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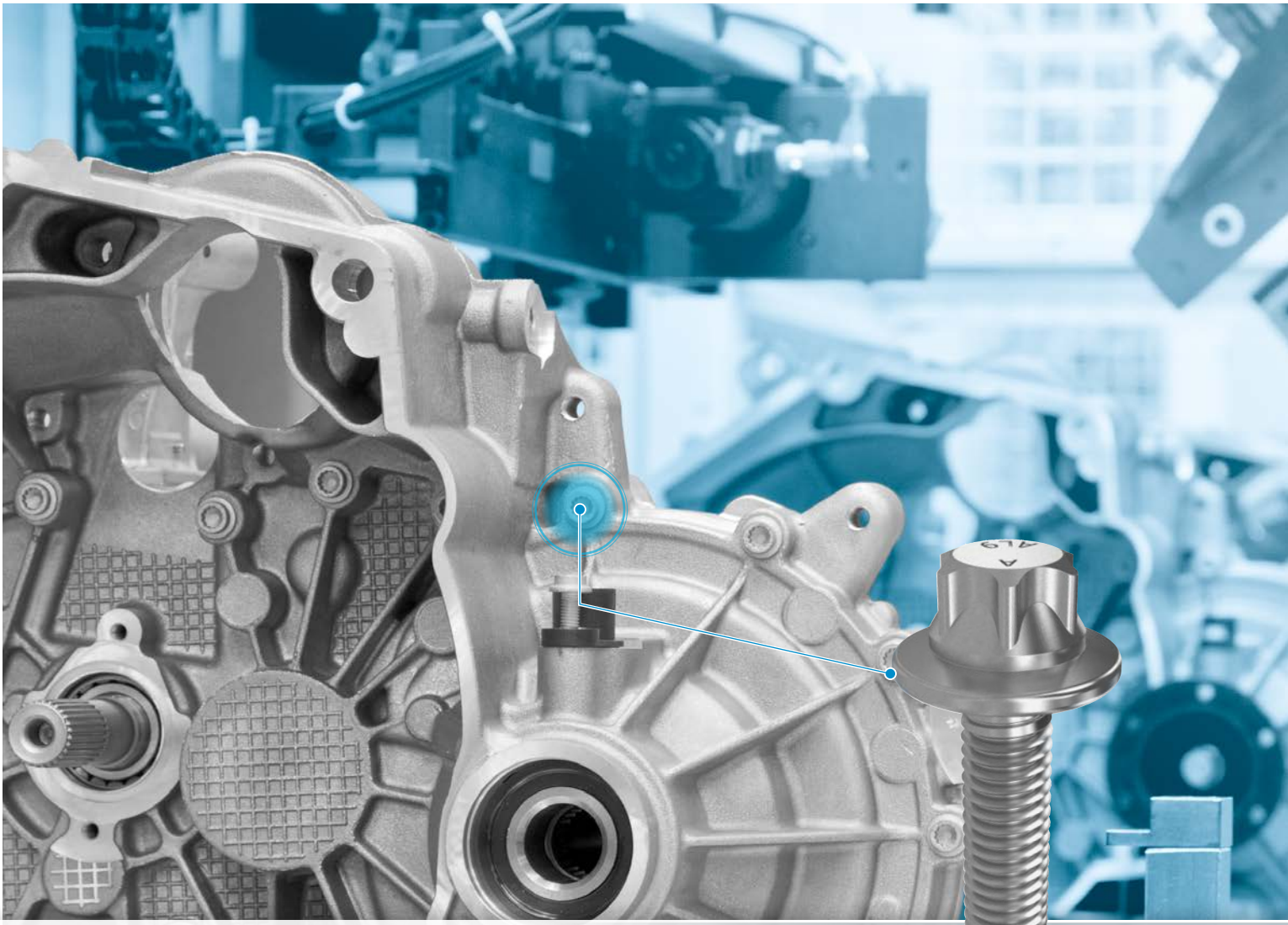
ARNOLD®
BlueFastening Systems



