



SURFACE VEHICLE RECOMMENDED PRACTICE

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Electromagnetic Compatibility Measurement Procedure
for Vehicle Components - Immunity to AC Power Line Electric Fields

RATIONALE

Off-road vehicles often negotiate areas crossed by high voltage (up to 1000000 V) power transmission lines. During operation, the vehicle electronics will be exposed to intense AC electric fields. The field intensity from power lines is expected to be higher for these "off-road" vehicles than "on-road" vehicles because of their close proximity to these power lines.

There is no known comparable SAE or ISO test method.

FOREWORD

This test method is most applicable to off-road vehicle use. Road vehicles have also seen disruptive fields in service and it may be wise to consider application of this test method during development.

Field levels measured during testing have reached as high as 15000 V/m. Laboratory testing for these conditions should always be performed for vehicle electronics for vehicles which routinely encounter off-road driving. Such vehicles would include agricultural and timber harvesting equipment, as well as earth moving and construction vehicles.

1. SCOPE

This SAE Recommended Practice covers the recommended testing techniques for the determination of electric field immunity of an automotive electronic device when the device and its wiring harness is exposed to a power line electric field. This technique uses a parallel plate field generator and a high voltage, low current voltage source to produce the field.

2. REFERENCES

2.1 Applicable Documents

The following publications form 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 Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1113-1 Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles, Boats (up to 15 m), and Machines (Except Aircraft) (16.6 Hz to 18 GHz)

SAE J1113-22 Electromagnetic Compatibility Measurement Procedure for Vehicle Components - Part 22 - Immunity to Radiated Magnetic Fields

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3. DEFINITIONS

For general definitions, refer to SAE J1113-1.

4. TEST APPARATUS

The test apparatus shall consist of the following:

4.1 Voltage Source

Any voltage source capable of supplying approximately at least 15000 VAC (50 or 60 Hz, as appropriate) at a current of at least 50 mA can be utilized. Some capacity above this voltage level is recommend to compensate for high voltage corona discharges on plate edges, bleeding currents from the system.

4.2 High Voltage Voltmeter

A high impedance voltmeter capable of measuring at least 15000 Vrms.

NOTE: An example of the construction of a parallel plate field generator is shown in Appendix B.

5. TEST SETUP

NOTE: Hazardous voltage and fields exist on and near the parallel plate field generator when the equipment is energized. Test personnel should ensure that no one is in contact with the field generator, the plates, field distribution wires, the generator, or cables during a test.

Test setup should be as shown in Figures 1 and 2. The device under test is installed central to and midway between the field plates of the parallel plate field generator. The resistors used in this fixture are glass, high voltage resistors.

Placing the equipment under test with its centroid at the mid-point between the plates, with its side at least 150 mm from the outer edges of the field plates is recommended to ensure field uniformity and test repeatability.

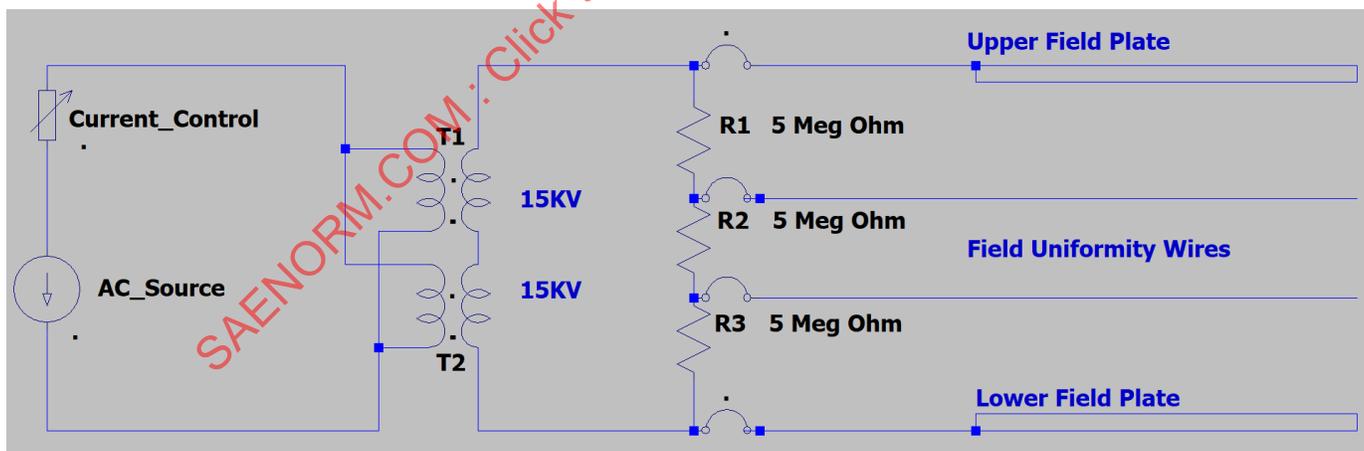


Figure 1 - Example of generator circuit

Commercially available neon sign transformers (T1 and T2) have been successfully used to construct the HV generator using a parallel input connection and series output connection. Connect the power lines from the generator to the top and bottom plate at the same point where the HV resistors are connected. The same points should be used to arrange connections via separate lines to a voltage metering system.

In practice, the input power should be supplied via a variable transformer to allow adjustment of the output voltage to the level needed for the test. Power supply and measurement cables should be high voltage, and it is recommended that they be separated by about 10 cm and supported off any conductive surfaces by 5 to 6 cm thick styrofoam or other suitable insulating materials. Length of the supply and measurement cables has not been shown to be of concern.

