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Motor Vehicle Connectors

Tests

Previous issues

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Changes

The following changes have been made to VW 75174: 2018-06:

- Table 1 and Table 2: References corrected
- Section 5.1: Cross section value changed
- Section 6.3: P 2.1 corrected; P 1.2 deleted
- Section 6.9: Batch size and P 8.2 corrected
- Section 6.18: Table 9 footnote "acceleration" corrected
- Section 6.20: L 19.2: Time specification corrected
- Section 6.21: L 20.1 corrected; L 20.2 added; L 20.3: Temperature changed from -20 °C to -40 °C
- Section 6.24: L 23.3 air temperature changed from 120 °C to T_{max}
- Section 6.31: P 0.1, L 20.1, P 29.2, P 0.1 deleted
- Table D.1: Resistance limits for 0.22 mm^2 and 0.35 mm^2 corrected
- Appendix E: Information corrected

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1 Scope

This Volkswagen standard (VW) specifies the requirements, tests, and test conditions for connectors used in motor vehicles.

Connectors are used to disconnect and connect cables in the motor vehicle. They are used to electrically and mechanically connect components or modules tom form functional units or to disconnect them from each other.

2 Abbreviations

L	Load
CPA	Connector position assurance
P	Determination of properties
SWS	Single-wire seal
ISIR	Initial sample inspection report
$F_{primary}$	Primary locking device pull-out strength
F_C	Closing force
$F_{C\ NOK}$	Not-OK (NOK) closing force
$F_{secondary}$	Secondary locking device pull-out strength
F_O	Opening force
CC	Climatic chamber
L_{APeak}	Peak level of locking noise
TG	Test group
p_0	Interior pressure, theoretically determined
p_{max}	Maximum measured holding pressure
R_V	Volume resistance
R_{Ins}	Insulation resistance
RT	Room temperature VW 50554 – 2
SE	Severity
SMBT	Slow-motion bend test
SOR	Sine-on-random
T	Read cycle time
T_{max}	Limit temperature
T_u	Upper cycle temperature
T_l	Lower cycle temperature
TC	Temperature change
V	Test voltage, DC

3 Definitions

Crimp	Connection between a contact and a cable (joining by plastic deformation) NOTE 1: For alternative connection techniques such as welding or soldering, the test conditions and requirements apply accordingly.
Scoop-proofing	Construction mechanism that prevents damage to the male multipoint connector when the connectors are mated at a skewed position
CPA	Part of the connector that assumes an acknowledgment function after a properly locked and latched mating process

4 Testing systematics

4.1 Structure of test numbers

First letter:

L	Load
P	Determination of properties
TG	Test group

First number:

The test group (TG) in which the test is first used

Second number:

Consecutive number

Final letter (optional):

A or no letter	Test for general requirements
L	Test for water-tight requirements
C	Test for increased requirements
D	Special testing

4.2 Loads and properties testing

4.2.1 Loads

See table 1

Table 1 – Overview of all loads

TG	Load type	Reference
L 5.1	"Inserting and extracting" one half of the batch size	See section 6.6
L 5.2	All devices under test (DUTs) are inserted	See section 6.6
L 5.3	Aging in dry heat, plugged	DIN EN 60068-2-2* VDE 0468-2-2, Test B
L 6.1	Drop test	DIN EN 60068-2-31* VDE 0468-2-31
L 8.1	Removing the contacts from the chamber 3 times	See section 6.9
L 11.1	Number of mating cycles	See section 6.12
L 15.1	The DUTs are inserted 2 x and extracted 2 x	See section 6.16
L 15.2	Temperature cycle/current cycle durability testing	See section 6.16
L 15.3	Damp heat, cyclic	DIN EN 60068-2-30
L 16.1	Friction load	See section 6.17
L 17.1	Dynamic load, sinusoidal	DIN EN 60068-2-6* VDE 0468-2-6
L 17.2	Dynamic load, broadband noise	DIN EN 60068-2-64* VDE 0468-2-64
L 17.3	Shock durability testing	DIN EN 60068-2-27* VDE 0468-2-27
L 18.1	The DUTs are inserted and extracted 2 x	See section 6.19.2
L 18.2	Salt spray, cyclic	DIN EN 60068-2-52
L 18.3	Salt spray with "Nordic-country salt," cyclic	DIN EN 60068-2-52
L 19.1	Thermal shock	DIN EN 60068-2-14* VDE 0468-2-14, Test Na
L 19.2	Temperature change	DIN EN 60068-2-14* VDE 0468-2-14, Test Nb
L 19.3	Aging in dry heat	DIN EN 60068-2-2* VDE 0468-2-2, Test B
L 19.4	Industrial climate (multi-component climate)	DIN EN 60512-11-7
L 19.5	Damp heat, cyclic	DIN EN 60068-2-30, Variant 2
L 19.6	Dynamic load, broadband noise	DIN EN 60068-2-64* VDE 0468-2-64
L 19.7	Mechanical shock testing (single shocks)	DIN EN 60068-2-27* VDE 0468-2-27
L 19.8	Extracting and inserting 1x	See section 6.20

TG	Load type	Reference
L 20.1	Aging in dry heat	DIN EN 60068-2-2* VDE 0468-2-2, Test B
L 20.2	Damp heat, constant	DIN EN 60068-2-30
L 20.3	Low-temperature aging	DIN EN 60068-2-1* VDE 0468-2-1
L 20.4	Extracting and inserting at -20 °C	See section 6.21
L 20.5	Aging in dry heat	DIN EN 60068-2-2* VDE 0468-2-2, Test B
L 21.1	Long-term aging in dry heat	DIN EN 60068-2-2* VDE 0468-2-2, Test B
L 22.1 A	Resistance to chemicals (general requirements)	See section 6.23.1
L 22.1 B	Resistance to chemicals (water-tight design)	See section 6.23.2
L 23.1	Immersion with pressure difference	DIN EN 60512-14-5, DIN EN 60068-2-13
L 23.2	Cable movement during immersion with pressure difference	See section 6.24
L 23.3	Thermal shock test	See section 6.24
L 23.4	Degree-of-protection testing/pressure washer test	ISO 20653
L 24.1	Dip painting	See section 6.25
L 27.1	Dynamic load, 1 000 h, sinusoidal	DIN EN 60068-2-6* VDE 0468-2-6
L 28.1	Aging	See section 6.29
L 31.1	Aging process (simulation of the soldering process)	See section 6.31

4.2.2 Properties testing

See table 2

Table 2 – Overview of all properties tests

TG	Properties test	Reference
P 0.1	Visual inspection	DIN EN 60512-1-1
P 0.2	Volume resistance	See section 6.1
P 0.2.1	Volume resistance in the contact area	DIN EN 60512-2-1
P 0.2.2	Volume resistance in the connecting area	DIN EN 60512-2-1
P 0.3	Insulation resistance	DIN EN 60512-3-1
P 1.1	Dimensions	DIN EN 60512-1-2
P 1.2	Dimensions of processed components	DIN EN 60512-1-2
P 2.1	Materials testing, contact parts	See section 6.3
P 2.2	Markings on the visible surface	See section 6.3
P 3.1	Materials testing, contact housing	See section 6.4
P 3.2	Markings on the surface	See section 6.4
P 4.1	Contact overlap	DIN EN 60512-1-3

TG	Properties test	Reference
P 5.1	Contact opening dimension	See section 6.6
P 5.2	Contact normal force	See section 6.6
P 6.1	Pointing accuracy of the contacts in the contact housing cavity (manufacturer's specification)	See section 6.7
P 6.2	Function of the primary locking device/latch play	See section 6.7
P 6.3	Function of the secondary locking device/latch play	See section 6.7
P 6.4	Actuation forces of the secondary locking device	See section 6.7
P 7.1	Distinctiveness of the contact housings (unequipped contact housings)	DIN EN 60512-13-5
P 7.2	Holding force of the contact housing latch/lock (unequipped contact housings)	DIN EN 60512-15-6
P 7.3	CPA function check	See section 6.8
P 7.4	Insertion force or actuation force for insertion and extraction aids	See section 6.8
P 8.1	Determining the contact insertion forces	See section 6.9
P 8.2	Contact pull-out strength from the contact housing	See section 6.9
P 8.2.1	Contact pull-out strength from the contact housing, primary locking device only	See section 6.9
P 8.2.2	Contact pull-out strength from the contact housing, secondary locking device only	See section 6.9
P 9.1	Determining the contact opening dimension, pin tip position, and pin geometry	See section 6.10
P 9.2	Max. possible pin insertion angle	See section 6.10
P 9.3	Scoop proof testing of contact housing	DIN EN 60512-1-4
P 10.1	Conductor pull-out strength (only in connection with crimp)	See section 6.11
P 10.2	Pull-out strength from the insulation displacement connector (only in connection with insulation displacement connector)	See section 6.11
P 11.1	Insertion and extraction force, without additional lubricants	See section 6.12
P 12.1	Current overtemperature	DIN EN 60512-5-1
P 12.2	Derating without contact housing	DIN EN 60512-5-2
P 13.1	Current overtemperature with contact housing	See section 6.14
P 13.2	Derating with contact housing	See section 6.14
P 14.0	Volume resistance, continuous monitoring, recording, and saving	DIN EN 60512-2-2
P 14.1	Thermal time constant	See section 6.15
P 16.0	Volume resistance, continuous monitoring, recording, and saving	DIN EN 60512-2-2
P 21.1	Function check	See section 6.22

TG	Properties test	Reference
P 28.1	Locking noise	See section 6.29
P 29.1	Theoretical determination of the internal pressure p_0	See section 6.30
P 29.2	Determining the holding force of the cavity plugs p_{max}	See section 6.30
P 31.1	"Pin/blade" holding force	See section 6.31

4.3 General requirements

All test procedures (as per VW 75174-3) including slow motion testing (as per VW 75174-2) must be performed as per the test matrix specified in VW 75174-1.

A cover sheet must be prepared for the test report, providing a summary of all tests performed and the respective test results of "passed" or "failed". Any deviations from the test conditions must be agreed with the appropriate department in advance, the reasons for the deviations must be stated, and the deviations must be clearly documented.

All DUTs for each TG must be described (e.g., OEM part number, supplier part number, International Material Data System (IMDS) number, manufacturer, date of manufacture, place of manufacture, cavity number, material, surfaces used).

This also applies to any corresponding mating pieces (e.g., pin contacts or device connectors). For all tests, it must be ensured that the DUTs correspond to the applicable drawing documents and product specifications.

The measurement frequency for continuously monitoring the measured values is defined in the appropriate PGs. The measured values must be recorded, stored, and represented for later evaluation.

If the TG does not contain a specification, the supplier must determine an appropriate measurement frequency.

Test reports will be accepted if the tests were performed by an independent institute that is accredited as per DIN EN ISO/IEC 17025. Acceptance of these test reports does not automatically result in a release.

Unless otherwise specified, the test report must include the following values:

Maximum value, average, and minimum value, as well as the standard deviation for all DUTs.

For resistances, the initial value, final value, standard deviation, and the resistance change of the respective DUT must be stated.

Unless otherwise specified, all tests must be performed with production parts. Selecting, lubricating, cleaning, or otherwise manipulating the DUTs is not permissible.

Only cables released as per VW 60306-1 and VW 60306-2 may be used for testing. The selected cable materials must be appropriate. The selected cable must not have a positive influence on the test result. In individual cases, an agreement must be reached with the department responsible for issuing the release. The cable types used must be documented in the test report.

Within a TG, all properties tests or loads must be performed on the DUTs of this TG. It is not permissible to transfer results of a test/load from one TG to another.

Input values of the TG can be transferred to or from TG 0.

All tensile tests must be performed at a speed of 50 mm/min.

5 Determining the volume resistance

The volume resistance is measured according to the four-terminal sensing method.

At each measuring point (e.g., contact), the cable at both ends (e.g., approx. 100 mm of cable each) is included in the measurement. The cable length must be subtracted from the resistance measurements, i.e., the reference cable with the corresponding cable length is included in the measurement.

The adjusted values of the resistance in mΩ and the value of the reference cable must be documented. These values are calculated from the voltage drop and from the measured current.

There are 2 measurement setups for resistance measurements:

5.1 Volume resistance determination for P 0.2

Description:

"Millivolt level method" ("dry circuit method") as per DIN EN 60512-2-1

The measurement is used to determine the before and after resistance values.

Properties:

In order to prevent the applied voltage from flowing through any pollution layers that may be present on the DUT, the terminal voltage for the open-circuit case is limited to 20 mV DC voltage. The maximum current in the event of a short circuit is limited to 100 mA. These devices generally operate in "current reverse mode", and the determined resistance is referred to as "dry circuit resistance".

While the test current may be indicated in the data sheet, the voltage drop at the contact (measurand) is not available to the user because the determined resistance is indicated directly. The terminal voltage applied during the measurement is generally less than the limit. The test current is the current that actually flows during the measurement. This current is less than the current limit. The test current is stored in the device or measuring mode as a fixed value. This measurement method is preferred for cable cross sections ≤ 10 mm^2.

For cable cross-sections > 10 mm^2, nanovoltmeters must be used. After the resistance measurement under dry circuit conditions have been completed, higher currents may be used in addition for an exact resistance measurement (minimal dispersion of measurement values).

