
Tolerances for fasteners —

Part 3:
**Washers for bolts, screws and nuts —
Product grades A, C and F**

Tolérances pour fixations —

Partie 3: Rondelles pour vis et écrous — Grades A, C et F



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 2, *Fasteners*.

This fourth edition cancels and replaces the third edition (ISO 4759-3:2000), which has been technically revised.

In comparison to ISO 4759-3:2000, the following changes have been made.

- a) the scope has been amended;
- b) the normative references have been updated;
- c) a new [Clause 3](#) "Symbols and abbreviated terms" has been added;
- d) new product grade F has been included (F for Fine tolerances);
- e) tolerances for chamfers have been included;
- f) in [Table A.1](#) tolerances for standard tolerance grades IT11 and IT14 have been included and IT16 has been deleted;
- g) in [Tables A.2](#) and [A.3](#) limit deviations for tolerance classes h13 and H12 respectively have been included;
- h) the bibliography has been updated;
- i) this part of ISO 4759 has been editorially 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: Washers for bolts, screws and nuts — Product grades A, C and F*

Tolerances for fasteners —

Part 3:

Washers for bolts, screws and nuts — Product grades A, C and F

1 Scope

This part of ISO 4759 specifies tolerances for flat washers of product grades A, C and F with nominal diameters of 1 mm to 150 mm inclusive, designed to be used in bolted joints in combination with bolts, screws, studs and nuts.

This part of ISO 4759 may be applied to non-flat washers however it does not include all the tolerances related to these washers.

It applies to non-captive and captive washers, and to standard and non-standard washers.

It does not apply to dynamic disc springs.

Washers of product grades F and A are intended to be used with bolts, screws, studs and nuts of product grades A and B; washers of product grade C are intended to be used with bolts, screws, studs and nuts of product grade C.

NOTE The product grade refers to a specific tolerance range related to dimensional and geometrical characteristics (product grade F for fine tolerances, product grade A for precise tolerances, product grade C for large tolerances).

[Annex A](#) presents tolerances taken from ISO 286-1 and ISO 286-2.

2 Normative references

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

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

ISO 2692, *Geometrical product specifications (GPS) — Geometrical tolerancing — Maximum material requirement (MMR), least material requirement (LMR) and reciprocity requirement (RPR)*

3 Symbols

c_1	height of the internal chamfer, mm
c_2	height of the external chamfer, mm
d_1	clearance hole, mm
d_2	outside diameter, mm

ISO 4759-3:2016(E)

e_1	radial difference between the clearance hole (area subject to shearing) and the end of the brittle fracture on the bearing side of the washer
e_2	radial difference between the outside diameter (area subject to shearing) and the end of the brittle fracture on the bearing side of the washer
h_{eff}	effective height of the washer, mm
t	nominal thickness of the washer, mm
t_{eff}	effective thickness of the washer, mm
t_1	part of the clearance hole within the tolerance specified for d_1
t_2	part of the outside diameter within the tolerance specified for d_2
y	coaxiality, mm
z	flatness (deflection), mm

4 Tolerances

The tolerances for washers of product grades A, C and F are specified in [Table 1](#).

Unless otherwise specified, the tolerances specified in this part of ISO 4759 apply to washers prior to coating.

Deviations from the tolerances specified in this part of ISO 4759 are permitted in product standards only for 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 latter takes precedence.

The tolerances of form and position are specified and indicated according to the definitions of ISO 1101 and ISO 2692.

