

**PERFORMANCE SPECIFICATION FOR AUTOMOTIVE UNIVERSAL SERIAL
BUS (USB) CONNECTION SYSTEM**

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*****WARNING*****

No electrical connector, terminal, or related USB component may be represented as having met USCAR/EWCAP specifications unless conformance to all applicable requirements of this specification have been verified and documented. All required verification and documentation must be done by the supplier of the part or parts. If testing is performed by another source, it does not relieve the primary supplier of responsibility for documentation of all test results and for verification that all samples tested met all applicable Acceptance Criteria. See section 4.3.

1 SCOPE

Procedures included within this specification are intended to cover performance testing at all phases of development, production, and field analysis of any USB cable assemblies and associated connections that constitute the electrical connection systems between the consumer peripheral interface and the USB computer source in road vehicle applications. These procedures are only applicable to the USB connector and the cable. Unless otherwise specified, all of the tests listed in this specification are for both consumer and nonconsumer interface connectors.

IMPORTANT NOTICE: All suppliers developing an automotive grade USB system must use components that have been validated and approved by an authorized USB testing facility per USB 2.0. In any intended vehicle application, if the products covered by this specification are, or may be, subjected to conditions beyond those described in this document, they must pass special tests simulating the actual conditions to be encountered before they can be considered acceptable for actual vehicle application. Products certified by their supplier as having passed specific applicable portions of this specification are not to be used in applications where conditions may exceed those for which the product has been satisfactorily tested.

The high frequency test methods are written for test professionals who are knowledgeable in the electronics field and are trained to use the referenced equipment. Because the measurement values are heavily influenced by the fixturing and equipment this method cannot describe all of the possible combinations. The major equipment manufacturers provide Application Notes for more in-depth technical description of how to optimize the use of their equipment.

The Authorized Person is the final authority as to what tests are to be performed on his or her parts and for what purpose these tests are required. He or she is also the final authority for resolving any questions related to testing to this specification and to authorizing any deviations to the equipment or procedures contained in this specification. Any such deviation must be documented and included in the final test report.

Guidance as to the recommended tests for selected purposes is given in the charts in Appendix C. In the absence of contrary direction from the Authorized Person in the test request/order, all electrical connectors and their associated terminals and other components are required to meet all applicable portions of this document with the following exception:

Specific tests that are not required or additional test requirements as specified in any document in the hierarchy of Section 3.1.

All suppliers of USB automotive assemblies must use certified USB 2.0 components (ie. USB mini-B receptacle, standard A stainless steel receptacle or equivalent ruggedized receptacle, mini B plug). For non-consumer interfaces, please refer to the USCAR footprint drawing labeled 999-U-USB-Z01.pdf. The drawing can be found at <https://uscar.org>

Refer to USB 2.0 website (www.usb.org) for approved supplier list

2 OUTLINE & GLOSSARY OF TERMS

2.1 GENERAL

Diagrams are provided where necessary to clarify the details of the various test procedures. The tests in each section must be performed in the order given unless otherwise specified in the test request/order. Construction details for selected test fixtures and equipment are provided in this specification.

A glossary of terms is provided in Appendix B. Terms defined in the definitions or glossary are capitalized (i.e. Room Temperature, Steady State, etc.). A list of definitions is provided in Appendix A.

3 REFERENCED DOCUMENTS REQUIRED

3.1 DOCUMENT HIERARCHY

In the event there is a conflict between performance specifications, part drawings, and other related standards or specifications, the requirements shall be prioritized as follows:

- 1st - Applicable FMVSS requirements and other applicable state and Federal requirements.
- 2nd - Applicable part drawings
- 3rd - Applicable product design specification(s).
- 4th - Automotive Industry Action Group (AIAG) Production Part Approval Process (PPAP)
- 5th - Applicable USCAR/EWCAP performance specifications
- 6th - Universal Serial Bus (USB) Specifications
- 7th - USB 2.0
- 8th - Other applicable standards and specifications

3.2 PART DRAWING

The part drawing for each connection system component should contain or reference:

All dimensional requirements (which must be in GD&T format).

Performance requirements.

Component part number.

Reference to applicable portions of this specification.

The typical mating connector.

Maximum permissible Temperature Class 1 (-40° C to +85° C) (per USCAR-2)

3.3 PRODUCT DESIGN SPECIFICATION

The product design specification may or may not be an integral part of the part drawing.

