Semplex Duro-PT®

Design guide for fasteners for thermoset plastics

DURO-PT®
Semflex Duro-PT® screws are designed for use in thermoset and thermohardening plastics.

The DURO-PT® fastener can be installed directly into punched, drilled, and molded holes without costly inserts or thread tapping operations.

A patented thread profile, coupled with tighter manufacturing tolerances, material-specific boss designs, and pretested assembly guidelines insure consistent and reliable installation and improved long term joint performance.

The DURO-PT® threadform was developed in cooperation with Bakelite GmbH, West Germany.

Development efforts were sponsored by the TPW Program of Nordrhein-Westfalen and were carried out with the assistance of the Institute of Material Technology, University of Darmstadt, and the Institute of Material Processing Methods, University of Kassel.

This brochure offers general guidelines for design of screw joints using the DURO-PT® threadcutting fastener in thermoset plastic materials.

Household appliances

Audio equipment

Automotive components

Electrotechnical applications

Lighting products
BENEFITS OF THE DURO-PT® SCREW

More consistent drive and strip torque values and high strip to drive ratios eliminate stripping during installation.

The narrower thread profile and recessed thread root of the DURO-PT® minimize variation and lower drive torques. A reduced thread cross-section, one half the size of the flank area of a standard sheet metal screw, significantly reduces the torque required to cut or form threads into the material. The recessed root further lowers drive torque by providing additional space between threads for material displaced during threadforming or chips removed during threadcutting.

In addition to lowering drive torque, the DURO-PT® is more resistant to stripping than other proprietary threadforms. The asymmetrical thread profile increases the friction force acting between the component part and the thread flank. As a result, a higher torque must be applied to fracture material between the screw threads.

Higher strip to drive torque ratios, coupled with more consistent drive and strip torque help customers achieve the highest possible quality level for installation of DURO-PT® fasteners.

Improved vibration resistance

Breakloose torque and vibration resistance are also improved by the wedging action of the DURO-PT®’s asymmetrical thread profile. Because of the angle of the thread flank, a higher friction force acts on the threads of the fastener. As a consequence, a higher breakloose torque must be applied to overcome static friction created by clamp load.

Additional vibration resistance is gained because the DURO-PT® has a finer pitch than either sheet metal or twin lead screws. Since more threads are engaged into the component part, sideloads encountered during vibration are distributed across a larger area, and contact stress levels are reduced.

Lower stress levels are less likely to cause material failure and vibration loosening of the fastened joint.

Repeat installation is possible with the DURO-PT® screw.

Repeat installation without stripping eliminates the need for costly threaded inserts in products which may require disassembly for maintenance or service.

Minimized boss expansion reduces boss cracking tendencies.

The DURO-PT®’s patented thread design helps lower radial stress acting on the boss. This reduces boss expansion and cracking during assembly.

A special design cutting notch is added to the fastener for threadcutting into thermoset materials.

Increased pull-out strength

Greater thread engagement improves pull-out strength of the DURO-PT® fastener.

A recessed thread root provides space for material, eliminating boss cracking.

Small flank area displaces less material to lower drive torque.

For thermoset plastics, a special cutting notch reduces radial stresses.

ADVANTAGES OF THE ASYMMETRICAL THREAD

The 30 degree flank angle allows high tightening and breakloose torques due to increased friction force at the thread flank.

\[ F_R = \mu \cdot N, \quad N = \frac{F_v}{\cos\beta} \]
### HOW TO SPECIFY:

To specify a DURO-PT" screw with head style WN 1742, Z-cross recess (B), cutting edge (S), nominal diameter 4.0 mm, and length 20.0 mm, part number is:

**DURO-PT" screw WN 1742 BS 40 x 20**

**Material:**
Through-hardened steel with material property PT 10

Stainless steel available on request

**Contact:** Semblex Engineering with the special requirements of your application.

### STANDARD SIZES DURO-PT" SCREWS

<table>
<thead>
<tr>
<th>Nominal diameter</th>
<th>22</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>80</th>
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<tbody>
<tr>
<td>External thread Ø</td>
<td>1.2</td>
<td>1.5</td>
<td>1.9</td>
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<td>3.0</td>
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<td>7.0</td>
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<td>Core Ø</td>
<td>0.9</td>
<td>0.95</td>
<td>1.05</td>
<td>1.42</td>
<td>1.70</td>
<td>2.17</td>
<td>2.56</td>
<td>3.23</td>
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<tr>
<td>Thread pitch</td>
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<td>0.49</td>
<td>0.49</td>
<td>0.56</td>
<td>0.68</td>
<td>0.88</td>
<td>1.05</td>
<td>1.23</td>
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<tr>
<td>Thread run-out</td>
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<td>1.3</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>4.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Head diameter</td>
<td>1.6</td>
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<td>2.4</td>
<td>3.1</td>
<td>3.8</td>
<td>4.6</td>
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<td>9.0</td>
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### STANDARD LENGTH TOLERANCES DURO-PT" SCREWS

<table>
<thead>
<tr>
<th>Nominal screw diameter (mm)</th>
<th>1.8</th>
<th>2.2</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>8.0</th>
<th>9.0</th>
<th>10.0</th>
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<tbody>
<tr>
<td>Length</td>
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<td>0.75</td>
<td>7</td>
<td>0.45</td>
<td>8</td>
<td>0.45</td>
<td>10</td>
<td>0.45</td>
<td>12</td>
<td>0.55</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.55</td>
<td></td>
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<td></td>
<td></td>
<td>18</td>
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<tr>
<td></td>
<td>22</td>
<td>0.65</td>
<td>25</td>
<td>0.65</td>
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<td></td>
<td>30</td>
<td>0.65</td>
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<td>0.80</td>
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<td></td>
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<tr>
<td></td>
<td>40</td>
<td>0.80</td>
<td>50</td>
<td>0.80</td>
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<tr>
<td></td>
<td>60</td>
<td>0.80</td>
<td>70</td>
<td>0.80</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>80</td>
<td>0.80</td>
<td>90</td>
<td>1.10</td>
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<tr>
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<td>1.10</td>
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</tbody>
</table>

### Special designs:

Variations of standard DURO-PT" screws are available on request. Added features include: combination cross recesses, tamper proof drives and captive washers. Next to the nominal diameters indicated DURO-PT" © 18, 70, 90, 100 can be provided.

### Contact Semblex Engineering with the special requirements of your application.
PRODUCT TESTING

In addition to optimal screw design, optimal boss and assembly process design is critical. Applications engineers at EJOT fully test and evaluate screw performance, simulating rpm and clutch accuracies of production line drive guns. Screw, boss, and assembly process designs are optimized before production begins, to ensure trouble free installation and improved long term joint performance.

IMPROVED VIBRATION RESISTANCE

Vibration tests performed at 33 Hz (amplitude = 0.25 mm) show the DURO-PT® screw retaining a larger percentage of initial clamp load than either sheet metal or chipboard screws. Comparative testing was performed in Phenodur H-1 material.
1. Estimate the minimum **clamp load** needed to withstand the service load on the joint.

   For example: If a minimum of 6 kN is required to withstand service loads, choose \( F_v = 6 \text{kN} \)

2. From the diagrams at the right, determine the **tightening torque** needed to achieve the desired clamp load.

   For boss material = Bakelite type 31, a clamp load of 6 kN provides a tightening torque of 5.5 to 7.5 kN.

   Choose a tightening torque of 6.5 kN.

   Note: For materials not shown, contact *Semblex* for design assistance.

3. Based on the repeat accuracy of the screw driver, determine the maximum **critical tightening torque** using the following formula:

   \[
   T_{a_{\text{max}}} = T_a (1 + \frac{W}{100});
   \]

   \( W \) = The repeat accuracy of the screw-driver.

   - Electric screw-driver with clutch, \( W = 30 \% \)
   - Pneumatic screw-driver with clutch, \( W = 15 \% \)
   - Pneumatic driver with precision clutch and air shutoff, \( W = 5 \% \)

   For \( W = 5 \% \)

   \[
   = 6.5 (1 + 0.05) = 6.83 \text{Nm}
   \]

**TIGHTENING TORQUE**

To ensure sufficient tightening without stripping, the statistical variation of the tightening torque must fall between the maximum installation torque, \( T_i \), and a minimum stripping torque, \( T_s \).

