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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-16/0617 of 2018/03/26

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	SPAX double thread self-tapping screws
Product family to which the above construction product belongs:	Screws for use in timber constructions
Manufacturer:	SPAX International GmbH & Co. KG Kölner Strasse 71-77 DE-58256 Ennepetal Tel. +49 23 33 799-0 Fax + 49 23 33 799-199 Internet www.spax.com
Manufacturing plant:	SPAX International GmbH & Co. KG Kölner Strasse 71-77 DE-58256 Ennepetal
This European Technical Assessment contains:	23 pages including 3 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	European Assessment document (EAD) no. EAD 130118-00-0603 “Screws for timber constructions”
This version replaces:	The ETA with the same number issued on 2016-08-19

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product
SPAX double thread screws are self-tapping screws to be used in timber structures. They shall be threaded over two parts of the length, one part at the screw tip and a second part at the screw head with a smooth shank in between. The screws shall be produced from carbon steel wire for nominal diameters of 8,0 mm to 10,0 mm or from stainless steel wire for a nominal diameter of 8,0 mm. Where corrosion protection is required, the material or coating shall be declared in accordance with the relevant specification given in Annex A of EN 14592.

Geometry and Material
The nominal diameter (outer thread diameter), d, of SPAX double thread screws shall not be less than 8,0 mm and shall not be greater than 10,0 mm. The overall length of the screws, ℓ, shall not be less than 100 mm and shall not be greater than 500 mm. Other dimensions are given in Annex A.

The ratio of inner thread diameter to outer thread diameter d_i/d ranges from 0,6 to 0,7.

The screws are threaded over a minimum length ℓ_g of 18 mm under the head and 4·d at the screw tip.

The lead p (distance between two adjacent thread flanks) ranges from 0,44·d to 0,60·d.

No breaking shall be observed at a bend angle, α, of less than $(45/d^{0,7} + 20)$ degrees.

2 Specification of the intended use in accordance with the applicable EAD

The screws are used for connections in load bearing timber structures between members of solid timber (softwood), glued laminated timber (softwood), cross-laminated timber, and laminated veneer lumber, similar glued members, wood-based panels or steel. The screws are also used for connections in load bearing members of solid timber (hardwood) or glued laminated timber (hardwood).

Furthermore SPAX double thread screws may also be used for the fixing of thermal insulation material on rafters.

Steel plates and wood-based panels except solid wood panels, laminated veneer lumber and cross laminated timber shall only be located on the side of the screw head. The following wood-based panels may be used:

- Plywood according to EN 636 or ETA
- Particleboard according to EN 312 or ETA
- Oriented Strand Board according to EN 300 or ETA
- Fibreboard according to EN 622-2 and 622-3 or ETA (minimum density 650 kg/m³)
- Cement bonded particleboard according to ETA
- Solid wood panels according to EN 13353 and EN 13986 and cross laminated timber according to ETA
- Laminated Veneer Lumber according to EN 14374 or ETA
- Engineered wood products according to ETA; if the ETA of the product includes provisions for the use of self-tapping screws, the provisions of the ETA of the engineered wood product apply

The screws are intended to be used in timber connections for which requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation 305/2011 (EU) shall be fulfilled.

The design of the connections shall be based on the characteristic load-carrying capacities of the screws. The design capacities shall be derived from the characteristic capacities in accordance with Eurocode 5 or an appropriate national code.

The screws are intended for use for connections subject to static or quasi static loading.

The zinc-coated screws are for use in timber structures subject to the dry, internal conditions defined by the service classes 1 and 2 of EN 1995-1-1:2010 (Eurocode 5).

The scope of the screws regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions. Section 3.11 of this ETA contains the corrosion protection for SPAX double thread screws made from carbon steel and the material specification for screws made from stainless steel.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the screws of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic	
3.1 Mechanical resistance and stability*) (BWR1)		
Tensile strength Screws made of carbon steel	Characteristic value $f_{tens,k}$: d = 8,0 mm: d = 8,2 mm: d = 9,0 mm: d = 10,0 mm:	 20 kN 20 kN 25 kN 36 kN
Screws made of stainless steel	Characteristic value $f_{tens,k}$: d = 8,0 mm:	 17 kN
Insertion moment	Ratio of the characteristic torsional strength to the mean insertion moment: $f_{tor,k} / R_{tor,mean} \geq 1,5$	
Torsional strength Screws made of carbon steel	Characteristic value $f_{tor,k}$: d = 8,0 mm: d = 8,2 mm: d = 9,0 mm: d = 10,0 mm:	 25 Nm 25 Nm 32 Nm 40 Nm
Screws made of carbon steel	Characteristic value $f_{tor,k}$: d = 8,0 mm:	 17 Nm
3.2 Safety in case of fire (BWR2)		
Reaction to fire	The screws are made from steel classified as performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC decision 96/603/EC, amended by EC Decision 2000/605/EC.	
3.3 Hygiene, health and the environment (BWR3) Influence on air quality	The product does not contain/release dangerous substances specified in TR 034, dated October 2015 *	
3.7 Sustainable use of natural resources (BWR7)	No Performance Determined	
3.8 General aspects related to the performance of the product	The screws have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service classes 1, 2 and 3	
Identification	See Annex A	

*) See additional information in section 3.9 – 3.12.

In addition to the specific clauses relating to dangerous substances contained in this European technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

3.9 Mechanical resistance and stability

The load-carrying capacities for SPAX double thread screws are applicable to the wood-based materials mentioned in paragraph 1 even though the term timber has been used in the following.

The characteristic lateral load-carrying capacities and the characteristic axial withdrawal capacities of SPAX double thread screws should be used for designs in accordance with Eurocode 5 or an appropriate national code.

Point side penetration length must be $\ell_{ef} \geq 4 \cdot d$, where d is the outer thread diameter of the screw. For the fixing of thermal insulation material on top of rafters, point side penetration must be at least 40 mm, $\ell_{ef} \geq 40$ mm.

European Technical Approvals for structural members or wood-based panels must be considered where applicable.

Reductions in the cross-sectional area caused by SPAX double thread screws with a diameter of 10 mm shall be taken into account in the member strength verification both, in the tensile and compressive area of members.

For screws in pre-drilled holes, the drill hole diameter should be considered in the member strength verification, for screws driven without pre-drilling, the inner thread diameter.

Lateral load-carrying capacity

The characteristic lateral load-carrying capacity of SPAX double thread screws shall be calculated according to EN 1995-1-1 (Eurocode 5) using the outer thread diameter d as the nominal diameter of the screw. The contribution from the rope effect may be considered.

The characteristic yield moment shall be calculated from:

SPAX double thread screws made of carbon steel:

d = 8,0 mm: $M_{y,k} = 20000$ [Nmm]
d = 8,2 mm: $M_{y,k} = 20000$ [Nmm]
d = 9,0 mm: $M_{y,k} = 25000$ [Nmm]
d = 10,0 mm: $M_{y,k} = 35000$ [Nmm]

SPAX double thread screws made of stainless steel:

d = 8,0 mm: $M_{y,k} = 13400$ [Nmm]

where
d outer thread diameter [mm]

The embedding strength for screws in non-pre-drilled holes arranged at an angle between screw axis and grain direction, $0° \leq \alpha \leq 90°$ is:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot d^{-0,3}}{2,5 \cdot \cos^2 \alpha + \sin^2 \alpha} \quad \text{[MPa]}$$

for screws in pre-drilled holes:

$$f_{h,k} = \frac{0,082 \cdot \rho_k \cdot (1 - 0,01 \cdot d)}{2,5 \cdot \cos^2 \alpha + \sin^2 \alpha} \quad \text{[MPa]}$$

Where
ρ_k characteristic timber density [kg/m³];
d outer thread diameter [mm];
α angle between screw axis and grain direction.

The embedding strength for screws arranged parallel to the plane of cross laminated timber, independent of the angle between screw axis and grain direction, $0° \leq \alpha \leq 90°$, shall be calculated from:

$$f_{h,k} = 20 \cdot d^{-0,5}$$

[N/mm²]

unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber.

Where
d outer thread diameter [mm]

The embedding strength for screws in the plane surface of cross laminated timber should be assumed as for solid timber based on the characteristic density of the outer layer.

The direction of the lateral force shall be perpendicular to the screw axis and parallel to the plane surface of the cross laminated timber.

