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Disc springs —

Part 2:
Technical specifications

Ressorts à disques —

Partie 2: Spécifications techniques

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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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 227, *Springs*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 19690 series can be found on the ISO website.

Disc springs —

Part 2:
Technical specifications

1 Scope

This document specifies two different grades of disc springs.

Grade A defines basic requirements of disc springs for static applications with low and moderate performance. Springs manufactured according to Grade A are not used for dynamic applications.

Grade B defines requirements on disc springs especially used for dynamic applications and high performance static applications. Disc springs according to Grade B ensure a better quality by higher demands on manufacturing processes and tolerance requirements. Grade B includes graphs showing the guaranteed fatigue life such as a function of stress.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 683-1, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering*

ISO 683-2, *Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering*

ISO 6507 (all parts), *Metallic materials — Vickers hardness test*

ISO 6508 (all parts), *Metallic materials — Rockwell hardness test*

ISO 16249, *Springs — Symbols*

ISO 26909, *Springs — Vocabulary*

EN 1654, *Copper and copper alloys — Strip for springs and connectors*

EN 10083-1, *Quenched and tempered steels — Technical delivery conditions for special steels*

EN 10083-2, *Quenched and tempered steels — Technical delivery conditions for unalloyed quality steels*

EN 10083-3, *Quenched and tempered steels — Technical delivery conditions for boron steels*

EN 10089, *Hot-rolled steels for quenched and tempered springs — Technical delivery conditions*

EN 10132-4, *Cold-rolled narrow steel strip for heat treatment — Technical delivery conditions — Part 4: Spring steels and other applications*

EN 10151, *Stainless steel strip for springs — Technical delivery conditions*

JIS G 3311, *Cold-rolled special steel strip*

JIS G 4801, *Spring steels*

JIS G 4802, *Cold-rolled steel strip for springs*

ASTM A240, *Standard specification for chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels and for general applications*

ASTM A332, *Specification for nickel-chromium-molybdenum steel bars for springs*

ASTM A506, *Standard specification for alloy and structural alloy steel, sheet and strip, hot-rolled and cold-rolled*

ASTM A568, *Standard specification for steel, sheet, carbon, structural, and high-strength, low-alloy, hot-rolled and cold-rolled, General requirements for*

ASTM A666, *Standard specification for annealed or cold-worked austenitic stainless steel sheet, strip, plate, and flat bar*

ASTM A682, *Standard specification for steel, strip, high carbon, cold rolled, General requirements for*

ASTM A684, *Standard specification for steel, strip, high carbon, cold rolled*

ASTM A689, *Standard specification for carbon and alloy steel bars for springs*

ASTM A693, *Standard specification for precipitation-hardening stainless and heat-resistant steel plate, sheet, and strip*

ASTM B103, *Standard specification for phosphor bronze pate, sheet, strip, and rolled bar*

ASTM B194, *Standard specification for copper-beryllium alloy plate, sheet, strip, and rolled bar*

ASTM B196, *Standard specification for copper-beryllium alloy rod and bar*

GB/T 1222, *Spring steels*

BS 970-2, *Specification for wrought steels for mechanical and allied engineering purposes: Requirements for steels for the manufacture of hot-formed springs*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 26909 apply.

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

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

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

4 Symbols and units

For the purposes of this document, the symbols and units given in ISO 16249, Table 1 and Figure 1 apply.

Table 1 — Symbols and units for design calculation

Symbol	Unit	Parameter
b_r	mm	width of scar (see Figure 2)
D	mm	external diameter of spring
D_0	mm	diameter of centre of rotation
d	mm	internal diameter of spring

NOTE 1 N/mm^2 = 1 MPa.

[a] *r* is not chamfered unless otherwise agreed between customer and supplier.

Table 1 *(continued)*

Symbol	Unit	Parameter
E	N/mm^2	modulus of elasticity of material (carbon steel and carbon alloy steel: 206 000 N/mm^2)
F	N	spring load
F_c	N	design spring load when spring is in the flattened position
F_G	N	spring load at the time of combining springs
F_t	N	spring test load at H_t
H_t	mm	height of spring when measuring spring test load, $H_t = H_0 - 0{,}75h_0$
H_0	mm	free height of spring
h_s	mm	clean cut (see Figure 2)
h_0	mm	initial cone height of spring without flat bearings, $h_0 = H_0 - t$
$h_{0,f}$	mm	initial cone height of spring with flat bearings, $h_{0,f} = H_0 - t_f$
i	—	number of springs combined in series
L_0	mm	free height at the time of combining springs
N	—	number of cycles for fatigue life
n	—	number of springs piled in parallel
OM	—	point at upper surface of the spring perpendicular to the centre line at point P
P	—	theoretical centre of rotation of disc cross section
R	N/mm	spring rate
r [a]	mm	radius at edge
s	mm	deflection of spring
s_G	mm	deflection of stack
s_1	mm	deflection of spring preloaded
t	mm	thickness of spring
t_f	mm	reduced thickness of single disc spring with flat bearings
V	mm	length of lever arms
V_f	mm	length of lever arms with flat bearings
ΔF	N	spring load loss
Δh_0	mm	initial cone height loss of spring
ν	—	Poisson's ratio of material
σ_H	N/mm^2	alternative stress, $\sigma_H = \sigma_{max} - \sigma_{min}$
σ_{OM}	N/mm^2	stress at position OM
σ_{max}	N/mm^2	maximum fatigue stress
σ_{min}	N/mm^2	minimum fatigue stress
σ_I	N/mm^2	stress at position I
σ_{II}	N/mm^2	stress at position II
σ_{III}	N/mm^2	stress at position III
σ_{IV}	N/mm^2	stress at position IV

