INTERNATIONAL STANDARD

ISO 20860-2

First edition
2009-03-01

Road vehicles — 50 Ω impedance radio frequency connection system interface —

Part 2: Test procedures

Véhicules routiers — Interface de système de connexion de radiofréquence d'une impédance de 50 Ω —

Partie 2: Méthodes d'essai

Reference number
ISO 20860-2:2009(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20860-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

ISO 20860 consists of the following parts, under the general title *Road vehicles — 50 Ω impedance radio frequency connection system interface*:

— *Part 1: Dimensions and electrical requirements*

— *Part 2: Test procedures*

Road vehicles — 50 Ω impedance radio frequency connection system interface —

Part 2: Test procedures

1 Scope

This part of ISO 20860 specifies the tests for male and female connectors of the 50 Ω impedance interface for radio frequency applications in road vehicles, and ensures communication to and within road vehicles.

These tests apply to all coaxial connectors for road vehicles with a 50 Ω radio frequency interface in accordance with ISO 20860-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 16949, *Quality management systems — Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations*

ISO 20860-1, *Road vehicles — 50 Ω impedance radio frequency connection system interface — Part 1: Dimensions and electrical requirements*

IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60169-10, *Radio-frequency connectors — Part 10: R.F. coaxial connectors with inner diameter of outer conductor 3 mm (0,12 in) with snap-on coupling — Characteristic impedence 50 ohms (Type SMB)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20860-1 and the following apply.

3.1.1
adapter "Adap 1"
Adap 1
apparatus consisting of a male ISO 20860-1 connector, mateable with a female ISO 20860-1 connector and on the other side with an SMA female connector

3.1.2
adapter "Adap 2"
Adap 2
apparatus consisting of a female ISO 20860-1 connector, mateable with a male ISO 20860-1 connector and on the other side with an SMA female connector

3.2 Abbreviated terms

CT/A continuity totalizer/analyzer

NWA network analyzer

PC printed circuit

RF radio frequency

SMA subminiature version A

VSWR voltage standing wave ratio

4 Principle

Connectors in accordance with ISO 20860-1 need to be tested as one unit consisting of connector and cable. The cable itself and the quality of the application to the connector can impact the test results. Therefore, only those cables approved by the vehicle manufacturer and those tools and processes recommended by the connector manufacturer shall be used for the preparation of the test samples. These tools and processes should be as similar as possible to those used for the series production. This instruction shall be applied to PC boards as appropriate, in the case of testing board mount connectors.

The test procedures are not intended to test the samples beyond their limits of resilience. After the tests, the samples shall not show any damage due to the excessive loads applied.

The condition of the test samples shall be the same as in regular production. The test samples shall not be specially prepared for the test procedures, apart from as specified in this part of ISO 20860.

The test procedures are planned in such a way that the test samples shall pass through one test sequence. If the vehicle manufacturer so requests, the test samples may be used for several test sequences. All individual requirements shall be fulfilled in that case as well.

All test results, laboratory reports and calibration records shall be stored in a central file. Such storage shall be in accordance with established ISO/TS 16949 requirements.

5 Preparation of the test samples

5.1 Dimensional characteristics

The part construction of the test samples shall conform to the dimensions, shape and detail attributes specified in ISO 20860-1 and as defined in the latest revision of the manufacturer's applicable part drawing(s).

5.2 Material characteristics

All material used in each test sample shall conform to the specifications in ISO 20860-1 and as defined in the latest revision of the manufacturer's applicable part drawing(s).

5.3 Making of the test samples

The quantity and details relative to making the test cable assemblies are given in the corresponding test procedures. The length of the cable assembly is the distance between the two reference planes as defined in ISO 20860-1, with an accuracy of $\pm$ 3 mm. The test samples shall be marked so that they can be identified individually during and after completion of each test sequence.

5.4 Quality test of the test samples

All dimensions specified in ISO 20860-1 shall be tested by adequate means. It shall be ensured that the centre contact and the outer contact of the samples are continuously conductive.

NOTE For proof of conductivity, flexible contact parts can be touched, but it is advisable not to expose them to a mating cycle.

5.5 Documentation of the test samples

Each single test cable shall be appropriately identified with a unique label, so that test data can be recorded and retained for evidence.

6 Visual inspection

6.1 Purpose

This test shall be used to document the physical appearance of the test samples. A comparison shall then be made with other test samples. In most cases, examinations shall be carried out by a person with normal or corrected vision and normal colour sensitivity, under cool white fluorescent lighting. Conformity with RAL colours shall be proven by comparison with the RAL colour table (see Reference [1]). An identical match is not required, but there shall be clear identification with the intended colour.

6.2 Apparatus

6.2.1 Magnification apparatus 20-times (as required).

6.2.2 Camera, digital camera or **video recorder**.

6.2.3 RAL colour table or **RAL-K5 reference kit** (see Reference [1]).

6.3 Test samples

The visual inspection shall be part of all test procedures. All test samples shall be inspected before and after testing. The cables and connectors that belong to the test apparatus shall be inspected and documented.

6.4 Reference samples

An additional and appropriately identified untested sample from each test group shall be retained for post-test physical comparisons. Alternatively, photographs and/or videos are encouraged as a more complete means of documentation instead of the extra sample.