For laterally loaded screws, the rules for multiple fastener connections in EN 1995-1-1, 8.3.1.1 (8) should be applied.

Bending angle

A minimum plastic bending angle of $45°/d^{0,7} + 20°$ was reached without breaking the screws.

Axial withdrawal capacity

The characteristic axial withdrawal capacity of SPAX screws at an angle of $15° \leq \alpha \leq 90°$ to the grain in solid timber (softwood and hardwood with a maximum characteristic density of 590 kg/m³), glued laminated timber and cross-laminated timber members or at an angle of $30° \leq \alpha \leq 90°$ to the grain in laminated veneer lumber members shall be calculated according to EN 1995-1-1:2008 from:

$$F_{ax,\alpha,Rk} = \frac{n_{ef} \cdot f_{ax,k} \cdot d \cdot \ell_{ef}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \quad [N]$$

Where

$F_{ax,\alpha,RK}$	characteristic withdrawal capacity of the screw at an angle α to the grain [N]
n_{ef}	effective number of screws according to EN 1995-1-1:2008
$f_{ax,k}$	Characteristic withdrawal parameter d = 8,0 mm: $f_{ax,k}$ = 12,0 N/mm² 8,0 mm < d ≤ 10,0 mm: $f_{ax,k}$ = 11,0 N/mm²
d	outer thread diameter [mm]
ℓ_{ef}	Penetration length of the threaded part according to EN 1995-1-1:2008 [mm]
α	Angle between grain and screw axis (α ≥ 15°)
ρ_k	Characteristic density [kg/m³]

For screws penetrating more than one layer of cross laminated timber, the different layers may be taken into account proportionally.

The axial withdrawal capacity is limited by the head pull-through capacity and the tensile or compressive capacity of the screw or threaded rod.

For axially loaded screws in tension, where the external force is parallel to the screw axes, the rules in EN 1995-1-1, 8.7.2 (8) should be applied.

For inclined screws in timber-to-timber or steel-to-timber shear connections, where the screws are arranged under an angle 30° ≤ α ≤ 60° between the shear plane and the screw axis, the effective number of screws n_{ef} should be determined as follows:

For one row of n screws parallel to the load, the load-carrying capacity should be calculated using the effective number of fasteners n_{ef}, where

$$n_{ef} = \max\left\{n^{0,9}\,;\,0,9 \cdot n\right\}$$

and n is the number of inclined screws in a row. If crossed pairs of screws are used in timber-to-timber connections, n is the number of crossed pairs of screws in a row.

Note: For screws as fasteners in mechanically jointed beams or columns or for the fixing of thermal insulation material, n_{ef} = n.

Head pull-through capacity

The characteristic head pull-through capacity of SPAX double thread screws shall be calculated according to EN 1995-1-1 from:

$$F_{ax,\alpha,Rk} = n_{ef} \cdot f_{head,k} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \quad [N]$$

where:

$F_{ax,\alpha,RK}$	Characteristic head pull-through capacity of the connection at an angle α ≥ 30° to the grain [N]
n_{ef}	Effective number of screws according to EN 1995-1-1:2008 For inclined screws: $n_{ef} = \max\left\{n^{0,9}\,;\,0,9 \cdot n\right\}$ (see axial withdrawal capacity)
$f_{head,k}$	Characteristic head pull-through parameter [N/mm²]
d_h	Diameter of the screw head or the washer [mm]. Outer diameter of heads or washers d_h > 32 mm shall only be considered with a nominal diameter of 32 mm.
ρ_k	Characteristic density [kg/m³], for wood-based panels ρ_k = 380 kg/m³

Characteristic head pull-through parameter for SPAX screws with second thread under the head in connections with timber and in connections with wood-based panels with thicknesses above 20 mm:

d_h ≤ 16 mm: $f_{head,k}$ = 29,0 - d_h [N/mm²]

16 mm < d_h ≤ 22 mm: $f_{head,k}$ = 13,0 [N/mm²]

22 mm < d_h ≤ 32 mm: $f_{head,k}$ = 16,0 - 0,5·(d_h - 16) [N/mm²]

Where

d_h head or washer diameter [mm]

Characteristic head pull-through parameter for screws in connections with wood-based panels with thicknesses between 12 mm and 20 mm:

$f_{head,k}$ = 8 N/mm²

Screws in connections with wood-based panels with a thickness below 12 mm (minimum thickness of the wood based panels of 1,2·d with d as outer thread diameter):

$f_{head,k}$ = 8 N/mm²

limited to $F_{ax,Rk}$ = 400 N

For SPAX double thread screws, the withdrawal capacity of the thread in the member with the screw head may be taken into account instead of the head pull-through capacity, if the head thread length is at least 4·d.

The minimum thickness of wood-based panels according to the clause 2.1 must be observed.

In steel-to-timber connections the head pull-through capacity is not governing.

Tensile capacity
The characteristic tensile capacity $f_{tens,k}$ of SPAX double thread screws made of carbon steel is:

d = 8,0 mm:	20 kN
d = 8,2 mm:	20 kN
d = 9,0 mm:	25 kN
d = 10,0 mm:	35 kN

The characteristic tensile capacity $f_{tens,k}$ of SPAX double thread screws made of stainless steel is:

d = 8,0 mm:	17 kN

The tear-off capacity of the screw head is greater than the tensile capacity of the screw.

Combined laterally and axially loaded screws
For screws subjected to a combination of axial and lateral load, the following expression should be satisfied:

$$\left(\frac{F_{ax,Ed}}{F_{ax,Rd}}\right)^2 + \left(\frac{F_{la,Ed}}{F_{la,Rd}}\right)^2 \leq 1$$

where
$F_{ax,Ed}$ axial design load of the screw
$F_{la,Ed}$ lateral design load of the screw
$F_{ax,Rd}$ design load-carrying capacity of an axially loaded screw
$F_{la,Rd}$ design load-carrying capacity of a laterally loaded screw

Thermal insulation material on top of rafters
See annex C.

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1, 2 and 3.
The SPAX double thread screws are produced from carbon wire. They are brass-plated, nickel-plated bronze finished or electro-galvanised and e.g. yellow or blue chromated with thicknesses of the zinc coating from 4 – 16 µm or have a zinc flake coating with thicknesses from 10 – 20 µm.
Steel no. 1.4016, 1.4401, 1.4567, 1.4578, 1.4529 and 1.4539 is used for screws made from stainless steel.

3.12 General aspects related to the intended use of the product

The screws are manufactured in accordance with the provisions of the European Technical Assessment using the automated manufacturing process as identified during the inspection of the plant by the assessment body issuing the ETA and the notified body and laid down in the technical documentation.

The screws are used for connections in load bearing members of solid timber (softwood), glued laminated timber (softwood), cross-laminated timber, and laminated veneer lumber, similar glued members, wood-based panels or steel members. The screws are also used for connections in load bearing members of solid timber (hardwood) or glued laminated timber (hardwood).

The screws may be used for connections in load bearing timber structures with structural members according to an associated ETA, if according to the associated ETA of the structural member a connection in load bearing timber structures with screws according to a ETA is allowed.

The screws may also be used for the fixing of thermal insulation material on top of rafters.

A minimum of two screws should be used for connections in load bearing timber structures. This does not apply for situations specified in National Annexes to EN 1995-1-1.

The minimum penetration depth in structural members made of solid, glued or cross-laminated timber is 4·d.

Wood-based panels and steel plates should only be arranged on the side of the screw head. The minimum thickness of wood-based panels should be 1,2·d. Furthermore, the minimum thickness for following wood-based panels should be:

- Plywood, Fibreboards: 6 mm
- Particleboards, OSB, Cement Particleboards: 8 mm
- Solid wood panels: 12 mm

For structural members according to ETA's the terms of the ETA's must be considered.

If screws with an outer thread diameter $d \geq 8$ mm are used in load bearing timber structures, the structural solid or glued laminated timber, laminated veneer lumber and similar glued members must be from spruce, pine or fir. This does not apply for screws in pre-drilled holes.

The minimum angle between the screw axis and the grain direction is $\alpha = 15°$.

