ENVIRONMENT SPECIFICATIONS OF ELECTRIC AND ELECTRONIC EQUIPMENTS ELECTRICAL CHARACTERISTICS

This standard PARTIALLY REPLACES standard B21 7090

This is a translation, the French original shall be used in all cases of litigation *Date of translation : 03/07/2008*

FOREWORD

The following documents, associated with the standard, are accessible internally within PSA through the link:

Annexes-en_B217110.zip

http://r2.dome.inetpsa.com/domdoc/armoire40/ASIN-4WYKDR.nsf/GetDoc/02072008-Y8SK-0EC3/$File/Complementary informations.zip?OpenElement&Login

- Comparison B21 7110 B§C.xls
- Emission limits of B21 7110-C.xls (EQ/MC 03 - § 6.5.3.7 and EQ/MR 01 - § 6.6.2.7)
- Application of the tests.xls (§ 5)
- Test Report requirements.xls (§ 4.3)
- Note AEEV_IVE07_0243-2.pdf (§ 6.1.7.7 et § 6.1.6.8)

The most important modifications of this standard are summarized in the file : Comparison B21 7110 B§C.xls

Note: *some new tests appear in this standard. Their numbering (EQ/ICxx) is done generally in historical order. The test number EQ/IC11 is voluntarily missing from this standard, to avoid a possible confusion with other automobile manufacturers' specifications.*

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RECORDS

Index	Date	Nature of the modifications
OR	11/07/2001	Created. This standard partially replaces B21 7090.
A	23/07/2004	Rewrite.
B	24/05/2005	**Environment – "General tests environment" § (4.5).** Purpose: deseverization of environment requirements. **Test EQ/IC 05 – "resistance to impulses 4 or 4 bis"** Purpose: deseverization of start-up pulse. **Test EQ/IC 01 – "resistance to impulses 1 or 1bis and 2a"** Reminder of B21 7110-A: "Wires concerned: all supply wires (successively and simultaneously). The supply associated with a network (ex: + VAN ; + CAN ; …) should be considered as a relayed power supply and tested as such. The test is also applicable on the outputs controlling inductive loads. The test is not applicable if the DUT is powered by a regular voltage supplied by another device." Purpose: the purpose of this addendum is to clarify the test method concerning the application of pulses 1 or 1bis on all the outputs controlling inductive loads. **Test EQ/IR 04 – "resistance to electrostatic discharges, powered equipment"** Purposes: clarification of § 6.4.2.6, for the diagram compliance; and deseverization of the requirement of § 6.4.2.7 for discharges on insulating parts at 4kV concerning the indirect 1h type points (consistency with requirements on conductive parts). **Test EQ/IR 05 – "immunity to onboard transmitters"** Purpose: addition of an informative appendix on portable emission devices. **Test VH/IR 01 – "Immunity to the radiated field (semi-anechoic or anechoic room)"** Purpose: consistency with the calibration method with the standard ISO 11451-2. **Test VH/IR 04 – "immunity to onboard transmitters"** Purpose: addition of an informative appendix on portable emission devices.
C	20/02/2008	Rewriting of the standard. A document which summarized the main modifications is accessible internally within PSA through the following link: Annexes-en_B217110.zip (Comparison B21 7110 B§C.xls)

PARTICIPANTS

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CONTENTS

1.OBJECT AND FIELD OF APPLICATION

The purpose of this document is the definition of the requirements to observe in order to ensure the electrical behaviour and the Electromagnetic Compatibility (EMC) of the vehicles (specific vehicles and utility vehicles) and of associated electric, electronic and pyrotechnic equipments.

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

The PSA development head (in agreement with the PSA head of ECM and electric validations) should define for the Supplier the retained requirements. Without Supplier proposal and PSA written agreement, this document is applied integrally.

Equipment is validated when it meets the test requirements on equipment or on vehicle. These tests on equipment should be carried out in an environment representing the operating mode on vehicle (system validation).

Any project has an independent electric and ECM independent validation: A validation obtained on a vehicle project is not systematically renewable on another vehicle project.

The general requirements relating to the electric and electronic equipment environment tests of the vehicles are listed in standard B21 7100.

2.REFERENCE DOCUMENTS

2.1.PSA DOCUMENTS

2.1.1.PSA STANDARDS

A10 0156 (2007)	Test reports - Drafting
B21 7100 (2005)	Environmental specifications for electrical and electronic equipments – General characteristics
B35 0010 (2007)	Standard EMC § electrical test plan for the electric and electronic equipments

2.1.2.OTHER DOCUMENTS

Note AEL_TDSE04_0091	Electrostatic discharges on diagnostic jack – BSI centralized protection – Validation test procedure
Note AEEV_IVE07_0243-2	Detail of the long duration overloads behaviour tests on the smart-power (or MOS) outputs.

2.2.EXTERNAL DOCUMENTS

2.2.1.INTERNATIONAL STANDARDS

CISPR 16-1 Ed 2.1 (10/2002)	CISPR specification for the devices and methods of measurement of electrical interference
CISPR 25 Ed. 3 (2008)	Limits and methods for measuring the characteristics of radio-electric interferences for the protection of the receivers used on board of the vehicles
IEC 60068-2-1 (2007)	Environment tests - Part 2-1: tests – Tests A: cold
IEC 61000-4-21 (2003)	Electromagnetic Compatibility (EMC) – part 4-21: Techniques for tests and measurement Test methods in the reverberation room
ISO 11452-2 (2004)	Road vehicles – Electrical interferences by irradiation with electromagnetic energy in narrow band – Equipment test method – Part 2 – Anechoic chamber
ISO 11452-4 (2005)	Road vehicles – Electrical interferences by irradiation with electromagnetic energy in narrow band – Equipment test method – Part 4 – Current injection method (BCI)

ISO 11452-8 (2007)	Road vehicles – Electrical interferences by irradiation with electromagnetic energy in narrow band – Equipment test method – Part 8 – Immunity to magnetic field
ISO 16750-1 (2004)	Road vehicles – Environment and test specifications of the electric and electronic equipment – Part 1 – Generalities
ISO 16750-2 (2004)	Road vehicles – Environment and test specifications of the electric and electronic equipment – Part 2 – Electric constraints
ISO 7637-2 (2004)	Road vehicles – Electric interferences by conduction and by coupling – Part 2: Transmission of transitory electric interferences by conduction only on power feeders
ISO 8820	Road vehicles – Fuses connections
ISO DIS 10605 (2007)	Road vehicles – Electric interferences due to electrostatic discharges
ISO 7637-3 Ed 2 (2007)	Electric interferences by conduction and by coupling – Private vehicles and light utility vehicles with nominal voltage of 12V – transmission of electric interferences by capacitive or inductive coupling on lines other than feeders
ISO 21848 (2005)	Road vehicles – Electric and electronic equipment for 42V network – Electric constraints
MIL STD 461 E	Requirements for the control of electromagnetic interference characteristics of subsystems and equipment

2.3.REGULATIONS

99/519/CE	Recommendation of the council of the European Union from 12 July 1999 relating to the limiting of the public exposure to electromagnetic fields (from 0 Hz to 300 GHz)
DC 2002-775	French decree no. 2002-775 from 3 May 2002 applied from 12° of article I.32 of the posts and telecommunications code and concerning the limit values of public exposure to electromagnetic fields emitted by equipments used in the telecommunication networks or by the radio-electric installations

2.4.EXPRESSION ON DOCUMENTS

For the requirements of this document, the expression on documents given in the standard B21 7100 is applied.

The application of the requirements of this document should be indicated on the documents in the following form: B21 7110.

3.TERMINOLOGY AND DEFINITION

A dictionary (glossary) of the main terms and their definitions used in the activities of the Technical-Industrial Upstream is consultable in internal via the Nectar glossary (http://nectar.inetpsa.com). This glossary is constantly updated.

3.1.DEFINITIONS

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

The abbreviations used in this document are listed below:

AM	:	Amplitude Modulation
FMECA	:	Analysis of the Failure Modes, of their Effect and Criticality.
+APC	:	Plus after contact
+BAT	:	Plus battery.
BCI	:	Bulk Current Injection (current injection method).
NB	:	Narrow Band.
BB	:	Broad Band.
BW	:	Bandwidth.
DUT		Device Under Test
EMC	:	Electro-Magnetic Compatibility.
CISPR	:	International special committee on radio interference.
CW	:	Continuous Wave.
DES	:	Electrostatic Discharge.
HT	:	High Voltage.
JIG	:	Calibration device.
N/A	:	Not Applicable
PM	:	Pulse Modulation.
PWM	:	Pulse Width Modulation
LISN	:	Line Impedance Stabilization Network.
TLS	:	Transmission Line System.
NTS/TS	:	Normative Technical Specification and Technical Specification (See standard A10 0310) Replaces the term “Detailed Technical Specification” (DTS)
STT		Stop and start
VED	:	Direct test voltage
VEK	:	After contact test voltage
VER	:	Relayed test voltage

3.2.VOLTAGES

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

3.3.TEMPERATURES

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

3.4.OPERATING MODES

For the requirements of this document, the operation modes given in the standard B21 7100 are applied. Within standard B21 7110, and for a given operating mode, the use of equipment under test should correspond in the worst susceptibility and/or emissivity case.

3.5.OPERATING CLASSES

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

Five operating classes take part in the definition of the DUT behaviour during and after the tests in this specification. For a reminder of the standard B21 7100, these classes are the following:

"*This paragraph describes the functional status of a device during and after a test.*
The minimum functional status must be indicated for each test. An additional test specification may be agreed upon between the equipment supplier and PSA.
Using the functional analysis, the analysis of failure modes and the preliminary risk assessment (PRA) of the equipment, a list of undesired event is deduced, rated by functional classes for the bench tests.
A piece of equipment may have several functions. Each of these may be subject to different functional classes.

Table 3 – Operating classes

Class	***Definition***
A	*The function (*) of the device/system performs as designed during and after the test.*
B	*The function (*) of the device/system performs as designed during the test; it may, however, go beyond the specified tolerances. All the functions automatically(*) return within normal limits after the test. Memory functions must remain in compliance with Class A.*
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 must conform with Class A after each test."*

3.6.CUSTOMER IMPACT LEVELS

Four customer's impact levels are defined. Each undesirable event (concrete EUT malfunction criteria) must be assessed in terms of its "customer impact" according to the following table:

Undesired EUT events	**Effects on the customer**	**Customer's impact levels**
To be formulated in the test plan	No direct or visible effect, acceptable deviation from design.	0
To be formulated in the test plan	Minor effect or negligible malfunction, without risk for man and the environment, slight inconvenience for the customer.	1
To be formulated in the test plan	Major effect with malfunction leading to serious inconvenience for the customer, without risk for man and the environment.	2
To be formulated in the test plan	Safety risk.	3

This table must be included in the test plan defined in § 4.2 for all tests concerned.

4.TEST CONDITIONS

4.1.VALIDATION PROCEDURE

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

4.2.DRAFT OF THE ENVIRONMENT TEST PLAN

For the demands of this document, the requirements on drafting the given environment test plan with standards B21 7100 and B35 0010 are applied.

4.3.TEST REPORT

The supplier should send a test report to the manufacturer when the tests are carried out.

The tests report should comply with standard A10 0156, with the following additions:

- The references of the tested equipment: type or designation, development status, Hardware and software reference.
- The number of samples tested for each test.
- The reference of the test plan applicable and any possible deviation in relation to it.
- The instrumentation used, with the calibration and/or checking dates for the critical equipment of the instrumentation chain (the instrumentation calibration certificates and the checking report should be made available to the Manufacturer).
- The uncertainty values associated with each test with a confidence level of 95.5% (k=2). The calculation procedure and/or method should be made available to the Manufacturer.
- The commitment of the supplier on the compliance or not of the DUT for each requirement. All possible analysis and/or opinion of the supplier on the test results should be clearly distinguished from the product compliance state.
- For the immunity tests:
    - the retained appraisal criteria (dreaded events and associated requirements in terms of client 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 operating modes and functional scenarios of the equipment used for the tests
    - The information required in the subchapter “test report” of the concerned test of this document.
- Any specific demand expressed in the test plan.

The Excel file (Test Report requirements.xls), which summarizes the demands above as well as demands specific to each test, is accessible internally within PSA through the following link : Annexes-en_B217110.zip

4.4.SUPPLIER'S RESPONSIBILITY

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

4.4.1.GENERAL ENVIRONMENT OF THE TESTS

For the needs of this document, the requirements on the general environment for tests given in the standard B21 7100 are applied.

4.4.2.TEMPERATURE

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

These requirements concern at least the “critical” measurement equipments.

Note: the “critical” measurement equipments are those required for the execution of a test and which have a significant incidence on the accuracy of the test result (the evaluation of measurement uncertainty is one of the means allowing the identification of critical equipments). The critical equipments include at least all measuring equipment that is the subject of calibration.

4.4.3.HUMIDITY

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

4.4.4.VOLTAGE

For the needs of this document, the voltage U_A requirements given in the standard B21 7100 are applied.

4.4.5.PRESSURE

No requirement is applied, except if otherwise stated in the standard.

4.4.6.TOLERANCES

For the needs of this document, the tolerance requirements given in the standard B21 7100 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).

4.5.SPECIFIC ENVIRONMENT OF THE TESTS

4.5.1.GENERALITIES

The configuration of the DUT and its environment should be representative of the real operating mode. The equipment under test (DUT) should be installed under the conditions approaching the most its normal conditions of use, in particular:

The DUT should be supplied by a battery and/or a source stabilized by internal resistance < 0.1 Ω and does not have to comprise superimposed ripple voltage > 0.1 V from peak to peak.

The ground connections should be in conformity with those indicated in the test plan or the schedule of conditions of the equipment.

The electrical connections with the ground plan (DUT, test material) when they are needed, have the characteristics:

- Inductance: $L \leq 100$ nH.
- Resistance: $R \leq 10$ mΩ.

The real DUT environment should be preferably used. However, in case of non feasibility, the use an environment simulator for sensors and actuators is allowed: it should have enough protection to not be disturbed by the disturbances generated during or after the test and to not trigger interferences.

The harness used for the tests should be representative of that used on vehicle, at least for the number of wire and their section. The length should comply with the specifications of the test concerned.

4.5.2.GROUND PLANE

The DUT is installed on a ground plane linked to the earth with minimum characteristics:

Length	:	at least 200 mm or length of the test bench increased by 500 mm (take the larger value of the two).
Width	:	width of the test bench increased by 200 mm for each side.
Thickness	:	≥ 0.5 mm.
Material	:	copper or brass.

4.5.3.INSULATED SUPPORT

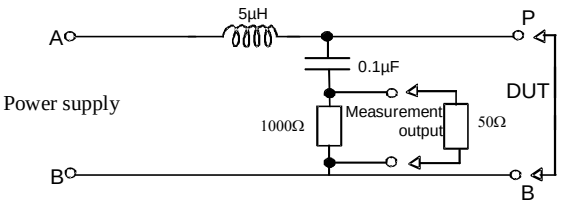
For all tests except EQ/IR03 and EQ/IR04, the DUT and the test wiring are insulated on the ground plane by a support with the characteristics:

Thickness	:	$50\ ^{+10}_{0}$ mm.
Relative permittivity	:	$\varepsilon r \leq 1.4$.
Relative permeability	:	$\mu r \leq 1.1$.

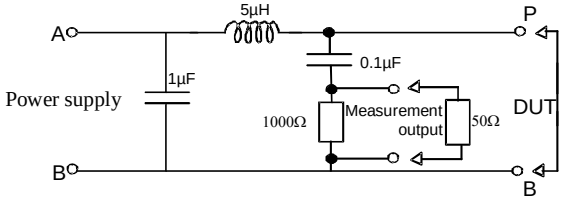
Note : *The wooden supports should not be used because of their relative high permittivity.*

4.5.4.DECOUPLING DEVICES (LSIN)

The use of a line impedance stabilization network (LSIN) allows us to perfectly define the supply network line impedance and protects the supply network against injected interferences.



LSIN compliant with standard ISO 7637-2



LSIN compliant with publication CISPR 25

LSIN connection (when necessary):

- If the bonding of the DUT is local on the vehicle (l < 200 mm), a LSIN should be connected on the power supply lead.
- If the bonding of the DUT is distant on the vehicle (l ≥ 200 mm), two LSIN should be connected on the power supply lead and on the ground conductor.

4.6.MEASUREMENT FACILITIES

The measurement chains with optical link should have a bandwidth adapted to the signals to be transmitted.

The electrical connections (and especially those made for tests in shielded chamber) should be shielded or equipped with adapted filters.

The capture device (oscilloscope, spectral analyzer, receiver) should have a bandwidth adapted to the signals to measure or a number of digitized points adapted to the treatments carried out.

The current or voltage probes should have a bandwidth adapted to the signals to be measured and enough immunity in regard to the electromagnetic environment linked to the test.

4.7.SPECIFIC CONDITIONS FOR IMMUNITY TESTS

The mode of use of the equipment under test should match the worst susceptibility case or the highest functional occurrence.

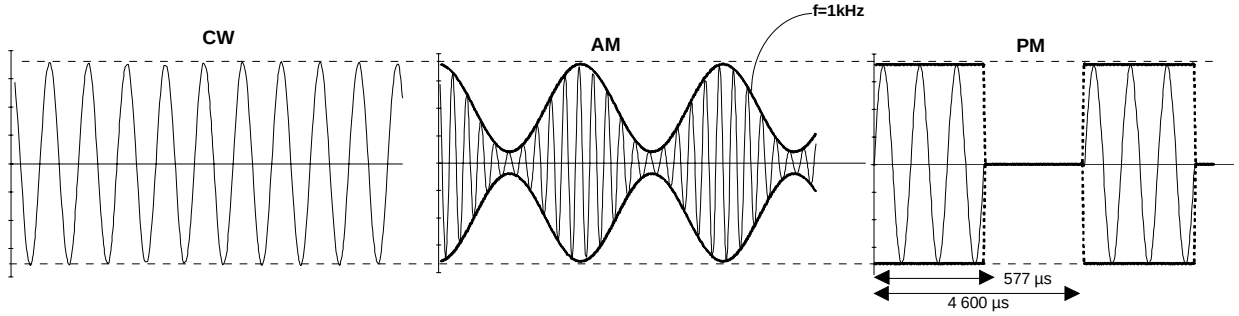
The test installation should be capable of generating the test signals required for the frequency bands defined in this document. The installation should comply with the legal prescriptions concerning the emission of electrical signals (use of a shielded chamber).

Note : *The test area can be subjected to important electromagnetic fields: it is the duty of the Supplier to take all necessary precautions (use of a shielded chamber for example).*

4.7.1.MODULATION

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

- Not modulated (CW).
- Amplitude modulated, 1 kHz 80% (AM)
- Pulse modulated, PM1 Frequency 217 Hz, Tone 577 µs (illustration below).
- Pulse modulated, PM2 Frequency 300 Hz, Tone 100 µs.
- Specificity of US market: pulse modulated, PM3 (radar pulses) Ratio of pulse repetition 300 Hz Tone 3 µs, with only 50 pulses each second.



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

Reminder concerning the conservation principle of the peak level:

Any sinusoidal signal s(t) (of current, field or voltage type) of the pulsation ω can be written as:

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

Its average power is:

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

Any sinusoidal signal s(t) modulated in amplitude can be written as:

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

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

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 preserve the peak value:

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

  For the 80% modulation rate, we have: $P_{AM} = 0.407 \cdot P_{CW}$ (-3.9 dB)

- measurement of the non modulated power before applying the modulation: $P_{CW\ before\ modulation} = \left(\frac{1}{1+m}\right)^2.P_{CW}$

  For the 80% modulation rate, we have: $P_{CW\ before\ modulation} = 0{,}309 \cdot P_{CW}$ (-5.1 dB)

4.7.2.FREQUENCY STEPS

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

F_{min}	F_{max}	No logarithmic frequency	No linear frequency
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 on equipment with the frequency steps above does not guarantee the behaviour of the requirements on vehicle with the same frequency steps (possible variation of the quality factor). We refer to the maximum steps between the two frequencies with the purpose of preventing any malfunctioning between the two; the accurate list of frequencies which results from it is by no means contractual.*

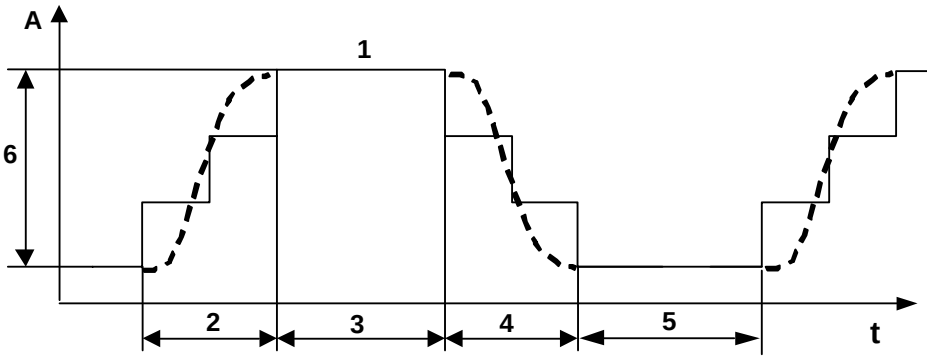
For information purposes, the immunity tests with the field of noise to external sources (semi-anechoic room) on vehicle are carried out with the maximum linear frequency steps indicated in this table.

4.7.3.EXPOSURE TIME

For the frequency immunity tests, for each frequency, the interference is applied progressively until reaching the specified level, and then reduced in the same way before switching to the next frequency.

Except for a specific agreement between the Supplier and the Manufacturer (to be specified in the EMC test plan), the application of the interference is carried out according to the figure below.

The holding time depends on the DUT. If using software filtering that adds temporization before the springing of a fault, the holding time will be extended consequently. It should be specified in the EMC test plan.



1 Specified level

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

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

4 Decrease time of the disturbance ($t_d \geq 0.5$ s)

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

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

4.8.SPECIFIC CONDITIONS FOR EMISSION TESTS

In order to ensure that no interfering noise or outer signal of sufficient amplitude will significantly influence the measurement, the measurements will be taken before or after the main test. During this measurement, the interfering noises or signals should be at least 6 dB lower than the appropriate reference limits (shielded chamber required).

The mode of use of the equipment under test should match the worst interferences case or the highest functional occurrence. In the case of reversible equipments, the evaluation of the interferences should be carried out in the two directions of the rotation.

In the case of equipment with some adjustable amplitudes (engine speed, brightness level…), the evaluation of the interferences is carried out in the worst case. Measurements of the pre-evaluation can then become necessary.

To ensure the reproducibility of the results on equipments having electro-mechanical contacts vulnerable to wear, prior running-in of the equipment being tested is required. The duration of this running-in should be in relation with the equipment mission profile.

5.APPLICATION GUIDE OF THE TESTS ON THE EQUIPMENT

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

The table that follows is a guide which allows the targeting of the applicability of each test according to the specificities of the equipment, and to help drafting the test or NTS/TS plan.

Each test chapter of this standard contains a paragraph called “CONDITIONS OF APPLICATION OF THE TEST” which provides the same information.

	Test not applicable by default, except if:	**Test always applicable, except if:**
EQ/TE 01: Resistance to usual power supply voltages		equipment powered by a regulated voltage supplied by another device.
EQ/TE 07: Resistance to exceptional supply voltage		equipment powered by a regulated voltage supplied by another device.
EQ/TE 02: Resistance to slow increase and decrease of supply 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: Resistance to unusual power supply voltages: 24V		equipment powered by a regulated voltage supplied by another device.
EQ/TE 04: Resistance to unusual power supply voltages: -13.5V		equipment powered by a regulated voltage supplied by another device.
EQ/TE 05: Resistance to short circuits		*exceptions are rare and should be studied case by case (simple motor, led…)*
EQ/TE 06: Resistance to long duration overloads	OR: Presence of output(s) likely to deliver more than 100mA. OR: Presence of inputs/output delivering a ground. OR: Presence of circuits having motors/actuators.	
EQ/IC 01: Resistance to pulses 1, 1 bis and 2a		equipment powered by a regulated voltage supplied by another device.
EQ/IC 10: Resistance to pulses on outputs switching inductive loads	equipment switching inductive loads (motors, actuators, external relay…)	
EQ/IC 02: Resistance to pulses 3a & 3b		OR: equipment powered by a regulated voltage supplied by another device. OR: does not contain active electronics. *In the case of 5V supplies, the test EQ/IC07 is applied on all the signal + feeders.*
EQ/IC 03: Resistance to pulse 5b		equipment powered by a regulated voltage supplied by another device.

	Test not applicable by default, except if:	Test always applicable, except if:
EQ/IC 04: Resistance to supply micro-interruptions 2 µs ------>		passive equipment or motor, having the following particularities: OR: Functions having insufficient mechanical or thermal inertia (seat motors, resistive heating system…) OR: Functions of the lighting or warning light type, for which flickering is authorized.
EQ/IC 04: Resistance to supply micro-interruptions 100 µs ------>		OR: equipment which have no supply line switched by a relay. OR: passive equipment or motor, having the following particularities: - Functions having a sufficient mechanical or thermal inertia (seat motors, resistive heating system…) - Functions of the lighting or warning light type, for which flickering is authorized.
EQ/IC 04: Resistance to supply micro-interruptions 5 ms ------>	AND: equipment supplied on vehicle via a contactor. AND: equipment including active electronics, which does not correspond to one of the following particularities: - Functions having a sufficient mechanical or thermal inertia (seat motors, resistive heating system…) - Functions of the lighting or warning light type, for which flickering is authorized.	
EQ/IC 05: Resistance to pulses 4 or 4 bis (starting)		OR: equipment powered by a regulated voltage supplied by another device. OR: equipment not connected during start-up.
EQ/IC 12: Resistance to re-start pulse (STT)		OR: equipment not to be installed in a vehicle with stop and start system (STT), OR: equipment powered by a regulated voltage supplied by another device.
EQ/IC 06: Resistance to ripple voltages		OR: equipment powered by a regulated voltage supplied by another device. OR: passive equipment or motors, having insufficient mechanical or thermal inertia (seat motors, resistive heating system…)
EQ/IC 07: Immunity to transients on the signal lines		the equipment does not contain active electronics.
EQ/IC 08: Immunity to Bulk current injection (BCI)		the equipment does not contain any electronic component. In the case of an equipment which does not have passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 300mA test is applicable, with the limited requirements.
EQ/IC 09: Immunity to high/low ignition voltage	equipment installed in engine compartment AND: OR: having an electric connection less than 200 mm away from the high voltage ignition system OR: running along the low voltage control wiring.	

	Test not applicable by default, except if:	Test always applicable, except if:
EQ/IR 01: Immunity to radiated field (anechoic room)		the equipment does not contain any electronic component. The applicability of the requirements specific to US market should be specified in the NTS/TS. In the case of an equipment which does not have passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 200/160V/m test is applicable, with the limited requirements.
EQ/IR 06: Immunity to radiated field in reverberation chamber		the equipment does not contain active electronics.
EQ/IR 02: Immunity to low frequency magnetic field	OR: equipments sensitive to magnetic field (sensors with Hall effect, audio circuits, …) OR: equipments located near a high source of magnetic field (alternator, DAE, …)	
EQ/IR 03: Immunity to ESD, equipment not powered	*Test still applicable.*	
EQ/IR 04: Immunity to ESD, equipment powered		the equipment does not contain active electronics.
EQ/IR 05: Immunity to on-board transmitters		OR: equipment located in the engine compartment OR: equipment does not contain active electronics.
EQ/MC 01: Measurement of the switching noises	OR: the equipment has a motor likely to operate in switch mode. OR: the equipment switches loads via relays (BSI, BSM…).	
EQ/MC 02: Measurement of low frequency conducted noises	the equipment consumes a current >1Aeff	
EQ/MC 03: measurement of radiofrequency conducted noises on the supply inputs		equipment having no frequency oscillator >9kHz and no motor.
EQ/MC 04: measurement of radio frequency conducted noises on the outputs	the equipment has a frequency oscillator >9kHz, or a motor, AND: OR: has supply or power outputs OR: has shielded cables.	
EQ/MR 01: Measurement of radiofrequency radiated noises		equipment having no frequency oscillator >9kHz and no motor.
EQ/MR 02: Measurement of low frequency magnetic field	OR: the equipment consumes a current >1Aeff OR: the equipment has an electric motor	

This table is accessible as an Excel file (Application of the tests.xls) internally within PSA through the following link: Annexes-en_B217110.zip

6.TEST PROCEDURES ON EQUIPMENT AND REQUIREMENTS

6.1.ELECTRICAL RESISTANCE TESTS

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

6.1.1.1.REFERENCE DOCUMENT

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

6.1.1.2.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 for the possible problem linked to the alternator).

The main characteristics of the test are the following:

- Minimum voltage 8; 9.5 or 10.5 V (or 30 V) in ambient temperature.
- Maximum permanent temperature 16 V (or 48 V) in ambient temperature.

This test cancels and replaces test CL03 of the standard B21 7130.

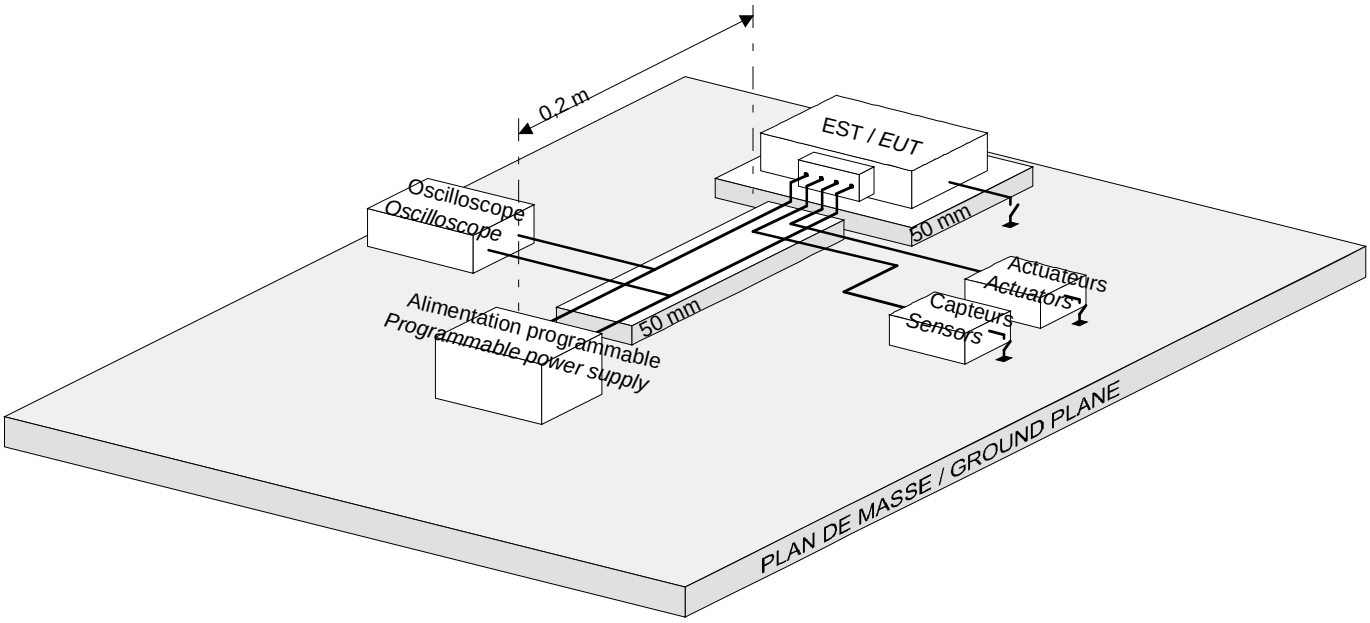
6.1.1.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all powered equipments. For equipments powered by a regulated voltage supplied by another device (especially 5V sensors), the NTS/TS will specify the operating voltage range. The test is carried out on the equipment feeders taken simultaneously.

6.1.1.4.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.

6.1.1.5.ASSEMBLY



6.1.1.6.PROCEDURE

Preparation:

A harness 2000 mm long should be preferably used (the real harness may be used). The test harness is placed on an insulating support, 50 mm thick.

The harness supply wires should be at most 200 mm long.

The DUT is possibly placed on an insulating support, 50 mm thick. It 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 500 mm.

Operating voltages:

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

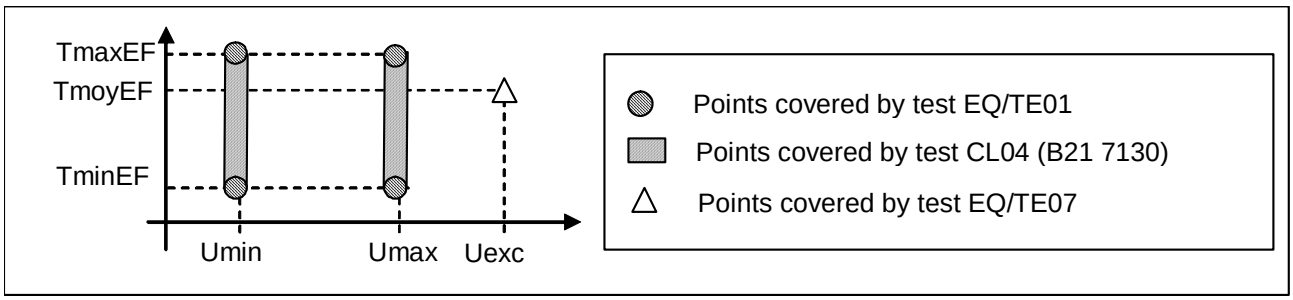
Network 12 V	Network 42 V	Power supply voltage
U_{min} = 8.0 V	U_{min} = 30 V	Minimum voltage 1 (equipment operational (*), engine not-running and generator not-operational).
U_{min} = 9.5 V	U_{min} = 30 V	Minimum voltage 2 (equipment operational (*), engine not-running and generator not-operational).
U_{min} = 10.5 V	U_{min} = 30 V	Minimum voltage (function operational (*), engine running and generator operational), and/or “stop” phase of the stop and start system.
U_{max} = 16.0 V	U_{max} = 48 V	Permanent maximum voltage.

The minimum voltage 1 is applied to equipments and/or functions that should work when the engine is not running with a non operational generator (example: starter control provided by CMM, +APC command provided by BSM…). Except if otherwise stated in the NTS/TS, this voltage will be 9.5V.

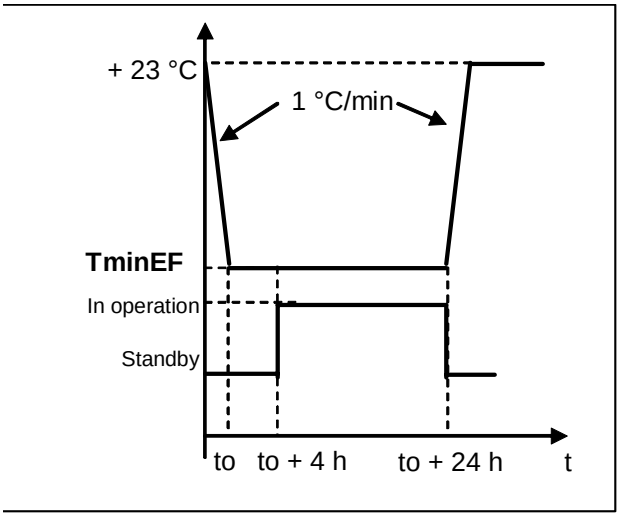
The minimum voltage 2 is applied to equipments and/or functions that are authorized to work when the engine is not running with a non operational generator (example: car radio, window regulator, parking aid…) and of which the NTS/TS authorizes a degrading of performance.

Test:

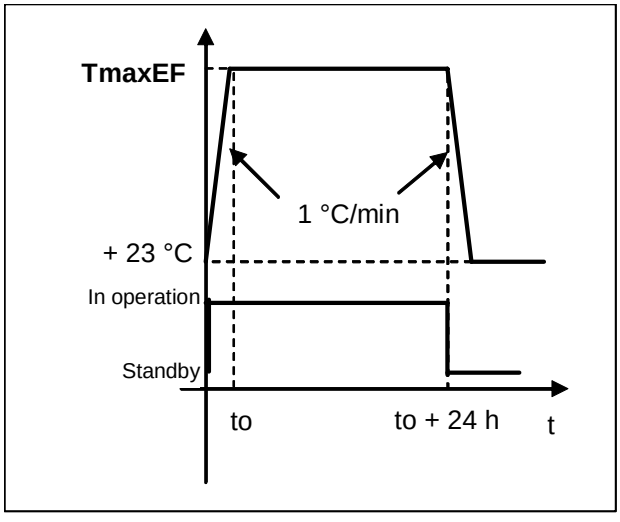
Apply a minimum voltage, then the voltages on all feeders as follows:



Test with Minimum extreme operating temperature	24 h at TminEF ± 3 °C. Operating mode: equipment in standby under Umin for 4 h, then in operation for 20 h under Umin, under the minimum operation load (the objective is to limit the internal heating). A complete functional test is carried out with Umin then Umax 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 with Maximum extreme operating temperature	24 h at TmaxEF ± 3 °C. Operating mode: equipment at Umax under nominal load. Complete functional test Umax then Umin 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 $\Delta T < 5$ °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).
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.

6.1.1.7.REQUIREMENTS

Test		Test level (12V network)	Operating classes	Customer impact levels
Minimum voltage	functions (*) that should be operational with the engine running with a non operational generator	8.0V	A	0
	functions (*) that can be operational with the engine running with a non operational generator	8.0V	C	1
		9.5V	A	0
	functions (*) that should be operational with the engine not running with a operational generator	10.5V	A	0
Maximum permanent voltage		16.0V	A	0

(*) Equipment is likely to regroup several functions.

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

6.1.2.1.REFERENCE DOCUMENT

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

6.1.2.2.OBJECTIVE OF THE TEST

This test is intended to verify the immunity of the equipments to exceptional voltage. This maximum voltage corresponds to a stop voltage, when the regulator from the alternator is broken.

The main characteristics of the test are the following: 18 V maximum voltage for 3 hours for a 12V network (or 50 V for a 42V network) at TmoyEF temperature.

This test cancels and replaces test CL05 of the standard B21 7130.

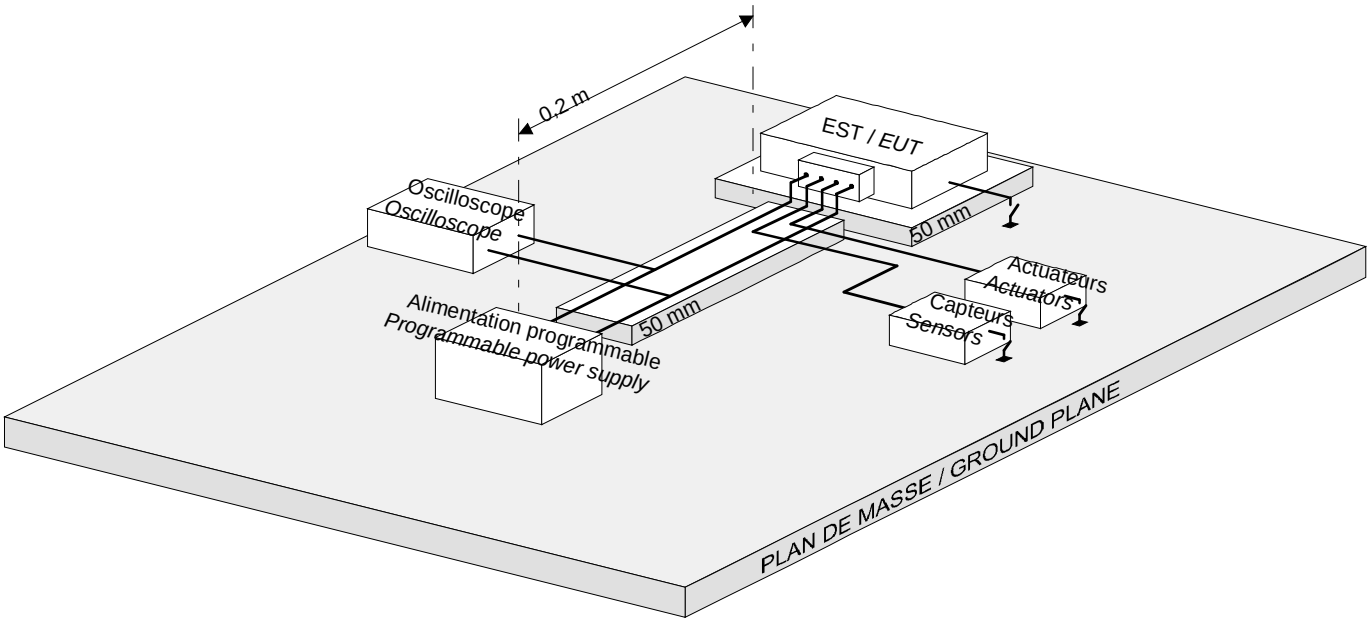
6.1.2.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all powered equipments. This test is not applied to equipments powered by a regulated voltage supplied by another device. The test is carried out on the equipment feeders taken simultaneously.

6.1.2.4.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.

6.1.2.5.ASSEMBLY



6.1.2.6.PROCEDURE

Preparation:

A harness 2000 mm long should be preferably used (the real harness may be used). The test harness is placed on an insulating support, 50 mm thick.

The harness supply wires should be at most 200 mm long.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

For this test at TmoyEF, 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 500 mm.

