PROCESS SPECIFICATION

SPEC NO. ES-X82114

TITLE: EMC PERFORMANCE REQUIREMENT – COMPONENTS

REV. SYM	REV. LET	DESCRIPTION OF CHANGE	TREV. PAGE	DATE	REV. BY
G	VW1180	Correction of errors, update	ALL	'17.04.24	A.KAWANO
F	TW0638	Correction of errors, update	ALL	'16.03.10	A.KAWANO
E	LJ4580			'11.01.05	Y.SENOO
D	KW0632			'09.03.19	K.SAKAI
C	HW0677			'07.04.04	Y.KAMIYA
B	GW2096			'06.09.21	K.TAKAHASHI

REVISION

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Contents

1. Scope of Application

This specification shall be applicable to electrical/electronic component which will be installed on passenger car, station wagon, van, truck and mini-car.

If something different from the content or specific indication of test condition is required, it will be indicated in drawing and precedence shall be given to such indication

1.1 Purpose of the Standard

The purpose of this engineering standard is to ensure electromagnetic compatibility (EMC) within the vehicle and between the vehicle and its electromagnetic environment. To support this, bench tests of the components not installed in a vehicle are described and the permissible emitted disturbances and the immunity requirements are defined in this standard. Deviations from the requirements contained in this standard are only allowed if agreed explicitly between the supplier and the appropriate vehicle line within MMC and documented in the applicable product specification(s).

The purpose of component testing is the pre-qualification of components from the supplier at a time when representative vehicles are not yet available. In addition to meeting the requirements for a module or component as specified in this standard, the module or component must comply with MMC Standard, EMC Performance Requirements – Vehicle when installed in a representative vehicle. MMC may change the specific requirements for a given component or module, as a result of testing to Standard. Vehicle testing is authoritative for EMC approval. The supplier shall comply with this standard and ensure that the current edition is used.

1.2 Use of this Standard ***

The requirements and test methods in this engineering standard are based on the international standards referenced in paragraph 2.1, wherever possible. Refer to the definitions in this standard and in the references ／for clarification of terms. The default tolerances are as stated in ISO 11452-1. Should a conflict exist between this standard and any of the referenced documents, the requirements of this standard shall prevail, except for regulatory requirements. MMC may change the specific requirements for a given component or module, as a result of testing to this standard. This standard applies to electrical and/or electronic components or modules that refer to this standard for their EMC requirements. These components are referred to in this standard as the component, module, motor, sample or the generic term DUT (device(s) under test).

The recommended procedure for assuring EMC compliance for an electronic module, electrical component or motor is to:

- Refer to this engineering standard in the component product drawing(s)
- Provide the supplemental information needed to classify the component or system functions,
- Identify any exceptions,
- Develop an EMC test plan,
- Confirm that required testing is completed at a MMC approved EMC laboratory and that the specified requirements for the DUT are met.

The supplier is responsible for assuring that the tests are performed to meet the requirements as specified in the releasing document, which refers to this standard. It is the responsibility of MMC designer to verify that the supplier performs these tests and that the requirements are met. MMC reserves the right to perform audit testing on sample parts to verify compliance with this standard.

Questions concerning this standard should be directed to Releasing Engineers.

1.2.1 Additional Information

Component testing to the requirements of this standard represents an empirical risk analysis of component performance versus derived approximations to known environmental threats and customer satisfaction requirements. The development of this standard is based on extensive experience in achieving correlation to expected vehicle performance with a high level of predictability. However, EMC testing, by its nature, is subject to more variation than mechanical testing. Because of coupling variability and measurement uncertainty, correlation between component level performance and final performance in the complete vehicle cannot be exact. In order to maintain a competitive and quality product, vehicle EMC testing will be performed to evaluate overall integrated system performance. Vehicle level analysis is not a substitute for component conformance to this standard.

1.3 Requirements for Applying this Generic Standard to a Specific Component ***

The releasing department shall define the following information when referencing this EMC engineering standard in the product specification(s):

- CATEGORY (and subcategory, if applicable) of the electronic component or module (see definitions)
- DUT FUNCTIONS and their FUNCTIONAL GROUP (affects test levels, see definitions and Appendix A)
- ACCEPTABLE PERFORMANCE LIMITS for these functions (to establish criteria for Function Performance Status I, II or III)
- DUT LOCATION, INTERNAL SIGNALS OR OTHER FACTORS that may affect the appropriate requirements.

NOTE: Starter motors, snow plow motors and similar high current motors are not covered by this standard unless they incorporate integral electronics. These devices are subject to evaluation at the vehicle level. Electro explosive devices (EEDs) or initiators are not covered by this standard.

Not all tests are applicable to all electrical or electronic components; the applicable tests shall be specified in the DUT product specification. For default requirements refer to Table 1, EMC Test Selection Matrix.

Table 1: EMC Test Selection Matrix ***

TEST	ELECTRONIC COMPONENTS									MOTORS		Inductive Devices	
	Category				Subcategory (in addition to Category)					Category		Category	
	P	A	B	HV	C	S	MS	X	Y	BCM	ECM	R	IP
EMISSIONS													
CISPR 25 CE (V & I)		X		I						V	X		V
CISPR 25 RE		X		X							X		
Magnetic RE								X		X	X		
Transient CE								X	X	X	X	X	X
IMMUNITY													
BCI		X		X							X		
TEM					X								
ALSE:ISO or SAE (with or without Ground Plane)		X	X	X							X		
Magnetic Field							X						
TRANSIENTS													
Power Lines	X	X								X	X		
I/O: fast transients (a+b)		X									X		
I/O: slow transients (± #2)						X							
ESD	X	X	X	X							X		

Note: **X** – requirement, **V** – Voltage emission test only, **I** – current emission test only, refer to Section 3 for definitions of the categories, sub-categories and abbreviations.

2. References

2.1 International Documents ***

CISPR 16-1 1999-10, Amendment 1 2002-08 & Amendment 2 2003-04 Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus

CISPR 25:2008 Radio disturbance characteristics for the protection of receivers used on-board vehicles, boats and on devices – Limits and methods of measurement

IEC 60050-161 1990-08, Amendment 1 1997 & Amendment 2 1998 International electro technical vocabulary, Chapter 161: Electromagnetic compatibility.

IEC 61000-4-2:2008 Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (Edition 1.2)

ISO/IEC 17011:2004 Calibration and testing laboratory accreditation systems - General requirements for operation and recognition.

ISO 10605 2001-12 Road vehicles – Test methods for electrical disturbances from electrostatic discharge

ISO 7637-1:2002/Amd 1:2008 Road vehicles, Electrical disturbance from conduction and coupling Part 1 – Definitions and general considerations

ISO 7637-2:2011 Road vehicles, Electrical disturbance from conduction and coupling Part 2 - Electrical transient conduction along supply lines only

ISO 7637-3:2007 Road vehicles, Electrical disturbance from conduction and coupling Part 3 - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

ISO 11452-1 2005/Amd 1:2008 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General and definitions

ISO 11452-2 2004 Road vehicles, Electrical disturbances by narrowband radiated electromagnetic energy - Component test methods Part 2 - Absorber-lined shielded enclosure

ISO 11452-3 2001-03 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 3: Transverse electromagnetic (TEM) cell

ISO 11452-4 2005 /Cor 1:2009 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 4: Bulk current injection (BCI)

ISO/IEC 17025:2005/Cor 1:2006 General requirements for the competence of testing and calibration laboratories

2.2 SAE Documents

SAE J1113-21, Oct 1,2005 Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Part 21: Immunity to Electromagnetic Fields, 10 kHz to 18 GHz, Absorber-Lined Shielded enclosure

2.3 Military Standards ***

MIL-STD-1576 (USAF), 1992-09 Military Standard - Electro explosive Subsystem Safety Requirements and Test Methods for Space Systems

MIL-STD-461E, 1999-08 Department of Defense Interface Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

2.4 UN/ECE Regulation

UN/ECE Regulation No. 10

Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

3. Abbreviations, Acronyms, Definitions, & Symbols

Refer to IEC 60050-161, ISO 11452-1 and ISO 7637-1 for additional definitions.

ALSE. Absorber-lined shielded enclosure (also known as anechoic or semi-anechoic chamber). Used in this document, together with ISO or SAE, to designate the test itself with reference to the method described in ISO 11452-1 or SAE J1113-21.

Anomaly. An effect that represents a deviation from performance as described in the DUT test plan (see effect).

Annex. Supplementary material attached to the end of a standard.

Approved Laboratory. An EMC laboratory that meets the requirements for acceptance by MMC through accreditation to ISO-17025. During a transition period of ISO-17025 to become indispensable condition for EU or Japanese Regulations, MMC only give the accreditation to ISO-17025 a recommendation.

Bulk Current Injection (BCI). Method for coupling common-mode RF current into a harness.

Category and subcategory. In this document, electronic modules, electric motors and inductive devices are classified into categories and subcategories, which determine the appropriate test requirements.

Electronic module categories:

- **P:** A passive electrical component or module. Examples: resistor, capacitor, blocking or clamping diode
- **A:** A component or module that contains active electronic devices. Examples: an analog op amp circuit, switching power supply or microprocessor controller.
- **B:** An electronic component that operates without a wiring connection to the vehicle (e.g. tire pressure monitor).
- **HV:** Components that operate at high voltage (greater than 60 V) for electric vehicle power systems.

Electronic module subcategories are in addition to the basic category designation if they apply.

- **C:** An electronic component that is subject to direct radiated coupling to the circuit board below 200 MHz. This is usually an unshielded component that has at least one dimension greater than 200 mm (e.g. instrument cluster).
- **S:** An electronic component or module operated from a regulated power source in another module. This is usually a sensor providing input to a controller.
- **MS:** An electronic component or module that contains magnetically sensitive elements.
- **X:** An electronic module that contains an electric or electronically controlled motor within its package.

- **Y:** An electronic module that contains a magnetically operated relay within its package.

Electric motor categories:

- **BCM:** A brush commutated dc electric motor.
- **ECM:** An electronically controlled or commutated dc electric motor.

Inductive device categories:

- **R:** Relays and solenoids
- **IP:** Inductive devices pulsed at a rate of 100 Hz or greater

CE. Conducted emission test.

CISPR. An acronym for “Comité International Spécial des Perturbations Radioeléctriques” (Special International Committee on Radio Interference).

Coupling Clamp. A coupling clamp is a device with defined dimensions and characteristics for the common-mode coupling of a disturbance with a test circuit without electrical connection to it.

Coupling Plane. A metal panel or plate on which discharges occur in order to simulate discharges of static electricity to objects in the vicinity of the DUT. Also referred to as **HCP**: Horizontal coupling plane or **VCP**: **Vertical** coupling plane.

Damage. A DUT is considered damaged when it no longer performs as specified in the DUT product specification or shows visual evidence (such as discoloration) of electrical or electronic components that have exceeded their ratings.

dBc. The ratio of the amplitude of the harmonics of the RF carrier to the RF carrier fundamental frequency amplitude, in dB.

dBpT. dB picotesla (160 dBpT or 10^{-4} tesla = 1 gauss).

Dedicated Lines. Lines connecting the DUT to a sensor, load or similar input or output without a conductive path, other than ground, to any other module or the vehicle electrical power system.

Diagnostic Indication. An output from the DUT that indicates system status and predefined failure conditions. This output might be an indicator light or a data link to a diagnostic readout.

Disturbance. Any electrical transient or electromagnetic phenomenon that may affect the proper operation of an electrical or electronic device (see stimulus).

DUT. An acronym for Device(s) Under Test. Any electrical or electronic component, module, motor, filter, etc. Also referred to as EUT, sample or equipment under test.

DP. Design Parts

E/E. Electrical and/or Electronic.

Effect. A detectable change in DUT performance due to an applied stimulus.

Effect Threshold. A repeatable transition of the DUT from normal to affected operation occurring at a value or over a range of values of an electrical test parameter.

Electronically Controlled Motor. A motor that has active electronic devices as part of the motor package.

ESD. Electrostatic discharge.

ESD - Air Discharge. Test method whereby the electrode of the test generator is brought near the DUT and discharge is accomplished through an arc to the DUT.

ESD - Contact Discharge. Test method whereby the electrode of the test generator is brought into contact with the DUT and the discharge is triggered by the discharge switch located on the generator.

ESD - Indirect discharge. A discharge onto a coupling plane in the vicinity of the DUT simulating a human discharge to objects in the vicinity of the device.

Fail-safe Mode. A predictable operating mode intended to minimize adverse effects by restricting or shutting down operation when a significant stimulus has made operation unreliable. Operation shall be recoverable after the stimulus is removed without permanent loss of function or corruption of stored data or diagnostic information.

Function. The intended operation of an electrical or electronic module for a specific purpose. The module can provide many different functions, which are, defined (functional group and acceptable performance) by the module specification.

Functional Group. Component or module functions are divided into four groups based on criticality of function. Immunity requirements are appropriate for the functional group - refer to Annex A for functional group classification examples:

- **Group A:** Any function that provides a convenience. Examples are entertainment systems and nonessential displays.
- **Group B:** Any function that enhances, but is not essential to, the operation and/or control of the vehicle. Examples are important information displays.
- **Group C:** Any function that controls or affects the essential operation of the vehicle. Examples are critical engine and transmission control functions, vehicle braking and steering ability.
- **Group D:** Any function that electronically controls the deployment of an electroexplosive device (EED) actuated by passive restraint system with the potential for inadvertent deployment. [Refer to definitions and background in MIL-STD-1576 (USAF)]

Function Performance Status. The performance of DUT functions, when subjected to a disturbance, is described by four performance status levels:

- **Status I:** The function operates as designed during and after a test or exposure to a disturbance.
- **Status II:** The function may deviate from designed performance to a specified level as defined in the product specification during a test or exposure to a disturbance; or it may revert to a fail-safe mode of operation as defined in the product specification but shall return to normal operation after the test is done or the disturbance is removed. (See fail-safe mode)
- **Status III:** The function may deviate from designed performance during a test or exposure to a disturbance. Driver action may be required to return the function to normal operation after the test is completed or the disturbance is removed (e.g. ignition off/on).
- **Status IV:** The device/function shall not sustain any permanent damage as a result of a test or exposure to a disturbance. Dealer action may be required to return the function to normal operation after the test is completed or the disturbance is removed (e.g. battery reset).

Function Status Classification. The required operation of vehicle electronic systems, when subjected to a stimulus, defined in terms of functional group (criticality of function) and function performance status.

HIRF. High Intensity Radiated Field.

Inductive Device. An electromechanical device that stores energy in a magnetic field. Examples are solenoids, relays, buzzers and electromechanical horns.

Informative. Additional (not normative) information intended to assist the understanding or use of the standard.

I/O. Input and output.

Motor - Auto Cycle. A motor that cycles automatically, without direct operator input. These motors are considered to be the same as long operating duration motors for EMC performance. Examples are radiator fan.

Motor - Long Operating Duration. A motor that is expected to be in operation for extended periods of time. (Also applies for other broadband sources.) Examples are blower and wiper motors.

Motor - Short Operating Duration. A motor that operates for short periods of time under operator control. Examples are power window, seat or mirror motors.

Motor - Very Short Cycle. A motor that operates a single cycle of less than one second duration under operator control (e.g. a power door lock actuator).

PCB. Printed Circuit Board.

Powered-down State. A DUT connected in its operating configuration with battery power applied but ignition or switched power turned off and all active functions timed out.

PRF. Pulse repetition frequency.

PP. Production Parts

PWM. Pulse Width Modulated or Modulation.

RE. Radiated emission test.

RF Boundary. An element of an EMC test setup that determines what part of the harness and/or peripherals is included in the RF environment and what is excluded. It may consist of, for example, ANs, RF absorber coated wire and/or RF shielding. Also: An RF-test-system implementation within which circulating RF currents are confined to the intended path between the DUT port under test and the RF-generator output port, in the case of immunity measurements, and to the intended path between the DUT port(s) under test and the measuring apparatus input port, in the case of emissions measurement, and outside of which stray RF fields are minimized. The boundary is maintained by insertion of shielded enclosures, and/or decoupling or filter circuits.

Releasing Engineer: MMC engineer with design and/ or product releasing responsibility (also some times referred as Development Engineer).

Stability. The condition where the DUT maintains control, within defined limits, of a specific function in the presence of an applied stimulus.

Stimulus. A change induced in the electrical environment of the DUT. This change may be an applied voltage level, transient, ac signal or RF field.

Substitution Method. The substitution method is a technique for mapping out the power required to produce a target RF field intensity in an empty test chamber at a designated reference position. When the test object is introduced into the test chamber, this previously determined reference power is then used to produce the exposure field.

Supply Voltage. The voltag１２e that will be available in the vehicle or as simulated on the bench to power the DUT. This voltage is applied to the battery and ignition lines and any DUT inputs or outputs sourced from battery or ignition voltage as configured in a DUT's complete system including circuit protection. This includes lines such as voltage sense, illumination and loads sourced from supply voltage and switched to ground in the DUT.

System Nominal Voltage. The nominal voltage of the onboard power system, which may be: 12, 24 or 42 V.

TEM. Transverse electromagnetic. Used in this document also as an abbreviation for "TEM cell test".

TEM Cell. An enclosed system, often a rectangular coaxial line, in which a wave is propagated in the transverse electromagnetic mode to produce a specified field for testing purposes.

4. Regulated Substances and Recyclability

All materials, procedures, processes, components, or systems must conform to the current regulatory (governmental) requirements regarding regulated substances and recyclability.

5. Test Requirements and Functional Status Classification

5.1 General ***

All test equipment used for measurement shall be calibrated in accordance with ISO 17025. Attention shall be directed to control of the RF boundary in both emission and immunity tests to reduce undesired interaction between the device under test, the test apparatus and the electromagnetic environment. The test equipment, test setups and test procedures shall be documented in lab procedures. MMC reserves the right to inspect the lab procedures. The DUT test plan shall specify the number of samples to be tested. For production parts(PP), a minimum of one sample shall be tested. For Design parts (DP) level parts, a minimum of two samples shall be tested. A DUT is expected to pass all tests, regardless of the order of testing.

A test fixture, or DUT exerciser, provided by the supplier shall be used to electrically simulate the DUT vehicle system and to exercise all of the required functions of the DUT. This system exerciser shall operate during the DUT testing without adverse effect. The system exerciser shall be able to simulate the appropriate load characteristics, i.e., equivalent resistance, capacitance and inductance as expected in a production vehicle. Production intent components should be used for the loads where ever possible. This is particularly critical for inductive and pulse width modulated (PWM) circuits.

For emission and immunity tests that require a shielded enclosure, connections to the DUT support equipment shall not compromise the shielded enclosure. This may be accomplished by either having the DUT support equipment located in the shielded enclosure or, for remotely located support equipment, by using feedthrough filters inline between the DUT and the support equipment. These inline filters shall be in a shielded box with a shielded cable from this box to the enclosure wall.

5.2 Test Conditions

5.2.1 Dimensions

All dimensions in this document are in millimeters unless otherwise specified.

5.2.2 Tolerances

Unless indicated otherwise, the tolerances specified in Table 2 are permissible:

Table 2: Permissible Tolerances

Voltage, current	± 5 %
Time interval, length, energy, power, field strength	± 10 %
Resistance, capacitance, inductance, impedance	± 10 %

5.2.3 Climatic test conditions

Unless indicated otherwise, the climatic test conditions are defined in Table 3.

Table 3: Climatic Test Conditions

Temperature	23 ± 5.0 degrees C (73.4 ± 9 degrees F)
Humidity	20 to 80% relative humidity (RH)

5.2.4 Test voltages

The permissible test voltages are indicated in Table 4.

Table 4: Permissible Test Voltages

Nominal System Voltage (V)	Acceptable Range (V)
12	12 – 14
24	24 – 28
42	36 – 42

5.3 Test Plan

Test plan are available to facilitate test development. The test plan for the DUT shall include:

– the DUT identification (manufacturer, model, serial number, hardware and software version, etc.)
– the voltage, current and appropriate impedance information for each pin
– the number of samples to be tested
– the tests to be performed specifying any available options and including test levels
– the precise test setup (measuring equipment involved, cabling including lengths, etc.)
– failure criteria (to determine functional status and monitoring)
– critical timing or operating parameters that may affect the testing of the DUT

5.4 Function Performance Status Classification

For immunity testing, the required operation of vehicle electronic systems, when subjected to an electromagnetic stimulus, is described by criticality of function (group) and function performance status. Refer to definitions for function, functional group and function performance status.

5.5 Test Report and Statement ***

On completion of the test, the results shall be submitted to the responsible development departments within MMC in the form of a test report with reference to the test plan (electronic data submission is preferred). The test setup shall be documented using photographs. A statement certifying the execution of the tests in accordance with this standard and compliance with its requirements shall be included in the test report.

6. Emissions (Emitted Disturbances)

6.1 General

Active devices and electronically controlled motors (categories A and ECM) shall be tested from 150 kHz to 1GHz unless otherwise specified in the product specification(s). Refer to Table 1 to determine which emissions tests are required for the category (and subcategory) that applies to the DUT. For categories A and ECM, both CISPR 25 voltage on supply lines and CISPR 25 current measurement on all lines shall be performed in the frequency range from 150 kHz to 110 MHz. For high voltage supply lines in high voltage (HV) electric vehicle (EV) or hybrid electric vehicle (HEV) components, the CISPR 25 voltage measurement is not required.

For components without a wiring harness, the CISPR 25 voltage and current measurements are not required. CISPR 25 radiated emissions shall be performed from 50 kHz to 550 kHz and from 30 MHz to 1 GHz.

Components that use a low power RF link (e.g. RF remote keyless entry) require special considerations for emission testing at their operating frequency, refer to Annex E.

Brush commutated electric motors (category BCM) and pulsed inductive devices (category IP) shall be tested for RF broadband emissions (no narrowband) over the frequency range from 150 kHz to 200 MHz using the CISPR 25 voltage method.

Passive devices (category P) are not tested for RF emissions. See Figure 1.