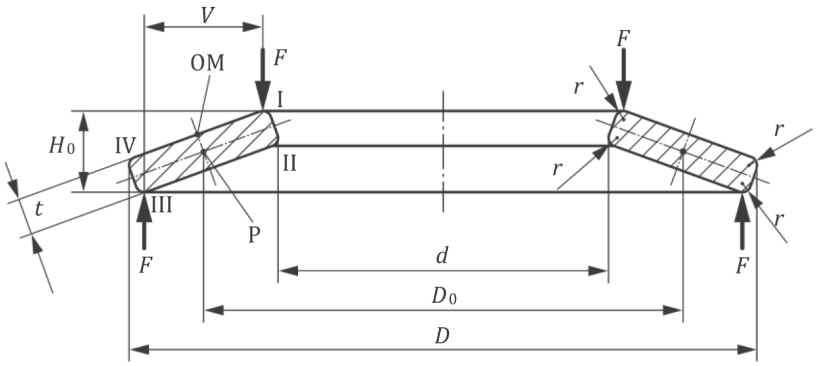
NOTE 1 N/mm^2 = 1 MPa.

[a] r is not chamfered unless otherwise agreed between customer and supplier.

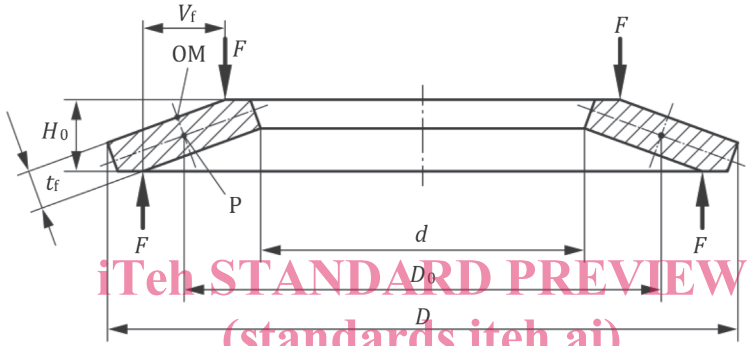
5 Dimensions and designation

5.1 General

Figure 1 illustrates a single disc spring, including the relevant positions of loading.



a) Without flat bearings — Group 1 and Group 2



b) With flat bearings — Group 3

Key

D external diameter of spring
D_0 diameter of centre of rotation
d internal diameter of spring
F spring load
H_0 free height of spring
OM point at upper surface of the spring perpendicular to the centre line at point P
P theoretical centre of rotation of disc cross section
r[a] radius at edge
t thickness of spring
t_f reduced thickness of single disc spring with flat bearings
V length of lever arms
V_f length of lever arms with flat bearings
I position I
II position II
III position III
IV position IV
[a] r is not chamfered unless otherwise agreed between customer and supplier.

Figure 1 — Single disc spring (sectional view), including the relevant positions of loading

5.2 Disc spring groups

Table 2 shows the disc spring groups.

Table 2 — Disc spring groups

Group	t mm	With flat bearings and reduced thickness
1	$0,2 \leq t < 1,25$	No
2	$1,25 \leq t \leq 6,0$	No
3	$6,0 < t \leq 14,0$	Yes

5.3 Dimensional series

Table 3 shows the dimensional series.

Table 3 — Dimensional series

Dimensional series	h_0/t	t_f/t	D/t
A	≈ 0,40	≈ 0,94	≈ 18
B	≈ 0,75	≈ 0,94	≈ 28
C	≈ 1,30	≈ 0,96	≈ 40

NOTE Refer to Annex A for typical disc spring dimensions.

6 Grade A — Basic performance requirements for static applications

6.1 Material

Unless otherwise agreed between customer and supplier, disc springs should be made from material conforming to Table 4.

6.2 Manufacturing process

Unless otherwise agreed between customer and supplier, disc springs should be made by the manufacturing process shown in Table 4.

Table 4 — Manufacturing process and material

Group	t mm	Manufacturing process	Material
1	$0{,}2 \leq t < 1{,}25$	Stamping, cold or hot forming, edge rounding	Carbon steel or alloy steel
2	$1{,}25 \leq t \leq 6{,}0$	Stamping, cold or hot forming, *D* and *d* turning[a], edge rounding	Carbon steel[b] or alloy steel
3	$6{,}0 < t \leq 14{,}0$	Cold or hot forming, turning on all sides, edge rounding or Stamping[c], cold or hot forming, *D* and *d* turning, edge rounding	Alloy steel

[a] *D* and *d* turning are optional.

