Version 06.2021
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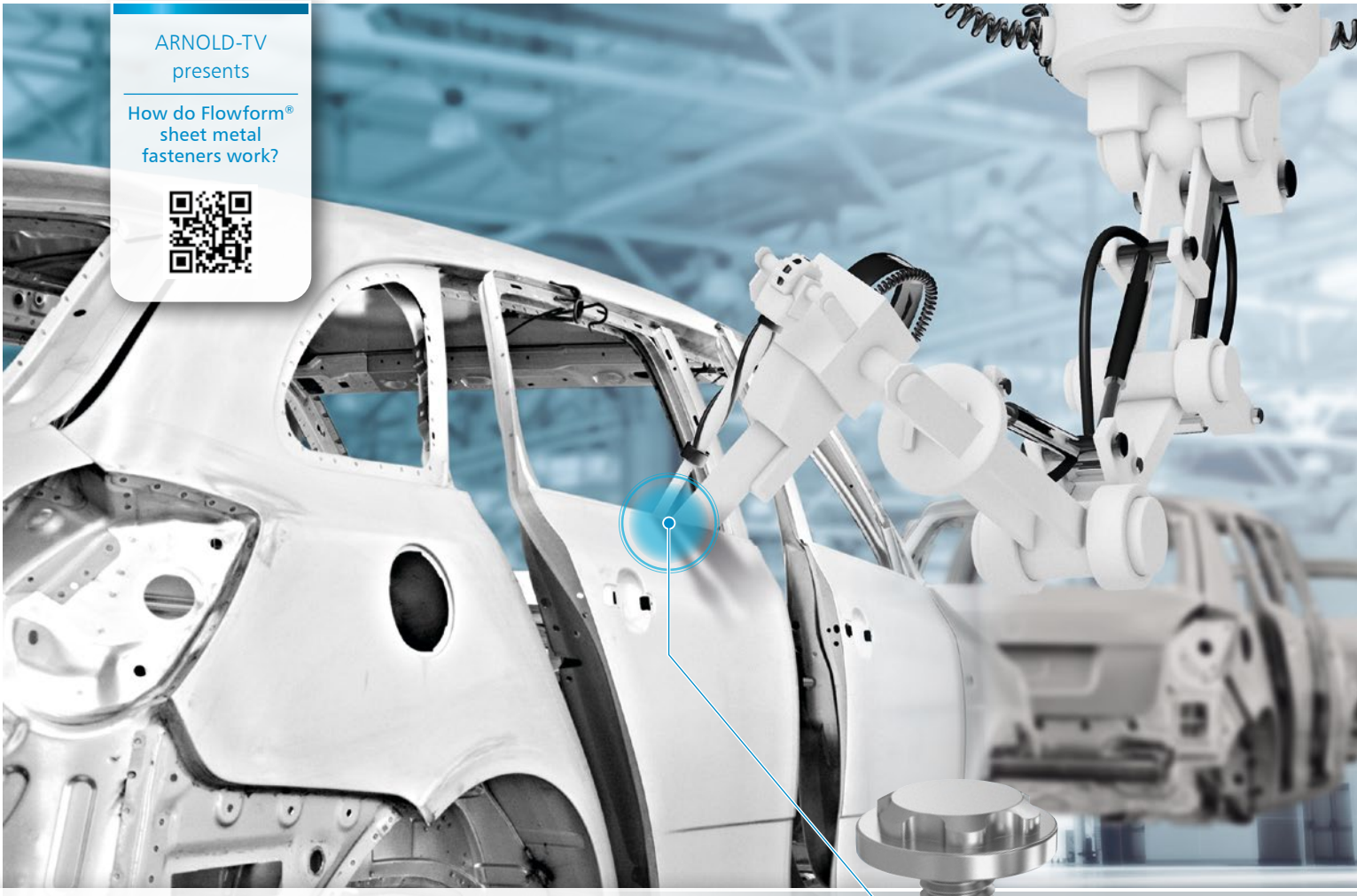
ARNOLD®
BlueFastening Systems



Flowform®
Flowform® Plus

Flowhole and thread-forming screws

- Self-piercing and extruding fastener
- Accessible from one side
- Capacity for undo the joint
- Fully automated and process reliable
- Economical
- Sheet metal joining technology
- Mixed structures – hybrid structures
- Lightweight structures

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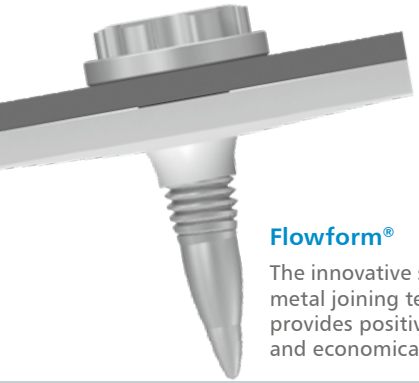
The sheet metal joining technology of the future: Flowform®



Flowform®
The innovative sheet-metal joining technology provides positive technical and economical benefits.

The In sheet-metal joining the trend is towards ever thinner sheet metals, and the fasteners used need to be higher strength than ever. The need at times to join highly disparate materials makes the task even more challenging. In such situations, conventional joining processes often reach their limits.
Our answer to the increasing challenges arising in the metal-joining sector is called Flowform®. **This self-Piercing and Extruding Fastener provides a fully automated join, with no pre-drilling and accessible from one side.** Flowform® fastenings are also very economical and reliable.

A COMPARISON OF CURRENT JOINING

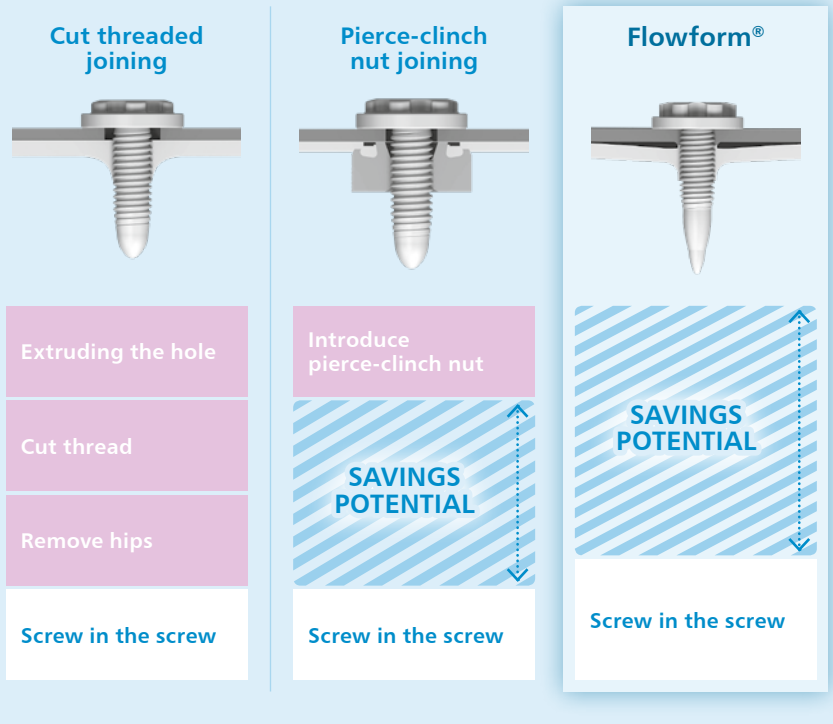
		Accessible from one side	Capacity to undo the joint	Axial joining forces	Joining properties
Flowform®		✓	✓	✓	✓
Solid Punch and Self-pierce Riveting		✗	✗	✗	✗
Bolt setting at high speed		✓	✗	✗	✗
Clinching		✗	✗	✗	✗
Bolt Friction welding		✗	✗	✗	✓
Resistance spot welding		✗	✗	✓	✓
Blind rivet nuts		✓	✗	✓	✓

Source: LWF® – Laboratory for Material and Joining Technology

Multi-materials mix	No pre-drilling joining
✓	✓
✓	✓
✓	✓
✓	✓
✓	✓
✗	✓
✓	✗

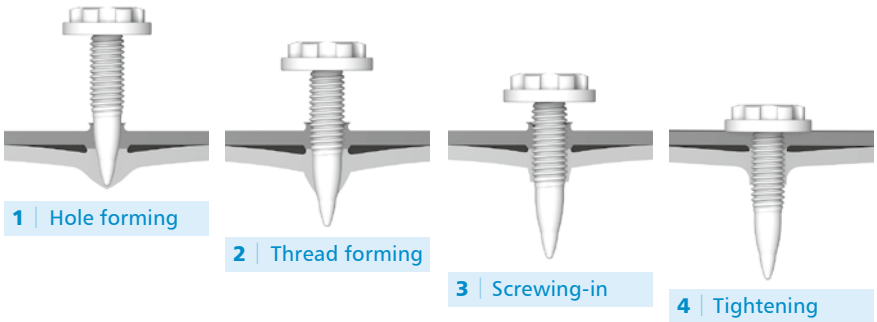
Save time and money with Flowform®

- No pre-drilling operations
- No thread cutting
- No chips formed during screw-in
- Greatly reduced cycle times



This is how Flowform® works

The Flowform® screw heats up and penetrates the sheet metal. With its polygonal tip geometry it forms a extruding hole and taps a thread. This thread is able to accept a metric screw if it ever needs repair. After it has been screwed in, the formed extruding hole adjusts optimally to the contours of the screw.



