

A2LA
Automotive Electromagnetic Compatibility
Laboratory Accreditation Program
(AEMCLAP)
Second Edition (Revised)¹

June 2001

¹ This revision of the Second Edition is an update to reference ISO/IEC 17025:1999. No changes have been made to the technical requirements, beyond renumbering to match the appropriate sections of ISO/IEC 17025. The Third Edition, including changes from the AEMCLAP Committee, will supercede this document.

Automotive EMC Laboratory Accreditation Program (AEMCLAP) Second Edition (Revised)

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I INTRODUCTION

This document has been developed jointly by personnel from DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation. The intent of the participants has been to establish common criteria for the evaluation of the competency of automotive EMC laboratories by third party accreditation bodies.

This document defines the requirements of the Automotive EMC Laboratory Accreditation Program (AEMCLAP) and the Automotive EMC Laboratory Recognition Program (AEMCLRP) and serves to:

- a) provide supplier and third party laboratories with the specific requirements they will be evaluated against, and
- b) provide accreditation agencies with specific requirements to be used in evaluating laboratories.

The Scope of Accreditation must include a list of the specific automotive EMC tests from this document for which accreditation has been granted.

The period of accreditation will be established by the accreditation bodies and the auto industry representatives. Typically the period will be two years with annual surveillance audits which include proficiency testing.

NOTE: IT MUST BE UNDERSTOOD THAT ACCREDITATION IS THE ACKNOWLEDGEMENT THAT A LABORATORY HAS BEEN ABLE TO DEMONSTRATE THAT IT HAS THE COMPETENCY TO CONDUCT THE TESTS INCLUDED IN SCOPE OF ACCREDITATION AT THE TIME OF ASSESSMENT. IT IS NOT A GUARANTEE OF THE ACCURACY OF DATA SUPPLIED BY THE TEST LAB TO THE PURCHASER.

It is the intent, as this program matures, to have at least two accreditation bodies participating in the program. Further, it is the intent that the accreditation process will be available to suppliers and third party laboratories, regardless of where they are located.

The cost of having a laboratory accredited is to be funded by the laboratory and is to be paid directly to the accrediting body.

Although details have not yet been worked out, it is intended that an integrated list of accredited Automotive EMC Laboratories will be maintained on the Internet and will be accessible to any interested party. This listing would most likely include the tests in the scope of accreditation and the end date of the period of accreditation.

The organizers of this program realize that for the assessors to perform their duties competently and fairly, training of assessors will be required initially and on an ongoing basis. The organizers are committed to supporting this activity.

There is an on-going effort to harmonize automotive EMC test procedures. This document will be updated on a regular basis to reflect changes resulting from this harmonization effort and changes in the reference test method documents.

Procedures are based on ISO procedures as a first priority; SAE procedures as a second priority; and company specific procedures as a third priority.

Each company using this program as part of their purchasing requirements will do so independently.

NOTE: DaimlerChrysler Corporation (DCC) will use accreditation by an accreditation body (with whom we have a Memorandum of Understanding or equivalent document) in accordance with this document as one alternative for a DCC supplier to gain entry into the DCC EMC Laboratory Correlation Program. The DCC EMC Laboratory Correlated Status is granted only by DCC. DCC has evaluated the amount of EMC testing being performed by presently correlated third party EMC laboratories and has determined that, at this time, additional third party laboratories are not warranted. Therefore, currently, no additional third party laboratories are being added to the correlation program. A supplier EMC laboratory wishing to achieve DCC Correlated Status should contact Andrew Shune (248-576-6919 or zx@daimlerchrysler.com) for information on self-assessment and the correlation process.

For an EMC laboratory that has been accredited by a recognized Accrediting Body (per ISO/IEC Guide 58), DCC will accept that accreditation as evidence that the laboratory has successfully met the basic requirements (Section II and Appendix D), but not the requirements for specific test methods.

II CRITERIA FOR AUTOMOTIVE EMC LABORATORY ACCREDITATION

II.A ISO/IEC 17025:1999 and the proficiency tests defined in this document are the basis for determining the competency of laboratories in this program.

II.B Application of ISO/IEC 17025

This section provides clarification and additional specific requirements applicable to the “Automotive EMC” laboratory accreditation. Each of the reference numbers below relates to the corresponding section of ISO/IEC 17025:1999.

1.0 Scope

1.1 This guide is for EMC laboratories interested in becoming accredited to conduct automotive specific EMC test procedures.

2.0 Normative References

Additional reference documents are included in Appendix A.

3.0 Terms and Definitions

Additional definitions are provided in Appendix B

5.2 Personnel

5.2.1 The laboratory supervisor and/or individual that has the following responsibilities:

- Laboratory technical operations and training
- Review and approval of test data and reports

shall hold a B.S.E.E. or B.S. Physics degree plus one of the following:

- 5 years experience in an EMC laboratory
- NARTE EMC Engineer Certification
- M.S.E.E. plus 3 years experience in an EMC laboratory

Exceptions must be approved by the AEMCLRP Committee prior to a laboratory being assessed by an authorized accrediting body.

5.9 Assuring the quality of test and calibration results

8.15.9.1 Proficiency test artifacts will be provided by the AEMCLRP Committee to the accrediting bodies. Refer to Section IV.

5.4 Test and calibration methods and method validation

5.4.1 Component and/or subsystem specific test plans are required in advance of performing any automotive EMC testing.

The lab is required to demonstrate compliance with the quality system and technical requirements of ISO/IEC 17025 and its own quality policies and procedures. In addition, lab capability to conduct specified procedures will be determined through a two part assessment. Part 1 consists of an on-site assessment, which will require the lab to respond to a standard set of questions specific to a particular test procedure. Part 2 requires a lab to demonstrate proficiency in EMC testing. Each test procedure will have specific requirements for proficiency testing. These procedures are outlined in the appropriate appendix. The formats for part 1 and part 2 of the assessment are given

below.

- 1) Pre-assessment
- 2) On-Site Assessment
 - Test setup
 - Test procedure

NOTE: It is the responsibility of the laboratory being assessed to have an appropriate DUT on hand for each test to be assessed and to use that DUT during the assessment of the test. The program's proficiency artifact may in some cases be suitable for this requirement.

- 3) Proficiency Testing
 - Test artifact and verification procedure
 - Repeatability
 - Correlation
 - Reporting of results
 - Performance history

Accreditation requires:

- Assessment and compliance with ISO/IEC 17025;
- Meeting OEM-specific program requirements as listed in each appendix;
- Demonstration of technical competency to perform one or more of the test methods (listed in Table 1) by participating in and meeting proficiency testing requirements.

A member company of the Committee may choose to withhold their recognition of the accreditation of an EMC laboratory based on their analysis of the information gathered.

Table 1. Specific Automotive Test Methods

| Test Method Requirements | Primary Document | Alternate Document(s) |
|---------------------------------------|----------------------------|-------------------------------------|
| Direct Injection | SAE J1113-3 | ISO11452-7 |
| Bulk Current Injection (BCI) | ISO 11452-4 | SAE J1113-4 / GMW3097GS / GMW3100GS |
| Electrostatic Discharge (ESD) | ISO 10605 | SAE J1113-13 |
| Absorption Chamber | SAE J1113-21 | ISO 11452-2 |
| Transverse Electromagnetic (TEM) Cell | ISO 11452-3 | SAE J1113-24 |
| Tri-Plate | SAE J1113-25 | |
| Reverberation | SAE J1113-27 | GMW3097 GS / GMW3100GS |
| Emissions | CISPR 25 | SAE J1113-41 |
| Radiated Emissions - Reverb Method | GMW3097GS / GMW 3100GS | |
| Conducted Emissions | DaimlerChrysler LP-388C-41 | |
| Audio Frequency Conducted Immunity | SAE J1113-2 | |

5.4.2 Automotive EMC lab accreditation and recognition applies to specified test procedures only. The criteria checklists are based on specific editions of the documents. However, participating laboratories must monitor the status of the referenced documents so that adequate planning can be in place to implement changes as required by the purchaser-supplier contractual agreements.

5.7 This section is not applicable for laboratories seeking accreditation and recognition to conduct the automotive EMC procedures specified in this document.

SAMPLING as it refers to the 'selection of representative samples' from items in a production line is not applicable to entities engaged in test activities only (i.e., third party test houses, or those not directly connected to the production of the test samples). In this case, the proper selection of test samples is the responsibility of the entities requesting tests. The test entities are therefore not obligated to meet the provisions in this Section 5.7 of ISO/IEC 17025:1999.

For those suppliers that are involved in the production AND testing of their own product, the provisions in Section 5.7 of ISO/IEC 17025:1999 still apply.

4.5 Sub-Contracting of Calibration or Testing

4.5.1 Sub-contractors must be accredited to conduct calibration or accredited and recognized to conduct the specific automotive EMC test procedures specified in this document.

II.C Automotive EMC laboratories who have a current ISO/IEC 17025 based accreditation with another EMC discipline included in its accreditation scope (i.e., FCC or Mil Std) need only be assessed on-site to determine compliance with the automotive specific requirements of II.B. For the purposes of this paragraph, accreditation based on EN45001 or ISO Guide 25:1990 is also accepted. Other accreditation programs shall be approved by the AEMCLRP Committee.

III. ACCREDITATION BODY AND ASSESSOR REQUIREMENTS

III.A Compliance with ISO/IEC Guide 58 is the criterion used for approving accreditation bodies to perform the assessments of laboratories in this program.

III.B Application of ISO/IEC Guide 58 in this program.

The only specific requirement applied to ISO/IEC Guide 58 is:

Assessors shall hold a B.S.E.E. or B.S. Physics degree plus one of the following:

- 10 years experience in an EMC laboratory
- NARTE EMC Engineer Certification
- M.S.E.E. plus 5 years experience in an EMC laboratory

Exceptions must be approved by the AEMCLRP Committee.

III.C Sampling or statistical assessment not accepted

Each individual test that the laboratory has requested be included in their scope of accreditation under this program shall be thoroughly and individually evaluated.

III.D Necessity of utilizing experience and knowledge during the assessment

The assessor shall use his/her accumulated EMC knowledge and expertise in addition to the specific check list requirements to establish the competence of the laboratory to perform each of the tests which the laboratory is seeking accreditation for.

IV PROFICIENCY TESTING MANAGEMENT

- 1) The AEMCLAP Committee will provide proficiency test artifacts for this program.
- 2) When a laboratory assessment is scheduled, the assessor body shall notify the AEMCLAP Committee and the Committee shall arrange for artifacts to be sent to the laboratory with the intent that the artifacts be available in the laboratory prior to the scheduled assessment date.
- 3) The artifacts shall be used by the laboratory being assessed to demonstrate proficiency. During the assessment, the assessor shall evaluate the proficiency test sample setup and the initial data collection.
- 4) Test results in the format specified in the relevant appendices in this document shall be sent to the Accreditation Body
- 5) The Accreditation Body shall remove laboratory identification from the data, apply a unique identification code and forward the data to the AEMCLAP Committee for review. After review of the data and individual committee member evaluation by all three participants, the laboratory shall be identified by the Accreditation Body.
- 6) In addition, the Accreditation Body shall evaluate the data from the proficiency artifacts to ensure that their internal quality and consistency requirements are met.
- 7) Damage to test artifacts resulting from improper test procedure, negligence, shipping damage, etc. is the responsibility of the laboratory being accredited and the laboratory shall be liable for the cost of repair or replacement and calibration. Failure to comply with this requirement shall be reason to withhold recognition of the accreditation.
- 8) In the event that an artifact is not defined for a test, the artifact does not arrive at the laboratory in time for the assessment, or the artifact is obviously malfunctioning, the laboratory shall substitute an automotive component/module in the artifact's place to demonstrate proper set-up for that test method. The laboratory shall still perform the proficiency tests on the artifact defined in each respective appendix of this document.
- 9) Completion of the proficiency testing in a timely manner is critical to the operation of this program. Therefore, it is to be understood that a time limit on completion of proficiency testing using an artifact is set at three weeks after completion of the on-site assessment. If a laboratory does not complete the tests within the specified time or receive an extension from the AEMCLRP Committee and return the artifact as instructed, that the Accreditation Body shall withdraw accreditation, if issued, and terminate its accreditation process. The laboratory may reinitiate its request for accreditation.

V. RECOGNITION OF ACCREDITATION PROCESS

AEMCLRP Committee reserves the option of reviewing the data gathered as part of the laboratory assessment and proficiency testing. A member company of the Committee may choose to withhold their recognition of the accreditation of an EMC laboratory based on their analysis of the information gathered.

VI. AEMCLAP APPENDICES

APPENDIX A – REFERENCE DOCUMENTS

* Relevant document not directly referenced in this document

- CISPR 25 Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicles
- DaimlerChrysler Corp PF-9326
- DaimlerChrysler Corp LP-388C-32
- DaimlerChrysler Corp LP-388C-33
- DaimlerChrysler Corp LP-388C-34
- DaimlerChrysler Corp LP-388C-35
- DaimlerChrysler Corp LP-388C-41
- DaimlerChrysler Corp LP-388C-42
- DaimlerChrysler Corp LP-388C-65
- EN 45001 - September 1989
- *EN 45002 - June 1989
- *EN 45003 - March 1995
- *EN 45011 - June 1989
- *EN 45012 - June 1989
- *EN 45013 - June 1989
- *EN 45014 - June 1989
- Ford Motor Company ES-XW7T-1A278-AB
- GMW3097GS - General Motors EMC Worldwide Specification / Verification Sections
- GMW3100GS - General Motors EMC Worldwide Specification / Requirements Sections
- ISO/IEC 17025 – First Edition 1999
- *ISO Guide 43-1 - Second Edition
- *ISO Guide 43-2 - First Edition 1996
- ISO/IEC Guide 58 - First Edition 1993
- *ISO 7637-2 Road vehicles - Electrical interference by conduction and coupling - Part 2: Electrical transient conduction along supply lines only
- *ISO 7637-3 Road vehicles - Electrical interference by conduction and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V nominal supply voltage - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines
- ISO TR10605 Road vehicles - Electrical disturbances from electrostatic discharges
- ISO 11452-1: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 1: General and definitions
- ISO 11452-2: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 2: Off-vehicle radiation source
- ISO 11452-3: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 3: Transverse electromagnetic mode (TEM) method
- ISO 11452-4: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 4: Bulk current injection method (BCI)
- ISO 11452-5: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 5: Strip-line method
- ISO 11452-7: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 7: Direct radio frequency (RF) power injection
- NIS 81 Edition 1, May 1994: The Treatment of Uncertainty in EMC Measurements
- SAE J1113-1 (July 95): Electromagnetic Compatibility Measurement Procedures and Limits For Vehicle Components (Except Aircraft) (60 Hz to 18 GHz)
- SAE J1113-2 (Sep 96): Conducted Immunity, 30 Hz to 250 kHz-All Leads

- SAE J1113-3 (99): Conducted Immunity, 250 kHz to 500 MHz, Direct Injection of Radio Frequency (RF) Power.
- SAE J1113-4 (May 97): Immunity to Radiated Electromagnetic Fields – Bulk Current Injection (BCI) Method.
- SAE J1113-13 (Feb 95): Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Part 13 – Immunity to Electrostatic Discharge.
- SAE J1113-21 (Oct 94): Road Vehicles – Electrical Disturbances by Narrowband Radiated Electromagnetic Energy – Component Test Method – Part 21 – Absorber-Lined Chamber
- SAE J1113-24 (99): Electromagnetic Compatibility Measurement Procedure For Vehicle Components – Immunity to Radiated Electromagnetic Fields – Transverse Electromagnetic Mode (TEM) Method.
- SAE J1113-25 (Sep 96): Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Immunity to Radiated Electromagnetic Fields, 10 kHz to 500 MHz – Tri-plate Line Method.
- SAE J1113-27 (Feb 95): Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Immunity to Radiated Electromagnetic Fields – Reverberation Method.
- SAE J1113-41 (Jul 95): Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used on Board Vehicles.

APPENDIX B – DEFINITIONS AND ACRONYMS

B.1 Additional definitions

AEMCLAP: Automotive EMC Laboratory Accreditation Program – A2LA Accreditation program.

AEMCLRP: Automotive EMC Laboratory Recognition Program – Big-3 Recognition of A2LA laboratory accreditation.

Accreditation (of a laboratory): A formal determination by an accrediting body that a laboratory is competent to carry out specific tests or calibrations or types of tests or calibrations.

Accreditation Criteria: A set of requirements used by an accrediting body, which a laboratory must meet in order to be accredited.

Approved Signatory (of an accredited laboratory): An individual who is recognized by the Automotive EMC Lab Accreditation Program or the accrediting body as competent to sign accredited laboratory calibration or test reports.

Assessment (of a laboratory): The on-site examination of a testing or calibration laboratory to evaluate its compliance with the conditions and criteria for accreditation.

Authorized Representative (of an accredited laboratory): An individual who is authorized by the laboratory or the parent organization to sign the Automotive EMC Lab Accreditation Program or the other accrediting body application form and commit the laboratory to fulfill the accrediting body requirements. (The Authorized Representative may also be recommended by the laboratory as an Approved Signatory.)

Calibration: A set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or system or values represented by a material measure, and the corresponding known values of a measurand.

Calibration report (or certificate): Document that presents calibration results and other information (repairs or adjustments made, as-found accuracy, as-left accuracy) relevant to a calibration.

Calibration method: A defined technical procedure for performing a calibration.

Certificate of Accreditation: A document issued by the accreditation body to a laboratory that has met the criteria and condition for accreditation. The Certificate of Accreditation may be used as proof of accredited status when accompanied by relevant Scope(s) of Accreditation document(s).

Client: Any person or organization that engages the services of a testing or calibration laboratory.

Competence: The ability of a laboratory to meet the Automotive EMC Lab Accreditation Program or the other accredited bodies conditions and to conform to the criteria in their publications for specific calibration and test methods.

Configuration Control List: The list of test equipment uniquely identified (e.g., by model and serial number), including cables, software and calibration/correlation data associated with a specific test stand.

Continuing Compliance: Non assessor witnessed periodic testing using specified test artifacts to demonstrate on-going proficiency.

DUT. Device under test.

Laboratory: An organization that performs calibrations and/or tests. When a laboratory is part of an organization that carries out activities additional to calibration and testing, the term "laboratory" refers only to those parts of that organization that are involved in the calibration and testing process. The laboratory activities may be carried out at or from a permanent location, at or from a temporary facility, or in or from a mobile facility.

