Field Correlated Life Test
Supplement to SAE/USCAR-2

SAE/USCAR-20 REVISION 2
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FIELD CORRELATED LIFE TEST
SUPPLEMENT TO SAE/USCAR-2

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This document has been declared “Stabilized” by USCAR and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX (724) 776-0790

SUMMARY OF CONTENTS

WARNING

No electrical terminal may be represented as having met this USCAR/EWCAP specification unless conformance to all applicable requirements of this document have been verified and documented. At least the minimum applicable sample size set forth in each test must have been tested with no sample in the entire group tested failing to meet all applicable Acceptance Criteria for that test. 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.

1. SCOPE

1.1 This life test for underhood/passenger/trunk connector systems may be used in place of Section 5.9.6, Connection System Electrical Table of SAE/USCAR-2. All other requirements of SAE/USCAR-2 remain applicable even when this test is used. Refer to SAE/USCAR-2 and Connector/Terminal Supplier for appropriate power rating and current cycle Testing.

1.2 When this life test is used in place of para. 5.9.6 of USCAR-2, complete Para 5.6.1-Sequence N (Thermal Shock) of SAE/USCAR-2 in it's entirety in order to demonstrate capability to withstand the 10-cycle service (mate/un-mate) requirement.

1.3 This test specification details the procedure for testing the performance of electrical connections to a test sequence (FCLT – Field Correlated Life Test) that has been correlated to automotive vehicle conditions. The correlation applies to crimps and interfaces used in automotive applications and has been established with thousands of samples and millions of product and vehicle environmental measurements. The testing is performed with mated connector assemblies. In general, testing of connections at two base temperatures, 85°C and 125°C, through two cycles of the FCLT has been shown to correlate to at least 150,000 miles (240,000 kilometers). See Reference Documentation section for questions regarding correlation issues.

1.4 This test shall be performed a minimum of two times using separate sample sets, once at a base temperature of 85°C and once at a base temperature of 125°C. The base temperature is the temperature to be used in the thermal aging conditioning steps and as the upper temperature in thermal shock conditioning steps. (Both temperatures must be tested regardless of intended USCAR temperature or sealing class, except when 85°C testing is waived per paragraph 1.4.1)

1.4.1 The 85°C test is included in USCAR 20 because some crimps perform worse at 85°C than at 125°C. In those cases where it has been demonstrated that the phenomenon does not exist for that design type, 85°C testing for similar design types can be waived for future testing of other connector assembly combinations.

1.4.2 Necessary conditions to waive 85°C FCLT:

1. The crimp has passed USCAR 21
2. The reference test produces acceptable crimp results.
3. It has been demonstrated that the 85°C results are not worse than the 125°C results (i.e. the phenomenon does not exist) for a given terminal design type (consider this as reference test). The crimp being waived is similar to the part in the reference test.

1.4.3 The Definition of a terminal similar to the reference test is as follows:

Similar terminal crimp is defined as having the same:

1. Terminal stock thickness
2. Material (alloy and temper)
3. The same terminal plating
4. The same terminal conductor wing dimensions (except core conductor cross sectional area related dimensions) and features (serrations, etc.)

1.4.4 Evaluation of whether the phenomenon exists.

1. Consider candidates for reference tests those where the maximum value of the 85°C and 125°C tests are each < 2 mohm.
2. Plot the Crimp Resistance Cumulative Distribution for the 85 °C and 125°C cycle 2 FCLT results. (this can easily be done using the Excel Rank and Percentile function). Plot the distributions with the resistance values on the abscissa (x-axis) and cumulative percent on the ordinate (y-axis).
3. Add 0.5 mohm to each of the 125°C test results and plot this distribution on the same graph as the results from step 2. This will shift the 125°C distribution by 0.5 mohm.
4. If the 85°C distribution lies completely to the left of the shifted 125°C distribution, then the phenomenon (85 °C worse than 125°C) will be deemed to not exist. If the 85 °C plot touches or crosses the 125°C shifted plot, then this test cannot be used to rule out the phenomenon.

Reference paragraph 3 “USCAR 20 -85°C Crimp Test Reduction Proposal” for further detail.

1.5 Modification to tests and conditioning procedures contained in this document may be made to accommodate special situations. However, no field correlation can be associated to these modifications. Such modifications shall be fully documented in the test report.

1.6 This procedure is valid for USCAR/EWCAP classes 1, 2, and 3. Correlation has not been established for class 4. Although class 1and 2 terminals may not be designed for continuous use at 125°C, conditioning at higher temperatures as directed in this procedure is necessary to properly accelerate aging.

2. OUTLINE

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.

