ETA-Danmark A/S
Göteborg Plads 1
DK-2150 Nordhavn
Tel. +45 72 24 59 00
Fax +45 72 24 59 04
Internet www.etadanmark.dk

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-20/0787 of 2020/11/04

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:	HAPAX and PFS+ wood screws
Product family to which the above construction product belongs:	Screws for use in timber constructions
Manufacturer:	pgb-Europe NV Gontrode Heirweg 170 BE-9090 Melle Tel +32 9 272 70 70 Internet www.pgb-europe.com
Manufacturing plant:	pgb-Europe NV Gontrode Heirweg 170 BE-9090 Melle
This European Technical Assessment contains:	33 pages including 4 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 130118-01-0603 “Screws and threaded rods for use in timber constructions”
This version replaces:	-

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Technical description of the product
pgb screws are self-tapping screws to be used in timber structures. They shall be threaded over a part of the length or over the whole length. The screws shall be produced from carbon steel wire for nominal diameters between 3,0 mm and 10,0 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 pgb screws shall not be less than 3,0 mm and shall not be greater than 10,0 mm. The overall length of the screws, ℓ, shall not be less than 30 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 0,58 to 0,71.

The screws are threaded over a minimum length ℓ_g of 4·d (i.e. $\ell_g \geq 4 \cdot d$).

The screws covered by this ETA have a bending angle, α, of at least $(45/d^{0,7} + 20)$ degrees.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

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

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, Type OSB/3 and OSB/4 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 shall be driven into softwood without pre-drilling or after pre-drilling with a diameter not larger than the inner thread diameter for the length of the threaded part and with a maximum of the smooth shank diameter for the length of the smooth shank.

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 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. Regarding environmental conditions, national provisions at the building site shall apply.

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 1995-1-1:2008 (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.

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 $f_{tens,k}$:	
	Screw d = 3,0 mm:	3,0 kN
	Screw d = 3,5 mm:	4,0 kN
	Screw d = 4,0 mm:	5,0 kN
	Screw d = 4,5 mm:	7,0 kN
	Screw d = 5,0 mm:	8,0 kN
	Screw d = 6,0 mm:	11 kN
	Screw d = 8,0 mm:	22 kN
	Screw d = 10,0 mm:	35 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 $f_{tor,k}$:	
	Screw d = 3,0 mm:	1,3 Nm
	Screw d = 3,5 mm:	1,8 Nm
	Screw d = 4,0 mm:	3,3 Nm
	Screw d = 4,5 mm:	4,5 Nm
	Screw d = 5,0 mm:	5,0 Nm
	Screw d = 6,0 mm:	10 Nm
	Screw d = 8,0 mm:	24 Nm
	Screw d = 10,0 mm:	45 Nm
3.2 Safety in case of fire (BWR2)		
Reaction to fire	The screws are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364	
3.7 Sustainable use of natural resources (BWR7)	No Performance assessed	
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 and 2	

*) See additional information in section 3.9 – 3.11.

3.9 Mechanical resistance and stability

The load-carrying capacities for pgb 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 pgb 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 rafters, point side penetration must be at least 40 mm, $\ell_{ef} \geq 40$ mm.

ETAs for structural members or wood-based panels must be considered where applicable.

Reductions in the cross-sectional area caused by pgb 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 pgb screws shall be calculated according to EN 1995-1-1:2008 (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 assumed as:

PFS+ wood screws type PWVTV, PWVTG, PWCTV, PWCTG screws:

d = 3,0 mm:	$M_{y,k}$ = 1,0 Nm
d = 3,5 mm:	$M_{y,k}$ = 1,6 Nm
d = 4,0 mm:	$M_{y,k}$ = 2,8 Nm
d = 4,5 mm:	$M_{y,k}$ = 3,7 Nm
d = 5,0 mm:	$M_{y,k}$ = 4,9 Nm
d = 6,0 mm:	$M_{y,k}$ = 8,7 Nm

PFS+ wood construction screws type PEVTG, PETTG, PFDCTG screws:

d = 5,0 mm:	$M_{y,k}$ = 5,9 Nm
d = 6,0 mm:	$M_{y,k}$ = 7,9 Nm
d = 8,0 mm:	$M_{y,k}$ = 20 Nm
d = 10,0 mm:	$M_{y,k}$ = 26 Nm

Hapax wood screws type HAWVTV, HAWVTG screws:

d = 3,0 mm:	$M_{y,k}$ = 1,3 Nm
d = 3,5 mm:	$M_{y,k}$ = 2,3 Nm
d = 4,0 mm:	$M_{y,k}$ = 3,3 Nm
d = 4,5 mm:	$M_{y,k}$ = 4,5 Nm
d = 5,0 mm:	$M_{y,k}$ = 5,5 Nm
d = 6,0 mm:	$M_{y,k}$ = 10 Nm

Hapax wood construction screws type HAEVTG, HAETTG screws:

d = 5,0 mm:	$M_{y,k}$ = 7,0 Nm
d = 6,0 mm:	$M_{y,k}$ = 10 Nm
d = 8,0 mm:	$M_{y,k}$ = 20 Nm

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:

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

and accordingly 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:

$$f_{h,k} = 20 \cdot d^{-0,5} \quad \text{[MPa]}$$

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 wide face of cross laminated timber should be assumed as for solid timber based on the characteristic density of the outer layer. If relevant, the angle between force and grain direction of the outer layer should be taken into account.

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

Axial withdrawal capacity

The characteristic axial withdrawal capacity of pgb screws at an angle of $0° \leq \alpha \leq 90°$ to the grain in solid timber, glued laminated timber and cross-laminated timber members shall be calculated according to EN 1995-1-1 from:

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

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
k_{ax}	Factor, taking into account the angle α between screw axis and grain direction $k_{ax} = 1{,}0$ for $45° \leq \alpha < 90°$ $k_{ax} = 0{,}3 + \frac{0{,}7 \cdot \alpha}{45}$ for $0° \leq \alpha < 45°$
$f_{ax,k}$	Characteristic withdrawal parameter $d \leq 4$ mm: $f_{ax,k} = 15$ MPa $d = 4{,}5$ mm: $f_{ax,k} = 14$ MPa $d = 5$ mm: $f_{ax,k} = 13$ MPa $d = 6$ mm: $f_{ax,k} = 12$ MPa $d \geq 8$ mm: $f_{ax,k} = 11$ MPa
d	outer thread diameter [mm]
ℓ_{ef}	Penetration length of the threaded part according to EN 1995-1-1 [mm]
α	Angle between grain and screw axis
ρ_k	Characteristic density [kg/m³]

For screws arranged under an angle between screw axis and grain direction of less than 90°, the minimum tip side penetration length is:

$\ell_{ef} \geq \min(4 \cdot d/\sin\alpha\ ;\ 20 \cdot d)$

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 capacity of the screw.

Head pull-through capacity

The characteristic head pull-through capacity of pgb 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 $\alpha \geq 30°$ to the grain [N]
n_{ef}	Effective number of screws according to EN 1995-1-1:2008
$f_{head,k}$	Characteristic head pull-through parameter [MPa]
d_h	Diameter of the screw head or the washer [mm]. Outer diameter of heads or washers $d_k > 20$ mm shall not be taken into account.
ρ_k	Characteristic density [kg/m³], for wood-based panels $\rho_k = 380$ kg/m³

Characteristic head pull-through parameter for pgb screws in connections with timber and in connections with wood-based panels with thicknesses above 20 mm:

$$f_{head,k} = \max\left\{\frac{50}{d}; 10\right\} \text{ MPa}$$

Where d is the outer thread diameter in mm.

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

$f_{head,k} = 8$ MPa

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

$f_{head,k} = 8$ MPa limited to $F_{ax,Rk} = 400$ N

The head diameter d_h shall be greater than $1{,}8 \cdot d_s$, where d_s is the smooth shank or the wire diameter. Otherwise the characteristic head pull-through capacity $F_{ax,\alpha,Rk} = 0$.

The minimum thickness of wood-based panels according to the clause 3.11 must be observed.

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

Tensile capacity

The characteristic tensile strength $f_{tens,k}$ of pgb screws made of carbon steel is:

Screw d = 3,0 mm:	3,0 kN
Screw d = 3,5 mm:	4,0 kN
Screw d = 4,0 mm:	5,0 kN
Screw d = 4,5 mm:	7,0 kN
Screw d = 5,0 mm:	8,0 kN
Screw d = 6,0 mm:	11 kN
Screw d = 8,0 mm:	22 kN
Screw d = 10,0 mm:	35 kN

For screws used in combination with steel plates, the tear-off capacity of the screw head including a washer shall be greater than the tensile capacity of the screw.

