The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J551/12

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Submitted for recognition as an American National Standard

VEHICLE ELECTROMAGNETIC IMMUNITY—ON-BOARD TRANSMITTER SIMULATION

Foreword—This SAE Standard adopts, with only editorial changes, ISO DIS 11451-3: Road vehicles—Electrical disturbances by narrowband radiated electromagnetic energy—Vehicle test methods—Part 3: On-board transmitter simulation.

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1. ***Scope***—This part of SAE J551 specifies on-board transmitter simulation test methods and procedures for testing passenger cars and commercial vehicles. The electromagnetic disturbances considered in this part of SAE J551 are limited to continuous narrow band electromagnetic fields.

   SAE J551/1 specifies general, definitions, practical use, and basic principles of the test procedure.

2. ***References***

2.1 Applicable Documents—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 PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J551/1—Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles and Devices (60 to 18 GHz)

SAE J551/2—Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicle, Motorboats, and Spark-Ignited Engine-Driven Devices Broadband, 30 kHz to 1.000 MHz

3. ***Test Conditions***—This test is performed in the laboratory or, where national regulations permit, at an Open Area Test Site (OATS).

3.1 Test Temperature and Supply Voltage—Heat is generated in the test facility when the vehicle is operated during the performance of the test. Sufficient cooling must be provided to ensure that the engine does not overheat.

The ambient temperature in the test facility shall be recorded if it is outside the range of 23 °C ± 5 °C.

For tests that require the vehicle engine to be running, the electrical charging system shall be functional. For tests where the vehicle engine is not required to be running, the battery voltage shall be maintained above 12.2 V and 24.4 V for 12 V and 24 V systems, respectively.

3.2 Frequency Range—The frequency range of the test method is 1.8 to 1300 MHz.

3.3 Modulation—If a transmitter according to Table 1 is used, use the built-in modulation type. If alternate method of 4.2.1 is used and no values are agreed between the users of this document, then the following shall be used:

a. No Modulation (CW)
b. 1 kHz sine-wave amplitude modulation (AM) 80%

3.4 Dwell Time—At each frequency, the DUT shall be exposed to the test levels for the minimum response time needed to control the DUT. In all cases, this minimum time of exposure shall be as shown in Equation 1:

$$t\ min = 2\ s \qquad \text{(Eq.1)}$$

3.5 Frequency Steps—Within the limitation of the equipment, the standard following maximum frequency step sizes applies as shown in Table 2.

TABLE 1—RF SIGNAL SOURCES

Frequency Band, MHz	Output Power, W
1.8 - 2	100
3.5 - 4	100
7 - 7.3	100
10.1 - 10.15	100
14 - 14.35	100
18.1 - 18.15	100
21 - 21.45	100
24.89 - 24.99	100
27 - 28	4[1]
28 - 29.7	100
30 - 50	120
50 - 54	150
60 - 87	100
120 - 130	100
144 - 148	150
148 - 172	120
220 - 225	150
420 - 470	100
851 - 928	10
1260 - 1300	10

[1] Maximum legal power allowed.

TABLE 2—FREQUENCY STEPS

Frequency Band	Maximum Frequency Step Size
1.8 MHz - 10 MHz	1 MHz
10 MHz - 200 MHz	2 MHz
200 MHz - 1 GHz	20 MHz
1 GHz - 1.3 GHz	200 MHz

Alternatively, logarithmic frequency steps, with the same minimum number of frequency steps in each frequency band, can be used. The values, as agreed by the users of this document, shall be documented in the test report.

NOTE— If it appears that the susceptibility thresholds of the DUT are very near the chosen test level, these frequency step sizes should be reduced in the concerned frequency range in order to find the minimum susceptibility thresholds.

If the equipment does not allow the use of these standard frequency steps, the values used have to be agreed between the users of this document and reported in the test plan.

4. ***Test Facility Description and Specifications***—This test would typically be performed in a shielded absorber-lined chamber. Where national regulations permit, the test can also be performed at an OATS. Where specified in the test plan, the tests shall also be run in a reflective enclosure.

4.1 Test Facility Specification

4.1.1 ABSORBER-LINED CHAMBER—An absorber-lined chamber with the characteristics given in SAE J551/2 is adequate for this test.

NOTE— At frequencies where absorbers are not effective, the reflections in the chamber can affect the exposure of the vehicle.

4.1.2 OPEN AREA TEST SITE—Where national regulations permit the use of an OATS, the OATS should have an area with a radius of 20 m free from large metal structures or objects. Care shall be taken, when performing OATS tests, to ensure that harmonic suppression regulations are met. The test operator shall comply with any regulations.

4.1.3 REFLECTIVE ENCLOSURE—When required in the testing, a reflective enclosure consisting of a shielded chamber shall be used. Where permitted, this may consist of a building with a metal roof and walls or similar structure such as a bridge with metal superstructure above the road surface.

4.2 Test Equipment

4.2.1 RADIO FREQUENCY (RF) SIGNAL SOURCES—Transmitters capable of generating RF power in the following frequency ranges with the listed output power in Table 1 should be considered for the tests.

Handheld transmitters with output power of 3 to 8 W may be required as specified in the test plan.

An alternate method of simulating a high-power on-board transmitter is to use the antenna(s) as specified in 4.2.3 to supply RF power from a broadband amplifier driven by a signal generator.

NOTE— A RF choke (ferrite or powdered iron toroid, depending on frequency) should be placed around the coaxial cable to the antenna in order to reduce skin currents and more closely simulate a transmitter installed in the vehicle.

4.2.2 RF POWER AND FIELD MONITORING EQUIPMENT—An in-line power meter is required for measuring power to the antenna. Both forward power and reverse power shall be measured and recorded.

An isotropic field probe is required for measuring field strengths inside the vehicle for personnel protection.

4.2.3 ANTENNAS—For the VHF and UHF bands, quarter-wave antennas should be given preference over 5/8-wave antennas, since there are higher skin currents created by quarter-wave antennas.

All antennas should be tuned for minimum VSWR (typically less than 1.5:1), if possible. The resulting VSWR must be compatible with the design of the RF source. An exception to tuning the antenna for minimum VSWR is when the test plan calls for testing with a specified VSWR to induce higher radiation within the vehicle resulting from skin currents on the antenna coaxial cable.

The mobile transmitting antenna shall be mounted in the location(s) specified in the test plan.

NOTE— VSWR is a fixed parameter related to the transmitting monopole; it shall not be adjusted by the test engineer when the antenna actually installed on the vehicle is used.

4.2.4 CALIBRATION OF TEST EQUIPMENT—The power meter shall be calibrated and shall be capable of measuring levels provided by the sampling device with a tolerance of ±1 dB.