The screws shall be driven into softwood without pre-drilling or after pre-drilling. The screws shall be driven into hardwood with a maximum characteristic density of 590 kg/m³. The drill hole diameters are:

Outer thread diameter	Drill hole diameter	
	Softwood	Hardwood
8,0	5,0	6,0
8,2	5,0	6,0
9,0	6,0	7,0
10,0	7,0	8,0

The hole diameter in steel members must be predrilled with a suitable diameter.

Only the equipment prescribed by SPAX GmbH & Co. KG shall be used for driving the screws.

In connections with screws with countersunk head according to Annex A the head must be flush with the surface of the connected structural member. A deeper countersink is not allowed.

Unless otherwise specified, minimum thickness for non-predrilled structural members is t = 30 mm for screws with outer thread diameter d = 8 mm or d = 8,2 mm, t = 40 mm for screws with outer thread diameter d = 9 mm or d = 10 mm.

For structural timber members, minimum spacing and distances for screws in predrilled holes are given in EN 1995-1-1 (Eurocode 5) clause 8.3.1.2 and table 8.2 as for nails in predrilled holes. These minimum spacing and distances also apply for SPAX screws with CUT or 4CUT drill tip in non-predrilled holes. Here, the outer thread diameter d must be considered. For SPAX screws with CUT or 4CUT drill tip in non-predrilled holes the following conditions shall be fulfilled:

- $a_1 \geq 5 \cdot d$
- $a_{3,c} \geq 12 \cdot d$
- $a_{3,t} \geq 12 \cdot d$
- minimum cross-section ≥ 40 d²
- screws with CUT drill tip:
  $t_{min} = \max\{5 \cdot d ; 20 \text{ mm}\}$ for d ≤ 6 mm,
  $t_{min} = 7 \cdot d$ for d ≥ 8 mm
- screws with 4CUT drill tip:
  $t_{min} = \max\{6 \cdot d ; 20 \text{ mm}\}$ for d ≤ 6 mm,
  $t_{min} = 7 \cdot d$ for d ≥ 8 mm

For SPAX screws not fulfilling the above conditions or for screws in laminated veneer lumber, minimum spacing and distances are given in EN 1995-1-1 clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes.

Alternatively, minimum distances and spacing for exclusively axially loaded SPAX screws with CUT or 4CUT drill tip in non-predrilled holes in members of solid timber, glued laminated timber or similar glued products with a minimum thickness t = 12·d may be taken as:

Spacing a_1 parallel to the grain $a_1 = 5 \cdot d$
Spacing a_2 perpendicular to the grain $a_2 = 5 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the end grain $a_{3,c} = 5 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the edge $a_{4,c} = 4 \cdot d$

Distance $a_{4,c}$ from centre of the screw-part in timber to the edge for screws with CUT or 4CUT drill tip only $a_{4,c} = 3 \cdot d$

Spacing a_2 perpendicular to the grain may be reduced from 5·d to 2,5·d, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

Alternatively, minimum distances and spacing for exclusively axially loaded SPAX screws in laminated veneer members with a minimum thickness t = 6 ·d may be taken as:

Spacing a_1 parallel to the grain $a_1 = 5 \cdot d$
Spacing a_2 perpendicular to the grain $a_2 = 5 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the end grain $a_{3,c} = 5 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the edge $a_{4,c} = 3 \cdot d$

Spacing a_2 perpendicular to the grain may be reduced from 5·d to 2,5·d, if the condition $a_1 \cdot a_2 \geq 25 \cdot d^2$ is fulfilled.

For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.

Minimum distances from loaded or unloaded ends must be 15·d for screws in non-predrilled holes with outer thread diameter d ≥ 8 mm and timber thickness t < 5·d.

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to 3·d also for timber thickness t < 5·d, if the spacing parallel to the grain and the end distance is at least 25·d.

Unless specified otherwise in the technical specification (ETA or hEN) of cross laminated timber, minimum distances and spacing for screws in the plane surface of cross laminated timber members with a minimum thickness $t_{CLT} = 10 \cdot d$ may be taken as (see Annex B):
Spacing a_1 parallel to the grain $a_1 = 4 \cdot d$
Spacing a_2 perpendicular to the grain $a_2 = 2{,}5 \cdot d$

Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end grain $a_{3,c} = 6 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end grain $a_{3,t} = 6 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge $a_{4,c} = 2{,}5 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge $a_{4,t} = 6 \cdot d$

Unless specified otherwise in the technical specification (ETA or hEN) of cross laminated timber, minimum distances and spacing for screws in the edge surface of cross laminated timber members with a minimum thickness $t_{CLT} = 10 \cdot d$ and a minimum penetration depth perpendicular to the edge surface of 10·d may be taken as (see Annex B):

Spacing a_1 parallel to the CLT plane $a_1 = 10 \cdot d$
Spacing a_2 perpendicular to the CLT plane $a_2 = 4 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end $a_{3,c} = 7 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end $a_{3,t} = 12 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge $a_{4,c} = 3 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge $a_{4,t} = 6 \cdot d$

For SPAX screws in predrilled holes the above requirements for minimum thickness do not apply.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/176/EC of the European Commission, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 3.

5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking

Issued in Copenhagen on 2018-03-26 by

Thomas Bruun
Managing Director, ETA-Danmark

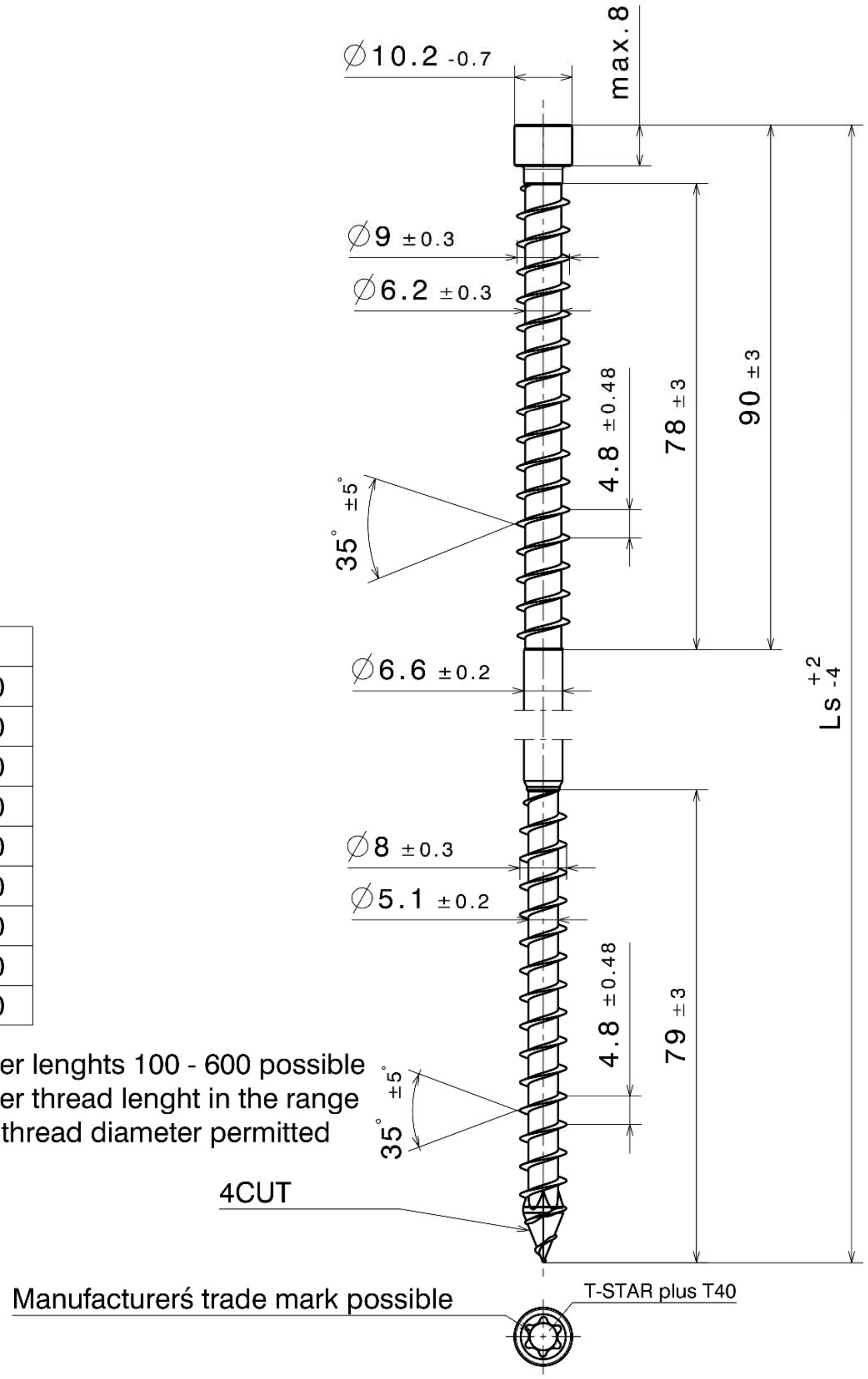
Annex A
Drawings of SPAX double thread screws

