PSA PEUGEOT CITROËN

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Specifications

B21 7110

ENVIRONMENT SPECIFICATIONS FOR ELECTRICAL AND ELECTRONIC EQUIPMENTS ELECTRICAL CHARACTERISTICS

Restrictions described in the standard

This is a translation, the French original shall be used in all cases of litigation *Date of translation : 18/07/2012*

WARNING

This standard of PSA was translated into English by an external company of translation

The quality of this translation has not been technically validated by the PSA Technical Discipline proprietor of this norm.

This document is available on-line in "Normes" Intranet (normes.inetpsa.com) as well as on the B2B portal (suppliers and industrial partners).

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RECORDS

Index	Date	Nature of modifications
OR	11/07/2001	Creation. This specification partially replaces the B21 7090.**Erreur ! Signet non défini.**
A	23/07/2004	Revision
B	24/05/2005	**Environment - Paragraph "general test environment" (§ 5.5.)** Object: making the environment requirements less stringent. **Test EQ/IC 05 - "resistance to 4 or 4 bis pulse"** Object: making the starting pulse less stringent. **Test EQ/IC 01 - "Resistance to pulses 1 or 1bis and 2a"** Highlights of the B21 7110-A: "Concerned wires: all the power supply wires (successively et simultaneously). The power supply associated with a network (ex: + VAN; + CAN; …) should be considered as a power supply relayed and tested as it is. The test is also applicable to all the outputs controlling the inductive loads The test is not applicable if the DUT is powered by a regulated voltage supplied by a control unit." Purpose: the goal of this addendum is to clarify the test method concerning the application of the pulses 1 or 1bis on all the outputs controlling the reactive loads. **Test EQ/IR 04 - "Resistance to electrostatic discharge, powered equipment"** Objects: clarification of the § 7.3.9 for consistency with the diagram; and making the requirement of the § 7.3.9.8 less stringent for the discharges on the insulating parts at 4kV concerning the points of 1h indirect type (to make it consistent with the requirements on the conducting parts). **Test EQ/IR 05 - "Immunity to the on-board transmitter"** Object: addition of an informative appendix to the portable transmission devices. **Test VH/IR 01- "Immunity to the radiated electric field (semi-anechoic or anechoic chamber)"** Object: making the calibration method consistent with the standard ISO 11451-2. **Test VH/IR 04 - "Immunity to the portable on-board transmitter"** Object: addition of an informative appendix of the portable emission devices.
C	19/05/2008	New release. The modifications are summarized in the document "Comparative B21 7110 B§C.xls", accessible within PSA through the following link: http://normes.inetpsa.com/normes/bv/bv01041/fr/Annexes_B21 7110.zip
D	03/07/2012	New releaseof the standard, in particular, addition of the specific features related to the electric and/or hybrid vehicles. A document which summarizes the main modifications is accessible within PSA through the following link: http://normes.inetpsa.com/normes/bv/bv01041/fr/Annexes_B21 7110.zip Note: Certain new tests appear in this standard. The numbering (EQ/ICxx) is done, in general, by historic order. The test number EQ/IC11 is voluntarily absent from this standard, to avoid a possible confusion with the specifications of other automobile constructors.

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1.OBJECT AND SCOPE OF APPLICATION

The purpose of this document is the definition of the requirements to be respected in order to ensure the electric resistance and the Electromagnetic Compatibility (EMC) of the vehicles (specific vehicles and small commercial vehicles) and of associated electric, electronic equipments.

The requirements defined in this document constitute the reference for consultation of the Suppliers.

The person in charge of development at PSA (in agreement with the person in-charge at PSA for EMC and electric validations) should define to the Supplier the requirements retained. by default, this document is applied integrally.

Equipment is validated when it satisfies the test requirements on the equipment and on the vehicle. The tests on the equipment should be carried out in an environment representing the procedure on vehicle (validation system).

The entire vehicle project has an electric validation and independent EMC: a validation obtained on a vehicle project is not systematically extendable to another vehicle project.

The general requirements concerning the environmental tests for the electrical and electronic equipment for the vehicles are listed in the B21 7100 standard.

The equipments connected to the alternative network (example: battery charger...) should, in addition to the requirements applicable to this document satisfying the specific requirements defined in the document ref. 02016_12_04631.

The equipments connected to the 48V network should, in addition, to the requirements applicable to this document satisfy, the specific requirements defined in the document ref. 02016_11_08687.

Note: The present document does not deal with the EMC approval aspects of the equipments which are defined in the document ECE-R10.

2.DOCUMENTARY REFERENTIAL

2.1.REFERENCE DOCUMENTS

2.1.1.NORMS

CISPR 16-1 Ed 3.1 (11/2010)	Specification for radio disturbance and immunity measuring apparatus and methods -- Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus
CISPR 25 Ed. 3 (2008)	Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers
IEC 60068-2-1 (2007)	Environmental testing - Part 2-1 : Tests – Test A Cold
ISO 11452-11 (09/2010)	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic10 energy -- Part 11: Reverberation chamber
ISO 11452-2 (2004)	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 2: Absorber-lined shielded enclosure
ISO 11452-4 (12/2011)	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 4: Harness excitation methods
ISO 11452-8 (2007)	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 8: Immunity to magnetic fields
ISO 11452-9 (2012)	Road vehicles -- Component test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 9: portable transmitters
ISO 16750-1 (08/2006)	Road vehicles -- Environmental conditions and testing for electrical and electronic equipment -- Part 1: General
ISO 16750-2 (03/2010)	Road vehicles -- Environmental conditions and testing for electrical and electronic equipment -- Part 2: Electrical loads

ISO 7637-2 Ed 3 (03/2011)	Road vehicles -- Electrical disturbances from conduction and coupling -- Part 2: Electrical transient conduction along supply lines only
ISO 8820	Road vehicles –fuse links
ISO 10605 (2008)	Road vehicles – Test means for electrical disturbances from electrostatic discharge
ISO 7637-3 Ed 2 (2007)	Road vehicles -- Electrical disturbances from conduction and coupling -- Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines.
MIL STD 461 E	Requirements for the control of electromagnetic interference characteristics of subsystems and equipment

2.1.2.REGULATIONS

Not applicable

2.1.3.OTHERS DOCUMENTS

Not applicable

2.2.APPLICABLE DOCUMENTS

2.2.1.NORMS

A10 0156	Test reports - Preparation
B21 7100	Technical specifications concerning the environment of electronic and electrical equipment electrical characteristics
B35 0010	EMC & Electrical type test plan for the electric and electronic equipments

2.2.2.REGULATIONS

99/519/CE	Recommendation of the council of the European Union from 12 July 1999 related to the limitation of exposure of the public to the electromagnetic fields (from 0 Hz to 300 GHz)
DC 2002-775	French decree no.2002-775 dated 03rd May 2002 taken under the 12° of the article l.32 of the postal and telecommunication code and related to limiting exposure the public to electromagnetic fields emitted by the equipments used in the telecommunication networks or by the radio-electric installations.
ECE-R10	Uniform limitations concerning the approval of the vehicles with regard to the electro-magnetic compatibility.

For information, the tests EQ/IC08, EQ/IR01, EQ/IR06, EQ/MC03, EQ/MC04 and EQ/MR01 contribute to the respect of the regulation ECE-R10. The test EQ/MR02 contribute to the respect of the recommendation 99/519/CE and of the decree DC 2002-775.

2.2.3.OTHERS DOCUMENTS

02016_11_06198	Protection Centralisée BSI Décharges Electrostatiques sur prise diagnostic
02016_12_04631	Spécifications CEM complémentaires pour les équipements connectés au réseau alternatif
02016_11_08687	Electric and electronic components in motor vehicles _ 48V power supply _ Requirements and tests.
02016_11_06161	PSA – BMW Equipment Specification _ Environment specifications of electric and electronic equipments _ Electrical characteristics
02016_11_03036	PSA – BMW Equipment Specification _ Environment specifications of electric and electronic equipments _ EMC characteristics

2.3.EXPRESSION ON DOCUMENTS

Not applicable

3.TERMINOLOGY

A dictionary (glossary) of the main terms and their definitions used in the Technical and Industrial Department, in the domain of automation, is provided in the E03.65.015.G standard.

3.1.DEFINITIONS

For the requirements of the present standard, the following terms are defined:

Operating classes:

For the requirements of this document, the definitions of the operating classes given in the B21 7100 standard are applied.

Four operating classes are used in the definition of the behavior of the DUT during and after the tests of the specifications. As a reminder to the standard B21 7100 (with the exception of the class B defined in the B21 7100 but not used in this document), the following are these classes:

"This paragraph describes the functional state of a device during and after a test."

The minimal functional state should be indicated in each test. An additionnal test specification can be agreed upon between the equipment manufacturer and PSA.

From the functional analysis, the analysis of the failure modes and the preliminary analysis of the equipment risks (APR), a list of dreaded events is prepared, events which are listed in operating classes for the bench tests.

Equipment can have multiple functions. Each of them may be subject to various operating classes.

Operating classes

Class	*Definition*
A	*The function (*) of the device/system performs as designed during and after the test.*
C	*The function (*) of the device/system does not perform as designed during the test but returns automatically(*) to normal operation after the test.*
D	*The function (*) of the device/system does not perform as designed during the test and does not return to normal operation afterwards, and the device/system is reset by a simple user action.*
E	*The function of the device/system does not perform as designed during and after the test, and cannot be returned to proper operation without repairing or replacing the device/system.*

(*) To be specified in the special specification.

Requirement: *Unless otherwise specified in the special specification, device operations should conform with Class A after each test."*

Functionnal operating modes:

In the case of equipment having many functions or operating phases which cannot be tested simultaneously, it is important that the tests carried out cover the worst cases of emission or of susceptibility.

By default, test all the procedures. The test plan and/or the TNS/TS should possibly define the modes which would not be tested, depending on the product design and technical arguments.

Temperatures:

For the requirements of this document, the definitions of the temperatures given in the B21 7100 standard are applied.

Voltages:

For the requirements of this document, the definitions of the LV voltages given in the B21 7100 standard are applied.

The electric characteristics for high voltage (HV) (“200V”) (D.C.) will be specified in the TNS/TS. The adequate voltage ranges are defined in the paragraph 7.2.1 in relation to the sizing of the battery.

Note: Due to various technologies of energy storage, the nominal voltage ranges of the HV network can be large (possibility of transversal equipment compatible with various battery sizes). Therefore, precautions should be taken in order to clearly define the appropriate voltage levels in the TNS/TS.

3.2.ACRONYMS

For the requirements of this standard, the following abbreviations are defined:

AM	Amplitude Modulation (Modulation of amplitude).
AMDEC	Analysis of Failure Modes, their Effects and their Criticality.
ASIL	**A**utomotive **S**afety **I**ntegrity **L**evel
+APC	Plus After Contact. – Primary ignition supply
+BAT	Plus BATtery.
BCI	Bulk Current Injection .
BP	Band width.
DUT	Device under test
HV	High Voltage (more than 60V DC).
EMC	Electro Magnetic Compatibility
+CPC	Centralized Power Switch
CISPR	Special International Committee for Radio electric Disturbances
CW	Continuous Wave (Continuous Wave).
DES	Electro-Static Discharge.
JIG	Calibration Device.
N / A	Not Applicable
PM	Pulse Modulation (Pulse Modulation).
PWM	Pulse Width Modulation (Pulse Width Modulation)
LSIN	Line Stabilization Impedance Network.
LV	low Voltage (less than 60V DC)
TNS/TS	Technical Normative Specification and Technical Specification (See A10 0310 standard) Replaces the term “Detailed Technical Specification” (STD)
STT	STop and sTart

For practical reasons, each test of this document is numbered in a specific way. The given numbers remain valid from an edition to an other of this document. A new test will be thus attributed with a new number in an increasing order, however it does not mean that the new test will be placed in this order in the summary. For information, the definition of the numbering is the following one :

EQ	**EQ**uipement
TE	**T**est **E**lectrique (Electrical Test)
IC	**I**mmunité **C**onduite (Conducted Immunity)
IR	**I**mmunité **R**ayonnée (Radiated Immunity)
MC	**M**utisme **C**onduit (Conducted emission)
MR	**M**utisme **R**ayonné (Radiated emission)
HV	**H**igh **V**oltage (terme utilisé en anglais pour le réseau basse tension, supérieur à 60V DC).

Therefor, as an example, the test EQ/MC_HV01 is named so because it is a test to be performed on an equipment, it allows to perform conducted emission measurement, and it concerns the high voltage (higher than 60V DC)

4.GENERAL PRESCRIPTIONS

Customer impact levels:

Four levels of customer impact are defined. The dreaded events (concrete criteria of malfunctioning of the DUT) are:

- defined during the preleminary analysis of the risks and the analysis of the failure modes realized within the framework of the dependability studies
- and/or specified in the absence or as a supplement to the dependability studies

They have to be evaluated in level terms of customer impacts, according to the following table :

Customer impact level	Evènements redoutés	
	Gravity (dependability)	Complementary definition
3	ER4 asils B, C et D	Failure which directly endangers the customer, his passengers or others
2	ER4 asil A, ER3 ER2	Failure which directly results in a breakdown of the vehicle, or endangers under certain conditions. Complete loss of a function, not resulting in non-availability of the vehicle
1	ER1	Degraded operation and/or failure leading to a minor inconvenience.
0		Deviation in relation to the nominal, but not perceptible by the customer.

This table should be present in the test plan defined in the § 5.2 For all concerned tests.

5.TEST CONDITIONS

5.1.VALIDATION PROCEDURE

For the requirements of this document, the validation procedure given in the standard B21 7100 is applied.

5.2.PREPARATION OF THE ENVIRONMENTAL TEST PLAN

For the needs of this document, the requirements for the preparation of the environmental test plan given in the standards B21 7100 and B35 0010 are applied.

5.3.TEST REPORT

According to CPPR (“clauses particulières et planning des résultats”, particular clauses and results schedules), the supplier should send a test report to the manufacturer when the tests are carried out.

The test report should be compliant with the standard A10 0156, with the following additions:

The references of the tested equipment: type or description, development status, Hardware and software reference.

- The number of samples tested for each test.
- The reference of the applicable test plan and all possible deviation in relation to it.
- The instrumentation used, with the calibration and/or verification dates for the critical equipment of the instrumentation chain (the calibration certificates and the instrumentation verification observations should be made available to the Manufacturer).
- The uncertainty values associated with each test with a confidence level of 95.5% (k=2). The procedure and/or method of calculation should be made available to the Manufacturer.
- The commitment of the supplier with regards to the compliance or the non compliance, of the DUT for each requirement. All possible analysis and/or opinion of the supplier about the test results should be clearly distinguished from the product compliance state.
- For the immunity tests :
  - The used susceptibility (dreaded events and associated requirements in terms of customer impacts)
  - Any malfunctioning in relation to the nominal should be specified and described, even if the deviation is acceptable in relation with the requirements.
- For each test:
  - the procedures and the functional scenarios of the equipment during the tests
  - The information requested for in the sub-chapter “test report” of the test concerned with this document.
- Any specific request made in the test plan

5.4.SUPPLIER’S RESPONSIBILITY

For the needs of this document, the requirements about the supplier responsibilities given in the B21 7100 standard are applied.

5.5.GENERAL TEST ENVIRONMENT

For the needs of this document, the requirements about the general test environment, given in the B21 7100 standard are applied.

5.5.1.TEMPERATURE

For the needs of this document, the requirements in relation to the temperature are given in the B21 7100 standard. These requirements pertain to a minimum of the "critical" measuring equipment.

Note : the “critical” measuring equipment are those necessary for the execution of a test and which have a significant impact on the accuracy of the test result (the evaluation of the uncertainties of the measurement is one of the means to identify the critical equipment). On a minimum, the critical equipments include all the measurement equipments subject to calibration.

5.5.2.HUMIDITY

No requirement is applied, unless otherwise specified in the concerned test chapter (electrostatic discharges).

5.5.3.VOLTAGE

For the needs of this document, the requirements for the U_A voltage given in the standard B21 7100 are applied.
For the voltages of the HV network, refer to the paragraph 7.2.1.

5.5.4.PRESSURE

No requirement is applied, unless otherwise specified in the TS.

5.5.5.TOLERANCES

For the needs of this document, the requirements for the tolerances given in the B21 7100 standard are applied, except for the following tests:

- BCI Immunity (EQ/IC08)
- Measurement of low frequency conducted noises (EQ/MC02)
- Measurement of radiofrequency conducted noises on the supply inputs (EQ/MC03)
- Measurement of radiofrequency conducted noises on the outputs (EQ/MC04)
- Measurement of low frequency magnetic fields (EQ/MR02)
- Measurement of radiofrequency radiated noises (EQ/MR01)
- Measurement of radiofrequency conducted noises on the supply inputs HV (EQ/MC_HV01)
- Measurement of coupling attenuation – active components (EQ/MC_HV02)
- Measurement of coupling attenuation – passive components (EQ/MC_HV03)
- Measurement of radiofrequency conducted noises on the DC (shielded) and three-phased lines of high voltage – current (EQ/MC_HV04)

5.6.SPECIFIC TEST ENVIRONMENT

5.6.1.GENERAL FEATURES

The configuration of the DUT and its environment should be representative of the real procedure. The equipment under test should be installed in the conditions which are as close as possible, to its normal use conditions, in particular:

- The DUT should be powered by a battery and/or a stabilized power supply source (or programmable) with an internal resistance < 0.1Ω and it should not have a peak to peak superimposed ripple voltage > 0.1 V.
- The connections to the ground should be compliant with those indicated in the test plan or the equipment specifications.
- The electric connections with the ground plan (DUT, test material) when they are necessary, have the following characteristics:
  - Inductance: L ≤ 100 NH.
  - Resistance: R ≥ 10 mΩ.

The real environment of the DUT should preferably be used. However, in the case of non feasibility, it is possible to use an environment simulator for the sensors and actuators: it is necessary that it has sufficient protections not be disturbed by the interference generated during or after the test and not to cause disturbances.

The harness used for the tests should be representative of that used on the vehicle, at least with regard to the number of wires and for their cross-section. The length should be compliant with the specifications of the concerned test.

5.6.2.GROUND PLANE

The DUT is installed on a ground plane connected to the earth with minimal characteristics:

Length : a minimum of 2000 mm or the length of the test bench increased by 500 mm (take the maximum value of the two).

Width : width of the test bench increased by 200 mm on each side.

Thickness : ≥ 0.5 mm.

Material : copper or brass.

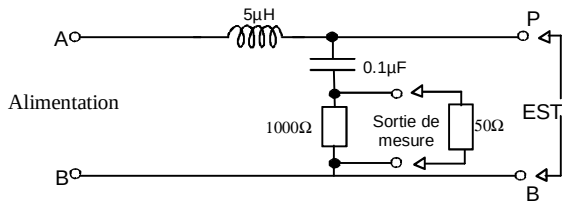
5.6.3.INSULATING SUPPORT

For all the tests except EQ/IR03 and EQ/IR04, the DUT and the harnesses of the test are insulated from the ground plane by a support with the following characteristics:

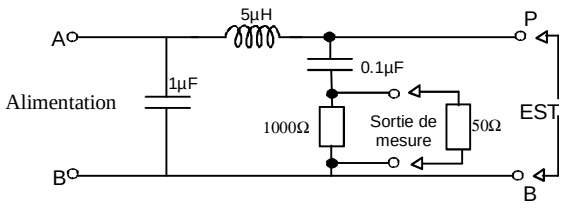
- Thickness : $50\ ^{+10}_{0}$ mm.
- Relative permittivity : εr ≤ 1.4.
- Relative permeability : μr ≤ 1.1.

Note : *The wooden supports are prohibited due to their relatively high permittivity.*

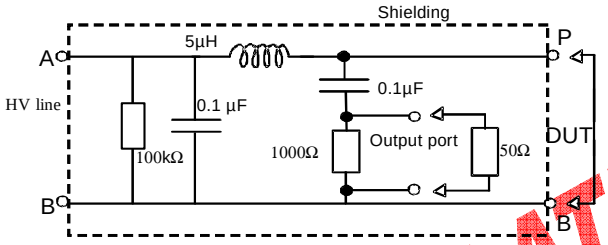
5.6.4.DECOUPLING DEVICES (LSIN)



LSIN compliant with the ISO 7637-2 standard



LSIN compliant with the CISPR 25 publication



LSIN for measurement on the high voltage lines

LSIN connection (when it is necessary):

- If the grounding of the DUT is local on the vehicle (l < 200 mm), connect a LSIN on the power supply wire.
- If the grounding of the DUT is distant on the vehicle (l ≥ 200 mm), connect two LSIN on the power supply and on grounding wires.

The LSIN used for the measurement on the HV lines should be shielded through the terminal B which will be connected to the shielding of the LSIN.

5.7.METHODS OF MEASUREMENT

The measurement chains with optical link should have a bandwidth adapted to the signals to be transmitted.
The electrical connections (and, in particular, those used for tests in shielded chamber) should be shielded or equipped with adapted filters.
The measuring devices (oscilloscope, spectral analyzer, and receiver) should have a suitable bandwidth for the signals to be measured or a number of digitized points adapted to the processing carried out.
The current or voltage probes should have a bandwidth adapted to the signals to be measured and enough immunity with regard to the electromagnetic environment related to the test.

5.8.SPECIFIC CONDITIONS FOR IMMUNITY TESTS

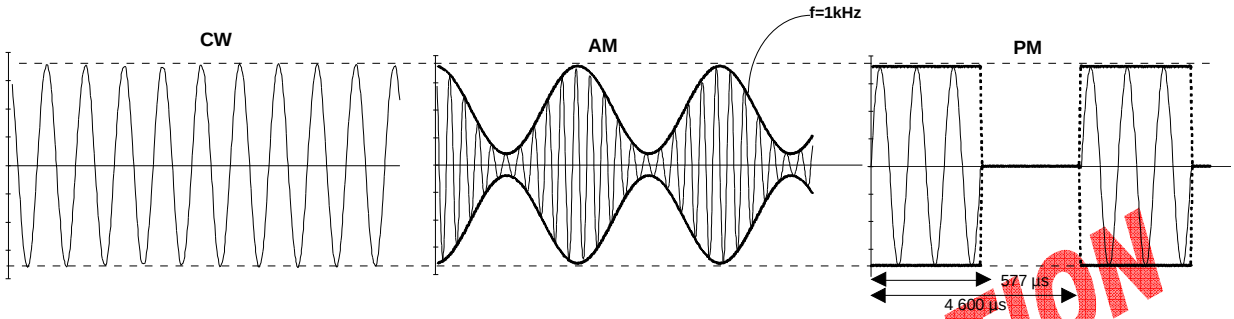
The operating mode of the equipment under test should correspond to the worst susceptibility case or the highest functional occurrence.
The test installation should be capable of generating the test signals required for the frequency bands defined in this document. The installation should be compliant with the legal prescriptions concerning the emission of electrical signals (use of a shielded chamber).

Note: *The test area can be subjected to high electromagnetic fields: the supplier has to take care about all the necessary precautions (use of a shielded chamber for example).*

5.8.1.MODULATION

The following are the various modulation types used in the procedures:

- Not modulated (CW).
- Amplitude modulated 1 kHz 80% (AM):
- PM1: frequency 217 Hz, Tone 577 µs (illustration below).
- PM2: frequency 300 Hz, Tone 3 µs.
- **Specific features for the US market:** PM3 (radar pulse train) : ratio of pulse repetition 300 Hz, Tone 3 µs, with only 50 pulses each second



CW, AM, PM modulation - Principle of conservation of the peak level

Reminder concerning the principle of conservation of the peak level:

Any sine wave signal s (t) (of the current, field or voltage type) with a pulse ω can be written as:

$s_{CW}(t)=s_0.\cos(\omega t)$

Therefore, its average power is:

$$P_{CW} = \frac{s_0^2}{2}$$

Any sine wave signal s(t) which is amplitude modulated can be written as:

$s_{AM}(t)=s_1.\cos(\omega'$ modulating signal).

$\mathbf{m} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$: modulation rate.

Therefore, its average power is: $P_{AM} = \left(1+\frac{m^2}{2}\right).\frac{s_1^2}{2}$

There are two ways of adjusting the signal in order to retaining the peak value:

- measurement of the modulated power: $P_{CW} = \frac{(1+m)^2}{1+\frac{m^2}{2}}.P_{AM}$

For 80% modulation rate, we get: $P_{AM} = 0{,}407 \cdot P_{CW}$
(-3.9 dB)

- measurement of the non-modulated power before application of the modulation:

$$P_{\text{CW before modulation}} = \left(\frac{1}{1+m}\right)^2.P_{CW}$$

For 80% modulation rate, we get: $P_{\text{CW before modulation}} = 0.309 \cdot P_{CW}$ (-5.1 dB)

5.8.2.FREQUENCY STEP

For the immunity tests of “frequency” type, the maximum frequency step is one of the two following choices:

F_{min}	F_{max}	Logarithmic frequency step	Linear frequency step
0 Hz	20 Hz	Not applicable	2Hz
20 Hz	100 kHz	10 %	Not applicable
100 kHz	1 MHz	5 %	25 kHz
1 MHz	20 MHz		500 kHz
20 MHz	30 MHz		1 MHz
30 MHz	100 MHz		2 MHz
100 MHz	200 MHz	2 %	2 MHz
200 MHz	400 MHz		5 MHz
400 MHz	1 GHz		10 MHz
1 GHz	1,7 GHz		20 MHz
1,7 GHz	2,5 GHz	1 %	20 MHz
2,7 GHz	3,2 GHZ		20 MHz

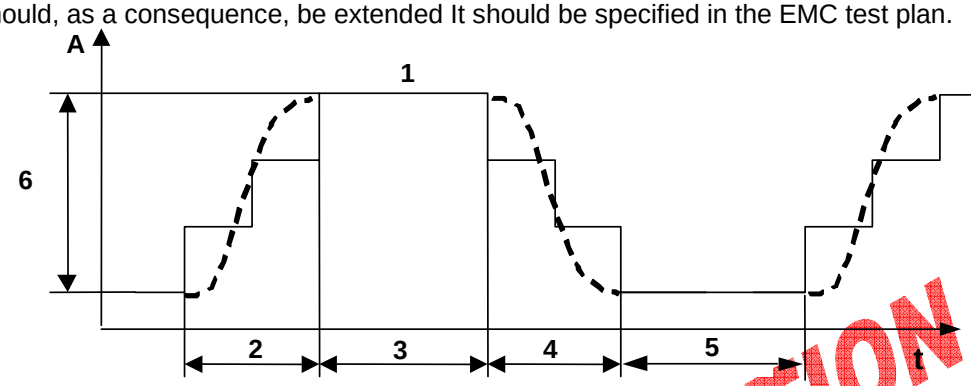
Note:	*The compliance with the requirements for the equipment with the above mentioned frequency step does not guarantee the respect of the vehicle requirement with the same frequency step (possible variation of the quality factor). It is about of maximum step between two frequencies whose philosophy is to make any malfunctioning between two steps improbable; the specific list of the frequencies which result from it is by no means contractual.*

5.8.3.EXPOSURE TIME

For the frequency immunity tests, the interference is progressively applied for each frequency until the pre-set value is reached, and then reduced in the same manner before switching to the next frequency.

If no specific agreement between the Supplier and the Manufacturer exists (to be specified in the EMC test plan), the application of the interference is done in conformity with the figure below.

The dwell time depends on the DUT. If using software filtering that adds a time delay before the springing a fault, the dwell time should, as a consequence, be extended It should be specified in the EMC test plan.



1 Preset level of the disturbance

2 Increase time for the disturbance ($t_m \geq 1$ s)

3 Dwell time of the specified pre-set level of the disturbance ($t_{application} \geq 1$ s)

4 Decrease time for the disturbance ($t_d \geq 0,5$ s)

5 Time between two frequencies for return to nominal state ($t_{recovery} \geq 0$ s)

6 Reduction of the signal between two frequencies for a return to nominal state (level ≥ 10 dB)

5.9.SPECIFIC CONDITIONS FOR EMISSION TESTS

In order to ensure that no noise or external signal of sufficient amplitude will significantly affect the measurement, measurements should be carried out before or after the main test. During this measurement, the noises or external signals should be at least 6 dB less than the appropriate reference limits for each detector (shielded chamber essential).

The operating mode of the equipment under test should correspond to the worst case of disturbances or to the highest functional occurrence. In the case of reversible equipments, the evaluation of the disturbances should be carried out in the two directions of rotation.

In the case for equipments where some amplitudes (motor speed, brightness level…) are adjustable, the evaluation of the disturbances should be carried out for the worst case. Then, the pre-evaluation measurements can be necessary.

To ensure the reproducibility of the results on equipments having electro-mechanical contacts susceptible to wear and tear, a prior run-in of the equipment under test is necessary. The duration of this run-in should be in relation with the mission profile of the equipment.

6.APPLICATION GUIDE FOR THE EQUIPMENT TESTS

The requirements and the tests to be carried out depend on the type of equipment, on the vehicle assembly and the various installation and/or operation conditions.

The following table forms a guide which enables to target the applicability of each test depending onthe specific features of the equipment, and to help in the preparation of the test plan or the TNS/TS plan.

Each test chapter of this standard contains a paragraph titled "TEST APPLICATION CONDITIONS" which provides the same information.

	Test not applicable by default, unless:	**Test always applicable, unless:**
EQ/TE 01 : immunity to usual power supply voltages		equipment powered by a regulated voltage supplied by another control unit (non mandatory test in this case, to be specified with the adaptation of the levels in the TNS/TS)
EQ/TE 08 : Resistance to voltage fluctuation in the usual “volt control” range		equipment powered by a regulated voltage supplied by an other control unit (neither the alternator nor the DC/DC convertor of an electric/hybride vehicle are concerned by the term « control unit »)
EQ/TE 07 : Resistance to exceptional supply voltage		equipment powered by a regulated voltage supplied by another control unit.
EQ/TE 02 : Immunity to slow drop and rise of voltage		equipment does not contain active electronics, microcontrollers and/or onboard software.
EQ/TE 03 : re-initialization test		equipment does not contain active electronics, microcontrollers and/or onboard software.
EQ/TE 04 : Immunity to unusual supply voltages: 24V		equipment powered by a regulated voltage supplied by another control unit.
EQ/TE 04 : Immunity to unusual supply voltages: -13.5V		equipment powered by a regulated voltage supplied by another control unit.
EQ/TE 05 : Immunity to short circuits		*the exceptions are rare and should be studied case by case (single motor, led…)*
EQ/IC 01 : Immunity to pulses 1, 1 bis and 2a		equipment powered by a regulated voltage supplied by another control unit.
EQ/IC 10 Immunity to pulses on the outputs controlling inductive loads	equipment switching inductive loads (motors, actuators, offset relay…)	
EQ/IC 02 : Immunity to the pulses 3a & 3b		OR: equipment powered by a regulated voltage supplied by another control unit. OR: does not contain active electronics. *In the case of 5V supplies, the test EQ/IC07 is applied on all the signal + supply lines*
EQ/IC 03 : Immunity to the pulse 5b		equipment powered by a regulated voltage supplied by another control unit.

	Test not applicable by default, unless:	Test always applicable, unless:
EQ/IC 04 : Immunity to short interruptions 2µs ------>		passive equipment or motor, having the following specific features: OR: Functions having sufficient mechanical or thermal inertia (seat motors, CTP …) OR: Lighting type or indicator light functions, for which flickering is authorized.
EQ/IC 04 : Immunity to short interruptions 100µs ----->		OR : equipment not having power supply lines switched by a relay OR: passive equipment or motor, having the following specific features: Functions having sufficient mechanical or thermal inertia (seat motors, CTP …) Lighting type or indicator light functions for which flickering is authorized. Functions of type
EQ/IC 04 : Immunity to short interruptions 5ms ----->	AND: equipment powered on the vehicle via a contact switch. AND: equipment having an active electronic components which does not correspond to one of the following specific features : - Functions having a sufficient mechanical or thermal inertia (seat motors, CTP…) - - Lighting type or indicator light functions for which flickering is authorized.	
EQ/IC 05 : Immunity to pulses 4 or 4 bis (start up)		OR: equipment powered by a regulated voltage supplied by another control unit. OR: equipment not connected during start-up.
EQ/IC 12: Immunity to re-start –up pulse (STT)		OR: equipment not likely to be installed in a vehicle with stop and start system (STT), OR: equipment powered by a regulated voltage supplied by another control unit.
EQ/IC 13: Resistance to pulse voltage “Volt control”		OR : equipment powered by a regulated voltage supplied by an other control unit (neither the alternator nor the DC/DC convertor of an electric/hybride vehicle are concerned by the term « control unit ») OR : equipment having nominal funtion during the test EQ/TE07
EQ/IC 06 : Immunity to ripple voltages		OR: equipment powered by a regulated voltage supplied by another control unit. OR: passive equipment or motors, having sufficient mechanical or thermal inertia (seat motors, CTP…)
EQ/TE_HV01: Resistance to power supply voltages	equipments connected and powered by the high voltage network	

	Test not applicable by default, unless:	Test always applicable, unless:
EQ/TE_ HV02: Resistance to drop and slow rise of the supply voltage	Equipments connected and powered by HV network, and having an active electronics, a microcontroller and/or onboard software.	
EQ/IC_HV03: Resistance to ripples of High voltage network	equipments connected and powered by the high voltage network	
EQ/IC_HV04: Resistance to transient overvoltage	equipments connected and powered by the high voltage network	
EQ/IC_HV05: Resistance to transient under voltage	equipments connected and powered by the high voltage network.	
EQ/IC_HV06: Resistance to Load dump pulses	equipments connected and powered by the high voltage network.	
EQ/IC_HV07: Resistance to start-up pulses	equipments connected and powered by the hgh voltage network during the start-up phase.	
EQ/IC_HV08: Resistance to brief breaks (melting of a fuse)	equipments connected and powered by the high voltage network.	
EQ/IC 07 : Immunity to transients on the signal lines		the equipment does not contain active electronics.
EQ/IC 08 : immunity BCI		the equipment does not contain any electronic component. In the case of an equipment which only has passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the test at 300mA is applicable, with the limited requirements.
EQ/IC 09 : Immunity to high/low ignition voltage	equipments installed in engine compartment AND: OR: having an electric connection passing less than 200 mm from the high voltage ignition system OR: running along the high voltage control wiring.	
EQ/IR 01 : immunity to the electric field	EQ/IR06 test applicable, but not performed considering the available test equipments	
EQ/IR 06 : Immunity to radiated electric field in reverberation chamber		The equipment does not contain any electronic component. The applicability of the requirements specific to US market is to be specified in the TNS/TS. In the case of an equipment which only has passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the test at 200 / 160V/m is applicable, with the limited requirements.

	Test not applicable by default, unless:	Test always applicable, unless:
EQ/IR 02 : immunity to the magnetic field	OR : equipments sensitive to the magnetic field (Hall effect sensors, audio circuits, …) OR : equipments located close to a strong source of magnetic field (alternator, DAE, …) OR: equipment localized in the passenger compartment of a vehicle equipped with the ADML function	
EQ/IR 03 : Immunity to DES, equipment not powered	*Test always applicable.*	
EQ/IR 04 : Immunity to DES, equipment powered		the equipment does not contain active electronics.
EQ/IR 05 : Immunity to on-board transmitters on table		OR: under-hood localized equipment OR: equipment does not contain active electronics.
EQ/MC 01 : Measurement of the switching noises	OR: the equipment has a motor likely to operate by switching. OR: the equipment switches the loads via relays (BSI, BSM…).	
EQ/MC 02 : measurement of low frequency/BF conducted noises	the equipment consumes a current >1Aeff	
EQ/MC 03 : measurement of Radiofrequency (RF) conducted noises on the supply inputs		equipment having neither frequency oscillator >9kHz, nor motor, nor transistor and not being powered by a PWM.
EQ/MC 04 : measurement of radio frequency conducted noises on the outputs	the equipment has a frequency oscillator >9kHz, a motor, a transistor AND: OR: has supply or power outputs (current > 0.25A). OR: has shielded cables.	
EQ/MR 01 : measurement of electric radiated electric field		equipment having neither frequency oscillator >9kHz, nor motor, nor transistor and not being powered by a PWM.
EQ/MR 02 : measurement of low frequency BF magnetic field	OR: the equipment consumes a current >1Aeff OR: the equipment has an electric motor OR: equipment localized in the passenger compartment of a vehicle equipped with the ADML function	

	Test not applicable by default, unless:	Test always applicable, unless:
EQ/MC_HV01: Measurement of radio frequency conducted noises on the HV power supply inputs	the equipment has a high voltage power supply line with DC AND: OR: The equipment contains a frequency oscillator greater than 9kHz OR: The equipment contains an electric motor OR: The equipment is powered by a PWM OR: The equipment has one or several transistors	
EQ/MC_HV02: Measurement of attenuation coupling – active components	The equipment has connections of high voltage lines (“200 V”) and low voltage (12V for example) ET: having active electronics	
EQ/MC_HV03: Measurement of coupling attenuation – passive components	The equipment has connections of high voltage lines (“200 V”) and low voltage (12V for example) ET: passive equipment	
EQ/MC_HV04: Measurement of radio frequency noises conducted on the direct current and three-phased lines (shielded) of the high voltage - current.	equipments having a shielded high DC or AC voltage line	

7. TEST PROCEDURES ON EQUIPMENT AND REQUIREMENTS

7.1. ELECTRICAL RESISTANCE TESTS FOR THE EQUIPMENTS CONNECTED TO THE LOW VOLTAGE NETWORK (12 V)

7.1.1. EQ/TE 01: RESISTANCE TO USUAL POWER SUPPLY VOLTAGES

7.1.1.1. Reference document

This test procedure is compliant with the ISO 16750-2 standard except for the test voltages, times and test temperatures.

7.1.1.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the minimal and maximum voltages of the on-board network.

The minimum voltage corresponds to the minimum voltage delivered to the DUT by taking into account the estimated voltage drops in the cables and a weak battery state. The “steady maximum” voltage corresponds to the maximum voltage delivered to the DUT (except for a possible problem linked to the alternator).

The following are the main characteristics of the test:

- Minimum voltage 8; 9.5 or 10.5 V (or 30 V) at TminEF and TmaxEF.
- Maximum steady voltage 16 V (or 48 V) at TminEF and TmaxEF.

7.1.1.3. Test application condition

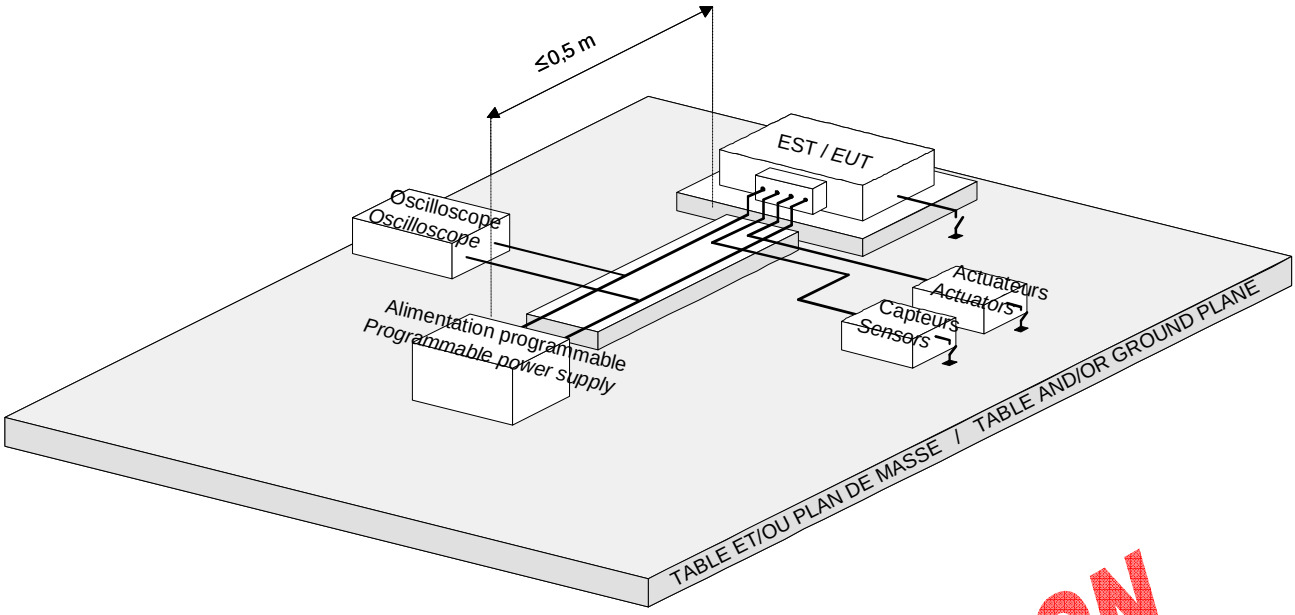
This test is applicable to all equipments powered by the low voltage network (12V).

This test can be used for the equipments powered by a regulated voltage supplied by another control unit (particularly 5V sensors), but with requirements and suitable voltage levels. The TS should specify the operating voltage range. .
The test is carried out on the power supply lines for the equipment considered simultaneously.

7.1.1.4. Test means

- Programmable power supply.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.

7.1.1.5. Assembly



7.1.1.6. Procedure

Preparation:

A wiring harness of a maximum length of 2000 mm should be preferably used (possibly, the real wiring harness can be used). The equipment should be installed indifferently on an insulated table or a ground plane.

The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.
The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

Operating voltages:

Adjust the programmable power supply in order to obtain the following operating supply voltages:

12 V Network	Power supply voltage
U_{min} = 8,0 V / 8.0 V	Minimum voltage 1 (operational equipment and/or function, engine not running and generator not operational)
U_{min} = 9,5 V / 9.5 V	Minimum voltage 2 (operational equipment and/or function, engine not running and generator not operational)
U_{min} = 10,5 V / 10.5 V	Minimum voltage (operational equipment and/or function, engine running and operational generator), and/or “stop” phase of the stop and start system.
U_{max} = 16,0 V / 16.0 V	Maximum steady voltage.

The voltage level should be considered as being those at the terminals of the equipment. The voltage could be adjusted at the terminals of the equipment. If needed, for simplification, the adjustment of the voltage level at the generator output can be accepted for any equipment consuming less than 10A (which amounts to the voltage drops in the cables being neglected).

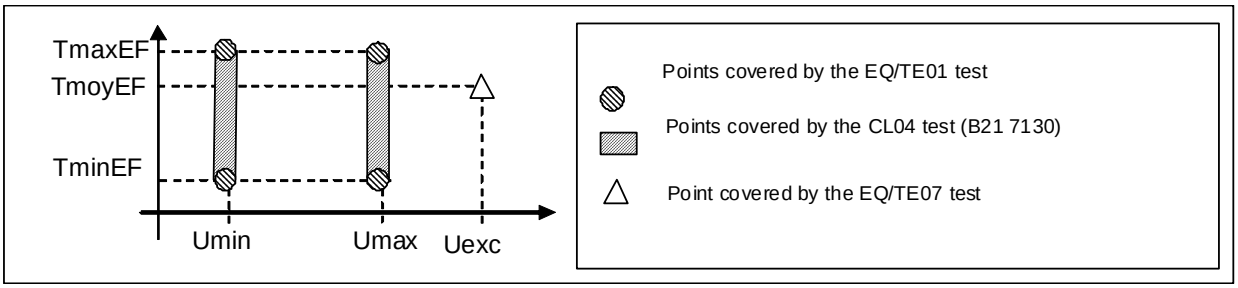
The minimum voltage of 1 is applied to the equipments and/or functions that should work when the engine is not running with a non operational generator (example: starter control provided by the CMM, +APC control provided by BSM…). Unless otherwise stated in the TS, this voltage will be 8.0V.

The minimum voltage of 2 is applied to the equipments and/or functions which are authorized to be operational when the engine is not running with a non operational generator (example: car radio, window-lift, parking aid…), and for which the TNS/TS authorizes a degradation of the service.

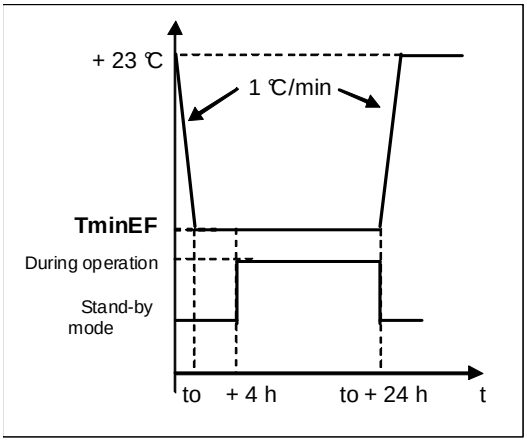
In the case of a power supply regulated by PWM (for example signal lights powered by a BSI, for which the power itself is provided by the PWM) the tests can be (if the operation of the DUT requires it) powered with the PWM to the corresponding cyclic ratio, but with the peak voltage of Umin then Umax as specified in this test. The TNS/TS and/or the test plan should therefore specify the characteristics of the signal to be applied.

Test:

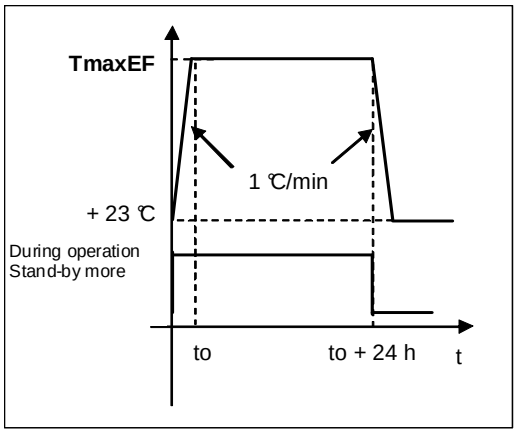
Apply the minimum voltage, then apply the voltages on all the power supply lines as follows:



Test at TminEF	24 hr. at TminEF ± 3 °C. Procedure: equipment in stand-by mode under Umin for 4 hr, then in operation for 20 hr. under Umin, under the minimum operational load (the purpose is to limit the internal heating). A complete functional test is carried out at Umin then Umax just before the end of the test.
	The variations of the temperature are carried out according to CEI 60068-2-1 standard - Ab test (with slow variation of temperature 1 °C/min).
Test at TmaxEF	24 hr. at TmaxEF ± 3 °C. Procedure: equipment at Umax under nominal load. Complete functional test at Umax, then at Umin just before the end of the test.
	The temperature variations are carried out according to CEI 60068-2-2 standard (with slow temperature variation 1 °C/min). • If the DUT does not dissipate the energy (heating of its surface ΔT < 5 °C): Bb test. • If DUT dissipates the energy: Bd test (the ventilation of the enclosure should not cool the DUT surface by more than 5 °C).
Number of components	On a minimum, two DUT per test. They are successively subjected to the tests at TminEF then to TmaxEF



Test at TminEF



Test at TmaxEF

Note: The definition of temperatures TminEF and TmaxEF is given in the B21 7130 standard.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: strand, the DUT environment.
- Parameters observed and failures detected during the test.

7.1.1.7. Requirements

Test		Test level (12V network)	Operating classes	Customer impact levels
Minimum voltage	functions (*) that should be operational with the engine not running with a non operational generator	8.0 V	A	0
	functions (*) that can be operational with the engine not running with a non operational generator	8.0 V	C	1
		9.5 V	A	0
	functions (*) that should be operational with the engine running with an operational generator and/ or “stop” phase of the stop and start system	10.5 V	A	0
Maximum steady voltage		16.5 V	A	0

(*) An equipment is likely to contain several functions.

7.1.2.EQ/TE 08: RESISTANCE TO THE VARIATIONS OF SUPPLY VOLTAGE IN THE USUAL RANGE “VOLT CONTROL”

7.1.2.1.Reference document

There is no reference document related to this test.

7.1.2.2.Purpose of the test

This test is intended to verify the immunity of the equipments to the variation of the voltage related to the “volt control “system. The voltages greater than 14V correspond to the deceleration phases of the vehicle and/or battery charge, and those less than 14V correspond to the phases of load-shedding of the alternator.

The following are the main characteristics of the test: variation of the voltage in the range of 10.5V to 16V, with gradients of 10V/s.

7.1.2.3.Conditions for application of the test

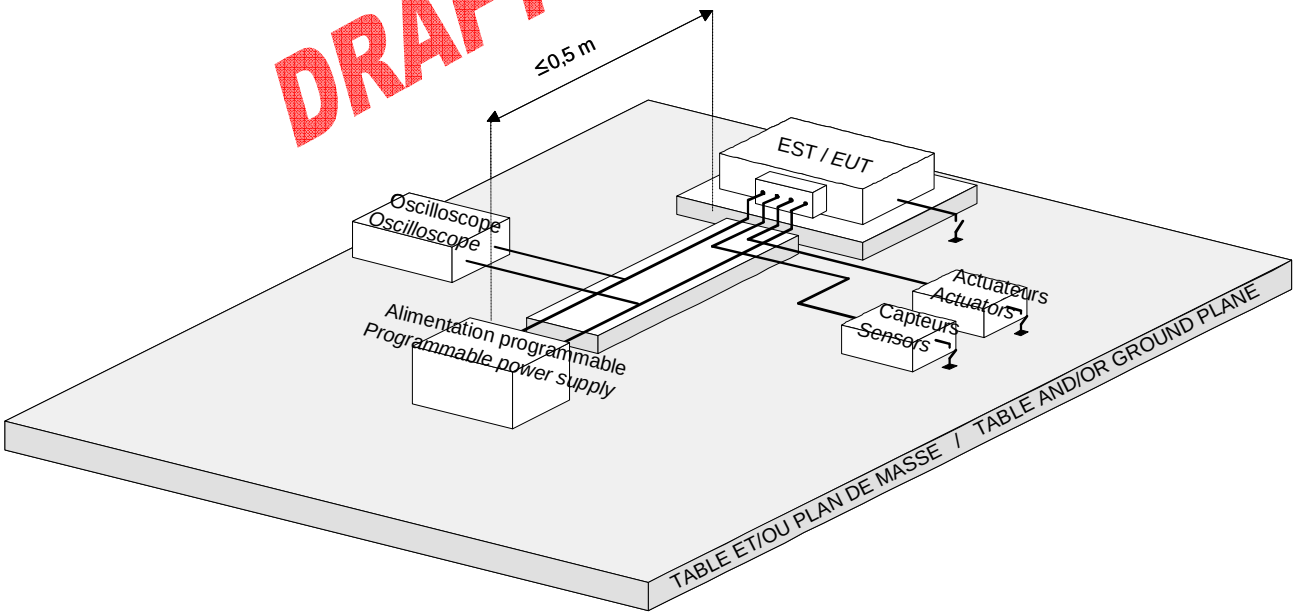
This test is applicable to all equipments powered by the low voltage network (12V), except those powered by a regulated voltage supplied by an other control unit (neither the alternator nor the DC/DC convertor of an electric/hybride vehicle are concerned by the term « control unit »)

The test is carried out on the equipment power supply lines considered simultaneously.

7.1.2.4.Test means

- Programmable supply.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.

7.1.2.5.Assembly



7.1.2.6.Procedure

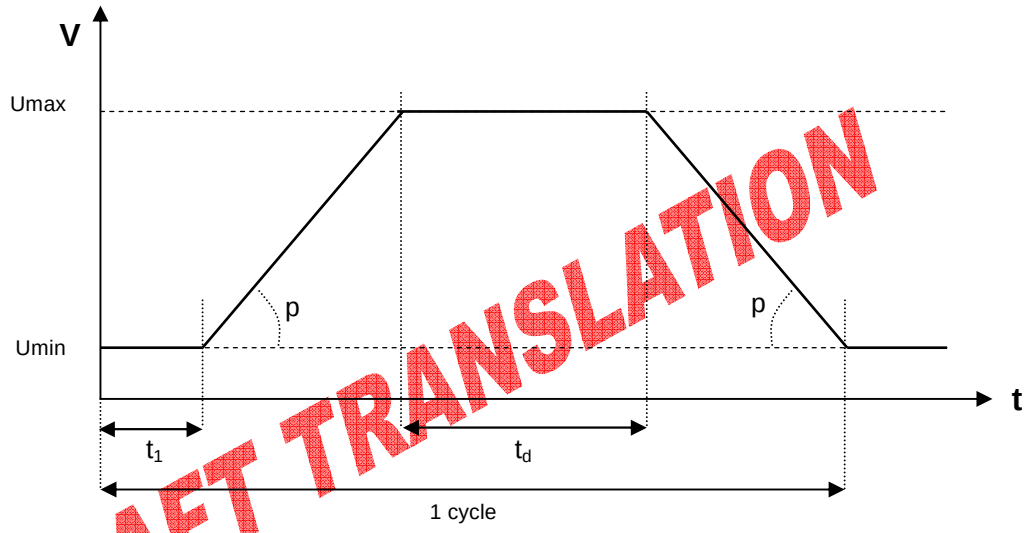
Preparation:

A wiring harness of maximum length 2000 mm should be preferably used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

Calibration:

Connect the oscilloscope (disconnected DUT) to the output of the programmable power supply (high impedance input), and adjust the generator in order to obtain the specified voltages.

12 V Network	Volt control pulse
Umax = 16 V Umin = 10.5 V t_1 > 5s t_d = 5s Gradient p = 10V/s Ri = 0.01 Ω	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 5 times the "volt control" pulse with a time lag of one minute on all the power supply lines considered simultaneously while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.
- Characteristics of the applied pulse.

7.1.2.7.Requirements

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Requirements	Operating classes	Customer impact levels
General case	A	0 (b)
Case of the DUT and/or functions for which certain momentary malfunctioning are accepted (a)	C	1 (b)

(a) Case of certain DUT and/or functions controlling an actuator (example: non LIN window wiper, for which a momentary change of speed is authorized), functions of lighting type and/or dimming (for which a momentary variation of lighting is authorized). This case should be specified by the TNS/TS. By default, the general case is applied.

(b) In the case where the DUT supplies a regulated voltage for another control unit or sensor, the latter should remain within its limits during the test.

7.1.3.EQ/TE 07: RESISTANCE TO EXCEPTIONAL SUPPLY VOLTAGE

7.1.3.1.Reference document

This test procedure complies with the ISO 16750-2 standard except for its test voltages, times and test temperatures.

7.1.3.2.Purpose of the test

This test is intended to verify the immunity of the equipments to the exceptional voltage. This maximum voltage corresponds to the limit voltage, when the regulator of the alternator has a breakdown.

The following are the main characteristics of the test: maximum voltage during 3 hours 18 V for a 12V network at the TmoyEF temperature.

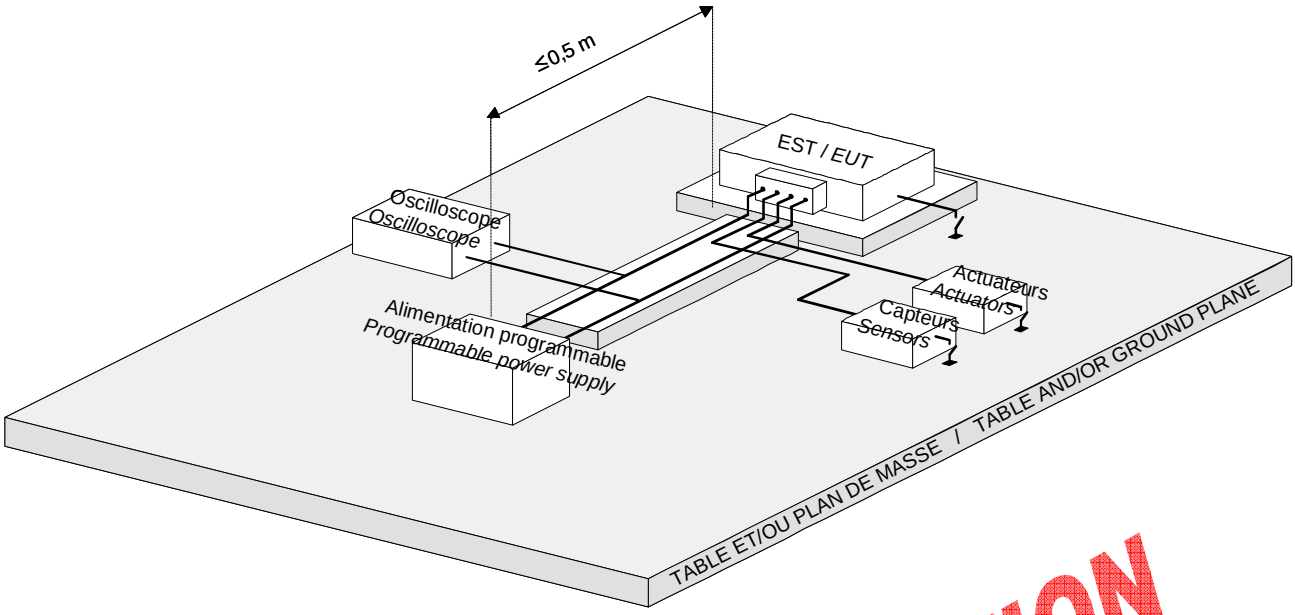
7.1.3.3.Test application conditions

This test is applicable to all the equipments powered by a 12V control unit. This test is not carried out for the equipments powered by a regulated voltage supplied by another control unit. The test is carried out on the power supply lines for the equipment considered simultaneously.