Compressive capacity

The characteristic compressive capacity $F_{ax,Rk}$ of fully threaded pgb screws embedded in timber shall be calculated from:

$$F_{ax,Rk} = \min\left\{k_{ax} \cdot f_{ax,k} \cdot d \cdot \ell_{ef} \left(\frac{\rho_k}{\rho_a}\right)^{0,8}; \kappa_c \cdot N_{pl,k}\right\} \quad [N]$$

Where

$$\kappa_c = \begin{cases} 1 & \text{for } \bar{\lambda}_k \le 0,2 \\ \dfrac{1}{k+\sqrt{k^2-\bar{\lambda}_k^2}} & \text{for } \bar{\lambda}_k > 0,2 \end{cases}$$

$$k = 0,5 \cdot \left[1 + 0,49 \cdot (\bar{\lambda}_k - 0,2) + \bar{\lambda}_k^2\right]$$

The relative slenderness ratio shall be calculated from:

$$\bar{\lambda}_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}}$$

Where

$$N_{pl,k} = \pi \cdot \frac{d_1^2}{4} \cdot f_{y,k} \qquad \text{[N]}$$

is the characteristic value for the axial capacity in case of plastic analysis referred to the inner thread cross section.

Characteristic yield strength for screws made of carbon steel:

$f_{y,k} = 1000$ [N/mm²]

Characteristic ideal elastic buckling load:

$$N_{ki,k} = \sqrt{c_h \cdot E_S \cdot I_S} \qquad \text{[N]}$$

Elastic foundation of the screw:

$$c_h = (0,19 + 0,012 \cdot d) \cdot \rho_k \cdot \left(\frac{\alpha}{180^\circ} + 0,5\right)$$

[N/mm²]

Modulus of elasticity:

$E_s = 210000$ [N/mm²]

Second moment of area:

$$I_S = \frac{\pi}{64} \cdot d_1^4 \qquad \text{[mm}^4\text{]}$$

d_1 inner thread diameter [mm]

α angle between screw axis and grain direction

ρ_k characteristic density [kg/m³]

Note: When determining design values of the compressive capacity it should be considered that $f_{ax,d}$ is to be calculated using k_{mod} and γ_M for timber according to EN 1995 while $N_{pl,d}$ is calculated using $\gamma_{M,1}$ for steel buckling according to EN 1993.

Combined laterally and axially loaded screws

For connections subjected to a combination of axial and lateral load, the following expression should be satisfied:

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

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

Slip modulus

The axial slip modulus K_{ser} of a screw for the serviceability limit state should be taken independent of angle α to the grain as:

$K_{ser} = 25 \cdot d \cdot \ell_{ef}$ [N/mm]

Where

d outer thread diameter [mm]

ℓ_{ef} thread penetration length in the structural member [mm]

Compression reinforcement

See annex C

Thermal insulation material on top of rafters

See Annex D

3.10 Aspects related to the performance of the product

3.10.1 Corrosion protection in service class 1 and 2.

The pgb screws are produced from carbon wire. Screws made from carbon steel are electrogalvanised and yellow or blue chromated or non-electrolytically zinc flake coated. The mean thickness of the zinc coating is 5µm.

3.11 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 and laid down in the technical documentation.

The installation shall be carried out in accordance with Eurocode 5 or an appropriate national code unless otherwise is defined in the following. Instructions from pgb-Europe nv should be considered for installation.

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

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

Furthermore, the screws with diameters between 6 mm and 10 mm may also be used for the fixing of insulation on top of rafters or at vertical facades.

A minimum of two screws should be used for connections in load bearing timber structures.

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 ≥ 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 screws shall be driven into the wood without pre-drilling or after pre-drilling with a diameter equal or less than the inner thread diameter.

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

Only the equipment prescribed by pgb-Europe nv 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.

For structural timber members, minimum spacing and distances for screws are given in EN 1995-1-1 (Eurocode 5) clause 8.3.1.2 and table 8.2 as for nails in predrilled or non-predrilled holes, respectively. Here, the outer thread diameter d must be considered.

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

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to 3·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 wide face of cross laminated timber members with a minimum thickness t = 10·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 = 10·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 a crossed screw couple the minimum spacing between the crossing screws is 1,5·d.

Minimum thickness for structural members is t = 24 mm for screws with outer thread diameter d < 8 mm, t = 30 mm for screws with outer thread diameter d = 8 mm and t = 40 mm for screws with outer thread diameter d = 10 mm.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/176/EC of the European Commission1, 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

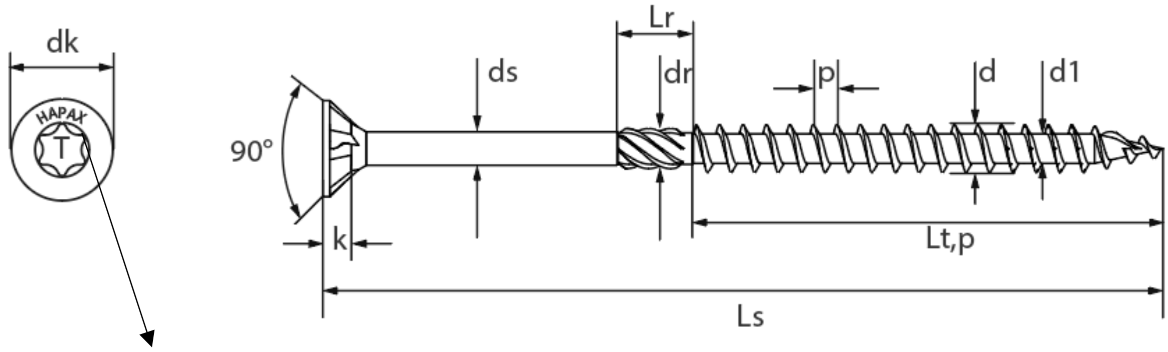
Issued in Copenhagen on 2020-11-04 by

Thomas Bruun
Managing Director, ETA-Danmark

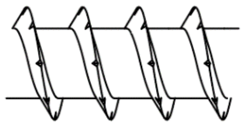
Annex A
Drawings and material specification

HAPAX wood screw, countersunk head

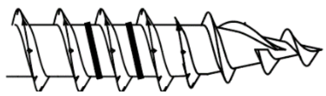
Partial thread (HAWVTG)



Manufacturer's trademark or symbol:
"HAPAX", "H.P.X",

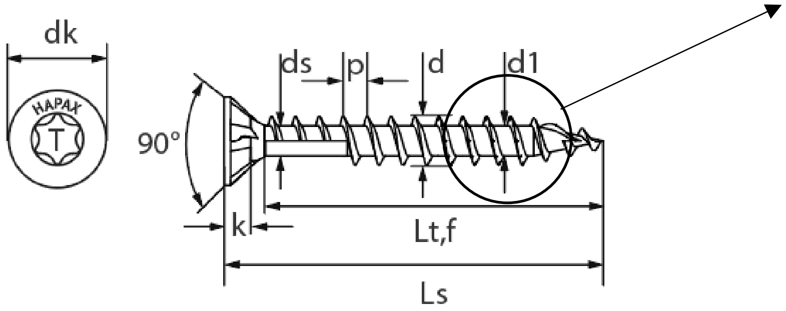


Saw thread only when Ls > 50mm



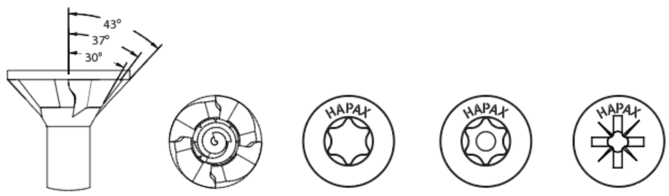
With or without shank rings
between the thread

Full thread (HAWVTG)



Head style

Multi milling ribs



T-drive T-Tap® Cross recess

Point style

Triple thread point

	Nominal diameter	**2,5**	**3,0**	**3,5**	**4,0**	**4,5**	**5,0**	**6,0**
d	**Thread size**	2,5	3,0	3,5	4,0	4,5	5,1	6,1
	Tolerance	± 0,15		± 0,20			± 0,25	
d1	**Core diameter**	1,7	2,0	2,5	2,8	3,2	3,5	4,0
	Tolerance	-0,25		-0,30		-0,40		+0,1/-0,3
dk	**Head diameter**	5,1	6,0	7,0	8,0	8,8	9,7	11,6
	Tolerance	-0,40				-0,50		
dr	**Reamer diameter**	-	-	-	-	3,45	3,90	4,75
	Tolerance	-		-		± 0,10		± 0,25
ds	**Shank diameter**	1,8	2,15	2,60	3,00	3,30	3,75	4,30
	Tolerance	± 0,10						
k	**Head height max**	1,6	1,8	2,1	2,4	2,7	2,9	3,4
p	**Thread pitch**	1,3	1,5	2,1	2,4	2,7	3,0	3,6
	Tolerance	± 0,1 x p						
T-drive	**Size**	T8	T10	T15	T20		T25	T30
	Cross recess type Z	1		2				3

