Class No.: 69606

Descriptors: vehicle push-on connectors, push-on connectors, contact, crimp, slow motion

Vehicle Contacts

Slow Motion Tests

Preface

This standard in the present issue has been drawn up by representatives of automobile manufacturers Audi AG, BMW AG, Daimler AG, Porsche AG, and Volkswagen AG.

This standard is stored as an MS Word file in the Audi AG Standards Department.

No claim is made as to its completeness. The automobile manufacturers are entitled to require additional tests according to the relevant state-of-the-art at any time.

As it is possible that individual automobile manufacturers might modify the specifications, testing according to this standard is not permitted. Instead, the supplier is obliged to ensure that it has the currently valid in-house standard of the respective automobile manufacturer. In the individual in-house standards, deviations with respect to this standard are represented in italics. If modifications to individual test sections become necessary in individual cases, these must be agreed upon separately between the responsible Engineering Department and the affected manufacturer.

Test reports are accepted as long as the tests are performed by an independent testing institute that is accredited according to DIN EN ISO/IEC 17025. Acceptance of the test reports does not automatically result in a release.

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1 General information

Express reference is made that no liability is accepted, either explicitly or implicitly, as to the complete and sufficient examination of products using the following test guideline upon acceptance of this test guideline by an automotive manufacturer, regardless of legal standing. No liability whatsoever is accepted for any unrecognized defects in products.

1.1 Scope

The objective of the following test is to record the properties of the connection between the line and the contact (crimp). With the currently defined measuring device parameters, lines of up to 4 mm^2 can be measured. The lines must correspond to the relevant standards (for metric lines, see *VW 60306*).

This standard applies to all electrical vehicle contacts. This standard does not supersede existing test guidelines (e.g. *VW 75174, Motor Vehicle Push On Connectors; Test Guidelines*).

2 Definitions

2.1 Climatic conditions RT

The following applies to all measurements at room temperature (RT):

Temperature: T = 23 ℃ ± 2 ℃,

Humidity: rF = 50% or uncontrolled

All measurements must be taken and verified in certified ovens or climate chambers. Otherwise, the temperature characteristics and humidity characteristics of the chamber must be recorded.

2.2 Accuracy

The measurement accuracy of the resistance measurement (or voltage measurement including current measurement) must be more precise than the test specimen resistance to be measured, by at least a factor of 10.

2.3 Documenting the measurement results

2.3.1 Documents to be submitted

a) Documentation of the test setup (and including measuring technology, direction of movement, sampling rate, and images of the specimens)
b) Product description with identification numbers
c) Test results: "Passed" or "Failed"
d) Information on the contacting parts and lines for all manufacturers for which the test reports are valid (manufacturer, line designation)
e) Noticeable flaws
f) Processing specifications (including crimp parameters)
g) Precisely measured crimp data for the contacts in the test (height and width)
h) Measurement results for the crimp resistance in table form and diagram form. The following values must be indicated in tables: For the initial value and end value and/or the resistance

change of the respective test: maximum value, mean value, and minimum value as well as the standard deviation for all specimens in each case

i) All results (diagrams and tables) must:
- Contain the measurement parameters, environmental parameters, and device parameters used
- Indicate the ordinates of the diagrams on a suitable scale (default value range is 0 to 50 mΩ)

j) One micro-section per test group

All resistance values must always be indicated including the line resistance. The line or the temperature influence must not be taken out of the results.

3 Slow motion test

3.1 Test object and batch sizes

The object of the measurement is the connection between the contact and the line in each case (according to *VW 60306*).

Metallic transitions within the contact are measured as well (weld points or embossings between the contact base body and the contact fins). The transition from the contact to the potential mating connectors or mating couplings (e.g., surfaces) must not influence the measuring result (see Section 3.2).

Test scope:

- Batch size: 10
- All crimp shapes described in the processing specification
- For lines: All cross-sections, type B strand structure, all surfaces and all insulation materials (currently: PVC 105 °C, other lines to be specified in more detail later)

Test conditions:

- Crimp height always at the upper tolerance (lowest compression)
- Test direction of the line movement: Horizontal (see Figure 1)

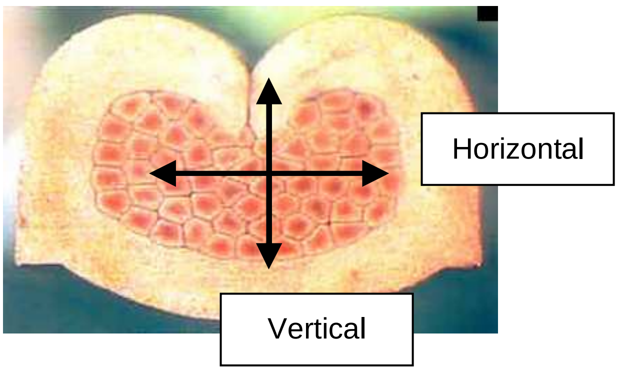

Figure 1: Definition of line movements

To check the measuring setup, at least one reference component must be measured with each measuring cycle. The reference component consists of the same parts as the test specimen (same identification numbers, same connections, same line lengths, etc.). In addition, the connection between the line and the contact is soldered.

3.2 Resistance measurement and data storage

3.2.1 Measurement setup

Make sure that the principle of a four-point measurement is implemented (see Appendix A.1). The voltage tap and the current input must never occur at the same point on the test specimen (e.g., at the soldering point).

The resistance value must be indicated in mΩ in the documentation. This value must be calculated from the voltage drop and the measured current (via a measurement shunt).

Setup

The test specimens must be set up according to Figure 2 and Figure 3. The soldering points must not be too close to the crimp. The first soldering point in the line must be no closer than $l_1 + l_2$. The soldered joint must comprise all strands. The line must not be cut at position 4 (remove wire insulation without cutting the copper strands).