7.1.3.4.Test means

- Programmable power supply.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.

7.1.3.5.Assembly



7.1.3.6.Procedure

Preparation:

A wiring harness having a maximum length of 2000 mm should preferably be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is only necessary in case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

Operating voltages:

Adjust the programmable supply in order to obtain the operating supply voltage as follows:

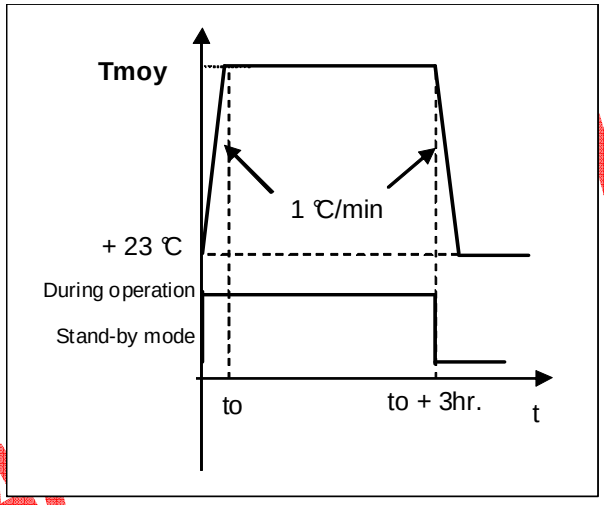
12 V Network	Power supply voltage
Uexc=18.0 V	Maximum exceptional voltage.

The voltage level should be considered to be that of the terminals of the equipment. The voltage should be adjusted at the terminals of the equipment. If needed, for simplification, the adjustment of the voltage level at the output of the generator should be accepted for any equipment consuming less than 10A (which amounts to neglecting the voltage drops in the cables).

Test:

Apply the minimum voltage, then apply the voltages on all the supply lines as follows:

General modalities	3hr. at TmoyEF ± 3 °C. The equipment is in its nominal procedure, under representative load, at Uexc. A complete functional test is carried out before the end of the test.
	The temperature variations are carried out in accordance with the CEI 60068-2-2 standard (with slow temperature variation 1 °C/min). • If the DUT does not dissipate energy (heating of its surface ΔT < 5 °C): Bb test. If DUT dissipates energy: Bd test (the ventilation of the enclosure should not cool more than 5 °C of the DUT surface).
Number of components	A minimum of two DUT.



EQ/TE07 Test

Note: The definition of the TmoyEF temperature is given in the B21 7130 standard.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: strand, the DUT environment
- Parameters observed and defects observed during the test.

7.1.3.7.Requirements

Test (18V)	Operating classes	Customer impact levels
Exceptional voltage (functions necessary for running: start-up, direction, braking, lighting)	Specific to the function	1
Exceptional voltage (Comfort functions: telematic, parking aid, driving aid)	Specific to the function	2

7.1.4.EQ/TE 02: RESISTANCE TO DROP AND SLOW INCREASE OF SUPPLY VOLTAGE

7.1.4.1.Reference document

This procedure is compliant with the ISO 16750-2 standard, except for “the test 2”, which proposes other gradients with 100 cycles.

7.1.4.2.Purpose of the test

This test is intended to verify the immunity of the equipments to the slow increase and decrease of the voltage on board electrical system.

The decrease / slow increase of the voltage corresponds to the discharging / slow charging of the battery, when the vehicle is
stopped. The test in addition contributes to test the robustness of the software, and in particular, limiting the risks of frozen EEPROM (case of EEPROM being external to the micro-controller) during the reset phases.

Moreover, the requirements related to this test enable the specification of the expected operation below 8.0V.

The following are the main characteristics of the test:

- Initial voltage of 16V.
- Test 1: decrease and increase of the voltage by 0.5V / 1min. (a cycle).
- Test 2: decrease and increase of the voltage by 16V / 1min (100 cycles).

7.1.4.3.Conditions for application of the test

The test 1 is applicable to all the equipments having active electronics, a micro-controller and/or an on-board software.

The test 2 is applicable, in addition to the test 1, to all the equipments having active electronics, a micro-controller and/or on-board software and having an EEPROM external to the micro-controller.

The two tests are carried out on the 12V power supply lines of the equipment taken successively and simultaneously.

This test can also be applicable, as characterization of an active 5V sensor.

7.1.4.4.Test means

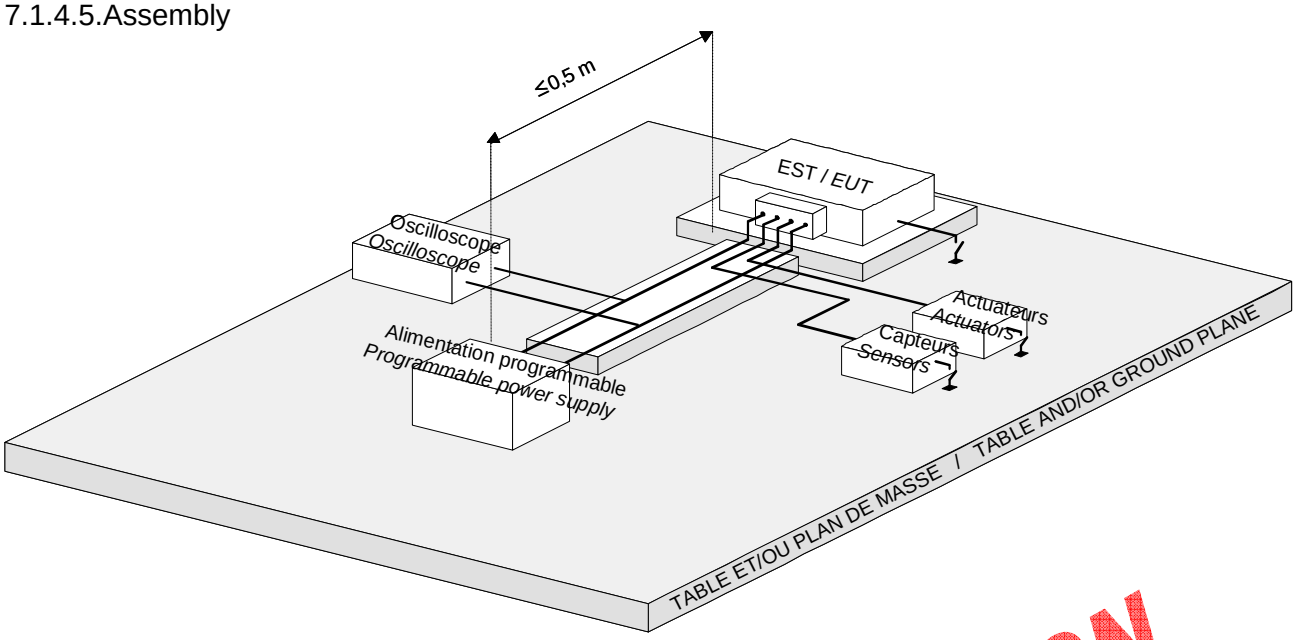
Programmable supply.

Devices necessary for monitoring the proper operation of the DUT.

DUT environment, real (sensors, actuators) or simulated.

Insulating support of a thickness of 50 mm.

7.1.4.5.Assembly



7.1.4.6.Procedure

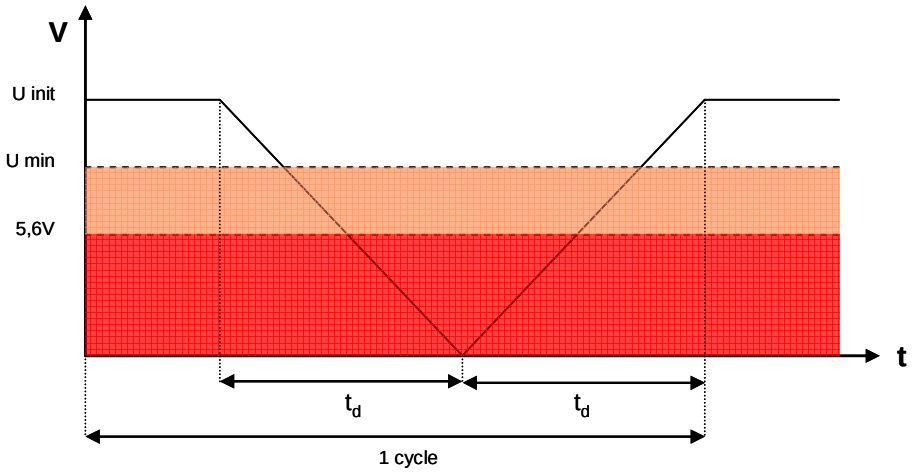
Preparation:

Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is only necessary in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

Calibration:

Connect the oscilloscope (disconnected DUT) to the output of the generator (high impedance input), and adjust the generator in order to obtain the specified pulses.

12 V Network	Decrease and increase of the voltage
U init = 16 V Test 1: t_d = 32mn 1 cycle Test 2: t_d = 1mn 100 cycles Umin: minimal voltage, as defined for EQ/TE01	

Note: Adjust the time between each cycle depending on the time for resetting the equipment, in order to verify the correct restarting between each cycle.

Test:

Run the DUT for a minimal period of 10 minutes.

Apply the test 1 cycle (gradient of 0.5V per minute, that is, td of 32 minutes) once, on all the power supply lines successively, then simultaneously on the whole while monitoring the DUT.

Apply the test 2 cycles (gradient of 16V per minute that is td of 1 minute) 100 times; on all the power supply lines successively, then simultaneously on the whole while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

Assembly used: wiring harness, DUT environment.

Parameters observed and defects encountered during the test, inclusive of those below Umin.

7.1.4.7.Requirements

Test 1 or 2	Behavior during the test	Behavior at the end of each cycle
U test > U min	Compliant with the EQ/TE 01 test	
U min > U test > 5.6V	Type A operation for the functions necessary for the starting of the vehicle. Type C / D operation for the remaining.	General case: nominal behavior, without loss of data in permanent memories. Case of equipments whose stoppage can be acceptable (ex. autoradio): class D, without loss of data in permanent memories.
U test < 5.6 V	No requirement	General case: nominal behavior, without loss of data in permanent memories. Case of equipments whose stoppage can be acceptable (ex. autoradio): class D, without loss of data in permanent memories.

Notes:

- For the equipments whose security strategy requires it, the class requested should be of type D for the test on
- *For voltages lower than Umin, the behavior of the equipment should be indicated, during both voltage decrease and increase of the voltage (transmission thresholds or not of the frames on the network, diagnosis operating threshold, reset voltage, current consumption…).*
- *For the equipments requiring a "power latch" type software strategy (requirement of power supply after receipt of the stand-by command, for example for the saving of the functional context in EEPROM before the product disconnects), a degraded operation can be authorized at the end of the cycle. This case is to be specified in the TNS/TS.*

7.1.5.EQ/TE 03: RE-INITIALIZATION TEST

7.1.5.1.Reference Document

This test procedure is compliant with the ISO 16750-2 standard except for the voltage steps (more refined around the reset voltage).

7.1.5.2.Purpose of the test

This test is intended to verify the correct re-initialization of the equipments during fluctuations of the on-board electrical system.

These voltage fluctuations can be caused by the activation of large consumers (on weak battery) and/or sudden current variations generated by a short circuit followed by the melting of a fuse.

In addition, the test contributes to the testing of the robustness of the software, particularly to limit the risks of frozen EEPROM (case of the EEPROM external to the microcontroller) during the reset phases.

The following are the main characteristics of the test:

- Drop of Voltage until 0 V, in steps of 0.5V or less (around the reset voltage).
- Time td for fluctuation: 5 s., cycle time T = 15 s., or more if the re-initialization time of the equipment requires it.

7.1.5.3.Conditions for application of the test

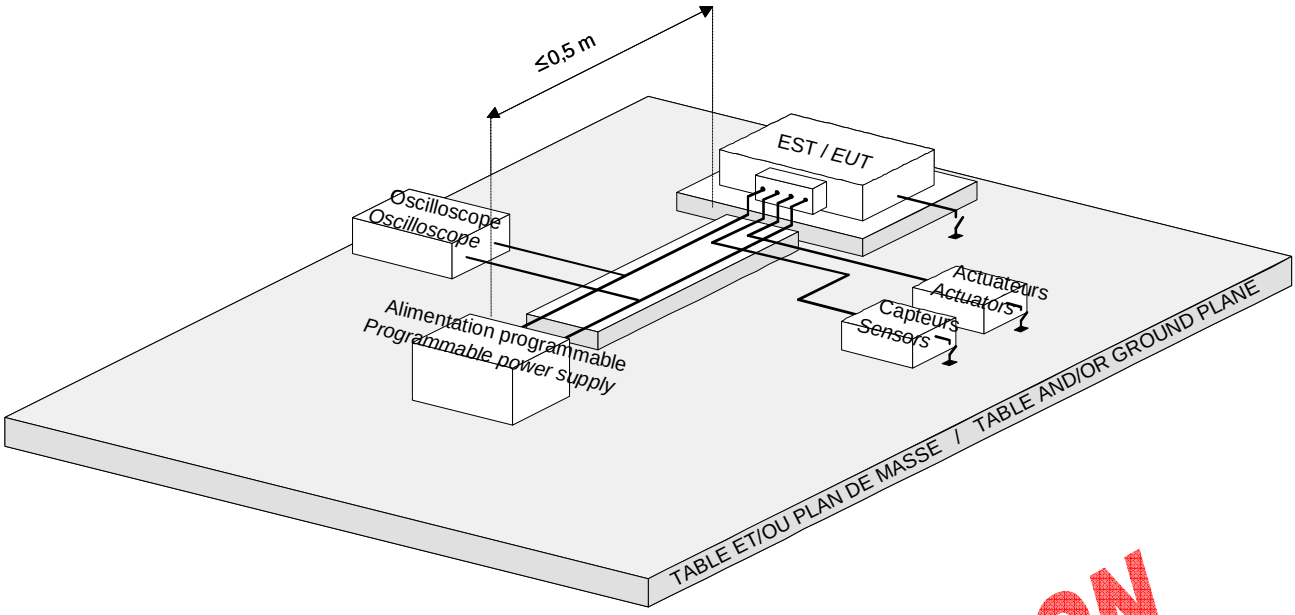
This test is applicable to all the equipment having an active electronics, a microcontroller and/or onboard software. The test is carried out on all the 12V power supply lines for the equipment considered successively and simultaneously.

This test can also be carried out for equipments powered by 5V, for the robustness of the software. In this case, the voltage levels will consequently be adjusted.

7.1.5.4.Test means

- Programmable power supply
- Device necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.

7.1.5.5.Assembly



7.1.5.6.Procedure

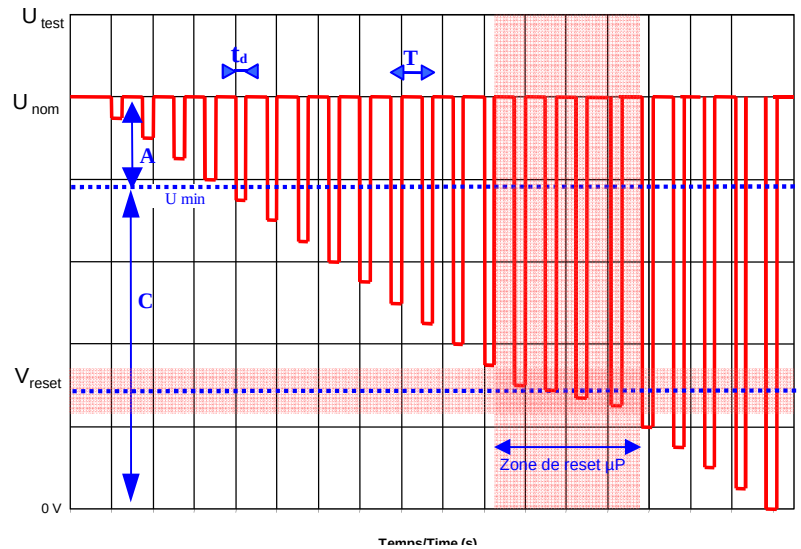
Preparation:

Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

Calibration:

Connect the oscilloscope (disconnected DUT) to the output of the generator (high impedance input), and adjust the generator in order to obtain the specific pulses.

12 V Network	Cut-off
U nominal = 14 V t_{fall} ≤ 1 ms t_{rise} ≤ 1 ms t_d = 5 s t_i > 10 s T = t_d + t_i <u>No voltage</u> General case: step of 0.5 V . Between V_{reset} + 5% and V_{reset} - 5%: 100 steps.	

Around the product reset voltage, voltage dips to be applied are to be refined as follows:

- Determine the reset threshold voltage of the equipment V_{reset}. For that purpose, the use of the test EQ/TE02 (during the slow voltage decrease phase) can suit.
- At the levels of voltage between V_{reset} + 5% and V_{reset} - 5%, apply a number of voltage dips of at least 100, by maximum voltage steps of 50mV. If the accuracy of the power supply permits it, it is preferable to apply more refined steps. Example of numerical application for a V_{reset} of 5.6V
  - 100 steps of 5.6mV each to cover the range [5.32 – 5.88] V.
  - Or: 20 groups of 5 voltage dips, spaced by 28mV per group to cover the range [5.32 – 5.88] V.

Test:

Run the DUT for a minimal period of 10 minutes.
Apply the fluctuation cycle on each power supply line successively, then on the whole while monitoring the DUT.

Test report:
The test report should, among other things, include the following elements:

Assembly used: wiring harness, the DUT environment.

- Parameters observed and defects encountered during the test.
- Characteristics of the applied pulses.

7.1.5.7.Requirements

Test	Operating classes	Customer impact levels
Re-initialization (Equipment and unsafe function)	C (see notes)	Not applicable

Notes:

- For the equipments for which the security strategy requires it, the requested class should be of type D for the test on each power supply successively (case to be specified in the TNS/TS).
- *The operation during the test, should continue to be of type A in the usual voltage range defined for EQ/TE01 test.*
- *The operation during the test should not cause unpredictable operation (untimely activations), nor change the EEPROM data.*
- *Between each fluctuation time td, the operation of the equipment should be of type A, without the time td having caused the loss of permanent memory.*
- *For the equipments requiring a "power latch" type software strategy (requirement of power supply after receipt of the stand-by command, for example for the saving of the functional context in EEPROM before the cut-off of the product), a degraded operation can be authorized at the end of the cycle. This case is to be specified in the TNS/TS.*

7.1.6.EQ/TE 04: RESISTANCE TO UNUSUAL POWER SUPPLY VOLTAGES

7.1.6.1.Reference document

This test procedure is compliant with the ISO 16750-2 standard.

7.1.6.2.Purpose of the test

This test is intended to verify the immunity of the equipments to the maximum voltage (use case of an auxiliary starting device) and polarity reversal of the on-board electrical system.

The following are the main characteristics of the test for the 12 V network:

- Maximum voltage of 24 V for 1 minute.
- Reverse voltage for 1 minute that is -14.0 V.

7.1.6.3.Conditions for application of the test

The test is applicable to all the powered equipment, except the following cases:

- The reverse voltage test is not applicable to the relays with free wheel diode.
- The test is not applicable if the DUT is powered by a regulated voltage supplied by a control unit.

For the alternator tests, the reverse voltage test should be carried out with the DUT fitted with its diode bridge.

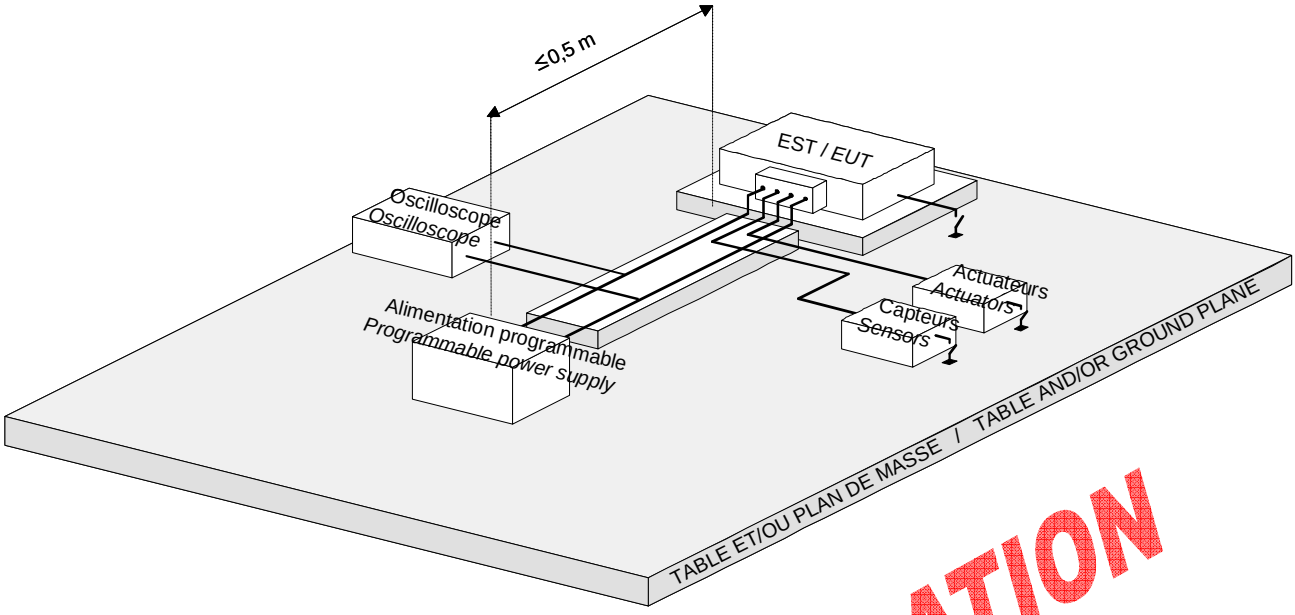
The test is carried out on the power supply lines for the equipment considered simultaneously.

In the case of sensors, in which a few output signals are connected through pull up resistors to 12V (for example, certain level sensors, whose output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

7.1.6.4.Test means

- Programmable power supply (or battery) and cabling ensuring the following impedance conditions :
  - For the power equipments (consumption > 20A), the source impedances as well as the lengths and cable cross-sections should be representative of the reality. It is necessary to ensure that the global impedance of the power supply and of its back and forth wiring is less than 20 mohms.
  - For the other equipment, the general impedance conditions of §5.6.1 (< 0.1Ω) are applied.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.

7.1.6.5.Assembly



7.1.6.6.Procedure

Preparation:

Preferably, a wiring harness of a maximum length of 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistance. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration:

Adjust the programmable power supply in order to obtain the operational power supply voltage as given below:

12 V Network	Power supply voltage
U_{max} = 24 V	Maximum voltage for 1 minute
U_{inv} = -14 V	Reverse voltage for 1 minute

The voltage levels should be considered to be those of the terminals of the equipment. The voltage should be adjusted at the terminals of the equipment. If needed, for simplification, the adjustment of the voltage level at the generator output can be accepted for all equipment consuming less than 10A (this amounts to neglecting voltage drops in the cabling).

Test:

- Run the DUT for a minimum period of 10 minutes.
- Switch off the DUT for at least 10 seconds.
- Apply the maximum voltage of 24V for one minute on all the power supply lines (12 V) while monitoring the DUT.
- Reduce the voltage to its nominal value of 14V (without passing through 0V), and apply it for one minute on all the power supply lines (12 V) while monitoring the DUT.
- Switch off the DUT for at least 10 seconds.
- Apply the reverse voltage for one minute on all the power supply lines (12 V) while monitoring the DUT.
- Repeat the test cycle at least 5 times.

Test report:

The test report should, among other things, include the following elements:

Assembly used: the wiring harness, the DUT environment.

7.1.6.7.Requirements

Test	Operating classes	Customer impact levels
Maximum voltage (functions necessary at startup)	C or D after returning to 14V (note 1) C after passing through zero volt	1 (note 2)
Maximum voltage (other functions: telematic, parking aid, driving aid)	C or D after returning to 14V (note 1) C after passing through zero volt	2
Reverse voltage	D	2

Note 1: for certain functions, the equipment cannot return to a nominal operating during its return from 24V to 14V. This case should be specified in the TNS/TS.

Note 2: for the test at maximum voltage of 24V, all the functions necessary for the startup should be maintained.

7.1.7.EQ/TE 05: RESISTANCE TO GROUNDING AND TO THE POSITIVE TERMINAL OF THE NETWORK

7.1.7.1. Reference Document

This test procedure is compliant with the ISO 16750-2 standard for the 12V.

7.1.7.2. Purpose of the test

This test is intended to verify the immunity of the equipment to the grounding and to the positive terminal of the on-board network of their various lines.

The following are the main characteristics of the test:

- Maximum voltage Umax (16 V) for 60 seconds.
- Minimum voltage 0 V for 1 minute.

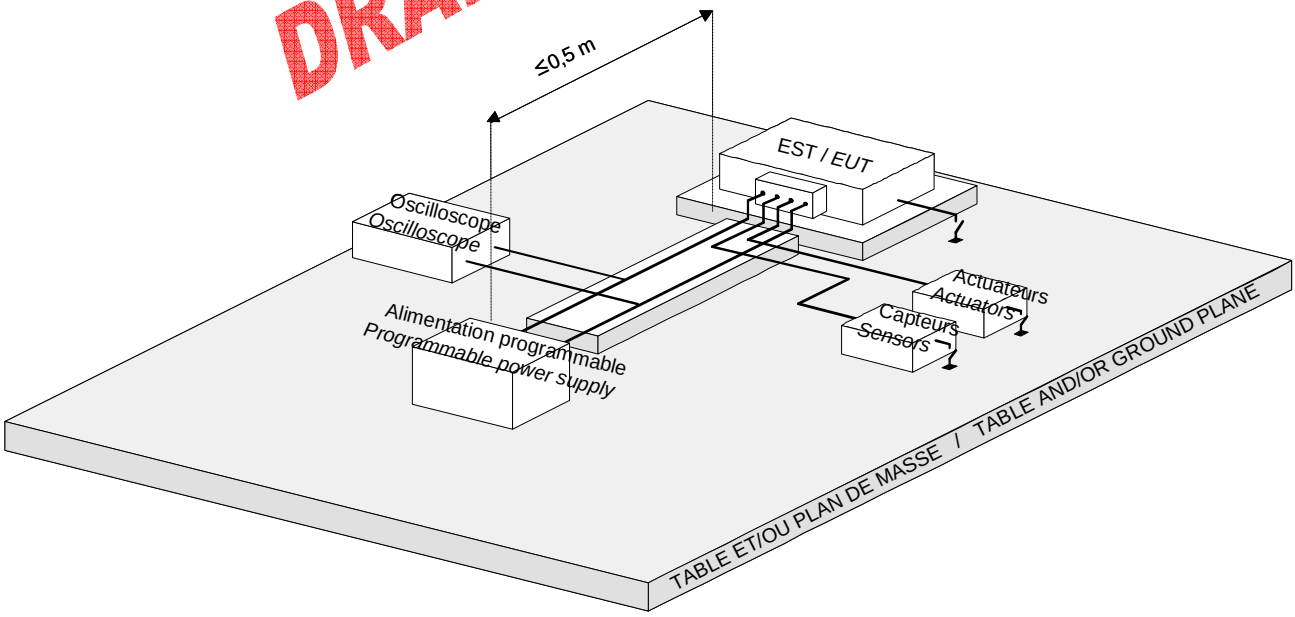
7.1.7.3. Conditions for application of the test

The test is applicable to all equipment and all the input-output pins, except the particular cases described in the § 7.1.7.8 and high voltage lines (>60V).

7.1.7.4. Test means

- Programmable power supply, internal resistance < 0.1 Ω.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.

7.1.7.5. Assembly



7.1.7.6. Procedure

Preparation:

Preferably a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

The impedance of the line ensuring the short-circuiting should be less than 0.1 Ω.

The positive power supply line of the equipment, and/or the positive power supply bringing about the short circuit should be limited in current (a fuse in series can be included, for example). The TNS/TS or the test plan should specify the value of the current. By default, its value will be 50A.

Calibration:

Adjust the programmable power supply in order to obtain the specified power supply voltage, at the terminals of the connector of the DUT:

12 V Network	Power supply voltage
U_{max} = 16 V	Maximum voltage for 60 seconds
U_{min} = 0 V	Minimum voltage for 1 minute

7.1.7.7. Test: General case

Test:

Run the DUT for a minimal period of 10 minutes.

Powered DUT (under 16V for the requirements of this test):

- Apply the maximum voltage for 60 seconds successively on each input/output line while monitoring the DUT.
- Apply the minimum voltage for 60 seconds successively on each input/output line while monitoring the DUT.

Power supplies + disconnected:

- Disconnect all power supply lines (terminals +) from the DUT
- Apply the maximum voltage for 60 seconds successively on each input/output line while monitoring the DUT.
- Re-connect the power supply lines.

Grounding lines disconnected:

- Disconnect all the grounding of the DUT.
- Successively apply the minimum voltage for 60 seconds on each input/output line while monitoring the DUT.

(Re-connect the grounding lines)

Note 1: *the return circuits (return of grounding sensors, actuators, …) are considered as grounding lines subjected to the Umax test. (An Umax connection to a non protected output (fuse…) will effectively damage the DUT, but no (CCA) (aggravated short-circuit) should be noted).*
Note 2 : *in the case of equipments having only one supply input, the tests of short-circuit on supply inputs are not useful, because ineffective on the DUT, and put under stress pointlessly the supply of the test. In the case of equipments having several supply inputs connected internally to the equipment in one circuit track, the risk has to be documented, and the relevant tests must be specified in the test plan.*

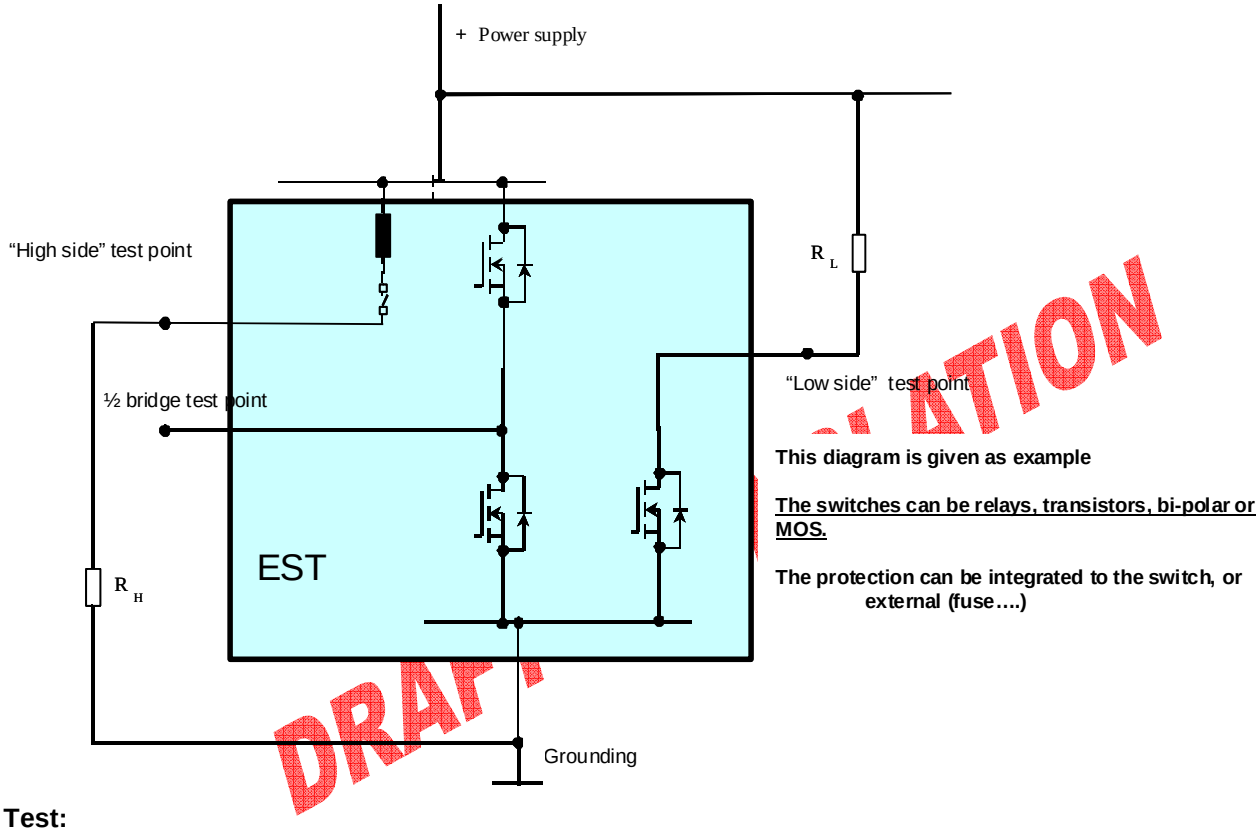
Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.

7.1.7.8. Test: particular case

In the case of outputs flowing on the charges likely to be damaged by the test, the tests can be alleviated as follows:



Test:

Run the DUT for a minimum period of 10 minutes.

The outputs should be controlled.

"High side" outputs (electronic switch or relay to + of the power supply): apply successively the minimum voltage for 60 seconds on each output line while monitoring the DUT.

"Low side" outputs (electronic switch or relay to the ground): apply successively the maximum voltage for 60 seconds on each output while monitoring the DUT.

"Half-bridge" outputs: apply successively the maximum voltage for 60 seconds on each output while monitoring the DUT then apply successively the minimum voltage for 60 seconds on each output line while monitoring the DUT.

Note 1: *the test is only carried out in one direction not to stress or damage the necessary loads on implementation of the DUT (R_H and R_L), which would not bear being powered by the maximum voltage for 1 minute.*

Note 2: *for the circuits protected by a fuse (integrated with the equipment), the test time can be possibly adjusted to take into account the time (ISO 8820 standard) required for melting the fuse.*

Note 3: *for the DUT with multiple power supplies (various voltage levels), the test procedures should be specified in the test plan or in the TNS/TS.*

Test report:
The test report should, among other things, have the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test in a table consisting of the list of pin tested / short-circuit type (to + or to the ground) / the DUT power supply state (connected power supply, ground or + disconnected) / observed failure.

7.1.7.9. Requirements

Test cases with connected power supplies:

Test			Operating classes	Customer impact levels
Equipment and/or function contributing to a customer impact 3			C	Not applicable
Equipment and/or function not contributing to a customer impact 3	case of protected power outputs (3)		C (see note 2)	Not applicable
	case of non protected power outputs (3)		E (see note 1)	Not applicable
	case of power inputs and outputs/inputs signal	Minimum voltage	C	Not applicable
		Maximum voltage	C	Not applicable

Note 1: *Only the non protected output should be damaged or destroyed and in any case, no aggravated short-circuit (CCA) should be observed. In the case of this document, the CCA naming includes:*

- *Thermal anomaly caused by an excessive local heating from electrical origin, leading to reach the ignition point of the materials.*
- *combustion of the substrate and/or flammability of other materials of the equipment.*

Note 2: *unless otherwise specified in the TNS/TS (e.g.: protection by fuse, where the class D is required).*
Note 3: *Power output means any output through which an electric current greater than 1Aeff flows. If needed, this threshold can be adjusted to specific features of the equipment in the TNS/TS or in the test plan.*

Case where tests with + power supply or ground disconnected:

Test			Operating classes	impact levels
Equipment and/or function contributing to a customer impact 3			A after reconnection	Not applicable
Equipment and/or function not contributing to a customer impact 3	case of protected power outputs (2)		E (see note 1)	Not applicable
	case of non protected power outputs (2)		E (see note 1)	Not applicable
	case of power input and signal input/output	Minimum voltage	A after reconnection	Not applicable
		Maximum voltage	A after reconnection	Not applicable

Note 1*: Only the non protected output should be damaged or destroyed and in any case, no aggravated short-circuit (CCA) should be observed. In the case of this document, the ASC naming includes:*

- *thermal anomaly caused by an excessive local heating from electrical origin, leading to the ignition point of the materials.*
- *combustion of the substrate and/or flammability of other materials of the equipment.*

Note 2: *Power output can be any output through which an electric current greater than 1Aeff flows. If needed, this threshold can be adjusted to specific features of the equipment in the TNS/TS or in the test plan.*
Note 3: *whatever the output type is, the DUT behavior should be documented, especially the risks of re-powering of the equipment itself or others by its inputs/outputs. The TNS/TS of the concerned equipment has to specify it:*

- *if the DUT can redistribute or not a positive or negative power supply on its power supply inputs and/or inputs/outputs,*
- *if the DUT can be or not re-powered and/or awakened by a short circuit on one of its inputs-outputs.*

7.1.8. EQ/TE 06: RESISTANCE TO LONG DURATION OVERLOADS

This test is deleted from the B21 7110, and henceforth is included in the standard **B21 7130** (test CL39).

7.1.9. EQ/IC 01: RESISTANCE TO THE PULSES 1 AND 2A

7.1.9.1. Reference document

This test procedure is compliant with the ISO 7637-2 standard, with the exception of the prescriptions on the ground plan which is not mandatory in this test.

7.1.9.2. Purpose of the test

Pulse 1:

This test is intended to verify the immunity of equipments to the transients caused by the disconnection of the power supply to the inductive loads (motors…) powered in parallel of the DUT.

The following are the main characteristics of the test:

- 500 pulses of - 100 V.
- Pulse width : 2ms.

Pulse 2a:

This test is intended to verify the immunity of the equipments to the transients due to an abrupt variation of a current in an inductance connected in series (in general the inductance is distributed on the cables)

The following are its main characteristics:

- 500 pulses of + 100 V.
- Width of pulse: 50 µs.

7.1.9.3. Conditions for application of the test

This test is applicable to all the power supply lines of the equipments, except those which are provided and regulated by another control unit.

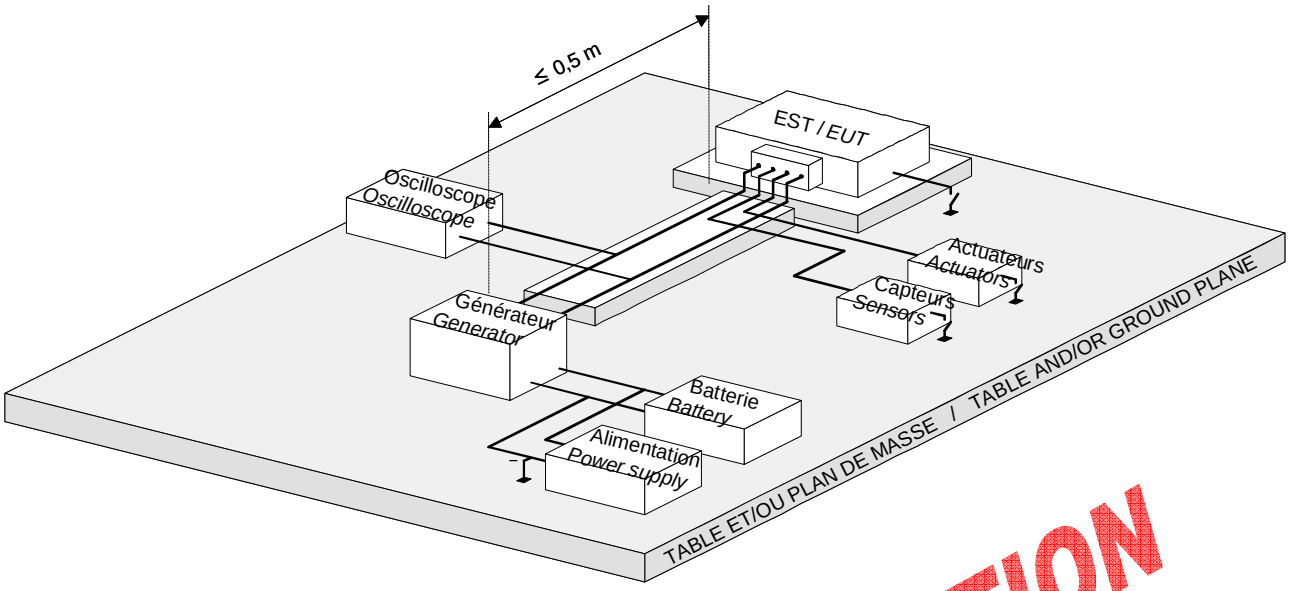
The test is carried out on all the supply lines of the equipment considered successively (pulse 1 and 2a) and simultaneously (pulse 2a). The power supply associated to a network (ex: + CAN …) should be considered as a relayed power supply and tested as such.

If the sensors for which the output signals are connected via pull up resistors to the 12V (for example, certain level sensors for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

7.1.9.4. Test means

- Power supply and/or battery
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Pulses generator.
- Climatic chamber for the tests at extreme temperatures.

7.1.9.5. Assembly



7.1.9.6. Procedure

Preparation:

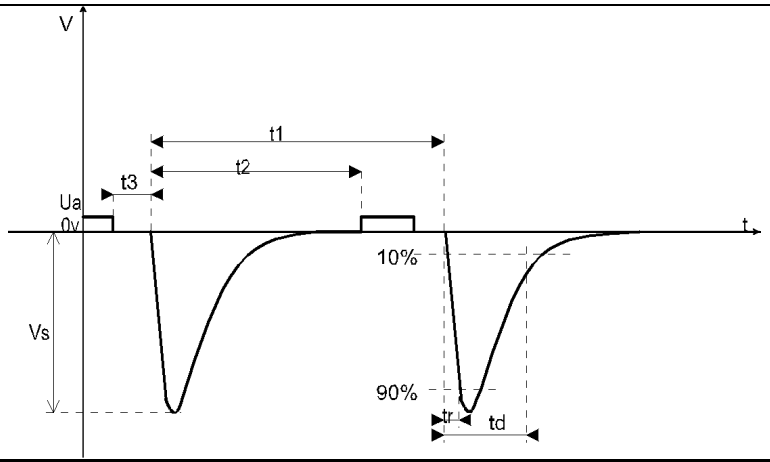
Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

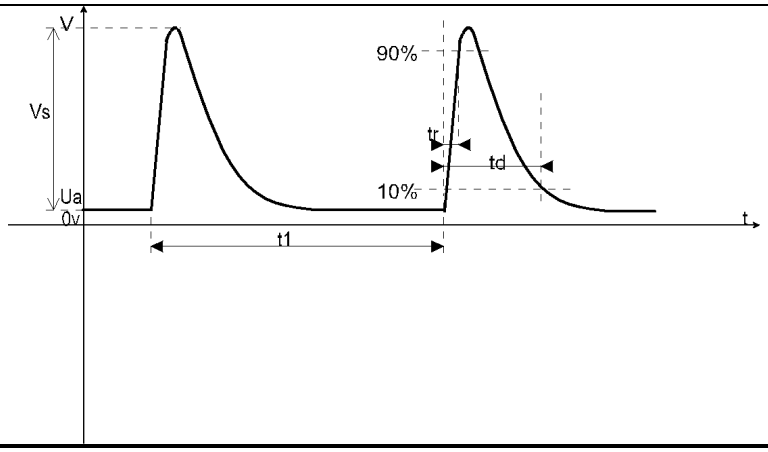
The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator via the equivalent resistance. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration:

Connect the oscilloscope (disconnected DUT) to the pulses generator (high impedance input), and adjust the generator in order to obtain the specified pulses with an internal resistance RI of the generator.

12 V Network	Pulse 1
U_a = 14 V V_s = -100 V R_i = 10 Ω t_d = 2 ms $t_r = (1^{+0}_{-0,5})$ µs $t_1 \geq 0,5$ s t_2 = 0.2 s. $t_3 \leq 100$ µs $t_3 \leq 100$ µs	

12 V Network	Pulse 2a
U_a = 14 V V_s = 100 V R_i = 2 Ω t_d = 0.05 ms t_r = ($1^{+0}_{-0,5}$) µs t_1 = 0.2 s to 5 s	

Note: for the pulse 1, the time t1 and [t1 - t2] could be extended in such a way that possible reset and/or re-initialization of the equipment can be carried out.

Test:

- Run the DUT for a minimal period of 10 minutes, this being placed at an ambient temperature of (23°±5).
- Apply 500 pulses, 1 on all the power supply lines (successively), while monitoring the DUT. In the case of a reset of the equipment during the tests, care has to be taken to verify that the reset of the equipment is carried out in the correct way between each pulse.
- Apply 500 pulses 2a on all the power supply lines (successively and simultaneously) while monitoring the DUT.
- **Repeat all the tests (pulses 1 and 2a) by placing the DUT at TminEF then at TmaxEF.**

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Measurements made by the oscilloscope at the terminals of the generator of each wave form, measured in open circuit and under adjusted load (see appendix D of the ISO 7637-2 standard).
- Parameters observed and defects encountered during the test for every test temperature.

7.1.9.7.Requirements

Test (ambient temperature, Tmin EF and TmaxEF)		Operating classes	Customer impact levels
Pulse 1 (note 3)	functions that should be de-activated with the cut-off of the + switched	C	see note 1
	functions that should be operational after the cut-off of a + switched (note 2)	A	0
Pulses 2a		Not applicable	0

Note1: the reset of the DUT is permitted. However, no data loss in the memory is permitted, and the malfunctioning, even momentary, should not cause any customer impact 2 or 3 defect.

Note 2: the concerned functions are those which are maintained by a power supply other than the one that is cut, in the case of equipment having many power supply inputs.

Note 3: between two pulses 1, verify the correct start up of the DUT. The spacing between the pulses can be extended in order to operate the necessary controls.

Note 4 : some quick dysfunctions with negligible customer effect can be tolerated (examples : hardly noticeable variation of luminosity, isolated erroneous frame recovered by the software …)

7.1.10.EQ/IC 10: RESISTANCE TO PULSES ON THE OUTPUTS SWITCHING THE INDUCTIVE LOADS

7.1.10.1. Reference document

There is no reference document related to this test.

7.1.10.2. Purpose of the test

This test is intended to verify the immunity of equipment to the transients caused by the disconnection of the inductive loads (motors, actuators, off-set relays…) placed in the output of the equipment. **Preferably, the test will be carried out by switching the real charges of the equipment. In the contrary case, the execution of the test with the pulse 1bis is permitted.**

The following are the main characteristics of the test:

- Case of the test on real load: use of the real charge, execution of 1000 pulses with a suitable cyclic ratio.
- Case of the test with 1 bis pulse:
  - Case of high side outputs: 1000 pulses of -100 V with activated output then 1000 pulses of -100V with de-activated output.
  - Case of low side outputs: 1000 pulses of +100 V with activated output, then 1000 pulses of +100V with de-activated output.

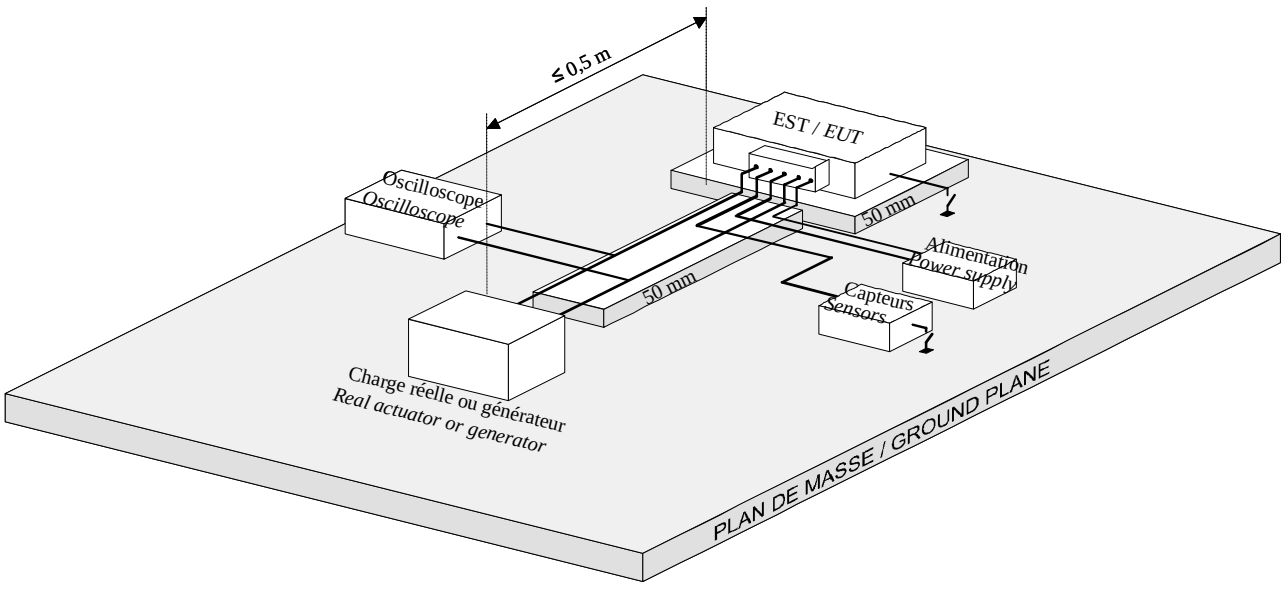
7.1.10.3. Conditions for application of the test

This test is applicable to any equipment switching the inductive loads (motors, actuators, off-set…)

7.1.10.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Preferable real load, or default pulses generator.

7.1.10.5. Assembly



7.1.10.6. Procedure

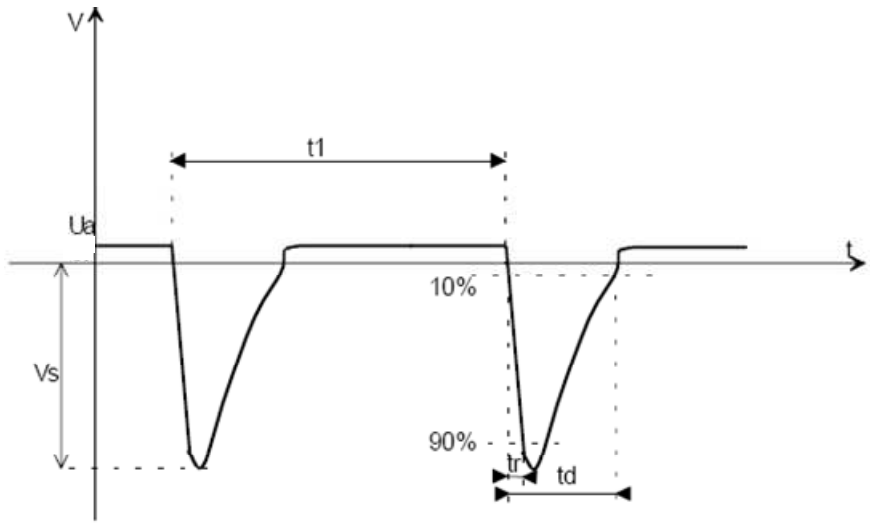
Preparation:

Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

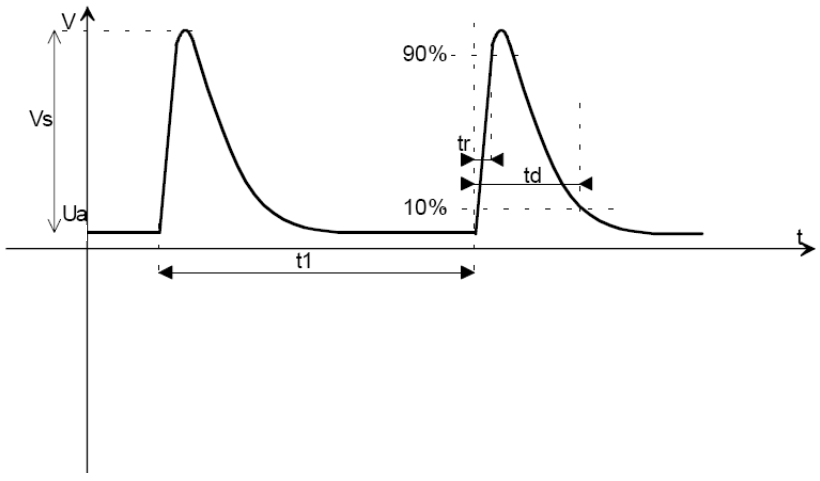
The wires connecting the output under the DUT test to the real load or to the generator should have a maximum length of 500 mm. The wiring harness under test is placed on an isolating support of 50 mm thickness.

Calibration:

In the case of use of a pulses generator, connect the oscilloscope (disconnected DUT) at the output of the pulses generator (high impedance input), and adjust the generator in order to obtain the pulse specified with the internal resistance of RI for the generator

12 V Network	Pulse 1 bis (case of a high side output)
U_a = 0 or 14 V in accordance with the test V_s = -100 V R_i = 10 Ω t_d = 2 ms t_r = $(1^{+0}_{-0,5})$ µs t_1 = 0.5 s to 5 s V_s = -100 V R_i = 10 Ω t_d = 2 ms. t_r = $(1^{+0}_{-0,5})$ µs. t_1 = 0.5 s. to 5 s	

Note: in reality, Ua = 14 V before de-activation of the output, and 0V afterwards. For the requirements of this test, a test will be carried out with the output activated with Ua = 14V, then another output deactivated with Ua = 0V.

12 V Network	Pulse 1 bis (case of a low side output)
U_a = 0 or 14 V in accordance with the test V_s = +100 V R_i = 10 Ω t_d = 2 ms t_r = $(1^{+0}_{-0,5})$ µs. t_1 = 0.5 s. to 5 s	

Note: in reality, Ua = 0V after deactivation of the output, and 14V after. For the requirements of this test, a test will be carried out with activated output with Ua = 0V, then another deactivated output with Ua = 14V.

Test:
Run the DUT for a minimal period of 10 minutes.

Case of the test on real load: run the DUT in a situation to control its real load during switching, by ensuring the use of a suitable cyclic ratio to avoid the overheating phenomena. Depending on the conditions of possible use of the function, TNS/TS and/or the test plan should be specified if the switched load is in blocked torque (worst case test) or not.

Carry out 1000 switching operations, on each of the concerned outputs.

Case of the test with pulse 1bis:

- Case of high side outputs:
  - 1000 pulses of -100 V are applied on all the concerned outputs (successively) and activated output, while monitoring the DUT. In this case, Ua = 14V.
  - Repeat the test with 1000 pulses of -100V on all the concerned outputs (successively) and deactivated output, while monitoring the DUT. In this case, Ua = 0V.
- Case of low side outputs:
  - Apply 1000 pulses of +100 V on all the concerned outputs (successively) and activated output, while monitoring the DUT. In this case, Ua = 0V.
  - Repeat the test with 1000 pulses of +100V on all the concerned outputs (successively) and deactivated output, while monitoring the DUT. In this case, Ua = 14V.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, type of load, the DUT environment.
- If the generator is used: oscilloscope measurements at the terminals of the generator for each wave form, measured in open circuit and under adapted load (see appendix D of the ISO 7637-2 standard), then under load (by the DUT).
- If the use of real loads: oscilloscope measurements at the terminals of the tested output, under load of some significant wave forms.
- Parameters observed and defects encountered during the test.

7.1.10.7. Requirements

Test	Operating classes	Customer impact levels
Pulses on the outputs switching an inductive load	A	0

7.1.11. EQ/IC 02: RESISTANCE TO PULSES 3A AND 3B

7.1.11.1. Reference document

This test procedure is compliant with the ISO 7637-2 standard.

7.1.11.2. Purpose of the test

This test is intended to verify the immunity of equipments to the transients resulting from the switching process.
The following are the main characteristics of the test:

- pulses of -150V for 1 hour (pulse 3a).
- pulses of +100V for 1 hour (pulse 3b).
- pulse width 0.1 µs.

7.1.11.3. Conditions for application of the test

This test is applicable to all the equipment having active electronics, except for those which are powered by a regulated voltage supplied by another control unit.

