

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

**ETA-11/0389**  
**of 11 January 2021**

English translation prepared by DIBt - Original version in German language

### General Part

Technical Assessment Body issuing the  
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

PanelFix screws

Product family  
to which the construction product belongs

PanelFix screws for use in timber constructions

Manufacturer

BFU Fixing GmbH  
Kirchgärten 4  
74626 Bretzfeld  
DEUTSCHLAND

Manufacturing plant

Hersteller 1, Hersteller 2, Hersteller 3, Hersteller 4,  
Hersteller 5

This European Technical Assessment  
contains

31 pages including 4 annexes which form an integral part  
of this assessment

This European Technical Assessment is  
issued in accordance with Regulation (EU)  
No 305/2011, on the basis of

EAD 130118-01-0603

This version replaces

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## Specific Part

### 1 Technical description of the product

PanelFix screws are self-tapping screws made from special carbon steel. They are hardened. They have a corrosion protection according to Annex A.2.6. The outer thread diameter is not less than 3.5 mm and not greater than 10.0 mm. The overall length of the screws is ranging from 30 mm to 400 mm. Further dimensions are shown in Annex 4. They have an anti-friction coating. The washers are made from carbon steel. The dimensions of the washers are given in Annex 4.

### 2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the screws are used in compliance with the specifications and conditions given in Annex 1 and 2.

Durability is only ensured if the specifications of intended use according to Annex 1 and 2 are taken into account.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the screws of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, 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

#### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic   | Performance               |
|--|---------------------------|
| Dimensions   | See Annex 4               |
| Characteristic yield moment  | See Annex 2               |
| Bending angle  | See Annex 2               |
| Characteristic withdrawal parameter  | See Annex 2               |
| Characteristic head pull-through parameter   | See Annex 2               |
| Characteristic tensile strength  | See Annex 2               |
| Characteristic yield strength  | No performance determined |
| Characteristic torsional strength  | See Annex 2               |
| Insertion moment   | See Annex 2               |
| Spacing, end and edge distances of the screws and minimum thickness of the wood-based material | See Annex 2               |
| Slip modulus for mainly axially loaded screws  | See Annex 2               |
| Durability against corrosion   | See Annex 2               |

**3.2 Safety in case of fire (BWR 2)**

| Essential characteristic | Performance |
|--------------------------|-------------|
| Reaction to fire         | Class A1    |

**3.3 Safety and accessibility in use (BWR 4)**

Same as BWR 1

**4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base**

In accordance with EAD No. 130118-01-0603 the applicable European legal act is: 97/176/EC.  
The system to be applied is: 3

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 11 January 2021 by Deutsches Institut für Bautechnik

Anja Dewitt  
Head of Section

*beglaubigt:*  
Vössing

## Annex 1 Specifications of intended use

### A.1.1 Use of the PanelFix screws only for:

- Static and quasi-static loads

### A.1.2 Base materials

The screws are used for connections in load bearing timber structures between wood-based members or between those members and steel members:

- Solid timber (softwood) according to EN 14081-1<sup>1</sup>,
- Glued laminated timber (softwood) according to EN 14080<sup>2</sup>,
- Laminated veneer lumber LVL of softwood according to EN 14374<sup>3</sup>, arrangement of the screws only perpendicular to the plane of the veneers,
- Glued solid timber (softwood) according to EN 14080,
- Cross-laminated timber (softwood) according to European Technical Approvals/Assessments.

The screws may be used for connecting the following wood-based panels to the timber members mentioned above:

- Plywood according to EN 636<sup>4</sup> and EN 13986<sup>5</sup>,
- Oriented Strand Board, OSB according to EN 300<sup>6</sup> and EN 13986,
- Particleboard according to EN 312<sup>7</sup> and EN 13986,
- Fibreboards according to EN 622-2<sup>8</sup>, EN 622-3<sup>9</sup> and EN 13986,
- Cement-bonded particle boards according to EN 634-2<sup>10</sup> and EN 13986,
- Solid-wood panels according to EN 13353<sup>11</sup> and EN 13986.

Wood-based panels are only arranged on the side of the screw head.

PanelFix screws with an outer thread diameter of 6 mm may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades.

|    |                         |  |
|----|-------------------------|--|
| 1  | EN 14081-1:2005+A1:2011 | Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements                              |
| 2  | EN 14080:2013           | Timber structures - Glued laminated timber and glued solid timber - Requirements   |
| 3  | EN 14374:2004           | Timber structures - Structural laminated veneer lumber - Requirements  |
| 4  | EN 636:2012+A1:2015     | Plywood - Specifications   |
| 5  | EN 13986:2004+A1:2015   | Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking  |
| 6  | EN 300:2006             | Oriented strand boards (OSB) – Definition, classification and specifications   |
| 7  | EN 312:2010             | Particleboards - Specifications  |
| 8  | EN 622-2:2004           | Fibreboards – Specifications – Part 2: Requirements for hardboards   |
| 9  | EN 622-3:2004           | Fibreboards - Specifications - Part 3: Requirements for medium boards  |
| 10 | EN 634-2:2007           | Cement-bonded particleboards – Specifications – Part 2: Requirements for OPC bonded particleboards for use in dry, humid and external conditions |
| 11 | EN 13353:2008+A1:2011   | Solid wood panels (SWP) – Requirements   |

|                                |         |
|--------------------------------|---------|
| PanelFix screws                | Annex 1 |
| Specifications of intended use |         |

### A.1.3 Use Conditions (environmental conditions)

The corrosion protection of the PanelFix screws is specified in Annex A.2.6.

### A.1.4 Installation provisions

EN 1995-1-1<sup>12</sup> applies for the installation.

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

The screws are driven into the wood-based member made of softwood without pre-drilling. The screw holes in steel members shall be pre-drilled with an adequate diameter greater than the outer thread diameter.

If screws with an outer thread diameter  $d \geq 8$  mm are driven into the wood-based member without pre-drilling, the structural solid or glued laminated timber, laminated veneer lumber and similar glued members shall be from spruce, pine or fir.

In the case of fastening battens on thermal insulation material on top of rafters the screws shall be driven in the rafter through the battens and the thermal insulation material without pre-drilling in one sequence.

Countersunk head screws may be used with washers according to Annex 4. After inserting the screw the washers shall touch the surface of the wood-based member completely.

By fastening screws in wood-based members the head of the screws shall be flush with the surface of the wood-based member. For wafer head and combi-head screws the head part remains unconsidered.

<sup>12</sup> EN 1995-1-1: 2004+AC:2006+A1:2008+A2:2014 Eurocode 5: Design of timber structures – Part 1-1: General - Common rules and rules for buildings

|                         |         |
|-------------------------|---------|
| PanelFix screws         | Annex 1 |
| Installation provisions |         |

## ANNEX 2 – Characteristic values of the load-carrying capacities

Table A.2.1 Characteristic load-carrying capacities of PanelFix screws

| Outer thread diameter [mm]                            | 3.5 | 4.0 | 4.5 | 5.0 | 6.0  | 8.0  | 10.0 |
|---|-----|-----|-----|-----|------|------|------|
| Characteristic yield moment<br>$M_{y,k}$ [Nm]         | 2.5 | 3.3 | 4.5 | 5.9 | 9.5  | 22.0 | 36.0 |
| Characteristic tensile strength<br>$f_{tens,k}$ [kN]  | 4.3 | 5.7 | 7.2 | 8.8 | 12.0 | 15.0 | 31.0 |
| Characteristic torsional strength<br>$f_{tor,k}$ [Nm] | 2.4 | 3.5 | 5.0 | 7.0 | 10.0 | 25.0 | 45.0 |

### A.2.1 General

All PanelFix screws achieve a bending angle  $\alpha$  of at least  $45/d^{0.7} + 20$ , where  $d$  is the outer thread diameter of the screws.

The minimum penetration length of the threaded part of the screw in the wood-based member  $l_{ef}$  shall be

$$l_{ef} = \min \begin{cases} \frac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{cases} \quad (2.1)$$

where

$\alpha$  angle between screw axis and grain direction

$d$  outer thread diameter of the screw.

The outer thread diameter of screws inserted in cross-laminated timber is at least 6 mm. The inner thread diameter  $d_i$  of the screws is greater than the maximal width of the gaps in the layer of cross laminated timber.

### A.2.2 Laterally loaded screws

#### A.2.2.1 General

The outer thread diameter  $d$  shall be used as effective diameter of the screw according to EN 1995-1-1.

The embedding strength for the screws in wood-based members or in wood-based panels shall be taken from EN 1995-1-1 unless otherwise specified in the following.

|   |         |
|---|---------|
| PanelFix screws                                       | Annex 2 |
| Characteristic values of the load-carrying capacities |         |

#### A.2.2.2 Cross laminated timber

The embedding strength for screws arranged in the edge surfaces parallel to the plane of cross laminated timber may be assumed according to equation (2.2) independent of the angle between screw axis and grain direction,  $0^\circ \leq \alpha \leq 90^\circ$ :

$$f_{h,k} = 20 \cdot d^{-0,5} \text{ in N/mm}^2 \quad (2.2)$$

unless otherwise specified in the technical specification of the cross laminated timber.

Where  $d$  is the outer thread diameter of the screws in mm.

Equation (2.2) is only valid for softwood layers. The provisions in the European Technical Approval/ Assessment of the cross laminated timber apply.

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. Where applicable, the angle between force and grain direction of the outer layer shall 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.

