GENERAL TECHNICAL SPECIFICATIONS CONCERNING THE ENVIRONMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT 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 : 13/09/2004*

CONTENTS

1.PURPOSE AND FIELD OF APPLICATION

The object of this specification is to define the requirements to be observed in order to provide the electrical performance and Electromagnetic Compatibility (EMC) of vehicles (passenger vehicles and light commercial vehicles) and associated electrical, electronic and pyrotechnic equipment.

The requirements defined in this specification are references for tenders to Suppliers. Each Supplier can propose adapted tests (methods, levels) resulting in cost reductions of the equipment or additional constraints in order to provide operation of the equipment on the vehicle.

The PSA system official (in agreement with the PSA official for EMC and electric validation) must provide the Supplier with a definition of the accepted requirements. With no proposal from the Supplier and written agreement from PSA, this document applies in its entirety.

The equipment is validated when it meets test requirements for equipment and for vehicles. Tests on the equipment shall be carried out in an environment representative of the vehicle procedure (system validation).

All vehicle projects have independent electric and EMC validation: validation obtained for a vehicle project is not systematically renewed for another vehicle project.

The general requirements concerning environment tests on electric and electronic equipment for vehicles are listed in document B21 7100.

2.EXPRESSION ON DOCUMENTS

For the purposes of this document, the expression on documents given in B21 7100 applies.

Application of the requirements of this Specification must be indicated on documents in the following form: B21 7110.

3.TERMS AND DEFINITIONS

3.1.DEFINITIONS

For the purposes of this document, the definitions given in B21 7100 apply.

The abbreviations used in this document are listed below:

AM	:	Amplitude Modulation.
FMECA		Failure mode Effect and Critical Analysis
+APC	:	Plus après contact (Ignition on Positive).
+BAT	:	Plus batterie (Battery positive).
BCI	:	Bulk Current Injection.
NB		Narrowband.
BB		Broadband.
BW	:	Bandwidth.
EMC		Electromagnetic compatibility
CISPR	:	Electromagnetic Interference Special International Committee.
CW	:	Continuous Wave.
ESD	:	Electro-Static Discharge
HT	:	High tension (High voltage).
JIG	:	Calibration device.
N/A	:	Not Applicable.
PAR	:	Position d'antenna ARrière (Rear Antenna Position).
PAV	:	Position d'antenna AVant (Front Antenna Position).
PLD	:	Position d'antenna Latérale Droite (Right Side Antenna Position).
PLG	:	Position d'antenna Latérale Gauche (Left Side Antenna Position).
PM	:	Pulse Modulation.
LISN	:	Line Impedance Stabilisation Network.
TLS	:	Transmission Line System.
STN/ST	:	Standard Technical Specification and Technical Specification (See norme A10 0310) Replaces Detailed Technical Specification (STD)
VBD	:	Direct Battery Voltage
VBK	:	Ignition on Positive Battery Voltage.
VBR	:	Relayed Battery Voltage

3.2.VOLTAGE

For the purposes of this document, the voltage definitions given in B21 7100 apply.

3.3.TEMPERATURES

For the purposes of this document, the temperature definitions given in B21 7100 apply.

3.4.PROCEDURES

For the purposes of this document, the procedure definitions given in B21 7100 apply.

Within the framework of B21 7110, and for a given procedure, the use of equipment being tested must correspond to the worst case scenario for sensitivity and/or emissivity.

3.5.FUNCTIONAL CLASSES

For the purposes of this document, the functional class definitions given in B21 7100 apply.

Five operating classes are used to define the behaviour of the EUT during and after the tests described in this specification. As a reminder of B21 7100, these classes are as follows:

"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 malfunction 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 – Functional class

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'S IMPACTS

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 paragraph 4.2 for all tests concerned.

4.TEST CONDITIONS

4.1.VALIDATION PROCESS

For the purposes of this document, the validation procedure given in B21 7100 applies.

4.2.DRAFTING THE ENVIRONMENTAL TEST PLAN

For the purposes of this document, the requirements for drafting the environmental test plan given in B21 7100 apply.

The following special procedure is in addition to the requirements in B21 7100:

Undesirable events (list of concrete equipment malfunction criteria) are to be assessed based on the operating classes and the levels of customer impact specified in the test in question by using the functional classes.

For each test in this specification, the level(s) of customer impact for each test is/are linked to operating classes and/or levels of customer impact.

Operating classes and levels of customer impact are not systematically linked:

Example 1: spurious, lasting extinction of the high beams is an impact 3, class D malfunction; whereas the spurious, lasting extinction of the dome light is an impact 1, class D malfunction.

Example 2: drift in transient measurement of the accelerator pedal sensor causing racing in the engine speed is an impact 3, class C malfunction; whereas a transient drift in the air conditioning temperature sensor is an impact 1, class C malfunction.

The concrete analysis of undesirable events should be carried out on a case by case basis depending on the device in question, and must give rise to a correspondence between each test and level of customer impact and undesirable events that can be verified on the test bench. The results of this analysis must be included in the test plan described in paragraph 4.2. of B21 7100.

This test plan is drawn up by the supplier and validated by PSA prior to the tests.

For certain tests, certain undesirable events or malfunctions cannot be tolerated (for example, triggering the airbag, etc.).

4.3.TEST REPORT

For the purposes of this document, the test report requirements given in B21 7100 apply.

A test report that complies with the requirements given in B21 7100, as well as those listed in each test procedure, must be supplied to the Car Manufacturer when the tests are performed. It must also contain a summary table of the tests (example given in Appendix A: "Supplier's EMC Follow-up /Synthesis Sheet ").

4.4.SUPPLIER'S RESPONSIBILITY

For the purposes of this document, the requirements concerning supplier's responsibilities given in B21 7100 apply.

4.5.GENERAL TEST ENVIRONMENT

For the purposes of this document, the general test environment requirements given in B21 7100 apply.

4.5.1.TEMPERATURE

For the purposes of this document, the temperature requirements given in B21 7100 apply.

4.5.2.HUMIDITY

Unless otherwise specified, the humidity requirements given in B21 7100 apply.

4.5.3.VOLTAGE

For the purposes of this document, the voltage requirements given in B21 7100 apply.

4.5.4.PRESSURE

For the purposes of this document, the pressure requirements given in B21 7100 apply.

4.5.5.TOLERANCES

For the purposes of this document, the tolerance requirements given in B21 7100 apply, with the exception of the following tests :

- Immunity to bulk current injection (EQ/IC08)
- Measurement of low frequency conducted noise (EQ/MC02)
- Measurement of radio frequency conducted noise (EQ/MC03)
- Measurement of low frequency magnetic fields (EQ/MR02)
- Measurement of radio frequency radiated noise (EQ/MR01).

4.6.SPECIAL TEST ENVIRONMENT

4.6.1.GENERAL

The configuration of the EUT and its environment must be representative of the real procedure. The equipment under test shall be installed under conditions as close as possible to normal conditions of use, in particular:

- The EUT shall be powered by a battery and/or a stabilised power supply with internal resistance less than 0.1 Ω and shall not present superimposed ripple voltage greater than 0.1 V peak to peak.
- Earthing shall comply with that given in the test plan or in the equipment Specification.
- Electrical connections with the earth plane (EUT, test equipment), where necessary, shall have the following characteristics:
  - Inductance: $L \leq 100$ nH.
  - Resistance: $R \leq 10$ mΩ.

The real environment of the EUT should preferably be used. If unavailable, however, it is possible to use an environment simulator for sensors and actuators: the equipment shall have sufficient protection so as not to be disturbed by interference generated during or after the test, and shall not cause disturbances.

The harnesses used for the tests must be representative of that actually used on the vehicle, at least concerning the number of wires and their cross-sections. Its length shall comply with the specifications for the test in question.

4.6.2.EARTH PLANE

The EUT is installed on an earth plane connected to earth with the following minimum characteristics:

- Length : 2000 mm minimum or length of the test bench plus 500 mm (whichever is greater).
- Width : width of the test bench plus 200 mm on each side.
- Thickness : ≥ 0.5 mm.
- Material : copper or brass.

4.6.3.INSULATING SUPPORT

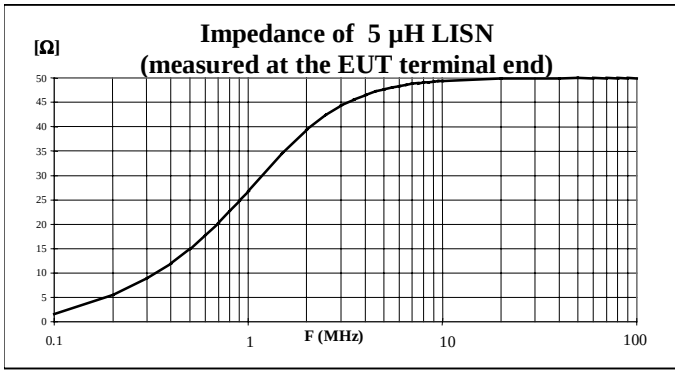
The EUT and the test harnesses are insulated from the earth plane by a support with the following characteristics:

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

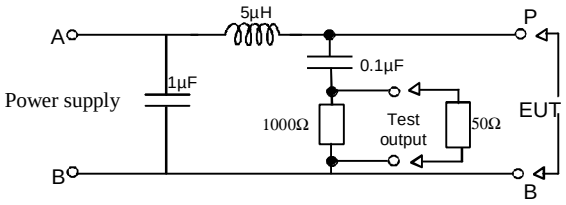
Note 2 : *Wooden supports are prohibited because of their high relative permittivity.*

4.6.4.DECOUPLING DEVICES (LISN)

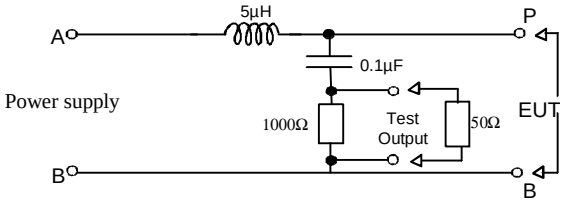
The use of a Line Impedance Stabilisation Network (LISN) gives a perfect definition of the line impedance of the power supply network and protects the power supply network from injected disturbances.



LISN characteristics and circuit diagram



LISN in accordance with CISPR 25



LISN in accordance with ISO/DIS 7637-2.3

LISN connection (where necessary):

- If the EUT is locally earthed to the vehicle (l < 200 mm), a LISN shall be connected to the power supply wire.
- If the EUT is remotely earthed to the vehicle (l ≥ 200 mm), two LISNs shall be connected to the power supply and earth wires.

4.7.MEASUREMENT FACILITIES

The optical link measurement chains must have a bandwidth suited to the signals to be transmitted.

The electrical connections (in particular those intended for shielded enclosure tests) shall be shielded or fitted with adapted filters.

The acquisition devices (oscilloscope, spectrum analyser, receiver) shall have bandwidths suited to the signals to be measured or a number of digitised points suited to the processing operations performed.

The current or voltage probes shall have a bandwidth suited to the signals to be measured and sufficient immunity with respect to the test-related electromagnetic environment.

4.8.SPECIFIC CONDITIONS FOR IMMUNITY TESTS

The mode of use for the equipment under test must correspond to the worst case of sensitivity or to the highest functional occurrence.

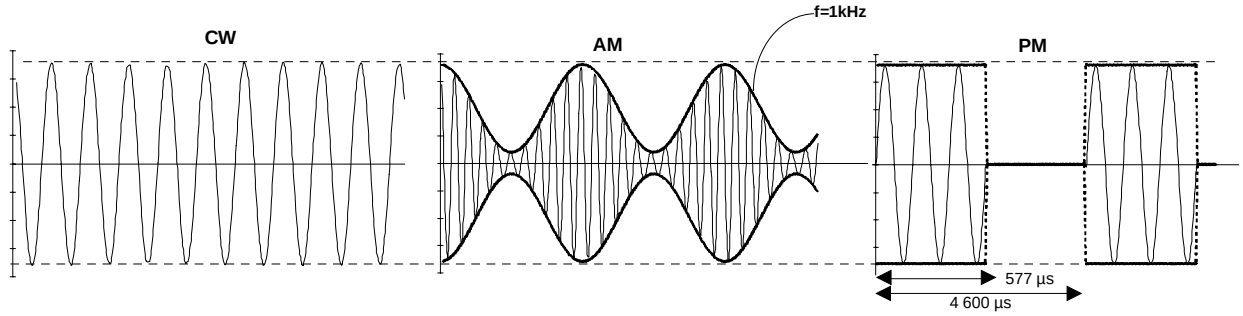
The test installation shall be capable of generating the test signals required over the frequency bands defined in this document. Insofar as electrical signal transmission is concerned, the installation shall conform to the legal requirements (use of shielded enclosure).

Note 2 : *The test area may be subjected to strong electromagnetic fields: it is the Supplier's responsibility to take all the necessary precautions (use of shielded enclosure, for example).*

4.8.1.MODULATION

The various types of modulation used in the procedures are as follows:

- Non-modulated (CW).
- Amplitude modulated, 1 kHz 80% (AM).
  - PM1 Frequency 217 Hz, Tone 577 µs (illustration below).
  - PM2 Frequency 300 Hz, Tone 100 µs.



CW, AM and PM modulation – Peak level conservation principle

Reminder concerning the peak level conservation principle:

Any sine wave signal s(t) (of the current, field or voltage type) of angular frequency ω can be written in the form:

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

The average power is then:

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

Any amplitude modulated sine signal s(t) can be written in the form:

- $s_{AM}(t)=s_1.\cos(\omega$' modulating signal.
- $\mathbf{m} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$: modulation depth.

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

There are two ways of setting the signal in order to have peak conservation:

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

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

- measurement of unmodulated power before application of modulation: $\mathbf{P_{CW\ avant\ modulation}} = \left(\frac{1}{1+m}\right)^2.\mathbf{P_{CW}}$

For 80% modulation depth, we obtain:

- $P_{CW\ before\ modulation}$ = 0.309 P_{CW} (-5.1 dB)

4.8.2. FREQUENCY STEP

For each type of frequency immunity test, the maximum frequency step is one of the following two:

F_{min}	F_{max}	Logarithmic frequency step	Linear frequency step
20 Hz	100 kHz	10 %	Not applicable
100 kHz	1 MHz	5 %	25 kHz
1 MHz	20 MHz	5 %	500 kHz
20 MHz	30 MHz	5 %	1 MHz
30 MHz	100 MHz	5 %	2 MHz
100 MHz	200 MHz	2 %	2 MHz
200 MHz	400 MHz	2 %	5 MHz
400 MHz	1 GHz	2 %	10 MHz
1 GHz	1.7 GHz	2 %	20 MHz
1.7 GHz	2 GHz	2 %	10 MHz
2 GHz	2.5 GHz	2 %	20 MHz
2.7 GHz	3.2 GHz	2 %	50 MHz

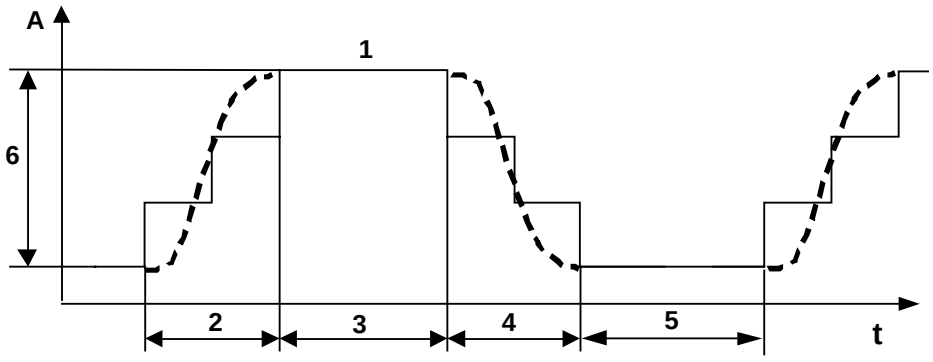
Note 2 :
- Fulfilment of component requirements with the frequency steps given above does not guarantee fulfilment of the requirements on a vehicle with the same frequency steps (possible variation of the quality factor).
- This is the maximum step between two frequencies, the reasoning being to make it highly improbably that any malfunction may occur between two steps; the exact list of frequencies to be tested is in no case contractual.

4.8.3.EXPOSURE TIME

For frequency immunity test, for each frequency, the disturbance is applied gradually to the specified level and then decreased gradually before moving on to the next frequency.

Unless there is a special agreement between the Supplier and the Car Manufacturer (to be specified in the EMC test plan), the disturbance is applied as indicated in the following figure.

The dwell time depends on the EUT. It must be specified in the EMC test plan.



1 Specified disturbance level

2 Disturbance increase time ($t_m \geq 1$ s)

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

4 Disturbance decrease time ($t_d \geq 0.5$ s)

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

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

4.9.CONDITIONS SPECIFIC TO NOISE TESTS

To ensure that no noise or interfering external signal of sufficient amplitude might affect the measurement in particular, measurements shall be carried out before or after the main test. In this measurement, the noise or interfering signals must be at least 6 dB less than the appropriate reference limits (shielded enclosure mandatory).

The procedure for the equipment under test shall correspond to the worst case scenario for disturbances or the highest functional occurrence. In the case of reversible equipment, disturbance measurements shall be performed in both directions of rotation.

In the case of equipment with certain adjustable amplitudes (engine speed, level of luminosity, etc.), disturbance measurements shall be for the worst case scenario. Pre-assessment measurements may be required in this case.

To ensure reproducibility of results on equipment with electromagnetic contacts sensitive to wear and tear, preliminary running-in of the equipment under tests is required. The duration of this running-in period must be related to the equipment mission profile.

5.EQUIPMENT TEST APPLICATION GUIDE

The requirements and tests to be carried out depend on the type of equipment, the assembly on the vehicle and the customer effects related to equipment malfunctions.

Tables 1 to 3 are a guide to be used to target the applicability of each test depending on the special features of the equipment and to help in drawing up the test plan or the STN/ST

It is a guide based on examples which are in no way limited or final. Furthermore, these examples may change with future technologies or changes in the vehicle architecture.

The tables should be understood as follows:

Tables 1 and 2 list the various tests. A cross or a distinctive sign is placed in each column for which the particular case or life situation of the EUT makes the test applicable.

Example: resistance to pulses 5b (EQ/IC 03, which simulates battery disconnection while the engine is running) should be carried out for all active electronics, with customer impact level 1 as the sanction. Nonetheless, in the case of operational equipment in the event of impact, customer impact level 0 is required (battery disconnection can be caused by impact). For electrical equipment (engines, sensors, etc.), the test is applicable except when the EUT runs on regulated voltage supplied by calculator (since, in this case, the calculator power supply will form a “buffer”).

Table 3 gives examples of equipment. A cross or a distinctive sign is placed in each column for which the life situation or special case is considered to be met. This work is to be done on a case-by-case basis for each piece of equipment, and the results must be included in the test plan or Specification specific to the equipment.

Example: the alarm is operational equipment when the generator is not operational (engine not running). This therefore implies (see table 1 and note 1c) a resistance to usual power supply voltage test with the lowest levels at 8 V (12 V powernet) or 30 V (42 V powernet). This enables low battery charge conditions to be taken into consideration. The associated electronic components are usually located in the boot or in the passenger compartment : the test of immunity to on board transmitter is applicable.

The list of tests to be applied and the requirements must be indicated in the test plan or Specification specific to the equipment.

List of tests	All equipment using active electronics												Electrical equipment: Engines, actuators, sensors and relays	Cases of pyrotechnic equipment
	General case: tests to be performed by default	Life situations				Other special cases: modifications to the default tests:								
		Operational generator (generally running engine)	Non-operational generator (generally non-running engine)	Operational during start-up	Operational during and/or after +APC cut-off	Safety part	Operational in the event of impact	Part located in the passenger compartment or boot	Part near or sensitive to a magnetic field	Audio circuits	EUT or wiring near the ignition (≤ 20 cm)	Activates inductive loads		
Resistance to usual power supply voltages. EQ/TE01	X (1a)	X (1b)	X (1c)			X (1c)							(2)	
Resistance to slow decrease and increase of power supply voltage EQ/TE 02	X													
Re-initialisation test EQ/TE 03	X													
Resistance to unusual power supply voltages. EQ/TE 04	X												(2)	
Resistance to earth and to the network positive terminal. EQ/TE 05	X												X	
Resistance to long-term overloads. EQ/TE 06	X												X	
Resistance to pulses 1 or 1bis and 2a. EQ/IC 01	X Customer impact 1				Customer impact 0								(2)	
Resistance to pulses 3a and 3b. EQ/IC 02	X												(2)	
Resistance to pulses 5b. EQ/IC 03	X Customer impact 1 Class C						Customer impact 0						(2)	
Resistance to power supply micro-cut-offs. EQ/IC 04	X												To be specified in the STN/ST or the test plan	
Resistance to pulses 4 or 4bis. EQ/IC 05	X			Class B									To be specified in the STN/ST or the test plan	
Resistance to on-board power network voltage ripples. EQ/IC 06	X													

List of tests	All equipment using active electronics												Electrical equipment: Engines, actuators, sensors and relays	Cases of pyrotechnic equipment
	General case: : tests to be performed by default	Life situations				Other special cases: modifications to the default tests:								
		Operational generator (generally running engine)	Non-operational generator (generally non-running engine)	Operational during start-up	Operational during and/or after +APC cut-off	Safety part	Operational in the event of impact	Part located in the passenger compartment or boot	Part near or sensitive to a magnetic field	Audio circuits	EUT or wiring near the coil or ignition control signals	Activates inductive loads		
Immunity to signal line transients. EQ/IC 07	X												For sensors only	
Immunity to bulk current injection (BCI). EQ/IC 08	X												For sensors only	
Immunity to ignition high/low voltage. EQ/IC 09											X		For sensors only	
Immunity to radiated field (anechoic chamber). EQ/IR 01	X												For sensors only	
Immunity to low frequency magnetic field. EQ/IR 02									X	X			If sensitive to magnetic field	
Immunity to on-board transmitters. EQ/IR 05								X						
Resistance to electrostatic discharges (equipment not powered) EQ/IR 03	X												For sensors and actuators	±30 kV (air)
Resistance to electrostatic discharges (equipment powered). EQ/IR 04	X												For sensors and actuators	
Measurement of switching noise. EQ/MC 01												X	(3)	
Measurement of LF conducted noise. EQ/MC 02	(4)												(4)	
Measurement of radio frequency conducted noise. EQ/MC 03	X												For engines	
Measurement of low frequency magnetic fields. EQ/MR 02								(5)					For engines	
Measurement of radio frequency radiated noise. EQ/MR 01	X												For engines	

Examples of cases of application of various special installation or operating conditions. ➔ this list is not final or limited and may change with new technologies	All equipment using active electronics												Electrical equipment: Engines, actuators, sensors and relays	Cases of pyrotechnic equipment
	Life situations				Other special cases: modifications to the default tests:									
	Operational generator (generally running engine)	Non-operational generator (generally non-running engine)	Operational during start-up	Operational during and/or after +APC cut-off	Safety part	Operational in the event of impact	Part located in the passenger compartment or boot	Part near a magnetic field	Part sensitive to a magnetic field	Audio circuits	EUT or wiring near the ignition (≤ 20 cm)	Activates inductive loads		
Airbag calculator	X	X	X		X	X	X							X
Accelerometer (satellite connected to the airbag calculator)	X	X	X		X	X		(7)	(7)				X	X
COM 2000/2002	X	X	X	X	X		X							
Accelerator pedal with Hall effect	X	X	X		X		X		X					
Car audio	X	X		X			X			X				
BSI	X	X	X	X	X	X	X		(7)			X		
Electric windows	X	X		X	(8)		X		(7) (8)			X		
Windscreen washer pump (6)													X	
Alarm		X					X							
ABS calculator	X	X	X	X	X			(7)	(7)			X		
Engine control calculator	X	X	X	X	X			(7)			X	X		
Electronic Motor driven fan	X	X		X				(7)				X		

(1a) {12 V → 18 V / 1 h powernet; 42 V → 50 V / 1 h powernet } Customer impact 1 ;

{12 V → 16 V / 1 h powernet; 42 V → 48 V / 1 h. powernet } Customer impact 0

(1b) Add the supplementary test: 12 V → 10.5 V powernet; 42 V → 30 V powernet. Customer impact 0.

(1c) Add the supplementary test: 12 V → 8 V powernet; 42 V → 30 V powernet. Customer impact 0.

(2) Test applicable, except when the EUT runs on regulated voltage supplied by a calculator.

(3) If activating an inductive load.

(4) If the signal greater than 1 A_{eff} might disturb the audio function or parts sensitive to magnetic fields.

(5) If the EUT consumes current >1A_{eff}.

(6) Meaning the engine alone, without its control electronics.

(7) Case by case, depending on the vehicle architecture or calculator design.

(8) In the case of the anti-toe system.

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 refers to the CL03 requirement of specification B21 7130.

6.1.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

- See specification B21 7130

6.1.1.3.TEST FACILITIES

- See specification B21 7130

6.1.1.4.TEST ASSEMBLY

- See specification B21 7130

6.1.1.5.PROCEDURE

See specification B21 7130 for the correct test procedures.

B21 7110 specifies the normal and exceptional operating voltages as follows :

12 V Powernet	42 V Powernet	Power supply voltage
U_{min} = 8 V	U_{min} = 30 V	Minimum voltage (Equipment operational, engine not running, generator not operational, and or safety).
U_{min} = 10.5 V	U_{min} = 30 V	Minimum voltage (Equipment operational, engine running and generator operational).
U_{max} = 16 V	U_{max} = 48 V	Permanent maximum voltage.
U_{excep} = 18 V		Exceptional maximum voltage.

6.1.1.6.REQUIREMENTS

Note : the requirements set out in specification B21 7130 are as follows :

Test	Operating classes	Customer impact levels
Minimum voltage	A	0
Permanent maximum voltage	A	0
Exceptional voltage	Depending on the function	1

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

6.1.2.1.REFERENCE DOCUMENT

This procedure conforms to the ISO 16750-2 standard.

6.1.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to the slow decrease and increase of the on-board power system voltage.

