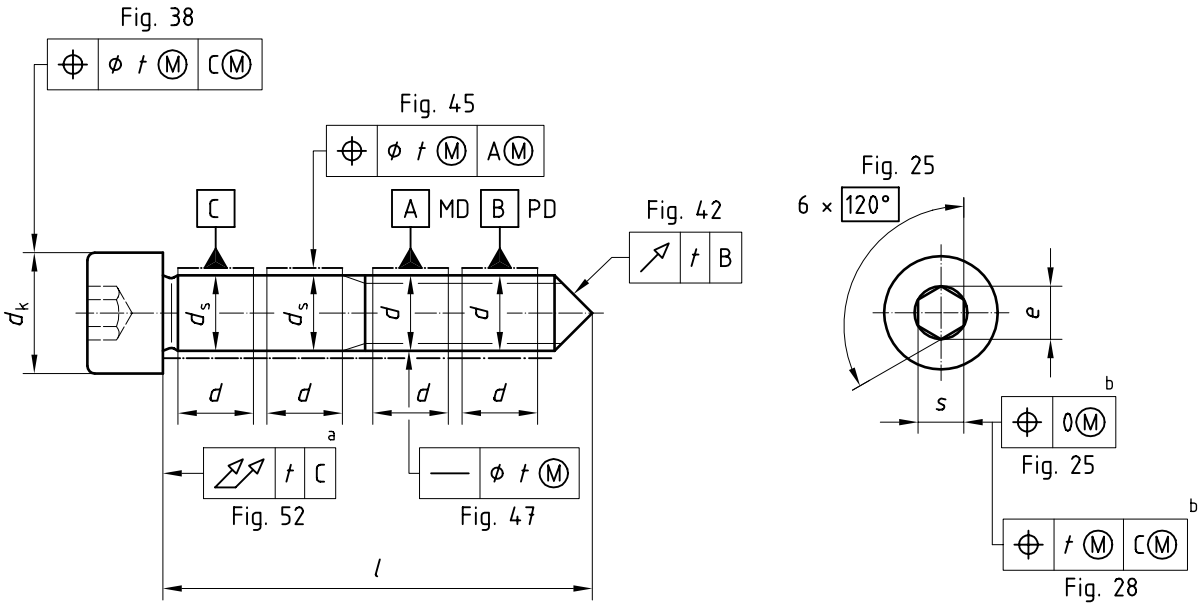
Nominal dimension		Limit deviations								
>	⩽	h13	h14	h15	h16	h17	js14	js15	js16	js17
	3	0 – 0,14	0 – 0,25	0 – 0,4	0 – 0,6	0 – 1	± 0,125	± 0,2	± 0,3	± 0,5
3	6	0 – 0,18	0 – 0,3	0 – 0,48	0 – 0,75	0 – 1,2	± 0,15	± 0,24	± 0,375	± 0,6
6	10	0 – 0,22	0 – 0,36	0 – 0,58	0 – 0,9	0 – 1,5	± 0,18	± 0,29	± 0,45	± 0,75
10	18	0 – 0,27	0 – 0,43	0 – 0,7	0 – 1,1	0 – 1,8	± 0,215	± 0,35	± 0,55	± 0,9
18	30	0 – 0,33	0 – 0,52	0 – 0,84	0 – 1,3	0 – 2,1	± 0,26	± 0,42	± 0,65	± 1,05
30	50	0 – 0,39	0 – 0,62	0 – 1	0 – 1,6	0 – 2,5	± 0,31	± 0,5	± 0,8	± 1,25
50	80	0 – 0,46	0 – 0,74	0 – 1,2	0 – 1,9	0 – 3,0	± 0,37	± 0,6	± 0,95	± 1,5
80	120	0 – 0,54	0 – 0,87	0 – 1,4	0 – 2,2	0 – 3,5	± 0,435	± 0,7	± 1,1	± 1,75
120	180	0 – 0,63	0 – 1	0 – 1,6	0 – 2,5	0 – 4	± 0,5	± 0,8	± 1,25	± 2
180	250	0 – 0,72	0 – 1,15	0 – 1,85	0 – 2,9	0 – 4,6	± 0,575	± 0,925	± 1,45	± 2,3
250	315	0 – 0,81	0 – 1,3	0 – 2,1	0 – 3,2	0 – 5,2	± 0,65	± 1,05	± 1,6	± 2,6
315	400	0 – 0,89	0 – 1,4	0 – 2,3	0 – 3,6	0 – 5,7	± 0,7	± 1,15	± 1,8	± 2,85
400	500	0 – 0,97	0 – 1,55	0 – 2,5	0 – 4	0 – 6,3	± 0,775	± 1,25	± 2	± 3,15