Alufast®

Light and easy fastening

- lightweight
- flexible
- durable
- stable
- environmentally friendly
- corrosion resistant

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Alufast® – aluminium screws and form parts

The trend – particularly in the automotive industry – is towards lightweight materials. Aluminium and magnesium alloys are in increasing use in many fields of technology. So fastening technology needs to adapt too. Aluminium offers countless options because the material is so versatile for cold forming. Under the Alufast® name ARNOLD UMFORMTECHNIK has brought together screw fasteners and form parts made from aluminium. Our many years of experience working with aluminium, including extensive research are your guarantee of optimum fastening results. We are constantly optimising our processes, ensuring that our Alufast® products are always at the latest state of technology.

Product groups

Aluminium screws

Aluminium form parts

Alufast® – Not just a fastener

- Material
- Weight
- Fastening properties
- Operating safety
- Thermal resistance
- Corrosion resistance
- Screw assembly
- Repeated screw assembly
- Design options and geometry
- Manufacturing feasibility

Component consisting of screw (EN AW 6056) and form part (EN AW 5754), securely assembled with an O-ring.

Note: The values shown are by way of example parameters. Specific values must always be determined by carrying out trials on original production parts. Our Fastener Testing Centre is always available to help.

Aluminium screws

Aluminium screws from our Alufast® range are primarily deployed in the lightweight automotive industry. Particularly when combined with magnesium, aluminium or synthetic components, aluminium delivers many benefits. We use EN AW 6056 (AlSi1MgCuMn) alloy as our original material, known by its designation class of AL9. Depending on the customer's requirements certain characteristics can be set using our optimally adjusted processes (see table).

M 8.0 x 55.0 fillister head screw

M 6.0 x 27.5 external torx screw with central collar

M 6.0 x 23.0 external torx screw with groove and O-ring

EN AW 6056 (AlSi1MgCuMn)

Tensile strength R_m	> 400 MPa
Elongation limit $R_{p0.2}$	> 350 MPa
Breaking elongation A_5	> 10%
Breaking elongation A (determined on a minimum of 1.5xd free loaded elongation lengths)	> 8%
Maximum operating temperature T (short-term temperature resistant up to 180°C)	< 150 °C
Density σ	2.7 g/cm³
Elasticity module E	69,000 MPa
Linear thermal expansion coefficient	23.1 x 10^{-6} K^{-1}
Heat capacity	960 J/(kgK)
Heat conductivity	230 W/(mK)

Alufast® Screw compared with 8.8 Steel Screw

	Alufast® screw	Steel screw 8.8
Designation of screw	Fillister head screw; M 6.0 x 16.0; T30 drive	Fillister head screw; M 6.0 x 18.0; T30 drive
Material used for screw	EN AW 6056 (AlSi1Mg-CuMn); Strength class T6	Standard material; strength class 8.8
Weight of screw	2.0 g	6.2 g
Free minimum breaking torque of the screw MB_{min}	6.8 Nm	13.0 Nm
Minimum tightening torque MA_{min}	Torque, angle-controlled assembly	8 Nm Torque assembly
Minimum preclamping force FV_{min}	5.8 kN	5.6 kN
Component material	Die cast magnesium AZ91	Die cast magnesium AZ91
Component strength	~ 110 HB2.5 / 62.5	~ 110 HB2.5 / 62.5

ALUMINIUM -65% WEIGHT ADVANTAGE

Fastening properties

Due to the low E-module, the flexibility of an aluminium screw is much greater than that of a steel screw (E = 70000 M Pa, E = 210000 M Pa). With the high elasticity of the connection made between the lightweight metal component and the aluminium screw, additional thermally induced stresses on the screw are lower than in comparable applications using steel screws. This minimises setting and creeping as well as preclamping force loss, resulting in a high level of assembly reliability.

