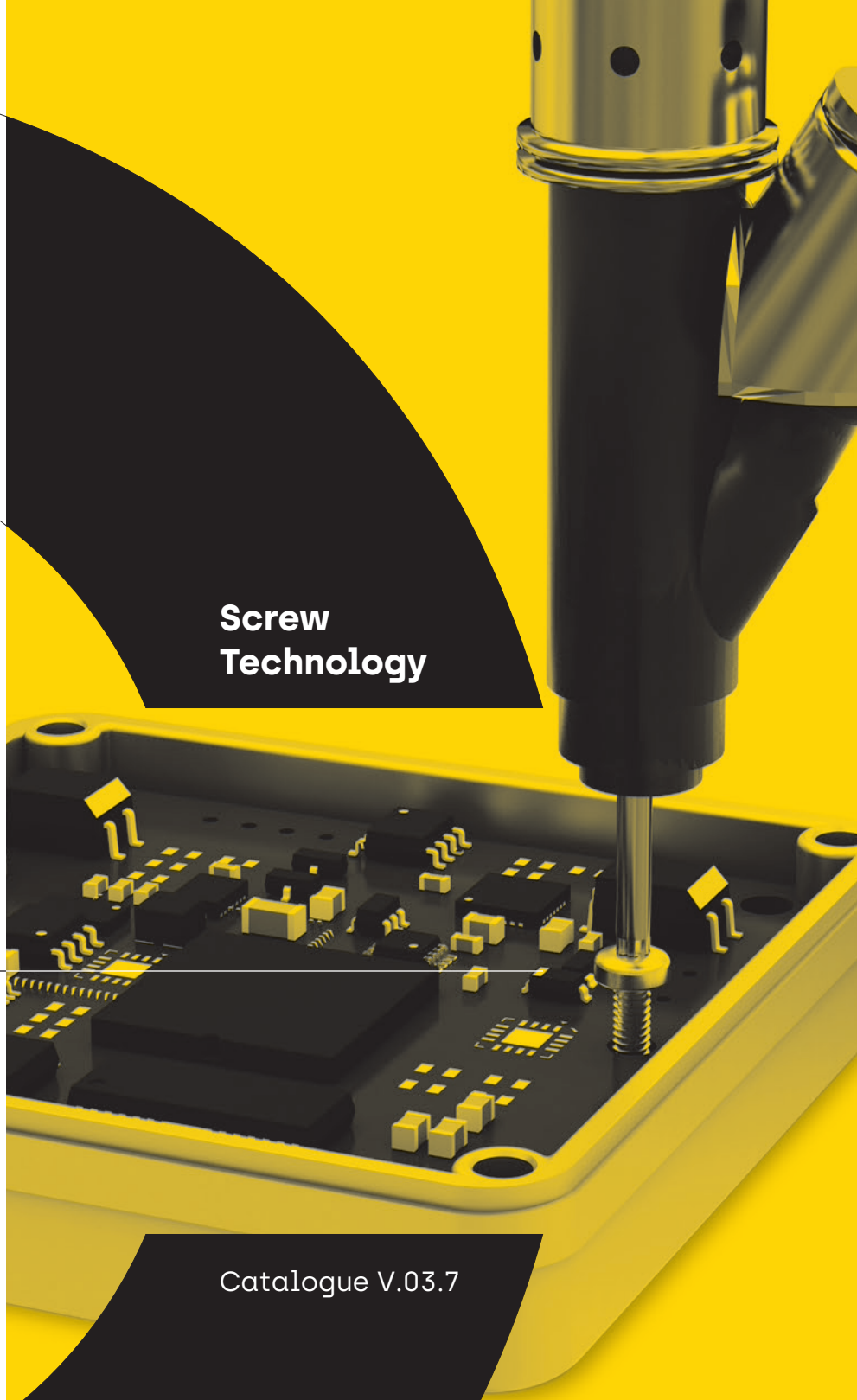
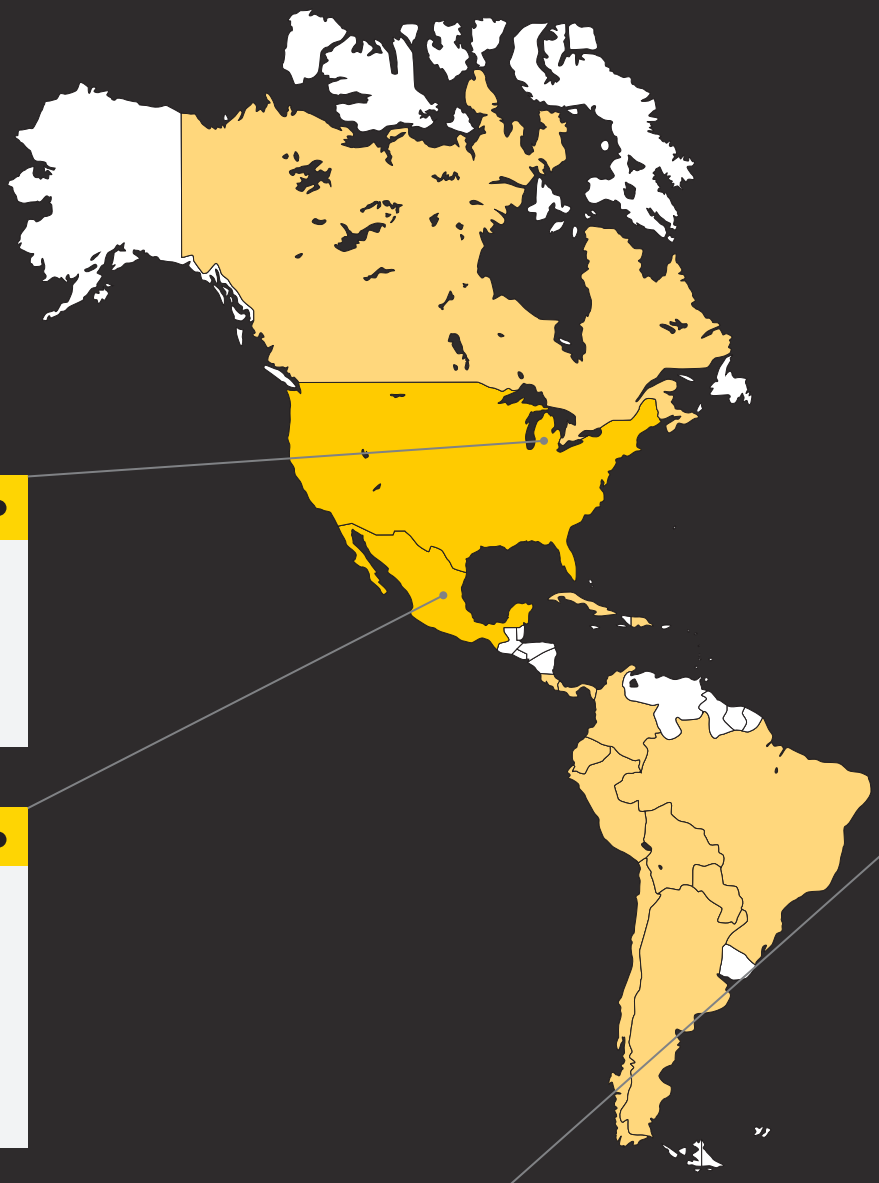
CELO

Screw Technology



Catalogue V.03.7

Locations



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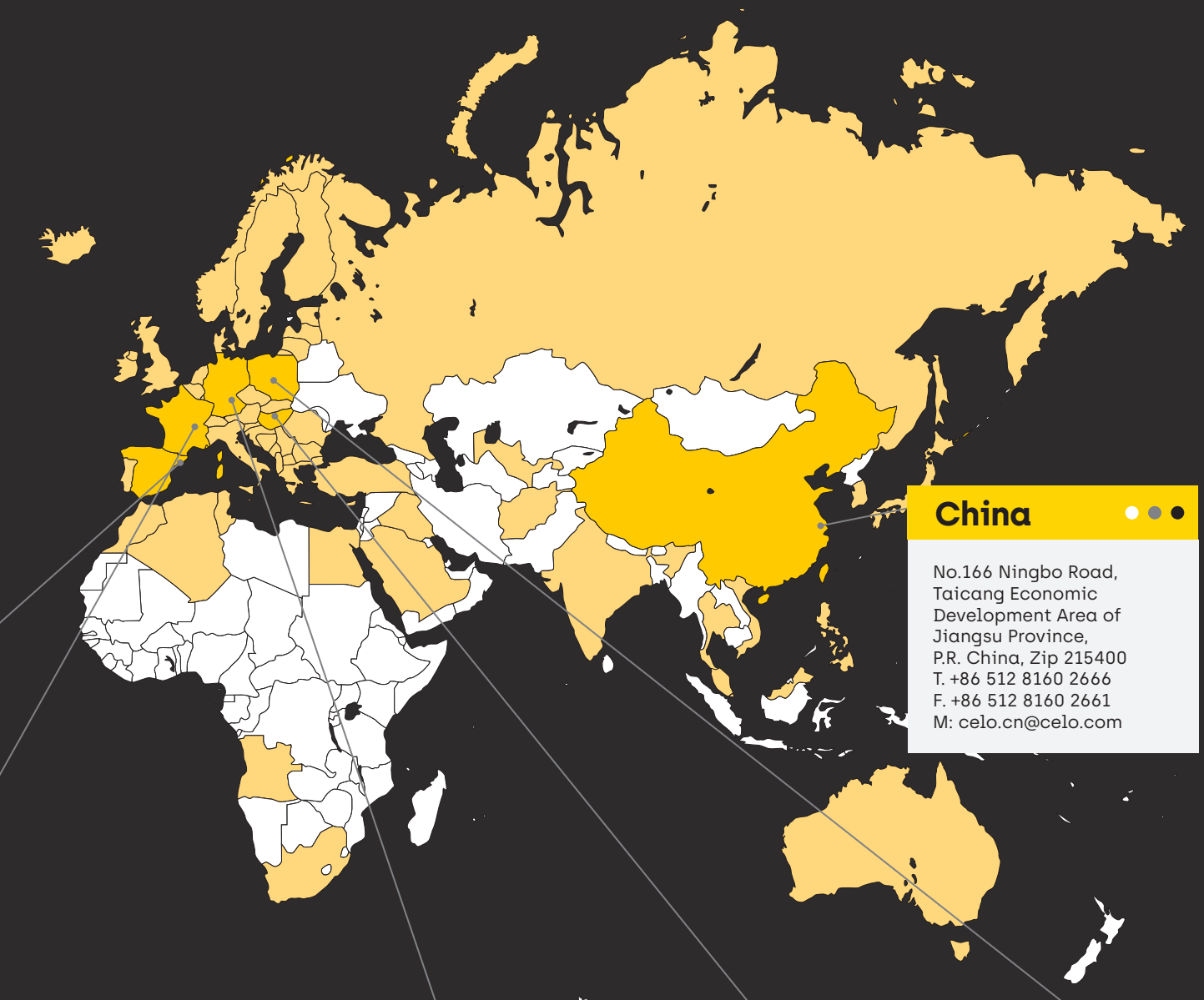

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At CELO, we know that our screws and fixings contribute a very small part to the total cost of an assembly. We take care in making our products competitive, while our main goal is to develop and innovate in products and services that reduce your costs... from design to installation.

We work to make our screws and fixings competitive in cost, but we also take care in reducing your total cost of installation, logistics and even of your production lines.

Our technical sales and application engineers are ready to assist you.

- **Your time. Our value**
- **Innovation**
- **Know-how**
- **Quality**

Company

At CELO, we take care of the small things:

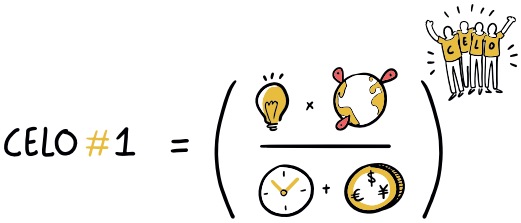
Small Things Matter

Look around you. Look at everything that makes our world work. From the biggest, to the smallest. From the simplest, to the most sophisticated. Everything, absolutely everything, is comprised of small pieces that, when united, form part of something bigger that cannot fail.

We know how important they are and that's why, as specialists, we take care of each and every piece, from creation to installation, applying the latest technology and innovating to make improvements every day.

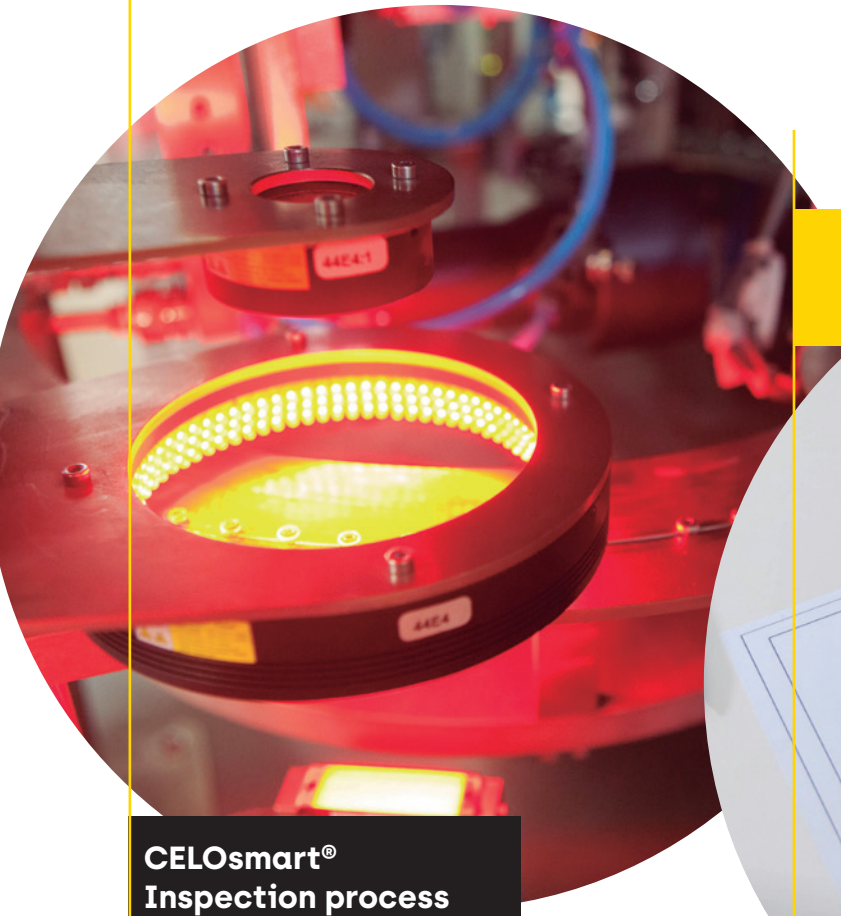
Quality, Know-how and Innovation

CELO´s vision is to become an international leader in innovative technical screws and technical fixings that reduce time and cost of installations and assemblies:



Our DNA is represented by a simple equation:

- Knowledge, innovation and international reach allow our company to grow.
- Saving time and reducing costs for our customers and for CELO make our company grow.
- Our team is the part of the equation that potentiates our development.



CELOsmart®
Inspection process

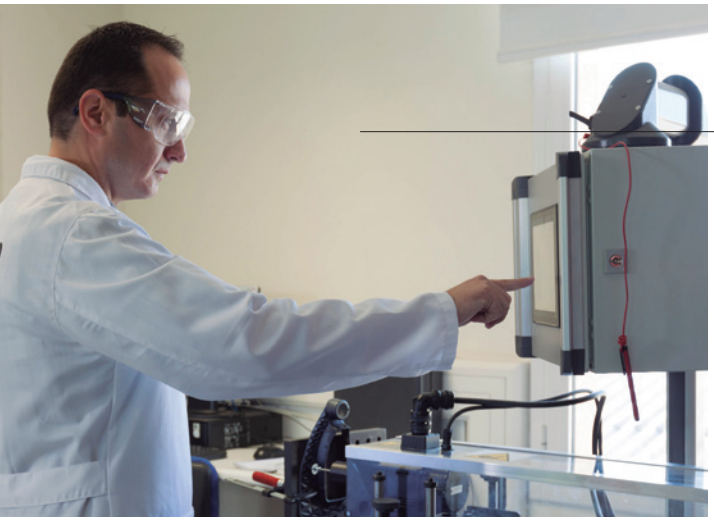
Tooling design and process simulation

Solutions for every need

Customer oriented

Your benefits

- **Innovative solutions** that save the user time and money.
- **Extensive range of products** for the industry under licenses REMINC/CONTI Fasteners, Acument and Mathread.
- **Partnership based on cooperation** to develope efficient assembly solutions.
- **More than 50 years of experience** in the development and production of fastening systems.
- **The highest quality** of products based on state-of-the-art technology.
- **Worldwide presence** for a close collaboration with our customers.



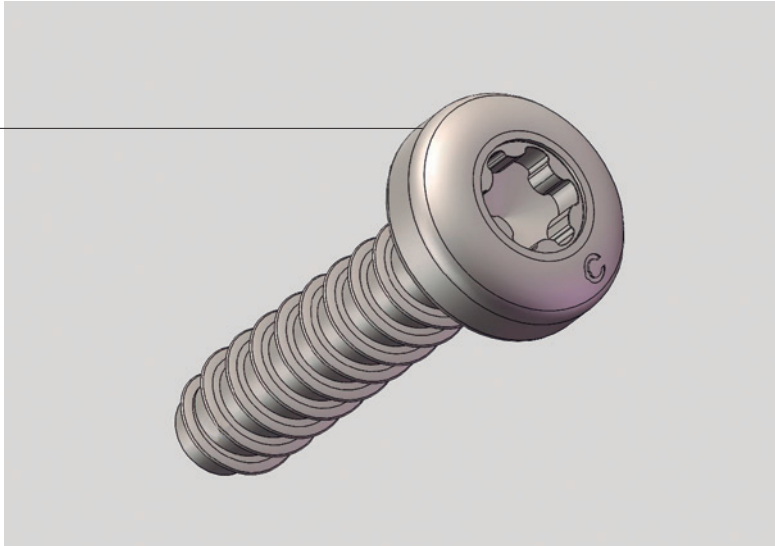
Technical test

To ensure maximum productivity and quality of the assembly process:

- Optimal assembly parameters (torque range, speed, angle, end-load, preload...)
- Mechanical resistance limits (tensile strength, shear strength...)
- Pull-out resistance determination
- Clamp load study
- Friction coefficient, load-temperature, tightening cycles...

CAD data

- CAD is typically used for industrial design of mechanical and electrical assemblies. CAD files contain part characteristics information to ensure components fit properly in its specified location.
- We provide CAD data of our products to be used in the design process of your components.



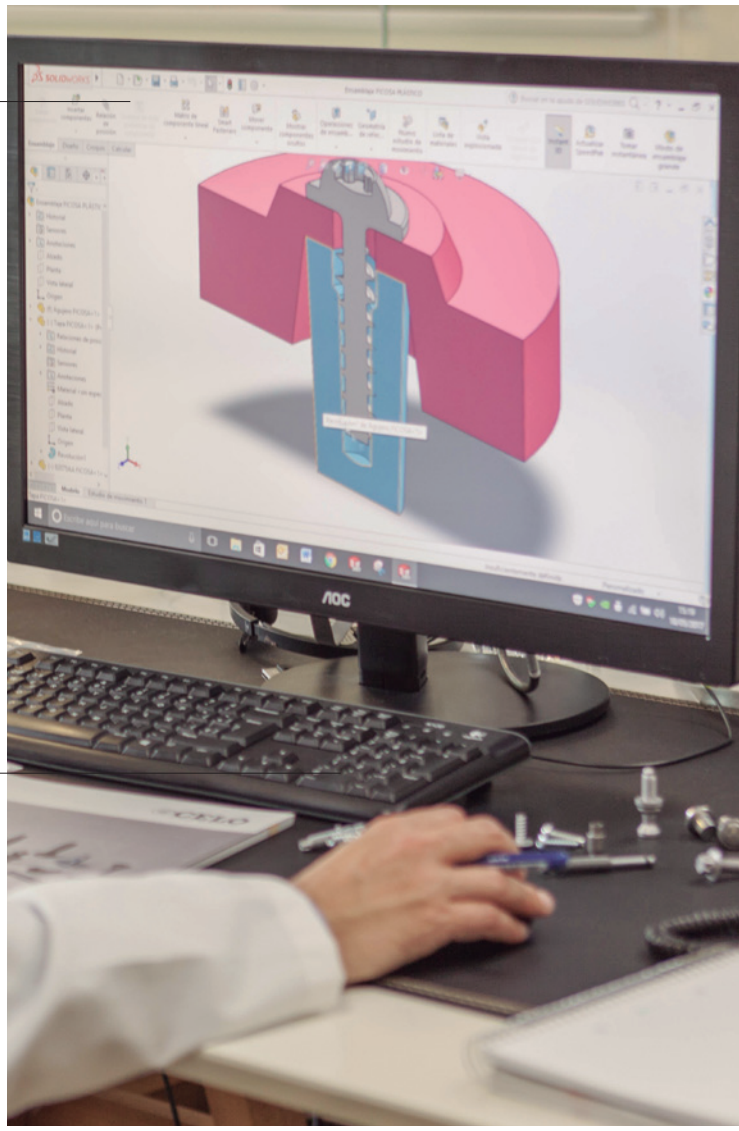
Training Center

- Sharing knowledge of Screw Technology
- Theoretical and practical product training
- Factory visit
- Certificate for successful completion

Application engineering

To assist our customers in the optimal assembly solution by:

- Application analysis
- Laboratory tests
- Project implementation in the production line
- Detection of cost saving opportunities in the assembly process



Design support

- Computer simulations to determine reliable preliminary values
- Feasibility of the joint design to guarantee its performance throughout service life
- Risk analysis evaluation to minimize defects or faults
- Fast samples for prototype building ready for use

Digital services

- Up-to-date product and service information
- Samples request
- CAD data download
- Catalogues and flyers
- Webinars, updates and company news

Screws for plastic

Screws for metal

Screws for metal

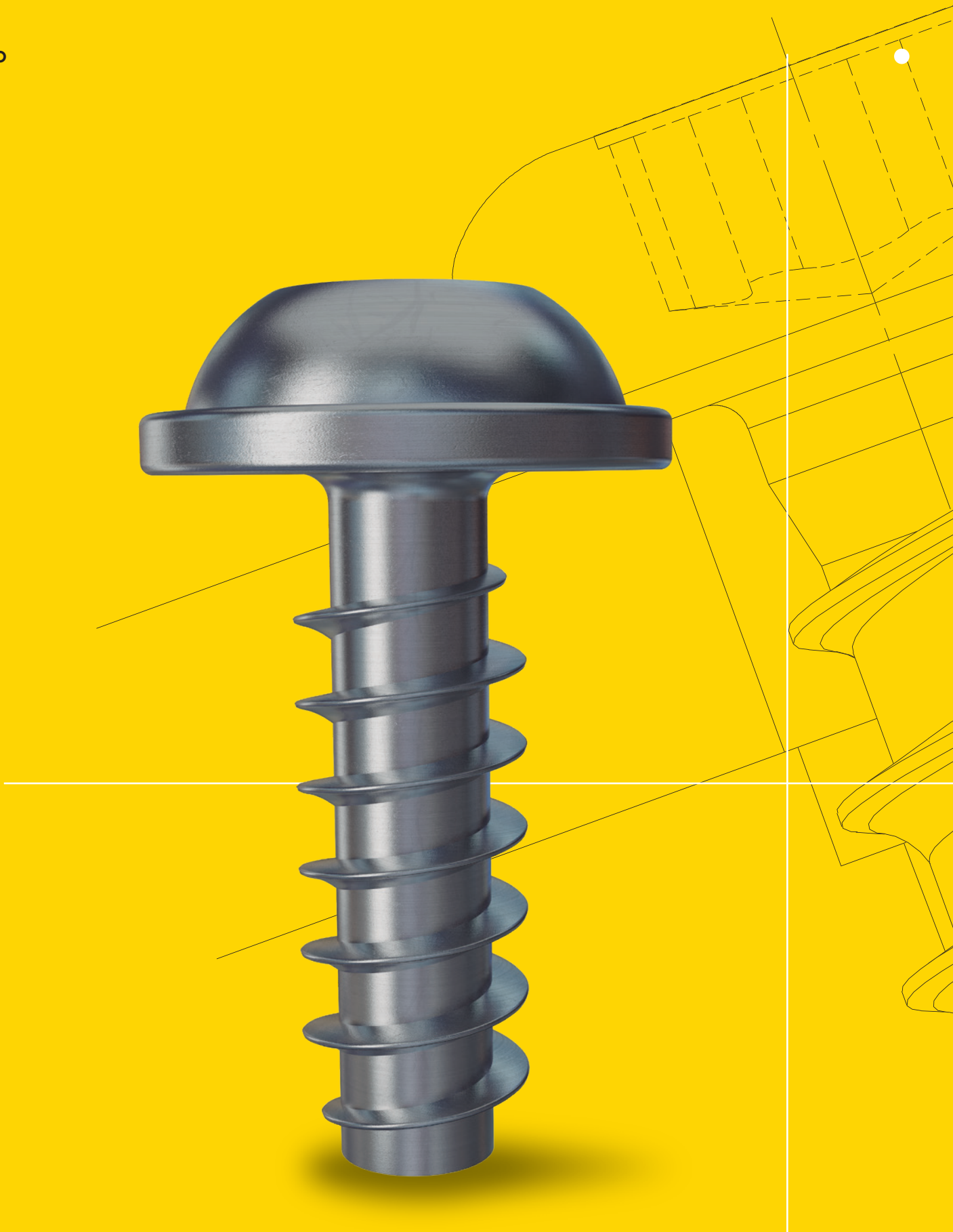
Screws for thin metal

Special solutions and functional parts

Technical information

Index

Screw Technology



Screws for plastic

REMFORM® II HS™

REMFORM® II HS™ (High Strength) screws have been developed for the direct assembly of thermoplastics in applications with high mechanical requirements.

The improved thread design results in a more resistant, safe and optimized assembly of fiber reinforced thermoplastics, offering high clamping force, pull-out and vibration loosening resistance.

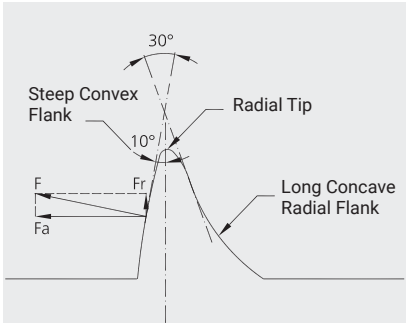


Fig.1. During thread forming, the Steep Convex Flank transfers most of the tightening load in the axial direction (Fa), minimizing radial force (Fr) and consequently plastic deformation. The axial force (Fa) is over 4,5 times greater than radial force (Fr).

1. Technical features

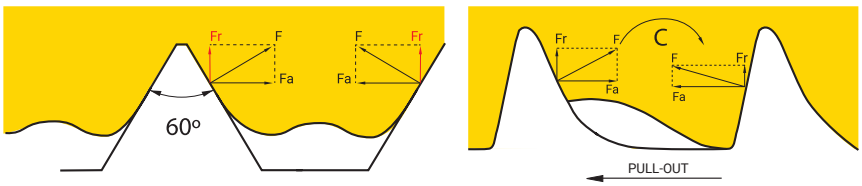
- **Asymmetric thread design of 30°**

Unique Radius Flank™ asymmetrical thread design remains the main characteristic of REMFORM® II HS™ thread. Its optimized design **reduces hoop stress** generated in the plastic during thread forming and consequently the risk of boss bursting. It consists of:

Steep Convex Flank also known as Trailing Pressure Flank. It has a subtle radius designed to **increase resistance to pull-out forces**, whether they are applied by a tensile load or induced by torque. It provides excellent material contact which results in a high resistance to stripping.

Long Concave Radial Flank also known as Leading Thread Flank. Its special radius form produces forces of variable directions which promotes efficient material flow increasing resistance to pull-out forces. Major surface contact with nut member material **increases vibration loosening resistance.**

Radial Tip helps to create better internal thread and reduces hoop stress in the plastic.



Self-tapping screw REMFORM® II HS™

Fig.2. Resolution of resultant forces on pressure and leading flank.

- **Optimized core diameter**
  The increase in core diameter results in **higher torsional and tensile strength,** usually required when assembly in fiber reinforced or high strength materials.

- **Optimized thread pitch**
  The reduction of the thread pitch allows more threads to be in contact with the plastic mating material increasing vibration loosening resistance and the possibility to reduce the length of thread engagement.

  The optimized core diameter and pitch distance result in better material flow toward the trailing flank, resulting in more material between the flanks. It reduces the risk of overstressing the plastic and provides higher pull-out resistance.

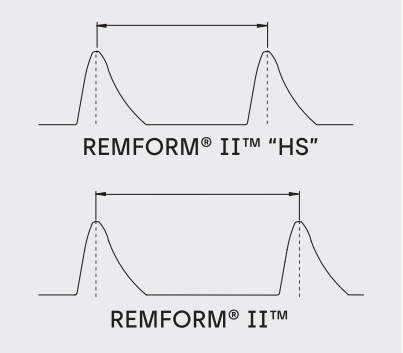


Fig.3. For the same thread diameter, the smaller pitch of REMFORM® II HS™ thread increases pull-out resistance.

2. Advantages

- The low radial forces minimize the risk of overstressing and cracking of the plastic. It allows for **bosses with smaller external diameter**, which offers great **opportunities for cost reduction**.

- **High resistance to pull-out forces, vibration loosening and stripping.**

- **Higher torsional and tensile strength** allows for a higher tightening torque and clamping force.

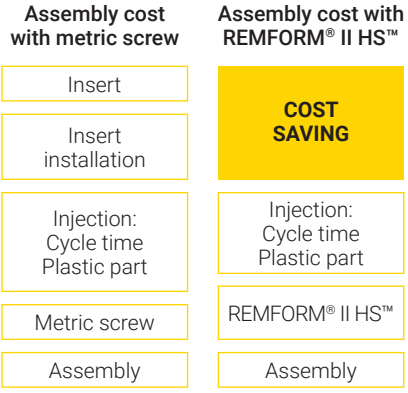
- **Low thread forming torque and high stripping torque** offer optimal safety during assembly.

- Thread design **permits to reuse the screw** reducing the risk of stripping.

- The technical advantages of REMFORM® II HS™ screw directly results in a **more resistant assembly, greater safety** during threading and **lower costs** of the assembly process.

3. Reduction of the cost of the assembly

The use of REMFORM® II HS™ screws offer substantial savings when comparing with conventional screws for plastics, self-tapping screws and threaded inserts.



- **Elimination of threaded inserts and its associated costs.**
  REMFORM® II HS™ screws create a strong nut member into reinforced plastics, replacing inserts and offering significant improvements in injection molding process and recycling of the parts.

- **Reduction in plastic weight components.**
  Minimal radial tension during thread forming allows for thinner walls and reduced length of engagement enables shallow insertions depth. The plastic part can be manufactured with less material and reduced cycles times in molding process.

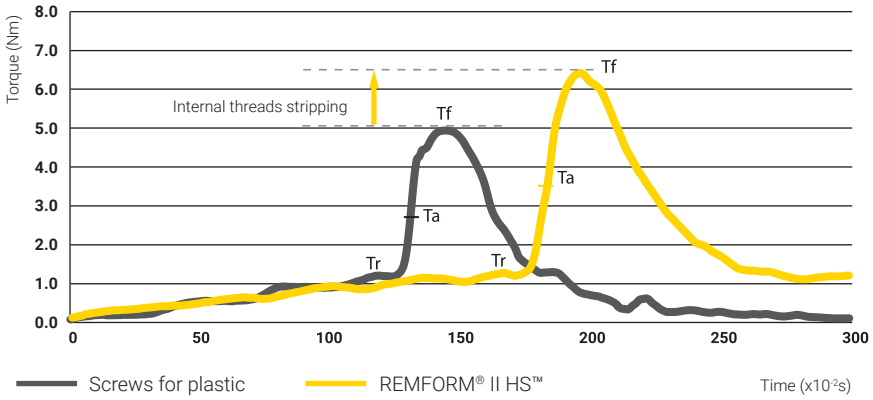
- **Reduction of screw diameter and/or length.**
  REMFORM® II HS™ screws achieve the same thread engagement than conventional screws for plastics but considering smaller diameter or shallow insertion depth.

REMFORM® II HS™ Minimum Breaking Torque	
d (mm)	Torque(Nm)
2.0	0.44
2.5	0.74
3.0	1.41
3.5	2.30
4.0	3.42
4.5	4.82
5.0	6.88
6.0	12.02
7.0	19.44
8.0	27.00

4. Threading curve

In fiber-reinforced plastics, the smaller pitch of REMFORM® II HS™ screw greatly improves failure torque without a significant increase of threading torque. The higher amount of threading energy provides the assembly with a higher prevailing torque which improves vibration loosening resistance of the assembly.

The graph below shows a comparison of threading curves for REMFORM® II HS™ and standard screw for plastic, both diameter Ø6,0 mm in a PP + 20% glass fiber part, core hole Ø5,0 and 12 mm engagement length.



When comparing with a conventional screw for plastic, REMFORM® II HS™ screw offers greater safety during assembly (difference between threading torque and failure torque). The higher stripping torque guarantees a more reliable assembly process and an increased stability during installation.

Threading torque (Tr) is the minimum torque necessary to ensure that some clamping force is loaded to the assembly. This value is represented by the maximum torque within this zone.

Failure torque (Tf) is the torque value when the assembly fails at any point. It is the maximum torque allowed in the system and corresponds to the maximum value (peak) of the curve. The failure mode determines the way the assembly fails. For the graph detailed before, the failure mode is stripping off (shearing of the internal threads).

Optimum tightening torque (Ta) ensures the right clamping force and avoids undesired deformation in plastic parts.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.

5. Boss design recommendations

In order to ensure a safe installation and stable clamping force, it is relevant to pay attention to the boss design, as it must resist mold extraction and cooling tension as well as tension created during screw installation.

It's important to include a relief bore to prevent damaging the boss when starting thread forming. The relief bore also helps to align the screw during threading.

The dimensions for external diameter, core hole diameter and minimum depth will vary based on the type of plastic.

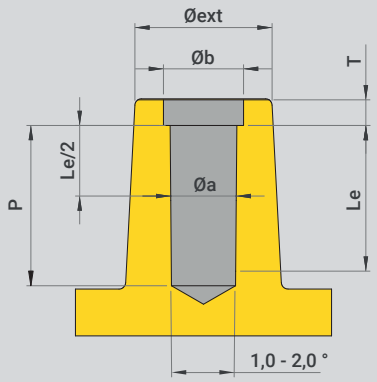
For additional information about the boss design for direct assembly in plastic parts, please contact our technical department.

Material	Øa	Øext
PC*	0.80 x d	2.1 - 2.6 x d
PE + 30GF	0.80 x d	2.1 - 2.6 x d
PA6 + 15GF	0.80 x d	2.1 - 2.6 x d
PC + 10GF	0.81 x d	2.1 - 2.6 x d
PMMA	0.81 x d	2.1 - 2.6 x d
PA66 + 15GF	0.81 x d	2.1 - 2.6 x d
ABS + 20GF	0.81 x d	2.0 - 2.5 x d
PPO + 30GF	0.82 x d	2.0 - 2.5 x d
ABS + 30GF	0.82 x d	2.0 - 2.5 x d
PC + 30GF	0.82 x d	2.0 - 2.5 x d

Material	Øa	Øext
PP + 30GF	0.82 x d	2.0 - 2.5 x d
POM + 30GF	0.82 x d	2.0 - 2.5 x d
PA6 + 30GF	0.82 x d	2.0 - 2.5 x d
PA66 + 30GF	0.82 x d	2.0 - 2.5 x d
PPA + 30GF	0.82 x d	2.0 - 2.5 x d
PET + 30GF	0.82 x d	2.0 - 2.5 x d
PBT + 30GF	0.82 x d	2.0 - 2.5 x d
PS + 30GF	0.83 x d	2.0 - 2.5 x d
PPS + 40GF	0.83 x d	2.0 - 2.5 x d
PA6/PA66 +45GF	0.84 x d	2.0 - 2.5 x d

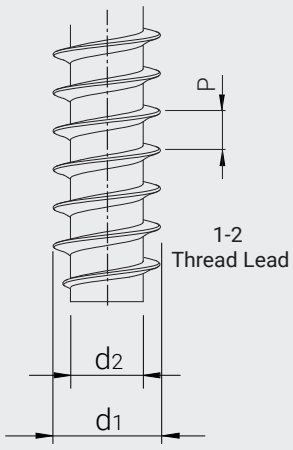
For softer plastics not listed above, use Øa = 0.75 x d and other parameters as detailed for PC.

This data is intended for guidance purposes. We recommend carrying out relevant tests on plastic parts to establish the precise values.



d = screw diameter
Length of engagement Le = 2.3 x d
Minimum depth P = 2.9 x d
T = 0.25 - 0.5 x d
Øb = 1.05 - 1.1 x d
***For PC:**
Le = 2 x d
Minimum depth P = 2.7 x d

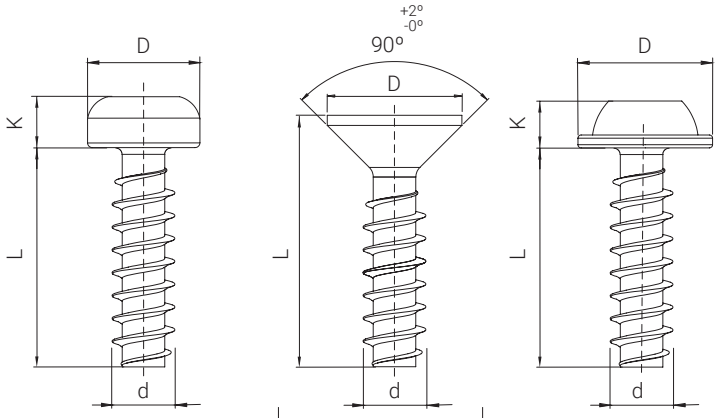
Suggested tolerances are:
+0.08 mm for holes ≤ Ø3.0 mm
+0.10 mm for holes Ø3.0 - Ø4.5 mm
+0.12 mm for holes > Ø4.5 mm



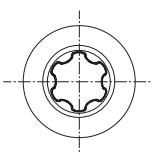
6. Technical data

REMFORM® II HS™ screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements. To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

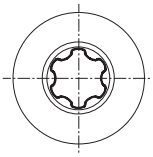
The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, please contact our technical department.