For angles  $45^\circ \leq \alpha < 90^\circ$  between screw axis and grain direction of the outer layer the characteristic load-carrying capacity may be assumed as 2/3 of the corresponding value for  $\alpha = 90^\circ$ , if only the penetration depth perpendicular to the wide face is taken into account.

#### A.2.3 Axially loaded screws

The axial slip modulus  $K_{ser}$  of the threaded part of a screw for the serviceability limit state shall be taken independent of angle  $\alpha$  to the grain as:

$$K_{ser} = 780 \cdot d^{0,2} \cdot l_{ef}^{0,4} \quad [\text{N/mm}] \quad (2.3)$$

Where

$d$  outer thread diameter of the screw [mm]

$l_{ef}$  penetration length of the threaded part of the screw in the wood-based member [mm].

##### A.2.3.1 Axial withdrawal capacity

The characteristic withdrawal capacity in solid timber, glued laminated timber, cross laminated timber or laminated veneer lumber members made from softwood at an angle of  $15^\circ \leq \alpha \leq 90^\circ$  to the grain shall be calculated as:

$$F_{ax,\alpha,Rk} = n_{ef} \cdot k_{ax} \cdot f_{ax,k} \cdot d \cdot l_{ef} \cdot \left( \frac{\rho_k}{350} \right)^{0,8} \quad (2.4)$$

where

$F_{ax,\alpha,Rk}$  Characteristic withdrawal capacity of a screw group at an angle  $\alpha$  to the grain [N]

$n_{ef}$  Effective number of screws according to EN 1995-1-1:2008, clause 8.7.2 (8)

For inclined screws with an angle between shear plane and screw axis  $30^\circ \leq \alpha \leq 60^\circ$ :

$$n_{ef} = \max \{ n^{0,9}; 0,9 \cdot n \} \quad (2.5)$$

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

$n$  Number of screws acting together in a connection. If crossed pairs of screws are used in timber-to-timber connections,  $n$  is the number of crossed pairs of screws.

$k_{ax}$  Factor, taking into account the angle  $\alpha$  between screw axis and grain direction

$$k_{ax} = 1,0 \quad \text{for } 45^\circ \leq \alpha \leq 90^\circ$$

$$k_{ax} = 0,3 + \frac{0,7 \cdot \alpha}{45^\circ} \quad \text{for } 15^\circ \leq \alpha < 45^\circ \quad (2.6)$$

|   |         |
|---|---------|
| PanelFix screws                                       | Annex 2 |
| Characteristic values of the load-carrying capacities |         |



|            |   |
|------------|---|
| $f_{ax,k}$ | Characteristic withdrawal parameter at an angle $\alpha = 90^\circ$ based on a characteristic density of the wood-based member $\rho_k$ of 350 kg/m <sup>3</sup><br>$f_{ax,k} = 14$ N/mm <sup>2</sup> for PanelFix screws with $3.5 \text{ mm} \leq d \leq 4.5 \text{ mm}$<br>$f_{ax,k} = 13$ N/mm <sup>2</sup> for PanelFix screws with $d = 5.0 \text{ mm}$<br>$f_{ax,k} = 12$ N/mm <sup>2</sup> for PanelFix screws with $d = 6.0 \text{ mm}$<br>$f_{ax,k} = 10.5$ N/mm <sup>2</sup> for PanelFix screws with $d > 6.0 \text{ mm}$<br>The characteristic withdrawal parameter is also valid for softwood layers of cross-laminated timber. |
| $d$        | outer thread diameter of the screw  |
| $l_{ef}$   | penetration length of the threaded part of the screw in the wood-based member   |
| $\rho_k$   | Characteristic density of the wood-based member, for LVL $\rho_k \leq 500 \text{ kg/m}^3$ ,   |

For screws penetrating more than one layer of cross laminated timber the different layers may be taken into account proportionally. In the lateral surfaces of the cross laminated timber the screws shall be fully inserted in one layer of cross-laminated timber.

### A.2.3.2 Head pull-through capacity

The characteristic value of the head pull-through parameter for PanelFix screws for a characteristic density of 350 kg/m<sup>3</sup> of the timber and for wood-based panels like

- Plywood according to EN 636 and EN 13986
- Oriented Strand Board, OSB according to EN 300 and EN 13986
- Particleboard according to EN 312 and EN 13986
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986
- Cement-bonded particle boards according to EN 634-2 and EN 13986,
- Solid-wood panels according to EN 13353 and EN 13986

with a thickness of more than 20 mm is

$f_{head,k} = 12 \text{ N/mm}^2$  for  $d_h \leq 22 \text{ mm}$  and

$f_{head,k} = 10 \text{ N/mm}^2$  for  $d_h > 22 \text{ mm}$  with  $d_h$  as screw head or washer diameter.

For wood-based panels a maximum characteristic density of 380 kg/m<sup>3</sup> and for LVL a maximum characteristic density of 500 kg/m<sup>3</sup> shall be used in equation (8.40b) of EN 1995-1-1.

The head diameter shall be equal to or greater than  $1.8 \cdot d_s$ , where  $d_s$  is the smooth shank or the inner thread diameter. Otherwise the characteristic head pull-through capacity in equation (8.40b) of EN 1995-1-1 is for all wood-based materials:  $F_{ax,\alpha,RK} = 0$ .

For wood based panels with a thickness  $12 \text{ mm} \leq t \leq 20 \text{ mm}$  the characteristic value of the head pull-through parameter for the screws is:

$f_{head,k} = 8 \text{ N/mm}^2$

For wood based panels with a thickness of less than 12 mm the characteristic head pull-through capacity for screws shall be based on a characteristic value of the head pull-through parameter of 8 N/mm<sup>2</sup>, and limited to 400 N complying with the minimum thickness of the wood based panels of  $1.2 \cdot d$ , with  $d$  as outer thread diameter and the values in Table A.2.2.

|   |         |
|---|---------|
| PanelFix screws                                       | Annex 2 |
| Characteristic values of the load-carrying capacities |         |

Table A.2.2 Minimum thickness of wood based panels

| Wood based panel                           | Minimum thickness [mm] |
|--|------------------------|
| Plywood                                    | 6                      |
| Fibreboards (hardboards and medium boards) | 6                      |
| Oriented Strand Boards, OSB                | 8                      |
| Particleboards                             | 8                      |
| Cement-bonded particle board               | 8                      |
| Solid wood Panels                          | 12                     |

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

|   |         |
|---|---------|
| PanelFix screws                                       | Annex 2 |
| Characteristic values of the load-carrying capacities |         |

#### A.2.4 Spacing, end and edge distances of the screws and minimum thickness of the wood based material

Minimum thickness for structural members made from solid timber, glued laminated timber, glued solid timber, laminated veneer lumber and cross laminated timber is  $t = 24$  mm for screws with  $d \leq 6$  mm,  $t = 30$  mm for screws with  $d = 8$  mm and  $t = 40$  mm for screws with  $d = 10$  mm.

##### A.2.4.1 Laterally and/or axially loaded screws

Screws in non pre-drilled holes

For PanelFix screws 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. Here, the outer thread diameter  $d$  shall be considered.

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

Minimum distances from loaded or unloaded ends shall be at least  $15 \cdot d$  for screws with outer thread diameter  $d \geq 8$  mm and timber thickness  $t < 5 \cdot d$ .

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

##### A.2.4.2 Only axially loaded screws

For PanelFix screws the minimum spacings, end and edge distances are given in EN 1995-1-1, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes and clause 8.7.2, Table 8.6.

##### A.2.4.3 Cross laminated timber

The minimum requirements for spacing, end and edge distances of screws in the plane or edge surfaces of cross laminated timber are summarised in Table A.2.3. The definition of spacing, end and edge distance is shown in Figure A.2.1 and Figure A.2.2. The minimum spacing, end and edge distances in the edge surfaces are independent of the angle between screw axis and grain direction. They may be used based on the following conditions:

- Minimum thickness of cross laminated timber:  $10 \cdot d$
- Minimum penetration depth in the edge surface:  $10 \cdot d$

For load components perpendicular to the plane surface (see Figure A.2.2 right) the tensile stresses perpendicular to the grain should be transferred by reinforcing screws.

