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# INTRODUCTION

## 1.1 Definition

The S-BT fasteners are threaded studs manufactured from hardened carbon steel 1038 and austenitic-ferritic (Duplex) stainless steel 1.4462 acc. DIN-EN 10088-1 (AISI 316 SS equivalent). The S-BT threaded studs are fasteners with male threads (metric M8 and M10 or inch W10) for attachment on one end and a threaded tip on the other end for embedment into the structural steel or aluminum. Carbon steel studs are supplied with an aluminum sealing washer Ø 10 mm, stainless steel studs are supplied with a stainless steel sealing washer Ø 12 mm, both with an chloroprene rubber sealing ring. The S-BT technology can be used as an alternative to the welds and bolts used to attach materials to structural steel and for fastening applications in shipbuilding environment and offshore structures. The S-BT fastener will be screwed in into a pre-drilled hole. The screw is tapping its own internal mating threads when installed into base material. A special stepped drill bit is needed to guarantee an accurately defined pre-drilled hole in terms of borehole depth and diameter. With this system reliable fastenings can be made in steel with a thickness 3 mm [0.12"] ≤ t ≤ 6 mm [0.24"] and in aluminum with a thickness 5 mm [0.20"] ≤ t ≤ 6 mm [0.24"] in pre-drilled through holes. For base materials steel and aluminum t ≥ 6 mm [0.24"] the fastener is intended to be set in a pre-drilled pilot hole. The benefit of pilot holes is no through penetration of the base material. If the real base material thickness t exceeds 6 mm [0.24"] no rework of the protective surface coating on the back side is needed. In case of a drill through hole or a pilot hole in thinner base material, rework of the coating on the back side of the plate / profile may be needed. For more details refer to section 3.2.4 "Corrosion information".

## 1.2 The S-BT system

### 1.2.1 S-BT fastener and designation

<table>
<thead>
<tr>
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<th>Stainless steel</th>
<th>Carbon steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-MR M8/7 SN 6</td>
<td>S-BT-GR M8/7 SN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 6 AL</td>
<td>S-BT-GR M8/7 SN 6 AL</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td>S-BT-MF M8/7 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6 AL</td>
<td>S-BT-MF M8/7 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td>S-BT-MF M10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6 AL</td>
<td>S-BT-MF M10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>S-BT-MF W10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>S-BT-MF W10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>Grating fastening</td>
<td>S-BT-GF M8/7 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6 AL</td>
<td>S-BT-GF M8/7 AN 6</td>
<td></td>
</tr>
</tbody>
</table>

### Electrical connections

| S-BT-ER M8/15 SN 6     | S-BT-EF M8/15 SN 6 |
| S-BT-ER M10/15 SN 6    | S-BT-EF M10/15 SN 6 |
| S-BT-ER W10/15 SN 6    | S-BT-EF W10/15 SN 6 |
| S-BT-ER M10 HC 35(*)   | S-BT-EF M10 HC 35(*) |
| S-BT-ER W10 HC AWG2(*) | S-BT-EF W10 HC AWG2(*) |
| S-BT-ER M10 HC 120     | S-BT-EF M10 HC 120 |
| S-BT-ER W10 HC AWG4/0  | S-BT-EF W10 HC AWG4/0 |
### 1.2.2 Drilling tool

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBT 4-A22</td>
<td>UCD tool</td>
<td>Drilling / Setting</td>
</tr>
<tr>
<td>SF BT 22-A</td>
<td>UCD tool</td>
<td>Drilling</td>
</tr>
<tr>
<td>(B22/2.6 or 5.2Ah)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF BT 18-A</td>
<td>UCD tool</td>
<td>Drilling</td>
</tr>
<tr>
<td>(B18/2.6 or 5.2Ah)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regarding the drilling time and the bore hole quality, a special tool with optimized revolutions per minute is needed. The cordless drilling machines SBT 4-A22, SF BT 22-A and SF BT 18-A are optimized for the drilling process in this application.

### 1.2.3 Stepped drill bit

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS-BT 5.5-74 S</td>
<td>Stepped drill bit for ≥ 3 mm [0.12&quot;] base material thickness</td>
<td>Drilling in steel</td>
</tr>
<tr>
<td>TS-BT 5.5-74 AL</td>
<td>Stepped drill bit for ≥ 5 mm [0.20&quot;] base material thickness</td>
<td>Drilling in aluminum</td>
</tr>
</tbody>
</table>

A stepped drill bit prevents the perforation of the base material (t ≥ 6 mm [0.24"]) and ensures a proper drilling depth and an accurate bore hole in terms of diameter. The front part generates the pilot hole in the base material in which the self-tapping thread will be set. The step (increased diameter) prevents the drill bit from further movement and through-penetration. Furthermore, the step will create a “shiny-ring” around the hole which allows the installer to recognize the end of the drilling process. Each S-BT sales box includes the corresponding TS-BT stepped drill bit. The stepped drill bit typically resists at least 100 bore holes with a constant geometry. Hilti recommends disposing of the used TS-BT stepped drill bit once the complete sales packaging S-BT studs are consumed. Hilti then advises using the new stepped drill bit out of the new sales packaging.
1.2.4 Installation tool

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBT 4-A22</td>
<td>UCD tool</td>
<td>Drilling / Setting</td>
</tr>
<tr>
<td>SFC 22-A (B22/2.6 or 5.2Ah)</td>
<td>UCD tool</td>
<td>Setting</td>
</tr>
<tr>
<td>SFC 18-A (B18/2.6 or 5.2Ah)</td>
<td>UCD tool</td>
<td>Setting</td>
</tr>
</tbody>
</table>

For the installation process, a recommended torque up to 13 Nm is needed. The cordless drill drivers SBT 4-A22, SFC 22-A and SFC 18-A fulfill the requirements for the installation process.

1.2.5 S-DG depth gauge with a S-CC calibration card

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-DG BT M8/7 Short 6</td>
<td>Depth gauge for S-BT M8/7 _N 6</td>
<td>Setting</td>
</tr>
<tr>
<td>S-DG BT M8/15 Long 6</td>
<td>Depth gauge for S-BT M8/15 _N 6</td>
<td>Setting</td>
</tr>
<tr>
<td>S-DG BT M10-W10/15 Long 6</td>
<td>Depth gauge for S-BT M10/W10 _N 6</td>
<td>Setting</td>
</tr>
<tr>
<td>S-DG BT M10-W10 HC 6</td>
<td>Depth gauge for S-BT M10/W10 HC _</td>
<td>Setting</td>
</tr>
<tr>
<td>S-CC BT 6</td>
<td>Calibration card for calibration of the depth gauge (short/long studs)</td>
<td>Calibration</td>
</tr>
<tr>
<td>S-CC BT HC 6</td>
<td>Calibration card for calibration of the depth gauge for S-BT M10/W10 HC _</td>
<td>Calibration</td>
</tr>
<tr>
<td>S-CG BT /7 Short 6</td>
<td>Check gauge for verification of the stand-off for short studs (7 mm)</td>
<td>Verification</td>
</tr>
<tr>
<td>S-CG BT /15 Long 6</td>
<td>Check gauge for verification of the stand-off for long studs (15 mm)</td>
<td>Verification</td>
</tr>
<tr>
<td>S-CG BT HC</td>
<td>Check gauge for verification of the stand-off for S-BT M10/W10 HC _</td>
<td>Verification</td>
</tr>
</tbody>
</table>

washer, the S-BT studs have to be installed with the appropriate depth gauge. With this tool the screw-in depth can be adjusted in a range of 0 - 1.5 mm (3 steps, 0.5 mm per step).

The S-CC BT calibration card is needed to check the initial stand-off of the S-BT stud (ensure the proper screw-in depth) and to adjust/calibrate the S-DG depth gauge. After finding the right adjustment level for the S-DG depth gauge, the gauge can be adjusted and the studs can be installed without additional check of the S-DG depth gauge.

The depth gauge has to be re-adjusted (calibrated) at following times:

• Start of the installation process
• Change of the working position (upwards, downwards, horizontal)
• and base material (thickness, strength, type)
• Installer change
• After each packaging respectively after the installation of 100 S-BT studs

Section 4 comprises the instructions for use (IFU) of the S-BT studs with a detailed illustration how to use the S-DG depth gauge and the S-CC calibration card. The installer is responsible for the correct setting of the S-BT studs. For the periodical verification of the correct stud stand-off the S-CG BT check gauge can be used.

The lifetime of the S-DG BT depth gauge is ≥ 1000 settings.
1.2.6 Installation temperature and service temperature

The **installation temperature** is the temperature at which the S-BT studs are installed. A distinction is made between the temperature of the base material and the temperature of the S-BT studs, drilling and installation tools and accessories. The installation temperature range can be found in the table below.

The **service temperature** is the temperature at which the S-BT studs operate. The S-BT studs will operate effectively and without any loss in performance (loads, sealing function, etc.) within the specified service temperature range. Outside this temperature range the S-BT studs may fail.

<table>
<thead>
<tr>
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<th>Installation temperature</th>
<th>Service temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Base material</td>
<td>-40 °C</td>
<td>+60 °C</td>
</tr>
<tr>
<td>S-BT studs</td>
<td>-10 °C</td>
<td>+60 °C</td>
</tr>
<tr>
<td>Drilling &amp; Installation tools and accessories</td>
<td>-10 °C</td>
<td>+60 °C</td>
</tr>
</tbody>
</table>

**Note:**

The service temperature range of the connected cable lugs and cables has to be observed. For details please contact the supplier of the cable lugs and cables. When using Hilti S-BT fasteners in combination with fire rated boundaries in Shipbuilding facilities, the max. service temperature for a period of 60 minutes is higher. For more details refer to section 5.10 “Fire resistance”.

1.3 Fastening mechanism

The S-BT fastener will be screwed in into a pre-drilled hole. The threaded stud is tapping its own internal mating threads when installed into base material. The S-BT fasteners are anchored in the base material by way of a keying effect, i.e. self-tapping screws form a thread in the base material. The ground cross-sections of an S-BT fastener in steel shows the thread of the fastener engaged with the base material.

1.4 S-BT system features and benefits – simplified fastening to steel

**No rework:**

Stud welding or through-bolting, for example, may require reworking of the protective surface coating. With the S-BT system, the stud is set into a small pre-drilled hole. In case of a pilot hole the drill entry point is then completely sealed by the stud washer during setting. If the real base material thickness $t_b$ exceeds 6 mm [$0.24”$] no rework of the protective surface coating on the back side is needed.

**Simple and fast:**

A minimal amount of training is all that is required for a user to be able to install up to 100 studs per hour.

**High corrosion resistance:**

The stainless steel S-BT fasteners are made from the duplex stainless steel type 1.4462, which is equivalent to AISI 316 (A4) steel grade and suitable for aggressive environments like in coastal and offshore applications.

The coating of the carbon steel S-BT fasteners consists of an electroplated Zn-alloy for cathodic protection and a top coat for chemical resistance (Duplex-coating).
The use of this coating is limited to indoor environments and outdoor (no coastal) environments with low pollution. Refer to section 5.9 for selection of the suitable fastener in terms of corrosion.

**High tension and shear load values:**
S-BT delivers performance comparable to methods such as stud welding. See load data tables in section 3.2 for details.

**Fasten to all steel shapes:**
Unlike clamps, which are limited by the configuration of the base steel, the S-BT is ideal for use on hollow sections, channel sections, wide flanges and angles.

**Fasten to thin steel and aluminum:**
In addition to fastening to standard construction steel $t_1 \geq 6 \text{ mm} [0.24\text{"}]$ (pilot hole), the S-BT can also be used to fasten to aluminum $t_1 \geq 6 \text{ mm} [0.24\text{"}]$ (pilot hole) and $5 \text{ mm} [0.20\text{"}] \leq t_1 < 6 \text{ mm} [0.24\text{"}]$ (drill through hole). Furthermore fastening in thin steel $3 \text{ mm} [0.12\text{"}] \leq t_1 < 6 \text{ mm} [0.24\text{"}]$ (drill through hole) is possible.
In case of a drill through hole, rework of the coating on the back side of the plate / profile may be needed.

**Cordless and Portable:**
The cordless drilling and installation tools eliminate the need for electrical cords and heavy welding equipment.

**No through-penetration for base material $t_1 \geq 6 \text{ mm} [0.24\text{"}]$:**
The special process of drilling and installation results in secure fastening of the fastener without through-penetration of the base material. If the real base material thickness $t_1$ exceeds $6 \text{ mm} [0.24\text{"}]$ no rework of the protective surface coating on the back side is needed.

## 2 APPLICATIONS

### 2.1 Grating fastening system

**X-FCM and X-FCM-M grating discs for use with S-BT-GF M8/7 or S-BT-GR M8/7**

**X-FCM-R grating discs (stainless steel) for use with S-BT-GR M8/7**

A fastening system designed for attaching metal or fiber-glass grating to coated steel.

**X-FCM, X-FCM-M, X-FCM-R grating discs**

**Important:** The X-FCM-R, X-FCM and X-FCM-M systems are not designed or intended to resist shear loads.

**X-SEA-R 30 M8 extension adaptor**

For use with X-FCM-R grating fasteners for fastening of grating with a height in excess of 50 mm [1.97"].

**X-SEA-R 30 M8 extension adaptor**
### Fastener selection

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<th>Designation</th>
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<td>23/0.91</td>
<td>25-30/0.98-1.18</td>
<td>55-60/2.16-2.36</td>
</tr>
<tr>
<td>X-FCM-R 1&quot;-1¼&quot;</td>
<td>27/1.06</td>
<td>29-34/1.14-1.34</td>
<td>59-64/2.32-2.52</td>
</tr>
<tr>
<td>X-FCM-R 35/40</td>
<td>33/1.30</td>
<td>35-40/1.38-1.57</td>
<td>65-70/2.56-2.75</td>
</tr>
<tr>
<td>X-FCM-R 45/50</td>
<td>43/1.69</td>
<td>45-50/1.77-1.97</td>
<td>75-80/2.91-3.15</td>
</tr>
<tr>
<td>X-FCM-M 25/30</td>
<td>23/0.91</td>
<td>25-30/0.98-1.18</td>
<td></td>
</tr>
<tr>
<td>X-FCM-M 1&quot;-1¼&quot;</td>
<td>27/1.06</td>
<td>29-34/1.14-1.34</td>
<td></td>
</tr>
<tr>
<td>X-FCM-M 35/40</td>
<td>33/1.30</td>
<td>35-40/1.38-1.57</td>
<td></td>
</tr>
<tr>
<td>X-FCM-M 45/50</td>
<td>43/1.69</td>
<td>45-50/1.77-1.97</td>
<td></td>
</tr>
</tbody>
</table>

### Installation instructions

1. Lay grating section in final position.
2. Expand grating openings if necessary.
3. Pre-drill until shoulder grinds a shiny ring. The drilled hole and the area around drilled hole must be clean and free from liquids and debris.
4. Screw-in S-BT studs into drilled hole.
5. Tighten X-FCM discs with 5 mm Allen-type bit with the suited installation torque.

**Important notes:**

These are abbreviated instructions which may vary by application. ALWAYS review / follow the instructions for use (IFU) accompanying the product. In case of a drill through hole, rework of the coating on the back side of the plate / profile may be needed.
2.2 Grating fastening system X-FCS-R

X-FCS-R grating fastener for use with S-BT-GR M8/7

The X-FCS-R system is a fastening system for grating fastening with tensile and shear resistance capability (shear relevant zones).

**Fastener selection**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Fastener height H [mm/in.]</th>
<th>Grating height h, range [mm/in.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-FCS-R-3-25 31/35</td>
<td>30.5/1.20</td>
<td>31-35/1.22-1.38</td>
</tr>
<tr>
<td>X-FCS-R-3-25 37/41</td>
<td>36.5/1.44</td>
<td>37-41/1.46-1.61</td>
</tr>
<tr>
<td>X-FCS-R-4-25 31/35</td>
<td>30.5/1.20</td>
<td>31-35/1.22-1.38</td>
</tr>
<tr>
<td>X-FCS-R-4-25 37/41</td>
<td>36.5/1.44</td>
<td>37-41/1.46-1.61</td>
</tr>
</tbody>
</table>

**Important:** The X-FCS-R system is suitable for rectangular gratings and square gratings with a bar spacing \( w = 25 \text{ mm } [0.98"] \) and bar thickness \( t = 5 \text{ mm } [0.20"] \).
2.3 S-BT with MM and MQ installation channel system

MM channel system for use with S-BT-MF
MQ channel system for use with S-BT-MF or S-BT-MR

Installation instructions

1. Mark location of each fastening.
2. Pre-drill with TS-BT stepped drill bit.
   Pre-drill until shoulder grinds a shiny ring.
   The drilled hole and the area around drilled hole must be clean and free from liquids and debris.

3. Screw-in S-BT studs into drilled hole.
4. Position channel on S-BT studs and hold in place.
   Tighten the nuts with the suited installation torque.

Note: In case of applied shear load, the S-BT should be placed according to illustration (end of slotted hole)

Two S-BT studs in one slotted hole
One S-BT stud in each slotted hole
2.4 Fastening instrumentation, junction boxes and lighting

S-BT screw-in threaded studs for attaching instrumentation, junction boxes and lighting to coated steel.

Installation instructions

1. Mark location of each fastening.
2. Pre-drill with TS-BT stepped drill bit.
3. Pre-drill until shoulder grinds a shiny ring. The drilled hole and the area around drilled hole must be clean and free from liquids and debris.
4. Position channel on S-BT studs and hold in place. Tighten the nuts with the suited installation torque.
5. Fasten the accessory on the channel with the suited installation torque.

For fastening the accessory on the Hilti channel or bracket always use the suitable Hilti wing nut in combination with a proper bolt.

The instruction for use (IFU) accompanying the sales packaging of the Hilti wing nuts comprises detailed information about the installation of the wing nut and the tightening torque $T_{rec}$.

**Important notes:**
These are abbreviated instructions which may vary by application. Always review / follow the instructions for use (IFU) accompanying the product. In case of a drill through hole, rework of the coating on the back side of the plate / profile may be needed.
2.5 Fastening cable / conduit connectors

Stainless steel and carbon steel S-BT screw-in threaded studs for fastening cable and conduit connectors (T-bars) to coated steel.

Installation instructions

1. Mark location of each fastening.
2. Pre-drill with TS-BT stepped drill bit.
3. Pre-drill until shoulder grinds a shiny ring. The drilled hole and the area around drilled hole must be clean and free from liquids and debris.
4. Screw-in S-BT studs into drilled hole.
5. Screw on the connector and hand tighten.
6. Align connectors. Fasten the cable / conduit on the connector.

2.5 Fastening cable tray supports

Stainless steel and carbon steel threaded studs for fastening cable trays to coated steel.

Installation instructions

Hold down clamp
Expansion guide clip

Important notes:
These are abbreviated instructions which may vary by application. Always review / follow the instructions for use (IFU) accompanying the product. In case of a drill through hole, rework of the coating on the back side of the plate / profile may be needed.
2.7 Electrical connections

Fasteners

- S-BT-ER M10/15 SN 6
- S-BT-ER W10/15 SN 6
- S-BT-EF M10/15 AN 6
- S-BT-EF W10/15 AN 6

- S-BT-ER M8/15 SN 6
- S-BT-ER M8/15 AN 6

- S-BT-ER M10 HC 35°
- S-BT-ER W10 HC AWG2°
- S-BT-ER M10 HC 120
- S-BT-ER W10 HC AWG4/0
- S-BT-EF M10 HC 35°
- S-BT-EF W10 HC AWG2°
- S-BT-EF M10 HC 120
- S-BT-EF W10 HC AWG4/0

Please refer to Part 5.8.1 for additional technical information with regards to the effect of S-BT-ER / S-BT-EF fasteners on integrity of pipe flange.

° this items are available only on special request

° only for Type A cable connections

Functional and protective bonding of pipes (outer diameter of installed surface ≥ 150mm)

Protective bonding circuit – Double point connection
2.7.1 Functional bonding and terminal connection in a circuit

For permanent current (leakage current) due to static charge built up in pipes or when closing an electrical circuit.

Recommended electrical connectors:  
Maximum allowable permanent current

- S-BT-ER M10/15 SN 6  
- S-BT-ER W10/15 SN 6  
- S-BT-EF M10/15 AN 6  
- S-BT-EF W10/15 AN 6  : $I_{th} = 57$ A
- S-BT-ER M8/15 SN 6  
- S-BT-EF M8/15 AN 6

- S-BT-ER M10 HC 35$^\star$)  
- S-BT-ER W10 HC AWG2$^\star$)  
- S-BT-EF M10 HC 35$^\star$)  
- S-BT-EF W10 HC AWG2$^\star$)  : $I_{th} = 125$ A

- S-BT-ER M10 HC 120
- S-BT-ER W10 HC AWG4/0
- S-BT-EF M10 HC 120
- S-BT-EF W10 HC AWG4/0  : $I_{th} = 269$ A

Note:

- Recommended maximal cross section of connected cable according IEC 60947-7-2 and IEC 60947-7-1:  
  - 10 mm² (8 AWG) copper (tested permanent current $I_{th} = 57$ A)  
  - 35 mm² (2 AWG) copper (tested permanent current $I_{th} = 125$ A)  
  - 120 mm² (4/0 AWG) copper (tested permanent current $I_{th} = 269$ A)

- Fastening of thicker cable is acceptable, if the maximum allowable permanent current $I_{th}$ is not exceeded and the provisions on cable lug thickness $t_c$ are observed.

*) this items are available only on special request
2.7.2 Protective bonding circuit

For discharging short circuit current while protecting electrical equipment or earth / ground cable trays and ladders.

**Single point connection:**

Recommended electrical connectors: Max. short circuit current according to IEC and UL

S-BT-ER M10/15 SN 6
S-BT-ER W10/15 SN 6
S-BT-EF M10/15 AN 6
S-BT-EF W10/15 AN 6
S-BT-ER M8/15 SN 6
S-BT-EF M8/15 AN 6
S-BT-ER M10 HC 35°
S-BT-ER W10 HC AWG2°
S-BT-EF M10 HC 35°
S-BT-EF W10 HC AWG2°

S-BT-ER M10 HC 120
S-BT-ER W10 HC AWG4/0
S-BT-EF M10 HC 120
S-BT-EF W10 HC AWG4/0

**Note:**

- Recommended maximal cross section of connected cable according IEC 60947-7-2 and IEC 60947-7-1:
  - 10 mm² (8 AWG) copper (tested short circuit current $I_{cw} = 1.20$ kA for 1 s)
  - 35 mm² (2 AWG) copper (tested short circuit current $I_{cw} = 4.20$ kA for 1 s)
  - 120 mm² (4/0 AWG) copper (tested short circuit current $I_{cw} = 14.40$ kA for 1 s)

  - According UL 467:
    - 10 AWG copper (tested short circuit current $I_{cw} = 0.75$ kA for 4 s)
    - 2 AWG copper (tested short circuit current $I_{cw} = 3.90$ kA for 6 s)
    - 4/0 AWG copper (tested short circuit current $I_{cw} = 10.10$ kA for 9 s)

- Fastening of thicker cable is acceptable, if the maximum short circuit current $I_{cw}$ and the exposure time is not exceeded and the provisions on cable lug thickness $t_c$ are observed.

  1° this items are available only on special request
Double point connection:

Recommended electrical connectors:

- S-BT-ER M10/15 SN 6
- S-BT-ER W10/15 SN 6
- S-BT-EF M10/15 AN 6
- S-BT-EF W10/15 AN 6
- S-BT-ER M8/15 SN 6
- S-BT-EF M8/15 AN 6

Max. short circuit current \( I_{cw} \) according to IEC

\[ \begin{align*}
I_{cw} &= 1.92 \text{ kA (IEC)}
\end{align*} \]

Note:

- Recommended maximal cross section of connected cable according IEC 60947-7-2 and IEC 60947-7-1:
  - 16 mm² (6 AWG) copper (tested short circuit current \( I_{cw} = 1.92 \text{ kA for 1 s} \))
- Fastening of thicker cable is acceptable, if the maximum short circuit current \( I_{cw} \) and the exposure time is not exceeded and the provisions on cable lug thickness \( t_{cu} \) are observed.

2.7.3 Lightning protection

For high temporary current due to lightning.

Single point connection (classification N acc. IEC 62561-1):

Recommended electrical connectors:

- S-BT-ER M10/15 SN 6
- S-BT-ER W10/15 SN 6
- S-BT-EF M10/15 AN 6
- S-BT-EF W10/15 AN 6
- S-BT-ER M8/15 SN 6
- S-BT-EF M8/15 AN 6

Maximum lightning current

\[ \begin{align*}
I_{\text{imp}} &= 50 \text{ kA for } \leq 5 \text{ ms} \\
&\quad \text{(according to IEC 62561-1)}
\end{align*} \]
S-BT Screw-in threaded studs

Single point connection (classification H acc. IEC 62561-1):

Recommended electrical connectors:
- S-BT-ER M10 HC 35")
- S-BT-ER W10 HC AWG2")
- S-BT-EF M10 HC 35")
- S-BT-EF W10 HC AWG2")
- S-BT-ER M10 HC 120
- S-BT-ER W10 HC AWG4/0
- S-BT-EF M10 HC 120
- S-BT-EF W10 HC AWG4/0

Maximum lightning current

Connection configuration:
Single point connections

Note:
When S-BT-ER / -EF is used in class H applications only type B cable connection is allowed.

Tightening torque of 8 Nm must be observed accurately for type B cable connection.