Measurement setup:

See figure 1

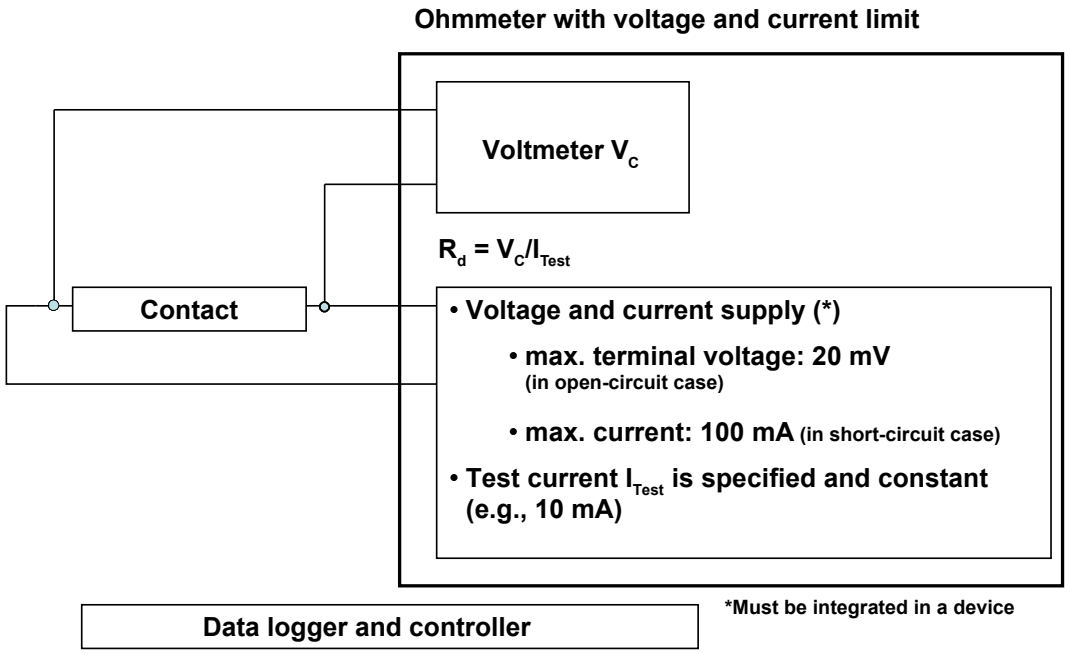


Figure 1 – Measurement setup P 0.2

5.2 Volume resistance determination for P 14.0

Description:

The measurement is performed with the specified current as per DIN EN 60512-2-2

The measurement is used to determine the loading of the contact with currents that extend from the mA-range far into the power range.

The current is specified in the corresponding PGs.

Properties:

The temperature is measured at different amperages after the contact has heated up (e.g., at the current overtemperature curve).

The voltage drop is measured as a function of the amperage.

The test current is provided for the case in which the voltage drops on the supply cables are greater than the limited terminal voltage from P 0.2 (see section 5.1). In this case, the DUTs are continually monitored at a certain measurement frequency.

Deviating from DIN EN 60512-2-2, the current may flow in one direction only.

Measurands (depending on the TG):

Voltage drop and temperature

Documentation (depending on the TG):

Resistance and temperature

NOTE 2: The voltage drop is not sufficient for documentation and monitoring (see section 5).

Measurement setup:

See figure 2

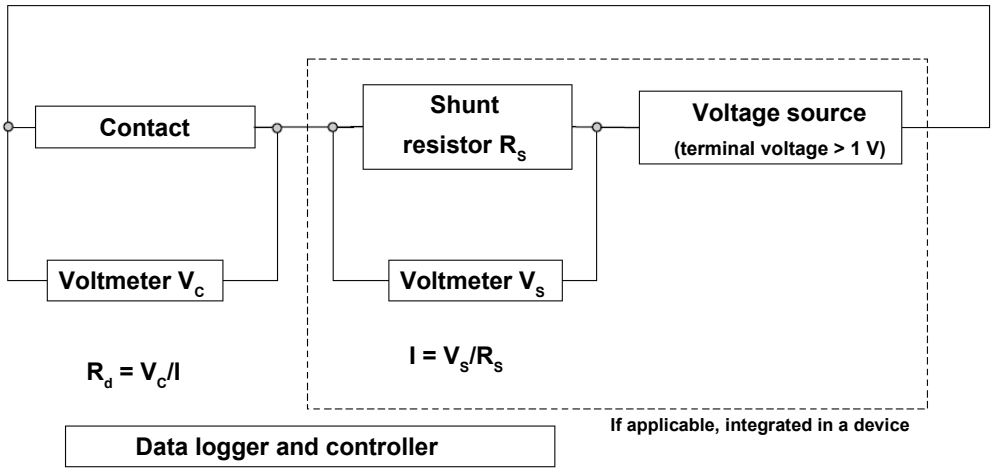


Figure 2 – Measurement setup P 14.0

5.3 Volume resistance determination for P 16.0

Description:

Analogous to P 0.2, however deviating for the continuous determination of the resistance (instead of a before-and-after determination, the resistance is measured continuously)

Properties:

Dry-circuit condition:

Terminal voltage limited to 100 mV in the open-circuit case (direct voltage)

Short-circuit current limited to 100 mA

Measurement setup:

Analogous to the measurement setup in figure 1

5.4 Applying the measurement methods in the PGs

See table 3

Table 3 – Use of the setups

TG	P 0.2 Dry circuit conditions; resistance determination before and after	P 14.0 "prescribed current"; continuous load/monitoring; the amperage is defined in the TG; measurands are TG-specific (voltage drop or temperature); documentation is TG-specific (resistance or temperature)	P 16.0 Dry circuit conditions; continuous resistance monitoring
0	X	-	-
12	-	X	-
13	-	X	-
14	-	X	-
15	X	X	-
16	-	-	X
17	X	X	-
18	X	-	-
19	X	X	-
21	X	-	-

6 Test scopes

6.1 TG 0 – Inspection of as-received condition

Purpose: Basic examination of all contact and contact housing parts in the unused condition, without prior loads.

Requirement:

Any deviations from a given target state must be determined

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

Contact parts: All variants that occur

Contact housings: All variants that occur

SWS: All variants that occur

The basic mechanical functions of the connector must be checked as part of the visual inspection.

P 0.2 Volume resistance as per DIN EN 60512-2-1

Contact parts: 10 DUTs per variant

Cable cross-section: All cable cross-sections that occur

Type of test:

P 0.2.1 Volume resistance in the contact area as per DIN EN 60512-2-1

P 0.2.2 Volume resistance in the connection area as per DIN EN 60512-2-1

Requirement:

The measured values must correspond to the manufacturer's specifications. The limits must be adhered to (see appendix D) and the measured values (initial value, final value, standard deviation, and resistance change for the respective DUTs) must be documented in the test report accordingly.

P 0.3 Insulation resistance as per DIN EN 60512-3-1

Contact parts: Any

Contact housings: 1 contact housing per cavity

Insulation resistance between all adjacent contacts (see figure 3)

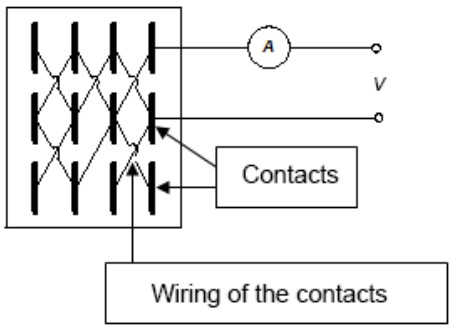


Figure 3 – Insulation resistance measurement setup

Requirement:

R_{ins} > 100 MΩ at V = 500 V, t = 60 s

6.2 TG 1 – Dimensions

Purpose: Dimension check on all contact parts, contact housing parts, and SWS

Batch size: 1 piece per mold or cavity

Contact parts: All crimped and non-crimped variants that occur; see appendix A for permissible double crimps

Contact housings: All variants that occur

SWS: All variants that occur

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 1.1 Dimensions as per DIN EN 60512-1-2

Requirements:

The measured values must correspond to the release drawing or the product specification. Measurement values must be provided in the measurement report.

Furthermore, all function-relevant dimensions for tightness, locking and latching geometries, clearances, and creepage distances, as well as the most important dimensions that ensure scoop-proofing and contact overlap must be documented. These measurements (ISIR dimensions and design dimensions) must be indicated in the release drawing. All scopes must be documented in a measurement report.

P 1.2 Dimensions (of processed components) as per DIN EN 60512-1-2

Requirement:

The measured values of processed contacts (crimp parameters, mircosections) must correspond to the release drawing and the product specification.

6.3 TG 2 – Materials and surface analysis, contacts

Purpose: Determining all materials parameters of the metal parts

Batch size: 5

Test subject: All materials and surfaces that occur

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 2.1 Materials testing, contact parts

Requirements:

The materials test must be verified for all individual parts of the contact (contact area and cable area).

All materials must be documented in the manufacturer's product specification.

1. Materials verification for the base material:

   Data sheets must be attached to the test report as verification:

   - Materials certificate
   - Electric conductances
   - Tensile strength

- Modulus of elasticity of the contact spring

2. Materials verification for the surface:
   - Materials certificates
   - Measurement of coating thickness in the completed contact area and the cable connection area
   - Measurement of surface roughness (if limits are specified, e.g., in drawings)
   - Verification that the surface was not damaged by the production process

P 2.2 Markings on the visible surface

The markings on the contact must be visible after processing (e.g., crimping), i.e., all information required as per the drawing must be legible and unambiguous.

Requirements:

– Confirmation that all materials are in conformance with applicable legal requirements and with the drawings
– Function-relevant pores, cracking, or other damage to the surface in the contact zone area and cable connection area are not permissible.
– The contact labels must be recognizable after processing. The nomenclature must be described in the product specification.
– The breakdown of the materials used must be available in the IMDS.

6.4 TG 3 – Materials and surface analysis, contact housings and SWSs

Purpose: Recording all materials parameters of the plastic and silicone parts

Batch size:	1 component per cavity
Contact housings:	All variants that occur
SWS:	All variants that occur

Type of test:

P 0.1 Visual inspection (evaluate injection faults, e.g., burrs) as per DIN EN 60512-1-1

P 3.1 Materials testing for contact housings and SWSs

Requirements:

Materials testing must be verified for the SWS and for all individual contact housing parts (incl. slides, CPA, sealing elements, and similar). Data sheets must be attached to the test report as verification. The proportion of the component's recycled sprue material must be documented in the release drawing.

All materials must be documented.

1. Verification of the materials:
   - Materials certificate and declaration of all possible materials
   - RAL colors (for all keyings)
2. Verification of the surface quality:
   - Measurement of the maximum permissible burrs in function-relevant locations

- Measurement of surface roughness (if limits are specified, e.g., in drawings) and verification that the surface was not damaged by the production process

P 3.2 Markings on the surface

The markings must be visible:

All contact housing labels required as per the drawing must be legible and unambiguous.

The markings on contact housing components must be visible after processing (e.g., manufacture of the wiring harness), i.e., all information required as per the drawing must remain legible and unambiguous.

Requirements:

Flash skins, tool offsets, and flashes must not have a negative effect on handling and function.

Burrs, tool offset, etc. are permissible only to the extent specified in the drawing.

Burrs are not permissible on actuation surfaces. Burrs, tool offset, or part markings are (owing to the design) not permissible on surfaces that come into contact with seals.

The breakdown of the materials used must be available in the IMDS.

6.5 TG 4 – Contact overlap

Purpose: Verifying the minimum required contact overlap under all worst conditions, including using theoretical studies (e.g., CAD)

Batch size:	3 contact housings (fully equipped up to 5-pin; for 6-pin and above, with 5 contacts)
Contact parts:	All variants, any conductor cross section and any surface
Contact housings:	All variants, any keying, and any color

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 4.1 Contact overlap

The contact overlap and the required clearance (as per the manufacturer's specifications) from the pin tip to the contact bottom must be verified by numerical simulation under all worst conditions of the contacts and contact housings and their locks (including, e.g., pulling on the cable until all locks are at the stop). The contact pin and the contact socket may only touch at their contact points.

Contact overlap definition (see figure 4)

NOTE 3: Contact overlap is the length of the contact pin at full width that enters the contact socket. Contact overlap is measured from the contact point of the socket contact to the end of the chamfer at the full width (in deviation from DIN EN 60512-1-3). The distance between the pin tip and the contact bottom is called the clearance. This clearance is mandatory for the floating support of the contact in the connector cavity and must still be present taking into consideration all tolerances of the pin/socket pair.

Requirements:

Contact overlap: > 1.00 mm for all contact points
Clearance: > 0 mm in the worst case
A tolerance stack-up analysis with dimensional specification is required.

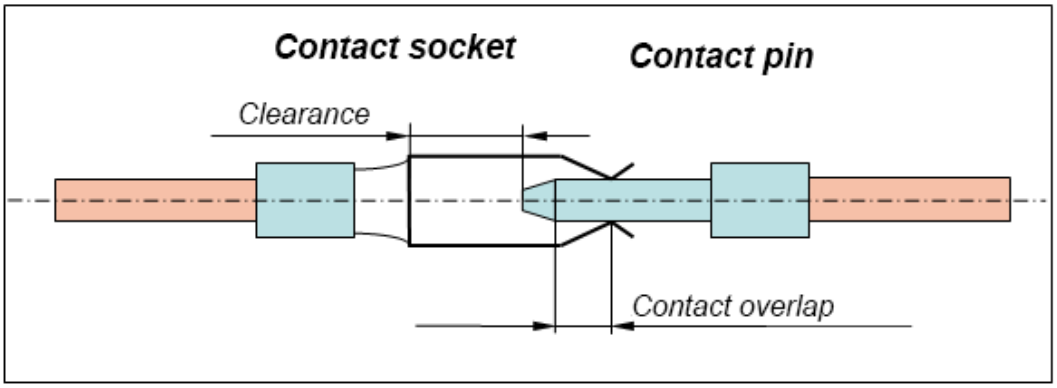


Figure 4 – Contact overlap of a pin/socket pair

6.6 TG 5 – Mechanical and thermal relaxation behavior

Purpose: Functional evaluation of the upper limit temperature (= T_{max}) of the contact system as specified by the manufacturer and of the normal force.

