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## Group standard

**TL 227**

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Descriptors: cathodic electrocoating, corrosion protection, metal surface, paint, paintwork, single-layer paint, surface protection, zinc, zinc-coated

## Single-Layer Paint Coating of Zinc-Coated Metal Surfaces

### Surface Protection Requirements

#### Previous issues

TL 227: 1980-11, 1986-12, 1992-07, 1995-12, 1996-07, 2004-04, 2011-11, 2016-11

#### Changes

The following changes have been made to TL 227: 2016-11:

- a) Section 3.10.1 „Corrosion cycle test“ revised
- b) Section 3.11 „Resistance to chemicals“ revised
- c) Standard edited
- d) Section "Applicable documents" updated

## 1 Scope

This standard defines the surface protection requirements for organic coatings (cathodic electrocoating) on hot-dip galvanized and electro-galvanized parts.

NOTE 1: For cathodic electrocoating of body skin parts made from aluminum semi-finished products, see Technical Supply Specification TL 178 [1].

## 2 Designation

As per Volkswagen standard VW 13750, section „Designation“

For example:

**OfI-x632**

If, deviating from the specifications in section 3.1, a single-layer liquid paint is to be used, the addition „liquid paint“ (spray or dip painting) must be used in the drawing, e.g.:

**OfI-x632 liquid paint**

### 3 Requirements

#### 3.1 Surface protection types

Cathodic electrocoating is always required. The color must be black or as per the drawing (as per the color combination table). Single-layer liquid paint is possible where necessary, and following agreement with the appropriate Materials Engineering department of the respective brand.

The surface protection types listed in [table 1](#) apply.

**Table 1 – Surface protection types**

Ofl-x632	After-fabrication hot-dip galvanizing and cathodic electrocoating
Ofl-x633	Zinc-coated semi-finished product and cathodic electrocoating
Ofl-x638	After-fabrication hot-dip galvanizing and cathodic electrocoating with increased layer thickness (thick-layer cathodic electrocoating)
Ofl-x639	Zinc-coated semi-finished product and cathodic electrocoating with increased layer thickness (thick-layer cathodic electrocoating)
Ofl-x640	For after-sales service body components (doors, covers, fenders, roofs, etc.) made from hot-dip galvanized or electro-galvanized semi-finished products

A paint structure based on alkyd resin is not permissible (aging results in problems with adhesion of the paint coat to zinc layers).

#### 3.2 General requirements

Approval of first supply and changes as per Volkswagen standard [VW 01155](#).

Material conformity as per [VW 91101](#).

After-fabrication hot-dip galvanized parts that are not painted immediately after zinc coating (e.g., in the case of shipping zinc-coated parts to the painting plant) must not be phosphated or sealed and must correspond to protection types Ofl-c310, Ofl-c340, or Ofl-c330 as per [TL 217](#). Any required transport or storage protection of zinc-coated parts, e.g., oiling, must be agreed upon with the painting plant. If painting is carried out at a plant in the Volkswagen Group, the transport or storage protection must correspond to Quality Specification QP A001.

The cutting burr on components must correspond at least to the manufacturing precision „fine“ as per [VW 01088](#). Justified deviations must be agreed upon with the appropriate Materials Engineering department of the respective brand and specified in the respective part drawing.

The coating must have the specified surface protection with the specified properties over the entire surface. The coatings must be free of pores, cracks, paint runs, foreign matter inclusions, damage, and other production-related imperfections that impair the corrosion protection and/or the specified appearance.

The paintwork must adhere firmly to the base material when the parts are used as intended.

The production process and its control must not impair the use properties of the finished part. Proper installation of parts must not result in damage that impairs the part's function and/or decreases the specified corrosion protection.

The coatings used must be free of compounds containing hexavalent chromium [Cr(VI)] or lead.

Eight finished parts are required for complete testing.

### 3.3 Base material

Material as per drawing

### 3.4 Conditioning

If air-drying coating systems are used and/or the paint system is not baked at elevated temperatures ( $> 60\text{ }^{\circ}\text{C}$ ), the components must be conditioned for 24 h at  $60\text{ }^{\circ}\text{C}$  before the tests and then cooled down to room temperature VW 50554 – 2.

### 3.5 Zinc coating

See table 2.

**Table 2 – Zinc coating**

OfI-x632, OfI-x638	OfI-c310, OfI-c330, in exceptional cases OfI-c340 as per TL 217 <sup>a)</sup>
OfI-x633, OfI-x639	Zinc coatings as per DIN EN 10152, DIN EN 10346, VW 50065, or drawing
OfI-x640	Zinc coating as per drawing
<sup>a)</sup> An electrolyte with the lowest possible amount of brighteners in the electrolyte must be used for electro-galvanizing to ensure optimal adhesion of the paint finish.	

### 3.6 Pre-treatment

See table 3.

