

**Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles,
Motorboats, and Spark-Ignited Engine-Driven Devices**

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- 1. Scope**—The limits in this SAE Standard are designed to provide protection for receivers of all types of radio transmissions when used in buildings. As a result, receivers of radio transmissions used out-of-doors may not be protected by the limits specified.

This publication applies to the emission of electromagnetic energy which may cause interference to radio reception and which is emitted from:

- a. Vehicles propelled by an internal combustion engine, electrical means or both (see SAE J551-1 for definition)
- b. Motorboats propelled by an internal combustion engine, electrical means or both

NOTE—For the purposes of this publication, motorboats are considered to be a subset of vehicles unless specifically mentioned to the contrary.

- c. Devices equipped with spark-ignited internal combustion engines (see SAE J551-1 for definition)

This publication does not apply to aircraft, traction systems (railway, tramway, and trolley bus), or to incomplete vehicles.

- 1.1 Rationale**—This document is being cancelled in favor of using the technically identical international standards CISPR 12 and CISPR 25. The linkage to these documents is included in the revised SAE J551-1 and SAE J1113-1.

2. References

- 2.1 Applicable Publications**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

- 2.1.1 SAE PUBLICATION**—Available from SAE, 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 J551-1—Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles and Devices (60 to 18 GHz)

- 2.1.2 ANSI PUBLICATION**—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI C63.5—Electromagnetic Compatibility—Radiated Emission Measurements in Electromagnetic Interference (EMI) Control—Calibration of Antennas

2.1.3 CISPR PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

CISPR 16 (1987)—CISPR specification for radio interference measuring apparatus and measurement methods

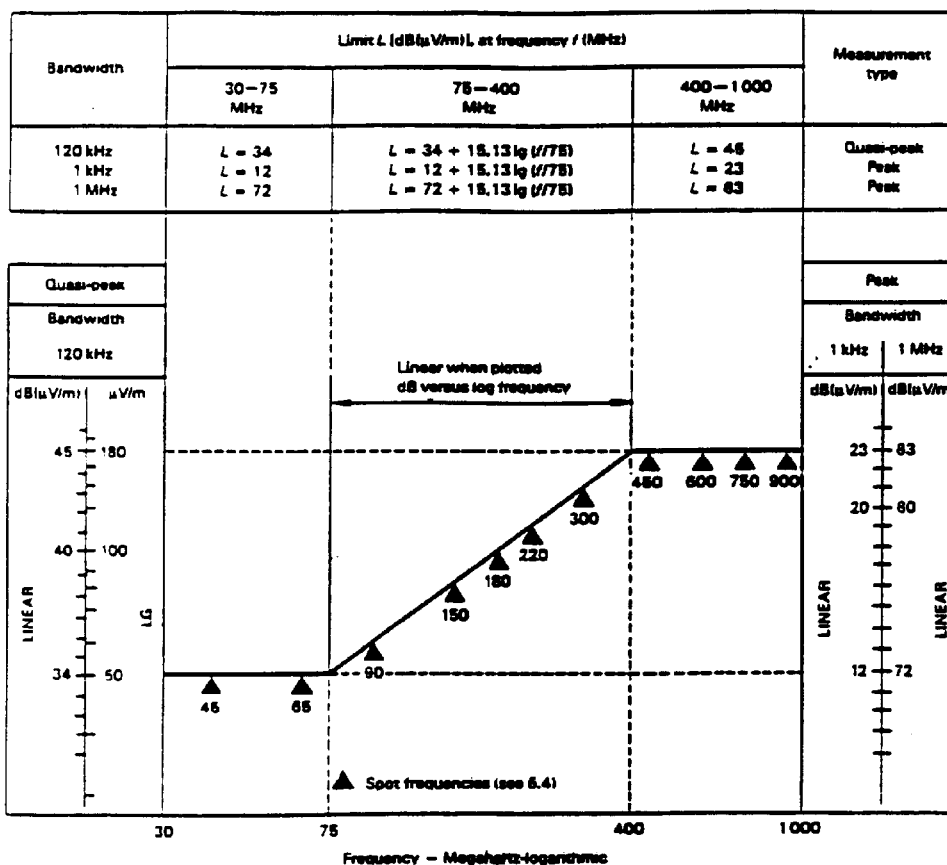
CISPR Report 37/2—Measurement of the insertion loss of ignition noise suppressors

CISPR Report 56—Antenna and transmission line calibration

CISPR Report 65 Construction features of motor vehicles affecting the radiation of ignition noise

3. **Definitions**—See SAE J551-1.

4. **Limits of Disturbance**—The limits for emissions are given in the table of Figure 1 and shown graphically in Figure 1. Only one of the bandwidths listed needs to be chosen for testing. For more accurate determination, the table given in Figure 1 shall be used.