Batch size: 5 test batches of 10 contact parts each per sampling time

Contact parts: All materials and design variants that occur in the contact area

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 5.1 Contact opening dimension in the unused condition (optical measurement) – all test batches

L 5.1 One half (5 pieces each) of all test batches is inserted and extracted 5 times before further loading.

P 5.1 Contact opening dimension of the DUTs inserted 5 times (optical measurement) – all test batches

P 5.2 Contact normal force

Determining the normal contact force – on test batch 1

The measuring method must be documented. Indirect measurement is permissible.

L 5.2 All DUTs of test batches 2 to 5 are inserted. The DUTs must remain connected until the measurement of the contact opening dimension and the normal contact force.

L 5.3 Aging in dry heat, plugged, as per DIN EN 60068-2-2* VDE 0468-2-2, Test B

Duration: 1 000 h

T_{max}: Limit temperature from derating curve (/= 0 A)

Test batches 2 to 5 are aged and then successively removed at the respective times (1 h, 100 h, 200 h, 500 h, and 1 000 h), and the normal force is measured.

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 5.1 Contact opening dimension (optical measurement) – on test batches 2 to 5

P 5.2 Contact normal force

Determining the normal contact force on all test batches

The measuring method must be documented. Indirect measurement is permissible.

Requirement:

The normal contact force must be documented.

Graphic representation (semi logarithmic time scale), extrapolated to 3 000 h

Intermediate values at 0 h, 1 h, 100 h, 200 h, 500 h and 1 000 h

The contact opening dimensions must be documented.

6.7 TG 6 – Interaction between contact and contact housing

Purpose: Verifying the function of the connector cavity and of the contact locks

Batch size: 3 fully equipped contact housings for P 6.2 and P 6.3

6 contact housings for L 6.1:

3 fully equipped contact housings, secondary locking device in final latching position

3 fully equipped contact housings, secondary locking device in pre-latching position

3 times 3 unequipped contact housings for P 6.4

Contact parts: Any

Cable cross-sections: Smallest and largest cable cross sections and, if applicable, permissible double crimps, see appendix A

Contact housings: All variants, any keying, and any color

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 6.1 Pointing accuracy of contacts in the contact housing cavity (theoretical verification as per manufacturer's specification)

P 6.2 Function of the primary locking device/latch play (with unused contact housings, see batch size)

P 6.3 Function of the secondary locking device/latch play (with unused contact housings, see batch size)

Requirements:

Pointing accuracy: Based on the connector cavity drawings and the pin drawings, it must be verified that the pin and the contact can be mated without risk of damage. The verification must be provided for the worst case, either graphically or by numerical simulation.

The latch play must be examined on the contact parts in the contact housing cavity. The primary locking device must latch with an audible click. The latch must be checked by pulling (≤ 10 N). At the final stop, it must be possible to lock the secondary locking device. It may only be possible to lock

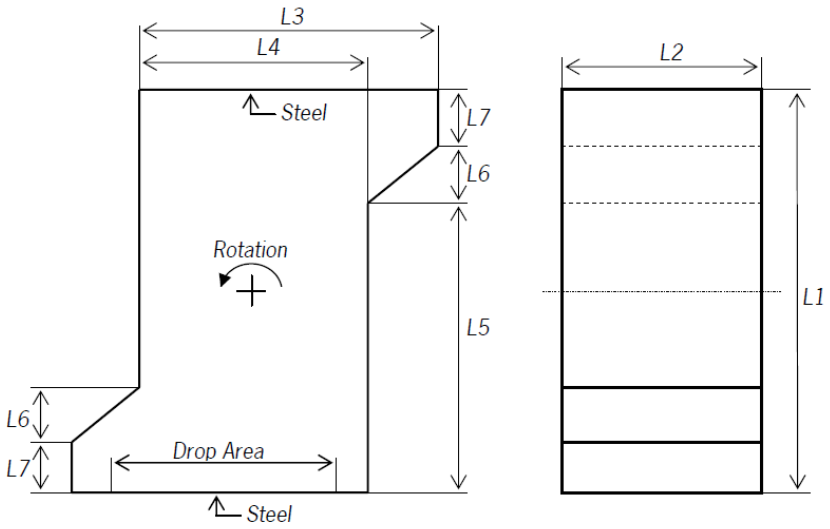
the secondary locking device after all contacts are correctly positioned and locked in the contact housing cavity.

L 6.1 Drop test (with unused contact housings, see batch size)

See figure 5

To test the stability of the contact housing and the locks, the contact housings (with cables cut off right behind the contact housing) are tested in a rotating drum (see DIN EN 60068-2-31* VDE 0468-2-31):

- Test at RT
- All DUTs are tested at the same time
- Rotational speed: e.g., 3 rpm (the speed must be set so that all parts strike in the drop area)
- Number of rotations: 30
- Thickness of the steel plate in the drop area: ≥ 5 mm



Legend

L1 =	1 200 mm	L4 =	500 mm
L2 =	500 mm	L5 =	1 000 mm
L3 =	700 mm	L6 = L7 =	100 mm

Figure 5 – Drop test in drum

P 0.1 Visual inspection as per DIN EN 60512-1-1

Requirements:

– The secondary locking device in pre-latching position (simulation of transport of unequipped contact housings) must not close during the drop test.
– The secondary locking device in final latching position (simulation of transport of equipped contact housings) must not open during the drop test.

P 6.4 Actuation forces for the secondary locking device (each with unused contact housings, see batch size) analogous to table 4

Table 4 – Requirements for actuation forces

Actuation	Condition	Limits
Opening	-	F_O = 10 N to 50 N
Closing	For film hinge, hinge length < 15 mm	F_C < 50 N
Closing	For film hinge, hinge length ≥ 15 mm	F_C < 75 N
Closing	For slide	F_C < 50 N
Closing NOK	At contact position, not in end position	F_C NOK > 3 times F_C
		at least F_C NOK > F_C + 50 N, for blade widths ≥ 0.63 mm
		at least F_C NOK > F_C + 25 N, for blade widths < 0.63 mm

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 6.5 Detecting secondary locking device via test adapter

The cable manufacturer must perform a final inspection on 100% of all parts to ensure that any open or only partially closed secondary locking devices are detected. The cable manufacturer must provide confirmation of this. This must preferably be clarified before tool creation.

6.8 TG 7 – Handling and functional reliability of the contact housings

Purpose: Contact housing testing, verification of the holding forces and actuation forces

Batch size: At least 10 equipped and unequipped contact housings

New components can be used for each of the following properties tests within this TG.

Contact housings: All variants that occur

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 7.1 Distinctiveness of the unequipped contact housings (keying/polarization) as per DIN EN 60512-13-5

P 7.2 Holding force of the contact housing latching/locking as per DIN EN 60512-15-6 (unequipped contact housings)

Applicable to contact housings for inline plug connections and device-mounted plug connections

Sample preparation: 10 complete connector couplings without contacts

If the pin housings are equipped with a CPA, the tests must be performed both with open and closed CPA.

The DUTs must be fastened in the tensile testing machine with suitable holders so that the housings are not damaged or deformed. The force must be applied opposite to the plugging direction of the contact housings. The maximum force on the first displacement millimeter is defined as the holding force (see figure 6).

P 7.3 CPA function check (unequipped contact housings)

P 7.4 Insertion force or actuation force for insertion and extraction aids (fully equipped housings)

The insertion force in the plugging direction or the actuation force of the insertion and extraction aid must be measured. The insertion force (including for insertion aids) must always be measured in the operating direction. The DUTs must be fastened in the tensile testing machine with suitable holders so that the housings are not damaged or deformed.

P 0.1 Visual inspection as per DIN EN 60512-1-1

Requirements:

- Cracks or tears are not permitted anywhere on the entire contact housing, incl. add-on parts (CPA, locks, levers, slides, film hinges, etc.).
- Actuated CPAs must not open as a result of the test.

Keying efficiency:	> 3 times the insertion force (equipped contact housing), however, ≥ 80 N
Polarization efficiency:	> 3 times the insertion force (equipped contact housing), however, ≥ 80 N

The contact housing holding forces must fulfill the requirements as per table 5 and table 6.

For mixed connectors, the value applies to the entire number of contacts and to the largest contact present in the connector.

Insertion/actuation force of fully equipped contact housings: ≤ 75 N

For higher insertion and extraction forces, an insertion/extraction aid (integrated or separate tool) must be provided for.

It must not be possible to actuate the CPA when the contact housing is not locked in the end position.

Alternatively, the CPA must be capable of locking incorrectly seated contact housings.

CPA actuation force when the contact housing is locked in the end position: (5 – 30) N;

CPA efficiency: > 1.5 times the maximum insertion force (equipped contact housing),

however, ≥ 80 N, for blade widths ≥ 0.63 mm

however, ≥ 60 N, for blade widths < 0.63 mm

The properties must correspond to the product specification or the drawing note.

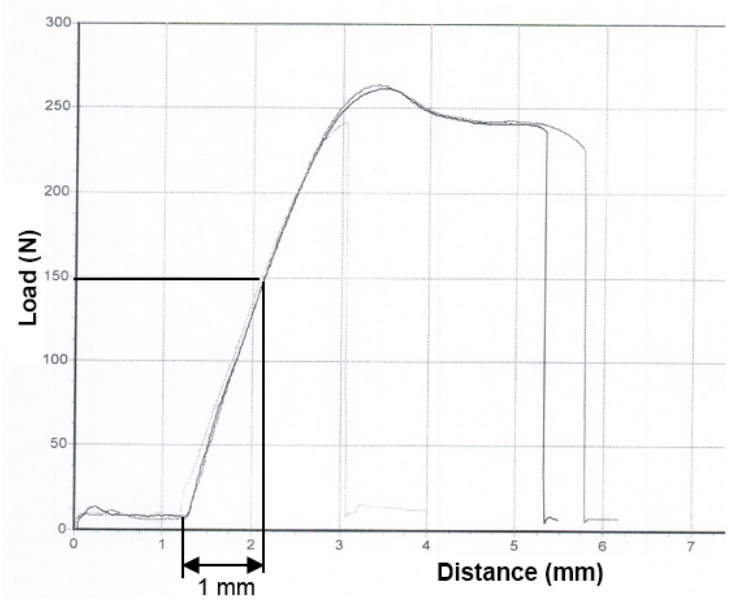


Figure 6 – Load-displacement curve of holding force

Table 5 – Positive-locking contact housing holding forces

Positive-locking contact housing holding forces			
Contact size in mm	Number of pins		
	1 to 2 pins	3 to 6 pins	> 6 pins
0.5	> 40 N	> 50 N	> 60 N
0.63 to 1.2	> 60 N	> 80 N	> 100 N
> 1.2 to 2.8	> 80 N	> 100 N	> 100 N
> 2.8 to 6.3	> 100 N	> 100 N	> 100 N
> 6.3	> 150 N	> 150 N	> 150 N

Table 6 – Friction-locking contact housing holding forces

Friction-locking contact housing holding forces			
Contact size in mm	Number of pins		
	1 to 2 pins	3 to 6 pins	> 6 pins
0.63 to 1.2	> 60 N	> 60 N	a)
> 1.2 to 2.8	> 80 N	> 80 N	a)
> 2.8 to 6.3	a)	a)	a)
> 6.3	a)	a)	a)

a) The values must be agreed upon with the appropriate department in each individual case; the use of positive-locking geometries is preferred.

6.9 TG 8 – Insertion and holding forces of the contact parts in the contact housing

Purpose: Verification of the cable manufacturability and of the contact locks

	Batch size:	At least 3 fully equipped contact housings per cavity, however at least 10 contacts
	Contact parts:	All variants that occur
	Contact housings:	All variants that occur (cavities)
	a) 2 fully equipped contact housings per cavity:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 8.1	Determining the contact insertion forces	
P 8.2	Contact pull-out strength from the contact housing	
P 8.2.1	Contact pull-out strength in the contact housing, primary locking device only (1 contact housing per cavity)	
P 8.2.2	Contact pull-out strength in the contact housing, secondary locking device only (1 contact housing per cavity)	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	b) 1 fully equipped contact housing per cavity (new parts):	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 8.1	Removal of the contacts 3 times with original release tools	
P 8.2	Contact pull-out strength in the contact housing, primary locking device only (1 contact housing per cavity), however at least 10 contacts with the lowest values from P 8.2.1	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Requirements:	
	The insertion forces of the contacts into the connector cavity must be measured and documented.	
	The contact pull-out strengths must correspond to table 7.	
	Testing displacement of primary locking device: $s \leq 1$ mm for required holding forces	

Table 7 – Contact pull-out strengths

Blade width in mm	$F_{primary}$ (locking lance)	$F_{primary}$ (clean body)	$F_{secondary}$
0.5	> 35 N	> 25 N	> 35 N
0.63 to 1.2	> 55 N	> 40 N	> 55 N
1.5 to 2.8	> 80 N	> 60 N	> 80 N
> 2.8 to 6.3	> 120 N	> 80 N	> 120 N
> 6.3 to 8.0	> 180 N	> 110 N	> 180 N
> 8.0	> 200 N	> 150 N	> 200 N

The table applies to parts in unused condition. After 3 removal operations, the measured values are documented.