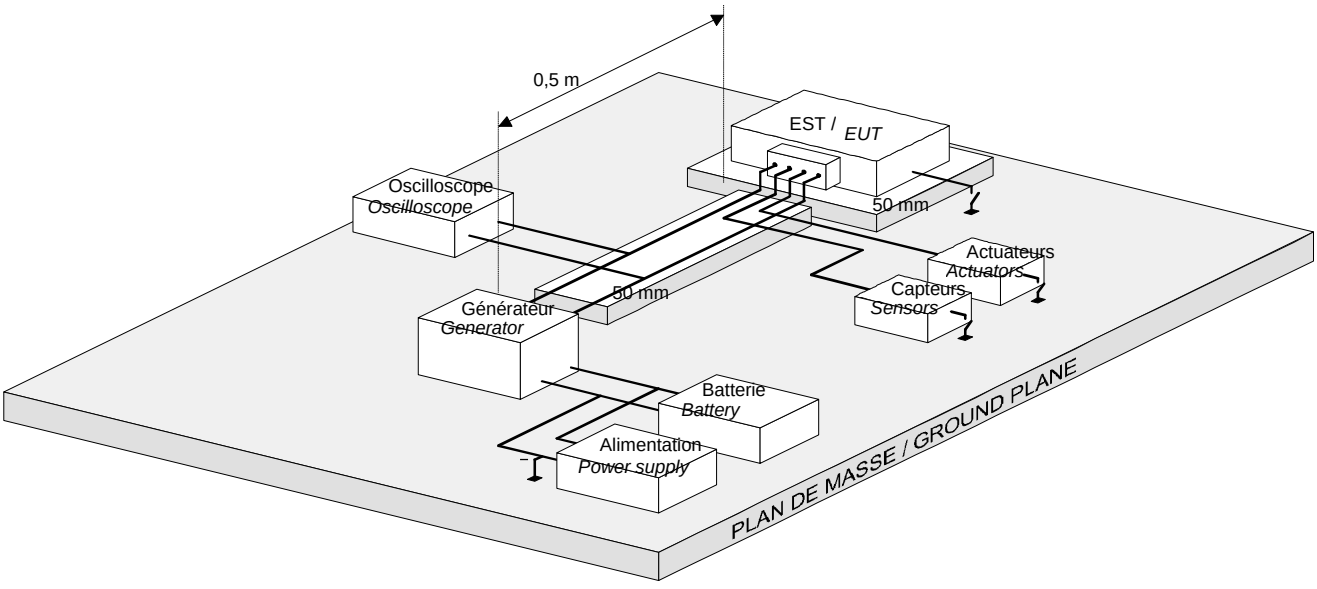
The test is carried out on all the power supply lines of the equipment considered successively and simultaneously. The power supply associated with a network (ex.: + CAN …) should be considered as a power supply relayed and tested as such.

In the case of sensors for which certain output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

7.1.11.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Pulses generator.

7.1.11.5. Assembly



7.1.11.6. Procedure

Preparation:

Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used).

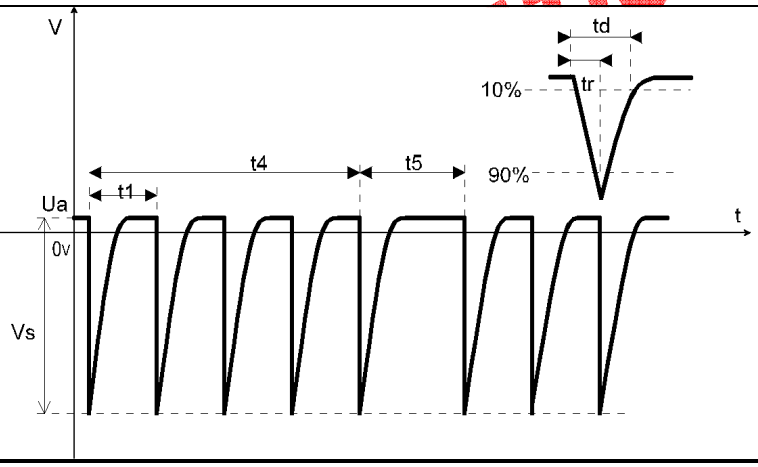
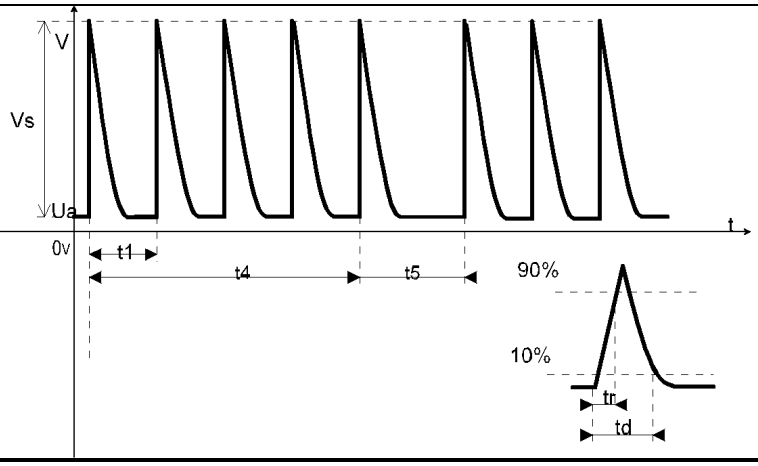
The DUT is placed on an isolating support of 50 mm thickness. It is linked to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a length of 500±100mm , and should be arranged on an insulating support of 50 mm thickness.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistance. Its value will be provided in the STN/TS and should be specified in the test plan.

Calibration:

- Connect the oscilloscope (disconnected DUT) to the output of the pulses generator (high impedance input), and adjust the generator in order to obtain the specified pulses with an internal resistor of the generator equal to Ri.

12 V Network	Pulse 3ª
U_a = 14 V V_s = - 150 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	
12 V Network	**Pulse 3b**
U_a = 14 V V_s = 100 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	

Test:

- Run the DUT for a minimal period of 10 minutes.
- Apply the pulses 3a for 1 hour and the pulses 3b for 1 hour on all the power supply lines (successively and simultaneously) while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Oscilloscope readings at the terminals of the generator each wave form, measured in open circuit and under adapted charge (see appendix D of the ISO 7637-2 standard).
- Parameters observed and defects encountered during the test.

7.1.11.7. Requirements

Test	Operating classes	Customer impact levels
Pulses 3a	A	0
Pulses 3b	A	0

7.1.12. EQ/IC 03: RESISTANCE TO 5B PULSES

7.1.12.1. Reference document

This test procedure is compliant with the ISO 16 750 standard.

7.1.12.2. Purpose of the test

This test is intended to verify the immunity of the equipment to transient pulses of Load Dump (disconnection of the battery, running engine and/or generator under operation) limited by the integrated protection to the alternator.

The following are the main characteristics of the test:

- 5 pulses of + 21.5 V (to be added to the network voltage of 14 V).
- Pulse width of 400 ms

7.1.12.3. Conditions for application of the test

This test is applicable to all the equipments, except for those which are powered by a regulated voltage supplied by another control unit.

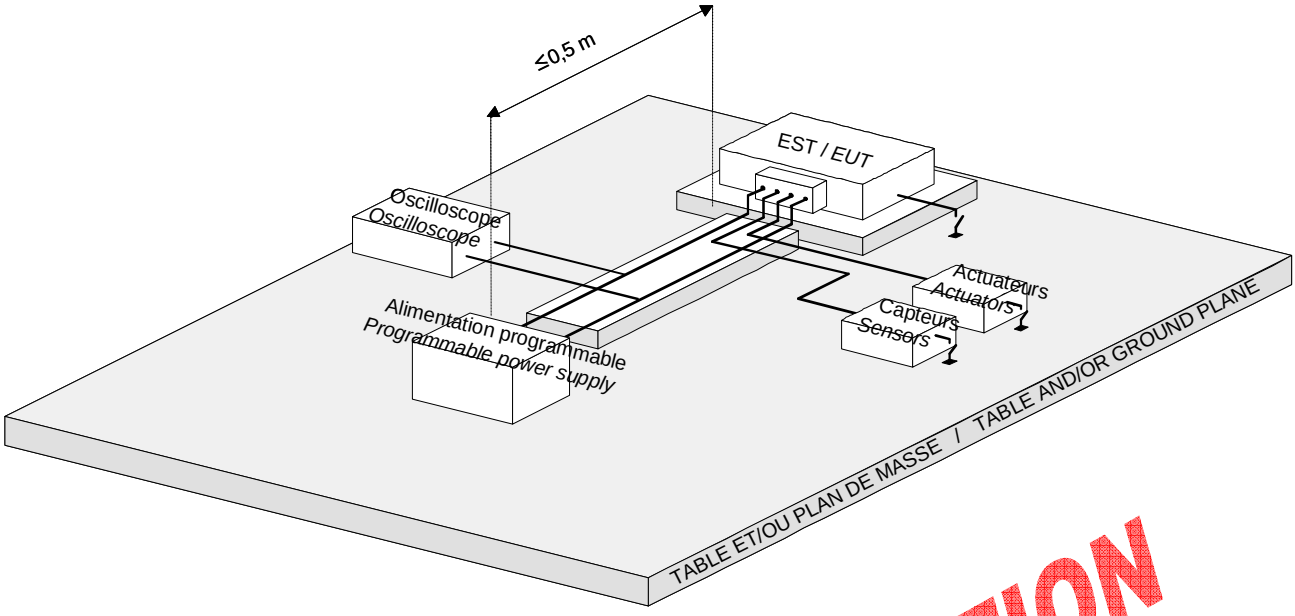
The test is carried out on all the power supply lines of the equipment considered simultaneously. The power supply associated with a network (ex.: + CAN …) should be considered like a relayed and tested power supply as such.

If the sensors for which the output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

7.1.12.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Pulses generator. The use of a pulse generator of type « current source » (without internal limiter) is authorized.

7.1.12.5. Assembly



7.1.12.6. Procedure

Preparation:

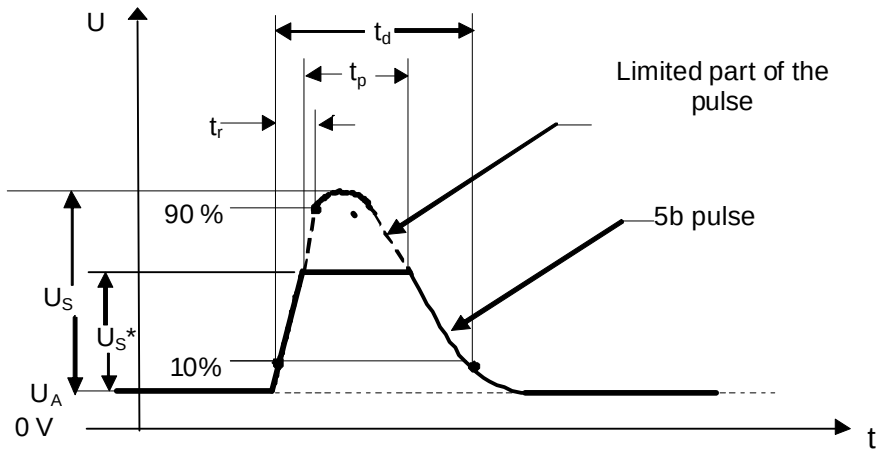
Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistance. Its value will be provided in the TNS/TS and should be specified in the test plan

Calibration:

Connect the oscilloscope (disconnected DUT) to the pulses generator (high input impedance), and the generator is adjusted in order to obtain the specific pulses with an internal resistance of the Ri generator.

12 V Network	5b pulse
$t_r \leq 10$ ms $U_a = 14$ V $U_s^* = 21.5$ V Us = 85V $R_i \leq 1\ \Omega$ td = 400 ms $t_r \leq 10$ ms	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 5 times the 5b pulses with an interval of a minute on all the power supply lines (grouped) while monitoring the DUT.

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Oscilloscope readings on the generator terminals of each wave form, measured in open circuit and under adapted charge.
- Parameter observed and defects encountered during the test.

7.1.12.7. Requirements

Test levels	Operating classes	Customer impact levels
5b pulses	C	2
5b pulses DUT operational in the case of shock	Not applicable	0 (note)

Note : some quick dysfunctions with negligible customer effect can be tolerated (examples : hardly noticeable variation of luminosity, isolated erroneous frame recovered by the software…)

7.1.13.EQ/IC 04: RESISTANCE TO SHORT INTERRUPTIONS OF THE POWER SUPPLY

7.1.13.1. Reference Document

There is no reference document related to this test.

7.1.13.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the short interruptions of the power supply due to imperfect contacts. Its main characteristics for the power inputs are the following:

- Short interruptions of 2 µs due to improper connector contacts.
- Short interruptions of 100 µs due to the presence of relays (case of the power supplies +APC, +CPC…)
- Short interruptions of 5 ms due to the presence of switches (strong current contactors, on low cost architecture)

7.1.13.3. Conditions for application of the test

General case:

- Short interruptions of 2 µs: this test is applicable to all the powered equipments, which includes the equipments powered by a regulated voltage supplied by a control unit (for example, a 5V sensor)
- Short interruptions of 100 µs: this test is applicable to the equipments having the power supply lines switched by a relay (and therefore not connected directly on the battery).
- Short interruptions of 5 ms: this test is applicable to the equipment having the power supply lines switched by a contact switch (and therefore not connected directly on the battery or through relay).

The test is carried out on the power supply lines of the equipment taken successively, then simultaneously.

If the sensors for which certain output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

Particular case (to be specified in TNS/TS):

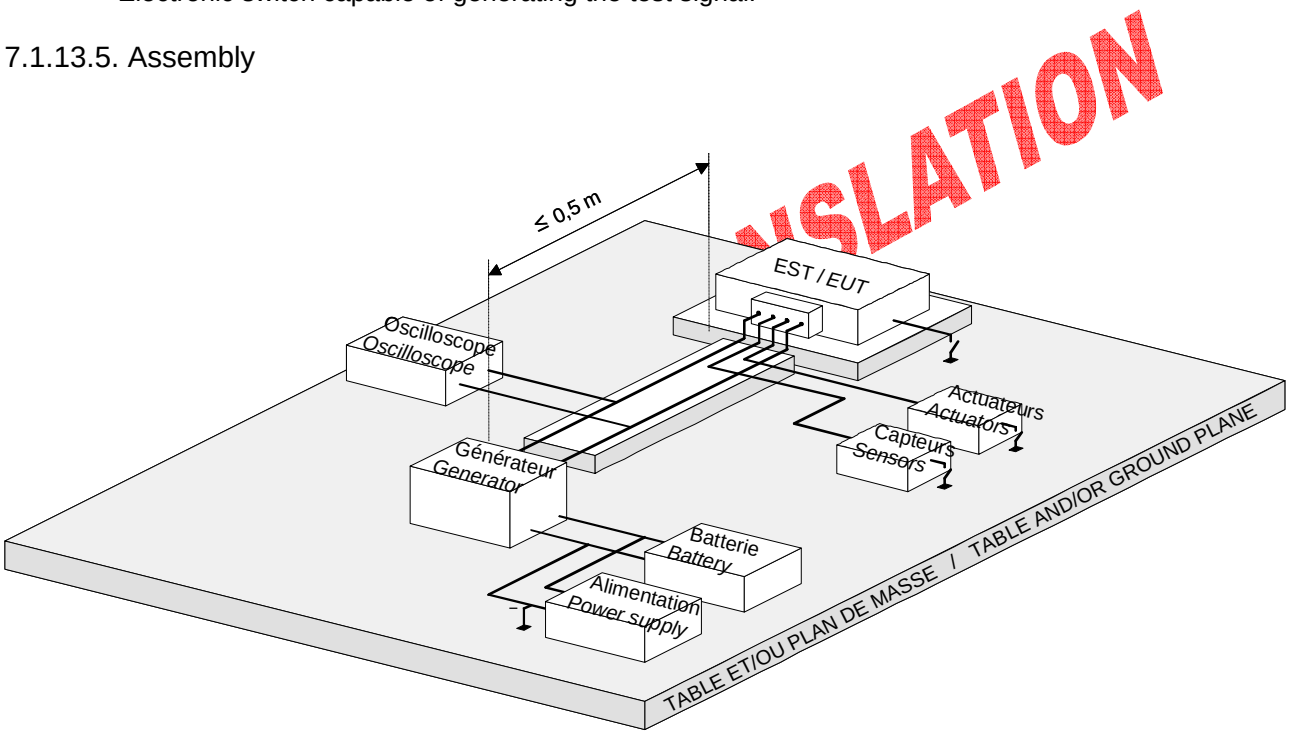
These tests are not applicable for some passive equipments –or motors, having the following particular features:

- Functions having a sufficient mechanical or thermal inertia (seat motors, CTP)
- Functions of the lighting or indicator light type, for which flickering is authorized.

7.1.13.4. Test means

- Power supply and/or battery
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Electronic switch capable of generating the test signal.

7.1.13.5. Assembly



7.1.13.6. Procedure

Preparation:

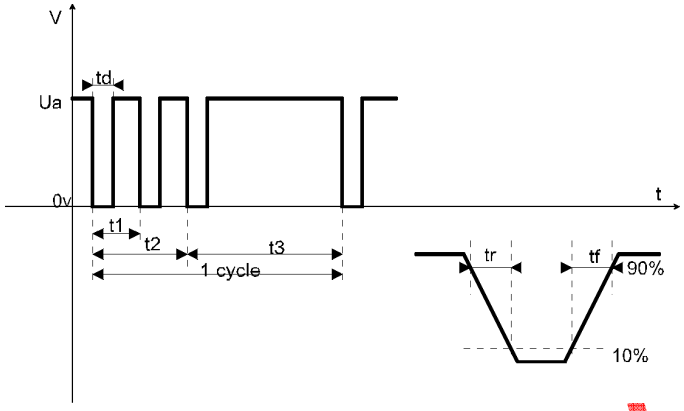
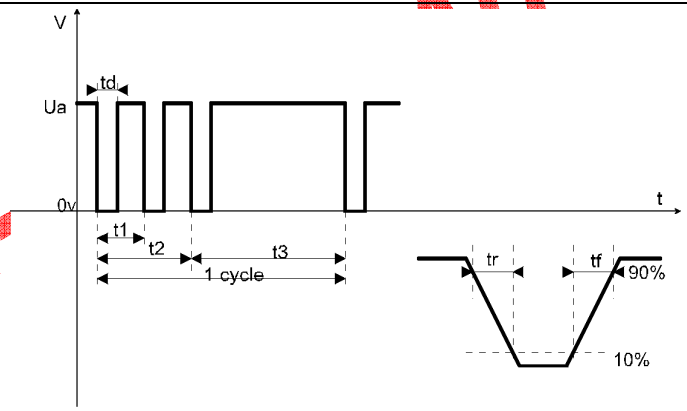
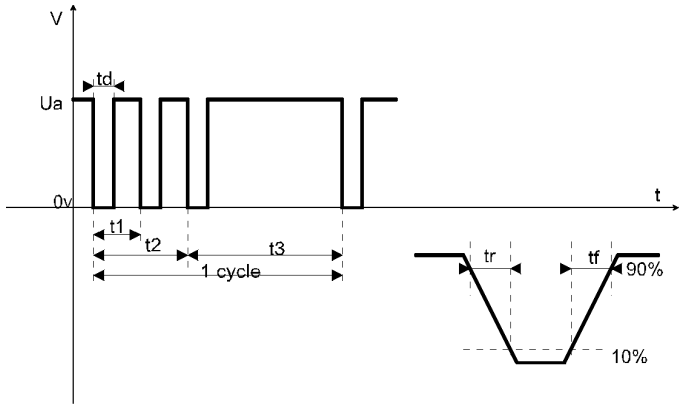
Preferably, a wiring harness of a maximum length of 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistance. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration:

Connect the oscilloscope (disconnected DUT) to the output of the pulses generator (high impedance input), and adjust the generator in order to obtain the specified pulses.

12 V Network	Short interruptions by the connectors (wave form under 1kΩ)
U_a = 14 V * $t_f \leq 1$ µs $t_r \leq 1$ µs td = 2 µs t1 = 1 ms t2 = 4 s t3 = 10 s	
Note: the voltage U_a can be adjusted (example: 5V sensor…)	
12 V Network	**Short interruptions by the relays**
U_a = 14 V $t_f \leq 1$ µs $t_r \leq 1$ µs td = 100 µs t1 = 1 ms t2 = 4 s t3 = 10 s	
12 V Network	**Short interruptions by the switches**
U_a = 14 V $t_f \leq 1$ µs $t_r \leq 1$ µs td = 5 ms t1 = 10 ms t2 = 100 ms t3 = 10 s	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 3 cycles of each of the pulses on each power supply line then on the whole while monitoring the DUT.

Note : *The cut-off of the power supply should be of "open" type. The characteristics of the switch should be specified in the test plan.*

Test report:

The test report should, among other things, include the following elements:

- Assembly used: the wiring harness, the DUT environment.
- Oscilloscope readings of the cut-offs during the calibration phase, under a resistive charge of 1 kΩ.
- Observed parameters and defects encountered during the test.
- Characteristics of the switch used and pulses applied.

7.1.13.7. Requirements

Test	Operating classes	Customer impact levels
Short interruptions of 2 µs	Not applicable	0
Short interruptions of 100 µs	Not applicable	0
Short interruptions of 5 ms	Not applicable	0

Note : *some quick dysfunctions with negligible customer effect can be tolerated (examples : hardly noticeable variation of luminosity, isolated erroneous frame recovered by the software …)*

7.1.14. EQ/IC 05 RESISTANCE TO PULSES 4 BIS:

7.1.14.1. Reference document

This test procedure is compliant with the ISO 16750 standard, except with regard to the voltage levels.

7.1.14.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the variations of the voltage during the cold start phase (pulse 4bis).

Below are the main characteristics of the test:

- Power supply that can go down until 5.6 V (12 V Network).
- 5 pulses spaced by 1 minute.

7.1.14.3. Conditions for application of the test

The pulses 4bis are applied on all the equipment powered during the start-up phase. They are not applied to equipments which are not powered and are not connected during the start-up, neither to the equipment powered by a regulated voltage supplied by another control unit.

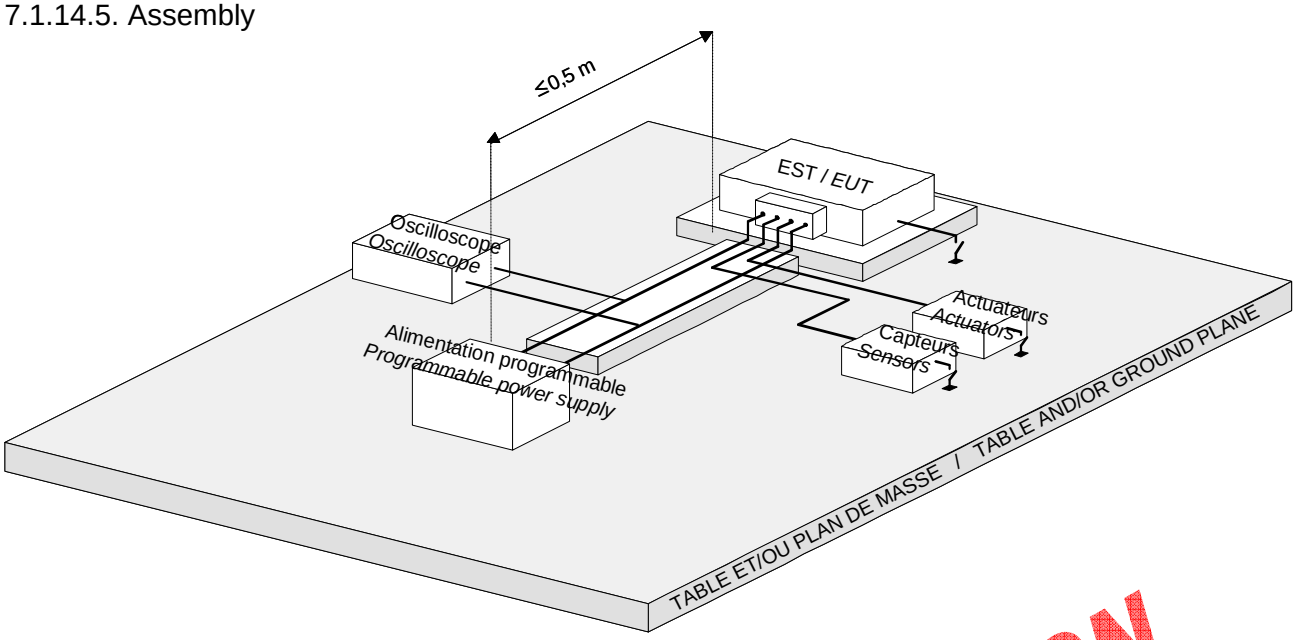
In the case of sensors for which the output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

The test is carried out on the equipment power supply lines considered simultaneously.

7.1.14.4. Test means

- Programmable supply.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Programmable power supply or pulses generator.
- Climatic chamber for the tests at TminEF (pulse II).

7.1.14.5. Assembly



7.1.14.6. Procedure

Preparation:

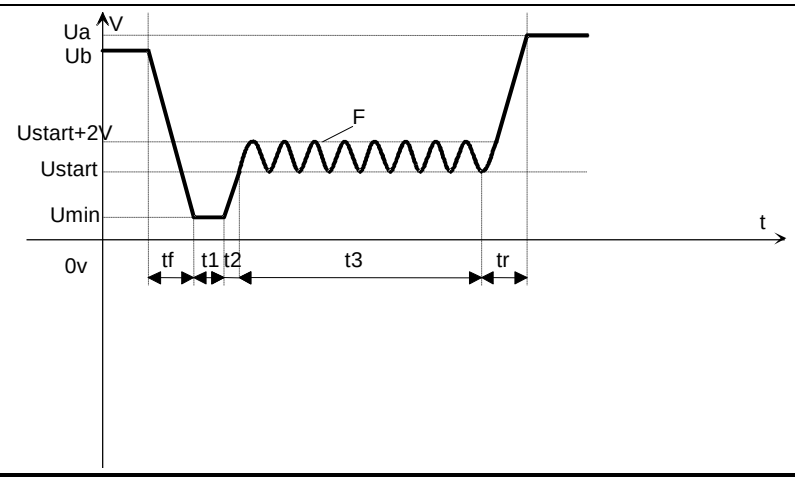
Preferably, a wiring harness having a maximum length of 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other ground connection is authorized.

The DUT power supply wires which undergo the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistance. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration for the 4bis pulses:

Connect the oscilloscope (disconnected DUT) to the pulses generator (high impedance input), and adjust the generator to obtain the specified pulses.

12 V Network	Pulse 4 bis
U_a = 14 V U_b = 12 V R_i = 0.01 Ω $t_f \leq 5$ ms t_r = 100 ms t_1 = 20 ms t_2 = 50 ms t_3 = 10 s F = 2 Hz	

Pulse number	I		II		III	
Parameters	**Umin**	**Ustart**	**Umin**	**Ustart**	**Umin**	**Ustart**
12 V Network	**8.0 V**	**9.5 V**	**5.6 V**	**6.5 V**	**3.0 V**	**5.0 V**

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 5 times the pulses 4 bis (pulses I, II and III) with an interval of one minute on all the power supply lines taken simultaneously while monitoring the DUT.

The DUT will be placed at an ambient temperature of (23°±5) for the pulses number I and III, and at TminEF for the pulse II.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: harness, the DUT environment.
- Parameters observed and defects encountered during the test.
- Characteristics of the applied pulse.

7.1.14.7.Requirements

Test	**Pulse no. I (T° surrounding)**		**Pulse no. II (Tmin EF)**		**Pulse no. III (T° ambient)**	
Requirements	Operational classes	Customer impact levels	Operational classes	Customer impact levels	Operational classes	Customer impact levels
Pulses 4 bis DUT and/or function which has to be operational during the (cold) start up phase of the vehicle	A	0	C	1 (b)	C (a)	NA
Pulses 4 bis DUT and/or non operational function during the (cold) start up phase of the vehicle	C (a)	NA	C (a)	NA	C (a)	NA

(a) the data in the memory are not lost.

(b) if DUT supplies a regulated voltage for another control unit or sensor, this voltage should remain within its tolerance during the test.

7.1.15. EQ/IC 12: RESISTANCE TO RE-START PULSE

7.1.15.1. Reference document

There is no reference document related to this test.

7.1.15.2. Purpose of the test

This test is intended to verify the immunity of the equipments to variations of the voltage during the hot restart phase of a stop and start system (STT).

The main characteristics of the test are the following:

- Power supply which can go down up to 8.0 V.
- 5 pulses spaced by 1 minute.

7.1.15.3. Conditions for application of the test

The re-start pulse is applicable to the equipment meeting all the following conditions:

- equipment likely to be installed in a vehicle with stop and start system (STT),
- equipment powered by the vehicle battery (not powered by a regulated voltage supplied by another control unit).

This test is not applied to the equipment for which the operation is nominal during the EQ/TE01 test at 9.5V.

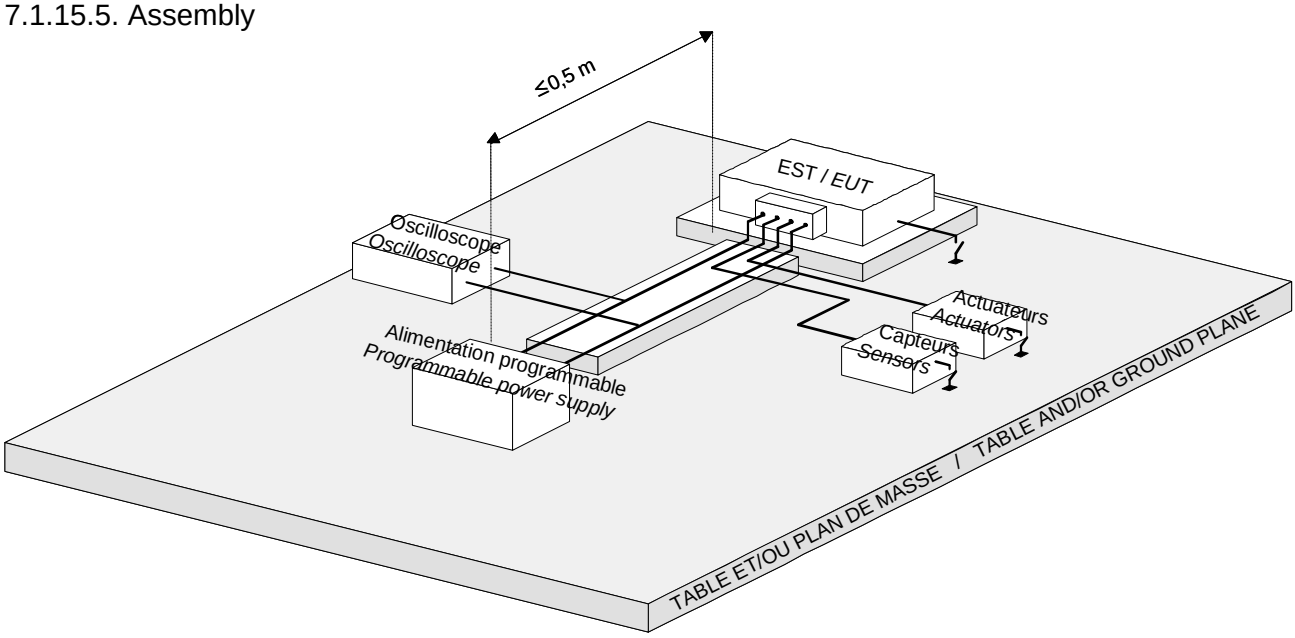
If the sensors for which the output signals are connected through pull up resistors to the 12V (for example, certain level sensors for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

The test is carried out on the power supply lines of the equipment taken simultaneously. The § "procedure" specifies the voltage profile to be applied, depending on whether the equipment benefits or not from a voltage maintaining device (DMT).

7.1.15.4. Test means

- Programmable power supply.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Programmable power supply or pulses generator.

7.1.15.5. Assembly



7.1.15.6.Procedure

Preparation:

Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane.

The use of the ground plane is necessary only in the case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

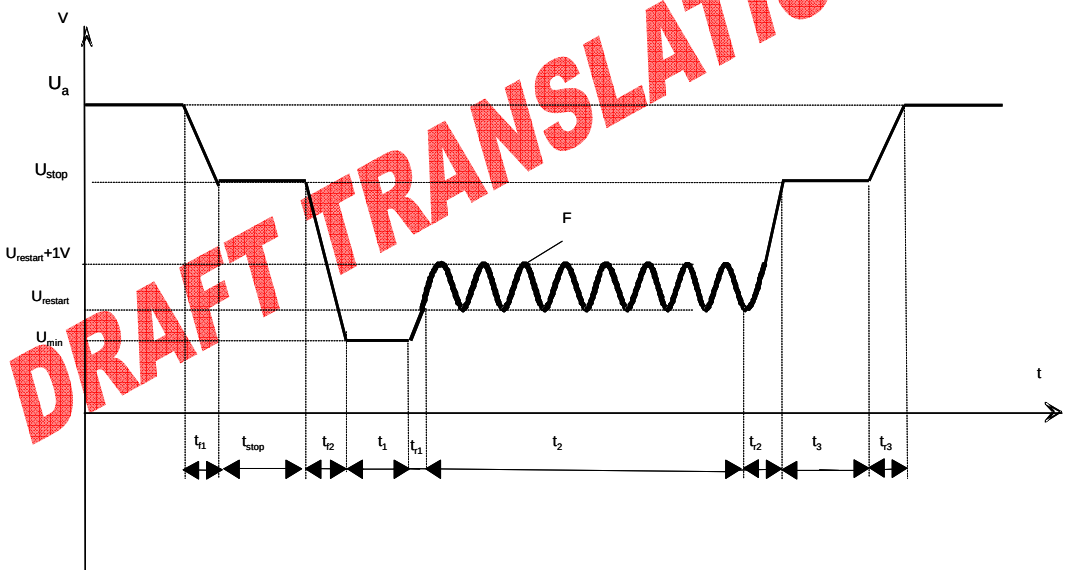
The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistor. Its value will be provided in the TNS/TS and should be specified in the test plan.

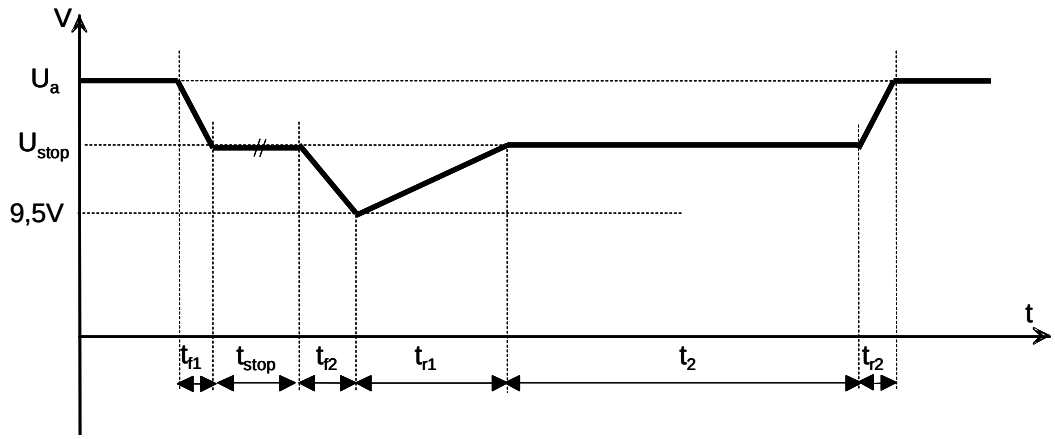
Calibration:

If the systems do not benefit from the voltage maintening device (DMT):

Connect the oscilloscope (disconnected DUT) to the pulses generator (high impedance input), and adjust the generator in order to obtain the specified pulses.

12 V Network	Re-start pulse (case without DMT)
Ua = 14.0 V Ustop = 10.5 V Umin = 8.0 V Urestart = 9.0 V tf1 = 100 ms tstop = 10s tf2 ≤ 5 ms t1 = 50 ms tr1 = 5ms t2 = 840 ms tr2 = 150 ms t3 = 2s tr3 = 100 ms F = 10Hz R_i = 0.01 Ω	

When the systems benefit from the voltage maintening device (DMT):

12 V Network	Re-start pulse (case with DMT)
U_a = 14 V U_{stop} = 10.5 V t_{f1} = 100 ms t_{stop} = 10s t_{f2} = 5 ms t_2 = 3s t_{r1} = 45 ms t_{r2} = 100 ms R_i = 0.01 Ω	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 5 times the re-start pulse at an interval of a minute on all the power supply lines taken simultaneously while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.
- Characteristics of the applied pulse.

7.1.15.7. Requirements

Requirements	Operating classes	Customer impact levels
General case	A	0 (b)
Case of the DUT and/or functions for which certain malfunctions are acceptable during the re-start (a)	C	1 (b)

(a) Case of certain DUT and/or functions controlling an actuator (example: window lift), functions of illumination and/or dimming type, and functions likely to discharge a high power (DAE, autoradio…). This case should be specified in the TNS/TS. By default, the general case is applied.

(b) In the case of DUT supplies a regulated voltage for another control unit or sensor, it should remain within its tolerances during the test.

7.1.16. EQ/IC 13: RESISTANCE TO "VOLT CONTROL" VOLTAGE PULSE

7.1.16.1. Reference document

There is no reference document related to this test.

7.1.16.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the variations of the voltage during the switching phases of the loads (heated rear window...), during phases at high voltage power supply to the “volt control” systems (deceleration phase).

The main characteristics of the test are the following:

- Power supply which can reach 18.0 V.
- 5 pulses with an interval of 1 minute.

7.1.16.3. Conditions for application of the test

This test is applicable to all equipments powered by a regulated voltage supplied by an other control unit (neither the alternator nor the DC/DC convertor of an electric/hybride vehicle are concerned by the term « control unit »)

If the sensors for which the output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

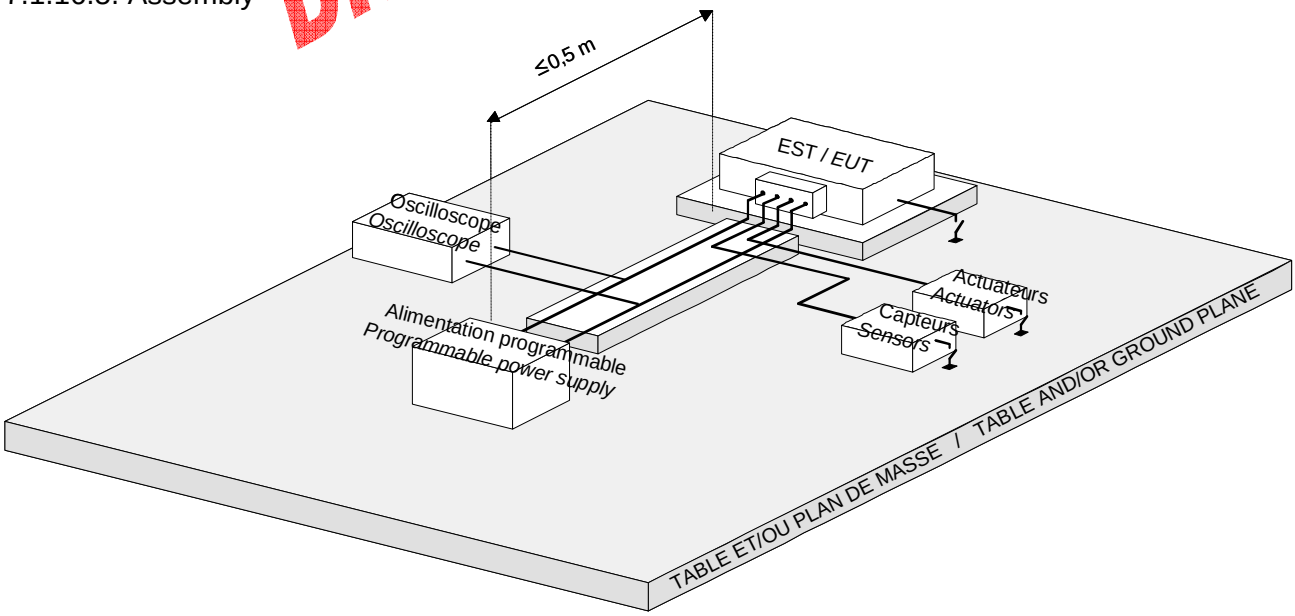
This test is not applied to the equipments whose operation is nominal (A0) at 18.0V.

The test is carried out on the power supply lines of the equipment taken simultaneously.

7.1.16.4. Test means

- Programmable power supply or pulses generator.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.

7.1.16.5. Assembly



7.1.16.6. Procedure

Preparation:

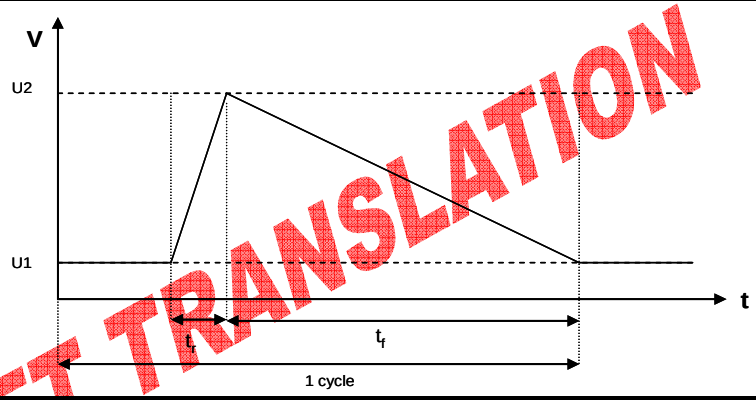
Preferably, a wiring harness having a maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment should be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other ground connection is authorized.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistor. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration:

Connect the oscilloscope (disconnected DUT) to the output of the pulses generator (high impedance input), and adjust the generator to obtain the specified pulses.

12 V Network	Volt control pulse
U_1 = 15.2 V U_2 = 18.0 V T_r = 1 ms T_f = 300ms R_i = 0.01 Ω	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply 5 times the "volt control" pulse with an interval of one minute on all the power supply lines taken simultaneously while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.
- Characteristics of the applied pulse.

7.1.16.7. Requirements

Requirements	Operating classes	Customer impact levels
General case	A	0 (b)
Case of the DUT and/or functions for which certain momentary malfunctions are accepted (a)	C	1 (b)

(a) Case of certain DUT and/or functions controlling an actuator (example: window wiper, for which a momentary change of speed is authorized), functions of lighting and/or dimming type (for which a momentary variation of lighting is authorized). This case should be specified by the TNS/TS. By default, the general case is applied.

(b) If the DUT supplies a regulated voltage for another control unit or sensor, this voltage should remain within its tolerances during the test.

7.1.17. EQ/IC 06: RESISTANCE TO VOLTAGE RIPPLES

7.1.17.1. Reference document

There is no reference document related to this test.

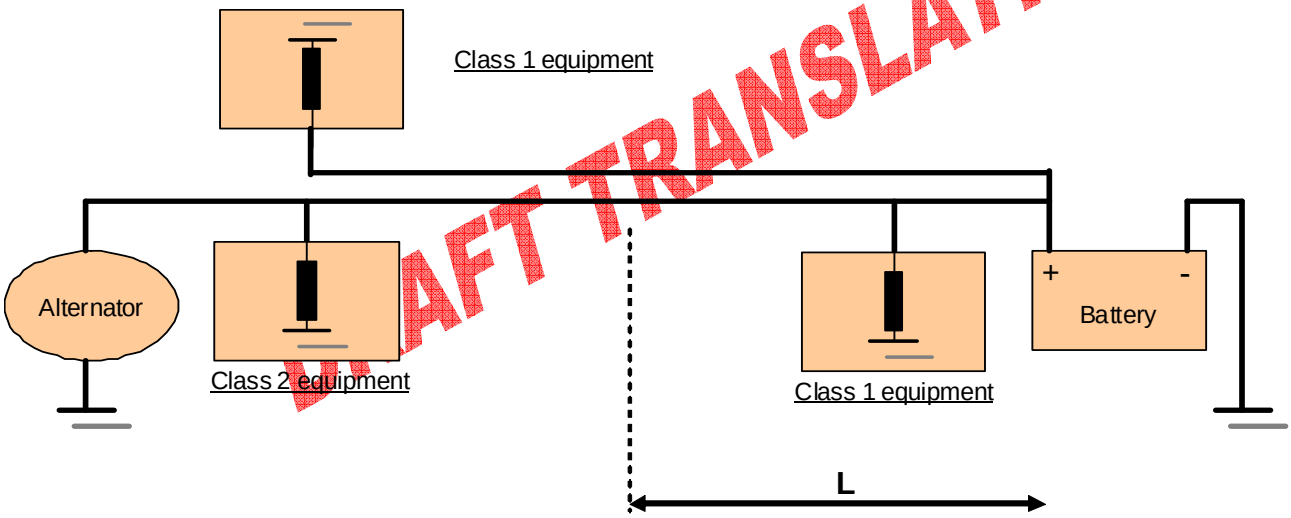
7.1.17.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the ripple voltage of the on-board electrical system, generated by the alternator/regulator or by certain consumers. The accelerated ageing phenomena (input capacity …) related to the application of ripples for long durations are not taken into account by the present specifications.

Its main characteristics are the following:

For the 12 V network: ripples from 1V to 2V peak to peak, from 50 Hz to 30 kHz. For the 12 V network, two classes of ripple voltage are distinguished.

- Class 1(1Vcc): equipments powered by the battery, and not connected directly to the alternator ; as well as the equipments connected to the alternator but localized at a distance less than L from the battery.
- Class 2 (2Vcc): equipments connected to the alternator and localized to a distance greater than L from the battery.
- The distance L depends on the architecture of the impacted vehicle, hence the choice of the class should be specified either in the TNS/TS of the equipment, or in the test plan. By default, the length L is 2 m.



7.1.17.3. Conditions for application of the test

General case:

This test is applied to all the equipments powered by the on-board electrical system. It is not applied to the equipments powered by a regulated voltage supplied by another control unit.

The test is carried out on all the supply lines of the equipment taken successively and simultaneously. The associated power supply to a network (e.g.: + CAN …) should be considered as a power supply relayed and tested as such.

If the sensors for which the output signals are connected through pull up resistors to the 12V (for example, certain level sensors, for which the output is connected to the 12V through a pull up resistor included in the control unit which makes the acquisition), the outputs in question are concerned by the test.

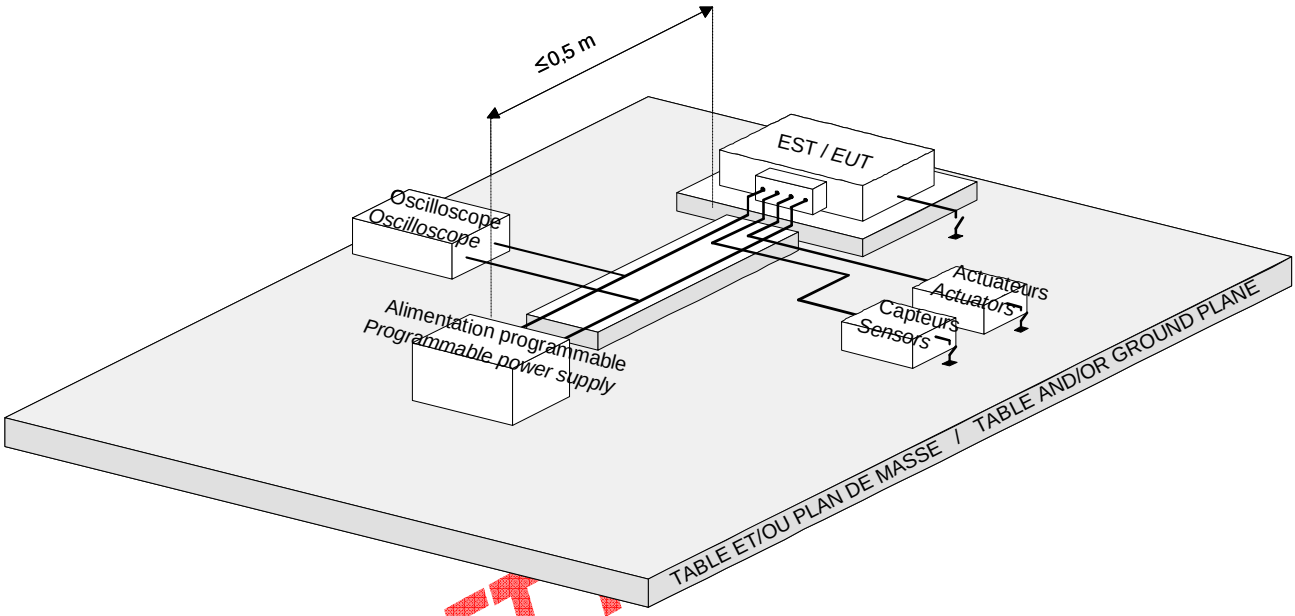
Particular case (to be specified in the TNS/TS):

These tests are not applicable for certain passive equipments –or motors, having sufficient mechanical or thermal inertia (seat motors, CTP …)

7.1.17.4. Test means

- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Programmable power supply or pulses generator.

7.1.17.5. Assembly



7.1.17.6. Procedure

Preparation:

Preferably, a wiring harness of maximum length 2000 mm should be used (possibly, the real wiring harness can be used). The equipment can be installed either on an insulated table or a ground plane. The use of the ground plane is necessary only in case of direct connection of the DUT or its sensors / actuators to the vehicle chassis. In this case, the DUT is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

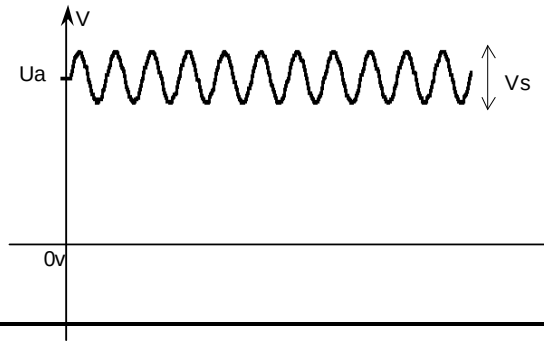
.

The DUT power supply wires which are subjected to the test should have a maximum length of 500 mm.

In the case of sensor outputs connected to the 12V through a pull up resistor, the concerned outputs should be connected to the generator through the equivalent resistor. Its value will be provided in the TNS/TS and should be specified in the test plan.

Calibration:

- Connect the oscilloscope (disconnected DUT) to the generator output (high impedance input), and adjust the generator in order to obtain the specific pulses.

12 V Network	On-board network ripple
Ua = 14 V	
Class 1: Vs = 1 Vcc Class 2: Vs = 2 Vcc	
F = 50 Hz - 30 kHz	

Note: for the frequencies greater than 10kHz, the proposed impedances by certain equipments can decrease and stress the generator to power levels that it cannot deliver. Therefore, calibration of the voltage under a load of 0.5 Ω, is permitted, the source impedance of generator not having to exceed 0.1Ω. If this case occurs, it should be indicated in the test report, and the current levels should be documented.

Test:

Run the DUT for a minimal period of 10 minutes (outside ripple voltage).

Apply the signal on all the power supply lines while monitoring the DUT.

Frequency steps and test duration: vary the frequency in a continuous way by programming a progressive ramp ranging from 30Hz to 30kHz. The total test period should be at least 15 minutes in order to enable the observation of possible effects at each frequency.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.

7.1.17.7. Requirements

Test	Operational state	Customer impact level
Ripple	A	0

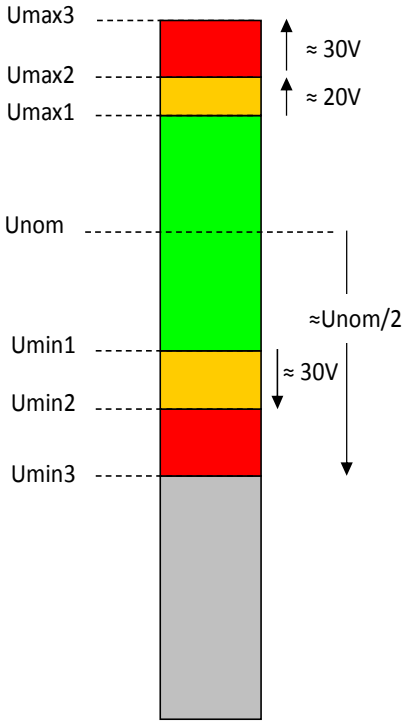
7.2.ELECTRICAL RESISTANCE TESTS FOR THE EQUIPMENTS CONNECTED TO THE HIGH VOLTAGE NETWORK ("160-430V")

7.2.1.GENERAL DEFINITION

LV Network voltage is highly dependant on the battery nominal voltage and technology. For this reason the voltage range is deduced from the battery technology (NiMH, Li …) and sizing (number of cells in serial)

The following table gives different voltage values depending on the number of cells and their voltages.

	Voltage Class				
	I	II	III	IV	V
Maximun voltage per cell	4,2	4,2	4,2	4,2	4,2
Mominal voltage per cell	3,75	3,75	3,75	3,75	3,75
Minimum voltage per cell	2,6	2,6	2,6	2,6	2,6
Number of cells	64	80	88	96	104
Umax3	330	390	440	450	470
Umax2	300	360	410	420	440
Umax 1	280	340	390	410	430
Unom	240	300	330	360	390
Umin1	160	200	230	240	260
Umin2	130	170	200	210	230
Umin3	100	120	140	150	160



Functional behaviour in each range shall be the following ones:

- Below Umin3: no operation
- Umin3 to Umin2: loss of function is allowed, but safety strategy and functions necessary for cranking phase shall work properly.
- Umin2 to Umin1: Deviation is acceptable if the consequences don't lead to safety impacts or complete loss of function, and if equipment returns automatically to normal operation.
- Umin1 to Umax1: nominal behaviour
- Umax1 to Umax2: Deviation is acceptable if the consequences don't lead to safety impacts or complete loss of function, and it equipment returns automatically to normal operation
- Umax2 to Umax3: loss of function is allowed, but safety strategy shall work properly
- Above Umax3: damage zone

Depending on the equipment, and regarding future developments, it might be interesting to be compliant with different ranges simultaneously. In such cases, Umax values of the upper range and Umin values of the lower one are applicable. For example, if we consider 80 and 88 cells ranges, then the Umax values correspond to the 88 cells maximum voltages and the Umin values represent those of the 80 cells. Unom value will correspond to the mean value of the wanted ranges (315V in the example above).

7.2.2.EQ/TE_HV01: USUAL AND OPERATING VOLTAGE

7.2.2.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.2.2.Objective of the test

This test is intended to verify the immunity of the equipments to the minimal and maximum voltages of the electrical network.
The minimum voltage corresponds to the minimum voltage delivered to DUT by taking into account the voltage drops estimated in the cables and a weak battery state. The “permanent maximum” voltage corresponds to the maximum voltage delivered to DUT (except transient phenomena and/or error of regulation).
The main characteristics of the test are the following:

- Minimum voltage Umin1.
- Maximum permanent Umax1.

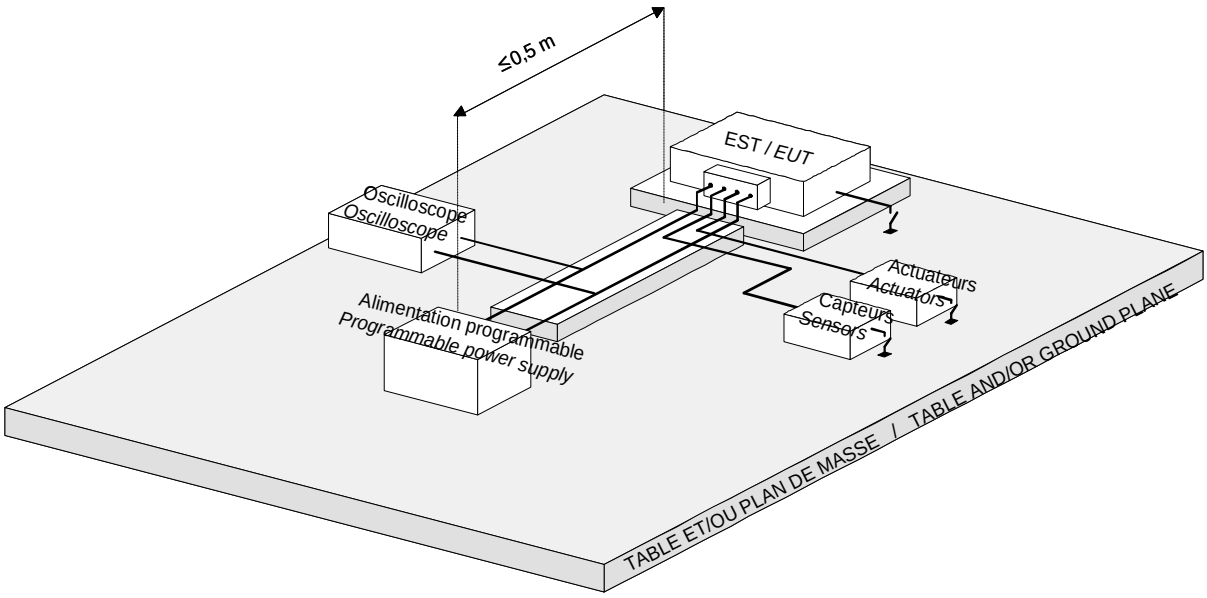
7.2.2.3.Conditions for application of the test

- This test is applicable to all component connected and supplied by the LV Network.

7.2.2.4.Test means

- Programmable supply.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.