3. REFERENCED DOCUMENTS

- SAE/USCAR-2 – Performance Standard for Automotive Electrical Connector Systems. Copies are available from SAE at www.sae.org or (724) 776-4970.
- "Lab-Field Correlation Program for Automotive Electrical Connections", Forty-Sixth IEEE Holm Conference on Electrical Contacts.
- "USCAR 20 -85°C Crimp Test Reduction Proposal", March 30, 2004 proposal documentation, available at www.uscar.org

4. SAMPLES

4.1 The minimum sample size is at least 30 terminal pairs and at least 4 connector assemblies per base temperature and connection type. This normally requires a minimum of 33 terminated leads for each gender and temperature to be tested. Three samples are used for deduct measurements of each gender. Deduct samples will not be subjected to any conditioning.

4.2 Make terminated lead samples a minimum of 150 mm in length (ref. Figure 1).

4.3 The requestor should identify samples completely by description, part number, date code (as applicable), and revision letter, when the test request is submitted. Individual samples should be uniquely identified in a fashion suitable to the environmental conditioning that they will experience.

5. EQUIPMENT

5.1 Dry Circuit Resistance - Dry circuit conditions require that the maximum voltage impressed across the test sample be limited to 20 millivolts and the maximum current through the sample be limited to 100 milliamperes. Measure resistances with a Micro-ohmmeter capable of satisfying the dry circuit conditions specified. The micro-ohmmeter must limit the open circuit voltage to 20 mV, limit the current applied to 100 mA, and use either offset compensation or current reversal methods to measure resistance. The 4-wire (Kelvin) connection method shall be used.

5.2 Thermal Aging - the test chamber shall be capable of maintaining the specified temperature within ± 3°C throughout the area where the components are placed. Air circulation and thermal capacity shall be sufficient to assure a uniform temperature.

5.3 Random Vibration - Vibration equipment shall consist of an Electrodynamic vibration test system, vibration control system, accelerometer and signal conditioner capable of operating and recording at the vibration range specified in paragraph 7.1.2. Mated connector assemblies must be mounted on fixtures for vibration testing. The fixtures must conform to the requirements of section 7.1.2.1.

5.4 Thermal Shock - The thermal shock equipment shall be set up such that samples can be transferred between temperature extremes within 30 seconds.

5.5 Temperature - Humidity - Use an automatic temperature/humidity chamber capable of maintaining 95-98 percent relative humidity and -40°C to +85°C ± 3 °C. Maximum transfer time between temperature extremes is 5 minutes.

5.6 Visual Inspection - Unless otherwise specified, no special devices are required. To assist documentation, photography of the samples may be employed.

6. PROCEDURE

6.1 Unless otherwise specified, make all dry circuit resistance measurements at 23 ± 5°C. All test chamber temperature tolerances are ±3°C and all time tolerances are ±5 minutes. Unless otherwise specified all resistance measurements are dry circuit resistances.

6.2 Visually examine each test specimen prior to conditioning noting any apparent defects. Following conditioning, re-examine each test specimen noting any additional defects. Samples may be disassembled after the last cycle measurement in order to measure crimp resistances.

6.3 To establish a resistance base line measurement, solder the stripped ends of the test and deduct sample cables at a point on the cable 150 ± 3mm from the rear edge of the terminal core crimp. All stranded wire ends should be soldered. Solder the crimps on the deduct samples. Crimp + cable resistance or soldered sample deduct resistance is measured between the cable end and a point on the terminal just in front of the core crimp for each crimp (see Figure 1).

6.4 Measure and record the deduct resistance of the 3 samples with soldered crimps for each crimp type. Appropriate similar measurements should be made for header type connectors in order to obtain pin bulk material deducts. (ref. SAE/USCAR-2, para 5.1.5 – Testing Headers & Direct Connect Components)

6.5 Measure and record the crimp + cable resistance of each test sample. The crimp resistance value will be determined from this measurement minus the average deduct of the corresponding terminal type. (optional but recommended, and required for those tests used as reference tests to waive future 85°C testing of similar crimp designs).

6.6 Assemble the terminated leads to the corresponding connectors and mate the connectors.

6.7 Measure and record the overall resistance between the cable ends for each male-female connection (see Figure 2). The crimp-interface-crimp value is determined from this measurement minus the average deduct of the corresponding terminal types.

6.8 Subject the samples to the first cycle as defined below. Note: for vibration conditioning, the connectors need to be attached to the vibration fixture prior to vibration and removed from the fixture after vibration. The fixture numbers should be recorded.

6.9 Measure and record the overall resistance at the end of each cycle. Measurements may also be taken at the end of each conditioning step, but are not required unless directed by the OEM.

6.10 If para. 6.11 is to be completed, disconnect the connector assemblies and remove the terminals from the connectors.

6.11 Measure and record each crimp + cable resistance (optional but recommended - required for those tests used as reference tests to waive future 85°C testing of similar crimp designs).