6.10 TG 9 – Pin insertion angle/misuse-proofing (scoop-proofing)

Purpose:	Verification using contact housings that the occurring skewed insertions cannot damage the contact

	Batch size:	Examination is performed using CAD
	Contact parts:	All variants that occur, provided they can affect the pin insertion angle
	Contact housings:	All variants that occur, provided they can affect the pin insertion angle

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
P 9.2	Max. possible pin insertion angle
	One insertion cycle each at the maximum possible pin insertion angle in the x- and y-directions (z is the insertion direction)
	The examination is performed using CAD.
P 9.1	Determining the contact opening dimension (optical measurement), pin tip position, and pin geometry
P 0.1	Visual inspection as per DIN EN 60512-1-1
P 9.3	Scoop proof testing of contact housing
	Examination is performed using CAD
P 0.1	Visual inspection as per DIN EN 60512-1-1

Requirements for "skewed insertion":

Before the contact pair touches, sufficient guiding of the contact housings must be achieved so that an expansion of the contacts or a bending of the pins is precluded in consideration of the permissible tolerances (worst case, design specifications).

The maximum pin insertion angle possible through contact housing and contact parts must be determined by the manufacturer for each contact housing or each contact and must be indicated on the release drawing. The pin insertion angle must not exceed the value permissible for the contact part.

Corresponding verification must be provided.

If an examination cannot be conducted in CAD, P 9.1 must be performed. The pin tip position and the contact opening dimension must change only within the specified tolerance.

Requirement for "scoop-proofing":

Scoop-proofing is required; appropriate verification must be provided.

During installation/removal, it may only be possible to touch signal- and current-carrying components (contacts) with their corresponding signal- and current-carrying mating piece (and its guide cup). The design must preclude contact with contact housing parts.

6.11 TG 10 – Contacts: Conductor pull-out strength

Purpose:	Evaluating the cable connection at the contact	
	Batch size:	At least 10 contact parts
	Contact parts:	All materials and surfaces that occur in the cable area, crimp height at upper and lower tolerance in each case
	Contact housings:	All variants that occur, for conductor pull-out strength see table 8

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
P 10.1	Conductor pull-out strength (only in connection with crimp)
P 10.2	Pull-out strength from the insulation displacement connector (only in connection with insulation displacement connector)
P 0.1	Visual inspection as per DIN EN 60512-1-1

Requirements:

Conductor pull-out strength from crimp (see table 8)

Table 8 – Conductor pull-out strengths

Cable cross-section (Cu)	Contact size in mm					
	0.5	0.63	1.2 or 1.5	2.8	4.8	9.5
0.35 mm² 0.13 mm² (CuMg)	50 N (75 N)					-
0.5 mm²	-	60 N (85 N)				-
0.75 mm²	-	85 N (105 N)				-
1.0 mm²	-	-	108 N (125 N)		140 N (162 N)	-
1.5 mm²	-	-	150 N (180 N)	150 N (180 N)		-
2.5 mm²	-	-	-	200 N (235 N)		
4.0 mm²	-	-	-	-	310 N (325 N)	
6.0 mm²	-	-	-	-	450 N	450 N
10.0 mm²	-	-	-	-	-	500 N
16.0 mm²	-	-	-	-	-	1 500 N
25.0 mm²	-	-	-	-	-	1 900 N

NOTE 4: If for production reasons, the conductor pull-out strength is measured with insulation crimp/SWS, the values in parentheses apply.

6.12 TG 11 – Contacts: Insertion and extraction forces; number of mating cycles

Purpose: Evaluating the contact surfaces by way of insertions and the forces that occur during these

Batch size:	At least 10 contact parts
Contact parts:	All materials and surfaces that occur
Contact housings:	None; if necessary, with contact housing to mount the contacts (low friction, without seals, latching hooks, etc.)

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
P 5.1	Contact opening dimensions
P 11.1	Insertion and extraction force, without additional lubricants
L 11.1	Number of mating cycles
	Surface:

	Sn:	20 mating cycles (unless otherwise specified)
	Ag:	50 mating cycles (unless otherwise specified)
	Au:	100 mating cycles (unless otherwise specified)
P 5.1	Contact opening dimension	
P 11.1	Insertion and extraction force, without additional lubricants	
P 0.1	Visual inspection as per DIN EN 60512-1-1	

Requirements:

The insertion force may change by at most 25% compared to the initial value.

The insertion and extraction forces must correspond to the drawing or the product specification.

Wearing through of the contact surface is not permissible. Corresponding verification must be provided.

6.13 TG 12 – Current heating, derating

Purpose:	Verifying the current-carrying capacity of contacts	
	Batch size:	3 contact part pairs
	Contact parts:	All surfaces are documented. It is permissible to measure one surface and to derive the values of the other surfaces from it.
	Cable cross-section:	All variants that occur
	Cable length:	As per DIN EN 60512-5-2
	Contact housings:	None

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
P 12.1	Current overtemperature (measurement setup basically like P 14.0) DIN EN 60512-5-1
P 12.2	Derating without contact housing as per DIN EN 60512-5-2
P 0.1	Visual inspection as per DIN EN 60512-1-1

Current overtemperature: Loading with incrementally increasing current and measurement of the current overtemperature

NOTE 5: The limit temperature of the derating graph is documented with the "Electrical stress test" TG one time for each material surface combination of the contact system.

Requirements:

The measured values must correspond to the manufacturer’s specifications.

The following must be marked in the derating graph:

– The statement "In free air" must be included.
– The 80-% characteristic curve of the measured values must be represented in the graph (as per DIN EN 60512-5-2). The nominal current is

the current that can be read from the derating curve at 80 °C ambient temperature.

– The documentation of the results must include the photograph of the contact showing the temperature sensors and the temperature specifications of the respective point. The aim of this examination is to locate the hottest point.
– The pin contact with which the derating has been determined must be specified. The geometry, the base material, and the surface must be described. Unless otherwise agreed, the cable that is attached to the pin contact is the same as the cable that is attached to the socket contact.

6.14 TG 13 – Influence of the contact housing on the derating

Purpose: Determining the maximum influence of the contact housing on the derating by supplying current to all neighboring contacts at the same time.

Batch size:	3 fully equipped contact housings each
Contact parts:	All surfaces are documented. It is permissible to measure one surface and to derive the values of the other surfaces from it.
Cable cross-section:	All cable cross-sections that occur, same cable cross section within one DUT
Cable length:	As per DIN EN 60512-5-2
Contact housings:	Sealed or unsealed contact housings For sealed contact housings, all sealing elements must be present. The number of pins must be agreed upon between the manufacturer and the user.

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 13.1 Current overtemperature with contact housing (measurement setup analogous to P 14.0) as per DIN EN 60512-5-1

The contact is measured for which the maximum temperature influence (e.g., due to adjacent connector cavities) is to be expected.

P 13.2 Derating with contact housing

P 0.1 Visual inspection as per DIN EN 60512-1-1

Current overtemperature: Loading with incrementally increasing current and measurement of the current overtemperature

NOTE 6: The limit temperature of the derating graph is documented with the "Electrical stress test" TG one time for each material surface combination of the contact system.

Requirements:

The measured values must correspond to the manufacturer’s specifications.

The following must be marked in the derating graph:

– The statement "Derating in the contact housing" must be included. The contact housing (incl. number of pins) must be described.
– The 80-% characteristic curve of the measured values must be represented in the graph (as per DIN EN 60512-5-2).

The documentation of the results must contain the following:

– Photograph of the contact arrangement in the contact housing (mating face view)
– Photograph of the contacts with the temperature sensors and the temperature specifications of the respective points. The aim of this examination is to locate the hottest points.
– Derating curves must be provided if contact housings are available; determined using a contact housing selected as an example:
  1. Low-pin (1 to 10 pins)
  2. High-pin (> 10 pins)
– The pin contact with which the derating has been determined must be specified. The geometry, the base material, and the surface must be described. Unless otherwise agreed, the cable that is attached to the pin contact is the same as the cable that is attached to the socket contact.

6.15 TG 14 – Thermal time constant (current overtemperature at n times the nominal current)

Purpose:	Evaluating the temporary exceedance of the maximum current-carrying capacity (peaks)	
	Batch size:	3 contact parts
	Contact parts:	All materials that occur
	Cable cross-section:	Maximum cable cross section
	Cable length:	As per DIN EN 60512-5-2
	Contact housings:	With or without contact housings, equipped with 1 contact part
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 14.0	Measurement setup for P 14.1 is analogous to P 14.0	
	The contact is measured for which the maximum temperature influence (e.g., due to adjacent connector cavities) is to be expected.	
P 14.1	Thermal time constant	
	The nominal current as determined in TG 12 must be used.	
	Test procedure:	
	Loading of a contact with 1/2/3/4/5times the nominal current and simultaneous recording of the temperature curve over time until stabilization occurs or until the max. permissible component temperature is reached.	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 14.2	Determining the contact opening dimension, surface analysis	
	Requirements:	

- The contacts must still be fully functional after the test.
- The measured values must correspond to the manufacturer's specifications.
- Documentation: The graph "Current over time" must be provided.

6.16 TG 15 – Electrical stress testing

Purpose: Functional evaluation of the upper limit temperature of the contact system specified by the manufacturer with current supply during temperature change and humid heat

Batch size:	At least 10 contact parts
Contact parts:	All materials and surfaces that occur
Cable cross-section:	Maximum cable cross section
Cable length:	Must be decided case by case
Contact housings:	Must be decided case by case: free contact or unsealed contact housing

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
L 15.1	The DUTs are inserted and extracted 2 times. The contact is measured for which the maximum temperature influence (e.g., due to adjacent connector cavities) is to be expected.
P 5.1	Contact opening dimension
P 0.2	Volume resistance as per DIN EN 60512-2-1
P 12.2	Derating as per DIN EN 60512-5-2 3 DUTs with the largest volume resistance of the previous P 0.2 Loading with test current, monitoring of the voltage drop on the DUTs, documentation of the resistance on the DUTs. It must be documented whether the test is performed with or without contact housings.
P 14.0	Continuous monitoring of volume resistance during L 15.2 at test current Measurement frequency: 1 measured value per 5 min The test current, the voltage drop, and the measured contact temperature are continuously recorded.
L 15.2	Temperature cycle durability testing/current cycle durability testing Number of cycles: 60 Determination of the upper climatic chamber temperature (T_0) before the start of the test: T_0 is determined once at the start of the test such that after thermal equilibrium is established, the contact temperature corresponds to the limit temperature. Description of the test cycle:

	Temperature in the climatic chamber:	-40 °C / T_0, progression see figure C.1
	Test current I_{test}:	Is read from the derating curve at 80 °C ambient temperature. The test current is constant. Current supply see appendix C
	Contact temperature:	The contact temperature is measured with temperature sensors at the contact in the climatic chamber and is brought to the limit temperature by changing T_0.
L 15.3	Damp heat, cyclic, as per DIN EN 60068-2-30 Number of cycles: 21 (1 day = 1 cycle) Relative humidity: 95%, T_l = *25 °C,* T_u = 55 °C	
P 14.0	Continuous monitoring of volume resistance during L 15.2 at test current Measurement frequency: 1 measured value per 5 min	
L 15.2	Temperature cycle durability testing/current cycle durability testing Number of cycles: 60	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
P 12.2	Derating as per DIN EN 60512-5-2 With the DUTs from previous derating It must be documented whether the test is performed with or without contact housings.	
P 5.1	Contact opening dimension	
P 0.1	Visual inspection as per DIN EN 60512-1-1 **Requirements:** – The contact opening dimension must be documented. – The resistance limits of table D.1 must not be exceeded. – For the derating before and after the test, the current-carrying capacity at 80 °C ambient temperature may change by no more than 20% relative to the derating at the start of the TG.	

6.17 TG 16 – Friction corrosion

Purpose:	Abrasion resistance of the surface finish (destructive test) "Fingerprint" snapshot of the contact surface	
	Batch size:	3 contact parts
	Contact parts:	All material/surface combinations that occur, all lubricants that occur
	Contact housings:	None
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 16.0	Continuous monitoring of volume resistance during L 16.1 Recording and saving: measurement frequency = 4 Hz	
L 16.1	Friction load	

	Friction displacement:	50 µm
	Cycle time:	1 Hz
	Number of cycles:	100 000
	Electrical load:	≤ 100 mV, 10 mA
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Requirements:	
	Graph: Progression of the volume resistance over the number of cycles	
	Specification of the number of friction cycles to achieve the volume resistance of 300 mΩ	
	Specification of lubricants used (material and amount)	

6.18 TG 17 – Dynamic loading

Purpose:	Basic requirements	
	Batch size:	At least 10 contact parts
		Distributed among at least 2 contact housings
	Contact parts:	All variants that occur
	Cable cross-section:	Must be determined case by case
	Contact housings:	Sealed/unsealed, must be determined case by case
	Cables:	The insulation must withstand the test temperature (see section 4.3)
	The cable type (see VW 60306-1 and VW 60306-2) must be documented in the test report.	
	The volume resistance (P 0.2) is measured before and after each spatial axis in the clamped and hardwired state before it is set up for testing along a new axis.	
	Before the vibration test is performed, it must be verified that the clamping fixture is resonance-free by performing a resonance analysis in the specified frequency range with a load of 1 g (this is not a component test but an examination of the test setup).	
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
P 14.0	Continuous monitoring of volume resistance during L 17.1 at test current (100 mA)	
	Measurement frequency: 1 measured value per minute	
L 17.1	Dynamic load, sinusoidal, as per DIN EN 60068-2-6* VDE 0468-2-6	
	Severity:	See table 9
	Dwell time:	1 oct./min
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 14.0	Continuous monitoring of volume resistance during L 17.2 at test current (100 mA)	
	Measurement frequency: 1 measured value per minute	

L 17.2	Dynamic load, broadband noise as per DIN EN 60068-2-64* VDE 0468-2-64
	Severity: see table 9
P 0.1	Visual inspection as per DIN EN 60512-1-1
	NOTE 7: L 17.1 and L 17.2 can also be performed simultaneously (SOR).
P 14.0	Continuous monitoring of volume resistance during L 17.3 at test current (100 mA)
	Measurement frequency: 1 measured value per minute
L 17.3	Shock durability testing as per DIN EN 60068-2-27* VDE 0468-2-27
	Severity: see table 9
P 0.1	Visual inspection as per DIN EN 60512-1-1
P 0.2	Volume resistance as per DIN EN 60512-2-1
L 17.4	Resonance frequency of the contact system
	Determining the resonance frequency of the contact housing parts including contacts and cables under sinusoidal vibration
	Vibration sensors of the smallest dimensions must be affixed to the contact housing, which must not be fastened to the shaker table.
	Dynamic load, sinusoidal, as per DIN EN 60068-2-6* VDE 0468-2-6
	Dwell time: 1 oct./min
	a = 10 m/s^2
	f = 5 Hz – 2 000 Hz – 5 Hz
	Requirement:
	The vibration responses of the contact housing must also be recorded and documented in the test report in the form of a graph along with the excitation profile.

