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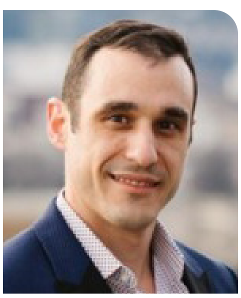
DAVID A. WESTON
iNARTE EMC Engineer

David A. Weston is an electromagnetic compatibility (EMC) consultant and certified National Association of Radio and Telecommunications Engineers (iNARTE) EMC engineer at EMC Consulting Inc. Merrickville, Ontario, Canada. A life member of the Institute of Electrical and Electronics Engineers, Weston has worked in electronic design for 55 years, specializing in the control, prediction, measurements, problem solving, analysis, and design aspects of EMC for the last 44 years.

He is the author of the third edition of the 1,157-page book Electromagnetic Compatibility, Methods, Analysis, Circuits, and Measurement published by CRC press in 2017, as well as numerous papers of a practical nature.



ZACHARIAH PETERSON
PCB Design Expert & Electronics Design Consultant

Zachariah Peterson received multiple degrees in physics from Southern Oregon University and Portland State University, and he received his MBA from Adams State University. In 2011, he began teaching at Portland State University while working towards his Ph.D. in Applied Physics. His research work originally focused on topics in random lasers, electromagnetics in random materials, metal oxide semiconductors, sensors, and select topics in laser physics; he has also published over a dozen peer reviewed papers and proceedings. Following his time in academia, he began working in the PCB industry as a designer and technical content creator. As a designer, his experience focuses on high-speed digital systems and RF systems for commercial and mil-aero applications. His company also produces technical content for major CAD vendors and consults on technology strategies for these clients. In total, he has produced over 2,000 technical articles on PCB design, manufacturing, simulation, modeling, and analysis. Most recently, he began working as CTO of Thintronics, an innovative PCB materials startup focusing on high-speed, high-density systems.

He is a member of IEEE Photonics Society, IEEE Electronics Packaging Society, American Physical Society, and the Printed Circuit Engineering Association (PCEA). He previously served as a voting member on the INCITS Quantum Computing Technical Advisory Committee working on technical standards for quantum computing and quantum electronics. He now sits on the IEEE P3186 Working Group focused on Port Interface Representing Photonic Signals Using SPICE-class Circuit Simulators.

MIKE VIOLETTE

iNARTE Certified EMC Engineer

Mike is CEO of Washington Laboratories and Director of American Certification Body. He has over 35 years of experience in the field of EMC evaluation and product approvals and has overseen the development of engineering services companies in the US, Europe and Asia. Mike is currently on the Board of Directors of the IEEE EMC Society.

He is a Professional Engineer, registered in the State of Virginia. He has given numerous presentations on compliance topics and is a regular contributor to technical and trade magazines.

TOM BRAXTON

iNARTE-Certified EMC Engineer and an iNARTE-Certified ESD Engineer

Tom Braxton has worked in the EMC industry since 1981, with experience at Lucent Technologies / AT&T Bell Laboratories, Shure Incorporated, and as an independent consultant.

Tom is an IEEE Life Senior Member, a past EMC Society Director at Large, and is the author of EMC-awareness articles for online and print publications. He chairs Technical Committee TC1 on EMC Management and was General Chair of the 2005 IEEE International EMC Symposium and Vice-Chair in 1994, both in Chicago. He is also the Vice-Chair and Program Chair of the EMC Society Chicago Chapter.

An iNARTE-Certified EMC Engineer and an iNARTE-Certified ESD Engineer, Tom holds a BSEET from Purdue University, an MSEE from the Illinois Institute of Technology, and Amateur Radio license WB9VRW.

DEAN LANDERS

E3 Engineer

Dean Landers is an Electromagnetic Environmental Effects (E3) engineer for a major defense contractor, working with the testing, simulations, and program management of all things involving E3 amongst several programs. Previously, he was the Supervisor of Applications Engineering for AR RF/ Microwave Instrumentation. He was actively engaged in new application and product development, system development and integration, customer support, and training with hardware demonstrations for both customers and AR personnel. Prior to working at Amplifier Research, Dean spent 9 years as an EMC Test Engineer at Retlif Testing Laboratories, managing military, commercial aviation, and commercial test programs, writing customer test procedures, and working with customers to help them understand their compliance needs and requirements. He also serves on the IEEE EMC Society Executive Committee.

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MPA1003	2.0 - 8.0 GHz	33	33
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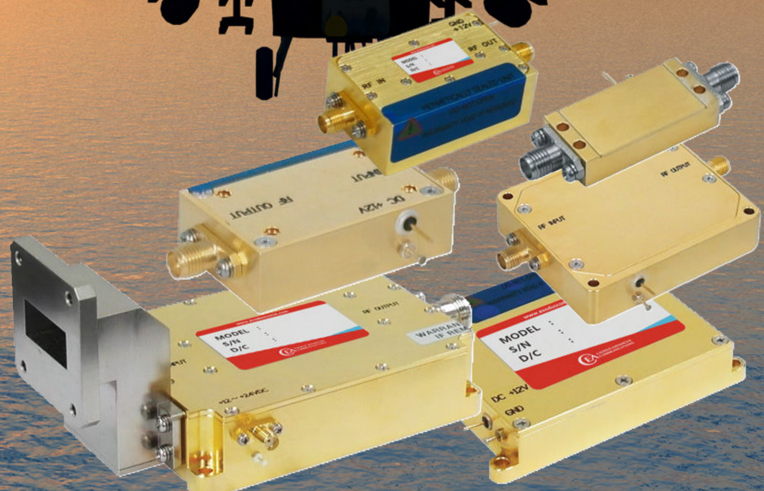

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EDITORIAL
A Legacy of EMC Engineering

Mike Violette, P.E.
iNARTE Certified EMC Engineer

The role of the EMC engineer has progressed over these years. The inclusion and mix of Software, Firmware, Artificial Intelligence (and who knows what is next) has compounded the complexity and scope of an EMC practitioner.

The physics of an advanced technological society demands that our roles go well beyond those of the early adopters of EMC as a discipline — never waived, never demeaned, always appreciated and seldom loved…sorry, folks. We are the dentists of electronics developments. Our work is painful and difficult, but absolutely necessary.

For the next twenty years, we will see an expanded energy, aerospace, and communications world where personal protections and cyber-security blend into the common vernacular of "EMC."

The pioneers of this practice knew little about the impact and importance of their work, but they believed that innovation and questioning of the smallest quantities of our measurement and all of the quantitative universe is paramount to the precision that lends understanding to our whole being.

It is not skipped over lightly, as it fuels a desire to understand.

We, as a community, have evolved from "noise guys" to product development czars. If you can take a look inside the complexity of the engineers' desires to make a device or system work, then you know.

Test labs — with the environs of all the electrical, environmental, and mechanical physical necessaries — need to appreciate all that goes into a product's lifecycle and resiliency.

This is where Bob Goldblum started this craft of reporting. And this issue, some 50+ years on, purports to educate, train, and share a legacy of engineering.

ADVANTAGES OF USING A PRE-CERTIFIED RADIO FREQUENCY MODULE IN AN IoT APPLICATION

Ignacio de Mendizabal
Hardware Engineer & EMC Expert

Learn the benefits of using a pre-certified radio frequency (RF) module in the design phase when building a new IoT application, and learn the implications in EMC and Radio certifications.

The Internet of Things (IoT) is revolutionizing the quantity and manner in which we exchange and store information. Historically, people exchanged information through reading and speaking. Today and in the future, machines will increasingly handle information management. The size of these machines has been drastically reduced, from room-sized computers to pocket-sized devices with even greater computing power.

The future is promising with the widespread adoption of 5G technology, which enables high data transfer rates and low latency. Additionally, shifting processing capacity closer to data sources, such as sensors, enhances real-time applications and supports increasingly advanced use cases.

Some IoT nodes use wired communication mediums like Ethernet or CAN. However, scalability and adaptability necessitate low-cost deployment and maintenance solutions. Therefore, wireless communications are the most cost-effective option for IoT networks. Compared to wired networks, wireless systems are easier to install, access, and monitor, and they are also simpler to scale, making them ideal for rapidly expanding networks.

When designing a new IoT electronic system, system architects must choose a radio protocol from options like ZigBee, Wi-Fi, Bluetooth, and LoRa. The choice depends on factors such as the coverage area, number of nodes, speed, latency, transmission power, and the battery life of the IoT nodes.

Once the protocol is chosen, the second big question is: should I develop all the electronics by myself? Or should I use a preexisting module that seems to be plug-and-play? This article aims to clarify the advantages and disadvantages of using existing RF modules and their impact on the development and certification roadmaps.

REGULATORY COMPLIANCE

Every product entering a new market, such as the EU or USA, must comply with various regulations, including chemical safety and electromagnetic interference (EMI). These requirements depend on the geographic regions where the products are sold, their regulatory agencies, and the product type. Each country has its regulatory framework governing RF technologies to avoid interference and ensure safe operation. In the United States, the Federal Communications Commission (FCC) oversees this, while Europe follows the Radio Equipment Directive (RED).

Manufacturers need to take care of three aspects related to the electronics of their products:

- **Safety:** manufacturers need to guarantee the health and safety of people, animals, and properties.
- **Electromagnetic Compatibility (EMC):** electronic products must not generate electromagnetic disturbances above the limit, and they must allow other equipment to operate properly.
- **Efficient use of the spectrum:** electronic products using radio communications must make an efficient use of the radio spectrum, respecting the designated frequency bands.

The requirements related to Radio Frequency are very strict, so manufacturers will not get approval if the device transmits energy “just a little bit” over the limits. They need to prove that the new product is clearly not emitting in unexpected bands, that the emissions are within the accepted transmission power, and that the product is not a hazard for the user.

USING AN EXISTING RF MODULE OR BUILDING A NEW ONE

Designers building a new application need to face the decision of using an existing module or designing a new one. Considering just the design stage, using an existing module brings the advantages of:

- Fast development of software, since the hardware platform is available at an early stage
- The hardware is validated, so fewer hardware re-spins are needed
- Support from an existing community, making development easier

On the other hand, using an existing module has disadvantages. Naming some of them:

- Limited customization, which means the modules are not suitable for all kinds of applications
- Modules are big, taking up considerable amount of the board space
- The modules might have more functionalities than needed, provoking excessive power consumption.

For most of the applications like industrial or home automations, space and power are not a limiting factor, so the disadvantages of using an existing module are less important than the benefits. It is then the most convenient approach to make a fast development. Small companies or startups do not have in-house knowledge of antenna engineering or specialized equipment such as vector network analyzers (VNA), spectrum analyzers (SA) or RF design and simulation software tools. Using a module reduces the need for all of them, giving manufacturers the chance of launching and validating new applications fast.

SELECTING A MODULE — CERTIFICATES

There are many existing modules in the market and not all of them have gone through the same levels of quality control and development stages. Pre-certified RF modules are wireless communication modules that have passed some regulation tests before being sold to manufacturers. To reduce the development time, it is better to choose a module that has gone through an intensive certification process like those in reference 1. While this is an advantage compared to building everything from scratch, manufacturers still need to do their work to have a complete certificated product.

Manufacturers should check all the documentation provided by the module manufacturer to avoid possible surprises. Certificates are linked to specific components such as the hardware version, software version, or the test conditions. Therefore, if any of those changes, the validity of the performed tests is at risk. Here is a non-exhaustive list of things to consider when selecting a module:

- **Market certification:** EU (CE), US (FCC)… the certification should be aligned with the intended manufacturer market. For example, FCC certifications are not valid in the EU market.
- **Hardware version:** the hardware version that has been certified should be the same as the one that will be installed in the new product during the whole lifecycle of the product.
- **Software version:** during the certification tests, the modules run a specific version of software (firmware). Changes in this software should not impact the result of the tests.

Having these certificates is very useful to have a baseline of some key metrics such as output power, frequency bands, and distance to the limits for new tests. So, even if they do not exempt manufacturers from testing their products, these certificates are useful to interpret results and build the technical file of them.

COMPLIANCE WITH A PRE-CERTIFIED MODULE

While using products that are already certified brings benefits in the product development phases, that does not mean that certification efforts are eliminated. The responsibility for the final product lies with the product manufacturer. Electronic products are complex, with power supplies, analog and digital circuits, and integrating communication capabilities with RF modules. Then, manufacturers cannot underestimate the steps needed to comply with the legal requirements and need to consider compliance of the whole product in the planning phase.

There are many factors that can affect the results of the EMC and radiation tests, provoking that the emissions and the radio measurements measured on the full product differ from the ones obtained by the module manufacturer. Manufacturers should take care of the following aspects:

Mechanical Enclosures

Metallic enclosures can have resonant effects at certain frequencies due to their physical dimensions, shape, and openings. If these resonances overlap with the frequency band of the RF module, it can modify the radiation pattern of the module.

Antenna Type and Position

Some of the RF modules have an external antenna that can be customized, changing its gain and direction depending on the application. Furthermore, the properties of the RF link can be affected by the position of the antenna in relation to other board components or conductive surfaces.

Printed Circuit Board (PCB) Design

The board stackup, the ground planes position and extension, and the position of other board components in relation to the RF module can significantly impact the behavior of the radiation pattern. When the RF modules are certified, they are being tested with the minimum number of components, so the two boards will significantly differ from each other.

Software

Software configuration related to output power, frequency, modulation schemes, and bandwidth selection will affect the radio frequency behavior. Manufacturers need a careful development of software, both for production and for the certification tests, to ensure that the emissions are within the limits.

CONCLUSION

Using a pre-certified module to build a new IoT electronic system reduces development time and the need for highly experienced designers or advanced design and simulation tools. However, it does not exempt manufacturers from meeting legal requirements. The new system often differs significantly from the unit certified by the module manufacturer, necessitating full testing to ensure compliance.

REFERENCES

1. ESP32 certificates (https://www.espressif.com/en/support/documents/certificates)

2. Modular Transmitter Integration Guide Guidance for Host Product Manufacturers (https://apps.fcc.gov/kdb/GetAttachment.html?id=bNCiEdkFEKnHsZF9GHCNdg%3D%3D&desc=996369%20D04%20Module%20Integration%20Guide%20V02&tracking_number=44637)

STATIC CONTROL RESILIENT FLOORING QUALIFICATION PROCEDURES ENSURE SPACE & DEFENSE ESD COMPLIANCE

Bob Vermillion, CPP
Fellow Certified, ESD & Product Safety Engineer-iNARTE®

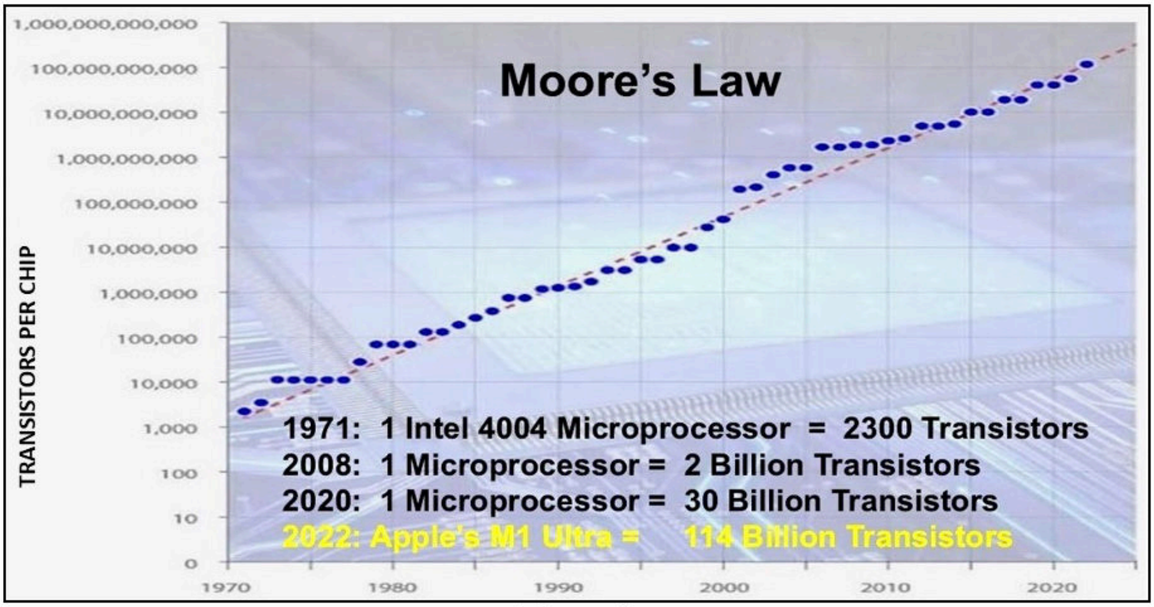


Figure 1

Due to the rapid densification of ESD sensitive devices (ESDS), static control resilient flooring (ESD flooring) has found its way into FAA towers, operating room theatres, MRI/CT scan flooring areas, aircraft terminals, IT data centers, Navy ships, space & defense flight lines, call centers, medical device manufacturing, pharmaceutical delivery and the manufacturing/assembly of microprocessor driven devices. In 1971, Intel's 4004 microprocessor equaled about 2300 transistors as compared to today's new vertical field-effect transistor (VFET) manufacturing process that built microprocessors with the world's most powerful chip, the Apple M1 Ultra at 114 billion transistor equivalencies.