Performance Deviation: Performance of the device under test that deviates from normal operation.

Recognition (of a laboratory): Affirmation from individual members of the AEMCLRP Committee that a laboratory has been accredited to ISO/IEC Guide 25 (or ISO/IEC 17025) and has met their respective proficiency requirements.

Sampling or statistical assessment: The assessment of some but not all of the procedures listed in the scope of accreditation as a means of inferring overall competency.

Sub-facility: A laboratory operating under the technical direction and quality system of a main facility that is accredited.

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure.

Test method: A defined technical procedure for performing a test.

Uncertainty of measurement: Parameter, associated with the result of a measurement, which characterizes the dispersion of the values that could reasonably be attributed to the measurand.

Uncertainty, Type A (evaluation of): Method of evaluation of uncertainty by the statistical analysis of series of observations.

Uncertainty, Type B (evaluation of): Method of evaluation of uncertainty by means other than the statistical analysis of series of observations.

B.2 Acronyms

Relevant information but not directly referenced in this document

| | |
|---------|---|
| A2LA | American Association for Laboratory Accreditation |
| AEMCLAP | Automotive EMC Laboratory Accreditation Program |
| AEMCLRP | Automotive EMC Laboratory Recognition Program |

| | |
|-------|--|
| BIPM | International Bureau of Weights and Measures |
| CASCO | ISO Council Committee for Conformity Assessment |
| CISPR | International Special Committee on Radio Interference |
| EN | European Norm |
| FCC | Federal Communications Commission (USA) |
| IEC | International Electrotechnical Commission |
| ISO | the International Organization for Standardization |
| NIST | National Institute of Standards and Technology |
| NVLAP | National Voluntary Laboratory Accreditation Program |
| SAE | Society of Automotive Engineers |
| SI | System International |
| VIM | International vocabulary of basic and general terms in metrology |
| WG | Working Group |

APPENDIX C - ASSESSMENT FOR GENERAL LAB REQUIREMENTS

GENERAL OPERATIONS CHECKLIST – A2LA General Criteria Assessor Checklist substituted in place of requirements of Appendix C.

APPENDIX D - ASSESSMENT FOR "DIRECT INJECTION" TEST PROCEDURE

Appendix modified Feb 21, 2000

Reference document(s): SAE J1113-3 (1999-XX): Conducted Immunity, 0.25 MHz to 500 MHz, Direct Injection of Radio Frequency (RF) Power [ISO 11452-7 is under revision. The proposed text is harmonized with SAE J1113-3.]

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods, a sketch showing the test set-up and the Configuration Control List for the test stand,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in Section 3, Proficiency Testing using a suitable DUT,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, or frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

The following requirements are in the form of positive requirement statements. A check mark may be used to signify compliance with the requirement and "NC" to signify non-compliance. All non-compliant conditions require explanation, if accreditation is granted.

NOTE: If a test facility has more than one test set-up for this test, each test set-up shall be evaluated separately.

An "*" before the requirement indicates probable significant impact on the test uncertainty.

A. Test setup

- _____ 1. The lab has a copy of the specified version of the standard.
- _____ 2. *The equipment, software (with revision level) and calibration/correlation date used in the test stand matches the data listed in the Configuration Control List.
- _____ 3. The ambient temperature is maintained between 18 and 28 degrees C.
- _____ 4. The supply voltage to the system under test is monitored and maintained between 13.0 and 14.0 volts for a nominal 12 volt system; between 26 and 28 volts for a nominal 24 volt system.
- _____ 5. The frequency range of the test signal is maintained between 0.25 MHz and 500 MHz.
- _____ 6. The test stand is capable of producing unmodulated (CW) radio frequency energy.

- _____ 7. The test stand is capable of producing 80 % amplitude modulation (AM) radio frequency energy with a modulating frequency of 1 kHz.
- _____ 8. *The dwell time is controllable and the dwell time is always 2 seconds or greater.
- _____ 9. *If used, the maximum linear frequency step sizes are in accordance with Table 3 of SAE J1113-1.
NOTE- SAE has decided that logarithmic frequency steps are preferable to linear steps.

Excerpt from SAE J1113-1 Table 3 - Frequency steps

| Frequency Band | Maximum frequency step size |
|--------------------|-----------------------------|
| 250 kHz to 1 MHz | 100 kHz |
| 1 MHz to 10 MHz | 1 MHz |
| 10 MHz to 200 MHz | 2 MHz |
| 200 MHz to 500 MHz | 20 MHz |

- _____ 10. *If logarithmic frequency steps are used, the number of frequencies in each band are the same or greater than the minimum number of steps of Table 3. Values, as agreed by the users of the standard, are documented in the test report.
- _____ 11. *The test set-up configuration conforms to Figure 1 of SAE J1113-3.
- _____ 12. *The leads from the BANs to the DUT are 150 mm maximum in length with lengths over 120 mm avoided.
- _____ 13. *The exposed center conductor lead, when used, (for connection to the DUT lead) is 50 mm or less in length.
- _____ 14. *All test equipment is within its required calibration or verification period.
- _____ 15. *A DC blocking capacitor is used. Its impedance is less than 5 Ohms over the frequency range required for the test and it is properly included in the test set-up when determining the power to be applied to the test set-up.
- _____ 16. *An attenuator is used in the test set-up (Item 6 of Figure 1 of SAE J1113-3) and it is properly included in the test set-up when determining the power to be applied to the test set-up.
- _____ 17. *An RF sampling device is used in the test set-up (Item 4 of Figure 1 of SAE J1113-3) and it is properly included in the test set-up when determining the power to be applied to the test set-up.
- _____ 18. *The impedance and through loss of the BAN(s) used in the test set-up meets the requirements of the following table (extracted from SAE J1113-3). If not, the impedance characteristics are defined in the test plan and included in the test report.

Current capacity up to 8 Amperes:

Series Impedance

| | |
|----------------------|--------------|
| 0.25 MHz to 0.50 MHz | 200 Ohms min |
| 0.50 MHz to 250 MHz | 500 Ohms min |
| 250 MHz to 500 MHz | 200 Ohms min |

Through Loss

| | |
|---------------------|-----------|
| 0.25 MHz to 1.0 MHz | 20 dB min |
| 1.0 MHz to 500 MHz | 35 dB min |

Current capacity greater than 8 amperes up to 30 Amperes:

| | |
|----------------------|--------------|
| Series Impedance | |
| 0.25 MHz to 0.50 MHz | 50 Ohms min |
| 0.50 MHz to 1.0 MHz | 100 Ohms min |
| 1.0 MHz to 2.0 MHz | 200 Ohms min |
| 2.0 MHz to 150 MHz | 400 Ohms min |
| 150 MHz to 500 MHz | 100 Ohms min |
| 250 MHz to 500 MHz | 100 Ohms min |

| | |
|---------------------|-----------|
| Through Loss | |
| 0.25 MHz to 500 MHz | 20 dB min |

_____ 19. *The ground plane is made of copper, brass or galvanized steel. It meets the minimum size requirement of SAE J1113-1.

_____ 20. *All of the BANs are bonded to the test stand ground plane with a resistance of less than 0.1 Ω .

B. Test Procedure

_____ 1. *The laboratory procedures require that a test plan be generated to define the test. Sufficient information is required to adequately define the test:

Frequency range
 Modulation
 Test level
 Log or linear frequency steps
 Frequency step sizes
 Supply voltage, if different from default
 Test temperature, if different from default
 Dwell time, if different from default
 Interface test points
 DUT mode of operation
 DUT acceptance criteria
 Special instructions
 Changes from standard test

_____ 2. *The dwell time used during testing is sufficient for "control of the DUT." Explain how "sufficient" is determined.

_____ 3. *The test stand reference level is measured and recorded relative to Watts into the power meter after the 10 dB attenuator and the DC blocking capacitor.

_____ 4. *The test stand reference level is verified prior to test after set-up and at least once a day in accordance with 6.2a of SAE J1113-3

_____ 5. Explain and demonstrate how to establish "80 percent constant peak" amplitude modulation

C. DaimlerChrysler Corp Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326, LP-388C-35 and LP-388C-65

_____ 2. The laboratory technical manager understands that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler EMC engineer (or other DaimlerChrysler authorized person) before a test is begun

- _____ 3. Demonstrate the capability to test using the DaimlerChrysler test frequencies defined in PF-9326
- _____ 4. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65.
- _____ 5. The dwell time shall be sufficient to exercise the DUT, but shall be 3 seconds minimum.
- _____ 6. Requirement B.4 above shall be interpreted to be at least once each the test is used.
- _____ 7. The alternate test clip method of J1113-3 paragraph 5.3 for connecting to the BAN is not acceptable for DaimlerChrysler Corporation tests.
- _____ 8. Test levels are recorded in milliwatts.
- _____ 9. The standard blocking capacitor and BAN(s) are used except when testing data bus leads and then shall be in compliance with LP-388C-35.
- _____ 10. The power meter is zeroed/self calibrated before beginning a test.
- _____ 11. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

3. Proficiency Testing

A. Test Artifact and Verification Procedure

The calibrated power meter used in the test stand is the test artifact.

B. Repeatability

To demonstrate the stability of the test stand, the power transfer function of 6.2.a of SAE J1113-3 shall be recorded each time the test reference level is determined or verified. A minimum of 12 data points are required for review prior to an accreditation assessment. Any significant deviations in the power transfer function data require explanation.

C. Correlation

The users of this document reserve the option to perform correlation tests in their own or a designated laboratory on product that has been tested by an accredited laboratory.

D. Reporting of Results

See 3.B above.

E. Performance History

See 3.B above.

APPENDIX E - ASSESSMENT FOR “BULK CURRENT INJECTION” TEST PROCEDURE

General Reference document(s):

- ISO 11452-4: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - component test methods - Part 4: Bulk current injection method (BCI)
- SAE J1113-4 - Immunity to radiated electromagnetic fields - Bulk current injection (BCI) method

GM Reference document(s):

- GMW3100GS Section 3.2.2 - Bulk current injection (Verification section)
- GMW3097GS Section 3.2.2 - Bulk current injection (Requirement section)

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

A. Generic Standard

Generic Test Setup: Consult SAE J1113-4 - Immunity to radiated electromagnetic fields - Bulk current injection (BCI) method

- 1 Test shall be performed in a shielded environment.
- 2 The negative lead of the battery feeding the DUT harness shall be electrically connected the ground plane.
- 3 The wiring harness shall be maintained (50 +/- 5) mm above the ground plane measured from the bottom of the wire bundle.
- 4 The wiring harness shall be centered in both the monitoring and injection probes.

- 5 _____ The DUT shall be at least 500 mm from the wall.
- 6 _____ The monitor probe shall be located (50 +/- 5) mm from the outermost edge of the DUT connector measured from the center of the probe. If possible, any wiring fan-out from the DUT connector should occur within the 50 mm adjacent to the DUT and not inside the probe.
- 7 _____ The injection probe shall be positioned (120 +/- 5) mm from the outermost edge of the DUT connector measured from the center of the probe. The test shall be repeated with injection probe located at (450 +/- 5) mm and (750 +/- 5) mm from the connector.
- 8 _____ The RF signal generator shall have a rated frequency range of 1 to 400 MHz minimum.
- 9 _____ The broadband power amplifier shall have a rated frequency range of 1 to 400 MHz minimum.
- 10 _____ The injection probe shall have a rated frequency range of 1 to 400 MHz minimum and a minimum power rating of 50 W.
- 11 _____ The monitor probe shall have a rated frequency range of 1 to 400 MHz minimum.
- 12 _____ The spectrum analyzer shall have a rated frequency range of 1 to 400 MHz minimum.
- 13 _____ Directional couplers/RF sampling devices shall have a rated frequency range of 1 to 400 MHz minimum.
- 14 _____ The DUT harness shall be at least 200 mm from the edges of the ground plane.
- 15 _____ Transfer impedance of the monitoring probe shall be available for inspection
- 16 _____ Remote monitoring capabilities that do not impose a load on the monitored device shall be used (i.e., fiber optic signal monitoring, visual, audio)
- 17 _____ The equipment used to monitor DUT functions shall not be susceptible to RF to the extent of not allowing proper determination of performance anomalies or deviations.

Generic Test Procedures: Consult SAE J1113-4 - Immunity to radiated electromagnetic fields - Bulk current injection (BCI) method

- 1 _____ Test procedures shall comply with general specifications in SAE J1113-4
- 2 _____ Equipment used for a particular test shall be traceable (i.e., Test reports or other documentation shall contain a list of equipment, serial numbers, etc., that associates equipment to a particular test in the event that test(s) need to be repeated)

B. GM Specific Requirements

GM Specific Test Setup Requirements

- 1 _____ The battery supply voltage shall be (13.5 +/- 0.1) V.
- 2 _____ If the outer case of the DUT is to be grounded when in the vehicle, it must be mounted and making connection to the ground plane during BCI testing. If not, the DUT shall be placed on an insulated support such that the bottom of its harness connector is positioned (50 +/- 5) mm above the ground plane. If this is not physically possible, the DUT position/orientation shall be documented in the test report.

- 3 _____ Both the injection and monitor probes shall be insulated from the ground plane.
- 4 _____ The ground plane shall be bonded to the chamber wall with bonding points no greater than 0.9 meter apart.
- 5 _____ LISNs shall not be used to isolate battery and harness/DUT.
- 6 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a one meter harness shall be used instead.

GM Specific Test Procedure Requirements

- 1 _____ RF injection at any given frequency shall stop if any of the following criteria (stop criteria) are met:
 - The maximum induced current level reaches 40 dBmA (unless otherwise specified in the test plan)
 - The forward output power of the amplifier reaches 47 +/- 0.5 dBm.
 - Any harmonic (up to and including the fifth) of the monitored current is within 9 dB of the fundamental test frequency current
- 2 _____ When measuring induced currents, the transfer impedance curve of the monitoring probe shall be applied to the fundamental and all its harmonic components.
- 3 _____ Testing shall be performed with RF On-Off, RF Off-On transitions as well as CW.
- 4 _____ Determination of deviation (anomaly) thresholds shall be accomplished as follows:
 - A. RF level shall be lowered until the anomaly, or deviation, disappears,
 - B. RF level shall be incremented until the anomaly, or deviation, reappears.

This last level is defined as the anomaly (or deviation) threshold.
- 5 _____ At any injection probe position, a resonant frequency is defined as a frequency at which the maximum required test current of 100 mA can not be achieved. At resonance, the decision of whether to record an anomaly or not, requires comparison of DUT test results from using all three injection probe positions. A deviation or performance anomaly that occurs at a resonant frequency shall be treated as follows:
 - The deviation or performance anomaly shall be **RECORDED** if at **ALL** injection probe positions and at the same resonant frequency, the maximum required test current of 100 mA **CANNOT** be achieved,
 - The deviation or performance anomaly shall be **DISREGARDED** if at any injection probe position and at the same resonant frequency, the maximum required test current of 100 mA **CAN** be achieved.
- 6 _____ Data shall be reported in dBmA.

C. Ford Specific Requirements

- 1 _____ The laboratory has the latest version copies of Ford specification ES-XW7T-1A278-AB
- 2 _____ The laboratory technical manager understands that Ford requires that a test plan be approved and signed off by a Ford EMC engineer and EMC technical specialist before a test is begun. Failure to do so will invalidate the test results.

D. General Items

- 1 _____ Laboratory shall have an up to date copy of the referenced standard(s).
- 2 _____ Automated test software, if used, shall be under change control and verified at a minimum of once per year.
- 3 _____ All equipment shall be in current calibration.
- 4 _____ Equipment that requires no calibration but is used in the normal course of testing shall be periodically verified for proper functionality. Records of this verification shall be available for inspection.
- 5 _____ Objective evidence of training of test personnel shall be available for inspection.

3. Proficiency Testing (Refer to attached diagram and pictures for typical test setup)

A. Test Artifact and Verification Procedure:

Artifact and hardware Setup:

- Verification Test Artifact (Including 1 m Harness)
- Test and setup instructions

Test Setup

- Verification test artifact should be grounded to the test bench ground plane.
- Attach battery to Verification Test Fixture. Verify battery voltage is 12.7 V or greater,
- **Monitor differentially the sensor output signal at the BNC jack labeled "ANALOG Vout". Signal return of Analog Output Terminal should not be connected to chamber ground.**
- Install injection/monitor probes on the test artifact,
- Turn switch to "ON". Wait 30 minutes for DUT to arrive at normal operating temperature.
- After 30 minutes, use an adjustment tool to adjust the DUT's Analog Voltage Output to read $2.54 \pm .005$ Volts,
- Proceed with proficiency test.

Deviation Definition:

- A deviation or performance anomaly is defined as a ± 100 mV change from the nominal output voltage.

Test Parameters:

- Test Frequencies: The BCI proficiency test shall be performed at the following test frequencies:

Frequency Range: 1 MHz – 30 MHz (35 frequencies)

Step Size: 7 Steps per Octave as calculated using the following equation:

$$f_{\text{injection}} = f_{\text{initial}} \times 2^{(k / \text{number_of_steps_per_octave})}$$

Where $f_{\text{injection}}$ is the frequency to inject,
 f_{initial} is the start frequency (e.g., 1.00 MHz)
 k is the index number of the injection frequency (i.e., 0, 1, 2, ...)