Table 9 – Severities

<table>
<tr><th>Severity</th><th>TC</th><th colspan="2">Noise with TC</th><th>Vibration excitation, sinusoidal, with TC</th><th>Number of shocks</th></tr>
<tr><td rowspan="3">1. "Body" unsealed</td><td rowspan="3">0 min/20 °C
60 min/-40 °C
150 min/-40 °C
300 min/105 °C
420 min/105 °C
480 min/20 °C</td><td colspan="2">8 h per axis;
RMS value
of acceleration:
19.7 m/s²</td><td rowspan="3">No sine wave</td><td rowspan="7">a [a] = 30 g
t [b] = 6 ms
sinusoidal
half-wave
No. of shocks:
6 000</td></tr>
<tr><th>Hz [c]</th><th>(m/s²)²/Hz [d]</th></tr>
<tr><td>10
55
180
300
360
1 000</td><td>10
3.25
0.125
0.125
0.07
0.07</td></tr>
<tr><td rowspan="3">2. "Body" sealed</td><td rowspan="3">0 min/20 °C
60 min/-40 °C
150 min/-40 °C
300 min/120 °C
420 min/120 °C
480 min/20 °C</td><td colspan="2">20 h per axis;
RMS value
of acceleration:
27.8 m/s²</td><td rowspan="3">No sine wave</td></tr>
<tr><th>Hz [c]</th><th>(m/s²)²/Hz [d]</th></tr>
<tr><td>10
55
180
300
360
1 000</td><td>20
6.5
0.25
0.25
0.14
0.14</td></tr>
</table>

Severity	TC	Noise with TC		Vibration excitation, sinusoidal, with TC		Number of shocks
3. "Applications close to the engine"	0 min/20 °C 60 min/-40 °C 90 min/-40 °C 240 min/120 °C 420 min/120 °C 480 min/20 °C	22 h per axis; RMS value of acceleration: 105.5 m/s²		22 h per axis		
		Hz [c]	**(m/s²)²/Hz** [d]	**Hz** [c]	**mm** [e]	
		20 95 110 380 410 800 1 500	10 10 0.01 0.01 20 10 5	100	0.095	
				Hz [c]	**m/s²** [a]	
				200 220 221 400	150 150 100 100	
4. "Engine-mounted parts" Requirement B	0 min/20 °C 60 min/-40 °C 90 min/-40 °C 240 min/140 °C 420 min/140 °C 480 min/20 °C	22 h per axis; RMS value of acceleration: 181 m/s²		22 h per axis		
		Hz [c]	**(m/s²)²/Hz** [d]	**Hz** [c]	**m/s²** [a]	
		10 100 300 500 2 000	10 10 0.51 20 20	100 150 200 240 255 440	100 150 200 200 150 150	
5. "Engine-mounted parts" Increased requirements	0 min/20 °C 60 min/-40 °C 90 min/-40 °C 240 min/150 °C 420 min/150 °C 480 min/20 °C	No noise		100 h per axis		
				Hz [c]	**m/s²** [a]	
				100 200 400 900 2 000	150 300 300 500 500	
6. "Engine-mounted parts" Special applications	0 min/20 °C 60 min/-40 °C 90 min/-40 °C 240 min/150 °C 420 min/150 °C 480 min/20 °C	No noise		100 h per axis		
				Hz [c]	**m/s²** [a]	
				100 200 400 900 2 000	150 500 500 800 800	

a) Acceleration
b) Cycle duration
c) Frequency
d) Power density spectrum
e) Distance

The test profiles for the sinusoidal vibration excitation are represented in figure 7 and figure 8, the noise is represented in figure 9.

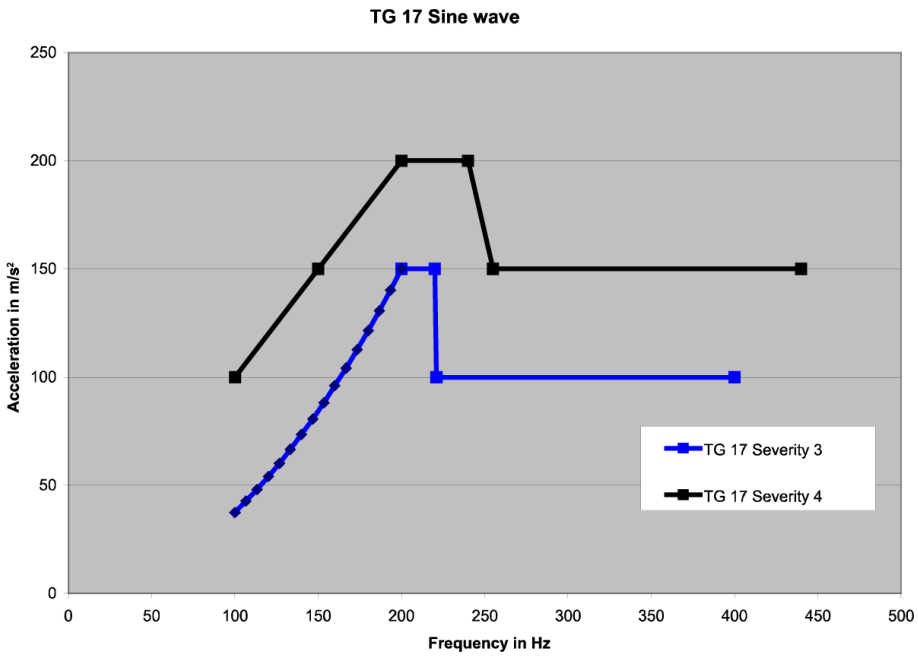


Figure 7 – Sinusoidal vibration excitation "Severities 3 and 4"

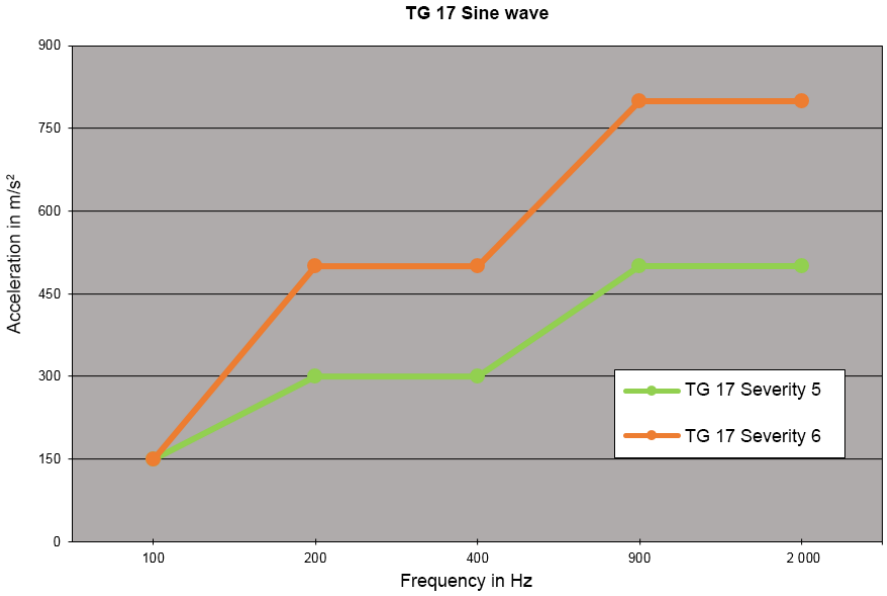


Figure 8 – Sinusoidal vibration excitation "Severities 5 and 6"

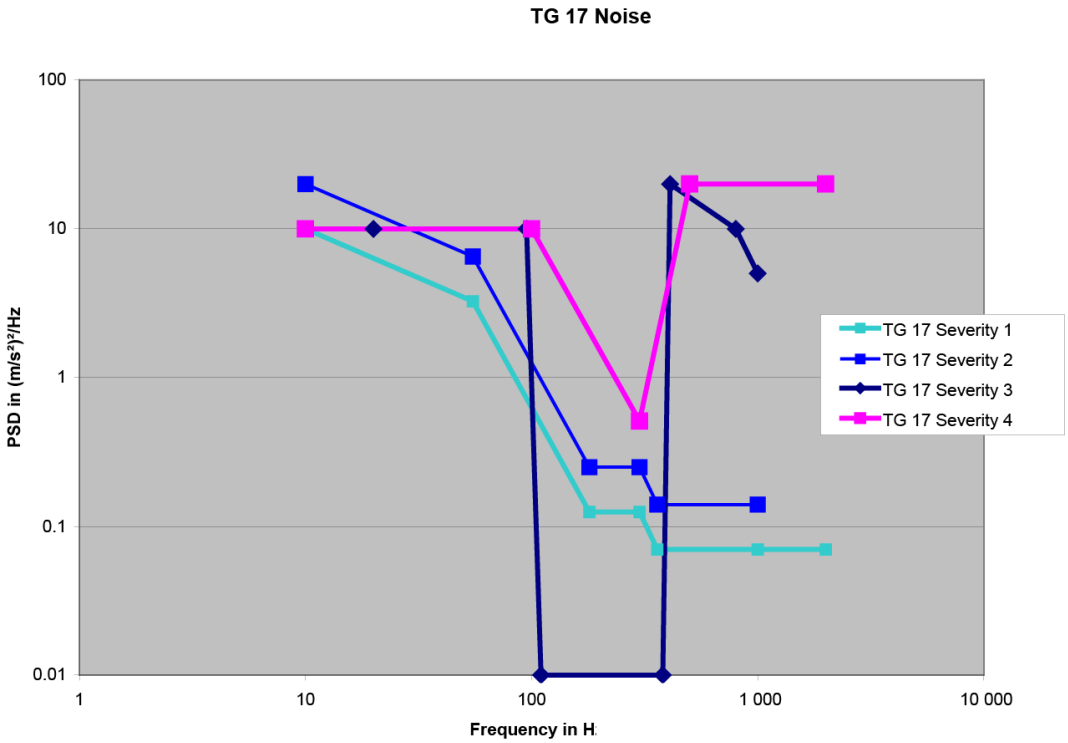


Figure 9 – "Noise" test profile

NOTE 8: The DUTs must be fastened to the vibration exciter as per appendix B. For particularly critical installation conditions, special agreements must be made between the manufacturer and user. In case of noise with TC and a load that lasts longer than 8 h, the temperature cycle for the specified runtime must always be repeated.

Requirement:

The maximum values of table D.1 must not be exceeded.

Documentation of the tested profiles and results in the specified form (e.g., form, customer drawing, and if applicable in OEM-specific databases) is required

No function-relevant damage must occur.

Current interruption monitoring takes place during the test. Permissible current interruption:
< 1 000 ns

The electric circuit is considered interrupted when the volume resistance exceeds 7 Ω. Interruptions are not permissible.

NOTE 9: Other limits may apply to other requirements (e.g., data transfers). These must be verified separately.

6.19 Climatic requirements

6.19.1 TG 18 A – Coastal climate load

Purpose: Test for metal parts (test for sea transport or use near the coast)
Batch size: 10 contact parts in unsealed contact housing(s)
Contact parts: All materials and surfaces that occur

	Contact housings:	Open (unsealed), plugged, median number of pins
	Cable cross-sections:	Any
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 18.1	The DUTs are inserted 2 times.	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
L 18.2	Salt spray, cyclic, as per DIN EN 60068-2-52	
	Severity 3	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Particularly in the attachment area of the cable and the contact zone with photographic documentation in the removed condition	
	Requirement:	
	The maximum values of table D.1 must not be exceeded.	

6.19.2 TG 18 C – De-icing salt load

Purpose:	Test for light metals (use of "Nordic country salt")	
	Batch size:	10 contact parts in unsealed contact housing(s)
	Contact parts:	All materials and surfaces that occur
	Contact housings:	Open (unsealed), plugged, median number of pins
	Cable cross-sections:	Any
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 18.1	The DUTs are inserted 2 times.	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
L 18.3	Salt spray, cyclic, as per DIN EN 60068-2-52	
	Severity 3	
	Salt mixture ("Nordic country salt"): 3-% solution, with 95% NaCl, 2.5% $MgCl_2$, and 2.5% $CaCl_2$	
P 0.2	Volume resistance as per DIN EN 60512-2-1	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Particularly in the attachment area of the cable and the contact zone with photographic documentation in the removed condition	
	Requirement:	
	The maximum values of table D.1 must not be exceeded.	

