

HILTI F-BT VISUAL EXAMINATION CATALOGUE

This document complements OTR/5724148/02 with the provisions for the added grinding surface preparation method.

The visual examination and assessment for Hilti F-BT studs is split in two parts. First, the examination of the surface preparation prior to welding and second, the examination for the F-BT stud welding itself.

Table 1 shows the surface tool recommendation for different parent material, coating types, thicknesses with an assignment to the corresponding studs and the examination tables to be used.

Table 1. Application and surface tool recommendation with corresponding surface preparation and weld examination tables

Application and surface tool recommendation			
Parent material coating	Non-weldable primer HDG coating Duplex coating Multi-layer coating	Weldable primer, Black steel with mill scale	
	≤ 1000 µm	≤ 25 µm	
Surface preparation tool	Surface tool		Grinding Tool
	SF 8M-A22, SF 6H-22, SBT 6-22		AG 5D-22, AG 4S-22, AG 6D-22
	FX 3-ST d20	FX 3-ST d14	AG-D-SP, AG-D SPX
Stud type	F-BT-MR F-BT-MR SN	F-BT-MR	F-BT-MR
Examination tables			
Surface preparation	Table 3	Table 4	Table 5
Weld	Table 6	Table 7	Table 8

The purpose of the examination catalogue is to assess the visual appearance as acceptable or not acceptable for use.

The criteria for the appearance of the stud are complementary to the requirements of EN ISO 14555:2017 Table A.5 and AWS D1.6 Clause 9.7. Using these standards as a basis, this document addresses the specifics of the Hilti F-BT welded studs.

The Hilti F-BT examination catalogue shall be used for the welding procedure qualification record (WPQR/PQR) as well as for stud examination during process control, production welding control and production surveillance.

Table 2 provides an explanation how to read the schematic sketches used in this catalogue.

Table 2: Schematics explanation

Schematic	Explanation
Surface preparation with surface tools	
	<p>Top-down view of a surface preparation on coated steel. The coating colour is red in this example. Uncoated steel will be represented in dark grey. In both schematics an outer ring is shown. The left schematic shows a "shiny ring" on the outside. While the right schematic shows a ring that has residuals, which will be a more dull color.</p> <p>The small circle in the center of each schematic represents the indentation formed by the center tip of the surface tool.</p>
Surface preparation with grinding tools	
	<p>Top-down view of a surface preparation with grinding. The primer colour is light brown in this example and uncoated steel would be represented by black surface.</p> <p>The left schematic represents a clean and shiny surface. While the right schematic shows a surface which has residuals, which will be a more dull color.</p> <p>The small circle in the center of the left schematic represents the indentation formed by a punching tool.</p> <p>Note: Punching is always to be done after grinding preparation.</p>
Welded stud examination	
	<p>Top-down view of an F-BT welded to the parent material prepared with FX 3-ST d20 surface tool.</p>
	<p>Top-down view of an F-BT welded to the parent material prepared with FX 3-ST d14 surface tool.</p>
	<p>Top-down view of an F-BT welded to the parent material prepared with grinding tool.</p>

Table 3: Surface preparation of coated steel with surface tool FX 3-ST d20











No	Schematics	Example images	Assessment	Recommended corrective action
1	<p style="text-align: center;">Blank and shiny ring</p> 		<p>ACCEPTABLE</p>	<p>None</p>
2	<p style="text-align: center;">Residuals on the outer ring</p> 		<p>NOT ACCEPTABLE: Residuals on the outer ring.</p>	<p>Continue the preparation process until the stop shoulder (outer ring) is clean 360° around. Change the surface tool if needed.</p>
3	<p style="text-align: center;">Inclined preparation surface</p> 		<p>NOT ACCEPTABLE: One sided residuals and inclined preparations.</p>	<p>Continue the preparation process and tilt the drilling machine slightly to the side, where residuals are found to remove them and provide an even surface for stud installation.</p>
4	<p style="text-align: center;">Uneven preparation</p> 		<p>NOT ACCEPTABLE: Residuals on the surface.</p>	<p>Hold and press the tool straight to the surface when preparing the surface. Avoid wobbling of the surface tool.</p>
5	<p style="text-align: center;">Unsymmetrical or doubled preparation</p> 		<p>NOT ACCEPTABLE: An unsymmetrical preparation showing a double circle.</p>	<p>Do not use unsymmetrical preparations for welding. Create a preparation at a new location. Next time hold and press the tool straight and firm during the preparation process.</p>