7.2.2.5.Assembly



7.2.2.6. Procedure

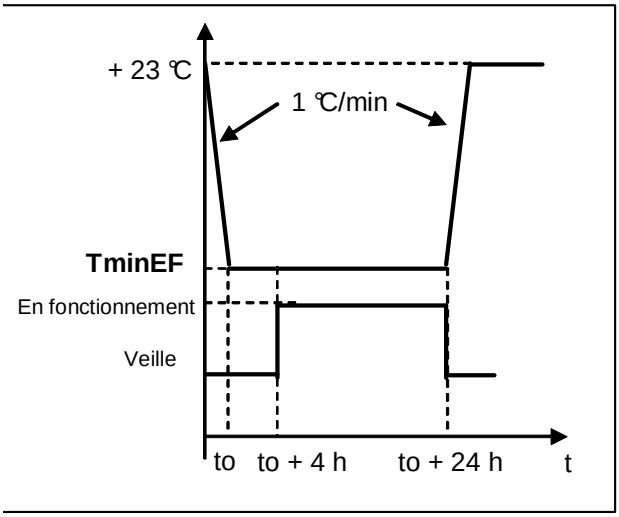
Preparation:

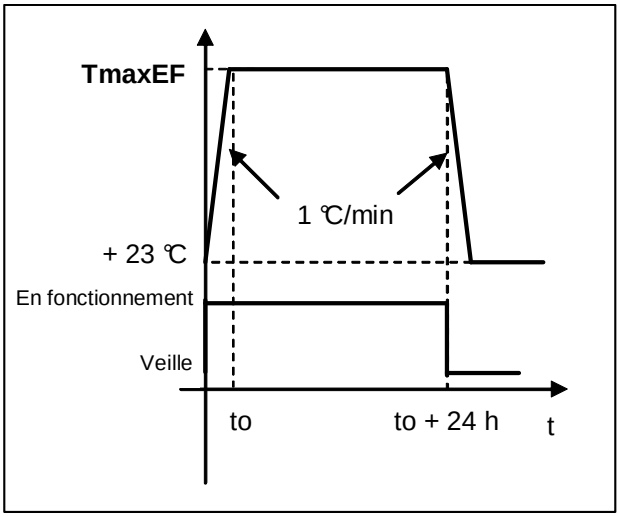
- A 2000 mm long harness should be preferably used (the real harness may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- In the case of tests TminEF to TmaxEF, the test setup can be adapted to practical constraints of use in a climatic chamber. The equipment ground connections should remain representative, and the DUT power supply wires to the generator can have a maximum length of 1000 mm.

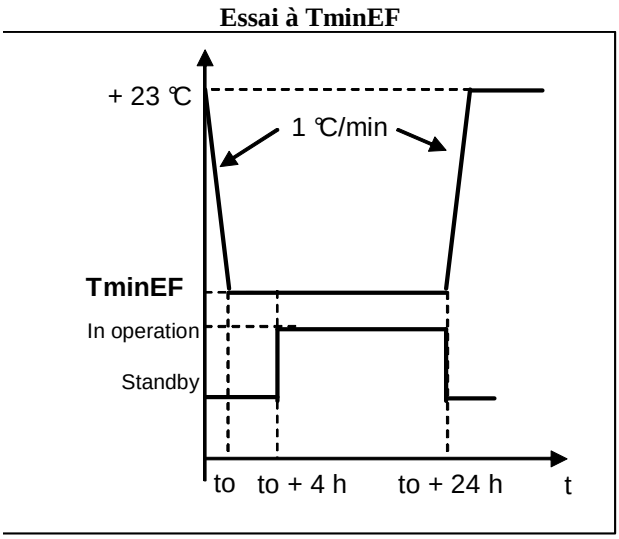
Test:

- Apply a minimum voltage, then the voltages on all positive lines as follows:

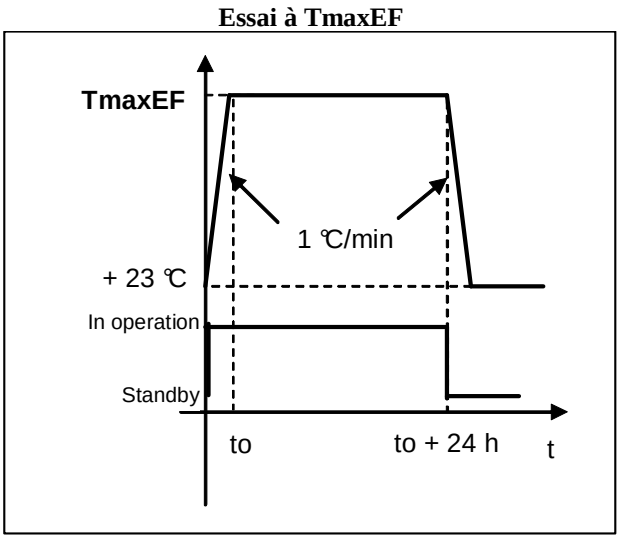
Test at TminEF **Test with** **Minimum extreme operating temperature**	24 h at TminEF ± 3 °C. Operating mode: equipment in standby under Umin1 for 4 h, then in operation for 20 h under Umin1, under the minimum operation load (the objective is to limit the internal heating). A complete functional test is carried out with Umin1 then Umax1 just before the end of the test.
	The temperature variations are performed according to standard CEI 60068-2-1 - Ab test (with slow variation of temperature 1 °C/min).
Test at TmaxEF **Test with** **Maximum extreme operating temperature**	24 h at TmaxEF ± 3 °C. Operating mode: equipment at Umax1 under nominal load. Complete functional test Umax1 then Umin1 is carried out with just before the end of the test.
	The temperature variations are performed according to standard CEI 60068-2-2 (with slow variation of temperature: 1 °C/min). • If DUT does not dissipate energy (heating of its surface ΔT < 5 °C): Bb test. • If DUT dissipates energy: Bd test (the ventilation of the enclosure should not cool the DUT surface for more than 5 °C).
Nombre de pièce **Number of parts**	At least two DUT per test. They are subjected successively to tests TminEF then to TmaxEF







Test at TminEF



Test at TmaxEF

Note: The definition of TminEF and TmaxEF temperature is given in the standard B21 7130.

Test report:

- The test report should, among other things, have the following elements:
- Assembly used: harness, DUT environment.
- Parameters observed and malfunctions observed during the test.

7.2.2.7.Requirements

Test level	Functions	Operating classes	Customer's impact levels
$U_{min1} < U < U_{max1}$	Nominal behaviour	A	0

7.2.3.EQ/TE_ HV02: INCREASE AND DECREASE OF SUPPLY VOLTAGE

7.2.3.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.3.2.Test objective

This test is intended to verify the immunity of the equipments to the slow increase and decrease of the voltage of the HV electrical network.
The voltage slow decrease/increase corresponds to the slow discharging/pre-charging of the capacitors, when the vehicle is initialised / stopped. The test contributes furthermore to testing the software robustness and especially to limit the risk concerning 12V supply derived from LV supply.

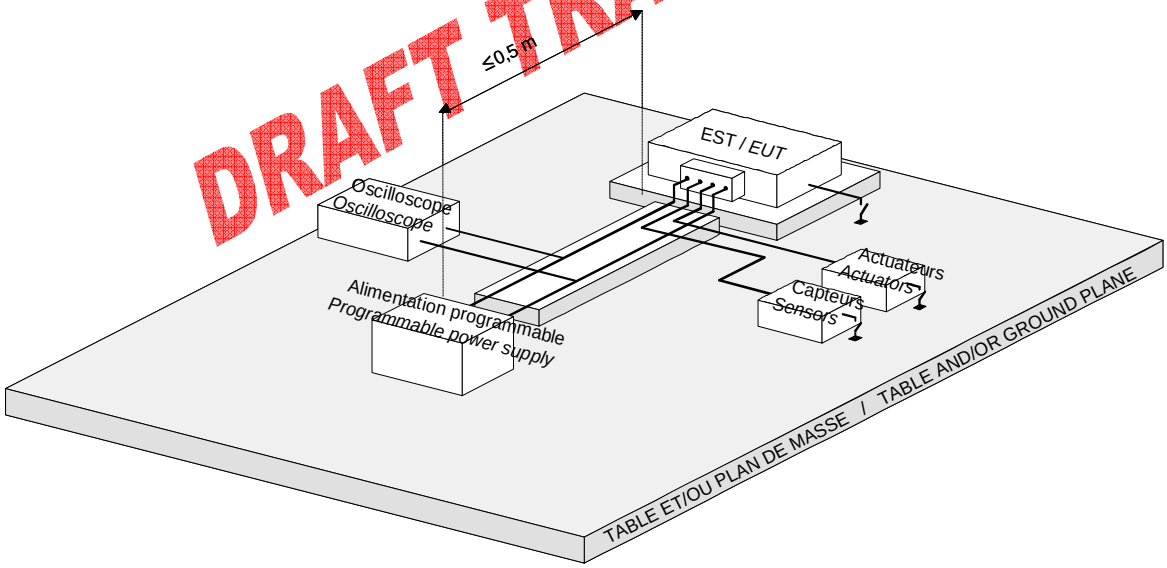
7.2.3.3.Conditions for application of the test

This test is applicable to all components connected and supplied by the LV Network, and having active electronics, a microcontroller and/or on board software.

7.2.3.4.Test means

- Programmable supply.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.

7.2.3.5.Assembly



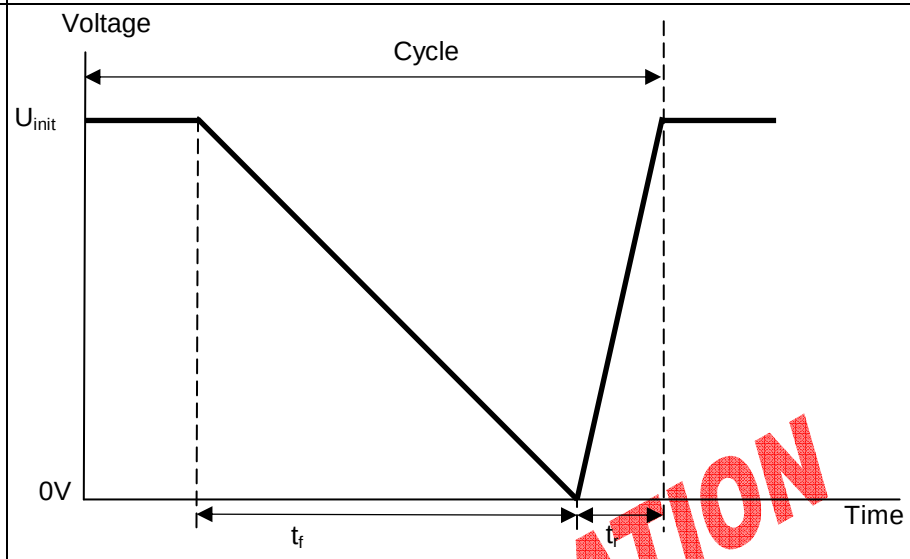
7.2.3.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires and the outputs subjected to the test should have a maximum length of 500 mm.

Calibration:

- Connect the oscilloscope (DUT disconnected) at the output of the test signal (high impedance input), and adjust the generator in order to obtain the signal specified.

200 V Network	Decrease and increase of supply voltage
Uinit =Umax1 tf = 200 s tr = 2 s Ri ≤ 0,01 Ω Number of cycles: 5	

Note: the time between two cycles is adapted according to the reset time of equipment, to verify proper reboot after each cycle.

Test:

Run the DUT for a minimal duration of 10 minutes

Apply the cycle of the test and monitoring the DUT.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during testing, including below Umin1.

7.2.3.7.Requirements

Test	Operating classes	Customer's impact levels
	C	N.A

Notes:

- For voltages lower than Umin1, the behaviour of the equipment should be filled in, during both voltage decrease and increase (emission thresholds or not of the frames on the network, diagnostic operating threshold, reset voltage, current consumption…)
- For equipment that requires a software strategy such as "power latch" (power needed after receiving the commend Standby, for example to save the functional context of EEPROM before switching off the product), degraded functional could be authorized at the cycle end (case to be specified in the specification).

7.2.4.EQ/IC_HV03: RIPPLE ON POWER SUPPLY

7.2.4.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.4.2.Objective and applicability of the test

This test is intended to verify the immunity of the equipments to the undulations of the voltage of the electrical network, generated by the electrical drive train components (converters, electrical machine, DC/DC …) or by certain consumers. The accelerated ageing phenomena (input capacitances …) linked to the application of waves on long periods of time are not acknowledged by the current specification.
Its main characteristics are the following: 16 to 8 V peak-to-peak, from 15 Hz to 30kHz, with decreasing to 0.5V from 30kHz to 50kHz.

7.2.4.3.Conditions for application of the test

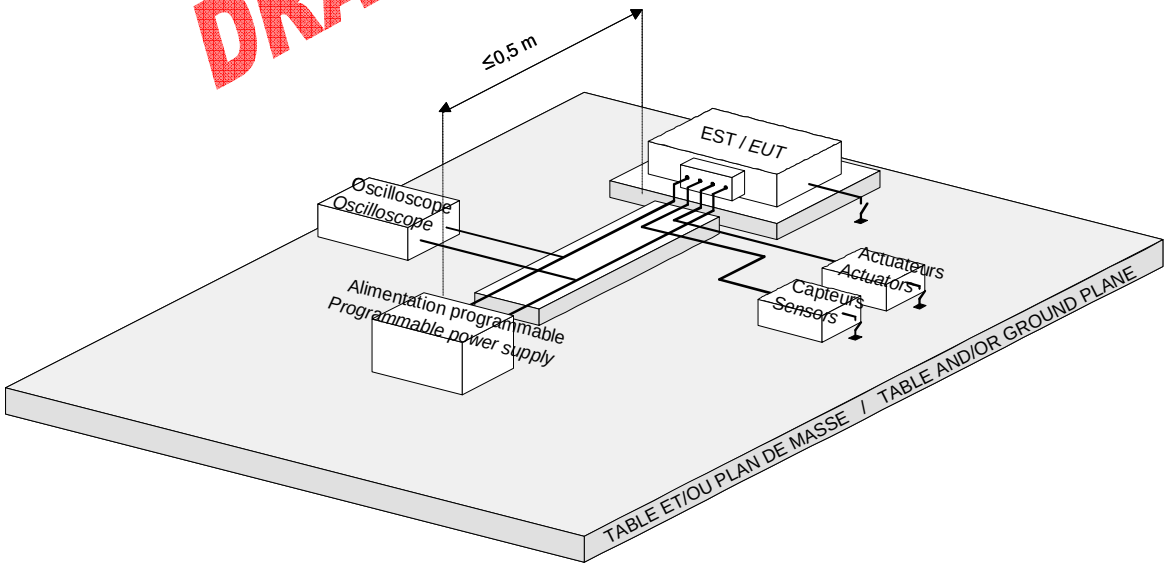
General case:
This test is applicable to all components connected and supplied by the HV Network. Two levels of severity can be applicable according to the vehicle. The TNS/TS shall specify which one is applicable.

Special case (to be specified in STN/ST) :
These tests are not applicable for certain passive equipment or motor, which have sufficient mechanical or thermic inertia (thermic resistor,…)

7.2.4.4.Test means

- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Programmable power supply or pulse generator.

7.2.4.5.Assembly



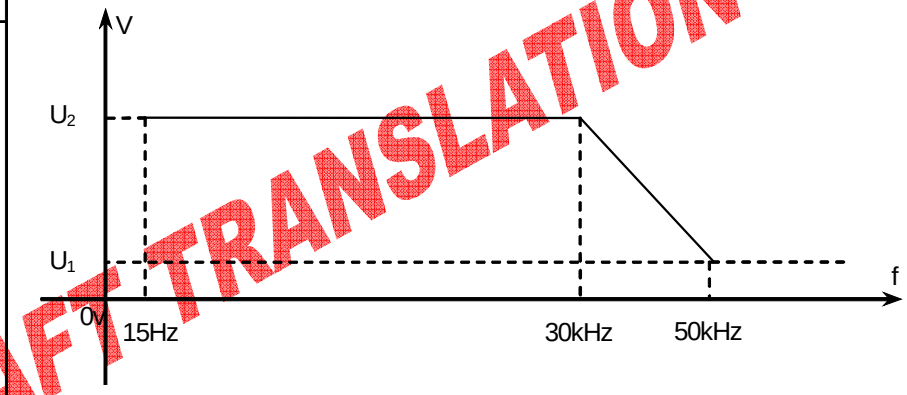
7.2.4.6.Procedure

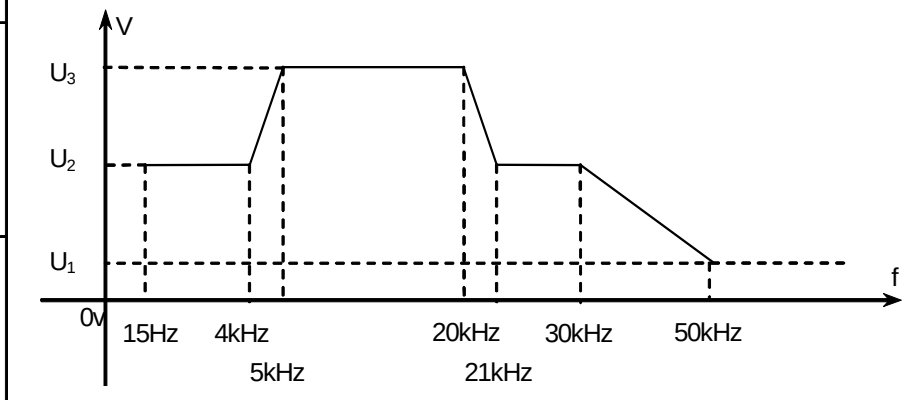
Preparation:

- A 2000 mm harness long should be preferably used (the real wiring may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires can have a maximum length of 500 mm.

Calibration:

- Connect the oscilloscope (DUT disconnected) at the output of the test signal (high impedance input), and adjust the generator in order to obtain the signal specified.

HV network	HV network ripple (severity level 1)
Utest = Umax1 and Umin1 U_1 = 0.5 Vcc U_2 = 8.0 Vcc	

HV network	HV network ripple (severity level 2)
Utest = Umax1 and Umin1 U_1 = 0.5 Vcc U_2 = 8.0 Vcc U_3 = 16.0 Vcc f = 15 Hz – 50 kHz	

Note : for frequencies higher than 10KHz, the impedances proposed by some equipments can decrease, and then force the generator to provide levels of power it can not provide. It is then allowed to calibrate the voltage under a 0,5 Ω load, because the source impedance of the generator can not exceed 0,1Ω.

Test:

- Run the DUT for a minimal duration of 10 minutes (without the voltage ripples).
- Apply the signal and monitor the DUT.

Frequency step and test duration : make the frequency vary in a continuous way by programming a progressive ramp from 15Hz to 50kHz. The total duration of the test should be at least 15 minutes so it would be possible to observe possible effects at each frequency.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during the test.
-

7.2.4.7.Requirements

Test	Operating classes	Customer's impact levels
Ripple	A	0

7.2.5.EQ/IC_HV04: TRANSIENT OVERVOLTAGE

7.2.5.1.Reference document

There is no international reference document for this test. This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.5.2.Objective and applicability of the test

This test is intended to verify the immunity of the equipments to the transient overvoltages witch may occur in the electric system due to the switching off or sudden variation (high speed variation, ~~vehicle jump~~...) of load.
Its main characteristics are the following:

- U2=Umax2, U1=Umax1.
- tr = 1ms and tf = 300ms.

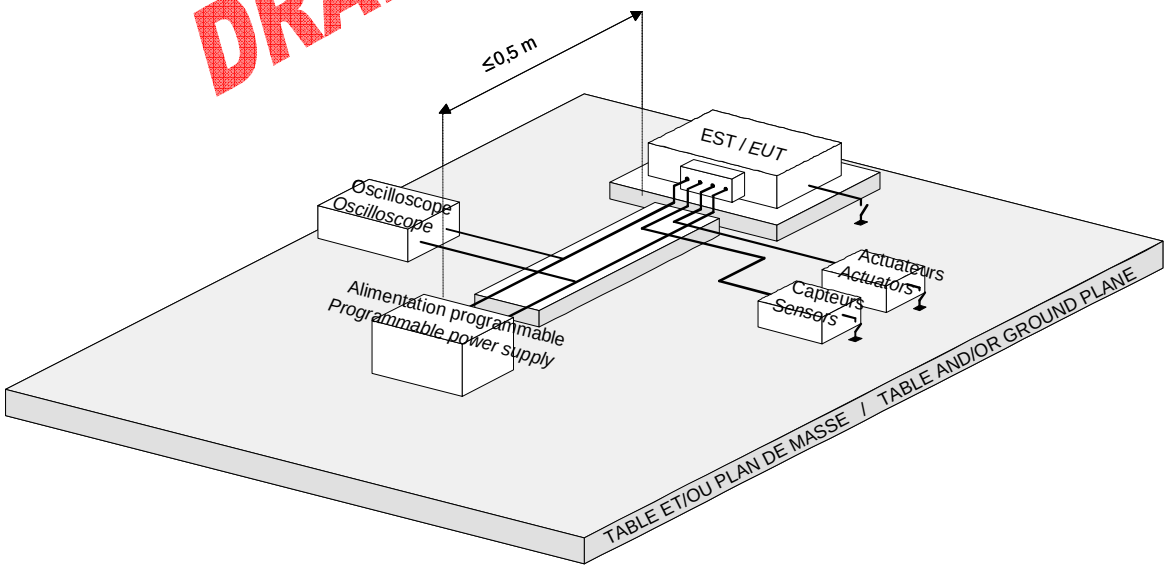
7.2.5.3.Conditions for application of the test

General case:
This test is applied to all equipments supplied via HV electric system.
The DUT is electrically connected and must be operated with maximum load. It must be operated in a way that maximum self-heating occurs (e.g. by means of a realistic maximization of a continuous output performance or frequent activation of external loads).

7.2.5.4.Test means

- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Programmable power supply or pulse generator.

7.2.5.5.Assembly



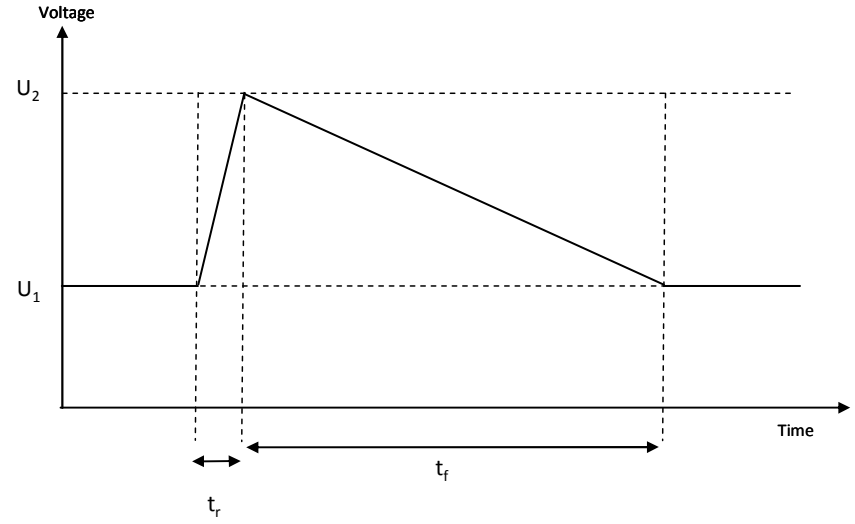
7.2.5.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires can have a maximum length of 500 mm.

Calibration:

- Connect the oscilloscope (DUT disconnected) at the output of the test signal (high impedance input), and adjust the generator in order to obtain the signal specified.

HV Network	Transient overvoltage
U_1 = Umax1 U_2 = Umax2 t_r = 1 ms t_f = 300ms $R_i \leq 0{,}01\ \Omega$ Number of cycles: **5**	

Test:

- Run the DUT for a minimal duration of 10 minutes (without the voltage ripples).
- Apply for 5 times the pulses with one minute recurrence and monitor the DUT.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during the test.
- Characteristics of the pulse applied.

7.2.5.7.Requirements

Test	Operating classes	Customer's impact levels
Transient overvoltage	A	0

7.2.6.EQ/IC_HV05: TRANSIENT UNDERVOLTAGE

7.2.6.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.6.2.Objective and applicability of the test

The purpose of this test is to check the immunity of the equipments to undervoltage when switching on loads or when a voltage drop occurs due to sudden load variation, in normal and low battery conditions.

7.2.6.3.Conditions for application of the test

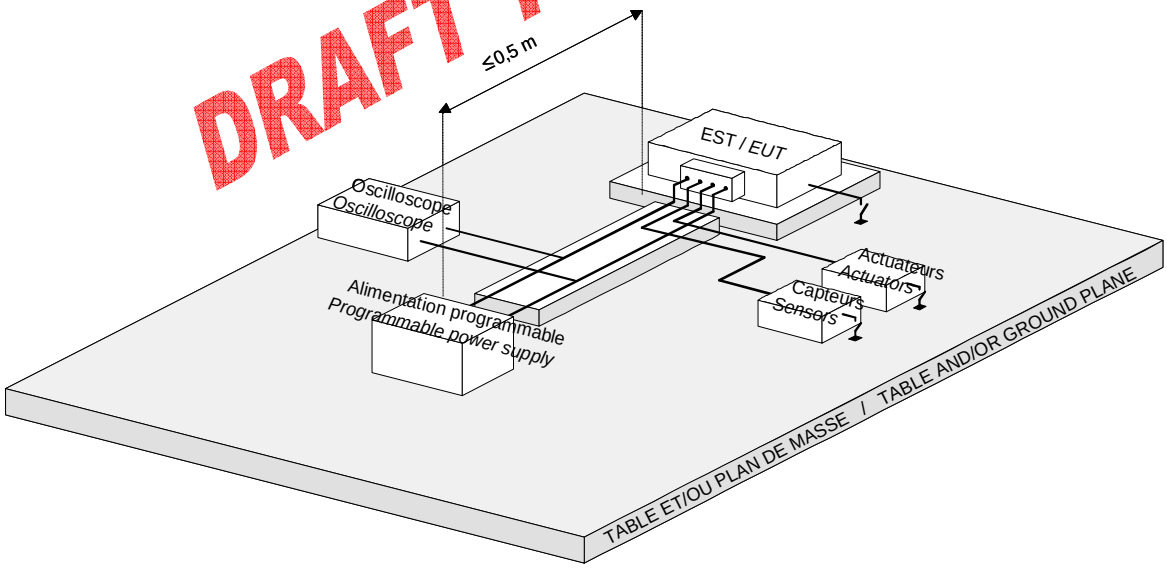
This test is applicable to all component connected and supplied by the LV Network.

The DUT is electrically connected and must be operated with maximum load. It must be operated in a way that maximum self-heating occurs (e.g. by means of a realistic maximization of a continuous output performance or frequent activation of external loads).

7.2.6.4.Test means

- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Programmable power supply or pulse generator.

7.2.6.5.Assembly



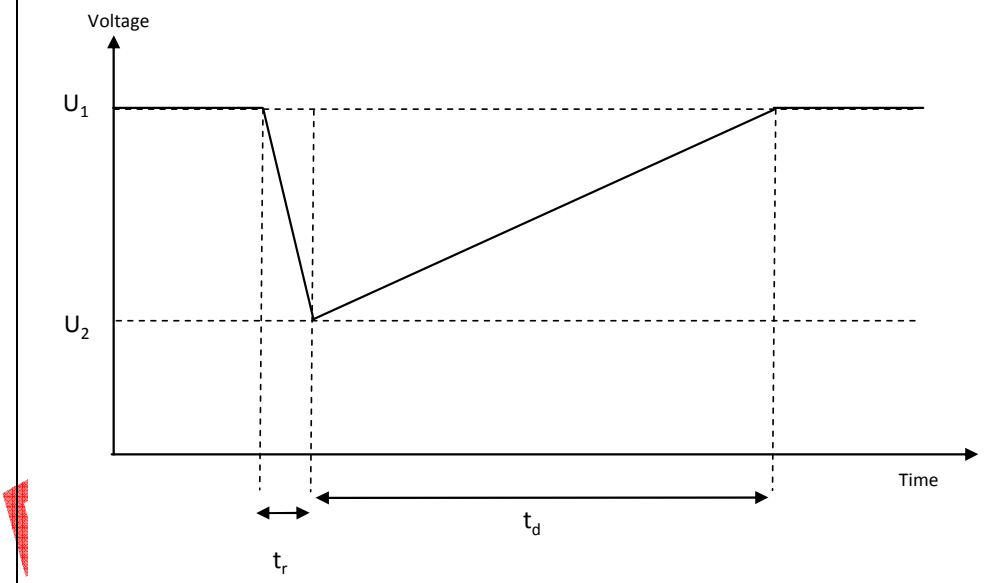
7.2.6.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires and the outputs subjected to the test should have a maximum length of 500 mm.

Calibration:

- Connect the oscilloscope (DUT disconnected) at the output of the pulse generator (high impedance input), and adjust the generator in order to obtain the pulses specified.

HV network	Transient undervoltages
U_1 = Umin1 U_2 = Umin2 t_d = 300 ms t_f = 1 ms $R_i \leq 0{,}01\ \Omega$ Number of cycles: 5	

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply for 5 times the pulses with one minute recurrence and monitor the DUT.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during the test.
- Characteristics of the pulse applied.

7.2.6.7.Requirements

Requirements	Operating classes	Customer's impact levels
General case	A	0

7.2.7.EQ/IC_HV06: RESISTANCE TO LOAD DUMP PULSES

7.2.7.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.7.2.Objective of the test

The purpose of this test is to check the immunity of the equipments to “load dump” transient pulses produced by a sudden shut-off of the main LV battery relay for example.

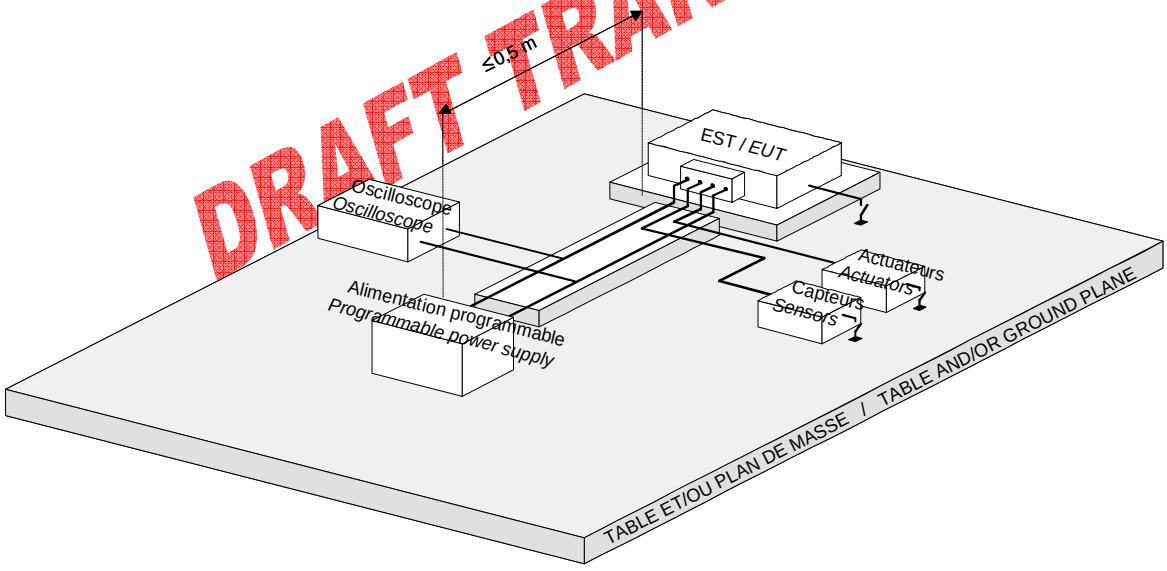
7.2.7.3.Conditions for application of the test

This test is applicable to all component connected and supplied by the LV Network.

7.2.7.4.Test means

- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Pulse generator.

7.2.7.5.Assembly



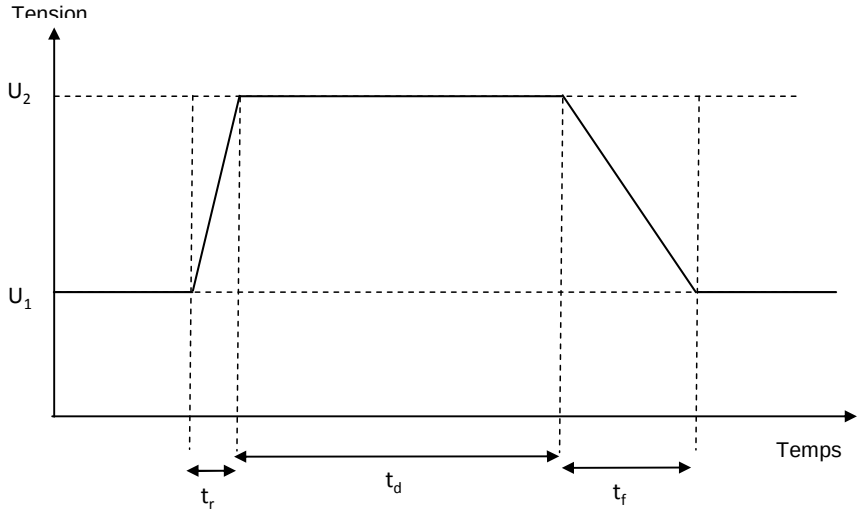
7.2.7.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires and the outputs subjected to the test should have a maximum length of 500 mm.

Calibration:

- Connect the oscilloscope (DUT disconnected) at the output of the pulse generator (high impedance input), and adjust the generator in order to obtain the pulses specified.

HV Network	Load dump
U_1= Unom U_2= Umax3 t_r = 1 ms t_d = 300 ms t_f = 100 ms $R_i \leq 0{,}01\ \Omega$ Number of cycles: **5**	

Test:

- Run the DUT for a minimal duration of 10 minutes.
- Apply for 5 times the pulse with one minute recurrence and monitor the DUT.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Oscilloscope reading at the terminals of the generator of each waveform, measured with open circuit and under matched load.
- Parameters observed and malfunctions observed during the test.

7.2.7.7.Requirements

Test levels	Operating classes	Customer's impact levels
load dump	C	2(*)

(*) All functions necessary to the contrôle and the dirigibility of the vehicle (example : DAE, breaks, …) shall be maintained even during the pulse.

7.2.8.EQ/IC_HV07: CRANKING PULSE

7.2.8.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.8.2.Objective and applicability of the test

The purpose of this test is to check the immunity of the equipment to voltage variations during the cold starting phase and/or re-starting phase.

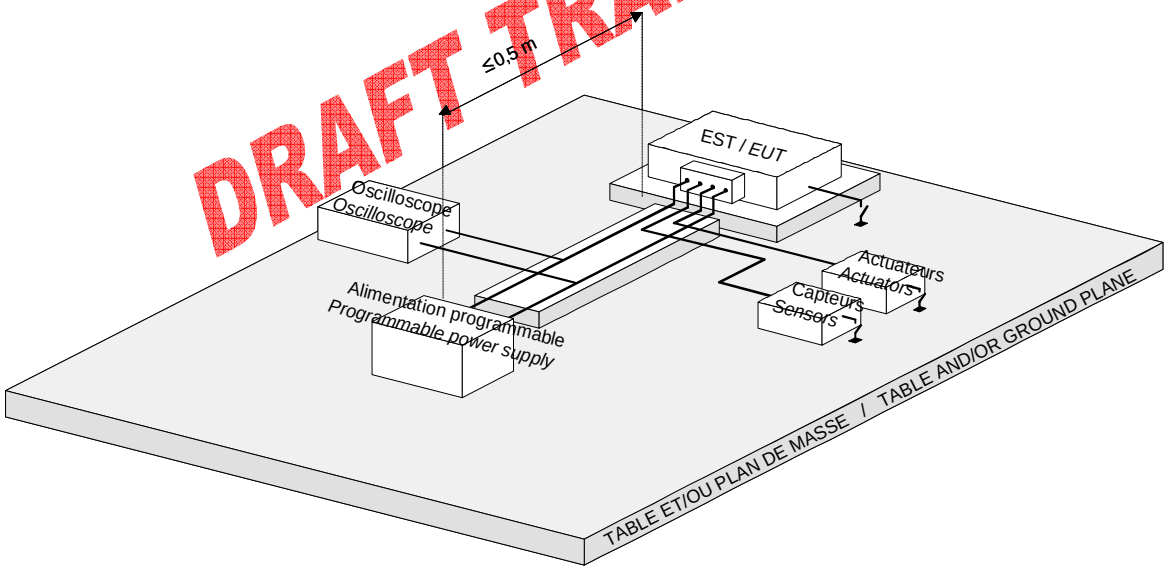
7.2.8.3.Conditions for application of the test

Cranking pulses are applied for all equipments powered during the starting phase.

7.2.8.4.Test means

- Power supply.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Programmable power supply.
- Environment chamber for the TminEF tests (pulse II).

7.2.8.5.montage Assembly



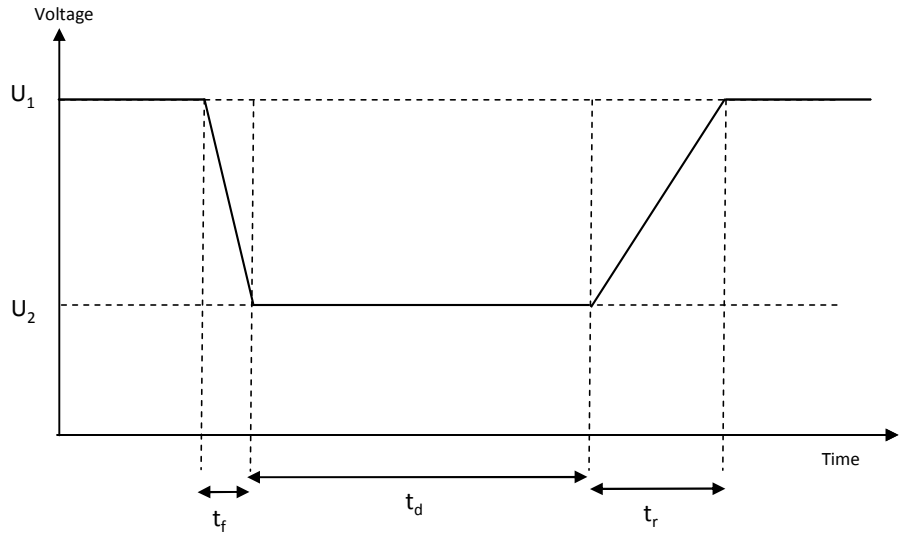
7.2.8.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used).
- The DUT power supply wires and the outputs subjected to the test should have a maximum length of 500 mm.
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- In the case of tests TminEF, the test assembly can be adapted to practical constraints of use in a climatic chamber. The equipment ground connections should remain representative, and the DUT power supply wires to the generator can have a maximum length of 1000 mm.

Calibration for cranking pulses:

- Connect the oscilloscope (DUT disconnected) at the output of the pulse generator (high impedance input), and adjust the generator in order to obtain the pulses specified.

HV Network	Cranking pulse
Pulse I (normal conditions): U_1 = Unom U_2 = Umin2 t_f = 10 ms t_d = 1000 ms t_r = 100 ms **Pulse II (cold battery conditions at TminEF):** U_1 = Unom U_2 = Umin3 t_f = 10 ms t_d = 5000 ms t_r = 100 ms	
Number of pulses: 5 $R_i \leq 0{,}01\ \Omega$	

Test:

- Run the DUT for a minimal duration of 10 minutes.
- Apply for 5 times the pulse I and 5 times the pulse II, with one minute recurrence and monitor the DUT.
- The DUT will be placed at TminEF for pulse II.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during the test.
- Characteristics of the pulse applied.

7.2.8.7.Requirements

	Re-starting phase (Pulse I)	
	Operating classes	Customer's impact levels
General case	A	0
Case when the DUT and/or the functions for which some malfunctions are tolerated during restart (a)	C	1

(a) Case of some DUT and/or functions controlling an actuator (example: compressor), heating and/or rheostating functions, and functions likely to output an important power (PTC…). This case should be specified by the NTS/TS. By default, the general case is applied.

	Cold starting phase (Pulse II)	
	Operating classes	Customer's impact levels
Starting pulse DUT and/or function should be operational during the start phase of the vehicle	A	0
Starting pulse DUT and/or function non-operational during the start phase of the vehicle	C (a)	NA

(a) the data in memory are not lost.

7.2.9.EQ/IC_HV08: VERY BRIEF VOLAGE DIP (BURN OF A FUSE)

7.2.9.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_06161 (PSA/BMW cooperation).

7.2.9.2.Objective and applicability of the test

This test is intended to verify the proper reset of the equipments during a drop caused by a short cicuit, which will melt a conventional fuse element in another electric branch.

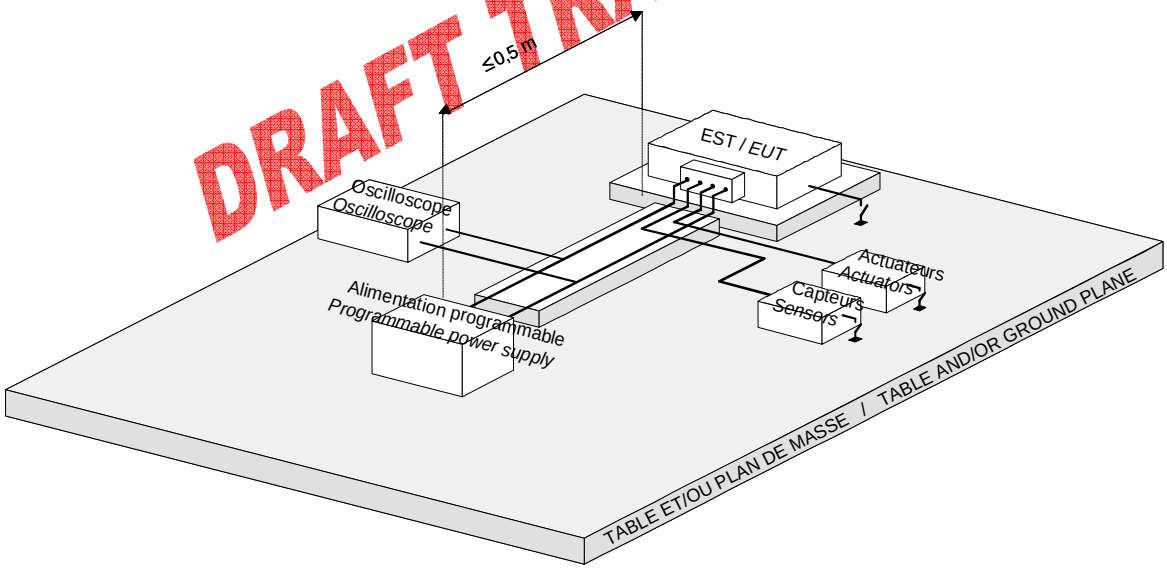
7.2.9.3.Conditions for application of the test

This test is applicable to all component connected and supplied by the LV Network.

7.2.9.4.Test means

- Power supply.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- Programmable power supply.

7.2.9.5.Assembly



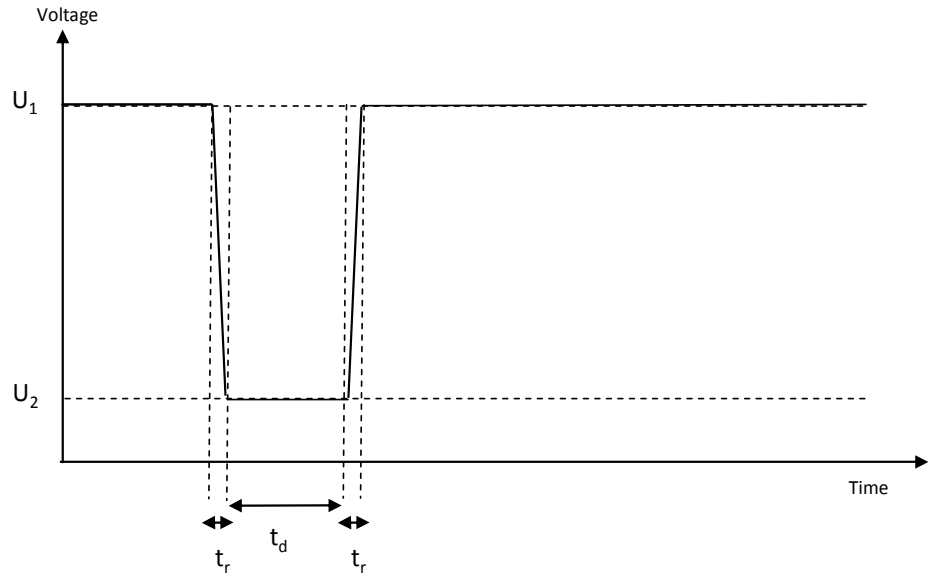
7.2.9.6.Procedure

Preparation:

- A 2000 mm long harness should be preferably used (the real wiring may be used).
- The equipment can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the DUT or the sensors or actuators are directly connected to the vehicle body. In this case, the DUT is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.
- The DUT power supply wires and the outputs subjected to the test should have a maximum length of 500 mm.

Calibration:

Connect the oscilloscope (DUT disconnected) at the output of the pulse generator (high impedance input), and adjust the generator in order to obtain the pulses specified.

HV V network	Transient undervoltages
U_1 = Unom U_2 = Unom/3 t_d = 100 ms t_r = 1 ms $R_i \leq 0{,}01\ \Omega$ Number of cycles: **5**	

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply for 5 time the undervoltage and monitor the DUT.

Test report:

The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Parameters observed and malfunctions observed during the test.
- Characteristics of the pulse applied.

7.2.9.7.Requirements

Requirements	Operating classes	Customer impact levels
General case	C (voir note)	NA

Notes :

- The operation during the test shall not generate random operation (unwanted activations), nor data change of the EEPROM.
- For equipments that need software strategy of type « power latch » (need of supply after receiving a stand-by order, for example for saving the functional context in EEPROM before shutting off the equipment), a degraded operation can be authorized at the end of the cycle. This case is to be specified in TNS/TS.

7.3. EMC IMMUNITY TESTS (GENERAL CASE)

7.3.1. EQ/IC 07: IMMUNITY TO THE TRANSIENTS ON THE SIGNAL LINES

7.3.1.1.Reference document

This test procedure is compliant with the ISO 7637-3 standard with the capacitive coupling clamp method.

7.3.1.2.Purpose of the test

This test is intended to verify the immunity of the equipments to the transients coupled on the signal lines.

The following are the main characteristics of the test:

- Coupling with pulses of type 3a (- 150 V) and 3b (+ 100 V).
- 10 minutes duration for each type of pulses.

7.3.1.3. Conditions for application of the test

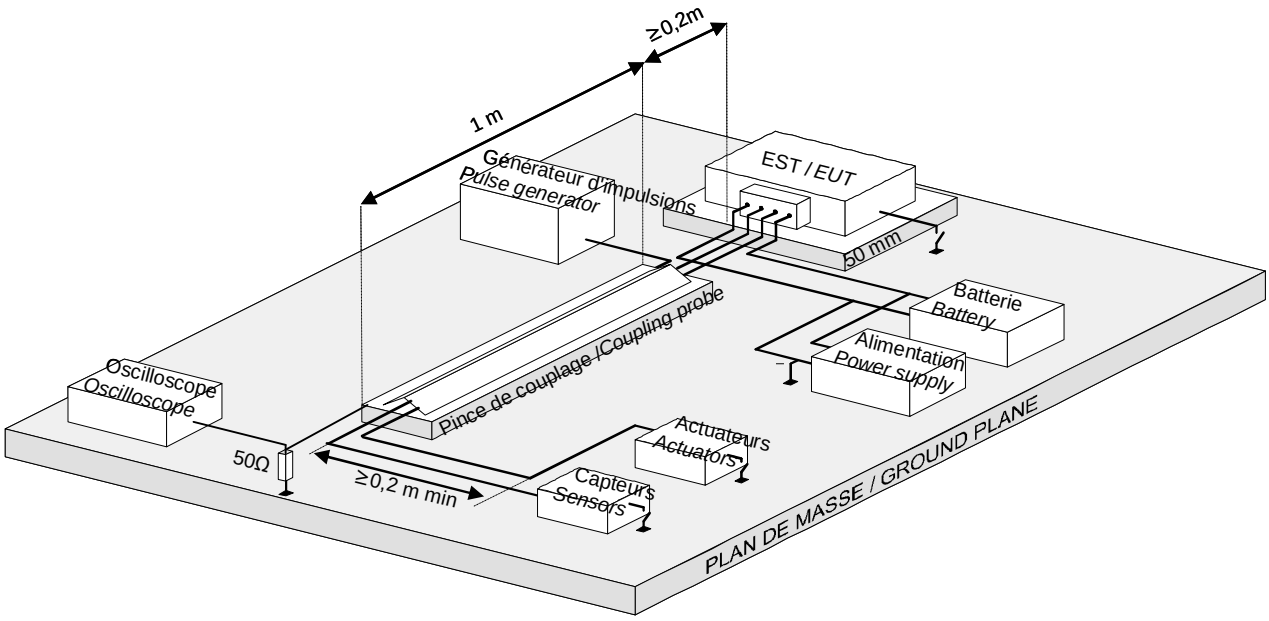
This test is applicable to all the equipment having active electronics.

The test is carried out on all the equipment lines except on those for grounding and for power supply. The tested lines are taken simultaneously. The power supply lines other than 12 V (5 V power supplies for sensors in particular) will be considered to be part of signal lines for this test.

7.3.1.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- Pulses generator.
- Oscilloscope.
- Coupling clamp compliant with the ISO 7637-3 standard.
- 50Ω load.

7.3.1.5. Assembly



7.3.1.6.Procedure

Preparation:

Preferably, a wiring harness having a maximum length of 2000 mm should be used (possibly, the real wiring harness can be used). The test wiring harness is placed on an insulating support of 50 mm thickness and should be placed at right angle to the exterior of the coupling clamp.

The DUT is placed on an insulating support of 50 mm thickness. It is linked to the ground plane in conformity with its real vehicle installation, and no other grounding connection is authorized.

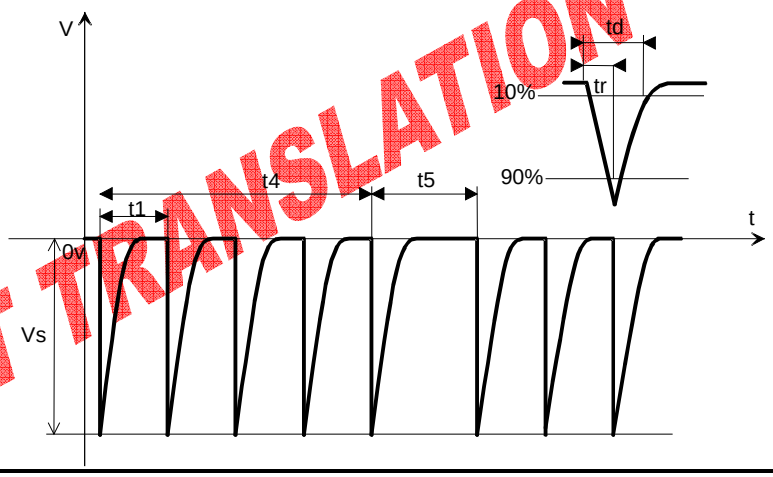
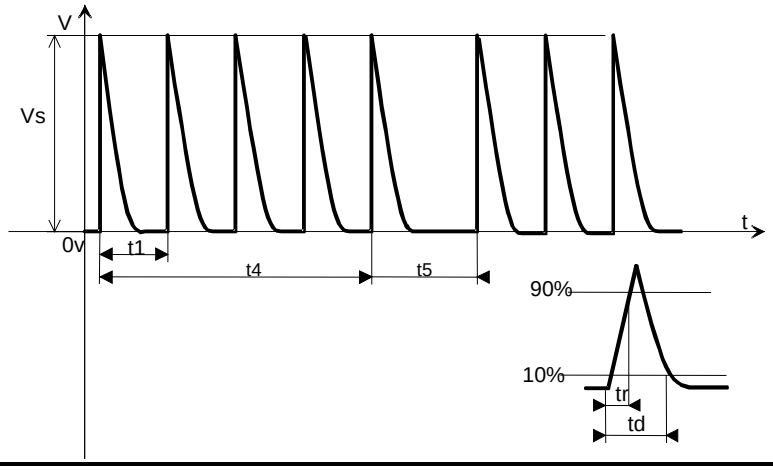
Place the wiring harness connected to the DUT in the coupling clamp except for the grounding and power supply wires.

The coupling clamp is loaded on 50Ω.

Calibration:

The pulses generator output is connected (disconnected DUT) on the coupling clamp.

Connect the oscilloscope (high impedance input) on the 50 Ω load and adjust the generator in order to obtain the specified pulses.

12 V Network	42 V Network	Pulse 3a
V_s = - 150 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	V_s = - 150 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	
12 V Network	**42 V Network**	**Pulse 3b**
V_s = 100 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	V_s = 100 V R_i = 50 Ω $t_d = (0.1^{+0,1}_{0})$ µs t_r = 5ns ± 1.5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply the 3a pulses for 10 minutes, and then apply the 3b pulses for 10 minutes on the coupling clamp while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.

7.3.1.7. Requirements

Test	Operating classes	Customer impact levels
3a pulses	A	0
3b pulses	A	0

7.3.2. EQ/IC 08: IMMUNITY TO CURRENT INJECTION (BCI)

7.3.2.1. Reference document

This procedure is compliant with the ISO 11452-4 standard.

7.3.2.2. Purpose of the test

This test is intended to verify the immunity of the equipment to the disturbances induced by the wiring harnesses, consecutive to the exposure of the equipment and its wiring harnesses to an electric field.

The main characteristics of the test are the following:

- CW and AM modulations.
- [1MHz - 400 MHz] frequency band.
- Regulation method on the measured current, with limitation of the direct power applied.

7.3.2.3. Conditions for application of the test

This test is applicable to all equipments having electronic components.

In the case of an equipment with multiple connectors and/or harnesses, it can be necessary to perform multiple injections successively. The choice of wires groups to be injected will be determined according to the following criteria:

- Wires that follow the same path for more than 1m starting from the connector have to be considered as being part of the same group. In the contrary, harnesses that split below 1m from the connector will be injected separately
- The signals typology (ex. :TOR input, analog input...) can also be taken into account to make groupings by family,

The method used to group the wires shall be specified in the TNS/TS. In the absence of precision in the TNS/TS, the test plan proposed by the supplier can specify the way of injecting, subject to PSA agreement. By default, and in case the path of harnesses is unknown at the time of the tests, an injection will be performed on each harness of each connector successively.

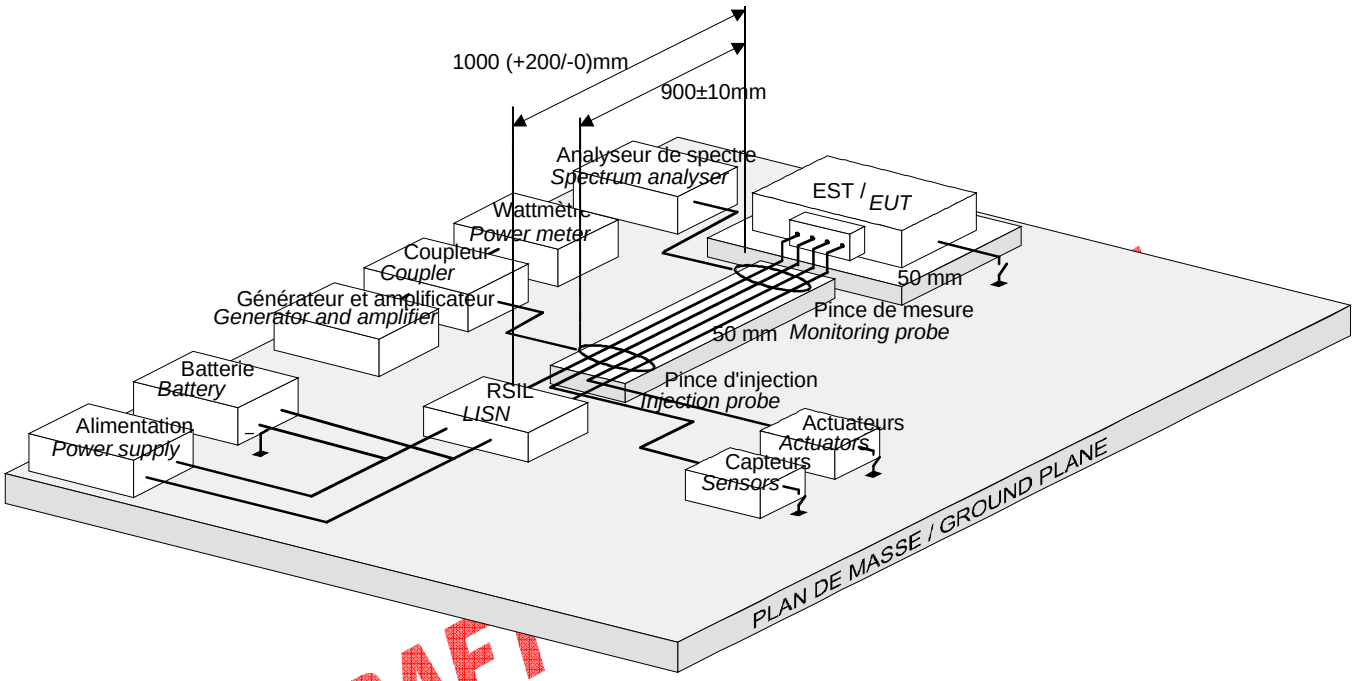
In the case of equipment only made of passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the test at 300mA is applicable, with restricted requirements.