An individual walking on an insulative tile floor can build up static electricity resulting in electrostatic discharges (ESD). When a hand touches a doorknob, it can take 3000 to 3500 volts to feel a sudden shock. Modern day microprocessors used in space & defense, cell phone and touch display pads can be killed at ±35 volts or below.

Static control flooring is manufactured for form and fit as follows:

- Raised Data Center Flooring
- Polymer Cushioned Floor Mats
- Tile
- Laminated Steel Framed Flooring
- Concrete
- Coated Floor Tile
- Modular interlocking or Snap-In Flooring
- Polymer Lay Down Floor Sections
- Special ESD Composite Flooring
- Special Antistatic Coatings
- Epoxy
- Interlocking Tile Flooring
- Carpet

Both non-compliant and suspect counterfeit static control flooring have infiltrated the supply chain. Today, a common practice by federal agencies is to require third-party installation certification of a static control floor before payment is issued. In order to prevent the potential bias of supplier self-certified testing, third-party qualification or installation certification ensures independent verification.

For proper selection and installation of static control flooring, several ESD flooring standards are being utilized. U.S. Government agencies call out a 09 6X XX designation for static resilient flooring. For instance, the DOT & FAA utilize 09 65 36. The federal sector references ASTM F150 and ANSI/ESD STM7.1 resistance testing for static control flooring protocols. So that everyone is on the same page, the definition of floor resistance is:

ASTM F150 Conductive flooring material: A floor material has a resistance between 2.5 x 10^4 ohms through 1.0 x 10^6 ohms. Dissipative floor material: A floor material has a resistance between 1.0 x 10^6 ohms to 1.0 x 10^9 ohms.

ANSI/ESD STM7.1 Conductive flooring material: A floor material has a resistance of less than 1.0 x 10^6 ohms. Dissipative flooring material: A floor material has a resistance of greater than or equal to 1.0 x 10^6 ohms and less than 1.0 x 10^9 ohms.

Important Notice regarding Constant Voltage (CV) for Resistance: Since the DOD has adopted ANSI/ESD S20.20, Resistance to a Groundable Point (RTG) and

Point to Point (R_{PP}) resistance shall be between 2.5 x 10^4 ohms to <1.0 x 10^6 ohms for conductive flooring with a CV of 10 volts, for a RTG and R_{pp} between 1.0 x 10^6 ohms to < 1.0 x 10^9 ohms, static dissipative flooring requires using CV=100 volts.

The Space & Defense sector has set a lower floor resistance of 2.5 x 10^4 ohms for personnel safety purposes as illustrated in *Figure 2.*

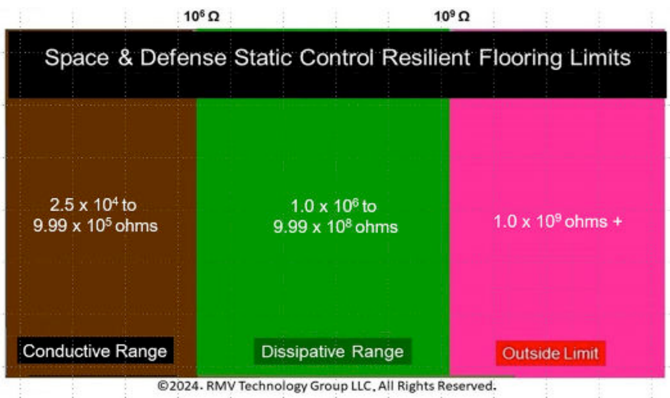


Figure 2

A new installation shall have no individual reading greater than the stated limits defined in Electrostatic Discharge (ESD) ANSI/ESD STM7.1 or ASTM F150. In addition, the plant or civil engineer, architect, facilities engineer, general contractor and ESD Program Manager should consider the following testing methods.

1. ANSI/ESD STM7.1 Resistance to a Groundable Point (RTG) at <1.0 x 10^9 ohms.
2. ANSI/ESD STM7.1 Point to Point Resistance (RTT) at <1.0 x 10^9 ohms.
3. ANSI/ESD STM97.1 Resistance in Combination with a Person at <1.0 x 10^9 ohms.
4. ANSI/ESD STM97.2 Voltage in Combination with a Person at <±100 volts.
5. Electrostatic Decay to satisfy US Government 09 6X XX designation requires Mil-STD-3010C, Method 4046 at ±5kV to 0 V in <0.25 seconds.
6. Verification of static control footwear using ANSI/ESD STM9.1.

One way to ensure a greater understanding of the requirements for ESD qualification is to show segments of SelecTile Conductive Black testing taking place in RMV's lab at NASA Ames.

1. ANSI/ESD STM7.1

In conducting ANSI/ESD STM7.1 qualification testing for RTG and RPP resistance, a test pattern is called out as illustrated in *Figure 3*. The five (5) test specimens shall be large enough that a 305 mm (12 inches) by 610 mm (24 inches) where a test area can be defined. Evaluation takes place in a preconditioned environment at both 12 ± 3% relative humidity (RH) and 23°C ± 3°C or 50 ± 5% relative humidity and 23°C ± 3°C (73°F ± 5°F). Preconditioning of the specimens shall be a period of at least 72 hours. Note: some flooring materials (carpet) may require longer time to reach the desired level. Resistance measurements are first conducted by connecting one lead to a Groundable Point A (GP-A) and placing the NFPA 5-lb electrode at six positions (1 – 6) clockwise from bottom left to left to right for RTG (*Figures 3* and *4*) and R_{PP} measurements using the appropriate CV of 10 volts for conductive flooring. After the first six measurements are taken, the lead is connected to GP-B and the measurement takes place in a counterclockwise manner from bottom right to left.

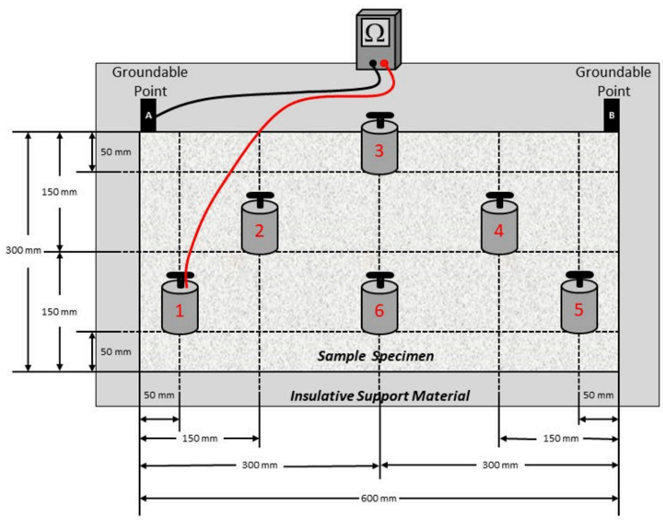


Figure 3: ANSI/ESD STM7.1 illustration[1]

The initial RTG and R_{PP} readings fell within the acceptance range for ESD control compliance at 50%RH after 72 hours of preconditioning. Every specimen measured at <1.0 x 10^6 ohms for a "conductive" designation. At 50%RH, the floor's performance should be less susceptible to charging.

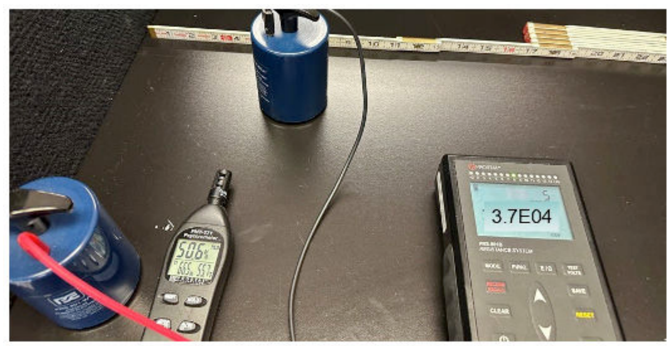


Figure 4: R_{PP} Resistance

[1] Thomas Ricciardelli, SelecTech, Inc. Image

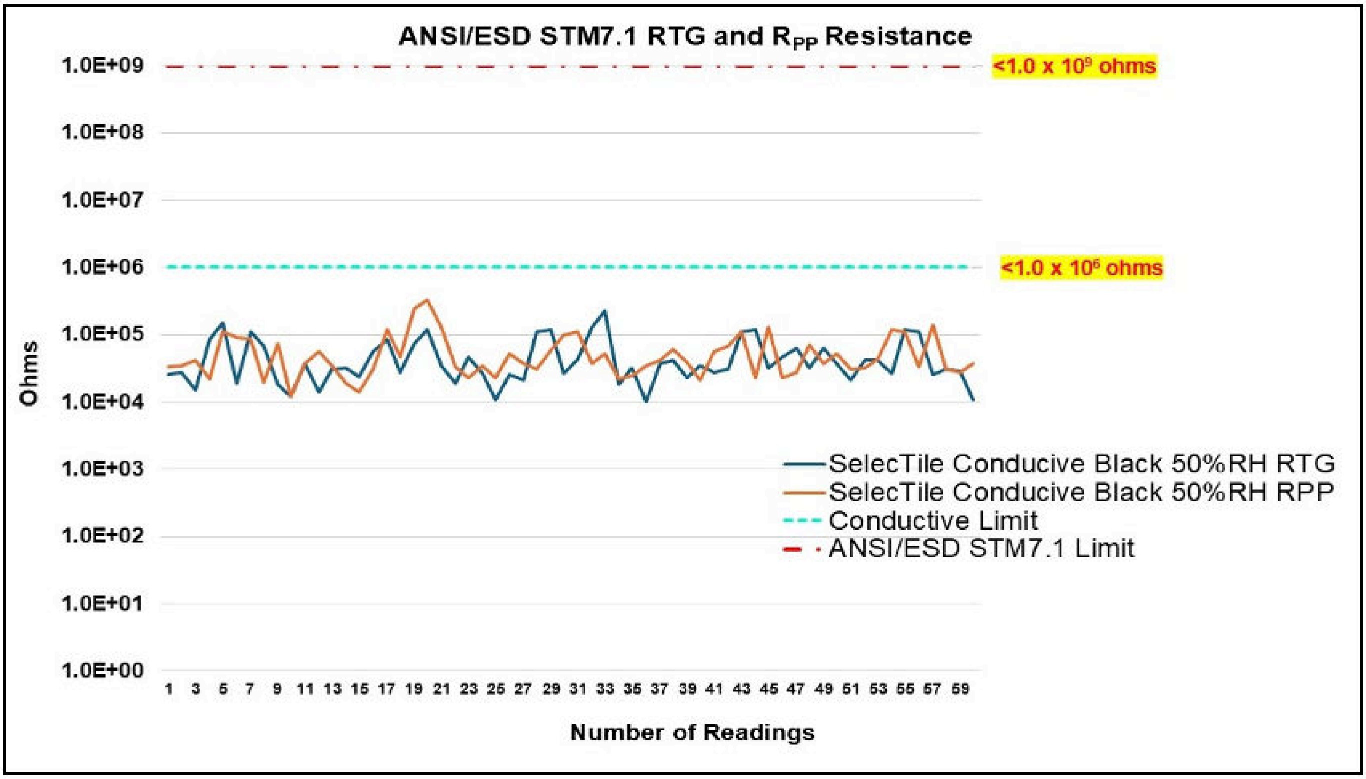


Figure 5

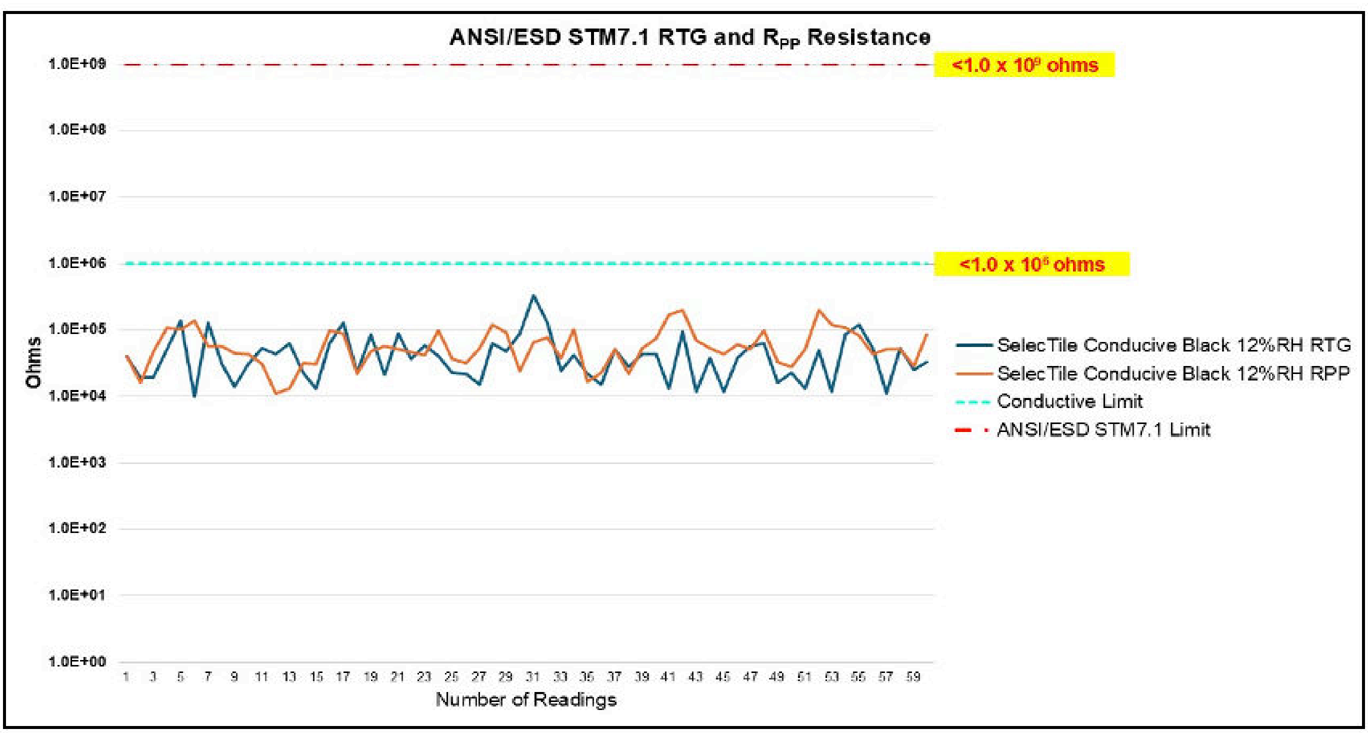


Figure 6

SelecTile Conductive Black at 50%RH					
RTG	Ω	Constant V	R_{PP}	Ω	Constant V
1	2.6E+04	10v	1	3.3E+04	10v
2	2.8E+04	10v	2	3.5E+04	10v
3	1.5E+04	10v	3	4.2E+04	10v
4	8.6E+04	10v	4	2.2E+04	10v
5	1.5E+05	10v	5	1.1E+05	10v
6	1.9E+04	10v	6	9.2E+04	10v
1	1.1E+05	10v	1	8.4E+04	10v
2	6.8E+04	10v	2	2.0E+04	10v
3	1.8E+04	10v	3	7.4E+04	10v
4	1.2E+04	10v	4	1.2E+04	10v
5	3.7E+04	10v	5	3.7E+04	10v
6	1.4E+04	10v	6	5.6E+04	10v
Average	4.9E+04	Sample 1/5	Average	5.1E+04	Sample 1/5
Median	2.7E+04		Median	4.0E+04	
Minimum	1.2E+04		Minimum	1.2E+04	
Maximum	1.5E+05		Maximum	1.1E+05	
St. Dev.	4.5E+04		St. Dev.	3.2E+04	

Table 1[2]: ANSI/ESD STM7.1 Data Format

The completed set of data tables (due to size restrictions) were not listed in this article. *Table 1* represents the format used in this report. Data tables are posted online; the resistance summary illustrations, however, can be viewed in *Figures 5* and *6*.