Table 4: Surface preparation of uncoated steel or steel with weldable primer (<25µm) with surface tool FX 3-ST d14

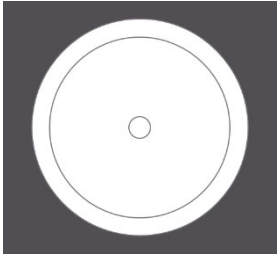
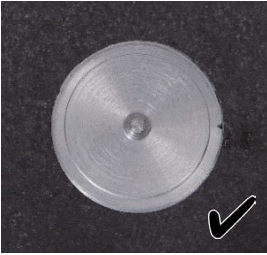
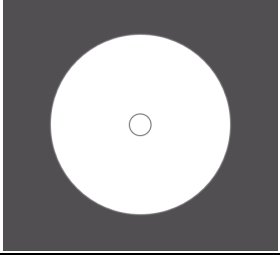

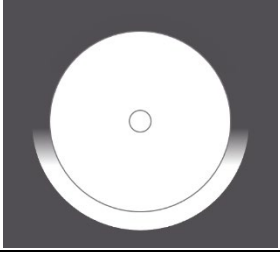

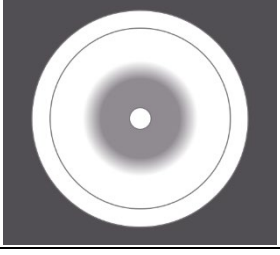

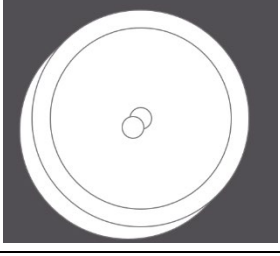

No	Schematics	Example images	Assessment	Recommended corrective action
1			ACCEPTABLE	None
2			NOT ACCEPTABLE: Residuals on the ring.	Continue the preparation process until the stop shoulder (outer ring) is clean 360° around. Change the surface tool if needed.
3			NOT ACCEPTABLE: One sided residuals and inclined preparations.	Continue the preparation process and tilt the drilling machine slightly to the side, where residuals are found to remove them and provide an even surface for stud installation.
4			NOT ACCEPTABLE: Residuals on the surface.	Hold and press the tool straight to the surface when preparing the surface. Avoid wobbling of the surface tool.
5			NOT ACCEPTABLE: An unsymmetrical or doubled preparation.	Do not use unsymmetrical preparations for welding. Create a preparation at a new location. Next time hold and press the tool straight and firm during the preparation process.

Table 5: Surface preparation of uncoated steel or steel with weldable primer ($\leq 25\mu\text{m}$) with grinding tool

No	Schematics	Example images	Assessment	Recommended corrective action
1	Preparation > $\text{Ø}20\text{mm}$ clean and shiny 		ACCEPTABLE	None
2	Punching after grinding 		ACCEPTABLE	None
3	Punching prior to grinding PUNCH ONLY AFTER GRINDING.		NOT ACCEPTABLE: Residuals remains in the punch mark.	Continue the preparation until punching mark disappears. Then punch again.
4	Preparation area too small 		NOT ACCEPTABLE: Too small area prepared.	Continue the preparation process until an area of diameter $\text{Ø}20\text{mm}$ is clean and shiny. Punch after grinding.

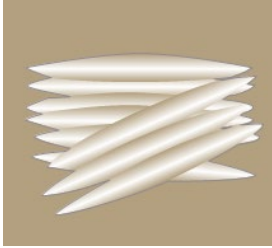



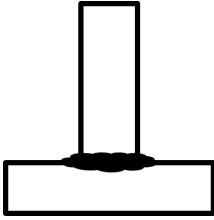
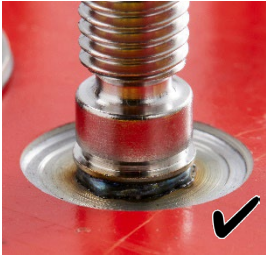


