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Background: Electromagnetic Compliance Industry

By investing $500,000 to build the world's largest antenna ground test plane, Liberty Labs sees a growing market for electromagnetic and radio frequency (EM/RF) compliance. Other signs of growth in the electromagnetic compliance industry include:

- An increased number of EMC test labs in the last ten years. Liberty Labs president Michael Howard estimates that the number of EMC test labs in the United States has doubled in the last ten years to approximately 600 altogether. Howard estimates that approximately 250 of today's EMC test labs are independent, while the remaining 350 are in-house labs maintained by major manufacturers of electrical/electronic equipment.
- Greater reliance on electromagnetic interference (EMI) test equipment at manufacturers in-house test labs. A recent study by Cahners Research found that 57% of engineering respondents used antennas for EMI testing; 51% use EMI emissions testers; and 36% use EMI susceptibility testers.

- More frequent usage of alternative test site methods, such as EMC test cells for emissions and immunity testing. Traditionally, manufacturers and independent labs have relied on room-sized anechoic chambers for EMC testing, but anechoic chambers can cost anywhere from $500,000 to millions of dollars. Within the last few years European manufacturers in particular have experimented with using smaller EMC test cells capable of fitting on a bench (typically measuring 700 by 700 by 700 millimeters) that cost as low as $30,000 apiece. Although suitable for only small equipment such as mobile phones, pagers and tiny instruments, the EMC test cells are ideal for small R&D departments working under tight product design deadlines.

What is EMC?

Any device or component with a flowing electrical current will produce an electromagnetic field comprised of both electric and magnetic field components. Through the phenomenon of coupling, electromagnetic fields can interact with other types of electrical or electronic circuitry and interfere with their performance. (For purposes of this discussion, "interference" is any electromagnetic activity which disturbs the regular performance of electrical or electronic equipment.) If equipment achieves electromagnetic compatibility (EMC), that means it will operate without causing -- or suffering from -- electromagnetic interference.

For example, EMC means electrical/electronic equipment won't interfere with broadcast or communication signals, while likewise being immune to such signals. EMC status also implies electrical/electronic products won't create high levels of conducted or radiated signals that might

interfere with other equipment. Examples of adverse effects from interference include everything from degradation of digitized data, to increased background noise in a communication channel, to the destruction of electronic circuits.

Interference may arise from either radiated or conducted sources. Most EMC standards work under the assumption that unwanted interference is conducted at frequencies below 30 MHz, or radiated at frequencies higher than 30 MHz.

Why increased attention on EMC?

Design and test engineers are paying more attention to EMC-related issues for three reasons:

1. The likelihood of electrical interference has increased because manufacturers are using smaller devices operating at higher frequencies. Higher speed switching logic increases emissions, while low operating voltages and currents (with circuits packaged more closely together), decreases a product's immunity. As the frequencies increase, high-performance electronic circuits become more susceptible to pulsed electromagnetic interference. "The faster clock speeds on today's computers are operating in the middle of communications bandwidths and producing radio signals," says Liberty Labs president Michael Howard. "You even have some situations where the third or fourth harmonic at 600 MHz can affect digital telephone services."

2. International governing bodies, especially the European Union, have tightened the standards for electromagnetic compatibility of products. "The regulations are greater in number, more complex and tighter than they've ever been," Howard says. Since January 1, 1996, manufacturers wishing to sell products in Europe must comply with stringent EMC tests mandated by the European Union. Failure to comply with EMC regulations would prevent manufacturers from selling into the lucrative European market.

3. Another factor related to -- but separate from -- the specific ratcheting of EMC regulations is the realization that regular calibration of test equipment enhances total quality control. In order to achieve ISO 9000 compliance, manufacturers now must adhere to tighter calibration schedules for all test equipment, rather than calibrate on an adhoc basis. Even if specific EMC regulations hadn't been tightened in the last few years, EMC test labs still would have seen more business related to antennas, amplifiers, probes and LISNs because of the calibration wave generated by ISO 9000.

In other words, the stakes have been raised for EMC testing. This has changed the behavior of product design and test engineers in two ways. First, engineers are factoring EMC-related issues into their design process much earlier, compared to ten years ago. Secondly, test and design engineers want higher levels of accuracy (or, phrased another way, lower values of measurement uncertainty) when they conduct EMC tests. If their products don't pass the EMC standard, then design engineers must either re-design the product or build-in extra EMI shielding. Neither

option is attractive: product re-designs consume too much time, while extra EMI shielding components raise production costs.

"Equipment manufacturers would like to reduce their time-to-market by utilizing existing product designs without making costly re-designs to meet EMC requirements," Howard says. "If they can test more accurately -- with a higher degree of certainty -- and feel comfortable about being in EMC compliance, then it saves them time."

Accurate EMC testing allows design engineers to discover very early in the product development process that electrical/electronic equipment falls far short of EMC regulations. It's better for them to know sooner rather than later, so they can avoid costly product re-builds deep in the product development cycle. "The worst thing for the manufacturer is a product recall, or not being able to ship product because they're not in compliance with the EMC regulations," Howard says. One trick to avoiding such nightmares is relying on highly accurate EMC emission and immunity tests that utilize regularly calibrated test & measurement equipment.

Conversely, with accurate EMC testing during the early design process, engineers might happily discover they can get by with less EMI shielding in their products and still achieve electromagnetic compliance. By reducing the amount of traditional noise suppression components (gaskets, filters, ferrite beads), manufacturers would save money on parts and production costs. "If they can design the product so that it's just within compliance, they can possibly save money on shielding," Howard says.

The overall goal -- achieving electromagnetic compliance at the lowest possible cost -- has generated a sub-industry of specialized independent EMC labs that typically service small to medium-sized electrical/electronic equipment manufacturers. (Larger manufacturers usually find it's faster and more cost-effective to bring EMC design and test functions in-house.) Such labs typically assist manufacturers at the drawing board stage with insight on how to control radiated emissions at the circuit board level, as well as power supplies, back planes, cabling and enclosure shieldings. Many labs provide troubleshooting strategies and techniques for correcting radiated EMI problems.

Throughout this process, engineers rely on EMC emission and immunity tests to see if design theory matches actual product performance. Immunity tests are conducted with specialized transmitting antennas (biconical, bi-logs, etc.) that create a known electromagnetic field. By creating a specific electromagnetic field, test engineers can determine whether electrical/electronic equipment is vulnerable to EMI/RFI. Conversely, test engineers can also determine if EMI emitted from the equipment complies with regulated emission limits for radiated and conducted fields.

To ensure the accuracy of the EMI immunity and emission tests, the transmitting and receiving antennas (along with other measurement accessories such as amplifiers and line impedance stabilization networks -- LISNs) must be calibrated and adjusted to make sure conversion factors used by test labs give an accurate representation of the immunity and emission fields they are measuring. Liberty Labs fills the niche of providing highly accurate antenna and accessory calibrations for independent test labs and manufacturers.

"We're betting that the need for very accurate EMI/RFI calibrations is going to grow," says Michael Howard. "More regulatory and voluntary organizations are putting in tighter requirements for product compliance and performance. For example, more wireless applications are coming on line all the time, and if those products are going to perform the way they're supposed, they can't create interference or be vulnerable to interference. We think we're well-positioned to capture a good deal of business from the growth in electromagnetic compliance testing."

Liberty Labs, Inc. calibrates antennas, isotropic probes, line impedance stabilization networks (LISNs), electrostatic discharge (ESD) guns, and other accessories used by laboratories involved with electromagnetic interference or radio frequency testing (EMI/RFI). The company is located in Kimballton, Iowa.