Operating voltages:

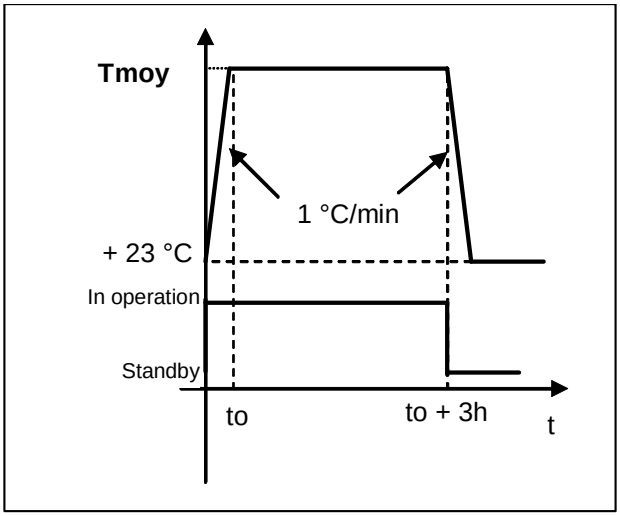
Adjust the programmable supply in order to obtain the operating supply voltage as follows:

Network 12 V	Network 42 V	Power supply voltage
Uexc=18.0 V	50V	Exceptional maximum voltage.

Test:

Apply a minimum voltage, then the voltages on all feeders as follows:

General procedures	3 hours at TmoyEF ± 3 °C. The equipment is in its nominal operating mode, under representative load, at Uexc. A complete functional test is carried out 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 $\Delta T < 5$ °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).
Number of parts	At least two DUT.



Test EQ/TE07

Note: The definition of TmoyEF 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.

6.1.2.7.REQUIREMENTS

Test	Test level (12V network)	Test level (42V network)	Operating classes	Customer impact levels
Unusual voltage	18.0V	50.0V	Function-specific	1

6.1.3.EQ/TE 02: RESISTANCE TO SLOW INCREASE AND DECREASE OF SUPPLY VOLTAGE

6.1.3.1.REFERENCE DOCUMENT

This procedure is in conformity with the standard ISO 16750-2.

6.1.3.2.TEST OBJECTIVE

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

The voltage slow decrease/increase corresponds to the slow discharge/charge of the battery, when the vehicle is stopped. The test contributes furthermore to testing the software robustness and/or to characterize some hysteresis (reset voltage…).

The main characteristics of the test are the following:

- Nominal voltage of 14 V or 48 V.
- Voltage drop of 0.5 V/1mn until 0V (linear decrease).
- Voltage rise of 0.5 V/1mn from 0 V to the nominal network value (linear increase).

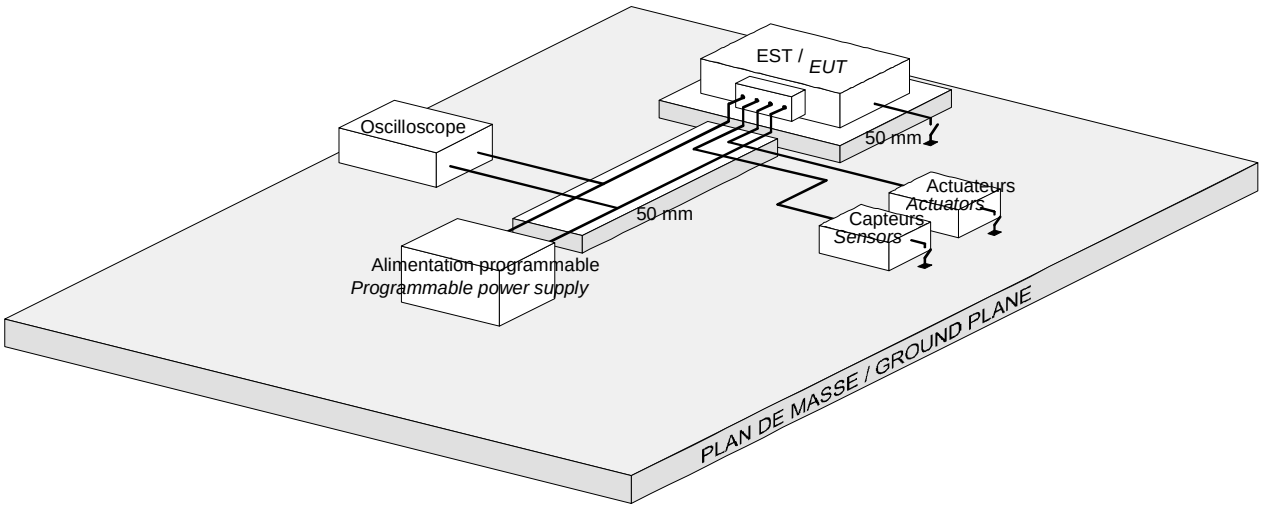
6.1.3.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all equipment having active electronics, a microcontroller and/or onboard software. The test is carried out on the equipment feeders taken simultaneously.

6.1.3.4.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.

6.1.3.5.ASSEMBLY



6.1.3.6.PROCEDURE

Preparation:

A wiring 2000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

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

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply the voltage drop and rise cycle on all the feeders (VED, VEK and VER) grouped by 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 Umin.

6.1.3.7.REQUIREMENTS

These requirements apply for the non running engine operational equipments:

Test	Operating classes	Customer impact levels
Decrease of voltage	C	Not applicable
Increase of voltage	C	Not applicable

Notes:

- *For the equipments where safety requires it, the requested class can be type D for the test on each supply successively (case to be specified in the NTS/TS).*
- *The operation should remain type A in the regular voltage range defined in § 6.1.1.*
- *For voltages lower than Umin, 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…).*

6.1.4.EQ/TE 03: REINITIALIZATION TEST

6.1.4.1.REFERENCE DOCUMENT

This procedure is in conformity with the standard ISO 16750-2.

6.1.4.2.OBJECTIVE OF THE TEST

This test is intended to verify the proper reset of the equipments during fluctuations of the electrical network.

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

The main characteristics of the test are the following:

- Voltage drop to 0 V, by steps of less than 5 %
- Fluctuation time td: 5 s, cycle time T = 15 s, or more if needed by the equipment reset time.

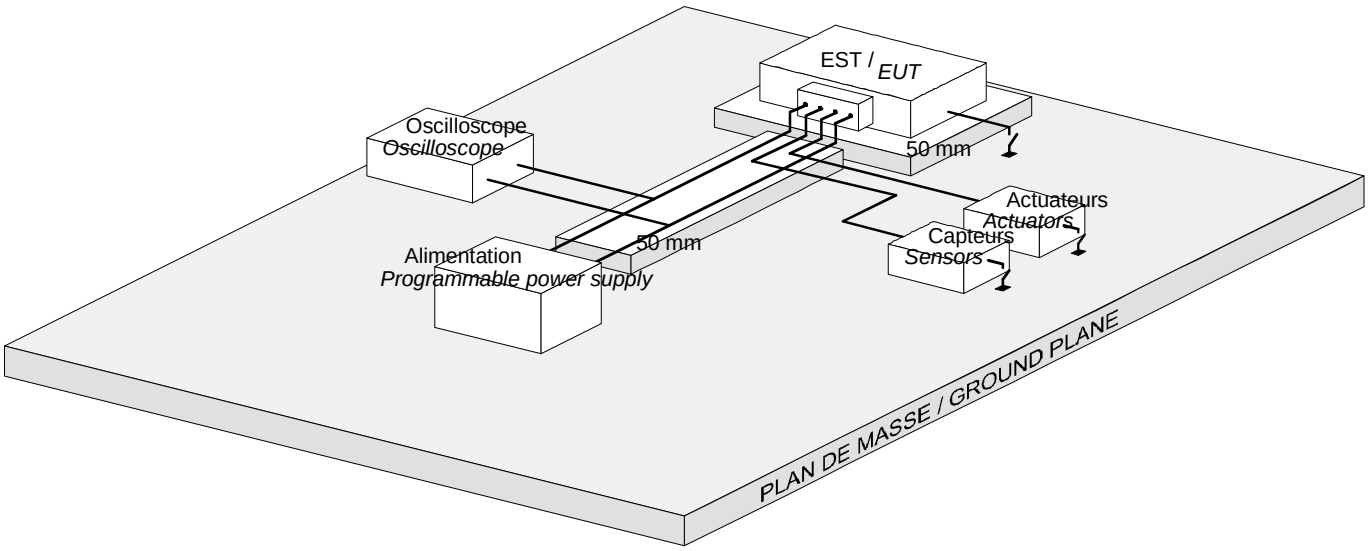
6.1.4.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all equipment having active electronics, a microcontroller and/or onboard software. The test is carried out on the equipment feeders (VED, VEK, VER) taken successively and simultaneously.

6.1.4.4.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.

6.1.4.5.ASSEMBLY



6.1.4.6.PROCEDURE

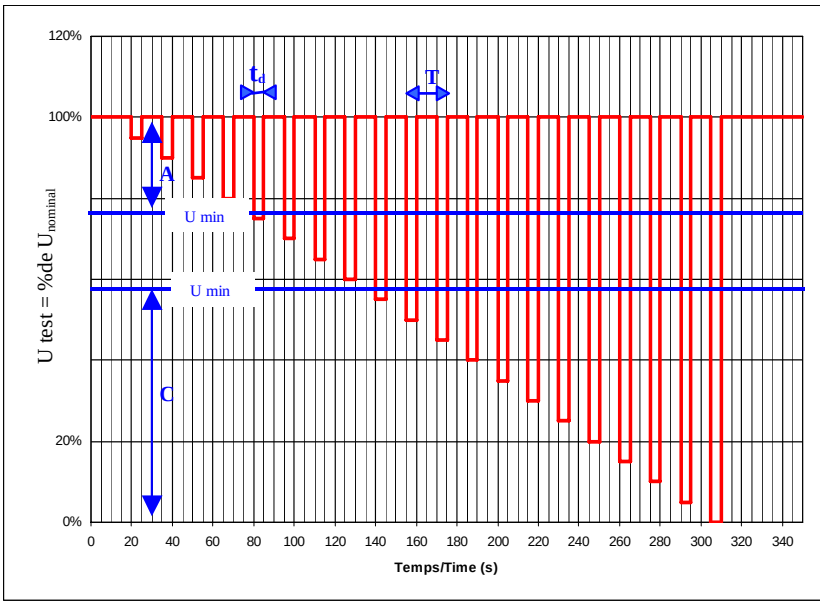
Preparation:

A wiring 2000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

Replace the DUT by a 1 kΩ resistance and connect the oscilloscope to the resistance terminals and adjust the generator in order to obtain the following waveform:

Network 12 V	Network 42 V	Cut-off on VED, VEK and VER
U nominal = 14 V $t_{fall} \leq$ 1 ms $t_{rise} \leq$ 1 ms t_d = 5 s t_i > 10 s T = t_d + t_i	U nominal = 48 V $t_{fall} \leq$ 1 ms $t_{rise} \leq$ 1 ms t_d = 5 s t_i > 10 s T = td + t_i	

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply the fluctuation cycle on each feeder successively (VED, VEK and VER) then on the set 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 pulses applied.

6.1.4.7.REQUIREMENTS

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

Notes:

- *For the equipments where safety requires it, the requested class can be type D for the test on each supply successively (case to be specified in the NTS/TS).*
- *The operation during testing should remain type A in the regular voltage range defined in § 6.1.1.*
- *Between each fluctuation time td, the equipment operation should be type A, without the time td causing a permanent memory loss.*

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

6.1.5.1.REFERENCE DOCUMENT

This procedure is in conformity with the standard ISO 16750-2.

6.1.5.2.OBJECTIVE AND APPLICABILITY OF THE TEST

This test is intended to verify the immunity of the equipments to maximum voltage (use category of an auxiliary starting device) and reversed polarity of the onboard network.

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

- Maximum voltage of 24 V for 1 minute.
- Reverse voltage for 1 minute or - 13.5 V.

The main characteristic is the following for the 42 V network:

- Maximum voltage - 2 V during 100 ms (because of the use of a centralized protection)

6.1.5.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all powered equipments, except the following cases:

- The reverse voltage test is not applicable to relays with clutch diode.
- The test is not applicable if the DUT is powered by a regular voltage supplied by another device.

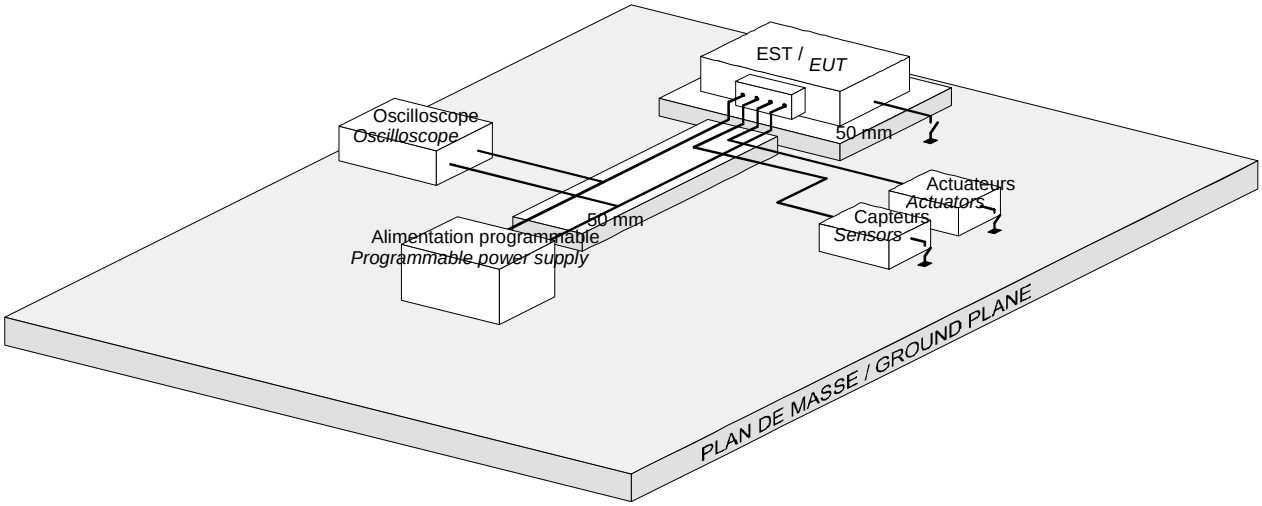
For the alternators test, the reverse voltage test should be carried out with the DUT fitted with its diode bridge.

The test is carried out on the equipment feeders taken simultaneously.

6.1.5.4.TEST MEANS

- Programmable supply (or battery) and cables that allow use to ensure the following impedance conditions:
    - For the high power equipments (consumption > 20A), the source impedances and the wiring sections lengths should represent reality. The global supply impedance and of its back and forth wiring should be lower than 20 mohms.
    - For other equipments, the general impedance conditions of §4.6.1 (< 0,1Ω) apply.
- 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.

6.1.5.5.ASSEMBLY



6.1.5.6.PROCEDURE

Preparation:

A wiring 2000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

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

Network 12 V	Network 42 V	Power supply voltage
U_{max} = 24 V		Maximum voltage for 1 minute
U_{inv} = -13.5 V		Reverse voltage for 1 minute
	UT = - 2 V	Reverse voltage limited to -2V for 100 ms (centralized protection)

Test:

- Run the DUT for a minimal duration of 10 minutes.
- Disconnect the DUT for at least 10 seconds.
- Apply the maximum voltage for a minute on all feeders (12 V) by monitoring the DUT.
- Disconnect the DUT for at least 10 seconds.
- Apply the reverse voltage for a minute on all feeders (12 V) by monitoring the DUT. Apply the reverse voltage limited at – 2 V for 100 ms on all feeders (42 V) by monitoring the DUT.
- Repeat the test cycle for at least 5 times.

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.

6.1.5.7.REQUIREMENTS

Test	Operating classes	Customer impact levels
Maximum voltage	C	1
Reverse voltage	D	2

6.1.6.EQ/TE 05: RESISTANCE TO GROUND AND POSITIVE SUPPLY VOLTAGES SHORT CIRCUIT

6.1.6.1.REFERENCE DOCUMENTS

This procedure complies with the standard ISO 16750-2 for 12V, and with standard ISO 21848 for the 42V.

6.1.6.2.OBJECTIVE OF THE TEST

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

The main characteristics of the test are the following:

- Maximum voltage Umax (16 V and 48 V respectively) for 60 seconds.
- Minimum voltage 0 V for 1 minute.

6.1.6.3.CONDITIONS FOR APPLICATION OF THE TEST

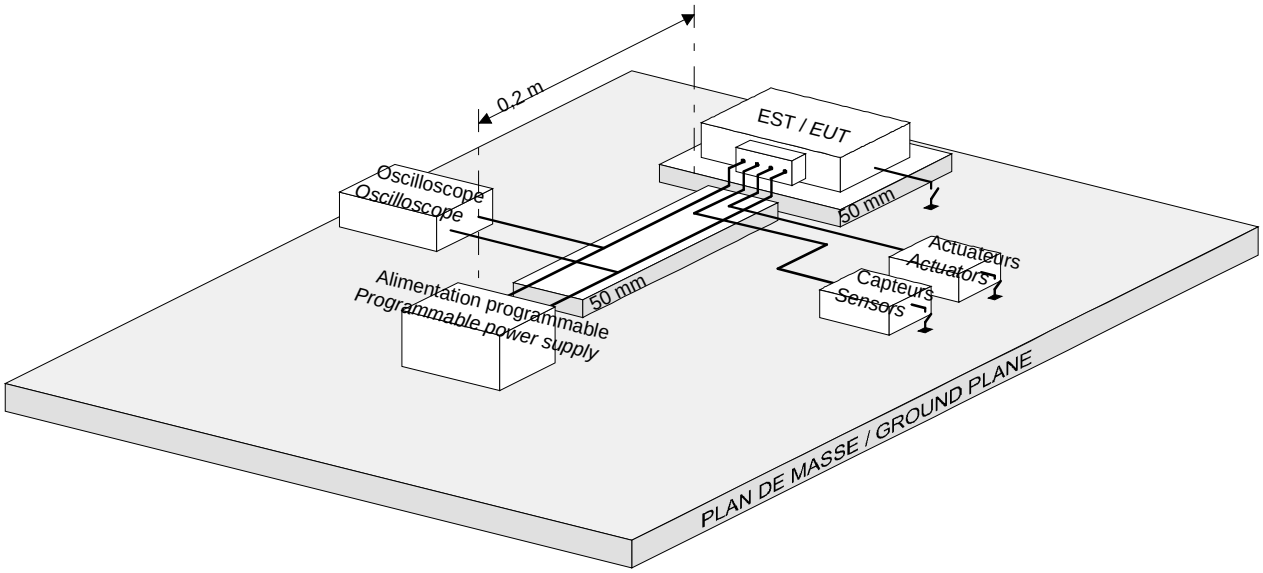
The test is applicable to all single voltage equipments (including those powered to 5V). In the case of equipments powered by two various voltages (12 V, 42 V …) see the NTS/TS or the specific test plan.

The test is carried out on each of the feeders, input and output.

6.1.6.4.TEST MEANS

- Programmable power supply, internal resistance < 0.1 Ω.
- 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.

6.1.6.5.ASSEMBLY



6.1.6.6.PROCEDURE

Preparation:

A wiring 2000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires and the outputs subjected to the test should have a maximum length of 200 mm. The line impedance that ensure the short-circuiting should be lower than 0.1 Ω.

The equipment positive power supply line and/or the positive power supply that brings the short-circuit can be limited in electric current (include a series fuse for example). The NTS/TS or the test plan should specify the electric current value. By default, the value will be 50A.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

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

Network 12 V	Network 42 V	Power supply voltage
U_{max} = 16 V	U_{max} = 48 V	Maximum voltage for 60 seconds
U_{min} = 0 V	U_{min} = 0 V	Minimum voltage for 1 minute

6.1.6.7.TEST: GENERAL CASE

Test:

Run the DUT for a minimal duration of 10 minutes.

DUT powered (under 16V for the needs of this test):

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

Power supply lines + disconnected:

- Disconnect all the DUT power supply lines (+ terminals)
- Apply successively the maximum voltage for 60 seconds on each input/output line and monitor the DUT.
- Reconnect the power supply lines

Ground lines disconnected:

- Disconnect all the DUT ground lines
- Apply successively the minimum voltage for 60 seconds on each input/output line and monitor the DUT. (reconnect the ground lines)

Important note: *the return circuits (return of sensors, actuators ground…) are considered as grounds subjected to the Umax test. (A Umax connection of a non protected output (fuse,…) will damage the DUT, but no aggravated short-circuit (ASC) should be noted).*

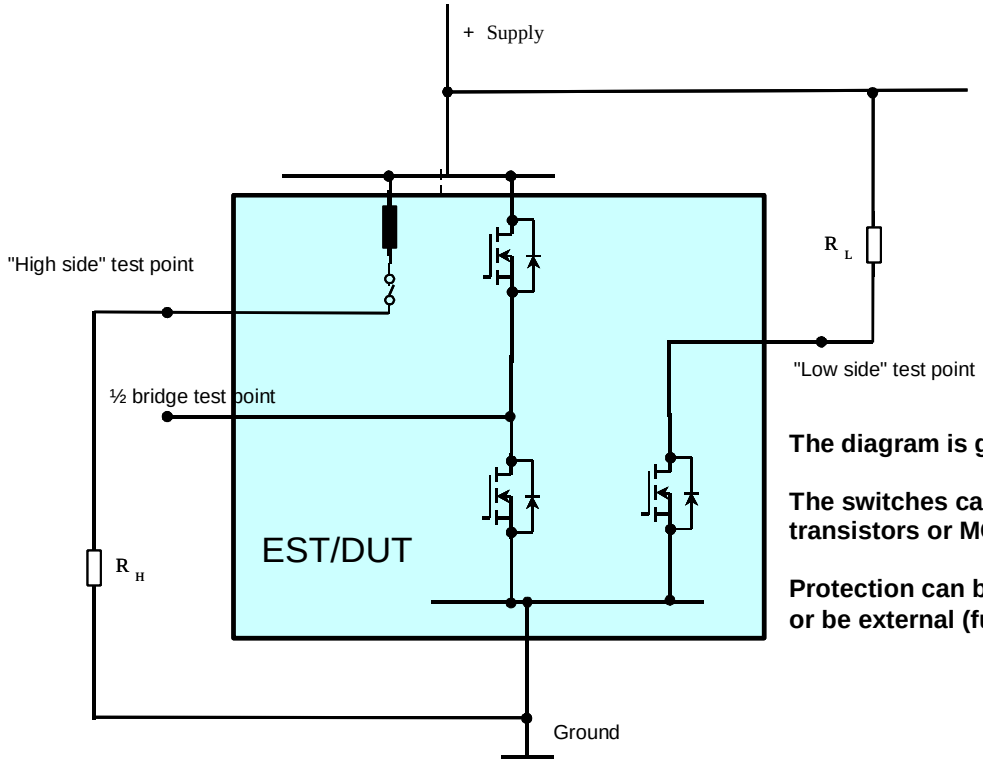
Test report:

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

- Assembly used: wiring, DUT environment.
- Parameters noted and malfunctions observed during testing, as a table including a pin list tested / type of short circuit (to + or to the ground) / the DUT power supply state (connected power supply, ground or + disconnected) / malfunction observed.

6.1.6.8.TEST: PARTICULAR CASE

In the case of outputs on charges which may be damaged by the test, the tests can be alleviated as follows:



The diagram is given as an example.

The switches can be relays, bipolar transistors or MOS, ...

Protection can be integrated in the switch or be external (fuse...)

Test:

Run the DUT for a minimal duration of 10 minutes.

The outputs should be controlled.

“High side” outputs (electronic switch or relay to + power supply)

- Apply successively the minimum voltage for 60 seconds on each line and monitor the DUT.

“Low side” outputs (electronic switch or relay to the ground)

- Apply successively the maximum voltage for 60 seconds on each line and monitor the DUT.

“Half-bridge” outputs

- Apply successively the maximum voltage for 60 seconds on each line and monitor the DUT.
- Apply successively the minimum voltage for 60 seconds on each line and monitor the DUT.

Note 1: *the test is only carried out in one direction in order not to stress or damage the loads needed for running the DUT (R_H and R_L), which cannot be powered to maximum voltage for 1 minute.*

Note 2: *for circuits protected by a fuse (integrated to the equipment), the test time can, if needed, be adapted to acknowledge the time (standard ISO 8820) required to melt the fuse.*

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

Test report:

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

- Assembly used: wiring, DUT environment.
- Parameters noted and malfunctions observed during testing, as a table including a pin list tested / type of short circuit (to + or to the ground) / the DUT power supply state (connected power supply, ground or + disconnected) / malfunction observed.

6.1.6.9.REQUIREMENTS

Case of tests with power supplies connected:

Test			Operating classes	Customer impact levels
Security function and equipment			C	Not applicable
Non security function and equipment	case of protected power (3) outputs		C (see note 2)	Not applicable
	case of non-protected power (3) outputs		E (see note 1)	Not applicable
	case of power inputs and of signal inputs/outputs	Minimum voltage	C	Not applicable
		Maximum voltage	C	Not applicable

Note 1: only the non-protected output should be damaged or destroyed and no aggravated short-circuit (ASC) should be noted. In the case of this document, the ASC naming groups:

- *thermal anomaly provoked by an excessive local heating of electric origin, leading to reach the inflammation point of the materials.*
- *combustion of the substrate and/or inflammation of the other materials of the equipment.*

Note 2: *except if otherwise stated in the NTS/TS (ex.: protection by fuse, where the D class is required).*

Note 3: *Power output is any output that yields electric current higher than 1Aeff. If needed, this threshold can be adapted to specificities of the equipment in the NTS/TS or on the test plan.*

Case of tests with + power supply or ground disconnected:

Test			Operating classes	Customer impact levels
Security function and equipment			A after reconnection	Not applicable
Non security function and equipment	case of protected power (3) outputs		E (see note 1)	Not applicable
	case of non-protected power (3) outputs		E (see note 1)	Not applicable
	case of power inputs and of signal inputs/outputs	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 no aggravated short-circuit (ASC) should be noted. In the case of this document, the ASC naming groups:

- *thermal anomaly provoked by an excessive local heating of electric origin, leading to reach the inflammation point of the materials.*
- *combustion of the substrate and/or inflammation of the other materials of the equipment.*

Note 3: *power output is any output that yields electric current higher than 1Aeff. If needed, this threshold can be adapted to specificities of the equipment in the NTS/TS or on the test plan.*

Note 4: *whatever the output type, the DUT behaviour should be documented, especially the risks of powering on the equipment or other inputs/outputs. It is the obligation of the NTS/TS of the concerned equipment to specify:*

- *if the DUT can redistribute a positive or negative power supply on its power supply inputs and/or inputs/outputs,*
- if the DUT can be powered and/or woken up by a short circuit of one of its inputs-outputs.

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

6.1.7.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.1.7.2.OBJECTIVE OF THE TEST

The purpose of this test is to verify the absence of any excessive local heating, following an abnormal DUT stress on its power supplies, inputs and/or outputs, such as:

- Sustained overload due to a modification or increase of the power of the elements to be controlled.
- Mechanical or software locking of an actuator (starter, window regulator, …),
- Incomplete short-circuit and/or complete but repetitive short-circuit.

6.1.7.3.CONDITIONS FOR APPLICATION OF THE TEST

The test type (1a, 1b, 1c, 2 or 3) should be determined for each output individually, so that equipment with several power supplies/inputs/outputs goes through several tests.

The type 1 bonding tests by an impedance are applicable only to equipments driving a motor or load likely to yield a current higher than 100 mA:

- Type 1a applicable for non-protected circuits.
- Type 1b applicable for the “smart power” type circuits or circuits protected by a software strategy.
- Type 1c applicable to circuits protected by fuse (integrated in the equipment)

The type 2 +BAT connection by an impedance are applicable in the case of inputs/outputs delivering a ground and to “low side” outputs likely to yield an electric current higher than 100mA:

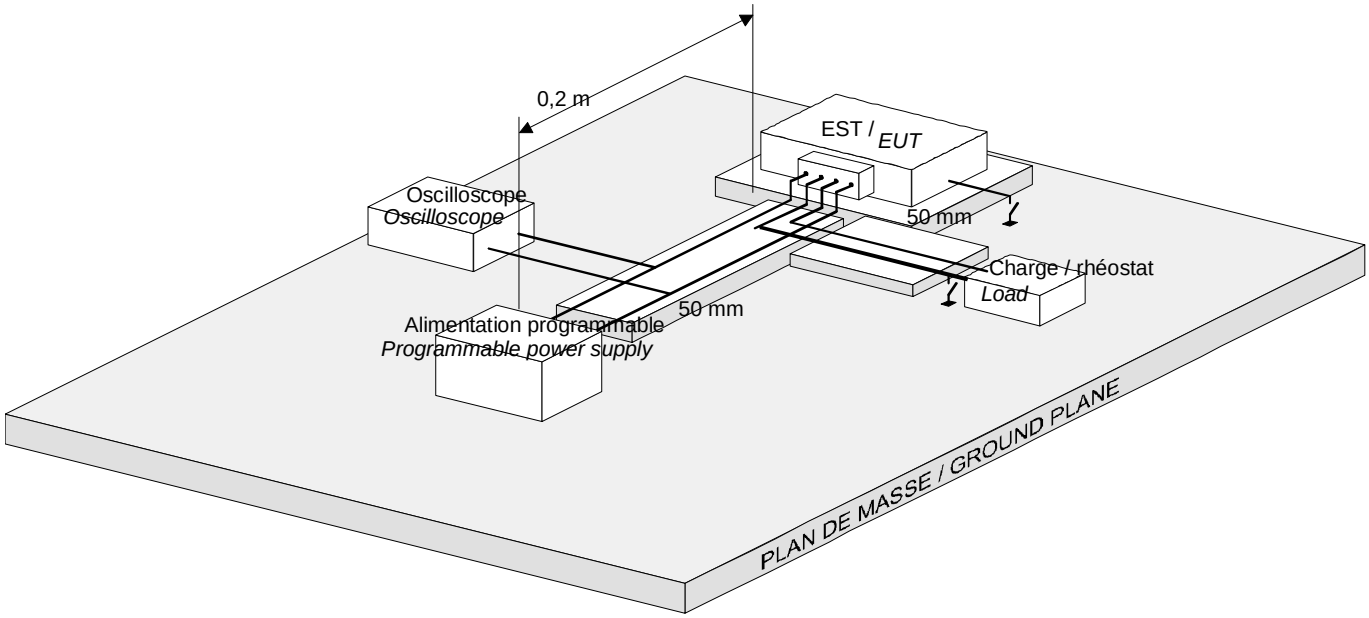
- Type 2a applicable for non-protected circuits
- Type 2c applicable for the “smart power” type circuits or circuits protected by a software strategy
- Type 2c applicable to circuits protected by fuse (integrated in the equipment and interchangeable)

The type 3 activation with mechanical locking test is applicable to all circuits having motors/actuators (example: seat, windscreen wiper, ENG, pump motor…), and likely to be locked and/or braked mechanically.

6.1.7.4.TEST MEANS

- Programmable power supply, with enough power to yield high currents.
- Loads or rheostat.
- 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.

6.1.7.5.ASSEMBLY



6.1.7.6.PREPARATION

The DUT is connected to the connectors and harnesses according to the installation on vehicle. The wiring should be rigorous and representative concerning the number of wires connected and their outer diameter. Wires take part in thermal dissipation. The tightening should to be series representative.

The DUT is possibly placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

6.1.7.7.TESTS DESCRIPTION

Adjust the programmable supply in order to obtain the 14 V supply voltage, at the terminals of the DUT connector. The action on the rheostat load should allow us to obtain the current specified in the tests that follow.

Test 2a: Grounding by an impedance, for the non-protected circuits:

The test is carried out on four test samples.

a) On two samples, the current is increased progressively and regularly until the circuit opens.

b) On the other two samples, from a current equal to 0.7 x I opening (average of the values previously determined), the current is increased by 2 % I of the failure, every 15 minutes. The test is extended until the circuit opens.

Test 1b: grounding by impedance, for the “smart power” electronic circuits or those protected by a software strategy:

The purpose of these tests is to verify the robustness of security (and if needed define the failure modes) of an electric part in case of accidental long duration current overload of the smart-power (or MOS) outputs.

The details of the tests and associated requirements is given in the note AEEV_IVE07_0243-2

Test 1c: grounding by impedance, for the circuits protected by fuse (integrated in the equipment):

An electric current with the value equal to 140% of the fuse is delivered by the output.

If the fuse is cut before the two hours expire, the fuse is changed then the test is restarted by lowering the current by 2 % of the fuse capacity value:

- for the remaining time if the test break is lower than one minute.
- for a duration of two hours, if the test break is higher than one minute.

This procedure is valid for each fuse cut-off, the number of iterations should be specified in the test report.

This test is also applicable to pulse type outputs. It then simulates a long duration normal activation.

Test 2a: connecting +BAT through impedance, for the non-protected circuits:

The test is carried out on four test samples.

c) On two samples, the current is increased progressively and regularly until the circuit opens.

d) On the other two samples, from a current equal to 0.7 x I opening (average of the values previously determined), the current is increased by 2% I of the failure, every 15 minutes. The test is extended until the circuit opens.

Test 2b: connection to +BAT by impedance, for the "smart power" electronic circuits or those protected by a software strategy:

The purpose of these tests is to verify the robustness of security (and if needed define the failure modes) of an electric part in case of accidental long duration current overload of the smart-power (or MOS) outputs.

The details of the tests and associated requirements are given in the note AEEV_IVE07_0243-2

Test 2c: connection to +BAT by impedance, for the circuits protected by fuse (integrated in the equipment and interchangeable):

An electric current with the value equal to 140% of the fuse is delivered by the output.

If the fuse is cut off before the two hours expire, the fuse is changed. Redo the test by decreasing the current by 2% of the value of the fuse capacity:

- for the remaining time if the test break is lower than one minute.
- for a duration of two hours, if the test break is higher than one minute.

This procedure is valid for each fuse cut-off, the number of iterations should be specified in the test report.

This test is also applicable to pulse type outputs. It then simulates a long duration normal activation.

In case of welded and/or interchangeable fuses, carry out the type 2a test.

Test 3: activation tests with mechanical locking, for the circuits controlling the motors:

The test is carried out on four test samples.

Brake and/or mechanically lock the motor rotor, so as to place it in the highest possible current consumption, and control it. The equipment will be tested with its possible thermal protection strategy. If the control is deactivated (via thermal protection), it will be reactivated as soon as the equipment software strategy allows it. Continue the test for two hours.

Test report:

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

- Assembly used: harness (wire number, length and section...), DUT environment.
- In the case of a protection by software strategy, the description is this.
- During the test: measurement and recording of the supply current, of the failure current; duration of the test.
- After the test: control of the operation of the output, failure mode, visual observation to signal any internal and external appearance modification of the part.

6.1.7.8.REQUIREMENTS

Test	Operating classes	Customer impact levels
Type 1a or 2a overload	E (see note)	Not applicable
Type 1b or 2b overload	See note AEEV_IVE07_0243-2	See note AEEV_IVE07_0243-2
Type 1c or 2c overload	D (A after changing the fuse)	Not applicable
Type 3 overload	C	Not applicable

Note : *the DUT can be damaged or destroyed, and no aggravated short-circuit (ASC) should be noted. Moreover, any anomaly leading to the breakage of the product should result in an open circuit.*

In the case of this document, the ASC naming groups:

- *thermal anomaly provoked by an excessive local heating of electric origin, leading to reach the inflammation point of the materials.*
- *combustion of the substrate and/or inflammation of the other materials of the equipment.*

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

6.1.8.1.REFERENCE DOCUMENT

This test procedure complies with the standard ISO 7637-2, except for the number of pulses and the pulse amplitude 2a.

6.1.8.2.OBJECTIVE OF THE TEST

Pulse 1:

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

The main characteristics of the test are the following:

- 5000 pulses of - 100 V.
- Pulse width: 2 ms.

Pulse 2a:

This test is intended to verify the immunity of the equipments to the transients due to abrupt variation of a current in an inductance connected in series (generally the distributed inductance from the wiring) to the DUT.

Its main characteristics are the following:

- 5000 pulses of + 100 V.
- Pulse width: 50 µs.

6.1.8.3.CONDITIONS FOR APPLICATION OF THE TEST

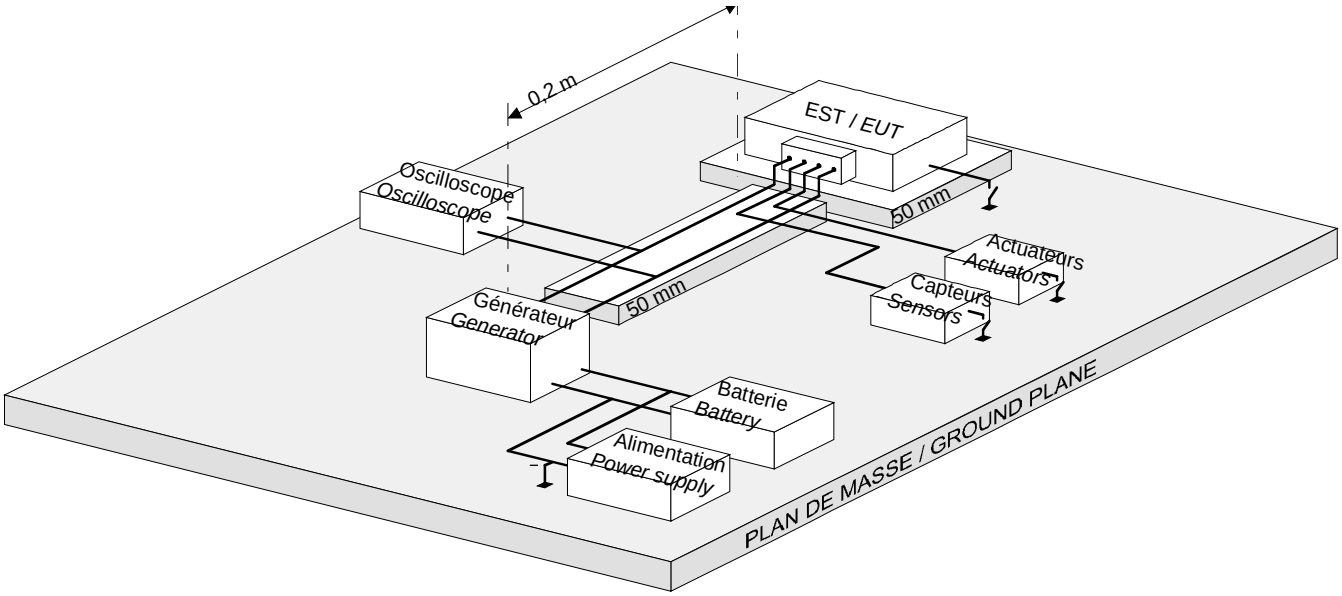
This test is applicable to all equipments power supply lines, except those supplied and regulated by another device.

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

6.1.8.4.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.
- Climatic chamber for the tests in extreme temperatures.

6.1.8.5.ASSEMBLY



6.1.8.6.PROCEDURE

A wiring 2000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

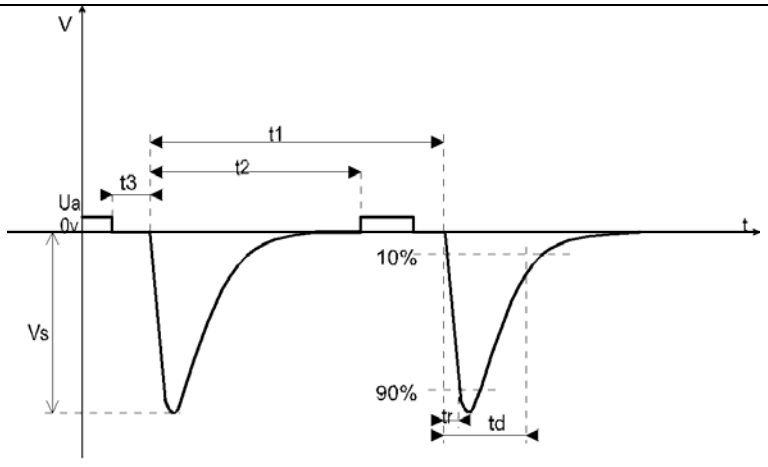
The DUT power supply wire to the generator should have a maximum length of 200 mm.

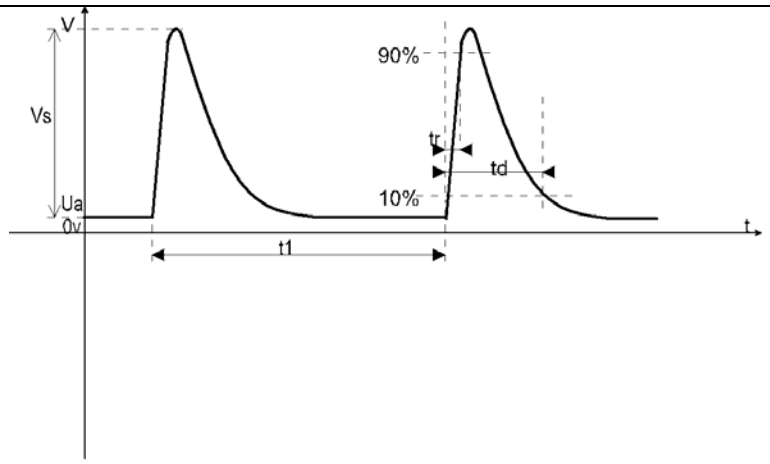
The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

In the case of tests TminEF to TmaxEF, the test 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 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 with an internal resistance of the Ri generator.