¹ this items are available only on special request

\[ I_{imp} = 100 \text{ kA for } \leq 5 \text{ ms} \]

(according to IEC 62561-1)
3 TECHNICAL DATA

3.1 Product data

3.1.1 S-BT material specifications and dimensions

<table>
<thead>
<tr>
<th>Material</th>
<th>Specifications</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>S-BT-MR</td>
<td>Ø 10/12 [0.39/0.47&quot;]</td>
</tr>
<tr>
<td></td>
<td>S-BT-GR</td>
<td>Ø 10/12 [0.39/0.47&quot;]</td>
</tr>
<tr>
<td>Carbon steel</td>
<td>S-BT-MF</td>
<td>Ø 10/12 [0.39/0.47&quot;]</td>
</tr>
<tr>
<td></td>
<td>S-BT-GF</td>
<td>Ø 10/12 [0.39/0.47&quot;]</td>
</tr>
</tbody>
</table>

Threads

<table>
<thead>
<tr>
<th>Material</th>
<th>Specifications</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>(CrNiMo alloy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S31803 (1.4462)</td>
<td></td>
</tr>
<tr>
<td>Zinc-coated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon steel</td>
<td>1038</td>
<td></td>
</tr>
</tbody>
</table>

Threaded shank

<table>
<thead>
<tr>
<th>Washer</th>
<th>Specifications</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SN 12-R</td>
<td>Ø 12 mm [0.47&quot;]</td>
<td></td>
</tr>
<tr>
<td>Stainless steel</td>
<td>(X2CrNiMo 17-12-2)</td>
<td></td>
</tr>
<tr>
<td>S31635 (1.4404)</td>
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<td></td>
</tr>
<tr>
<td>Duplex-coated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon steel</td>
<td>1038</td>
<td></td>
</tr>
<tr>
<td>Carbon steel</td>
<td>(EN AW-5754)</td>
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</tr>
</tbody>
</table>

Washer

<table>
<thead>
<tr>
<th>Serrated flange nut</th>
<th>Specifications</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>grade A4 - 70/80</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon steel</td>
<td>HDG, grade 8</td>
<td></td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Serrated flange nut

Sealing ring of sealing washer

<table>
<thead>
<tr>
<th>Material</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td></td>
</tr>
</tbody>
</table>

*) S-BT-GR and S-BT-GF for grating fastening. Package does not include serrated flange nuts

**) for use in aluminum base material
3.1.2 Drilling tool, setting tool, accessories and inserts

For more details refer to section 3.2.9 “Fastener selection and system recommendation”

Approvals

LR: 16/00063, BV: 45116/A BV, Russian Maritime Register of Shipping:
16.40059.250, UL: File E257069

The S-BT fastening systems holds several Type Approvals internationally valid for the ship-building and off-shore industry. These approvals are issued by international classification bodies relevant for these industries.

These bodies are:
• ABS – American Bureau of Shipping
• DNV-GL
• LR – Lloyds Register
• BV – Bureau Veritas
• Russian Maritime Register of Shipping

The UL-listing (File E257069) addresses the use of S-BT-ER / -EF and X-BT-ER as grounding and bonding equipment.

Chapter 7 summarizes print-outs of the Type Approvals as well as the ESR-4185. These printouts allow for a general survey of the scope of the approvals, being valid mid of 2018.

Approvals are subject to continuous changes related to code developments, product portfolio updates and new research results. Current approvals can be downloaded from Hilti website or from the websites of most Certification Bodies.
3.2 Load data

3.2.1 Recommended loads

<table>
<thead>
<tr>
<th>S-BT-__________6</th>
<th>Drill hole type and base material thickness</th>
<th>Pilot hole, ( t_i \geq 6 \text{ mm [0.24&quot;]} )</th>
<th>Drill through hole, ( 5 \text{ mm [0.20] } t_i &lt; 6 \text{ mm [0.24&quot;]} )</th>
<th>Drill through hole ( 3 \text{ mm } t_i &lt; 5 \text{ mm} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base material</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S235</td>
<td>S355</td>
<td>Grade 50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A36</td>
<td>Grade 50</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel</td>
<td>S235</td>
<td>S355</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grade 50</td>
<td>Grade 50</td>
<td>Grade 50</td>
</tr>
<tr>
<td></td>
<td>Tension, ( N_{rec} [kN/lb] )</td>
<td>1.8 / 405</td>
<td>2.3 / 520</td>
<td>1.0 / 225</td>
</tr>
<tr>
<td></td>
<td>Shear, ( V_{rec} [kN/lb] )</td>
<td>2.6 / 585</td>
<td>3.2 / 720</td>
<td>1.5 / 340</td>
</tr>
<tr>
<td></td>
<td>Moment, ( M_{rec} [Nm/lbf] )</td>
<td>7.0 / 5.2</td>
<td>7.0 / 5.2</td>
<td>4.8 / 3.5</td>
</tr>
</tbody>
</table>

Conditions for recommended loads:
- Use S-BT-MR and S-BT-MF (multipurpose fastening) only with the attached Hilti serrated flange nuts M8, M10, W10 (⃝ or ⃞ refer to section 3.1.1)
- Global factor of safety \( \Omega \) for static pull-out and static shear ≥ 3 (based on 5% fractile ultimate test value).
- Minimum edge distance = 6 mm [0.24"], spacing ≥ 18 mm [0.709”]
- Effect of base metal vibration and stress (e.g. areas with tensile stress) considered.
- Redundancy (multiple fastening) must be provided.
- If eccentric loading exists (e.g. use of an angle clip), moments caused by off-center loading must be considered.

3.2.2 Design resistance

<table>
<thead>
<tr>
<th>S-BT-__________6</th>
<th>Drill hole type and base material thickness</th>
<th>Pilot hole, ( t_i \geq 6 \text{ mm [0.24&quot;]} )</th>
<th>Drill through hole, ( 5 \text{ mm [0.20] } t_i &lt; 6 \text{ mm [0.24&quot;]} )</th>
<th>Drill through hole ( 3 \text{ mm } t_i &lt; 5 \text{ mm} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base material</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S235</td>
<td>S355</td>
<td>Grade 50</td>
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<td>A36</td>
<td>Grade 50</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel</td>
<td>S235</td>
<td>S355</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grade 50</td>
<td>Grade 50</td>
<td>Grade 50</td>
</tr>
<tr>
<td></td>
<td>Tension, ( N_{nd} [kN/lb] )</td>
<td>2.5 / 560</td>
<td>3.2 / 720</td>
<td>1.4 / 315</td>
</tr>
<tr>
<td></td>
<td>Shear, ( V_{nd} [kN/lb] )</td>
<td>3.6 / 810</td>
<td>4.5 / 1010</td>
<td>2.1 / 470</td>
</tr>
<tr>
<td></td>
<td>Moment, ( M_{nd} [Nm/lbf] )</td>
<td>9.8 / 7.2</td>
<td>9.8 / 7.2</td>
<td>6.7 / 4.9</td>
</tr>
</tbody>
</table>

Conditions for design resistance:
- Use S-BT-MR and S-BT-MF (multipurpose fastening) only with the attached Hilti serrated flange nuts M8, M10, W10 (⃝ or ⃞ refer to section 3.1.1)
- The design resistance can be used for the design according the partial safety concept, e.g. EN 1993-1-1 (Eurocode 3).
- Minimum edge distance = 6 mm [0.24"], spacing ≥ 18 mm [0.709”]
- Effect of base metal vibration and stress (e.g. areas with tensile stress) considered.
- Redundancy (multiple fastening) must be provided.
- If eccentric loading exists (e.g. use of an angle clip), moments caused by off-center loading must be considered.

Cyclic loading:
S-BT threaded studs are only to be used for fastenings subject to static or quasi-static loading.
Inquire at Hilti for test data if cyclic loading has to be considered in the design.
3.2.3 Recommended interaction formula for combined loading – steel and aluminum base materials

\[
\begin{align*}
\text{V–N (shear and tension)} & & \frac{V}{V_{\text{rec}}} + \frac{N}{N_{\text{rec}}} \leq 1.2 \text{ with } \frac{V}{V_{\text{rec}}} \leq 1.0 \text{ and } \frac{N}{N_{\text{rec}}} \leq 1.0 \\
\text{V–M (shear and bending)} & & \frac{V}{V_{\text{rec}}} + \frac{M}{M_{\text{rec}}} \leq 1.2 \text{ with } \frac{V}{V_{\text{rec}}} \leq 1.0 \text{ and } \frac{M}{M_{\text{rec}}} \leq 1.0 \\
\text{N–M (tension and bending)} & & \frac{N}{N_{\text{rec}}} + \frac{M}{M_{\text{rec}}} \leq 1.0 \\
\text{V–N–M (shear, tension and bending)} & & \frac{V}{V_{\text{rec}}} + \frac{N}{N_{\text{rec}}} + \frac{M}{M_{\text{rec}}} \leq 1.0
\end{align*}
\]

3.2.4 Base material thickness \(t_{\text{II}}\) and type of bore hole

<table>
<thead>
<tr>
<th>Pilot hole</th>
<th>Drill through hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>💫</td>
<td>💫</td>
</tr>
</tbody>
</table>

Base material thickness
steel and aluminum:
\(t_{\text{II}} \geq 6 \text{ mm } [0.24"]\)

Thickness of base material corrosion protection layer \(\leq 0.8 \text{ mm } [0.0315"]\).
For thicker coatings, please contact Hilti.

**Corrosion information:**

The S-BT stainless steel fasteners are made from the duplex stainless steel type 1.4462, which is equivalent to AISI 316 (A4) steel grade. This grade of stainless steel is classified in the corrosion resistance class IV according to DIN EN 1993-1-4:2015, which makes the material suitable for aggressive environments like in coastal and offshore applications. The microstructures of duplex stainless steels consist of a mixture of austenite and ferrite phases. Compared to the austenitic stainless steel grades, duplex stainless steels are magnetic. The surface of the S-BT stainless steel fasteners is zinc-coated (anti-friction coating) in order to reduce the thread forming torque when the stud is screwed in into the base material.

The coating of the carbon steel S-BT fasteners consists of an electroplated Zn-alloy for cathodic protection and a top coat for chemical resistance (Duplex-coating). The thickness of the coating is 35 \(\mu\)m. This product is designed for use in corrosive categories C1, C2 and C3 according the standard EN ISO 9223. For higher corrosion categories stainless steel fasteners should be used.

In case of a drill through hole or a pilot hole in thin base material, rework of the coating on the back side of the plate / profile may be needed.

<table>
<thead>
<tr>
<th>Corrosivity category</th>
<th>S-BT_______AN 6</th>
<th>S-BT_______SN 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3 medium corrosive</td>
<td>Topside protection</td>
<td>Backside protection</td>
</tr>
<tr>
<td>Drill through hole</td>
<td>✓</td>
<td>x°</td>
</tr>
<tr>
<td>3 mm [0.12&quot;] (t_{\text{II}} \leq 6 \text{ mm } [0.24&quot;])</td>
<td>✓</td>
<td>x°</td>
</tr>
<tr>
<td>Pilot hole</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6 mm [0.24&quot;] (t_{\text{II}} \leq 7 \text{ mm } [0.28&quot;])</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pilot hole</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(t_{\text{II}} \leq 7 \text{ mm } [0.28&quot;])</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

1) Real base material thickness, not nominal material thickness or material thickness with coating.
2) Damage of the coating on the back side of the plate/profile require a rework of the coating.
3) Damage of the coating on the back side of the plate / profile require a rework of the coating, if the drilling tools SF BT 22-A or SF BT 18-A were used for drilling the bore hole. If the tool SBT 4-A22 was used for drilling the bore hole, no damage of the coating on the back side of the plate / profile will occur.

Specifications page 23
3.2.5 Thickness of fastened material \( t_1 \),

\[
\begin{align*}
S-BT-______ / 7_____ & \quad 1.6 \text{ mm } [0.063"] \leq t_1 \leq 7.0 \text{ mm } [0.28"] \\
S-BT-______ / 15_____ & \quad 1.6 \text{ mm } [0.063"] \leq t_1 \leq 15.0 \text{ mm } [0.59"]
\end{align*}
\]

3.2.6 Spacing and edge distances

Edge distance: \( \geq 6 \text{ mm } [0.24"] \)

Spacing:

\( \geq 6 \text{ mm } [0.24"] \) for all S-BT M8
\( \geq 22 \text{ mm } [0.866"] \) for all S-BT M10 and S-BT W10

3.2.7 Installation temperature and service temperature

The **installation temperature** is the temperature at which the S-BT studs are installed. A distinction is made between the temperature of the base material and the temperature of the S-BT studs, drilling and installation tools and accessories. The installation temperature range can be found in the table below.

The **service temperature** is the temperature at which the S-BT studs operate. The S-BT studs will operate effectively and without any loss in performance (loads, sealing function, etc.) within the specified service temperature range. Outside this temperature range the S-BT studs may fail.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Installation temperature</th>
<th>Service temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Base material</td>
<td>-40 °C</td>
<td>+60 °C</td>
</tr>
<tr>
<td>S-BT studs</td>
<td>-10 °C</td>
<td>+60 °C</td>
</tr>
<tr>
<td>Drilling &amp; Installation tools</td>
<td>-10 °C</td>
<td>+60 °C</td>
</tr>
<tr>
<td>and accessories</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

The service temperature range of the connected cable lugs and cables has to be observed. For details please contact the supplier of the cable lugs and cables. When using Hilti S-BT fasteners in combination with fire rated boundaries in Shipbuilding facilities, the max. service temperature for a period of 60 minutes is higher. For more details refer to section 5.10 “Fire resistance”. 
3.2.8 Application limit and thickness of base material

The base material is limited to steel grade with a maximum tensile strength \( f_u = 630 \text{ MPa} \) [91 ksi].

The minimum tensile strength of steel is \( f_u \geq 340 \text{ MPa} \) [49 ksi].

The minimum tensile strength of aluminum is \( f_u \geq 270 \text{ MPa} \) [39 ksi].

Minimum thickness of base material \( t_i \): refer to section 3.2.4

Maximum thickness of base material \( t_i \): no limits

3.2.9 Fastening quality assurance and fastening inspection

Verify stud stand-off \( h_{\text{NVS}} \) with calibration card S-CG BT

\[
\begin{align*}
\text{S-BT-}_{{\text{_____}/ \text{7} \text{_____} 6}} & \quad h_{\text{NVS}} = 18.6 \text{ mm to 19.1 mm} \ [0.732'' \text{ to } 0.752''] \\
\text{S-BT-}_{{\text{_____}/ \text{15} \text{_____} 6}} & \quad h_{\text{NVS}} = 29.3 \text{ mm to 29.8 mm} \ [1.153'' \text{ to } 1.173'']
\end{align*}
\]
### 3.210 Fastener selection and system recommendation

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Drilling Tool</th>
<th>Setting Tool</th>
<th>Drill bit</th>
<th>Depth gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-MR M8/7 SN 6</td>
<td>SBT 4-A22, SF BT 18-A or SF BT 4-A22</td>
<td>TS-BT 5.5-74 S</td>
<td>S-DG BT M8/7 Short 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 6 AL</td>
<td></td>
<td>TS-BT 5.5-74 AL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6 AL</td>
<td></td>
<td>TS-BT 5.5-74 AL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>S-DG BT M8/7 Short 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6 AL</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td>S-DG BT M8/7 Short 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER M10/15 SN 6</td>
<td></td>
<td>TS-BT 5.5-74 AL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER W10/15 SN 6</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER M10 HC 35°</td>
<td>S-DG BT M10-W10 HC 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER W10 HC AWG 2°</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER M10 HC 120</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-ER W10 HC AWG 4/0</td>
<td></td>
<td>TS-BT 25-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>S-DG BT M8/7 Short 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MF M8/7 AN 6</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MF M8/15 AN 6</td>
<td></td>
<td>S-DG BT M8/15 Long 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M8/15 AN 6</td>
<td></td>
<td>S-DG BT M10-W10 Long 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10/15 AN 6</td>
<td></td>
<td>TS-BT 15-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN 6</td>
<td></td>
<td>S-DG BT M10-W10 HC 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10 HC 35°</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10 HC AWG 2°</td>
<td></td>
<td>TS-BT 15-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10 HC 120</td>
<td></td>
<td>TS-BT 5.5-74 S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10 HC AWG 4/0</td>
<td></td>
<td>TS-BT 25-74 S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) this items are available only on special request
3.2.11 Installation details

**S-BT fastener made of stainless steel with washer-∅ 12 mm (S-BT-_R)**
Fastened material hole ∅ ≥ 13 mm [0.51”]

**S-BT fastener made of carbon steel with washer-∅ 10 mm (S-BT-_F)**
Fastened material hole ∅ ≥ 11 mm [0.43”]

Remark: for group fastenings subjected to shear loading the fastened material hole diameter should not exceed 14 mm [0.55”] (S-BT-_R) and 12 mm [0.47"] (S-BT-_F) respectively.

- Mark location for each fastening
- Pre-drill with TS-BT stepped drill bit
  Usage of SBT 4-A22 or SF BT18-A or SF BT22-A. Pre-drill until the shoulder grinds a shiny ring to assure proper drilling depth. Before fastener installation: The drilled hole and the area around the drilled hole must be clear of liquids and debris.
- Screw-in S-BT studs into drilled hole
  Usage of SBT 4-A22, SFC 18-A or SFC 22-A in combination with the calibrated depth gauge S-DG BT. Verify stud stand-off hNVS with check gauge S-CG BT. Sealing washer must be properly compressed!
- Hang channel or accessory on studs
  Tighten nuts by hand
- Tighten the nuts with the suited tightening torque T_{rec}
  T_{rec} refer to table below.
  Tighten the serrated flange nuts using
  - SBT 4-A22, SFC 18-A or 22-A with socket S-NS
  - torque tool X-BT ¼” (8 Nm) or S-BT ¼” (5 Nm)
  - torque wrench

<table>
<thead>
<tr>
<th>Trec</th>
<th>5 Nm</th>
<th>8 Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilti screw driver:</td>
<td>Torque setting:</td>
<td></td>
</tr>
<tr>
<td>SBT 4-A22</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SFC 18-A</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SFC 22-A</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Tightening torque serrated flange nut (Multipurpose Fastenings):

<table>
<thead>
<tr>
<th>S-BT</th>
<th>6</th>
</tr>
</thead>
</table>
| Drill hole type and base material thickness | Pilot hole, t ≥ 6 mm [0.24"]
Drill through hole, 5 mm [0.20] ≤ t < 6 mm [0.24”] | Drill through hole 3 mm ≤ t < 5 mm |
| Base material | Steel | Steel | Aluminum | Steel | Steel |
| | S235 | S355 | Grade 50 | S235 | S355 |
| | A36 | | | A36 | Grade 50 |
| Tightening torque serrated flange nut T_{rec} [Nm/lbft] | 8 / 5.9 | 8 / 5.9 | 5 / 3.6 | 5 / 3.6 | 5 / 3.6 |
Important notes:
The tightening torque \( T_{\text{req}} \) for the serrated flange nut is dependent on the stud type, the base material type and thickness, and the drill hole type. Exceeding the tightening torque \( T_{\text{req}} \) leads to damage of the S-BT stud’s anchorage with negative impact on the load values and the sealing function.

**Tightening torque S-BT-ER and S-BT-EF (Electrical Connections):**

**Single point connection type A and double point connection type A**

Hold the bottom nut with a spanner while tightening the upper nut.

Tightening Torque: Min. 8Nm
Max. 20Nm

---

**Single point connection type B**

The tightening torque is **8 Nm**.
Exceeding or falling below this tightening torque value is not allowed.
Tighten the nut using torque tool X-BT ¼” (8Nm), torque wrench or Hilti screw driver SBT 4-A22, SFC 18-A or SFC 22-A (torque setting 5) with socket S-NS.

**Tightening torque X-FCM discs and X-FCS-R grating fastener (Grating Fastening Systems):**

Refer to chapter 2.1 and 2.2.

These are abbreviated instructions which may vary by application.
ALWAYS review / follow the instructions for use (IFU) accompanying the product. In case of a **drill through hole**, rework of the coating on the back side of the plate / profile may be needed.
4  METHOD STATEMENT

4.1 Instruction for use - S-BT-MF M6, M8, M10, W6, W10

S-BT-MF M6/15 AN 6
S-BT-MF W6/15 AN 6
S-BT-MF M8/15 AN 6
S-BT-MF W8/15 AN 6
S-BT-MF M10/15 AN 6
S-BT-MF W10/15 AN 6

Hex nut with flange M6-F
Hex nut with flange W6-F
Hex nut with flange M8-F
Hex nut with flange M10-F
Hex nut with flange W10-F

Torque tool X-BT ¼"
8 Nm / 5.9 ft.lb

S-BT-MF M6/M8/M10
S-BT-MF W6/W10
4.2 Instruction for use - S-BT-MF M8/7 AN 6

- **S-BT-MF M8/7 AN 6**: Hex nut with flange M8-F

- **SF BT 18 / 22-A**
- **TS-BT 5.5-74 S**
- **SFC 18 / 22-A**
- **S-DG BT M8/7 Short 6**
- **S-CC BT 6**

- **Torque tool X-BT ¼"**: 8 Nm / 5.9 ft.lb

- **S-NS 13 C 95/3 ¾"**

- **S-BT-MF M8/7 AN 6** (1-3)
- **S-DG BT M8/7 Short 6** (1-3)

- **Ø θ ≥ 11 mm**: 7 /16”

- **1.6-7 mm**: 1/16 - 0.28”
4.3 Instruction for use - S-BT-MR M6, M8, M10, W6, W10 SN 6

- S-BT-MR M6/15 SN 6
- S-BT-MR M8/15 SN 6
- S-BT-MR M10/15 SN 6
- S-BT-MR W6/15 SN 6
- S-BT-MR W10/15 SN 6

Hex nut with flange M6-A4
Hex nut with flange W6-A4
Hex nut with flange M8-A4
Hex nut with flange M10-A4
Hex nut with flange W10-A4

- SBT 4-A22
- SF BT 18/22-A

- TS-BT 5.5-74 S
- SBT 4-A22
- SFC 18/22-A

- S-DG BT M6 - W6 / 15 Long 6
- S-DG BT M8 / 15 Long 6
- S-DG BT M10 - W10 / 15 Long 6

- S-CC BT 6

- Torque tool X-BT ¼"
  8 Nm / 5.9 ft.lb

- S-NS 10 C 95/3 ¾" (M6)
- S-NS 10 C 95/3 ¾" (M8)
- S-NS 13 C 95/3 ¾" (M10)
- S-NS ¾" C 95/3 ¾" (W6)

- S-NS 9/16" C 95/3 ¾" (W10)

- Hex nut with flange M6-A4
- Hex nut with flange W6-A4
- Hex nut with flange M8-A4
- Hex nut with flange M10-A4
- Hex nut with flange W10-A4

- SBT 4-A22
- SF BT 18/22-A
4.4 Instruction for use - S-BT-MR M8/7 SN 6

Hex nut with flange M8-A4

SBT 4-A22
SF BT 18/22-A
TS-BT 5.5-74 S
SBT 4-A22
SFC 18/22-A
S-DG BT M8/7 Short 6
S-CC BT 6

Torque tool X-BT ¼"
8 Nm / 5.9 ft.lb

S-NS 13C C 95/3 ¾"
4.5 Instruction for use - S-BT-MR M6, M8, M10, W6, W10 SN 6 AL

S-BT-MR M6/15 SN 6
S-BT-MR W6/15 SN 6
S-BT-MR M8/15 SN 6
S-BT-MR M10/15 SN 6
S-BT-MR W10/15 SN 6

Hex nut with flange M6-A4
Hex nut with flange W6-A4
Hex nut with flange M8-A4
Hex nut with flange M10-A4
Hex nut with flange W10-A4

S-BT-MR M6/M8/M10 AL
S-BT-MR W6/W10 AL

Torque tool X-BT ¼"
5 Nm / 3.7 ft.lb

S-NS 10 C 95/3 ¾" (M6)
S-NS ¾" C 95/3 ¾" (W6)
S-NS 13 C 95/3 ¾" (M8)
S-NS 15 C 95/3 ¾" (M10)
S-NS ¾" C 95/3 ¾" (W10)

SBT 4-A22
SF BT 18/22-A
T5-BT 5.5-74 AL
SFT 4-A22
SFC 18/22-A
S-DG BT M6 - W6 / 15 Long 6
S-DG BT M8 / 15 Long 6
S-DG BT M10 - W10 / 15 Long 6
S-CC BT 6

GEAR #2
SBT 4-A22
SF BT 18/22-A
SBT 4-A22
SFC 18/22-A

GEAR #1

S-NS 10 C 95/3 ¾" (M6)
S-NS ¾" C 95/3 ¾" (W6)
S-NS 13 C 95/3 ¾" (M8)
S-NS 15 C 95/3 ¾" (M10)
S-NS ¾" C 95/3 ¾" (W10)

S-DG BT M6 - W6 / 15 Long 6
S-DG BT M8 / 15 Long 6
S-DG BT M10 - W10 / 15 Long 6
S-CC BT 6

GEAR #2
SBT 4-A22
SF BT 18/22-A
SBT 4-A22
SFC 18/22-A

GEAR #1
4.7 Instruction for use - S-BT-GF M8/7 AN 6

1. Torque tool X-BT ¼” 8 Nm / 5.9 ft.lb

2. SBT 4-A22 SF BT 18/22-A

3. GEAR #2 SBT 4-A22 SF BT 18/22-A

4. SBT 4-A22 SF BT 18/22-A S-DG BT M8/7 Short 6

5. Max. Max. S-BT-GF M8/7 AN 6

6. 1x 2x

7. Ø ≥ 11 mm 7 /16”