7.3.2.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- LSIN is compliant with the CISPR 25 publication (2 LSIN for a DUT with remote grounding) and/or 2 high voltage LSIN (with shielding connected to the shielding of the high voltage lines) depending upon the type of power supply to the DUT.
- 50Ω load(s).
- High frequency signal generator.
- Wide band power amplifier.
- A 50Ω coupler.
- Power measurement equipment or equivalent.
- Current injection clamp.

- Current measurement clamp.
- Calibration device for the injection clamp (JIG).
- Shielded chamber (desirable in order to preserve the integrity of the electromagnetic spectrum).

7.3.2.5. Assembly



In the case of an equipment for which multiple wiring harnesses are tested successively, the wiring harness(es) momentarily not submitted to the test will be placed on an insulating support of 50mm thickness. This support will be separated by a distance of at least 10cm from the wiring harness being tested.

7.3.2.6.Procedure

Preparation:

A wiring harness of (1000 +200/-0) mm length, straight on its entire length, should be used. The wiring harness of the test is placed on an insulating support of 50 mm thickness.

The DUT is placed on an insulating support of 50 mm thickness. It is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

Install the injection clamp at 900±10 mm of the DUT connector, centered on all the wires of the harness, including the possible power supply wires.

Install the measurement clamp at 50±10 mm of the DUT connector, centered on all the wires of the harness, including the possible power supply wires.

Calibration:

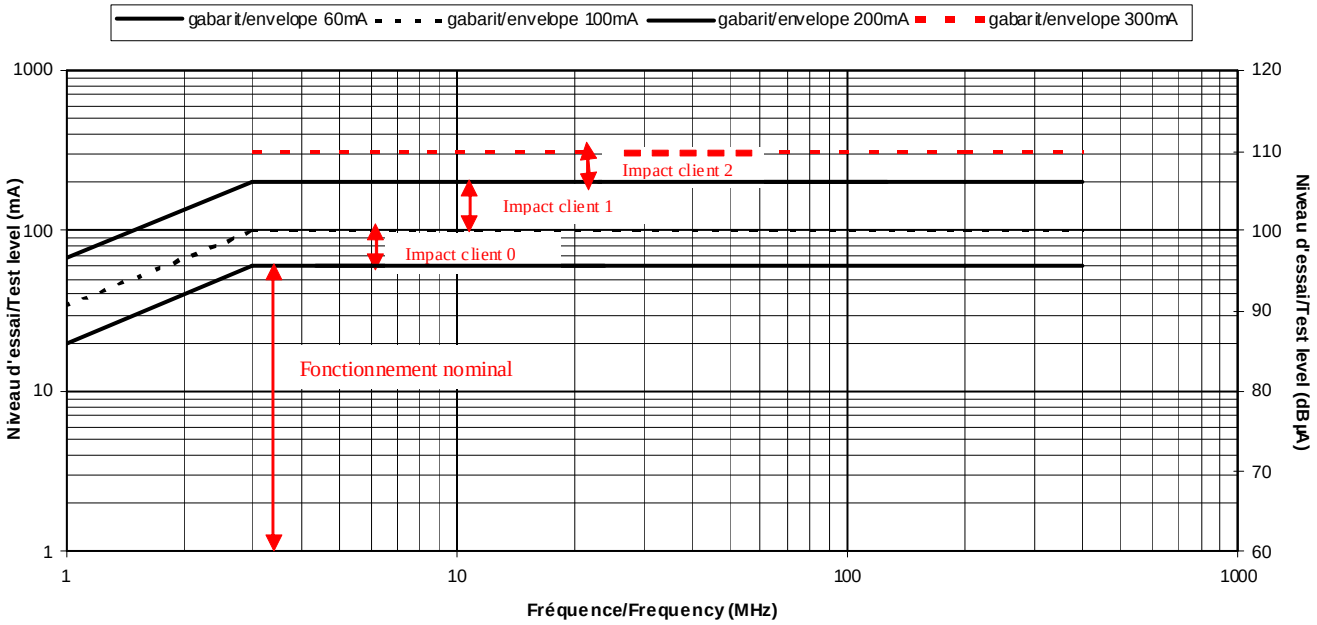
The calibration is carried out only in CW.

Install the injection clamp around the JIG calibration loaded with 50 Ω on each of its two ports.

Retrieve the direct power Pcalibration necessary to induce the specified current Icalibration in CW on the JIG.

Frequency (MHz)	60mA gauge	100mA gauge	200mA gauge	300 mA gauge
1 - 3	60 x F/3 MHz	100 x F/3 MHz	200 x F/3 MHz	No test
3 - 400	60	100	200	300

(The currents in the above table are given in effective mA and the frequencies in MHz).



Test:

Run the DUT for a minimum period of 10 minutes.

Increase the direct power applied on the injection clamp progressively until the measured current reaches $I_{setpoint}$ or reaches $4*P_{setpoint}$, with $P_{setpoint} = P_{calibration} * \left(\frac{I_{setpoint}}{I_{calibration}} \right)^2$

Retrieve the appearance thresholds of the possible defects (I_{defect}, P_{defect}) , when these defects are lower than the specified threshold.

In no case, the injected power should exceed the compression dB of the amplifier.

Progressively decrease the direct power applied on the injection clamp and change the frequency.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment
- Curves by modulation with: F_{test} , $I_{setpoint}$, $I_{measured}$ and/or I_{defect}
- Curves by modulation with: F_{test} , $P_{setpoint}$, $P_{measured}$ and/or P_{defect} (incident power)
- Table of defects with: F_{defect} , I_{defect}, $I_{requirement}$, P_{defect} , modulation and titled with the defect
- Curve of the wiring harness transfer function defined by: $Z_{transfer}(\Omega) = 100.\frac{I_{calibration}}{I_{measured}}.\sqrt{\frac{P_{incident}}{P_{calibration}}}$
- **The immunity thresholds are required, and should appear on the curves (I_{defect} and P_{defect})**

In addition to the test report, all the data F_{test} and / or D_{efect}, $I_{setpoint}$, $I_{measured}$ and/or I_{defect}, $P_{setpoint}$, $P_{measured}$ and/or P_{defect} (incidental powers), modulation, $Z_{transfer}$ and the defect titles should be provided in digital form in an Excel table in this order.

7.3.2.7. Requirements

Test	Operating classes	Expected behavior
≤ 60mA	not applicable	Nominal
≤ 100mA	not applicable	Nominal or customer impact of 0
≤ 200mA	not applicable	Nominal or customer impact of 0 or 1
≤ 300mA	not applicable	Nominal or customer impact of 0, 1 or 2

Note 1: *in the case of DUT including a radio receiver type function (examples: autoradio, mobile phone), certain dreaded events of the radio function (for example: audio quality, binary error rate) are allowed in a frequency band of F0 ± 5%; F0 being the tuning frequency used for the test. The tuning frequency as well as the malfunctioning allowed will be specified in the test plan.*

Note 2: *if7.3.2.8. the equipment has only passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the 300mA test is applicable.*

Note 3: *no damage or customer impact 3 defect is accepted for the levels ≤300mA.*

7.3.3. EQ/IC 09: IMMUNITY TO VOLTAGE IGNITION

7.3.3.1. Reference document

There is no reference document related to this test.

7.3.3.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the interferences generated by the ignition system.

Its main characteristics are the following:

- Signal on 15 kΩ: 420 V peak.
- Coupling with the DUT strand on 1 m: continuous
- Test period: 10 minutes.

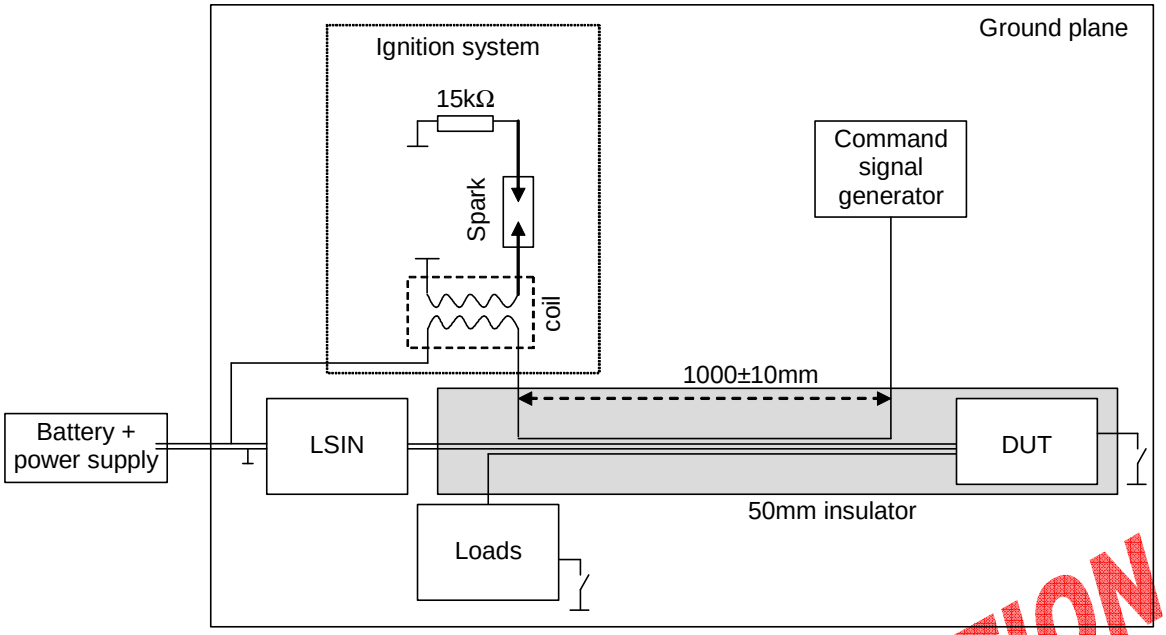
7.3.3.3. Conditions for application of the test

The ignition voltage test is applicable to the equipments installed in the engine compartment and having an electrical connection running parallel to the wiring harness control of the ignition system.

7.3.3.4. Test means

- Power supply and battery.
- Devices necessary for monitoring the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- LSIN compliant with the CISPR 25 publication and/or LSIN/LSIN high voltage (with screening connected to the screening of the high voltage lines) depending upon the power supply type to the DUT.
- 15 kΩ load.
- Discharger.
- Device for generating the signal, consisting of:
  - Voltage generator or ignition control, integrating the IGBT transistors which generate the voltage of 420V with frequency, cyclic ratio, and adjustable current.
  - An ignition coil. For the requirements of this test, two examples of coils are suitable:
    - Coil of the EP turbo engine, Delphi brand, 4 valves, primary current: 9.5A +/- 0.5A.
    - Coil of the EP engine, Bosch brand, 4 valves, primary current: 8A +/- 0.3A.
- Representative control wiring harness.

7.3.3.5. Assembly



7.3.3.6. Procedure

Preparation:

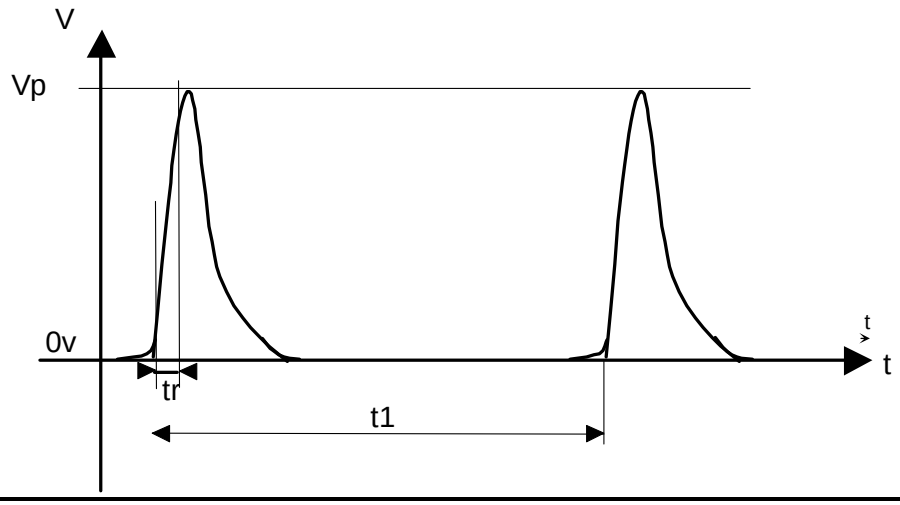
A wiring harness of maximum length 2000 mm should be preferably used (possibly, the real wiring harness can be used). The test wiring harness is placed on an insulating support of 50 mm thickness.

The DUT is placed on an insulating support of 50 mm thickness. It is linked to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The high voltage representative wiring harness is placed on an insulating support of thickness of 50mm, and the strand of the DUT should be continuous to the high voltage wiring harness on a length of 1000±10mm.

Calibration:

Adjust the ignition command generator as well as the distance between the electrodes of the discharger, in order to obtain the desired output signal of the generator.

12 V Network	Ignition voltage signal
V_p = 420 V $t_r \leq 10\mu s$ $t_1 \geq 5$ ms	

Test:

Run the DUT for a minimal period of 10 minutes.

Apply the high voltage signal for 10 minutes while monitoring the DUT.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Parameters observed and defects encountered during the test.
- The wave form of the low voltage ignition signals.

7.3.3.7.Requirements

Test	Operating state	Customer impact level
High/low voltage coupling	A	0

7.3.4. EQ/IR 01: IMMUNITY TO RADIATED ELECTRIC FIELD (SEMI-ANECHOIC OR ANECHOIC CHAMBER)

7.3.4.1. Reference document

This test procedure is compliant with the ISO 11452-2 standard, except for the frequency from which the antenna is shifted facing the DUT, the number of faces to be tested, as well as the selection of modulations for frequencies greater than 1.2 GHz.

7.3.4.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the electromagnetic field in the [200 MHz – 3.2 GHz] frequency band. Its main characteristics are the following:

- Tests on 3 faces (except for closed metallic box),
- Modulations
  - CW and AM in the [200 MHz – 800 MHz] frequency band.
  - CW, AM and PM1 in the [800 MHz – 1 GHz] frequency band.
  - CW and PM1 in the [1 GHz – 1.2 GHz] frequency band.
  - CW and PM2 in the [1.2 GHz – 1.4 GHz] frequency band.
  - **US market specific tests:**: add the PM3 modulation in the [1.2 GHz – 1.4 GHz] frequency band.
  - CW and PM1 in the [1.4 GHz – 2.7 GHz] frequency band.
  - CW and PM2 in the [2.7 GHz – 3.2 GHz] frequency band.
- Substitution method.
- Vertical polarization in the [200 MHz – 3.2 GHz] frequency band, horizontal polarization in the [400 MHz – 3.2 GHz] frequency band.
- Test on a metallic ground plane.

7.3.4.3. Conditions for application of the test

This test is applicable to all equipments having electronic components. The applicability of the requirements specific to US market is to be specified in the TNS/TS.

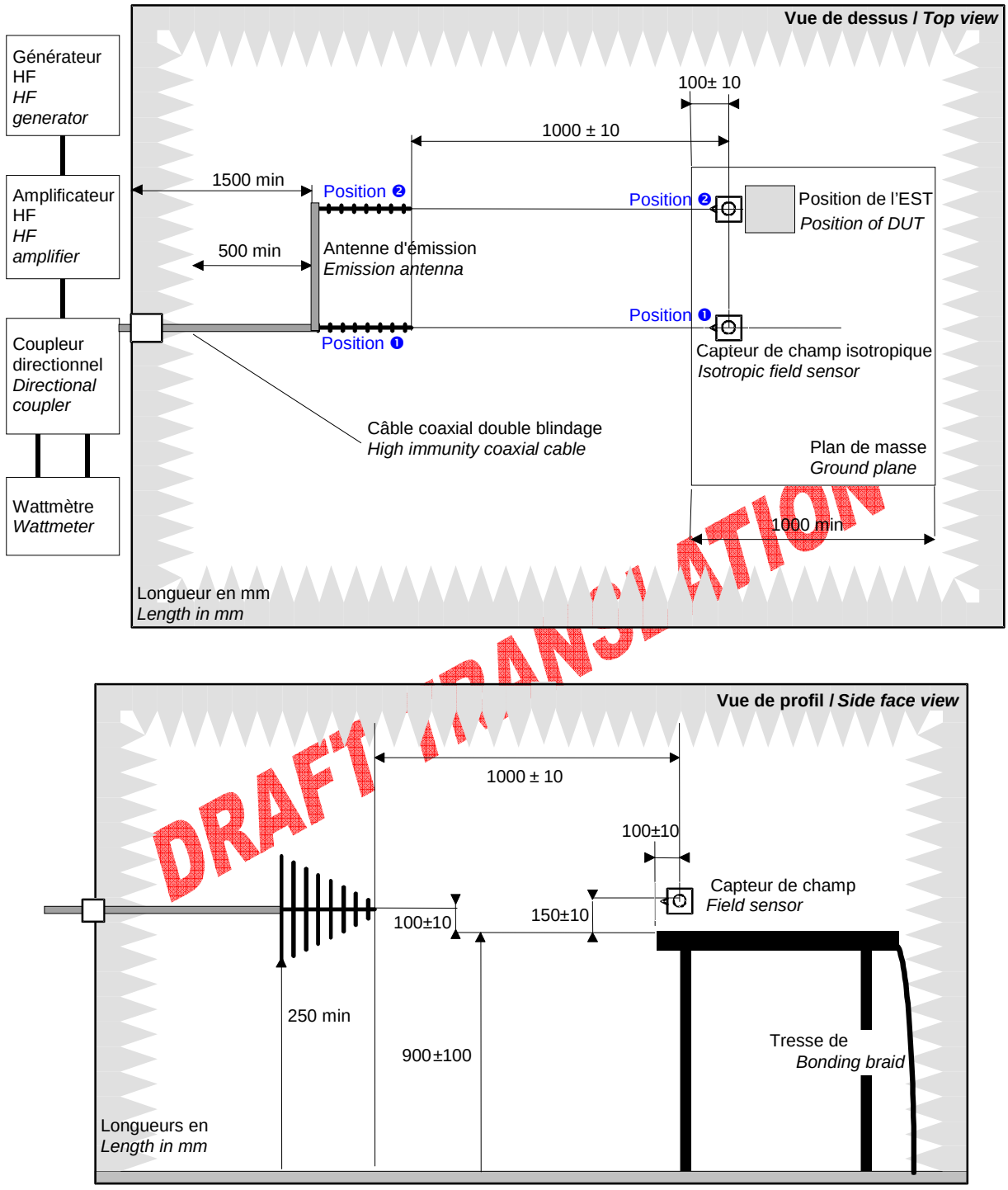
This test method is an alternative to the EQ/IR06 test, carry out the EQ/IR06 test that as a priority over EQ/IR01. The test plan should specify which of the two methods is applied.

If the equipment only has passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the test at 200 / 160 V/m is applicable, with limited requirements.

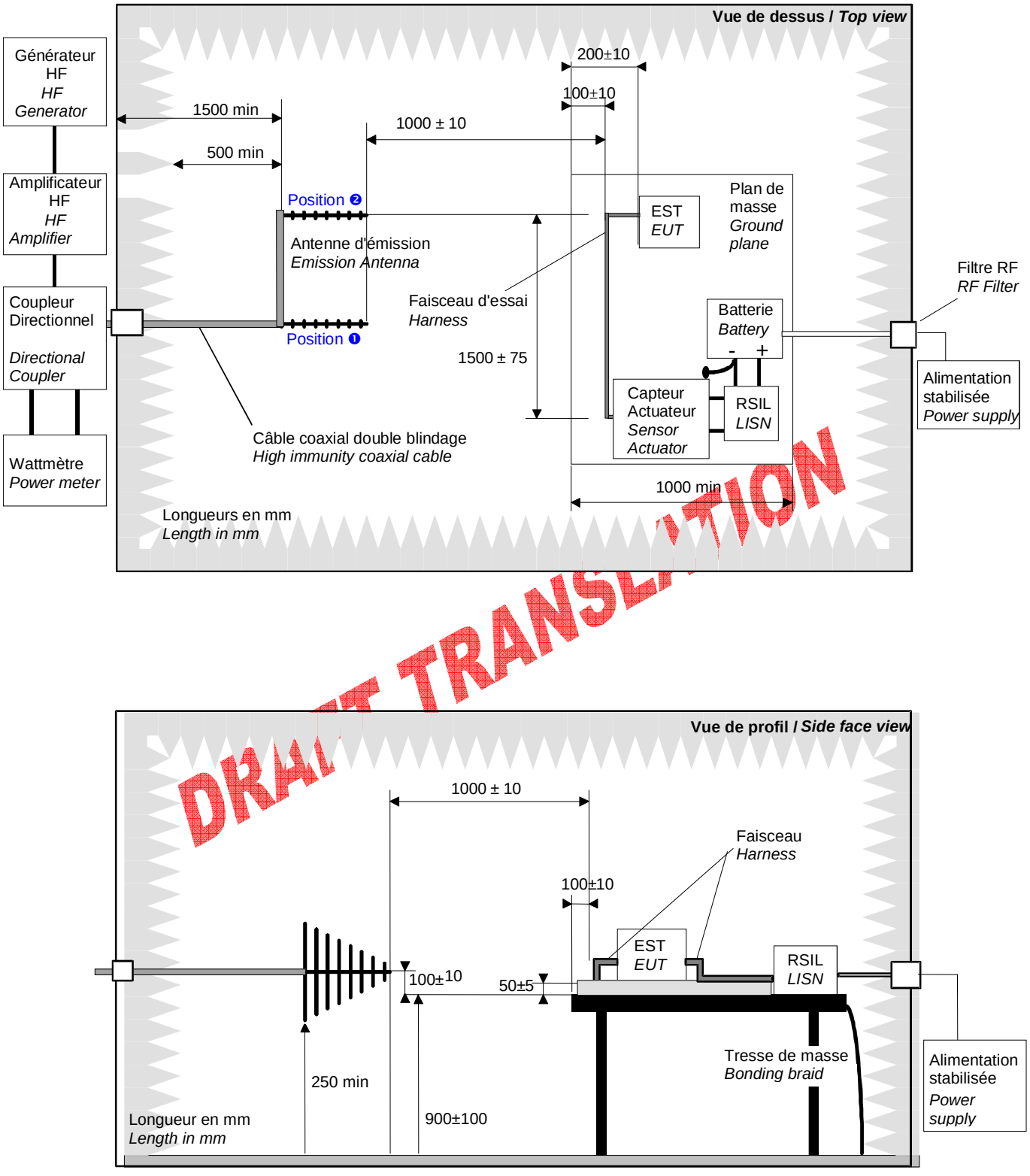
7.3.4.4. Test means

- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- The DUT environment, real (sensors, actuators) or simulated.
- Insulating support of a thickness of 50 mm.
- LSIN is compliant with the CISPR 25 publication (2 LSIN for a DUT with off-set grounding) and/or 2 high voltage LSIN (with screening connected to the screening of the high voltage lines) in accordance with the power supply type of the DUT.
- 50Ω load(s).
- High frequency signals generator and wide band power amplifiers.
- 50Ω couple.
- Wattmeter.
- Log-periodic, double log periodic or horn antenna.
- Isotropic field sensor with optical fiber.
- Shielded anechoic or semi- anechoic chamber.

7.3.4.5.Assembly



Configuration de calibrage



Test configuration

7.3.4.6. Procedure

The adopted method is the substitution method. The tests are carried out in the [200 MHz - 3.2 GHz] frequency bands for vertical polarization and in the [400 MHz - 3.2 GHz] frequency bands for horizontal polarization.

The tests are carried out for every modulation defined in the § 7.3.4.2, and on 3 faces (except the case of an entirely closed metallic box).

All the tests are carried out with maintenance of the peak level for the modulated signals.

Preparation:

A wiring harness of total length of (1700 +300/-0) mm should be used between the DUT and the loads bench.

The DUT is placed on an insulating support of 50 mm thickness. It is linked to the ground plane in conformity with its real installation on the vehicle, and no other ground connection is authorized.

Faces to be tested: the DUT will be oriented in conformity with the faces to be tested and that are defined in the test plan. In the case of an entirely covered metallic box (without opening), a single face will be tested (connector facing the antenna). In all other cases, **the number of faces to be tested will be three.** The faces will be selected so that the couplings are maximized, and will be defined in the specification and/or the equipment test plan.

Calibration:

The calibration is carried out only in CW.

Place the center of the isotropic field sensor phase at a height of 150 mm from the ground plane and at a distance of 100 mm from the terminal of the ground plan.

Place the extremity of the antenna at a distance of 1000 mm from the isotropic field sensor. The calibration is carried out for two antenna and sensor positions: facing the center of the wiring harness (position❶) until 800 MHz, facing the DUT (position❷) beyond 800 MHz

The calibration will be carried out at least for the maximum test level, without exceeding the amplifier output power level corresponding to the compression dB. Retrieve the direct power Pcalibration necessary to generate the specified field in CW for each frequency.

Test:

Run the DUT for a minimal period of 10 minutes.

Place the emission antenna in the same position as used during the calibration and place the phase center on the right of the wiring harness center. The test is carried out for two antenna positions: facing the center of the wiring harness (position❶) until 800 MHz, facing the DUT (position❷) beyond 800 MHz

Progressively increase the direct power applied to the antenna until it reaches Ppreset while monitoring the DUT, with

$$P_{setpoint} = P_{calibration} * \left(\frac{E_{setpoint}}{E_{calibration}} \right)^2$$

Retrieve the appeared thresholds of the eventual defects (Edefect), while these are less than the specified threshold.

Progressively decrease the direct power applied to the antenna and change the frequency.

Repeat the test on the other possible faces to be tested.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, the DUT environment.
- Curves per modulation and per polarization with: F_{test} , $E_{setpoint}$, $E_{reached}$ and/or E_{defect}
- Curves per modulation and per polarization with: F_{test} ,$P_{setpoint}$ and $P_{measured}$ (incident powers)
- Fault tables with: F_{defect}, E_{defect}, $E_{requirement}$, modulation, polarization and fault title.
- The immunity thresholds are required, and should appear on the curves (E_{defect}), and this is true for each tested face.

In addition to the test report, all the data F_{test} and / or F_{defect}, $E_{setpoint}$, $E_{reached}$ and/or E_{defect}, $P_{setpoint}$ and $P_{measured}$ (incident power), modulation, polarization and the faults titles should be provided in digital form in an Excel table in this order.

7.3.4.7. Requirements

Test		Operating classes	Expected behavior
≤ 60 V/m		not applicable	Nominal
≤ 100 V/m		not applicable	Nominal or customer impact 0
≤ 150 V/m	≤ 120 V/m (1)	not applicable	Nominal or customer impact 0 or 1
≤ 200 V/m	≤ 160 V/m (1)	not applicable	Nominal or customer impact 0, 1 or 2

Note 1: The levels of 120 and 160 V/m are applicable (insteadof 150 and 200 V/m respectively) in the following bands: 200-380 MHz, 520-1200 MHz and 1400-2700 MHz

Note 2: if the equipment has only passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the 200/160 V/m test is applicable.

Note 3: no damage or customer impact 3 defect is accepted for the levels ≤200 V/m / 160 V/m (1).

US market specific tests:

As an addition, the following table is applied for the US market with the PM3 modulation in the 1200-1400 MHz band (to be specified in the TNS/TS):

Test	Operating classes	Authorized customer impact levels
≤ 180 V/m	not applicable	Nominal
≤ 300 V/m	not applicable	Nominal or customer impact 0
≤ 450 V/m	not applicable	Nominal or customer impact 0 or 1
≤ 600 V/m	not applicable	Nominal or customer impact 0, 1 or 2

Note 1: the test in the 1200-1400 MHz band with the PM3 modulation can be carried out with a test setup without ground plane and without LSIN, which allows executing the field level required with less power. The test plan should specify which configuration is retained.

Note 2: no damage or customer impact 3 defect is accepted for the levels ≤600 V/m.

Radio receivers' transmitters' specific tests:

In the case of DUT including a radio receiver type function (examples: autoradio, mobile phone), certain dreaded events of the radio function (for example: audio quality, binary error rate) are allowed in a frequency band of F0 ± 5%; F0 being the tuning frequency used for the test. The tuning frequency as well as the malfunctioning allowed will be specified in the test plan.

In the case of DUT including a transmitter-receiver radio in the bands 315 and 433 MHz (examples: plip, DSG), the measures to lessen the severities in appendix A are applied.

7.3.5. EQ/IR 06: IMMUNITY TO RADIATED ELECTRIC FIELD IN REVERBERATION CHAMBER

7.3.5.1. Reference document

This test procedure is compliant with the ISO 11452-11 standard, expect concerning the generated field level (no compensation of the loading effect of the DUT in relation to empty calibration), as well as the possibility to carry out the continuous stirring test.

The present paragraph specifies the field levels, modulation types and applicable requirements, as well as certain availabilities concerning the test setup.

7.3.5.2. Purpose of the test

This test is intended to characterize the equipments immunity to the electromagnetic fields in the frequency band [200 MHz - 3.2 GHz].

Their principle characteristics are the following:

- Modulations
  - CW and AM in the [200 MHz – 800 MHz] frequency band.
  - CW, AM and PM1 in the [800 MHz – 1 GHz] frequency band.
  - CW and PM1 in the [1 GHz – 1.2 GHz] frequency band.
  - CW and PM2 in the [1.2 GHz – 1.4 GHz] frequency band.
  - **US market specific tests:** add the Pm3 modulation in the [1.2 GHz – 1.4 GHz] frequency band.
  - CW and PM1 in the [1.4 GHz – 2.7 GHz] frequency band.
  - CW and PM2 in the [2.7 GHz – 3.2 GHz] frequency band.
- Substitution method.
- Minimum test volume respecting the homogeneity criteria: 1m x 2m (width / length) x 1m (height).
- Stirring of the field in step by step mode (except eventual phase of re-research of the sensible frequencies). The number of positions of advised stirring is that of table B.1 of the ISO 11452-11 standard.

In the general case, the test is performed on an insulating support without ground plane. In the case of equipments having a ground connection directly by the housing, the test has to be performed on a ground plane (in this case, a ground plane of dimensions 1m x 2m connected to the cage is used, and the calibration « empty room » is used).

7.3.5.3.Conditions for application of the test

This test is applicable to all the equipments with the electronic components. The applicability of the specific requirements in US market is to be specified in the TNS/TS.

This test should be preferably carried out at the EQ/IR01 test. However, the EQ/IR01 test can be considered as alternative methods. The test plan should specify which of the two methods is applied. If the two tests are to be carried out (possibly by different laboratories),then the results in reverberation chamber will prevail.

If the equipment only consists of passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the test at 200 / 160 V/m is applicable, with the limited requirements.

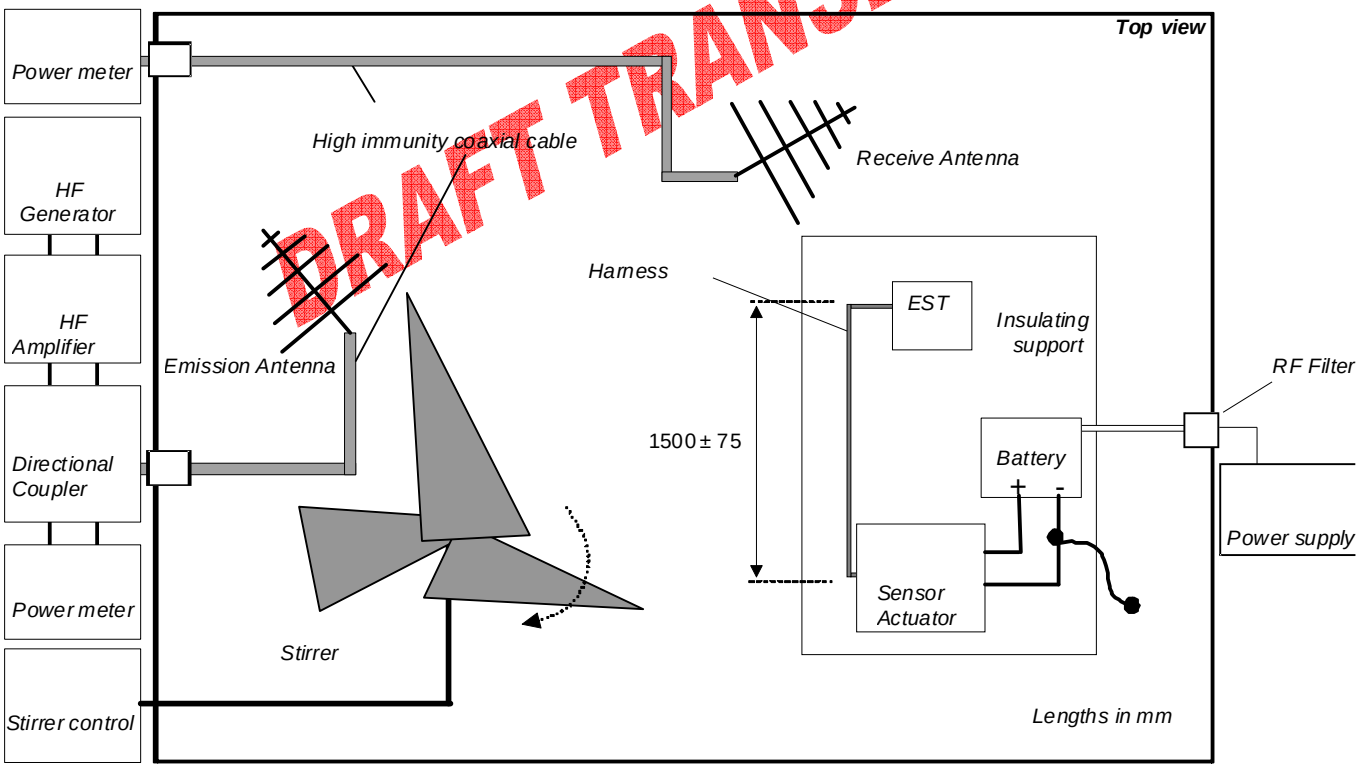
7.3.5.4.Test means

- Power supply and/or battery.
- Necessary devices for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating table with a height of 40cm minimum.
- Ground plane (if necessary, case of equipments whose housing is directly grounded)
- LSIN (optional)
- High frequency signals generator and wide power band amplifiers.
- 50 Ω coupler.
- Wattmeter
- Long periodic antennas, horn or equivalent (one in transmission and one in reception).
- Isotropic field sensor equipped with optical fiber.
- Reverberation chamber.

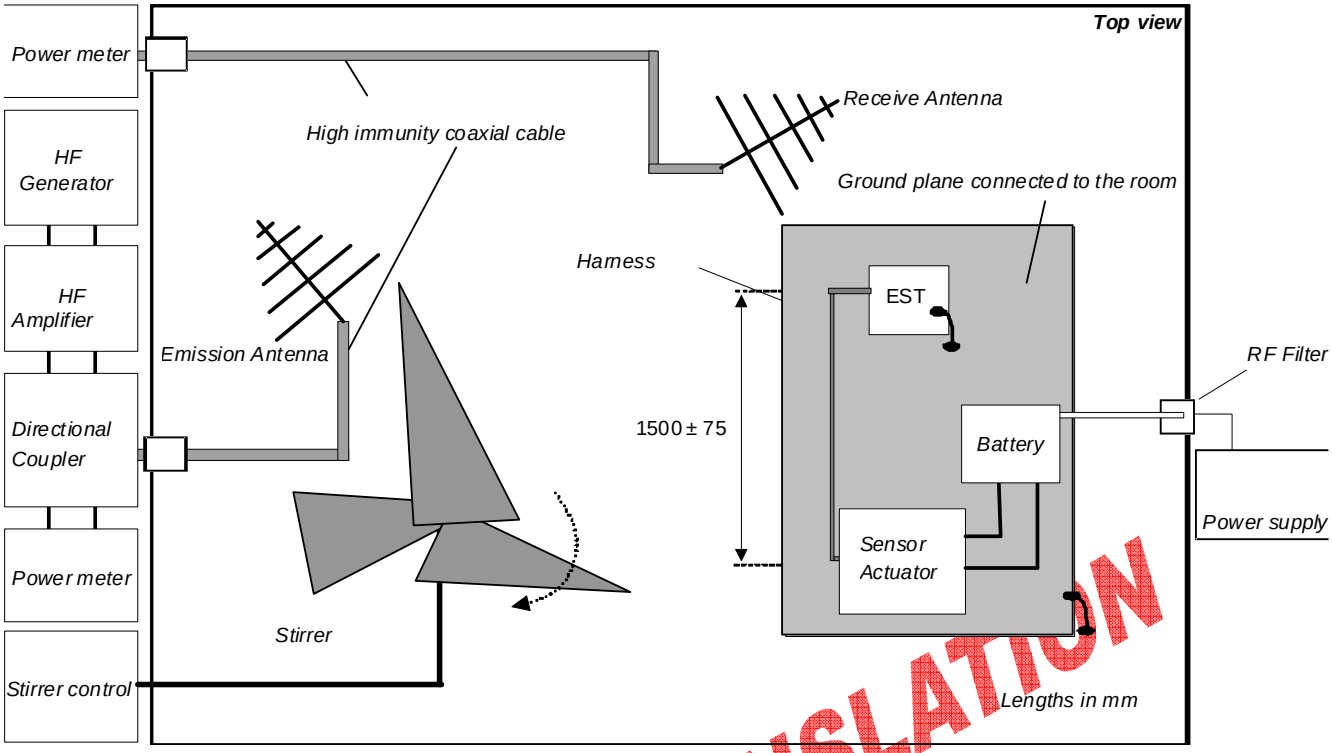
7.3.5.5.Assembly

Calibration configuration: refer to the ISO 11452-11 standard.

Test configuration without ground plane (general case):



Test configuration with ground plane (case of equipments with grounding on the housing):



7.3.5.6.Procedure

The tests are carried out in the [200 MHz – 3.2 GHz] frequency band.

The tests are carried out for each of the defined modulations in 7.3.5.2, with conservation of peak level.

Calibration:

The calibration is uniquely carried out in CW.

Apply the ISO 11452-11 test protocol.

In order to optimize the test time, it is recommended to carry out a calibration with an optimized number of stirring steps. To do this, the use of a reverberation chamber of large dimension is preferred (shift of the use low-frequency downwards). The addition of a load placed to reside in the cage (during calibration and tests) can also allow to improve the statistic uniformity of the field (due to the spectral spreading of the resonance modes), because this load is reasonable and allows to meet the ISO 11452-11 criteria.

Preparation:

Case of equipments having no direct grounding by the housing: configuration without ground plane:

A rectilinear wiring harness with a total length of (1700 +300/-0) mm between the DUT and the loads bench inside the test volume should be used.
The DUT and its wiring harness are placed on an insulating table of minimum 40cms high (> λ/4), and in the test volume.

Case of equipments having a direct grounding by the housing: configuration with ground plane:

A rectilinear wiring harness with a total length of (1700 +300/-0) mm between the DUT and the bench inside the test volume should be used.
The DUT and its wiring harness are placed on an insulating table of minimum 40cms high (> λ/4), and equipped with a ground plane. This ground plane is located in the test volume, and connected to the CRBM ground. The wiring harness is placed on an insulated support of 50mm thickness in relation to the ground plane. The DUT is connected to the ground plane according to its installation connected on vehicle, and any other ground connection is authorized.

In all cases (with or without ground plane), the zero volt power supply of the system should be taken as reference ground point, be located on the load bench side and be connected to the CRBM ground. Any ground connection necessary for the system under test (ground plane, load bench ground, LSIN if used…) should be carried out on this ground point of reference.

Test:

Run the DUT for a minimal period of 10 minutes.

Place the transmission antenna at the same position as during the calibration.

Progressively increase the direct power applied at the antenna until it reaches $P_{setpoint}$ while monitoring the DUT, and this on each step of stirring successively with:

$$P_{consigne} = P_{étalonnage} * \left(\frac{E_{consigne}}{E_{étalonnage}} \right)^2$$

Note: This formula is different from that of the ISO 11452-11, and cannot take into account the equipment load factor (CLF). This factor should however be estimated during the test, and documented in the report. This will have to stay as low as possible, and under no circumstances exceed 10dB.

Retrieve the appearance threshold of possible defects (E_{defect}), when they are lower than the specified threshold.

Progressively decrease the direct power applied to the antenna and change the frequency.

Note: in order to optimize the test time, a first frequency sweep can be carried out by rotating the stirrer continuously. For this test, the frequency / power file obtained during calibration (by step by step) will be used. The exposure time at the set point for each frequency will be adapted in order to ensure at least one complete revolution, and this in CW and for each modulation.

The research of immunity thresholds at frequencies presenting non conformities will be conducted in a step by step mode at sensitive frequencies.

This method allows to reduce consistently the duration of tests, but works only if the response time of the equipment is brief (<100ms). The continuous stirring will not be retained for the equipments presenting reaction time greather than 100ms. A particular attention should be given to the equipments having software type filtering strategies.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Calibration characteristics of the reverberation chamber used with especially :
  - Its dimensions
  - Its quality factor
  - The insertion losses
  - The curves of the deviation types on the field value such as defined in the ISO 11452-11 standard.
  - The level of necessary power to carry out a set point of the given field.
- The parameters measured during the following test:
  - Curve of load factor (CLF). This factor is based on the average power received during the empty calibration then the calibration with equipment (possibly, the calibration with equipment can be avoided, and the CLF estimated during the test itself, since the field level during the test is not balanced at CLF).
  - Curves by modulation with: F_{test}, $E_{setpoint}$, $E_{reached}$ and/or E_{defect}
  - Curves by modulation with: F_{test}, $P_{setpoint}$, $P_{measured}$ and/or P_{defect} (incident power)
  - Table of defects with: F_{defect}, E_{defect}, $E_{requirement}$, modulation and defect description.
  - The immunity thresholds are required, and should appear on the curves (E_{defect}).

In addition to the test report, the totality of the data F_{test} and/or F_{defect}, $E_{setpoint}$, $E_{reached}$ and/or E_{defect}, $P_{setpoint}$, $P_{measured}$ and/or P_{defect} (incident power) modulation and defect described should be provided in a digital form in an Excel table in this order.

7.3.5.7. Requirements

Test		Operating classes	Expected behavior
≤ 60 V/m		not applicable	Nominal
≤ 100 V/m		not applicable	Nominal or customer impact 0
≤ 150 V/m	≤ 120 V/m (1)	not applicable	Nominal or customer impact 0 or 1
≤ 200 V/m	≤ 160 V/m (1)	not applicable	Nominal or customer impact 0, 1 or 2

Note 1: the levels from 120 to 160 V/m are applicable (respectively instead of 150 and 200 V/m) in the following bands: 200-380 MHz, 520-1200 MHz and 1400-2700 MHz

Note 2: if the equipment only consists of passive electronic components (example: pressure sensor with stress gauge, temperature sensor…), only the test at 200 / 160 V/m is applicable, with the limited requirements.

Note 3: no destruction or defect of customer impact 3 is accepted for the levels ≤200 V/m / 160 V/m (1).

US market specific tests:

The following table is applied in addition for the US market with the PM3 modulation in the band 1200-1400MHz (to specify in the TNS/TS)

Test	Operating classes	Permitted levels of customer impact
≤ 180 V/m	not applicable	Nominal
≤ 300 V/m	not applicable	Nominal or customer impact 0
≤ 450 V/m	not applicable	Nominal or customer impact 0 or 1
≤ 600 V/m	not applicable	Nominal or customer impact 0, 1 or 2

Note 1: the test in the 1200-1400 MHz frequency band with the PM3 modulation can be carried out with a setup of tests without ground plane and without LSIN, this which allows carrying out the field level required with less power. The test plan should specify which configuration is chosen.

Note 2: for the tests in PM2 or PM3, the duration of the radar pulses should be ranging from 3µs to 6µs, in order to take into account the time constant of the chamber.

Note 3: no destruction or defect of customer impact 3 is accepted for the levels ≤600 V/m.

Radio transceivers specific features:

In the case of DUT including a function of wireless receivers (examples: car radio, mobile phone), certain dreaded events of the radio function (for example: audio quality, binary error rate) are admitted in a frequency band of F0 ± 5%; F0 being the tuning frequency used for the test. The tuning frequency as well as the malfunctions admitted will be specified in the test plan.
In the DUT case including a radio transceivers type function in the bands 315 and 433 MHz (examples: plip, DSG), the measures to lessen the severities of the appendix A are applied.

Note: for the test in reverberation chamber of the radio receivers, it can be difficult to maintain a stable radio link between the DUT and the equipments of control placed outside the cage. In this case, the establishment of the radio link in a conducted mode can be preferable.

7.3.6.EQ/IR 02: IMMUNITY TO LOW FREQUENCY MAGNETIC FIELD

7.3.6.1. Reference document

This test procedure is compliant with the ISO 11452-8 standard, except for the low limit frequency.

7.3.6.2. Purpose of the test

This test is intended to verify the immunity of the equipment of the magnetic field.

Its principle characteristics are the following:

- Sine-wave signal
- [0 Hz - 150 kHz] frequency band, with addition of the following discrete frequencies: 16.67 Hz, 50 Hz and 60 Hz.
- Substitution method.
- Generation of a magnetic field of sine-wave form by circulation of current in loop(s).
- 3 orientations of the DUT or the injection loop.

7.3.6.3. Conditions for application of the test

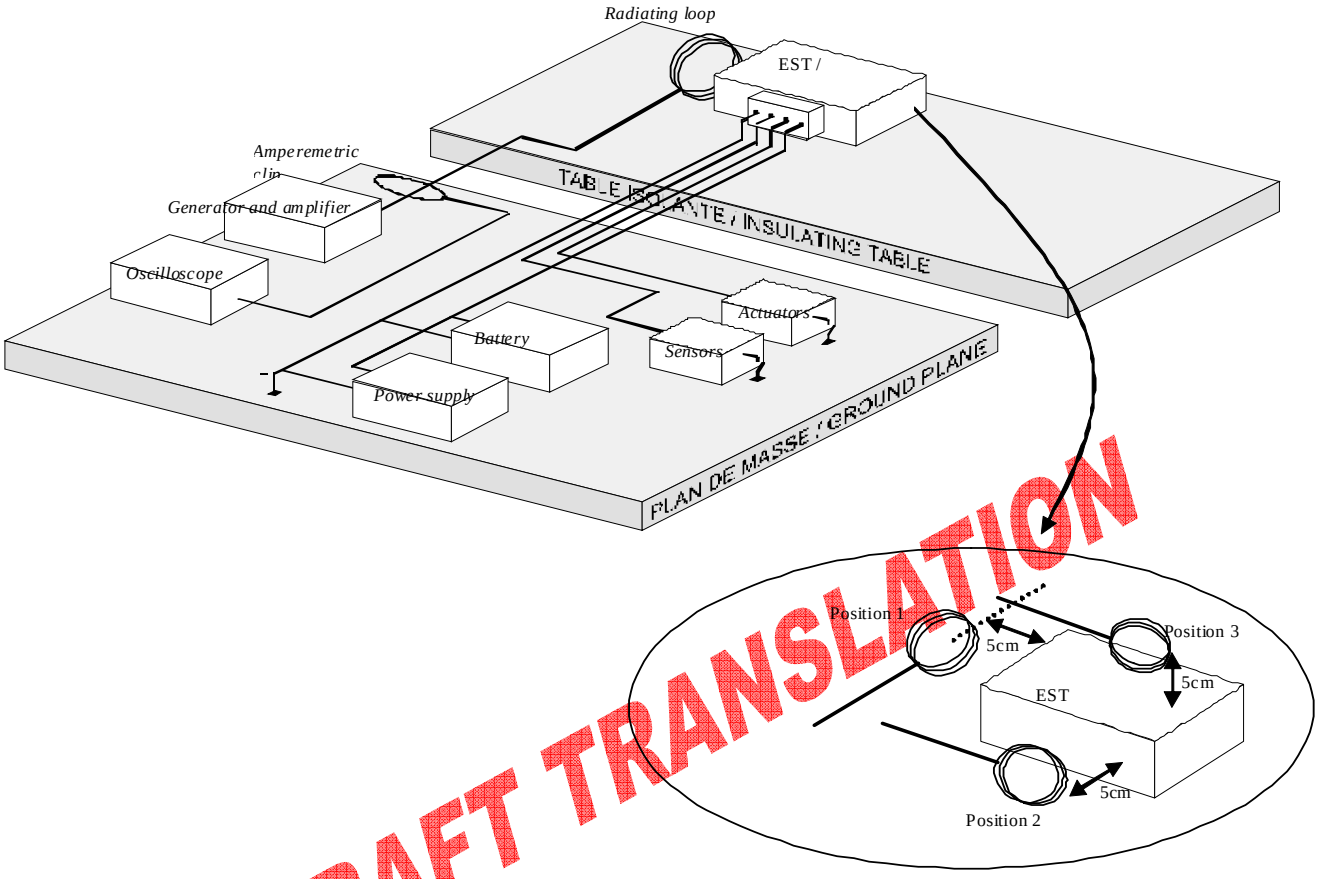
This test is applicable to all the equipments satisfying at least one of the following conditions:

- The equipment contains components sensitive to the magnetic field (Hall effect sensors, magneto resistive sensor, radio amplifier…)
- The equipment is located in the passenger compartment (including the boot) of a vehicle equipped with the ADML function.
- The equipment is located close to a strong source of magnetic field (alternator, electric machine, DAE…).

7.3.6.4. Test means

- Power supply and/or battery.
- Necessary devices for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating table.
- Low frequency signals generator.
- Power amplifier
- Low frequency magnetic field sensor
- Ampere metric clamp
- Oscilloscope
- A loop having the characteristics of the MIL STD 461E is recommended :
  - Diameter: 120mm.
  - Number of turns: 20.
  - Wire diameter: approximately 2mm.
- The field thus created by a current I to a distance of 50mm responds to the equation: H= 75.61 (A/m).
- A Helmholtz coil is however authorized as alternative solution. The assembly with the Helmholtz coil is described in the ISO 11452-8 standard.

7.3.6.5. Assembly



7.3.6.6. Procedure

The method adopted is the substitution method.

Preparation:

A wiring harness with maximum 2000mm long should be preferably used (possibly, the real wiring harness can be used).

The DUT is placed on an insulating table (or at the centre of the Helmholtz coils).

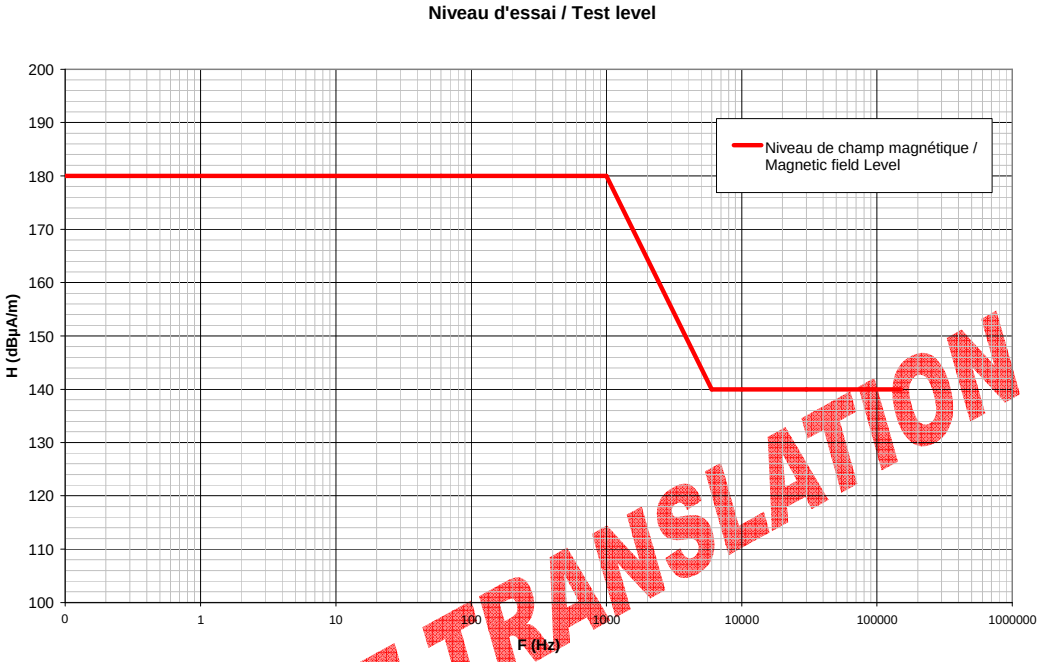
Calibration:

Place the magnetic field sensor at 50mm from the radiating loop (or at the centre of the Helmholtz coils) on the insulating table.

Retrieve the current $I_{calibration}$ (amplifier output) necessary to generate the specific field at each frequency.

The requirements below should be used.

Frequency band (HZ)	Spectral envelope of the magnetic field (dBµA/m)
0 - 1000	180
1000 - 6000	180 – 51.41 x log (F/1000)
6000 - 150000	140



Test:

Run the DUT for a minimal period of 10 minutes.

Apply the current coming from the calibration in the coil(s), and carry out the frequency sweep.

Carry out the test by placing the radiating coil at 50mm from the DUT and in parallel to it, as well as moving the coil in every point of the DUT such as defined in the test plan. Carry out the test in the three axes if the Helmholtz coil is used.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Characteristics of coils used.
- Table of defects with: F_{defect}, H_{defect}, $H_{requirement}$, position and defect description.

7.3.6.7. Requirements

Test	Operating classes	Customer impact levels
Magnetic field	A	0

Note: *In the case of DUT including a radio transceiver type function (example: badge to F_0 kHz), the malfunctioning of the function is allowed for the exclusion band around F_0 (to be specified in the test plan).*

7.3.7. EQ/IR 05: IMMUNITY TO ONBOARD TRANSMITTERS

7.3.7.1. Reference document

This test procedure is compliant with the second DIS of the ISO 11452-9 standard.

7.3.7.2. Purpose of the test

This test is intended to verify the immunity of equipments to onboard transmitters with integrated antenna (cellular phone, bluetooth transmitter…).

The main characteristics of the test are the following:

- Closed loop control on transmitted power (direct power – reflected power) at the bottom of the portable transmission device (housing + antenna).
- Generation of an electric field with portable transmission device.
- 3 orientations of the DUT or of the on board transmitter.

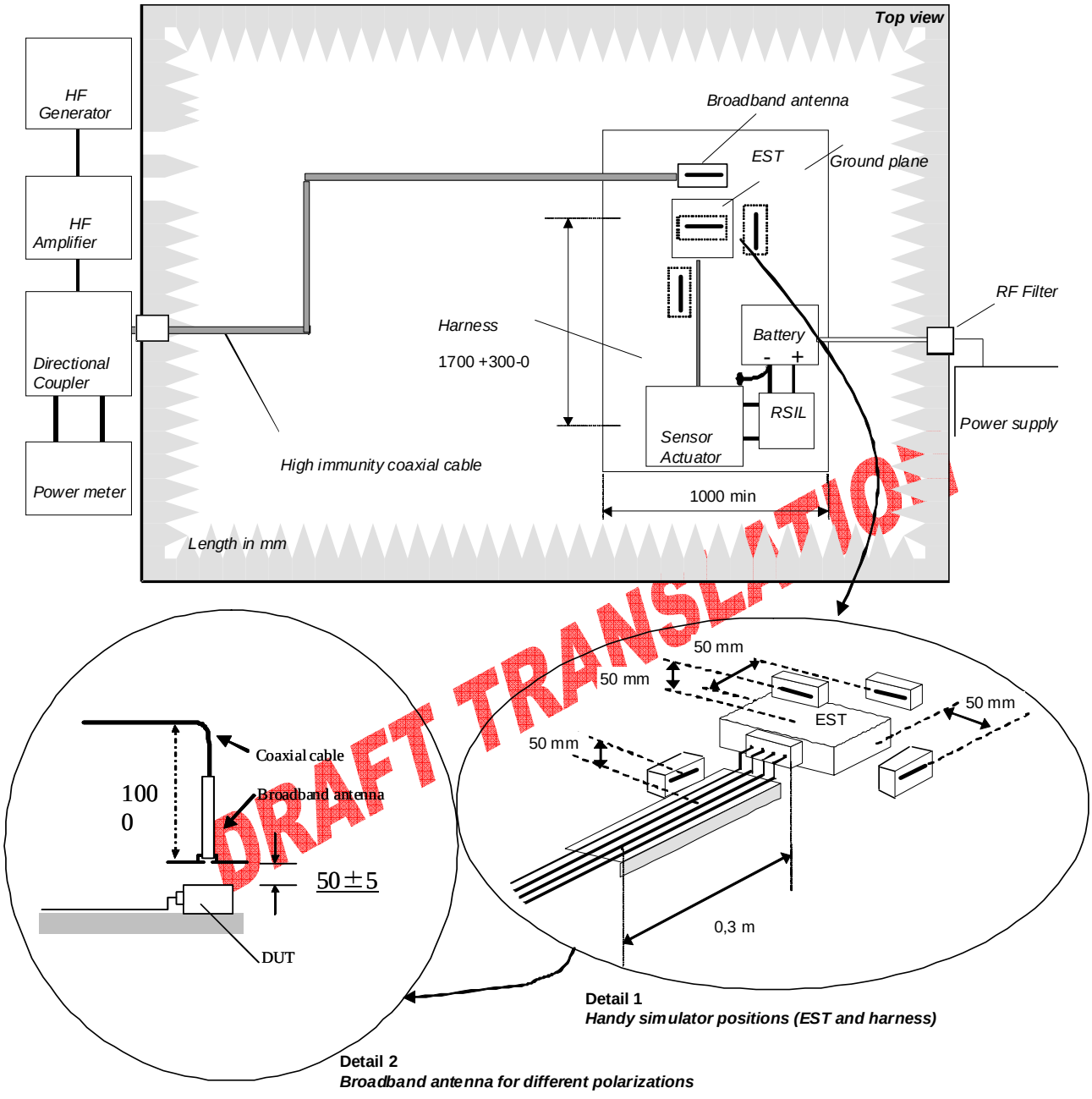
7.3.7.3.Conditions for application of the test

This test is only applicable on the equipments located in the passenger compartment or in the boot, and having an active electronics.