Table A.2.3 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 A.2.1) | $4 \cdot d$  | $6 \cdot d$  | $6 \cdot d$ | $2,5 \cdot d$ | $6 \cdot d$ | $2,5 \cdot d$ |
| Edge surface (see Figure A.2.2)  | $10 \cdot d$ | $12 \cdot d$ | $7 \cdot d$ | $4 \cdot d$   | $6 \cdot d$ | $3 \cdot d$   |

|                                 |         |
|---------------------------------|---------|
| PanelFix screws                 | Annex 2 |
| Spacing, end and edge distances |         |

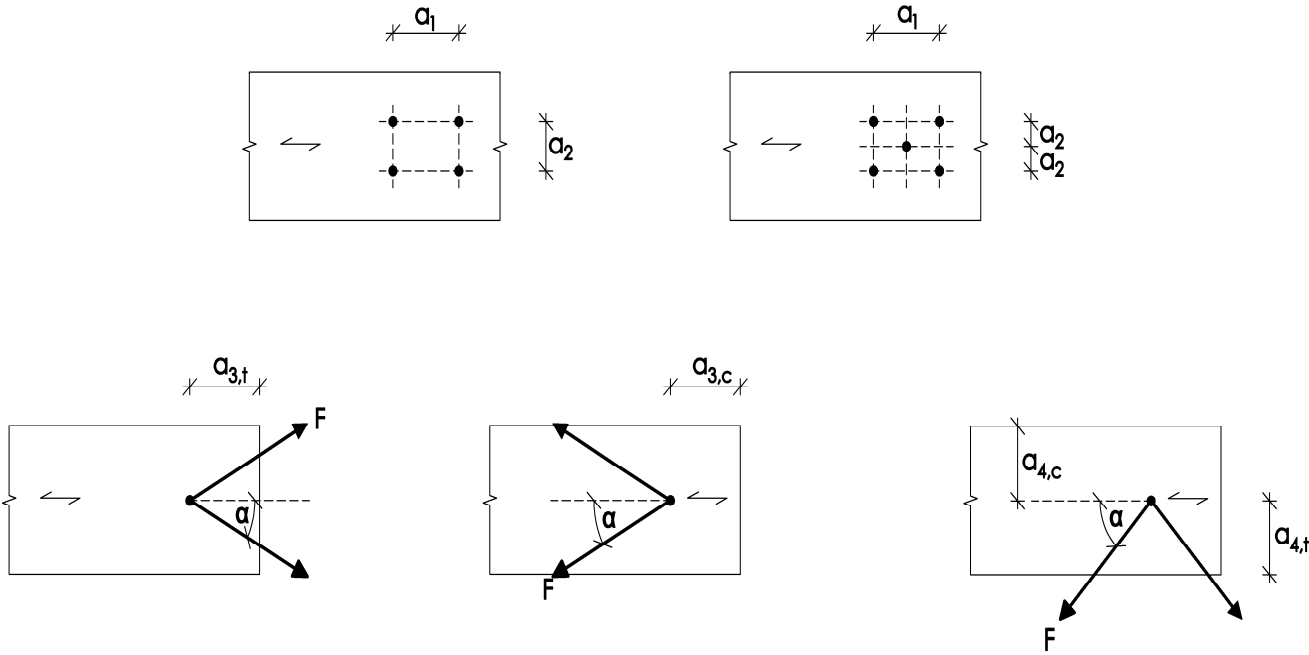


Figure A.2.1 Definition of spacing, end and edge distances in the plane surface of the cross laminated timber

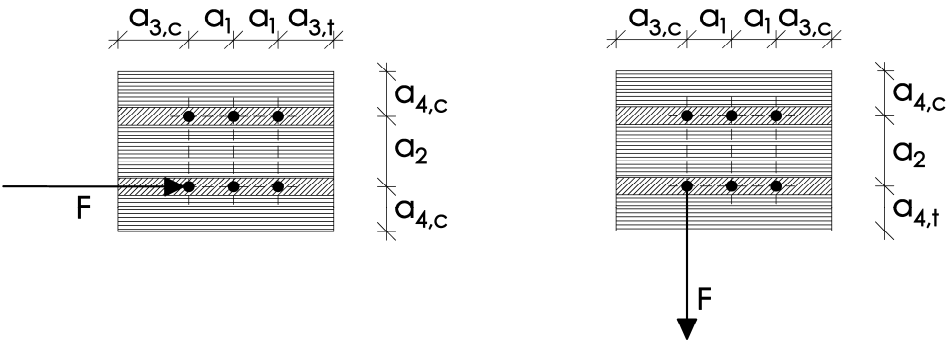


Figure A.2.2 Definition of spacing, end and edge distances in the edge surface of the cross laminated timber. For screws in the edge surface,  $a_1$  and  $a_3$  are parallel to the CLT plane face,  $a_2$  and  $a_4$  perpendicular to CLT plane face.

|                                 |         |
|---------------------------------|---------|
| PanelFix screws                 | Annex 2 |
| Spacing, end and edge distances |         |

#### A.2.5 Insertion moment

The ratio between the characteristic torsional strength  $f_{tor,k}$  and the mean value of insertion moment  $R_{tor,mean}$  fulfills the requirement for all PanelFix screws.

#### A.2.6 Durability against corrosion

Screws and washers made from carbon steel may have the coatings according to Table A.2.4

Table A.2.4 Coatings of the PanelFix screws

| Coating             |                  | Mean thickness of the coating [ $\mu\text{m}$ ] |
|---------------------|------------------|---|
| electrogalvanised   | blue chromaed    | 6   |
|                     | yellow chromated |   |
| Zinc flake basecoat |                  | 5   |

|   |         |
|---|---------|
| PanelFix screws                                   | Annex 2 |
| Insertion moment and durability against corrosion |         |

## ANNEX 3 - Fastening of thermal insulation material on top of rafters

### A.3.1 General

PanelFix screws with an outer thread diameter of at least 6 mm are used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades. In the following, the meaning of the word rafter includes wood-based members with inclinations between 0° and 90°.

The thickness of the thermal insulation material is up to 300 mm. The thermal insulation material is applicable as insulation on top of rafters.

The battens have to be from solid timber according to EN 338/ EN 14081-1. The minimum thickness  $t$  and the minimum width  $b$  of the battens are given in table A.3.1:

Table A.3.1 Minimum thickness and minimum width of the battens

| Outer thread diameter<br>[mm] | Minimum thickness $t$<br>[mm] | Minimum width $b$<br>[mm] |
|-------------------------------|-------------------------------|---------------------------|
| 6 and 8                       | 30                            | 50                        |
| 10                            | 40                            | 60                        |

Instead of battens the wood-based panels specified in chapter A.3.2.1 can be used. Only screws with countersunk head are used for fixing wood-based panels on rafters with thermal insulation material as interlayer.

The minimum width of the rafters is 60 mm.

The spacing between screws are not more than 1.75 m.

Friction forces are not considered for the design of the characteristic axial load of the screws.

The anchorage of wind suction forces as well as the bending stresses of the battens shall be considered for design. Screws perpendicular to the grain of the rafter (angle  $\alpha = 90^\circ$ ) may be arranged where required considering the design of the battens.

### A.3.2 Parallel inclined screws and thermal insulation material in compression

#### A.3.2.1 Mechanical model

The system of rafter, thermal insulation material on top of rafter and counter battens parallel to the rafter may be considered as a beam on elastic foundation. The counter batten represents the beam, and the thermal insulation material on top of the rafter the elastic foundation. The minimum compressive stress of the thermal insulation material at 10 % deformation, measured according to EN 826<sup>13</sup>, shall be  $\sigma_{(10\%)} = 0.05 \text{ N/mm}^2$ . The counter batten is loaded perpendicular to the axis by point loads  $F_b$  transferred by regularly spaced battens. Further point loads  $F_s$  are caused by the shear load of the roof due to dead and snow load, which are transferred from the screw heads into the counter battens.

Instead of battens the following wood-based panels may be used to cover the thermal insulation material if they are suitable for that use:

- Plywood according to EN 636 and EN 13986,
- Oriented Strand Board, OSB according to EN 300 and EN 13986,
- Particleboard according to EN 312 and EN 13986
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986.

The minimum thickness of the wood-based panels shall be 22 mm.

The word batten includes the meaning of wood-based panels in the following.

<sup>13</sup> EN 826:2013 Thermal insulating products for building applications - Determination of compression behaviour

|  |         |
|--|---------|
| PanelFix screws  | Annex 3 |
| Fastening of thermal insulation material on top of rafters |         |

