Lead-Free Solder Validation Test Plan

SAE/USCAR40-1
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SUMMARY OF CONTENTS

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

1. INTRODUCTION

This Test Plan shall be completed by the supplier and submitted to the OEMs 6 weeks prior to start of test for approval by the OEM representative. All sections shall be included as stated in the outline, only additions of new sections are allowed. If a section is not applicable, this shall be stated in this Test Plan along with supporting justification in the relevant section description.

This document has been developed and agreed upon by a joint workgroup consisting of the following OEM representatives:

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Tom Boettger – Ford Motor Company
Keith Hodgson – Ford Motor Company
Tom Hagen – General Motors Corporation

1.1 Scope

This guideline is applicable to existing lead solder production products that will change to lead-free solder processes to meet the ELV Directive 2000/53/EC Annex II, exemption 8B requirements. This guideline is applicable to similar products used by multiple OEM's that have the same manufacturing processes / equipment. The intent is to streamline the supplier's environmental testing via common qualification to reduce timing, quantities, and costs.

1.2 Purpose

The purpose of this Test Plan documents the procedures for all tests according to this USCAR guideline. It describes all test set-ups and the procedures to verify the environmental robustness of a lead free connector on glass.

1.3 Functional Requirement of the Connection

The functional requirement for the solder joint is to provide an electrical connection between wiring elements and a glazing component for the life of the vehicle.

Life Requirements
Target Life = 10 years, 150k Miles

Electrical Load - Minimum/Maximum
11 – 15 operating voltage

Operating Temperature Range
Ambient temperature and at T0, also part temperature
T_{min} = -40 to
Tmax_ 85°, 95 105 or 115 C, per component/OEM specification

1.4 Parameter and Tolerance Requirements

Unless stated otherwise, the following shall define the test environment parameters and tolerances to be used for all validation testing:

Parameter	Tolerance
Ambient Temperature	Spec. ± 3 °C
Test Time	Spec. -0,+2 %
Room Ambient Relative Humidity	30 - 70 %
Chamber Humidity	Spec. ± 5 %
Voltage	Spec. ± 0.3 V
Current	Spec. ± 1 %
Random Acceleration (G_{RMS})	Spec. ± 20 % (PSD deviations from applicable tables are not permitted)
Acceleration (Mechanical Shock, G)	Spec. ± 20 %
Frequency	Spec. ± 1 %
Distance (Excluding Dimensional Check)	Spec. ± 5 %

2. CONNECTION DESCRIPTION

2.1 Connection Family Description

A family consists of a glazing material substrate (annealed, tempered or polymeric), a silver conductive paste, a solder alloy, and a connector geometry. No one member or multiple members of this family may be changed without revalidating the entire family.

3. PERFORMANCE VERIFICATION

3.1 DUT Specimens

Provide a brief DUT product family description, including any similarities and differences of hardware implementation within the family. Please state the justification and rationale for choosing the specific DUT sample which represents the entire product family.

DUT Name (no abbreviations): *(TBD)*	Revision Date: *(TBD)*	Revision Number: *(TBD)*
DUT Part Number: *(TBD)*	DUT Manufacturer: *(TBD)*	
DUT Project Information: *(TBD: First vehicle application, including model year and program name)*	DUT Mounting Location in Vehicle: *(TBD)*	
Prepared by (Supplier): *(TBD)*	Surrogate Applications: *(TBD: Other DUTs, including model year and program name, validated by the test results)*	
Approved by (Supplier): *(TBD)*	Approved by OEM Responsible Engineers: *Chrysler (TBD)* *Ford (TBD)* *General Motors (TBD)*	

3.2 Test Sequence

3.3 Test Matrix

(see matrix below)