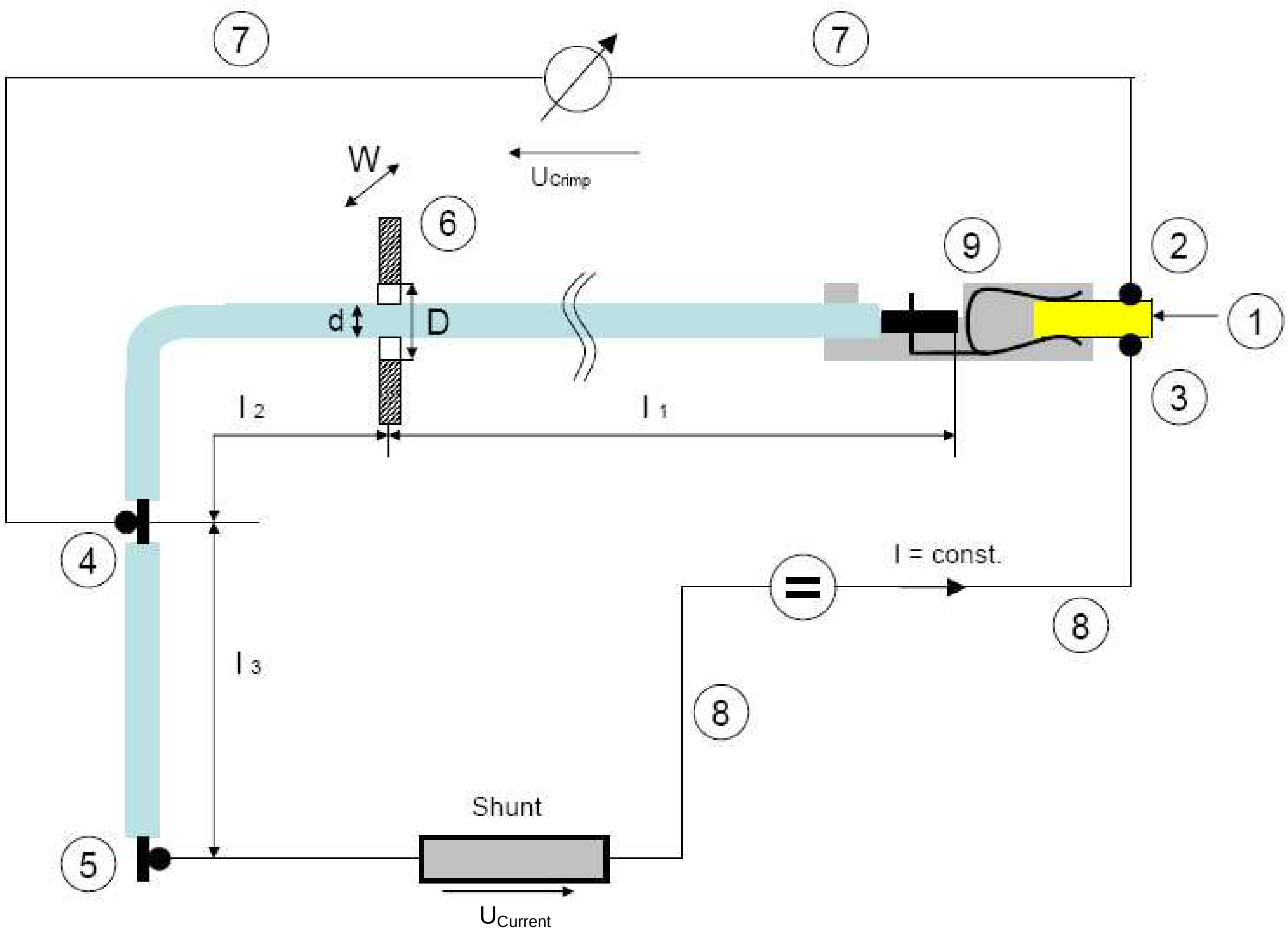

Figure 2: 4-point measurement (overview)

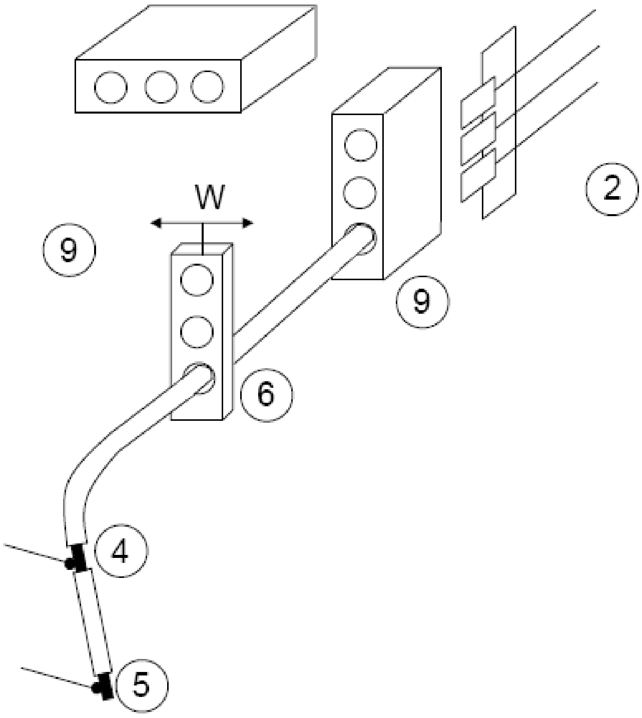

Figure 3: 4-point measurement (in detail)

Keys to Figure 2 and Figure 3:

Pos 1 PC board comb at top and bottom with copper conductor (see Figure 4)

Pos 2 Soldering point at top (voltage tap)

Pos 3 Soldering point at bottom (current feed)

Pos 4 Soldering point on the line (voltage tap)

Pos 5 Soldering point on the line (current feed)

Pos 6 Movement slide with through-hole for wire routing

Pos 7 Line for voltage measurement (use small cross-sections due to temperature effects; 0,35 mm² max.)

