

uFlex



Precision springs
Customer-specific designs

www.u-flex.swiss

Kundenspezifische Präzisionsfedern

Springs are traditionally known as standard parts manufactured from alloyed or unalloyed spring steel in a cold or hot forming process with a round, square, or rectangular cross section. Less well known is the machined spring cut from a single piece. Just like standard springs, these special springs can be loaded with compression, extension and torsional forces. However, the clever feature of these springs is that they enable an optimally coordinated combination of different spring values.

The significant advantage of this spring shape compared to wire-wound springs is their highly precise and constant spring rate of up to $\pm 0.1\%$ with a reproducibility of up to 1%. The springs are manufactured from solid material, e.g. from a rod or pipe, into which a helical slot is cut. This machining process better lends itself to the application than winding a spring, since unlike the forming process, only the natural tension of the material is used rather than creating an internal "artificial" stress. This lends the spring a linear spring characteristic curve with high reproducibility and fatigue strength.

Furthermore, the machine-cutting process of machined springs means that they offer a much wider range of possible configurations and benefits:

- Versatile attachment options (high tensile strength/ service life, because there are no bent spring ends)
- Integration of functions
- Wide variety of materials
- Multi-start and/or reversing coil solution prevents buckling or rotation of free spring ends



Example application: specialist compression spring

Original solution (left):

Compression spring with three components

New solution (right):

Precision spring with one component

Advantages of the new solution:

- Greater accuracy and functional reliability
- Only one component for the main function as „compression spring“
- Minimised procurement and stock-keeping requirements

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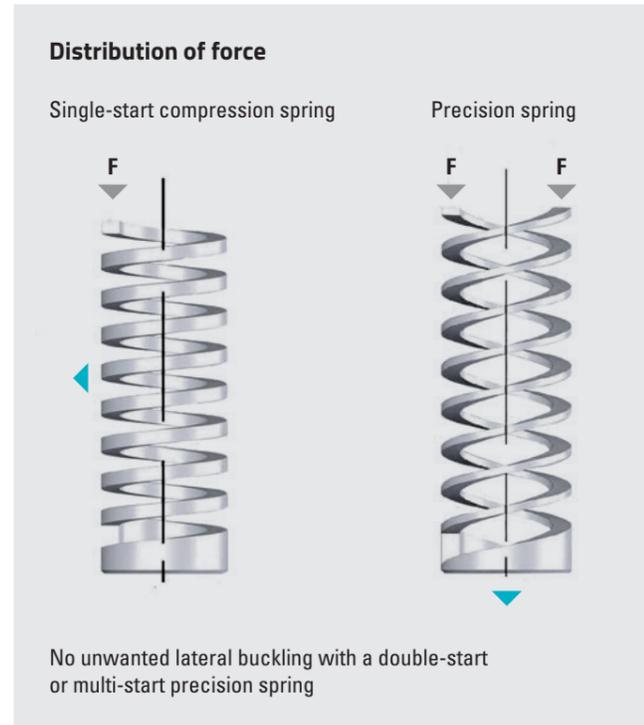
Technical principles

Conventional compression and extension springs, as well as single-start machined springs, consist of a continuous coil that starts at one side and ends at the other. Any force exerted on these springs acts via only a single point and results in overturning. The clearance between the longitudinal axis and the centreline of the spring acts as the torsion arm, causing long helical compression screws to buckle under load.

This buckling is a dangerously unstable state, since the spring no longer transmits its force and can rapidly give way.

To prevent lateral movement or bending of a single-start spring, from a certain length, the spring must be guided in a mandrel or a sleeve. However, this can generate friction, which has a negative influence on the smooth function and service life of the spring. Lubrication of the components is often required, but this is not always desirable in all applications.

In multi-start springs, the extension pressure is distributed across multiple points, which results in an even parallel distribution of force to the centreline of the spring. The greater the number of starts, the more precisely the parallelism is converted on compression or extension.