Table 1 — Tolerances for washers

Dimensions in millimetres

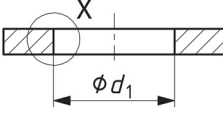
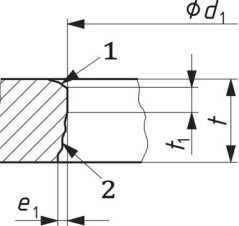
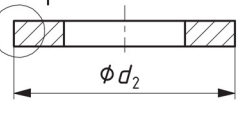
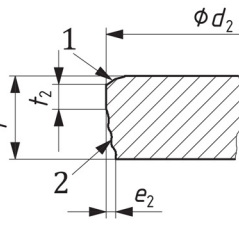
Feature	Thickness <i>t</i>	Tolerances						
		Product grade						
		F		A		C		
4.1 Clearance hole  Detail X for punched hole  Key 1 rollover 2 fracture	$t < 2$ $2 \leq t < 4$ $t \geq 4$	d_1 tol. H12 H12 H13	t_1 min. $0,5 t$ $0,3 t$ $0,2 t$	e_1 max. $0,10 t$ $0,15 t$ $0,20 t$	d_1 tol. H13 H13 H14	t_1 min. $0,3 t$ $0,25 t$ $0,2 t$	e_1 max. $0,15 t$ $0,20 t$ $0,25 t$	d_1 tol. H14 H14 H15
	Rollover is undefined but allowed.						Fracture (e_1), t_1 , and rollover are undefined but allowed.	
	t_1 is the part of the hole within the tolerance specified for d_1 .							
Feature	Thickness <i>t</i>	Tolerances						
		Product grade						
		F		A		C		
4.2 Outside diameter  Detail Y for outside diameter  Key 1 rollover 2 fracture	$t < 2$ $2 \leq t < 4$ $t \geq 4$	d_2 tol. h13 h13 h14	e_2 max. $0,13 t$ $0,15 t$ $0,18 t$	d_2 tol. h14 h14 h15	e_2 max. $0,18 t$ $0,20 t$ $0,25 t$	d_2 tol. h16 h16 h16		
	Rollover and t_2 are undefined but allowed.						Fracture (e_2), t_2 and rollover are undefined but allowed.	
	t_2 is the part of the outside diameter within the tolerance specified for d_2 .							

Table 1 — (continued)

Dimensions in millimetres

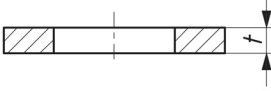
Feature	Thickness <i>t</i>	Tolerances		
		Product grade		
		F	A	C
4.3 Thickness  Tolerance on thickness shall be measured after removal of burrs.	$t \leq 0,5$	±0,04	±0,05	±0,10
	$0,5 < t \leq 1$	±0,06	±0,10	±0,20
	$1 < t \leq 2,5$	±0,12	±0,20	±0,30
	$2,5 < t \leq 4$	±0,16	±0,30	±0,60
	$4 < t \leq 6$	±0,20	±0,60	±1,00
	$6 < t \leq 10$	±0,24	±1,00	±1,20
	$10 < t \leq 20$	±0,28	±1,20	±1,60

Table 1 — (continued)

Dimensions in millimetres

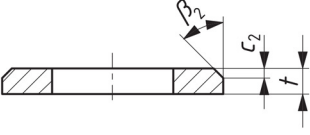
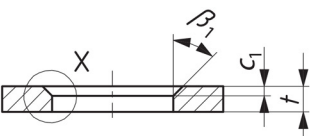
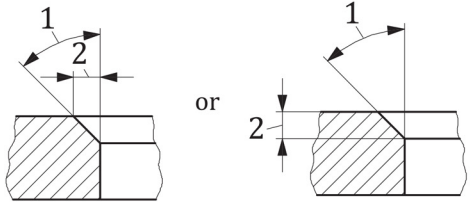
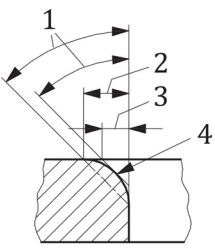
Feature	Thickness <i>t</i>	Tolerances					
		Product grade					
		F		A		C	
4.4 Chamfers	nom.	<i>c</i> ₁ min.	<i>c</i> ₂ min.	<i>c</i> ₁ min.	<i>c</i> ₂ min.	<i>c</i> ₁ min.	<i>c</i> ₂ min.
	$1 \leq t < 2$	0,20 <i>t</i>	0,25 <i>t</i>	0,20 <i>t</i>	0,25 <i>t</i>	0,20 <i>t</i>	0,25 <i>t</i>
	$2 \leq t < 4$	0,18 <i>t</i>	0,22 <i>t</i>	0,18 <i>t</i>	0,22 <i>t</i>	0,18 <i>t</i>	0,22 <i>t</i>
	$t \geq 4$	0,15 <i>t</i>	0,20 <i>t</i>	0,15 <i>t</i>	0,20 <i>t</i>	0,15 <i>t</i>	0,20 <i>t</i>
<p>4.4.1 Outer chamfer</p>  <p>4.4.2 Inner chamfer</p> <p>Dimension <i>t</i>₁ in accordance with 4.1 shall be achieved irrespective to the height of the inner chamfer.</p>  <p>The chamfer dimensioning shall be considered as follows:</p>  <p>Key - dimensioning</p> <p>1 angle 2 dimension ± tolerance</p>  <p>Key - shape</p> <p>1 angle 2 dimension + tolerance 3 dimension - tolerance 4 undefined shape</p>							
							$\beta_1 = 35^\circ \text{ to } 45^\circ$ $\beta_2 = 35^\circ \text{ to } 45^\circ$