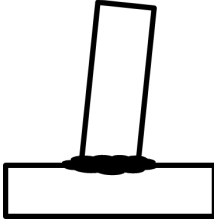

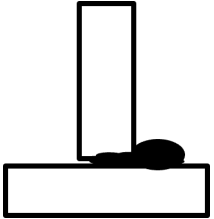

No	Schematics	Example images	Assessment	Recommended corrective action
5	<p style="text-align: center;">Wavy preparation</p> 		<p>NOT ACCEPTABLE: Non-uniform surface, Residues still visible.</p>	<p>Continue surface preparation until acceptable appearance is given. Don't press hard in one place. Move the grinding tool over the surface to produce a flat prepared are for grinding. Punch after grinding.</p>
6	<p style="text-align: center;">Incomplete preparation</p> 		<p>NOT ACCEPTABLE: Residuals on the surface.</p>	<p>Continue the surface preparation until the surface is shiny. Punch after grinding.</p>

Table 6: Visual examination catalogue for F-BT studs welded on coated steel – surface tool FX 3-ST d20

No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
1	<p>Regular and complete collar</p> 		ACCEPTABLE	None.	Table A.5, No. 4 of EN ISO 14555:2017
2	<p>Eccentric stud</p> 		NOT ACCEPTABLE: Studs welded eccentric to the circular preparation. → Remove and reinstall stud	Center the tip of the stud in the middle of the surface preparation. Hold the hand tool FX 3-HT centered, perpendicular and calm.	Table A.5, No. 4 of EN ISO 14555:2017
3	<p>Inclined stud >2°</p> 		NOT ACCEPTABLE: Inclined studs >2°. → Remove and reinstall stud	Hold the hand tool perpendicular and firm during welding. Assure that the surface preparation is parallel to the parent material surface.	Table A.5, No. 4 of EN ISO 14555:2017
4	<p>One-sided connection, weld drop protruding</p> 		NOT ACCEPTABLE: One-sided weld connection. → Test or remove the welded stud	Comply with the surface preparation requirements in Table 3. Comply with base clamp, stud, and edge spacing requirements.	Table A.5, No. 4 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017





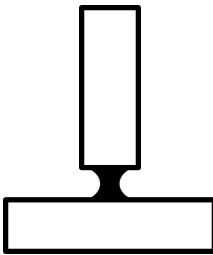



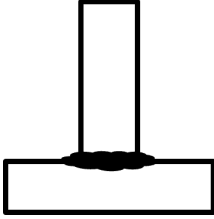



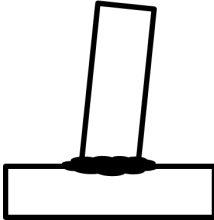

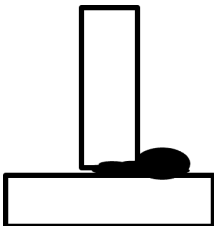

No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
5	<p>Soot around the weld</p> 		<p>NOT ACCEPTABLE: Studs with soot around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 3. Make sure that the surface preparation and the stud are free of any contamination.</p>	<p>Table A.5, No. 3 and 4 of EN ISO 14555:2017</p>
6	<p>Splatter or sparks</p> 		<p>NOT ACCEPTABLE: Studs with splatter or sparks around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 3. Make sure that the surface preparation and the stud are free of any contamination.</p>	<p>Table A.5, No. 3 and 5 of EN ISO 4555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017</p>
7	<p>Weld diameter reduced, unusual stand off</p> 		<p>NOT ACCEPTABLE: Studs with reduced diameter or unusual high stand-off. → Remove and reinstall stud</p>	<p>Check Weld Code (H-Code) setting. Comply with the surface preparation requirements in Table 3. Make sure that the surface preparation and the stud are free of any contamination.</p>	<p>Table A.5, No. 2 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017</p>
8	<p>F-Code displayed on the tool</p> 		<p>NOT ACCEPTABLE: Studs with F-Code displayed after the weld. → Follow the actions required in Table 9.</p>	<p>Corrective actions depending on F-Code listed in Table 9.</p>	

Table 7: Visual examination catalogue for F-BT studs welded on uncoated steel or steel with weldable primer ($\leq 25\mu\text{m}$) – surface tool FX 3-ST d14

