

**Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft)—Conducted Immunity, 30 Hz to 250 kHz—All Leads**

1. **Scope**—This document is an SAE Standard and covers the requirements for determining the immunity characteristics of automotive electronic equipment, subsystems, and systems to EM energy injected individually onto all leads. This test may be used over the frequency range of 30 Hz to 250 kHz. The method is applicable to all input, output, and power leads. The method is particularly useful in evaluating DUTs with acoustic or visible display functions.
2. **References**
  - 2.1 **Applicable Publications**—The following publication forms a part of this specification to the extent specified herein. Unless otherwise specified, the latest version 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 Procedure and Limits for Vehicle Components (Except Aircraft) (60 Hz to 18 GHz)
  - 2.2 **Related Publications**—The following publication is provided for information purposes only and is not a required part of this document.
    - 2.2.1 MILITARY PUBLICATIONS—Available from ????  
  
MIL-STD-461/462—
3. **Definitions**—See SAE J1113-1 for definitions.
4. **Measurement Philosophy**—For the frequency range of this test, the impedances seen by the signal, load, and power supply leads are generally known and can be treated as lumped constants. In this test a wide range audio voltage source is coupled through a transformer in differential mode to each specified pin of the DUT. The signal source impedance must be low in comparison to the impedance of the circuit being tested. Experience has shown that a signal source impedance of 0.5  $\Omega$  maximum is adequate for the test. The DUT should be connected so it will operate in its normal manner. Actual loads and sources should be used where appropriate or may be simulated.

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Filters incorporated into DUTs may experience excessive and potentially damaging current flow. To prevent this type of over stress in the DUT, a current probe is included in the test setup.

The impedance characteristics of the DUT line being tested may cause distortion to the test signal. This complicates the use of an AC voltmeter or EMI meter. A method of addressing this phenomenon is included in the test procedure.

5. **Test Limits**—See Appendix A for recommended limits.
6. **Test Set-Up**—The test set-up is shown in Figure 1.