Table A.3 — Limit deviations for holes

Nominal dimension		Limit deviations												
>	⩽	C13	C14	D9	D10	D11	D12	EF8	11	E12	H14	H15	JS9	K9
	3	+ 0,2 + 0,06	+ 0,31 +0,06	+ 0,045 + 0,02	+ 0,06 + 0,02	+ 0,08 + 0,02	+ 0,12 + 0,02	+ 0,024 + 0,01	+ 0,074 + 0,014	+ 0,114 + 0,014	+ 0,25 0	+ 0,4 0	± 0,012 5	0 – 0,025
3	6	+ 0,25 + 0,07	+ 0,37 + 0,07	+ 0,06 + 0,03	+ 0,078 + 0,03	+ 0,105 + 0,03	+ 0,15 + 0,03	+ 0,032 + 0,014	+ 0,095 + 0,02	+ 0,14 + 0,02	+ 0,3 0	+ 0,48 0	± 0,015	0 – 0,03
6	10					+ 0,13 + 0,04	+ 0,19 + 0,04	+ 0,04 + 0,018	+ 0,115 + 0,025	+ 0,175 + 0,025	+ 0,36 0	+ 0,58 0	± 0,018	0 – 0,036
10	18						+ 0,23 + 0,05		+ 0,142 + 0,032	+ 0,212 + 0,032	+ 0,43 0	+ 0,7 0		
18	30						+ 0,275 + 0,065				+ 0,52 0	+ 0,84 0		
30	50						+ 0,33 + 0,08				+ 0,62 0	+ 1 0		
50	80						+ 0,4 + 0,1				+ 0,74 0	+ 1,2 0		
80	120						+ 0,47 + 0,12				+ 0,87 0	+ 1,4 0		
120	180										+ 1 0	+ 1,6 0		
180	250										+ 1,15 0	+ 1,85 0		
250	315										+ 1,3 0	+ 2,1 0		
315	400										+ 1,4 0	+ 2,3 0		
400	500										+ 1,55 0	+ 2,5 0		

Annex B
(informative)

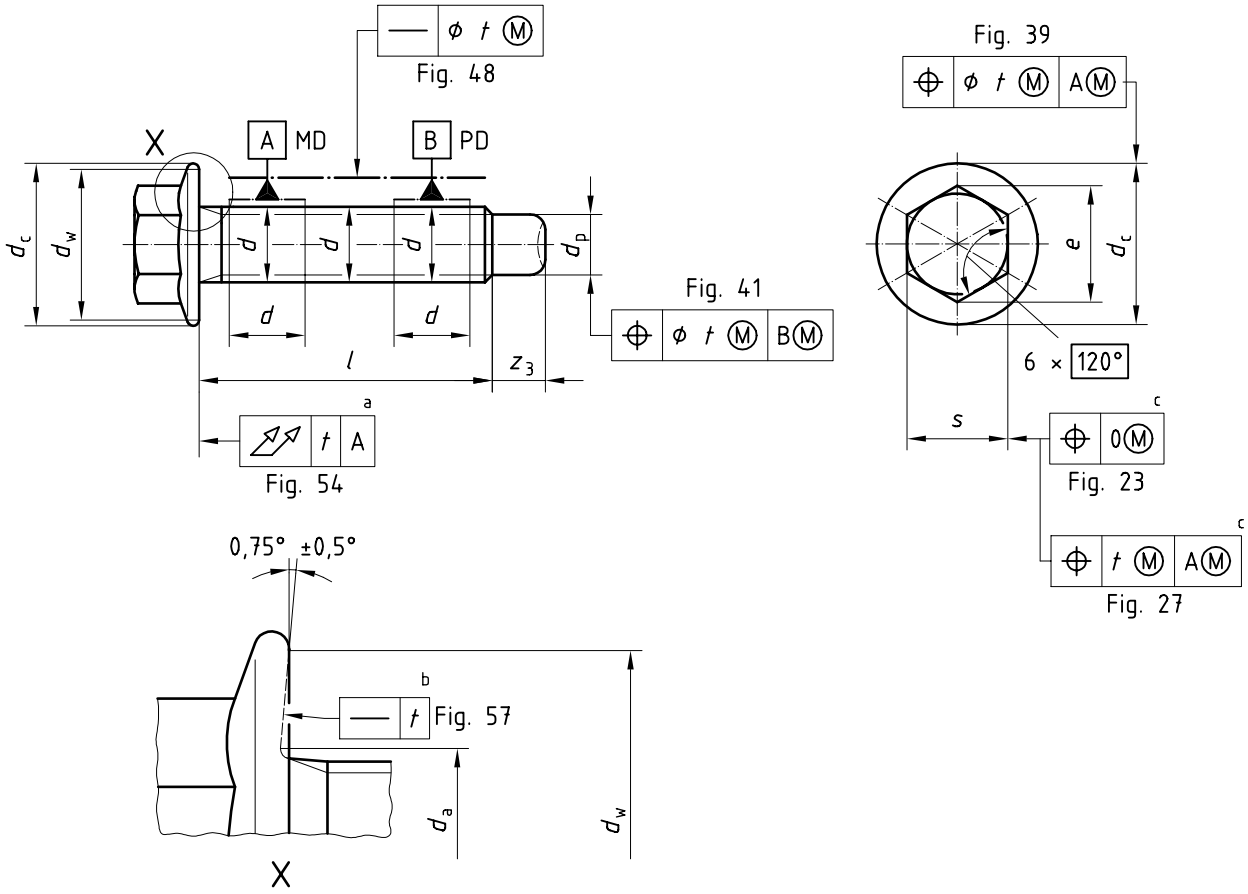
Examples of dimensioned and toleranced fasteners



a Up to 0,8 d_k diameter only.

b 3 × simultaneously.