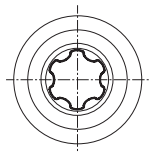
Ref. HS81PA



Ref. HS82PA



Ref. HS87PA



Nominal Value (mm)	Tolerance h14	Tolerance h15
To 3	0 -0.25	0 -0.40
Over 3 to 6	0 -0.30	0 -0.48
Over 6 to 10	0 -0.36	0 -0.58
Over 10 to 18	0 -0.43	0 -0.70

d	d1	d2 min.	P	Breaking torque min.(Nm)	D h14	K h14	TORX Plus® AUTOSERT®	D h14	TORX Plus® AUTOSERT®	D h15	K h14	TORX Plus® AUTOSERT®
1.8	1.8 +0.08	1.17	0.71	0.25	3.20	1.50	5 IP			4.20	1.40	5 IP
2.0	2.0 +0.08	1.28	0.78	0.41	3.40	1.60	6 IP	4.00	6 IP	4.30	1.50	6 IP
2.5	2.5 +0.10	1.64	0.95	0.85	4.30	2.10	8 IP	5.00	8 IP	5.30	2.10	8 IP
3.0	3.0 +0.10	2.01	1.12	1.55	5.30	2.30	10 IP	6.00	10 IP	6.30	2.20	10 IP
3.5	3.5 +0.10	2.37	1.29	2.52	6.20	2.60	15 IP	7.00	15 IP	7.30	2.60	15 IP
4.0	4.0 +0.10	2.73	1.46	3.83	7.00	3.10	20 IP	8.00	20 IP	8.30	2.90	20 IP
4.5	4.5 +0.10	3.09	1.63	5.53	7.50	3.40	20 IP					
5.0	5.0 +0.15	3.43	1.80	7.50	9.00	3.60	25 IP	10.00	25 IP	10.50	3.60	25 IP
6.0	6.0 +0.15	4.16	2.14	13.30	10.80	4.20	30 IP	12.00	30 IP	12.50	4.00	30 IP
7.0	7.0 +0.18	4.86	2.48	19.44	12.50	4.80	40 IP			15.00	4.80	40 IP
8.0	8.0 +0.18	5.58	2.82	32.10	14.00	4.80	40 IP			17.00	5.00	40 IP

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

7. Products in Stock

HS81PA	HS87PA	HS82PA	HSX81PA
			
• Pan head • TORX Plus® AUTOSERT® recess • Zinc plated Cr (III) 8µm + Sealant + Baking	• Pan head flange • TORX Plus® AUTOSERT® recess • Zinc plated Cr (III) 8µm + Sealant + Baking	• Countersunk head • TORX Plus® AUTOSERT® recess • Zinc plated Cr (III) 8µm + Sealant + Baking	• Pan head • TORX Plus® AUTOSERT® recess • Stainless steel A2

Electroplated Zinc plated Cr (III) 8 µm + Sealant provides better corrosion resistance and guarantees **144 hours in Neutral Salt Spray (NSS) test without red rust.**

8. Applications

REMFORM® II HS™ screws are the optimal solution for the assembly of high strength or fiber reinforced materials that require:

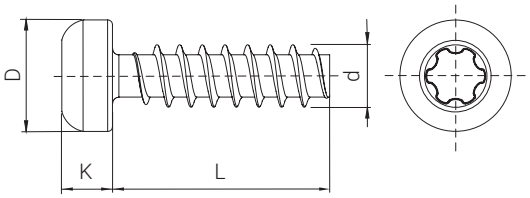
- High clamping force.
- High pull-out resistance.
- High resistance to vibration loosening.

Automotive, electric material, electronics and household appliances.

HS81PA

REMFORM® II HS™

- **Pan head**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Sealant + Baking (144 h NSS)**



d mm	1.8	2.0	2.5	3.0	3.5	4.0	5.0	6.0
D mm	3.2	3.40	4.30	5.30	6.20	7.00	9.00	10.80
K mm	1.5	1.60	2.10	2.30	2.60	3.10	3.60	4.20
TORX Plus® AUTOSERT®	5 IP	6 IP	8 IP	10 IP	15 IP	20 IP	25 IP	30 IP

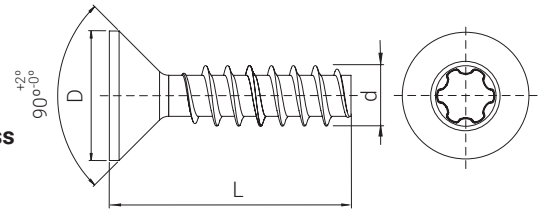
L mm	**Ø1.8**	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
4	○	○	–	–	–	–	–	–
5	○	○	–	–	–	–	–	–
6	●	○	○	●	–	–	–	–
8	○	●	●	●	●	●	–	–
10	○	○	○	●	●	●	–	–
12	–	○	○	●	●	●	●	○
13	–	–	○	○	○	○	○	○
14	–	–	○	○	○	○	○	○
15	–	–	○	○	○	○	○	○
16	–	–	○	●	●	●	○	○
18	–	–	○	○	○	○	○	○
20	–	–	–	●	○	●	●	○
22	–	–	–	○	○	○	○	○
25	–	–	–	○	○	○	○	○
30	–	–	–	–	○	○	○	○
35	–	–	–	–	○	○	○	○
40	–	–	–	–	○	○	○	○
45	–	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

HS82PA

REMFORM® II HS™

- **Countersunk head**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Sealant + Baking (144 h NSS)**



d mm	2.0	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.00	5.00	6.00	7.00	8.00	10.00	12.00
TORX Plus® AUTOSERT®	6 IP	8 IP	10 IP	15 IP	20 IP	25 IP	30 IP

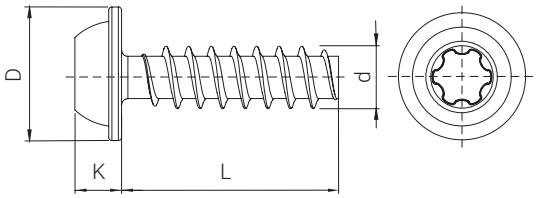
L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	○	●	–	–	–	–
8	●	○	●	○	○	–	–
10	○	○	○	●	○	–	–
12	○	○	●	●	●	–	–
13	○	○	○	○	○	○	–
14	○	○	○	○	○	○	–
15	○	○	○	○	○	○	○
16	–	○	●	○	●	○	○
18	–	○	○	○	○	○	○
20	–	○	○	○	○	○	○
22	–	–	○	○	○	○	○
25	–	–	○	○	○	○	○
30	–	–	○	○	○	○	○
35	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

HS87PA

REMFORM® II HS™

- **Pan head flange**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Sealant + Baking (144 h NSS)**



d mm	2.0	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.30	5.30	6.30	7.30	8.30	10.50	12.50
K mm	1.50	2.10	2.20	2.60	2.90	3.60	4.00
TORX Plus® AUTOSERT®	6 IP	8 IP	10 IP	15 IP	20 IP	25 IP	30 IP

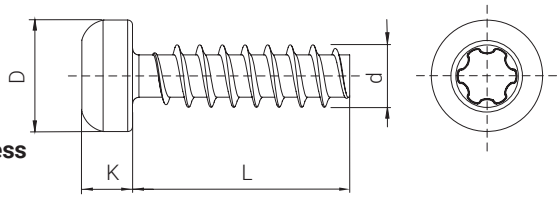
L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	○	○	–	–	–	–
8	●	●	●	○	○	–	–
10	○	○	●	○	○	○	–
12	○	○	●	●	●	○	○
13	○	○	○	○	○	○	○
14	○	○	○	○	○	○	○
15	○	○	○	○	○	○	○
16	–	○	○	○	●	○	○
18	–	○	○	○	○	○	○
20	–	○	○	○	●	●	●
22	–	○	○	○	○	○	○
25	–	○	○	○	○	○	○
30	–	–	–	○	○	○	●
35	–	–	–	○	○	○	○
38	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design. please contact our sales department.
Information about packaging conditions in page 130.

HSX81PA

REMFORM® II HS™

- **Pan head**
- **TORX Plus® AUTOSERT® recess**
- **Stainless steel A2**



d mm	3.0	3.5	4.0	5.0	6.0
D mm	5.60	6.20	7.00	8.20	10.00
K mm	2.20	2.40	2.60	3.05	3.55
TORX Plus® AUTOSERT®	10 IP	10 IP	15 IP	20 IP	25 IP

L mm	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	–	–	–	–
8	●	●	○	–	–
10	○	○	●	○	–
12	●	○	○	○	○
13	○	○	○	○	○
14	○	○	○	○	○
15	○	○	○	○	○
16	○	○	●	○	○
18	○	○	○	○	○
20	○	○	○	●	○
22	–	○	○	○	○
25	–	○	○	○	○
30	–	○	○	○	○
35	–	–	○	○	○
40	–	–	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

REMFORM® II™

REMFORM® II™ thread forming screw has been developed for the direct fastening into ductile and medium thermoplastics in applications under medium mechanical requirements.

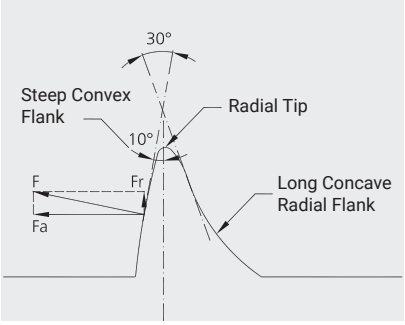


Fig.4. During thread forming, the Steep Convex Flank transfers most of the tightening load in the axial direction (Fa), minimizing radial force (Fr) and consequently plastic deformation. The axial force (Fa) is over 4,5 times greater than radial force (Fr).

1. Technical features

REMFORM® II™ thread employs the Asymmetric thread design of REMFORM® II HS™ but different core diameter and thread pitch, adapted to the assembly requirements of thermoplastics in applications under medium mechanical loads.

- **Asymmetric thread design of 30°**
  Unique Radius Flank™ asymmetrical thread design remains the main characteristic of REMFORM® II™ thread. It provides low thread forming torque and minimizes radial tension generated in the plastic during thread forming, **reducing the risk of boss bursting**.

The efficient material displacement to the Trailing Pressure Flank increases **resistance to pull-out** and major surface contact with nut member material **increases vibration loosening resistance**.

2. Advantages

- The low radial forces minimize the risk of overstressing and cracking of the plastic. It allows for **bosses with smaller external diameter**, which offers **great opportunities for cost reduction.**
- **High resistance to pull-out forces, vibration loosening and stripping.**
- Low thread forming torque and high stripping torque offer **optimal safety during assembly.**

The technical advantages of REMFORM® II™ screw directly results in a **more resistant assembly,** greater safety during threading and **lower costs of the assembly** process.

3. Boss design recommendations

In order to ensure a safe installation and stable clamping force, it is important to pay attention to the boss design, as it must resist mold extraction and cooling tension, as well as tension created during screw installation.

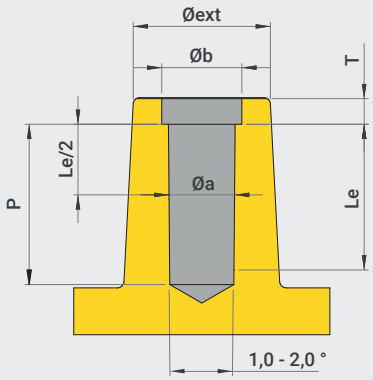
The boss dimensions will vary based on the type of plastic. It's important to include a relief bore to prevent damaging the boss when starting thread forming. The relief bore helps to align the screw during threading.

For additional information, please contact our technical department.

Material	Øa	Øext
PTFE	0.73 x d	2.1 - 2.6 x d
PE	0.75 x d	2.1 - 2.6 x d
PA6 / PA66	0.75 x d	2.1 - 2.6 x d
PP	0.75 x d	2.1 - 2.6 x d
PPO	0.75 x d	2.1 - 2.6 x d
ABS	0.75 x d	2.1 - 2.6 x d
ASA	0.78 x d	2.0 - 2.5 x d
PBT	0.78 x d	2.0 - 2.5 x d
PS	0.78 x d	2.0 - 2.5 x d
POM	0.78 x d	2.0 - 2.5 x d

Material	Øa	Øext
PET	0.78 x d	2.0 - 2.5 x d
PC + ABS	0.80 x d	2.0 - 2.5 x d
PP + 15GF	0.80 x d	2.0 - 2.5 x d
PC	0.82 x d	2.0 - 2.5 x d
PE + 30GF	0.82 x d	2.0 - 2.5 x d
PA6 + 15GF	0.82 x d	2.0 - 2.5 x d
PC + 10GF	0.83 x d	2.0 - 2.5 x d
PMMA	0.83 x d	2.0 - 2.5 x d
PA66 + 15GF	0.83 x d	2.0 - 2.5 x d
ABS + 20GF	0.83 x d	2.0 - 2.5 x d

This data is intended for guidance purposes. We recommend carrying out relevant tests on plastic parts to establish the precise values.



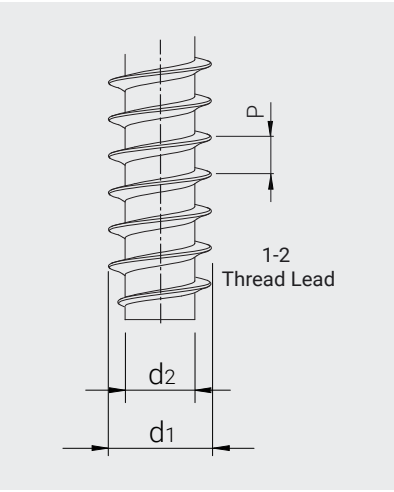
d = screw diameter
Length of engagement Le = 2.3 x d
Minimum depth P = 2.9 x d
T = 0.25 - 0.5 x d
Øb = 1.05 - 1.1 x d

Suggested tolerances are:
+0.08 mm for holes ≤ Ø3.0 mm
+0.10 mm for holes Ø3.0 - Ø4.5 mm
+0.12 mm for holes > Ø4.5 mm

4. Technical data

d	d1 max.	d1 min.	d2 min.	Pitch P
2.0	2.10	2.0	1.20	1.00
2.5	2.60	2.5	1.51	1.15
3.0	3.10	3.0	1.93	1.35
3.5	3.60	3.5	2.25	1.55
4.0	4.10	4.0	2.57	1.75
4.5	4.60	4.5	2.89	2.00
5.0	5.15	5.0	3.20	2.25
6.0	6.15	6,0	3.84	2.65
7.0	7.18	7.0	4.48	3.10
8.0	8.18	8.0	5.11	3.50

Dimensions in mm.



5. Applications

REMFORM® II™ screws are recommended for the assembly of wide range of plastics in automotive, electric material, electronics and household appliances.

It's a custom-made screw. For further information, please contact our sales department.

REMFORM® II F™

REMFORM® II F™ (Fine Thread) screws are especially recommended for the direct assembly of low ductility materials, such as high content glass fiber reinforced plastics, thermoset plastics, phenolic resins and application in plastic where the length of engagement is lower than optimal.

1. Technical features

REMFORM® II F™ thread employs the Asymmetric thread design of REMFORM® II HS™ but increased core diameter and smaller thread pitch, **adapted to the assembly requirements of materials with low ductility.**

The smaller pitch thread of REMFORM® II F™ screw increases the number of threads along the shank of the screw. In this way, the number of contact points increases and consequently, **pull-out resistance is greatly improved.**

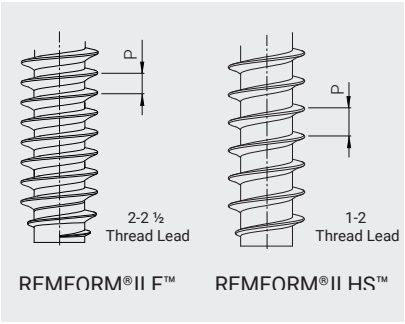


Fig.5. For the same screw diameter and engagement, the smaller pitch of REMFORM® II F™ thread increases the number of contact points with the base material.

2. Advantages

- The low radial forces **minimize the risk of overstressing and cracking of the plastic.**
- Tensile strength of over 1,000 N/mm^2 and reduced thread pitch **ensures high pull-out resistance.**
- Larger core diameter provides **higher torsional and tensile strength,** fundamental requirement for the assembly of low ductility materials.
- Reduced length of engagement enables the assembly of plastic with low insertion depth **assuring high clamping and pull-out resistance.**
- Low thread forming torque and high stripping torque offer **optimal safety during assembly.**

The technical advantages of REMFORM® II F™ screw directly results in a **more resistant assembly**, greater safety during threading and **lower costs** of the assembly process.

3. Boss design recommendations

In order to ensure a safe installation and stable clamping force, it is important to pay attention to the boss design, as it must resist mold extraction and cooling tension, as well as tension created during screw installation.

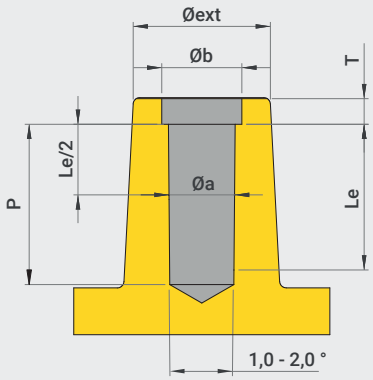
The boss dimensions will vary based on the type of plastic. It's important to include a relief bore to prevent damaging the boss when starting thread forming. The relief bore also helps to align the screw during threading.

For additional information, please contact our technical department.

Material	Øa	Øext
PC	0.83 x d	2.2 - 2.6 x d
PE + 30GF	0.83 x d	2.2 - 2.6 x d
PA6 + 15GF	0.83 x d	2.2 - 2.6 x d
PC + 10GF	0.84 x d	2.2 - 2.6 x d
PMMA	0.84 x d	2.2 - 2.6 x d
PA66 + 15GF	0.84 x d	2.2 - 2.6 x d
ABS + 20GF	0.84 x d	2.1 - 2.5 x d
PPO + 30GF	0.86 x d	2.1 - 2.5 x d
ABS +30GF	0.86 x d	2.1 - 2.5 x d
PC + 30GF	0.86 x d	2.1 - 2.5 x d

Material	Øa	Øext
PP +30GF	0.86 x d	2.1 - 2.5 x d
POM + 30GF	0.86 x d	2.1 - 2.5 x d
PA6 + 30GF	0.86 x d	2.1 - 2.5 x d
PA66 + 30GF	0.86 x d	2.1 - 2.5 x d
PPA + 30GF	0.86 x d	2.1 - 2.5 x d
PET + 30GF	0.86 x d	2.1 - 2.5 x d
PBT + 30GF	0.86 x d	2.1 - 2.5 x d
PS + 30GF	0.87 x d	2.1 - 2.5 x d
PPS + 40GF	0.87 x d	2.1 - 2.5 x d
PA6/PA66 +45GF	0.88 x d	2.1 - 2.5 x d

This data is intended for guidance purposes. We recommend carrying out relevant tests on plastic parts to establish the precise values.



d = screw diameter
Length of engagement Le = 1.5 x d
Minimum depth P = 2.1 x d
T = 0.20 - 0.40 x d
Øb = 1.05 - 1.1 x d

Suggested tolerances are:
+0.08 mm for holes ≤ Ø3.0 mm
+0.10 mm for holes Ø3.0 - Ø4.5 mm
+0.12 mm for holes > Ø4.5 mm

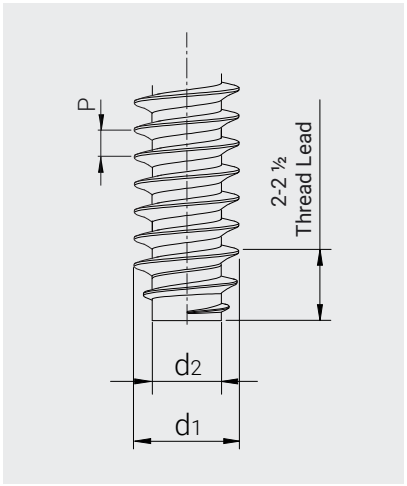
4. Applications

REMFORM® II F™ screws are recommended for the assembly of highly reinforced plastics and thermoplastic parts in applications where the length of engagement is lower than optimal.

Automotive, electric material, electronics and household appliances, liquid pumps.

Fig.6. Eliminates the use of inserts and avoids damage in polyester part.

Fig.7. Ensures joint tightness in liquid pumps.

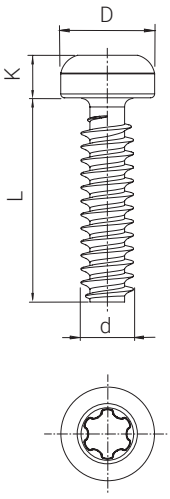


5. Technical data

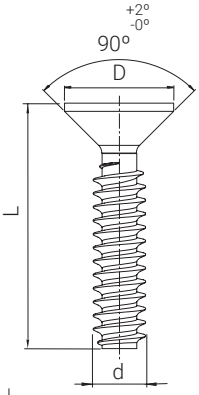
REMFORM® II F™ screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements. To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, please contact our technical department.

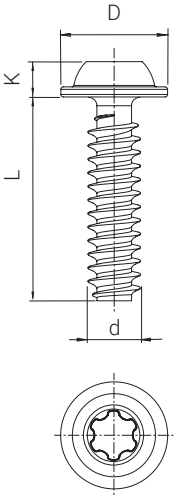
Nominal Value (mm)	Tolerance h14	Tolerance h15
To 3	0 -0.25	0 -0.40
Over 3 to 6	0 -0.30	0 -0.48
Over 6 to 10	0 -0.36	0 -0.58
Over 10 to 18	0 -0.43	0 -0.70



Ref. F282PA



Ref. F282PA



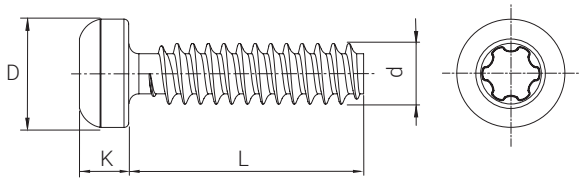
Ref. F287PA

d	d1	d2 min.	P	Breaking torque min. (Nm)	D h14	K h14	TORX Plus® AUTOSERT®	D h14	TORX Plus® AUTOSERT®	D h15	K h14	TORX Plus® AUTOSERT®
1.8	1.8 +0.10	1.19	0.55	0.32	3.20	1.50	6 IP			4.20	1.40	6 IP
2.0	2.0 +0.10	1.33	0.60	0.48	3.40	1.60	6 IP	4.00	6 IP	4.30	1.50	6 IP
2.5	2.5 +0.10	1.68	0.70	0.92	4.30	2.10	8 IP	5.00	8 IP	5.30	2.10	8 IP
3.0	3.0 +0.10	2.02	0.80	1.56	5.30	2.30	10 IP	6.00	10 IP	6.30	2.20	10 IP
3.5	3.5 +0.10	2.37	0.95	2.45	6.20	2.60	15 IP	7.00	15 IP	7.30	2.60	15 IP
4.0	4.0 +0.10	2.71	1.05	3.51	7.00	3.10	20 IP	8.00	20 IP	8.30	2.90	20 IP
5.0	5.0 +0.15	3.40	1.25	6.97	9.00	3.60	25 IP	10.00	25 IP	10.50	3.60	25 IP
6.0	6.0 +0.15	4.09	1.40	12.60	10.80	4.20	30 IP	12.00	30 IP	12.50	4.00	30 IP
8.0	8.0 +0.15	5.46	1.75	31.80	14.00	4.80	40 IP			17.00	5.00	40 IP

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

F281PA

REMFORM® II F™



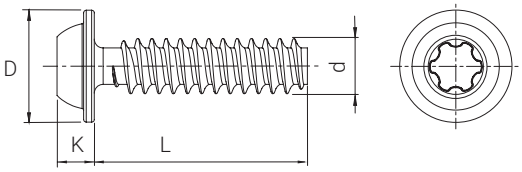
- **Pan head**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Baking + Sealant (144h NSS)**

d mm	3.0	3.5	4.0	5.0	6.0
D mm	5.30	6.20	7.00	9.00	10.60
K mm	2.30	2.60	3.10	3.60	4.20
TORX Plus® AUTOSERT®	10 IP	15 IP	20 IP	25 IP	30 IP

L mm	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	○	○	–	–
7	○	○	○	○	–
8	●	○	○	○	○
10	●	●	●	○	○
12	○	○	●	○	○
16	○	○	○	○	○
18	○	○	○	○	○
20	●	○	○	●	○
25	–	○	○	○	○
30	–	–	○	○	○
35	–	–	○	○	○
40	–	–	○	○	○
50	–	–	–	–	○

F287PA

REMFORM® II F™



- **Pan head flange**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Baking + Sealant (144h NSS)**

d mm	2.0	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.30	5.30	6.30	7.30	8.30	10.50	12.50
K mm	1.50	2.10	2.20	2.60	2.90	3.60	4.00
TORX Plus® AUTOSERT®	6 IP	8 IP	10 IP	15 IP	20 IP	25 IP	30 IP

L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	●	○	●	–	–	–	–
8	●	●	●	○	○	–	–
10	●	●	●	●	●	○	–
12	○	○	●	○	○	○	○
13	○	○	○	○	○	○	○
14	○	○	●	○	○	○	○
15	○	○	○	○	○	○	○
16	–	○	○	○	○	○	○
18	–	○	○	○	○	○	○
20	–	○	○	○	○	○	○
22	–	○	○	○	○	○	○
25	–	○	○	○	○	○	○
30	–	–	–	○	○	○	○
35	–	–	–	○	○	○	○
38	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○
50	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130

CELOspArk®

CELOSPARK® screw has been developed for the direct fastening into ductile and medium thermoplastics. CELOSPARK® special thread geometry provides high pull-out resistance, enables an easy assembly and prevents deformation of plastic bosses, greatly improving the technical properties of self-tapping screws.

1. Technical features

- **30° thread angle**
  During the threading process, the thread angle of 30° provides a 50% reduction in radial tension (Fr) when compared to self-tapping screws, reduces the problem of boss bursting and allows for bosses with smaller diameter.

- **Increased thread height and thread pitch**
  Raising the height of the thread gives 26% more penetration in plastic materials. The volume of plastic in the shearing zone for CELOspArk® (area between thread flanks) is much bigger than for a self-tapping screw, resulting in a more resistant nut member and consequently, an increase in pull-out and stripping resistance.

- **Progressive point**
  Allows for a quick alignment of the screw and improves material displacement during thread forming process.

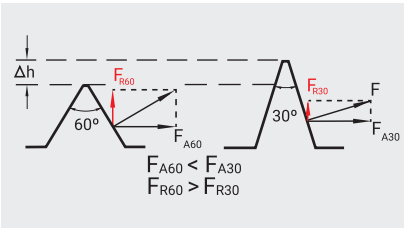


Fig.8. If we carry out a resolution of resultant forces, a 30º thread angle provides higher axial force (Fa) and lower radial force (Fr) when comparing with 60º thread angle.

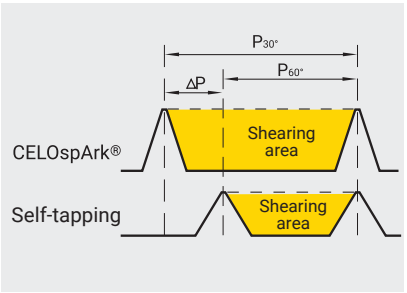


Fig.9. Increasing the screw thread pitch provides a larger shearing zone and a more resistant nut member in the plastic.

2. Advantages

- **Less radial tension in plastic.** Reduces the problem of boss bursting and allows for bosses with smaller diameter.

- **Low thread forming torque** and high stripping torque provides a safer installation process.

- **Higher pull-out and stripping resistance** enable its use in assemblies with demanding mechanical requirements.

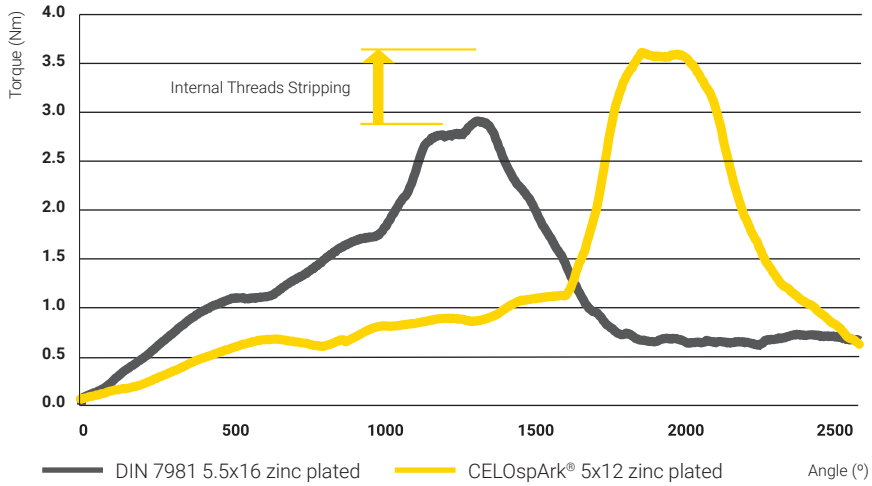
- Quick alignment of the screw **reduces assembly time.**

- The increase of surface contact between threads and nut member improves **vibration loosening resistance.**

- **Possibility to reuse the screw** due to its lower risk of stripping.

The technical advantages of CELOspArk® screw directly translate into a **more resistant assembly, greater safety** during threading and lower costs of the assembly process.

3. Threading curve



PP + 20% GF piece, core hole Ø 4.1 mm; length of engagement 10 mm.

When comparing CELOspArk® screw and self-tapping screw threading curves, the larger difference between threading torque and failure torque of CELOspArk® screw provides greater safety during assembly.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.

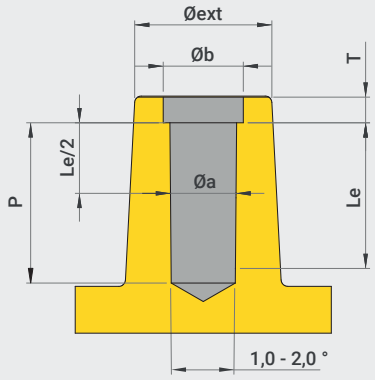
CELOspArk® Minimum breaking torque	
d (mm)	Torque (Nm)
1.8	0.25
2.0	0.30
2.3	0.34
2.5	0.40
3.0	1.20
3.5	2.00
4.0	2.80
4.5	3.50
5.0	4.20
6.0	7.00
7.0	10.00
8.0	13.00

4. Boss design recommendations

In order to ensure a strong fixing and guarantee the clamping of the assembly, it is relevant to pay attention to the boss design, as it must resist mold extraction and cooling tension, as well as tension created during screw installation.

The boss dimensions will vary based on the type of plastic. It's important to include a relief bore to prevent damaging the boss when starting thread forming. The relief bore also helps to align the screw during threading

For additional information, please contact our technical department.



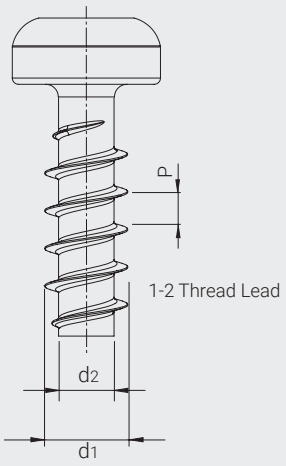
d = screw diameter
Length of engagement Le = 2.3 x d
Minimum depth P = 2.9 x d
T = 0.25 - 0.5 x d
Øb = 1.05 - 1.1 x d

Material	Øa	Øext
PTFE	0.73 x d	2.1 - 2.6 x d
PE	0.75 x d	2.1 - 2.6 x d
PA6 / PA66	0.75 x d	2.1 - 2.6 x d
PP	0.75 x d	2.1 - 2.6 x d
PPO	0.75 x d	2.1 - 2.6 x d
ABS	0.75 x d	2.1 - 2.6 x d
ASA	0.78 x d	2.0 - 2.5 x d
PBT	0.78 x d	2.0 - 2.5 x d
PS	0.78 x d	2.0 - 2.5 x d
POM	0.78 x d	2.0 - 2.5 x d

Material	Øa	Øext
PET	0.78 x d	2.0 - 2.5 x d
PC + ABS	0.80 x d	2.0 - 2.5 x d
PP + 15GF	0.80 x d	2.0 - 2.5 x d
PC	0.82 x d	2.0 - 2.5 x d
PE + 30GF	0.82 x d	2.0 - 2.5 x d
PA6 + 15GF	0.82 x d	2.0 - 2.5 x d
PC + 10GF	0.83 x d	2.0 - 2.5 x d
PMMA	0.83 x d	2.0 - 2.5 x d
PA66 + 15GF	0.83 x d	2.0 - 2.5 x d
ABS + 20GF	0.83 x d	2.0 - 2.5 x d

This data is intended for guidance purposes. We recommend carrying out relevant tests on plastic parts to establish the precise values.

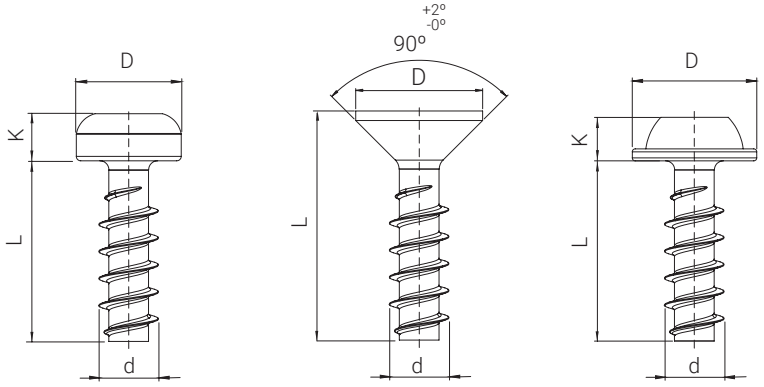
Suggested tolerances are:
+0.08 mm for holes ≤ Ø3.0 mm
+0.10 mm for holes Ø3.0 - Ø4.5 mm
+0.12 mm for holes > Ø4.5 mm



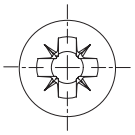
5. Technical data

CELOspArk® screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements.

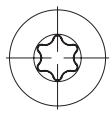
The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, contact our technical department.