12 V Network	42 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 = 0.5 s to 5 s t_2 = 0.2 s $t_3 \leq$ 100 µs	U_a = 48 V V_s = -100 V R_i = 10 Ω t_d = 2 ms $t_r \leq$ 1 µs t_1 = 0.5 s to 5 s t_2 = 0.2 s $t_3 \leq$ 100 µs	
12 V Network	**42 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	U_a = 48 V V_s = 100 V R_i = 2 Ω t_d = 0.05 ms $t_r \leq 1$ µs t_1 = 0.2 s to 5 s	

Note: for pulse 1, the times t1 and [t1 - t2] can be lengthened so that to possible reset and/or reinitialization of the equipment can be carried out.

Test:

- Run the DUT for at least 10 minutes, the DUT being placed in ambient temperature (23°±5).
- Apply 5,000 pulses 1 on all the power supply lines (successively), and monitor the DUT.
- Apply 5,000 pulses 2a on all the power supply lines (successively and simultaneously), and monitor 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, 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 (see appendix D of the standard ISO 7637-2).
- Parameters observed and malfunctions observed during the test, for each test temperature.

6.1.8.7.REQUIREMENTS

Test (room temperature, Tmin EF and TmaxEF)		Operating classes	Customer impact levels
Pulses 1	functions that should deactivate themselves when relayed power is switched of	C	1 (see note)
	functions that should be operational after relayed power is switched of	B	0
Pulses 2a		B	0

Note: the DUT reset is allowed. However, no loss of memory data is allowed, and the malfunctioning, even if transient, should not generate any client 2 or 3 impact fault.

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

6.1.9.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.1.9.2.OBJECTIVE OF THE TEST

This test is intended to verify the immunity of the equipments to the transients caused by the disconnection of the supply of the inductive loads (motors, actuators, depressed relays…) placed at the exit of the equipments. **The test will be carried out preferably by switching the real equipment loads. Otherwise, the execution of a test with pulse 1bis is allowed.**

The main characteristics of the test are the following:

- Case of test on real load: use of a real load, execution of 1,000 pulses with an adequate duty factor.
- Case of the test with 1bis pulse:
  - Case of high side outputs: 1,000 -100 V pulses output activated, then 1,000 -100V pulses output deactivated.
  - Case of low side outputs: 1,000 +100 V pulses output activated, then 1,000 +100V pulses output deactivated.

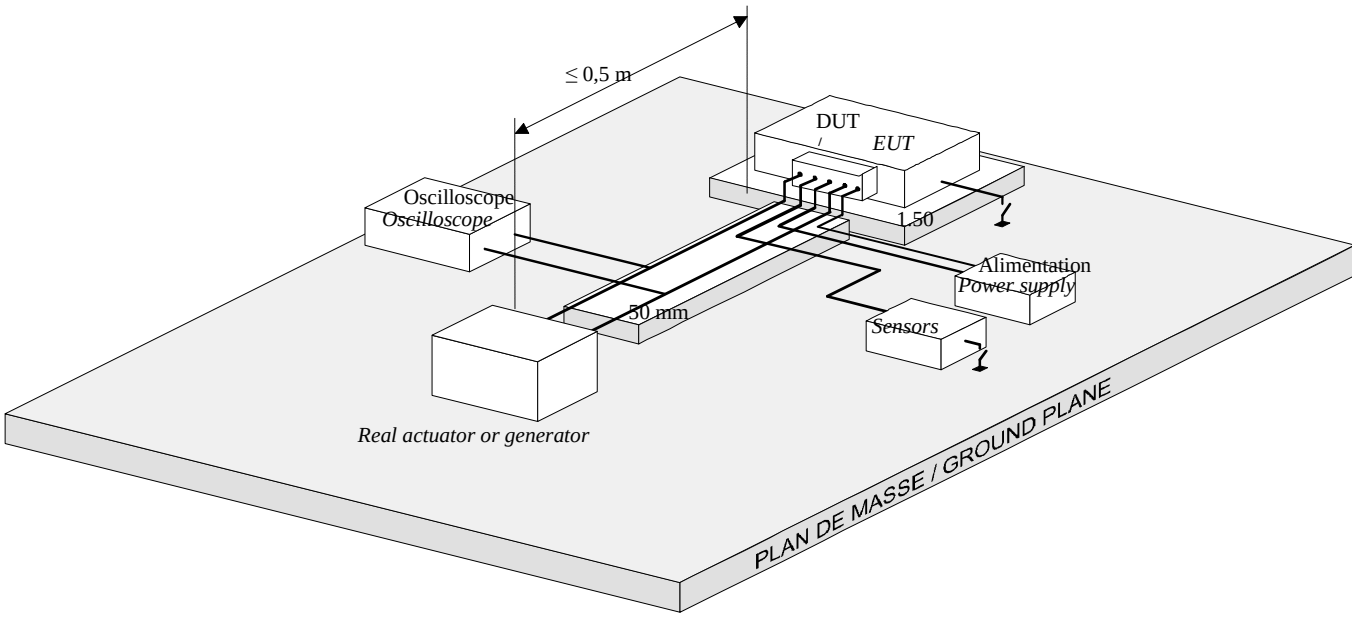
6.1.9.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to any equipment switching inductive loads (motors, actuators, external relay…).

6.1.9.4.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.
- Active load preferably, or by default pulse generator.

6.1.9.5.ASSEMBLY



6.1.9.6.PROCEDURE

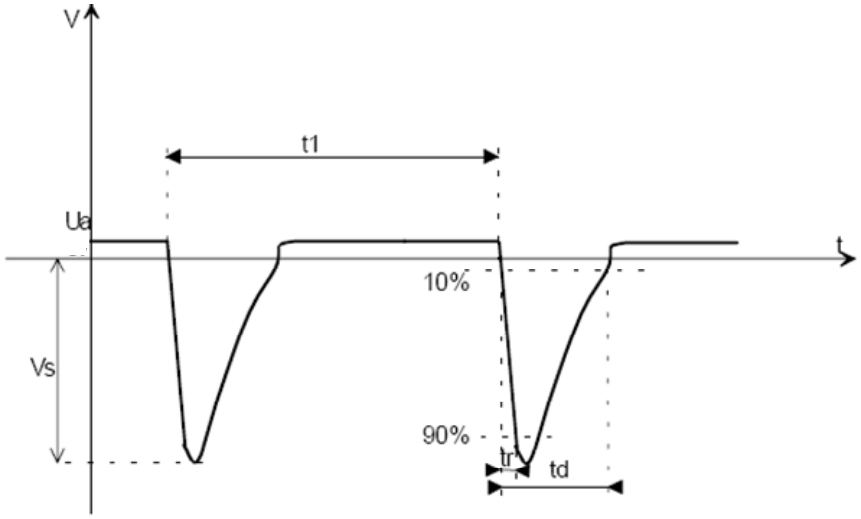
The wires that link the output of the DUT to the generator test or the active load should have a maximum length of 500 mm. The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

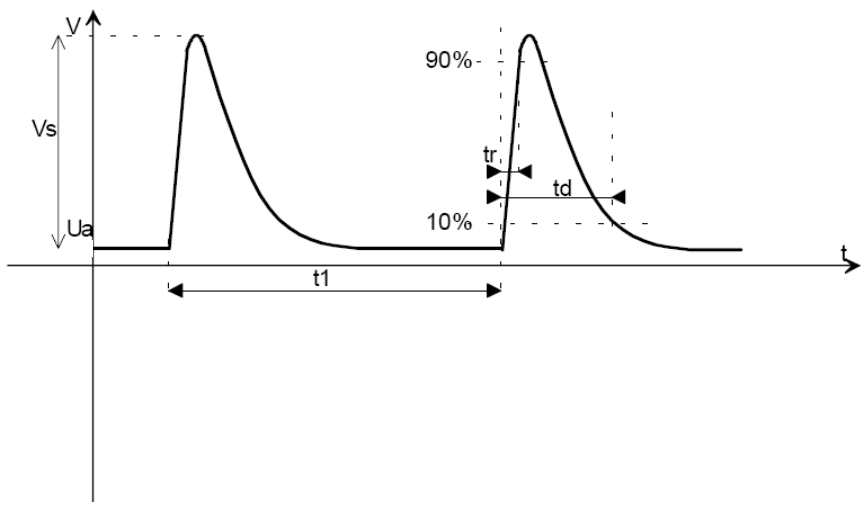
The actuator is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

If using a pulse generator, 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 with an internal resistance of the Ri generator.

12 V Network	1 bis pulses (case of a high side output)
U_a = 0 or 14 V according to 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 = 14V before output deactivation, and 0V after. For the needs of this run, a test will be carried out output activated with Ua = 14V, then another output deactivated with Ua = 0V.

12 V Network	1 bis pulses (case of a low side output)
U_a = 0 or 14 V according to 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 t_2 = 0.2 s	

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

Test:

Run the DUT for a minimal duration of 10 minutes.

Test case on active load: put the DUT in the situation to control its active load in switch mode, making sure to use an adequate duty cycle to avoid overheating phenomena. Depending on the possible conditions of use of the function, the NTS/TS and/or the test plan should specify if the switched load is in locked torque (worst case test) or not.

Carry out 1,000 switches, on each of the concerned outputs.

Case of the test with 1bis pulse:

- Case of high side outputs:
  - apply 1,000 -100 V pulses on all the concerned outputs (successively) and output activated, and monitor the DUT. In this case, Ua = 14V.
  - Repeat the test with 1,000 -100V pulses on all the concerned outputs (successively) and outputs deactivated, and monitor the DUT. In this case, Ua = 0V.
- Case of low side outputs:
  - apply 1,000 +100 V pulses on all the concerned outputs (successively) and output activated, and monitor the DUT. In this case, Ua = 0V.
  - Repeat the test with 1,000 +100V pulses on all the concerned outputs (successively) and outputs deactivated, and monitor the DUT. In this case, Ua = 14V.

Test report:

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

- Assembly used: wiring, type of load, DUT environment.
- If using a generator: oscilloscope reading at the terminals of the generator of each waveform, measured with open circuit and under matched load (see appendix D of the standard ISO 7637-2), then with load (by DUT).
- If using active loads: oscilloscope measurement at the terminals of the tested output, with load, of some relevant waveforms.
- Parameters observed and malfunctions observed during the test.

6.1.9.7.REQUIREMENTS

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

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

6.1.10.1.REFERENCE DOCUMENT

This test procedure complies with the standard ISO 7637-2 for the 12 V network and with the SICAN project for the 42 V network.

6.1.10.2.OBJECTIVE OF THE TEST

This test is intended to verify the immunity of the equipments to the transients resulting from switching processes.

The main characteristics of the test are the following:

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

6.1.10.3.CONDITIONS FOR APPLICATION OF THE TEST

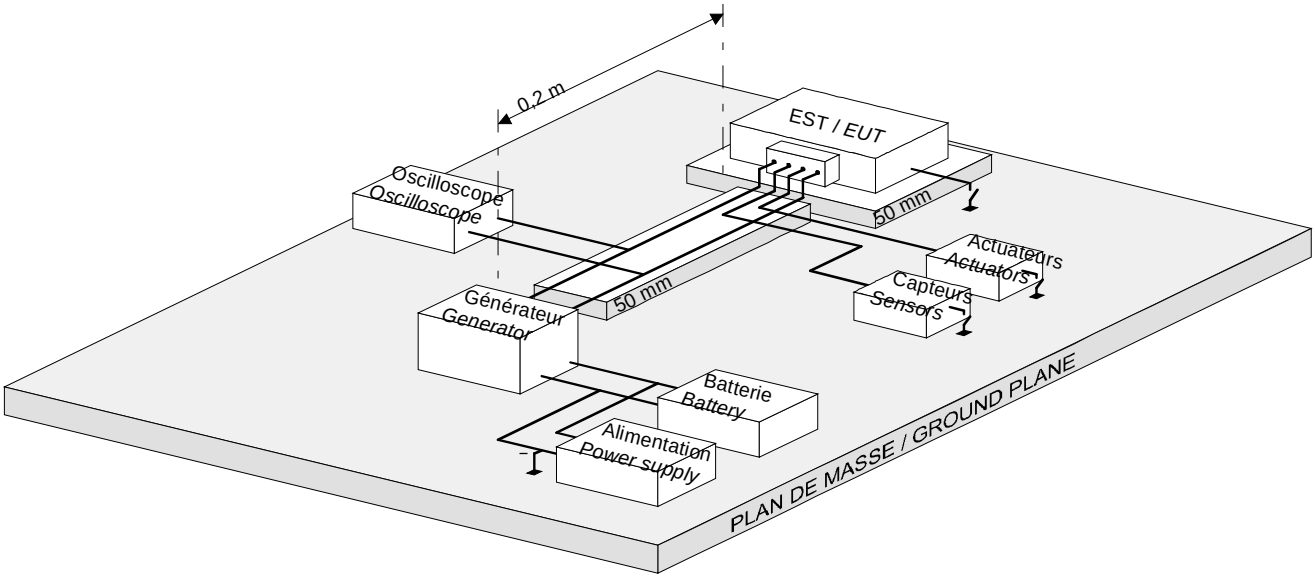
This test is applicable to all equipments having active electronics, with the exception of those who are powered by a regulated voltage provided by another calculator.

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

6.1.10.4.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.

6.1.10.5.ASSEMBLY



6.1.10.6.PROCEDURE

Preparation:

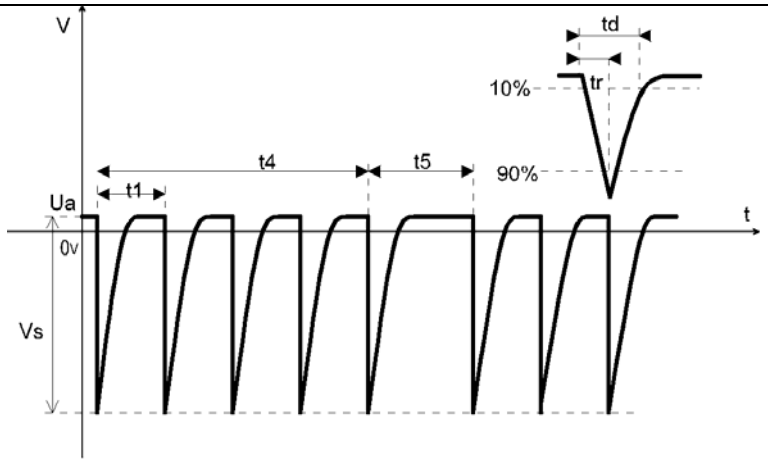
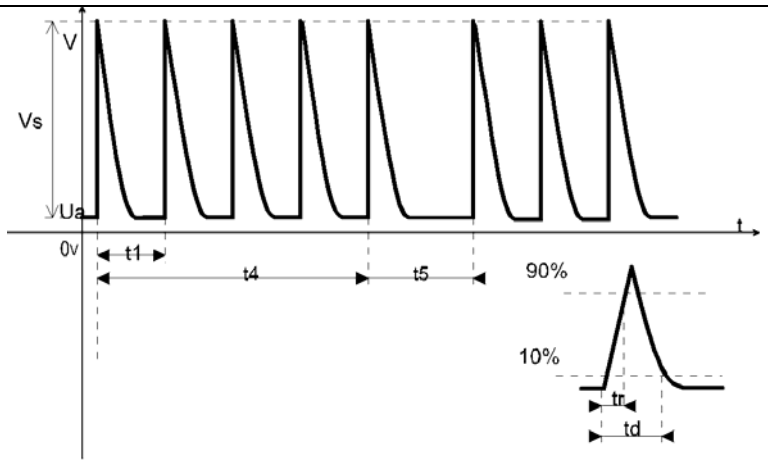
A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires should have a maximum length of 200 mm.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

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 with an internal resistance of the Ri generator.

12 V Network	42 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	U_a = 48 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	**42 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	U_a = 48 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 duration of 10 minutes.

Apply pulses 3a for 1 hour and pulses 3b for 1 hour on all the power supply lines (successively and simultaneously), 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 (see appendix D of the standard ISO 7637-2).
- Parameters observed and malfunctions observed during the test.

6.1.10.7.REQUIREMENTS

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

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

6.1.11.1.REFERENCE DOCUMENT

This procedure complies with the standard ISO 16 750-2 for the 12 V network, and with standard ISO 21848 for the 42 V.

6.1.11.2.OBJECTIVE OF THE TEST

The purpose of this test is to check the immunity of the equipments to Load Dump transient pulses (battery disconnected, engine running and/or generator online) limited by the integrated alternator protection.

The main characteristics of the test are the following:

- Five 21.5 V pulses (12 V network) or + 16 V (42 V network).
- Pulse width 400 ms.

6.1.11.3.CONDITIONS FOR APPLICATION OF THE TEST

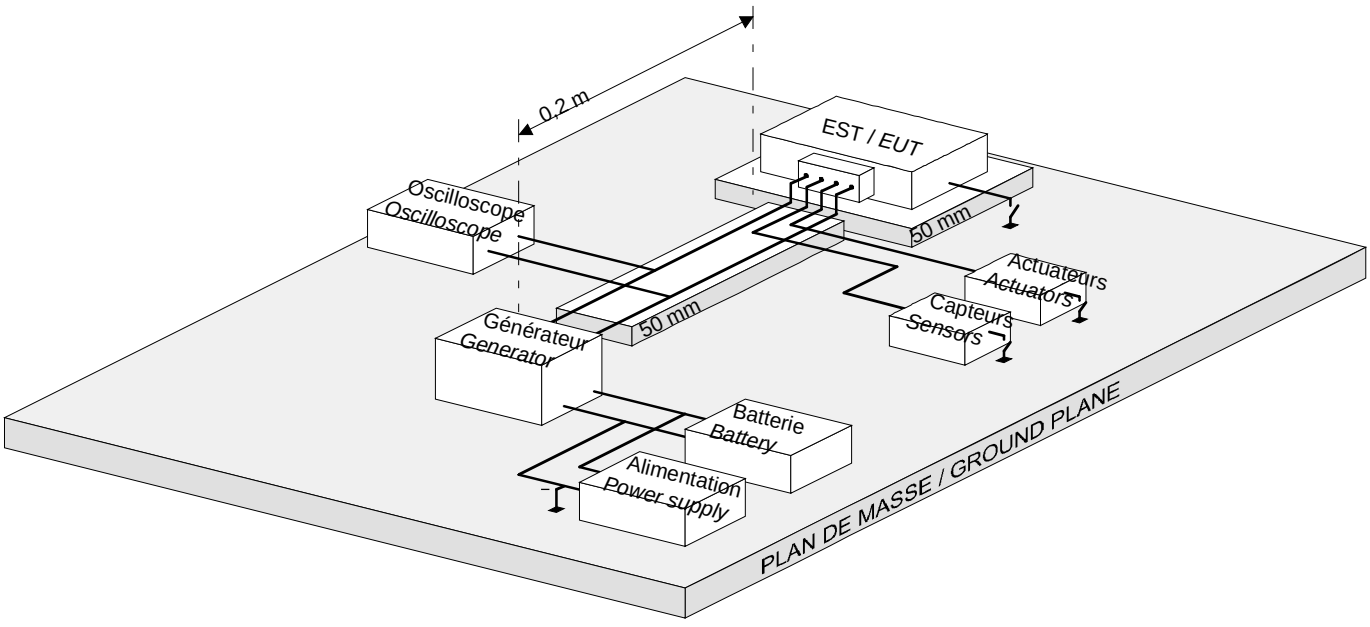
This test is applicable to all equipments, with the exception of those who are powered by a regulated voltage provided by another calculator.

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

6.1.11.4.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.

6.1.11.5.ASSEMBLY



6.1.11.6.PROCEDURE

Preparation:

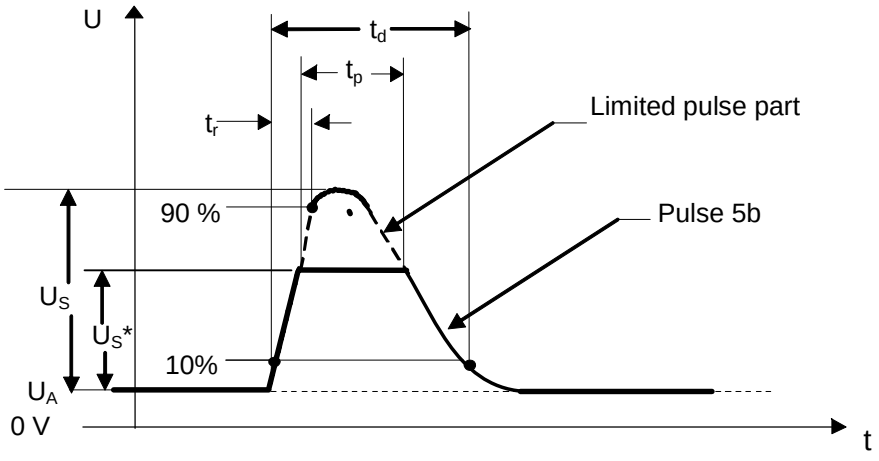
A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires should have a maximum length of 200 mm.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

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 with an internal resistance of the Ri generator.

12 V Network	42 V Network	Pulse 5b
U_a = 14 V U_s* = 21.5 V $R_i \leq 1\ \Omega$ td = 400 ms $t_r \leq 10$ ms	U_a = 42 V U_s* = 16 V $R_i \leq 0.5\ \Omega$ t_p = 400 ms $t_r \leq 10$ ms	

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply for 5 times the 5b pulses with one minute recurrence on all power supply lines (grouped) 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.

6.1.11.7.REQUIREMENTS

Test levels	Operating classes	Customer impact levels
Pulses 5b	C	1
Pulses 5b DUT operational in case of shock	B	0

6.1.12.EQ/IC 04: RESISTANCE TO SUPPLY MICRO-INTERRUPTIONS

6.1.12.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.1.12.2.OBJECTIVE OF THE TEST

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

- 2 µs brown-outs due to improper connector contacts.
- 100 µs brown-outs due to the presence of relays.
- 5 ms brown-outs due to the presence of switches.

6.1.12.3.CONDITIONS FOR APPLICATION OF THE TEST

General case:

- Power disturbances of 2 µs: this test is applicable to all powered equipments, which includes equipments powered by a regulated voltage provided by another calculator.
- Power disturbances of 100 µs: this test is applicable to equipments having power supply lines switched by a relay (and therefore not directly connected to the battery).
- Power disturbances of 5 ms: this test is applicable to equipments having power supply lines switched by a contactor (and therefore not directly connected to the battery or via relays).

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

Specific case (to be specified in the NTS/TS):

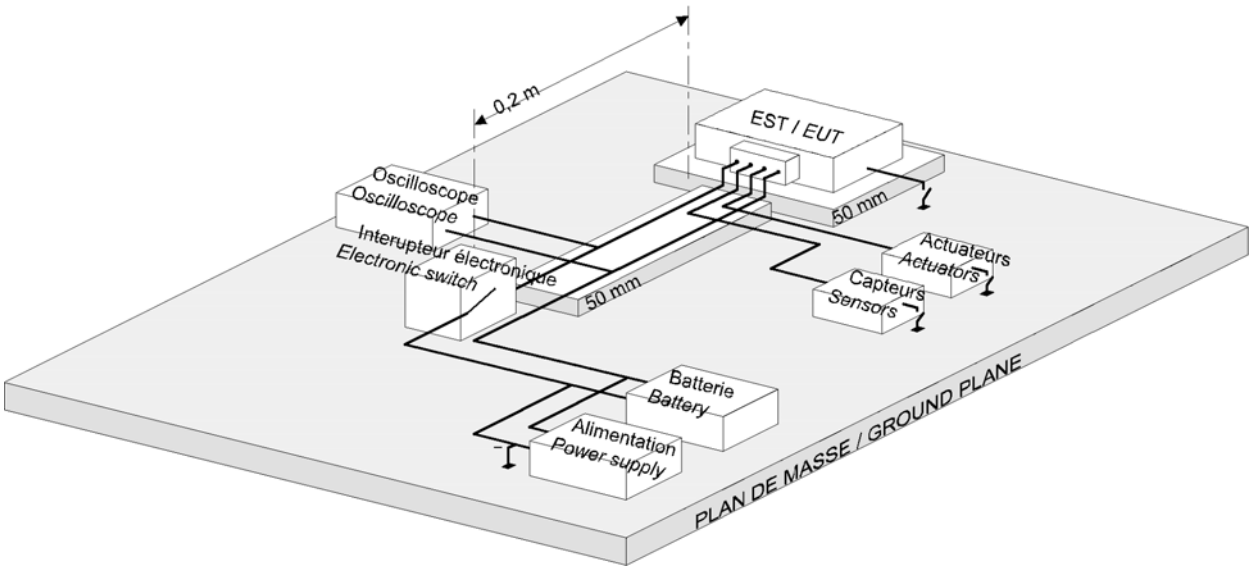
These tests are not applicable for some passive equipments or motors, having the following particularities:

- Functions having insufficient mechanical or thermal inertia (seat motors, resistive heating system…)
- Functions of the lighting or warning light type, for which flickering is authorized.

6.1.12.4.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.
- Electronic switch capable of generating the test signal.

6.1.12.5.ASSEMBLY



6.1.12.6.TEST PROCEDURE

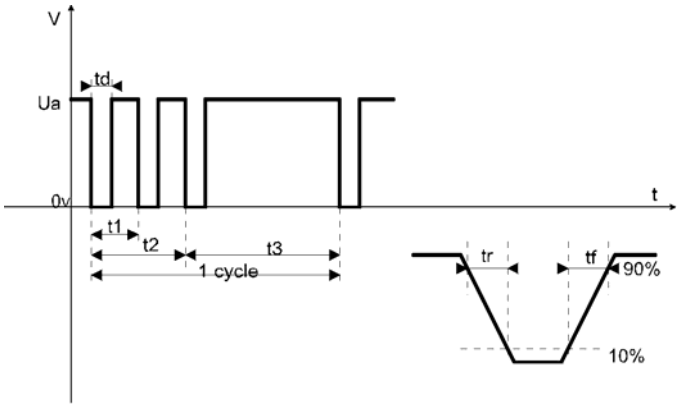
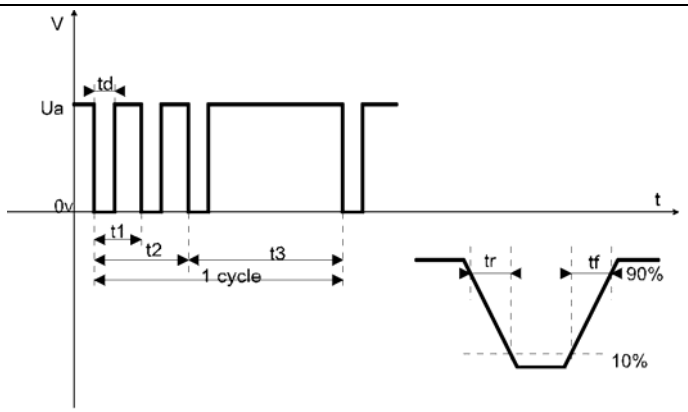
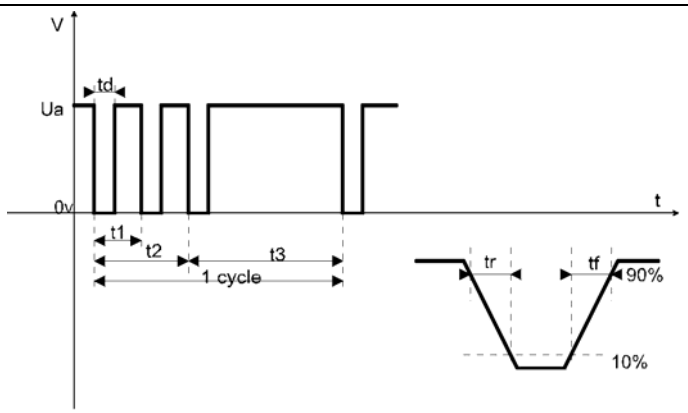
Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

Replace the DUT by a 1 kΩ resistance and connect the oscilloscope to the resistance terminals and adjust the generator controlling the switch in order to obtain the specified signals.

12 V Network	42 V Network	Power disturbance for the connectors (waveform 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	U_a = 48 V $t_f \leq 1$ µs $t_r \leq 1$ µs td = 2 µs t1 = 1 ms t2 = 4 s t3 = 10 s	
Note: U_a voltage may be adapted in some cases (example: 5V sensor…)		
12 V Network	**42 V Network**	**Micro-cuts 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	U_a = 48 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	**42 V Network**	**Micro-cuts 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	U_a = 48 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 duration of 10 minutes.

Apply the 3 cycles for each pulse on each power supply line then on the set by monitoring the DUT.

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

Test report:

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

- Assembly used: wiring, DUT environment.
- Oscilloscope reading of the cuts during the calibration phase, under a 1 kΩ resistive load.
- Parameters observed and malfunctions observed during the test.
- Characteristics of the switch used and of the pulses applied.

6.1.12.7.REQUIREMENTS

Test	Operating classes	Customer impact levels
Power disturbances of 2 µs	B	0
Power disturbances of 100 µs	B	0
Power disturbances of 5 ms	B	0

6.1.13.EQ/IC 05: RESISTANCE TO PULSES 4 OR 4BIS:

6.1.13.1.REFERENCE DOCUMENT

This procedure complies with the standard ISO 16750 for the 12 V network, and with ISO 21848 for the 42V.

6.1.13.2.OBJECTIVE AND APPLICABILITY OF THE TEST

The purpose of this test is to check the immunity of the equipments to voltage variations during the cold start-up phase (pulse 4 or 4bis). Pulse 4 can be used when we don't have a generator capable of producing the pulse 4bis.

The main characteristics of the test are the following:

- Power supply than can decrease to 5.6 V (12 V network) or 18 V (42V network).
- 5 pulses at 1 minute intervals.

6.1.13.3.CONDITIONS FOR APPLICATION OF THE TEST

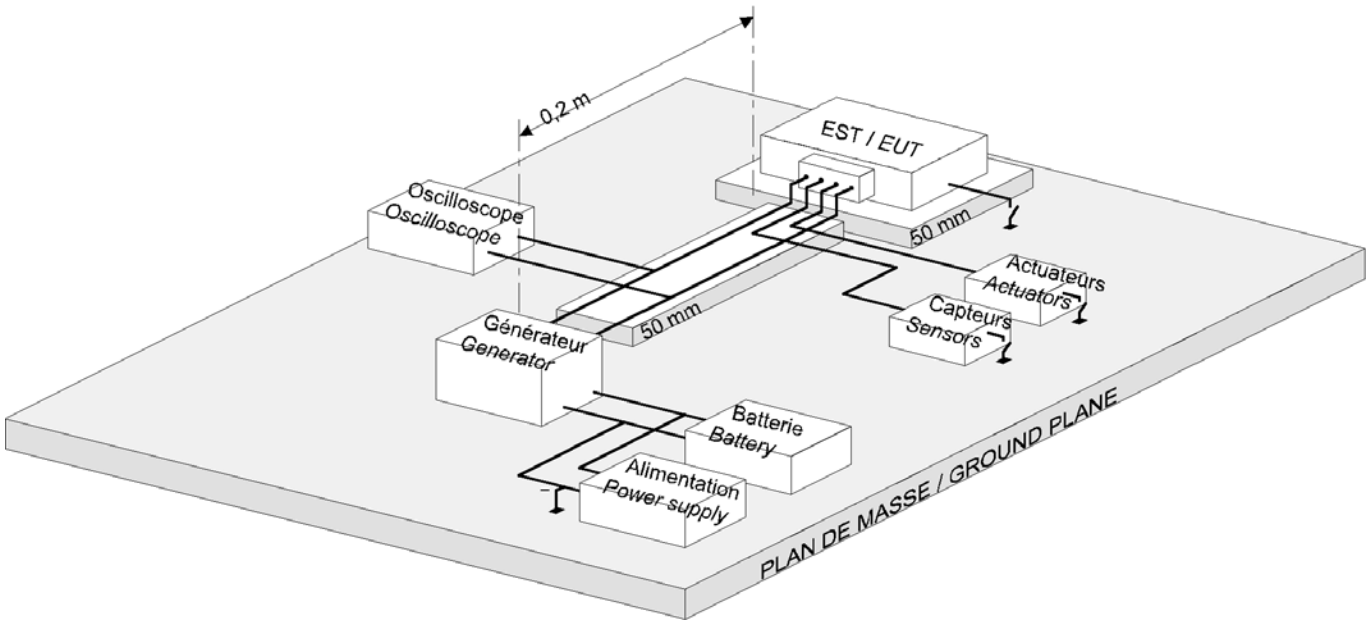
Pulses 4 or 4bis are applied for all equipments powered during the start-up phase. It is not applied to equipments not powered and not connected during start, or to equipments powered by a regular voltage provided by another device.

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

6.1.13.4.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.
- Programmable power supply or pulse generator.
- Environment chamber for the TminEF tests (pulse II).

6.1.13.5.ASSEMBLY



6.1.13.6.PROCEDURE

Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires and the outputs subjected to the test should have a maximum length of 200 mm.

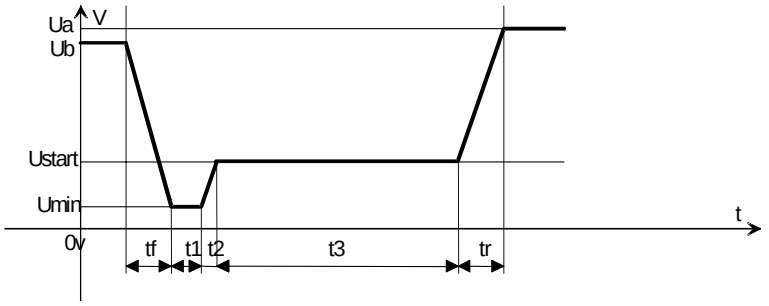
The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

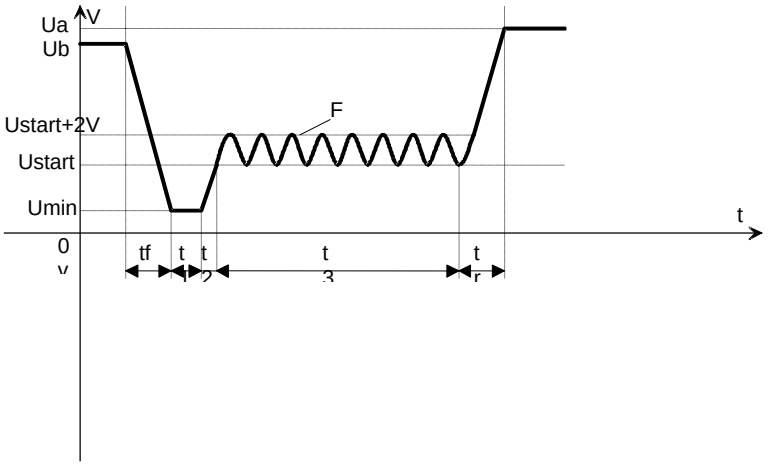
In the case of tests TminEF, the test assembly can be adapted to practical constraints of use in a climatic chamber. The equipment ground connections should remain representative, and the DUT power supply wires to the generator can have a maximum length of 500 mm.

Calibration for pulses 4 or 4bis:

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.

Pulse number	I		II		III	
Parameters	**Umin**	**Ustart**	**Umin**	**Ustart**	**Umin**	**Ustart**
Network 12 V	8.0V	9.5V	5.6V	6.5V	3.0V	5.0V
Network 42 V	_	_	18V	21V	_	_

12 V Network	42 V Network	Pulse 4
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	U_a = 48 V U_b = 36 V R_i = 0.03 Ω $t_f \leq 5$ ms t_r = 100 ms t_1 = 15 ms t_2 = 50 ms t_3 = 10 s	

12 V Network	42 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		

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply for 5 times the 4 or 4bis pulses (I, II and III pulses), with one minute recurrence on all power supply lines taken simultaneously and monitor the DUT.

The DUT will be placed at room temperature (23°±5) for pulses no. I and III, and at TminEF for pulses 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.

6.1.13.7.REQUIREMENTS

Test	Pulse no. I (Ambient temperature)		Pulse no. II (Tmin EF)		Pulse no. III (Ambient temperature)	
Requirements	Operating classes	Customer impact levels	Operating classes	Customer impact levels	Operating classes	Customer impact levels
Impulses 4 or 4 bis DUT and/or function should be operational during the (cold) start phase of the vehicle	A	0	B	1 (b)	C (a)	NA
Impulses 4 or 4 bis DUT and/or function non-operational during the (cold) start phase of the vehicle	C (a)	NA	C (a)	NA	C (a)	NA

(a) the data in memory are not lost.

(b) if the DUT provides a regulated voltage for another device or sensor and it should remain within its tolerances during the test.

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

6.1.14.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.1.14.2.OBJECTIVE AND APPLICABILITY OF THE TEST

The purpose of this test is to check the immunity of the equipments to voltage variations during the warm restart phase of a stop and start system (STT).

The main characteristics of the test are the following:

- Power supply than can drop to 8.0V.
- 5 pulses at 1 minute intervals.

6.1.14.3.CONDITIONS FOR APPLICATION OF THE TEST

The restart pulse is applicable to equipment that complies with the following conditions:

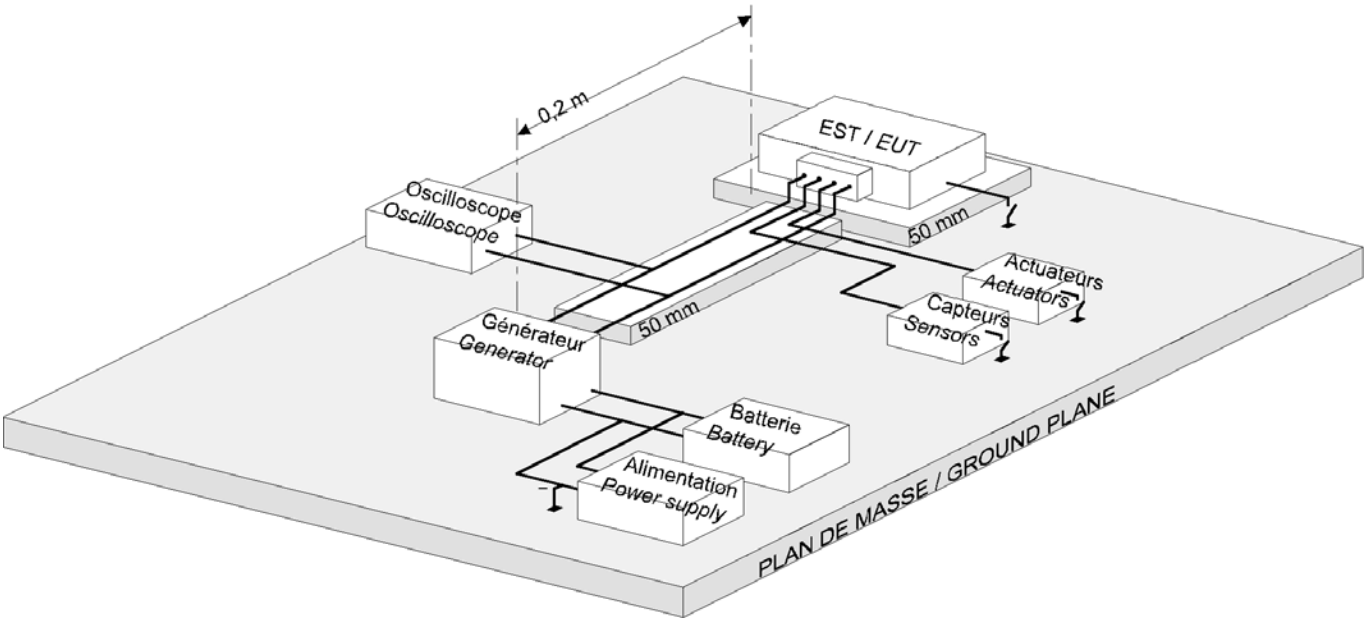
- equipment likely to be installed in a vehicle with stop and start system (STT),
- equipment powered by a vehicle battery (not powered by a regulated voltage supplied by another device).

The test is carried out on the equipment supply lines taken simultaneously. The § “procedure” precise which voltage profile is applicable, depending the use of a maintaining voltage system or not.

6.1.14.4.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.
- Programmable power supply or pulse generator.

6.1.14.5.ASSEMBLY



6.1.14.6.PROCEDURE

Preparation:

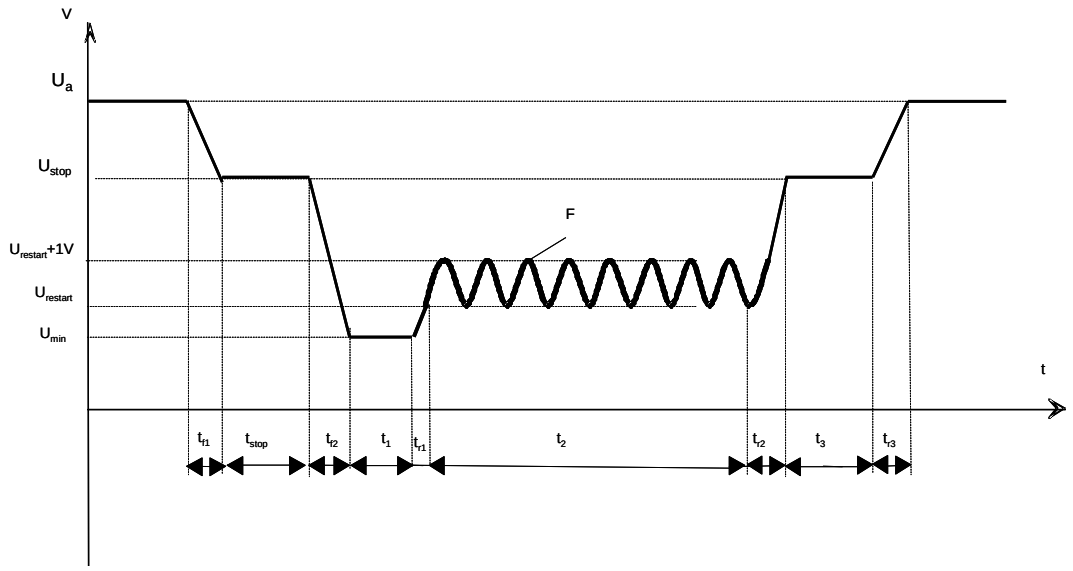
A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires and the outputs subjected to the test should have a maximum length of 200 mm.