CAUTION: When constructing an HV generator, pay careful attention to placement and use of high voltage components and cables. Mounting all components on 1/2 inch thick plexiglas with nylon bolts and separating the two transformers with 1/2 inch plexiglas panels proved necessary, as well as the use of high voltage feed through socket and plug connectors.

The cables between the HV generator and the field plates must also have sufficient insulation rating to withstand the voltage stress.

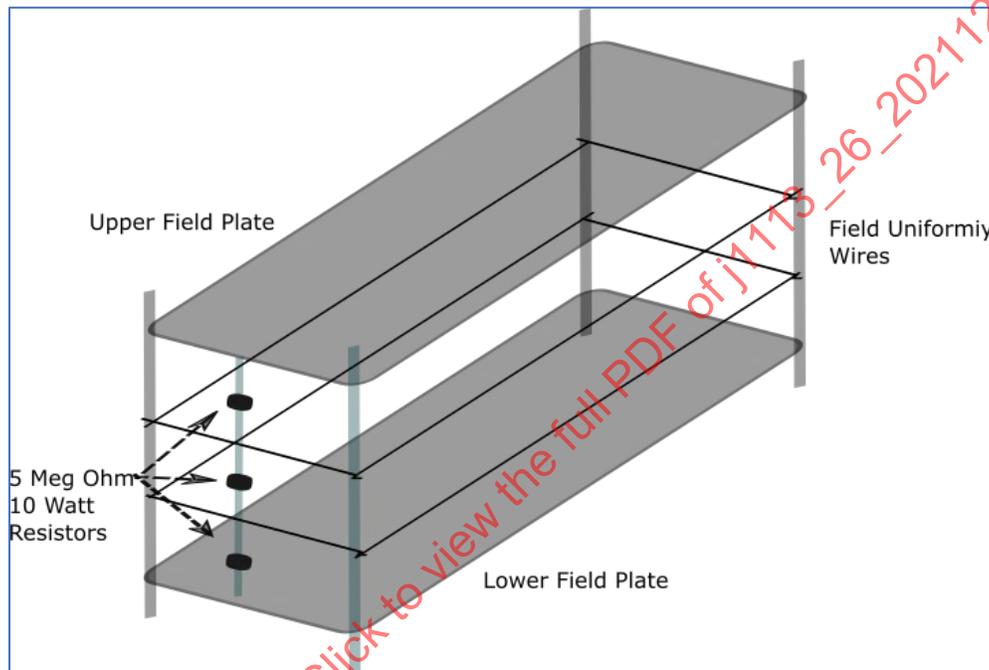


Figure 2 - Example of field plate arrangement

Note that the shape and configuration of the field plates is lab dependent. However, avoid any sharp edges or corners in the construction of the plates as any sharp point or edge will quickly become a source of an HV “corona discharge,” and can be detected by careful listening for the “hiss.” Caution should also be exercised when soldering the HV resistors and their lines. A smooth solder joint, with no bumps or sharp corners, is necessary.

The DUT and wire harness shall be placed in a non-conductive support midway between the plates. The harness should leave the field area parallel to the field generating plates for at least 0.5 m beyond the outer edge of the plates. Note that the primary function of the fixture is to fix the positions of the harness and DUT to ensure the most repeatable results and should be constructed with this in mind. This non-conductive fixture should be constructed of material with a low dielectric constant (e.g., PVC, polystyrene, or equivalent).

When peripheral devices are used for operating or monitoring the device under test, they should be the original vehicle devices, where possible.

The AC field shall be generated as required. The plate voltage, E_v , may be measured by using a high voltage voltmeter at the connections to the plates in the same location where the cables from the generator are connected. If the plates are spaced 1 m apart, the field between the plates will equal the excitation voltage per meter.

NOTE: If field intensities higher than 15000 V/m are desired, the height of the parallel plate antenna could be reduced in order to generate higher field intensities. The antenna height shall not be reduced to less than 0.5 m and care should be taken that the DUT height does not exceed 1/3 the antenna height (unless otherwise approved in the test plan). Field intensity in V/m is calculated by:

$$\text{Field Levels (V/m)} = \text{Voltage Applied (Vrms)} \times 1/\text{distance between plates (in meters)}$$

where "voltage applied" is measured voltage at the plates.

6. TEST PROCEDURE

Three test configurations are feasible, and are represented by the three orthogonal axes through the DUT. Each of the three axes should be oriented to the primary field of the parallel plate field generator and the module exposed to the AC field in that position for the required dwell time.

6.1 Test Fixture

The test fixture may be used in the following manner:

Slowly increase the voltage gradient between the plates to the upper immunity limit noting any malfunctions, their nature, and the field strength levels. The dwell time shall be long enough to detect any malfunction of the DUT. When completed, set the excitation voltage to 0 V and allow the system to bleed off the charge before allowing personnel to come in contact with the fixture or with the DUT.

CAUTION: After removing power from the test fixture, monitor the voltage to ensure that the voltage has fallen to a safe level before personnel are allowed to approach. Some capacitive effects will be present in the test fixture and HV generator. Never assume that the voltage has dissipated and the fixture is safe. Always check the voltage levels on the plates before allowing any test personnel to approach the fixture.

7. TEST SEVERITY LEVELS

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 of this document.

8. NOTES

8.1 Special Considerations

For most designs of a parallel plate field generator, the field strength is uniform to within approximately 150 mm of the edge of either plate. Closer to the edge, the field rolls off. For this reason, it is recommended that the DUT be placed as close to the center of the space between the plates as can be arranged.

If a conductive DUT exceeds more than 1/3 of the spacing between the plates, the test field will be perturbed resulting in a stronger field than indicated by the measured voltage.

8.2 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.