6.5 Procedure

Visually inspect each test specimen prior to testing and/or conditioning. Any manufacturing or material defects such as cracks, tarnishing, flash, etc. shall be documented. Special attention shall be paid to contact areas and locking mechanisms.

Record in detail the condition of the samples before and after the test procedures and document any differences that may occur.

6.6 Requirements

No deviations which may affect the electrical or mechanical performance of the samples, or degrade the long term performance of the samples, shall be allowed.

7 Connector electrical tests

7.1 General

Perform the tests in accordance with the corresponding test sequence plans in Clause 10. For each sequential test, the same test samples shall be used.

7.2 Contact resistance

7.2.1 Purpose

This test, which conforms to IEC 60512-2-1, determines the electrical resistance of both the outer conductor crimps and corresponding contact interface and the inner conductor crimps and corresponding contact interface.

7.2.2 Apparatus

7.2.2.1 A **micro-ohmmeter**, which limits the open circuit voltage to 20 mV and limits the current applied to 100 mA.

7.2.3 Test samples

Ten sample test cables, each 100 mm cable dielectric length, with a female connector in accordance with ISO 20860-1 on one end and a male SMA connector on the other end.

Ten sample test cables, each 100 mm cable dielectric length, with a male connector in accordance with ISO 20860-1 on one end and a male SMA connector on the other end.

7.2.4 Reference samples

Three reference cable assemblies, each 200 mm in length, minus the equivalent length of the mated ISO 20860-1 connectors, with male SMA connectors on both ends.

7.2.5 Procedure

Mate two sample cable assemblies. The SMA connectors on the remaining ends shall be connected in an adequate way to the test apparatus. The resistance of the whole cable length between the SMA connectors shall be determined for the centre conductor and for the outer conductor.

The same measurement shall be carried out for the reference sample cable assemblies in order to determine the average resistance of the SMA connectors and the cable itself. This resistance shall be deducted from the resulting resistance of the cable assemblies with the two test sample connectors.

7.2.6 Requirements

The total contact resistance of both the inner conductor and the outer conductor shall be in accordance with ISO 20860-1.

7.3 Insulation resistance

7.3.1 Purpose

This test, which conforms to IEC 60512-3-1, Method A, verifies that the electrical resistance between the centre contact and the outer contact will prevent detrimental electrical conductivity.

7.3.2 Apparatus

7.3.2.1 A **megohmmeter**, capable of detecting 25 µA or less of leakage current at 500 V d.c.

7.3.3 Test samples

Use ten test samples as described in 7.2.3.

7.3.4 Reference samples

No reference samples are required.

7.3.5 Procedure

Mate two sample cable assemblies. The SMA connectors on the remaining ends shall be connected in an adequate way to the test apparatus. Raise the voltage to 500 V d.c. and maintain for a minimum of 15 s. Perform the test at a relative humidity of between 45 % and 75 %. The resistance shall be measured and recorded. The minimum value shall be used for the requirements.

7.3.6 Requirements

The centre contact to outer contact resistance shall comply with ISO 20860-1.

7.4 Dielectric withstand voltage

7.4.1 Purpose

This test, which conforms to IEC 60512-4-1, Method A, shall be used to verify that the connection is able to withstand momentary over-potentials. It serves to determine whether insulating materials and spacing within the connector are adequate.

7.4.2 Apparatus

7.4.2.1 Adjustable a.c. power supply.

7.4.3 Test samples

Use ten test samples as described in 7.2.3.

7.4.4 Reference samples

No reference samples are required.

7.4.5 Procedure

Mate two test sample cable assemblies. The SMA connectors on the remaining ends shall be connected in an adequate way to the test apparatus. The a.c. voltage shall be linearly increased to 500 V and maintained for 60 s. Perform the test at a relative humidity of between 45 % and 75 %.

7.4.6 Requirements

No dielectric breakdowns or flashover are permitted.

7.5 Return loss (VSWR)

7.5.1 Purpose

This test verifies the RF electrical load corresponding to 50 Ω systems.

7.5.2 Apparatus and calibration

7.5.2.1 An **adapter "Adap 1"** with an inherent return loss of more than 34 dB [1)] to test a female connector in accordance with ISO 20860-1.

7.5.2.2 An **adapter "Adap 2"** with an inherent return loss of more than 34 dB[1)] to test a male connector in accordance with ISO 20860-1.

The tests are carried out with an NWA with a standard PC 3,5 (f) port, which shall be adjusted to "one-port" return loss measurement in the frequency range between 50 MHz and 4 000 MHz.

7.5.3 Test samples

Use ten test samples as described in 7.2.3.

7.5.4 Reference samples

Use the same reference samples as in 7.2.4.

The reference samples are verified as described below.

The measurement with the NWA shall not result in a return loss of:

— $\leqslant$ 34 dB at frequencies $\leqslant$ 2 000 MHz[2)];

— $\leqslant$ 30 dB at frequencies between 2 000 MHz and 4 000 MHz[3)].

7.5.5 Procedure

The female connector shall be in accordance with ISO 20860-1.

The test sample shall be connected with the measurement port at the NWA. The adapter "Adap 1" shall be connected to the test sample and terminated with a 50 Ω load on the SMA connector side (see Figure 1).

1) This equates to a VSWR of 1,04.