**Table 3 – Pre-treatment**

OfI-x632, OfI-x638	Zinc phosphating, preferably tri-cation phosphating (zinc, nickel, and manganese); in exceptional cases for electrolytic zinc coating OfI-c340 with additional Cr(VI)-free passivation layer
OfI-x633, OfI-x639	Zinc phosphating, preferably tri-cation phosphating (zinc, nickel, and manganese)
OfI-x640	Tri-cation phosphating (zinc, nickel, and manganese) or alternatively, equivalent nickel-free systems

### 3.7 Coating thickness

See table 4.

**Table 4 – Coating thickness**

OfI-x632, OfI-x633	15 $\mu\text{m}$ to 30 $\mu\text{m}$
OfI-x638, OfI-x639	30 $\mu\text{m}$ to 60 $\mu\text{m}$
OfI-x640	<ul style="list-style-type: none"> <li>– Outer/inner area 17 <math>\mu\text{m}</math> to 22 <math>\mu\text{m}</math></li> <li>– Cavities <math>&gt; 10\text{ }\mu\text{m}</math></li> </ul>

### 3.8 Adhesion and brittleness

Cross-cut test as per DIN EN ISO 2409.

The test must be performed using adhesive tape with a bond strength of  $(10 \pm 1)$  N per 25 mm width. The adhesive tape must be firmly pressed onto the surface by hand with the cross cut applied, and then pulled off with an abrupt movement perpendicularly to the surface.

Requirement: characteristic  $\leq 1$

NOTE 1: For this test, e.g., tesa® 4657<sup>1)</sup> is suitable.

### 3.9 Stone-chip resistance

Test as per DIN EN ISO 20567-1, method B with visual examination.

If the test cannot be performed on the components – for example, due to their geometry – a reference examination must be performed on accordingly painted sheets.

Requirement: characteristic  $\leq 2$

### 3.10 Corrosion resistance

#### 3.10.1 Corrosion cycle test

Test as per PV 1210 with scribe mark<sup>2)</sup>; evaluation as per DIN EN ISO 4628-8

Laser-printed part markings on the surface, such as QR codes for example, must still be readable after the test and must not have clearly visible corrosive impairments in the area of the laser marking. Slight zinc corrosion in the adjacent area with a width of 1,5 mm is permissible.

#### Requirements for OfI-x632, OfI-x633, and OfI-x640:

- After a test duration of 5 cycles:  
No surface changes, including cut edges and welds
- After a test duration of 15 cycles:  
No blistering and no zinc corrosion on the surface; isolated occurrences of zinc corrosion and blistering are permissible at cut edges and welds, loss of adhesion d at scribe mark  $< 1,5$  mm
- After a test duration of 30 cycles:  
No blistering and no zinc corrosion on the surface outside the scribe mark; slight zinc corrosion and blistering are permissible at cut edges. The requirement as per section 3.8 must be fulfilled. For OfI-x633 and OfI-x640, isolated occurrences of base metal corrosion are permissible at cut edges.

<sup>1)</sup> tesa® 4657 is the manufacturer's product designation. It is produced by tesa SE.

This information is only intended for informational purposes for the users of this in-house standard. This does not signify an endorsement of the mentioned product by the Volkswagen Group. Equivalent products may be used if it can be verified that they lead to the same results.

<sup>2)</sup> Scribe mark as per DIN EN ISO 9227, appendix C.4 and DIN EN ISO 9227; scribing tools are permissible as per DIN EN ISO 9227, which produce rectangular or trapezoidal scribe mark profiles (Sikkens scribing tool), or as per DIN EN ISO 17872, appendix A, which produce U-shaped scribe mark profiles (van Laar scribing stylus).

### Requirements for OfI-x638 and OfI-x639:

- After a test duration of 5 cycles:  
No surface changes, including cut edges and welds
- After a test duration of 30 cycles:  
No blistering and no zinc corrosion on the surface; isolated occurrences of zinc corrosion and blistering are permissible at cut edges and welds, loss of adhesion d at scribe mark < 2,5 mm
- After a test duration of 60 cycles:  
No blistering and no zinc corrosion on the surface outside the scribe mark; slight zinc corrosion and blistering are permissible at cut edges. The requirement as per section 3.8 must be fulfilled. For OfI-x639, isolated occurrences of base metal corrosion are permissible at cut edges.

### 3.10.2 Constant condensation-water atmosphere (CH)

Testing in standard atmosphere CH as per DIN EN ISO 6270-2, test duration 240 h; the specimens are then acclimatized for 30 min at room temperature VW 50554 – 2 .

Requirements:

- No blistering, no zinc corrosion, no base metal corrosion; the requirement as per section 3.8 must be fulfilled.

### 3.11 Resistance to chemicals

The paint supplier must test and ensure the resistance to chemicals.