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 1.000 | 1.104 | 1.219 | 1.346 | 1.486 | 1.641 | 1.811 | 2.000 |
| 2.208 | 2.438 | 2.692 | 2.972 | 3.281 | 3.623 | 4.000 | 4.416 |
| 4.876 | 5.384 | 5.944 | 6.563 | 7.246 | 8.000 | 8.833 | 9.752 |
| 10.77 | 11.89 | 13.13 | 14.49 | 16.00 | 17.67 | 19.50 | 21.53 |
| 23.78 | 26.25 | 28.98 | | | | | |

Frequency Range: 30 MHz – 400 MHz (94 Frequencies)

Step Size: 25 Steps per Octave

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 30.00 | 30.84 | 31.71 | 32.60 | 33.52 | 34.46 | 35.43 | 36.43 |
| 37.45 | 38.50 | 39.59 | 40.70 | 41.84 | 43.02 | 44.23 | 45.47 |
| 46.75 | 48.06 | 49.42 | 50.80 | 52.23 | 53.70 | 55.21 | 56.76 |
| 58.36 | 60.00 | 61.69 | 63.42 | 65.20 | 67.04 | 68.92 | 70.86 |
| 72.85 | 74.90 | 77.01 | 79.17 | 81.40 | 83.68 | 86.04 | 88.46 |
| 90.94 | 93.50 | 96.13 | 98.83 | 101.6 | 104.5 | 107.4 | 110.4 |
| 113.5 | 116.7 | 120.0 | 123.4 | 126.8 | 130.4 | 134.1 | 137.8 |
| 141.7 | 145.7 | 149.8 | 154.0 | 158.3 | 162.8 | 167.4 | 172.1 |
| 176.9 | 181.9 | 187.0 | 192.3 | 197.7 | 203.2 | 208.9 | 214.8 |
| 220.8 | 227.1 | 233.4 | 240.0 | 246.7 | 253.7 | 260.8 | 268.1 |
| 275.7 | 283.4 | 291.4 | 299.6 | 308.0 | 316.7 | 325.6 | 334.7 |
| 344.1 | 353.8 | 363.8 | 374.0 | 384.5 | 395.3 | | |

- Maximum Injected Current: 40 dBmA (100 mA)

Verification Instructions:

- BCI testing shall be performed using the standard GM injection probe positions (i.e., 12, 45, and 75 cm). Each 'test' is composed of evaluation at these three positions.
- Fixture shall be tested three (3) times (each including runs at injection probe positions of 12, 45 and 75 cm).
- Between each test, the test setup shall be dismantled and re-assembled.
- The same test operator shall perform all three tests.
- For each test frequency and probe position the anomaly threshold shall be documented.

B. Repeatability:

The deviation profile from test runs performed at a specific injection probe location shall conform to the following:

The differences in the deviation profiles of the three test runs (at a particular injection probe position) shall be within 6 dB of separation over 90% of the frequencies tested.

C. Correlation: (Correlation to results obtained at REFERENCE LABORATORY). . NOTE: These are the tests that are performed to determine correlation to the REFERENCE LABORATORY and are provided here for information purposes to laboratories seeking accreditation/recognition.

Test 1: The average difference in the deviation or performance anomaly profiles of the three test runs (at a particular probe position) shall comply with the following expression:

$$\frac{\sum \sqrt{(P_i - P_{ri})^2}}{n} \leq 20 \text{ mA} \quad \text{Expression E.1}$$

Where P_i is the AVERAGE anomaly threshold, in units of mA, at frequency f_i obtained over three runs at a particular injection probe location,
 P_{ri} is the anomaly threshold, in units of mA, at frequency f_i of the REFERENCE curve,
 n is the number of frequencies tested.

Please note that for Test 1, averaging must be performed on absolute units of current (i.e., mA), and not on logarithmic units (i.e., dBmA).

Test 2: The difference in the deviation or performance anomaly profiles of each of the three test runs (at a particular probe position) shall comply with the following expression:

$$\left| \sum_{i=1}^n (R_i - P_i - \gamma) - \sum_{i=1}^n (R_i - P_{ri}) \right| \leq 20 \quad \text{Expression E.2}$$

Where $|\gamma| \leq 5$

Where P_i is the anomaly threshold, in units of dBmA, at frequency f_i obtained over three runs at a particular injection probe location obtained at laboratory being assessed,
 P_{ri} is the AVERAGE anomaly threshold, in units of dBmA, at frequency f_i obtained over three runs at a particular injection probe location obtained at REFERENCE laboratory,
 R_i is the Level 2 Requirement, in units of dBmA, at frequency f_i (Refer to GMW3097GS for Bulk Current Injection performance requirement levels)
 n is the number of frequencies tested.
 $|\gamma|$ is the minimum offset value that satisfies Expression E.2.

Please note that for Test 2, calculations must be performed on logarithmic units (i.e., dBmA), and not on absolute units (i.e., mA)

D. Reporting of results:

- Reports shall be in ASCII, comma delimited, and shall contain at a minimum: the injection probe location in cm; frequencies of injection in MHz; and anomaly thresholds in dBmA.
- Data shall be submitted in the following form:

Line 1: Lab/Test information - Discretionary
 Line 2: Lab/Test information - Discretionary
 Line 3: Lab/Test information - Discretionary
 Line 4: Lab/Test information - Discretionary
 Line 5: Injection probe location - Required
 Line 6: Frequency 1 (MHz), Anomaly threshold 1 (dBmA), Signal Generator Output Power (dBm), Amplifier Output Power (dBm) - Required
 Line 7: Frequency 2 (MHz), Anomaly threshold 2 (dBmA), Signal Generator Output Power (dBm), Amplifier Output Power (dBm) - Required

....
....
....

Line n: Frequency n (MHz), Anomaly threshold n (dBm), Signal Generator Output Power (dBm), Amplifier Output Power (dBm) - Required

Example of data file content:

General Motors EMC Department – Milford Proving Grounds

Test Number: MC9999

Test Date: 4/1/1998

Test on BCI Verification Source – Run #3

Probe located at the 45 cm mark

1.000,43.5,23.4,34.4

1.104,47.0,34.2,45.3

....

....

....

395.0,12.0,23.1,32.5

- Three data sets, each containing 12 cm, 45 cm and 75 cm test results shall be submitted. Based on these results, compliance to the Repeatability and Correlation requirements will be determined by comparison to data obtained at the GM Reference Laboratory.

E. Performance History:

Objective evidence of site performance verifications shall be available for inspection. The objective of this requirement is to demonstrate reproducibility of the test setup over time. Example, such performance verifications may be performed by testing a stable device and comparing results obtained over time.

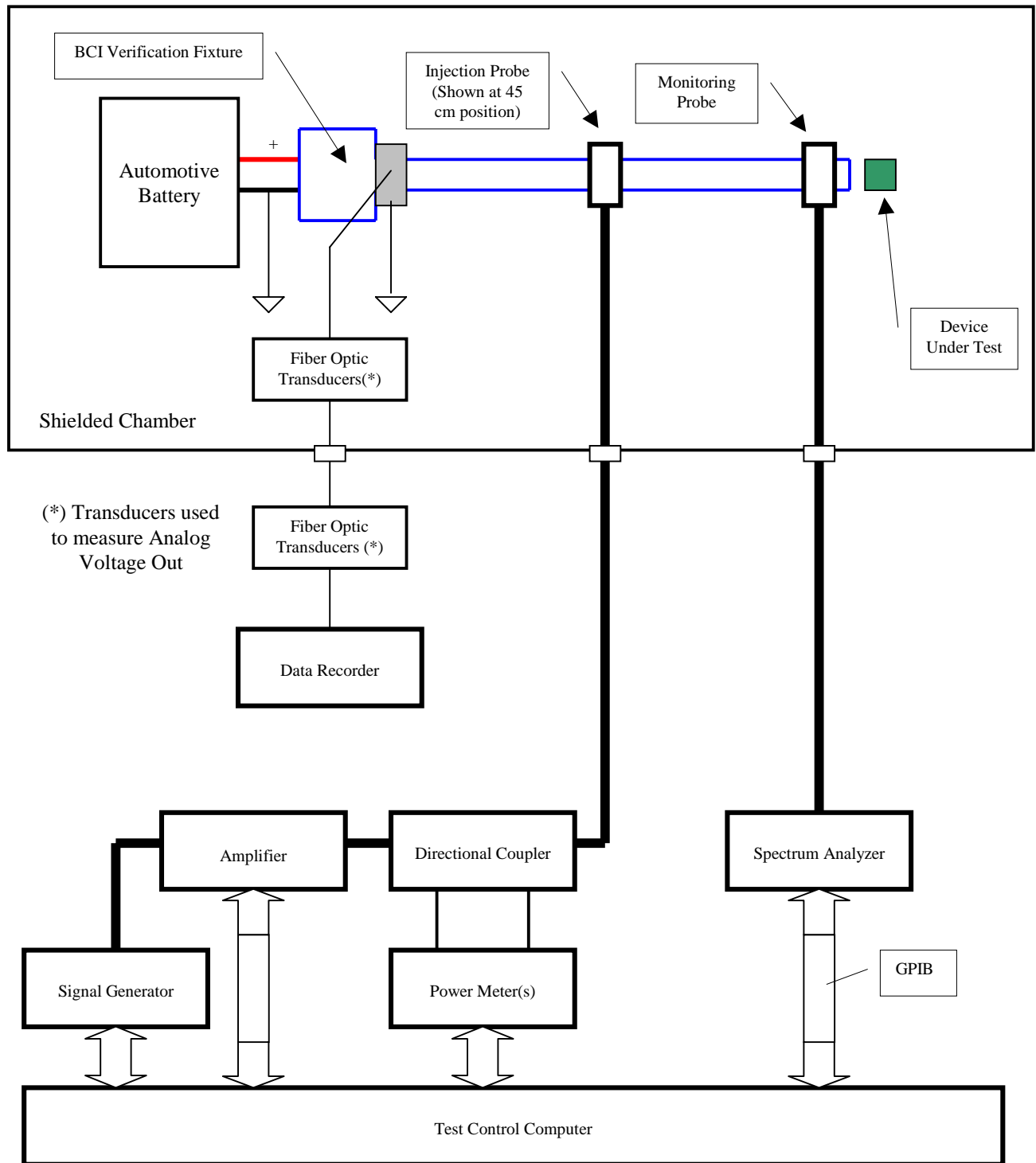
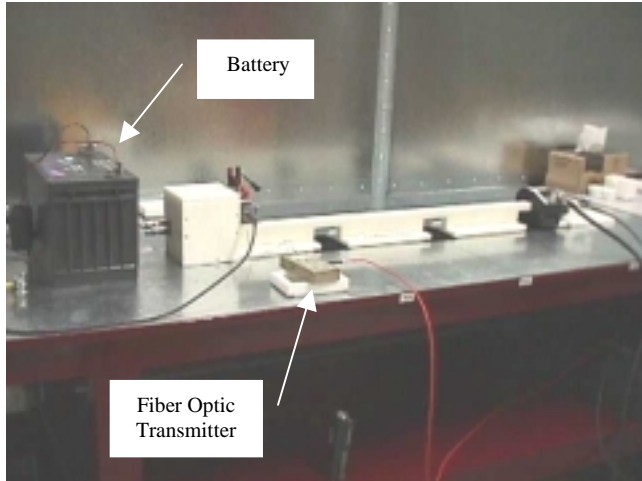
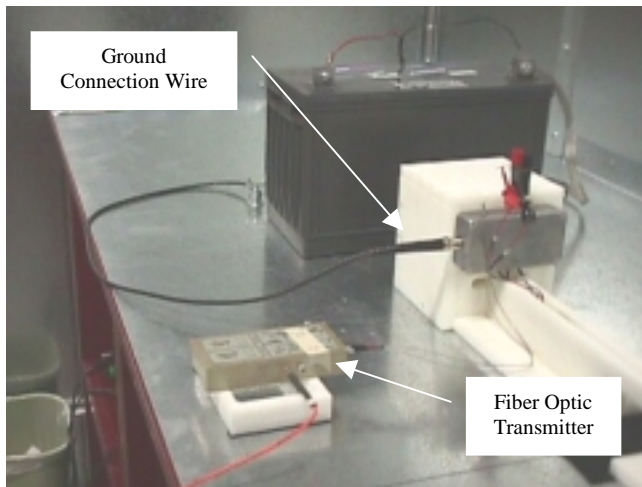


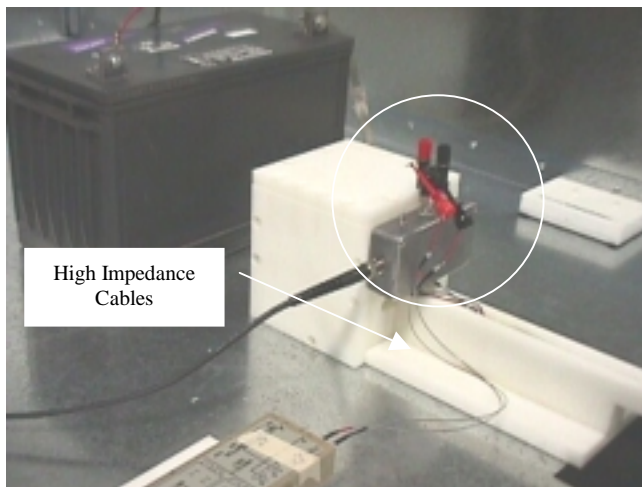
Diagram E.1 - Typical BCI Setup Diagram For Testing BCI Verification Fixture



Picture E.1: Typical BCI Verification Fixture setup at the GM Laboratory. Note that the BCI Verification Fixture is powered by a battery.

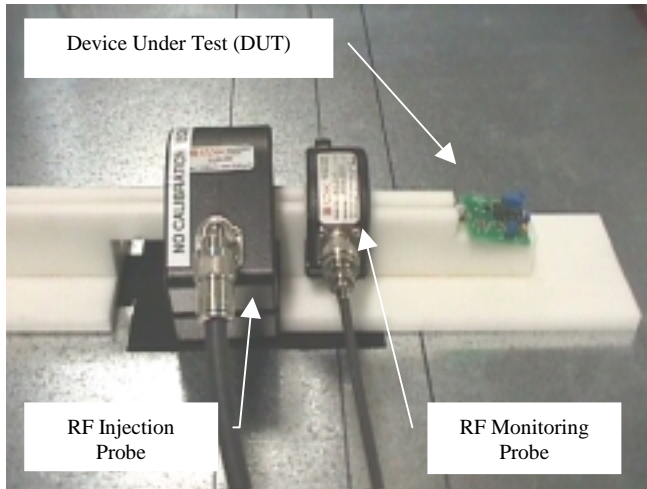


Picture E.2: Close up of ground connection to Verification Fixture.

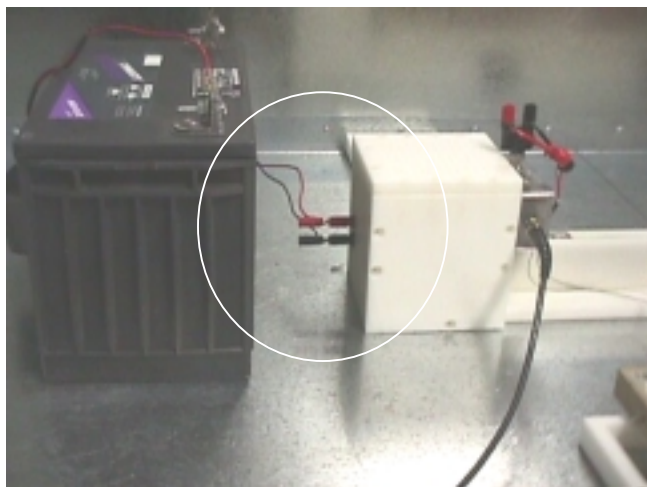


Picture E.3: Close up of voltage monitoring leads connected to the ANALOG VOUT terminal of the BCI Verification Test Fixture.

At the GM Laboratory, analog voltages are monitored via high impedance cables attached to fiber optic transducers. High impedance cables and clips shown.

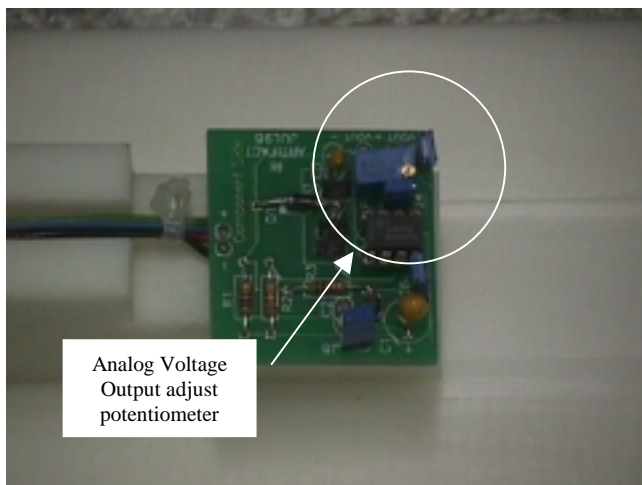


Picture E.4: Close up of monitoring and injection probe installation. Injection probe is shown attached to the 12 cm (120 mm) position.



Picture E.5: Details of battery connection to BCI Verification Fixture. Simple banana plugs are used to supply battery power to fixture.

Note: Fixture is reverse voltage protected.



Picture E.6: Close up of device under test (DUT). Please note the location of the analog voltage output adjustment potentiometer. This adjustment is used to set the Analog Voltage Output to 2.54 Volts.

APPENDIX F - ASSESSMENT FOR “ELECTROSTATIC DISCHARGE” TEST PROCEDURE

General Reference document(s):

- SAE J1113-13 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components - Part 13 - Immunity To Electrostatic Discharge

DaimlerChrysler Reference documents:

- DaimlerChrysler Corp documents: PF-9326, LP-388C-42, and LP-388C-65

GM Reference documents:

- GMW3100GS Section 3.4 - Electrostatic Discharge (Verification Section)
- GMW3097GS Section 3.4 - Electrostatic Discharge (Requirement Section)

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

A. Generic Standard

Generic Test Setup: Consult SAE J1113-13 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components- Part 13 - Immunity To Electrostatic Discharge.

- 1 _____ The ESD simulator shall comply with the specifications listed in SAE J1113-13 (ISO TR 10605) for simulating a person both inside and outside of the vehicle.

- 2 _____ The ground plane shall be connected to facility earth ground by a ground strap.
- 3 _____ The ESD simulator high voltage ground shall be connected to the ground plane (if used) or to earth ground.

Generic Test Procedures: Consult SAE J1113-13 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components- Part 13 – Immunity To Electrostatic Discharge.

B. GM Specific Requirements

GM Specific Test Setup Requirements

- 1 _____ The surface area of the ground plane shall be a minimum of 1 m².
- 2 _____ The ground plane shall project beyond the DUT by at least 100 mm on all sides.
- 3 _____ During testing, the test environment temperature shall be maintained between 20-26 °C.
- 4 _____ During testing, the test environment relative humidity shall be maintained between 20-40%.

GM Specific Test Procedure Requirements

- 1 _____ Each discharge point shall be subjected to a series of ten discharges at each voltage level at both positive and negative polarity.
- 2 _____ Intended operation of DUT functionality shall be verified after each series of ten discharges. After discharging to all the points of the DUT at one of the specified positive and negative voltage levels, the DUT shall meet all applicable functional tests (After each positive or after each negative voltage level).
- 3 _____ For DUT points accessible to a person standing outside of a vehicle, air discharges shall also be applied using a 150 pF simulator probe.