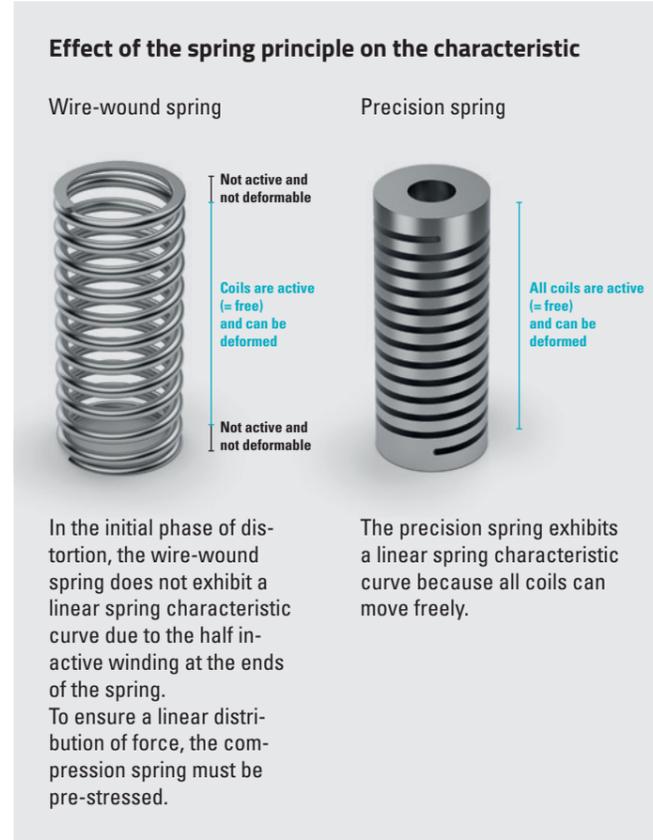


Maximum precision in all areas

The machining process used to manufacture the precision springs does not generate any residual stresses that need to be overcome in order to exert the required force. The precision machining also means that all spring coils are active. The spring is therefore deformed evenly when loaded, and resumes its original form when released. This lends the spring its linear spring characteristics.

The spring rate of a wire-wound spring is within a tolerance range of $\pm 10\%$. Precision springs, on the other hand, have a tolerance range of $\pm 5\%$ and can be manufactured for specific applications with a tolerance of $\pm 1\%$.

A high spring precision with a hundred percent linear characteristic curve is particularly desirable for very small stroke movements in high-precision control systems. Precision springs have already been implemented in one project with a spring rate of $\pm 0.1\%$.



Single-start spring

Double-start spring

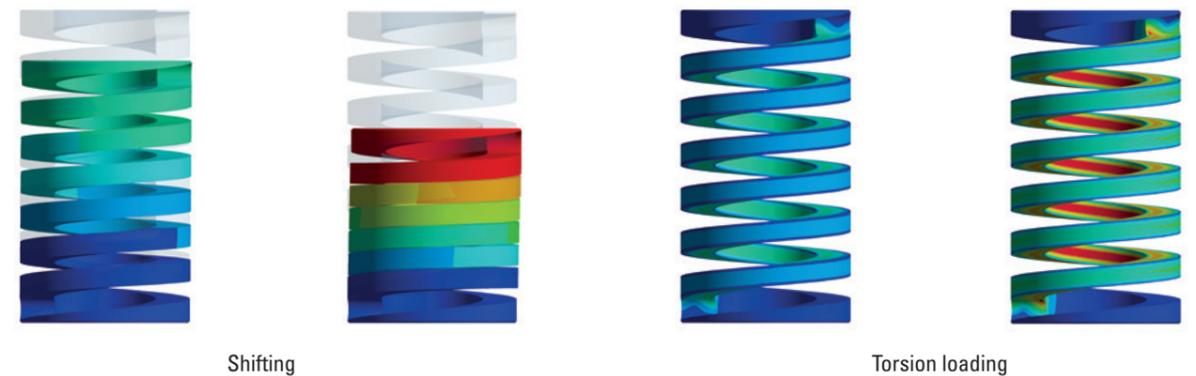


Both left-handed and right-handed helices can be machined into one spring at the same time. This prevents unwanted distortion at the end of the spring.



