Automotive EMC Laboratory Recognition Program (9/4/2002)

The readers of the attached Automotive EMC Laboratory Recognition Program document are encouraged to provide comment to any of the contacts listed below:

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I INTRODUCTION

This document has been developed jointly by personnel from DaimlerChrysler (DC), Ford Motor Company (Ford) and General Motors Corporation (GM). 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 Recognition Program 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, CISPR, SAE, and company specific procedures.

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

NOTE: DaimlerChrysler AG (DC) will use the AEMCLRP. Beginning January 1, 2003, all component EMC test data submitted to DC is required to be from an EMC lab approved by DC. Accreditation by an accreditation body (with whom we have a Memorandum of Understanding or equivalent document) will be accepted by Mercedes-Benz and Chrysler as the basis for interim recognition/approval of an automotive EMC laboratory's competence to perform the DC EMC tests. DC reserves the right to arrange for follow-up correlation tests and on site visits to evaluate the DC test methods not included in the AEMCLRP requirements and to further review and discuss the tests defined in the DC EMC Specification. A laboratory which refuses such follow-up activities or for which significant discrepancies are found is subject to having its approval/recognition withdrawn. Laboratories which have DC (Chrysler Group) EMC Laboratory Correlated Status will be required to be accredited to AEMCLRP by

January 1, 2004. They will not lose their approved status in the interim unless significant discrepancies are found. Questions regarding this policy should be addressed to Andrew Shune (248-576-6919 or zx@daimlerchrysler.com) at DaimlerChrysler Auburn Hills or to the EMC team at Mercedes-Benz passenger car development.

II CRITERIA FOR AUTOMOTIVE EMC LABORATORY ACCREDITATION

II.A ISO/IEC 17025 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.

1.0 Scope

1.1 These requirements are for EMC laboratories interested in becoming accredited and recognized 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.

4.5. Subcontracting of Tests and Calibrations

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.

5.2 Personnel

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

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

Shall meet one of the following list of requirements:

- NARTE EMC Engineer Certification;
- B.S.E.E or B.S. Physics degree (or equivalent) plus 5 years technical experience in an EMC laboratory;
- M.S.E.E. (or equivalent) plus 3 years technical experience in an EMC laboratory;
- Associates degree in electronics (or equivalent) plus 10 years technical experience in an EMC laboratory.

Exceptions must be approved by the AEMCLRP Committee prior to a laboratory being assessed by an authorized accrediting body. Equivalent degrees under different titles will be given consideration.

Any changes of personnel with the responsibilities listed above must be communicated to the Assessor body and the AEMCLRP Committee.

5.4 Test and Calibration Methods and Method Validation

5.4.1 General

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.

5.4.2 Selection of Methods

Table 1. Specific Automotive Test Methods

Test Method Requirements	Appendix	Applicable OEM			Primary Document	*Alternate Document(s)*
		DC	Ford	GM		
Direct Injection	D	✓			SAE J1113-3	*ISO11452-7*
Bulk Current Injection (BCI), Closed-Loop Method	E		✓	✓	ISO 11452-4	*SAE J1113-4 / GMW3097 / GMW3100*
Electrostatic Discharge (ESD)	F	✓	✓	✓	ISO 10605	*SAE J1113-13*
Absorption Chamber	G	✓	✓		SAE J1113-21	*ISO 11452-2*
Transverse Electromagnetic (TEM) Cell	H	✓			ISO 11452-3	*SAE J1113-24*
Tri-Plate	I		✓		SAE J1113-25	
Reverberation Radiated Immunity, Mode Stirring	J			✓	SAE J1113-27	*GMW3097 / GMW3100*
Radiated Emissions	K	✓	✓	✓	CISPR 25	*SAE J1113-41*
Radiated Emissions - Reverberation Method	L			✓	GMW3097 / GMW3100	
Conducted Emissions	M	✓			DaimlerChrysler LP-388C-41	
Reverberation Radiated Immunity, Mode Tuned	N			✓	GMW3097 / GMW3100	
Bulk Current Injection (BCI), Substitution Method	O	✓	✓	✓	ISO 11452-4	*SAE J1113-4 / GMW3097 / GMW3100*

Automotive EMC lab accreditation and recognition apply to specified test procedures only. NOTE: Some procedures have OEM specific requirements. The criteria check lists 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.

5.4.6 Estimation of Uncertainty of Measurement

5.4.6.2. The application of uncertainty to automotive EMC test methods has not been developed at this time. For the purposes of this program (applicable to laboratory tests, not calibration), uncertainty calculation/estimations are not required to be included in the test data. Automotive EMC laboratories being accredited under this program, however, must analyze the implementation of the test methods (including applicable software) and determine the major contributors to uncertainty. The laboratory shall estimate the contribution of the major contributors and, in addition, develop a continued improvement program to reduce the uncertainty of the test methods.

5.4.7 Control of Data

5.4.7.2 For the purposes of this program, the requirements of 5.4.7.2 (a) shall apply to purchased as well as user-developed software. Test control software shall be validated at least once a year.

5.5 Equipment and Reference Materials

5.5.1 Proficiency test artifacts will be provided by the AEMCLRP Committee to the accrediting bodies. Refer to

Section IV.

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 'sampling of substances, materials, or products for subsequent testing or calibration' 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 Section 5.7 of ISO/IEC 17025.

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 still apply.

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. Other accreditation programs shall be approved by the AEMCLRP Committee.

The assessment cycle for the technical requirements shall consist of the following:

- A full assessment, including full proficiency test evaluation, shall be performed every three years at a minimum.
- Interim assessments shall be performed once annually at a minimum. During this assessment, historical performance data shall be evaluated for all tests in the laboratory's scope of accreditation. Sampling of procedures to be assessed during an annual on-site assessment is permitted.
- The quality system assessment cycle will be determined by the assessor body.

Note: If a major change is made to a test method, the Committee has the option of requesting that the test method be evaluated at the next interim assessment.

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 except under the conditions specified in II.C above.

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 checklist requirements to establish the competence of the laboratory to perform each of the tests which the laboratory is seeking accreditation for.

III.E Assessor body report requirements

The assessor's report shall meet, at a minimum, the following requirements.

- The report shall be written in English.
- All deficiencies noted during the accreditation by an auditor must be included.
- A copy of the final scope of accreditation (AEMCLRP procedures) must be included.

IV PROFICIENCY TESTING MANAGEMENT

1) The AEMCLRP Committee will provide proficiency test artifacts for this program.

2) When a laboratory assessment is scheduled, the assessor body shall notify the AEMCLRP 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. The laboratory to be assessed is not to contact the Committee members to obtain an artifact.

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 evaluate the data from the proficiency artifacts to ensure that their internal quality and consistency requirements are met.

6) The Accreditation Body shall forward the data to the AEMCLRP Committee for review.

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. However, the laboratory is still responsible for performing the proficiency tests on the artifact defined in each respective appendix of this document. Accreditation shall not be granted until the proficiency testing on the defined artifact is successfully completed.

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, the Accreditation Body shall withhold or withdraw accreditation, if issued, and terminate its accreditation process for all AEMCLRP test methods in that laboratory's scope. 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 AEMCLRP APPENDICES

APPENDIX A – REFERENCE DOCUMENTS

* Relevant document not directly referenced in this document

- CISPR 25 Second Edition (2002) Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicle
- DaimlerChrysler Joint Engineering Standard DC-10614
- DaimlerChrysler PF-9326 Rev. D/2001
- DaimlerChrysler PF-10540/2001
- DaimlerChrysler LP-388C-32 11/2000
- DaimlerChrysler LP-388C-34 3/2001
- DaimlerChrysler LP-388C-35 3/2000
- DaimlerChrysler LP-388C-41 3/2000
- DaimlerChrysler LP-388C-42 11/2000
- DaimlerChrysler LP-388C-65 7/1997
- Ford Motor Company ES-XW7T-1A278-AB
- GMW3097 - General Motors EMC Worldwide Specification / Verification Sections, August 2001
- GMW3100 - General Motors EMC Worldwide Specification / Requirements Sections, August 2001
- 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 10605 Road vehicles - Electrical disturbances from electrostatic discharges -1994
- ISO 11452-1: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 1: General and definitions - 2001
- ISO 11452-2: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 2: Off-vehicle radiation source - 1995
- ISO 11452-3: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 3: Transverse electromagnetic mode (TEM) method – 2001
- ISO 11452-4: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 4: Bulk current injection method (BCI) - 2001
- ISO 11452-7: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 7: Direct radio frequency (RF) power injection - 1995
- NIS 81 Edition 1, May 1994: The Treatment of Uncertainty in EMC Measurements
- NIST Handbook 150: Procedures and General Requirements
- NIST Handbook 150 - 11: Electromagnetic Compatibility and Telecommunications FCC Methods
- SAE J1113-1 (July 95): Electromagnetic Compatibility Measurement Procedures and Limits For Vehicle Components (Except Aircraft) (60 Hz to 18 GHz)
- SAE J1113-3 (99): Conducted Immunity, 250 kHz to 500 MHz, Direct Injection of Radio Frequency (RF) Power.
- SAE J1113-4 (Feb 98): Immunity to Radiated Electromagnetic Fields – Bulk Current Injection (BCI) Method.
- SAE J1113-13 (Oct 97): Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Part 13 – Immunity to Electrostatic Discharge.
- SAE J1113-21 (Jan 98): Road Vehicles – Electrical Disturbances by Narrowband Radiated Electromagnetic Energy – Component Test Method – Part 21 – Absorber-Lined Chamber
- SAE J1113-24 (May 00): Electromagnetic Compatibility Measurement Procedure For Vehicle Components –

Immunity to Radiated Electromagnetic Fields – Transverse Electromagnetic Mode (TEM) Method.

- SAE J1113-25 (Mar 99): 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 (May 00): 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

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 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

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
NARTE	National Association of Radio and Telecommunications Engineers
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 – GENERAL REQUIREMENTS

C.1 PREREQUISITES

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

a. Performed a satisfactory self-assessment of ISO 17025 requirements and Section 2 of all Appendices in the laboratory's intended scope of accreditation,

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. Submitted test plans and test reports (including photographs of the test set-up) for three separate automotive components for each test method in the laboratory's intended scope of accreditation.

d. Provided a summary of the historical data required in Section 3, Proficiency Testing using a suitable DUT,

e. Provided 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 Committee Member Companies as listed on page 1.

Note: Documents and data marked 'Confidential', 'Secret', 'Proprietary', etc. cannot be reviewed by the AEMCLRP Committee.

C.2 IMMUNITY THRESHOLDING

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.

C.3 GENERAL ITEMS

1 _____ Laboratory shall have an up to date copy of the referenced standard(s).

2 _____ All equipment shall be in current calibration.

3 _____ 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.

4 _____ Objective evidence of training of test personnel shall be available for inspection.

APPENDIX D - ASSESSMENT FOR DIRECT INJECTION TEST PROCEDURE

Appendix modified July 9, 2002

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. 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 Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, PF-9326, LP-388C-32 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. The dwell time shall be sufficient to exercise the DUT, but shall be 3 or 2 seconds minimum depending on the requirements document.

____ 5. Requirement B.4 above shall be interpreted to be at least once each time the test is used.

____ 6. The alternate test clip method of J1113-3 paragraph 5.3 for connecting to the BAN is not acceptable for DaimlerChrysler tests.

____ 7. Test levels are recorded in milliwatts.

____ 8. The standard blocking capacitor and BAN(s) are used except when testing data bus leads and then shall be in compliance with PF-9326.

____ 9. The power meter is zeroed/self calibrated before beginning a test.

_____ 10. The leads from the BAN(s) to the DUT shall be at least 50 mm above the ground plane.

_____ 11. AM Modulation is not required.

_____ 12. The DaimlerChrysler frequency range in DC-10614 is 1 to 400 MHz.

2. 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 1.B above.

E. Performance History

See 1.B above.

APPENDIX E - ASSESSMENT FOR BULK CURRENT INJECTION (BCI), CLOSED-LOOP METHOD 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

NOTE: If a test facility has more than one test setup for this test, each test setup shall be evaluated separately. This procedure will be removed from the next revision of this document.

1. 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.
3	_____	The negative lead of the battery feeding the DUT harness shall be electrically connected the ground plane.
5	_____	The wiring harness shall be maintained (50 +/- 5) mm above the ground plane measured from the bottom of the wire bundle.
6	_____	The wiring harness shall be centered in both the monitoring and injection probes.
7	_____	The DUT shall be at least 500 mm from the wall.
8	_____	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.
9	_____	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.
10	_____	The RF signal generator shall have a rated frequency range of 1 to 400 MHz minimum.
11	_____	The broadband power amplifier shall have a rated frequency range of 1 to 400 MHz minimum.
12	_____	The injection probe shall have a rated frequency range of 1 to 400 MHz minimum and a minimum power rating of 50 W.
13	_____	The monitor probe shall have a rated frequency range of 1 to 400 MHz minimum.
14	_____	The spectrum analyzer shall have a rated frequency range of 1 to 400 MHz minimum.
15	_____	Directional couplers/RF sampling devices shall have a rated frequency range of 1 to 400 MHz minimum.

