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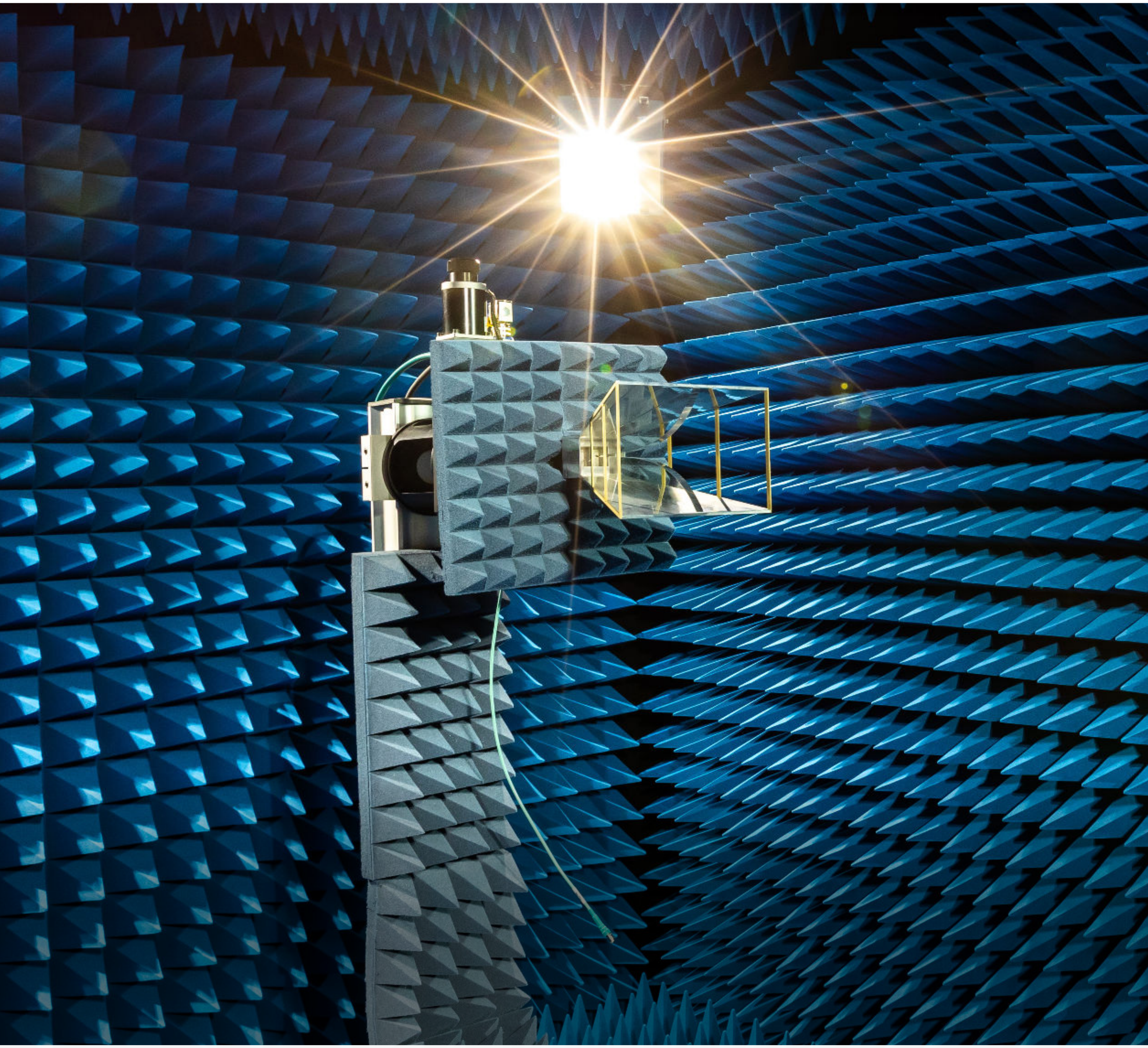
2023 EMC TESTING GUIDE



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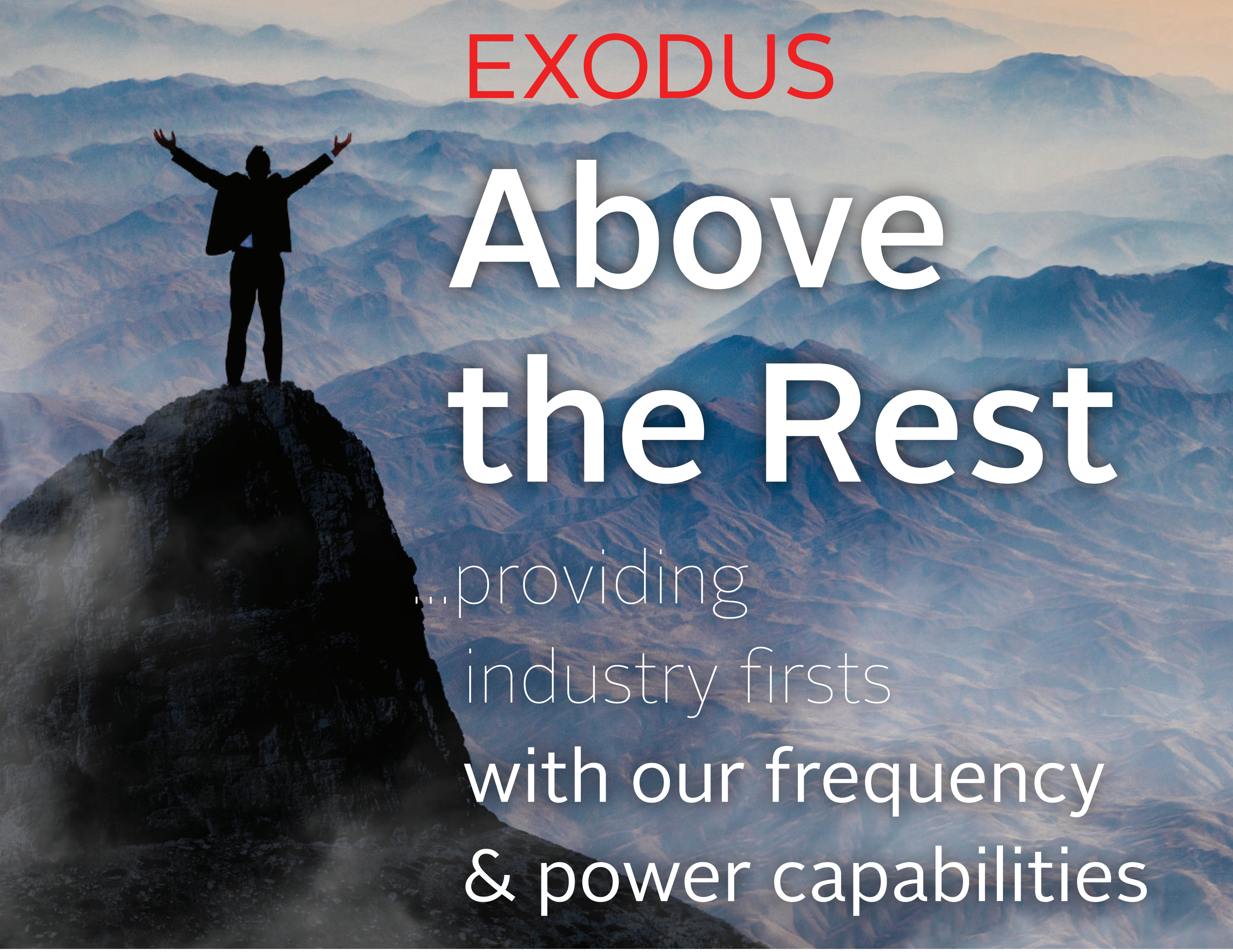
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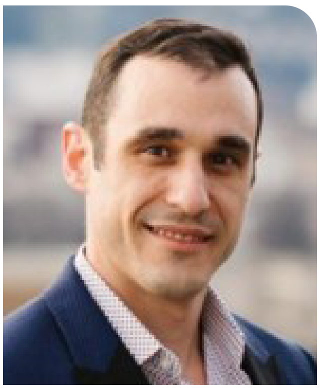
TECHNICAL EDITORS SPOTLIGHT



Many areas of electronics design, testing, manufacturing, and simulation can seem esoteric to newcomers and to young people seeking to start their careers in the electronics industry. I remember when I first started working in the electronics industry as a young, hungry consultant with zero past industry experience.

I had just left academia, and during the prior half-decade I spent a significant amount of time working on topics in optics and lasers. After finding myself disillusioned with university politics, and having no appetite for the adjunct treadmill, I opted to forge my own path in the professional world. The transition for me was easier than most, but I was helped along by great industry publications like *Interference Technology* and its sister publication, *Electronics Cooling*. Knowledge is power, and I was a voracious reader of these publications as I started to make my way into the highly competitive electronics industry.