SPAX®

Self - tapping cylindric head screw with fixing thread

Material: Cold rolled wire according to SPAX - Factory Standard
Screw of high-carbon steel

Ls
210
230
250
270
300
330
360
400
500

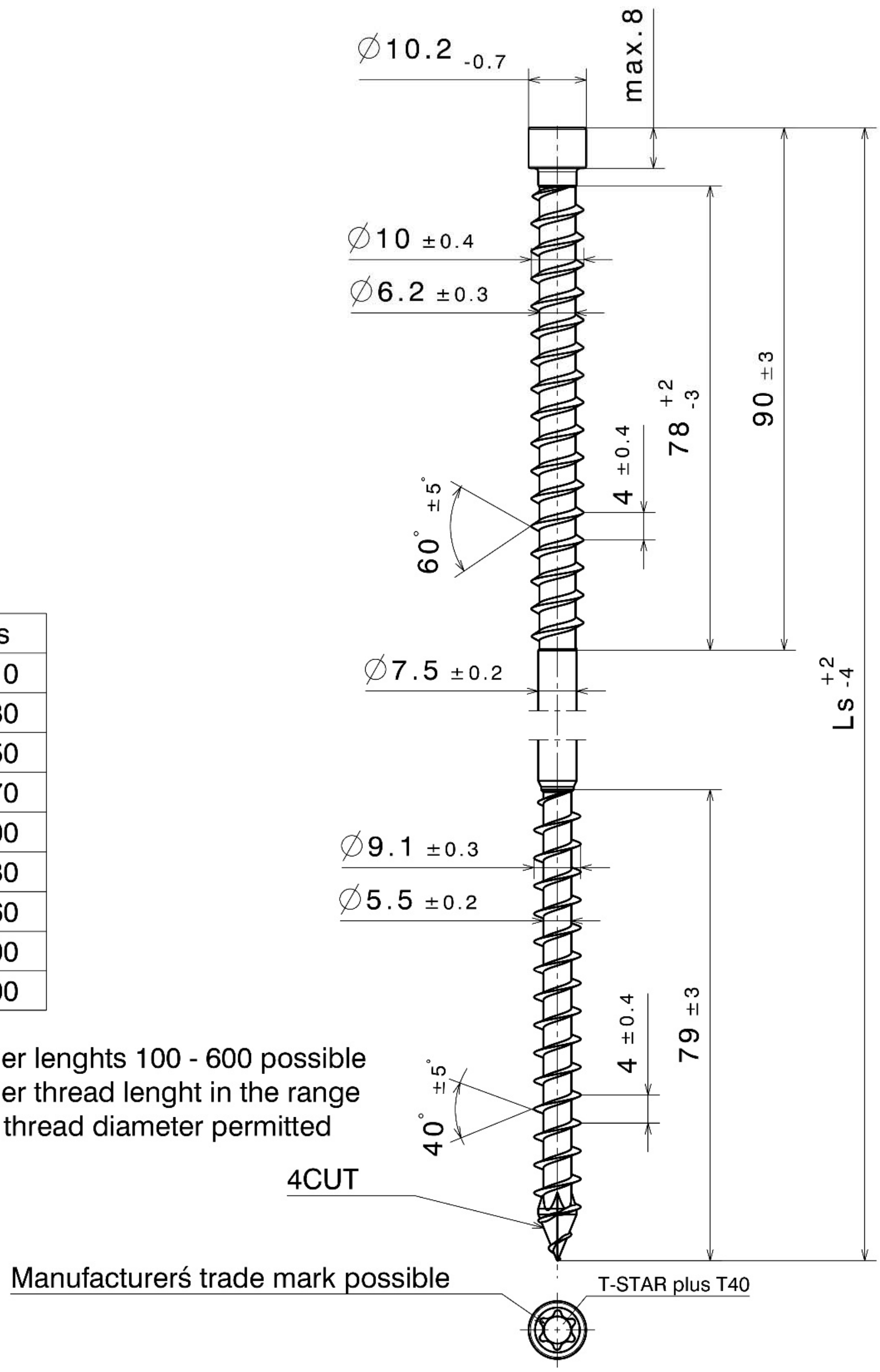


- Other lenghts 100 - 600 possible
- Other thread lenght in the range ≥ 4x thread diameter permitted

SPAX®	Self - tapping cylindric head screw with fixing thread
	Material: Cold rolled wire according to SPAX - Factory Standard Screw of high-carbon steel

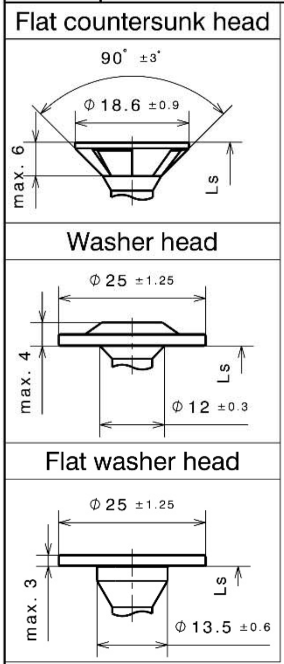
Ls
210
230
250
270
300
330
360
400
500

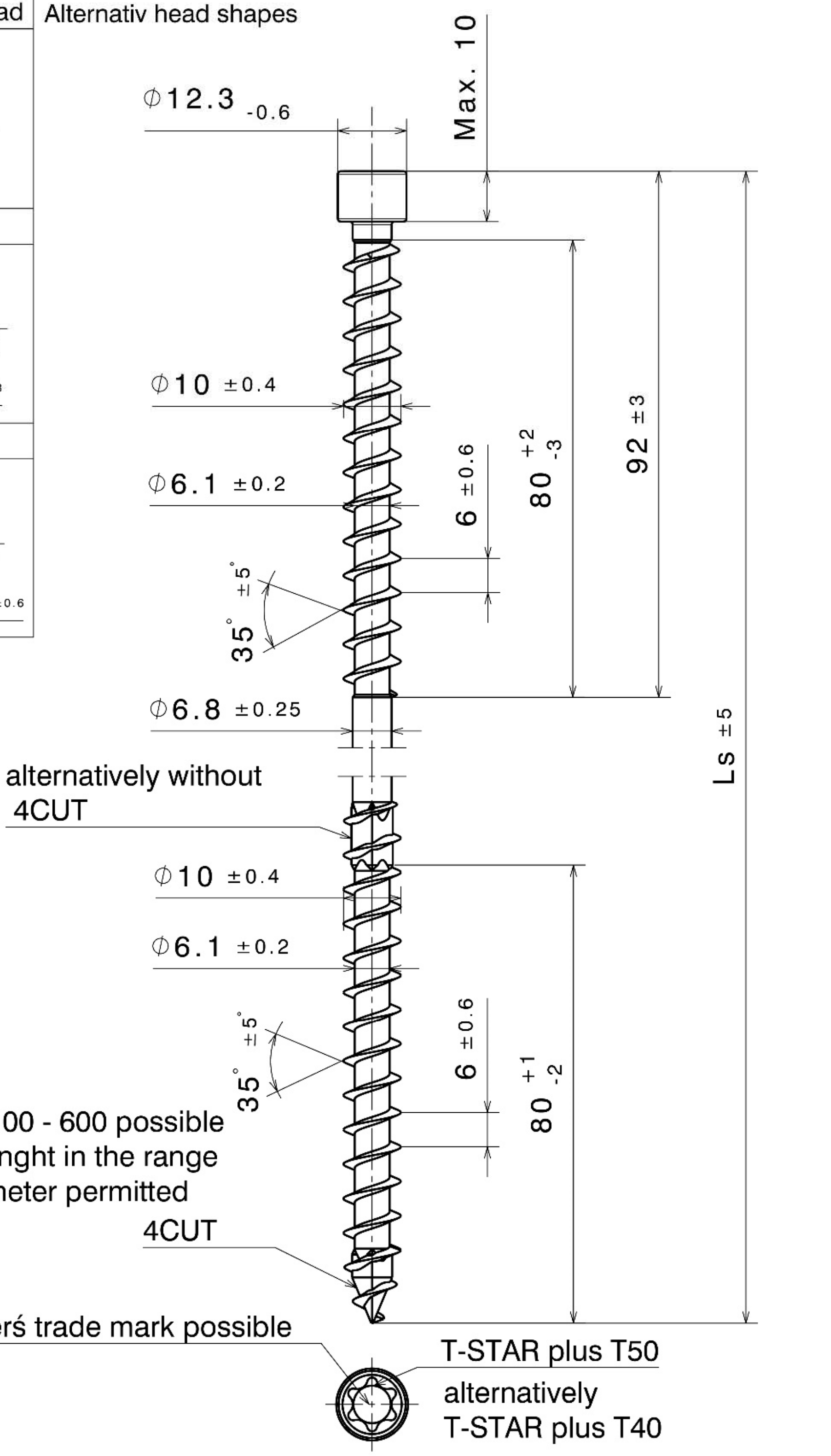
- Other lenghts 100 - 600 possible
- Other thread lenght in the range ≥ 4x thread diameter permitted