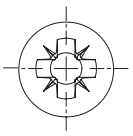
Ref. SP81T



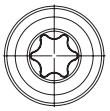
Ref. SP81Z



Ref. SP82T



Ref. SP82Z



Ref. SP87T

Ref. SP87Z

Nominal Value (mm)	Tolerance h14	Tolerance h15
To 3	0 -0.25	0 -0.40
Over 3 to 6	0 -0.30	0 -0.48
Over 6 to 10	0 -0.36	0 -0.58
Over 10 to 18	0 -0.43	0 -0.70

d	d1	d2 min.	P ± 0.05	Breaking torque min. (Nm)	D h14	K h14	Pozi	TORX® TORX Plus®	D h14	Pozi	TORX® TORX Plus®	D h15	K h14	Pozi	TORX® TORX Plus®
1.8	1.8 +0.10	0.70	0.80	0.25	3.20	1.50	0	T5 / 5 IP				4.20	1.40		T5 / 5 IP
2.0	2.0 +0.10	0.80	1.00	0.30	3.40	1.60	1	T6 / 6 IP	4.00	1	T6 / 6 IP	4.30	1.50	1	T6 / 6 IP
2.3	2.3 +0.15	1.00	1.10	0.34	3.90	1.70	1	T7 / 7 IP	4.60	1	T7 / 7 IP	4.50	1.70	1	T7 / 7 IP
2.5	2.5 +0.15	1.20	1.15	0.40	4.30	2.10	1	T8 / 8 IP	5.00	1	T8 / 8 IP	5.30	2.10	1	T8 / 8 IP
3.0	3.0 +0.18	1.50	1.35	1.20	5.30	2.30	1	T10 / 10 IP	6.00	1	T10 / 10 IP	6.30	2.20	1	T10 / 10 IP
3.5	3.5 +0.18	1.66	1.55	2.00	6.20	2.60	2	T15 / 15 IP	7.00	2	T15 / 15 IP	7.30	2.60	2	T15 / 15 IP
4.0	4.0 +0.18	2.11	1.80	2.80	7.00	3.10	2	T20 / 20 IP	8.00	2	T20 / 20 IP	8.30	2.90	2	T20 / 20 IP
4.5	4.5 +0.18	2.30	2.00	3.50	7.50	3.40	2	T20 / 20 IP							
5.0	5.0 +0.18	2.64	2.24	4.20	9.00	3.60	2	T25 / 25 IP	10.00	2	T25 / 25 IP	10.50	3.60	2	T25 / 25 IP
6.0	6.0 +0.22	3.20	2.70	7.00	10.80	4.20	3	T30 / 30 IP	12.00	3	T30 / 30 IP	12.50	4.00	3	T30 / 30 IP
7.0	7.0 +0.23	3.70	3.15	10.00	12.50	4.80	3	T40 / 40 IP				15.00	4.80	3	T40 / 40 IP
8.0	8.0 +0.24	4.65	3.60	13.00	14.00	4.80	3	T40 / 40 IP				17.00	5.00	3	T40 / 40 IP

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

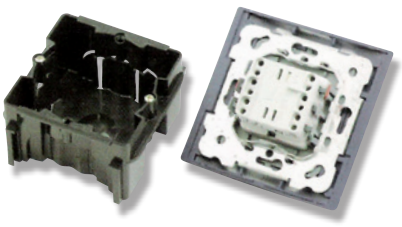
6. Products in stock

SP81T	SP81Z	SP87T
		
• Pan head • TORX® recess • Zinc plated Cr (III) 5µm	• Pan head • POZI recess • Zinc plated Cr (III) 5µm	• Pan head flange • TORX® recess • Zinc plated Cr (III) 5µm

SP87Z	SP82T	SP82Z
		
• Pan head flange • POZI recess • Zinc plated Cr (III) 5µm	• Countersunk head • TORX® recess • Zinc plated Cr (III) 5µm	• Countersunk head • POZI recess • Zinc plated Cr (III) 5µm

7. Applications

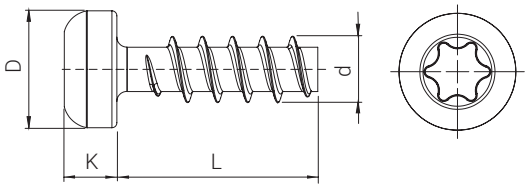
- Automotive
- Electric material
- Lighting
- Household appliances
- Industrial products



SP81T

CELOspArk®

- **Pan head**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm**



d mm	1.8	2.0	2.3	2.5	3.0	3.5	4.0	4.5	5.0	6.0
D mm	3.20	3.40	3.90	4.30	5.30	6.20	7.00	7.50	9.00	10.80
K mm	1.50	1.60	1.70	2.10	2.30	2.60	3.10	3.40	3.60	4.20
TORX®	5 IP[1]	6 IP[1]	7 IP[1]	8 IP[1]	T 10	T 15	T 20	T 20	T 25	T 30

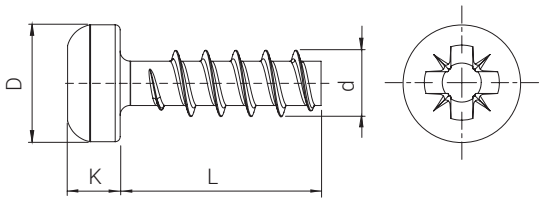
L mm	**Ø1.8**	**Ø2.0**	**Ø2.3**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø4.5**	**Ø5.0**	**Ø6.0**
3	–	–	–	–	–	–	–	–	–	–
4	○	○	–	–	–	–	–	–	–	–
5	○	○	–	–	–	–	–	–	–	–
6	●	●	○	○	●	–	–	–	–	–
8	○	○	○	●	●	●	●	–	–	–
10	○	○	○	○	●	●	●	–	–	–
12	–	○	○	○	●	●	●	○	●	–
13	–	–	○	○	○	○	○	○	○	○
14	–	–	○	○	○	○	○	○	○	○
16	–	–	○	○	●	●	●	○	○	○
18	–	–	○	○	○	○	○	○	○	○
19	–	–	○	○	○	○	○	○	○	○
20	–	–	○	○	●	○	●	○	●	○
22	–	–	–	–	○	○	○	○	○	○
25	–	–	–	–	○	○	○	○	○	○
30	–	–	–	–	–	○	○	○	○	○
35	–	–	–	–	–	○	○	○	○	○
40	–	–	–	–	–	○	○	○	○	○
50	–	–	–	–	–	○	○	○	○	○

● Product available in stock. ○ Product available upon request. [1] TORX PLUS®
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

SP81Z

CELOspArk®

- **Pan head**
- **POZI recess**
- **Zinc plated Cr (III) 5µm**



d mm	1.8	2.0	2.3	2.5	3.0	3.5	4.0	4.5	5.0	6.0
D mm	3.20	3.40	3.90	4.30	5.30	6.20	7.00	7.50	9.00	10.80
K mm	1.50	1.60	1.70	2.10	2.30	2.60	3.10	3.40	3.60	4.20
POZI	Z 0	Z 1	Z 1	Z 1	Z 1	Z 2	Z 2	Z 2	Z 2	Z 3

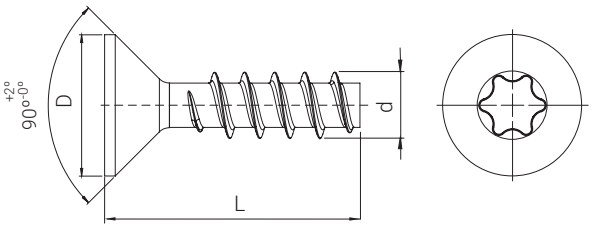
L mm	**Ø1.8**	**Ø2.0**	**Ø2.3**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø4.5**	**Ø5.0**	**Ø6.0**
3	–	–	–	–	–	–	–	–	–	–
4	○	○	–	–	–	–	–	–	–	–
5	○	○	–	–	–	–	–	–	–	–
6	○	○	●	●	●	–	–	–	–	–
8	○	○	●	●	●	●	–	–	–	–
10	○	○	●	●	●	●	●	–	–	–
12	–	○	●	●	●	●	●	○	○	–
13	–	–	○	○	○	●	○	○	○	–
14	–	–	○	○	○	○	○	○	○	–
16	–	–	○	●	●	●	●	●	●	–
18	–	–	○	○	●	○	○	○	○	–
19	–	–	○	○	○	○	○	○	○	○
20	–	–	○	○	●	●	●	●	●	○
22	–	–	–	–	○	○	●	○	○	○
25	–	–	–	–	○	○	●	○	○	○
30	–	–	–	–	–	○	●	○	●	●
35	–	–	–	–	–	○	○	○	○	○
40	–	–	–	–	–	○	○	○	○	○
50	–	–	–	–	–	○	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

SP82T

CELOspArk®

- **Countersunk head**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm**



d mm	2.3	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.60	5.00	6.00	7.00	8.00	10.00	12.00
TORX®	7 IP[1]	8 IP[1]	T 10	T 15	T 20	T 25	T 30

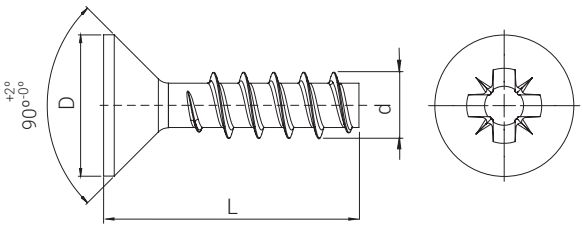
L mm	**Ø2.3**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	○	●	–	–	–	–
8	○	○	●	○	–	–	–
10	○	○	○	●	○	–	–
12	○	○	●	●	●	–	–
13	○	○	○	○	○	–	–
14	○	○	○	○	○	–	–
16	○	○	●	○	●	○	–
18	○	○	○	○	○	○	–
19	○	○	○	○	○	○	○
20	○	○	○	○	○	○	○
22	–	–	○	○	○	○	○
25	–	–	○	○	○	○	○
30	–	–	○	○	○	○	○
35	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○
50	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request. [1] TORX PLUS®
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

SP82Z

CELOspArk®

- **Countersunk head**
- **POZI recess**
- **Zinc plated Cr (III) 5µm**



d mm	2.3	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.60	5.00	6.00	8.00	8.00	10.00	12.00
POZI	Z 1	Z 1	Z 1	Z 2	Z 2	Z 2	Z 3

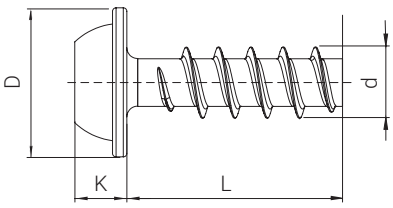
L mm	**Ø2.3**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	○	○	–	–	–	–
8	○	○	●	●	–	–	–
10	○	●	●	●	○	–	–
12	○	○	●	○	●	–	–
13	○	○	○	○	○	–	–
14	○	○	○	○	○	–	–
16	○	○	○	●	●	○	–
18	○	○	○	○	○	○	–
19	○	○	○	○	○	○	○
20	○	○	○	○	○	○	○
22	–	–	○	○	○	○	○
25	–	–	○	○	○	○	○
30	–	–	–	○	●	○	○
35	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○
50	–	–	–	○	○	○	○

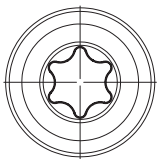
● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

SP87T

CELOspArk®

- **Pan head flange**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm**





d mm	2.5	3.0	3.5	4.0	5.0	6.0
D mm	5.30	6.30	7.30	8.30	10.50	12.50
K mm	2.10	2.20	2.60	2.90	3.60	4.00
TORX®	8 IP[1]	T 10	T 15	T 20	T 25	T 30

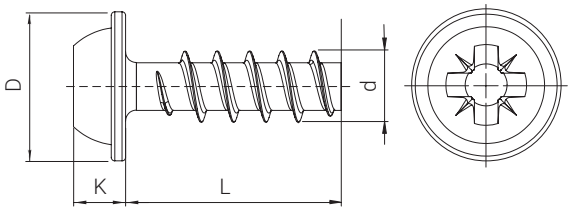
L mm	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	–	–	–	–	–
8	●	●	○	–	–	–
10	○	●	○	○	–	–
12	○	●	●	●	○	–
13	○	○	○	○	○	–
14	○	○	○	○	○	–
16	○	○	○	●	○	○
18	○	○	○	○	○	○
19	○	○	○	○	○	○
20	○	○	○	●	●	●
22	–	○	○	○	○	○
25	–	○	○	○	○	○
30	–	–	○	○	○	●
35	–	–	○	○	○	○
40	–	–	○	○	○	○
50	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request. [1] TORX PLUS®
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

SP87Z

CELOspArk®

- **Pan head flange**
- **POZI recess**
- **Zinc plated Cr (III) 5µm**



d mm	2.5	3.0	3.5	4.0	5.0	6.0
D mm	5.30	6.30	7.30	8.30	10.50	12.50
K mm	2.10	2.20	2.60	2.90	3.60	4.00
POZI	Z 1	Z 1	Z 2	Z 2	Z 2	Z 3

L mm	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
6	○	●	–	–	–	–
8	○	●	●	–	–	–
10	○	●	●	○	–	–
12	○	○	○	○	○	–
13	○	○	○	○	○	–
14	○	○	○	○	○	–
16	○	○	○	○	○	○
18	○	○	○	○	○	○
19	○	○	○	○	○	○
20	○	●	○	○	○	○
22	–	○	○	○	○	○
25	–	○	○	○	○	○
30	–	–	○	○	○	○
35	–	–	○	○	○	○
40	–	–	○	○	○	○
50	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

PLASTITE®

PLASTITE® TRILOBULAR® thread-rolling screws were developed specifically for use in plastics. They combine a unique TRILOBULAR® cross-sectional form with deep, wide, spaced threads.

There are different types of PLASTITE® threads, depending on the requirements of the assembly: PLASTITE® 60, PLASTITE® 45 and PLASTITE® 48-2.

PLASTITE® screws are legacy products and have been superseded by REMFORM® II HS™ screws (page 14).

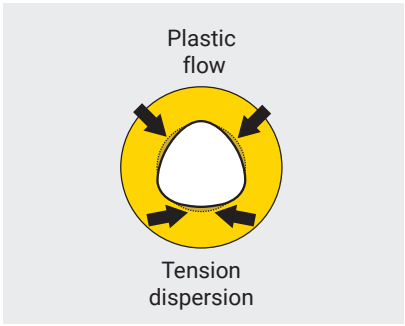


Fig.10. Material flows towards the interior. The space between the lobes absorbs and disperses the tension created during threading.

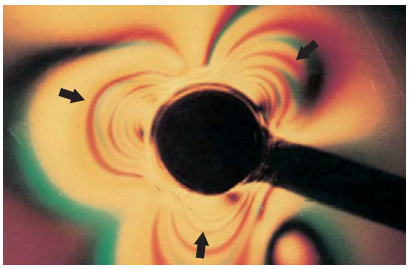
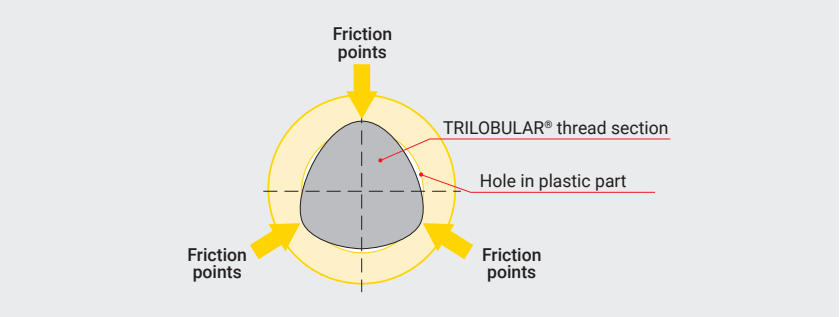


Fig.11. Stress created during thread forming with a TRILOBULAR® section screw.

1. Technical features

- **TRILOBULAR® thread section**
  The three lobes on the thread exert localized stress on the hole, which **reduces friction** during threading process.

The TRILOBULAR® section allows the plastic material to flow in the space between the lobes, and therefore relieves the tension created during threading.



Unlike screws with a circular section, the stress generated on the plastic during threading is concentrated on three points, reducing the radial stress and thread forming torque.

- **Flat crest lead thread**
  The shape of the lead threads easies alignment and material displacement during thread forming.

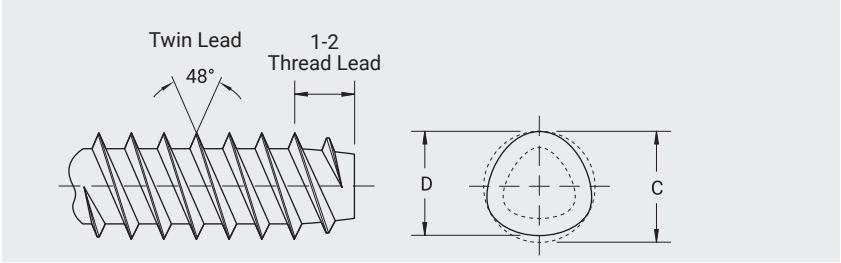
PLASTITE® 60

It was the first version of PLASTITE® screws. It had the same thread profile as self-tapping screws, flank angle of 60º and TRILOBULAR® thread section to reduce friction during thread forming. PLASTITE 60º has been replaced by subsequent versions.

PLASTITE® 48-2

It is the first improvement on the PLASTITE® 60 design aiming to reduce stress on plastic materials during the threading process.

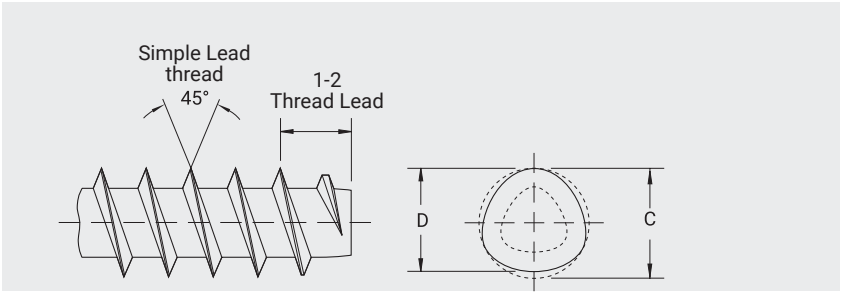
Main features of PLASTITE® 48-2 thread are 48° thread angle and twin lead thread. The steeper helix angle improves stripping resistance.



PLASTITE® 45

PLASTITE® 45 is the latest version of TRILOBULAR® screws for plastic.

The larger thread pitch gives more tension relief over a larger plastic surface, resulting in an increased pull-out and stripping resistance.



2. Boss design recommendations

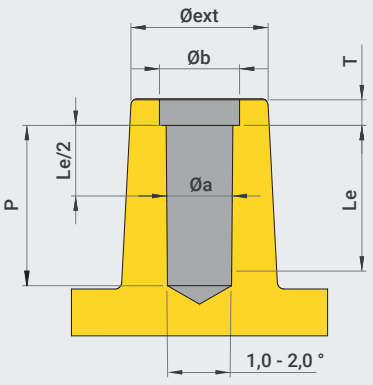
In order to ensure a strong fixing and guarantee the clamping of the assembly, it is relevant to pay attention to the boss design, as it must resist mold extraction and cooling tension, as well as tension created during the insertion of the screw.

It's important to include a relief bore to prevent damaging the tube when starting thread forming. The relief bore also helps to align the screw during threading.

The dimensions for external diameter, core hole diameter and minimum depth will vary based on the type of plastic.

For additional information, please contact our technical department.

	Ductile plastics		Hard plastics	
	Øa	Le	Øa	Le
PLASTITE® 45	0.78 x d	2.2 x d	0.82 x d	2.2 x d
PLASTITE® 48-2	0.9 x d	2 x d	0.92 x d	2 x d
PLASTITE® 60	0.9 x d	2 x d	0.92 x d	2 x d

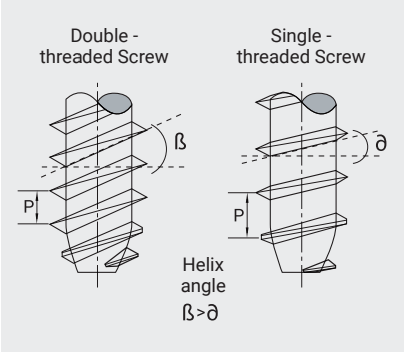


d = screw diameter
Minimum depth P = 2.7 x d
T = 0.25 - 0.5 x d
Øb = 1.05 - 1.1 x d
Øext = 2.0 - 2.5 x d

PCB screw

PCB screws have been designed for the assembly of printed circuit boards (PCB) and thin hard plastic parts.

In the assembly of thin hard plastic parts using standard screws for plastic, the engagement length is not enough to avoid stripping and guarantee the pull-out resistance of the assembly. The special design of PCB screw ensures high pull-out resistance and provides a more resistant joint.



1. Technical features of PCB screw

- **40º thread angle**
  The 40º thread angle reduces radial force (Fr) generated during threading process, thereby **reducing the problem of bursting the plastic material or damaging the PCB.**

- **Special twin-lead thread**
  It provides greater surface contact with the base material which increases friction and reduces the risk of stripping.

- **Reinforced core**
  The reinforced core allows for a higher assembly torque without breaking the screw and ensuring the resistance of the screw during assembly. This is essential when working with a hard-base material.

Fig.12. Assembly of a bathroom fan with PCB screws.

2. Advantages

- In the assembly of thin hard plastic parts:
  - Minimizes the risk of overstressing and cracking of the plastic and allows for **bosses with smaller external diameter.**
  - **High stripping torque** offers optimal safety during assembly.
  - **Higher torsion strength and pull-out resistance.**

- In the assembly on PCBs:
  - The head of the screw is set directly on the connector, **avoiding interference with the tracks and allowing for a better use of the available surface on the PCB.**
  - **Direct fixing** without damaging the PCB.
  - **Higher resistance to vibrational loosening.**
  - Twin-lead thread increases threading speed.

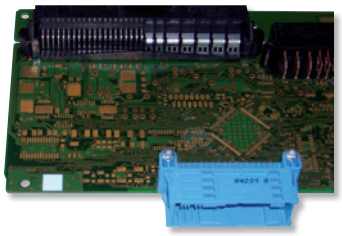
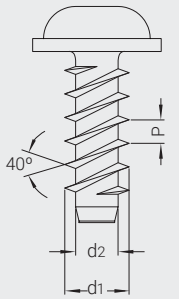


Fig.13. PCB assembly connector with PCB screws.

PCB screw is the solution to the problems that present other fastening systems when it's required to achieve high clamping forces on PCB assembly:

Inverted assembly. The assembly is done through the circuit and threading on the assembled part, for which a low assembly torque is necessary to avoid deformation of the printed circuit board. The head of the screw takes up a lot of space on the board.

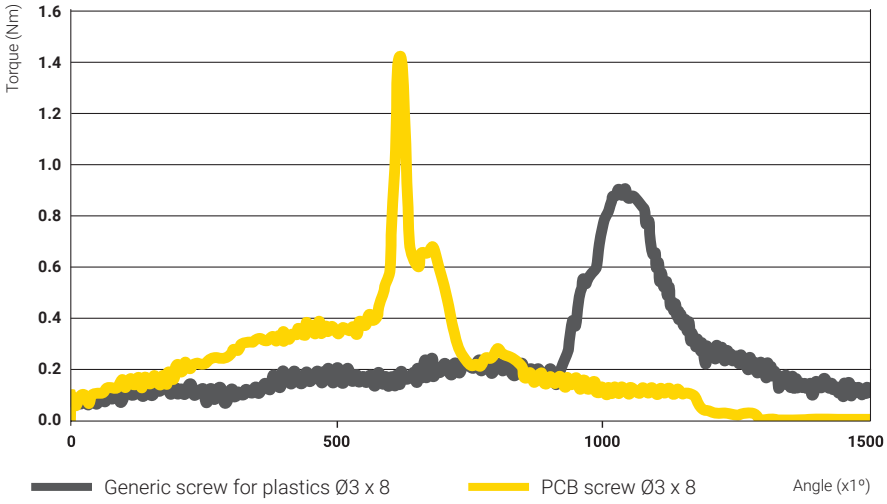
Use of plastic clips. The union can loosen in time due to the ageing of the plastic clips.



3. Threading curve

When comparing PCB screw and standard screw for plastics, threading curve of PCB screw shows faster fixing speeds due to the twin lead thread and safer assembly torque range: the failure torque is much higher with a PCB screw and the thread forming torque values are similar in both cases.

The optimum tightening torque is determined based on threading curve tests in the laboratory.



PBT plastic part, 2.5 mm thickness

4. Boss design recommendations

We recommend contacting our technical department for hole dimension and boss geometry recommendations.

5. Applications

- Assemblies on thin hard plastic.
- Assembly of components on printed circuit boards.

This is a custom-made screw. For further information, please contact our sales department.

IBI-ZAS

IBI-ZAS screws are specially recommended for the assembly of thermoset plastics. Due to the nature of these plastics, it is not recommended to use standard screws for plastics, as the radial stress the base part is subjected to during thread forming can cause boss bursting.

IBI-ZAS screws are also a good choice when assembling aluminum and metal alloy parts with cone-shaped holes.

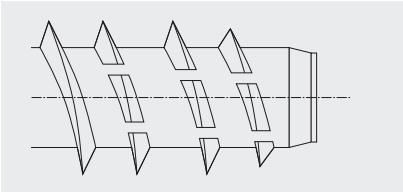


Fig.14. The cuts on the first three leads remove material during threanding, reducing thread forming torque and boss bursting.

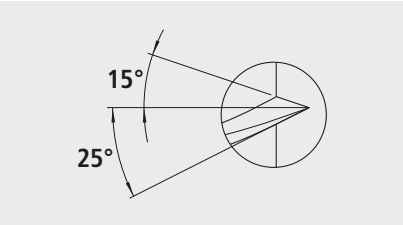


Fig.15. The asymmetric thread guarantees better pull-out and stripping resistance.

1. Technical features

- **Cutting thread**
  The first three lead threads of the screw have cuts that remove chips during threading process, decreasing the thread forming torque and the stress generated on the plastic material.

- **Asymmetric thread**
  The leading flank angle of 25º and trailing flank angle of 15º provide:
  - Increased pull-out resistance.
  - Increased stripping resistance due to the harpoon effect of the threads.

- **Reinforced core**
  It ensures screw resistance during assembly. This is an essential requirement due to the extreme hardness of the base material.

- **Reduced thread pitch**
  It increases contact points with the base material, **increasing resistance to vibration loosening and thread failure.**

2. Advantages

- **Reduction of thread forming torque** results in a more ergonomic assembly.

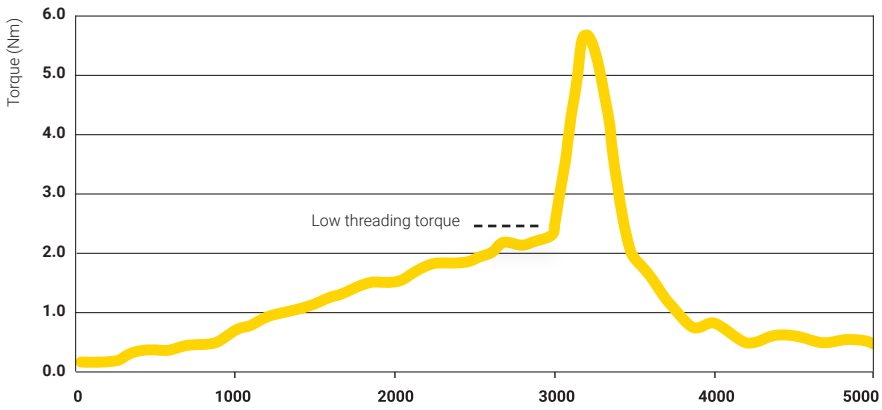
- **Improved breaking torque** due to the screw's reinforced core.

- **Reduction in assembly costs:**
  - The quality of the nut member allows the screw to be reused.
  - It avoids the use of expensive metal inserts.

- IBI-ZAS thread design avoids threading problems in cone-shaped holes (angle of mold extraction >4º) in aluminum and metal alloys.

3. Threading curve

Threading curve of IBI-ZAS screw on Bakelite material. The removal of material considerably reduces thread forming torque, offering a wide safe assembly torque range.



IBI-ZAS Screw Ø5x13.5
core hole ø 4.6 mm, 9 mm length of engagement.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability.
The optimum tightening torque is determined based on threading curve tests in the laboratory.

IBI-ZAS Minimum Breaking Torque	
d (mm)	Torque(Nm)
3.0	1.60
3.5	2.40
4.0	3.80
5.0	7.00
6.0	11.50

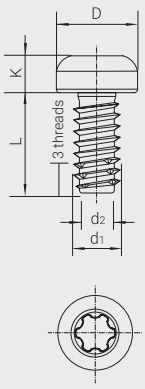
4. Boss design recommendations

We recommend contacting our technical department for hole dimension and boss geometry recommendations.

5. Technical data

d	d_1	d_2	Pitch	D max.	K max.	TORX®	TORX Plus®
3.0	3.0 + 0.10	2.18	0.80	5.30	2.30	T 10	10 IP
3.5	3.5 + 0.10	2.56	0.95	6.20	2.60	T 15	15 IP
4.0	4.0 + 0.10	2.93	1.05	7.00	3.15	T 20	20 IP
5.0	5.0 + 0.15	3.68	1.25	9.00	3.60	T 25	25 IP
6.0	6.0 + 0.15	4.42	1.40	10.80	4.20	T 30	30 IP

Dimensions in mm. The values shown are nominal. For tolerances and other data, please contact our technical department.



6. Applications

IBI-ZAS screw is designed for the assembly of thermoset plastics and Bakelite parts. It can also be used for assembly of aluminum and metal alloy pieces with cone-shaped holes.

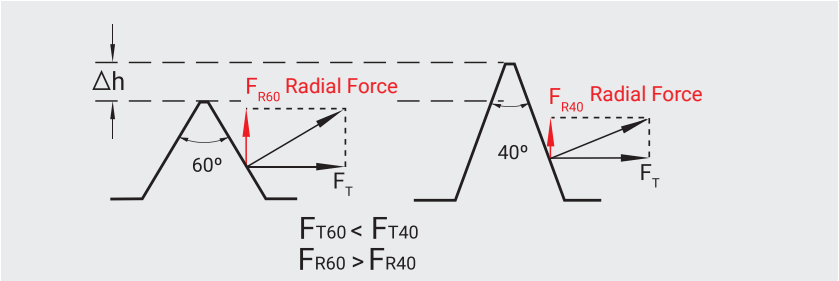
This is a custom-made screw. For further information, please contact our sales department.

TWINPLAST

TWINPLAST thread was developed by CELO to solve assembly problems on very thin plastics, especially blown plastic parts without core hole.

1. Technical features

- **40º thread angle**
  The 40º thread angle generates less radial tension (Fr) during threading process which helps to prevent cracks in the plastic.



- **Twin lead thread**
  The steeper angle **increases the stripping torque value and improves assembly speed.**

- **Sharp point**
  Allows for the **insertion of the screw with no pilot hole.**

- **Pan head flange**
  Improves the distribution of tension on plastic material.

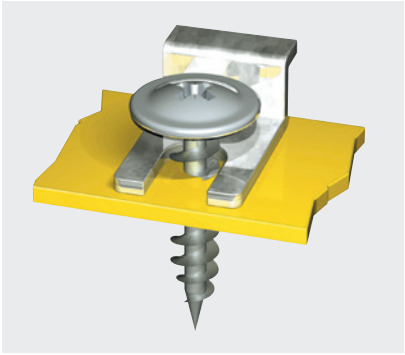


Fig.16. TWINPLAST screw is recommended for the assembly of thin plastic parts.

Diameter d (mm)	Max. thickness (mm)
3.0	2.0
3.5	2.5
4.0	3.0
5.0	3.5

The table shows the maximum material thickness to drill through based on TWINPLAST screw diameter.

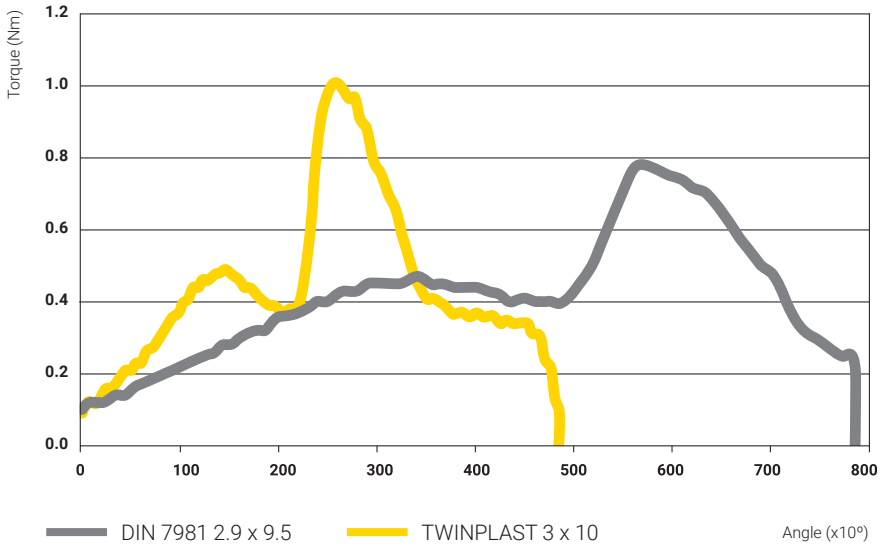
2. Advantages

- Allows for the assembly of plastic parts with a **minimum thickness of 1/3 the diameter of the screw.**
- **Prevents the design of bosses,** improving the plastic distribution during the blowing process.
- **Reduction of thread forming torque,** offering a more ergonomic assembly.
- Provides assembly with **better pull-out resistance.**
- Higher stripping resistance, which **prevents repairing damaged parts** during the assembly.
- The larger contact surface of the head allows for a **better stress distribution on the plastic.**
- Allows the **reuse of the screw,** reducing the risk of stripping.

3. Threading curve

Threading curve of TWINPLAST screw and self-tapping screw on PE blown part, thickness of 2 mm.

When comparing TWINPLAST screw and self-tapping screw threading curves, the larger difference between threading torque and failure torque of TWINPLAST screw provides greater safety during assembly.



TWINPLAST Minimum Breaking Torque	
d (mm)	Torque (Nm)
3.0	1.60
3.5	2.30
4.0	3.25
4.5	4.60

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.

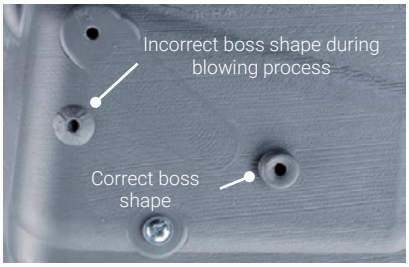


Fig.17. Flow problems with plastics in bosses for blown plastic parts. The use of TWINPLAST screw avoids the need to design bosses and ensures fixing on blown plastic parts. data, please contact our technical department.

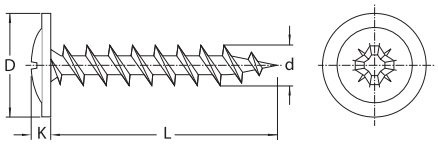
4. Applications

Assemblies on blown plastic parts.

TP88Z

TWINPLAST

- **Pan head flange**
- **POZI recess**
- **S point**
- **Zinc plated Cr (III) 5µm**



d mm	3.0	3.5	4.0	4.5
D mm	7.0	8.0	9.0	10.0
K mm	1.7	2.1	2.2	2.6
	Z1	Z2	Z2	Z2

L mm	Ø3.0	Ø3.5	Ø4.0	Ø4.5
10	●	○	○	○
12	○	●	○	○
16	○	○	●	○
19	○	○	○	●

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

PUSHTITE® II™

The TRILOBULAR® PUSHTITE® screw has been designed to be pressed into holes in plastic or aluminum parts with a single straight-line stoke, with the possibility to be removed without damaging the assembly.

It represents the greatest exponent in time saving and total assembly cost reduction.

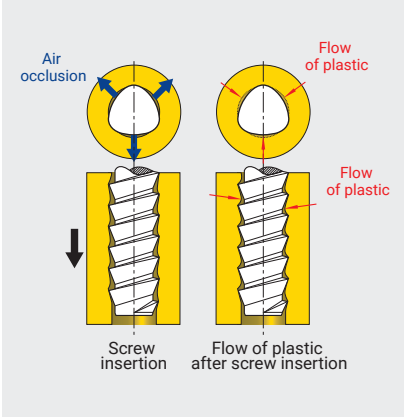


Fig.18. During screw insertion, the friction with the plastic material is reduced at three points. Once the screw is inserted, the plastic flows along the shank of the screw.

1. Technical features

- **TRILOBULAR® thread section**
  Unlike screws with a circular section, the stress generated on the plastic during threading is concentrated on three points, reducing radial stress and thread forming torque.

  The space between the lobes permits air to escape easily during insertion.

- **Asymmetric thread**
  Leading flank of 70º for an easy entry of the screw with a single, straight-line stoke. Trailing flank of 10º provides a high pull-out resistance.

- **Helical harpoon thread**
  It permits displaced air to escape during insertion and allows the screw to be removed without damaging the thread and inserted again if necessary.

2. Advantages

- **Time and cost savings** in assembly operations.

- The TRILOBULAR® thread section:
  - Minimizes the stress during screw insertion, **avoiding cracks in the plastic.**
  - Easies the air to escape, providing a **quick and efficient insertion.**
  - **Prevents boss bursting** by air occlusion.

- **High pull-out resistance.**

- **Thread Leads allow pefecte alignment into pilot hole.**

- **Allows the reuse of the screw** without boss damaging.

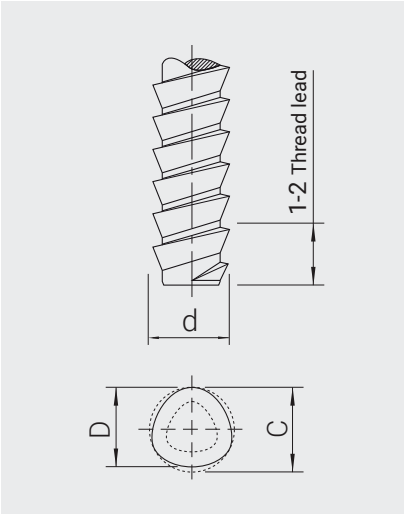
3. Technical data

PUSHTITE® II™ screws can be manufactured with different head designs and dimensions to fit your exact application requirements.

PUSHTITE® II™ screws are normally available with a recess in the head for removal, adjustment or final tightening. In case this is not requested, PUSHTITE® II™ screws can be supplied without recess for a tamper resistant screw.

d	Pitch	C	D
2.0	1.05	2.03	1.95
2.5	1.15	3.54	2.44
3.0	1.20	3.03	2.94
3.5	1.35	3.54	3.42
4.0	1.55	4.04	3.90
4.5	1.70	4.55	4.40
5.0	1.80	5.05	4.87
6.0	2.10	5.05	5.85

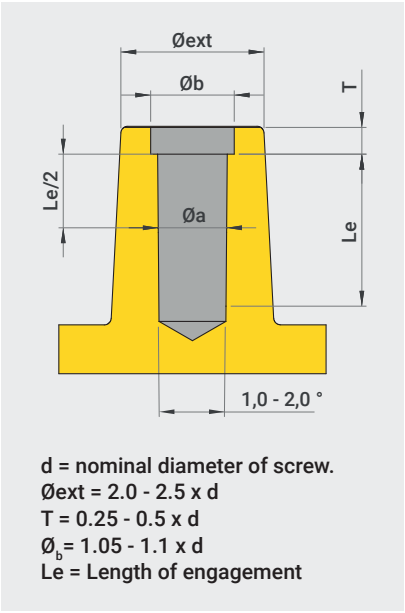
Dimensions in mm. The values shown are nominal. For tolerances and other data, contact our technical department.



4. Boss design recommendations

Material	Øa	Le
Polyethylene (PE)	0.85 x d	2.5 x d
Polypropylene (PP)	0.87 x d	2.5 x d
ABS	0.90 x d	3.0 x d
Polyamide (PA)	0.90 x d	3.0 x d
Phenilene Polyoxide (PPO)	0.90 x d	3.0 x d

This data is intended for guidance purposes. We advise doing tests beforehand with the recommended dimensions.



d = nominal diameter of screw.
Øext = 2.0 - 2.5 x d
T = 0.25 - 0.5 x d
$Ø_b$= 1.05 - 1.1 x d
Le = Length of engagement

5. Applications

PUSHTITE® II™ screw is recommended for low mechanical requirements or Non-structural assemblies of ductile plastics or aluminum die casting parts where it is needed to reduce the assembly time.

This is a custom-made screw. For more information, please contact our sales department.

Fig.19. PCB assembly in control systems

Criteria for thread design selection

For the selection of the right thread design, it is important to consider the type of plastic, the geometry of the parts to assemble and the different requirements of the application.

The table below is a guide to select the thread to use based on the listed selection criteria, but field tests will determine the best possible solution.

CELO offers the application laboratory at your disposal, where suitable tests are conducted (threading, failure torque, pull-out resistance, etc.) in order to recommend the type of thread that best meets the application requirements.

Thread type selection

Conditions	CELOspArk®	REMFORM® II™	REMFORM® II HS™	REMFORM® II F™	PLASTITE® 45	PLASTITE® 48-2	PUSHTITE®	TWINPLAST	IBI-ZAS	PCB
Ductile plastic	●	●	-	–	●	●	–	●	–	–
Hard plastic	–	●	●●	●	●	–	–	–	–	●●
Very hard plastic	–	–	●	●●	–	–	–	–	●●	–
Phenolic resin	–	–	–	●	–	–	–	–	●●	–
Blown plastic	–	–	–	–	–	–	–	●●	–	–
Low thickness plastic	–	–	–	●	–	–	–	–	–	●●
Low thickness boss	–	●●	-	–	●	–	–	–	–	–
Deep assemblies	–	●●	●	–	●	–	–	–	–	–
Shallow holes	–	●	●	●●	–	●●	–	–	–	●●
High tolerance holes	●●	●●	●●	–	–	●●	–	–	–	–
Oversized holes	–	●●	●●	–	–	–	–	–	–	–
Fast assembly	–	–	–	–	–	●●	●●	●●	●●	●●
Vibration loosening resistance	●	●●	●●	●●	●●	●	●	●	●●	●●
Pull-out resistance	●	●●	●●	●●	●	●	●	●	●●	●●
Stripping resistance	●	●●	●●	●●	●	●	–	●●	●	●●
High assembly torque required	–	●●	●●	●●	–	–	–	–	●	●
Low threading torque required	●	●	●	–	●●	–	–	–	–	–
Reusable screws	●	●●	●	–	●	–	–	–	–	–

● Correct ●● Optimal – Not recommended

Micro screws

Recent technological advances have made it possible to design smaller and smaller electronic components with a higher mechanical performance, requiring the appropriate assembly solution for each situation. In the market there are different techniques for the assembly of electronic components such as clips, welding and rivets.

For certain applications, where the technical requirements of the assembly demand for recyclability and higher levels of pull-out and vibration loosening resistance, CELO offers special product range for TAPTITE 2000®, Machine, CELOspArk® and REMFORM® II HS™ microscrews.

