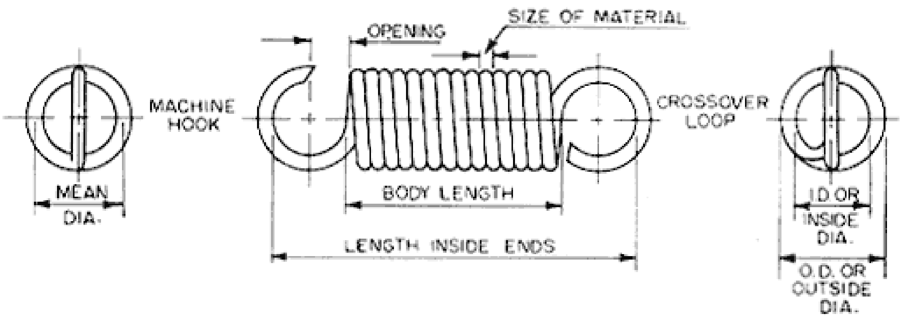
Extension Springs Specification Form



Mandatory Specifications
(fill in only those required)

1. LENGTH INSIDE ENDS
   a. ____in. max., ____in. min. or
   b. ____in. ± ____in. or
   c. approx. ____in.
2. OUTSIDE DIAMETER
   a. ____in. max. or
   b. ____in. ± ____in.
3. INSIDE DIAMETER
   a. ____in. min. or
   b. ____in. ± ____in.
4. Load ____lb. ± ____lb. @____in.
   Load ____lb. ± ____lb. @____in.
   Rate ____lb. per in. ± ____lb. per in.
   between ____in. and ____in.
5. Maximum extended length (inside ends) without set ____in.
6. Relative loop position, ____° max. separation of loop planes.
7. Direction of helix (L, R or optional) ____________
8. Type of ends____________

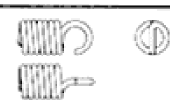
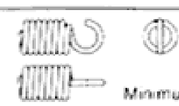
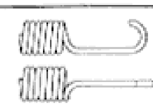
Advisory Data

1. Wire diameter____in.
2. Mean coil diameter____in.
3. No. of active coils____
4. Body length____in.
5. Initial tension____lbs.

Special Information

1. Type of material ____________
2. Finish ____________
3. Frequency of extension, ____cycles/sec, and working range, ____in. to ____in. of length.
4. Operating temp. ____°F
5. End use or application____________
   ____
   ____
6. Other____________
   ____

Table 1

		RECOMMENDED LENGTH[a]	
LOOP TYPE		**Min.**	**Max.**
Machine		½ I.D.[b]	1.1 × I.D.
Crossover	 Minimum Recommended Index = 7	I.D.	I.D.
Side		I.D.	I.D.
Extended		1.1 × I.D.	As Required
Special: as required by design		As Required	

a. Length is distance from last body coil to inside of end.
b. I.D. is inside diameter of adjacent coil in spring body.

EXAMPLE 2

Design an extension spring to meet the following requirements O.D. = .655 in.$_{max}$ free length L = 5.125 in., initial load P_1 = 50 lb. ± 5 lb. at initial length L_1 = 5.625 in. inside hooks, P_2 = 105 lb. $_{max}$ at final length L_2 = 6.250 in. inside hooks, .725 in. minimum hook extension. The material specified is music wire.

Wire Diameter

The first step is to determine a trial wire diameter which will carry the maximum load. Using a minimum tensile strength S_t = 250,000 psi for music wire, the trial design stress will be .40(250,000) = 100,000 psi. Assuming a trial mean diameter equal to the maximum O.D. and solving for d.

$$d = \sqrt[3]{\frac{8PD}{\pi S}} = \sqrt[3]{\frac{8(105)(.655)}{\pi(100{,}000)}} = .1205 \text{ in.}$$

Proceed with design, using the actual wire size of .120 in. diameter. The corrected mean diameter is determined by subtracting this wire diameter and a coil diameter tolerance of .010 in. (an estimate based on the coil diameter tolerances given in Table 2 on page 8 from the O.D.)
D = .655 — (.120 + .010) = .525 in.