16 _____ The DUT harness shall be at least 200 mm from the edges of the ground plane.

17 _____ Transfer impedance of the monitoring probe shall be available for inspection

18 _____ Remote monitoring capabilities that do not impose a load on the monitored device shall be used (i.e., fiber optic signal monitoring, visual, audio)

19 _____ 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 +0.5/-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 and 80% 1 kHz Conservation of Peak AM.

4 _____ A resonant condition manifests when enough power can not be injected to achieve the 100 mA requirement. If performance anomalies, or deviations, appear in the same resonant frequency areas for ALL three injection probe positions, these anomalies shall be disregarded.

5 _____ Data shall be reported in dBuA.

C. Ford Specific Requirements

1 _____ The laboratory 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.

2. 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 and load should be isolated (5 cm) from 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 connector. 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, adjust the DUT's Analog Voltage Output to read 2.54 ± .005 Volts,
- Proceed with proficiency test.

Note: It is recommended that, after an anomaly threshold is reached at a frequency, the test be continued at the next frequency without increasing to the maximum injected current.

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 test frequencies as calculated using the following equation:

$$f_{test} = f_0 \times 2^{(k/n)}$$

Where f_{test} is the frequency to inject,
f_0 is the start frequency (e.g., 1.00 MHz)
k is the index number of the injection frequency (i.e., 0, 1, 2, …)

Frequency Range	f_0	n	Lowest Test Frequency in Range
1 MHz...< 30 MHz	1 MHz	7	1.000 MHz
30 MHz...< 400 MHz	30 MHz	25	30.00 MHz

Verification Instructions:

- BCI testing shall be performed using one specified GM injection probe position (i.e., 12, 45, or 75 cm). Each 'test' is composed of evaluation at this probe position.
- Fixture shall be tested three (3) times with CW only. No other modulation is required.
- 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 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:

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

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., dBuA).

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:

$$\left|\sum_{i=1}^{n}(106 - P_i - \gamma) - \sum_{i=1}^{n}(106 - P_{ri})\right| \leq 20 \qquad \text{Expression E.2}$$

$$\text{Where } |\gamma| \leq 5$$

Where P_i *is the anomaly threshold, in units of dBuA, 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 dBuA, 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 dBuA, at frequency* f_i *(Refer to GMW3097 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., dB.uA), 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; all frequencies of injection in MHz; and anomaly thresholds in dBuA.
- 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 (dBuA),Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
Line 7: ***Frequency 2 (MHz), Anomaly threshold 2 (dBuA),Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
….
….
….
Line n: ***Frequency n (MHz), Anomaly threshold n (dBuA), 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: 2/12/2002
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 test results from the specified probe position, 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.

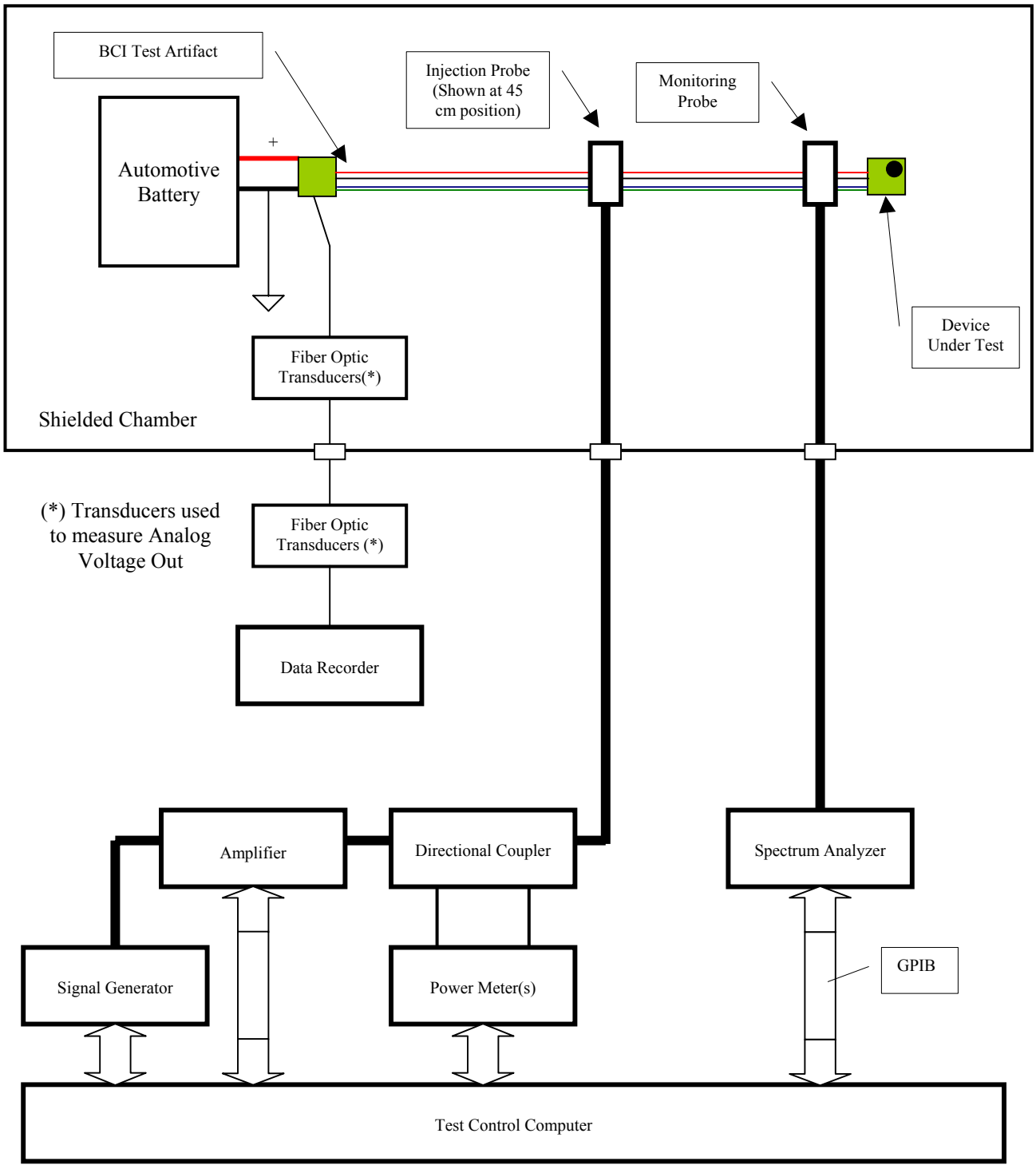
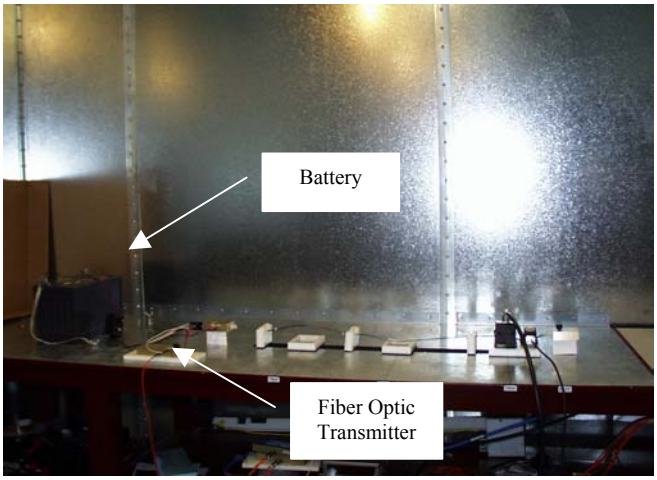
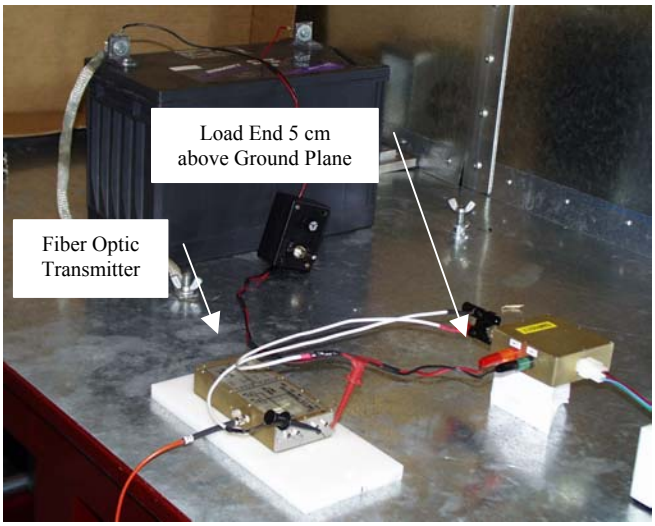


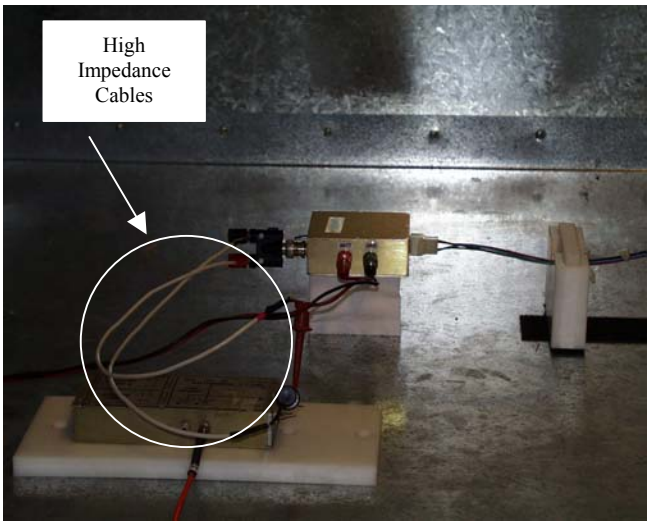
Diagram E.1 - Typical BCI Setup Diagram For Testing BCI Test Artifact



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

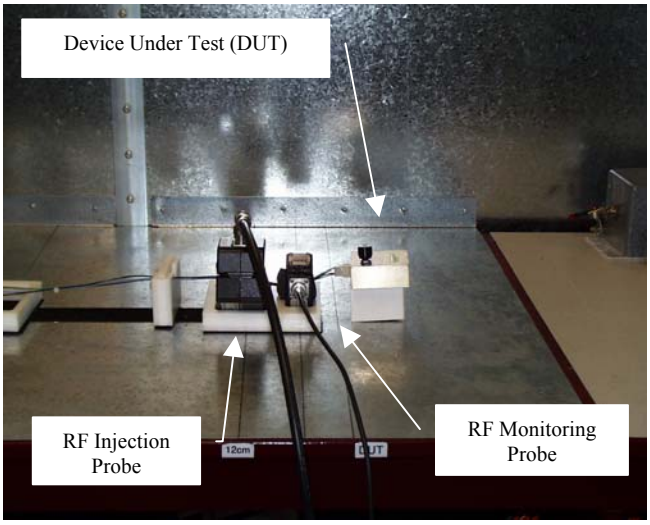


Picture E.2: Close up of load end of RI Artifact.



Picture E.3: Close up of voltage monitoring leads connected to the ANALOG VOUT terminal of the BCI RI Artifact.

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 position.

APPENDIX F - ASSESSMENT FOR ELECTROSTATIC DISCHARGE TEST PROCEDURE

General Reference document(s):

- ISO 10605 – Road vehicles – Electrical disturbances from electrostatic discharges
- SAE J1113-13 - Electromagnetic Compatibility Measurements Procedure For Vehicle Components - Part 13 - Immunity To Electrostatic Discharge

DaimlerChrysler Reference documents:

- DaimlerChrysler documents: DC-10614, PF-10540, PF-9326, LP-388C-42, and LP-388C-65

GM Reference documents:

- GMW3100 Section 3.2.1.4 - Electrostatic Discharge (Verification Section), August 2001
- GMW3097 Section 3.2.1.4 - Electrostatic Discharge (Requirement Section), August 2001

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

1. 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 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 m^2.

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 $^{\circ}$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 five discharges at each voltage level at both positive and negative polarity.

2 _____ Intended operation of DUT functionality shall be verified after each series of five 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 (including the trunk interior), air discharges shall also be applied using a 150 pF simulator.

4 _____ The risetime requirement for ESD simulator air discharge verification shall be ≤ 20 ns.

5 _____ In determining the RC time constant, the RC time constant shall be calculated in the exponentially decaying portion of the waveform after the leading edge and/or ringing.