8a. Max. Max. S-BT-GF M8/7 AN 6

8b. Min. Min. S-BT-GF M8/7 AN 6

9a. ≤ 8 Nm S-BT-GF M8/7 AN 6

9b. 8 Nm / 5.9 ft.lb S-BT-GF M8/7 AN 6

10. SBT 4-A22 SFC 18/22-A

11. GEAR #1 SBT 4-A22 SFC 18/22-A

12a. 8 Nm / 5.9 ft.lb SBT 4-A22 SFC 18/22-A

12b. ≤ 8 Nm SBT 4-A22 SFC 18/22-A

12c. X-FCM-M SBT 4-A22 SFC 18/22-A

12d. ≤ 8 Nm SBT 4-A22 SFC 18/22-A
4.8 Instruction for use - S-BT-GR M8/7 SN 6

1. GEAR #2
   SBT 4-A22
   SF BT 18/22-A

2. No drilling
   SBT 4-A22
   SF BT 18/22-A

3. ø
   ≥ 13 mm
   1/2" 
   1.6 - 7 mm
   1/16 - 0.28" 

4. No drilling
   SBT 4-A22
   SF BT 18/22-A

5. SFC 18/22-A
   GEAR #1

6. Torque tool X-BT ¼"
   8 Nm / 5.9 ft.lb

7. Torque tool X-BT ¼"
   8 Nm / 5.9 ft.lb

8a. S-BT-GR M8/7 SN 6

8b. SBT 4-A22
   SF BT 18/22-A

8c. SBT 4-A22
   SF BT 18/22-A

9a. ≥ 7 mm
   0.28"

9b. ≤ 8 Nm

10. Ø
   ≥ 13 mm
   1/2"

11. Ø
   ≥ 13 mm
   1/2"

12a. SBT 4-A22
   SF BT 18/22-A

12b. ≤ 8 Nm

12c. ≤ 8 Nm
4.9 Instruction for use - S-BT-GR M8/7 SN 6 AL

1. Torque tool X-BT ¼”
   5 Nm / 3.7 ft.lb

2. SBT 4-A22
   SF BT 18/22-A

3. GEAR
   #2

4. SBT 4-A22
   SF BT 18/22-A

5. SBT 4-A22
   SFC 18/22-A

6. GEAR
   #1

7. X-FCM-R

Specifications
4.10 Instruction for use – S-BT-EF M6/W6/M8

1. GEAR G2
2. SBT 4-A22 SF BT 18/22-A
3. ≤ 7 mm 0.28"
4. SBT 4-A22 SFC 18/22-A
5. ≥ 6 mm ¼"
6. ≥ 6 mm ¼"
7. < 0,8 mm 0.03"
8. ≤ 0,8 mm 0.03"
9a. < 0,8 mm 0.03"
9b. ≤ 0.28"
10. ≤ 7 mm 0.28"
11a. ≤ 7 mm 0.28"
11b. ≤ 0,8 mm 0.03"
12. ≥ 6 mm ¼"

Hex Thin nut M6/W6/M8-F
Spring washer M6/W6/M8-F
Hex Thin nut M6/W6/M8-F

SBT 4-A22 SF BT 18/22-A
TS-BT 5.5-74 S
SBT 4-A22 SFC 18/22-A
S-DG BT M6/15 Long 6
S-DG BT M6-W6/15 Long 6
S-CC BT 6

Torque tool X-BT ¼"
8 Nm / 5.9 ft.lb

S-NS 10 C 95/3 ¾" (M6)
S-NS 13 C 95/3 ¾" (M8)

Specifications

< 0,8 mm 0.03"
≤ 0.28"
≥ 6 mm ¼"
< 0.8 mm 0.03"
4.11 Instruction for use – S-BT-EF M10/W10

1. !
   S-BT-EF M10/W10
   SBT 4-A22
   SF BT 18/22-A

2. !
   ≥6 mm
   ¼"
   <0.8 mm
   0.03"
   ≤3 mm
   0.12"

3. !
   Hex Thin nut M10/W10-F
   Spring washer M10/W10-F
   Hex Thin nut M10/W10-F

4. !
   GEAR
   #2
   ≥6 mm
   ¼"
   <0.8 mm
   0.03"

5. !
   SBT 4-A22
   SFC 18/22-A
   GEAR
   #1

6. !
   GEAR
   #1

7. !
   Hex Thin nut M10/W10-F
   Spring washer M10/W10-F

8. !
   Torque tool X-BT ¼"
   8 Nm / 5.9 ft.lb

9. !
   S-NS 15 C 95/3 ¾" (M10)
   S-NS 9/16" C 95/3 ¾" (W10)
4.12 Instruction for use – S-BT-ER M6/W6/M8

1. GEAR #2
2. SBT 4-A22 SF BT 18/22-A
3. S-DG BT M8/15 Long 6
4. S-DG BT M6-W6/15 Long 6
5. SBT 4-A22 SFC 18/22-A

Min. 8 Nm / 5.9 ft.lb
Max. 20 Nm

< 0.8 mm 0.03"
≥ 7 mm 0.28"
≤ 0.8 mm 0.03"

S-BT-ER M6/W6/M8/15 SN6
Hex Thin nut M6/W6/M8-R
Spring washer M6/W6/M8-R
Hex Thin nut M6/W6/M8-R

SBT 4-A22 SF BT 18/22-A
TS-BT 5.5-74 S
SBT 4-A22 SFC 18/22-A
S-DG BT M8/15 Long 6
S-DG BT M6-W6/15 Long 6
S-CC BT 6
Torque tool X-BT ¼" 8 Nm / 5.9 ft.lb
S-NS 10 C 95/3 ¾" (M6)
S-NS ¾ C 95/3 ¾" (W6)
S-NS 10 C 95/3 ¾" (M8)

Specifications
4.13 Instruction for use – S-BT-ER M10/W10

1. GEAR #2
2. SBT 4-A22 SF BT 18/22-A
3. ≤ 3 mm 0.12"
4. Torque tool X-BT ¼"

Hex Thin nut M10/W10-R
Spring washer M10/W10-R
Hex Thin nut M10/W10-R

SBT 4-A22 SF BT 18/22-A
TS-BT 5.5-74 S
SBT 4-A22 SFC 18/22-A
S-DG-BT M10-W10/15 Long 6
S-CC BT 6

Torque tool X-BT ¼"
8 Nm / 5.9 ft.lb

S-NS 15 C 95/3 ¾" (M10)
S-NS ¾" C 95/3 ¾" (W10)
4.14  Instruction for use – S-BT-EF W10 HC AWG2 / 4/0 and S-BT-EF M10 HC 35 / 120
4.15 Instruction for use – S-BT-ER W10 HC AWG2 / 4/0 and S-BT-ER M10 HC 35 / 120
5. PERFORMANCE

5.1 Nomenclature and symbols

The symbols and nomenclature used in the technical data are listed below.

<table>
<thead>
<tr>
<th>Fastener test data and performance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong> and <strong>V</strong></td>
<td>Tensile and shear forces in a general sense</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>Combined force (resulting from <strong>N</strong> and <strong>V</strong>) in a general sense</td>
</tr>
<tr>
<td><strong>N_s</strong> and <strong>V_s</strong></td>
<td>Tensile and shear forces in a design calculation</td>
</tr>
<tr>
<td><strong>F_s</strong></td>
<td>Combined force (resulting from <strong>N_s</strong> and <strong>V_s</strong>) in a design calculation</td>
</tr>
<tr>
<td><strong>N_u</strong> and <strong>V_u</strong></td>
<td>Ultimate tensile and shear forces that cause failure of the fastening, statistically, the reading for one specimen</td>
</tr>
<tr>
<td><strong>N_u,m</strong> and <strong>V_u,m</strong></td>
<td>Mean ultimate tensile and shear forces that cause failure of the fastening, statistically, the average for a sample of several specimens</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td>The standard deviation of the sample</td>
</tr>
<tr>
<td><strong>N_R,k</strong> and <strong>V_R,k</strong></td>
<td>Characteristic tensile and shear resistance of the fastening, statistically, the 5% fractile. For example, the characteristic strength of a fastening whose ultimate strength can be described by a standard Gauss type distribution is calculated by: $N_{R,k} = N_{u,m} - k \times S$ where $k$ is a function of the sample size, $n$ and the desired confidence interval.</td>
</tr>
<tr>
<td><strong>N_rec</strong> and <strong>V_rec</strong></td>
<td>Recommended maximum tensile and shear loads of the threaded fastener tip: $N_{rec} = \frac{N_{R,k}}{\Omega}$ and $V_{rec} = \frac{V_{R,k}}{\Omega}$ where $\Omega$ is the overall factor of safety</td>
</tr>
<tr>
<td><strong>M_rec</strong></td>
<td>Recommended elastic moment for the fastener shank $M_{rec} = \frac{M_{R,k}}{\Omega}$ where $M_{R,k}$ is the characteristic elastic moment resistance of the threaded fastener tip and $\Omega$ is an overall factory of safety. Unless otherwise stated on the product data sheets, the $M_{rec}$ values in this manual include a safety factor of “1.9” for static loading.</td>
</tr>
<tr>
<td><strong>N_{R,d}</strong> and <strong>V_{R,d}</strong></td>
<td>Design tensile and shear resistance of the fastening $N_{R,d} = \frac{N_{R,k}}{\gamma_m}$ and $V_{R,d} = \frac{V_{R,k}}{\gamma_m}$ where $\gamma_m$ is the partial factor of safety</td>
</tr>
<tr>
<td><strong>T_{rec}</strong></td>
<td>Recommended tightening torque [Nm or lbft]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fastening details</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>h_{ef}</strong></td>
<td>Screw-in depth of the threaded fastener tip below the surface of the base material</td>
</tr>
<tr>
<td><strong>h_NVST</strong></td>
<td>S-BT stud head stand-off above the surface of the base material</td>
</tr>
<tr>
<td><strong>t_l</strong></td>
<td>Thickness of the fastened material</td>
</tr>
<tr>
<td><strong>t_b</strong></td>
<td>Thickness of the base material</td>
</tr>
<tr>
<td>$\sum t_l$</td>
<td>Total thickness of the fastened material (where more than one layer is fastened)</td>
</tr>
<tr>
<td><strong>t_{Nut}</strong></td>
<td>Thickness of the serrated flange nut</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of steel and other metals</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>f_y</strong></td>
<td>Yield strength of metals [in N/mm$^2$ or MPa]</td>
</tr>
<tr>
<td><strong>f_u</strong></td>
<td>Ultimate tensile strength of metals [in N/mm$^2$ or MPa]</td>
</tr>
</tbody>
</table>
5.2 Design concepts

The recommended working loads $N_{\text{rec}}$ and $V_{\text{rec}}$ are generally suitable for use in typical working load designs.

**Working load concept**

$$N_s \leq N_{\text{rec}} = \frac{N_{R,k}}{\Omega}$$

where $\Omega$ is an overall factor of safety including allowance for:

- errors in estimation of load
- deviations in material and workmanship

and $N_s$ is, in general, a characteristic acting load.

$$N_s \approx N_{S,k}$$

**Partial safety concept**

$$N_{S,d} \leq N_{R,d}$$

$$N_{S,d} = N_{S,k} \times \gamma_F$$

$$N_{R,d} = N_{R,k} / \gamma_m$$

where $\gamma_F$ is a partial factor of safety to allow for errors in estimation on the acting load.

$\gamma_m$ is a partial factor of safety to allow for deviations in material and workmanship.
5.3 Static capacity of the S-BT threaded stud

5.3.1 Tensile load deformation behavior of S-BT threaded stud fastenings


<table>
<thead>
<tr>
<th>Base material</th>
<th>Steel, 6 mm thick, S235</th>
<th>360 MPa</th>
<th>Steel, 5 mm thick, S235</th>
<th>360 MPa</th>
<th>Steel, 3 mm thick, S235</th>
<th>360 MPa</th>
<th>Aluminum, 6 mm thick, EN AW 5754</th>
<th>270 MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S355</td>
<td></td>
<td>S355</td>
<td></td>
<td>S355</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>470 MPa</td>
<td></td>
<td>470 MPa</td>
<td></td>
<td>470 MPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of fastenings in test

- 90
- 50 in steel S235
- 30 in steel S355
- 10 in Aluminum

Conclusions

- Pull out strength increases with increasing base material strength and screw-in depth
- The fasteners show a well-tempered elastic behavior with a maximum displacement from 1 – 2.8 mm until the maximum load value is reached.
- Elastic stiffness is independent from the base material strength. It depends on the fastener material and base material thickness. Carbon steel fasteners behave a little stiffer than stainless steel fasteners.
- After the maximum loading capacity of the fastener is reached, no remaining load value is left due to the pull out of the tapped thread of the base material.
5.3.2 Pull out strength of S-BT threaded stud fastenings

Tension, shear and bending tests with S-BT screw-in threaded studs,

<table>
<thead>
<tr>
<th>Base material</th>
<th>ref. to 5.3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fastenings in test</td>
<td>ref. to 5.3.1</td>
</tr>
</tbody>
</table>

Ultimate pull-out load
The effect of the base material type, strength and base material thickness (screw-in depth) can be observed.

Conclusions
• The failure mode for all tensile tests was pull out of the fastener from the bore hole.
• The effect of the base material strength is given for all tested base metal thickness.
• The most important parameter affecting the pull out strength is the screw-in depth and the type of the base material (steel vs. aluminum).
• The thread size of the upper part of the fastener doesn’t affect the pull out load value because the geometry of the tapping thread is identical for all studs made of the same material.
5.3.3 Shear strength of S-BT threaded stud fastenings

Tension, shear and bending tests with S-BT screw-in threaded studs,

<table>
<thead>
<tr>
<th>Base material</th>
<th>ref. to 5.3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fastenings in test</td>
<td>ref. to 5.3.1</td>
</tr>
</tbody>
</table>

Ultimate shear load

The shear failure occurs through breakage of the stud in the cross section of the tap thread or through plastic deformation of the hole in the base material which leads to tilting and pull-out of fastener.

Conclusions

- Failure mode of the tested S-BT studs:
  - 85% failed due to shear fracture in the cross section of the tap thread
  - 15% failed due to plastic deformation of the bore hole ⇒ tilting ⇒ pull-out
- The effect of the steel base material strength is rather low.
- The most important parameters affecting the shear load capacity is the screw-in depth, the type of the base material (steel vs. aluminum) and the material of the S-BT stud.
- The thread size of the upper part of the fastener doesn’t affect the shear load capacity because the geometry of the tapping thread is identical for all studs made of the same material.
### 5.4 Vibration effects on S-BT threaded stud fastenings

Experimental investigations on the effect of base metal vibrations on the ultimate pull-out
Report No. XSEhac-01-15_07; Hilti AG; Schaan 2015

<table>
<thead>
<tr>
<th>Base material:</th>
<th>Steel, S235</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam section:</td>
<td>HEA 100, 8 mm flange, 5 mm web</td>
</tr>
<tr>
<td>Beam span:</td>
<td>720 mm</td>
</tr>
<tr>
<td>Test procedure:</td>
<td>Beam loaded in center with $F_{\text{max}} / F_{\text{min}}$</td>
</tr>
<tr>
<td>Step 1: $F_{\text{max}}$ = 59 kN, $F_{\text{min}}$ = 22 kN</td>
<td>Frequency = 6 Hz, 2 Million cycles</td>
</tr>
<tr>
<td>Step 2: $F_{\text{max}}$ = 59 kN, $F_{\text{min}}$ = 7 kN</td>
<td>Frequency = 6 Hz, 0.5 Million cycles</td>
</tr>
<tr>
<td>Step 3: $F_{\text{max}}$ = 10 kN, $F_{\text{min}}$ = -10 kN</td>
<td>Frequency = 30 Hz, 1.5 Million cycles</td>
</tr>
<tr>
<td>Step 4: $F_{\text{max}}$ = 2.5 kN, $F_{\text{min}}$ = -2.5 kN</td>
<td>Frequency = 60 Hz, 5 Million cycles</td>
</tr>
</tbody>
</table>

Number of fastenings:
32 S-BT M8 in with FCM-disc “Grating”
32 S-BT M10 in with MQ-Channel “Multipurpose”

Ultimate pull-out loads of S-BT fasteners before and after cyclic loading of the steel beam

#### Conclusions
- **Tension flange**: The ultimate pull load value after the vibration test is on the same level compared to the unstressed value. No negative influence visible.
- **Compression flange**: The ultimate pull load value in the compressed flange is slightly higher compared to the tension flange. This could be an indicator for solidification of the thread in the compression.
- Cyclic loading applied to steel beams, which causes vibration on the fastener, as tested above did not result in loosening of grating X-FCM grating discs or loosening of S-BT studs.

#### Notes
- The specific test parameters and range, as detailed above, were chosen to be representative of most common vibration cases as they may occur at installation sites.
- This summary is not a complete representation of the wide range of possible vibration conditions as they may occur at specific sites. Once vibration conditions are outside this range, further verifications will be required before a clear statement can be given.

This summary is intended to be representative of the test(s) carried out. It is not intended to be a full and complete test report.
5.5 Resistance of S-BT fastenings under dynamic tensile loading

Report No. XSEhac-01-15_06; Hilti AG; Schaan 2015

General comments
The tests were performed to investigate the effect of repeated tensile loads on the anchorage of the S-BT fastenings. Therefore Wöhler charts for S-BT fastenings have been evaluated in view of the resistance of vibrations in axial direction (repeated tensile loads).

Test concept
The S-BT fasteners were subjected to a harmonic pulsating tensile loading. The minimal load of the harmonic loading was 0.2 kN in all tests. Tests were performed at 4 different load levels. The applied maximal loads were 1.8, 3.6, 4.5 and 5.4 kN. Tests were stopped if no failure occurred within 10 million load cycles. As a testing frequency 50 Hz were chosen.

The tests were performed on the upper application limit for the base material strength (European Grade S355 with an ultimate tensile strength \( f_u = 630 \) MPa) in combination with a minimum thread intersection of 0.2 mm.

Minimum thread intersection is defined as the lowest tolerance field of the stud thread engagement with the base material, ref. to figure in section 5.7.

Test results

<table>
<thead>
<tr>
<th>Level</th>
<th># tests</th>
<th>( F_{\text{max}} ) (kN)</th>
<th>( F_{\text{min}} ) (kN)</th>
<th>( \Delta F )</th>
<th>( \sigma_{\text{max}} ) (N/mm²)</th>
<th>( \sigma_{\text{max}} ) (N/mm²)</th>
<th>( \sigma_{\text{max}} ) (N/mm²)</th>
<th>( \sigma_{\text{mean}} ) (N/mm²)</th>
<th>Ratio R</th>
<th>Cycles</th>
<th>Fail</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>1.8</td>
<td>0.2</td>
<td>115</td>
<td>12.8</td>
<td>63.9</td>
<td>51.1</td>
<td>102.2</td>
<td>0.11</td>
<td>12'000</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>3.6</td>
<td>0.2</td>
<td>230</td>
<td>12.8</td>
<td>121.4</td>
<td>108.6</td>
<td>217.2</td>
<td>0.06</td>
<td>11'705</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>4.5</td>
<td>0.2</td>
<td>298</td>
<td>12.8</td>
<td>160.4</td>
<td>137.6</td>
<td>275.2</td>
<td>0.04</td>
<td>10'200</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5.4</td>
<td>0.2</td>
<td>346</td>
<td>12.8</td>
<td>179.4</td>
<td>166.6</td>
<td>333.2</td>
<td>0.04</td>
<td>10'000</td>
<td>Pass</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>9'180</td>
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<td></td>
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<td>5'900</td>
<td>Pull out</td>
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<td></td>
<td></td>
<td></td>
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<td>5'817</td>
<td>Pull out</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3'200</td>
<td>Pull out</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>1'775</td>
<td>Repeate</td>
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<td></td>
<td>789</td>
<td>Repeate</td>
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<td></td>
<td></td>
<td>520</td>
<td>Repeate</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10'000</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5'141</td>
<td>Pass</td>
<td></td>
</tr>
</tbody>
</table>

Test results of fatigue tests with S-BT fasteners (1.4462) loaded with harmonic pulsating tensile loads

The intended maximum recommended tensile load of S-BT fasteners in steel S355 amounts to 2.3 kN \( (\sigma_{\text{max}} = 147 \text{ N/mm}^2) \). Therefore, tests were performed around this load to assess the fatigue resistance under service load conditions. At level 1 all samples passed the load level of 1.8 kN. At the second level 4 out of 5 samples passed the load level of 3.6 kN. Consequently, higher maximal loads were applied to increase the probability of failure. At level 3 and 4 the majority of the samples failed.

In all tests the governing failure mode was fatigue fracture of the S-BT stud or pull out from the base material.
Linear regression of fatigue test results

As often done in fatigue design, the characteristic resistance $\Delta \sigma_k (= 5\%-fractile or 95\% probability of survival) is assessed by reducing the linear regression with the double of the standard deviation "s" of the test data. "s" corresponds to the standard deviation of the difference between the test results and the mean trend. Applying this procedure, the characteristic fatigue strength determines to:

$$\log N_k = 9.8626 - 1.8396 \times \log \Delta \sigma_k$$

<table>
<thead>
<tr>
<th>Load $N_{\text{rec}}$ [kN]</th>
<th>Cycles $N_k$ [-]</th>
<th>$\Delta \sigma$ [N/mm²]</th>
<th>log $\Delta \sigma$ [-]</th>
<th>log $N_k$ [-]</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>1'175'000</td>
<td>115</td>
<td>2.062</td>
<td>6.070</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>748'000</td>
<td>147</td>
<td>2.186</td>
<td>5.874</td>
<td>$N_{\text{rec}} = 2.3 \text{ kN for S355 / Grade 50 steel}$</td>
</tr>
</tbody>
</table>

Characteristic cycle life $N_k$ at tension service load level $N_{\text{rec}}$

Conclusions

• The values given in the table can be used for fatigue design of the stainless steel S-BT fasteners in steel grade S355 / Grade 50.
• In case fatigue design with higher load cycles beyond 1'175'000 cycles is required, the characteristic fatigue design curve (Reg. – 2s) can be conservatively used.
• The results presented allow the use of S-BT-fasteners in applications, where wind suction is involved or to cover many typical “dynamic” parts of in principle static working loads.
• If high cycle fatigue design is necessary, the corresponding characteristics can be used to assess the principle suitability of S-BT fasteners for the specific purpose. Nevertheless, high cycle fatigue design is beyond the scope of the S-BT fasteners.

Notes

• In case of static loading, sufficient redundancy of the entire fastening must be provided.
• The values stated apply for axial tensile loading. The constructive detail has to be checked with regards to this condition. If bending stresses – for example due to imperfections – might occur, these have to be considered in fatigue design. Imperfections will lead to a reduction of the characteristic cycle lives.
• The partial safety factors for fatigue actions as well as fatigue resistance have to be considered according to fatigue design provisions (for example: Eurocode 4 or AISC-LRFD) in agreement with the statistical evaluation of $N_k$.
• If global safety concepts are applied, the global factors of safety have to be taken in agreement with the statistical evaluation of $N_k$ meeting the conditions of the used design standard.

This summary is intended to be representative of the test(s) carried out. It is not intended to be a full and complete test report.
5.6 Effect of S-BT threaded stud fastenings on the fatigue strength of base material structural steel


General comments
When using Hilti S-BT fasteners installed into structural steel elements that are subjected to cyclic loading, the effect of the fastener on the fatigue strength of the steel base material has to be considered. Hilti has completed a comprehensive fatigue test program in order to classify the constructional detail “Structural steel base material with Hilti S-BT screw-in threaded studs” in compliance with different fatigue codes and standards, namely EN 1993-1-9 [5], AWS D1.1/D1.1M [6], ABS [7], BV [8], DNVGL-RP-C203 [9] and BS 7608 [10]. A corresponding evaluation was made by Prof. U. Kuhlmann and Prof. H.-P. Günther from the University of Stuttgart (Report No. 2017-38X, [4]).

Test Concept
9 different test series were carried out varying the following parameters which can influence the fatigue resistance:

- 5 different plate thickness’ (t = 3, 4, 6, 8 and 20 mm),
- 2 different stress ratios (R = +0.1 and +0.3),
- 2 different installation conditions (correctly installed and fastener removed),
- 2 different fastener materials (stainless steel and carbon steel)

The steel base material was conservatively chosen to grade S235JR acc. to EN 10025-2, being aware that higher strength and fine grain steel show in general better fatigue resistance for non-welded details.

<table>
<thead>
<tr>
<th>Name of series</th>
<th>Thickness t [mm]</th>
<th>Stress ratio R [-]</th>
<th>Installation condition</th>
<th># of test specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>235-03-01-cl</td>
<td>3</td>
<td>+0.1</td>
<td>studied correctly installed</td>
<td>10</td>
</tr>
<tr>
<td>235-04-01-cl</td>
<td>4</td>
<td>+0.1</td>
<td>studied correctly installed</td>
<td>10*2</td>
</tr>
<tr>
<td>235-04-01-io</td>
<td>4</td>
<td>+0.1</td>
<td>studied installed and overwound</td>
<td>7*</td>
</tr>
<tr>
<td>235-06-01-cl</td>
<td>6</td>
<td>+0.1</td>
<td>studied correctly installed</td>
<td>10</td>
</tr>
<tr>
<td>235-06-03-cl</td>
<td>6</td>
<td>+0.3</td>
<td>studied correctly installed</td>
<td>10</td>
</tr>
<tr>
<td>235-08-01-cl</td>
<td>8</td>
<td>+0.1</td>
<td>studied correctly installed</td>
<td>11*2</td>
</tr>
<tr>
<td>235-08-01-ip</td>
<td>8</td>
<td>+0.1</td>
<td>studied installed and pulled out</td>
<td>9</td>
</tr>
<tr>
<td>235-08-03-cl</td>
<td>8</td>
<td>+0.3</td>
<td>studied correctly installed</td>
<td>6</td>
</tr>
<tr>
<td>235-20-01-cl</td>
<td>20</td>
<td>+0.1</td>
<td>studied correctly installed</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1: Overview of the test program
Test results and evaluation procedure

The statistical evaluation of the test results and the final set-up of a fatigue reference class and S-N curve were done in three steps.