Instructions must be included in the product design specification for any special tests required for the associated part and for any exceptions or modifications to the general specifications and requirements in this document.

3.4 TEST REQUEST/ORDER

3.4.1 Samples, Test Type and Special Tests

The laboratory test request/order shall provide location and documentation of test samples, identify the type of test to be performed (development, validation, special purpose, etc.) and describe any special tests that are not a part of this specification. Any required revisions to, or deviations from any tests in this specification must include detailed instructions for each change.

3.4.2 Test Request/Order Instructions

Instructions must be included in the test request/order concerning applicable tests and the order in which the tests are to be performed if different than outlined by this specification.

3.4.3 Performance and Durability Test Instructions

Instructions must be given in the test request/order concerning limits for performance and durability tests, including definition of the conditions under which those limits apply, if they are different than outlined in this specification.

3.4.4 Development Tests

Development tests are frequently used to evaluate specific areas of the design. They are tools for evaluating design alternatives, proposed improvements, cost reduction proposals, or determining root causes of field problems.

3.4.5 Validation Tests

Validation tests or sample approval tests are acceptance type tests. Consideration must be given to the inherent repeatability or subjectivity of certain tests outlined by this specification before designating it as a validation or compliance test.

3.4.6 Special Purpose Tests

Portions of this specification may be useful for special purpose testing. For example, verifying a process or material change may, in the judgment of the Authorized Person, require only one or two specific tests, or a portion of a test, to verify that no adverse consequence resulted from the change. Any portion of a test or any combination of tests contained in this specification may be used individually or may be combined with other testing, described outside this specification, in any phase of product development, production testing, or analysis of parts from the field.

3.5 OTHER REFERENCED DOCUMENTS

SAE/USCAR-20: Field Correlated Life Test

SAE/USCAR-25: Electrical Connector Assembly Ergonomic Design Criteria

AIAG: Measurement Systems Analysis Reference Manual

ISO TS16949

IEC 68-2-32 – Basic Environmental Test Procedures – part 2

USB 2.0: Universal Serial Bus Specification

USB Cable and Connector Class Document

4 GENERAL REQUIREMENTS

4.1 RECORD RETENTION

The supplier shall maintain a central file for the storage of laboratory reports and calibration records. Such record storage must be in accordance with established ISO TS16949 and AIAG policies and practices.

4.2 SAMPLE DOCUMENTATION

All test samples shall be identified in accordance with the requirements of ISO TS16949 and the AIAG PPAP.

4.3 SAMPLE SIZE

Minimum sample sizes are given for each test in this specification. A greater number of samples may be required by the test request/order. However, no part or device may be represented as having met this specification unless the minimum sample size has been tested and all samples of the group tested have met the applicable Acceptance Criteria for that test. It is never permissible to test a larger group, then select the minimum sample size from among those that passed and represent that this specification has been met.

4.4 DEFAULT TEST TOLERANCES

Default Tolerances, expressed as a percentage of the nominal value unless otherwise indicated:

Temperature	=	$\pm 3^{\circ} \text{C}$
Voltage	=	$\pm 5\%$
Current	=	$\pm 5\%$
Resistance	=	$\pm 5\%$
Length	=	$\pm 5\%$
Time	=	$\pm 5\%$
Force	=	$\pm 5\%$
Frequency	=	$\pm 5\%$
Relative Humidity	=	$\pm 5\%$

4.5 TEST DEFAULT CONDITIONS

When specific test conditions are not given either in the product design specification, the test request/order or elsewhere in this specification, the following basic conditions shall apply:

Room Temperature	=	$23 \pm 5^{\circ} \text{C}$
Relative Humidity	=	Ambient

4.6 EQUIPMENT

Neither this list nor the list in each test section is all-inclusive. It is meant to highlight specialized equipment or devices with particular accuracy requirements. Many other items of customary laboratory equipment and supplies will also be required.