2) This equates to a VSWR of more than 1,04 or a reflection factor of more than 0,02.

3) This equates to a VSWR of more than 1,06 or a reflection factor of more than 0,031 6.

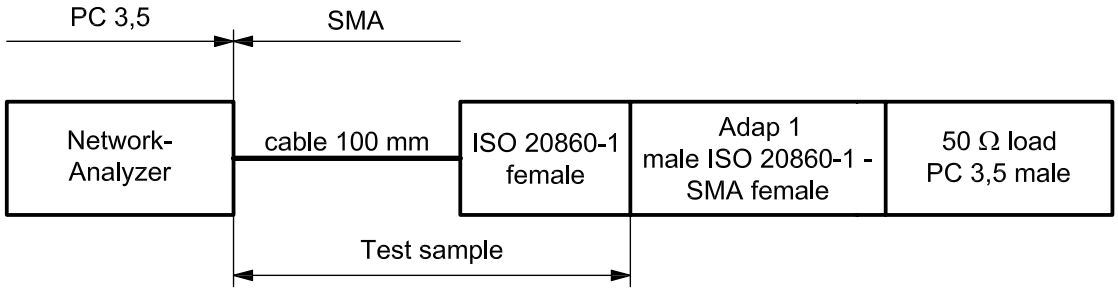


Figure 1 — Test configuration for female connector

The male connector shall be in accordance with ISO 20860-1.

The test sample shall be connected with the measurement port at the NWA. The adapter “Adap 2” shall be connected to the test sample and terminated with a 50 Ω load on the SMA connector side (see Figure 2).

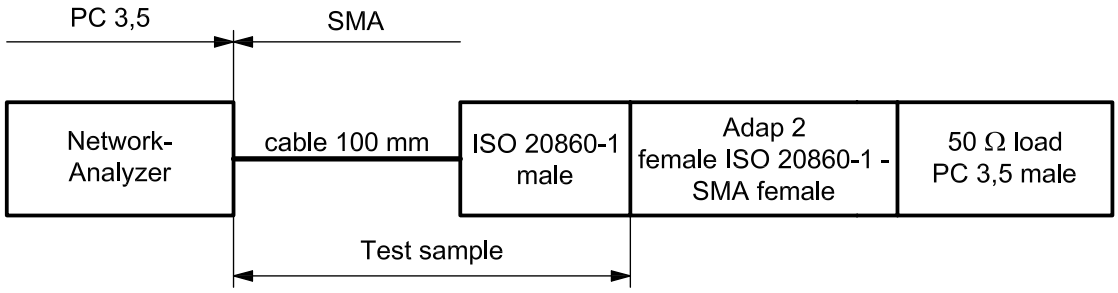


Figure 2 — Test configuration for male connector

7.5.6 Requirements

For the requirements of return loss, see ISO 20860-1.

7.6 Insertion loss

7.6.1 Purpose

This test verifies the dielectric losses of insulating materials and resistance losses of contacts.

7.6.2 Apparatus and calibration

The tests are carried out with an NWA, which shall be adjusted to “full two-port” measurement in the frequency range between 50 MHz and 4 000 MHz.

7.6.3 Test samples

Use ten test samples as described in 7.2.3. Ten additional cable assemblies are needed, as follows:

— five cables of 100 mm length, each assembled with two female connectors in accordance with ISO 20860-1;

— five cables of 100 mm length, each assembled with two male connectors in accordance with ISO 20860-1.

7.6.4 Reference samples

Use three reference cables, each 400 mm in length, minus the equivalent length of three mated ISO 20860-1 connectors, with SMA connectors on both ends.

The reference samples are verified as described below.

The measurement with the NWA shall not result in a return loss of:

— $\leqslant$ 34 dB at frequencies $\leqslant$ 2 000 MHz[4];

— $\leqslant$ 30 dB at frequencies between 2 000 MHz and 4 000 MHz[5].

7.6.5 Procedure

The test shall be performed with three pairs of connectors in series (see Figure 3).

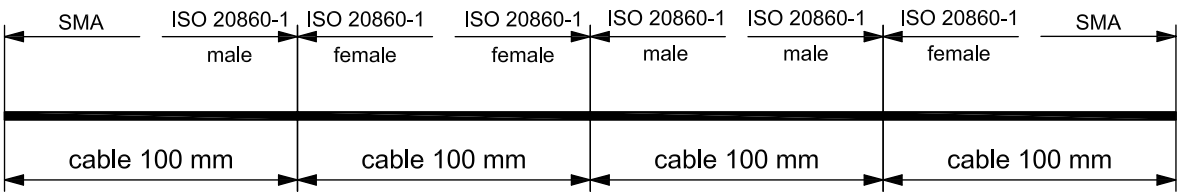


Figure 3 — Test configuration

Connect both SMA connectors to the NWA and read the insertion loss.

In a second measurement of the 400 mm long reference cable assembly, read the corresponding insertion loss. The difference of the losses of the two measurements divided by three shall be the resulting insertion loss of one pair of connectors, male and female.

7.6.6 Requirements

For the resulting insertion loss, see ISO 20860-1.

7.7 RF leakage (screening effectiveness)

7.7.1 Purpose

This test verifies the leakage of the RF connectors, measured in dB.

NOTE Verification of the leakage of the RF connectors is also referred to as screening effectiveness.