7.3.7.4.Test means

- Power supply and/or battery.
- Necessary devices for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Table with ground plane.
- Insulating support of thickness 50mm.
- LSIN is compliant with the CISPR 25 publication (2 LSIN for a DUT to ground offset) and/or 2 LSIN high voltage (with a shielding connected to shielding of the high voltage lines) according to the type of power supply of the DUT.
- 50 Ω load(s)
- High frequency signal generator and wide power band amplifiers.
- 50 Ω coupling.
- Wattmeter
- Portable transmission device: biconical antenna broadband miniature, as defined in the appendix B2 of the ISO 11 452-9 standard.

7.3.7.5. Assembly



7.3.7.6. Procedure

The method adopted is the closed loop control method on power transmitted (power transmitted = direct power – reflected power) at the bottom of the portable transmission device.

Preparation:

A wiring harness of total length (1700 +300/-0) mm between the DUT and the load bench should be used.
The wiring harness under test is placed on an insulating support of low relative permittivity, to (50 ± 5) mm at the bottom of the ground plane.

The wiring harness under test should be placed at least 200 mm to the edge of ground plane.
The DUT is placed on an insulating support of (50 ± 5) mm thick. It is connected to the ground plane in accordance to its real installation on vehicle, and no other ground connection is authorized.

Calibration:

Run the DUT for a minimal period of 10 minutes.

Adjust the HF generator to obtain the level of transmitted power $P_{calibration}$ (measured in CW), at the bottom of the portable transmission device corresponding to that indicated in the table hereafter. This adjustment should be carried out in a configuration for which the portable transmission device is positioned to a minimal distance of 1 m of any metallic part (cage wall, equipment, ground plane) and of 0.4m of absorbents.

Simulator approach method:

There are two ways (to choose) of positioning the simulator for the test:

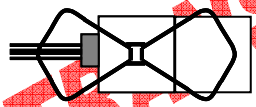
- Apply the modulation indicated in the table hereafter, then the portable transmission device is approached (without any power break) until various specified positions (DUT and wiring harness).
- Apply the modulation indicated in the table hereafter. Switch off the power, then the portable transmission device is placed at various specified positions (DUT and wiring harness). Re-apply the power with modulation (in “ON/OFF mode”), without any level modification.

Test:

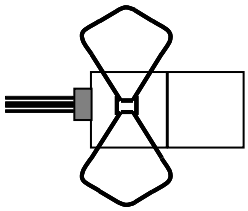
Test on equipment:

The surface of DUT should be partitioned into squares of 100x100 mm. The antenna should be placed at a distance of 50 mm and the centre of each cell should be exposed to the centre of the antenna and of its radiating elements of the antenna in two orthogonal orientations (4 exposures in total).

1/ Place the antenna parallel to a wiring harness of the DUT with its centre aligned with the center of the first cell, and expose the DUT to the specified levels.

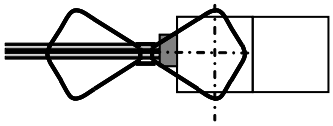


2/ Repeat the step 1 by turning the antenna to 90°

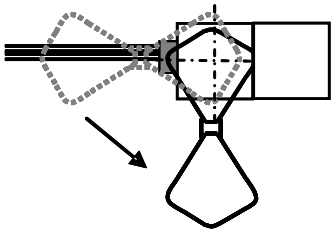


3/ Align the antenna to the centre of the following cell, and repeat the steps 1 and 2 until all the cells have been exposed in two orthogonal orientations.

4/ Place the new antenna on the first cell. Align the radiating element of the antenna to the centre of the cell, and expose the DUT to the specified levels.



5/ Repeat the step 4 by turning the antenna to 90°

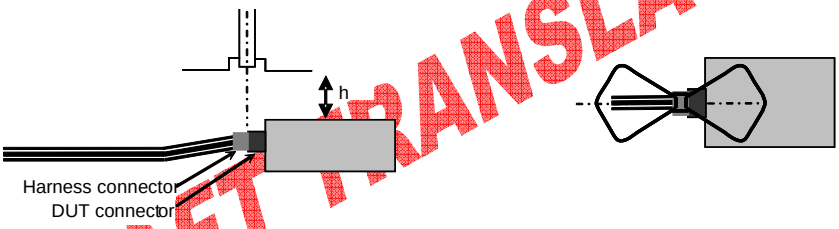


6/ Repeat the steps 4 and 5 until all the cells have been exposed. During the test of equipment with the multiple cells, certain cells will be exposed to the radiating elements of the antenna during the steps 1 to 3 on the adjacent cells. In these cases, it is not obligatory to repeat the steps 4 and 5 in order to avoid the repetition of certain tests. If there is a doubt on the effective exposition of a cell, the steps 4 and 5 should be carried out.

7/ Repeat the steps 1 to 6 for each surface of the equipment. The test therefore requires the rotation of the DUT, so that each surface to be tested is parallel to the ground plane. An insulating support of low permittivity should be used to insulate the equipment, so that the face to be tested is placed in front of the antenna.

Test on the wiring harness:

Place the antenna centered on the connector to be tested and parallel to the wiring harness. Align the center of the antenna with the extremity of the connector.Expose the DUT to the specified levels. In the case of an equipment with various connectors spaced by more than 100 mm, the test should be repeated several times.



(a) Side view (b) Top view

Frequencies, powers and modulations to be applied:

Frequency bands (MHz)	Frequency range (MHz)	Test frequencies (MHz)	Effective transmitted power in CW ($P_{calibration}$) (1)		Modulation to superpose (to test on DUT)
			P1 level	P2 level	
4G	832 - 862	832 / 842 / 852 / 862	6,7 W	20,0 W	PM 217 Hz T_{on} 577 µs
GSM 900	880 - 915	880.2 / 890.2 / 902.4 / 914.8	6.7 W	20.0 W	PM 217 Hz T_{on} 577 µs
GSM 1800	1710 - 1785	1710.2 / 1747.4 / 1784.8	3.3 W	10.0 W	PM 217 Hz T_{on} 577 µs
UMTS / UMTS	1920 - 1980	1920 / 1950 / 1980	0.8 W	2.5 W	PM 217 Hz T_{on} 577 µs
Bluetooth / Wi-Fi (802.11 b/g)	2402 - 2480	2402 / 2441 / 2480	0.3 W	1.0 W	PM 700 kHz Duty factor 0.5
4G	2500 - 2570	2500 / 2535 / 2570	0,8 W	2,5 W	PM 217 Hz T_{on} 577 µs

Note 1: Power transmitted (direct power – reflected power) at the bottom of the portable transmission device.

US and Mercosur market specific tests:

The following table is applied in addition for the US market:

Frequency bands (MHz)	Frequency range (MHz)	Test frequencies (MHz)	Effective transmitted power in CW ($P_{calibration}$) (1)		Modulation to superpose (to test on DUT)
			P1 level	P2 level	
GSM 850	824 - 849	824.2 / 836.4 / 848.8	6.7 W	20.0 W	PM 217 Hz T_{on} 577 µs
GSM 1900	1850 - 1910	1850.2 / 1880.0 / 1909.8	3.3 W	10.0 W	PM 217 Hz T_{on} 577 µs

Note 1: Power transmitted (direct power – reflected power) at the bottom of the portable transmission device.

Japanese/Korean market specific tests:

The following table is applied in addition for the Japanese market:

Frequency bands (MHz)	Frequency range (MHz)	Test frequencies (MHz)	Effective transmitted power in CW ($P_{calibration}$) (1)		Modulation to superpose (to test on DUT)
			P1 level	P2 level	
PDC 800	810 - 826	810.2 / 818.0 / 825.8	2.7 W	8.0 W	PM 217 Hz T_{on} 577 µs
PDC 1500	1429 - 1453	1429.2 / 1441.0 / 1453.8	2.7 W	8.0 W	PM 217 Hz T_{on} 577 µs

Note 1: Power transmitted (direct power – reflected power) at the bottom of the portable transmission device.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Characteristics in portable transmission device (housing + antenna): housing dimensions, type of antenna, TOS value at the central frequency of the band.
- Table of defects with: F_{defect}, P_{defect}, $P_{requirement}$, (powers transmitted), position, orientation and defect description.

In addition to the test report, the totality of the data F_{test} and/or F_{defect}, $P_{setpoint}$, $P_{reached}$ and/or P_{defect} (powers transmitted), TOS, position, orientation and the defect description should be provided in a digital form in an Excel table in this order.

7.3.7.7. Requirements

Test	Operating classes	Customer impact levels
P1 power level	A	0
P2 power level	C	1

7.3.8. EQ/IR 03: RESISTANCE TO ELECTROSTATIC DISCHARGES, EQUIPMENT NOT CONNECTED

7.3.8.1. Reference documents

This test procedure is based on the ISO 10605 publication, except for the applicability conditions of discharges in contact or in the air.

7.3.8.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the electrostatic discharges produced directly by the operators during the storage, handling and maintenance operations or intervention on vehicle.

Its main characteristics are the following:

- Contact discharge: ± 2 kV, ± 4 kV and ±8 kV. The discharges ± 4kV and ± 8kV are applicable on the conductive parts of the equipment housing and the discharges ± 2 kV and ± 4 kV on the connector pins.
- Discharge in the air: ± 8 kV, ± 15kV. These discharges are applicable on the insulating parts of the equipment (search for the housing gaps…).
- Energy accumulation capacity of 150pF.
- Discharge resistance 330Ω.
- Positive polarity and negative polarity
- 10 spaced discharges from 1s to 10s maximum for each level, polarity and application point .
- Application points of discharges (to be specified in the test plan): points or accessible surfaces of the equipment during the packing, handling and maintenance operations and on each of the accessible connector pins.

7.3.8.3. Conditions for application of the test

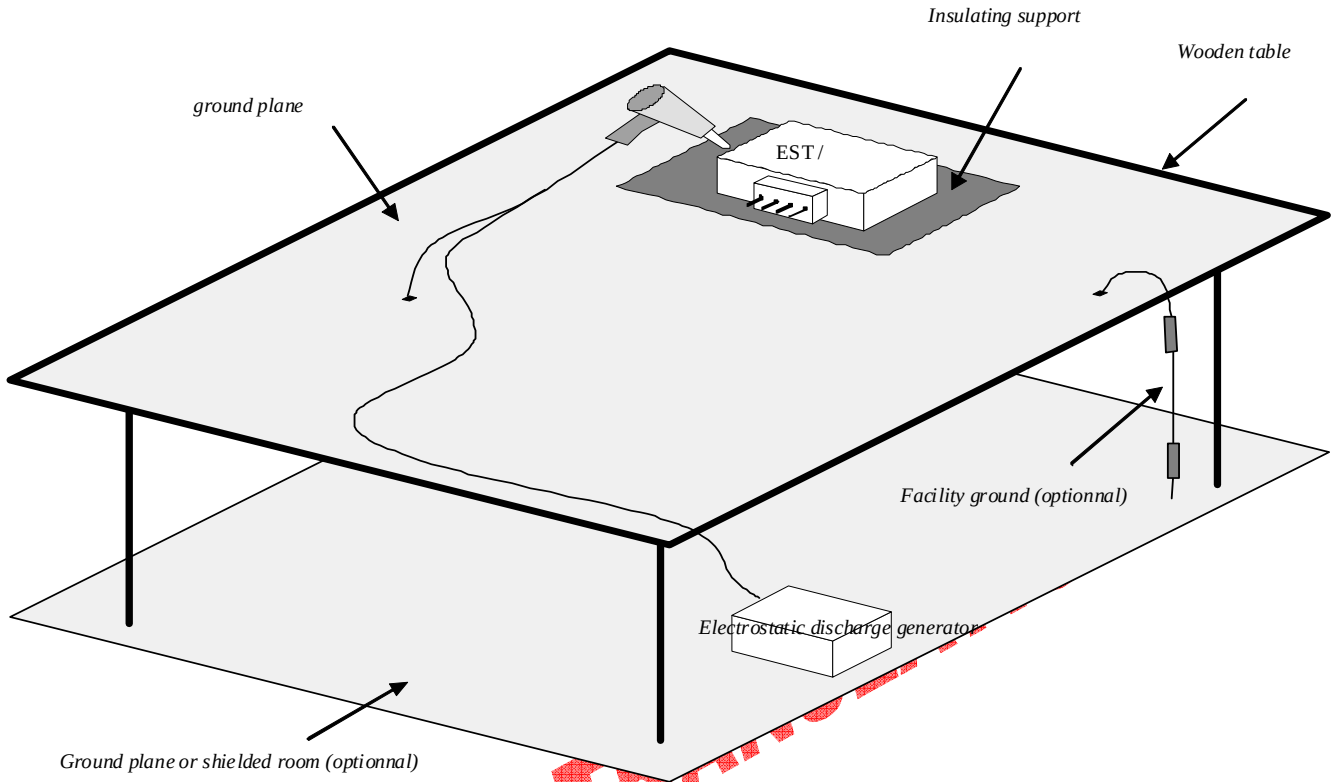
This test is applicable to all the equipments

For the particular case of pyrotechnic modules, this test does not apply. The method of test and the requirements associated to the pyrotechnic modules are described in the specification of concerned equipments.

7.3.8.4. Test means

- Insulating support of a thickness of 2 to 3mm for the DUT. The purpose of the support is to avoid any direct arc between the DUT and the ground plane during discharge.
- Electrostatic discharge generator.

7.3.8.5. Assembly



7.3.8.6. Procedure

The tests should be carried out when the relative humidity is between 20% and 60%. A value of 30% is preferred.

These requirements concern at least:

- Test setup (test equipment and associated peripherals).
- The electro static discharge (DES) generator

Preparation:

The DUT is placed on an insulating support of 2 to 3 mm thickness. The tests are carried out by default in the insulated configuration box (figure above, with insulating support). In the case of a housing having a conductive part, carry out an additional test by linking this conductive part to the ground plane (and by removing the insulating support).

Calibration:

Calibrate the electro static discharge generator according to the ISO 10 605.

Contact discharges: use a pointed end electrode.

Discharge in the air: use a round toe-end electrode.

Test:

Place the electrostatic discharge gun in direct contact on each of the defined discharge points for the conductive parts of housing, and trigger a series of 10 discharges of + 4 kV (then + 8 kV) spaced at least by 1s, then a series of 10 discharges of – 4 kV (then – 8 kV) spaced at least by 1 s.

Verify the functioning of the DUT after the application of all the pulses.

For the insulating parts, approach the electrostatic discharge gun slowly, and carry out a search of zones allowing the arcs by slowly displacing the gun to proximity of gaps. Thus identify the sensitive zones and note their locations.

Approach the electro static discharge gun slowly at the level of previously identified zones as well as those described in the test plan until 10 consecutive breakdown times (with a spacing of at least 1s) towards each of the discharge points defined for the insulating parts (surfaces or accessible points), the gun being loaded at +8 kV (then 15 kV), then at – 8 kV (then – 15kV).

Verify the functioning of the DUT after the application of all the pulses.

Place the electro static discharge gun in direct contact on each of the connector pins, and trigger a series of 10 discharges of +2 kV (then +4 kV) each spaced by at least 1s, then a series of 10 discharges of -2 kV (then – 4 KV) each spaced by at least 1s.

Verify the functioning of the DUT after the application of all the pulses.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Detailed description (diagrams and/or photos) of the discharge points on DUT and/or wiring harness.
- Climatic environment conditions (temperature and hygrometry)
- Table with: test level and/or defect level, polarity, requirement level, discharge point, and description of the defect if necessary.

7.3.8.7. Requirements

Test				
Test level	**Equipment case**		**Connector pins**	**Operating state**
	Conductive parts	**Insulating parts**		
I	Not applicable	Not applicable	Discharge in contact ± 2 kV	A after reconnection
II	Discharge in contact ± 4 kV	Discharge in the air ± 8 kV	Discharge in contact ± 4 kV	A after reconnection
III	Discharge in contact ± 8 kV	Discharge in the air ± 8 kV	Not applicable	A after reconnection

Note: *The test levels I, II and III are to be tested successively. The test plan specifies in which order all the tests have to be carried out. It is advisable to verify at the end of the test that certain filter components are not damaged (particularly condensers).*

7.3.9. EQ/IR 04: RESISTANCE TO ELECTROSTATIC DISCHARGES, SWITCHED ON EQUIPMENT

7.3.9.1. Reference documents

This test procedure is based on the ISO DIS 10605 publication and its appendix F.

7.3.9.2. Purpose of the test

This test is intended to verify the immunity of the equipments to the electrostatic discharges produced during the operation or maintenance by the user.

Its main characteristics are the following:

- Contact discharge: ± 2 kV, ± 4 kV, ±8 kV and ± 15 kV. These discharges are applicable on the conductive parts of the equipment.
- Discharge in the air: ± 4 kV, ± 8 kV, ±15 kV and ± 25 kV (according to installation). These discharges are applicable on the insulating parts of the equipment.
- Contact discharges on the plane of horizontal coupling: ± 4 kV, ± 8 kV and ±15 kV. The discharge points are to be specified in the test plan.
- The characteristics of gun for the direct discharge on the equipment are the following :
    - Energy accumulation capacity of 330pF.
    - Discharge resistance of 2 kΩ.
- The characteristics of gun for the indirect discharge on the coupling plane are the following :
    - Energy accumulation capacity of 330pF.
    - Discharge resistance of 330 kΩ.
- Positive polarity and negative polarity.
- 10 discharged spaced at least by 1s for each level, polarity and application point.

7.3.9.3.Conditions for application of the test

This test is applicable to all the equipments having an active electronics.

7.3.9.4.Application points of discharge

For the direct discharge on the equipment, the application points of discharges are rated as follows:

- Points of type 1h direct: each point of DUT passenger compartment (buttons, livers, screens, warning lights, displays) can be directly (without removal) accessible by the users.
- Points of type 1h indirect: each point of DUT passenger compartment can be indirectly accessible (following a removal, maintenance,..) in procedure (wiring harness and connectors, back cover of a unit,)
- Points of type 1 m: each point of DUT engine compartment (housing, wiring harness and connectors,), or accessible only from the outside of the passenger compartment (example: parking aid sensor,)
- Points of type 2h direct: each input-output pin that can be directly accessible by the users in a remote manner (connector for slinging door system)
- Points of type 2h indirect: each input-output pin can be accessible by the users in a remote manner, after handling (diagnostic jack pin, whether they are placed downstream to the centralized protection of upstream).

- Points of type 3h: offset elements (located in the passenger compartment) of a control assembly made of various equipments (example: electronic door buttons…). The tests can be carried out on each element in system with the inter-connected assembly, according to the diagram in § 7.3.9.6. In case of unavailability of the offset element, it is also accepted to carry out the tests powered equipment at the level of the pins of the DUT concerned connector. In this case, the test will be carried out with decreased levels (see § requirements). The configuration of test is to be specified in the test plan.
- Points of type 3 m: offset elements (located under the hood) of a control assembly made of various equipments (example: actuator and sensor in relation to the control unit…)
  The tests can be carried out on each element in system with the inter-connected assembly, according to the diagram § 6.4.2.5. The test configuration is to be specified in the test plan.

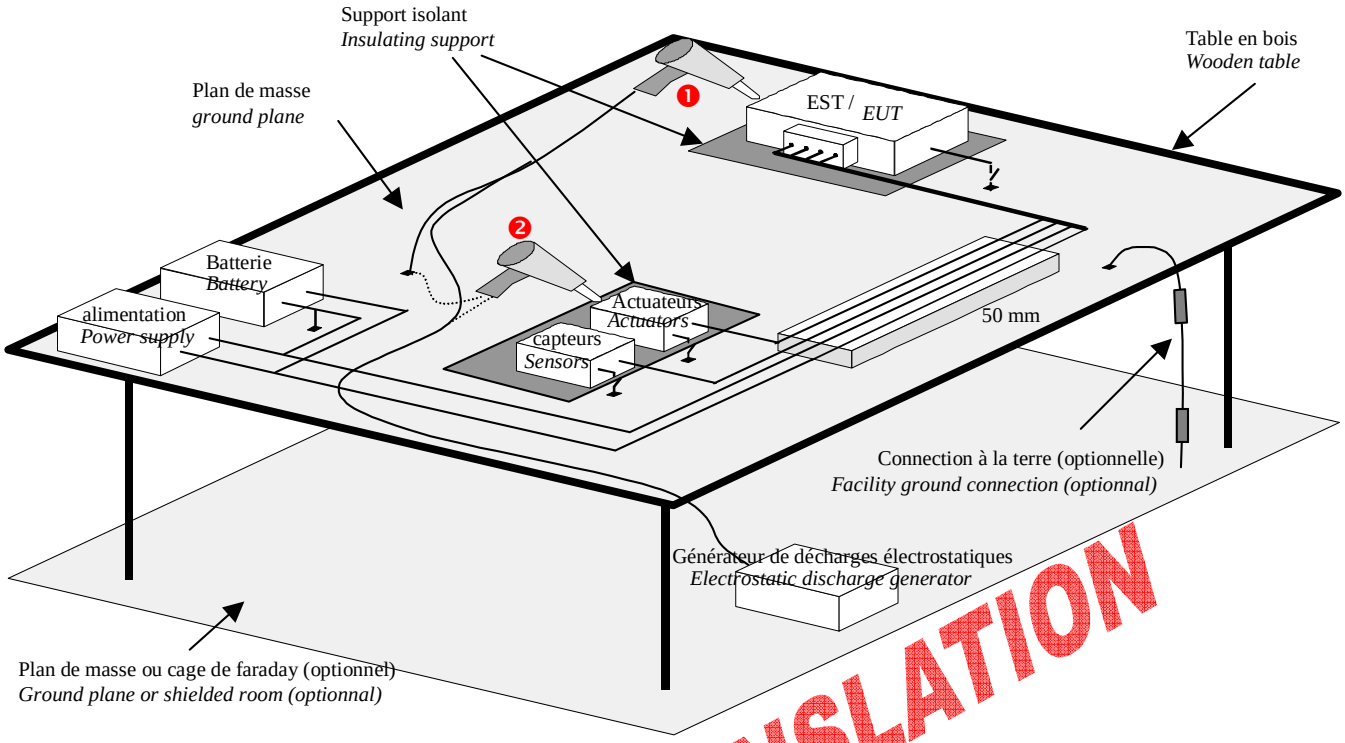
Accessibility and location		DUT case	Remotely accessible pin or contact	Case of an offset element
Directly accessible	Passenger compartment	1 h direct	2 h direct	3 h
	Engine compartment or outside the vehicle	1 m	*N/A*	3 m
Accessible after handling or removal	Passenger compartment	1 h indirect	2 h indirect	1 h indirect
	Engine compartment or outside the vehicle	1 m	*N/A*	3 m

Note: *the classification by type is to be specified in the TNS/TS or the test plan for each point.*

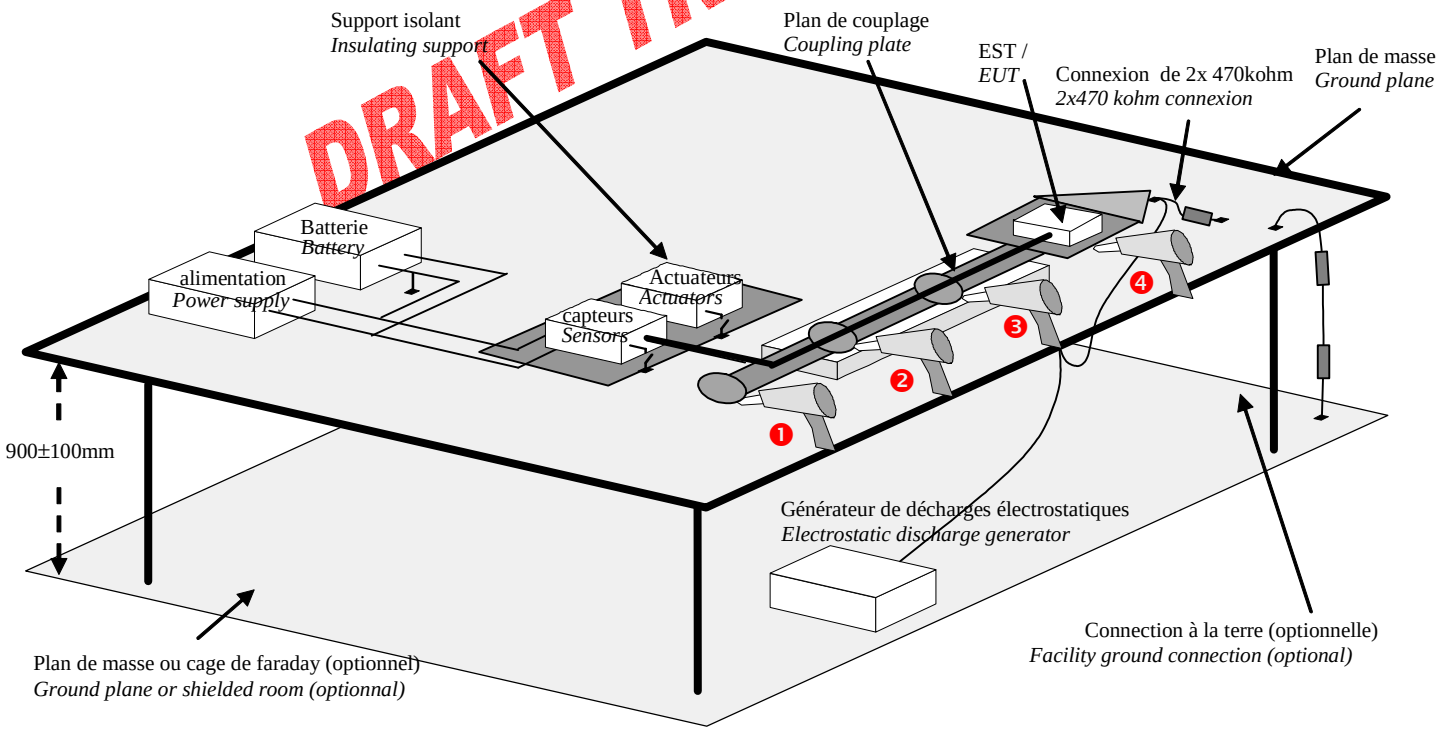
7.3.9.5. Test means

- Power supply and/or battery.
- Necessary devices for verification of the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Coupling plate. It is compliant with the appendix F of the ISO 10605 standard.
- Insulating support of 50mm thickness for the wiring and wiring harnesses.
- Insulating support of a thickness from 2 to 3mm for the DUT. The goal of this support is to avoid any direct arc entry of the DUT and the ground plane during discharge.
- Electrostatic discharge generator.
- Shielded chamber (if possible)

7.3.9.6.Assembly



Direct discharge on equipment



Indirect discharge on coupling plate

7.3.9.7. Procedure

The tests should be carried out with a relative humidity between 20% and 60%. A value of 30% is preferred.

These requirements concern at least:

- The test set-up (test equipment and associated peripherals)
- The “critical” measurement equipments

NOTE: the “critical” measurement equipment are those necessary for the execution of a test and which have a significant incidence on the accuracy of the test result (the evaluation of the measurement uncertainty is one of the means allowing to identify the critical equipments). The critical equipments include at least, but are not necessarily limited; all the measuring equipment subject to calibration.

Preparation:

Direct discharge (gun 2kΩ / 330pF):

The DUT is placed on an insulating support of thickness from 2 to 3 mm, itself placed above the ground plane. The tests are carried out in the configurations of insulated housing or housing connected to ground plane in conformity with its real installation on vehicle, and no other grounding connection is authorized.

A wiring harness of a total length of (1700 +300/-0) mm between DUT and the load bench should be used. The wiring harness of the test is placed on an insulating support of thickness 50 mm.

The ground of electrostatic discharge generator is connected to ground plane by a connection whose length should not exceed 1000mm. The ground plane can then be connected to the installation ground or to the ground of the Faraday cage (for security or comfort reasons).

Indirect discharges (gun 2kΩ / 330pF):

The DUT is placed on an insulating support of thickness from 2 to 3 mm, itself placed above the coupling plane. The tests are carried out in the configurations of insulated housing or housing connected to coupling plane in conformity with its real installation on vehicle, and no other grounding connection is authorized.

A wiring harness of a total length of (1700 +300/-0) mm between DUT and the load bench should be used. The wiring harness of the test is placed directly on the coupling plane.

The grounding of the electrostatic discharge generator is connected to the extremity of the coupling plane (DUT side) by a connection whose length should not exceed 1000mm, in accordance with the prescriptions of the appendix F of the ISO 10605 standard.

Notes:

- For the case of application points of type 2h direct or 2h indirect (as defined in § 7.3.9.4) that can impact several equipment (example : CAN inter-system), the pins concerned by the test should be tested by contact discharges through the addition of a wiring harness, insulated from the coupling plane at a height of 50 mm, whose length is defined in test plan. By default, this length is of 10 cm.
- For the discharges on the 3h type points and in case of non-availability of the offset element, it is acceptable to carry out the tests on the equipment powered directly at the pins level of the concerned connector only if the operation of connector is not affected by the disconnection of the offset element (case of a push for example).

Calibration:

Calibrate the electrostatic discharges generator according to the ISO 10605.

Air discharges: use a round end electrode.

Contact discharges: use a pointed end electrode.

Test:

Run the DUT for a minimal period of 10 minutes.

Contact discharge:

- Place the electrostatic discharge gun in contact on each of the defined discharge points for the conductive parts and trigger a series of 10 discharges of + 2 kV separated at least by 1s, then a series of 10 discharges of - 2 kV separated at least by 1 s.
- Verify the functioning of the DUT during and after the application of all the pulses.
- Repeat the test with ± 4 kV then ± 8 kV and ± 15kV.

Air discharges:

- Approach the electrostatic discharge gun slowly, and carry out a search of zones allowing the arcs by slowly moving the gun closer to the voids. Thus identify the sensitive zones and note their locations.
- Approach the electrostatic discharge gun slowly at the level of previously identified zones as well as those described in the test plan until 10 consecutive breakdowns (with an interval of at least 1s) towards each of the discharge points defined for the insulating parts (connection configuration and wiring harness included), the gun being charged at + 4 kV, then at – 4 kV.
- Verify the functionning of the DUT during and after the application of all the pulses.
- Repeat the test with ± 8 kV then ± 15 kV and ± 25kV.

Contact discharge, on coupling plate:

- Place the electrostatic discharge gun in contact on the edge of the coupling plane at the locations provided for this purpose (points 1 to 3), as well as at the rectangular part level which supports the DUT (point 4). Successively, on each of these points, trigger a series of 10 discharges of +2 kV at an interval of at least 1s, then a series of 10 discharges of -2 kV at an interval of at least 1s.
- Verify the functionning of the DUT during and after the application of the all the pulses.
- Repeat the test with ± 4 kV then ± 8 kV and ± 15kV.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Detailed description (diagrams and/or photos) of the discharge points on DUT and/or wiring harness.
- Climatic environment conditions (temperature and hygrometry)
- Table with: Test level and/or defect level, polarity, requirement level, discharge point, and defect description, if necessary.

7.3.9.8. Requirements

The operation classes and the associated customer impact levels are given in the following table:

Classes and customer impact levels (example : A0 = class A and customer impact level 0)									
Test		**Discharge on conductive parts (1)**				**Discharge on insulating parts**			
Equipment localization	Discharge points (discharge type)	± 2 kV (contact)	± 4 kV (contact)	± 8 kV (contact)	± 15 kV (contact)	± 4 kV (air)	± 8 kV (air)	± 15 kV (air)	± 25 kV (air)
Direct passenger compartment	Points of type 1h direct	A0	A0	C1	C1	A0	A0	C1	C1
	Points of type 2h direct					Not applicable			
	Points of type 3h (4)					A0	A0	C1	C1
Indirect passenger compartment	Points of type 1h indirect	C1	C1	D2	(3)	C1	C1	D2	(3)
	Points of type 2h indirect	A0	A0	C1 (2)	C1 (2)	Not applicable			
Engine compartment or outside passenger compartment	Points of type 1 m	A0	C1	C1	(3)	A0	C1	C1	(3)
	Points of type 3 m								
	Points of type 2h indirect	A0	A0	C1 (2)	C1 (2)	Not applicable			
Discharges on the coupling plane		NA	A0	C1	C1	Not applicable			

(1): or on coupling plan.

(2): this test is applicable to non-protected lines (example : line K) and lines placed upstream of a possible central protection (example : BSI CAN inter-system input). It is not applicable for the lines placed upstream of central protection of an other equipment (example : inter-system CAN, see note ref. 02016_11_06198)

(3): This test is required only for characterization. In case of destruction or defect of customer impact 3, the malfunctions and immunity thresholds should be indicated.

(4): In case of unavailability of the offset element, it is acceptable to carry out the equipment tests powered at the level of the pins of the DUT concerned connector. In this case, the tests will be carried out in contact (the pin being conductive) with a maximum level of 8kV.

7.4. EMC EMISSION TESTS (GENERAL CASE)

7.4.1. EQ/MC 01: MEASUREMENT OF SWITCHING NOISES

7.4.1.1. Reference document

This test procedure is compliant with the ISO 7637-2 standard, with the exception of the measuring assembly which only uses “rapid transients”.

7.4.1.2. Purpose of the test

This test is intended to evaluate the switching noises of the equipments.

Its main characteristics are the following:

- Concerned wires : power supply wires
- Methodology: the tests simulate the activation/deactivation of the starting contact switch and the start-up/break of the DUT.

7.4.1.3. Conditions for application of the test

This test is only applicable to the equipment including an inductive load likely to operate in switching (motors, actuators, relay control coils…).

This test is applied to the 12V power supply lines as well as to the high voltage lines (“200V”). Considering the typical values of inductance of the coils, only requirement levels differ depending on the network.

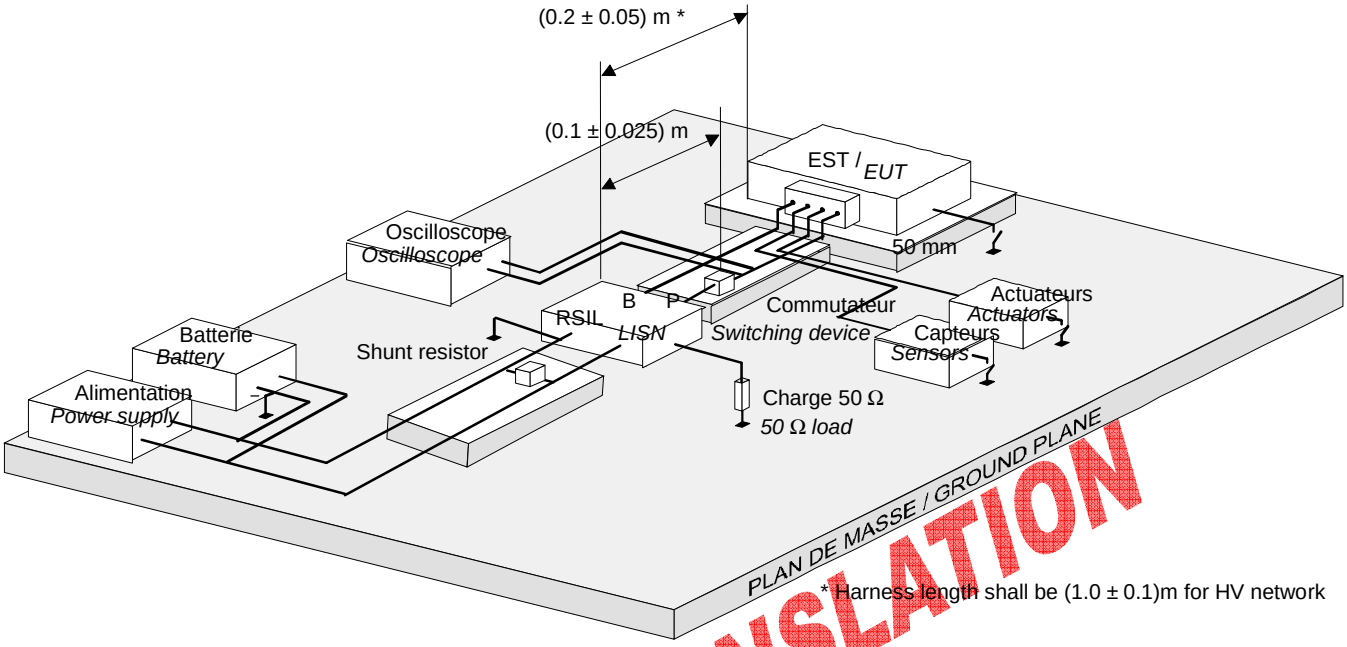
7.4.1.4. Test means

- Power supply and battery.
- Necessary devices for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of thickness 50mm.
- Digital oscilloscope with a real time bandwidth greater or equal to 500 MHz and a sampling frequency greater or equal to 1 GHz.
- High impedance voltage probes with a bandwidth greater or equal to 500 MHz, for the 12V network.
- High impedance differential voltage probes with a bandwidth greater or equal to 500 MHz for the high voltage network (“200V”).
- LSIN compliant with the ISO/DIS 7637-2.3 standard loaded on 50Ω for the 12V network.
- Shielded LSIN (see § 5.6.4) loaded on 50Ω for the high voltage network (“200V”). The shielding of the LSIN should be connected to the test ground plane.
- 40 Ω load
- Switching unit of the same technical family than the one associated to the equipment on vehicle. In the absence of a device of this type, it is necessary to use a relay having characteristics as defined in § 5.3 of the ISO/DIS 7637-2.3 standard.

Note: *the switching unit is not mandatory if it is already integrated in the DUT. The switching unit is then controlled by the DUT itself.*

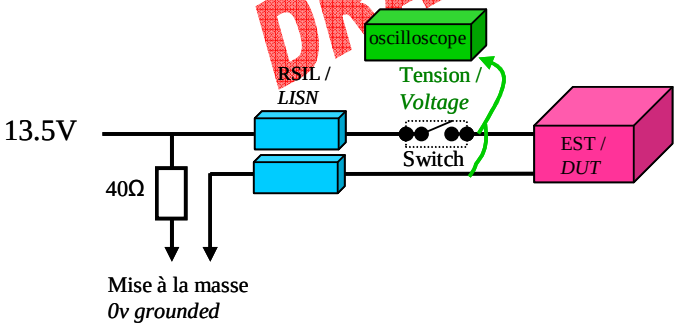
7.4.1.5.Assembly

General assembly

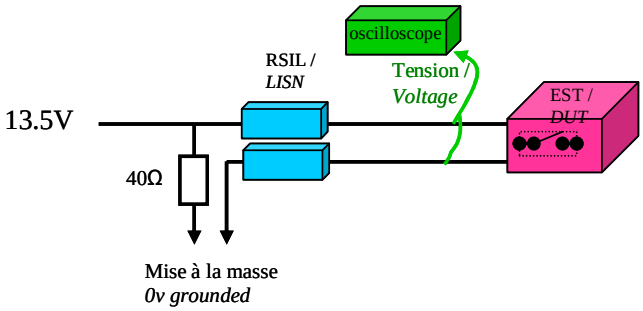


* Harness length shall be (1.0 ± 0.1)m for HV network

Details for the measurements on 12V network



Case of equipments without an internal switch



Case of equipments with internal switch

Note: An adapted connector should allow its connection to the core of the high voltage shielded cables without highly degrading the shielding. The LSIN shielding should be connected to the test ground plane.

7.4.1.6. Procedure

A series of measurements should be carried out by activating the switch, which simulates the activation/de-activation of the DUT by an offset relay, but which can possibly be included into the DUT.

The load placed before the LSIN simulates the resistance in DC of other devices of the vehicle which are connected in parallel to the DUT. Unless otherwise specified in the specifications, this load is 40Ω.

Preparation:

A wiring harness of 200 mm length should be used for the 12V power supply lines under test. The length will be of 1000mm for the shielded cables in the case of high voltage network.

The test wiring harness is placed on an insulating support of 50 mm thickness. The placement of the LSIN should necessarily respect the distance indicated on the assembly diagram.

The DUT is placed on an insulating support of 50 mm thickness. It is connected to the ground plane in conformity with the real installation on vehicle, and no other grounding connection is authorized.

Place the switching unit in accordance with the assembly diagram.

Test:

To determine the maximum amplitude of pulses created, 100 switching operations are required, with a time interval separating two successive switching operations greater than the DUT stabilization time.

Determine the maximum amplitude of the voltage measured in the DUT during various phases of the DUT operation (start-up, operation, and break) by activating the switching unit.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- The parameters of the signals measured (duration, increase and decrease time, voltage values) by specifying to which DUT operation mode they correspond (break, start-up).
- Oscilloscope measurements of some representative wave forms.

7.4.1.7. Requirements

Test	Maximum amplitude
12V network	± 80 V
high voltage network(“200 V”)	± 50 V

7.4.2. EQ/MC 02: MEASUREMENT OF LOW FREQUENCY CONDUCTED NOISES

7.4.2.1. Reference document

There is no reference document that refers to this test.

7.4.2.2. Purpose of the test

This test is intended to evaluate the low frequency transmissions by conduction produced by the DUT and its wiring.

Concerned wires: various types of measurements should be successively carried out:

- Measurement of all the wires connected to the DUT taken in common mode by connector (measurement by successive wiring harnesses in the case of equipment with several connectors).
- Measurement on each power supply + wire and each grounding wire taken separately

7.4.2.3. Conditions for application of the test

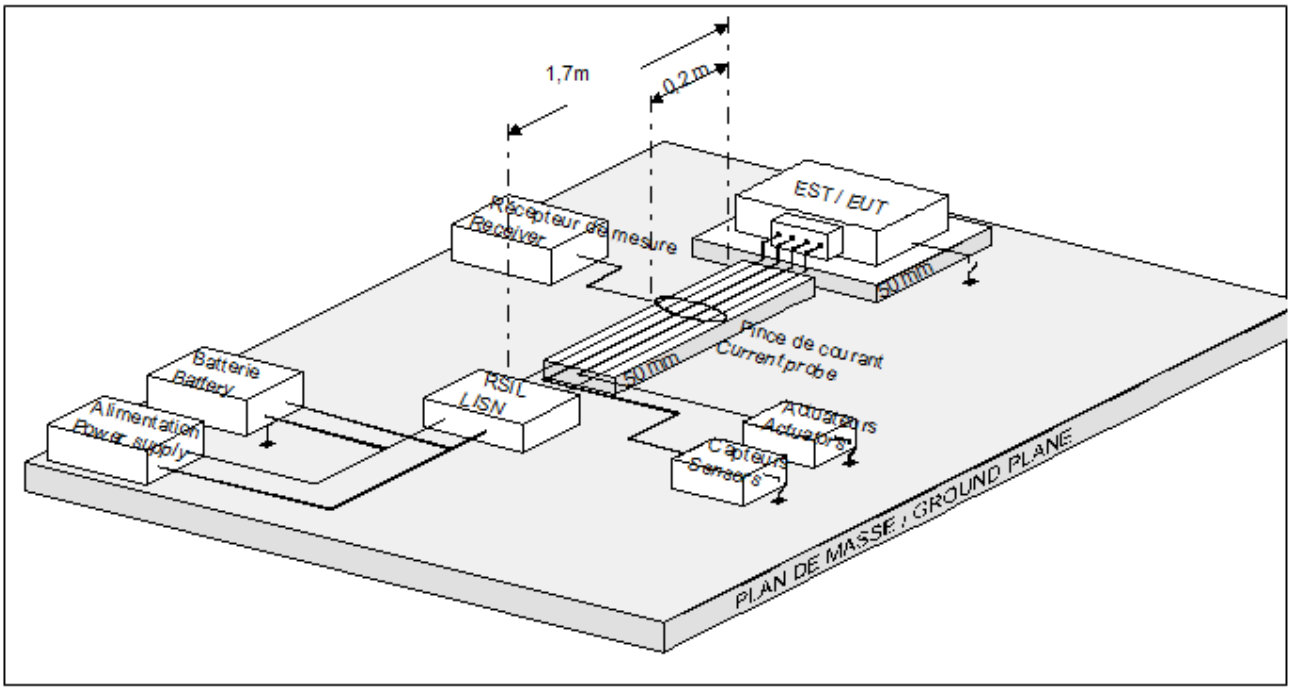
This test is applicable to equipments which consume a current >1Aeff, whatever is powered by 12V power supply lines or high voltage lines (“200V”).

This test does not apply to equipment only having a gateway function for the currents >1Aeff (example: relay), and does not use this current for its own (no transistorized output power nor PWM).

7.4.2.4. Test means

- Power supply and battery.
- Devices necessary for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of thickness 50mm.
- LSIN compliant with the CISPR 25 publication (2 LSIN for a DUT at offset grounding), and/or 2 LSIN high voltage (with a shield connected to the shielding of the high voltage lines) depending upon the power supply type of the DUT.
- 50 Ω load(s)
- Ampere metric clamp
- Receiver or spectrum analyzer

7.4.2.5. Assembly



7.4.2.6. Procedure

Preparation:

Preferably, the real DUT environment and the real wiring harness should be used (possibly, a wiring harness of maximum length 2000 mm can be used). The test wiring harness is placed on an insulating support of 50 mm thickness.

The DUT is placed on an insulating support of 50 mm thickness. It is connected to the ground plane in conformity with its real installation on vehicle, and no other grounding connection is authorized.

The length of the power supply lines will be 1700_{-0}^{+300} mm.

The ampere metric clamp is placed at 200 mm from the DUT.

In the case of a shielded power supply line, the current probe will be positioned around the shielding.

Calibration:

In order to avoid measurement errors, especially due to the saturation of the ampere metric clamp or to an improper decoupling respecting to the power supply, it is advisable to carry out a calibration.

The suggested method is as follows:

- Make a sine wave current of level equal to the specified limit circulate in a known load.
- Measure this current using the ampere metric clamp / measurement device set.
- Compare the results with the voltage measured by an oscilloscope at the load terminals.

Parameters of the measuring device:

Its main characteristics are the following:

- Peak detection
- Frequency band [20 Hz – 20 kHz].
- 6 dB bandwidth of the analysis filter :
  - F <1 kHz: 10 Hz.
  - F ≥ 1 kHz: 100 Hz.

- Using video filtering to limit the analysis bandwidth is not accepted.
- Minimum scanning time for a scanning receiver or spectral analyzer :
  - F < 1 kHz: 150 ms/Hz.
  - F ≥ 1 kHz: 15 ms/Hz.
- Hold time for digital receiver (values recommended in the absence of maximum amplitude search) :
  - F < 1 kHz: 150 ms.
  - F ≥ 1 kHz: 15 ms.
- Increase in frequency (digital receiver) equal to half of the bandwidth of the analysis filter.

A surveyor based on a Fourrier transformed method can be used for the transmission measurements. It should sample and evaluate the signal continuously during the measurement times.

Test:

- Run the DUT for a minimal period of 10 minutes.
- Place the ampere metric clamp around the wiring harness to be tested.
- Connect the measuring device to the clamp by a coaxial cable.
- Carry out the frequential scanning and measure the current in the wiring harness.
- Repeat the operation for all the wiring harnesses connected to the DUT, that have one or several wires conducting a current >1Aeff.
- Repeat the operation on each power supply wire conducting a current >1Aeff taken separately, then on the grounding wire.

Test report :

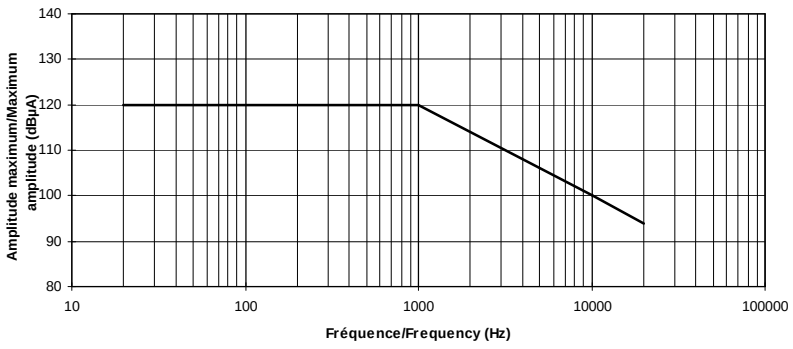
The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- Curve per measurement with : F, I_{eff}, limit (currents in dBuA)

Table of overruns with: F (in Hz), I_{eff}, deviation / limit (currents in dBuA, deviations in dB). In the case of continuous overruns (wide band noise) on a frequency band, only the maximum overrun is required.

7.4.2.7. Requirements

Frequency	Maximum amplitude (effective dBµA)
20 Hz - 1 kHz	120
1 kHz - 20 kHz	120 - 20 x log(F) (F in kHz)



7.4.3. EQ/MC 03: MEASUREMENT OF RADIO FREQUENCY CONDUCTED NOISES ON THE POWER SUPPLY INPUTS

7.4.3.1. Reference document

This test procedure is based on the CISPR 25 publication, except as regards the extension in low frequency to 100 kHz.

7.4.3.2. Purpose of the test

This test is intended to evaluate the radio frequency disturbances emitted by conduction, by the DUT and its power supply wiring.

The wires concerned by the test are the following:

- All the power supply + wires for the DUT taken as a whole in the case of local grounding.
- On all the power supply + wires taken as a whole then grounding in the case of offset grounding from the DUT

7.4.3.3. Conditions for application of the test

This test is applied to the equipment in which at least one of the following conditions is fulfilled:

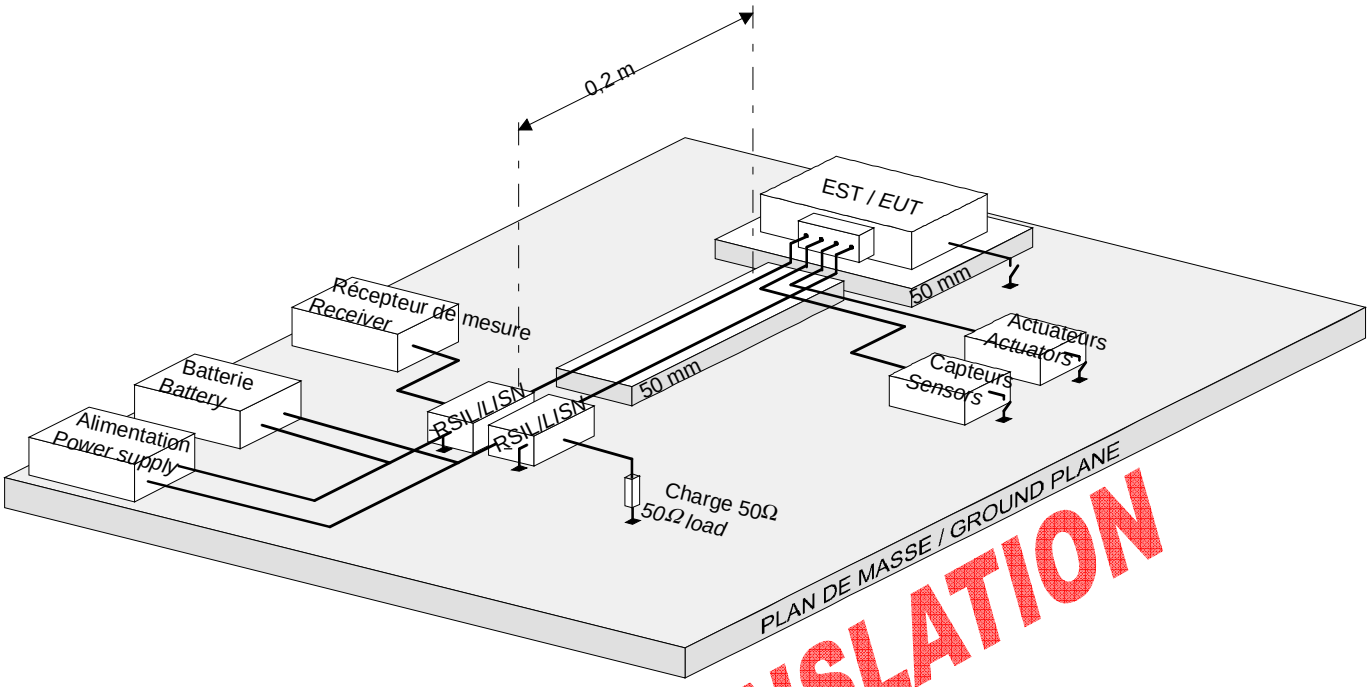
- The equipment contains a frequency oscillator greater than 9kHz
- The equipment contains an electric motor.
- The equipment is supplied in power by a PWM
- The equipment contains one or several transistors (example : LED lights)

This test is not directly applied on the possible high voltage power supply lines (“200V”). The measurement conditions specific to this network are specified in the EQ/MC_HV_01 test.

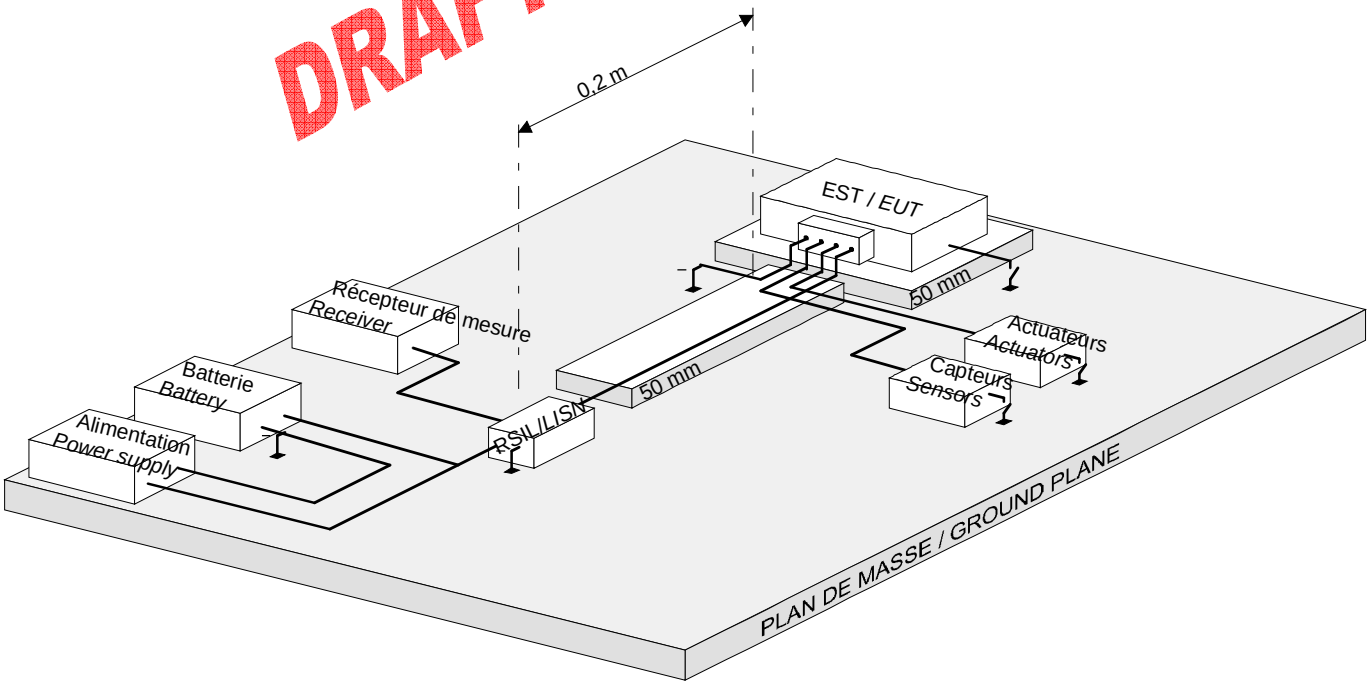
7.4.3.4. Test means

- Power supply and battery.
- Devices necessary for the verification of the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of 50mm thickness.
- LSIN compliant with the CISPR 25 publication (2 LSIN for a DUT with offset grounding), and/or 2 high voltage LSIN (with a shielding connected to the shielding of the high voltage lines) depending upon the power supply type of the DUT.
- 50 Ω load
- Receiver or spectrum analyzer and possibly preselector
- Shielded chamber.