Position	Test Results – Footwear		
#1-Left	2.21E+06	2.21E+06	2.21E+06
#1-Right	2.03E+06	2.03E+06	2.03E+06
#2-Left	2.15E+06	2.15E+06	2.15E+06
#2-Right	2.00E+06	2.00E+06	2.00E+06
#3-Left	2.20E+06	2.20E+06	2.20E+06
#3-Right	2.31E+06	2.31E+06	2.31E+06
Max	2.31E+06	2.31E+06	2.31E+06
Min	2.00E+06	2.00E+06	2.00E+06
Ave	2.15E+06	2.15E+06	2.15E+06

Table 2: ANSI/ESD STM9.1 Limit: <1.0 x 10^9 ohms

Testing at 12±3%RH determines if the flooring maintains its resistance integrity in areas that could be subjected to winter or Santa Anna Wind conditions when the humidity could drop to 4% to 7%RH. Results for the conductive flooring were favorable at 12%RH, producing results within 2 orders of magnitude.

Two NFPA 5-lb electrodes were verified before conducting measurements at 1.1 x 10^2 ohms.

2. ANSI/ESD STM97.1

ANSI/ESD STM97.1 measures the electrical system resistance of floor materials in combination with a person wearing static control footwear. ANSI/ESD S20.20 sets a limit of <1.0 x 10^9 ohms. This test is useful to determine the resistance of a floor and a person wearing static control footwear such as shoes, heel and sole grounders.

The resistance of the footwear influences the readings despite the floor's individual resistance measurements measured slightly above 1.0 x 10^6 ohms. As a system, a person wearing ESD footwear has greater contact area combined with a higher resistance compared to NFPA 5-lb electrodes.

SelecTile Conductive Black at 12%RH					
Feet to Sample	Ω	Constant V	Feet to Sample	Ω	Constant V
Both Feet 1	1.2E+06	100v	Both Feet 1	1.1E+06	100v
Both Feet 2	1.2E+06	100v	Both Feet 2	1.3E+06	100v
Both Feet 3	1.2E+06	100v	Both Feet 3	1.2E+06	100v
Left Foot 1	2.3E+06	100v	Left Foot 1	2.1E+06	100v
Left Foot 2	2.3E+06	100v	Left Foot 2	2.1E+06	100v
Left Foot 3	2.0E+06	100v	Left Foot 3	2.1E+06	100v
Right Foot 1	2.0E+06	100v	Right Foot 1	2.1E+06	100v
Right Foot 2	2.4E+06	100v	Right Foot 2	2.3E+06	100v
Right Foot 3	2.0E+06	100v	Right Foot 3	2.2E+06	100v
Average	1.8E+06		Average	1.8E+06	
Median	2.0E+06		Median	2.1E+06	
Minimum	1.2E+06		Minimum	1.1E+06	
Maximum	2.4E+06		Maximum	2.3E+06	
St. Dev.	5.1E+05		St. Dev.	4.8E+05	

Table 3

[2] Full data is posted for both 50%RH and 12%RH

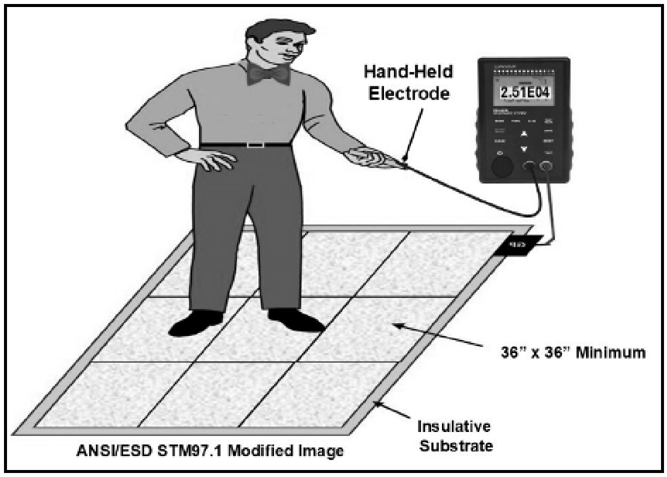


Figure 7: ANSI/ESD STM97.1

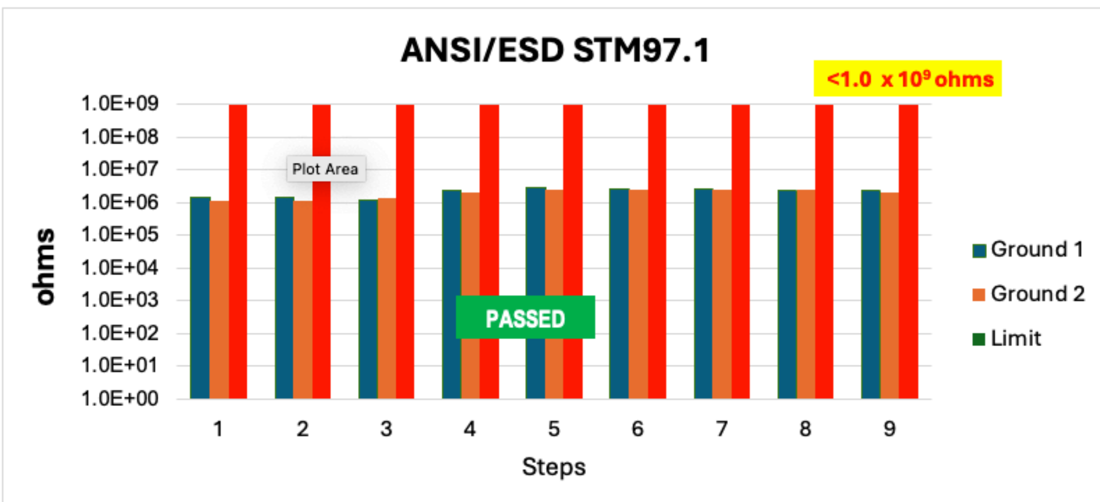


Figure 8

3. ANSI/ESD STM97.2

This critical standard test method attests to the static control resilient flooring's ability to minimize charge build-up and provides the user with traceable data to assign a voltage flooring rating within the EPA.

Static Generation or Voltage in Combination with a Person (*Figure 10*) testing requires a result at <±300 volts for static control carpet when tested per AATCC-134 (Electrostatic Propensity of Carpets) wearing conductive footwear. However, this test method is superseded by use of ANSI/ESD STM97.2 that sets a requirement of <±100 volts. ANSI/ESD STM97.2 applies for all types of flooring and is not limited to carpets.

The following walking pattern is required per ANSI/ESD STM97.2 when conducting ESD qualification and installing testing as illustrated in *Figure 10, right side*.

SelecTile Conductive Black at 12%RH					
Ground 1	Peak V	Start V	STM97.2	Peak V	Start V
1	5.2	0v	1	-8.8	0v
2	6.7	0v	2	-9.1	0v
3	6.0	0v	3	-10.4	0v
4	7.0	0v	4	-13.8	0v
5	4.8	0v	5	-7.2	0v
Average	5.9		Average	-9.9	
Median	6.0		Median	-9.1	
Minimum	4.8		Minimum	-13.8	
Maximum	7.0		Maximum	-7.2	
St. Dev.	0.9		St. Dev.	2.5	

Table 4: ANSI/ESD STM97.2

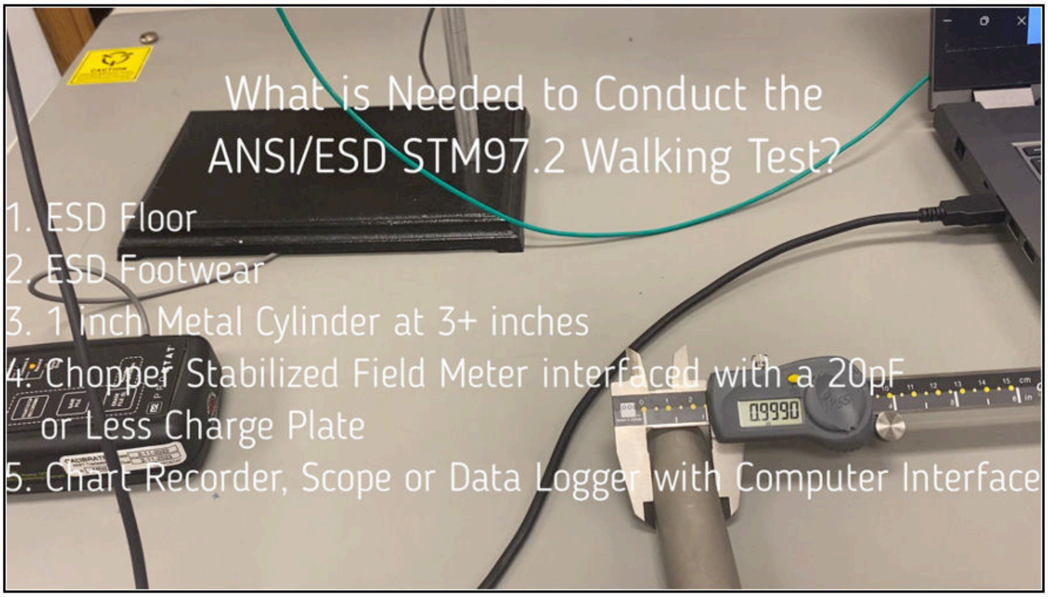


Figure 9

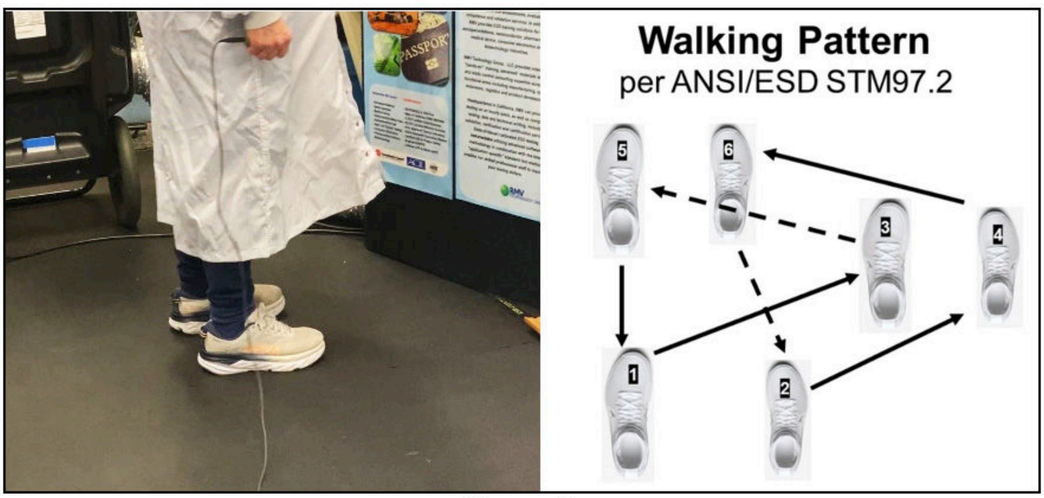


Figure 10

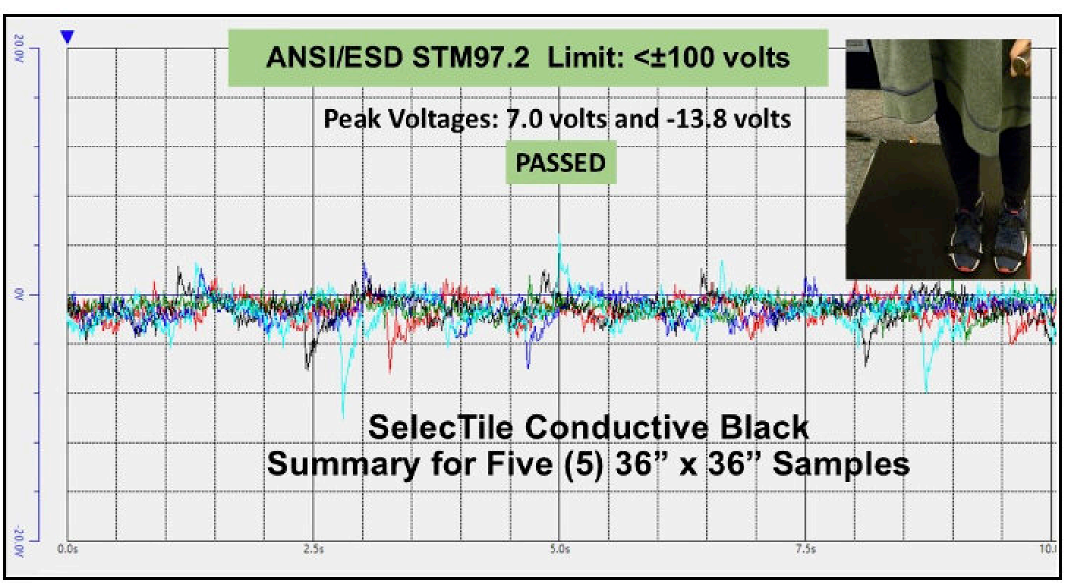


Figure 11

The voltage in combination with a person, flooring, and footwear per ANSI/ESD STM97.2 produced no voltage in excess of -13.8 volts for a PASS at <±100 volts. This floor product PASSED the test and was very low charging.

4. ANSI/ESD STM97.2 WALKING TEST IN PERSPECTIVE

This discussion compares the results of floor performance for charge build-up while a person traverses various type of floors wearing regular tennis shoes or static control footwear in combination with both non ESD vinyl tile and SelecTile Conductive Black.

The reader can see that regular tile at 53.5%RH wearing tennis shoes (*Figure 12*) generates a peak voltage of 387 volts and -2885 volts in combination with a person. The peak voltage represents a risk to personnel in an explosive environment and ESD protected area (EPA) moving ESD sensitive devices (ESDS) in unshielded packaging.

When the evaluator wears tennis shoes and walks over the FreeStyle Conductive Black Tile (Figure 13), a peak voltage of -444 volts was recorded at 12%RH. This may not be suitable for an EPA in proximity to ESDS devices but low enough to minimize the risk of sparking in an explosive environment.

Lastly, at 12%RH, the evaluator wears ESD safe footwear traversing across FreeStyle Conductive Black Tile floor produced a very low peak voltage at 12.5 volts and -10.0 volts. The peak voltage is well below the ANSI/ESD S20.20, Table 2; NASA-STD-8739.6B, Section 7 and the DOD 09 6X XX designation.