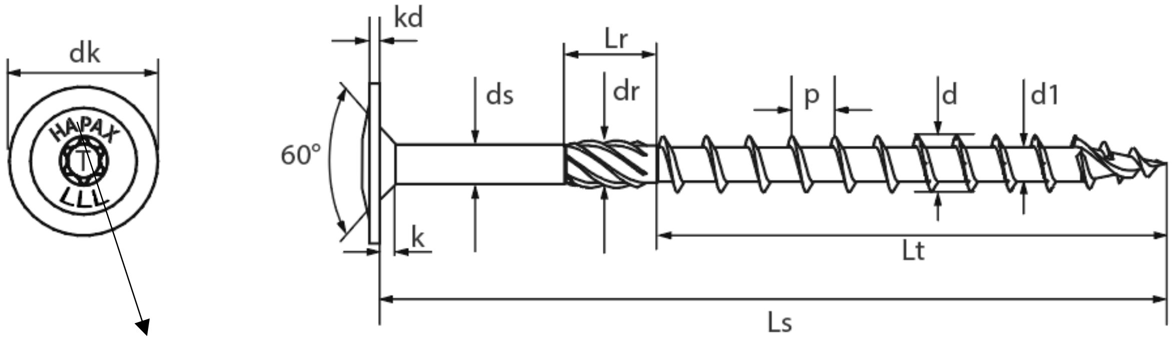
Ls	**Screw length**		Standard thread lengths (full thread = Lt,f/partial thread = Lt,p)													
Nom. dim	Min	max	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**
12	12,0	13,5	10,0													
15	14,0	15,5	12,0		12,5											
16	16,0	17,5	14,0		14,0											
20	18,5	20,5	17,0	12,0	17,0		16,0		16,0							
25	23,5	25,5	22,0	18,0	21,0	18,0	21,0	18,0	21,0		20,0		20,0			
30	28,5	30,5	27,0	18,0	26,0	18,0	25,0	18,0	25,0	18,0	25,0		25,0		24,0	
35	33,5	36,0		22,0	31,0	23,0	30,0	23,0	30,0	23,0	30,0	25,0	30,0	25,0	29,0	
40	38,5	41,0		22,0	36,0	23,0	35,0	23,0	35,0	23,0	34,0	25,0	35,0	27,0	34,0	24,0
45	43,5	46,0		28,0		28,0		30,0	40,0	30,0	39,0	30,0	39,0	30,0	38,0	29,0
50	48,5	51,0				28,0		32,0	45,0	32,5	44,0	32,5	44,0	32,0	43,0	32,0
55	53,5	56,0				36,0		35,0	50,0	35,0	49,0	37,0	49,0	37,0	48,0	37,0
60	58,5	61,0						35,0	50,0	35,0	54,0	37,0	54,0	37,0	53,0	37,0
65	63,5	66,0						40,0	50,0	37,5	59,0	42,0	59,0	41,0	58,0	41,0
70	68,5	71,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
75	73,5	76,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
80	78,5	81,0							50,0	37,5	59,0	47,0	61,0	46,0	61,0	46,0
90	88,5	91,5									59,0	47,0		61,0		61,0
100	98,5	101,5												61,0		61,0
110	108,5	111,5												69,0		68,0
120	118,5	121,5												69,0		68,0
130	128,0	132,0														68,0
140	138,0	142,0														68,0
150	148,0	152,0														68,0
160	158,0	162,0														68,0
180	178,0	182,0														68,0
200	198,0	202,0														68,0

Other thread lengths in the range ≥ 4xd to max. standard length permitted.
Intermediate lengths are possible.

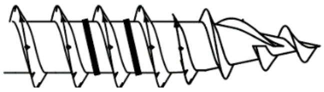
Lr	**Reamer length**	Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0
	Tolerance		-0,60

HAPAX wood construction screw

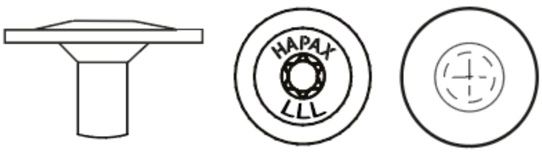
Flange head (HAETTG)



Manufacturer's trademark or symbol:
"HAPAX", "H.P.X",
LLL = Nominal screw length indication



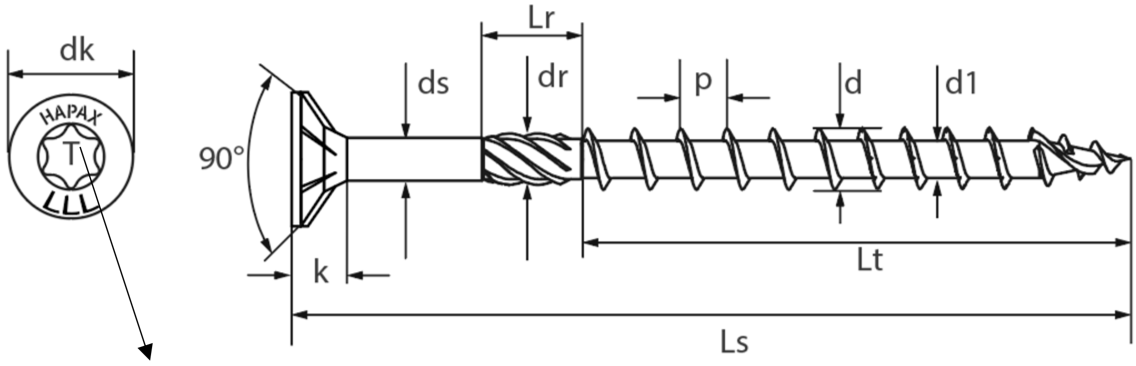
With or without shank rings between the thread

Head style	Point style
Flange head, T-drive 	Triple thread point 

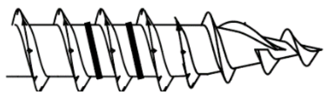
Nominal diameter			6	8	10
d	**Thread size**		6	8	10,1
	Tolerance		± 0,15	± 0,2	
d1	**Core diameter**		4,05	5,4	6,4
	Tolerance		± 0,1	± 0,15	
dk	**Head diameter**		14,0	21,0	24,5
	Tolerance		± 0,5	± 1,0	
dr	**Reamer diameter**		4,85	7,15	8,65
	Tolerance		± 0,15		
ds	**Shank diameter**		4,35	5,8	7,0
	Tolerance		± 0,1		
k	**Head height max (ref)**		5,0	5,0	5,0
kd	**Thickness of the flange**		2,6	3,2	3,6
			± 0,2		
p	**Thread pitch**		4,9	5,2	6,6
	Tolerance		± 0,5		± 0,7
T-drive	**Size**		T30	T40	
Ls	**Screw length**		**Standard thread lengths (Lt)**		
Nom. dim	Min	max	**6**	**8**	**10**
40	38,5	41,0	24		
45	43,5	46,0	27		
50	48,5	51,0	30	30	
60	58,5	61,0	36	36	36
70	68,5	71,0	42	42	42
80	78,5	81,0	48	48	48
90	88,5	91,5	54	54	54
100	98,5	101,5	60	60	60
110	108,5	111,5	65	65	65
120	118,5	121,5	75	75	75
130	128,0	132,0	80	80	80
140	138,0	142,0	80	80	80
150	148,0	152,0	90	90	90
160	158,0	162,0	90	90	90
180	178,0	182,0	100	100	100
200	198,0	202,0	100	100	100
220	217,7	222,3	100	100	100
240	237,7	242,3	100	100	100
260	257,5	262,5	100	100	100
280	277,5	282,5	100	100	100
300	297,5	302,5	100	100	100
320	317,5	322,5		100	100
340	337,5	342,5		100	100
360	357,5	362,5		100	100
380	377,5	382,5		100	100
400	397,5	402,5		100	100
to					
600	597,5	602,5		100	100
Other thread lengths in the range ≥ 4xd to max. standard length permitted. Intermediate lengths are possible. In case of shorter lengths : full thread					
Lr	**Reamer length**		Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0	
	Tolerance		-0,60		

HAPAX wood construction screw

Countersunk head (HAEVTG)



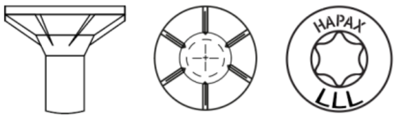
Manufacturer's trademark or symbol:
"HAPAX", "H.P.X",
LLL = Nominal screw length indication



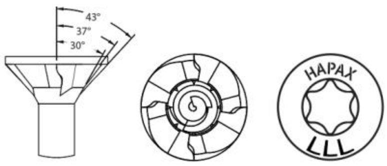
With or without shank rings
between the thread

