

BUMAX[®] – HIGH-TENSILE STAINLESS STEEL FASTENERS

REYHER – your partner for the BUMAX range

BUMAX[®]
THE WORLD'S STRONGEST
STAINLESS STEEL BOLT





- ▶ **BUMAX 88 and BUMAX 109 ready for delivery from stock**
- ▶ **Wide range of BUMAX materials for special parts available on request**
- ▶ **High corrosion resistance**
- ▶ **Possible to use in a wide temperature range from -200°C to $+815^{\circ}\text{C}$ (-328°F to 1499°F)**
- ▶ **High strength**
- ▶ **Very good fatigue strength**
- ▶ **Lower permeability (magnetism)**

Application examples



■ **BUMAX® – high-tensile stainless steel fasteners**

BUMAX are known as the strongest stainless steel fasteners in the world. They fulfil the highest requirements with respect to quality, corrosion resistance, high strength, fatigue strength and heat resistance.

The combination of high strength and high corrosion resistance is always a challenge for screwed fastenings. Up to now steel screws with metallic and non-metallic corrosion protection coatings have been most used because of their high strength. Known as a self-sacrificing corrosion protective coating, they provide adequate protection depending on surrounding conditions. But there are limits to what these coatings can achieve.

The BUMAX range offers fasteners with high strength as well as excellent corrosion protection virtually uncompromisingly linked together. In addition are suitable for a temperature range from -200°C to +815°C (-328°F to 1499°F). BUMAX is a registered trademark of the BUFAB Group. The products are manufactured in Sweden in BUFAB's own plant. The raw material are sourced solely from European premium stainless steel producers.

REYHER is the exclusive partner for Germany for the complete BUMAX range.

The BUMAX range includes

- ▶ product groups BUMAX 88 and BUMAX 109, on stock and ready for immediate delivery. They correspond to carbon steel property classes 8.8 and 10.9.
- ▶ a various range of other BUMAX materials. These special parts are available on request. Some of the materials are unique: BUMAX is the only producer worldwide.

■ **Technical Competence**

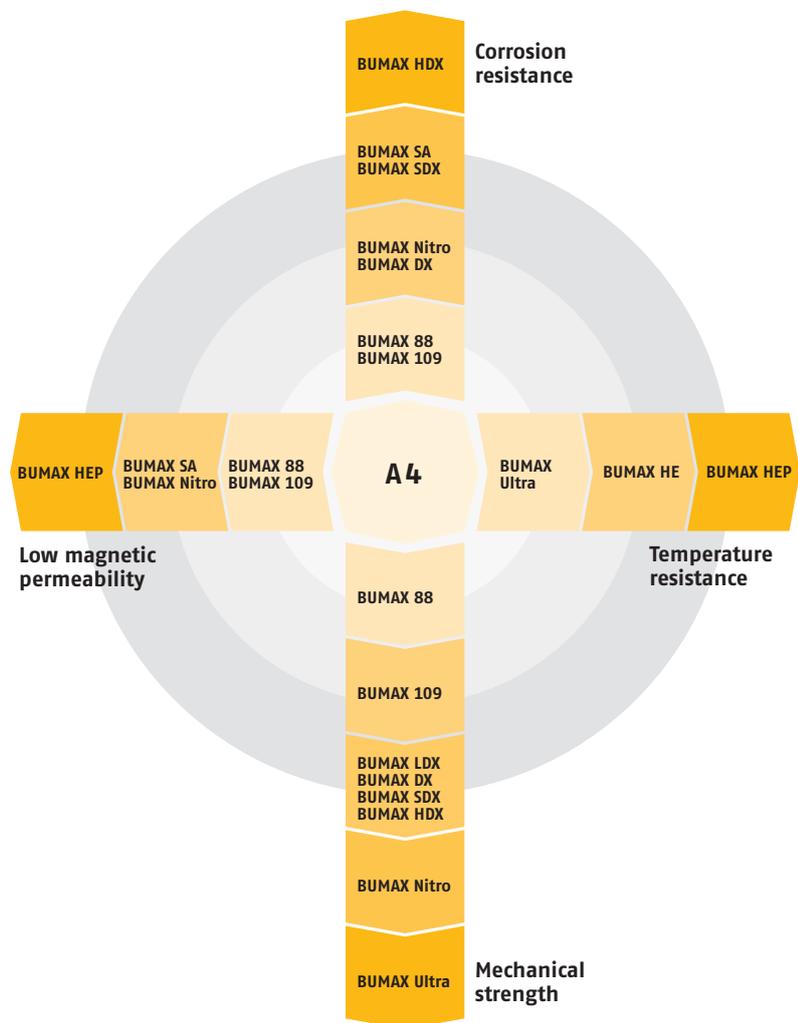
REM – REYHER Engineering Management deals with all technical matters and details involving fasteners and fixing technology. Through continuous in-service training our staff keep their all-round technical knowledge up to the latest standards. Our expert engineers and technicians are happy to give advice on questions about BUMAX.