No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
1	<p>Regular complete collar around the weld pin</p> 		ACCEPTABLE	None.	Table A.5, No. 4 of EN ISO 14555:2017
2	<p>Eccentric stud</p> 		<p>NOT ACCEPTABLE: Studs welded eccentric to the circular preparation. → Remove and reinstall stud</p>	<p>Center the tip of the stud in the middle of the surface preparation. Hold the hand tool FX 3-HT centered, perpendicular and calm.</p>	Table A.5, No. 4 of EN ISO 14555:2017
3	<p>Inclined stud $>2^\circ$</p> 		<p>NOT ACCEPTABLE: Inclined studs $>2^\circ$. → Remove and reinstall stud</p>	<p>Hold the hand tool perpendicular and firm during welding. Assure that the surface preparation is parallel to the parent material surface.</p>	Table A.5, No. 4 of EN ISO 14555:2017
4	<p>One-sided connection, weld drop protruding</p> 		<p>NOT ACCEPTABLE: One-sided weld connection. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 4. Comply with base clamp, stud, and edge spacing requirements.</p>	Table A.5, No. 4 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017




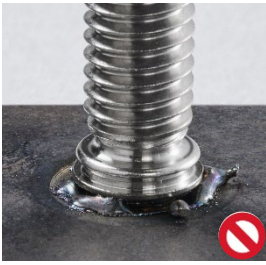
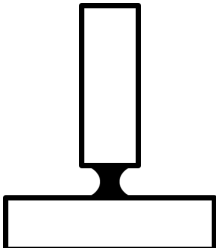
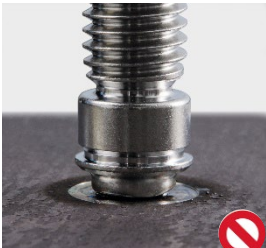


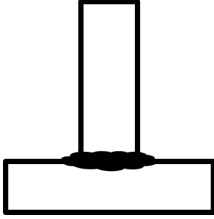



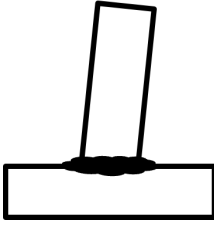

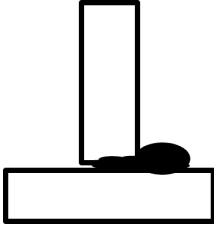

No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
5	<p>Soot around the weld</p> 		<p>NOT ACCEPTABLE: Studs with soot around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 4. Make sure that the surface preparation and the stud are free of any contamination.</p>	Table A.5, No. 3 and 4 of EN ISO 4555:2017
6	<p>Splatter or sparks</p> 		<p>NOT ACCEPTABLE: Studs with splatter or sparks around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 4. Make sure that the surface preparation and the stud are free of any contamination.</p>	Table A.5, No. 3 and 5 of EN ISO 4555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017
7	<p>Weld diameter reduced, unusual stand off</p> 		<p>NOT ACCEPTABLE: Studs with reduced diameter or unusually high stand-off. → Remove and reinstall stud</p>	<p>Check Weld Code setting. Comply with the surface preparation requirements in Table 4. Make sure that the surface preparation and the stud are free of any contamination.</p>	Table A.5, No. 2 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017
8	<p>F-Code displayed on the tool</p> 		<p>NOT ACCEPTABLE: Studs with F-Code displayed after the weld. → Follow the actions required in Table 9.</p>	<p>Corrective actions depending on F-Code listed in Table 9.</p>	

Table 8: Visual examination catalogue for F-BT studs welded on uncoated steel or steel with weldable primer ($\leq 25\mu\text{m}$) – Grinding tool