C. DaimlerChrysler Specific Requirements

1 _____ The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, 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 _____ DC-10614 requires discharge networks of 150 pF/330 Ohm and 330 pF/330 Ohm.

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.

2. 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

- ISO 11452-2: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods - Part 2: Off-vehicle radiation source
- 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 DaimlerChrysler and Ford)
_____ Closed loop method
_____ Metallic bench (required by Ford; allowed for DaimlerChrysler DC-10614 tests)
_____ Nonmetallic bench(required by DaimlerChrysler for PF-9326 and PF-10540 tests, allowed for DC-10614 tests)
_____ Nonmetallic bench with metallic surface
_____ Frequency range

Modulation
_____ Unmodulated (CW)
_____ Amplitude modulation
_____ Other

1. 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 compatible with the laboratory selected frequency range.

_____ 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 using the conservation of peak concept defined in ISO 11452-1.

_____ 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 ± 10%.

_____ 20. * The test harness segment parallel to the front of the test bench is 1500 ± 75 mm long.

_____ 21. The length of test harness from the front segment to the DUT to the ANs is 100 ± 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 m^2 minimum; smaller side 0.75 m minimum.

_____ 35. * The ground plane (when used) is bonded to 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 bench [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 Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, PF-9326, LP-388C-34, LP-388C-35 and LP-388C-65.

____ 2. Demonstrated that the substitution method is used with a nonconductive bench when use of PF-10540 or

PF-9326 is required.

_____ 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. The chamber wall bulkhead filter meets the requirements of LP-388C-34 and LP-388C-35.

____ 6. For the nonmetallic bench method, the antenna is located a minimum of 1000 mm from the DUT rather than being referenced to the wire harness.

____ 7. Demonstrate that the field uniformity requirement of LP-388C-35 is fulfilled for nonmetallic bench method.

____ 8. The power meter is zeroed/self calibrated before beginning a test.

____ 9. AM modulation is not required.

____ 10. The non-conductive bench, when required, may be higher than 950 mm as required to achieve the test field uniformity.

____ 11. The nonmetallic bench, when used, shall be made from low RF absorption material (e.g., Styrofoam, not wood.).

____ 12. The dwell time shall be sufficient to exercise the DUT, but shall be 3 or 2 seconds minimum depending on the requirements document.

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.

2. 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)
- SAE J1113-24 : Electromagnetic Compatibility Measurement Procedure For Vehicle Components – Immunity to Radiated Electromagnetic Fields – Transverse Electromagnetic Mode (TEM) Method.

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 DaimlerChrysler)
_____ 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 components are required to use the Calculated field strength method and Exposure of DUT and harness method.

1. 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 using the conservation of peak concept as defined in ISO 11452-1.

_____ 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 ε_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 only method is used, the dielectric support is 50 +/-5 mm high.

_____ 14. When the exposure of the DUT only method 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 Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, 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. The dwell time shall be sufficient to exercise the DUT, but shall be 3 or 2 seconds minimum depending on the requirements document.

_____ 8. The power meter is zeroed/self calibrated before beginning a test.

_____ 9. Demonstrate that the field monitoring probe provides reasonable correlation with the calculated field strength.

_____ 10. The chamber wall bulkhead filter meets the requirements of LP-388C-34.

_____ 11. If the amplifier output signal quality has harmonic content of –20 dBc or better, then the low-pass filter is not needed.

_____ 12. AM modulation is not required.

2. 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

(revised 7/02)

General Reference document(s);

- SAE J1113-25 - Immunity to Radiate Electromagnetic Fields - Tri-Plate Line Method (March 1999)

Ford Motor Company specific reference documents(s)

- Ford Electronic Component EMC Requirements and Test Procedures (ES-X7T-1A278-XX). Latest addition may be found at http://www.fordemc.com

1. Onsite Assessment Questionnaire

A. Test Setup

_____ Is the RF field strength meter capable of measuring 200 V/m up to 1000 MHz?

_____ Has the RF field strength meter been calibrated within the last year?

_____ Do the signal source and power amplifier develop modulated and unmodulated power at the immunity levels specified in the SAE J1113-25?

_____ Are the in-line directional couplers and RF watt meters used that are capable of handling the maximum power and frequency range?

_____ Is the frequency resolution of the signal source less than 100 Hz?

_____ Are harmonics and spurious outputs of the signal source and power amplifier less than -20 dBc referred to the fundamental power?

_____ Does the laboratory power supply meet the following specifications?:

- Power Supply voltage is 13.5V$\pm$1V. May be either a vehicle battery or a linear type (not switching) power supply, isolated from the AC mains.
- Short circuit capacity of 200 amps
- Maximum ripple voltage: $\pm$ 0.20 volts.
- If a automotive battery is used, it is a maintenance free type with open circuit voltage $\geq$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.

_____ Is all test equipment used for this test calibrated?

_____ Are the measurements performed in a shielded enclosure?

_____ Are the shielded enclosure walls and ceiling lined with RF absorbers?

_____ Is the TPL ground plane electrically bonded to the shielded chamber

_____ Are feed and load ends of the TPL no closer than 0.5 meters from the RF absorber?

_____ Are the open sides of the TPL no closer than 1 meter from the RF absorber?

_____ Is the ambient temperature during the test 23 degrees +/- 5 degrees C?

_____ Is the TPL fixture constructed in accordance with the requirements delineated in SAE J1113/25?

_____ Are the peripheral monitoring or operating devices that are used inside the chamber shielded and filtered?

_____ Are the leads fed through the wall of the shielded test chamber equipped with adequate RF filters at the wall?

_____ Is a non-conductive fixture present to locate the DUT and its test harness in the center of the TPL, parallel to its major axis, and supported midway between the septum and the ground plane?

_____ Does the non-conductive support maintain a constant wire harness height between the DUT and the Test Fixture?

_____ Does the non-conductive fixture have a dielectric constant less than 1.4?

_____ Are the coax cables, signal sources and amplifiers checked each morning for proper operation?

B. Test Procedure

_____ Does the lab have a copy of the referenced version of the standard(s)?

_____ Has the lab completed characterization of the TPL as required in Appendix A of SAE J1113-25?

_____ Is the dwell time at each frequency adjustable to facilitate DUT response? (The minimum time of exposure shall be 2 seconds.)

_____ Is the maximum frequency step size equal to 1 MHz over the frequency range from 1 MHz to 10 MHz?

_____ Is the maximum frequency step size equal to 2 MHz over the frequency range from 10 MHz to 200 MHz?

C. Ford Motor Company Specific Requirements

_____ Does the lab have a latest copy of the Ford Reference Standard (ES-XW7T-1A278-XX)? The latest copy may be found at http://www.fordemc.com.

_____ Is the maximum frequency step size equal to 5 MHz for the frequency range from 200 MHz to 400 MHz?

_____ Is the maximum frequency step size equal to 10 MHz for the frequency range from 200 MHz to 1000 MHz?

2. 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 test equipment listed shall be supplied by the test laboratory unless otherwise specified.

Test Hardware Description	Recommended Equipment	Supplied by AEMCLRP
Test Artifact	NA	Yes
PCB with SMA connector		
2 meter coaxial cable (Type N, SMA connectors)		
3 dB, 2 watt coaxial attenuator		
20 dB, 2 watts 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) Verify that the characterization procedure delineated in Appendix A of SAE J113-25 has been completed.

b) Connect the Test Artifact as illustrated in Figures 1 and 2. The Test Artifact should 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.

c) 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 4 for details.

d) Connect the 3dB coaxial attenuator to the "P1 IN" connector of the Termination Box. Connect the Test Artifact Cable to the other end of the attenuator.

e) 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 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:

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

where:

$P_A(f) =$ Normalized Power (dBm at 1 V/m) at Test Artifact cable connector.

$P_M(f) =$ Measured Power (dBm) at Spectrum Analyzer Input

$A =$ Coaxial Attenuator value (dB) at test frequency (Select 3dB or 20 dB)

$E(f) =$ Actual field strength (V/m) at test frequency

$C(f) =$ Cable attenuation at test frequency (applies to cables between test fixture and Spectrum Analyzer)

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) Replace the 3 dB coaxial attenuator with the 20 dB coaxial attenuator without disturbing the Test Artifact cable layout. 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 test equipment listed shall be supplied by the test laboratory unless otherwise specified.

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

2. Test Setup

   a) Verify that Characterization Procedure delineated in SAE J113-25 (see section F) has been completed.

   b) Use the same test setup described in Procedure 1, steps a) and b) except use Figures 1 and 3.

   c) Connect the 3dB coaxial attenuator to the "P2 IN" connector of the Termination Box. Connect the Test Artifact Cable to the other end of the attenuator.

   d) 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 3. 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:

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

where:

$V_A(f)$ = Normalized signal level (DC volts at 1 V/m) at Test Artifact cable connector.

A = Attenuation factor
= 1.413 (3 db attenuator)
= 10 (20 db attenuator)

$V_M(f)$ = Test Artifact signal level (DC volts) measured by voltmeter

$E(f)$ = 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

Characterization Verification

Test Setup and Procedure

a) Remove the TA and all attached cabling from the TPL and insert an RF field probes at Position #1 as delineated in Figure 4.

b) At each test frequency (from Procedure 1 or Procedure 2), apply power to the TPL at a calculated field strength of 25 V/m. Measure and record the field strength from the RF field probe at each test frequency.

c) Repeat b) at the other 4 probe locations delineated in figure 4.

B. **Repeatability** (Requirements are presently being drafted)

C. Correlation (Requirements are presently being drafted)

D. Reporting of Results

Recorded data from Procedure #1 shall be saved in a Microsoft Excel format listing each test frequency and recorded peak levels (e.g. dBm) from the spectrum analyzer in addition to the actual generated field strength. All calculations shall be included. The frequency and data shall also be plotted on a 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 a Microsoft Excel format listing each test frequency, recorded voltage reading, and actual generated field strength. All calculations shall be included. The frequency and voltage data shall also be plotted on a 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 data.

Recorded Data from the Characterization Verification shall be saved in a Microsoft Excel format listing each test frequency and the field strength readings from all 5 probe positions. All calculations shall be included. Table 3 provides an example of the formatted data.

Table 1 Example of Procedure #1 Data Report Format

Freq (MHz)	Req. FS (V/m)	Actual FS (V/m)	Level (dBm)
1	25	26	-30.0
2	25	27	-25.4
3	25	29	-20.1
4	25	25	-15.7
5	25	27	-16.4
6	25	27	-5.3
.	.	.	.
.	.	.	.

Table 2 Example of Procedure #2 Data Report Format

Freq (MHz)	Req. FS (V/m)	Actual FS (V/m)	Volts (Volts)
1	25	26	.0030
2	25	27	.0041
3	25	29	.0138
4	25	25	.0345
5	25	27	.0834
6	25	27	.1178
.	.	.	.
.	.	.	.

Table 3 Example of Characterization Data Report Format

Measured Field Strength @ 25 V/m

Freq (MHz)	E1 (V/m)	E2 (V/m)	E3 (V/m)	E4 (V/m)	E5 (V/m)	P_F (watts)	P_R (watts)	P_{OUT} (watts)	Z(f) {ohms}
1	25.2	25.5	26.0	24.3	25.0	10	2	10	70
2	25.5	24.3	25.0	25.2	24.3	15	1	11	70.8
3	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

