SAE International™

SURFACE VEHICLE STANDARD

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Function Performance Status Classification for EMC Immunity Testing

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1. Scope

This SAE Standard provides a general method for defining the function performance status classification for the functions of automotive electronic devices upon application of the test conditions specified as described in appropriate EMC test standards (for example, SAE J1113 & SAE J551). Testing of devices could be performed either on or off vehicles. Appropriate test signal and methods, Function Performance status, and test signal severity level would have to be specified in the individual cases.

2. References

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, 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, Boats (up to 15 m), and Machines (50 Hz to 18 GHz)
SAE J551-11—Vehicle Electromagnetic Immunity—Off-Vehicle Source
SAE J551-12—Vehicle Electromagnetic Immunity—On-Board Transmitter Simulation
SAE J551-13—Vehicle Electromagnetic Immunity—Bulk Current Injection
SAE J551-15—Vehicle Electromagnetic Immunity—Electrostatic Discharge (ESD)
SAE J551-17—Vehicle Electromagnetic Immunity – Power Line Magnetic Fields
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)
SAE J1113-2—Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft)—Conducted Immunity, 30 Hz to 250 kHz—All Leads
SAE J1113-3—Conducted Immunity, 250 KHz To 500 MHz, Direct Injection Of Radio Frequency (RF) Power
SAE J1113-4—Immunity To Radiated Electromagnetic Fields—Bulk Current Injection (BCI) Method
SAE J1113-11—Immunity to Conducted Transients on Power Leads
SAE J1113-12—Electrical Interference by Conduction and Coupling—Coupling Clamp and Chattering Relay
SAE J1113-13—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 13: Immunity to Electrostatic Discharge
SAE J1113-21—Electronmagnetic Compatibility Measurement Procedure for Vehicle Components—Part 21: Immunity to Electromagnetic Fields, 10 kHz to 18 GHz, Absorber-Lined Chamber
SAE J1113-22—Electromagnetic Compatibility Measurement Procedure For Vehicle Components—Part 22—Immunity To Radiated Magnetic Fields From Power Lines
SAE J1113-23—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Strip Line Method
SAE J1113-24— Immunity to Radiated Electromagnetic Fields; 10 kHz to 200 MHz—Crawford TEM Cell and 10 kHz to 5 GHz—Wideband TEM Cell
SAE J1113-25—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to Radiated Electromagnetic Fields, 10 KHz to 1000 MHz— Tri-Plate Line Method
SAE J1113-26—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Immunity to AC Power Line Electric Fields
SAE J1113-27—Electromagnetic Compatibility Measurements Procedure For Vehicle Components—Part 27—Immunity To Radiated Electromagnetic Fields—Reverberation Method

3. Definitions

See SAE J1113-1 or SAE J551-1

4. Measurement Philosophy

Electrical and radio frequency interference occurs during the normal operation of many items of motor vehicle equipment and when the vehicle is subjected to electromagnetic noises from the outside environment. It is generated over a wide frequency range with various electrical characteristics and may be distributed to on-board electronic devices and systems by conduction and/or radiation.

During recent years, an increasing number of electronic devices have been introduced into vehicle designs in order to perform, control, monitor and display various functions including the engine management system. It has been necessary therefore, to consider the electrical and electromagnetic environment in which these devices are required to operate. Interference can be generated in the vehicle electrical system itself by the normal operation of various power devices such as power window, power lock, air conditioning, etc. This interference can cause a temporary malfunction or even permanent damage to the electronic equipment. Significant numbers of performance deviations, resulting from this interference, have been reported.

Narrow band and broad band signals generated from sources inside or outside the vehicle could also be coupled into the electrical/electronic system, affecting the normal performance of electronic devices. These sources of electromagnetic disturbance are, for example, vehicle's ignition system, mobile telephones, broadcast transmitters, etc. Protection from this potential interference has to be considered in a total system validation.

It must be emphasized that components or systems shall only be tested with the conditions, as described in individual test method, that represent the simulated automotive electromagnetic environments to which the devices would actually be subjected. This will help to assure a sound technically and economically optimized design for potentially susceptible components and systems.

It should also be noted that this document is not intended to be a product specification and cannot function as one. It should be used in conjunction with a test procedure/test plan such as the SAE J1113 & SAE J551 or product specifications in defining the expected performance objectives of the product. Therefore, no specific values for the test pulse severity level are given in the document (only examples re provided) since they are to be determined by the vehicle manufacturer and the supplier. Nevertheless, using the concepts described in this document and by careful application and agreement between manufacturer and supplier, it could, in fact, be a statement of how a function of particular device is expected to perform when exposed to the specified test signals.

Examples for the application of how the concept of function performance status classification could be applied to the conducted and radiated immunity testing are included in this document (See Appendix A&B).

5. Essential Elements of Function Performance Status Classification (FPSC)

Four elements are required to describe a function performance status classification. They can be generically applied to all immunity testing for electromagnetic disturbances (both conducted and radiated). These elements are listed below. The application of these essential elements is illustrated in appendix A & B.

5.1 Test Signal and Test Method

This element defines the test signals applied to the device under test and the test method used. They are usually referred to in specific test procedures. The test procedures used and methods of application are to be described in specific standards.