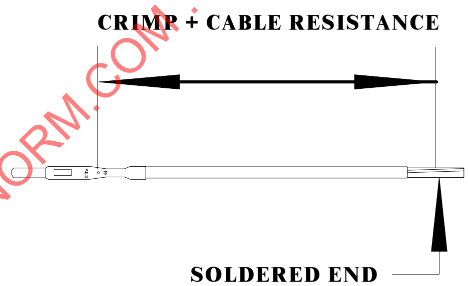

Figure 1: Crimp + Cable Resistance

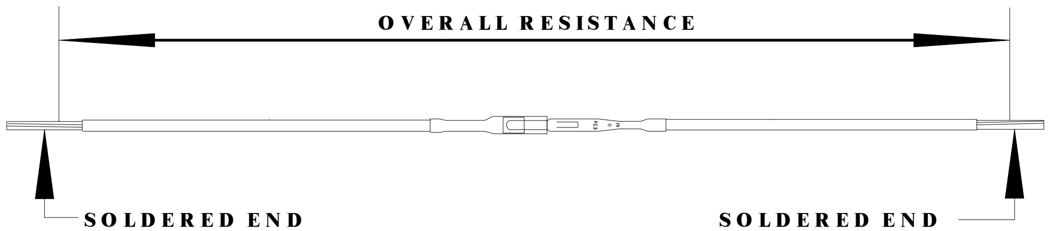

Figure 2: Overall Resistance

7. TEST CONDITIONS

7.1 Cycle Steps

7.1.1 Step 1 Thermal Aging – 72 hours at base temperature

7.1.2 Step 2 Random Vibration – 12 hours (4 hours/plane) – 3.2g rms

7.1.2.1 Vibration Fixtures – Connectors shall be restrained in a fashion that limits connector movement during vibration. Connector restraint shall be used on only one of the connectors of the mating assembly. The restraint should not limit movement in any direction allowed by design clearances or interfere with any locking mechanism. Connectors shall be firmly clamped around the connector body but not distorted. Wires shall be clamped at approximately 35 mm from the point where they exit the corresponding connector. The clamping mechanism shall hold the wires firmly but not damage the insulation. Wires shall dress straight out of the back of the connector or as determined by design features such as strain reliefs. Vibration fixtures should have an identifying number.

7.1.2.2

Breakpoint Frequency, hertz	Spectral Density Magnitude, g^2 /hertz
10	.070
20	.070
40	.020
350	.020
550	.005
700	.001
750	.0001
2000	.0001

Table 1: Vibration Profile – RMS g level = 3.2 g's

7.1.2.3 The maximum g level shall be limited to 3 times the rms level.

7.1.2.4 Tolerance shall be ±4.0 dB from the reference spectrum level for the test frequency band 10 to 2000 hertz.

7.1.2.5 Below 10 hertz and above 2000 hertz, the vibration spectrum shall roll-off at the maximum capability of the control system.

7.1.2.6 Unless otherwise specified, the test specimens shall be subjected to 4 hours ± 5 minutes of the above test regimen in each of three mutually perpendicular planes.

7.1.2.7 Unless otherwise specified, vibration testing shall take place at an ambient temperature of 23 ± 5°C.

7.1.3 Step 3 Thermal Shock – 72 hours, 72 cycles from -40°C to base temperature, typically 30 minutes at each temperature. Maximum transfer time between chambers is 30 seconds.