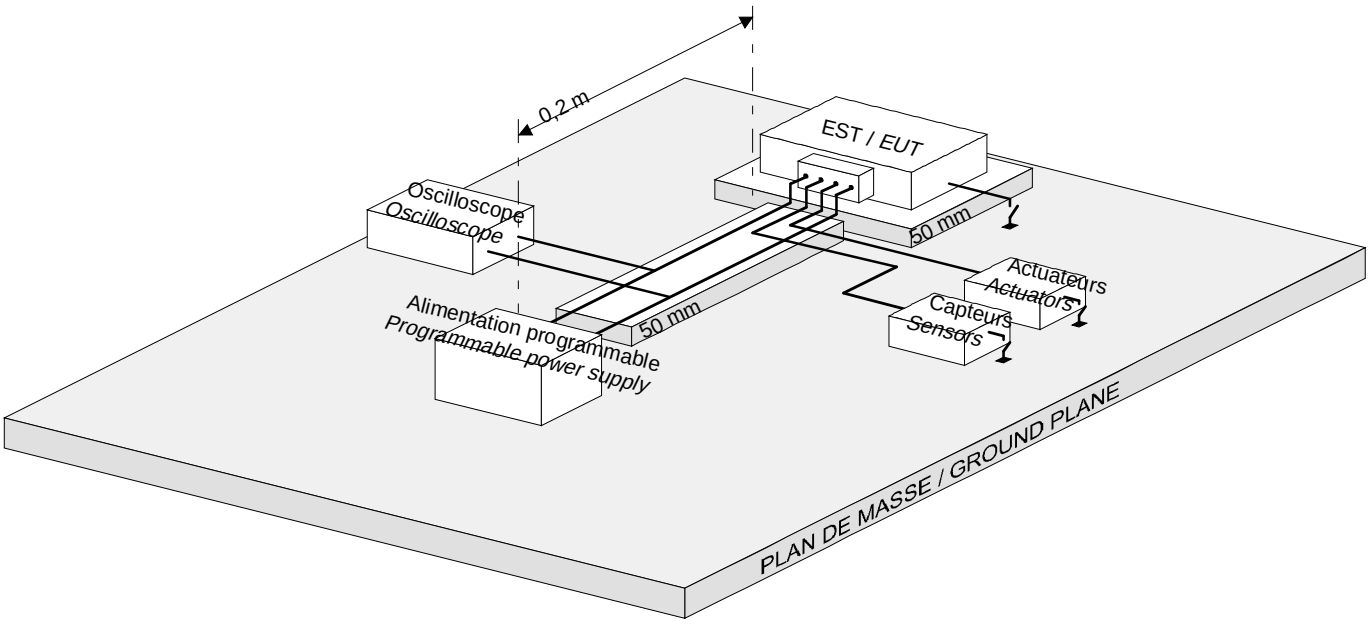
Its principal characteristics are as follows:

- Rated voltage of 14 V or 48 V.
- Voltage decrease of 0.5 V / 1 mn down to 0 V (linear decrease).
- Voltage increase of 0.5 V / 1 mn from 0 V up to the network's rated voltage (linear increase).

6.1.2.3.TEST FACILITIES

- Programmable power supply.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.

6.1.2.4.TEST ASSEMBLY



6.1.2.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT may be placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Set the programmable power supply to obtain the specified power supply voltage on the terminals of the EUT connector.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Apply the decrease and increase voltage cycle to all the grouped supply lines (VBD, VBK and VBR) while monitoring the EUT.

Test report:

- Amongst other information, the test report shall include the following:
- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.1.2.6.REQUIREMENTS

These requirements apply when equipment is operating while the engine is off :

Test	Operating classes	Customer impact levels
Voltage decrease	C	N/A
Voltage increase	C	N/A

Operation must remain type A for the usual voltage range defined in paragraph 6.1.1.

No equipment (including non-operating equipment while the engine is off), shall generate interferences with other equipments or functions (eg; interference with the CAN network…). Undesirable effects (class and/or customer impacts) must be indicated in the STN/ST or the test plan.

6.1.3.EQ/TE 03: RE-INITIALISATION TEST

6.1.3.1.REFERENCE DOCUMENT

This procedure conforms to the ISO 16750-2 standard project.

6.1.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the proper re-initialisation of the equipment during on-board power supply fluctuations.

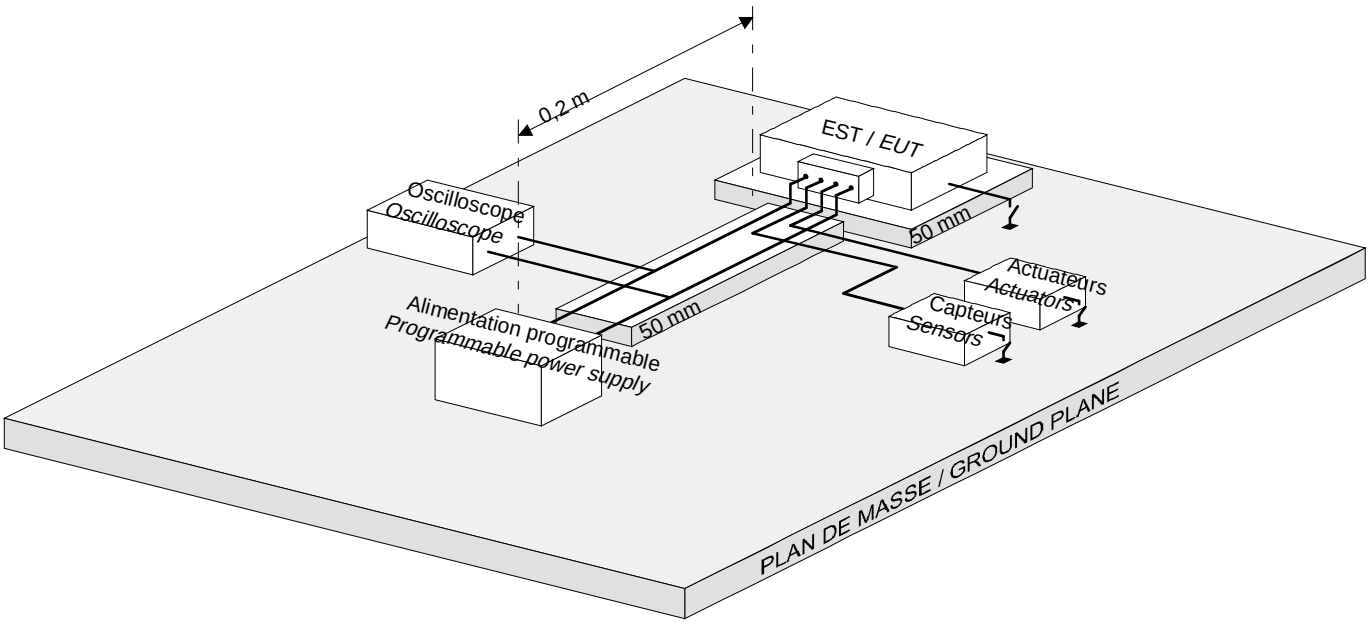
Its principal characteristics are as follows:

- Voltage decrease down to 0 V by minus 5% steps.
- Fluctuation time td: 5 s, cycle time T = 15 s, or more if required for the equipment re-initialisation time.
- Application of fluctuations to each power supply (VBD, VBK, VBR).

6.1.3.3.TEST FACILITIES

- Programmable power supply.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.

6.1.3.4.TEST ASSEMBLY



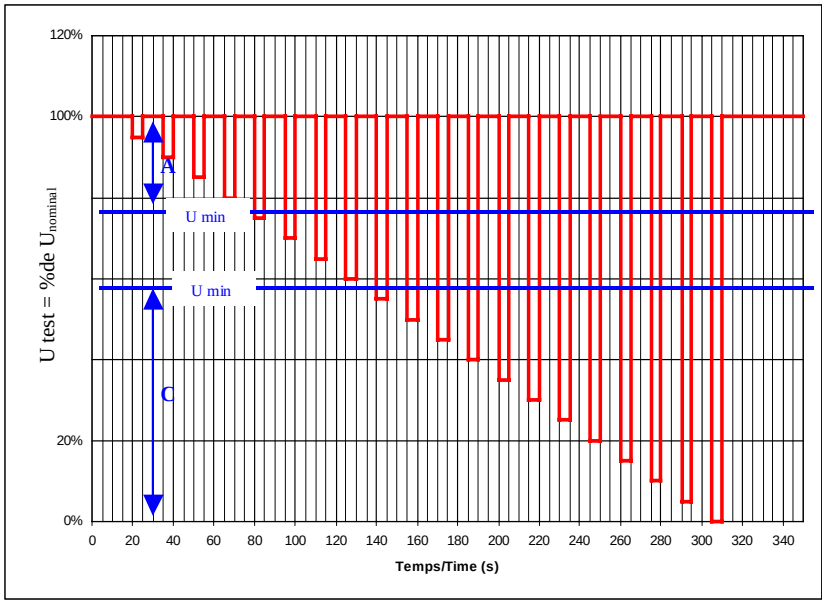
6.1.3.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT may be placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Replace the EUT by a 1 kΩ resistor and connect the oscilloscope to the resistor terminals and set the generator to obtain the following waveform:

12 V Powernet	42 V Powernet	Cut-off on VBD, VBK and VBR
U rated = 14 V $T_{dec} \leq 1$ ms $T_{inc} \leq 1$ ms $t_d = 5$ s $t_i > 10$ s $T = t_d + t_i$	U rated = 48 V $t_{dec} \leq 1$ ms $t_{inc} \leq 1$ ms $t_d = 5$ s $t_i > 10$ s $T = td + t_i$	

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Apply the fluctuation cycle successively to each power supply line (VBD, VBK and VBR) and then to the whole while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Characteristics of the pulses applied.

6.1.3.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Re-initialisation (Non-safety function and equipment)	C (See note)	Not applicable

Note :

- For equipment for which safety strategy so requires, the class demanded may be type A for the test on each power supply, successively (case to be indicated in the STN/ST.
- Operation during the test must remain type A within the usual voltage range defined in paragraph 6.1.1.
- Between each fluctuation time, td, equipment operation must be type A, without time td causing permanent memory loss.

6.1.4.RESISTANCE TO UNUSUAL POWER SUPPLY VOLTAGES

6.1.4.1.REFERENCE DOCUMENT

This procedure conforms to the ISO 16750-2 standard.

6.1.4.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to the maximum voltage (case where an auxiliary start-up system is used) and reversed polarity of the on-board power system.

The reversed voltage test does not apply to relays with a clutch diode.

The test does not apply if the EUT runs on regulated voltage supplied by calculator .

For the alternator test, the reversed voltage test must be performed with the EUT equipped with its diode bridge, with a programmable power supply with a source impedance less than 0.1 Ω.

Its principal characteristics are as follows for the 12 V power system:

- Maximum voltage of 24 V for 1 minute.
- Reversed voltage for 1 minute, i.e. –13.5 V.

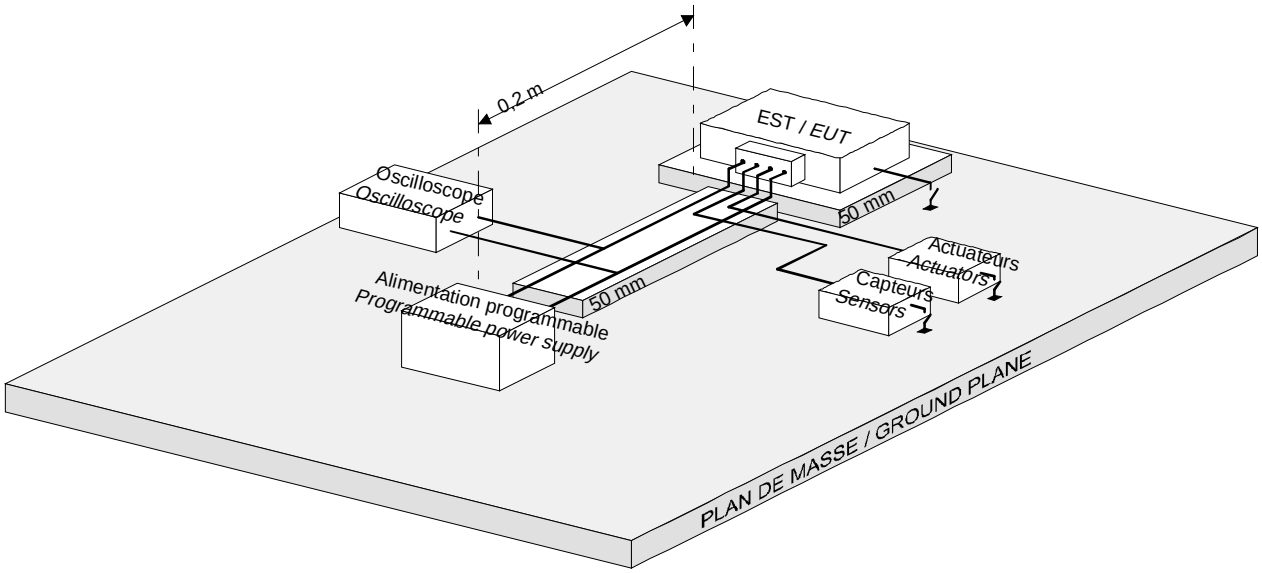
Its principal characteristics are as follows for the 42 V power system:

- Maximum voltage of –2 V for 100 ms (as a centralised protection system is used).

6.1.4.3.TEST FACILITIES

- Programmable power supply.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.

6.1.4.4.TEST ASSEMBLY



6.1.4.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT may be placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Set the programmable power supply to obtain the specified power supply voltage on the terminals of the EUT connector.

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

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Apply the maximum voltage for one minute to all the power supply lines (12 V) while monitoring the EUT.
- Apply the reversed voltage for one minute to all the power supply lines (12 V) while monitoring the EUT.
- Apply the reversed voltage limited to –2 V for 100 ms to all the 42 V power supply lines while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.1.4.6.REQUIREMENTS

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

6.1.5.EQ/TE 05: RESISTANCE TO EARTH AND TO THE NETWORK POSITIVE TERMINAL

6.1.5.1.REFERENCE DOCUMENT

ISO standard 16750-2, paragraph 4.9 and ISO project standard 21848, paragraph 4.9.

6.1.5.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to earth and to the positive terminal of the on-board network input and output lines. It applies to single-voltage equipment. In the case of equipment run by two different voltages (12 V, 42 V, etc.), see the STN/NT or special test plan.

The tests are separate for the power and signal circuits.

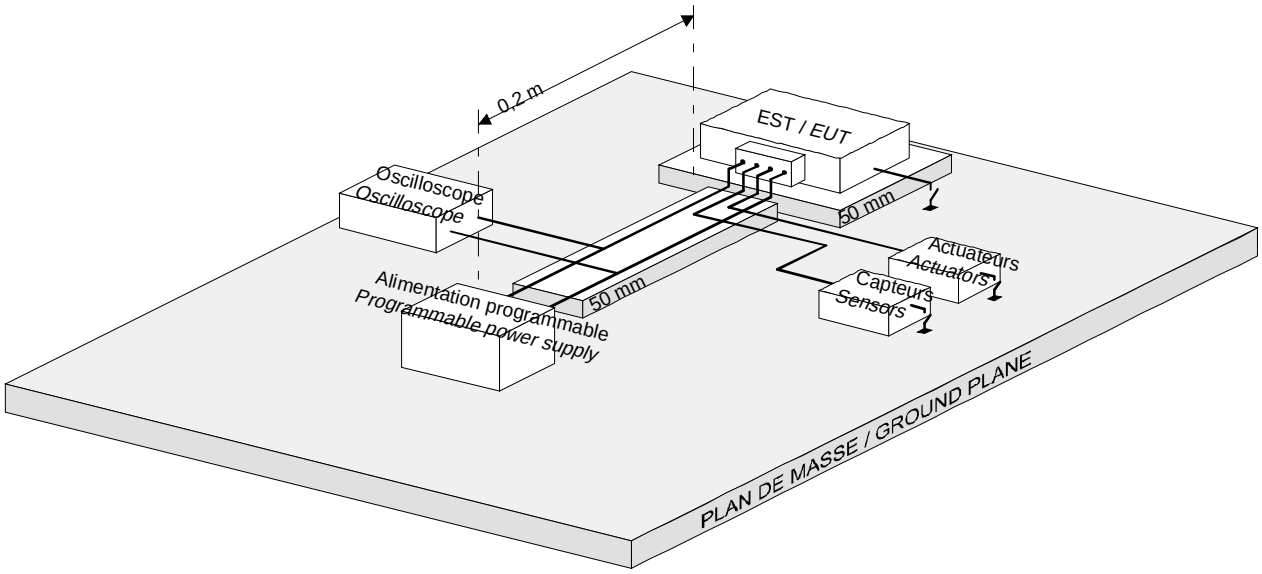
Their principal characteristics are as follows:

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

6.1.5.3.TEST FACILITIES

- Programmable power supply, internal resistance < 0,1 Ω.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.

6.1.5.4.TEST ASSEMBLY



6.1.5.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT power supply wires and the outputs undergoing the test must have a maximum length of 200 mm. The impedance of the line providing the short-circuit line must be less than 0,1 Ω.
- The EUT may be placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Set the programmable power supply to obtain the specified power supply voltage on the terminals of the EUT connector.

12 V Powernet	42 V Powernet	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

6.1.5.6.TEST: GENERAL CASE

Test:

- Run the EUT for a minimum duration of 10 minutes.
- The EUT is running:
  - Successively apply the maximum voltage for 60 seconds on each input/output line while monitoring the EUT.
  - Successively apply the minimum voltage for 60 seconds on each input/output line while monitoring the EUT

- Power supplies + disconnected:
  - Disconnect all power supplies (+ terminals) from the EUT
  - Successively apply the maximum voltage for 60 seconds on each input/output line while monitoring the EUT
  - Reconnect the power supplies
  -
- Earthing disconnected:
  - Disconnect all earth connections from the EUT
  - Successively apply the minimum voltage for 1 minute on each input/output line while monitoring the EUT.
    (Reconnect the earth connections)

Important note: *the return circuits (earth return for sensors, actuators, etc.) are considered as earthings subjected to the Umax test. (An unprotected Umax connection (fuse, etc.) will damage the EUT, but no aggravated short circuit (ASC) should be observed).*

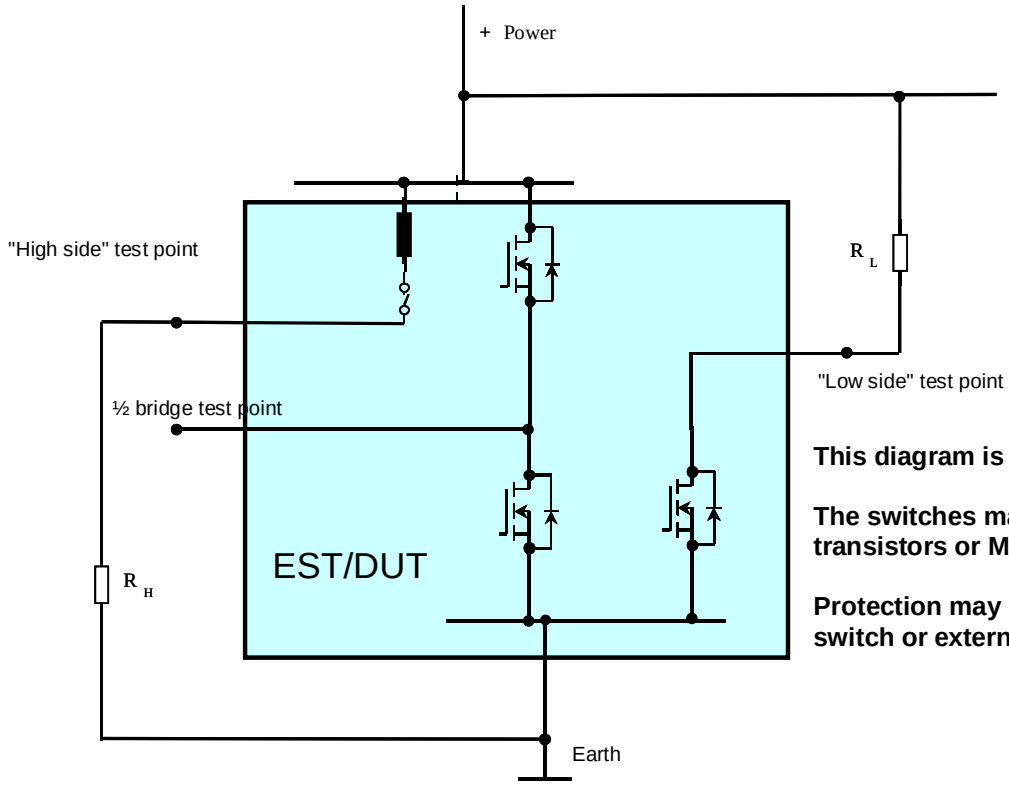
Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.1.5.7.TEST: SPECIAL CASE

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



This diagram is given as an example.

The switches may be relays, bipolar transistors or MOSs, etc.

Protection may be integrated into the switch or external (fuse, etc.).

Test:

- Run the EUT for a minimum duration of 10 minutes.
- The outputs must be controlled.
- The “High side” outputs (electronic switch or relay to + power supply).
  - Successively apply the minimum voltage for 60 seconds on each output while monitoring the EUT.
- “Low side” outputs (electronic switch or relay to earth)
  - Successively apply the maximum voltage for 60 seconds on each output while monitoring the EUT.
- ”Half-bridge” outputs.
  - Successively apply the maximum voltage for 60 seconds on each output while monitoring the EUT.
  - Successively apply the minimum voltage for 60 seconds on each output while monitoring the EUT.

Note 1: *the test is performed in one direction only so as not to stress or damage the charges required for running the EUT (R_H and R_L), which would not resist the maximum voltage power supply for 1 minute.*

Note 2: *for circuits protected with a fuse (included in the equipment), the test time may have to be adapted to take into account the time required (ISO 8820 standard) to melt the fuse.*

Note 3: *for the case of EUTs with multiple power supplies (different voltage levels), the test procedure will have to be specified in the test plan and/or the STN/ST.*

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.1.5.8.REQUIREMENTS

Test			Operating classes	Customer impact levels
Safety equipment and function			C	Not applicable
Non-safety equipment and function	Case of protected power (3) outputs		C (see note 2)	Not applicable
	Case of unprotected power (3) outputs		E (see note 1)	Not applicable
	Case of power inputs and signal inputs/outputs	Minimum voltage	D	Not applicable
		Maximum voltage	C	Not applicable

Note 1 : *only the unprotected output should be damaged or destroyed and, in any case, no aggravated short circuit (ASC) should be observed. The term ASC covers:*

- heat abnormalities caused by excessive local overheating of electrical origin, leading to the materials ignition point to be reached.
- combustion of the substrate and/or inflammation of other materials in the equipment.

An ASC is considered when the presence of flames or combustion is not confined to the inside of the equipment and/or a determined intervention is needed to stop it.

Note 2 : *unless otherwise specified in the STN/ST (fuse protection, for example, where class D is automatically required).*

Note 3 : *by power output, is meant any current output in excess of 1Aeff. If necessary, this level can be adapted to the particularities of specific equipment in the STN/ST or the test plan.*

6.1.6.EQ/TE 06: RESISTANCE TO LONG TERM OVERLOADS

6.1.6.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

6.1.6.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check that no fire starts following an abnormal stress to the EUT on its power supplies, inputs and/or outputs, such as:

- mechanical or calculator blocking of a command or an actuator (starter, automatic windows, etc.), malfunction of a limit switch (engine limit stop, etc.)
- idle running leading to centrifugation or gripping.
- incomplete short circuit between two harnesses.

Type 1a, 1b and 1c tests (as defined in paragraph 6.1.6.5) do not apply to equipment that does not run any motor or load which might give a current greater than 100 mA.

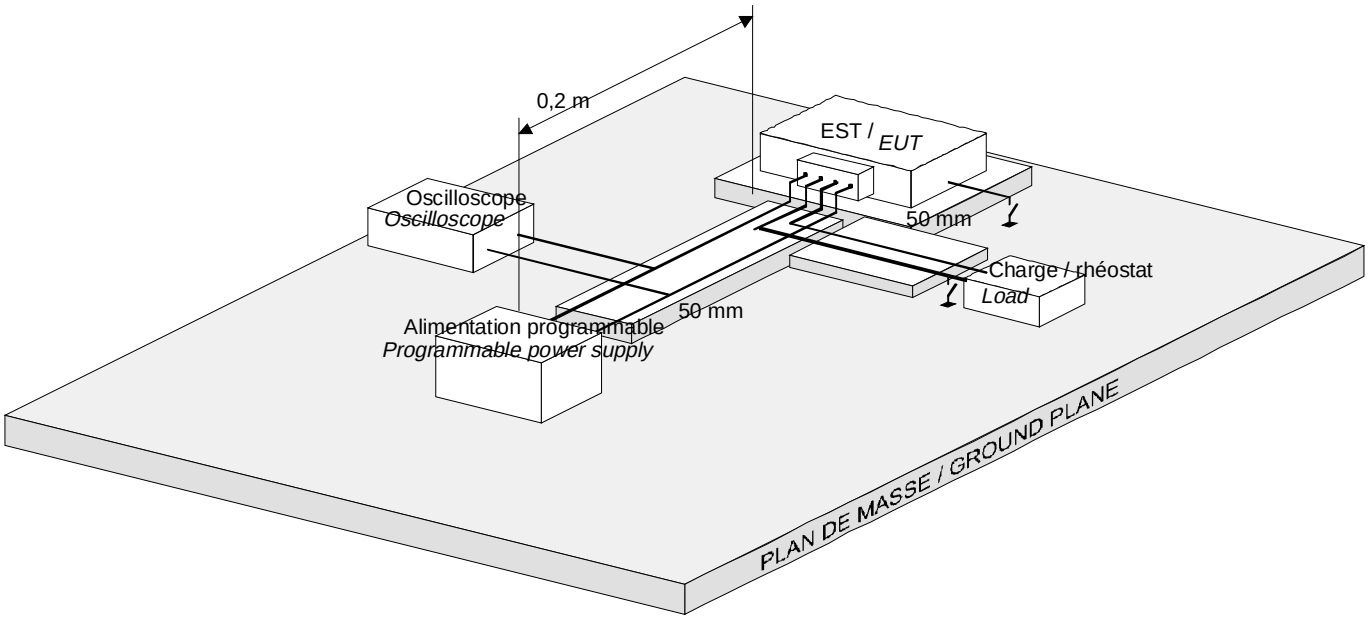
The type of test (1a, 1b, 1c or 2) is to be determined for each output individually, so that a piece of equipment with several power supplies/inputs/outputs may have several tests applied to it.

Note*: An additional test at limit conditions indicates the failure modes of electronic components (cf. work requirement ELE-QCE03_0220/2).*

6.1.6.3.TEST FACILITIES

- Programmable power supply, with sufficient power to provide strong currents.
- Loads or rheostat.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.

6.1.6.4.TEST ASSEMBLY



6.1.6.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The power supply wires of the EUT and the outputs to be tested must be no longer than 200mm.
- The EUT is connected with the connectors and harnesses in accordance with vehicle installation. The harness must be strictly representative in terms of the number of wires connected and their external diameter. The harness participates in heat dissipation. Crimping must be representative of production.
- The EUT may be placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Adjust the programmable power supply to obtain a power supply voltage of 14 V on the terminals of the EUT connector. Adjusting the load or rheostat will provide the current specified in the following tests.

Test 1a: earthing by impedance, for unprotected circuits:

The test is carried out on four test specimens.

a) On two specimens, starting with the rated operating current, the current supplied by the output is increased by 10% of the rated operating current every fifteen minutes. The test is extended to malfunction of the unit supplied.

b) On the other two specimens, the value of the current supplied shall be equal to 0.9 x I malfunction (average of the values determined above) for two hours.

Test 1b: earthing by impedance, for "smart power" electronic circuits or those protected by a calculator strategy:

The test is carried out on three test specimens.

The maximum value of the real effective current (RMS) that can be supplied by the circuit is determined by experimentation. This value is then maintained for 2 hours.

Test 1c: earthing by impedance, for circuits protected by fuses (included in the equipment) :

A current with a value equal to 140% of the fuse calibre is supplied by the output.

If the fuse blows before the end of the two hours, the fuse is changed and the test resumes, lowering the current by 2% of the fuse calibre value:

- for the remaining time if the test was interrupted for less than one minute.
- for a duration of two hours if the test was interrupted for more than one minute.

