Disc Spring Data Sheet

Conical disc springs to DIN EN 16983 (formerly DIN 2093)

What is a disc spring?

Disc springs (Belleville springs) are conically formed annular discs loaded in the axial direction. They give high loads in small spaces, are used to absorb energy or apply a load, and work statically or dynamically. They can be used singly but are most often stacked in series, in parallel, or both. When they are used dynamically, fatigue must always be considered.

Standards

- **DIN EN 16983**: quality requirements and dimensions (replaces DIN 2093, with no substantive technical change).
- **DIN EN 16984**: calculation (replaces DIN 2092).
- **DIN 6796**: Belleville load washers for static bolted connections (a different product, with wider tolerances).

Groups (by single-disc thickness t)

Group	Thickness t	Manufacture
1	less than 1.25 mm	Stamped, cold formed, corners rounded
2	1.25 mm to 6 mm	Stamped, cold formed, D_e and D_i turned, corners radiused
3	over 6 mm up to 14 mm	Cold or hot formed, machined all over, corners radiused, contact flats and reduced thickness t′. Our speciality; thicker non-standard discs made to order

Series (load curve shape)

Series	D_e/t	h_0/t	Characteristic
A	≈ 18	≈ 0.4	Stiff, nearly linear
B	≈ 28	≈ 0.75	Intermediate
C	≈ 40	≈ 1.3	Soft, strongly curved

In all three series $D_e/D_i \approx 2$. Group 3 discs have contact flats that shorten the moment arm, so thickness is reduced to t′ to keep the free height and loads interchangeable.

Materials

Material	Use
C75S / SAE 1075 (1.1248)	Cold-rolled strip to DIN EN 10132-4 for Group 1 disc springs
51CrV4 / SAE 6150 (1.8159)	Our standard for Groups 2 and 3; up to 150 °C without significant relaxation (DIN EN 16983)
X10CrNi18-8 (1.4310), 17-7 PH (1.4568), 1.4401	Corrosion-resistant stainless spring steels (1.4310 and 1.4568 become partly magnetic when cold formed)
1.4923, 1.4122, INCONEL X-750 / 718	High-temperature service
CuBe2 (2.1247), CuSn8 (2.1030)	Non-magnetic, corrosion resistant; CuBe2 suits very low temperatures

Published data use E = 206 000 N/mm² and μ = 0.3 (spring steel). Other materials give different forces, so we recalculate every design in the actual material.

Hardness, tolerances and inspection

- Spring steel disc springs are through hardened to 42–52 HRC (about 412–544 HV), as DIN EN 16983 requires; tempering is controlled and certified.
- Every disc is preset (set removal) after heat treatment to prevent loss of height and force in service.
- Sampling inspection to ISO 2859-1 / ANSI/ASQ Z1.4 at AQL 1.0.

Diameter (mm)	< 6	6–10	10–18	18–30	30–50	50–80
D_i (H12)	+0.12	+0.15	+0.18	+0.21	+0.25	+0.30
D_e (h12)	–0.12	–0.15	–0.18	–0.21	–0.25	–0.30

80–120 mm: D_i +0.35, D_e –0.35; over 120 mm: H12 / h12 (e.g. D_i +0.40, D_e –0.40 at 120–180 mm).

t (mm)	< 0.6	0.6–1.25	1.25–2	2–3	3–3.8	3.8–6	6–15	15–25	25–40
Thickness t	+0.02 –0.06	+0.03 –0.09	+0.04 –0.12	+0.04 –0.12	+0.04 –0.12	+0.05 –0.15	±0.10	±0.12	±0.15
Free height l_0	+0.10 –0.05	+0.10 –0.05	+0.15 –0.08	+0.20 –0.10	+0.30 –0.15	+0.30 –0.15	±0.30	±0.50	±1.00
Load at 0.75 h_0	+25 % –7.5 %	+25 % –7.5 %	+15 % –7.5 %	+15 % –7.5 %	+10 % –5 %	+10 % –5 %	±5 %	±5 %	±5 %

Tolerances per DIN EN 16983, as applied in our design workbook (RP-form-9.1.1).

Surface treatment

- **Shot peening** puts the surface in compression and slows fatigue cracks; DIN EN 16983 fatigue diagrams assume shot-peened springs.
- **Black oxide**, lightly oiled, is our corrosion protection, which in our experience is superior to zinc phosphating.
- **Electroplating is discouraged**, because hydrogen embrittlement can cause failure.