No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
1	<p>Regular complete collar around the weld pin</p> 		ACCEPTABLE	None.	Table A.5, No. 4 of EN ISO 14555:2017
2	<p>Eccentric stud</p> 		<p>NOT ACCEPTABLE: Stud welded not in the center of preparation → Remove and reinstall stud</p>	<p>Center the tip of the stud in the center punch in middle of the surface preparation. Hold the hand tool FX 3-HT centered, perpendicular and calm.</p>	Table A.5, No. 4 of EN ISO 14555:2017
3	<p>Inclined stud $>2^\circ$</p> 		<p>NOT ACCEPTABLE: Inclined studs $>2^\circ$. → Remove and reinstall stud</p>	<p>Hold the hand tool perpendicular and firm during welding. Assure that the surface preparation is parallel to the parent material surface.</p>	Table A.5, No. 4 of EN ISO 14555:2017
4	<p>One-sided connection, weld drop protruding</p> 		<p>NOT ACCEPTABLE: One-sided weld connection. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 5. Comply with base clamp, stud, and edge spacing requirements.</p>	Table A.5, No. 4 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017





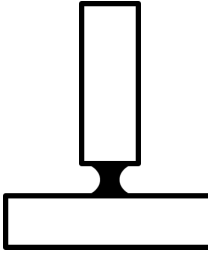



No	Schematics	Example images	Assessment	Recommended corrective action	Complementary to
5	<p>Soot around the weld</p> 		<p>NOT ACCEPTABLE: Studs with soot around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 5. Make sure that the surface preparation and the stud are free of any contamination.</p>	Table A.5, No. 3 and 4 of EN ISO 4555:2017
6	<p>Splatter or sparks</p> 		<p>NOT ACCEPTABLE: Studs with splatter or sparks around the weld. → Test or remove the welded stud</p>	<p>Comply with the surface preparation requirements in Table 5. Make sure that the surface preparation and the stud are free of any contamination and make sure that punch was done after grinding.</p>	Table A.5, No. 3 and 5 of EN ISO 4555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017
7	<p>Weld diameter reduced, unusual stand off</p> 		<p>NOT ACCEPTABLE: Studs with reduced diameter or unusually high stand-off. → Remove and reinstall stud</p>	<p>Check Weld Code setting. Comply with the surface preparation requirements in Table 5. Make sure that the surface preparation and the stud are free of any contamination.</p>	Table A.5, No. 2 of EN ISO 14555:2017 and Clause 9.7.1 of AWS D1.6/D1.6M: 2017
8	<p>F-Code displayed on the tool</p> 		<p>NOT ACCEPTABLE: Studs with F-Code displayed after the weld. → Follow the actions required in Table 9.</p>	<p>Corrective actions depending on F-Code listed in Table 9.</p>	

Table 9: F-Code list, failure case requiring removal or inspection of stud

F-Code	Failure case	Required action										
F06	Hand tool inner mechanics sticky	<p style="text-align: center;">Either:</p> <p>Test the stud to the tensile proof load with the HAT 28 FX. The proof load depends on the Weld Code (H-Code) of the stud. If the stud withstands the proof load, it is good to be used, else it shall be re-installed.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Weld code (H-Code)</th> <th>Tensile proof load in kN (lbf)</th> </tr> </thead> <tbody> <tr> <td>H1</td> <td>6 (1350)</td> </tr> <tr> <td>H2</td> <td>9 (2025)</td> </tr> <tr> <td>H3</td> <td>17 (3820)</td> </tr> <tr> <td>H10</td> <td>22 (4950)</td> </tr> </tbody> </table>	Weld code (H-Code)	Tensile proof load in kN (lbf)	H1	6 (1350)	H2	9 (2025)	H3	17 (3820)	H10	22 (4950)
Weld code (H-Code)	Tensile proof load in kN (lbf)											
H1	6 (1350)											
H2	9 (2025)											
H3	17 (3820)											
H10	22 (4950)											
F07	Electrical connection bad											
F10	Stud embedment not proper											
F14	Operator interrupted process											
F16	Spot contaminated	<p style="text-align: center;">Or:</p> <p>Remove and reinstall the stud directly without testing.</p>										
F17	Process aborted	Remove and reinstall the stud										

- For corrective actions to avoid repeated occurrence of F-Codes see Sticker inside of the Kit box or see the Quick start guide on the tool. Additionally, check that the software installed on the tool is the latest version available, see in CSF Technical Manual.
- For troubleshooting of F-Codes not listed here see Sticker inside of the Kit box or on the tool or in operating instructions of the FX 3-A.
- Recommendation on how to remove and reinstall F-BT can be found in the repair procedure for F-BT.