



SURFACE VEHICLE STANDARD

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Performance Levels and Methods of Measurement of Electromagnetic Compatibility
of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz)

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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FOREWORD

This document brings together methodology for testing the electromagnetic emissions and immunity characteristics of vehicles and devices. The writers of this document have participated extensively in the drafting of CISPR Subcommittee D and ISO TC 22 Subcommittee 3 Working Group 3 documents. By intent, the methods and limits of this document closely resemble the counterpart international standards.

The SAE J551 series consists of the following parts:

SAE J551-1 General and Definitions

SAE J551-2 Withdrawn as a complete standard. Reserved for use as an exception document to IEC CISPR 12

[Part 3 reserved for future use]

SAE J551-4 Withdrawn as a complete standard. Reserved for use as an exception document to IEC CISPR 25

SAE J551-5 Performance Levels and Methods of Measurement of Magnetic and Electric Field Strength from Electric Vehicles, Broadband, 9 kHz to 30 MHz

[Parts 6 through 10 reserved for future use]

SAE J551-11 Withdrawn as a complete standard. Reserved for use as an exception document to ISO 11451-2

SAE J551-12 Withdrawn as a complete standard. Reserved for use as an exception document to ISO 11451-3

SAE J551-13 Withdrawn as a complete standard. Reserved for use as an exception document to ISO 11451-4

[Part 14 reserved for future use]

SAE J551-15 Vehicle Electromagnetic Immunity - Electrostatic Discharge (ESD)

SAE J551-16 Electromagnetic Immunity - Off-Vehicle Source (Reverberation Chamber Method) - Part 16 - Immunity to Radiated Electromagnetic Fields

SAE J551-17 Vehicle Electromagnetic Immunity - Power Line Magnetic Fields

1. SCOPE

This SAE Standard covers the measurement of radio frequency radiated emissions and immunity. Each part details the requirements for a specific type of electromagnetic compatibility (EMC) test and the applicable frequency range of the test method.

The methods are applicable to a vehicle, boat, machine or device powered by an internal combustion engine or battery powered electric motor. Operation of all engines or motors (main and auxiliary) of a vehicle, boat, machine or device is included. All equipment normally operating when the vehicle, boat, machine or device is in operation is included. Operator controlled equipment is included or excluded as specified in the individual document parts.

As a special case, CISPR 12 applies to battery powered floor finishing equipment, but robot carpet sweepers are excluded. By reference, IEC CISPR 12 and CISPR 25 are adopted as the standards for the measurement of vehicle emissions. In the event that an amendment is made or a new edition is published, the new IEC document shall become part of this standard six months after the publication of the IEC document. SAE reserves the right to identify exceptions to the published IEC documents with the exceptions to be documented in SAE J551-2 and SAE J551-4, respectively. Also by reference, ISO 11451-2, ISO 11451-3 and ISO 11451-4 are adopted as standards for the measurement of vehicle immunity. In the event that an amendment is made or a new edition is published, the new ISO document shall become part of this standard six months after the publication of the ISO document. SAE reserves the right to identify exceptions to the published ISO documents with the exceptions to be documented in SAE J551-11, SAE J551-12 and SAE J551-13, respectively.

The recommended levels apply only to complete vehicles in their final manufactured form. Vehicle-mounted rectifiers used for charging in electric vehicles are included in this series of documents when operated in their charging mode.

Emissions from intentional radiators are not controlled by this document. (See applicable, appropriate regulatory documents.) The immunity of commercial mains powered equipment to over voltages and line transients is not covered by this document.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J551-5	Performance Levels and Methods of Measurement of Magnetic and Electric Field Strength from Electric Vehicles, Broadband, 9 kHz to 30 MHz
SAE J551-15	Vehicle Electromagnetic Immunity - Electrostatic Discharge (ESD)
SAE J551-16	Electromagnetic Immunity - Off-Vehicle Source (Reverberation Chamber Method) - Part 16 - Immunity to Radiated Electromagnetic Fields
SAE J551-17	Vehicle Electromagnetic Immunity - Power Line Magnetic Fields
SAE J1812	Function Performance Status Classification for EMC Immunity Testing

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ANSI/IEEE STD 100 Standard Dictionary of Electrical and Electronic Terms

2.1.3 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

CISPR 12 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers

CISPR 25 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers

IEC Publication 60050-161 International Electrotechnical Vocabulary - Electromagnetic Compatibility