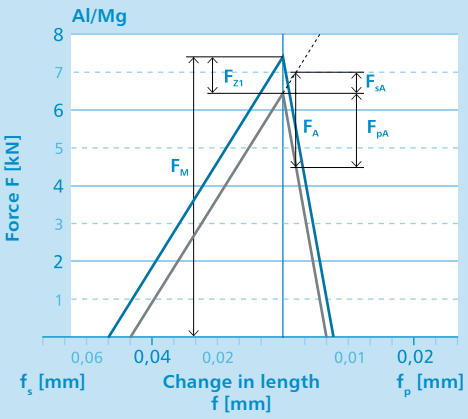
Alufast® Screw compared with steel screw 8.8

	Material
Alufast® screw	✓
Steel screw 8.8	✗

40% less preclamping force loss caused by thermally induced irreversible expansion of the screw connection

Al/Mg

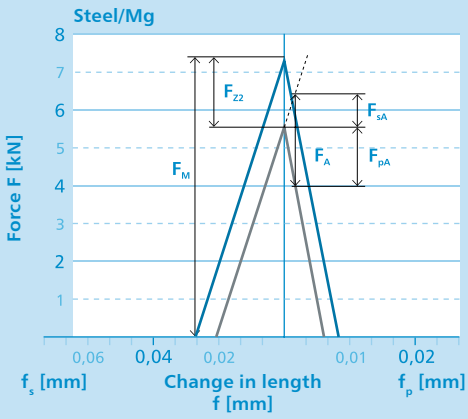
Alufast® screw/clamping part in magnesium AZ91



F_{zn} = loss of preclamping force as result of setting
F_A = operating force
F_M = assembly preclamping force
F_{pA} = proportion of operating force that relieves the clamped parts
F_{sA} = proportion of operating force that additional relieves the screw
f_s = change in length of screw
f_p = change in length of clamped parts

Steel/Mg

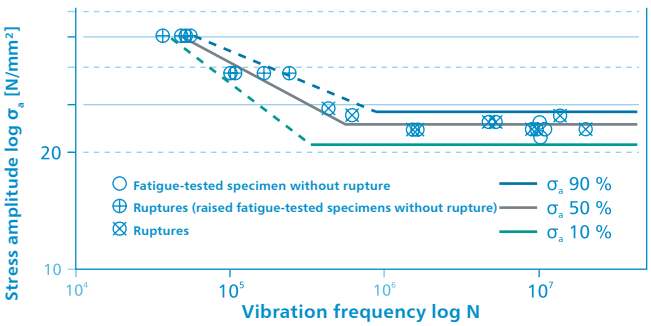
8.8 steel screw/clamping part in AZ91 magnesium



Operating safety

The high level of flexibility is also a benefit when subject to vibration stress. Over an endurance test of 10^7 vibration cycles, our Alufast® screws achieve vibration resistance values of at least 20 MPa at an average stress of 70% of the screw's elongation limit $R_{p0.2}$. This means that in tests and in practice they create secure and enduring fastenings.

Dynamic strength in endurance fatigue test as per DIN 969



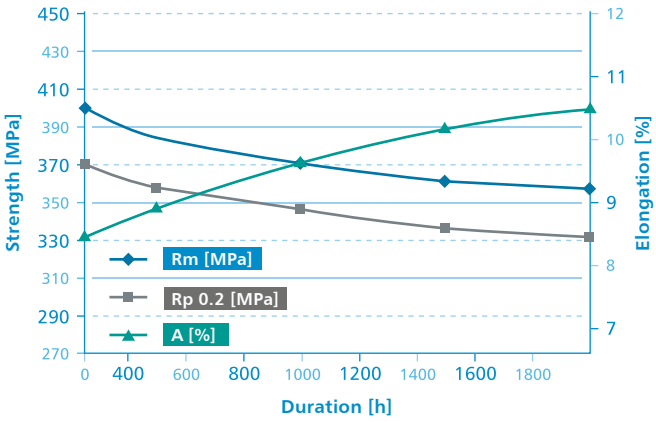
Weight	Fastening properties	Operating safety	Corrosion resistance	Design options and geometry
✓	✓	–	✓	✓
✗	✗	–	✗	✗