Figure B.1 — Hexagon socket head cap screw with shank and cone point

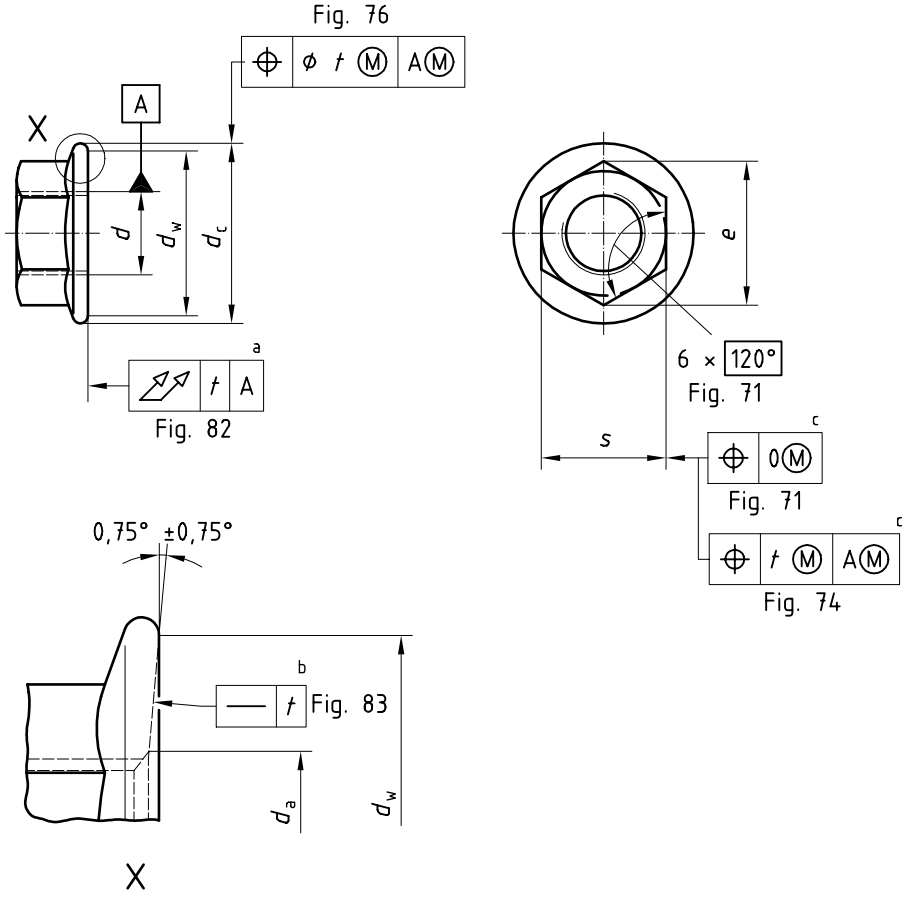


a Line of highest points on any radial line.

b Radial lines between $d_{a\,max}$ and $d_{w\,min}$.

c 3 × simultaneously.

Figure B.2 — Hexagon head bolt with flange and pilot point



a Line of highest points on any radial line.

b Radial lines between $d_{a\,max}$ and $d_{w\,min}$.

c 3 × simultaneously.

Figure B.3 — Hexagon nut with flange

Annex C
(informative)

Examples of gauges and other measuring devices

C.1 Application

This annex gives examples of gauges and other measuring devices which can verify whether the tolerances specified in this part of ISO 4759 are satisfied.

The thread of gauges and measuring devices shall be within the limits for GO gauges. Guides shall have such an accuracy that errors due to the guides during inspection are negligible compared to the workpiece tolerance t (e.g. less than 10 % of t).

If the datum is not associated with the maximum material requirements, indicated by Ⓜ, the following applies:

— when the datum is an external thread, the major diameter axis (MD) or the pitch diameter axis (PD) is the datum as specified in this part of ISO 4759. When the datum is the major diameter, the part may be fixed in a 3 jaw chuck;

— when the datum is an internal thread, in the examples of this annex the nut is tightened against a conical spring washer. Another possibility is to use a tapered threaded mandrel for this purpose;

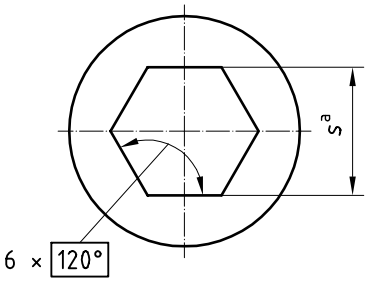
— when the datum is a plain shaft or a tapping screw thread it may be fixed in a 3 jaw chuck regardless of the feature size;

C.2 Gauges and other measuring devices

NOTE All gauges given in this annex are GO gauges. Diameter d_g, if existant, should be chosen by the gauge manufacturer.