IEC Publication 60050-726 International Electrotechnical Vocabulary - Transmission Lines and Waveguides

2.1.4 IEEE Publications

Available from IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE C63.2 Electromagnetic Noise and Field Strength Instrumentation, 10 kHz to 40 GHz Specifications

IEEE C63.4 American National Standard for Methods of Measurement of Radio - Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz IEEE C95.1 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

IEEE STD 291 IEEE Standard Methods for Measuring Electromagnetic Field Strength of Sinusoidal Continuous Waves, 30 Hz to 30 GHz

2.1.5 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ISO 10605 Road vehicles - Test methods for electrical disturbances from electrostatic discharge

ISO 11451-1 Road vehicles - Vehicle test methods for electrical disturbances by narrowband radiated electromagnetic energy - Part 1: General and definitions

ISO 11451-2 Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Off-vehicle radiation source

ISO 11451-3 Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 3: On-board transmitter simulation

ISO 11451-4 Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 4: Bulk current injection (BCI)

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 1-724-776-4970 (outside USA and Canada), www.sae.org.

SAE HS-3600 Surface Vehicle Electromagnetic Compatibility (EMC) Standards Manual

SAE Paper 810333 Kinderman, J.C., Blink, R.P., Eisenlord, D.J., Laskowski, M.G. et al., "Implementation of EMC Testing of Automotive Vehicles," 1981

SAE Paper 831011 Vrooman, G.F.E., "An Indoor 60 Hz to 40 GHz Facility for Total Vehicle EMC Testing," 1983

2.2.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ANSI C63.5 American National Standard for Electromagnetic Compatibility - Radiated Emissions Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas (9 kHz to 40GHz)

ANSI C63.14 Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP), and Electrostatic Discharge (ESD)

ANSI C63.16 American National Standard Guide for Electrostatic Discharge Test Methodologies and Criteria for Electronic Equipment

2.2.3 IEC Publication

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

CISPR 22 Limits and methods of measurement of radio interference characteristics of information technology equipment

2.2.4 ISO Publication

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ISO 10305 Generation of standard em fields for calibration of power density meters 20 kHz to 1000 MHz

2.2.5 IEEE Publications

Available from IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE STD 211 IEEE Standard Definition of Terms for Radio Wave Propagation

Nichols, F. J., and Hemming, L. H., "Recommendations and Design Guides for the Selection and Use of RF Shielded Anechoic Chamber in the 30-1000 MHz Frequency Range," IEEE International Symposium on EMC, Boulder, CO, August 18-20, 1981, pp. 457-464

2.2.6 Other Publications

Adams, J. W., Taggart, H. E., Kanda, M., and Shafer, J., "Electromagnetic Interference (EMI) Radiative Measurements for Automotive Applications," NBS Tech. Note 1014, June 1979

Tippet, J. C., Chang, D. C., and Crawford, M. L., "An Analytical and Experimental Determination of the Cutoff frequencies of higher-order TE modes in a TEM cell," NBSIR 76-841, June 1976

Tippet, J. C., Modal Characteristics of Rectangular Coaxial Transmission Line, Thesis submitted June 1978 for degree of Doctor of Philosophy to University of Colorado, Electrical Engineering Dept., Boulder, CO

3. DEFINITIONS

The definitions listed as follows apply to certain terms used in the various parts of SAE J551 and are not intended to be an exhaustive list. For more information, check other resources such as ISO 11451-1, IEC publications 60050-161 and 60050-726 and the latest editions of ANSI/IEEE Dictionaries of Technological terms. Definitions without a source reference were defined within the SAE committee activities.

3.1 ABSORBER-LINED SHIELDED ENCLOSURE

Shielded enclosure/screened room with radio frequency absorbing material on its internal ceiling and walls.

Note 1 to entry: The common practice is for the room to have a metallic floor, but absorbing material can also be used on the floor. [SOURCE: ISO 11451-1].

3.2 AMPLITUDE MODULATION AM

Process by which the amplitude of a carrier wave is varied following a specified law, resulting in an AM signal.

3.3 ARTIFICIAL MAINS NETWORK AMN

Provides a defined impedance to the EUT at radio frequencies, couples the disturbance voltage to the measuring receiver, and decouples the test circuit from the supply mains.

[SOURCE: ISO 11451-1]

NOTE 1 TO ENTRY: There are two basic types of AMN, the V-network (V-AMN) which couples the unsymmetrical voltages and the delta-network which couples the symmetric and the asymmetric voltages separately. The terms line impedance stabilization network (LISN) and V-AMN are used.