Use of the finite element method (FEM)

FEM analysis can be used to make precise statements about spring strength and service life in specific applications.



Wide variety of materials

The modulus of elasticity or shear is a decisive factor when selecting a material for a spring. These material properties express the relationship between extension and compression, and their values should be as high as possible.

Depending on the application, the following material properties may also be important for springs:

- High permissible stresses even at increased temperatures with no significant loss of force (low relaxation)
- High fatigue strength (fine granular structure with no impurities)
- Maximum surface slip properties
- Protection against corrosion
- Electrically conductive or anti-magnetic in specific applications

Wire-wound springs are usually manufactured from spring steel wire in accordance with EN 10270-1. Precision springs can be manufactured from a much wider variety of materials because the material is not required to have a particular level of deformability. Any machinable material can be used. For example, lightweight aluminium springs, electrically insulated springs made of plastic, or even high-strength titanium springs can be manufactured.

Guideline values for the use of precision springs

Compression and extension springs

- Compression/extension force from 2 to 4,500 N
- External diameter from 1.5 to 80 mm
- Lengths from 6 to 500 mm

Torsion springs

- Torsion moment from 5 to 225 Nm
- Torsion angle from 1 to 360°
- External diameter from 1.5 to 80 mm
- Lengths from 6 to 500 mm

Design features

The right choice of attachment

Wire-wound coil springs are normally attached with the use of wire tangs, ground ends, pins, hooks, or loops created from the spring steel itself.

The small bend radii generate excessive material loads and are a frequent cause of component failure. These attachment points at the start or end of the spring are not able to transmit the torsional moment generated within the spring under compression, extension, or torsional loads to the adjacent components. These moments cause bending under load.

The attachments used in machined springs are reduced to the required minimum and can be reinforced where required. Unstable moments are prevented, for example, by the use of double pins, cross recesses, slots, attachment flanges, etc.

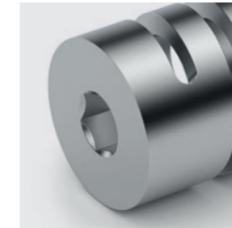
The use of these integrated attachments extends the service life of the spring and optimises the installation space. This can also often reduce production and assembly costs.