Head style

Countersunk head with 6 cutting ribs



Countersunk head with multi milling ribs



Point style

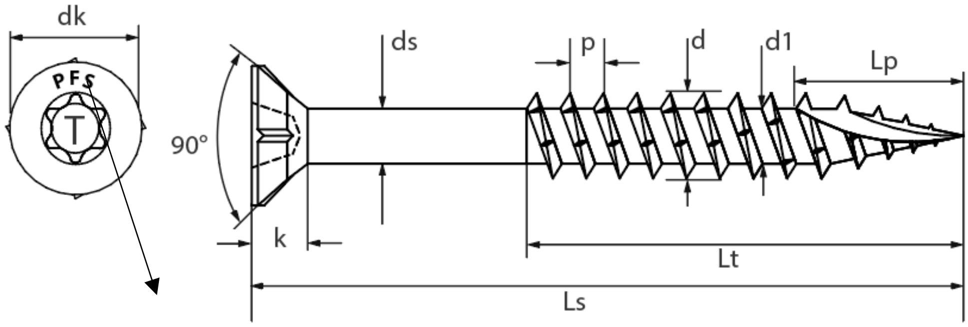
Triple thread point

Nominal diameter		5	6	8	10
d	**Thread size**	5	6	8	10,1
	Tolerance	± 0,15		± 0,2	
d1	**Core diameter**	3,4	4,05	5,4	6,4
	Tolerance	± 0,1		± 0,15	
dk	**Head diameter**	10	12	14,5	18
	Tolerance	± 0,3	± 0,4		± 0,5
dr	**Reamer diameter**	3,9	4,85	7,15	8,65
	Tolerance	± 0,1	± 0,15		
ds	**Shank diameter**	3,65	4,35	5,8	7,0
	Tolerance	± 0,1			
k	**Head height max**	4,5	5,65	7,2	8,45
	Tolerance	± 0,15	± 0,25		
p	**Thread pitch**	3,1	4,9	5,2	6,6
	Tolerance	± 0,3	± 0,5		± 0,7
T-drive	**Size**	T25	T30	T40	

Ls	**Screw length**		**Standard thread lengths (Lt)**			
Nom. dim	Min	max	**5**	**6**	**8**	**10**
40	38,5	41,0	24	24		
45	43,5	46,0	27	27		
50	48,5	51,0	30	30	30	
60	58,5	61,0	36	36	36	36
70	68,5	71,0	42	42	42	42
80	78,5	81,0	48	48	48	48
90	88,5	91,5	54	54	54	54
100	98,5	101,5	60	60	60	60
110	108,5	111,5	65	65	65	65
120	118,5	121,5	70	75	75	75
130	128,0	132,0	75	80	80	80
140	138,0	142,0	80	80	80	80
150	148,0	152,0		90	90	90
160	158,0	162,0		90	90	90
180	178,0	182,0		100	100	100
200	198,0	202,0		100	100	100
220	217,7	222,3		100	100	100
240	237,7	242,3		100	100	100
260	257,5	262,5		100	100	100
280	277,5	282,5		100	100	100
300	297,5	302,5		100	100	100
320	317,5	322,5			100	100
340	337,5	342,5			100	100
360	357,5	362,5			100	100
380	377,5	382,5			100	100
400	397,5	402,5			100	100
to						
600	597,5	602,5			100	100
Other thread lengths in the range ≥ 4xd to max. standard length permitted. Intermediate lengths are possible. In case of shorter lengths : full thread						
Lr	**Reamer length**		Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0		
	Tolerance			-0,60		

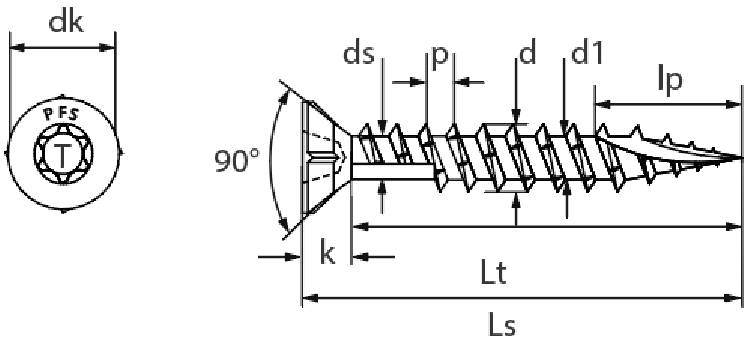
PFS+ wood screw, countersunk head

Partial thread (PFWVTG)



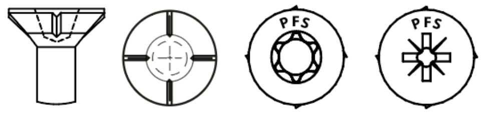
Manufacturer's trademark : "pfs" or "PFS"

Full thread (PFWVTV)



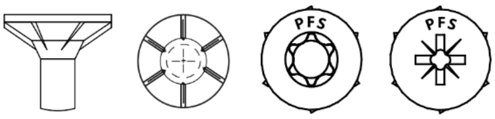
Head style

Countersunk head with 4 cutting ribs



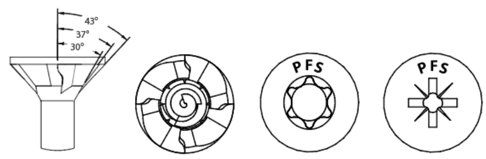
T-drive   Cross recess type Z

Countersunk head with 6 cutting ribs



T-drive   Cross recess type Z

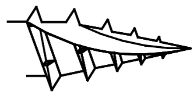
Countersunk head with multi milling ribs



T-drive   Cross recess type Z

Point style

Cutting point type 17



With our without supplementary green lubricant

Nominal diameter		2,5	3,0	3,5	4,0	4,5	5,0	6,0
d	Thread size	2,5	3,0	3,5	4,0	4,5	5,0	6,0
	Tolerance	± 0,1					± 0,15	
d1	Core diameter	1,7	1,9	2,2	2,5	2,9	3,2	3,9
	Tolerance	± 0,1						
dk	Head diameter	4,85	5,8	6,8	7,75	8,75	9,75	11,75
	Tolerance	± 0,15	± 0,2		± 0,25			
ds	Shank diameter	1,8	2,15	2,45	2,85	3,20	3,55	4,30
	Tolerance	± 0,1						
k	Head height max	3,0	3,5	4,0	4,4	4,7	5,2	5,9
Lp	Point length	no P17	7,0	8,1	9,0	9,9	11,25	13,5
			± 0,5	± 0,9	± 1,0	± 1,1	± 1,25	± 1,5
p	Thread pitch	1,3	1,5	2,1	2,4	2,7	3,0	3,6
	Tolerance	± 0,1 x p						
T-drive	Size	T8	T10	T15	T20		T25	T30
Cross recess type Z		1		2				3

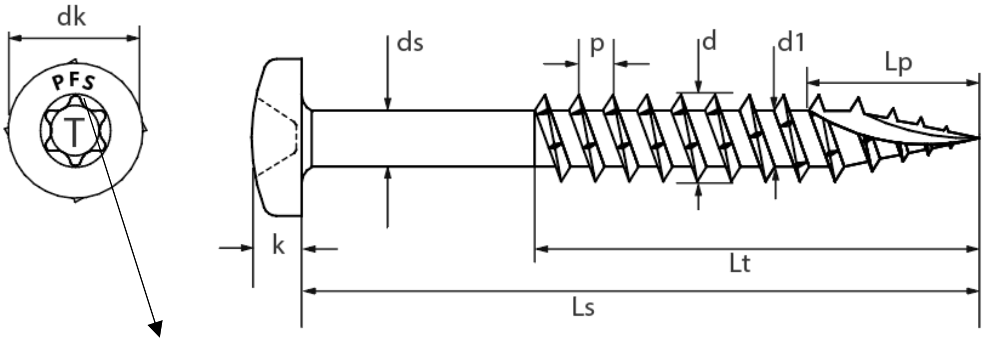
Ls	Screw length		Standard thread lengths (full thread = Lt,f/partial thread = Lt,p)													
Nom. dim	Min	max	Lt,f	Lt,p	Lt,f	Lt,p	Lt,f	Lt,p	Lt,f	Lt,p	Lt,f	Lt,p	Lt,f	Lt,p	Lt,f	Lt,p
12	12,0	13,5	10,0													
15	14,0	15,5	12,0		12,5											
16	16,0	17,5	14,0		14,0											
20	18,5	20,5	17,0	12,0	17,0		16,0		16,0							
25	23,5	25,5	22,0	18,0	21,0	18,0	21,0	18,0	21,0		20,0		20,0			
30	28,5	30,5	27,0	18,0	26,0	18,0	25,0	18,0	25,0	18,0	25,0		25,0		24,0	
35	33,5	36,0		22,0	31,0	23,0	30,0	23,0	30,0	23,0	30,0	25,0	30,0	25,0	29,0	
40	38,5	41,0		22,0	36,0	23,0	35,0	23,0	35,0	23,0	34,0	25,0	35,0	27,0	34,0	24,0
45	43,5	46,0		28,0		28,0		30,0	40,0	30,0	39,0	30,0	39,0	30,0	38,0	29,0
50	48,5	51,0				28,0		32,0	45,0	32,5	44,0	32,5	44,0	32,0	43,0	32,0
55	53,5	56,0				36,0		35,0	50,0	35,0	49,0	37,0	49,0	37,0	48,0	37,0
60	58,5	61,0						35,0	50,0	35,0	54,0	37,0	54,0	37,0	53,0	37,0
65	63,5	66,0						40,0	50,0	37,5	59,0	42,0	59,0	41,0	58,0	41,0
70	68,5	71,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
75	73,5	76,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
80	78,5	81,0							50,0	37,5	59,0	47,0	61,0	46,0	61,0	46,0
90	88,5	91,5									59,0	47,0		61,0		61,0
100	98,5	101,5												61,0		61,0
110	108,5	111,5												69,0		68,0
120	118,5	121,5												69,0		68,0
130	128,0	132,0														68,0
140	138,0	142,0														68,0
150	148,0	152,0														68,0
160	158,0	162,0														68,0
180	178,0	182,0														68,0
200	198,0	202,0														68,0

Other thread lengths in the range ≥ 4xd to max. standard length permitted.
Intermediate lengths are possible.