Technical consulting
Tel: +49 40 85363-999



■ **BUMAX® material classes**

Stainless steel fasteners have properties which make them attractive choices for a wide range of applications. It is essential to consider the properties that are required, such as corrosion resistance, temperature resistance, mechanical strength and magnetic permeability. Correctly chosen materials will guarantee a trouble-free lifetime and low lifecycle cost. The diagram of material classes will help you to select the material best suited to your needs.



BUMAX® stock range – ready for immediate delivery

■ BUMAX 88 and BUMAX 109 products

✓ Can be used in a wide temperature range from –200°C to +400°C (–328°F to 752°F)

At lower temperatures the BUMAX 109 still reaches an impact strength of 29.5 joule, the BUMAX 88 even reaches 47.4 joule. At temperatures of +400°C the minimum yield strength of 0.2% is reduced by not more than 20% compared to the room temperature value. This facilitates a wide field of use, especially for applications subject to high temperature variations.

✓ High corrosion resistance

Due to their high molybdenum content BUMAX 88 and BUMAX 109 have higher corrosion resistance compared to standard fasteners in material class A4.

✓ High strength

BUMAX 88 and BUMAX 109 correspond to steel property classes 8.8 and 10.9. BUMAX 109 is made of the same material as BUMAX 88, but has higher hardness due to a special manufacturing process.

✓ Very good fatigue strength

Material fatigue occurs when fasteners are under dynamic stress. The stress concentration in inclusions or slag can lead to damage in the surfaces or even to fatigue break. BUMAX is a highly uniform material which is hardly ever subject to inclusions or slag. In comparison to standard A4 materials BUMAX has a distinct advantage because of its high-quality finish.

✓ BUMAX 88 conforms to the Pressure Equipment Directive (PED)

BUMAX 88 screws and nuts with a diameter range of M 6 to M 36 and a minimum length of 3 x d can be used in pressure vessels in line with the Pressure Equipment Directive. Suitability is confirmed with inspection certificate 3.1, which is generally available. The requirements are defined in an individual expert report by TUV Nord (PMA Nr. 1326W101430_rev_01).

✓ Limited permeability (magnetism)

BUMAX fasteners are used in many applications where very limited magnetic permeability is necessary. The magnetic permeability of BUMAX is at $<1,01 \mu$ several times lower than standard A2/A4 fasteners.

✓ Batch tracing

All relevant information, necessary to trace the items back to, the material heat code, is displayed on the label of the supplied goods.

✓ Defined tightening torques and preload forces by setting friction values

By lubricating the BUMAX fasteners, unlike with standard A 2 and A 4 fasteners, and applying defined tightening torques specific preloading forces can be achieved.

Information: The BUMAX 88 range is available on request for steel construction in accordance with EN 15048 with "SB" marking.

Impact strength

Designation	Impact strength in Joule [J]				
	20°C	–50°C	–100°C	–140°C	–196°C
BUMAX 88	79.5	74.5	69.0	60.0	47.4
BUMAX 109	36.0	34.0	32.9	31.0	29.5

Mechanical properties at elevated temperatures

Designation	Remaining yield strength $R_{p0,2}$ in % relative to $R_{p0,2}$ at room temperature			
	100°C	200°C	300°C	400°C
BUMAX 88	90	90	85	80
BUMAX 109	95	95	95	90