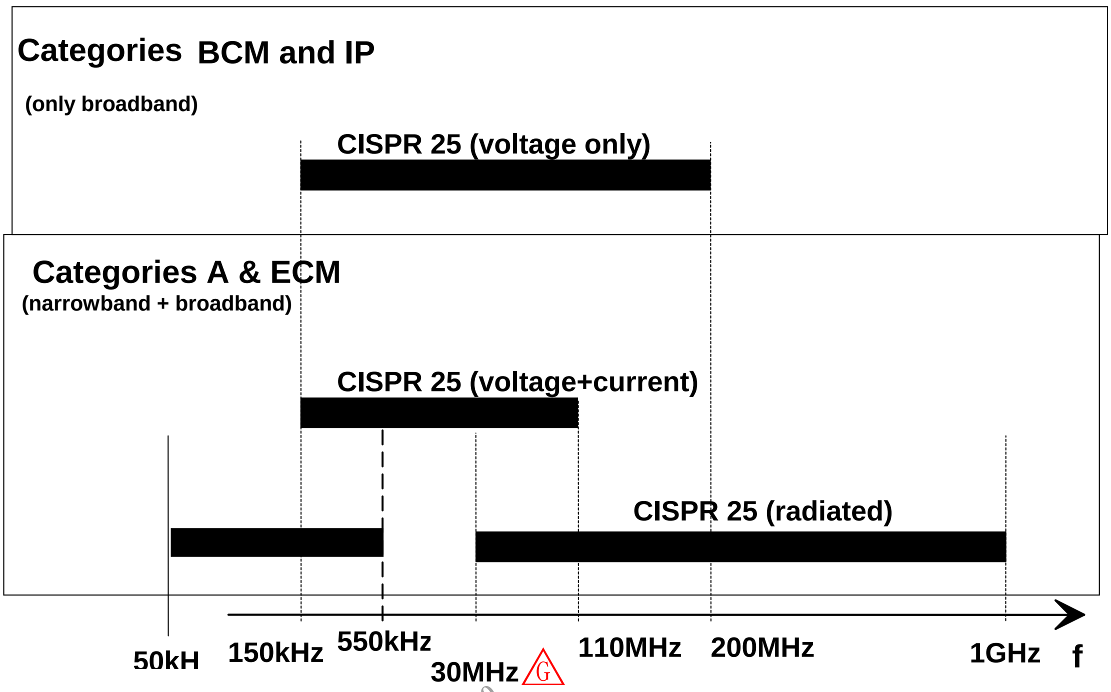


Figure 1: Test Methods versus Frequency ***

For narrowband emissions both peak (P) and average (AV) detectors are allowed, unless specified otherwise. For broadband emissions both peak and quasi-peak (QP) detectors are allowed to 200 MHz and only peak above 200 MHz, unless specified otherwise. When a spectrum analyzer is used for peak or quasi-peak detector measurements, the video bandwidth shall be at least three times the resolution bandwidth. For receivers, frequency step sizes shall be ≤ 50% of the measurement bandwidth unless otherwise specified in the product specification and/or test plan.

If a spectrum analyzer is used the sweep rate shall be 1 MHz per second or slower for 9/10 kHz resolution bandwidth (RBW) and 10 MHz per second or slower for 100/120 kHz RBW. For QP, these sweep rates become 1 kHz or slower for 9/10 kHz RBW~~B~~ and 10 kHz or slower for 100/120 kHz RWB. Minimum receiver measurement times are in Table 5.

Table 5: Minimum Receiver Measurement Time ***

Detector Type	Minimum Measurement Time (ms)
Peak (P) or Average (AV)	50
Quasi-peak (QP)	1000

Limits are given for the continuous frequency ranges (150 kHz to 110/200 MHz and 76 MHz to 1 GHz) and for the specified frequency ranges where protection for onboard receivers is required. At transition frequencies where the limit changes, the lower level will apply. Consideration will be given to emissions at frequencies between 5% below the lower frequency and 5% above the upper frequency for each onboard receiver band.

E/E components and devices that represent a potential threat to other devices due to their emission of magnetic fields (e.g. motors or other inductive devices) shall be tested for their magnetic emissions in the frequency range from 15Hz to 30 kHz. Refer to paragraph 6.6.

E/E components and systems shall fulfill the requirements for transient emissions as specified in paragraph 6.7 unless otherwise specified in the product specification(s).

6. 2 CISPR 25 Conducted RF Emissions - (Voltage on Supply Lines) ***

Radio disturbance emissions conducted along supply lines shall be measured in accordance with CISPR 25 within the frequency range of 150 kHz to 110/200 MHz (see Figure 1) using one or several mains Networks(AN) allowing the decoupling of the disturbance voltage. Artificial mains Network(s) in accordance with CISPR 25 shall be used. The test setups for devices under test with several supply voltage connections shall be implemented using the appropriate number of ANs.

6.2.1 Requirement

The measurements shall be made in the frequency range from 150 kHz to 30 MHz with a measuring bandwidth of 9 or 10 kHz. The measurements shall be made in the frequency range from 30 MHz to 110/200 MHz with a measurement bandwidth of 100 or 120 kHz except where additional narrowband measurements with 9/10 kHz bandwidth are specified. The measured values shall be below the limit values indicated in Tables 9. (the limit values indicated on Table 10 and 11 are selectable)

Table 9: CISPR 25 Conducted RF Emissions Basic Limit Levels on Power Lines

Frequency Range	NB Limit (dBμV) P or AV	BB Limit (dBμV) P or QP
150 to 500 kHz	94 to 70	104 to 80
500 kHz to 6.3 MHz	70	80
6.3 to 30 MHz	60	70
30 to 110/200 MHz	50	60

Table 10: CISPR 25 Measurement Settings and Narrowband CE Limit Levels on Power Lines for Specified Frequency Bands

Qq	Usage	Frequency Range (MHz)	Measuring Instrument Bandwidth (kHz)	Limit Value (dBμV) P or AV
Global Requirements				
G1	**LW AM (EU)**	**0.15 – 0.28**	**9/10**	**50**
G2	**MW AM**	**0.53 – 1.7**	**9/10**	**34**
G3	**SW AM (EU)**	**5.8 – 6.3**	**9/10**	**33**
G4	**Communications (NA)**	**30 – 54**	**9/10**	**24**
G5	**Communications/TV (EU)**	**65 – 87.5**	**100/120**	**24**
G6	**VHF**	**87.5 – 108**	**100/120**	**24**
Optional Requirements for Europe				
OEU1	Fleet	7.1 – 7.6 9.3 – 10.0 11.5 – 12.1 13.6 – 13.8 15.0 – 15.7	9/10	33
OEU2	Communications	25 – 30	9/10	24
OEU3	TV I	41 – 65	100/120	24
OEU4	Fleet	84.015 – 87.255	9/10	12
Optional Requirements for North America				
ONA1	Fleet	30 – 54	9/10	12

Table 11: CISPR 25 Measurement Settings and Broadband CE Limit Levels on Power Lines for Specified Frequency Bands

Test No.	Usage	Frequency Range (MHz)	Limit Value (dBμV) P or QP
Global Requirements			
G1	**LW AM (EU)**	**0.15 – 0.28**	**60**
G2	**MW AM**	**0.53 – 1.7**	**50**
G3	**SW AM (EU)**	**5.8 – 6.3**	**40**
G4	**Communications (NA)**	**30 – 54**	**24**
G5	**Communications/TV (EU)**	**65 – 87.5**	**24**
G6	**VHF**	**87.5 – 108**	**24**
G7	**Communications**	**140 – 180**	**24**
Optional Requirements for Europe			
OEU1	SW AM Fleet	7.1 – 7.6 9.3 – 10.0 11.5 – 12.1 13.6 – 13.8 15.0 – 15.7	40
OEU2	Communications	25 – 30	24
OEU3	TV I TV III	41 – 65 180 – 200	24

6.2.2 Test setup

Test setup is described in detail in CISPR 25. The test setup for devices under test with several supply voltage connections shall be implemented accordingly. Action shall be taken to ensure that the DUT emits its maximum disturbance power (occurring during normal operation) during the measurement.

6.3 CISPR 25 Conducted RF Emissions - (Current on all Lines in Harness) ***

The emitted radio disturbance currents shall be measured on the wiring harness in accordance with CISPR 25 using a current probe within the frequency range of 150 kHz to 110 MHz including the power leads in the current probe. The power supply shall be connected via an Artificial mains Network (AN) in accordance with CISPR 25

6.3.1 Requirements

The measurements shall be made in the frequency range from 150 kHz to 30 MHz with a measuring bandwidth of 9 or 10 kHz. The measurements shall be made in the frequency range from 30 MHz to 110/200 MHz with a measurement bandwidth of 100 or 120 kHz except where additional narrowband measurements with 9/10 kHz bandwidth are specified. All measured values shall be below the limit values in Tables 12. (the limit values indicated on Table 13 and 14 are selectable)

Table 12: CISPR 25 Conducted RF Emissions Basic Limit Levels on All Lines

Frequency Range	NB Limit (dBμA) P or AV	BB Limit (dBμA) P or QP
150 to 500 kHz	68 to 44	78 to 54
500 kHz to 6.3 MHz	38	48
6.3 to 30 MHz	26	36
30 to 110/200 MHz	16	26

Table 13: CISPR 25 Measurement Settings and Narrowband CE Limit Levels on All Lines for Specified Frequency Bands

Test No.	Usage	Frequency Range (MHz)	Measuring Instrument Bandwidth (kHz)	Limit Value (dBμA) P or AV
Global Requirements				
G1	**LW AM (EU)**	**0.15 – 0.28**	**9/10**	**30**
G2	**MW AM**	**0.53 – 1.7**	**9/10**	**6**
G3	**SW AM (EU)**	**5.8 – 6.3**	**9/10**	**-1**
G4	**Communications (NA)**	**30 – 54**	**9/10**	**-6**
G5	**Communications/TV (EU)**	**65 – 87.5**	**100/120**	**-10**
G6	**VHF**	**87.5 – 108**	**100/120**	**-10**
Optional Requirements for Europe				
OEU1	Fleet	7.1 – 7.6 9.3 – 10.0 11.5 – 12.1 13.6 – 13.8 15.0 – 15.7	9/10	-1
OEU2	Communications	25 – 30	9/10	-6
OEU3	TV I	41 – 65	100/120	-10
OEU5	Fleet	84.015 – 87.255	9/10	-16
Optional Requirements for North America				
ONA1	Fleet	30 – 54	9/10	-6

Table 14: CISPR 25 Measurement Settings and Broadband CE Limit Levels on All Lines for Specified Frequency Bands

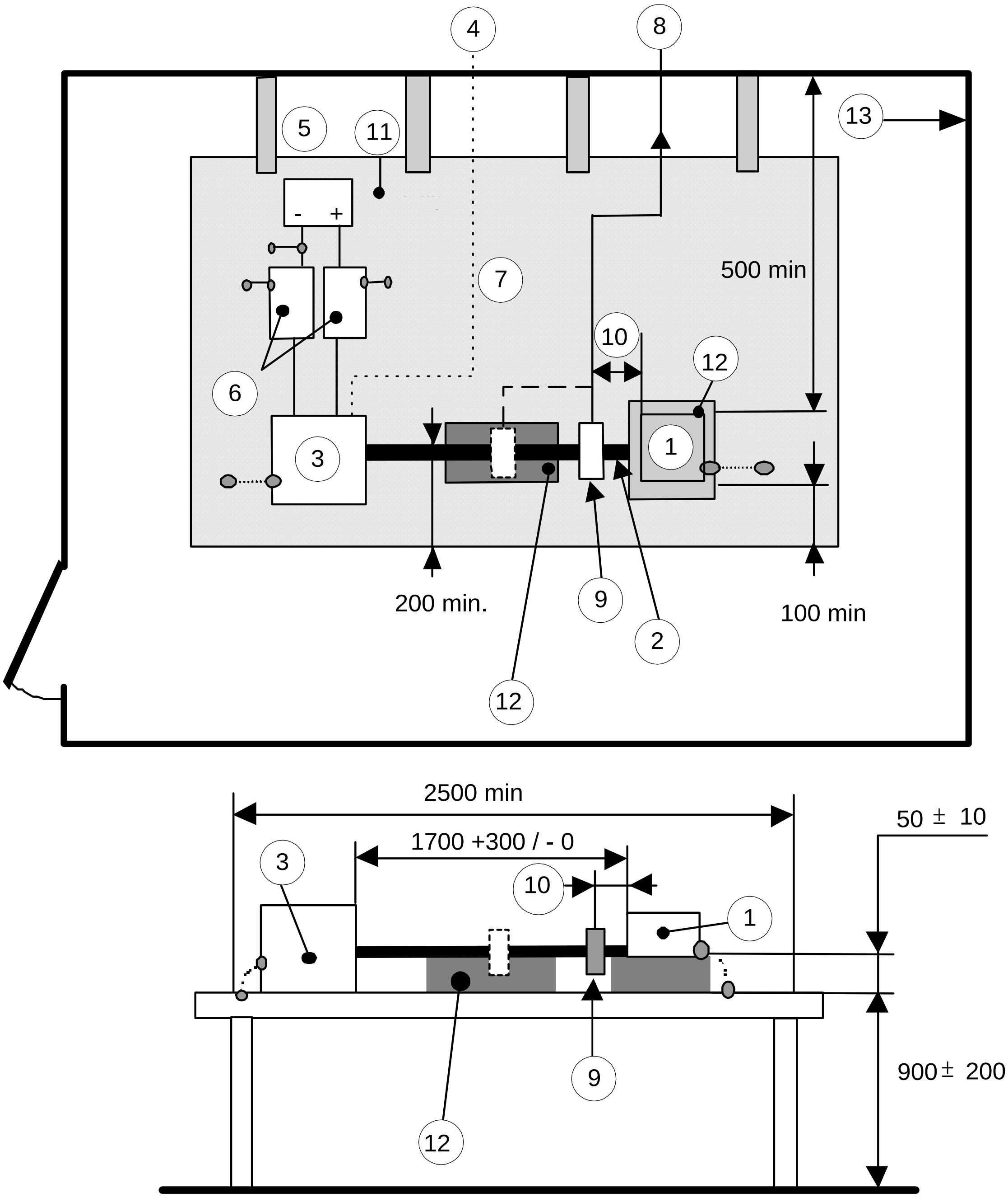
Test No.	Usage	Frequency Range (MHz)	Limit Value (dBμA) P or QP
Global Requirements			
G1	**LW AM**	**0.15 – 0.28**	**40**
G2	**MW AM**	**0.53 – 1.7**	**22**
G3	**SW AM**	**5.8 – 6.3**	**6**
G4	**Communications (NA)**	**30 – 54**	**6**
G5	**Communications/TV (EU)**	**65 – 87.5**	**-10**
G6	**VHF**	**87.5 – 108**	**-10**
G7	**Communications**	**140 – 180**	**-10**
Optional Requirements for Europe			
OEU1	SW AM Fleet	7.1 – 7.6 9.3 – 10.0 11.5 – 12.1 13.6 – 13.8 15.0 – 15.7	6
OEU2	Communications	25 – 30	6
OEU3	TV I TV III	41 – 65 180 – 200	-10

6.3.2 Test setup

CISPR 25 applies with the following exceptions:

- The test harness shall be 1700 (+ 300, – 0) mm long and routed 50 mm above the ground plane (this harness can also be used for BCI testing)
- Measurements shall be taken at the following one or two points:
- at a distance of 50 ± 10 mm from the DUT connector or case over all frequencies;
- at a distance of 750 ± 50 mm from the DUT connector or case for frequencies above 30 MHz;

For a schematic diagram of the measuring setup, refer to Figure 3.



Key:

1 Device under test (connected to ground if specified in the test plan)
2 Wiring harness
3 Load simulator (placement and ground connection according to ISO 11452-4)
4 Stimulation and monitoring system
5 Power supply
6 AN
7 Optical fibers
8 Measurement equipment
9 Current probe (represented at 2 positions)
10 The distance from the DUT to the closest probe position
11 Ground plane (connected to the shielded room)
12 Insulating support
13 Shielded room

This figure is adapted from ISO WD 11452-4.

Figure 3: Measurement of Radio Disturbance Currents Conducted along the Wiring Harness

6.4 CISPR 25 Radiated Emissions ***

The emission of components shall be measured in accordance with CISPR 25 in an absorber-lined shielded enclosure with an antenna or antennas in the frequency range of 30 MHz to 1000 MHz (unless otherwise specified in the product specification).

6.4.1 Requirements ***

The measurements shall be made in the frequency range from 76 to 1000 MHz with a measurement bandwidth of 100 or 120 kHz except where additional narrowband measurements with 9/10 kHz bandwidth are specified. The measured values shall be below the limit values in Tables 15. (the limit values indicated on Table 16 and 17 are selectable).

Table 15: CISPR 25 Radiated Emissions Basic Limit ***

Frequency Range	NB Limit (dBμV/m) P or AV	BB Limit (dBμV/m) P or QP(1)
30 to 200 MHz	40	50
200 to 400 MHz	45	55
400 to 1000 MHz	50	60

Note 1: up to 200 MHz

Table 16: CISPR 25 Radiated Measurement Settings and Narrowband Limit Levels for Specified Frequency Bands

Test No.	Usage	Frequency Range (MHz)	Measuring Instrument Bandwidth (kHz)	Limit Value (dBμV/m) P or AV
Global Requirements				
	IMB	**0.05 – 0.55**	**3/9**	**50**
G6	**VHF**	**76 – 108**	**100/120**	**12**
G7	**Communications**	**140 – 180**	**9/10**	**12**
G8	**TETRA/Trunking**	**380 – 430**	**9/10**	**12**
G9	**Remote Keyless Entry (Immobilizer)**	**430 – 433** **433 – 435** **435 – 438**	**9/10**	**8** **6** **8**
G10	**Communications**	**420 – 520**	**9/10**	**18**
G11	**Cell Phone**	**869 – 894**	**9/10**	**18**
G12	**GSM 30 cm**	**925 – 960**	**9/10**	**18**
Optional Requirements for Europe				
OEU3	TV III TV IV/V	174 – 230 470 – 890	100/120	18 24
OEU4	Fleet	147 – 164	9/10	0
OEU5	Fleet	84.015 – 87.255 167.56 – 169.38 172.16 – 173.98	9/10	0
Optional Requirements for North America				
ONA2	Fleet	140 – 180	9/10	0
ONA3	Remote Keyless Entry	310 – 314 314 – 316 316 – 320	9/10	8 6 8
ONA4	Fleet	420 – 520	9/10	12
ONA5	Fleet	869 – 894	9/10	14
ONA6	Fleet	925 – 960	9/10	14
Optional Requirements for Japan				
OJP1	Remote Keyless Entry	311 – 317	9/10	4
OJP2	TV IV/V	470 – 770	100/120	24
OJP3	Cell phone	810 – 885	9/10	18

Table 17: CISPR 25 Radiated Measurement Settings and Broadband Limit Levels for Specified Frequency Bands ***

Test No.	Usage	Frequency Range (MHz)	Limit Value (dBµV/m) P or QP[1]
Global Requirements			
G6	**VHF**	**76 – 108**	**12**
G7	**Communications**	**140 – 180**	**12**
G8	**TETRA 70 cm**	**380 – 430**	**24**
G10	**Communications**	**420 – 520**	**32**
G11	**Cell Phone**	**869 – 894**	**36**
G12	**GSM 30 cm**	**925 – 960**	**36**
Optional Requirements for Europe			
OEU 3	TV III TV IV/V	174 – 230 470 – 700 700 – 890 G	18 32 36
Optional Requirements for North America			
ONA 2	Remote Keyless Entry	310 – 320	30
Optional Requirements for Japan			
OJP1	TV II TV IV/V	90 – 108 470 – 700 700 – 770	12 32 36
OJP2	Remote Keyless Entry	311 – 317	30
OJP3	Cell phone	810 – 885	36

Note 1: up to 200 MHz

6.4.2 Test setup ***

The test setup is given in detail in CISPR 25. The outer surface of the DUT with the greatest disturbance emission, if known, shall be facing the antenna.

6.5 Magnetic Field Emissions

Electrical and electronic motors and components generate a magnetic field proportional to current that falls off with distance. This magnetic field emissions requirement is based on a minimum separation of 250 mm between the DUT and a magnetically sensitive module (e.g. blower motor to radio/cassette unit).

This test shall not apply to parts or systems not-generating magnetic field.

Small motors (current draw less than 0.5 A) or motors that are an integral part of a module with magnetically sensitive components (e.g. drive motors contained in radio/cassette unit) are expected to be compatible with the overall function of the module and are not evaluated for this requirement.

6.5.1 Requirement

The magnetic flux density measured at a distance of 250 mm from the periphery of the DUT shall not exceed 160 + 20 log(D/250) dBpT (dB picotesla) from 30 Hz to 60 Hz and above 60 Hz this shall decrease at a rate of 12 dB per octave to 52 + 20 log(D/250) dBpT at 30 kHz where ‘D’ represents the distance in millimeters from the periphery of the DUT to the nearest magnetically sensitive module. The measurements shall be performed at all six sides of the DUT to detect the position with the highest emission levels.

6.5.2 Test setup

The magnetic field emissions from the DUT shall be measured with the DUT configured so that it is drawing its rated operating current. If this is not practical, the actual current is to be measured and the magnetic emissions scaled at 6 dB increase for each doubling of DUT current to reach rated current.

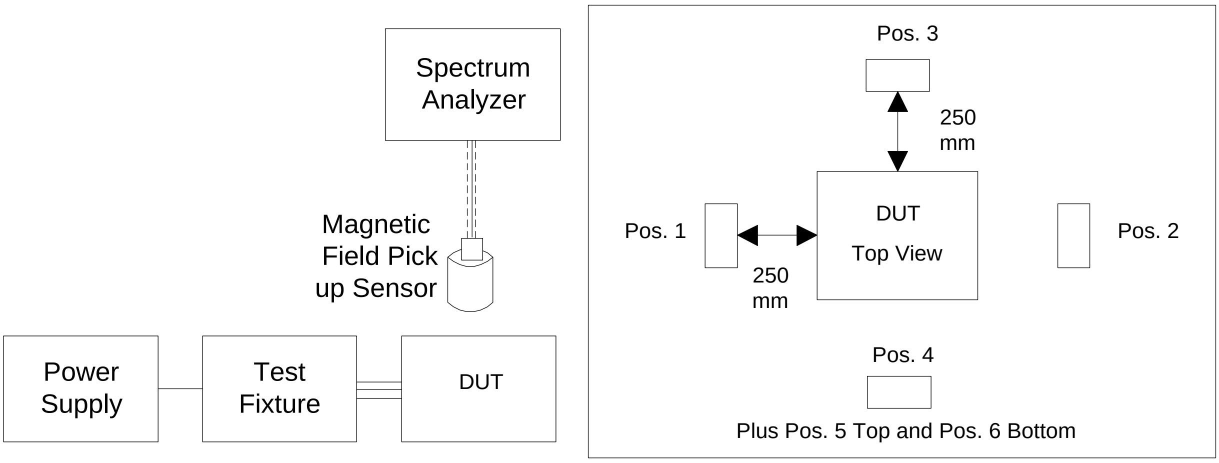


Figure 4: Magnetic Emissions Test Setup

6.6 Conducted Transient Emissions

The DUT shall conform to the following restrictions on switching transients. Inductive devices (Category R or IP) are to be tested with any intended parallel suppression in place. If this suppression is remotely located at a driver in a module, the inductive device must be tested as a system with the module or with the suppression simulated across the inductive device. Conducted transient emissions shall be measured in accordance with ISO 7637-2.

