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Electrical/Electronic Requirements for HV Contacts

Performance Specification

Preface

This standard is based on template LV 215-1, which was prepared by representatives of automo bile manufacturers Audi AG, BMW AG, Daimler AG, Porsche AG, and Volkswagen AG in working group 4.3.3.

Deviations from the LV 215-1 are listed on the cover sheet of this standard. If modifications to indi vidual test sections become necessary in individual cases, these must be agreed upon separately between the appropriate department and the relevant manufacturer.

Test reports will be accepted as long as the tests were performed by an independent testing insti tute that is accredited as per DIN EN ISO/IEC 17025. Acceptance of the test reports will not auto matically result in a release.

NOTE 1: The LV numbers listed in this document will be converted as per table 1.

Table 1

WG document number	Volkswagen Standard num ber
LV 123	VW 80303
LV 214	VW 75174
LV 215-2	VW 80302

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Contents

1 Scope

This Supply Specification (LV 215-1) describes the technical and functional requirements that apply to electrical plug-in connections and threaded connections used in HV (high voltage) electric systems. Unless a distinction is explicitly made, both connection types will hereinafter be referred to as "plug-in connections". This LV applies only to new designs and will only be used by the original equipment manufacturer (OEM) for the first approval.

In the case of releases for further applications (PPAP, first-sample test report [EMPB], etc.), reference to the data yielded is possible. HV systems already in production will not be changed.

2 Referenced standards

The following documents cited in this standard are necessary to its application.

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.

For dated references, only the referenced issue is valid. For undated references, the most recent issue of the referenced document (including all changes) is valid.

2000/53/EC	Directive of the European Parliament and of the Council on End-of-Life Vehicles, incl. Appendices
DIN EN 60529	Degrees of Protection Provided by Enclosures (IP Code)
DIN EN 60664-1	Insulation Coordination for Equipment within Low-Voltage Systems – Part 1: Principles, Requirements, and Tests
ECE-R 100	Uniform Provisions concerning the Approval of Battery Electric Vehicles with regard to specific Requirements for the Construction, Functional Safety, and Hydrogen Emission
ISO 6469-3	Electrically Propelled Road Vehicles – Safety Specifications – Part 3: Protection of Persons against Electric Shock
ISO 20653	Road Vehicles – Degrees of Protection (IP Code) – Protection of Electrical Equipment Against Foreign Objects, Water and Access
LV 123	Electrical Characteristics and Electrical Safety of HV Components in Motor Vehicles – Requirements and Tests
LV 214	WG Test Guideline for Motor Vehicle Connectors
LV 215-2	Motor Vehicle High-Voltage Contacts – Test Specification
SAE J 1742	Connections for High Voltage On-Board Road Vehicle Electrical Wiring Harnesses Test Methods and General Performance Requirements

SAE J 2223/2	Connections for On-Board Road Vehicle Electrical Wiring Harnesses Part 2: Tests and General Performance Requirements
VDA Volume 3, Part 2	VDA Series of Standards; Quality Management in the Automotive Industry, Volume 3, Part 2, Reliability Assurance at Automakers and Suppliers; Reliability Methods and Tools
VG 95214-11	Test of Components – Part 11: Measuring Methods for Transfer Impedance and Screening Attenuation, Transfer Impedance of Screened Components (Line-Injection Method, KS 11 B)
VG 96933-2	Electrical Connection Elements – Part 2: Generic Specification

3 Glossary, definitions, and abbreviations

Abbreviations:

Abbreviation	Explanation
HV	High voltage
LH	Performance Specification
LV	Supply Specification
PPAP	Production Part Approval Process
EMPB	First-sample test report
DC	Direct current
AC	Alternating current
EMC	Electromagnetic compatibility
HVIL	High-voltage interlock
AT-PZEV	Advanced Technology Partial Zero-Emission Vehicle
BMG	Build sample approval
AV	Implementation regulation
LV	Low voltage
V_{max}	Max. voltage
V_{rated}	Operating voltage
CPA	Connector Position Assurance

Definition of an "HV system":

An HV system comprises the HV circuits in their entirety, including the corresponding cable routing (cables, connectors) and components (consuming devices, generator, batteries). Regardless of their function, all components connected directly or indirectly to the HV circuit are referred to as HV components.