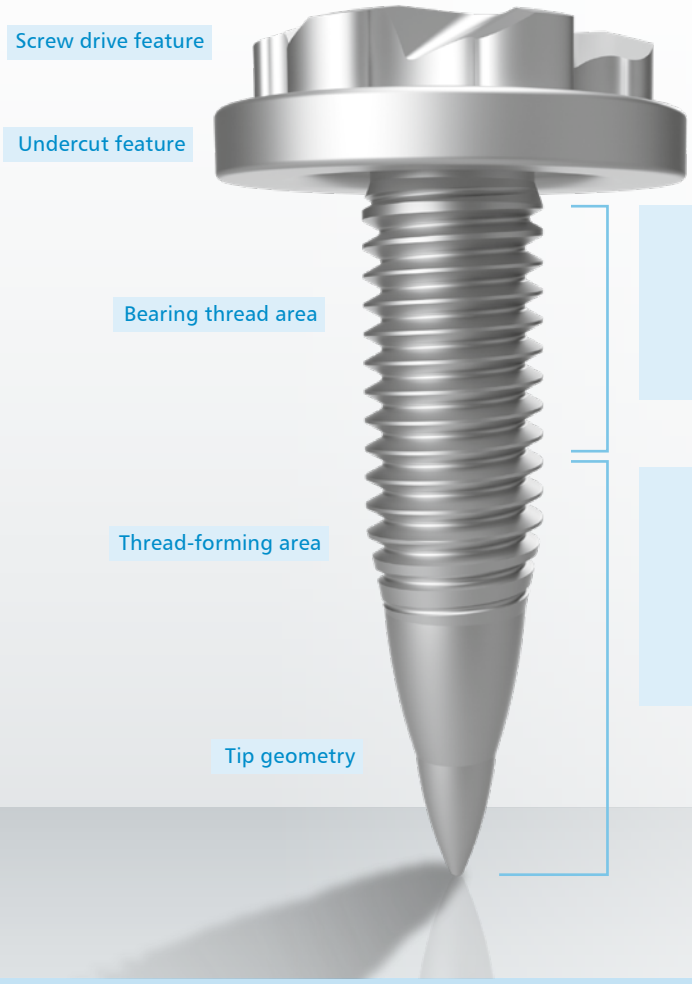
1 | Hole forming

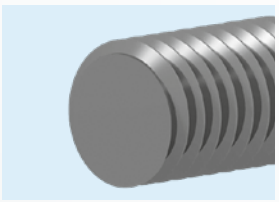
2 | Thread forming

3 | Screwing-in

4 | Tightening

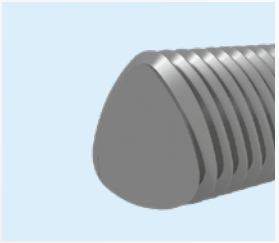
Flowform® – from head to tip





Round shaft cross-section

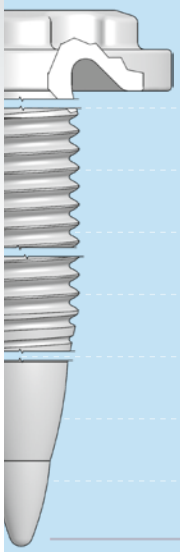
- 60° flank profile
- Over-sized thread diameter



Polygonal shaft cross-section

- Radius flank profile
- increasing shape of thread over the thread-forming area

Flowform® shaft of screw: benefits and specifics



bearing thread area

Over-sized thread diameter
- the over-sized thread provides 100% thread engagement
- high pull-out forces
- high tightening torque
- formed thread able to accept a metric screw

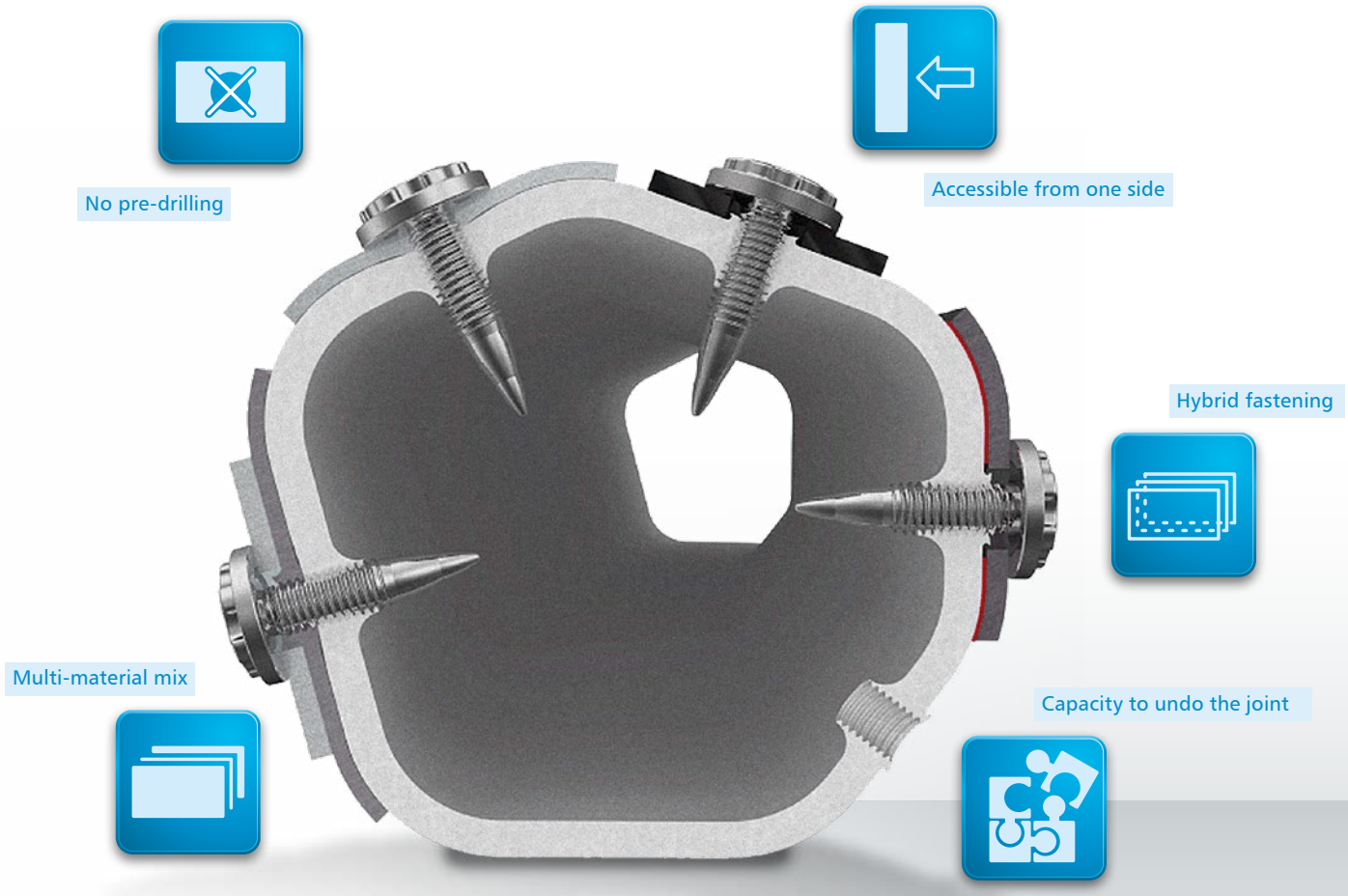
thread-forming area

Thread-forming area
- low thread-forming torques
- no chip formation during thread-forming

tip geometry

Slim tip shape
- low axial joining forces
- fast cycle times
- short penetration times
- little component deformation
- no chip formation