6.20 TG 19 – Environmental simulation

Purpose:	Test for pin contacts	
	Batch size:	3 groups with at least 10 contact parts per group
	Contact parts:	All materials and surfaces that occur

	Cables:	The insulation must withstand the test temperature, i.e., PVC is not permissible
	Cable cross-sections:	Must be determined case by case
	Contact housings:	Open (unsealed), must be determined case by case, inserted
	Description of the 3 groups:	
	See table 10	
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 0.2	Volume resistance (all groups) as per DIN EN 60512-2-1	
L 19.0	Group inserting and extracting, see table 8	
P 0.2	Volume resistance (all groups) as per DIN EN 60512-2-1	
P 14.0	Continuous monitoring of volume resistance during L 19.1 at 100 mA test current (groups 2 and 3 only)	
	Measurement frequency: 1 measured value per minute	
L 19.1	Temperature shock (all groups) DIN EN 60068-2-14* VDE 0468-2-14, Test Na	
	Duration:	144 cycles
	Temperature:	-40 °C/T_{max} per 15 min
	Acclimatization period:	10 s maximum
P 14.0	Continuous monitoring of volume resistance during L 19.2 at 100 mA test current (groups 2 and 3 only)	
	Measurement frequency: 1 measured value per 5 min	
L 19.2	Temperature change (all groups) as per DIN EN 60068-2-14* VDE 0468-2-14, Test Nb	
	Duration:	20 cycles
	Temperature:	-40 °C/T_{max} per 3 h
	Time for temperature change:	2 h maximum
P 14.0	Continuous monitoring of volume resistance during L 19.3 at 100 mA test current (groups 2 and 3 only)	
	Measurement frequency: 1 measured value per 5 min	
L 19.3	Aging in dry heat (all groups) as per DIN EN 60068-2-2* VDE 0468-2-2, Test B	
	Duration:	120 h
	Temperature:	T_{max}
P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 19.4	Industrial climate (multi-component climate, all groups) as per DIN EN 60512-11-7	
	0.2 ppm SO_2, 0.01 ppm H_2S, 0.2 ppm NO_2, 0.01 ppm Cl_2 / 25 °C / 75% relative humidity / 21 d	
	Volumetric flow rate: 1 m^3/h	

P 14.0	Continuous monitoring of volume resistance during L 19.5 at 100 mA test current (groups 2 and 3 only)
	Measurement frequency: 10 measured values per minute
L 19.5	Damp heat, cyclic, (all groups) as per DIN EN 60068-2-30, variant 2
	Relative humidity: 95% constant
	Duration: 10 cycles per 24 h
	Temperatures: T_l = 25 °C, T_u = 55 °C
P 0.1	Visual inspection as per DIN EN 60512-1-1
P 14.0	Continuous monitoring of volume resistance during L 19.6 at 100 mA test current (groups 2 and 3 only)
	Measurement frequency: 10 measured values per minute
L 19.6	Dynamic load as per DIN EN 60068-2-64* VDE 0468-2-64
	Broadband noise (groups 2 and 3 only)
	6 h per axis
	RMS value of acceleration 13.9 m/s^2, see table 11
	Before the vibration test is performed, it must be verified that the clamping fixture is resonance-free by performing a resonance analysis in the specified frequency range (load: 1 g). This is not a component test but an examination of the test setup.
P 14.0	Continuous monitoring of volume resistance during L 19.7 at 100 mA test current (groups 2 and 3 only)
	Measurement frequency: 10 measured values per minute
L 19.7	Mechanical shock testing (individual shocks, all groups) as per DIN EN 60068-2-27* VDE 0468-2-27
	Acceleration: a = 30 g
	Individual shock duration: t = 6 ms, sinusoidal half-wave
	Number of shocks: 50 per spatial axis
L 19.8	One-time extraction and insertion (all groups)
P 0.2	Volume resistance (all groups) as per DIN EN 60512-2-1
P 0.1	Visual inspection as per DIN EN 60512-1-1

Requirements:

- The volume resistance must not exceed the maximum values specified in table D.1 during any test.
- No corrosion must occur in the area of the contact zone.
- Wearing through is not permissible in the contact area.

Table 10 – Description of the 3 groups

	Group 1	Group 2	Group 3
Batch size	10	10	10
Insertions before loads	1×	1×	Half the required number of mating cycles

	Group 1	Group 2	Group 3
During loading	No inserted	Inserted	Inserted
Resistance measurement method	P 0.2	P 14.0	P 14.0

Table 11 – Broadband noise

Frequency in Hz	Power density spectrum in $(m/s^2)^2/Hz$
10	5
55	1.625
180	0.0625
300	0.0625
360	0.035
1 000	0.035

6.21 TG 20 – Climatic load of the housing

Purpose: Testing the pin housing/basic requirement

Batch size: 5 contact housings, up to 5-pin, fully equipped; for 6-pin and above, with 5 contacts

Contact parts: Any design

Contact housings: All variants that occur (any keying, any color)

Cables: The insulation must withstand the test temperature

Increased requirements (e.g., temperatures) must be agreed upon with the OEM.

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 0.3 Insulation resistance as per DIN EN 60512-3-1

L 20.1 Aging in dry heat as per DIN EN 60068-2-2* VDE 0468-2-2, Test B

Duration: 120 h

Temperature: T_{max}

L 20.2 Aging in damp heat, constant, as per DIN EN 60068-2-30

Duration: 10 d

Temperature: 40 °C

Relative humidity: 95%

The insulation resistance must be measured at the earliest 30 min and at the latest 60 min after conclusion of test L 20.2.

P 0.3 Insulation resistance as per DIN EN 60512-3-1

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 20.3 Low-temperature aging as per DIN EN 60068-2-1* VDE 0468-2-1

Duration: 48 h

Temperature: -40 °C

L 20.4 Extracting and inserting at -20 °C

P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 20.5	Aging in dry heat as per DIN EN 60068-2-2* VDE 0468-2-2, Test B	
	Duration:	48 h
	Temperature:	80 °C
L 6.1	Drop test in the unplugged state	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Requirements:	
	After completion of the tests, no function deviations must have occurred.	
	Even at -20 °C, it must be possible to open and then close the connector again.	
	Any existing film hinges and latching elements must not break or tear during actuation.	
	The drop test must cause no function-impairing damage to the DUTs. Locks must not open.	

6.22 TG 21 – Long-term temperature aging

Purpose:	Testing the long-term stability of the contact housings and the contact parts	
	Batch size:	2 groups, 5 contact housings per group
	Contact housings:	Group 1 unequipped
		Group 2 for each contact size: up to 5-pin, fully equipped; for 6-pin and above, with 5 contacts
	Contact parts:	By arrangement, however, at least 10 contact pairs for volume resistance measurements
	SWS:	All variants that occur
	Cables:	The insulation must withstand the test temperature
	Conductor cross section:	Cables with max. conductor cross-section
	Contact housings:	All
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1 (all parts)	
P 0.2	Volume resistance as per DIN EN 60512-2-1 (group 2 only)	
L 21.1	Long-term aging in dry heat (all parts) as per DIN EN 60068-2-2* VDE 0468-2-2, Test B	
	Duration:	1 000 h
	Temperature:	T_{max}
	Subsequent aging:	48 h at RT
P 0.2	Volume resistance as per DIN EN 60512-2-1 (group 2 only)	
P 21.1	Function check with both groups:	
	Actuating:	Inserting the pin housings until completely latched, opening the lock and completely disconnecting the pin housings
	Number of cycles:	5
L 6.1	Drop test (group 1 only) as per DIN EN 60068-2-31* VDE 0468-2-31	
P 8.2	Contact extraction forces for all contacts of group 2	

As per section 6.9, the limit is the value for secondary locking devices even if in this case the primary and the secondary locking devices are closed.

P 0.1 Visual inspection as per DIN EN 60512-1-1

Requirements:

After completion of the test, there must be no detectable functional impairments on the housings. Cracking or delamination that affect the function are not permissible.

Volume resistance: The limits of table D.1 must be adhered to.

Contact pull-out strength: The locking limits from the requirements table in section 6.9 must be complied with.

6.23 Resistance to chemicals

6.23.1 TG 22 A – Resistance to chemicals

Purpose: Testing the contact housings for resistance to chemicals

For water-tightness requirements, testing must be performed as per section 6.23.2

Batch size: 2 fully equipped contact housings per testing medium

Contact parts: Any design

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 0.3 Insulation resistance as per DIN EN 60512-3-1

L 22.1 A Resistance to chemicals (general requirements)

Procedure:

The DUTs must be exposed to the media (for chemicals and method, see appendix E) and aged for 48 h at the required aging temperature.

After the test is complete, the DUTs must be thoroughly rinsed with water and dried.

P 0.3 Insulation resistance as per DIN EN 60512-3-1

P 0.1 Visual inspection as per DIN EN 60512-1-1

P 1.1 Dimensions as per DIN EN 60512-1-2

Requirements:

- No functionally significant structural or dimensional change
- Any deviations from the original state must be documented.
- Insulation resistances: > 100 MΩ
- The function must remain fully intact.

6.23.2 TG 22 B – Chemical resistance, extended testing

Purpose: Extended testing of the chemical resistance of the contact housing material

Batch size: 2 fully equipped sealed contact housings + 1 contact housing with cavity plugs for each testing medium

Contact parts: Any design

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
P 0.3	Insulation resistance as per DIN EN 60512-3-1
L 22.1 B	Resistance to chemicals (water-tight design)

Procedure:

The DUTs must be exposed to the media (for chemicals and method, see appendix E) and aged for 48 h at the required aging temperature.

In contrast to section 6.23.1, the DUTs are not rinsed with water.

P 0.3	Insulation resistance as per DIN EN 60512-3-1
P 0.1	Visual inspection as per DIN EN 60512-1-1
P 1.1	Dimensions as per DIN EN 60512-1-2

Requirements:

- No functionally significant structural or dimensional change
- Any deviations from the original state must be documented.
- Insulation resistances: > 100 MΩ
- The function must remain fully intact.

6.24 TG 23 – Water tightness

Purpose: Testing the tightness of sealed pin housings, cavity plugs, and SWSs

Group 1:	Pin housings with cavity plugs
Group 2:	Pin housings with SWSs (SWS, etc.)
Batch size:	Group 1: 2 housings
	Group 2: 5 fully equipped housings
Contact parts:	Any
Contact housings:	All water-tight designs
Cable cross-section:	Smallest and largest permissible conductor cross-sections per sealing element
Cables:	The insulation must withstand the test temperature.

The ends of all stranded cables are sealed pressure-tight.

For sealing systems without SWS, the contacts must be removed once before loading and reinserted.

Type of test:

P 0.1	Visual inspection as per DIN EN 60512-1-1
L 19.3	Aging in dry heat (all groups, plugged state) as per DIN EN 60068-2-2* VDE 0468-2-2, Test B
	Duration: 120 h
	Temperature: T_{max}
L 19.1	Temperature shock (all groups) DIN EN 60068-2-14* VDE 0468-2-14, Test Na
	Duration: 144 cycles
	Temperature: -40 °C/ T_{max} per 15 min
	Acclimatization period: 10 s maximum

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 23.1 Immersion with pressure difference (all groups) as per DIN EN 60512-14-5 and DIN EN 60068-2-13

Both groups are pressurized using suitable means. The remaining connector cavities are closed off with cavity plugs or sealed cable ends.

Subsequently, pressure differences to the environment (normal pressure) are set in the interior of the contact housing.

The specified hold times apply once the required pressure values (1. – 4.) are maintained.

Medium: Low surface-tension 5% NaCl solution

1. Normal pressure
2. -10 kPa, hold time 5 min
3. -50 kPa, hold time 5 min
4. Normal pressure

Pressure change: 10 kPa/min

L 23.2 Cable movement during immersion with pressure difference (vacuum):

for group 2 only

For contact housings with cover, the test must be performed without the cover. For contact housings that cannot be installed without covers (e.g., for insertion and extraction aids), this test section is omitted.

Definition of the cable movement:

– No fixed clamping of the cables (no tension on the cables)
– Free, moving cable length: 100 mm
– Movement profile:

  a) Deflection of the cable bundle by 100 mm (final position) at a distance of 100 mm from the SWS

  b) Hold for 10 s

  C) Deflection to the opposite final position

  D) Hold for 10 s
– This movement profile is performed once for each pressure stage during the pressurization.
– Direction of movement: vertically to the branch-off direction, in both spatial axes

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 23.3 Thermal shock testing (all groups)

Medium:	Low surface-tension 5% NaCl solution
Air temperature:	T_{max}, duration: 30 min each
Water temperature:	0 °C, duration: 15 min each
Number of cycles:	5

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 23.4 Degrees of protection testing/pressure washer test (all groups) as per ISO 20653

Severity:	IP X9K

		Deviating from ISO 20653, all 3 sides of the DUT must be exposed to the water jet. In particular, the jet must also be directed at the sealing elements of the DUT.
	Test duration per side:	15 s
	Distance from nozzle to DUT:	100 mm to 150 mm
	Pressure:	80 bar
	Temperature:	80 °C
		The test is performed 3 times.
P 0.3	Insulation resistance as per DIN EN 60512-3-1 (for group 2 only)	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
P 1.1	Dimensions as per DIN EN 60512-1-2	
	Requirements:	
	– No medium must penetrate the connector (if applicable, water finding paste must be used).	
	– Insulation resistance: > 100 MΩ	
	– The function of the locking or releasing elements must remain fully intact.	
	– The dimensions of the contact housings must correspond to the release drawing before and after the tests.	