To provide a margin of safety, the minimum stripping torque should exceed the maximum critical tightening torque by 25 \%.

Below, torque values are represented with minimum and maximum statistical variations.
4. Once the maximum critical tightening torque has been determined, refer to the table at right and select the **screw diameter** which provides the next greater torque strength.

Screw size = K 50, which gives a 10 Nm breaking torque.

5. The **optimum hole diameter** for each material is given in the boss tables at right.

For the sample boss (Bakelite Type 31), \( d_b = 0.85 \cdot d \), where 

\[ d = \text{nominal screw diameter} \]

\[ d_b = 0.85 \cdot 5.0 \]

\[ = 4.25 \text{ mm} \]

**Note:** A hole diameter within the range of 0.85 \( d \) and 0.89 \( d \) is permissible in all applications.

6. Use the equations in the table to determine the **external diameter of the boss**.

\[ D = (8.567 \cdot d) - 6.667 \cdot d_b \]

\[ = (8.567 \cdot 5.0) - (6.667 \cdot 4.25) \]

\[ = 14.5 \text{ mm} \]

7. Recommended **penetration depth** is 2 to 3 times the nominal screw diameter.

Choose \( t_e = 2.5 \cdot d \)

\[ = 12.5 \text{ mm} \]

8. **Chip space depth** should be between 0.8 and 1.2 times the nominal screw diameter.

\( t_s = 1.0 \cdot d = 5.0 \text{ mm} \)

9. **Boss counterbore.**

High tightening torques and large tensile stresses may cause a cone-shaped expansion and failure at the end of the boss. Designing the boss with the appropriate counter-sink reduces edge stress and alleviates cracking.

\[ X = \tan 30^\circ \cdot \left( D - 1.08 \cdot d \right) \]

\[ = 0.289 \cdot (14.5 - 1.08 \cdot 5) \]

\[ = 2.6 \text{ mm} \]

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**TORQUE STRENGTH OF DURO-PT® SCREWS**

<table>
<thead>
<tr>
<th>Nominal diameter (mm)</th>
<th>2.2</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>8.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breaking torque (Nm)</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>3.0</td>
<td>5.0</td>
<td>10.0</td>
<td>15.0</td>
<td>25.0</td>
</tr>
</tbody>
</table>

**BAKELITE MATERIAL BOSS GEOMETRY**

<table>
<thead>
<tr>
<th>Type</th>
<th>Type of resin</th>
<th>Filling material</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Phenol</td>
<td>saw dust</td>
<td>1.4</td>
</tr>
<tr>
<td>181</td>
<td>Melam.Phen.</td>
<td>cellulose</td>
<td>1.5</td>
</tr>
<tr>
<td>B 1040</td>
<td>Phenol</td>
<td>asbestos</td>
<td>1.75</td>
</tr>
<tr>
<td>802</td>
<td>Polyester</td>
<td>glass fiber +</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mineral powder</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Hole diameter ( d_b ) (mm)</th>
<th>Boss diameter ( D ) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 31</td>
<td>0.85 ( d )</td>
<td></td>
</tr>
<tr>
<td>Type 181</td>
<td>0.88 ( d )</td>
<td></td>
</tr>
<tr>
<td>Type 802</td>
<td>0.85 ( d )</td>
<td></td>
</tr>
<tr>
<td>Type B 1040</td>
<td>0.88 ( d )</td>
<td>( (8.567 \cdot d) - (6.667 \cdot d_b) )</td>
</tr>
</tbody>
</table>

General recommendations are provided as a guideline only. Specific applications may require modification to optimize joint performance.

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**Material** | **Installation depth \( t_e \) (mm)** | **Chip space depth \( t_s \) (mm)** | **Counterbore depth \( x \) (mm)**
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Type 31</td>
<td>2( d ) ( \leq t_e )</td>
<td>0.8 ( d ) to 1.2 ( d )</td>
<td>( \tan 30^\circ \cdot \left( D - d_b \right) )</td>
</tr>
<tr>
<td>Type 181</td>
<td>( t_s ) ( \leq 3d )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 803</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B 1040</td>
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</table>