HV plug connections ensure the transmission of power for components that have a voltage of >60 V.

Definition of "live parts":

All conductors and conductive parts to which voltage is applied under normal use.

Definition of "operating voltage":

The maximum root mean square (RMS) voltage in a circuit, as specified by the manufacturer, that can be measured with any insulation, with the circuit open or under normal operating conditions.

Definition of "direct contact":

People or animals (pets and farm animals) coming into contact with live parts.

Definition of "crimp connection":

Normally, the connection between a contact element and a cable is made by crimping. For alternative connection techniques such as welding or possibly soldering, the test conditions and requirements apply accordingly. If necessary, deviations must be coordinated with the purchaser.

In this document, this connection is referred to as a crimp for the sake of clarity and simplification.

Definition of "electrical ground":

A set of conductive parts that are electrically (galvanically) connected to one another as well as all other conductive parts that are electrically (galvanically) connected to this set of parts and that use their potential as a reference. The HV circuit does not use this potential as a reference, with the exception of the shielding and equipotential bonding.

Definition of "exposed conductive part" (also "bare conductive part"):

Any conductive part that can be easily touched and that, although not normally live, may be energized in the event of a fault.

Definition of an "HV electric system":

The infrastructure for supplying electrical power to the HV system, but without components for consuming, storing, and generating electrical power and without controllers.

Definition of "indirect contact":

People or animals (pets and farm animals) coming into contact with electrical equipment that may be energized in the event of a fault.

Definition of "creepage distance":

As per DIN EN 60664-1, the shortest distance along the surface of an insulating material between two conductive parts.

Definition of a "conductive part":

A conductive part is a part that is able to conduct current, although it is not necessarily live under normal operating conditions.

Definition of "clearance":

Shortest air gap distance between two conductive parts.

Definition of a "live part":

A live part is any conductor or part that conducts voltage during normal operation.

Definition of a "bare conductive part":

A bare conductive part is a part that can be easily touched and that, although not live during normal use, may conduct voltage in the event of a fault (insulation fault). This term is specified in relation to a specific circuit, e.g., a vehicle body can be a live part of the auxiliary circuit, but a bare conductive part of the drive circuit.

Voltage class B

As per the defined voltage ranges, the HV system must be classified as a voltage class B system:

? 60 V_DC < V ≤1 500 V_DC

The following voltage range is defined for AC voltages belonging to voltage class B:

? 25 V_AC (RMS) < V ≤1 000 V_AC (RMS)

The AC voltage specification is relevant to HV system circuits in which AC or three-phase current components, such as the electric drive system, are used.

4 Requirements – development framework

4.1 Quality

4.1.1 General information

The desired quality objective is zero defects. To achieve the desired quality objective, the supplier must conduct and present a design FMEA and a process FMEA (FMEA: Failure Modes and Effects Analysis) on its own initiative.

4.1.2 Supply quality

The supply quality is defined as zero-defect quality. The supply quality limits must be defined together with the individual OEM's quality entities.

4.1.3 Reliability

4.1.3.1 Full functional capability

The item being developed must be designed in such a way that full functional capability will be guaranteed for

at least 15 years (? 8 000 h of operation + 30 000 h of charging) or

at least 300 000 km

while taking into account the specified operating conditions for use in passenger cars.

If used in commercial vehicles, the item being developed must be designed in such a way that full functional capability will be guaranteed for

at least 15 years and

at least 1 000 000 km

while taking into account the specified operating conditions.

It must be verified that the reliability requirements have been met. For this purpose, service life tests must have already been conducted before the start of production and the results (failures over mileage) must be statistically evaluated with a Weibull analysis as per VDA volume 3, part 2, for example.

The tests must be designed in such a way that they will make it possible to reach conclusions regarding failures in the field. A representative sample of specimens must be used for this purpose.

The number of specimens must be defined for product validation purposes. When choosing the specimens, it is necessary to ensure that they represent the expected production dispersions.

4.1.3.2 Warranty and goodwill

The resulting rate of complaints from warranty and goodwill claims during this warranty period must be defined with the pertinent quality indicators. These indicators are defined separately by the individual OEMs' appropriate quality entities.

4.1.4 Maintenance intervals

The plug-in connections must be designed in such a way that their functional capability will be ensured for the vehicle's entire service life without any maintenance.

