SPRING TERMINOLOGY

Active Coils – those coils which are free to deflect under load.

Buckling – bowing or lateral deflection of compression springs when compressed, related to the slenderness ratio (L/D).

Closed Ends – ends of compression springs where pitch of the end coils is reduced so that the end coils touch.

Closed and Ground Ends – as with closed ends, except that the end is ground to provide a flat plane.

Close-Wound – coiled with adjacent coils touching.

Coils Per Inch – see Pitch.

Deflection – motion of spring ends or legs under the application or removal of an external load.

Endurance Limit – maximum stress at which any given material will operate indefinitely without failure for a given minimum stress.

Free Angle – angle between the legs of a torsion spring when the spring is not loaded.

Free Length – the overall length of a spring in the unloaded position.

Frequency (natural) – the lowest inherent rate of free vibration of a spring itself (usually in cycles per second) with ends restrained.

Helix – the spiral form (open or closed) of compression, extension and torsion springs.

Hooks – open loops or ends of extension springs.

Hydrogen Embrittlement – hydrogen absorbed in electroplating or pickling of carbon steels, tending to make the spring material brittle and susceptible to cracking and failure, particularly under sustained loads.

Hysteresis – the mechanical energy loss that always occurs under cyclic loading and unloading of a spring, proportional to the area between the loading and unloading load-deflection curves within the elastic range of a spring.

Initial Tension – the force that tends to keep the coils of an extension spring closed and which must be overcome before the coils start to open.

Load – the force applied to a spring that causes a deflection.

Loops – coil-like wire shapes at the ends of extension springs that provide for attachment and force application.

Mean Coil Diameter – outside spring diameter (O.D.) minus one wire diameter.

Open Ends, Not Ground – end of a compression spring with a constant pitch for each coil.

Open Ends Ground – "open ends, not ground" followed by an end grinding operation.

Passivating – acid treatment of stainless steel to remove contaminants and improve corrosion resistance.

Permanent Set – a material that is deflected so far that its elastic properties have been exceeded and it does not return to its original condition upon release of load is said to have taken a "permanent set".

Pitch – the distance from centre to centre of the wire in adjacent active coils (recommended practice is to specify number of active coils rather than pitch).

Rate – change in load per unit deflection, generally given in pounds per inch or Newtons per millimetre.

Remove Set – the process of closing to solid height a compression spring which has been coiled longer than the desired finished length, so as to increase the apparent elastic limit.

Residual Stress – stress induced by set removal, shot peening, cold working, forming or other means. These stresses may or may not be beneficial, depending on the application.

Scragged – see Remove Set.

Set – permanent distortion which occurs when a spring is stressed beyond the elastic limit of the material.

Solid Height – length of a compression spring when under sufficient load to bring all coils into contact with adjacent coils.

Spring Index – ratio of mean coil diameter (D) to wire diameter (d).

Stress Relieve – to subject springs to low-temperature heat treatment so as to relieve residual stresses.

Shot Peening – a cold-working process in which the material surface is peened to induce compressive stresses and thereby improve fatigue life.

Torque – a twisting action in torsion springs which tends to produce rotation, equal to the load multiplied by the distance (or moment arm) from the load to the axis of the spring body.

Total Number of Coils – number of active coils plus the coils forming the ends.