6.6.1 Requirement

The DUT shall be tested with the fast transient setup from ISO 7637-2. The transients for 12 and 42 V systems are limited to +75 volts and -100 volts regardless of their wave shape. The transients for 24 V systems are limited to +80 volts and -150 volts.

6.6.2 Test setup

For details on the test setup, refer to ISO 7637-2 fast transient setup. The setup for the measurements is shown in figure 5.

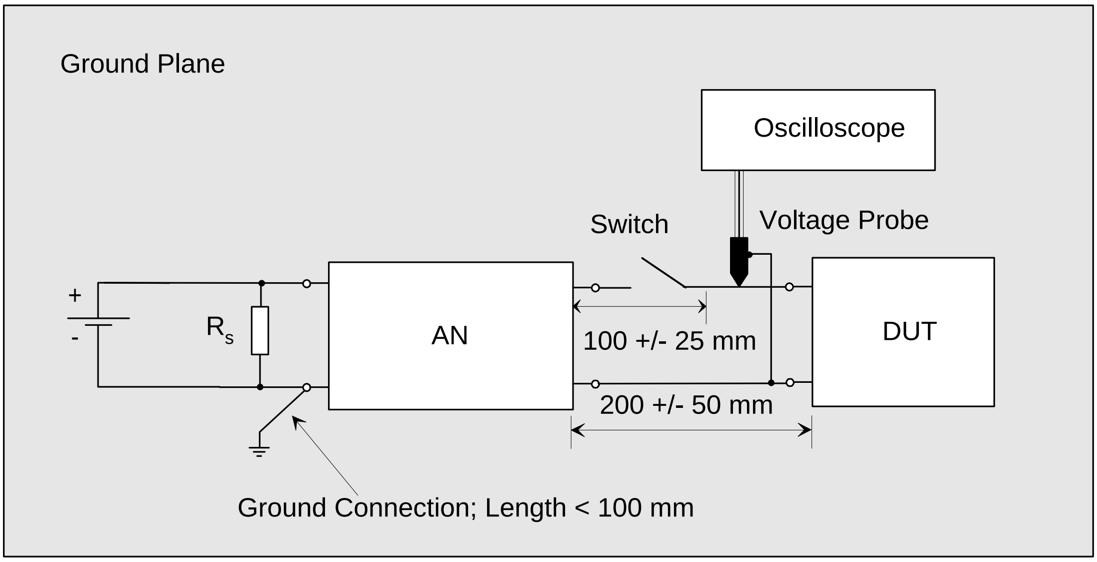


Figure 5: Transient Emissions Test Setup

Representative loading shall be used for the DUT whenever possible. Measure the transient voltages generated by the DUT (motor, inductive device or module) with a storage scope (sampling rate of 1 giga samples per second minimum) while exercising the DUT functions and while turning the DUT on and off ten times using the appropriate vehicle system switch or relay or a switch or relay specified in the test plan. Use an AN between the power supply and the DUT. The conducted transient is measured across the DUT with the power switched on the load side of the AN. The rise time, peak voltage and pulse width shall be captured and recorded.

7. RF Immunity

7.1 General ***

RF Immunity testing shall be performed over the frequency range of 1 MHz to 3.2 GHz. Refer to Table 1 to determine which immunity tests are required for the category (and subcategory) that applies to the DUT. As required in Table 1:

- RF immunity testing is performed from 1 to 400 MHz using a conducted test method and from 200 MHz to 3.2 GHz using a radiated test method.
- Select BCI (refer to 7.3) for conducted immunity testing from 1 MHz to 400 MHz. For high voltage (HV) electric vehicle (EV) or hybrid electric vehicle (HEV) components, BCI shall be used.
- Select either ALSE with a ground plane (refer to 7.4) or without ground plane (refer to 7.5) for radiated immunity testing from 200 MHz to 3.2 GHz.
- Determine if TEM cell testing (refer to 7.6) is also required (subcategory C only).

Deviating from the requirements in this section, in very special cases, such as when a module is already specified and used in a vehicle application but needs additional validation for an application in a vehicle like a bus with many variants (i.e. testing in all variants is not practical), the method defined in Annex F or H for testing, especially in the frequency bands of handheld transmitters, may be used as a substitute above 1 GHz. However, this shall be explicitly agreed to between the supplier and the responsible MMC Releasing Engineers.Figure 6 gives an overview of the test methods.

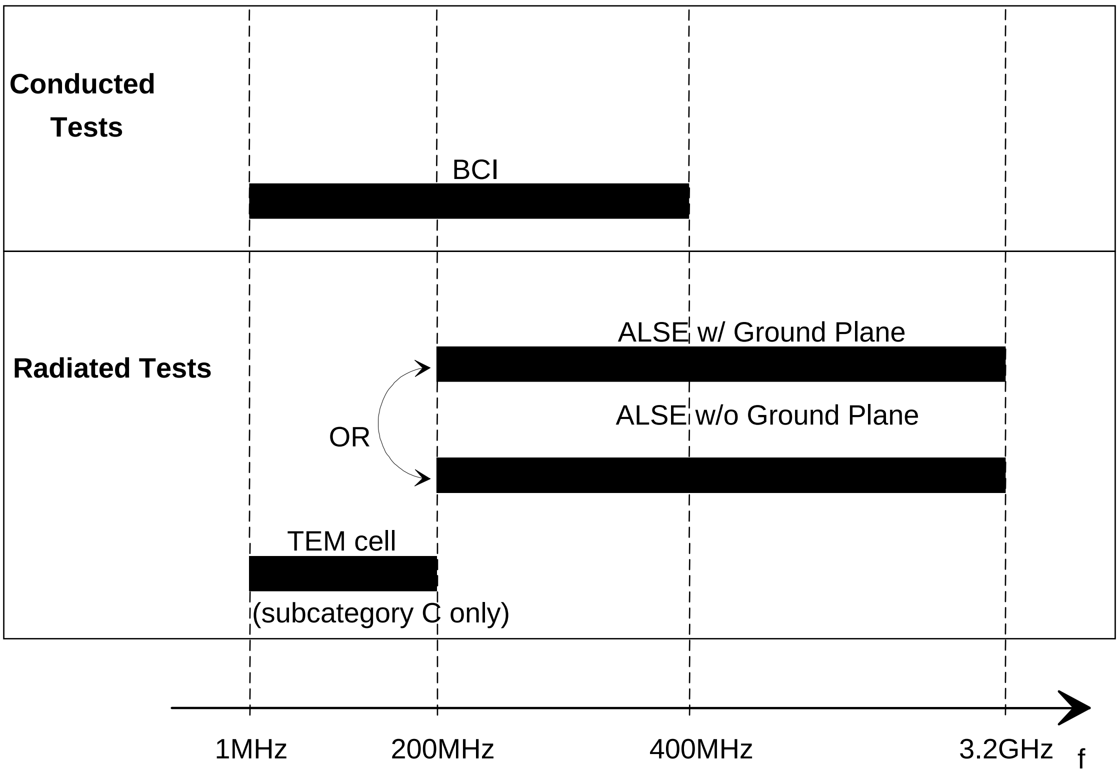


Figure 6: RF Immunity Testing

Normally, testing is done at the level of the highest immunity requirement for the most critical functional group for the DUT. A quick scan at the specified test level, noting the frequency range of any effects, followed by a thresholding scan over these identified effect frequency ranges is the preferred test procedure. Thresholding is done to determine the actual immunity level for other functional groups and status levels. For the thresholding scan, the test level is incremented up to the required level at each test frequency. As an alternative to thresholding, testing may be performed at several levels (e.g. 800, 400, 200, 100 mW). For transition frequency points between basic and HIRF (High Intensity Radiated Field) test levels, the higher level shall be applied. The DUT shall be monitored for effects. Refer to Annex D for CAN bus testing adaptations. Bus modules and systems shall be evaluated for increased ignition off current draw (IOD) resulting from inadvertent wake up from standby or power-down modes during RF exposure. Components that use a low power RF link (e.g. RF remote keyless entry) require special considerations for immunity testing near their operating frequency, refer to Annex E.

Refer to Table 19. Other modulation techniques may be appropriate if the known DUT characteristics indicate a potential for reduced immunity to modulated signals. This information, if known, shall be incorporated in the product specification and/or test plan.

Table 19: Default Modulation for RF Immunity Testing ***

Frequency Range	**Up to 800MHz**	**Above 800 MHz**
Modulation	**CW** and **AM** (1kHz, 80%, constant peak)	**CW** and **Pulse** (217 Hz (± 10%), 12.54% duty cycle)

The minimum dwell time for the immunity tests is 2 seconds. If the DUT or its software require a longer dwell time for comprehensive testing, this shall be incorporated in the DUT EMC test plan. For all the immunity requirements, the components shall be evaluated for functional performance as specified in paragraph 5.4 and the referenced definitions.

All immunity tests shall be conducted with frequency step sizes (logarithmic or linear) not greater than those specified in Table 20. The harmonics of the immunity test signal shall be at least - 12 dBc with a target of - 20 dBc. Care shall be taken to avoid equipment switching transients.

Table 20: RF Immunity Test Frequency Resolution (Maximum frequency step sizes) ***

Frequency Range (MHz)	**>1～10**	**>10～200**	**>200～400**	**>400～1000**	**>1000～3200** G
Linear steps(MHz)	1	5	10	20	40
Logarithmic steps(%)	10	5	5	2	2

The severe environment frequency ranges for HIRF testing are defined in Table 21.

Table 21: Severe Environment Simulation – Frequency Ranges for HIRF Test Level ***

Frequency Range (MHz)	Usage
1 – 30	MW & SW
30 – 54	Communications in North America
65 – 88	Communications in Europe
140 - 180	Communications
380 - 520	Communications
1 200 - 1 400 ,(1345)	Radar
2 700 - 3 200	Radar

Refer to Figure 6 for appropriate test methods.

7.2 Bulk Current Injection (BCI) Test ***

This test exposes the test harness to which the DUT is connected to radiation using the BCI method in accordance with ISO 11452-4 as modified below. This test applies in the frequency range from 1 to 400 MHz.

7.2.1 Requirement

The immunity requirements are based on environmental data and are adapted to BCI through correlation with vehicle data. The immunity performance requirements are specified in Tables 24 to 27.

Table 24: BCI Immunity Performance Requirements, 1 to 30 MHz for Group A, B, C and D

<table>
<tr><th>Test Level (mA)</th><th>Group A Status</th><th>Group B Status</th><th>Group C Status</th><th>Group D Status</th></tr>
<tr><td>500</td><td>No Test</td><td>No Test</td><td>No Test</td><td rowspan="4">II</td></tr>
<tr><td>375</td><td>III</td><td>III</td><td rowspan="3">II</td></tr>
<tr><td>250</td><td rowspan="2">II</td><td rowspan="2">II</td></tr>
<tr><td>180</td></tr>
<tr><td>107</td><td>I</td><td>I</td><td>I</td><td>I</td></tr>
</table>

Table 25: BCI Immunity Performance Requirements, 30 to 100 MHz for Group A, B, C and D

<table>
<tr><th rowspan="2">Test Level (mA)</th><th colspan="2">Group A Status</th><th colspan="2">Group B Status</th><th colspan="2">Group C Status</th><th colspan="2">Group D Status</th></tr>
<tr><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th></tr>
<tr><td>400</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="2">No Test</td><td>II</td></tr>
<tr><td>300</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>200</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td><td rowspan="2">II</td></tr>
<tr><td>140</td><td>II</td><td>II</td><td rowspan="2">I</td><td>II</td></tr>
<tr><td>107</td><td>I</td><td>I</td><td>I</td><td>I</td><td>I</td></tr>
</table>

Table 26: BCI Immunity Performance Requirements, 100 to 220 MHz for Group A, B, C and D

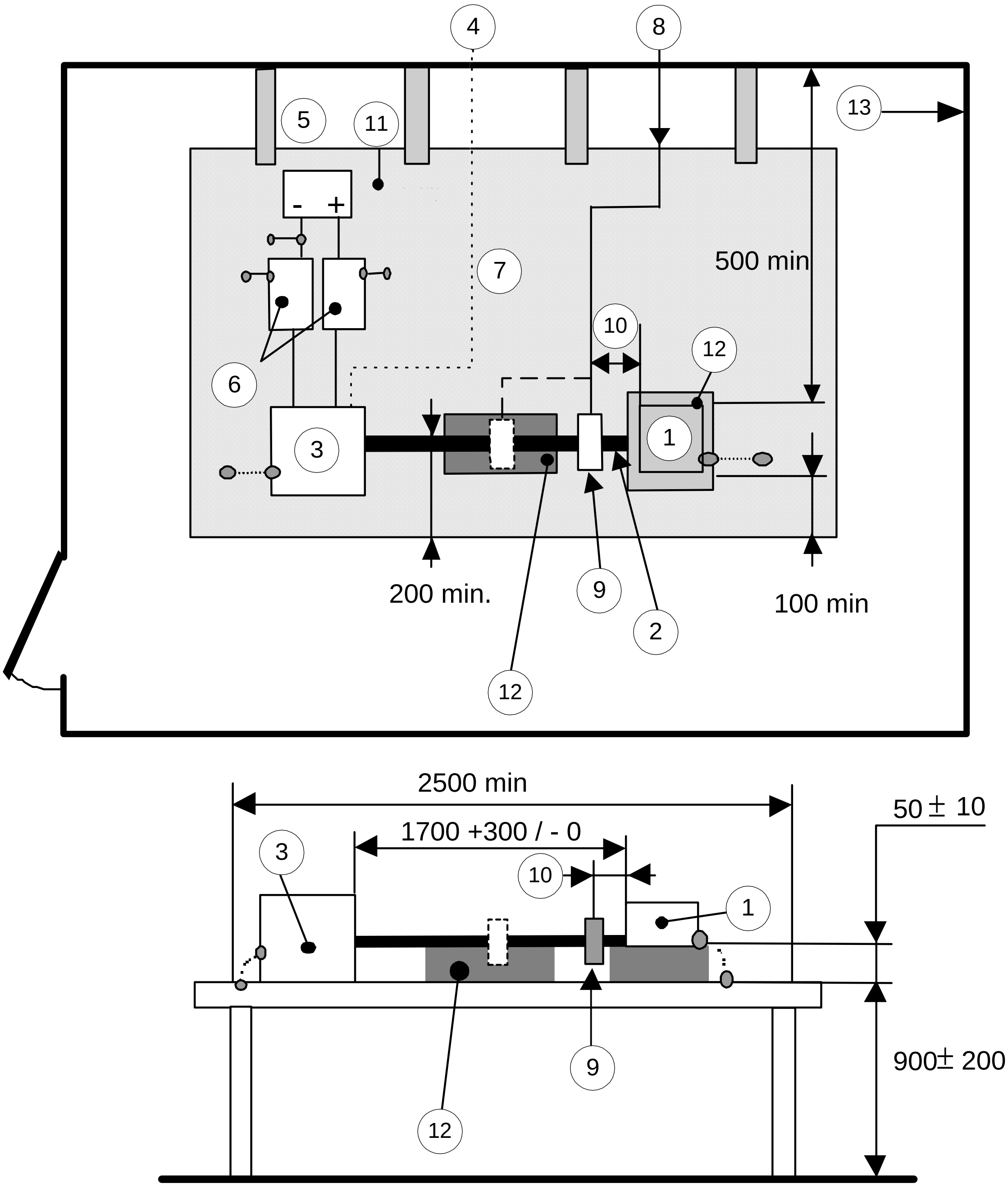
<table>
<tr><th rowspan="2">Test Level (mA)</th><th colspan="2">Group A Status</th><th colspan="2">Group B Status</th><th colspan="2">Group C Status</th><th colspan="2">Group D Status</th></tr>
<tr><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th></tr>
<tr><td>300</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="2">No Test</td><td>II</td></tr>
<tr><td>225</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>150</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td><td>II</td></tr>
<tr><td>107</td><td>II</td><td rowspan="2">I</td><td rowspan="2">I</td><td rowspan="2">I</td><td rowspan="2">I</td></tr>
<tr><td>50</td><td>I</td><td>I</td></tr>
</table>

Table 27: BCI Immunity Performance Requirements, 220 to 400 MHz for Group A, B, C and D

<table>
<tr><th rowspan="2">Test Level (mA)</th><th colspan="2">Group A Status</th><th colspan="2">Group B Status</th><th colspan="2">Group C Status</th><th colspan="2">Group D Status</th></tr>
<tr><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th></tr>
<tr><td>200</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="2">No Test</td><td>II</td></tr>
<tr><td>150</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>107</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td><td rowspan="3">I</td></tr>
<tr><td>70</td><td>II</td><td rowspan="2">I</td><td rowspan="2">I</td><td rowspan="2">I</td></tr>
<tr><td>35</td><td>I</td><td>I</td></tr>
</table>

7.2.2 Test Setup ***

Due to changes with respect to ISO 11452-4, refer to Figure 8 for a schematic diagram of the test setup.



Key:

1 Device under test (connected to ground if specified in the test plan)
2 Wiring harness
3 Load simulator (placement and ground connection according to ISO 11452-4)
4 Stimulation and monitoring system
5 Power supply
6 AN
7 Optical fibers
8 High frequency equipment
9 Injection probe (represented at 2 positions)
10 The distance from the DUT to the closest probe position
11 Ground plane (connected to the shielded room)
12 Insulating support
13 Shielded room

This figure is adapted from ISO WD 11452-4.

Figure 8: Immunity Test Using the BCI Method - Schematic Diagram of the Test Setup

- A current injection probe shall be used; a current monitoring probe is optional.
- Use substitution method with forward power.
- The test setup shall be on a sufficiently large ground plane, so that the plane shall extend beyond the test setup by at least 100 mm on all sides.
- The distance between the test setup and all other conductive structures (such as the walls of the shielded enclosure) with the exception of the ground plane shall be no less than 500 mm.
- Where part of the system to be tested is normally connected electrically with the vehicle body, this part shall be placed directly on the ground plane and connected with it.
- Deviating from ISO 11452-4, the test harness shall be 1700 (+ 300, – 0) mm long and routed 50 mm above the ground plane (this harness can also be used for CISPR 25 Radiated Emission testing).
- The current injection probe shall be located on the test harness at three points, a distance of 150 mm, 450 mm and at 750 mm from the DUT. Where the harness has a number of branches, the test shall be repeated, so that the current injection probe shall be attached around each branch.
- The voltage supply and the periphery shall be filtered and shielded (alternative: outside the shielded enclosure); exception: peripherals which are not susceptible to radiated disturbances (such as mechanical switches).
- Wherever possible, production intent vehicle switching devices and sensors shall be used.

7.3 ALSE with a Ground Plane

The DUT shall be subjected to radiated immunity testing using an antenna for field generation in accordance with ISO 11452-2 (with ground plane) with changes as defined in this document.

7.3.1 Requirement

For Group A, B and C evaluation, the basic test level is 70 V/m and the HIRF test level is 150 V/m from 200 MHz to 3.2 GHz. For Group D evaluation, the basic test level is 100 V/m and the HIRF test level is 200 V/m from 200 MHz to 1.4 GHz and 150 V/m from 1.4 to 3.2 GHz. The test levels and functional status requirements by frequency range and functional group are specified in Table 28.