4.2 Operating and ambient conditions

Operational reliability must be ensured under all expected operating conditions (heat, cold, humidity, vibration, contact with media, current loads, voltage loads, etc.).

The corresponding plug-in connections must be designed for the conditions prevalent in the corresponding packaging space. The maximum voltage occurring within this context is 850 V DC. The operating voltages must be ensured for an elevation of 4 000 m above sea level.

The plug-in connections must be specified for use within a temperature range of -40 °C to 140 °

4.3 Environmental compatibility and emissions

4.3.1 Environmental compatibility

The End-of-Life Vehicles Directive restricts the selection of materials, additives, and process materials.

4.4 Operational and product safety

4.4.1 Operational safety

A single hardware fault or software error, or a single error made by a trained person, must not result in a safety hazard to people or pets.

All HV safety requirements must be met and implemented.

4.4.2 Product safety

The plug-in connections must be secured against unauthorized opening so that people and pets are not endangered.

4.5 Requirements – protection against electrical hazards

The HV safety requirements in LV 123 must be met and implemented.

4.5.1 IP degree of protection

The IPXXD degree of protection as per ISO 20653 applies to all components that are fully assembled and plugged in. The IPXXD degree of protection as per ISO 20653 applies to HV connectors that are not fully assembled.

4.5.1.1 Protection against direct contact with live parts – general information

Direct contact with live parts in HV plug-in connections must be prevented.

4.5.2 Protection against indirect contact – general information

High-voltage plug-in connections must be designed, installed, and manufactured in such a way that no insulation faults occur. Protection against indirect contact must be provided by means of insulation. In addition, any exposed conductive parts must be galvanically connected to each other and to ground.

4.5.3 Contact system

Electrical connections must be designed in such a way that they make it impossible for the connection to be opened by accident.

Connectors must have reverse polarity protection. It must not be possible to mix them up by mistake.

4.5.4 HV interlock (HVIL)

4.5.4.1 General information

The HVIL protects people and pets who interact with the HV system. The HV interlock circuit makes it possible to detect a disconnected plug-in system in the HV system. This makes it possible to shut down the HV system if a plug-in system in the HV system has been disconnected. The question as to whether HVIL contacts must be provided must be agreed upon on a case-by-case basis.

4.5.4.2 Design

If an HVIL is required in a plug-in connection, it must be implemented with separate contacts.

4.6 Part markings on HV connectors

HV connectors must have an orange color similar to RAL 2003. It is not necessary to mark them separately with an adhesive label.

4.6.1 Functional samples and prototypes

Functional samples and prototypes are assembly-specific, relate to agreed-on development statuses, and are subject to mandatory documentation.

Sample parts must be marked in a clear manner that makes it possible to identify them. The durability and type of these markings must be agreed upon with the purchaser.

4.6.2 Production parts

Production parts must be marked with the part number and a revision index.

4.7 Electrical/electronic design – electromagnetic compatibility

To classify the HV contacts' shielding characteristics, the transfer impedance (line injection method) and the DC shield contact resistance are measured.

A qualification report must be prepared for every hardware change that has an impact on EMC.

4.8 Documentation

The documentation type and method (CAD models and drawings, releases and changes, sample inspections) must be agreed upon with the purchaser.

4.9 Corrosion resistance

The item being developed must meet the following corrosion resistance requirements:

- No functional impairments caused by corrosion products in the item's installed condition within 15 years of the vehicle being delivered
- No base material corrosion on components installed in the vehicle interior in a visible area

The item being developed must successfully pass the corrosion test as evidence of the fact that this requirement is being met.

5 Requirement – integration framework

5.1 Dimensional requirements

The requirements for the pertinent interface result from the specifications of both interface counterparts.

Coordination between the two interface partners is mandatory and must be defined with an interface drawing (implementation regulation).

The HV connectors must be designed in such a way that the individual phases/cables cannot be mixed up in any way.

Cable routing separations must have the following angles:

a) 180 °

b) 90 ° , does not apply to threaded connections

5.2 Thermal requirement

The HV plug-in system must be designed for ambient temperatures between -40 °C and 140 °C.

5.3 Mechanical requirements

The plug-in system must be designed for the expected mechanical load.

In general, the load must be specified as per a severity 3 vibration profile and a severity 4 temperature profile.