✓ positive ✗ negative – neutral

Thermal Resistance

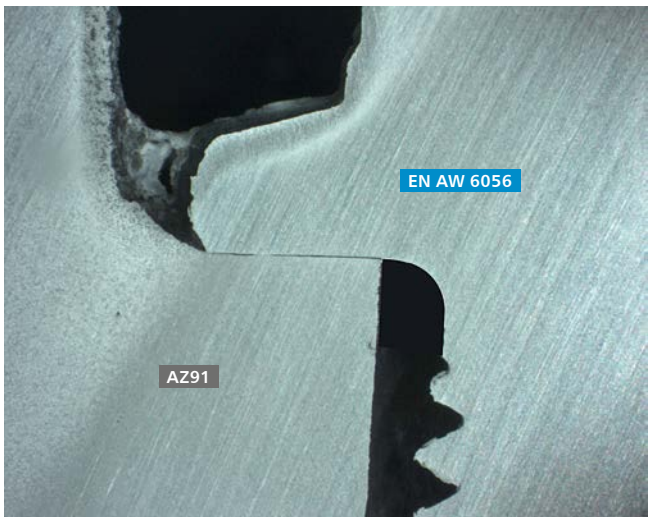
The specifications set by the automotive industry are explicit: a metric screw made of aluminium must guarantee strength loss of less than 10% under the effects of temperature (2000 hours at 150°C), in relation to its nominal strength (RmNenn = 380 MPa). In long term endurance tests our Alufast® screws meet this requirement and can therefore be used inside thermally stressed components such as gear boxes and engines. As opposed to steel, aluminium, magnesium and synthetic materials possess high thermal expansion coefficients. The aluminium screw is therefore a suitable material pairing for lightweight components.

Strength change under the effects of temperature 2000 hours at 150°C



Corrosion resistance

Thanks to our constant optimisation of processes and materials technology our Alufast® screws meet the ISO 11846 method B intercrystalline corrosion requirements. Screws made of the EN AW 6056 alloy can be put to use without problem in all standard aluminium and magnesium die cast alloys. There are two reasons for the low contact corrosion: similar electro-chemical potential and heat treatment that is designed especially for the material. It means that the corrosion protection costs can be greatly reduced. And of course, the EN AW 6056 alloy is also fully resistant to stress crack corrosion. In particular this property must be guaranteed for notched components which are permanently under stress.



Contact area of Alufast® screw (EN AW 6056) and housing flange (AZ91) after 720 hours salt spray test (ISO 9227)

Note: The values shown are by way of example parameters. Specific values must always be determined by carrying out trials on original production parts. Our Fastener Testing Centre is always happy to answer any further questions you may have.

Screw assembly

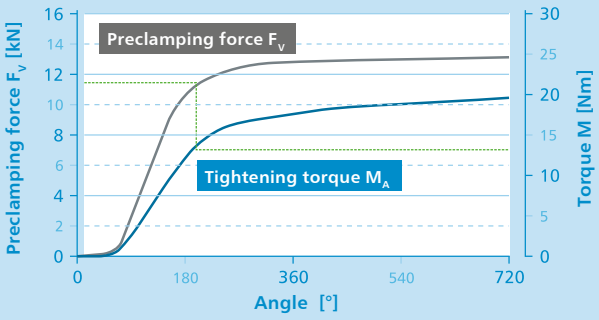
In the main our customers tighten Alufast® screws under torque control and torque-angle control.
To benefit to the maximum from screw strength we recommend a super-elastic screw assembly, such as using the torque-angle controlled tightening procedure. Due to the material used and depending on the clamping length l_K present sufficient ductility is available, as shown on the graph for an M8 x 55 screw. A poorly torque controlled screw assembly has a weakness in that the screw-in torque is directly dependent upon the screw's friction coefficient. We therefore provide various coatings with set friction characteristics. The table shows some guideline values. They do not take into consideration any special characteristics of customer-specific applications. Please always verify your actual assembly specifications with trials in actual practice. Our staff at the FASTENER TESTING CENTER will be delighted to assist you with this.

