SAE International™

SURFACE VEHICLE STANDARD

SAE J1113-42

CAN-CELLED DEC2010

Issued 1994-09
Cancelled 2010-12

Superseded by ISO 7637-2

Electromagnetic Compatibility—Component Test Procedure—Part 42—Conducted Transient Emissions

1. Scope

1.1 This SAE Standard defines a component-level test procedure to evaluate automotive electrical and electronic components for Conducted Emissions of transients, and for other electromagnetic disturbances, along battery feed (B+) or switched ignition inputs of a Device Under Test (DUT). Test apparatus specifications outlined in this procedure were developed for components installed in the 12-V passenger cars, light trucks, 12 V heavy-duty trucks, and vehicles with 24 V systems.

1.2 Measurement Philosophy

Various inductive loads installed in a vehicle could be a source of electromagnetic disturbances during switching and/or operating conditions. These disturbances, propagating in the vehicle's electrical system through the interconnecting wiring harness, could adversely affect the proper performance of the on-board electronics. In order to achieve Electromagnetic Compatibility (EMC) of the system, the characteristics of these disturbances should be analyzed. This procedure provides a uniform means for evaluating transients and other disturbances conducted from the DUT along its power supply lines. These tests are performed in a laboratory (bench test). A DUT which is considered to be a potential source of disturbances should be tested according to the procedure described in this document.

NOTE 1—While this procedure is aimed mainly at measuring transients of simple inductive devices (motors, solenoids, relays, etc.), it also applies to subsystems comprised of inductive devices combined with electronics and/or switches. When such a subsystem is fed with both direct feed power supply line and switched ignition power supply line, the test plan should specify where transients are to be measured, and whether these two power supply lines should be tied together for the test.

NOTE 2—This document is a part of the SAE J1113-XX series, EMC Measurement Procedures and Limits for Vehicle Components.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/J1113/42_201012

1.3 Rationale

SAE J1113-42 is cancelled in favor of using ISO 7637-2.

2. References

2.1 Applicable Publications

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, 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 J1113 (various parts)—Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft)
SAE J1113-1—Electromagnetic Compatibility—Component Test Procedure—Part 1: General and Definitions

3. Definitions

See SAE J1113-1.

4. Apparatus

4.1 Test Facility

Care shall be taken to ensure that the surrounding electromagnetic environment would not interfere with the measurement setup.

4.2 Test Instrumentation

4.2.1 ARTIFICIAL NETWORK (AN)

A 5 µH AN unit capable of handling DUT load current shall be used for all measurements (50 A typical). The impedance curve for the AN is shown in Figure 1. If the AN has an EMI port, it should be terminated with a 50 Ω load (this load could be within a measuring instrument.) See Figure 2 for example 5 µH AN schematic.