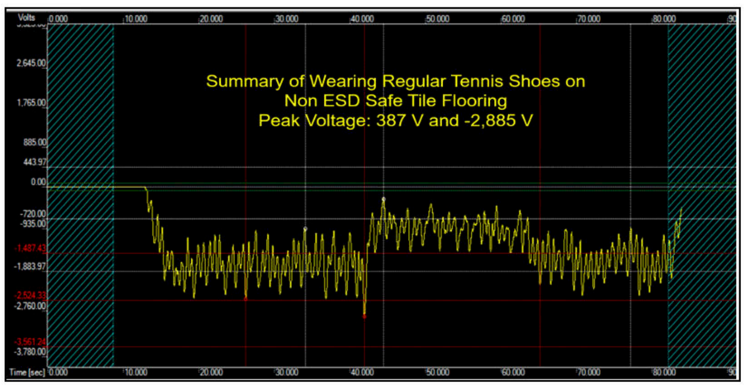


Figure 12

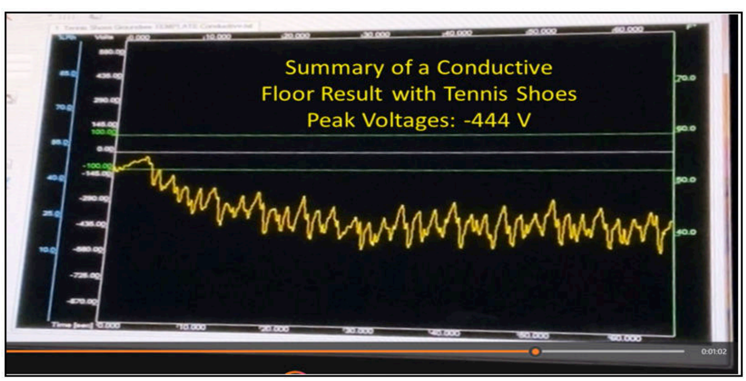


Figure 13

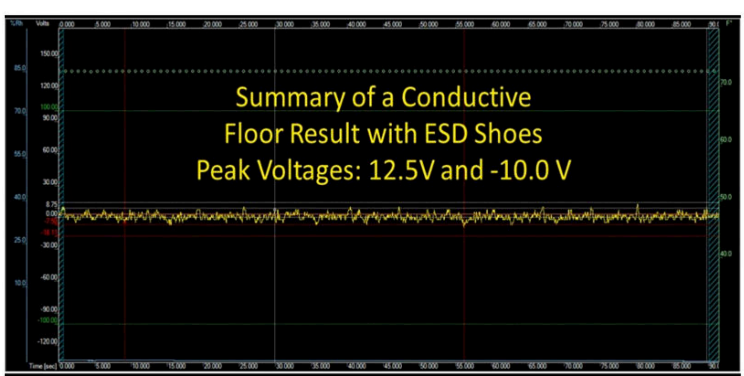


Figure 14

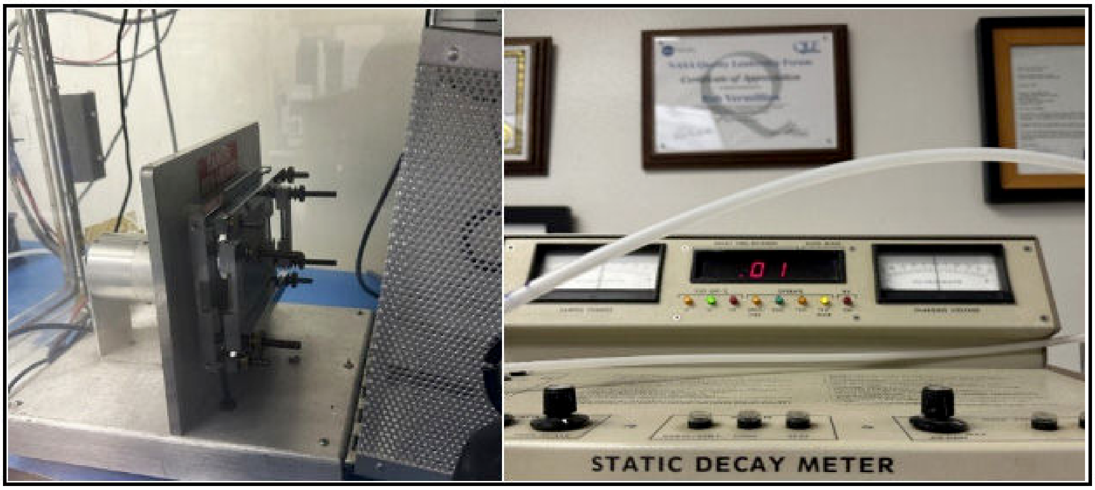


Figure 15

5kV to 0 volts			-5kV to 0 volts		
Sample Number	Seconds	Starting	Sample Number	Seconds	Starting
1	0.05	5000v	1	0.06	-5000v
2	0.04	5000v	2	0.04	-5000v
4	0.06	5000v	4	0.08	-5000v
4	0.03	5000v	4	0.05	-5000v
5	0.04	5000v	5	0.07	-5000v
Average	0.04		Average	0.06	
Maximum	0.06		Maximum	0.08	
St. Dev.	0.01		St. Dev.	0.02	

Table 5: MIL-STD-3010C, Method 4046 at 12% (Electrostatic Decay)

5. ELECTROSTATIC DECAY

Current federal 09 6X XX requirements incorrectly call out Fed-STD-101C/4046.1. Today, this test method has been revised to Mil-STD-3010C, Method 4046 and is conducted in a controlled environment. The test is conducted using precut floor samples measuring 3-1/2” x 5-1/2” and clamped into the fixturing of an electrostatic decay testing system (*Figure 15, left side*). The specimens are charged to ±5000 volts and grounded to facilitate static decay to 0 volts for a limit of <0.25 seconds.

This test demonstrates the flooring’s ability to bleed off charge and is appropriate for US Government qualification and installation certification to a 09 6X XX designation.

In short, due to the significant investment required for static control flooring, dependence upon a supplier’s technical data sheet alone can prove costly!

The FreeStyle Conductive Black Tile static resilient flooring performance met all the requirements for qualification to the following test methods:

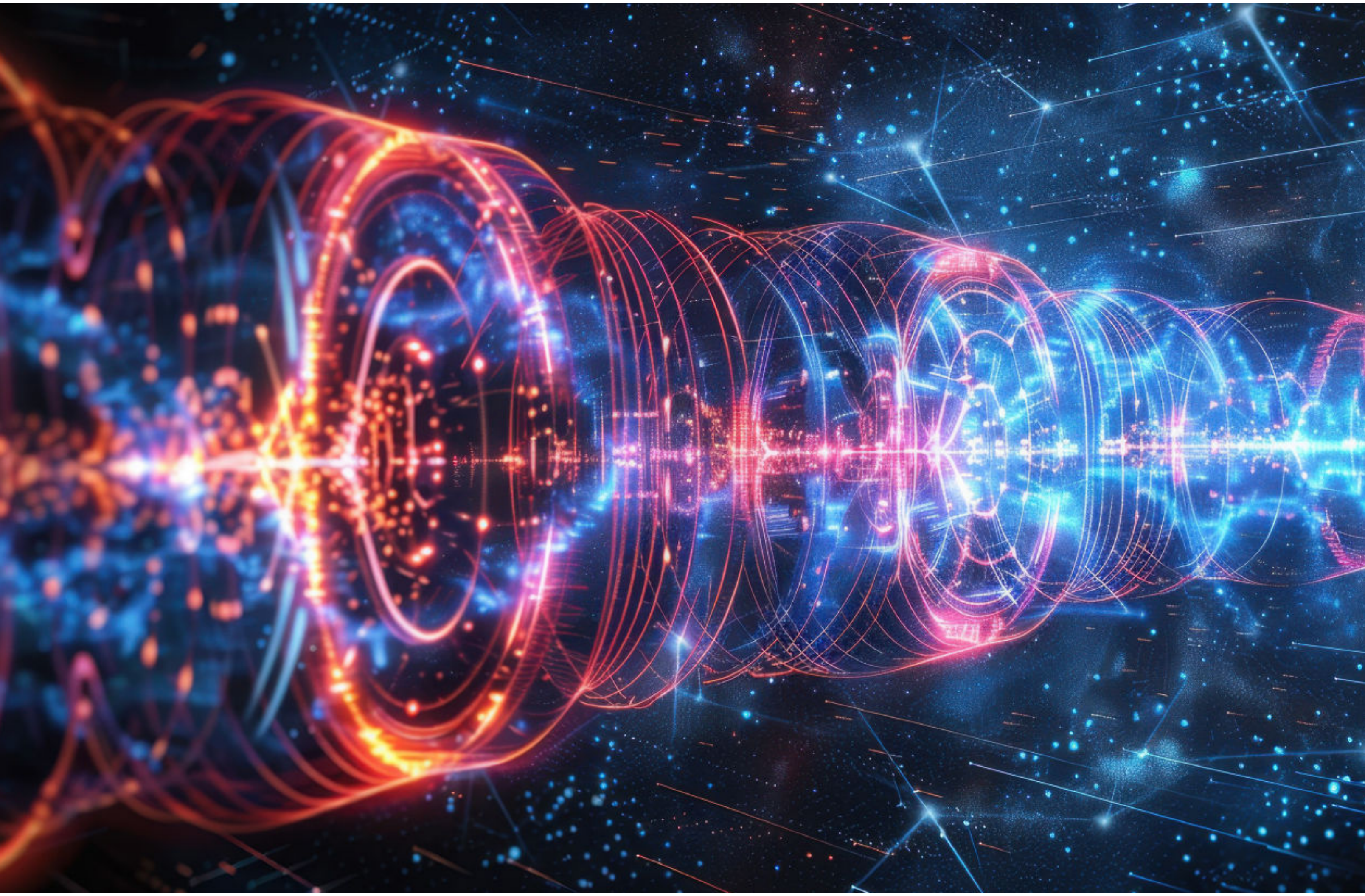
1. ANSI/ESD STM7.1 for Resistance to a Groundable Point & Point to Point Resistance
2. ANSI/ESD STM97.1 for Resistance in Combination with a Static Control Floor and ESD Footwear
3. ANSI/ESD STM97.2 for Voltage in Combination with a Person and Flooring wearing ESD Footwear
4. MIL-STD-3010C, Method 4046 for Electrostatic Decay of the Floor Material

ACKNOWLEDGEMENT

A Special Thank you to Mr. Thomas Ricciardelli, CEO & Owner of SelecTech, Inc., Flooring Products for providing the samples for testing that made this article possible. Tom can be reached at telephone number 508.583.3200 or tricca@selectech.com

MILLIMETER WAVE APPLICATIONS AND PROMISE

Mike Violette, P.E.
President, Washington Laboratories



Imagine a radio frequency wavelength about the thickness of your pinky nail. This is a new area for technology applications.

A growing area in spectrum development is exploding. For many decades, very high frequencies (millimeter waves) have been the playground of radio-astronomers to image our solar system, stars, and galaxies. This space is "new" fertile ground for sensing and communications in terrestrial (and extra-terrestrial) use.

The millimeter wave space is opening up for these applications, which promise enormous multi-gigahertz bandwidths for innovation across many sectors.

Typically reserved for passive sensing of the mysteries of the Earth and our galactic environment, the 100+ GHz spectrum is, in a way, "off to the races." Radar applications for mobile devices (automobile and other) are being allocated on an increased basis. The applications are numerous, and the challenges are unique. Because of the physics of dealing with these high frequencies, the use of these frequencies is confined to very focused applications, requiring precision and tight control on propagation between the devices that transmit and receive mmWave energy.

In the industry, the mmWave Coalition (mmwavecoalition.org) works on these new areas, monitoring and focusing on the allocations mandated by The Federal Communications Commission (FCC) and other regulatory bodies. Tossed in the salad of interests are incumbent users of this spectrum (NASA, radio-astronomy users, research institutions as mentioned before) and a host of Earth- and space-based sensing systems.

What is tricky is the reasonable parsing of these new spectrum spaces. As terahertz (THz) applications are borne and deployed, there is a balance that must be considered for the use and protection of the incumbents without stifling innovation from other interests. This is doubly necessary as the existing and future roles of terahertz technologies include Earth observations of weather and climate.

The radiometry applications (sensing at a distance based on the "temperature" of the Earth's surface, as measured by wide-band sensors) are critical. Additional clutter and noise in the GHz frequencies can clog and distort the science that is necessary to predict winds, waves, ocean, Earth's surface temperature and other weather and physical phenomena that give eyes to what is happening on our planet. Something as mundane as the nightly weather report is dependent on good satellite data for small and large weather patterns that affect daily life, crop predictions, safety, and incident prediction. Other applications use radiometers to predict surface winds, all important for naval and ocean-going navigation and planning (see: Tropical Rainfall Measurement Mission https://gpm.nasa.gov/missions/trmm). As NASA explains: "TRMM provided much needed information on rainfall and its associated heat release that helps to power the global atmospheric circulation that shapes both weather and climate. In coordination with other satellites in NASA's Earth Observing System."

1. Various groups are very interested in this particularly large chunk of the spectrum. For the present, the FCC's allocations end at 90GHz and the radio frequency spectrum, challenged and fiercely protected by research and other groups, is being weighed as new applications arise.
2. Members of the mmWave Coalition include several applications-based organizations that are learning to capitalize and expand on mmWave capabilities. One member, for instance, equipment manufacturer Virginia Diodes, can expand sensing and measurements and, with their extension modules can detect, measure and synthesize frequencies in excess of 1000 GHz, which is remarkable.

According to the commonly used equation, the wavelength of an RF signal is equal to *c/f* (speed of light divided by frequency), or 300*10^8/1000X10^9. This means that the wavelengths are on the order of 0.3 millimeters, or about the thickness of your pinky nail. What is amazing is the high frequencies allow for multi-GHz wide bandwidths, which allow for tremendous gains in communication operating data rates.

With these very small wavelengths, the physical structure of antennas and associated waveguides are attendantly small (we are talking pin-head small), precisely machined and carefully aligned. Care is required for connecting waveguide structures — no dirt and grime and grit, or the game is off.

The real challenges arise in making and sensing these frequencies because a few hindrances need to be noted and properly dealt with, namely the directionality of these mmWaves and the propagation losses associated with these very high frequencies. In addition, the beamwidths of these high frequency phenomena are extremely tight. No longer can a large and lopey broadband antenna be used to measure this energy properly. Laser-like precision is necessary to collect and quantify these quantities. We have worked on a system that used a 275 GHz operating frequency to sense and image packages for safety and security measures. Automotive radar applications at ~60 GHz are now commonplace.

PROPAGATION LOSSES

The propagation losses are extremely high, which limits the practical range for these applications. The Free-Space Propagation Losses (FSPL) are well-known. The FSPL are a function of frequency, fundamentally, and can be calculated according to the following equation:

$$FSPL = 20\log(d) + 20\log(f) + 20\log(4\pi/c) - G_{Tx} - G_{Rx}$$

Where d is the distance, in meters, f is frequency in Hertz and G_{Tx} and G_{Rx} are the transmit and receive gain of the antennas, respectively. c is the speed of light in m/s and π is my favorite irrational constant.

All other terms aside, the driving function in the above equation is the frequency of the RF energy, so the loss monotonically increases with frequency. At 100 GHz, the losses are 40 dB higher than at 1 GHz, which is a significant increase in propagation loss. But there are derived benefits from this naturally occurring FSPL, namely, there are isolation losses that occur as a result and, in addition, the tight beamwidths tend to allow more isolation between devices that may be sharing the same spectrum, thus, much of the communications and sensing applications are point-to-point and necessarily so.

There are naturally occurring losses in the atmosphere, due to water vapor absorption — and these losses are substantial (see the figure below, note the large losses at ~100 GHz and l85 GHz). This is not at all a “bad” thing because one can take advantage of these deep losses to put sensitive communications in those bands.

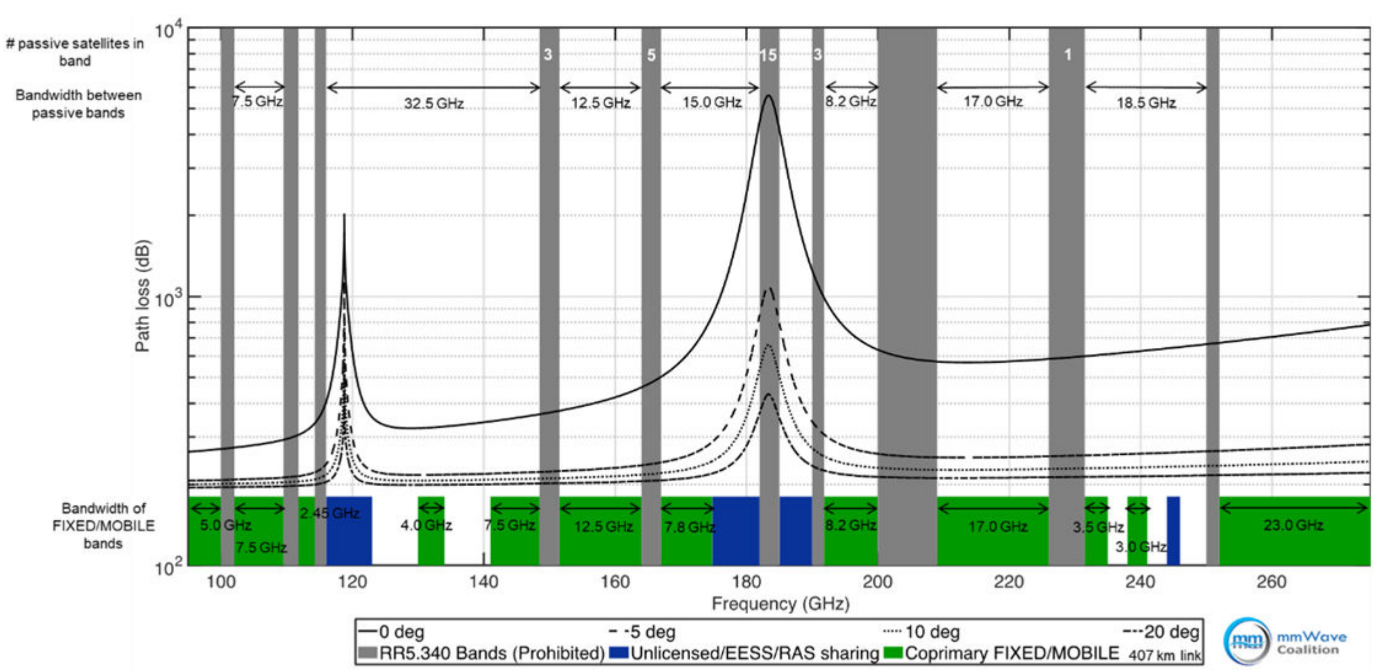
For laboratory applications, it is critical that measurement personnel understand these physical realities and the correct use of measurement instruments be well-applied. This demands that spectrum/receiver extension modules be correctly reasoned and applied. For example, most spectrum analyzer have baseband measurement input that can extend to 50GHz (or so). Above that frequency extension modules use mixer-based extensions that “use” the local oscillator (LO) of the analyzer and beat the incoming signal to be measured against various harmonics of the LO. This produces an input Intermediate Frequency (IF) that the analyzers can recognize and produce a display that, using conversion gains associated with the external mixer (from nominally 10 to 40 dB), can produce a calibrated response. Again, a little tricky, but not impossible.

