

Performance Specification for Automotive RF Connector Systems

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PERFORMANCE SPECIFICATION FOR AUTOMOTIVE RF CONNECTOR SYSTEMS

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1. SCOPE

1. This document contains procedures for testing performance of SMB-style electrical terminals, connectors, and components for coaxial cable connection systems intended for road vehicle applications. These are often called FAKRA II designs. This specification does not apply to the Non-RF portion of a Hybrid RF connection system.
2. The intent of this specification is to qualify sealed and unsealed RF connectors that operate at frequencies from DC to 6 GHz. The characteristic impedance of the SMB/FAKRA connection system is 50 ohms however this specification does not exclude the use of these RF connectors on non-50-ohm cables or systems.
3. This specification does not apply to single conductor wire or twisted pair connection systems.
4. This specification (along with SAE/USCAR-18) is designed to provide the mechanical and electrical data required to ensure that assemblies from various manufacturers will perform reliably in actual conditions. There is intermateability testing included in this specification. End users who may be concerned about intermateability are responsible to request the supplier complete this testing.

2. REFERENCES

SAE/USCAR-2	Performance Standard for Automotive Electrical Connector Systems
SAE/USCAR-18	FAKRA SMB RF Connector Supplement
SAE/USCAR-25	Electrical Connector Assembly Ergonomic Design Criteria
IEC 62153-4-7	Metallic Communication Cable Test Methods – part 4-7 Triaxial Tube in Tube Method
EIA-364-30A	Capacitance Test Procedure for Electrical Connectors and Sockets

3. GENERAL REQUIREMENTS

3.1 Sample Size

1. Terminals used for validation testing are applied to cables using the manufacturers' recommended tools and processes.
2. The total number of test samples required for each test is listed in Tables 5.2, 5.3, and 5.4.
3. Number each sample pair of connectors and record crimp dimensions as applicable from a representative group from each set of samples (see Tables 5.2, 5.3, and 5.4). Document cable information such as type, supplier, and supplier part number. All test data, including swept SWR and IL, must be maintained by the supplier for possible review. The supplier must also keep the test samples such that each new customer can visually inspect the samples or confirm SWR and IL.

3.2 Connector Qualification

1. The RF connection system will be qualified for a specific coaxial cable per these procedures. The guidelines in Table 3.2 apply for qualifying the product for use on additional cables sizes and constructions. The connection system must meet the dimensional characteristics specified in SAE/USCAR-18

Table 3.2 - Connector qualification for additional cable construction

Connector construction (dimensions/materials) same as originally validated. Example: connector for RG 174 versus RG 316 having same cable interface dimensions.	Complete 4.2.1 (Mechanical Pull) and 4.3 (Terminal Electrical Tests) only and other testing as required by end customer.
Connector construction differs from originally validated design due to coax cable size/geometry. Example: connector for RG 174 versus RG 58 and having different cable interface dimensions.	Complete re-qualification is required.

2. Final determination as the level of testing needed for qualification on additional cables shall be determined by agreement between the supplier and the OEM. The qualified coaxial cable(s) and frequency range of interest must be listed on the connector drawing.
3. This specification is a supplement to the SAE/USCAR-2 Performance Specification for Automotive Electrical Connector Systems and all requirements herein must be met in addition to all requirements of the most recent revision of SAE/USCAR-2, unless otherwise specified. RF connector related additions and/or subtractions to the SAE/USCAR-2 specification are contained in this document.

3.3 Equipment

In addition to the equipment listed in the SAE/USCAR-2 Performance Specification, the equipment listed in Table 3.3 is required.

Table 3.3 - RF conn. additional equipment

Item	Description	Requirements
1	High Voltage Source	800 VAC
2	8 GHz Network Analyzer	S Parameter with Time Domain Capability. Min. Frequency as required for certifying the CUT performance within the required frequency range

4. TEST AND ACCEPTANCE REQUIREMENTS

4.1 General

Refer to the SAE/USCAR-2 Performance Specification for the majority of RF connector test and acceptance requirements. The exceptions to those tests are listed in the following sections.

1. The Terminal – Mechanical tests of SAE/USCAR-2 are not required for the Center - Inner Terminal for RF connector qualification.
2. The Terminal Bend Resistance test is to be considered as optional dependent on the terminal design as determined by agreement between the supplier and the OEM.
3. The Maximum Test Current Capability test is optional.

