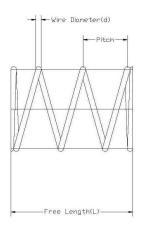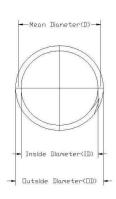# Compression Spring Design

Compression springs apply a force by compressing or pushing on them. Our stock compression springs are all cylindrical and made out of round stainless steel or music wire. Compression springs can also be made in many shapes including barrel, conical, hourglass or oval. The wire can be also be square, rectangular or virtually any shape, size or material.

	Spring ends			
	Flat ground (FEG)	Flat (FE)	Plane (PE)	Plane Ground (PEG)
Active Coils	Nt-2	Nt-2	Nt	Nt -1
Solid Height	d x Nt	d(Nt+1)	d(Nt+1)	d x Nt

Common Spring Materials	Max. recommended % tensile
Music Wire	45%
Chrome Silicon	45%
Chrome Vanadium	45%
302 Stainless Steel	35%
316 Stainless Steel	35%
17-7 Stainless Steel	45%

*See our material data sheet for a more complete list

Spring Terms
OD = Outside Diameter
D = Mean Diameter
d = wire diameter
Na= number of active coils
Nt = number of total coils
R= Spring Rate
P = applied force
S = wire stress
c = spring index
ΔL = deflection
FEG = ends flat and ground
FE= ends flat not ground
PEG = ends plane and ground
PE = ends plane not ground
UTS= Ultimate Tensile Strength

Design tips

- If a spring force or spring rate is specified coil count must be reference only
- Only two of the following may be specified; spring rate, load at L1, load at L2 and Free Length
- Spring index(c) should fall between 4 and 25
- P should only be specified between 15% and 85% of total travel
- Alert manufacturer to any close fitting parts or assemblies

Calculations
D = OD – d

$$R = \frac{Gd^4}{8d^3 N_A} \quad \text{and} \quad P = R * \Delta\text{L}$$

$$S = \left(\frac{8*D*P}{\pi*d^3}\right) * \left(\frac{4*c-1}{4*c-4}\right) + \frac{4*P}{\pi*d^2}$$

$$\% \text{ tensile} = 100 \times \frac{S}{UTS} \qquad \text{*See tables for UTS}$$

For assistance designing a custom spring don't hesitate to contact our experienced engineering department. Or try your own with our custom spring calculator and 3d CAD models at
www.mrspring.com

Tolerances

The following tables give tolerances that can be used as a reference. Actual manufacturing tolerances will depend on the spring specifics. Usually Murphy and Read can manufacture to tolerances 25% smaller than the Spring Manufacturers Institute(SMI) Guidelines.

Outside Diameter Tolerances

Wire Diameter (in)	Spring Index, D/d						
	4	6	8	10	12	14	16
0.015	0.002	0.002	0.003	0.004	0.005	0.006	0.007
0.023	0.002	0.003	0.004	0.006	0.007	0.008	0.01
0.035	0.002	0.004	0.006	0.007	0.009	0.011	0.013
0.051	0.003	0.005	0.007	0.01	0.012	0.015	0.017
0.076	0.004	0.007	0.01	0.013	0.016	0.019	0.022
0.114	0.006	0.009	0.013	0.018	0.021	0.025	0.029
0.171	0.008	0.012	0.017	0.023	0.028	0.033	0.038
0.25	0.011	0.015	0.021	0.028	0.035	0.042	0.049
0.375	0.016	0.02	0.026	0.037	0.046	0.054	0.064
0.5	0.021	0.03	0.04	0.062	0.08	0.1	0.125

Free Length Tolerances

Number of Coils per in.	Spring Index, D/d						
	4	6	8	10	12	14	16
0.5	0.01	0.011	0.012	0.013	0.015	0.016	0.016
1	0.011	0.013	0.015	0.016	0.017	0.018	0.019
2	0.013	0.015	0.017	0.019	0.02	0.022	0.023
4	0.016	0.018	0.021	0.023	0.024	0.026	0.027
8	0.019	0.022	0.024	0.026	0.028	0.03	0.032
12	0.021	0.024	0.027	0.03	0.032	0.034	0.036
16	0.022	0.026	0.029	0.032	0.034	0.036	0.038
20	0.023	0.027	0.031	0.034	0.036	0.038	0.04

- End Squareness of Flat Ground Springs ± 3 degrees
- Spring Rate Tolerance ± 10%
- Load at Length Tolerance ± 10%

Standard Compression Springs

Selection

Springs are organized in order of increasing diameter and wire size. Note that in each category the spring rate decreases as the free length increases. After selecting the proper outside diameter of the spring needed, choose a range for either load or wire diameter (not both) and then select a range for free length. The broader the range entered the more options will be shown.

Units of Measure

All units are in Inches, Pounds for Loads and Pounds per Inch for spring rate.

Loads

The Length at L1 is the deflected length at 75% of full travel for music wire springs. Load at L1 is force generated at Length L1. To determine the load at any point Lx, multiply the deflection to Lx by the Spring Rate. **Load at Lx = R(FL-Lx)**

Stress

Stress at L1 is given as a percent of tensile when the spring is at 75% of total deflection. The spring designs vary throughout the catalogue and it is important to use this value to determine the suitability of a spring for your specific application. In general, lower Stress yields greater life expectancy. Music Wire springs should have a value of 45% or less for average use. Stainless Steel springs should have a value of 35% or less. The following formula can be used to determine stress at any load length. **SLX=SL1/75 x (FL-LX)/(FL-SH)**

Inside Diameter

To determine the Inside Diameter of any spring subtract two sire sizes from the Outside Diameter. Please allow adequate clearance if fitting over a shaft as there is always some variation from manufacturing tolerance and natural burrs.

Ends

.006-.012 Wire Dia.: Flat Ends Not Ground*

.014-.225 Wire Dia.: Flat Ends Ground +-3 Degrees

*Springs with an outside diameter/wire diameter ratio greater than 17-1 have unground ends.

Material

Music Wire: ASTM-A228

250 degree maximum operating temperature.

Stainless Steel Type 302: ASTM-A313

500 degree maximum operating temperature.

Plain finish. Plating, Shot Peening and Passivation can be supplied on request. Please allow additional time.

Certification

Certificate of conformance to our specification, copies of dimensional and load testing and material certification are available at additional cost.

Tolerances

End Squareness of Ground Springs ± 3 Degrees

Spring Rate ± 10%   Load at L1 ± 10%

Outside Diameter

0.063 to 0.119 ± .003	1.001 to 1.225 ± .020
0.120 to 0.240 ± .005	1.226 to 1.460 ± .030
0.241 to 0.500 ± .008	1.461 to 2.000 ± .040
0.501 to 1.000 ± .015	

Custom Compression Springs

If you are unable to find a suitable spring in our stock selection we have provided a specification sheet on the following page for your convenience. If you need further assistance please call our Engineering Department.