6.25 TG 24 – Impenetrability to paint

Purpose:	Testing the resistance to painting	
	Batch size:	10 contact housings mounted on the PCB and connected according to the applicable installation specifications
	Contact parts:	All contact parts that occur
	Contact housings:	All contact housing designs that come into contact with liquid dip paint during further processing
	Type of test:	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
L 24.1	Dip painting	
	The contact housing parts or PCBs are immersed in liquid paint (e.g., "SL 1331 N" [1)]) for 1 min and subsequently dried for 6 h at 80 °C.	
P 0.1	Visual inspection as per DIN EN 60512-1-1	
	Requirement:	
	The dip paint must not penetrate the contact area. The mechanical and electrical functions must not be impaired.	

1) *SL 1331 N* is the manufacturer's designation for the product manufactured by *Lackwerke Peters GmbH & Co. KG*.
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.

6.26 TG 25

This TG is omitted.

6.27 TG 26

This TG is omitted.

6.28 TG 27

This TG is omitted.

6.29 TG 28 – Latching noise

Purpose: All locks to be actuated during vehicle assembly must produce an audible locking feedback.

Batch size: 2 fully equipped contact housings per cavity

Contact housings: All variants that occur, does not apply to contact housings with assembly aid

Type of test:

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 28.1 Aging

24 h at RT as per VW 50554 – 2

P 28.1 Locking noise

Distance to the measuring microphone: (600 ± 50) mm

Actuating the lock: Manually, with as little contact as possible, avoiding distorting reflections from the surface below (table) or close-by walls (see figure 10)

P 0.1 Visual inspection as per DIN EN 60512-1-1

Requirements:

- The measured dB(A) values must be documented.
- For this purpose, the signal-to-noise ratio between the locking noise and the ambient noise must be at least 7 dB(A).
- The locking noise must be at least $L_{Apeak} \geq 70$ dB(A).

  NOTE 10: L_{Apeak}: peak level of the sound level with frequency weighting A

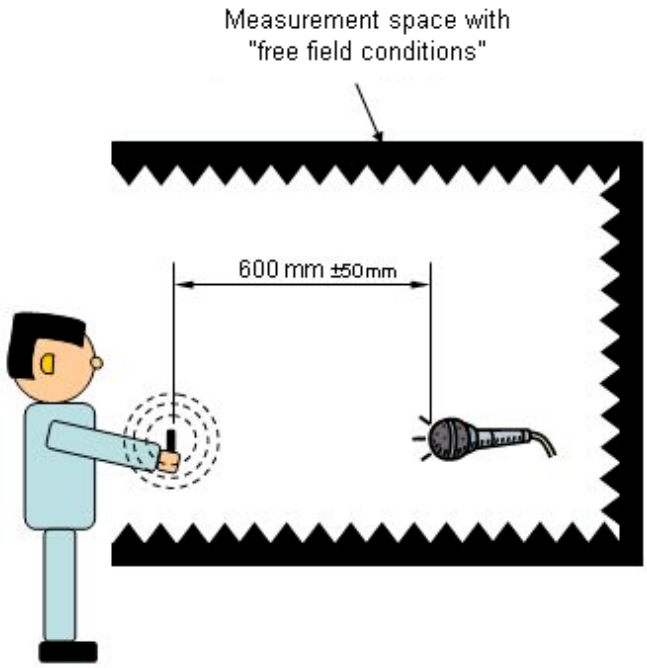


Figure 10 – Schematic of the measurement setup for the volume measurement

6.30 TG 29 – Cavity plug holding force

Purpose: Validating the cavity plug holding force in relation to the internal pressure of the sealed contact system during the contacting process

If it has been ensured that the possible internal pressure is ≤ 0.5 bar, this TG may be replaced by the inclusion of an overpressure test in L 23.1.

Batch size: 3 fully equipped contact housings, however at least 10 cavity plugs

Contact parts: None

P 29.1 Theoretical determination of the internal pressure p_0

Determination of the air volumes in the interior of the contacting housing in the closed state and in the state in which the housing seal touches the mating piece for the first time

With the two volumes, the maximum possible internal pressure p_0 can be computed.

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 20.1 Aging in dry heat as per DIN EN 60068-2-2* VDE 0468-2-2, Test B

Duration: 2 h

Temperature: 60 °C

P 29.2 Determining the holding force of the cavity plugs p_{max}

The pressure difference between the closed and locked contacting and the exterior environment must be continuously increased (0.5 bar/min) until at least one cavity plug slides out (= p_{max}), see figure 11

This may be achieved by increasing the internal pressure or by decreasing the external pressure.

Requirement:

$p_{max} > 1.5 \times p_0$

P 0.1 Visual inspection as per DIN EN 60512-1-1

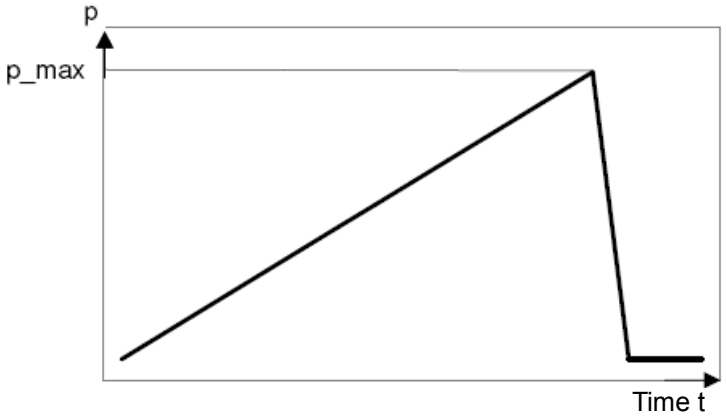


Figure 11 – Pressure vs. time graph of the holding force

6.31 TG 31 – Holding forces for contact pins and contact blades in plastic contact housings

Purpose: Verifying the contact plug holding forces required for the mating process in device-mounted connector receptacles/interfaces/molded-on connector receptacles to ensure sufficient contact overlap

Batch size: 3 multi-pin connectors or male multipoint connectors per cavity (fully equipped or the variant with the most contacts)

Contact parts: All contacts must be measured for each multi-pin connector or male multipoint connector.

P 0.1 Visual inspection as per DIN EN 60512-1-1

L 31.1 Aging process (simulation of the soldering process)

Duration: 2 h

Temperature: 85 °C, then cooling down to RT

P 31.1 Pin/blade holding force

The pins/blades of the DUTs are pushed out of the shrouded pin header (see figure 12) and a load-displacement curve is recorded.

The distance between two pins/blades to be tested must be large enough to preclude mutual interference during the measurement. The number of DUTs (shrouded pin headers) must be adjusted such that a statement can be made about each connector cavity.

Suitable support must be provided for the shrouded pin header near the point of force application.

Test speed: v = 50 mm/min

Starting force (preliminary force): $F_{(0)}$ = 5 N ($s_{(0)}$ = 0 mm)

Requirements:

Visual inspection (unused condition): no damage to the metal surface in the connecting area

The measured holding forces must meet the requirements for holding forces in the range between 0 mm and 0.2 mm as specified in the pin/blade definition (see figure 13).

The recorded load-displacement progression must be evaluated based on the criteria presented in figure 14.

The documentation in the test report may be in graphic form or in table form.

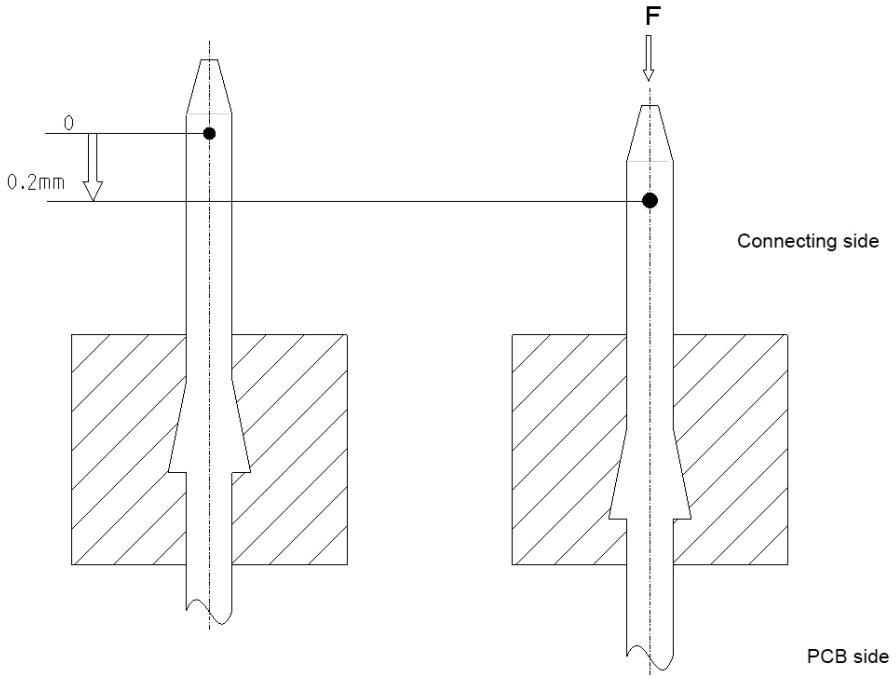


Figure 12 – Schematic representation of the relative displacement of the contact as compared to its housing by 0.2 mm

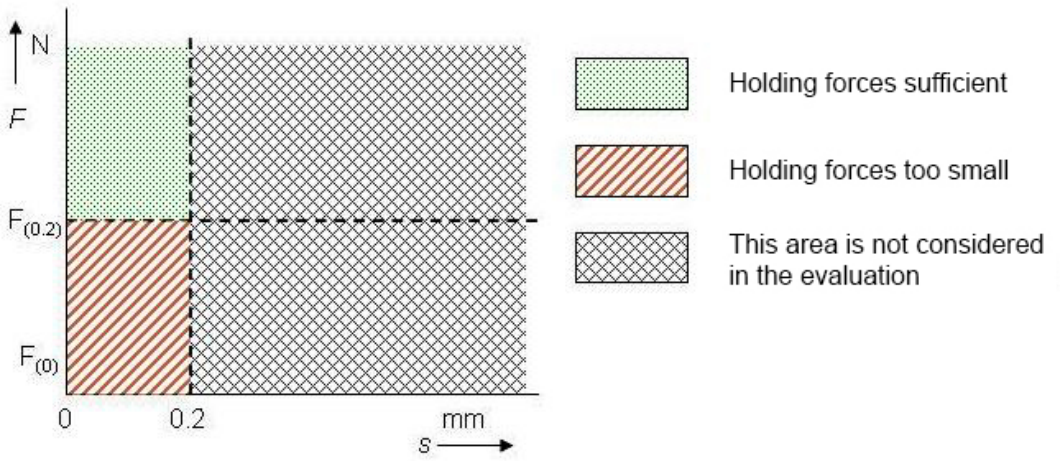


Figure 13 – Load-displacement curve with the target corridor for the holding force represented in green

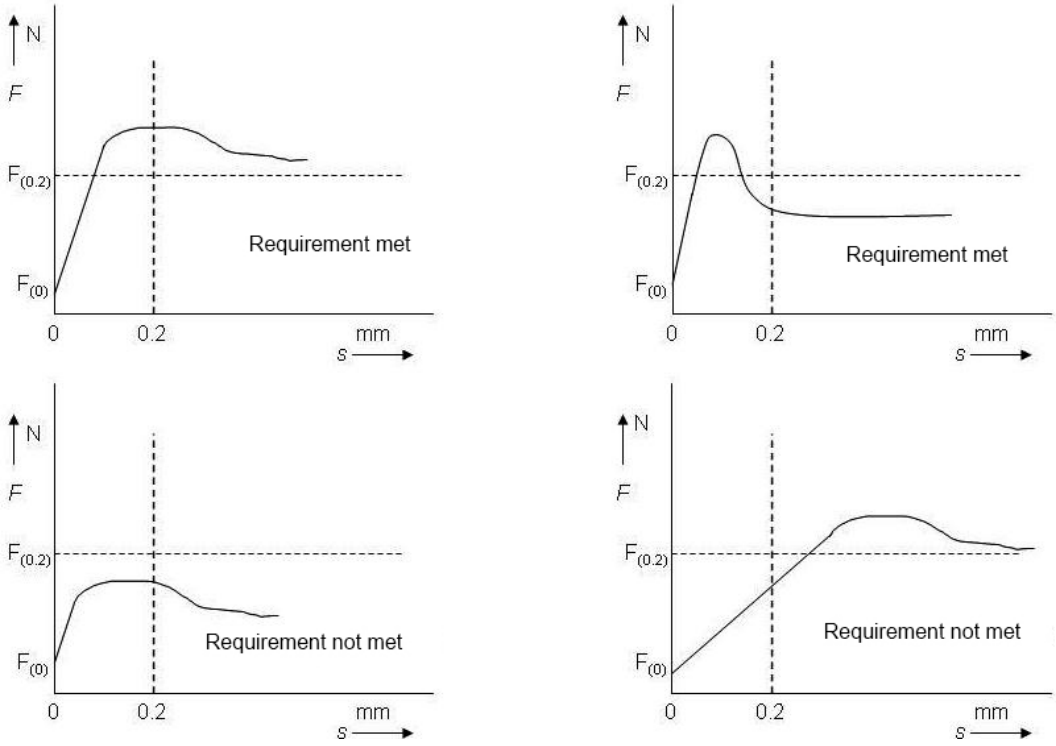


Figure 14 – Exemplary holding force characteristics

7 Applicable documents

The following documents cited are necessary to the application of this document:

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.