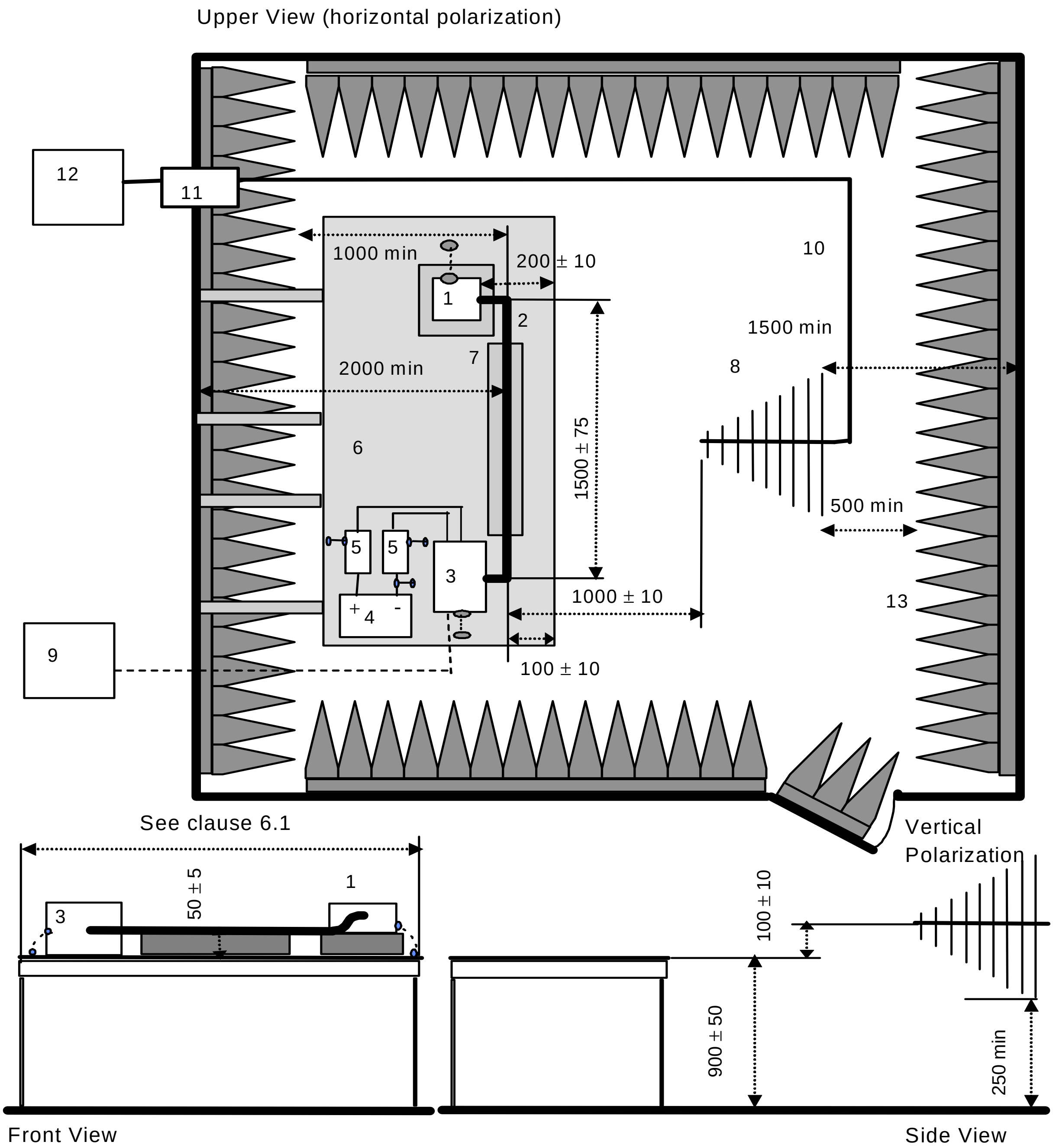
Table 28: Performance Requirements for ALSE Testing, Group A, B, C and D

<table>
<tr><th rowspan="2">Test Level V/m</th><th colspan="2">Group A Status</th><th colspan="2">Group B Status</th><th colspan="2">Group C Status</th><th colspan="2">Group D Status</th></tr>
<tr><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th></tr>
<tr><td>200 (to 1.4 GHz)</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="2">No Test</td><td>II</td></tr>
<tr><td>150</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>100</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td><td rowspan="3">I</td></tr>
<tr><td>70</td><td>II</td><td rowspan="2">I</td><td rowspan="2">I</td><td rowspan="2">I</td></tr>
<tr><td>35</td><td>I</td><td>I</td></tr>
</table>

7.3.2 Test setup

Due to changes with respect to ISO 11452-2, refer to Figures 9 and 10 for schematic diagrams of the test setups. The following deviations from and additions to ISO 11452-2 apply:

- Use substitution method with forward power.
- For frequencies ≤ 1 GHz, the antenna shall be positioned in front of the middle of the harness (refer to Figure 9). For frequencies above 1 GHz, the antenna shall be sighted on the DUT (refer to Figure 10).
- For modules in a metal case, the DUT connector(s) should be oriented toward the antenna.
- Wiring harness length and routing shall be controlled and documented.
- Production intent vehicle sensors and loads shall be used as peripheral devices wherever possible.
- The test shall be carried out with vertical antenna polarization only up to 400 MHz and with vertical and horizontal antenna polarization above 400 MHz.

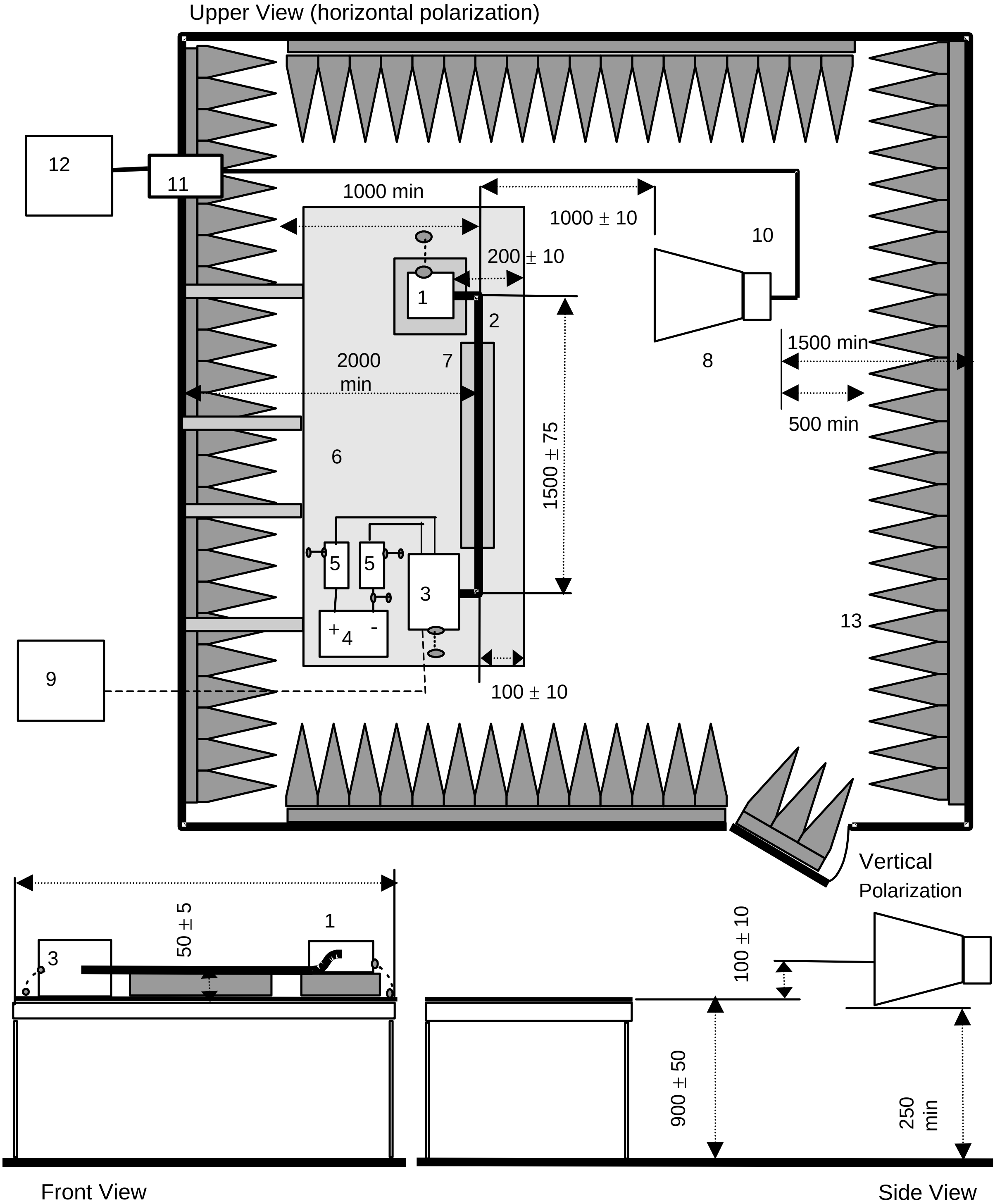


Key:

1 DUT (grounded locally if required in test plan)
2 Test harness
3 Load simulator (placement and ground connection according to ISO 11452-2)
4 Power supply (location optional)
5 Artificial mains Network (AN)
6 Ground plane (bonded to shielded enclosure)
7 Low relative permittivity support ($\varepsilon_r \leq 1.4$)
8 Log-periodic antenna
9 Monitoring device
10 Double-shielded coaxial cable (50 ohm)
11 Bulkhead connector
12 RF Amplifier System
13 RF absorber material

The figure is adapted from ISO 11452-2.

Figure 9: Radiated Immunity Test in an ALSE with a Ground Plane (≤1000 MHz)



Key:

1	DUT (grounded locally if required in test plan)	7	Low relative permittivity support ($\varepsilon_r \leq 1.4$)
2	Test harness	8	Horn antenna
3	Load simulator (placement and ground connection according to ISO 11452-2)	9	Monitoring device
4	Power supply (location optional)	10	Double-shielded coaxial cable (50 ohm)
5	Artificial mains Network (AN)	11	Bulkhead connector
6	Ground plane (bonded to shielded enclosure)	12	RF Amplifier System
		13	RF absorber material

The figure is adapted from ISO 11452-2.

Note: Horn antenna has been moved to sight on the DUT.

Figure 10: Radiated Immunity Test in an ALSE with a Ground Plane (>1000 MHz)

7.4 ALSE without a Ground Plane

The DUT shall be subjected to radiated immunity testing using an antenna for field generation in accordance with SAE J1113-21 (without ground plane). RF uniformity requirement: define a 0.5x1.0 meter rectangular vertical plane through the field reference location perpendicular to the line from the antenna to the DUT. Measure the uniformity at all the defined points for the lowest and highest frequency used for each antenna. The uniformity shall be less than or equal to 6 dB relative to the reference point

7.4.1 Requirement

For Group A, B and C evaluation, the basic test level is 70 V/m and the HIRF test level is 150 V/m from 200 MHz to 3.2 GHz. For Group D evaluation, the basic test level is 100 V/m and the HIRF test level is 200 V/m from 200 MHz to 1.4 GHz and 150 V/m from 1.4 to 3.2 GHz. The test levels and functional status requirements by frequency range and functional group are specified in Table 28.

7.4.2 Test setup

For a schematic diagram of the test setup refer to Figure 11.

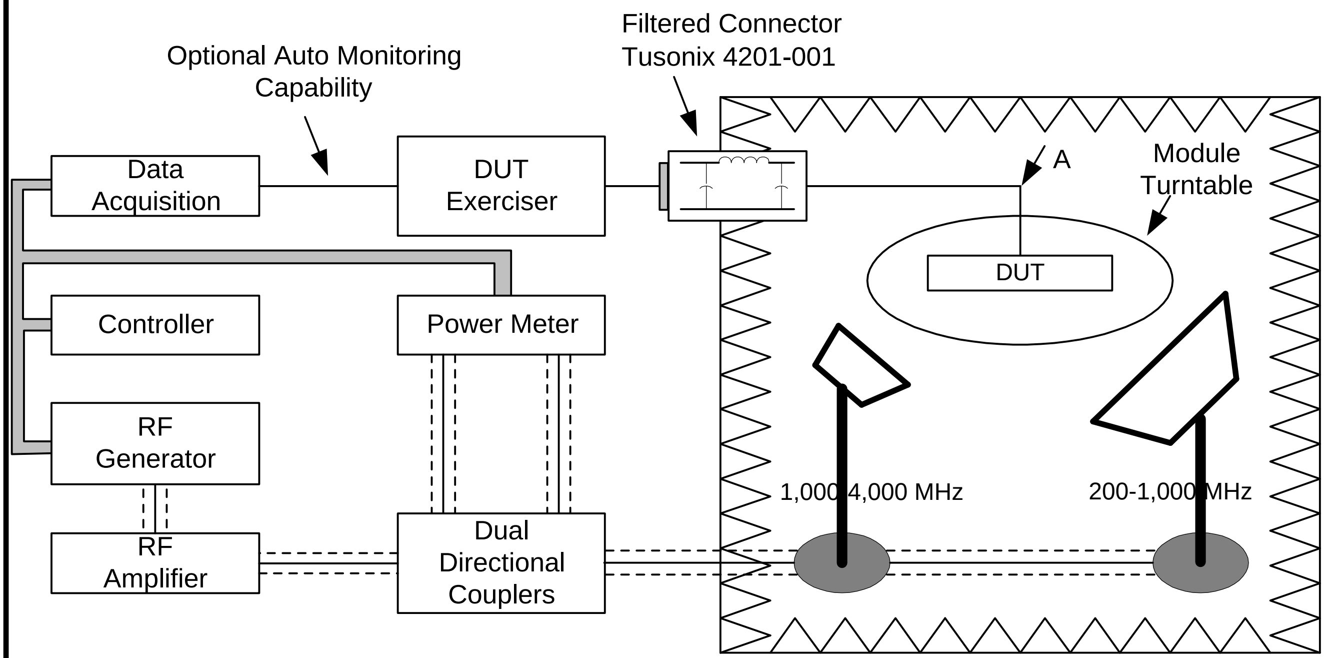


Figure 11: Radiated Immunity Test in an ALSE without a Ground Plane

- Use substitution method with forward power and specified uniformity.
- The antenna shall be sighted on the DUT
- DUT to point “A” is an unshielded wiring harness of 600 ± 50 mm in length.
- From point “A”, the harness goes vertically 1 meter to the floor and along the floor to the wall bulkhead feedthrough filter.
- The DUT shall be 1 meter above the floor.
- The DUT shall be a minimum of 1 meter from the antenna and any other conductive surface and a minimum of 1 meter from any absorber.
- Vertical polarization shall be used.
- The DUT shall be tested in three mutually perpendicular orientations (principal planes): (i) with the main circuit board in the DUT parallel to the chamber floor (vehicle mounting surface down), (ii) with the main circuit board perpendicular to the chamber floor edge on to the antenna and (iii) with the

main circuit board perpendicular to the chamber floor and broadside to the antenna. These three orientations shall be chosen from the six possible orthogonal orientations, to allow visibility of the DUT, if required, and to maintain a consistent and repeatable routing of the DUT harness and direct exposure of DUT apertures to the antenna.

- For modules in a metal case, the DUT connector(s) should be orientated upward or toward the antenna.
- Wiring harness routing shall be controlled and documented.

7.5 TEM Cell Test

Subcategory C components shall be subjected to radiated immunity testing with reference to ISO 11452-3 over the frequency range of 1 to 200 MHz. The TEM cell used shall have a VSWR not to exceed 1.3:1 (empty cell) from 1 to 200 MHz. The TEM cell shall have a feedthrough filter assembly to provide RF isolated interfacing between the DUT and its system simulator outside the cell.

7.5.1 Requirement

From 1 to 30 MHz, the basic test level is 150 V/m for Group A, B and C functions and 200 V/m for Group D functions. From 30 MHz to 200 MHz, the basic test level is 75V/m and the HIRF test level is 150 V/m for Group A, B and C functions; the basic test level is 100 V/m and the HIRF level is 200 V/m for Group D functions. The immunity performance requirements are specified in Tables 29 and 30.

Table 29: TEM Cell Immunity Performance Requirements, 1 to 30 MHz, Group A, B, C and D

<table>
<tr><th>Test Level V/m</th><th>Group A Status</th><th>Group B Status</th><th>Group C Status</th><th>Group D Status</th></tr>
<tr><td>200</td><td>No Test</td><td>No Test</td><td>No Test</td><td>II</td></tr>
<tr><td>150</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>100</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td></tr>
<tr><td>70</td><td rowspan="2">I</td></tr>
<tr><td>35</td><td>I</td></tr>
</table>

Table 30: TEM Cell Immunity Performance Requirements, 30 to 200 MHz, Group A, B, C and D

<table>
<tr><th rowspan="2">Test Level V/m</th><th colspan="2">Group A Status</th><th colspan="2">Group B Status</th><th colspan="2">Group C Status</th><th colspan="2">Group D Status</th></tr>
<tr><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th><th>Basic Level</th><th>HIRF Level</th></tr>
<tr><td>200</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="3">No Test</td><td>No Test</td><td rowspan="2">No Test</td><td>II</td></tr>
<tr><td>150</td><td>III</td><td>III</td><td>II</td><td rowspan="4">I</td></tr>
<tr><td>100</td><td rowspan="2">II</td><td>II</td><td rowspan="3">I</td><td rowspan="3">I</td></tr>
<tr><td>75</td><td>II</td><td rowspan="2">I</td><td rowspan="2">I</td><td rowspan="2">I</td></tr>
<tr><td>35</td><td>I</td><td>I</td></tr>
</table>

7.5.2 Test setup

Details on the test setup are given in ISO 11452-3 and in Figure 12.

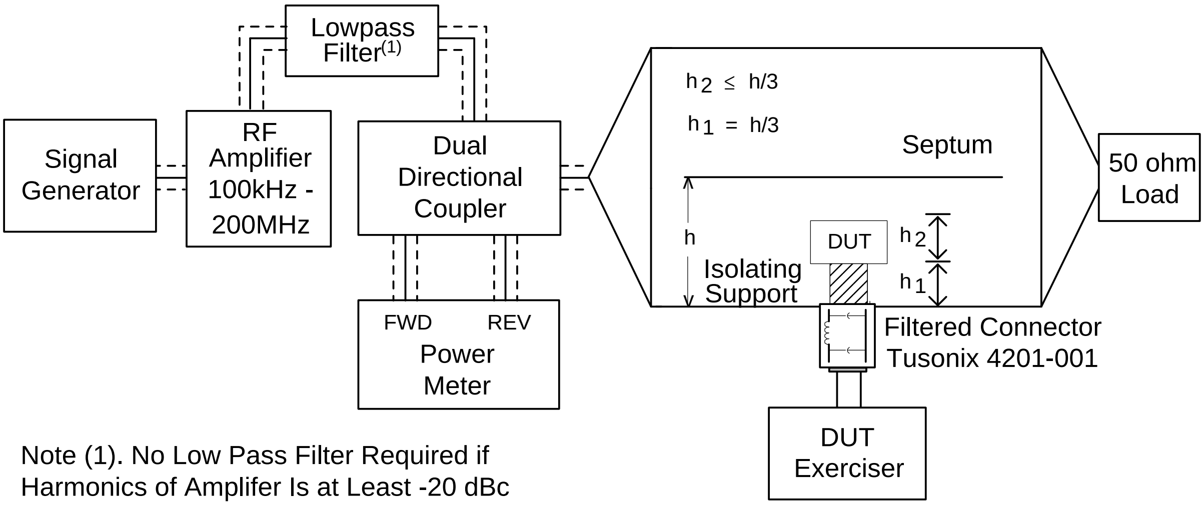


Figure 12: TEM Immunity Test Setup

Deviating from ISO 11452-3:

- The forward power required to achieve the specified field strengths shall be calculated with the formula in ISO 11452-3 using the actual impedance over frequency as measured for the TEM cell being used. To verify this calculation, the field strength achieved in an empty cell shall be measured using a field strength probe.
- THE USE OF A FEEDTHROUGH FILTER ASSEMBLY IS NOT OPTIONAL BUT REQUIRED.
- The DUT shall be connected to the filter assembly with an unshielded wiring harness of 600 ± 50 mm in length running diagonally from the DUT connector(s) to the TEM cell bulkhead connectors. The orientation of this harness in the TEM cell shall be controlled and documented. Any excess DUT harness shall be fastened with nonconductive tape to the TEM cell floor at the bulkhead connector end.
- The DUT shall be located in the approximate center of the TEM cell, midway between the septum and floor; it may be shifted off center to allow for a direct harness routing but it shall remain in the center two thirds volume of the cell. The position of the DUT shall be consistent and documented.
- DUT shall be tested in two orthogonal orientations: (i) with the main circuit board in the DUT parallel to the TEM cell floor (vehicle mounting surface down) and (ii) with the main circuit board perpendicular to the TEM cell floor or rotated 90 degrees about its vertical axis if perpendicular to the cell floor is not feasible due to exceeding the 1/3 floor to septum distance. These two orientations shall be chosen from the six possible orthogonal orientations, to allow visibility of the DUT, if required, and to maintain a consistent and repeatable routing of the DUT harness.
- The DUT connector(s) should be orientated toward the TEM cell door.
- The VSWR shall be monitored with the DUT under test and the data is indeterminate if this VSWR is greater than 1.5:1. The VSWR information shall be included in the test report.

8. Magnetic Field Immunity

For subcategory MS modules only: DUTs that incorporate components sensitive to magnetic fields (e.g. Hall effect sensors or magnetic pickups) shall be subjected to magnetic field immunity testing either Radiating Loop method as described in MIL-STD-461E or Helmholtz Coil method as described in JASO D001-94. For vehicle applications where the battery is located other than in the engine compartment, the routing of high current carrying conductors near vehicle electronics raises the magnetic environment.

Scope： For subcategory MS modules only

8.1 Requirements ***

Subcategory MS DUTs shall not be affected by a magnetic flux density of 160 dBpT (dB picotesla) from 30 Hz to 60 Hz and above 60 Hz this flux density shall decrease at a rate of 6 dB per octave to 106 dBpT at 30 kHz. Subcategory MS DUTs in severe magnetic environments (e.g. located within 0.5 meter of a battery cable or other power feed carrying 50 A or more of current) shall not be affected by a flux density of 160 dBpT from 30 Hz to 30 kHz.

8.2 Test ***

- Test frequency steps shall be at least 10 per decade (corresponding to a maximum expected Q of 4).
- The DUT shall be exposed to a flux density of 160 dBpT from 30 Hz to 60 Hz using a sine wave test signal.
- For DUTs not in a severe magnetic field environment, the DUT shall be exposed to a 60 Hz square wave test signal that generates 160 dBpT amplitude of the 60 Hz component of the test signal.
- For DUTs not in a severe magnetic field environment, the sine wave scan using the 6 dB per octave decreasing limit shall be performed only if there are effects noted during the square wave test.
- DUTs in severe magnetic environments shall be tested at 160 dBpT over the full frequency range.
- Bus modules and systems shall be evaluated for increased ignition off current draw (IOD) resulting from inadvertent wake up from standby or power-down modes during magnetic exposure.
- A Helmholtz coil may be used with three mutually orthogonal orientations of the DUT instead of the six positions of the test coil shown in Figure 13.

8.2.1 Test Setup

For Radiating Loop method, refer to Figure 13 for test setup.