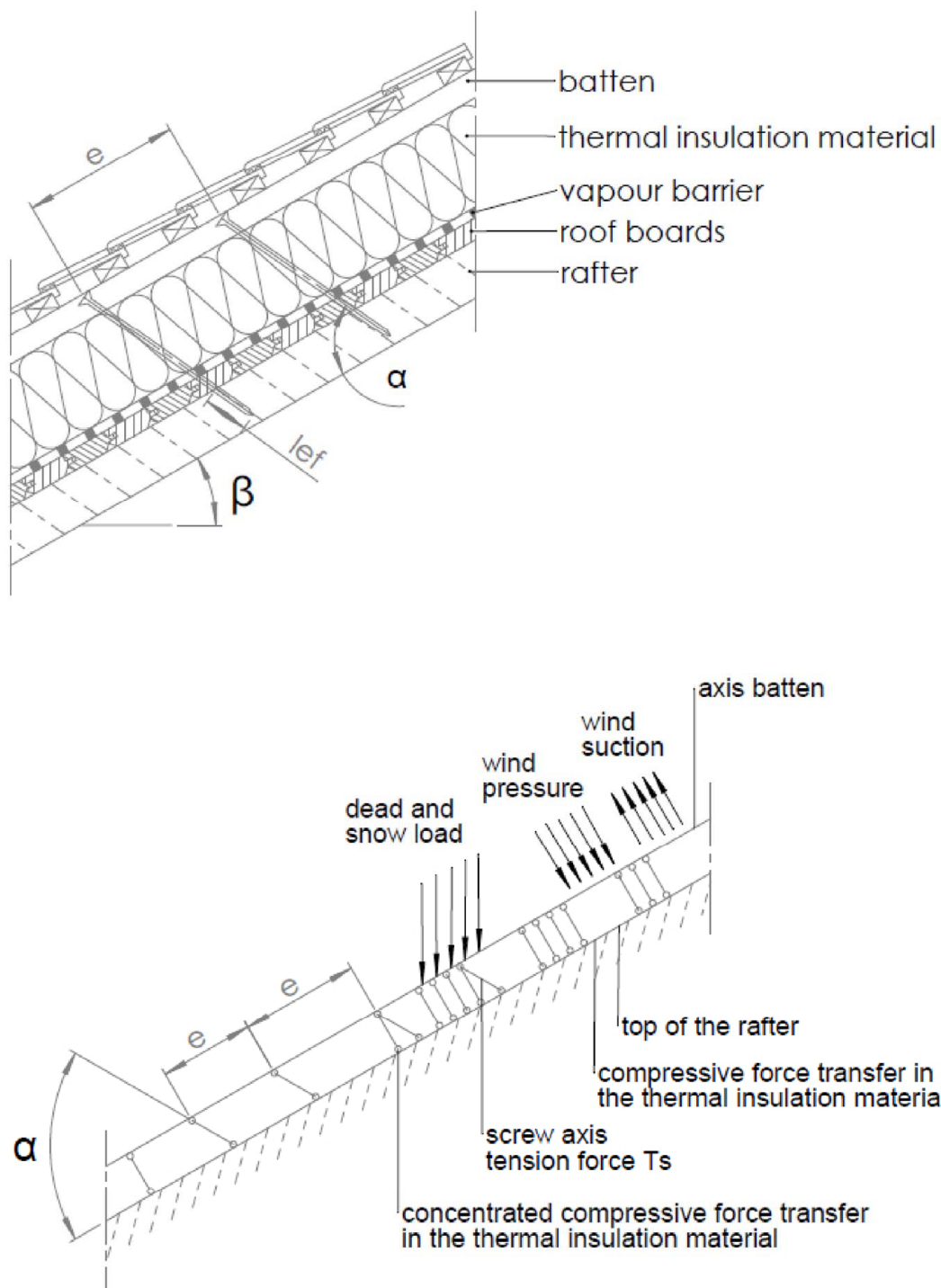


Figure A.3.1 Fastening of the thermal insulation material on top of rafters - structural system

|  |         |
|--|---------|
| PanelFix screws  | Annex 3 |
| Fastening of thermal insulation material on top of rafters |         |

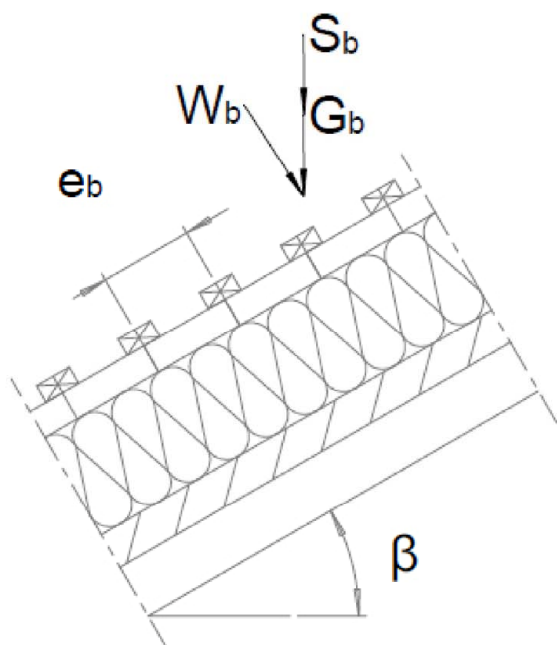


Figure A.3.2:  
Point loads  $F_b$  perpendicular to the battens

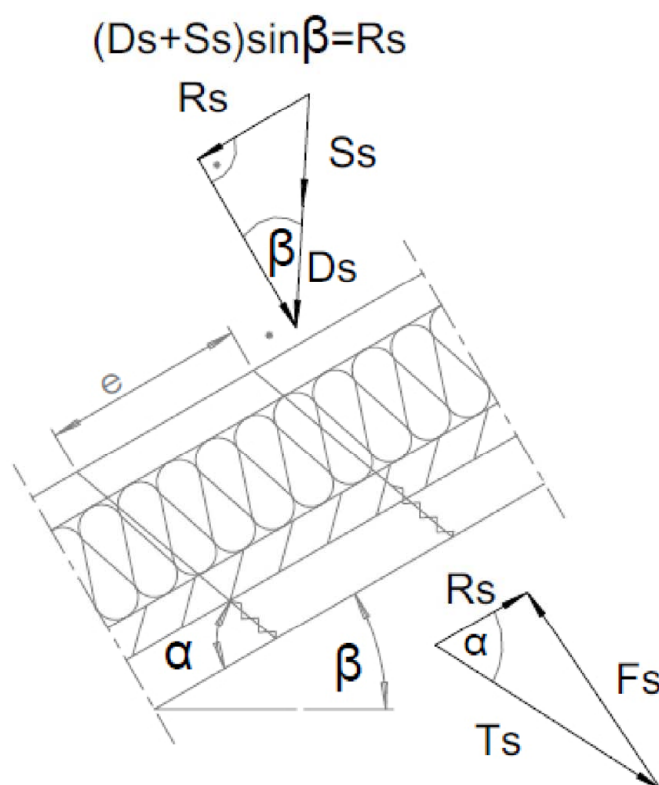


Figure A.3.3:  
Point loads  $F_s$  perpendicular  
to the battens,  
load application in the area  
of the screw heads

|  |         |
|--|---------|
| PanelFix screws  | Annex 3 |
| Fastening of thermal insulation material on top of rafters |         |



### A.3.2.2 Design of the battens

It's assumed that the spacing between the counter battens exceeds the characteristic length  $l_{\text{char}}$ .

The characteristic values of the bending stresses are calculated as:

$$M_k = \frac{(F_{b,k} + F_{s,k}) \cdot l_{\text{char}}}{4} \quad (3.1)$$

where

$$l_{\text{char}} = \text{characteristic length } l_{\text{char}} = 4 \sqrt{\frac{EI}{w_{\text{ef}} \cdot K}} \quad (3.2)$$

$EI$  = bending stiffness of the batten

$K$  = coefficient of subgrade

$w_{\text{ef}}$  = effective width of the thermal insulation material

$F_{b,k}$  = point loads perpendicular to the battens

$F_{s,k}$  = 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  $E_{\text{HI}}$  and the thickness  $t_{\text{HI}}$  of the thermal insulation material if the effective width  $w_{\text{ef}}$  of the thermal insulation material under compression is known. Due to the load extension in the thermal insulation material the effective width  $w_{\text{ef}}$  is greater than the width of the batten or rafter, respectively. For further calculations, the effective width  $w_{\text{ef}}$  of the thermal insulation material may be determined according to:

$$w_{\text{ef}} = w + t_{\text{HI}} / 2 \quad (3.3)$$

where

$w$  = minimum from width of the batten or rafter, respectively

$t_{\text{HI}}$  = thickness of the thermal insulation material

$$K = \frac{E_{\text{HI}}}{t_{\text{HI}}} \quad (3.4)$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \leq 1 \quad (3.5)$$

For the calculation of the section modulus  $W$  the net cross section shall be considered.

The characteristic values of the shear stresses shall be calculated according to:

$$V_k = \frac{(F_b + F_s)}{2} \quad (3.6)$$

The following condition need to be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \cdot V_d}{A \cdot f_{v,d}} \leq 1 \quad (3.7)$$

For the calculation of the cross section area the net cross section shall be considered.

|  |         |
|--|---------|
| PanelFix screws  | Annex 3 |
| Fastening of thermal insulation material on top of rafters |         |

#### A.4.2.3 Design of the thermal insulation material

The characteristic value of the compressive stresses in the thermal insulation material shall be calculated according to:

$$\sigma_k = \frac{1.5 \cdot F_{b,k} + F_{s,k}}{2 \cdot l_{\text{char}} \cdot w} \quad (3.8)$$

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

#### A.4.2.4 Design of the screws

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

$$T_{S,k} = \frac{R_{S,k}}{\cos \alpha} \quad (3.9)$$

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 according to Annex 2.

In order to limit the deformation of the screw head for thermal insulation material with thickness over 220 mm or with compressive strength below 0.12 N/mm<sup>2</sup>, respectively, the axial withdrawal capacity of the screws shall be reduced by the factors  $k_1$  and  $k_2$ :

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{k_{ax} \cdot f_{ax,d} \cdot d \cdot l_{ef} \cdot k_1 \cdot k_2}{1.2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left( \frac{\rho_k}{350} \right)^{0.8}; f_{head,d} \cdot d_h^2 \cdot \left( \frac{\rho_k}{350} \right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}} \right\} \quad (3.10)$$

where:

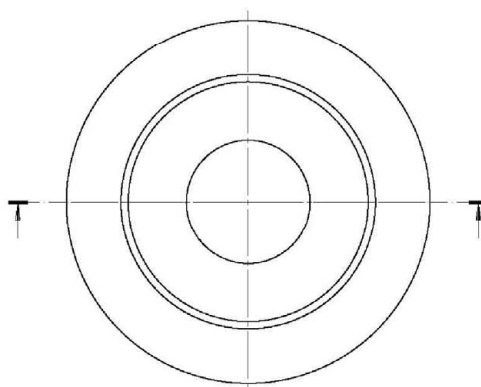
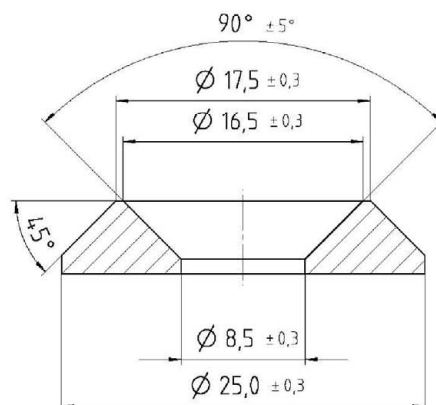
|                 |   |
|-----------------|---|
| $k_{ax}$        | factor, taking into account the angle $\alpha$ between screw axis and grain direction according to A.2.3.1  |
| $f_{ax,d}$      | design value of the axial withdrawal parameter of the threaded part of the screw [N/mm <sup>2</sup> ]   |
| $d$             | outer thread diameter of the screw [mm]   |
| $l_{ef}$        | penetration length of the threaded part of the screw in the rafter [mm], $40 \text{ mm} \leq l_{ef} \leq 100 \text{ mm}$                                |
| $\rho_k$        | characteristic density of the wood-based member [kg/m <sup>3</sup> ], for LVL the assumed characteristic density shall not exceed 500 kg/m <sup>3</sup> |
| $\alpha$        | angle $\alpha$ between screw axis and grain direction, $15^\circ \leq \alpha \leq 90^\circ$   |
| $f_{head,d}$    | design value of the head pull-through parameter of the screw [N/mm <sup>2</sup> ]   |
| $d_h$           | head diameter of the screw [mm]   |
| $f_{tens,k}$    | characteristic tensile capacity of the screw according to Annex 2 [N]   |
| $\gamma_{M2}$   | partial factor according to EN 1993-1-1 in conjunction with the particular national annex   |
| $k_1$           | $\min \{1; 220/t_{HI}\}$  |
| $k_2$           | $\min \{1; \sigma_{10\%}/0.12\}$  |
| $t_{HI}$        | thickness of the thermal insulation material [mm]   |
| $\sigma_{10\%}$ | compressive stress of the thermal insulation material under 10 % deformation [N/mm <sup>2</sup> ]   |

If equation (3.10) is fulfilled, the deflection of the battens does not need to be considered when designing the load-carrying capacity of the screws.

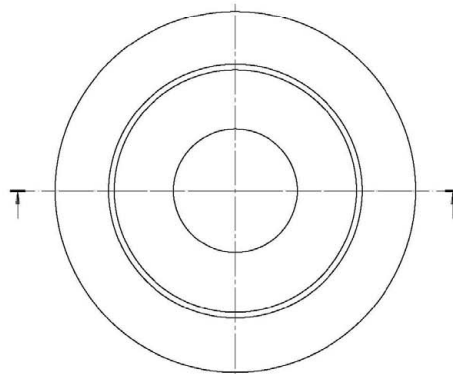
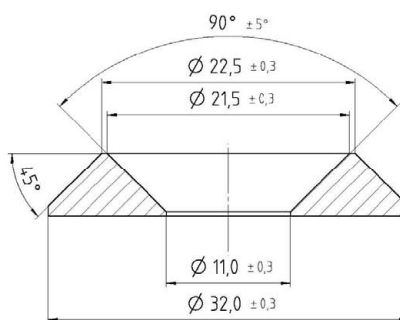
|  |         |
|--|---------|
| PanelFix screws  | Annex 3 |
| Fastening of thermal insulation material on top of rafters |         |

## Wafer for PanelFix

### Wafer for PanelFix diameter 8,0



### Wafer for PanelFix diameter 10,0

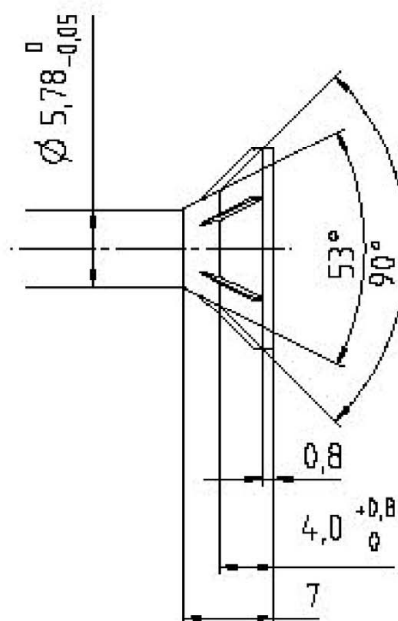
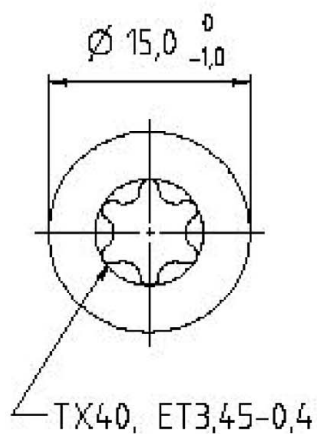


PanelFix screws

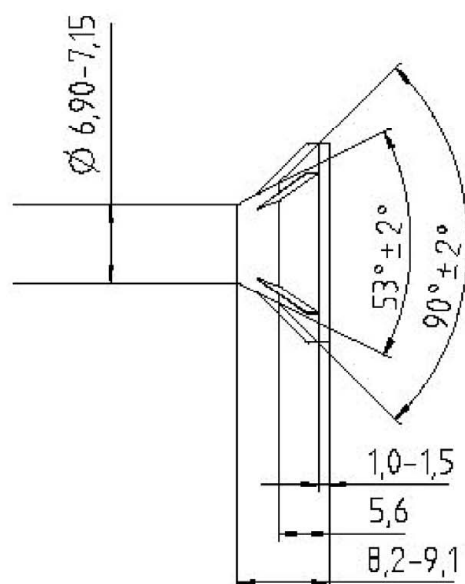
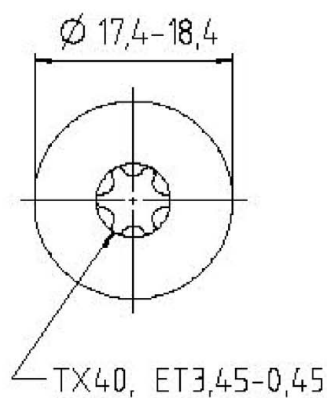
Washers for screws with flat head

Annex 4.1

Flat head diameter 8,0



Flat head diameter 10,0

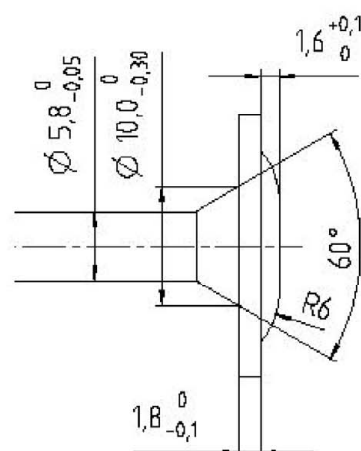
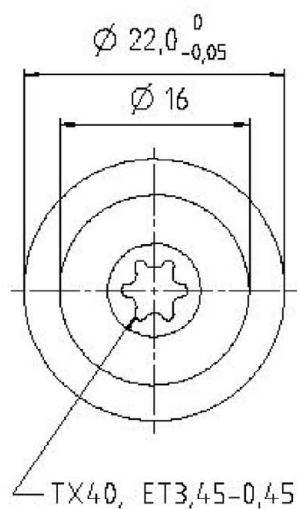


PanelFix screws

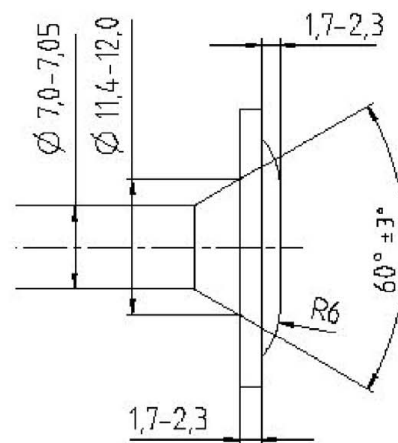
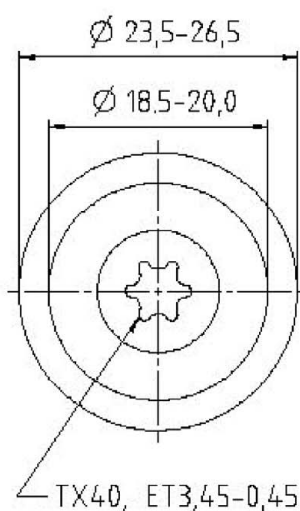
Flat head