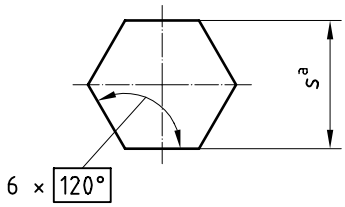
The gauges and measuring devices given in this annex are intended for the verification of geometrical tolerances specified in 3.2, 4.2 and 5.2.

Each gauge and measuring device is allocated to one or more figures in the main body of this part of ISO 4759 in order to make clear which tolerance is verified by which gauge or measuring device.



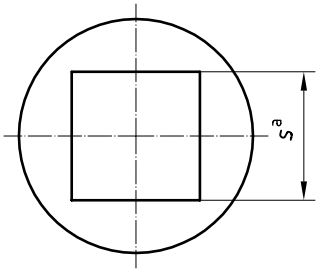
[a] Maximum material size.

Figure C.1 — Gauge for verifying form tolerance specified in Figures 23, 71 and 94



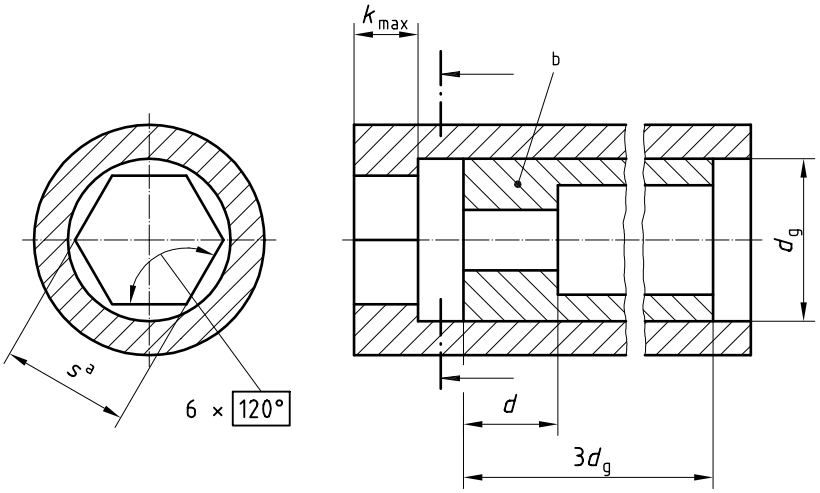
a Maximum material size.

Figure C.2 — Gauge for verifying form tolerance specified in figure 25



a Maximum material size.

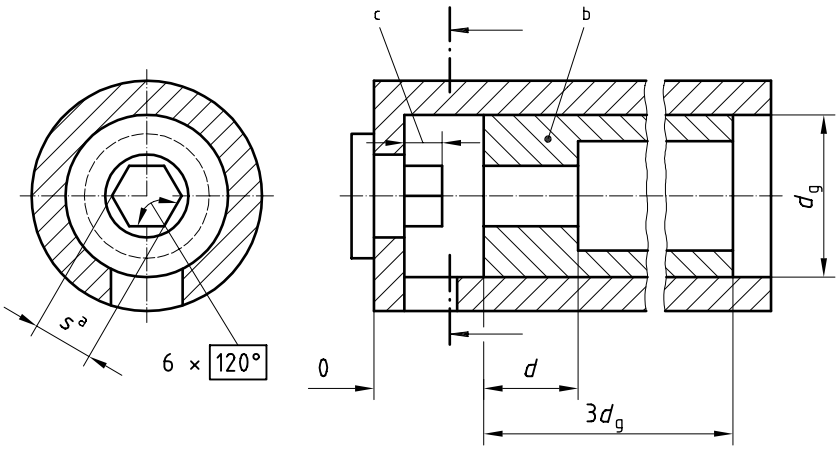
Figure C.3 — Gauge for verifying form tolerance specified in Figures 24 and 72



a Maximum material size + t.

b The GO gauge is a plain hole of maximum material size.