Lr	Reamer length	Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0
	Tolerance		-0,60

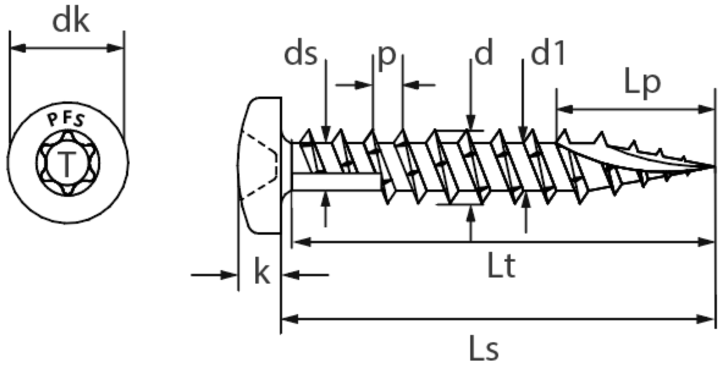
PFS+ wood screw, pan head

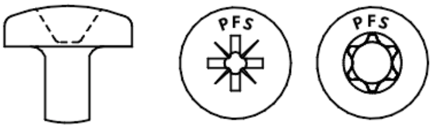
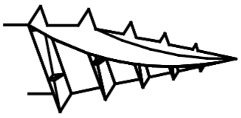
Partial thread (PFWCTG)



Manufacturer's trademark : "pfs" or "PFS"

Full thread (PFWCTV)



Head style	Point style
Pan head with 4 cutting ribs  T-drive Cross recess type Z	Cutting point type 17  With our without supplementary green lubricant 

Nominal diameter		**2,5**	**3,0**	**3,5**	**4,0**	**4,5**	**5,0**	**6,0**
d	**Thread size**	2,5	3,0	3,5	4,0	4,5	5,0	6,0
	Tolerance	± 0,1					± 0,15	
d1	**Core diameter**	1,7	1,9	2,2	2,5	2,9	3,2	3,9
	Tolerance	± 0,1						
dk	**Head diameter**	4,85	5,85	6,85	7,85	8,85	9,85	11,85
	Tolerance	± 0,1						
ds	**Shank diameter**	1,8	2,15	2,45	2,85	3,20	3,55	4,30
	Tolerance	± 0,1						
k	**Head height max**	2,0	2,25	2,6	2,9	3,2	3,5	4,3
Lp	**Point length**	no P17	7,0	8,1	9,0	9,9	11,25	13,5
			± 0,5	± 0,9	± 1,0	± 1,1	± 1,25	± 1,5
p	**Thread pitch**	1,3	1,5	2,1	2,4	2,7	3,0	3,6
	Tolerance	± 0,1 x p						
T-drive	**Size**	T8	T10	T15	T20		T25	T30
Cross recess type Z		1		2				3

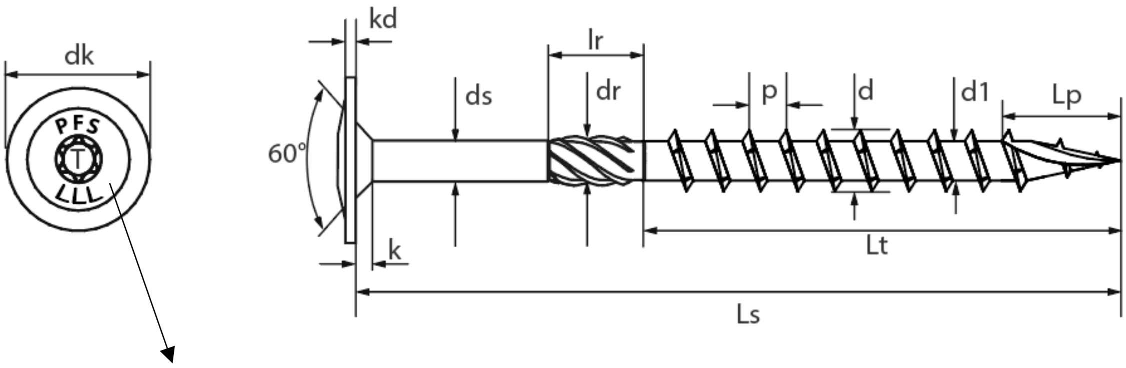
Ls	**Screw length**		Standard thread lengths (full thread = Lt,f/partial thread = Lt,p)													
Nom. dim	Min	max	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**	**Lt,f**	**Lt,p**
12	12,0	13,5	10,0													
15	14,0	15,5	12,0		12,5											
16	16,0	17,5	14,0		14,0											
20	18,5	20,5	17,0	12,0	17,0		16,0		16,0							
25	23,5	25,5	22,0	18,0	21,0	18,0	21,0	18,0	21,0		20,0		20,0			
30	28,5	30,5	27,0	18,0	26,0	18,0	25,0	18,0	25,0	18,0	25,0		25,0		24,0	
35	33,5	36,0		22,0	31,0	23,0	30,0	23,0	30,0	23,0	30,0	25,0	30,0	25,0	29,0	
40	38,5	41,0		22,0	36,0	23,0	35,0	23,0	35,0	23,0	34,0	25,0	35,0	27,0	34,0	24,0
45	43,5	46,0		28,0		28,0		30,0	40,0	30,0	39,0	30,0	39,0	30,0	38,0	29,0
50	48,5	51,0				28,0		32,0	45,0	32,5	44,0	32,5	44,0	32,0	43,0	32,0
55	53,5	56,0				36,0		35,0	50,0	35,0	49,0	37,0	49,0	37,0	48,0	37,0
60	58,5	61,0						35,0	50,0	35,0	54,0	37,0	54,0	37,0	53,0	37,0
65	63,5	66,0						40,0	50,0	37,5	59,0	42,0	59,0	41,0	58,0	41,0
70	68,5	71,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
75	73,5	76,0							50,0	37,5	59,0	42,0	61,0	41,0	61,0	41,0
80	78,5	81,0							50,0	37,5	59,0	47,0	61,0	46,0	61,0	46,0
90	88,5	91,5									59,0	47,0		61,0		61,0
100	98,5	101,5												61,0		61,0
110	108,5	111,5												69,0		68,0
120	118,5	121,5												69,0		68,0
130	128,0	132,0														68,0
140	138,0	142,0														68,0
150	148,0	152,0														68,0
160	158,0	162,0														68,0
180	178,0	182,0														68,0
200	198,0	202,0														68,0

Other thread lengths in the range ≥ 4xd to max. standard length permitted.
Intermediate lengths are possible.

Lr	**Reamer length**	Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0
	Tolerance		-0,60

PFS+ wood construction screw

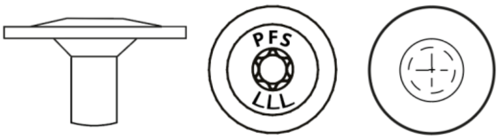
Flange head (PFETTG)



Manufacturer’s trademark : “pfs” or “PFS”
LLL = Nominal screw length indication

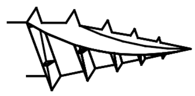
Head style

Flange head, T-drive



Point style

Cutting point type 17

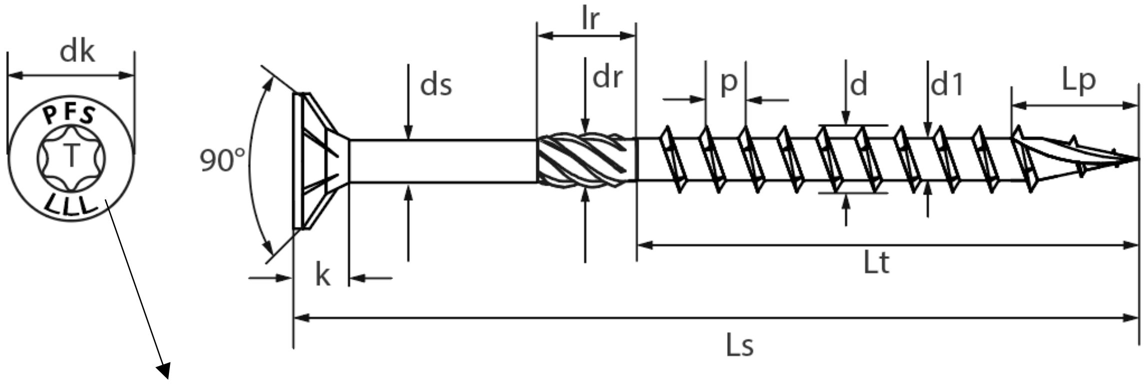


Nominal diameter		6	8	10
d	**Thread size**	6	8	10,1
	Tolerance	± 0,15	± 0,2	
d1	**Core diameter**	4,05	5,4	6,4
	Tolerance	± 0,1	± 0,15	
dk	**Head diameter**	14,0	21,0	24,5
	Tolerance	± 0,5	± 1,0	
dr	**Reamer diameter**	4,85	7,15	8,65
	Tolerance	± 0,15		
ds	**Shank diameter**	4,35	5,8	7,0
	Tolerance	± 0,1		
k	**Head height max (ref)**	5,0	5,0	5,0
kd	**Thickness of the flange**	2,6	3,2	3,6
	Tolerance	± 0,2		
Lp	**Point length**	11,5	12,25	14,25
	Tolerance	± 0,5	± 0,25	
p	**Thread pitch**	4,9	5,2	6,6
	Tolerance	± 0,5		± 0,7
T-drive	**Size**	T30	T40	