If cable routing and securing are required on the vehicle to ensure the HV plug-in system's functionality, they must always be designed and tested in line with the requirements for the HV wiring harness.

5.3.1 Electrical requirements

5.3.1.1 Contact system and cable cross-sectional area

The cable cross-sectional area and contact size to be used must be appropriate for the expected current spectrum.

The HV contacts are subdivided into five classes; see Table 1.

Table 1: Contact systems

Class	Pin dimensions	Preferred cable cross-sectional area (Cu)	To be reserved for	Preferred contact system as per WG 4.3
1	(2,8 x 0,8) mm	(2,5 – 4) mm2	Plug-in connection	4-pin box-type contact (QKK)/multiple contact point (MCP) 2,8
2	(4,8/6,3 x 0,8) mm	(4 – 6) mm2	Plug-in connection	4-pin box-type contact (QKK)/multiple contact point (MCP) 6,3
3	(9,5 x 1,2) mm	(10 – 16) mm2	Plug-in connection	QKK 9,5
4	8 mm round/ cable lug	(16 – 50) mm2	Threaded and plug-in connections	8 mm round / M8 cable lug
5	Cable lug	(70 – 120) mm2	Threaded joint	M8 cable lug

5.3.1.2 Ampacity

The HV contact system must be designed for the ampacity values in table 2.

The following conditions apply to the values:

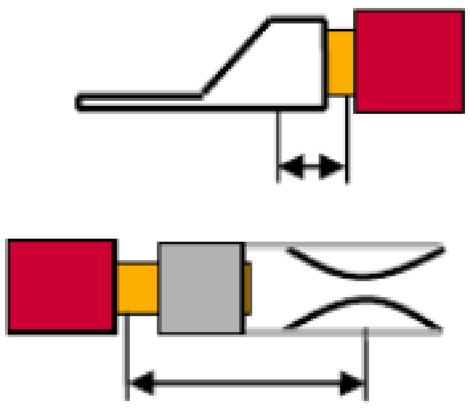
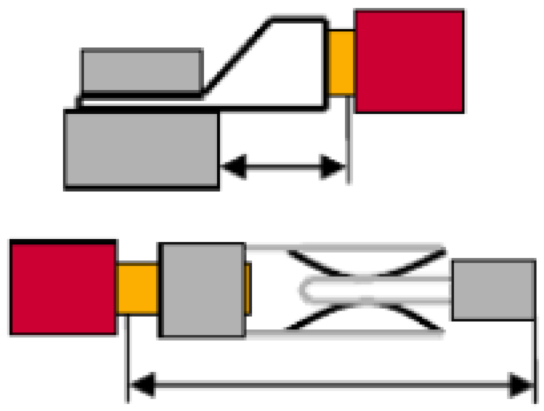
- 80% value for connectors as per DIN EN 60512-5-2
- Contact in open air
- Max. temperature at contact point: 180 °C

Table 2: Ampacity values

Class	Cross-sectional area	Ampacity at specific ambient temperatures			
		65 °C	85 °C	125 °C	140 °C
1	4 mm2	34 A	30 A	19 A	12 A
2	6 mm2	56 A	56 A	43 A	40 A
3	16 mm2	105 A	105 A	90 A	80 A
4 Plug-in	35 mm2	220 A	200 A	150 A	130 A
	50 mm2	305 A	275 A	210 A	180 A
4 Threaded	35 mm2	270 A	235 A	190 A	160 A
	50 mm2	340 A	305 A	235 A	200 A

The contact resistances in Table 3 must not be exceeded within this context:

Table 3: Contact resistances

Cable cross-sectional area mm2	Crimp resistance		Contact resistance (total resistance incl. crimp connection)	
	Unused m Ω	After aging m Ω	Unused m Ω	After aging m Ω
2,5	0,17	0,35	1,17	2,34
4,0	0,11	0,22	0,72	1,44
6,0	0,09	0,18	0,68	1,36
16	0,05	0,10	0,43	0,86
25	0,035	0,07	0,40	0,80
35	0,029	0,059	0,39	0,78
50	0,025	0,05	0,36	0,72
				

5.3.1.3 Dielectric strength and insulation resistance

The dielectric strength and the insulation resistance must be specified as per ISO 6469-3; VDE 0303-11:2010-05:2010-05.