1. Determination of linear regression line (mean S-N curve) of fatigue test series
2. Determination of a characteristic design S-N curve with a certain probability of failure based on the requirements with regards to the statistical intervals (confidence level, probability of survival) as given in the specific codes and standards.
3. Recommendation of a final design S-N curve and fatigue reference class based on the aforementioned statistical evaluation and engineering judgment taking into account the specific S-N curve types and classes as given in the relevant codes and standards.

Table 2 summarizes the results of a statistical evaluation acc. to EN 1993-1-9 combining all test results with regards to the base material thickness, stress ratio R, installation condition and fastener material.

![Table 2: Statistical evaluation combining all test results](image)

In Figure 1, all test data and the statistically evaluated design S-N curve are plotted in comparison to the detail category 100 (m = 5) as given in EN 1993-1-9 [5] and the IIW-Recommendations [11]. Both curves fit very well, which means that the fatigue strength of Hilti S-BT fastening system can be well described by the detail category 100 (m = 5).

![Figure 1: Statistical evaluation of all test results](image)
Recommendation of a design S-N curve according to different codes

On the basis of the existing test results and a statistical evaluation of these test data according to the provisions given in EN 1993-1-9:2005 (Eurocode 3) it is recommended to use following general design S-N curve for the Hilti S-BT fastening system. The structural steel grades S235 up to S355 acc. to EN 10025-2, EN 10025-3 and EN 10225 are covered.

\[
\log N = \log a - m \cdot \log S
\]

with

\( \log N \) \hspace{1cm} \text{logarithm to base 10 of corresponding number of cycles to failure N}
\( \log a = 16.300 \) \hspace{1cm} \text{intercept on the log N axis}
\( m = 5.0 \) \hspace{1cm} \text{negative slope of S-N-curve being linear on a log-log basis}
\( \log S \) \hspace{1cm} \text{logarithm to base 10 of stress range } \Delta \sigma

<table>
<thead>
<tr>
<th>Number of load cycles N</th>
<th>Stress range ( \Delta \sigma ) [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ( \cdot 10^5 )</td>
<td>181.9</td>
</tr>
<tr>
<td>1 ( \cdot 10^6 )</td>
<td>114.8</td>
</tr>
<tr>
<td>2 ( \cdot 10^6 )</td>
<td>100.0</td>
</tr>
<tr>
<td>5 ( \cdot 10^6 )</td>
<td>83.2</td>
</tr>
<tr>
<td>1 ( \cdot 10^7 )</td>
<td>72.4</td>
</tr>
<tr>
<td>1 ( \cdot 10^8 )</td>
<td>45.7</td>
</tr>
</tbody>
</table>

EN 1993-1-9:2005 (Eurocode 3)

It is recommended to use the following design S-N curve respectively detail category given in Table 3 for the constructional detail “Steel base material with Hilti S-BT screw-in threaded studs”.

![Table 3: Recommendation of fatigue S-N curve and detail category acc. to EN 1993-1-9:2005](image)

AWS D1.1/D1.1M:2015

It is recommended to use the following design S-N curve respectively stress category termed “S-BT” given in Table 4 and Figure 2 for the constructional detail “Steel base material with Hilti S-BT screw-in threaded studs”.

**Figure 2:** Comparison of Hilti S-BT fatigue test data with AWS D1.1; D1.1M:2015 fatigue categories and new proposed fatigue stress category “S-BT” for Hilti S-BT fastener

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>m [-]</th>
<th>$C_r$ [ksi]</th>
<th>$C_r \times 329$ [ksi]</th>
<th>$F_{TH}$ [ksi]</th>
<th>$F_{TH}$ [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.0</td>
<td>250 x $10^8$</td>
<td>8.225 x $10^{12}$</td>
<td>23.9</td>
<td>165.0</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
<td>120 x $10^8$</td>
<td>3.948 x $10^{12}$</td>
<td>16.0</td>
<td>110.0</td>
</tr>
<tr>
<td>B'</td>
<td>3.0</td>
<td>61 x $10^8$</td>
<td>2.007 x $10^{12}$</td>
<td>12.0</td>
<td>83.0</td>
</tr>
<tr>
<td>C</td>
<td>3.0</td>
<td>44 x $10^8$</td>
<td>1.448 x $10^{12}$</td>
<td>10.0</td>
<td>69.0</td>
</tr>
<tr>
<td>D</td>
<td>3.0</td>
<td>22 x $10^8$</td>
<td>7.238 x $10^{11}$</td>
<td>7.0</td>
<td>48.0</td>
</tr>
<tr>
<td>E</td>
<td>3.0</td>
<td>11 x $10^8$</td>
<td>3.619 x $10^{11}$</td>
<td>4.5</td>
<td>31.0</td>
</tr>
<tr>
<td>E'</td>
<td>3.0</td>
<td>39 x $10^8$</td>
<td>1.283 x $10^{11}$</td>
<td>2.6</td>
<td>18.0</td>
</tr>
<tr>
<td>F</td>
<td>6.0</td>
<td>150 x $10^{10}$</td>
<td>1.650 x $10^{17}$</td>
<td>8.0</td>
<td>55.0</td>
</tr>
<tr>
<td>S-BT</td>
<td>5.0</td>
<td>6065 x $10^{10}$</td>
<td>1.995 x $10^{16}$</td>
<td>12.6</td>
<td>87.0</td>
</tr>
</tbody>
</table>

**Table 4:** Recommendation of fatigue S-N curve and stress category acc. to AWS D1.1:2015
ABS:2014

It is recommended to use the following design S-N curve respectively stress category termed “S-BT” given in Table 5 and Figure 3 for the constructional detail “Steel base material with Hilti S-BT screw-in threaded studs”.

Figure 3: Comparison of Hilti S-BT fatigue test data with ABS-(A) Offshore S-N curves and new proposed fatigue class “S-BT” for Hilti S-BT fastener

<table>
<thead>
<tr>
<th>Curve Class</th>
<th>A</th>
<th>m</th>
<th>r</th>
<th>N₀</th>
<th>S₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>1.01x10¹⁵</td>
<td>4.48x10¹¹</td>
<td>5.0</td>
<td>1.0x10³</td>
<td>100.2</td>
</tr>
<tr>
<td>C</td>
<td>4.23x10¹⁴</td>
<td>4.93x10¹⁰</td>
<td>3.5</td>
<td>2.59x10¹⁴</td>
<td>6.35x10¹⁰</td>
</tr>
<tr>
<td>D</td>
<td>1.52x10¹⁴</td>
<td>4.65x10⁹</td>
<td>3.0</td>
<td>4.33x10¹⁴</td>
<td>2.79x10¹⁰</td>
</tr>
<tr>
<td>E</td>
<td>1.04x10¹⁴</td>
<td>3.18x10⁹</td>
<td>3.0</td>
<td>2.30x10¹⁴</td>
<td>1.48x10¹⁰</td>
</tr>
<tr>
<td>F</td>
<td>6.30x10¹³</td>
<td>1.93x10⁹</td>
<td>3.0</td>
<td>9.97x10¹³</td>
<td>6.24x10¹⁰</td>
</tr>
<tr>
<td>F2</td>
<td>4.30x10¹³</td>
<td>1.31x10¹⁰</td>
<td>3.0</td>
<td>5.28x10¹³</td>
<td>3.40x10¹⁰</td>
</tr>
<tr>
<td>G</td>
<td>2.50x10¹³</td>
<td>7.64x10⁹</td>
<td>3.0</td>
<td>2.14x10¹⁳</td>
<td>1.38x10¹⁰</td>
</tr>
<tr>
<td>W</td>
<td>1.60x10¹³</td>
<td>4.88x10⁹</td>
<td>3.0</td>
<td>1.02x10¹⁴</td>
<td>6.54x10¹⁰</td>
</tr>
<tr>
<td>S-BT</td>
<td>1.995x10¹⁶</td>
<td>1.28x10¹⁰</td>
<td>5.0</td>
<td>1.995x10¹⁵</td>
<td>1.28x10¹⁰</td>
</tr>
</tbody>
</table>

Table 5: Recommendation of fatigue S-N curve and fatigue class acc. to ABS-(A):2014

Description and notes on mode of failure
Hilti S-BT screw-in stainless and carbon steel threaded studs with pre-drilled hole in structural steel base material. Imperfect fastener installations as e.g. overwound or pulled-out fasteners are covered. Potential crack initiation at the edge or tip of the pre-drilled hole.

Parameter of design S-N curve class S-BT

<table>
<thead>
<tr>
<th>Curve Class</th>
<th>A</th>
<th>m</th>
<th>r</th>
<th>N₀</th>
<th>S₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT</td>
<td>1.995x10¹⁶</td>
<td>1.28x10¹⁰</td>
<td>5.0</td>
<td>1.995x10¹⁵</td>
<td>1.28x10¹⁰</td>
</tr>
</tbody>
</table>

BV:2016

It is recommended to use the following design S-N curve respectively stress category termed “S-BT” given in Table 6 and Figure 4 for the constructional detail “Steel base material with Hilti S-BT screw-in threaded studs”.

Figure 4: Comparison of Hilti S-BT fatigue test data with BV:2016 fatigue curves and new proposed fatigue curve “S-BT” for Hilti S-BT fastener

### Table 9.4

<table>
<thead>
<tr>
<th>Curve</th>
<th>FAT</th>
<th>First slope</th>
<th>Slope intersection</th>
<th>Second slope</th>
<th>Reference thickness [mm]</th>
<th>Thickness exponent n</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>150.00</td>
<td>4.0</td>
<td>15.0056</td>
<td>10⁷</td>
<td>100.32</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>123.81</td>
<td>3.5</td>
<td>13.6260</td>
<td>10⁷</td>
<td>78.19</td>
<td>6</td>
</tr>
<tr>
<td>D</td>
<td>91.25</td>
<td>3.0</td>
<td>12.1818</td>
<td>10⁷</td>
<td>53.36</td>
<td>5</td>
</tr>
<tr>
<td>E (1)</td>
<td>80.31</td>
<td>3.0</td>
<td>12.0153</td>
<td>10⁷</td>
<td>46.96</td>
<td>5</td>
</tr>
<tr>
<td>F</td>
<td>68.10</td>
<td>3.0</td>
<td>11.8004</td>
<td>10⁷</td>
<td>39.82</td>
<td>5</td>
</tr>
<tr>
<td>F2 (1)</td>
<td>59.95</td>
<td>3.0</td>
<td>11.6345</td>
<td>10⁷</td>
<td>35.06</td>
<td>5</td>
</tr>
<tr>
<td>P_L</td>
<td>91.25</td>
<td>3.0</td>
<td>12.1818</td>
<td>10⁷</td>
<td>53.36</td>
<td>5</td>
</tr>
<tr>
<td>S-BT</td>
<td>100.00</td>
<td>5.0</td>
<td>16.3000</td>
<td>10⁷</td>
<td>72.40</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 6: Recommendation of fatigue design S-N curve and stress category acc. to BV:2016, air

<table>
<thead>
<tr>
<th>Parameter of design S-N curve S-BT</th>
<th>Curve</th>
<th>FAT</th>
<th>First slope</th>
<th>Slope intersection</th>
<th>Second slope</th>
<th>Thickness exponent n</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT</td>
<td>100</td>
<td>5.0</td>
<td>16.3000</td>
<td>10⁷</td>
<td>72.40</td>
<td>5</td>
</tr>
</tbody>
</table>

It is recommended to use the following design S-N curve respectively stress category termed "S-BT" given in Table 7 and Figure 5 for the constructional detail "Steel base material with Hilti S-BT screw-in threaded studs".

**Table 7:** Recommendation of fatigue S-N curve and detail category according to DNVGL-RP-C03, air

<table>
<thead>
<tr>
<th>Construction detail</th>
<th>Description</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilti S-BT screw-in stainless and carbon steel threaded studs with pre-drilled hole in structural steel base material. Imperfect fastener installations as e.g. overwound or pulled-out fasteners are covered.</td>
<td>Lip to be calculated by the gross cross-section. Installation, static loading and spacing of fasteners only in accordance with the requirements given in [1] or [2]. Plate thickness $t \geq 3$ mm. Steel base material up to yield strength 355 MPa.</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 5:** Comparison of Hilti S-BT fatigue test data with DNVGL-RP-C203:2016 fatigue curves and new proposed fatigue curve "S-BT" for Hilti S-BT fastener

<table>
<thead>
<tr>
<th>S-N curve</th>
<th>$N \leq 10^7$ cycles</th>
<th>$N &gt; 10^7$ cycles</th>
<th>Fatigue limit at $10^7$ cycles [MPa]</th>
<th>Thickness exponent $k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_1$</td>
<td>$log a_1$</td>
<td>$m_2 = 5.0$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>4.0</td>
<td>15.117</td>
<td>17.146</td>
<td>106.97</td>
</tr>
<tr>
<td>B2</td>
<td>4.0</td>
<td>14.885</td>
<td>16.858</td>
<td>93.59</td>
</tr>
<tr>
<td>C1</td>
<td>3.0</td>
<td>12.592</td>
<td>16.320</td>
<td>73.10</td>
</tr>
<tr>
<td>C2</td>
<td>3.0</td>
<td>12.449</td>
<td>16.081</td>
<td>65.50</td>
</tr>
<tr>
<td>D</td>
<td>3.0</td>
<td>12.164</td>
<td>16.606</td>
<td>52.63</td>
</tr>
<tr>
<td>E</td>
<td>3.0</td>
<td>12.010</td>
<td>16.081</td>
<td>46.78</td>
</tr>
<tr>
<td>F</td>
<td>3.0</td>
<td>11.855</td>
<td>19.091</td>
<td>41.52</td>
</tr>
<tr>
<td>F1</td>
<td>3.0</td>
<td>11.699</td>
<td>14.832</td>
<td>36.84</td>
</tr>
<tr>
<td>F3</td>
<td>3.0</td>
<td>11.546</td>
<td>14.576</td>
<td>32.75</td>
</tr>
<tr>
<td>S-BT</td>
<td>5.0</td>
<td>16.300</td>
<td>16.300</td>
<td>72.4</td>
</tr>
</tbody>
</table>

Table 10.5: Basic design S-N curves in air, see Table 2-1 of DNVGL-RP-C203

Table 10.4: S-N curve and new proposed fatigue curve for Hilti S-BT fastener

**Figure 34:**

**Diagram:**

- Hilti S-BT fastener (correctly installed)
- Hilti S-BT fastener (installed and removed)
- Proposed design S-N curve

**Legend:**

- Hilti S-BT fastener
- Proposed design S-N curve
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Description:**

- Nominal stress range $\Delta \sigma$ [MPa]
- Number of cycles $N$ [-]
- S-N curves
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Notes:**

- Nominal stress range $\Delta \sigma$ [MPa]
- Number of cycles $N$ [-]
- S-N curves
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Details:**

- Nominal stress range $\Delta \sigma$ [MPa]
- Number of cycles $N$ [-]
- S-N curves
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Elements:**

- Nominal stress range $\Delta \sigma$ [MPa]
- Number of cycles $N$ [-]
- S-N curves
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Annotations:**

- Nominal stress range $\Delta \sigma$ [MPa]
- Number of cycles $N$ [-]
- S-N curves
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Legends:**

- Hilti S-BT fastener
- Proposed design S-N curve
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Symbols:**

- Hilti S-BT fastener
- Proposed design S-N curve
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles
- Fatigue limit at $10^7$ cycles

**Diagram Figures:**

- Figure 34
- Figure 5
- Table 7
- Table 10.5
- Table 10.4
- Table 9.5
- Table 9.1

**Diagram Sources:**

BS 7608:2014

It is recommended to use the following design S-N curve respectively stress category termed “S-BT” given in Table 8 and Figure 6 for the constructional detail “Steel base material with Hilti S-BT screw-in threaded studs”.

Figure 6: Comparison of Hilti S-BT fatigue test data with BS 7608:2014 fatigue curves and new proposed fatigue curve “S-BT” for Hilti S-BT fastener

<table>
<thead>
<tr>
<th>Class</th>
<th>C₂</th>
<th>log₁₀C₂</th>
<th>m</th>
<th>SD of log₁₀N</th>
<th>C₂</th>
<th>N=10^7 (N/mm²)</th>
<th>N=5×10^7 (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2.343×10^2</td>
<td>15.697</td>
<td>4.0</td>
<td>0.1621</td>
<td>1.01×10^6</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>C</td>
<td>1.082×10^2</td>
<td>14.034</td>
<td>3.0</td>
<td>0.2041</td>
<td>4.23×10^6</td>
<td>78</td>
<td>49</td>
</tr>
<tr>
<td>D</td>
<td>3.988×10^2</td>
<td>12.606</td>
<td>3.0</td>
<td>0.2096</td>
<td>1.52×10^6</td>
<td>53</td>
<td>31</td>
</tr>
<tr>
<td>E</td>
<td>3.289×10^2</td>
<td>12.171</td>
<td>3.0</td>
<td>0.2509</td>
<td>1.04×10^6</td>
<td>47</td>
<td>27</td>
</tr>
<tr>
<td>F</td>
<td>1.726×10^2</td>
<td>12.237</td>
<td>3.0</td>
<td>0.2183</td>
<td>6.32×10^6</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>F2</td>
<td>1.231×10^2</td>
<td>12.902</td>
<td>3.0</td>
<td>0.2279</td>
<td>4.31×10^6</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td>G</td>
<td>5.656×10^2</td>
<td>11.752</td>
<td>3.0</td>
<td>0.1793</td>
<td>2.48×10^6</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>G3</td>
<td>3.907×10^2</td>
<td>11.591</td>
<td>3.0</td>
<td>0.1952</td>
<td>1.59×10^6</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>S1</td>
<td>5.902×10^2</td>
<td>16.771</td>
<td>5.0</td>
<td>0.2350</td>
<td>2.00×10^6</td>
<td>46 (10^7 cyc.)</td>
<td>46 (10^9 cyc.)</td>
</tr>
<tr>
<td>S2</td>
<td>3.949×10^2</td>
<td>16.595</td>
<td>5.0</td>
<td>0.3900</td>
<td>6.55×10^6</td>
<td>37 (10^7 cyc.)</td>
<td>37 (10^9 cyc.)</td>
</tr>
<tr>
<td>S-BT</td>
<td>5.902×10^2</td>
<td>16.771</td>
<td>5.0</td>
<td>0.2350</td>
<td>2.00×10^6</td>
<td>74.2</td>
<td>52.5</td>
</tr>
</tbody>
</table>

Table 8: Recommendation of fatigue S-N curve and detail category acc. to BS 7608:2014
Literature:


5.7 Influence of glue coatings on the loosening torque

Experimental investigations on the influence of glue coatings on the loosening torque
Report No. XSEhac-01-15_15; Hilti AG; Schaan 2015

General comments
The design intent is that the nut can be removed without the S-BT stud unscrewing from the base material. To increase the loosening torque of the stud from the base material, the stainless steel and carbon steel S-BT fasteners are equipped with a “micro encapsulation” Pre-cote 80-8 on the tapping thread. This helps to increase the loosening torque compared to uncoated fasteners.

Test concept
The test program included in summary 100 specimen for 20 test series. Various coating types have been tested in combination with variable thread intersections. The influence of the screw-in depth was tested for the complete screw-in depth range of the S-BT fastener. As a final parameter, the influence of the maximum and minimum base material strength was tested.

Test results
**Thread intersection:** For all tested thread intersections an increase of the loosening torque was visible due to the coating.

**Screw-in depth:** Based on the test results, the effect of the glue coating decreased with lower screw-in depth.

**Base material strength:** No significant influence could be found.

![Loosening torque of glued / standard studs as a function of the screw-in depth](image)

Conclusions
- For 6 mm base material, a loosening torque of 3.6 to 4.6 Nm can be achieved.
- For 5 mm base material, a loosening torque of 2.5 to 3.6 Nm can be achieved.
- Reusing the stud is prohibited due to the wear of “micro encapsulation” pre-cote 80-8, and potential thread wear.

Notes
- The “micro encapsulation” has no impact on the pull out load capacity of the S-BT fastener. The application temperature range for pre-cote 80-8 is -60°C up to +170°C.
- The installation temperature of the base material must be > -20°C (for the curing process of the glue coating).

This summary is intended to be representative of the test(s) carried out. It is not intended to be a full and complete test report.
5.8 S-BT-ER and S-BT-EF screw-in threaded studs for electrical connections

<table>
<thead>
<tr>
<th>Fasteners</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-ER M10/15 SN6</td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN6</td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td>S-BT-ER M10/15 SN6</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN6</td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
</tbody>
</table>

*) this items are available only on special request

Report No. 17-IK-0093.S02: Suitability of Hilti S-BT-ER and S-BT-EF threaded studs as connection point in protective grounding and earthing circuits and for lighting protection; Electrosuisse, Fehraltorf, Switzerland; July 2017

Electrosuisse expert report für HC von 2018 ergänzen

Report No. 17-IK-0021.S04: Suitability of Hilti S-BT-EF/-ER M10 HC 35, ..W10 AWG2 and S-BT-EF/-ER M10 HC 120, ..W10 AWG4/0 threaded studs as connection point in protective grounding and earthing circuits and for lighting protection; Electrosuisse, Fehraltorf, Switzerland; August 2018

Test Report No. FRM-1648, FRM-1649, FRM-1650
Dehn + Söhne GmbH + Co.KG., Neumarkt, Germany; March 2017

Test Report No. FRM-1795;
Dehn + Söhne GmbH + Co.KG., Neumarkt, Germany; June 2018

Test Report No. FRM-1689;
Dehn + Söhne GmbH + Co.KG., Neumarkt, Germany; June 2017

Test Report No. FRM-1798 and PAM-1834;
Dehn + Söhne GmbH + Co.KG., Neumarkt, Germany; May 2018 and July 2018

UL-listing (File E257069)
5.8.1 Effect of S-BT-ER / S-BT-EF studs on integrity of pipe flange

Installation of a Hilti S-BT-ER / S-BT-EF threaded stud is not expected to have negative influence on the integrity of flanged pipe joints made from typical ductile steel materials, when installed in the center of the radial face of the flange ring between two bolts.

Hilti’s recommendations for edge distance, spacing, minimum flange diameter and minimum base material thickness, as well as Hilti’s printed literature, must be considered during design and installation.

- Outer diameter pipe flange is
  - greater than or equal to 150 mm (6 inches) for installation in the radial face
  - greater than or equal to 100 mm (4 inches) for installation in the flat face
- Minimum edge distance = 6 mm
- Minimum pipe flange thickness = 12 mm (installation in radial flange face)
- Minimum pipe flange thickness = 6 mm (installation in flat flange face)
- S-BT-ER / S-BT-EF installed on center of pipe flange and between 2 tension bolts

Only Type A cable connections are allowed to be installed in pipe flanges. Type B cable connections are not suitable for this application.

5.8.2 Permanent current

For permanent current (leakage current) due to static built up in pipes or when closing an electrical circuit.

Test Standard Requirements or Test criteria

<table>
<thead>
<tr>
<th>Test Standard</th>
<th>The temperature of the fastening point should not exceed the limits of the cable under permanent current, e.g. 45 °C for PVC cables. Test duration: till stable temperature is reached.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60947-7-1</td>
<td></td>
</tr>
<tr>
<td>IEC 60947-7-2</td>
<td></td>
</tr>
</tbody>
</table>
Tested configuration | Fasteners
---|---
| Single point connection, Type A
| S-BT-ER M10/15 SN 6
| S-BT-ER W10/15 SN 6
| S-BT-EF M10/15 AN 6
| S-BT-EF W10/15 AN 6
| S-BT-ER M8/15 SN 6
| S-BT-EF M8/15 AN 6

| Single point connection, Type B
| S-BT-ER M10 HC 35*)
| S-BT-ER W10 HC AWG2*)
| S-BT-EF M10 HC 35*)
| S-BT-EF W10 HC AWG2*)
| S-BT-ER M10 HC 120
| S-BT-ER W10 HC AWG4/0
| S-BT-EF M10 HC 120
| S-BT-EF W10 HC AWG4/0

Conclusions:
- Recommended maximal cross section of connected cable according IEC 60947-7-2 and IEC 60947-7-1:
  - 10 mm² (8 AWG) copper (tested permanent current Iₚₜ = 57 A)
  - 35 mm² (2 AWG) copper (tested permanent current Iₚₜ = 125 A)
  - 120 mm² (4/0 AWG) copper (tested permanent current Iₚₜ = 269 A)
- Fastening of thicker cable is acceptable, if the maximum allowable permanent current Iₚₜ is not exceeded if the provisions on cable lug thickness tₘₜ are observed.

*) this items are available only on special request

5.8.3 Short circuit current

For discharging short circuit current while protecting electrical equipment or earth / ground cable trays and ladders.