Pos 8 Line for constant current (0,5 mm² max.)

Pos 9 Contact for testing in a contacting housing (alternatively, contacts may also be clamped)

l1, l2, l3 Line lengths (see "Parameters")

Notes:

If a PC board comb cannot be used (e.g. because of a round contact), the measurement line to the voltage tap must be glued (electrically conducting) to the contact body. The line must not be soldered (no soldering permitted close to the crimp). For glued connections, the measurement from Section 3.2.4 must be taken at the start and end of the measurement sequence.

For pin contacts, "Kelvin clips" (instead of the PC board comb) must be used.

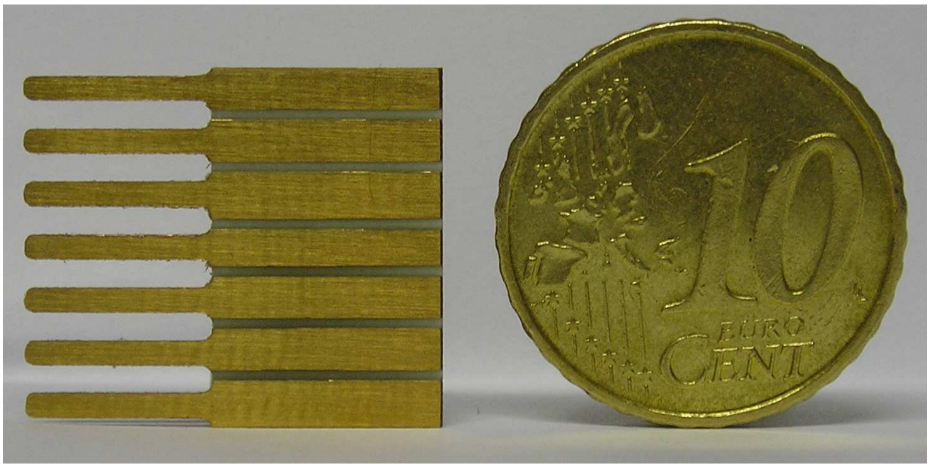

Figure 4: PC board comb with surface coating on both sides

Parameters for Figure 4:

Material:	Common PC board (PCB) with Cu conductors with pore-free Au surface
PCB thickness:	Must match the pin dimension of the contact to be tested (typical thicknesses: 0,6 mm or 0,8 mm). The tolerances of the pin design specification (for standard production parts) do not have to be met. The nominal thickness must be achieved, including the conductor thickness of the Cu layer.
Grid dimension:	The grid dimension must match that for the contact housing used for the test (e.g. 2,54 mm). Keep in mind that, if applicable, only every other housing chamber must be populated (refer to dimensions of "Diameter D of the passage of the wire routing").
Note:	see A.1.3.4

3.2.2 Data acquisition and data filtering

With the data acquisition, make sure that data is recorded for 30 minutes each time (at room temperature (RT), without movements) before and after the loads (for both pre-aging and slow motion testing).

It must be possible to generate the limit values at the start and at the end using the constant resistance values.

Differentiation must be made between raw data and filter data with the data acquisition.

– Raw data: The specimen's resistance is sampled continuously at 1 Hz. The measurement current flows constantly (without interruption, no cycling). This raw data must be recorded.
– Filtered data (optional): The raw data may be additionally filtered and stored ("MMM data": maximum value, mean value, minimum value). In this process, for example, three values are determined for three minutes each from the raw data:
    - The maximum value during these three minutes
    - The mean value during these three minutes (geometric mean)
    - The minimum value during these three minutes
      (Example: 9 minutes of raw data will generate 9 values)

3.2.3 Storing of measurement data

The data must be stored during pre-conditioning and the slow motion test.

Only the MMM data will be required in the end. However, it is recommended to retain the raw data until after data preparation and discussion of the results.

3.2.4 Final measurement

Once the entire measurement process is complete, all of the current circuits and voltage circuits must be remeasured using a two-point measurement and documented. To this end, all of the measuring devices are removed and replaced by resistance measuring devices one after the other.

Note: The corresponding contact resistances (conductive adhesive points, soldering joints, PC board plug-ins, etc.) must not be extensive enough that they would influence the 4-point measurement (see Appendix A.1).

3.3 Pre-conditioning via temperature shock

During pre-conditioning, the resistance values must be determined.

Pre-conditioning must take place on the completely finished test specimens (i.e., contacts in the contacting housing, all measurement lines attached, movement slide is threaded, etc.).

Parameters:

Maximum temperature	T_{max} = 125 ℃
Minimum temperature	T_{min} = -40 ℃
Acclimatization period:	< 10 s
Hold time	$t_{max} = t_{min}$ = ½ h
Number of cycles	100

3.4 Slow motion test

The movement cycles (slow-motion) are superimposed by a temperature change.

The measurement setup must be designed such that it can be adjusted in a climate chamber so that the movement cycles can be conducted under various climatic conditions. To that end, the measurement lines must be routed out of the climate chamber.

3.4.1 Definition of the movement sequence

The pre-conditioning of the finished components and measurement lines can be done with or without the movement device. In each case, the goal is to have the most stress-free possible installation (without force being applied to the contacts). The contacts are not removed from the housing parts used.

During the ongoing test, the components must not be subjected to any additional mechanical load. Any shaking, rattling, wobbling or even touching of the lines or contacts is not permitted.

Setup

The entire test setup must be constructed from lightweight materials to the extent possible in order to achieve a short timeframe until a steady state is reached during the superimposed temperature change.