4.2 Connector Mechanical Tests

4.2.1 Mechanical Pull Test and Side Load Test

4.2.1.1 Purpose

This test verifies that the connector latch, terminal retention system, and cable attachment will maintain continuity when subjected to mechanical stress.

This Mechanical Pull test is in addition to the mechanical connector tests in SAE/USCAR-2 Performance Specification. This is a stand-alone test and requires samples for each cable type qualified.

NOTE: The Mechanical Pull Test is a design validation test and shall not be used as a production acceptance or quality control test.

4.2.1.2 Procedure

1. Prepare Connector Under Test (CUT) assemblies for each cable being qualified per Procedure 4.4.2.2, Steps 1 through 7.
2. Attach a continuity tester to check continuity through both the center contact and shield of the mated connector pair.
3. Subject Inline, Board, and Panel Mount connection systems to a direct pull force parallel with the axis of the cable. Any method can be used. If an SMA connector is present for testing, gripping on the SMA connectors can be effective. For samples prepared for SWR measurement (see 4.4.2.2, Note C), it is also acceptable to wrap the cable around a 2-inch diameter mandrel, securing the cable to the mandrel with electrical tape or some other suitable means. Board mount connectors may have the circuit board end firmly attached to a suitable fixture.
4. Increase the pull force at a uniform rate not to exceed 50 mm/min until the force equals 110N, or the applicable value in SAE/USCAR-17 Table 4.2.6.5-B, not to exceed 110N maximum.
5. Hold the force for 5 seconds while monitoring for continuity.
6. Additional Board and Panel Mount testing only. Grab far-end SMA connector (or other available area) and apply 75N of force in the following directions using the same test sample: 1C, 3C, 5B, 7B, 8C (see Figure 4.2.1.2). The sequence of force application is not mandatory. Direction vectors B and C revolve 360 degrees around the connector axis.

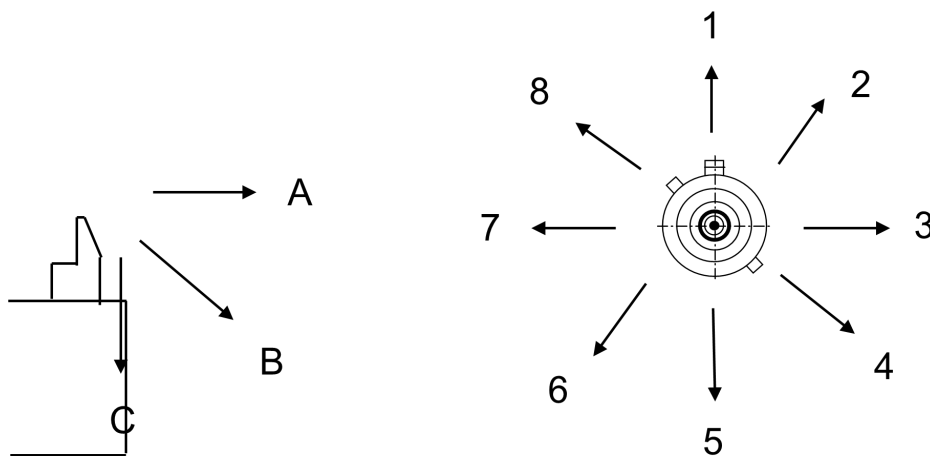
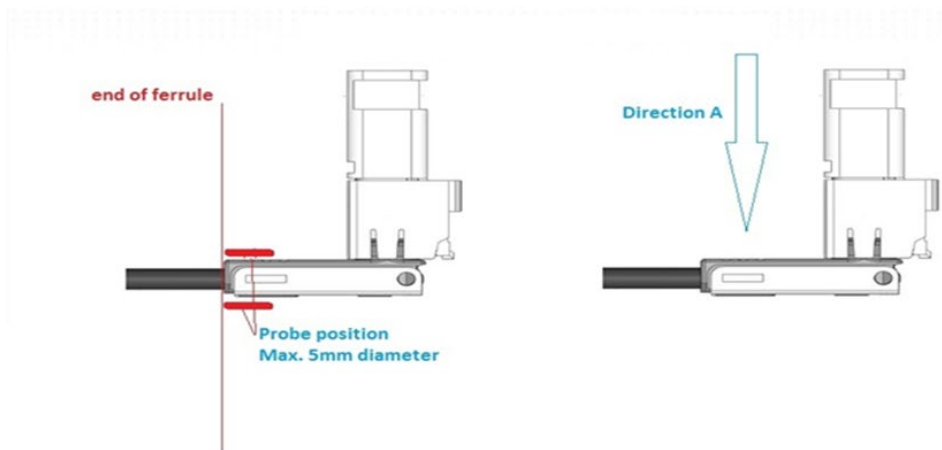


