

HEICO-LOCK

Information for assembly



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1.) Inspection of the type of bolt parts for compatibility with HEICO-LOCK

The standard versions of HEICO-LOCK wedge lock washer pairs (WLW) must only be combined with bolts with metric ISO coarse thread (DIN 13) or UNC thread (ANSI B1.1) in the correct nominal sizes. For bolts with fine thread and other thread types, please contact us before use. Special designs of HEICO-LOCK WLW might be required.

In unfastened condition, the HEICO-WLW must make full-surface contact with the underside of the bolt head. The shaft or thread diameter and the radius at the transition zone between bolt head and bolt shaft, as well as the internal diameter of the HEICO-LOCK WLW must be taken into account.

Bolts and nuts made of carbon steel (strength categories acc. to DIN EN ISO 898-1: 8.8, 10.9 and 12.9 and < 8.8 or equal) are secured using HEICO-LOCK WLW made of heat-treated steel (Mat.No. 1.1191 acc. to EN 10027). Stainless steel bolting components (e. g. acc. to ISO 3506 A2-70 and A4-80 or equal) are secured using HEICO-LOCK stainless steel WLW (Mat.No. 1.4404 acc. to EN 10027).

The use of plain washers in combination with HEICO-LOCK WLW is generally not recommended. However, in case that installation of a plain washer is required, it must be fixed such that it cannot rotate around the bolt axis (i.e. by form-closed contact).

Info: If the HEICO-LOCK WLW is integrated on a non-fixed plain washer, the plain washer may turn on the mating material due to vibration so that the securing effect of the HEICO-LOCK WLW is eliminated.

Integration of additional securing elements or securing methods is superfluous (e.g. gluing of the thread for screw-in joints) and is not recommended.

Info: The securing function of the HEICO-LOCK WLW is based on the movement option between the wedge surfaces of the individual washers and the resulting impairment of the detachment process due to the wedging effect and/or the increase of tightening force in case of rotation of the bolt into the direction of detachment (cf. item 8). Additional locking measure for the thread would lever out the HEICO-LOCK WLW!

2.) Visual inspection of the bolting components and the HEICO-LOCK wedge lock washer

Are bolt and nut free from dirt?

Can the thread be easily turned in? Any damage at the thread (e.g. kinks, dents) does not interfere with turning in?

Info: Soiling and damage in the thread may increase the assembly torque and thus affect the assembly tightening force to be achieved! The same applies for painted threaded holes. If possible, cover threaded holes before painting.

For initial assembly, unused bolts should be used.

Info: With used bolts, technicians are mostly unaware of any previous mechanical loads or stresses. Often, previous damage is difficult to identify. Therefore, we recommend using new bolts!

Have the HEICO-LOCK wedge lock washers been glued in pairs? If this is not the case, make sure to insert the individual washers in the correct position. Wedge surfaces on the inside and radial fins on the outside (see Figure 1).

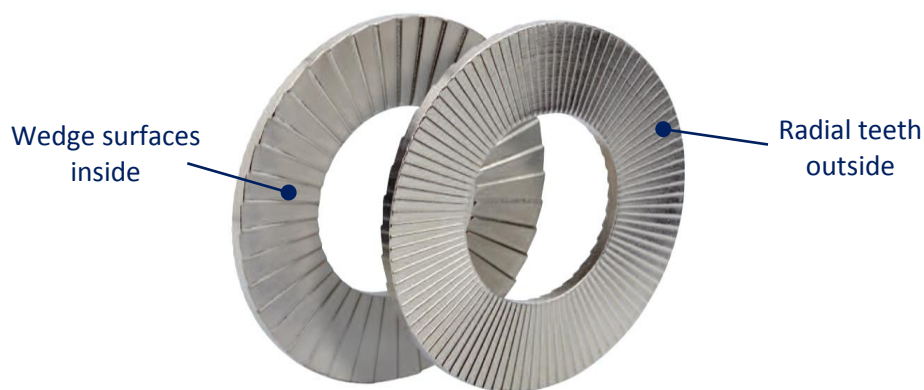


Figure 1: Orientation of the individual washers

Info: Addition of glue between the individual washers of HEICO-LOCK WLW ensures insertion of washers with correct orientation and does not have any effect on their securing function (cf. item 8).