This test shall be a stand-alone test for in-line connectors only, requiring samples for each cable type being qualified. Samples shall be made as short as possible in order to minimize the effects of RF leakage from the coaxial cable.

4) This equates to a VSWR of more than 1,04 or a reflection factor of more than 0,02.

5) This equates to a VSWR of more than 1,06 or a reflection factor of more than 0,031 6.

7.7.2 Procedure

The following procedures are acceptable:

a) IEC 61726 (mode stirrer);

b) EN 122001 (triax chamber);

c) IEC 61196-1, (matched triaxial);

d) IEC 60512-23-3 (line injection).

7.7.3 Requirements

See ISO 20860-1.

8 Connector mechanical tests

8.1 Gauge mechanical pull test

8.1.1 Purpose

The gauge mechanical pull force shall be taken as a criterion for the elasticity of flexible contact parts and for the long-term confidence in the electrical contacts.

8.1.2 Apparatus

8.1.2.1 Gauge for the centre conductor in accordance with IEC 60169-10, weight 0,28 N (equating to a mass of 28,5 g).

8.1.2.2 Gauge for the outer conductor in accordance with IEC 60169-10, weight 2 N (equating to a mass of 204 g).

8.1.2.3 Insertion/extraction force tester with peak reading feature.

8.1.3 Test samples

Use ten test samples as described in 7.2.3.

8.1.4 Reference samples

No reference samples are required.

8.1.5 Procedure

The gauge pull force for the inner and outer contact shall be measured and recorded from new female connectors of the test samples. Each of the female test samples shall be mated 25 times with a corresponding male test sample, and then the gauges shall be mated to each female connector for evaluation of the requirements.

8.1.6 Requirements

When held in a vertical position, the gauge shall not drop out of the test sample.

8.2 Connector-connector mating/unmating force

8.2.1 Purpose

This test verifies the mating/unmating forces associated with manual mating and unmating of complete connector assemblies. Mating forces are an important consideration in determining the suitability of a given connector design for use in production. Unmating forces are important in determining the serviceability of the design and ensuring the connection will stay mated for the service life of the vehicle.

8.2.2 Apparatus

8.2.2.1 Insertion/extraction force tester with peak reading feature.

8.2.3 Test samples

The test samples shall be as follows:

— ten sample cable assemblies with a female connector in accordance with ISO 20860-1 on one end, undefined length and performance of the other end;

— ten sample cable assemblies with a male connector in accordance with ISO 20860-1 on one end, undefined length and performance of the other end.

8.2.4 Reference samples

No reference samples are required, as the critical condition is the first mating, when connectors are still brand new.

8.2.5 Procedure

Secure one male and one female connector in the appropriate fixture of the force tester. Adjust the force tester to insert the male connector straight into the female connector. Straight-in engagement is critical to avoid side loads and binding, which can affect force measurements. Increase the mating force at a uniform rate not exceeding 50 mm/min. Record the mating force required to completely mate each set of connectors into their locked position.

To test the unmating force, use the same samples without removing the samples from the fixture. For five samples, the locking latch shall be disabled before the unmating procedure. Increase the unmating force at a uniform rate not exceeding 50 mm/min until complete separation occurs. Record the force required to completely separate the connectors.

8.2.6 Requirements

Shall be in accordance with ISO 20860-1.

8.3 Polarization and coding feature effectiveness

8.3.1 General

This test does not need to be performed if the polarization and coding effectiveness of the housing has already been proven. Test results shall be submitted.

8.3.2 Purpose

This test ensures that incorrect mating of a connector housing with its intended mate is prevented, and also prevents mating of a connector housing with any unintended mate. The applied force for the mating of connectors with unintended mates shall be distinctly higher than the mating force needed for connectors with intended mates. This force shall be confirmed for mating between intended connectors at 90° from proper orientation and between connectors with incorrect mates.

8.3.3 Apparatus

8.3.3.1 Insertion/extraction force tester with peak reading feature.

8.3.3.2 Adjustable power supply.

8.3.3.3 Circuit indicator.

8.3.4 Test samples

The test samples shall be as described below.

— One female connector for each of the defined codes in accordance with ISO 20860-1, assembled with the suitable cable. The length of the cable is undefined; the free end is simply stripped off.

— One male connector for each of the defined codes in accordance with ISO 20860-1, assembled with the suitable cable. The length of the cable is undefined; the free end is simply stripped off.

8.3.5 Reference samples

No reference samples are required.

8.3.6 Procedure

Secure the connectors (one male and one female, each with housing) in the appropriate fixtures of the force tester, so that they can be mated with lowest possible mating force at suitable code condition. Connect the centre contacts of the free ends of the cable assemblies with the power supply. A measurable current shall be recorded as soon as the two connectors enter into electrical contact. Engage the connectors at a uniform rate not exceeding 50 mm/min. In the case of mismatching polarization of the two connectors, if it is possible to mate them at a force below 40 N, the engagement shall be continued until the electrical contact is indicated by the current flow. The force applied shall be recorded.

The test shall be performed with all available codes mated with each other.

8.3.7 Requirements

The mismating force shall exceed 40 N. If the mating force does not exceed 40 N, no electrical contact shall be established.