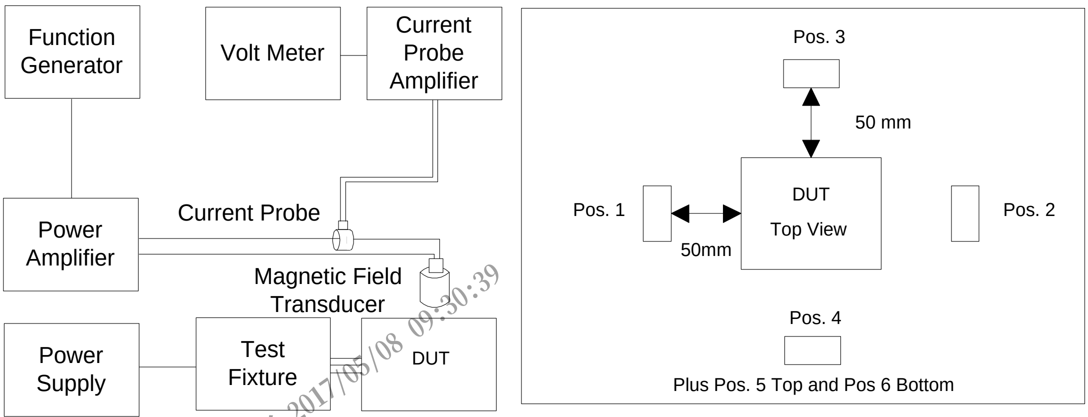


Figure 13: Magnetic Immunity Test Setup

9. Transient Immunity

The DUT shall be subjected to Transient Immunity testing as described in ISO7637-2(transient disturbances conducted along supply lines), ISO7637-3(transient disturbances conducted along I/O or sensor lines),and ANNEX G(Impulse testing, Fast transient testing).

9.1 Transient Disturbances Conducted along Supply Lines

9.1.1 Requirement

The DUT shall be subjected to repetitive voltage spikes with reference to ISO 7637-2. The DUT shall be monitored during operation while being subjected to the supply voltage transients as specified for the appropriate system voltage. These voltage spikes are referenced to a ground plane under the DUT (refer to ISO 7637-2 for details). These pulses are applied simultaneously to the battery and ignition lines and any inputs or outputs supplied from battery or ignition voltage as configured in a DUT's complete system. The DUT shall also be tested in a powered-down state, if appropriate, to check for inadvertent turn on (applies to modules that have logic power-up capability). For all the supply voltage transients, there shall be no damage to the DUT, no lockups of the DUT requiring power off reset and no effect on stored data or false diagnostic indication (Status II, except where specified otherwise). The DUT shall be tolerant of transient voltages generated by the operation of its own system (Status I). Refer to Table 31.

Table 31: Supply Voltage Transients - Immunity Requirements

Transient Pulse	Performance Status Group A	Performance Status Groups B, C and D
Pulse #1	II	II
Pulse #2a, #2b	II	I
Pulse #3a, #3b	II	I
Pulse #4	II	I

Note: Pulse # 1 includes a 200 ms dropout during which some DUT may reset. In this case, Status II applies for the specified test interval (the DUT shall recover normal operation at the end of the test).

DUT powered from regulated supplies in other modules (subcategory S) shall be tested as a system with the sourcing module or an equivalent power supply. This requirement is waived if the sourcing module product specification provides that, when subjected to the supply voltage transients, the output of the sourcing module's regulated supply meets the requirements of the supplied module.

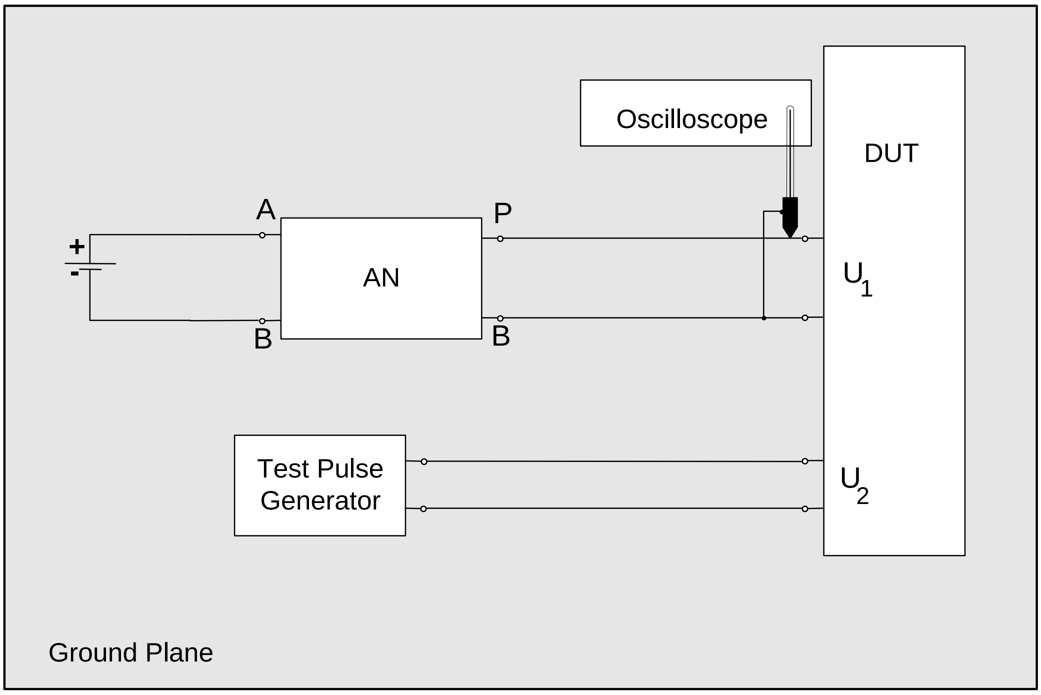
For components with several supply voltage connections, the disturbance emission of the second connection shall be measured during immunity testing of the first, i.e. where the 42 V terminals of one DUT are exposed to test pulses the disturbance emission of the 12 V supply connections shall be measured and vice versa. In this process, the disturbance voltage emission shall not exceed the limit values specified in paragraph .6.6.1

9.1.2 Test Conditions ***

At the start of the test, the pulse level should be stepped up to the specified level in 5 approximately equal increments after which the specified pulses shall be applied.

9.1.3 Test Setup

For devices with one supply voltage connection, refer to ISO 7637-2 for the test setup. Figure 14 illustrates the test setup for devices with 2 supply voltage connections.

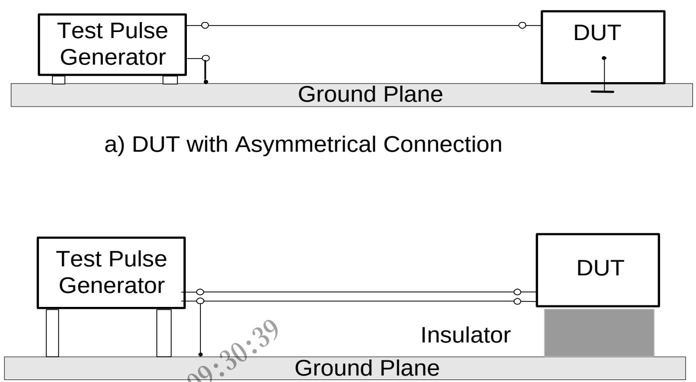


Key:

A	Mains	U_1	Supply voltage terminal 1
B	Ground	U_2	Supply voltage terminal 2
P	DUT		

Figure 14: Test Setup for Devices with Two Voltage Supply Connections

Electrically asymmetrical and electrically symmetrical devices under test shall be connected as illustrated in Figure 15. (The oscilloscope, probe and switch or relay are not illustrated.)



a) DUT with Asymmetrical Connection

b) DUT with Symmetrical Connection

Figure 15: Connection of the DUT

- Devices under test where the ground connection in the vehicle is via the vehicle body shall be placed directly on the ground plane and connected with it. The ground plane serves as ground connection of the DUT with the test pulse generator, refer to Figure 15, example a).

- Devices under test where the ground connection in the vehicle is via dedicated cable shall be placed on a 50 mm high insulating base, refer to Figure 15, example b).
- Lines between the DUT and the test pulse generator shall be routed at a height of 50 mm above the ground plane and shall be 200 mm in length.

9.1.4 Test pulses

9.1.4.1 Test pulse 1

Test pulse 1 simulates the switch-off of a supply voltage to an inductance switched parallel to the DUT. Only switched supply lines shall be exposed to this test pulse.

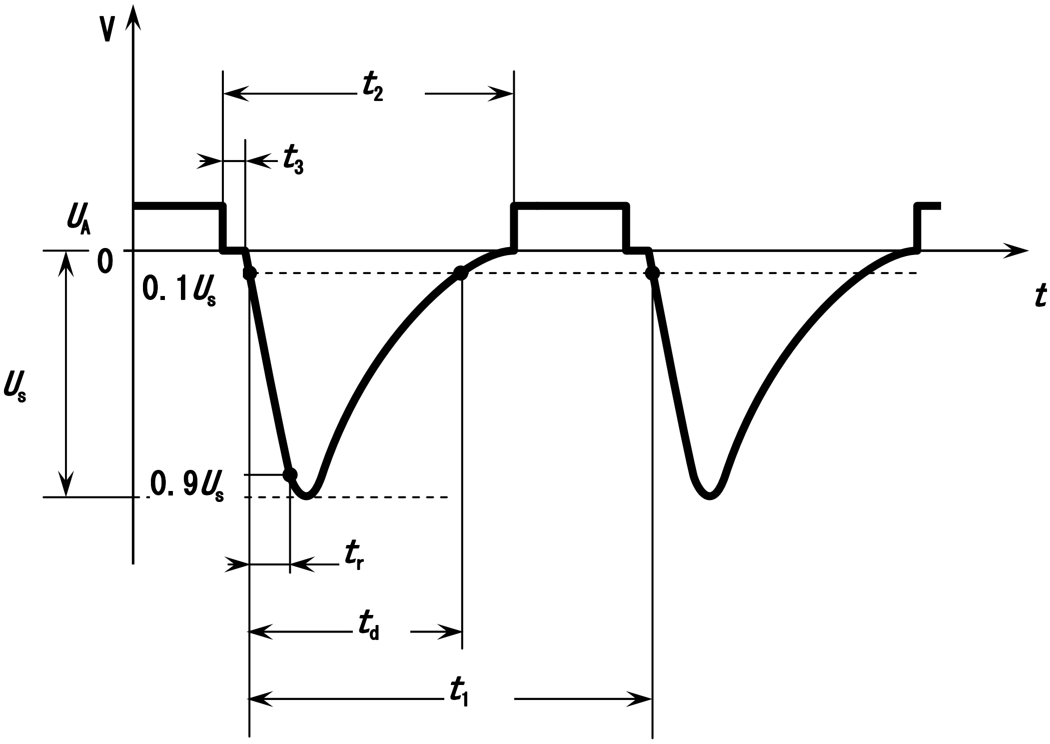


Figure 16: Test Pulse 1

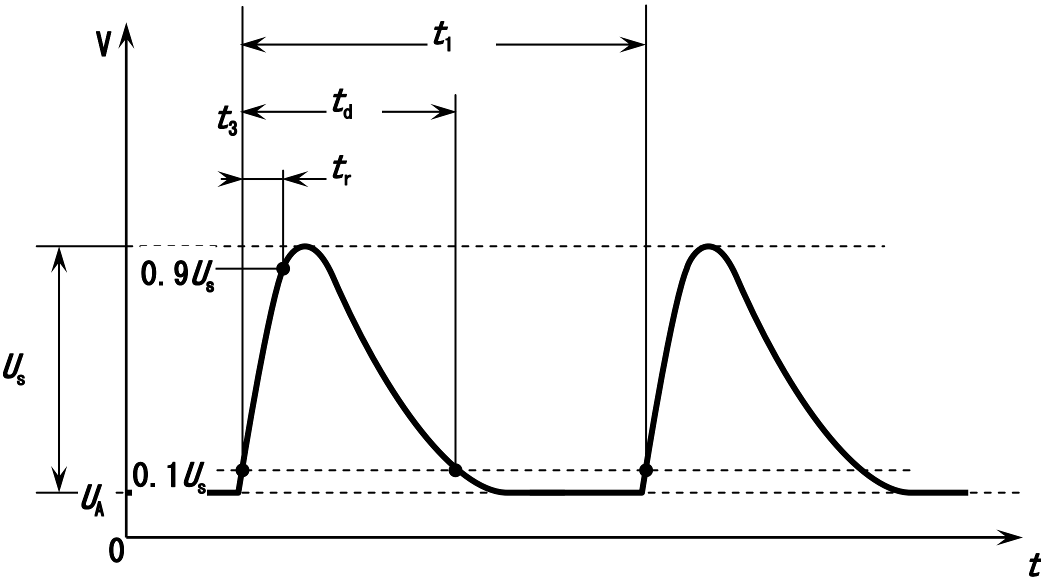
Table 32: Test Pulse 1 – Parameters

Parameters	**12 V System**	**24 V System**
U_A	13.5 V	27 V
U_s	- 150 V	- 600 V
t_r	$(1\ ^{0}_{-0.5})$ µs	$(3\ ^{0}_{-1.5})$µs
t_d	2 ms	1 ms
t_1*	≥ 0.5 s	≥ 0.5 s
t_2	200 ms	200 ms
t_3	< 100 µs	< 100µs
R_i	10 Ω	50 Ω
Min.number of pulses	5000	5000

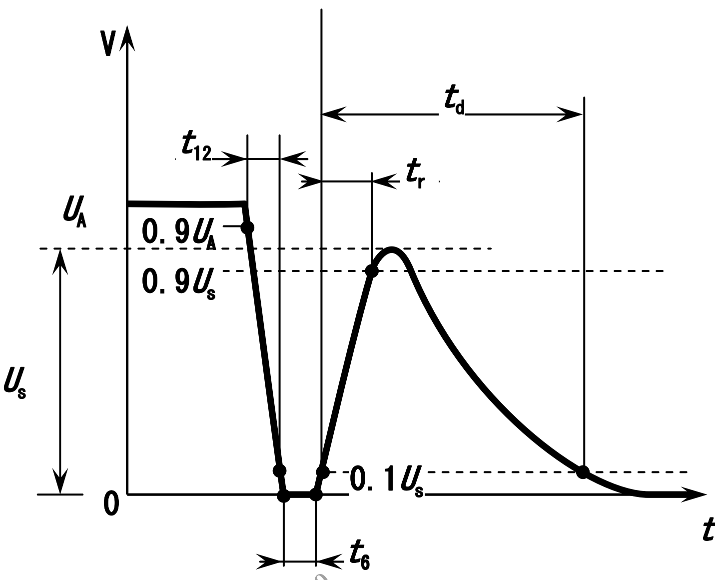
NOTICE *:
t_1 shall be chosen such that it is the minimum time for the DUT to be correctly initialized before the application of the next pulse and shall be ≥0.5s.

9.1.4.2 Test pulse 2a and 2b

Test pulse 2a simulates the interruption of a current through an inductance switched in series with the DUT. Only switched supply lines shall be exposed to this test pulse. Test pulse 2b simulates transients from dc motors acting as generators after the ignition is switched off.



a) Test Pulse 2a



b) Test Pulse 2b

Figure 17: Test Pulse 2

Table 33: Test pulse 2 - Parameters

a) Test pulse 2a – Parameters

Parameters	12 V System	24 V System
U_s	+ 112V	
R_i	2 Ω	
t_d	0.05 ms	
t_r	$(1^{0}_{-0.5})$ μs	
t_1*	0.2 s to 5 s	
Min.number of pulses	5000	

NOTICE *
The repetition time t_1 can be short depending on the switching.
The use of a short repetition time reduces the test time.

b) Test pulse 2b – Parameters

Parameters	12 V System	24 V System
U_s	10 V	20 V
R_i	0 Ω to 0.05 Ω	
t_d	0.2 s to 2 s	
t_{12}	1 ms ± 0.5 ms	
t_r	1 ms ± 0.5 ms	
t_6	1 ms ± 0.5 ms	
Min.number of pulses	10	

9.1.4.3 Test Pulses 3a and 3b

Test pulses 3a and 3b simulate the pulse bursts generated during switching operations (e.g. in relays).

- **Test Pulse 3a**

Test pulse 3a simulates the negative pulses. It is defined by Figure 18 and Table 34.

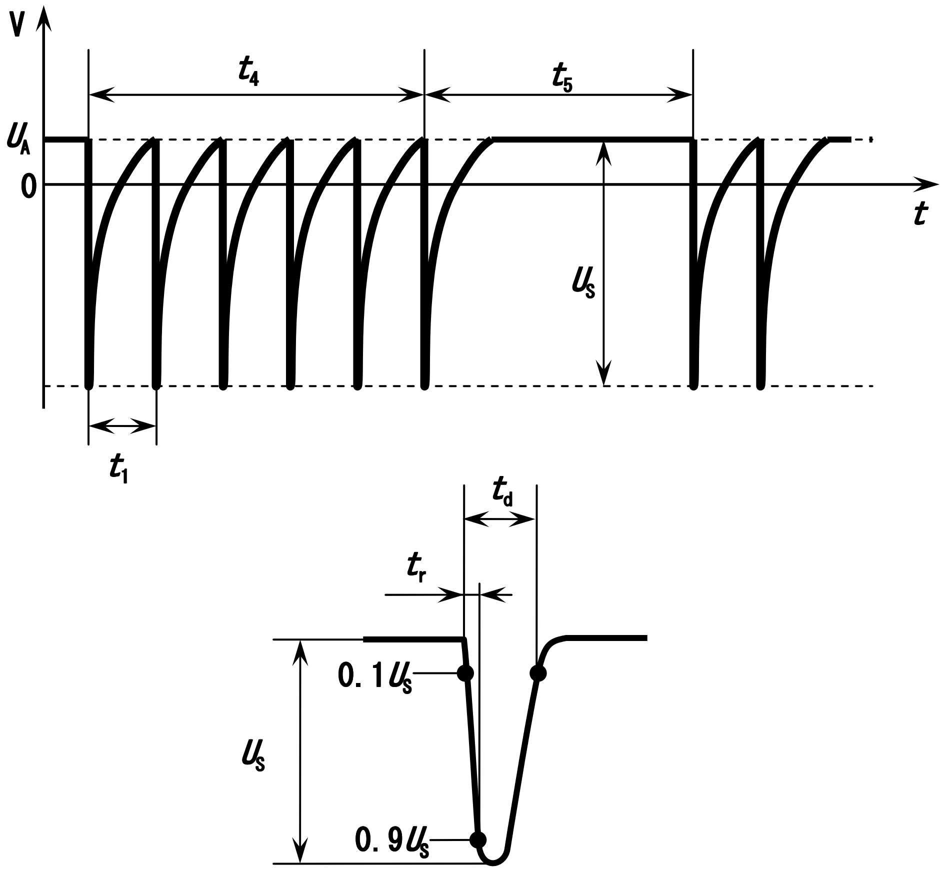


Figure 18: Test Pulse 3a

Table 34: Test Pulse 3a – Parameters

Parameters	12 V System	24 V System
U_p	13.5 V	27 V
U_s	- 220 V	- 300 V
t_r	5 ns ± 1.5 ns	
t_d	150ns ± 45 ns	
t_1	100 µs	
t_4	10 ms	
t_5	90 ms	
R_i	50 Ω	
Test duration	1 hour	

- Test Pulse 3b

Test pulse 3b simulates the positive pulses. It is defined by Figure 19 and Table 35.

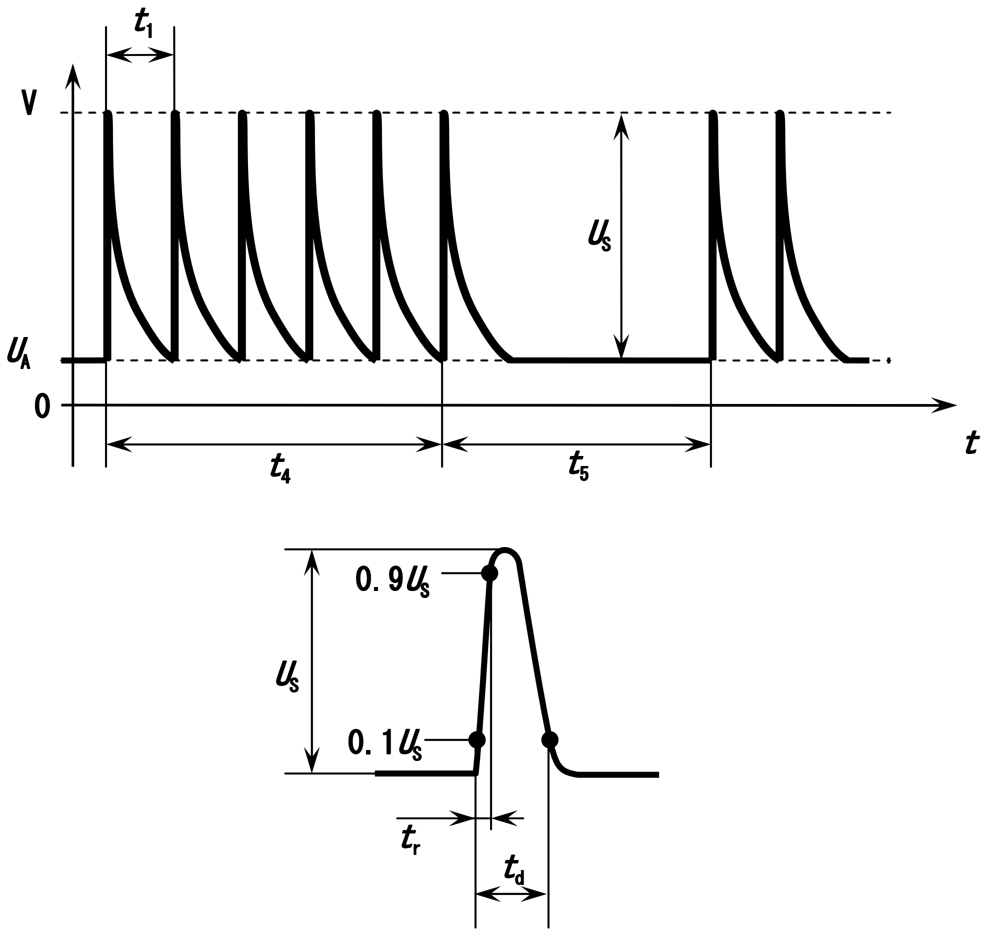


Figure 19: Test Pulse 3b

Table 35: Test Pulse 3b – Parameters

Parameters	**12 V System**	**24 V System**
U_p	13.5 V	27 V
U_s	+ 150 V	+ 300 V
t_r	5 ns ± 1.5 ns	
t_d	150ns ± 45 ns	
t_1	100 µs	
t_4	10 ms	
t_5	90 ms	
R_i	50 Ω	
Test duration	1 hour	

9.1.4.4 Test Pulses 4

Test pulse 4 simulates supply voltage reduction caused by energizing the starter-motor circuits of internal combustion engines, excluding spikes associated with starting.