This procedure is valid for each fuse blown, the number of resumptions shall be indicated in the test report.

This test also applies to pulse outputs. In this case, it simulates abnormal; long lasting activation.

Test 2: +BAT by impedance, for all circuits:

This test is carried out on four test specimens.

a) On two specimens, the current in progressively and regularly increased until the circuit opens.

b) On the other two specimens, starting with a current equal to 0.7 x I opening (average of the values determined above), the current is increased by 10% of I malfunction every 15 minutes. The test is extended until the circuit opens.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness (number and sections of the wires, etc.), EUT environment.
- In the case of protection by calculator strategy, a description thereof.
- During the test: measurement and recording of the power supply current, the malfunction current; the duration of the test.
- After the test: operating checks on the output, mode of malfunction, visual observation to detect any modification of the internal and external appearance of the component.

6.1.6.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Overload, type 1a, 1b or 2	E (see note)	Not applicable
Overload, type 1b	C	Not applicable
Overload, type 1c	D (A after changing the fuse)	Not applicable

Note : *the EUT may be damaged or destroyed, but in no case should an aggravated short circuit (ASC) be observed. The term ASC covers:*

- heat abnormalities caused by excessive local overheating of electrical origin, leading to the materials ignition point to be reached.
- combustion of the substrate and/or inflammation of the other materials in the equipment.

An ASC is considered when the presence of flames or combustion is not confined to the inside of the equipment and/or a determined intervention is needed to stop it.

6.1.7.EQ/IC 01: RESISTANCE TO PULSES 1 OR 1 BIS AND 2A

6.1.7.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 7637-2.3 standard, except for the number of pulses.

6.1.7.2.PRINCIPAL CHARACTERISTICS OF THE TEST

Pulse 1 or 1bis:

The purpose of this test is to check the immunity of the equipment to transients caused by disconnection of the power supply to the inductive loads. Pulse 1 bis may be used if no generator capable of producing pulse 1 is available.

Its principal characteristics are as follows:

- 5000 pulses of –100 V.
- Pulse width: 2 ms.
- Wires involved: all power supply wires (successively and simultaneously). Power supplies used with a network (for example, +VAN ; +CAN ; etc.) must be considered as power supplies that are relayed and tested as such. The test also applies to all outputs that activate inductive loads. The test does not apply if the EUT runs on regulated voltage supplied by calculator.

Pulse 2a:

The purpose of this test is to check the immunity of the equipment to transients caused by a sudden current variation in an inductance connected in series with the test system.

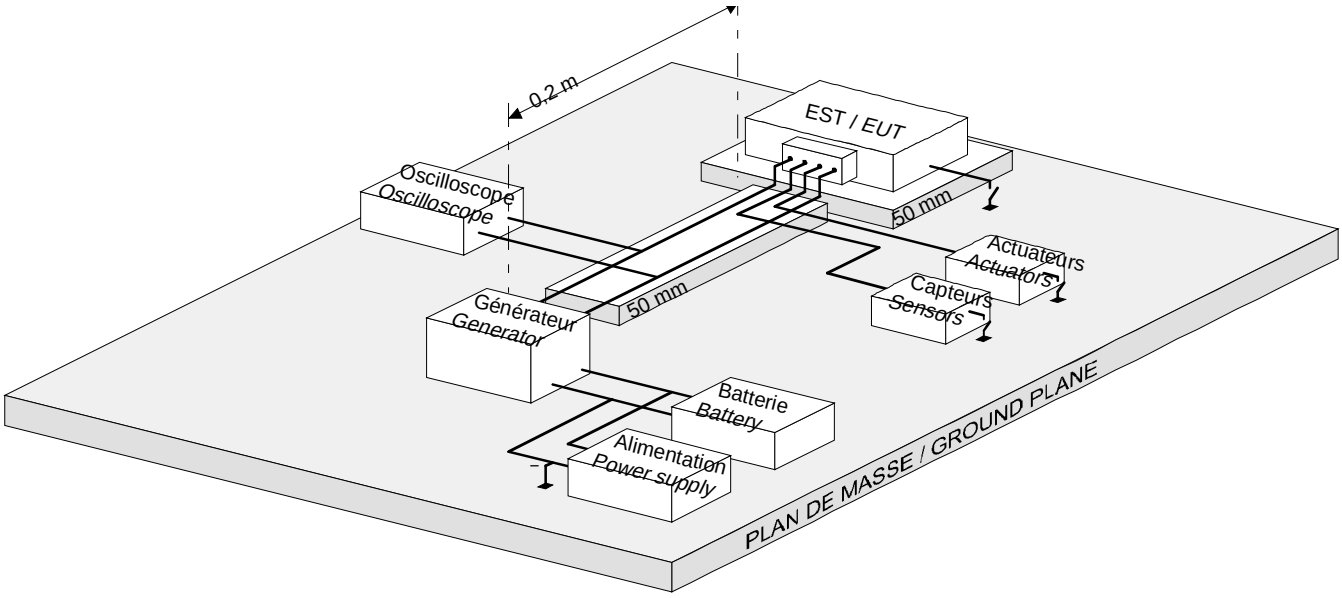
Its principal characteristics are as follows:

- 5000 pulses of +100 V.
- Pulse width: 50 µs.
- Wires involved: all power supply wires (successively and simultaneously). Power supplies used with a network (for example, +VAN ; +CAN ; etc.) must be considered as power supplies that are relayed and tested as such. The test does not apply if the EUT runs on regulated voltage supplied by calculator.

6.1.7.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Pulse generator.

6.1.7.4.TEST ASSEMBLY



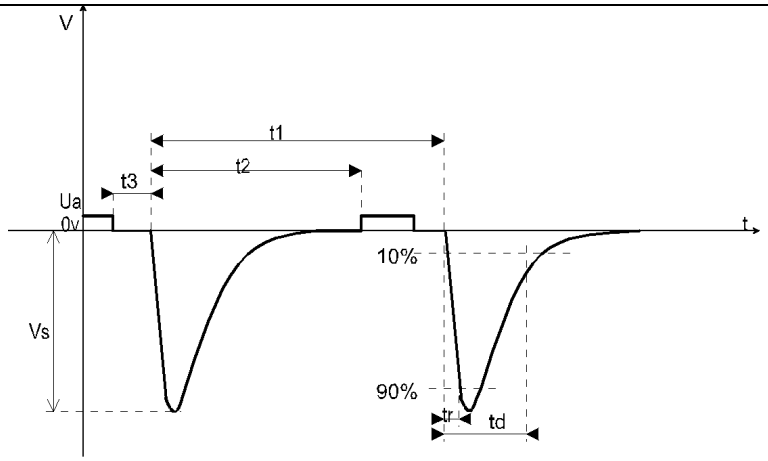
6.1.7.5.PROCEDURE

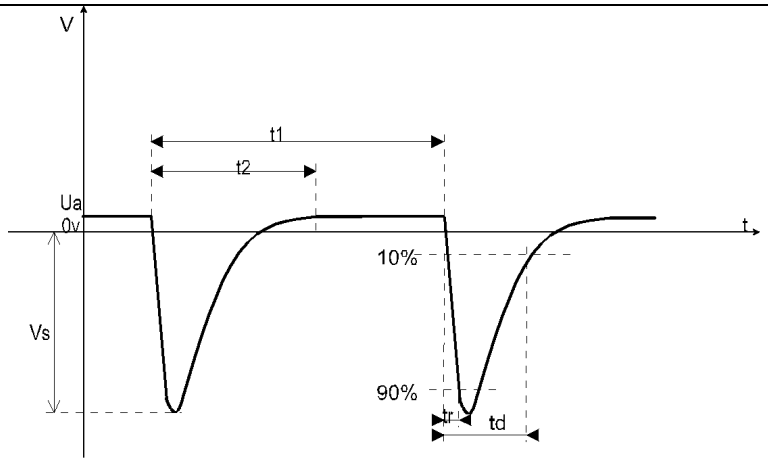
Preparation:

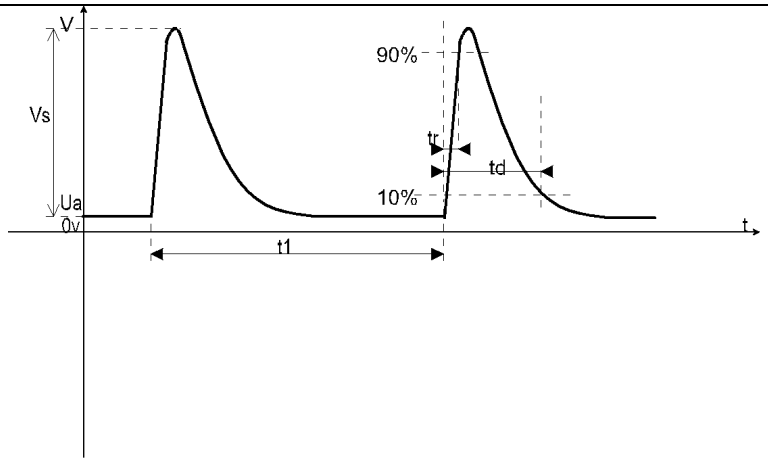
- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The maximum length of the power supply line shall be 200 mm.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Connect the oscilloscope (EUT disconnected) to the pulse generator output (high impedance input) and set the generator to obtain the specified pulses with an internal generator resistance Ri.

12 V Powernet	42 V Powernet	Pulse 1
U_a = 14 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	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 Powernet	42 V Powernet	Pulse 1 bis
U_a = 14 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	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	

12 V Powernet	42 V Powernet	Pulse 2a
U_a = 14 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	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	

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Apply 5000 1 or 1 bis pulses to all the power supply lines and outputs involved (successively and simultaneously) while monitoring the EUT.
- Apply 5000 2a pulses to all the power supply lines (successively and simultaneously) while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Measurement of the waveform for each kind of pulse, measured in an open circuit and in a matched load (see annexe D of Norme ISO 7637).
- Parameters observed and malfunctions encountered during the test.

6.1.7.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Pulses 1 or 1 bis	C	1
Pulses 2a	B	1
Pulses 1 or 1 bis EUT powered in +APC and operational during and/or after the +APC cut-off	B	0
Pulses 2a EUT powered in +APC and operational during and/or after the +APC cut-off	B	0

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

6.1.8.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 7637-2.3 standard for the 12 V Powernet and to the SICAN project for the 42 V Powernet.

6.1.8.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to transients resulting from switching processes.

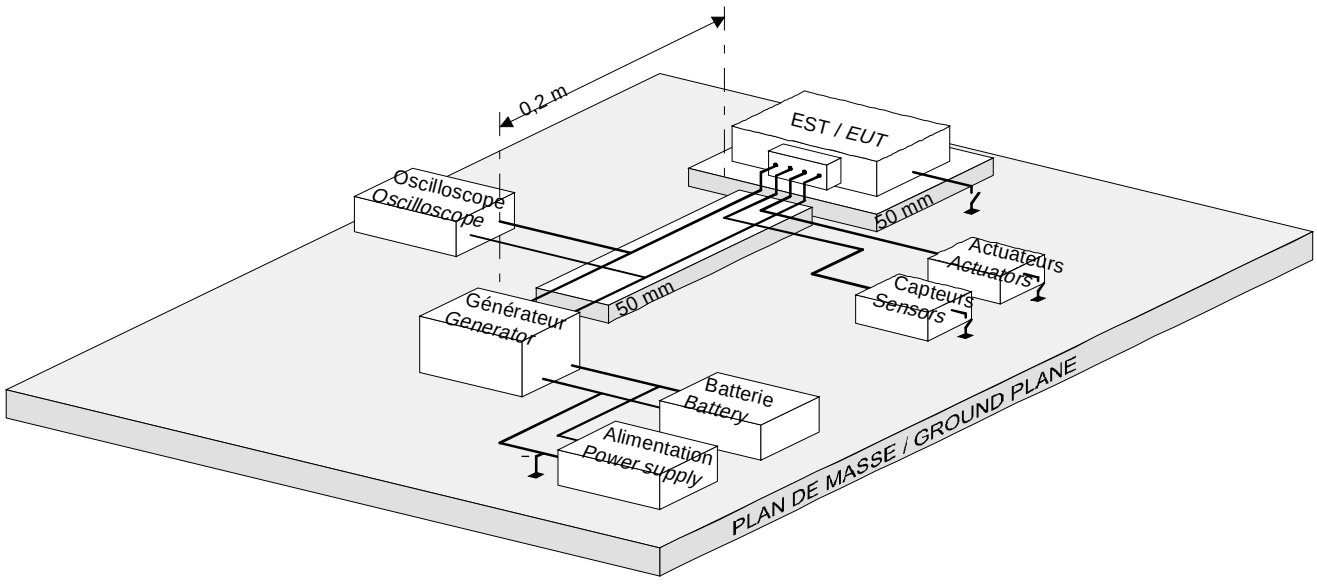
Its principal characteristics are as follows:

- Pulses of –150 V for 1 hour (Pulse 3a).
- Pulses of +100 V for 1 hour (Pulse 3b).
- Pulse width: 0.1 µs.
- Wires involved: all power supply wires (successively and simultaneously). Power supplies used with a network (for example, +VAN ; +CAN ; etc.) must be considered as power supplies that are relayed and tested as such. The test does not apply if the EUT runs on regulated voltage supplied by calculator.

6.1.8.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Pulse generator.

6.1.8.4.TEST ASSEMBLY



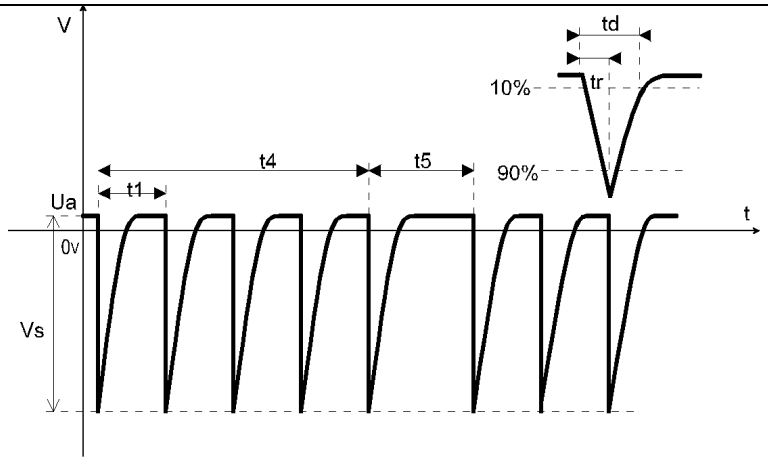
6.1.8.5.PROCEDURE

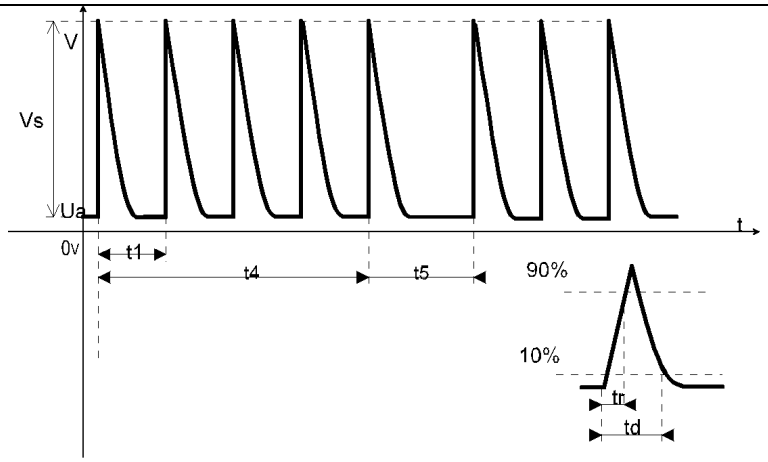
Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The maximum length of the power supply line shall be 200 mm.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Connect the oscilloscope (EUT disconnected) to the pulse generator output (high impedance input) and set the generator to obtain the specified pulses with an internal generator resistance Ri.

12 V Powernet	42 V Powernet	Pulse 3a
U_a = 14 V V_s = - 150 V R_i = 50 Ω t_d = 0.1 µs $t_r \leq$ 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 µs $t_r \leq$ 5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	

12 V Powernet	42 V Powernet	Pulse 3b
U_a = 14 V V_s = 100 V R_i = 50 Ω t_d = 0.1 µs $t_r \leq$ 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 µs $t_r \leq$ 5 ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	

Test:

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

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Measurement of the waveform for each kind of pulse, measured in an open circuit and in a matched load (see annexe D of Norme ISO 7637).
- Parameters observed and malfunctions encountered during the test.

6.1.8.6.REQUIREMENTS

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

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

6.1.9.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 7637-2.3 standard for the 12 V Powernet and to the ISO 21848 project for the 42 V Powernet.

6.1.9.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to load dump transient pulses clipped by the protection built into the alternator.

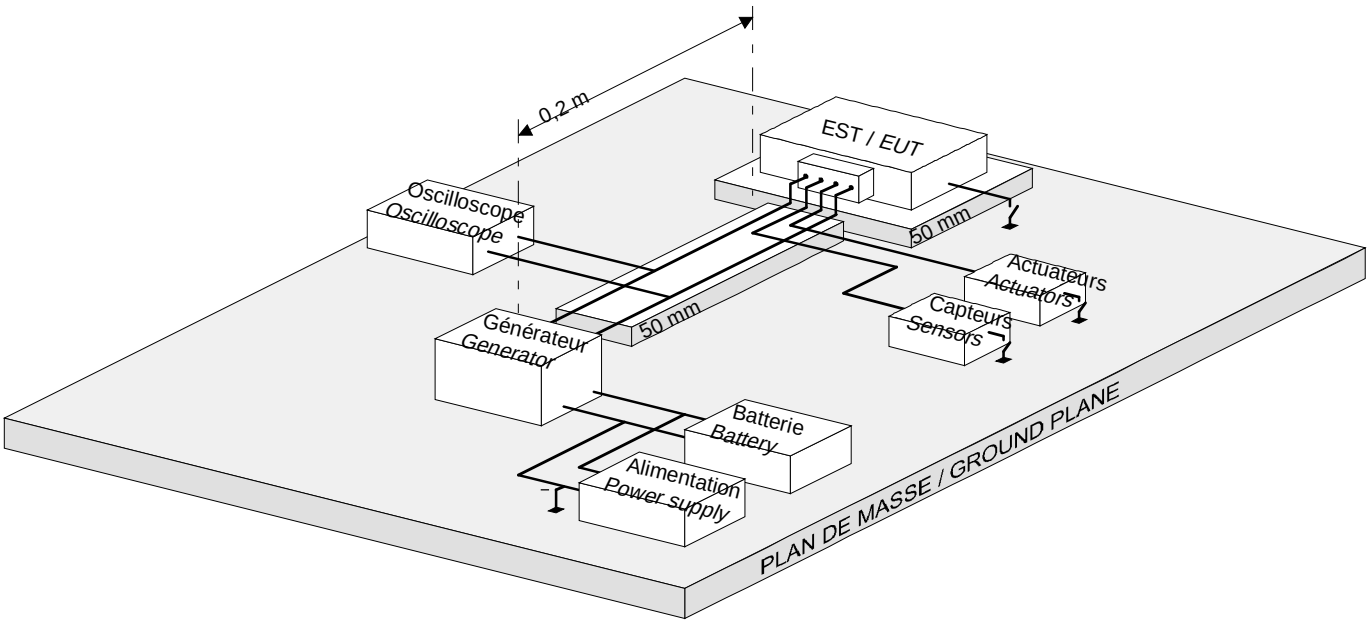
Its principal characteristics are as follows:

- 5 pulses de + 21.5 V (12 V Powernet) or + 16 V (42 V Powernet).
- Pulse width: 400 ms.
- Wires involved: all power supply wires (simultaneously). Power supplies used with a network (for example, +VAN ; +CAN ; etc.) must be considered as power supplies that are relayed and tested as such. The test does not apply if the EUT runs on regulated voltage supplied by calculator .

6.1.9.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Pulse generator.

6.1.9.4.TEST ASSEMBLY



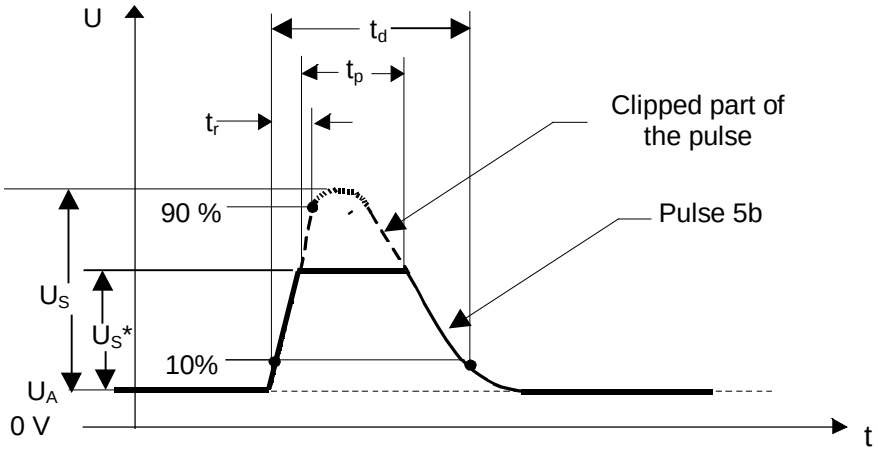
6.1.9.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The maximum length of the power supply line shall be 200 mm.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Connect the oscilloscope (EUT disconnected) to the pulse generator output (high impedance input) and set the generator to obtain the specified pulses with an internal generator resistance Ri.

12 V Powernet	42 V Powernet	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 EUT for a minimum duration of 10 minutes.
- Apply 5b pulses 5 times with a recurrence frequency of one minute to all the power supply lines (grouped) while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Measurement of the waveform for each kind of pulse, measured in an open circuit and in a matched load (see annexe D of Norme ISO 7637).
- Parameters observed and malfunctions encountered during the test.
- Pulses applied.

6.1.9.6.REQUIREMENTS

Test levels	Operating classes	Customer impact levels
Pulses 5b	C	1
Pulses 5b EUT operational in the event of impact	B	0

6.1.10.EQ/IC 04: RESISTANCE TO POWER SUPPLY MICRO-CUT-OFFS

6.1.10.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

6.1.10.2.PRINCIPAL CHARACTERISTICS OF THE TEST

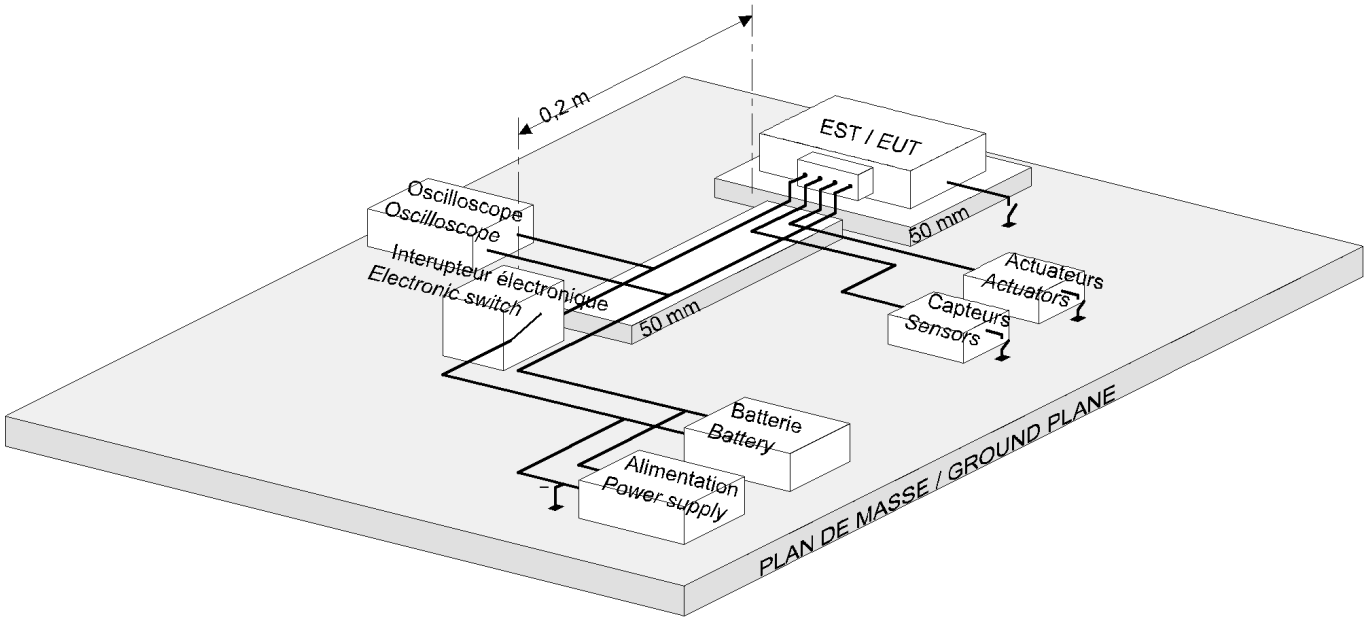
The purpose of this test is to check the immunity of the equipment to power supply micro-cut-offs due to imperfect contacts. Its principal characteristics are as follows for the power inputs:

- 1 µs micro-cut-offs (due to poor contacts with the connectors).
  - Wires involved : all power supply wires taken separately and together. This test also applies to equipment that runs on regulated voltage supplied by calculator.
- 100 µs micro-cut-offs (due to the presence of relays).
  - Wires involved : all power supply wires taken separately and together, in the case where the equipment is supplied by the vehicle via a relay (and therefore not connected directly to the battery).
- 5 ms micro-cut-offs (due to the presence of switches).
  - Wires involved : all power supply wires taken separately and together, in the case where the equipment is supplied by the vehicle via a contact (and therefore not connected directly to the battery or by relay).
-

6.1.10.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Electronic switch capable of generating the test signal.

6.1.10.4.TEST ASSEMBLY



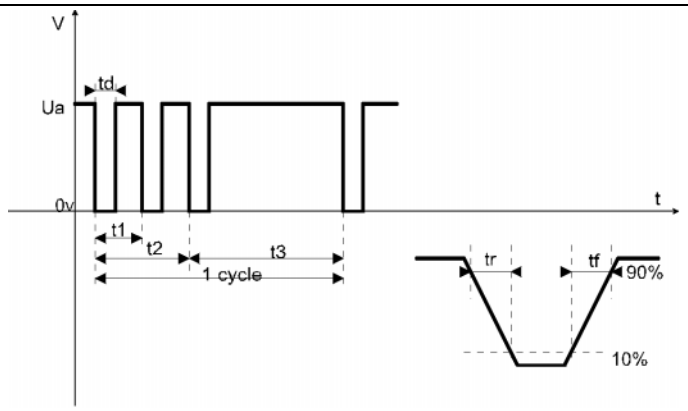
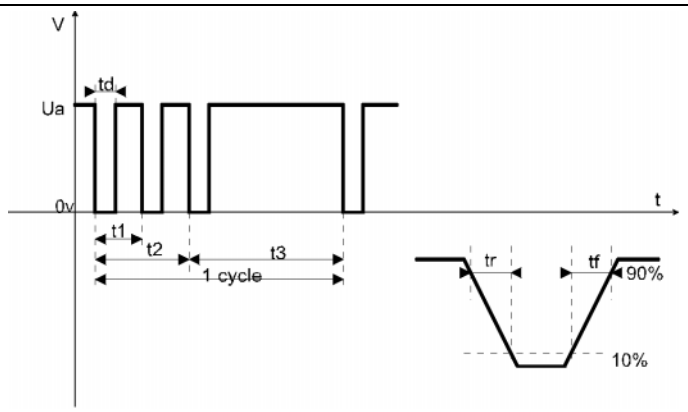
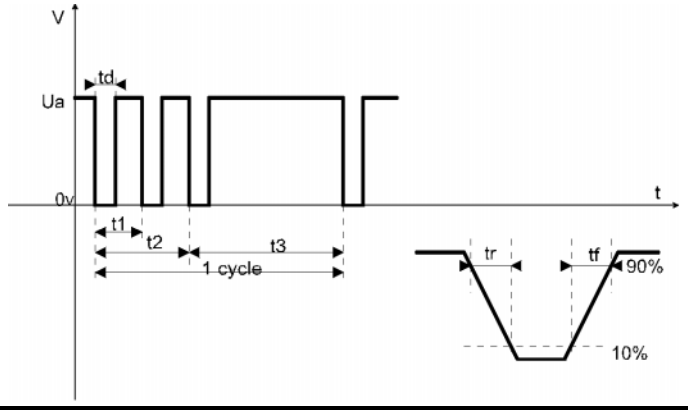
6.1.10.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Replace the EUT by a 1 kΩ resistor and connect the oscilloscope to the resistor terminals and set the generator controlling the switch to obtain the specified signals.

