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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1113/4

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IMMUNITY TO RADIATED ELECTRIC FIELDS— BULK CURRENT INJECTION (BCI) METHOD

1. ***Scope***—This SAE Recommended Practice defines a method for evaluating the immunity of automotive electrical/electronic devices to radiated electromagnetic fields coupled to the vehicle wiring harness. The method, called Bulk Current Injection (BCI), uses a current probe to inject RF current from 1 to 400 MHz into the wiring harness of automotive devices. BCI is one of a number of test methods that can be used to simulate the electromagnetic field. For a list of others, see SAE J1113/1.

1.1 **Measurement Philosophy**—As a vehicle is driven near high power transmitting antennas or when a mobile transmitter is used on a vehicle, the radiated electric field couples, either directly or through the wiring harness, into electronic devices on the vehicle. In the frequency range of 1 to 400 MHz, coupling occurs mostly through the wiring harness. To simulate this coupling, BCI can be used. BCI provides a method of compatibility evaluation by inducing high-frequency current into the wiring harness. It is a nonintrusive method since the wiring harness is not broken. BCI lends itself to the case of devices with many interconnecting wires.

2. ***References***—General information regarding this document, including definitions, references, and general safety considerations is found in SAE J1113/1.

2.1 **Applicable Document**—The following publication forms a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1113/1—Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft)

3. ***Test Equipment***

3.1 **RF Signal Generator**—1 to 400 MHz.

3.2 **Broadband Power Amplifier**—1 to 400 MHz, 50 Ω minimum. The amplifier should be able to drive a load of any impedance mismatch without damage to itself.

3.3 **Current Injection Probe**—1 to 400 MHz high power capability. More than one type of probe may be required.

3.4 **Current Monitoring Probe**—1 to 400 MHz. The monitor probe output voltage (V_{out}) should be converted to the induced current (I_{ind}) by the following relationship:

$$I_{ind}\ [dBmA] = V_{out}\ [dBmV] - Z_t\ [dB\Omega] \qquad \text{(Eq.1)}$$

where:

Z_t = Current probe transfer impedance

The transfer impedance of the current monitoring probes shall be verified and/or updated yearly.

3.5 Spectrum Analyzer or Equivalent—(For use with monitoring probe.)

3.6 Directional Coupler (Optional)

3.7 Power Meter

3.8 Computer Control (Optional)

4. Test Setup

4.1 The test setup is shown in Figure 1.

NOTE (a) If a regulated power supply is used to power the DUT, then a LISN shall to be used in the supply line. This network (LISN) is specified in SAE J1113/1.

(b) When a battery is used, a charging source may be required to maintain the specified supply voltage.

4.2 The test shall be performed in a shielded room.

4.3 The ground plane requirements are specified in SAE J1113/1.

4.4 The grounding of the DUT and/or its outer case depends on its application in the vehicle. If the DUT will be grounded when installed in the vehicle, it must be mounted to the ground plane in the bench test. If not, the DUT shall be placed on an insulated support 50 mm above the ground plane (measured from its horizontal centerline).

4.5 The production intent harness should be used. If unavailable, a 1 m test harness is recommended. The harness used shall be recorded in the test report.

4.6 The centerline of the wiring harness must be maintained 50 mm above the ground plane along its entire length.

4.7 The battery's negative terminal must be grounded to the ground plane.

4.8 The harness ground at the simulator end must be attached to the ground plane.

4.9 The current injection and current monitoring probes shall be insulated from the ground plane and supported (if needed) to keep the probes concentric about the harness.

4.10 The current monitoring probe shall be located 50 mm from the outer-most edge of the DUT connector (measured from the center of the probe) as shown in Figure 1.

