Standards emerging for IC EMC measurement

Ross Carlton - November 01, 2003

In the past, EMC compliance has been a unit-level or system-level problem. Now, manufacturers of electronic equipment are beginning to require semiconductor manufacturers to specify radiated and immunity levels for integrated circuits (IC). Some semiconductor companies have responded by developing proprietary test methods, while others have joined with equipment makers and the International Electrotechnical Commission (IEC) to develop standard methods for test and measurement.

Technical Committee (TC) 47—Semiconductor Devices—is heading up the work for the IEC. The committee assigned the work on EMC measurement standards to its Sub-Committee (SC) 47A—Integrated Circuits. SC47A created Working Group (WG) 9 to prepare the test and measurement methods. Working with other industry and national standards bodies, such as the Society of Automotive Engineers (SAE) in the US and the Verband der Elektrotechnik Elektronik Informationstechnik (VDE) in Germany, WG9's program of work includes two families of standards for measuring RF emissions and RF immunity.

Emissions measurement: IEC 61967

IEC 61967, "Integrated circuits—Measurement of electromagnetic emissions, 150 kHz to 1 GHz" specifies methods for measuring emissions from an IC. This standard consists of six parts: a general guidance document and five emissions test methods. Parts 1, 4, 5, and 6 have been approved; parts 2 and 3 should receive approval by the end of the year (Table 1).

• **General conditions and definitions.** IEC 61967-1 describes requirements that are common to all of the IC conducted and radiated emissions evaluation methods that make up the standard. These include measurement conditions, test equipment, general test setup, and test procedures, as well as the content of the test report. A test method summary table is provided in Annex A of 61967-1 to compare the applicability and usage of the measurement methods in Parts 2 through 6.

A large part of 61967-1 covers the description of the IC EMC test board, a required test fixture PCB for the device under test (DUT). The schematic and layout requirements are specified to minimize differences in boards built by different companies, so users can compare the EMC performance of ICs no matter who makes the measurements.

The standard also specifies that for programmable ICs, such as microcontrollers, you must write software to fully exercise the part. The software must loop in a relatively short time compared to the spectrum analyzer sweep time to ensure a proper measurement. Requirements include: using the maximum DUT clock frequency, exercising internal address and data buses, exercising on-chip peripherals, and enabling internally generated clock sources.
The software must also provide some indication that it is operating properly, and you should include a listing of the software in the test report to help ensure repeatability.

- **Radiated Emissions—TEM cell method.** The IEC 61967-2 draft standard specifies how to measure radiated emissions using a transverse electromagnetic (TEM) cell. To use this method, you mount the DUT on an IC EMC test board and then install the board in a mating port cut in the top or bottom of a TEM cell or wideband TEM cell (also called a GTEM cell). You test the DUT in at least two orientations to capture the total emission.

- **Radiated Emissions—Surface scan method.** IEC 61967-3, also a draft standard, defines a method of measuring the radiated electromagnetic emissions from an IC by scanning a near-field probe over the surface of the package or die. Mount the DUT on either an IC EMC test board or an application board installed in a test fixture to provide stability. Use a variety of probes to perform the surface scan including electric field probes, magnetic field probes, or a combined electromagnetic field probe.

- **Conducted Emissions—Direct coupling method.** IEC 61967-4 defines a method of determining an IC’s conducted electromagnetic emissions by measuring the radio frequency (RF) voltage developed across a standard load. The standard defines procedures for measuring the conducted emissions from both power pins and signal (input, output, and bidirectional) pins. This method requires that the DUT be mounted on an IC EMC test board.

Measure the conducted emissions on signal pins by terminating the pin into a 150-Ω to 50-Ω impedance-matching network and measuring the RF voltage. You can measure the conducted emissions on power pins in the same way or by summing all return currents at one location and measuring them across a 1-Ω resistor using a probe defined in the standard.

- **Conducted Emissions—Workbench Faraday Cage (WBFC) method.** IEC 61967-5 defines a method of measuring the conducted electromagnetic emissions at defined common-mode points in order to estimate the emissions radiated by connected cables. Mount the DUT on either an IC EMC test board or an application board if it fits inside the WBFC. With all input, output, and power connections to the test board filtered and connected to common-mode chokes, the conducted noise is measured at PCB locations specified by the standard. Since this method allows the DUT to be mounted on an application board, it is useful for optimizing both the IC and PCB design or the PCB design alone.