They can be manufactured with pan head, pan head flange and countersunk head, PHILIPS, POZI and TORX PLUS® recess. TORX PLUS® is the most recommended recess.

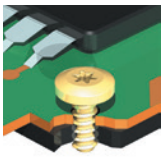
These products are custom-made, therefore we recommend contacting our sales department for availability and minimum order quantities.

CELOspArk® screw

CELOspArk® screws are recommended for the assembly of thermoplastic materials with a bending modulus between 500 and 30,000 kg/cm^2, which corresponds to ductile, medium plastics.
The required assembly depth is between 1.5 and 3 times the diameter of the screw.

Production range:
- Ø1.6 x 2.5 mm to Ø1.6 x 12 mm
- Ø1.8 x 2.5 mm to Ø1.8 x 12 mm

REMFORM® II HS™ screws



For the assembly of thermoplastic materials with glass fibers and bending modulus between 30,000 and 80,000 kg/cm^2. It is also recommended for assemblies with shallow holes and high pull-out resistance requirements.
The required assembly depth is between 1.5 and 3 times the diameter of the screw.

Production range:
- Ø1.6 x 2.5 mm to Ø1.6 x 12 mm
- Ø1.8 x 2.5 mm to Ø1.8 x 12 mm
- Ø2 x 3 mm to Ø2 x 12 mm

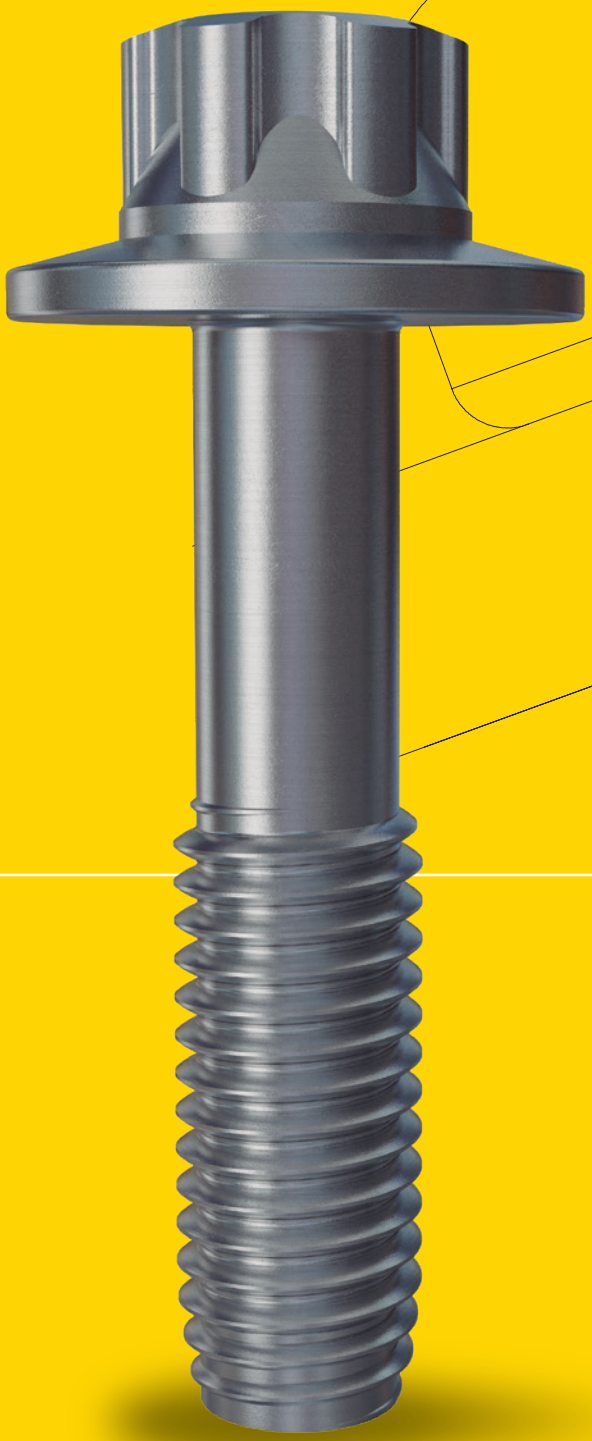
TAPTITE 2000® screw

The screw creates its own nut member in ductile metal and metal alloys.

Production range:
- M1.5 x 3 mm to M1.5 x 15 mm
- M2 x 5 mm to M2 x 15 mm

MACHINE screw

Production range:
- M1.6 x 2 mm to M1.6 x 12 mm



Screws for metal

TRILOBULAR® TAPTITE®

TAPTITE® TRILOBULAR® thread rolling screws provide assemblies with high pull-out and vibration loosening resistance and greatly reduce assembly costs.

TAPTITE® TRILOBULAR® screws are used to create a resistant and uniform thread into untapped holes during the assembly process. Their use offers many advantages, both economically with an increase in productivity during assembly and by generally reducing costs, and technically, as they offer high mechanical performance during the assembly lifespan.

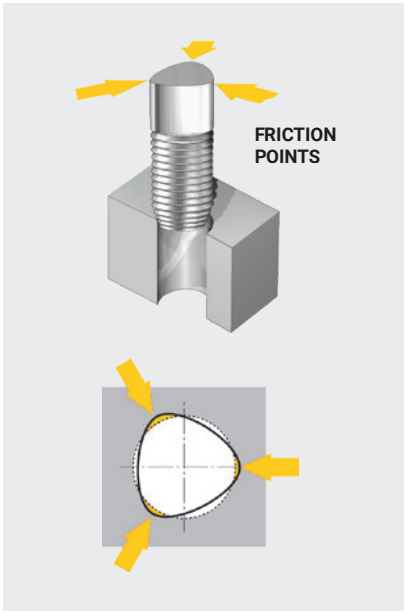


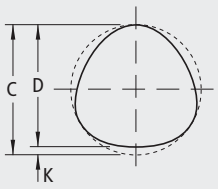
Fig.20. The three lobes put localized pressure at three points, reducing friction during thread forming.

Fig.21. The material displacement during threading flows between the lobes, wrapping the shank of the screw.

1. Technical features

TRILOBULAR® TAPTITE® screws have a thread profile similar to that of a metric thread with a 60º thread angle and a machine thread pitch, but with TRILOBULAR® section (three lobes).

The TRILOBULAR® shape is defined in two dimensions instead of one, as with standard machine screws.



D = Screw diameter
C = Circumscribed diameter of screw
C-D = K = Lobe alignment

TRILOBULAR® effect
The lobe alignment K is the difference between the screw diameter and circumscribed diameter. Low stability in the lobe alignment values affects the screw's performance. A low K value increases the strength of the assembly, but also means a high thread forming torque.

The stability in K value guarantees stable parameters while fixing the screws. **Only with the use of TAPTITE® original screws you can ensure the stability of this parameter.**

- During thread forming process, the three lobes on the thread put localized pressure on the hole, which **reduces friction during and allows for more ergonomic assembly torque.**

- The thread is formed by material lamination without chips creation, crucial in electronic assemblies. The material displaced during threading, flows to fill the space between the lobes, wrapping around the shank of the screw completely and eliminating the tolerance between the screw and the thread in the nut member.

- The progressive point allows for **excellent axial alignment** of the screw into core hole, requiring minimum low starting end load.
- TRILOBULAR® TAPTITE® screws form threads into untapped nut member with the tolerance of a machine thread. In this way, in case of repair, it is possible to replace TAPTITE® screw with a standard machine screw.
- The manufacturing process for the TRILOBULAR® screws includes heat treatment process that will vary depending on the application and particular screw mechanical requirements. The most common heat treatments are case hardening and CORFLEX® N™. To ensure the thread rolling feature of the screw, it is necessary to reach a surface hardness of at least 250 HV higher than the base material.

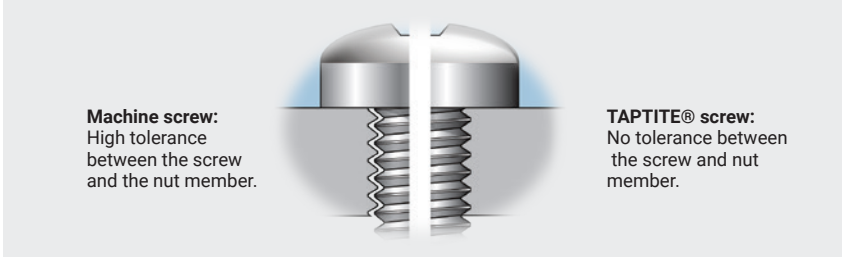


Fig.23. TRILOBULAR® screw creates a thread in nut member by lamination and without tolerance.

- Due to the hardness of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).
- TAPTITE® are lubricated to reduce friction during threading process.
- The detailed features and associated advantages can only be achieved with TAPTITE® screws manufactured according to the manufacturing standards of CONTI Fasteners AG.

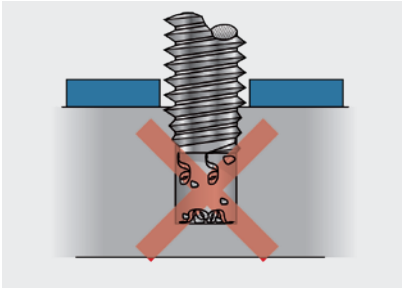


Fig.22. Thread forming by material lamination avoids chip creation.

2. Advantages

- **Low threading torque** allowing for a **more ergonomic assembly.**
- Forming thread by lamination avoids chips creation and ensures a **high pull-out resistance and high stripping torque.** It eliminates the cost of losses or repair of stripped holes.
- High values of prevailing torque ensure **excellent vibration loosening resistance.**
- As it is a thread rolling screw, it **avoids cross threading** and associated costs.
- The perfect axial alignment of the screw is an **ideal solution for automated assembly lines:**
  - Allows for an **easy insertion into the hole**
  - Requires **low starting end load**

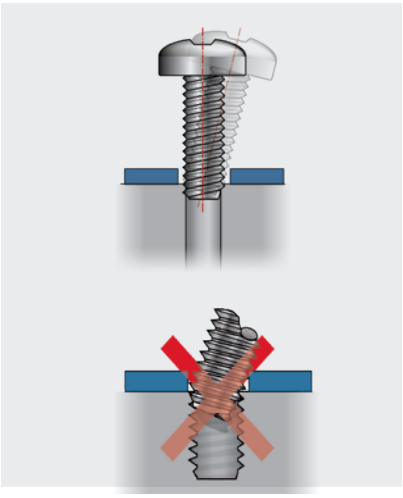


Fig.24. The progressive point facilitates axial alignment in core hole.

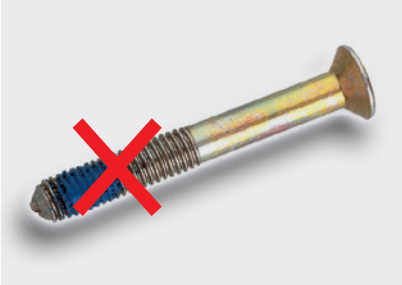


Fig.25. The adhesive patches on the thread are limited in temperature resistance and the screw cannot be reused.

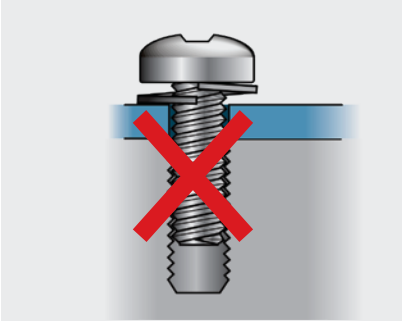
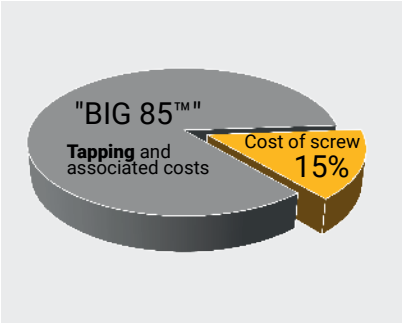


Fig.26. Use of TRILOBULAR® screws prevents the use of grower washers. These are used to maintain compression after setting the screw, which does not prevent vibration loosening.



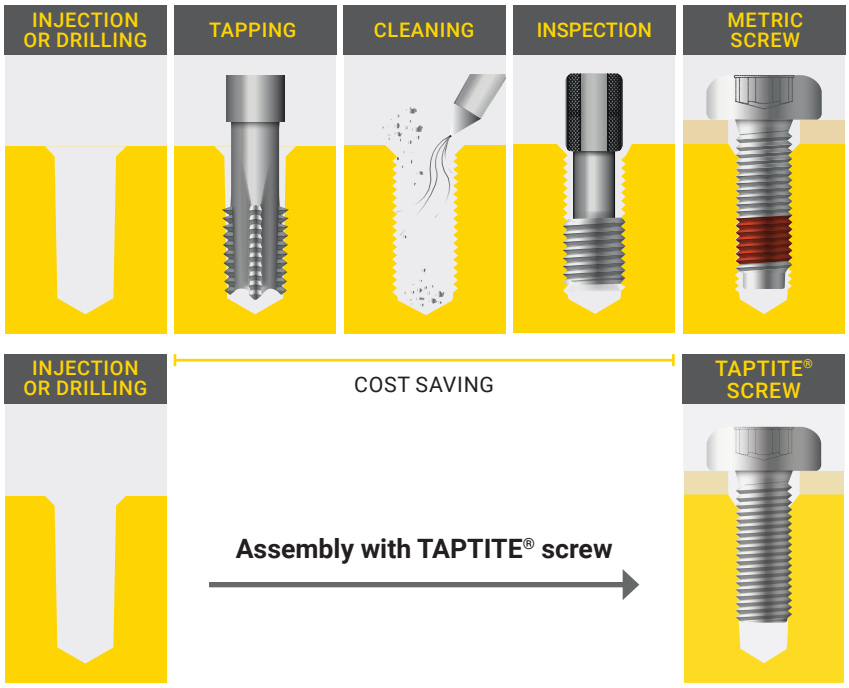
TRILOBULAR® TAPTITE® screws eliminate the problems of:

- Misalignment of machine screws in tapped holes, avoiding the use of guiding components (screws with dog point…).
- Screw vibrational loosening:
  - Avoid the use of blocking elements (lock washers, adhesives patches, etc.)
  - Eliminates retightening (which does not prevent vibration loosening).

3. Reduction of total cost of assembly

When fastening machine screws in metal assemblies, screw represents only 15% of the total in-place cost. The remaining 85% corresponds to tapping operations, cleaning oil and chips, use of additional elements to prevent vibration loosening and cross-threading and labor expenses. All of these elements are known as "BIG 85™".

TRILOBULAR® TAPTITE® thread screws have been specially designed to reduce the remaining 85%.



TRILOBULAR® TAPTITE® screws eliminate tapping operations and associated costs of:

- Direct or indirect labor cost.
- Tapping elements (lubricants, gauges, taps…).
- Cleaning of oils and chips.
- Inspection for class of fit in tapped holes.
- Loss or repair of tapped assemblies due to undersize or oversize tapped threads.
- Additional elements to prevent cross threading.
- Additional elements to secure the screw against looseness.

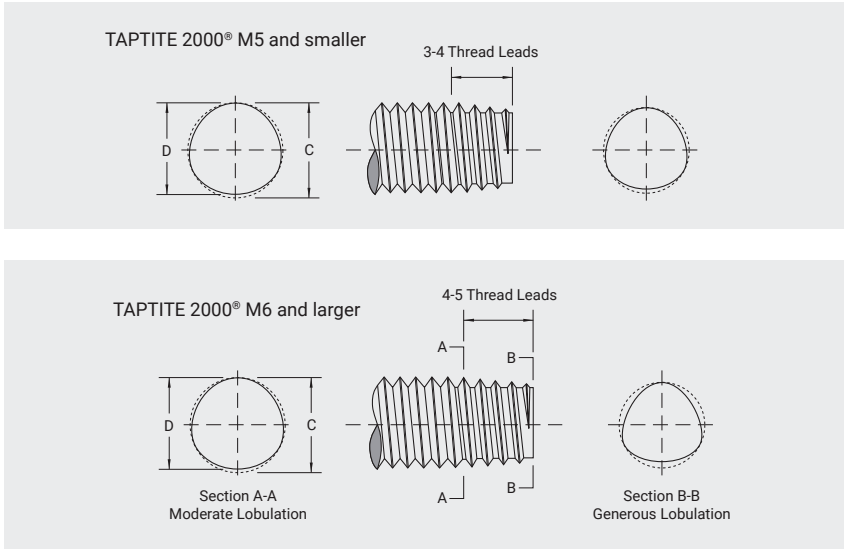
TAPTITE 2000®

TAPTITE 2000® thread rolling screws are recommended for the assembly of steel sheet and die casting parts.

TAPTITE 2000® thread design includes innovative Radius Profile™ thread and optimized TRILOBULAR® section that improves the thread forming process and strengthens the assembly, increasing the vibration loosening resistance.

TAPTITE 2000® screws afford users with enhanced opportunities to reduce the overall cost of assembly and provide excellent mechanical and assembly properties.

1. Technical features



- **Reduced TRILOBULAR® thread section**
  TAPTITE 2000® thread section has moderate lobulation (less TRILOBULAR®) which generates larger surface contact between the screw and the nut member.

  Double TRILOBULAR® thread design for M6 and larger screws:
  - The thread leads (Section B-B) have generous lobulation, which **reduces friction during fixing process** and allows for a lower thread forming torque.
  - The shank of the screw (Section A-A) has moderate lobulation, which increases contact surface between the screw and nut member, **improving pull-out and vibration loosening resistance.**

- **Radius Profile™ thread**
  Radius Profile™ thread geometry reduces thread forming torque and ensures the maximum surface contact between the screw and nut member, resulting in higher pull-out and vibration loosening resistance.

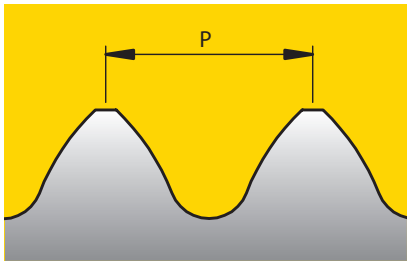


Fig.27. Radius Profile™ thread increases surface contact between screw and nut member.

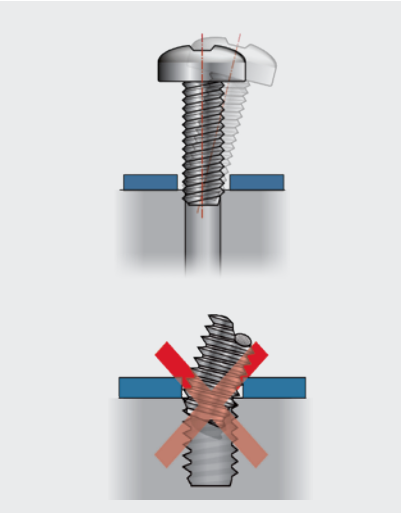
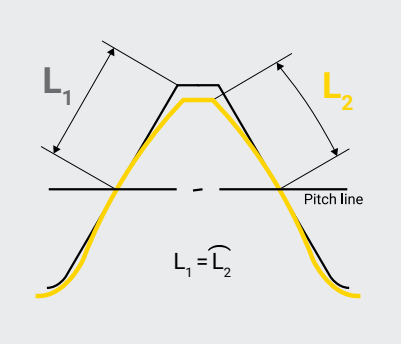


Fig.28. The progressive point facilitates axial alignment in core hole.



TAPTITE 2000® thread profile

TAPTITE II® thread profile

- **Progressive point**
  Thread leads enhance the screw insertion and permit low axial end load to initiate thread forming.

- **Machine thread configuration**
  TAPTITE 2000® screws form threads into untapped nut member with the tolerance of a machine thread. In this way, in case of repair, TAPTITE 2000® screw can be replaced with a standard machine screw.

2. Advantages

- As it is a thread rolling screw, it **avoids cross threading** and associated costs.

- The **excellent axial alignment** of the screw in core hole is an ideal solution for automated assembly lines:
  - Allows for **an easy insertion into the hole**
  - Requires **low axial end load** to initiate thread forming, providing a **more ergonomic assembly.**

- Volume of material displaced during thread forming is lower, requiring **low thread forming torque.**

- Forming thread by lamination **avoids chips creation**. Radius Profile™ improves material displacement and ensures a **high pull-out resistance and high stripping torque.**

- It allows a higher assembly torque, transmitting **higher clamping** to the assembly.

- Applying the same assembly torque than other thread rolling screws, TAPTITE 2000® permits **higher compression** while **optimizing mechanical properties** of the assembly.

- High prevailing torque allows **excellent vibration loosening resistance.**

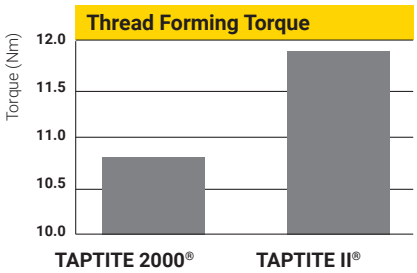
Advantages of TAPTITE 2000® screws compared to TAPTITE II®.

Double TRILOBULAR® thread for M6 and larger screws:

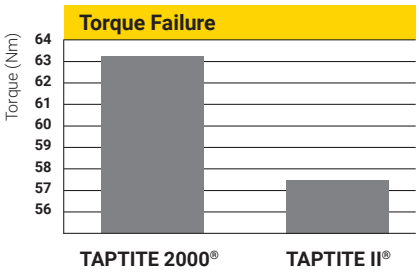
- **Reduces thread forming torque** providing a more ergonomic assembly. For the same diameter, thread forming torque of TAPTITE 2000® is approximately 10%* lower than TAPTITE II® torque value.

- Increased surface contact **improves pull-out and vibration loosening resistance.**

Tests done with TAPTITE 2000® and TAPTITE II® screws, M8x1,25:



The geometry of TAPTITE 2000® thread reduces threading torque by 9.25% in comparison with TAPTITE II® screw.



The geometry of TAPTITE 2000® thread increases torque failure by 10% in comparison with TAPTITE II® screw.

* Depending on the diameter of the screw.

TAPTITE 2000® compared to other alternative solutions.

Screw	Cost of screw	Cost of assembly process	Disadvantages	Advantages
Machine screw	•	••• Tapped holes	Low vibration loosening resistance Cross threading	Market availability
Machine screw + locking patch	•••	••• Tapped holes	Non reusable screw Cross threading	Vibration loosening resistance
Machine screw + locking patch + dog point	••••	••• Tapped holes	Non reusable screw Risk of cross threading for misalignment > 7°	Vibration loosening resistance Minimizes cross threading risk
TAPTITE 2000®	••	• Untapped holes		Eliminates problems of: - Vibrational loosening - Cross threading

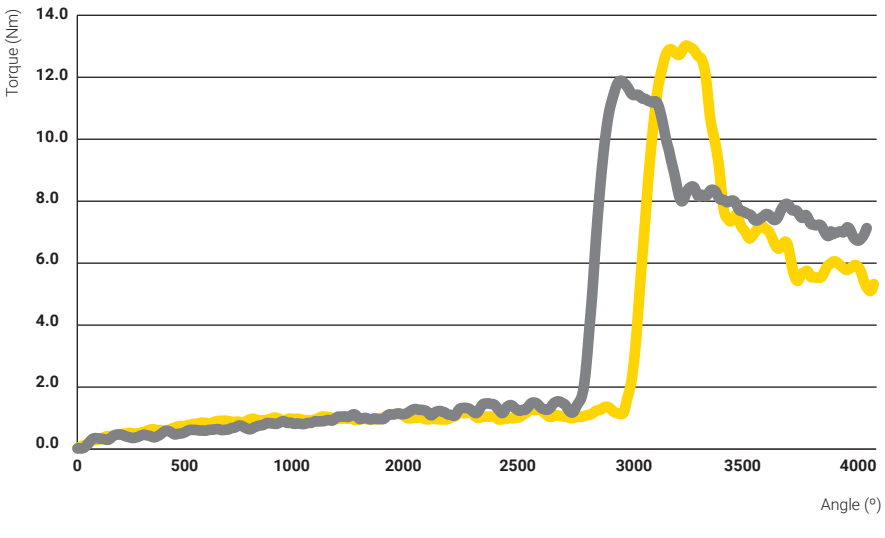
• Low •• Medium ••• High •••• Very high

In case that tapped holes are a customer requirement or specified by regulation, we recommend POWERLOK® screw with special locking concept that prevents vibrational loosening and keeps high clamping force.

3. Threading curve

The graph shows the threading curve of a TAPTITE 2000® screw on aluminium die casting part injected holes. The wide margin between low threading torque and high failure torque offers a safe assembly torque range and permits higher compression of the assembly.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.

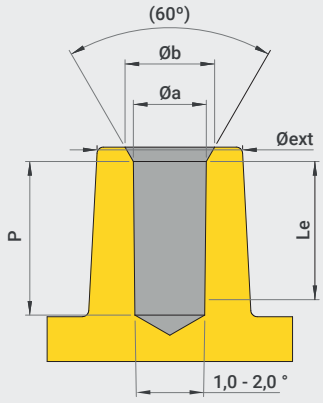


Aluminum die casting, core hole Ø5.6 mm, 12 mm engagement length.

4. Recommended hole diameter in light alloys die casting

The table shows the design recommendations for TAPTITE 2000® in aluminum die casting parts. The values in the table should be used as a reference.
We recommend to carry out relevant tests on die casting parts to establish the precise values.

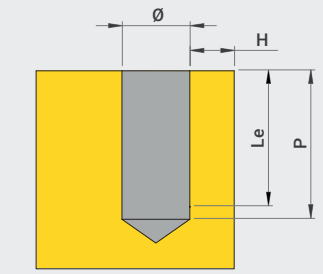
For additional information, please, contact our technical department.



P = Minimum depth
Le = Length of engagement

Table 1. Die casting parts with injected holes

d	Øa	Tolerance +	Tolerance -	Øext min.	Øb	Le	P
M2	1.87	0.03	0.04	3.4	2.6	3.4	4.6
M2.5	2.35	0.03	0.04	4.2	3.2	4.3	5.6
M3	2.84	0.03	0.05	5.0	3.9	5.1	6.8
M3.5	3.30	0.03	0.05	5.8	4.5	5.9	7.8
M4	3.77	0.03	0.05	6.7	5.2	6.8	8.8
M5	4.74	0.03	0.05	8.3	6.5	8.5	11.0
M6	5.67	0.04	0.06	10	7.7	10.2	13.0
M7	6.67	0.04	0.07	11.6	9.1	11.9	15.0
M8	7.59	0.05	0.08	13.3	10.4	13.6	17.0
M10	9.51	0.05	0.10	16.6	13.0	17.0	21.5



P = Minimum depth
Le = Length of engagement

Table 2. Die casting parts with drilled holes

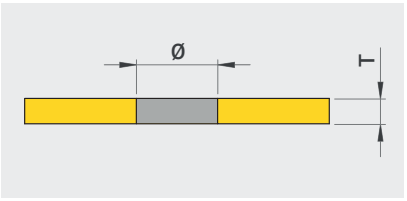
d	Ø	Tolerance +	Tolerance -	H min.	Le	P
M2	1.82	0.03	0.04	1.0	4.0	4.6
M2.5	2.29	0.03	0.04	1.2	5.0	5.6
M3	2.77	0.03	0.05	1.3	6.0	6.8
M3.5	3.23	0.03	0.05	1.6	7.0	7.8
M4	3.68	0.03	0.05	1.8	8.0	8.8
M5	4.64	0.03	0.05	2.1	10.0	11.0
M6	5.54	0.04	0.06	2.6	12.0	13.0
M7	6.54	0.04	0.07	2.6	14.0	15.0
M8	7.43	0.05	0.08	3.3	16.0	17.0
M10	9.32	0.05	0.10	3.9	20.0	21.5

Dimensions in mm.

5. Recommended pilot hole diameter in steel sheet

Plate thickness T	M2	M2.5	M3	M3.5	M4	M5	M6	M8
0.5 - 0.9	1.75	2.24	2.71	o	o	o	-	-
1.0 - 1.5	1.77	2.27	2.74	3.15	3.59	o	o	-
1.6 - 2.0	1.79	2.30	2.75	3.19	3.64	4.53	o	-
2.1 - 2.5	1.80	2.31	2.77	3.21	3.64	4.58	5.42	-
2.6 - 3.0	-	2.32	2.78	3.23	3.68	4.58	5.48	7.27
3.1 - 3.5	-	2.32	2.79	3.25	3.68	4.64	5.48	7.35
3.6 - 4.0	-	-	2.80	3.26	3.70	4.64	5.55	7.35
4.1 - 5.0	-	-	-	3.27	3.71	4.65	5.55	7.37
5.1 - 6.0	-	-	-	-	3.73	4.66	5.58	7.43
6.1 - 7.0	-	-	-	-	-	4.69	5.58	7.43
7.1 - 8.0	-	-	-	-	-	-	5.61	7.47
8.1 - 11.0	-	-	-	-	-	-	-	7.51

o We recommend FASTITE®2000™ screws for thin metal sheet.



Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values.

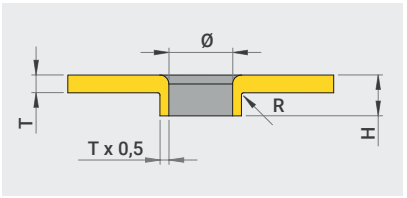
Suggested tolerances are:
+0.03 / -0.04 mm for holes < Ø2.0 mm
+0.03 / -0.05 mm for holes Ø2.0 - Ø5.0 mm
+0.04 / -0.05 mm for holes Ø5.1- Ø7.0 mm
+0.05 / -0.08 mm for holes > Ø7.0 mm

6. Recommended extruded pilot hole diameter

Table 1. Pilot hole diameter in steel sheet with extruded holes

d	Plate thickness (T)				
	0.50 – 0.69	0.70 – 0.99	1.00 – 1.49	1.50 – 2.49	2.50 – 3.00
M2.5	2.22	2.24	2.27	-	-
M3	2.7	2.72	2.76	2.82	-
M3.5	3.13	3.15	3.2	3.25	3.28
M4	3.55	3.57	3.6	3.64	3.68
M5	-	4.48	4.51	4.53	4.56
M6	-	-	5.38	5.42	5.46
M8	-	-	-	7.25	7.3

Example: Assembly on metal sheet of 0.6 mm thickness with M3 screw. Following the recommendations from Table 1, we should make 2.7 mm pilot hole diameter, and as shown in Table 2, flange height (H) would be 1.2 mm and radius (R) 0.13 mm.



Suggested tolerances are:
+0.03 / -0.04 mm for holes < Ø2.0 mm
+0.03 / -0.05 mm for holes Ø2.0 – Ø5.0 mm
+0.04 / -0.05 mm for holes > Ø5.0 mm

Tolerance for H: +0.40 mm

Table 2. Height and radius of extruded holes in metal sheet from a given pilot hole diameter

Ø	Plate thickness (T)											
	0.50-0.90		0.91-1.35		1.36-1.99		2.00-2.39		2.40-2.75		2.76-3.00	
	H	R	H	R	H	R	H	R	H	R	H	R
2.06-2.54	1.00	0.13	1.00	0.13	1.00	0.15	1.10	0.25	–	–	–	–
2.57-3.30	1.20	0.13	1.20	0.13	1.20	0.15	1.30	0.25	1.40	0.25	–	–
3.33-3.81	1.30	0.13	1.30	0.13	1.30	0.15	1.50	0.25	1.60	0.25	1.80	0.33
3.84-4.57	–	–	1.50	0.13	1.55	0.15	1.80	0.25	1.90	0.25	2.20	0.33
5.60-5.59	–	–	1.80	0.13	1.80	0.15	2.30	0.25	2.40	0.25	2.60	0.33
5.61-6.60	–	–	–	–	1.90	0.15	2.50	0.25	2.70	0.25	3.05	0.33
6.63-7.62	–	–	–	–	2.10	0.15	2.95	0.25	3.20	0.25	3.60	0.33

We recommend using FASTITE®2000™ screws or extruded holes for the assembly of thin metal sheet. Extruded holes nearly double the length of thread engagement over original material thickness with the objective to increase resistance to stripping and vibrational loosening.

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values. The size of the extrusion can vary depending on the material used and tool design.

CORFLEX® N™ Hardness	
Core	Surface
327–382 HV	min. 336 HV

Fig.29. Washing machine heater assembled with TAPTITE 2000® CORFLEX® N™ screws.

7. CORFLEX® N™ heat treatment

For the assembly of die casting injected parts in aluminum and other light alloys, we recommend TAPTITE 2000® screws with neutral hardening CORFLEX® N™ (similar strength to grade 10.9) that improves bending and heavy load cycles resistance. Surface hardness of the screw doesn't allow its use in steel assemblies.

CORFLEX® N™ heat treatment is specially recommended for assemblies in **aluminum and other light alloys** exposed to:

- Shear stress
- Alternating loads
- Severe temperature cycles
- Vibrations
- Corrosion

Advantages

The reduction of carbon content on the screw surface minimizes the risk of galvanic corrosion with the aluminum.

- Provides excellent resistance to alternating loads and thermal shock.
- Allows deep thread engagements.
- Reduces the risk of hydrogen embrittlement.
- All TRILOBULAR® screws manufactured at CELO can be treated with CORFLEX® N™ upon request.

Stock item NT5T corresponds to TAPTITE 2000® thread with CORFLEX® N™ heat treatment.

Fig.30. Assembly of electronic components in exterior lighting.

Fig.31. Rear-view mirror motor assembled on aluminum housing.

8. Applications of TAPTITE 2000® screws

TAPTITE 2000® screws have been specially designed for assemblies in steel and light alloys in:

- Components that require a low threading torque to avoid damaging other components, e.g. PCB assembly.
- Structural components that require high pull-out resistance.
- Components that require a high tightness level.

Examples
Automotive components
Electric material
Household appliances
Electronics

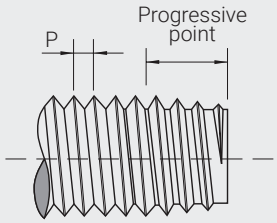
Fig.32. Partial detail of PCB assembly of aluminum for an On Board Charger (OBC) in electric vehicles.

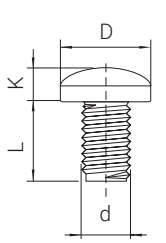
9. Technical data

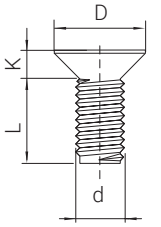
TAPTITE 2000® screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements.

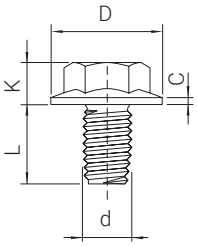
TAPTITE 2000® are lubricated to reduce friction during thread forming process. To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

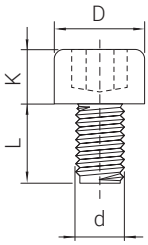
The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, please contact our technical department.

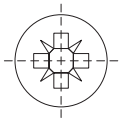












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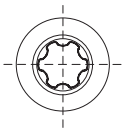

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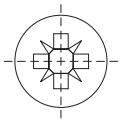

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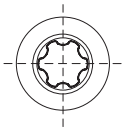

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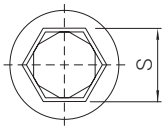
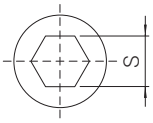


Ref. T278



Ref. T212

d	P Paso	Progressive point	D max.	K max.	TORX Plus®	Pozi	D max.	K Ref.	TORX Plus®	Pozi	D max.	K max.	C	S	D max.	K max	S
M2	0.40	1.40	3.40	1.60	6 IP	Z1	3.80	1.20	6 IP	Z1	-	-	-	-	-	-	-
M2.5	0.45	1.58	4.30	2.15	8 IP	Z1	4.70	1.50	8 IP	Z1	-	-	-	-	-	-	-
M3	0.50	1.75	5.30	2.30	10 IP	Z1	5.60	1.65	10 IP	Z1	-	-	-	-	-	-	-
M3.5	0.60	2.10	6.20	2.60	15 IP	Z2	6.50	1.93	15 IP	Z2	-	-	-	-	-	-	-
M4	0.70	2.45	7.00	3.15	20 IP	Z2	7.50	2.20	20 IP	Z2	9.00	3.50	0.72	7	7.00	4.00	3
M5	0.80	2.80	9.00	3.60	25 IP	Z2	9.20	2.50	25 IP	Z2	11.00	4.50	0.82	8	8.50	5.00	4
M6	1.00	4.50	10.80	4.20	30 IP	Z3	11.00	3.00	30 IP	Z3	13.50	5.30	1.02	10	10.00	6.00	5
M8	1.25	5.63	14.00	4.80	40 IP	Z3	-	-	-	-	17.00	7.00	1.12	13	-	-	-

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

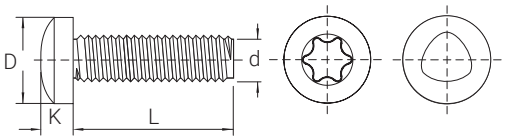
Heat treatment	Hardness (HV)		Minimum Breaking Torque (Nm)							
	Surface	Core	M2	M2.5	M3	M3.5	M4	M5	M6	M8
Case hardening	min. 446	286 -372	0.60	1.2	2.2	3.5	5.2	10.5	17.7	43.0
CORFLEX® N™	min. 336	327-382	0.45	1.0	1.9	3.0	4.4	9.3	16.0	40.0

Nominal length (mm)	Tolerance (mm)
≤ 3	± 0.2
3 < L ≤10	± 0.3
10 < L ≤ 16	± 0.4
16 < L ≤ 50	± 0.5
> 50	± 1.0

NT85T CORFLEX® N™

TAPTITE 2000®

- **Pan head**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**



d mm	M2	M2.5	M3	(M3.5)	M4	M5	M6
D mm	4.0	5.0	6.0	7.0	8.0	10.0	12.0
K mm	1.6	2.0	2.4	2.7	3.1	3.8	4.6
TORX®	6 IP[1]	8 IP[1]	T10	T15	T20	T25	T30

L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
5	○	○	○	○	○	–	–
6	●	○	●	○	○	○	–
7	○	○	○	○	○	○	–
8	○	●	●	○	●	○	○
10	○	○	○	○	●	●	○
12	–	○	●	○	●	●	●
16	–	–	●	○	●	○	○
18	–	–	○	○	○	○	○
20	–	–	○	○	○	○	●
25	–	–	–	○	○	○	○
30	–	–	–	–	○	○	○
35	–	–	–	–	○	○	○
40	–	–	–	–	○	○	○
50	–	–	–	–	–	–	○

● Product available in stock. ○ Product available upon request. [1] TORX PLUS®
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

This screw can't be used for the assembly of steel parts. NT85T screws with CORFLEX® N™ heat treatment are specially recommended for **assemblies in aluminum and other light alloys.**

TAPTITE 2000® CA™

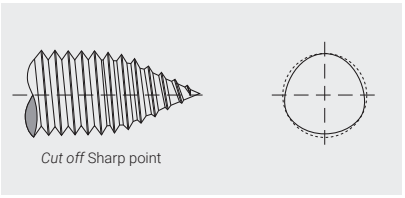
TAPTITE 2000® CA™ screws are recommended for the assemblies where the clearance and pilot holes are not aligned.