The minimum tensile strength for .120 in. music wire is 263,000 psi, so that allowable design stress becomes .40 (263,000) = 105,000 psi.

Spring Rate

Allowing for a load tolerance of 10 percent on the 105-lb. maximum load (interpolating from Table 8 on page 10), consider the actual final load to be P_2 = .9(105) = 94.5 lb. at L_2 = 6.250 in. Calculate the spring rate (R)

$$R = \frac{(P_2 - P_1)}{(L_2 - L_1)} = \frac{(94.5 - 50.0)}{(6.250 - 5.625)} = 71.2 \text{ lb. per in.}$$

Initial Tension

The required initial tension (P_i) will be equal to P_1 minus the load generated by deflecting from free length (L) to L_1

$$P_i = P_1 - R(L_1 - L) = 50 - (71.2)(5.625 - 5.125) = 14.4 \text{ lb. (required)}$$

Using the chart on this page, an initial tension stress S_i = 22,000 psi is readily attainable for a spring with an index of D/d = .525/.120 = 4.4

$$P_i = \frac{\pi S_i d^3}{8D} = \frac{\pi(22{,}000)(.120)^3}{8(.525)} = 28.4 \text{ lb. (attainable)}$$

Therefore, the required 14.4 lb. initial tension is possible.

Number of Active Coils

Transposing spring rate formula 1 and solving for number of active coils (n)

$$n = \frac{Gd^4}{8RD^3} = \frac{11.5 \times 10^6 (.120)^4}{8(71.2)(.525)^3} = 29 \text{ coils}$$

Length Characteristics

Body length = d(n + 1) = .120(29 + 1) = 3.600 in.
Length of hooks = (5.125 − 3.600)/2 = .762 in.

The hooks will extend .762 in. from the body, which satisfies the specified .725 in. minimum extension.

Stress

Using the stress formula and considering the Wahl curvature stress correction factor (K)

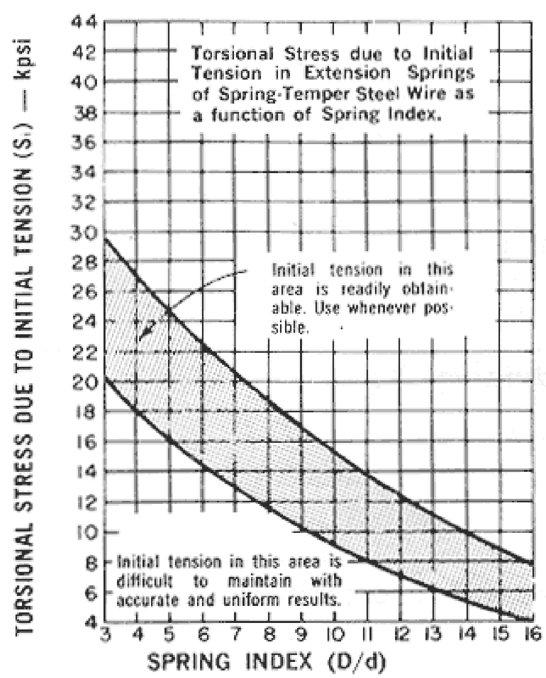
$$S_2 = \frac{8P_2D}{\pi d^3} = \frac{8(94.5)(.525)}{\pi(.120)^3} = 73{,}000 \text{ psi (uncorrected)}$$

$$K = \frac{4(4.4) - 1}{4(4.4) - 4} + \frac{0.615}{4.4} = 1.36$$

S_{2k} = 1.36(73,000) = 99,000 psi (corrected)

Since this value is less than the allowable design stress of 105,000 psi, the design is safe for the application.

Figure 2.



For computer programming purposes, the following is an empirical formula for determining S_i as given in the above chart.

$$S_i = \frac{33500}{e^{.105C}} \text{ or } \frac{33500}{10^{.0456C}} \text{ where } C = \frac{D}{d}$$