Annex A2

ABC	SPAX®	Self-tapping cylindric head screw with fixing thread
		Material: cold rolled wire according to SPAX - Factory Standard screw of high-carbon steel





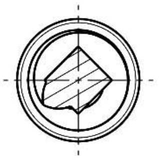
Ls
200
230
260
290
320
350
400
450
500

- Other lenghts 100 - 600 possible
- Other thread lenght in the range ≥ 4x thread diameter permitted

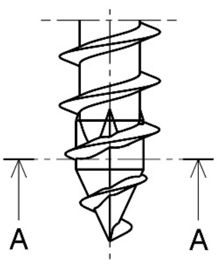
Annex A3

SPAX®	Self-tapping cylindric head screw with fixing thread
	Material: cold rolled wire according to SPAX - Factory Standard Stainless steel screw

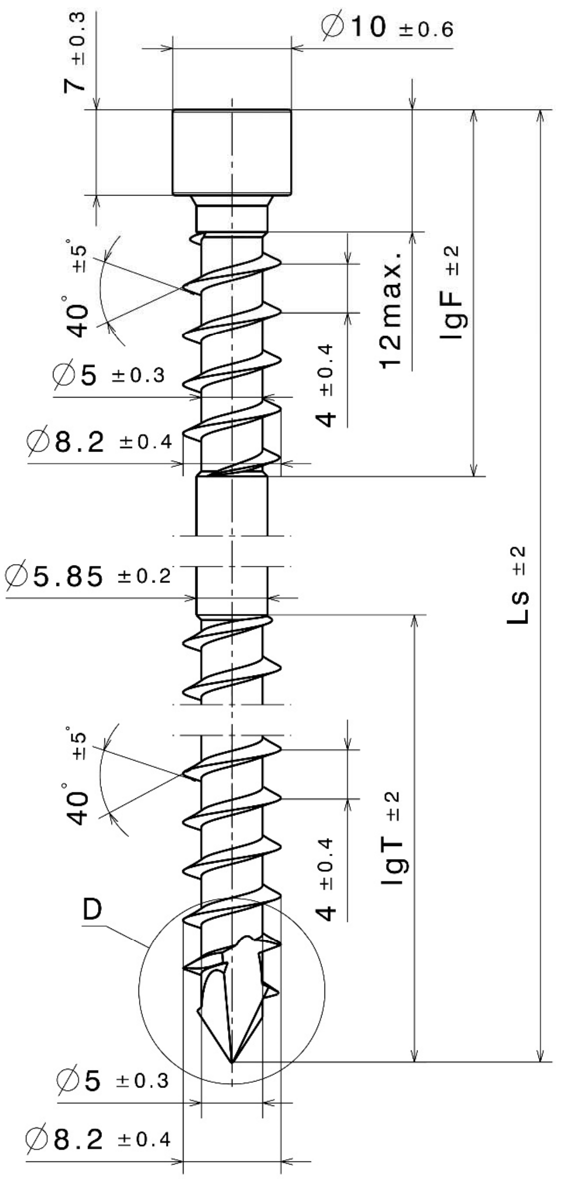
Cross section A-A
4CUT-point:
Square point
in core



D: alternatively
with 4CUT

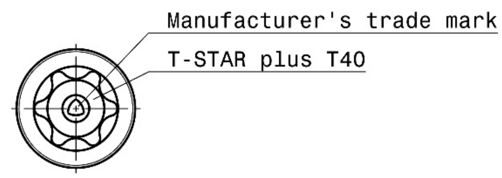


Screw with CUT-point



200	90	50
180	80	40
160	70	40
140	60	30
120	50	30
100	40	30
Ls	lgT*	lgF

- Other lenghts 100 - 600 possible
- Other thread lenght in the range ≥ 4x thread diameter permitted



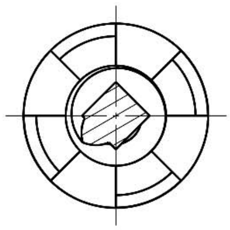
Annex A4

SPAX®

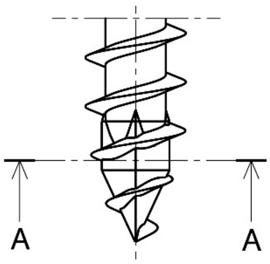
Self-tapping flat countersunk head screw with fixing thread

Material: cold rolled wire according to SPAX - Factory Standard
Stainless steel screw

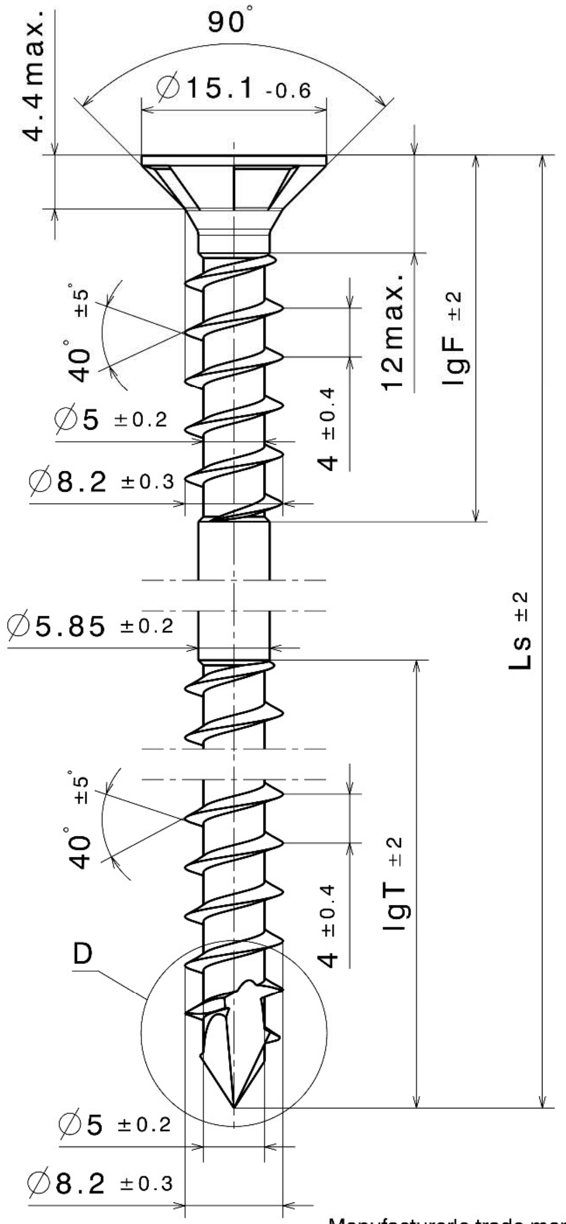
Cross section A-A
4CUT-point:
Square point
in core