It is defined by Figure 7-1 and Table 7-2 in ES-X82115.

9.2 Transient Disturbances Conducted along I/O or Sensor Lines

9.2.1 Requirement

The immunity testing of lines other than power supply lines shall be carried out in accordance with ISO 7637-3. For subcategory S modules, testing with Pulse #2 using both positive and negative polarity and direct capacitive coupling is also required. Components shall be subjected to voltage transients on input and output lines while monitoring the DUT during operation. There shall be no damage to the DUT, no lockups of the DUT requiring power off reset and no effect on stored data or false diagnostic indication (Status II). Group B, C and D functions of the DUT shall not be affected by these voltage transients (Status I). Refer to Table 36.

Table 36: Transients on I/O or Sensor Lines - Immunity Requirements

Transient Pulse	Performance Status Group A	Performance Status Groups B, C and D
Pulse # 2 (+ and –) (Subcategory S only)	II	I
Pulse a	II	I
Pulse b	II	I

9.2.2 Test Conditions

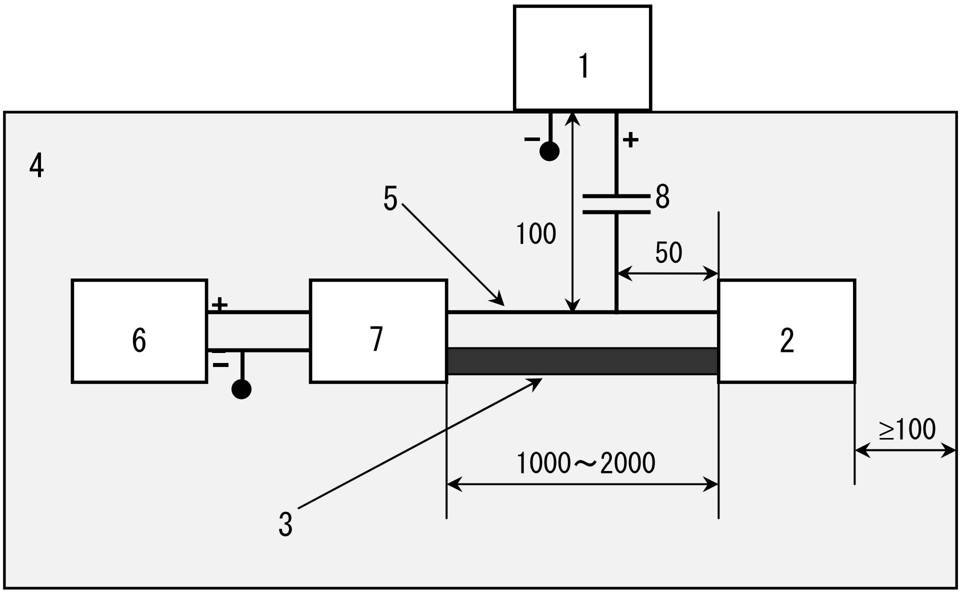
Modules shall be subjected to repetitive voltage spikes that are capacitively coupled to the line(s) under test. This may be implemented by using a capacitive coupling clamp or by direct capacitive coupling for Pulses a and b, but direct capacitive coupling is required for Pulse 2 (+ and -). These voltage transients are the pulses illustrated in Figures 21, 22, 23 and 24 and Tables 37, 38, 39 and 40. These pulses shall be applied to all input and output lines; simultaneously (CCC) or line by line (DCC) for Pulses a and b and line by line (DCC) only for Pulse 2 (+ and -). The test pulse voltages are set open circuit and are referenced to module ground. They are applied for 5 minutes each.

9.2.3 Capacitive Coupling Clamp (CCC) Test Setup ***

For a schematic diagram of the capacitive coupling clamp test setup refer to ISO 7637-3. This method applies for Pulses a and b only. Supply voltage lines are not included in the clamp for this test.

9.2.4 Direct Capacitor Coupling (DCC) Test Setup

Direct capacitive coupling may be used replacing the capacitive coupling clamp for Pulses a and b, and is required to couple Pulse 2 (+and-) to the DUT. Refer to Figure 20 for the test setup



All harness are(50±5)mm above ground plane.

Key:

1 Test pulse generator
2 DUT
3 Harness
4 Ground plane
5 I/O line under test
6 Power supply
7 DUT exerciser
8 High-voltage (200V minimum) ceramic capacitor*
* Capacitor values:
Pulse#2(+ and -): 0.1 µF
Pulse a,b: 100 pF

Figure 20: Direct Capacitor Coupling Test Setup

9.2.5 Test Pulses

Test Pulse 2, Positive and Negative Polarity in Figures 21 and 22 and in Tables 37 and 38.

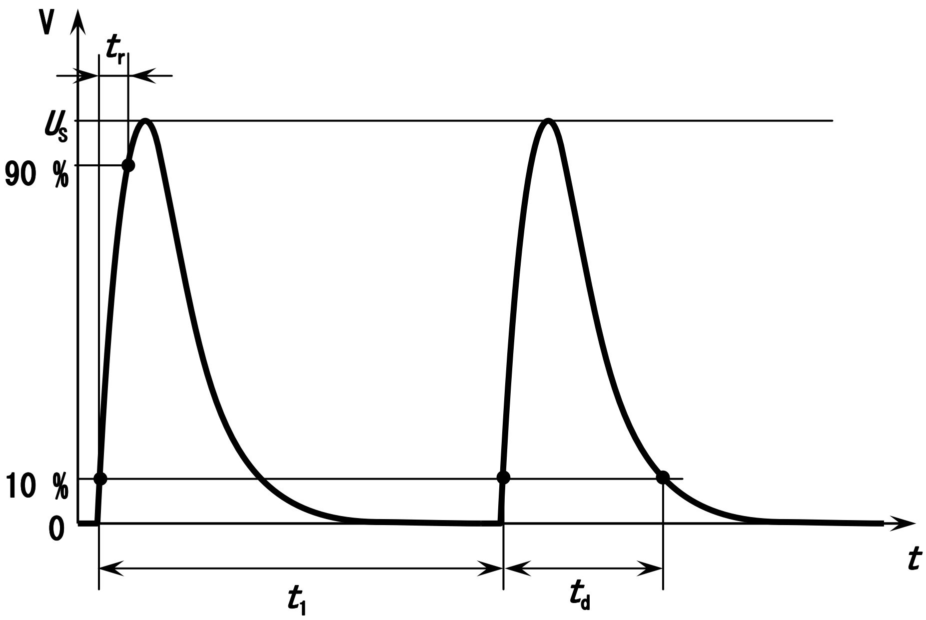


Figure 21: Positive Pulse 2 for I/O Coupling Test

Table 37: Positive Pulse 2 - I/O Coupling Parameters ***

Parameters	**12 V System**	**24 V System**	**42 V System**
U_s	+ 30 V	+ 45 V	+ 30 V
t_r	≤ 1 µs		
t_d	50 µs		
t_1	0.5 to 5 s		
R_i	2 Ω		
Test duration	5 minutes		

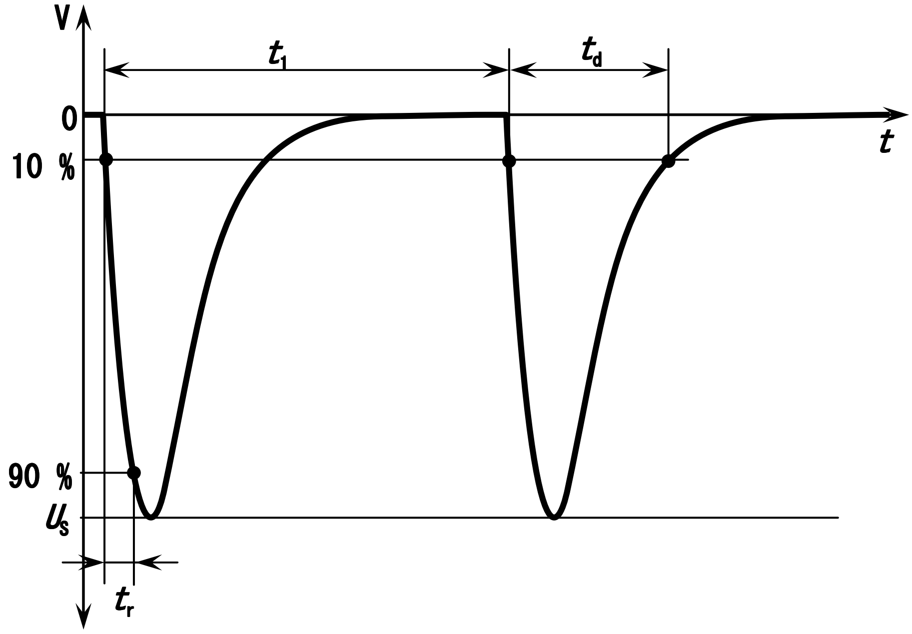


Figure 22: Negative Pulse 2 for I/O Coupling Test

Table 38: Negative Pulse 2 - I/O Coupling Parameters ***

Parameters	**12 V System**	**24 V System**	**42 V System**
U_s	- 30 V	- 45 V	- 30 V
t_r	≤ 1 µs		
t_d	50 µs		
t_1	0.5 to 5 s		
R_i	2 Ω		
Test duration	5 minutes		

9.2.5.1 Test Pulse a

This test pulse simulates the coupling of test pulse a onto control and signal lines. It is defined by Figure 23 and Table 39.

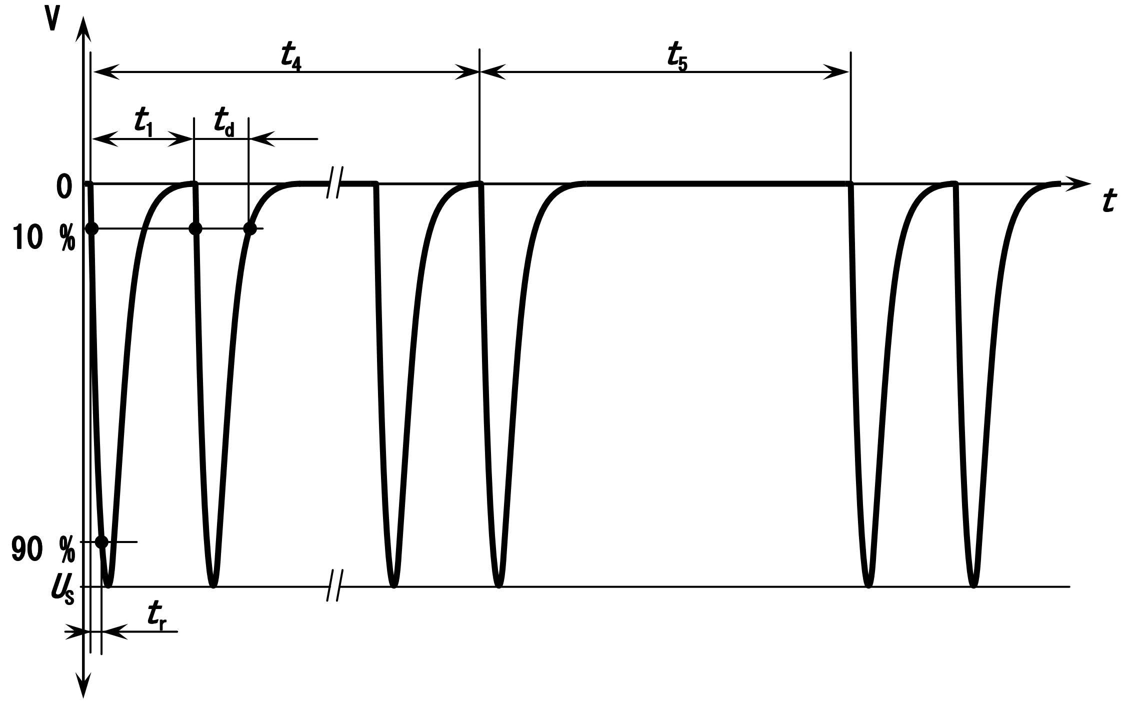


Figure 23: Test Pulse a

Table 39: Test Pulse a – Parameters

Parameters	**12 V System**	**24 V System**	**42 V System**
U_s	- 60 V	- 80 V	- 60 (-120) V
t_r	5 ns		
t_d	0.1 µs		
t_1	100 µs		
t_4	10 ms		
t_5	90 ms		
R_i	50 Ω		
Test duration	10 minutes		

9.2.5.2 Test pulse b

This test pulse simulates the coupling of test pulse b onto control and signal lines. It is defined by Figure 24 and Table 40.

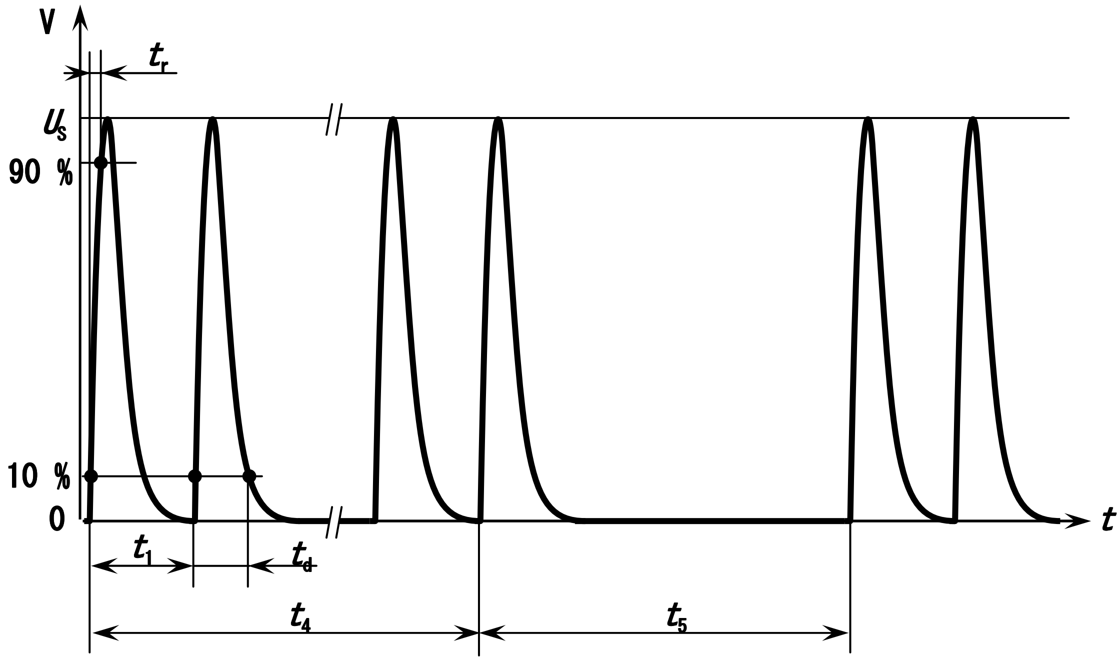


Figure 24: Test Pulse b

Table 40: Test Pulse b – Parameters

Parameters	12 V System	24 V System	42 V System
U_s	+ 40 V	+ 80 V	+ 40 (+ 80) V
t_r	5 ns		
t_d	0.1 µs		
t_1	100 µs		
t_4	10 ms		
t_5	90 ms		
R_i	50 Ω		
Test duration	10 minutes		

10. Electrostatic Discharge (ESD)

The immunity tests against electrostatic discharges shall be carried out in accordance with ISO 10605 for the handling test and IEC 61000-4-2 for the operating test with modifications as given in paragraph 10.2. All DUT shall be subjected to the unpowered handling test and the indirect discharge operating test. DUT that are accessible to the occupants in a vehicle, or in readily accessible underhood or trunk locations, shall be subjected to the direct discharge operating test. For the operating test, the DUT shall be put in operation with all its connected switches, displays, sensors, actuators etc. Wherever possible, production intent parts shall be used. For these tests, the ambient humidity shall be monitored and maintained in the range of 20% to 60% RH. The pulse produced by the ESD simulator shall be characterized using a calibration target as described in IEC 61000-4-2. The pulse shall be measured with a storage scope (sampling rate of 4 giga samples per second minimum, 1GHz analog bandwidth) which shall be shielded from the coaxial target and ground plane assembly. Direct contact characterization shall be used.

Table 43 gives an overview of the test methods.

Table43：ESD Testing

For discharges at points	Test Voltage（kV）	Conditions	Requirements
Pins (Handling test)	±4	3 discharges of positive and 3 discharges of negative	Status IV: The device/function shall not sustain any permanent damage as a result of exposure to a disturbance. Dealer action may be required to return the function to normal operation after the disturbance is removed.
Case (handling test)	±8	3 discharges of positive and 3 discharges of negative	Status IV: The device/function shall not sustain any permanent damage as a result of exposure to a disturbance. Dealer action may be required to return the function to normal operation after the disturbance is removed.
Potentially all points which can be touched by the user after installation, including any DUT switches, displays, cables, plugs etc, and the HCP as well as the VCP. （Operating test）	Contact discharges Table 42	For each polarity and voltage,10 discharges shall be carried out at each of the specified discharge points. Both direct and indirect discharge shall be carried out.	Table 42
	Air discharges Table 42	For each polarity and voltage,10 discharges shall be carried out at each of the specified discharge points. Both direct and indirect discharge shall be carried out.	Table 42

10.1 Handling Test

The DUT, with all leads disconnected, shall be placed on a 50 mm thick nonconductive spacer centered on the HCP. The case, if conductive and case grounded in the vehicle application, shall be similarly connected to the HCP. Use an ESD simulator with a discharge network of 150 pF and 330 ohms.

10.1.1 Handling test requirements

For the handling (unpowered) test, there shall be no damage to the DUT and the DUT shall operate as specified, without effect on stored data, after the test. This is considered Status IV in this case as the DUT is not being monitored during the test and no judgment about effects can be made. This is a direct contact discharge test. Refer to Table 41.

Table 41: ESD Immunity Requirements – Handling Test

Test Voltage – Case	Test Voltage - Pins	Group A, B, C and D Status
±8 kV	**±4 kV**	IV

10.1.2 Handling test setup

For a diagram of the test setup, refer to Figure 25.

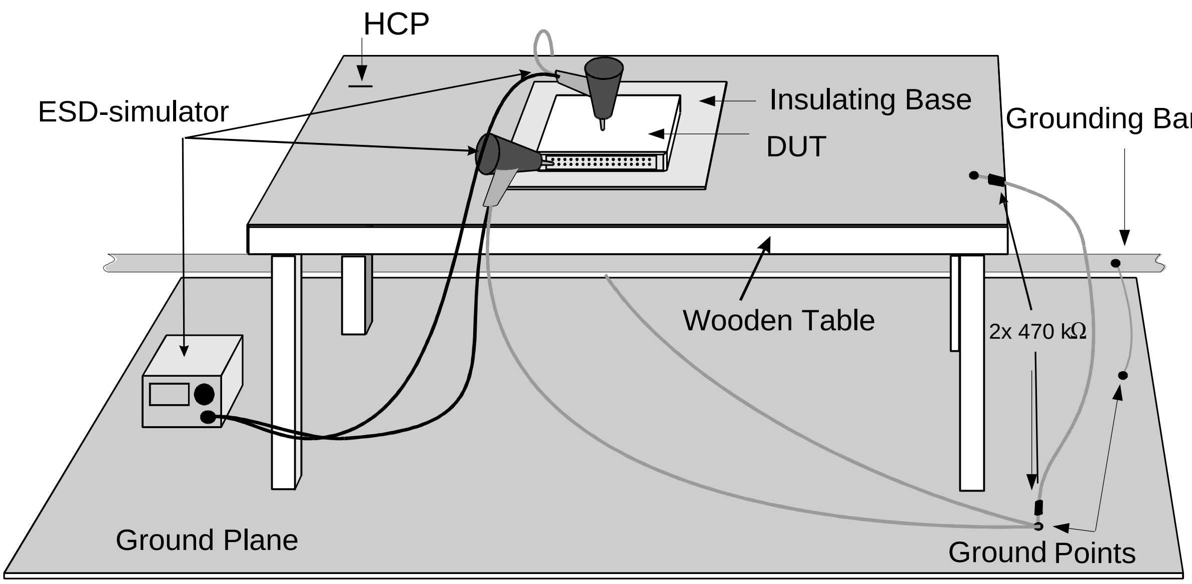


Figure 25: ESD Handling Test Setup

- An ESD simulator and contact discharge electrode according to IEC 61000-4-2 shall be used.
- The HCP shall be placed on the test bench and connected to the ground reference plane via two series 470 kohm resistors. The HCP shall be large enough so as to protrude beyond the DUT on all sides by at least 100 mm.

10.1.3 Handling test conditions ***

- Before testing commences, the discharge voltage of the ESD simulator shall be verified.
- Discharge points: potentially all points that can be touched by the user during packaging, installation or dismantling. In the case where the connector(s) on the DUT are configured so that individual pins are not readily accessible, or the pins are closely spaced such that discharge to individual pins is not practical, then an extender cable shall be used. This cable shall be 100 mm in length (solid wire recommended) and discharges shall be made to the fanned out leads at the end of this cable. The individual discharge points shall be specified in the test plan.
- For each of the required discharge voltages, 3 discharges of positive and 3 discharges of negative polarity shall be performed at each of the specified discharge points.
- Between two individual discharges, the charge applied shall be removed via a grounded discharge resistor with approximately 1 megohm resistance (e.g. 2 × 470 kohm resistors in series) by touching the discharge point and the housing. Alternatively, at least 5s an be allowed to pass between two discharges.
- After all discharges have been carried out at each voltage level, a functional performance test shall be conducted. The results shall be documented in the test report.

10.2 Operating Test ***

DUT that are accessible to occupants inside the vehicle shall be tested using an ESD simulator with a discharge network of 330 pF and 330 ohms. For DUT that are in underhood or trunk locations use a discharge network of 150 pF and 330 ohms.

10.2.1 Operating Test Requirements

For the operating (powered) tests, the DUT shall be monitored during operation. There shall be no lockups of the DUT requiring power off reset and Group C and D functions of the DUT shall not be affected by the ESD (Status I), Group A and B functions are allowed Status II. Refer to Table 42.