Threaded pin



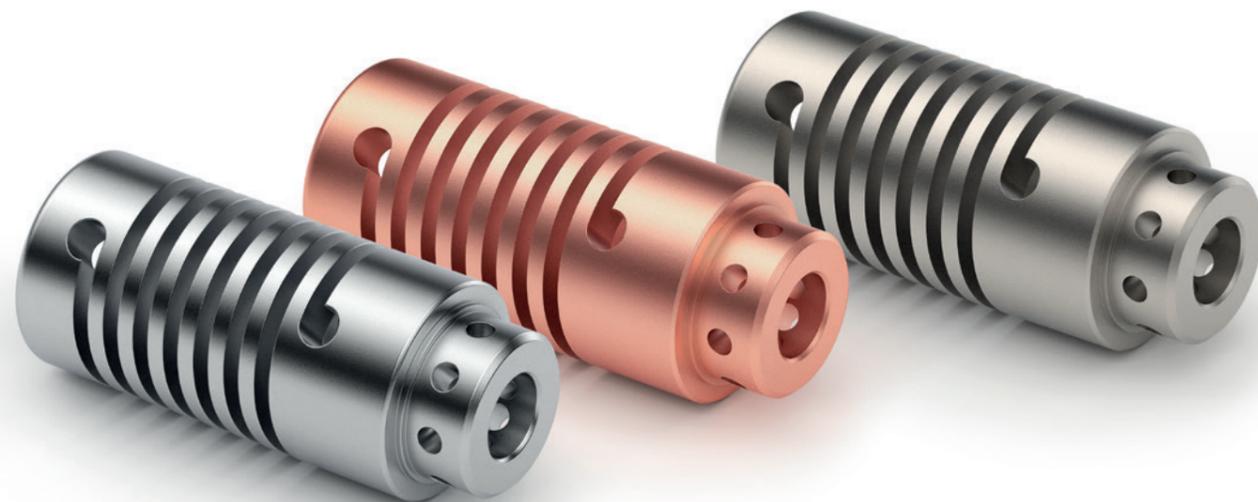
Dowel holes



Hexagon socket



Slots



Compression springs made from stainless steel (left), copper (centre) or titanium (right)



Customer-specific torsion spring, material C 300

Extended service life

The following measures are some examples of how the service life of a precision spring can be extended:

- „Stress relief” bores at the end of the coil reduce the notch stress. The larger the bore, the lower the stress, and therefore the higher the number of possible load cycles.
- A „thickening” at the end of the coil can increase the rigidity of the spring in the critical area, with a positive impact on service life.
- Nickel-plating the surface is a further option for extending the service life. This guarantees hardness, an optimised resistance to friction wear, and excellent corrosion protection.

Integrated functions – reduction of components

Together with the wide variety of options for attachments or spring connections, a range of different functions can also be integrated in the component.

The advantages:

Reduction in overall costs

- Fewer components for one function
- Shorter assembly times
- Minimised procurement requirements

Increased safety

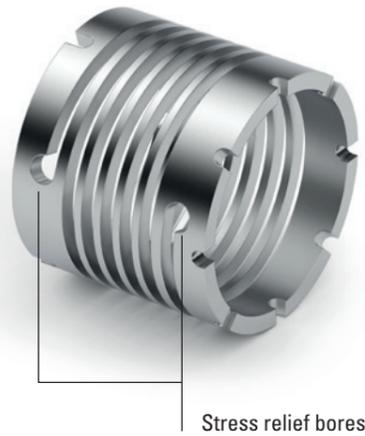
- Only one component – clear interfaces
- One contact person for multiple functions – improved system safety and quality standards

Your storage and administration costs are optimised

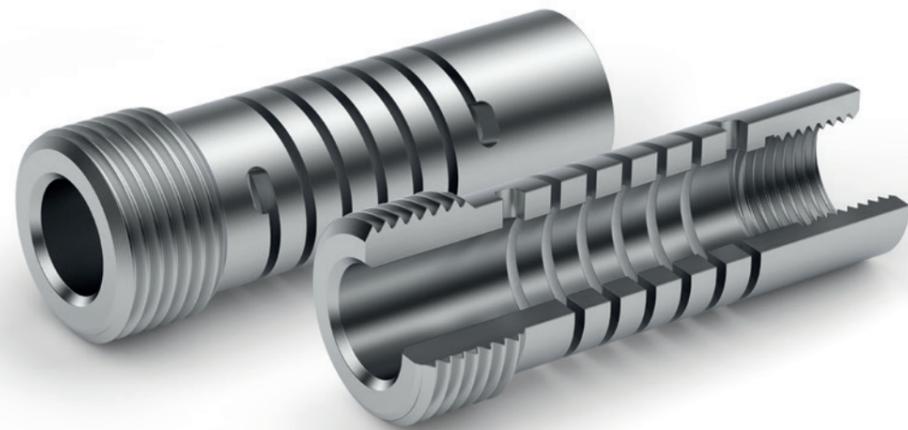
- Fewer components in the warehouse
- Minimisation of orders and suppliers

Reduced development workload

- We can compile free design proposals on request
- Use our calculation software



Stress relief bores



Industry: Printing machines
Application: Helix coupling as compression spring in clamp coupling

Facts & figures

Standard spring



- Only available in a single-start wound-wire design
- Customer-specific attachments are limited and are manufactured after the spring is formed
- Precise internal and external diameters require a subsequent grinding process
- It is not possible to combine different types of spring (compression, extension, torsion)
- The coil has a residual tension that influences performance
- Spring rates can vary considerably within a single production batch
- Limited choice of materials
- Variable parallelism and perpendicularity under load (buckling)
- Integrated functions are difficult to realise and require different components