Ls	**Screw length**		**Standard thread lengths (Lt)**		
Nom. dim	Min	max	**6**	**8**	**10**
40	38,5	41,0	24		
45	43,5	46,0	27		
50	48,5	51,0	30	30	
60	58,5	61,0	36	36	36
70	68,5	71,0	42	42	42
80	78,5	81,0	48	48	48
90	88,5	91,5	54	54	54
100	98,5	101,5	60	60	60
110	108,5	111,5	65	65	65
120	118,5	121,5	75	75	75
130	128,0	132,0	80	80	80
140	138,0	142,0	80	80	80
150	148,0	152,0	90	90	90
160	158,0	162,0	90	90	90
180	178,0	182,0	100	100	100
200	198,0	202,0	100	100	100
220	217,7	222,3	100	100	100
240	237,7	242,3	100	100	100
260	257,5	262,5	100	100	100
280	277,5	282,5	100	100	100
300	297,5	302,5	100	100	100
320	317,5	322,5		100	100
340	337,5	342,5		100	100
360	357,5	362,5		100	100
380	377,5	382,5		100	100
400	397,5	402,5		100	100
to					
600	597,5	602,5		100	100
Other thread lengths in the range ≥ 4xd to max. standard length permitted. Intermediate lengths are possible. In case of shorter lengths : full thread					
Lr	**Reamer length**		Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0	
	Tolerance		-0,60		

PFS+ wood construction screw

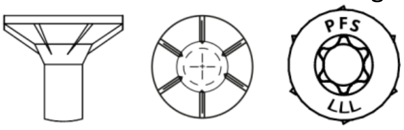
Countersunk head (PFEVTG)



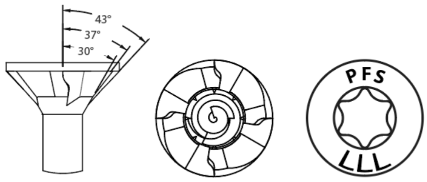
Manufacturer's trademark : "pfs" or "PFS"
LLL = Nominal screw length indication

Head style

Countersunk head with 6 milling ribs

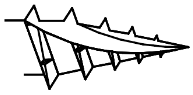


Countersunk head with multi milling ribs



Point style

Cutting point type 17

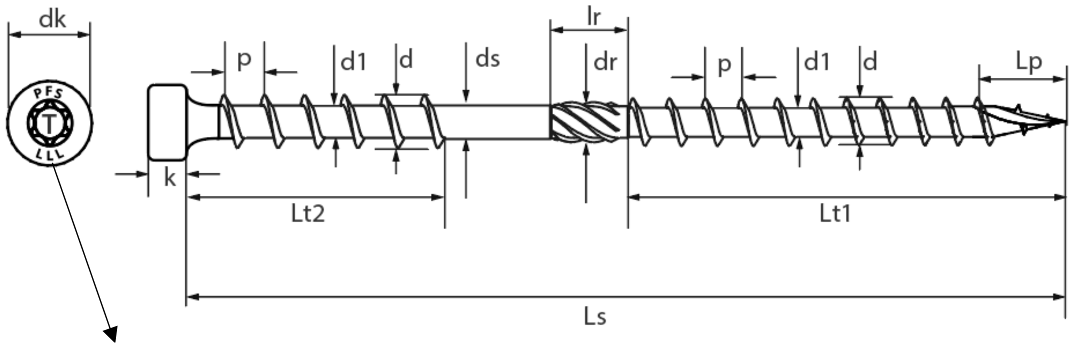


Nominal diameter		5	6	8	10
d	**Thread size**	5	6	8	10,1
	Tolerance	± 0,15		± 0,2	
d1	**Core diameter**	3,4	4,05	5,4	6,4
	Tolerance	± 0,1		± 0,15	
dk	**Head diameter**	10	12	14,5	18
	Tolerance	± 0,3	± 0,4		± 0,5
dr	**Reamer diameter**	3,9	4,85	7,15	8,65
	Tolerance	± 0,1	± 0,15		
ds	**Shank diameter**	3,65	4,35	5,8	7,0
	Tolerance	± 0,1			
k	**Head height max**	4,5	5,65	7,2	8,45
	Tolerance	± 0,15	± 0,25		
Lp	**Point length**	9,5	11,5	12,25	14,25
	Tolerance	± 0,5		± 0,25	
p	**Thread pitch**	3,1	4,9	5,2	6,6
	Tolerance	± 0,3	± 0,5		± 0,7
T-drive	**Size**	T25	T30	T40	

Ls	**Screw length**		**Standard thread lengths (Lt)**			
Nom. dim	Min	max	**5**	**6**	**8**	**10**
40	38,5	41,0	24	24		
45	43,5	46,0	27	27		
50	48,5	51,0	30	30	30	
60	58,5	61,0	36	36	36	36
70	68,5	71,0	42	42	42	42
80	78,5	81,0	48	48	48	48
90	88,5	91,5	54	54	54	54
100	98,5	101,5	60	60	60	60
110	108,5	111,5	65	65	65	65
120	118,5	121,5	70	75	75	75
130	128,0	132,0	75	80	80	80
140	138,0	142,0	80	80	80	80
150	148,0	152,0		90	90	90
160	158,0	162,0		90	90	90
180	178,0	182,0		100	100	100
200	198,0	202,0		100	100	100
220	217,7	222,3		100	100	100
240	237,7	242,3		100	100	100
260	257,5	262,5		100	100	100
280	277,5	282,5		100	100	100
300	297,5	302,5		100	100	100
320	317,5	322,5			100	100
340	337,5	342,5			100	100
360	357,5	362,5			100	100
380	377,5	382,5			100	100
400	397,5	402,5			100	100
to						
600	597,5	602,5			100	100
Other thread lengths in the range ≥ 4xd to max. standard length permitted. Intermediate lengths are possible. In case of shorter lengths : full thread						
Lr	**Reamer length**		Ls <89 mm Ls >89 mm Ls >119 mm	- 5,0 10,0		
	Tolerance			-0,60		

Sarking screw with double thread

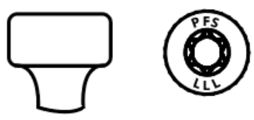
Cylinder head (PFDCTG, HADCTG)



Optionally with
Manufacturer's trademark : "pfs" or
"PFS" or "Hapax" or "H.P.X"
LLL = Nominal screw length indication

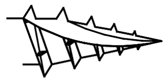
Head style

Cylinder head, T-drive



Point style

Cutting point type P17



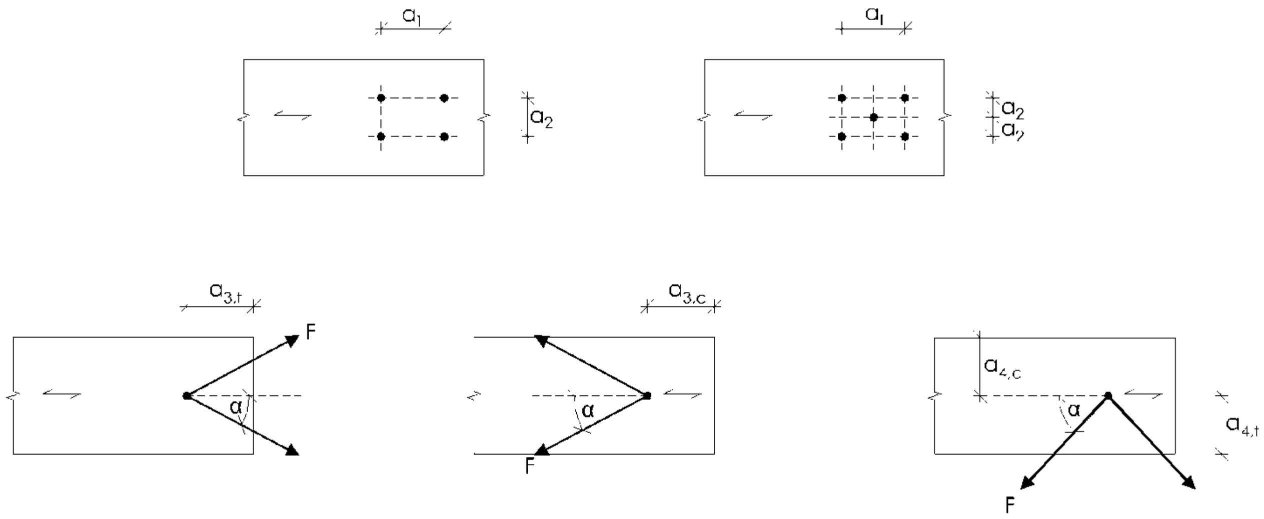
Triple thread point

Nominal diameter		**8**	
d	**Thread size**	8,0	
	Tolerance	± 0,2	
d1	**Core diameter**	5,2	
	Tolerance	± 0,25	
dk	**Head diameter**	11	
	Tolerance	-0,1	
dr	**Reamer diameter**	7,0	
	Tolerance	± 0,3	
Lr	**Reamer length**	12,0	
	Tolerance	± 1,5	
ds	**Shank diameter**	5,8	
	Tolerance	± 0,05	
k	**Head height**	6,0	
	Tolerance	± 0,5	
Lp	**Point length (P17 only)**	12,25	
	Tolerance	± 0,25	
p	**Thread pitch**	5,2	
	Tolerance	0,1 x p	
T-drive	**Size**	T40	
Ls	**Screw length**	**Lt1**	**Lt2**
	165-200	**80**	**60**
	201-300	**100**	**60**
	301-400	**100**	**60**
	401-500	**100**	**60**
	501-600	**100**	**60**
	Tolerance	± 1,5	± 1,5