<table>
<thead>
<tr>
<th>Test Standard</th>
<th>Requirements or Test criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60947-7-1</td>
<td>A grounding connection must be capable of withstanding a high test current (Iₜₑₜ) for an exposure time of 1 second.</td>
</tr>
<tr>
<td>IEC 60947-7-2</td>
<td>Iₜₑₜ = Aₖₓₚ [mm²] x 120 [A/mm²]</td>
</tr>
<tr>
<td></td>
<td>where Aₖₓₚ = cross sectional area of the attached cable, exposure time 1 second i.e. for wire size 10 mm², a current of 1200 A for 1 sec</td>
</tr>
<tr>
<td>UL 467</td>
<td>A grounding connection must be capable of withstanding a high test current (Iₜₑₜ) for an exposure time of 4 seconds (10 AWG), 6 seconds (2 AWG) or 9 seconds (4/0 AWG)</td>
</tr>
</tbody>
</table>

\[ I_{\text{test}} = A_{\text{cable}} [\text{mm}^2] \times 120 [\text{A/mm}^2] \]
## Fasteners

<table>
<thead>
<tr>
<th>Type</th>
<th>M</th>
<th>Size</th>
<th>Connection Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-ER</td>
<td>10</td>
<td>15</td>
<td>Single point</td>
<td>SN 6</td>
</tr>
<tr>
<td>S-BT-ER</td>
<td>10</td>
<td>15</td>
<td>Single point</td>
<td>W10/15</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td>10</td>
<td>15</td>
<td>Single point</td>
<td>SN 6</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td>10</td>
<td>15</td>
<td>Single point</td>
<td>W10/15</td>
</tr>
<tr>
<td>S-BT-ER</td>
<td>8</td>
<td>15</td>
<td>Single point</td>
<td>SN 6</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td>8</td>
<td>15</td>
<td>Single point</td>
<td>W10/15</td>
</tr>
<tr>
<td>S-BT-ER</td>
<td>10</td>
<td></td>
<td>Double point</td>
<td>HC 35*)</td>
</tr>
<tr>
<td>S-BT-ER</td>
<td>10</td>
<td></td>
<td>Double point</td>
<td>AWG2*)</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td>10</td>
<td></td>
<td>Double point</td>
<td>HC 35*)</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td>10</td>
<td></td>
<td>Double point</td>
<td>AWG2*)</td>
</tr>
</tbody>
</table>

*) this items are available only on special request

### Tested configuration

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Short circuit current ( I_{cw} )</th>
<th>Exposure time ( t_d )</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single point</td>
<td>( 1.20 \text{ kA (IEC)} )</td>
<td>1 s</td>
<td>pass</td>
</tr>
<tr>
<td></td>
<td>( 0.75 \text{ kA (UL)} )</td>
<td>4 s</td>
<td>pass</td>
</tr>
<tr>
<td>Double point</td>
<td>( 1.92 \text{ kA} )</td>
<td>1 s</td>
<td>pass</td>
</tr>
<tr>
<td>Single point</td>
<td>( 4.20 \text{ kA (IEC)} )</td>
<td>1 s</td>
<td>pass</td>
</tr>
<tr>
<td></td>
<td>( 3.90 \text{ kA (UL)} )</td>
<td>6 s</td>
<td>pass</td>
</tr>
<tr>
<td></td>
<td>( 14.40 \text{ kA (IEC)} )</td>
<td>1 s</td>
<td>pass</td>
</tr>
<tr>
<td></td>
<td>( 10.10 \text{ kA (UL)} )</td>
<td>9 s</td>
<td>pass</td>
</tr>
</tbody>
</table>
5.8.3 Lightning current

For high temporary current due to lightning.


Test criteria

Electrical test with stress of 3 times 50 or 100 kA (signal form 10/350 μs) lightning current as follows:

- **class H**
  - $I_{\text{imp}} = 100 \text{ kA} \pm 10\%$, $W/R = 2.5 \text{ MJ/Ω} \pm 20\%$, $t_d \leq 2 \text{ ms}$

- **class N**
  - $I_{\text{imp}} = 50 \text{ kA} \pm 10\%$, $W/R = 0.63 \text{ MJ/Ω} \pm 20\%$, $t_d \leq 2 \text{ ms}$

Tested Configuration Tested Fasteners Test Results

<table>
<thead>
<tr>
<th>Current Exposure time</th>
<th>Contact resistance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kA 2 ms</td>
<td>&lt; 2.5 m Ω</td>
<td>PASS</td>
</tr>
<tr>
<td>100 kA 2 ms</td>
<td>&lt; 2.5 m Ω</td>
<td>PASS</td>
</tr>
</tbody>
</table>

Note: Higher currents for an exposure time of 2 ms will result in failed lightning connection.

In this connection configuration, the X-BT-ER is used as a fastener and not as an electrical conductor. The cable lug must be in direct contact with non-coated base material. Please refer to requirements in 2.6.3.

5.8.4 Lightning current

For high temporary current due to lightning.

<table>
<thead>
<tr>
<th>Test Standard</th>
<th>Requirements or Test criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 62561-1</td>
<td>Electrical test with stress of 3 times 50 kA or 100 kA (signal form 10/350 μs) lightning current as follows:</td>
</tr>
<tr>
<td></td>
<td>• Classification N</td>
</tr>
<tr>
<td></td>
<td>$I_{\text{imp}} = 50 \text{ kA} \pm 10%$, $W/R = 0.625 \text{ MJ/Ω} \pm 35%$, $t_d \leq 5 \text{ ms}$</td>
</tr>
<tr>
<td></td>
<td>• Classification H</td>
</tr>
<tr>
<td></td>
<td>$I_{\text{imp}} = 100 \text{ kA} \pm 10%$, $W/R = 2.5 \text{ MJ/Ω} \pm 35%$, $t_d \leq 5 \text{ ms}$</td>
</tr>
<tr>
<td></td>
<td>• Conditioning / ageing of the test samples</td>
</tr>
<tr>
<td></td>
<td>• Test with three lightning impulse currents</td>
</tr>
<tr>
<td></td>
<td>• Evaluation of mechanical strengths of test samples</td>
</tr>
<tr>
<td></td>
<td>• Measurement of the contact resistance</td>
</tr>
<tr>
<td></td>
<td>• Measurement of the loosening torque</td>
</tr>
</tbody>
</table>

Fasteners

<table>
<thead>
<tr>
<th>Single point connection, Type A</th>
<th>S-BT-ER M10/15 SN 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-ER W10/15 SN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-ER M8/15 SN 6</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M8/15 AN 6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Single point connection, Type B</th>
<th>S-BT-ER M10 HC 35(^{1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-ER W10 HC AWG2(^{1})</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10 HC 35(^{1})</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10 HC AWG2(^{1})</td>
<td></td>
</tr>
<tr>
<td>S-BT-ER M10 HC 120</td>
<td></td>
</tr>
<tr>
<td>S-BT-ER W10 HC AWG4/0</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF M10 HC 120</td>
<td></td>
</tr>
<tr>
<td>S-BT-EF W10 HC AWG4/0</td>
<td></td>
</tr>
</tbody>
</table>

*) this items are available only on special request
### Conclusions:

Based on IEC 62561-1:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Exposure time</th>
<th>Fastener</th>
<th>Connection configuration</th>
</tr>
</thead>
</table>
| **Classification N** | 1 ms | S-BT-ER M10/15 SN 6  
S-BT-ER W10/15 SN 6  
S-BT-EF M10/15 AN 6  
S-BT-EF W10/15 AN 6  
S-BT-ER M8/15 SN 6  
S-BT-EF M8/15 AN 6  
S-BT-ER M10 HC 35\(^*\)  
S-BT-ER W10 HC AWG2\(^*\)  
S-BT-EF M10 HC 35\(^*\)  
S-BT-EF W10 HC AWG2\(^*\)  
S-BT-ER M10 HC 120  
S-BT-ER W10 HC AWG4/0  
S-BT-EF M10 HC 120  
S-BT-EF W10 HC AWG4/0 | Single point connection: Type A  
Single point connection: Type B |
| **Classification H** | 1 ms | S-BT-ER M10 HC 120  
S-BT-ER W10 HC AWG4/0  
S-BT-EF M10 HC 120  
S-BT-EF W10 HC AWG4/0 | Single point connection: Type B |

\(^*\) this items are available only on special request
5.9 Corrosion resistance

5.9.1 Selection of a suitable fastener

If a fastening has to be perfectly satisfactory and reliable for its entire service life, all surrounding conditions must be ascertained before a suitable fastener can be selected. Therefore, it is necessary to take into account where the parts are installed, indoor or outdoor. For outdoor applications, a distinction is made between rural, urban, industrial and marine atmospheres. Nevertheless, there are special applications like waste water treatment plants, industrial installations, road tunnels and swimming pools. In view of this, each application must be evaluated separately and the findings must be considered when selecting a material with the required corrosion behavior or a system that provides adequate corrosion protection. When material combinations are used, an evaluation of their electrochemical behavior has to be performed to avoid contact corrosion.

Notes
• The information in the following section may be of assistance as it provides some important points that aid selection. The table, however, cannot cover all individual aspects for each application.
• The ultimate decision on the required corrosion protection must be made by the customer. Hilti accepts no responsibility regarding the suitability of a product for a specific application, even if informed of the application conditions. The tables are based on an average service life for typical applications. For metallic coatings, e.g. zinc layer systems, the end of lifetime is the point at which red rust is visible over a large fraction of the product and widespread structural deterioration can occur – the initial onset of rust may occur sooner.
# Specifications

## S-BT Screw-in threaded studs

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Carbon steel</th>
<th>Stainless steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-MF</td>
<td>S-BT-GF</td>
<td>S-BT-MR</td>
</tr>
<tr>
<td>S-BT-EF</td>
<td></td>
<td>S-BT-GR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S-BT-ER</td>
</tr>
</tbody>
</table>

| Coating / material | Duplex-coated carbon steel | A4 AISI 316 |

### Environmental conditions

<table>
<thead>
<tr>
<th>Environmental conditions</th>
<th>Fastened part</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Dry indoor" /></td>
<td>Steel (zinc-coated, painted), aluminium, stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Indoor with temporary condensation" /></td>
<td>Steel (zinc-coated, painted), aluminium</td>
</tr>
<tr>
<td><img src="image" alt="Outdoor with low pollution" /></td>
<td>Steel (zinc-coated, painted), aluminium, Stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Outdoor with moderate concentration of pollutants" /></td>
<td>Steel (zinc-coated, painted), aluminium, Stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Coastal areas" /></td>
<td>Steel (zinc-coated, painted), aluminium, Stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Outdoor, areas with heavy industrial pollution" /></td>
<td>Steel (zinc-coated, painted), aluminium, Stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Close proximity to roads" /></td>
<td>Steel (zinc-coated, painted), aluminium, Stainless steel</td>
</tr>
<tr>
<td><img src="image" alt="Special applications" /></td>
<td>Consult experts</td>
</tr>
</tbody>
</table>

- = expected lifetime of S-BT fasteners made from this material is typically satisfactory in the specified environment based on the typically expected lifetime of a building.

- = a decrease in the expected lifetime of non-stainless fasteners in these atmospheres must be taken into account (≤ 25 years). Higher expected lifetime needs a specific assessment.

- = S-BT fasteners made from this material are not suitable in the specified environment. Exceptions need a specific assessment.

1) From a technical point of view, duplex coatings are suitable for outdoor environments with certain lifetime and application restrictions. This is based on long-term experience with these materials as reflected e.g. in the corrosion rates for Zn given in the ISO 9224:2012 (corrosivity categories, C-classes).

**Important notes:**

National or international codes, standards or regulations, customer and/or industry specific guidelines must be independently considered and evaluated. These guidelines apply to atmospheric corrosion only. Special types of corrosion, such as crevice corrosion must be independently evaluated.

The tables published in this brochure describe only a general guideline for commonly accepted applications in typical atmospheric environments.

Suitability for a specific application can be significantly affected by localized conditions, including but not limited to:

- Elevated temperatures and humidity
- High levels of airborne pollutants
- Direct contact with corrosive products, such as found in some types of chemically-treated wood, waste water, concrete additives, cleaning agents, etc.
- Direct contact to soil, stagnant water
- Direct contact to fresh/young concrete (less than 28 days old)
- Electrical current
- Contact with dissimilar metals
- Confined areas, e.g. crevices
- Physical damage or wear
- Extreme corrosivity due to combined effects of different influencing factors
- Enrichment of pollutants on the product
- Nature of fastening part: fastener must be made of a more noble material or the same material than the fastened part.
5.9.2 Galvanic (contact) corrosion

Galvanic corrosion refers to corrosion damage where two dissimilar metals have an electrically conducting connection and are in contact with a common corrosive electrolyte. Generally, the less noble metal will be dissolved (anodic metal dissolution), whereas the more noble part is not attacked by corrosion (serves only as the cathode for oxygen reduction). Where galvanic corrosion takes place, the rate of corrosion of the less noble metal is higher than it would be in a free corroding environment without contact to another metal.

Galvanic corrosion can be avoided by the right choice of material combinations. To minimize galvanic corrosion, the difference in free corrosion potential between the materials should be as low as possible, and/or the surface ratio of less noble metal to nobler metal should be very high. The free corrosion potential depends on the standard potential, a given thermodynamic value for each metal and the corrosive environment.

As a general rule of thumb, a fastener should always be made of the same or a more noble metal than the part to be fastened in order to prevent failure of the fastener. The fastener typically has the smaller surface area.

The following table shows the impact of galvanic corrosion under atmospheric outdoor conditions for various material combinations.

In dry indoor applications contact corrosion can be neglected and usually there are no susceptible material combinations.

<table>
<thead>
<tr>
<th>Fastener (small area)</th>
<th>Fastened part (large area)</th>
<th>Carbon steel (Duplex-coated)</th>
<th>Stainless steel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S-BT-MF</td>
<td>S-BT-MR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S-BT-GF</td>
<td>S-BT-GR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S-BT-EF</td>
<td>S-BT-ER</td>
<td></td>
</tr>
<tr>
<td>Electrogalvanized</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Hot-dip galvanized</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Structural or cast steel</td>
<td>■</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Stainless steel (CrNi or CrNiMo)</td>
<td>■</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Brass</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
</tbody>
</table>

☐ = No impact on lifetime
◼ = moderate impact on lifetime, technically accepted in many cases
■ = strong impact on lifetime

Impact on lifetime of the S-BT fastener by galvanic (contact) corrosion

Corrosion potential of various metals in sea water

This is a typical case of contact corrosion. Zinc-plated carbon steel (washer) and stainless steel (screw and part) were used together. The surface area of the more noble metal – the stainless steel – is larger, causing strong corrosion of the washer.
5.9.3 Carbon steel S-BT studs

General comments
The coating of the carbon steel S-BT fasteners consists of an electroplated Zn-alloy for cathodic protection and a top coat for chemical resistance (Duplex-coating). The thickness of the coating is 35 μm. The use of this coating is limited to the corrosion category C1, C2 and C3 according to the standard EN ISO 9223. For higher corrosion categories stainless steel fasteners should be used.
Thanks to extensive research in close cooperation with renowned universities and laboratories, designers can trust and rely on the multilayer coating for S-BT.

Indoor applications

Dry indoor environments
(heated or air-conditioned areas) without condensation, e.g. office buildings, schools

Indoor environments with temporary condensation
(unheated areas without pollutants), e.g. storage sheds

Outdoor applications

Outdoor, rural or urban environment with low pollution
Large distance (> 10 km) from the sea

Outdoor, rural or urban environment with moderate concentration of pollutants and/or salt from sea water
Distance from the sea 1-10 km

Environmental conditions for usage of coated carbon steel S-BT studs

Test concept
Laboratory and field tests are performed to assess the expected lifetime and technical safety aspects for fasteners. The duplex coating on the S-BT was tested in neutral salt spray according to DIN EN ISO 9227, which is the most commonly used accelerated corrosion test for corrosion assessment. This test is suitable for quality assessment but does not reflect real environmental conditions.

In contrast, cyclic corrosion tests like ISO 16701 reproduce and accelerate corrosion mechanisms that occur under real environmental conditions. This test is well adapted for lifetime assessment under moderate atmospheric conditions. The fasteners are subjected through cycled climate conditions such as temperature variations, humidity and dry periods as well as corrosion attack through salt.

Results of laboratory tests are verified by mid- and long term field tests in natural climatic conditions.

During the setting process, the fastener is subjected to strong impacts. To ensure that the corrosion resistance of the S-BT remains intact, Hilti performs all corrosion tests on S-BT in mounted condition and the fasteners are installed in steel plates with the appropriate tools.
Neutral salt spray test
S-BT studs with duplex-coating are subjected to a neutral salt spray test according to DIN EN ISO 9227. Under this test, the corrosion resistance of S-BT studs with duplex-coating is significantly higher as compared to hot dip galvanized (HDG) systems with at least 40µm coating thickness. Grade A4 stainless steel S-BT studs remain stable under this test and withstand corrosion due to passive surface.

Cyclic corrosion test
The cyclic corrosion test gives a more realistic assessment of corrosion resistance under natural environments. Under this test, the corrosion resistance of S-BT studs with duplex-coating is comparable and even higher than HDG systems. Grade A4 stainless steel S-BT studs also remain stable under this cyclic corrosion test.

Test results
On the S-BT studs with aluminum sealing washer no corrosion was found after 12 weeks in the cyclic corrosion test. All aluminum sealing washers have adequately sealed the drilled holes over the test period of time. There was no visible corrosion in the bore holes.

Conclusions
• In the ISO 16701 test, the material combination of aluminum sealing washer and the duplex-coating of the carbon steel S-BT studs has been found to be optimal.
• After 12 weeks in the cyclic climate chamber the coating system of the carbon steel S-BT studs showed no tendencies to contact corrosion. The combination is suitable for use in C1, C2 and C3 environment acc. DIN EN ISO 9223:2012
• No corrosion was found in the drilled holes. This is strong evidence that the sealing washer provides an effective seal.

5.9.4 Stainless steel S-BT studs

General comments
The S-BT stainless studs are made from the duplex stainless steel type 1.4462. This grade of stainless steel is classified as corrosion resistance class IV according to DIN EN 1993-1-4:2015, which makes the material suitable for aggressive environments like in coastal and offshore applications. The microstructures of duplex stainless steels consist of a mixture of austenite and ferrite phases. Compared to the austenitic stainless steel grades, duplex stainless steels are magnetic. The surface of the S-BT stainless steel fasteners is zinc plated (anti-friction coating) in order to reduce the thread forming torque when the stud is screwed in into the base material.

The Hilti X-BT system was developed by Hilti Corporation especially for applications on steel structures that form part of oil and gas production facilities, in shipbuilding and in general steel construction. Therefore comprehensive corrosion tests (electrochemical tests, field test) have been performed on the X-BT stud. The stainless steel S-BT studs are intended to be used for the same applications and the studs are made of the same material as the shank of the X-BT fastener, duplex steel type 1.4462.
Environmental conditions for usage of stainless steel S-BT studs.

Test concept
The corrosion behavior of the X-BT fastener was assessed by MPA Stuttgart in 2009. Based on these investigations, MPA Stuttgart assessed the corrosion behavior of the stainless steel S-BT fasteners.

The MPA report evaluates and assesses the S-BT stainless studs in terms of the following corrosion topics:

- Evaluation and assessment of atmospheric corrosion
  - Pitting or crevice corrosion
  - Stress corrosion cracking
  - Bimetallic corrosion
- Corrosion resistance of stainless steels on the basis of their composition
- Long-term exposure tests in maritime atmospheres
- Electrochemical tests

Test results
- On the basis of the investigations mentioned above, MPA Stuttgart assumed that the stainless S-BT studs have very good resistance to corrosion, even in atmospheres containing chlorides and are comparable to that of the X-BT.
- Tests at MPA Stuttgart confirmed high resistance to pitting or crevice corrosion.
- Tests carried out at the University of Leoben showed that the material also has good resistance to stress corrosion cracking even in highly aggressive media.

Conclusions
- Hilti S-BT stainless fasteners made from stainless steel offer excellent corrosion resistance in atmospheres containing chloride ions, i.e. coastal areas and areas near roads treated with de-icing salts.
- Based on the examinations from MPA Stuttgart, the estimated life time in typical atmospheres, from a corrosion-specific point of view, is at least 40 years.

5.9.5 Conductivity disc of S-BT-ER / -EF electrical connectors

The conductivity disc of the S-BT-ER / -EF HC is made from copper alloy CuSn8 with a tin-coating on the surface and a sealing ring on the bottom side. The copper alloy is classified as largely insensitive to stress corrosion cracking and pitting corrosion. The conductivity disc is designed for use in corrosion categories C1 - C5 according to EN ISO 9223. It is therefore suitable for use in aggressive environments like coastal and offshore applications.
5.10 Fire resistance

Test Report No. 20161614 and No. 20170384

General comments
When using Hilti S-BT fasteners in combination with fire rated boundaries in Shipbuilding facilities, the effect of the fastener on the mechanical resistance of the steel base material (bulkheads, decks) has to be considered. Furthermore the behavior of the Hilti S-BT screw-in threaded studs under fire conditions, whilst supporting a load, has to be checked.

Test concept
The tests were performed according the requirements of IMO Resolution MSC.307(88), Fire Test Procedure Code, 2010, part 3 [3]. In order to test the S-BT fastener in the most onerous manner, a “A-0” class bulkhead (uninsulated) was tested at MPA Dresden. For the test, two bulkhead sizes were used.

The big A-0 bulkhead is a 2980 mm square. The plate of the bulkhead consists of a 5 mm thick steel plate with 65 x 65 x 6 mm L-stiffener along the vertical edges. The constructional details of the test specimen used are given in the corresponding test report [1] and Figure 1. The small A-0 bulkhead is a 980 mm square and is fabricated in two halves. Viewed from the unexposed face the left hand side of the bulkhead consists of a 3 mm steel plate with a Bulb flat 80 x 5.0 stiffener along the vertical edge. The right hand side of the bulkhead consists of a 6 mm steel plate with a Bulb flat 80 x 5.0 stiffener along the vertical edge. There is also a central stiffener (Bulb flat 80 x 5.0). The constructional details of the test specimen used are given in the corresponding test report [2] and Figure 2.

The bulkheads were installed such that the stiffeners and the S-BT studs were on the unexposed face of the specimen.
A total of eight S-BT threaded studs (big bulkhead) and ten S-BT threaded studs (small bulkhead) were fitted to the bulkhead and were subjected to either a tension or shear load.

The loading details of each S-BT stud and an overview of the selected test program are given in Table 1 and Table 2.

<table>
<thead>
<tr>
<th>Stud #</th>
<th>Force [kN]</th>
<th>Typ of force</th>
<th>S-BT Type</th>
<th>Base material thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.53</td>
<td>Tension</td>
<td>S-BT-MR M8/15 SN6</td>
<td>6.0 (L-stiffener)</td>
</tr>
<tr>
<td>2</td>
<td>0.51</td>
<td>Tension</td>
<td>S-BT-MR M8/15 SN6</td>
<td>5.0 (Plate)</td>
</tr>
<tr>
<td>3</td>
<td>0.52</td>
<td>Tension</td>
<td>S-BT-MF M8/15 AN6</td>
<td>5.0 (Plate)</td>
</tr>
<tr>
<td>4</td>
<td>0.52</td>
<td>Tension</td>
<td>S-BT-MF M8/15 AN6</td>
<td>6.0 (L-stiffener)</td>
</tr>
<tr>
<td>5</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MR M8/15 SN6</td>
<td>6.0 (L-stiffener)</td>
</tr>
<tr>
<td>6</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MR M8/15 SN6</td>
<td>5.0 (Plate)</td>
</tr>
<tr>
<td>7</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MF M8/15 AN6</td>
<td>5.0 (Plate)</td>
</tr>
<tr>
<td>8</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MF M8/15 AN6</td>
<td>6.0 (L-stiffener)</td>
</tr>
</tbody>
</table>

Table 1: Test program of the big bulkhead 2980 mm x 2980 mm
According to [3], for all “A” class divisions the following requirements shall be satisfied for the minimum test duration of 60 min.

- Flaming: there shall be no flaming and smoke on the unexposed face
- Gap gauges: it shall not be possible to enter the gap gauge into any opening in the specimen
- Stability of the test specimen. For “A-0” class bulkheads the average unexposed-face temperature rise is not applicable.

In addition to the requirements above a further requirement is defined:

- The installed S-BT studs shall maintain their loads (tension or shear) for a period of 60 minutes

During the test the average furnace temperature, the unexposed surface temperature adjacent to the installed S-BT studs and the deflection of the bulkhead were measured and recorded.

The test setup, measurements and the results are described in detail in [1] and [2].

### Test results

For the tests, S-BT-MR M8/15 (stainless steel) and S-BT-MF M8/15 (carbon steel) were used. The threaded tip of the S-BT studs and the sealing washer (area A in Figure 3) is identical for all dimensions. Only the threads (e.g. M8, M10, W10) for attachment of supported materials (area B in Figure 3) are different. For this reason S-BT studs with thread M8 were chosen for the tests in order to adopt the test results to the bigger threads M10 / W10.

#### Table 2: Test program of the small bulkhead 980 mm x 980 mm

<table>
<thead>
<tr>
<th>Stud #</th>
<th>Force [kN]</th>
<th>Typ of force</th>
<th>S-BT Type</th>
<th>Base material thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.53</td>
<td>Tension</td>
<td>S-BT-MR M8/15 SN6</td>
<td>Bulb Flat 80 x 5.0</td>
</tr>
<tr>
<td>2</td>
<td>0.26</td>
<td>Tension</td>
<td>S-BT-MR M8/15 SN6</td>
<td>3.0 (Plate) (drill through hole)</td>
</tr>
<tr>
<td>3</td>
<td>0.52</td>
<td>Tension</td>
<td>S-BT-MF M8/15 AN6</td>
<td>6.0 (Plate)</td>
</tr>
<tr>
<td>4</td>
<td>0.52</td>
<td>Tension</td>
<td>S-BT-MF M8/15 AN6</td>
<td>Bulb Flat 80 x 5.0</td>
</tr>
<tr>
<td>5</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MR M8/15 SN6</td>
<td>Bulb Flat 80 x 5.0</td>
</tr>
<tr>
<td>6</td>
<td>0.25</td>
<td>Shear</td>
<td>S-BT-MR M8/15 SN6</td>
<td>3.0 (Plate) (drill through hole)</td>
</tr>
<tr>
<td>7</td>
<td>0.25</td>
<td>Shear</td>
<td>S-BT-MF M8/15 AN6</td>
<td>3.0 (Plate) (drill through hole)</td>
</tr>
<tr>
<td>8</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MR M8/15 SN6</td>
<td>6.0 (Plate)</td>
</tr>
<tr>
<td>9</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MF M8/15 AN6</td>
<td>6.0 (Plate)</td>
</tr>
<tr>
<td>10</td>
<td>0.50</td>
<td>Shear</td>
<td>S-BT-MF M8/15 AN6</td>
<td>Bulb Flat 80 x 5.0</td>
</tr>
</tbody>
</table>

Figure 3: Geometry of S-BT studs

Stability of the test specimen was given during the 60 test minutes. All installed S-BT studs were able to maintain their loads (ref. to Table 1 and Table 2) for a period of 60 minutes whilst the bulkhead was subjected to a test, which utilized the conditions given in IMO Resolution MSC.307(88), FTP Code, 2010 for “A-0” bulkheads. There was no occurrence of any flaming or smoke on the unexposed surface of the specimen during the test. In the test specimen there were no openings or cracks visible during the whole test period.
Conclusions
Both bulkheads passed the performance criteria of IMO Resolution MSC.307(88), FTP Code, 2010 for “A-0” bulkheads. The installed S-BT studs didn’t affect the fire resistance of steel bulkheads and the studs were able to maintain their loads for a period of 60 minutes.