3.) Ambient conditions

Depending on the ambient conditions, different materials are recommended for HEICO-LOCK WLW and the bolt parts.

For general application cases we recommend HEICO-LOCK wedge lock washers made of heat-treated steel (Mat.No. 1.1191 acc. to EN 10027) in combination with bolt parts made of steel with appropriate corrosion protection.

Info: HEICO-LOCK WLWs made of heat-treated steel are coated with zinc flake coating (f/znc 720 h acc. to ISO 10683), which provides appropriate corrosion protection under normal ambient conditions.

In acidic ambience, in case of contact with chemical substances, or in tap water we recommend using HEICO-LOCK WLW made of stainless steel. Resistance must be verified for individual cases.

If used in sea water or in off-shore areas, we recommend using HEICO-LOCK WLW made of 254 SMO® (Mat.No. 1.4547 acc. to EN 10027) or Inconel® 718 and/or Alloy 718 (Mat.No. 2.4668 acc. to EN 10027).

From application temperatures above 200°C, HEICO-LOCK WLW made of stainless steel (Mat.No. 1.4404 acc. to EN 10027) or SMO254 (Mat.No. 1.4547 acc. to EN 10027) must be used. For temperatures above 500°C, HEICO-LOCK WLW made of Inconel® 718 or Alloy 718 (Mat.No. 2.4668 acc. to EN 10027) are available and can be used in temperatures of up to 700°C. Evaluation of individual application cases may be required. Please contact us.

With very low ambient temperatures HEICO-LOCK WLW made of heat-treated steel (Mat.No. 1.1191 acc. to EN 10027) can be used up to temperatures as low as -40°C. For even lower application temperatures, we recommend using HEICO-LOCK WLW made of stainless steel (Mat.No. 1.4404 acc. to EN 10027), 254 SMO® (Mat.No. 1.4547 acc. to EN 10027), Inconel® 718 or Alloy 718 (Mat.No. 2.4668 acc. to EN 10027) suitable up to minimum application temperatures of -200°C. Evaluation of individual application cases may be required. Please contact us.

Info: It must always be ensured that also bolting components suitable for the respective ambient conditions are used. Bolting parts and HEICO-LOCK WLW used together should be made of similar materials. E.g. HEICO-LOCK made of heat-treated steel must be combined with steel bolting parts, and HEICO-LOCK made of stainless steel must be combined with stainless steel bolting parts. For high temperatures, the corresponding bolting parts must be made of heat-resistant or high-temperature resistant materials (DIN EN 10269 and DIN 267-29). For low temperatures, the corresponding bolting parts must be made of low-temperature resistant materials (DIN EN 10028, DIN EN 10222, DIN EN 10269 and DIN 267-29).

4.) Surface condition and surface hardness of fastened parts

In general, the surface of fastened parts, particularly the areas in contact with HEICO-LOCK WLW, must be free from coarse soiling and as even and smooth as possible before assembly.

With great paint or coat thicknesses (> 250 µm) the efficiency of HEICO-LOCK wedge lock washers must be verified by experiments. If possible, the bolt joint using HEICO-LOCK WLW should be fastened prior to painting or coating.

Info: With very thick surface coats, there is a risk that the radial teeth on the outside of the HEICO-LOCK WLW may not indent into the base material. Consequently, the securing effect of the HEICO-LOCK WLW may be eliminated due to cohesive or adhesive tearing of the coating or the paint layer.