Guideline values for screw assembly

	M5	M6	M8	M10	M12
Minimum breaking torque M_{Bmin} [Nm]*	4.0	6.8	16.0	32.5	58.0
Minimum breaking force F_{Bmin} [kN]	5.6	8.0	14.6	23.2	33.7
Tightening torque M_A [Nm]** ± 7 %	2.8	4.6	11.7	23.4	41.0
Preclamping force $F_{V\,min}$ [kN]**	2.6	3.5	6.6	10.6	15.5
Preclamping force $F_{V\,max}$ [kN]**	4.3	5.9	11.1	17.9	26.2
Preclamping force $F_{V\,min}$ [kN]***	4.0	5.8	10.7	17.1	25.1
Preclamping force $F_{V\,max}$ [kN]***	5.4	7.7	14.0	22.2	32.4

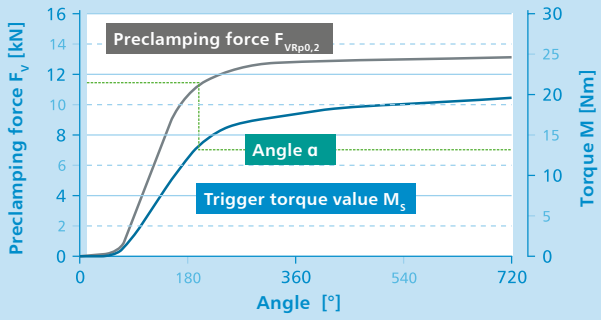
The values in this table are calculated on the basis of a friction coefficient of 0.09 – 0.15 μ and an elongation limit $R_{p0.2}$ of 350 MPa.
* Minimum breaking torque M_{Bmin} at pure torsion load on screw according to ISO 898-7
** Tightening torque M_A, and achievable preclamping force F_V during torque-controlled screw assembly.
*** Preclamping force during torque-angle controlled assembly above elongation limit. For this tightening process select a minimum clamping thickness of 1 x d.
We recommend carrying out screw driving trials at original production locations in order to ascertain the tightening specifications (torque and angle-controlled assembly).

Torque-controlled assembly



Curve values as per previous table for M8 x 55

Torque-angle controlled assembly



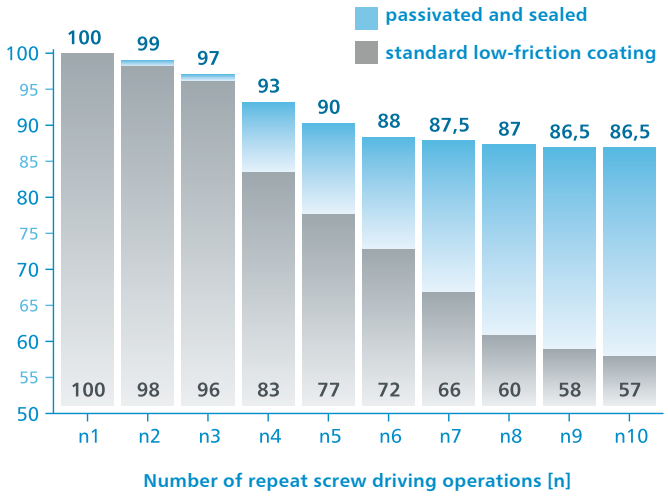
Curve values as per previous table for M8 x 55

Repeated screw assembly

Our customers want to be able to use fasteners several times in order to be able to make repairs or reworks. We can meet this need by using resistant surfaces with an integral low-friction additive. It means that we can reduce the drop in preclamping force level to a minimum, compared with a standard low-friction coating.

