

Electromagnetic Compatibility Measurement Procedure for Vehicle Components— Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Strip Line Method

1. **Scope**—This SAE Recommended Practice covers the recommended testing techniques for the determination of electric field immunity of an automotive electronic device. This technique uses a strip line¹ from 10 kHz to 200 MHz and is limited to exposing the harnesses (and/or devices) which have a maximum height of equal to or less than 1/3 the strip line height.

NOTE—This method is being replaced by the Tri-plate Line (SAE J1113-25) which is considered to be a superior test method. It will be retained for historical purposes for a period of 5 years where upon it will be considered to be withdrawn.

2. **References**—For general references, see SAE J1113-1.

- 2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

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

SAEJ1113-1—Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft) (60 Hz to 18 GHz)

SAEJ1113-25—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Radiated Electromagnetic Fields, 10 kHz to 500 MHz—Tri-Plate Line Method

- 2.1.2 OTHER PUBLICATIONS

M.V. Schneider, "Micro Striplines for Microwave Integrated Circuits," Systems Technical Journal 48 #5, May-June 1969

Clayton R. Paul, "Literal Solutions for the Time-Domain Response of a Two-Conductor Transmission Line Excited by an Incident Electromagnetic Field," IEEE Transactions on Electromagnetic Compatibility May 1995, Volume 37, Number 2, IEMCAE (ISSN 0018-9375)

1. Strip line in this document refers to a giant version of an unbalanced parallel plate 'micro strip line' with a single driven plate above a ground plane. See Figure 1 for a physical description of this configuration.

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3. Definitions—For general definitions, see SAE J1113-1.

4. Test Equipment—The test apparatus shall consist of the following:

4.1 Signal Source—Any signal source and power amplifier capable of supplying approximately 50 W of modulated or unmodulated power to develop the immunity levels specified in the test plan shall be used, provided the following requirements are met:

- a. Residual FM shall be less than 10 Hz
- b. Frequency resolution shall be less than 100 Hz
- c. Harmonics and spurious outputs shall not be more than -20 dB when referred to the fundamental power

4.2 RF Voltmeter—An RF voltmeter capable of measuring 100 V up to 10 MHz.

4.3 In-Line directional coupler with an RF wattmeter capable of measuring 50 W up to the maximum frequency in use.

4.4 Field Strength Meter—A RF field strength meter capable of measuring 200 V/m up to 200 MHz.

4.5 Strip line—An example construction of a strip line is shown in Appendix A.

5. Test Setup

CAUTION—Hazardous voltages and fields exist on and near the strip line when the equipment is energized. Test personnel should ensure that no one is in the test chamber during a test.

5.1 Test setup should be as shown in Figures 1 and 2.

The DUT is installed next to and parallel to the strip line. The distance between the closest edges of the driven conductor and the DUT shall be 200 mm (+20 -0 mm).

The distance from any peripheral device to the closest edge of the driven conductor shall be at least 200 mm.

5.2 The DUT wire harness should be placed in a nonconductive fixture in the center of the strip line, parallel to its major axis, supported midway between the plates. Note that the primary function of the fixture is to lock 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 shall be constructed of material with a very low dielectric constant (e.g., polystyrene or equivalent $\epsilon_R \leq 1.4$). The length of the harness section under the active conductor shall be at least 1.5 m. Deviations of the height above the ground plane are only permitted near the DUT or the peripheral device. Peripheral devices are to be bonded to the ground plane, if possible.

When peripheral devices are used for operating or monitoring the DUT, they should be the original vehicle devices, if possible. The original peripheral devices are placed on the ground plane, and electrically/mechanically bonded to it as in the vehicle application.

The power supply shall be equipped with an adequate filter to prevent overloading the front end regulator by induced RF current. The impedance of this filter, as seen from the DUT, shall correspond to the vehicle power supply system impedance as close as possible.