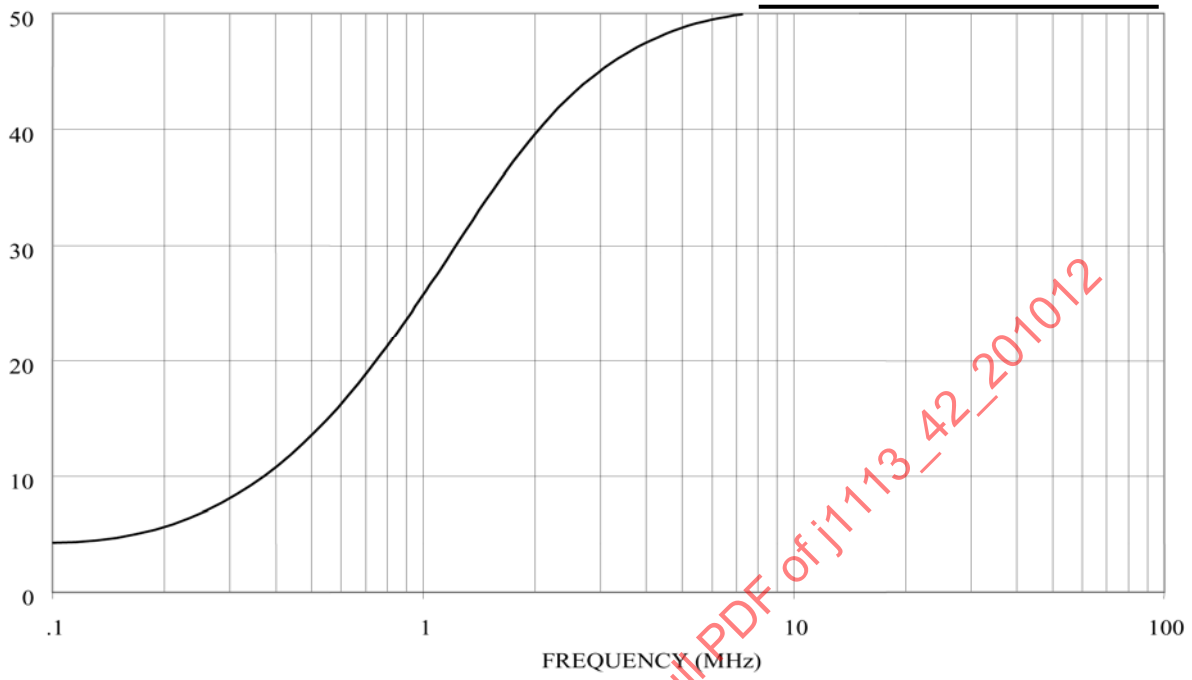

FIGURE 1—IMPEDANCE CURVE FOR ARTIFICIAL NETWORK (AN)

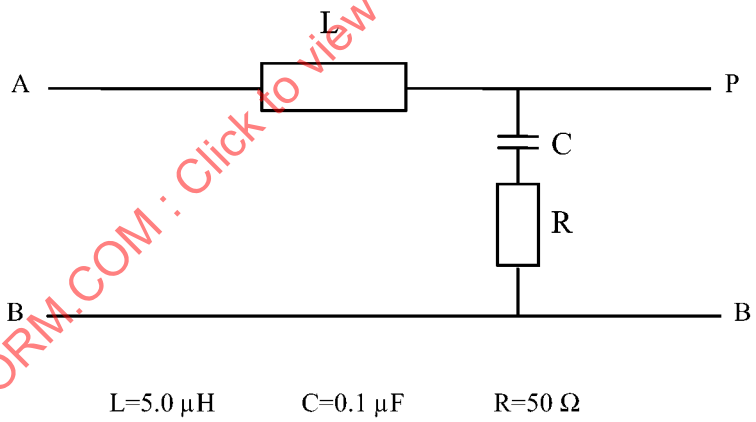

FIGURE 2—EXAMPLE OF 5 µH AN SCHEMATIC

4.2.2 DATA ACQUISITION EQUIPMENT

The equipment utilized should meet the following requirements:

4.2.2.1 Oscilloscope

Use of a digitizing oscilloscope is preferred. If a digitizing oscilloscope is not available, a storage oscilloscope may be used. The oscilloscope used must meet the following requirements.

a. Digitizing Oscilloscope
   1. Minimum Sampling Time—0.5 ns/sample or less
   2. Memory Size—2000 samples minimum
   3. Bandwidth—DC to 400 MHz minimum (at –3 dB)
   4. Input Sensitivity—5 mV/division minimum
   5. High Impedance (input impedance >1 MΩ) oscilloscope shall be used
b. Storage Oscilloscope
   1. Bandwidth—DC to 400 MHz minimum (at –3 dB)
   2. Input Sensitivity—5 mV/division minimum
   3. Writing Speed—100 cm/μs minimum
   4. High Impedance (input impedance >1 MΩ) oscilloscope shall be used

NOTE—The recording may be made with an oscilloscope camera or any other appropriate recording device. Oscilloscopes with other specifications may be substituted as required. Substituted oscilloscope specifications shall be documented in the test report.

4.2.2.2 Voltage Probes

Different voltage probes should be used depending on the magnitudes:

a. Voltage Transients with amplitude exceeding 200 V
   1. Attenuation—100:1 (100x probe)
   2. Input Breakdown Voltage—1.5 kV minimum
   3. Bandwidth—DC to 400 MHz minimum
   4. Input Impedance—1 MΩ minimum
   5. Probe Cable Length—3 m maximum
   6. Probe Ground Lead Length—130 mm maximum
   7. Probe capacitance C< 10pf
b. Voltage Transients with amplitude equal and below 200 V
   1. Attenuation—10:1 (10x probe)
   2. Input Breakdown Voltage—250 V minimum
   3. Bandwidth—DC to 400 MHz minimum
   4. Input Impedance—1 MΩ minimum
   5. Probe Cable Length—3 m maximum
   6. Probe Ground Lead Length—130 mm maximum
   7. Probe capacitance C< 10pf