While not the main focus of my daily work designing electronics, electromagnetic interference (EMI) and electromagnetic compatibility (EMC), are evergreen topics in electronics design and testing, and they are the focus of *Interference Technology*. Any product that is introduced into the market must comply with specific regulatory standards relating to these areas. While technology may be getting more advanced, with more data and features packed into smaller spaces, these two basic areas still pervade electronics development. Even as the tech gets more advanced, the same old compliance and noise problems still arise, and any company, startup, or innovator with a great idea for a new product might see their hopes dashed by a failed compliance test.

Interference Technology is one of the few publications that aims to arm engineers with the knowledge and skills they need to overcome these challenges, get to market faster, and build better products. In this upcoming issue, as has been the case in past issues, we revisit fundamental yet critical concepts in test and measurement that apply to systems engineers, test engineers, PCB designers, component designers, and EMC compliance professionals. This issue's educational opportunities highlight the experience and knowledge of our seasoned editorial board members, as well as important concepts in probes for test and measurement, and some of the most common errors observed during compliance testing.

As always, we editors welcome your feedback and invite you to submit your own article to be included in a future issue.

Zachariah Peterson

TECHNICAL EDITORIAL BOARD MEMBERS

Meet the 2023 Editorial Board

PATRICK ANDRE | iNARTE CERTIFIED MASTER DESIGN ENGINEER

Patrick G. André received his physics degree in 1982 from Seattle University, with post graduate work in Electrical Engineering and Physics. He has worked in the Electromagnetic Compatibility (EMC) field over 35 years. He is an iNARTE Certified Engineer in both EMC (Electromagnetic Compatibility – EMC-001335-NE) and ESD (Electrostatic Discharge – ESD-00078-NE). He was honored as an iNARTE Certified Master Design Engineer - EMCD-00053-ME.

He has worked in the military and aerospace environment for his entire career and worked with commercial electronics for over 25 years. Projects worked on vary from semiconductors, satellite equipment, industrial and test equipment, cellular installations, to writing the procedures and reports, and performing or supervising EME testing of many panels for the flight deck of several aircraft. He has successfully worked with, and given input to, all branches of the military, NASA, the RTCA, the FAA, as well as several of their subcontractors. He has a strong ability in the test, measurement, and troubleshooting of EMC, and is president of André Consulting, Incorporated.

He is a third-party auditor for local governments and has provided expert opinions on the use of cellular transmitters, including health and safety concerns. Patrick has published numerous articles for a variety of magazines. He is the co-author of EMI Troubleshooting Cookbook for Product Designers.

Patrick has been a senior member of the IEEE EMC Society which he joined in 1984, serving as chairman, vice chairman, secretary, and arrangements chairman of the Puget Sound Section, and has received The Legends of the IEEE Seattle Section Award in 2010. He also been on the Board of Trustees of the Seattle Gilbert and Sullivan Society where he also works as the sound engineer and. He enjoys audio and video recording musical groups, mostly in the Seattle area, and has engineered and mastered several CD's. And when he is not busy with all this, he can be found hiking somewhere with his camera.

GHERY PETTIT | PRESIDENT, PETTIT EMC CONSULTING LLC

Ghery S. Pettit received the BSEE degree from Washington State University in 1975. He has worked in the areas of TEMPEST and EMC for the past 47 years. Employers were the US Navy, Martin Marietta Denver Aerospace, Tandem Computers and Intel Corporation, prior to retiring from industry in 2015 and becoming an independent consultant.

Mr. Pettit is presently serving as Chair of CISPR SC I and is one of CISPR's representatives on the Advisory Council on EMC (ACEC) within the IEC. He has been involved in CISPR activities since 1998, both as a member of the US Technical Advisory Groups to CISPR SC G and CISPR SC I and as an active member of CISPR SC I and its maintenance teams, CISPR SC I MT7 (CISPR 32 maintenance) and CISPR SC I MT8 (CISPR 35 maintenance). He is also a member of the working groups preparing the next editions of ANSI C63.4, C63.9 and C63.16.

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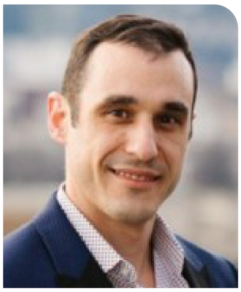


ZACHARIAH PETERSON | NORTHWEST ENGINEERING SOLUTIONS

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 President 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.

DAVID A. WESTON | iNARTE EMC ENGINEER

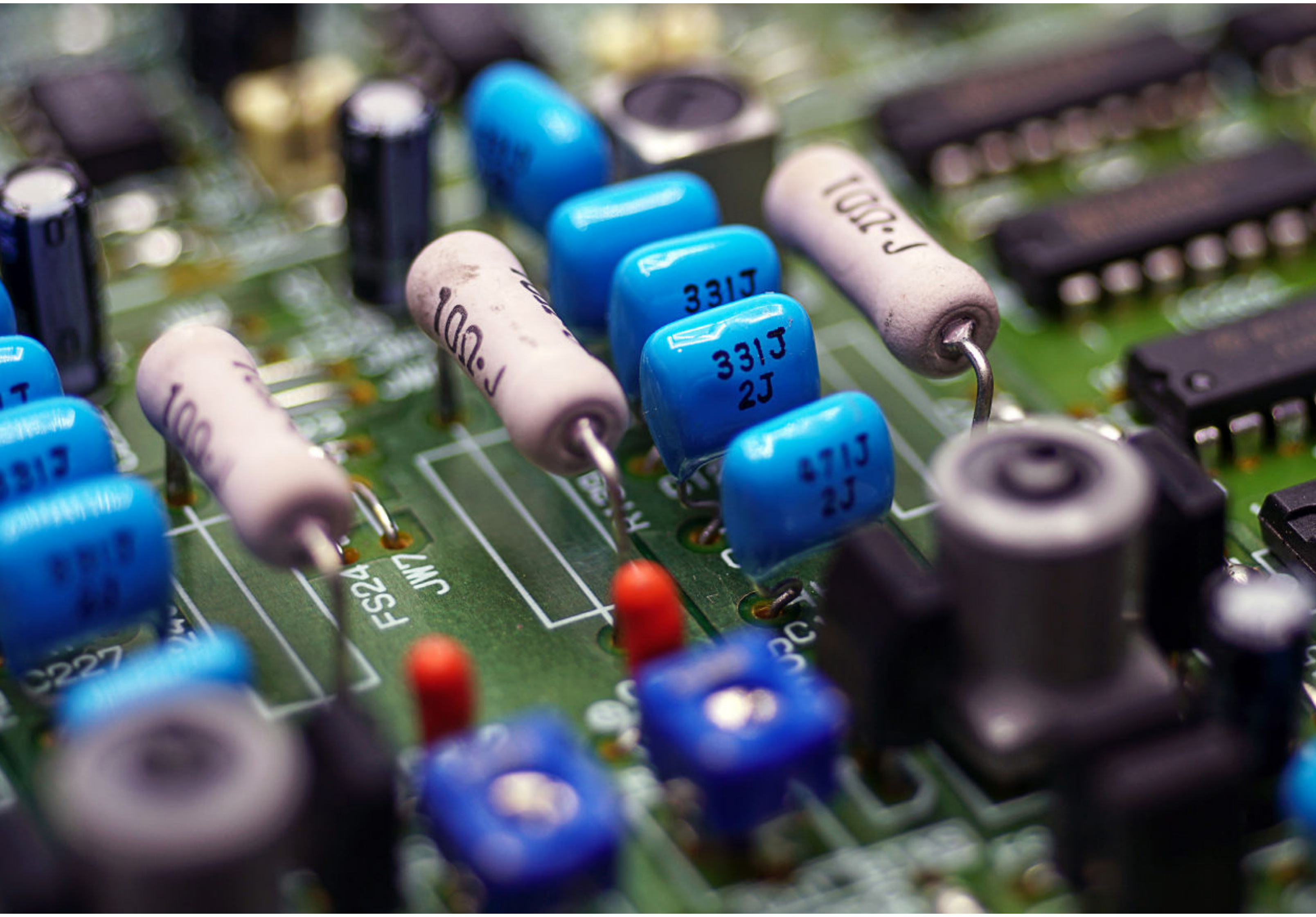
David A. Weston is an electromagnetic compatibility (EMC) consultant and certified National Association of Radio and Telecommunications Engineers (iNARTE) EMC engineer at EMC Consulting Inc. Merrickville, Ontario, Canada. A life member of the Institute of Electrical and Electronics Engineers, Weston 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.