C. DaimlerChrysler Corp Specific Requirements

- 1 _____ The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326, LP-388C-42, and LP-388C-65
- 2 _____ The laboratory technical manager understand that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler EMC engineer (or other DaimlerChrysler authorized person) before a test is begun
- 3 _____ Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65

D. Ford Specific Requirements

- 1 _____ The lab has the latest version copies of Ford specification ES-XW7T-1A278-AB
- 2 _____ Include discharge network with magnetic loop (Key Tek CIA-20 Current Injector and FT-12 Loop – or equivalent)
- 3 _____ The laboratory technical manager understand that Ford requires that a test plan be approved and signed off by a Ford EMC engineer and EMC technical specialist before a test is begun. Failure to do so will invalidate the test results.

E. General Items

- 1 _____ Laboratory shall have an up to date copy of the referenced standard(s).
- 2 _____ Automated test software, if used, shall be under change control and verified at a minimum of once per year.
- 3 _____ All equipment shall be in current calibration.
- 4 _____ Equipment that requires no calibration but is used in the normal course of testing shall be periodically verified for proper functionality. Records of this verification shall be available for inspection.
- 5 _____ Objective evidence of training of test personnel shall be available for inspection.

3. Proficiency Testing

- A. Test Artifact And Verification Procedure: Not Required.**
- B. Repeatability: Not Required.**
- C. Correlation: Not Required.**
- D. Reporting of results: Not Required.**
- E. Performance History:**

Objective evidence of ESD gun (ESD Simulator) performance verifications shall be accumulated for a minimum period of 4 weeks prior to audit and shall be available for inspection. The discharge profiles must show no significant degradation over this period of time.

APPENDIX G - ASSESSMENT FOR “ABSORPTION CHAMBER” TEST PROCEDURE

SAE J1113-21: Road Vehicles - Electrical Disturbances By Narrowband Radiated Electromagnetic Energy - Component Test Method - Part 21- Absorber-Lined Chamber.

The laboratory shall specify the methods of test to be assessed.

- Substitution method (required by DCC)
- Closed loop method
- Metallic table
- Nonmetallic table (required by DCC)
- Nonmetallic table with metallic surface
- Frequency range

Modulation

- Unmodulated (CW)
- Amplitude modulation
- Other

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods, a sketch showing the test set-up and the Configuration Control List for the test stand,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

The following requirements are in the form of positive requirement statements. A check mark may be used to signify compliance with the requirement and "NC" to signify non-compliance. All non-compliant conditions require explanation, if accreditation is granted.

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

An “*” before the question indicates probable significant impact on test uncertainty.

A. Test setup

- 1. The lab has a copy of the referenced version of the standard.

- _____ 2. * The equipment used in the test set-up matches the equipment listed in the Configuration Control List or equivalent list.
- _____ 3. * The Artificial Network(s) used meets the defined impedance requirements.
- _____ 4. * All of the following equipment are in calibration or verification:
- Power meter(s)
 - Field strength probe(s)
 - Directional coupler(s)
 - Signal generator(s)
 - Artificial network(s)
- _____ 5. The ambient temperature is maintained between 18 and 28 degrees C.
- _____ 6. * The test frequency range of the test chamber is within the standard's range of 200 MHz to 18 GHz.
- _____ 7. The test stand is capable of producing unmodulated (CW) radio frequency energy.
- _____ 8. The test stand is capable of producing 80 % amplitude modulation (AM) radio frequency energy with a modulating frequency of 1 kHz.
- _____ 9. * The dwell time is controllable and the dwell time is always 2 sec or greater.
- _____ 10. * Referring to Figure 2 of SAE 1113-21, items 1 through 6 are present in the test stand and are appropriate for the frequency range being tested and the power level used for the test.
- _____ 11. * Radiation from external components (and harnesses) is adequately controlled.
- _____ 12. * Net power is used to control the test level.
- _____ 13. * The DUT is monitored via (fiber) optic links or high resistance leads?
- _____ 14. * The test is performed in an absorber lined shielded enclosure.
- _____ 15. * The chamber meets the design objective of -10 dB (or less) reflectivity in the test area.
- _____ 16. * The field generating device is capable of fields with the polarity defined in the test region.
- _____ 17. * The field probes are isotropic.
- _____ 18. * The field probes are coupled by high resistance or fiber optic links.
- _____ 19. * The test bench height is 900 mm \pm 10%.
- _____ 20. * The test harness segment parallel to the front of the test bench is 1500 \pm 75 mm long.
- _____ 21. The length of test harness from the front segment to the DUT to the ANs is 100 \pm 10 mm.
- _____ 22. * The test harness is located 100 mm min from the front edge of the test bench.
- _____ 23. * The test harness is located 50 +10-0 mm above the test bench.
- _____ 24. The test harness is located a minimum of 500 mm from any absorber material.

- _____ 25. The test harness is located a minimum of 900 mm from the shielded enclosure wall behind the harness.
- _____ 26. * The antenna is located 1000 ± 10 mm from the test harness.
- _____ 27. * The closest element of the antenna is a minimum of 500 mm from any wall or ceiling absorber material.
- _____ 28. * The closest element of the antenna is a minimum of 250 mm from the floor; a minimum of 1500 mm from the walls or ceiling of the shielded chamber.
- _____ 29. * The center of the antenna is 1000 ± 10 mm from the floor.
- _____ 30. * The closest antenna element is a minimum of 500 mm from the front edge of the test bench.
- _____ 31. * The coaxial cable to the antenna is fed through a bulkhead connector to maintain shielding integrity.
- _____ 32. * Double shielded (or solid shielded) coaxial cable is used.
- _____ 33. * The ground plane (when used) meets the thickness requirement of 0.5 mm minimum thickness and the material requirement of copper, brass or galvanized steel metal.
- _____ 34. * The ground plane (when used) meets the requirement of 2.25 m² minimum; smaller side 0.75 m minimum.
- _____ 35. * The ground plane (when used) is bonded to the wall of the shielded enclosure at intervals no greater than 300 mm and the bonding resistance less than 2.5 milliohms.
- _____ 36. * The calibration point for the substitution method and the measurement point for the feedback method (for both horizontal and vertical polarizations) are defined as 100 ± 10 mm above the mid-point of the test harness and 1000 ± 10 mm from the antenna.

B. Test Procedure

- _____ 1. The laboratory procedures require that a test plan be generated to define the test. Sufficient information is required to adequately define the test:

Typical information to be included:

Substitution or closed loop method

Metallic or nonmetallic table [NOTE: at the March, 1997 ISO/TC22/SC3/WG3 meeting, it was decided to only allow testing using a ground plane for the next edition of the standard.]

Standard test harness or actual harness

Frequency range

Modulation

Test level(s)

Log or linear frequency steps

Frequency step sizes

Antenna polarization

Supply voltage, if different from default

Test temperature, if different from default

Dwell time, if different from default

Interface test points

DUT mode of operation

DUT acceptance criteria

Function classification

Special instructions

Changes from standard test

- _____ 2. * The supply voltage to the system under test is maintained between 13.0 and 14.0 volts for a nominal 12 volt system; between 26 and 28 volts for a nominal 24 volt system.
- _____ 3. * Net power to the antenna is used as the control parameter for the substitution method.
- _____ 4. The dwell time used during testing is sufficient for "control of the DUT."
- _____ 5. Data is collected and reported in V/m field strength.

C. DaimlerChrysler Corp Specific Requirements

- _____ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326, LP-388C-34, LP-388C-35 and LP-388C-65.
- _____ 2. Demonstrated that the substitution method is used with a nonconductive table.
- _____ 3. The laboratory technical manager understand that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler releasing engineer (or other DaimlerChrysler authorized person) before a test is begun.
- _____ 4. Demonstrate the capability to test using the DaimlerChrysler test frequencies defined in PF-9326.
- _____ 5. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65.
- _____ 6. The chamber wall bulkhead filter meets the requirements of LP-388C-34 and LP-388C-35.
- _____ 7. The antenna is located a minimum of 1000 mm from the DUT rather than being referenced to the wire harness.
- _____ 8. Demonstrate that the field uniformity requirement of LP-388C-35 is fulfilled.
- _____ 9. The power meter is zeroed/self calibrated before beginning a test.
- _____ 10. Demonstrate the ability to determine and record event threshold levels.
- _____ 11. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

D. Ford Specific Requirements

- _____ 1. The lab has the latest version copies of Ford specification ES-XW7T-1A278-AB
- _____ 2. The laboratory technical manager understand that Ford requires that a test plan be approved and signed off by a Ford EMC engineer and EMC technical specialist before a test is begun. Failure to do so will invalidate the test results.

3. Proficiency Testing

(PROFICIENCY TESTING REQUIREMENTS ARE PRESENTLY BEING DRAFTED)

While a test artifact is being developed for this test, the laboratory shall provide a test module with appropriate load simulator to be used to demonstrate the ability to perform the test and monitor function of the DUT. Functions to be monitored include voltages, visual function or other attributes.

- A. Test Artifact and Verification Procedure**
- B. Repeatability**
- C. Correlation**
- D. Reporting of Results**
- E. Performance History**

To demonstrate the stability of the test stand, the following data shall be collected:

For a test stand that is assembled to perform the test on a periodic basis, data shall be collected and recorded each time the test stand is assembled. Correlate the field strength meter reading from the calibration process to the reading of net power used to control the power level during the test. Data shall be recorded until 12 sets of data have been collected. If the 12 sets of data show test stand stability, the correlation shall be tested at least once each three months. If unsatisfactory stability is demonstrated in the quarterly check, the period shall revert to each time the test stand is assembled.

For a test stand that is left intact on a permanent basis, data shall be collected and recorded at least once a week for a period of at least 3 months to correlate the field strength meter reading from the calibration process to the reading of net power used to control the power level during the test. [Additional information, that will be of benefit to the laboratory, includes recording the signal generator output to determine the stability of the amplifier gain.] If the data shows test stand stability during the three month period, data shall be collected and recorded at least once each three months.

APPENDIX H - ASSESSMENT FOR “TRANSVERSE ELECTROMAGNETIC (TEM) CELL” TEST PROCEDURE

ISO 11452-3 TEM Cell Test Method Technical Requirements (Based on the First Edition)

The laboratory shall specify the methods of the test to be assessed. [A and/or B must be selected; C and/or D must be selected.]

- A. Calculated field strength method (Required by DCC)
- B. Measured field strength method [NOTE - The ISO TC22/SC3/WG3 has recommended the deletion of this option from the 2nd Edition of the standard.]
- C. Exposure of DUT and wiring harness method
- D. Exposure of DUT method

Laboratories performing tests on DaimlerChrysler Corporation components are required to use the Calculated field strength method and Exposure of DUT and harness method.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods, a sketch showing the test set-up and the Configuration Control List for the test stand,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

The following requirements are in the form of positive requirement statements. A check mark may be used to signify compliance with the requirement and "NC" to signify non-compliance. All non-compliant conditions require explanation, if accreditation is granted.

A. Test setup

- 1. The lab has a copy of the referenced version of the standard.
- 2. The ambient temperature is maintained between 18 and 28 degrees C.
- 3. The supply voltage to the system under test maintained between 13.0 and 14.0 volts for a nominal 12 volt system; between 26.0 and 28.0 volts for a nominal 24 volt system.
- 4. The upper test frequency is compatible with the size of the TEM cell in use. See Annex B of ISO 11452-3 for guidance.

- _____ 5. The test stand is capable of producing unmodulated (CW) radio frequency energy.
 - _____ 6. The test stand is capable of producing 80 % amplitude modulation (AM) radio frequency energy with a modulating frequency of 1 kHz.
 - _____ 7. The dwell time is controllable and is always 2 sec or greater.
 - _____ 8. Referring to Figure 2 of ISO 11452-3, items 1 through 6 are present in the test stand and are appropriate for the frequency range being tested and the power level used for the test.
 - _____ 9. The DUT is restricted in size to comply with the 1/6 cell height requirement.
 - _____ 10. When the test method to expose the DUT and the harness is used, the dielectric support of Figure 3 of ISO 11452-3(Item 2) meets the 1/6 cell height requirement.
 - _____ 11. The dielectric support of Figure 3 of ISO 11452-3(Item 2) meets the relative dielectric constant requirement of $\epsilon_r = 1.4$ or less.
- NOTE:** Styrofoam is one material that complies with this requirement.
- _____ 12. When the test method to expose the DUT and the harness is used, a printed circuit board (or printed lead card) is used or the wiring harness supported.
 - _____ 13. When the exposure of the DUT method only is used, the dielectric support is 50 +/-5 mm high.
 - _____ 14. When the exposure of the DUT method only is used, the harness is routed to the floor of the TEM cell and covered with metal tape with conductive adhesive.
 - _____ 15. The radiation from external components (and harnesses) is adequately controlled.
 - _____ 16. When the "Calculation method" is used, net power is used to control the test level.
 - _____ 17. The directional coupler and the power measuring system are within their calibration or verification period.
 - _____ 18. When the "Field strength measurement method" is used, the field probe is within its calibration period.

B. Test Procedure

- _____ 1. The laboratory procedures require that a test plan be generated to define the test. Sufficient information is required to adequately define the test:

- Calculation or measured field strength method
- Frequency range
- Modulation
- Test level
- Log or linear frequency steps
- Frequency step sizes
- Supply voltage, if different from default
- Test temperature, if different from default
- Dwell time, if different from default
- Interface test points
- DUT mode of operation

DUT acceptance criteria
Special instructions
Changes from standard test

- _____ 2. The dwell time used during testing is sufficient for "control of the DUT."
- _____ 3. Data is collected and reported in V/m field strength.

C. DaimlerChrysler Corp Specific Requirements

- _____ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326, LP-388C-34 and LP-388C-65
- _____ 2. The laboratory technical manager understands that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler releasing engineer (or other DaimlerChrysler authorized person) before a test is begun
- _____ 3. Demonstrate that the calculation method and exposure of DUT and harness options are used for DaimlerChrysler Corporation tests.
- _____ 4. Demonstrate that the TEM Cell meets the VSWR requirement.
- _____ 5. Demonstrate the capability to test using the DaimlerChrysler log step test frequencies defined in PF-9326
- _____ 6. Demonstrate that the requirement to monitor VSWR as a means of detecting cell resonances is understood.
- _____ 7. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65.
- _____ 8. The dwell time shall be sufficient to exercise the DUT, but shall be 3 seconds minimum.
- _____ 9. The power meter is zeroed/self calibrated before beginning a test.
- _____ 10. Demonstrate that the field monitoring probe provides reasonable correlation with the calculated field strength.
- _____ 11. The chamber wall bulkhead filter meets the requirements of LP-388C-34.
- _____ 12. Demonstrate the ability to determine and record event threshold levels.
- _____ 13. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

3. Proficiency Testing

The proficiency test is under development

- A. Test Artifact and Verification Procedure**
- B. Repeatability**
- C. Correlation**
- D. Reporting of Results**

E. Performance History

APPENDIX I - ASSESSMENT FOR TRI-PLATE LINE (TPL) TEST PROCEDURE

General Reference document(s);

- SAE J1113-25 - Immunity to Radiate Electromagnetic Fields - Tri-Plate Line Method

Ford Motor Company specific reference documents(s)

- Ford Electronic Component EMC Requirements and Test Procedures (ES-X7T-1A278-AB)

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods, a sketch showing the test set-up and the Configuration Control List for the test stand,
- c. Written or used a test plan, successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. Onsite Assessment Questionnaire

A. Test Setup (per SAE J1113-25)

- _____ 1. The RF field strength meter shall be capable of measuring field strengths from 50 to 200 V/m over a frequency range of 10KHz to 1000MHz
- _____ 2. The RF field strength meter shall have been calibrated within the last year.
- _____ 3. The signal source and power amplifier shall develop CW and AM modulated power at the immunity levels specified in the SAE J1113-25. CW vs AM modulated signals shall conform to requirements delineated in Appendix C of SAE J1113-1.
- _____ 4. In-line directional couplers and RF watt meters shall be facilitate measurement of forward, reflected, and TPL output power up to maximum power required to produce field strengths up to 200 V/m over a frequency range of 10KHz to 1000MHz.
- _____ 5. Residual FM of the signal source shall be less than 10 Hz.
- _____ 6. Frequency resolution of the signal source shall be less than 100 Hz.

- _____ 7. Harmonics and spurious outputs of the signal source and power amplifier shall be less than -20 dBc referenced to the fundamental power.
- _____ 8. The laboratory power supply shall meet the requirements delineated in SAE J1113-1. The power supply negative return shall be referenced (connected) to the TPL ground plane.
- _____ 9. All test equipment used for this test shall be calibrated/characterized.
- _____ 10. Measurements shall be performed in a shielded enclosure.
- _____ 11. The shielded enclosure shall be absorber lined or RF absorbing panels shall be used between the TPL and the enclosure walls. The absorber shall be selected to reduce the reflected E-field by 10 db or greater in the vicinity of the TPL at frequencies above 100 MHz.
- _____ 12. The TPL shall be located in the shielded enclosure such that the minimum distance between the open sides of the TPL and the absorber material shall be greater than 1 meter. The minimum distance between the ends of the TPL and absorber material shall be greater than 0.5 meters. The TPL ground plane shall be bonded to the shield room walls or floor via bonding straps, or via the braid of the coaxial feed and load cables if either cable is less than 2 meters in length.
- _____ 13. The ambient temperature during the test shall be 23 degrees \pm 5 degrees C.
- _____ 14. The TPL fixture shall be constructed in accordance with the requirements delineated in SAE J1113-25.
- _____ 15. All peripheral monitoring or operating devices that are used inside the chamber shall be shielded and filtered.
- _____ 16. A 3 axis, isotropic field RF probes shall be used to calibrate the TPL fixture.
- _____ 17. The leads fed through the wall of the shielded test chamber shall be equipped with adequate RF filters at the wall. Evaluations shall be made to assure that the RF filters do not affect the test results.
- _____ 18. A non-conductive support fixture shall be present to support the DUT in the center of the TPL, parallel to its major axis, and supported midway between the septum and the outer plate. The support fixture shall maintain a constant wire harness height between the DUT and the Test Fixture.
- _____ 19. The non-conductive fixture shall have a dielectric constant less than 1.4.
- _____ 20. DUT peripheral loads (resistive, reactive) shall be contained in a shielded Test Fixture. The Test Fixture shall be located no closer than 100 mm to the nearest edge of the TPL and shall not extend beyond the TPL taper.
- _____ 21. The physical height of the DUT shall not exceed 10 cm.
- _____ 22. If the DUT has a metal enclosure and the enclosure is normally connected directly to the vehicle structure, the EUT enclosure shall be electrically/mechanically bonded to the TPL lower ground plate via methods similar or identical to that used in the vehicle (e.g. brackets, braided straps etc.). If the EUT metal enclosure is not connected directly to the vehicle structure, it shall be placed directly on the non-conducting support fixture. DUT power return wiring shall be connected to the TPL ground plane via the Test Fixture
- _____ 23. Coax cables, signal sources, and amplifiers shall be checked at the beginning of each test day for proper operation.
- _____ 23. The TPL shall be characterized per Appendix A of J1113-25

B. Test Procedure (per SAE J1113-25)

- _____ 1. The lab shall have a copy of the referenced version of the standard(s).
- _____ 2. The dwell time at each frequency shall be adjustable to facilitate DUT response. (The minimum time of exposure shall be 2 seconds.)
- _____ 3. The maximum frequency step size for the frequency range from 10 kHz to 100 kHz shall be 10 kHz.
- _____ 4. The maximum frequency step size for the frequency range from 100 kHz to 1 MHz shall be 100 kHz.
- _____ 5. The maximum frequency step size for the frequency range from 1 MHz to 10 MHz shall be 1 MHz.
- _____ 6. The maximum frequency step size for the frequency range from 10 MHz to 200 MHz shall be 2 MHz.
- _____ 7. The maximum frequency step size for the frequency range from 200 MHz to 500 MHz shall be 20 MHz.

