As ICs become more like entire systems on a chip, they begin to suffer from system-level problems. The susceptibility to and generation of electromagnetic interference is one such problem. With single-chip designs becoming common, product developers are starting to look to chip vendors to solve electromagnetic compatibility (EMC) issues. To support that effort, a new group of international standards is emerging to define how to measure the EMC of chips.

The International Electrotechnical Commission (IEC; www.iec.ch) is one of the standards bodies addressing the need for standardized EMC test methods at the IC level. The organization is trying to coordinate with other standards bodies working on the same issue, such as the Society of Automotive Engineers (SAE) in the US and the VDE in Germany, to gain consistency for users. The IEC standards being developed break the testing of IC EMC into two areas: RF emissions and RF immunity.

The RF emissions standards are the furthest along in development. The IEC has created a working group (SC47A-WG9) under its IC technical committee to create the standards, and the group will have the full standard set for emissions (IEC 61967, “Integrated Circuits—Measurement of electromagnetic emissions, 150 kHz to 1 GHz”) either published or available in draft form by mid-2004. The immunity standards are about a year behind, with completion estimated for 2005.

The IEC 61967 emissions test specifications call for TEM cell measurement of radiated emissions, a surface scan for radiated emissions, a test of conducted emissions across a load, and conducted emissions using a magnetic probe. There is also a test of conducted emissions designed to estimate the radiation of connecting cables in an application using an applications board. All other tests use a defined test board.

The defined test board is a key part of the emission standards. Because the emission level of a powered device is so highly dependent on the coupling and radiating efficiency of the chip’s connection circuitry, the standard specifies the design and fabrication of the test printed circuit board (PCB) in great detail. The drawback of controlling the test board so tightly is that the measured results are difficult to correlate with the performance of a chip in its application PCB. Yet, the tight control is necessary if the tests are to provide a meaningful basis of comparison. Testing based on the specification, then, is best used to compare ICs from different manufacturers or in different package options rather than as a predictor of system emissions.

Similar considerations affect the immunity test specifications in IEC 62132, “Integrated Circuits—Measurement of electromagnetic immunity, 150 kHz to 1 GHz.” As with emissions, a well-defined test board is an essential part of the specifications and is described in Part 1 of the draft standard.

The IEC SC47A WG 9 has more to do after it finishes the immunity test specifications. The group fully expects that many issues will arise with the specifications that will need resolution. Already an amendment to IEC 61967 Part 4 is under consideration. The group also has plans to create additional specifications, such as transient immunity test standards for ICs. But the trend is clear. EMC testing is moving to the chip level.

### Table 1 EMC standards for ICs

<table>
<thead>
<tr>
<th>IEC 61967—EMISSIONS</th>
<th>PUBLISHING DATE</th>
<th>IEC 62132—IMMUNITY</th>
<th>PUBLISHING DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1—General</td>
<td>March 2002</td>
<td>Part 1—General</td>
<td>End 2004</td>
</tr>
<tr>
<td>Part 3—Radiated, Surface Scan Method</td>
<td>Early 2004</td>
<td>Part 3—Bulk Current Injection Method</td>
<td>End 2004</td>
</tr>
<tr>
<td>Part 4—Conducted, ( \Omega/150 \ \Omega ) Direct Coupling Method</td>
<td>April 2002</td>
<td>Part 4—Direct RF Power Injection Method</td>
<td>End 2004</td>
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<tr>
<td>Part 6—Conducted Magnetic Probe Method</td>
<td>June 2002</td>
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_www.tmworld.com_
EMC in the driver’s seat

Richard A. Quinnell, Technical Editor

EMC engineers can look forward to an increasing demand for their knowledge and services, and the Internet is a major driving force. Web connectivity is taking on an ever-greater role in the world, with wireless links becoming key to many emerging applications. The resulting combination of high digital clock speeds, multiple RF linkages, and customer expectation of wire-line reliability levels is making EMC a key to success for many industries.