Based on the test results the use of S-BT studs for applications in fire rated boundaries on ships can be recommended.

Recommended loads for applications in fire rated boundaries

| S-BT-______________6 | Base material | Steel with yield strength $R_{y,ht}$
| | | $235 \text{ MPa} \leq R_{y,ht} \leq 355 \text{ MPa}$
| | (ordinary strength e.g. S235, Grade A up to higher strength e.g. S355, Grade AH36) |
| Drill hole type and base material thickness | Pilot hole, $t_1 \geq 6 \text{ mm } [0.24"]$ |
| | Drill through hole, $5 \text{ mm } [0.20"] \leq t_2 < 6 \text{ mm } [0.24"]$ |
| | Drill through hole, $3 \text{ mm } \leq t_3 < 5 \text{ mm}$ |
| Tension, $R_{60, N_{rec,fi}}$ [kN/lb] | 0.50 / 112 |
| Shear, $R_{60, V_{rec,fi}}$ [kN/lb] | 0.50 / 112 |

Conditions for recommended loads:
- Use S-BT-MR and S-BT-MF (multipurpose fastening) only with the attached Hilti serrated flange nuts M8, M10, W10 (⃣ or ⃤ refer to section 3.1.1)
- S-BT studs installed on the unexposed face of the bulkhead
- Global factor of safety $\Omega_{fi}$ for static pull-out and static shear = 1.0.
- Minimum edge distance = 6 mm [0.24”], spacing ≥ 18 mm [0.709”]
- Redundancy (multiple fastening) must be provided.
- If eccentric loading exists (e.g. use of an angle clip), moments caused by off-center loading must be considered.

Literature:
5.11 Volume swelling of SN 12 sealing washer (stainless steel S-BT studs)

(Refer to section 3.1.1 material No. ③)

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Volume swell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 20%</td>
</tr>
<tr>
<td>1. Water at 80°C</td>
<td></td>
</tr>
<tr>
<td>2. Sea water</td>
<td></td>
</tr>
<tr>
<td>3. Zinc chloride 10%</td>
<td></td>
</tr>
<tr>
<td>4. Sodium chloride 15%</td>
<td></td>
</tr>
<tr>
<td>5. Hydrochloric acid 10%</td>
<td></td>
</tr>
<tr>
<td>6. Acetic acid</td>
<td></td>
</tr>
<tr>
<td>7. Acrylonitrile</td>
<td></td>
</tr>
<tr>
<td>8. Aniline</td>
<td></td>
</tr>
<tr>
<td>9. n-Butyl acetate</td>
<td></td>
</tr>
<tr>
<td>10. Diethyl ether</td>
<td></td>
</tr>
<tr>
<td>11. Ethanol</td>
<td></td>
</tr>
<tr>
<td>12. Glycerol</td>
<td></td>
</tr>
<tr>
<td>13. n-Hexane</td>
<td></td>
</tr>
<tr>
<td>14. Methanol</td>
<td></td>
</tr>
<tr>
<td>15. Methyl ethyl ketone</td>
<td></td>
</tr>
<tr>
<td>16. Nitrobenzene</td>
<td></td>
</tr>
<tr>
<td>17. 1-Propanol</td>
<td></td>
</tr>
<tr>
<td>18. Oil (ASTM-1) at 80°C</td>
<td></td>
</tr>
<tr>
<td>19. Oil (ASTM-2) at 80°C</td>
<td></td>
</tr>
<tr>
<td>20. Oil (ASTM-3) at 80°C</td>
<td></td>
</tr>
<tr>
<td>21. Reference fuel B (isooctane/toluene, 70/30)</td>
<td></td>
</tr>
<tr>
<td>22. Reference fuel C (isooctane/toluene, 50/50)</td>
<td></td>
</tr>
<tr>
<td>23. Hydraulic brake fluid</td>
<td></td>
</tr>
<tr>
<td>24. Hydraulic brake fluid at 100°C</td>
<td></td>
</tr>
<tr>
<td>25. Antifreeze (ethylene glycol/water 50/50) at 125°C</td>
<td></td>
</tr>
</tbody>
</table>

Material: 3.1107 Elastomer; CR ozone and UV resistance Temperature range: -40°C to +100°C

Volume swelling is a reaction of the material of the washer when it’s in contact with the different substances. It’s used as a parameter to describe the chemical reaction. The swelling factor gives an indication of the behavior of the material, but swelling does not lead directly to loss of the sealing property. With an installed stainless steel S-BT stud, the washer is compressed against the base steel. Without any specific requirement a general guideline is that the washer material is resistant to all substances where the volume swelling value is ≤ 40%.

The table above is valid only for stainless steel S-BT studs.
5.12 Material safety data sheet for SN12 sealing washer acc. to ISO/DIS 11014

5.12.1 Identification of substance

Product details

Trade name: Plate 2.0x650x50.000 mm OE 3.1107
Application of the substance / the preparation: Rubber compound
Manufacturer/supplier:
PHOENIX CBS GmbH, Hannoversche Straße 88, D-21079 Hamburg
Information department:
Conseo GmbH Abteilung Umweltschutz, Hannoversche Straße 88
D-21079 Hamburg, 040 32809 2794
Emergency information:
0049(0)40 7667 2233

5.12.2 Composition/data on components

Chemical characterization

Description: Mixture of the substances listed below with non-hazardous additions

**Dangerous components**

<table>
<thead>
<tr>
<th>Substance ID</th>
<th>Substance Name</th>
<th>Hazard Classifications</th>
<th>Hazard Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>117-81-7</td>
<td>bis(2-ethylhexyl) phthalate</td>
<td>R 60-61</td>
<td>2.5-10%</td>
</tr>
<tr>
<td>1309-48-4</td>
<td>magnesium oxide</td>
<td></td>
<td>2.5-10%</td>
</tr>
<tr>
<td>1314-13-2</td>
<td>zinc oxide</td>
<td></td>
<td>2.5-10%</td>
</tr>
<tr>
<td>68953-84-4</td>
<td>N,N'-Diaryl-p-phenylenediamine</td>
<td>Xi, N; R 43-50/53</td>
<td>≤ 1.0%</td>
</tr>
<tr>
<td>97-39-2</td>
<td>1,3-di-o-tolylguanidine</td>
<td>T; R 25</td>
<td>≤ 1.0%</td>
</tr>
</tbody>
</table>

Additional information: For the wording of the listed risk phrases refer to section 16.

5.12.3 Hazards identification

Hazard description U

Information pertaining to particular dangers for man and environment:
The product has been classified in accordance with EU directives / national laws respectively. In the version marketed, it presents no risk to the environment or to health. Following directive 67 / 548 EC, annex VI, point 9.3 it is not necessary to be labelled.

Classification system

The classification was made according to the latest editions of international substances lists and expanded upon from company and literature data.

**NFPA ratings (scale 0 - 4)**

Health = 0, Fire = 0, Reactivity = 0

**HMIS-ratings (scale 0–4)**

Health = *, Fire = 0, Reactivity = 0
5.12.4 First aid measures

General information: No special measures required.
After inhalation: Supply fresh air; consult doctor in case of complaints.
After skin contact: Generally the product does not irritate the skin.
After eye contact: Rinse opened eye for several minutes under running water.
After swallowing: If symptoms persist consult doctor.

5.12.5 Fire fighting measures

Suitable extinguishing agents:
CO₂, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

Special hazards caused by the material, its products of combustion or resulting gases:
Formation of toxic gases is possible during heating or in case of fire.
In case of fire, the following can be released:
Carbon monoxide (CO), Sulphur dioxide (SO₂), Hydrogen chloride (HCl)

Protective equipment: No special measures required.

5.12.6 Accidental release measures

Person-related safety precautions: Not required.
Measures for environmental protection: No special measures required.
Measures for cleaning/collecting: Pick up mechanically.
Additional information: No dangerous substances are released.

5.12.7 Handling and storage

Handling
Information for safe handling: No special measures required.
Information about protection against explosions and fires:
No special measures required.

Storage
Requirements to be met by storerooms and receptacles:
No special requirements.
Information about storage in one common storage facility: Not required.
Further information about storage conditions: None.
5.12.8 Exposure controls and personal protection

Additional information about design of technical systems:
No further data; see item 7.

Components with limit values that require monitoring at the workplace:
When working with the product N-nitrosamines can be liberated

<table>
<thead>
<tr>
<th>Substance</th>
<th>PEL</th>
<th>REL</th>
<th>TLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>117-81-7 bis(2-ethylhexyl) phthalate</td>
<td>5 mg/m³</td>
<td>Short-term value: 10 mg/m³</td>
<td>5 mg/m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long-term value: 5 mg/m³</td>
<td></td>
</tr>
<tr>
<td>1309-48-4 magnesium oxide</td>
<td>15 mg/m³</td>
<td>10 mg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1314-13-2 zinc oxide</td>
<td>15 mg/m³</td>
<td>15 mg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

Additional information
The lists that were valid during formulation were used as a basis.

Personal protective equipment
General protective and hygienic measures:
The usual precautionary measures for handling chemicals should be followed.

Protection of hands
The glove material must be impermeable and resistant to the product / the substance / the preparation.
As no test information is available, no recommendation about glove material can be given for the product / the preparation / the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

Glove material
Selection of suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and must therefore be checked prior to the application.

Penetration time of glove material
The exact breakthrough time must be stated by the manufacturer of the protective gloves and must be observed.

Eye protection
Not required.
5.12.9 Physical and chemical properties

**General Information**

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form:</td>
<td>Solid</td>
</tr>
<tr>
<td>Color:</td>
<td>According to product specification</td>
</tr>
<tr>
<td>Odor:</td>
<td>Characteristic</td>
</tr>
</tbody>
</table>

**Change in condition**

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting point/melting range:</td>
<td>Undetermined.</td>
</tr>
<tr>
<td>Boiling point/boiling range:</td>
<td>Undetermined.</td>
</tr>
<tr>
<td>Flash point:</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Ignition temperature:</td>
<td>370.0°C (698°F)</td>
</tr>
<tr>
<td>Auto igniting:</td>
<td>Product is not self-igniting.</td>
</tr>
<tr>
<td>Danger of explosion:</td>
<td>Product does not present an explosion hazard.</td>
</tr>
<tr>
<td>Density at 20°C (68°F):</td>
<td>1.380 g/cm³</td>
</tr>
</tbody>
</table>

**Solubility in / miscibility with water:**

<table>
<thead>
<tr>
<th>Solvent content:</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic solvents:</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Solids content:</td>
<td>94.5 %</td>
</tr>
</tbody>
</table>

5.12.10 Stability and reactivity

**Thermal decomposition / conditions to be avoided**

No decomposition if used according to specifications.

**Dangerous reactions**

No dangerous reactions known.

**Dangerous products of decomposition**

Hydrogen chloride (HCl)

Toxic pyrolysis products.

5.12.11 Toxicological information

**Acute toxicity**

**LD/LC50 values that are relevant for classification**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Oral LD50</th>
<th>Dermal LD50</th>
</tr>
</thead>
<tbody>
<tr>
<td>117-81-7 bis(2-ethylhexyl) phthalate</td>
<td>30600 mg/kg (rat)</td>
<td>25000 mg/kg (rbl)</td>
</tr>
</tbody>
</table>

**Primary irritant effect**

**On the skin:** No irritant effect.

**On the eye:** No irritating effect.

**Sensitization:** No sensitizing effects known.

**Additional toxicological information**

The product is not subject to classification according to internally approved calculation methods for preparations.

When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us.
5.12.12 Ecological information

General notes
Generally not hazardous to water

5.12.13 Disposal considerations

Product

Recommendation
Smaller quantities can be disposed of with household waste.
Can be disposed of under observance of the technical instructions after consultation with the local authorities and waste disposers.
Use one of the following waste key numbers.

Uncleaned packagings
Recommendation: Disposal must be according to official regulations.

5.12.14 Transport information

DOT regulations:
Hazard class: -
Land transport ADR/RID (cross-border):
ADR/RID class: -
Maritime transport IMDG:
IMDG Class: -
Marine pollutant: No
Air transport ICAO-TI and IATA-DGR:
ICAO/IATA Class: -

Transport/additional information:
Not hazardous according to the above specifications.

5.12.15 Regulations

Sara
Section 355 (extremely hazardous substances):
None of the constituents are listed.
Section 313 (Specific toxic chemical listings):
117-81-7 bis(2-ethylhexyl) phthalate
TSCA (Toxic Substances Control Act):
9010-98-4 Polychloropren CR
117-81-7 bis(2-ethylhexyl) phthalate
1309-48-4 magnesium oxide
1314-13-2 zinc oxide
97-39-2 1,3-di-o-tolyguanidine
101-67-7 bis(4-octylphenyl)amine
97-74-5 tetramethylthiuram monosulphide
Proposition 65

Chemicals known to cause cancer:

117-81-7  bis(2-ethylhexyl) phthalate

Chemicals known to cause reproductive toxicity:

None of the constituents are listed.

Cancerogenity categories

<table>
<thead>
<tr>
<th>Agency</th>
<th>Substance</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA (Environmental Protection Agency)</td>
<td>117-81-7  bis(2-ethylhexyl) phthalate</td>
<td>B2</td>
</tr>
<tr>
<td></td>
<td>1314-13-2  zinc oxide</td>
<td>D</td>
</tr>
<tr>
<td>IARC (International Agency for Research on Cancer)</td>
<td>117-81-7  bis(2-ethylhexyl) phthalate</td>
<td>2B</td>
</tr>
<tr>
<td>NTP (National Toxicology Program)</td>
<td>117-81-7  bis(2-ethylhexyl) phthalate</td>
<td>R</td>
</tr>
<tr>
<td>TLV (Threshold Limit Value established by ACGIH)</td>
<td>117-81-7  bis(2-ethylhexyl) phthalate</td>
<td>A3</td>
</tr>
<tr>
<td>MAK (German Maximum Workplace Concentration)</td>
<td>None of constituents are listed.</td>
<td></td>
</tr>
<tr>
<td>NIOSH-Ca (National Institute for Occupational Safety and Health)</td>
<td>None of constituents are listed.</td>
<td></td>
</tr>
<tr>
<td>OSHA-Ca (Occupational Safety &amp; Health Administration)</td>
<td>None of the constituents are listed.</td>
<td></td>
</tr>
</tbody>
</table>

Product-related hazard information

Observe the general safety regulations when handling chemicals.
The product has been classified in accordance with EU directives / national laws respectively.
In the version marketed, it presents no risk to the environment or to health.
Following directive 67 / 548 EC, annex VI, point 9.3 it is not necessary to be labelled.

Hazard symbols

U

National regulations

Technical instructions (air)

<table>
<thead>
<tr>
<th>Class</th>
<th>Share in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.4</td>
</tr>
<tr>
<td>NK</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Water hazard class: Generally not hazardous to water.

Other regulations, limitations and prohibitive regulations

Subject to the regulations for N-Nitrosamines.

5.12.16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Department issuing MSDS: Conseo GmbH Abteilung Umweltschutz

Contact: Hr. Dr. Kräbig / Hr. Dr. Laugwitz
## 6. FASTENER PROGRAM

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item no.</th>
<th>Product name</th>
<th>Comment</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>2140527</td>
<td>Threaded stud</td>
<td>use with X-FCM grating disc</td>
<td>Grating</td>
</tr>
<tr>
<td>S-BT-MF M8/7 AN 6</td>
<td>2139174</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MF M8/15 AN 6</td>
<td>2148618</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td>2140528</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>2139173</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>2140529</td>
<td>Threaded stud</td>
<td>use with X-FCM grating disc</td>
<td>Grating</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6 AL</td>
<td>2140742</td>
<td>Threaded stud</td>
<td>use with X-FCM grating disc</td>
<td>Grating</td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 6</td>
<td>2139172</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 6 AL</td>
<td>2140743</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td>2148612</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td>2140740</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>2140741</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6 AL</td>
<td>2140745</td>
<td>Threaded stud</td>
<td>package includes serrated flange nut</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-EF M8/15 AN 6</td>
<td>2186208</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF M10/15 AN 6</td>
<td>2186204</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN 6</td>
<td>2186206</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF M10 HC 35°</td>
<td>2204930</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF M10 HC AWG2&quot;</td>
<td>2204931</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF M10 HC 120</td>
<td>2204932</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-EF M10 HC AWG3/0</td>
<td>2206612</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER M8/15 SN 6</td>
<td>2186307</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER M10/15 SN 6</td>
<td>2188203</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER W10/15 SN 6</td>
<td>2188205</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER M10 HC 35°</td>
<td>2204737</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER W10 HC AWG3/2&quot;</td>
<td>2204738</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER M10 HC 120</td>
<td>2204739</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>S-BT-ER W10 HC AWG3/0</td>
<td>2206611</td>
<td>Threaded stud</td>
<td>package includes nuts and lock washers and conductor discs</td>
<td>Electrical connections</td>
</tr>
<tr>
<td>TS-BT 5.5-74 S</td>
<td>2143137</td>
<td>Stepped drill bit</td>
<td>for base material steel</td>
<td></td>
</tr>
<tr>
<td>TS-BT 5.5-74 AL</td>
<td>2143138</td>
<td>Stepped drill bit</td>
<td>for base material aluminum</td>
<td></td>
</tr>
<tr>
<td>TS-BT 15-74 S</td>
<td>2204935</td>
<td>Coating removal drill bit</td>
<td>for removal of the coating from the base material</td>
<td></td>
</tr>
<tr>
<td>TS-BT 25-74 S</td>
<td>2204736</td>
<td>Coating removal drill bit</td>
<td>for removal of the coating from the base material</td>
<td></td>
</tr>
<tr>
<td>TS-BT 15-74 S</td>
<td>2204935</td>
<td>Coating removal drill bit</td>
<td>for removal of the coating from the base material</td>
<td></td>
</tr>
<tr>
<td>TS-BT 25-74 S</td>
<td>2204736</td>
<td>Coating removal drill bit</td>
<td>for removal of the coating from the base material</td>
<td></td>
</tr>
<tr>
<td>S-DG BT M8/7 Short 6</td>
<td>2143260</td>
<td>Depth gauge</td>
<td>for exact setting of the S-BT</td>
<td></td>
</tr>
<tr>
<td>S-DG BT M10/15 Long 6</td>
<td>2143261</td>
<td>Depth gauge</td>
<td>for exact setting of the S-BT</td>
<td></td>
</tr>
<tr>
<td>S-DG BT M8/15 Long 6</td>
<td>2148575</td>
<td>Depth gauge</td>
<td>for exact setting of the S-BT</td>
<td></td>
</tr>
<tr>
<td>S-DG BT M10/15 HC 6</td>
<td>2204933</td>
<td>Depth gauge</td>
<td>for exact setting of the S-BT ____ HC ____</td>
<td></td>
</tr>
<tr>
<td>S-CG BT /7 Short 6</td>
<td>2143262</td>
<td>Check gauge</td>
<td>for verification of the stud stand-off</td>
<td></td>
</tr>
<tr>
<td>S-CG BT /15 Long 6</td>
<td>2143263</td>
<td>Check gauge</td>
<td>for verification of the stud stand-off</td>
<td></td>
</tr>
<tr>
<td>S-CG BT HC</td>
<td>2208475</td>
<td>Check gauge</td>
<td>for verification of the stud stand-off</td>
<td></td>
</tr>
<tr>
<td>S-BT 1/4&quot; ~ 5 Nm</td>
<td>2143271</td>
<td>Torque tool</td>
<td>manual torque tool (5 Nm)</td>
<td></td>
</tr>
<tr>
<td>X-BT 1/4&quot; ~ 8 Nm</td>
<td>2119272</td>
<td>Torque tool</td>
<td>manual torque tool (8 Nm)</td>
<td></td>
</tr>
<tr>
<td>S-NS 13 C 95/3 3/4&quot;</td>
<td>2149244</td>
<td>Nut setter</td>
<td>for serrated flange nut M8</td>
<td></td>
</tr>
<tr>
<td>S-NS 15 C 95/3 3/4&quot;</td>
<td>2149245</td>
<td>Nut setter</td>
<td>for serrated flange nut M10</td>
<td></td>
</tr>
<tr>
<td>S-NS 9/16&quot; C 95/3 3/4&quot;</td>
<td>2149246</td>
<td>Nut setter</td>
<td>for serrated flange nut W10</td>
<td></td>
</tr>
</tbody>
</table>

1) This items are available only on special request
# 7. APPROVALS

## 7.1 American Bureau of Shipping (ABS)

### Confirmation of Product Type Approval

Please refer to the "Service Restrictions" shown below to determine if Unit Certification is required for this product. This certificate reflects the information on the product in the ABS Records as of the date and time the certificate is printed.

Pursuant to the Rules of the American Bureau of Shipping (ABS), the manufacturer of the below listed product held a valid Manufacturing Assessment (MA) with expiration date of 18-SEP-2021. The continued validity of the Manufacturing Assessment is dependent on completion of satisfactory audits as required by the ABS Rules.

And, a Product Design Assessment (PDA) valid until subject to continued compliance with the Rules or standards used in the evaluation of the product.

The above entitle the product to be called Product Type Approved.

The Product Design Assessment is valid for products intended for use on ABS classed vessels, MODUs or facilities which are in existence or under contract for construction on the date of the ABS Rules used to evaluate the Product.

ABS makes no representations regarding Type Approval of the Product for use on vessels, MODUs or facilities built after the date of the ABS Rules used for this evaluation.

Due to wide variety of specifications used in the products ABS has evaluated for Type Approval, it is part of our contract that; whether the standard is an ABS Rule or a non-ABS Rule, the Client has full responsibility for continued compliance with the standard.

**Product Name:** Fastening System


**Presented to:**
HILTI AKTIENGESELLSCHAFT
FELDKIRCHERSTR. 100
Liechtenstein

**Intended Service:**
For fastening of fastened materials to base materials of carbon steel or aluminum in the Ship and Shipbuilding environment and in Offshore Structures.

**Description:**
1. In the S-BT fasteners, the threaded stud is set into a small pre-drilled pilot hole and the drill entry point is then completely sealed by the stud washer during setting. This doesn't require any rework of the protective surface coating because there is no through penetration of the base material. 2. For the S-BT System there is also the possibility to set the stud into a drill through hole in thin base material. In this case a rework of the protective surface on the backside is potentially needed. 3. Dimensions and material specifications of S-BT fasteners: refer to the Data

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Certificate Number: 16-HS1550085-1-PDA
16/MAR/2018
Sheets ("S-BT screw-in stainless steel and carbon steel threaded studs Product Data", "S-BT-ER and S-BT-EF screw-in stainless steel and carbon steel threaded studs for electrical connections Product Data" & "Hilti S-BT Screw-in threaded studs"). 4. The fasteners are to be installed and inspected using installation procedures and tools recommended by the manufacturer as in the Data Sheet: a) Drilling tool: SF BT 18-A, SF BT 22-A or SBT 4-A22; b) Drill bits: TS-BT 4.3-74 S, TS-BT 5.5-74 S, TS-BT 5.5-74 AL. 5. Base material thickness tII and type of bore hole: a) Pilot hole, base material steel: tII >= 6 mm [0.24”]; b) Pilot hole, base material aluminum: tII >= 8 mm [0.24”]; c) Drill through hole, base material steel: 6 mm [0.24”] > tII >= 3mm [0.12”]; d) Drill through hole, base material aluminum: 6 mm [0.24”] > tII >= 5mm [0.20”]. 6. Composite fasteners are either made from stainless steel (X-FCM-R) or from duplex coated steel (X-FCM-M).

Tier: 3

Ratings: 1. Refer to the Data Sheets ("S-BT screw-in stainless steel and carbon steel threaded studs Product Data", "S-BT-ER and S-BT-EF screw-in stainless steel and carbon steel threaded studs for electrical connections Product Data" & "Hilti S-BT Screw-in threaded studs") for the recommended maximum loading in tension, shear, moment and torque, in association with the recommended loads specified therein. 2. Refer to the Data Sheets for the application requirements to the followings: a) Base material thickness and type of bore hole; b) Thickness of fastened material; c) Edge distance >= 6 mm [0.24”]; Spacing >= 18 mm [0.71”]; d) Corrosion information. 3. Service Temperature: -40 to 100 Celsius.