1. Advantages

Additionally to the advantages offered by TAPTITE 2000® screws, TAPTITE 2000® CA™ screws have a gimlet point especially designed to:

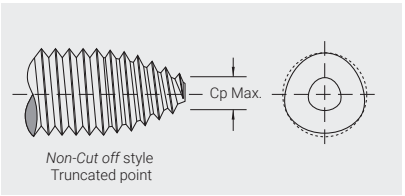
- Achieve the perfect **alignment of the screw** in applications when clearance and pilot holes are not aligned and rapid hole finding is essential.
- Provide the assembly with more ergonomics by **lowering the initial threading torque**

The **"CA" point** can be fitted with a sharp point (known as cut off) or with a truncated blunt point *(non-cut off)*.



The **cut off point** is recommended for applications in which it is necessary to pierce into the material without making a pilot hole.

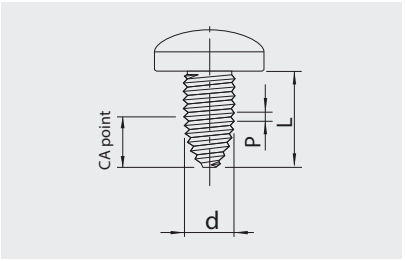
The **non-cut off point** is recommended for applications in which a sharp point could be a potential hazard to other assembly components, cables, assembly lines or for personnel safety.



2. Technical data

d	Pitch P	"CA" Point Ref.
M2.5	0.45	2.48
M3	0.5	2.75
M3.5	0.6	3.30
M4	0.7	3.85
M5	0.8	4.40
M6	1.0	5.50
M8	1.25	6.88

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on die casting parts to establish the precise values.



3. Applications

TAPTITE 2000® CA™ screws are recommended for:

- Assemblies where the clearance and pilot holes are not aligned.
- Difficult access applications and deep holes.
- Assemblies where it is required to pierce material without making a pilot hole (*Cut Off point*).

This is a custom-made product. Please, contact our sales department for further information.

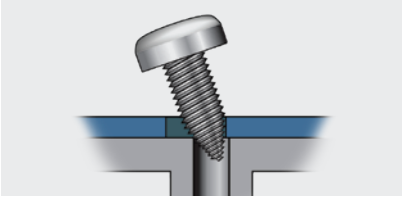
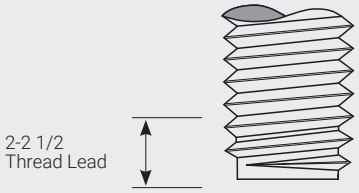


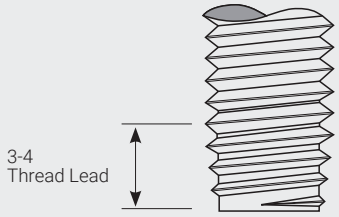
Fig.33. TAPTITE 2000® CA™ screws allows for alignment in misaligned holes.

TAPTITE 2000® SP™

TAPTITE 2000® SP™ screws have shorter thread leads point than standard TAPTITE 2000® screws to maximize the full thread engagement in shallow blind holes or in those application where depth isn't long enough for a screw point with major number of thread leads.



TAPTITE 2000® SP™

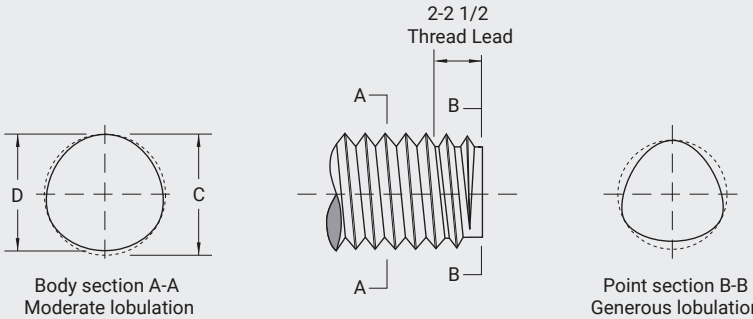


TAPTITE 2000®

Shorter point in TAPTITE 2000® SP™ screws, from 2-2 1/2 thread leads, maximizes full thread engagement in shallow blind holes or assemblies. In these cases an increase in contact points of full thread engagement is critical. In most cases, the failure mode changes from stripping to breaking of the screw, which is the desired result in die casting parts.

Recommended hole dimensioning in light alloys die casting are the same as detailed in TAPTITE 2000® screws (page 60).

This is a custom-made product. Please, contact our sales department for further information.



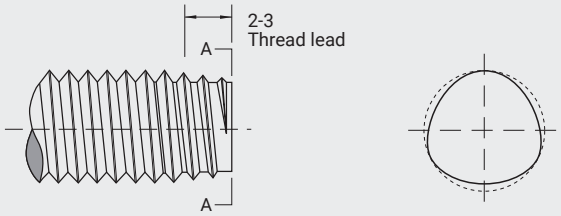
TAPTITE II®

TAPTITE II® thread rolling screws are the most popular in the TRILOBULAR® family, superseded by TAPTITE 2000®. TAPTITE II® screws create a high-performance nut into drilled, punched or extruded holes in steel and light alloys.

TAPTITE II® screws afford users with enhanced opportunities to reduce the overall cost of assembly and provide excellent mechanical and assembly properties.

1. Technical features

- **TRILOBULAR® thread section.**
- **60° thread angle and machine thread configuration.** TAPTITE II® screws form threads into untapped nut member with the tolerance of a machine thread. If a repair is needed, it is possible to replace TAPTITE II® screw with a standard machine screw.
- **Progressive point that reduces threading torque.** TAPTITE II® screws have 2-3 thread leads that enhance the screw insertion, eliminate cross threading problems and permit low axial end load.



2. Advantages

- **Low threading torque** even in deep holes, ensuring ergonomic assembly.
- **Axial alignment** allows for an easy insertion into the hole.
- Forming thread by lamination avoids chips creation and ensures a **high pull-out resistance and high stripping torque.**
- High prevailing torque allows **excellent vibration loosening resistance,** eliminating the need of additional elements.
- Nut member has the tolerance of a machine thread. It is possible to replace TAPTITE II® screw with a standard machine screw.

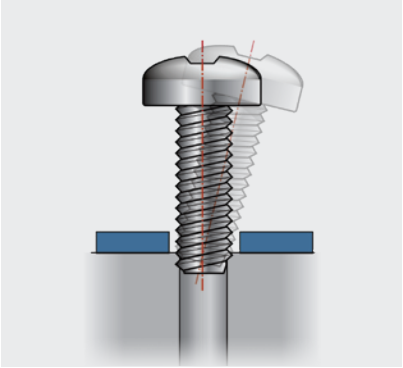
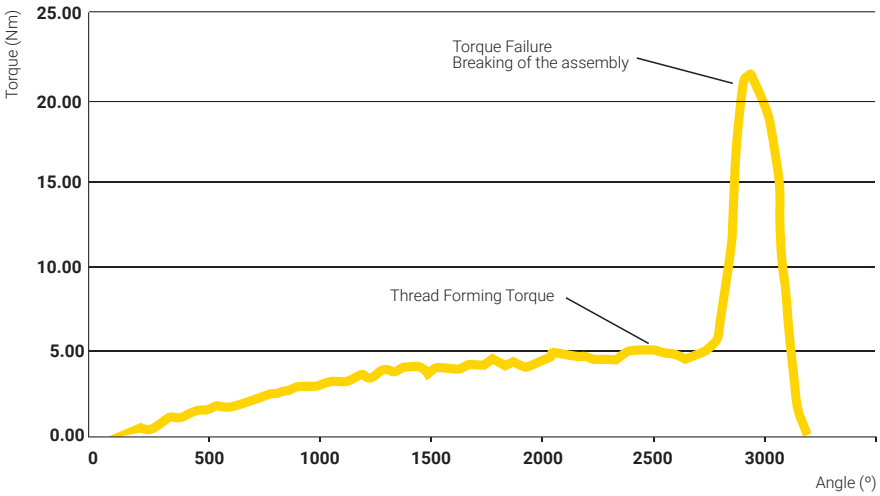


Fig.34. The progressive point facilitates axial alignment in core hole.

3. Threading curve

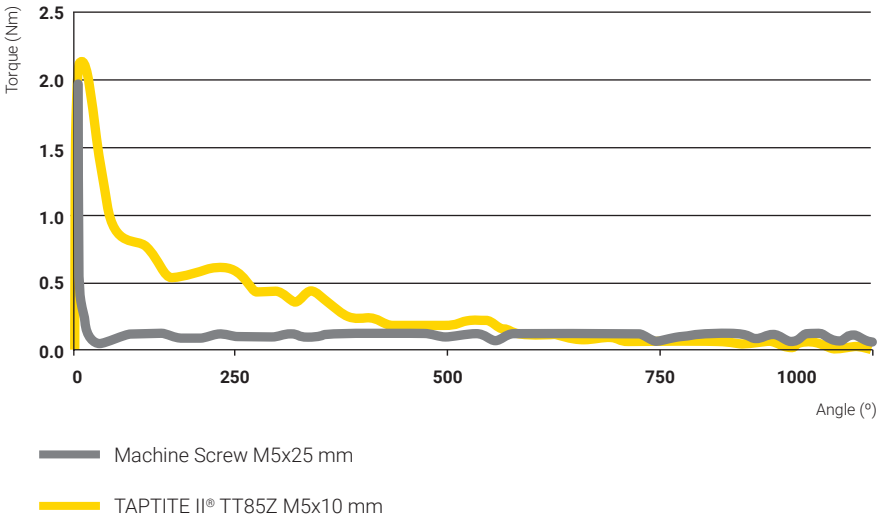
The graph shows the threading curve angle/torque of a TAPTITE II® screw in aluminum die casting part injected holes. The TRILOBULAR® shape offers a safe assembly torque range due to the wide margin between the low threading torque and high failure torque.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.



TAPTITE II® M6 x 20; Core hole Ø5.5 mm, length of engagement 12 mm.

The following graph shows the loosening resistance of TAPTITE II® M5x10 screw compared with a machine screw M5x25. Tightening torque applied is 4.5 Nm.TAPTITE II® screw needs breakaway torque of 2.15 Nm, while machine screw needs just 1 Nm with a sudden torque loss..

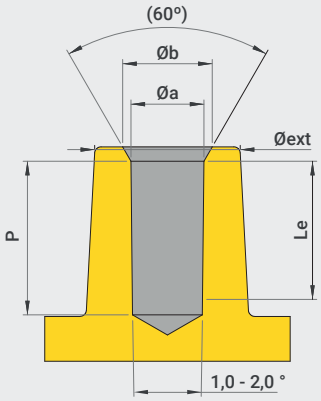


4. Recommended hole diameter in TAPTITE II® in aluminum die casting

The table shows the design recommendations for TAPTITE II® in aluminum die casting parts. The values in the table should be used as a reference.
We recommend to carry out relevant tests on die casting parts to establish the precise values.

Table 1. Die casting parts with injected holes

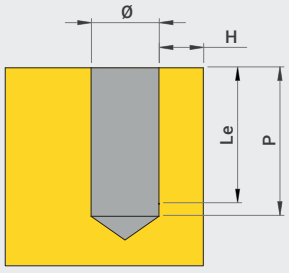
d	Øa	Tolerance +	Tolerance -	Øext min.	Øb	Le	P
M2	1.87	0.03	0.04	3.4	2.6	3.4	4.6
M2.5	2.35	0.03	0.04	4.2	3.2	4.3	5.6
M3	2.84	0.03	0.05	5.0	3.9	5.1	6.8
M3.5	3.30	0.03	0.05	5.8	4.5	5.9	7.8
M4	3.77	0.03	0.05	6.7	5.2	6.8	8.8
M5	4.74	0.03	0.05	8.3	6.5	8.5	11.0
M6	5.67	0.04	0.06	10	7.7	10.2	13.0
M7	6.67	0.04	0.07	11.6	9.1	11.9	15.0
M8	7.59	0.05	0.08	13.3	10.4	13.6	17.0
M10	9.51	0.05	0.10	16.6	13.0	17.0	21.5



P = Minimum depth
Le = Length of engagement

Table 2. Die casting parts with drilled holes

d	Ø	Tolerance +	Tolerance -	H min.	Le	P
M2	1.82	0.03	0.04	1.0	4.0	4.6
M2.5	2.29	0.03	0.04	1.2	5.0	5.6
M3	2.77	0.03	0.05	1.3	6.0	6.8
M3.5	3.23	0.03	0.05	1.6	7.0	7.8
M4	3.68	0.03	0.05	1.8	8.0	8.8
M5	4.64	0.03	0.05	2.1	10.0	11.0
M6	5.54	0.04	0.06	2.6	12.0	13.0
M7	6.54	0.04	0.07	2.6	14.0	15.0
M8	7.43	0.05	0.08	3.3	16.0	17.0
M10	9.32	0.05	0.10	3.9	20.0	21.5



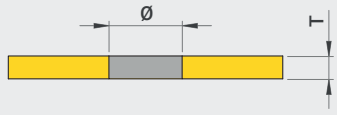
P = Minimum depth
Le = Length of engagement

5. Recommended pilot hole diameter in steel sheet.

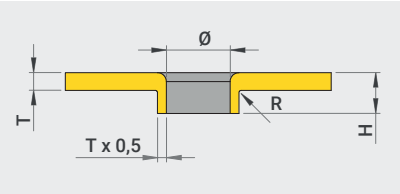
Plate thickness T	M2	M2.5	M3	M3.5	M4	M5	M6	M8
0.5 - 0.9	1.75	2.24	2.71	o	o	o	-	-
1.0 - 1.5	1.77	2.27	2.74	3.15	3.59	o	o	-
1.6 - 2.0	1.79	2.30	2.75	3.19	3.64	4.53	o	-
2.1 - 2.5	1.80	2.31	2.77	3.21	3.64	4.58	5.42	-
2.6 - 3.0	-	2.32	2.78	3.23	3.68	4.58	5.48	7.27
3.1 - 3.5	-	2.32	2.79	3.25	3.68	4.64	5.48	7.35
3.6 - 4.0	-	-	2.80	3.26	3.70	4.64	5.55	7.35
4.1 - 5.0	-	-	-	3.27	3.71	4.65	5.55	7.37
5.1 - 6.0	-	-	-	-	3.73	4.66	5.58	7.43
6.1 - 7.0	-	-	-	-	-	4.69	5.58	7.43
7.1 - 8.0	-	-	-	-	-	-	5.61	7.47
8.1 - 11.0	-	-	-	-	-	-	-	7.51

o We recommend FASTITE® 2000™ screws for thin metal sheet assembly.

Suggested tolerances are:
+0.03 / -0.04 mm for holes < Ø2.0 mm
+0.03 / -0.05 mm for holes Ø2.0 - Ø5.0 mm
+0.04 / -0.05 mm for holes Ø5.1- Ø7.0 mm
+0.05 / -0.08 mm for holes > Ø7.0 mm



Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on die casting parts to establish the precise values.



Suggested tolerances are:
+0.03 / -0.04 mm for holes < Ø2.0 mm
+0.03 / -0.05 mm for holes Ø2.0 – Ø5.0 mm
+0.04 / -0.05 mm for holes > Ø5.0 mm

Tolerance for H: +0.40 mm

Example: Assembly on metal sheet of 0.6 mm thickness with M3 screw. Following the recommendations from Table 1, we should make 2.7 mm pilot hole diameter, and as shown in Table 2, flange height (H) would be 1.2 mm and radius (R) 0.13 mm.

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values. The size of the extrusion can vary depending on the material used and tool design.

6. Recommended extruded pilot hole diameter

Table 1. Pilot hole diameter in steel sheet with extruded holes

d	Plate thickness (T)				
	0.50 – 0.69	0.70 – 0.99	1.00 – 1.49	1.50 – 2.49	2,50 – 3.00
M2.5	2.22	2.24	2.27	-	-
M3	2.7	2.72	2.76	2.82	-
M3.5	3.13	3.15	3.2	3.25	3.28
M4	3.55	3.57	3.6	3.64	3.68
M5	-	4.48	4.51	4.53	4.56
M6	-	-	5.38	5.42	5.46
M8	-	-	-	7.25	7.3

Table 2. Height and radius of extruded holes in metal sheet from a given pilot hole diameter.

Ø	Plate thickness (T)											
	0.50-0.90		0.91-1.35		1.36-1.99		2.00-2.39		2.40-2.75		2.76-3.00	
	H	R	H	R	H	R	H	R	H	R	H	R
2.06-2.54	1.00	0.13	1.00	0.13	1.00	0.15	1.10	0.25	–	–	–	–
2.57-3.30	1.20	0.13	1.20	0.13	1.20	0.15	1.30	0.25	1.40	0.25	–	–
3.33-3.81	1.30	0.13	1.30	0.13	1.30	0.15	1.50	0.25	1.60	0.25	1.80	0.33
3.84-4.57	–	–	1.50	0.13	1.55	0.15	1.80	0.25	1.90	0.25	2.20	0.33
5.60-5.59	–	–	1.80	0.13	1.80	0.15	2.30	0.25	2.40	0.25	2.60	0.33
5.61-6.60	–	–	–	–	1.90	0.15	2.50	0.25	2.70	0.25	3.05	0.33
6.63-7.62	–	–	–	–	2.10	0.15	2.95	0.25	3.20	0.25	3.60	0.33

We recommend using FASTITE®2000™ screws or extruded holes for the assembly of thin metal sheet. Extruded holes nearly double the length of thread engagement over original material thickness with the objective to increase resistance to stripping and vibrational loosening.

Fig.35. Assembly of gas valve components.

7. Applications

TAPTITE II® screws offer cost saving and improvement of mechanical properties in:

- Assemblies on steel parts with drilled, punched or extruded holes.
- Assemblies on light alloys.
- Assemblies subjected to vibrations and severe temperatures.
- Assemblies with free of chips contamination requirement.

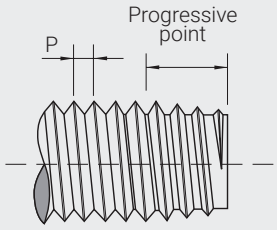
Examples:
Automotive components
Electric material
Household appliances
Locks

8. Technical data

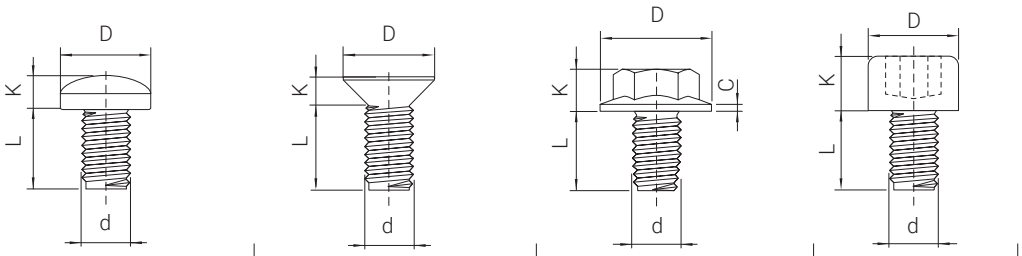
TAPTITE II® screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements.

TAPTITE II® are lubricated to reduce friction during thread forming process. To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, please contact our technical department.



2-3 **Thread lead**



Ref. TT85Z

Ref. TT85T

Ref. TT65Z

Ref. TT65T

Ref. TT78

Ref. TT12

d	P Pitch	Progressive point	D max.	K max.	Torx®	Pozi	D max.	K Ref.	Torx®	Pozi	D max.	K max.	C	S	D max.	K max.	S
M2	0.4	1.00	4.0	1.6	T6*	Z1	3.8	1.2	T6*	Z1	-	-	-	-	-	-	-
M2.5	0.45	1.13	5.0	2.0	T8*	Z1	4.7	1.5	T8	Z1	-	-	-	-	-	-	-
M3	0.5	1.25	6.0	2.4	T10	Z1	5.6	1.65	T10	Z1	-	-	-	-	-	-	-
M3.5	0.6	1.50	7.0	2.7	T15	Z2	6.5	1.93	T15	Z2	-	-	-	-	-	-	-
M4	0.7	1.75	8.0	3.1	T20	Z2	7.5	2.2	T20	Z2	9.0	3.5	0.72	7.0	7.0	4.0	3.0
M5	0.8	2.00	10.0	3.8	T25	Z2	9.2	2.5	T25	Z2	11.0	4.5	0.82	8.0	8.5	5.0	4.0
M6	1	2.50	12.0	4.6	T30	Z3	11.0	3.0	T30	Z3	13.5	5.3	1.02	10.0	10.0	6.0	5.0
M8	1.25	3.13	16.0	6.0	T40	Z3	-	-	-	-	17.0	7.0	1.12	13.0	-	-	-

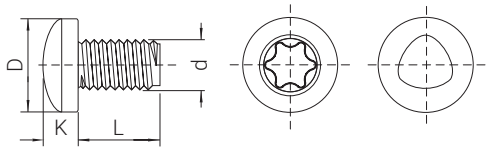
* We recommend TORX PLUS® recess. Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

Heat treatment	Hardness (HV)		Minimum Breaking Torque (Nm)							
	Surface	Core	M2	M2.5	M3	M3.5	M4	M5	M6	M8
Case hardening	min. 446	286 -372	0.60	1.2	2.2	3.4	5.0	10.0	17.0	41.0
CORFLEX® N™	min. 336	327-382	0.45	1.0	1.9	3.0	4.4	9.3	16.0	40.0

Nominal length (mm)	Tolerance (mm)
≤ 3	± 0.2
3 < L ≤10	± 0.3
10 < L ≤ 16	± 0.4
16 < L ≤ 50	± 0.5
> 50	± 1.0

TT85T

TAPTITE II®



- **Pan head**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**

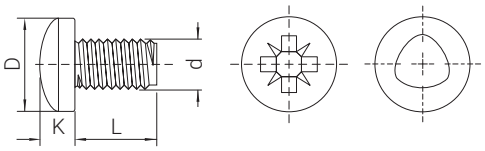
d mm	M2	M2.5	M3	(M3.5)	M4	M5	M6
D mm	4.0	5.0	6.0	7.0	8.0	10.0	12.0
K mm	1.6	2.0	2.4	2.7	3.1	3.8	4.6
TORX®	T6	T8	T10	T15	T20	T25	T30

L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
5	○	○	○	○	○	–	–
6	○	○	●	○	●	–	–
7	○	○	●*	○	○	○	–
8	○	○	●	○	●	○	○
10	○	○	●	○	●	●	●
12	–	○	●	○	●	○	●
16	–	–	●	○	●	○	●
18	–	–	○	○	○	○	○
20	–	–	○	○	●	○	●
25	–	–	–	○	●	○	●
30	–	–	–	–	○	○	○
35	–	–	–	–	○	○	○
40	–	–	–	–	○	○	○
50	–	–	–	–	–	–	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department.Information about packaging conditions in page 130. * Available until end of stock.

TT85Z

TAPTITE II®



- **Pan head**
- **POZI recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**

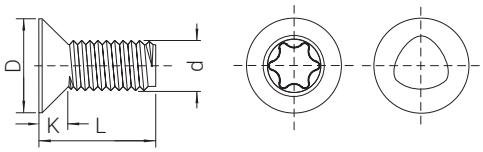
d mm	M2	M2.5	M3	(M3.5)	M4	M5	M6
D mm	4.0	5.0	6.0	7.0	8.0	10.0	12.0
K mm	1.6	2.0	2.4	2.7	3.1	3.8	4.6
POZI	Z1	Z1	Z1	Z2	Z2	Z2	Z3

L mm	**Ø2.0**	**Ø2.5**	**Ø3.0**	**Ø3.5**	**Ø4.0**	**Ø5.0**	**Ø6.0**
5	○	○	○	○	○	–	–
6	○	○	●	○	●	○	–
7	○	○	○	○	○	○	–
8	○	○	●	○	●	●	○
10	○	○	●	○	●	●	○
12	–	○	●	●	●	●	○
16	–	–	●	○	●	●	○
18	–	–	○	○	●	○	○
20	–	–	○	○	●*	○	○
25	–	–	–	○	○	○	○
30	–	–	–	–	○	○	○
35	–	–	–	–	○	○	○
40	–	–	–	–	○	○	○
50	–	–	–	–	–	–	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

TT65T

TAPTITE II®



- **Countersunk head**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**

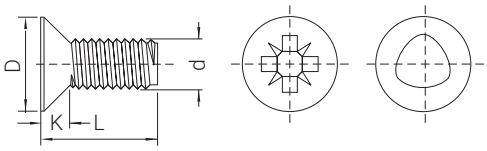
d mm	M2	M2.5	M3	(M3.5)	M4	M5	M6
D mm	4.0	5.0	6.0	7.0	8.0	10.0	12.0
K mm	1.6	2.0	2.4	2.7	3.1	3,8	4.6
TORX®	T1	T8	T10	T15	T20	T25	T30

L mm	Ø2	Ø2.5	Ø3	Ø3.5	Ø4	Ø5	Ø6
5	○	○	○	○	○	–	–
6	○	○	●	○	○	–	–
7	○	○	○	○	○	○	–
8	○	○	●	○	○	○	–
10	○	○	○	○	●	○	●
12	–	○	●	○	○	○	○
16	–	–	○	○	○	○	●
18	–	–	○	○	○	○	○
20	–	–	○	○	○	○	○
25	–	–	–	○	○	○	○
30	–	–	–	–	○	○	○
35	–	–	–	–	○	○	○
40	–	–	–	–	○	○	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

TT65Z

TAPTITE II®



- **Countersunk head**
- **POZI recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**

d mm	M2	M2.5	M3	(M3.5)	M4	M5	M6
D mm	3.8	4.7	5.6	6.5	7.5	9.2	11.0
K mm	1.2	1.5	1.65	1.93	2.2	2.5	3.0
POZI	Z1	Z1	Z1	Z2	Z2	Z2	Z3

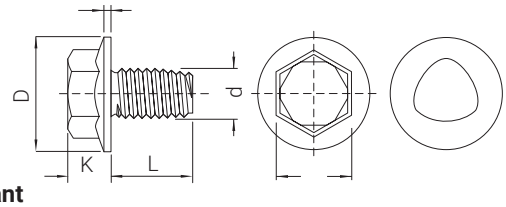
L mm	Ø2.0	Ø2.5	Ø3.0	Ø3.5	Ø4.0	Ø5.0	Ø6.0
5	○	○	○	–	–	–	–
6	○	○	○	○	○	–	–
7	○	○	○	○	○	○	–
8	○	○	●	○	●	○	○
10	○	○	○	○	●	○	○
12	–	○	○	○	●	○	○
16	–	–	○	○	●	○	○
18	–	–	○	○	○	○	○
20	–	–	○	○	○	○	○
25	–	–	–	○	○	○	○
30	–	–	–	–	○	○	○
35	–	–	–	–	○	○	○
40	–	–	–	–	○	○	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

TT78

TAPTITE II®

- **Hexagonal flange head**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**



d mm	M4	M5	M6	M8
D mm	9.0	11.0	13.5	17.0
K mm	3.5	4.5	5.3	7.0
C mm	0.72	0.82	1.02	1.12
S mm	7.0	8.0	10.0	13.0

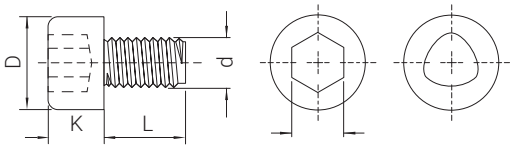
L mm	Ø4.0	Ø5.0	Ø6.0	Ø8.0
6	○	○	○	○
7	○	○	○	○
8	●	○	○	○
10	●	●	○	○
12	○	●	●	○
16	–	–	●	○
18	–	–	○	○
20	–	–	○	○
25	–	–	–	○
30	–	–	–	–
35	–	–	–	–
40	–	–	–	–
50	–	–	–	–

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

TT12

TAPTITE II®

- **Cylindrical head**
- **Six socket recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**



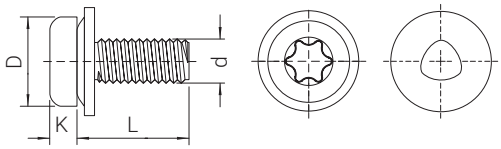
d mm	M4	M5	M6
D mm	7.0	8.5	10.0
K mm	4.0	5.0	6.0
S mm	3.0	4.0	5.0

L mm	Ø4.0	Ø5.0	Ø6.0
8	○	○	○
10	○	●	○
12	○	○	○
16	○	○	○
18	○	○	○
20	○	○	●
22	○	○	○
25	○	○	○
30	○	○	○
35	○	○	○
40	○	○	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

TT22T

TAPTITE II®

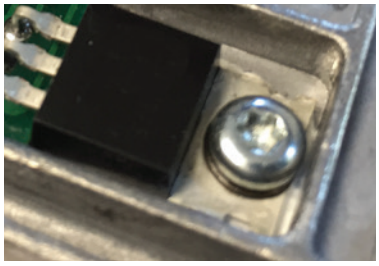


- **Pan head with conical washer**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm + Lubricant + Baking**

d mm	M3	M4	M5
D mm	6.0	8.0	10.0
K mm	2.4	3.1	3.8
TORX®	T10	T25	T25

L mm	**Ø3.0**	**Ø4.0**	**Ø5.0**
8	●	○	–
10	○	○	–
12	○	○	○

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.



The conical washer offers the following advantages:

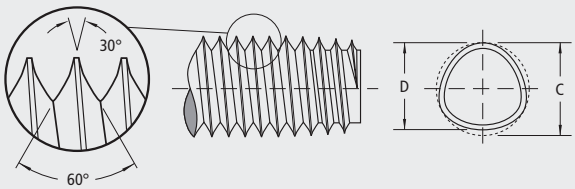
- **Increases the elasticity** of the assembly in applications subjected to axial loads, compensating the loss of compression by thermal or dynamic relaxation.
- **Prevents damage on the PCB** during assembly.

For further information on washer dimension please contact our sales department.

POWERLOK®

TRILOBULAR® POWERLOK® thread is recommended to solve loosening problems in tapped holes, especially in applications exposed to severe vibration conditions or cycles of expansion/contraction.

TRILOBULAR® POWERLOK® screw for the assembly into tapped holes, is the only one with the locking concept: the thread design provides locking action over the entire length of the screw thread without using patches, adhesives or other features. The locking action is independent of the base material and the temperatures reached during assembly lifespan.



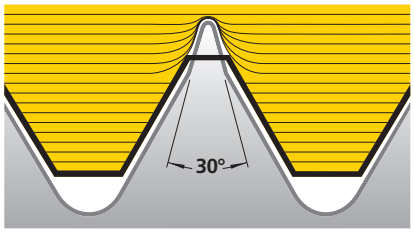


Fig.36. 30° thread interferes in the nut thread, eliminating the tolerance and providing locking action.

POWERLOK® hardness	
Core	Surface
327–382 HV	min. 336 HV

1. Technical features

- DUAL-ANGLE™ thread form:
  30° thread overlapped to the standard 60° thread centralizes in the root of the nut thread, eliminating tolerance and **providing "live-action" locking** along the entire length of the screw.
- TRILOBULAR® thread body section:
  - **Reduces friction** during installation.
  - **Prevents vibrational loosening** by providing additional locking action.
- Neutral hardened in accordance to POWERLOK® manufacturing standards.
- POWERLOK® screws are lubricated to make the insertion process easier.
- Due to the hardness of the screw, it is necessary to apply baking treatment to reduce the risk of hydrogen embrittlement (page 124).

To ensure a correct performance of the screw, it should have higher hardness value than the nut member. We recommend contacting our technical department to confirm the feasibility of POWERLOK® screws for each particular application.

2. Advantages

- **Immediate and continuous locking action** over the entire length of the screw allowing for repeated insertions and removals without affecting its locking properties and independently of nut tolerance. Unlike time-sensitive chemical locking agents, the locking action with POWERLOK® screws is instantaneous and no reaction or curing time is required.
- **Excellent vibration loosening resistance.** POWERLOK® screw eliminates loosening problems in tapped holes and nuts without the use of additional locking elements (lock nuts, spring washers, adhesive patches, etc...)
- The spring effect of 30° thread crest **maintains clamping.**
- **Cost reduction** by eliminating the need for additional locking elements.
- Meets **the standards of regulation IFI 524** concerning screws loosening resistance
- Locking action is **not affected by temperature**. POWERLOK® screws, being an all-metal locking screw, do not lose their efficiency in high operating temperatures.
- POWERLOK® screw maintains **continued locking effectiveness**, even after **repeated insertions and removals.**

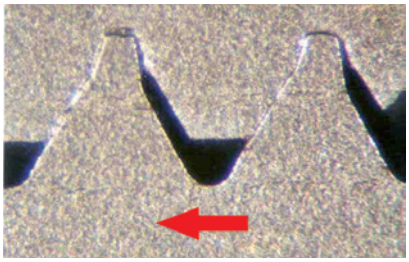


Fig.37. The spring effect of 30° thread crest maintains clamping.

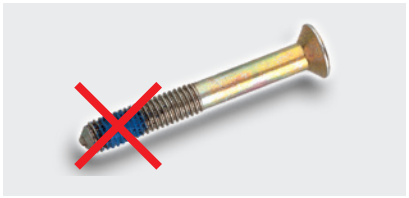


Fig.38. Adhesive patch or non-metallic additives lose much of their developed force and deteriorate with time under the influence of high temperatures. The screw cannot be reused and assembly costs are high.

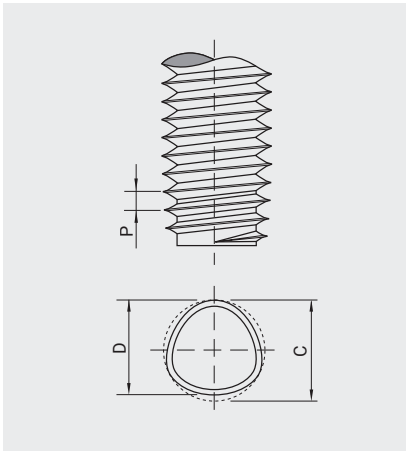
3. Technical data

POWERLOK® screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements.

For additional information, please contact our sales department.

d	Pitch P	Minimum Breaking torque (Nm)	C	D
M3	0.50	1.90	3.18	3.08
M3.5	0.60	3.00	3.69	3.57
M4	0.70	4.40	4.22	4.08
M5	0.80	9.30	5.26	5.10
M6	1.00	16.00	6.30	6.10

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on die casting parts to establish the precise values.



Nominal length (mm)	Tolerance (mm)
≤ 3	± 0.2
3 < L ≤10	± 0.3
10 < L ≤ 16	± 0.4
16 < L ≤ 50	± 0.5
> 50	± 1.0

4. Applications

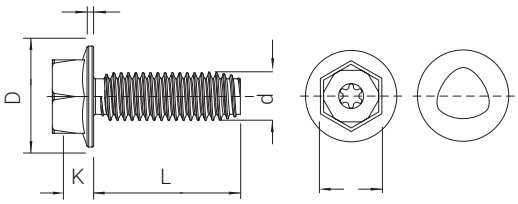
Assembly of components under severe vibration conditions or cycles of expansion / contraction in tapped holes.

Cost reduction and better performance eliminating the use of adhesive patches and under-head locking elements such as lock washers in metric screws and locking nuts.

Examples:
Automotive components
Household appliances
Motors and industrial equipment

PL78T

POWERLOK®



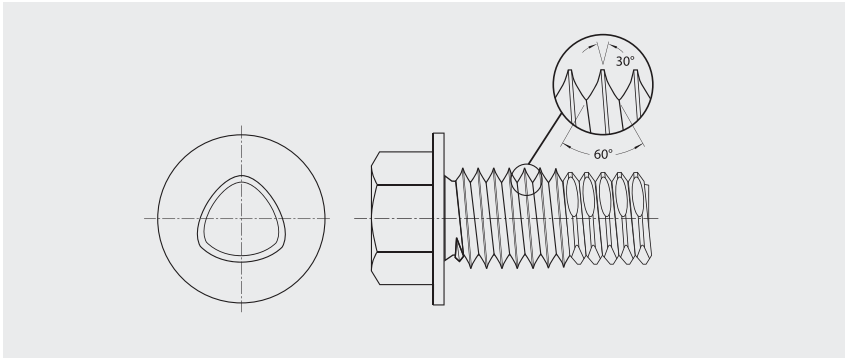
- **Hexagonal Flange head**
- **TORX® recess**
- **Zinc plated Cr (III) 10µm + Sealant + Lubricant + Baking**

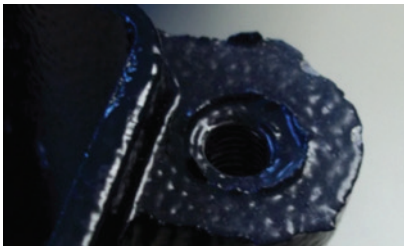
d mm	M5	M6
D mm	11	13.5
K mm	4.5	5.3
C mm	0.82	1.02
S mm	8	10
TORX®	**T20**	**T25**
L mm	Ø5	Ø6
16	○	●
20	●	●

● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

KLEERTITE®- KLEERLOK®

Occasionally, in applications where pre-tapped holes are contaminated by paint, weld splatter, primer or other foreign matter, the point of KLEERTITE® screw allows installations without blocking. The special KLEERTITE® point geometry is specially designed to clear threads in contaminated pre-tapped holes and ease the screw installation. KLEERLOK® screws combine POWERLOK® thread locking with KLEERTITE® clearing feature to scrap material.





The special point design in **KLEERLOK®** screws helps to carefully clean the contaminated holes, keeping acceptable ergonomic threading torque values, and ensures locking action along the entire length of the screw.

Applications of KLEERLOK® screws:

KLEERLOK® screws are recommended for the assembly of fry pans, anodized aluminum parts and shelving systems (painted frames).

This is a custom-made product. Please contact our sales department for further information.

REMFORM® II F™

REMFORM® II F™ (Fine Thread) screw is specifically recommended for the assembly of aluminum and magnesium die casting parts, extruded aluminum profiles, high content glass fiber reinforced plastics and other low ductility materials.

REMFORM® II F™ employs the same asymmetric thread design than REMFORM® II HS™ but with a smaller thread pitch.