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CONVERSION TABLE

	Multiply by	To Convert	To	Divide by
LENGTH	25.4	INCHES	MILLIMETRES	0.0393701
	0.0254		METRES	39.3701
	304.8	FEET	MILLIMETRES	0.003281
	0.3048		METRES	3.2808
	0.0393701	MILLIMETRES	INCHES	25.4
	0.003281		FEET	304.8
	39.3701	METRES	INCHES	0.0254
	3.2808		FEET	0.3048
RATE	0.017858	POUND f/in	kg/mm	55.998
	0.175133		N/mm	5.7099
	91.358	NEWTON/mm	ozf/in	0.0109458
	5.7099		lbf/in	0.175133
	0.101968		kgf/mm	9.807
	895.97	KILOGRAM f/mm	ozf/in	0.0011612
	55.998		lbf/in	0.017858
	9.807		N/mm	0.101968
FORCE	453.6	POUNDS	GRAMS	0.0022046
	0.4536		KILOGRAMS	2.2046
	4.448		NEWTONS	0.22487
	0.0022046	GRAMS	POUNDS	453.6
	0.001		KILOGRAMS	1000
	0.009807		NEWTONS	102
	2.2046	KILOGRAMS	POUNDS	0.4536
	1000		GRAMS	0.001
	9.807		NEWTONS	0.102
	0.22487	NEWTONS	POUNDS	4.448
	102		GRAMS	0.009807
	0.102		KILOGRAMS	9.807
TORQUE	0.0625	OUNCE FORCE – INCH	lbf – in	16
	0.72		kgf – mm	1.3887
	0.007062		N – m	141.6069
	11.52125	POUND FORCE – INCH	kgf – mm	0.086796
	0.1129889		N – m	8.850413
	1.3887	KILOGRAM FORCE – MILLIMETRE	ozf – in	0.72
	0.086796		lbf – in	11.52125
	0.009807		N – m	101.968
	141.6069	NEWTON – METRE	ozf – in	0.007062
	8.850413		lbf – in	0.1129889
	101.968		kgf – mm	0.009807
		To obtain	**From**	**Multiply by above**

COMPRESSION SPRINGS

In a spring, which has its coils spaced uniformly and is compressed by pressure applied to its ends, all the adjacent coils will approach each other equally, because all are subjected to the same pressure and all have the same resistance to that pressure.

Consequently, as a spring is compressed, the load increases in a linear manner and the strength of a spring is expressed as the load obtained from one inch of deflection (rate per inch). In fact, for approximately the last 15% of the total deflection of spring, the rate becomes non-linear due to the active coil at each end of the spring closing up and becoming inactive.

The formula for calculation of rate is

$$\frac{Gd^4}{8nD^3}$$

where G = Modulus of rigidity (11.5 x 10^6 for carbon steel)
d = Wire diameter
n = Number of working coils
D = Mean diameter of coils

Another important factor in design is the stress which the spring can withstand without taking a permanent set.

Generally speaking, this should not exceed 80,000 pounds per square inch (for carbon steel) although various manufacturing techniques and the use of special materials can, in certain circumstances, make practical the design of springs with stresses in excess of this figure.

The formula for the calculation of stress is

$$\frac{8WDK}{\pi d^3}$$

where W= Load
D = Mean diameter of coils
$K = \frac{4C+2}{4C-3}$
C = Spring index $\left(\frac{D}{d}\right)$
d = Wire diameter

K represents the WAHL factor which corrects the formula in respect of the increased stress on the wire at the inside diameter of the spring.

STANDARD WIRE GAUGES

Gauge	Inch	mm	Gauge	Inch	mm	Gauge	Inch	mm
9/16″	0.562	14.288	4G	0.232	5.893	1/16″	0.062	1.575
7/OG	0.500	12.700	5G	0.212	5.385	17G	0.056	1.422
6/OG	0.464	11.786	6G	0.192	4.877	18G	0.048	1.219
7/16″	0.437	11.113	3/16″	0.187	4.763	19G	0.040	1.016
5/OG	0.432	10.973	7G	0.176	4.470	20G	0.036	0.914
4/OG	0.400	10.160	8G	0.160	4.064	21G	0.032	0.813
3/8″	0.375	9.525	9G	0.144	3.658	22G	0.028	0.711
3/OG	0.372	9.449	10G	0.128	3.251	23G	0.024	0.610
2/OG	0.348	8.839	1/8″	0.125	3.175	24G	0.022	0.559
OG	0.324	8.229	11G	0.116	2.946	25G	0.020	0.508
5/16″	0.312	7.938	12G	0.104	2.642	26G	0.018	0.457
1G	0.300	7.620	13G	0.092	2.337	27G	0.0164	0.417
2G	0.276	7.010	14G	0.080	2.032	28G	0.0148	0.376
3G	0.252	6.401	15G	0.072	1.829	29G	0.0136	0.345
1/4″	0.250	6.350	16G	0.064	1.626	30G	0.0124	0.315

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COMPRESSION SPRING SPECIFICATION

MATERIALS

METRIC RANGE & GENERAL RANGE:

Music Wire to DIN 17223, Class C.No.1.1200 or BS 1408 CR3.

Stainless Steel Wire to DIN 17224 No.1.4310 or BS 2056 302S26.