Table 1 — (continued)

Dimensions in millimetres

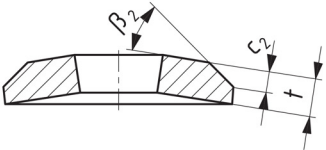
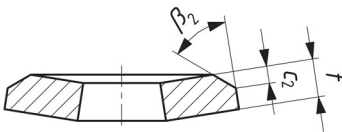
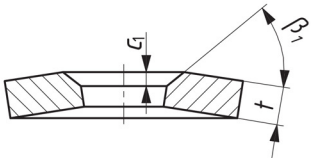
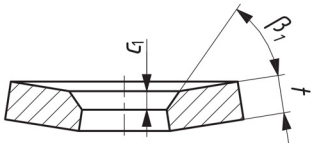
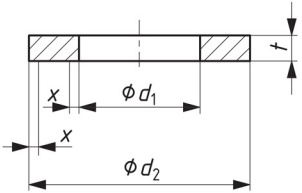
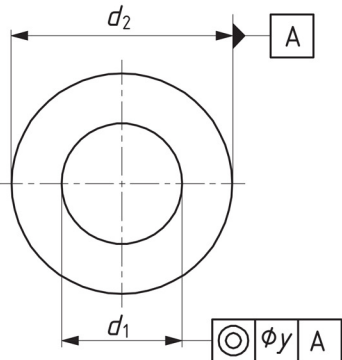
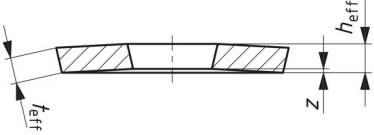
Feature	Thickness <i>t</i>	Tolerances		
		Product grade		
		F	A	C
<p>4.4.3 Supplementary optional requirements for captive washers</p> <p>When required by the purchaser, the position of the chamfer(s) relative to the deflection resulting from punching process shall be specified at the time of the order.</p>				
				
<p>a) Outer chamfer opposite to concave side</p>		<p>b) Outer chamfer opposite to convex side</p>		
				
<p>c) Inner chamfer opposite to concave side</p>		<p>d) Inner chamfer opposite to convex side</p>		

Table 1 — (continued)

Dimensions in millimetres

Feature	Thickness <i>t</i>	Tolerances		
		Product grade		
		F	A	C
4.5 Tolerances of form and position 4.5.1 Thickness variation Δt on the same part  <p>Requirements for Δt apply at a distance of $x = 0,1 (d_2 - d_1)$ from the edge of the hole and outer edge, i.e. only the 60 % of the ring width.</p>	$t \leq 0,5$ $0,5 < t \leq 1$ $1 < t \leq 2,5$ $2,5 < t \leq 4$ $4 < t \leq 6$ $6 < t \leq 10$ $10 < t \leq 20$	Δt max. 0,020 0,030 0,060 0,080 0,100 0,120 0,140	Δt max. 0,025 0,050 0,100 0,150 0,200 0,300 0,400	 No requirements
4.5.2 Coaxiality 	$t < 2$ $2 \leq t < 4$ $t \geq 4$	y max. 2IT11 2IT12 2IT13	y max. 2IT12 2IT13 2IT14	y max. 2IT13 2IT14 2IT15
4.5.3 Flatness (deflection)  <p>Flatness (deflection), z, is the difference between the effective height, h_{eff}, of the washer and the effective thickness, t_{eff}, of the material.</p> <p>NOTE 1 Tolerance z is always independent of the tolerance on the thickness.</p> <p>NOTE 2 Additional processes (e.g. grinding or calibrating) may be required to minimize deflection.</p> <p>Tolerance on flatness shall be measured after removal of burrs.</p>	$t \leq 0,5$ $0,5 < t \leq 1$ $1 < t \leq 2,5$ $2,5 < t \leq 4$ $4 < t \leq 6$ $6 < t \leq 10$ $10 < t \leq 20$	z max. 0,07 0,10 0,20 0,30 0,40 0,60 1,00	z max. 0,10 0,15 0,20 0,30 0,40 0,60 1,00	z max. 0,13 0,20 0,25 0,30 0,40 0,60 1,00