- **Conducted Emissions—Magnetic probe method.** IEC 61967-6 defines a method for calculating the conducted emissions from an IC pin using a magnetic field probe to measure the magnetic field associated with a connected PCB trace. The preferred test configuration is with the DUT mounted on an IC EMC test board with the standardized layout patterns to maximize repeatability and minimize probe coupling to other circuits.

The IC EMC test board for this method has the same schematic as the board used in Part 4 but uses layout patterns that makes it easier to test with a magnetic probe.

**Immunity measurements: IEC 62132**

For assessing the immunity of ICs to radiated and conducted emissions, SC47A WG 9 is also developing IEC 62132, "Integrated circuits—Measurement of electromagnetic immunity, 150 kHz to 1 GHz." This standard consists of five parts: a general guidance document and four immunity test methods. The test methods in this standard use a continuous wave signal, either modulated or unmodulated. The IEC expects to begin approving the parts of this standard in late 2004 (Table 2).
• **General information and definitions.** IEC 62132-1 describes requirements common to all of the methods that make up the 62132 standard, including measurement conditions, test equipment, general test setup, test procedures, and the content of the test report. The standard also defines classes to characterize IC immunity performance.

As with IEC 61967, IEC 62132-1 provides design guidance for the test fixture PCB. An important characteristic for this test board is that the PCB and support circuitry as well as the test and support equipment not be affected by the immunity test.

For programmable ICs, you must write software that fully exercises the part. The software must also be able to report a susceptibility to the test technician and not include features that would improve immunity performance.

• **Radiated Immunity—TEM cell method.** IEC 62132-2 defines a method of measuring an IC's immunity to radiated emissions. To test an IC using this method, you mount the DUT on the test board and install it in a mating port cut in the top or bottom of a TEM cell or GTEM cell. You must test the DUT in at least two orientations to ensure complete exposure to the generated electric field.

• **Conducted Immunity—Bulk Current Injection (BCI) method.** IEC 62132-3 defines a method of evaluating immunity of the DUT to electromagnetic fields coupled to cables or cable bundles connected to the package pins. You can use this method to evaluate the immunity of IC pins connected to cables and also to evaluate other pins as well. The test signal is inductively coupled to the pin or pins under test using a current probe. Since you must connect the pins of the DUT to a cable or wire to inject the test signal, you can use a DUT application board or an IC EMC test board to perform this test.

• **Conducted Immunity—Direct RF Power Injection (DPI) method.** IEC 62132-4 also defines a method of evaluating immunity of the DUT to electromagnetic fields coupled to cables or cable bundles connected to the package pins. When using this method, however, you directly inject the test signal using capacitive coupling to inject the signal on the cable or wire. The DUT can be mounted on either an IC EMC test board or an application board.

• **Conducted Immunity—Workbench Faraday Cage (WBFC) method.** IEC 62132-5 defines a method for evaluating the immunity of an IC to signals injected at defined common-mode points. The DUT can be mounted on either an IC EMC test board or an application board, provided the board fits in the cage. With all input, output, and power connections to the test board filtered and connected to common-mode chokes, you must inject the conducted noise at PCB locations specified by the standard.

Using the standards

You can obtain copies of the published standards from the IEC ([www.iec.ch](http://www.iec.ch)). To participate in the development of these standards, contact a Working Group member or your national IEC committee chairman. A list of Working Group members can be found at the TC47/SC47A dashboard on the IEC Web site.

Remember that IEC 61967 and IEC 62132 are works in progress and will evolve as new issues are identified and resolved. To maximize the effectiveness of the standards, users should submit their comments about the defined test and measurement methods to the Working Group.

Table 1. Status of IEC 61967 (RF emissions)
Table 2. Status of IEC 62132 (RF immunity)

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<td>1</td>
<td>Committee draft</td>
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</tr>
<tr>
<td>2</td>
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<td>3</td>
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References