E. Performance History (Requirements are presently being drafted)

Figure 1 Test Artifact Detail

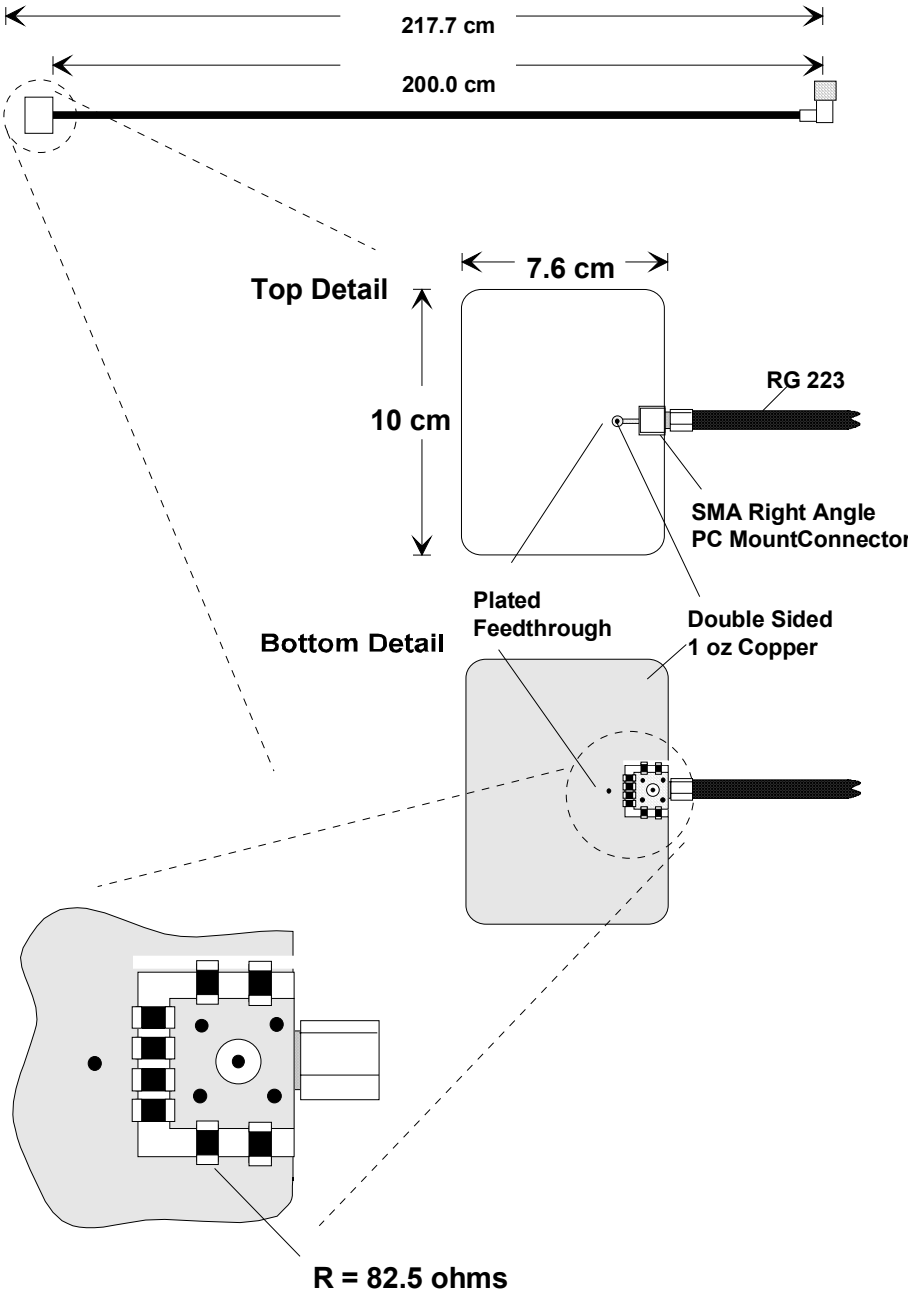


Figure 2 Test Procedure #1 Test Setup

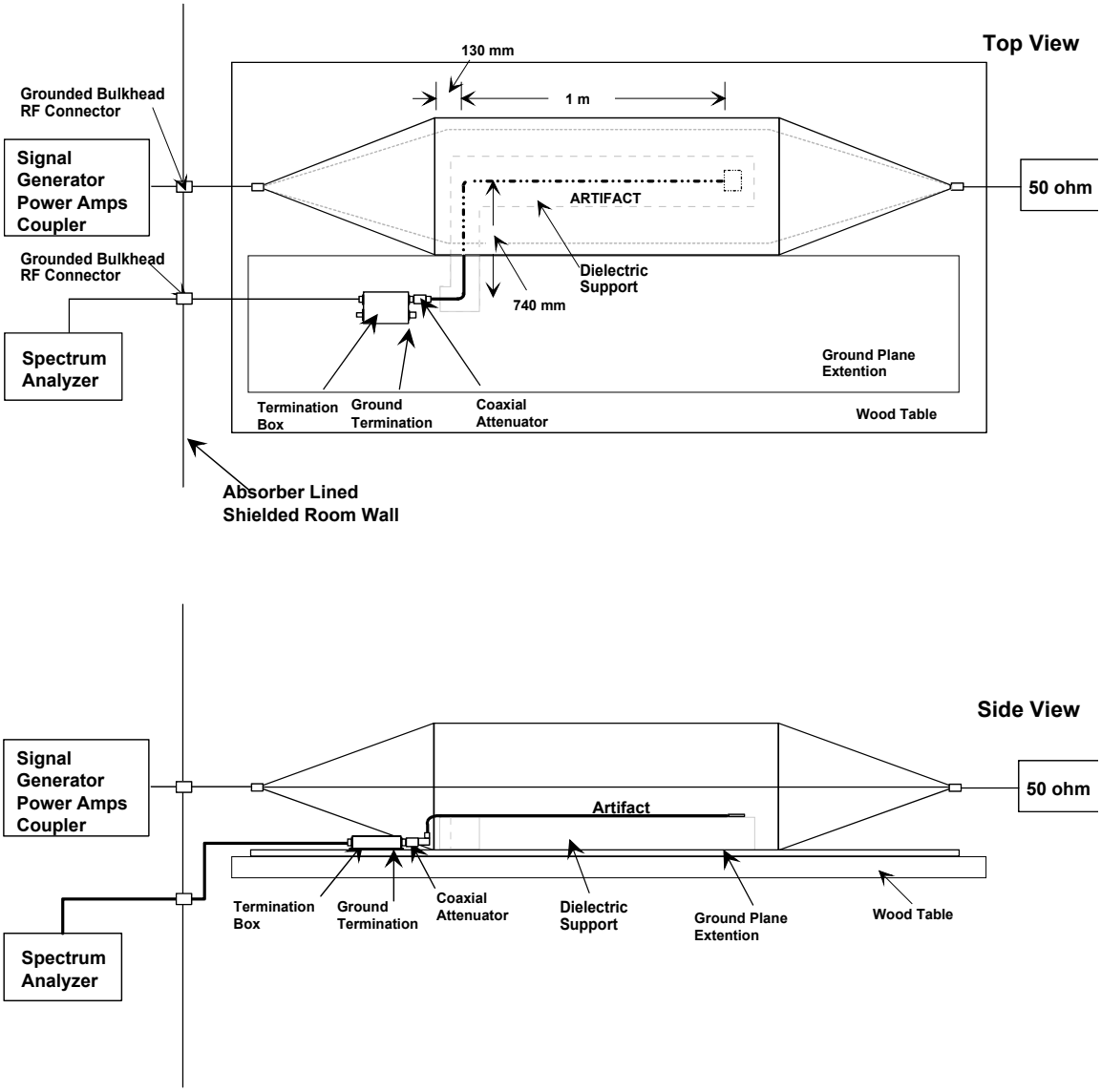


Figure 3 Test Procedure #2 Test Setup

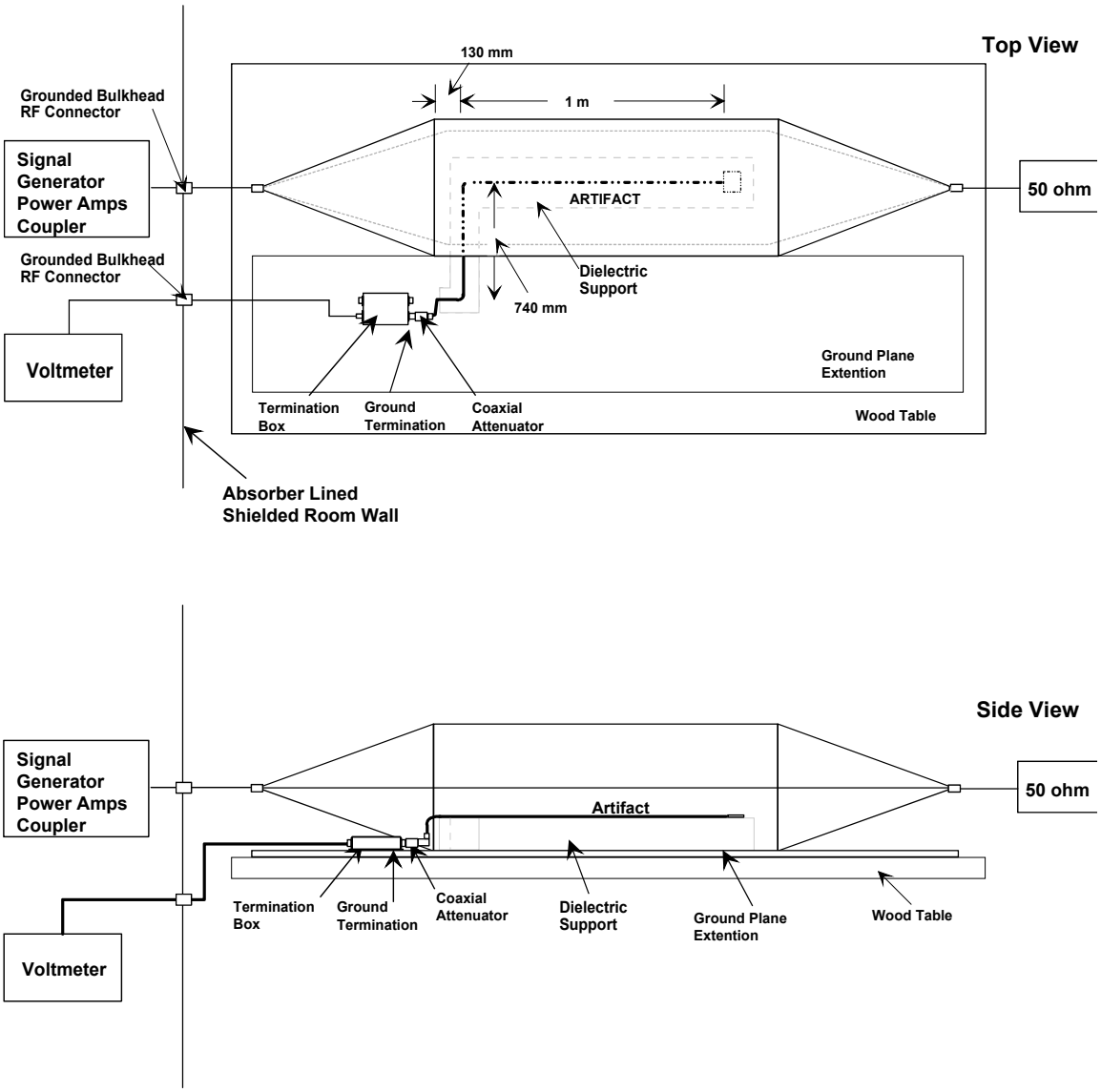
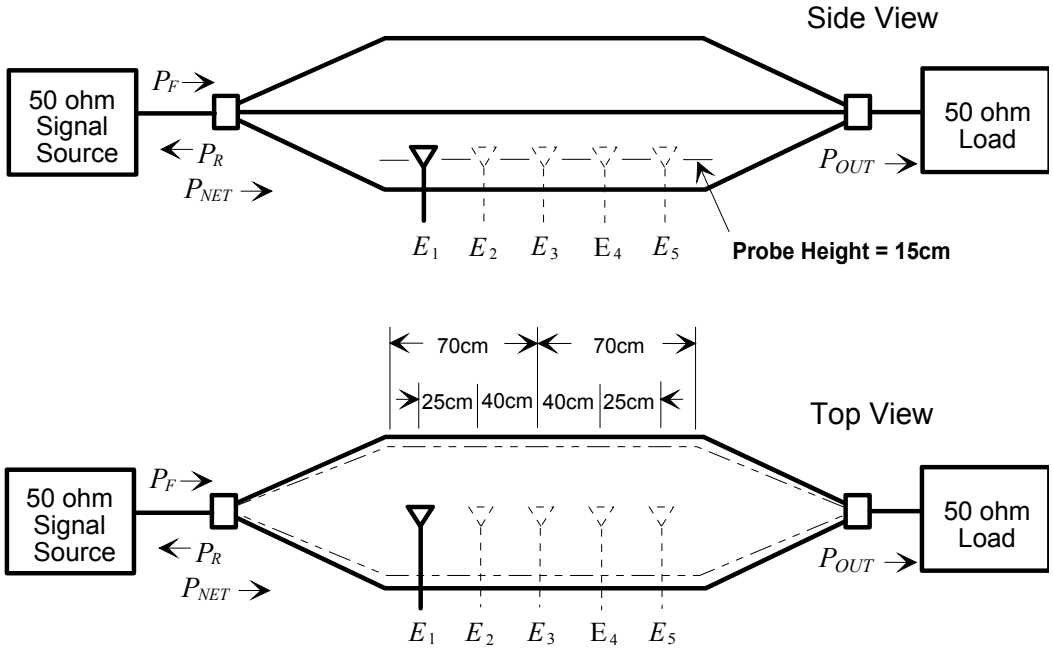


Figure 4 TPL Characterization Setup



APPENDIX J - ASSESSMENT FOR RADIATED IMMUNITY REVERBERATION METHOD – MODE STIRRING 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:

- GMW3100 Section 3.2.1.2.1 - Reverberation Chamber Test, Mode Stirring (Verification Section), August 2001
- GMW3097 Section 3.2.1.2.1 - Reverberation Chamber Test, Mode Stirring (Requirement Section), August 2001

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

1. 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 capable of producing the field strengths indicated in GMW3097 Section 3.2.1.2.1 - Reverberation Chamber Test, Mode Stirring (Requirement Section), August 2001 at the required frequencies.