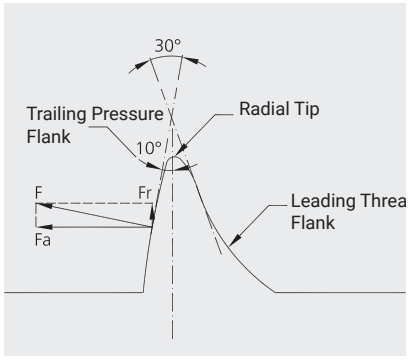
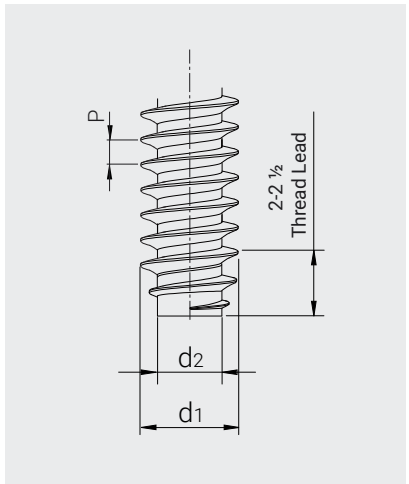


Fig.39. Asymmetric thread design of REMFORM® II F™. Trailing Pressure Flank minimizes radial stress (Fr) during threading and optimizes pull-out resistance.



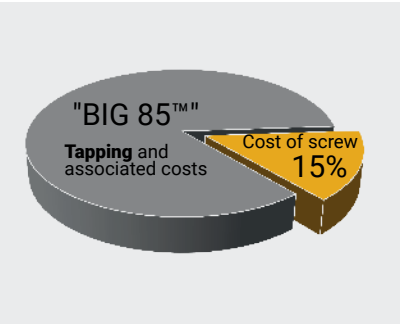
1. Technical features

- Asymmetric thread design of 30° minimizes the disturbance of a low ductility nut member during thread forming and efficient material displacement **requires minimum energy during threading process.**
- The finer thread pitch of REMFORM® II F™ screws is perfectly suit to magnesium, soft aluminum, thermoset plastics, and other low ductility material. It provides larger shearing zone, increasing **resistance to pull-out** and **vibrational loosening.**
- In applications on magnesium, the hole diameter may have a wide spread, an inherent consequence of the magnesium injection process. The design of REMFORM® II F™ screw allows absorbing this variability in the diameter and **ensures thread forming in pilot holes with a wide tolerance.**
- The lead threads **facilitate alignment into the hole,** avoiding the possibility of blockage.
- Magnesium is in the lowest part of the galvanic series. Therefore, in contact with other metals, its corrosion is accelerated due to the potential difference of the materials. In some applications, it's necessary to use screws with **special coating to minimise the risk of galvanic corrosion of magnesium parts.** We recommend contacting our technical department for additional information.

2. Advantages

- Larger core diameter provides **higher torsional and tensile strength** and allows higher tightening torque.
- Tensile strength of over 1,000 N/mm^2 and reduced thread pitch **ensures high pull-out resistance.**
- **High stripping resistance.**
- Reduced length of engagement enables the assembly of plastic with low insertion depth **assuring high clamping and pull-out resistance.**
- Low thread forming torque and high stripping torque offer **optimal safety during assembly.**

3. Cost reduction



A screw represents only 15% of the total in-place cost. The remaining 85% corresponds to tapping operations, cleaning oil and chips, usage of additional elements to prevent vibration loosening and cross-threading, labor expenses and scrap.

In the assembly of magnesium parts, REMFORM® II F™ screws provide important opportunities for cost saving:

- Thread design ensures thread forming in pilot holes with a wide tolerance, avoiding blockage and stripping problems.
- Progressive point ensures excellent screw alignment, avoiding blockage and ensuring thread forming in pilot holes with a wide tolerance.
- Eliminate tapping process and all associated costs: drilling, tapping, cleaning oil and chips, verification...

All of these technical advantages guarantee optimal assembly in automated lines and improved productivity resulting in reduction of line downtime and adjustments.

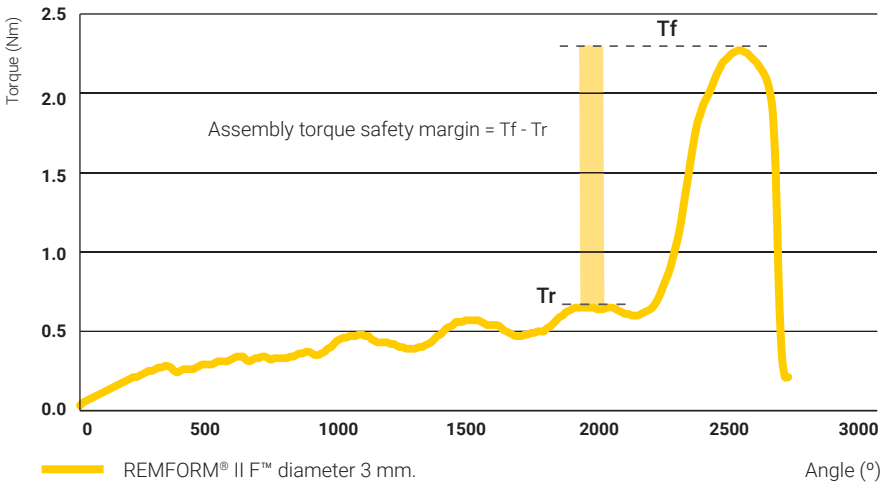
In the assembly of aluminum extruded profiles parts, REMFORM® II F™ screws also provide important opportunities for cost saving:

- 30° thread design minimizes radial stress and allows for bosses with thinner walls. In applications on extruded aluminum open hole, it ensures the stability of assembly process during screw insertion.
- Progressive point ensures excellent screw alignment, avoiding the tip to escape from the open hole.

4. Threading curve

The graph below shows the threading curve of REMFORM® II F™ in magnesium die casting part, pilot hole diameter 2.7 mm, engagement length 6 mm.

The difference between threading torque (Tr) and failure torque (Tf) guarantees a greater safety and an increased stability during screw installation.

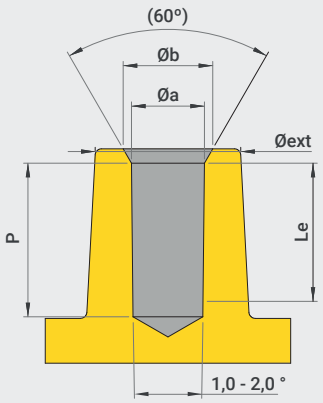


REMFORM® II F™ Minimum breaking torque	
d (mm)	Torque (Nm)
2.5	0.92
3.0	1.56
3.5	2.45
4.0	3.51
5.0	6.97
6.0	12.6
8.0	31.8

The optimum tightening torque is determined based on threading curve tests in the laboratory.

5. Recommended hole diameter in light alloys die casting

The tables show the boss structure design recommendations for REMFORM® II F™ in aluminum and magnesium:

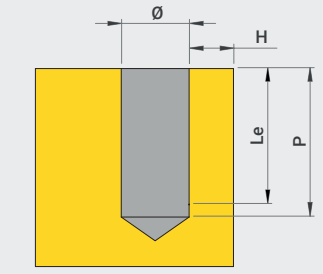


P = Minimum depth
Le = Length of engagement

Table 1. Die casting parts with injected holes

Screw diameter	Magnesium assemblies					
	Øa	Tolerance	Øext min.	Øb	Le	P
2.0	1.87	±0.04	3.80	2.70	5.00	5.70
2.5	2.32	±0.04	4.50	3.20	6.25	7.00
3.0	2.78	±0.04	5.30	3.90	7.50	8.25
3.5	3.22	±0.04	6.10	4.50	8.75	9.50
4.0	3.68	±0.04	7.00	5.20	10.00	10.75
5.0	4.61	±0.04	8.90	6.50	12.50	13.25

Screw diameter	Aluminum assemblies					
	Øa	Tolerance	Øext min.	Øb	Le	P
2.0	1.89	±0.04	3.80	2.70	5.00	5.70
2.5	2.36	±0.04	4.50	3.20	6.25	7.00
3.0	2.88	±0.04	5.30	3.90	7.50	8.25
3.5	3.35	±0.04	6.10	4.50	8.75	9.50
4.0	3.87	±0.04	7.00	5.20	10.00	10.75
5.0	4.87	±0.04	8.90	6.50	12.50	13.25



P = Minimum depth
Le = Length of engagement

Table 2. Die casting parts with drilled holes

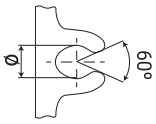
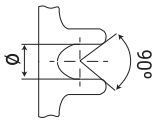
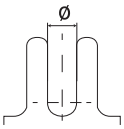
Screw diameter	Magnesium assemblies				
	Ø	Tolerance	H min.	Le	P
2.0	1.78	±0.04	1.4	5.00	5.70
2.5	2.22	±0.04	1.8	6.25	7.00
3.0	2.66	±0.04	2.2	7.50	8.25
3.5	3.09	±0.04	2.6	8.75	9.50
4.0	3.53	±0.04	2.9	10.00	10.75
5.0	4.45	±0.04	3.6	12.50	13.25

Screw diameter	Aluminum assemblies				
	Ø	Tolerance	H min.	Le	P
2.0	1.80	±0.04	1.4	5.00	5.70
2.5	2.25	±0.04	1.8	6.25	7.00
3.0	2.75	±0.04	2.2	7.50	8.25
3.5	3.20	±0.04	2.6	8.75	9.50
4.0	3.70	±0.04	2.9	10.00	10.75
5.0	4.65	±0.04	3.6	12.50	13.25

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values.

6. Recommended hole diameter in aluminum profiles

For assemblies in aluminium profiles please use the recommendations indicated in the following table:

		Open hole 60°		Open hole 90°		Open hole in U	
							
Screw diameter	**Tolerance Ø**	**Ø**	**L**	**Ø**	**L**	**Ø**	**L**
2.5	±0.04	2.3	3 - 5	2.3	3 - 5	2.2	3 - 5
3.0	±0.04	2.75	4 - 6	2.75	4 - 6	2.65	4 - 6
3.5	±0.04	3.2	5 - 7	3.2	5 - 7	3.1	5 - 7
4.0	±0.05	3.65	6 - 8	3.6	6 - 8	3.55	6 - 8
5.0	±0.05	4.65	7 - 10	4.6	7 - 10	4.4	7 - 10
6.0	±0.07	5.55	9 - 12	5.5	9 -12	5.3	9 - 12
8.0	±0.10	7.45	12 - 16	7.4	12 - 16	7.1	12 - 16

Dimensions in mm. This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values.
L = Length of engagement

7. Applications

REMFORM® II F™ screws are recommended for the assembly of:

- Magnesium and aluminum die casting parts with drilled or injected holes.
- Aluminum open profiles.

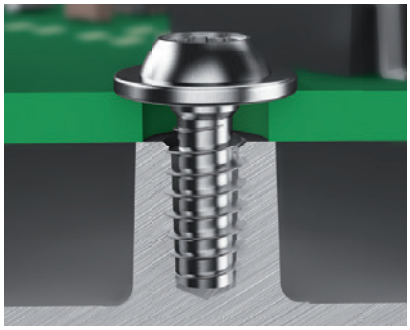


Fig.40. PCB assembly on magnesium housing with injected holes.

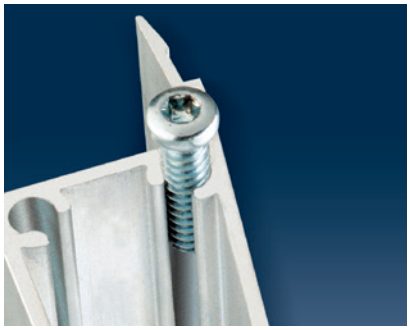
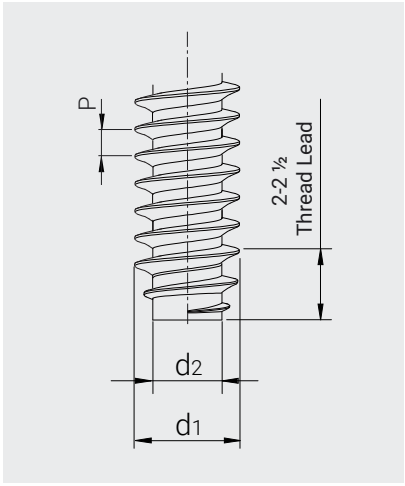


Fig.41. Aluminum profiles with open hole.



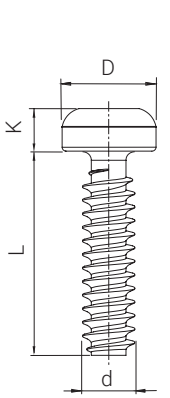
8. Technical data

REMFORM® II F™ screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements.

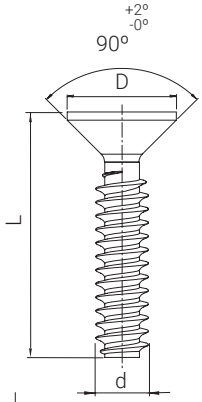
To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

The table shows thread and head dimensions under CELO manufacturing standards. For different head design, recess or threaded length, please contact our technical department.

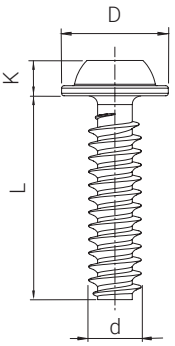
Nominal Value (mm)	Tolerance h14	Tolerance h15
To 3	0 -0.25	0 -0.40
Over 3 to 6	0 -0.30	0 -0.48
Over 6 to 10	0 -0.36	0 -0.58
Over 10 to 18	0 -0.43	0 -0.70



Ref. F282PA



Ref. F282PA



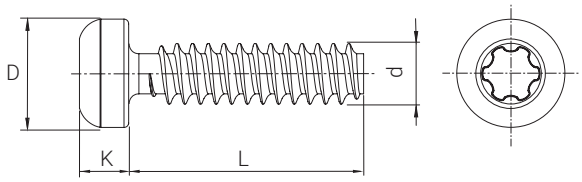
Ref. F287PA

d	d1	d2 min.	P	Breaking Torque min. (Nm)	D h14	K h14	TORX Plus® AUTOSERT®	D h14	TORX Plus® AUTOSERT®	D h15	K h14	TORX Plus® AUTOSERT®
1.8	1.8	1.22	0.55	0.32	3.20	1.50	6 IP			4.20	1.40	6 IP
2.0	2.0 +0.10	1.33	0.60	0.48	3.40	1.60	6 IP	4.00	6 IP	4.30	1.50	6 IP
2.5	2.5 +0.10	1.68	0.70	0.92	4.30	2.10	8 IP	5.00	8 IP	5.30	2.10	8 IP
3.0	3.0 +0.10	2.02	0.80	1.56	5.30	2.30	10 IP	6.00	10 IP	6.30	2.20	10 IP
3.5	3.5 +0.10	2.37	0.95	2.45	6.20	2.60	15 IP	7.00	15 IP	7.30	2.60	15 IP
4.0	4.0 +0.10	2.71	1.05	3.51	7.00	3.10	20 IP	8.00	20 IP	8.30	2.90	20 IP
5.0	5.0 +0.15	3.40	1.25	6.97	9.00	3.60	25 IP	10.00	25 IP	10.50	3.60	25 IP
6.0	6.0 +0.15	4.09	1.40	12.60	10.80	4.20	30 IP	12.00	30 IP	12.50	4.00	30 IP
8.0	8.0 +0.15	5.46	1.75	31.80	14.00	4.80	40 IP			17.00	5.00	40 IP

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department.

F281PA

REMFORM® II F™



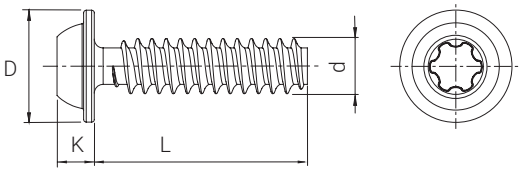
- **Pan head**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 5µm + Baking (144h NSS)**

d mm	3.0	3.5	4.0	5.0	6.0
D mm	5.30	6.20	7.00	9.00	10.60
K mm	2.30	2.60	3.10	3.60	4.20
TORX Plus® AUTOSERT®	10 IP	15 IP	20 IP	25 IP	30 IP

L mm	Ø3.0	Ø3.5	Ø4.0	Ø5.0	Ø6.0
6	○	○	○	–	–
7	○	○	○	○	–
8	●	○	○	○	○
10	●	●	●	○	○
12	○	○	●	○	○
16	○	○	○	○	○
18	○	○	○	○	○
20	●	○	○	●	○
25	–	○	○	○	○
30	–	–	○	○	○
35	–	–	○	○	○
40	–	–	○	○	○
50	–	–	–	–	○

F287PA

REMFORM® II F™

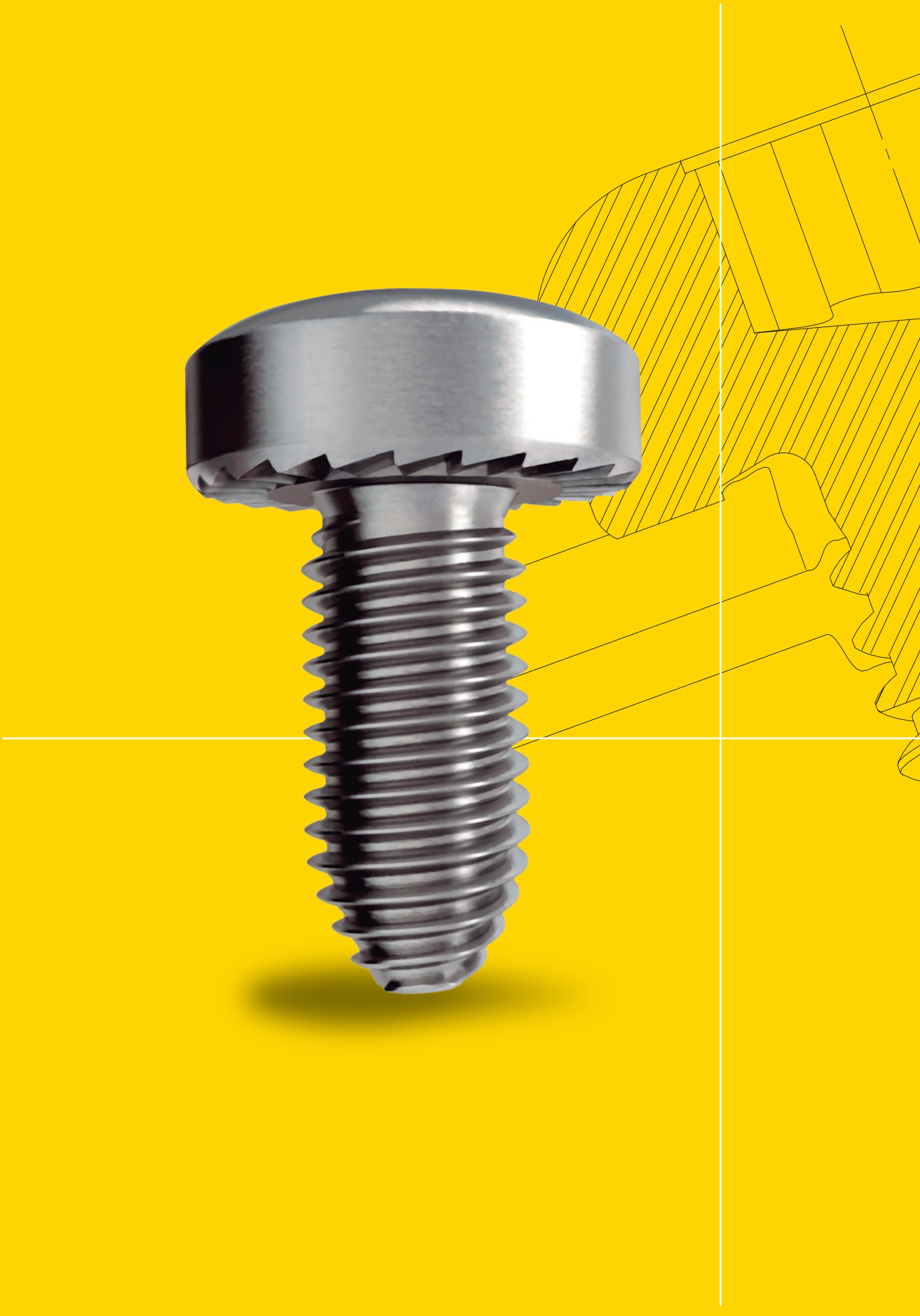


- **Pan head flange**
- **TORX Plus® AUTOSERT® recess**
- **Zinc plated Cr (III) 8µm + Baking + Sealant (144h NSS)**

d mm	2.0	2.5	3.0	3.5	4.0	5.0	6.0
D mm	4.30	5.30	6.30	7.30	8.30	10.50	12.50
K mm	1.50	2.10	2.20	2.60	2.90	3.60	4.00
TORX Plus® AUTOSERT®	6 IP	8 IP	10 IP	15 IP	20 IP	25 IP	30 IP

L mm	Ø2.0	Ø2.5	Ø3.0	Ø3.5	Ø4.0	Ø5.0	Ø6.0
6	●	○	●	–	–	–	–
8	●	●	●	○	○	–	–
10	●	●	●	●	●	○	–
12	○	○	●	○	○	○	○
13	○	○	○	○	○	○	○
14	○	○	●	○	○	○	○
15	○	○	○	○	○	○	○
16	–	○	○	○	○	○	○
18	–	○	○	○	○	○	○
20	–	○	○	○	○	○	○
22	–	○	○	○	○	○	○
25	–	○	○	○	○	○	○
30	–	–	–	○	○	○	○
35	–	–	–	○	○	○	○
38	–	–	–	○	○	○	○
40	–	–	–	○	○	○	○
50	–	–	–	○	○	○	○

● Product available in stock. ○ Product available upon request.
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.



Screws for thin metal

FASTITE® 2000™

FASTITE® 2000™ thread rolling screws have been specially developed for the assembly into untapped thin metal sheet (thickness of less than 1/3 the diameter of the screw), guaranteeing joint compression without risk of stripping.

FASTITE® 2000™ screws provide high pull-out and vibration loosening resistance, and excellent opportunities for cost reductions when compared to other screw types and assemblies.

1. Technical features

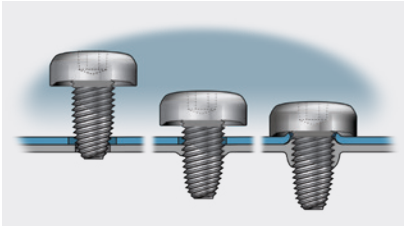
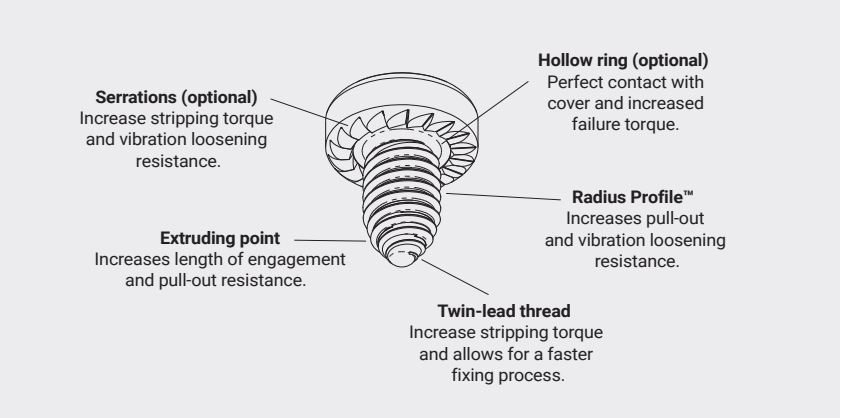


Fig.42. FASTITE® 2000™ screw starts straight and finishes straight, providing a safe, tight assembly. The twin-lead thread centers the screw in the hole.



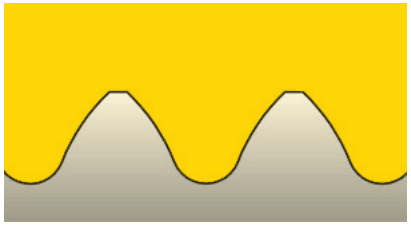
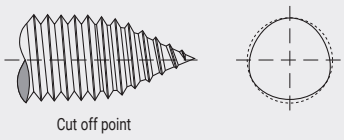


Fig.43. Radius Profile™ increases surface contact between the screw and nut member, providing higher pull-out and vibration loosening resistance.

- Twin-lead thread **increases stripping resistance and provides starting stability,** allowing for a fast fixing process.
- The **special extruding point increases length of engagement** during screw insertion.
- **Radius Profile™** thread design of TAPTITE 2000® increases contact surface between the screw and nut member, increasing **vibrational loosening resistance.**
- The serrations under the screw head **increase resistance to stripping and vibrational loosening.**
- **Fully threaded shank** to **avoid clipping** when joining thin metal sheets.
- **TRILOBULAR® body** to **reduce threading torque** and provide **additional resistance to loosening.**

- Hollow ring under screw head to absorb the metal sheet deformation and allow for a perfect seal between screw head and cover.
- Cut off point (optional) permits piercing in sheets with no prepared hole without deforming the sheet. (PG screw with cut-off point available in stock).



2. Advantages

- **High stripping resistance.**
- Fully threaded shank **avoids clipping when joining thin metal sheets.**
- Excellent alignment of screw in the pilot hole during complete insertion process, **providing a safe and tight assembly.**
- **High pull-out and vibration loosening resistance.**
- **High clamping of the assembly.**
- **Cost savings** by **eliminating tapping operations** and sheet metal extrusion.
- Profitable and cost-effective alternative to expensive solutions such as inserts or clinching nuts.
- Cut off point permits piercing in sheets without previous pilot hole.

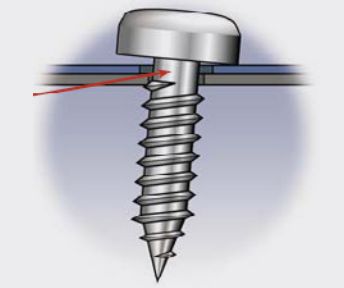


Fig.44. Self-tapping screw unthreaded length below the head is larger than the thickness of the assembly, causing the screw to clip the sheet. The screw leans over during insertion and causes stripped threads or loose assemblies.

3. FASTITE® 2000™ compared to other alternative solutions

FASTITE® 2000™ screws provide technical and economic advantages when compared to other screw types and assemblies for thin metal sheet.

The table below shows a comparison in terms of cost, technical advantages and disadvantages of the most frequently solutions used for the assembly of thin metal sheet:

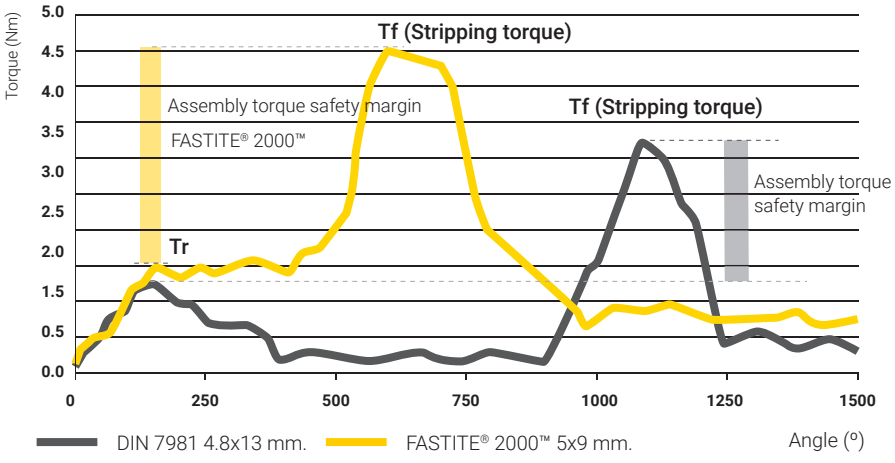
Screw	Cost of assembly element	Cost of assembly process	Disadvantages	Advantages
Self-tapping screw	•	•	Low Stripping resistance Loosening problems Low clamping Unstable threading process	Market availability
Blind rivet	•••	••	Loosening problems Low clamping Non reusable screw	Market availability
Thread rolling screw + extruded hole	••	••• Extruded pilot hole	Higher assembly cost	Strong joint Safe and reliable assembly
Metric screw + insert or clinched nut	••••	••••	Loosening problems Risk of Cross threading	Market availability
FASTITE® 2000™	••	•		High Stripping resistance Vibration loosening resistance Safe and tight assembly

• Low •• Medium ••• High •••• Very high

4. Threading curve

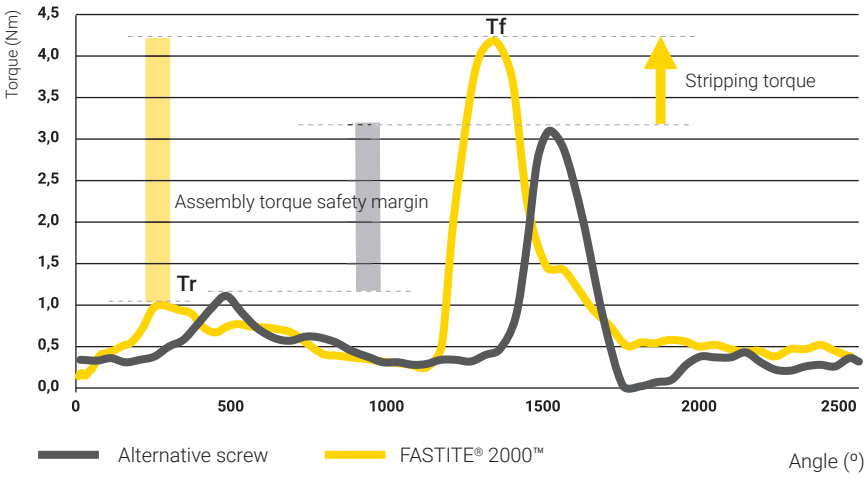
The following graph shows a comparison between DIN 7981 and FASTITE® 2000™ screw in aluminum sheet of 1.4 mm thickness.

FASTITE® 2000™ screw offers an improved assembly security and process reliability (because of the difference between low threading torque and high failure torque) as well as a fast fixing process. The twin-lead thread and larger engagement length results in a higher stripping torque value.



Tf = Failure torque Tr = Threading torque Assembly torque safety margin = Tf - Tr

The following graph shows the threading curve of FASTITE® 2000™ 4x7 zinc plated screw (47FT85T) compared to another screw of similar characteristics, for the assembly of a reactance on painted steel 0.5 mm thickness and pilot hole diameter 1.8 mm.

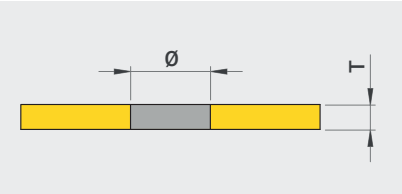


Tf = Failure torque Tr = Threading torque Assembly torque safety margin = Tf - Tr

From the results obtained, we can conclude that FASTITE® 2000™ screw manufactured by CELO has better performance: Lower threading torque (ergonomic assembly) and higher failure torque ensures a safe assembly.

The tightening torque depends on the screw breaking torque, friction coefficient, hole dimensions, length of engagement and screwdriver stability. The optimum tightening torque is determined based on threading curve tests in the laboratory.

5. Recommended pilot hole diameter



The following tables show the recommended pilot hole diameter for different plate thickness in relation to the nominal diameter of the screw.

Screw diameter	Aluminum plate thickness (T)				
	0.5	1	1.5	2	2.5
3	2.25	2.40	2.50	2.60	-
4	2.85	3.00	3.15	3.30	3.50
5	-	3.70	3.90	4.15	4.35
6	-	4.35	4.60	4.90	5.20

Dimensions in mm.

Screw diameter	Steel plate thickness (T)				
	0.5	1	1.5	2	2.5
3	2.25	2.40	2.60	2.70	-
4	2.90	3.10	3.30	3.50	3.65
5	-	3.80	4.00	4.20	4.50
6	-	4.65	4.90	5.15	5.40

Dimensions in mm.

Suggested tolerances are:
+0.03 / -0.04 mm for holes < Ø2.0 mm
+0.03 / -0.05 mm for holes Ø2.0 – Ø5.0 mm
+0.04 / -0.05 mm for holes > Ø5.0 mm

This data is intended for guidance purposes. We recommend carrying out relevant tests on definitive parts to establish the precise values.

6. Applications

FASTITE® 2000™ screws have been specially designed for the assembly into untapped thin aluminum and steel sheets.

Examples
Automotive
Assembly of IT and electric material
Lighting
Small household appliances
Metallic constructions

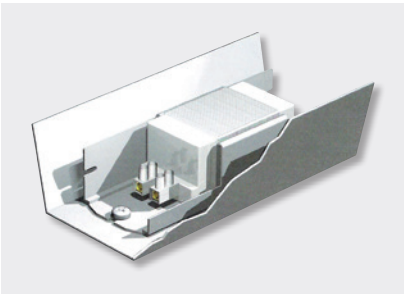
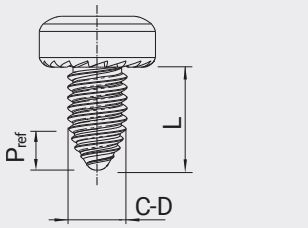
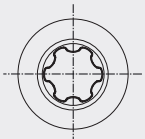


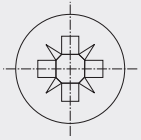
Fig.45. Assembly of lighting components.

Fig.46. Assembly of cooktops components.

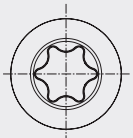




TORX® PLUS



POZI



TORX®

7. Technical data

FASTITE® 2000™ screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements. For additional information, please contact our sales department.

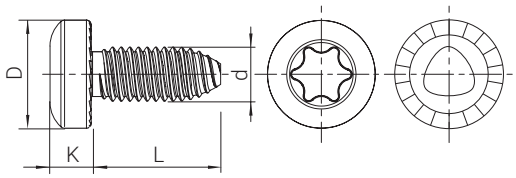
To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

Screw diameter	Pitch	C_{max}	D_{max}	$P_{ref.}$ Extruding point	Pozi	TORX®	TORX Plus®
2.5	0.45	2.52	2.48	2.03	Z1	T8	8 IP
3	0.5	3.02	2.97	2.25	Z1	T10	10 IP
3.5	0.6	3.52	3.46	2.70	Z2	T15	15 IP
4	0.7	4.02	3.95	3.15	Z2	T20	20 IP
5	0.8	5.02	4.94	3.60	Z2	T25	25 IP
6	1	6.03	5.93	4.50	Z3	T30	30 IP

Dimensions in mm. Unless expressly stated, the values shown are nominal. For tolerances and other data, please contact our technical department

FT85T

FASTITE® 2000™



- **Pan head with serrations**
- **TORX® recess**
- **Zinc plated Cr (III) 5µm + Baking**

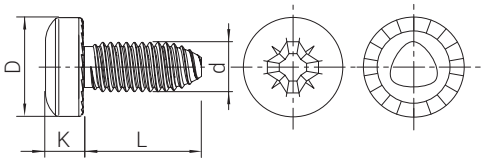
d mm	2.0	3.0	4.0	5.0	6.0
D mm	4.0	6.0	8.0	10.0	12.0
K mm	1.6	2.6	3.4	4.1	5.05
TORX®	6IP[1]	T10	T20	T25	T30

L mm	Ø2.0	Ø3.0	Ø4.0	Ø5.0	Ø6.0
5	○	○	–	–	–
6	–	●	●	–	–
7	–	○	●	–	–
9	–	○	○	●	–
10	–	○	○	○	–
12	–	–	●	●	●

● Product available in stock. ○ Product available upon request. [1] TORX PLUS®
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

FT85Z

FASTITE® 2000™



- **Pan head with serrations**
- **POZI recess**
- **Zinc plated Cr (III) 5µm + Baking**

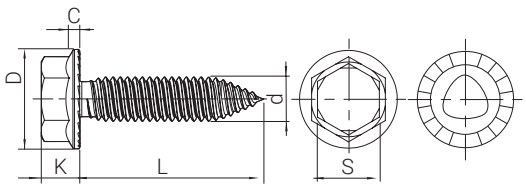
d mm	2.0	3.0	4.0	5.0	6.0
D mm	4.0	6.0	8.0	10.0	12.0
K mm	1.6	2.6	3.4	4.1	5.05
POZI	Z1	Z1	Z2	Z2	Z3

L mm	**Ø2.0**	**Ø3.0**	**Ø4.0**	**Ø5.0**	**Ø6.0**
5	○	○	–	–	–
6	–	●	○	–	–
7	–	○	●	○	–
9	–	○	○	●	–
12	–	–	○	○	○

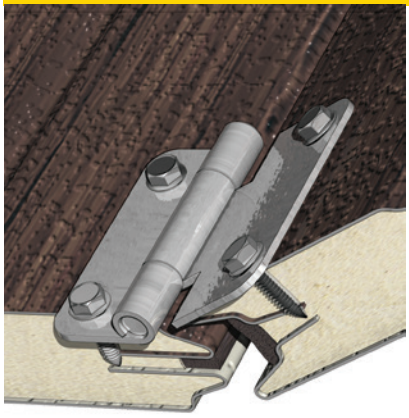
● Product available in stock. ○ Product available upon request. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

PG

FASTITE® 2000™



- **Hexagonal Flange head with serrations**
- **Cut off point**
- **Zinc plated Cr (III) 5µm + Baking**



PG screw for hinges assembly in sectional garage door.

d mm	6.0
D mm	13.5
K mm	5.25
S mm	10.0

L mm	Ø6.0
25	●

● Product available in stock.
For other plating, thread dimensions and head design, please contact our sales department.
Information about packaging conditions in page 130.

FASTITE® 2000™ SELF-DRILLING screw

FASTITE® 2000™ Self-drilling screw combines the features and advantages of FASTITE® 2000™ with a self-drilling point specially designed to drill and extrude thin metal sheets.

1. Advantages

Additionally to the advantages of the standard FASTITE® 2000™ screw, self-drilling variant offers:

- **Cost reduction opportunities,** as it is no longer necessary to drill the two parts of the assembly.
- **Higher stripping torque** compared with standard self-drilling screws.
- **Removable fixing, providing the ability to remove the screw if necessary.**

Maximum sheet thickness		Drilling speed
Aluminum	Steel	(rpm)
0.5 - 2.5	0.5 - 2.0	1200 - 1800

2. Applications

FASTITE® 2000™ Self-drilling screw is ideal for assemblies on metallic frames and substitution of rivets and caged nuts.