2023 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		
	APITech	www.apitech.com			X			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		
	BHD Test & Measurement	https://bhdtm.com/	X							X							X		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															

	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
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			
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/us/en								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				
	MILMEGA	www.ametek-cts.com	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		

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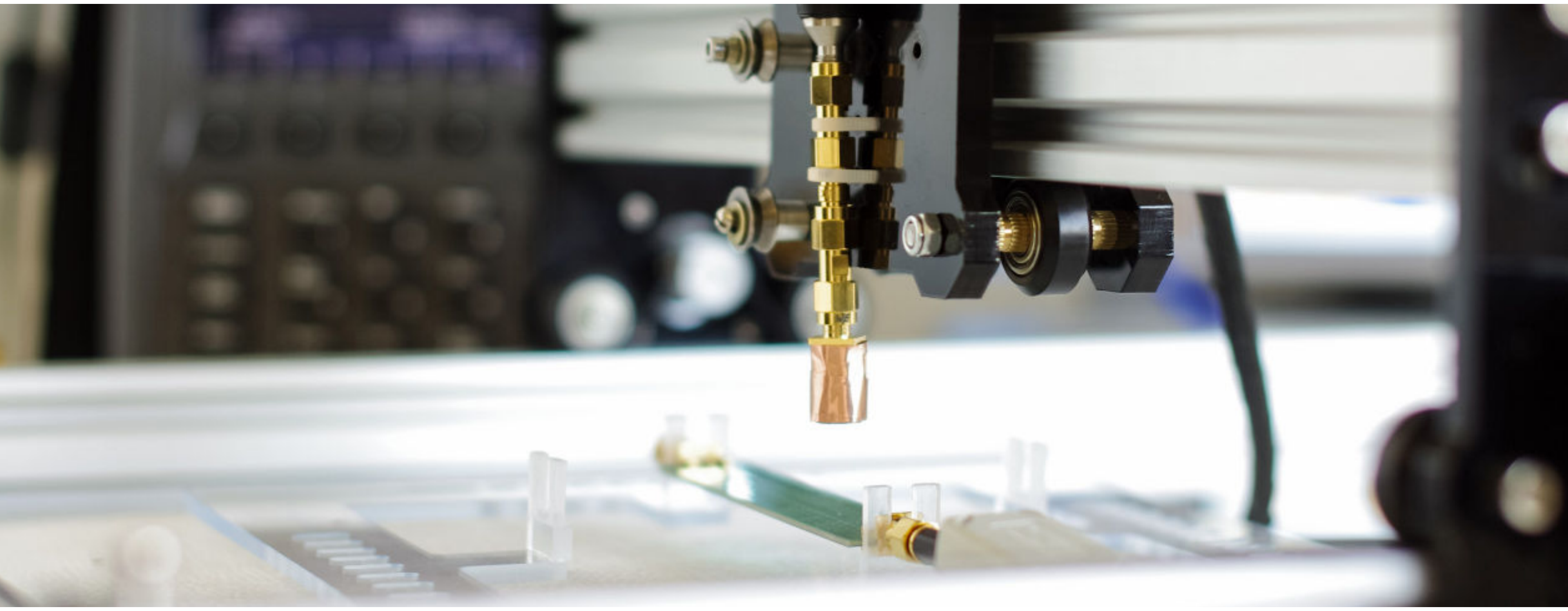
R	Radiometrics	www.radiomet.com																				X	
	R&B Laboratory, Inc.	www.rblaboratory.com																				X	
	Retlif Testing Laboratories	www.retlif.com																			X	X	X
	RECOM Power GmbH	www.recom-power.com									X										X		
	RIGOL Technologies	www.rigolna.com	X							X							X	X		X			
	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		
	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/leasing/	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						
	TPI	www.rf-consultant.com					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								

COMMON ERRORS IN, AND SOME GUIDELINES TO, EMI TESTING

David A Weston
EMC Consulting Inc



Common errors have been seen in EMI testing over a great number of years and the guidelines used for successful EMI Testing

GENERAL ERRORS APPLICABLE TO MOST TEST

Inadequate testing methods and flagging all possible failures. *Reference 3* 9.4.11.2.1 details the correct method of functional testing the Equipment Under Test.

The shielding of power cables must remain unshielded. Aerospace and avionic equipment power input cable shielding are often prohibited. MIL-STD 461F and above prohibits the use of shielded cables unless the platform on which the equipment is to be installed shields the Power Bus from the point of origin to the load. However, MIL-STD-461F specifically states that input (primary) power leads, returns, and wire grounds shall not be shielded.

Not including 2m of power cables and interconnecting cables routed parallel to the front edge of the setup. This requirement is not applicable if the cables in the EUT installation are shorter than 2m in which case the installation length shall be used. See *reference 3* for other notes on cables 9.6.4 and general test guidelines.

Forgetting to apply the required modulation to the test level in a susceptibility/immunity test.

Having poor or non-existent grounding of the 10uF capacitor, LISN, and the EUT. This may reduce common mode currents and allow the EUT to pass whereas with proper grounding it may fail.

Many of the tests require a system check prior to testing and sometimes these tests are omitted.

If an EUT fails a susceptibility/immunity test failing to reduce the test level to determine the level at which the EUT passes as this provides an indication of how much improvement is required. It is surprising how often this step is missed but it is very useful in solving the problem.

COMMON ERRORS IN RADIATED EMISSION MEASUREMENTS MADE IN A CHAMBER

1)
The ambient inside the shielded room is too high due to RF common mode current flow on signal interconnections or primary power cables. The ambient must be at least 6dB below the applicable limit.

This is typically sourced by functional test equipment or Electrical Ground Support Equipment (EGSE) located outside the room. The source may also be due to a high electromagnetic ambient outside the room coupling to cables entering the room. The ambient may be due to high-power TV or radio transmitters or wireless internet.
Solutions include better shielding of the interface cables, the addition of signal filters, and the application of ferrite beads (baluns,) as shown in *references 1* and *3*. Unshielded cables would typically need a filtered connector, depending on the signal level. For low-level signals, such as analog, a filtered connector as well as a shielded cable may be required.

Although ferrite baluns on cable can very effectively reduce the RF current flow, when the source of the current is an RF field incident on the baluns then it may result in the cable becoming a more effective receiving antenna and the current instead increase.

Reference 3 describes these steps in more detail. Sometimes the power amplifier is located in the room, to reduce the length of and thus the attenuation of the cable between the antenna and the power amplifier. In this configuration, feedback between the antenna and the signal input to the power amplifier can result in maximum output from the power amplifier. Therefore first test the setup with the EUT outside of the room using an extended frequency range. Use the monitoring antenna/field sense device to measure the level of the radiated field. If feedback occurs use a cable with more shielding effectiveness or add a braid over the existing cable with the braid clamped to the connector shell at both ends.

One good solution to coupling through the chamber wall is the use of filtered D-type adapters on bulkhead-mounted D-type connectors. These adapters may also be mounted on the connectors on the test equipment/EGSE, although the connection in the shielded room is almost certainly better.

It is also possible to mount filter components between back-to-back connectors.

If filter connectors are not possible, e.g. cables coming through a stuffing tube, then the shields should be terminated on the wall of the stuffing tube with ferrite cores (baluns) between the external test equipment/EGSE and the termination of the shields to the stuffing tube.

Reference 1 describes the application of the baluns and filter adapters. The stuffing tube is typically designed to be a waveguide below cut-off and will work as such with fiber optic cable or non-metal reinforced rubber or plastic air or water hoses. However, it is a mistake to believe that the waveguide below the cut-off function works with shielded cables or it contains internal conductive wires. Even cables that contain tap water will conduct RF currents into the room due to the conductivity of tap water.
To keep RF currents out of the room they must be shunted to the room wall at the point of entry. Another source is a noisy power supply, typically switching, outside of the room which is not sufficiently attenuated by the power line filters mounted on the shielded room wall. Use a linear power supply.

2)
Use of incorrect measurement bandwidth at a change in the frequency measured, missing a repeat measurement with a different antenna polarization, exceeding the calibration frequency range of antennas or preamplifiers.

3) Non-representative test setup, use of a different type of cable than the delivered type, non-representative EUT, different software than the delivered, addition of aluminum foil, copper tape, or braid over cables that are not to be shielded.

4)
The argument that cable-generated emissions are not the concern of the manufacturer of the EUT when the cable harness is supplied by the customer. Regardless of the type of cable (shielded or unshielded), it is the EUT that injects the noise onto the cable and it is the manufacturer of the EUT who must reduce emissions at the source or persuade the customer to change their cable type. If a manufacturer believes the emission limit will not be met with a customer-supplied unshielded cable, and circuit modification will be a problem, then the customer may allow a deviation or waiver. In equipment designed for use in space, if meeting requirements means that the equipment is removed from the spacecraft and the frequency and level of emission will not result in EMI, then a waiver is often allowed.

5)
Software-controlled measurements have a number of potential problems. The majority of these programs do not allow multiple sweeps using peak or maximum hold, but instead take data over a single sweep, a snapshot in effect. Emissions often vary in amplitude significantly from one sweep to the next. With a snapshot of the data, there is no guarantee that the worst-case level has been captured. The argument has been made that this has become an industry standard, but it rarely results in a

worst-case measurement, which is the goal. If broadband (BB) and narrowband (NB) emission measurements are required, then emissions are characterized to determine if the BB or NB limit applies. Four different techniques may be used to determine this, and the software normally only applies one which may lead to an incorrect assessment. When confronted, some manufacturers admit to the deficiency in their programs.