STANDARD RANGE:

Spring Steel to BS 5216 HS3, Galvanised.

Stainless Steel Wire to DIN 17224 No.1.4310 or BS 2056 302S26.

ENDS

METRIC RANGE:

Wire sizes up to 0.8mm squared and unground.

Wire sizes 1.0mm and over squared and ground.

GENERAL RANGE:

Wire sizes up to 0.012″ squared and unground.

Wire sizes 0.014″ and over squared and ground.

STANDARD RANGE:

As individually described.

DIRECTION OF HELIX

METRIC RANGE	:	Right Hand
GENERAL RANGE	:	Left Hand
STANDARD RANGE	:	Right Hand

TOLERANCES

All dimensions and forces conform to DIN 2095 (Grade 2) or BS 1726 Class B.

Standard Range Rates are Nominal and given for guidance only.

SURFACE FINISH

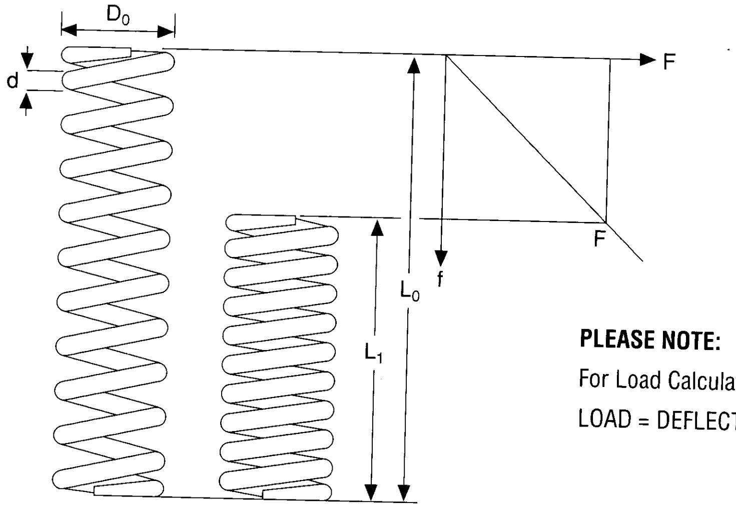
Music Wire	:	Oiled
Stainless Steel	:	Self
BS 5216 HS3	:	Galvanised

Alternative surface finishes are available at extra cost, including Shot-peening, Zinc Plating, Phosphate.

RECOMMENDED WORKING TEMPERATURES

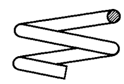
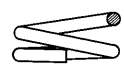
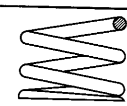
Music Wire/Spring Steel	:	120°C (max.)
Stainless Steel	:	300°C (max.)
Chrome Vanadium (Die Springs)	:	220°C (max.)

COMPRESSION SPRING ENQUIRY DATA



PLEASE NOTE:

For Load Calculation at any Working Length use
LOAD = DEFLECTED LENGTH x RATE

Do	OUTSIDE DIAMETER	mm/in		
Lo	FREE LENGTH	mm/in		
d	WIRE DIAMETER	mm/in		
Nr	TOTAL COILS	mm/in		
	RATE	N/mm/lbs/in		
	TO SUPPORT	F Kgs + lbs –	Kgs lbs	(L_1) mm/ ins
Lmin	MIN. WORKING LENGTH	mm/in		
	STYLE OF ENDS	 OPEN ENDS	 CLOSED ENDS	 CLOSED AND GROUND ENDS
	DIRECTION OF HELIX	RIGHT	LEFT	OPTIONAL
	MATERIAL			
	SURFACE FINISH			
	OTHER INFORMATION			

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EXTENSION SPRINGS

EXTENSION SPRINGS

Design of extension springs is virtually the same as that of compression springs, the formulae for rate and stress being identical. Extension springs, however, are different in two ways. Firstly, they are normally close-coiled whereas in compression springs the coils are open. Secondly, initial tension can be put into extension springs so that a particular load has to be applied to the spring before the coils begin to open. This can only be done in springs manufactured from cold-drawn material and the maximum initial tension which can be obtained is calculated as follows:

$$W_1 = \frac{\pi S_1 d^3}{16R}$$

where W_1 = Initial tension load
S_1 = Initial tension stress
d = Wire diameter
R = Mean radius of coil

The initial tension stress is taken from the following table.