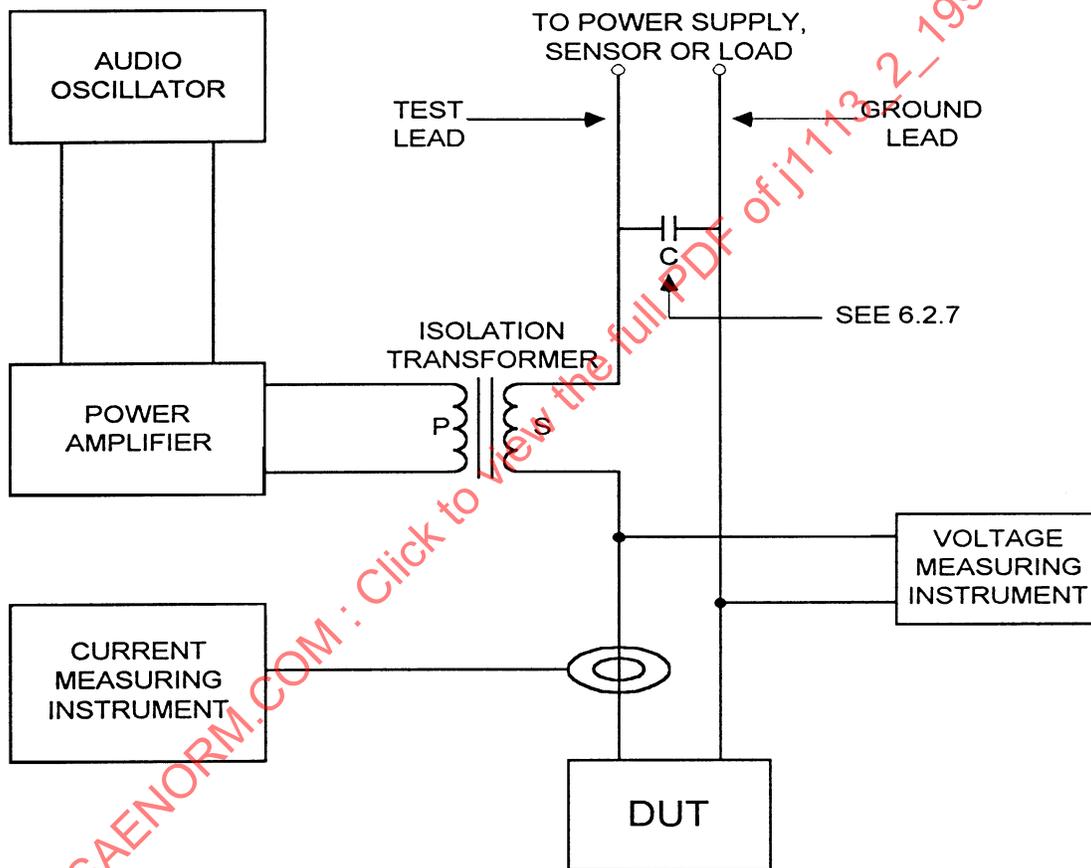


FIGURE 1—TEST SET-UP FOR MEASURING CONDUCTED IMMUNITY, 30 HZ TO 250 KHZ, POWER LEADS

- 6.1 **Grounding and Shielding**—For the stated frequency range there are no special grounding and shielding requirements.
- 6.2 **Apparatus**—The primary functional requirement is that the apparatus present a source impedance of less than  $0.5 \Omega$  to the DUT over the test frequency range. Appendix A details a procedure for verifying the source impedance of the test apparatus. The frequency range of the equipment used for the test must meet the test plan frequency range requirements.

NOTE— 1) The upper frequency limit for the equipment in 6.2.1, 6.2.2, and 6.2.3 can be reduced in accordance with the user's frequency range requirements.

NOTE— 2) It is recognized that other types of equipment can produce equivalent signals, e.g., a Power Oscillator can replace the oscillator and amplifier; a Power Operational Amplifier can replace the amplifier and power supply, etc.

6.2.1 AUDIO OSCILLATOR—30 Hz to 250 kHz frequency range.

6.2.2 AUDIO POWER AMPLIFIER—30 Hz to 250 kHz frequency range; 50 W output power minimum with output impedance equal to or less than 2.0  $\Omega$  (capable of delivering 50 W into a 0.5  $\Omega$  resistive load connected across the specified isolation transformer secondary.) The amplifier shall be capable of operating open circuit without damage.

6.2.3 ISOLATION TRANSFORMER—30 Hz to 250 kHz frequency range; 4:1 impedance ratio; secondary as connected shall be capable of handling the total lead (supply plus test signal) current flow without saturating the core.

6.2.4 VOLTAGE MEASURING INSTRUMENT—Oscilloscope, AC Voltmeter, or other suitable high impedance meter.

6.2.5 CURRENT MEASURING INSTRUMENT—Negligible series impedance inducing probe with appropriate magnitude capability.

NOTE— A clip-on Hall effect probe is suitable.

6.2.6 POWER SUPPLY—The power supply used for this test shall have the equivalent of a 100  $\mu\text{F}$  (minimum) capacitor across the output terminals.

6.2.7 CAPACITOR—A 100  $\mu\text{F}$  capacitor may be used (for lines other than power lines) to shunt the source end of the isolation transformer to ground, if difficulty is encountered in obtaining sufficient test voltage.

NOTE— Verify that desired signals are not excessively disturbed by the inclusion of the 100  $\mu\text{F}$  capacitor.

## 7. Test Procedure

7.1 The system power supply voltage shall be set as specified in the test plan. The user should take the voltage drop of the isolation transformer into account.

7.2 The audio oscillator shall be tuned through the required frequency range as specified in the test plan.

7.3 The injected signal level shall be progressively increased toward the level specified in the test plan. The lead current shall be simultaneously monitored to ensure that no more than 1  $A_{\text{rms}}$  of test current is allowed to flow. Alternatively the test signal may be held at a specified test level and, if an effect on the DUT is detected, the test voltage reduced to determine the threshold.

7.4 The DUT shall be monitored for (a) malfunction, (b) degradation of performance, or (c) deviation of parameters beyond tolerances indicated in the equipment specification or the test plan.

7.5 Where the impedance of the DUT lead causes significant distortion of the test signal, a suggested method of measuring the amplitude of the test signal is to connect a 4  $\Omega$  noninductive load in place of the DUT lead. This will allow an accurate reading to be taken in the substitute configuration. Do not change the signal generator or amplifier controls when substituting the 4  $\Omega$  resistor in place of the DUT lead.

7.6 The effects resulting from the injection of electromagnetic energy, the frequency and the threshold level shall be recorded.

8. **Levels**—See Appendix B for recommended test level(s).

PREPARED BY THE SAE EMI STANDARDS COMMITTEE

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## APPENDIX A

**(INFORMATIVE) PROCEDURE TO VERIFY SOURCE IMPEDANCE**

- A.1** The following procedure can be used to verify the signal source impedance at the isolation transformer secondary terminals.
- Set a voltage level at the primary terminals and measure the open circuit secondary voltage ( $V_{oc}$ )
  - Connect a known load  $R$  of approximately 0.5 W across the secondary and measure the closed-circuit secondary voltage ( $V_{cc}$ ).
  - The impedance shall be calculated as follows in Equation A1:

$$Z = \frac{R_L(V_{oc} - V_{cc})}{V_{cc}} (\Omega) \quad (\text{Eq. A1})$$

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