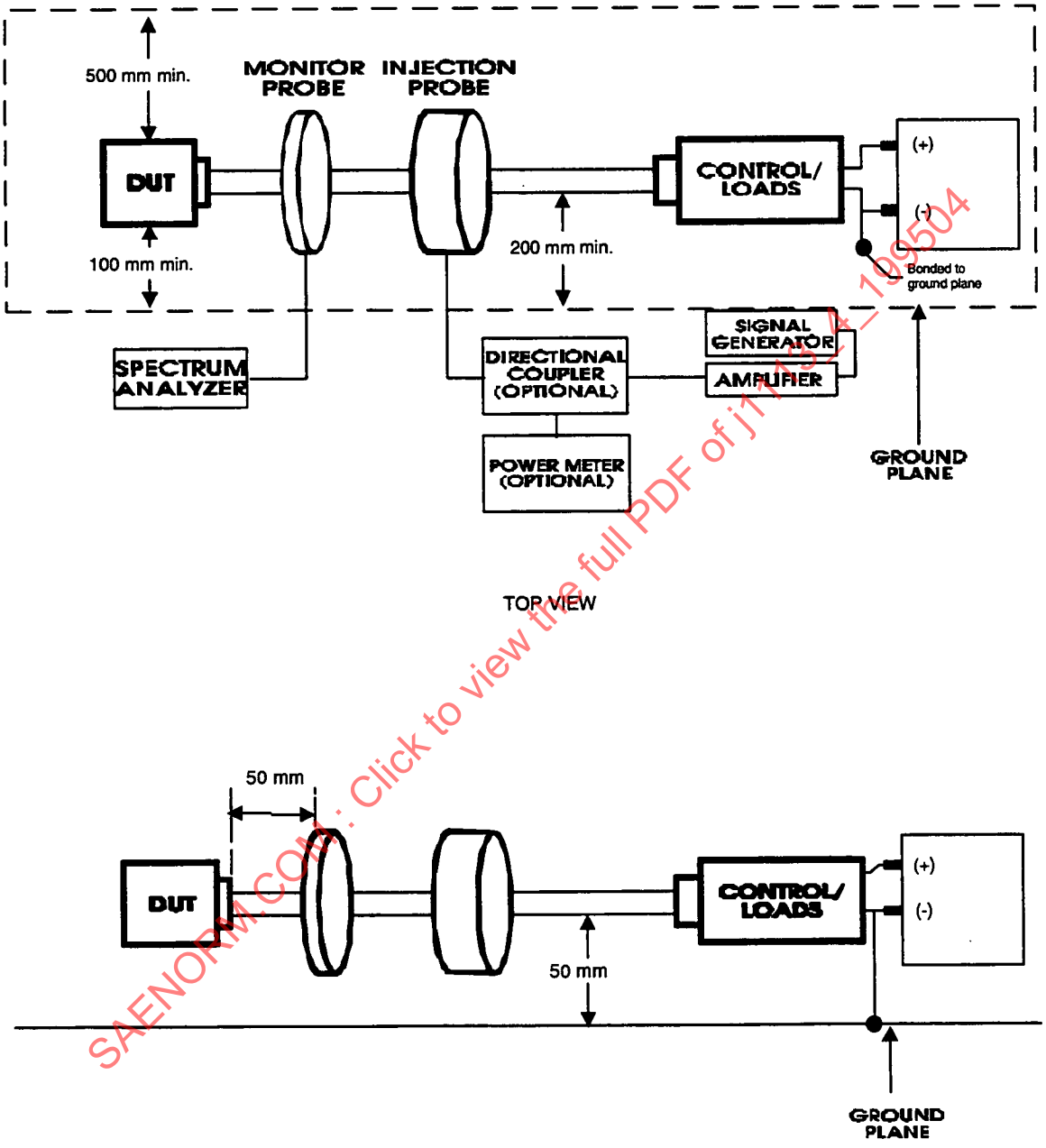

FIGURE 1—BCI TEST SETUP

4.11 The current injection probe shall be positioned 120 mm from the outer-most edge of the DUT connector (measured from the center of the probe). The test shall be repeated with the injection probe at 450 and 750 mm from the connector.

4.12 The DUT is to be operated in its designed modes. Therefore, appropriate control signals should be provided and actual or simulated loads used.

4.13 DUT performance anomalies should be accurately defined. Appropriate instrumentation for monitoring the anomalies should be provided.

4.14 Proper steps should be taken to prevent the RF energy from coupling into control and/or monitoring equipment.

5. Test Procedure

5.1 Test Plan—Prior to performing the tests, a test plan shall be generated which shall include interface test points, DUT mode of operation, DUT acceptance criteria, and any special instructions and changes from the standard test. Every DUT shall be verified under the most significant situations; i.e., at least in stand-by and in a mode where all the actuators can be excited.

5.2 Frequency Range—The frequency range of the BCI test method is 1 to 400 MHz. The frequency range of the BCI test method is a direct function of the current probe characteristic. More than one type of current probe may be required. Frequency steps are defined in SAE J1113/1.

5.3 Test Method—There are two test methods for the BCI test; the monitor current probe method (closed-loop) and the calibrated injection probe method (substitution). For both tests, the test equipment shall be connected in a similar manner to that shown in Figure 1.

CAUTION—HAZARDOUS VOLTAGES AND FIELDS MAY EXIST WITHIN THE TEST AREA. CARE SHOULD BE TAKEN TO ENSURE THAT THE REQUIREMENTS FOR LIMITING THE EXPOSURE OF HUMANS TO RF ENERGY ARE MET.