Testing in oils and brake fluid only for parts used in the engine compartment.

As part of the initial sample inspection, resistance to chemicals may also be demonstrated by a certificate issued by the coating material manufacturer.

Test media and requirements must be taken from table 5.

**Table 5 – Resistance to chemicals**

No.	Test medium	Requirement	
		Single-layer liquid paint	Cathodic electrocoating
1	For all parts		
1.1	Mineral Oil and Fuel Standardization Committee FAM B test fuel as per DIN 51604-2. Test as per DIN EN ISO 2812-4, method A, 10 min at room temperature VW 50554 – 2	Characteristic $\leq 2$ , but characteristic $\leq 1$ after rest period of 5 h	Evaluation after  1. 1 h at room temperature as per VW 50554 – 2 No visible changes, if changes occur, carry out step 2
1.2	B7 diesel fuel as per TL 788-B Test as per DIN EN ISO 2812-4, method A, 10 min at room temperature VW 50554 – 2		2. 2 h at 60 °C reflow aging; No visible changes
2	Only for parts in the engine compartment		
2.1	Factory-fill engine oil as per TL 52167 Test as per DIN EN ISO 2812-4, method A, 60 min at room temperature VW 50554 – 2	Characteristic $\leq 2$ , but characteristic $\leq 1$ after rest period of 5 h	Evaluation after  1. 1 h at room temperature as per VW 50554 – 2 No visible changes, if changes occur, carry out step 2
2.2	Hydraulic fluid as per TL 52146 Test as per DIN EN ISO 2812-4, method A, 16 h at room temperature VW 50554 – 2		2. 2 h at 60 °C reflow aging; No visible changes
2.3	Brake fluid as per TL 766-Z Test as per DIN EN ISO 2812-4, method A, 60 min at room temperature VW 50554 – 2		
3	Only for coolant pipes		
3.1	Coolant as per TL 774, blend L5 aging for 500 h at 90 °C	Not permissible	Detachment or blistering of the coating and fading of the coating to gray are not permissible.

#### 4 Applicable documents

The following documents cited in the standard are required for the application of this standard:

Some of the cited documents are translations from the German original. The translations of German terms in such documents may differ from those used in this standard, resulting in terminological inconsistency.

Standards whose titles are given in German may be available only in German. Editions in other languages may be available from the institution issuing the standard.

PV 1210	Body and Add-On Parts/Hang-On Parts; Corrosion Test
QP A001	Prelubricant, Hot-Melt Adhesive, Blank Washing Oil, Drawing Compound, Slushing Oil (General-Type)
TL 217	Zinc Coatings for Batch-Galvanized Components; Surface Protection Requirements
TL 52146	Hydraulic Oil; Lubricant Requirements

TL 52167	Factory-Fill Engine Oil SAE 5W-40; Lubricant Requirements
TL 766	Brake Fluid; Material Requirements
TL 774	Ethylene-Glycol-Based Coolant Additive; Materials Requirements
TL 788	Diesel Fuel; Fuel Requirements
VW 01088	Workpiece Edges; Definitions, Drawing Specifications
VW 01155	Vehicle Parts; Approval of First Supply and Changes
VW 13750	Surface Protection for Metal Parts; Surface Protection Types, Codes
VW 50065	Flat Products Made of Steel for Cold Working; Material Requirements; updated translation: 2021-05
VW 50554	Standard Atmospheres and Room Temperatures; Requirements on Standard Atmospheres
VW 91101	Environmental Standard for Articles; Material and Chemical Conformity
DIN 51604-2	FAM-testing fluid for polymer materials - Composition and requirements - Part 2: Testing Fluid B, containing methanol
DIN EN 10152	Electrolytically zinc coated cold rolled steel flat products for cold forming - Technical delivery conditions
DIN EN 10346	Continuously hot-dip coated steel flat products for cold forming - Technical delivery conditions
DIN EN ISO 17872	Paints and varnishes - Guidelines for the introduction of scribe marks through coatings on metallic panels for corrosion testing
DIN EN ISO 20567-1	Paints and varnishes - Determination of stone-chip resistance of coatings - Part 1: Multi-impact testing
DIN EN ISO 2409	Paints and varnishes - Cross-cut test
DIN EN ISO 2812-4	Paints and varnishes - Determination of resistance to liquids - Part 4: Spotting methods
DIN EN ISO 4628-8	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 8: Assessment of degree of delamination and corrosion around a scribe or other arti...
DIN EN ISO 6270-2	Paints and varnishes - Determination of resistance to humidity - Part 2: Condensation (in-cabinet exposure with heated water reservoir)
DIN EN ISO 9227	Corrosion tests in artificial atmospheres - Salt spray tests

## 5 Bibliography

- [1] TL 178 – Cathodic Electrocoating of Body Skin Parts Made from Aluminum Semi-Finished Products; Surface Protection Requirements