Figure C.4 — Gauge for verifying position tolerance specified in Figures 26, 27 and 95

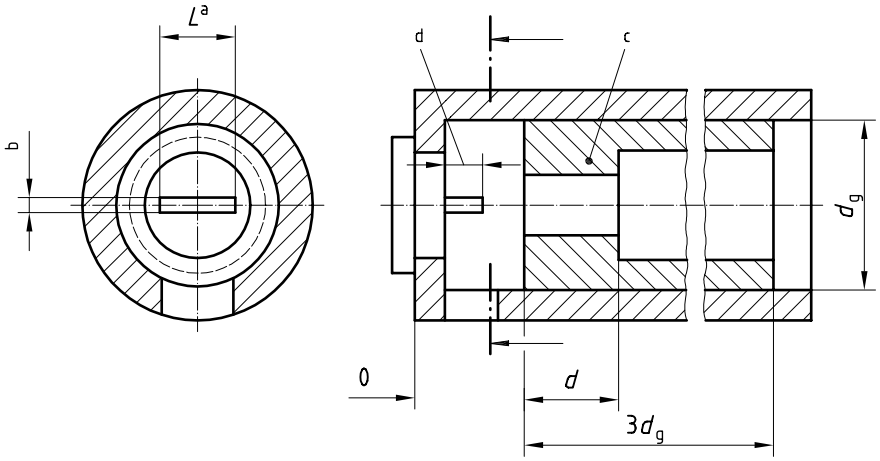


a Maximum material size – t.

b The GO gauge is a plain hole of maximum material size.

c Minimum socket depth.

Figure C.5 — gauge for verifying position tolerance specified in Figures 28, 29, 30 and 31



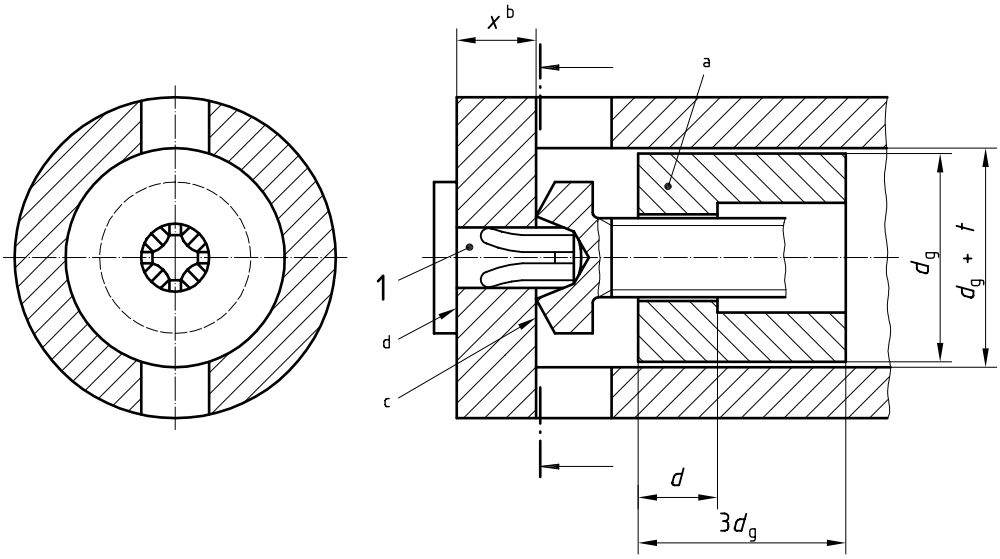
a $L > s$ (see Figures 32 and 98); $L > d_k$ (see Figures 33, 34, 96 and 97); $L > d$ (see Figure 35).

b Maximum material size – t.

c The GO gauge is a plain hole of maximum material size.

d Minimum slot depth.

Figure C.6 — Gauge for verifying position tolerance specified in Figures 32, 33, 34, 35, 96, 97 and 98



Key

1 Gauge pin in accordance with ISO 4757

NOTE This gauge does not check the size of the recess, e.g. an oversized cross recess is not recognized.

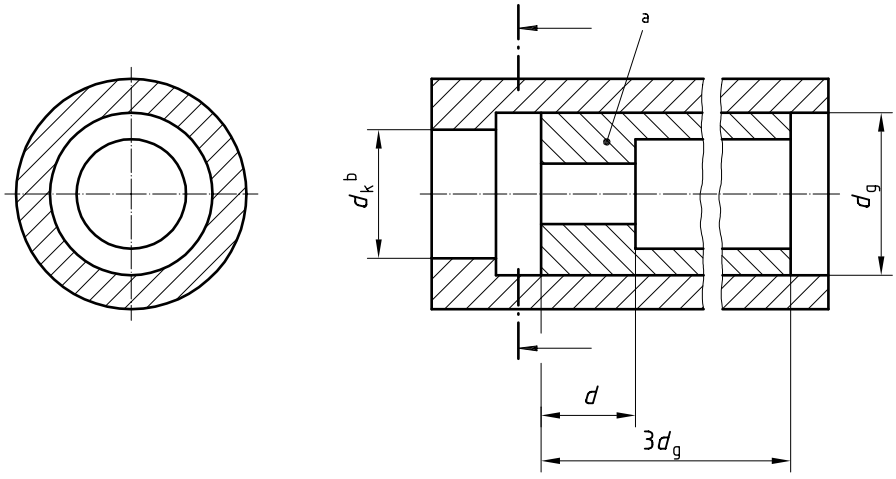
a The GO gauge is a plain hole of maximum material size.

b x is a function of length of gauge pin and the required penetration of the recess.

c First contact.

d Contact shall be achieved.