The resulting dielectric strength and insulation resistance are specified in section 6.7.

5.3.1.4 Shield connection

The shield contact resistance must not exceed the values in Table 4 at any point during the item's service life. The resistance is measured directly from the shield (incl. the cable shield transition on the connector) to the unit across the pin header.

Table 4: Shield contact resistances

			Requirements
DC contact resistances in contact system	Cable shield – connector shield	R_1	<3 mΩ [1]
	Connector shield – header shield	R_2	<4 mΩ [1]
	Header shield – unit	R_3	<2 mΩ [1]
Delta transfer impedance, terminated on one end, at 2 MHz			<10 mΩ/m
Delta transfer impedance, terminated on one end, at 30 MHz			<50 mΩ/m
1) Differences between the initial condition and after the service life test > factor of 2 must be indicated in regard to the physical mechanism behind them.			

The shield must have a minimum continuous current capacity of 10 A and a minimum 60-s current capacity of 25 A. This must be ensured for the entire temperature range.

Metalized plastic must not be used as a sole EMC measure.

6 Requirements – functionality

6.1 Overall functionality

The HV plug-in system's main function is to ensure the safe transmission of power with consideration of the pertinent voltage and the required installation conditions. All high-voltage safety requirements must be met within this context as well.

6.2 Functional characteristics

6.2.1 Contact overlap, not relevant for threaded connections

6.2.1.1 Pin-socket contacts

The contact overlap must be designed as per LV 214-1.

6.2.1.2 Butting contacts

Butting contacts are impermissible.

6.2.2 Contact insertion, not relevant for threaded connections – insertion forces

The insertion forces of the contact parts into the housing must not exceed the following limits:

2,5 mm2:	<12,0 N
4,0 mm2:	<15,0 N
6,0 mm2:	<18,0 N
≥ 6,0 mm2	<30,0 N

6.2.3 Contact engagement, not relevant for threaded connections

The contacts must engage in a clearly perceptible/recognizable manner. It must be possible to insert the contact parts by hand.

6.2.4 Contact securing, not relevant for threaded connections

6.2.4.1 Securing in the contact chamber

Connectors must be designed in such a way that the contact parts are secured in the following manner:

a) With a primary latching mechanism when the contact is inserted into the contact chamber
b) Or with an independently acting, secondary latching mechanism on the housing

6.2.4.2 Removing the contact part

It must be possible to remove or release unused contact parts and an unused secondary latching mechanism and then re-engage them at least five times without any functional impairment.

The contact part must not be removed by anyone except the manufacturer.

6.2.4.3 Holding forces

The required holding forces must be generated by the primary latching mechanism and the secondary latching mechanism acting independently from one other.

The force specifications in LV 214-1 apply to HVIL contacts and other signal contacts.

6.2.4.4 Primary latching mechanism holding force

For requirements, see LV 215-2.

6.2.4.5 Secondary latching mechanism holding force

For requirements, see LV 215-2.

6.2.5 Secondary latching mechanism function, not relevant for threaded connections

Both active and passive secondary latching mechanisms are permissible.

6.2.5.1 Active secondary latching mechanism

In its insertion position, the secondary latching mechanism (slider, flap, etc.) must be positioned in such a way that it cannot hinder the contact while it is being inserted. It is also permissible to insert the latching slider into the socket housing subsequently.

The secondary latching mechanism's activation force must not exceed 40 N. It must be impossible to open or close the secondary latching mechanism by accident (transportation, handling, etc.).

The design must rely on standard tools (e.g., screwdrivers) for the final locking step. Requiring special tools is impermissible.

The secondary latching mechanism's engagement element must be able to withstand a force of at least 100 N. If the force it can withstand is less, this must be discussed with the appropriate OEM departments.

The engagement elements must be stress-free in their final engagement position.

The secondary latching mechanism's locking position must be visually recognizable.

The secondary latching mechanism must be designed in such a way that the receptacle housing can only be inserted if the mechanism is in its final engagement position.

6.2.6 Keying, color coding, and polarization

6.2.6.1 Keying and color coding

The mechanical keying must be easy to understand and designed in such a way that the connector cannot be plugged in the wrong way. It must be impossible to plug in connectors the wrong way without destroying them, even if large amounts of force are used to do so (min. 300 N).