5.2 Function Performance Status

This element defines the expected performance objectives for the function of the device under test subjected to the test conditions. The four Function Performance status (s) of the function (expected behavior of the function observed during test) are listed below:

5.2.1 STATUS I

Normal performance within the specification limits during and after exposure to a disturbance

5.2.2 STATUS II

Temporary degradation or loss of function or performance that which is self-recoverable after the disturbance is removed

5.2.3 STATUS III

Temporary degradation or loss of function or performance which requires operator intervention or system reset after the disturbance is removed

5.2.4 STATUS IV

The device/function shall not have sustained any damage after the disturbance is removed.

5.3 Test Signal Severity Level

This element defines the specification of test signal severity level of essential signal parameters. The test signal severity level is the stress level (voltage, volts per meter, induced current, etc.) applied to the device under test for any given test method. The test signal severity levels should be determined by the vehicle manufacturer and supplier depending on the operational characteristics of the function. The severity levels could be separated into number of Groups. The number of Groups as well as the severity levels associated with each of the Group are to be determined by the vehicle manufacturer (examples for how the test signal severity level could be applied are included in the Appendices A & B).

6. Notes

6.1 Marginal Indicia

The change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE ELECTROMAGNETIC IMMUNITY STANDARDS COMMITTEE

APPENDIX A
ILLUSTRATION OF FUNCTION PERFORMANCE STATUS CLASSIFICATION

A.1 Application of Function Performance Status & Test signal Severity Level

This illustration demonstrates the relationship between the test signal severity levels (Severity Levels) and their corresponding Function performance status (Status). In other words, based on the table listed below, the function must exhibit: **Status I** performance up the severity level L_1, **Status II** (status I allowed) performance up to severity level L_2, etc.

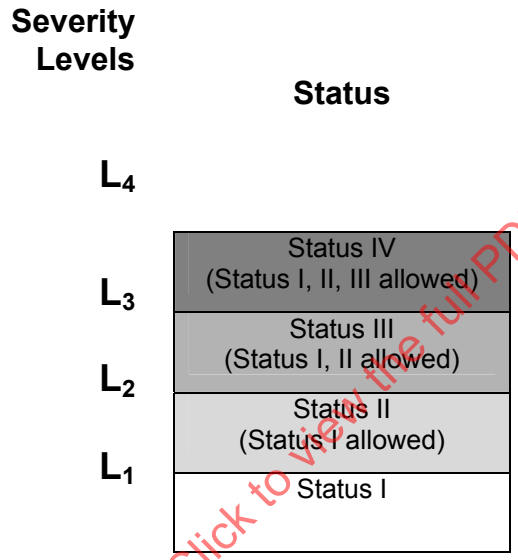

FIGURE A1—ILLUSTRATION OF FUNCTION PERFORMANCE STATUS CLASSIFICATION

APPENDIX B
APPLICATION OF FUNCTION PERFORMANCE STATUS CLASSIFICATION

B.1 Example of application of function performance status classification

In certain applications, the function performance status classification is required to be expressed in multiple Groups (such as critical nature of the function as related to the operation of the vehicle or frequency bands of the test signals etc.).

This example illustrates the concept how the function can be expressed for 3 different Groups (Table B1).

It also demonstrate, as an example how the severity levels can be specified for application to the testing of immunity to two different test methodologies: 1. Electrical disturbances by narrowband radiated electromagnetic energy - absorber-lined chamber method (SAE J1113-21) and 2. Immunity to conducted transients on power leads test method (J1113-11 Pulse 1) (Table B2). It is important to point out the severity levels given in this example are for purpose of demonstration only and are not recommended values. The actual requirements must be determined by vehicle manufacturers.

TABLE B1—ILLUSTRATION OF FSPC WITH 3 GROUPS

Severity Levels	Group 1	Group 2	Group 3
L_4	Status IV (Status I, II, III allowed)	Status IV (Status I, II, III allowed)	Status IV (Status I, II, III allowed)
L_3	Status III (Status I, II allowed)	Status III (Status I, II allowed)	Status III (Status I, II allowed)
L_2	Status II (Status I allowed)	Status II (Status I allowed)	Status II (Status I allowed)
L_1	Status I	Status I	Status I

Status	Group 1	Group 2	*Group 3*
IV	L_{41}	L_{42}	L_{43}
III	L_{31}	L_{32}	L_{33}
II	L_{21}	L_{22}	L_{23}
I	L_{11}	L_{12}	L_{13}

TABLE B2—ILLUSTRATION OF SEVERITY LEVELS FOR RADIATED AND CONDUCTED IMMUNITY TESTING

Status	SAE J1113-21			SAE J1113-11 Pulse 1		
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
IV	150 V/m	150 V/m	150 V/m	- 120 V	- 120 V	- 120 V
III	100 V/m	100 V/m	100 V/m	- 80 V	- 100 V	- 100 V
II	40 V/m	60 V/m	80 V/m	- 60 V	- 80 V	- 100 V
I	20 V/m	40 V/m	60 V/m	- 40 V	- 60 V	- 80 V