The surface hardness of the fastened parts must be lower than that of HEICO-LOCK wedge lock washers and not exceed a hardness value of max. 460 HV (approx. 46 HRc) for using HEICO-LOCK WLW out of heat treated steel. For application with HEICO-LOCK out of stainless steels the max. surface hardness of the mating parts should not exceed 520 HV (approx. 50 HRc).

With soft mating material, we recommend using a HEICO-LOCK WLW with large contact surface (HLB-XX) in combination with flange bolts and/or flange nuts to reduce the surface pressure.

5.) Type of bolt joints and geometry of the threaded hole

For bolt-and-nut joints a HEICO-LOCK WLW must be integrated below the bolt head and between the nut and component, respectively (see. Fig. 2a).

For tapped thread joints it is sufficient to integrate one HEICO-LOCK wedge lock washer below the bolt head (see. Fig. 2b). Additional locking of the thread (e.g. by means of adhesive) is not required (cf. item 1).

For threaded rod joints the HEICO-LOCK WLW must be integrated below the nut(s) (cf. Fig. 2c).

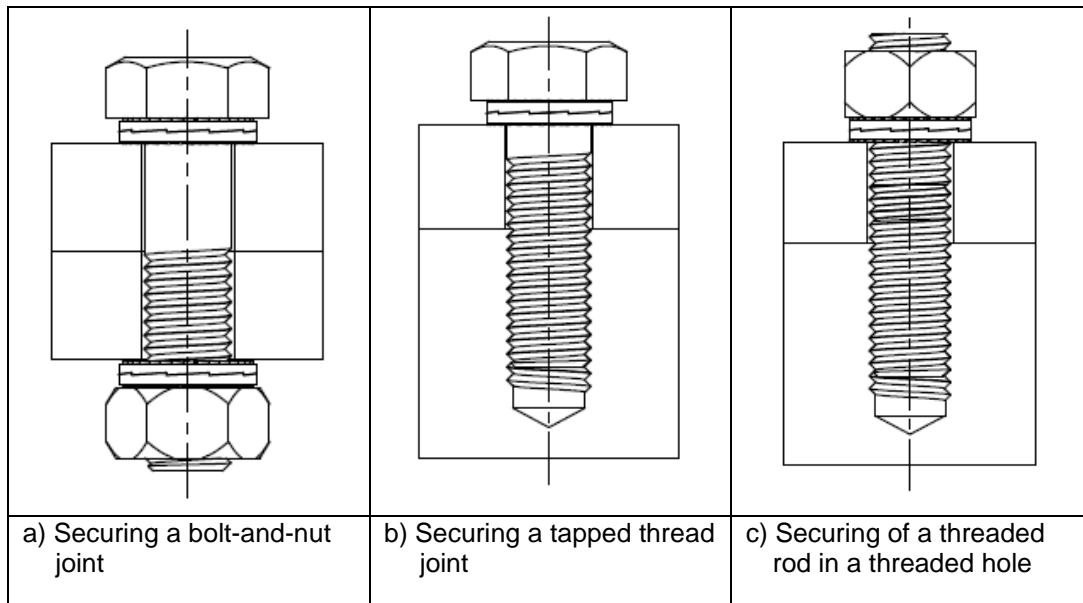


Figure 2: Assembly based on the type of bolted joint

With round or countersunk holes (see. Fig. 3a) it is possible to use HEICO-LOCK WLW with small contact surface (HLS-XX).

With slot holes we recommend using a HEICO-LOCK WLW with large contact surface (HLB-XX). Use of flanged bolts and/or flanged nuts is also possible, as necessary (Fig. 3b).