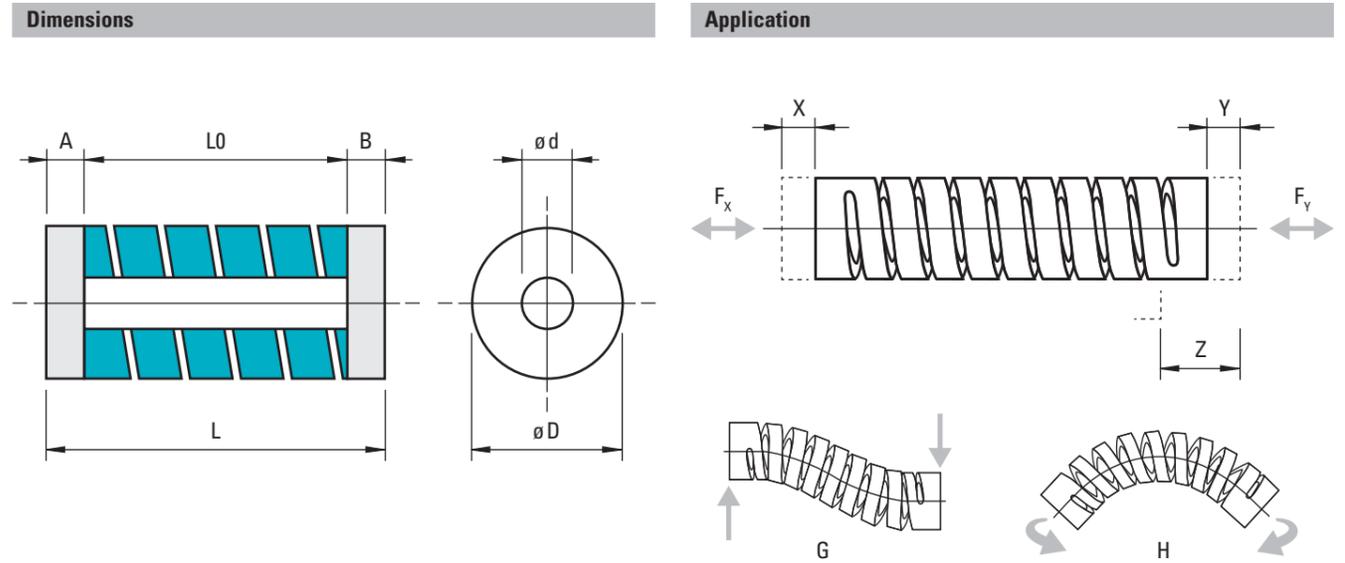
Precision spring



- Single, double, and triple-start designs
- Integrated, customer-specific attachments almost unlimited in type
- Machined single-piece manufacturing guarantees adherence to customer specifications
- The specific compression, extension, or torsion characteristic curves and all misalignment values are precisely coordinated and parameters can be combined
- Minimal residual stress in the coil
- Spring rates within one production batch are identical, reproducibility of up to 1% can be engineered
- Wide variety of possible materials: steel, aluminium, titanium, plastic, etc.
- High performance and reliability due to perfect parallelism and perpendicularity of the springs
- One manufacturer for the complete function (spring and attachments, integrated functions)

Query

Customer-specific precision compression/extension springs



Geometry/material	
External diameter (D)	mm
Internal diameter (d)	mm
Spring length (L0)	mm
Overall length (L)	mm
Custom attachment (A), optional	
Custom attachment (B), optional	
Material	
Ambient temperature	°C
Corrosive environment	<input type="checkbox"/> yes <input type="checkbox"/> no