4.3 Power for the DUT

The DUT shall be powered by a fully charged 12 V battery maintained at 13.0 V ± 0.5 V with the DUT connected and operating. Should a charger be required to maintain the required voltage, it should be disconnected during the actual data acquisition. If a power supply is used either to supplement or used in place of the battery, the power supply must simulate the battery's low output impedance and it must be capable of supplying at least twice the rated current of the DUT, refer to SAE J11131, 6.6.

4.4 Shunt Resistor R_s (Optional)

The shunt resistor R_s (see Figure 3) simulates the DC resistance of other vehicle devices which are connected in parallel to the device under test and are not disconnected from it by the ignition switch. R_s is selected to correspond to the resistance measured on the wiring harness between the disconnected ignition switch terminal and ground, with the switch off, and shall be specified by the vehicle manufacturer. In the absence of any specification, a value of R_s = 40 Ω shall be used. If a wire-wound resistor is used, the winding shall be bifilar (i.e., with a minimum reactive component.)

NOTE—In order to simulate the worst-case condition, R_s may be deleted.

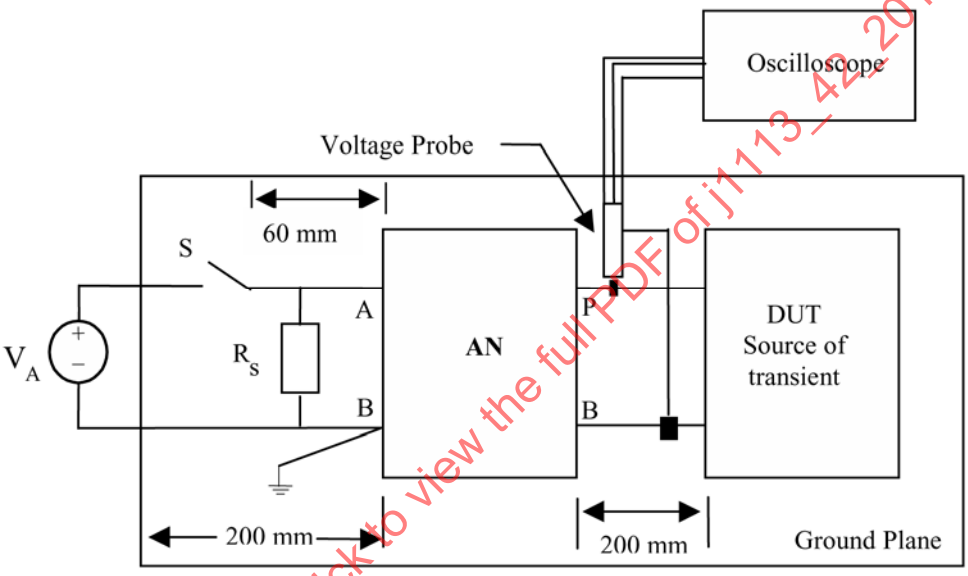

FIGURE 3A—TEST SET UP WITH SWITCH S LOCATED BETWEEN BATTERY AND AN

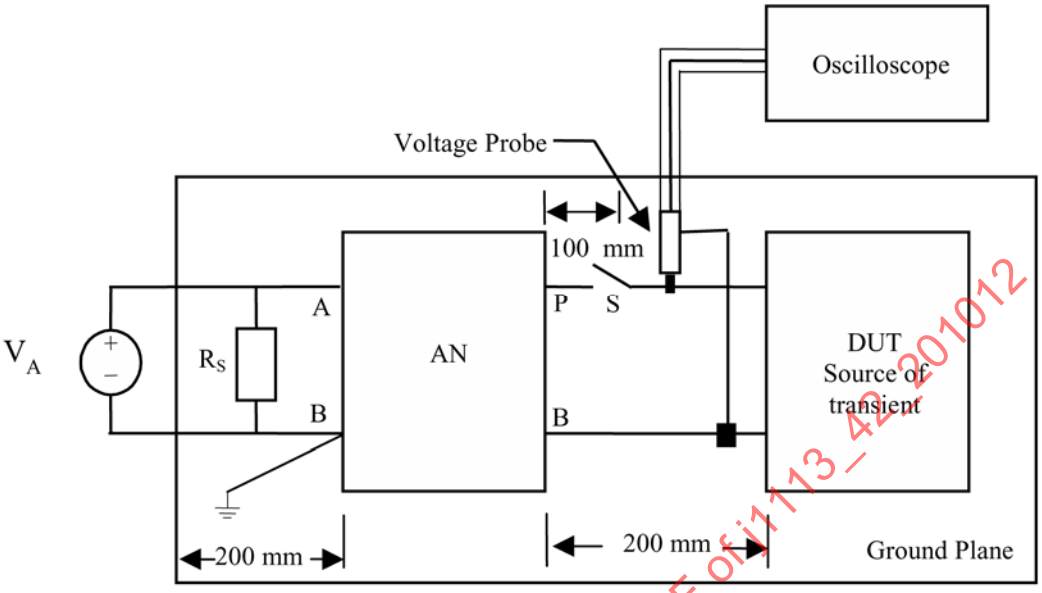

FIGURE 3B—TEST SET UP WITH SWITCH S LOCATED BETWEEN DUT AND AN

4.5 Switch S – Characteristics and location

The Switch S can be located on either side of the artificial network as shown in Figure 3 depending on the actual application in the vehicle. For the measurement of slower transients (t_r or t_f in the ms), use test setup illustrated in Figure 3A. For the measurement of fast transients (t_r or t_f in the ns to µs range), use test setup illustrated in Figure 3B. If the switch position is unspecified, test configurations 3A & 3B should be performed. The selection of the test configuration shall be specified in the test plan prior to the test and documented in the test report. As the Switch S could significantly influence the disturbance transient characteristics, the characteristics of the recommended switching devices are described as follows:

4.5.1 For the measurement of transients with amplitudes exceeding 400 V, Switch S is recommended to be a standard production switch that is used in the vehicle with the device under test. If such a device is not available, an automotive relay with the following characteristics shall be used:

a. Contact Rating—I = 30 A, continuous, resistive load
b. High purity silver contact material
c. No suppression across relay contact
d. Single/double position contact electrically insulated from the coil circuit
e. Coil with transient suppression (with resistor) (Note—ratio of resistance between suppressing resistor and coil resistance should be 12 ± 20%.

NOTE—The switching relay shall be replaced if significant contact degradation occurs.

4.5.2 For the measurement of transients with amplitudes below 400 V, the switching device could either be the switch as described in 4.5.1 or an electronic switch (with reproducible properties). It is probable that amplitudes of disturbance are higher than those normally encountered with conventional switches (arcing). This shall be taken into account when evaluating test results. The characteristics of the electronic switch are as follows:

a. Maximum Voltage—V max = 400 V at 25 A
b. Maximum Current—Imax = 25 A continuously, 100 A for $\Delta t \leq 1$ s
c. Voltage Drop—$\Delta V \leq 1$ V at 25 A
d. Test Voltages—V_A = 13.5 V for 12 V system, V_A = 27 V for 24 V system
e. Switching Time—Δt_s = 300 ns ± 20% with device under test
f. R = 0.6 Ω, L = 50 µH (1 kHz)
g. Shunt Resistor—R_s = 10 Ω, 20 Ω, 40 Ω, and connection for external resistors
h. Trigger—internal and external
i. Voltage Probe—1:100

NOTE 1—The switch shall withstand short-circuiting.

NOTE 2—If the internal construction of the electronic switch includes all or part of the equipment listed in the test setup (i.e., AN, R_s...), those equipment shall not be duplicated in the test setup.

5. Bench Setup Description

5.1 All test devices and interconnecting wiring are to be setup over a metal ground plane. The schematic diagram of the test setup is described in Figure 3. The DUT should not be grounded to the ground plane unless it is specified in the test plan and in such a case, it should be documented in the test report. The ground plane shall meet requirements listed in SAE J1113-1, 6.6.

5.2 All wiring connections between power source, fuse, AN, switch device, and the DUT should be spaced 50 mm above the metal ground plane, with conductors separated by 20 mm (between supply and return conductors). The minimum gauge size of the conductor should be 14 unless the DC current exceeds the rating of the 14gauge conductor.