Table 42: ESD Immunity Requirements – Operating Test

Test Voltage		Group A	Group B	Group C	Group D
Air	Contact	Status	Status	Status	Status
± 25 kV	No Test	No Test		No Test	I
± 20 kV				II	I
± 15 kV	± 8 kV	II	II	I	I
± 8 kV	± 4 kV	II	I	I	I
± 4 kV	± 3 kV	II	I	I	I

10.2.2 Operating test setup ***

For a schematic diagram of the test setup during the performance of direct and indirect discharges refer to Figures 26 and 27.

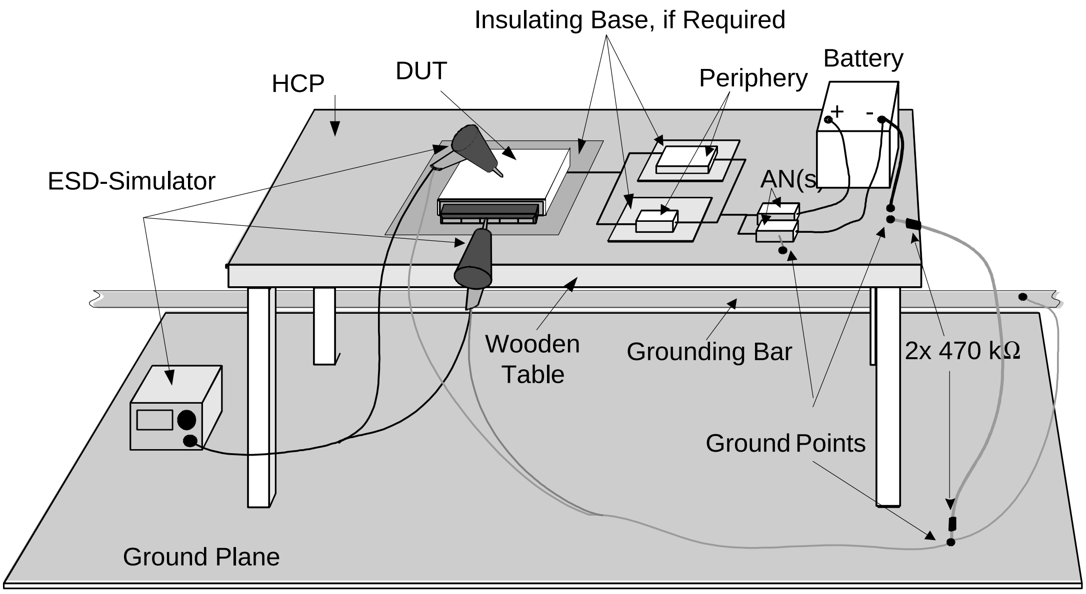


Figure 26: ESD Operating Test - Direct Discharge

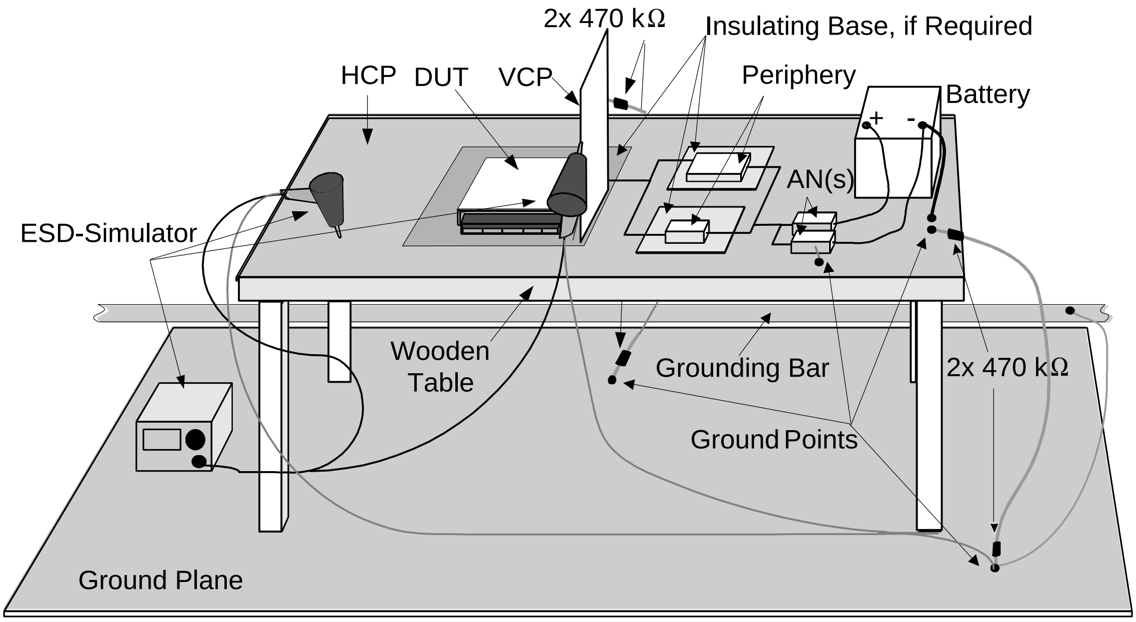


Figure 27: ESD Operating Test - Indirect Discharge

- An ESD simulator and discharge electrode according to IEC 61000-4-2 shall be used.
- DUT with metal enclosures shall be placed directly on the HCP and conductively connected with it; all other devices shall be placed on a 50 mm thick nonconductive spacer centered on the HCP.
- The ground connection of the DUT shall be connected as intended in the vehicle - directly via the vehicle body (i.e. the HCP) or via the wiring harness.
- The battery ground shall be electrically connected to the HCP.
- Any peripheral support equipment shall be separated from the DUT by at least 200 mm.
- Wherever possible, the production intent wiring harness shall be used.

10.2.3 Operating test conditions

- Before testing commences, the discharge voltage of the ESD simulator shall be verified.
- Discharge points: Potentially all points which can be touched by the user after installation, including any DUT switches, displays, cables, plugs (ex. diagnosis connector) etc, and the HCP as well as the VCP. The individual discharge points shall be specified in the test plan.
- For discharges at points which can be touched by a person remaining inside the vehicle, a discharge capacity of 330 pF shall be used, otherwise use 150 pF. For indirect discharges to the HCP and VCP, 330 pF shall be used. The discharge capacity shall be specified in the test plan.
- For indirect discharges into the HCP and VCP, the distance to the DUT shall be 100 mm and the air discharges may be omitted.
- For each polarity and voltage, 10 contact discharges shall be carried out at each of the specified discharge points. In this process, the ESD simulator with the contact discharge electrode shall be positioned on the device and then discharged.
- For each polarity and voltage, 10 air discharges shall be carried out at each of the specified discharge points. In this process, the ESD simulator with the air discharge electrode shall be moved towards the discharge point as quickly as possible until discharge occurs.
- Between two individual discharges, the charge applied shall be removed via a grounded discharge resistor with approximately 1 megohm resistance (e.g. 2×470 kohm resistors in series) by touching the discharge point and the housing. Alternatively, at least 1 s can be allowed to pass between two discharges.

End of Main Document

# # # # #

ANNEX A(informative)

Functional Status Classification Examples ***

Group A Functions:

- adaptive speed control operation
- chime operation (nonregulated function)
- climate control display
- electronic compass operation
- entertainment systems operation (radio, navigation, video, voice recognition system, CD, phone)
- headlamp cleaning operation
- illuminated entry operation
- informational diagnostic capability (nonregulated)
- instrument cluster nonregulated functions & convenience indicators
- intermittent windshield wiper operation
- navigational display operation
- parking aid system operation
- rain sensor operation
- rear wiper operation ability
- remote keyless entry operation
- seat and steering wheel heating operation
- time or information display
- trip odometer operation

Group B Functions:

- antilock brake system operation (with fail-safe default)
- chime operation (regulated function)
- instrument cluster enhancement functions (fuel gauge, indicators)
- license plate lamp operation and daytime running lights (DRL) (regulated function)
- motor cooling fan operation
- tire pressure monitoring
- vehicle anti-theft system operation
- vehicle electrical charging system (alternator) operation
- vehicle immobilizer operation

Group C Functions:

- antilock brake system operation (without fail-safe default)
- automatic headlamp operation
- back up lamp operation (regulated function)
- brake lamp and center high mounted brake light (CHMSL) operation (regulated function)
- brake system malfunction indicator lamp (MIL) operation
- child occupancy detection operation

- data bus system operation (CAN-B, C, D, LIN-Bus, other serial bus systems, MOST /optical, D2B /optical)
- diagnostic memory stability and Group C functional inhibit capability
- dynamic vehicle control system (ESP) stability including steering angle sensor stability
- electronic transmission control
- engine malfunction indicator lamp (MIL) operation (regulated function)
- engine control
- entertainment system volume stability
- fog lamp/high beam interlock operation (regulated function)
- headlamp and tail lamp operation
- headlamp leveling operation
- horn operation (regulated function)
- instrument cluster (malfunction information, odometer, speedometer operation, regulated warnings)
- mirror stability (rearview and outside)
- neutral start function (regulated function)
- park and marker lamp operation (regulated function)
- park brake indicator lamp operation (regulated function)
- photochromatic mirror operation
- power door stability
- power folding mirror stability
- power seat position stability
- power window stability and window express up/down function stability
- transmission gear indicator (regulated function)
- seat memory stability
- start ability
- steering wheel positioning stability
- turn signal and indicator operation (regulated function)
- vehicle immobilizer stability
- vehicle steering stability
- windshield defrost system operation
- windshield washer operation
- windshield wiper operation

Group D Functions:

Any function that has the potential to inadvertently deploy a passive restraint system actuated by an electroexplosive device (EED).

End of ANNEX A

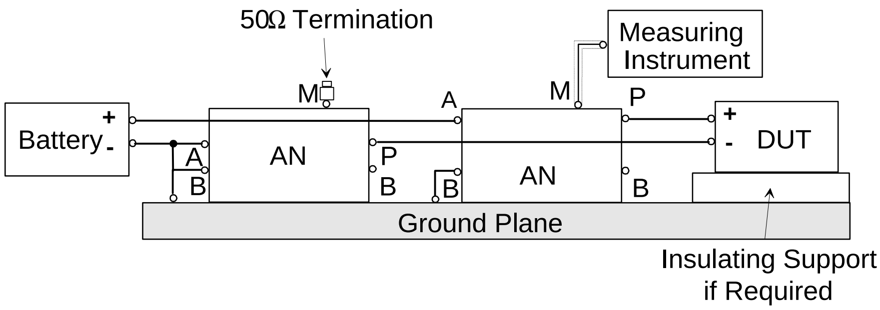
ANNEX B(informative)

Information for Application

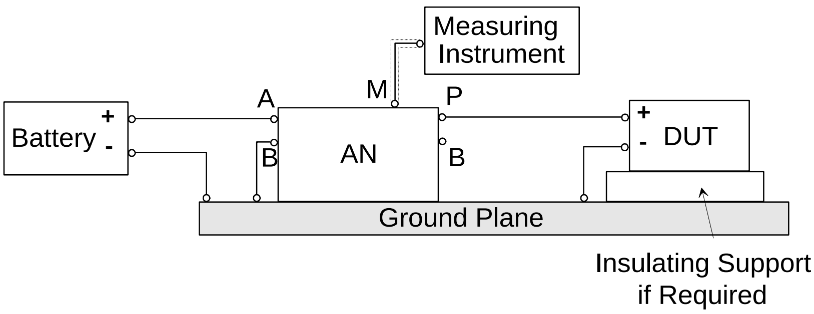
This annex provides short descriptions of the test setups to supplement that given in the main document. The intent is to serve as a sketchbook that supports discussions between EMC experts and those who are not that familiar with the test methods. Additionally, included are the parameters which have to be checked prior to testing but are hard to keep in mind since there are a lot of similar tests existing in ISO and IEC. But of course, this annex can not and is not intended to serve as a replacement of careful study of the referenced standards.

B.1 CISPR 25 – Voltage Method

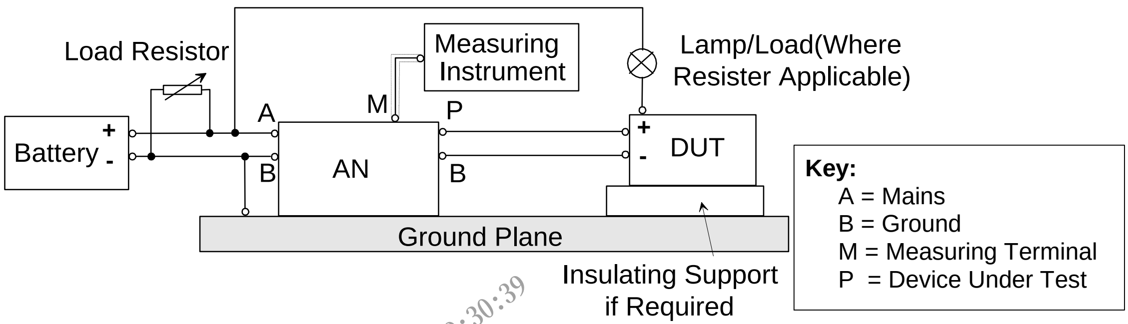
CISPR 25 voltage method measures RF emissions conducted along supply lines using one or several Artificial mains Networks. Test setups are illustrated in Figure B.1.



a) Device Under Test with Long Ground Line



b) Device Under Test with Short Ground Line



c) Alternators and Generators.

Figure B.1: Test setup of CISPR 25, voltage method

- The ground plane shall be no smaller than 400 mm x 1000 mm.
- Artificial mains Networks in accordance with CISPR 25 shall be used.
- A measuring receiver or spectrum analyzer in accordance with CISPR 16-1 shall be connected to the measuring terminals M of the Artificial mains Network.
- The cables between the device under test and the Artificial mains Network shall be routed at a height of 50 mm above the ground plane and shall be no longer than 200 mm.
- The test setups for devices under test with several supply voltage connections shall be implemented accordingly.
- Action shall be taken to ensure that the device under test emits its maximum disturbance power (occurring during normal operation) during the measurement.

B.2 CISPR 25 – Radiated Emissions

CISPR 25 measures radiated RF emission of components in an absorber-lined shielded enclosure with an antenna. For a schematic diagram of the measuring setup, refer to Figure B.2.

- The test shall be carried out in an absorber-lined shielded enclosure.
- Artificial mains Network in accordance with CISPR 25 shall be used
- The test bench, on which the device under test, the test harness and the Artificial mains Network are arranged, shall be 900 mm high and no less than 2500 mm long. A ground plane with the same dimensions shall be placed on this bench and conductively connected with the wall of the shielded enclosure (care has to be taken, that the inductance of this connection is small).
- The test harness shall be 1700 (+ 300, – 0) mm long and routed 50 mm above the ground plane (this harness can also be used for BCI testing)
- For devices under test with short ground line, an Artificial mains Network is required for the positive supply line; for devices under test with long ground return, two Artificial mains Networks are required (one for the positive supply line and one for the ground return).
- The antenna shall be arranged at a distance of 1000 ± 10 mm from the test cable center (i.e. for logarithmic periodic antennas and monopole antennas, the nearest element and the center for biconical antennas). The height of the antenna center above the floor of the absorber-lined chamber shall be 1000 mm.
- The device under test and the harness shall be installed at a distance of 100 ± 10 mm away from the edge of the test bench.
- Measurements shall be taken with both horizontal and vertical polarization.
- The outer surface of the device under test with the greatest disturbance emission, if known, shall be closest to the antenna.
- The correction factors for cable and antenna shall be taken into account.

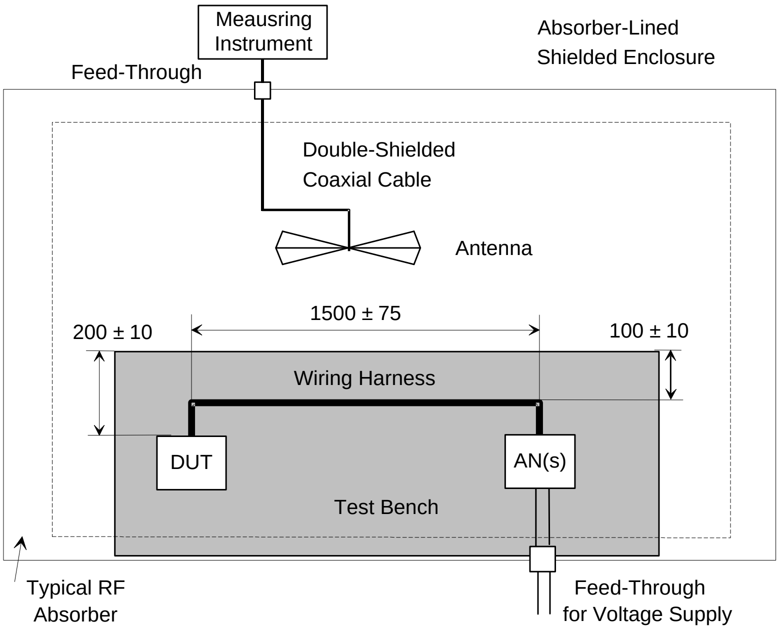


Figure B.2: Test setup CISPR 25, radiated RF emissions

B.5 Capacitive Coupling Clamp

The capacitive coupling clamp method to couple transients to all I/O-lines at once is described in detail in ISO 7637-3. Figure B.5 gives a brief sketch of the test setup.

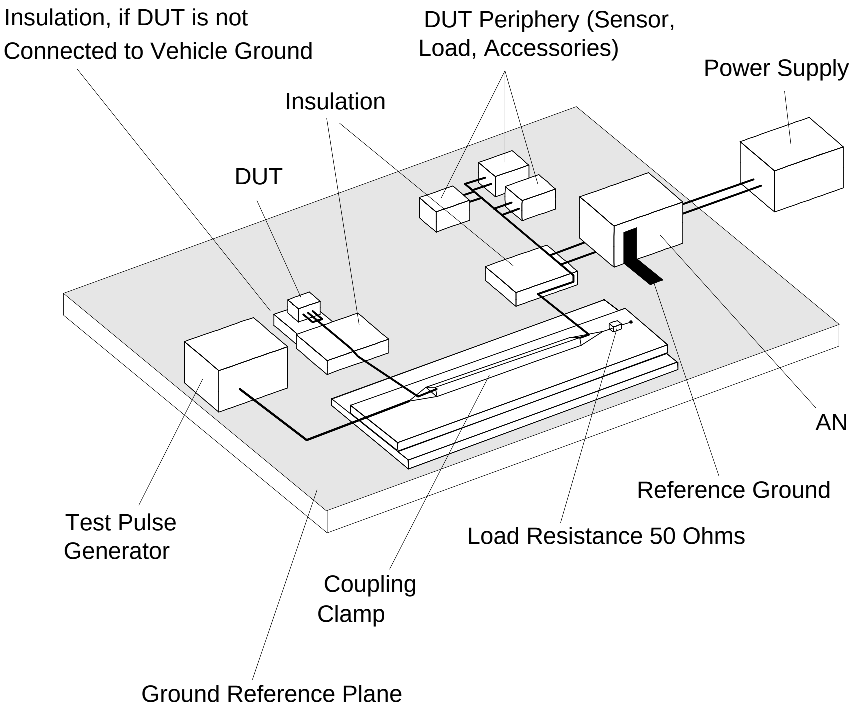


Figure B.5: Capacitive Coupling Clamp - Test Setup

- Where the DUT is not connected to the vehicle conductive structure via the housing, it must be placed on an insulating base (50 mm thick); otherwise it shall be placed directly on the ground plane and connected with it.
- The power supply source(s) shall be connected to the test harness using one (or more) Artificial mains Networks in accordance with ISO 7637-3 or ISO 11452.

End of ANNEX B

ANNEX D(Informative)

EMC Testing Information for Module / System with CAN Bus

The default CAN Data Bus Functional Classification requirements are:

CAN B:

Bus system communications (vehicle bus disabled due to latching or streaming):	Group C
Fault indicator lamp on, no diagnostic trouble code recorded:	Group C
DUT CAN communication faults (DUT not communicating correctly):	Group C

CAN C:

Bus communications (vehicle bus is disabled due to latching or streaming):	Group C
Fault indicator lamp on, no diagnostic trouble code recorded:	Group C
DUT CAN communication faults (DUT not communicating correctly):	Group C

The above functional classification information is offered as a guideline to be referred to when writing the DUT test plan. The actual CAN bus functional classification requirements depend on the criticality of the message content carried on the bus that the DUT is connected to. For example, if the CAN B bus is used for vehicle immobilizer to allow the vehicle to start, the CAN B bus would be considered Group C for Bus communications (vehicle bus is disabled due to latching or streaming).

For CAN applications, a PC based CANoe (CAN open environment) simulation program, along with the vehicle message matrix (VMM) are required to provide the correct CAN bus traffic. The hardware interface between the PC and the DUT is comprised of a CANcardX (PCMCIA card) and either a CANcab 1054 (CAN B node and cable connecting the CANcardX to the DUT CAN B transceiver) or a CANcab 251 (CAN C node and cable connecting the CANcardX to the DUT CAN C transceiver). The CAN bus shall be monitored for stability via the CANoe tool error frame rate indicator and VMM mismatch indicator.

Bulk Current Injection (BCI): Fiber Optical CAN interface

Radiated Immunity (TEM CELL): Fiber Optical CAN interface

Radiated Immunity (ALSE - Anechoic Chamber): CAN shall be optically coupled for the test.

End of ANNEX D

ANNEX E(informative)

Additional Information ***

E.2 Number of Available Test Samples

Additional test samples should be available to the EMC test lab in addition to those required for testing. For production parts (PP), a minimum of two samples should be provided to the test lab. For design parts (DP) level parts, a minimum of three samples should be provided to the test lab.

E.3 Component Location in the Vehicle

Emissions

For most module locations in a metallic vehicle, the vehicle body provides some shielding. However, the risk of interference increases for modules in exposed or unshielded locations that have enhanced visibility to the vehicle antenna(s). For front mounted vehicle antennas, these exposed locations are the high instrument panel area (instrument cluster) and the overhead console. For vehicles with rear-mounted antennas or nonmetallic body panels, other locations may have enhanced visibility to the vehicle antenna(s).