6)
Room resonances.
If a chamber with the minimum absorber as required in MIL-STD-461 or DO-160 is used, then reflections and resonances will still occur. Thus measurements made at one facility may differ strongly from those made at another. *Reference 2* shows the variation seen from one facility to another. Explaining the discrepancy to a customer, who is less familiar with this issue, can be a problem as the assumption may be made that the customer's measurement is the correct one. Ideally, measurements made in a chamber will have a good correlation to those made on an Open Area Test Site (OATS) which has met the OATS requirements (see errors in ATS measurements). *Reference 3* describes the design of a room that does correlate well to an OATS, and *reference* 2 shows the type of absorber that is most likely to achieve a good correlation.

7)
Not excluding transmitting antennas.
Even when not transmitting the fundamental broadband noise generated by the transmitter may result in a failure in low-level emission limits. Transmitting antennas should be replaced by a shielded load resistor.

COMMON ERRORS MADE IN RADIATED EMISSION MEASUREMENTS ON AN OPEN AREA TEST SITE (OATS)

The correlation between OATS is often extremely poor. The correlation between two test sites with measurements made on the same EUT with the same software, and cable orientation was up to 10.4dB from 212 to 216MHz, *references 4* and *5*.

In one case, a consistent 26dB of difference was seen between one site and another. Only after the site with the higher level measurement was asked to use a signal generator to check the test equipment was the problem found. The instrument had a switchable 26dB preamplifier, and the inclusion or otherwise of the preamplifier was not indicated on the front panel.

This illustrates the importance of making the test facility perform a sanity check on the antennas, cables, and measuring equipment. A number of times a cable instead of going open circuit had a significantly high attenuation which could be easily missed. In an OATS measurement, the use of the known levels from local FM radio stations is a useful check on the measurement system.

Emission close to and masked by an ambient; the frequency of emissions from a EUT should be characterized in a shielded room before measurements on an OATS. If an ambient seems to be at one of the characterized EUT emissions frequencies, narrowing the frequency sweep may enable the display of the emissions to be separated. Using a narrower measurement bandwidth will reduce the displayed width of the emissions and help in the differentiation. If the ambient is broadband and the EUT narrowband narrowing the measurement bandwidth may reduce the broadband level to below the narrowband level.

An emission that is harmonically related (from the same source) should be measured and the measurement bandwidth reduced to that used in the initial measurement. Although not ideal, if the emission amplitude of the harmonic is reduced then the amplitude of the out-of-specification emission can be corrected accordingly.

The configuration of the EUT should be varied to maximize emissions. Interconnecting cables should be of the type and length which will be delivered. However, it makes no sense to orient cables in a configuration that will never be used. The correct configuration is shown in the test requirement. One test facility incorrectly had cables oriented vertically above the test then horizontally above the EUT and then back to the table which is incorrect.

COMMON ERRORS MADE IN CONDUCTED EMISSION MEASUREMENTS

Many of the errors described for radiated emissions apply to conducted emissions.

Most of the measurements are made with a Line Impedance Stabilization Network (LISN), which supplies a controlled and calibrated impedance. A separate LISN may be used for the power and the power return or a LISN supply both. Measurements are made at a measuring port. When the measuring instrument is connected to one port, then it is important to remember to terminate the unused port with a 50-ohm termination. When the test limit is in dBuA then the measurement is of the noise current measured using a current probe. It is important that the current probe is at the location described in the test requirement. For MIL-STD 461 CE01/CE03 it is at the 10uF capacitor, which is used instead of the LISN. For DO-160 it is 5cm from the backshell of a connector on the EUT. The current probe should not be contacting the metal ground plane on the table but rather be lifted up on an insulator.

Leaving the current probe around a power cable in a conducted emissions test and switching on or off the power supply, as the resultant spike can damage the measuring instrument. For this reason, try to avoid measurements with 0dB input attenuation.

Not grounding the measuring instrument to the ground plane with the use of an isolation transformer. Following this rule will keep ground currents, typically at the harmonics of the AC power, from corrupting the test.

If a preamplifier is used, make sure that it is not in compression due to a high-level emission. This emission may be outside of the measurement bandwidth, e.g. 50Hz, 60Hz, or 400Hz power line frequencies. Add a 6dB attenuator to the input of the preamplifier. If the measured level does not reduce by 6dB then the preamplifier is compressing and may not be needed.

COMMON ERRORS IN MIL-STD-CS101, DO-160 AUDIO FREQUENCY CONDUCTED SUSCEPTIBILITY, DIFFERENTIAL MODE, SECTION 18, OR VOLTAGE SPIKE, SECTION 17

All these tests use an injection transformer inserted in series with the power line to inject the test level. Most EUTs have a switching power supply at the input power line which generates transient currents. The secondary of the injection transformer has an inductance of 1.55mH. If this inductance were seen by the EUT then a transient may set up a resonance due to this inductance and the capacitor at the input of the EUT power input. This can result in very high voltages in the filter and possible damage.

To avoid this the following steps should be followed to maintain a low input impedance at all times:

To power up:
With the EUT unpowered,

1. Remove the signal from the input of the audio power amplifier.
2. Short transformer secondary.
3. Power on the power amplifier and the EUT.
4. Remove the short at the transformer secondary.
5. Connect a signal generator and proceed with testing.

To power down:

1. Disconnect the signal generator at the input of the power amplifier.
2. Short transformer secondary.
3. Power down EUT and power the amplifier.

As the frequency is scanned it will hit the resonant frequency of the EUT input power line filter and very high currents may flow, to the extent that components may heat up and become unsoldered. Although the test method may specify a maximum input power level for the test this may not be sufficiently low enough to protect the EUT. It is known that at least two commercial test facilities avoid dwelling at the resonant frequency. It is important to inform the customer of this possibility and that even though the test destroys the EUT power input the test has been correctly performed.

This warning should be given to the customer for all susceptibility tests.

A consensus on the pass/fail criteria of the test may not have been decided by the customer. For example, a few white spots on a display or some minor distortion may be acceptable, whereas multiple images or major distortion is almost certainly not. Similarly, some bit error rate in data communication may be acceptable whereas total loss in communication is not. The pass-fail criteria should be agreed on prior to testing.

In conducting susceptibility tests on input power, monitor the test level at the wrong location. It must be across the EUT. It must not be across the injection transformer primary, secondary, or at the output of the power amplifier.

COMMON ERRORS MADE IN RADIATED SUSCEPTIBILITY TESTING IN A CHAMBER

1)
Chamber resonances can result in either very low or very high electric fields at the EUT. If the field at the EUT is low then the power amplifier may not have sufficient power to generate the specified field. Or if the field is achieved at a location away from the EUT such as down the length of the cable then the field may be very high at this location. In the section on common errors in radiated emission measurements described chambers that have very uniform fields. Although a field uniformity test may be a requirement. Some of the test locations are deleted and these may be at very high levels.

2)
A consensus on the pass/fail criteria of the test may not have been decided by the customer. For example, a few white spots on a display or some minor distortion may be acceptable, whereas multiple images or major distortion is almost certainly not. Similarly, some bit error rate in data communication may be acceptable whereas total loss in communication is not. The pass-fail criteria should be agreed on prior to testing.

3)
The test frequency range may cover 14kHz to 18GHz or above. Although the test levels and field strength should be tailored to the electromagnetic ambient the EUT will operate in this may not be known or EUT will be operated at several locations. If the EUT contains receiving antennas the EUT will not be operated in locations where very high levels of in-band frequencies exist. For this reason,

and to avoid damage to the front end of the receiver the in-band and close-to-in-band test frequencies should not be included in the radiated susceptibility test, or the antenna be replaced with a termination.

4)
Personnel should not be allowed to view displays, indicator lights, or meters during a radiated susceptibility test due to the potential danger.

Mirrors may be set up so that the EUT can be viewed through the waveguide below the cut-off. Alternatively, a camera that is immune to the test field and is connected via a fiber optic to a display outside of the chamber. If a voltage has to be viewed then a meter may be enclosed in a metal enclosure with a wire mesh face for viewing and short wires to the EUT However connecting the meter to the EUT may result in an incorrect measurement.

5)
Coupling between the signal generator input cable and the power amplifier output cable before it enters the chamber or between the transmitting antenna and the input cable to the power amplifier when the amplifier is located inside the chamber may result in positive feedback and the generation of very high E fields. Always monitor the E-field level outside of the test frequency, as well as, within it to detect this feedback.

6)
Non-representative test setup, use of a different type of cable than that delivered with the EUT, the addition of aluminum foil, copper tape, or braid over cables which will not be delivered with these.

7)
Missing a repeat measurement with a different antenna polarization, exceeding antenna or power amplifier calibration frequency range.

All of these problems can be avoided by the use of a checklist of the test, with tick boxes to ensure a test has not been missed.