ITEM	DESCRIPTION	REQUIREMENTS*
1	Micro-ohmmeter	⇒ 0-20 mV ⇒ 0-100 mA Limits the open circuit voltage to 20 mV and limits the current applied to 100 mA. The micro-ohmmeter must also use either offset compensation or current reversal methods to measure resistance
2	Digital Multimeter (DMM)	* Capable of measuring the following at an accuracy of ≤0.5% of full scale: ⇒ 0-50 Volts DC ⇒ 0-10 Megohms
3	Insertion/Extraction Force Tester	Capable of 1.0% accuracy, full scale
4	Temperature Chamber	⇒ -40°C to +100°C or as required by Temperature Class ⇒ 0% to 95% RH
5	Vibration Controller	As Required
6	Vibration Table	⇒ 2640N (600 Lbs.) Sine Force ⇒ 2200N (500 Lbs.) RMS Force
7	Megohmmeter	Accuracy <5% of full scale
8	Decibel Meter	+/- 1.5 dB "C" scale
9	Durability Cycler	Capable of a maximum 200 cycles per hour
10	Network Analyzer	100 to 500 MHz
11	Digital Sampling Oscilloscope	Tektronix 11801B or equivalent (must be capable and able to measure up to 200ps and 5.2ns/meter)
12	Shielding Effectiveness	HP 8593EM signal analyzer or equivalent
13	Camera/Video Recorder	Typical industry standard equipment
14	Microscope	10x magnification
15	Discontinuity Analyzer	Capable of monitoring 1 microsecond

Table 4.6.1: Equipment

NOTE: on requirements: Use of equipment with a lesser range is acceptable for specific tests where the required range for that test can be met. The equipment range specified does not preclude use of equipment with a larger range, but the accuracy must remain within the specified tolerance. For example, a DMM with a range of 0-100 volts could be substituted for one specified as 0-50 volts, with the provision that the accuracy could be maintained as $\pm 0.5\%$ of the 50 volts full scale, or 0.25 volts, not 0.5% of the 100 volt full scale of the substituted equipment.

4.7 MEASUREMENT RESOLUTION

Unless otherwise specified, meters and gauges used in measurements of the test sample(s) shall be capable of measuring with a resolution one decimal place better than the specified value. For example, even though a wire diameter specified as 0.1 mm might actually be the same as one specified as 0.10 mm, calipers capable of 0.01 mm resolution may be used to measure the first wire but a micrometer with 0.001 mm resolution is required to measure the second wire.

4.8 TEST REPEATABILITY & CALIBRATION

All equipment used for test sample evaluation shall be calibrated and maintained according to the applicable standards and requirements set forth by ISO TS16949 and the AIAG publication Measurement Systems Analysis Reference Manual. Copies of this Manual can be obtained from the AIAG. Documentation is to be recorded and retained in accordance with Section 4.1 of this USCAR/EWCAP specification.

4.9 CONFORMANCE DETERMINATION

Test conformance shall be determined by the performance requirements of the test being conducted. All samples must satisfy the performance requirements regardless of sample age, test cycles, or test temperature, except where a test to failure is specified.

4.10 DISPOSITION OF SAMPLES

Should a premature non-conformance occur during a test, contact the requesting party to determine if the test is to be continued to gain additional product experience or if testing is to be suspended or terminated. When contact cannot be immediately made, the type of test shall determine the disposition of the samples. If the test order indicates that the test is investigative in nature, continue until the requesting party or parties are available. If the test order is for sample approval or validation, stop the test until the requesting party can be contacted. If the test must be stopped or terminated for any other reason (safety, equipment failure, etc.) the Authorized Person must be contacted for concurrence before the test is restarted. The test request/order should always specify desired sample disposition at the conclusion of the applicable testing.

4.11 PART ENDURANCE

Successful completion of all requirements of this specification is intended to demonstrate that the design and construction of the components and connector systems tested are capable of operating in their intended vehicle environment and application.

5 TEST & ACCEPTANCE REQUIREMENTS

5.1 GENERAL

The tests detailed in this specification are qualitative in nature and are not expected to stress any part beyond its anticipated application limit, except where tests to failure are specified.

The test procedures that follow were written as stand-alone tests and may be used as such. However, they should be performed in sequence as specified in section 6. Common sense is required to overcome any redundancies in sample preparation or in procedures. For example, if samples have already been prepared for the preceding test in a sequence, it should be obvious that the sample preparation step for that individual test (included so that test can be used as a stand alone test) should be skipped. Should any conflicts or questions arise concerning procedures and/or requirements, contact the Authorized Person.

5.1.1 Performance Requirements

All connection systems must meet all performance test requirements for the appropriate Temperature Class (-40° C to + 85° C.)