Annex 4.2

Wafer head for diameter 8,0



Wafer head for diameter 10,0

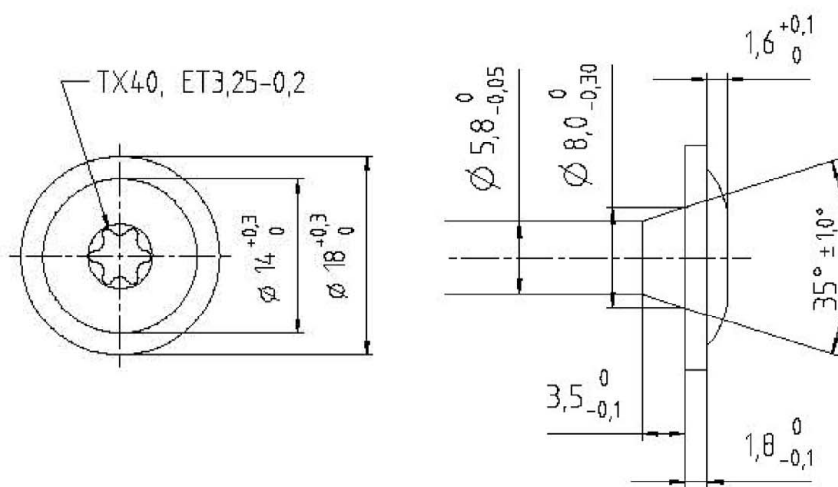


PanelFix screws

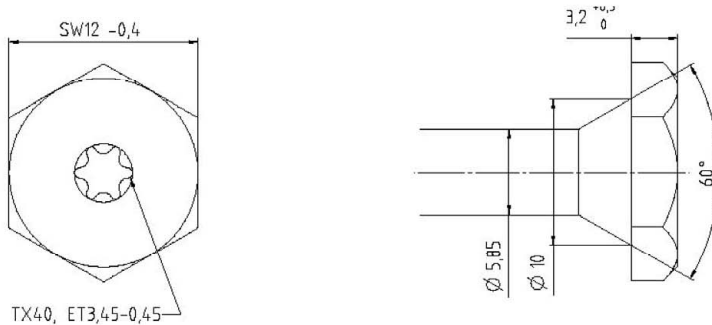
Wafer head

Annex 4.3

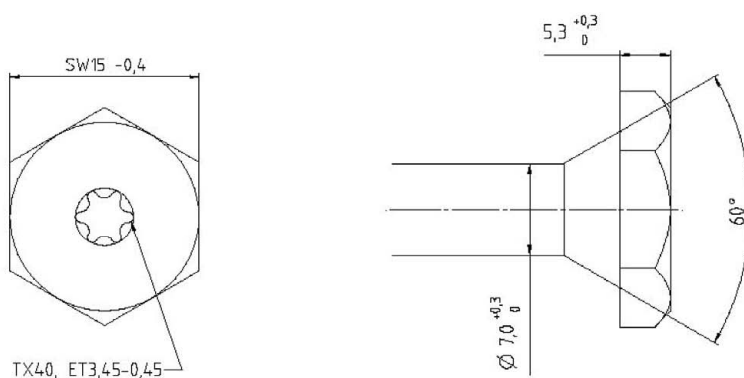
**Wafer head for diameter 8,0**



**Combi-head for diameter 8,0**



**Combi-head for diameter 10,0**

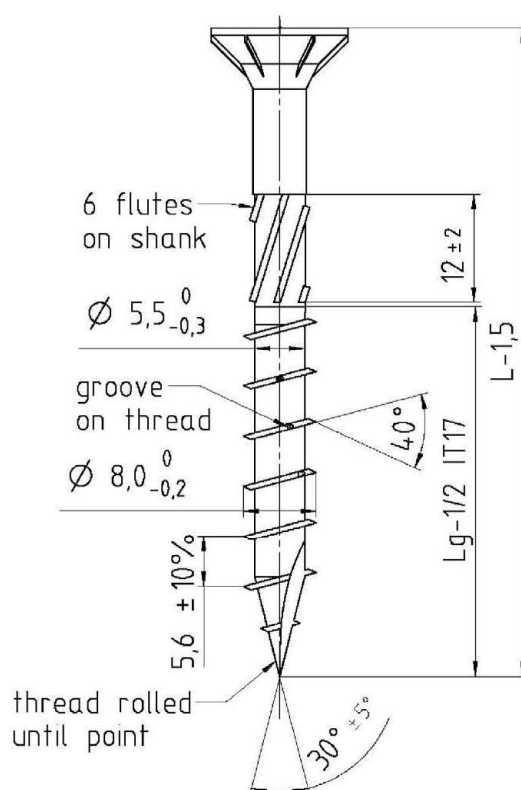


PanelFix screws

Wafer head and Combi-head

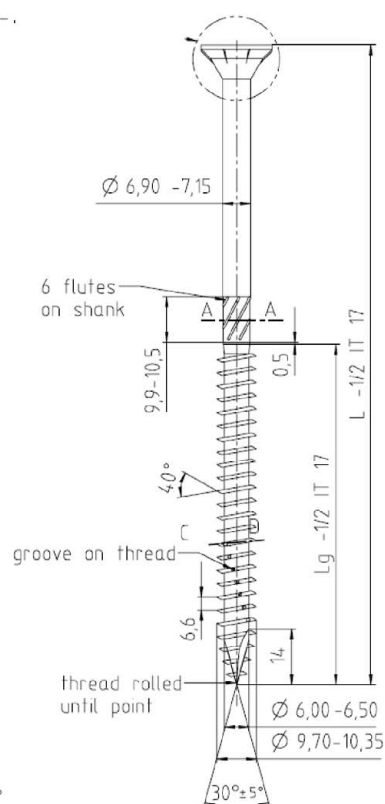
Annex 4.4

**Flat head, normal thread and  
1-cut point diameter 8,0**



| L   | Lg     |
|-----|--------|
| 80  | 52     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

**Flat head, normal thread and  
1-cut point diameter 10,0**



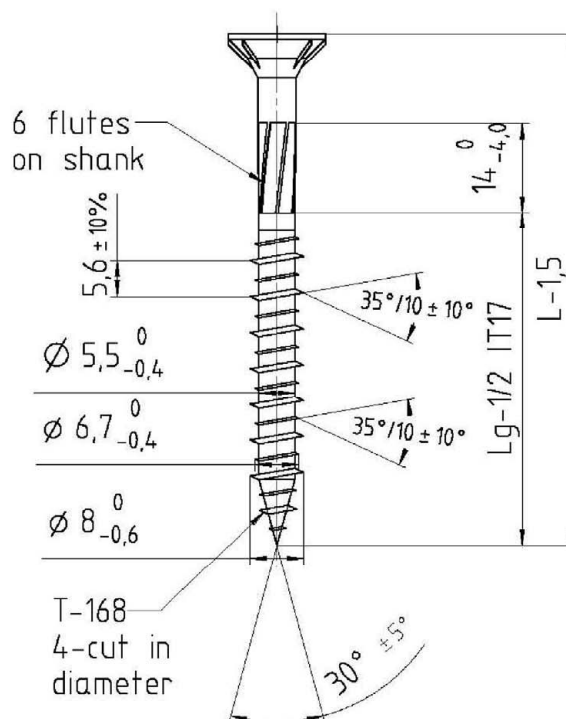
| L   | Lg     |
|-----|--------|
| 80  | 48     |
| 90  | 54     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

PanelFix screws

Flat head screw with normal thread

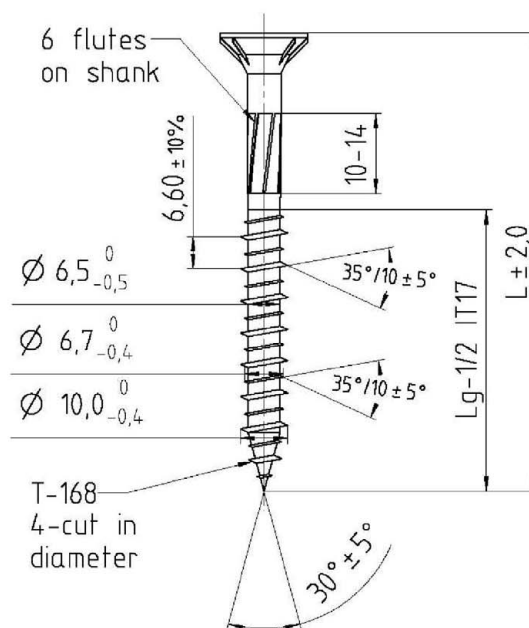
Annex 4.5

**Flat head, hilo thread and  
4-cut point diameter 8,0**



| L   | Lg     |
|-----|--------|
| 80  | 52     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

**Flat head, hilo thread and  
4-cut point diameter 10,0**



| L   | Lg     |
|-----|--------|
| 80  | 52     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/100 |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

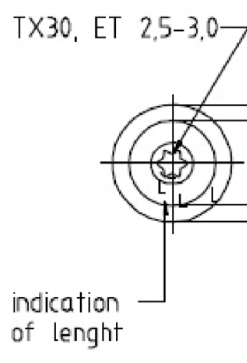
PanelFix screws

Flat head screw with hilo thread

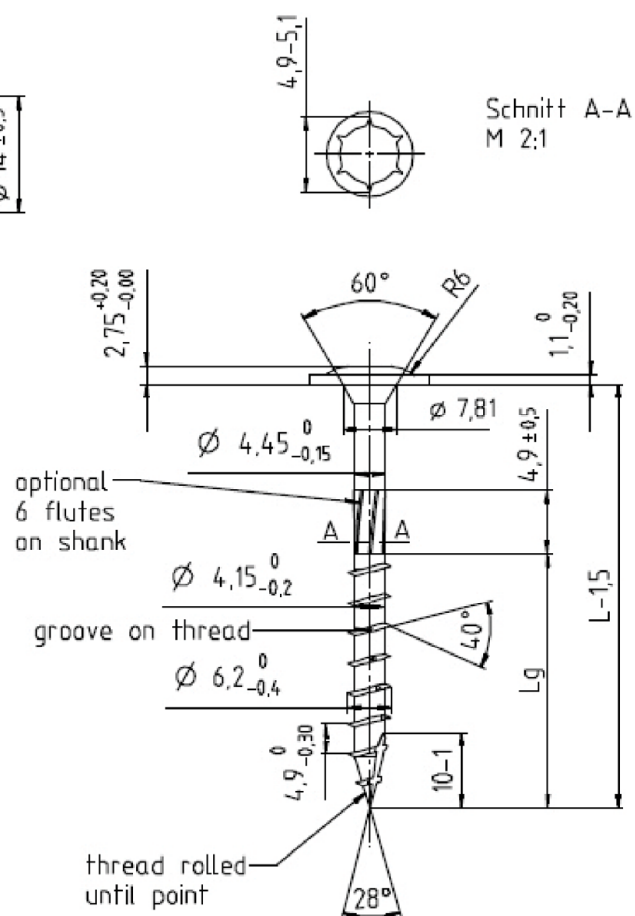
Annex 4.6



**Wafer head,  
normal thread and  
1-cut point  
diameter 6,0**



| L   | Lg |
|-----|----|
| 30  | 24 |
| 40  | 34 |
| 50  | 44 |
| 60  | 40 |
| 70  | 40 |
| 80  | 48 |
| 90  | 54 |
| 100 | 70 |
| 110 | 70 |
| 120 | 70 |
| 130 | 70 |
| 140 | 70 |
| 160 | 70 |
| 180 | 70 |
| 200 | 70 |
| 220 | 70 |
| 240 | 70 |
| 260 | 70 |
| 280 | 70 |
| 300 | 70 |