Fields of application for Flowform®



Areas of application

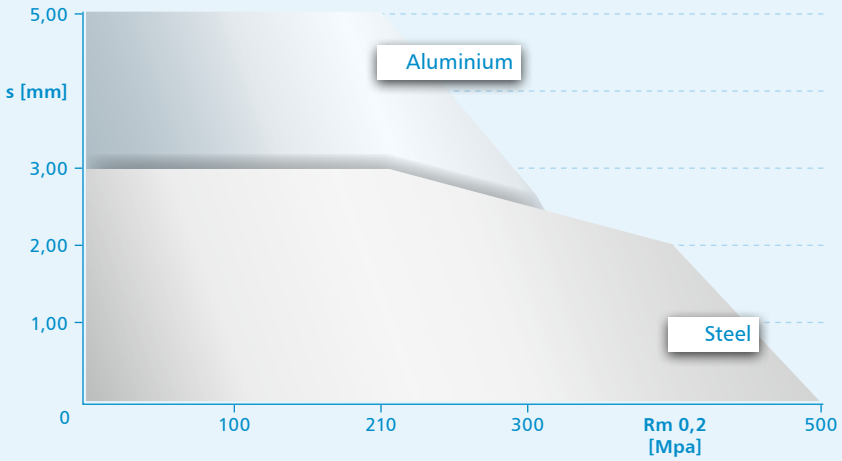
- hybrid fastenings
- multiple sheet metals
- fibre-reinforced applications
- high-strength sheet metals

White goods

Automotive

Other metal machining industry

Illustration showing the application field for materials, thickness and strength



The image shows the range of applications for Flowform® screws. It is based on experience gained during practical use.

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 applications laboratory is always happy to answer any further questions

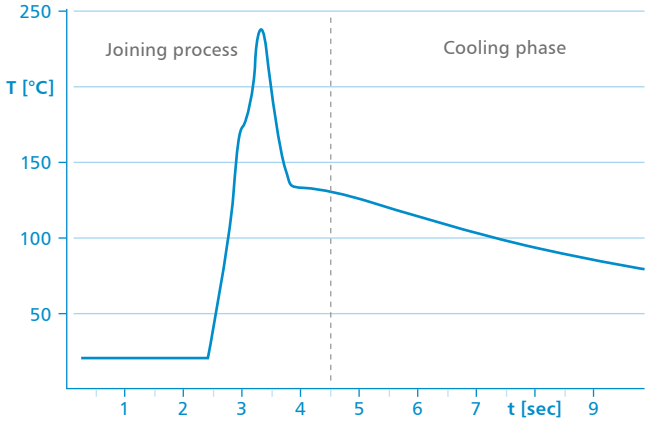
The screw-in process and process parameters

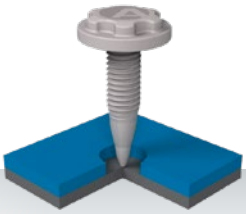
The screw-in process is divided into five separate steps. Different parameters need to be selected for each of these steps. These parameters depend on the joining combinations. Material thickness and strength, heat conductivity and the component rigidity all play a significant role in selecting the parameters.

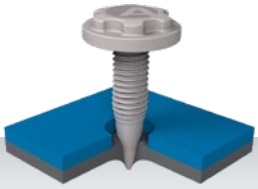
The process parameters for each step consist of control, target and monitoring variables. See page 12 for further information

Temperatue curve

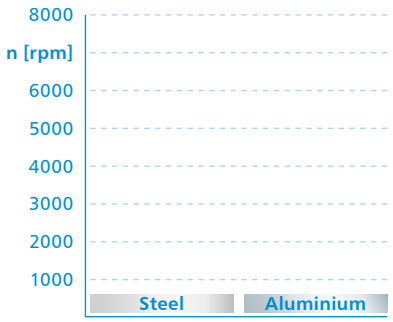
The graph shows a typical temperature curve during the joining process.





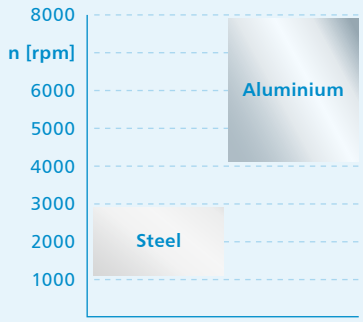


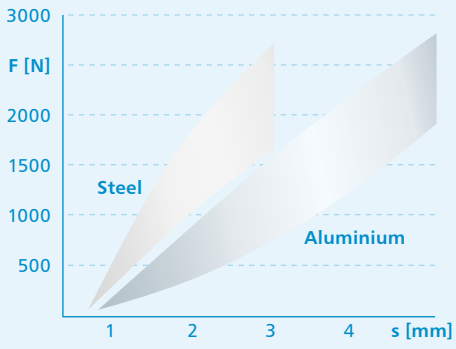
0 Positioning



- Feed fastener
- Find drive engagement
- Use hold-down plate to clamp metal plates together
- Position the fastener

1 Hole forming





- Initiate rotation speed
- Initiate axial joining force
- Locally plastify the joining area
- Tip penetrates

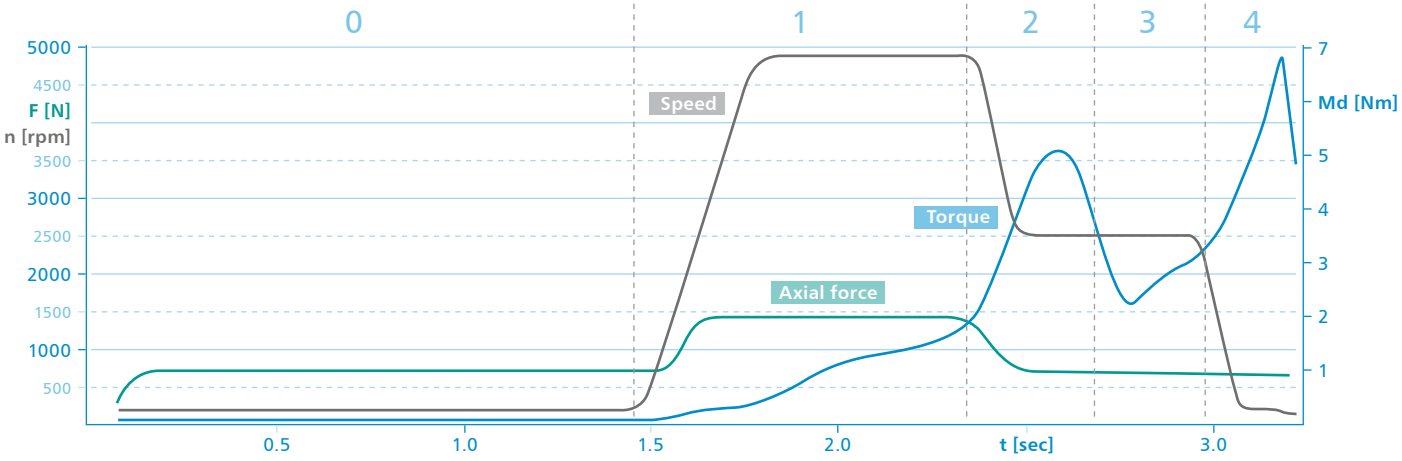
Rotation speed and axial joining force depend on material and thickness

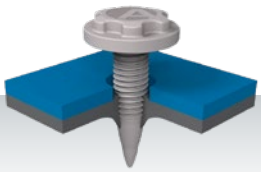
Note: The values shown are by way of example parameters. Specific values must always be determined by carrying out trials on original production parts. Our applications laboratory is always happy to answer any further questions you may have.

ARNOLD®
BlueFastening Systems

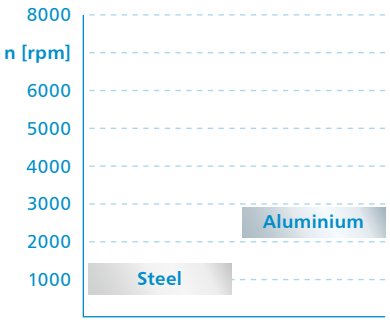
Flowform® screw curve

The values shown are simply examples. The actual occurring and necessary values must be investigated on the original component.

