RFID Takes AIM

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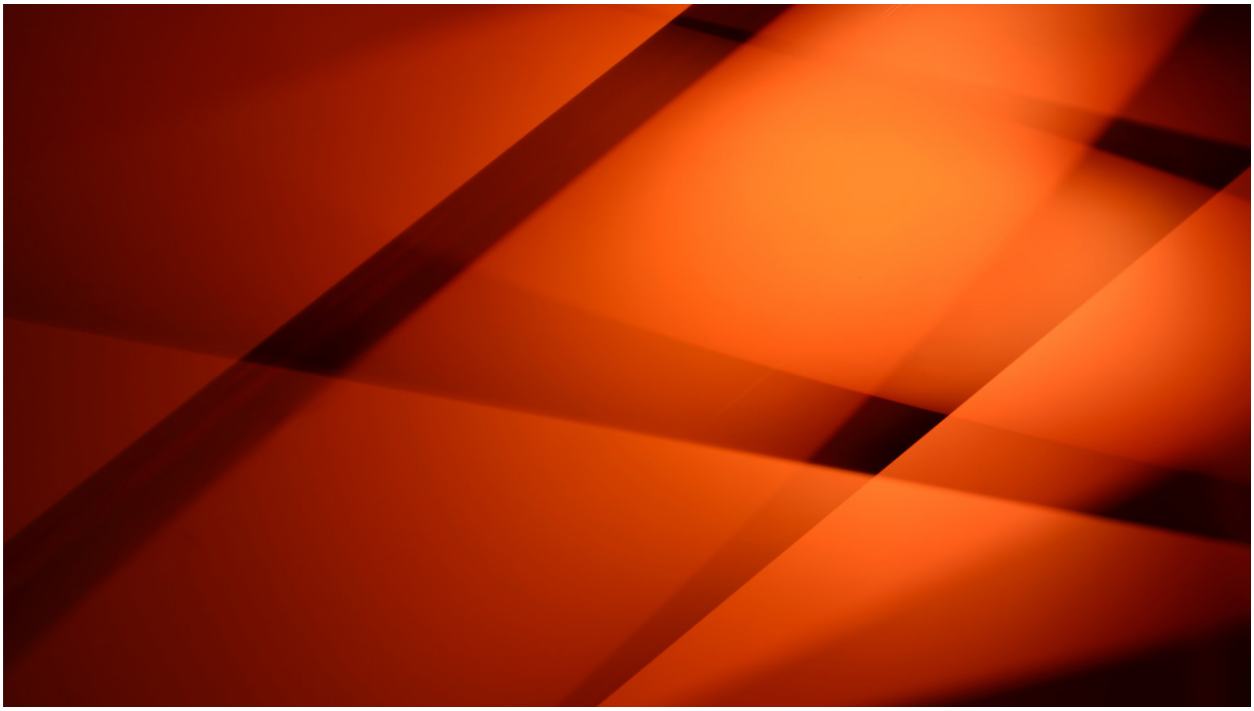

Radio-Frequency Identification (RFID) technology has been in use for the last 50 years. The technology is used as an identifier of a device for inventory or status tracking. It serves similar functionality as bar-coding, with continuously increasing advantages. The reduction in costs to produce the components of RFID has caused the technology to proliferate in recent years. The task of inventory control and animal identification has progressed into monitoring and error prevention in electronic devices. The following is a brief insight into RFID's inclusion into electro-magnetic compatibility testing of electronic devices that operate in RFID environments and/or utilize RFID technology. This requires new test methods to fill the gaps of traditional electromagnetic compatibility testing.

The basic components to an RFID system are the reader and the tag. The reader is what we at an EMC test laboratory are simulating. The reader performs read/write operations with a tag. The tag is either a passive or active device incorporated into other electronic equipment or stand-alone on non-electronic equipment. The reader generates magnetic or electric energy to acquire information from a tag. In some passive RFID tags, it induces momentary electrical power to the tag. The information the tag responds with contains location, identification and status of the device the tag is attached to. An important reminder is that the equipment under test (EUT) or any device utilizing an RFID tag in an RFID network needs to be immune in an RFID environment. In other words, your device can be vulnerable to RFID energy even if that device does not use RFID technology.

There are numerous RFID frequencies and modulation schemes currently in use. The magnetic (H-field) frequencies include 134.2kHz and 13.56MHz. The higher electric (E-Field) frequencies are 433MHz, 860-960MHz, and 2.45GHz. Simulating these frequencies requires specialized equipment not normally used for electromagnetic compatibility testing. To deliver a simulated realistic RFID signal, the following components are necessary: vector signal generator, amplifier and antenna. The vector signal generator needs to be programmed or controlled via a software package to deliver the modulation requirements prescribed by Advancing Identification Matters (AIM). AIM is a group of RFID experts that prescribe the basic set of RFID immunity requirements for equipment operating in RFID environments. These requirements contain the field intensity, modulations and word structure of the simulated RFID transmissions.

Since tag readers can be fixed or mobile, full immersion of the EUT by the reader signal is desired. The magnetic (H-field) frequencies require more manipulation to accomplish this. Producing the magnetic field intensities required by AIM restricts the area of exposure of the magnetic field. Simply stated, less power is required for a smaller area of magnetic field exposure. For sizable EUTs, the magnetic loop antenna will be moved about the EUT to adequately expose the EUT to the various RFID transmissions. Likewise, the electric and magnetic fields decrease in intensity with distance. Magnetic field intensity decreases much more rapidly with distance than electric fields. The magnetic field RFID frequencies require close proximity between the magnetic antenna and the EUT with the RFID tag. These magnetic fields find their way onto wire bundles, ribbon cables, and circuits on a PC board that have paths and loop areas. Magnetic fields through circuit loops induce a voltage – often large enough to change bit states and overtax display illumination and indicator lighting. Illuminating the EUT with the electric field (E-field) frequencies is similar to testing to IEC 61000-4-3. Most, if not all, of the EUT can be illuminated at a distance in the horizontal and vertical polarities.