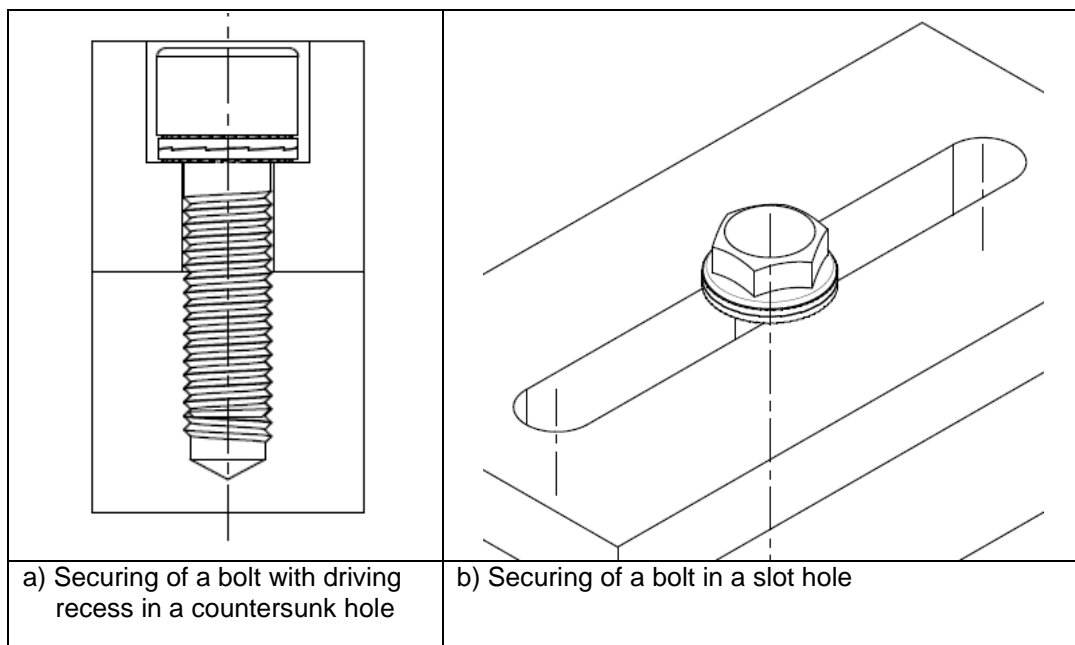


Figure 3: Assembly based on the geometry of the threaded hole

6.) Lubrication of the bolted joint

We recommend lubricating the bolted joint at the engaged thread and at the bearing surfaces of the bolt head and the nut (depending on the side that is tightened) prior to assembly in order to maintain the assembly tightening torque and/or the assembly tightening force within a certain range.

Info: Threads with a thick coating may get stuck. Stainless steel threads (e.g. A2 and A4) are prone to cold welding or "seizure". Use a suitable lubricant.

7.) Tightening the bolted connection

We urgently request you to use at least one calibrated, adjustable torque wrench for assembly, in order to ensure correct tightening/fastening of the bolted connection. We strongly advise against purely "manual" assembly ("feeling the torque").

If, for assembly of the bolted joint, another tightening force than that recommended by HEICO in item 9 is required, please contact us. Experimental examination may be required for individual cases.

Info: A minimum tightening force is required to ensure that the radial teeth on the outer face make correct form-closed connection with the mating material! The HEICO-LOCK WLWs meet the criteria of the test regulations according to E-DIN 25201-4, Annex B. According to these regulations, sufficient securing effect is available at a tightening force of 50% of the maximum assembly tightening force (acc. to VDI 2230-1, Table A1) with varying transversal load at a defined amplitude of the transversal shift during 2000 load reversal cycles on a vibration test stand acc. to DIN 65151, provided that at least 80% of the tightening force is maintained in the bolted connection at the beginning of the test (50% $F_{M,max}$).

The recommended tightening torque values are based on the assumed friction values under the coating and lubrication conditions specified. In individual cases the tightening torques required for obtaining the assembly tightening force must be verified by means of a tightening torque/force test using the original installation set-up.

For assembly of bolt-and-nut joints, one side (either the bolt head or the nut) must be locked or fixed while the joint is tightened from the opposite side.

8.) Functioning of the HEICO-LOCK wedge lock washer

After assembly (taking into account the information given above) the radial teeth on the outer faces of the HEICO-LOCK wedge lock washer indent into the mating material and the bolt head / nut faces (see Fig. 4) and make a form-closed connection due to the greater surface hardness of the washer.