VW 50554	Standard Atmospheres and Room Temperatures; Requirements on Standard Atmospheres
VW 60306-1	Electric/Electronic Systems; Electric Wiring in Motor Vehicles; Part 1: Copper Cable; Single-Wire, Unshielded
VW 60306-2	Electric/Electronic Systems; Electric Wiring in Motor Vehicles; Part 2: Aluminum Cable; Single-Wire, Unshielded
VW 75174-1	Motor Vehicle Connectors; Test Matrix
VW 75174-2	Vehicle Contacts, Slow Motion Tests
VW 75174-3	Motor Vehicle Connectors; Test Sequences
DIN 70070	Diesel engines - NOx-Reduction agent AUS 32 - Quality requirements
DIN EN 14214	Liquid petroleum products - Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods
DIN EN 590	Automotive fuels - Diesel - Requirements and test methods

DIN EN 60068-2-1* VDE 0468-2-1	Environmental Testing – Part 2-1: Tests – Test A: Cold
DIN EN 60068-2-13	Environmental testing - Part 2: Tests; test M: Low air pressure
DIN EN 60068-2-14* VDE 0468-2-14	Environmental Testing – Part 2-14: Tests – Test N: Change of Temperature
DIN EN 60068-2-2* VDE 0468-2-2	Environmental Testing – Part 2-2: Tests – Test B: Dry Heat
DIN EN 60068-2-27* VDE 0468-2-27	Environmental Testing – Part 2-27: Tests – Test Ea and Guidance: Shock
DIN EN 60068-2-30	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)
DIN EN 60068-2-31* VDE 0468-2-31	Environmental Testing – Part 2-31: Tests – Test Ec: Rough Handling Shocks, Primarily for Equipment-Type Specimens
DIN EN 60068-2-52	Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)
DIN EN 60068-2-6* VDE 0468-2-6	Environmental Testing – Part 2-6: Tests – Test Fc: Vibration (Sinusoidal)
DIN EN 60068-2-64* VDE 0468-2-64	Environmental Testing – Part 2-64: Tests – Test Fh: Vibration, Broadband Random and Guidance
DIN EN 60352-2	Solderless connections - Part 2: Crimped connections - General requirements, test methods and practical guidance
DIN EN 60512-1-1	Connectors for electronic equipment - Tests and measurements - Part 1-1: General examination; Test 1a: Visual examination
DIN EN 60512-1-2	Connectors for electronic equipment - Tests and measurements - Part 1-2: General examination; Test 1b: Examination of dimension and mass
DIN EN 60512-1-3	Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 1: General examination; Section 3: Test 1c: Electrical engagement length
DIN EN 60512-1-4	Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 1: General; Section 4: Test 1d: Contact protection effectiveness (scoop-proof)
DIN EN 60512-11-7	Connectors for electronic equipment - Tests and measurements - Part 11-7: Climatic tests - Test 11g: Flowing mixed gas corrosion test
DIN EN 60512-13-5	Connectors for electronic equipment - Tests and measurements - Part 13-5: Mechanical operation tests - Test 13e: Polarizing and keying method
DIN EN 60512-14-5	Connectors for electronic equipment - Tests and measurements - Part 14-5: Sealing tests - Test 14e: Immersion at low air pressure
DIN EN 60512-15-6	Connectors for electronic equipment - Tests and measurements - Part 15-6: Connector tests (mechanical) - Test 15f: Effectiveness of connector coupling devices

DIN EN 60512-2-1	Connectors for electronic equipment - Tests and measurements - Part 2-1: Electrical continuity and contact resistance tests; Test 2a: Contact resistance; Millivolt level method
DIN EN 60512-2-2	Connectors for electronic equipment - Tests and measurements - Part 2-2: Electrical continuity and contact resistance tests - Test 2b: Contact resistance - Specified test current method
DIN EN 60512-3-1	Connectors for electronic equipment - Tests and measurements - Part 3-1: Insulation tests; Test 3a: Insulation resistance
DIN EN 60512-5-1	Connectors for electronic equipment - Tests and measurements - Part 5-1: Current-carrying capacity tests; Test 5a: Temperature rise
DIN EN 60512-5-2	Connectors for electronic equipment - Tests and measurements - Part 5-2: Current-carrying capacity tests; Test 5b: Current-temperature derating
DIN EN ISO/ IEC 17025	General requirements for the competence of testing and calibration laboratories
DIN EN ISO 175	Plastics - Methods of test for the determination of the effects of immersion in liquid chemicals
ISO 20653	Road vehicles - Degrees of protection (IP code) - Protection of electrical equipment against foreign objects, water and access

Appendix A (normative) Double crimp

For permissible conductor cross-section combinations for double crimp, solderless connections, see table A.1

Table A.1 – Permissible conductor cross-section combinations for double crimp, solderless connections

	Conductor 1							
Conductor 2	mm^2	0.35	0.50	0.75	1.0	1.5	2.5	4.0
	0.35	×	×					
	0.50	×	×	×				
	0.75		×	×	×			
	1.0			×	×	×		
	1.5				×	×	×	
	2.5					×	×	×
	4.0						×	×

Only insulation-reduced cables with stranded wires may be used.

Solid conductors are not permissible.

The use of double crimps for coaxial cables in SWS systems and on engines and transmissions is not permitted.

Appendix B (normative) Shaker table mounting

See figure B.1 and figure B.2

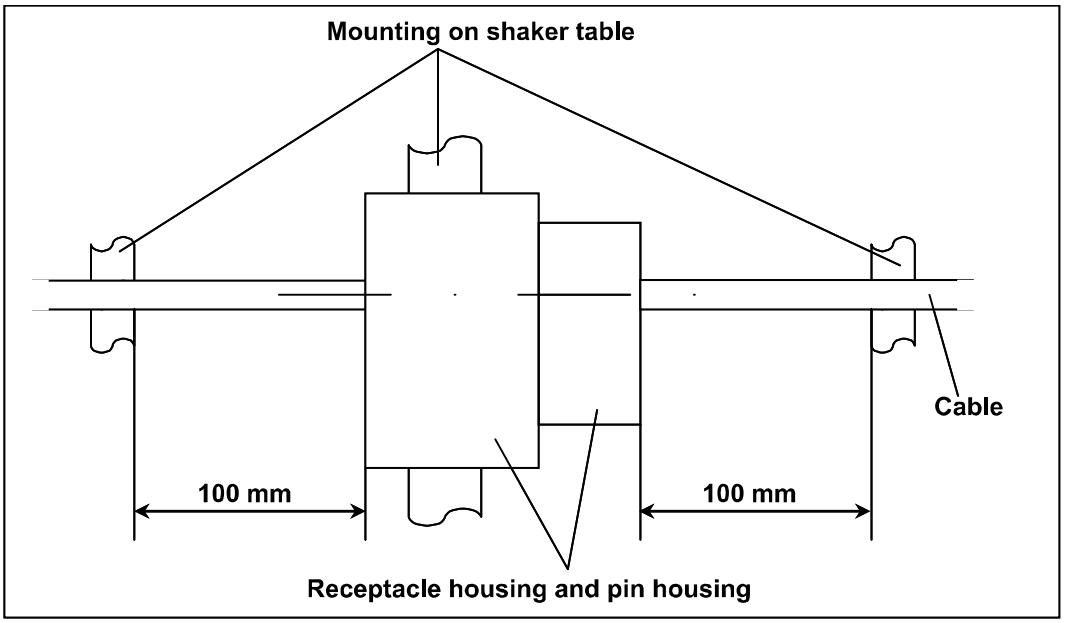


Figure B.1 – Mounting on shaker table, coupling

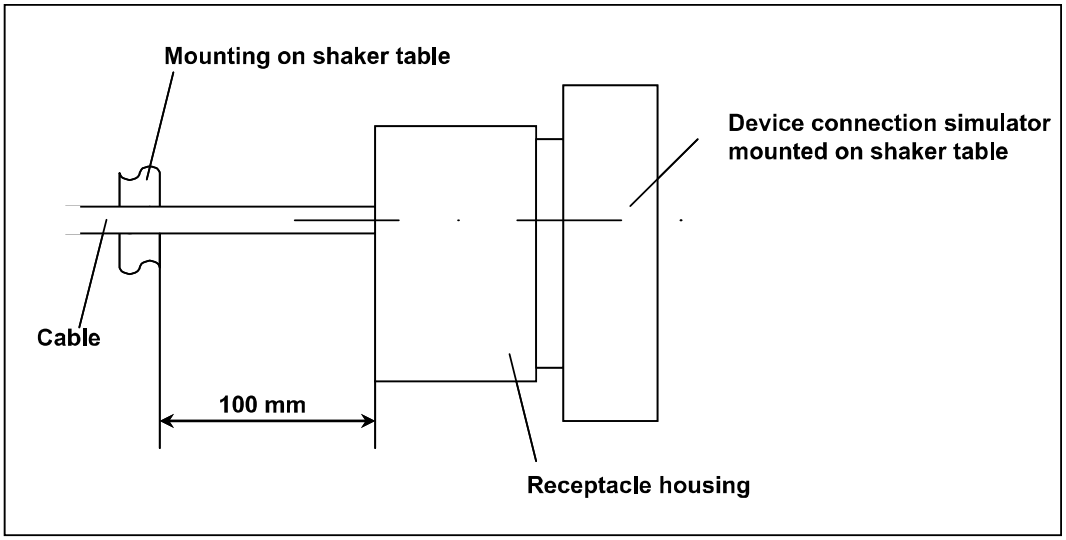


Figure B.2 – Mounting on shaker table, device connection

Appendix C (normative) Temperature cycle with current supply

Temperature cycle with current supply (see figure C.1) at I_N during the heat-up phase and the hold time at T_u

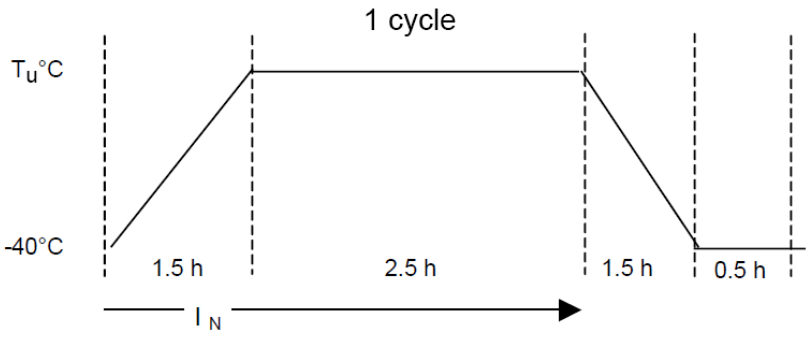


Figure C.1 – Temperature cycle

Appendix D (normative) Resistance limits

See table D.1

Maximum limits of the volume resistance in mΩ at RT after aging

The values include: contact volume resistance + 2× crimp volume resistance, measured as per DIN EN 60512-2-1

Cables as per VW 60306-1 and VW 60306-2 (Cable Test Specification, low-voltage cables)

Contact material conductivity > 20% International Annealed Copper Standards (IACS), correction factor for lower conductivities as per DIN EN 60352-2

The limits apply to all surfaces (e.g., Au, Ag, Sn)

Table D.1 – Resistance limits

	Group 1						Group 2					Group 3	
Conductor cross section in mm^2/**contact size** in mm	**0.13**	**0.22**	**0.35**	**0.5**	**0.75**	**1**	**1.5**	**2.5**	**4**	**6**	**10**	**16**	**> 16**
0.5	50	40	30	-	-	-	-	-	-	-	-	-	-
0.63	30	30	15	15	15	-	-	-	-	-	-	-	-
1.2	20	20	15	15	15	15	10	-	-	-	-	-	-
1.5	15	15	15	15	15	15	10	10	-	-	-	-	-
2.8	15	15	15	15	15	10	10	10	5	-	-	-	-
4.8 – 6.3	10	10	10	8	8	8	5	5	3	3	2	-	-
8	-	-	-	-	-	-	-	3	3	3	2	2	-
9.5 – 12	-	-	-	-	-	-	-	-	3	2	2	1	1

Appendix E (normative) Media list

See section 6.23.1, section 6.23.2, and table E.1

At least 100 ml of the chemical must be used in each case.

Dousing:	At least 8 ml of the test fluid must be used for each cm^2 of the total surface of the DUT (see DIN EN ISO 175).
Rubbing in:	Damp cotton cloth
Spray duration:	Approx. 1 s on each side

Table E.1 – Media list

No.	TG	Chemical	Description	Application of the medium			Aging temperature in °C (48 h)
				Dousing	Rubbing in	Spraying	
1	22 A	Cold-cleaning agent/cockpit cleaning agent	Commercial	-	-	x	50
2	22 A	Penetrating oil	Commercial	-	-	x	50
3	22 A	Washer fluid antifreeze, undiluted	Commercial	x	-	-	50
4	22 A	Isopropanol	Commercial	x	-	-	RT
5	22 A	Lubricating grease	Hot bearing grease	-	x	-	50
6	22 B	Brake fluid	DOT 4/DOT 5	x	-	-	50
7	22 B	FAM test fuel (gasoline/premium)	Commercial	x	-	-	RT
8	22 B	Diesel fuel	DIN EN 590	x	-	-	RT
8	22 B	Biodiesel	DIN EN 14214	x	-	-	RT
8	22 B	Diesel additive AdBlue®	DIN 70070	x	-	-	RT
9	22 B	Engine oil 5W-30	Fully synthetic	x	-	-	50
10	22 B	Power steering fluid	According to requirement	x	-	-	50
10	22 B	Automatic transmission fluid	Fully synthetic	x	-	-	50
11	22 B	Radiator antifreeze agent	stable down to -40 °C	x	-	-	50
12	22 B	Battery electrolyte: Relevant only for DUTs that can come into contact with battery electrolyte	Diluted sulfuric acid (density: 1.28 g/ml)	x	-	-	50
13	22 B	De-icing salt solution	Mixture as per L 18.3	x	-	-	50