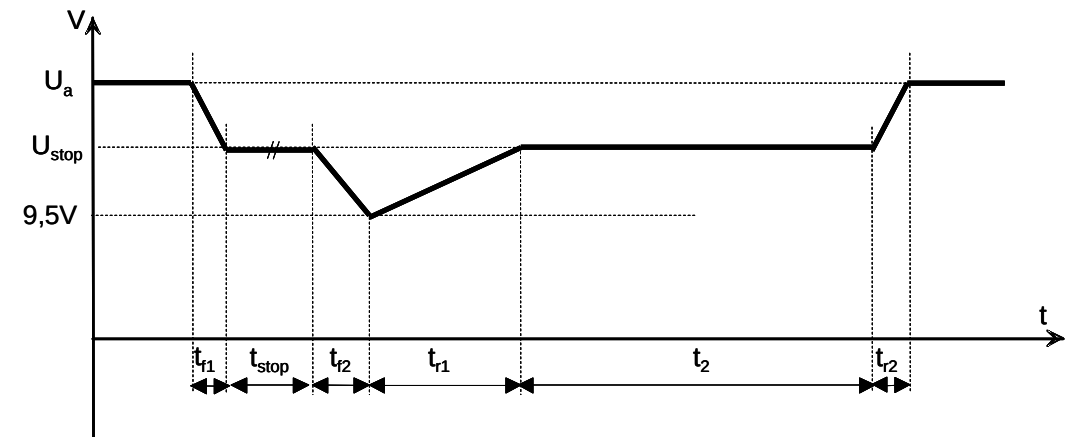
The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

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.

Calibration for systems which are not connected to a maintaining voltage system:

12 V network	Restart pulse (without maintaining voltage system)
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	

Calibration for systems which are connected to a maintaining voltage system:

12 V network	Restart pulse (with maintaining voltage system)
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 duration of 10 minutes.

Apply for 5 times the restart pulse with one minute recurrence on all power supply lines taken simultaneously 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.

6.1.14.7.REQUIREMENTS

Requirements	Operating classes	Customer impact levels
General case	A	0 (b)
Case when the DUT and/or the functions for which some malfunctions are tolerated during restart (a)	B	1 (b)

(a) Case of some DUT and/or functions controlling an actuator (example: window regulator), lighting and/or rheostating functions, and functions likely to output an important power (Electrical steering assistance, car radio…). This case should be specified by the NTS/TS. By default, the general case is applied.

(b) if the DUT provides a regulated voltage for another device or sensor and it should remain within its tolerances during the test.

6.1.15.EQ/IC 06: RESISTANCE TO VOLTAGE RIPPLES

6.1.15.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.1.15.2.OBJECTIVE AND APPLICABILITY OF THE TEST

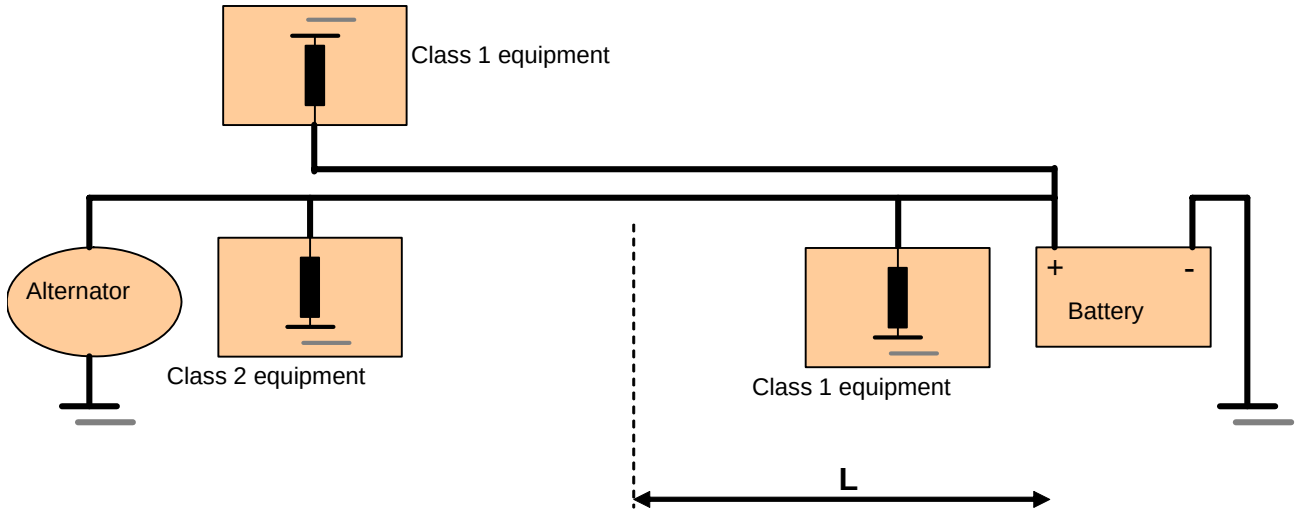
This test is intended to verify the immunity of the equipments to the undulations of the voltage of the electrical network, generated by the alternator/regulator or by certain consumers. The accelerated ageing phenomena (input capacitances …) linked to the application of waves on long periods of time are not acknowledged by the current specification.

Its main characteristics are the following:

For the 12V network: 1 V or 2 V peak-to-peak, from 50 Hz to 20 kHz. There are two ripple voltage classes for the 12 V network:

- Class 1 (1 Vcc): equipments powered by the battery and not directly connected to the alternator; as well as the equipments connected to the alternator but located at a distance lower than L from the battery.
- Class 2 (2 Vcc): equipments connected to the alternator located at a distance higher than L from the battery.

The L distance depends on the architecture of the impacted vehicle, which is why the class choice should be specified in the NTS/TS of the equipment or in this test plan. By default, the length L is 2 m.



For the 42 V network: 4 V wave peak-to-peak from 50 Hz to 1kHz, then 1 V peak-to-peak from 1 kHz to 20 kHz superimposed to the power supply voltage.

6.1.15.3.CONDITIONS FOR APPLICATION OF THE TEST

General case:

This test is applied to all equipments powered by the on board network. It is not applied to equipments powered by a regulated voltage supplied by another device.

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

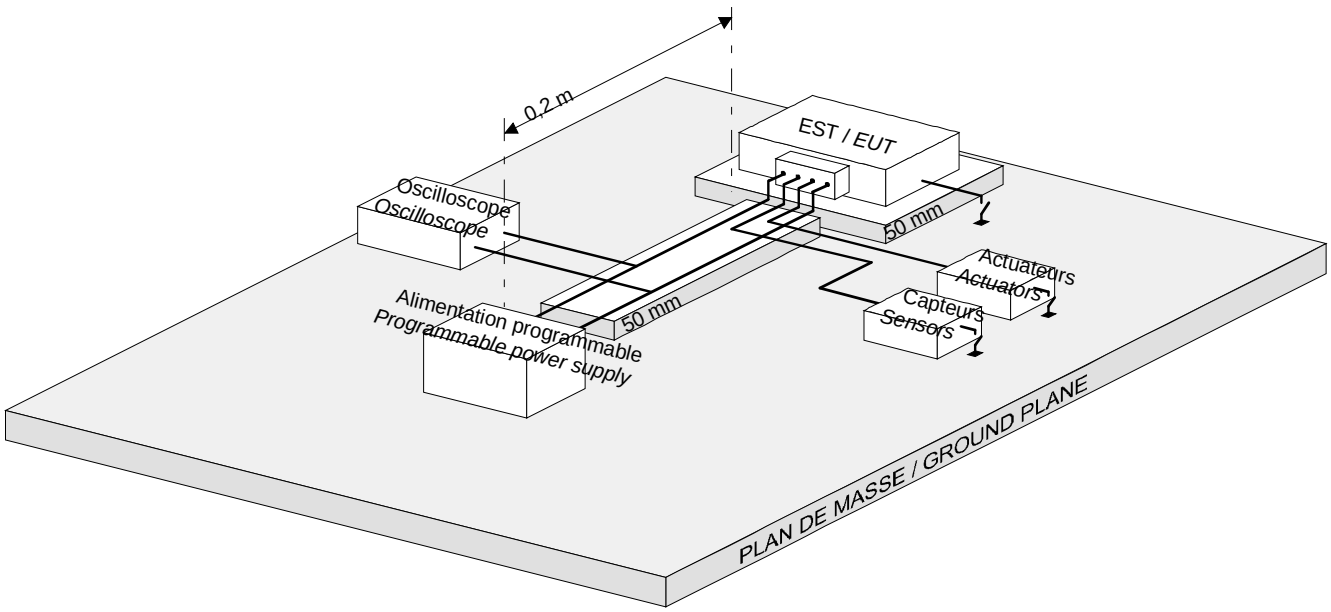
Specific case (to be specified in the NTS/TS):

These tests are not applicable to some passive equipments or motors, having insufficient mechanical or thermal inertia (seat motors, resistive heating system…).

6.1.15.4.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.

6.1.15.5.ASSEMBLY



6.1.15.6.PROCEDURE

Preparation:

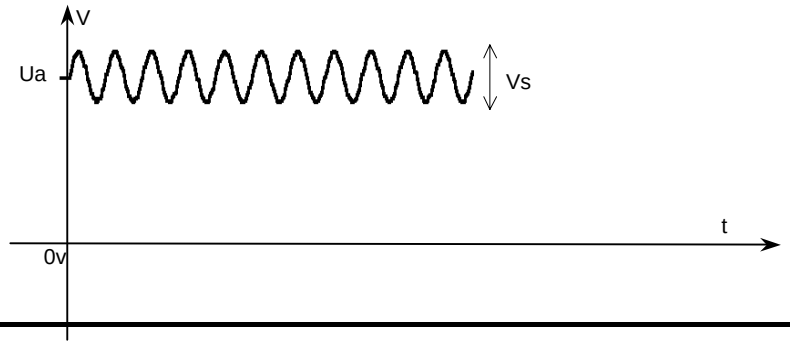
A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT power supply wires and the outputs subjected to the test should have a maximum length of 200 mm.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

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.

12 V Network	42 V Network	On-board network ripple
Ua = 14 V	Ua = 48 V and 32 V	
Class 1: Vs = 1 Vcc Class 2: Vs = 2 Vcc	Vs = 4 Vcc for F = 50 Hz – 1 kHz	
F = 50 Hz – 20 kHz	Vs = 1 Vcc for F = 1 kHz – 20 kHz	

Note: for frequencies higher than 10kHz, the impedances proposed by some equipments can decrease and put a stress on the generator at power levels which it is not able to supply. The calibration of the voltage under a 0.5 Ω load is then allowed, the source impedance of the generator should not exceed 0.1Ω.

Test:

Run the DUT for a minimal duration of 10 minutes (without the voltage ripples).

Apply the signal on all the power supply lines and monitor the DUT. The test duration is sized by applying paragraphs 4.8.2 and 4.7.3 of this specification.

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.

6.1.15.7.REQUIREMENTS

Test	Operating state	Customer impact levels
Ripple	A	0

6.2.IMMUNITY TESTS BY CONDUCTION

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

6.2.1.1.REFERENCE DOCUMENT

This test procedure complies with standard ISO 7637-3 with the capacitive coupling clamp.

6.2.1.2.OBJECTIVE OF THE TEST

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

The main characteristics of the test are the following:

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

6.2.1.3.CONDITIONS FOR APPLICATION OF THE TEST

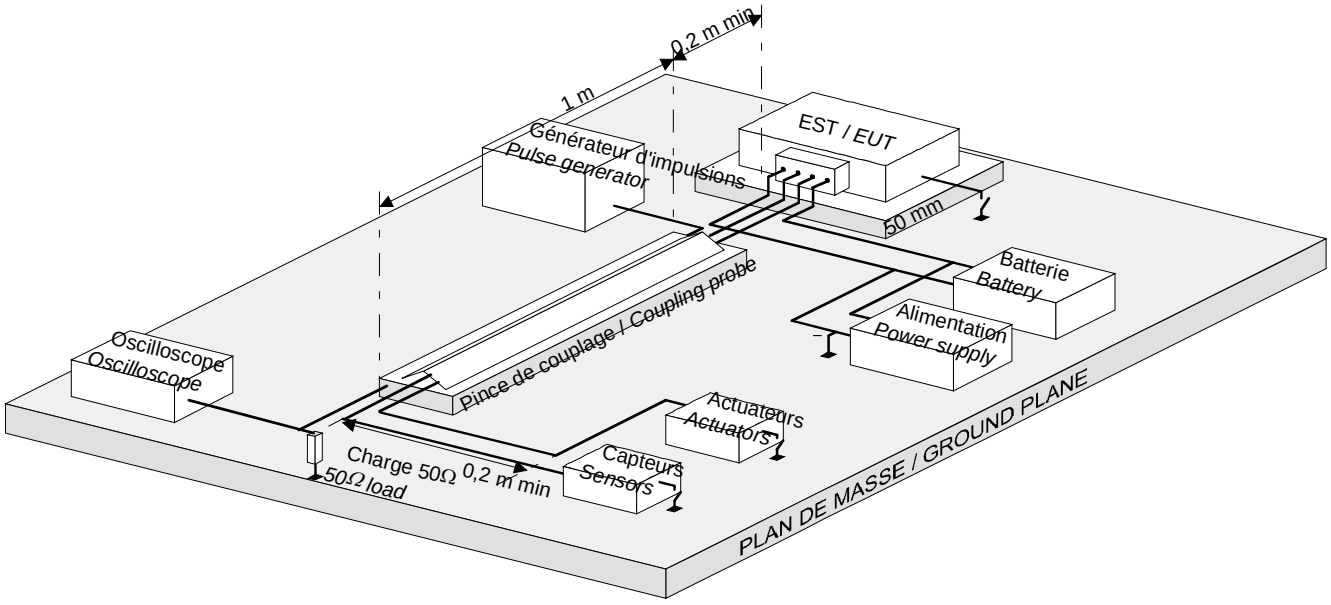
This test is applicable to all powered equipments having active electronics.

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

6.2.1.4.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.
- Oscilloscope.
- Coupling clamp compliant with standard ISO 7637-3
- 50 Ω load.

6.2.1.5.ASSEMBLY



6.2.1.6.PROCEDURE

Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating holder with a 50 mm thickness and should be placed on right angle on the outside of the coupling clamp.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

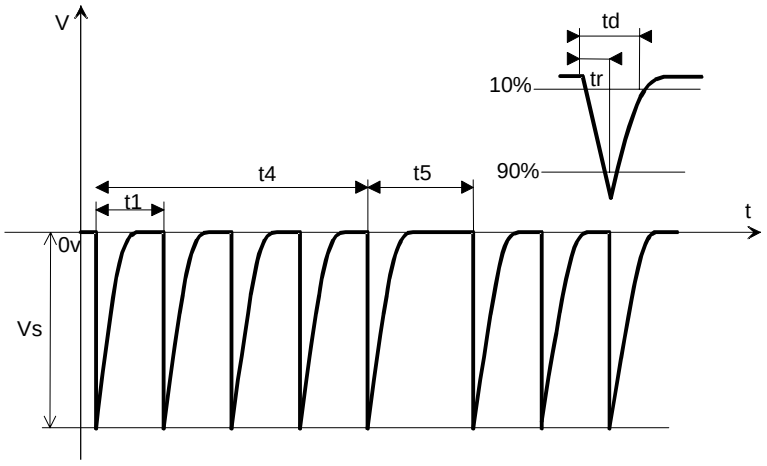
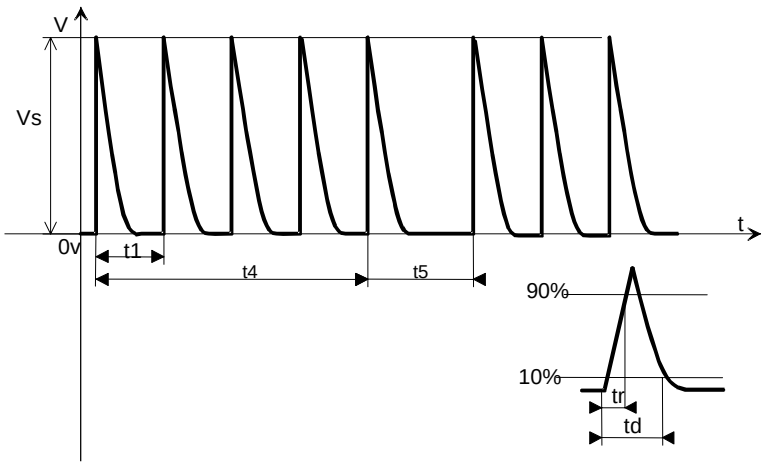
Place in the coupling clamp the wiring linked to the DUT with the exception of grounding and power supply wires.

Load the coupling clamp on 50 Ω.

Calibration:

Connect the output of the pulse generator (DUT disconnected) on the coupling clamp.

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

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 duration of 10 minutes.

Apply the pulses 3a for 10 minutes, then the pulses 3b for 10 minutes on the coupling clamp 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.

6.2.1.7.REQUIREMENTS

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

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

6.2.2.1.REFERENCE DOCUMENT

This procedure is in conformity with the standard ISO 11452-4.

6.2.2.2.OBJECTIVE OF THE TEST

The purpose of this test is to check the equipment immunity to interferences induced by wiring harnesses, consecutive to the exposure of the equipment and of its 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 based on the measured current (closed loop method), with limitation of the forward power applied.

6.2.2.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all powered equipments having electronic components.

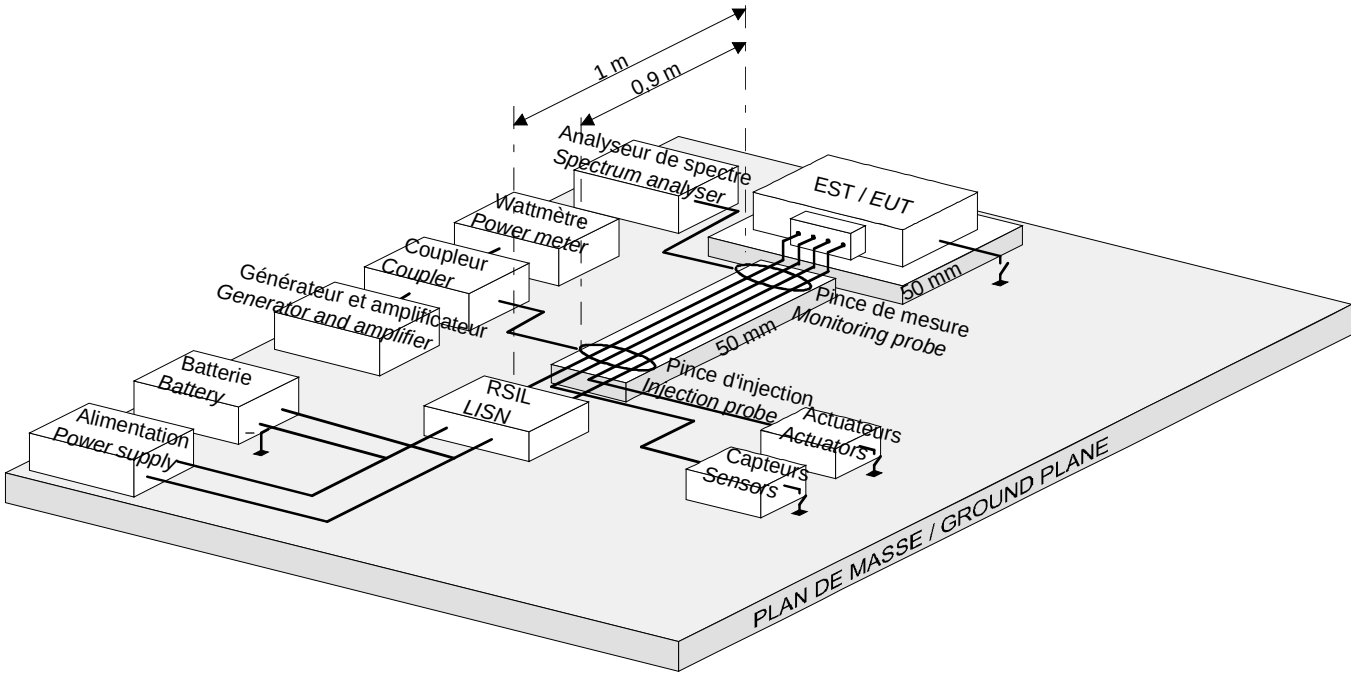
In the case of equipment with several connectors, an injection should be carried out on each separate harness. However, the test plan could agree on any other way of injecting (regrouping of all or of some bundles, according to the real path on the vehicle).

In the case of an equipment which have only passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 300mA test is applicable, with the limited requirements.

6.2.2.4.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.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a DUT with offset weight).
- 50 Ω load(s).
- High frequency signals generator.
- Wide band power amplifier.
- A 50Ω coupler.
- Power measurement equipment or equivalent.
- Current injection clamp.
- Current measurement clamp.
- Device for calibrating the injection clamp (JIG).
- Shielded chamber (desirable in order to preserve the integrity of the electromagnetic spectre).

6.2.2.5.ASSEMBLY



6.2.2.6.PROCEDURE

Preparation:

A harness 1 m in length, rectilinear on its entire length, should be used. The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Mount the injection clamp 0.9 m away from the DUT connector, centred on all the harness wires including the power supply wires.

Mount the measurement clamp 50 mm away from the DUT connector, centred on all the harness wires including the power supply wires.

Calibration:

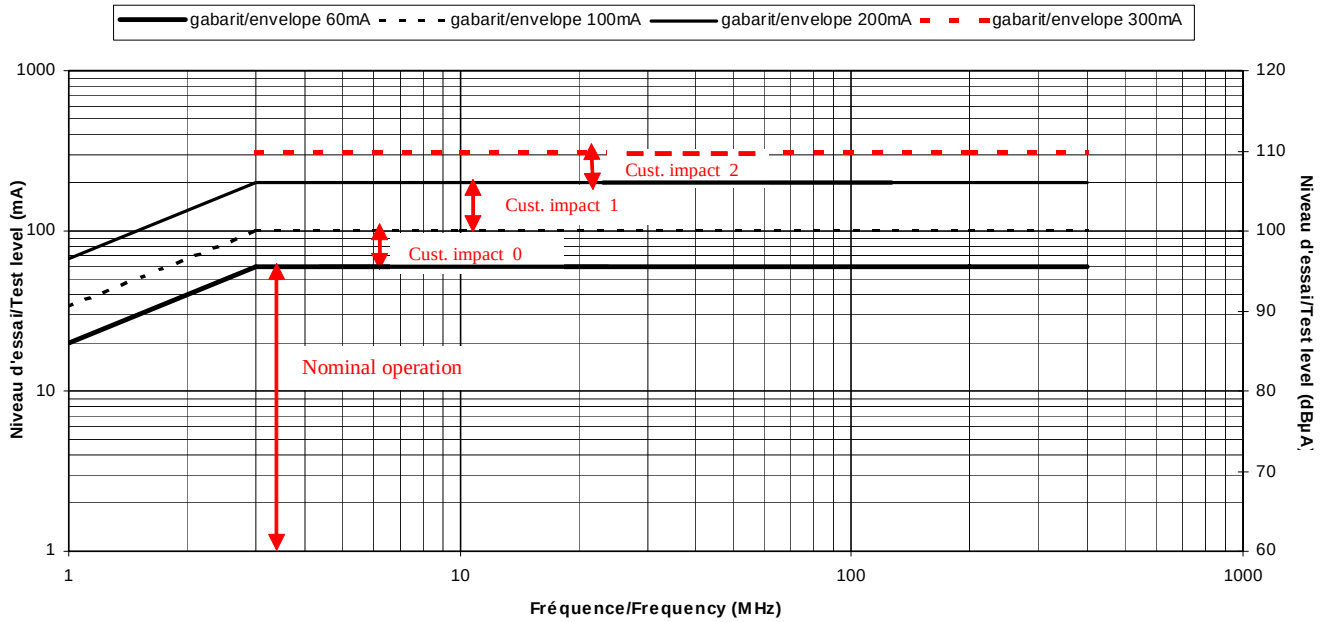
Calibration is carried out only for CW.

Mount the injection clamp centred on the calibration JIG loaded by 50 Ω on each of its two ports.

Measure the forward power $P_{calibration}$ need to induce the current specified $I_{calibration}$ in CW on the JIG.

Frequency (MHz)	60 mA envelope	100 mA envelope	200 mA envelope	300 mA envelope
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 electric currents in this table are given in effective mA and the frequencies in MHz).



Test:

Run the DUT for a minimal duration of 10 minutes.

Progressively increase the forward power applied to the injection clamp until the measured current reach $I_{setpoint}$, or it reaches 4*$P_{setpoint}$, with $P_{setpoint} = P_{calibration} * \left(\frac{I_{setpoint}}{I_{calibration}} \right)^2$.

Measure the threshold of appearance of the possible faults (I_{fault}, P_{fault}), when they are lower than the specified threshold.

The injected power should by no means exceed the "1dB compression point" of the amplifier.

Decrease progressively the forward power that is applied to the injection clamp and change the frequency.

Test report:

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

- Assembly used: wiring, DUT environment.
- Curves by modulation with: F_{test}, $I_{setpoint}$, $I_{measured}$ and/or I_{fault}
- Curves by modulation with: F_{test}, $P_{setpoint}$, $P_{measured}$ and/or P_{fault} (incident powers)
- Fault tables with: F_{fault}, I_{fault}, $I_{requirement}$, P_{fault}, modulation and description of the fault
- Curve of the test 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_{fault} and P_{fault}).**

In addition to the test report, all the data F_{test} and/or F_{fault}, $I_{setpoint}$, $I_{measured}$ and/or I_{fault}, $P_{setpoint}$, $P_{measured}$ and/or P_{fault} (incident powers), modulation, $Z_{transfer}$ and faults descriptions should be provided on digital support in an Excel table in this order.

6.2.2.7.REQUIREMENTS

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

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

Note 2: *in the case of an equipment which have only passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 300mA test is applicable.*

Note 3: *no damage or customer impact level 3 fault is tolerated for levels ≤300mA.*

6.2.3.EQ/IC 09: IMMUNITY TO HIGH/LOW IGNITION VOLTAGE

6.2.3.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.2.3.2.OBJECTIVE OF THE TEST

This test is intended to verify the immunity of the equipments to the interferences generated by the ignition system: high voltage or low voltage (coils control).

Its main characteristics are the following:

- Signal on 15 kΩ: 10 kV (high voltage), 420 V peak (low voltage).
- Coupling with the DUT harness on 1 m: at a distance of 100 mm (high voltage), adjacent (low voltage).
- Test duration: 10 minutes.

6.2.3.3.CONDITIONS FOR APPLICATION OF THE TEST

The tests are applicable only to equipment installed in the engine compartment and having a high voltage ignition system.

Particularly:

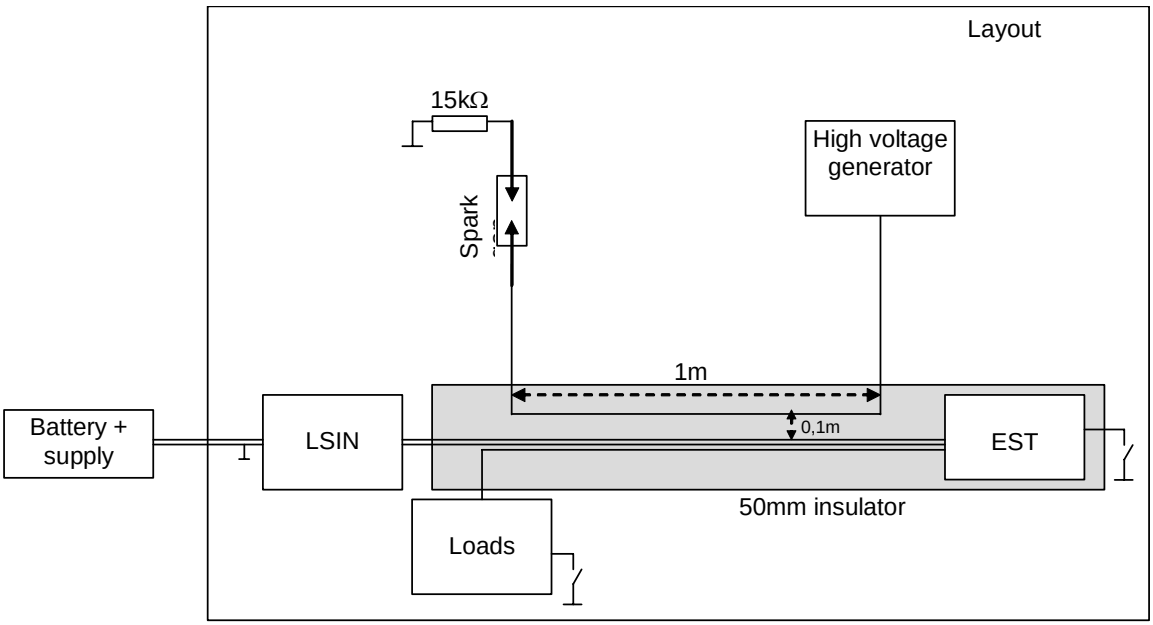
- the high voltage test is applied to equipment having a bonding running less than 200mm from the ignition system,
- the low voltage test is applied to equipment having a bonding running allow the control harness.

6.2.3.4.TEST MEANS

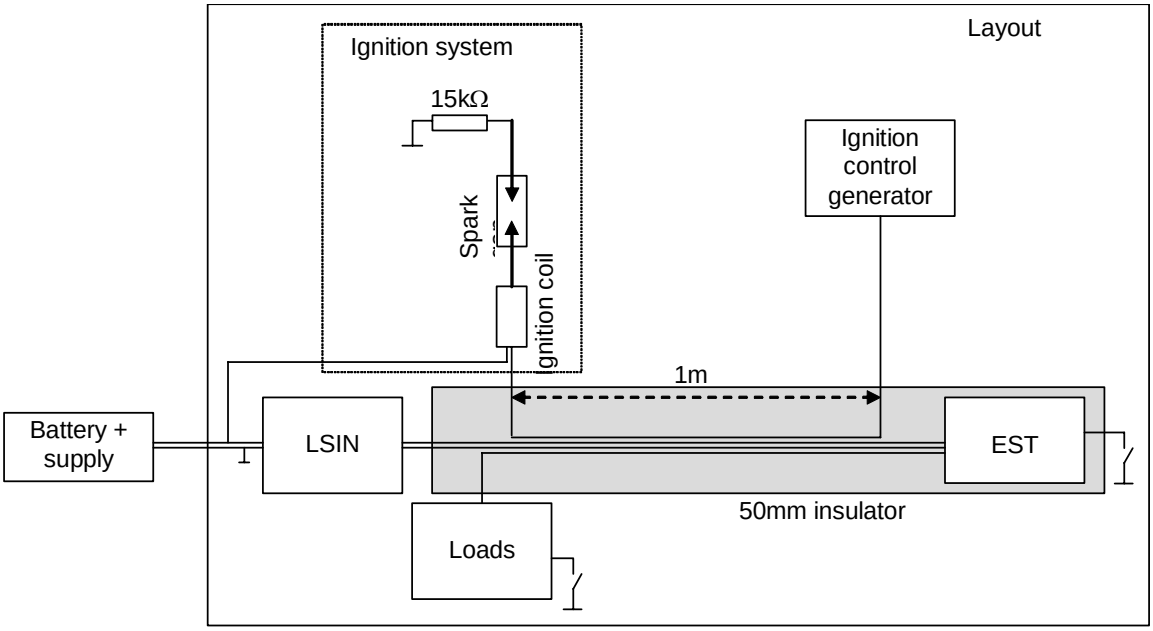
- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- LSIN compliant with the publication CISPR 25 loaded on 50 Ω.
- 15 kΩ load.
- Sparker.
- High voltage or ignition control generator.
- Representative control harness.
- For the ignition low voltage test, an ignition coil reference 597079 (manufactured by Peugeot and/or Citroën – TU 8 valve engine).

6.2.3.5.ASSEMBLY

High Voltage:



Low voltage:



6.2.3.6.PROCEDURE

Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick.

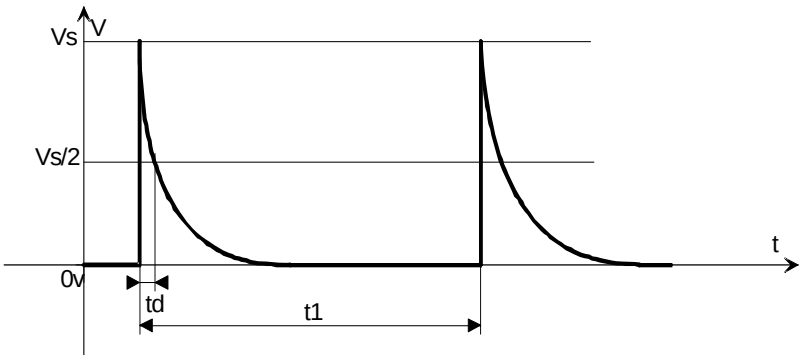
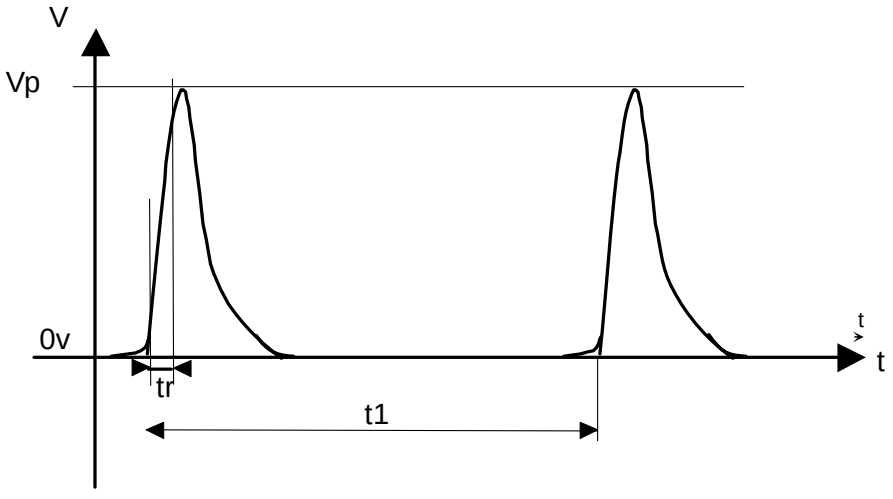
The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

The high voltage harness (non resistive) is placed on an insulating support 50 mm thick, and the DUT harness should be located 100 mm away from the high voltage harness on a 1 m length.

The Low voltage harness is placed on an insulating support 50 mm thick, and the DUT harness should be adjacent to the low voltage harness on a 1 m length.

Calibration:

Adjust the high voltage generator and the sparker or the ignition control generator in order to obtain the desired signal measured on the load.

Network 12 V	Network 42 V	High voltage signal
V_s = 10 kV $t_d \geq 5$ µs $t_1 \geq 5$ ms	V_s = 10 kV $t_d \geq 5$ µs $t_1 \geq 5$ ms	
Network 12 V	**Network 42 V**	**Low voltage signal**
V_p = 420 V $t_r \leq 2$ µs $t_1 \geq 5$ ms	V_p = 420 V $t_r \leq 2$ µs $t_1 \geq 5$ ms	

Test:

Run the DUT for a minimal duration of 10 minutes.

Apply the high / low voltage signal for 10 minutes by 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 the test.
- The waveform of the high/low ignition voltage.

6.2.3.7.REQUIREMENTS

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

6.3.IMMUNITY TESTS BY RADIATION

6.3.1.EQ/IR 01: IMMUNITY TO RADIATED FIELD (SEMI-ANECHOIC OR ANECHOIC ROOM)

6.3.1.1.REFERENCE DOCUMENT

This test procedure complies with the standard ISO 11452-2, except for the frequency from which the antenna is shifted facing the DUT, as well as the choice of modulations for frequencies higher than 1.2 GHz.

6.3.1.2.OBJECTIVE OF THE TEST

This test is designed to check the equipments immunity to an electromagnetic field in the [200 MHz – 3.2 GHz] and [2.7 GHz – 3.2 GHz] frequency bands. Its main 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.
    - Specificity of US market: add the PM3 modulation in the [1.2 GHz – 1.4 GHz] frequency band.
    - CW and PM1 in the [1.4 GHz – 2.5 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.

6.3.1.3.CONDITIONS FOR APPLICATION OF THE TEST

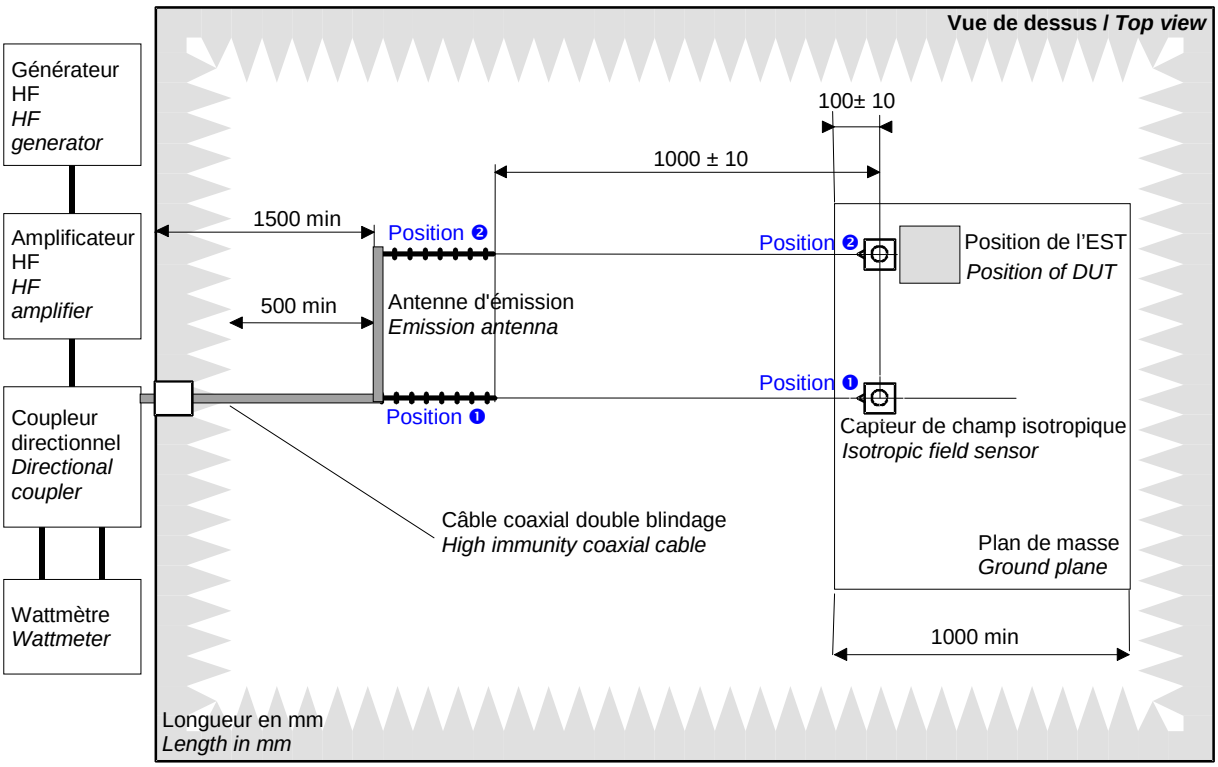
This test is applicable to all powered equipments having electronic components. The applicability of the requirements specific to US market should be specified in the NTS/TS.