Our experience evaluating to the AIM 7351731 standard has revealed vulnerabilities in devices previously immune to traditional radiated susceptibility testing such as IEC 61000-4-3. One EUT utilizing a 13.56MHz RFID technology had an immunity problem at 433MHz. Another 13.56MHz transmission caused a device laden with stepper motors to twitch like a break-dancing robot. The occurrence of the responses has been unpredictable and do not favor or occur more frequently at a particular frequency or modulation scheme. But why are devices that have been previously evaluated to IEC 61000-4-3 and even medical standard IEC 60601-1-2 suddenly vulnerable to AIM immunity requirements?

Frequency range, for one. The typical IEC 61000-4-3 encompasses a frequency range of 80MHz-2.7GHz. Obviously, this does not come close to covering 13.56MHz and 134.2kHz RFID frequencies. It is also an electric field immunity specification and not a magnetic field immunity test that these low frequency technologies utilize. Addressing the increasingly occupied RF frequency spectrum, the IEC 60601-1-2 medical standard has many additional frequencies from 385MHz-5.785GHz with higher test levels along with pulse and FM modulation types. These frequency bands coincide with European and American two-way radios, analog and digital cell phones, 2.4GHz technologies, and WLAN.

The modulation types used in IEC standards try to mimic modulations used in various public frequency bands. The AM, FM and pulse modulations are fixtures on many commercially available signal generators and are the backbone for all electromagnetic compatibility standards. Specifying highly specific modulation schemes that employ phase and amplitude modulation, as well as the data to be encoded are unprecedented requirements. These are among the requirements of AIM. One necessary portion of those requirements is the capabilities of the vector signal generator.

Magnetic field immunity is typically accomplished by IEC 61000-4-8 or similar standard. This tests an EUT's ability to withstand magnetic fields from either 50 or 60Hz AC power. Anyone who performs magnetic field measurements where 50Hz (or 60Hz domestically) is present knows how prevalent and inescapable this characteristic of the power distribution network is. It makes perfect sense that an EUT be immune to this phenomenon. This is verified by immersing the EUT in a Helmholtz coil generated magnetic field of up to 30A/M. AIM Standard 7351731 requires magnetic immunity at 134.2kHz with a 65A/M level, and 13.56MHz with a 12A/M maximum level. IEC 61000-4-8 and all product standards that reference it was never intended to test immunity to RFID magnetic frequencies. This is a reason why AIM developed the RFID requirement.

Figure 1 – Setting up the AIM RFID susceptibility test. Photo, courtesy D.L.S. Electronic Systems.

A typical RFID testing session at an EMC laboratory will include the following procedure:

1. EUT setup and organized per IEC 61000-4-3. Discuss EUT operation, fault criteria, test locations and locations where essential EUT operation could be affected.
2. Develop one of the nine AIM RFID transmissions utilizing software, vector signal generator, RF coaxial cabling, and transmit antenna for the appropriate frequency.
3. Verify a field intensity at a deliberate and precise distance using a calibrated measurement antenna and spectrum analyzer for magnetic fields. A calibrated electric field measurement probe and an analyzer will be utilized to verify electric field level.
4. Place the transmitting antenna at the proper distance at various locations about the EUT to expose the EUT to the realistic RFID magnetic or electric field intensities. This simulates the EUT operating in an RFID environment being exposed to the reader.

The RFID test administered per AIM 7351731 provides a realistic immunity check to magnetic and electric fields present in RFID transmissions. The broad range of frequencies and technologies employed demand a considerable amount of equipment to properly perform the tests. EUTs in critical applications such as medical, aerospace, industrial and military may operate in an RFID environment and utilize RFID themselves. Consider the AIM 7351731 RFID test as part of your scope of testing for your product as recognized by the FDA.

References

1. AIM is Advancing identification Matters. Their website is: https://www.aimglobal.org/store/ListProducts.aspx?catid=172566

1. The standard may be accessed here: https://www.aimglobal.org/store/ViewProduct.aspx?id=7351731

About the Author

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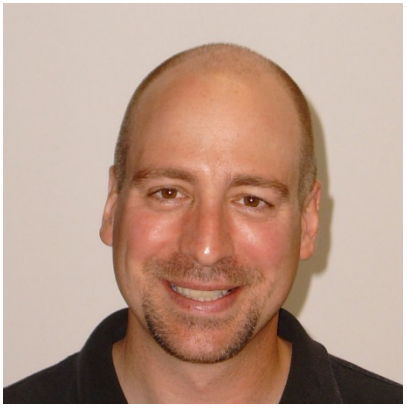

Tim Lusha, Senior EMC and Consulting Engineer, has been with D.L.S. Electronic Systems, Inc., a large independent EMI and Environmental testing laboratory for the past 22 years, working at both D.L.S.'s Wheeling, IL and Genoa City, WI testing facilities. Tim works in the area of FDA, FCC, EU, IC and VCCI requirements as well as transmitter measurement, power quality, uncertainty, and calibrations, including custom test setups, software programs and networks for testing. Tim's background also includes MIL-STD-461 and DO-160 testing. He is a member of the IEEE EMC Society and the ESDA, is a lead instructor of the DLS EMI by Your Design training program, and is a graduate of the Milwaukee School of Engineering. He can be reached at: tlusha@dlsemc.com.