Validation Testing Requirements for Lead-Free Solder BL Terminals

Rev. 8/12/10

	Ambient Temperature Exposure (baseline) (Note 9)	High Temperature Exposure	Low Temperature Exposure	Humidity with Temperature	Temperature Cycle (ref. GMW3172, Sec. 9.3.1.4 and ISO 16750-4 G, Sec. 5.3.2.2)	GM Vibration Test (Note 1)	Power Cycle at Cold Temperature (Note 1)	Continuous Power On Test
DV (Design Validation)	X	X	X	X	X	X	X	X
PV (Product Validation)		X		X	X		X	X
Temperature	23 C	105 C	- 40 C	50 C	- 40 C to 90 C		- 40 C	23 C
Humidity	not specified	not specified	not specified	90% min	not specified		not specified	not specified
Creep Load	1 lb	1 lb	1 lb		1 lb			
Temperature Cycle					Time, min / Temp., C: 0 / 20; 60 / 40; 150 / 40; 210 / 20; 300 / 90; 410 / 90; 480 / 20		Power on 10 min @ VN; off until glass temperature returns to - 40 C. Use circulating fan in chamber to reduce cooling time.	
# of Cycles					30 cycles		1000 cycles	
Total Time	500 hrs	500 hrs	500 hrs	336 hrs	240 hrs. Power up @ 14.5V (Lower BW) during last cycle at cold temperature.			100 hrs @ VN
Visual Inspection	X	X	X	X	X		X	X
Continuity Check	X	X	X	X	X		X	X
Pull Test (100N Shear)	X	X	X	X	X		X	X
Pull Test (Tensile)	X	X	X	X	X		X	X
Tensile Pull Test to Failure (record failure load value)	X	X	X	X	X		X	X

Notes:

1. The OEM has the right to add or modify test requirements based on the customer's needs.
2. Surrogate parts or 12" x 12" test pieces may be used for DV testing but must be the same glass thickness and have the same enamel and silver as the actual part.
3. Sample size to be 12 pieces minimum (30 pieces preferred) for each test
4. A control group of leaded solder connectors of equal sample size will be tested for each test
5. The pull test data from the ambient temperature exposure group will be used as a basis for comparison with the results after testing at each test condition.
6. Conduct 100% visual inspection of all solder joints prior to testing
7. Record failure mode of pull testing to failure (e.g. pulled glass, glass broke, clip failure, etc.)
8. Parts to be positioned at installation angle for all PV testing
9. First validation of a new technology
10. High Temperature Exposure Test temperature reduced to 105 C (was 110 C)

3.4 Evaluation Criteria

3.4.1 Failure Analysis

All failures/non compliance parts shall be evaluated using the requesting OEM/suppliers in house Failure Analysis process.

Sample forms and directions to be supplied along with the any additional Acceptance Criteria at the time of the test request.

3.5 Acceptance Criteria
Defined by each OEM prior to start of test

3.5.1 Visual Inspection

Procedure

1. All soldered joints are visually inspected to detect micro cracks with the method described below.
2. Initial micro crack inspection should be conducted at least 24 hours after soldering.
3. The inspection must be performed prior to all other tests.
4. The inspection must also be performed as the first inspection after completion of the other tests.
5. If a micro crack is detected, the inspection result is not passed.

Inspection Method for micro cracks

1. The outside glass surface of the test part is cleaned with a glass cleaner leaving no impurities.
2. Viewing through the outside glass surface (opposite the silver printed side), the interface area of the solder joint to the glass or frit is inspected for micro cracks.
3. A bright spot light (65W minimum) is used to illuminate the soldered area.
4. The light should be held at an angle of approximately 45 degrees and a distance of 6 - 12 inches (15 - 30 cm) from the glass surface. The light should be moved around the part to illuminate the soldered area from different directions to ensure detection of the micro crack.
5. A micro crack is visible due to its light scattering properties and will be detectable as a white/silver spot or reflection.
6. If a defect is observed a 10X magnifier should be used with spot light illumination to verify that the defect is in fact a micro crack (i.e. not a paint void or bubble, glass surface scratch, etc.).

3.5.2 Continuity Check

Windows and electrical connectors tested

Cycles are at 13.5 V or the design voltage whichever is greater, +/- 0.3 VDC

Design Voltage is the normal engine on operating voltage expected at the terminals of the window based on voltage regulation, electrical distribution wiring resistance, and window current draw.

Functional test

Soak to specific time and temp
Measure current draw at operating voltage and record

Environmental Cycles

25C for 30 minutes -- measure current draw at operating voltage
-30C for 30 minutes -- measure current draw at operating voltage
50C for 30 minutes -- measure current draw at operating voltage