3 _____ Ground planes, if used, shall be at least $\lambda/3$ (at the lowest frequency) from the floor.

4 _____ The negative lead of the battery feeding the DUT harness shall be electrically connected the ground plane, if used.

5 _____ Thickness of the ground plane, if used, shall be a minimum of 0.5 mm.

6 _____ The area of the ground plane, if used, shall be a minimum of 2 m^2.

7 _____ The ground plane, if used, shall be bonded to the chamber wall with a strap with a minimum width of 60 mm.

8 _____ Antennas shall be at a minimum distance of 70 cm from the chamber walls and corners.

9 _____ DUT shall be at a minimum distance of $\lambda/3$ (at the lowest test frequency) from the mode stirrer, chamber walls.

10 _____ Antennas shall be aimed at different corners of the test chamber. An upward tilt of 20 degrees or more shall be used.

11 _____ Antennas 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 1 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 +0/-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.

GM Specific Test Procedure Requirements

1 _____ Testing shall be performed with CW, 80%, 1 kHz AM (conservation of peak as defined in ISO 11452-4), and Pulsed modulation.

2. 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 "Output". 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 ± .005 Volts,
- One modulation type per frequency will be specified with each artifact.
- 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:

Test frequencies are calculated using the following equation:

$$f_{test} = f_0 \times 2^{(k/n)}$$

Where f_{test} is the frequency to inject,
f_0 is the start frequency (e.g., 400.00 MHz)
k is the index number of the injection frequency (i.e., 0, 1, 2, …)

Frequency Range	**f 0**	**n**	**Lowest Test Frequency in Range (rounded)**
400 MHz...< 1.0 GHz	400 MHz	25	400 MHz
1.0 GHz...2 GHz	400 MHz	25	1.000 GHz

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.
- CW is the only required modulation type.

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:

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

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 linear units of field strength (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:

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

$$\text{Where } |\gamma| \leq 5$$

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 GMW3097 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 linear 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 V/m
- 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: ***Lab/Test information - Discretionary***

Line 6: ***Frequency 1 (MHz), Anomaly threshold 1 (V/m), Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
Line 7: ***Frequency 2 (MHz), Anomaly threshold 2 (V/m), Signal Generator Output (dBm),Amplifier Output Power (dBm) - Required***
….
….
….
Line n: ***Frequency n (MHz), Anomaly threshold n (V/m), Signal Generator Output (dBm),Amplifier Output Power (dBm) - Required***

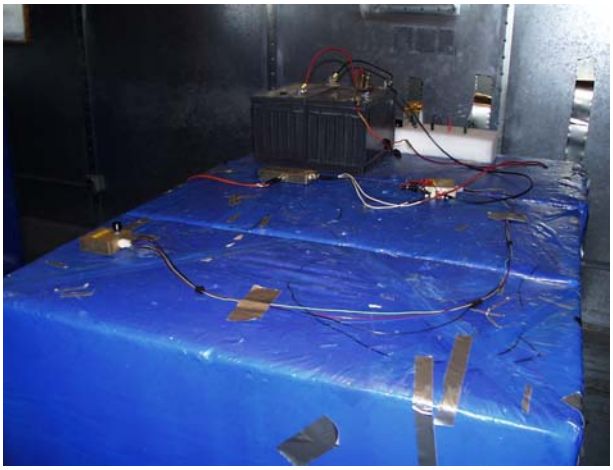
Example of data file content:

General Motors EMC Department – Milford Proving Grounds
Test Number: MC9999
Test Date: 4/1/1998
Test on Reverb Verification Source – Run #3
Line unused
400,33.5,25.0,23.0

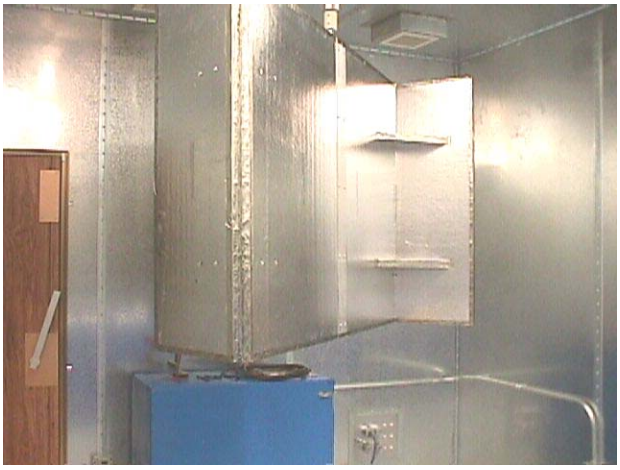
411.25,32.0, 23.0,24.2
….
….
….
1013.96,12.0,23.4,34.2

E. Performance History:

Objective evidence of site performance verifications shall be 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 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 E Picture E.3 for the Bulk Current Injection test procedure.



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

APPENDIX K - ASSESSMENT FOR CISPR 25 RADIATED EMISSIONS TEST PROCEDURE

General reference document(s)

- CISPR 25 Module Radiated Emissions Test Method Technical Requirements (Based on the Second Edition dated 2002)

DaimlerChrysler specific reference document

- DC-10614

Ford Motor Company Reference document

- ES-XW7T-1A278-AB, RE310

GM Reference documents

- GMW 3097, Section 3.2.1.1.2

1. 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. Generic Standard

Generic Test Setup: Consult CISPR 25 (2002)

_____ 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 there provision to bond the Artificial Network(s) 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 performed in an absorber lined shielded enclosure (ALSE)?

_____ 8. Can testing be performed over the standard's specified frequency range from 150 kHz to 1000 MHz?

_____ 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 ± 50mm?

_____ 11. Is the test harness located 100 mm $\pm$ 10 mm from the front edge of the ground plane?

_____ 12. Is the test harness located 50 ±5 mm above the ground plane?

_____ 13. Is the test harness located a minimum of 1000 mm from the absorber on the wall behind the harness?

_____ 14. Is the antenna reference point located 1000 ± 10 mm from the test harness?

_____ 15. Is any element of the antenna a minimum of 1000 mm from any wall or ceiling absorber material?

_____ 16. Is any element of the antenna a minimum of 250 mm from the floor and a minimum of 2000 mm from the walls or ceiling of the shielded chamber?

_____ 17. Is the center of the antenna (Biconical, Log antennas) at 100 ± 10 mm relative to the bench ground plane?

_____ 18. When a rod antenna is used, is the counterpoise bonded to the ground plane of the test bench?

_____ 19. Is the coaxial cable to the antenna fed through a bulkhead connector to maintain shielding integrity?

_____ 20. Is double braided shield (or solid shield) coaxial cable used?

_____ 21. Does the ground plane meet the thickness and material requirements of 0.5 mm minimum thickness and copper, brass or galvanized steel metals?

_____ 22. Does the ground plane meet the requirement of 2 m minimum length or underneath entire equipment plus 200 mm, whichever is larger?

_____ 23. Is the ground plane bonded to the shielded enclosure at intervals no greater than 300 mm?

_____ 24. Does the ground plane depth meet the requirement of 1 m minimum?

_____ 25 Is the test harness location a minimum of 1000 mm from the any wall or ceiling absorber material?

_____ 26 Is the length of test harness from the front segment to the DUT and to the Artificial Networks 100 ±10 mm?

Generic Test Procedures: Consult CISPR 25 (2002)

_____ 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 rate requirements of Table 2 of CISPR 25 met?

_____ 4. If the measurement instrument is a scanning receiver, is the maximum frequency step size limited to 50% of the measurement system BW?

____ 5. Is the supply voltage maintained at 13.5 ± 0.5 Volts for nominal 12 V system components?

_____ 6. Are all objects not pertinent to the test removed from the absorber lined shielded enclosure?

_____ 7. Are all personnel not actively involved in the test excluded from the absorber lined shielded enclosure?

_____ 8. Is data collected and reported in dB (uV/m) field strength?

B. DaimlerChrysler Corp Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler documents: DC-10614 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. The DaimlerChrysler frequency range is 80 to 1000 MHz.

C. GM Specific Requirements

_____ 1. The lab has a copy of the latest version of General Motors specification of GMW3097 and GMW3100.

_____ 2. Testing can be performed over the specified frequency range from 0.15 to 2500 MHz.

_____ 3. At frequencies above 30 MHz, the DUT is tested with horizontal and vertical antenna polarizations and with 3 orthogonal DUT orientations at a minimum.

_____ 4. The Measurement Instrument bandwidth is 10 kHz from 0.15 to 2500 MHz.

_____ 5. For the frequency range of 1000 to 2500 MHz the antenna is moved 0.75 m parallel to the front edge of the ground plane towards the DUT in order to point at the DUT instead of the center of the wiring harness.

D. Ford Specific Requirements

_____ 1. The lab has a copy of the latest version of Ford Motor Company's engineering specification ES-XW7T-1A278. Specific methods and limits delineated in this specification supersede those in CISPR25 where applicable.

_____ 2. Frequency coverage is from 0.15 to 2500 MHz.

_____ 3. For the frequency range above 1 GHz the antenna is moved 0.75 m parallel to the front edge of the ground plane towards the DUT in order to point at the DUT instead of the center of the wiring harness *(new requirement not delineated in existing Ford specification)*

_____ 4. The laboratory technical manager understands that Ford Motor Company requires that a test plan be approved and signed off by a Ford EMC engineer and EMC technical specialist before testing may begin. Failure to do so will invalidate the test results

2. Proficiency Testing

A comb generator (e.g., ComPower CG-501 or CG-515) is used as the proficiency "Test Artifact." Repetition rate should be set to 1 MHz.

A. Test Artifact Measurements

1. Source Measurement:

a) Check the "Test Artifact" battery voltage (with unit turned off) by connecting adapter (red and black wires w/ banana jacks) to the "charge" port. If the battery voltage is lower than 5.0 Volts, recharge the unit. If the battery voltage is below 4.8 volts, discontinue testing and report this to the accrediting body.

b) Disconnect the adaptor and attach the output of "Test Artifact" to the input of the measuring instrument using a short (< 100 mm) coaxial cable. If a longer length cable is used, attenuation characteristics of the cable must be considered.

c) Turn on the "Test Artifact" and verify the green LED (Power) is on and the red LED (Battery Low) is off. Measure the "Test Artifact's" output signal over the frequency range of 1 MHz to 1000 MHz. All measurements shall be performed using either a 9 kHz or 10 kHz measurement instrument bandwidth. Step size shall not exceed 50% of the selected bandwidth. If a spectrum analyzer is used, the maximum scan rate shall not exceed those values listed in CISPR 25, section 4.5.1, Table 2. Peak detection shall be used for all measurements. Record and plot this data.

d) Turn off the “Test Artifact”

2. Radiated Emissions Measurement

a) Re-check the "Test Artifact" battery voltage per the procedures delineated in 2.A.1, step a) above.

b) Remove the adaptor and connect the long (290 mm) rod antenna to the "Test Artifact" output connector.

c) Position the "Test Artifact" directly on the test bench as illustrated in Figures K1. Note the position of the chassis of the artifact with respect to its position on the test bench. Also verify that the "Test Artifact" is resting on its attached Teflon pad and the rod antenna Teflon support fixture is configured as shown in Figure K2. *The Teflon pad and antenna support fixture assure the antenna is 5 cm above the test bench.*

d) Turn on the "Test Artifact" and verify the green LED (Power) is on and the red LED (Battery Low) is off. Perform radiated measurements using vertical antenna polarization over the frequency range of 1 MHz to 100 MHz using the same measurement system setup (e.g. bandwidth, step size etc.) used in 2.A.1, step c) above. Antenna selection shall conform to 5.1 of CISPR 25.

e) Repeat step d) in horizontal polarization over the frequency range of 30 MHz to 100 MHz.

f) Replace the 290 mm long rod antenna with the short (60 mm) antenna. Repeat steps c) and d) over the frequency range of 100 MHz to 1000 MHz.

g) Repeat steps b), c), and d) for a second set of data with vertical polarization in the frequency range of 1 MHz to 100 MHz.

h) Turn off the "Test Artifact."

i) Run a test chamber ambient sweep from 0.15 MHz to 2500 MHz using the same equipment and setup that was used for the "Test Artifact" testing (i.e. measurement instrument settings, antennas, cables, etc.). Measure and plot this data for both vertical and horizontal polarization where applicable.

B. Repeatability

Deviation to within ±6 dB in 80% of the frequency ranges obtained over the two separate and complete runs.