8.4 Mechanical pull test

8.4.1 Purpose

This test verifies that the connector latch, terminal retention system and cable attachment will maintain continuity and not break apart when subjected to mechanical stress.

8.4.2 Apparatus

8.4.2.1 **Insertion/extraction force tester** with peak reading feature.

8.4.2.2 **CT/A** or **bit error analyzer**.

8.4.2.3 **NWA**.

8.4.2.4 **Ohmmeter**.

8.4.3 Test samples

The test samples shall be as follows:

— use ten test samples as described in 7.2.3, and

— ten sample cable assemblies, each 100 mm in length, assembled with a female connector in accordance with ISO 20860-1 on one end and a male connector in accordance with ISO 20860-1 on the other end.

8.4.4 Reference samples

One sample cable assembly 300 mm in length, assembled with SMA connectors on both ends.

8.4.5 Procedure

For the test samples as well as the reference sample, the contact resistance in accordance with 7.2.5 and return loss in accordance with 7.6.5 shall be measured and recorded. Connect the test samples (in accordance with Figure 4) and the SMAs to the continuity tester, in order to check continuity through both the centre contact and shield of the mated connectors. Subject the locked connection system to a direct pull force parallel with the axis of the connectors by gripping on the shoulder of the SMA connectors in accordance with Figure 4.

Increase the pull force at a uniform rate up to 100 N. Maintain the force for 5 s while monitoring for continuity. The same procedure shall be carried out for the reference sample.

After the test, measure the contact resistance and the return loss of the test samples and the reference samples, and record the values. The test samples shall be disengaged and visually inspected in accordance with Clause 6.

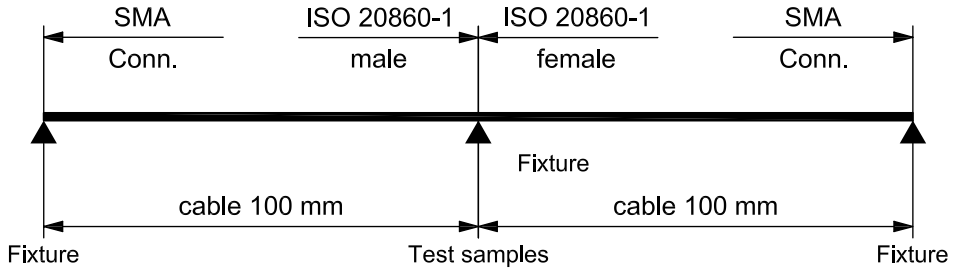


Figure 4 — Test schema — Test set-up

8.4.6 Requirements

There shall be no interruption in continuity and no bit error measurable on any sample during the test.

In the case of using a cable type that cannot withstand the pull force, it shall be proven by visual inspection that the cable braid is fully torn off and that the crimping is not impacted.

The contact resistance and the return loss values shall be as required in ISO 20860-1.

There shall be no visual damage to any part of the connection system after the stress.

9 Environmental tests

9.1 Vibration/mechanical shock

9.1.1 Purpose

This test subjects a connector system to variable vibration, simulating accelerated exposure to actual vehicle conditions. Vibrations and shock can cause wear of the terminal interfaces, intermittent electrical contact and failure of mechanical components of the connector system. The test shall prove that such failures do not occur to the test samples.

9.1.2 Apparatus

9.1.2.1 **Power supply** (0 V to 20 V d.c.).

9.1.2.2 **Micro-ohmmeter**.

9.1.2.3 **NWA**.

9.1.2.4 **Vibration table**.

9.1.2.5 **Vibration controller**.

9.1.2.6 **CT/A** or **bit error analyzer**.

9.1.2.7 **Accelerometers**.

9.1.3 Test samples

Use 20 test samples as described in 7.2.3.

9.1.4 Reference samples

No reference samples are required.

9.1.5 Procedure

9.1.5.1 General

The mounting apparatus shall be constructed and secured to minimize added effects such as harmonics, damping and resonance, etc. Mount the mated connector pair directly to the mounting bracket on the vibration table. Do not use a “Christmas tree” or any other type of mounting device. Create the electrical contact via the SMA connectors in an appropriate way. The SMA contacts act as fixture points and therefore shall be securely mounted to the vibration table.

The tests described in 9.1.5.2 and 9.1.5.3 shall be carried out.

9.1.5.2 Shock

The shock test shall be carried out in accordance with IEC 60068-2-27:

— ten shocks in each of the three mutually perpendicular axes;

— half sine acceleration 35 g;

— duration 10 ms.