Achievable assembly preclamping force FM values for repeated screw driving operations, determined on AL9 class aluminium screws and aluminium nuts with a hardness value of min. 80HB. The aluminium nuts were in bright condition, and oil and grease-free.

Assembly preclamping force F_M achievable on repeated screw driving operations [%]



Design options and geometry

In principle there are no design restrictions on aluminium screws. The product range shown shows only our standard range. The external and internal force applications guarantee the best possible transfer of force and – particularly for joining lightweight metals – good surface pressure. We will be delighted to check your own aluminium components for manufacturing feasibility.

Head shape	Nominal diameter/shaft length		Thread type	Surface condition
 External Torx with flange	M5	10 mm – 80 mm	metric	bright
 External hexagon with flange	M6	12 mm – 80 mm		low friction coating
 Fillister head	M8	16 mm – 75 mm	fine	anodised
	M10	20 mm – 65 mm	Special design	passivated and sealed
 Cylinder head with flange	M12	20 mm – 55 mm		standard clamping and adhesive coatings

Formed aluminium parts

Complex extruded parts from our Alufast® range such as inserts, sleeves, bushes and nuts are widely applied in synthetic materials. They are used to strengthen component parts in the form of functional elements with toothing and fits, or in the form of a counterpart for self-tapping screw fastening. To this end we mainly use the EN AW 5754 alloy.

EN AW 5754 (AlMg3)

Tensile strength R_m	> 250 MPa
Elongation limit $R_{p0,2}$	> 200 MPa
Breaking elongation A	> 6%
Maximum operating temperature T (short-term temperature resistant up to 100 °C)	< 80 °C
Density σ	2.7 g/cm³
Elasticity module E	70,500 MPa
Linear thermal expansion coefficient	23.7 x 10^{-6} K^{-1}
Heat capacity	897 J/(kgK)
Heat conductivity	132 W/(mK)