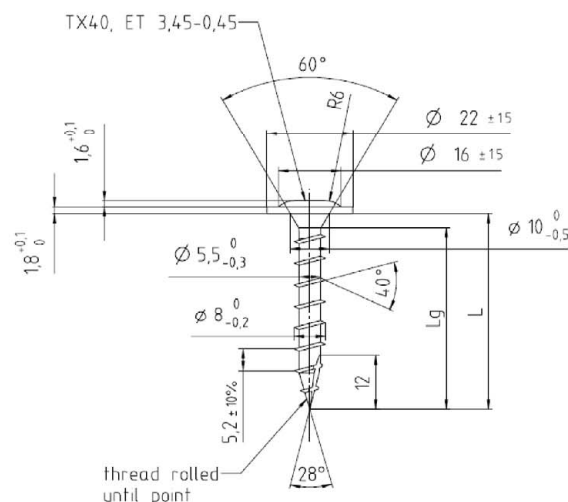


PanelFix screws

Wafer head screw with normal thread

Annex 4.7

**Wafer head,  
full thread and  
1-cut point  
diameter 8,0**

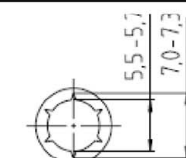


TX40, ET3, 45-0,45

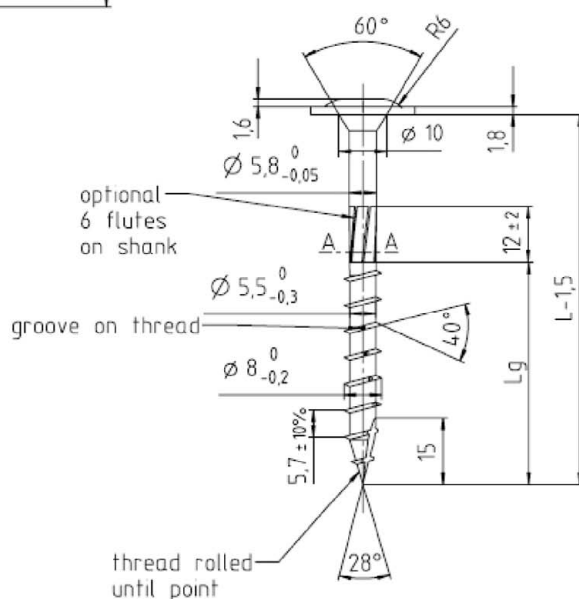


indication  
of length

| L   | Lg     |
|-----|--------|
| 40  | 33     |
| 50  | 43     |
| 60  | 53     |
| 80  | 48     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |



Schnitt A-A  
M 2:1

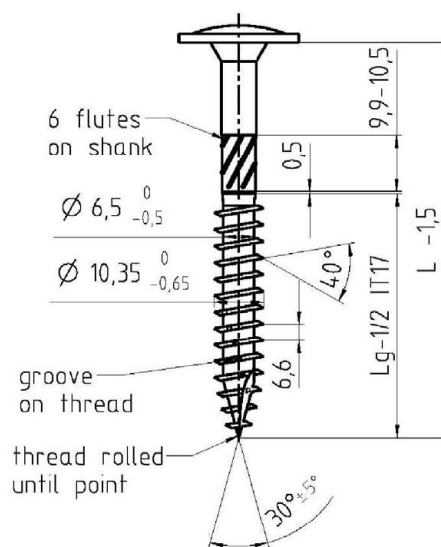


PanelFix screws

Wafer head screw with normal thread

Annex 4.8

**Wafer head, normal thread and  
1-cut point diameter 10,0**



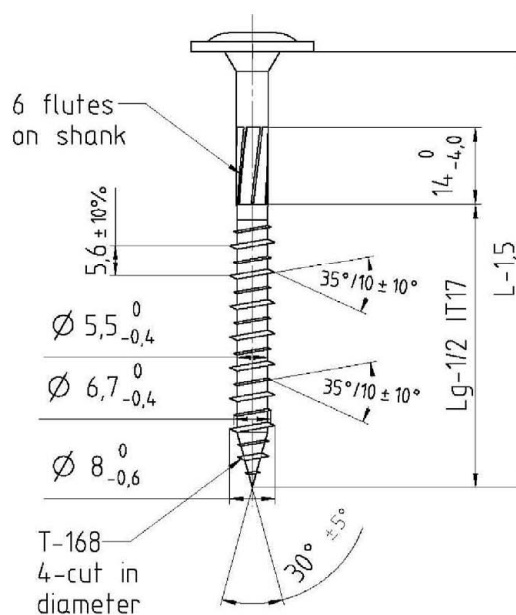
| L   | Lg     |
|-----|--------|
| 80  | 48     |
| 90  | 54     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

PanelFix screws

Wafer head screw with normal thread

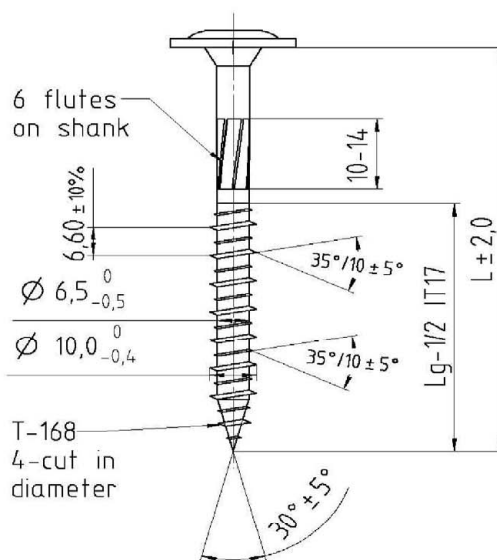
Annex 4.9

**Wafer head, hilo thread and  
4-cut point diameter 8,0**



| L   | Lg     |
|-----|--------|
| 40  | 33     |
| 50  | 43     |
| 60  | 53     |
| 80  | 48     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