Figure 4.2.1.2 - Board mount mechanical pull

7. Additional test for Right Angle Cabled Connectors: Axial loads are less practical when applied to right angle cabled connectors therefore a side load shall be applied to the extreme end of the ferrule (furthest from the centerline). The load of 75N shall be applied for 5 seconds while monitoring continuity. SWR measurements and visual inspection for damage shall be done before and after the side load test (see drawing below).



NOTE: Cable to connector retention to meet force values according to Table 4.2.6.5.B Pull Criteria.

- 7.1 Measure SWR and IL per Procedure 4.4.2.2, Steps 4 and 6. Sections of this test apply to all RF connector types (see 4.4.2 for application specifics).
- 7.2 Disassemble each sample and visually check for damage that could affect the performance of the connection system.

NOTE: Optionally, to account for SMA crimp degradation and the corresponding increased insertion loss, a minimum of 10 SMA connector assemblies (same crimp process and length as CUT assembly per Figure 4.4.2.2.1a.) may be subjected to this test (statistical evaluation).

4.2.1.3 Acceptance Criteria

1. There shall be no interruptions in continuity on any sample during the test.
2. The RF connector SWR and Insertion Loss values must be equal to or less than those listed in Table 4.4.2.3 after the test.
3. There shall be no visual damage to any part of the connection system including connector body, metal terminals, or cable attachment. Failure of the SMA terminals is not to be interpreted as a failure of the CUT. Samples identified as having SMA failures through failure analysis may be replaced and retested through the entire sequence.
4. SMB Connection Systems Minimum Retention Force
 - a. 110N minimum in direction A for Inline, Board, and Panel Mount Connectors
 - b. 75N minimum in directions B and C for Board and Panel Mount Connectors
 - c. 75N minimum Side load for Right Angle Connectors
5. The Outer (braid/shield) Crimp must meet the requirement of 4.2.6.5, Step 3.

4.2.2 Connector Mating and Un-mating

4.2.2.1 Mating/Un-mating Forces

4.2.2.1.1 Purpose

This test determines the mating/un-mating forces associated with RF connectors.

4.2.2.1.2 Procedure

Follow the procedure for Connector Mating/Un-mating Force found in the latest revision of SAE/USCAR-2. The acceptance criteria are specified in SAE/USCAR-25.

4.2.2.1.3 Acceptance Criteria

Must meet the requirements of SAE/USCAR-25.

4.2.2.2 Mating Under Side Load

4.2.2.2.1 Purpose

This test is designed to simulate the mating of an 8.0 mm centerline dual connector pair when the cables are constrained at an angle perpendicular to the mating direction of the connectors.

4.2.2.2.2 Equipment

Wedge shown in Appendix B.

4.2.2.2.3 Procedure

There are two sections to this test. The first section is designed to validate the female connector, and the second section validates the male connector. Perform the test on five sets of constrained female connectors and five sets of constrained male connectors.

4.2.2.2.3.1 Female Connector Constrained

1. Attach the wedge to the Two-Way Female contact with 8.0 mm Center Inline FAKRA Connector in the manner shown in Figure 4.2.2.2.3.A.
2. Secure the housing of the Two-Way Female contact with 8.0 mm Center Inline FAKRA using the intended clip provision (when available) and typical mounting clip. If there is nothing available fix the assembly on the female connector housing.
3. Mate the pair, measure and record the Center and Outer Contact Resistance.
4. Attach a continuity monitoring device to each connection point (both Outer and Inner contacts).
5. Grasp the mating Male connector by the housing only leaving the coaxial leads unrestricted. Mate the Male connector to the stationary Female connector 10 times. Continuity must be detected during each mating cycle.
6. Leave the pair mated, measure and record the Center and Outer Contact Resistance.
7. Visually inspect both interfaces for damage.