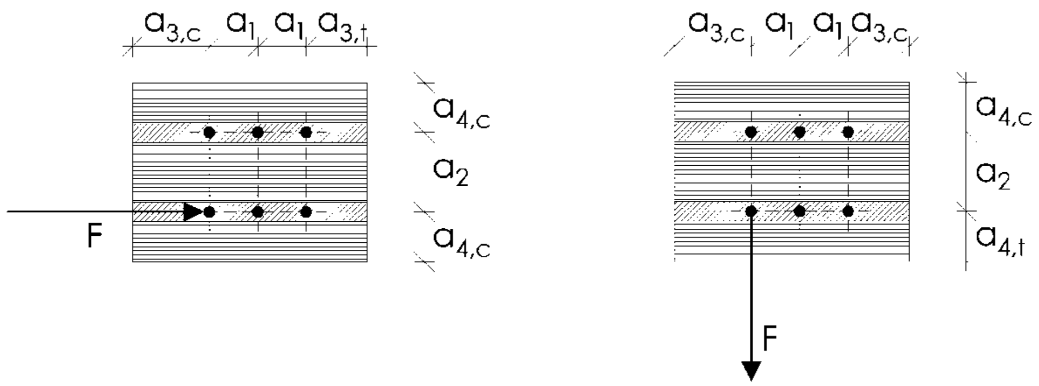
Annex B
Minimum distances and spacing

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:



For screws in the edge surface, a_1 and a_3 are parallel to the CLT plane face, a_2 and a_4 perpendicular to CLT plane face.

Table B1: Minimum spacing, end and edge distances of screws in the plane or edge surfaces of cross laminated timber

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Plane surface (see Figure 1)	$4 \cdot d$	$6 \cdot d$	$6 \cdot d$	$2,5 \cdot d$	$6 \cdot d$	$2,5 \cdot d$
Edge surface (see Figure 2)	$10 \cdot d$	$12 \cdot d$	$7 \cdot d$	$4 \cdot d$	$6 \cdot d$	$3 \cdot d$

Annex C
Compression reinforcement

pgb wood screws with a full thread may be used for reinforcement of timber members with compression stresses at an angle α to the grain of $45° \leq \alpha \leq 90°$. The compression force must be evenly distributed over all screws. The screw head must be flush with the surface of the timber member.

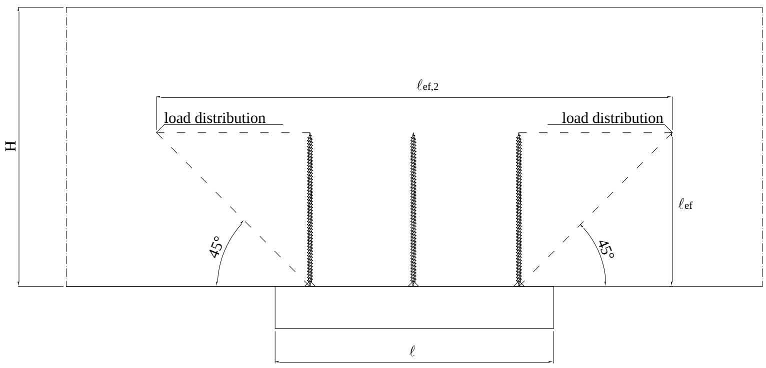
The characteristic load-carrying capacity for a contact area with screws with a full thread at an angle α to the grain of $45° \leq \alpha \leq 90°$ shall be calculated from:

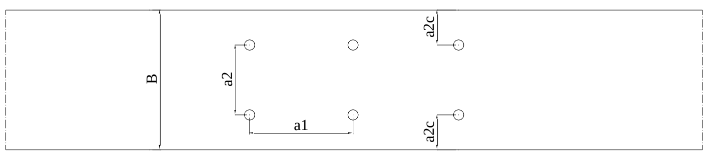
$$F_{90,Rk} = \min \begin{cases} k_{c,90} \cdot B \cdot \ell_{ef,1} \cdot f_{c,90,k} + n \cdot F_{ax,Rk} \\ B \cdot \ell_{ef,2} \cdot f_{c,90,k} \end{cases}$$

Where

$F_{90,Rk}$	Load-carrying capacity of reinforced contact area [N]
$k_{c,90}$	factor for compression perpendicular to the grain according to EN 1995-1-1
B	bearing width [mm]
$\ell_{ef,1}$	effective length of contact area according to EN 1995-1-1 [mm]
$f_{c,90,k}$	characteristic compressive strength perpendicular to the grain [N/mm²]
n	number of reinforcement screws, $n = n_0 \cdot n_{90}$
n_0	number of reinforcement screws arranged in a row parallel to the grain
n_{90}	number of reinforcement screws arranged in a row perpendicular to the grain
$F_{ax,Rk}$	characteristic compressive capacity [N]
$\ell_{ef,2}$	effective distribution length in the plane of the screw tips [mm]
$\ell_{ef,2}$	$= \ell_{ef} + (n_0 - 1) \cdot a_1 + \min (\ell_{ef}; a_{1,c})$ for end-bearings [mm]
$\ell_{ef,2}$	$= 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1$ for centre-bearings [mm]
ℓ_{ef}	point side penetration length [mm]
a_1	spacing parallel to the grain [mm]
$a_{1,c}$	end distance [mm]

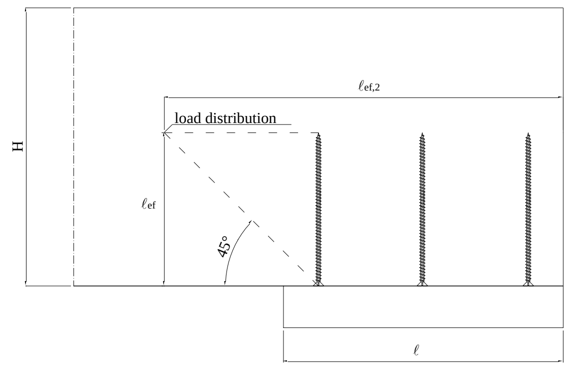
Reinforced centre-bearing

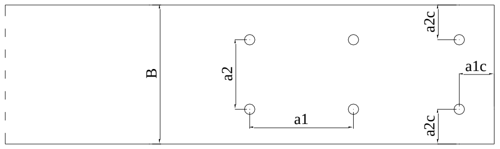




H	component height [mm]
B	bearing width [mm]
ℓ_{ef}	point side penetration length [mm]
$\ell_{ef,2}$	effective distribution length in the plane of the screw tips [mm] $= 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1$ for centre-bearings

Reinforced end-bearing





H	component height [mm]
B	bearing width [mm]
ℓ_{ef}	point side penetration length [mm]
$\ell_{ef,2}$	effective distribution length in the plane of the screw tips [mm]
	$= \ell_{ef} + (n_0 - 1) \cdot a_1 + \min(\ell_{ef}; a_{1,c})$ for end-bearings

Reinforcing screws for wood-based panels and hardwoods are not covered by this European Technical Assessment.

Annex D
Thermal insulation material on top of rafters

pgb screws with an outer thread diameter 6 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 300 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 14081, cross-laminated timber, or laminated veneer lumber according to EN 14374 or to ETA or similar glued members according to ETA.

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 = 10 mm: b_{min} = 60 mm t_{min} = 40 mm

The insulation must comply with an ETA.