C. Ford Motor Company Specific Requirements

- _____ 1. The lab shall have a copy of the Ford Reference Standard (ES-XW7T-1A278-AB).
- _____ 2. The TPL shall be located on a wooden table at a height of 1 meter from the floor of the shielded, absorber lined room.
- _____ 3. The laboratory power supply may be either a vehicle battery or a linear type (non switching) power supply, isolated from the AC mains. If an automotive battery is used, it is a maintenance free type with open circuit voltage ≥ 12.5 volts. The battery charger used to maintain battery charge is not connected during testing. The battery voltage shall not fall below 11.5 volts during testing.

3. Proficiency Testing

A. Test Artifact and verification Procedure

Test Procedure #1

- 1. Required Test Equipment

The following test hardware is required for test procedure #1. Note that the test laboratory shall supply test equipment listed unless otherwise specified.

| Test Hardware Description | Recommended Equipment | Supplied by Accreditation Agency |
|--|-----------------------|----------------------------------|
| Test Artifact (See Figure 1) | NA | Yes |
| PCB with SMA connector | | |
| 2 meter coaxial cable (Type N, SMA connectors) | | |
| 3 dB, 2 watt coaxial attenuator | | |
| 20 dB, 2 watt coaxial attenuator | | |
| Termination Box | | |
| Spectrum Analyzer (1 - 1000 MHz) ¹ | HP 8568B | No |
| Miscellaneous Coaxial Cables | RG223 | No |

¹ EMI receiver may be used instead of Spectrum Analyzer

2. Test Setup

- a) Connect the Test Artifact as illustrated in Figure 2. The Test Artifact shall be placed on a dielectric (nonconductive) support in the center of the TPL, parallel to its major axis, supported midway between the septum and the outer plate. Characteristics of the dielectric support along with TPL physical dimensions and other information about the TPL method may be found in SAE J1113-25. The bends in the coaxial cable required to get the cable out of the TPL should have a bend radius of approximately 3 cm. The height of the coaxial cable must be kept at a constant height as close as possible to the terminating bulkhead connector. Route the Test Artifact cable out of the TPL, as illustrated in Figure 2 to the Termination Box, which is electrically bonded (via screw attachments) to the TPL ground plane. Variations in the Test Artifact cable routing are permitted outside of the TPL as long as the cable height above the ground plane is maintained. However, any cable routing variations must be documented.
- b) Attach the Termination Box to the TPL ground plane using the four (4) screw hole locations located on the box's two mounting flanges. See Figure 2 for details.
- c) Connect the 3 dB coaxial attenuator to the "P1 IN" connector of the Termination Box. Connect the Test Artifact Cable to the other end of the attenuator.
- d) The "P1 OUT" connector of the Termination Box shall be connected to a spectrum analyzer or EMI receiver located outside of the shielded, absorber lined test chamber as illustrated in Figure 2. RG223 (or equivalent) coaxial cable shall be used for this connection.

3. Test Procedure

- a) Set the RF Spectrum analyzer center frequency to 1 MHz. The resolution and video bandwidths should both be set to 30 kHz. The frequency span shall be set to 300 kHz.
- b) Set the RF signal generator to 1 MHz and apply RF power to the TPL so as to generate an electric field of 25 V/m. When the desired field strength is reached, adjust the spectrum analyzer's internal attenuation and/or reference level to get a convenient display of the induced signal. Record the peak RF level, in dBm, measured at this frequency.

- c) Record the actual calculated field strength generated. *Example: 25 V/m selected, actual calculated field strength generated (25.7 V/m).*
- d) Calculate the signal level appearing at the artifact connector/attenuator interface normalized to a field strength of 1 V/m using the following expression:

$$P_A(f) = P_M(f) + A(f) - 20 \text{LOG}\{E(f)\} + C(f) + TF(f)$$

Where:

- $P_A(f)$ Is the Normalized Power (dBm at 1 V/m) at Test Artifact cable connector.
- $P_M(f)$ Is the Measured Power (dBm) at Spectrum Analyzer Input
- $A(f)$ Is the Coaxial Attenuator value (dB) at test frequency (Calibration provided with Test Artifact)
- $E(f)$ Is the actual field strength (V/m) at test frequency
- $C(f)$ Is the cable attenuation at test frequency (applies to cables between test fixture and Spectrum Analyzer)
- $TF(f)$ Is the Test Fixture attenuation (dB) at test frequency

- e) Repeat step a through d at the frequencies listed in the table below:

| Frequency Range (MHz) | Frequency Step Size (MHz) |
|-----------------------|---------------------------|
| 1 - 100 | 1 |
| 102 - 200 | 2 |
| 205 - 400 | 5 |
| 410 - 1000 | 10 |

- f) Without disturbing the Test Artifact Cable layout, replace the 3 dB coaxial attenuator with the 20 dB coaxial attenuator. Repeat steps a through e with the field strength modifications shown below:

| Frequency Range (MHz) | Frequency Step Size (MHz) | Applied Field Strength (Volts/meter) |
|-----------------------|---------------------------|--------------------------------------|
| 1 - 100 | 1 | 200 |
| 102 - 200 | 2 | 200 |
| 205 - 400 | 5 | 200 |
| 410 - 510 | 10 | 200 |
| 520 - 1000 | 10 | 100 |

Test Procedure #2

1. Required Test Equipment

The following test hardware is required for test procedure #2. Note that the test laboratory shall supply test equipment listed unless otherwise specified.

| Test Hardware Description | Recommended Equipment | Supplied by Accreditation Agency |
|--|-----------------------|----------------------------------|
| Test Artifact (See Figure 1) | NA | Yes |
| PCB with SMA connector | | |
| 2 meter coaxial cable (Type N, SMA connectors) | | |
| 3 dB, 2 watt coaxial attenuator | | |
| 20 dB, 2 watt coaxial attenuator | | |
| Termination Box | | |
| DC Voltmeter (< .1mV sensitivity) | Fluke 8842A | No |
| Miscellaneous Coaxial Cables | RG223 | No |

2. Test Setup

- a) Use the same test setup described in Procedure 1, steps a) and b) except use Figure 3.
- b) Connect the 3 dB coaxial attenuator to the "P2 IN" connector of the Termination Box. Connect the Test Artifact Cable to the other end of the attenuator.
- c) The "P2 OUT" connector of the Termination Box shall be connected to a DC voltmeter located outside of the shielded, absorber lined test chamber as illustrated in Figure 5. RG223 (or equivalent) coaxial cable shall be used for this connection..

3. Test Procedure

- a) Set the RF signal generator to 1 MHz and apply RF power to the TPL so as to generate an electric field of 25 V/m. When the desired field strength is reached, record the DC voltage reading from the voltmeter. Also record the test frequency and the actual measured (or calculated) field strength generated. *Example: 25 V/m selected, actual field strength generated (25.7 V/m).*
- b) Calculate the signal level appearing at the artifact connector/attenuator interface normalized to a field strength of 1 V/m using the following expression:

$$V_A(f) = A \{V_M(f)\} / E(f)$$

Where:

- $V_A(f)$ Is the normalized signal level (DC volts at 1 V/m) at Test Artifact cable connector
- A Is the attenuator factor:
= 1.413 (3db attenuator)
= 10 (20 db attenuator)
- $V_M(f)$ Is the Test Artifact signal level (DC volts) measured by voltmeter
- $E(f)$ Is the actual field strength (V/m) at test frequency

- c) Repeat step a and b at the frequencies listed in the table below:

| Frequency Range (MHz) | Frequency Step Size (MHz) |
|-----------------------|---------------------------|
| 1 - 100 | 1 |
| 102 - 200 | 2 |
| 205 - 400 | 5 |
| 410 - 1000 | 10 |

- d) Replace the 3 dB coaxial attenuator with the 20 dB coaxial attenuator without disturbing the Test Artifact cable layout. Repeat steps a through c with the field strength modifications shown below:

| Frequency Range (MHz) | Frequency Step Size (MHz) | Applied Field Strength (Volts/meter) |
|-----------------------|---------------------------|--------------------------------------|
| 1 - 100 | 1 | 200 |
| 102 - 200 | 2 | 200 |
| 205 - 400 | 5 | 200 |
| 410 - 510 | 10 | 200 |
| 520 - 1000 | 10 | 100 |

B. Repeatability (No Requirements defined)

C. Correlation (No Requirements defined)

D. Reporting of Results

Recorded data from Procedure #1 shall be saved in an ASCII format listing test frequency and recorded peak levels (e.g. dBm) from the spectrum analyzer in addition to the actual generated field strength. The frequency and data shall also be plotted on a log-linear scale. This shall be done for both field strength values (e.g. 25, 200 V/m). Table 1 provides an example of the formatted ASCII data.

Recorded data from Test Procedure #2 shall also be saved in an ASCII format listing test frequency and recorded voltage reading and actual generated field strength. The frequency and voltage data shall also be plotted on a log-log scale. Note that the voltage readings will be negative in value, therefore the absolute value must be used for plotting purposes. Table 2 provides an example of the formatted ASCII data.

Table 1 Example of Procedure #1 ASCII Data Format

| Freq (MHz) | Req. FS (V/m) | Actual FS (V/m) | Cable Losses (db) | Measured Power (dbm) | Normalized Power (dBm) |
|------------|---------------|-----------------|-------------------|----------------------|------------------------|
| | | $E(f)$ | $C(f)$ | $P_M(f)$ | $P_A(f)$ |
| 1 | 25 | 26 | .01 | -45 | -30.0 |
| 2 | 25 | 27 | .01 | -40.6 | -25.4 |
| 3 | 25 | 29 | .02 | -35.2 | -20.1 |
| 4 | 25 | 25 | .04 | -30 | -15.7 |
| 5 | 25 | 27 | .04 | -31.1 | -16.4 |
| 6 | 25 | 27 | .05 | -20 | -5.3 |
| . | . | . | . | . | . |
| . | . | . | . | . | . |

Table 2 Example of Procedure #2 ASCII Data Format

| Freq (MHz) | Req. FS (V/m) | Actual FS (V/m) $E(f)$ | Measured Voltage (Volts) V_M | Normalized Voltage (Volts) $V_A(f)$ |
|------------|---------------|---------------------------|-----------------------------------|--|
| 1 | 25 | 26 | .0010 | .0030 |
| 2 | 25 | 27 | .00045 | .0041 |
| 3 | 25 | 29 | .00563 | .0138 |
| 4 | 25 | 25 | .00412 | .0345 |
| 5 | 25 | 27 | .00837 | .0834 |
| 6 | 25 | 27 | .01142 | .1178 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |

E. Performance History

Objective evidence of site performance verifications shall be available for inspection. The objective of this requirement is to demonstrate reproducibility of the test setup over time. Example, such performance verifications may be performed by testing a stable device and comparing results obtained over time.

F. TPL Calibration Procedure (from SAE J1113-25)

The field intensity generated between the septum and ground plates of the TPL is a function of the TPL impedance and the power dissipated into the TPL as given by Equation 1:

$$E_V(f) = \frac{\sqrt{P_{MID}(f) \times Z(f)}}{h} \tag{Eq. 1}$$

Where:

- $E_V(f)$ is the field between the septum and ground plates of the TPL in Volts/meter.
- $Z(f)$ is defined as the characteristic impedance of the TPL in ohms.
- H is defined as the separation between the septum and either of the ground plates of the TPL in meters.
- $P_{MID}(f)$ is the midpoint Power which is the mean between the net power and output power defined by:

$$P_{MID} = \frac{(P_{NET} + P_{OUT})}{2} \tag{Eq. 2}$$

Where:

- P_{NET} is the net RF power (in watts) into the TPL defined as: $P_F - P_R$
- P_F is the forward RF power (in watts) into the 50 Ω coaxial line feeding the TPL.
- P_R is the reflected RF power (in watts) reflected at the interface between the 50 Ω coaxial line and the TPL.
- P_{OUT} is the RF power output from the TPL into a 50 Ω load.

Field calibration requires that the TPL impedance $Z(f)$ be determined. The following procedure shall be used:

- a) At each test frequency (f), apply power to the empty TPL (no harness or EUT in place) and measure the field strength between the septum and lower ground plate of the TPL using a small RF field probe located at each of 5 positions as shown in Figure 4. Note the probe height above the TPL ground plate shall be the same as that specified for the EUT and its attached cable harness (i.e. 15 cm).
- b) In addition to the 5 field strength measurements, record the forward, reverse, and output powers: $P_F(f)$, $P_R(f)$, $P_{OUT}(f)$.

- c) Calculate the average field strength using the following expression:

$$E_{AVG} = \frac{1}{5} \sum_{N=1}^5 E_N \quad \text{Eq. 3}$$

Where:

E_N is the field strength measured at each probe position shown in Figure 6

- d) Calculate the midpoint power, $P_{MID}(f)$ using Equation 2.
- e) Substituting E_{AVG} for E_V in Equation 1, along with $P_{MID}(f)$ from step d), above, solve for $Z(f)$:

$$Z(f) = h^2 \times \frac{E_{AVG}^2(f)}{P_{MID}(f)} \quad \text{Eq. 4}$$

- f) $Z(f)$ shall be determined at frequency steps no larger than those listed in Table 3 of SAE J1113-1.

The resulting array of $Z(f)$ shall be used during testing of the EUT to determine the input power required to achieve the required field strength $E_V(f)$.