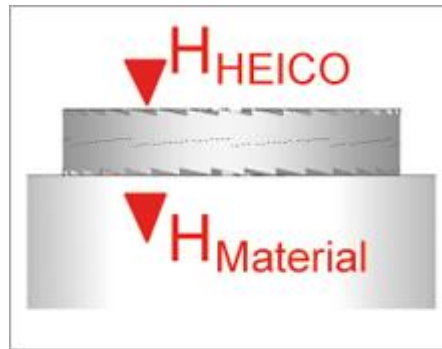


Figure 4: Indentation of the HEICO-LOCK WLW due to greater surface hardness

Due to the form-closed indentation of the radial teeth on the outer faces into the respective mating surface, rotating movement is only possible by means of the wedge surfaced on the inner faces due to the lower friction value compared to the outer faces (Fig. 5).

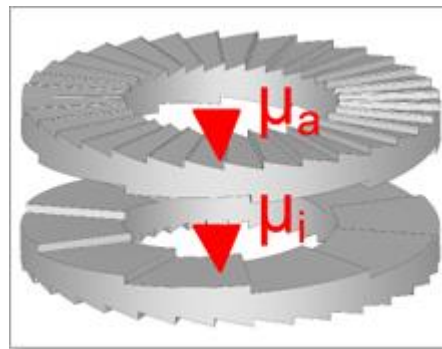


Figure 5: Different friction values at the inner and outer faces, respectively

The securing principle of HEICO-LOCK WLW is based on the angles present at the wedge surfaces, which are greater than the pitch angle of the thread (see. Fig. 6). In case that the bolt detaches due to self-loosening by rotation, the wedge effect causes self-retention.

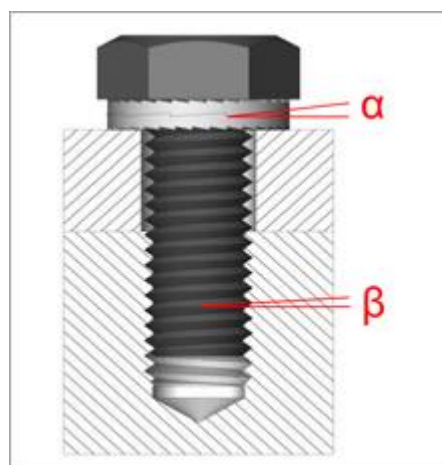


Figure 6: Wedge angle greater than pitch angle

Info: The angle at the wedge surface of the HEICO-LOCK WLW is adjusted to the pitch angle of the bolt (ISO coarse thread or UNC thread) in the corresponding nominal size.

When loosening the joint using a wrench, the clamp load increases intermittently when the bolt head is forced over the wedge surfaces (see Fig. 7), also referred to as the “clicking” effect.