8)
The argument that cable-induced susceptibility is not the concern of the manufacturer of the EUT when the cable harness is supplied by the customer. Regardless of the type of cable, shielded or unshielded, it is the EUT circuit/s that are susceptible to the noise induced on the cable and it is the manufacturer of the EUT who must harden the circuit to make it immune or persuade the customer to change his cable type.

COMMON ERRORS MADE IN THE CS06 TRANSIENT AND OTHER TRANSIENT TESTS

Not applying the relaxation on the CS06 test level for equipment and subsystems which contain Varistors, Transorbs, or similar transient protection devices. The relaxed test level is at the maximum safe level for the device. However, the maximum transients possible on the power line should be analyzed or measured to ensure that these are not above the device's safe level.

Conducted susceptibility spike test; When testing ac power the spike position shall be moved over a full 180 degrees of the AC waveform on either side of the zero crossing point.

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RADIATED EMISSIONS TESTING

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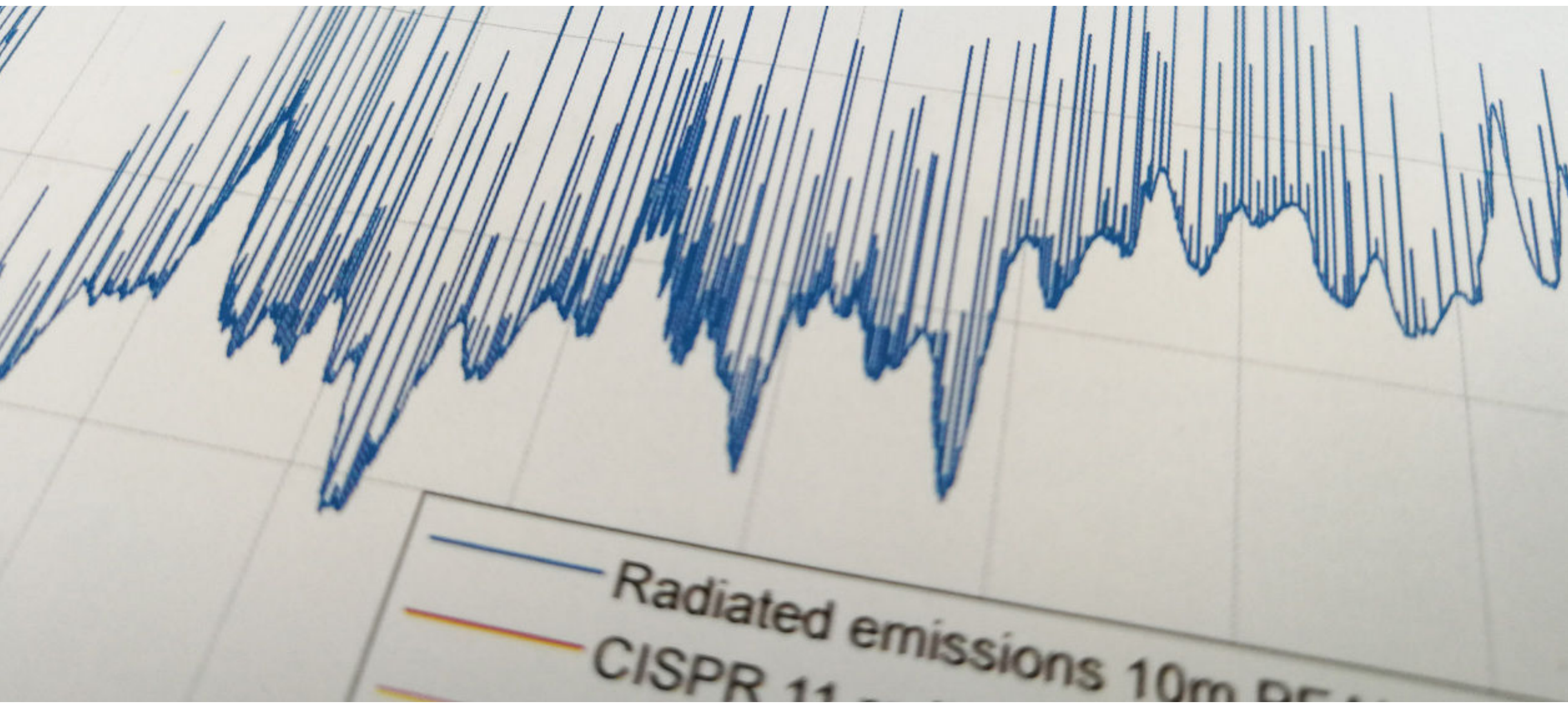

INTRODUCTION

Radiated emissions testing is only one part of emissions testing. CISPR 32, the document that lays out limits and methods of measurement for emissions (radiated and conducted) for Information Technology Equipment (ITE), broadcast receivers and multimedia equipment is 120 pages in length. ANSI C63.4 deals with only the testing part (limits are contained in a separate regulation) and likewise is a long (and getting longer in the next version) document. Other standards may provide different measurement techniques. This article will deal only with radiated emissions, and then only in a summary fashion, as it relates to CISPR 32 (and ANSI C63.4).

Radiated emissions testing can be broken down into three basic parts: first, is a preliminary test, second is a final test, and the last part is data reduction and comparison with the applicable limits.

PRELIMINARY TEST

This test (or series of tests) is designed to serve a few different purposes. The first is to determine the appropriate Equipment Under Test (EUT) configuration and layout in the test laboratory. The second is to determine the final configuration of the system under test and possibly frequencies to be measured in the next step (final test). The third is part of the first – determine the size of the system and location of the antenna so that the measurement distance can be determined per the standard.

The EUT configuration is one that allows the EUT to function as intended. This may be the EUT by itself in the case of a simple EUT, or it may require the use of additional equipment and cables to allow the EUT to exercise various ports relating to the EUT. These may include ports, such as those needed for external devices such as a monitor, printers, or other devices. The EUT may be a module, in which case there are specific requirements on how it is to be incorporated into a complete system in order to be tested.

CISPR 32 uses a system called “ports” to determine what tests need to be performed. These are different than what a user may regard as ports, in that the EUT as a whole may be regarded as a port (enclosure port), where the user does not think of the enclosure as being a port. This is something that the laboratory or the organization performing the test must be aware of.

For radiated emissions testing (the only port called out for this test is the “enclosure port”) this test would be performed using a less rigorous set of antenna heights and turntable positions. This would be repeated as necessary to find the worst-case configuration for the EUT (arrangement, cable positions, etc.) and to potentially identify the frequencies to be measured in the final test. Where some regulators only require the six worst-case signals to be reported, others may want more. The reader should be aware of the requirements in every country in which the product will be marketed.

CISPR 32 does not call out a separate preliminary test and a final test. However, it may be necessary to consider both, especially if the lab is such that a 3-meter RF semi-anechoic chamber is used for preliminary testing from 30 MHz to 1 GHz and a 10-meter Open Area Test Site (OATS) is used for final testing over this frequency range. Preliminary testing, and a version of the final tests, were performed in a 3-meter RF semi-anechoic chamber and final tests were performed at a 10-meter OATS. If a signal was blocked by an ambient signal at the OATS, then the 3-meter reading in the chamber was used for that frequency. Typically the 20 or so worst frequencies found in the chamber were re-measured at the OATS. As one backed off from 3 meters (in the chamber) to 10 meters (OATS) the relative positions of the signals might change, so the 6 worst in the chamber might not be the 6 worst at the OATS. Twenty frequencies were found to be more than enough to ensure that the 6 worst were captured at the OATS.

How do you determine the measurement distance? *Figures C.1* and *C.2* of CISPR 32 show sample systems under test where 3 units are labeled as “AE/EUT”. AE means “Auxiliary Equipment”, not the EUT, but required to allow the EUT to function. The figure labels all three (there may be more or less) as AE/EUT so that no particular device must be in one specific location. A circle is drawn that encloses all the AE/EUT boxes and interconnecting cables. This circle is considered to be the boundary of the EUT and is the point from which the distance to the antenna is measured. Note that the center of this circle is the center of the turntable, not the center of the system containing the EUT. The figure in CISPR 32 shows it as the center of one of the boxes on the turntable. This may or may not be the actual case. Where on the antenna do you measure from to determine the measurement distance? From the reference point used for the antenna calibration. This point is typically clearly marked on a log periodic dipole array antenna and generally is the center point of a biconical antenna.

Note that the measurement does not necessarily have to be performed at 3, 5, or 10 meters. There is a formula that allows computation of the limit at distances other than the distances shown in *Tables A.2* to *A.7* (assuming that the test facility has been validated at the distance to be used). This new limit is given using:

$L_2 = L_1 + 20 \log(d_1/d_2)$

Where:

L_2 is the new limit at distance d_2
L_1 is the given limit at distance d_1

When using this formula, the test report shall show the limit L2 and the actual measurement distance d2. Measurements shall be performed at the 10-meter distance (up to 1 GHz) and the 3-meter distance (above 1 GHz) whenever possible and shall be used as the basis for calculations of limits at other measurement distances.