9.1.5.3 Vibration (sinusoidal)

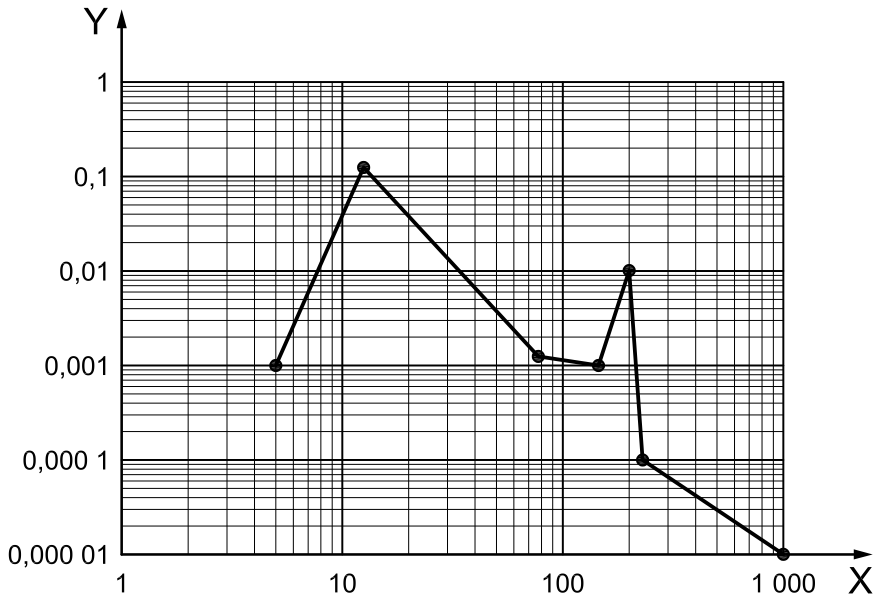
The vibration (sinusoidal) test shall be carried out in accordance with IEC 60068-2-6:

— classification: see Table 1 and Figure 5;

— duration: 8 h in each of the mutually perpendicular axes, at a speed of 1 octave per minute.

Table 1 — Vibration (sinusoidal)

Frequency Hz	**Power spectral density** g^2/Hz
5,0	0,002 00
12,5	0,248 00
77,5	0,003 20
145,0	0,002 00
200,0	0,011 80
230,0	0,000 32
1 000,0	0,000 02
g_{rms} = 1,81.	



Key

X frequency, Hz

Y power spectral density, g^2/Hz

Figure 5 — Classification for vibration test

9.1.6 Requirements

There shall be no electrical interruptions exceeding one microsecond.

9.2 Thermal shock

9.2.1 Purpose

This test subjects the connector assembly to extreme temperature cycles, which cause expansion and contraction of the various materials used in the connector system. This is intended to produce accelerated wear at the terminal-to-terminal interface.

9.2.2 Apparatus

9.2.2.1 **Power supply** (0 V to 20 V d.c. at 0 A to 150 A).

9.2.2.2 **Micro-ohmmeter**.

9.2.2.3 **CT/A**.

9.2.2.4 Alternative: **apparatus for bit error measurements**.

9.2.2.5 **Temperature chamber(s)** (−40 °C to +105 °C).

9.2.3 Test samples

Use 20 test samples as described in 7.2.3.

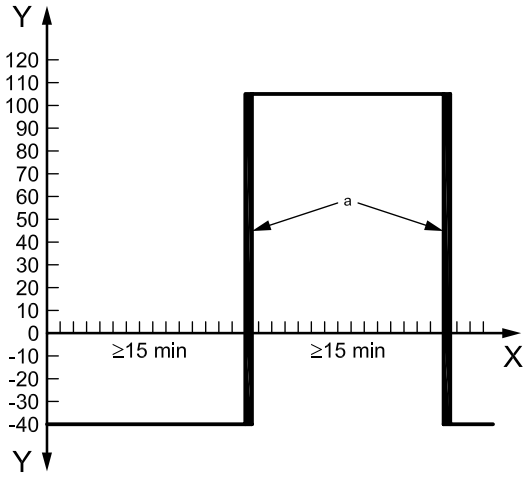
9.2.4 Reference samples

No reference samples are required.

9.2.5 Procedure

Completely mate and unmate each female and male connector once. Before performing the tests, mate and unmate half of the test samples another ten times and finally mate them again for testing. Place the samples in the chamber such that there is no substantial obstruction to air flow across and around the samples, and such that the samples do not touch each other. A current of 100 mA shall be maintained.

Place the test samples in the temperature chamber at − 40 °C for at least 15 min. Move the samples to the next temperature chamber at + 105 °C for at least another 15 min, and then back into the cold chamber. The time taken to transfer the samples from the cold to the hot chamber (and back) shall not exceed 30 s (see Figure 6). Repeat these changes a total of 100 times.



Key

X time

Y temperature, °C

a Maximum transition time is 30 s.

Figure 6 — Thermal shock — Temperature cycle

9.2.6 Requirements

There shall be no electrical interruptions exceeding one microsecond.

9.3 Temperature/humidity cycling

9.3.1 Purpose

This test simulates actual operating conditions using temperature and humidity variations as aging mechanisms for evaluation of a connector system's electrical durability. High humidity and temperature can promote galvanic and electrolytic corrosion of the terminals, which may cause electrical and mechanical degradation. Temperature cycling promotes relative movement of the contact surfaces that can cause wear and fretting corrosion. The test samples shall be resistant to these influences.

9.3.2 Apparatus

9.3.2.1 **Power supply** (0 V to 20 V d.c. at 0 A to 150 A).

9.3.2.2 **CT/A**.

9.3.2.3 Alternative: **apparatus for bit error measurements**.

9.3.2.4 **Temperature chamber(s)** (− 40 °C to + 105 °C, 0 % to 95 % relative humidity).

9.3.3 Test samples

Use ten test samples as described in 7.2.3.