Figure 1 Test Artifact Detail

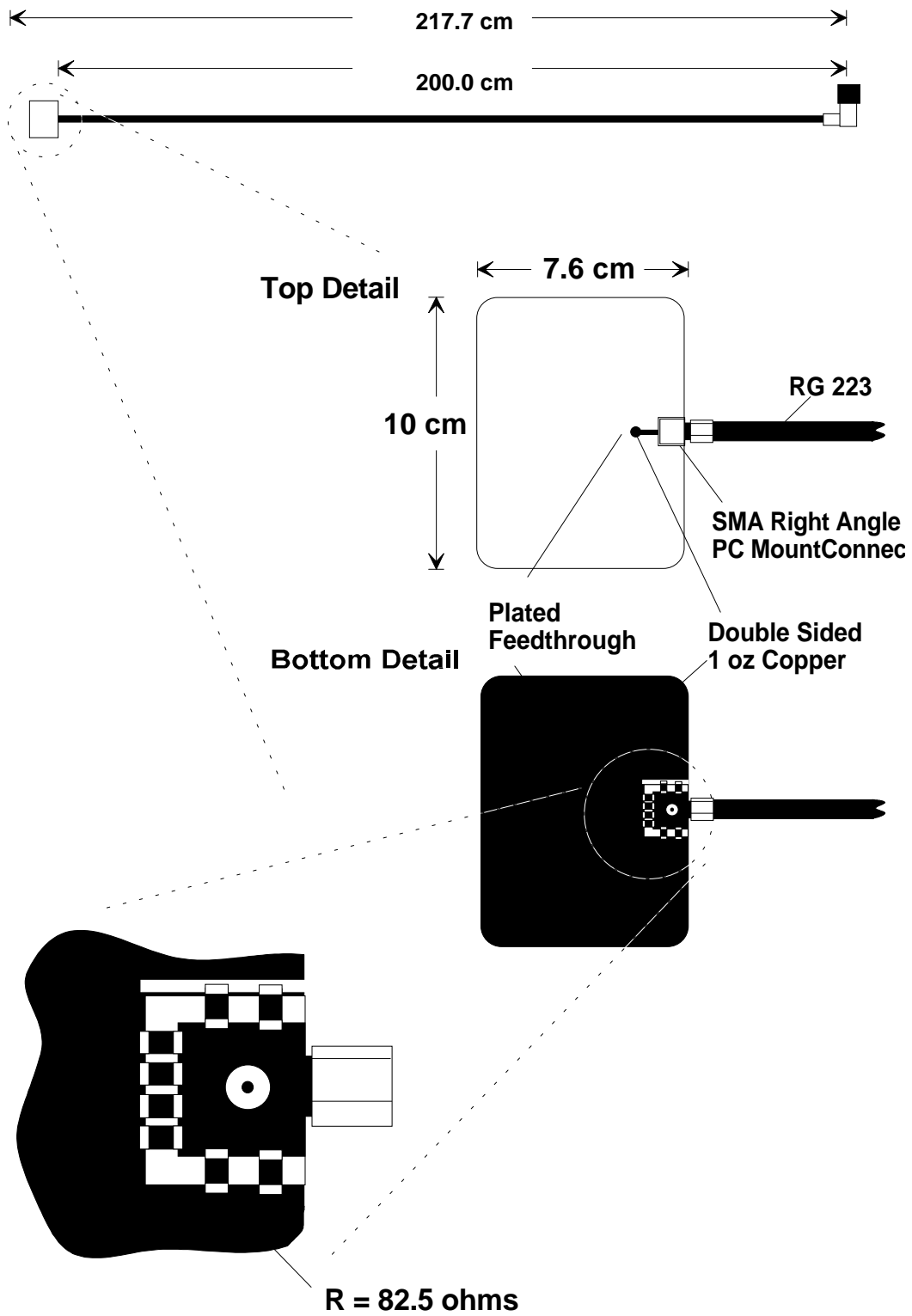


Figure 2 Test Procedure #1 Test Setup

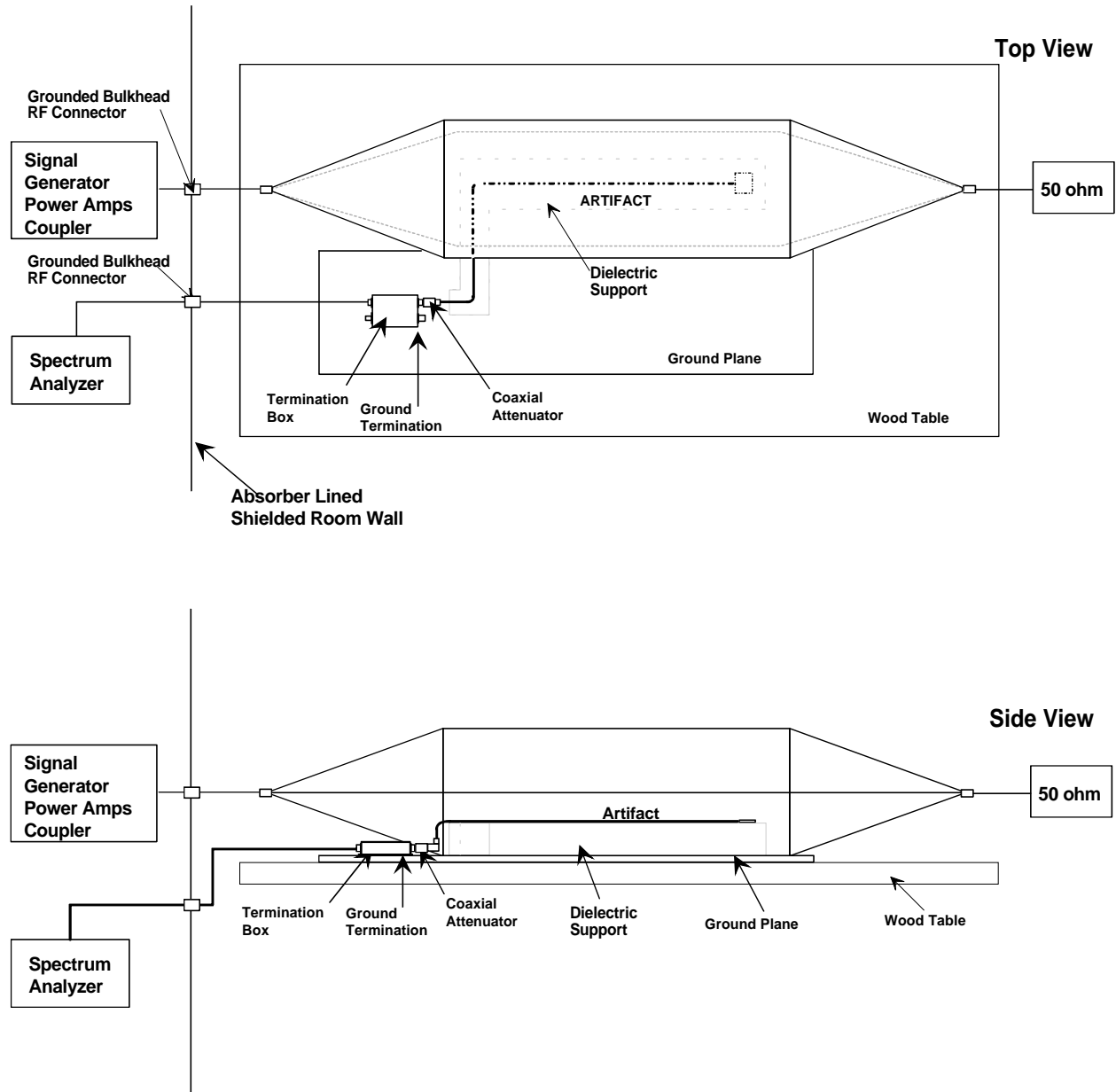


Figure 3 Test Procedure #2 Test Setup

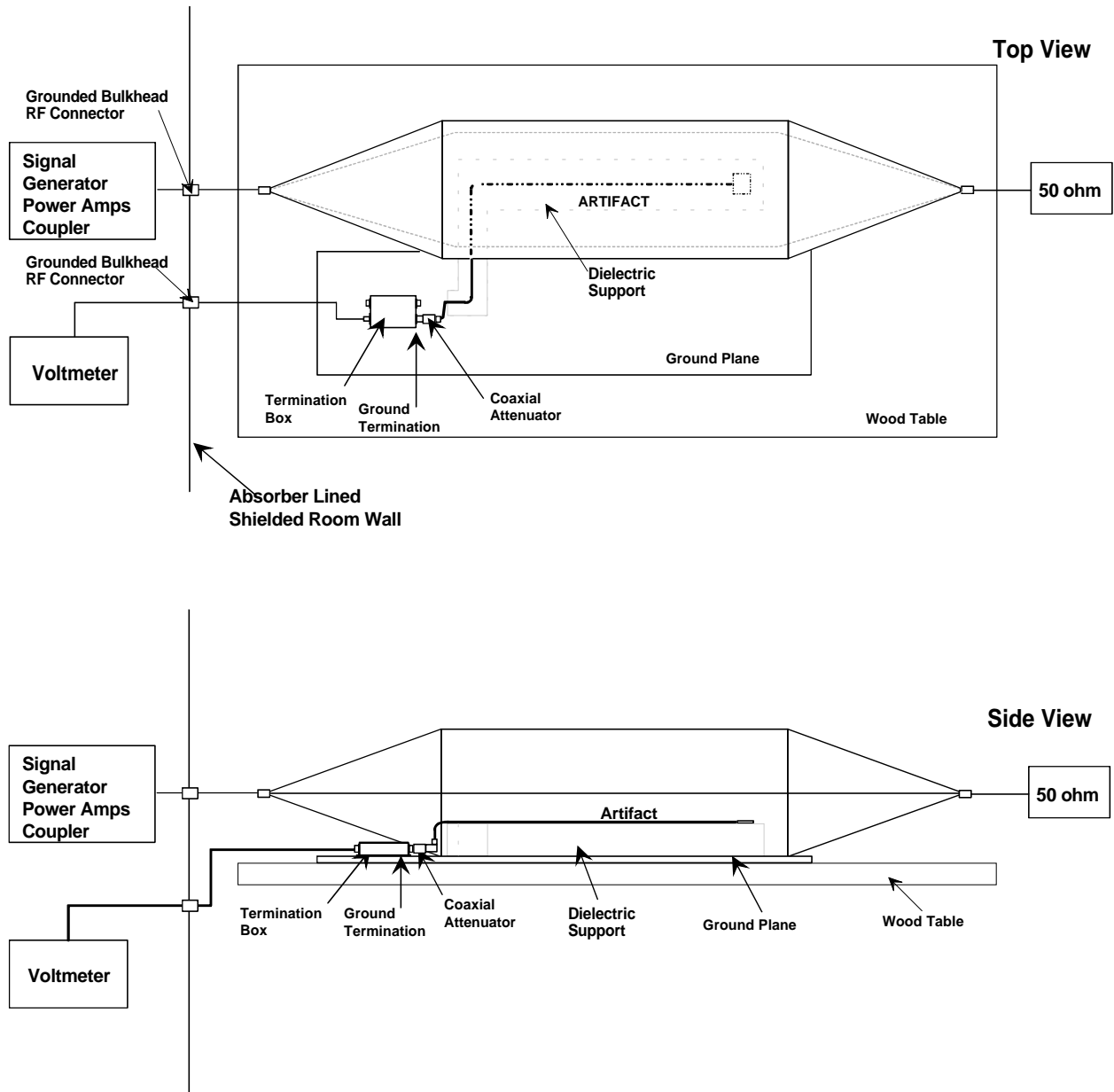
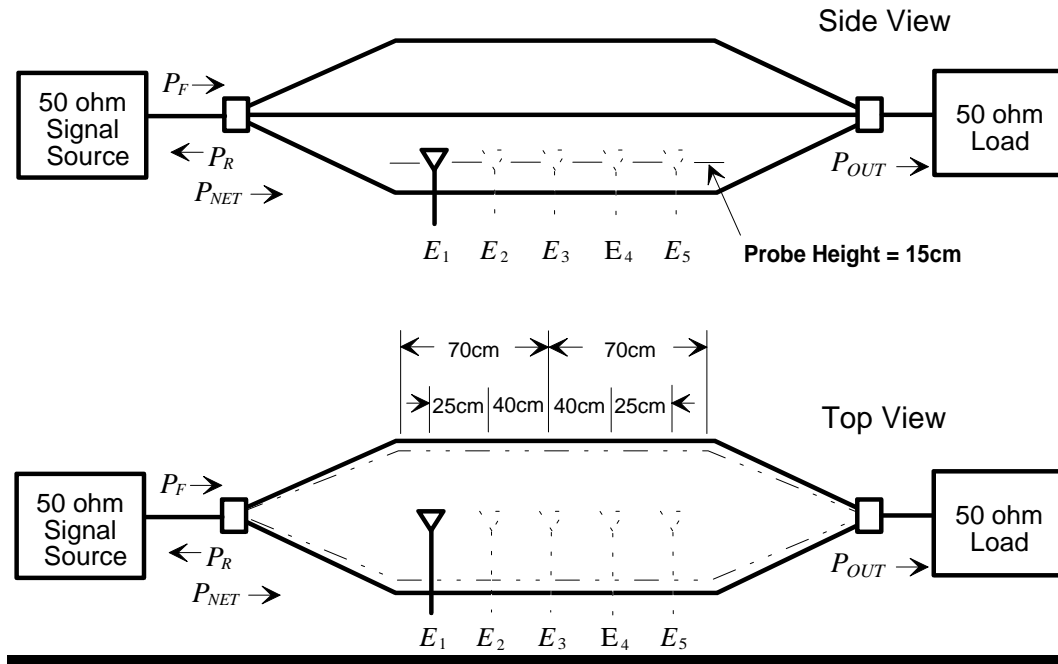


FIGURE 4 TPL Calibration Setup



APPENDIX J - ASSESSMENT FOR “RADIATED IMMUNITY REVERBERATION METHOD” TEST PROCEDURE

General Reference document(s):

- SAE J1113-27 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components- Part 27 - Immunity To Radiated Electromagnetic Fields (Radiated Immunity Reverberation Method)

GM Reference documents:

- GMW3100GS Section 3.2.1 - Reverberation Chamber Test (Verification Section)
- GMW3097GS Section 3.2.1 - Reverberation Chamber Test (Requirement Section)

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods,
- c. Written or used a test plan and successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

A. Generic Standard

Generic Test Setup: Consult SAE J1113-27 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components- Part 27 - Immunity To Radiated Electromagnetic Fields (Radiated Immunity Reverberation Method)

- 1 _____ The test chamber shall be clear of RF absorbing material.
- 2 _____ Amplifier output power shall be a minimum of 50 W below 1 GHz and 200 W above 1 GHz.
- 3 _____ Ground planes, if used, shall be at least $\lambda/3$ (at the lowest frequency) from the floor.
- 4 _____ Thickness of the ground plane, if used, shall be a minimum of 0.5 mm.
- 5 _____ The area of the ground plane, if used, shall be a minimum of 2 m².

- 6 _____ The ground plane, if used, shall be bonded to the chamber wall with a strap with a minimum width of 60 mm.
- 7 _____ Antennas, probes, and DUT shall be at a minimum distance of $\lambda/3$ (at the lowest test frequency) from the chamber walls and corners.
- 8 _____ DUT shall be at a minimum distance of $\lambda/3$ (at the lowest test frequency) from the mode stirrer.
- 9 _____ Antennas shall be aimed at different corners of the test chamber. An upward tilt of 20 degrees or more shall be used.
- 10 _____ Antennas shall be placed over RF non-intrusive supports (e.g., Styrofoam or similar stands).
- 11 _____ Probes, if used, shall be placed over RF non-intrusive supports (e.g., Styrofoam or similar stands)
- 12 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a one meter harness shall be used instead.
- 13 _____ Remote monitoring capabilities that do not impose a load on the monitored device shall be used (i.e., fiber optic signal monitoring connected via high impedance probes, cameras)
- 14 _____ The equipment used to monitor DUT functions shall not be susceptible to RF to the extent of not allowing proper determination of performance anomalies or deviations.
- 15 _____ Proper measures shall be taken to prevent RF energy from coupling into control rooms.

Generic Test Procedures: Consult SAE J1113-27 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components- Part 27 - Immunity To Radiated Electromagnetic Fields (Radiated Immunity Reverberation Method)

- 1 _____ Test procedures shall comply with general specifications in SAE J1113-27
- 2 _____ Equipment used for a particular test shall be traceable (i.e., Test reports or other documentation shall contain a list of equipment , serial numbers, etc., that associates this equipment to a particular test in the event that test needs to be repeated)

B. GM Specific Requirements

GM Specific Test Setup Requirements

- 1 _____ The battery supply voltage shall be (13.5 +/-1) V.
- 2 _____ Objective evidence of proper chamber performance (e.g., Statistical figures of merit – Chi-square distribution, standard deviation from theoretical Chi-Square, max/min received power ratio, field uniformity) shall be available for inspection.
- 3 _____ Mode stirrer shall conform to the specifications listed in SAE J1113-27 with the following modification: mode stirrer paddle dimension tolerances are ± 3 cm.
- 4 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a one meter harness shall be used instead.

GM Specific Test Procedure Requirements

1 _____ Determination of deviation (anomaly) thresholds shall be accomplished as follows:

- A. RF level shall be lowered until the anomaly disappears,
- B. RF level shall be incremented until the anomaly reappears.

This last level is defined as the anomaly (or deviation) threshold.

General Items

- 1 _____ Laboratory shall have an up to date copy of the referenced standard(s).
- 2 _____ Automated test software, if used, shall be under change control and verified at a minimum of once per year.
- 3 _____ All equipment shall be in current calibration.
- 4 _____ Equipment that requires no calibration but is used in the normal course of testing shall be periodically verified for proper functionality. Records of this verification shall be available for inspection.
- 5 _____ Objective evidence of training of test personnel shall be available for inspection.

3. Proficiency Testing (Refer to attached pictures for typical test setup)

A. Test Artifact and Verification Procedure:

Artifact and hardware Setup:

- Test Fixture (Including 1 m Harness)
- Test and setup instructions

Test Setup

- Verification Test Artifact shall be positioned 1 meter above ground. Any conductive surface shall be at least 1 meter from the fixture.
- Attach battery to Verification Test Fixture. Verify battery voltage is 12.7V or greater,
- **Monitor differentially the sensor output signal at the BNC jack labeled "ANALOG Vout". Signal return of Analog Output Terminal should not be connected to chamber ground.**
- Turn switch to "ON". Wait 30 minutes for DUT to arrive at normal operating temperature.
- After 30 minutes, use an adjustment tool to adjust the DUT's Analog Voltage Output to read $2.54 \pm .005$ Volts,
- Proceed with proficiency test.

Verification Test Artifact performance anomaly (performance deviation) definition:

- A performance anomaly or performance deviation is defined as ± 100 mV change from the nominal output voltage.

Test Parameters:

- Test Frequencies:

For the frequency range: 400 MHz – 1000 MHz use the following frequencies:
 Step Size: 25 Steps per Octave as calculated using the following equation:

$$f_{\text{test}} = f_{\text{initial}} \times 2^{(k / \text{number_of_steps_per_octave})}$$

Where f_{test} is the test frequency,

f_{initial} is the start frequency (e.g., 400.00 MHz)

k is the index number of the injection frequency (i.e., 0, 1, 2, ...)

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 400.0 | 411.2 | 422.8 | 434.7 | 446.9 | 459.5 | 472.4 | 485.7 |
| 499.3 | 513.4 | 527.8 | 542.6 | 557.9 | 573.6 | 589.7 | 606.3 |
| 623.3 | 640.9 | 658.9 | 677.4 | 696.4 | 716.0 | 736.2 | 756.8 |
| 778.1 | 800.0 | 822.5 | 845.6 | 869.4 | 893.8 | 919.0 | 944.8 |
| 971.4 | 998.7 | 1027 | 1056 | 1085 | 1116 | 1147 | 1179 |

For the frequency range: 1213 MHz – 9570 MHz use the following frequencies:
 Step Size: 50 Steps per Octave

| | | | | | | | |
|------|------|------|------|------|------|------|------|
| 1213 | 1230 | 1247 | 1265 | 1282 | 1300 | 1318 | 1337 |
| 1355 | 1374 | 1393 | 1413 | 1433 | 1453 | 1473 | 1493 |
| 1514 | 1535 | 1557 | 1579 | 1601 | 1623 | 1646 | 1669 |
| 1692 | 1715 | 1739 | 1764 | 1788 | 1813 | 1839 | 1864 |
| 1890 | 1917 | 1943 | 1971 | 1998 | 2026 | 2054 | 2083 |
| 2112 | 2141 | 2171 | 2202 | 2232 | 2264 | 2295 | 2327 |
| 2360 | 2393 | 2426 | 2460 | 2494 | 2529 | 2564 | 2600 |
| 2636 | 2673 | 2711 | 2748 | 2787 | 2826 | 2865 | 2905 |
| 2946 | 2987 | 3028 | 3071 | 3114 | 3157 | 3201 | 3246 |
| 3291 | 3337 | 3384 | 3431 | 3479 | 3527 | 3577 | 3627 |
| 3677 | 3728 | 3781 | 3833 | 3887 | 3941 | 3996 | 4052 |
| 4108 | 4166 | 4224 | 4283 | 4343 | 4403 | 4465 | 4527 |
| 4590 | 4654 | 4719 | 4785 | 4852 | 4920 | 4988 | 5058 |
| 5129 | 5200 | 5273 | 5346 | 5421 | 5497 | 5573 | 5651 |
| 5730 | 5810 | 5891 | 5974 | 6057 | 6141 | 6227 | 6314 |
| 6402 | 6492 | 6582 | 6674 | 6767 | 6862 | 6958 | 7055 |
| 7153 | 7253 | 7354 | 7457 | 7561 | 7667 | 7774 | 7882 |
| 7992 | 8104 | 8217 | 8332 | 8448 | 8566 | 8685 | 8807 |
| 8930 | 9054 | 9181 | 9309 | 9439 | 9570 | | |

- Maximum field strength: 40 dBV/m (100 V/m)

Verification Instructions:

- Fixture shall be tested three (3) times
- Between each test, the test setup shall be dismantled and re-assembled
- The same test operator shall perform all three tests
- For each test frequency the anomaly threshold shall be documented.