The contacts may be installed in a housing manufactured under standard production conditions.

Contacts with sealing elements (single core seal) must be tested with suitable single core seals in standard production housing units.

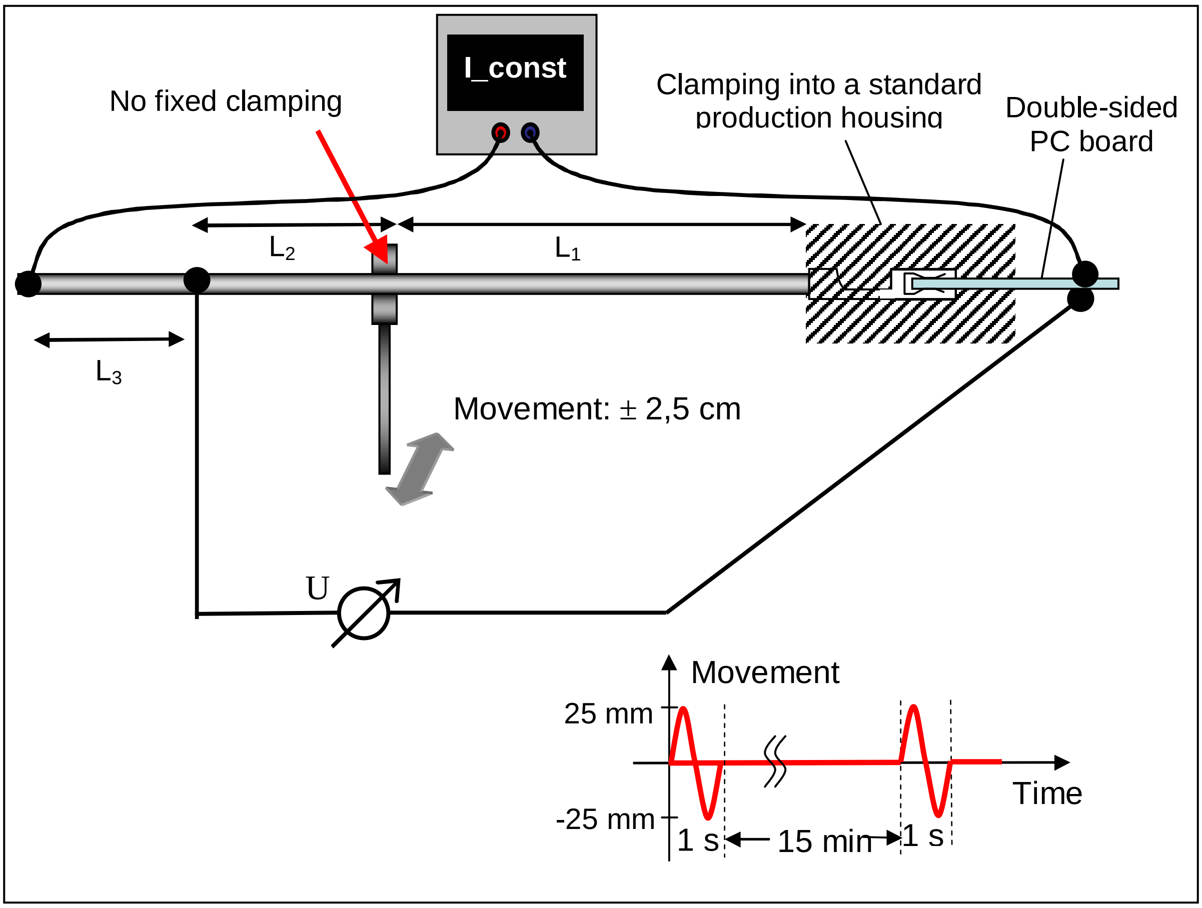

Figure 5: Setup principle

Parameters:

Crimp slide length	L_1 = 10 cm (length of the strands in the zero setting of the movement)
Voltage tap slide length	L_2 = 5 cm
Voltage/current tap length	L_3 = 5 cm
Deviation of wire routing in the slide from the crimp axis (Figure 2 and Figure 3, Item 6)	3°
Diameter D of the passage of the wire routing (Figure 2 and Figure 3, Item 6)	D = (line diameter + 20%) or (max. 5 mm)
Current (I_Const)	100 mA
Sampling rate	1 Hz
Movement amplitude (actual)	± 25 mm (within one second, sinusoidal)
Number of movement cycles	720

3.4.2 Definition of temperature cycle

The following temperature cycle (see Figure 6) is superimposed on the movement sequence.

Temperature cycle	T_{min} = RT, t_{min} = 1 h
	T_{max} = 80 ℃, t_{max} = 3,5 h
Gradient 1,33 K/min	
	(= 45 min change time ⇒ 1 temperature cycle lasts 6 h)
Number of temperature cycles	30