D: alternatively
with 4CUT

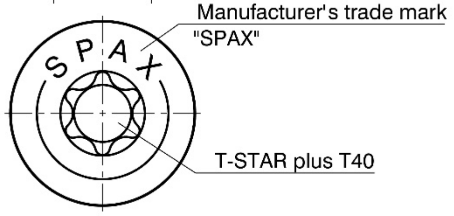


Screw with CUT-point



200	90	50
180	80	40
160	70	40
140	60	30
120	50	30
100	40	30
Ls	lgT*	lgF

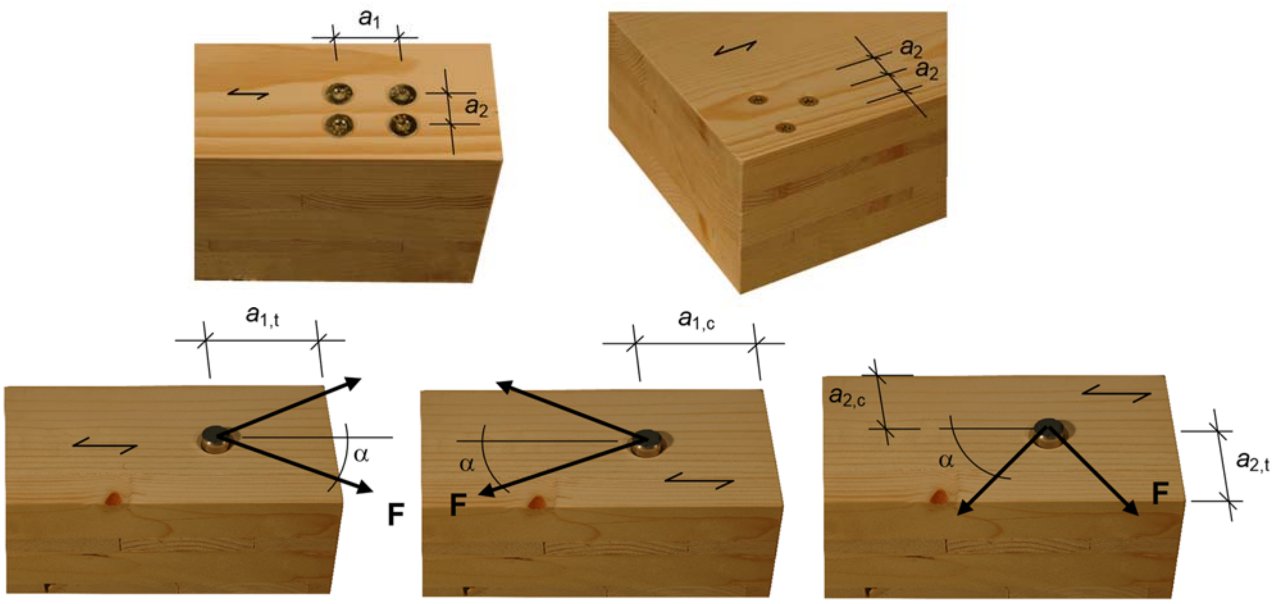
- Other lenghts 100 - 600 possible
- *Other thread lenght in the range
≥ 4x thread diameter permitted



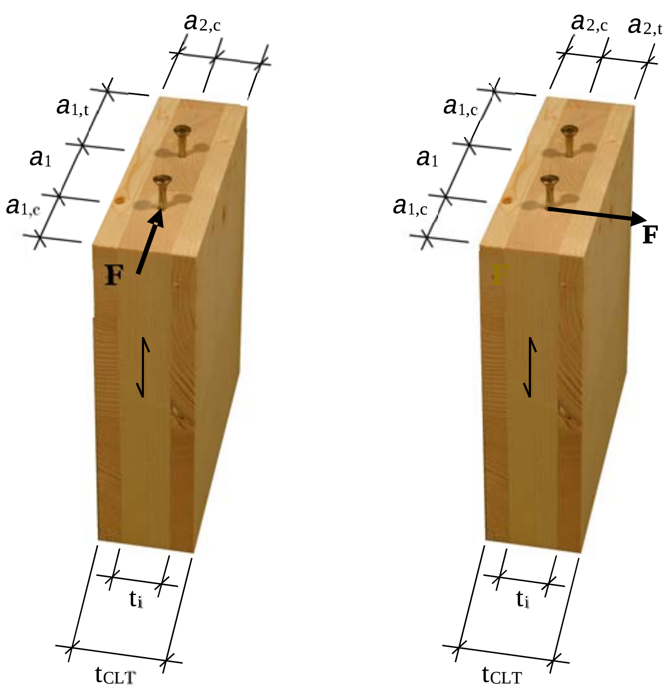
Annex B
Minimum distances and spacing

Axially or laterally loaded screws in the plane or edge surface of cross laminated timber

Definition of spacing, end and edge distances in the plane surface unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:



Definition of spacing, end and edge distances in the edge surface unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber:



Annex C
Thermal insulation material on top of rafters

SPAX double thread screws with an outer thread diameter 8/9 mm ≤ d ≤10 mm may be used for the fixing of Thermal insulation material on top of rafters.

The thickness of the insulation shall not exceed 400 mm. The rafter insulation must be placed on top of solid timber or glued laminated timber rafters or cross-laminated timber members and be fixed by battens arranged parallel to the rafters or by wood-based panels on top of the insulation layer. The insulation of vertical facades is also covered by the rules given here.

Screws must be screwed in the rafter through the battens or panels and the insulation without pre-drilling in one sequence.

The angle α between the screw axis and the grain direction of the rafter should be between 30° and 90°.

The rafter consists of solid timber (softwood) according to EN 338, glued laminated timber according to EN 14080, cross-laminated timber, or laminated veneer lumber according to EN 14374 or to European Technical Approval or similar glued members according to European Technical Approval and has a minimum width of 60 mm.

The battens must be from solid timber (softwood) according to EN 338:2003-04. The minimum thickness t and the minimum width b of the battens is given as follows:

Screws d = 8,0 mm: b_{min} = 50 mm t_{min} = 30 mm
Screws d = 8,2 mm: b_{min} = 50 mm t_{min} = 30 mm
Screws d = 9,0 mm: b_{min} = 60 mm t_{min} = 40 mm
Screws d = 10 mm: b_{min} = 60 mm t_{min} = 40 mm

Alternatively to the battens, panels with a minimum thickness of 20 mm from plywood according to EN 636, particleboard according to EN 312, oriented strand board OSB/3 and OSB/4 according to EN 300 or European Technical Approval and solid wood panels according to EN 13353 may be used.

The insulation must comply with a European Technical Approval.

Friction forces shall not be considered for the design of the characteristic axial capacity of the screws.

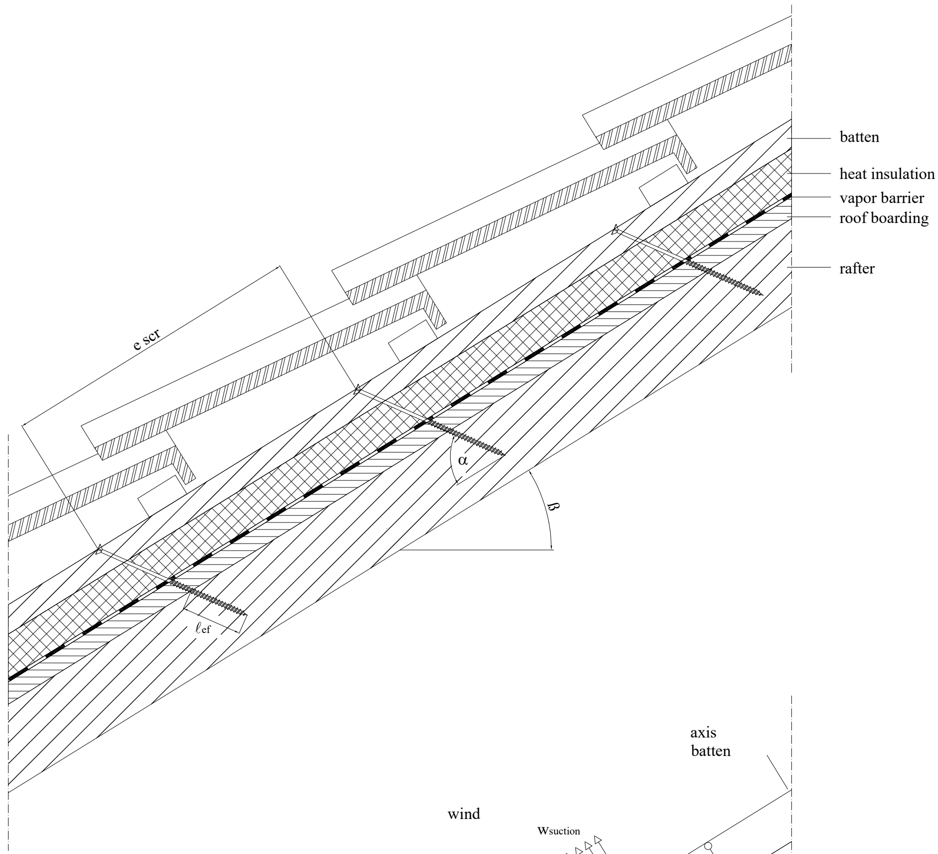
The anchorage of wind suction forces as well as the bending stresses of the battens or the boards, respectively, shall be considered in design. Additional screws perpendicular to the grain of the rafter (angle α = 90°) may be arranged if necessary.