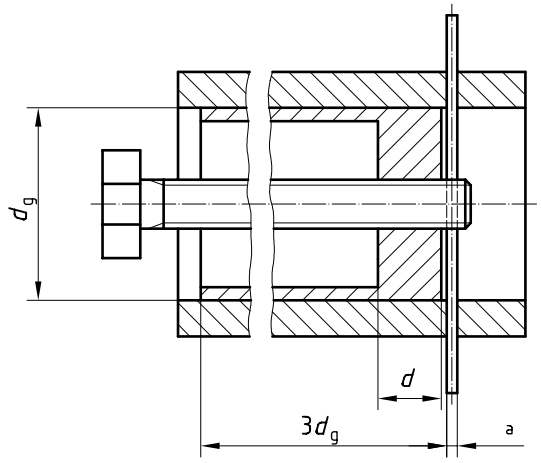
Figure C.7 — Gauge for verifying position tolerance specified in Figures 36, 37, 99 and 100



a The GO gauge is a plain hole of maximum material size.

b Maximum material size + t.

Figure C.8 — Gauge for verifying position tolerance specified in Figures 38, 39 and 101



a Maximum material size – t

Figure C.9 — Gauge for verifying position tolerance specified in Figure 40

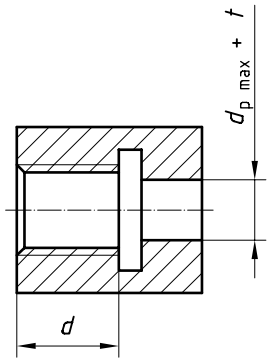
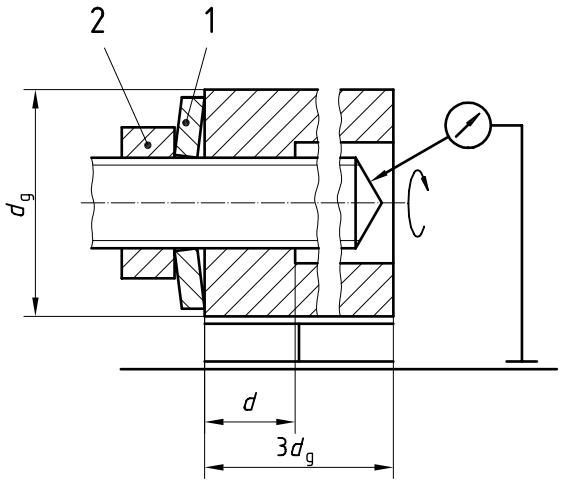


Figure C.10 — Gauge for verifying position tolerance specified in Figure 41

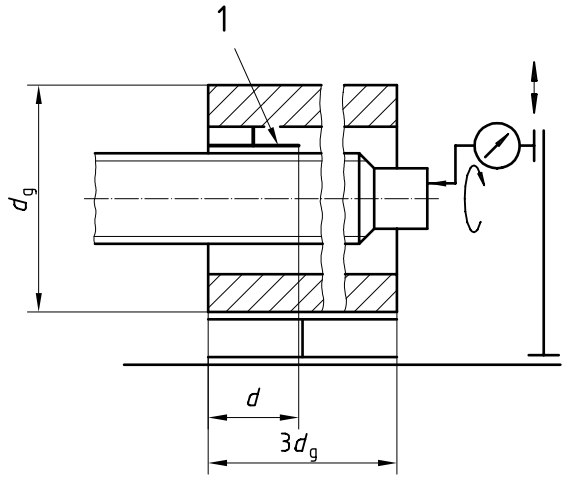


Key

1 Gauge conical spring washer

2 Gauge counter nut

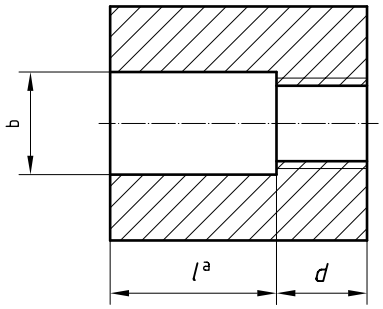
Figure C.11 — Measuring device for verifying run-out specified in Figures 42 and 43



Key

1 Three jaw chuck

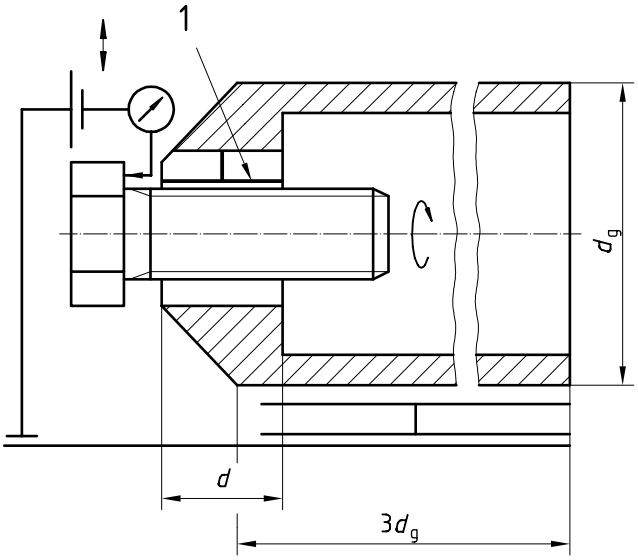
Figure C.12 — Measuring device for verifying total run-out specified in Figure 56



a l depends on the distance between the datum feature and the end of the toleranced feature.

b Maximum material size + t.