5.3 The power source for the DUT should be located off one edge of the ground plane.

5.4 The AN should be located midway between the power source terminals and the DUT to standardize the impedance loading. If the AN has a metal enclosure, it should be placed flat on the ground plane and the ground terminal on the power source end should be connected to the ground plane using as short a wire as possible.

5.5 Measurement Attachment Points

The voltage across the DUT shall be recorded according to the test setup (Figure 3).

5.6 Unless otherwise specified, Switch S with characteristics as defined in 4.5.1 and 4.5.2 shall be used.

NOTE—If a standard automotive switch, as defined in 4.5.1 and 4.5.2 is used, it should be exercised for 10 cycles, using the DUT as a load, before transient waveforms are recorded and it should be replaced after 10 000 load cycles.

6. DUT Operating Conditions

DUT operating conditions of particular interest in the measurements are the turn on, the turn off, and the exercising of the various operating modes of the DUT. Exact operating conditions of the DUT must be specified in the Test Plan.

7. Data Acquisition Procedure

The transient voltage waveforms shall be measured and recorded at the specified test point. All measurements for current are optional.

7.1 Coupling

All voltage input channels on the instrument should be set for DC coupling.

7.2 Voltage Input Channels Selection

Differential voltage input channels for the instrument are preferred. If single-ended (unbalanced) input channels are used, then instrument signal ground and power main ground should be isolated from one another for the voltage measurement.

7.3 Sampling Rate

Two different sampling rates are required. The first sampling rate is selected to yield a waveform displaying the complete duration of the transient, and the second sampling rate is selected to display, with good resolution, the highest voltage portion of the transient.

7.3.1 PROCEDURE FOR ACQUIRING TRANSIENT WAVEFORM

7.3.1.1 Trigger Level Selection

Select the voltage channel as the trigger source. The trigger level should be initially set to the highest possible amplitude of the instrument. If no triggering occurs, the trigger level should be gradually reduced until the waveform is obtained. Select positive slope for off-to-on transitions, negative slope for on-to-off. If no triggering occurs, the trigger level should be gradually changed until the waveform is obtained.

NOTE—An iteration process may be required.

7.3.1.2 Sampling Time

The data should be taken at a sample time interval that will record the entire transient event (showing a steady-state value before and after the transient.) A sample interval that results in a 1 ms record is a suggested starting place. The data for the high amplitude portion shall be taken at the minimum sample time interval of the instrument (maximum sample rate) in order to record these transient peaks with the maximum resolution.

7.4 Criteria for Waveform Selection

7.4.1 Perform iteration with various triggering levels and sampling rates until similar, successive waveforms are observed.

7.4.2 The voltage amplitude shall be recorded by actuating the device under test according to the test plan. Other transient parameters, such as rise time, fall time, transient duration, etc., may also be recorded. Unless otherwise specified, ten waveform acquisitions are necessary. It is necessary to only report the waveforms with highest positive and negative amplitude (with their associated parameters, if applicable.)

7.5 Types of Waveform Measurements

DUT switching transients are to be measured from on-to-off and off-to-on, unless otherwise specified in the test plan.

8. Transient Waveform Evaluation

The measured transient shall be compared to the transient amplitude limits table in Tables A2 and A3 of Appendix A. (See Appendix A for further explanation.)

9. Records and Reports

The following items should be included in a report unless otherwise prescribed in the Test Plan or the product specification of the DUT:

9.1 Part number and/or description of the DUT.

9.2 Copy of the original Test Plan and note any deviations.

9.3 Any deviation from the Test Procedure.

9.4 Description of the test setup and equipment used.

9.5 Full description of the operating conditions of the DUT.

9.6 Description of the switching device (switch or relay).

9.7 Points where transients were acquired (pin number, letter, or name).

9.8 All waveform data for each operating mode of the DUT.

Unless otherwise specified, report the waveforms with highest positive and negative amplitude.

9.9 Required Parameters to be Reported

Highest peak voltage (both positive and negative).

9.10 If required per test plan, include transient evaluation result with respect to the performance objective as specified in the test plan.

9.11 Instrument calibration data, unless otherwise preserved in the test facility records.

10. Notes

10.1 Marginal Indicia

The change bar (l) 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 EMI TF OF EMC STANDARDS COMMITTEE