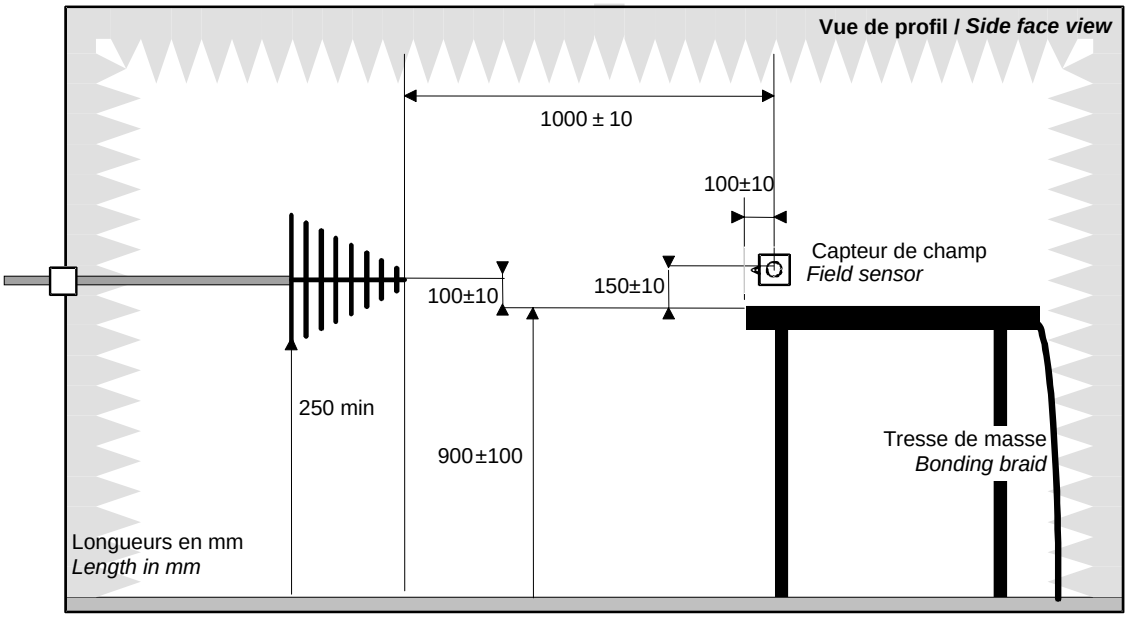
In the case of an equipment which have only passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 200/160 V/m test is applicable, with limited requirements.

6.3.1.4.TEST MEANS

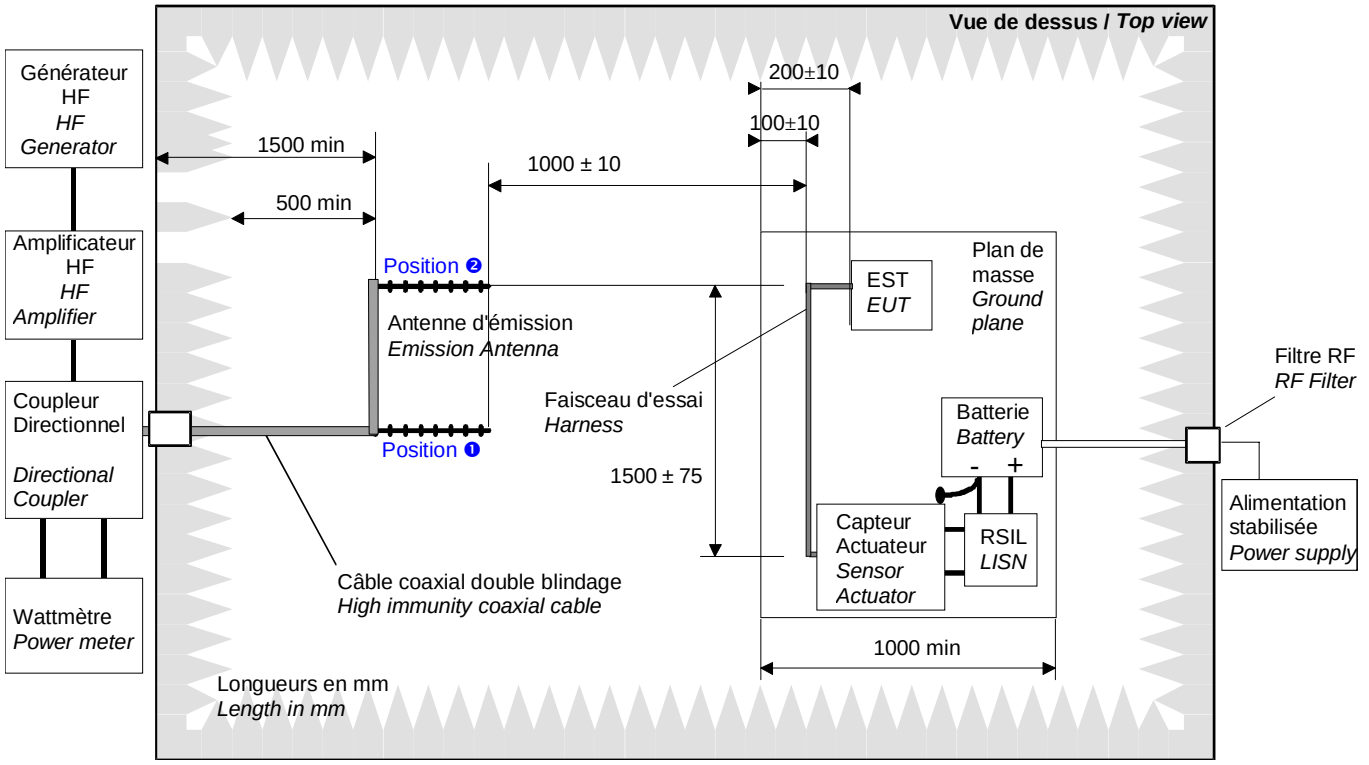
- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a remote earth DUT).
- 50 Ω load(s).
- High frequency signals generator and wide band power amplifiers.
- 50Ω coupler.
- Wattmeter.
- Log-periodic antenna or horn.
- Isotropic field sensor with optical fibre.
- Semi-anechoic or anechoic shielded chamber.

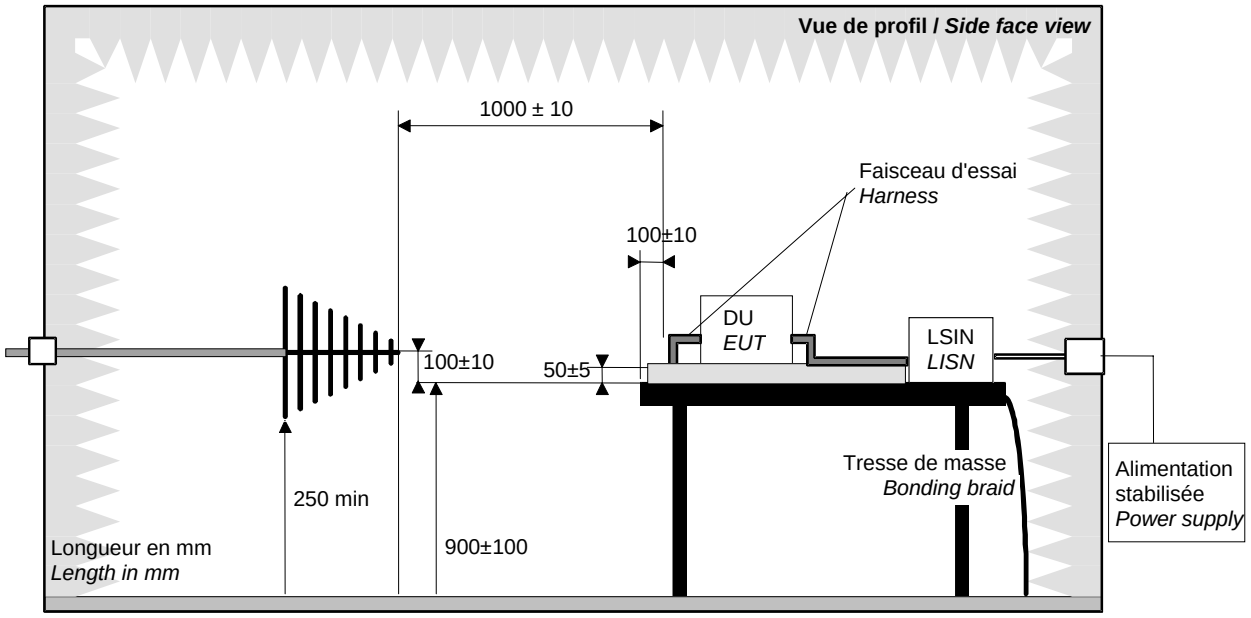
6.3.1.5.ASSEMBLY





Calibration configuration





Test configuration

6.3.1.6.PROCEDURE

The method adopted is the substitution method. The tests are carried out within the [200 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands for the vertical polarization and within the [400 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] for the horizontal polarization.

The tests are carried out for each of the modulations defined in § 6.3.1.2.

All the tests are carried out with a preservation of the peak level for the sinusoidal and modulated signals.

Preparation:

A harness with a maximum length of 2,000 mm, of which 1,500 ± 75 mm is parallel to the edge of the table, should be used. The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Calibration:

Calibration is carried out only for CW.

Place the centre of the isotropic field sensor at a height of 150 mm from the ground plane and at a distance of 100 mm from the edge of the ground plane.

Place the tip of the antenna at a distance of 1,000 mm from the isotropic field sensor. The calibration is carried out for the two antennas and sensor positions: face to the middle of the harness (position❶) until 800 MHz, face to the DUT (position ❷) above 800 MHz.

The calibration will be carried out at least for the maximum test level, without exceeding the output power level of the amplifier corresponding to the “1dB compression point”. Measure the forward power $P_{calibration}$ required to generate a field specified in the CW for each frequency.

Test:

Run the DUT for a minimal duration of 10 minutes.

Place the emission antenna in the same position as during calibration and the phase centre directly in front of the middle of the harness. The test is carried out for the two antenna positions: face to the middle of the harness (position❶) until 800 MHz, face to the DUT (position ❷) beyond 800 MHz.

Increase the forward power applied to the antenna progressively until it reaches $P_{setpoint}$ and monitor the DUT, with $P_{setpoint} = P_{calibration} * \left(\frac{E_{setpoint}}{E_{calibration}} \right)^2$.

Measure the immunity threshold of the possible faults (E_{fault}), when they are lower than the specified level.

Progressively decrease the forward power that is applied to the antenna and change the frequency.

Test report:

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

- Assembly used: wiring, DUT environment.
- Curves by modulation and by polarization with: $F_{test,}$ $E_{setpoint,}$ $E_{reached}$ and/or E_{fault}
- Curves by modulation and by polarization with: $F_{test,}$ $P_{setpoint}$ et $P_{measured}$ (incident powers)
- Fault tables with: $F_{fault,}$ E_{fault}, $E_{requirement}$, modulation, polarization and description of the fault
- The immunity thresholds are required, and should appear on the curves (E_{fault}).

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

6.3.1.7.REQUIREMENTS

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

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

Note 2: *in the case of an equipment which have only passive electronic components (example: pressure sensor with constraint gauge, temperature sensor…), only the 200/160 V/m test is applicable.*

Note 3: *no damage or customer impact level 3 fault is tolerated for levels ≤200 V/m / 160 V/m (1).*

Specificities of US market:

The following table applies as an addition for the US market with the PM3 modulation in the 1200-1400 MHz band (to be specified in the NTS/TS):

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

Note 1: *the test for the 1200-1400 MHz bandwidth with the PM3 modulation can be made with a test setup without ground plane and without LSIN, which allows the implementation of the field level required with less power. The test plan should specify which configuration is retained.*

Note 2: *the use of the reverberation chamber method (according to the test EQ/IR06), as an alternative to the anechoic chamber method, is accepted for the PM3 tests in the 1200-1400 MHz band. If using this method, the duration of the radar pulses PM3 should be extended from 3µs to 6µs, in order to acknowledge the time constant of the chamber.*

Note 3: *no damage or customer impact level 3 fault is tolerated for levels ≤600 V/m.*

Specificities of radio receivers emitters:

In the case of a DUT including a radio receiver type function (examples: car radio, mobile phone), some unexpected events of the radio function (for example: audio quality, binary error rate) are allowed in a frequency band of F0 ± 5%; F0 is the tuning frequency used for the test. The tuning frequency as well as the types of malfunctioning allowed will be specified in the test plan.
In the case of a DUT including a transmitter-receiver radio type function for the 315 and 433 MHz bands (examples: plip, DSG), the deseverizations in appendix A are applied.

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

6.3.2.1.REFERENCE DOCUMENT

This test procedure complies with the standard EN 61000-4-21. This paragraph specifies the field levels, the modulation types and requirements to be applied, as well as some arrangements concerning the test setup.

6.3.2.2.OBJECTIVE OF THE TEST

This test is designed to characterize the equipments immunity to an electromagnetic field in the [200 MHz – 3.2 GHz] and [2.7 GHz – 3.2 GHz] frequency bands.

Its main 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.
  - Specificity of US market: add the PM3 modulation in the [1.2 GHz – 1.4 GHz] frequency band.
  - CW and PM1 in the [1.4 GHz – 2.5 GHz] frequency band.
  - CW and PM2 in the [2.7 GHz – 3.2 GHz] frequency band.
- Substitution method.
- Minimum test working volume that complies with the homogeneity criteria: 1m x 2m (width / length) x 1m (height).
- Stirring of the field in step by step mode. The number of tuner positions suggested is the one in table B1. of the standard EN 61000-4-21. It can however be decreased if the standard deviation from table B.2 of the standard EN 61000-4-21 are fulfilled.
- For equipments with the case not connected to the ground, the test is carried out on an insulating support. In the case of equipments with the box directly grounded, the test will be carried out on a ground plane (in this case a 1m x 2m ground plane connected to the chamber will be used, and the “empty chamber calibration” will be used).

6.3.2.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is a characterization test. It is mandatory to perform it. It is applicable to all powered equipments having active electronics.

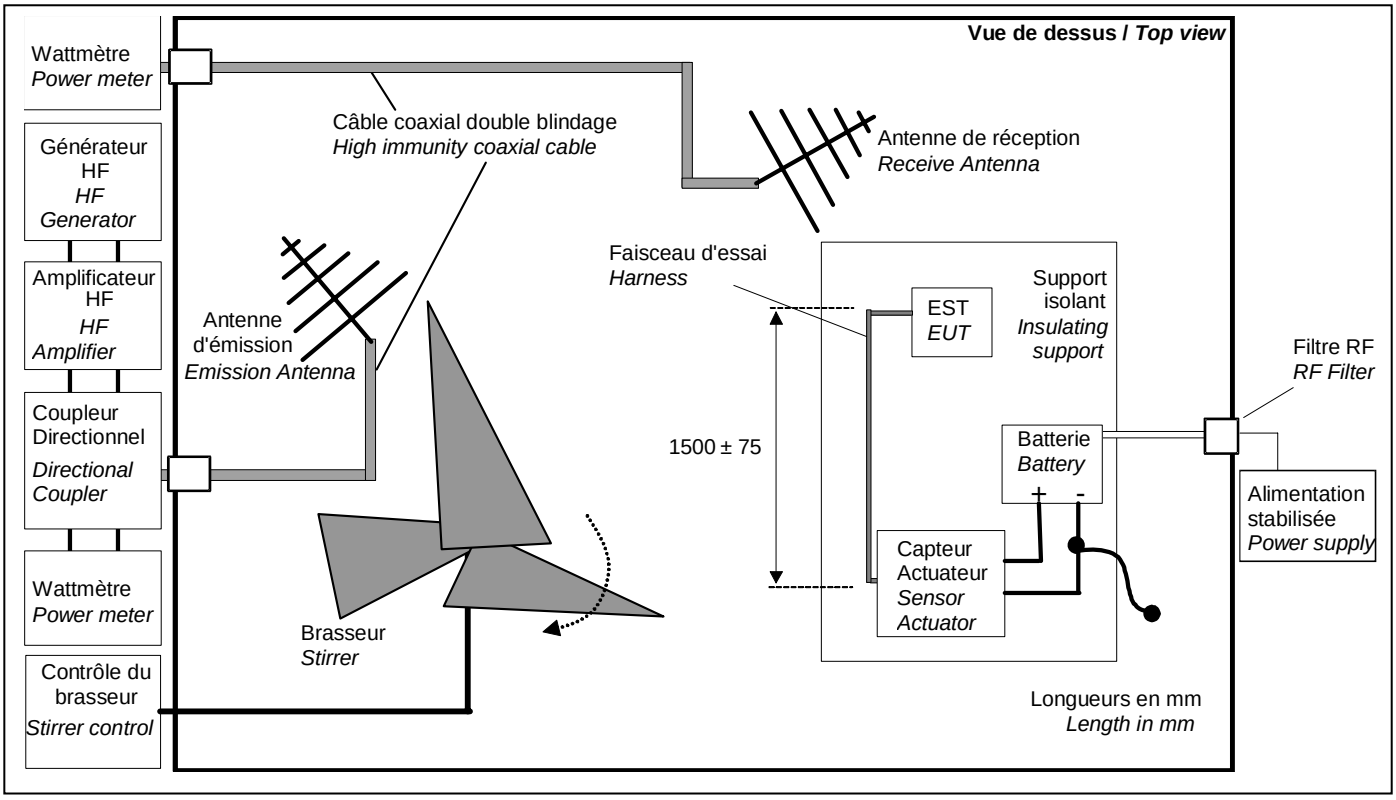
6.3.2.4.TEST MEANS

- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating table with a height of at least 40 cm.
- Layout (if needed, case of equipments with the box is directly grounded)
- LSIN (optional)
- High frequency signals generator and wide band power amplifiers.
- 50Ω coupler.
- Wattmeter.
- Log-periodic antenna, horn or equivalent (one in emission and one in reception).
- Isotropic field sensor fitted with fibre optic.
- Reverberation chamber.

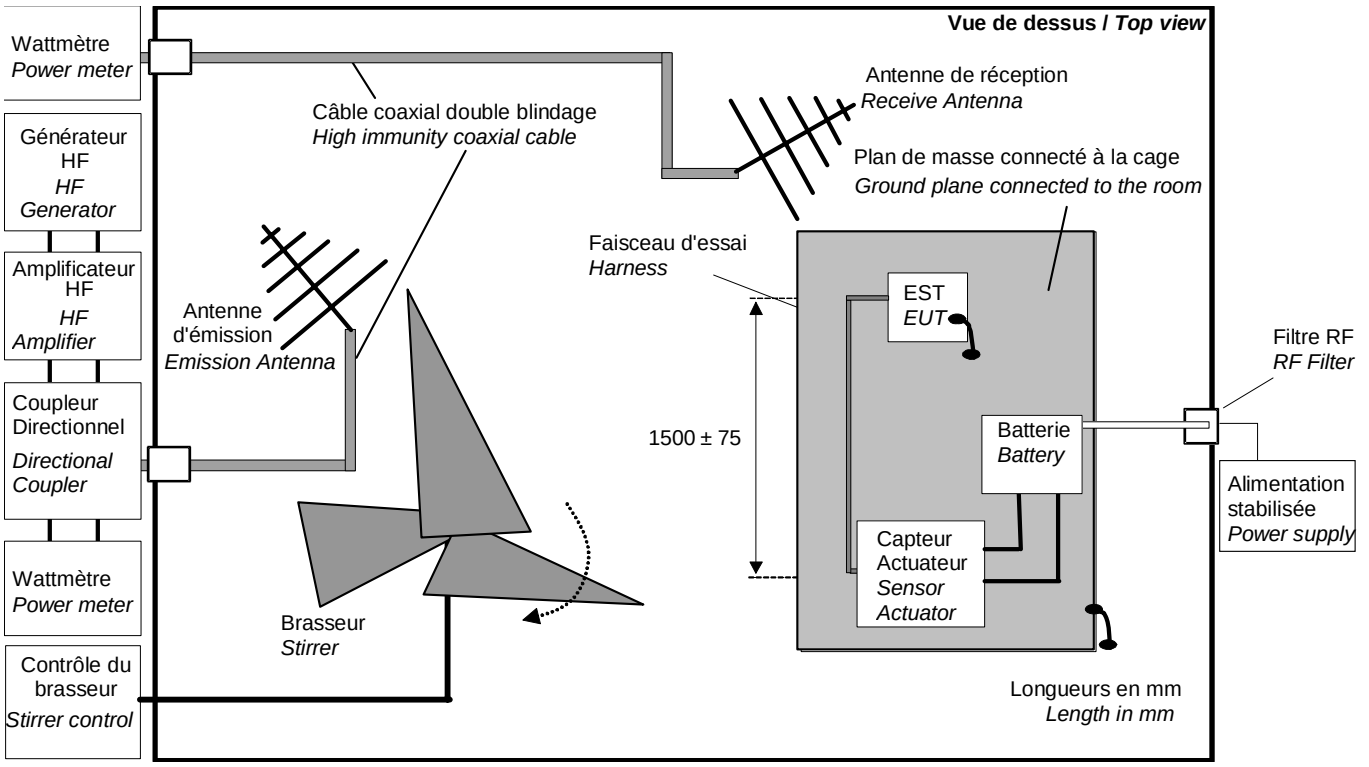
6.3.2.5.ASSEMBLY

Calibration configuration: see standard EN 61000-4-21.

Test configuration without ground plane (general case):



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



6.3.2.6.PROCEDURE

The tests are carried out on the [200 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands.

The tests are carried out for each of the modulations defined in § 6.3.2.2, with preservation of the peak level.

Calibration:

Calibration is carried out only for CW.

Apply the test protocol of the EN 61000-4-21.

Preparation:

Case of equipments having no direct grounding via the box: configuration without ground plane:

A harness with a maximum length of 2,000 mm, of which 1,500 ± 75 mm is in a rectilinear way and inside the working volume, should be used.

The DUT and its harness are placed on an insulation table at least 40 cm high (> λ/4), and in the test volume.

Case of equipments having a direct grounding via the box: configuration with ground plane:

A harness with a maximum length of 2,000 mm, of which 1,500 ± 75 mm is in a rectilinear way and inside the working volume, should be used.

The DUT and its harness are placed on an insulation table at least 40 cm high (> λ/4), and which has a ground plane. This ground plane is located in the working volume, and connected to the ground via the chamber. The wiring is placed on an insulating support, 50 mm thick in relation to the ground plane. The DUT is linked to the ground plane according to its real vehicle installation and no other earth 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 side and be connected to the chamber ground. Any ground connection required for the system under test (ground plane, load bench ground, LSIN if used) should be carried out on this reference ground point.

Test:

Run the DUT for a minimal duration of 10 minutes.

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

Increase the forward power applied to the antenna progressively until it reaches $P_{setpoint}$ and monitor the DUT, and with each mixer step successively, with $P_{setpoint} = P_{calibration} * \left(\frac{E_{setpoint}}{E_{calibration}} \right)^2$.

Measure the threshold of appearance of the possible faults (E_{fault}), when they are lower than the specified threshold.

Progressively decrease the forward power that is applied to the antenna and change the frequency.

Test report:

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

- Calibration characteristics of the reverberation room used with especially:
  - Its size
  - Its quality factors
  - The insertion losses
  - The curves of the standard deviations on the field value as defined in § B1.1 of the EN 61000-4-21
  - The power level required to carry out a setpoint of the given field.
- The parameters measured during the following tests:
  - The field made during the tests, based on the power injected and on the calibration file
  - The load factor (CLF) estimated with the help of the receiving antenna. This factor is based on the average powers received during empty calibration then the calibration with equipment (or possibly the test itself). The B.12 formula of the standard EN 61000-4.21 gives details on the calculation.
- Assembly used: wiring, DUT environment.
  - Curves by modulation with: F_{test}, $E_{setpoint}$, $E_{reached}$ and/or E_{fault}
  - Curves by modulation with: $F_{test,}$ $P_{setpoint}$, $P_{measured}$ and/or P_{fault} (incident powers)
  - Fault tables with: $F_{fault,}$ E_{fault}, $E_{requirement}$, modulation, and description of the fault
  - The immunity thresholds are required, and should appear on the curves (E_{fault}).

In addition to the test report, all the data F_{test} and/or F_{fault}, $E_{setpoint}$, $E_{reached}$ and/or E_{fault}, $P_{setpoint}$ and $P_{measured}$ and/or P_{fault} (incident powers), modulation, and faults descriptions should be provided on digital support in an Excel table in this order.

6.3.2.7.TEST LEVELS

This test is a characterization test.

For optimizing the test duration, only the highest customer impact unexpected event applicable to the equipment should be acknowledged with search for the susceptibility thresholds and for a maximum test level of:

- 150 V/m if the customer impact is higher than level 3
- 80 V/m if the customer impact is higher than level 2
- 30 V/m if the customer impact is higher than level 1.

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

6.3.3.1.REFERENCE DOCUMENT

This test procedure complies with standard ISO 11452-8, with the exception of the frequency low limit.

6.3.3.2.OBJECTIVE OF THE TEST

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

Its main characteristics are the following:

- Sine-wave signal.
- [20 Hz – 150 kHz] frequency band.
- Substitution method.
- Generation of a magnetic field as a sine-wave shape by circulating electric current in its loop(s).
- 3 DUT or injection loop orientations.

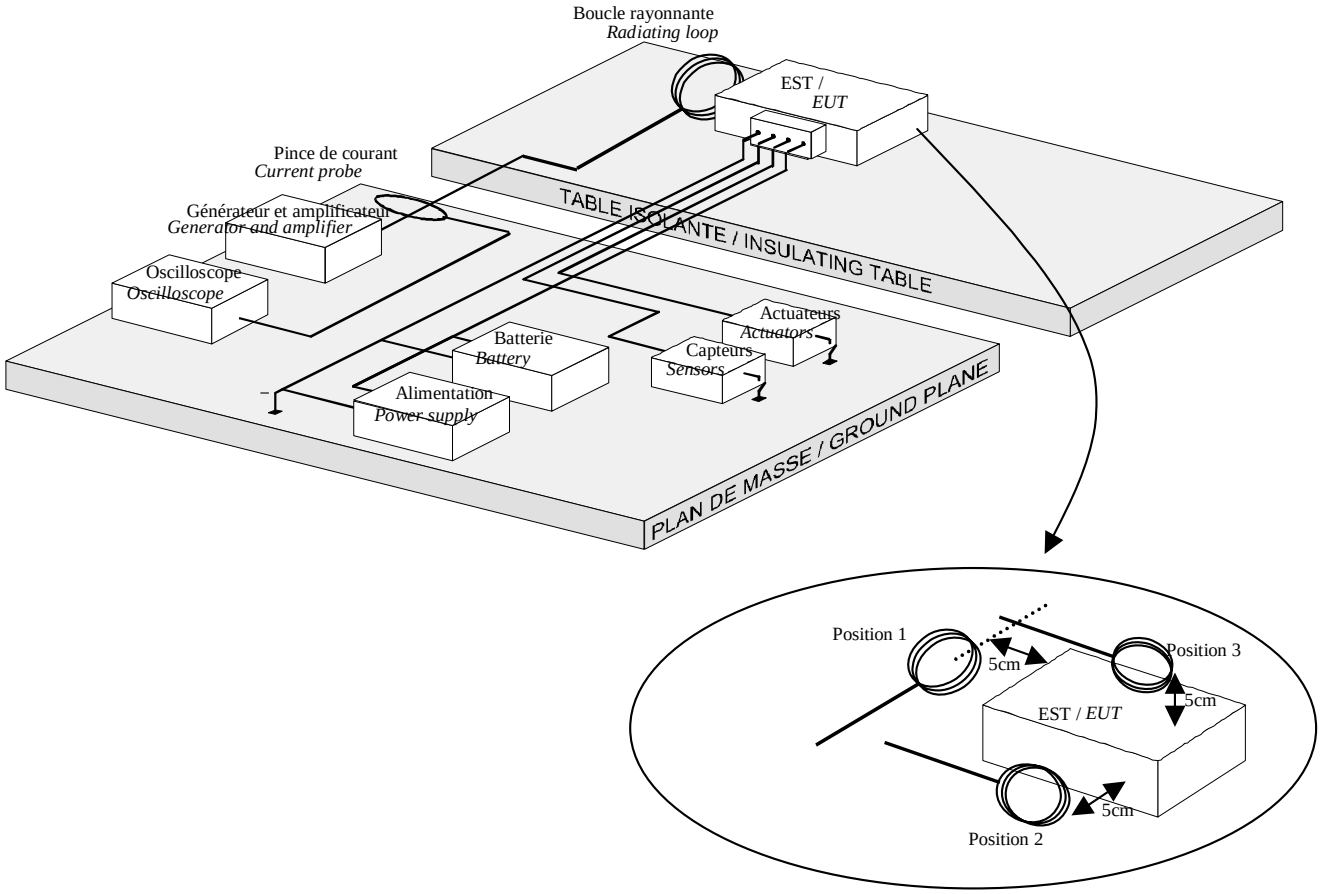
6.3.3.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to equipments sensitive to the magnetic field (Hall effect sensors, audio circuits…), as well as to equipments located near a high source of magnetic field (alternator, Electrical steering assistance...). The NTS/TS and/or the test plan will specify if the test is applicable.

6.3.3.4.TEST MEANS

- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulation table.
- Low frequency signals generator.
- Power amplifier.
- Low frequency magnetic field sensor.
- Current probe.
- Oscilloscope.
- A loop having the characteristics in MIL STD 461E is recommended:
    - Diameter: 120 mm.
    - Number of turns: 20.
    - Wire diameter: approximately 2 mm.
- The field thus created by a current I at a 50 mm distance answers the equation: H = 75.6 I (A/m).
- A Helmholtz coil is however authorized as an alternative solution. Assembly with the Helmholtz coil is described in the standard ISO 11 452-8.

6.3.3.5.ASSEMBLY



6.3.3.6.PROCEDURE

The method adopted is the substitution method.

Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used).

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

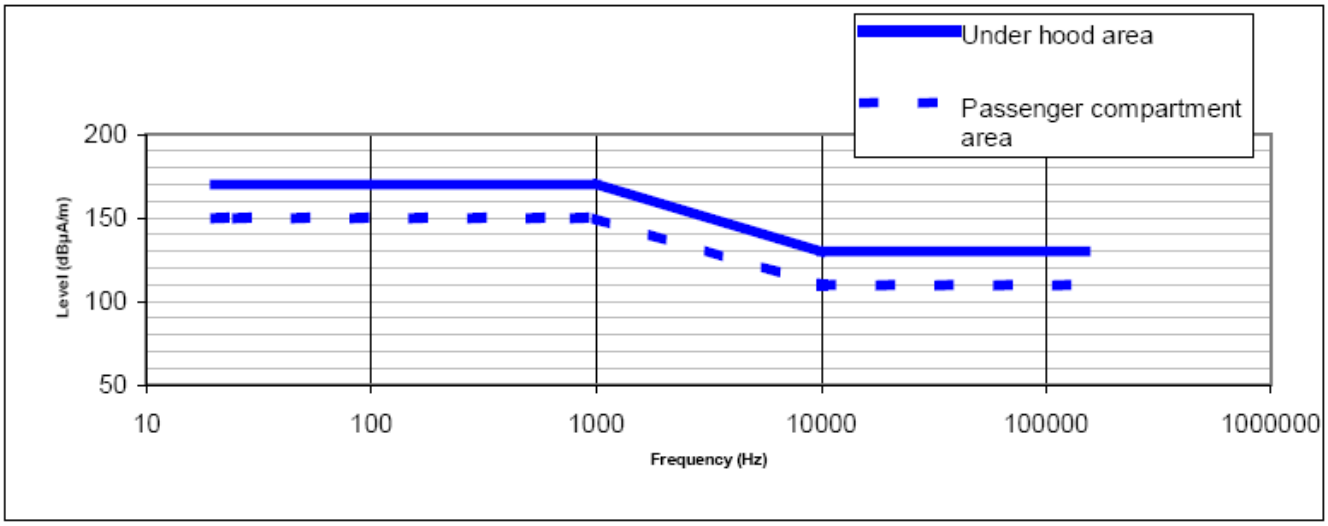
Calibration:

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

Measure the current $I_{calibration}$ (amplifier output) required to generate the field specified for each frequency.

The requirements below should be used. The test plan or the NTS/TS should specify which of the two requirements is applicable, depending on whether the DUT is located in engine or in the passenger compartment.

Frequency band (Hz)	Spectrum envelope of the magnetic field (dBµA/m)	
	Area under the hood	Passenger compartment area
20 - 1000	170	150
1000 - 10000	170 - 40 x log (F/1000)	150 - 40 x log (F/1000)
10000 - 150000	130	110



Test:

Run the DUT for a minimal duration 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 antenna coil 50 mm away from the DUT so it is parallel to it; then move the coil in every DUT point 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, have the following elements:

- Assembly used: wiring, DUT environment.
- Characteristics of the coils used.
- Fault tables with: $F_{fault,}$ E_{fault}, $E_{requirement}$, modulation, and description of the fault.

6.3.3.7.REQUIREMENTS

Test	Operating classes	Customer impact levels
Magnetic field	A	0

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

6.3.4.EQ/IR 05: IMMUNITY TO ON-BOARD TRANSMITTERS

6.3.4.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.3.4.2.OBJECTIVE OF THE TEST

The purpose of this test is to check the equipments immunity to onboard transmitters with integrated antenna (cellular phone, Bluetooth transmitter…).

The main characteristics of the test are the following:

- Regulation with closed loop method on the transmitted power (forward power – reflected power) at the bottom of the portable emission device (box + antenna).
- Generation an electric field with portable emission device.
- 3 DUT orientations or of the onboard transmitter.

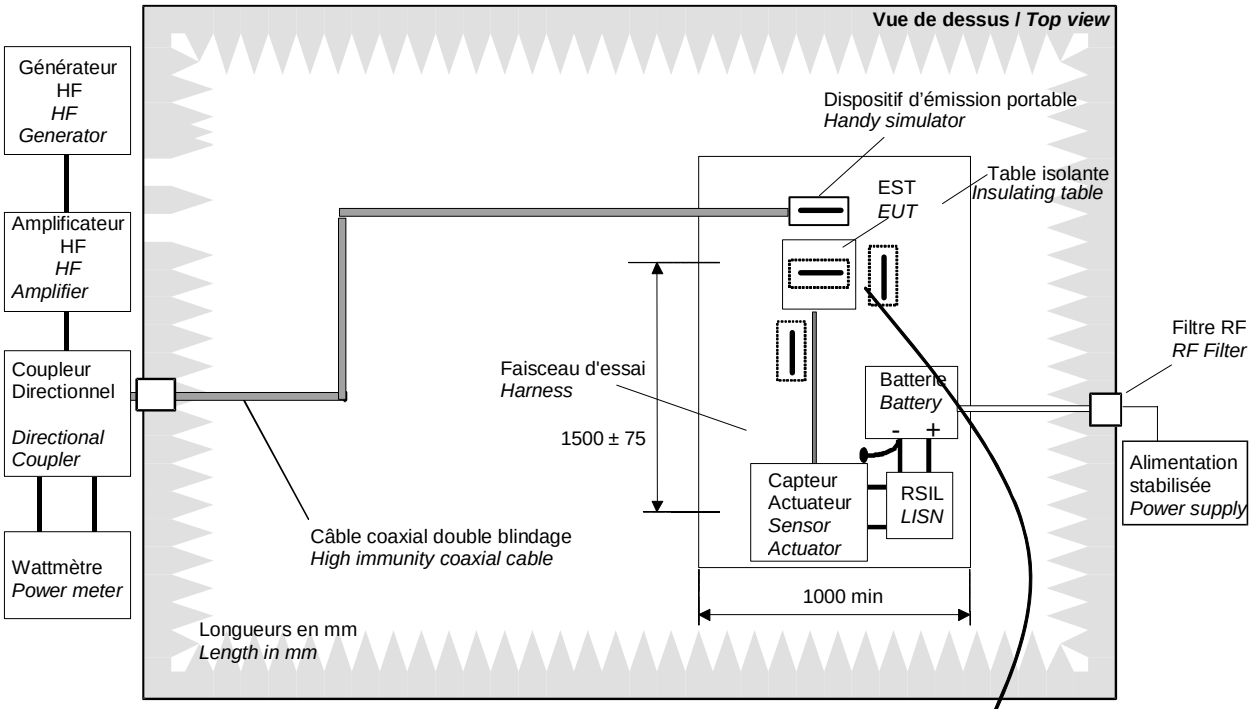
6.3.4.3.CONDITIONS FOR APPLICATION OF THE TEST

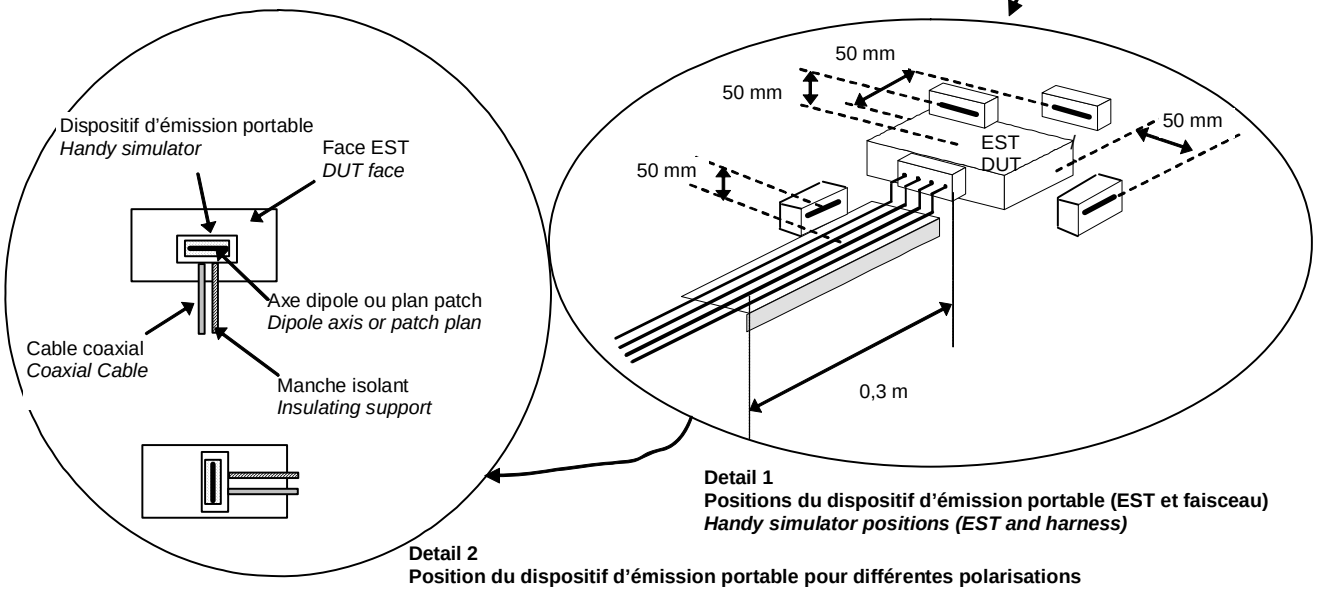
This test applies only to equipments located in the passenger compartment or in the trunk, and which have active electronics.

6.3.4.4.TEST MEANS

- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulation table by default. In the case of equipment connected to the chassis by a specific ground connection, we use a ground plane with insulation support 50 mm thick.
- Insulating support with a thickness of 50 mm.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a DUT with remote earth).
- 50 Ω load(s).
- High frequency signals generator and wide band power amplifiers.
- 50Ω coupler.
- Wattmeter.
- Portable emission device with the characteristics defined in appendix B:
    - GSM 900, GSM 850 and PDC 800 ranges: dipole antenna.
    - GSM 1800, UMTS, GSM 1900 and PDC 1500 ranges: dipole antenna or patch.
    - Bluetooth Range: patch antenna.

6.3.4.5.ASSEMBLY





Detail 1
Positions du dispositif d'émission portable (EST et faisceau)
Handy simulator positions (EST and harness)

Detail 2
Position du dispositif d'émission portable pour différentes polarisations
Handy position for different polarisations

6.3.4.6.PROCEDURE

The method adopted is the closed loop regulation method, based on transmitted power (transmitted power = forward power – reflected power) at the bottom of the portable emission device.

Preparation:

A harness with a maximum length of 2,000 mm, of which 1,500 ± 75 mm is parallel to the edge of the table, should be used (if needed, the real harness can be used).

The DUT is placed on an insulation table 900±100 mm in length. In the case the DUT is connected to the chassis by a specific ground connection, we use a ground plane with insulation support 50 mm thick.

Calibration:

Run the DUT for a minimal duration of 10 minutes.

Adjust the HF generator to obtain a level of transmitted power $P_{calibration}$ (measured in CW), at the bottom of the portable emission device corresponding to the one indicate in the table hereafter. This adjustment should be carried out in a configuration for which the portable emission device is located at least 1 m away from any metal part (frame wall, equipment, ground plane) and 0.5m away from absorbents.

Approach method for the simulator:

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

- Apply the modulation indicated in the table hereafter, and then approach the portable emission device (without any power cut) until reaching various positions specified (DUT and harness).
- Apply the modulation indicated in the table hereafter. Switch of the power, then place the portable emission device in the various positions specified (DUT and wiring). Reapply the power with modulation (in "OFF/ON mode"), without modifying the level.

Test:

DUT Test:

For each DUT side, place the portable emission device 50 mm away from the DUT side. The 50 mm distance corresponds to the distance between the centre of the antenna and the DUT side (according to detail 1 on the assembly).

The dipole axis on the patch antenna plan should be parallel to the DUT test side (according to detail 1 on assembly).

Place the simulator in various positions along the side for the two orientations (polarizations) of the antenna parallel to the DUT surface (according to detail 2 on the assembly).

Bundle test:

Place the portable emission device 50 mm away from the harness. The 50 mm distance corresponds to the distance between the centre of the antenna and the harness (according to detail 1 on the assembly).

The dipole axis should be parallel to the harness; for a patch antenna, the patch antenna polarization should be parallel to the harness (or if the antenna is not known, carry out the tests for the two polarizations).

Place the simulator in various positions along the harness on a 0,3 m length starting with the DUT connector.