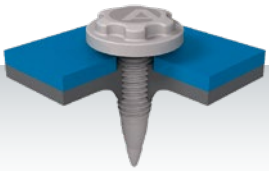




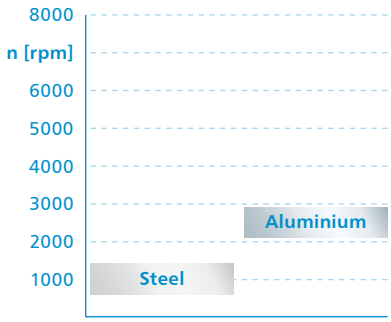
2 Thread forming



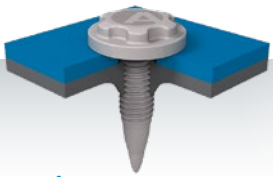
- Reduce rotation speed
- Reduce axial joining force
- Create a thread that is able to accept a metric screw



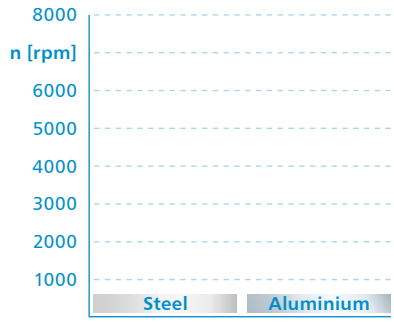
3 Screwing in



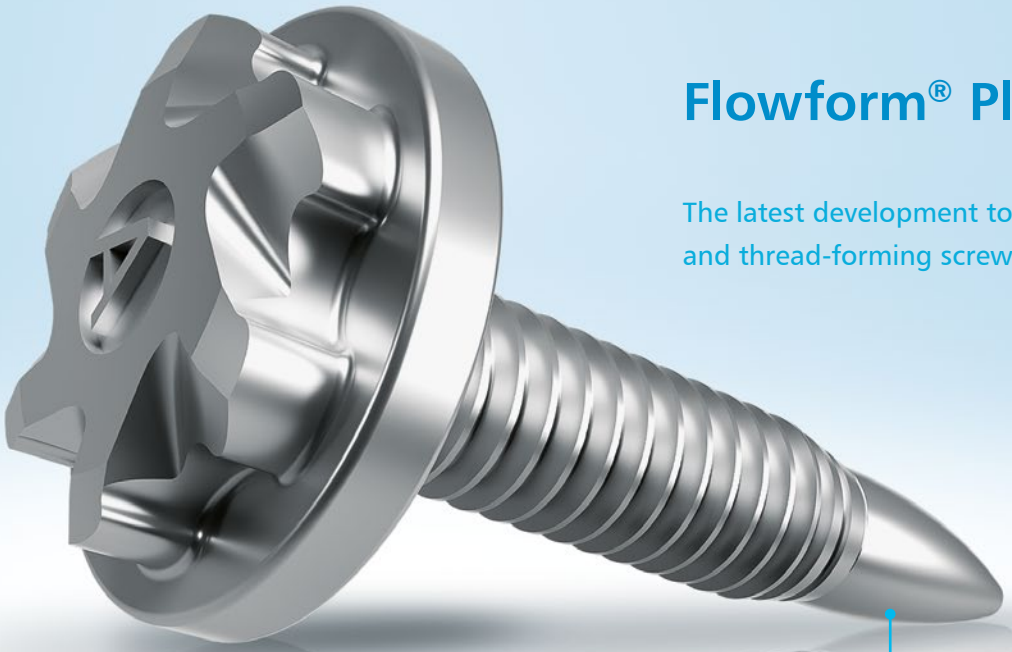
- Maintain rotation speed
- Maintain axial joining force
- Calibrate the formed thread



4 Tightening

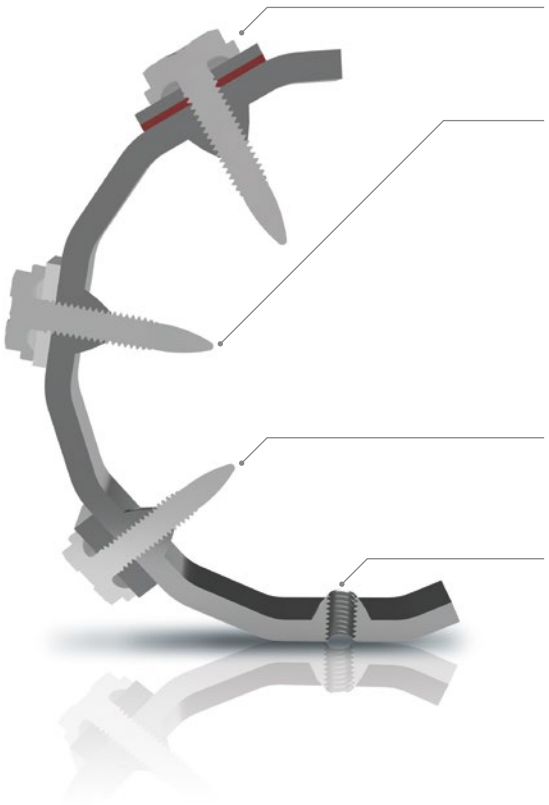


- Reduce rotation speed
- Maintain axial joining force
- Create pre-load force by final tightening torque
- Joining point cools down

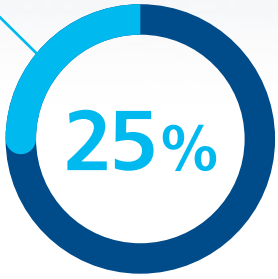


Flowform® Plus

The latest development to enhance flow-hole and thread-forming screws



- Steel sheets up to 1,000 MPa with a thickness ≤ 1.0 mm in combination with an aluminum bottom layer are joinable
- Ideal for joining aluminum sheets without pre-holes, while also reducing gap formation
- Despite the smaller size, it has very good fastening properties due to the ductile and very high strength screw material
- Can be used on existing series production equipment
- 25% weight saving by scaling down the size of the fastener
- In thicker joint pairings, no pre-hole is required in the clamping part
- Can be removed



lighter

than Flowform®
due to downsizing

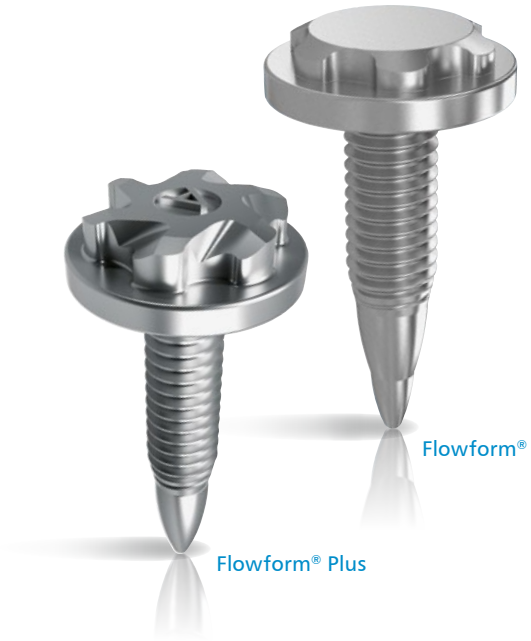
Comparison relates to
the same length of screw

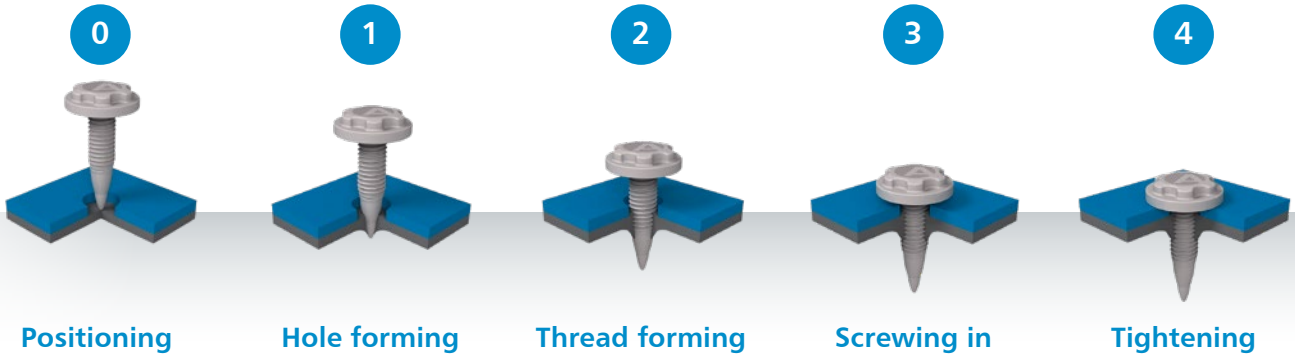
Flowform® Plus
Screw curve (right)