In addition to mechanical keying, the housing parts must have a clearly recognizable color marking as per Table 5.

Table 5: Color code

Keying	Color	Similar to RAL
A	Black	9005
B	Natural/white	9010
C	Blue	5012
D	Purple	4004
E	Green	6017
F	Brown	8011
Z	Aqua blue	5021

6.2.6.2 Polarization

Polarization elements must be included to reliably prevent connector halves that correspond to each other from being plugged in the wrong way.

The polarization elements must be designed in such a way that contacts that do not correspond to each other cannot come into contact if the connector is plugged in the wrong way by accident.

6.2.7 Housing guide, not relevant for threaded connections

6.2.7.1 Housing guide

Before the receptacle housing and the unit's contact part come into contact with each other, a suitable guide must be used to place the receptacle housing in a sufficiently parallel position relative to the unit.

6.2.7.2 Inclined housing insertion

The maximum angle at which the receptacle housing can be inserted in an inclined position relative to the unit (or pin housing) must not cause any plastic deformation in the contacts. This must be verified by means of a tolerance computation.

6.2.7.3 Scoop-proofing

It must be ensured that the contact pins in the unit will not be damaged in any way if the receptacle housing is plugged in the wrong way.

6.2.8 Housing locking/latching mechanism, not relevant for threaded connections

The locking mechanism must be designed with an actuation force between 5 N and 30 N.

The locking mechanism must be symmetrical and have its engaging parts on two opposite sides.

The locking mechanism must be designed in such a way that it is possible to feel when it locks into place. Joining and locking must occur at the same time as a result of the respective mechanisms' design.

The active locking elements must be placed on the receptacle side.

It must not be possible to perform the final locking step unintentionally. It must not be possible to separate the two housing parts unless the locking mechanism has been released first.

6.2.9 CPA, not relevant for threaded connections

A CPA mechanism must be provided as an option. Combining the HVIL with the HV connector locking mechanism as a CPA solution is permissible.

6.2.10 Crimping

Crimp connections must be designed as per the contact manufacturer's and OEM's requirements.

The crimp connections' quality must be verified as per LV 214.

The aforementioned verification must be provided for alternative joining methods.

6.2.11 Crimp connection pull-out strengths

If the pull-out strengths are measured with the insulation crimp connection/single-wire seal for production-related reasons, the values in parentheses apply.

The crimp connection pull-out strengths must be adhered to:

2,5 mm2	200 N (235 N)
4,0 mm2	310 N (325 N)
6,0 mm2	450 N
16,0 mm2	1 500 N
25,0 mm2	1 900 N
35,0 mm2	2 300 N
50,0 mm2	2 800 N
70,0 mm2	3 400 N
95,0 mm2	4 200 N
120,0 mm2	4 800 N

6.3 Installation forces

6.3.1 Insertion force

The limit as per LV 214 applies to the max. joining force up to class 3. Starting with class 4, a joining force of 100 N must not be exceeded. If necessary, appropriate aids such as slides or levers must be provided on the connector.

6.3.2 Removal force

The same forces listed in section 6.3.1 apply to the removal forces as relevant.

6.4 IP degrees of protection (leak-tightness/protection against contact)

6.4.1 Protection against contact

6.4.1.1 When not plugged in

When not plugged in, the receptacle housing, unit connections, and pin housing must be protected against contact as per DIN EN 60529, IPXXB (protection against finger contact).

6.4.1.2 When plugged in

When plugged in, the HV plug-in system must be protected against contact as per DIN EN 60529, IPXXD.

6.4.1.3 HVIL system, mechanism

An HVIL jumper may be integrated into HV plug-in connections. In this case, it must be ensured that the HVIL circuit will be reliably disconnected whenever the plug-in connection is disconnected.

6.4.1.3.1 HV plug-in system with integrated HVIL system

In HV plug-in systems with an integrated HVIL system, the HVIL contacts must be leading in the drawing process (min 1,0 mm at all tolerance zone positions).

6.4.2 Leak-tightness

6.4.2.1 When plugged in

When plugged in, the HV plug-in system must adhere to the following IP degrees of protection regardless of the location of installation (soiling degree 2): IP6K9K, IPX7.

This applies to the entire connector, incl. the cables.

