Technical Data Sheet
UGI® S316

Chemical analysis (%)

C	Si	Mn	Cr	Ni	Mo	N	P	S
≤ 0.07	≤ 1.0	≤ 2.0	16.5 – 18.5	10.0 – 13.0	2.0 – 2.5	≤ 0.11	≤ 0.045	≤ 0.015

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General presentation

UGI® S316 is a grade that is less commonly used than UGI® S302 in the manufacture of stainless steel springs. However, thanks to the presence of the molybdenum element in its composition, this grade offers:

- Better corrosion resistance than the standard UGI® S302 grade, particularly in marine and aggressive industrial environments.
- Good corrosion resistance which allows it to be used at temperatures of around 250°C, higher than those recommended for UGI® S302.

Finally, the advantage of UGI® S316 is that it is practically non-magnetic, even after significant work-hardening and a cross-section reduction of more than 80%.

Classification

Austenitic stainless steel

Designation

Material No.

Europe			USA		Japan
EN	**DIN**	**ISO**	**AISI**	**UNS**	**JIS**
1.4401	1.4401	X5CrNiMo17-12-2	316	S31600	SUS316

Compatible with the following standards: EN 10088-3, EN 10270-3, ASTM A313, ASTM A959, ISO 6931-1

Mechanical properties

Tensile data in the annealed condition

Temperature	Yield strength	Tensile strength	Elongation
T	**YS 0.2%**	**UTS**	**E**
(°C)	**(MPa)**	**(MPa)**	**(%)**
20°C	≥ 200	≥ 500	≥ 45

The mechanical characteristics obtained on cold work-hardened wires reach the considerably higher values of $YS_{0.2}$ and UTS shown in the cold transformation section.

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Physical properties

Temperature	Density	Elastic modulus	Thermal conductivity	Expansion coefficient	Specific heat	Electrical resistivity
(°C)	(g/cm^3)	(GPa)	($W.m^{-1}.K^{-1}$)	($K^{-1}.(x10^{-6})$)	($J.kg^{-1}.K^{-1}$)	(μΩ.cm)
20	7.9	200	15		500	80
100	7.9	194	16	16.0 (0 / 100°C)		85
200	7.9	186	18	16.5 (0 / 200°C)		95
300	7.9	179	19	17.0 (0 / 300°C)		100

The maximum working temperature for UGI® S316 must not exceed 250°C.
The relative magnetic permeability (μr) of the grade is only slightly influenced by cold transforming the material. In the annealed and non work-hardened condition, μ_r is 1.01 lower, but in the work-hardened condition with spring wire characteristics, the relative permeability (μr) increases but does not exceed 3.

Corrosion resistance

UGI® S316 has very good corrosion resistance in moderately corrosive environments (natural waters, urban or industrial atmospheres). It can be used in humid or aqueous environments with limited chloride content (marine environment) and in many acidic environments (sulphuric, phosphoric, organic) under certain temperature and concentration conditions (corrosion tables are available on request).

Hot transformation

UGI® S316 has good forgeability at high temperature. Forging temperatures range from 950°C to 1180°C (with the best results obtained between 1100 and 1180°C). Once forged, the parts must be rapidly cooled, i.e. water cooled or air-cooled, to avoid the problem of sensitizing the grade to possible corrosion at grain boundaries.

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Cold transformation

Drawing – Profiling

UGI® S316 is highly work-hardened during cold transformation, as is the case with all austenitic molybdenum grades, but slightly less than UGI® S302 because it forms less hardening martensite during cold transformation. It has good ductility up to a cross-section reduction of 90% and more.

The mechanical properties of the spring wires shown in the table below in the as-delivered condition are then significantly higher than in the annealed condition.

Nominal diameter	UTS range		YS 0.2
	Min.	Max.	Min.
(mm)	(MPa)	(MPa)	(MPa)
d ≤ 0.20	1725	1990	1550
0.20 < d ≤ 0.30	1700	1960	1525
0.30 < d ≤ 0.40	1675	1930	1500
0.40 < d ≤ 0.50	1650	1900	1480
0.50 < d ≤ 0.65	1625	1870	1460
0.65 < d ≤ 0.80	1600	1840	1440
0.80 < d ≤ 1.00	1575	1820	1420
1.00 < d ≤ 1.25	1550	1790	1390
1.25 < d ≤ 1.50	1500	1730	1350
1.50 < d ≤ 1.75	1450	1670	1300
1.75 < d ≤ 2.00	1400	1610	1260
2.00 < d ≤ 2.50	1350	1560	1220
2.50 < d ≤ 3.00	1300	1500	1170
3.00 < d ≤ 3.50	1250	1440	1125
3.50 < d ≤ 4.25	1225	1410	1100
4.25 < d ≤ 5.00	1200	1380	1080
5.00 < d ≤ 6.00	1150	1330	1030
6.00 < d ≤ 7.00	1125	1300	1000
7.00 < d ≤ 8.50	1075	1240	950
8.50 < d ≤ 10.0	1050	1210	920

These Rm values comply with the standard mechanical strength range specified in European standard EN 10270-3 for grade 1.4401. The $YS_{0.2}$ values are given for information only.

The ratio UTS / $YS_{0.2}$ for spring wires made of UGI® S316 is generally about 0.9.
The range of resistance values (Rm) is generally found:
– In a batch manufactured at 100 MPa
– In a packaging unit (reels, coils, rims) at 60 MPa.

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Bending - Forming

As UGI® S316 is a ductile grade, even in the work-hardened condition, it has very good forming and bending properties. Since the ductile / brittle transition temperature is markedly lower than the ambient temperature, fast strain rates and therefore high spring conformation rates are possible.
In the annealed condition, UG I® S316 can be used for cryogenic applications.

Heat treatment

The mechanical strength of the springs can be increased up to 150 MPa (depending on the diameters) by heat-treating the springs. The ratio $YS_{0.2}$ / UTS may increase by 5% after such treatment.

Static treatment

– Heat treatment temperature, 350/425°C
Recommended time 0.5 to 4 hours depending on batch size

Continuous oven treatment

– Heat treatment temperature 25°C higher than for static treatment
Minimum treatment time 3 minutes

Available products

Product	Form	Finish	Dimension	
Wire rod	Round	Pickled	5.0 to 32	mm
Drawn wire	Round	Unpolished	0.2 to 15.0	mm
Bar	Round	Bright	1.0 to 15.0	mm
Rolled wire	Profiles	Bright	2 to 70	mm²

Other: contact us

UGI® S316 is derived from processes that comply with the Montreal rules on CFCs and European regulations on heavy metals.
Safety sheet available on request

Spring applications

– Torsion bars, torsion springs
– Compression springs
– Tension spring