**Wafer head, hilo thread and  
4-cut point diameter 10,0**

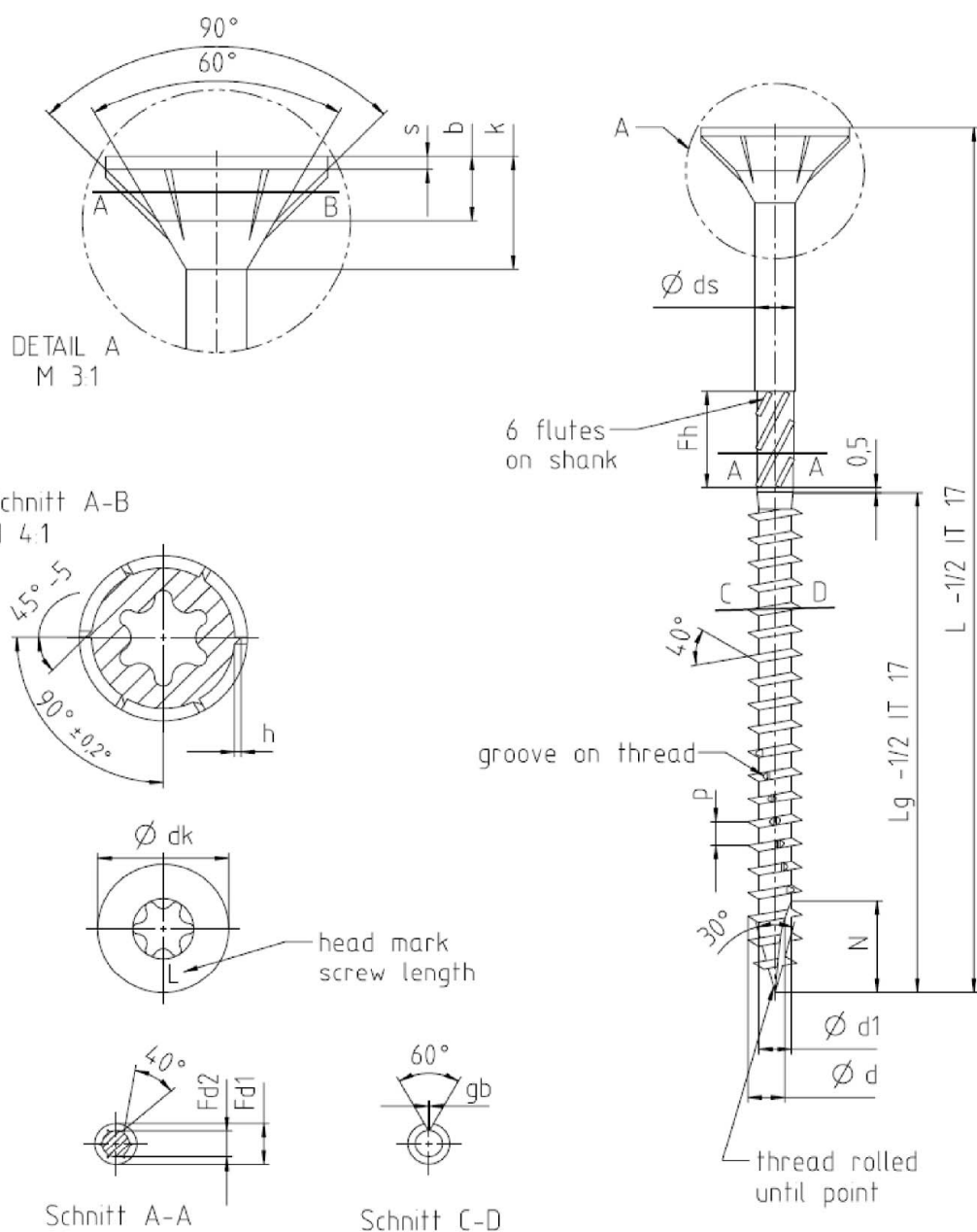


| L   | Lg     |
|-----|--------|
| 40  | 33     |
| 50  | 43     |
| 60  | 53     |
| 80  | 48     |
| 100 | 60     |
| 120 | 80     |
| 140 | 80     |
| 160 | 80/90  |
| 180 | 80/100 |
| 200 | 80/100 |
| 220 | 80/100 |
| 240 | 80/100 |
| 260 | 80/100 |
| 280 | 80/100 |
| 300 | 80/100 |
| 320 | 80/100 |
| 340 | 80/100 |
| 360 | 80/100 |
| 380 | 80/100 |
| 400 | 80/100 |

PanelFix screws

Wafer head screw with hilo thread

Annex 4.10



|                                    |            |
|------------------------------------|------------|
|                                    |            |
| PanelFix screws                    | Annex 4.11 |
| Flat head screw with normal thread |            |

**Flat head, normal thread and  
1-cut point diameter  
3,5 – 6,0**

| Nominal size           |     | Ø 3,5       | Ø 4,0       | Ø 4,5       | Ø 5,0       | Ø 6,0       |
|------------------------|-----|-------------|-------------|-------------|-------------|-------------|
| <b>d</b>               | min | 3,30        | 3,75        | 4,25        | 4,70        | 5,75        |
|                        | max | 3,70        | 4,10        | 4,60        | 5,15        | 6,20        |
| <b>d<sub>1</sub></b>   | min | 2,00        | 2,35        | 2,60        | 3,00        | 3,80        |
|                        | max | 2,25        | 2,65        | 2,80        | 3,45        | 4,20        |
| <b>d<sub>k</sub></b>   | min | 6,60        | 7,50        | 8,50        | 9,50        | 11,50       |
|                        | max | 7,00        | 8,00        | 9,00        | 10,00       | 12,00       |
| <b>k</b>               | min | 3,00        | 3,45        | 4,15        | 4,50        | 5,40        |
|                        | max | 3,30        | 3,75        | 4,65        | 5,00        | 5,95        |
| <b>b</b>               | min | 1,45        | 1,55        | 1,90        | 2,00        | 2,20        |
|                        | max | 1,75        | 1,85        | 2,20        | 2,30        | 2,50        |
| <b>h</b>               | min | 0,20        | 0,25        | 0,30        | 0,35        | 0,40        |
|                        | max | 0,40        | 0,45        | 0,50        | 0,55        | 0,60        |
| <b>s</b>               | min | 0,35        | 0,45        | 0,70        | 0,70        | 1,10        |
|                        | max | 0,65        | 0,70        | 1,00        | 1,10        | 1,35        |
| <b>N</b>               |     | 6,0-7,0     | 7,0-8,0     | 8,0-9,0     | 9,0-10      | 10,0-12,0   |
| <b>hs</b>              | min |             |             |             |             |             |
|                        | max |             |             |             |             |             |
| <b>Ls</b>              |     |             |             |             |             |             |
| <b>F<sub>h</sub></b> ~ |     | 3,8-4,0     | 4,8-5,0     | 6,8-7,0     | 7,9 - 8,5   | 9,9-10,5    |
| <b>d<sub>s</sub></b>   | min | 2,20        | 2,60        | 2,80        | 3,60        | 4,30        |
|                        | max | 2,40        | 2,80        | 3,10        | 3,80        | 4,50        |
| <b>F<sub>d1</sub></b>  |     | 2,60 - 2,80 | 2,80 - 3,05 | 3,30 - 3,50 | 3,80 - 4,00 | 4,50 - 5,00 |
| <b>F<sub>d2</sub></b>  |     | 2,05-2,25   | 2,50-2,80   | 2,65 - 2,80 | 3,15 - 3,30 | 4,15 - 4,30 |
| <b>g<sub>b</sub></b>   |     | 0,2         | 0,2         | 0,2         | 0,20        | 0,20        |
| <b>P</b> ± 10%         |     | 2,24        | 2,52        | 2,80        | 3,10        | 4,90        |
| <b>TX</b>              |     | 20          | 20          | 20/25       | 25/30       | 30          |
| <b>ET</b>              | min | 1,65        | 2,00        | 2,20        | 2,30        | 2,60        |
|                        | max | 1,80        | 2,15        | 2,30        | 2,40        | 3,05        |

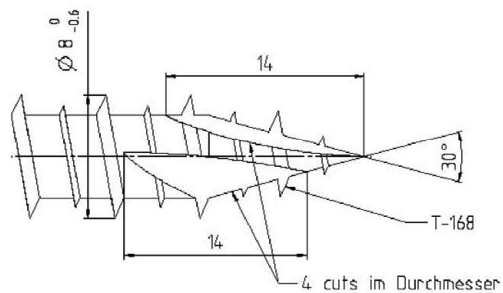
| Diameter |        | Ø 3,5            | Ø 4,0 | Ø 4,5 | Ø 5,0 | Ø 6,0 |
|----------|--------|------------------|-------|-------|-------|-------|
| Length   |        | Thread length lg |       |       |       |       |
| L max.   | L min. |                  |       |       |       |       |
| 20       | 19,00  | 17               |       |       |       |       |
| 25       | 24,00  | 22               | 22    |       |       |       |
| 30       | 28,95  | 18               | 18    | 18    |       |       |
| 35       | 34,95  | 21               | 21    | 21    | 21    |       |
| 40       | 38,75  | 24               | 24    | 24    | 24    | 24    |
| 45       | 43,75  | 27               | 27    | 27    | 27    | 27    |
| 50       | 48,75  | 30               | 30    | 30    | 30    | 30    |
| 60       | 58,50  |                  | 36    | 36    | 36    | 36    |
| 70       | 68,50  |                  | 42    | 42    | 42    | 42    |
| 80       | 78,50  |                  | 48    | 48    | 48    | 48    |
| 90       | 88,25  |                  |       |       | 54    | 54    |
| 100      | 98,25  |                  |       |       | 60    | 60    |
| 110      | 108,25 |                  |       |       | 70    | 70    |
| 120      | 118,25 |                  |       |       | 70    | 70    |
| 130      | 128,00 |                  |       |       |       | 70    |
| 140      | 138,00 |                  |       |       |       | 70    |
| 150      | 148,00 |                  |       |       |       | 70    |
| 160      | 158,00 |                  |       |       |       | 70    |
| 180      | 178,00 |                  |       |       |       | 70    |
| 200      | 197,70 |                  |       |       |       | 70    |
| 240      | 237,70 |                  |       |       |       | 70    |
| 260      | 257,40 |                  |       |       |       | 70    |
| 280      | 277,40 |                  |       |       |       | 70    |
| 300      | 297,40 |                  |       |       |       | 70    |

PanelFix screws

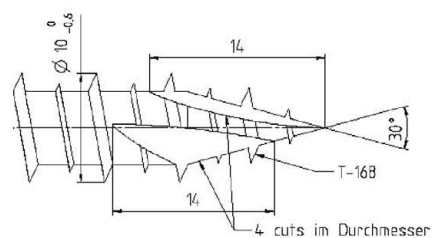
Flat head screw with normal thread

Annex 4.12

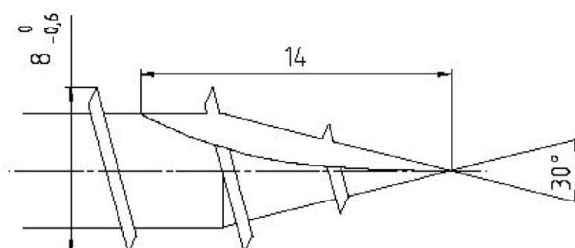
**4-cut point for diameter 8,0**



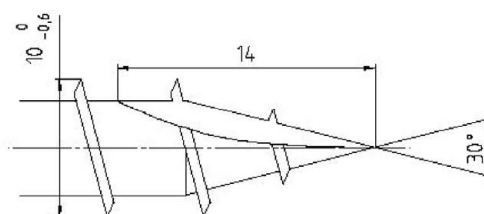
**4-cut point for diameter 10,0**



**1-cut point for diameter 8,0**



**1-cut point for diameter 10,0**



PanelFix screws

Screw points

Annex 4.13