6.4.2.2 Sealing element and sealing surface design

The sealing element must be integrated exclusively on the wiring harness side. Sufficiently constant sealing compression across the entire sealing surface is absolutely required. Radial seal systems must be used. It must be ensured that all sealing surfaces and sealing elements are protected against mechanical damage.

There must not be any parting lines in the sealing area.

If the sealing element needs to be designed as a molded part, it must be positioned exactly and placed in a manner that will prevent it from rotating.

The sealing system must be designed in such a way that it will provide the required leak-tightness at all tolerance zone positions for its entire service life.

6.4.2.3 Seal on cable side

6.4.2.3.1 Plug-in system with assembly capability

The connector must have single-wire seals on the cable side.

The sealing elements must ensure that all cables being used will meet the required leak-tightness specifications.

To prevent the sealing elements on the cable side from being directly exposed to splash water and water from pressure washers, a splash shield cap receptacle must be incorporated into the receptacle housing.

A longitudinal water seal based on a cable grommet between the cable and the receptacle housing is not permissible as a sole sealing solution.

6.4.3 Functional reliability

It must be possible to plug in the HV plug-in system at least 50 times without any negative effect on its leak-tightness.

Common soiling on or inside the connector must not have a negative effect on leak-tightness.

6.5 Assembly capability

An independent manufacturer must provide confirmation of the fact that the system can be assembled under production conditions.

6.6 EMC requirement

In general, the requirements in 6.6.2 apply.

6.6.1 Shielding

6.6.1.1 Inside the HV connector

In general, the HV plug-in system must have 360° shielding. Shielding gaps when the system is plugged in are impermissible.

6.6.1.2 From the HV wiring harness to the HV connector

In general, a common shield must be provided for multicore cables (classes 1 and 2).

Single-core shielded cables are also permissible (classes 3, 4, and 5).

6.6.2 Metal face – geometric design

For HV plug-in systems made of plastic, the shielding must be implemented with metal faces.

No elements must interfere with the insertion of the metal face into the chamber.

Nothing must interfere with joining the two metal faces (socket housing and unit), and joining the faces must not damage them or any other parts.

The metal face thickness must be selected in such a way that no mechanical damage will occur when the system is plugged in.

The holding forces must be able to handle at least twice the insertion force of the metal face.

The metal face's thickness and the coverage provided by the metal face must ensure that all pertinent EMC requirements and HV safety requirements are met.

The sheet metal, surface, and springiness characteristics must be designed for at least 50 plug-in cycles.

6.6.3 Shield connection

All the values in table 5 must be adhered to throughout the entire service life.

The measurement must be performed between the cable's shielding braid, directly on the HV connector and unit housing.

6.6.3.1 Shield connection between receptacle housing and cable

The shield connection between the HV cable and the HV receptacle housing must be a 360 ° transition.

6.6.3.2 Shield connection between receptacle housing and unit connection

The shield coverage between the unit connection and the receptacle housing must span the entire 360 ° and have no gaps. Inside the unit, the shield must transition to the vehicle's ground.

6.7 Electrical requirements

In general, the contact system must be designed as per the requirements in section 5.3.1.2, "Ampacity".

The current spectrum that will actually exist, and the system limits arising from it, must be agreed upon with the OEM.

6.7.1 Dielectric strength

The HV plug-in system's dielectric strength is defined based on ISO 6469-3, equipment class 1.

6.7.2 Insulation resistance

The insulation resistance must be measured as per ISO 6469-3. The insulation resistance must be greater than 200 MΩ under all conditions. The creepage distances needed to meet this requirement must be adhered to accordingly.

6.8 Housing marking and inscription

6.8.1 Housing chamber

Easily legible, consecutive numbers must be applied to the housing chambers on both the plug-in and component sides.

6.8.2 Part markings

In general, the requirements in section 4.6 apply.

6.9 Housing color

In general, the requirements in section 4.6 apply.

6.10 Material selection

Materials that meet the pertinent functional requirements under the vehicle-specific usage conditions throughout the vehicle's entire service life must be used.

Plastics with an appropriate insulation material group must be used to adhere to the clearance and creepage distance requirements in DIN EN 60664-1.

Materials already released by the purchaser must be used. A release must be obtained from the OEM for any other materials.

7 Testing and validation

The test requirements in LV 215-2 must be met.