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(R) Measurement of Radiated Emissions from Integrated Circuits— TEM/Wideband TEM (GTEM) Cell Method; TEM Cell (150 kHz to 1 GHz), Wideband TEM Cell (150 kHz to 8 GHz)

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1. ***Scope—***This measurement procedure defines a method for measuring the electromagnetic radiation from an integrated circuit (IC). The IC being evaluated is mounted on an IC test printed circuit board (PCB) that is clamped to a mating port (referred to as a wall port) cut in the top or bottom of a TEM or wideband TEM (GTEM) cell. **The test board is not in the cell as in the conventional usage but becomes a part of the cell wall.** This method is applicable to any TEM or GTEM cell modified to incorporate the wall port; however, the measured RF voltage is affected by the septum to test board (wall) spacing. This procedure was developed using a 1 GHz TEM cell with a septum to wall spacing of 45 mm and a GTEM cell with average septum to wall spacing of 45 mm over the port area. Other cells may not produce identical spectral output but may be used for comparative measurements, subject to their frequency and sensitivity limitations. A conversion factor may allow comparisons between data measured on TEM or GTEM cells with different septum to wall spacing. The IC test board controls the geometry and orientation of the operating IC relative to the cell and eliminates any connecting leads within the cell (these are on the backside of the board, which is outside the cell). For the TEM cell, one of the 50 Ω ports is terminated with a 50 Ω load. The other 50 Ω port for a TEM cell, or the single 50 Ω port for a GTEM cell, is connected to the input of a spectrum analyzer or receiver that measures the RF emissions emanating from the IC and coupled onto the septum of the TEM cell (see Figure 1).

1.1 **Measurement Philosophy—**The RF voltage appearing at the input to the spectrum analyzer is related to the electromagnetic radiation potential of the IC and of the electronic module of which it would be a part. The intent is to provide a quantitative measure of the RF emissions from ICs for comparison or other purposes.

2. ***References—***General information supporting this document is in SAE J1752-1, Integrated Circuit EMC Measurement Procedures, General and Definitions.

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

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

SAE J1752-1—Electromagnetic Compatibility Measurement Procedures for Integrated Circuits—Integrated Circuit EMC Measurement Procedures—General and Definitions

2.2 **Related Publications—**The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 IEC PUBLICATION—Available from International Electrotechnical Commission, 3, rue de Verambe, P.O. Box 131, 1211 Geneva 20, Switzerland.

IEC 61967—Measurement of RF Emissions from Integrated Circuits

2.2.2 IEEE PUBLICATIONS—Available from IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

Characterization of the RF Emissions from a Family of Microprocessors Using a 1 GHz TEM Cell, J. P. Muccioli, T. M. North, K. P. Slattery, 1997 IEEE International Symposium on Electromagnetic Compatibility, August 1997.

Model of IC Emissions into a TEM Cell, A. Engel, 1997 IEEE International Symposium on Electromagnetic Compatibility, August 1997.

Investigation of the Theoretical Basis for Using a 1 GHz TEM Cell to Evaluate the Radiated Emissions from Integrated Circuits, J. P. Muccioli, T. M. North, K. P. Slattery, 1996 IEEE International Symposium on Electromagnetic Compatibility, August 1996.

The Measurement of Radiated Emissions from Integrated Circuits, R. R. Goulette of Bell Northern Research, Ottawa, Ontario, Canada, 1992 IEEE International Symposium on Electromagnetic Compatibility, August 1992.

2.2.3 OTHER PUBLICATION

A New Method for Determining the Emission Characteristics of an Unknown Interference Source, G. H. Koepke, and M. T. Ma, Proc. 5th Intl. Zurich Symposium & Technical Exhibition on EMC, (Zurich, Switzerland), March 1983, pp. 35-40.

3. Definitions—See SAE J1752-1.

4. Test Conditions

4.1 Supply Voltage—The supply voltage shall be as specified by the IC manufacturer. If other values are agreed to by the users of this procedure, they shall be documented in the test report.

4.2 Frequency Range—The usable frequency range of this radiated emissions procedure is determined by the test cell used. For a 1 GHz TEM cell, the range is 150 kHz to 1 GHz. For a wideband TEM cell (GTEM), the range is 150 kHz to 8 GHz, or as limited by the GTEM and test PCB characteristics. This is to be verified using the appropriate procedure in 5.4 or 5.5.

5. Test Equipment

5.1 Shielding—The use of double shielded or semi-rigid coaxial cable is required. Depending on the local ambient conditions, operation in a shielded enclosure may be required.

5.2 RF Measuring Instrument—The spectrum analyzer or receiver resolution bandwidth shall be 9 or 10 kHz and the video bandwidth shall not be less than three times the resolution bandwidth. Spectrum analyzer sweep is to be in calibrated or coupled mode (auto sweep). The instrument shall be set for peak reading and max hold with measurements in dBµV [for 50 Ω system: (dBm readings) –107 = dBµV].

5.3 Preamplifier—Typically, a 20 to 30 dB gain, low noise preamplifier is required.

5.4 TEM cell—The TEM cell used for this test procedure shall be fitted with a wall port sized to mate with the IC test board. The TEM cell shall not exhibit higher order modes over the frequency range being measured. For this procedure, the recommended TEM cell frequency range is 150 kHz to 1 GHz. The frequency range being evaluated shall be covered using a single cell. The VSWR over the frequency range being measured shall be less than 1.5 to 1. See Appendix A.