You can see the growing importance of EMC test and measurement by looking at EMC standards. Some standards are new, such as those for IC testing. Others, such as those for automotive testing, are being revised to extend their scope. Standards bodies are working overtime, it seems, to keep ahead of the technology curve.

Staying ahead of the technology is a challenge. Not only are IC clock speeds doubling every 18 months or so, extending the range of EMC concerns beyond 1 GHz, but the amount of electronic content in products is increasing. With automobiles, for instance, your biggest concern used to be the ignition system in the engine. Now, there are high-speed processors, GPS receivers, broadband Internet receivers, motor controllers, and a variety of data networks inside a car, all generating noise and all susceptible to EMI.

For you, this proliferation of potential radiators and receivers is good news. Many industries will need your expertise. Your problem will be keeping ahead of the standards.

Contact Richard A. Quinnell at richquinnell@att.net.

NEWS

EMC workshop in central US

A TWO-DAY WORKSHOP on the practical applications of EMC design is being offered April 29 and May 3 in Northbrook, IL. The workshop, offered by DLS Electronic Systems, will provide a step-by-step design process that can help you avoid EMC problems while designs are still on paper. The workshop covers both design techniques and the calculations required to have a design comply with regulations.

www.dlsenc.com

EU standards list available

THE OFFICIAL JOURNAL of the European Union, a daily publication covering legislative activity for the EU as well as providing information and notices about new legislation, recently published a list of all EMC standards in effect in the EU. The list includes information on the expiration date of existing standards and the implementation of their replacements. The list appeared in the November 12, 2003, issue and includes EN61000 (Electromagnetic Compatibility), scheduled for replacement in July 2004.


Measurement uncertainty guide available

A GUIDE TO measurement uncertainty in EMC tests is now available from Schaffner EMC. The guide provides the basic concepts for identifying and calculating contributions to uncertainty as well as examples on how to set up uncertainty budgets for common EMC emissions measurements. The guide also briefly covers the effect of new CISPR standards documents on the calculation and reporting of measurement uncertainty. The guide “EMC Measurement Uncertainty, a Handy Guide” is available as a free download at www.schaffner.com/test_systems/en/download_ti.asp?level=3$7&language_id=12.

Cypress acquires CPI

THE CYPRESS GROUP, a private New-York-based equity firm, has completed the acquisition of Communications and Power Industries (CPI) in a transaction valued at $300 million. CPI is a provider of medical, communications, and satellite equipment as well as microwave power amplifiers used in EMC testing. The companies expect to work together to grow CPI, building on its design and manufacturing capabilities for vacuum electron devices (VEDs) as well as other specialized microwave and RF equipment.


New EMC standards manual

EMC ENGINEERS working on automotive applications have a new resource available. The Society of Automotive Engineers has published its “Surface Vehicle Electromagnetic Compatibility (EMC) standards Manual 2004 Edition.” The manual contains 39 documents, including three new standards and 21 standards revised since it was last published. It contains all the documents pertaining to EMC for vehicles, motorboats, and other internal-combustion-engine driven machinery.

www.store.sae.org.

Calendar

EMC 2004
August 9-13
Santa Clara Convention Center
Santa Clara, CA,
www.emc2004.org

EOS/ESD Symposium
September 19-23
Gaylord Texan Resort & Conference Center
Grapevine (Dallas), TX
www.esda.org
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With the electronic content of automobiles growing, so is the concern for electromagnetic compatibility (EMC) of automotive systems. The methods designers have been using, as well as the specifications, are being challenged by such changes in automotive technology as telematics, electric power, and the use of electronic control systems in place of mechanical ones. Research teams are developing new methods, tools, and standards for automotive EMC testing.

The growth of electronics in automobiles has been staggering. Many industry analysts expect that by 2010, nearly 30% of an automobile’s cost will be its electronic component. Vehicles will contain noise-canceling entertainment systems, wireless voice and digital communications, active suspension, antilock brakes, and satellite navigation just for starters. Electronic locks, keyless entry, power windows and mirrors, and power seating will combine with intelligence that recognizes a driver from the entry code and adjusts the car to his or her personal settings. Complex wire harnesses will be replaced with serial communications buses and wireless signaling for sensors, and traditional mechanical systems such as steering and braking will become electrically controlled.