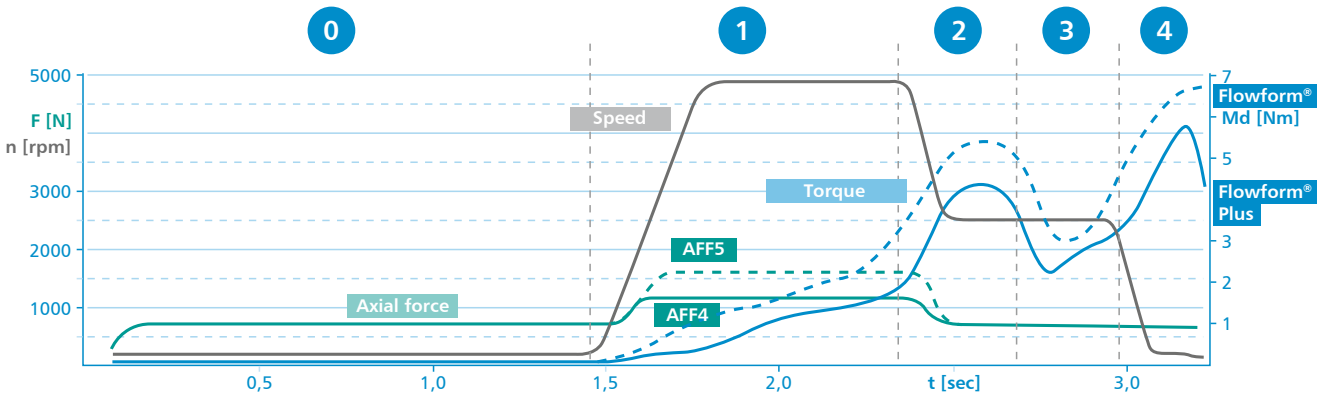
The values shown are simply examples. The actual occurring and necessary values must be investigated on the original component.

Flowform® Plus – the advanced screw that weighs less

- Reduces thread forming torque
- 25% weight reduction
- Can join sheet steel up to 1,000 Mpa strength
- Expands the range of applications
- Less gap formation

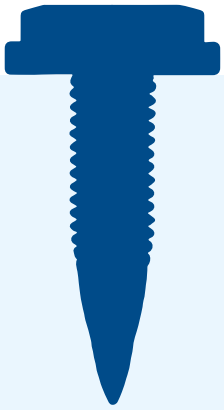


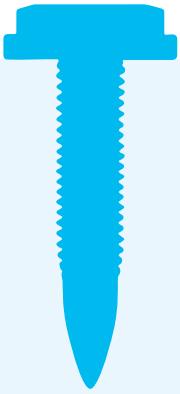




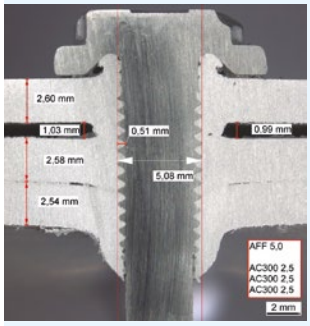
Flowform® Plus – reducing weight by decreasing the diameter of the fastener

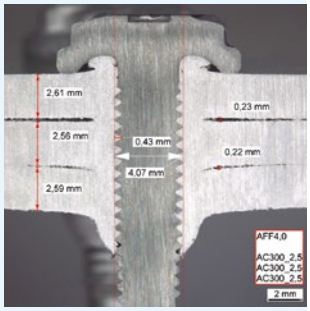
Flowform® Plus – creating the lightweight advantage



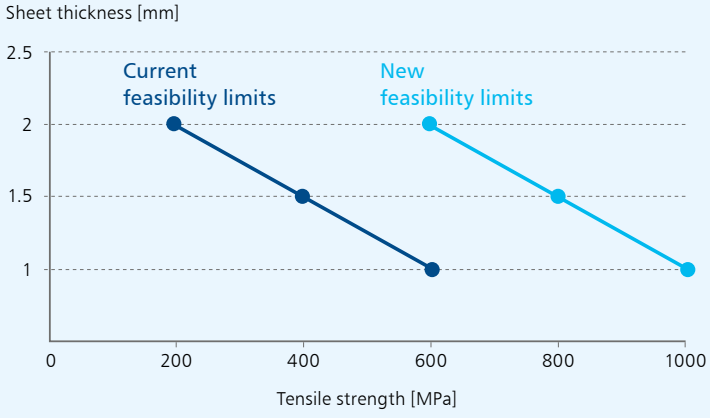


Flowform®		Flowform® Plus
5.0	Diameter	4.0
4 g	Weight approx.	3 g
✗	Join without pre-hole	✓
Pre-hole in top layer **necessary**		Pre-hole in top layer **not necessary**

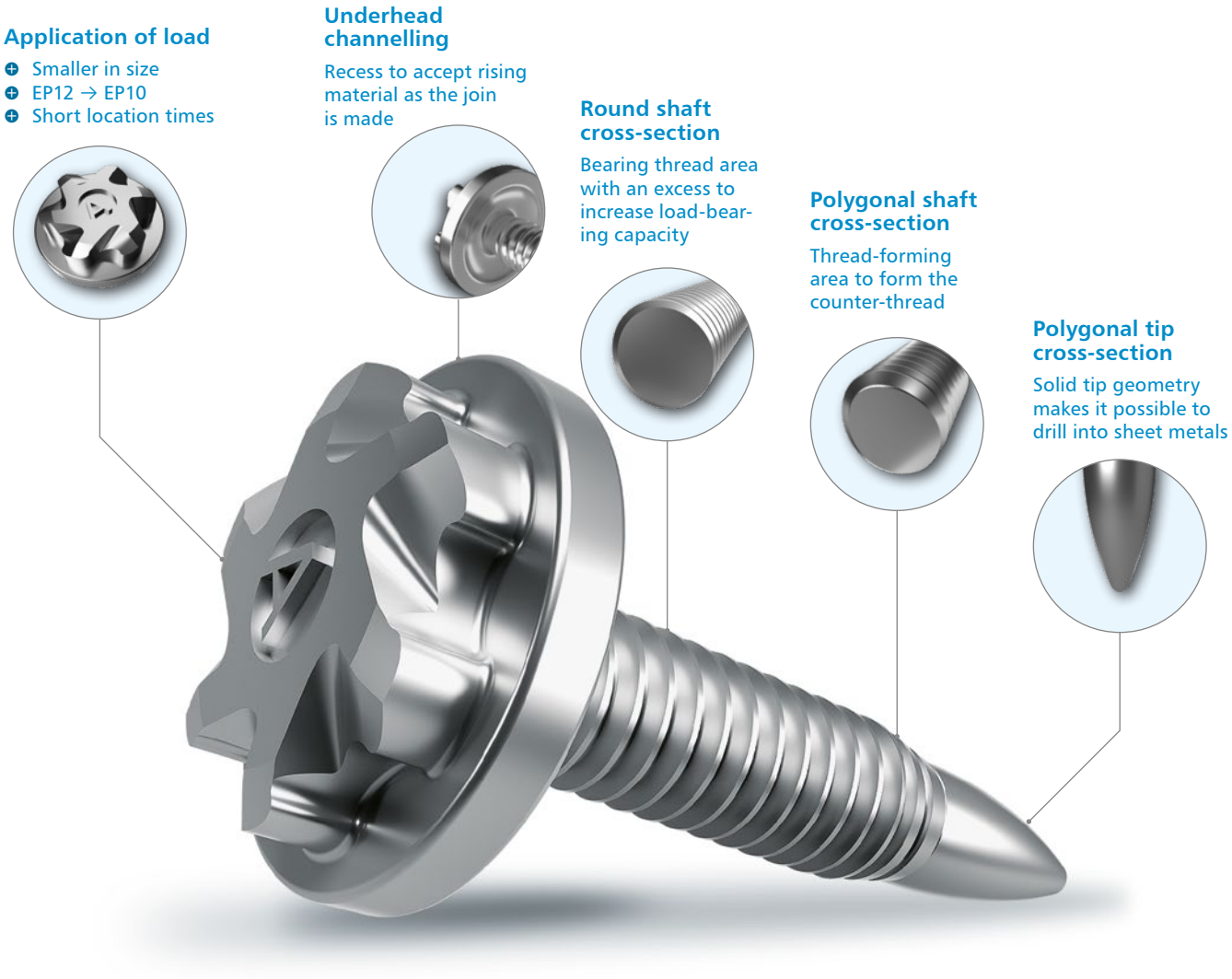




Feasibility limits



Flowform® Plus – it's the structure that makes the difference



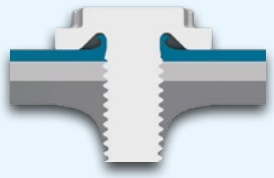
The **polygonal cross-section** in the functional tip allows for lower joining forces when forming the holes, or with the same force, reduces the hole-forming time. The adapted radius at the end of the tip makes it possible to place more load on the tip, so that it can also be used in higher-strength sheet steel. The polygonal cross-section in the thread-forming area allows for low tapping torques and prevents chip formation during the screw-driving process.