7.4.3.5. Assembly



DUT remotely connected to the ground



DUT locally connected to the ground

7.4.3.6. Procedure

Preparation:

Preferably, a wiring harness of maximum length of 2000 mm should be used (possibly, the real wiring harness can be used). The test wiring harness is placed on an insulating support of 50 mm thickness. The length of the 12V power supply wires should be 200 $^{+200}_{0}$ mm.

The potential high voltage power supply cables (“200V”) will be connected to high voltage LSIN (with a shielding connected to the shielding of high voltage lines), through a length of 1000_{-0}^{+300} mm. These cables will be placed on an insulating support of 50 mm thickness.

The other wires should be plated directly on the ground plane at a minimum distance of 200 mm from the power supply wires

The DUT is placed on an insulating support of 50 mm thickness. It is connected to the ground plane in conformity with its real installation on vehicle, and no other grounding connection is authorized.

In the case of use of several LSIN, the measurement device is successively connected on each LSIN. The non connected LSIN(s) are loaded by 50Ω.

Calibration:

This test does not require any specific calibration.

Parameters of the measuring device:

The following detectors are used:

- peak detector for the evaluation of the levels in relation to the “peak” limit,
- average value detector for the evaluation of the levels in relation to the “average value” limit,
- quasi peak detector can be used (if required) in the 150 kHz – 300 kHz, 530 kHz – 2 MHz and 76-108 MHz bands, for the evaluation of levels in relation to the “quasi-peak” limit.

Note: to reduce the scanning time it is possible to carry out the measurements with a peak detector only. If the measured value is less than the “average value” limit, then the result is accepted.

The values of the bandwidth and scanning times are the following:

- For the spectrum analyzers:

Service / Frequency band (MHz)		Peak detector		Quasi peak detector		Average value detector	
		Band width at -3 dB	Scanning time	Band width at -6 dB	Scanning time	Band width at -3 dB	Scanning time
ADML system	0.1 – 0.15	100Hz	100s/MHz	Not applicable	Not applicable	Not applicable	Not applicable
AM radio and mobile services	0.15 - 30	9/10 kHz	10 s / MHz	9 kHz	200 s / MHz	9/10 kHz	10 s / MHz
FM radio	76 - 108	100/120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100/120 kHz	100 ms / MHz

- For the receivers:

Service / Frequency band (MHz)		Peak detector			Quasi peak detector			Average value detector		
		Band width at -6 dB	step	Holding time	Band width at -6 dB	step	Holding time	Band width at -6 dB	step	Holding time
ADML system	0.1 – 0.15	200Hz	100Hz	500ms	does not apply	does not apply	does not apply	does not apply	does not apply	does not apply
AM radio and mobile services	0.15 - 30	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
FM radio	76 - 108	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	/ 50 kHz	5 ms
Note: for the transmissions generated by the brush motors that do not have any electronic control unit, the maximum frequency step can be increased up to 5 times the bandwidth.										

Note: A surveyor based on a Fourrier transformation method can be used for the transmission measurements. It should sample and evaluate the signal continuously during the measurement time. The minimum measurement time as well as the timing considerations are defined in the CISPR 16-2-3 and 3.1 (chapters 6.6.2 and 6.6.6).

Test:

Run the DUT for a minimal period of 10 minutes. Carry out the measurements, with peak detection (quasi-peak) and with average value detection at the LSIN terminals.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment.
- The operating procedures of the DUT likely to have an impact on the test result (consumption, PWM cyclic ratio…)
- Curve per measurement with: F, V_{avg}, V_{peak}, $V_{quasi-peak}$ (if requested), peak limits, average value and possibly quasi-peak (voltages in dBuV)
- Table of overruns with: F (in MHz with 3 digits after the comma), V_{avg}, V_{peak}, $V_{quasi-peak,}$ deviation/peak limit and deviation/ average value limit or possibly deviation /quasi-peak limit (voltage in dBuV, deviation in dB). In the case of continuous overruns (broad band noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with 3 digits after the comma), V_{avg}, V_{peak} or $V_{quasi-peak}$, average value, peak and possibly quasi-peak limits (voltages in dBuV), wire(s) measured should be provided in digital form in an Excel table in this order.

7.4.3.7. Requirements

The values measured at the LSIN terminals, in peak detection and in average value detection should not exceed the following values (the two peak and average value requirements should be satisfied):

Services and frequencies (MHz)		Peak limit detector "permanent" noises		Peak limit detector "short duration" noises (1)		Average value limit detector	
		Class	Limit in dBµV	Class	Limit in dBµV	Class	Limit in dBµV
ADML system (4)	0.10 – 0.15	_	80	_	_	_	_
LW (2)	0.15 – 0.30	4	80 67 (quasi peak) (3)	3	86 73 (quasi peak) (3)	4	60
MW (2)	0.53 – 1.8	3	70 57 (quasi peak) (3)	2	76 63 (quasi peak) (3)	3	50
SW (2)	5.9 – 6.2	3	65	2	71	3	45
CB	26 - 28	3	56	2	62	3	36
VHF	30 - 54	2	62	1	68	2	42
VHF	68 – 87	4	44	3	50	4	24
FM (2)	76 - 108	4	44 31 (quasi peak) (3)	3	50 37 (quasi peak) (3)	4	24

(1) Unless otherwise specified, the "short duration" qualification corresponds to the equipment whose use is less than a minute (examples such as window-lift noise, windscreen washer pump; examples of constant noises: wind screen wiper, GMV…).

(2) In the case of equipments located close to the receiving or AM and/or FM screen printed antenna (rear window, quarter panel, top of the windscreen…), these levels should get their severity increased by 10 db in the considered frequency bands. This case is to be specified in the TNS/TS or the EMC test plan.

(3) The given levels with quasi-peak detector are applicable on specific request (example: PWM signals…)

(4) The limit in the 100-150kHz band is not applicable to equipments which are localized under the hood.

(5) The measurements lower than 30MHz should be carried out on the entire band at 0.1 – 30MHz, even if no limit is applied in certain sub-bands.

7.4.4. EQ/MC 04: MEASUREMENT OF RADIO FREQUENCY CONDUCTED NOISES ON THE OUTPUTS

7.4.4.1. Reference document

This test procedure is based on the CISPR 25 publication, except as regards the position of the measurement clamp.

7.4.4.2. Purpose of the test

This test is intended to evaluate the radio frequency disturbances emitted by conduction, by the DUT and its power output wiring and/or shielded cables.

The wires concerned by the test are the following:

- **Shielded cables (coaxial antenna, LVDS cable…):** the measurements are carried out on each shielded cable successively.
- **Power outputs:** a power output is any output (PWM or DC) likely to deliver more than 0.25A peak. In this case, the measurements are carried out on all the power outputs (differential and/or common mode outputs) grouped, by excluding the other wires (signals, grounding returns other than those of differential power output). If this measurement shows a surpassing of the requirement, additional measurements should also be carried out :
    - on each differential power output (2 associated back and forth wires)
    - on all common mode power outputs (by excluding all the other wires).

Note : in order to avoid the bursting of the wiring harness of the test bench, it is allowed to leave certain output wires in the measuring clamp (TOR signals, sensors..), provided that the return grounding wires (other than those of differential output power) and the inputs of the power supply remains outside the clamp. In this case, the test plan should accurately describe the tested configuration.

The high voltage power supply lines (“200V”), are subject to specific test conditions, which are mentioned in the EQ/MC_HV_04 test.

7.4.4.3.Conditions for application of the test

This test is applied to the equipments for which the EQ/MR01 test is applicable and which moreover:

- have power supply outputs or power outputs likely to deliver more than 0.25A peak (examples : relayed BSI or BSM outputs, BSI or BSM “smart power” outputs, PWM control output of a CMM towards a turbo…)

Or

- have shielded cables (coaxial antenna, LVDS cable…)

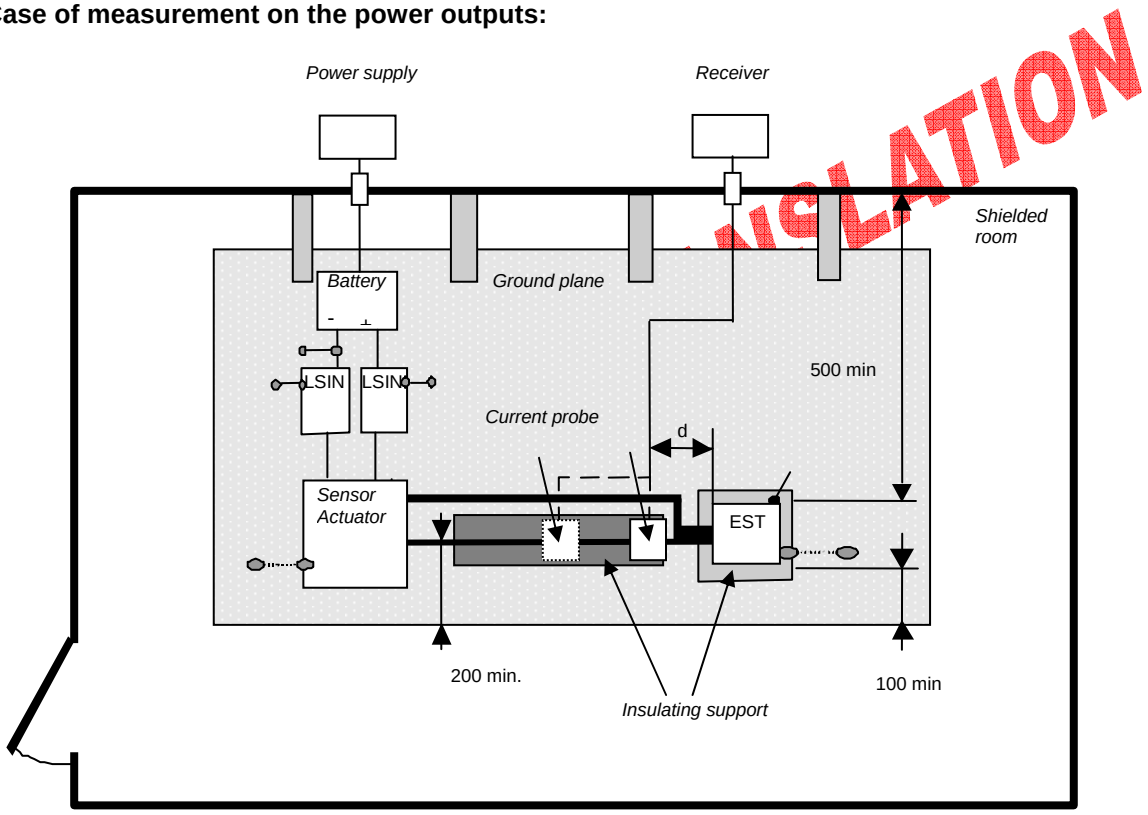
All input-output other than those of power or of shielded cables can - if needed - be subjected to the test (periodic scanning signals, PWM with low current…) if the feedback justifies it. In this case, the TNS/TS will specify to which input-output the test is applied.

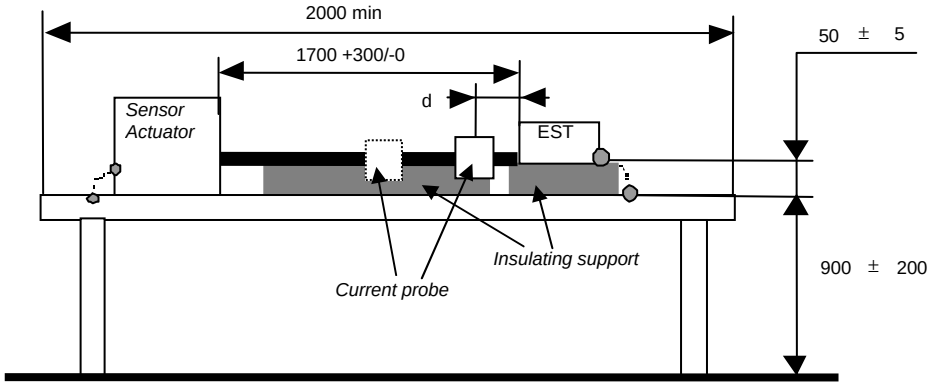
7.4.4.4. Test means

- Power supply and battery.
- Devices necessary for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of 50mm thickness.
- LSIN compliant with the CISPR 25 publication and/or 2 high voltage LSIN (with a shielding connected to the shielding of the high voltage lines) depending upon the type of power supply to the DUT.
- Current prove
- 50 Ω load
- Receiver or spectrum analyzer and possibly preselector
- Shielded chamber.

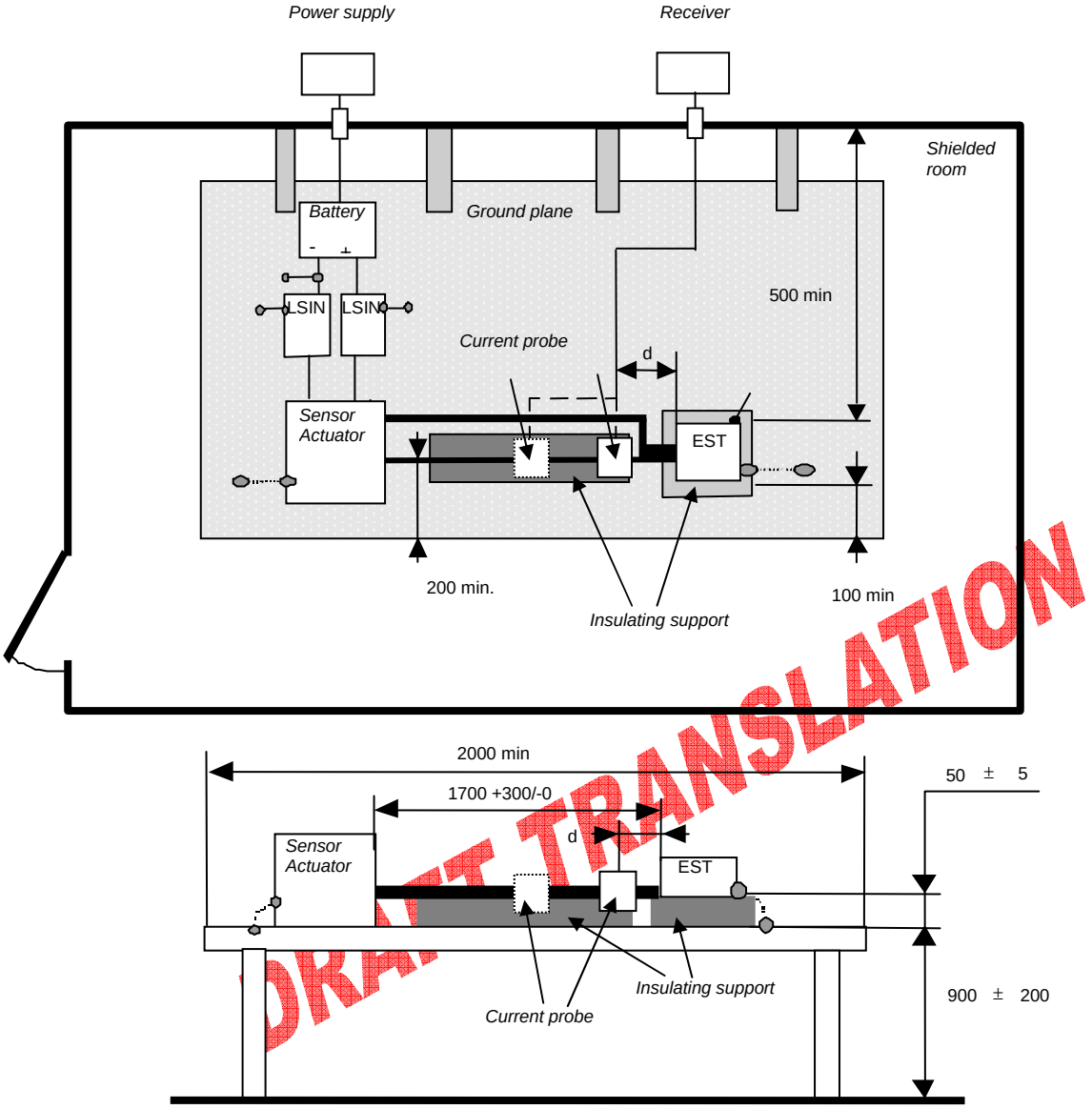
7.4.4.5. Assembly

Case of measurement on the power outputs:





Measurements case on the power outputs:



7.4.4.6. Procedure

Preparation:

A wiring harness of a total length of 1700 $_{-0}^{+300}$ mm between the DUT and the load bench should be used. In the case of a shielded cable, the length of the cable which is the object of the test will be 1700 $_{-0}^{+300}$ mm.

The arm of the wiring harness on which the measurement will be carried out is placed on an insulating support of 50 mm thickness.

The possible high voltage power supply cables (“200V”) will be connected to high voltage LSIN (with shielding connected to the shielding of the high voltage lines), through a length of 1000 $_{-0}^{+300}$ mm. These cables will be placed on an insulating support of 50 mm thickness.

The other arms are separated by at least 10 cm from that of the object of the measurement, and arranged on the ground plane.

The DUT is placed on an insulating support of 50 mm thickness. It is linked to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The current probe will be placed successively at various positions along the wiring harness or of the concerned arm, as indicated hereinafter.

Calibration:

This test requires no specific calibration.

Parameters of the measuring device:

The bandwidth values and scanning time are the following:

- For the spectrum analyzers:

Service /Frequency band (MHz)		Peak detector		Quasi peak detector		Average value detector	
		Band width at -3 dB	Scanning time	Band width at -6 dB	Scanning time	Band width at -3 dB	Scanning time
AFML system	0.1 – 0.15	100Hz	100s/MHz / 100s/MHz	Non applicable / Not applicable	Non applicable / Not applicable	Non applicable / Not applicable	Not applicable
AM radio and mobile services	0.15 - 30	9/10 kHz	10 s / MHz / 10 s / MHz	9 kHz /9 kHz	200 s / MHz / 200 s / MHz	9/10 kHz / 9/10 kHz	10 s / MHz
FM radio or DAB	76 - 108	100/120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100/120 kHz	100 ms / MHz

- For the receivers:

Service / Frequency band (MHz)		Peak detector			Quasi peak detector			Average value detector		
		Band width at -6 dB	step	Holding time	Band width at -6 dB	step	Holding time	Band width at -6 dB	step	Holding time
ADML system	0.1 – 0.15	200Hz	100Hz	500ms	does not apply	does not apply	does not apply	does not apply	does not apply	does not apply
AM radio and mobile services	0.15 - 30	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
FM radio or DAB	76 - 108	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
Note: for the transmissions generated by the brush motors that do not have an electronic control unit, the maximum frequency step can be increased up to 5 times the bandwidth.										

Note: the noise level of the measurement chain should be less than 6dB of the specified limits. To satisfy this criterion, it can be necessary to insert a preamplifier.

Note: A surveyor based on a Fourrier transformation method can be used for the transmission measurements. It should sample and evaluate the signal continuously during the measurement time. The minimum measurement time as well as the timing considerations are defined in the CISPR 16-2-3 and 3.1 (chapters 6.6.2 and 6.6.6).

Test:

- Run the DUT for a minimum period of 10 minutes.
- Carry out the measurements, in peak detection (quasi-peak) and in average value detection, at the clamp terminals.
- Carry out the current measurements for the various following clamp positions:
- **Measurement case on the power outputs**: at 50 mm from the DUT for all the frequency bands, as well as at 750mm from the DUT (in addition to the measurement at 50 mm) for the FM and DAB bands.

- **Measurement case on the shielded cables**: at 50 mm from the shielded cable end (opposite to the DUT) for all the frequency bands, as well as at 50mm from the DUT for the FM and DAB bands, the shielded cable grounding being connected to its end in short circuit to the test ground plane.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment, positions of the measurement clamps
- Description of the outputs tested and their load condition.
- The operating procedures of the DUT likely to have an impact on the test result (consumption, PWM cyclic ratio….).
- Curve by measurement with : F, I_{avg} , I_{peak} , or $I_{quasi-peak}$ (if requested), peak limits, average value and possibly quasi-peak (current in dBuA)

Table of overruns with: F (in MHz with 3 digits after the comma), I_{avg}, I_{peak}, or $I_{quasi-peak,}$ (if requested), deviation/peak limit and deviation/ average limit value or possible deviation /quasi-peak limit (current in dBuA, deviation in dB). In the case of continuous overruns (broad band noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with 3 digits after the comma), I_{avg}, I_{peak}, or $I_{quasi-peak}$, average limit value, peak and possibly quasi-peak (currents in dBuA), wire(s) measured should be provided in digital form in an Excel table in this order.

7.4.4.7. Requirements

The values of measured current in peak detection and in average detection value should not exceed the following values (the two peak and average value requirements should be satisfied):

Services and frequencies (MHz)		Peak detector limit "Permanent" noises		Peak detector limit "Short duration" noises **(1)**		Average value detector limit	
		Class	Limit in dBµV	Class	Limit in dBµV	Class	Limit in dBµV
Key less system (3)	0.10 – 0.15	_	66	_	NA	_	NA
LW **(4)**	0.15 – 0.30	4	60 47 (quasi peak) (2)	3 / 3	66 53 (quasi peak) (2)	4	40
MW **(4)**	0.53 – 1.8	3	42 29 (quasi peak) (2)	2 / 2	48 35 (quasi peak) (2)	3	22
SW **(4)**	5.9 – 6.2	3	31	2 / 2	37	3	11
FM **(4)**	76 - 108	4	10 -3 (quasi peak) (2)	3 / 3	16 3 (quasi peak) (2)	4	-10
DAB III **(4)**	171 - 245	_	14	_	20	_	-6

(1) Unless otherwise specified, the "short duration" qualification corresponds to the equipments which are used for less than 1 minute (examples window lift noises, windscreen washer pump; examples of constant noises: windscreen wiper, GMV…)

(2) The levels given with quasi-peak detector are applicable on specific request (example: PWM signals,)

(3) The limit in the 100-150 kHz band is not applicable to equipments which are localized under the hood.

(4) In the case of equipments located near a printed reception antenna AM, FM and/or DAB III (rear-window, quarter windows, top of the windshield…), those levels have to be severized by 10dB in the frequency bands considered. This case has to be specified in the TNS/TS or the EMC test plan.

7.4.5. EQ/MR 02: MEASUREMENT OF LOW FREQUENCY MAGNETIC FIELD

7.4.5.1. Document reference

1999/519/CE European recommendation and no. 2002-775 decree of 03rd May 2002.

7.4.5.2. Purpose of the test

This test is intended to evaluate the levels of magnetic fields radiated by the electrical/electronic components of the vehicle in order to limit the exposure to people. For the 100-150 kHz band, this test is also intended to protect the ADML system.

7.4.5.3. Test application conditions

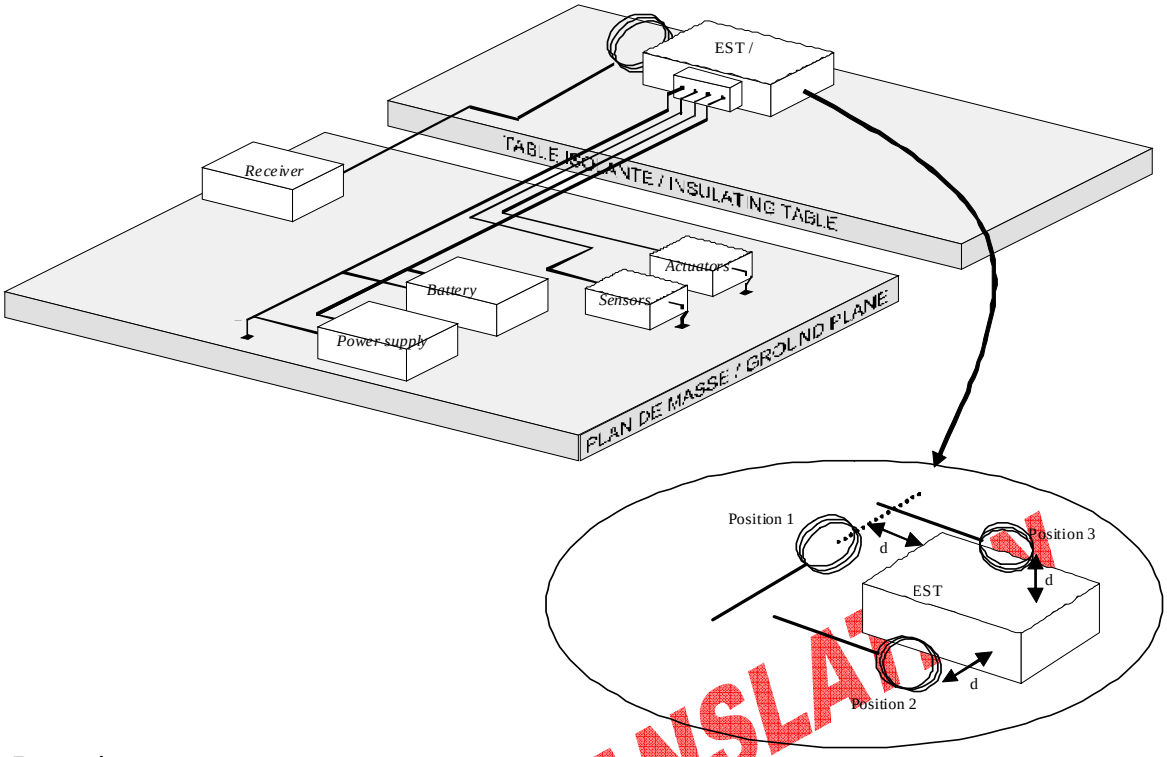
This test is applicable from 5Hz to 150 Hz only for motors and to equipments consuming a current > 1Aeff, whatever is their localization: application of the "healthy" limit.

The measure in the 100 – 150 kHz band is applicable to all the equipments located in the passenger compartment (including the boot): application of the "protection of the ADML system" limit.

7.4.5.4. Test means

- Tests area without high magnetic field source.
- Power supply and/or battery.
- Devices necessary for monitoring the proper operation of the DUT.
- The DUT environment, real (sensors, actuators) or simulated.
- Receiver or spectrum analyzer.
- A loop having the characteristics of the MIL STD 461E is recommended:
    - Diameter: 13.3 cm
    - Number of turns: 36

7.4.5.5. Assembly



7.4.5.6. Procedure

Preparation:

The measurements should be carried out in the most disturbing DUT configuration (see § 5.9).

The distinction of the two types of equipments will be made below:

Equipments located in the passenger compartment zone.

Equipments located in the engine compartment.

Test:

The measurement zone to be considered is a case which includes the surface of the DUT defined by a distance d in relation to the DUT. The distance d between the sensor and the DUT is to be defined in the TNS/TS or the test plan. By default it is 7 cm for the equipments located in the passenger compartment zone and 30 cm for the equipments of the engine compartment.

Run the DUT for at least 10 minutes.

Run the vehicle procedure(s) defined in the test plan.

Carry out the measurement of the magnetic fields at the DUT level by scanning the first zone of the selected measurement by searching the maximum level and by respecting the characteristics of the response time measurement device.

Calibration:

This test does not require any specific calibration.

Parameters of the measuring instrument:

Its main characteristics are the following:

- Effective value.
- Frequency band: [5Hz – 150 kHz].

- Bandwidth of 6 dB of the analysis filter:
  - F < 100Hz : 1 Hz
  - 100Hz < F < 1 kHz : 10 Hz
  - F ≥ 1 kHz : 100 Hz
- The use of video filtering to limit the analysis bandwidth is not accepted.
- Minimum scanning time for a scanning receiver or spectrum analyzer:
  - F < 100Hz : 1500 ms/Hz
  - 100Hz < F < 1 kHz : 150 ms/Hz
  - F ≥ 1 kHz : 15 ms/Hz
- Holding time for the digital receiver (values recommended in the absence of maximum amplitude search):
  - F < 100Hz : 1500 ms
  - 100Hz < F < 1 kHz : 150 ms
  - F ≥ 1 kHz : 15 ms
- Increase of frequency (digital receiver) equal to half of the bandwidth of the analysis filter.

Note: A surveyor based on a Fourrier transformation method can be used for the transmission measurements. It should sample and evaluate the signal continuously during the measurement period.

Test report:

The test report should, among other things, include the following elements:

- Curve by measurement with: F, Heff, limit (field in A /m) for the worst case in position.
- Table of overruns with: F (in Hz), Heff, deviations/limit (field in A /m) for the worst case in position.

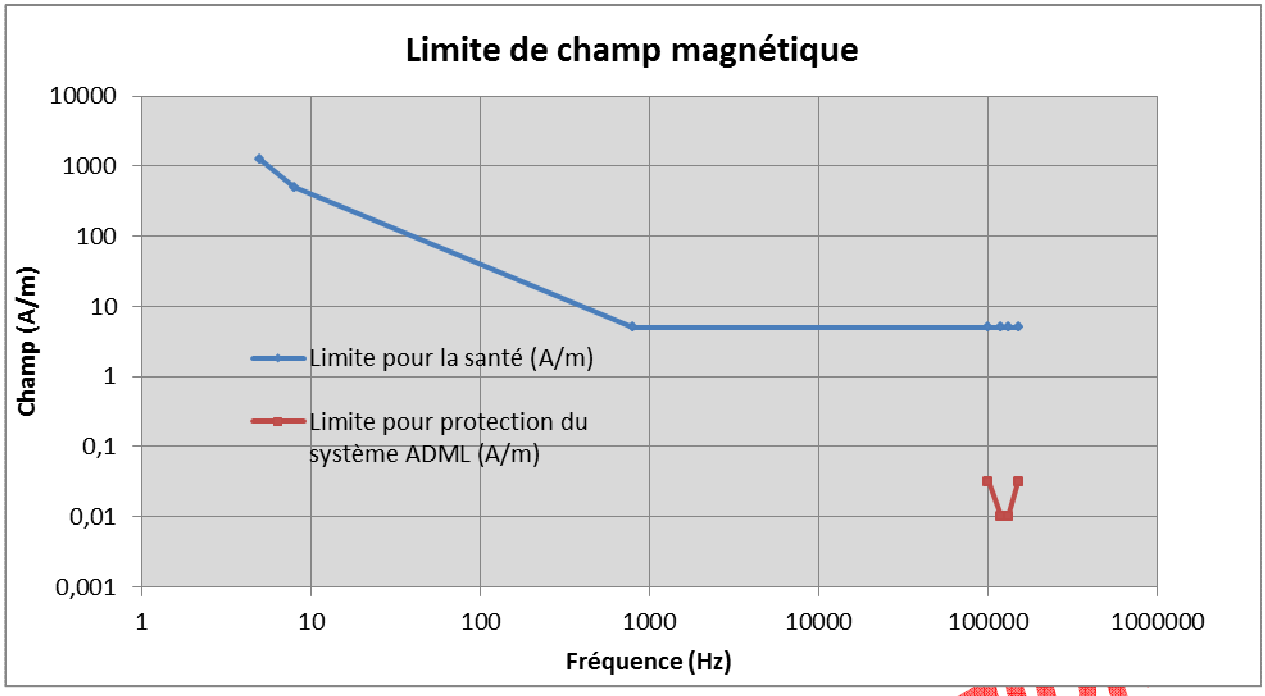
7.4.5.7. Requirements

The levels which are not to be exceeded for the "health" limit are the following:

Frequency (Hz)	Limit (A/m)	Limit (µT)
5 – 8	3.2 x 104/ F2	4 x 104/ F2
8 – 800	4000/F	5000/F
800 – 150000	5	6.25

The levels which are not to be exceeded for the limit related to the protection of the "key less system" system are the following:

Frequency (kHz)	Limit (dBµA/m)	Limit (mA/m)	Limit (nT)
100 - 119	Decreasing from 90 to 80	Decreasing from 31.6 to 10	Decreasing from 39.8 to 12.6
119 - 131	80	10	12.6
131 - 150	Increasing from 80 to 90	Decreasing from 10 to 31.6	Increasing from 12.6 to 39.8



7.4.6. EQ/MR 01: MEASUREMENT OF RADIATED RADIO FREQUENCY NOISES

7.4.6.1. Reference document

This test procedure is based on the CISPR 25 publication, except for:

- The consideration of the disturbances outside the bands CISPR 25.
- The extension in low frequency at 100 kHz.
- The number of faces to be tested for frequencies higher than 30 MHz (3 faces, unless the housing is made from metal and sealed) Le nombre de faces à tester pour les fréquences supérieures à 30MHz, (3 faces, sauf si le boîtier de l'équipement est métallique et fermé).
- The antenna position (facing the equipment) for the measurements beyond 800 MHz (instead of 1000MHz in the CISPR 25).
- Use of a peak detector in addition to the average value detector for the GPS band.

7.4.6.2. Purpose of the test

This test is intended to evaluate the radio frequency disturbances transmitted by radiation by the DUT and its wiring.

7.4.6.3. Conditions for application of the test

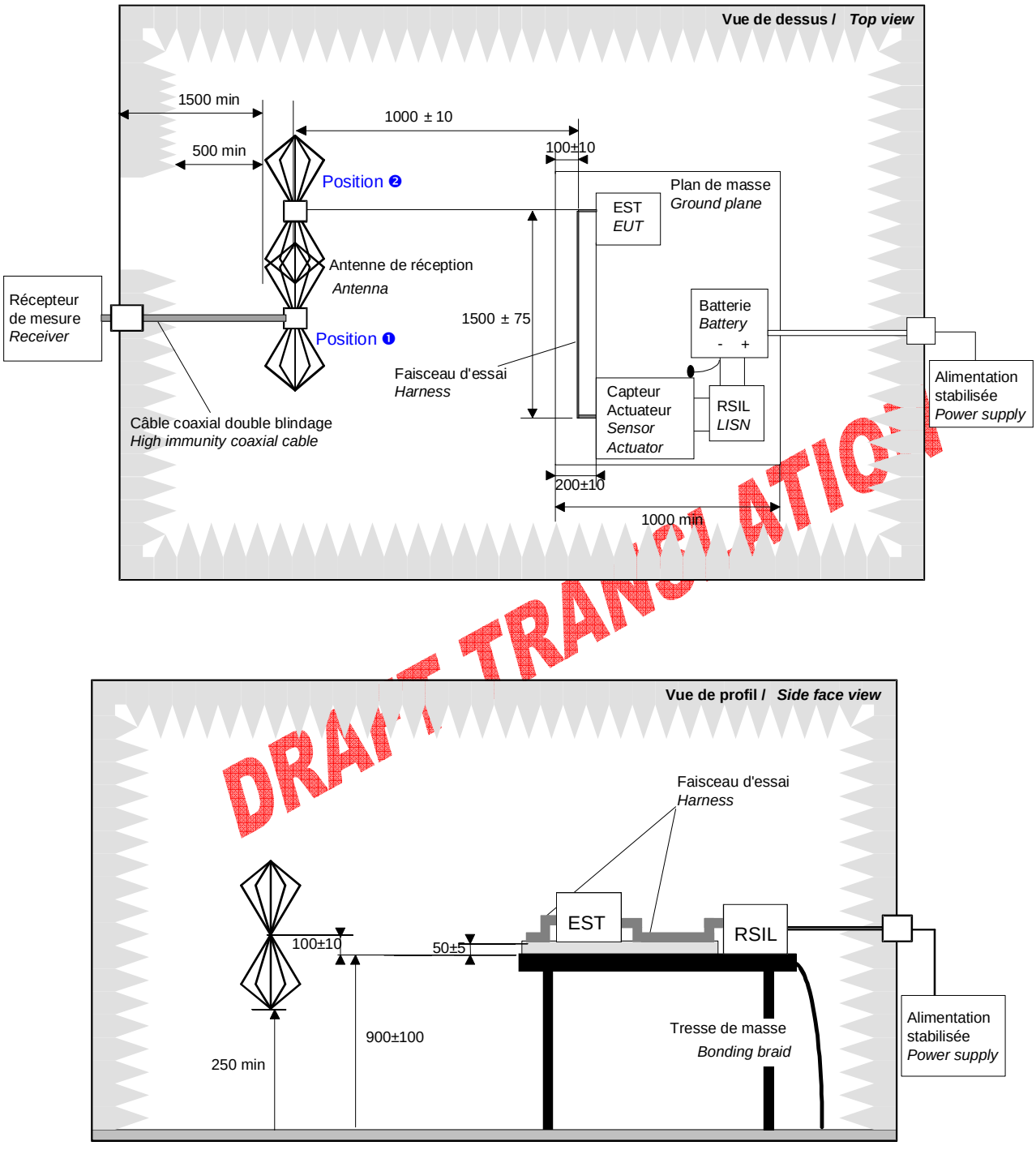
This test is applied to the equipment in which at least one of the following conditions is fulfilled:

- The equipment contains a frequency oscillator greater than 9kHz
- The equipment contains an electric motor.
- The equipment is powered by a PWM
- The equipment contains one or several transistors (example : LED lights)

7.4.6.4. Test means

- Power supply and battery.
- Devices necessary for the verification of proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support of 50mm thickness.
- LSIN compliant with the CISPR 25 publication (2 LSIN for a DUT with offset grounding), and/or 2 high voltage LSIN (with a shielding connected to the shielding of the high voltage lines) depending upon the type of power supply to the DUT.
- 50 Ω load (s)
- Receiver or spectrum analyzer compliant with CISPR 16-1 standard.
- Measurement antennae: Vertical mono-pole 1 m, bi-conical, log-periodic or cone.
- Semi-anechoic or anechoic chamber

7.4.6.5. Assembly



7.4.6.6. Procedure

Preparation:

A wiring harness of a total length of 1700 $_{-0}^{+300}$ mm between the DUT and the load bench should be used.

The test wiring harness is placed on an insulating support of 50 mm thickness.

The possible high voltage power supply cables (“200V”) will be connected to high voltage LSIN (with shielding connected to high voltage shielded lines), through a length of 1700 $_{-0}^{+200}$ mm. These cables will be placed on an insulating support of 50 mm thickness.

The DUT is placed on an insulating support of 50 mm thickness. It is connected to the ground plane in conformity with its real installation on the vehicle, and no other grounding connection is authorized.

The LSIN is placed at 2000 mm maximum from the DUT.

Calibration:

This test does not require any specific calibration.

Parameters of the measuring device:

The following detectors are used:

- peak detector for the evaluation of the levels in relation to the “peak” limit,
- average value detector for the evaluation of the levels in relation to the “average value” limit,
- quasi-peak detector can be used (if required) in the 150 kHz – 300 kHz, 530 kHz – 2 MHz and 76-108 MHz bands, for the evaluation of levels in relation to the “quasi-peak” limit.

Note: *to reduce the scanning time, it is possible only to carry out the measurements with only a peak detector. If the measured value is less than the limit “average value”, then the result is accepted.*

The values of bandwidth and scanning times are as follows:

- For the spectrum analyzers :

Service / Bande de fréquence MHz		Détecteur crête		Détecteur quasi crête		Détecteur valeur moyenne	
		Bande passante à -3 dB	Temps de balayage	Bande passante à -6 dB	Temps de balayage	Bande passante à -3 dB	Temps de balayage
AM broadcast and mobile services	0,15 - 30	9/10 kHz	10 s / MHz	9 kHz	200 s / MHz	9/10 kHz	10 s / MHz
FM broadcast	76 - 108	100/120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100/120 kHz	100 ms / MHz
GPS L1 civil	1567 - 1583	9/10 kHz	1 s / MHz	Non applicable	Non applicable	9/10 kHz	1 s / MHz
Autres services ou bandes	30 - 2500	100/120 kHz	100 ms / MHz	Non applicable	Non applicable	100/120 kHz	100 ms / MHz

- For the receivers :

Service / Bande de fréquence MHz		Détecteur crête			Détecteur quasi crête			Détecteur valeur moyenne		
		Bande passante à -6 dB	Pas	Temps de maintient	Bande passante à -6 dB	Pas	Temps de maintient	Bande passante à -6 dB	Pas	Temps de maintient
AM broadcast and mobile services	0,15 - 30	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
FM broadcast	76 - 108	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
GPS L1 civil	1567 - 1583	9 kHz	5 kHz	5 ms	Non applicable	Non applicable	Non applicable	9 kHz	5 kHz	5 ms
Autres services ou bandes	30 - 2500	120 kHz	50 kHz	5 ms	Non applicable	Non applicable	Non applicable	120 kHz	50 kHz	5 ms
NOTE : pour les émissions générées par les moteurs à balais ne disposant d'aucune électronique de commande, le pas de fréquence maximal peut être étendu à 5 fois la bande passante.										

Note : To reduce the scanning time in the mobile bands with average value detector, it is possible to carry out the measurement with a bandwidth of 120 kHz (100 kHz for a spectrum analyzer) instead of 9 kHz. If the value measured is lower than the average value limit indicated in the test plan, then the result of the average measurement value is accepted. The measurement bandwidth value used in this frequencies range should be indicated in the test plan.

Note : The noise level of the measurement chain should be less than 6dB at the specified limits. To satisfy these criteria, it can be necessary to insert a preamplifier with a gain of 30dB nearest to the antenna. If these precautions are not enough, it is possible to reduce the bandwidth in the considered band to reduce the measurement noise, in which case the applicable requirements should be defined in agreement with the manufacturer.

Note: A surveyor based on a Fourrier transformation method can be used for the transmission measurements. It should sample and evaluate the signal continuously during the measurement time. The minimum measurement time as well as the timing considerations are defined in the CISPR 16-2-3 and 3.1 (chapters 6.6.2 and 6.6.6).

Faces to be tested :

For the frequencies higher than 30 MHz, the DUT is oriented according to the faces to be tested described in the test plan. In the case of a metal housing entirely sealed (without any opening), one face is tested (connector in front of the antenna). In all other cases, the number of faces to be tested is Three. The faces have to be chosen in ordrer to maximize the coupling, and have to be defined in the equipment's specification and/or the test plan.

Test:

Run the DUT for a minimal period of 10 minutes.

Carry out the measurements in horizontal and vertical polarizations, in peak detection (quasi-peak) and in average value detection.

The measurements should be carried out for two antenna positions: opposite to the middle of the wiring harness (position❶) of 150 kHz to 800 MHz, opposite to the DUT (position❷) of 800 MHz to 2.5 GHz.

For frequencies higher than 30 MHz, repeat all the measures on all the faces to be tested.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring harness, DUT environment
- The operating procedures of the DUT likely to have an impact on the test result (consumption, PWM duty factor….).
- Curves by measurement with : F, E_{avg} , E_{peak} , $E_{quasi-peak}$ (if requested), peak limits, average value and possibly quasi-peak (field in dBuV/m). Each result for each face tested has to be reported in a separate curve, although the three curves can appear on the same graph.
- Table of overruns with: F (in MHz with 3 digits after the comma), E_{avg}, E_{peak}, $E_{quasi-peak,}$ (if requested), deviation/peak limit and deviation/ average value limit or possible deviation/quasi-peak limit (current in dBuV/m, deviation in dB). In the case of continuous overruns (broad band noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with 3 digits after the comma), E_{avg}, E_{peak}, $E_{quasi-peak}$, average limit value, peak and possibly quasi-peak (currents in dBuV/m), polarization should be provided in digital form in an Excel table in this order.

7.4.6.7. Requirements

The values measured in peak detection and in average value detection should not exceed the following values (the two requirements peak and average value should be satisfied):

		Peak limit detector "Constant" noises		Peak limit detector "Short duration" noises (1)		Average value limit detector	
		Class	Limit in dBµV/m	Class	Limit in dBµV/m	Class	Limit in dBµV/m
Services and frequencies (radiodiffusion) (MHz) (6)							
LW (2)	0.15 – 0.30	4	56 43 (quasi peak) (5)	3	62 49 (quasi peak) (5)	4	36
MW (2)	0.53 – 1.8	3	56 43 (quasi peak) (5)	2	62 49 (quasi peak) (5)	3	36
SW (2)	5.9 – 6.2	3	52	2	58	3	32
FM (2)	76 - 108	5	38 25 (quasi peak) (5)	4	44 43 (quasi peak) (5)	5	18
DAB III (2)	171 - 245	_	42	_	48	4	22
DTTV	470 - 770	3	57	2	63	3	47
DAB L band	1447 - 1494	_	44	_	50	4	24
Services and frequencies (mobile services) (MHz) (6)							
CB	26 - 28	3	52	2	58	3	32 / 32
VHF	30 - 54	2	58	1	64	2	38
VHF	68 - 87	4	41	3	47	4	21
VHF	142 -175	3	47	2	53	3	27
analog UHF	380 - 512	3	50	2	56	3	30
RKE (3)	300 - 330	3	44	2	50	5	18 (3)
RKE (3)	420 - 450	3	44	2	50	5	18 (3)
4G	791 - 821	_	50	_	56	_	30
analog UHF	820 - 960	3	56	2	62	3	36
GSM 800 and AMPS USA	860 - 895	4	50	3	56	4	30
EGSM/GSM 900 and PDC Japan	925 - 960	4	50	3	56	4	30
PDC Japan	1477-1501	4	50	3	56	4	30
GPS L1 civil (4)	1567 - 1583	4	36 (4)	3	42 (4)	4	16 (4)
GSM 1800 (PCN)	1803 - 1882	4	50	3	56	4	30
GSM 1900	1850 - 1990	4	50	3	56	4	30
3G and PCS USA	1900 - 1992	4	50	3	56	4	30
3G	2010 - 2025	4	50	3	56	4	30
3G	2108 - 2172	4	50	3	56	4	30
Bluetooth/802.11	2400 - 2500	4	50	3	56	4	30
4G	2620 - 2690	_	50	_	56	_	30
Frequencies which correspond to 2004-104 (MHz)							
30-75		62 – 25.13 log (F/30)				52 – 25.13 log (F/30)	
75-400		52 + 15.13 log (F/75)				42 + 15.13 log (F/75)	
400-1000		63				53	

(1) Unless otherwise specified, the « short duration » qualification correponds to equipments the use of which is lower than a minute (examples of such noises : electric window motors, washer pump ; examples of permanent noises : windscreen wipers, fan-motor assembly..)

(2) In the case of equipments located near a printed reception antenna AM, FM and/or DAB III (rear-window, quarter windows, top of the windshield…), those levels have to be severized by 10dB in the frequency bands considered. This case has to be specified in the TNS/TS or the EMC test plan.

(3) For the RKE (300-330 and/or 420-450MHz) bands, the average limit value of 18dBµV/m mentioned in the table refers to the central frequency of the band. The limit applicable is given in the table 1 and figures 1 and 2. This limit is applied to the equipment capable of being powered before startup or after disconnection of the +APC. In the case of non-powered equipments as soon as the +APC is disconnected (and before the network goes into standby mode), the limit of 30dBµV/m is applied to the entire band.

(4) For the GPS L1 (1567-1583MHz) band, the peak limits and average value mentioned in the table refer to the central band frequency. The applicable template is given in the table 1 and figure 3.

(5) The levels given with quasi-peak detector are applicable on specific request (example: PWM signals,)

(6) Certain limits cannot be applicable in certain frequency bands, depending upon the geographical destination of the vehicle. The applicability of services and corresponding limits depending on the regions is given in the table 2.

(7) The measurement of the field from 1 GHz to 2.5 GHz is not mandatory for the equipments neither motor nor oscillator likely to generate harmonics of high frequency (measurement will be the main criteria : presence of levels having less than 20 dB margin in relation to specified limits of 470MHz to 1 GHz).

(8) The measurements lower than 30MHz should be carried out on the entire band 0.1 – 30MHz, even if no limit is applied in certain sub-bands.

(9) In the case of intentional transmitters (examples: plip, GSM…), the requirements are not applied for the operation frequency of the transmitter and of its harmonics, subject to compliance with the regulation and/or the specific applicable radio-communications standards.

Table 1: points for the specific limits in the RKE (plip) and GPS bands:

Service	Fréquence	limite crête permanent	limite crête courte durée	limite valeur moyenne
Plip Japon	300	44	50	30
	312,85	44	50	30
	313,85	44	50	18
	314,85	44	50	18
	315,85	44	50	18
	316,85	44	50	30
	330	44	50	30
Plip	420	44	50	30
	431,92	44	50	30
	432,92	44	50	18
	433,92	44	50	18
	434,92	44	50	18
	435,92	44	50	30
	450	44	50	30
GPS	1567	76	82	56
	1574,42	36	42	16
	1576,42	36	42	16
	1583	76	82	56

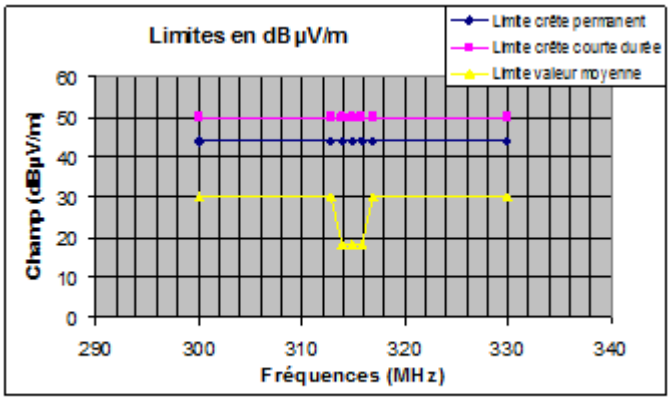


Figure 1 : limites en bande RKE (Japon)

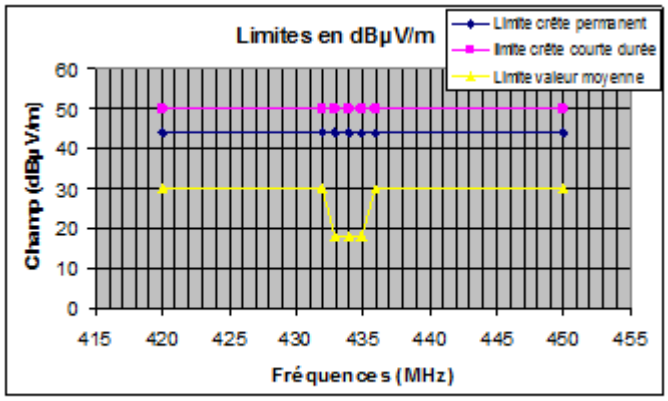


Figure 2 : limites en bande RKE (cas général)

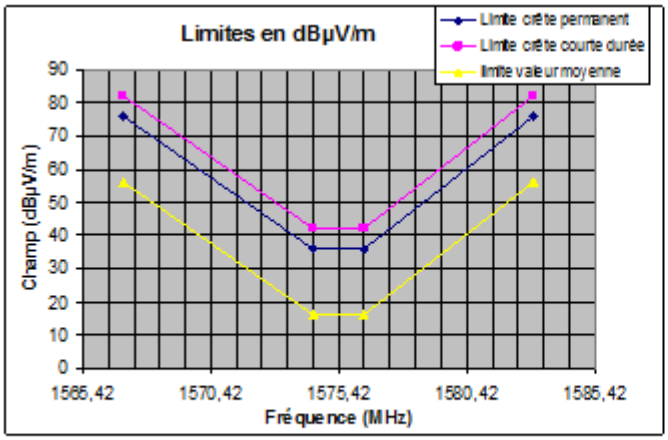


Figure 3 : limites en bande GPS

Table 2: applicability of the corresponding services and limits in accordance with the regions:

		Signification de l'abrégé	Cas général	Supplément Mercosur + USA	Supplément Japon + Corée
Fréquences des services radio (MHz)					
LW	0,15 - 0,30	Long wave	x		
MW	0,53 - 1,8	Medium wave	x		
SW	5,9 - 6,2	Short wave	x		
FM	76 - 108	Frequency Modulation	x		
DAB III	171 - 245	Digital audio broadcasting	x		
DTTV	470 - 770	Digital Terrestrial Television	x		
DAB L band	1447 - 1494	Digital audio broadcasting	x		
Fréquences des services mobiles (MHz)					
CB	26 - 28		x		
VHF	30 - 54	Very high frequency	x		
VHF	68 - 87	Very high frequency	x		
VHF	142 -175	Very high frequency	x		
UHF	380 - 512	Ultra high frequency	x		
RKE	300 - 330	Remote keyless entry			x
RKE	420 - 450	Remote keyless entry	x		
UHF	820 - 960	Ultra high frequency	x		
GSM 800 et AMPS USA	860 - 895			x	
EGSM/GSM 900 et PDC japon	925 - 960				x
PDC japon	1477-1501	Personal Digital Cellular			x
GPS L1 civil	1567 - 1583	Global positioning system	x		
GSM 1800 (PCN)	1803 - 1882	Global system mobile	x		
GSM 1900	1850 - 1990	Global system mobile		x	
3G et PCS USA	1900 - 1992	PCS : Personal Communications Service 3G : Third generation		x	
3G	2010 - 2025	Third generation	x		
3G	2108 - 2172	Third generation	x		
Bluetooth/802.11	2400 - 2500		x		

7.5.EMC TRANSMISSION TESTS SPECIFIC TO EQUIPMENTS CONNECTED TO HIGH VOLTAGE NETWORK (“200V”)

The specific setups and measurement parameters due to a high voltage (“200V”) connexion are detailed in the corresponding test procedure if they are applicable (EQ/MC01, EQ/MC02, EQ/MR01, EQ/MR02…).

Nevertheless, some requirements are specific to the high voltage (“200V”) network.

In addition to the generic test procedures and requirements described in clause 7.3 and 7.4, this clause describes the specific additional test procedures and requirements which shall be considered for equipment connected to high voltage lines (“200V” DC or AC power lines).

Devices connected to AC network (eg. Battery charger) shall fulfill, in addition to the requirements in the present document, the requirements defined in document ref. 02016_12_04631.

Those requirements are applicable for specific PSA developments. For devices which are developed for the PSA/BMW joined venture, the requirements included in the document reference 02016_11_03036 shall replace those ones.

7.5.1.EQ/MC_HV01: MEASUREMENT OF RADIOFREQUENCY CONDUCTED NOISES ON DC HIGH VOLTAGE LINES

7.5.1.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_03036 (PSA/BMW cooperation), with other limits.

7.5.1.2.Objective of the test

This test is intended to evaluate radio frequency voltage disturbances, conducted by the EUT through its DC high voltage lines.

7.5.1.3.Conditions for application of the test

This test is applied to all equipments which have DC high voltage lines, and for which one of those conditions are fulfilled:

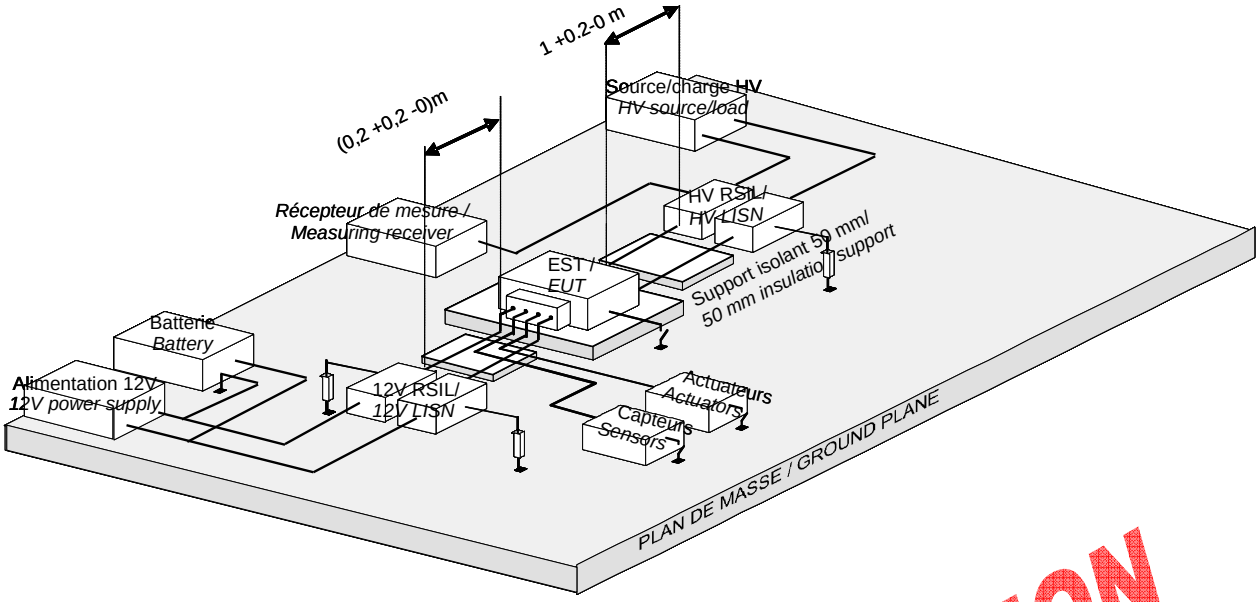
- The device includes an oscillator, with a frequency greater than 9kHz
- The device includes an electrical motor
- The device is powered by a PWM
- The device includes one or more transistors

Both inputs or outputs DC HV lines are concerned and should be tested successively.