C. Correlation

TBD

D. Reporting the Results

The following data/information must be submitted for review:

a) Plot of the test chamber ambient data up to 2500 MHz if applicable.

b) Plots of Test Artifact Radiated Emissions testing per 2.A.2

Plot 1: Run 1 – Vertical Polarization (1 to 1000 MHz)
Plot 2: Run 1 – Horizontal Polarization (30 to 1000 MHz)
Plot 3: Run 2 – Vertical Polarization (1 to 1000 MHz)

c) Tabular data for each measured data set (i.e source, radiated emissions - vertical, horizontal polarization) using the format illustrated in Table K1. Note that only the peak value measured over each frequency band shall be reported. The data may be formatted in either comma delimited text file or an Excel worksheet (preferred).

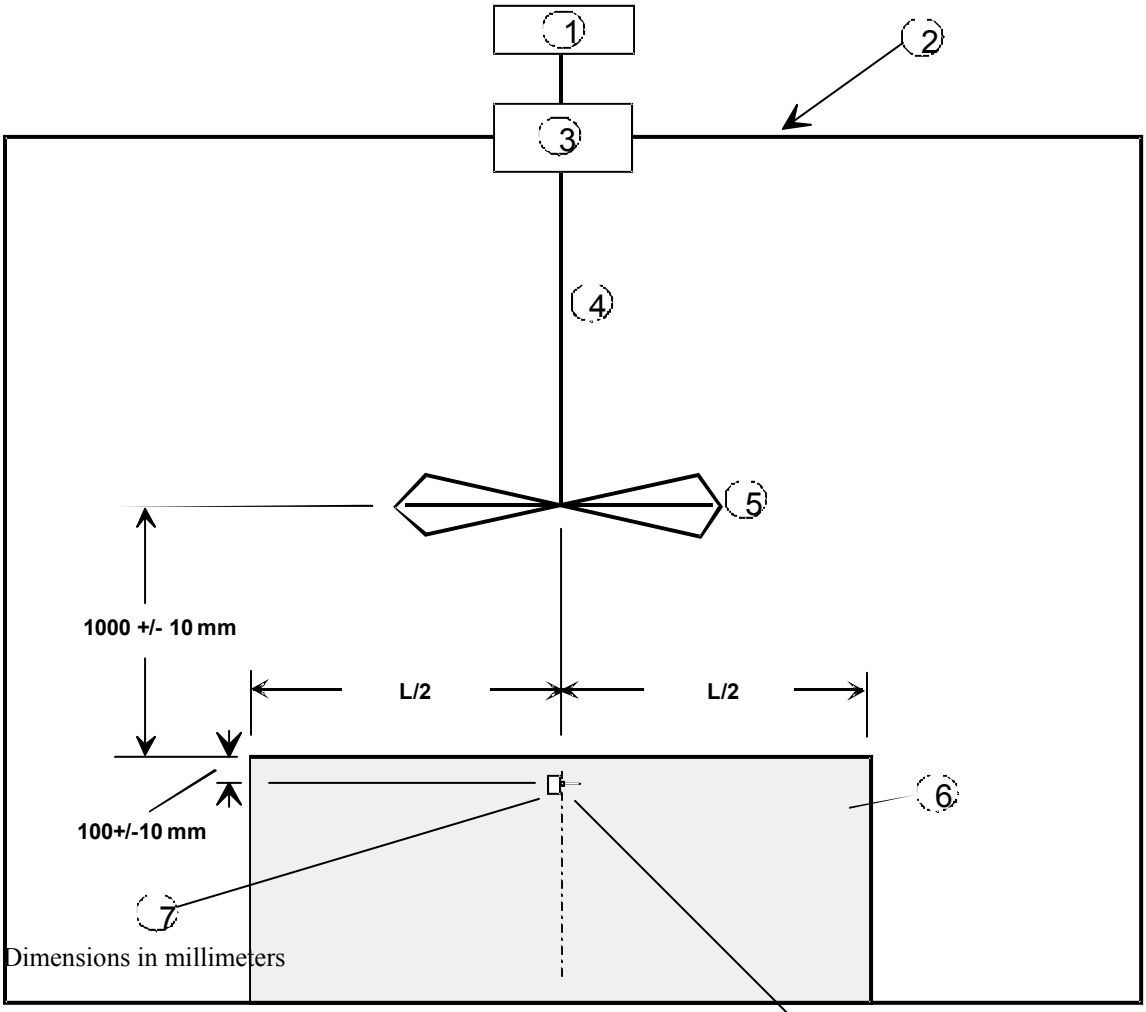
Table K1 Tabular Reporting Format

Band #	Freq (MHz)		Peak Measurement per band *Example Data*			
	Start Freq	Stop Freq	Source Output (dbuV)	Radiated Emissions (dbuV/m)		
				Vertical Polarization	Horizontal Polarization	Vertical Polarization *(2nd run)*
1	0.50	1.50	90.2	29.6	---	35.5
2	1.50	2.50	89.7	15.2	---	13.1
3	2.50	3.50	75.5	25.5	---	26.5
.	.		.	.	.	.
.	.		.	.	.	.
31	30.5	31.5	72.8	10.6	20.1	13.4
32	31.5	32.5	71	12.3	17.6	11.9
.	.	.	.	.	.	.
.	.	.	.	.	.	.
100	99.50	**100.50**	72.3	25.6	27.1	22.2
101	100.50	102.50	71.5	12.8	16.9	12.8
102	102.50	104.50	71.5	12.8	18.3	13.7
.	.	.	.	.	.	.
.	.	.	.	.	.	.
150	199.50	**200.50**	69.2	19.7	20.8	19.6
151	200.50	205.50	67.5	22.7	20.3	23.9
152	205.50	210.50	66.9	23.2	19.6	22.2
.	.	.	.	.	.	.
.	.	.	.	.	.	.
190	395.50	**400.50**	64.5	25.9	21.1	24.9
191	400.50	410.50	63.8	25.1	24.4	25.3
192	410.50	420.50	63	24.4	25.2	24.7
.	.	.	.	.	.	.
	.	.	.	.	.	.
250	990.50	**1000.50**	52	34.1	36.6	39.3

Note: Data listed is shown only for example. It is not indicative of the actual measured data.

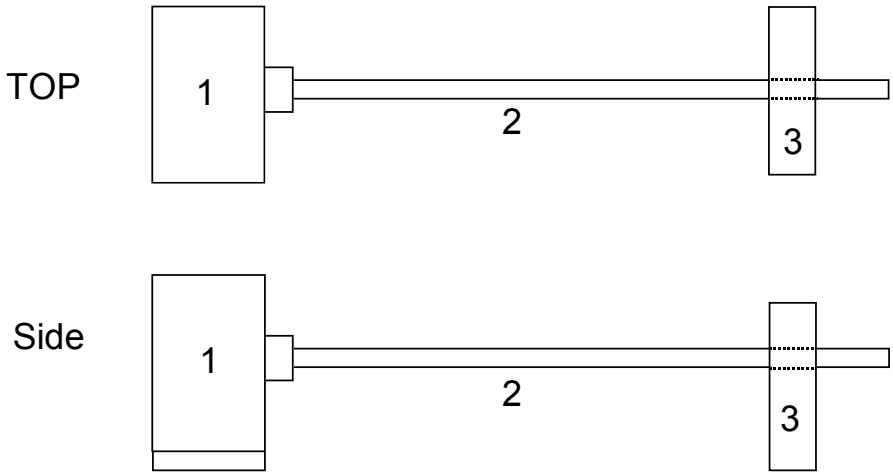
1. Performance History

Objective evidence of site performance verifications shall be available for inspection. Performance verifications may be performed by testing a stable device (e.g. ComPower CG-501) and comparing the results obtained over time. The objective of this requirement is to demonstrate reproducibility of the test setup over time.



Key:
1. Measuring Instrument
2. Absorber Lined Shielded Room
3. Bulkhead Connector
4. Double Shielded Coaxial Cable
5. Measurement Antenna
6. Ground Plane/Test Bench
7. Test Artifact

Figure K1 Test Artifact Setup



Key:

1. Test Artifact
2. Long Antenna
3. Teflon Antenna Support
4. Teflon Spacer

Figure K2 Test Artifact Cable Support

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

GM Reference documents:

- GMW3100 Section 3.2.1.1.1 - Reverberation Chamber Test (Verification Section), August 2001
- GMW3097 Section 3.2.1.1.1 - Reverberation Chamber Test (Requirements Section), August 2001

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

1. On-Site Assessment Questionnaire

A. GM Specific Requirements

GM Specific Test Setup Requirements

1 _____ Chamber dimensions shall comply with GMW3100.

2 _____ A monopole antenna shall be used in the frequency range of 150 kHz to 30 MHz.

3 _____ A biconical antenna shall be used in the frequency range of 30 MHz to 200 MHz.

4 _____ A log periodic antenna shall be used in the frequency range of 200 MHz to 1000 MHz.

5 _____ A Double-Ridged Guide antenna shall be used in the frequency range of 1000 MHz to 2500 MHz.

6 _____ Proper data acquisition algorithm shall be followed.

7 _____ Non-spark generated and spark-generated emissions shall be differentiated and reported separately.

8 _____ Antenna cable shall be protected against common mode currents. For example, RF chokes may be installed along the length of the antenna cable to minimize the presence of common mode currents on the shield.

9 _____ 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 GMW3100 specifications.

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

A. Test Artifact and Verification Procedure:

Artifact:

- Noise Source (set to 1 MHz repetition rate)
- Battery Charger

Procedure:

1. Source / Spectrum Analyzer Verification:

   a) Check the "Test Artifact" battery voltage (with unit turned off) by connecting adapter (red and black wires w/ banana jacks) to the "charge" port. If the battery voltage is lower than 5.0 Volts, recharge the unit. If the battery voltage is below 4.8 volts, discontinue testing and report this to the accrediting agency.

   b) Attach the output of "Test Artifact" and input of the measuring instrument using a short (< 600 mm) coaxial cable. If a longer length cable is used, attenuation characteristics must be considered.

   c) Use the following measuring instrument settings: Start Frequency = 1 MHz, Stop Frequency = 100 MHz, Res BW = 10 kHz & VidBW = 30 kHz, Attenuation = 20 dB

   d) Turn on the "Test Artifact" and verify the green LED (Power) is on and the red LED (Battery Low) is off. Set the measuring instrument to "Max hold" and wait until display "fills in". Plot this screen.

   e) Change the measuring instrument settings to: Start Frequency = 100 MHz, Stop Frequency = 1000 MHz, Res BW = 1 MHz, & VidBW = 3 MHz, Attenuation = 40 dB

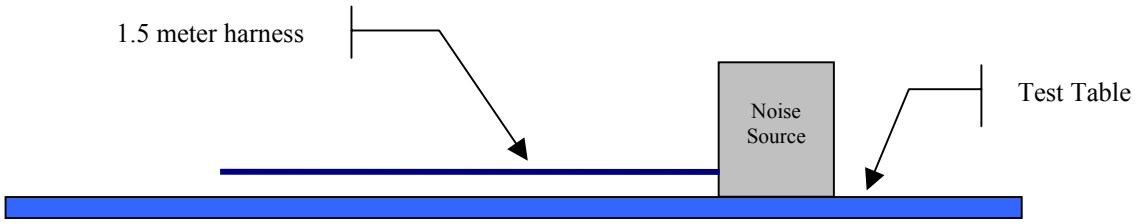
   f) Repeat step d). Plot this screen.

   g) Compare these two plots with data shown in Figures 1 and 2. If there are any differences in amplitude greater than 5 dB, efforts must be must be made to resolve these discrepancies before any testing may continue. If this cannot be accomplished, discontinue further work and report this to the accrediting agency.

2. Radiated Emissions Testing:

   a) Run a chamber quiet sweep using all equipment that will be used for the actual testing (i.e. antennas, cables, etc.) from 150 kHz to 2500 MHz.

   b) Connect the 1.5 meter harness to the "Test Artifact" output connector. Set up the Noise source in the same manner an ordinary DUT would be positioned for this test as shown below.



c) Turn on the "Test Artifact" and verify the green LED (Power) is on and the red LED (Battery Low) is off. Perform two GMW3100 reverberant room radiated emissions tests for the frequency range of 1 MHz to 1000 MHz. Use 10 kHz Resolution Bandwidth, 30 kHz Video Bandwidth and coupled sweep times. Assume the source to be a **narrow band radiator.**

E. Repeatability:

Deviation to within ±6 dB in 80% of the GMW3100 frequency ranges obtained over the two separate and complete runs.

F. Correlation:

Deviation to within ±6 dB in 80% of the GMW3100 frequency ranges when compared to the Reference Curve obtained at the 'GM Reference Laboratory'.