In the face of such a vast array of electronic functions, the need for automotive EMC test has become critical. In 1995, the European Union (EU) created directive 95/54/EC to specify the test methods and legislated limits for radiated emissions and immunity of both vehicles and electronic subassemblies (ESA) used in vehicles. No legislation defining such limits exists within the US, although the Society of Automotive Engineers (SAE; www.sae.org) has had standards since the early 1990s for testing, and manufacturers have developed their own internal performance standards in order to meet the requirements of their geographical markets.

Those specifications, however, have needed frequent revision, and new standards have emerged. In 1995, the International Electrotechnical Commission (IEC; www.iec.ch) released CISPR 12 (covering the limits and measurement methods for emissions) and CISPR 25 (covering immunity of vehicles and ESAs). In addition, the International Standards Organization (ISO; www.iso.ch) has revised and expanded its standards covering ESA immunity to transients (ISO 7637), electrostatic discharge (ISO 10605), and radiated energy (ISO 11452). As a result of these organizations’ efforts, the CISPR and ISO standards have essentially replaced the SAE and manufacturer

Table 1. Automotive EMC test specifications

<table>
<thead>
<tr>
<th>STANDARD</th>
<th>ISSUING BODY</th>
<th>SCOPE</th>
<th>APPLICABILITY</th>
<th>TOPIC</th>
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<td>European Union</td>
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<td>ESD</td>
<td>2001</td>
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<td>North America</td>
<td>X</td>
<td>Radiated emissions and immunity</td>
<td>1995</td>
</tr>
</tbody>
</table>
Automotive EMC

standards. (A summary of public standards and their applicability appears in Table 1.)

But the changes are far from over. EU directive 95/54/EC is undergoing revision, and the SAE has released a 2004 edition of its Surface Vehicle EMC Standards Manual, reflecting the addition of new RF sources in vehicles. The automotive industry is also looking at the impact alternative-power vehicles will have on EMC. Alternative power, such as batteries, fuel cells, and battery-gasoline hybrid engines, can significantly add to the EMC problems in automobiles.

Papers offer alternatives

Some of the recent investigations into such EMC problems were presented at the IEEE Symposium on Electromagnetic Compatibility held in August 2003 in Boston, MA. The presentations indicate that both standards and test procedures will need further change to properly characterize the behavior of electrically driven vehicles (Ref. 1). And one group of researchers found that new test instruments may also be needed.

In their paper entitled, “Investigation of Electromagnetic Emissions Measurements Practices for Alternative Powertrain Road Vehicles,” Alastair Ruddle et al. note that standard broadband emissions tests call for the vehicle’s engine to be disengaged, idling at a constant speed. Narrowband emissions tests require that the engine be off but the electrical power be on to test the ESA emissions.

With alternative-power vehicles, however, these conditions do not exercise the drive system. Electric motors draw current based on their load and draw no current when not engaged, so the standard test setup would not stimulate emissions from the motor or its power system. Further, with the motor off, some ESA components would not be active, so the standard test setup would miss any emissions from these modules.

When the authors tested a variety of electric vehicles under steady driving conditions, by running the vehicle at a constant speed on a dynamometer, the vehicles showed excessive emissions from 30 MHz to 127 MHz. These emissions would have been missed under the standard test conditions. The conclusion is that existing test conditions and methods will fail to adequately characterize alternative-power vehicle emissions. Automotive EMC test methods will have to change as alternative-power vehicles become more common. The nature of the change is uncertain, however, and Ruddle and his co-authors recommend testing alternative-power vehicles under load.

Chingchi Chen, of Ford Motor Co., offers a different approach in his paper, “Characterization of Power Electronics EMI Emission.” Chen investigated the relationship between the switching pattern of a power system and its radiated emissions. Using a two-pulse test technique to reproduce switching transitions, he recorded system transient responses under different load conditions. He was then able to accurately predict the power system’s emissions by modeling the pulse width modulation (PWM) pattern the system would generate under load.