7.5.1.4.Test means

- 12V power supply
- Shielded HV load (with HV lines shielding connected to HV load shielding) bonded to ground plane
- Shielded HV source (with HV lines shielding connected to HV source shielding) bonded to ground plane
- Devices necessary for checking the proper operation of the EUT.
- EUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- 12V LISN compliant with CISPR 25 standard (2 LISN for a EUT with remote grounding)
- High voltage LISN (with LISN shielding connected to HV lines shielding)
- 50 Ω load.
- Spectrum analyzer or receiver and, if needed, pre-selector.
- Shielded enclosure.

7.5.1.5.Assembly



7.5.1.6.Procedure

Preparation:

- A harness with a maximum length of 2000 mm should be used (the real wiring may be used). The test wiring is placed on an insulating support (50 ± 5) mm above the ground plane.
- The length of the high voltage lines should 1000 $^{+200}_{0}$ mm. The length of the 12 V power lines between 12V LISN and the EUT should be 200 $^{+200}_{0}$ mm. The other wires should be placed directly on the ground plane at a minimum distance of 200 mm from the HV lines.
- The high voltage LISNs shielding shall be connected to the DC high voltage lines shielding.
- The EUT is placed on an insulating support (50 ± 5) mm above the ground plane. It is connected to the ground plane according to its real vehicle installation and no other ground connection is authorized.
- All LISN terminals not connected to the measuring receiver shall be loaded by 50Ω.

Calibration:

- This test requires no specific calibration.

Parameters of the measurement device:

- Following detectors shall be used :
- peak detector for the evaluation of the levels for « peak »limit,
- average value detector for the evaluation of the levels for « average value »limit

Note : in order to reduce test time, it is possible to perform the test with peak detector only. If the measured value is below the “average value limit”, test result will be compliant.

Following bandwidth and scan time or dwell times shall be used:

- For spectrum analyzers :

Service / Frequency range (MHz)		Peak detection		Quasi peak detection		Average detection	
		RBW at -3 dB	Scan time	RBW at -6 dB	Scan time	RBW at -3 dB	Scan time
ADML system	0,1 - 0,15	100Hz	100s/Mhz	does not apply	does not apply	does not apply	does not apply
AM broadcast and mobile services	0,15 - 30	9/10 kHz	10 s / MHz	9 kHz	200 s / MHz	9/10 kHz	10 s / MHz
FM broadcast	76 - 108	100/120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100/120 kHz	100 ms / MHz

- For receivers :

Service / Frequency range (MHz)		Peak detection			Quasi peak detection			Average detection		
		BW at -6 dB	Step size	Dwell time	BW at -6 dB	Step size	Dwell time	BW at -6 dB	Step size	Dwell time
ADML system	0,1 - 0,15	200Hz	100Hz	500ms	does not apply	does not apply	does not apply	does not apply	does not apply	does not apply
AM broadcast and mobile services	0,15 - 30	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
FM broadcast	76 - 108	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
NOTE : for emissions generated by brush commutator motors without an electronic control unit, the maximum step size may be increased to 5 times the bandwidth.										

Note : To decrease the sweep time for mobile bands with the average value detector, the measurements can be carried out with a 120 kHz bandwidth (100 kHz for the spectrum analyzer) instead of 9 kHz. If the measured value is lower than the average value limit indicated in the test plan, then the result of the average value measurement is accepted. The measurement bandwidth value used in the frequency range should be indicated in the test plan.

Test:

- Run the EUT for a minimal duration of 10 minutes. Carry out the measurements, with peak, quasi peak (if necessary) and average detector, at the LISN terminals.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: wiring, EUT environment.
- The functional operating mode used for EUT, which might have an impact on the test result (consumption, PWM duty factor…)
- Measurement curves with: frequency, V_{avg}, V_{peak}, peak , and average limits (voltages in dBuV)
- Table of exceedings with: frequency (in MHz with three significant digits), V_{avg}, V_{peak} deviation/peak limit and deviation/average limit (voltages in dBuV, deviations in dB). In the case of continuous exceedings (wideband noise) on a frequency band, only the maximum exceeding is required.

In addition to the test report, all the frequency data (in MHz with three significant digits), V_{avg}, V_{peak} , average and peak limits (voltages in dBuV), measured on the HV lines should be provided as data in an Excel table or text file in this order.

7.5.1.7. Requirements

The measured values shall not exceed the following values (all peak, quasi peak and average limits must be fulfilled):

Services and frequencies (MHz)		Peak limit "permanent" noises		Peak limit "short duration" noïses **(1)**		Average limit	
		class	Limit in dBµV	class	Limit in dBµV	class	Limit in dBµV
ADML system **(4)**	0,10 - 0,15	–	130	–	–	–	–
LW **(2)**	0.15 - 0.30	–	129 116 (quasi peak) (3)	–	135 122 (quasi peak) (3)	–	109
MW **(2)**	0.53 - 1.8	–	113 100 (quasi peak) (3)	–	119 106 ((quasi peak) (3)	–	93
SW **(2)**	5.9 - 6.2	–	101	–	107	–	81
CB	26 - 28	–	87	–	93	–	67
VHF	30 - 54	–	92	–	98	–	72
VHF	68 - 87	–	70	–	76	–	50
FM **(2)**	76 - 108	–	70 57 (quasi peak) (3)	–	76 63 (quasi peak) (3)	–	50

(1) Except if otherwise stated, the "short duration" qualification corresponds to the equipments which are used for less than one minute (examples such as window regulator, windscreen washer pump noises; examples of permanent noises: windscreen wiper, GMV, …)

(2) In the case of equipments located near a printed reception antenna AM, FM and/or DAB III (rear-window, quarter windows, top of the windshield…), those levels have to be severized by 10dB in the frequency bands considered. This case has to be specified in the TNS/TS or the EMC test plan.

(3) The levels given by the quasi-peak detector are applicable on specific request (example : PWM signals…)

(4) For the frequency range 100 - 150 KHz, the peak limit mentioned in the table concerns the centrale frequency of the frequency range. The applicable envelop is given in table 1 and figure 1.

Measurements for frequencies lower than 30 MHz have to be performed on all the frequency range 0,1 – 30 MHz, even if some sub-bands dont have applicable limits.

7.5.2.EQ/MC_HV02: MEASUREMENT OF COUPLING ATTENUATION – ACTIVE COMPONENTS

7.5.2.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_03036 (PSA/BMW cooperation).

7.5.2.2.Objective of the test

This test is intended to evaluate the coupling attenuation of active equipments between high voltage and 12V voltage connections.

7.5.2.3.Conditions for application of the test

This test is applied to all equipments which have connections to high voltage (“200V”) lines and very low voltage (e.g 12 V).

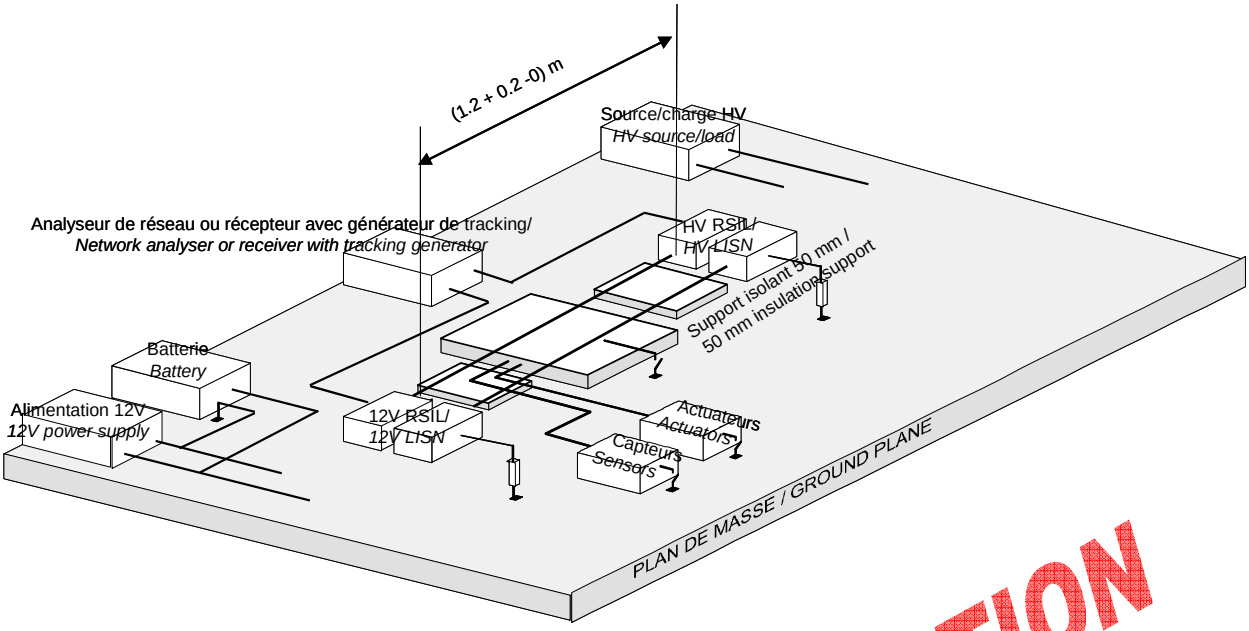
The measurements shall be performed with the high voltage (“200V”) equipment powered on.

For equipments with multiple positive/negative high voltage or positive/negative very low voltage connections (eg. 12V), the measurement configurations (multiple connections taken separately or connected together, consideration of “switched” connections…) shall be defined in the test plan.

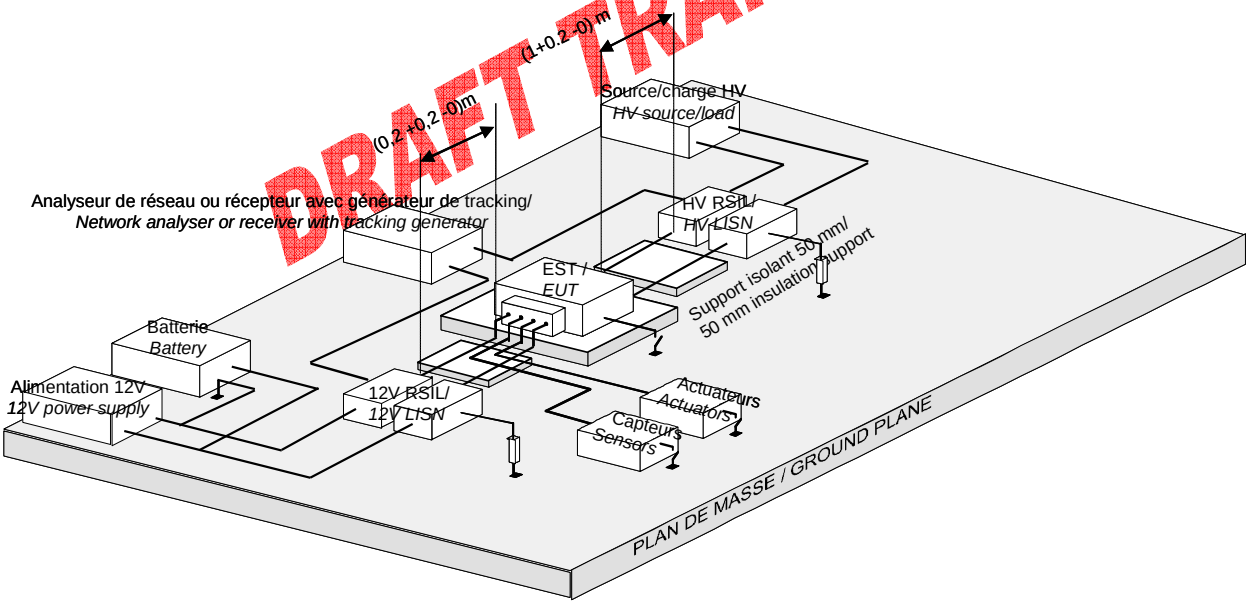
7.5.2.4.Test means

- Insulating support with a thickness of 50mm
- 12V LISN compliant with CISPR 25 standard (2 LISN for a EUT with remote grounding)
- High voltage LISN (with LISN shielding connected to HV lines shielding)
- Shielded HV load (with HV lines shielding connected to HV load shielding) bonded to ground plane
- Shielded HV source (with HV lines shielding connected to HV source shielding) bonded to ground plane
- 50 Ω load
- Network analyser or receiver with tracking generator.

7.5.2.5. Assembly



Test set-up for active measurements without EUT



Test set-up for active measurements with EUT

7.5.2.6. Procedure

- The measurements shall be performed in two or three phases:
  - full-port calibration if the measurements are performed with a network analyser
  - measurement without the equipment
  - measurement with the equipment

Preparation:

- A harness with a maximum length of 2000 mm should be used (the real wiring may be used). The test wiring is placed on an insulating support (50 ± 5) mm above the ground plane.
- The length of the high voltage (“200V”) lines between HV LISN and the EUT should be 1000 $^{+200}_{0}$ mm. The length of the 12 V power lines between 12V LISN and the EUT should be 200 $^{+200}_{0}$ mm. The other wires should be placed directly on the ground plane at a minimum distance of 200 mm from the 12V and high voltage (“200V”) lines.
- The high voltage (“200V”) LISNs shielding shall be connected to the DC high voltage (“200V”) lines shielding.
- The EUT is placed on an insulating support (50 ± 5) mm above the ground plane. It is connected to the ground plane according to its real vehicle installation and no other ground connection is authorized.

Calibration:

- This test requires full-port calibration if a network analyser is used. The calibration planes are at the measurement ports of the 12 V LISN and of the high voltage (“200V”) LISN.

Parameters of the measurement device:

- The following characteristics shall be used for a network analyser:

- Power level : 0 dBm
- Averaging factor : 4 (averaging on 4 sweeps)
- Frequency steps : l logarithmic

- The following characteristics shall be used for measuring receiver with tracking generator:

- Power level : 0 dBm
- RBW : 120 kHz
- Frequency steps : logarithmic

Test:

Measurement without the equipment (according to test set-up for active measurements without EUT):

- The high votlage lines (between high voltage (“200V”) LISN and the EUT) shall be directly connected to the 12 V power lines (between 12V LISN and the EUT), without EUT, with a length of 1200 $^{+200}_{0}$ mm. The other wires shall be placed directly on the ground plane at a minimum distance of 200 mm from the 12V and high voltage (“200V”) lines.
- The high voltage (“200V”) LISNs shielding shall be connected to the DC high voltage lines shielding.
- **Notes:**
- the test plan may precise how should be realized the connections between HV Lines and 12 V power lines (directly with adaptors, through a capacitor, with use of shielded box including capacitors, …)
- the terminations to be used on 12 V LISN side disconnected from 12 V power supply and on HV LISN side disconnected from HV source/load should be defined in the test plan.
- Carry out the coupling S_{21ref} attenuation measurements for the following configurations :

Network analyser or receiver		
	Output port	Measuring port
Configuration 1	LISN Positive DC high voltage line	LISN Positive 12 V line
Configuration 2	LISN Positive DC high voltage line	LISN negative 12 V line (ground)
Configuration 3	LISN negative DC high voltage line	LISN Positive 12 V line
Configuration 4	LISN negative DC high voltage line	LISN negative 12 V line (ground)
Note : the measurement ports of the two LISN (one high voltage and one 12 V) which are not connected to the output port or the measuring port shall be connected to a 50 Ω load.		

Measurement with the equipment (according to test set-up for active measurements with EUT):

- The EUT is placed on an insulating support (50 ± 5) mm above the ground plane. It is connected to the high voltage (“200V”) lines and to the 12V power lines and to the ground plane according to its real vehicle installation and no other ground connection is authorized.
- Run the EUT for a minimal duration of 10 minutes. Carry out the coupling S_{21EUT} attenuation measurements for the following configurations :

Network analyser or receiver		
	Output port	Measuring port
Configuration 1	LISN Positive DC high voltage line	LISN Positive 12 V line
Configuration 2	LISN Positive DC high voltage line	LISN negative 12 V line (ground)
Configuration 3	LISN negative DC high voltage line	LISN Positive 12 V line
Configuration 4	LISN negative DC high voltage line	LISN negative 12 V line (ground)
Note : the measurement ports of the two LISN (one high voltage and one 12 V) which are not connected to the output port or the measuring port shall be connected to a 50 Ω load.		

The coupling attenuation S_{21HV} is obtained by the following formula:

$$S_{21HV} = S_{21EUT} - S_{21ref}$$

Test report:

The test report shall, among other things, include the following elements:

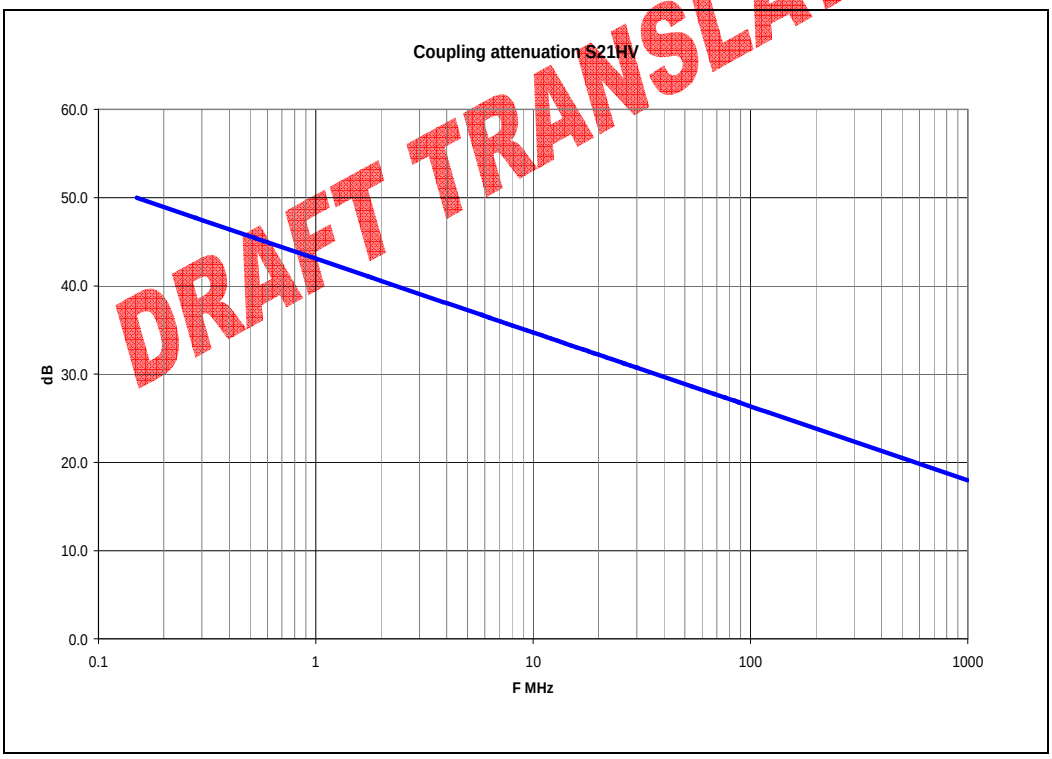
- Assembly used: wiring, EUT environment
- The functional mode used, for EUT operation likely to have an impact on the test result (consumption, PWM duty factor…)
- Noise floor of test assembly without EUT
- Measurement curves with: frequency, S_{21ref}, S_{21EUT}, S_{21HV}, limits (in dB)
- Table of exceedings with: frequency (in MHz with three significant digits), S_{21HV},, deviation/ limit.

Results of frequency, S_{21ref}, S_{21EUT}, S_{21HV} have to be provided in an excel file in this order.

7.5.2.7.Requirements

The minimum coupling attenuation S_{21HV} is given in the following table :

Frequency (MHz)	Minimum coupling attenuation $S_{21\ coupling}$ (dB)
0,15 - 1000	43.1 -8.37 * log(F_{MHz})



7.5.3.EQ/MC_HV03: MEASUREMENT OF COUPLING ATTENUATION – PASSIVE COMPONENTS

7.5.3.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_03036 (PSA/BMW cooperation).

7.5.3.2.Objective of the test

This test is intended to evaluate the coupling attenuation of passive equipments between high voltage and 12V voltage connections or between high voltage connections and ground.

7.5.3.3.Conditions for application of the test

This test is applied to all equipments which have connections to high voltage (“200V”) lines and very low voltage (e.g 12 V).

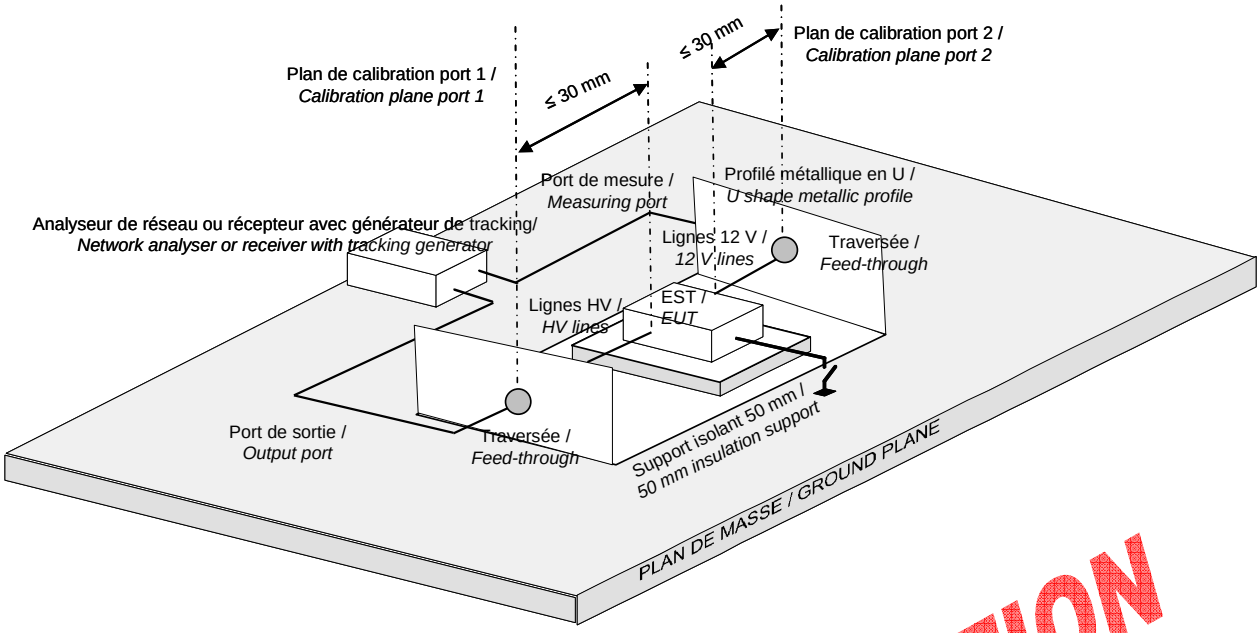
The measurements shall be performed with the equipment unpowered.

For equipments with multiple positive/negative HV connections or positive/negative high voltage connections, the measurement configurations (multiple connections taken separately or connected together) shall be defined in the test plan.

7.5.3.4.Test means

- Insulating support with a thickness of 50 mm.
- Network analyser or receiver with tracking generator
- Metallic U-Shape profile

7.5.3.5. Assembly



Test set-up for passive measurements

7.5.3.6.Procedure

- The measurements shall be performed in one or two phases:
- full-port calibration if the measurements are performed with a network analyser
- measurement with the equipment.

Preparation:

- The EUT is placed on an insulation support (50 ± 5) mm above the metallic U-shape profile.
- The length of the connections between the U-shape profile feed-through connectors and the EUT inputs shall not exceed 30mm.
- The U shape profile shall be connected to the bench ground plane with an impedance of less than 10 mΩ.
-

Calibration:

- This test requires full-port calibration for the network analyzer. The calibration planes are the feed-through connectors of the U shape profile.

Parameters of the measurement device:

- The following characteristics shall be used for a network analyser:
- Power level : 0 dBm
- Averaging factor : 4 (averaging on 4 sweeps)
- Frequency steps : logarithmic
- The following characteristics shall be used for measuring receiver with tracking generator:
- Power level : 0 dBm
- RBW : 120 kHz
- Frequency steps : logarithmic

Test:

With the EUT not powered, carry out the coupling attenuation measurements for the following configurations :

Network analyser or receiver				
	Output port	Measuring port	Specific requirement (1)	EUT ground connection
Configuration 1	LISN Positive DC high voltage line	LISN Positive 12 V line	Negative 12 V line connected to ground plane	Open
Configuration 2	LISN Positive DC high voltage line	LISN Positive 12 V line		Open
Configuration 3	LISN negative DC high voltage line	LISN Positive 12 V line	Negative 12 V line connected to ground plane	Open
Configuration 4	LISN negative DC high voltage line	LISN Positive 12 V line		Open
Configuration 5	LISN Positive DC high voltage line	LISN negative 12 V line (ground)		Open
Configuration 6	LISN negative DC high voltage line	LISN negative 12 V line (ground)		Open
Configuration 7	LISN Positive DC high voltage line	LISN Positive 12 V line	Negative 12 V line connected to ground plane	Closed
Configuration 8	LISN Positive DC high voltage line	LISN Positive 12 V line		Closed
Configuration 9	LISN negative DC high voltage line	LISN Positive 12 V line	Negative 12 V line connected to ground plane	Closed
Configuration 10	LISN negative DC high voltage line	LISN Positive 12 V line		Closed
Configuration 11	LISN Positive DC high voltage line	LISN negative 12 V line (ground)		Closed
Configuration 12	LISN negative DC high voltage line	LISN negative 12 V line (ground)		Closed
Configuration 13	LISN Positive DC high voltage line	Ground Plane		
Configuration 14	LISN negative DC high voltage line	Ground Plane		

(1) Unless otherwise specified, the EUT connections (DC high voltage, 12 V) which are not connected to the output port or measuring port shall be left floating.

Test report:

The test report should, among other things, include the following elements:

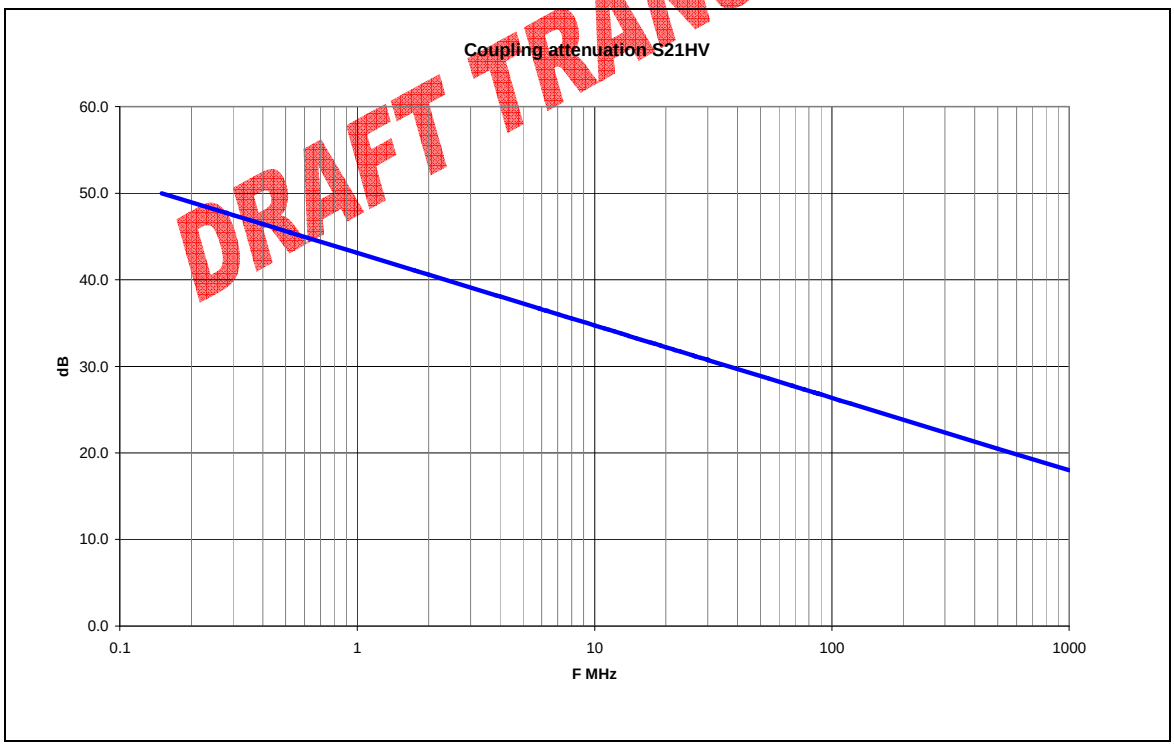
- Assembly used: wiring, EUT environment.
- The functional mode used, EUT operation is likely to have an impact on the test result (consumption, PWM duty factor…)
- Noise floor of test assembly without EUT
- Measurement curves with: frequency, S_{21}, limits (in dB)
- Table of exceedings with: frequency (in MHz with three significant digits), $S_{21,}$ deviation/ limit

Results of frequency / S_{21} have to be provided in an excel file in this order.

7.5.3.7.Requirements

The minimum coupling attenuation S_{21} is given in the following table :

Frequency (MHz)	Minimum coupling attenuation S_{21} (dB)
0,15 - 1000	43.1 -8.37 * log(F_{MHz})



7.5.4.EQ/MC_HV04: MEASUREMENT OF RADIOFREQUENCY CONDUCTED NOISES ON DC OR 3 PHASES SHIELDED LINES - CURRENT

7.5.4.1.Reference document

There is no international reference document for this test.
This test is based on document ref. 02016_11_03036 (PSA/BMW cooperation), with other limits.

7.5.4.2.Objective of the test

This test is intended to evaluate radio frequency current disturbances, conducted by the EUT through its 3 phases machine and/or DC HV shielded lines.

- The measurement results of this test are directly dependant of the HV cables shielding quality (transfer impedance of the used shielded cables). In order to have significant test measurements, the requirements of this test are given in term of equivalent voltage. The equivalent voltage requirements are derived from current measurements on shielded cables with a defined “reference transfer impedance”.
- The current measurements shall be carried out :
  - on each shielded cable successively,
  - on all DC HV shielded cables together,
  - on all 3 phases machine HV shielded cables together.

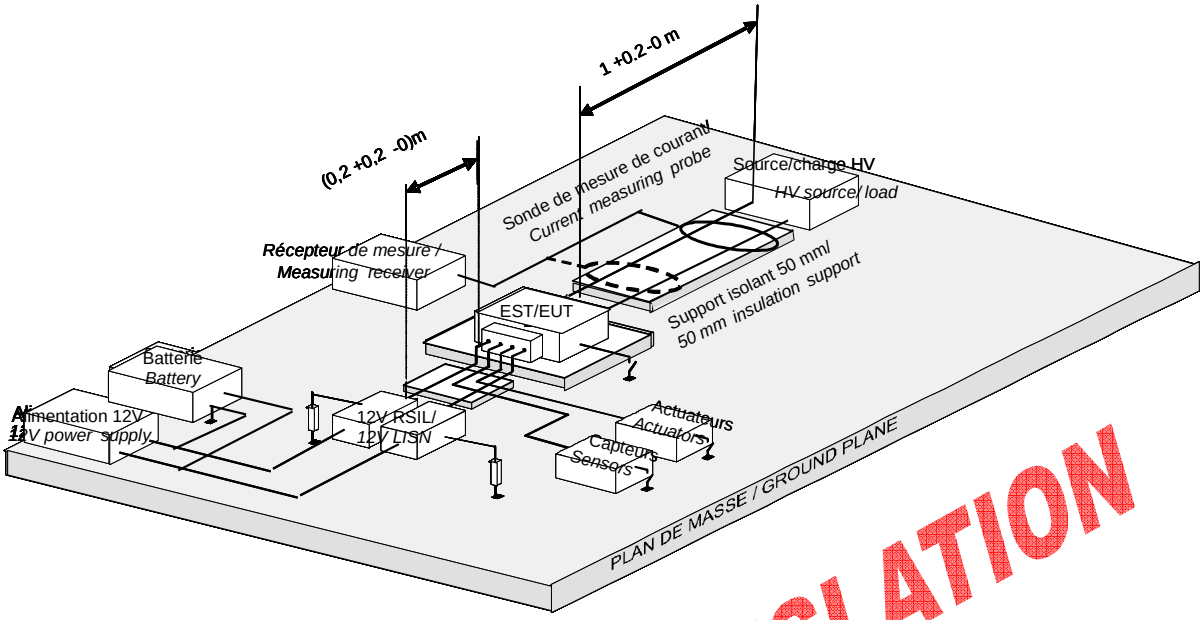
7.5.4.3.Conditions for application of the test

This test applies only to all equipments having high voltage (“200V”) DC or AC shielded cables.

7.5.4.4.Test means

- Power supply
- Devices necessary for checking the proper operation of the EUT
- EUT environment, real (sensors, actuators) or simulated
- Shielded HV load (with HV lines shielding connected to HV load shielding) bonded to ground plane
- Shielded HV source (with HV lines shielding connected to HV source shielding) bonded to ground plane
- Insulating support with a thickness of 50 mm
- 12V LISN compliant with CISPR 25 standard (2 LISN for a EUT with remote grounding) if needed
- high voltage (“200V”) LISN (with LISN shielding connected to lines shielding)
- Current probe
- 50 Ω load
- Spectrum analyzer or receiver and, if needed, pre-selector
- Shielded enclosure.

7.5.4.5.Assembly



Test set-up for current measurements on high voltage (“200V”) shielded lines

7.5.4.6.Procedure

Preparation:

- A harness with a maximum length of 2000 mm should be used (the real wiring may be used). The test wiring is placed on an insulating support (50 ± 5) mm above the ground plane.
- The length of the shielded high voltage (“200V”) lines should 1000 $^{+200}_{0}$ mm. The length of the 12 V power lines between 12V LISN and the EUT should be 200 $^{+200}_{0}$ mm. The other wires should be placed directly on the ground plane at a minimum distance of 200 mm from the high voltage (“200V”) lines.
- The EUT is placed on an insulating support (50 ± 5) mm above the ground plane.It is connected to the ground plane according to its real vehicle installation and no other ground connection is authorized.
- All LISN measuring terminals shall be loaded by 50 Ω..
- The shielded cable(s) subjected to the measurement shall be placed on an insulation support (50 ± 5) mm above the ground plane.
- The current measuring probe shall be placed successively in various positions along the concerned branch, as indicated hereafter.
- Note: the described test set-up does not require HV LISN. The test plan shall precise the set-up if HV LISN are required for specific measurement configurations. In this case the HV LISNs shielding shall be connected to the DC HV lines shielding.

Calibration:

- This test requires no specific calibration.

Parameters of the measurement device:

The minimum scan times or dwell times to be used are the following:

- For the spectrum analyzers:

Service / Frequency range (MHz)		Peak detection		Quasi-peak detection		Average detection	
		RBW at -3 dB	Scan time	RBW at à -6 dB	Scan time	RBW at -3 dB	Scan time
Key less system	0,1 - 0,15	100Hz	100s/Mhz	does not apply	does not apply	does not apply	does not apply
AM broadcast and mobile services	0,15 - 30	9/10 kHz	10 s / MHz	9 kHz	200 s / MHz	9/10 kHz	10 s / MHz
FM or DAB broadcasting	76 - 245	100/120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100/120 kHz	100 ms / MHz

- For the receivers:

Service / Bande de fréquence (MHz)		Peak detection			Détecteur quasi crête			Détecteur valeur moyenne		
		BW at -6 dB	Step size	Dwell time	BW at -6 dB	Step size	Dwell time	BW at -6 dB	Step size	Dwell time
Key less system	0,1 - 0,15	200Hz	100Hz	500ms	does not apply	does not apply	does not apply	does not apply	does not apply	does not apply
AM broadcast and mobile services	0,15 - 30	9 kHz	5 kHz	50 ms	9 kHz	5 kHz	1 s	9 kHz	5 kHz	50 ms
FM or DAB broadcasting	76 - 245	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms
NOTE : for emissions generated by brush commutator motors without an electronic control unit, the maximum step size may be increased up to 5 times the bandwidth										

Note: The ambient noise level shall be lower than 6dB within the specified limits. To meet this criterion, an amplifier may be inserted, if necessary.

Test:

- Run the EUT for a minimal duration of 10 minutes.
- Carry out the measurements, with average, peak or quasi-peak detector, at the probe terminal.
- Carry out the current measurement for the following various probe positions:
  - 50 mm away from the edge of the HV shielded cable (opposite the EUT) for all frequency bands,
  - and also 50 mm away from the EUT for the FM band.

Test report:

The test report should, among other things, include the following elements:

- Assembly used: harness, EUT environment, measuring probe positions.
- Description of the tested outputs and their load conditions.
- The functional mode used, likely to have an impact on the test result (consumption, PWM Duty factor…).
- Measurement curves with: frequency, I_{avg}, I_{peak}, $I_{quasi\text{-}peak}$ (if required), (currents in dBµA)
- Calculated curves with: frequency, V_{avg}, V_{peak}, $V_{quasi\text{-}peak}$ (if required), peak, average and quasi-peak limits (voltage in dBµV)
- Table of exceedings with: frequency (in MHz with three significant digits), V_{avg}, V_{peak} or $V_{quasi\text{-}peak,}$ deviation/peak limit and deviation/average limit or deviation/quasi-peak limit (voltages in dBµV, deviations in dB). In the case of continuous exceedings (wideband noise) on a frequency band, only the maximum exceeding is required.

In addition to the test report, all the frequency data (in MHz with three significant digits), V_{avg}, V_{peak} or $V_{quasi-peak}$, average, peak and if necessary quasi-peak limits (voltages in dBµV), calculated voltage (in dBµV) from the measured currents on the shielded cables, should be provided as data in an Excel table or text file in this order.

7.5.4.7. Requirements

- The requirements are defined in terms of :
- current: requirement defined for “EQ/MC04 :Measurement of radiofrequency conducted noises on outputs”
- equivalent voltage: derived from current measurements on shielded cables with a defined “reference transfer impedance” (in dBΩ).
  - The conformance should normally be obtained by at least compliance to the equivalent voltage requirement.
  - Note: the test plan shall precise when compliance is required for both current requirements and equivalent voltage requirements.
  - **Note:** The real transfer impedance of the cables shall never be used because of eventual future modifications.

Equivalent voltage requirements :

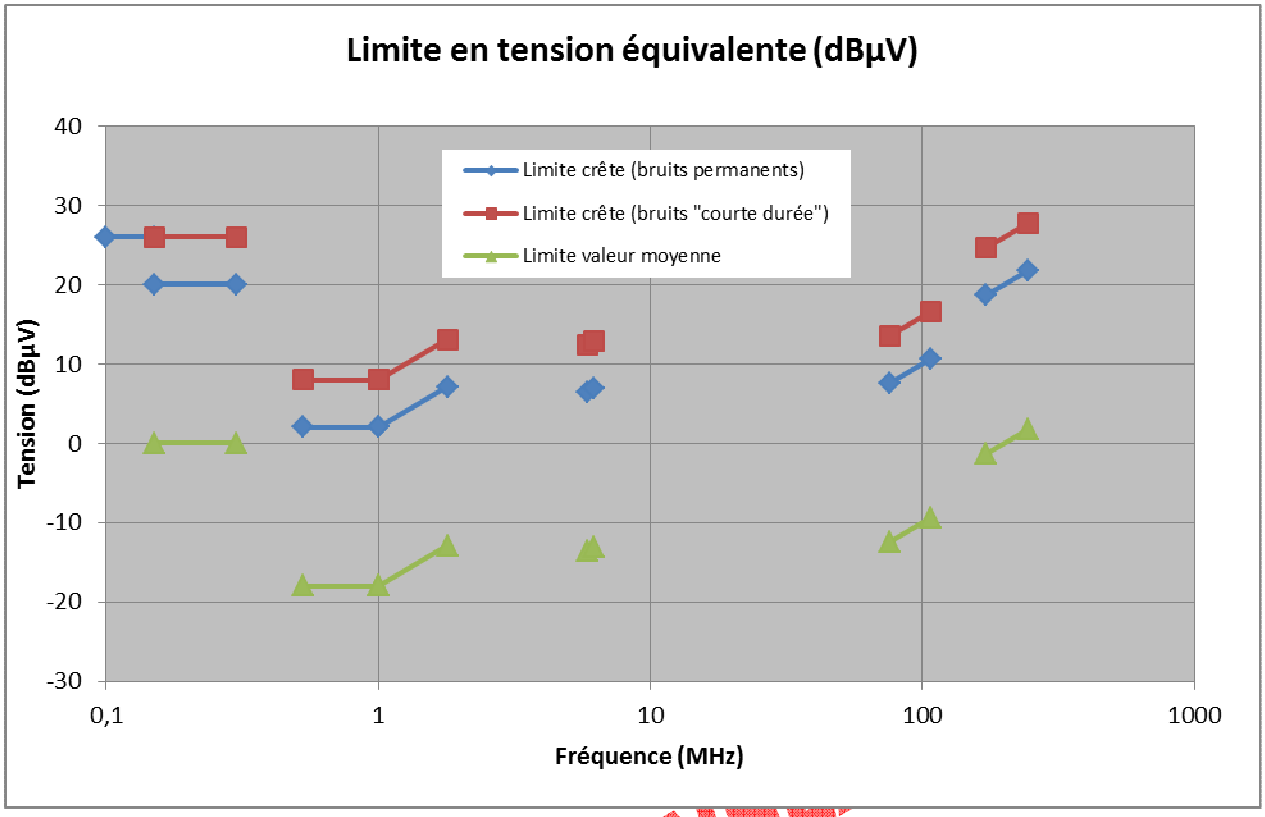
The measured values with peak, quasi peak and average detector shall not exceed the following values (both peak and average limits must be fulfilled):

		Peak limit "permanent" noïses		Peak limit "short duration" noïses " (1)		Average limit	
		class	Limit in dBµV	class	Limit in dBµV	class	Limit in dBµV
Services and frequencies (MHz)							
Key less system(3)	0,10 - 0,15	_	26	_	NA	_	NA
LW	0,15 - 0,30	_	20 7 (quasi peak) (2)	_	26 13 (quasi peak) (2)	_	0
MW	0,53 - 1,0	_	2 -11(quasi peak) (2)	_	8 -5 (quasi peak) (2)	_	-18
	1,0 - 1,8	_	42 + 20*log(FMHz/100) 29 + 20*log(FMHz/100) (quasi peak) (2)	_	48 + 20*log(FMHz/100) 35 + 20*log(FMHz/100) (quasi peak) (2)	_	22 + 20*log(FMHz/100)
SW	5,9 - 6,2	_	31 + 20*log(FMHz/100)	_	37 + 20*log(FMHz/100)	_	11 + 20*log(FMHz/100)
FM	76 - 108	_	10 + 20*log(FMHz/100) -3 + 20*log(FMHz/100) (quasi peak) (2)	_	16 + 20*log(FMHz/100) 3 + 20*log(FMHz/100) (quasi peak) (2)	_	-10 + 20*LOG(FMHz/100)
DAB III	171 - 245	_	14 + 20*log(FMHz/100)	_	20 + 20*log(FMHz/100)	_	-6 + 20*log(FMHz/100)

(1) Except if otherwise stated, the “short duration” qualification corresponds to the equipments which are used for less than one minute(examples such as window regulator, windscreen washer pump noises; examples of permanent noises: windscreen wiper, GMV…).

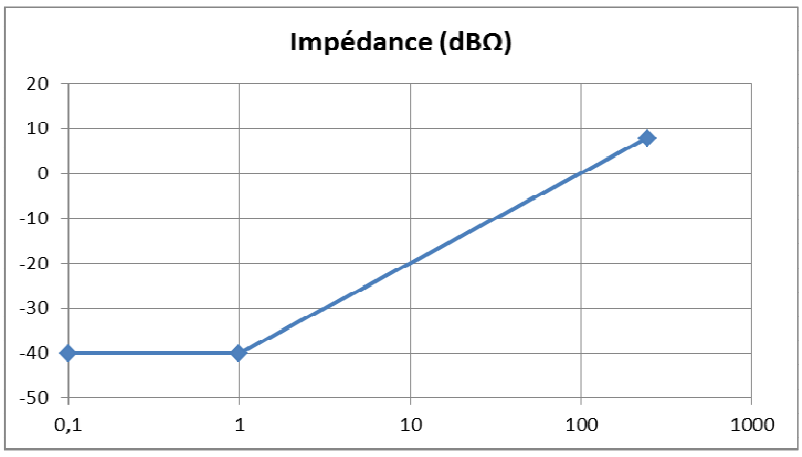
(2) The levels given by the quasi-peak detector are applicable on specific request (example: PWM signals…)

(3) The limit in the band 100 – 150 KHz is not applicable to under-the-hood equipments.



Note: Equivalent voltages levels (in dBµV) are obtained by adding to the measured current levels (in dBµA) the following typical transfer impedance values (in dBΩ):

Service	Frequency (MHz)	Typical transfer impedance	
		mΩ/m	dBΩ
--	0.1 - 1	10	-40
	1 - 245	$10*F_{MHz}$	$20*\log(F_{MHz}/100)$



Curent requirements:

The measured values with peak, quasi peak and average detector shall not exceed the limits from EQ/MC04 test.

APPENDIX A (normative)

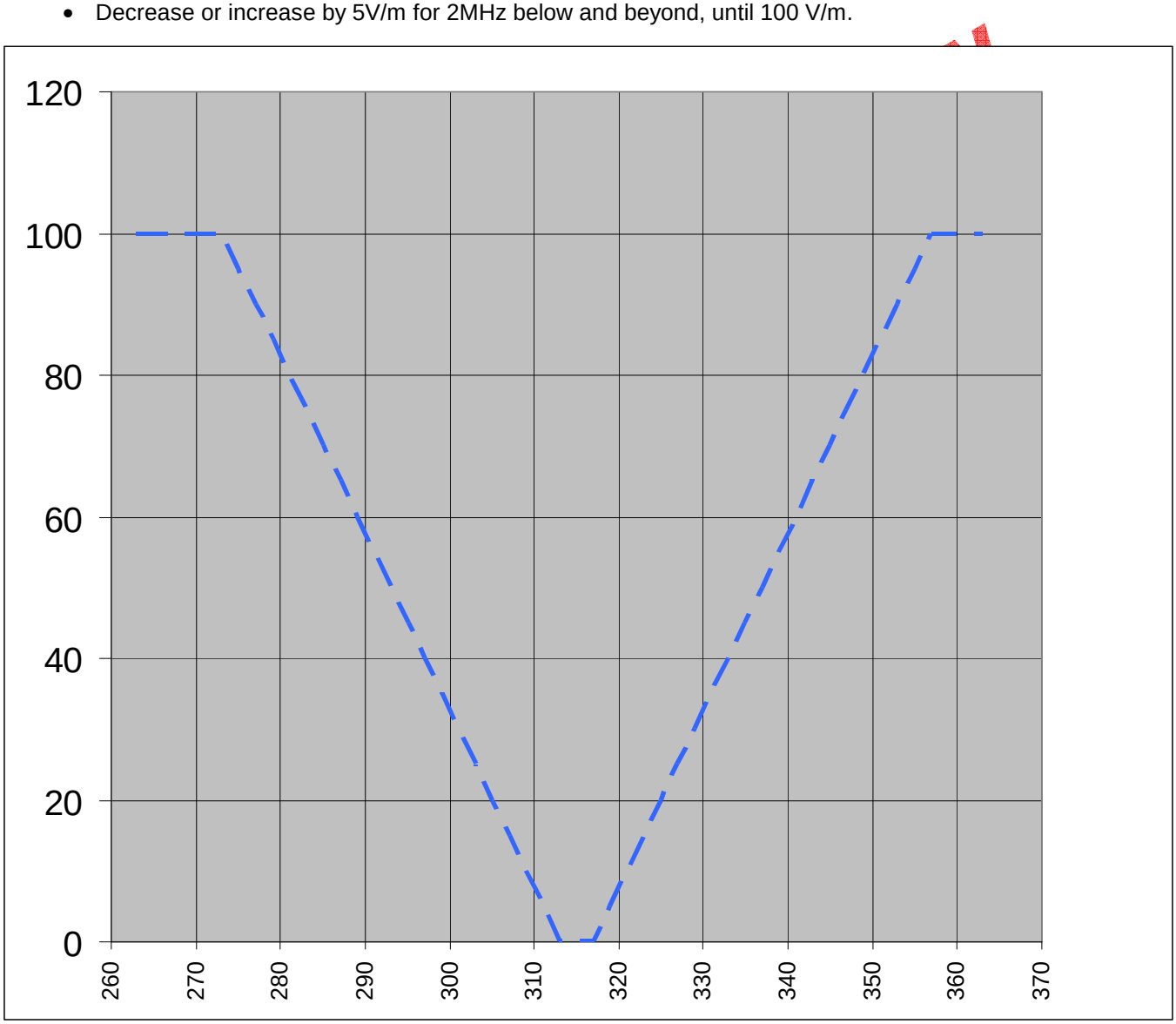
IMMUNITY REQUIREMENTS IN ELECTRIC FIELD APPLICABLE TO RECEIVERS IN THE 315MHz AND 433MHz BANDS (PLIP AND DSG)

Certain dreaded events of the radio function (for example: absence of control or non acquisition of the HF frame) are allowed in a frequency band around the central frequency. The malfunctions allowed should be specified in the test plan or in the TNS/TS specific to the equipment. Certain events of customer impact 2 or 3 are not allowed (example unexpected opening).

315MHz band:

The immunity limit applicable to the dreaded events thus defined is the following:

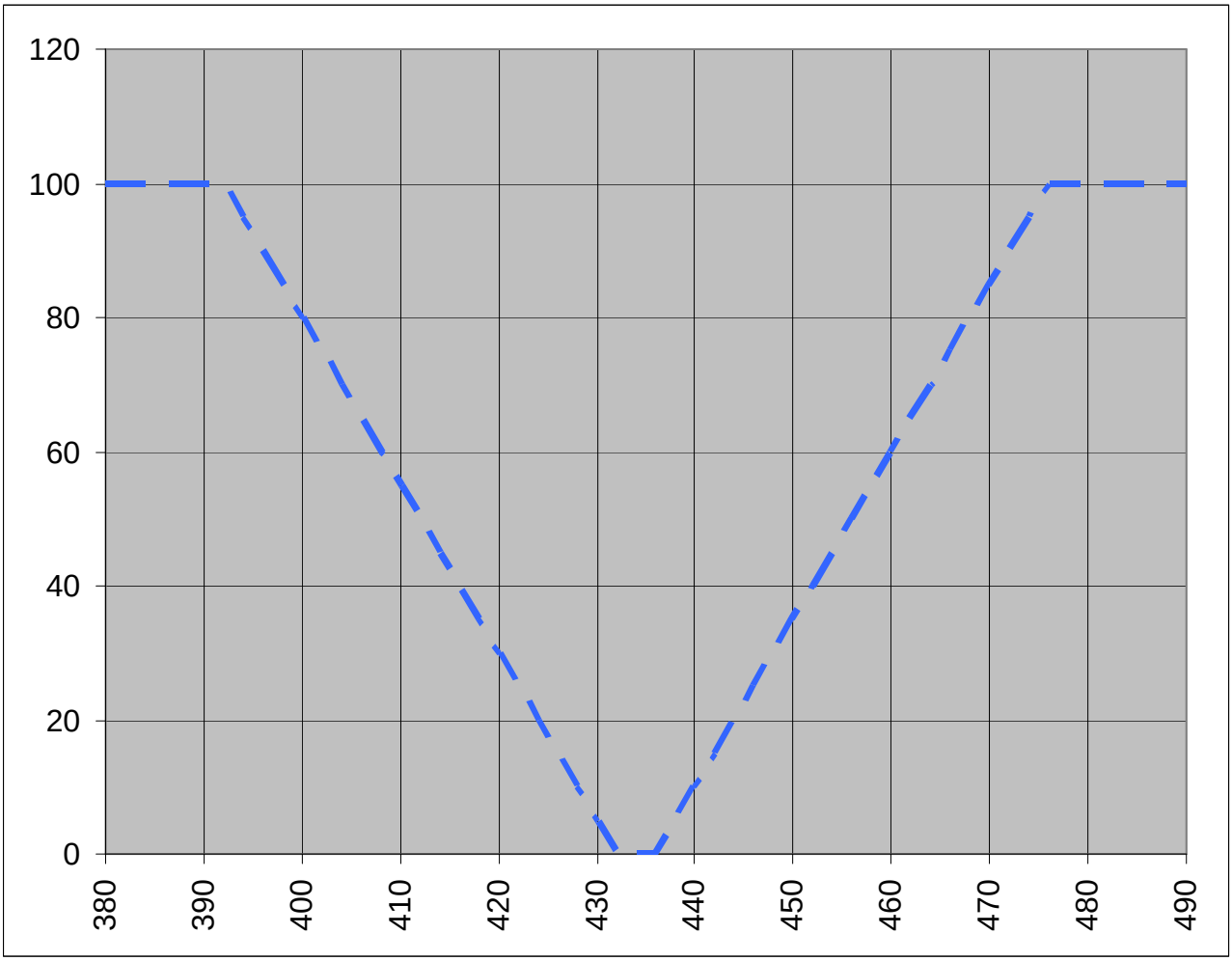
- Zero V/m from 313 to 317 MHz
- Decrease or increase by 5V/m for 2MHz below and beyond, until 100 V/m.



433MHz band:

The immunity limit applicable to the dreaded events thus defined is the following:

- Zero V/m from 432 to 436 MHz
- Decrease or increase by 5V/m for 2MHz below and beyond, until 100 V/m.



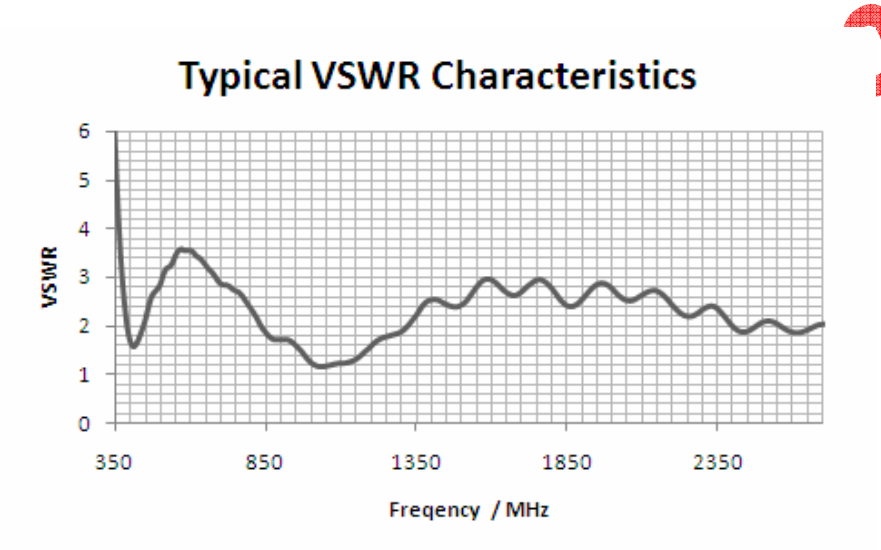
APPENDIX B (NORMATIVE)

PORTABLE TRANSMISSION DEVICES

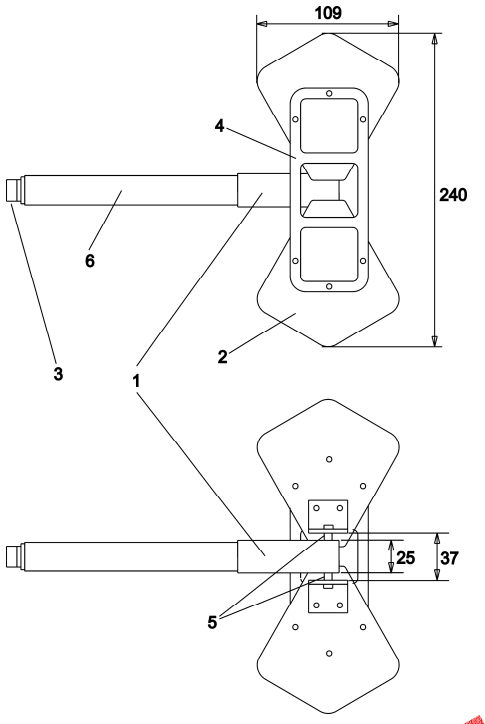
This appendix provides the details concerning the miniature broad band antenna used for the EQ/IR05 test.

This antenna is identical to that described and suggested in the ISO 11452-9 standard.
These specific characteristics are:

- Input impedance: 50 Ohms
- Balun transformation ratio: 1:1
- Frequency range: 360 - 2700 MHz
- Radiating element dimensions: 240 x 109 mm
- Maximum input power: 20 W
- Connector: Type N-female



Typical VSWR characteristics



1 *Balun*
2 *Flat antenna elements*
3 *N-female connector*
4 *Element fixture and spacing frame (5 mm, non metallic)*
5 *Symmetrical terminals, M4*
6 *22 mm tube for handling or fixture*

Construction details of antenna