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

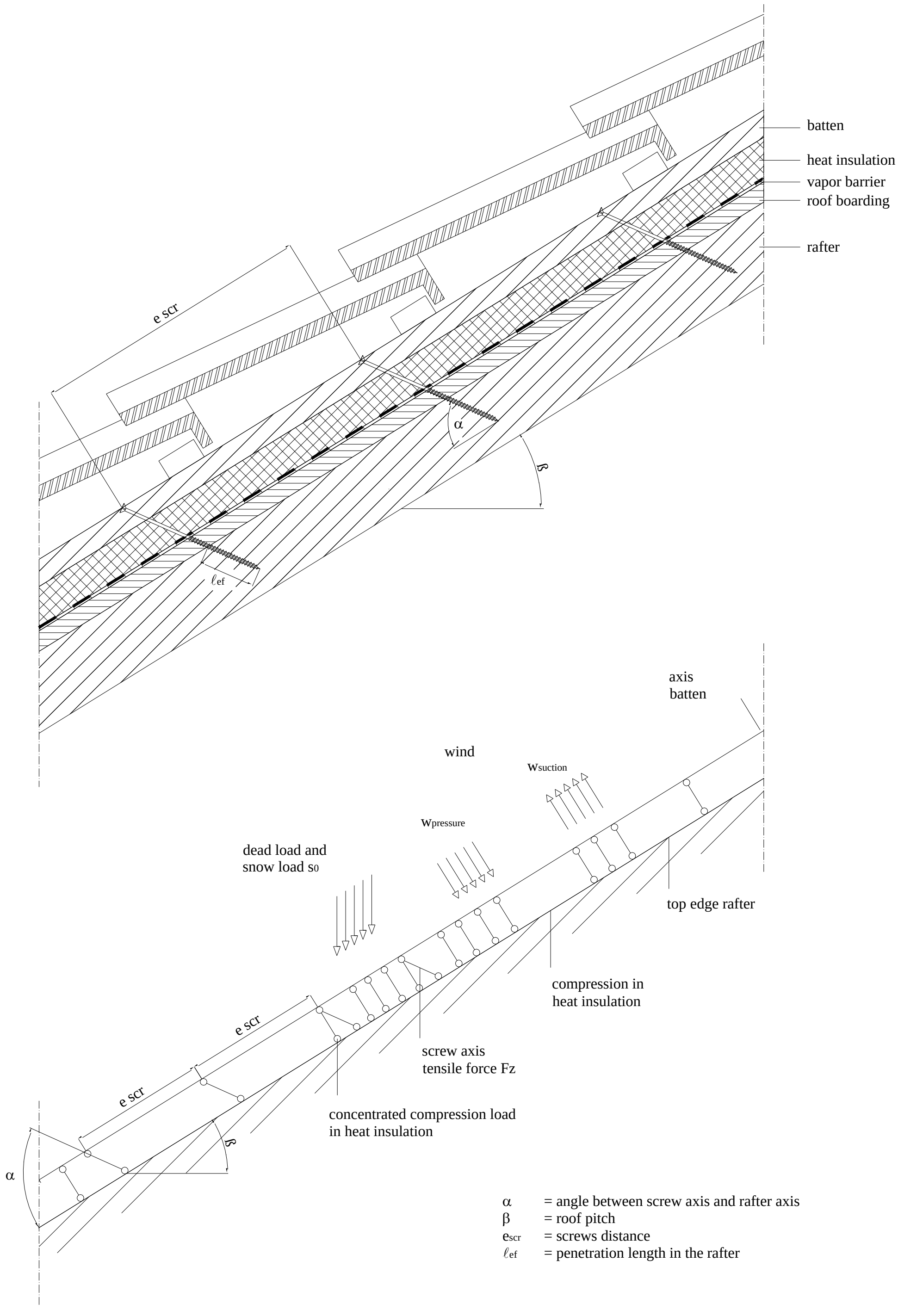
The anchorage of wind suction forces as well as the bending stresses of the battens or the boards, respectively, shall be considered in design. Additional screws perpendicular to the grain of the rafter (angle α = 90°) may be arranged if necessary.

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, heat insulation 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 heat insulation on top of the rafter the elastic foundation. The minimum compression stress of the heat insulation 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 heat insulation

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 heat insulation if the effective width w_{ef} of the heat insulation under compression is known. Due to the load extension in the heat insulation 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 heat insulation 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 heat insulation

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

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 heat insulation

The compressive stresses in the heat insulation 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:

$$F_{ax,\alpha,Rd} = \min\left\{k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef} \cdot k_1 \cdot k_2 \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; f_{head,d} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350}\right)^{0.8}; f_{tens,d}\right\} \quad \text{for screws with partial thread}$$

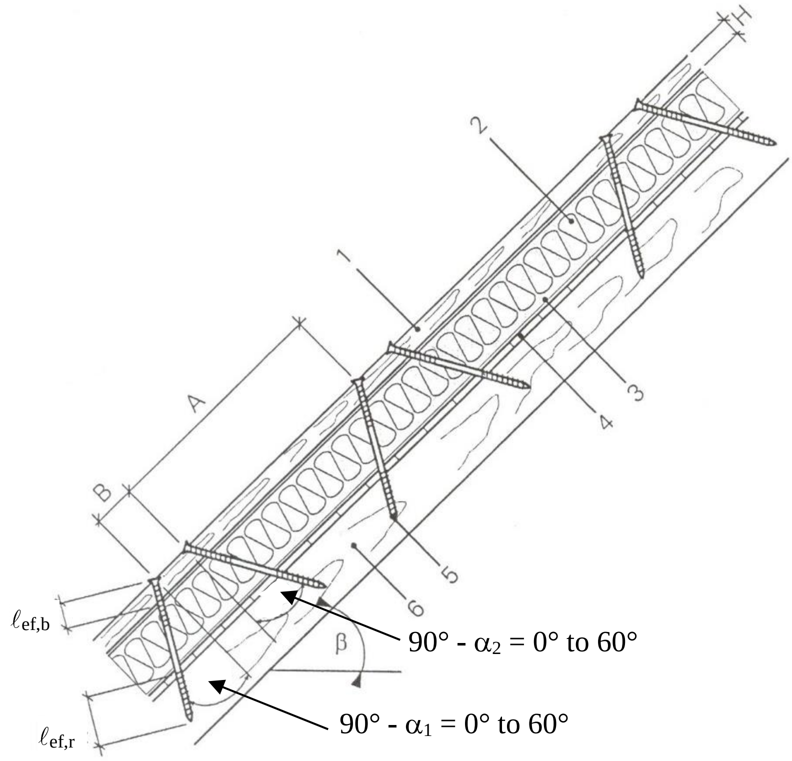
$$F_{ax,\alpha,Rd} = \min\left\{\begin{array}{c} k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef} \cdot k_1 \cdot k_2 \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \\ \max\left\{f_{head,d} \cdot d_h^2; k_{ax} \cdot f_{ax,d} \cdot d \cdot \ell_{ef,b} \cdot k_1 \cdot k_2\right\} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \\ f_{tens,d} \end{array}\right\} \quad \text{for screws with full thread}$$

Where:

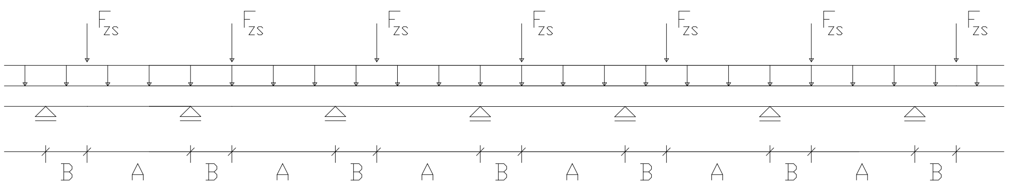
$f_{ax,d}$	design value of the axial withdrawal parameter of the threaded part of the screw
d	outer thread diameter of the screw
ℓ_{ef}	Point side penetration length of the threaded part of the screw in the batten, $l_{ef} \geq 40$ mm
ρ_k	characteristic density of the wood-based member [kg/m³]
$f_{head,d}$	design value of the head pull-through capacity of the screw
d_h	head diameter
$f_{tens,d}$	design value of the tensile capacity of the screw
k_1	min {1; 200/t_{HI}}
k_2	min {1; $\sigma_{10\%}$/0,12}
t_{HI}	thickness of the heat insulation [mm]
$\sigma_{10\%}$	compressive stress of the heat insulation under 10 % deformation [N/mm²]

If 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 22 mm from plywood according to EN 636, particle board according to EN 312, oriented strand board according to EN 300 or ETA and solid wood panels according to EN 13353 or cross laminated timber 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 ℓ = 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:

$$F_{ax,\alpha,Rd} = \min\left\{k_{ax}\cdot f_{ax,d}\cdot d\cdot \ell_{ef,b}\cdot\left(\frac{\rho_{b,k}}{\rho_a}\right)^{0.8}; k_{ax}\cdot f_{ax,d}\cdot d\cdot \ell_{ef,r}\cdot\left(\frac{\rho_{r,k}}{\rho_a}\right)^{0.8}; f_{tens,d}\right\}$$

Screws loaded in compression:

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

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, $30° \leq \alpha_1 \leq 90°$, $30° \leq \alpha_2 \leq 90°$
$f_{tens,d}$ design value of the tensile capacity of the screw
γ_{M1} 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]	PFDCTG screw ∅ 8 mm $\kappa_c \cdot N_{pl,k}$ [kN]	Free screw length [mm]	PFDCTG screw ∅ 8 mm $\kappa_c \cdot N_{pl,k}$ [kN]
≤ 100	6,09	280	1,15
120	4,68	300	1,02
140	3,70	320	0,91
160	2,99	340	0,82
180	2,48	360	0,73
200	2,07	380	0,67
220	1,76	400	0,61
240	1,51	420	0,55
260	1,32	440	0,51