12 V Powernet	42 V Powernet	Connector micro-cut-off (waveform less than 1kΩ)
U_a = 14 V $t_f \leq 1$ µs $t_r \leq 1$ µs td = 1 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 = 1 µs t1 = 1 ms t2 = 4 s t3 = 10 s	
12 V Powernet	**42 V Powernet**	**Relay micro-cut-off**
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 Powernet	**42 V Powernet**	**Switch micro-cut-off**
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 EUT for a minimum duration of 10 minutes.
- Apply 3 cycles of each of the pulses to all the power supply lines taken separately and then grouped while monitoring the EUT.

Note 2 : *Power supply cut-off shall be of an "open" circuit type. The characteristics of the switch should be specified in the test plan.*

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Oscilloscope readings for the cut-offs during the calibration phase, with a 1 kΩ resistive load.
- Parameters observed and malfunctions encountered during the test.
- Characteristics of the switch used and the pulses applied.

6.1.10.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
1 µs micro-cut-offs	B	0
100 µs micro-cut-offs	B	0
5 ms micro-cut-offs	B	0

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

6.1.11.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 7637-2.3 standard for the 12 V Powernet and to the ISO 21848 standard for the 42V.

6.1.11.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to voltage variations during the start-up phase. Pulse 4 may be used if no generator capable of producing pulse 4 bis is available.

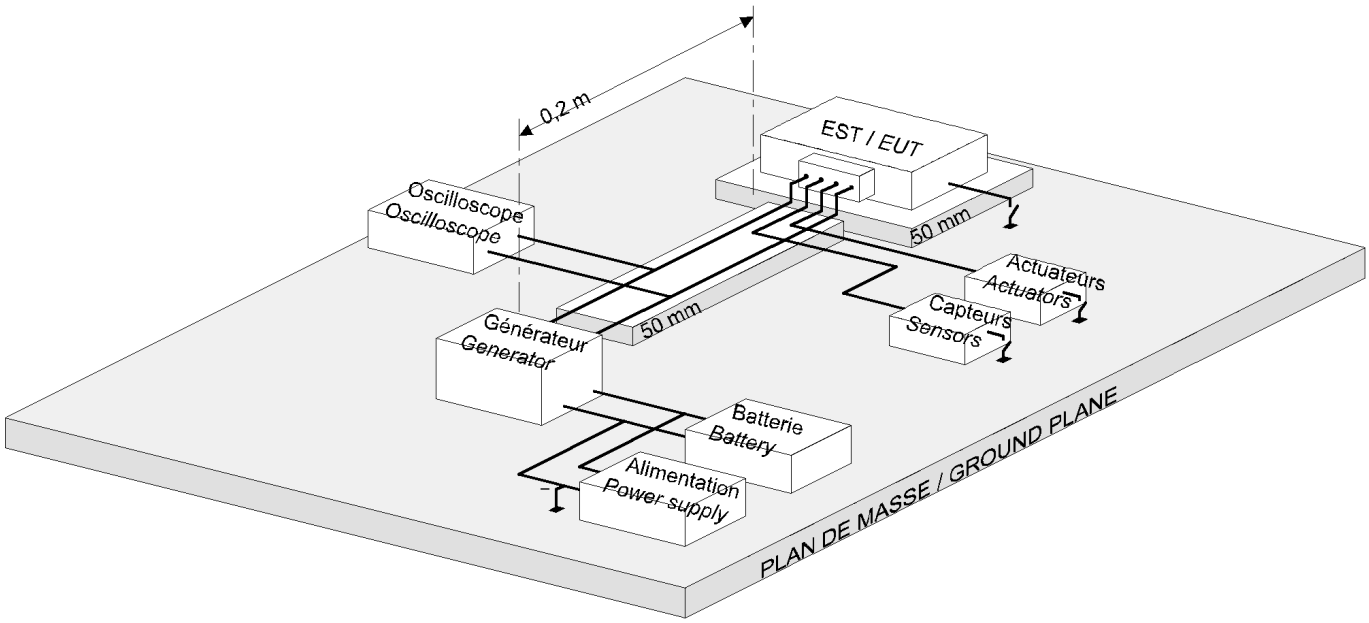
Its principal characteristics are as follows:

- Power supply which can drop down to 4.9 V (12 V Powernet) or 18 V (42 V Powernet).
- 5 pulses at 1 minute intervals.
- Wires involved: all power supply wires taken simultaneously.

6.1.11.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Programmable power supply or pulse generator.

6.1.11.4.TEST ASSEMBLY



6.1.11.5.PROCEDURE

Preparation:

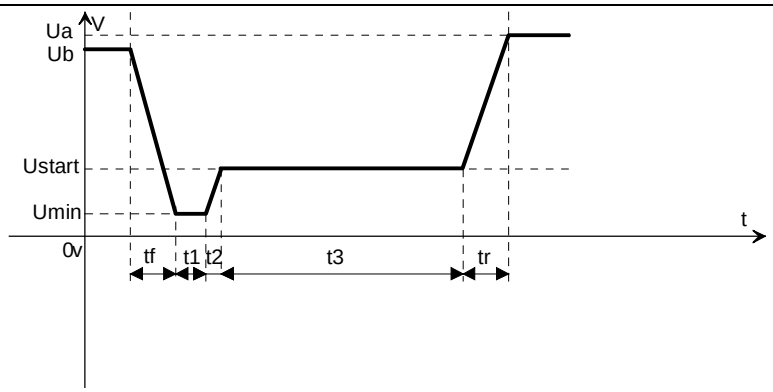
- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The power supply wires of the EUT and the outputs to be tested must be no longer than 200mm.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

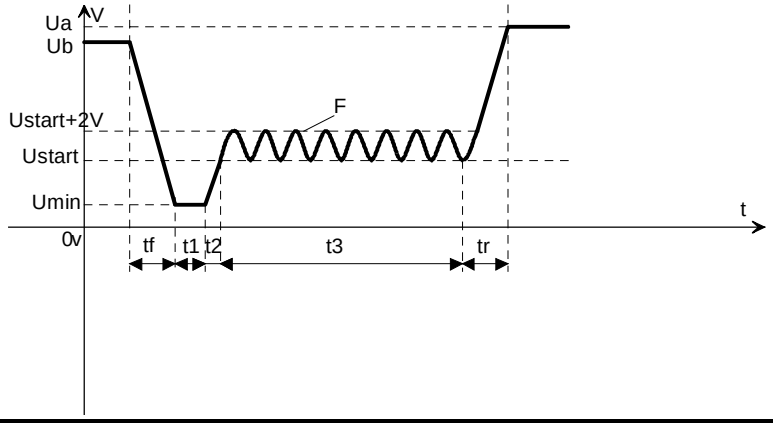
Calibration:

- Connect the oscilloscope (EUT disconnected) to the pulse generator output (high impedance input) and set the generator to obtain the specified pulses.

The default values for U_{min} and U_{start} are indicated in the following table for the 12 V and 42 V powernets. By default, the values of 4.5V and 5.5V are applied to the 12V powernet.

	Petrol engine		Diesel engine	
	U_{min}	**U_{start}**	**U_{min}**	**U_{start}**
12 V Powernet	4.9V	6.5V	4.5V	6,0V
42 V Powernet	18 V	21 V	18 V	21 V

12 V Powernet	42 V Powernet	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 Powernet	42 V Powernet	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 EUT for a minimum duration of 10 minutes.
- Apply pulses 4 or 4 bis 5 times with a recurrence frequency of one minute to all the power supply lines simultaneously while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Characteristics of the pulse applied.

6.1.11.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Pulses 4 or 4 bis EUT must be operational during the vehicle start-up phase	B	0
Pulses 4 or 4 bis EUT non-operational during the vehicle start-up phase	C	1

6.1.12.EQ/IC 06: RESISTANCE TO ON-BOARD POWER NETWORK VOLTAGE RIPPLES

6.1.12.1.REFERENCE DOCUMENT

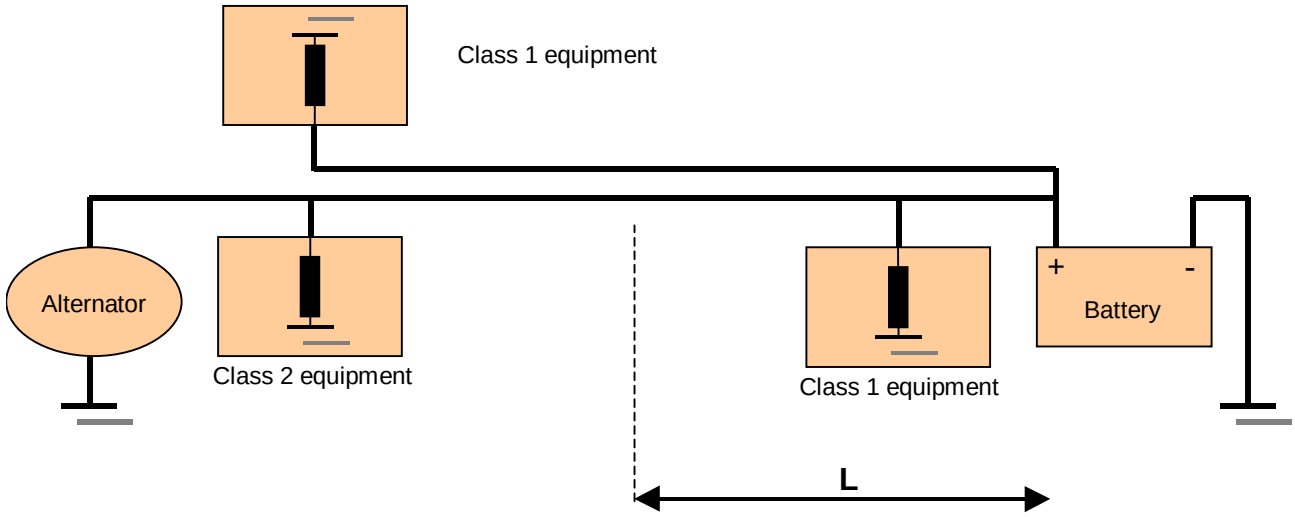
There is no reference document concerning this test.

6.1.12.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to ripples in the on-board power network voltage, generated by the alternator/regulator or by certain consuming elements. Phenomena of accelerated ageing (input capacities, etc.) related to the application of ripples over long periods of time are not taken into account by this Specification.

Its principal characteristics are as follows:

- **For the 12 V Powernet**: 1 V or 2 V peak-to-peak ripple, 50 Hz to 20 kHz. There are two voltage ripple classes for the 12 V powernet:
  Class 1 (1 V DC): equipment powered by the battery and not connected directly to the alternator; as well as equipment connected to the alternator but located at a distance of less than L from the battery.
  Class 2 (2 V DC): equipment connected to the alternator and located at a distance greater than L from the battery.
  The distance L depends on the architecture of the vehicle affected, that is why the choice of class will be specified in the equipment STN/ST or in the test plan. By default, length L shall be 2 m.

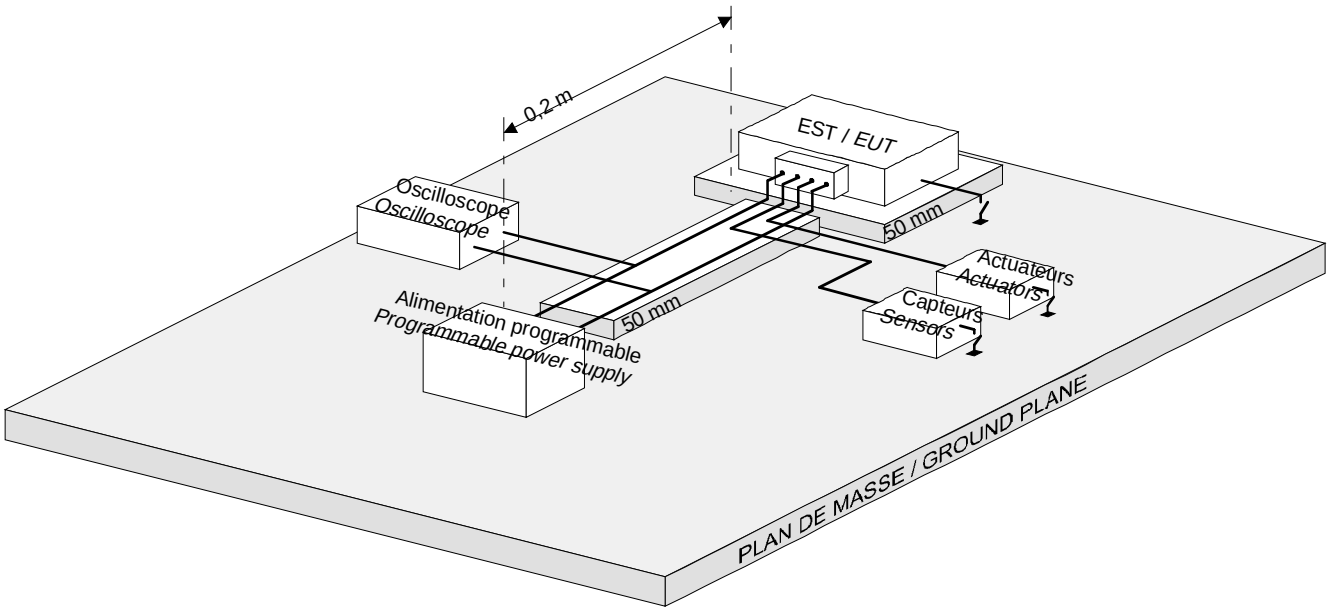


- **For the 42 V Powernet**: 4 V peak-to-peak ripple, 50 Hz to 1 kHz, then 1 V peak-to-peak, 1 kHz to 20 kHz superimposed on the power supply voltage.
-
  - Wires involved: all power supply wires. Power supplies used with a network (for example, +VAN ; +CAN ; etc.) must be considered as power supplies that are relayed and tested as such.

6.1.12.3.TEST FACILITIES

- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Programmable power supply or pulse generator.

6.1.12.4.TEST ASSEMBLY



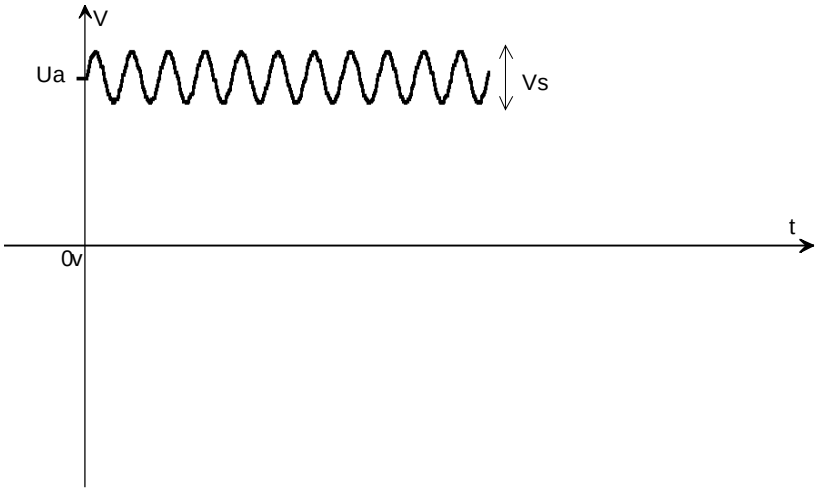
6.1.12.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The power supply wires of the EUT and the outputs to be tested must be no longer than 200mm.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

- Connect the oscilloscope (EUT disconnected) to the test signal generator output (high impedance input) and set the generator to obtain the specified signal.

<table>
<tr><th>12 V Powernet</th><th>42 V Powernet</th><th>On-board power network voltage ripples</th></tr>
<tr><td>Ua = 14 V</td><td>Ua = 48 V and 32 V</td><td rowspan="3"> 
</td></tr>
<tr><td>Class 1: Vs = 1 V DC
Class 2: Vs = 2 V DC</td><td>Vs = 4 V DC for
F = 50 Hz - 1 kHz</td></tr>
<tr><td>F = 50 Hz - 20 kHz</td><td>Vs = 1 V DC for
F = 1 kHz - 20 kHz</td></tr>
</table>

Test:

- Run the EUT for a minimum duration of 10 minutes (without voltage ripples).
- Apply the signal to all the power supply lines while monitoring the EUT. The test duration is determined by application of paragraphs 4.8.2 and 4.8.3 of this Specification.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.1.12.6.REQUIREMENTS

Test	Operating class	Customer impact level
Ripple	A	0

6.2.IMMUNITY BY CONDUCTION TESTS

6.2.1.EQ/IC 07: IMMUNITY TO SIGNAL LINE TRANSIENTS

6.2.1.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO 7637-3 standard.

6.2.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

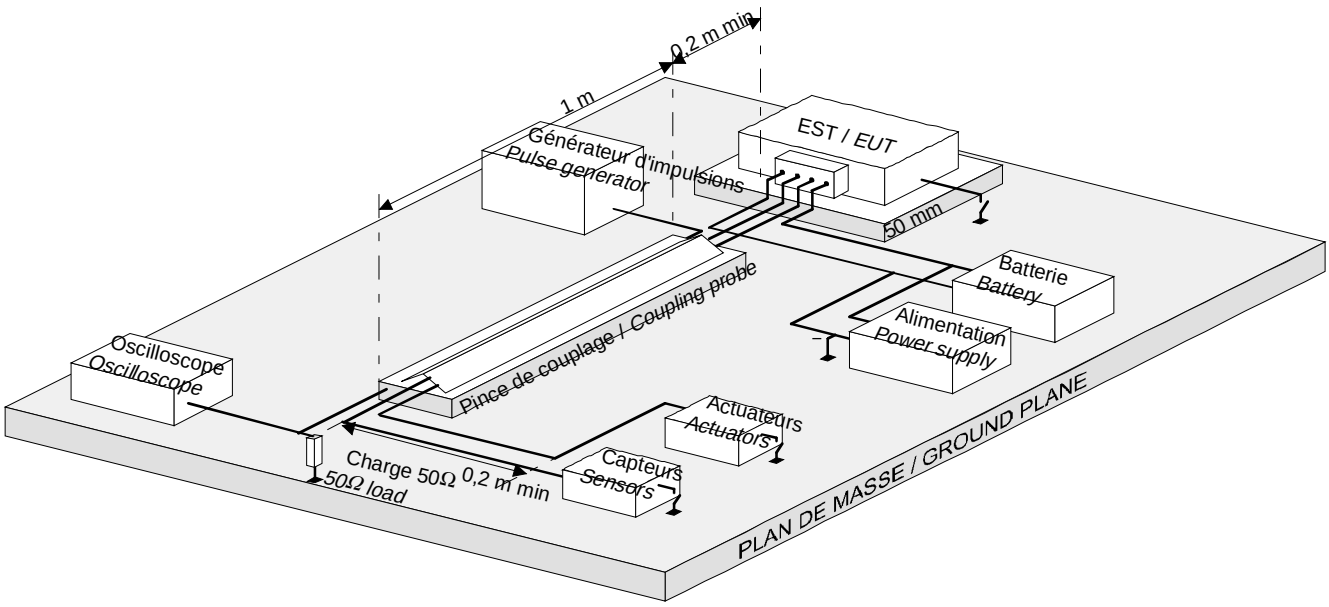
The purpose of this test is to check the immunity of the equipment to coupled transients on signal lines.
Its principal characteristics are as follows:

- Coupling with type 3a (–150 V) and 3b (+100 V) pulses.
- Duration: 10 minutes for each type of pulse.
- Wires involved: all except earth and power supply wires.

6.2.1.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Pulse generator.
- Oscilloscope.
- Coupling probe complying with the ISO 7637-3 standard.
- 50 Ω load.

6.2.1.4.TEST ASSEMBLY



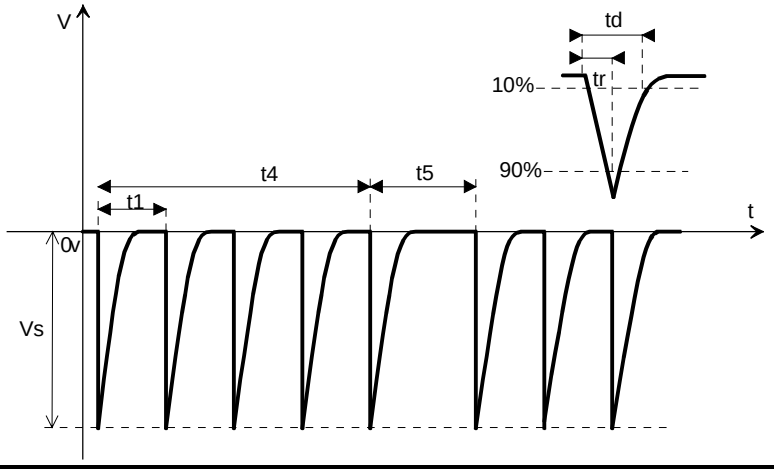
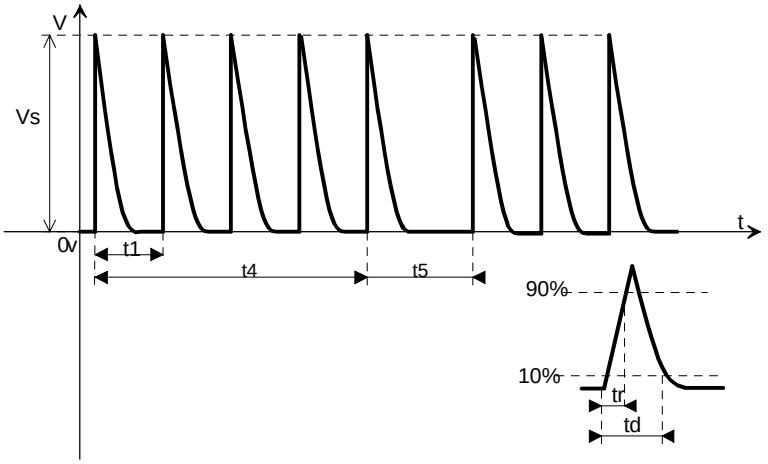
6.2.1.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support and must be placed at a right angle to the outside of the coupling probe.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- Place the harness connected to the EUT in the coupling probe, except for the earth and power supply wires.
- Load the coupling probe with 50 Ω.

Calibration:

- Connect the pulse generator output (EUT disconnected) to the coupling probe.
- Connect the oscilloscope (high impedance input) to the 50 Ω load and set the generator to obtain the specified pulses.

12 V Powernet	42 V Powernet	Pulse 3a
V_s = - 150 V R_i = 50 Ω t_d = 0.1 µs $t_r \leq 5$ 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 µs $t_r \leq 5$ ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	
12 V Powernet	**42 V Powernet**	**Pulse 3b**
V_s = 100 V R_i = 50 Ω t_d = 0.1 µs $t_r \leq 5$ 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 µs $t_r \leq 5$ ns t_1 = 100 µs t_4 = 10 ms t_5 = 90 ms	

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Apply pulses 3a for 10 minutes and pulses 3b for 10 minutes to the coupling probe while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.

6.2.1.6.REQUIREMENTS

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

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

6.2.2.1.REFERENCE DOCUMENT

This procedure conforms to the ISO/DIS 11452-4 standard.

6.2.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to common mode disturbances inducted by wiring harnesses.

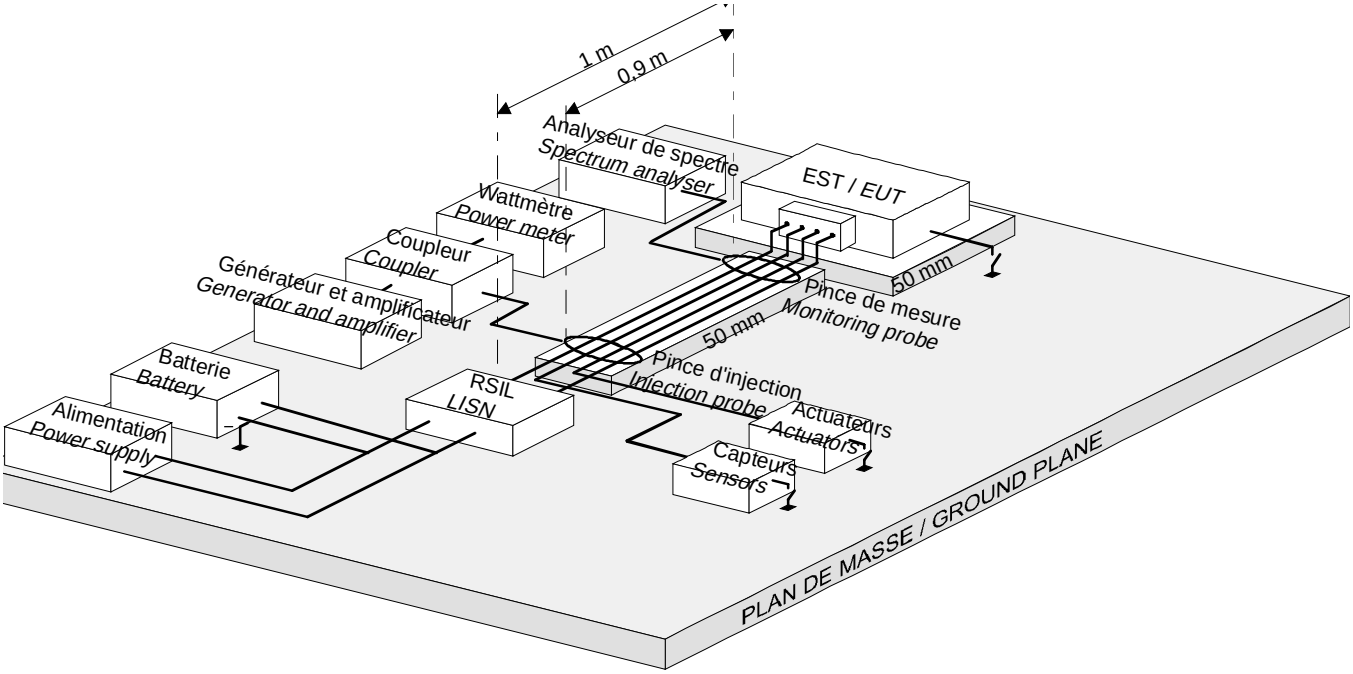
Its principal characteristics are as follows:

- CW and AM modulation.
- Frequency band [1 MHz - 400 MHz].
- Power application method based on the measured current (closed loop method) with limitation of applied forward power.
- Wires involved: in the case of equipment with several connectors, injection must be performed on each separate harness. However, the test plan may cover (in accordance with PSA) any other injection scenario (grouping of all or part of the harness(es) in coherence with the real vehicle configuration).