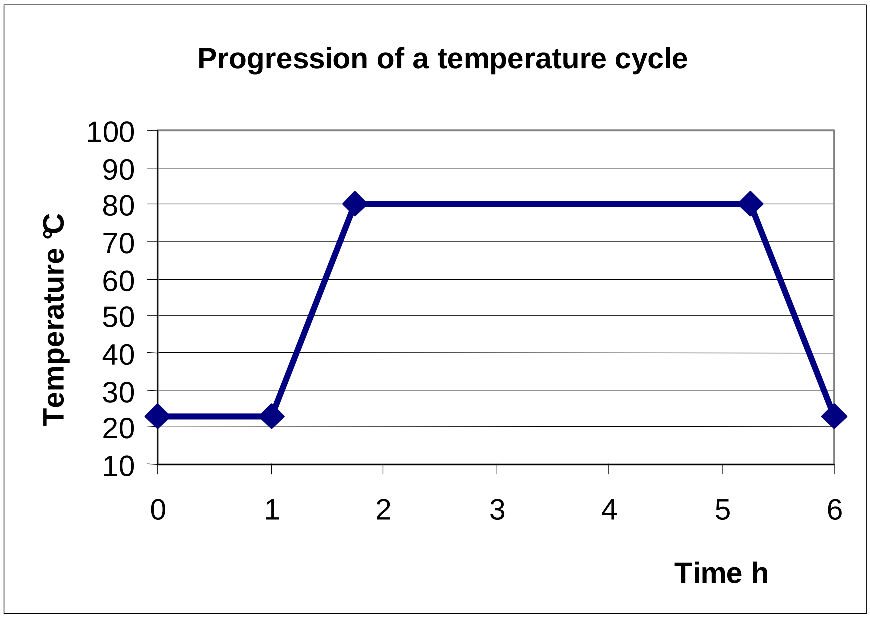

Figure 6: Temperature cycle

3.5 Limits

There are three criteria for forming the limit value (see Figure 7 through 9):

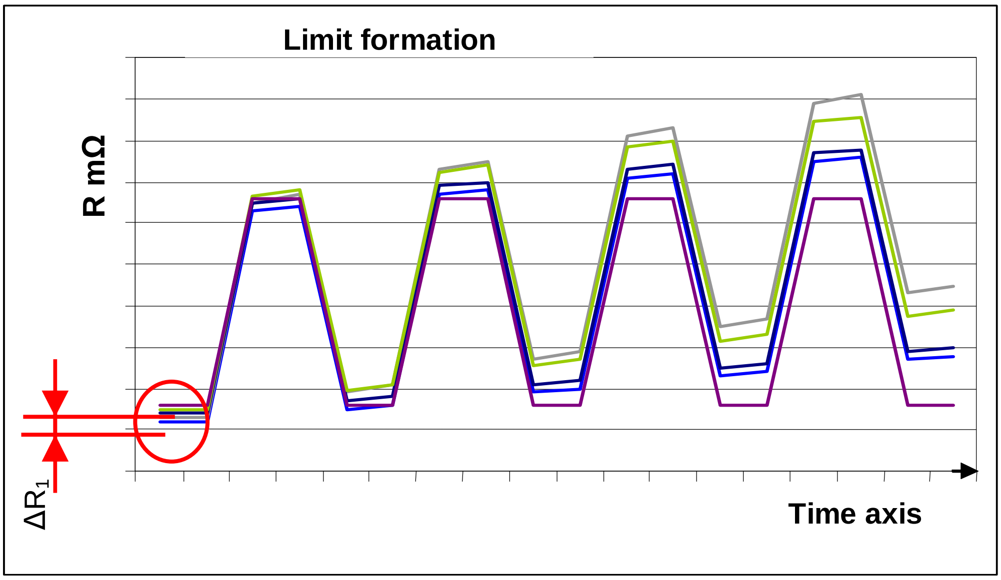

Figure 7: Criterion 1: Maximum dispersion of the measurement values (minimum/maximum difference) for all test specimens at the start of the measurement (only displayed schematically)

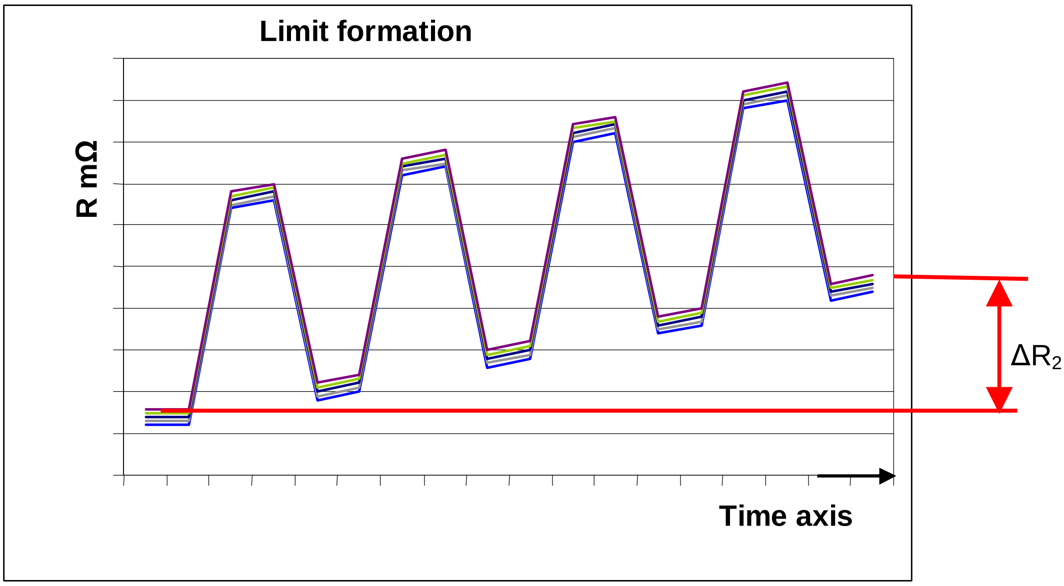

Figure 8: Criterion 2: Maximum change of each individual test specimen (only displayed schematically)