B. Repeatability:

The deviation profile shall conform to the following:

The differences in the deviation or performance anomaly profiles of the three test runs shall be within 6 dB of separation over 90% of the frequencies tested.

C. Correlation: *(Correlation to results obtained at REFERENCE LABORATORY).NOTE: These are the tests that are performed to determine correlation to the REFERENCE LABORATORY and are provided here for information purposes to laboratories seeking accreditation/recognition.*

Test 1: The average difference in the deviation profiles of the three test runs shall comply with the following expression:

$$\frac{\sum \sqrt{(P_i - P_{ri})^2}}{n} \leq 20 \text{ V/m} \quad \text{Expression J.1}$$

Where P_i is the AVERAGE anomaly threshold, in units of v/m, at frequency f_i obtained over three test runs,
 P_{ri} is the anomaly threshold, in units of V/m, at frequency f_i of the REFERENCE curve,
 n is the number of frequencies tested.

Please note that for Test 1, calculations must be performed on absolute units of current (i.e., V/m), and not on logarithmic units (i.e., dBV/m).

Test 2: The difference in the deviation or performance anomaly profiles of each of the three test runs shall comply with the following expression:

$$\left| \sum_{i=1}^n (R_i - P_i - \gamma) - \sum_{i=1}^n (R_i - P_{ri}) \right| \leq 20 \quad \text{Expression J.2}$$

Where $|\gamma| \leq 5$

Where P_i is the anomaly threshold, in units of dBV/m, at frequency f_i obtained over three runs at laboratory being assessed,

P_{ri} is the AVERAGE anomaly threshold, in units of dBV/m, at frequency f_i obtained over three runs at REFERENCE laboratory,

R_i is the Level 2 Requirement, in units of dBV/m, at frequency f_i (Refer to GMW3097GS for Radiated Immunity Reverberation performance requirement levels)

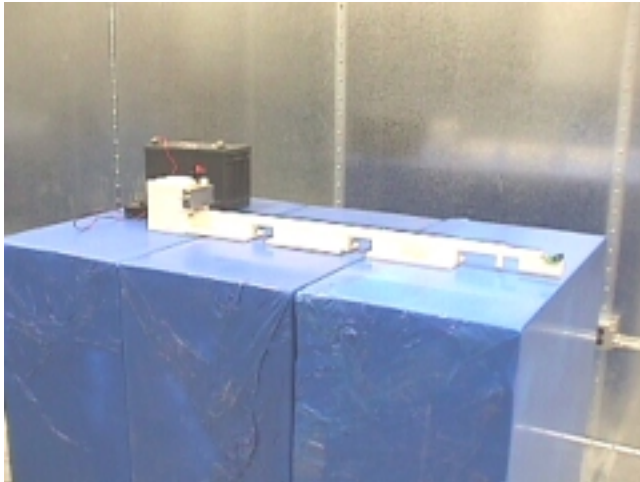
$|\gamma|$ is the minimum offset value that satisfies Expression J.2.

Please note that for Test 2, calculations must be performed using logarithmic units of current (i.e. dBV/m), and not absolute units (i.e., V/m).

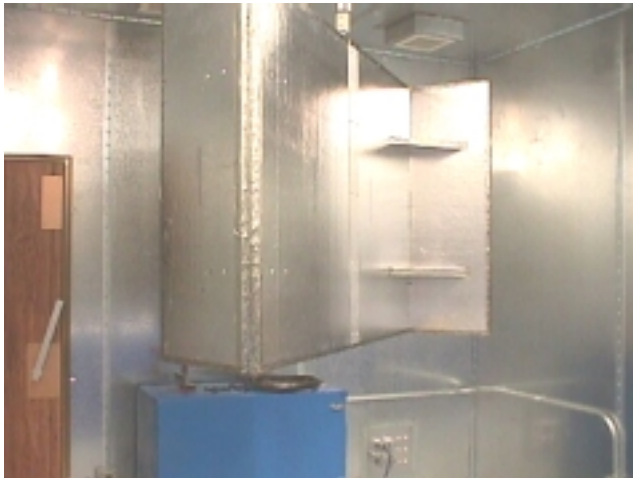
D. Reporting of results:

- Reports shall be in ASCII, comma delimited and shall contain at a minimum, the test frequencies in MHz, and anomaly thresholds in dBV/m
- Data shall be submitted in the following form:

Line 1: Lab/Test information - Discretionary



Picture J.1: Placement of RI Proficiency Artifact in reverb chamber. Monitoring of the artifact's Analog Voltage Output is performed through fiber optic transducers as shown in Appendix N Picture F.3 for the Bulk Current Injection test procedure.



Picture J.2: Photo of the mode stirrer used in GM Reverb Chamber.

APPENDIX K - ASSESSMENT FOR “CISPR 25 RADIATED EMISSIONS” TEST PROCEDURE

CISPR 25 Module Radiated Emissions Test Method Technical Requirements
(Based on the First Edition dated 1995)

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods,
- c. Written or used a test plan and successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

A. Test setup

- _____ 1. Does the lab have a copy of the referenced version of the standard?
- _____ 2. Does the equipment used in the test set-up match the equipment listed in the Configuration Control List or equivalent?
- _____ 3. Does the measuring instrument meet the requirements of CISPR 16-1?
- _____ 4. Does the Artificial Network(s) used meet the defined impedance requirements?
- _____ 5. Is the Artificial Network(s) bonded to the ground plane?
- _____ 6. Is calibration or verification current for the following equipment?:
- Measuring instrument
Antenna(s)
Coaxial cable attenuation
Artificial network(s)
- _____ 7. Is the test frequency range of the test chamber within the standard's range of 30 MHz to 1 GHz?
- _____ 8. Is the test performed in an absorber lined shielded enclosure?

- _____ 9. Does the chamber meet the design objective of -6 dB (or less) reflectivity in the test area over the frequency range of 70 to 1000 MHz? Absorber material manufacturer's data or compliance with 3 m chamber NSA requirements may be used as a basis for demonstrating compliance.
- _____ 10. Is the test bench height 900 mm \pm 10%?
- _____ 11. Is the test harness segment parallel to the front of the test bench 1500 mm \pm 75 mm long?
- _____ 12. Is the length of test harness from the front segment to the DUT and to the Artificial Networks 100 \pm 10 mm?
- _____ 13. Is the test harness located a minimum of 100 mm from the front edge of the ground plane?
- _____ 14. Is the test harness located 50 +10,-0 mm above the ground plane?
- _____ 15. Is the test harness located a minimum of 1000 mm from any absorber material?
- _____ 16. Is the test harness located a minimum of 2000 mm from the shielded enclosure wall behind the harness?
- _____ 17. Is the antenna located 1000 \pm 10 mm from the test harness?
- _____ 18. Is the closest element of the antenna a minimum of 1000 mm from any wall or ceiling absorber material?
- _____ 19. Is the closest element of the antenna a minimum of 250 mm from the floor? Is there a minimum of 2000 mm from the walls or ceiling of the shielded chamber?
- _____ 20. Is the center of the antenna at 1000 \pm 10 mm from the floor?
- _____ 21. When a rod antenna is used, is the counterpoise bonded to the ground plane of the test bench?
- _____ 22. Is the coaxial cable to the antenna fed through a bulkhead connector to maintain shielding integrity?
- _____ 23. Is double shielded (or solid shielded) coaxial cable used?
- _____ 24. Does the ground plane meet the thickness and material requirements of 0.5 mm minimum thickness and copper, brass or galvanized steel metals?
- _____ 25. Does the ground plane meet the requirement of 2.5 m minimum length?
- _____ 26. Is the ground plane bonded to the shielded enclosure at intervals no greater than 300 mm?
- _____ 27. Does the ground plane meet the depth of 1 m minimum?

B. Test Procedure

- _____ 1. Do the laboratory procedures require that a test plan be generated to define the test? Is sufficient information required to adequately define the test?

Standard test harness or actual
 Frequency range
 Disturbance classification (broadband long or short duration - or narrowband)
 Emission limits
 Antenna polarization
 Supply voltage

DUT mode of operation
Special instructions
Changes from standard test

- _____ 2. Are the ambient levels and equipment noise floor verified to be at least 6 dB less than the test limits in the test plan?
- _____ 3. Are the minimum scan time requirements of Table 2 of CISPR 25 met?
- _____ 4. Is the supply voltage maintained at 13.5 ± 0.5 V for nominal 12 V system components?
- _____ 5. Are all objects not pertinent to the test removed from the absorber lined shielded enclosure?
- _____ 6. Are all personnel not actively involved in the test excluded from the absorber lined shielded enclosure?
- _____ 7. Is data collected and reported in dB(uV/m) field strength?

C. DaimlerChrysler Corp Specific Requirements

- _____ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326 and LP-388C-65
- _____ 2. The laboratory technical manager understands that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler EMC engineer (or other DaimlerChrysler authorized person) before a test is begun
- _____ 3. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65.
- _____ 4. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

D. Ford Specific Requirements

- _____ 1. The lab has the latest version copies of Ford specification ES-XW7T-1A278-AB
- _____ 2. The laboratory technical manager understand that Ford requires that a test plan be approved and signed off by a Ford EMC engineer and EMC technical specialist before a test is begun. Failure to do so will invalidate the test results.

3. Proficiency Testing

A. Test Artifact and Verification Procedure

1. Source / Spectrum Analyzer Verification:

- a) Check the RefRad battery voltage (with unit turned off) by connecting adapter (black and white wires w/ banana jacks) to the "charge" port. If voltage is less than 11 Volts, recharge the unit with the supplied battery charger.
- b) Remove the nylon antenna adapter from the RefRad by pulling the two pins and replace with the "N" connector adapter (replace the two pins). Attach the supplied coaxial cable and 30 dB

attenuator (to prevent DAMAGE to the spectrum analyzer) to the output of RefRad and input of the spectrum analyzer.

- c) Use the following spectrum analyzer settings: Start Frequency = 10 kHz, Stop Frequency = 20 MHz, Resolution BW = 3 kHz, Video BW = 3 kHz, & Amplitude Offset = 30 dB.
- d) Turn on RefRad, set comb spectrum output to 0.01 MHz and "max hold" the spectrum analyzer until display "fills in". Plot this screen.
- e) Preset the spectrum analyzer and enter the following settings: Start Frequency = 20 MHz, Stop Frequency = 200 MHz, Resolution BW = 1 MHz, Video BW = 1 MHz, & Amplitude Offset = 30 dB.
- f) Set the RefRad to the 1.0 MHz comb spectrum output and "max hold" the spectrum analyzer. Plot this screen.
- g) Preset the spectrum analyzer and enter the following settings: Start Frequency = 200 MHz, Stop Frequency = 1000 MHz, Resolution BW = 3 MHz, Video BW = 3 MHz, & Amplitude Offset = 30 dB.
- h) Set the RefRad to the 5.0 MHz comb spectrum output and "max hold" the spectrum analyzer. Plot this screen.
- i) Compare these three plots with the three supplied plots. If there is a significant difference (> 5 dB) in the amplitude levels across frequency, there is a discrepancy that must first be addressed before testing continues.

2. Radiated Emissions Testing, Procedure 1

- a) Run a chamber quiet sweep using all equipment that will be used for the RefRad testing (i.e. antennas, cables, etc.).
- b) Replace the RefRad's antenna adapter (that was removed in Step 1b) and connect the loop antenna.
- c) Position the RefRad on the standard test bench at the same location as a typical DUT would be placed, with the loop antenna in the horizontal plane. The reference point of the RefRad is at the edge of the loop antenna element (See Figure L1). The test arrangement may be the mirror image of that shown (left for right). The ANs may be left in place on the ground plane.
- d) Orient the body of the RefRad in the direction the wiring harness is normally placed (toward center of room) and the loop antenna facing the wall.
- e) Record the RefRad's battery voltage and turn the unit on. Note: If battery voltage is ever lower than 11 Volts, recharge the unit.
- f) Set the RefRad to the 0.01 MHz comb spectrum output and run the test for the frequency range <20 MHz.
- g) Set the RefRad to the 1.0 MHz comb spectrum output for the frequency range of 20 MHz to 200 MHz.
- h) Set the RefRad to the 5.0 MHz comb spectrum output for the frequency range > 200 MHz.
- i) Record the RefRad's battery voltage.

- j) Repeat this test (Steps 2f through 2i) two more times for a total of three tests.

3. Radiated Emissions Testing, Procedure 2

- a) Remove the RefRad's loop antenna and connect the supplied 1.5 meter twin lead cable.
- b) Position the RefRad on the standard test bench at the same location a typical DUT would be placed, with the twin lead directed toward the center of the room. The reference point is the twin lead cable simulating a test harness (See Figure L2).
- c) Secure the twin lead cable in the position and direction that the DUT wiring harness would normally be placed.
- d) Record the RefRad's battery voltage and turn the unit on. Note: If battery voltage is ever lower than 11 Volt, recharge the unit.
- e) Set the RefRad to the 0.01 MHz comb spectrum output and run the test for the frequency range <20 MHz.
- f) Set the RefRad to the 1.0 MHz comb spectrum output for the frequency range of 20 MHz to 200 MHz.
- g) Set the RefRad to the 5.0 MHz comb spectrum output for the frequency range > 200 MHz.
- h) Record the RefRad's battery voltage.
- i) Repeat this test (Steps 3e through 3h) two more times for a total of three tests.

B. Repeatability

TBD

C. Correlation

TBD

D. Reporting of Results

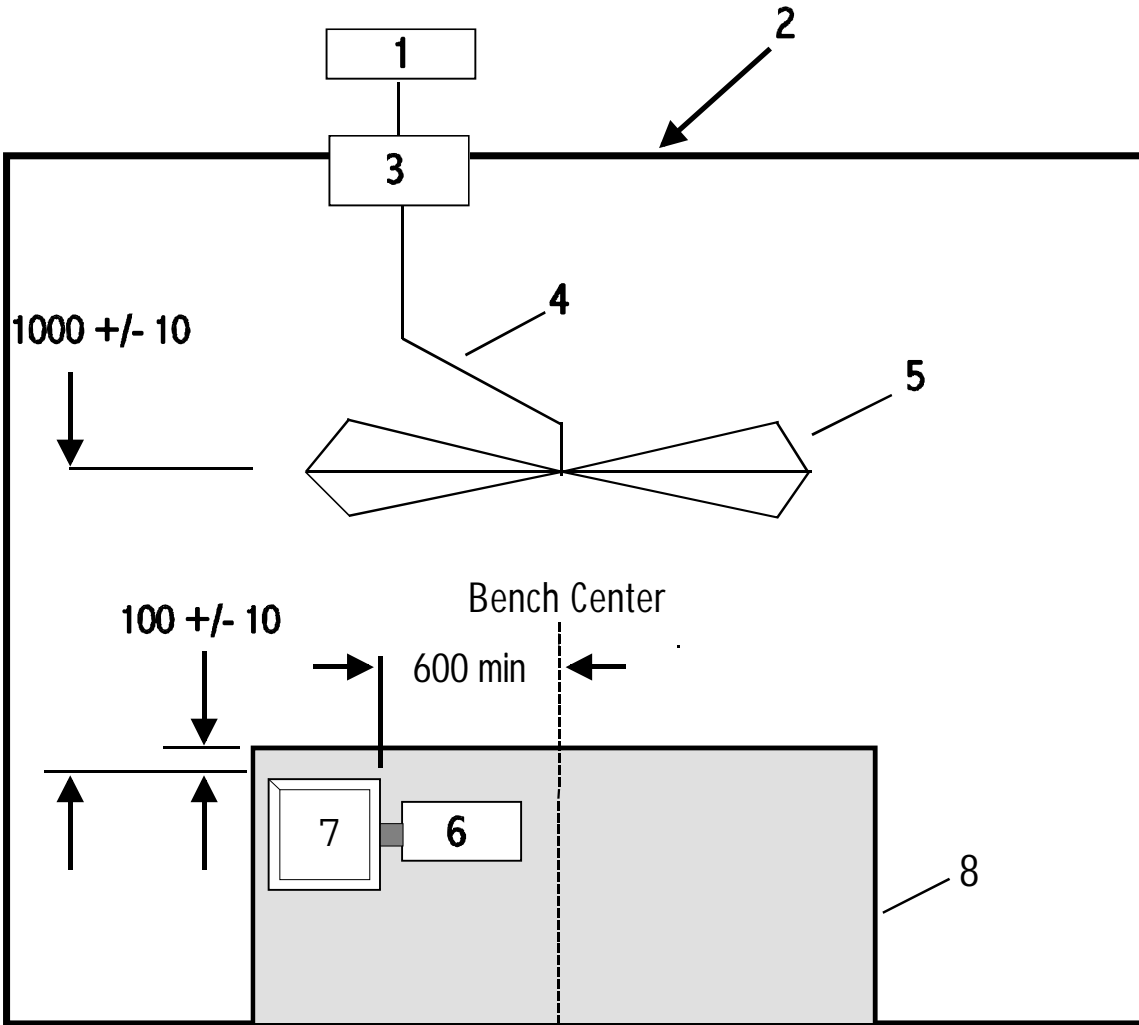
Data To Be Supplied.

After testing is complete, please submit the following data/information

- a) Three plots from the Source / Spectrum Analyzer Verification (Section 2.A.1).
- b) Plots from Radiated Emissions Testing Procedure 1 (Section 2.A.2).
- c) Plots from Radiated Emissions Testing Procedure 2 (Section 2.A.3).
- d) Plot of the chamber quiet sweep.
- e) Antenna factors for all antennas used for the above testing.

f) RefRad battery voltages before and after each run.