■ BUMAX 88 and BUMAX 109 – REYHER stock items

Norm	Designation	Sizes	Material property	Articles code
BUMAX 88				
DIN 938	Studs, metal end ≈ 1 d	M 6 x 25 – M 20 x 80	A4 BUMAX 88	00938.941
DIN 976	Stud bolts, type B	BM 5 x 1000 – BM 36 x 1000	A4 BUMAX 88	00976.943
ISO 4014	Hexagon head bolts with shank	M 6 x 30 – M 36 x 200	A4 BUMAX 88	04014.941
ISO 4017	Hexagon head screws with thread up to head	M 4 x 10 – M 36 x 150	A4 BUMAX 88	04017.941
ISO 4032	Hexagon nuts, ISO type 1	M 6 – M 36	A4 BUMAX 88	04032.941
ISO 4762	Hexagon socket head cap screws	M 3 x 6 – M 24 x 150	A4 BUMAX 88	04762.941
ISO 7089	Plain washers, normal series, product grade A, without chamfer	5 – 36	A4 BUMAX 88 200 HV	07089.941
BUMAX 109				
ISO 4014	Hexagon head bolts with shank	M 6 x 35 – M 16 x 120	A4 BUMAX 109	04014.942
ISO 4017	Hexagon head screws with thread up to head	M 4 x 16 – M 20 x 80	A4 BUMAX 109	04017.942
ISO 4032	Hexagon nuts, ISO type 1	M 6 – M 20	A4 BUMAX 109	04032.942
ISO 4762	Hexagon socket head cap screws	M 4 x 12 – M 16 x 140	A4 BUMAX 109	04762.942
ISO 7089	Plain washers, normal series, product grade A, without chamfer	6 – 20	A4 BUMAX 109 300 HV	07089.942

BUMAX® special parts – available on request

■ Further materials

BUMAX Nitro is an austenitic stainless steel with high nitrogen content that is characterised by its very high strength and fatigue resistance achieving good corrosion resistance. These products can even be supplied in the property class 12.9 up to M 42.

BUMAX Super Austenite (SA), high-alloy austenitic stainless steel for seawater as well as other aggressive chloride-containing media. Excellent resistance to general, crevice, pitting and stress corrosion.

BUMAX Lean Duplex (LDX) offers a cost-effective solution for high strength fasteners in medium corrosive environments.

BUMAX Duplex (DX) is characterised by excellent strength, ductility and fatigue resistance in combination with good general, pitting, crevice and stress corrosion properties.

BUMAX Super Duplex (SDX) is characterised by excellent mechanical properties and very good corrosion resistance. Excellent resistance to general crevice, pitting and stress corrosion in chloride-containing media.

BUMAX Hyper Duplex (HDX), a groundbreaking alloy used in the most demanding applications. Suited for use in severe corrosive environments such as hot chlorinated seawater and for aggressive acidic chloride containing media in the chemical, oil/gas, marine and petrochemical industries.

BUMAX Ultra, a unique precipitation hardenable stainless steel that can be delivered in ultra-high strength grades (14.9–16.9). Strongest stainless steel fastener on the market. Good corrosion resistance in chloride environments.

BUMAX Heat (HE), high temperature-resistant material for applications requiring high strength and good oxidation resistance at temperatures up to 700°C. Can be precipitation hardened.

BUMAX Heat Plus (HEP), precipitation hardenable high temperature-resistant material with excellent oxidation resistance and high tensile and creep properties at temperatures up to 815°C.

See the following pages for further technical details.

Technical Information

Chemical composition

Material classes	EN	Microstructure	C max	Cr	Ni	Mo	Other	PREN ¹
A 4	ISO 3506	Austenitic	0.08	16–18.5	10–15	2–3	Cu	25
BUMAX 88	1.4432, 1.4436, 1.4435	Austenitic	0.03	17	11.5	2.7	–	27
BUMAX 109	1.4432, 1.4436, 1.4435	Austenitic	0.03	17	11.5	2.7	–	27
BUMAX Nitro	–	Austenitic	0.035	20.5	10	2.4	N 0.4	35
BUMAX SA	1.4547	Austenitic	0.01	20	18	6.2	N, Cu	43
BUMAX LDX ²	1.4162	Ferrite–austenitic	–	21.5	1.5	0.3	N 0.22 Mn 5	26
BUMAX DX	1.4462	Ferrite–austenitic	0.03	22	5.2	3.2	N 0.18	36
BUMAX SDX	1.4410	Ferrite–austenitic	0.03	25	7	4	N 0.3	42
BUMAX HDX	1.4658	Ferrite–austenitic	0.03	27	6.5	4.8	N 0.4, Co	49
BUMAX Ultra	–	Martensitic	0.02	12	9	4	Al, Ti, Cu	25
BUMAX HE	1.4980	Austenitic	0.08	15	26	1.5	Ti, V	–
BUMAX HEP	2.4952	Austenitic	0.10	19	>65	–	Al, Ti, Co	–