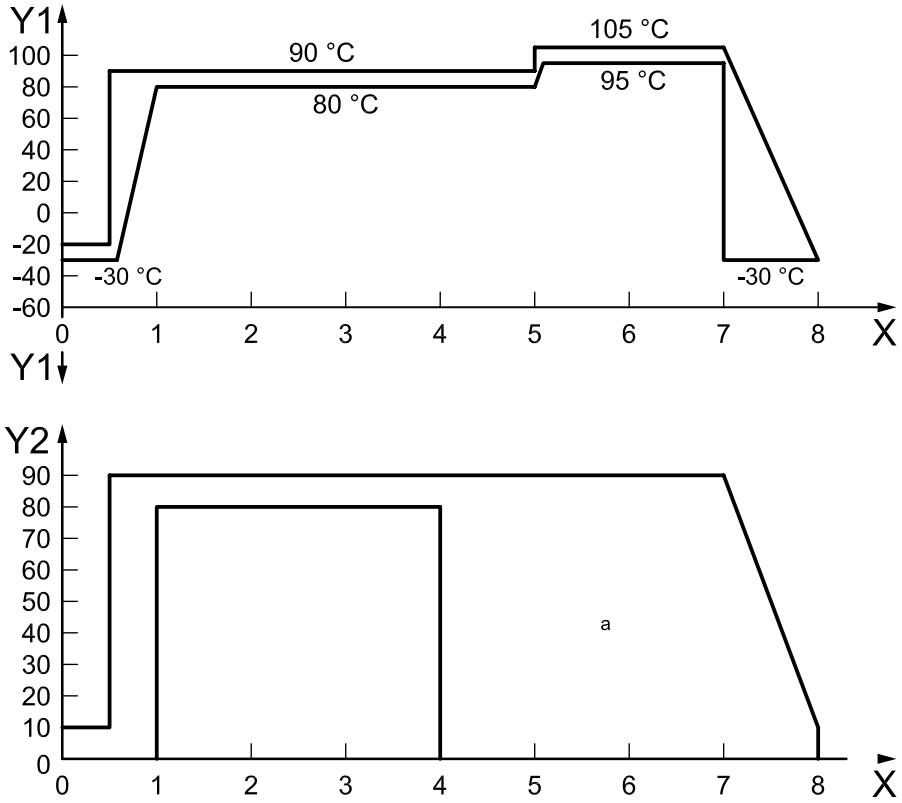
9.3.4 Reference samples

No reference samples are required.

9.3.5 Procedure

Completely mate and unmate each female and male connector once. Before performing the tests, mate and unmate half of the test samples another ten times and finally mate them again for testing. Place the samples in the chamber such that there is no substantial obstruction to air flow across and around the samples, and such that the samples do not touch each other. A current of 100 mA shall be maintained.

The test starts at the lowest temperature. Use the temperature and humidity cycling schedule in accordance with Figure 7. The maximum temperature is set to + 105 °C. Cycle the test samples 30 times in direct series.



Test parameters shall remain between the lines.

Key

X time, h

Y1 temperature, °C

Y2 humidity, %

[a] Humidity after 4 h.

Figure 7 — Temperature and humidity cycling schedule

9.3.6 Requirements

There shall be no electrical interruptions exceeding one microsecond.

9.4 High temperature exposure

9.4.1 Purpose

This test evaluates the effects of long term exposure to elevated temperature on connector assembly components. Thermal aging may cause changes in metal and plastic materials, including stress relaxation in important flexing members of the terminal or its connector. These possibly detrimental changes to electrical and physical performance shall not occur in the test samples.

9.4.2 Apparatus

9.4.2.1 **Temperature chamber**.

9.4.3 Test samples

Use ten test samples as described in 7.2.3.

9.4.4 Reference samples

No reference samples are required.

9.4.5 Procedure

Completely mate and unmate each female and male connector once. Before performing the tests, mate and unmate half of the test samples another ten times and finally mate them again for testing. Place the samples in the chamber such that there is no substantial obstruction to air flow across and around the samples, and such that the samples do not touch each other.

The heating chamber shall be stabilized at the maximum temperature of 105 °C. Keep the test samples for a period of 1 008 h under these conditions within the heating chamber. A continuous monitoring for breaks with the test samples is not necessary.

9.4.6 Requirements

The samples shall fulfil the subsequent tests in accordance with test sequence 5 (see Figure 9).

10 Test sequence plans

Figure 8 presents the test sequence plan 0 and the special tests; Figure 9 presents the other necessary test sequence plans. Test sequence 0 shall be performed on all samples prior to test sequences 1 to 5. The special tests shall be performed on separate samples.