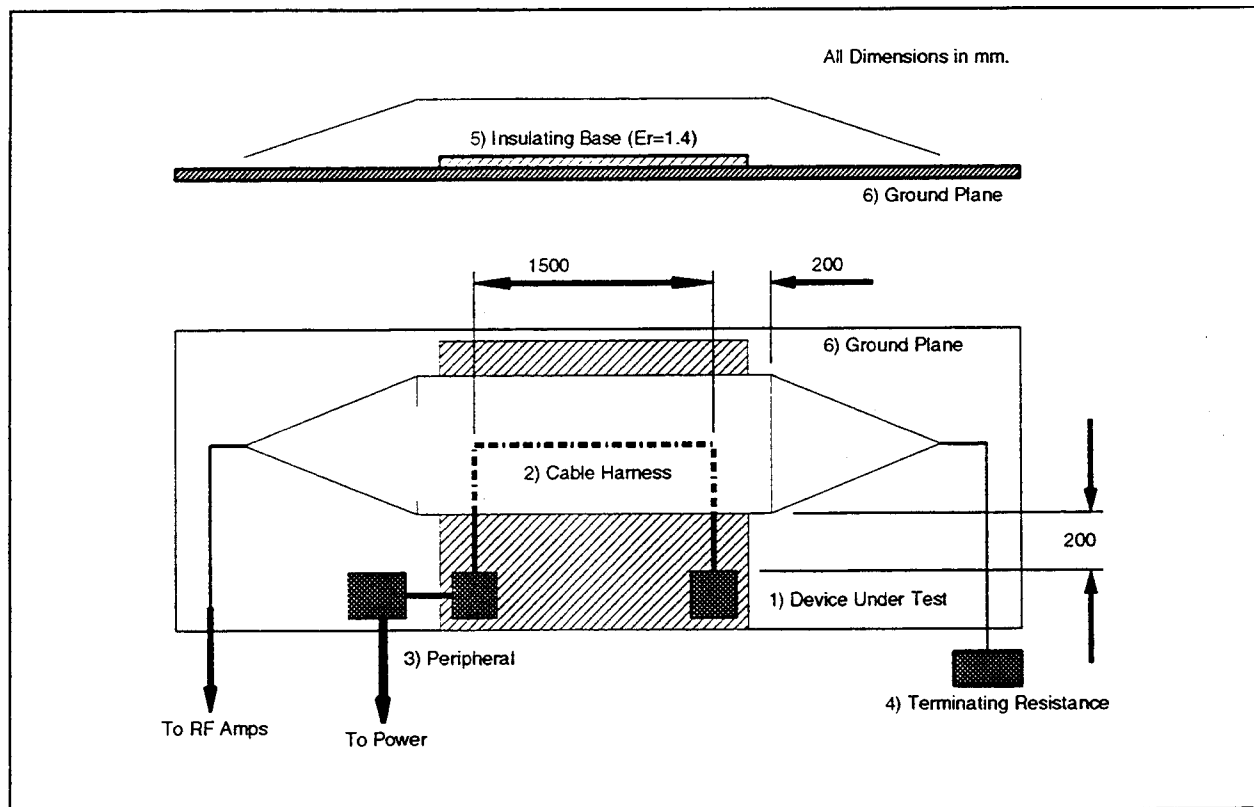


FIGURE 1—STRIP LINE TEST CONFIGURATION

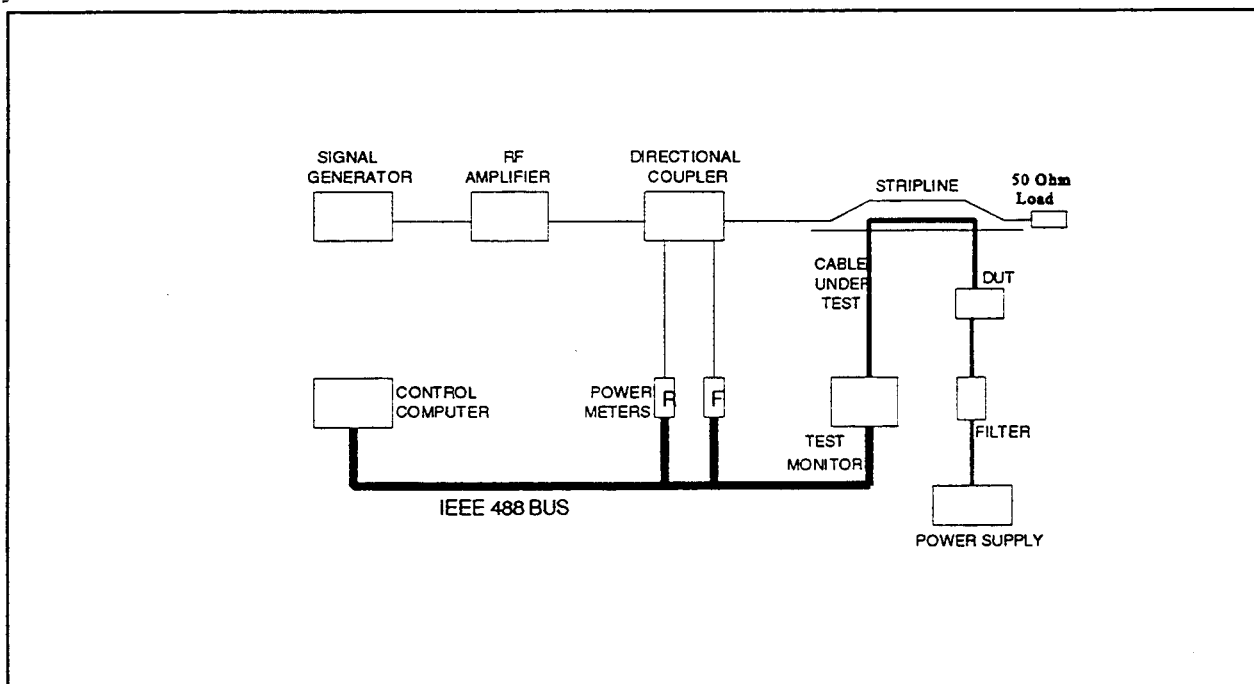


FIGURE 2—TEST SETUP FOR A STRIP LINE

The remaining peripheral devices can be installed in one of three ways depending on their size and inherent RF immunity.

- a. Outside of the shielded testing chamber
- b. Shielded and filtered, in the shielded testing chamber
- c. In the case of exclusively passive periphery (resistors, capacitors, coils, ferrites, mechanical switches, etc.) or radiation resistant periphery, unshielded and unfiltered in the shielded testing chamber

Lines fed through the wall of the shielded testing chamber shall be equipped with adequate RF filters at the wall. This prevents these lines from emitting significant radiation outside of the testing chamber, and possibly influencing the external measuring system, or causing other interference.

- 5.3** When a DUT or peripheral device with a metal housing used for the measurement are electrically connected directly to the vehicle mass (by screws, rivets, etc.), they shall be bonded to the ground plane by a low inductance connection.

When the DUT or peripheral is not electrically connected directly to the vehicle mass, they shall be placed on an insulating support. This insulating support shall be constructed of material with a low dielectric constant (e.g., foamed polystyrene or equivalent $1 \leq \epsilon_R \leq 1.4$) and shall have the same height as the insulating support on which the wire harness is installed.

- 6. Test Procedure**—Three test configurations are feasible; exposure of the wiring harness alone, exposure of the DUT alone, or exposure of both the harness and DUT together.