6.2.2.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω loads.
- High frequency signal generator.
- Broadband power amplifier.
- One 50 Ω coupler.
- Power meter or equivalent.
- Current injection probe.
- Current measurement probe.
- Injection probe calibration device (JIG).
- Shielded enclosure (where possible, to preserve electromagnetic spectrum integrity).

6.2.2.4.TEST ASSEMBLY



6.2.2.5.PROCEDURE

Preparation:

- A 1-m long harness, straight throughout its length, must be used. The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- Connect the injection probe 0.9 m from the EUT connector, centred around the group of harness wires including the power supply wires.
- Connect the measurement probe 50 mm from the EUT connector, centred around the group of harness wires including the power supply wires.

Calibration:

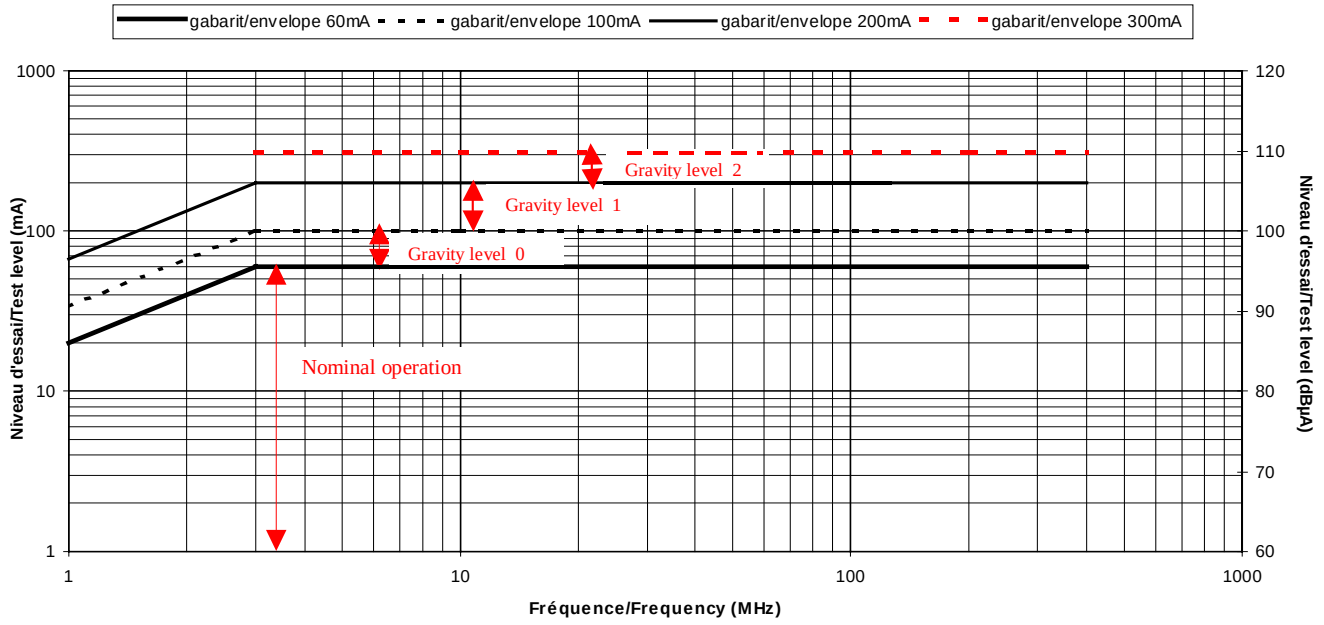
Calibration is performed in CW only.

- Connect the injection probe centred around the calibration JIG loaded with 50 Ω on both of its ports.
- Record the forward power $P_{calibration}$ required to induce the specified current, $I_{envelope}$, in CW on the JIG. The limit forward power to be applied to the injection probe is equal to four times the calibration power:

$$P_{limit} = 4 \times P_{calibration}$$

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 currents in this table are given in effective mA and the frequencies in MHz).



Test:

- Run the EUT for a minimum duration of 10 minutes.
- Gradually increase the forward power applied to the injection probe until the measured current reaches $I_{envelope}$, or until it reaches P_{limit} or until a malfunction occurs ($I_{malfunction}$, $P_{malfunction}$).
- Gradually decrease the forward power applied to the injection probe and change the frequency.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test: required sensitivity thresholds.
- Values and curves of $I_{measured}$, $I_{malfunction}$, $P_{malfunction}$, $P_{incident}$, P_{limit}.
- Test harness transfer function defined by:
  - $$Z_{transfert}(\Omega) = 100.\frac{I_{envelope}}{I_{measured}}.\sqrt{\frac{P_{incident}}{P_{calibration}}}$$
  - or:
  - $Z_{transfert}(dB\Omega) = 40 + I_{evelope}(dB\mu A)\quad I_{measured}(dB\mu A) + P_{incident}(dBm)\quad P_{calibration}(dBm)$

6.2.2.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
60 mA envelope	not applicable	0
100 mA envelope	not applicable	1
200 mA envelope	not applicable	2
300 mA envelope	D	3

Note 1 : *Undesired events with customer impact level x are prohibited below the test level associated with customer impact level x.*

Note 1 : *In the case of an EUT which includes a radio transmitter/receiver function (eg; remote control at F_0 MHz), the function may be non-operational (to be specified in the test plan) within a frequency range of $F_0 \pm 5\%$.*

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

6.2.3.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

6.2.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to disturbances generated by the high voltage or low voltage ignition system (coil controls).

The high voltage test applies to equipment installed in the engine compartment with an electrical connection routed at less than 200 mm from the high voltage ignition system.

The low voltage test applies to equipment installed in the engine compartment with an electrical connection alongside the control harness.

Its principal characteristics are as follows:

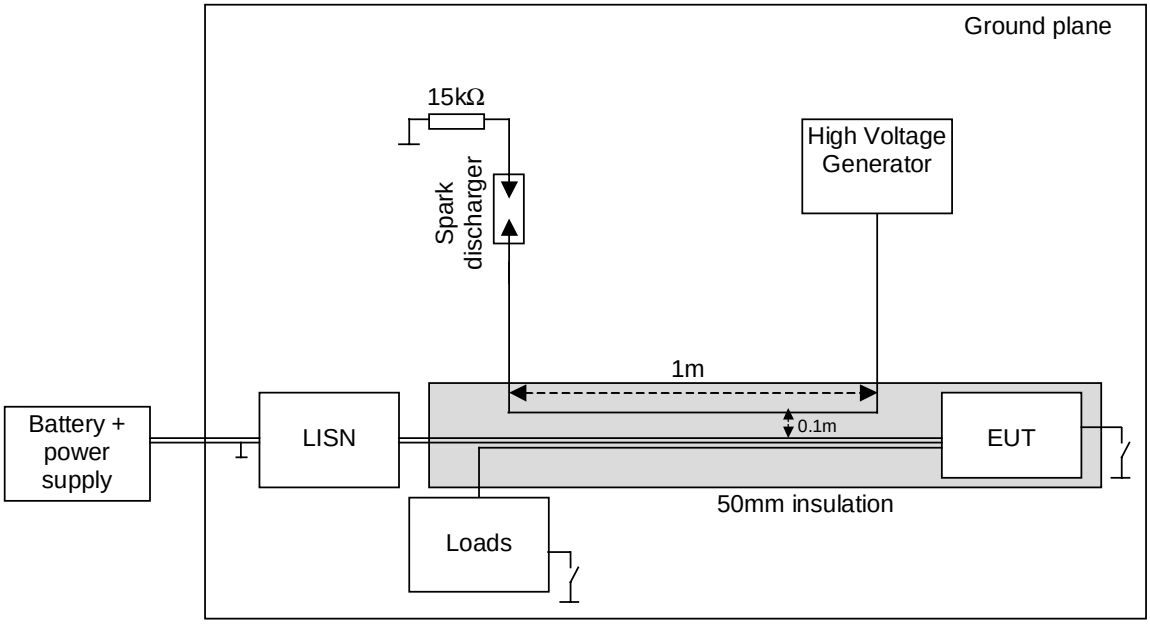
- Signal on 15 kΩ: 10 kV (high voltage), 420 V peak (low voltage).
- Coupling with the EUT harness strand over 1 m: at a distance of 100 mm (high voltage), contiguous (low voltage).
- Duration of the test: 10 minutes.

6.2.3.3.TEST FACILITIES

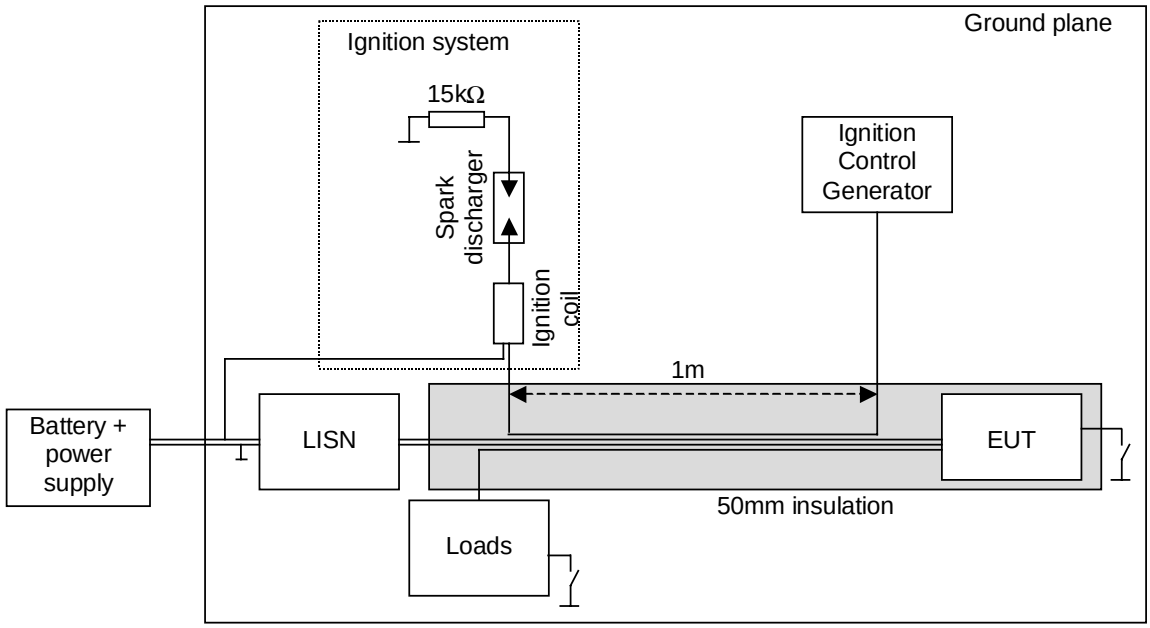
- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication, loaded with 50 Ω.
- 15 kΩ load.
- Spark discharger.
- High voltage generator or ignition control.
- Representative control harness.
- For the low voltage ignition test, an ignition coil is necessary (Reference 597079 – Peugeot and/or Citroen – TU 8 valve engine)

6.2.3.4.TEST ASSEMBLY

High voltage:



Low voltage:



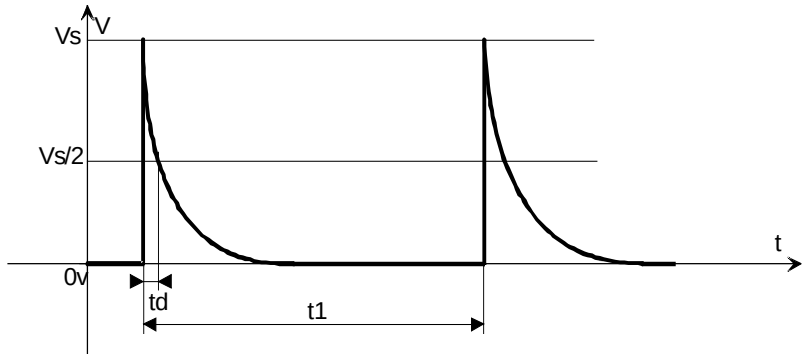
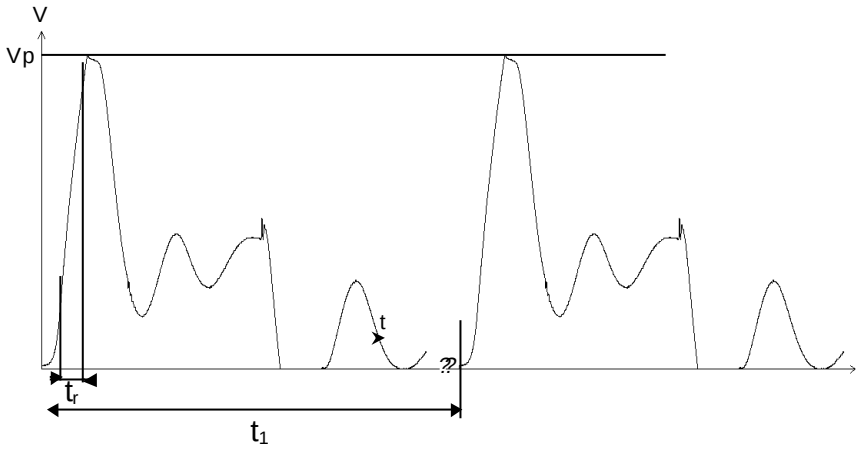
6.2.3.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- The high voltage (non resistive) harness is placed on a 50-mm thick insulating support and the EUT harness strand must be located 100 mm from the high voltage harness over a length of 1 m.
- The representative low voltage harness is placed on a 50-mm thick insulating support and the EUT harness strand must be contiguous to the low voltage harness over a length of 1 m.

Calibration:

Set the high voltage generator and the spark discharger or the ignition command generator to obtain the desired signal measured on the load.

12 V Powernet	42 V Powernet	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	
12 V Powernet	**42 V Powernet**	**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 EUT for a minimum duration of 10 minutes.
- Apply the high / low voltage signal for 10 minutes while monitoring the EUT.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- The waveform of the high / low ignition voltage signals,

6.2.3.6.REQUIREMENTS

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

6.3.IMMUNITY TO RADIATED DISTURBANCE TESTS

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

6.3.1.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 11452-2 standard, except for the frequency from which the antenna is shifted in front of the EUT, as well as the choice of modulations for the frequencies above 1.2GHz.

6.3.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to the electromagnetic field in the [200 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands.

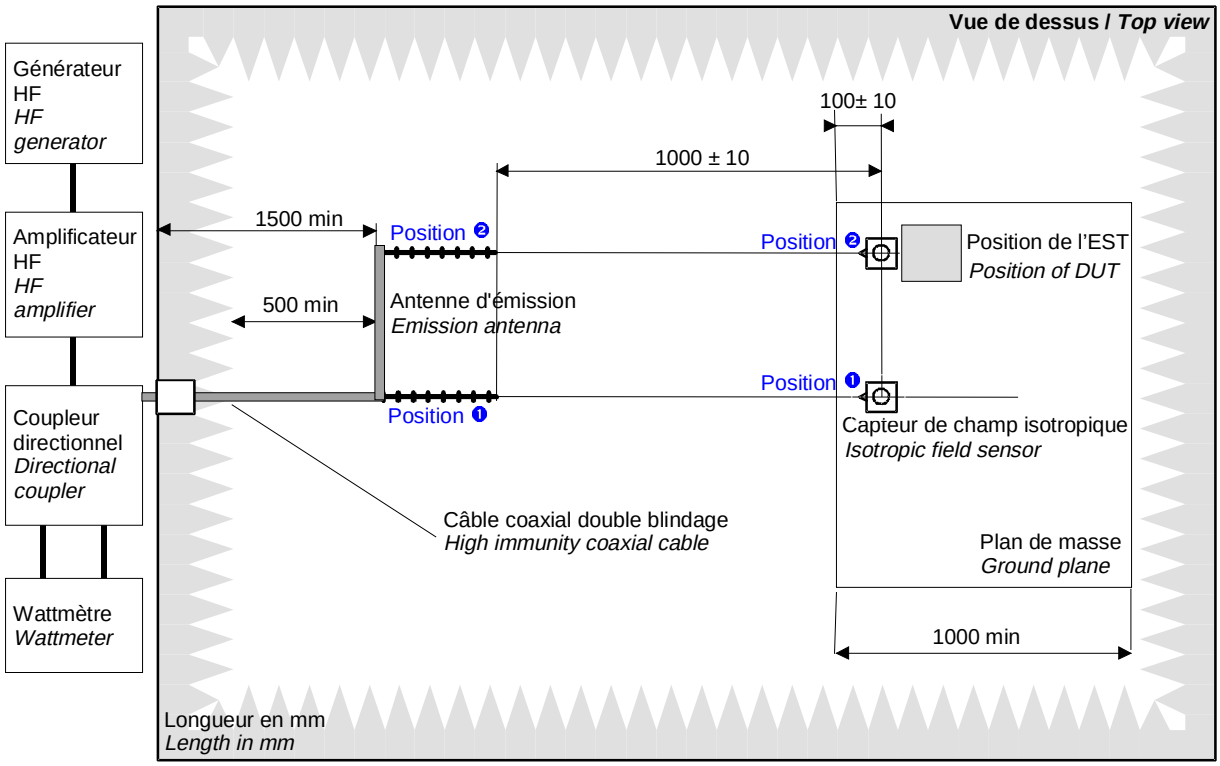
Its principal characteristics are as follows:

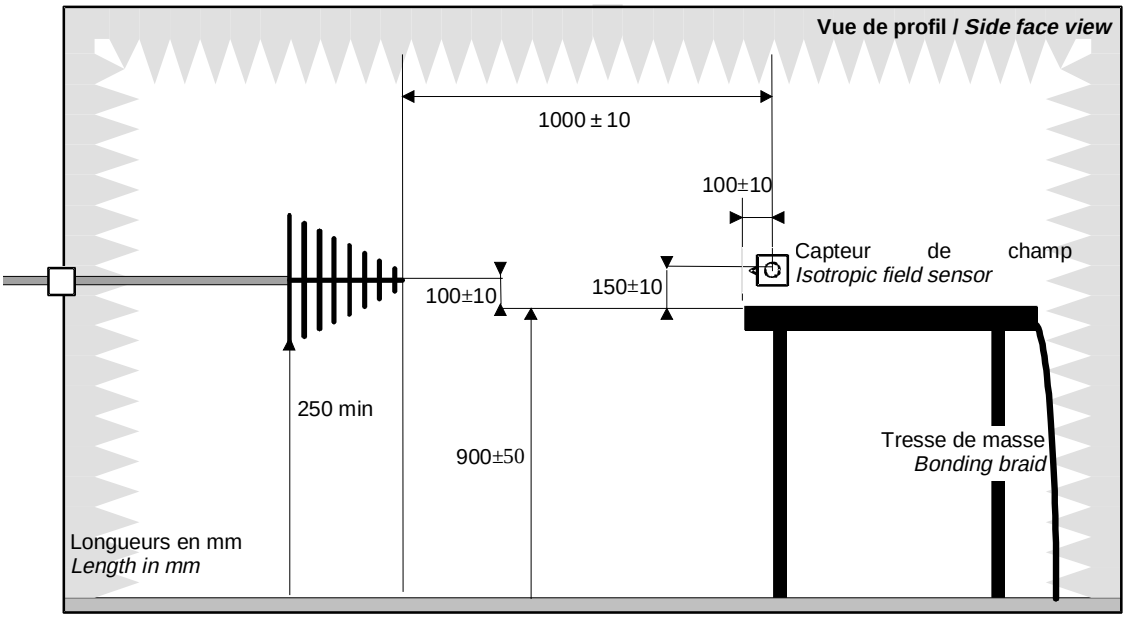
- Modulations
  - CW and AM in the [200 MHz – 800 MHz] frequency band.
  - CW, AM and PM1 in the [800 MHz – 1 GHz] frequency band.
  - CW and PM1 in the [1 GHz – 1.2 GHz] frequency band.
  - CW and PM2 in the [1.2 GHz – 1.4 GHz] frequency band.
  - CW and PM1 in the [1.4 GHz – 2.5 GHz] frequency band.
  - CW and PM2 in the [2.7 GHz – 3.2 GHz] frequency band.
- Substitution method.
- Vertical polarisation in the [200 MHz – 3.2 GHz] frequency band.
- Horizontal polarisation in the [400 MHz – 3.2 GHz] frequency band.
- Test on a metal earth plane.

6.3.1.3.TEST FACILITIES

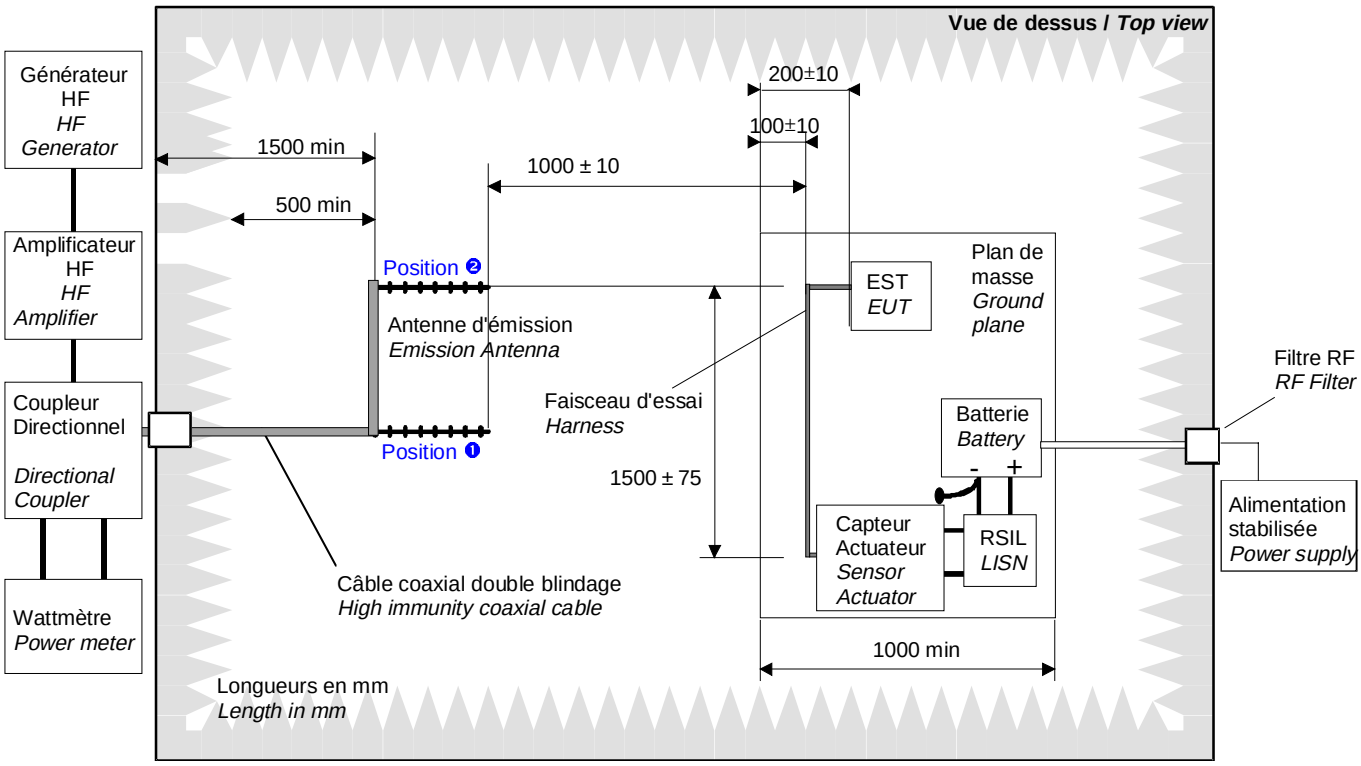
- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω load(s).
- High frequency signal generator and broadband power amplifiers.
- 50 Ω coupler.
- Watt meter.
- Log-periodic antenna or horn antenna.
- Isotropic field sensor equipped with optical fibre.
- Semi-anechoic or anechoic shielded enclosure.

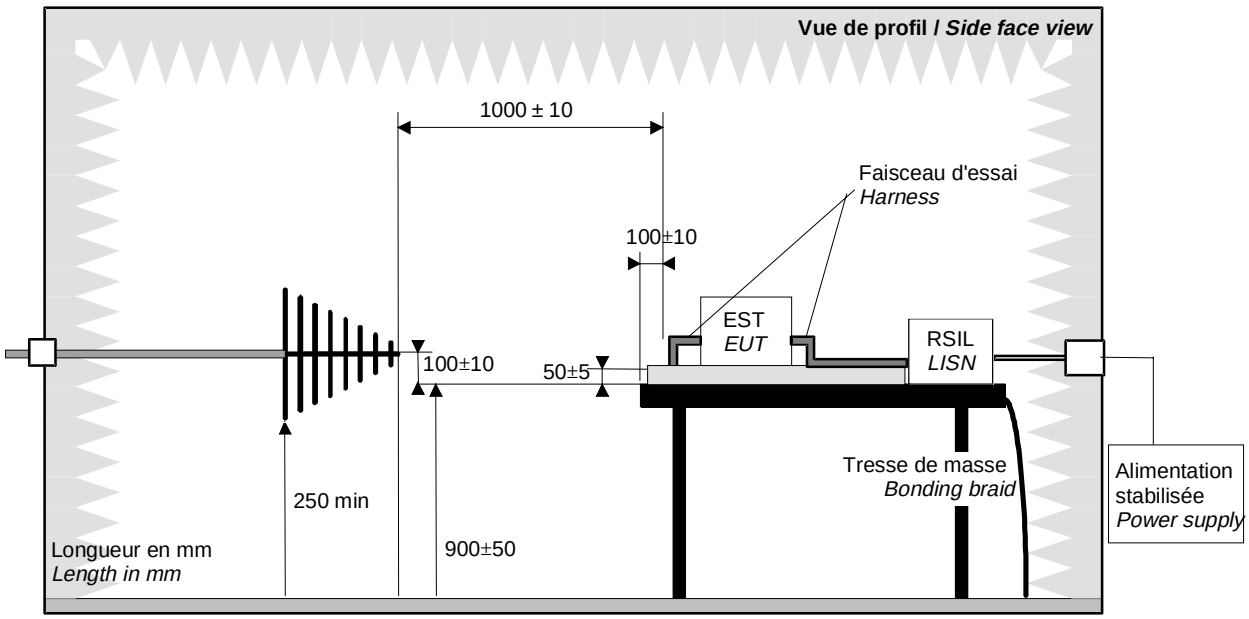
6.3.1.4.TEST ASSEMBLY





Calibration configuration





Test configuration

6.3.1.5.PROCEDURE

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

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

All of the tests are carried out preserving the peak level for modulated and sine wave signals.