¹ The PRE (Pitting Resistance Equivalent) number shows the pitting corrosion resistance of stainless steels. A higher PRE number indicates better corrosion resistance. The PRE is defined as follows, in weight %: $PRE = \% Cr + 3.3 \times \% Mo + 16 \times \% N$

² The standard version of BUMAX Lean Duplex is 1.4162 (PRE 26), but we are also able to supply 1.4661 (PRE 33).

Physical properties at 20 °C

Material classes	Thermal expansion coefficient, mean values in temperature ranges ($\times 10^{-6}$) per °C						Magnetic permeability
	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C	20–600°C	
BUMAX 88	16.5	17	17.5	17.5	18	18	1.006
BUMAX 109	16.5	17	17.5	17.5	18	18	1.007
BUMAX Nitro	–	15.5	16	16.5	17	17	1.003
BUMAX SA	16	16	16.5	16.5	17	17	1.003
BUMAX LDX	12.5	13	13.5	13.5	14	14.5	100
BUMAX DX	12.5	13	13.5	13.5	14	14.5	100
BUMAX SDX	12.5	13	13.5	13.5	14	14.5	100
BUMAX HDX	12.5	13	13.5	13.5	14	14.5	100
BUMAX Ultra	11.5	12	12	12.5	12.5	13	1000
BUMAX HE	16.5	16.5	17	17	17.5	17.5	1.007
BUMAX HEP	12	13	13	13.5	13.5	14	1.001

Corrosion resistance

Material classes	Urban	Marine, salt water		Hydrochloric acid (HCl) at 50°C				Sulphuric acid (H ₂ SO ₄) at 50°C		
	High ²	Low ¹	High ²	0.1%	1%	2%	3%	1%	10%	30%
BUMAX 88	○	○	○	○	●	●	●	○	●	●
BUMAX 109	○	○	○	○	●	●	●	○	●	●
BUMAX Nitro	○	○	○	○	○	●	●	○	○	○
BUMAX SA	○	○	○	○	○	○	●	○	○	○
BUMAX LDX	○	●	○	○	●	●	●	○	○	●
BUMAX DX	○	○	○	○	○	●	●	○	○	●
BUMAX SDX	○	○	○	○	○	○	●	○	○	○
BUMAX HDX	○	○	○	○	○	○	○	○	○	○
BUMAX Ultra	○	○	●	●	●	●	●	○	●	●

○ No corrosion under normal conditions

● Not suitable, corrosion is likely to occur

○ Possible risk of corrosion, but the steel grade might be suitable depending on requirement, environment, design and maintenance.

¹ **Low:** Mild condition, such as low concentrations at low temperatures.

² **High:** Severe condition, such as high concentrations at elevated temperatures.

■ Mechanical properties in condition as delivered

Material classes	Dimensions	Property classes	Screws and stud bolts				Elongation, min	Nuts	Washers		
			Tensile strength R_m , min.		Yield strength $R_{p0.2}$, min.					Stress under proof load, min.	Hardness, min.
			MPa	ksi	MPa	ksi					
BUMAX 88	M3 – M36	88	800	116	640	92	0.3 d	800	200		
BUMAX 88 PED	M6 – M30	88	800	116	640	92	0.4 d	800	200		
BUMAX 109	M3 – M12 > M12	109	1,000	145	900	130	0.2 d	1,000	300		
BUMAX Nitro	≤ M42	109	1,000	145	900	130	0.2 d	See note ²	See note ²		
		129	1,200	174	1,080	156					
BUMAX SA	≤ M42	88	800	116	640	92	0.2 d	See note ²	See note ²		
		109	1,000	145	800	116					
BUMAX LDX	≤ M42	88	800	116	640	92	0.3 d	See note ²	See note ²		
		109	1,000	145	900	130					
		129	1,200	174	1,080	156					
BUMAX DX	≤ M42	88	800	116	640	92	0.3 d	See note ²	See note ²		
		109	1,000	145	900	130					
		129	1,200	174	1,080	156					
BUMAX SDX	≤ M42	88	800	116	640	92	0.3 d	See note ²	See note ²		
		109	1,000	145	900	130					
		129	1,200	174	1,080	156					
BUMAX HDX	≤ M8	88	800	116	640	92	0.3 d	See note ²	See note ²		
		109	1,000	145	900	130					
		129	1,200	174	1,080	156					
BUMAX Ultra ¹	≤ M16	149	1,400	203	1,260	182	0.2 d	See note ²	See note ²		
		159	1,500	217	1,350	195					
		169	1,600	232	1,440	208					