Service Restrictions: Unit Certification is not required for this product. If the manufacturer or purchaser request an ABS Certificate for compliance with a specification or standard, the specification or standard, including inspection standards and tolerances, must be clearly defined. 1) The base material is limited to steel grade with the following properties: a) For Steel as base material, Maximum ultimate tensile strength of steel fu = 630 MPa [91 ksi] & Minimum ultimate tensile strength of steel fu >= 340 MPa [49 ksi]; b) For Aluminum as base material, Minimum ultimate tensile strength of aluminum fu >= 270 MPa [39 ksi]; c) Minimum thickness of base material: refer to the Data Sheet; d) Maximum thickness of base material: no limits. 2) In general, type approved S-BT fasteners are NOT to be used for the following: a) Shell plating (i.e. bottom plating, side plating, main deck plating); b) Tank Boundaries c) Watertight boundaries where through penetration of the base materials is required; d) Fire rated boundaries other than A6; e) Structural members which require fatigue design; f) Members with significant thermal stresses; g) Highly stressed structural members 3) On Watertight bulkheads or decks (decks other than main deck or strength deck), the installation shall be to a doubler plate, with no through penetration, welded onto the bulkhead/deck plating. 4) Hilti fasteners often may be used for the listed applications by following the Manufacturer’s recommendations and guidance. The attending Surveyor and Owner are to be consulted and agree with the use of the fasteners; 5) Hilti fasteners may also be used for additional applications other than those listed above. Some applications may require an engineering review in advance. 6) Structural members that are sensitive to stress patterns or variations and in areas where notch toughness is of paramount importance, the curve class S-BT (as per specification binder) applies for fatigue design for base materials of thickness >= 4mm and yield strength ranging from 235 MPa to 355 MPa at an edge distance >= 15 mm. 7) Only the S-BT-ER & S-BT-EF models are to be used for grounding and bonding equipment. 8) Models X-FCM-R and X-FCM-M are to be used in association with S-BT-GR & S-BT-GF models only.

Comments: The Manufacturer has provided a declaration about the control of, or the lack of Asbestos in this product. In general, the Hilti S-BT fasteners may be used to fasten materials in areas where welding or drilling for bolting is permissible e. g. gratings, installation channels, installation rails, junction boxes and lighting, control panels, cable trays, cable channels. It is recommended that fasteners be installed no closer than 6 mm [0.24”] from the edge of a flange or cutout and no closer than 15 mm [0.71”] between fasteners. The following additional guidance is provided for applications on ship structures: 1) Acceptable applications: a) The securing of grating panels for S-BT-GF & S-BT-GR models along with X-FCM-R or X-CFM-M; b) The securing of checker plate; c) The securing of electrical cable trays; d) The securing of electrical cable clips; e) The securing of joiner bulkhead tracks to plating in deck modules; f) The securing of light duty fixtures and light hangers; g)
Securing of items (a-f) above in A0 fire rated divisions; h) The securing of wall panel struts; i) The securing of exterior and interior outfitting; j) The security of safety equipment; k) Use of S-BT-EF & S-BT-ER models as grounding and bonding equipment. 2) Acceptable locations: a) Locations other than those listed in "Service Restrictions". Some example of acceptable locations are as follows, provided they do not have "Service Restriction" applicability: i) Platform decks & flats ii) Non-tight bulkheads iii) Lower decks iv) Transverse side frames v) Superstructure & Deckhouse bulkheads vi) Topside Deck members and plating vii) Deck modules viii) Longitudinal and Transverse Frames of hulls ix) A-0 Fire rated boundaries 3) The fasteners may also be used for applications other than those listed above, where special care is recommended by following the manufacturer's recommendation, such as hangers for pipe systems with high thermal stresses and sprinkler systems. Such applications must be to the satisfaction of the attending surveyor. 4) The intended use comprises connections for indoor (mainly the carbon steel fasteners) and outdoor applications (mainly the stainless steel fasteners) with predominantly static loads (e.g. dead loads). 5) ABS approvals are general based on the product test reports furnished by recognized institutions and laboratories which may reflect specific local conditions. If any application is in a jurisdiction where the fasteners are subject to the approval process or specific guidelines are to be followed, the approved technical data or design guidelines take precedence over technical data presented herein. The arrangement and details of each vessel-specific installation are to be reviewed to ABS Rules as applicable.

Notes / Documentation:

- S-BT screw-in stainless steel and carbon steel threaded studs Product Data, Revision:-, Pages: 8
- S-BT-ER and S-BT-EF screw-in stainless steel and carbon steel threaded studs for electrical connections Product Data, Revision:-, Pages:7

Term of Validity:

This Product Design Assessment (PDA) Certificate 16-HS1550085-1-PDA, dated 19/Jan/2018 remains valid until 18/Sep/2021 or until the Rules or specifications used in the assessment are revised (whichever occurs first). This PDA is intended for a product to be installed on an ABS classed vessel, MODU or facility which is in existence or under contract for construction on the date of the ABS Rules or specifications used to evaluate the Product. Use of the Product on an ABS classed vessel, MODU or facility which is contracted after the validity date of the ABS Rules and specifications used to evaluate the Product, will require re-evaluation of the PDA. Use of the Product for non ABS classed vessels, MODUs or facilities is to be to an agreement between the manufacturer and intended client.

ABS Rules:


National Standards:

Certificate Number: 16-HS1550085-1-PDA

ABS has used due diligence in the preparation of this certificate and it represents the information on the product in the ABS Records as of the date and time the certificate was printed. Type Approval requires Drawing Assessment, Prototype Testing and assessment of the manufacturer's quality assurance and quality control arrangements. Limited circumstances may allow only Prototype Testing to satisfy Type Approval. The approvals of Drawings and Products remain valid as long as the ABS Rule, to which they were assessed, remains valid. ABS cautions manufacturers to review and maintain compliance with all other specifications to which the product may have been assessed. Further, unless it is specifically indicated in the description of the product, Type Approval does not necessarily waive witnessed inspection or survey procedures (where otherwise required) for products to be used in a vessel, MODU or facility intended to be ABS classed or that is presently in class with ABS. Questions regarding the validity of ABS Rules or the need for supplemental testing or inspection of such products should, in all cases, be addressed to ABS.

Government Authority:
EUMED:
Others: Manufacturer's Standards

<table>
<thead>
<tr>
<th>Model Certificate</th>
<th>Model Certificate No</th>
<th>Issue Date</th>
<th>Expiry Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDA</td>
<td>16-HS1550085-1-PDA</td>
<td>02-MAR-2018</td>
<td>18-SEP-2021</td>
</tr>
</tbody>
</table>

ABS Programs
Type Approval Certificate Extension

This is to certify that Certificate No. 16/00063 for the undernoted products is extended and renumbered as shown.

This certificate is issued to:

PRODUCER: Hilti Corporation

PLACE OF PRODUCTION: Feldkircherstrasse 100
4494 Schaan
Principality of Liechtenstein

DESCRIPTION: Hilti S-BT mechanical fastening system, comprising Hilti fastening tool & drill bit.

TYPE: Hilti S-BT screw-in stainless steel and carbon steel threaded studs.

- S-BT-MR M10/15 SN 6
- S-BT-MR M10/15 SN 6 AL
- S-BT-MR W10/15 SN 6
- S-BT-MR M10/15 SN 6 AL
- S-BT-MF M10/15 AN 6
- S-BT-MF W10/15 AN 6
- S-BT-MR M10/15 SN 5
- S-BT-MR W10/15 SN 5
- S-BT-MR M8/15 SN 6
- S-BT-MR M8/15 SN 6 AL
- S-BT-MR M8/15 AN 6
- S-BT-MR M8/7 SN 6
- S-BT-MR M8/7 SN 6 AL

Certificate No.: 16/00063(E1)

Issue Date: 13 March 2018

Expiry Date: 7 September 2021

Sheet: 1 of 3

Lloyd's Register EMEA
71 Fenchurch Street, London EC3M 4BS

Lloyd's Register EMEA
is a subsidiary of Lloyd's Register Group Limited. Its affiliates and subsidiaries and their respective officers, employees or agents are individually and collectively, referred to in the clauses as the "Lloyd's Register". Lloyd's Register is not responsible and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or otherwise provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.
S-BT-GR MB/7 SN 6
S-BT-GR MB/7 SN 6 AL
S-BT-MF MB/15 AN 6
S-BT-MF MB/7 AN 6
S-BT-GP MB/7 AN 6
S-BT-MR MB/15 SN 5
S-BT-MR MB/7 SN 5
S-BT-GR MB/7 SN 5

Composite Fasteners

X-PCM
X-PCM-M
X-PCM-R

APPLICATION
Fastenings in marine, offshore and industrial environments.

STANDARD
Hilti SF Development Report XSM/Se-01-16
Hilti SF Development Report XSM/Se-01-17
Hilti S-BT screw-in threaded studs - Specification binder” (Edition 08/2017)

OTHER CONDITIONS
The minimum strength of the base material must be as stated in the Hilti S-BT Threaded Fastener Specification.

The end user must ensure that the base and fastened materials possess adequate corrosion resistance for the environments in which they are to be used.

Certificate No. 16/00063(E1)
Issue Date 13 March 2018
Expiry Date 7 September 2021
Sheet 2 of 3

Lloyd's Register EMEA
71 Fenchurch Street, London EC3M 4BS
S-BT Screw-in threaded studs

For use on LR Classed ships, the locations and systems for which they are to be used are to be to the satisfaction of the attending surveyor.


"This Certificate is not valid for equipment, the design, ratings or operating parameters of which have been varied from the specimens tested. The manufacturer should notify Lloyd’s Register EMEA of any modifications or changes to the equipment in order to obtain a valid certificate."

The attached Design Approval Document No. UK/TSQ/3128661/ENG/TA and its supplementary Type Approval Terms and Conditions form part of this Certificate.

All other details remain as the previous Certificate No. 16/00063 to which this extension should be attached.

Certificate No. 16/00063(E1)

Issue Date 13 March 2018

Expiry Date 7 September 2021

Sheet 3 of 3

Lloyd’s Register EMEA

71 Fenchurch Street, London EC3M 4BS
This is to certify:

That the Structural Connecting Elements

with type designation(s)

HILTI S-BT FASTENING SYSTEM SCREW-IN THREADED STUDS

Issued to

Hilti AG
Schaan, Liechtenstein

is found to comply with

ISO/TR 14345:2012 Fatigue – Fatigue testing of welded components – Guidance
ISO 16701:2015 Corrosion of metals and alloys – Corrosion in artificial atmosphere – Accelerated corrosion test involving exposure under controlled conditions of humidity cycling and intermittent spraying of a salt solution
ISO 9227:2017 Corrosion tests in artificial atmospheres – Salt spray tests
IEC 62561-1:2017 Lightning protection system components (LPSC) – Part 1: Requirements for connection components
IEC 60947-7-1:2009 Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors
IEC 60947-7-2:2009 Low-voltage switchgear and controlgear – Part 7-2: Ancillary equipment – Protective conductor terminal blocks for copper conductors

Application:
The HILTI S-BT fastening system is type examined for installation on board ships and other structures classed by DNV GL.

Issued at Hamburg on 2018-01-31

This Certificate is valid until 2023-01-30.

DNV GL local station: Augsburg

Approval Engineer: Christian Kaemmer

Olaf Drews
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.

The validity date relates to the Type Examination Certificate and not to the approval of equipment/systems installed.
Product description

The S-BT fasteners are threaded studs manufactured from hardened carbon steel and austenitic-ferritic (Duplex) stainless steel 1.4462 acc. DIN-EN 10088-1 (AISI 316 SS equivalent). The S-BT threaded studs are fasteners with male threads (metric or inch) for attachment on one end and a threaded tip on the other end. All studs are supplied with a sealing washer. The S-BT fastener will be screwed in into a pre-drilled hole. The screw is tapping its own internal mating threads when installed into steel material. For drilling the hole into the base material a special stepped drill bit is needed to guarantee an accurately defined hole in terms of borehole depth and diameter.

The metallic sealing washer with a sealing ring made of chloroprene rubber CR 3.1107 offers weather resistant fastenings against moisture or condensation. The washer seals the hole to prevent moisture from dripping into the fastener threads. The sealing washer also prevents the base material from corrosion around the drilled hole.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
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<tbody>
<tr>
<td>S-BT-MR M10/15 SN 6</td>
<td>Stainless steel threaded stud M10 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 6 AL</td>
<td>Stainless steel threaded stud M10 with sealing washer, for base material aluminum</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>Stainless steel threaded stud W10 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6 AL</td>
<td>Stainless steel threaded stud W10 with sealing washer, for base material aluminum</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td>Carbon steel threaded stud M10 with sealing washer</td>
<td>Multipurpose</td>
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<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>Carbon steel threaded stud W10 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M10/15 SN 5</td>
<td>Stainless steel threaded stud M10 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 5</td>
<td>Stainless steel threaded stud W10 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6 AL</td>
<td>Stainless steel threaded stud M8 with sealing washer, for base material aluminum</td>
<td>Multipurpose</td>
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<tr>
<td>S-BT-MR M8/7 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 6 AL</td>
<td>Stainless steel threaded stud M8 with sealing washer, for base material aluminum</td>
<td>Multipurpose</td>
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<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
<td>Grating</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6 AL</td>
<td>Stainless steel threaded stud M8 with sealing washer, for base material aluminum</td>
<td>Grating</td>
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<td>S-BT-MF M8/15 AN 6</td>
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<td>S-BT-MF M8/7 AN 6</td>
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<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>Carbon steel threaded stud M8 with sealing washer</td>
<td>Grating</td>
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</tbody>
</table>
### Material specification S-BT fasteners:

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<td>S-BT-GR M8/7 SN 5</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
<td>Grating</td>
</tr>
<tr>
<td>S-BT-ER M10/15 SN 6</td>
<td>Stainless steel threaded stud M10 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>S-BT-ER W10/15 SN 6</td>
<td>Stainless steel threaded stud W10 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>S-BT-EF M10/15 AN 6</td>
<td>Carbon steel threaded stud M10 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>S-BT-EF W10/15 AN 6</td>
<td>Carbon steel threaded stud W10 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>S-BT-ER M8/15 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>S-BT-EF M8/15 AN 6</td>
<td>Carbon steel threaded stud M8 with sealing washer and grounding equipment kit</td>
<td>Electrical Connection</td>
</tr>
<tr>
<td>X-FCM-M</td>
<td>Grating fastener, carbon steel, duplex coated</td>
<td>Grating</td>
</tr>
<tr>
<td>X-FCM-R</td>
<td>Grating fastener, stainless steel</td>
<td>Grating</td>
</tr>
</tbody>
</table>

**Material specification Washer:**

- **Upper part:** metric or inch thread with a HEX head 6.35 (1/4") for M10 / W10 and HEX 5.3 (0.21") for M8
- **Lower part:** tapping screw thread
- **Material:**
  - S-BT stainless steel: stainless steel 1.4462 acc. DIN-EN 10088-1 (AISI 316 SS equivalent), zinc-coated
  - S-BT carbon steel: carbon steel 1038, duplex-coating Zn-alloy & top coat

**Material specification grating disk:**

- **Grating disk X-FCM-R**
  - Disc: Stainless steel X2CrNiMo18-14-3, X2CrNiMo17-12-2
  - Threaded stem: Stainless steel X2CrNiMo17-13-2, X5CrNiMo17-12-2, X6CrNiMoTi17-12-2

- **Grating disk X-FCM-M**
  - Disc: Cold rolled carbon steel DC04 to EN 10130
  - Threaded stem: Bright (free cutting) steel 11SMnPb30+C to EN 10277.
  - Disk and threaded stem duplex-coated.
Application/Limitation

ALUMINUM / CARBON STEEL BASE MATERIAL

The HILTI S-BT Fastening System is type examined for fastening various materials to base metals of carbon steel and aluminum on board ships and other structures classed by DNV GL as follows:

- Metal and fiberglass gratings to steel and aluminum
- Cable, conduit and tubing connectors to steel and aluminum
- Trays, channels and struts to steel and aluminum for cable, conduit and tubing runs
- Instrumentation, junction boxes, lighting
- Pipe hangers
- Signage
- Door frames
- Mounting cabinets, securing furniture, utensils, etc.
- Grounding and bonding equipment (e.g. for equipment, pipe flanges, storage tanks, junction boxes etc.)

The fasteners may also be used for applications other than those listed above, subject to special consideration either by the local DNV GL Surveyor.

The base material is limited to steel grade with a maximum ultimate tensile strength $f_u = 630$ MPa (91ksi). The minimum ultimate tensile strength of steel is $f_u \geq 340$ MPa (49 ksi). The minimum ultimate tensile strength of aluminum is $f_u \geq 270$ MPa (39 ksi).

In general the installation of the fasteners may be carried out in areas where drilling for bolting is permissible. Fasteners are not be installed closer than 6 mm (0.236") from the edge of a flange or cutout and closer than 18 mm (0.709") between fasteners.

FATIGUE DESIGN to CARBON STEEL BASE MATERIAL

The S-BT fasteners are type examined to be used on structural members made from carbon steel that require fatigue verification. Fatigue verification of structural members in ship structures has to be made in compliance with DNVGL RP-C203.

For fatigue verification the fatigue S-N curve "S-BT", as described in the "Hilti S-BT screw-in threaded studs-Specification binder ", shall be used. This curve applies for base material thickness $\geq 3$ mm, edge distance $\geq 15$ mm. This is applicable for structural steel grades with nominal yield strength ranging from 235 MPa to 355 MPa.

Other constructions which require fatigue verification are to be made in compliance with Eurocode 3 (EN 1993-1-9: Eurocode 3: Design of Steel structures – Part 1.9 (Fatigue). For Fatigue verification of normal stresses the detail category 100 (m=5) acc. to EN 1993-1-9 applies.

Description of constructional detail:
Hilti S-BT screw-in stainless and carbon steel threaded studs with pre-drilled hole in structural steel base material.
Requirement / Limitation

The nominal stress range [N/mm²] is to be calculated by the gross cross-section fulfilling the requirements of the nominal stress approach.

| Plate thickness: | t>3 [mm] |
| Minimum edge distance: | 15 [mm] |
| Minimum spacing of fasteners: | 18 [mm] |

Structural steel grades: S235 up to S355 grades acc. to EN 10025-2, EN 10025-3 and EN 10225.

The S-BT fastening system is to be observed in view of the project specific static and dynamic load in conjunction with the latest product data sheets.

COMPONENTS OF S-BT FASTENING SYSTEM

Drilling tool

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF BT 22-A (B22/2.6 or 5.2Ah)</td>
<td>Drilling tool for Europe, Asia</td>
<td>Drilling</td>
</tr>
<tr>
<td>SF BT 18-A (B18/2.6 or 5.2Ah)</td>
<td>Drilling tool for HNA</td>
<td>Drilling</td>
</tr>
<tr>
<td>SBT 4-A22 (B22/2.6 or 5.2Ah)</td>
<td>Drilling tool</td>
<td>Drilling, setting, nut fastening</td>
</tr>
</tbody>
</table>

Stepped drill bit

<table>
<thead>
<tr>
<th>Designation</th>
<th>Item Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS-BT 4.3-74 S</td>
<td>Stepped drill bit</td>
<td>Drilling in steel</td>
</tr>
<tr>
<td>TS-BT 5.5-74 S</td>
<td>Stepped drill bit</td>
<td>Drilling in steel</td>
</tr>
<tr>
<td>TS-BT 5.5-74 AL</td>
<td>Stepped drill bit</td>
<td>Drilling in aluminium</td>
</tr>
</tbody>
</table>

The S-BT fasteners are not to be used for the following locations:

- For attachment of structural fire protection insulation
- On bulkheads and decks with a thickness less than 5 mm (0.20”), if through penetration of the base material is not accepted. If through penetration is accepted, the base material thickness can be reduced to minimum 3 mm (load reductions according to “Hilti S-BT screw-in threaded studs – Specification binder)
- On the shell plating, sea chests and collision bulkheads

The selection of the HILT S-BT Fastening System for the corresponding application and the proper assembly are to be in accordance with the instructions of the manufacturer.

Type Examination documentation

- EVALUATION REPORT ON S-BT THREADED STUDS, HTL RANKWEIL, Hilti-Report XSMSse-01-16, dated: 2016-02-12
- EVALUATION REPORT ON S-BT THREADED STUDS, Hilti-Report XSMSse-01-16 S-BT, dated: 2016-02-19
- Manufacturing Drawing Carbon 01 – Carbon 05, Stainless 01 – 03, Hilti-Report XSMSse-01-16, dated: 2016-02-12
- Hilti Direct Fastening Technology Manual, X-FCM grating fastening system data sheet, dated 2017-12


MPA Dresden: Test Report No. 20170384, MPA Dresden GmbH – IMO Recognized Test Laboratory, Dresden (D), July 20th, 2017

MPA Dresden: Test Report No. 20161614, MPA Dresden GmbH – IMO Recognized Test Laboratory, Dresden (D), July 21th, 2017

MPA Dresden: Test Report No. 20161614/01, MPA Dresden GmbH – IMO Recognized Test Laboratory, Dresden (D), August 3rd, 2017

Tests carried out

- Documentation of tests performed forming the basis for this type examination are referenced in the list above.
- DNV GL Ref.-No. 11-069328, 12-004312, 15-056411, 15-067232, 15-073637

Marking of product

For traceability to this type examination the products are to be marked with:
- Manufacturers name or trade mark
- Type designation

Certificate Retention Survey

For retention of the type examination certificate periodical assessments shall be carried out at production places by DNVGL surveyor. The objective of the periodical assessment is to verify that the design and production conditions for the type examination have not been altered.

Main scope of the assessment:
- verification of the production and quality control system
- review of quality control documentation of recent deliveries
- review of drawings in production to verify any design changes which may have an impact on data specified in the type approval certificate, performance and range of application
- verification of the product marking

Periodical assessment is to be performed after 2 years and after 3.5 years. A renewal assessment will be performed at renewal of the certificate.
7.4 Russian Maritime Register of Shipping

Hilti Aktiengesellschaft
Feldkircherstrasse 100, 9494 Schaan, Liechtenstein.

Mechanical fastening systems of S-BT and X-FCM types.

Code of nomenclature: 11210000

This Type Approval Certificate is valid until 07.11.2021

This Type Approval Certificate becomes invalid in cases stipulated in Rules for the Technical Supervision during Construction of Ships and Manufacture of Shipbuilding Materials and Products.
Technical data

The S-BT series of screw-in threaded studs, designed for use inertial environments, is characterized by high reliability and long life due to the use of corrosion-resistant materials and high-quality manufacturing processes. The studs are made of stainless steel and are designed to meet the requirements of various industries, including aerospace and defense. The series includes a range of sizes and types, allowing for flexibility in applications.

Specifications

- Material: Stainless steel
- Thread type: Screw-in threaded studs
- Thread size: Various sizes available
- Nominal diameter: 10 mm
- Pitch: 1.75 mm
- Thread length: 15 mm
- Head size: 8 mm
- Head style: Hexagonal
- Finish: Polished

The S-BT series is ideal for applications requiring high reliability and durability, such as in high-temperature or high-vibration environments. The studs are also suitable for use in applications where corrosion resistance is a critical factor.
TYPE APPROVAL CERTIFICATE

This certificate is issued to
Hilti Aktiengesellschaft
SCHAAN - LIECHTENSTEIN

for the type of product
MECHANICAL FASTENING SYSTEM
HILTI S-BT MECHANICAL FASTENING SYSTEM

Requirements:
BUREAU VERITAS Rules for the Classification of Steel Ships
BUREAU VERITAS Rules for the Classification of Offshore Units
BUREAU VERITAS Rules for the Classification of Naval Ships
BUREAU VERITAS Rules for the Classification of Yachts

This certificate is issued to attest that Bureau Veritas Marine & Offshore did undertake the relevant approval procedures for the product identified above which was found to comply with the relevant requirements mentioned above.

This certificate will expire on: 20 Apr 2021

For Bureau Veritas Marine & Offshore,
At BV OHMVERS, on 13 Nov 2017,
Aditus Deere

This certificate remains valid until the date stated above, unless cancelled or revoked, provided the conditions stated in the subsequence page(s) are complied with and the product remains satisfactory in service. This certificate will not be valid if the applicant makes any changes or modifications to the approved product, which have not been notified to, and agreed in writing with Bureau Veritas Marine & Offshore. Should the specified regulations or standards be amended during the validity of this certificate, the product(s) will be re-approved prior to listing being placed on board vessels to which the amended regulations or standards apply. This certificate is issued within the scope of the General Conditions of Bureau Veritas Marine & Offshore available on the internet site www.veristar.com. Any person not a party to the contract pursuant to which this document is delivered may not assign a claim against Bureau Veritas Marine & Offshore for any liability, arising out of errors or omissions which may be contained in said document, or for errors of judgement, fact or negligence committed by personnel of the Society or of its Agents in establishment or issuance of this document, and in connection with any activities for which it may provide.

The electronic version is available at: http://www.veristar.com/veristarjx/np/viewPublicPdfType.jsp?id=177257
BV Mod. Ad.E 530 June 2017

This certificate consists of 5 page(s)
THE SCHEDULE OF APPROVAL

1. PRODUCT DESCRIPTION:

The Hilti S-BT fasteners are threaded studs manufactured from hardened carbon steel 1038 and austenitic-ferritic (Duplex) stainless steel 1.4462. The S-BT threaded studs are fasteners with made threads (metric M8 and M10 or inch W10) for attachment on one end and a threaded tip on the other end for embedment into the structural steel or aluminum. Carbon steel studs are supplied with an aluminum sealing washer Ø 10 mm, stainless steel studs are supplied with a stainless steel sealing washer Ø 12 mm, both with an EPDM sealing ring. Fastenings are made by screwing in the S-BT stud in a predrilled pilot hole (without penetration of the base material) or a drill through hole. The Hilti S-BT mechanical fastening system comprises the Hilti drilling tool, Hilti step drill bit, setting tool, depth gauge, screw-in stainless steel and carbon steel threaded studs S-BT and accessories.