Frequencies, powers and modulations to apply:

Frequency bands (MHz)	Frequency ranges (MHz)	Test frequencies (MHz)	Effective Transmitted Power measured in CW ($P_{calibration}$) (1)		Modulation to add (for test on DUT)
			Level P1	Level P2	
GSM 900	890 - 915	880.2 / 890.2 / 902.4 / 914.8	2 W	6 W	PM 217 Hz T_{on} 577 µs
GSM 1800	1710 - 1785	1710.2 / 1747.4 / 1784.8	1 W	3 W	PM 217 Hz T_{on} 577 µs
UMTS	1920 - 1980	1920 / 1950 / 1980	0.25 W	0.75 W	PM 217 Hz T_{on} 577 µs
Bluetooth	2402 - 2480	2402 / 2441 / 2480	100 mW	300 mW	PM 700 kHz Duty factor 0.5

Note 1: *Power transmitted (forward power – reflected power) at the bottom of the portable emission device.*

Specificities of US and Mercosur market:

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

Frequency bands (MHz)	Frequency ranges (MHz)	Test frequencies (MHz)	Effective Transmitted Power measured in CW ($P_{calibration}$) (1)	Modulation to add (for test on DUT)

			Level P1	Level P2	
GSM 850	824 - 849	824.2 / 836.4 / 848.8	2 W	6 W	PM 217 Hz T_{on} 577 µs
GSM 1900	1850 - 1910	1850.2 / 1880.0 / 1909.8	1 W	3 W	PM 217 Hz T_{on} 577 µs

Note 1: *Power transmitted (forward power – reflected power) at the bottom of the portable emission device.*

Korea/Japan market specificities:

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

Frequency bands (MHz)	Frequency ranges (MHz)	Test frequencies (MHz)	Effective Transmitted Power measured in CW ($P_{calibration}$) (1)		Modulation to add (for test on DUT)
			Level P1	Level P2	
PDC 800	810 - 826	810.2 / 818.0 / 825.8	0.8 W	2.4 W	PM 217 Hz T_{on} 577 µs
PDC 1500	1429 - 1453	1429.2 / 1441.0 / 1453.8	0.8 W	2.4 W	PM 217 Hz T_{on} 577 µs

Note 1: *Power transmitted (forward power – reflected power) at the bottom of the portable emission device.*

Test report:

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

- Assembly used: wiring, DUT environment.
- Characteristics of the portable emission device (box + antenna): box size, antenna type, TOS value of the central band frequency.
- Fault tables with: $F_{fault,}$ P_{fault}, $P_{requirement}$, (powers transmitted), position, orientation, and description of the fault

In addition to the test report, all the data F_{test} and/or F_{fault}, $P_{setpoint}$, $P_{reached}$ and/or P_{fault}, (powers transmitted), TOS, position, orientation and faults descriptions should be provided on digital support in an Excel table in this order.

6.3.4.7.REQUIREMENTS

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

6.4.TESTS OF THE RESISTANCE TO ELECTROSTATIC DISCHARGES

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

6.4.1.1.REFERENCE DOCUMENTS

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

6.4.1.2.OBJECTIVE OF THE TEST

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

Its main characteristics are the following:

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

6.4.1.3.CONDITIONS FOR APPLICATION OF THE TEST

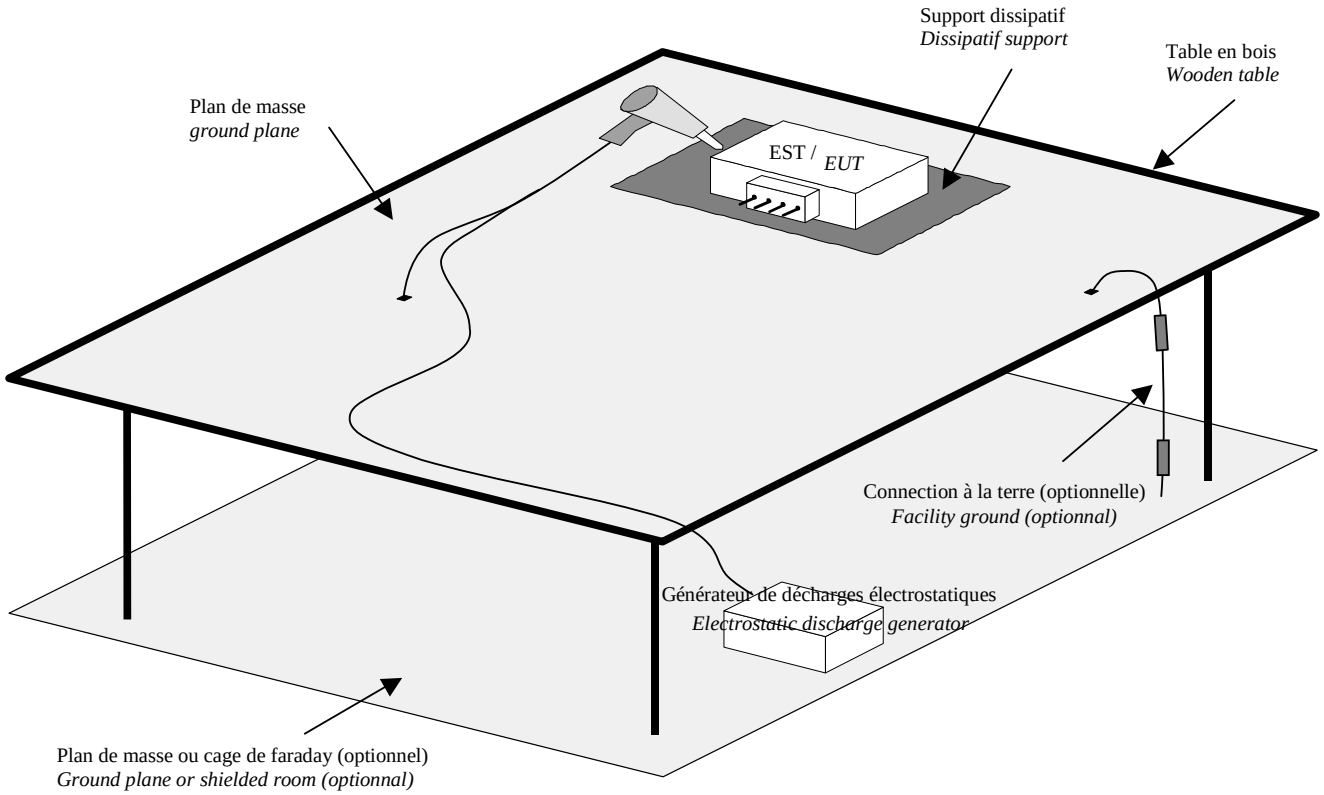
This test is applicable to all equipments.

For the specific case of pyrotechnic modules, this test does not apply. The test method and its requirements associated to the pyrotechnic modules are described in technical specification ref. IHPC_ADMR07_0043.

6.4.1.4.TEST MEANS

- Dissipating support 0.5 to 5 mm thick for the DUT. The purpose of this support is to avoid any direct arc between the DUT and the ground plane during discharge, and to ensure the DUT return to 0 potential for the following discharge. A transverse resistivity of (10^7 to 10^{10} Ω.m) is proper for this use.
- Electrostatic discharge generator.

6.4.1.5.ASSEMBLY



6.4.1.6.PROCEDURE

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

These requirements concern at least:

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

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

Preparation:

The DUT is placed on a dissipating support, 0.5 to 5 mm thick. The tests are carried out by default in the insulated box configuration (figure above with dissipating support). In the case of a box having a conductive part, an additional test is carried out by linking this conductive part to the ground plane (and by removing the dissipating support).

Calibration:

Calibrate the electrostatic discharge generator according to ISO 10 605.

Contact discharges: use a cone point electrode.

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

Test:

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

Check the DUT operation after application of all the pulses.

Slowly approach the electrostatic discharge gun until breakdown 10 consecutive times (with a spacing of at least 1 s) towards each of the discharge points defined for the insulation parts (accessible surfaces or points), the gun being loaded at + 8 kV (then +15 kV), then at - 8 kV (then -15 kV).

Check the DUT operation after application of all the pulses.

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

Check the DUT operation after application of all the pulses.

Test report:

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

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

6.4.1.7.REQUIREMENTS

Test				Operating state
Test level	Equipment envelope		Connector pins	
	Conductive parts	Insulator parts		
I	Not applicable	Not applicable	Discharge in contact with ± 2 kV	A after reconnection
II	Discharge in contact with ± 4 kV	Discharge in the air with ± 8 kV	Discharge in contact with ± 4 kV	A after reconnection
III	Discharge in contact with ± 8 kV	Discharge in the air with ± 15 kV	Not applicable	A after reconnection

Note : *Test levels I, II and III have to be tested successively. The test plan will precise in which order all tests have to be performed. It is advisable to check at the end of the test the degree of damage of some filter components (most likely condensers).*

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

6.4.2.1.REFERENCE DOCUMENTS

This test procedure is based on the publication ISO/DIS 10605, except for the following:

- the applicability conditions of the discharges in contact or in the air,
- the addition of the indirect discharge test on the coupling plan,
- the thickness of the insulation support.

6.4.2.2.OBJECTIVE OF THE TEST

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

Its main characteristics are the following:

- Contact discharges: ± 2 kV, ± 4 kV, ± 8 kV and ± 15 kV. These discharges are applicable on the conductive equipment parts.
- Air discharges: ± 4 kV, ± 8 kV, ± 15 kV and ± 25 kV (according to installation). These discharges are applicable for the insulating equipment parts (search for the box gaps…).
- Discharges on contact with the horizontal coupling plan: ± 4 kV, ± 8 kV and ± 15 kV. The points of discharge should be specified in the test plan.
- Energy accumulation capacity of 330 pF.
- Discharge resistance 2 kΩ.
- Positive polarity and negative polarity.
- 10 discharges at 1 s intervals for each level, polarity and point of application.

6.4.2.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applicable to all powered equipments having active electronics.

6.4.2.4.POINTS OF APPLICATION OF DISCHARGES

The points of application of the discharges are rated as follows:

- Point of type 1 h direct: each point of passenger compartment DUT (buttons, levers, warning lights, displays) can be directly (without removal) accessible by the users.
- Point of type 1 h indirect: each point of the DUT passenger compartment can be indirectly accessible (following removal, maintenance…) in operating mode (wiring harness and connectors, rear side of a unit…).
- Points of 1 m type: each DUT point in engine compartment (boxes, wiring and connectors harness …), or accessible only outside the passenger compartment (example: parking aid sensor …).
- Point of type 2 h direct: each input-output pin that can be directly accessible by the users in a remote manner (connector for sliding door system…).
- Point of type 2 h indirect: each input-output pin that can be accessible by the users in a remote manner, after handling (diagnostic jack pins…).
- Point of type 3 h direct: remote elements (located in the passenger compartment) of a control assembly made of several equipments (example: door electronics buttons …). The tests can be made on each system element with the assembly inter-connected, according to the diagram from § 6.4.2.5. The tests configuration should be specified in the test plan.
- Points of 3 m type: remote elements (located under the hood) of a control assembly made of several equipments (example: actuator and sensor in relation to the device …).
  The tests can be made on each system element with the assembly inter-connected, according to the diagram from § 6.4.2.5. The tests configuration should be specified in the test plan.

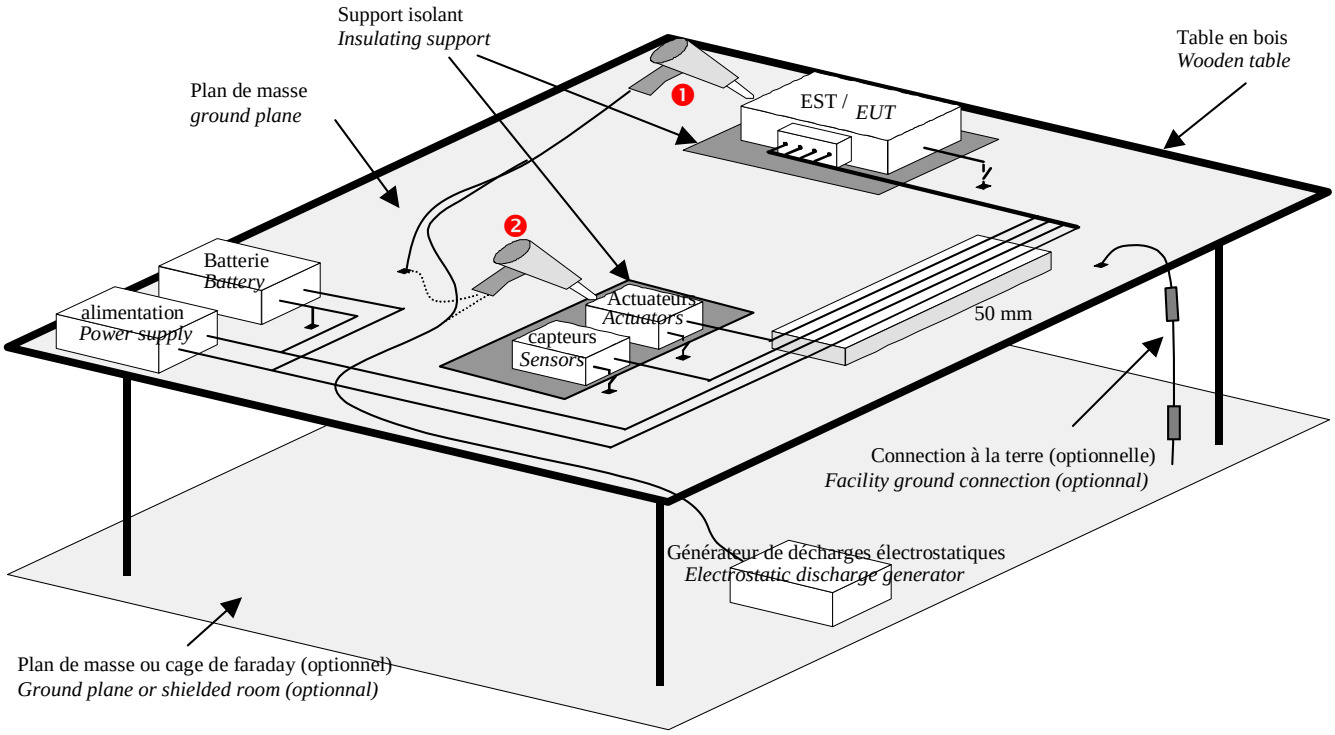
Accessibility and location		DUT envelope	Pin or contact accessible remotely	Envelope of a remote element
Directly accessible	Passenger compartment	1 h direct	2 h direct	3 h
	In engine compartment or outside the vehicle	1 m	*Not applicable*	3 m
Accessible after handling or removal	Passenger compartment	1 h indirect	2 h indirect	1 h indirect
	In engine compartment or outside the vehicle	1 m	*Not applicable*	3 m

Note : *the classification by type should be specified in the* NTS/TS *or in the test plan for each point.*

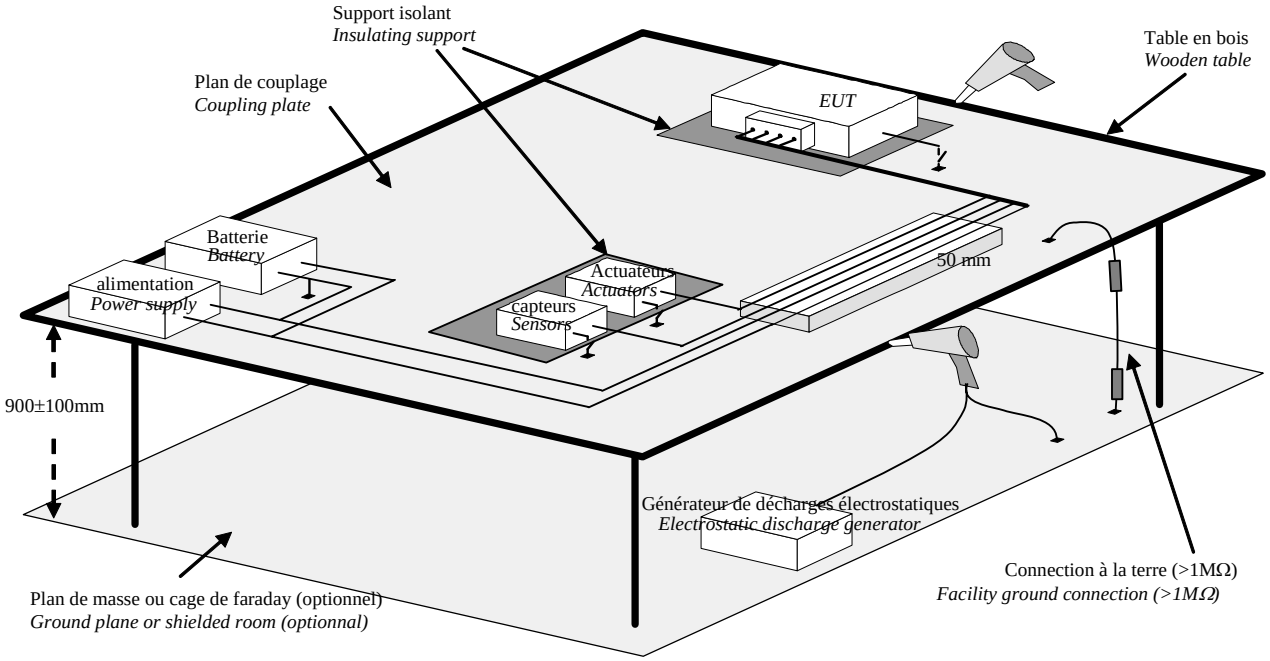
6.4.2.5.TEST MEANS

- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Metal coupling plane. It can be linked (according to the test type) to the chamber ground by a wire having a resistance with the value higher than or equal to 1 MΩ, to ensure the return to zero potential of the coupling plane between the two discharges.
- Insulating support 50 mm thick for wiring and harnesses.
- Insulating support 0.5 to 5 mm thick for the DUT.
- Electrostatic discharge generator.
- Shielded chamber (if possible).

6.4.2.6.ASSEMBLY



Direct discharge on the equipment



Indirect discharges on the coupling plane

6.4.2.7.PROCEDURE

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

These requirements concern at least:

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

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

Preparation:

A harness 1,500 mm to 2,500 mm long should be used to link the DUT to the various loads and actuators. The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulation support, 0.5 to 5 mm thick. The tests are carried out either with the configuration with the insulated support or with the configuration with case connected to the coupling plane according to its real installation on vehicle. No other ground connection is allowed.

For direct discharges, the electrostatic discharges generator ground is linked to the coupling plane by a bond no longer than 1000 mm.

For indirect discharges, the electrostatic discharges generator ground is linked directly to the reference ground (chamber, earth) by a bond no longer than 1000 mm.

Note : *for the cases involving 2h direct or 2h indirect points of application (as defined in § 6.4.2.4) that can impact on several equipments (example: inter-system CAN) the pins referred to by the test could be tested by contact discharges (or in the air for 25 kV) via adding a harness, insulated from the coupling plan at a height of 50 mm, with the length defined in the test plan. By default, this length 10 cm.*

Calibration:

Calibrate the electrostatic discharge generator according to ISO 10605.

Air discharges: use a round point electrode.

Contact discharges: use a cone point electrode.

Test:

Run the DUT for a minimal duration of 10 minutes.

Contact discharges:

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

Air discharges:

- Slowly approach the electrostatic discharge gun until breakdown 10 consecutive times (with a spacing of at least 1 s) towards each of the discharge points defined for the insulation parts (terminal and harness included), the gun being loaded at + 4 kV, then at - 4 kV.
- Check the DUT operation during and after application of all the pulses.
- Repeat the test with ± 8 kV then ± 15 kV and ± 25 kV.

Discharges on contact, with the horizontal coupling plan:

- Place the electrostatic discharge gun in contact with the slice of the horizontal coupling plan in various points. Make sure the DUT is located 10 cm away from the edge of the coupling plan. Trigger a series of 10 + 2 kV discharges at least at 1 s intervals, then a series of 10 – 2 kV discharges at least at 1 s intervals.
- Check the DUT operation during and after application of all the pulses.
- Repeat the test with ± 4 kV then ± 8 kV and ± 15kV.

Test report:

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

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

6.4.2.8.REQUIREMENTS

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

<table>
<tr><th colspan="10">Customer impact levels and classes (example: (A0 = class A and customer impact level 0)</th></tr>
<tr><th colspan="2">Test</th><th colspan="4">Discharge on conductive parts (1)</th><th colspan="4">Discharge on insulating parts</th></tr>
<tr><td>Equipment location</td><td>Discharge points (type of discharge)</td><td>± 2 kV (contact)</td><td>± 4 kV (contact)</td><td>± 8 kV (contact)</td><td>± 15 kV (contact)</td><td>± 4 kV (air)</td><td>± 8 kV (air)</td><td>± 15 kV (air)</td><td>± 25 kV (air)</td></tr>
<tr><td rowspan="3">Direct - passenger compartment</td><td>Point of type 1 h direct</td><td rowspan="3">A0</td><td rowspan="3">A0</td><td rowspan="3">C1</td><td rowspan="3">C1</td><td>A0</td><td>A0</td><td>C1</td><td>C1</td></tr>
<tr><td>Point of type 2 h direct</td><td colspan="4">Not applicable</td></tr>
<tr><td>Point of type 3 h</td><td>A0</td><td>A0</td><td>C1</td><td>C1</td></tr>
<tr><td rowspan="2">Indirect - passenger compartment</td><td>Point of type 1 h indirect</td><td>C1</td><td>C1</td><td>D2</td><td>(3)</td><td>C1</td><td>C1</td><td>D2</td><td>(3)</td></tr>
<tr><td>Point of type 2 h indirect</td><td>A0</td><td>A0</td><td>C1 (2)</td><td>C1 (2)</td><td colspan="4">Not applicable</td></tr>
<tr><td rowspan="3">Engine compartment or outside passenger compartment</td><td>Points of 1m type</td><td rowspan="2">A0</td><td rowspan="2">C1</td><td rowspan="2">C1</td><td rowspan="2">(3)</td><td rowspan="2">A0</td><td rowspan="2">C1</td><td rowspan="2">C1</td><td rowspan="2">(3)</td></tr>
<tr><td>Points of 3 m type</td></tr>
<tr><td>Point of type 2 h indirect</td><td>A0</td><td>A0</td><td>C1 (2)</td><td>C1 (2)</td><td colspan="4">Not applicable</td></tr>
<tr><td colspan="2">Discharges on the coupling plane</td><td>NA</td><td>A0</td><td>C1</td><td>C1</td><td colspan="4">Not applicable</td></tr>
</table>

(1): or on the coupling plane.

(2): this test is applicable for non-protected lines (example: K line). It is not applicable for lines protected by a central protection of another equipment (example: intersystem CAN, see note DMFV_AEL04_0091).

(3): The equipment is required only for characterization. In case of destruction or of customer impact 3 fault, the malfunctions and immunity thresholds should be filled in.

6.5.EMISSION TESTS BY CONDUCTION

6.5.1.EQ/MC 01: MEASUREMENT OF SWITCHING NOISES

6.5.1.1.REFERENCE DOCUMENT

This test procedure complies with standard ISO 7637-2 with modification of the resistance value RS. A LSIN is added after the battery. Voltage and electric current gradient measurements are added.

6.5.1.2.OBJECTIVE OF THE TEST

This test is intended to estimate the switching noises of the equipments.

Its main characteristics are the following:

- Wires concerned: power supply wires.
- Procedure: the tests simulate the activation/deactivation of the starting contactor and the start-up/cut of the DUT.

6.5.1.3.CONDITIONS FOR APPLICATION OF THE TEST

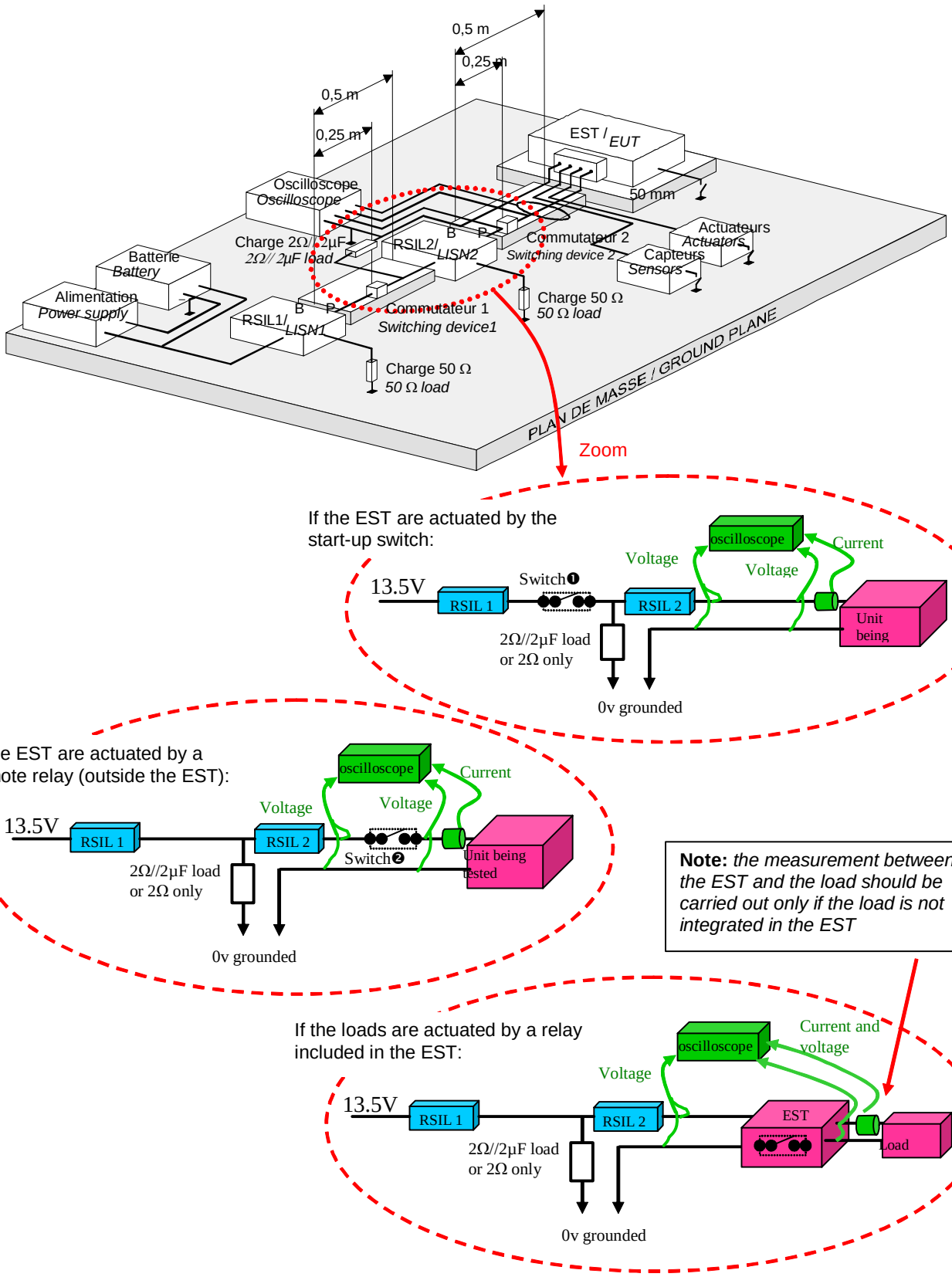
This test applies only to equipments switching inductive loads (window regulator...), as well as to the motors themselves if they can work in switch mode.

6.5.1.4.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.
- Digital oscilloscope with a real time bandwidth higher than or equal to 500 MHz and a sampling frequency higher than or equal to 1 GHz.
- High impedance voltage probes with a bandwidth higher than or equal to 500 MHz.
- Electric current probes with a bandwidth higher than or equal to 500 MHz.
- LSIN (1) compliant with the publication CISPR 25 loaded on 50 Ω.
- LSIN (2) compliant with the standard ISO/DIS 7637-2.3 loaded on 50 Ω.
- Switching unit 1 of the same technological family as the start-up switch fitted on the vehicle. If there is no device of this type, a relay having the characteristics defined in § 5.3 of the standard ISO/DIS 7637-2.3 can be used.
- Switching unit 2 of the same technological family as the one associated with the equipment on the vehicle. If there is no device of this type, a relay having the characteristics defined in § 5.3 of the standard ISO/DIS 7637-2.3 can be used.

Note : *Switching unit 2 is not mandatory if it is already integrated in the DUT. Switching unit 2 is then controlled by the DUT itself. Switching units 1 and 2 should be controlled independently.*

6.5.1.5.ASSEMBLY



6.5.1.6.PROCEDURE

A series of measurements should be carried out, according to the DUT power supply conditions, either by actuating switch 1 (which simulates the activation/deactivation of the start-up contactor), or by actuating switch 2, (which simulates the DUT activation/deactivation through a remote relay which can, if needed, be included in the DUT). If the two power supply types are possible, the two series of tests should be carried out.

The load placed before LSIN 2 represents the DUT power supply line on vehicle. The load that simulates the +BAT power supply is only a 2 Ω resistor. The load that simulates the + APC power supply is a 2 Ω resistor parallel with a 2 µF capacitor. The test should therefore be made: either with 2 Ω on the + BAT power supply lines, or with 2 Ω + 2 µF on the + PAC power supply lines.

Preparation:

A wiring 1,000 mm long (2 times 500 mm) should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick. The LSIN location should compulsorily comply with the distances indicated in the assembly diagram.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

Place the switch units 1 and/or 2 according to the assembly diagram.

Test:

To determine the maximum amplitude of the pulses created, 100 switches are required, with a time interval that separates two successive switches that is higher than the DUT stabilizing time.

Measurements at the terminals P and B of LSIN 2 (before the switch relay):

Measure the maximum amplitude of the voltage measured at the terminals P and B of LSIN 2 during the various DUT operation phases (start-up, operation, cut-off) by activating the switching unit(s).

Measurements at the load terminals (after the switch relay):

Measure the maximum amplitude of the voltage and electric current measured at the terminals of the DUT (or of its load) during the various DUT operation phases (start-up, operation, cut-off) by activating the switching unit(s). If these amplitudes are higher than the requirement thresholds, ± 100 V and ± 50 A, then determine the maximum voltage and electric current gradients.

Note : *the maximum gradient or voltage can correspond to one of the over voltage bounces, and not to its first pulse rise.*

Test report:

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

- Assembly used: wiring, DUT environment.
- The parameters of the measured signals (duration, rise and fall time, voltage values) by specifying to which DUT operation mode they correspond (cut-off, start-up).
- Oscilloscope measurements of some representative waveforms.

6.5.1.7.REQUIREMENTS

Test	Maximum amplitude
Measurement at P and B of LSIN 2	± 40 V
Measurement at the terminals of the DUT (or of its load): before switching relay (1).	± 100 V et ± 50 A at the equipment terminals. In the case of goings beyond, the DUT can however be in conformity if it respects the following limits: ± 200 V/µs ± 30 A/µs

(1): in the case of loads actuated by a relay included in the DUT, this measurement is not practically doable, and is not applicable.

6.5.2.EQ/MC 02: MEASUREMENT OF LOW FREQUENCY CONDUCTED NOISES

6.5.2.1.REFERENCE DOCUMENT

There is no reference document that refers to this test.

6.5.2.2.OBJECTIVE OF THE TEST

This test is meant to evaluate the low frequencies emissions by conduction generated by the DUT and its power supply wiring.

Wires concerned: various types of measurements should be carried out successively:

- Measurement of all the wires connected to the DUT taken in common mode.
- Measurements on each + power supply wire and each ground wire taken separately.

6.5.2.3.CONDITIONS FOR APPLICATION OF THE TEST

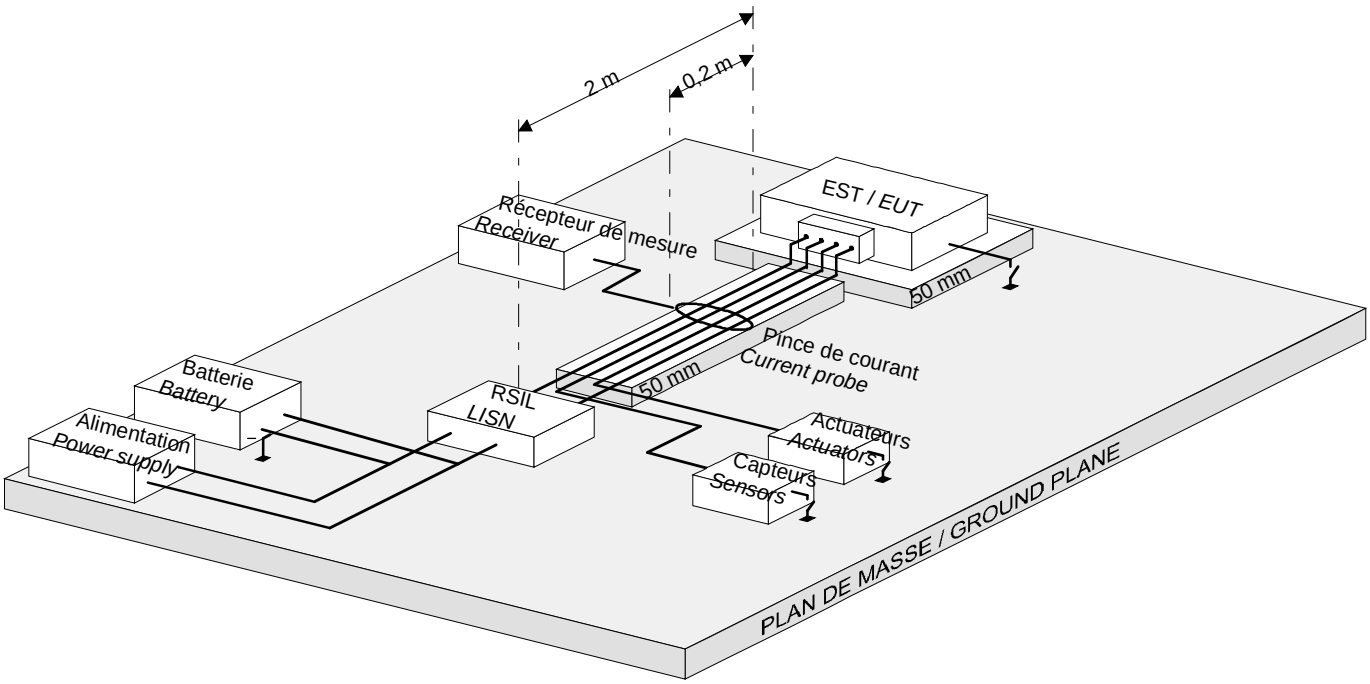
This test is applicable to equipments likely to interfere with elements sensitive to the magnetic field or to audio systems. Equipments consuming high currents and/or controlling outputs via PWM are especially concerned.

The test is not applicable if no electric current >1Aeff is consumed or output by the equipment.

6.5.2.4.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.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a DUT with offset weight).
- 50 Ω load(s).
- Metric ampere clamp.
- Spectrum analyzer or receiver.

6.5.2.5.ASSEMBLY



6.5.2.6.PROCEDURE

Preparation:

The real DUT environment and the real harness should be preferably used (possibly, a 2,000 mm long harness can be used). The test wiring is placed on a 50 mm thick insulating support.

The DUT is placed on a 50 mm thick insulating support. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

The LSIN is placed 2,000 mm away from the DUT.

The metric ampere clamp is placed 200 mm away from the DUT.

Calibration:

In order to avoid measurement errors, especially due to the saturation of the metric ampere clamp or to an improper decoupling in relation to the sector, performing a calibration is advised.

The suggested procedure is as follows:

- Circulate in a known load a sinusoidal current with the level equal to the limit specified.
- Measure this current by using a metric ampere clamp / measurement device set.
- Compare the results to the voltage measured by an oscilloscope at the terminals of the load.

Parameters of the measurement device:

Its main characteristics are the following:

- Peak detection.
- [20 Hz – 20 kHz] frequency band.
- - 6 dB bandwidth:
    - F < 1 kHz: 10 Hz.
    - F > 1 kHz: 100 Hz.
- Using video filtering to limit the analysis bandwidth is not accepted.
- Minimum sweep time for a sweep receiver or spectral analyzer:

- F < 1 kHz: 150 ms/Hz.
- F > 1 kHz: 15 ms/Hz.

- Step size for digital receiver (recommended value in the absence of maximum amplitude search):
  - F < 1 kHz: 150 ms
  - F ≥ 1 kHz: 15 ms
- Frequency steps (digital receiver) equal to half of the bandwidth of the analysis filter.

Test:

- Run the DUT for a minimal duration of 10 minutes.
- Place the metric ampere clamp around the wiring harness, including the power supply wires.
- Connect the measurement device to the clamp via a coaxial cable.
- Carry out the frequency sweep and measure the current in the harness.
- Repeat the operation for all harnesses connected to the DUT.
- Repeat the operation on each power supply and ground wire.

Test report:

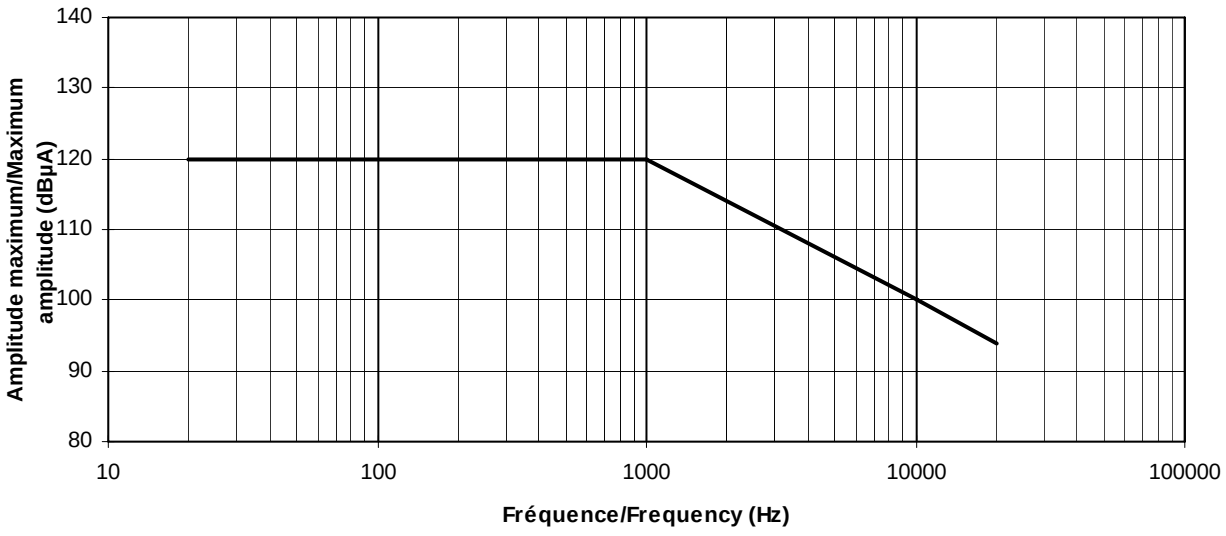
The test report should, among other things, have the following elements:

- Assembly used: wiring, DUT environment.
- Curves by 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 (wideband noise) on a frequency band, only the maximum overrun is required.

6.5.2.7.REQUIREMENTS

Frequency	Maximum amplitude (effective dBµA)
20 Hz - 1 kHz	120
1 kHz - 20 kHz	120 - 20 x log(F) (F in kHz)



6.5.3.EQ/MC 03: MEASUREMENT OF RADIOFREQUENCY CONDUCTED NOISES ON THE SUPPLY INPUTS

6.5.3.1.REFERENCE DOCUMENT

This test procedure is based on the publication CISPR 25, except for things concerning the extension in low frequency at 100 kHz.

6.5.3.2.OBJECTIVE OF THE TEST

This test is intended to evaluate radio frequency disturbances, conducted by the DUT and its power supply wiring.

The wires concerned by the test are the following:

- All DUT + power supply wires taken as a whole in the case of a local grounding.
- On all + power supply wires taken as a whole in the case of a DUT remote grounding.

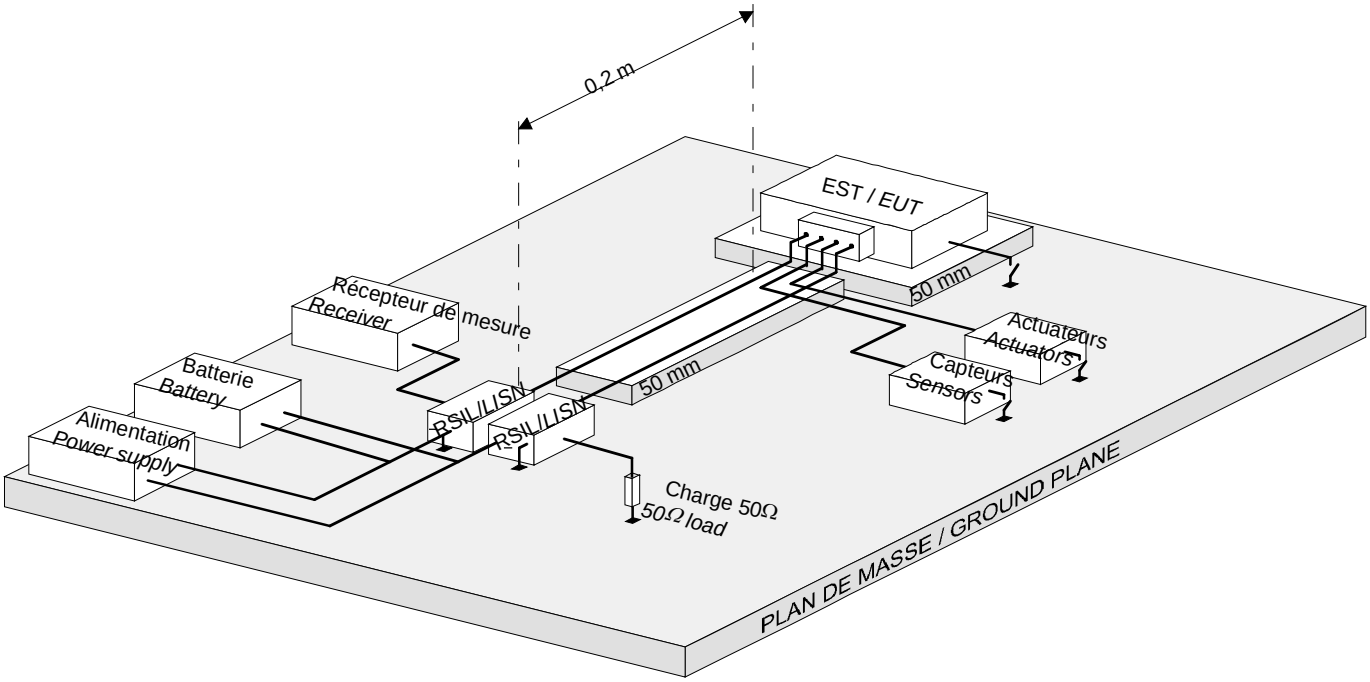
6.5.3.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applied to all equipments, except those having neither a frequency oscillator > 9kHz nor an motor.