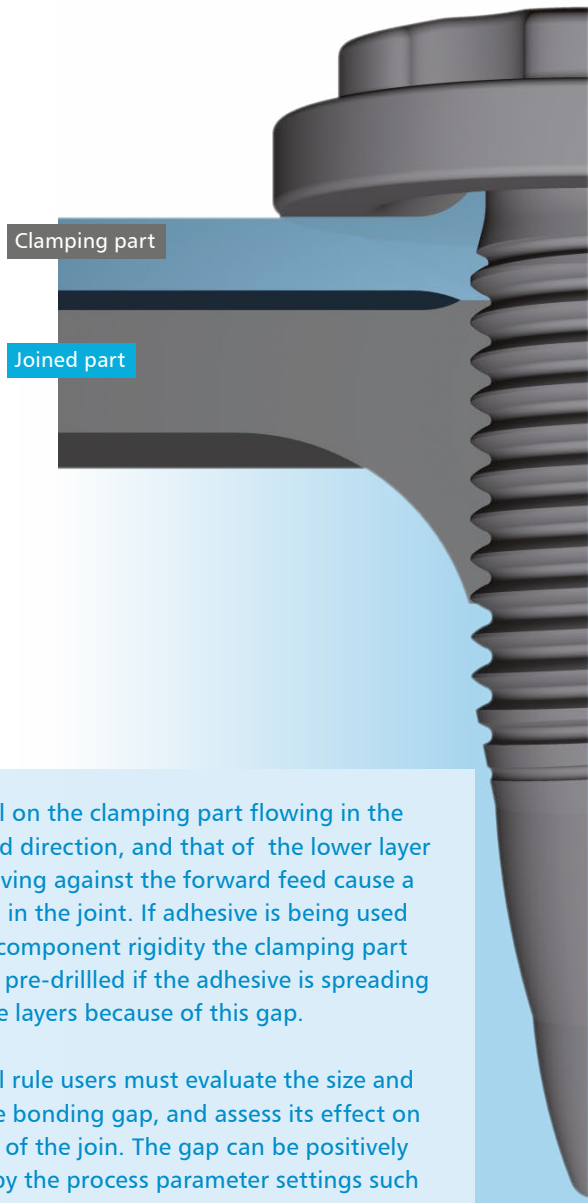
In the bearing thread area the **round shaft cross-section** ensures optimum load capacity and a metric nut thread. The **underhead channeling** accepts the material that rises during the hole-forming process.
With its lead-in chamfer, the **external force application** offers the shortest and best location process, thus reducing the cycle time. While the load application flank offers the best possible torque force transmission.

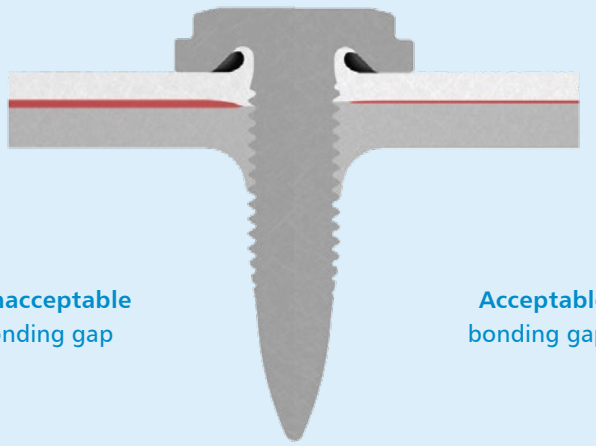
The difference between this version and Flowform® is the size and choice of material, and also that its heat treatment has been adapted. While in most cases the standard Flowform® has a diameter of 5.0 mm, the Flowform® Plus is just 4.0 mm in size (scaling down). The base material and the heat treatment are also different for these fasteners.

With or without pre-drilling

No pre-drilling. Why and when?

JOINING WITHOUT PRE-DRILLING	
Flat head with external drive	
Fastening two sheets without pre-drilling	Fastening three sheets without pre-drilling
	





Unacceptable bonding gap

Acceptable bonding gap

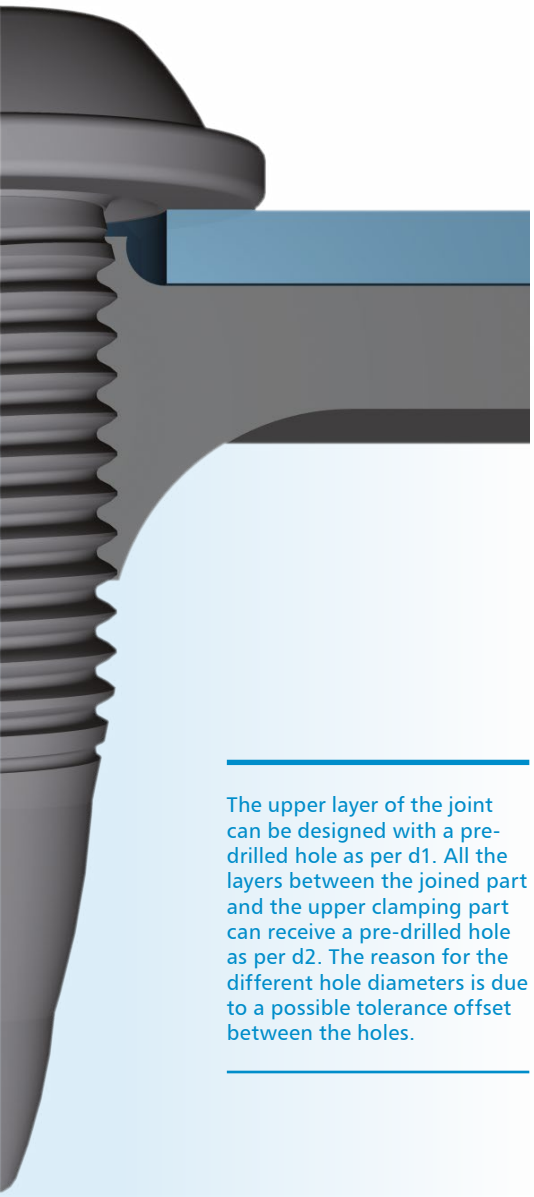
The material on the clamping part flowing in the forward feed direction, and that of the lower layer which is moving against the forward feed cause a gap to form in the joint. If adhesive is being used to increase component rigidity the clamping part needs to be pre-drillled if the adhesive is spreading between the layers because of this gap.

As a general rule users must evaluate the size and shape of the bonding gap, and assess its effect on the stability of the join. The gap can be positively influenced by the process parameter settings such as clamping force, axial joining force, and tightening torque.

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 applications laboratory is always happy to answer any further questions you may have.

Pre-drilling. Why and when?

The decision to pre-drill depends on a number of different influencing factors. If the overall thickness of the component is too great, then a hole needs to be pre-drilled to a residual thickness that can be joined reliably. A pre-drilled hole is also necessary if the screw head does not reach the head setting because of rising material or if the necessary axial joining force is too great. The illustration below shows pre-drilled holes with various head varieties, as well as the options for sizing and forming the pre-drilled holed.

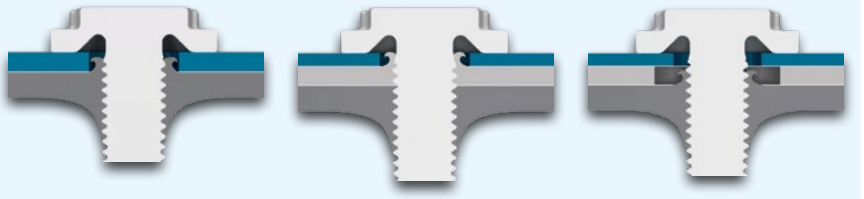


The upper layer of the joint can be designed with a pre-drilled hole as per d1. All the layers between the joined part and the upper clamping part can receive a pre-drilled hole as per d2. The reason for the different hole diameters is due to a possible tolerance offset between the holes.