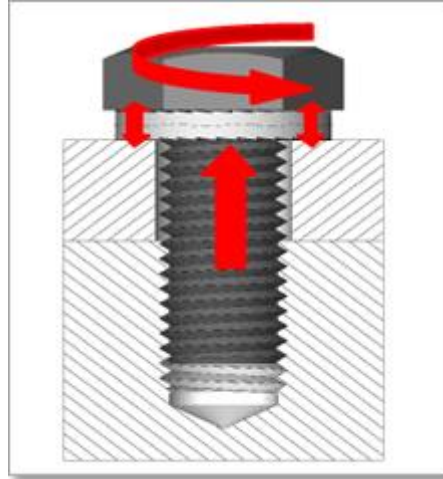


Figure 7: Increase of clamp load during loosening

9.) Quick reference guide for assembly

- 1) Inspect bolt parts for soiling and damage.
- 2) Check for correct positioning / orientation of the HEICO-LOCK WLW (not applicable with glued individual washers).
- 3) Check for correct matching of the HEICO-LOCK WLW and the bolt head or the nut, as well as the threaded rod, if applicable.
- 4) Choose the correct material for HEICO-LOCK WLW depending on the ambient conditions (we recommend agreement with the manufacturer).
 - a) HEICO-LOCK WLW made of heat-treated steel (1.1191) with zinc flake coating for normal ambient conditions from -40°C up to 200°C.
 - b) HEICO-LOCK WLW made of stainless steel (1.4404) for application in corrosive, non-acidic ambient conditions from -200°C up to 500°C.
 - c) HEICO-LOCK WLW made of 254 SMO® (1.4547) for application in acidic (chlorides, e.g. sea water) ambient conditions from -200°C up to 500°C.
 - d) HEICO-LOCK WLW made of Inconel 718® or Alloy 718® (2.4668) for temperatures above 500°C to maximum 700°C. Minimum temperature -200°C.
- 5) The surface hardness of the fastened components must be lower than the hardness value of HEICO-LOCK WLW. We recommend a maximum surface hardness of 430 HV (approx. 44 HRC). With soft mating material, use HEICO-LOCK WLW with large contact surfaces (HLB-XX) in combination with flange bolts and/or flange nuts.
- 6) With great coating or paint thicknesses the function must be verified by experiment.
- 7) Select the appropriate model of HEICO-LOCK WLW depending on the geometry of the threaded hole.
 - a) With round or countersunk holes use HEICO-LOCK WLW with small contact surface (HLS-XX).
 - b) With slot holes use HEICO-LOCK WLW with large contact surface (HLB-XX). Use in combination with flanged bolts/nuts, if required.
- 8) Positioning and orientation of HEICO-LOCK WLW depending on the bolt type.
 - a) HEICO-LOCK WLW below bolt head or nut for bolt joints.
 - b) HEICO-LOCK WLW below bolt head and nut for bolt-and-nut joints.
 - c) HEICO-LOCK WLW below the nut for assembly of a threaded rod in a threaded hole.
 - d) HEICO-LOCK WLW below the nut for assembly of a threaded rod in a through hole.
- 9) The surface of fastened parts, particularly the areas in contact with HEICO-LOCK WLW, must be free from coarse soiling and as even and smooth as possible.
- 10) The engaged thread, as well as the bolt head and nut contact faces must be lubricated using a suitable lubricant. This must be ensured in any case for stainless steel materials due to their tendency for "seizure".
- 11) Tighten the bolted joint applying the assembly torque required for generating the assembly tightening force using a torque wrench with a dial or with "clicking" sound. The torque depends on friction (surface coating, lubrication, etc.). Torque recommendations are merely guiding values. The individually required assembly tightening torque must be established by experiment.

10.) Torque recommendations

The tightening torque values recommended in the tables below are based on the assumed friction values under the coating and lubrication conditions specified. In individual cases the tightening torques required for obtaining the assembly tightening force must be verified by means of a tightening torque/force test using the original installation set-up, if possible.

The following torque recommendations are only for bolted joints with ISO coarse threads acc. to DIN 13-1.