NOTES

- 1 For vehicles equipped with electric propulsion motors, see 4.3.2.2.
- 2 For peak type measurements, see 4.5.3.
- 3 The correlation factor between quasi-peak and peak measurements is +20 dB at 120 kHz bandwidth.
- 4 Limits from 1 to 22 GHz are under consideration.

FIGURE 1—LIMITS OF DISTURBANCE

5. Methods of Measurement

NOTE—Methods of measurement from 1 to 22 GHz are under development.

5.1 Measuring Instrument Requirements

5.1.1 MEASURING INSTRUMENT

5.1.1.1 *Type*—The measuring instrument shall comply with the requirements of CISPR 16.

NOTE—Manual or automatic frequency scanning may be used. Spectrum analyzers and scanning receivers are particularly useful for interference measurements. Special consideration shall be given to overload, linearity, selectivity, and the normal response to pulses. The peak detection mode of spectrum analyzers and scanning receivers provides a display indication which is never less than the quasi-peak indication for the same bandwidth. It may be convenient to measure emissions using peak detection because of the faster scan possible than with quasi-peak detection.

When quasi-peak limits are being used, any peak measurements close to the limit shall be measured using the quasi-peak detector.

5.1.1.2 *Minimum Scan Time*—The scan rate of a spectrum analyzer or scanning receiver shall be adjusted for the CISPR frequency band and detection mode used. The minimum sweep time/frequency (i.e., most rapid scan rate) is listed in Table 1:

TABLE 1—MINIMUM SCAN TIME

	Band	Peak Detection	Quasi-Peak Detection
A	9–150 kHz	Does not apply	Does not apply
B	0, 15–30 MHz	Does not apply	Does not apply
C, D	30–1000 MHz	1 ms/100 ms/MHz ⁽¹⁾	20 s/MHz

Band definition from CISPR 16 Part 1.

Certain signals (e.g., low repetition rate or intermittent signals) may require slower scan rates or multiple scans to ensure that the maximum amplitude has been measured.

1. When 9 kHz bandwidth is used, the 100 ms/MHz value shall be used.

5.1.1.3 *Measuring Instrument Bandwidth*—The bandwidth of the measuring instrument shall be chosen such that the noise floor is at least 6 dB lower than the limit curve. The bandwidths in Table 2 are recommended.

NOTE—When the bandwidth of the measuring instrument exceeds the bandwidth of a narrowband signal, the measured signal amplitude will not be affected. The indicated value of impulsive broadband noise will be lower when the measuring instrument bandwidth is reduced.

TABLE 2—MEASURING INSTRUMENT BANDWIDTH (6 DB)

Frequency Band MHz	Broadband Peak	Broadband q-Peak	Narrowband Peak	Narrowband Average
0.15 – 30	Does not apply	Does not apply	Does not apply	Does not apply
30 – 1000	FM broadcast	120 kHz	120 kHz	120 kHz
	Mobile service	120 kHz	120 kHz	9 kHz

If a spectrum analyzer is used for peak measurements, the video bandwidth shall be at least three times the resolution bandwidth.

For the narrowband/broadband discrimination according to Figure 1, both bandwidths (with peak and average detectors) shall be identical.

5.1.2 ANTENNA TYPES

5.1.2.1 Reference Antenna—The reference antenna shall be a balanced half-wave resonant dipole (see CISPR 16).

5.1.2.2 Broadband Antennas—Any linearly polarized receiving antenna is permitted, provided that it can be normalized to the reference antenna.

A broadband antenna is required when making measurements with an automated receiving system using a scanning measuring instrument. Such a broadband antenna is usable for measuring emission levels (over the frequency spectrum covered by this document), provided that its output can be normalized to the output of the reference antenna in the actual test environment at the actual test site.

NOTE—When broadband antennas are used, they should meet the requirements for complex antennas given in CISPR 16. Examples of factors to be considered include:

- The effective aperture area of the antenna, including its polar response (horizontal and vertical planes)
- The effect of a phase center which moves with frequency
- The effect of ground reflection characteristics (including multiple ray reflections which may arise at specific frequencies at about 500 MHz vertical polarization and 900 MHz horizontal polarization).

5.1.3 CALIBRATION—See Appendix A.

5.1.4 ACCURACY—The measurement system, excluding source, shall measure electric field strength over the frequency range of 30 to 1000 MHz with a maximum uncertainty of ± 5 dB. The frequency tolerance shall be less than $\pm 1\%$.