Preparation:

- A harness with a maximum length of 2000 mm, 1500 ± 75 mm of which is parallel to the edge of the table, should preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.

Calibration:

Calibration is performed in CW only.

- Place the centre of the isotropic filed sensor phase at a height of 150 mm from the earth plane and at a distance of 100 mm from the edge of the earth plane.
- Place the tip of the antenna at a distance of 1000 mm from the isotropic field sensor. Calibration shall be carried out for two antenna and sensor positions: facing the middle of the harness (position ❶) up to 800 MHz and facing the EUT (position ❷) above 800 MHz.
- Record the forward power level $P_{calibration}$ required to generate the specified field in CW for each frequency: 60 V/m, 100 V/m, 150 V/m and 200 V/m (effective values).

Test:

- Run the EUT for a minimum 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 shall be carried out for two antenna positions: facing the middle of the harness (position ❶) up to 800 MHz and facing the EUT (position ❷) above 800 MHz.
- Gradually increase the forward power applied to the antenna until it reaches $P_{calibration}$ while monitoring the EUT.
- Gradually decrease the forward power applied to the antenna and change the frequency.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test: required sensitivity thresholds.

6.3.1.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
60 V/m (effective)	not applicable	0
100 V/m (effective)	not applicable	1
150 V/m (effective)	not applicable	2
200 V/m (effective)	D	3

Note 1 : *Undesired events with customer impact level x are prohibited below the test level associated with customer impact level x.*

Note 1 : *In the case of an EUT which includes a radio transmitter/receiver function (eg; remote control at $F_{0\ MHz}$), the function may be non-operational (to be specified in the test plan) within a frequency range of $F_0 \pm 5\%$.*

6.3.2.EQ/IR 02: IMMUNITY TO LOW FREQUENCY MAGNETIC FIELDS

6.3.2.1.REFERENCE DOCUMENT

This test procedure conforms to the MIL STD 461 E standard, except for the upper frequency limit.

6.3.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of equipment sensitive to magnetic fields. (Hall effect sensors, audio circuits, etc.), as well as equipment located near a strong magnetic field source (alternator, DAE, etc.).

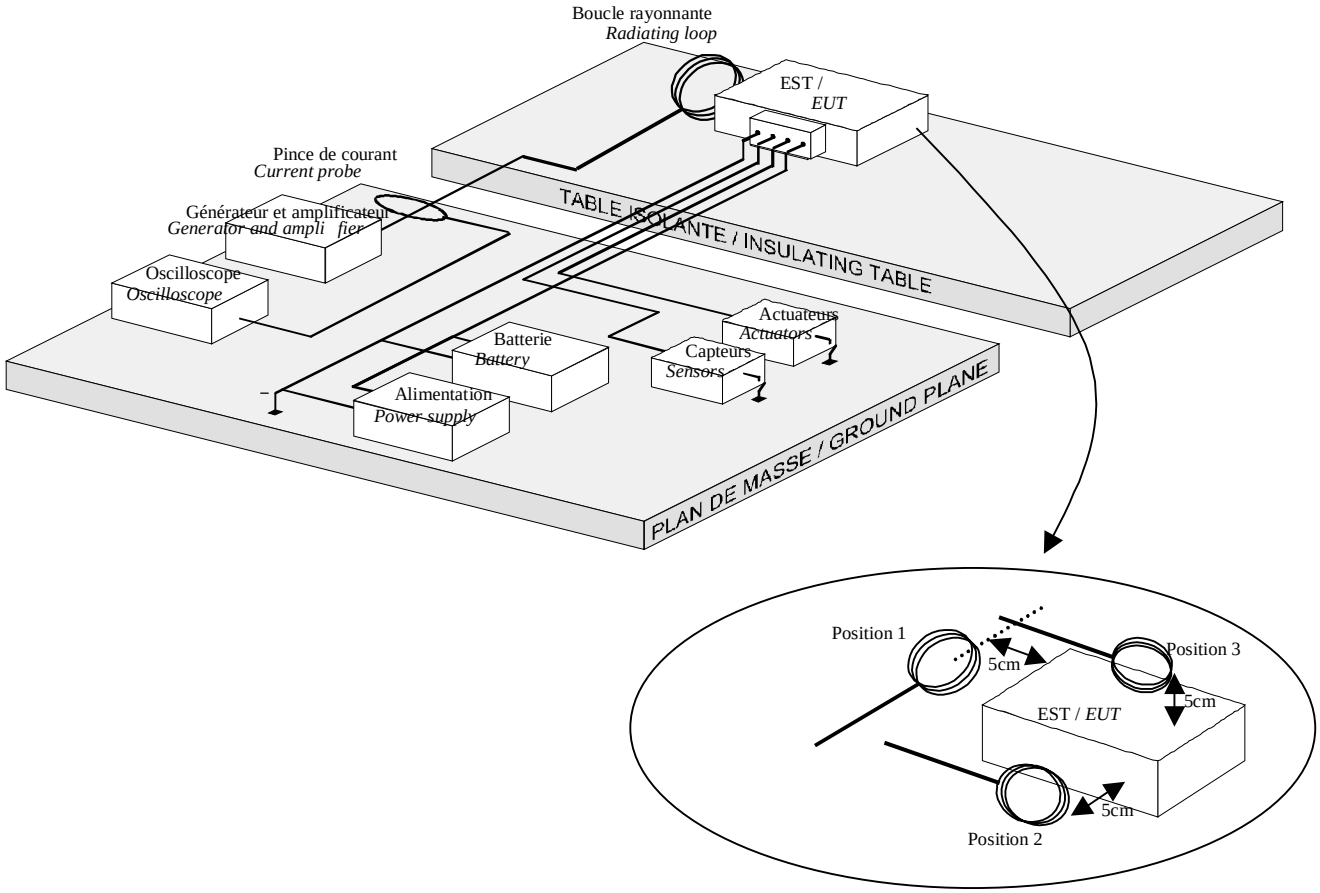
Its principal characteristics are as follows:

- Sine wave signal.
- Frequency band [20 Hz - 150 kHz].
- Substitution method.
- Generation of a magnetic field with sinusoidal shape by circulating the current in a coil(s).
- 3 EUT or injection coil orientations.

6.3.2.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- Insulating table.
- Low frequency signal generator.
- Power amplifier.
- Low frequency magnetic field sensor.
- Current probe.
- Oscilloscope.
- A coil with the MIL STD 461E characteristics is recommended:
- Diameter : 120 mm
- Number of turns : 20
- Wire diameter : approximately 2 mm
- The field thus created by a current I at a distance of 50 mm fulfils the equation : $H = 75.6\ I$ (A/m)
- A Helmholtz coil may be permitted as an alternative solution.

6.3.2.4.TEST ASSEMBLY



6.3.2.5.PROCEDURE

The method used is the substitution method.

Preparation:

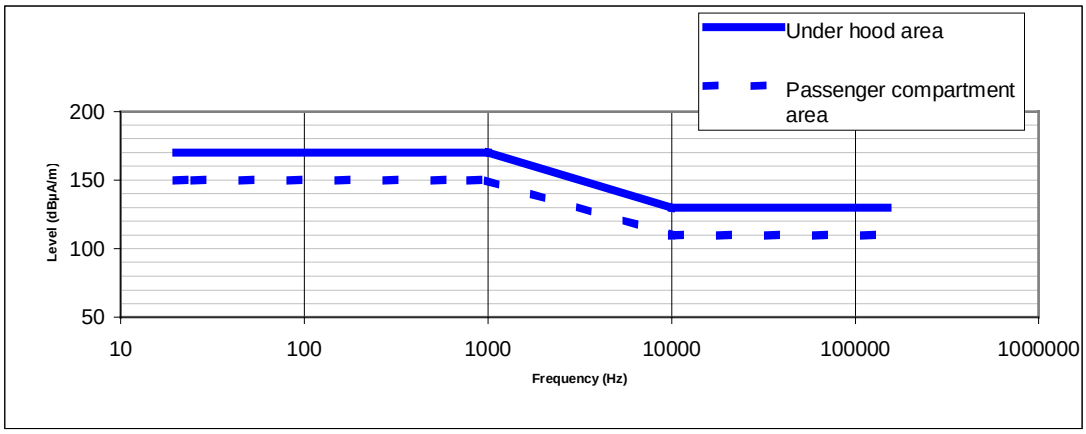
- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used).
- The EUT is placed on an insulating table (or in the centre of the Helmholtz coils).

Calibration:

- Place the magnetic field sensor 50 mm from the radiating coil (or in the centre of the Helmholtz coils) on the insulating table.
- Record the $I_{calibration}$ current (amplifier output) required to generate the specified field for each frequency.

The following requirements must be used. The test plan or the STN/ST shall specify which of the two requirements applies, depending on whether the EUT is located in the engine or in the passenger compartment.

Frequency band(Hz)	Magnetic field spectrum envelope (dBµA/m)	
	Engine compartment	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 EUT for a minimum duration of 10 minutes.
- Apply the $I_{calibration}$ current to the coil(s) and perform the frequency sweep.
- Carry out the test by placing the radiating coil 50 mm from the EUT and parallel to it and moving the coil to all the EUT points defined in the test plan. Carry out the test along the three axes if a Helmholtz coil is used.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Characteristics of the coils used.

6.3.2.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Magnetic field	A	0

Note : *In the case of an EUT which includes a radio transmitter/receiver function (eg; remote control at $F_{0\ Mhz}$), the function may be non-operational (to be specified in the test plan) within a frequency range of $F_0 \pm 5\%$.*

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

6.3.3.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

6.3.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to on-board transmitters with built-in antennas (cellular telephones, Bluetooth transmitter, etc.). This test only applies to equipment located in the passenger compartment or in the boot.

Its principal characteristics are as follows:

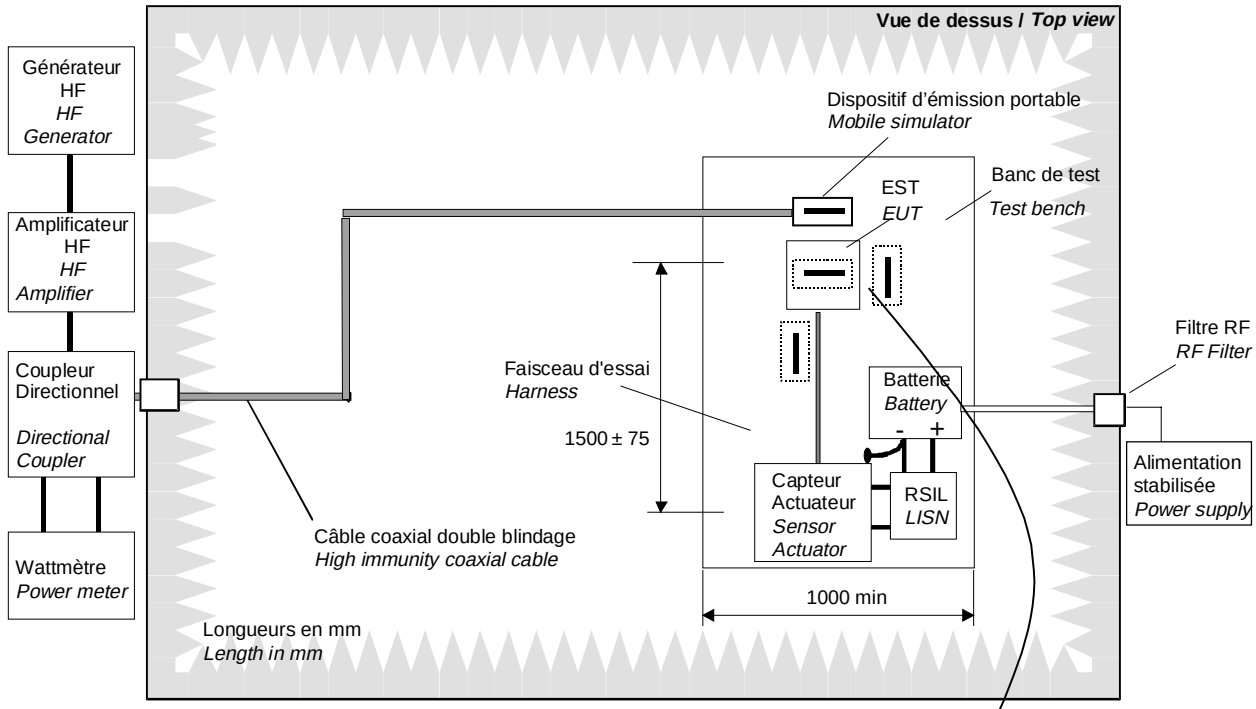
- Closed feedback loop on the transmitted power (forward power – reflected power) at the terminal of the mobile transmission device (housing + antenna).
- Generation of an electric field with the mobile transmission device.
- 3 EUT or on-board transmitter orientations.

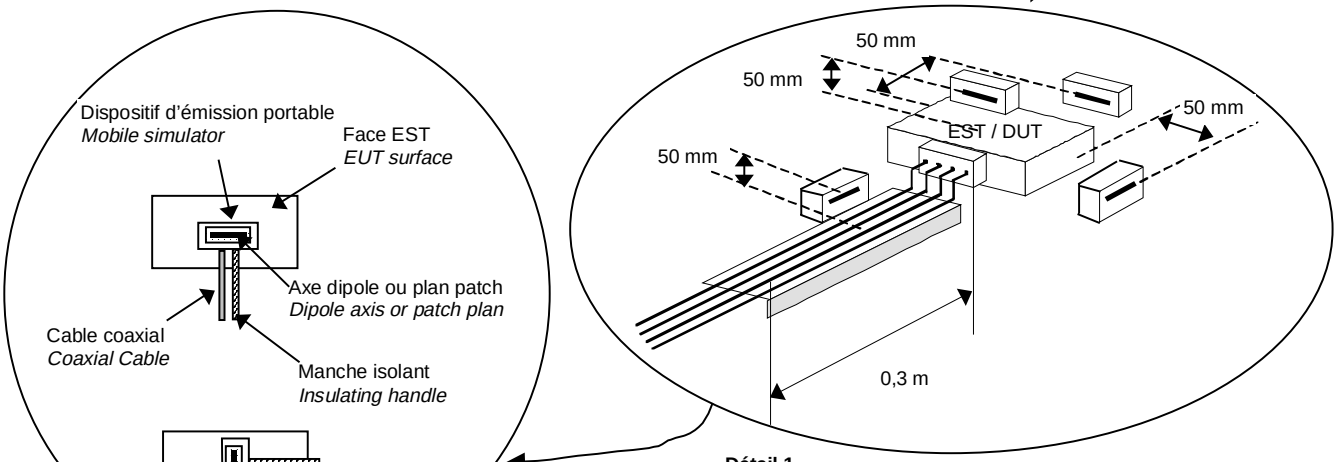
6.3.3.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- Insulating table by default (an additional 50-mm thick insulation support may be used for the practical test performance and positioning of the transmitter simulator in relation to the EUT). In the case of equipment connected to the chassis by a special earth link, an earth plane with a 50-mm thick insulating support shall be used.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω load(s).
- High frequency signal generator and broadband power amplifiers.
- 50 Ω coupler.
- Watt meter.
- Mobile transmission device with the following characteristics (by default):
    - 890 - 915 MHz range: dipole antenna.
    - 1710 - 1785 MHz range: dipole or patch antenna.
    - 2402 – 2480 MHz range: patch antenna.

Note: *The use of a monopole antenna is not recommended (test feasibility with different polarisations).*

6.3.3.4.TEST ASSEMBLY





Détail 1
Positions du dispositif d'émission portable (EST et faisceau)
Mobile simulator positions (EUT and harness)

Détail 2
Position du dispositif d'émission portable pour différentes polarisations
Mobile simulator position for different polarisations

6.3.3.5.PROCEDURE

- The method used is the closed feedback loop method on transmitted power (transmitted power = forward power – reflected power) at the terminal of the mobile transmission device.

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used).
- The EUT is placed on an insulating table. In the case of equipment connected to the chassis by a special earth link, an earth plane with a 50-mm thick insulating support shall be used.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Set the HF generator to obtain the transmitted power level $P_{calibration}$ (measured in CW) at the terminal of the mobile transmission device which corresponds to that indicated in the following table. This setting must be made in a configuration in which the mobile transmission device is positioned at a distance of at least 1 m from all metal parts (shell wall, equipment, earth plane) and 0.5 m from absorbers.
- Then apply the modulation indicated in the following table and move forward the mobile transmission device to the various positions indicated (EUT and harness). The mobile transmission devices must be used with an insulating support (or handle) at least 0.5 m in length to limit operator influence on tests carried out manually.

Frequency bands (MHz) (1)	Test frequencies (MHz) (2)	Effective transmitted power measured in CW ($P_{calibration}$) (3)	Modulation to be superimposed (for EUT test)
890 - 915	902.4	6 W	PM 217 Hz T_{on} 577 µs
1710 - 1785	1747.4	3 W	PM 217 Hz T_{on} 577 µs
2402 - 2480	2441	300 mW	PM 700 kHz Duty cycle 0.5

Note 1: *There are other frequency ranges on different markets which correspond to on-board transmitters with built-in antennas (PDC Japan, AMPS USA, GSM 1900 USA, etc.).*
The list of possible additional frequency ranges (with test frequency, power and signals to be applied) must be specified in the test plan or Specification specific to the equipment.

Note 2: *Unless there is a special specification in the test plan or in the Specification specific to the equipment, the tests shall be carried out for the central frequency in the band.*

Note 3: *Transmitted power (forward power – reflected power) at the terminal of the mobile transmission device.*

EUT test:

- For each surface of the EUT, place the mobile transmission device at a distance of 50 mm from the EUT's surface. The distance of 50 mm corresponds to the distance between the centre of the antenna and the surface of the EUT (cf. detail 1 of the test assembly).
- The axis of the dipole or plane of the patch antenna must be parallel to the surface of the EUT being tested (cf. detail 1 of the test assembly).
- Move the simulator along the surface for two orientations (polarisations) of the antenna parallel to the surface of the EUT (cf. detail 2 of the test assembly).

Harness test:

- Place the mobile transmission device at a distance of 50 mm from the harness. The distance of 50 mm corresponds to the distance between the centre of the antenna and the harness (cf. detail 1 of the test assembly).
- The axis of the dipole must be parallel to the harness; for a patch antenna, ensure that the polarisation of the patch antenna is parallel to the harness (or if the polarisation is unknown, perform the tests for both polarisations).
- Carry out the test by moving the simulator along the harness over a length of 0.3 m from the EUT connector.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Characteristics of the mobile transmission device (housing + antenna): size of the housing, type of antenna, VSWR value at the central frequency of the band.
- Parameters observed and malfunctions encountered during the test.

6.3.3.6.REQUIREMENTS

Test	Operating classes	Customer impact levels
Level of power in paragraph 6.3.3.5	C	1

6.4.RESISTANCE TO ELECTROSTATIC DISCHARGE TESTS

6.4.1.EQ/IR 03: RESISTANCE TO ELECTROSTATIC DISCHARGE, EQUIPMENT NOT POWERED

6.4.1.1.REFERENCE DOCUMENT

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

- Conditions of applicability for air and contact discharges.
- The use of a dissipating support for the tests.

6.4.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to electrostatic discharges produced by operators during storage, handling and maintenance operations or vehicle interventions.

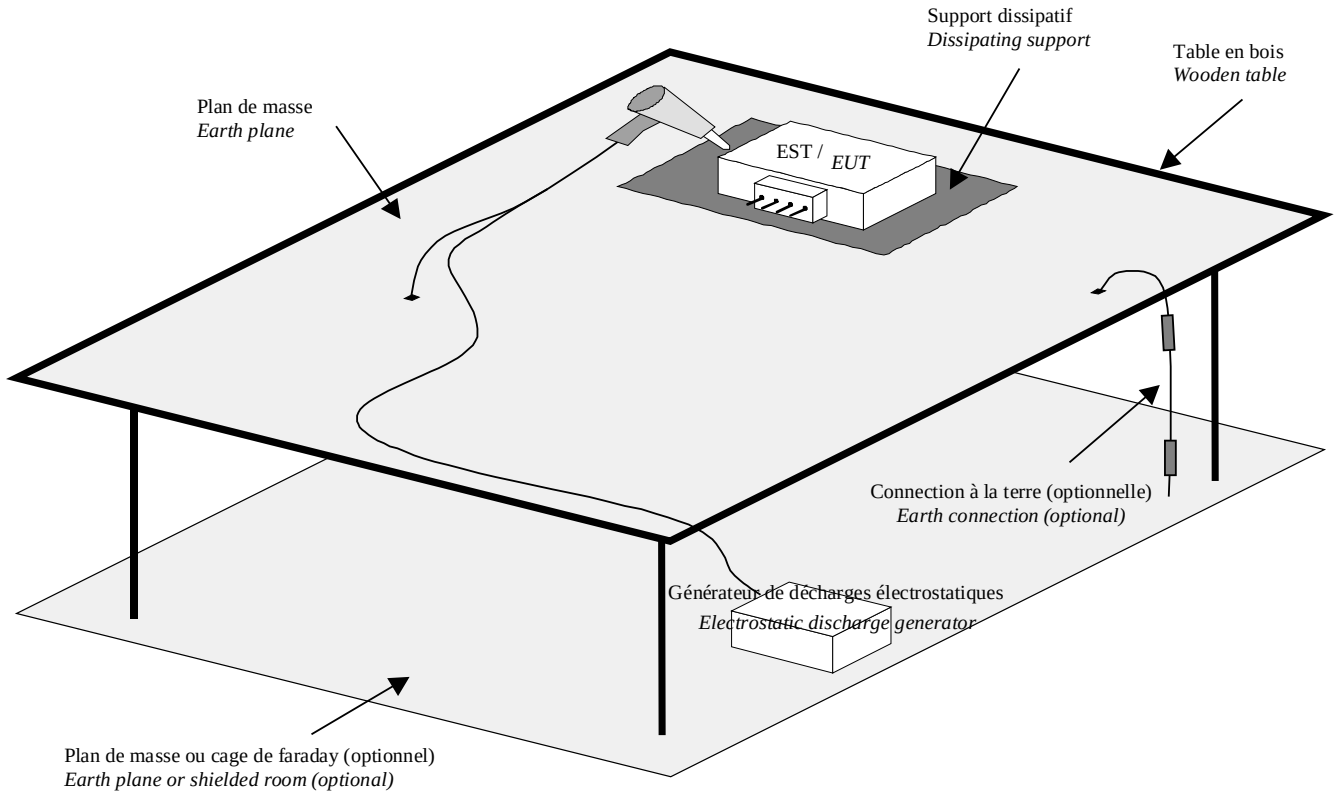
Its principal characteristics are as follows:

- Contact discharges: ± 2 kV and ± 4 kV. These discharges apply to the conductive parts of the equipment (metal housing, connector pins, etc.).
- Air discharges: ± 8 kV or ± 30 kV for pyrotechnic devices. These discharges apply to the insulating parts of the equipment (search for interstices on the housing, etc.).
- Energy accumulation capacity:150 pF.
- Discharge resistance: 330 Ω.
- Positive polarity and negative polarity.
- 10 discharges spaced out by at least 1s to 10s maximum for each level, polarity and application point.
- Discharge application points (to be defined in the test plan): accessible points or surfaces of the equipment during storage, handling and maintenance operations and on each of the accessible connector pins.

6.4.1.3.TEST FACILITIES

- Dissipating support with a thickness of 0.5 to 5 mm for the EUT. The purpose of this support is to avoid any direct arc between the EUT and the earth plane during the discharge, while ensuring EUT return to 0 potential for the following discharge. Resistivity of (10^7 to 10^{10} Ω.m) may be suitable for this use.
- Electrostatic discharge generator.

6.1.4.4.TEST ASSEMBLY



6.4.1.5.PROCEDURE

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

Preparation:

- The EUT is placed on an insulating support with a thickness of 0.5 to 5 mm. The tests are carried out by default in the housing insulated configuration (figure above, with dissipating support). In the case of a housing with a conductive part, an additional test shall be carried out, connecting the conductive part to the earth plane (and removing the dissipating support).

Calibration:

- Calibrate the electrostatic charge generator in accordance with the ISO 10 605 standard.
- Contact discharges: use a sharp-tipped electrode.
- Air discharges: use a round-tipped electrode.

Test:

- Place the electrostatic discharge gun in direct contact with each of the discharge points defined for the conductive parts and trigger a series of 10 discharges of + 2 kV (then + 4 kV) spaced out by at least 1s, then a series of 10 discharges of – 2 kV (then – 4 kV) spaced out by at least 1s.
- Check EUT operation after all the pulses have been applied.
- Slowly bring the electrostatic discharge gun to flash-over 10 times in succession (with spaces of at least 1s) toward each of the discharge points defined for the insulating parts (accessible surfaces or points), with the gun charged to + 8 kV (or + 30 kV), then to – 8 kV (or – 30 kV).
- Check EUT operation after all the pulses have been applied.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Climatic environment conditions (temperature and humidity).

6.4.1.6.REQUIREMENTS

Test	Operating mode
Contact discharges at ± 2 kV (electrical or electronic equipment)	A after reconnection
Contact discharges at ± 4 kV (electrical or electronic equipment)	A after reconnection
Air discharges at ± 8 kV (electrical or electronic equipment)	A after reconnection
Air discharges at ± 30 kV (pyrotechnic module)	A after reconnection

6.4.2.EQ/IR 04: RESISTANCE TO ELECTROSTATIC DISCHARGE, EQUIPMENT POWERED

6.4.2.1.REFERENCE DOCUMENT

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

- Conditions of applicability for air and contact discharges.
- The addition of the test by indirect discharge on the coupling plate.
- The thickness of the insulating support.

6.4.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of the equipment to electrostatic discharges produced during operation or maintenance by the user.

Its principal characteristics are as follows:

- Contact discharges: ± 2 kV, ± 4 kV and ± 8 kV. These discharges apply to the conductive parts of the equipment.
- Air discharges: ± 4 kV, ± 8 kV, ± 15 kV and ± 25 kV (depending on location). These discharges apply to the insulating parts of the equipment (search for interstices on the housing, etc), as well as the conductive parts for the 25 kV level.
- Contact discharges on the horizontal coupling plate: ± 4 kV, ± 8 kV and ± 15 kV. The discharge points are to be specified in the test plan.
- Energy accumulation capacity: 330 pF.
- Discharge resistance: 2 kΩ.
- Positive polarity and negative polarity.
- 10 discharges spaced out by at least 1s for each level, polarity and application point.

6.4.2.3.DISCHARGE APPLICATION POINTS

- The discharge application points are categorised as follows:
- Type 1 h direct points: each point of the EUT passenger compartment (buttons, handles, screens, indicator lights, displays) which may be directly accessible (without disassembly) to users.
- Type 1 h indirect points: each point of the EUT passenger compartment which may be indirectly accessible (following disassembly, maintenance, etc.) in operating mode (wire harness and connectors, rear side of a cluster, etc.).
- Type 1 m points: each point of the EUT in the engine compartment (connectors, housings, etc.), or accessible from outside the passenger compartment only (for example: parking aid sensor, etc.).
- Type 2 h direct points: every input-output pin which may be directly accessible to users in a remote manner (door socket connector, etc.).
- Type 2 h indirect points: every input-output pin accessible to users in a remote manner, after manipulation (diagnostic plug pins, etc.).
- Type 3 h points: remote parts (located in the passenger compartment) of a piloting unit comprising several pieces of equipment (for example: door electronic switches, etc.). The tests may be carried out on each part of the system with the whole interconnected, in application of the diagram in paragraph 6.4.2.5.
  The test configuration shall be specified in the test plan.
- Type 3m points: remote parts (located in the engine compartment) of a piloting unit comprising several pieces of equipment (for example: actuator and sensor with a calculator, etc.).
  The tests may be carried out on each part of the system with the whole interconnected, in application of the diagram in paragraph 6.4.2.5. The test configuration shall be specified in the test plan.