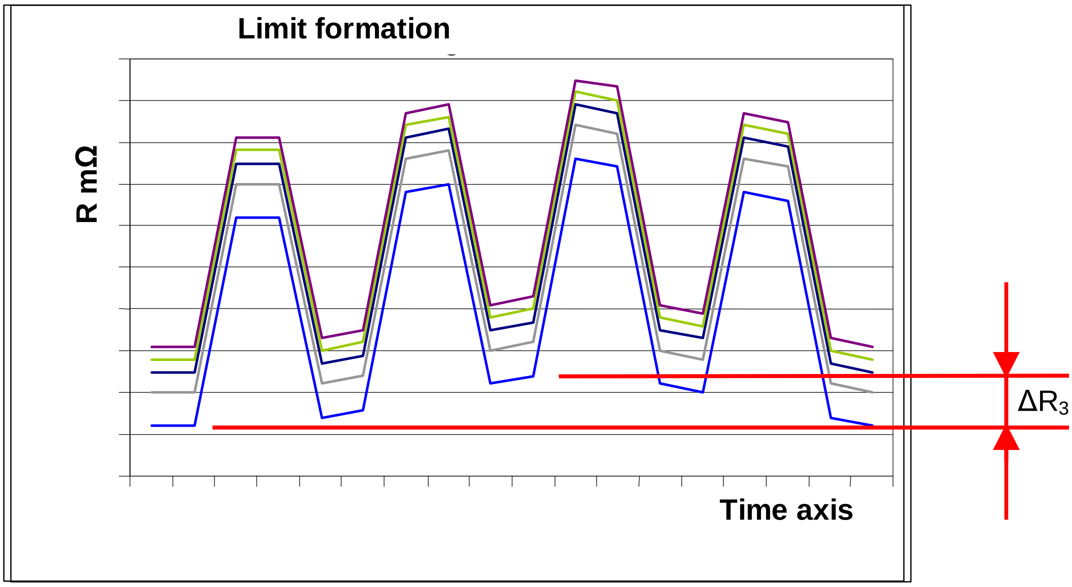

Figure 9: Criterion 3: Maximum change (including during the test progression) of each individual test specimen (only displayed schematically)

Maximum permissible resistance change ΔR (applies to small line cross-sections < 1 mm^2)

≤ 1 mΩ for ΔR_1 dispersion of all test specimens (new state)

≤ 3 mΩ for ΔR_2, ΔR_3 for each specimen (from the start of the test to the end)

4 Referenced documents

The following documents cited in this standard are necessary for application. In this Section, terminological inconsistencies may occur as the original titles are used.

VW 60306 *Electric Wiring in Motor Vehicles; Single-Wire, Unshielded*

A.1 Appendix (informative)

A.1.1 The 4-point measurement

A.1.2 Description of a 4-point measurement

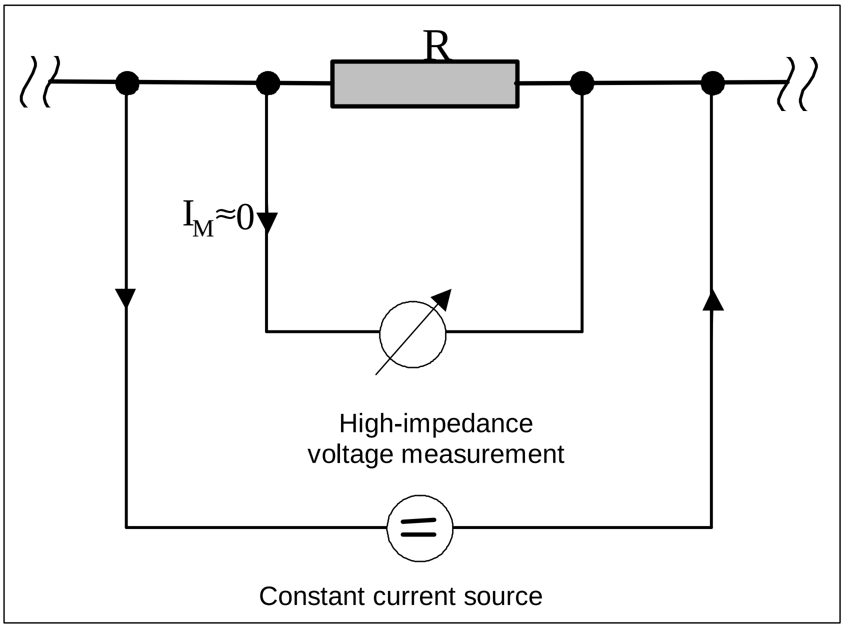

Figure A.1.1: Principle circuit diagram, 4-point measurement

A 4-point measurement (also known as a 4-conductor measurement) is used for precise recording of resistance values without the influence of feed line resistance or terminal resistance or their temperature progressions.

The measuring setup is always as shown in Figure A.1.2.

A constant direct current is fed into the resistance to be measured (current path). A voltage tap (voltage path) is applied on each of the two sides, as close as possible (see 3.4.1) to the resistance to be measured.

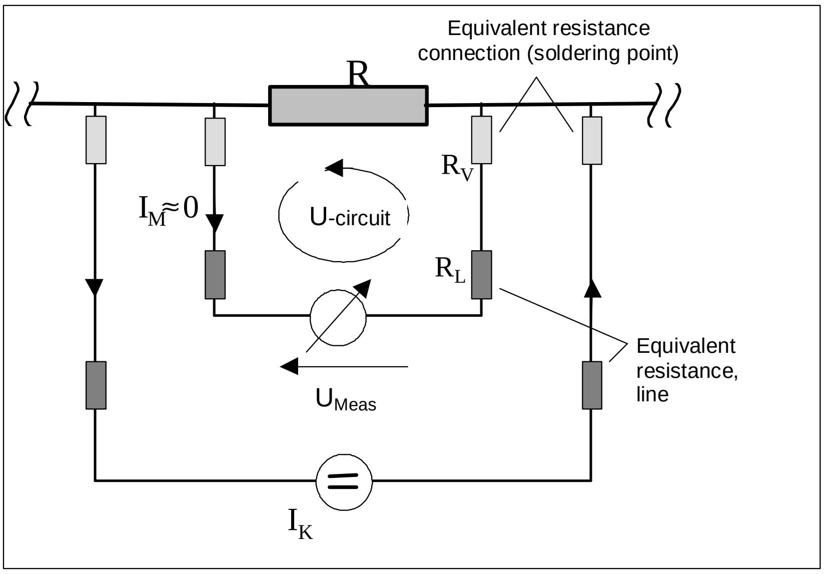

Figure A.1.2: Equivalent circuit diagram of a 4-point measurement

In this case, make sure that the feed of current and the tap of the voltage path does not occur at the same point (e.g., not at the same soldering point).