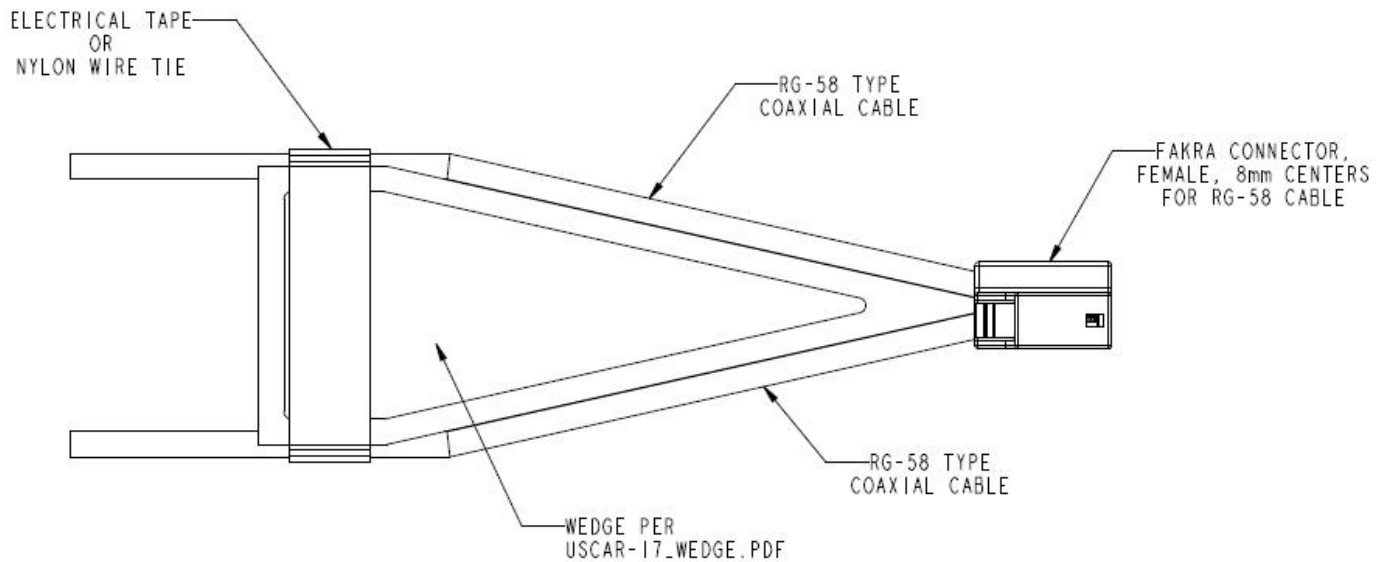


Figure 4.2.2.3.A - Female connector with wedge

4.2.2.3.2 Male Connector Constrained

1. Attach the Wire Tie around the cables of the Two-Way Male contact with 8.0 mm Center Inline FAKRA Connector approximately 12.7 mm from the end of the ferrules in the manner shown in Figure 4.2.2.3.B.
2. Secure the housing of the Two-Way Female contact with 8.0 mm Center Inline FAKRA using the intended Clip Provision (when available) and typical mounting clip. If there is nothing available, fix the assembly on the female connector housing. Leave the coaxial leads of the Female connector unrestricted.
3. Mate the pair, measure and record the Center and Outer Contact Resistance.
4. Attach a continuity monitoring device to each connection point (both Outer and Inner contacts).
5. Grasp the mating Male connector by the housing with the coaxial leads constrained with the Wire Tie. Mate the Male connector to the stationary Female connector 10 times. Continuity must be detected during each mating cycle.
6. Leave the pair mated, measure and record the Center and Outer Contact Resistance.
7. Visually inspect both interfaces for damage.