| TORQUE GUIDELINES - carbon steel | | | | | | |
|--|----------------------------|--------------------------|---|------------------------|---|------------------------|
| HEICO-LOCK zinc flake coated (for screws class 8.8 (galvanized or zinc plated)) | | | | | | |
| | | | oiled, GF=0,75, $\mu_{th} = 0,10, \mu_b = 0,16$ | | dry, GF=0,62, $\mu_{th} = 0,15, \mu_b = 0,18$ | |
| bolt size | article description | thread pitch [mm] | torque [Nm] | clamp load [kN] | torque [Nm] | clamp load [kN] |
| M3 | HLS-3 | 0.50 | 1.3 | 2.4 | 1.3 | 2.0 |
| M4 | HLS-4 | 0.70 | 3.1 | 4.2 | 3.1 | 3.5 |
| M5 | HLS-5 | 0.80 | 6.0 | 6.8 | 6.0 | 5.6 |
| M6 | HLS-6 | 1.00 | 10.5 | 9.7 | 10.5 | 8.0 |
| M8 | HLS-8 | 1.25 | 25 | 18 | 25 | 15 |
| M10 | HLS-10 | 1.50 | 49 | 28 | 50 | 23 |
| M12 | HLS-12 | 1.75 | 85 | 40 | 85 | 33 |
| M14 | HLS-14 | 2.00 | 135 | 55 | 136 | 46 |
| M16 | HLS-16 | 2.00 | 205 | 75 | 208 | 62 |
| M18 | HLS-18 | 2.50 | 288 | 92 | 291 | 76 |
| M20 | HLS-20 | 2.50 | 402 | 118 | 408 | 97 |
| M22 | HLS-22 | 2.50 | 548 | 146 | 557 | 120 |
| M24 | HLS-24 | 3.00 | 693 | 169 | 703 | 140 |
| M27 | HLS-27 | 3.00 | 1,010 | 221 | 1,028 | 182 |
| M30 | HLS-30 | 3.50 | 1,379 | 269 | 1,401 | 222 |
| M33 | HLS-33 | 3.50 | 1,855 | 333 | 1,889 | 275 |
| M36 | HLS-36 | 4.00 | 2,394 | 392 | 2,436 | 324 |
| M39 | HLS-39 | 4.00 | 3,087 | 468 | 3,145 | 387 |
| M42 | HLS-42 | 4.50 | 3,820 | 538 | 3,890 | 445 |

GF = ratio of yield point (using the yield strength $R_{p0.2}$ [%])

μ_{th} = thread friction coefficient

μ_h = friction coefficient of wedge lock washer

| HEICO-LOCK zinc flake coated (for non-plated screws class 10.9) | | | | |
|--|---------------------|-------------------|--|-----------------|
| | | | oiled, GF=0,75, $\mu_{th} = 0,10, \mu_b = 0,16$ | |
| bolt size | article description | thread pitch [mm] | torque [Nm] | clamp load [kN] |
| M3 | HLS-3 | 0.50 | 1.8 | 3.2 |
| M4 | HLS-4 | 0.70 | 4.1 | 5.6 |
| M5 | HLS-5 | 0.80 | 8.1 | 9.1 |
| M6 | HLS-6 | 1.00 | 14.1 | 12.9 |
| M8 | HLS-8 | 1.25 | 34 | 23 |
| M10 | HLS-10 | 1.50 | 67 | 37 |
| M12 | HLS-12 | 1.75 | 115 | 54 |
| M14 | HLS-14 | 2.00 | 183 | 74 |
| M16 | HLS-16 | 2.00 | 279 | 100 |
| M18 | HLS-18 | 2.50 | 391 | 123 |
| M20 | HLS-20 | 2.50 | 547 | 156 |
| M22 | HLS-22 | 2.50 | 745 | 194 |
| M24 | HLS-24 | 3.00 | 942 | 225 |
| M27 | HLS-27 | 3.00 | 1,375 | 294 |
| M30 | HLS-30 | 3.50 | 1,875 | 358 |
| M33 | HLS-33 | 3.50 | 2,526 | 443 |
| M36 | HLS-36 | 4.00 | 3,259 | 522 |
| M39 | HLS-39 | 4.00 | 4,203 | 624 |
| M42 | HLS-42 | 4.50 | 5,202 | 716 |