Another issue to deal with during preliminary testing is the EUT cycle time and the measurement dwell time. The dwell time normally would be longer than the EUT cycle time but may be limited to 15 seconds.

Annex E (which is informative, not normative) provides a list of issues that should be considered during a prescan test (called a preliminary test in this article).

FINAL TEST

This test may be performed in a qualified RF semi-anechoic chamber or a qualified OATS or FSOATS, depending on the frequencies to be measured. Regardless of the frequency range, the following is appropriate.

The system under test, including the EUT, auxiliary equipment (AE) and cables shall be configured as shown during the preliminary tests to be the worst case. Any software needed to exercise the EUT during the test needs to be loaded and run.

Two options exist for the test lab during the final test. The EUT may be tested over the entire frequency range for the test and the 20 or more worst-case signals fully measured. The second option will likely be used when a 10-meter RF semi-anechoic chamber isn’t available, but a 3-meter chamber is available, along with a 10-meter OATS. In this case, a full final test would be performed in the chamber at 3 meters and the final 20 or so frequencies found during this test would be re-measured at the OATS. Only re-measuring the final 6 frequencies at the OATS would be a poor choice as the worst 6 signals found at 3 meters might not be the same as the 6 found at the OATS. The author recommends that if a full test is performed at an OATS that 10 or more signals be reported, rather than the 6 that some regulators call out as this provides a safety margin for the lab. The same goes for testing in a 3-meter RF semi-anechoic chamber, followed by testing at the worst cast frequencies at 10 meters at an OATS. 20 or more frequencies are recommended in this case for the reason pointed out above and the fact that one or more of the frequencies identified in the chamber may be blocked by ambient signals at the OATS. The author found a number of years ago that a certain regulator "required" measurements at 10 meters, but would accept a few measurements at 3 meters when the OATS data was blocked by ambient signals. Having more than 6 signals reported eased this relaxation of the requirements.

A final test, regardless of the test facility requires that the EUT be fully exercised by the software and that the EUT's emissions be fully evaluated over the full range of turntable positions (0 to 359 degrees), antenna heights (1 to 4 meters) and both polarities (horizontal and vertical).

DATA REDUCTION AND COMPARISON WITH THE LIMITS

The first part of this section (data reduction) needs to be performed for each signal during preliminary and final testing. While the receiver reads the voltage at its input terminal, the limit (discussed later) is a field strength. The conversion needs to consider the loss in the cables, any pre-amplifier gain, and any antenna factors that convert field strength to voltage. These are simply added together as follows:

$\text{Field Strength}_{\text{dBiV/m}} = \text{Received Voltage}_{\text{dBuV)}} + \text{Cable Loss}_{\text{dB}} – \text{Preamplifier Gain}_{\text{dB}} + \text{Antenna Factor}_{\text{dB/m}}$

Where field strength is the final result, received voltage is the voltage at the input of the receiver, cable loss is the frequency-dependent loss over the length of all cables used in the measurement, preamplifier gain is the frequency-dependent gain of the preamplifier (if used) and the antenna factor is the frequency-dependent factor for that antenna that allows mathematical conversion of the received signal strength to the voltage at the antenna terminals.

This final field strength would be recorded along with the distance between the antenna and EUT, turntable position, antenna height, and polarity for each final signal received from the EUT.

The current edition of CISPR 32 requires that the laboratory compute their measurement instrumentation uncertainty and compare it with a value provided in CISPR 16-4-2 as amended. If their computed measurement instrumentation uncertainty is less than or equal to that value provided in CISPR 16-4-2 (called U_{CISPR} in the standard) then the limit provided in *Tables A.1, A.2, A.3, A.4, A.5, A.6* or *A.7* as applicable are compared against the recorded data directly and a pass/fail determination is made. If the lab's computed measurement equipment uncertainty is greater than the value of U_{CISPR} provided in CISPR 16.4.2 as amended, then the difference between the lab's computed measurement uncertainty and U_{CISPR} is added to the recorded data and that result is compared with the limit that is applicable to the test and a pass/fail determination is made. U_{CISPR} is a value that any reasonably equipped and competent laboratory should be able to meet, so this shouldn't be a problem that the laboratory and customer would have to deal with, but it is a point that both should be aware of. ANSI C63.4 (used in the US) does not have a similar requirement.

CONCLUSION

This summary should give the reader a starting point and understanding of the basic requirements for radiated emissions testing. While it is based on CISPR 32 and ANSI C63.4, the other standards are similar and this should provide the reader with a starting point. Read the applicable standard to your product and follow it. If there are any differences found, follow the applicable standard for your product.

FUNDAMENTALS OF OSCILLOSCOPE PROBES

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As electronics have become more advanced, so has the equipment used to measure their signal behavior and system performance. In the realm of EMC compliance, oscilloscopes are one of the important tools used to measure signals, hunt down noise sources, and identify time-domain measurements that may contribute to radiated or conducted emissions. Without a properly selected probe, an accurate oscilloscope measurement is not possible.

Most probes supplied with an oscilloscope are the passive type, possibly with up to 10x attenuation, and moderate bandwidth (50 or 100 MHz). For the newer test engineer who is building up their lab and capabilities, what factors should you examine when selecting probes for accurate scope measurements?

If you only need passive probes, with bandwidths reaching below 1 GHz, then the main specs to consider are:

- Probe bandwidth
- Attenuation
- Compensation

IMPORTANT OSCILLOSCOPE PROBE SPECIFICATIONS

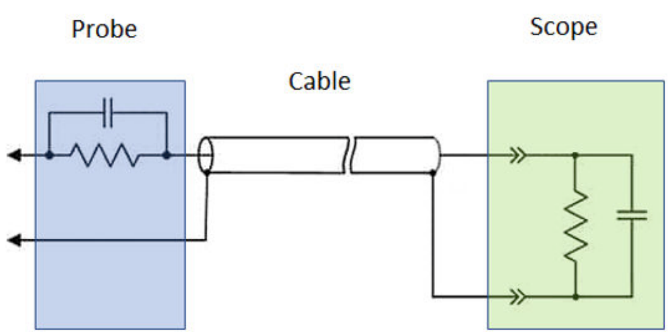
Probe Bandwidth and Equivalent Circuits

The bandwidth of an oscilloscope probe limits the range of signals that can be accurately measured with an oscilloscope. The term "accuracy" as used here means that the signal captured with an instrument has the closest resemblance to the actual signal behavior in the system being examined. Therefore, looking at an arbitrary input signal in the frequency domain, the probe bandwidth needs to exceed the signal bandwidth. Mathematically, we would write:

BW (Probe) > BW (signal)

Basic probes that are packaged with most lower-cost oscilloscopes will have probe bandwidths reaching ~100 MHz. More advanced oscilloscopes might be supplied with a probe that offers much higher bandwidth, or a specialized probe must be purchased to reach higher bandwidth.

Bandwidth is further defined based on the equivalent circuit of an oscilloscope probe. The typical circuit model describing probes is shown below.

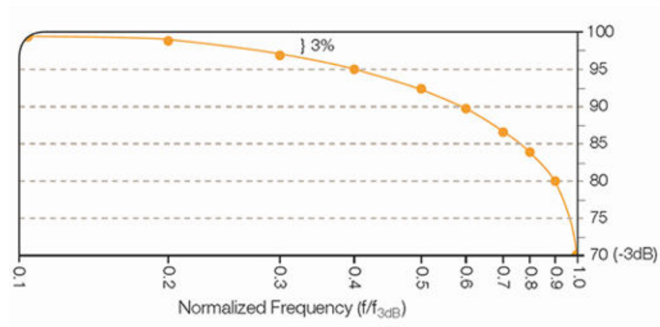


Passive oscilloscope probe equivalent circuit

The basic parallel RC circuit model shown above is applicable to most oscilloscope probes without applied compensation, and thus they exhibit limited measurement bandwidth through via low-pass filter behavior. Another way to think of this is in the time domain; the input capacitance and the probe's parallel resistance will limit the responsiveness of the probe to a fast input AC signal. In other words, we would have two effects:

- The amplitude of a measured harmonic signal will appear lower if the probe bandwidth is too low
- The edge rate of a measured switching signal will appear slower if the probe bandwidth is too low

The roll-off in amplitude of each frequency component in a broadband spectrum can be seen in the transfer function for a parallel RC circuit, again assuming a probe is uncompensated. If we set define the probe's bandwidth limit as the -3 dB attenuation point, then the amplitude measurement accuracy can still exceed 95% up to about 40% of the probe's rated bandwidth. In other words, your 100 MHz probe is only going to give very highly accurate measurements up to about 40 MHz. Some scope vendors (e.g., Keysight) will quote this "flat response" range as being up to 50% of the bandwidth specification.



