Case-Hardened Transmission Components
Drawing Notes on Material and Component Properties

Descriptors: case-hardened, transmission component, transmission, gearbox, internal stress, CHD, case-hardening depth, case depth, case hardening, surface hardness, dedendum core hardness, drawing note

Changes
The following changes have been made as compared to Volkswagen standard VW 500 19, 2003-10:
- Determination and testing of the case depth changed

Previous issues
1999-06; 2003-02; 2003-10

1 Scope
This standard applies to case-hardened transmission components. It specifies how requirements on material and component properties shall be represented in technical drawings and defines the measuring points for internal stresses, case-hardening depth, surface hardness and dedendum core hardness.

2 Description
Description example for an indexing wheel of the material according to Technical Supply Specification TL 4521:
Carbonitrated and tempered to ≥ 680 HV 30;
CHD according to VW 500 19, class 0.5;
Gear tooth system shot peened according to VW 500 19, class 3;
Dedendum core hardness: (400 + 100) HV30

3 Requirements
Deviations from the specifications below shall be documented in the drawing.

3.1 Material quality, heat treatment and shot peening
The requirements according to DIN 3990-5, quality of MQ case hardening steel, apply. Deviations from this are specified by this standard and/or drawing note.

Shot peening on parts without hardening treatment shall be performed directly after case hardening and tempering.
For hardening-treated parts, shot peening occurs after hardening treatment. Functional surfaces that shall not be shot peened shall be identified in the drawing.
3.2 Transmission steels

3.2.1 Normal load

According to TL 4227 (differentiated according to hardenability).

Replacement for TL 4123, TL 4124, TL 4125, TL 4128, TL 4129, TL 4130, TL 4131, TL 4221 and TL 4220. These Technical Supply Specifications must no longer be used for new designs.

3.2.2 Maximum load

According to TL 4521 (differentiated according to hardenability).

NOTE: The use of other materials is not excluded for normal and maximum load; if required, it shall be agreed upon with the responsible material test laboratory.

3.3 Dedendum core hardness

For measuring point see Section 3.6,

- for steel according to TL 4227 = (340 + 140) HV 30,
- for steel according to TL 4521 = (400 + 100) HV 30,
- for steel components according to TL 4521 that are subject to a straightening operation after heat treatment or are very voluminous (e.g. crown wheels) = (350 + 130) HV 30.

3.4 Case depth and surface hardness

CHD according to DIN EN ISO 2639. See Table 1. Measuring point see Section 3.6.

Basis: three classes, usage depends on module, only one limit hardness of 550 HV 1.

If the selected class is not sufficient due to increased loads, the next higher class shall be selected. Class 0.6 shall only be used for components which are to be straightened (e.g. shafts).

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit hardness (HV 1)</th>
<th>CHD (mm)</th>
<th>Module mₙ</th>
<th>CHD [mm] of ground surfaces</th>
<th>CHD [mm] of finished tooth flanks</th>
<th>Surface hardness after heat treatment</th>
<th>Surface hardness after hardening treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3¹)</td>
<td>550</td>
<td>0.3 + 0.2</td>
<td>1.0 to 1.99</td>
<td>≥ 0.20</td>
<td>²)</td>
<td>≥ 680 HV 10</td>
<td>≥ 680 HV 5</td>
</tr>
<tr>
<td>0.5</td>
<td>550</td>
<td>0.5 + 0.3</td>
<td>2.0 to 2.99</td>
<td>≥ 0.35</td>
<td>≥ 0.4</td>
<td>≥ 680 HV 30</td>
<td>≥ 680 HV 10</td>
</tr>
<tr>
<td>0.6</td>
<td>550</td>
<td>0.6 + 0.3</td>
<td>2.5 to 3.99</td>
<td>≥ 0.45</td>
<td>≥ 0.5</td>
<td>≥ 680 HV 30</td>
<td>≥ 680 HV 30</td>
</tr>
<tr>
<td>0.8</td>
<td>550</td>
<td>0.8 + 0.4</td>
<td>3.0 to 6.0</td>
<td>≥ 0.65</td>
<td>≥ 0.7</td>
<td>≥ 680 HV 30</td>
<td>≥ 680 HV 30</td>
</tr>
</tbody>
</table>

¹) Recommended for synchronizer hubs and operating sleeves
²) Finished gear systems not permissible. The next class shall be selected.
3.5 **Internal stress values and surface oxidation depth**

See Table 2. Measurements according to Test Specification PV 1005.

<table>
<thead>
<tr>
<th>Class</th>
<th>Material</th>
<th>Compressive internal stresses (Mpa)</th>
<th>Surface oxidation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Measuring point:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measuring point:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tolerance:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1 to 5) µm</td>
<td>(10 to 30) µm</td>
<td>≥ 50 µm</td>
</tr>
<tr>
<td>2</td>
<td>TL 4521</td>
<td>≥ 600</td>
<td>≥ 800</td>
<td>≥ 600</td>
</tr>
<tr>
<td></td>
<td>TL 4227</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>TL 4521</td>
<td>≥ 800</td>
<td>≥ 1,000</td>
<td>≥ 800</td>
</tr>
<tr>
<td></td>
<td>TL 4227</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>TL 4521</td>
<td>≥ 900</td>
<td>≥ 1,100</td>
<td>≥ 1,100</td>
</tr>
<tr>
<td></td>
<td>TL 4227</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>hardening-treated surface</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 2*

1) Two directed compressed air blasting processes with consideration of the required roughness according to part drawing
2) No surface oxidation exists in hardening-treated areas

3.6 **Measuring points for measuring of internal stresses and material testing**

See Figures 1 to 3.

**Figure 1 – Spur wheel**

Measuring point for internal stress: Measuring beam tangential to the minimum Ø of the flank test area

**Figure 2 – Bevel wheel**

Measuring point for internal stress on traction flank (concave pinion, convex crown wheel): measuring beam tangential to end of dedendum radius
Legend
1 Tooth flank
2 Dedendum radius
3 Tooth base
4 Tooth flank, center (1/2 tooth height)
onoptional measuring point for CHD and surface hardness
5 Drawing requirement = acceptance criterion
30° tangent (crossing point tangent/dedendum radius)
CHD with HV 1,
hardness within surface distance of 0.05 mm $\geq$ 680 HV 0.5
= surface hardness (additional value)
6 Measuring point for dedendum hardness (HV 30),
tooth center between dedendum radii

Figure 3 – Microsection
(normal section at b/2)

4 Referenced standards*)

PV 1005 Internal Stress Measurement; Determination of Depth Characteristics of Internal Stresses on Ferritic Iron Materials

TL 4227 Einsatzstahl, legiert; Werkstoffanforderungen (currently only available in German)

TL 4521 Einsatzstahl, Ni-legiert; Werkstoffanforderungen (currently only available in German)

DIN 3990-5 Calculation of Load Capacity of Cylindrical Gears; Endurance Limits and Material Qualities

DIN EN ISO 2639 Steels – Determination and Verification of the Depth of Carburized and Hardened Cases

*) In this section, terminological inconsistencies may occur as the original titles are used.