¹ BUMAX Ultra is a grade that is tailor-made to solve customer needs with respect to strength, ductility, fatigue and wear resistance. Values in the table are typical strength values, but even higher strength levels can be achieved with some designs and dimensions, up to tensile strength levels of 2,500 MPa.

² On request.

The data shown in the table are typical and representative for the majority of standard fasteners. May be subject to alterations, depending on size and design.

■ Properties at high temperatures

The properties of fasteners change at high temperatures. In addition to typical yield strength losses (see diagrams) we regard the changes in further mechanical properties when long time use at high temperatures is required. The changes include ageing and creep deformation.

Ageing, which occurs in all stainless steel materials, is increased with high tension in the material together with high temperatures or temperature variations. It can lead to a loss in ductility in the material.

By creep deformation we mean slow plastic deformation under the influence of mechanical stress, which can even be lower than the $R_{p0.2}$, in case of long time influences. This behaviour is further amplified by high temperatures. BUMAX HE and BUMAX HEP are high temperature-resistant materials which are optimised for use at high temperatures. In comparison to standard stainless steel are considerably more resistant to ageing, gas oxidation, creeping and strength loss.

■ Properties at low temperatures

Increased brittleness at temperatures under -20°C is typical for all steel. Brittleness is mainly depending on its microstructure, chemical composition and internal stress.

Generally, at very low temperatures austenitic stainless steel has a higher impact strength than a duplex alloy or ferritic or martensitic stainless steel.

Yield strength $R_{p0.2}$ (MPa)

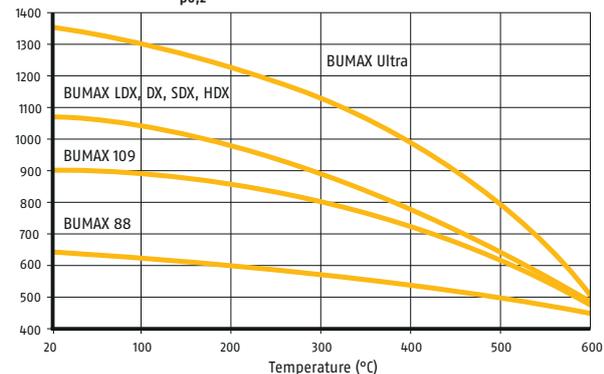


Fig 1. Typical yield strength losses at higher temperature for stainless steel

Yield strength $R_{p0.2}$ (MPa)

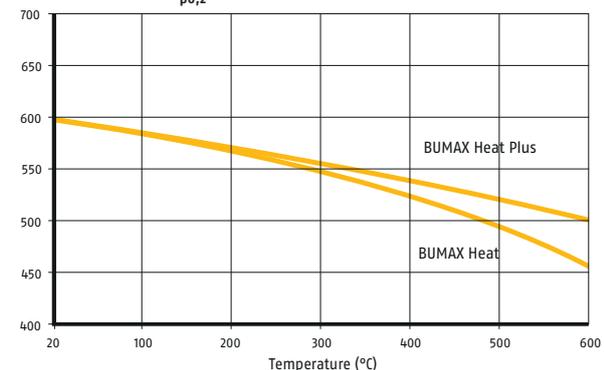


Fig 2. Typical yield strength losses at higher for heat resistant grades



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 - ▶ Further BUMAX materials for special parts on request
- ✓ Possible temperature range from -200°C to $+815^{\circ}\text{C}$ (-328°F to 1499°F)
- ✓ High corrosion resistance
- ✓ High strength
- ✓ Very good fatigue strength
- ✓ Low permeability (magnetism)

Information: REYHER ist not the manufacturer of the BUMAX products. The manufacturer reserves all rights for technical modifications. Understandably, the application of the products assumes expertise on their use and assembly as well as standards.