JOINT MADE WITH PRE-DRILLED HOLE ON CLAMPING SIDE

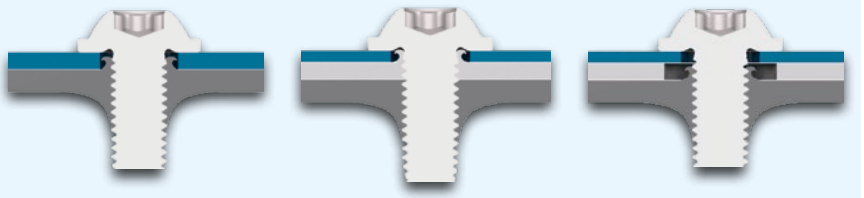
Flat head with external drive

Two sheet fastening with 1 pre-drilled hole	Three sheet fastening with 1 pre-drilled hole	Three sheet fastening with 2 pre-drilled holes



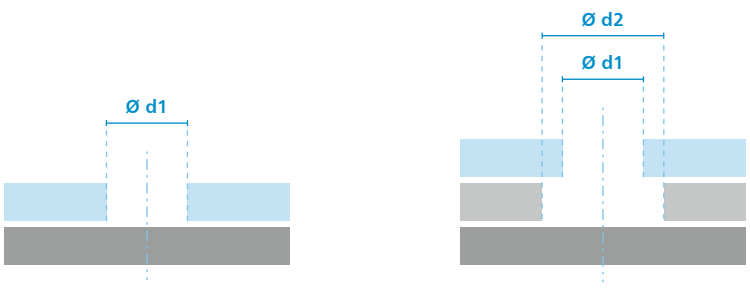
Flat head with internal drive

Two sheet fastening with 1 pre-drilled hole	Three sheet fastening with 1 pre-drilled hole	Three sheet fastening with 2 pre-drilled holes



DIMENSIONING THE PRE-DRILLED HOLES

Dimensions	Ø d1 + 0.3 [mm]	Ø d2 + 0.3 [mm]
M4	6.0 mm	9.0 mm
M5	7.0 mm	10.0 mm
M6	8.0 mm	11.0 mm



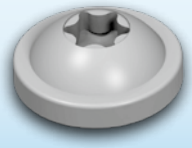
Finding the right Flowform®

Selecting the head shape and drive

The Flowform® screw comes with two different head variants. They differ principally in the undercut feature and the drive geometry. The head geometry is selected according to the requirements of the application in question. Other designs can be obtained by arrangement with ARNOLD.

Flat head with external drive
Factory standard: AWN-02-01-06

- Large underhead feature possible
- Can accept rising material
- Can join several sheet combinations without pre-drilled hole
- Low head height



Truss head with internal drive
Factory standard: AWN-02-01-03

- Easier to find the drive
- Smaller underhead recess
- Economical

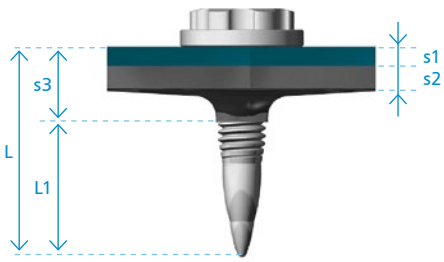
Other head shapes and drive options available upon request.

Selecting the right screw length

The length of screw necessary depends on the overall thickness of the sheet metals that are being joined. Because the penetration depth increases during the flow-hole forming process it is necessary to add in the height of the extrusion-hole.

FLOWFORM® SCREW				
Length L [mm]	**M3,5**	**M4**	**M5**	**M6**
12,00 + 0,8	✓	✗	✗	✗
14,00 + 0,8	✓	✓	✓	✗
16,00 + 0,8	✓	✓	✓	✗
20,00 + 0,8	✗	✓	✓	✓
25,00 + 0,8	✗	✓	✓	✓
30,00 + 0,8	✗	✗	✗	✓
Dimension: L1	7,1 mm	8,4 mm	10,4 mm	12,6 mm

Other dimensions available upon request



1) **s3** = s1 + 3 × s2
2) **L** = s3 + L1

Calculation example

Desired screw size: M5 clamping part (s1) Sheet metal thickness 1.0 mm Screw-in part (s2): Sheet metal thickness 2.0 mm

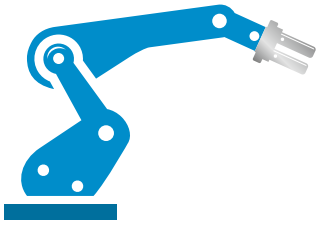
s3 = 1.0 mm + 3 × 2.0 mm = 7.0 mm
L = 7.0 mm + 10.4 mm = 17.4 mm

- Selecting the length according to the list: 20.00 mm

The factor of "3" to achieve the depth of the extrusion depends on the material and the joining parameters and may vary.

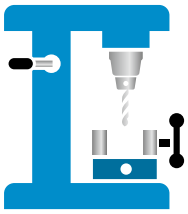
The right process technology

Flowform® is based on an interplay between the screw, the customer's application and the processing technology used. The challenge is to achieve a short cycle time and thus control the axial joining force and rotation speed during all five steps of the Flowform® screw-in process. Special screwdriving systems have been developed to handle Flowform® screws and these can be obtained from our partners.



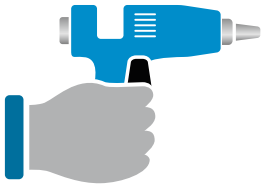
Robot-assisted screw fastening

- Different joining combinations
- Different positioning to component



Stationary screw fastening

- Joining combinations with fixed positions on the component
- Component can be placed into stationary installation



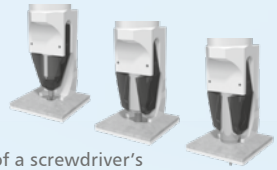
Manual fastening

- Joining combinations with sheet thicknesses and strengths for low axial force, suitable for manual fastening

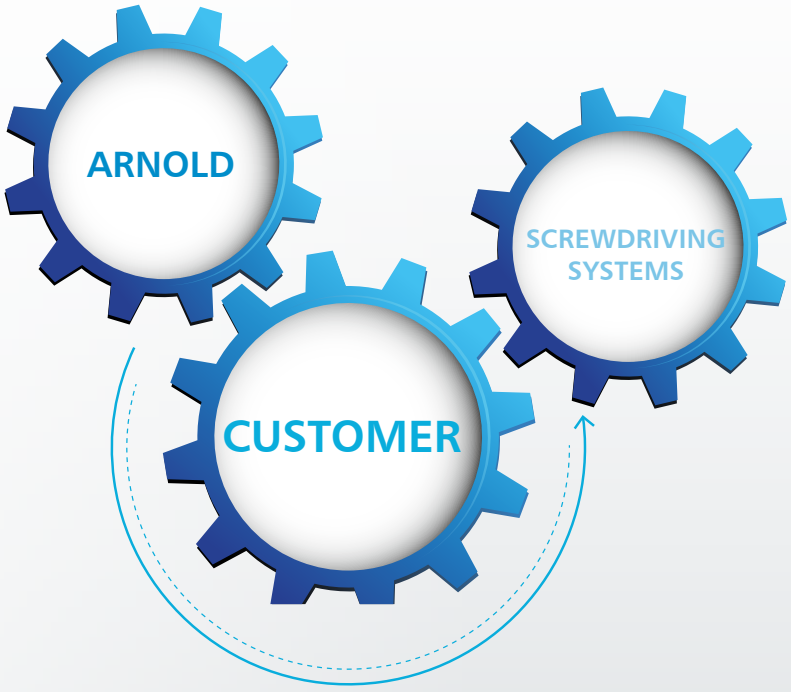
Screwdiving system data

- Automatic screw feed
- Torque transducer
- Rotation speed drive motor (0–9000 rpm)
- Compressed-air cylinder (max. 6 bar) for axial force up to 3600 N
- Hold-down plate with path measurement system for pre-compressing the joining partner.

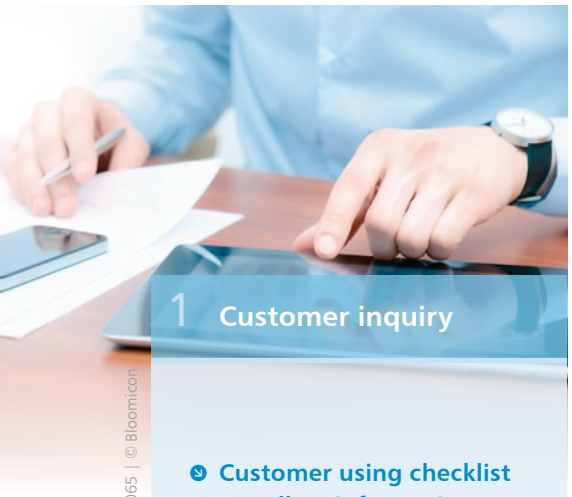
The screw feeds in a fully automated process to the screw-driver's die and then is held in position by jaws. A hold-down plate fixes the joining partner which sufficient axial force for the purpose, thus reducing the gap between the plates while the fastening is made. The hold-down plate defines the position for the Flowform® fastening.



Example of a screwdriver's die with jaws.