As allocations increase, applications for mmWave are expanding. As the frequencies increase, the phenomena of RF communications begins to be more light-like and the cross-over between RF and optics becomes less hazy.

Innovative companies, such as those associated with the mmWave Coalition, are working to implement a balanced approach to use of these high frequency/short wavelength physics.

For the immediate future, the allocations for these devices are going to be negotiated and settled.

Stay tuned.

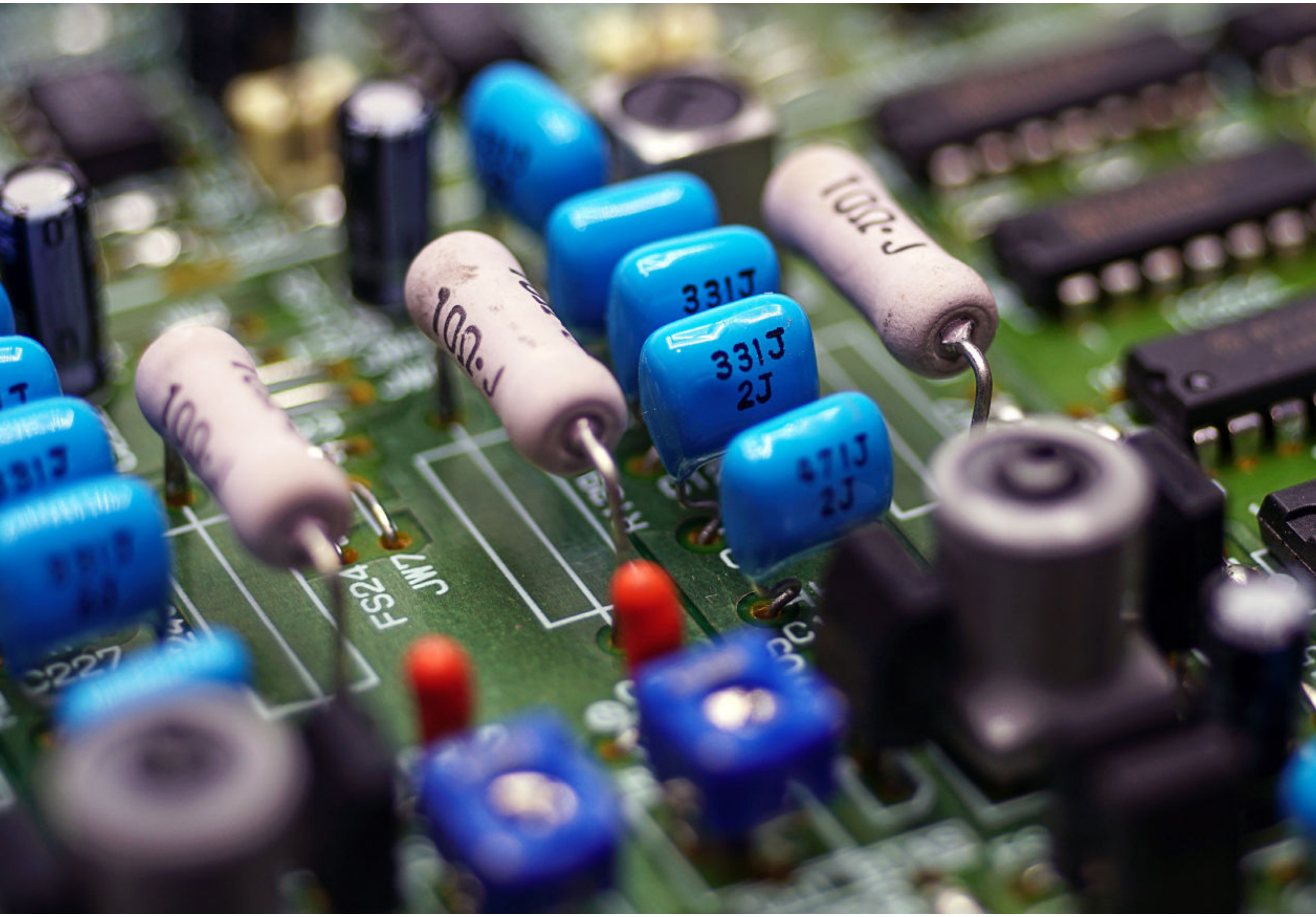


Source: mmWave Coalition

2024 EMC SUPPLIER GUIDE

Introduction

In this section, we provide a quick guide to some of the top suppliers in each EMC category–test equipment, components, materials, services, and more. To find a product that meets your needs for applications, frequencies, standards requirements, etc., please search these individual supplier websites for the latest information and availability. If you have trouble finding a particular product or solution, email info@interferencetechnology.com for further supplier contacts.



	COMPANY	WEBSITE	AMPLIFIERS	ANTENNAS	CABLES & CONNECTORS	CERTIFICATION	CONSULTANTS	COMPONENTS	DESIGN / SOFTWARE	EMI RECEIVERS	FILTERS / FERRITE'S	LIGHTNING & SURGE	MEDIA	SEALANTS & ADHESIVES	SHIELDING	SHIELDED ROOMS	SPECTRUM ANALYZERS	TEST EQUIPMENT	TEST EQUIPMENT RENTALS	TEST EQUIPMENT OTHER	TESTING	TESTING LABORATORIES	TRAINING SEMINARS & WORKSHOPS
A	Aaronia AG	www.aaronia.com	X	X						X							X						
	Advanced Test Equipment Corp. (ATEC)	www.atecorp.com	X	X		X				X		X			X	X	X	X	X	X	X		
	AH Systems, Inc.	www.ahsystems.com	X	X	X													X	X	X			
	Altair- US	www.altair.com					X		X														
	American Certification Body Inc.	https://acbcert.com/				X	X		X												X	X	X
	Ametek- CTS Compliance Test Solutions	www.ametek-cts.com	X	X														X		X			X
	Anritsu Company	www.anritsu.com		X													X	X		X	X		
	AR RF/Microwave Instrumentation	www.arworld.us	X	X	X				X									X	X				
B	Beehive Electronics	www.beehive-electronics.com																			X		
	Bulgin	www.bulgin.com				X																	
C	Captor Corporation (EMC Div.)	www.captorcorp.com									X												
	Coilcraft	www.coilcraft.com						X			X												
	CPI- Communications & Power Industries (USA)	www.cpii.com/emc	X																				
D	Dassault System Simulia Corp	www.3ds.com/							X														
	Delta Electronics (Americas) Ltd.	www.delta-americas.com									X												
	DLS Electronic Systems, Inc.	www.dlsemc.com					X															X	
E	Electro Rent	www.electrorent.com	X							X				X			X		X				
	Elite Electronic Engineering Co.	www.elitetest.com																				X	
	EMC Live	www.emc.live																					X
	EMC Partner	www.emc-partner.com																X					
	Empower RF Systems, Inc.	www.empowerrf.com	X																X				
	EM TEST USA	www.emtest.com																X					
	Exemplar Global (iNarte)	www.exemplarglobal.org																					X
	EXODUS Advanced Communications	www.exoduscomm.com	X	X	X													X					
F	F2 Labs	www.f2labs.com				X	X														X	X	X
	Fair-Rite Products Corp.	www.fair-rite.com						X							X								
	Fischer Custom Communications	www.fischercc.com																		X			
	Frankonia Solutions	www.frankonia-solutions.com													X	X		X				X	
G	Gauss Instruments	www.gauss-instruments.com								X							X						
	Gowanda Electronics	www.gowanda.com						X															
H	Haefely	www.haefely.com							X									X			X		
	Heilind Electronics, Inc	www.heilind.com									X												
	HV TECHNOLOGIES, Inc.	www.hvtechnologies.com	X	X						X		X				X	X	X		X			

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I	Interference Technology	www.interferencetechnology.com																					X
	Intertek	www.intertek.com																				X	
	ITG Electronics	www.itg-electronics.com									X												
K	Keysight Technologies	www.keysight.com								X							X		X	X			
	Kikusui America, Inc.	www.kikusuiamerica.com/solution/	X															X					
	Krieger Specialty Products	www.kriegerproducts.com														X							
	Kyocera AVX	www.kyocera-avx.com		X	X			X			X												
L	Laird a DuPont Business	www.laird.com									X			X	X								
	Langer EMV-Technik	www.langer-emv.de/en/index																		X			
M	Magnetic Shield Corp.	www.magnetic-shield.com													X								
	Master Bond Inc.	www.masterbond.com												X									
	MBP Srl	www.mbp.it/en/							X											X			
	Microlease	www.microlease.com	X							X							X		X				
	Montrose Compliance Services	www.montrosecompliance.com					X																
	MVG Microwave Vision Group	www.mvg-world.com		X		X					X				X	X							
N	Narda Safety Test Solutions	www.narda-sts.com	X	X						X							X			X			
	Noise Laboratory Co., Ltd.	www.noiseken.com																				X	
	NTS	www.nts.com																			X		
O	Ohmite	www.ohmite.com								X													
	Ophir RF	www.ophirrf.com	X																				
P	Parker Chomerics	www.chomerics.com													X								
	Pearson Electronics	www.pearsonelectronics.com						X															
	Polymer Science, Inc.	www.polymerscience.com												X	X								
	PPG Cuming Lehman Chambers	www.cuminglehman.com													X	X					X		
	PPG Engineering Materials	www.dexmet.com													X								
	Prana	www.prana-rd.com	X																				
	Pulse Power & Measurement	https://ppmtest.com/																		X			
Q	Quell Corporation	www.eeseal.com			X						X	X									X		
R	Radiometrics	www.radiomet.com																				X	
	R&B Laboratory, Inc.	www.rblaboratory.com																				X	
	Retlif Testing Laboratories	www.retlif.com																			X	X	X
	RECOM Power GmbH	www.recom-power.com									X										X		
	RF Consultant	www.rf-consultant.com					X																
	RIGOL Technologies	www.rigolna.com	X							X							X	X		X			

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R	R&K Company Limited	www.rk-microwave.com	X							X													
	Rohde & Schwarz GmbH & Co. KG	www.rohde-schwarz.com/de	X	X						X					X	X	X	X					
	Rohde & Schwarz USA, Inc.	www.rohde-schwarz.com	X	X						X					X	X	X	X					
S	Schaffner EMC, Inc.	www.schaffner.com						X			X										X	X	
	Schurter, Inc.	www.schurter.com			X		X	X			X												
	Schwarzbeck Mess-Elektronik	www.schwarzbeck.com		X																			
	Select Fabricators	www.select-fabricators.com													X	X							
	Siglent Technologies	www.siglentna.com																X					
	Signal Hound	www.signalhound.com						X		X							X				X		
	Spectrum Control	www.spectrumcontrol.com	X		X			X			X	X									X	X	
	Solar Electronics	www.solar-emc.com		X																			
	Spira Manufacturing Corp.	www.spira-emi.com													X								
	Standex Electronics	www.standexelectronics.com						X															
T	TDK	www.tdk.com						X			X					X				X			
	Tektronix	www.tek.com																X					
	Teledyne LeCroy	www.teledynelecroy.com																X					
	TESEQ Inc.	www.teseq.com																X					
	Test Equity	www.testequity.com	X							X							X		X				
	Thurlby Thandar (AIM-TTi)	www.aimtti.com								X							X						
	Toyotech (Toyo)	www.toyotechus.com/emc-electromagnetic-compatibility/	X	X						X							X						
	Transient Specialists	www.transientspecialists.com																	X				
	TRSRenTelCo	www.trsrentelco.com/categories/spectrum-analyzers/emc-test-equipment	X	X						X							X	X	X		X		
V	Vectawave Technology	www.vectawave.com	X																				
	V Technical Textiles / Shieldex US	www.vtechtextiles.com													X								
W	Washington Laboratories	www.wll.com				X	X		X			X									X	X	X
	Windfreak Technologies	www.windfreaktech.com																X			X		
	Würth Elektronik eiSos GmbH & Co. Kg	www.we-online.com		X	X			X	X		X	X			X								X
	Wyatt Technical Services	www.wyatt-tech.net					X																X
X	XGR Technologies	www.xgrtec.com													X								

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MIKE VIOLETTE, P.E., CEO
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Email: mikev@wll.com
www.wll.com

DAVID A. WESTON/EMC ENGINEER
Consultancy Services: EMC Analysis, Circuit and Equipment Design for EMC, EMI Problem Solving, R&D
David A. Weston
Phone: (613) 269-4247
Email: emccons0@gmail.com
www.emcconsultinginc.com

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Zach Peterson
Phone: (833) 330-6937
Email: zmp@nwengineeringllc.com
https://www.nwengineeringllc.com/

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Phone: (360) 790-9672
Email: Ghery@PettitEMCConsulting.com
www.PettitEMCConsulting.com

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Email: pat@andreconsulting.com
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Kenneth Wyatt, Principal Consultant
Phone: (719) 310-5418
www.emc-seminars.com

2024 CONSOLIDATED STANDARDS

MANY IEC STANDARDS have been adopted by the European Union with and EN designation replacing the IEC while maintaining the same number. In several cases the standard may have been modified. When using an IEC standard, one should check for IEC – EN differences and in both cases check for the current edition.

The standards list adds a category column to help assign the identified standard to a particular type or discipline. Most are self-explanatory, but to avoid confusion the category assignments follow. Often a particular standard could fit in more than one category, so the assignment is simply a judgement call.

- Apparatus – this category is used to group standards for a product or device where it fails to fit in a specific group. For example, a medical device could be a product but it fits into the medical category more closely.
- Auto/Vehicle – standard primarily deals with automotive but includes ship or rail.
- General – primarily deals with definitive or general EM control information.
- Generic – deals with product standards not assigned to a particular group.
- Medical – medical equipment or methods
- MIL/Aero – MIL-STD, Space, Aeronautical equipment, or methods – includes associated design guides.
- Test – primarily deals with test methods
- Wireless – primarily deals with intentional RF emitters or receivers.