A high-impedance (MOhm) voltage measuring device is then connected in the voltage path (i.e. a current of only I << mA flows in the voltage path constrained by the measuring device (as compared to the current fed into the current path, this is approximately = 0).

The following is obtained with a "voltage circulation" in the voltage path:

$$0 = -U_{Meas} + 2 * (I_{Meas} * R_{Line}) + 2 * (I_{Meas} * R_{Conn}) + (I_K * R)$$

In this equation, line resistance or contact resistance in the current path is not included and thus cannot influence the measurement results.

Where approximately $I_{Meas} = 0$, the measuring cabling including the contact resistance of the connection technology of the voltage path is omitted, resulting in the following:

$$U_{Meas} = I_K * R$$

or

$$R = U_{Meas} / I_K$$

Figure A.1.3 and Figure A.1.4 show the circuitry of the 4-point measurement with a PC board comb coated on both sides (yellow).

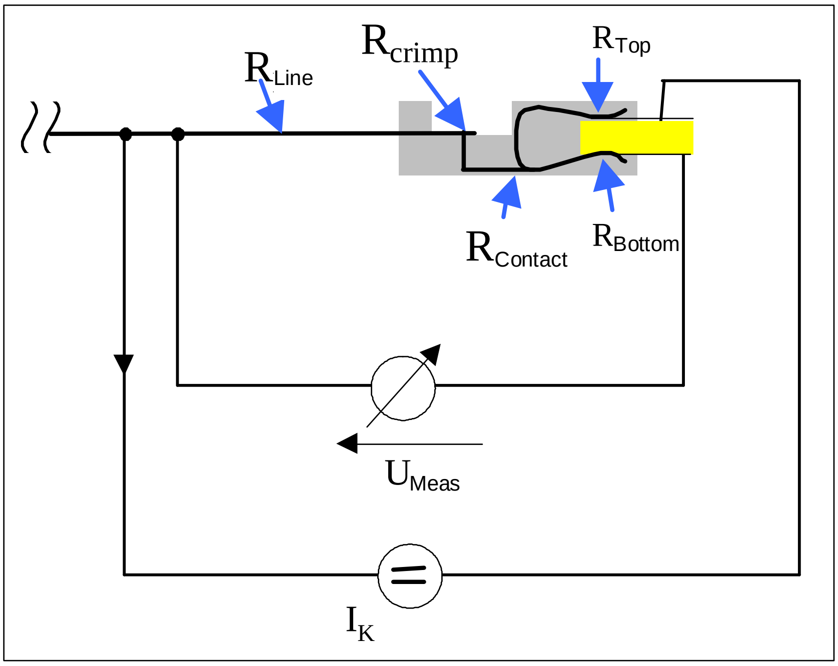

Figure A.1.3: Equivalent circuit diagram of the 4-point measurement with PC board comb

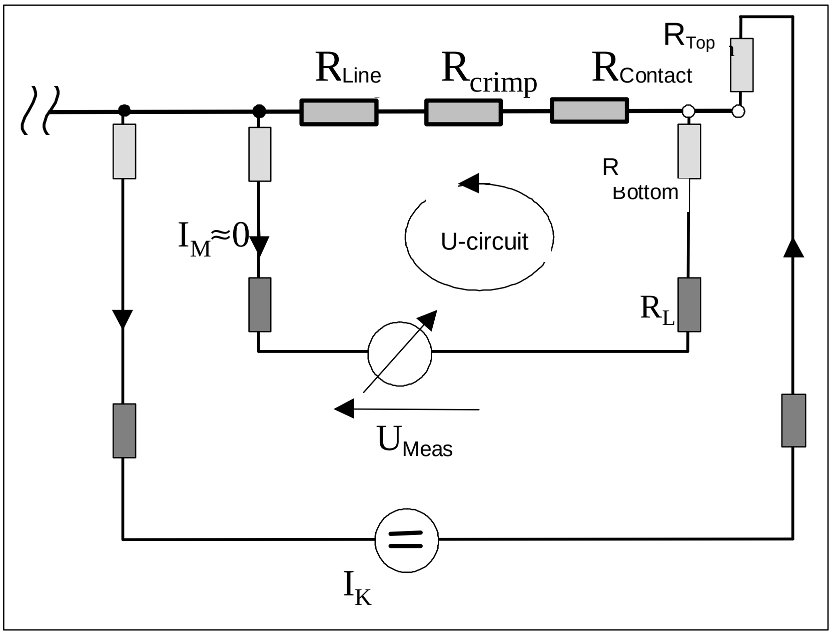

Figure A.1.4: Equivalent circuit diagram of the 4-point measurement with PC board comb

A.1.3 Possible errors in 4-point measurements

The following errors, which can effect the measurement results, are possible in the setup and execution of 4-point measurements.

A.1.3.1 Common U-soldering point and I-soldering point

The voltage circulation is then:

$$0 = -U_{Meas} + 2 * (I_{Meas} * R_{Line}) + 2 * (I_K * R_{Conn}) + (I_K * R)$$

Where $I_{Meas} = 0$, we have the following:

$$U_{Meas} = I_K * (R + 2 * R_{Conn})$$

or

$$R = U_{Meas} / I_K – 2 * R_{Conn}$$

This means that the connection of the measurement lines whose amount of the resistance is not known goes directly into the measurement results.