Joining point analysis



1 Customer inquiry

- **Customer using checklist to collect information**

General Information
- Description of project
- Contact details
- Scheduling
- Contact

Application
- Clamping part
- Drawing
- Part for joining
- Corrosion protection
- Pre-drilling
- Initial application
- Material thickness
- Leak requirement
- Material
- Safety criticality

Fastener
- Dimensions
- Undercut feature
- Shape of drive
- Quantity required
- Initial sample
- Tensile strength
- Corrosion protection requirements

Several validation steps are required to ensure a reliable series process. This includes a laboratory joinability investigation as well as further screw validations using original components. Then the applications characteristics achieved using Flowform® need to be checked for functionality by the user. The investigations illustrated here merely show the preliminary trials under laboratory conditions.

2 Investigating availability

Contol variables
- Rotation speed
- Axial joining force
- Force of hold-down plate

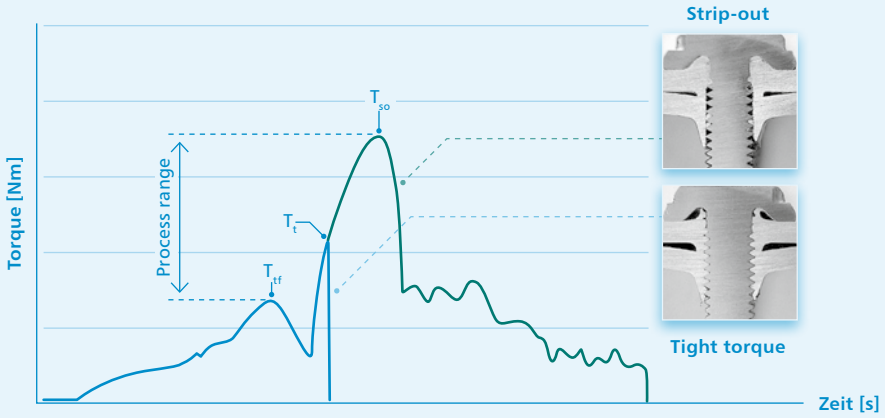
The control variables are determined on an experimental basis for the specified joining point.

Target variables
- Path
- Torque
- Angle

With the target variables determined it is possible to find the switch points in the joining process and define the fastening's characteristics, such as tightening torque.

Monitoring variables
- Time / path
- Torque
- Angle

These variables are used to monitor the joining process so as to maintain optimum fastening characteristics.



Torque curve

As joining points are validated the torques produced, such as thread **forming torque (T_{tf})** and **strip-out torque (T_{so})** are determined. Torques are influenced by the rotation speed and axial joining force variables and can vary for every combination of sheet metals. The **tightening torque (T_t)** can be derived from the characteristic torque curve..

Documentation

The results of the laboratory test are gathered together into a final document, and then discussed with the user.

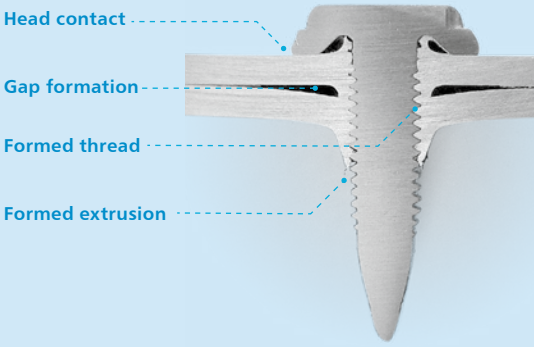
4 Documentation

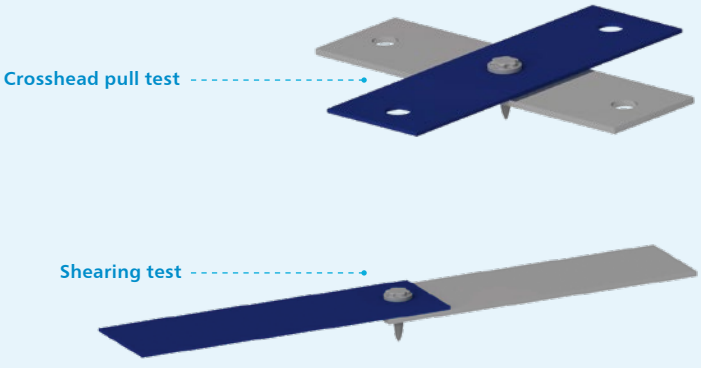
Create the test report

- Selecting the screw, basic drawing
- Component designation (Clamping and joined part)
- Measured values, statistics and screw-in curves
- Micro-sections
- Predictions
- Notes

3 Investigating the fastening properties

We create a **micro-section** in order to examine the thread and extrusion hole with internal thread, as well as the gap formation between the sheet layers, and the contact between the head and the clamping part.



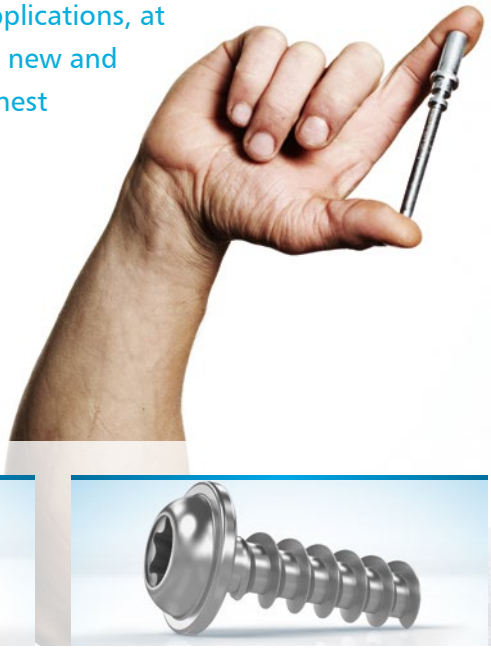


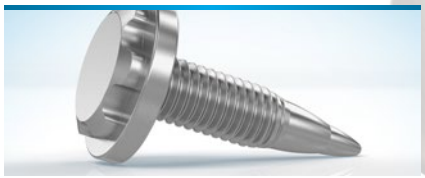
Fastening properties

We use shearing and cross-head pull tests to examine other fastening properties. These tests are based on the DVS/EFB guidelines (leaflet 3480-1). They are used to compare the failure parameters of similar joining procedures.

We do not compromise on our product … because for us the smallest contribution counts.

We create successful innovation. With our excellent manufacturing expertise, by aligning ourselves to our customer's wishes, and by constantly analysing our products and applications, at ARNOLD we are able to create new and individual solutions to the highest quality.





Flowform®

The innovative metal fastening makes it possible to join several components without pre-drilling.

REMFORM®

This plastic direct screw fastening in future will ensure that inserts are no longer required.

MAThread®

Innovative dog point to prevent the screw from penetrating at a slant.

TAPTITE 2000®

No more thread-cutting thanks to autonomous, non-cutting, thread-forming metal fasteners.

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Quick fastener system for ultra-short assembly times when fastening plastics and light metals.

Alufast®

Aluminium screws indicating less contact corrosion and clamping force loss than steel screws when fastened into light metals, thus allowing tighter component dimensioning.

Conform®

Cost-optimised multi-function parts with up to six forming stages for bearing pins and a wide variety of parts.

LocTec®

A fastening which is resistant to most tampering attempts is made thanks to a combination of screw-driver and assembly tool.

Other products

We have even more innovative products for you in our overall product range.

Talk to us.

Seamless service …
because we contribute our expertise.

At Arnold optimum customer service is a given. So, besides the typical ARNOLD success factors of innovative power and product quality, our Competence Center provides something else – unique to the industry. As an expert partner, we get involved in the design and development process at a very early stage so that our customers can find the best solution for them.

Fastener Forum

Compact seminars provide information about the latest developments in fastening technology.

ThreadLoc®

The full range of thread locks creates fastenings for sustained success.

Cleancon®

Increased operating reliability with technical cleanliness in fastener production.

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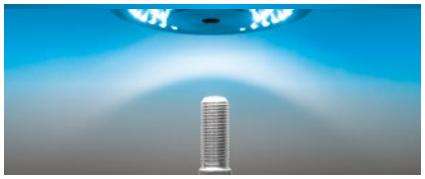
Prototypes and functional samples – in the correct quality right from the start.

Arncad®

e-Engineering for the design of fasteners to join metals and synthetics directly.

Innovation plant

Designing innovative, cost-optimised fastening solutions from specific market requirements.



Fastener Testing Center

Full service programme to carry out checks, tests, measurements and qualifications on metal components.

Effective Programme

An integrated approach to sustainable cost optimisation in fastening technology.

Other services

We can offer even more services for you in our overall portfolio.

Talk to us.

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The values shown in this brochure are by way of examples. Specific values must always be determined by carrying out trials on original production parts. Our applications laboratory is always happy to answer questions.

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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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