Tolerance y is based on dimension d_2 (see [Table A.1](#)).

Annex A (informative)

Tolerances

Standard tolerance grades for IT values are given in [Table A.1](#) and the limit deviations for shafts and holes in [Tables A.2](#) and [A.3](#), respectively. These tolerances are taken from ISO 286-1 and ISO 286-2.

Table A.1 — IT values of standard tolerance grades

Dimensions in millimetres

Nominal dimensions		Standard tolerance grades				
		IT11	IT12	IT13	IT14	IT15
over	to	Tolerances				
	3	0,06	0,10	0,14	0,25	0,40
3	6	0,08	0,12	0,18	0,30	0,48
6	10	0,09	0,15	0,22	0,36	0,58
10	18	0,11	0,18	0,27	0,43	0,70
18	30	0,13	0,21	0,33	0,52	0,84
30	50	0,16	0,25	0,39	0,62	1,00
50	80	0,19	0,30	0,46	0,74	1,20
80	120	0,22	0,35	0,54	0,87	1,40
120	180	0,25	0,40	0,63	1,00	1,60
180	250	0,29	0,46	0,72	1,15	1,85

Table A.2 — Limit deviations for shafts

Dimensions in millimetres

Nominal dimensions		Limit deviations			
over	to	h13	h14	h15	h16
	3	0 -0,14	0 -0,25	0 -0,40	0 -0,60
3	6	0 -0,18	0 -0,30	0 -0,48	0 -0,75
6	10	0 -0,22	0 -0,36	0 -0,58	0 -0,90
10	18	0 -0,27	0 -0,43	0 -0,70	0 -1,10
18	30	0 -0,33	0 -0,52	0 -0,84	0 -1,30
30	50	0 -0,39	0 -0,62	0 -1,00	0 -1,60
50	80	0 -0,46	0 -0,74	0 -1,20	0 -1,90
80	120	0 -0,54	0 -0,87	0 -1,40	0 -2,20
120	180	0 -0,63	0 -1,00	0 -1,60	0 -2,50
180	250	0 -0,72	0 -1,15	0 -1,85	0 -2,90

Table A.3 — Limit deviations for holes

Dimensions in millimetres

Nominal dimensions		Limit deviations			
over	to	H12	H13	H14	H15
	3	+0,10 0	+0,14 0	+0,25 0	+0,40 0
3	6	+0,12 0	+0,18 0	+0,30 0	+0,48 0
6	10	+0,15 0	+0,22 0	+0,36 0	+0,58 0
10	18	+0,18 0	+0,27 0	+0,43 0	+0,70 0
18	30	+0,21 0	+0,33 0	+0,52 0	+0,84 0
30	50	+0,25 0	+0,39 0	+0,62 0	+1,00 0
50	80	+0,30 0	+0,46 0	+0,74 0	+1,20 0
80	120	+0,35 0	+0,54 0	+0,87 0	+1,40 0
120	180	+0,40 0	+0,63 0	+1,00 0	+1,60 0
180	250	+0,46 0	+0,72 0	+1,15 0	+1,85 0

Bibliography

- [1] ISO 286-1, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 1: Basis of tolerances, deviations and fits*
- [2] ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