G. Reporting of results:

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

a) One plot for each data run of the frequencies specified in GMW3100 (Two plots).

b) Radiated Emissions and ambient data in tabular form using the format below (place in either comma-delimited text file or Excel worksheet). The value in the table will be a peak value in the frequency band defined by the start and stop frequencies in the first two columns.

Band #	**Freq (MHz)**		**Peak Radiated Emissions (dBuV/m)** *Example Data*	
	Start freq	**Stop freq**	**Run 1 V**	**Run 2 V**
1	0.50	1.50	12.8	12.4
2	1.50	2.50	12.8	12.4
3	2.50	3.50	12.8	12.4
.	.	.	12.8	12.4
.	.	.	12.8	12.4
100	99.50	**100.50**	12.8	12.4
101	100.50	102.50	12.8	12.4
102	102.50	104.50	12.8	12.4
.	.	.	12.8	12.4
.	.	.	12.8	12.4
150	199.50	**200.50**	12.8	12.4
151	200.50	205.50	12.8	12.4
152	205.50	210.50	12.8	12.4
.	.	.	12.8	12.4
.	.	.	12.8	12.4
190	395.50	**400.50**	12.8	12.4
191	400.50	410.50	12.8	12.4
192	410.50	420.50	12.8	12.4
.	.	.	12.8	12.4
	.	.	12.8	12.4
250	990.50	**1000.50**	12.8	12.4
251	1000.50	1020.50	12.8	12.4
252	1020.50	1040.50	12.8	12.4
.	.	.	12.8	12.4
.	.	.	12.8	12.4
325	2480.50	**2499.50**	12.8	12.4

c) Plots of the chamber quiet sweep for each of the frequencies specified in GMW3100.

E. Performance History:

Objective evidence of site performance verifications shall be 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.

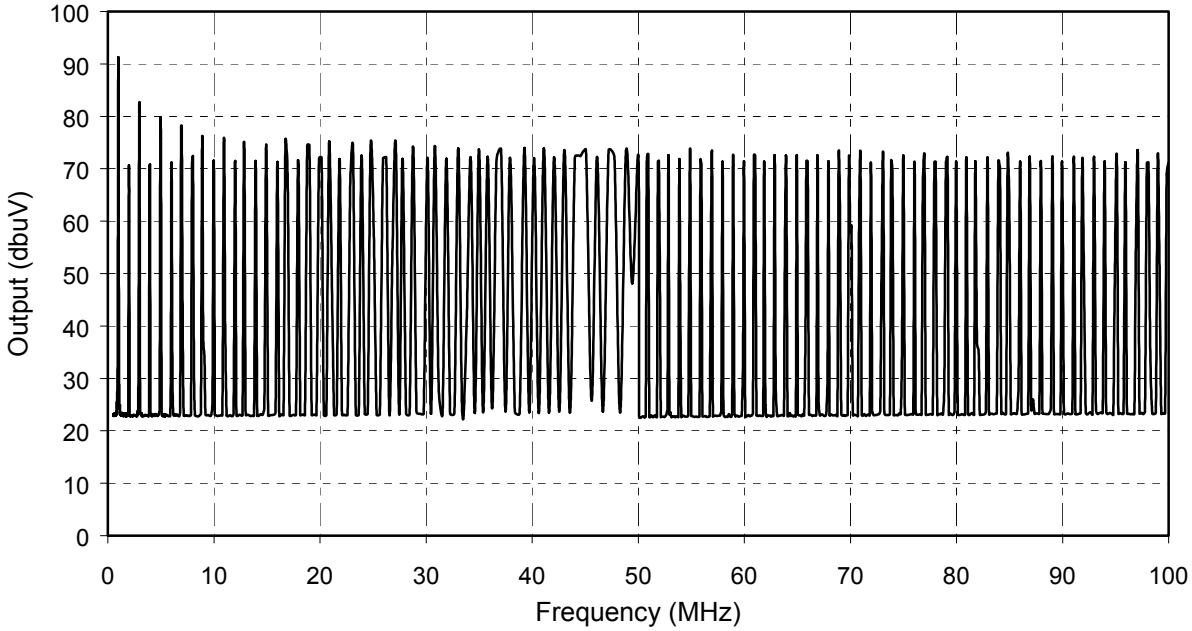


Figure 1 Test Artifact Output Characteristics (1 – 100 MHz)

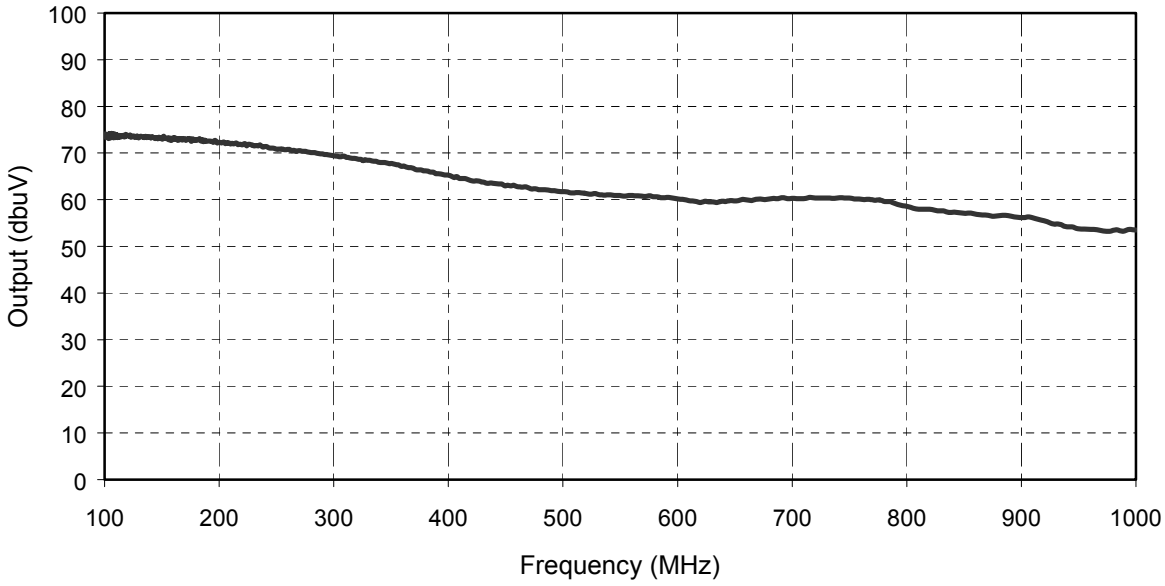


Figure 2 Test Artifact Output Characteristics (100 – 1000 MHz)

APPENDIX M - ASSESSMENT FOR CONDUCTED EMISSIONS TEST

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

1. 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 Specific Requirements

_____ 1. The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, 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. A single frequency signal of known amplitude shall be used to cross-check the system characterization in each measurement band.

2. Proficiency Testing

A. Procedure

TBD

B. Repeatability

TBD

C. Correlation:

TBD

D. Reporting of Results

TBD

E. Performance History

TBD

APPENDIX N - ASSESSMENT FOR "RADIATED IMMUNITY REVERBERATION METHOD - MODE TUNED" TEST PROCEDURE

GM Reference documents:

- GMW3100 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Verification Section), August 2001
- GMW3097 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Requirement Section), August 2001

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

1. On-Site Assessment Questionnaire

A. Test Setup: Consult GMW3100 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Verification Section), August 2001

1 _____ The test chamber shall be clear of RF absorbing material.

2 _____ Amplifier output power shall be capable of producing the field strengths indicated in GMW3097 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Requirement Section), August 2001 at the required frequencies.

3 _____ Antenna shall be at a minimum distance of 25 cm from the chamber walls, corners, and mode tuner.

4 _____ DUT shall be at a minimum distance of 25 cm from the chamber walls, and mode tuner.

5 _____ Antennas shall be aimed at corners of the test chamber. An upward tilt of 20 degrees or more shall be used.

6 _____ Antennas shall be cross polarized.

7 _____ Antennas shall be placed over RF non-intrusive supports (e.g., Styrofoam or similar stands).

8 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a 1.5 meter harness shall be used.

9 _____ 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)

10 _____ 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.

11 _____ Proper measures shall be taken to prevent RF energy from coupling into control rooms.

12 _____ The battery supply voltage shall be (13.5 +0.5/-1) V.

13 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a 1.5 meter harness shall be used.

14 _____ Objective evidence of proper chamber performance (Field Uniformity Validation, Appendix B.1.1 GMW 3100) shall be available for inspection.

15 _____ Objective evidence of proper chamber performance (Calibration and DUT Loading Check, Appendix B.2 GMW 3100) shall be available for inspection.

B. Test Procedure: Consult GMW3100 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Verification Section), August 2001

1 _____ Test procedures shall comply with general specifications in GMW3100 Section 3.2.1.2.2 - Reverberation Chamber Test, Mode Tuning (Verification Section), August 2001.

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).

3 _____ Testing shall be performed with CW, 80%, 1 kHz AM (conservation of peak as defined in ISO 11452-4), and Pulsed modulation.

4 _____ The CW, AM, and Pulsed modulation dwell time shall be at least two seconds.

5 _____ Data shall be reported in V/m.

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

A. Test Artifact and Verification Procedure:

Artifact and hardware Setup:

- Test Artifact (Including 1.5 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 "Output". 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 ± .005 Volts,
- One modulation type per frequency will be specified with each artifact.
- 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:

Test frequencies are calculated using the following equation:

$$f_{test} = f_0 \times 2^{(k/n)}$$

Where f_{test} is the frequency to inject,
f_0 is the start frequency (e.g., 1.00 MHz)
k is the index number of the injection frequency (i.e., 0, 1, 2, …)

Frequency Range	f_0	n	Lowest Test Frequency in Range (rounded)
400 MHz...< 1.0 GHz	400 MHz	25	400 MHz
1.0 GHz...2 GHz	400 MHz	50	1.000 GHz

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:

$$\frac{\Sigma\sqrt{(P_i - P_{ri})^2}}{n} \leq 20\,V/m \qquad \text{Expression N.1}$$

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 linear units of field strength (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:

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

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 field strength (i.e. dBV/m), and not linear 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 V/m
- 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: ***Lab/Test information - Discretionary***
Line 6: ***Frequency 1 (MHz), Anomaly threshold 1 (V/m), Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
Line 7: ***Frequency 2 (MHz), Anomaly threshold 2 (V/m), Signal Generator Output (dBm),Amplifier Output Power (dBm) - Required***
….
….
….
Line n: ***Frequency n (MHz), Anomaly threshold n (V/m), Signal Generator Output (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 Reverb Verification Source – Run #3
Line unused
400,33.5,25.0,23.0

411.25,32.0, 23.0,24.2
….
….
….
1013.96,12.0,23.4,34.2

E. Performance History:

Objective evidence of site performance verifications shall be 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.

APPENDIX O - ASSESSMENT FOR "BULK CURRENT INJECTION – SUBSTITUTION METHOD" 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)

GM Reference document(s):

- GMW3100 Section 3.2.1.2.4 - Bulk current injection (Verification section), August 2001
- GMW3097 Section 3.2.1.2.4 - Bulk current injection (Requirement section), August 2001

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

1. On-Site Assessment Questionnaire

B. Generic Standard

Generic Test Setup: Consult ISO 11452-4: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - component test methods - Part 4: Bulk current injection method (BCI)

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 the injection probe.

5 _____ The DUT shall be at least 500 mm from the wall.

6 _____ The injection probe shall be positioned (150 +/- 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.

7 _____ The RF signal generator(s) shall have a rated frequency range of 1 to 400 MHz minimum.

8 _____ The broadband power amplifier(s) shall have a rated frequency range of 1 to 400 MHz minimum.

9 _____ The injection probe(s) and calibration jig(s) shall have a rated frequency range of 1 to 400 MHz minimum.

10 _____ The current and power measurement instrument(s) shall have a rated frequency range of 1 to 400 MHz minimum.

11 _____ Directional couplers/RF sampling devices shall have a rated frequency range of 1 to 400 MHz minimum.

12 _____ The DUT harness shall be at least 200 mm from the edges of the ground plane.

13 _____ Forward power calibration curves shall be available for inspection.

14 _____ Remote monitoring capabilities that do not impose a load on the monitored device shall be used (i.e., fiber optic signal monitoring, visual, audio).

15 _____ Proper measures shall be taken to prevent RF energy from coupling into control rooms.

16 _____ 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 ISO 11452-4: Road vehicles - Electrical disturbances by narrowband radiated electromagnetic energy - component test methods - Part 4: Bulk current injection method (BCI)

1 _____ Test procedures shall comply with general specifications in ISO 11452-4

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 _____ The injection probe 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 _____ The simulator/load box shall be located within the test chamber.

6 _____ Production harnesses shall be used whenever possible. In the event that the production harness is not available a 1.5 meter harness shall be used instead.