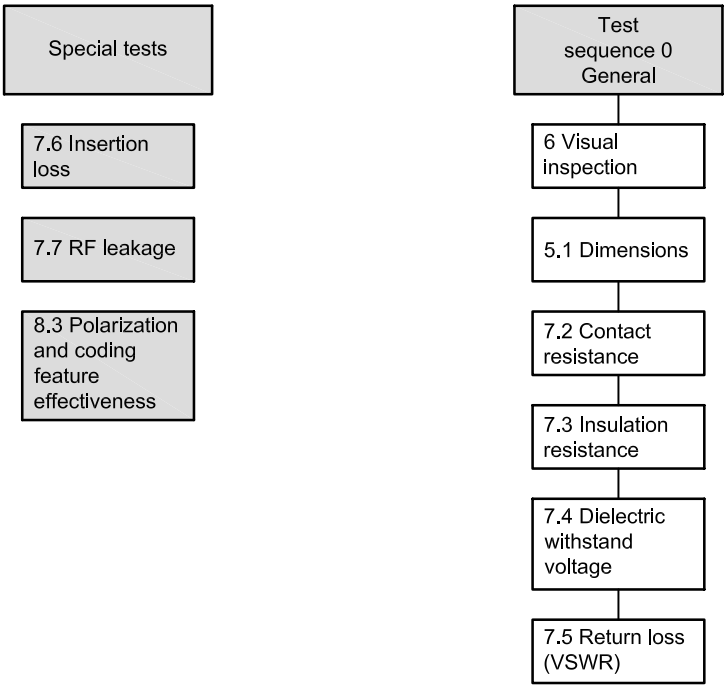


Figure 8 — Test sequence plan 0 and special tests

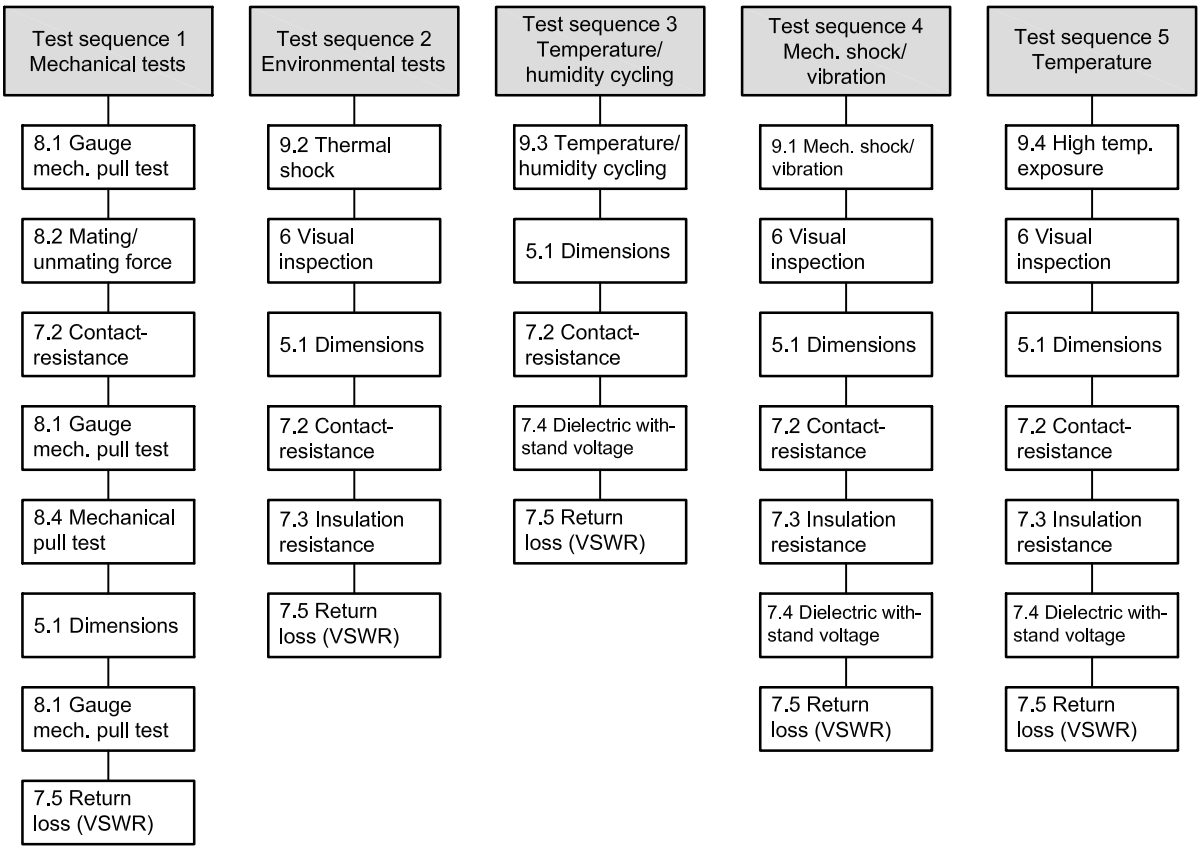


Figure 9 — Test sequence plans 1 to 9

Bibliography

[1] RAL, *The classic colour collection RAL 840-HR — standard for choosing colours*

[2] IEC 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*

[3] IEC 60512-3-1, *Connectors for electronic equipment — Tests and measurements — Part 3-1: Insulation tests — Test 3a: Insulation resistance*

[4] IEC 60512-4-1, *Connectors for electronic equipment — Tests and measurements — Part 4-1: Voltage stress tests — Test 4a: Voltage proof*

[5] IEC 60512-23-3, *Electromechanical components for electronic equipment — Basic testing procedures and measuring methods — Part 23-3: Test 23c: Shielding effectiveness of connectors and accessories*

[6] IEC 61196-1, *Coaxial communication cables — Part 1: Generic specification — General, definitions and requirements*

[7] IEC 61726, *Cable assemblies, cables, connectors and passive microwave components — Screening attenuation measurement by the reverberation chamber method*

[8] EN 122001, *Blank detail specification: CECC military specification for radio frequency connectors (type MIL-C-39012)*

ICS 43.040.10

Price based on 21 pages