NOTE 2 TO ENTRY: This network is inserted in the power mains of the vehicle in charging mode which provides, in a given frequency range, a specified load impedance and which isolates the vehicle from the power mains in that frequency range. [SOURCE: ISO 11451-1].

3.4 ARTIFICIAL NETWORK AN; LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Network inserted in the supply lead or signal/load lead of apparatus to be tested which provides, in a given frequency range, a specified load impedance for the measurement of disturbance voltages and which can isolate the apparatus from the supply or signal sources/loads in that frequency range" [SOURCE: ISO 11451-1].

NOTE 1 TO ENTRY: This network is inserted in the DC power lines of the vehicle in charging mode which provides, in a given frequency range, a specified load impedance and which isolates the vehicle from the DC power supply in that frequency range.

3.5 ASYMMETRIC ARTIFICIAL NETWORK AAN

Network used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric signal (e.g., telecommunication) lines while rejecting the symmetric (differential mode) signal.

NOTE 1 TO ENTRY: This network is inserted in the communication/signal lines of the vehicle in charging mode to provide a specific load impedance and/or a decoupling (e.g., between communication/signal lines and power main).

[SOURCE: ISO 11451-1]

3.6 BONDED (GROUND CONNECTION AND DC RESISTANCE)

Used to describe a grounding connection within this standard, where the purpose of the bonding is to provide the lowest possible impedance (resistance and inductance) connection between two metallic parts.

NOTE 1: The DC resistance of this connection shall not exceed 2,5 mΩ.

NOTE 2: A low current (≤ 100 mA) 4-wire milliohm meter is recommended for this measurement.

[SOURCE: ISO 11451-1]

3.7 BROADBAND ARTIFICIAL NETWORK (BAN)

A network that presents a controlled impedance to the device under test over a specified frequency range while allowing the device under test to be interfaced to its support system. It is used in power, signal and control lines.

3.8 BULK CURRENT

Total amount of common mode current in a harness [SOURCE: ISO 11451-1].

3.9 COMPRESSION POINT

Input signal level at which the measurement system becomes non-linear.

NOTE 1: When the measurement system is non-linear, the output value will deviate from the value given by an ideal linear system. [SOURCE: ISO 11451-1].

3.10 COUPLING

Means or device for transferring power between systems .

[SOURCE: ISO 11451-1]

3.11 CURRENT INJECTION PROBE

Device for injecting current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits [SOURCE: ISO 11451-1].

3.12 CURRENT (MEASURING) PROBE

Device for measuring the current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits.

[SOURCE: ISO 11451-1]

3.13 DEVICE

1. An electrical or electronic component, module subassembly or system. Each could include a wiring harness(es).
2. (As used in CISPR 12) A machine driven by an internal combustion engine which is not primarily intended to carry persons or goods. Devices include, but are not limited to, chainsaws, irrigation pumps, snow blowers, air compressors, and landscaping equipment (see Machine).

3.14 DEGRADATION (OF PERFORMANCE)

Undesired departure in the operational performance of any device, equipment, or system from its intended performance.

NOTE 1: The term “degradation” can apply to temporary or permanent failure.

[SOURCE: ISO 11451-1]

3.15 DUAL DIRECTIONAL COUPLER

Four-port device consisting of two transmission lines coupled together in such a manner that a single travelling wave in any one transmission line will induce a single travelling wave in the other, the direction of propagation of the latter wave being dependent upon that of the former.

[SOURCE: ISO 11451-1]

3.16 ELECTROMAGNETIC COMPATIBILITY EMC

Ability of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment.

[SOURCE: ISO 11451-1]

3.17 ELECTROMAGNETIC DISTURBANCE

Any electromagnetic phenomenon which can degrade the performance of a device, equipment, or system or adversely affect living or inert matter.

EXAMPLE: An electromagnetic disturbance can be an electromagnetic noise, an unwanted signal, or a change in the propagation medium itself.

[SOURCE: ISO 11451-1]

3.18 ELECTROMAGNETIC INTERFERENCE (EMI)

Degradation of the performance of equipment, transmission channel, or system caused by electromagnetic disturbance.

NOTE 1: The English words “interference” and “disturbance” are often used indiscriminately.

[SOURCE: ISO 11451-1]

3.19 ELECTROMAGNETIC IMMUNITY (TO A DISTURBANCE)

Ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance.

[SOURCE: ISO 11451-1]