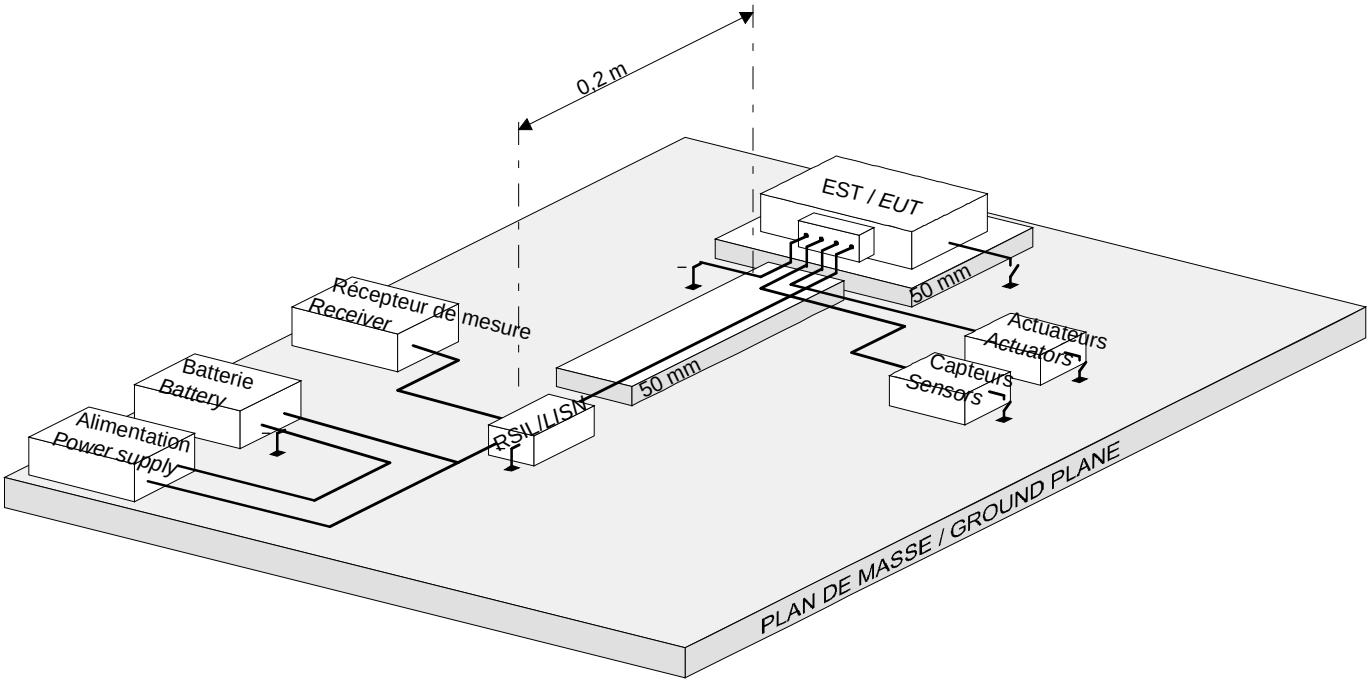
6.5.3.4.TEST MEANS

- 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.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a DUT with offset weight).
- 50 Ω load.
- Spectrum analyzer or receiver and, if needed, pre-selector.
- Shielded chamber.

6.5.3.5.ASSEMBLY



DUT connected to the remote ground



DUT connected locally to the ground

6.5.3.6.PROCEDURE

Preparation:

A wiring 2,000 mm long should be preferably used (the real wiring may be used). The test wiring is placed on an insulating support, 50 mm thick. The length of the power supply wires should 200 $^{+200}_{0}$ mm. 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, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

If using the two LSIN, the measurement device is connected successively to the two LSIN. The non-connected LSIN is loaded by 50 Ω.

Calibration:

This test requires no specific calibration.

Parameters of the measurement 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 levels evaluation in relation to the “quasi-peak” limit.

Note : to decrease the sweep time, the measurements can be carried out with only a peak detector. If the measured value is lower than the “average value” limit, then the result is accepted.

The values for the bandwidth and the sweep times 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 -6 dB	Scan time	RBW at -3 dB	Scan time
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
Autres services ou bandes	30 - 2500	100/120 kHz	100 ms / MHz	does not apply	does not apply	100/120 kHz	100 ms / MHz

- For the 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
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
Autres services ou bandes	30 - 2500	120 kHz	50 kHz	5 ms	Does not apply	Does not apply	Does not apply	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 : *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 DUT for a minimal duration of 10 minutes. Carry out the measurements, with peak (quasi-peak) detector and with average detector, at the LSIN terminals.

Test report:

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

- Assembly used: wiring, DUT environment.
- The functional mode used, for DUT operation likely to impact on the test result (consumption, PWM duty factor…)
- Curves by measurement with: F, V_{avg}, V_{peak}, $V_{quasi-peak}$ (if required), 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} or $V_{quasi-peak,}$ deviation/peak limit and deviation/average value limit or possibly deviation/quasi-peak limit (voltages in dBuV, deviations in dB). In the case of continuous overruns (wideband noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with three digits after the comma), V_{avg}, V_{peak} or $V_{quasi-peak}$, average value limits, peak and possible quasi-peak (voltages in dBuV), measured wire(s) will be provided as data in an Excel table in this order.

6.5.3.7.REQUIREMENTS

The values measured at the LSIN terminals, in peak detection and average value detection (except if stated otherwise) should not exceed the following values (the two peak and average value requirements should be fulfilled):

The limits are accessible as an Excel file (Emission limits of B21 7110-C.xls) internally within PSA through the following link: Annexes-en_B217110.zip

		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)							
LW	0.15 - 0.30	4	80 67 (quasi peak) (3)	3	86 73 (quasi peak) (3)	4	60
MW	0.53 - 1.8	3	70 57 (quasi peak) (3)	2	76 63 (quasi peak) (3)	3	50
SW	5.9 - 6.2	3	65	2	71	3	45
FM **(2)**	76 - 108	4	44 31 (quasi peak) (3)	3	50 37 (quasi peak) (3)	4	24
Services and frequencies (MHz)							
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
Other frequencies (MHz)							
0.1 - 0.15		_	103	_	109	_	70

(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 the receiving or serigraphy antenna AM and/or FM (rear window, quarter panel, top of the windscreen…), these levels should have their severity increased by 10 dB in the considered frequency bands. This case should be specified in the NTS/TS or in the EMC test plan.*

(3) *The levels given by the quasi-peak detector are applicable on specific request (example: PWM signals…).*

(4) measurements lower than 30MHz should be carried out on the entire 0.1 - 30MHz band, even if no limit applies to some sub-bands.

6.5.4.EQ/MC 04: MEASUREMENT OF RADIOFREQUENCY CONDUCTED NOISES ON THE OUTPUTS

6.5.4.1.REFERENCE DOCUMENT

This test procedure is based on the publication CISPR 25, except for the positions of the measurement clamp.

6.5.4.2.OBJECTIVE OF THE TEST

This test is intended to evaluate radio frequency disturbances, conducted by the DUT and its power output wiring and/or shielded cables.

The wires concerned by the test are the following:

- Shielded cables (antenna coaxials, LVDS cable…): measurements are carried out on each shielded cable successively.
- Power outputs: a power output is any output (PWM or continuous current) likely to deliver more than 1A peak. In this case, measurements will be carried out on all the grouped power outputs (differential and/or common mode outputs), by excluding the other wires (signals, ground returns other than those of the differential power outputs). If this measurement shows that the requirement is exceeded, additional measurements should also be carried out:
    - o on each differential power output (2 forth and back associated wires) successively
    - o on all common mode power outputs (excluding all other wires).

  Note: in order to avoid the burst of the test bench harnesses, leaving some output wires (TOR signals, sensors…) in the measurement clamp is allowed, if the ground return wires (other than those of the differential power outputs) and the power supply inputs remain outside the clamp. In this case, the test plan should accurately describe the tested configuration.

6.5.4.3.Conditions for application of the test

This test applies only to:

- equipments having power supply or power outputs likely to deliver more than 1A peak (examples: relayed BSI or BSM outputs, “smartpower” BSI or BSM outputs, PWM control output of a CMM to a turbo…)

or

- equipments having shielded cables (antenna coaxials, LVDS cable…)

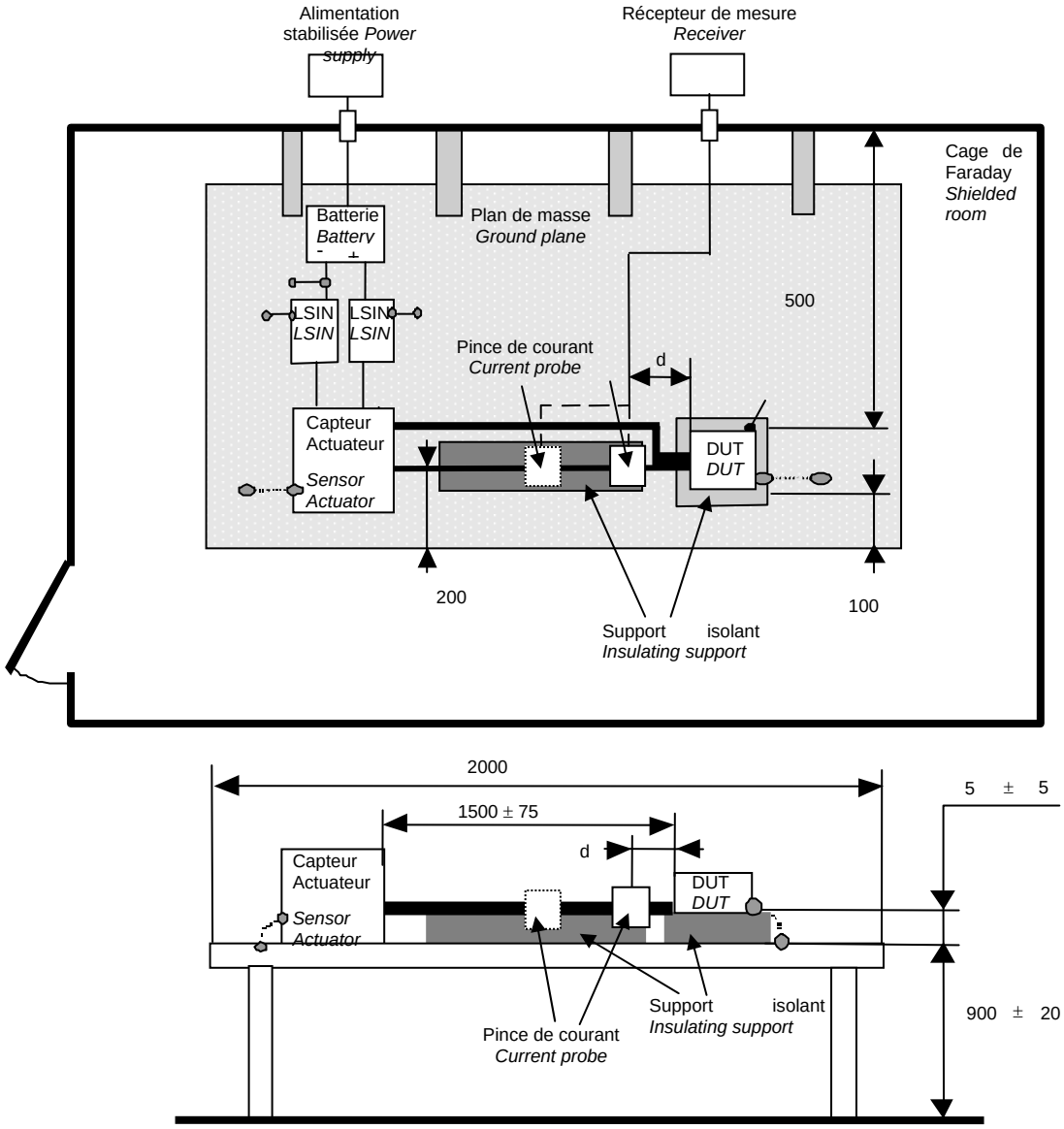
This test is not applied to analog outputs and to sensors power supplies.

6.5.4.4.TEST MEANS

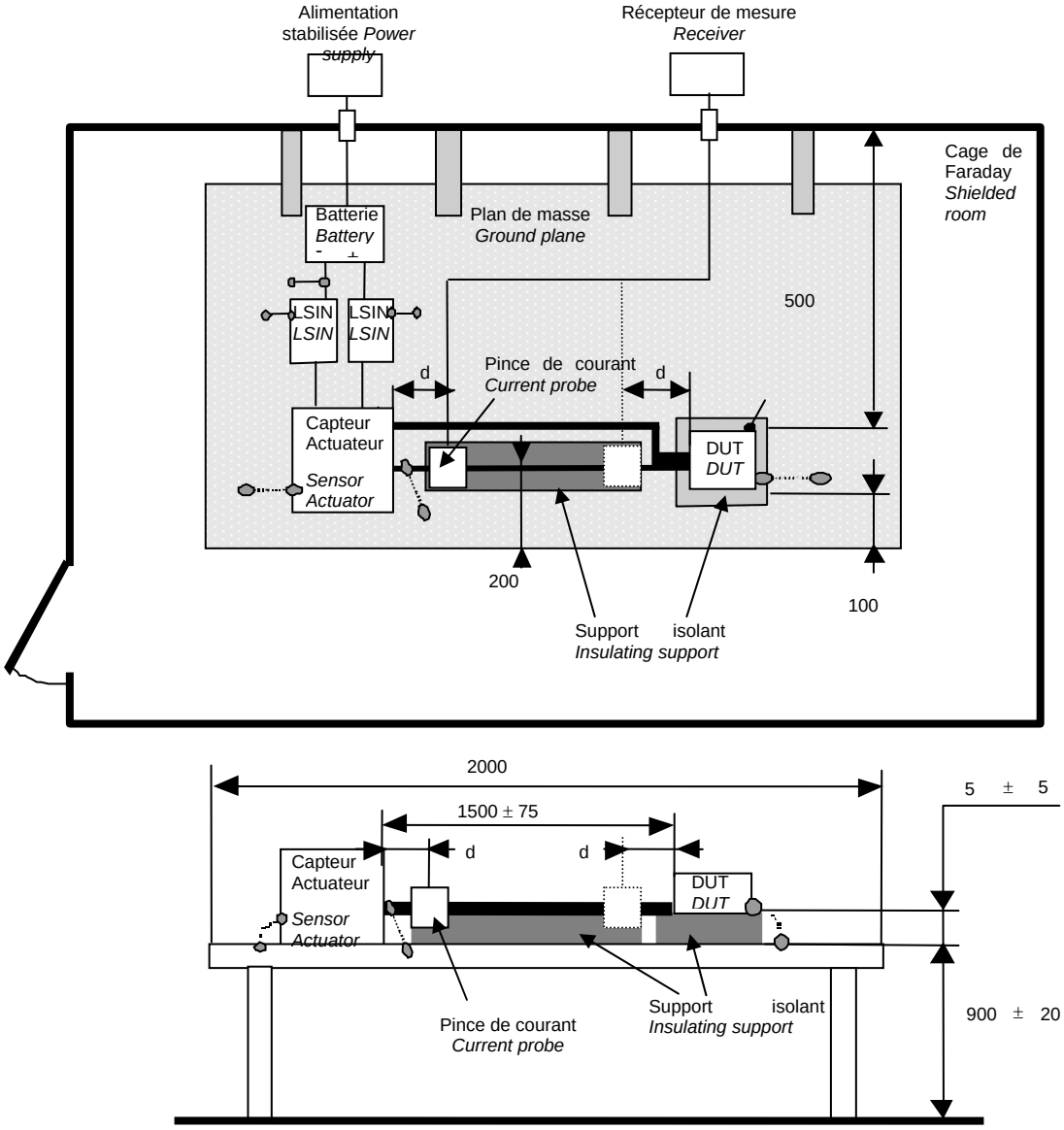
- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Insulating support with a thickness of 50 mm.
- LSIN compliant with publication CISPR 25.
- Connection terminal
- 50 Ω load.
- Spectrum analyzer or receiver and, if needed, pre-selector.
- Shielded chamber.

6.5.4.5.ASSEMBLY

Case of measurements of power outputs:



Case of measurements of shielded cables:



6.5.4.6.PROCEDURE

Preparation:

A harness with a maximum length of 2,000 mm, of which 1,500 ± 75 mm is parallel to the edge of the table, should be used (if needed, the real harness can be used). In the case of a shielded cable, the length of the test object cable will be 1500 ± 75 mm.

The arm of the subject harness of the measurement will be placed on an insulation support 50 mm thick. The other arms are spaced at least 10 cm away from the measuring one, and placed on the ground plane.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

The connection terminal will be placed successively in various positions along the harness or the concerned arm, as indicated hereafter.

Calibration:

This test requires no specific calibration.

Parameters of the measurement device:

The values for the bandwidth and the sweep times 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 -6 dB	Scan time	RBW at -3 dB	Scan time
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
Autres services ou bandes	30 - 2500	100/120 kHz	100 ms / MHz	does not apply	does not apply	100/120 kHz	100 ms / MHz

- For the 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
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
Autres services ou bandes	30 - 2500	120 kHz	50 kHz	5 ms	Does not apply	Does not apply	Does not apply	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 noise level of the measuring circuit should be lower than 6dB within the limits specified. To meet this criterion, an amplifier might be inserted, if necessary.

Test:

- Run the DUT for a minimal duration of 10 minutes.
- Carry out the measurements, with peak (quasi-peak) detector and with average detector, at the LSIN terminals.
- Carry out the current measurement for the following various clamp positions:
  - Case of measurements of power outputs: 50 mm away from the DUT for all frequency bands, as well as 750mm away from the DUT (in addition to the 50 mm) for the FM band.
  - Case of measurements of shielded cables: 50 mm away from the edge of the shielded cable (opposite the DUT) for all frequency bands, and also 50 mm away from the DUT for the FM band, the ground of the shielded cable being connected at its end in short circuit to the test ground plane.

Test report:

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

- Assembly used: harness, DUT environment, measuring clamp positions.
- Description of the tested outputs and their load conditions.
- The functional mode used, likely to impact on the test result (consumption, PWM duty factor…).
- Curves by measurement with: F, V_{avg}, V_{peak}, $V_{quasi-peak}$ (if required), peak limits, average value and possibly quasi-peak (currents in dBuA)

Table of overruns with: F (in MHz with 3 digits after the comma), I_{avg}, I_{peak} or $I_{quasi-peak}$ (if required), deviation/peak limit and deviation/average value limit or possibly deviation/quasi-peak limit (voltages in dBuA, deviations in dB). In the case of continuous overruns (wideband noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with three digits after the comma), I_{avg}, I_{peak} or $I_{quasi-peak}$, average value limits, peak and possible quasi-peak (currents in dBuA), measured wire(s) will be provided as data in an Excel table in this order.

6.5.4.7.REQUIREMENTS

The measured current values, in peak detection and average detection should not exceed the following values (the two peak and average value requirements should be fulfilled):

		Peak limit "permanent" noïses		Peak limit "short duration" noïses**(1)**		Average limit	
		class	Limit in dBµA	class	Limit in dBµA	class	Limit in dBµA
Services and frequencies (MHz)							
LW	0.15 - 0.30	4	60 47 (quasi peak) (2)	3	66 53 (quasi peak) (2)	4	40
MW	0.53 - 1.8	3	42 29 (quasi peak) (2)	2	48 35 (quasi peak) (2)	3	22
SW	5.9 - 6.2	3	31	2	37	3	11
FM	76 - 108	4	10 -3 (quasi peak) (2)	3	16 3 (quasi peak) (2)	4	-10

(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 …).*

6.6.EMISSION TESTS BY RADIATION

6.6.1.EQ/MR 02: MEASUREMENT OF LOW FREQUENCY MAGNETIC FIELDS

6.6.1.1.REFERENCE DOCUMENT

European recommendation 1999/519/CE and decree no. 2002-775 from 3 May 2002.

6.6.1.2.OBJECTIVE OF THE TEST

The purpose of this test is to evaluate the magnetic fields radiated by the electric/electronic units of the vehicle in order to limit the exposure of persons.

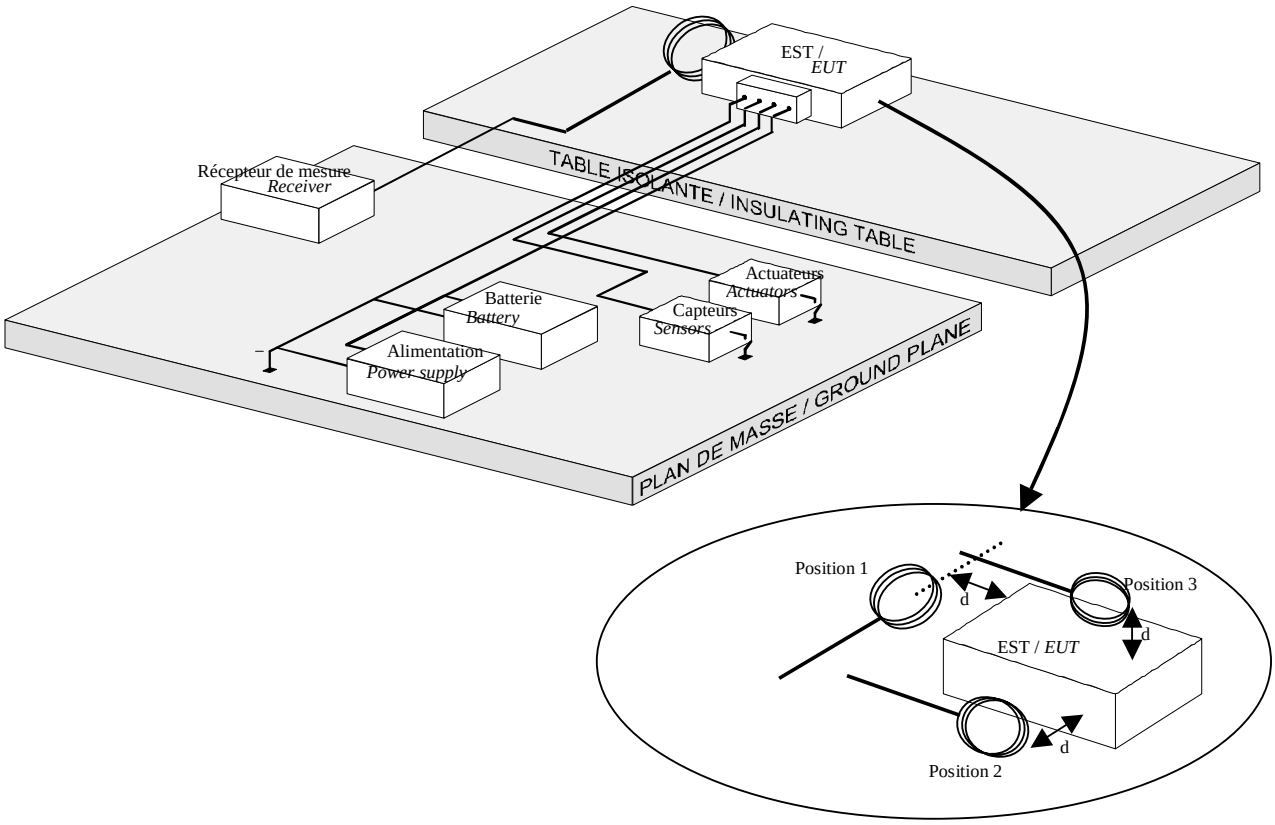
6.6.1.3.CONDITIONS FOR APPLICATION OF THE TEST

This test applies only to motors and equipments consuming a current >1Aeff.

6.6.1.4.TEST MEANS

- Test area without a high magnetic field source.
- Power supply and battery.
- Devices necessary for checking the proper operation of the DUT.
- DUT environment, real (sensors, actuators) or simulated.
- Spectrum analyzer or receiver.
- A loop having the characteristics in MIL STD 461E is recommended:
    - Diameter: 13.3 cm
    - Number of turns: 36
- An isotropic wideband magnetic field sensor is authorized, as an alternative solution. Needed measures will have to be taken to identify the source frequencies, and to ensure they do not exceed the requirements.

6.6.1.5.ASSEMBLY



6.6.1.6.PROCEDURE

Preparation:

Measurements should be carried out in the most interfering DUT configuration (see § 4.9).

The following two types of equipments are recognized:

- Equipments located in the passenger compartment area.
- Equipments situated in the engine compartment.

Test:

The measurement area to consider is an envelope including the DUT surface defined by a distance d in relation to it. The distance d between the sensor and the DUT should be defined in the NTS/TS or in the test plan. It is by default 7 cm for equipments located in the passenger compartment area and 30 cm for equipments in the engine compartment.

Run the DUT and leave it working for 10 minutes.

Perform the measurements with DUT running in the operating mode(s) defined in the test plan.

Carry out the measurement of the magnetic fields at DUT level by sweeping the first selected measurement area through searching for the maximum level and by complying with the response time characteristics of the measuring device.

Calibration:

This test requires no specific calibration.

Parameters of the measurement device:

Its main characteristics are the following:

- Effective value.
- Frequency band: [5Hz – 150kHz].
- - 6 dB bandwidth:
    - F < 1 kHz: 10 Hz.
    - F > 1 kHz: 100 Hz.
- Using video filtering to limit the analysis bandwidth is not accepted.
- Minimum sweep time for a sweep receiver or spectral analyzer:
    - F < 1 kHz: 150 ms/Hz.
    - F > 1 kHz: 15 ms/Hz.
- Step size for digital receiver (recommended value in the absence of maximum amplitude search):
    - F < 1 kHz: 150 ms.
    - F > 1 kHz: 15 ms.
- Frequency steps (digital receiver) equal to half of the bandwidth of the analysis filter.

Test report:

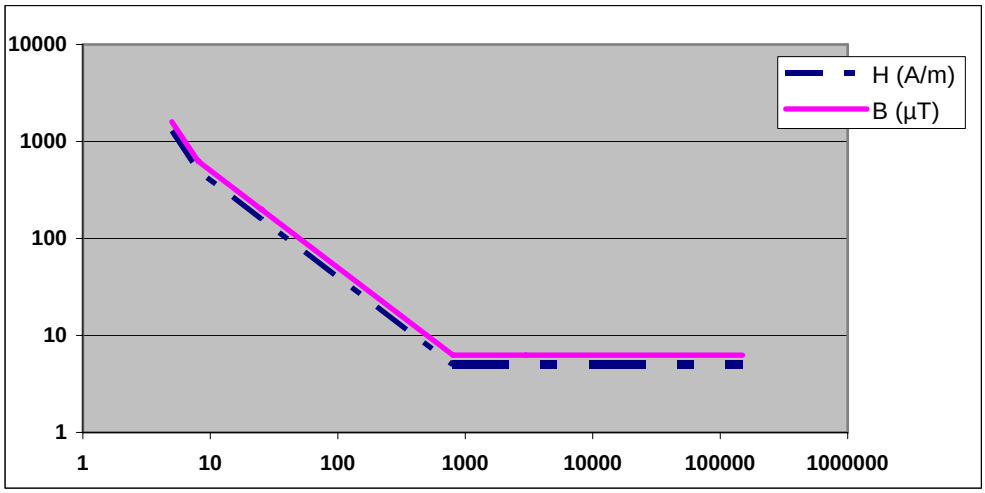
The test report should, among other things, have the following elements:

- Curves 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.

6.6.1.7.REQUIREMENTS

The following levels should not be exceeded:

Frequency (Hz)	Magnetic field limit (H) in A/m	Magnetic induction limit (B) in µT
5 – 8 Hz	$3.2 \times 10^4 / F^2$	$4 \times 10^4 / F^2$
8 – 800 Hz	4000/F	5000/F
800 – 150000 Hz	5	6.25



6.6.2.EQ/MR 01: MEASUREMENT OF RADIOFREQUENCY RADIATED NOISES

6.6.2.1.REFERENCE DOCUMENT

This test procedure is based on the publication CISPR 25, except for the following:

- The acknowledgement of the out of band interferences CISPR 25.
- The extension in low frequency at 100 kHz.
- The position of the antenna (facing the equipment) for measurements above 800 MHz (instead of 1,000MHz in the CISPR 25).
- Using a peak detector besides the average value detector for the GPS band.

6.6.2.2.OBJECTIVE OF THE TEST

This test is intended to evaluate radio frequency disturbances, radiated by the DUT and its power supply wiring.

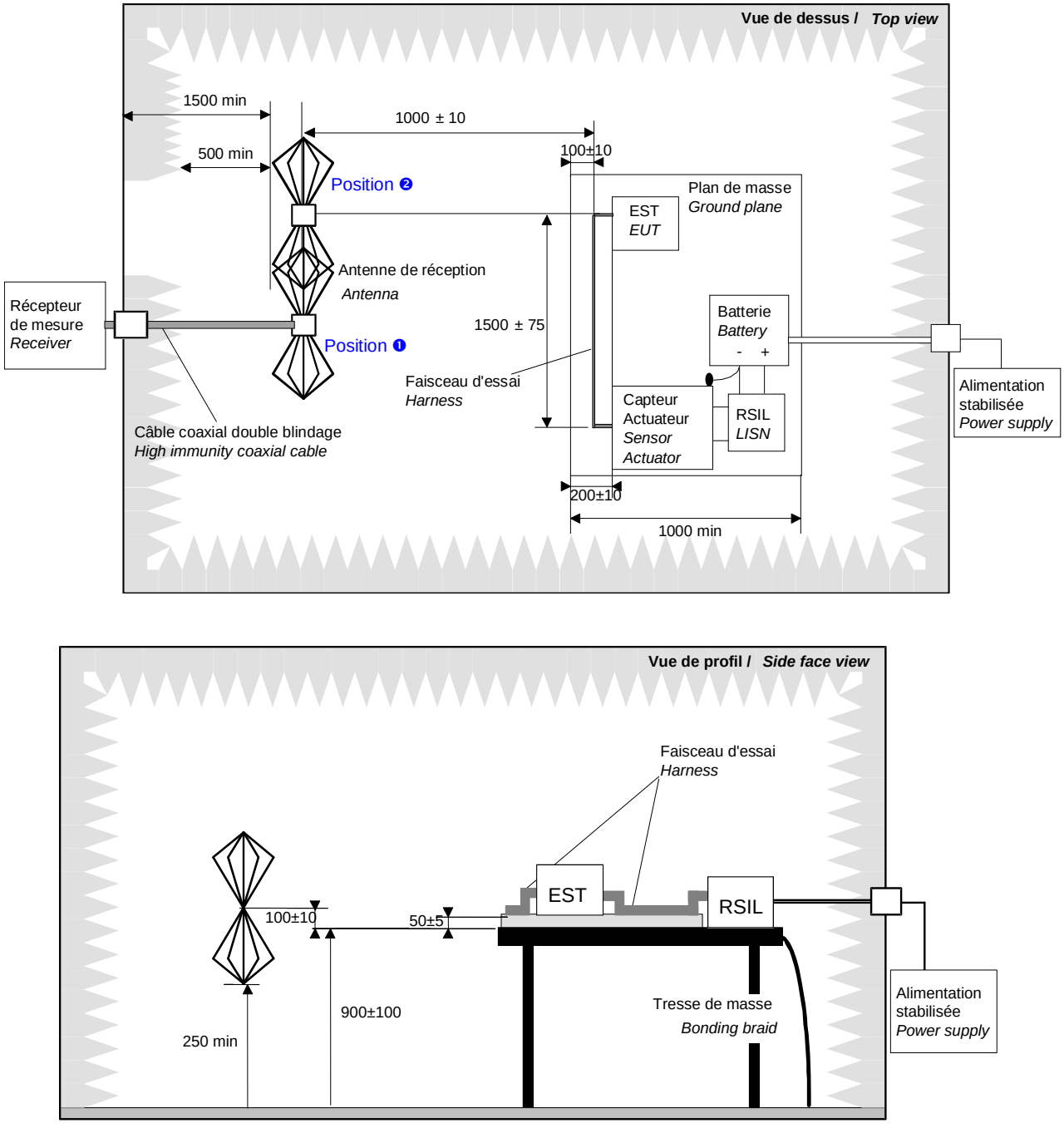
6.6.2.3.CONDITIONS FOR APPLICATION OF THE TEST

This test is applied to all equipments, except those having neither a frequency oscillator > 9kHz nor motor.

6.6.2.4.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.
- LSIN compliant with the publication CISPR 25 (2 LSIN for a DUT with offset weight).
- 50 Ω load(s).
- Spectrum receiver or analyzer compliant with the standard CISPR 16-1.
- Measurement antennas: vertical monopoly 1 m, biconical, log-periodical or horn.
- Semi-anechoic or anechoic room

6.6.2.5.ASSEMBLY



6.6.2.6.PROCEDURE

Preparation:

A harness with a maximum length of 2,000 mm, of which 1500 ± 75 mm is parallel to the edge of the table, should be used (if needed, the real harness can be used). The test wiring is placed on an insulating support, 50 mm thick.

The DUT is placed on an insulating support, 50 mm thick. It is linked to the ground plane according to its real vehicle installation and no other earth connection is authorized.

The LSIN is placed no more than 2,000 mm away from the DUT.

Calibration:

This test requires no specific calibration.

Parameters of the measurement device:

The following detectors are used:

- peak detector for the evaluation of the levels in relation to the “peak” limit,
- average detector for the evaluation of the levels in relation to the “average” 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 levels evaluation in relation to the “quasi-peak” limit.

Note : to decrease the sweep time, the measurements can be carried out with only a peak detector. If the measured value is lower than the “average value” limit, then the result is accepted.

The values for the bandwidth and the sweep times 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 -6 dB	Scan time	RBW at -3 dB	Scan time
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	does not apply	does not apply	9/10 kHz	1 s / MHz
Autres services ou bandes	30 - 2500	100/120 kHz	100 ms / MHz	does not apply	does not apply	100/120 kHz	100 ms / MHz

- For the 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
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	Does not apply	Does not apply	Does not apply	9 kHz	5 kHz	5 ms
Autres services ou bandes	30 - 2500	120 kHz	50 kHz	5 ms	Does not apply	Does not apply	Does not apply	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 : 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.

Note : The noise level of the measuring circuit should be lower than 6 dB within the limits specified. To meet this criterion, it might be necessary to insert a preamplifier with a gain of about 30dB nearest to the antenna. If these precautions are not enough, reducing the bandwidth in the considered band is allowed to decrease the measurement noise, in which case the requirements applicable should be identified in agreement with the manufacturer.

Test:

Run the DUT for a minimal duration of 10 minutes.

Carry out the measurements of the horizontal and vertical polarizations, with peak (quasi-peak) detector and with average detector.

The measurements should be carried out for the two antenna positions: face to the middle of the harness (position❶) from 150 kHz to 800 MHz, face to the DUT (position ❷) from 800 MHz to 2,5 GHz.

Test report:

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

- Assembly used: wiring, DUT environment.
- The functional mode used, likely to impact on the test result (consumption, PWM duty factor…)
- Curves by measurement with: F, E_{avg}, E_{peak}, $E_{quasi-peak}$ (if required), peak limits, average value and possibly quasi-peak (field in dBuV/m)
- Table of overruns with: F (in MHz with 3 digits after the comma), E_{avg}, E_{peak} or $E_{quasi-peak}$ (if required), deviation/peak limit and deviation/average value limit or possibly deviation/quasi-peak limit (currents in dBuV/m, deviations in dB). In the case of continuous overruns (wideband noise) on a frequency band, only the maximum overrun is required.

In addition to the test report, all the F data (in MHz with three digits after the comma), E_{avg}, E_{peak} or $E_{quasi-peak}$, average value limits, peak and possible quasi-peak (field in dBuV/m), polarisation will be provided as data in an Excel table in this order.

6.6.2.7.REQUIREMENTS

The values measured in peak detection and average detection (except if stated otherwise) should not exceed the following values (the two peak and average value requirements should be fulfilled):

The limits are accessible as an Excel file (Emission limits of B21 7110-C.xls) internally within PSA through the following link: Annexes-en_B217110.zip

		Peak limit "permanent" noïses		Peak limit "short duration" noïses **(1)**		Average limit	
		class	Limit in dBµV/m	class	Limit in dBµV/m	class	Limit in dBµV/m
Services and frequencies (MHz) **(6)**							
LW	0,15 - 0,30	4	56 43 (quasi peak) (5)	3	62 49 (quasi peak) (5)	4	36
MW	0,53 - 1,8	3	56 43 (quasi peak) (5)	2	62 49 (quasi peak) (5)	3	36
SW	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	171 - 245	4	32	3	38	4	22
DTTV	470 - 770	3	57	2	63	3	47
DAB L band	1447 - 1494	4	34	3	40	4	24
Services and frequencies (MHz) **(6)**							
CB	26 - 28	3	52	2	58	3	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)**
analog UHF	820 - 960	3	56	2	62	3	36
GSM 800 et AMPS USA	860 - 895	4	50	3	56	4	30
EGSM/GSM 900 et PDC japon	925 - 960	4	50	3	56	4	30
PDC japon	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 et 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
Frequencies wich correspond to 2004-104 european regulation (MHz)							
30-75		75 - 25,13 log (F/30)				65 - 25,13 log (F/30)	
75-400		65 + 15.13 log (F/75)				55 + 15.13 log (F/75)	
400-1000		76				66	
Other frequencies (MHz)							
0,1 - 0,15		_	86	_	92	_	41

(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 the receiving or serigraphy antenna AM and/or FM (rear window, quarter panel, top of the windscreen…), these levels should have their severity increased by 10 dB in the considered frequency bands. This case should be specified in the NTS/TS or in the EMC test plan.*

(3) *For the RKE bands (300-330MHz and/or 420-450MHz), the average value limit of 18dBµV/m specified in the table concern the central frequency of the band. The applicable limit is given in table 1 and figures 1 and 2. This limit applies to equipments capable of being powered before start-up or after +APC cut-off. In the case of non-powered equipments when the +APC is cut off (and before the network standby), the 30dBµV/m limit is applied on the entire band.*

(4) *For the GPS L1 (1567-1583MHz) band, the peak and average value limits specified in the table refer to the central band frequency. The applicable limit is given in table 1 and figure 3.*

(5) *The levels given by the quasi-peak detector are applicable on specific request (example: PWM signals …).*

(6) *Some limits cannot be applied in some frequency bands, according to the geographical destination of the vehicle. The applicability of the services and limits corresponding in function to the regions is given in table 2.*

(7) *The measurement of the field from 1 GHz to 2.5 GHz is not mandatory for equipments that do not have a motor or an oscillator likely to generate harmonics of high frequency (measurement will be the main criterion: presence of levels having less than 20 dB of margin in relation to the limits specified from 470 MHz to 1 GHz).*

(8) Measurements lower than 30MHz should be carried out on the entire 0.1 - 30MHz band, even if no limit applies to some frequency bands.