⇒ The measurement result U_{Meas} is too large and can change during the measurement time (standard deviation will increase).

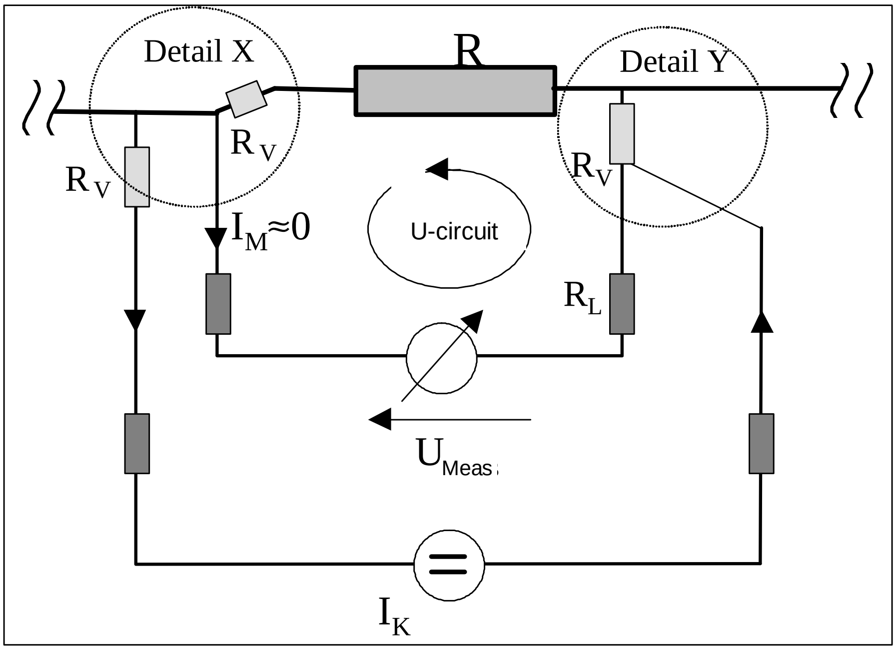

Figure A.1.5: Equivalent circuit diagram with common soldering point

For detailed views of X and Y, see Figure A.1.6. The same applies to a "cut line" to the resistance to be measured.

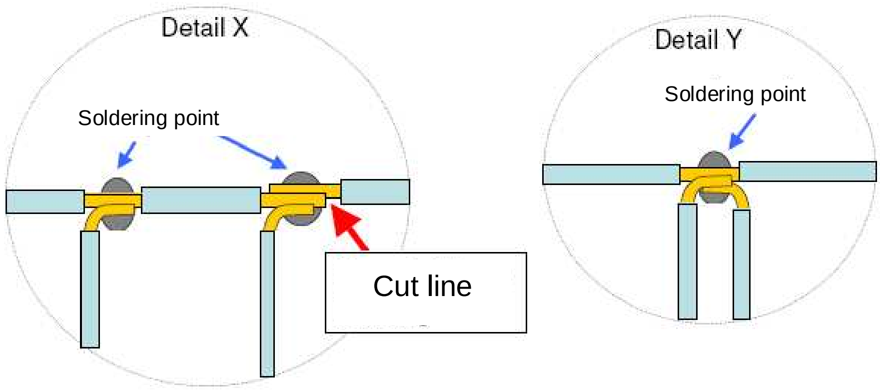

Figure A.1.6: Detailed views from Figure A.1.5

A.1.3.2 Resistance values in the voltage path too large

Typically applies to voltage taps R_{Conn} (e.g. soldering point) that can change during the measurement time. A significant measurement error occurs when R_{Conn} is in the same value range as the input resistance of the U-measuring device (high-impedance voltage divider).

If U-measuring devices with input resistance values ≥ 1 MΩ are used, these effects are negligible up to R_{Conn} < 1 kΩ (see Section 3.2.4).

A.1.3.3 Resistance in the current path lets constant current collapse

Usually applies to current taps R_{Conn} (e.g. soldering point) or a test specimen with conspicuous behavior during the measuring time. Regular checks of the measurement data of the fed-in constant current I are recommended. In the event of an interruption or an uncontrollable test specimen, a measurement series can be "saved" by bridging the interruption or the specimen at a suitable location with an appropriate resistance (e.g. 1 Ω wire resistor). A qualification examination can be ended immediately.

A.1.3.4 One-piece and two-piece contact fins

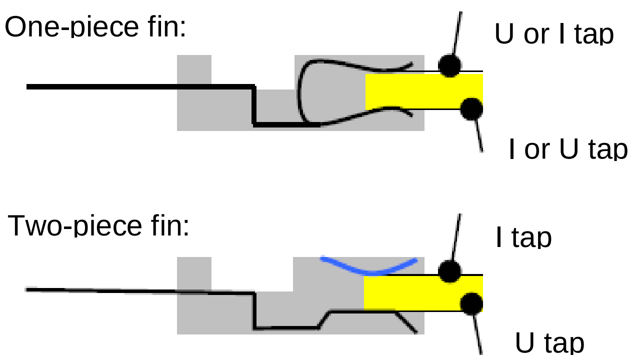

Figure A.1.7: One-piece and two-piece contact fins

While examining contacts whose upper and lower fins are formed by a single strip of sheeting, the sequence for the circuitry of current tap and voltage tap on the PC board comb may essentially be selected at will.

On the other hand, if contacts are examined in which the normal contact force is formed by two different materials (with different conductivity), the voltage tap is to be conducted on the side that is formed by the contact body (normally the material that has the better conductivity). In this case, not only the fed-in current on the other side must be measured and checked; the voltage and the current source must also be recorded in order to determine whether the current source is at the limit of its capacity.

With this setup, the current, as a quasi-insecure variable, can be subsequently checked for the entire measurement time; this is not possible for the voltage.