5.1.2 Dimensional Characteristics

Part construction shall conform to the dimensions, shape, and detail attributes specified in the latest revision of the applicable part drawing(s).

5.1.3 Material Characteristics

Parts are intended to be in their "as furnished for vehicle assembly" condition when testing begins, unless specific instructions as to any pre-test "conditioning" are contained in the test request/order. For example, electrical terminals typically have residual die lubricant on them when finally assembled into a vehicle. This same condition must prevail for test samples unless part cleaning is specified in the Test Request/Order.

All material used in each test sample shall conform to the material specifications shown on the latest revision of the applicable part drawing(s).

5.1.4 Temperature Classifications

USB assembly to meet USCAR class 1 temperature requirement (-40° C to + 85° C)

5.1.5 Testing Headers & Direct Connect Components

Cases frequently arise where only one half of a connector, usually the female half, is available and it mates directly to a Header or to a receptacle in an electrical component or device. This presents special problems for testing. In order to completely test the electrical connection, access must be gained to the terminals in the device or header.

Therefore, in situations where there is more than 50 mm from the point of contact in the connection nearest to the Header or device to the point where the terminal "tail" or buss bar connects to the device, these two options are available. (1) Attach the millivolt lead at a convenient common distance from the contact to be measured. Then subtract the bulk resistance of the selected common length when calculating the resistance of the associated Header or device connection. (2) Measure bulk resistance of each individual Header terminal or component buss bar from the connection to be measured to the point of millivolt lead attachment and subtract this resistance when calculating the resistance of the associated Header or device connection.

It may be that the electrical component or device being connected is not itself capable of withstanding the tests to which the connector is usually subjected. In these cases samples of just the connector receptacle portion of the device must be obtained

In any case, the Authorized Person must be consulted and must approve any deviation from the normal tests of this performance specification.

5.1.6 Sample Preparation (LLCR)

1. Perform Visual Inspection on all parts per Section 5.1.8 (reference page 15).
2. Identify and label all samples with a unique label (test request/order number) and relevant test name.
3. Test points can be any convenient length between 75 mm and 300 mm away from point where wires exit the back of the connector; use this length for all samples of this test.

NOTE: Wire lengths shorter than 75 mm introduce room for errors during setup.

4. If part of a longer wire harness/cable assembly, cut off relevant length of the wire for testing purposes.
5. Strip off jacket of cable, pull back shield to expose the circuits' wires.
6. Strip insulation from the appropriate wire to be tested using care not to nick or cut any individual wire strands. Tin the exposed conductor ends.

NOTE: Ensure that every length of wire stripped is matching to ensure repeatability in measurements.

7. Obtain a matching length/type of wire for each wire size tested for the wire deduct sample.
8. Prepare the ends of the deduct wire as described in Steps 4, 5 and 6 above.
9. Prepare any mating headers/devices as described in note on page 14 of this specification.

NOTE: Lead wires can be attached to the pins of the headers directly, pins can be shorted together to measure two contacts at a time, or test boards can be attached to the header to facilitate easier access for attachment points. Ensure to deduct all relevant bulk/wire resistances from the overall measurements.

NOTE: Seek prior approval of the Authorized Person for all preparation plans.

5.1.7 Connector Cycling

5.1.7.1 Purpose

This procedure preconditions a connection system pair or terminal system pair prior to a test sequence. Connectors may be subjected to repeated cycling due to in-plant and/or service repair prior to and during the life of the connector. Complete this procedure only once when conducted as part of a series of tests as in section 6 (Test Sequence).

5.1.7.2 Equipment

Durability Cycler

5.1.7.3 Sample Preparation

No special preparation required.

5.1.7.4 Procedure

The test shall be performed per the latest revision of the Universal Serial Bus Cables and Connectors Class Document with the following exceptions:

- a) The consumer interface connection shall be cycled 5,000 times (each sample in the lot to be tested)
- b) The mini-B connector shall be cycled 10 times (each sample in the lot to be tested).

Re-mate connectors for one last time in preparation for future test sequences.

5.1.7.5 Acceptance Criteria

Complete the Visual Examination per section 5.1.8

The low level circuit resistance shall meet the requirements listed in the Universal Serial Bus Specification 2.0 Electrical and Mechanical Compliance Standards.