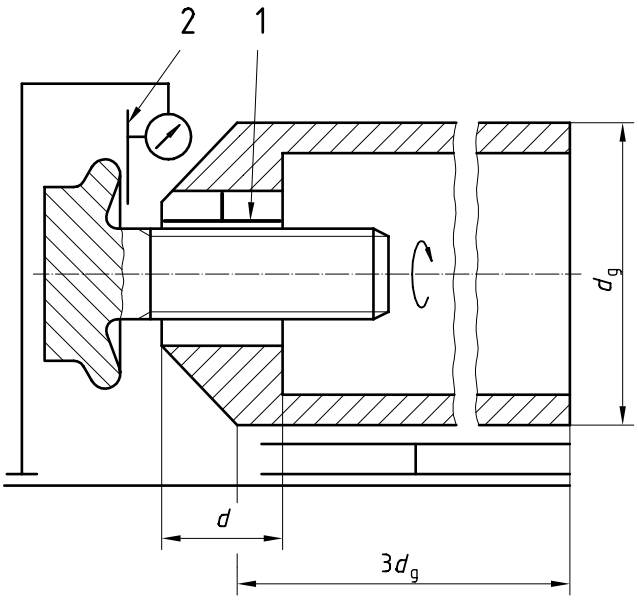
Figure C.13 — Gauge for verifying position tolerance specified in Figures 44, 45 and 46



Key

1 Three jaw chuck

Figure C.14 — measuring device for verifying perpendicularity (total run-out) specified in Figures 51, 52, 53, 55, 102 and 103

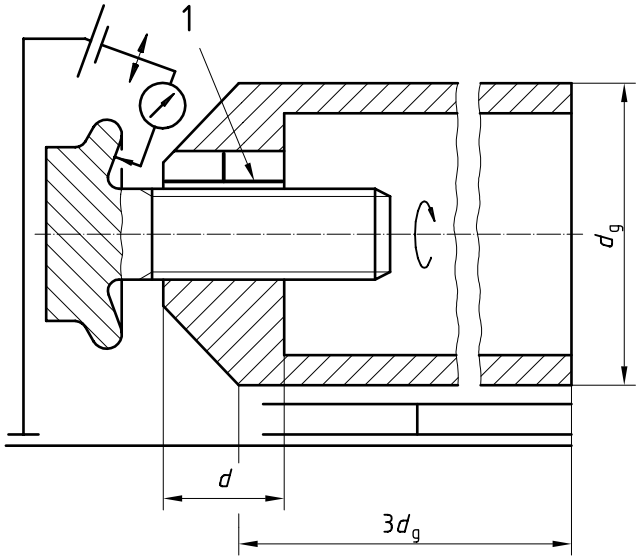


Key

1 Three jaw chuck

2 Straight edge anvil

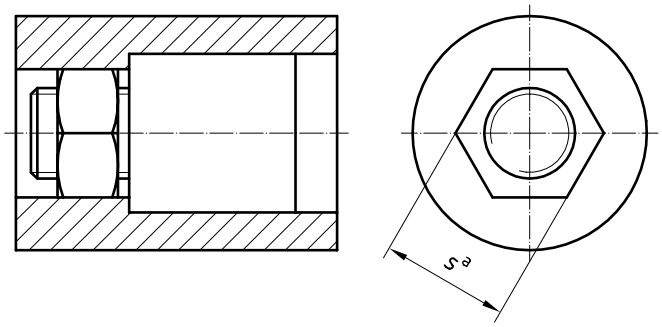
Figure C.15 — Measuring device for verifying perpendicularity (total run-out) specified in Figure 54



Key

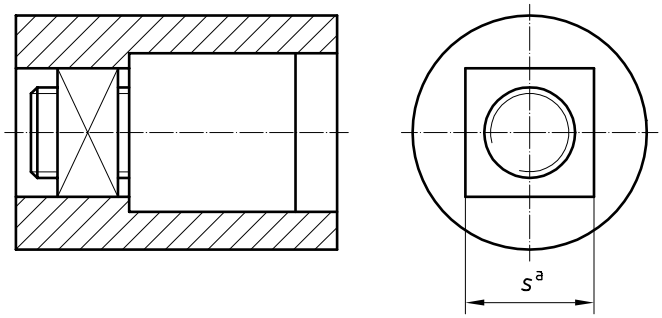
1 Three jaw chuck

Figure C.16 — Measuring device for verifying permissible deviation from the form of bearing face specified in Figure 57



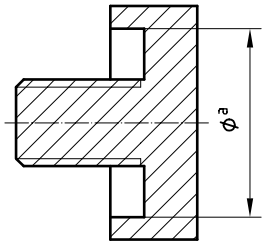
[a] Maximum material size + *t*.