5.3.1 MONITOR CURRENT PROBE METHOD (CLOSED-LOOP METHOD)

5.3.1.1 The RF power to the injection probe shall be increased until:

a. At each frequency, the predetermined maximum test current level (within +10%), according to Section 6 and Appendix A, is reached. This induced current is measured using the monitor probe.

or

b. The forward output power, to the injection probe reaches 50 W ± 0.5 W.

or

c. The harmonics of the injected current reach within 9 dB of the fundamental frequency.

Record the threshold of susceptibility as a function of frequency.

5.3.2 CALIBRATED INJECTION PROBE METHOD (SUBSTITUTION METHOD)

5.3.2.1 Calibrate the injection probe according to the method described in Appendix B.

5.3.2.2 Mount the current injection probe around the harness as defined in 4.11. Where the harness contains a number of branches, the test should be repeated with the current probe(s) clamped around each of the branches. Under these test conditions, the monitoring probe, if used, shall be left at its previous distance from the DUT.

5.3.2.3 Using either the pre-calibrated level of net power or a relatively high level of fixed net power, a search for deviations shall be conducted over the frequency range of the injection probe.

5.3.2.4 For each event the lowest net power to the probe shall be recorded as the threshold of immunity even if this is found with the injection probe in different positions at different frequencies. The use of current monitoring probe as defined in 4.10 is optional.

5.4 Test Reports—When required in the test plan, a test report should be submitted detailing information regarding the test equipment, test site, systems tested, length of test harness used, frequencies, power levels, system interactions, and any other relevant information regarding the test.

6. Test Severity Levels

6.1 A full description and discussion of the Function Performance Status Classification including Test Severity levels are given in SAE J1113/1 Appendix A. Please review it prior to using the suggested Test Severity Levels presented in Appendix A.

PREPARED BY THE SAE EMI STANDARDS AND TEST METHODS STANDARDS COMMITTEE

APPENDIX A
TEST SEVERITY LEVELS

A.1 The test levels in Figure A1 are the recommended performance objectives for this test.

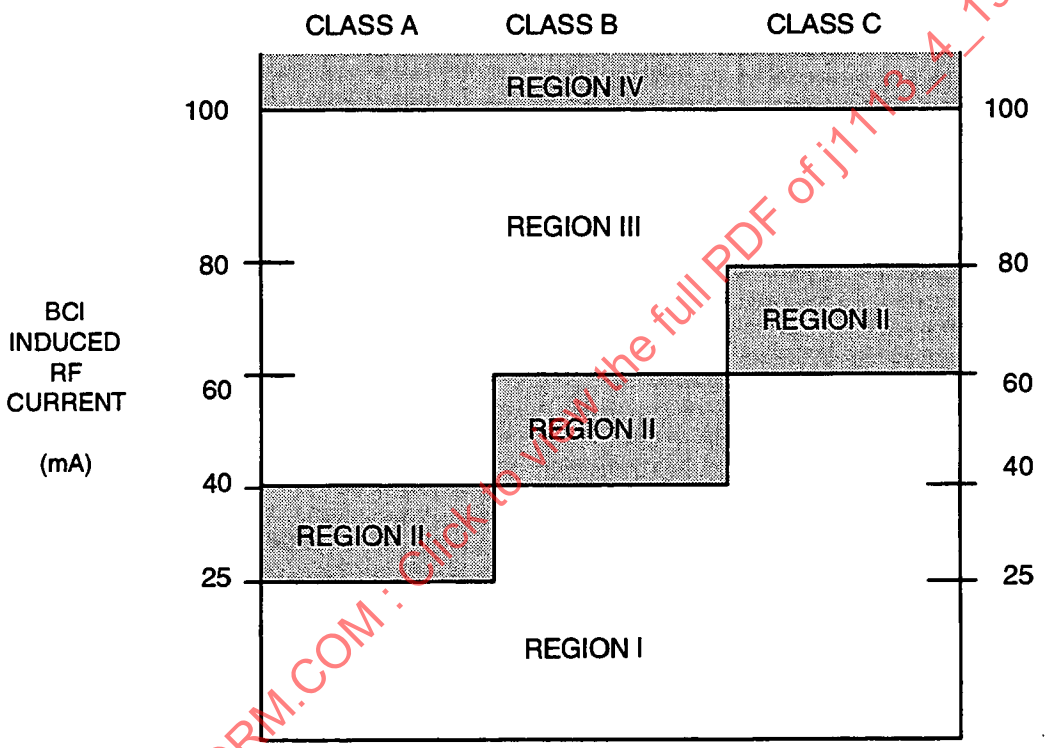

FIGURE A1—SUGGESTED TEST SEVERITY LEVELS