Useful websites associated with standards include but not limited to:

ANSI	http://webstore.ansi.org; www.ansi.org; www.c63.org
APLAC	Asia Pacific Laboratory Accreditation Cooperation (APLAC) https://www.apac-accreditation.org/
BSMI	https://www.bsmi.gov.tw/wSite/mp?mp=1
CSA	http://www.cnca.gov.cn/
EN	https://www.en-standard.eu/
FCC	Federal Communications Commission (FCC) www.fcc.gov; Electronic Code of Fderal Regulations https://www.ecfr.gov
FDA	FDA Center for Devices & Radiological Health (CDRH) https://www.fda.gov/MedicalDevices/default.htm
Ford	https://www.fordemc.com
GM	https://global.ihs.com
IC	Industry Canada (Certifications and Standards) http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf06165.html
IEC / CISPR	https://webstore.iec.ch
IEEE	IEEE Standards Association https://standards.ieee.org/
IEEE EMC	IEEE EMC Society Standards Development Committee (SDCOM) https://standards.ieee.org/develop/index.html
ISED	Innovation, Science and Economic Development Canada; https://www.ic.gc.ca/eic/site/icgc.nsf/eng/home
ISO	ISO (International Organization for Standards) http://www.iso.org/iso/home.html
MIL-STD	https://quicksearch.dla.mil/qsSearch.aspx
RTCA	https://www.rtca.org
Russia	Gosstandart (Russia) https://gosstandart.gov.by/en
SAE	SAE EMC Standards Committee www.sae.org
VCCI	VCCI (Japan, Voluntary Control Council for Interference) http://www.vcci.jp/vcci_e/

Category	Publisher	Number	Title
Apparatus	IEC	60118-13	Electroacoustics - Hearing aids - Part 13: Electromagnetic compatibility (EMC)
Apparatus	IEC	60255-26	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements
Apparatus	IEC	60364-4-44	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbance
Apparatus	IEC	60728-12	Cabled distribution systems for television and sound signals - Part 12: Electromagnetic compatibility of systems IEC (continued)
Apparatus	IEC	60728-2	Cabled distribution systems for television and sound signals - Part 2: Electromagnetic compatibility for equipment
Apparatus	IEC	60870-2-1	Telecontrol equipment and systems - Part 2: Operating conditions - Section 1: Power supply and electromagnetic compatibility
Apparatus	IEC	60974-10	Arc welding equipment - Part 10: Electromagnetic compatibility (EMC) requirements
Apparatus	IEC	61000-3-11	Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems - Equipment with rated current <= 75 A and subject to conditional connection IEC (continued)
Apparatus	IEC	61000-3-12	Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and <=75 A per phase
Apparatus	IEC	61000-3-2	Electromagnetic compatibility (EMC)–Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
Apparatus	IEC	61000-3-3	Electromagnetic compatibility (EMC)–Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
Apparatus	IEC	61000-3-8	Electromagnetic compatibility (EMC) - Part 3: Limits - Section 8: Signaling on low-voltage electrical installations - Emission levels, frequency bands and electromagnetic disturbance levels
Apparatus	IEC	61326-1	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements
Apparatus	IEC	61326-2-1	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-1: Particular requirements - Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications
Apparatus	IEC	61326-2-2	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems
Apparatus	IEC	61326-2-3	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-3: Particular requirements - Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning
Apparatus	IEC	61326-2-4	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-4: Particular requirements - Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9
Apparatus	IEC	61326-2-5	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-5: Particular requirements - Test configurations, operational conditions and performance criteria for field devices with field bus interfaces according to IEC 61784-1

Category	Publisher	Number	Title
Apparatus	IEC	61326-2-6	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-6: Particular requirements - In vitro diagnostic (IVD) medical equipment
Apparatus	IEC	61326-3-1	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications
Apparatus	IEC	61326-3-2	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - Industrial applications with specified electromagnetic environment
Apparatus	IEC	61543	Residual current-operated protective devices (RCDs) for household and similar use - Electromagnetic compatibility
Apparatus	IEC	61800-3	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
Apparatus	IEC	61967-1	Integrated circuits - Measurement of electromagnetic emissions, 150 kHz to 1 GHz - Part 1: General conditions and definitions
Apparatus	IEC	62040-2	Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility EMC) requirements
Apparatus	IEC	62041	Power transformers, power supply units, reactors and similar products - EMC requirements
Apparatus	IEC	62209-1528	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-worn wireless communication devices - Human models, instrumentation and procedures (Frequency range of 4 MHz to 10 GHz)
Apparatus	IEC	62310-2	Static transfer systems (STS) - Part 2: Electromagnetic compatibility (EMC) requirements
Apparatus	IEC	CISPR 11	Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement
Apparatus	IEC	CISPR 14-1	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission
Apparatus	IEC	CISPR 14-2	Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity – Product family standard
Apparatus	IEC	CISPR 15	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
Apparatus	IEC	CISPR 32	Electromagnetic compatibility of multimedia equipment – Emission requirements
Apparatus	IEC	CISPR 35	Electromagnetic compatibility of multimedia equipment - Immunity requirements
Apparatus	IEC	TR 61000-3-13	Electromagnetic compatibility (EMC) - Part 3-13: Limits - Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems
Apparatus	IEC	TR 61000-3-14	Electromagnetic compatibility (EMC) - Part 3-14: Assessment of emission limits for harmonics, interharmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems
Apparatus	IEC	TR 61000-3-15	Electromagnetic compatibility (EMC) - Part 3-15: Limits - Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network

Category	Publisher	Number	Title
Apparatus	IEC	TR 61000-3-6	Electromagnetic compatibility (EMC) - Part 3: Limits - Section 6: Assessment of emission limits for distorting loads in MV and HV power systems - Basic EMC publication
Apparatus	IEC	TR 61000-3-7	Electromagnetic compatibility (EMC) - Part 3: Limits - Section 7: Assessment of emission limits for fluctuating loads in MV and HV power systems - Basic EMC publication
Apparatus	IEC	TR 63170	Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz
Apparatus	IEC	TS 61000-3-4	Electromagnetic compatibility (EMC) - Part 3-4: Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A
Apparatus	IEC	TS 61000-3-5	Electromagnetic compatibility (EMC) - Part 3: Limits - Section 5: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A
Apparatus	IEC/IEEE	63195-1	Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) - Part 1: Measurement procedure
Auto/Vehicle	Audi	TL 82466	Electrostatic Discharge
Auto/Vehicle	BMW	600 13.0	Electric- / Electronic components in cars BMW GS 95002 Electromagnetic Compatibility (EMC) Requirements and Tests
Auto/Vehicle	BMW	GS 95003-2	GS 95003-2 Electric- / Electronic assemblies in motor vehicles
Auto/Vehicle	Chrysler	PF 9326	Electrical electronic modules and motors
Auto/Vehicle	Diamer Chrysler	DC-10614	EMC Performance Requirements – Components
Auto/Vehicle	Diamer Chrysler	DC-10615	Electrical System Performance Requirements for Electrical and Electronic Components
Auto/Vehicle	Diamer Chrysler	DC-11223	Performance Requirements -- Vehicle Automotive Electromagnetic Compatibility Standards
Auto/Vehicle	Diamer Chrysler	DC-11224	EMC Performance Requirements – Components
Auto/Vehicle	Diamer Chrysler	DC-11225	EMC Supplemental Information and Alternative Component Requirements
Auto/Vehicle	Fiat	9.90110	Electric and electronic devices for motor vehicles Freightliner 49-00085 EMC Requirements
Auto/Vehicle	FORD	EMC-CS-2009.1	Component EMC Specification. EMC-CS-2009.1
Auto/Vehicle	FORD	F-2	Electrical and Electronics System Engineering
Auto/Vehicle	FORD	WSF-M22P5-A1	Printed Circuit Boards, PTF, Double Sided, Flexible
Auto/Vehicle	GM	GMW3091	General Specification for Vehicles, Electromagnetic Compatibility (EMC)-Engl; Revision H; Supersedes GMI 12559 R and GMI 12559 V
Auto/Vehicle	GM	GMW3097	General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility-Engl; Revision H; Supersedes GMW12559, GMW3100, GMW12002R AND GMW12002V
Auto/Vehicle	GM	GMW3103	General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility Global EMC Component/ Subsystem Validation Acceptance Process-Engl; Revision F; Contains Color; Replaces GMW12003, GMW12004 and GMW3106
Auto/Vehicle	Honda	3838Z-S5AA-L000	Noise Simulation Test

Category	Publisher	Number	Title
Auto/Vehicle	Honda	3982Z-SDA-0030	Battery Simulation Test
Auto/Vehicle	Hyundia Kia	ES 39111-00	EMC Requirements
Auto/Vehicle	Hyundia Kia	ES 95400-10	Battery Simulation Tests
Auto/Vehicle	Hyundia Kia	ES 96100-01	EMC Requirements
Auto/Vehicle	IEC	60533	Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hull
Auto/Vehicle	IEC	61851-21-1	Electric vehicle conductive charging system - Part 21-1 Electric vehicle on-board charger EMC requirements for conductive connection to AC/DC supply
Auto/Vehicle	IEC	61851-21-2	Electric vehicle conductive charging system - Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply - EMC requirements for off board electric vehicle charging systems
Auto/Vehicle	IEC	62236-1	Railway applications - Electromagnetic compatibility - Part 1: General
Auto/Vehicle	IEC	62236-2	Railway applications - Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world
Auto/Vehicle	IEC	62236-3-1	Railway applications - Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle
Auto/Vehicle	IEC	62236-3-2	Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus
Auto/Vehicle	IEC	62236-4	Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signaling and telecommunications apparatus
Auto/Vehicle	IEC	62236-5	Railway applications - Electromagnetic compatibility - Part 5: Emission and immunity of fixed power supply installations and apparatus
Auto/Vehicle	IEC	CISPR 12	Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers
Auto/Vehicle	IEC	CISPR 25	Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers
Auto/Vehicle	IEC	TR 62482	Electrical installations in ships - Electromagnetic compatibility - Optimizing of cable installations on ships - Testing method of routing distance
Auto/Vehicle	ISL	11451-3	Road vehicles -- Electrical disturbances by narrowband radiated electromagnetic energy -- Vehicle test methods -- Part 3: On-board transmitter simulation
Auto/Vehicle	ISO	10605	Road vehicles -- Test methods for electrical disturbances from electrostatic discharge
Auto/Vehicle	ISO	11451-1	Road vehicles -- Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 1: General principles and terminology
Auto/Vehicle	ISO	11451-2	Road vehicles -- Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 2: Off-vehicle radiation sources
Auto/Vehicle	ISO	11451-4	Road vehicles -- Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 4: Bulk current injection (BCI)
Auto/Vehicle	ISO	11452-1	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology

Category	Publisher	Number	Title
Auto/Vehicle	ISO	11452-10	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 10: Immunity to conducted disturbances in the extended audio frequency range
Auto/Vehicle	ISO	11452-11	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 11: Reverberation chamber ISO 13766 Earth-moving machinery – Electromagnetic compatibility
Auto/Vehicle	ISO	11452-2	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Absorber-lined shielded enclosure
Auto/Vehicle	ISO	11452-3	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 3: Transverse electromagnetic mode (TEM) cell
Auto/Vehicle	ISO	11452-4	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 4: Bulk current injection (BCI)
Auto/Vehicle	ISO	11452-5	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 5: Stripline
Auto/Vehicle	ISO	11452-7	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 7: Direct radio frequency (RF) power injection
Auto/Vehicle	ISO	11452-8	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 8: Immunity to magnetic fields
Auto/Vehicle	ISO	7637-1	Road vehicles -- Electrical disturbances from conduction and coupling -- Part 1: Definitions and general considerations
Auto/Vehicle	ISO	7637-2	Road vehicles -- Electrical disturbances from conduction and coupling -- Part 2: Electrical transient conduction along supply lines only
Auto/Vehicle	ISO	7637-3	Road vehicles -- Electrical disturbance by conduction and coupling -- Part 3: Vehicles with nominal 12 V or 24 V supply voltage -- Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines
Auto/Vehicle	ISO	TR 10305-1	Road vehicles -- Calibration of electromagnetic field strength measuring devices -- Part 1: Devices for measurement of electromagnetic fields at frequencies > 0 Hz
Auto/Vehicle	ISO	TR 10305-2	Road vehicles -- Calibration of electromagnetic field strength measuring devices -- Part 2: IEEE standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz
Auto/Vehicle	ISO	TS 14907-1	Road transport and traffic telematics -- Electronic fee collection – Test procedures for user and fixed equipment – Part 1: Description of test procedures
Auto/Vehicle	ISO	TS 14907-2	Road transport and traffic telematics – Electronic fee collection -- Test procedures for user and fixed equipment -- Part 2: Conformance test for the onboard unit application interface
Auto/Vehicle	ISO	TS 21609	Road vehicles -- (EMC) guidelines for installation of aftermarket radio frequency transmitting equipment
Auto/Vehicle	KVECO	16-2103	EMC Requirements
Auto/Vehicle	Lotus	17.39.01	Lotus Engineering Standard: Electromagnetic Compatibility
Auto/Vehicle	Mack	606GS15	EMC Requirements MAN 3285 EMC Requirements
Auto/Vehicle	Mazda	MES PW 67600	Automobile parts standard (electronic devices)

Category	Publisher	Number	Title
Auto/Vehicle	Mercedes	A 211 000 42 99	Instruction specification of test method for E/Ecomponents
Auto/Vehicle	Mercedes	AV EMV	Electric aggregate and electronics in cars
Auto/Vehicle	Mercedes	MBN 10284-2	EMC requirements and tests of E/E-systems (component test procedures)
Auto/Vehicle	Mercedes	MBN 2200-2	Electric / electronic elements, devices in trucks
Auto/Vehicle	Mitsubishi	ES-X82010	General specification of environment tests on automotive electronic equipment
Auto/Vehicle	Nissan	28400 NDS03	Low frequency surge resistance of electronic parts
Auto/Vehicle	Nissan	28400 NDS04	Burst and Impulse Waveforms
Auto/Vehicle	Nissan	28400 NDS07	Immunity against low frequency surge (induction surge) of electronic parts
Auto/Vehicle	Nissan	28401 NDS02	EMC requirements (instruction concerning vehicle and electrical ...)
Auto/Vehicle	Peugeot	B217110	Load Dump Pulses
Auto/Vehicle	Porsche	AV EMC EN	EMC Requirements
Auto/Vehicle	PSA	B21 7090	EMC Requirements (electric and electronics equipment)
Auto/Vehicle	PSA	B21 7110	EMC requirements (electric and electronics equipment)
Auto/Vehicle	Renault	36.00.400	Physical environment of electrical and electronic equipment
Auto/Vehicle	Renault	36.00.808	EMC requirements (cars and electrical / electronic components)
Auto/Vehicle	SAE	J1113/1	Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles, Boats (Up to 15 M), and Machines (Except Aircraft) (50 Hz to 18 Ghz)
Auto/Vehicle	SAE	J1113/11	Immunity to Conducted Transients on Power Leads
Auto/Vehicle	SAE	J1113/12	Electrical Interference by Conduction and Coupling - Capacitive and Inductive Coupling via Lines Other than Supply Lines
Auto/Vehicle	SAE	J1113/13	Electromagnetic Compatibility Measurement Procedure for Vehicle Components - Part 13: Immunity to Electrostatic Discharge
Auto/Vehicle	SAE	J1113/2	Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft)--Conducted Immunity, 15 Hz to 250 kHz--All Leads
Auto/Vehicle	SAE	J1113/21	Electromagnetic Compatibility Measurement Procedure for Vehicle Components - Part 21: Immunity to Electromagnetic Fields, 30 MHz to 18 GHz, Absorber-Lined Chamber
Auto/Vehicle	SAE	J1113/26	Electromagnetic Compatibility Measurement Procedure for Vehicle Components - Immunity to AC Power Line Electric Fields
Auto/Vehicle	SAE	J1113/27	Electromagnetic Compatibility Measurements Procedure for Vehicle Components - Part 27: Immunity to Radiated Electromagnetic Fields - Mode Stir Reverberation Method
Auto/Vehicle	SAE	J1113/28	Electromagnetic Compatibility Measurements Procedure for Vehicle Components--Part 28--Immunity to Radiated Electromagnetic Fields--Reverberation Method (Mode Tuning)
Auto/Vehicle	SAE	J1113/4	Immunity to Radiated Electromagnetic Fields-Bulk Current Injection (BCI) Method
Auto/Vehicle	SAE	J1752/1	Electromagnetic Compatibility Measurement Procedures for Integrated Circuits-Integrated Circuit EMC Measurement Procedures-General and Definition
Auto/Vehicle	SAE	J1752/2	Measurement of Radiated Emissions from Integrated Circuits -- Surface Scan Method (Loop Probe Method) 10 MHz to 3 GHz

Category	Publisher	Number	Title
Auto/Vehicle	SAE	J1752/3	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)
Auto/Vehicle	SAE	J1812	Function Performance Status Classification for EMC Immunity Testing
Auto/Vehicle	SAE	J2556	Radiated Emissions (RE) Narrowband Data Analysis--Power Spectral Density (PSD)
Auto/Vehicle	SAE	J2556	Radiated Emissions (RE) Narrowband Data Analysis–Power Spectral Density (PSD)
Auto/Vehicle	SAE	J2628	Characterization--Conducted Immunity
Auto/Vehicle	SAE	J2628	Characterization–Conducted Immunity
Auto/Vehicle	SAE	J551/15	Vehicle Electromagnetic Immunity--Electrostatic Discharge (ESD)
Auto/Vehicle	SAE	J551/16	Electromagnetic Immunity - Off-Vehicle Source (Reverberation Chamber Method) - Part 16 - Immunity to Radiated Electromagnetic Fields
Auto/Vehicle	SAE	J551/17	Vehicle Electromagnetic Immunity -- Power Line Magnetic Fields
Auto/Vehicle	SAE	J551/5	Performance Levels and Methods of Measurement of Magnetic and Electric Field Strength from Electric Vehicles, Broadband, 9 kHz To 30 MHz
Auto/Vehicle	Scania	TB1400	EMC Requirements
Auto/Vehicle	Scania	TB1700	Load Dump Test
Auto/Vehicle	Smart	DE10005B	EMC requirements (electric aggregate and electronics in cars)
Auto/Vehicle	Toyota	TSC203G	Engineering standard (ABS-TRC computers)
Auto/Vehicle	Toyota	TSC7001G	Engineering standard (electric noise of electronic devices)
Auto/Vehicle	Toyota	TSC7001G-5.1	Power Supply Voltage Characteristic Test
Auto/Vehicle	Toyota	TSC7001G-5.2	Field Decay Test
Auto/Vehicle	Toyota	TSC7001G-5.3	Floating Ground Test
Auto/Vehicle	Toyota	TSC7001G-5.4	Induction Noise Resistance
Auto/Vehicle	Toyota	TSC7001G-5.5.3	Load Dump Test-1
Auto/Vehicle	Toyota	TSC7001G-5.5.4	Load Dump Test-2
Auto/Vehicle	Toyota	TSC7001G-5.5.5	Load Dump Test-3
Auto/Vehicle	Toyota	TSC7001G-5.6	Over Voltage Test
Auto/Vehicle	Toyota	TSC7001G-5.7.3	Ignition Pulse (Battery Waveforms) Test-1
Auto/Vehicle	Toyota	TSC7001G-5.7.4	Ignition Pulse (Battery Waveforms) Test-2
Auto/Vehicle	Toyota	TSC7001G-5.8	Reverse Voltage
Auto/Vehicle	Toyota	TSC7006G-4.4.2	Wide Band-Width Antenna Nearby Test (0.4 to 2 GHz)
Auto/Vehicle	Toyota	TSC7006G-4.4.3	Radio Equipment Antenna nearby Test (28 MHz ...)
Auto/Vehicle	Toyota	TSC7006G-4.4.4	Mobile Phone Antenna Nearby Test (835 MHz ...)
Auto/Vehicle	Toyota	TSC7018G	Static Electricity Test
Auto/Vehicle	Toyota	TSC7025G-5	TEM Cell Test (1 to 400 MHz)
Auto/Vehicle	Toyota	TSC7025G-6	Free Field Immunity Test (20 MHz to 1 GHz AM, 0.8 to 2 GHz PM)
Auto/Vehicle	Toyota	TSC7025G-7	Strip Line Test (20 - 400 MHz)
Auto/Vehicle	Toyota	TSC7026G-3.4	Narrow Band Emissions