Technical data	Side X		Side Y
	Spring travel	mm	mm
Max. spring travel (Z)			mm
Compression or extension force (F)	N	N	
Tolerance (10% = standard)	%	%	%
Application	<input type="checkbox"/> static	<input type="checkbox"/> dynamic	
	<input type="checkbox"/> High radial misalignment (G)*		
	<input type="checkbox"/> Skewed misalignment (H), three-dimensional*		
Frequency			Hz
Service life/No. of load cycles (one load cycle = load/release)			

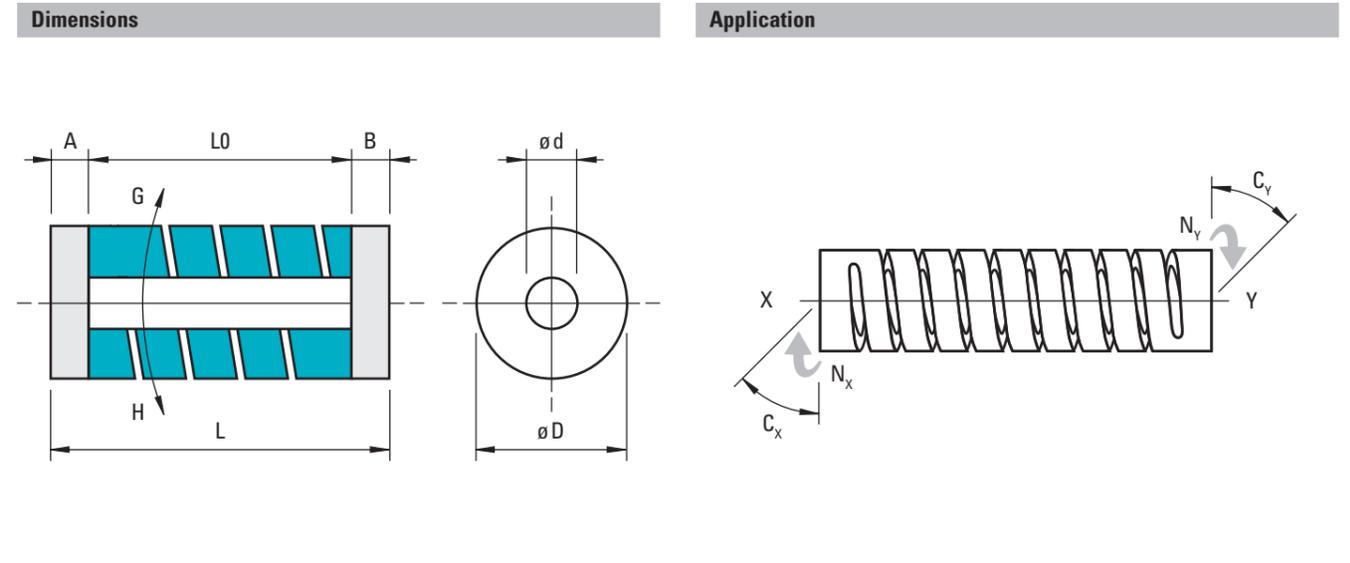
Notes

Attachments drawing * Please contact u-Flex technology to discuss your requirements

Please send requests via email to info@u-flex.swiss

Query

Customer-specific precision torsion springs



Geometry/material	
External diameter (D)	mm
Internal diameter (d)	mm
Spring length (L0)	mm
Overall length (L)	mm
Custom attachment (A), optional	
Custom attachment (B), optional	
Torsion moment/Dir. of rotation	<input type="checkbox"/> G <input type="checkbox"/> H <input type="checkbox"/> both sides
Material	
Ambient temperature	°C
Corrosive environment	<input type="checkbox"/> yes <input type="checkbox"/> no

Technical data	Side X		Side Y
	Distortion angle (C)	°	°
Torsion moment (N)	Nm	Nm	Nm
Tolerance (10% = standard)	%	%	%
Application	<input type="checkbox"/> static	<input type="checkbox"/> dynamic	
Frequency			Hz
Service life/No. of load cycles (one load cycle = load/release)			

Notes

Attachments drawing

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