Stacking

Arrangement	Load F	Deflection S	Free height L_0
i discs in series	F_{single}	i · s	i · l_0
n discs in parallel	n · F_{single}	s	l_0 + (n – 1) · t
i packets of n	n · F_{single}	i · s	i · [l_0 + (n – 1) · t]

Friction in parallel stacks raises the loading force and lowers the unloading force; our stack designs allow for it. Combining configurations gives progressive or degressive load curves.

Load-deflection characteristic

Load and stresses are calculated with the Almen–László method of DIN EN 16984. The curve shape depends on h_0/t: Series A is stiff and nearly linear, Series C is soft and strongly curved. Disc springs should normally work below 0.75 h_0; the force at 0.75 h_0 is the design load.

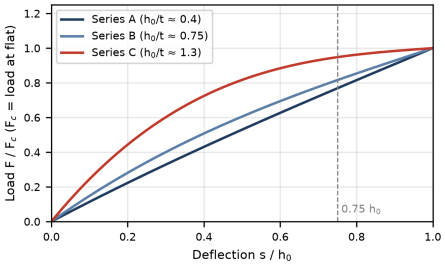


Fig. 1 – Normalised load F/F_c against deflection s/h_0 for a single disc of each series (DIN EN 16984, no friction).

Stresses and fatigue life

- Stresses are checked at four points, σ_I to σ_{IV}. Compressive σ_I (top inner edge) governs static loads and setting; tensile σ_{II} and σ_{III} (underside) govern fatigue, because cracks start there. Our product lists give σ_I to σ_{III} at 25%, 75% and 100% deflection.
- **Static or dynamic:** statically loaded springs are checked on σ_I; dynamically loaded springs need a fatigue estimate.
- **Fatigue estimate:** find σ_{II} and σ_{III} at preload (σ_U) and final load (σ_O); the point with the larger range governs and is plotted on the DIN EN 16983 (modified Goodman) diagram for the group.
- **Life lines:** 10^5, 5×10^5 and 2×10^6 cycles. 2×10^6 cycles or more is regarded as fatigue resistant; below 10^5 no estimate is possible, which is not acceptable for a dynamic design. Diagrams give 99% survival probability under ideal conditions.
- **Minimum preload** for dynamic duty: $s_1 \approx 0.15$ to $0.20 \times h_0$.
- **Limits:** diagrams apply only to shot-peened, hardened and tempered spring steel (e.g. C75S, 51CrV4), $t \leq 14$ mm, and stacks of up to about 10 in series and 2 in parallel. Corrosion, heat, impact or poor guidance shorten life.
- Our online force and stress calculator (www.reliable-pressings.co.za) gives loads, spring rates and stresses at any deflection; we verify every design for you.

Size range (DIN EN 16983 sizes on our website)

Group	Series	Sizes	D_e range (mm)	t range (mm)	Force at flat (N)
1	A	18	8 – 23	0.4 – 1.2	238 – 2 876
1	B	41	8 – 35.5	0.3 – 1.2	90 – 2 696
1	C	20	8 – 50	0.2 – 1.2	42 – 1 832
1	Outside series	16	10 – 40	0.4 – 1.2	173 – 2 174
2	A	54	23 – 125	1.6 – 6	3 652 – 71 583
2	B	54	40 – 180	1.6 – 6	2 867 – 58 981
2	C	17	56 – 200	1.6 – 6	3 185 – 44 669
2	Outside series	31	34 – 150	1.6 – 6	4 067 – 69 350
3	A	88	100 – 500	7 – 37	95 754 – 2 267 776
3	B	38	200 – 600	8 – 24	85 259 – 1 044 245
3	C	9	225 – 400	6.5 – 12	48 744 – 199 198
3	Outside series	22	125 – 600	7 – 22	72 739 – 799 077

408 sizes in total. "Force at flat" is the calculated load at full deflection (h_0) for spring steel. Popular Group 2 sizes are kept in stock; full dimensions and loads for every size can be searched and filtered on our website.

Quality documentation

On request, each order can be supplied with a load characteristic curve for the disc or stack, a material certificate, a heat treatment certificate with Rockwell C hardness, an independent witnessed load cycle test (CSIR or SGS Metlab) and ISO 9001:2015 traceability records.

How to order

Request a quote at **www.reliable-pressings.co.za** (Request a Quote). Tell us the size ($D_e \times D_i \times t$), material, quantity, whether the springs are stacked (packets, discs in parallel and number of stacks), spares, and any witnessed testing. Not sure which disc you need? Send us your loads, travel and installation space and we will recommend the disc spring and stack, supported by our in-house stack calculation sheet (form RP-form-9.1.1-r12), giving load points, stresses at 25, 50, 75 and 100% deflection and best-case fatigue life at 99% survival. Lead times: disc springs 15–25 days; washers 5–15 days.