Category	Publisher	Number	Title
Auto/Vehicle	Toyota	TSC7203	Voltage Drop / Micro Drops
Auto/Vehicle	Toyota	TSC7508G-3.3.1	Conductive Noise in FM and TV Bands
Auto/Vehicle	Toyota	TSC7508G-3.3.2	Conductive noise in LW, AM and SW Bands
Auto/Vehicle	Toyota	TSC7508G-3.3.3	Radiated Noise in FM and TV Bands
Auto/Vehicle	Toyota	TSC7508G-3.3.4	Radiated Noise in AM, SW, and LW Bands
Auto/Vehicle	Toyota	TXC7315G	Electrostatic Discharge (Gap Method)
Auto/Vehicle	Viston	ES-XU3F-1316-AA	Electronic Component - Subsystem Electromagnetic Compatibility (EMC) Requirements and Test Procedures
Auto/Vehicle	Volvo	N/A	EMC Requirements EMC requirements for 12V and 24V systems
Auto/Vehicle	VW	TL 801 01	Electric and electronic components in cars
Auto/Vehicle	VW	TL 820 66	Conducted Interference
Auto/Vehicle	VW	TL 821 66	EMC requirements of electronic components - bulk current injection (BCI)
Auto/Vehicle	VW	TL 823 66	Coupled Interference on Sensor Cables
Auto/Vehicle	VW	TL 824 66	Immunity Against Electrostatic Discharge
Auto/Vehicle	VW	TL 965	Short-Distance Interference Suppression
General	ANSI	S20.20	ESD Association Standard for the Development of and Electrostatic Discharge Control Program for the Protection of Electronic Parts, Assemblies, and Equipment
General	IEC	60050-161	International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility
General	IEC	60469	Transitions, pulses and related waveforms - Terms, definitions and algorithms
General	IEC	60940	Guidance information on the application of capacitors, resistors, inductors and complete filter units for electromagnetic interference suppression
General	IEC	61000-1-2	Electromagnetic compatibility (EMC) - Part 1-2: General - Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena
General	IEc	61000-2-10	Electromagnetic compatibility (EMC) - Part 2-10: Environment - Description of HEMP environment - Conducted disturbance
General	IEC	61000-2-11	Electromagnetic compatibility (EMC) - Part 2-11: Environment - Classification of HEMP environments
General	IEC	61000-2-12	Electromagnetic compatibility (EMC) - Part 2-12: Environment - Compatibility levels for low-frequency conducted disturbances and signaling in public medium-voltage power supply systems
General	IEC	61000-2-13	Electromagnetic compatibility (EMC) - Part 2-13: Environment - High-power electromagnetic (HPEM) environments - Radiated and conducted
General	IEC	61000-2-2	Electromagnetic compatibility (EMC) - Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems
General	IEC	61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances
General	IEC	61000-2-9	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 9: Description of HEMP environment - Radiated disturbance. Basic EMC publication

Category	Publisher	Number	Title
General	IEC	61000-5-5	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 5: Specification of protective devices for HEMP conducted disturbance. Basic EMC Publication
General	IEC	61000-5-7	Electromagnetic compatibility (EMC) - Part 5-7: Installation and mitigation guidelines - Degrees of protection provided by enclosures against electromagnetic disturbances (EM code)
General	IEC	61000-5-8	Electromagnetic compatibility (EMC) - Part 5-8: Installation and mitigation guidelines - HEMP protection methods for the distributed infrastructure
General	IEC	61000-5-9	Electromagnetic compatibility (EMC) - Part 5-9: Installation and mitigation guidelines - System-level susceptibility assessments for HEMP and HPEM
General	IEC	62305-1	Protection against lightning - Part 1: General principles
General	IEC	62305-2	Protection against lightning - Part 2: Risk management
General	IEC	62305-3	Protection against lightning - Part 3: Physical damage to structures and life hazard
General	IEC	62305-4	Protection against lightning - Part 4: Electrical and electronic systems within structures
General	IEC	TR 61000-1-1	Electromagnetic compatibility (EMC) - Part 1: General - Section 1: Application and interpretation of fundamental definitions and terms
General	IEC	TR 61000-1-3	Electromagnetic compatibility (EMC) - Part 1-3: General - The effects of high-altitude EMP (HEMP) on civil equipment and systems
General	IEC	TR 61000-1-4	Electromagnetic compatibility (EMC) - Part 1-4: General - Historical rationale for the limitation of power-frequency conducted harmonic current emissions from equipment, in the frequency range up to 2 kHz
General	IEC	TR 61000-1-5	Electromagnetic compatibility (EMC) - Part 1-5: General - High power electromagnetic (HPEM) effects on civil systems
General	IEC	TR 61000-1-6	Electromagnetic compatibility (EMC) - Part 1-6: General - Guide to the assessment of measurement uncertainty
General	IEC	TR 61000-1-7	Electromagnetic compatibility (EMC) - Part 1-7: General - Power factor in single-phase systems under non-sinusoidal conditions
General	IEC	TR 61000-2-1	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signaling in public power supply systems
General	IEC	TR 61000-2-14	Electromagnetic compatibility (EMC) - Part 2-14: Environment - Overvoltages on public electricity distribution networks
General	IEC	TR 61000-2-3	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 3: Description of the environment - Radiated and non network-frequency-related conducted phenomena
General	IEC	TR 61000-2-5	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 5: Classification of electromagnetic environments. Basic EMC publication
General	IEC	TR 61000-2-6	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 6: Assessment of the emission levels in the power supply of industrial plants as regards low-frequency conducted disturbances
General	IEC	TR 61000-2-8	Electromagnetic compatibility (EMC) - Part 2-8: Environment - Voltage dips and short interruptions on public electric power supply systems with statistical measurement results
General	IEC	TR 61000-5-1	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 1: General considerations - Basic EMC publication
General	IEC	TR 61000-5-2	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 1: General considerations - Basic EMC publication

Category	Publisher	Number	Title
General	IEC	TR 61000-5-3	Electromagnetic compatibility (EMC) - Part 5-3: Installation and mitigation guidelines - HEMP protection concepts
General	IEC	TR 61000-5-6	Electromagnetic compatibility (EMC) - Part 5-6: Installation and mitigation guidelines - Mitigation of external EM influences
General	IEC	TR-61000-2-7	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 7: Low frequency magnetic fields in various environments
General	IEC	TS 61000-5-4	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 4: Immunity to HEMP - Specifications for protective devices against HEMP radiated disturbance. Basic EMC Publication
Generic	IEC	61000-6-1	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity standard for residential, commercial and light-industrial environments
Generic	IEC	61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
Generic	IEC	61000-6-3	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
Generic	IEC	61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
Generic	IEC	61000-6-5	Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for power station and substation environments
Generic	IEC	61000-6-6	Electromagnetic compatibility (EMC) - Part 6-6: Generic standards - HEMP immunity for indoor equipment
Generic	IEC	61000-6-7	Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
Medical	IEC	60601-1-1	Safety requirements for medical electrical systems
Medical	IEC	60601-1-10	Requirements for the development of physiologic closed-loop controllers
Medical	IEC	60601-1-11	Medical electrical equipment and medical electrical systems used in the home healthcare environment
Medical	IEC	60601-1-12	Medical electrical equipment and medical electrical systems used in the medical services environment
Medical	IEC	60601-1-2	Medical electrical equipment–Part 1-2: General requirements for basic safety and essential performance - Collateral Standard: Electromagnetic disturbances - Requirements and tests
Medical	IEC	60601-1-3	Radiation protection in diagnostic x-ray equipment
Medical	IEC	60601-1-6	General requirements for basic safety and essential performance – Usability
Medical	IEC	60601-1-8	General requirements for basic safety and essential performance - Alarm systems
Medical	IEC	60601-1-9	Requirements for environmentally conscious design
Medical	IEC	60601-2-2	Medical electrical equipment–Part 2-2: Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories
Medical	IEC	60601-4-2	Medical electrical equipment–Part 4-2: Guidance and interpretation - Electromagnetic immunity: performance of medical electrical equipment and medical electrical systems
Medical	IEC	TR 60601-4-2	Electromagnetic immunity performance

Category	Publisher	Number	Title
Medical	IEC	TR 60601-4-3	Considerations of unaddressed safety aspects in the third edition of IEC 60601-1
Medical	IEC	TR 62354	General testing procedures for medical electrical equipment
Medical	ISO	14708-1	Active implantable medical devices
MIL/Aero	AIAA	S-121	Electromagnetic Compatibility Requirements for Space Equipment and Systems, 2017
MIL/Aero	DoD	ADS-37A-PRF	Electromagnetic Environmental Effects (E3) Performance and Verification Requirements, 28 May 1996 (Army Aviation and Troop Command)
MIL/Aero	DoD	DoDD 4650.01	Policy and Procedures for Management and Use of the Electromagnetic Spectrum, 09 Jan 2009
MIL/Aero	DoD	DoDI 3222.03	DoD Electromagnetic Environmental Effects (E3) Program, Change Notice 2, 10 October 2017.
MIL/Aero	DoD	DoDI 6055.11	Protecting Personnel from Electromagnetic Fields, 19 Aug 2009
MIL/Aero	DoD	DOD-STD-1399-70	Section 070 Part 1 D.C. Magnetic Field Environment, (Notice 1 Validation, 30 Nov 1989)
MIL/Aero	DoD	MIL-HDBK-1195	Radio Frequency Shielded Enclosures, 30 Sep 1988
MIL/Aero	DoD	MIL-HDBK-1857	Grounding, Bonding and Shielding Design Practices, 27 Mar 1998
MIL/Aero	DoD	MIL-HDBK-2036	Preparation of Electronic Equipment Specifications, 1 November 1999
MIL/Aero	DoD	MIL-HDBK-235-1D	Military Operational Electromagnetic Environment Profiles Part 1D General Guidance, 03 April 2018
MIL/Aero	DoD	MIL-HDBK-237D	Electromagnetic Environmental Effects and Spectrum Certification Guidance for the Acquisition Process, 20 May 2005. (Notice 1 Validation 04 April 2013)
MIL/Aero	DoD	MIL-HDBK-240-1	Electromagnetic Environmental Effects to Ordnance Guide Part 1 General Guidance
MIL/Aero	DoD	MIL-HDBK-240-2	Electromagnetic Environmental Effects to Ordnance Guide Part 2 Hazards of Electromagnetic Radiation to Ordnance testing
MIL/Aero	DoD	MIL-HDBK-240-3	Electromagnetic Environmental Effects to Ordnance Guide Part 3 Electrostatic Discharge to Ordnance
MIL/Aero	DoD	MIL-HDBK-240-4	Electromagnetic Environmental Effects to Ordnance Guide Part 4 External Radio Frequency Electromagnetic Environments
MIL/Aero	DoD	MIL-HDBK-240-5	Electromagnetic Environmental Effects to Ordnance Guide Part 5 Lightning Effects to Ordnance (Notice 1 is administrative placeholder)
MIL/Aero	DoD	MIL-HDBK-240-6	Electromagnetic Environmental Effects to Ordnance Guide Part 6 Characterization of the Electromagnetic Environment for HERO
MIL/Aero	DoD	MIL-HDBK-240-7	Electromagnetic Environmental Effects to Ordnance Test Guide Part 7 Hazards of Electromagnetic Radiation to Ordnance Operational Guidance
MIL/Aero	DoD	MIL-HDBK-274A	Electrical Grounding for Aircraft Safety, 14 Nov 2011. (Notice 2 Validation 20 May 2021)
MIL/Aero	DoD	MIL-HDBK-335	Management and Design Guidance Electromagnetic Radiation Hardness for Air Launched Ordnance Systems, Notice 4, 08 Jul 2008. (Notice 5 Cancellation 01 August 2013)
MIL/Aero	DoD	MIL-HDBK-419A	Grounding, Bonding, and Shielding for Electronic Equipment and Facilities, 29 Dec 1987. (Notice 1 Validation 20 February 2014)
MIL/Aero	DoD	MIL-HDBK-454C	General Guidelines for Electronic Equipment

Category	Publisher	Number	Title
MIL/Aero	DoD	MIL-STD-1275E	Characteristics of 28 Volt DC Power Input to Utilization Equipment in Military Vehicles, 22 March 2013
MIL/Aero	DoD	MIL-STD-1310H	Shipboard Bonding, Grounding, and Other Techniques foe Electromagnetic Compatibility, Electeomagnetic Pulse (EMP) Mitigation, and Safety, 17 Sep 2009 (Notice 1 Validation 12 Aug 2014)
MIL/Aero	DoD	MIL-STD-1377	Effectiveness of Cable, Connector, and Weapon Enclosure Shielding and Filters in Precluding Hazards of EM Radiation to Ordnance; Measurement of, 20 Aug 1971 (Notice 1 Validation 19 Jan 2021)
MIL/Aero	DoD	MIL-STD-1399-300-1	Department of Defense Interface Standard Sectio 300, Part 1 Low Voltage Electric Power, Alternating Current
MIL/Aero	DoD	MIL-STD-1399-300-2	Department of Defense Interface Standard Sectio 300, Part 2 Medium Voltage Electric Power, Alternating Current
MIL/Aero	DoD	MIL-STD-1542B	Electromagnetic Compatibility and Grounding Requirements for Space System Facilities, 15 Nov 1991
MIL/Aero	DoD	MIL-STD-1605A	Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships), 08 Oct 2009 (Notice 1 Validation 12 Aug 2014)
MIL/Aero	DoD	MIL-STD-188-124B	Grounding, Bonding, and Shielding for Common Long Haul/Tactical Communications-Electronics Facilities and Equipment, 4 April 2013
MIL/Aero	DoD	MIL-STD-220C	Test Method Standard Method of Insertion Loss Measurement, 14 May 2009 (Notice 2 Validation 8 Oct 2019)
MIL/Aero	DoD	MIL-STD-331B	Fuze and Fuze Components, Environmental and Performance Tests for, 31 May, 2017
MIL/Aero	DoD	MIL-STD-449D	Radio Frequency Spectrum Characteristics, Measurement of, 22 Feb 1973 (Notice 2 Validation 4 Apr 2013)
MIL/Aero	DoD	MIL-STD-461G	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 11 Dec 2015
MIL/Aero	DoD	MIL-STD-464D	Electromagnetic Environmental Effects Requirements for Systems, 24 Dec 2020
MIL/Aero	DoD	MIL-STD-704F	Aircraft Electric Power Characteristics, Change Notice 1, 05 December 2016 (Notice 3 Validation 17 Sep 2021).
MIL/Aero	DoD	TOP-01-2-511A	Protecting Personnel from Electromagnetic Fields, 19 Aug 2009
MIL/Aero	DoD	TOP-01-2-620	High-Altitude Electromagnetic Pulse (HEMP) Testing, 10 November 2011
MIL/Aero	DoD	TOP-01-2-622	Vertical Electromagnetic Pulse Testing, 11 September 2009
MIL/Aero	RTCA	DO-160G	Environmental Conditions and Test Procedures for Airborne Equipment (Change 1)
MIL/Aero	RTCA	DO-233	Portable Electronic Devices Carried on Board Aircraft
MIL/Aero	RTCA	DO-235B	Assessment of Radio Frequency Interference Relevant to the GNSS L1 Frequency Band
MIL/Aero	RTCA	DO-292	Assessment of Radio Frequency Interference Relevant to the GNSS L5/ E5A Frequency Band
MIL/Aero	RTCA	DO-294C	Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDs) on Aircraft
MIL/Aero	RTCA	DO-307A	Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance
MIL/Aero	RTCA	DO-307A	Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance

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MIL/Aero	RTCA	DO-357	User Guide Supplement to DO-160
MIL/Aero	RTCA	DO-363	Guidance for the Development of Portable Electronic Devices (PED) Tolerance for Civil Aircraft
MIL/Aero	RTCA	DO-364	Minimum Aviation System Performance Standards (MASPS) for Aeronautical Information/ Meteorological Data Link Services
MIL/Aero	SAE	ARP 5583A	Guide to Certification of Aircraft in a High Intensity Radiation (HIRF) Environment
MIL/Aero	SMC	SMC-S-008	Electromagnetic Compatibility Requirements For Space Equipment and Systems, 13 Jun 2008
Test	ANSI	C63.4	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
Test	IEC	60060-1	International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility
Test	IEC	60060-2	High-voltage test techniques - Part 2: Measuring systems
Test	IEC	60060-3	High-voltage test techniques - Part 3: Definitions and requirements for on-site testing
Test	IEC	61000-4-10	Electromagnetic compatibility (EMC) - Part 4-10: Testing and measurement techniques - Damped oscillatory magnetic field immunity test
Test	IEC	61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests
Test	IEC	61000-4-12	Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test
Test	IEC	61000-4-13	Electromagnetic compatibility (EMC) - Part 4-13: Testing and measurement techniques - Harmonics and interharmonics including mains signaling at a.c. power port, low frequency immunity tests
Test	IEC	61000-4-14	Electromagnetic compatibility (EMC) - Part 4-14: Testing and measurement techniques - Voltage fluctuation immunity test
Test	IEC	61000-4-15	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 15: Flickermeter - Functional and design specifications
Test	IEC	61000-4-16	Electromagnetic compatibility (EMC) - Part 4-16: Testing and measurement techniques - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
Test	IEC	61000-4-17	Electromagnetic compatibility (EMC) - Part 4-17: Testing and measurement techniques - Ripple on d.c. input power port immunity test Electromagnetic compatibility (EMC) - Part 4-17: Testing and measurement techniques - Ripple on d.c. input power port immunity test
Test	IEC	61000-4-18	Electromagnetic compatibility (EMC) - Part 4-17: Testing and measurement techniques - Ripple on d.c. input power port immunity test
Test	IEC	61000-4-19	Electromagnetic compatibility (EMC) - Part 4-19: Testing and measurement techniques - Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at a.c. power ports
Test	IEC	61000-4-2	Electromagnetic compatibility (EMC)–Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
Test	IEC	61000-4-20	Electromagnetic compatibility (EMC) - Part 4-20: Testing and measurement techniques - Emission and immunity testing in transverse electromagnetic (TEM) waveguides

Category	Publisher	Number	Title
Test	IEC	61000-4-21	Electromagnetic compatibility (EMC) - Part 4-21: Testing and measurement techniques - Reverberation chamber test methods
Test	IEC	61000-4-22	Electromagnetic compatibility (EMC) - Part 4-22: Testing and measurement techniques - Radiated emissions and immunity measurements in fully anechoic rooms (FARs
Test	IEC	61000-4-23	Electromagnetic compatibility (EMC) - Part 4-23: Testing and measurement techniques - Test methods for protective devices for HEMP and other radiated disturbances
Test	IEC	61000-4-24	Electromagnetic compatibility (EMC) - Part 4-24: Testing and measurement techniques - Test methods for protective devices for HEMP conducted disturbance
Test	IEC	61000-4-25	Electromagnetic compatibility (EMC) - Part 4-25: Testing and measurement techniques - HEMP immunity test methods for equipment and systems
Test	IEC	61000-4-27	Electromagnetic compatibility (EMC) - Part 4-25: Testing and measurement techniques - HEMP immunity test methods for equipment and systems
Test	IEC	61000-4-28	Electromagnetic compatibility (EMC) - Part 4-28: Testing and measurement techniques - Variation of power frequency, immunity test
Test	IEC	61000-4-29	Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
Test	IEC	61000-4-3	Electromagnetic compatibility (EMC)–Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
Test	IEC	61000-4-30	Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods
Test	IEC	61000-4-31	Electromagnetic compatibility (EMC) - Part 4-31: Testing and measurement techniques - AC mains ports broadband conducted disturbance immunity test
Test	IEC	61000-4-33	Electromagnetic compatibility (EMC) - Part 4-33: Testing and measurement techniques - Measurement methods for highpower transient parameters
Test	IEC	61000-4-34	Electromagnetic compatibility (EMC) - Part 4-33: Testing and measurement techniques - Measurement methods for highpower transient parameters
Test	IEC	61000-4-36	Electromagnetic compatibility (EMC) - Part 4-36: Testing and measurement techniques - IEMI immunity test methods for equipment and systems
Test	IEC	61000-4-4	Electromagnetic compatibility (EMC)–Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test
Test	IEC	61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
Test	IEC	61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
Test	IEC	61000-4-7	Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
Test	IEC	61000-4-8	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
Test	IEC	61000-4-9	Electromagnetic compatibility (EMC) - Part 4-9: Testing and measurement techniques - Impulse magnetic field immunity test
Test	IEC	61340-3-1	Electrostatics - Part 3-1: Methods for simulation of electrostatic effects - Human body model (HBM) electrostatic discharge test waveforms

Category	Publisher	Number	Title
Test	IEC	62153-10	Metallic communication cable test methods - Part 4-10: Electromagnetic compatibility (EMC) - Transfer impedance and screening attenuation of feed-throughs and electromagnetic gaskets - Double coaxial test method
Test	IEC	62153-11	Metallic communication cable test methods - Part 4-11: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables - Absorbing clamp method
Test	IEC	62153-12	Metallic communication cable test methods - Part 4-12: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of connecting hardware - Absorbing clamp method
Test	IEC	62153-13	Metallic communication cable test methods - Part 4-13: Electromagnetic compatibility (EMC) - Coupling attenuation of links and channels (laboratory conditions) - Absorbing clamp method
Test	IEC	62153-14	Metallic communication cable test methods - Part 4-14: Electromagnetic compatibility (EMC) - Coupling attenuation of cable assemblies (Field conditions) absorbing clamp method
Test	IEC	62153-15	Metallic communication cable test methods - Part 4-15: Electromagnetic compatibility (EMC) - Test method for measuring transfer impedance and screening attenuation - or coupling attenuation with triaxial cell
Test	IEC	62153-4	Metallic communication cable test methods - Part 4-0: Electromagnetic compatibility (EMC) - Relationship between surface transfer impedance and screening attenuation, recommended limits
Test	IEC	62153-4-1	Metallic communication cable test methods - Part 4-1: Electromagnetic compatibility (EMC) - Introduction to electromagnetic screening measurements
Test	IEC	62153-4-2	Metallic communication cable test methods - Part 4-2: Electromagnetic compatibility (EMC) - Screening and coupling attenuation - Injection clamp method
Test	IEC	62153-4-3	Metallic communication cable test methods - Part 4-3: Electromagnetic compatibility (EMC) - Surface transfer impedance - Triaxial method
Test	IEC	62153-4-4	Metallic communication cable test methods - Part 4-4: Electromagnetic compatibility (EMC) - Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method
Test	IEC	62153-4-5	Metallic communication cables test methods - Part 4-5: Electromagnetic compatibility (EMC) - Coupling or screening attenuation - Absorbing clamp method
Test	IEC	62153-4-6	Metallic communication cable test methods - Part 4-6: Electromagnetic compatibility (EMC) - Surface transfer impedance - Line injection method
Test	IEC	62153-4-7	Metallic communication cable test methods - Part 4-7: Electromagnetic compatibility (EMC) - Test method for measuring of transfer impedance ZT and screening attenuation aS or coupling attenuation aC of connectors and assemblies up to and above 3 GHz - Triaxial tube in tube method
Test	IEC	62153-4-8	Metallic communication cable test methods - Part 4-8: Electromagnetic compatibility (EMC) - Capacitive coupling admittance
Test	IEC	62153-4-9	Metallic communication cable test methods - Part 4-9: Electromagnetic compatibility (EMC) - Coupling attenuation of screened balanced cables, triaxial method
Test	IEC	CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus
Test	IEC	CISPR 16-1-2	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements

Category	Publisher	Number	Title
Test	IEC	CISPR 16-1-3	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-3: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Disturbance power
Test	IEC	CISPR 16-1-4	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements
Test	IEC	CISPR 16-1-5	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-5: Radio disturbance and immunity measuring apparatus - Antenna calibration sites and reference test sites for 5 MHz to 18 GHz
Test	IEC	CISPR 16-1-6	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration
Test	IEC	CISPR 16-2-1	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements
Test	IEC	CISPR 16-2-2	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-2: Methods of measurement of disturbances and immunity - Measurement of disturbance power
Test	IEC	CISPR 16-2-3	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements
Test	IEC	CISPR 16-2-4	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-4: Methods of measurement of disturbances and immunity - Immunity measurements
Test	IEC	CISPR 16-4-2	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-2: Uncertainties, statistics and limit modeling - Measurement instrumentation uncertainty
Test	IEC	CISPR 17	Methods of measurement of the suppression characteristics of passive EMC filtering devices
Test	IEC	CISPR TR 16-2-5	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-5: In situ measurements for disturbing emissions produced by physically large equipment
Test	IEC	CISPR TR 16-3	Specification for radio disturbance and immunity measuring apparatus and methods - Part 3: CISPR technical reports
Test	IEC	CISPR TR 16-4-1	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-1: Uncertainties, statistics and limit modeling - Uncertainties in standardized EMC tests
Test	IEC	CISPR TR 16-4-3	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-3: Uncertainties, statistics and limit modeling - Statistical considerations in the determination of EMC compliance of mass-produced products
Test	IEC	CISPR TR 16-4-4	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-4: Uncertainties, statistics and limit modeling - Statistics of complaints and a model for the calculation of limits for the protection of radio services
Test	IEC	CISPR TR 16-4-5	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-5: Uncertainties, statistics and limit modeling - Conditions for the use of alternative test methods
Test	IEC	CISPR TR 18-1	Radio interference characteristics of overhead power lines and high-voltage equipment - Part 1: Description of phenomena
Test	IEC	CISPR TR 18-2	Radio interference characteristics of overhead power lines and high-voltage equipment - Part 2: Methods of measurement and procedure for determining limits

Category	Publisher	Number	Title
Test	IEC	CISPR TR 18-3	Radio interference characteristics of overhead power lines and high-voltage equipment - Part 3: Code of practice for minimizing the generation of radio noise
Test	IEC	TR 61000-4-32	Electromagnetic compatibility (EMC) - Part 4-32: Testing and measurement techniques - High-altitude electromagnetic pulse (HEMP) simulator compendium
Test	IEC	TR 61000-4-35	Electromagnetic compatibility (EMC) - Part 4-35: Testing and measurement techniques - HPEM simulator compendium
Test	IEC	TR 61000-4-37	Electromagnetic compatibility (EMC) - Part 4-36: Testing and measurement techniques - IEMI immunity test methods for equipment and systems
Test	IEC	TR 61000-4-38	Electromagnetic compatibility (EMC) - Part 4-38: Testing and measurement techniques - Test, verification and calibration protocol for voltage fluctuation and flicker compliance test systems
Test	IEC	TS 60816	Guide on methods of measurement of short duration transients on low-voltage power and signal lines
Wireless	ETSI EN	300 220	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW
Wireless	ETSI EN	300 328	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2.4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering essential requirements
Wireless	ETSI EN	300 330	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 9kHz to 25MHz frequency range and inductive loop systems in the 9kHz to 30MHz frequency range
Wireless	ETSI EN	300 440	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 1GHz to 40GHz frequency range
Wireless	ETSI EN	301 489-17	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Wideband data and HIPERLAN equipment
Wireless	ETSI EN	301 489-3	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short Range Devices (SRD) operating on frequencies between 9kHz and 40GHz
Wireless	ETSI EN	301 893	Broadband Radio Access Networks (BRAN); 5 GHz high performance RLAN; Harmonized EN covering essential requirements
Wireless	ETSI EN	303 413	GPS receivers
Wireless	ETSI EN	303 417	Wireless Power Transfer

EMC STANDARDS ORGANIZATIONS

American National Standards Institute (ANSI)
www.ansi.org

ANSI Accredited C63
www.c63.org

Asia Pacific Laboratory Accreditation Cooperation (APLAC)
https://www.apac-accreditation.org/

Bureau of Standards, Metrology and Inspection (BSMI)
http://www.bsmi.gov.tw/wSite/mp?mp=95

Canadian Standards Association (CSA)
www.csa.ca

Comité International Spécial des Perturbations Radioélectriques (CISPR)
http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1298,25

China – Certification and Accreditation Administration (CNCA)
http://www.cnca.gov.cn/

FDA Center for Devices & Radiological Health (CDRH)
https://www.fda.gov/MedicalDevices/default.htm

Federal Communications Commission (FCC)
www.fcc.gov

Gosstandart (Russia)
https://gosstandart.gov.by/en/

International Electrotechnical Commission (IEC)
http://www.iec.ch

Institute of Electrical and Electronics Engineers (IEEE) Standards Association
https://standards.ieee.org/

IEEE EMC Society Standards Development Committee (SDCOM)
https://standards.ieee.org/develop/index.html

Industry Canada (Certifications and Standards)
http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf06165.html

ISO (International Organization for Standards)
http://www.iso.org/iso/home.html

Radio Technical Commission for Aeronautics (RTCA)
https://www.rtca.org

Society of Automotive Engineers (SAE) EMC Standards Committee
www.sae.org

SAE EMC Standards
http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVEES17

Japan – Voluntary Control Council for Interference (VCCI)
http://www.vcci.jp/vcci_e/

USEFUL EMC TESTING REFERENCES

RECOMMENDED BOOKS & JOURNALS

André and Wyatt
EMI Troubleshooting Cookbook for Product Designers
SciTech Publishing, 2014.
Includes chapters on product design and EMC theory & measurement. A major part of the content includes how to troubleshoot and mitigate all common commercial EMC test failures.

Archambeault
PCB Design for Real-World EMI Control
Kluwer Academic Publishers, 2002.

Bogatin
Signal & Power Integrity - Simplified
Prentice-Hall, 2018 (3rd Edition).
Great coverage of signal and power integrity from a fields viewpoint.

Hall, Hall, and McCall
High-Speed Digital System Design - A Handbook of Interconnect Theory and Design Practices
Wiley, 2000.

Joffe and Lock
Grounds For Grounding
Wiley, 2010.
This huge book includes way more topics on product design than the title suggests. Covers all aspects of grounding and shielding for products, systems, and facilities.

Johnson and Graham
High-Speed Digital Design - A Handbook of Black Magic
Prentice-Hall, 1993.
Practical coverage of high speed digital signals and measurement.

Johnson and Graham
High-Speed Signal Propagation - Advanced Black Magic
Prentice-Hall, 2003.
Practical coverage of high speed digital signals and measurement.

Kimmel and Gerke
Electromagnetic Compatibility in Medical Equipment
IEEE Press, 1995.
Good general product design information.

Mardiguian
EMI Troubleshooting Techniques
McGraw-Hill, 2000.
Good coverage of EMI troubleshooting.

Mardiguian
Controlling Radiated Emissions by Design
Springer, 2016.
Good content on product design for compliance.

Montrose
EMC Made Simple
Montrose Compliance Services, 2014.
The content includes several important areas of EMC theory and product design, troubleshooting, and measurement.

Morrison
Digital Circuit Boards - Mach 1 GHz
Wiley, 2012.
Important concepts of designing high frequency circuit boards from a fields viewpoint.

Morrison
Grounding And Shielding - Circuits and Interference
Wiley, 2016 (6th Edition).
The classic text on grounding and shielding with up to date content on how RF energy flows through circuit boards.

Morrison
Fast Circuit Boards
Wiley, 2018.
Morrison explains how signals propagate via transmission lines and why it's so important to include reference planes for every signal layer.

Ott
Electromagnetic Compatibility Engineering
Wiley, 2009.
The "bible" on EMC measurement, theory, and product design.

Paul
Introduction to Electromagnetic Compatibility
Wiley, 2006 (2nd Edition).
The one source to go to for an upper-level course on EMC theory.

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