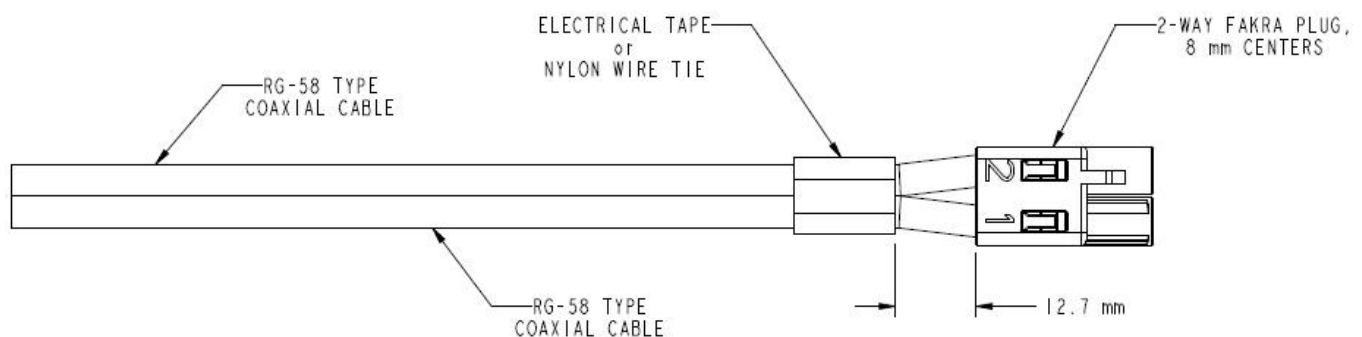


Figure 4.2.2.3.B - Male connector constrained

4.2.2.2.4 Acceptance Criteria

The mated connectors must meet the electrical values specified in 4.3.1.3.

4.2.3 Polarization Feature Effectiveness

4.2.3.1 Purpose

This test prevents mating of a connector housing with any unintended mate.

4.2.3.2 Procedure

Follow the procedure of SAE/USCAR-2 "Polarization Feature Effectiveness" with the following exceptions:

1. Test a minimum of three sets for each selected mis-orientation or mis-index.
2. Terminals with electrical access to the center conductor are required to be loaded in each connector of each test pair to allow verification of continuity.

4.2.3.3 Acceptance Criteria

1. For single contact SMB connection systems, the minimum mis-mating force to achieve center contact electrical continuity is 80N.
2. For multiple contact SMB connection systems, the minimum mis-mating force to achieve center contact electrical continuity is 100N.

4.2.3.3.1 Design Notes Related to Polarization Criteria

1. It is known that certain key code combinations may not meet this requirement. Therefore, the combinations listed below should be avoided.
 - a. A & B
 - b. I & G
 - c. C & N
 - d. F & H
 - e. K & L
 - f. K & M
 - g. L & M
 - h. E & F
 - i. E & H
 - j. E & B
2. The "Z" or Neutral Key Code may not mate with L, M, or N Key Codes and should be used solely for developmental or prototype applications.

4.2.4 Connector-to-Connector Audible Click Test:

4.2.4.1 Purpose

Studies show that assembly plant technicians depend on audible and coincident tactile feedback that indicate full seating of electrical connectors regardless of background noise. This test measures the level of noise generated when two connectors are mated. Connectors are mated by hand for this test rather than being clamped into a fixture which could suppress or amplify the sound.

4.2.4.2 Equipment

dB Meter

4.2.4.3 Procedure

Refer to SAE/USCAR-2.

4.2.4.4 Acceptance Criteria

The Values measured in this test shall be documented in the test report. These values should be considered for information only and are used to compare connector designs or to assist in the connector selection/wire harness design process.

4.2.5 Center Contact Retention

4.2.5.1 Purpose

The purpose of this test is to assure that the center contact is sufficiently captivated within the insulator to withstand forces exerted by excessive mating forces as well as thermal expansion and contraction of the cable and connector.

4.2.5.2 Equipment

Force Gauge.

4.2.5.3 Procedure

Use standard production tooling to terminate 10 male connector samples for each wire size specified.

Allow the samples to stabilize at room temperature (25 °C) for a minimum of 24 hours to allow the dielectric materials to cold flow around contact retention features.

Measure the maximum force required to completely extract the center contact from the dielectric material on five samples.

Measure the actual force required to push the center contact below the minimum dimensional limits of the manufacturers recommended interface for the other five samples.

4.2.5.4 Acceptance Criteria

In both tests, the center contact must withstand an axial load of 10N minimum.