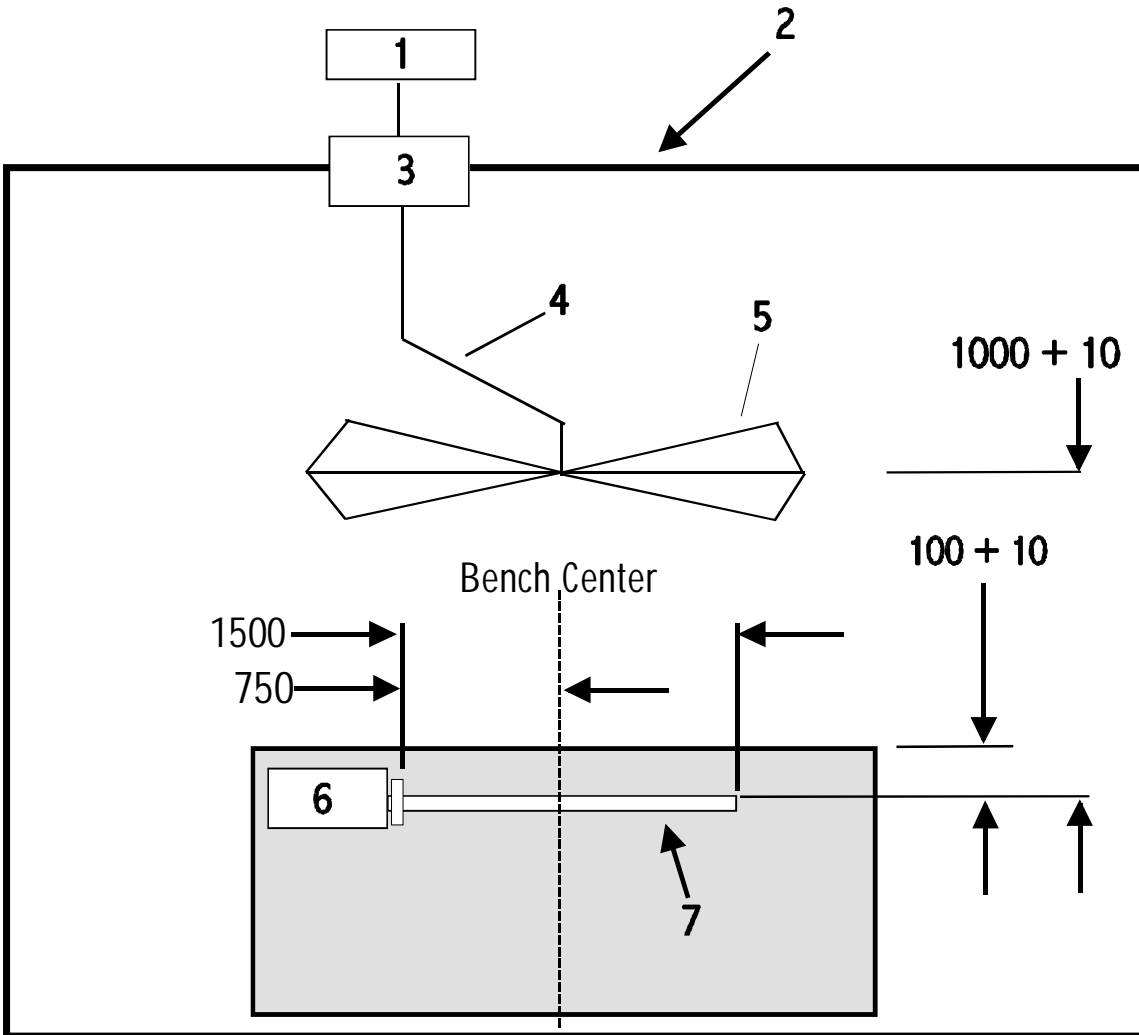
E. Performance History



Dimensions in millimeters

1. Measuring Receiver
2. ALSE
3. Bulkhead connector
4. Double-shielded coax
5. Antenna
6. Refrad
7. Loop Antenna
8. Test bench

Figure 1 - Radiated Emissions Procedure 1



Dimensions in millimeters

1. Measuring Receiver
2. ALSE
3. Bulkhead connector
4. Double-shielded coax
5. Antenna
6. Refrad
7. Test harness

Figure 2 - Radiated Emissions Procedure 2

APPENDIX L - ASSESSMENT FOR “RADIATED EMISSIONS – REVERBERATION METHOD” TEST PROCEDURE

GM Reference documents:

- GM9114P – EMC Component Test Procedures / Radiated Emissions From 10 kHz to 1000 MHz.
- GMW3100GS Section 3.1.1 - Reverberation Chamber Test (Verification Section)
- GMW3097GS Section 3.1.1 - Reverberation Chamber Test (Requirements Section)

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided copies of internal lab procedures for the base method and any user specific methods,
- c. Written or used a test plan and successfully collected data and written a test report (including photographs of the test set-up) for three separate automotive components,
- d. Gathered and summarized the historical data required in the Proficiency Testing Section,
- e. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, power level, defined modulation, frequency stepping capability, and
- f. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body) for review as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

A. GM Specific Requirements

GM Specific Test Setup Requirements

- 1 _____ Chamber dimensions shall comply with GMW3100GS.
- 2 _____ A monopole antenna shall be used in the frequency range of 150 kHz to 20 MHz.
- 3 _____ A biconical antenna shall be used in the frequency range of 20 MHz to 200 MHz.
- 4 _____ A log periodic antenna shall be used in the frequency range of 200 MHz to 1000 MHz.
- 5 _____ Proper data acquisition algorithm shall be followed.
- 6 _____ Narrowband and a broadband emission shall differentiated and reported separately.
- 7 _____ Antenna cable shall be protected against common mode currents. Example, RF chokes may be installed along the length of the antenna cable to minimize the presence of common mode currents on the shield.

8 _____ Spectrum analyzer PEAK (MAX HOLD) detection mode shall be used.

GM Specific Test Procedure Requirements

- 1 _____ Steps shall be taken to guard against radio noise meter or preamplifier overload.
- 2 _____ The laboratory shall have a procedure to check for radio noise meter or preamplifier overload.
- 3 _____ Antenna factors shall be applied to the antenna terminal voltage to arrive at a field strength reading.
- 4 _____ Only vertical antenna polarization shall be used.
- 5 _____ The measurement system noise floor shall be lower than the Radiated Emissions Requirements by 6 dB or more. If the 6 dB criterion is not achieved, data documenting the noise floor (typically referred to as room ambient) shall be provided with the performance data for the DUT.
- 6 _____ The electromagnetic emissions of any support equipment (simulator/exerciser) shall be lower than the Radiated Emissions Requirements by 6 dB or more. If the 6 dB criterion is not achieved, data documenting these emissions shall be provided with the performance data for the DUT.
- 7 _____ The frequency bands used in this test shall comply with the GMW3100GS specifications.

B. General Items

- 1 _____ Laboratory shall have an up to date copy of the referenced standard(s).
- 2 _____ Automated test software, if used, shall be under change control and verified at a minimum of once per year.
- 3 _____ All equipment shall be in current calibration.
- 4 _____ Equipment that requires no calibration but is used in the normal course of testing shall be periodically verified for proper functionality. Records of this verification shall be available for inspection.
- 5 _____ Objective evidence of training of test personnel shall be available for inspection.

3. Proficiency Testing (Refer to attached pictures for typical test setup)

A. Test Artifact and Verification Procedure:

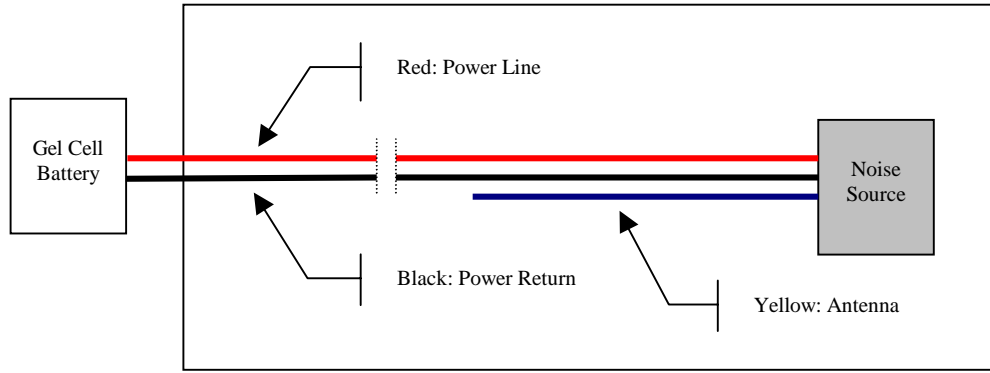
Artifact:

- Noise Source
- 3 meter harness
- 12 V Gel Cell Battery
- Battery Charger

Procedure:

Source / Spectrum Analyzer Verification:

- a) Check gel cell battery voltage by measuring the battery BNC connector. If voltage is less than 11V, recharge the unit with the supplied battery charger.
- b) Attach the Noise source, 3 meter harness and gel cell battery in the same manner a ordinary DUT would be positioned for this test as shown below. The noise source is powered as soon as harness and battery are connected.



- c) Run a chamber quiet sweep using all equipment that will be used for the actual testing (i.e. antennas, cables, etc.).
- d) Perform three GMW3100GS reverberant room radiated emissions tests. Assume the source to be a **narrow band radiator**.

B. Repeatability:

Deviation to within ± 5 dB in 90% of the GMW3100GS frequency ranges obtained over the three separate and complete runs.

C. Correlation:

Deviation to within ± 5 dB in 90% of the GMW3100GS frequency ranges when compared to the Reference Curve obtained at the 'GM Reference Laboratory'.

D. Reporting of results:

Data To Be Supplied. After testing is complete, please submit the following data/information:

- a) Three separate plots for each of the frequency bands specified in GMW3100GS.
- b) Plots of the chamber quiet sweep for each of the bands specified in GMW3100GS.

E. Performance History:

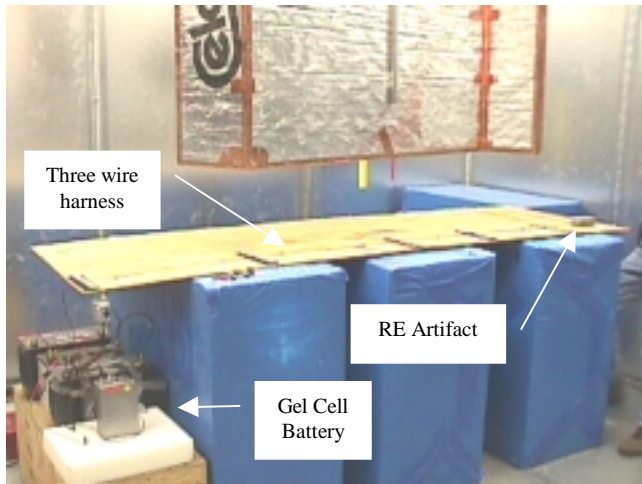
Objective evidence of site performance verifications shall be available for inspection. Such performance verifications may be performed by testing a stable device and comparing results obtained over time. The objective of this requirement is to demonstrate reproducibility of the test setup over time.



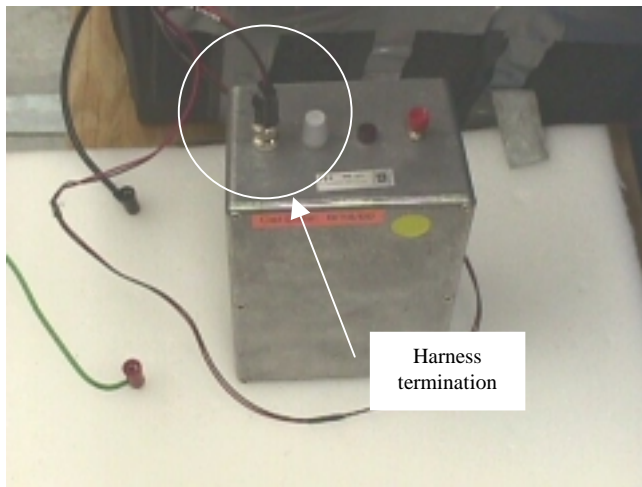
Picture L.1: RE Reverberation artifact.



Picture L.2: Photo of harness placing along test table.



Picture L.3: Photo of complete test setup. Three wire harness (Red, Black and Yellow wire harness) is draped over test table and connects to the Gel Cell battery.



Picture L.4: Close up view of the Gel Cell battery connections.

APPENDIX M - ASSESSMENT FOR CONDUCTED EMISSIONS TEST

DaimlerChrysler LP-388-C-41, *Conducted RF Emissions*, is the base document for this test.

1. Prerequisites

On-site assessment shall be initiated only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provide a copy of the internal lab procedure, a sketch showing the test set-up and a Configuration Control List for the test stand,
- c. Written or used a test plan and successfully collected data and written a test report (including photographs of the test set-up) for three distinct automotive components including at least one motor and one electronic module,
- d. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, noise floor, etc., and
- e. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

The following requirements are in the form of positive requirement statements. A check mark may be used to signify compliance with the requirement and "NC" to signify non-compliance. All non-compliant conditions require explanation, if accreditation is granted.

NOTE: If a test facility has more than one test set-up for this test, each test set-up shall be evaluated separately.

An "*" before the question indicates probable significant impact on the test uncertainty.

A. Test Set-up

- ___ 1. The lab has a copy of the referenced version of the standard.
- ___ 2. *The equipment, software (with revision level) and calibration/correlation date used in the test stand matches the data listed in the Configuration Control List.
- ___ 3. *The supply voltage is obtained from a nominal 12.6 volt vehicle battery. The voltage is maintained above 12.1 volts.
- ___ 4. *The Broadband Isolation Networks (called BANs in other documents) each meet the required minimum impedance requirements.
- ___ 5. *The BANs are bonded to the ground plane.
- ___ 6. *All equipment is within its required calibration or verification period.
- ___ 7. *The specified ferrite clamps are used and are in the specified locations.
- ___ 8. *The noise floor shall be at least 6 dB below the required test limit
- ___ 9. *The preamplifier is not used for measurements below 2 MHz.

B. Test Procedure

- ___ 1. *The correct resolution and video bandwidths, as well as sweep times, are used.
- ___ 2. *The correct sweep speeds are used.
- ___ 3. *The non-coherent noise source test is performed and the procedure is followed.
- ___ 4. *The maximum lead length criteria of 10 and 15 cm are implemented.
- ___ 5. *The procedure for determining the Correction Factor for each band is implemented.
- ___ 6. *The data is scrutinized for possible measured data compression.
- ___ 7. The ambient level is plotted with the lead measurement data for each lead and frequency range.
- ___ 8. *The guidance for DUT grounding in PF-9326 is understood and followed.

C. DaimlerChrysler Corp Specific Requirements

- ___ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF- 9326, LP-388C-41 and LP-388C-65
- ___ 2. The laboratory technical manager understands that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler releasing (EMC) engineer (or other DaimlerChrysler authorized person) before a test is begun
- ___ 3. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65
- ___ 4. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

3. Proficiency Testing

A. Procedure
TBD

B. Repeatability
TBD

C. Correlation:
TBD

D. Reporting of Results
TBD

E. Performance History
TBD

APPENDIX N - ASSESSMENT FOR AUDIO FREQUENCY CONDUCTED IMMUNITY TEST

SAE J1113-2 is the base document for this test.

1. Prerequisites

On-site assessment shall be performed only after the laboratory has:

- a. Performed a satisfactory self-assessment of Appendix C and Section 2 of this Appendix,
- b. Provided a copy of the internal lab procedure, a sketch of the test set-up and a Configuration Control List for the test stand,
- c. Written or used a test plan and successfully collected data and written a test report (including photographs of the test set-up) for three distinct automotive components,
- d. Prepared a statement identifying any limitations in meeting the capability of the test method, such as: frequency range, noise floor, etc., and
- e. Provided a legible copy of the above deliverables to the assessor body (or to the assessor at the direction of the assessor body as part of the assessment application package. In addition, a copy of the deliverables is to be provided to each of the Lead Persons as listed on page 1.

2. On-Site Assessment Questionnaire

The following requirements are in the form of positive requirement statements. A check mark may be used to signify compliance with the requirement and "NC" to signify non-compliance. All non-compliant conditions require explanation, if accreditation is granted.

NOTE: If a test facility has more than one test set-up for this test, each test set-up shall be evaluated separately.

An "*" before the question indicates probable significant impact on the test uncertainty.

A. Test Set-up

- ___ 1. The lab has a copy of the referenced version of the lab procedure.
- ___ 2. *The equipment, software (with revision level) and calibration/correlation date used in the test stand matches the data listed in the Configuration Control List.
- ___ 3. *The supply voltage is maintained within 13.0 to 14.0 volts.
- ___ 4. *The test apparatus provides a source impedance of less than 0.5 Ohm.
- ___ 5. The test set-up is as shown in SAE J1113-2 including the use of the current probe.

B. Procedure

- ___ 1. The injected test signal voltage is measured from the DUT lead to ground, not across the transformer secondary winding

C. DaimlerChrysler Corp Specific Requirements

- _____ 1. The lab has the latest version copies of DaimlerChrysler Corp documents: PF-9326, LP-388C-33, and LP-388C-65
- _____ 2. The laboratory technical manager understands that DaimlerChrysler requires that a test plan be approved by a DaimlerChrysler EMC engineer (or other DaimlerChrysler authorized person) before a test is begun
- _____ 3. Demonstrate that data is compiled so that it can be transmitted to DaimlerChrysler in accordance with LP-388C-65.
- _____ 4. The circular cross section of wiring for the DUT and loads is compatible with the current in the wires.
- _____ 5. Automated test software, if used, shall be under change control and verified at a minimum of once per year.

NOTE: This test method is under study at DCC and a new or revised Lab Procedure is expected in the near future. The requirements in this appendix are likely to be modified.

3. Proficiency

A. Procedure

TBD

B. Repeatability

TBD

C. Correlation:

TBD

D. Reporting of Results

TBD

E. Performance History

TBD

VIII. Revision History

| <u>Date</u> | <u>Description</u> |
|----------------------|--|
| <u>June 29, 2001</u> | <u>Updated to reference ISO/IEC 17025.</u> <u>Section II requirements renumbered to match ISO/IEC 17025</u> <u>Document Revision History section added.</u> <u>No other changes made.</u> |