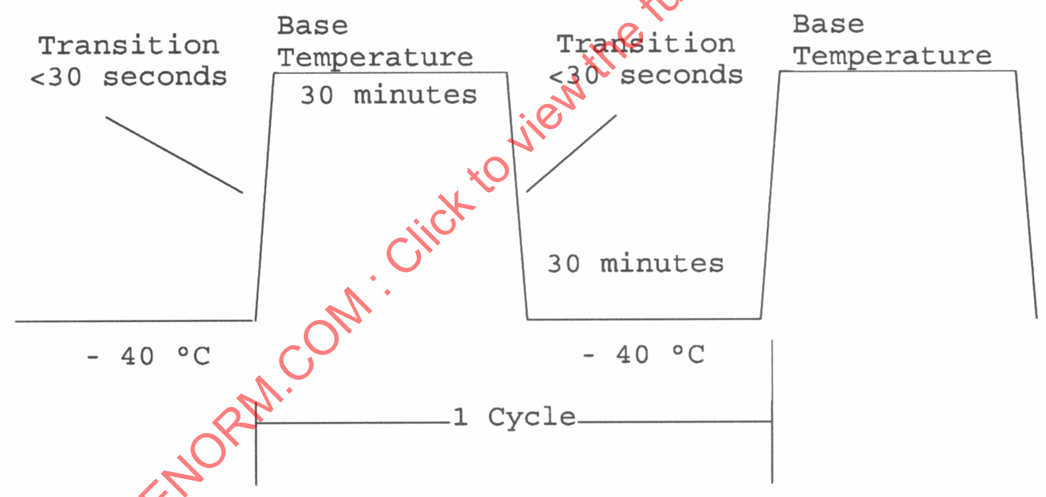

Figure 3: Thermal Shock Cycle

7.1.4 Step 4 Temperature Humidity – 24 hours, 16 hours at 65°C and 95-98% RH (humidity is uncontrolled for the remainder of the cycle), 2 hours at -40°C, 2 hours at 85°C, 4 hours at 25°C. Maximum transfer time between chambers is 5 minutes.

7.2 Test Flow Chart

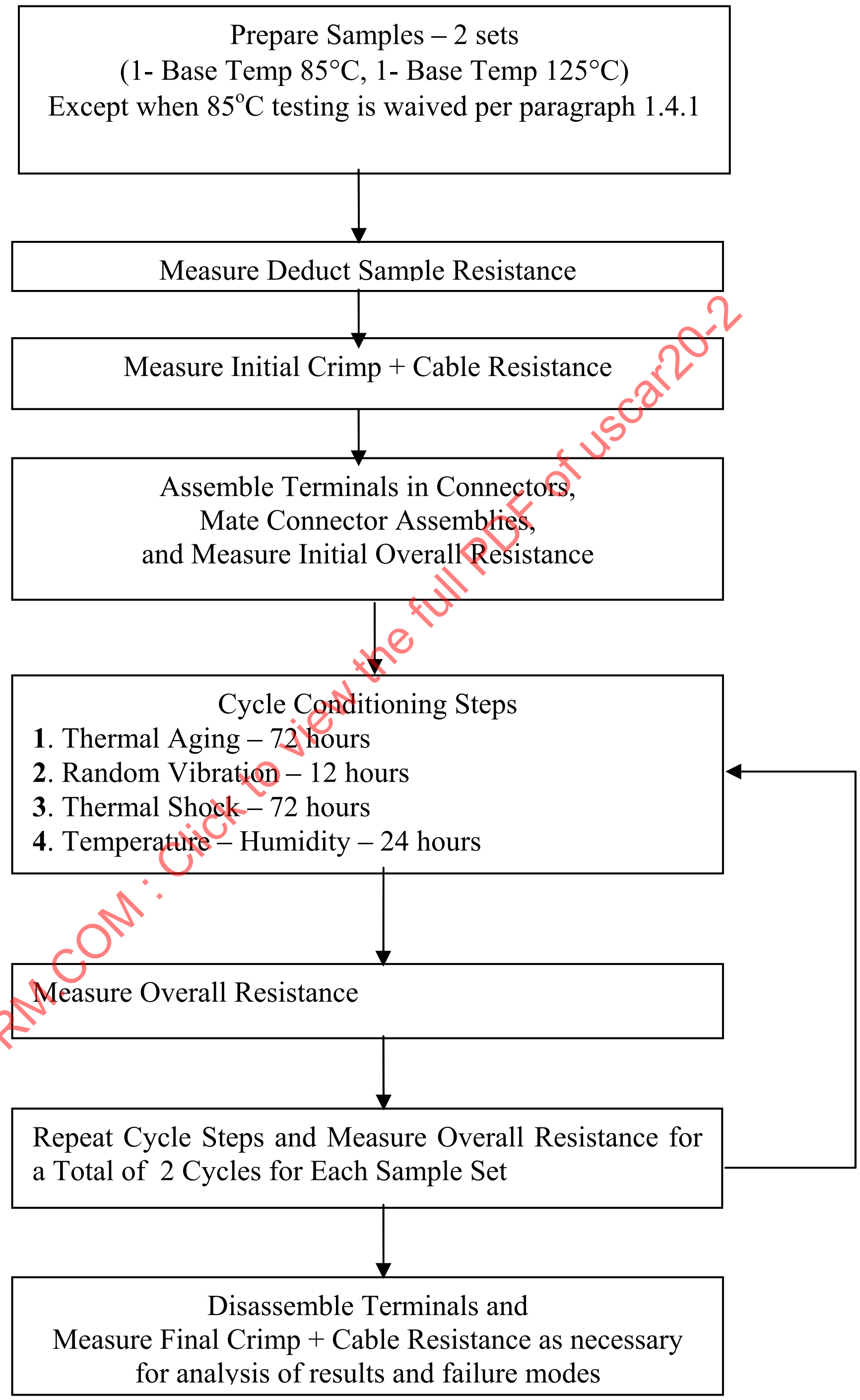

Figure 4: Test Flow Chart