Immunity

A wide range of factors including location, wiring interconnects and the shielding effectiveness of the vehicle affects the actual EMC performance of a system as installed in a vehicle. Some level of shielding may be provided by the vehicle body. Instrument clusters and overhead consoles are in locations where shielding effectiveness cannot be assumed and therefore they may be at increased risk of RF exposure. Other modules in exposed or unshielded locations, or any electronics in a nonmetallic vehicle, may also require special considerations in order to maintain the required vehicle immunity levels in MMC standard. This should be considered in the product specification and EMC test plan.

E.6 RF Immunity of RF Link Systems ***

Vehicle systems that use a low power RF link (i.e., RF remote keyless entry), require a low RF environment near their operating frequency to realize their normal operating range. In the presence of RF sources within this "window of vulnerability", devices such as RF RKE will exhibit reduced range or inhibited remote operation. This immunity window can be reduced by improved filtering in the receive module and should not exceed ± 5% of the system operating frequency. The product specification should define the acceptable performance limits for the system in the vicinity of its operating frequency range and the EMC test plan should take this into account.

E.7 RF Emissions of RF Link Systems

RF link systems will necessarily have emissions at their operating frequency and these emissions may exceed the emission limits specified for that band. Typically, these emission requirements are to control the emissions from unintended radiators in order to protect the operation of RF link devices and are not intended to inhibit the range or operation of these RF link systems themselves. The EMC test plan should take this into account.

End of ANNEX E

\# # # # #

ANNEX F(informative)

Immunity to Handheld Transmitters ***

F.1 General

In a few cases, from an economical point of view, component tests instead of a lot of vehicle tests might be more efficient. This is especially true, when the component is already used in other vehicles, and a quick reliable test method is needed just to check for compliance in the new intended vehicle platform. This is even more the case, when the intended vehicle platform has a lot of variants which is common for buses and other commercial vehicles.

Recent publications and testing have shown that the tube coupler method can be used for immunity testing even above 1 GHz. It was especially designed for testing immunity of components to handheld transmitters.

This test applies for testing immunity to handheld transmitters operating in the bands GSM 900 and GSM 1800/1900. It applies only if explicitly agreed to between supplier and the MMC Releasing Engineers.

F.2 Requirements

The immunity requirements are based on environmental data and are adapted to the tube coupler test method through correlation with vehicle data. The immunity performance requirements are specified in Table F.1.

Table F.1: Simulated Handheld Transmitter Immunity Performance Requirements

GSM Band	Test Level*	Performance Status Group A	Performance Status Groups B, C and D
900	200 mW	II	I
1800/1900	100 mW	II	I

*:Peak power level, note that the power meter in Figure F.2 will read the average value and for a 12% duty cycle rectangular pulse this will be approximately 12% of the peak value.

The power levels given in table F.1 are the forward power levels into the tube coupler reduced by the insertion loss (L_i) of the tube coupler and measured in dB using the procedure in F.5:

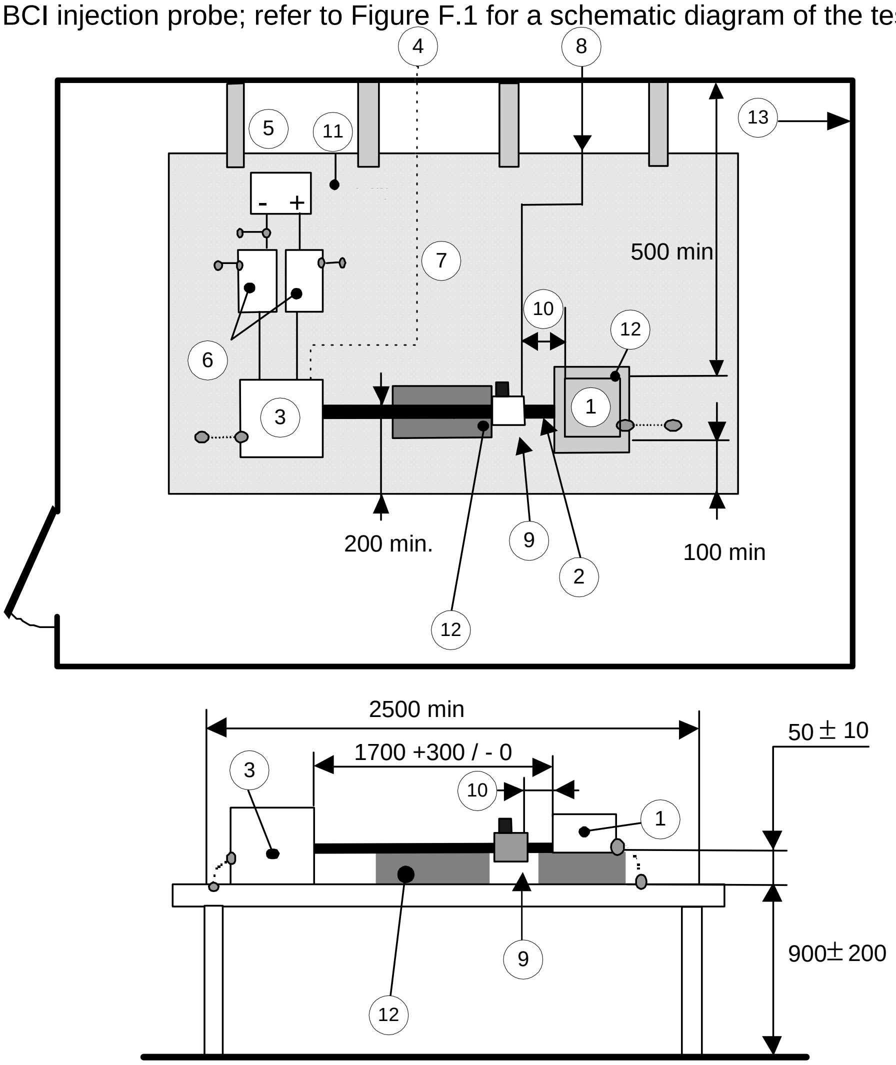
$$P_{test}\Big|_{dBm} = P_{forward}\Big|_{dBm} - L_i\Big|_{dB}$$

or in a linear scale using a transfer factor:

$$P_{test} = P_{forward} \cdot S_{21}$$

F.3 Test Setup

The test setup is essentially the same as for BCI testing (see 7.4). However, a tube coupler is used instead of a BCI injection probe; refer to Figure F.1 for a schematic diagram of the test setup.



Key:

1 Device under test (connected to ground if specified in the test plan)
2 Wiring harness
3 Load simulator (placement and ground connection according to ISO 11452-4)
4 Stimulation and monitoring system
5 Power supply
6 AN
7 Optical fibers
8 High frequency equipment
9 Tube coupler (2nd port loaded with 50 ohms)
10 The distance from the DUT to the tube coupler position
11 Ground plane (connected to the shielded room)
12 Insulating support
13 Shielded room

This figure is adapted from ISO WD 11452-4.

Figure F.1: Immunity Test Using the Tube Coupler Method - Test Setup

- A tube coupler shall be used.
- The second input of the tube coupler shall be loaded with 50 ohms.
- Use substitution method with forward power.
- The test setup shall be on a sufficiently large ground plane, so that the plane shall extend beyond the test setup by at least 100 mm on all sides.

- The distance between the test setup and all other conductive structures (such as the walls of the shielded enclosure) with the exception of the ground plane shall be no less than 500 mm.
- Where part of the system to be tested is normally connected electrically with the vehicle body, this part shall be placed directly on the ground plane and connected with it.
- The test harness shall be 1700 (+ 300, – 0) mm long and routed 50 mm above the ground plane (this harness can also be used for CISPR 25 radiated emission testing).
- The tube coupler shall be located on the test harness 100 mm from the DUT. Where the harness has a number of branches, the test shall be repeated, so that the tube coupler shall be attached around each branch in turn.
- The voltage supply and the periphery shall be filtered and shielded or located outside the shielded enclosure, an exception is peripherals which are not susceptible to radiated disturbances (such as mechanical switches).
- Wherever possible, production intent vehicle switching devices and sensors shall be used.

F.4 Tube Coupler

A tube coupler is a coaxial system having two input ports that can be clamped around the wiring harness similar to a current probe. It consists of two tubes having the same axis. They form an outer coaxial system having 50 ohms impedance, and the inner tube together with the wiring harness forms an inner coaxial system. Both systems are coupled at the ends of the tubes.

F.5 Calibration

Calibration is done in a method similar to ISO 11452-4 deviating in that the calibration jig shall be designed to form a 150-ohm system together with the tube coupler in the jig. Both ends of the jig shall be loaded by 150 ohms. The calibration setup is shown in figure F.2.

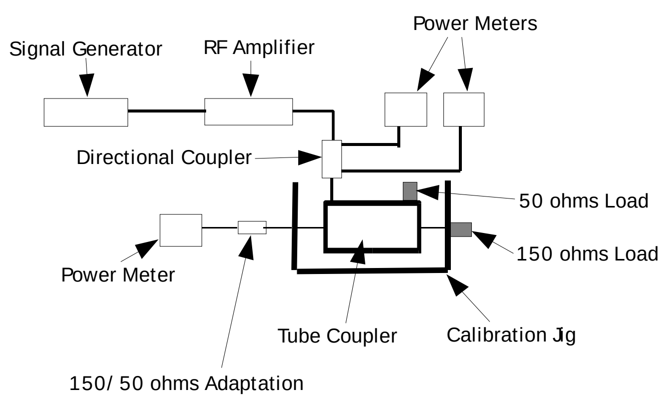


Figure F.2: Immunity Test Using the Tube Coupler Method - Calibration Setup

Calibration involves measuring the transfer factor from port 1 to port 2, i.e. the S-parameter S_{21}. RF power is injected into the system at port 1 using a signal generator and possibly an amplifier if needed (both with 50 ohm output impedance). At port 2, the transferred power through the tube coupler is measured using a power meter or equivalent (with 50 ohms input impedance). Care shall be taken to include the effects of the 150 ohms / 50 ohms matching network. Alternatively, a network analyzer can be used. The insertion loss L_i is given by the negative of the absolute value of S_{21} in dB.

End of ANNEX F

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ANNEX G

Impulse Noise Test ,Fast Transient Noise Test

G.1 Impulse Noise Test

In a test setup shown in Fig.G-1, each wiring harness shall be injected respectively with an output voltage of a noise simulator being increased gradually.

All deviation from normal operation shall be recorded and an evaluation shall be made by the standard shown in Table G-1. This test may be omitted or alternative tests may be allowed with the discussion among related engineers including the electronics testing section.

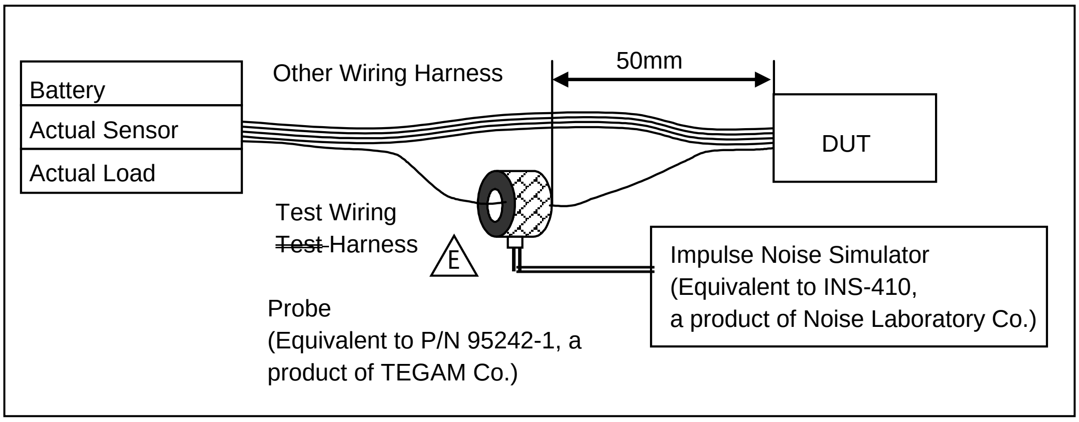

Figure G -1 Impulse Noise Test Setup

Table G-1 Impulse Noise Test Condition

Pulse Width	1μsec	
Injection Period	10msec	
Test Time	10min	
Evaluation Standard	≤±500V	To be free from a malfunction
	±500V~2kV	In case of a malfunction, necessity of countermeasures shall be determined according to fault contents

6.2 Fast Transient Noise Test

In a test setup shown in Fig.G-2, each wiring harness shall be injected respectively with an output voltage of a noise simulator being increased gradually.

All deviation from normal operation shall be recorded and an evaluation shall be made by the standard shown in Table G-2. This test may be omitted or alternative tests may be allowed with the discussion among related engineers including the electronics testing section.

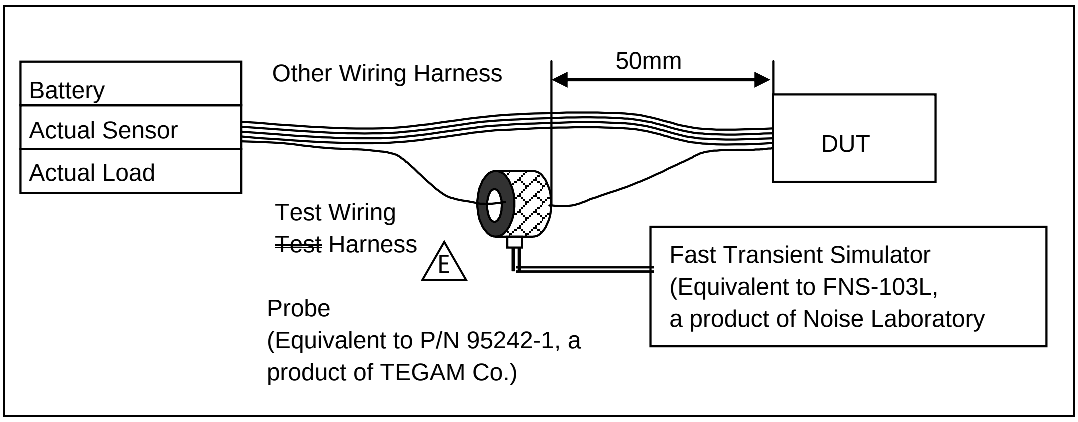

Figure G-2 Fast Transient Noise Test Setup

Table G-2 Fast Transient Noise Condition

Injection Period(Bf)	200μsec	
Burst Length(Bl)	15ms	
Burst repetition time(Br)	300ms	
Test Time(T)	10min	
Evaluation Standard	≤±2kV	To be free from a malfunction
	±2kV~4kV	In case of a malfunction, necessity of countermeasures shall be determined according to fault contents

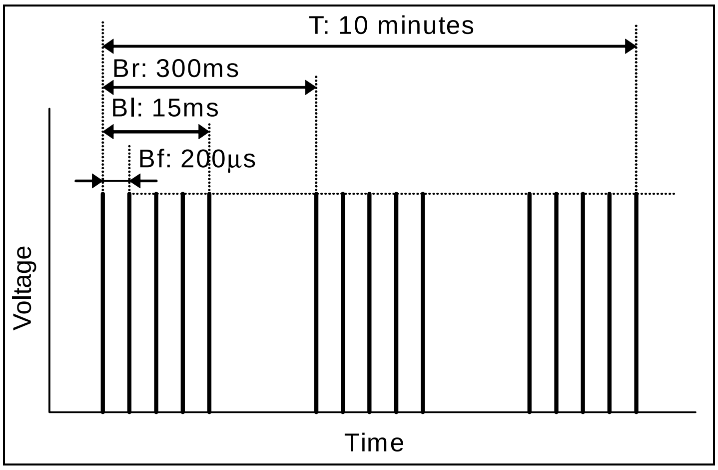

Figure G-3 Fast Transient Noise

End of ANNEX G

# # # # #

ANNEX H

Electromagnetic Immunity Test (Handy Transceiver Method)

A handy transceiver of a specification as shown below shall be held above an DUT in a way as shown in Fig.H-1 and moved along wiring harness for 30cm while radio wave is being transmitted. The unit shall suffice the following condition in this instance. The antenna of transceiver shall be pointed in 3 directions namely, (1) parallel with wiring harness, (2) at right angle to wiring harness and (3) front tip of antenna pointed to wiring harness.

Distance between Wiring Harness and Antenna	Evaluation Standard (Please see Table H-1.)
0cm*1	To be free from a malfunction of Rank I.
3cm	To be free from malfunction of Rank Iand II.
8cm	To be free from malfunction of Rank I, II and III.

*1: An electronic equipment to be installed in engine compartment or truck space, or to be shielded by a protection cover or trim cover shall be subjected to an irradiation of radio wave transmitted in 3cm distance.

○Applicable Handy Transceiver

(An output is a nominal value set by a manufacturer.)

144MHz 5W(CW, FM)

430MHz 5W(CW, FM)

900MHz 5W(CW, FM):When a handy type transceiver is not available, a car mounting type personal radio unit may be used.

1200MHz 1W(CW, FM)

○Portable telephone(digital)

PDC(925-960MHz,1420-1460MHz)

PHS(1890-1920MHz)

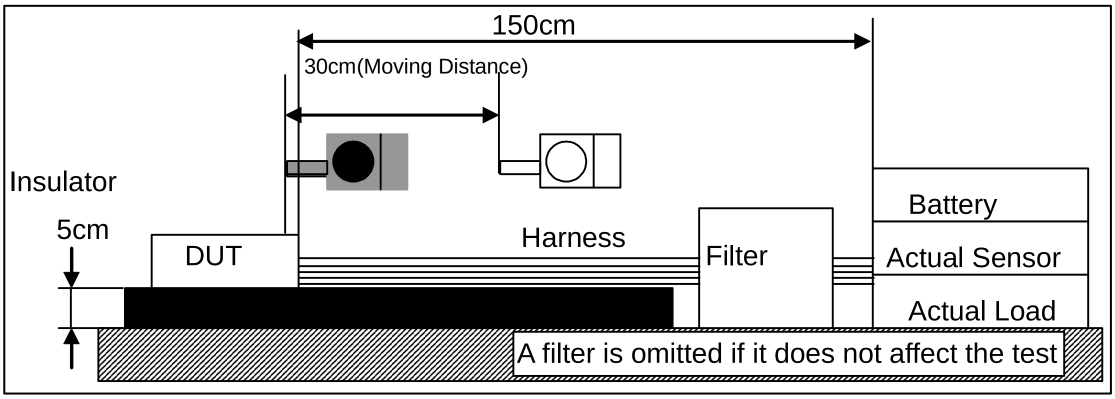

Figure H-1 Handy Transceiver Test Method

Table H-1 Classification of Malfunctions

Classification		Example
Rank I	Malfunction or breakdown which would impair a vehicle safety or bring forth a difficulty to a cruising function.	･Engine stall ･Uncontrollable run ･Brake malfunction ･Headlamp off ･Faulty explosion and non operation of air bag
Rank II	Malfunction or breakdown which would bring forth a difficulty to cruising function except for rank I.	･Stop of turn signal lamp flashing ･Erasure of memory ･Malfunction of fail-safe mechanism
Rank III*	Malfunction or breakdown which will not be directly associated with vehicle's function.	･Swinging of tachometer pointer ･Transient malfunction

*:A need for a remedial action for rank III failure will be discussed in each occasion and an action shall be taken by considering the necessity and also considering a level of action taken in the competitive models.

End of ANNEX H

# # # # #

Applying SPECs and standards list

NUMBER	CL	NAME
CISPR16-1	99	SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS - PART 1: RADIO DISTURBANCE AND IMMUNIT
CISPR25	08	RADIO DISTURBANCE CHARACTERISTICS FOR THE PROTECTION OF RECEIVERS USED ON-BOARD VEHICLES
ES-X82115	F	ELECTRICAL SYSTEM PERFORMANCE REQUIREMENT FOR E/E COMPONENTS
IEC60050-161	90	VOCABULARY, CHAPTER 161: ELECTROMAGNETIC COMPATIBILITY.
IEC61000-4-2	08	ELECTROMAGNETIC COMPATIBILITY (EMC) - PART 4-2: TESTING AND MEASUREMENT TECHNIQUES - ELECTROSTATIC DISCHARGE IMMUNITY
ISO/IEC17011	04	CALIBRATION AND TESTING LABORATORY ACCREDITATION SYSTEMS - GENERAL REQUIREMENTS FOR OPERATION AND RECOGNITION.
ISO/IEC17025	05	GENERAL REQUIREMENTS FOR THE COMPETENCE OF TESTING AND CALIBRATION LABORATORIES
ISO10605	02	ROAD VEHICLES TEST METHODS FOR ELECTRICAL DISTURBANCES FROM ELECTROSTATIC DISCHARGE
ISO11452-1	05	ROAD VEHICLES COMPONENT TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY PART
ISO11452-2	04	ROAD VEHICLES, ELECTRICAL DISTURBANCES BY NARROWBAND RADIATED ELECTROMAGNETIC ENERGY - COMPONENT TEST METHODS PART
ISO11452-3	01	ROAD VEHICLES COMPONENT TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY PART
ISO11452-4	05	ROAD VEHICLES COMPONENT TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY PART
ISO7637-1	02	ROAD VEHICLES, ELECTRICAL DISTURBANCE FROM CONDUCTION AND COUPLING PART 1 - DEFINITIONS AND GENERAL CONSIDERATIONS
ISO7637-2	11	ROAD VEHICLES, ELECTRICAL DISTURBANCE FROM CONDUCTION AND COUPLING PART 2 - ELECTRICAL TRANSIENT CONDUCTION ALONG SUPPLY
ISO7637-3	07	ROAD VEHICLES, ELECTRICAL DISTURBANCE FROM CONDUCTION AND COUPLING PART 3 - ELECTRICAL TRANSIENT TRANSMISSION BY CAPACIT
MIL-STD-1576	92	MILITARY STANDARD - ELECTRO EXPLOSIVE SUBSYSTEM SAFETY REQUIREMENTS AND TEST METHODS FOR SPACE SYSTEMS
MIL-STD-461E	99	DEPARTMENT OF DEFENSE INTERFACE STANDARD, REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS
SAEJ1113-21	92	ELECTROMAGNETIC COMPATIBILITY MEASUREMENT PROCEDURE FOR VEHICLE COMPONENTS PART 21: IMMUNITY TO ELECTROMAGNETIC FIELDS
UN/ECE NO.10	14	UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO ELECTROMAGNETIC COMPATIBILITY