| HEICO-LOCK zinc flake coated (for non-plated screws class 12.9) | | | | |
|--|---------------------|-------------------|--|-----------------|
| | | | oiled, GF=0,75, $\mu_{th} = 0,10, \mu_b = 0,16$ | |
| bolt size | article description | thread pitch [mm] | torque [Nm] | clamp load [kN] |
| M3 | HLS-3 | 0.50 | 2.0 | 3.9 |
| M4 | HLS-4 | 0.70 | 4.6 | 6.7 |
| M5 | HLS-5 | 0.80 | 9.1 | 10.9 |
| M6 | HLS-6 | 1.00 | 15.8 | 15.4 |
| M8 | HLS-8 | 1.25 | 38 | 28 |
| M10 | HLS-10 | 1.50 | 75 | 44 |
| M12 | HLS-12 | 1.75 | 128 | 65 |
| M14 | HLS-14 | 2.00 | 204 | 89 |
| M16 | HLS-16 | 2.00 | 311 | 120 |
| M18 | HLS-18 | 2.50 | 437 | 148 |
| M20 | HLS-20 | 2.50 | 610 | 188 |
| M22 | HLS-22 | 2.50 | 831 | 233 |
| M24 | HLS-24 | 3.00 | 1,052 | 270 |
| M27 | HLS-27 | 3.00 | 1,533 | 352 |
| M30 | HLS-30 | 3.50 | 2,091 | 430 |
| M33 | HLS-33 | 3.50 | 2,815 | 532 |
| M36 | HLS-36 | 4.00 | 3,633 | 626 |
| M39 | HLS-39 | 4.00 | 4,683 | 748 |
| M42 | HLS-42 | 4.50 | 5,799 | 860 |

| TORQUE GUIDELINES - stainless steel | | | | | | |
|--|---------------------|-------------------|--|-----------------|--|-----------------|
| HEICO-LOCK stainless steel (AISI 316L (EN 1.4401/4404) or equivalent alloy) | | | | | | |
| [with screw stainless steel] | | | A4-70, MoS2, GF=0,65, $\mu_{th} = 0,14, \mu_b = 0,15$ | | A4-80, MoS2, GF=0,65, $\mu_{th} = 0,14, \mu_b = 0,15$ | |
| bolt size | article description | thread pitch [mm] | torque [Nm] | clamp load [kN] | torque [Nm] | clamp load [kN] |
| M3 | HLS-3S | 0.50 | 0.9 | 1.5 | 1.2 | 2.0 |
| M4 | HLS-4S | 0.70 | 2.0 | 2.6 | 2.7 | 3.4 |
| M5 | HLS-5S | 0.80 | 3.9 | 4.2 | 5.3 | 5.5 |
| M6 | HLS-6S | 1.00 | 6.9 | 5.9 | 9.2 | 7.8 |
| M8 | HLS-8S | 1.25 | 17 | 11 | 22 | 14 |
| M10 | HLS-10S | 1.50 | 33 | 17 | 43 | 23 |
| M12 | HLS-12S | 1.75 | 56 | 25 | 75 | 33 |
| M14 | HLS-14S | 2.00 | 89 | 34 | 119 | 45 |
| M16 | HLS-16S | 2.00 | 136 | 46 | 181 | 61 |
| M18 | HLS-18S | 2.50 | 191 | 56 | 254 | 75 |
| M20 | HLS-20S | 2.50 | 267 | 72 | 356 | 96 |
| M22 | HLS-22S | 2.50 | 351 | 89 | 468 | 118 |
| M24 | HLS-24S | 3.00 | 460 | 103 | 613 | 138 |
| M27 | HLS-27S | 3.00 | 671 | 134 | 895 | 179 |
| M30 | HLS-30S | 3.50 | 915 | 164 | 1,220 | 219 |
| M33 | HLS-33S | 3.50 | 1,233 | 203 | 1,644 | 271 |
| M36 | HLS-36S | 4.00 | 1,591 | 239 | 2,121 | 319 |
| M39 | HLS-39S | 4.00 | 2,053 | 285 | 2,737 | 381 |
| M42 | HLS-42S | 4.50 | 2,585 | 333 | 3,447 | 443 |

GF = ratio of yield point (using the yield strength $R_{p0.2}$ [%])

μ_{th} = thread friction coefficient

μ_h = friction coefficient of wedge lock washer