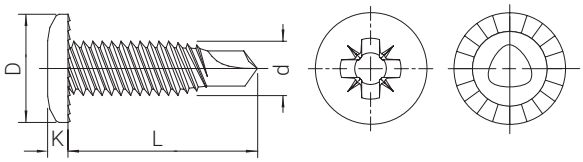
Apart from the reference available in stock, we produce customized FASTITE® 2000™ self-drilling screw under different dimensions and coating configurations.

For additional information please contact our sales department.

FTA85Z

FASTITE® 2000™

- **Low Pan head**
- **POZI recess**
- **Zinc plated Cr (III) 5µm + Baking**



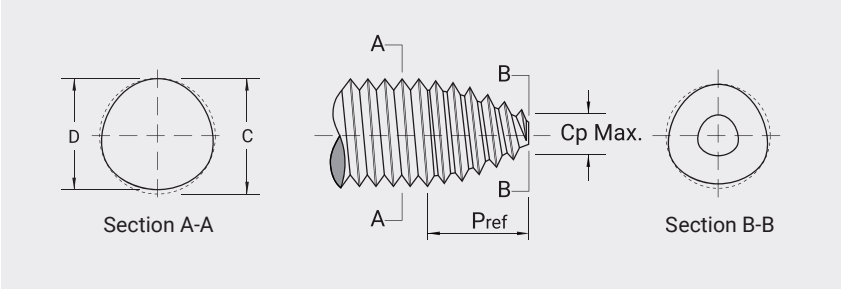
d mm	4.0
D mm	8.1
K mm	2.3
L mm	**Ø4.0**
10	●

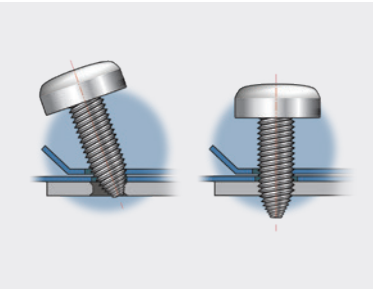
● Product available in stock. For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

EXTRUDE-TITE®

TRILOBULAR® EXTRUDE-TITE® screws have been designed to provide optimal performance in assemblies in aluminum or steel thin sheet metal that require high stripping resistance and metric thread configuration.

1. . Technical features





- Reduced TRILOBULAR® section **guarantees larger contact surface** with the nut member and ensure **high stripping resistance in thin metal sheet.**
- Non-cut off point style for quick and effective screw insertion, ensuring the axial alignment.

2. Advantages

- **High stripping resistance.**
- **Perfect axial alignment** of the screw allows its use in application where the clearance and pilot holes are not aligned.
- Requires **low axial end load** to initiate thread forming and provides **better ergonomics.**
- **EXTRUDE-TITE®** screws form threads into untapped nut member with the tolerance of a machine thread.
- **High vibration loosening resistance.**
- Possibility of piercing thin materials with the optional cut off point.
- **Opportunities for cost savings:**
  - Allows the assembly of thinner and lighter materials.
  - Eliminates the need of repairs to due stripping and off-centered screws.

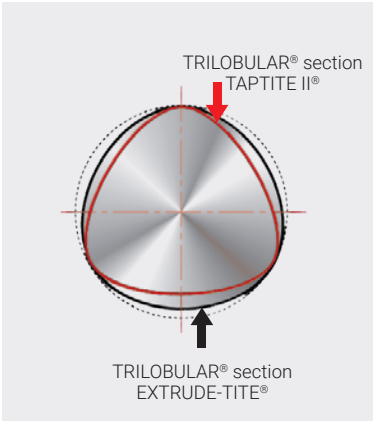
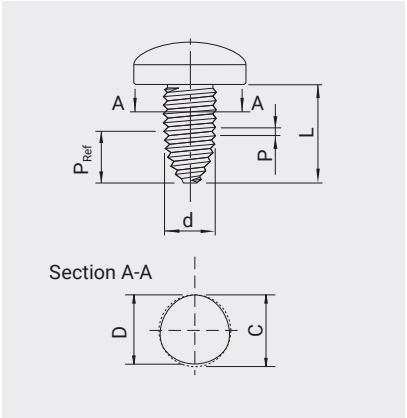


Fig.47. Back of a washing machine assembled with EXTRUDE-TITE® screws.



3. Recommended hole diameter for aluminum and steel sheets

Please refer to the information detailed for FASTITE® 2000™ on page 91.

4. Applications

EXTRUDE-TITE® screws are recommended for assemblies on thin metal sheets that require a screw with high mechanical performance and machine thread configuration.

Examples:
Grounding connections
Household appliances
Electric material

5. Technical data

EXTRUDE-TITE® screws can be manufactured with different head types, recess, dimensions and coating configuration to fit your exact application requirements. For additional information, please contact our sales department.

To ensure the quality of the screw we apply baking process to reduce the risk of hydrogen embrittlement (more information in page 124).

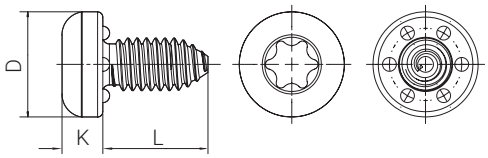
Screw diameter	Pitch	Minimum Breaking Torque (Nm)	Extruding point P_{ref}	C	D
M2.5	0.45	1.2	2.48	2.57	2.52
M3	0.50	2.2	2.75	3.07	3.02
M4	0.70	5.2	3.85	4.08	4.01
M5	0.80	10.5	4.40	5.09	5.01
M6	1.00	17.7	5.50	6.10	6.00

Dimensions in mm. The values shown are nominal. For tolerances and other data, please contact our technical department.

EX85T

EXTRUDE-TITE®

- **Pan head**
- **TORX® recess**
- **Pointed serrations to ensure electrical conductivity**
- **Zinc plated Cr (III) 5µm + Baking**



d mm	M4
D mm	8.0
K mm	3.1
TORX®	T20
L mm	**Ø4.0**
8	●

● Product available in stock.
For other plating, thread dimensions and head design, please contact our sales department. Information about packaging conditions in page 130.

Grounding connections:

The screws used in grounding assemblies should meet the requirements indicated in regulation **EN 60335-1:2002**, with the aim of offering a correct assembly and guaranteeing electrical conductivity.

The screw reference EX85T meets the requirements established in regulation **EN 60335-1:2002**, which are listed below:

- The screw should be tightened and loosened 5 times maintaining its initial properties and required clamping level.
- This test is conducted with the correct tool and using the assembly torque indicated on the table.

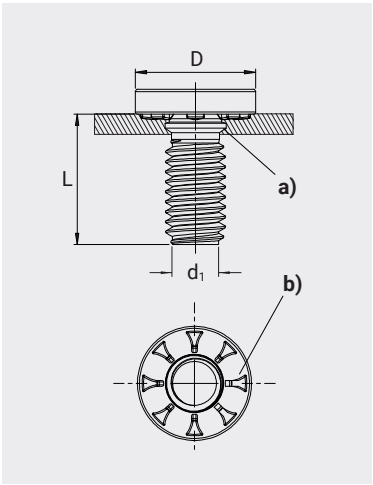
Screw diameter	Tightening Torque (Nm)
M3	0.5
M3.5	0.8
M4	1.2

Pointed serrations below the head ensure electrical conductivity, indispensable requirement in the assemblies of grounding connections.

CELOSTAMP®

CELOSTAMP® clinching system is a solution for fixing the screw in thin metal sheets. CELOSTAMP® screws are a high-performance alternative solution when welding is not possible or undesirable, such as applications with dissimilar materials, special pre-coated materials, temperature sensitive joints, etc...

Installation of CELOSTAMP® screw is made by hydraulic or mechanical presses, depending on whether the assembly line is manual or automated.



a) Retaining groove keeps the displaced material and increases resistance to torque out and push-out.

b) Patented design of serrations optimizes the material flow during insertion.

1. Technical features

- The patented curved and progressive **radial design of the lobes displaces more material** towards the hole during insertion. It reduces considerably the hole diameter in metal sheet during insertion.

Moreover, the lobes oppose radially to the rotation of the screw and, in case of displacement, enable material to flow towards the groove, **improving even more the retention and blocking.**

- Retaining groove keeps the displaced material during insertion, assuring **screw retention during handling.**

2. Advantages

- It requires low insertion force **minimizing the risk of sheet deformation.**
- Lobes and retention groove design provide **high torque-out and high push-out** during assembly shelf-life.
- It enables **joining of dissimilar materials**
- **Minimizes risk of material damage**.
- Easy installation **lowers in-place costs.**

Results obtained with CELOSTAMP® M6 screw :

Plate thickness (mm)	Insertion force (kN)	Minimum Push-out (N)	Minimum Torque-out (N)
2.0	30	1800	13
1.5	30	1250	12

These are custom-made parts. For further information, please contact our sales department.

Special solutions and functional parts

FUNCTIONAL PARTS

There are many applications in the industry which require specific functional parts that fit project requirements, parts geometry, mechanical loads and installation parameters.

At CELO we have developed specific solutions adapted to the needs of these applications and manufactured according to project requirements, which allows for great opportunities for cost reduction and the optimization of the application.

These functional parts are normally manufactured by multi-stage cold-forming process (over 3 dies) and performed second operation when it's requested to make drill holes, clearance grooves, undercuts or other complex geometry. Multi-stage machines provide the possibility to manufacture complicated geometries with the highest quality demands and improved productivity, achieving significant cost savings in comparison with classical turned part manufacturing.

Based on the materials to join and its functionality, metric, imperial or special thread for plastic and metal is considered. The strength is achieved through heat treatment process. This will depend on the mechanical requirements and the type of thread, being applicable the standard DIN ISO 898-1 for metric threads and REMINC standards for TAPTITE® and REMFORM®II™ range of products. Surface treatment to apply will depend on application requirements.

Some examples of functional parts manufactured under our customers specifications are listed below:

MAThread®

MAThread® point is applied to machine screws to avoid blocking and cross threading problems during insertion. This improves the ergonomics of the assembly by an easier insertion into a tapped hole or nut.

Double end studs

Double end stud combines two threads along both sides of its shaft offering great possibilities for cost savings.

It is designed for individual applications when it’s necessary to assemble two pieces. One of the threads is installed in the first part, leaving the machine thread waiting to be mounted later to the second part by a nut.

Ball studs

Ball studs consist on a spherical shape head and a shank with different thread designs depending on the material to assembly. The special head is designed to allow a rapid assembly and disassembly, while certain mobility of the assembled parts are allowed.

Ball studs are manufactured by multi-stage cold forming combined with machining to achieve the surface finishing and tight tolerances required.

Large head-to-shank ratio screws

There are many applications in which parts functionality require a complex head geometry, high volume, with large head-to-shank ratio, captive washers in steel or EPDM as an alternative to machined parts or other assembly systems.
The larger surface contact of the head and cover reduces stress, increases friction and stripping resistance. It includes parts with multiple diameter, shoulders and blind/through holes.

Rivets and pins

Rivets consist on a cylindrical shaft with a head at one of its ends. Once the rivet is installed, it deforms to achieve a permanent assembly of the two elements. Based on the customer-specific requirements, the rivets can be a solid or a semi-hollow part.

In some applications these parts are used as moving link elements or spacers between components.

Over molding parts

Over molding parts consist of a threaded shank and a special head design on which a plastic part is injected. The head is designed to provide a strong and perfect connection with the plastic and very high pull-out resistance.

Press-in studs

Press-in studs are manufactured with a radial or an axial knurl. They provide permanent male threads in thin metal sheets and provide excellent push-out resistance.

The usage of press-in studs reduces assembly costs, assembly time and improves product quality.

Complex parts with second operations

For certain applications the screws manufactured by cold-forming process require for drill holes, clearance grooves, undercuts or other complex geometry parts. In these situations, parts are CNC machining finished. When it's requested to add spacers or EPDM joints, special assembly takes place once the surface treatment process is completed.

These parts are specially designed for specific applications, its functionality provides many opportunities for cost saving.

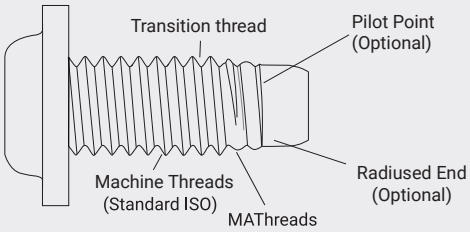
These are custom-made parts. For further information please ask our sales department.

MAThread® POINT

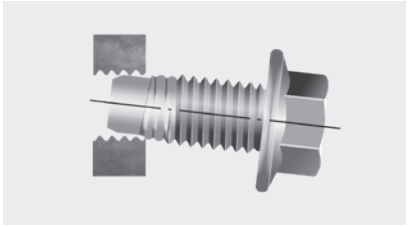
MAThread® point uses a patented thread design applied to machine screws to avoid cross-threading and blocking problems during installation.

MAThread® point allows an easy assembly and rapid thread engagement in tapped holes or nuts on the assembly line, improving ergonomics and providing great opportunities for cost saving.

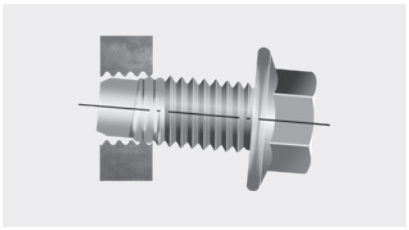
1. Technical features



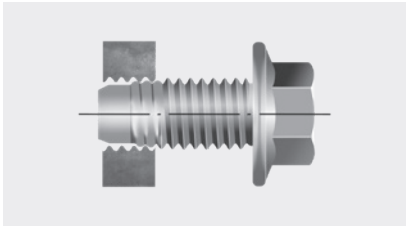
- **Perfect alignment of screw in nut member.** Transition zone aligns the screw to fit into the nut member. **MAThread® point engages with optimum interference into the nut** to straighten the screw with misalignment up to 15°.
- MAThread® point parts can be **made from all common cold-forming steels,** copper and stainless steel.



1.Helix misalignment.



2.Mathread® point helps threads come into place.



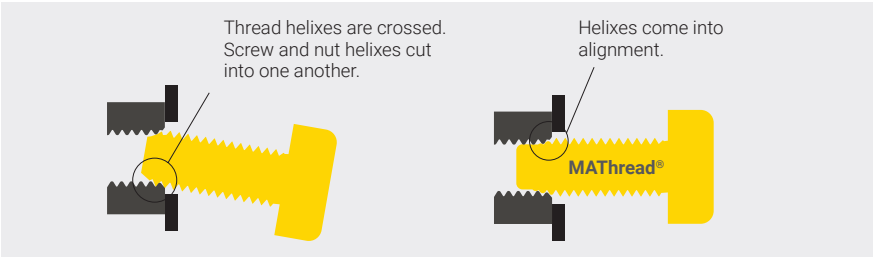
3.Threads drive normally into the nut.

2. Advantages

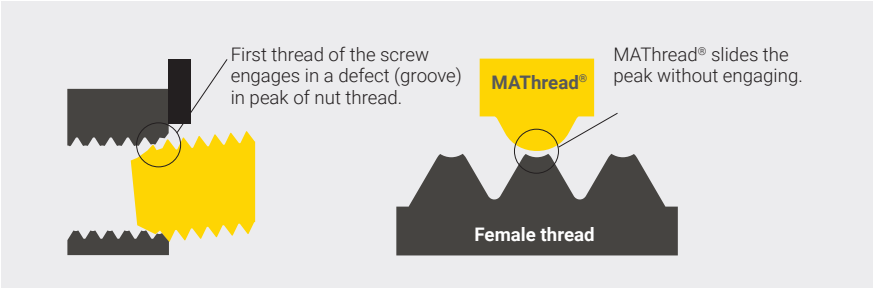
- It **reduces the cost of assembly**: MAThread® point allows an **easy and rapid insertion** without reducing the installation speed and **avoid cross-threading or blocking problems:**
  - Reduces the screw installation time.
  - Eliminates the costs derived from downtime, rework and scrap associated to the assembly with standard screws.
- MAThread® performance is **unaffected by installation speed.**
- MAThread® **improves the ergonomics** of the assembly by an easier insertion into the tapped hole or nut. It reduces operator stress during run-down.

MAThread® point solves the problems of:

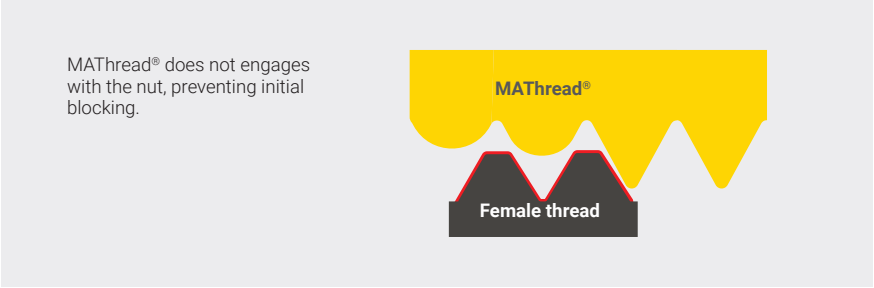
- Cross-threading because of angular misalignment of screw and nut: This happens when the second thread of the screw is engaged with the first thread of the nut.



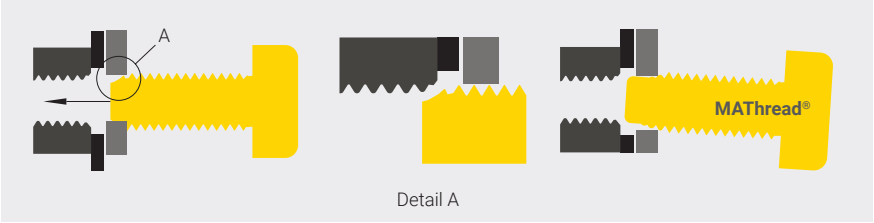
- False threading: Jamming with minimal or no angular misalignment. Peak of screw thread engages the groove, and during continued rotation, the nut thread is damaged and the screw is blocked. Thread strips, weakening the assembly.

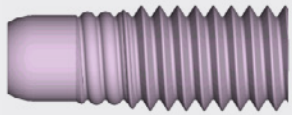


- Galling: Jamming due to excess paint or fit problems. When inserted at an angle, screw threads interfere with paint on flanks and friction builds up, causing thread failure.
MAThread® threads does not contact the paint on the flanks or root until it is aligned and preventing initial blocking.

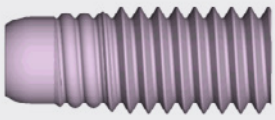


- Winking: Thread damage caused by component misalignment. Screw lead threads interfere with the component causing damaged thread. Mathread® round thread is not damaged by the first contact on insertion. Mathread® point helps the screw to align and fit better into the nut thread when there's a misalignment between cover and base part which, in other situations could damage the screw thread.

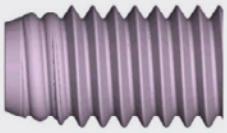




Standard MAThread®



MATpoint®



VS Point®

There are different point designs adapted to the application requirements:

Standard MAThread®

- It absorbs misalignments up to 15°.
- It's recommended for applications where the length of the point is not a problem.
- It's not recommended for the assembly of high weight cover parts which require positioning during the assembly process.

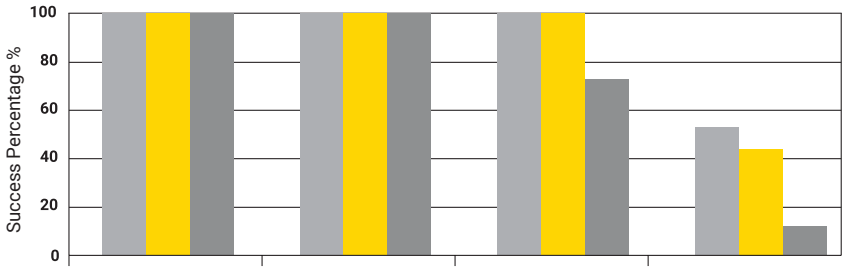
MATpoint®

- It's an optimized MAThread® point.
- It absorbs misalignments up to 12°.
- It's compatible to the great majority of applications.

VS Point®

- It's a MAThread® point hardly without pilot point.
- It absorbs misalignments up to 7°.
- It's recommended for applications where the engagement length is limited.

Anti-Cross-Thread Performance Comparison



	MAThread®	MATpoint®	VS Point®	Dog point
7º	100	100	100	53
9º	100	100	100	44
12º	100	100	73	12

3. Applications

MAThread® point screws and its different variants are recommended for assemblies into nuts or tapped holes in full automated assembly lines and applications susceptible to cross-threading problems.

This is a custom-made screw. For further information, please contact our sales department.

DOUBLE END STUDS

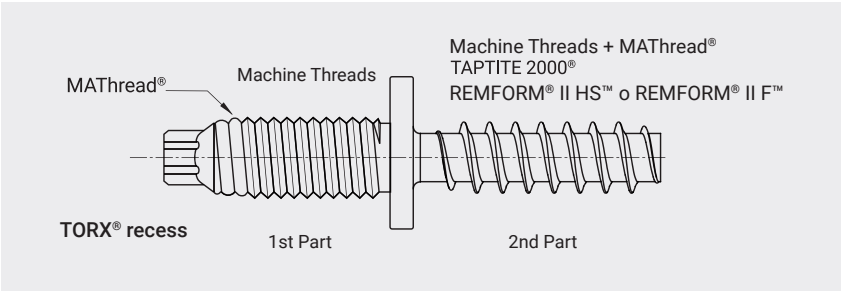
Double end studs are designed for those applications in which it's necessary to assemble two pieces. One of the threads is installed in the first part, leaving the machine thread to be mounted later to the second part by a nut.

Its functionality provides great opportunities for assembly cost saving.

1. Technical features

The Double end stud combines two threads along both sides of its shaft, which may be the same thread type or different depending on the materials and the final requirements of the assembly:

First, the thread rolling part is installed (part 2) in the first component, leaving the machine thread (part 1) waiting to be mounted later to the final support.



1st part: Machine thread + External recess.

Double end studs have a machine thread head of the screw that will be installed into a nut or tapped hole. We recommend considering MAThread® point to allow the rapid thread engagement and avoid cross-threading problems. For further information on MAThread®, please refer to page 104.

Double end studs can be driven by various methods. TORX® recess is most popular solution (further information on page 121):

- TORX® STEM
- TORX PLUS® STEM
- TORX PLUS® Maxx

External recess or hexagonal washer will allow installation into base material. It is also possible to use an intermediate hexagonal washer to install stud part 2 into base material

2nd part: Thread rolling or machine thread

On the second part of the Double end stud, there can be different threads depending on the specific application or material to assemble:

- **REMFORM® II HS™, REMFORM® II F™, REMFORM® II™ or CELOspArk® thread** for the assembly of plastic parts.
- **TAPTITE 2000® thread** for the assembly of light alloy parts (Zamak, aluminum,...).
- **Machine thread** for the assembly of metal parts with tapped holes or into a nut. In this case we also recommend considering MAThread® point.

In all cases, it is recommended to incorporate the **Optical or Laser Sorting** to the manufacturing process (refer to page 126).

2. Advantages

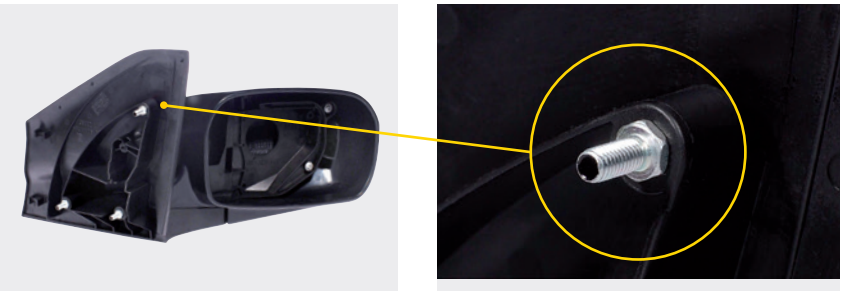
Double End Studs **enhance the assembly of two parts** as it has two sets of threads in one unique part. Its functionality **reduces the assembly system** and provides **great opportunities for assembly cost saving,** avoiding alternative solutions that represent more elements and the design of more complicated parts.

To maximize cost savings, it's important that Double end studs are considered at the initial phase of the assembly project, when the design of the components to assemble takes place.

3. Applications

Double end studs can be used in all applications where it's necessary to assemble two pieces.

This is a custom-made screw. For further information, please contact our sales department.

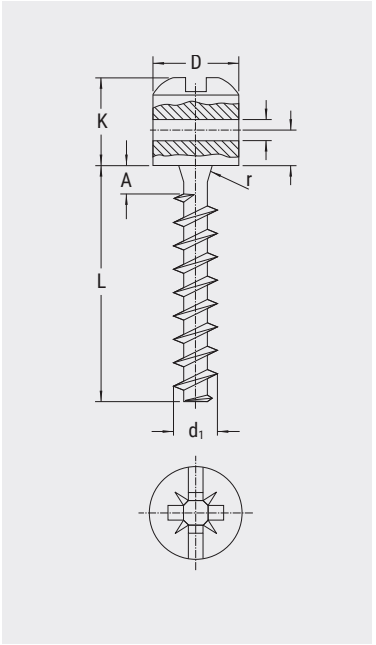


SEALING SCREW

Sealing screws are recommended for assemblies where it is necessary to ensure that the product is sealed to avoid any tampering by unauthorized personnel. Sealing screws manufactured by cold stamping process provides many technical and economic advantages with respect other sealing systems available on the market.

Machining sealing screws are one of the most widely used solution, but it has limitations with regard to thread and recess design, as well as materials used and cost is much higher.

1. Technical features



Head type:

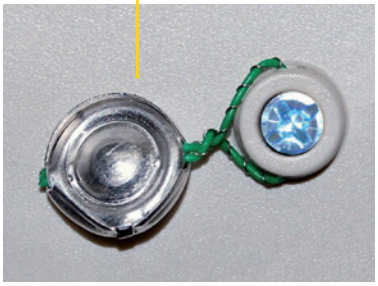
- Cylindrical head with the possibility to make **one or two holes.**
- Combined recess **POZI + SLOT** allows installation in automated assembly lines and makes the SLOT accessible for the installer.

Thread type:

- The stamping manufacturing process makes it possible for thread rolling screws for plastics (CELOspArk®, REMFORM® II HS™) and no metal inserts are needed.
- Machine thread and partial threaded is also possible.

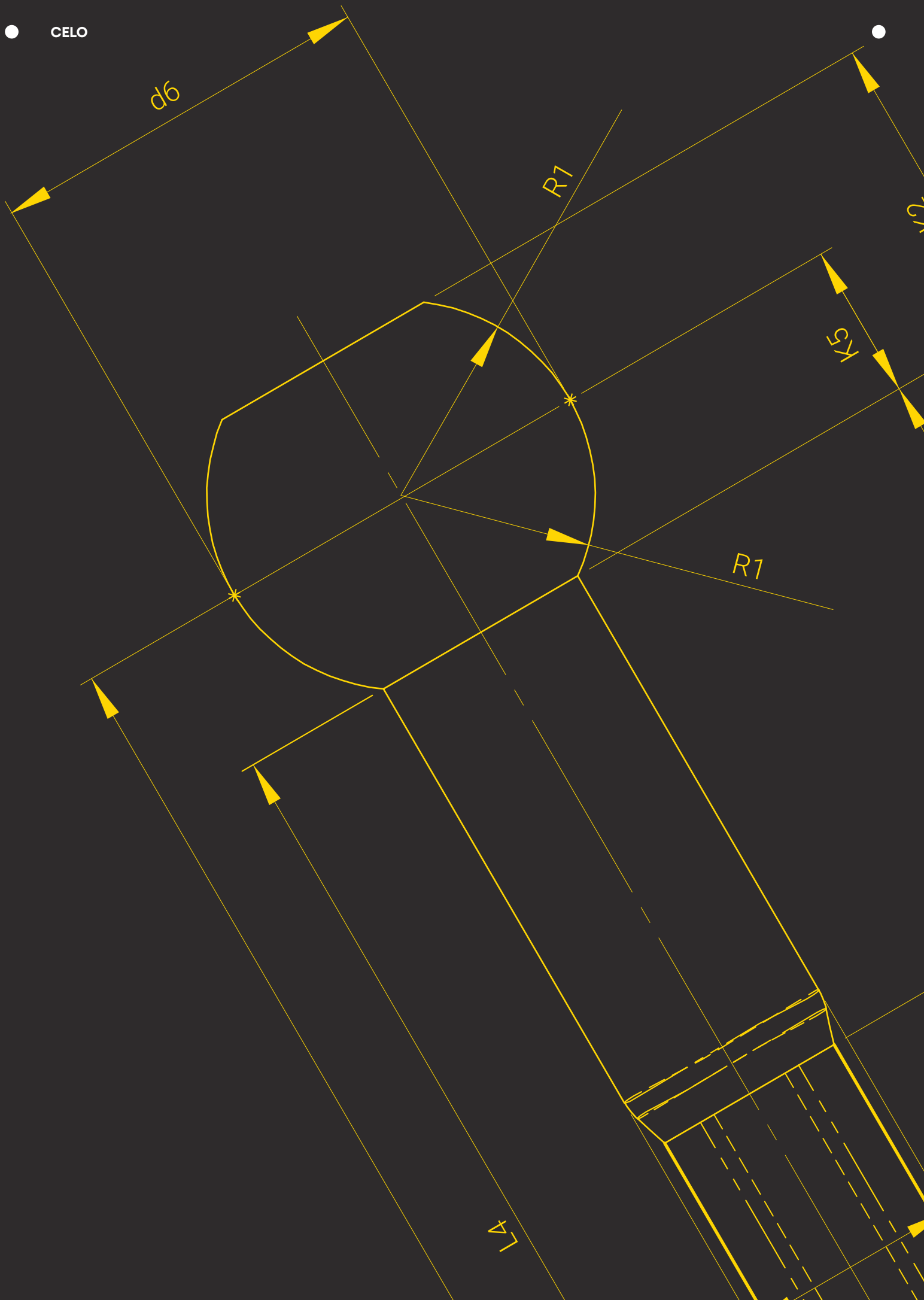
2. Advantages

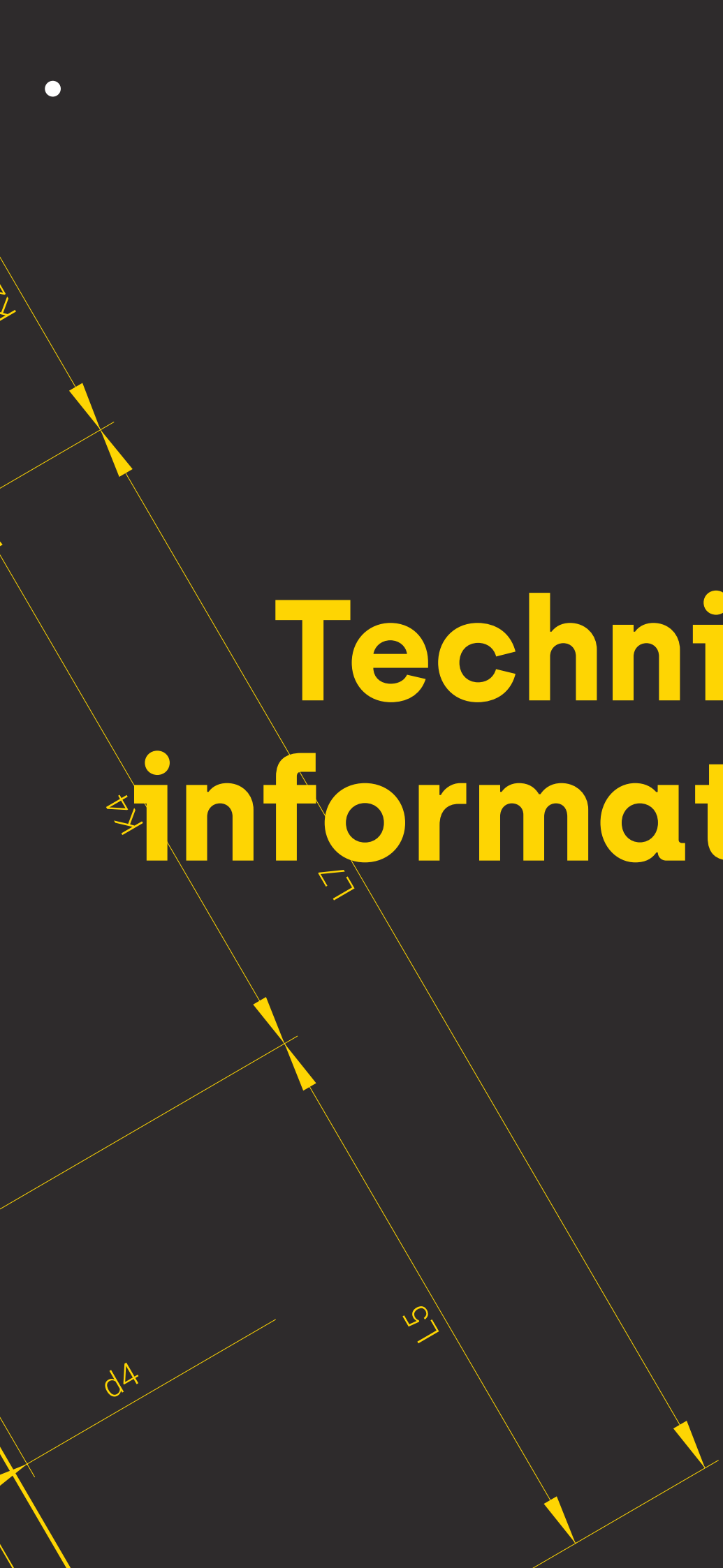
- Screws made of steel allow for **cost reduction** and provide **better mechanical properties**. Normally, sealing screws manufactured by machining are made of nickel-plated brass.
- The POZI + SLOT recess improves the installation in automated assembly lines and makes the SLOT accessible for the installer.
- The plastic thread eliminates the need of metal inserts, offering:
  - Cost reduction both in the price of the insert and injection process cost.
  - Material can be easily recicled.
  - Increased vibration loosening resistance. For further information, please refer to CELOspArk® and REMFORM® II HS™ sections.



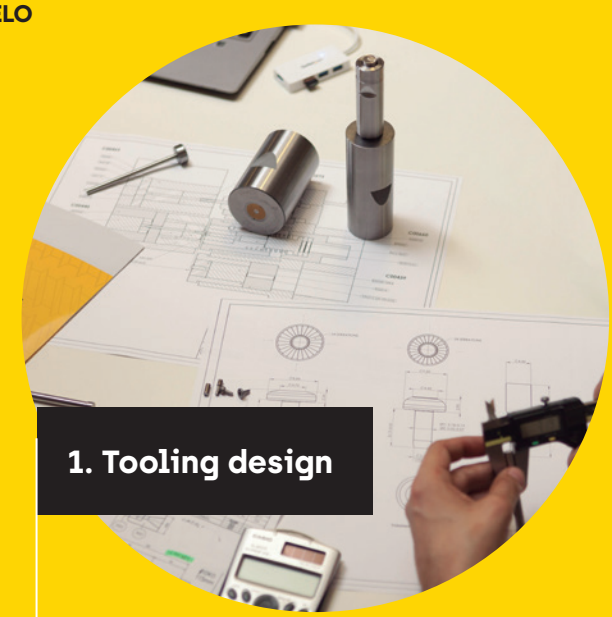
3. Applications

Electrical boxes, enclosures, electric meters, gas meters, taximeters.


d6
R1
K5
R1
L4



Technical information

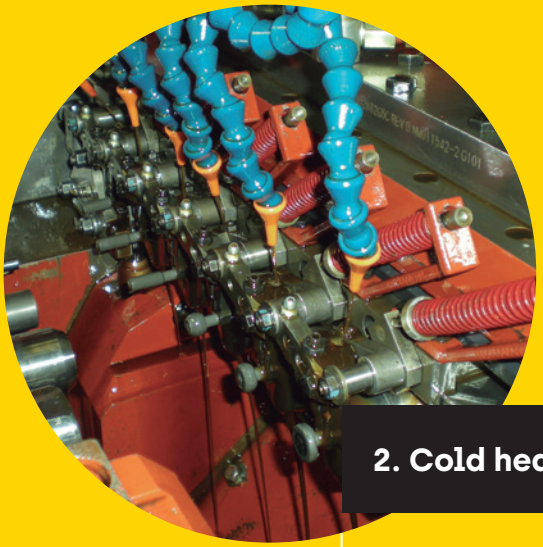


1. Tooling design

The optimal tooling design is a key process to guarantee the quality of the products that we produce. CELO's Production Engineering department designs the tooling for the manufacturing of all the references in our production plants. They use computer aided engineering software to simulate different effort and deformation situations of the pieces prior to their industrial production.
Tool-making facilities that ensure optimum and immediate support to the production lines.

3. Thread forming

The thread of the screw is made by rolling process: hardened rolling dies put high controlled pressure along the screw blank to form the threads by material lamination.
The captive washers are assembled in a special machine designed to insert the washer through the shaft and roll immediately after.
All production lines are monitored to control the rolling forces.



2. Cold heading

Cold heading forming process starts from a wire that is cut to a specific length and deformed to make the head, recess and shaft of the screw. Depending on the shape and complexity of the screw geometry, it can be manufactured in heading machines of 2, 3, 4 or 5 stages. All production lines are monitored to detect any broken punches and discard faulty pieces.

Manufactur

4. Heat treatment

In order to achieve the required mechanical properties, case hardening and neutral hardening is applied in accordance with DIN ISO 898 or the technical specification of TAPTITE® and REMFORM® II™ products family. For more than 10 years, all the coil wire used in our production plants are phosphate free, contributing to environmental care and reducing brittleness related problems.
Process parameters are controlled by a specific software that guarantees the process conditions, as well as the traceability of all the processed batches.

6. CELOSmart®

CELOsmart® inspection system includes different sorting technologies to guarantee homogeneity of the manufactured parts and its optimal installation in automated assembly lines.
Based on customer assembly requirements, the parts go through laser, optical or mechanical sorting process.

5. Surface treatment

Screws have a surface treatment to protect them against corrosion and improve aesthetics. We can apply an extensive range of different coatings both electrolytic and organic, reaching up to 1000 h resistance in Salt Spray Chamber.
More information about surface treatment available in page 122.

7. Packaging

The packaging system in-line with the sorting lines avoids mixing or contamination once the batch has been inspected.
The packaging system in the optical sorting lines includes the option of carboard boxes and ESD bags.

ting process

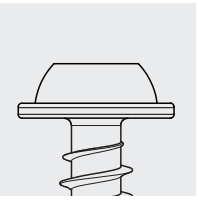
Head styles

The screw head houses the drive system and transmits clamping force to the parts to be assembled. The head design will depend on its function in the application and the bearing surface. It is recommended to follow ISO/DIN standards for each type of screw. ISO/DIN standards specify the head dimensions for different driving systems, thread type and strength category. These general recommendations can be modified in accordance with the application requirements, reducing or increasing head height or diameter, or adding a flange.