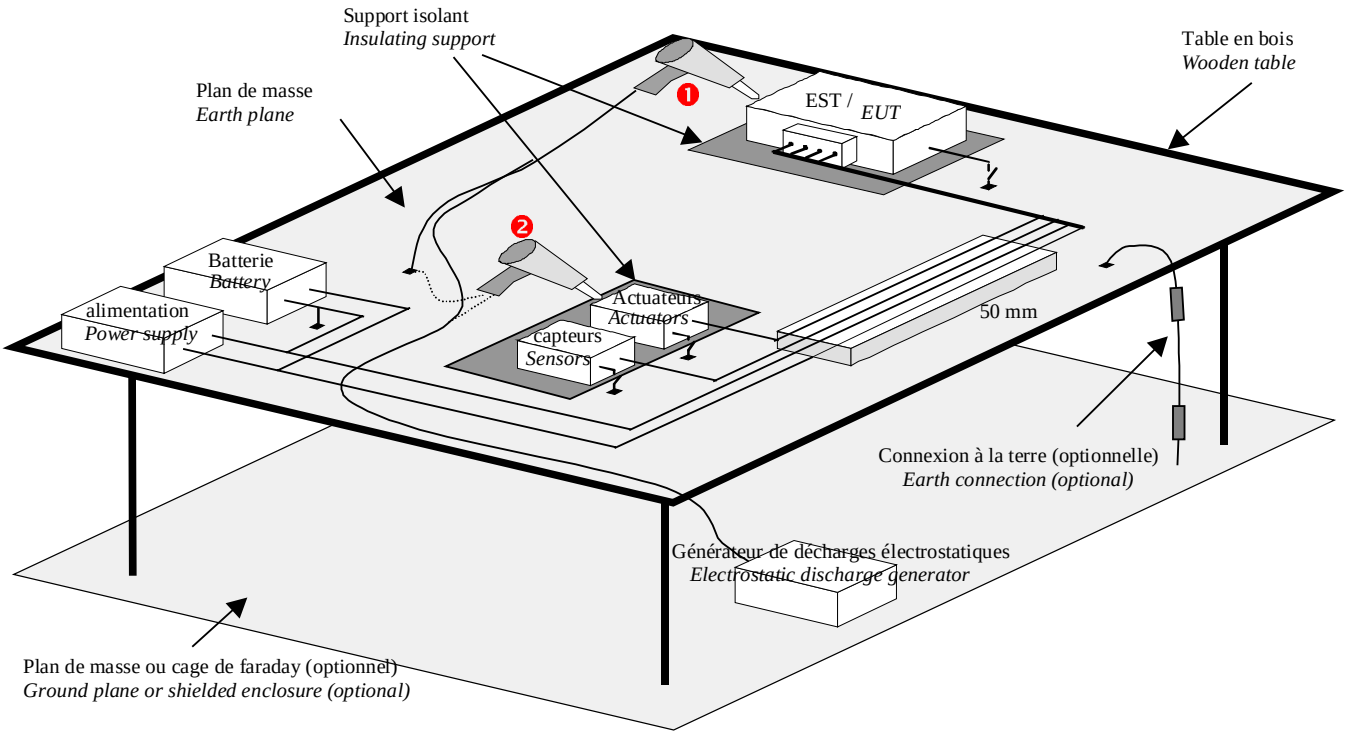
Accessibility and location		EUT envelope	Pin or contact accessible in a remote manner	Envelope of a remote part
Directly accessible	Passenger compartment	1 h direct	2 h direct	3 h
	In the engine compartment or outside the vehicle	1 m	*Not applicable*	3 m
Accessible after manipulation or disassembly	Passenger compartment	1 h indirect	2 h indirect	1 h indirect
	In the engine compartment or outside the vehicle	1 m	*Not applicable*	3 m

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

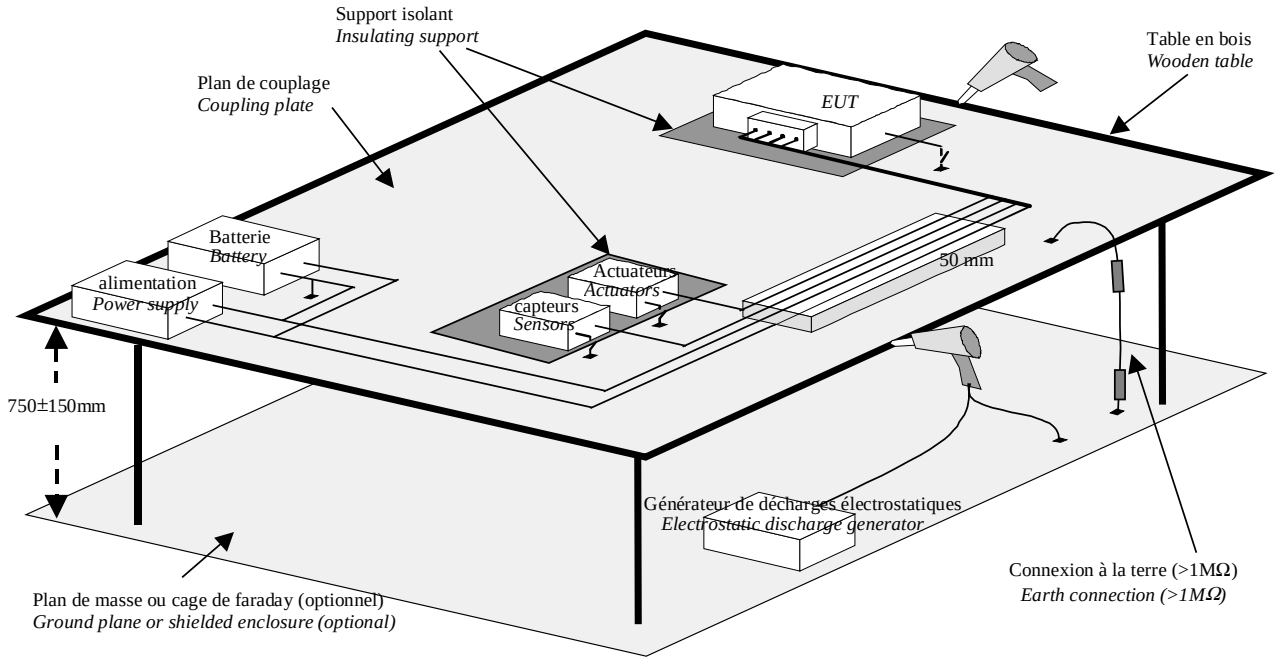
6.4.2.4.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- Metal coupling plate. This may be connected (depending on the type of test) to the frame earth by a wire equipped with a resistor with a value greater than or equal to 1 MΩ, to ensure the coupling plate's return to zero potential between two discharges.
- 50-mm thick insulating support for wires and harnesses.
- 0.5 to 5 mm thick insulating support for the EUT.
- Electrostatic discharge generator.
- Shielded enclosure (if possible).

6.4.2.5.TEST ASSEMBLY



Direct discharges on the equipment



Indirect discharges on the coupling plate

6.4.2.6.PROCEDURE

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

Preparation:

- A cable with a length between 1500 mm and 2500 mm shall be used to connect the EUT to its various charges and actuators. The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on an insulating support with a thickness of 0.5 to 5 mm. The tests are carried out in the configurations with the housing insulated or the housing connected to the coupling plate in accordance with its real installation on the vehicle, and no other earth connection is permitted.
- The electrostatic discharge generator earth is directly connected to the reference earth (frame, ground, etc.) by a link with a length not exceeding 1000 mm.

Note : *for the case of type 2h direct or 2h indirect application points (as defined in paragraph 6.4.2.3) which may have an impact on several pieces of equipment (for example: inter-system CAN), the pins involved in the test may be tested by contact discharges (or air discharges for 25 kV) by adding a harness insulated from the coupling plate at a height of 50 mm and with a length specified in the test plan. By default, this length shall be 10 cm.*

Calibration:

- Calibrate the electrostatic discharge generator according to the ISO 10605 standard.
- Air discharges: use a spherical-tipped electrode.
- Contact discharges: use a pointed-tipped electrode.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Contact discharges:
  - Place the electrostatic discharge gun in contact with each of the discharge points defined for the
  - conductive parts and trigger a series of 10 discharges of + 2 kV spaced out by at least 1s, then a series
  - of 10 discharges of – 2 kV spaced out by at least 1s.
  - Check EUT operation during and after application of all of the pulses.
  - Repeat the test with ± 4 kV and then ± 8 kV.

- Air discharges:
  - Slowly bring the electrostatic discharge gun to flash-over 10 times in succession (with spaces of at least 1s) towards each of the discharge points defined for the insulating parts (including connectors and harnesses), with the gun charged to + 4 kV and then – 4 kV
  - Check EUT operation during and after application of all of the pulses.
  - Repeat the test with ± 8 kV , ± 15 kV and then ± 25 kV.

- Contact discharges, on the horizontal coupling plate:
  - Place the electrostatic discharge gun in contact with the side of the horizontal coupling plate at various points. Ensure that the EUT is located 10cm from the edge of the coupling plate. Trigger a series of 10 discharges of + 2 kV spaced out by at least 1s, then a series of 10 discharges of – 2 kV spaced out by at least 1s.
  - Check EUT operation during and after application of all of the pulses.
  - Repeat the test with ± 4 kV and then ± 8 kV.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Climatic environment conditions (temperature and humidity).

6.4.2.7.REQUIREMENTS

The operating classes and the related customer impact levels are given in the following table:

Test		**Discharge on conductive parts (1)**				**Discharge on insulating parts**			
Equipment location	Discharge points (type of discharge)	± 2 kV (contact)	± 4 kV (contact)	± 8 kV (contact)	± 25 kV (air)	± 4 kV (air)	± 8 kV (air)	± 15 kV (air)	± 25 kV (air)
Passenger compartment direct	Type 1 h direct points	A0	A0	C1	C1	A0	A0	C1	C1
	Type 2 h direct points					Not applicable			
	Type 3 h points					A0	A0	C1	C1
Passenger compartment indirect	Type 1 h indirect points	C1	C1	D2	D2	A0	C1	D2	D2
	Type 2 h indirect points	A0	A0	C1 (2)	C1 (2)	Not applicable			
In the engine compartment or outside passenger compartment	Type 1 m points	A0	C1	C1	NA	A0	C1	C1	NA
	Type 3 m points								
	Type 2 h indirect points	A0	A0	C1 (2)	C1 (2)	Not applicable			

Note (1): *or on the coupling plate for levels at 2, 4 and 8kV.*

Note (2): *this test applies to unprotected lines (for example: line K). It does not apply to lines protected by centralised protection on another piece of equipment (for example: inter-system CAN, see note DMFV_AEL04_0091).*

6.5.CONDUCTED EMISSION TESTS

6.5.1.EQ/MC 01: MEASUREMENT OF SWITCHING NOISE

6.5.1.1.REFERENCE DOCUMENT

This test procedure conforms to the ISO/DIS 7637-2.3 standard, with a modified value of resistor RS. A LISN is added after the battery. Current and voltage slew rate measurements are added.

6.5.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

This test is intended to evaluate the switching noise of the equipment. It only applies to equipment which switches inductive loads (engines, etc.), as well as the engines themselves.

Its principal characteristics are as follows:

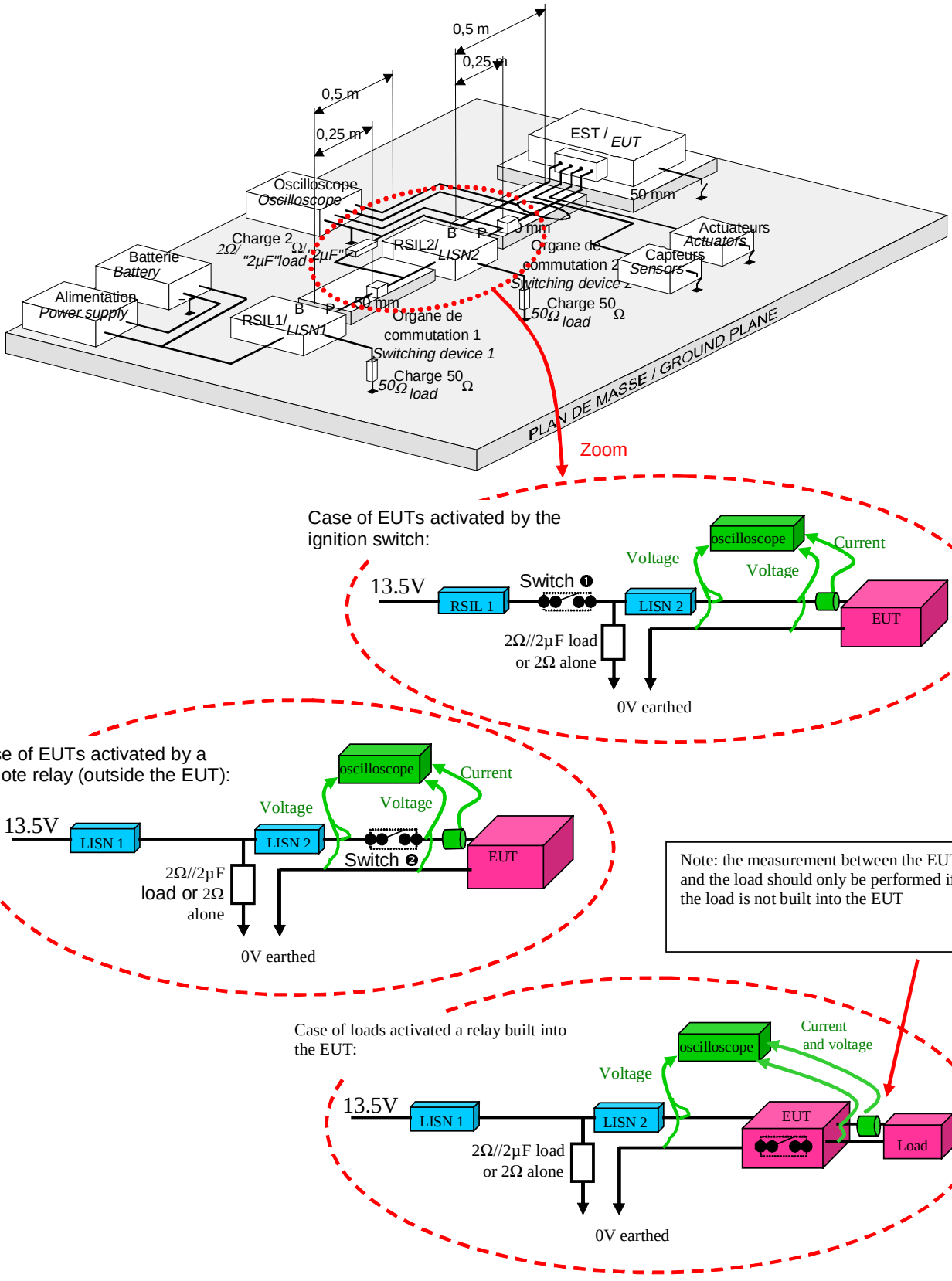
- Wires involved: power supply wires.
- Methodology: the tests simulate activation/deactivation of the ignition switch and the EUT on/offs.

6.5.1.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- Digital oscilloscope with real time bandwidth greater than or equal to 500 MHz and a sampling frequency greater than or equal to 1 GHz.
- High impedance voltage probes with bandwidth greater than or equal to 500 MHz.
- Current probe with a bandwidth greater than or equal to 500 MHz.
- LISN(1) in compliance with the CISPR 25 publication, with a 50 Ω load.
- LISN(2) in compliance with the ISO/DIS 7637-2.3 standard, with a 50 Ω load.
- Switching device 1 of the same technology family as the ignition switch installed on the vehicle. If this type of system is lacking, a relay that has the characteristics specified in paragraph 5.3, of the ISO/DIS 7637-2.3 standard should be used.
- Switching device 2 of the same technology family as that associated with the equipment on the vehicle. If this type of system is lacking, a relay that has the characteristics specified in paragraph 5.3, of the ISO/DIS 7637-2.3 standard should be used.

Note : *Switching device 2 is not mandatory if it is already built into the EUT. Switching device 2 is then controlled by the EUT itself. Switching devices 1 and 2 must be controlled independently.*

6.5.1.4.TEST ASSEMBLY



6.5.1.5.PROCEDURE

- A series of measurements must be carried out, depending on the EUT power supply conditions, either by activating switch 1 (which simulates activation / deactivation of the ignition switch), or by activating switch 2 (which simulates activation / deactivation of the EUT by a remote relay which may be built into the EUT). In cases where both types of power supply are possible, both test series must be carried out.
- The load placed before LISN 2 is representative of the EUT's power supply line on the vehicle. The load simulating the +BAT power supply is a 2 Ω resistor alone. The load simulating the +APC power supply is a 2 Ω resistor in parallel with a 2 µF capacitor. The test is thus carried out either with 2 Ω on the +BAT power supply lines or with 2 Ω + 2µF on the +APC power supply lines.

Preparation:

- A harness with a length of 1000 mm (2 x 500 mm) should preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support. The LISN must be positioned so as to strictly observe the distances indicated in the test assembly diagram.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- Place switching devices 1 and/or 2 as shown in the test assembly diagram.

Calibration:

This test does not require any special calibration.

Test:

To determine the maximum amplitude of the pulses created, 100 switching operations are required, with a time interval between two successive switching operations greater than the EUT stabilisation time.

Measurements on terminals P and B of LISN 2:

- Determine the maximum amplitude of the voltage measured on terminals P and B of LISN 2 during the various EUT operating phases (start-up, operation, cut-off) by activating the switching device(s).

Measurements on the EUT terminals:

- Determine the maximum amplitude of the voltage and current measured on the EUT terminals (or its load) during the various EUT operating phases (start-up, operation, cut-off) by activating the switching device(s). If these amplitudes are greater than the required thresholds, ± 100 V and ± 50 A respectively, determine the maximum current and voltage slew rates.

Note : *the maximum slew rate or voltage may correspond to one of the overvoltage rebounds rather than the first positive transition.*

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- The parameters of the signals measured (duration, increase and decrease times and voltage values), indicating to which EUT operating mode they correspond (cut-off, start-up).

6.5.1.6.REQUIREMENTS

Test	Maximum amplitude
Measurement on terminals P and B of LISN 2	± 40 V
Measurement on the EUT terminals	± 100 V and ± 50 A on the equipment terminals. In the event of excesses, the EUT may be in compliance if it observes the following limits: ± 200 V/µs ± 30 A/µs

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

6.5.2.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

6.5.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

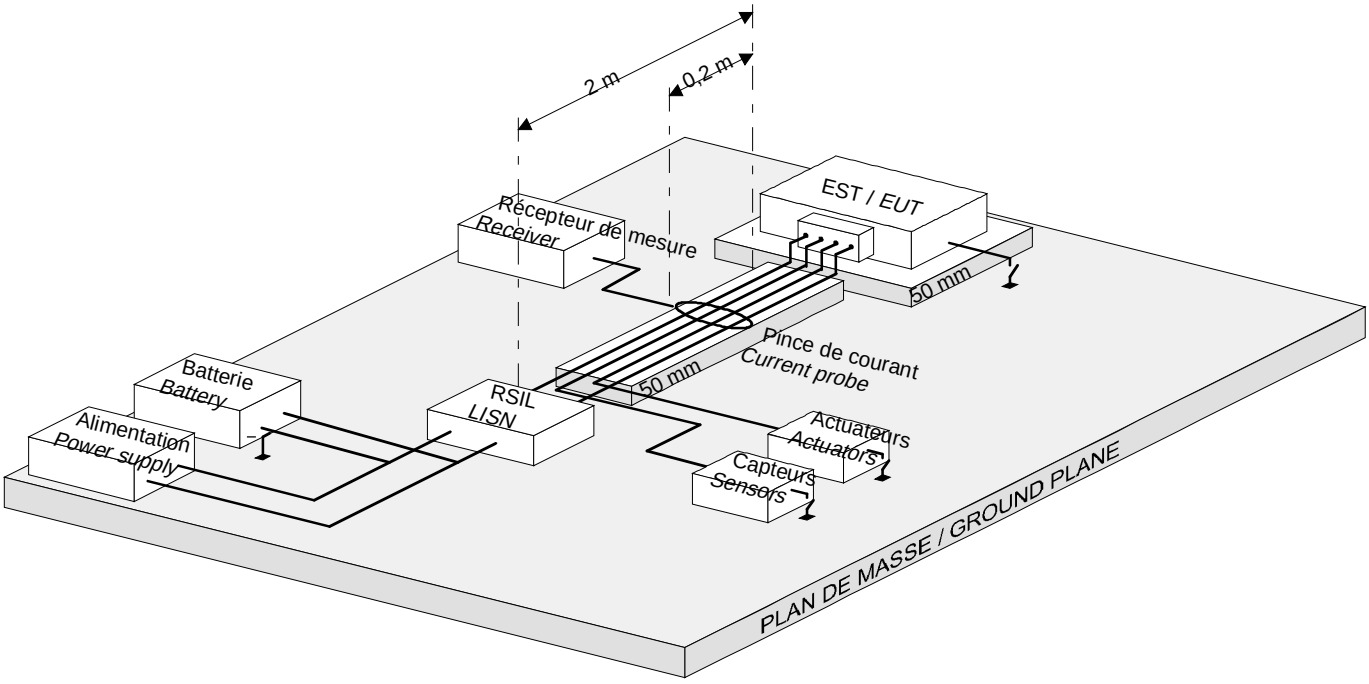
This test is intended to evaluate low frequency conducted emissions produced by the EUT and its wiring, and liable to disturb parts that are sensitive to magnetic fields or audio functions.
The test does not apply if no current >1Aeff is consumed or run on the equipment.
Its principal characteristics are as follows:

- Peak detection.
- Frequency band [20 Hz - 20 kHz].
- Analysis filter bandwidth at 6 dB:
  - F < 1 kHz: 10 Hz
  - F ≥ 1 kHz: 100 Hz
- The use of video filtering to limit the analysis bandwidth is not permitted.
- Minimum sweep time for sweeping receiver or spectrum analyser:
  - F < 1 kHz: 150 ms/Hz.
  - F ≥ 1 kHz: 15 ms/Hz.
- Dwell time for digital receiver (recommended values without maximum amplitude search):
  - F < 1 kHz: 150 ms.
  - F ≥ 1 kHz: 15 ms.
- Frequency increment (digital receiver) equal to half the analysis filter bandwidth.
- Wires involved: various types of measurements to be carried out successively:
  - Measurement on all the wires connected to the EUT taken in common mode.
  - Measurements on each +power supply wire and each earth wire taken individually.

6.5.2.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω loads.
- Current probe.
- Receiver or spectrum analyser.

6.5.2.4.TEST ASSEMBLY



6.5.2.5.PROCEDURE

Preparation:

- The real EUT environment and the real harness should preferably be used (if necessary, a harness with a maximum length of 2000 mm may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- The LISN is placed 2000 mm from the EUT.
- The current probe is placed 200 mm from the EUT.

Calibration:

To prevent measurement errors, particularly due to saturation of the current probe or to incorrect decoupling with respect to the mains, calibration is recommended.

The following method is suggested:

- Run a sine wave current at a level equal to the specified limit through a known load.
- Measure this current using the current probe / measuring device assembly.
- Compare the results to the voltage measured with an oscilloscope on the load terminals.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Fit the current probe around the wiring harness, including the power supply wires.
- Connect the measuring device to the probe with a coaxial harness.
- Perform the frequency sweep and measure the current in the harness.
- Repeat the operation for all the harnesses connected to the EUT.
- Repeat the operation for each power supply and earth wire.

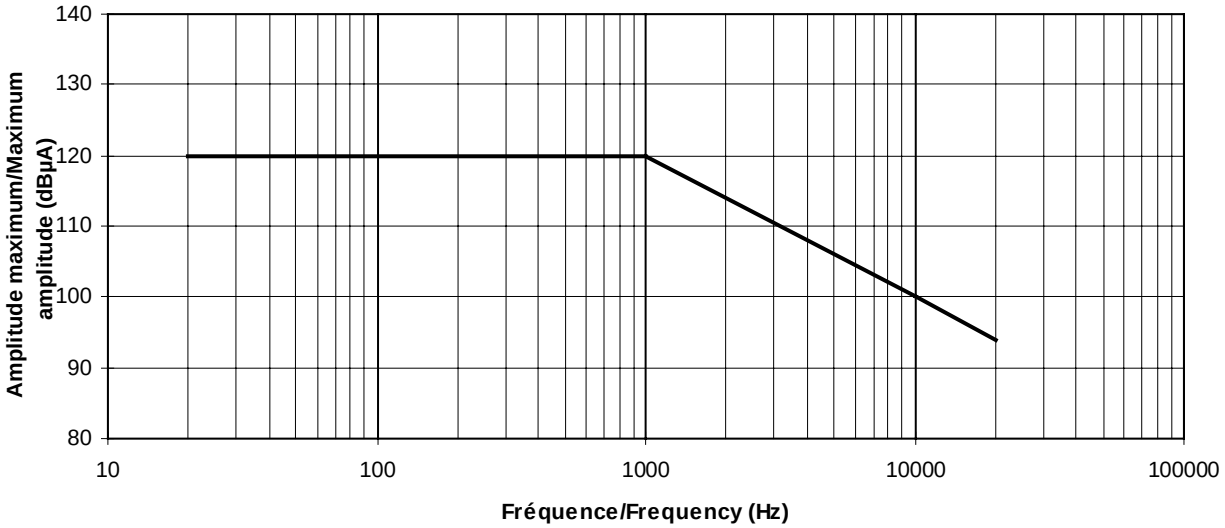
Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Spectrum curves and limits specified for the various frequency bands.

6.5.2.6.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 RADIO FREQUENCY CONDUCTED NOISE

6.5.3.1.REFERENCE DOCUMENT

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

- Taking into account disturbances outside the CISPR 25 bands.
- Low frequency extension to 100 kHz.
- Dropping the narrowband – broadband distinction: the evaluation of disturbances with two different detectors (peak / quasi-peak and average value) in relation to two different limits (peak / quasi-peak and average value).
- The use of the "narrowband" limits in CISPR 25 for measurements with a detector for the average value and the "broadband" limits in CISPR 25 for the measurements with the peak / quasi-peak detector.

6.5.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

This test is intended to evaluate radio frequency disturbances emitted through conduction by the EUT and its power supply harnesses.

Its principal characteristics are as follows:

- Peak detection to evaluate levels in relation to the “peak” limit, and average value detection to evaluate the levels in relation to the “average value” limit. Quasi-peak detection may be used (if requested) in the 150 kHz – 300 kHz, 530 kHz – 2 MHz and 76 – 108 MHz bands to evaluate the levels in relation to the “quasi-peak” limit.