(9) *In the case of intentional transmitters (examples: plip, GSM…), the requirements are not applied for the operating frequency of the transmitter and of its harmonics, subject to compliance with the regulation and/or the specific radio-communications standards applicable.*

Table 1: points for the specific limits in the RKE (plip) and GPS bands:

Services	Frequencies (MHz)	Permanent peak limit	Short duration peak limit	Average limit
Japan RKE	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
RKE (general case)	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

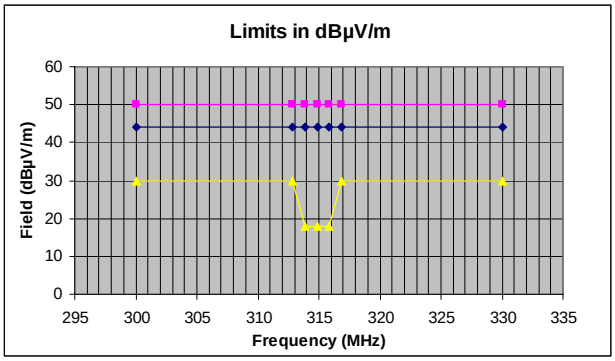


Figure 1: limits in RKE band (Japan)

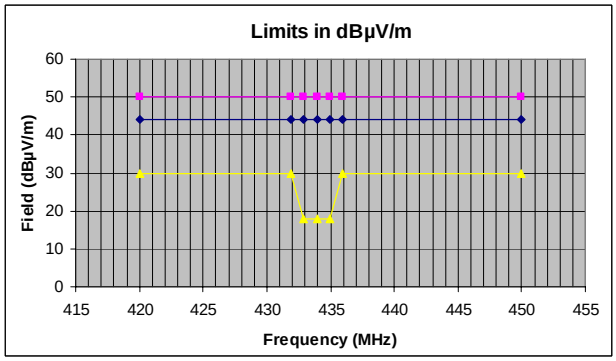


Figure 2: limits in RKE band (general case)

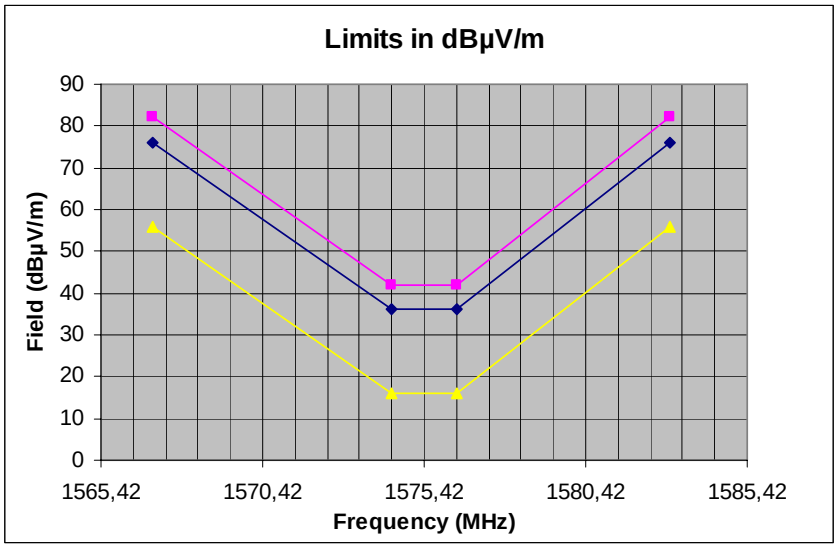


Figure 3: limits in GPS band

Table 2: applicability of the corresponding services and limits according to regions:

		Signification	General case	Addition for Mercosur + USA	Addition for Japan + Korea
Frequencies and radio services (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		
Frequencies and radio services (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		

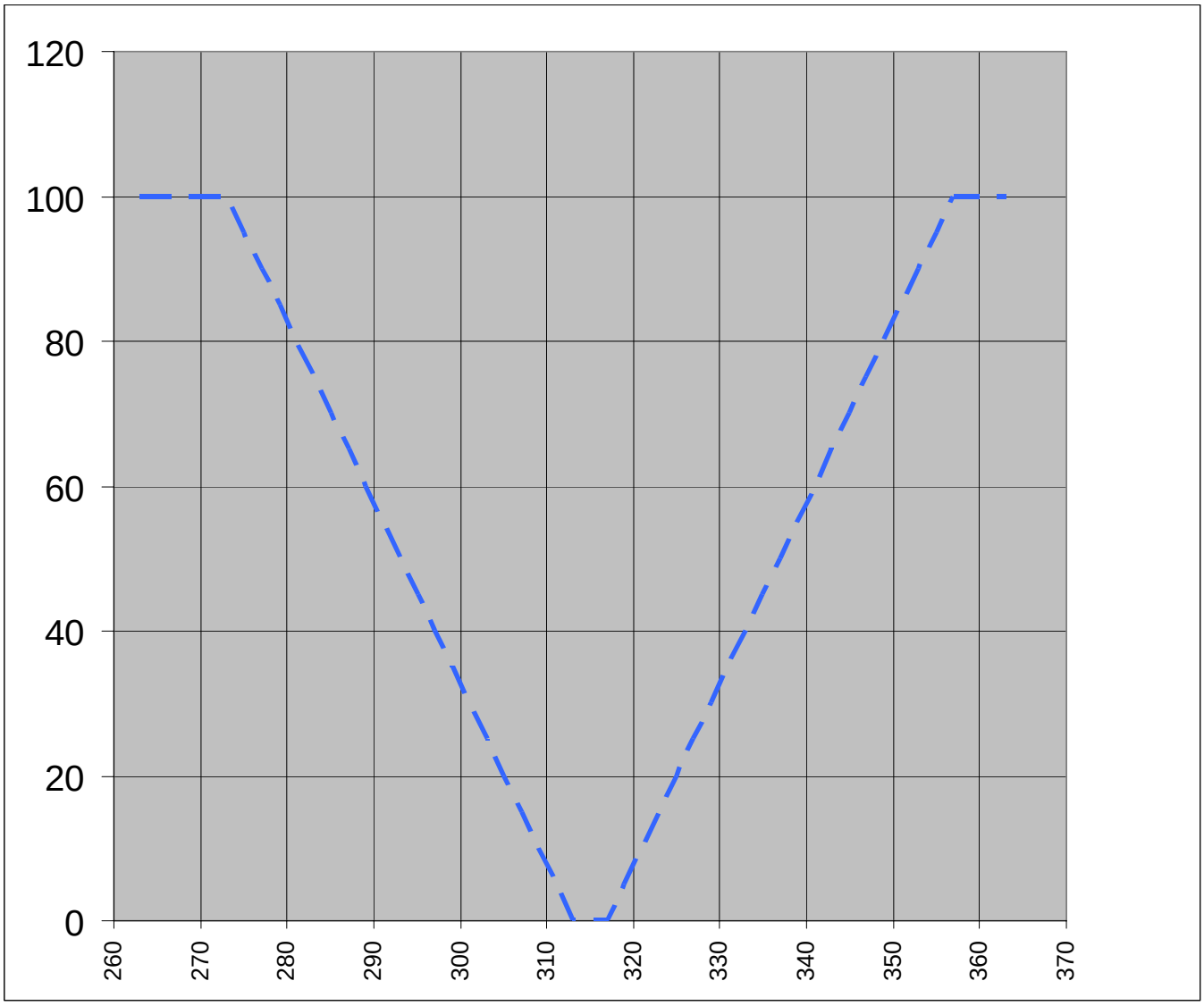
APPENDIX A (normative)

IMMUNITY REQUIREMENTS IN ELECTRIC FILED APPLICABLE TO RECEIVERS IN THE 315MHz AND 433MHz BANDS (PLIP AND DSG)

Some unexpected events of the radio function (for example: lack 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 NTS/TS specific to the equipment. Some customer impact 2 or 3 events are not allowed (example: inopportune opening).

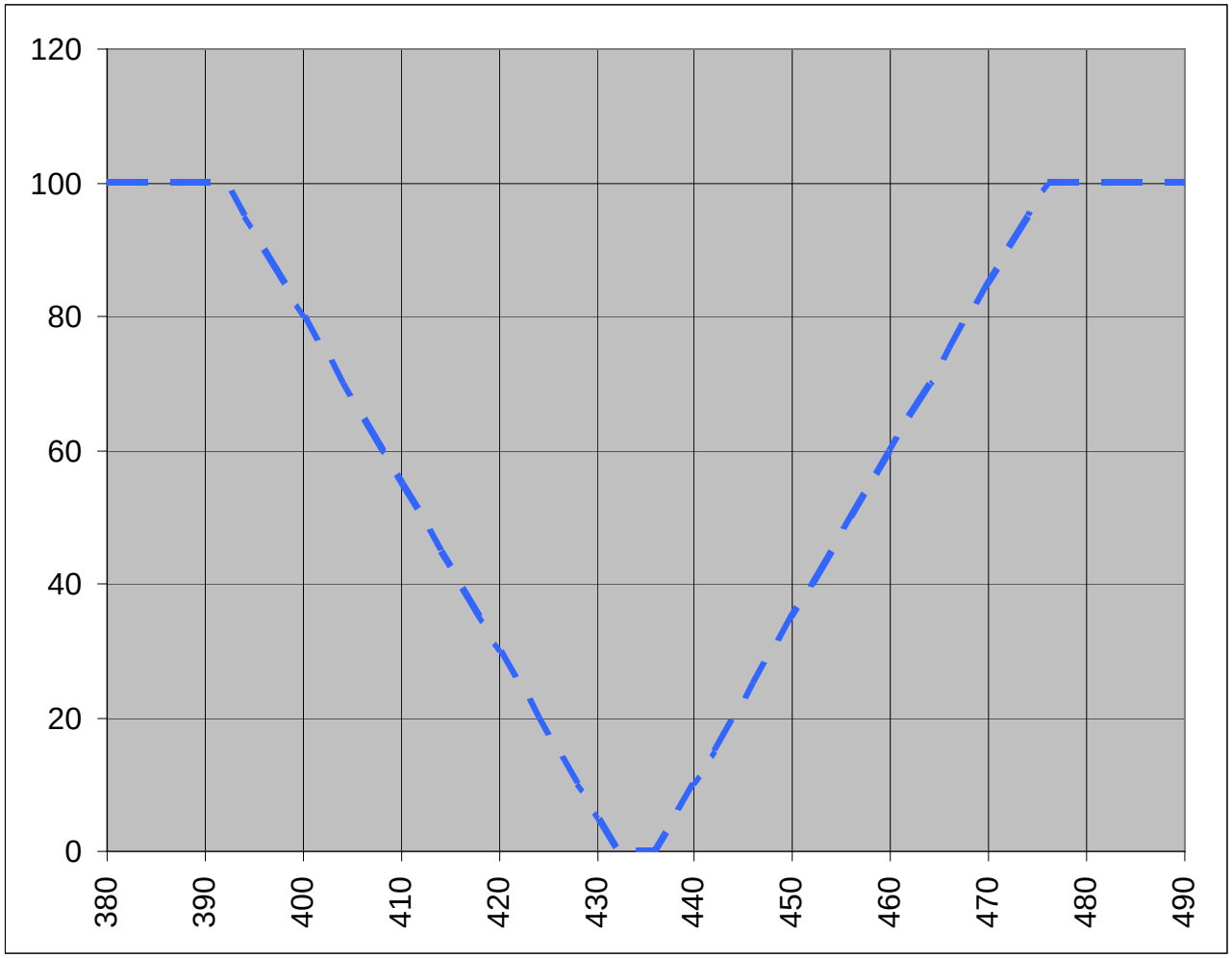
315 MHz band:
The immunity limit applicable to the unexpected events thus defined is the following:

- Zero V/m from 313 to 317 MHz
- Decrease or increase by 5V/m for 2MHz below and beyond, until 100 V/m.



433 MHz band:
The immunity limit applicable to the unexpected events thus defined is the following:

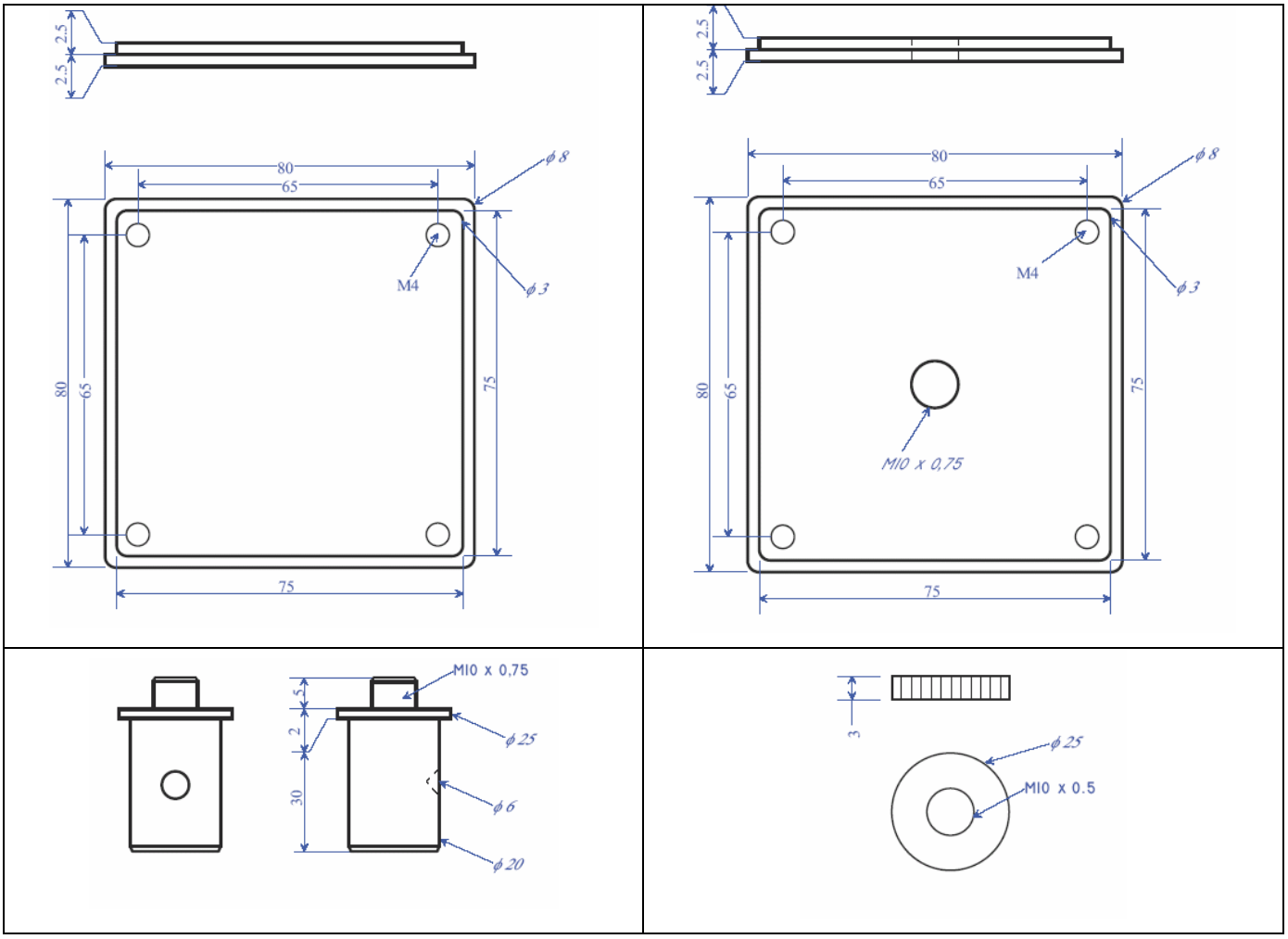
- Zero V/m from 432 to 436 MHz
- Decrease or increase by 5V/m for 2MHz below and beyond, until 100 V/m.



APPENDIX B (normative)

PORTABLE EMISSION DEVICES

The antenna is integrated in a box made of PVC material fitted with an altuglas window that allows the visualization of the antenna inside the window. This box is also fitted with a type SMA wall crossing and with a mechanical connector on which a handle is nested that allows us to keep the antenna at a distance. The shard characteristics (by all antennas) for building this box are shown hereafter.

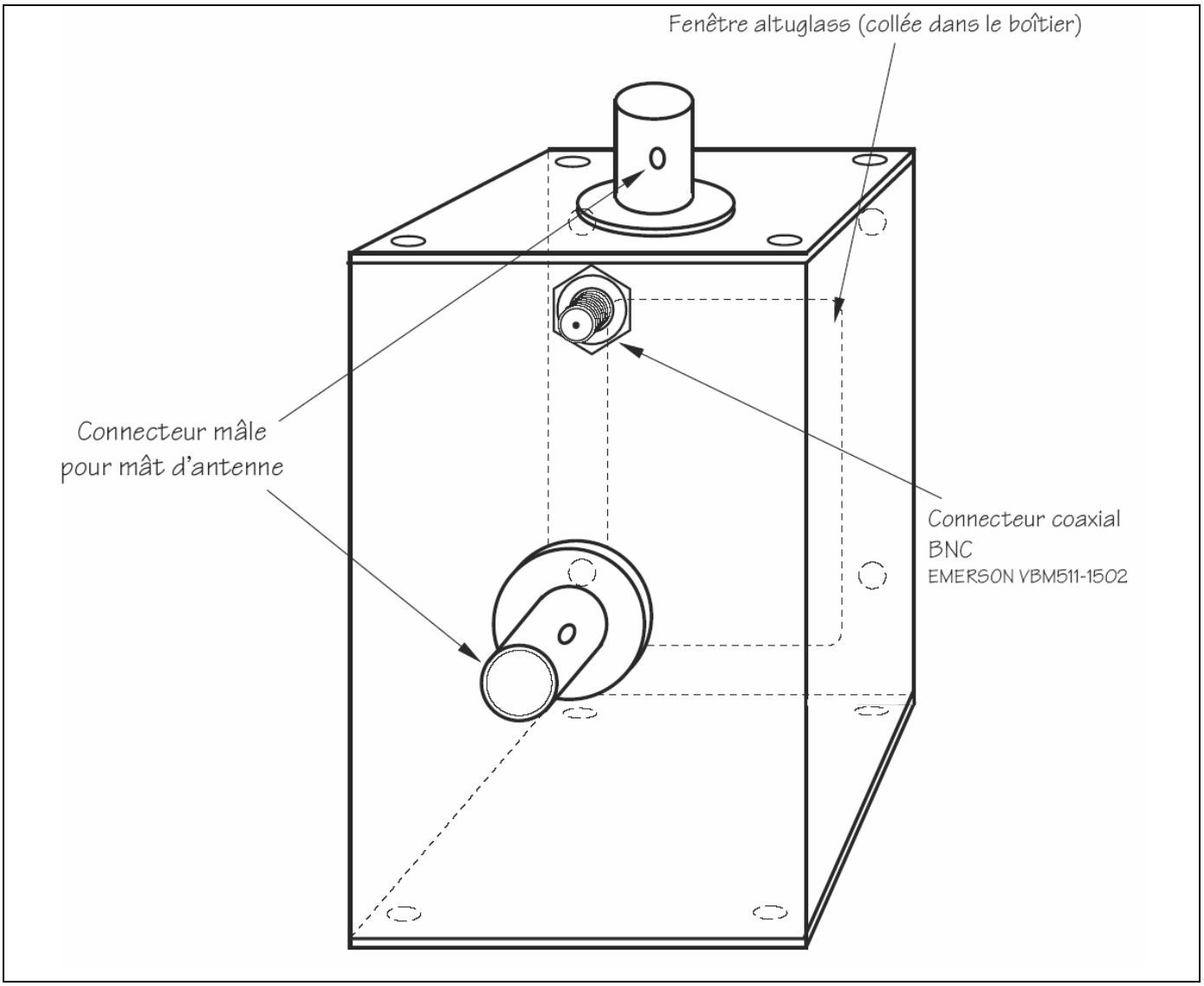


Notes:

- using this box to carry out the tests with the antenna located 50mm away from the DUT requires using a 10 mm hold. It is possible to make the boxes with an outer side of 100mm instead of 80mm, in order to eliminate the need of another hold.
- the arrangement of the box used for the antenna is not important, only the specifications of the antenna elements detailed in this appendix are normative.
- these antennas are, for information purposes, distributed for example by the following supplier:

  Siepel S.A., Z. A. de Kermarquer – BP 87, 56470 La Trinité sur Mer, France

  Contact: Bertrand LEFEBVRE



Fenêtre altuglass (collée dans le boitier)	Altuglass window (glued in the box)
Connecteur male pour mat d'antenne	Male connector for antenna mast
Connecteur coaxial	Coaxial connector

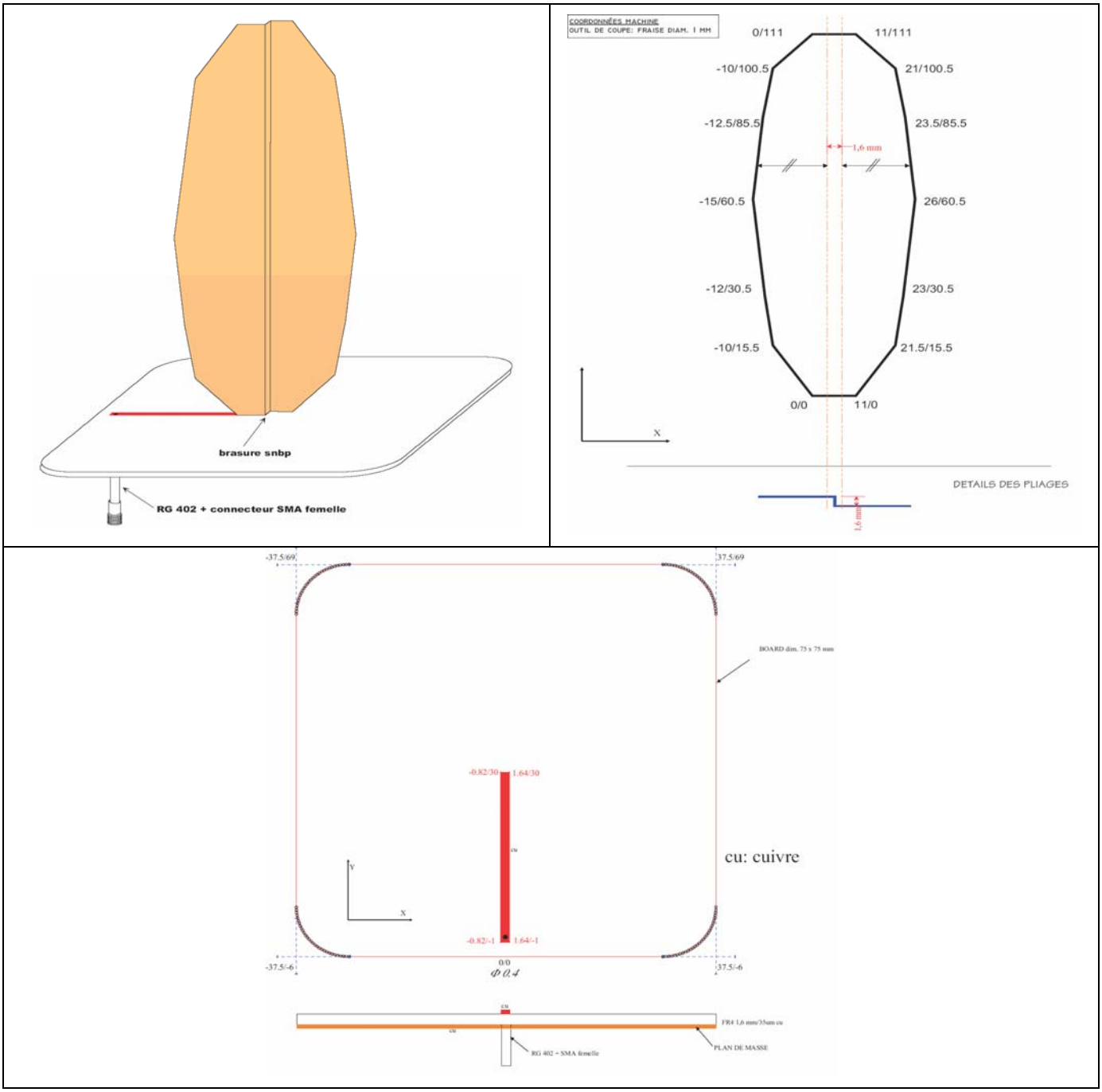
Aerial used for GSM 900, GSM 850 and PDC 800 bands:

ELECTRICAL SPECIFICATIONS

- Pass-band of the antenna: 890-915 MHz (min)
- Input impedance: 50 Ohms
- Permissible power: 20 Watts
- Connector: Type SMA
- Gain: 0.5dB +/- 0.5dB typically
- Reflection factor S11: < -10 dB on the entire band.

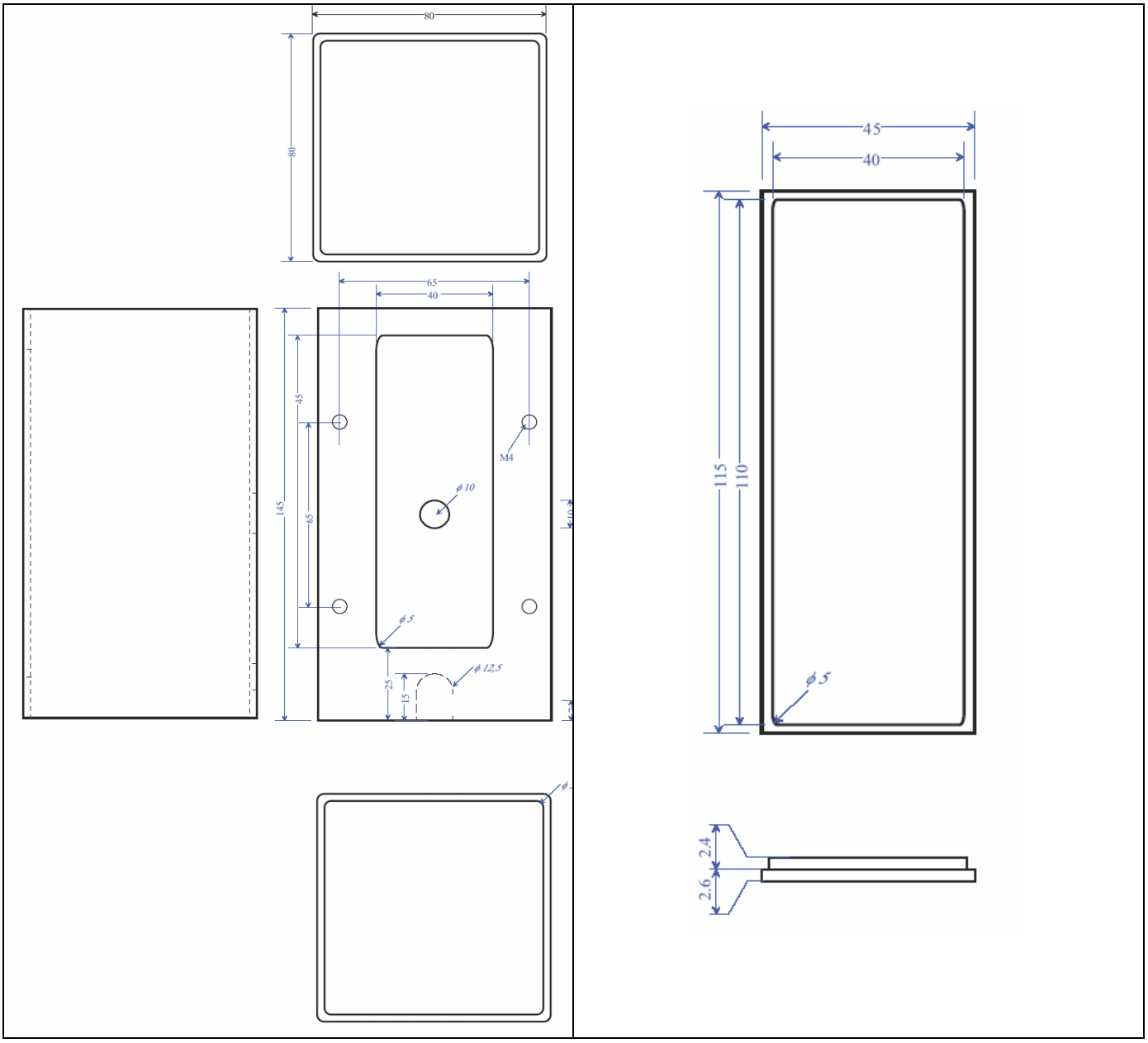
CONSTRUCTION OF THE ANTENNA

The antenna is made from a FR4 printed circuit, and is powered in its centre by a microstrip line. The antenna element is made by a leave shaped monopoly placed vertically to the ground plane. The geometrical characteristics of the set are indicated below.



ANTENNA INTEGRATION IN ITS BOX

The construction details of this box are indicated below.



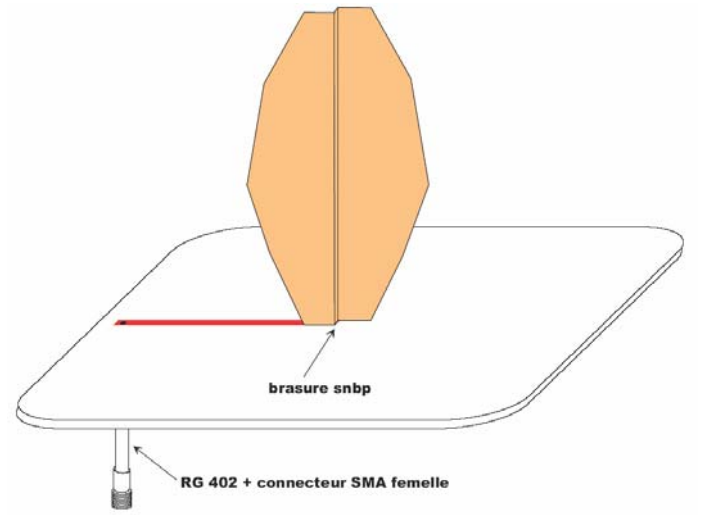
Aerial used for GSM 1800, UMTS, GSM 1900 and PDC 1500 bands:

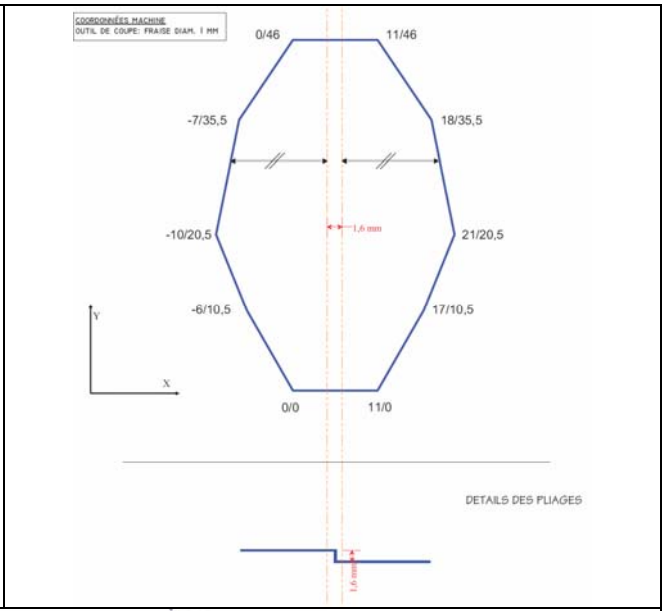
ELECTRICAL SPECIFICATIONS

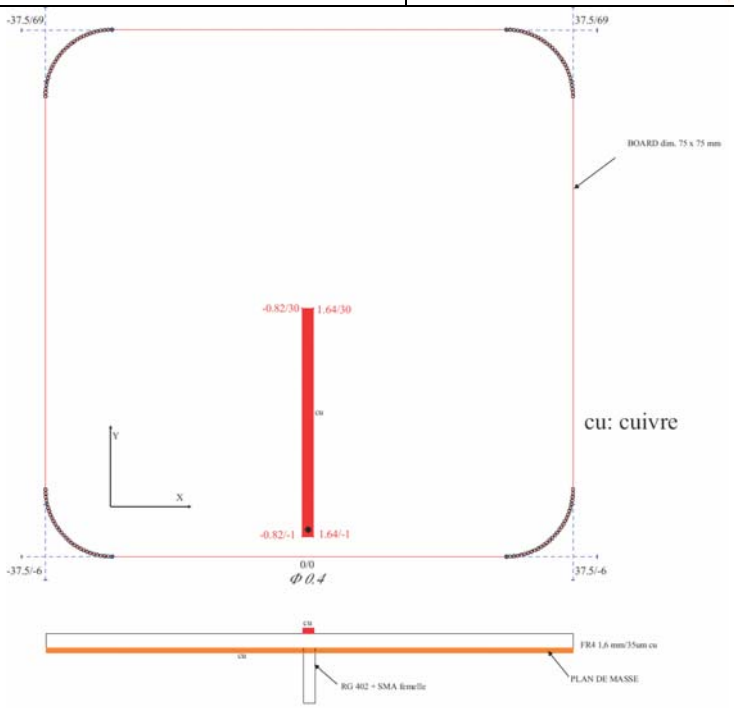
- Pass-band of the antenna: 1710-2,025 MHz (min)
- Input impedance: 50 Ohms
- Permissible power: 20 Watts
- Connector: Type SMA
- Gain: 0 dB +/- 1 dB typically
- Reflection factor S11: < -10 dB on the entire band.

CONSTRUCTION OF THE ANTENNA

The antenna is made from a FR4 printed circuit, and is powered in its centre by a microstrip line. The antenna element is made by a leave shaped monopoly placed vertically to the ground plane. The geometrical characteristics of the set are indicated below.





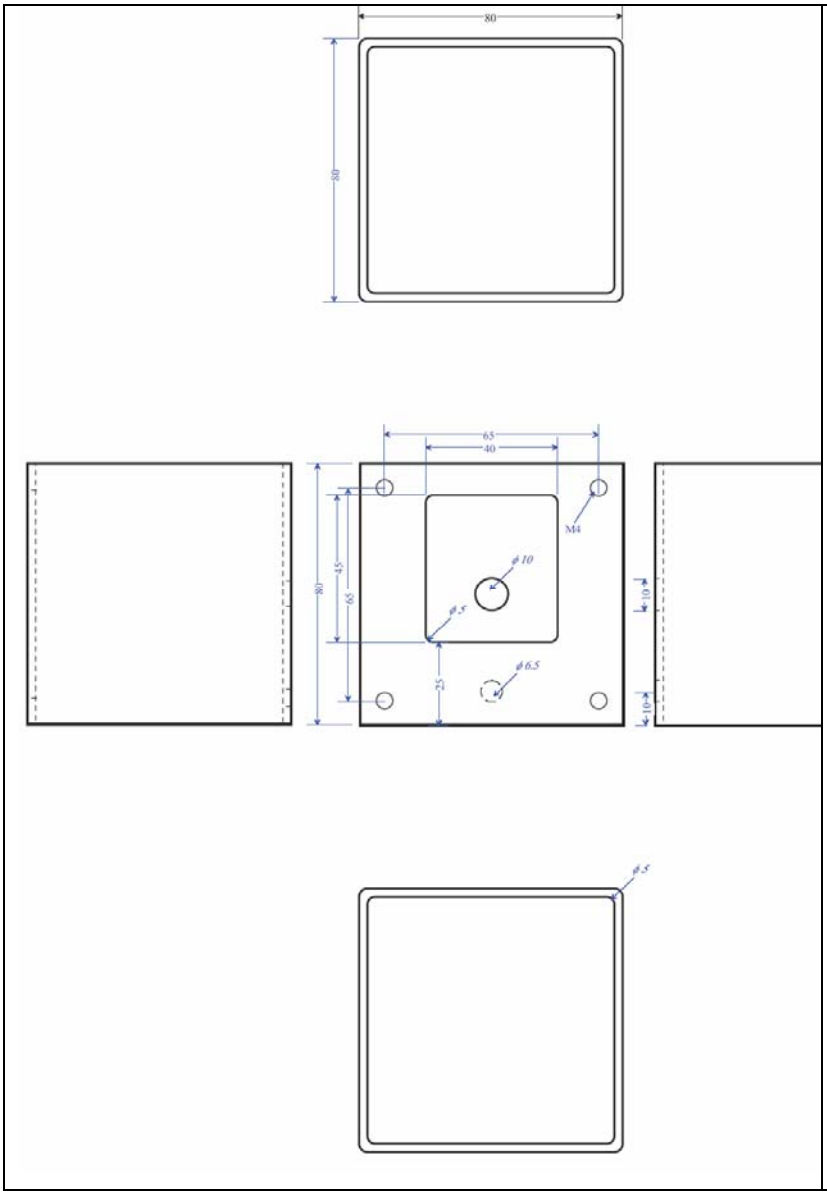


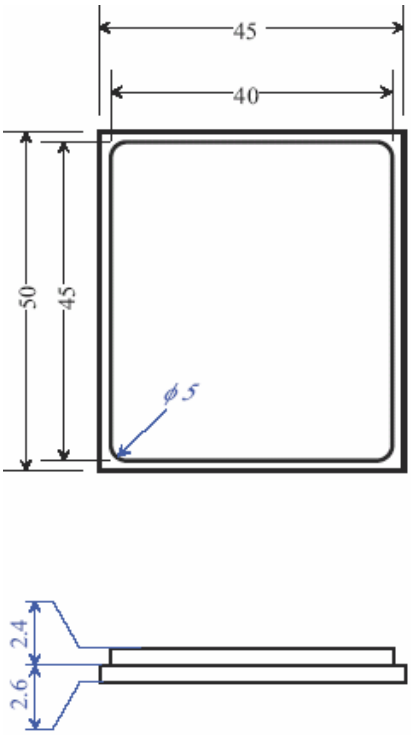
Cuivre	Copper

Montage vis+écrou nylon	Nylon screw + nut assembly
brasure	Braze
Connecteur SMA femelle	Female SMA connector
Coordonnées machine	Machine coordinates
Détails des pliages	Foldings details

ANTENNA INTEGRATION IN ITS BOX

The construction details of this box are indicated below.





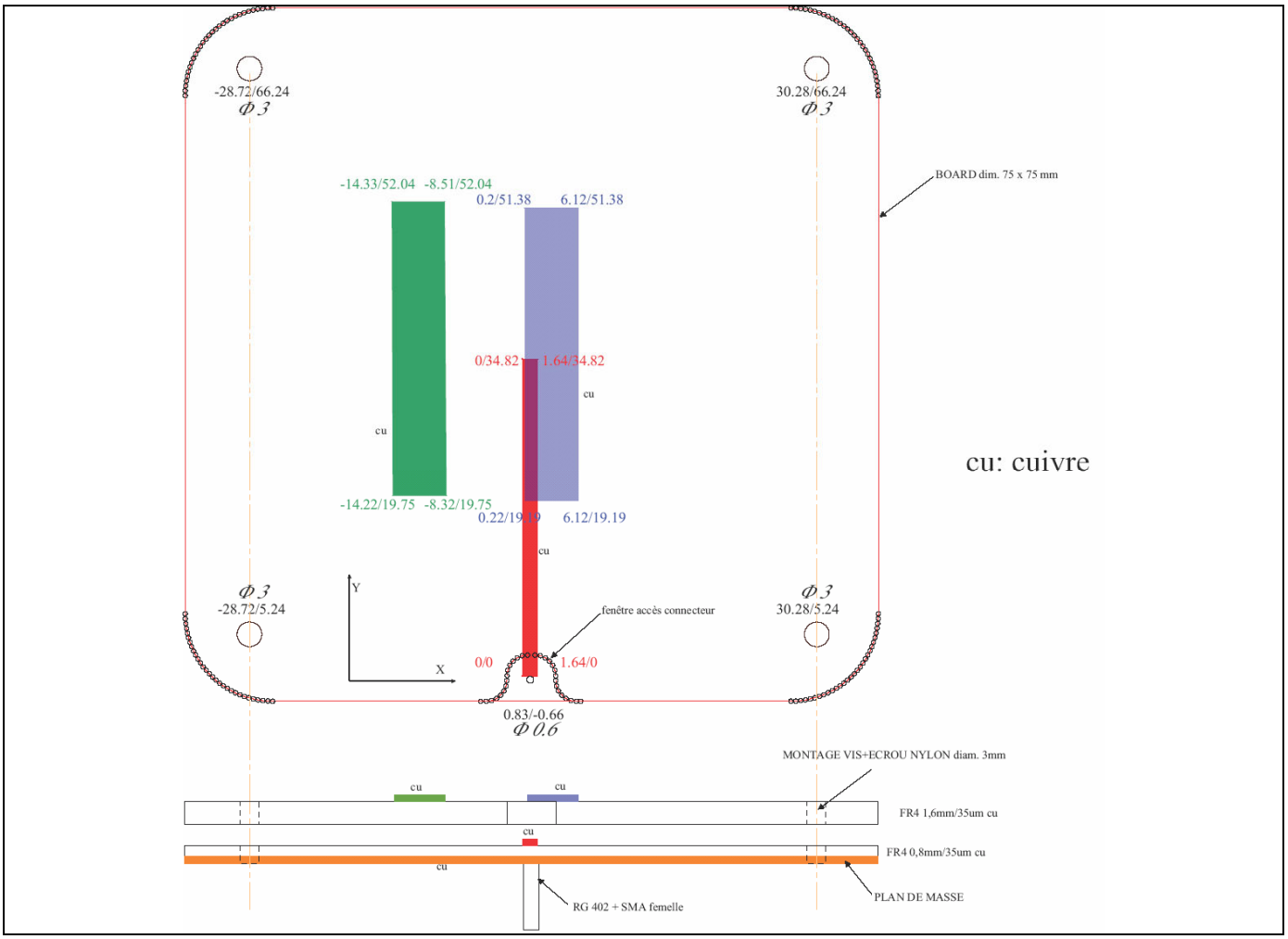
Bluetooth band (2,402 – 2,480 MHz):

ELECTRICAL SPECIFICATIONS

- Pass-band of the antenna: 2,402-2,480 MHz (min)
- Input impedance: 50 Ohms
- Permissible power: 20 Watts
- Connector: Type SMA
- Gain: Typically
  - ✓ 0 dB +/- 0.5 dB to 2,402 MHz
  - ✓ -1 dB +/- 0.5 dB to 2,420 MHz
  - ✓ -2 dB +/- 0.5 dB to 2,440 MHz
  - ✓ -3 dB +/- 0.5 dB to 2,460 MHz
  - ✓ -5 dB +/- 0.5 dB to 2,480 MHz
- Reflection factor S11: < -10 dB on the entire band.

CONSTRUCTION OF THE ANTENNA

The antenna is made from a FR4 printed circuit, and is powered in its centre by a microstrip line. The antenna element is made from a printed dipole coupled to a parasite dipole parallel to the first. The geometrical characteristics of the set are indicated below.



ANTENNA INTEGRATION IN ITS BOX

The construction details of this box are indicated below.