- 6.1 Exposure of Wiring Harness Alone**—This is the most commonly used test configuration permitting the widest frequency range of testing. The RF fields induced in the harness couple into the DUT using the harness wiring as 'antennas' for the received signal. When the strip line is used above the frequency where the wavelength of the wave is less than twice the length of the strip line, the length of cable is sufficiently long to ensure that the field is 'integrated' or 'averaged' along the cable thus producing the effect of maintaining a uniform field where, in fact, it is no longer uniform.

- 6.2 Exposure of the DUT Alone**—When it is desired to determine DUT immunity directly, the DUT may be placed between the driven portion of the strip line and the ground plane with the attached cable harness exiting at 90 degrees to the main axis of the strip line to minimize induction into the wiring harness. Care must be taken to ensure that the physical size of the DUT does not exceed 1/3 of the height between the driven element and the ground plane of the strip line as this may distort the test field.

NOTE—Caution must be exercised not to exceed the frequency at which the wavelength exceeds twice the length of the strip line during this type of test as the moving peaks and nodes of the field under the strip line above this frequency may place the DUT in fields which are either much lower or much higher than instruments indicate, possibly producing erroneous test results. This requires special agreement between the users.

- 6.3 Exposure of both the DUT and its Wiring Harness**—Both the DUT and its harness may be exposed simultaneously to the field of the strip line if the provisions of the previous paragraph are taken into account.

NOTE—This requires special agreement between the users.

- 6.4** Fields should be generated as required in the test plan. The field level is determined using the information gathered from the directional coupler and power meters in accordance with the method outlined in Appendix A.

For calibration purposes, at frequencies of 100 kHz or below, E_v can be measured by using an RF voltmeter connected across the elements of the line. For calculation of the field under the strip line, see Appendix A.