Figure C.17 — Gauge for verifying position tolerance specified in Figures 73 and 74



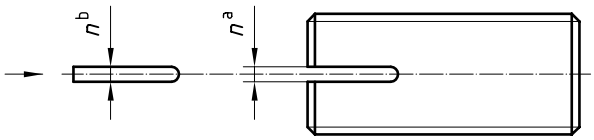
[a] Max. mat. size + *t*.

Figure C.18 — Gauge for verifying position tolerance specified in Figure 75



a Max. mat. size + *t*.

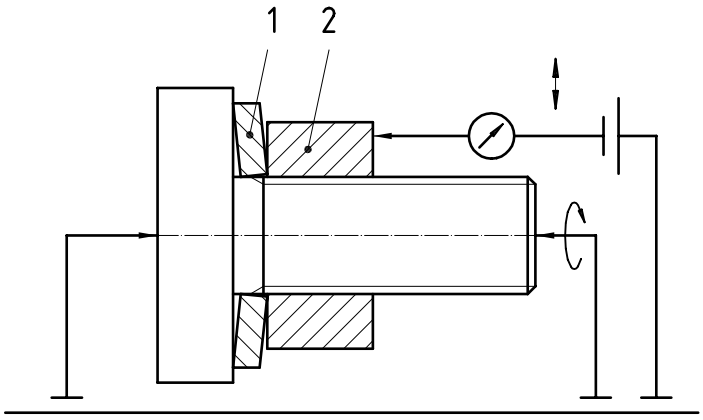
Figure C.19 — Gauge for verifying position tolerance specified in Figures 76 and 78



a Max. mat. size.

b Max. mat. size – *t*.

Figure C.20 — Gauge for verifying position tolerance specified in Figure 77

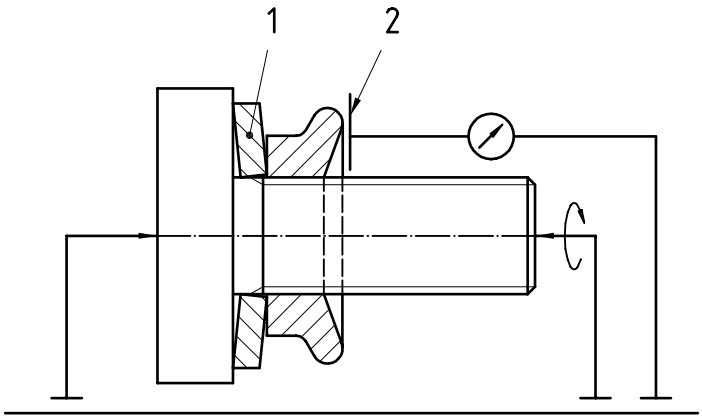


Key

1 Gauge conical spring washer

2 Fastener

Figure C.21 — measuring device for verifying perpendicularity (total run-out) specified in Figures 79, 80 and 81

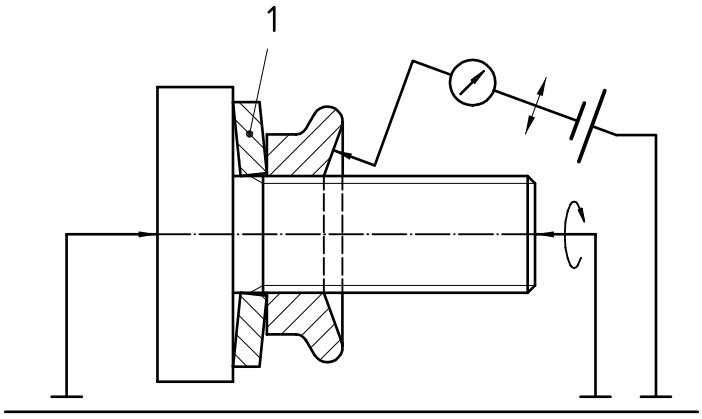


Key

1 Gauge conical spring washer

2 Straight edge anvil

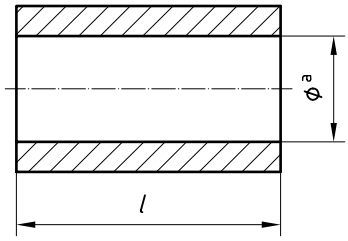
Figure C.22 — Measuring device for verifying perpendicularity (total run-out) specified in Figure 82



Key

1 Gauge conical spring washer

Figure C.23 — Measuring device for verifying permissible deviation from the form of bearing face specified in Figure 83



[a] Maximum material size + t.

Figure C.24 — Gauge for verifying straightness specified in Figures 47, 48, 49, 50 and 104

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