[b] Carbon steel used $1{,}25 \leq t \leq 2{,}0$ only.

[c] Stamping without *D* and *d* turning is not permitted.

6.3 Permissible stresses

For disc springs made of steels according to materials shown in Table 4, which are subject to static loading, the design stress, σ_{OM}, at maximum deflection shall not exceed 1 400 N/mm^2.

NOTE The design stress, σ_{OM}, is derived from the formulae given in ISO 19690-1.

6.4 Presetting

After heat treatment, each disc spring shall be loaded until it is in the flat position. After loading the disc spring with twice its spring test load, F_t, the tolerances for the spring load as specified in Table 8 shall be met.

6.5 Surface condition and corrosion protection

The surface treatment should be agreed between customer and supplier.

The surface shall be free from defects such as scars, cracks and corrosion.

As disc springs are easy to be rusted, it is preferable to apply suitable corrosion protection to them.

Whether and which corrosion protection is to be provided shall depend on the particular spring application. Suitable corrosion protections include phosphating, black finishing and the application of protective metallic coatings such as zinc or nickel. This shall be agreed between customer and supplier.

It is possible that the galvanizing processes using aqueous solutions that are currently available do not preclude the risk of hydrogen embrittlement. Disc springs with a hardness exceeding 40 HRC are more prone to the risk of hydrogen embrittlement than softer springs. Special care shall therefore be taken when selecting the material, manufacturing process, heat treatment and surface treatment. When ordering disc springs with galvanic surface protection, it is advisable to consult the spring manufacturer.

For disc springs, galvanic surface protection should be avoided.

Phosphating and oiling form the standard corrosion protection for disc springs.

6.6 Tolerances

6.6.1 Thickness

The tolerances on thickness are shown in Table 5.

For information on testing of thickness, see Annex B.

Table 5 — Tolerances on thickness

Dimensions in mm

Group	*t*	Tolerance
1	$0{,}2 \le t \le 0{,}6$	+0,03 −0,06
	$0{,}6 < t < 1{,}25$	+0,06 −0,09
2	$1{,}25 \le t \le 3{,}8$	+0,09 −0,12
	$3{,}8 < t \le 6{,}0$	+0,10 −0,15
3	$6{,}0 < t \le 14{,}0$	±0,15

6.6.2 External- internal diameter and coaxiality

The tolerances on external diameter and internal diameter are shown in Table 6. The tolerances are determined by the tolerance grade IT13, which is specified in ISO 286-2.

Coaxiality tolerance: 2 × IT13

For information on testing of external diameter and internal diameter, see Annex B.

Table 6 — Tolerances on external diameter and internal diameter

Dimensions in mm

D or *d*		Tolerance, *D*	Tolerance, *d*
over 3	up to 6	0 −0,18	+0,18 0
over 6	up to 10	0 −0,22	+0,22 0
over 10	up to 18	0 −0,27	+0,27 0
over 18	up to 30	0 −0,33	+0,33 0
over 30	up to 50	0 −0,39	+0,39 0
over 50	up to 80	0 −0,46	+0,46 0
over 80	up to 120	0 −0,54	+0,54 0
over 120	up to 180	0 −0,63	+0,63 0
over 180	up to 250	0 −0,72	+0,72 0

6.6.3 Free height

The tolerances on free height are shown in Table 7.

For information on testing of free height, see Annex B.

Table 7 — Tolerances on free height

Dimensions in mm

Group	t	Tolerance
1	$0{,}2 \le t < 1{,}25$	$^{+0{,}10}_{-0{,}05}$
2	$1{,}25 \le t < 2{,}1$	$^{+0{,}15}_{-0{,}08}$
	$2{,}1 \le t < 3{,}5$	$^{+0{,}20}_{-0{,}10}$
	$3{,}5 \le t \le 6{,}0$	$^{+0{,}30}_{-0{,}15}$
3	$6{,}0 < t \le 14{,}0$	±0,30

6.6.4 Spring load

The spring load, F_t, shall be determined at test height $H_t = H_0 - 0{,}75h_0$. The tolerances on spring loads are shown in Table 8. The measurement is taken while loading between flat plates, using a suitable lubricant. The flat plates shall be hardened, ground and polished. In the case of stacking the springs, the tolerance on spring load should be agreed between customer and supplier.

To comply with the specified load tolerances, it can be necessary to exceed the tolerance values specified for H_0 and t.

Table 8 — Tolerances on spring load

Group	t mm	Tolerance F_t ($H_t = H_0 - 0{,}75h_0$) N
1	$0{,}2 \le t < 1{,}25$	+30 % −10 %
2	$1{,}25 \le t \le 3{,}0$	+20 % −10 %
	$3{,}0 < t \le 6{,}0$	+15 % −7,5 %
3	$6{,}0 < t \le 14{,}0$	±10 %

6.7 Clearance between disc spring and guiding element

A guiding element is necessary to keep the disc spring in position. This should preferably be a mandrel. In the case of external positioning, a sleeve is preferred.

Table 9 shows clearance of guide.