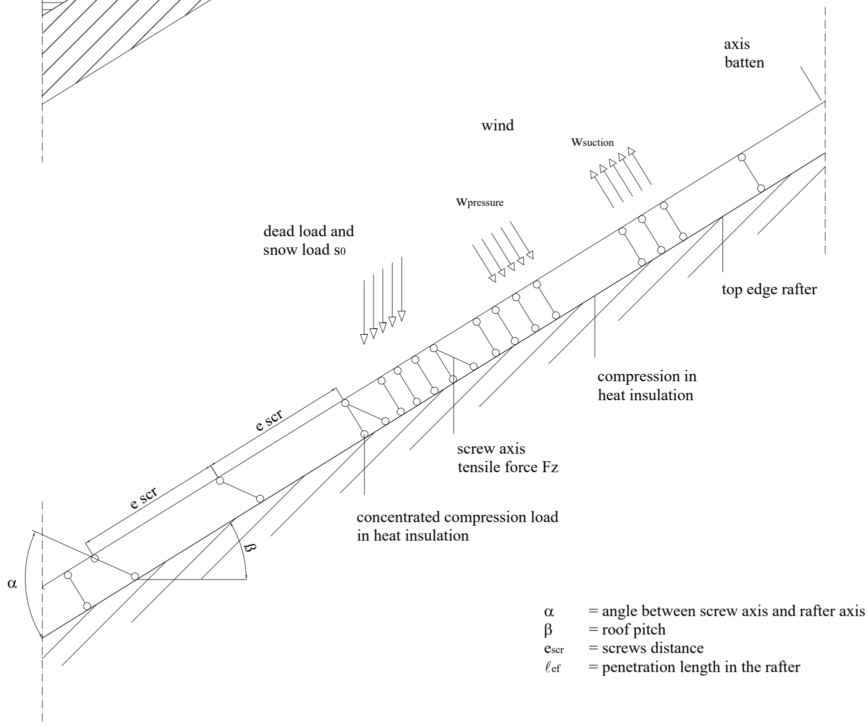
The maximum screw spacing is e_S = 1,75 m.

Thermal insulation material on rafters with parallel inclined screws

Mechanical model

The system of rafter, Thermal insulation material on top of rafter and battens parallel to the rafter may be considered as a beam on elastic foundation. The batten represents the beam, and the Thermal insulation material on top of the rafter the elastic foundation. The minimum compression stress of the Thermal insulation material at 10 % deformation, measured according to EN 826[1], shall be $\sigma_{(10\,\%)} = 0{,}05$ N/mm². The batten is loaded perpendicular to the axis by point loads F_b. Further point loads F_s are from the shear load of the roof due to dead and snow load, which are transferred from the screw heads into the battens.





[1] EN 826:1996 Thermal insulating products for building applications - Determination of compression behaviour

Design of the battens

The bending stresses are calculated as:

$$M = \frac{(F_b + F_s) \cdot \ell_{char}}{4}$$

Where

ℓ_{char} = characteristic length $\ell_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}}$

EI = bending stiffness of the batten

K = coefficient of subgrade

w_{ef} = effective width of the Thermal insulation material

F_b = Point loads perpendicular to the battens

F_s = Point loads perpendicular to the battens, load application in the area of the screw heads

The coefficient of subgrade K may be calculated from the modulus of elasticity E_{HI} and the thickness t_{HI} of the Thermal insulation material if the effective width w_{ef} of the Thermal insulation material under compression is known. Due to the load extension in the Thermal insulation material the effective width w_{ef} is greater than the width of the batten or rafter, respectively. For further calculations, the effective width w_{ef} of the Thermal insulation material may be determined according to:

$$w_{ef} = w + t_{HI} / 2$$

where

w = minimum width of the batten or rafter, respectively

t_{HI} = thickness of the Thermal insulation material

$$K = \frac{E_{HI}}{t_{HI}}$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \leq 1$$

For the calculation of the section modulus W the net cross section has to be considered.

The shear stresses shall be calculated according to:

$$V = \frac{(F_b + F_s)}{2}$$

The following condition shall be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1,5 \cdot V_d}{A \cdot f_{v,d}} \leq 1$$

For the calculation of the cross section area the net cross section has to be considered.

Design of the Thermal insulation material

The compressive stresses in the Thermal insulation material shall be calculated according to:

$$\sigma = \frac{1,5 \cdot F_b + F_s}{2 \cdot \ell_{char} \cdot w}$$

The design value of the compressive stress shall not be greater than 110 % of the compressive stress at 10 % deformation calculated according to EN 826.

Design of the screws

The screws are loaded predominantly axially. The axial tension force in the screw may be calculated from the shear loads of the roof R_s:

$$T_S = \frac{R_S}{\cos \alpha}$$

The load-carrying capacity of axially loaded screws is the minimum design value of the axial withdrawal capacity of the threaded part of the screw, the head pull-through capacity of the screw and the tensile capacity of the screw.

In order to limit the deformation of the screw head for Thermal insulation material thicknesses over 200 mm or with compressive strength below 0,12 N/mm², respectively, the axial withdrawal capacity of the screws shall be reduced by the factors k_1 and k_2:

$$F_{ax,\alpha,Rd} = \min\left\{\frac{f_{ax,d} \cdot d \cdot \ell_{ef} \cdot k_1 \cdot k_2}{1.2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; f_{head,d} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}}\right\}$$ for SPAX screws with partial thread

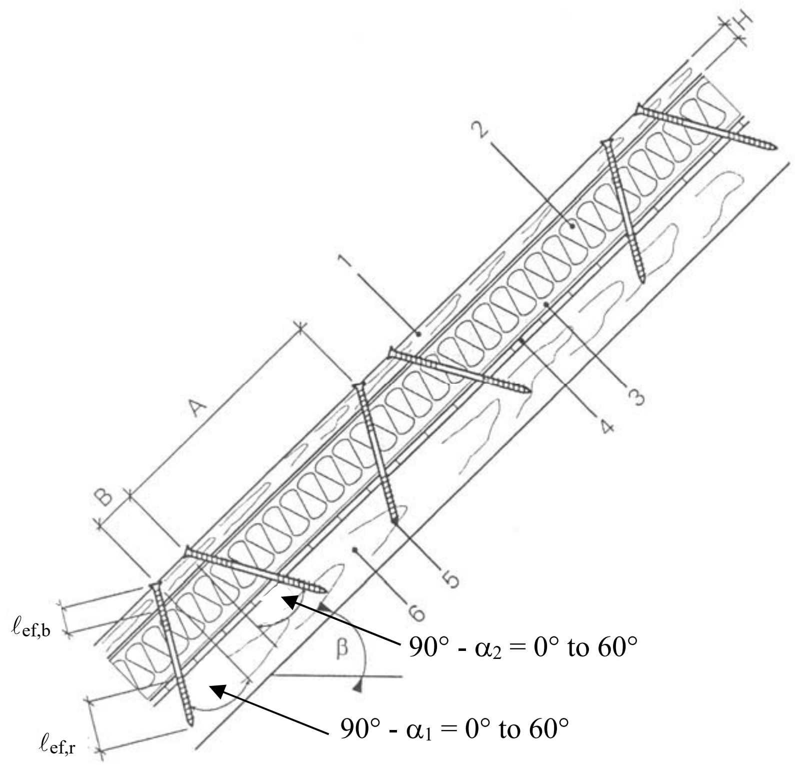
$$F_{ax,\alpha,Rd} = \min\left\{\begin{array}{c} \frac{f_{ax,d} \cdot d \cdot \ell_{ef} \cdot k_1 \cdot k_2}{1,2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \\ \max\left\{f_{head,d} \cdot d_h^2; \frac{f_{ax,d} \cdot d \cdot \ell_{ef,b} \cdot k_1 \cdot k_2}{1,2 \cdot \cos^2\alpha + \sin^2\alpha}\right\} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \\ \frac{f_{tens,k}}{\gamma_{M2}} \end{array}\right\}$$ for SPAX screws with full or double thread

where:

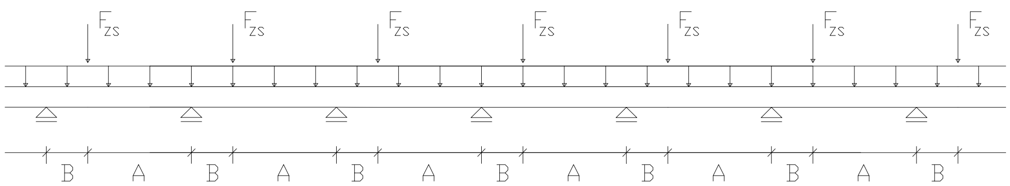
$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw
d	outer thread diameter of the screw
ℓ_{ef}	Point side penetration length of the threaded part of the screw in the batten, $l_{ef} \geq 40$ mm
$\ell_{ef,b}$	Length of the threaded part in the batten including the head for tensile and excluding the head for compressive force [mm]
α	Angle between grain and screw axis ($\alpha \geq 30°$)
ρ_k	characteristic density of the wood-based member [kg/m³]
$f_{head,d}$	design value of the head pull-through capacity of the screw
d_h	head diameter
$f_{tens,k}$	characteristic tensile capacity of the screw
γ_{M2}	partial factor according to EN 1993-1-1 or to the particular national annex
k_1	min {1; $200/t_{HI}$}
k_2	min {1; $\sigma_{10\%}/0,12$}
t_{HI}	thickness of the Thermal insulation material [mm]
$\sigma_{10\%}$	compressive stress of the Thermal insulation material under 10 % deformation [N/mm²]

If equation k_1 and k_2 are considered, the deflection of the battens does not need to be considered. Alternatively to the battens, panels with a minimum thickness of 20 mm from plywood according to EN 636 or an ETA or national provisions that apply at the installation site, particle board according to EN 312 or an ETA or national provisions that apply at the installation site, oriented strand board according to EN 300 or an ETA or national provisions that apply at the installation site and solid wood panels according to EN 13353 or an ETA or national provisions that apply at the installation site or cross laminated timber according to an ETA may be used.

Thermal insulation material on rafters with alternatively inclined screws



1 Counter batten
2 Insulation
3 Vapour barrier
4 Sheathing
5 Compressive screw
6 Rafter



Mechanical model

Depending on the screw spacing and the arrangement of tensile and compressive screws with different inclinations the battens are loaded by significant bending moments. The bending moments are derived based on the following assumptions:

- The tensile and compressive loads in the screws are determined based on equilibrium conditions from the actions parallel and perpendicular to the roof plane.
  These actions are constant line loads $q_\perp$ and $q_{||}$.
- The screws act as hinged columns supported 10 mm within the batten or rafter, respectively. The effective column length consequently equals the length of the screw between batten and rafter plus 20 mm.
- The batten is considered as a continuous beam with a constant span $\ell = A + B$.
  The compressive screws constitute the supports of the continuous beam while the tensile screws transfer concentrated loads perpendicular to the batten axis.

The screws are predominantly loaded in withdrawal or compression, respectively. The screw's normal forces are determined based on the loads parallel and perpendicular to the roof plane:

Compressive screw:

$$F_{c,Ed} = (A+B) \cdot \left(-\frac{q_{II}}{\cos\alpha_1 + \sin\alpha_1 / \tan\alpha_2} - \frac{q_\perp \cdot \sin(90° - \alpha_2)}{\sin(\alpha_1 + \alpha_2)} \right)$$

Tensile screw:

$$F_{t,Ed} = (A+B) \cdot \left(\frac{q_{II}}{\cos\alpha_2 + \sin\alpha_2 / \tan\alpha_1} - \frac{q_\perp \cdot \sin(90° - \alpha_1)}{\sin(\alpha_1 + \alpha_2)} \right)$$

The bending moments in the batten follow from the constant line load $q_\perp$ and the load components perpendicular to the batten from the tensile screws. The span of the continuous beam is (A + B). The load component perpendicular to the batten from the tensile screw is:

$$F_{ZS,Ed} = (A+B) \cdot \left(\frac{q_{II}}{1/\tan\alpha_1 + 1/\tan\alpha_2} - \frac{q_\perp \cdot \sin(90° - \alpha_1) \cdot \sin\alpha_2}{\sin(\alpha_1 + \alpha_2)} \right)$$

Where:

q_{II}	Constant line load parallel to batten
$q_\perp$	Constant line load perpendicular to batten
α_1	Angle between compressive screw axis and grain direction
α_2	Angle between tensile screw axis and grain direction

A positive value for F_{ZS} means a load towards the rafter, a negative value a load away from the rafter.

Design of the screws

The load-carrying capacity of the screws shall be calculated as follows:

Screws loaded in tension:

$$F_{ax,\alpha,Rd} = \min\left\{ \frac{f_{ax,d} \cdot d \cdot \ell_{ef,b}}{1.2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{b,k}}{350}\right)^{0.8}; \frac{f_{ax,d} \cdot d \cdot \ell_{ef,r}}{1.2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{r,k}}{350}\right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}} \right\}$$

Screws loaded in compression:

$$F_{ax,\alpha,Rd} = \min\left\{ \frac{f_{ax,d} \cdot d \cdot \ell_{ef,b}}{1.2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{b,k}}{350}\right)^{0.8}; \frac{f_{ax,d} \cdot d \cdot \ell_{ef,r}}{1.2 \cdot \cos^2\alpha + \sin^2\alpha} \cdot \left(\frac{\rho_{r,k}}{350}\right)^{0.8}; \frac{\kappa_c \cdot N_{pl,k}}{\gamma_{M1}} \right\}$$

where:

$f_{ax,d}$	design value of the axial withdrawal capacity of the threaded part of the screw
d	outer thread diameter of the screw
$\ell_{ef,b}$	penetration length of the threaded part of the screw in the batten
$\ell_{ef,r}$	penetration length of the threaded part of the screw in the rafter, $l_{ef} \geq 40$ mm
$\rho_{b,k}$	characteristic density of the batten [kg/m³]
$\rho_{r,k}$	characteristic density of the rafter [kg/m³]
α	angle α_1 or α_2 between screw axis and grain direction, $30° \leq \alpha_1 \leq 90°$, $30° \leq \alpha_2 \leq 90°$
$f_{tens,k}$	characteristic tensile capacity of the screw
γ_{M1}, γ_{M2}	partial factor according to EN 1993-1-1 or to the particular national annex
$\kappa_c \cdot N_{pl,k}$	Buckling capacity of the screw

Free screw length [mm]	8,0/9,0 mm	9,0/10,0 mm	10,0/10,0 mm
	$\kappa_c \cdot N_{pl,k}$ [kN]	$\kappa_c \cdot N_{pl,k}$ [kN]	$\kappa_c \cdot N_{pl,k}$ [kN]
≤ 100	9,75	15,3	10,6
120	7,57	12,1	8,29
140	6,02	9,68	6,63
160	4,89	7,91	5,41
180	4,05	6,57	4,48
200	3,40	5,54	3,78
220	2,91	4,73	3,22
240	2,50	4,10	2,79
260	2,18	3,57	2,43
280	1,91	3,14	2,13
300	1,69	2,78	1,89
320	1,51	2,48	1,68
340	1,35	2,23	1,51
360	1,22	2,01	1,36
380	1,10	1,82	1,24
400	1,01	1,66	1,13
420	0,92	1,52	1,03
440	0,84	1,39	0,95
460	0,78	1,29	0,87
480	0,72	1,19	0,81