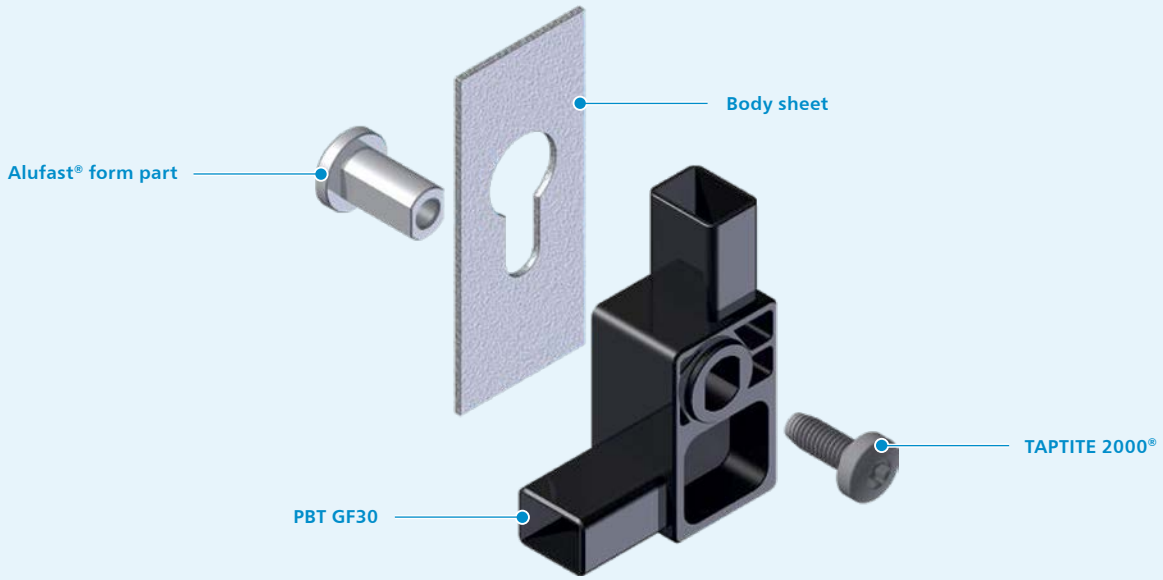
Application example

The “plastic connector” component is used in the automotive industry. It consists of a plastic moulded part (PBT GF30) with integral electronics, an aluminium extruded part (EN AW 5754) and our self-tapping TAPTITE® 2000 M6 screw (20MnB4) The extruded part is pre-assembled into the plastic component, then suspended into the carrier plate and screw-fastened with the TAPTITE® 2000 M6. The large flange and its double-flat design ensure outstanding pull-out and torsion properties, and thus a secure fastening result.

Where requirements cannot be met with the standard material stated, a different alloy will need to be selected. For example, this would apply to increased thermal resistance, greater strength, a defined electrical conductivity or solderability. Once we have analysed your application, we are able with certainty to find the appropriate solution for your application, on the basis of aluminium's versatility.

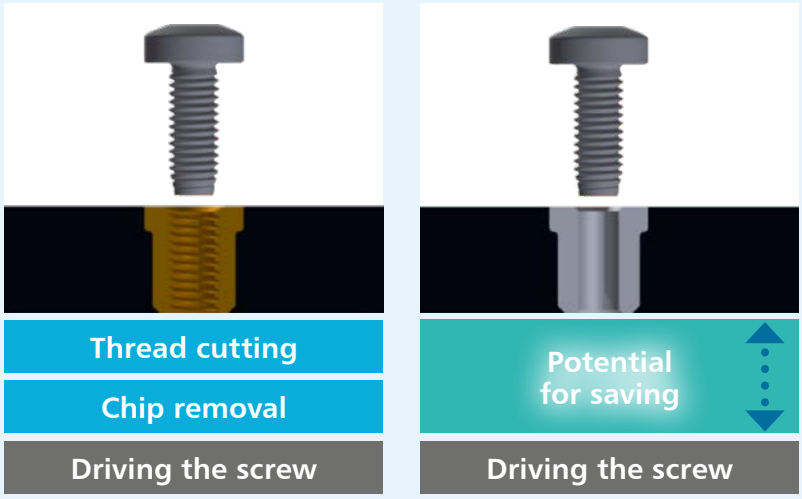
Alufast® form part compared with brass turned part

	Material
Alufast® Form part	✓
Brass turned part	✗



Added value with self-tapping screw fastening

The product range at ARNOLD UMFORMTECHNIK also provides many combination options.
For example, using a TAPTITE 2000® self-tapping screw into form parts made of aluminium delivers outstanding connection properties as well as an overall savings potential in fastenings.



Weight	Fastening properties	Operating safety	Corrosion resistance	Design options and geometry
✓	✓	✓	✓	✓
✗	✗	✗	✗	✗

✓ positive ✗ negative – neutral

Operating safety

The operating safety of a fastening is crucially determined by the partnering connecting piece. The decisive features are the choice of material and the geometric design of the fasteners. The right combination will guarantee a high level of functionality and the maximum possible flexibility. At our FASTENER TESTING CENTRE some simple assembly trials demonstrate failure scenarios by imposing static, dynamic, and thermally induced influencing factors. Our staff will be delighted to assist you in this respect.