GM Specific Test Procedure Requirements

1 _____ Ground (return) lines shall be removed from the injection probe during differential mode testing (below 30 MHz).

2 _____ Ground (return) lines shall be routed through the injection probe during common mode testing.

3 _____ Testing shall be performed with RF On-Off, RF Off-On transitions as well as CW and 1kHz, 80% Modulation as specified in ISO 11452-4.

4 _____ The CW and AM dwell time shall be at least 2 seconds.

5 _____ Data shall be reported in dBμA.

C. Ford Specific Requirements

1 _____ The laboratory 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.

D. DaimlerChrysler Specific Requirements

1 _____ The lab has the latest version copies of DaimlerChrysler documents: DC-10614, PF-10540, PF-9326, LP-388C-42, 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 _____ DaimlerChrysler uses only two probe positions at 150 and 750 mm from the DUT.

4 _____ The dwell time shall be sufficient to exercise the DUT, but shall be 3 or 2 seconds minimum depending on the requirements document.

2. 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 1.5 m Harness)
- Test and setup instructions

Test Setup

- Attach battery to Verification Test Fixture. Verify battery voltage is 12.7 V or greater,
- **Monitor differentially the sensor output signal at the BNC connector labeled "Output". Signal return of Analog Output Terminal should not be connected to chamber ground.**
- Install injection probe 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 ± .005 Volts,
- Modulation (CW or AM) and injection probe location (15, 45, or 75cm) will be specified with each artifact.
- Proceed with proficiency test.

Note: It is recommended that, after an anomaly threshold is reached at a frequency, the test be continued at the next frequency without increasing to the maximum injected current.

Deviation Definition:

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

Test Parameters:

- Test Frequencies: The BCI proficiency test shall be performed at the test frequencies as calculated using the following equation:

$$f_{test} = f_0 \times 2^{(k/n)}$$

Where f_{test} is the frequency to inject,
f_0 is the start frequency (e.g., 1.00 MHz)
k is the index number of the injection frequency (i.e., 0, 1, 2, …)

Frequency Range	f_0	n	Lowest Test Frequency in Range
1 MHz...< 30 MHz	1 MHz	7	1.000 MHz
30 MHz...< 400 MHz	30 MHz	25	30.00 MHz

Verification Instructions:

- BCI testing shall be performed using one standard GM injection probe position (i.e., 15, 45, or 75 cm). Each 'test' is composed of evaluation at this probe position.
- 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 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 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:

$$\frac{\Sigma\sqrt{(P_i - P_{ri})^2}}{n} \leq 20\ mA \qquad \text{Expression O.1}$$

Where P_i *is the AVERAGE anomaly threshold, in units of mA, at frequency* f_i *obtained over three runs at the specified 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 linear units of current (i.e., mA), and not on logarithmic units (i.e., dBμA).

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

$$\left| \sum_{i=1}^{n} (106 - P_i - \gamma) - \sum_{i=1}^{n} (106 - P_{ri}) \right| \leq 20 \qquad \text{Expression O.2}$$

$$\text{Where } |\gamma| \leq 5$$

Where P_i *is the anomaly threshold, in units of dBμA, at frequency* f_i *obtained over three runs at a specified injection probe location obtained at laboratory being assessed,*
P_{ri} *is the* ***AVERAGE*** *anomaly threshold, in units of dBμA, at frequency* f_i *obtained over three runs at a specified injection probe location obtained at REFERENCE laboratory,*
n is the number of frequencies tested.
$|\gamma|$ *is the minimum offset value that satisfies Expression O.2.*

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

D. Reporting of results:

- Reports shall be in ASCII, comma delimited, and shall contain at a minimum: the specified injection probe location in cm; frequencies of injection in MHz; and anomaly thresholds in dBμA.
- 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 (dBμA),Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
Line 7: ***Frequency 2 (MHz), Anomaly threshold 2 (dBμA),Signal Generator Output Power (dBm),Amplifier Output Power (dBm) - Required***
….
….
….
Line n: ***Frequency n (MHz), Anomaly threshold n (dBμA), 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 the specified probe location 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:

a) performance verifications may be demonstrated by testing a stable device and comparing results obtained over time,
b) demonstrate that forward power to induced current characterization curves are stable over time.

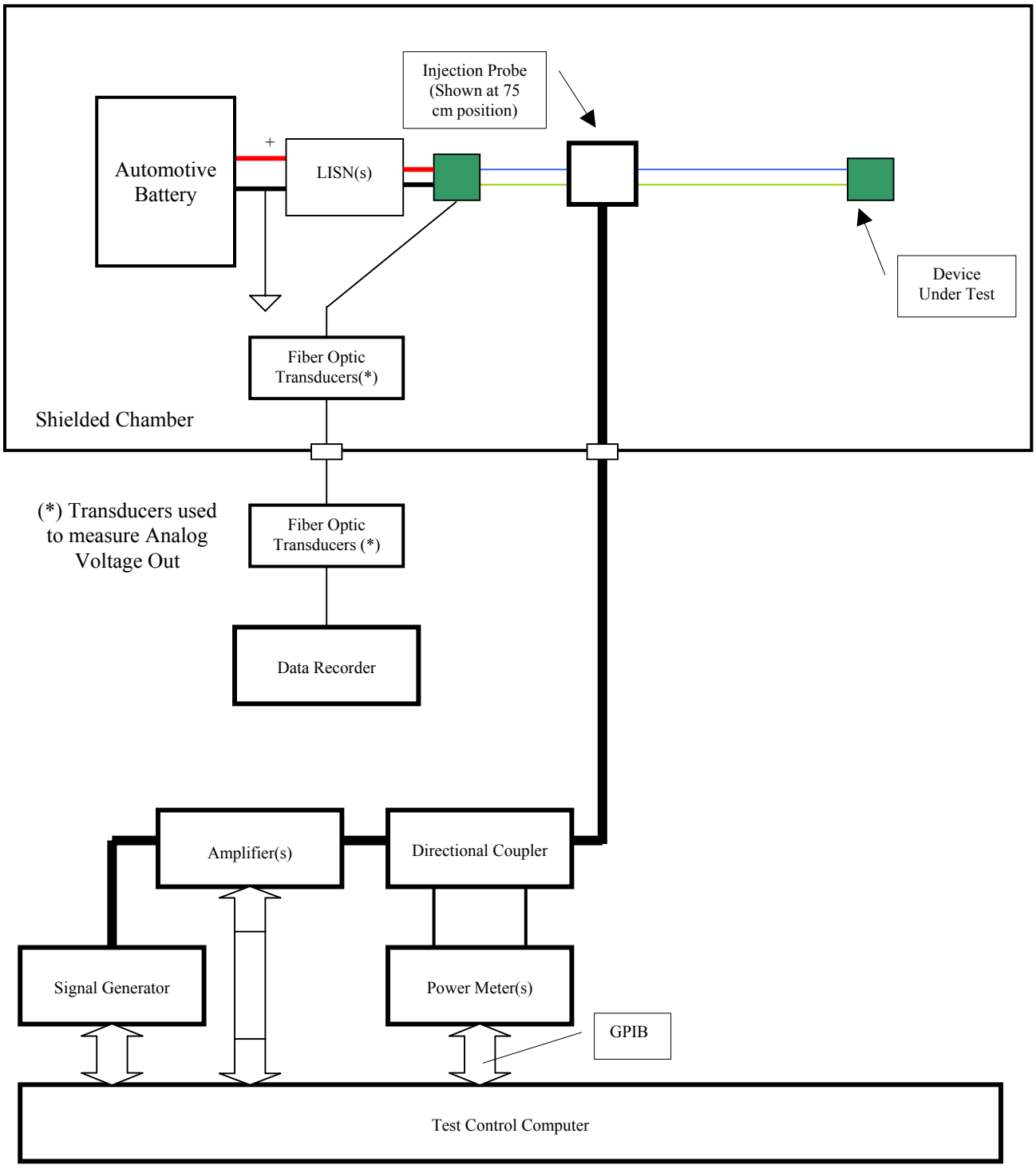
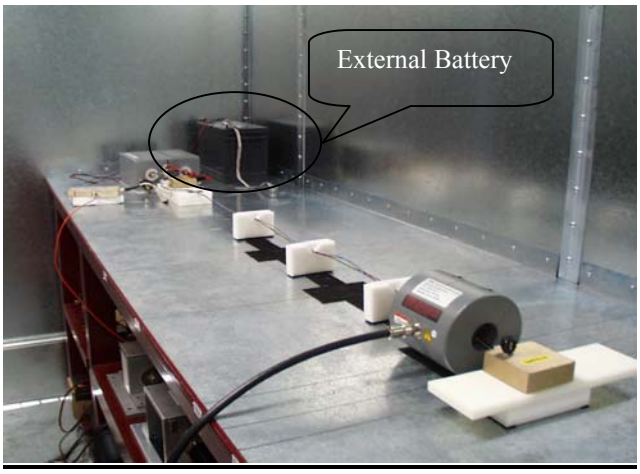
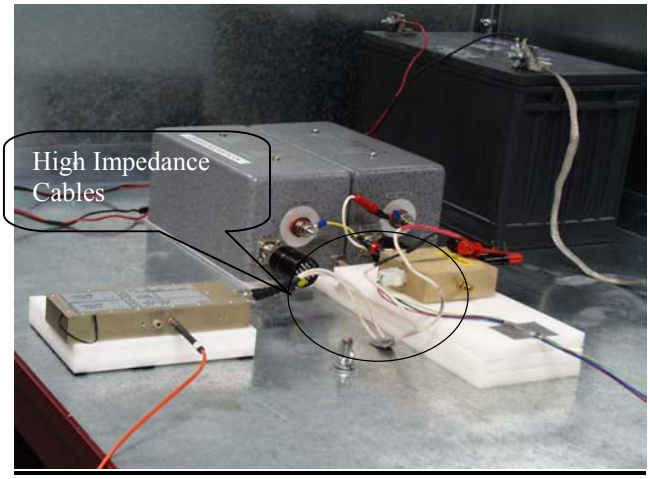


Diagram O.1 - Typical BCI Setup Diagram For Testing BCI Verification Fixture

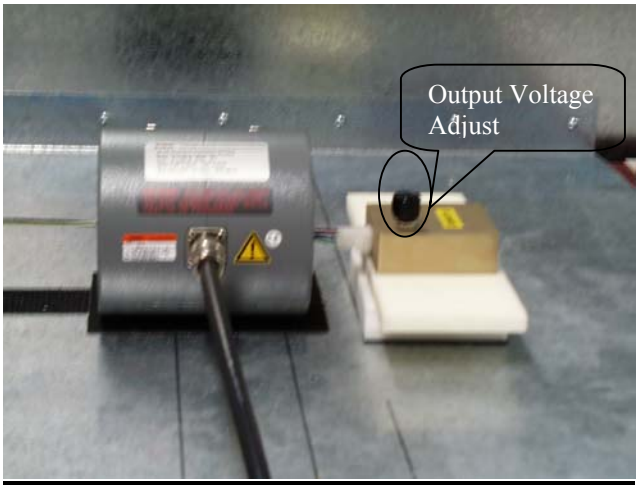


Picture O.1: Typical BCI Verification Artifact setup at the GM Laboratory. Note that the BCI RI Artifact is powered by an external battery.

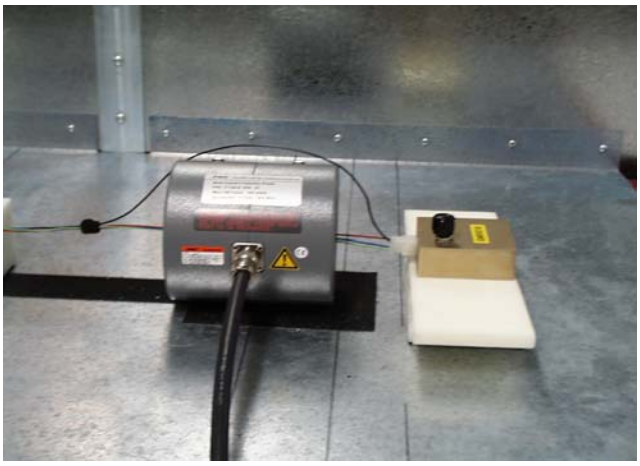


Picture O.2: Close up of battery feed and fiber optic connections to Verification Test Fixture.

At the GM Laboratory, analog voltages are monitored via high impedance cables attached to fiber optic transducers. High impedance cables Shown in white.



Picture O.3: Close up of injection probe installation for common-mode testing (above 30 MHz). Please note the location of the analog voltage output adjustment potentiometer on the DUT. This adjustment is used to set the Analog Voltage Output to 2.54 Volts.



Picture O.4: Close up of injection probe installation for differential-mode testing (below 30 MHz). Probe shown at 15 cm position.