Whether or not such modeling is acceptable as part of a specifications test, it is a useful design diagnostic tool. An ability to accurately predict the EMC behavior of system components helps designers implement corrective action early in the design phase. That was the goal of a European research project described in the paper “Continuous Simula-
tion of System-Level Automotive EMC Problems” by a team of university and automotive researchers from Europe.

The researchers began their modeling process by using SPICE models to characterize the EMC behavior of the control module’s processor chip. The characterization then moved to board-level and on to the vehicle level, as the team used SPICE to model the CAN bus as a transmission line network. Even the vehicle chassis itself was modeled using the CAD data for the car frame; a field solver was used to calculate scattering parameters and develop the SPICE model for bus-to-antenna coupling in the vehicle. With all the models in place, the team could simulate system-level EMC.

The researchers tested their models against measurements and found good agreement. This level of simulation will not replace final validation tests, but it does serve as an early detection system for potential EMC problems. It also implies that future automotive EMC control efforts could involve sharing of models from the chip level on up in the design process.

Along with new modeling schemes, test methods, and specifications, research into automotive EMC is leading to the development of new test tools. Researchers M. Kull et al. created a remote probe system with optical links, which they described in “A New Test System for Measurements of Fast Transients in Passenger Cars.” The probe system was used to measure the spikes caused in cable harnesses by the switching of high-power devices such as active suspension systems and antilock brakes. The optical links to the probes were necessary to avoid introducing ground loops in probe shields when making simultaneous measurements at several points in a vehicle. In addition, the links protected the measurement from picking up signals during high-field-strength immunity tests.

This creation of new test instrumentation and methods demonstrates that automotive system EMC test is far from a settled discipline. With the continual introduction of new electronic systems, including electric drive, EMC specifications and standards are trying to hit a moving target. EMC test engineers can thus look forward to continual growth and change in automotive EMC test for years to come.

Reference
Amplifier simulates radar of car

AR Worldwide has introduced a traveling wave tube amplifier (TWTA) that is designed to simulate the effect of a car driving through a radar beam. The 1000TP1G3 provides a pulse output that generates 600-V/min radar packets for testing automotive immunity. The device meets both Ford and GM specifications and works in two bands: 1.15 GHz—1.45 GHz and 2.7 GHz—3.1 GHz. AR Worldwide, Souderton, PA. 215-723-8181; www.ar-worldwide.com.

Broadband meter measures RF pollution

Laplace Instruments has released its TriField Broadband handheld meter. The TriField is a combination of a magnetic AC gaussmeter, an electric field strength meter, and an RF field strength meter. Its RF range (100 kHz to 2.5 GHz) and electric field range (40 Hz to 100 kHz) make it usable in detecting radiated fields for a broad range of sources, from overhead power lines to wireless LANs. Laplace Instruments, Norfolk, UK. +44-0-1263-515160; www.laplaceinstruments.com.

Power amp targets automotive test

The Ophir RF broadband power amplifier targets immunity and automotive testing by providing more than 500 W of power in the frequency range 200 MHz to 1000 MHz. The amplifier offers harmonic rejection, placing harmonics more than 30 dBc below the fundamental, and input and output RF protection. The input protection prevents overdrive for signals as strong as 13 dBm. On the output side, the unit has high-load VSWR detection that will give a warning at a user-set reflected power level. The unit also offers built-in test diagnostics that monitors the amplifier’s health to the module level. Ophir RF, Los Angeles, CA. 310-306-5556; www.ophirrf.com.

Interfax offers EMC scanner

Canadian distributor Interfax Systems is now offering the EMC scanner from Detectus of Sweden. The scanner combines an XYZ mobile platform with an electromagnetic (EM) sensor and software. The unit is able to automatically produce a 2-D or 3-D EM intensity profile of a circuit board using a PC as the control and display device. The sensor’s resolution allows a 1-mm step size, allowing users to view EM emissions at the component level. A heat sensor is also available. Interfax Systems, Toronto, ON, Canada. 416-674-8970; www.interfaxsystems.com.

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