Amplitude accuracy rolloff as bandwidth limit is approached. Source: Tektronix

Probe Compensation

Every oscilloscope probe, along with the oscilloscope's front-end, has a defined input capacitance that influences the bandwidth and impedance matching for a desired attenuation level. To counterbalance the input capacitance on the scope and the cable's capacitance, the probe's capacitance can be adjusted with a precision variable capacitor. This process is known as oscilloscope probe compensation.

Probe compensation is performed manually while monitoring measurement of a reference waveform or oscillator; this reference waveform is normally a square wave with fixed amplitude that can be accessed on the front port of the scope. This typically involves adjustment of a variable capacitor with a screw or dial, which is built into the oscilloscope probe at the scope-end of the cable. This modifies the capacitance seen by the signal as it reaches the input of the oscilloscope. While this method is commonly implemented for passive probes, compensation can also be applied in active probes (see below), which may involve adjusting the capacitance before the amplification stage in the probe.

When the square wave is monitored during compensation adjustment, the edges of the wave will exhibit overshoot or undershoot when excessive or insufficient compensation is applied, respectively. Verification is done visually; when the probe is properly compensated, the waveform measured with the probe will appear most closely to that of a true square wave.

The function of compensation that produces this response is two-fold:

- When undercompensated, the variable capacitor reduces the amplitude of high-frequency components without limiting the bandwidth.
- When overcompensated, the variable capacitor band-limits the response, and the scope produces an overshoot artifact through its sampling action.

In both scenarios, if the probe remains imperfectly compensated, a measured signal would appear distorted, but the probe user might not realize the probe is producing an inaccurate result.

Probe Attenuation

Basic probes that come in-the-box with an oscilloscope may have an attenuation setting, which is switchable between 1x and 10x attenuation values. Attenuation drops the signal level that enters the oscilloscope, but this is only one possible reason for applying >1x attenuation. The more important reason for applying attenuation has to do with loading of test circuits with low output impedance.

In general, to prevent the probe and scope from altering the signal behavior by loading the test circuit, we require the following condition:

$$Z\ (\text{probe} + \text{scope}) \gg Z\ (\text{circuit})$$

In other words, if the circuit under test has higher output impedance, you would want to increase the attenuation to the 10x value. If the signal being measured has low amplitude but the circuit has high output impedance, a more advanced probe may be needed to ensure the measured signal is accurate while still being visible above the scope's noise floor.

More Advanced Measurements

When more advanced (in other words, higher frequency, higher voltage, and/or lower amplitude) measurements need to be performed, the simple pin/hook lead probe with a ground lead probably won't do the trick. Although the probe might have sufficient bandwidth to do the job, the input of these probes will have excessive inductance, will require excessive compensation, or will be unable to measure the signal (e.g., for differential signals). Alternative probe types include:

- Compact probes
- Probes terminated to 50 Ohm impedance
- Differential-mode probes
- Active probes
- Current probes
- High-voltage probes

Each of these deserves its own discussion for which we don't have room in this article, but will instead reserve for a future issue.

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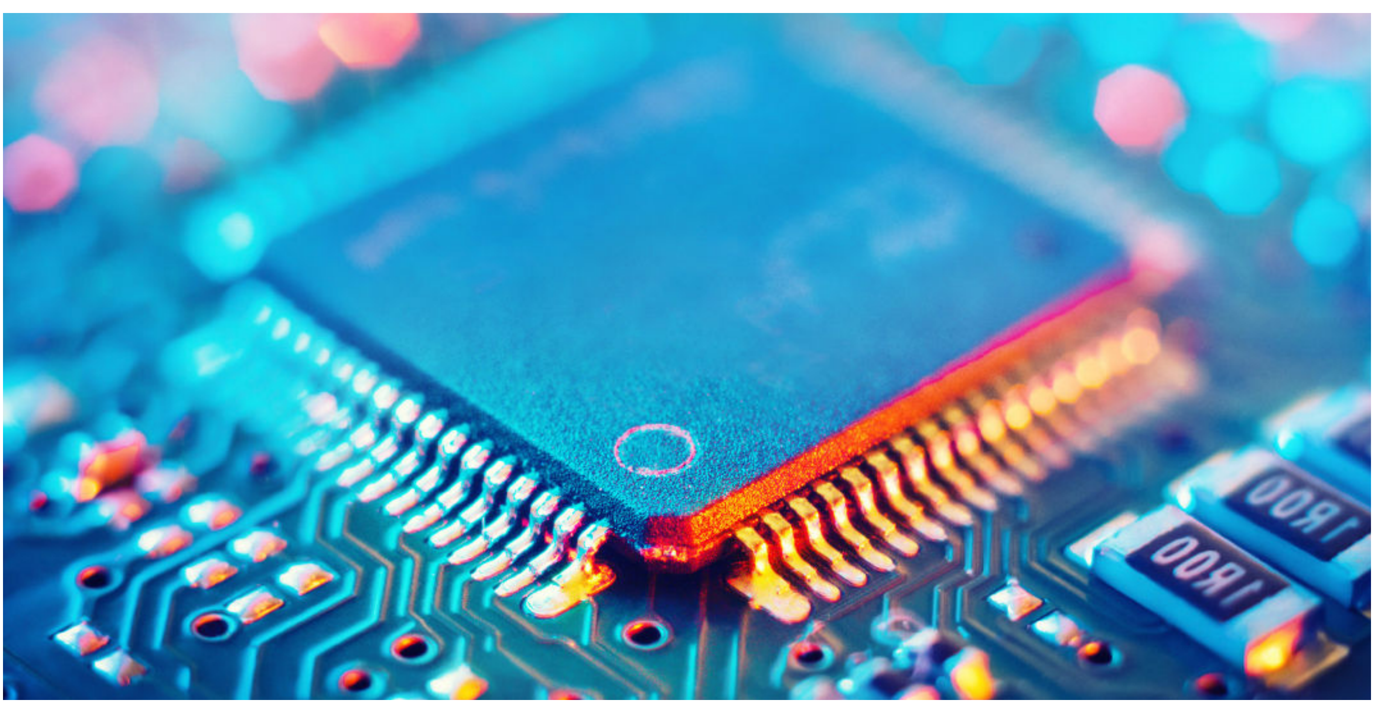

2023 CONSOLIDATED STANDARDS

MANY IEC STANDARDS have been adopted by the European Union with an 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 judgment 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.
- Commercial – primarily deals with test methods
- Wireless – primarily deals with intentional RF emitters or receivers.

Useful websites associated with standards include but are not limited to:

ANSI	https://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=95
CSA	https://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) https://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 and Education Committee (SDECom) 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) https://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 https://www.sae.org/
UK EMCIA	Electromagnetic Compatibility Industry Association UK https://www.emcia.org
VCCI	VCCI (Japan, Voluntary Control Council for Interference) https://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

Category	Publisher	Number	Title
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
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	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

Category	Publisher	Number	Title
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
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	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
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

Category	Publisher	Number	Title
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
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	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)
Auto/Vehicle	Mercedes	A 211 000 42 99	Instruction specification of test method for E/Ecomponents

Category	Publisher	Number	Title
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)

Category	Publisher	Number	Title
Auto/Vehicle	Toyota	TSC7026G-3.4	Narrow Band Emissions
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
Commercial	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
Commercial	IEC	60060-1	International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility
Commercial	IEC	60060-2	High-voltage test techniques - Part 2: Measuring systems
Commercial	IEC	60060-3	High-voltage test techniques - Part 3: Definitions and requirements for on-site testing
Commercial	IEC	61000-4-10	Electromagnetic compatibility (EMC) - Part 4-10: Testing and measurement techniques - Damped oscillatory magnetic field immunity test
Commercial	IEC	61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests
Commercial	IEC	61000-4-12	Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test
Commercial	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
Commercial	IEC	61000-4-14	Electromagnetic compatibility (EMC) - Part 4-14: Testing and measurement techniques - Voltage fluctuation immunity test
Commercial	IEC	61000-4-15	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 15: Flickermeter - Functional and design specifications
Commercial	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
Commercial	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