Index $\left(\frac{D}{d}\right)$	Stress (p.s.i.)
3	25,000
4	22,500
5	20,000
6	18,000
7	16,200
8	14,500
9	13,000
10	11,600
11	10,600
12	9,700
13	8,800
14	7,900
15	7,000

where D = Mean diameter of coil
d = Wire diameter

STANDARD WIRE GAUGES

Gauge	Inch	mm	Gauge	Inch	mm	Gauge	Inch	mm
9/16″	0.562	14.288	4G	0.232	5.893	1/16″	0.062	1.575
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1/4″	0.250	6.350	16G	0.064	1.626	30G	0.0124	0.315

EXTENSION SPRING SPECIFICATION

MATERIALS

METRIC RANGE & GENERAL RANGE:

Music Wire to DIN 17223, Class C.No.1.1200 or BS 1408 CR3.

Stainless Steel Wire to DIN 17224 No.1.4310 or BS 2056 302S26.

STANDARD RANGE:

Spring Steel to BS 5216 HS3, Galvanised.

Stainless Steel Wire to DIN 17224 No.1.4310 or BS 2056 302S26.

ENDS

METRIC RANGE : German loops, random position

GENERAL RANGE : German loops, random position

STANDARD RANGE : English loops, random position

NOTE: All Springmasters Extension Springs are right hand coiled.

TOLERANCES

All dimensions and forces conform to DIN 2095 (Grade 2) or BS 1726 Class B.

Standard Range rates are nominal and given for guidance only.

SURFACE FINISH

Music Wire : Oiled
Stainless Steel : Self
BS 5216 HS3 : Galvanised

Alternative surface finishes are available at extra cost, including Shot-peening, Zinc Plating, Phosphate.

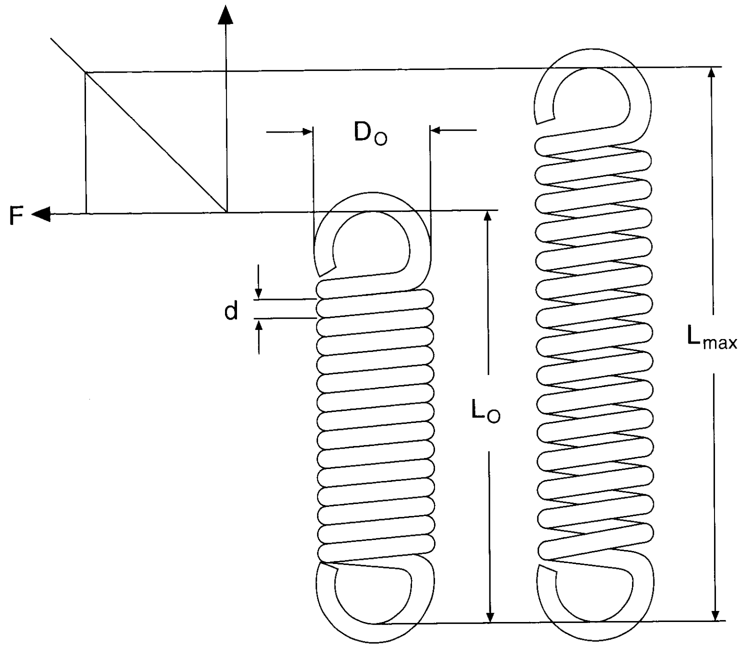
RECOMMENDED WORKING TEMPERATURES

Music Wire/Spring Steel : 120°C (max.)

Stainless Steel : 300°C (max.)

EXTENSION SPRING ENQUIRY DATA

EXTENSION SPRINGS



Do	OUTSIDE DIAMETER	mm/ins
Lo	FREE LENGTH	mm/ins
d	WIRE DIAMETER	mm/ins
Nr	TOTAL COILS	
	RATE	N/mm lbs/in
	INITIAL TENSION	N
Lmax	MAX. EXTENDED LENGTH	mm/ins
	TO SUPPORT	F Kgs + lbs – Kgs lbs (L_1) mm/ ins
	STYLE OF ENDS	
	MATERIAL	
	SURFACE FINISH	
	OTHER INFORMATION	

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