FASTENER TESTING CENTER

Corrosion resistance

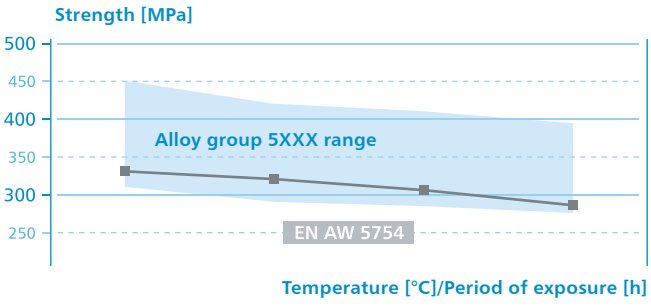
As a general rule EN AW 5754 alloy formed parts can be used without problem both inside and outside the vehicle. The natural oxide layer and the low proportion of elements prone to corrosion are in favour of a high level of resistance to base material corrosion. In the ISO 9227 SS test fasteners in the alloy group concerned indicate resistance of over 720 hours with no additional surface treatment.

Micro-section showing corrosion analysis

Thermal resistance

Aluminium inserts, sleeves, bushes and formed parts are essentially used as strengthening elements or embedded into applications involving synthetic materials. Of course in addition to the fastener itself, we also examine how our customers will be processing it. For example, as early as the material selection stage we can take into consideration any loss of strength likely to occur due to thermal load. It is also possible to user them in components subject to consistently high operating temperatures.

Alloy group 5XXX strength under thermal load

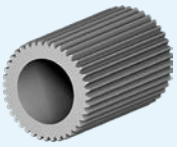


Design options and geometry

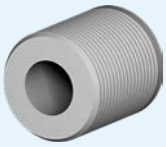
The multiple manufacturing and design option make aluminium a universal engineering material. We supply standardised fasteners as well as custom parts from your drawings.

Moreover, our products can also fasten to components (screws, O-rings, sleeves). Here are some examples.

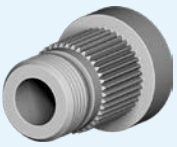
Fasteners pressed into synthetic materials



Longitudinal knurl



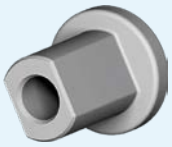
Longitudinal knurl



Combination

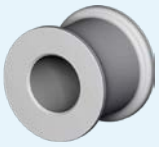
Flange bushing with longitudinal knurl

Fasteners for plastic moulding



Double flat

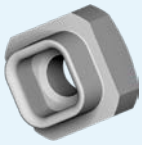
Multi-faceted



Rear section

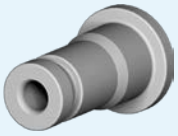
Flange bushing in double flat version

Parts from drawing / functional elements as per customer specifications



Clinch nut

Shaft with toothing

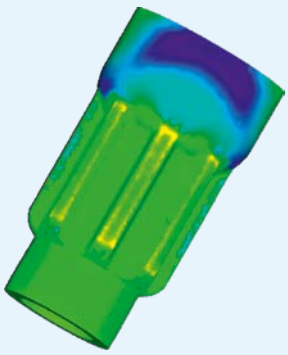


Bushing with groove (O-ring)

Aluminium clinch nut with internal thread

Manufacturing feasibility

There are various ways to evaluate your particular fastening task. We can use FEM simulation to intensively examine the technical manufacturing feasibility for complex form and extruded parts. Further, our FASTENER EXPRESS service can provide functional samples and prototypes, and our FASTENER TESTING CENTRE is available for trials.



Extract from FEM simulation

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The ARNOLD GROUP

Wherever customers need us.

The ARNOLD GROUP

ARNOLD – this name is internationally renowned for efficient and sustainable fastening systems on the highest level. With a foundation of many years of expertise in the production of intelligent fastening systems and very complex extruded parts, the ARNOLD GROUP has developed over a number of years into a comprehensive supplier and development partner for complex fastening systems. With our positioning of "BlueFastening Systems" this development process will continue under a united and harmonized structure. Engineering, fasteners, and functional parts, together with feeding and processing systems, all from a single source – efficient, sustainable and international.

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