Identification of Components:

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<tr>
<td>S-BT-MR M8/7 SN 5</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
</tr>
<tr>
<td>S-BT-MR M8/7 SN 5</td>
<td>Stainless steel threaded stud M8 with sealing washer</td>
</tr>
<tr>
<td>S-BT-MR ER M10/15 SN 6</td>
<td>Stainless steel threaded stud M10 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>S-BT-MR ER W10/15 SN 6</td>
<td>Stainless steel threaded stud W10 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>S-BT-MF M10/15 AN 6</td>
<td>Carbon steel threaded stud M10 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>Carbon steel threaded stud W10 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>S-BT-MR M8/15 SN 6</td>
<td>Stainless steel threaded stud M8 with sealing washer for electrical connections</td>
</tr>
<tr>
<td>X-FCM</td>
<td>Grating fastener, carbon steel, zinc plated</td>
</tr>
<tr>
<td>X-FCM-M</td>
<td>Grating fastener, carbon steel, duplex coated</td>
</tr>
<tr>
<td>X-FCM-R</td>
<td>Grating fastener, stainless steel</td>
</tr>
</tbody>
</table>

2. DOCUMENTS AND DRAWINGS:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Revision / Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilti Direct Fastening Technology Manual – S-BT product pages</td>
<td>08/2017</td>
</tr>
<tr>
<td>Hilti S-BT screw-in threaded studs – Specifications basis</td>
<td>08/2017</td>
</tr>
</tbody>
</table>


BV Mod. Ad. E 530 June 2017

This certificate consists of 5 page(s)
3. TEST REPORTS:

According to the following tests:
- Test report no. 279/15 at HTL Rankweil, Bautechnische Versuchsanstalt/AUSTRIA dd. February 12th, 2016
- Report no. TM-144/14 at Hilti AG / Liechtenstein dd. Oct 07 2015
- Investigation report 903 0150 0003F at MPA University of Stuttgart / GERMANY dd. 14.09.2015
- Test report no. 5214011585/e at Empa Dübendorf / SWITZERLAND dd. April 26th, 2016
- Test report no. 5214013022/e.cor at Empa Dübendorf / SWITZERLAND dd. June 29th, 2017
- Test report no. 5214014401/e at Empa Dübendorf / SWITZERLAND dd. April 11th, 2017
- Test report no. 20170384 at MPA Dresden / GERMANY dd. 2017-07-20
- Test report no. 20161614 at MPA Dresden / GERMANY dd. 2017-07-21
- Test report no. 20161614 at MPA Dresden / GERMANY dd. 2017-08-03
- Test report no. FRM-1648 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 21 March 2017
- Test report no. FRM-1649 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 21 March 2017
- Test report no. FRM-1650 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 21 March 2017
- Test notes no. FRM-1651 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 21 March 2017
- Test notes no. FRM-1652 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 21 March 2017
- Test report no. FRM-1658 at DEHN + SOHNE GmbH + Co KG, Neumarkt / GERMANY dd. 30 June 2017
- Report no. 17.IK-0093.502 at Electromesse, Forschung / SWITZERLAND dd. 14/07/2017
- Report no. 16.IK-0021.502 Annex at Electromesse, Forschung / SWITZERLAND dd. 30/06/2017
- Report no. XSM/2017-01-17 at Hilti AG / Liechtenstein dd. September 18, 2017

4. APPLICATION / LIMITATION:

4.1 The mechanical fastening system is intended for fastening applications in shipbuilding, offshore and crane structures as far as the BUREAU VERITAS Rules are complied with:
- Metal and fibreglass grating
- Cable, conduit and tubing connectors
- Trays, channels and struts for cable, conduit and tubing runs
- Instrumentation, junction boxes, lighting
- Pipe hangers
- Signage
- Door frames
- Mounting cabinets, securing furniture, utensils, etc.
- Earthling (Grounding), bonding (e.g. for equipment, pipe flanges, storage tanks, junction boxes etc.) to coated steel and to structural steel according to EN 10025 (S235, S275, S355).

4.2 The thickness of the base material is 3 mm ≤ t ≤ 6 mm (steel) and 5 mm ≤ t ≤ 6 mm (aluminium) for pre-drilled through holes and t ≥ 6 mm (steel and aluminium) for fasteners intended to be set in pre-drilled pilot holes.

4.3 The thickness of the fastened material is for the S-BT M8 studs ≤ 7 mm and ≤ 15 mm respectively and for the S-BT M10 / S-BT W10 ≤ 15 mm.

4.4 The minimum distance to the edge of a flange or cutout is not to be less than 6 mm and the minimum spacing between fasteners is not to be less than 18 mm for all S-BT M8 and 22 mm for all S-BT M10 / S-BT W10.

4.5 The minimum tensile strength of the steel base material is not to be less than 340 N/mm² and not to be less than 270 N/mm² for aluminium base material. The maximum tensile strength of the steel base material is not to be more than 630 N/mm².

4.6 No limits with regards to the thickness of the base material.

4.7 The S-BT fastening system may be used in areas where drilling into the base material is permissible.

4.8 The maximum tightening torque of grating dice or nut fitted to the threaded fastener is not to be more than 5 Nm (steel base material thickness 3 mm ≤ t ≤ 6 mm and aluminium) and not to be more than 8 Nm for steel base material thickness t ≥ 6 mm.
4.9 The S-BT fasteners are allowed to be used on structural members made from carbon steel that require fatigue verification. Fatigue verification of structural members in ship structures has to be made with the corresponding BUREAU VERITAS Rules and is subject to special consideration of BUREAU VERITAS. Fatigue verification of crane-structures are to be made in compliance with Eurocode 3 (EN 1993-1-9; Eurocode 3: Design of Steel Structures – Part 1.9: Fatigue). For fatigue verification of normal stresses the detail category 100 (nr–5) according to EN 1993-1-9 applies. 

Description of constructional detail:
Hilti S-BT screw-in stainless and carbon steel threaded studs with pre-drilled hole in structural steel base material.

Imperfect fastener installations as e.g. overwound or pulled-out fasteners are covered.
The nominal stress range [N/mm²] is to be calculated by the gross cross-section fulfilling the requirements of the nominal stress approach.
Plate thickness: ≤ 3 mm, minimum edge distance: 15 mm, minimum spacing of fasteners: 18 mm, structural steel grades: S235 up to S355 grades according to EN 10025-2, EN 10025-3 and EN 10225

For fatigue verification in compliance with BUREAU VERITAS, the fatigue S-N curve “S-BT”, as described in the “Hilti S-BT screw-in threaded studs – Specification binder”, shall be used. This curve applies for base material thickness ≥ 3 mm, edge distance ≥ 15 mm. This is applicable for structural steel grades with nominal yield strength ranging from 235 MPa to 355 MPa.

4.10 The manufacturer’s assembly instructions and recommendations are to be complied with.

5.0 PRODUCTION SURVEY REQUIREMENTS:

5.1 The mechanical fastening systems are to be supplied by the manufacturer in compliance with the type described in this certificate.

5.2 This type of product is within the category IBV of BUREAU VERITAS Rule Note NR320.

5.3 Hilti Aktiengesellschaft has to make the necessary arrangements to have its works recognised by BUREAU VERITAS in compliance with the requirements of NR320 for IBV products:
Hilti Plant 1
Feldkircherstrasse 100
PO Box 333
FL-94984 Schaan
Liechtenstein
and
Presitec s.r.o.
Pavel Studené 7
74221 Kopřivnice
Czech Republic

The accessory, the grating fastener X-FCM, X-FCM-M and X-FCM-R, are manufactured at the following production sites:
WP-Wiegartner Productions GmbH
Bahnhofstraße 21
A-6372 Oberndorf
Austria

6.0 MARKING OF PRODUCT:
The mechanical fastening system should be clearly identified with:
- Manufacturer’s name or logo
- Type designation

7.0 OTHERS:

7.1 The mechanical fastening systems will be delivered with the relevant documentation/ user’s guide.
7.2 This approval is given on the understanding that the Society reserves the right to require check tests to be carried out on the units at any time and that Hilti Aktiengesellschaft, Schaan – Liechtenstein will accept full responsibility for informing shipbuilders, ship owners or their subcontractors of the proper methods of use and general maintenance of the units and the conditions of this approval.

7.3 This certificate supersedes the Type Approval Certificate N° 45116/A0 BV issued on 20 Apr 2016 by the Society.

*** END OF CERTIFICATE ***
7.6 International Code Council - Evaluation Service (ICC-ES)

ICH-ES Evaluation Report

ES

Most Widely Accepted and Trusted

 ICC-ES Evaluation Report

ES

7.6 International Code Council - Evaluation Service (ICC-ES)

S-BT Screw-in threaded studs

ES

S-BT Screw-in threaded studs

ES

S-BT Screw-in threaded studs

7.6 International Code Council - Evaluation Service (ICC-ES)

S-BT Screw-in threaded studs

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S-BT Screw-in threaded studs

ES

S-BT Screw-in threaded studs

7.6 International Code Council - Evaluation Service (ICC-ES)
DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

REPORT HOLDER:
HILTI, INC.
7250 DALLAS PARKWAY, SUITE 1000
PLANO, TEXAS 75024
(800) 879-8000
www.us.hilti.com
HILTITechnicalServices@hilti.com

EVALUATION SUBJECT:
HILTI S-BT SCREW-IN FASTENERS

1.0 EVALUATION SCOPE

Compliance with the following codes:
- 2018, 2015 and 2012 International Residential Code® (IRC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see ESR-4185 LARC and LARC Supplement.

Property evaluated:
Structural

2.0 USES

The Hilti S-BT Screw-in Fasteners are used to attach nonstructural components including architectural, mechanical, electrical and similar components, which are not part of the primary load-bearing or lateral-force-resisting systems, to a supporting steel substrate. The fasteners may be used for structures regulated under the IRC, when an engineered design is submitted in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 S-BT Screw-in Fasteners:

Hilti S-BT Screw-in Fasteners are self-tapping fasteners with a short, blunt threaded portion on one end for embedment into the supporting steel, and a standard thread along the majority of the shank for attachment of supported materials. A sealing washer with a chloroprene rubber (CR) sealing ring is premounted on the tapping end of the fastener. A serrated flange nut is supplied with S-BT Screw-in Fasteners for multipurpose fastenings (S-BT-M.). The S-BT Screw-in Fasteners for grating fastenings (S-BT-G.) are not supplied with serrated flange nuts and are intended for use in fastening grating.

The S-BT fasteners must be installed in a predrilled hole. See Table 1 for available fastener materials, thread designations and lengths. See Figure 1 for illustrations of the S-BT fasteners.

3.1.1 S-BT-MR and S-BT-GR Screw-in Fasteners: These fasteners are formed from stainless steel complying with the manufacturer's specification, with chemical composition of 1.5462 X2CrNiMoN22-5-3, and are zinc plated to facilitate installation. The premounted sealing washer has a diameter of 0.472 inch (12 mm) and is manufactured from SAE 316 stainless steel, bonded to the CR material (denoted by 'SN' in the product designation). Serrated flange nuts for the S-BT-MR fasteners are also manufactured from stainless steel.

3.1.2 S-BT-MF and S-BT-GF Screw-in Fasteners: These fasteners are formed from Grade 1038 carbon steel and have a duplex coating. The coating consists of an electropolished zinc alloy layer and a top coat, with a total coating thickness of 35 µm. The premounted sealing washer has a diameter of 0.394 inch (10 mm) and is manufactured from an aluminum-magnesium alloy, bonded to the CR material (denoted by 'AN' in the product designation). Serrated flange nuts for the S-BT-MF fasteners are manufactured from carbon steel with a hot-dipped galvanized coating.

3.2 Steel Substrates:

The supporting steel substrate must be structural steel complying with the minimum strength requirements of ASTM A58, ASTM A572 Grade 50 or ASTM A992, and must have the minimum thickness, yield strength and tensile strength shown in Tables 2 and 3, as applicable.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 Allowable Static Loads: The most critical applied loads, excluding seismic load effects, resulting from the load combinations in IBC Section 1605.3.1 or 1605.3.2 must not exceed the allowable loads shown in Tables 2 and 3, as applicable. For fasteners that are subjected to seismic loads, see Section 4.1.3 for additional information. The stress increases and load reductions described in IBC Section 1605.3 are not allowed.

Allowable shear loads and tension (pullout) loads in this report apply to the connection of the fastener to the supporting steel substrate only. Limit states such as pull-over and lateral bearing, which are governed by the
properties of attached materials, are outside the scope of this report. Design of the connection of the attached material to the steel substrate must take into account the properties of the attached material, accounting for interaction between the attached material, the screw-in fastener, and the steel substrate, and must comply with the applicable requirements of the IBC.

4.1.2 Combined Loading: For fasteners subjected to both tension and shear loads, compliance with the following interaction equation must be verified:

\[(p/p_s) + (v/v_s) \leq 1\]

where:
- \(p\) = Actual applied tension load on fastener, lbf (N).
- \(P_s\) = Allowable tension load on fastener, lbf (N).
- \(v\) = Actual applied shear load on fastener, lbf (N).
- \(V_s\) = Allowable shear load on fastener, lbf (N).

4.1.3 Seismic Considerations: The S-BT Screw-in Fasteners are recognized for use when subjected to seismic loads as follows:

1. The fasteners may be used for attachment of non-structural components listed in Section 13.1.4 of ASCE/SEI 7, which are exempt from the requirements of ASCE/SEI 7.
2. When the fasteners listed in Table 1 are installed in steel base materials and subjected to seismic loads, the most critical load applied to each individual fastener must be determined from the equations in IBC Section 1605.3.1 or Section 1605.3.2 which include seismic load effects, and must not exceed the allowable load shown in Table 2 or 3, as applicable.

4.2 Installation:
The S-BT Screw-In Fasteners must be installed in accordance with this report and the manufacturer's published installation instructions. A copy of these instructions must be available on the job site at all times during installation. The instructions shown in Figure 5 are abbreviated instructions and are shown for illustrative purposes only. Installation must be in accordance with the complete installation instructions which accompany the product.

Installation is limited to dry, interior locations, except for stainless steel fasteners, which may be installed in exterior or damp environments, provided the base material is protected from corrosion.

Fastener placement requires a predrilled hole. The hole must be drilled into, but not through, the steel substrate, or must be drilled all the way through the steel substrate, as indicated in Tables 2 and 3. See Figure 2 for an illustration of an S-BT fastener installed in a hole drilled into the steel and Figure 3 for an illustration of an S-BT fastener installed in a hole drilled through the steel. The hole must be drilled to the required depth with a Hilti TBM Drilled drilled bit and the Hilti SF BT or SBT 4-A22 cordless drill driver supplied by Hilti.

After the required hole is drilled, the fastener must be installed using a proper depth gauge and the Hilti SFC or SBT 4-A22 setting tool supplied by Hilti, Inc.

For S-BT-M fasteners, after installation of the supported material, the serrated flange must be screwed onto the fastener and tightened to the recommended torque (see Table 4) using a tool in accordance with Hilti, Inc. recommendations. The S-BT-M fasteners must be installed only with Hilti supplied serrated flange nuts.

For the S-BT-G fasteners, after installation of the supported grating, a grating disc or similar component must be installed, in accordance with the instructions supplied with this component.

Minimum spacing between fasteners must be 1 inch (25.4 mm) and minimum edge distance must be 1/2 inch (12.7 mm). The installed fasteners must have a stand-off dimension, hws, (defined in Figure 2), as stipulated in Table 1. Recommended spacing and edge distances apply to the fasteners installed in the steel base material. Greater spacing and edge distances may be needed due to requirements for the attached material.

5.0 CONDITIONS OF USE

The Hilti S-BT Screw-In Fasteners described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Fasteners must be manufactured and identified in accordance with this report.
5.2 Fasteners must be installed in accordance with this report and the Hilti, Inc., published installation instructions. In the event of conflict between this report and the Hilti, Inc., published instructions, the more restrictive requirements govern.
5.3 Calculations and details demonstrating compliance with the applicable codes and this report, including verifying that the applied loads are less than the allowable loads described in Section 4.1, must be submitted to the code official for approval. The calculations and details must be prepared by a registered design professional whose work is required by the statutes of the jurisdiction in which the project is constructed.
5.4 Stainless steel fasteners may be installed in exterior, damp environments. Use of carbon steel fasteners is limited to dry, interior locations, which include exterior walls which are protected by an exterior wall envelope.
5.5 If the fastener nut or attached materials are removed and replaced, proper thread engagement for the fastener must be reconfirmed in accordance with the Hilti installation instructions.
5.6 The Hilti products addressed in this report are manufactured under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Screw-In Fasteners Installed into Steel Elements (AC499) dated February 2018.

7.0 IDENTIFICATION

Packages of fasteners bear the product designation, the manufacturer's name (Hilti, Inc.), and the evaluation report number (ESR-4185). The stainless steel fasteners are imprinted with an "H" on the end of the fastener, and the carbon steel fasteners are imprinted with "H" on the end of the fastener, as shown in Figure 4.
### TABLE 1—5 BT SCREW-IN FASTENER DESCRIPTIONS

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>FASTENING THREAD DESIGNATION [inch (mm)]</th>
<th>NOMINAL FASTENING THREAD LENGTH [inch (mm)]</th>
<th>NOMINAL TAPPING THREAD LENGTH [inch (mm)]</th>
<th>MATERIAL</th>
<th>REQUIRED STAND-OFF, ( h_{req} ) [inch (mm)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>Metric 8 mm</td>
<td>0.67 (17.05)</td>
<td>0.23 (5.8)</td>
<td>Stainless Steel</td>
<td>0.732 – 0.752 (18.6 – 19.1)</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>UNC ( \frac{1}{4} )-inch</td>
<td>1.06 (27.75)</td>
<td>0.24 (6.15)</td>
<td>Carbon Steel</td>
<td>1.153 – 1.173 (29.3 – 29.8)</td>
</tr>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>Metric 8 mm</td>
<td>0.67 (17.05)</td>
<td>0.23 (5.8)</td>
<td>Carbon Steel</td>
<td>0.732 – 0.752 (18.6 – 19.1)</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>UNC ( \frac{1}{4} )-inch</td>
<td>1.06 (27.75)</td>
<td>0.24 (6.15)</td>
<td></td>
<td>1.153 – 1.173 (29.3 – 29.8)</td>
</tr>
</tbody>
</table>

For St: 1 inch = 25.4 mm.

1See Figure 2 for depiction of \( h_{req} \).

### TABLE 2—ALLOWABLE LOADS FOR 5 BT SCREW-IN FASTENERS INSTALLED INTO ASTM A36 STEEL (lbft)\(^{1,2} \)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>TAPPING THREAD DIAMETER (inch)</th>
<th>STEEL THICKNESS, ( t ) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1/8 ( \leq t \leq 1/4 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tension</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>0.23</td>
<td>225</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>0.23</td>
<td>225</td>
</tr>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
</tbody>
</table>

For St: 1 inch = 25.4 mm, 1 lb-ft = 4.4 N·m, 1 kN·m = 6.896 MPa.

1All allowable load capacities above are for installation into steel base material with a minimum yield strength \( (F_y) \) of 36 ksi and a minimum tensile strength \( (F_t) \) of 55 ksi.

2Allowable loads are applicable to static and seismic loads in accordance with Section 4.1.

3The predrilled hole must extend all the way through the steel base material, and the stand-off dimension, \( h_{req} \), must comply with Table 1.

4The predrilled hole must extend into the steel base material as far as the drill bit allows, and the stand-off dimension, \( h_{req} \), must comply with Table 1.

### TABLE 3—ALLOWABLE LOADS FOR 5 BT SCREW-IN FASTENERS INSTALLED INTO ASTM A572 STEEL (lbft)\(^{1,2} \)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>TAPPING THREAD DIAMETER (inch)</th>
<th>STEEL THICKNESS, ( t ) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1/8 ( \leq t \leq 1/4 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tension</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>0.23</td>
<td>295</td>
</tr>
</tbody>
</table>

For St: 1 inch = 25.4 mm, 1 lb-ft = 4.4 N·m, 1 kN·m = 6.896 MPa.

1All allowable load capacities above are for installation into steel base material with a minimum yield strength \( (F_y) \) of 50 ksi and a minimum tensile strength \( (F_t) \) of 65 ksi.

2Allowable loads are applicable to static and seismic loads in accordance with Section 4.1.

3The predrilled hole must extend all the way through the steel base material, and the stand-off dimension, \( h_{req} \), must comply with Table 1.

4The predrilled hole must extend into the steel base material as far as the drill bit allows, and the stand-off dimension, \( h_{req} \), must comply with Table 1.

### TABLE 4—RECOMMENDED TIGHTENING TORQUE ON SERRATED FLANGE NUT (lb·in)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>STEEL THICKNESS (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8 ( \leq t \leq 3/16 )</td>
<td>t ( \geq 3/16 )</td>
</tr>
<tr>
<td>S-BT-GR M8/7 SN 6</td>
<td>3.6</td>
</tr>
<tr>
<td>S-BT-MR W10/15 SN 6</td>
<td>3.6</td>
</tr>
<tr>
<td>S-BT-GF M8/7 AN 6</td>
<td>5.9</td>
</tr>
<tr>
<td>S-BT-MF W10/15 AN 6</td>
<td>5.9</td>
</tr>
</tbody>
</table>

For St: 1 inch = 25.4 mm, 1 lb-ft = 1.36 Nm.
**S-BT Screw-in threaded studs**

**FIGURE 1—HILTI S-BT SCREW-IN FASTENER WITH SEALING WASHER**

**FIGURE 2—DEPICTION OF STAND-OFF DIMENSION, *h*, AND HOLE DRILLED INTO STEEL BASE MATERIAL**

**FIGURE 3—DEPICTION OF HOLE DRILLED THROUGH STEEL BASE MATERIAL**

**FIGURE 4—DEPICTION OF IDENTIFYING MARKING "H" FOR HILTI S-BT SCREW-IN STAINLESS STEEL FASTENERS, "H" FOR HILTI S-BT SCREW-IN CARBON STEEL FASTENERS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mark location for each fastening</td>
</tr>
<tr>
<td>2</td>
<td>Pre-drill with TS-BT stopped drill bit</td>
</tr>
<tr>
<td>3</td>
<td>Screw S-BT fasteners into drilled hole</td>
</tr>
<tr>
<td>4</td>
<td>Attach material over the S-BT fastener</td>
</tr>
</tbody>
</table>

- Use an SBT 4-A22, SBT 10-A or SBT 22-A tool. Pre-drill until the shoulder grinds a shiny ring to ensure proper drilling depth, as shown below.
- The drilled hole and the area around the drilled hole must be clear of dust and debris. In the case of a hole through the steel, rework the coating on the back side of the plate/profile may be needed.
- Use an SBT 4-A22, SBT 10-A or SBT 22-A tool in combination with the calibrated depth gauge S-DG BT. Verify fastener stand-off dimension, *h*, with check gauge S-CG BT. Sealing washer must be properly compressed!
- Position attached item on S-BT fasteners and hold in place. Tighten the nuts using:
  - SBT 4-A22, SBT 10-A or SBT 22-A with socket S-NS
  - torque tool X-BT 1/2", 5.9 ft-lb (8 Nm)
  - S-BT 1/2", 3.6 ft-lb (5 Nm)
- Torque wrench

<table>
<thead>
<tr>
<th>Hilti screwdriver</th>
<th>Torque setting on tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>S-NS</td>
</tr>
<tr>
<td>5</td>
<td>S-NS</td>
</tr>
<tr>
<td>5</td>
<td>S-NS</td>
</tr>
<tr>
<td>5</td>
<td>S-NS</td>
</tr>
</tbody>
</table>

**FIGURE 5—ILLUSTRATIVE INSTALLATION INSTRUCTIONS FOR HILTI S-BT SCREW-IN FASTENERS**

Note: These are typical installation procedures shown for general understanding of the product. Specific installation procedures in the manufacturer's published installation instructions included with the product, must be followed.
ICC-ES Evaluation Report

ESR-4185 LABC and LARC Supplement

www.icc-es.org | (800) 423-6587 | (862) 699-0543

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DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

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EVALUATION SUBJECT:
HILTI S-BT SCREW-IN FASTENERS

1.0 REPORT PURPOSE AND SCOPE

Purpose:
The purpose of this evaluation report supplement is to indicate that the Hilti S-BT Screw-in Fasteners, described in ICC-ES master evaluation report ESR-4185, have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:
- 2017 City of Los Angeles Building Code (LABC)
- 2017 City of Los Angeles Residential Code (LARC)

2.0 CONCLUSIONS

The Hilti S-BT Screw-in Fasteners, described in Sections 2.0 through 7.0 of the master evaluation report ESR-4185, comply with the LABC Chapter 22, and the LARC, and are subject to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Hilti S-BT Screw-in Fasteners described in this evaluation report must comply with all of the following conditions:
- All applicable sections in the master evaluation report ESR-4185.
- The design, installation, conditions of use and identification of the Hilti S-BT Screw-in Fasteners are in accordance with the 2015 International Building Code® (2015 IBC) provisions noted in the master evaluation report ESR-4185.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable strength values listed in the master evaluation report and tables are for the connection of the screw-in fasteners to steel substrate. The connection between the screw-in fasteners and the attached building material must be checked for capacity (which may govern).

This supplement expires concurrently with the master report, issued June 2018.
DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

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EVALUATION SUBJECT:

HILTI S-BT SCREW-IN FASTENERS

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Applicable code editions:
- 2017 Florida Building Code—Building
- 2017 Florida Building Code—Residential

2.0 CONCLUSIONS

The Hilti S-BT Screw-in Fasteners, described in Sections 2.0 through 7.0 of the master evaluation report ESR-4185, are in compliance with the Florida Building Code—Building and the Florida Building Code—Residential, provided the design and installation are in accordance with the 2015 International Building Code provisions noted in the master report.

Use of the Hilti S-BT Screw-in Fasteners has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the Florida Building Code—Building and the Florida Building Code—Residential under the following conditions:

For products falling under Florida Rule 9N-3, verification that the report holder's quality-assurance program is audited by a quality-assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the master report, issued June 2018.