Category	Publisher	Number	Title
Commercial	IEC	61000-4-18	Electromagnetic compatibility (EMC) - Part 4-17: Testing and measurement techniques - Ripple on d.c. input power port immunity test
Commercial	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
Commercial	IEC	61000-4-2	Electromagnetic compatibility (EMC)–Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
Commercial	IEC	61000-4-20	Electromagnetic compatibility (EMC) - Part 4-20: Testing and measurement techniques - Emission and immunity testing in transverse electromagnetic (TEM) waveguides
Commercial	IEC	61000-4-21	Electromagnetic compatibility (EMC) - Part 4-21: Testing and measurement techniques - Reverberation chamber test methods
Commercial	IEC	61000-4-22	Electromagnetic compatibility (EMC) - Part 4-22: Testing and measurement techniques - Radiated emissions and immunity measurements in fully anechoic rooms (FARs
Commercial	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
Commercial	IEC	61000-4-24	Electromagnetic compatibility (EMC) - Part 4-24: Testing and measurement techniques - Test methods for protective devices for HEMP conducted disturbance
Commercial	IEC	61000-4-25	Electromagnetic compatibility (EMC) - Part 4-25: Testing and measurement techniques - HEMP immunity test methods for equipment and systems
Commercial	IEC	61000-4-27	Electromagnetic compatibility (EMC) - Part 4-25: Testing and measurement techniques - HEMP immunity test methods for equipment and systems
Commercial	IEC	61000-4-28	Electromagnetic compatibility (EMC) - Part 4-28: Testing and measurement techniques - Variation of power frequency, immunity test
Commercial	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
Commercial	IEC	61000-4-3	Electromagnetic compatibility (EMC)–Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
Commercial	IEC	61000-4-30	Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods
Commercial	IEC	61000-4-31	Electromagnetic compatibility (EMC) - Part 4-31: Testing and measurement techniques - AC mains ports broadband conducted disturbance immunity test
Commercial	IEC	61000-4-33	Electromagnetic compatibility (EMC) - Part 4-33: Testing and measurement techniques - Measurement methods for highpower transient parameters
Commercial	IEC	61000-4-34	Electromagnetic compatibility (EMC) - Part 4-33: Testing and measurement techniques - Measurement methods for highpower transient parameters
Commercial	IEC	61000-4-36	Electromagnetic compatibility (EMC) - Part 4-36: Testing and measurement techniques - IEMI immunity test methods for equipment and systems
Commercial	IEC	61000-4-4	Electromagnetic compatibility (EMC)–Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test
Commercial	IEC	61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
Commercial	IEC	61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields

Category	Publisher	Number	Title
Commercial	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
Commercial	IEC	61000-4-8	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
Commercial	IEC	61000-4-9	Electromagnetic compatibility (EMC) - Part 4-9: Testing and measurement techniques - Impulse magnetic field immunity test
Commercial	IEC	61340-3-1	Electrostatics - Part 3-1: Methods for simulation of electrostatic effects - Human body model (HBM) electrostatic discharge test waveforms
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	IEC	62153-14	Metallic communication cable test methods - Part 4-14: Electromagnetic compatibility (EMC) - Coupling attenuation of cable assemblies (Field conditions) absorbing clamp method
Commercial	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
Commercial	IEC	62153-4	Metallic communication cable test methods - Part 4-0: Electromagnetic compatibility (EMC) - Relationship between surface transfer impedance and screening attenuation, recommended limits
Commercial	IEC	62153-4-1	Metallic communication cable test methods - Part 4-1: Electromagnetic compatibility (EMC) - Introduction to electromagnetic screening measurements
Commercial	IEC	62153-4-2	Metallic communication cable test methods - Part 4-2: Electromagnetic compatibility (EMC) - Screening and coupling attenuation - Injection clamp method
Commercial	IEC	62153-4-3	Metallic communication cable test methods - Part 4-3: Electromagnetic compatibility (EMC) - Surface transfer impedance - Triaxial method
Commercial	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
Commercial	IEC	62153-4-5	Metallic communication cables test methods - Part 4-5: Electromagnetic compatibility (EMC) - Coupling or screening attenuation - Absorbing clamp method
Commercial	IEC	62153-4-6	Metallic communication cable test methods - Part 4-6: Electromagnetic compatibility (EMC) - Surface transfer impedance - Line injection method
Commercial	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

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Commercial	IEC	62153-4-8	Metallic communication cable test methods - Part 4-8: Electromagnetic compatibility (EMC) - Capacitive coupling admittance
Commercial	IEC	62153-4-9	Metallic communication cable test methods - Part 4-9: Electromagnetic compatibility (EMC) - Coupling attenuation of screened balanced cables, triaxial method
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	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
Commercial	IEC	CISPR 17	Methods of measurement of the suppression characteristics of passive EMC filtering devices
Commercial	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
Commercial	IEC	CISPR TR 16-3	Specification for radio disturbance and immunity measuring apparatus and methods - Part 3: CISPR technical reports
Commercial	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
Commercial	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

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Commercial	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
Commercial	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
Commercial	IEC	CISPR TR 18-1	Radio interference characteristics of overhead power lines and high-voltage equipment - Part 1: Description of phenomena
Commercial	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
Commercial	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
Commercial	IEC	TR 61000-4-32	Electromagnetic compatibility (EMC) - Part 4-32: Testing and measurement techniques - High-altitude electromagnetic pulse (HEMP) simulator compendium
Commercial	IEC	TR 61000-4-35	Electromagnetic compatibility (EMC) - Part 4-35: Testing and measurement techniques - HPEM simulator compendium
Commercial	IEC	TR 61000-4-37	Electromagnetic compatibility (EMC) - Part 4-36: Testing and measurement techniques - IEMI immunity test methods for equipment and systems
Commercial	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
Commercial	IEC	TS 60816	Guide on methods of measurement of short duration transients on low-voltage power and signal lines
ESD	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

Category	Publisher	Number	Title
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
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

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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
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

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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
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)

Category	Publisher	Number	Title
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
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)
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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
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MIL/Aero	DoD	MIL-STD-704F	Aircraft Electric Power Characteristics, Change Notice 1, 05 December 2016 (Notice 3 Validation 17 Sep 2021).
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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

Category	Publisher	Number	Title
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
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
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

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American National Standards Institute
www.ansi.org

ANSI Accredited C63
www.c63.org

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

BSMI (Taiwan)
https://www.bsmi.gov.tw/wSite

Canadian Standards Association (CSA)
www.csa.ca

CISPR
http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1298,25

CNCA (China)
https://www.cnca.gov.cn/

Electromagnetic Compatibility Industry Association UK
http://www.emcia.org

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/

IEC
http://www.iec.ch/index.htm

IEEE Standards Association
https://standards.ieee.org/

IEEE EMC Society Standards Development and Education Committee (SDECom)
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

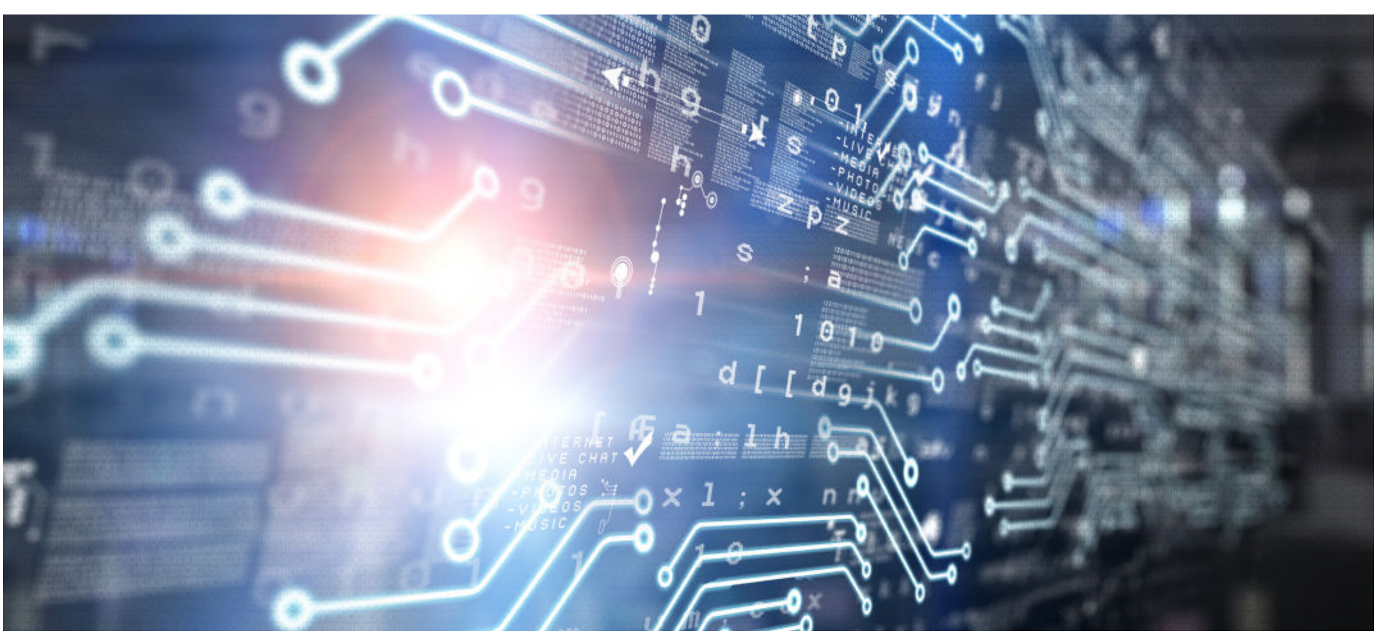
ISO (International Organization for Standards)
http://www.iso.org/iso/home.html

RTCA
https://www.rtca.org

SAE EMC Standards Committee
www.sae.org

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

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



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