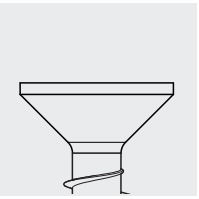
In many cases, is requested an oversized screw head compared to the thread diameter, that's a high head-to-shank ratio screw. This may be due to a larger washer to achieve higher surface contact, bigger head to avoid breaking during assembly, over-molding screws or ball studs. In these cases, it is important to analyze the feasibility of the heading process and proceed to manufacture in a multiple step forming process, 4 or 5 dies or second operations in CNC machining.

The most common head styles manufactured by CELO are detailed below:

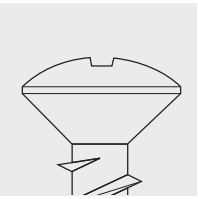
Pan head
TORX®, TORX Plus® / AUTOSERT®
Cruciform recess
(Pozi, Phillips, Combi)



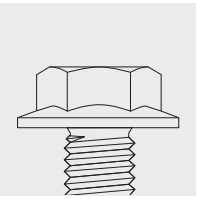
Pan head flange
TORX®, TORX Plus® / AUTOSERT®
Cruciform recess
(Pozi, Phillips)



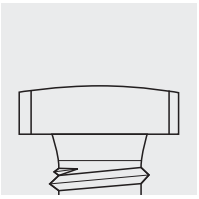
Countersunk head
TORX®, TORX Plus® / AUTOSERT®
Cruciform recess
(Pozi, Phillips)



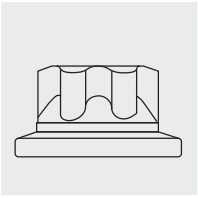
Oval Countersunk
TORX®, TORX Plus® / AUTOSERT®
Cruciform recess
(Pozi, Phillips, Combi)



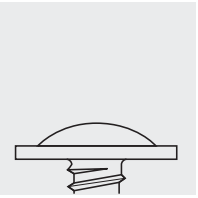
Hexagonal flange
Optional TORX®, TORX Plus® / AUTOSERT®



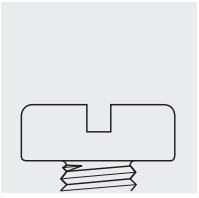
Square head
May include undercuts or clearance grooves



TORX Plus®
External with flange



Extra Low head
Phillips low depth



Cylindrical head
TORX®, TORX Plus® / AUTOSERT®
Cruciform combi recess

Drive systems

The recess is the junction point between the fastening system and the screw. The recess is one of the main elements of a screw as it transmits the rotation of the screwdriver and permits the installation of the screw. The turning force is measured by a scale known as torque, the recess absorbs the torque and transmits it to the screw.

The recess is usually a notch or socket in the head, although there are other series of indented or concaved recesses. The recess affects product design, assembly speed, downtime, ergonomics and the number of scrapped components.

Basic features

There are many parameters that define the recess performance. The most important factors to consider are listed below:

- **Torque transmission:** This is the most important recess feature. The less effort lost at the transition point in the recess, the better torque transmission will achieve. A higher torque transmission allows to save energy in the tightening process and avoids problems of rounding and damaging the recess and the driver bit.

- **Cam-out effect:** This is the force that pushes the screwdriver out of the screw. Due to the conical shape of the internal walls, the screwdriver has the tendency to slip out of the screw head and it can even damage the screw or the cover surface. The user must apply increased axial force to counteract this Cam-out effect: This is a common problem with conventional conical profiles, such as Phillips or Pozi recess. Cam-out greatly reduces torque transmission and make assembly difficult.

- **Alignment:** A feature in some recesses that enhance guiding the screw along the rotation axis in order to ease its position into the hole, so that we can apply the proper end load on the self-drilling or self-piercing screws without slipping out.

- **Engagement speed:** Is the speed in which the bit of the screwdriver finds the recess and starts to transmit torque. Typically, the less angle the bit turns to enter the recess, the higher the engagement speed will be. For this reason, six-lobed symmetrical recesses have a faster engagement speed than cross-shaped ones (with only four lobes).

- **Ageing:** Screwdriver bits are damaged over time. Friction or heavy workloads are some of the factors that weaken the bit. It is important to choose a recess that minimizes the wear on bits due to their high cost. It is likewise important to ensure that the bit-recess system is used correctly.

- **Stick fit:** This is the ability of some bit-recess systems to connect without a magnetic bit holder. This ability is due to the friction created by the bit and the inner walls of the recess. This feature is very valuable in operations with low accessibility, and it is generally not used in automatic assembly lines.
  - Tamper-proof recesses require specific bits to allow for adequate torque transmission.
  - One-way recesses do not allow for removal once the screw is in place.

- **Tamper-proof recesses:** Require specific bits to allow for adequate torque transmission.

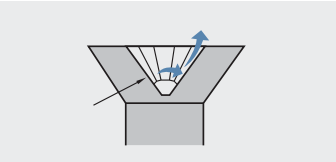
- **One-way recesses:** Do not allow for removal once the screw is in place.

Many of the existing recesses are patented by different companies and others follow the standards defined by relevant international organizations. The best-known international standards refer to Phillips and Six-Lobes recesses, but there are other widely used original patented designs that offer an improved tip-recess system.

It is important to remember that the correct engagement is achieved by using the appropriate bit for each recess. Licensed recesses undoubtedly make up an essential part of the system if we do not want to reduce the crimping properties between them.

A small variation in tolerance, inner wall angle or depth of the recess can increase the wear on bits and cause ergonomic problems.

The following international standards define the recess design:
DIN EN ISO 10664 - DIN EN ISO 4757

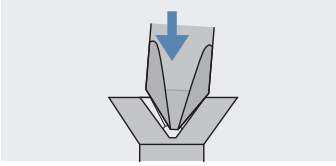


The cone-shaped walls cause the bit to slip out, known as cam-out effect.

PHILLIPS

Cruciform PHILLIPS recess main feature is its cross and conical shape that can be combined with a slot.

- The main problem of PHILLIPS recess is the **cam-out effect.** Due to the conical shape of the internal walls, the screwdriver bits have the tendency to slip out of the screw head. To counteract this cam-out effect, the user must apply increased axial force that reduces bit life and causes worker fatigue or injury.
- The difficulty in bit engagement **reduces the torque transmission**.



Additional force (end load) must be placed against the driver to counteract cam-out.

POZI

POZI Cruciform recess improves the performance of PHILLIPS recess. It has a set of tick marks set at 45° from the main cross recess to make it visually distinct from PHILLIPS recess.

- The internal walls are less cone-shaped, reducing the cam-out effect.
- Improved torque transmission compared to PHILLIPS recess.
- Although less cone-shaped of internal walls, **cam-out effect and low torque transmission still occurs.**

COMBI

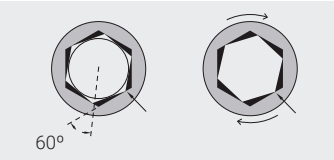
COMBI recess is a POZI or PHILLIPS recess combined with a SLOT, mainly used in the electric sector.

- It is made by stamping, which greatly reduces costs compared with the slot recess.
- Allows for the use of POZI or PHILLIPS tips on assembly lines, leaving the SLOT for the installer.

HEX SOCKET

Hexagonal recess with vertical walls. The strength of the hex socket bits allows for systems requiring a high assembly torque (class 12.9, 10.9, etc.) and headless screws. It's not recommended for automatic assembly lines.

- The 60° angle of incidence makes difficult the torque transmission.
- The screwdriver bit pointwise contacts the edges of the recess, resulting in recess damaging and stress risers to develop.
- To ensure efficient torque transmission, high recess depth and high head height is necessary.

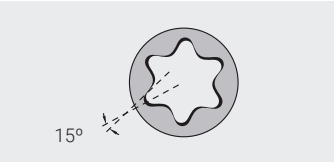


Point contact causes stress, which damages driver bit and screw recess.

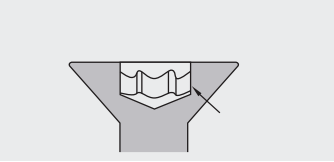
TORX®

Six-Lobes TORX® recess represented a great improvement for automated and manual assembly lines.

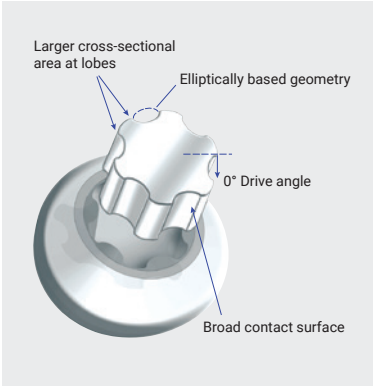
- Straight sides eliminate cam-out effect. There is no need to apply axial end load, increasing driver bit life and allowing more ergonomic installation.
- The six lobes allow for faster engagement speed than cruciform recess and better torque transmission than Hex socket recess.
- 15° drive angle still permits a small amount of radial stress, which can reduce bit life.
- Allows higher torque than Cruciform recesses.
- To ensure effective transmission, it needs to be a deeply cut notch.
- Tool may be difficult to align properly in high-speed assemblies.
- Wide tolerances can result in a loose fit between screw and tool bit.



15° drive angle still permits a small amount of radial stress, which can reduce bit life.



The vertical sidewalls eliminate the cam-out effect.



TORX PLUS®

TORX PLUS® recess is an improvement of TORX® recess that allows for a more efficient assembly, **increases productivity and reduces costs** in automated assembly lines.

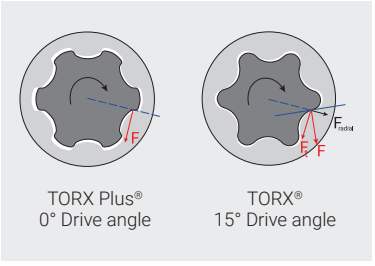
Advantages

- The increase in ultimate torsional strength of the total drive system allows for **higher torque transmission and higher torque removal capability.**
- The increased tool bit life **reduces tooling cost and increases productivity** (reduction in line shut down to change the bit).
- The absence of Cam-out effect ensures an **ergonomic assembly** in manual and semi-automated systems.

The design and functionality of **TORX PLUS® drive make it one of the best drive systems for automated assembly lines.**

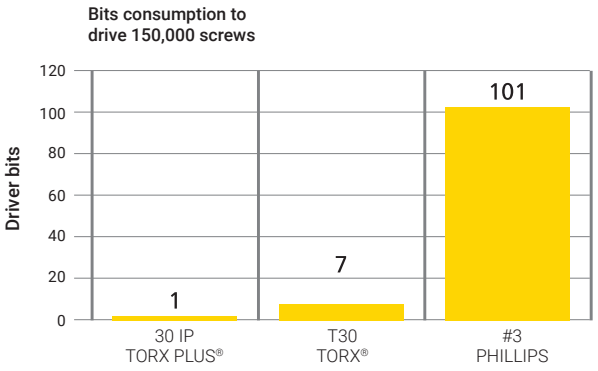
Features

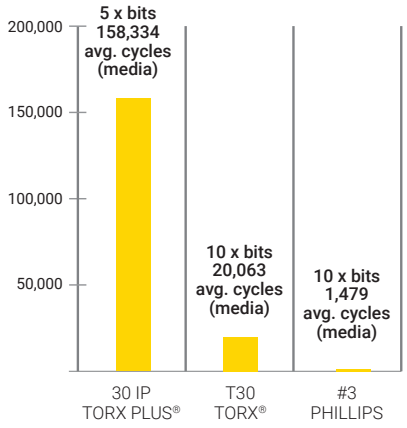
- The **elliptically based geometry** configuration of the TORX PLUS® Drive System maximizes engagement between driver and recess. It spreads driving forces over bigger surface area, improving torque transmission and **extending tool bit life.**
- The straight, vertical sidewalls virtually eliminate cam-out effect:
  - Driver bits offer perfect engagement, thereby reducing the risk of tool slippage and minimizing damage to fastener and surrounding surfaces.
  - The absence of cam-out effect eliminates the need to end-load to keep the driver engaged in the recess, reducing fatigue and muscular stress during manual installation of screws.
- 0° drive angle ensure **optimum torque transmission** and virtually eliminates the **radial stresses to increase tool bit life.**
- Six Lobes with larger cross-sectional areas allow a **faster tool engagement, maximizes torque transfer and increases torsional strength.**



TORX Plus®
0° Drive angle

TORX®
15° Drive angle



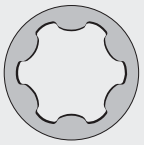


Drive Durability Test Results
Average number of screws driven per drive bit.

Drive durability tests confirm **important cost savings in production and improved productivity** resulting from less bit consumption and reduction of line downtime due to bit replacing and other incidences (rework, rejects due to poor torque transfer).

Screws with TORX PLUS® recess can be driven with TORX® bits. This solution is only recommended in exceptional situations, as the advantages and performance of TORX PLUS® drive will not be effective.

TORX® drive bit in
TORX Plus® recess



TORX Plus® drive bit in
TORX Plus® recess

TORX PLUS® drive sizes

The size of recess will vary based on the diameter of the screw and it can be modified according to the specific requirements of the application or product.

The table below shows the recommended recess size for different thread types

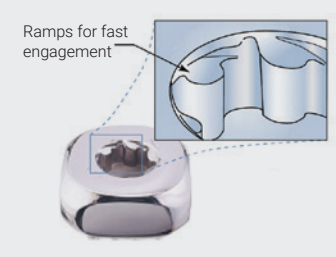
REMFORM® II™ (1) and CELOspArk® product range

Screw diameter												
1.6	**1.8**	**2.0**	**2.3**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**6.0**	**7.0**	**8.0**
5 IP	5 IP	6 IP	7 IP	8 IP	10 IP	15 IP	20 IP	20 IP	25 IP	30 IP	40 IP	40 IP

TAPTITE® (2) and machine screws product range

Screw diameter								
M1.5	**M2**	**M2.5**	**M3**	**M3.5**	**M4**	**M5**	**M6**	**M8**
5 IP	6 IP	8 IP (3)	10 IP	15 IP	20 IP	25 IP	30 IP	40 IP

TORX® recess will follow the same recommendations in all cases.
(1) Includes REMFORM® II™, REMFORM® II HS™ and REMFORM® II F™
(2) Includes TAPTITE 2000®, TAPTITE II®, POWERLOK®, FASTITE®2000™ and EXTRUDE-TITE®
(3) 10 IP for countersunk head



TORX PLUS® AUTOSERT®

TORX PLUS AUTOSERT® includes compound angle ramps that guide the driver bit into the recess, creating a self-centering and engaging action.

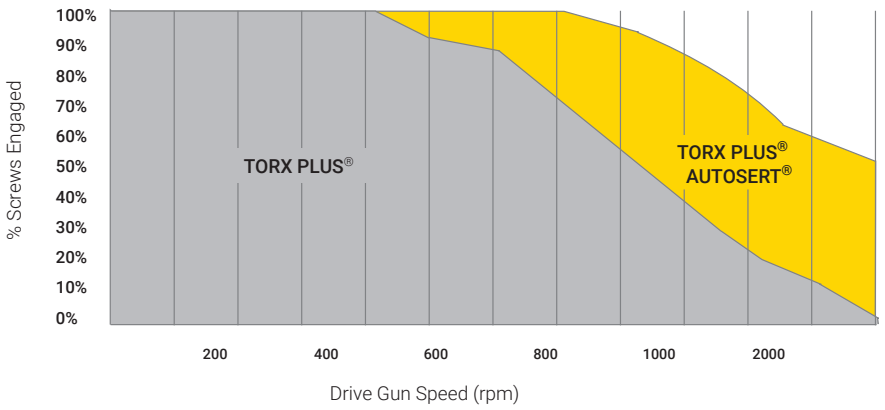
The AUTOSERT® feature is specially recommended for automated, robotic and other assembly situations, where the driver bit is continuously rotating.

Advantages

- **Speed engagement.**
- Allows for **higher rpm engagement,** it's not necessary to slow down assembly line to ensure proper fastening.
- **Reduces assembly time.**

AUTOSERT® technical features allow for a productivity increase in assembly line up to 5% (depending on production rate).

Laboratory testing reveals 100% of screws using AUTOSERT® feature were engaged with TORX PLUS® Drive bits rotating at 700 rpm.



depending on screw diameter and head design:
Screws with TORX PLUS AUTOSERT® recess are assembled with TORX PLUS® bits.

TORX PLUS® drive variations

- **TAMPER-RESISTANT TORX PLUS® drive**
  Tamper-resistant TORX PLUS® recess has five lobes instead of six and a solid post formed in the center of the recess. It's available for screw diameter over M2.5.

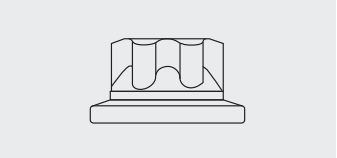
  Tamper-resistant TORX PLUS® bits are under controlled distribution, available only through license screw manufacturers, thus removal is made only by authorized personnel.

  Even destroying the solid post, it's not possible to remove the screw without the special Tamper resistant TORX PLUS® bit.

TORX PLUS® Tamper resistant.

- **EXTERNAL TORX PLUS® DRIVE SYSTEM**
  Designed with the same elliptical configuration than TORX PLUS®, this version allows the highest torque transmission available.

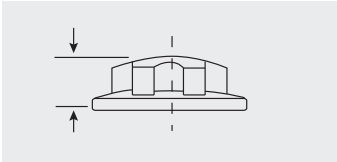
  TORX PLUS® sockets are required for installation and removal, as TORX® sockets are not compatible.



TORX PLUS® External.

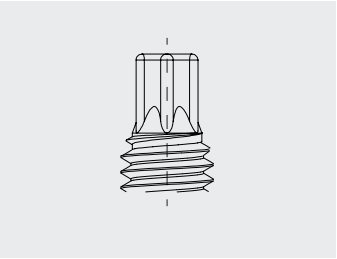
- **EXTERNAL TORX PLUS® low-profile head**
  This version provides higher torque transmission than corresponding internal recesses. Head height similar to pan or indented hex head but lower weight.

  The optimized design minimizes the required space to accommodate head and reduces tool socket wear. It requires special sockets for installation and removal.



TORX PLUS® External Low Profile.

- **TORX PLUS® STEM**
  An external TORX PLUS® configuration, extruded onto one end of the double-end stud, simplifies driving. The improved torsional strength enhances the clamping of the parts.

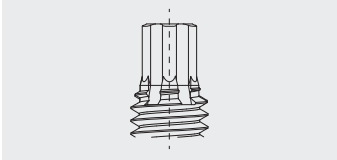


TORX PLUS® STEM.

- **TORX PLUS® MAXX**
  TORX PLUS® MAXX is an improvement of TORX PLUS® STEM which allows for a higher assembly torque.

  This new version eliminates the transition area from the recess to the thread, increasing the breaking torque.

  It requires special sockets for installation and removal.



TORX PLUS® MAXX.

Surface treatment

Fig.48. Measurement of layer thickness by X-rays.

Screws and other fixing elements made of steel and its alloys should have a surface treatment to protect them against corrosion and improve aesthetics. The corrosion resistance is indicated in HSS (Hours Salt Spray).

There are many different surface treatments which corrosion resistance depends not only on the coating type itself but also on the reliability of the process applied. There are many available tests to evaluate their performance: thickness layer, climatic test, adherence test,... These are complementary tests and should be applied and used correctly to avoid wrong conclusions. In all cases, we recommend following the international standards.

Layer Thickness

There are many methods to determine the layer thickness. It will depend basically on the base material, applied and part geometry. For screws and other fixing ferrous elements with complicated geometry (that's small flat surface), the X-rays measurement system is the most widely used for its rate and reliability. In this case, the coating layer must be homogeneous, e.g. Zinc, Nickel and Copper electrolytic coatings.

ISO 4042 standard describes the optimal thickness measurement point and the maximum values recommended according to the screw pitch and thread diameter.

It's commonly thought that the higher the thickness is, the better the corrosion resistance will be. This is not fully correct, as the efficiency depends on other factors like adherence, passivated quality and sealant presence. These parameters can't be evaluated by any thickness measurement technique and should be complemented by the tests described below.

Salt Spray Chamber

Fig.49. White corrosion and red corrosion appearance.

Salt Spray Chamber (SSC) is a climatic test that tries to simulate the worst environmental conditions for a ferrous material, like the marine environment. This test allows for a total quality evaluation of the coating, but its long testing time (from 3 to 48 days depending on the coating) makes it not suitable for the daily quality control.

There are many reference standards like DIN 50.021, ISO 9227 and ATSM B-117, equivalent between them, which describes the chamber test dimensions, the fogging and the salt concentration (5% NaCl). On the other hand, there's no indication about samples distribution neither results evaluation.

The Salt Spray Chamber test evaluates the time (in hours) in which appears white and red corrosion. White corrosion indicates that Zinc oxidation has started. It will continue until Zinc is exhausted and iron oxidation starts when red corrosion appears.
Red corrosion leads to the screw embrittlement and a potential break may occur; therefore, it's very important to prevent its appearance. White corrosion is only relevant in terms of aesthetics issues.

It is important to mention that there's no direct relationship between the hours of resistance in Salt Spray Chamber to the corrosion resistance in real environment. The approximations made are based on environmental data that may be different to the real conditions under which the coating will be exposed.

Accelerated corrosion measurement methods are currently being promoted that consider cyclic changes in the test conditions regarding salinity and temperature (cycle tests).

Fig.50. The test in Salt Spray Chamber are made based on Control Plan.

Electrolytic coating

The electrolytic coating consists in a metallic protective layer deposited on the screw surface by immersion in an aqueous solution. The process is the following: electric current is applied between the negative electrode with the chemical element for the screw's protection (Zn, Ni, Cu, Sn) and the positive electrode in contact with the pieces to coat. The screw is coated by electrolytic exchange.

The chemical element will depend on the coating performance desired: protection against oxidation, conductivity and aesthetics.

For screws and other fixing elements where high corrosion resistance is required, the chemical elements used are Zinc and its alloys Zn-Ni and Zn-Fe. The Zinc layer and its alloys are not enough resistant and requires passivation, which will determine the final corrosion resistance and color.

RoHS and ELV European Directives restrict the use of certain hazardous substances. Initially it was only applied in Automotive and Electronic equipment, but now it is widely applied in other sectors.

During the last years, new sealants have been developed for their application on electrolytic coatings (Zn, Zn-Ni and Zn-Fe) to improve the corrosion resistance. Cr (VI) is the last Chrome oxidation stage and it provides very high corrosion resistance. According to RoHS requirements, Cr (III) is substituting Cr (VI), but it needs sealants to reach the previous corrosion resistance. The aesthetic appearance of Cr (III) coatings in yellow and black finishing is not as good as the obtained with Cr (VI) coatings.

The following table shows the most common electrolytic coating used:

Coating	Thickness (µm)	White corrosion (h)	Red corrosion (h)	ISO 4042 Denomination
Zinc plated Cr (III)	5	24	72	Zn5/An
Zinc plated Cr (III) + sealant	5	48	96	Zn5/An/T2
Black Zinc plated Cr (III) + sealant	10	48	120	Zn10/Fn/T2
Zinc plated Cr (III) + sealant	8	72	144	Zn8/An/T2
Zinc plated Iridiscent Cr (III)	8	72	168	Zn8/Cn
Zinc plated Iridiscent Cr (III) + sealant	8	96	240	Zn8/Cn/T2
Clear Zn-Ni + sealant	8	240	720	ZnNi8/An/T2
Black Zn-Ni + sealant	8	200	720	ZnNi8/Fn/T2
Clear Zn-Ni + sealant high resistance	8	240	960	ZnNi8/An/T7
Black Zn-Ni + sealant high resistance	8	240	960	ZnNi8/Fn/T7

Hydrogen embrittlement

The hydrogenation is the occlusion of hydrogen atoms in the metallic structure of the steel during electrolytic coating, causing microscopic cracks and loose of ductility or ability to undergo significant plastic deformation before rupture. When a high assembly torque is applied or the screw is under high loads, the hydrogen atom can move through the screw core, creating internal tensions and causing break of the screw. This is known as hydrogen embrittlement and it could be detected as the screw head is broken some hours after the assembly.

To reduce the hydrogen embrittlement risk, a tension relieving heat treatment is applied to the parts. This process is known as baking.

The hydrogen embrittlement affects to high hardness screws, so the standard ISO 4042 recommends applying baking process on all screws with hardness over 360HV.
The Standard ISO 4042 establishes that, even applying a baking process, it is not possible to guarantee the complete elimination of hydrogen embrittlement risk. If further reduced probability is desired it is needed alternative procedures.

At CELO, baking process is applied to the following families of screws

- TAPTITE 2000®, TAPTITE II®, FASTITE® 2000™, POWERLOK®, EXTRUDE-TITE®
- REMFORM® II™, REMFORM® II HS™, REMFORM® II F™
- IBI-ZAS
- PLASTITE®
- Screws Class 8.8, 10.9 and 12.9
- CELOspArk® and self-tapping screws under customer demand

Organic coating. Zinc-Aluminum flake coating

Organic coating made of Zinc and aluminum flakes in solvent based dispersion. It can be applied by dipping or spraying, depending on the size of the parts, and requires post curing with high temperature.

Zinc Flake organic coating offers high performance corrosion protection and long durability on the screws, without risk of hydrogen embrittlement.

At CELO, the organic coating is applied in a non-electrolytic dip-spin. It is recommended to apply a minimum of two layers to guarantee a uniform protective layer.
The polymerization takes place in the oven at 200°C. The final thickness of the coating and the number of layers, is limited by the screw diameter, or, to be more exact, by the thread pitch. The Standard ISO 10683 specifies the maximum thickness for ISO machine threads according to their tolerance.

The combination of different bases and topcoats enables it customization for specific requirements: corrosion resistance improvement, specific color or friction coefficient with integrated lubricants or applied over the base coat.

We can produce in many different colors. Grey, black and blue colors are the most widely used.

The Base Coat, in grey color provides the real corrosion protection. Top Coat can be in many different colors. Grey, black and blue colors are the most widely used.
The application process is the same for both coats. Black, blue or other colors need from one to two grey layers, resulting in 4 to 5 layers application.

The higher the number of layers is, the higher the probability to block the thread and the recess. The color and high corrosion resistance application requirement can affect the thread performance.

The organic coating accomplishes ELV and RoHS European Environmental Directives. It's free of Cr VI and heavy metals like Cadmium, Lead and Mercury.

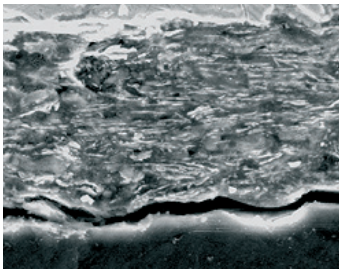


Fig.51. Microscopic capture of Zn - Al lamella.

Advantages:

- **Excellent corrosion resistance.** Multiple Zn-Al lamellar flakes provide excellent corrosion resistance. The high Zinc content provides galvanic protection, which is maintained up to 200° C.
- **Good bimetallic corrosion resistance** thanks to the high aluminum content.
- **No risk of hydrogen embrittlement.** Zn-Al flake coated products don't have a risk of hydrogen embrittlement as it is not an electrolytic process.
- **Solvent resistance.** Once fully cured, Zn-Al flake coating is resistant to solvents, fuel and brake fluids.

CELOsmart®

CELO Inspection System for automated assembly lines.

The screw is one of the smallest components included in our customer's products, and normally considered as C-parts. However, without a doubt, the quality of these small components is essential to achieve the maximum efficiency of the assembly line and guarantee the functionality of the ultimate product along its lifespan.

Additionally, the progress of our customers towards automation requires more precise, reliable and "zero defect" parts that allow effective installation in fully automated assembly lines.

CELOsmart® process begins at the application design stage. CELO application engineers, in cooperation with our customers, define the screw geometry and tolerances to reduce down-times and ensure the maximum productivity in the automated assembly lines.

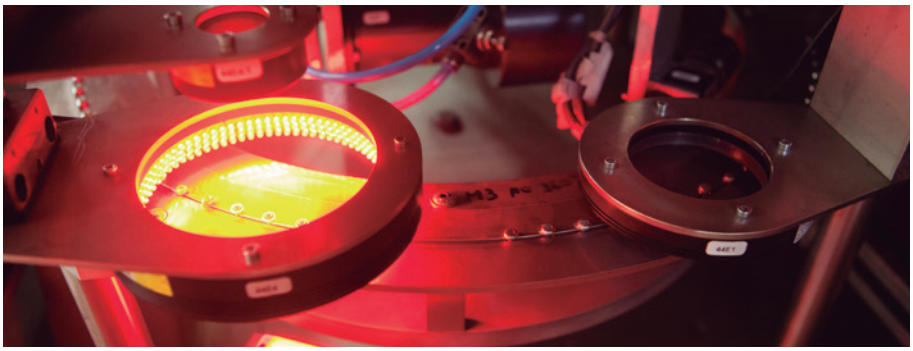
The relevant characteristics of every single part are identified, monitored and registered along the production stages according to the Control Plan. In order to maintain each process capabilities and to consistently reduce the number of non-conformity pieces, we have incorporated quality control systems in all production processes:

- Process Monitoring modules in Cold-Forming and Thread forming machines
- Controls for dimensional verification
- Statistical Process Control (SPC)
- Controls for Heat treatment process conditions
- Process control and thickness measurement for Surface treatment stage

The last stage of CELOsmart® process is the inspection on 100% of production batches to minimize the number of non-conformity pieces.

CELOsmart® process includes different inspection methods that ensure a high-quality level of our products to achieve the best performance in automated lines. Depending on our customer installation requirements, the parts are inspected in Laser, Eddy current, optical or mechanical sorting lines.

These sorting processes are considered under special demand. For further information and quotation, please contact our sales department.



Optical and laser sorting

CELO

CELOsmart®

Smart sorting
Automated assemblies

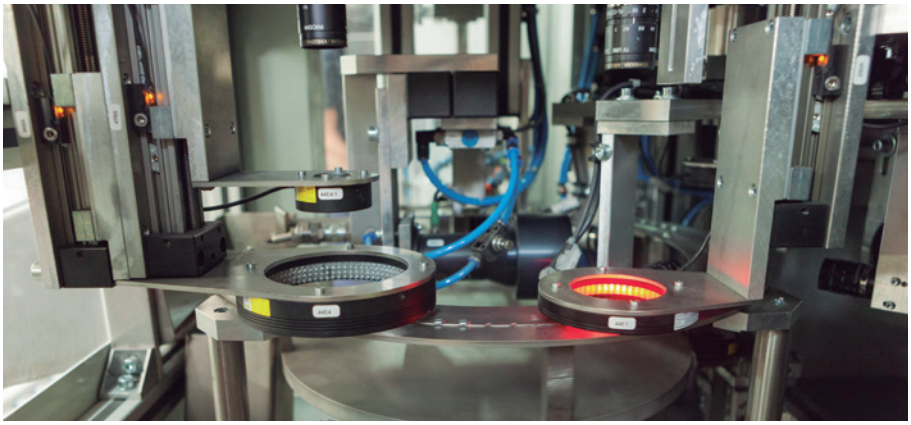
We have implemented in our facilities the latest state-of-the-art technology in optical and 3D laser inspection technology on 100% of our production batches, which allow us 360º detection of any faults at the head, recess, shank or thread dimensions. Thanks to our inspection system, we can guarantee the conformity of the pieces within the control parameters established according to our customer requirements.

Our optical sorting machines have different number of cameras that allow a better inspection according to the complexity of the part and the features to control.
In order to achieve a more effective sorting, it is very important to limit the number of features to inspect, these features are specified in the drawing.

Eddy current technique provides metallurgical inspection of the part, which means an opportunity to detect the most critical metallurgical defects by a visual deviation in the magnetic display.

The concept "zero defect" is the objective, but it doesn't mean 0 ppm*. According to Standard UNE-EN ISO 16426, after automatic inspection process (optical or laser) there is still an average remaining level of non-conformities of about 10ppm for each single specified characteristic.

*parts per million, is the number of defective parts accepted per 1,000,000 parts inspected.



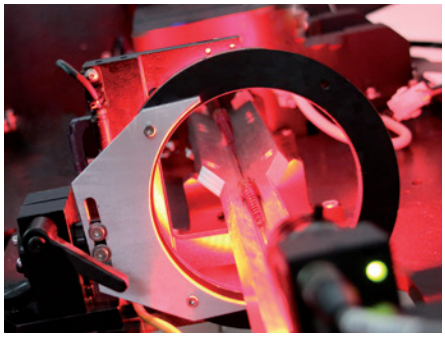


Fig.52. Detail of laser sorting machine.

Fig.53. Register control screen.

CELO

CELOsmart®

Mechanical sorting
Automated assemblies

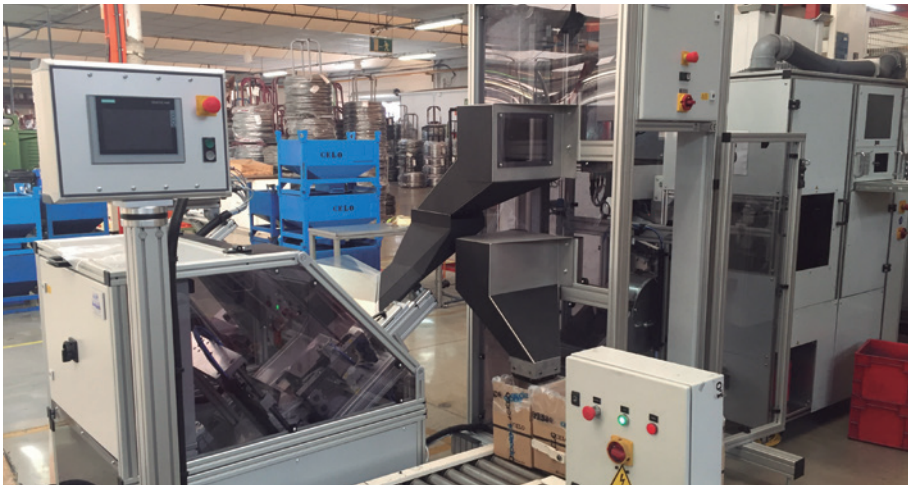
Mechanical sorting

Mechanical sorting is a verification process that allows us to detect problems of mixing or contamination of screws that may occur at any step of the production process, as well as any difference in the head diameter.

Packaging

To avoid contamination once the batch has been sorted, our sorting lines have the packaging process included immediately after and in-line the sorting process.

The packaging process in the sorting lines includes the option of plastic bags (optionally, antistatic). We recommend this option as an alternative to cardboard boxes for electronic products manufacturing plants.



Licenses and patents

CELO manufacturing plants in the United States, Spain and China are licensed suppliers for:

- Products licensed by REMINC/CONTI Fasteners AG:
  REMFORM® II HS™, REMFORM® II™, REMFORM® II F™, PLASTITE® 60,
  PLASTITE® 48-2, PLASTITE® 45, PUSTITE® II™, TAPTITE II® , TAPTITE 2000®,
  TAPTITE 2000® SP™, TAPTITE 2000® CA™, FASTITE® 2000™, EXTRUDE-TITE®,
  POWERLOK®, KLEERTITE®, KLEERLOK®

- MAThread® point is a product registered by Mathread Inc.

- Products registered by Acument Intellectual Properties, LLC:
  TORX®, TORX PLUS®, AUTOSERT®, TORX PLUS® STEM, TORX PLUS® MAXX

All the procedures used in the manufacturing of these products comply with the licensee specifications.

CELOspArk®, CELOSTAMP® y CELOsmart® are products licensed by CELO.

Packaging of products in stock

The screw references available in stock are packed in plastic bags.
The quantity per bag will depend on the dimensions and weight of the screw.

The screw reference and production batch number are printed on the bag label, allowing for a perfect traceability of the pieces.

The screw references under special production, the packaging will depend on the conditions agreed and confirmed in purchase order. The quantity per box and its dimensions will depend on the dimensions and weight of the screw.

For additional information, please contact our sales department.

References: SP81T, SP81Z, SP82T, SP82Z, HS81PA, HS82PA, F281PA

L (mm)	Screw diameter (mm)								
	1.8	2.0 - 2.3	2.5	3.0	3.5	4.0	4.5	5.0	6.0
6	●	●	●	●	●				
8	●	●	●	●	●	○			
10	●	●	●	●	●	○			
12	●	●	●	●	○	○	+	+	
13	●	●	●	●	○	○	+	+	
14	●	●	●	○	○	○	+	+	
16	●	●	●	○	○	○	+	+	◊
18	○	○	○	○	○	+	+	+	◊
20	○	○	○	○	○	+	+	+	◊
22						+	+	–	◊
25						+	+	–	◊
30						–	–	–	◊
35						–	–	◊	◊
40							◊	◊	◊
50							◊	◊	◊

● 5,000 PCS / ○ 2,500 PCS / + 1,250 PCS / – 1,000 PCS / ◊ 500 PCS

References: SP87T, SP87Z, TP88Z, HS87PA, F287PA

L (mm)	Screw diameter (mm)						
	2.0 - 2.3	2.5	3.0	3.5	4.0	4.5	5.0
6	●	●	●				
8	●	●	●	●			
10	●	●	●	●	○		
12	●	●	●	○	○	○	
14	●	●	●	○	○	○	
16	●	●	●	○	+	+	–
18	●	●	○	○	+	+	–
20	●	●	○	+	+	+	–
22			○	+	+	+	–
25			○	+	+	+	–
30				+	+	+	◊
35				+	+	+	◊
40				+	+	+	◊
50				+	+	+	◊

● 5,000 PCS / ○ 2,500 PCS / + 1,250 PCS / – 1,000 PCS / ◊ 500 PCS

References: TT85T, TT85Z, TT65T, TT65Z, TT12, TT78, TT22T, NT85T, PL78T, FT85T, FT85Z, EX85T, PG, FTA85Z

L (mm)	Screw diameter (mm)						
	2.0	2.5	3.0	4.0	5.0	6.0	8.0
3	●	●	●	●			
4	●	●	●	●			
5	●	●	●	●			
6	●	●	●	○	○		
7	●	●	●	○	○		
8	●	●	●	○	+	+	
10	●	●	●	○	+	+	
12	●	●	●	○	+	–	
15	●	●	●	○	+	–	◊
16	●	●	●	○	+	–	#
18	●	●	○	○	+	◊	#
20	●	●	○	+	–	◊	#
22			○	+	–	◊	#
25			○	+	–	◊	#
28			○	–	–	◊	#
30			○	–	–	◊	#
35			○	–	◊	◊	#

● 5,000 PCS / ○ 2,500 PCS / + 1,250 PCS / – 1,000 PCS / ◊ 500 PCS / # 250 PCS

Small Things Matter

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