NOTE—To ensure that the measurements defined in this document are within the stated tolerances, consideration should be given to all pertinent characteristics of measuring equipment (e.g., frequency and amplitude stability, image rejection, cross-modulation, overload levels, selectivity, time constants, and signal/noise ratio), as well as those affecting the antenna and transmission line.

5.1.5 REPEATABILITY—The repeatability of the measurement system shall be established and periodically checked to detect variability; the input/output characteristics of the measuring instrument shall be checked at shorter intervals of time.

NOTE—It is reasonable to expect variations of as much as ± 3 dB in measurements made of an electric field (see A.16) within the range of 30 to 1000 MHz. These are caused by variations in ground conductivity and other factors influencing repeatability.

5.2 Measuring Location Requirements

5.2.1 OPEN AREA TEST SITE (OATS) REQUIREMENTS

5.2.1.1 The test site shall be a clear area free from electromagnetic reflecting surfaces within a circle of minimum radius 30 m measured from a point midway between the vehicle or device and the antenna.

NOTE—The site requirements defined in 4.2.1.1 are the application of CISPR 16 to large automotive objects.

5.2.1.2 The measuring set, test hut, or vehicle in which the measuring set is located may be within the test site, but only in the permitted region indicated by the crosshatched area of Figure 2.

5.2.1.3 Ambient Requirements—To ensure that there is no extraneous noise or signal of a magnitude sufficient to affect materially the measurement, measurements shall be taken before and after the main test, but without the engine under test running. In both of these measurements, the ambient noise (exclusive of known radio transmissions) shall be as low as possible, but at least 6 dB below the limits of disturbance given in Section 3. This requirement also applies to the reduced limit for testing wet vehicles.

5.2.2 ABSORBER-LINED SHIELDED ENCLOSURE (ALSE) REQUIREMENTS

5.2.2.1 Correlation—Anechoic chambers may be used provided that the results obtained can be correlated with those obtained using the OATS described in 4.2.1.

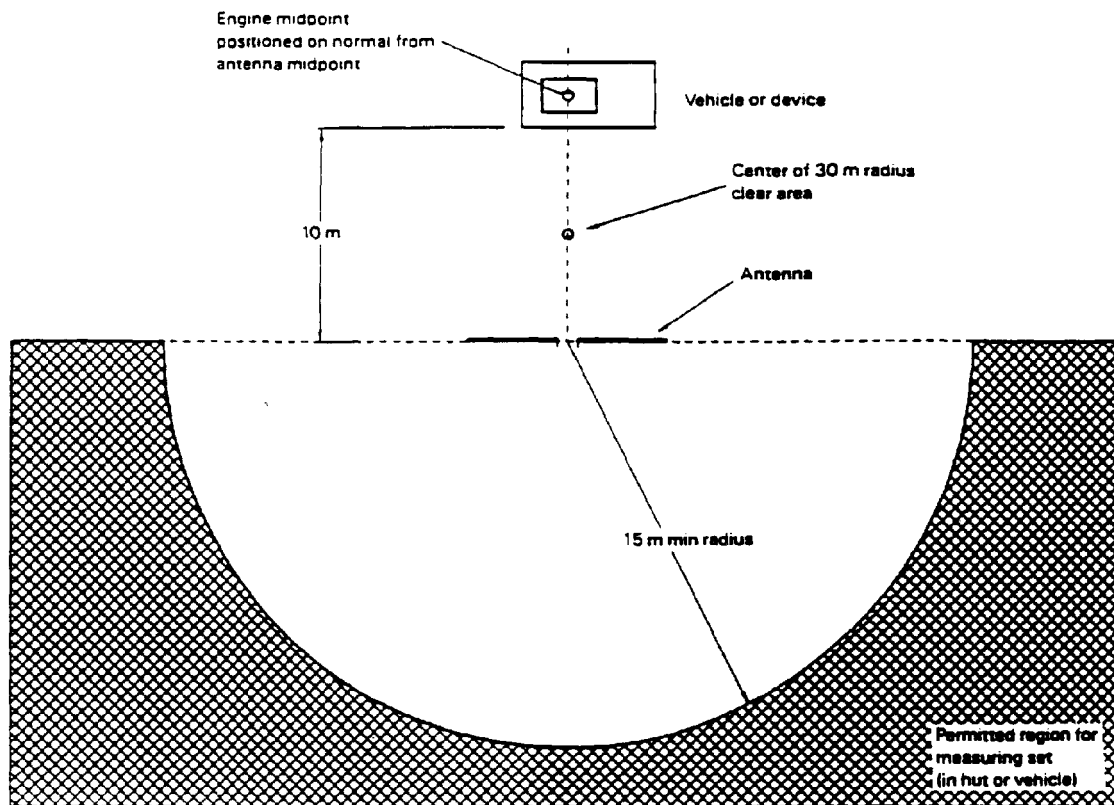
NOTE—Such chambers have the advantages of all-weather testing, controlled environment, and improved repeatability because of stable chamber electrical characteristics.

5.2.2.2 Ambient Requirements—The ambient noise level shall be as low as possible, but at least 6 dB below the limits of disturbance given in Section 3. The ambient level shall be verified periodically or when test results indicate the possibility of noncompliance.

5.2.3 ANTENNA POSITION REQUIREMENTS—At Each Measuring Frequency, Measurements Shall Be Taken For Horizontal And Vertical Polarization Figure 3 And Figure 4.

Electrical interaction between the antenna elements and the antenna support/guy system shall be avoided.

Theoretical considerations of antenna and transmission-line geometry demand that the transmission line not interact electrically with the antenna elements. One acceptable transmission-line geometry for a dipole antenna is to route the transmission line horizontally rearward for a distance of 6 m at a height of 3 m before descending to ground level or below. Other geometries are acceptable if they can be shown not to affect the measurements, or if the effects can be included in equipment calibration.



All dimensions ± 0.2 m

FIGURE 2—MEASURING SITE

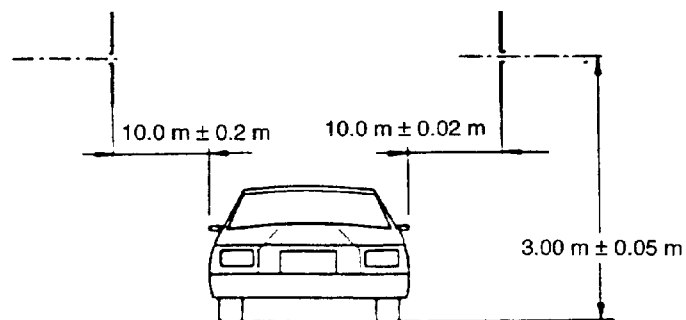


FIGURE 3—ANTENNA POSITION TO MEASURE EMISSIONS: VERTICAL POLARIZATION

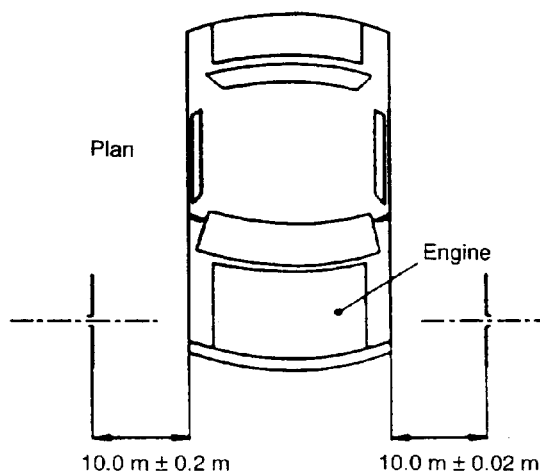


FIGURE 4—ANTENNA POSITION TO MEASURE EMISSIONS: HORIZONTAL POLARIZATION

- 5.2.3.1 *Height*—The center of the antenna shall be $3.00\text{ m} \pm 0.05\text{ m}$ above the ground or water surface.
- 5.2.3.2 *Distance*—The horizontal distance of the antenna to the nearest metal part of the vehicle or device shall be $10.0\text{ m} \pm 0.2\text{ m}$.
- 5.2.3.3 *Auxiliary (Multiple) Antennas*—Auxiliary antennas are permitted, but if two antennas are facing each other, one shall be vertically polarized while the other is horizontally polarized.

The test site clear area requirement of 4.2.1.1 shall be applied also to the point midway between the vehicle or device and the auxiliary antenna(s).

5.3 Test Object Conditions

5.3.1 WEATHER CONDITIONS

- 5.3.1.1 *Dry Measurements*—Certification measurements made while the vehicle or device is dry, or made more than 10 min after the rain has stopped falling shall use the limit curve shown in Figure 1.

For outboard engines and devices, all surfaces other than those normally in contact with water shall be dry.

- 5.3.1.2 *Wet Measurements*—If circumstances dictate that certification measurements be made while precipitation is falling, or within 10 min after it has stopped, the vehicle or boat shall be deemed to comply with the requirements of this document if the measured levels do not exceed a level of 10 dB below that shown in Figure 1.

In the event of any dispute concerning compliance, it shall be resolved by carrying out measurements under dry conditions.

Compliance based on good faith wet measurements (and with the performance penalty mentioned in 4.3.1.2) shall remain valid until such time as it may be contested and dry measurements prove noncompliance. In such cases retrofitting of vehicle, devices, or boats sold during the period when there was deemed compliance shall not be required.