  Note: *to reduce the sweep time, measurements can be taken with a peak detector only. If the measured value is below the “average value” limit, the result is accepted.*

- Frequency band [100 kHz - 108 MHz].
- Analysis filter bandwidth at 6 dB (broadband and narrowband):
  - F < 26 MHz: 9 kHz (10 kHz for the spectrum analyser)
  - F ≥ 26 MHz: 120 kHz (100 kHz for the spectrum analyser) except for mobile transceiver bands with 9 kHz average value detection (10 kHz for the spectrum analyser)

  Note: *to reduce the sweep time in the mobile bands with the average value detector, measurements can be taken with a bandwidth of 120 kHz (100 kHz for a spectrum analyser) rather than 9 kHz. If the measured value is below the average value limit specified in the test plan, the result of the average value measurement is accepted. The value of the measurement bandwidth used in this frequency range must be specified in the test plan.*

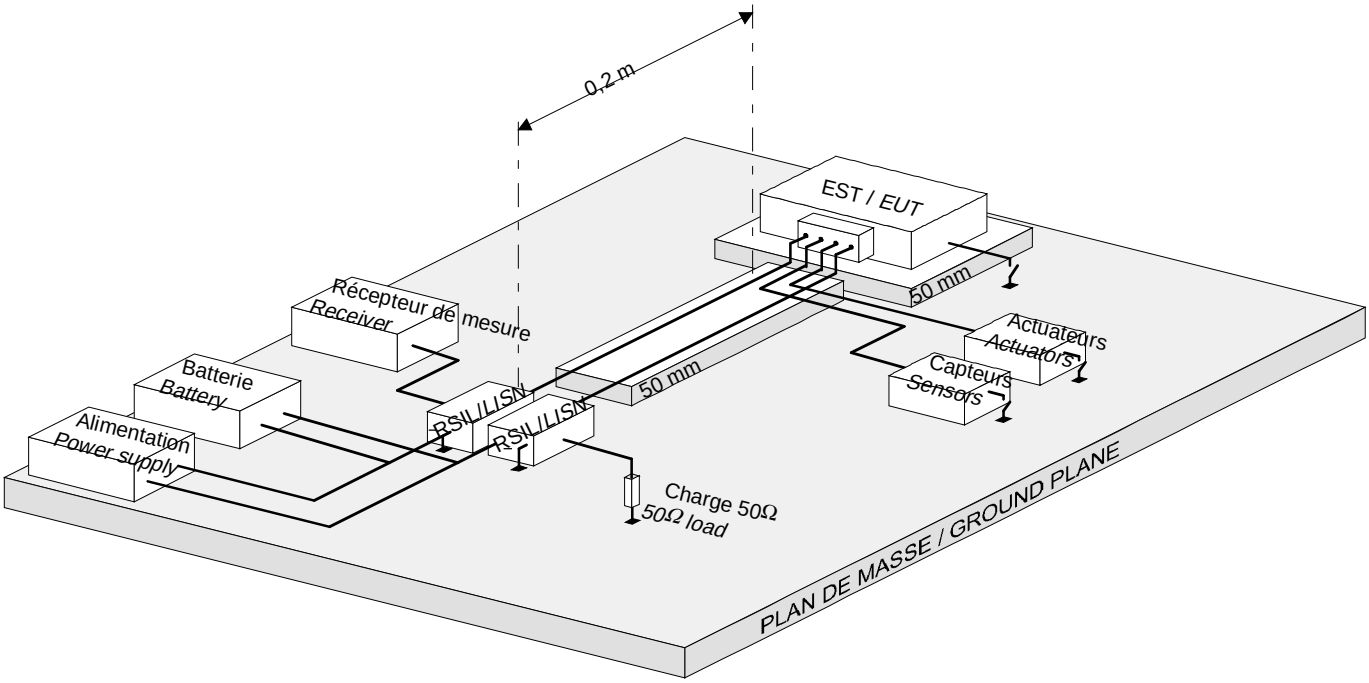
- For the measurements with a spectrum analyser, the total time and speed of the sweep (or number of sweeps) must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. These parameters must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 100 ms/MHz (BW 9 kHz)
  - F ≥ 26 MHz: 1 ms/MHz (BW 120 kHz) or 100 ms/MHz (BW 9 kHz)

  Higher values may be required for signals with low repetition rates.
- For the measurements with a receiver, dwell time must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. The dwell time must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 10 ms/MHz (BW 9 kHz)
  - F ≥ 26 MHz: 5 ms (BW 120 kHz and BW 9 kHz)
- For measurements with a receiver, maximum frequency step (digital receiver) of 0.6 x BW.
- Wires involved (taken together):
  - All EUT + power supply wires taken together in the case of local earthing.
  - On all the + power supply wires taken together, then the earth wires in the case of remote EUT earthing.

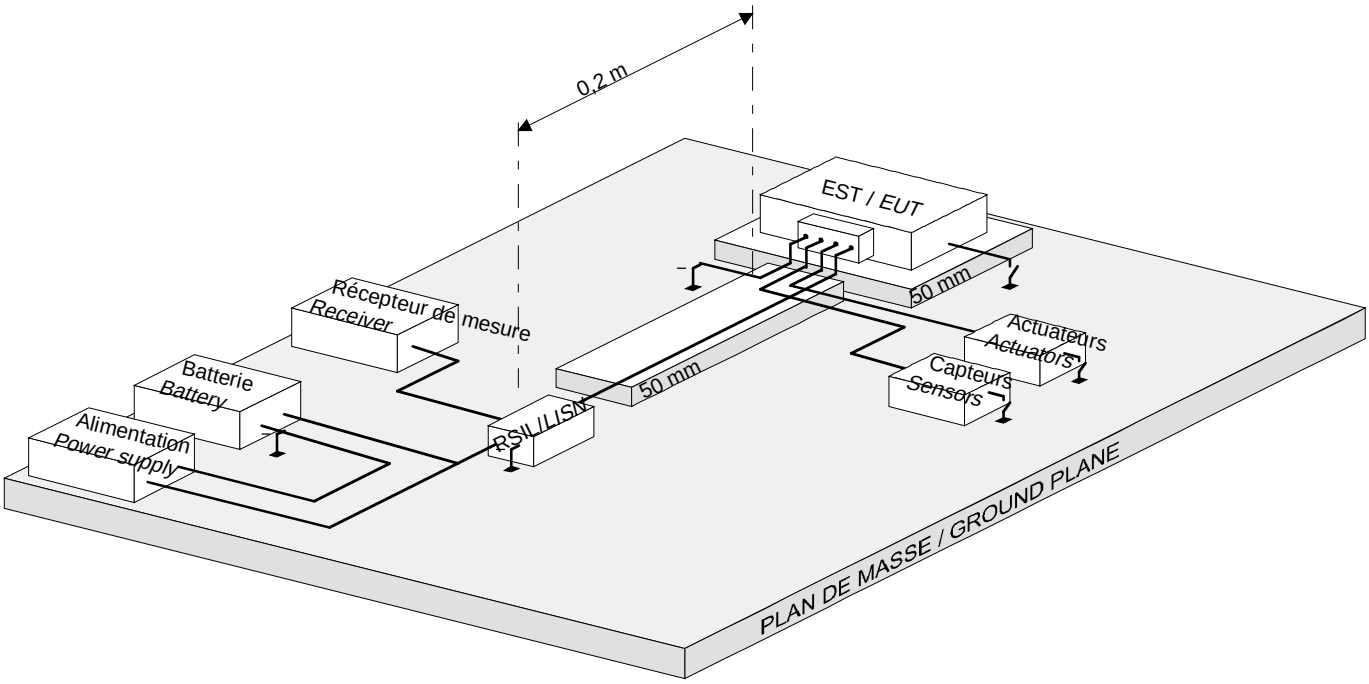
6.5.3.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω load.
- Receiver or spectrum analyser and, if necessary, a pre-selector.
- Shielded enclosure.

6.5.3.4.TEST ASSEMBLY



EUT connected to remote earth



EUT connected to local earth

6.5.3.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support. The length of the power supply wires should be 200 $^{+200}_{0}$ mm. The other wires must be laid out directly on the earth plane at a distance of at least 200 mm from the power supply wires.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- If two LISNs are used, the measuring device is successively connected to the two LISNs. The non-connected LISN receives the 50 Ω load.

Calibration:

- This test does not require any specific calibration.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Carry out the measurements in peak (quasi-peak) detection and average value detection modes on the LISN terminals.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Spectrum curves and limits required for the various frequency bands.

6.5.3.6.REQUIREMENTS

The values measured on the LISN terminals in peak detection mode and in average value detection mode (unless otherwise specified) must not exceed the following values (both the peak requirement and the average value requirement must be met):

Frequency band (MHz)	Limits with peak detector – permanent noise (dBµV) (3)	Limits with peak detector – "short duration" noise (dBµV) (3)	Bandwidth for peak detector measurements (1)	Limits with average value detector (dBµV)	Bandwidth for average value detector measurements (1)
0.1 – 0.15	103	109	9 kHz	70	9 kHz
0.15 – 0.3 (2)	83 70 (Quasi-peak) (5)	89 76 (Quasi-peak) (5)	9 kHz	60	9 kHz
0.3 – 0.53	103	109	9 kHz	70	9 kHz
0.53 – 2 (2)	71 58 (Quasi-peak) (5)	77 64 (Quasi-peak) (5)	9 kHz	42	9 kHz
2 – 5.9	87	93	9 kHz	50	9 kHz
5.9 – 6.2	71	77	9 kHz	45	9 kHz
6.2 – 26	71	77	9 kHz	45	9 kHz
26 – 54	71	77	120 kHz	40	9 kHz
54 – 68	71	77	120 kHz	40	9 kHz
68 – 76 (4)	49	55	120 kHz	24	9 kHz
76 – 108 (2)	43 30 (Quasi-peak) (5)	49 36 (Quasi-peak) (5)	120 kHz	24	120 kHz

(1) These bandwidths are given for cases of acquisition with a measurement receiver. If a spectrum analyser is used, 10 kHz (instead of 9) and 100 kHz (instead of 120) resolutions may be used.

(2) For equipment located in the rear (back seats and doors, boot) of a vehicle equipped with an AM and/or FM reception window antenna (back window, rear quarter panel, etc.), these levels should be tightened by 10 dB in the frequency bands in questions.
For example: radiation from a park-assist-system located in the boot, in relation to the window antenna in the rear window. This situation should be specified in the STN/ST or EMC test plan.

(3) Unless otherwise specified in the STN/ST or EMC test plan, the term "short duration" corresponds to equipment which is used for less than one minute.
Examples of short-duration noises: automatic windows, windscreen washer pump, convertible roof, etc.
Examples of permanent noises: windscreen wipers, air conditioning motor, Motor-driven fan, etc.

(4) The limits specified are those to be used in cases where the sensitivity of the specific receiver (police, gendarmerie, etc.) on board the vehicle is unknown. If it is specified, the limits to be used for these tests must be adapted appropriately.

(5) The levels given with the quasi-peak detector apply to special demands (for example: PWM signals, etc.).

6.6.RADIATED NOISE TEST

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 dated 03 May, 2002.

6.6.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to evaluate the levels of the magnetic fields radiated by electrical/electronic parts of the vehicle so as to limit human exposure. This test only applies to engines and to equipment consuming a current >1Aeff.

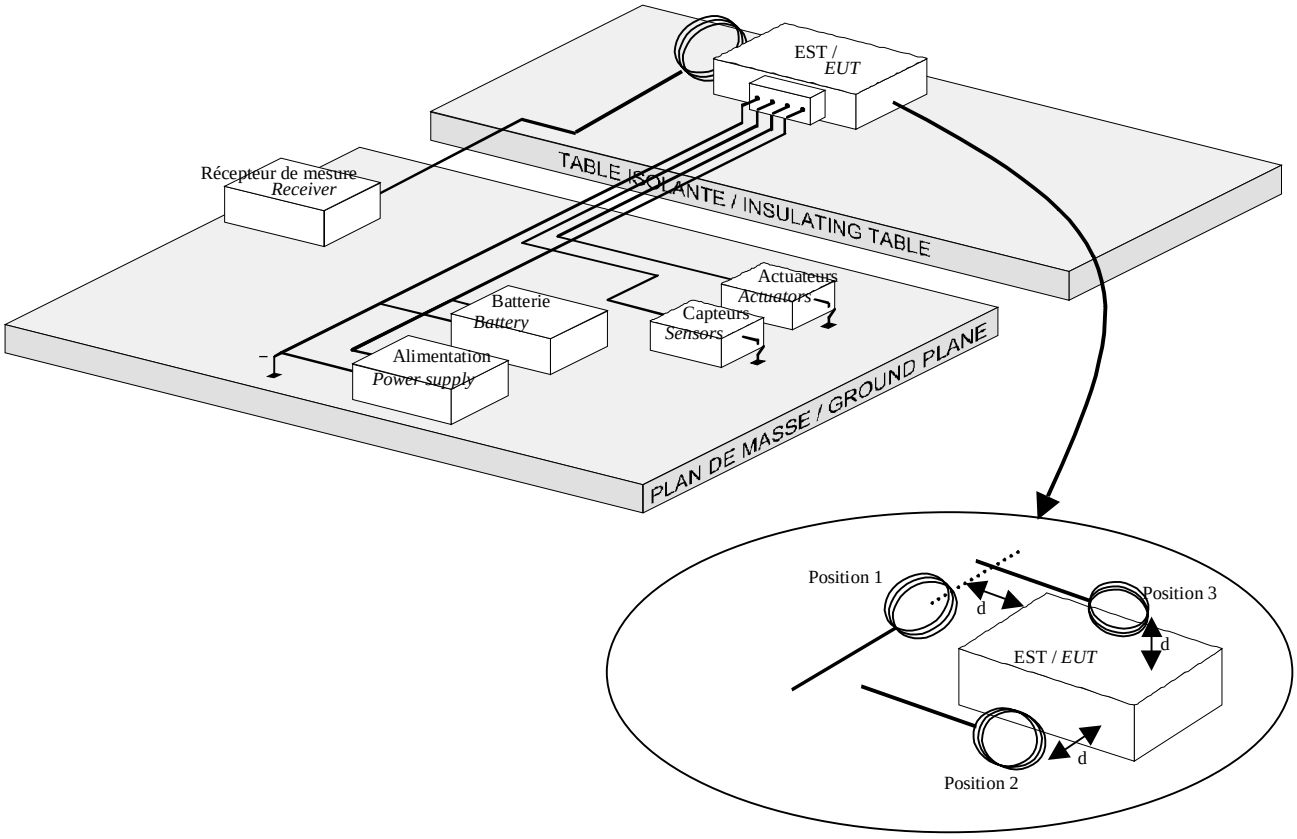
Its principal characteristics are as follows:

- RMS value.
- Frequency band: [5Hz – 150kHz].
- Analysis filter bandwidth at 6dB:
  - F < 1 kHz: 10 Hz.
  - F ≥ 1 kHz: 100 Hz.
  - The use of video filtering to limit the analysis bandwidth is not permitted.
- Minimum sweep time for sweeping receiver or spectrum analyser:
  - F < 1 kHz: 150 ms/Hz.
  - F ≥ 1 kHz: 15 ms/Hz.
- Dwell time for digital receiver (recommended values without maximum amplitude search):
  - F < 1 kHz: 150 ms
  - F ≥ 1 kHz: 15 ms
- Frequency increment (digital receiver) equal to half the analysis filter bandwidth.

6.6.1.3.TEST FACILITIES

- Test area with no high magnetic field source.
- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- Receiver or spectrum analyser.
- A coil with the characteristics given in MIL STD 461E is recommended:
  - Diameter: 13.3 cm
  - Number of turns: 36
- A broadband isotropic magnetic field sensor can be permitted as an alternative solution. The necessary steps must be taken to identify the source frequencies and ensure that none of them exceeds the requirements.

6.6.1.4.TEST ASSEMBLY



6.6.1.5.PROCEDURE

Preparation:

The measurements must be taken in the EUT configuration with the most disturbances (see paragraph 4.9).

- A distinction shall be made between the following two types of equipment:
- Equipment located in the passenger compartment area.
- Equipment located in the engine compartment.

Test:

- The measurement area in question is an envelope covering the surface of the EUT defined by a distance d in relation thereto. The distance d between the sensor and the EUT shall be defined in the STN/ST or the test plan. By default, it shall measure 7 cm for equipment located in the passenger compartment area and 30 cm for equipment in the engine compartment.
- Run the EUT for a minimum duration of 10 minutes.
- Proceed with the vehicle operating mode(s) specified in the test plan.
- Carry out the magnetic field measurements on the EUT by sweeping the first measurement area selected, searching for the maximum level and observing the measuring device response time characteristics.

Test report:

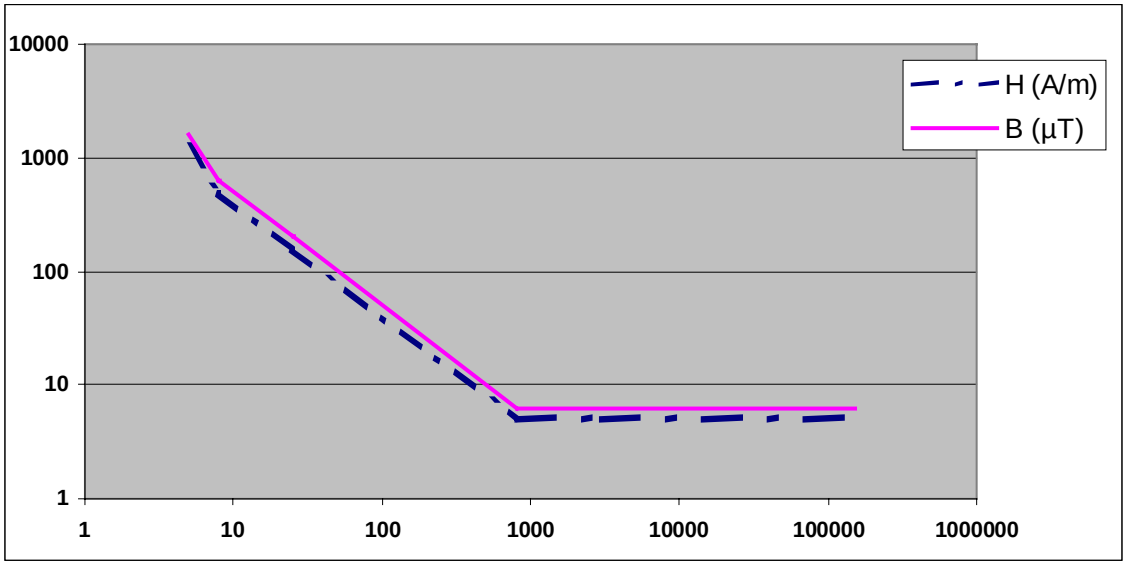
Amongst other information, the test report shall include the following:

- The maximum levels and the corresponding frequency.
- The location of the maximum and the predominant source in each area.

6.6.1.6.REQUIREMENTS

The following levels must 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 RADIO FREQUENCY RADIATED NOISE

6.6.2.1.REFERENCE DOCUMENT

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

- Disturbances outside the CISPR bands (taking into account Directive 95/54/CE).
- Dropping the narrowband – broadband distinction: the evaluation of disturbances with two different detectors (peak / quasi-peak and average value) in relation to two different limits (peak / quasi-peak and average value).
- The use of the "narrowband" limits in CISPR 25 for measurements with a detector for the average value and the "broadband" limits in CISPR 25 for the measurements with the peak / quasi-peak detector.
- Extension of low frequency measurements to 100 kHz and high frequency measurements to 2.5 GHz.
- Measurements in a semi-anechoic chamber, excluding the TEM cell method.
- The antenna position (facing the equipment) for measurements above 800 MHz.

6.6.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

This test is intended to evaluate radio frequency disturbances radiated by the EUT and its wiring.

Its principal characteristics are as follows:

- Peak detection to evaluate levels in relation to the “peak” limit, and average value detection to evaluate the levels in relation to the “average value” limit. Quasi-peak detection may be used (if requested) in the 150 kHz – 300 kHz, 530 kHz – 2 MHz and 76 – 108 MHz bands to evaluate the levels in relation to the “quasi-peak” limit.

  Note: *to reduce the sweep time, measurements can be taken with a peak detector only. If the measured value is below the “average value” limit, the result is then accepted.*

- Frequency band [100 kHz – 2,5 GHz].
- Horizontal and vertical polarisations.
- Analysis filter bandwidth at 6dB (broadband and narrowband):
  - F < 26 MHz: 9 kHz (10 kHz for the spectrum analyser)
  - F ≥ 26 MHz: 120 kHz (100 kHz for the spectrum analyser) except for mobile transceiver bands with 9 kHz average value detection (10 kHz for the spectrum analyser)

  Note: *to reduce the sweep time in the mobile bands with the average value detector, measurements can be taken with a bandwidth of 120 kHz (100 kHz for a spectrum analyser) rather than 9 kHz. If the measured value is below the average value limit specified in the test plan, then the result of the average value measurement is accepted. The value of the measurement bandwidth used in this frequency range must be specified in the test plan.*
- For the measurements with a spectrum analyser, the total time and speed of the sweep (or number of sweeps) must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. These parameters must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 100 ms/MHz (BW 9 kHz)
  - F ≥ 26 MHz: 1 ms/MHz (BW 120 kHz) or 100 ms/MHz (BW 9 kHz)

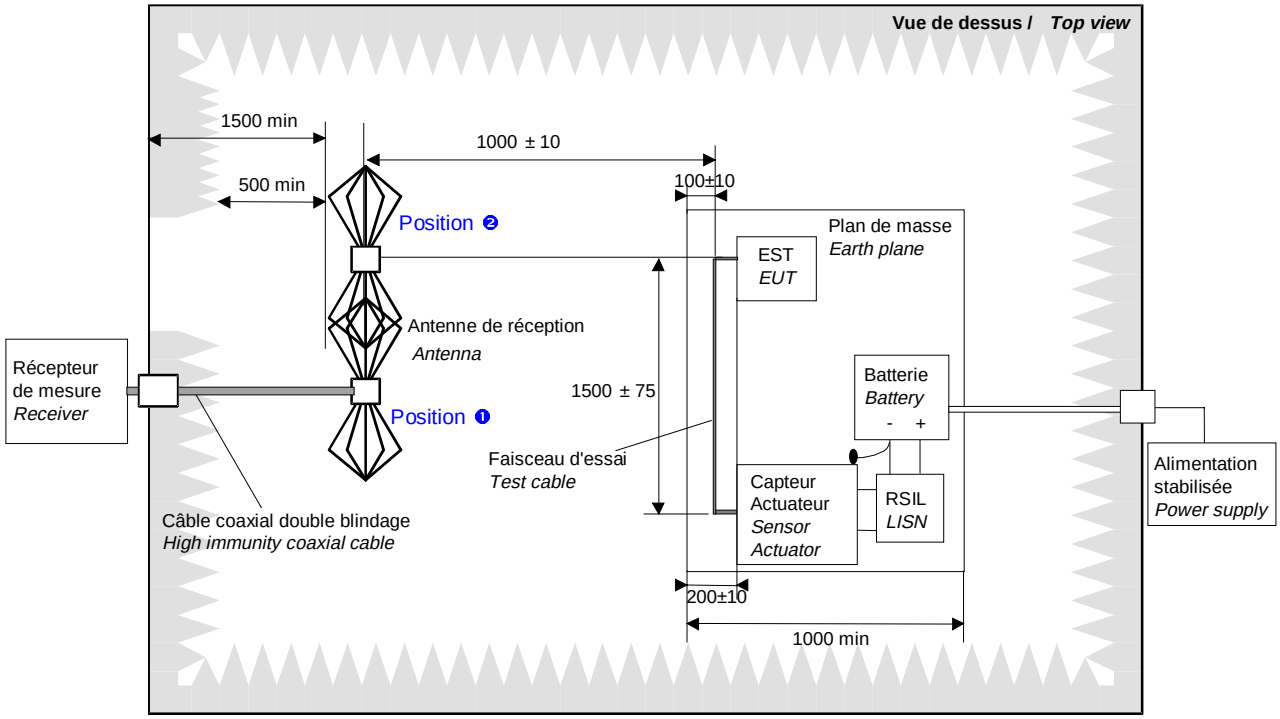
Higher values may be required for signals with low repetition rates.

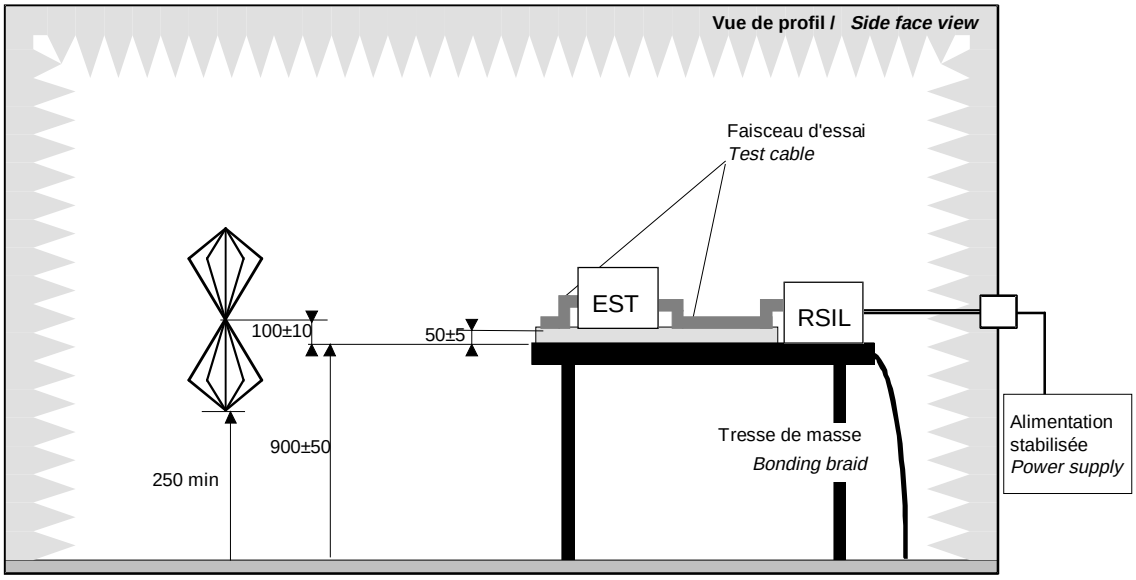
- For the measurements with a receiver, dwell time must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. The dwell time must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 10 ms (BW 9 kHz)
  - F ≥ 26 MHz: 5 ms (BW 120 kHz and BW 9 kHz)
- For the measurements with a receiver, maximum frequency step (digital receiver) of 0.6 x BW.

6.6.2.3.TEST FACILITIES

- Power supply and battery.
- Equipment required to check correct operation of the EUT.
- Real (sensors, actuators) or simulated EUT environment.
- 50-mm thick insulating support.
- LISN conforming to the CISPR 25 publication (2 LISNs for a remoted earth EUT).
- 50 Ω load(s).
- Receiver or spectrum analyser in compliance with the CISPR 16-1 standard.
- Measurement antennas: 1-m vertical monopole, biconical and log-periodical or horn.
- Semi-anechoic or anechoic chamber.

6.6.2.4.TEST ASSEMBLY





6.6.2.5.PROCEDURE

Preparation:

- A harness with a maximum length of 2000 mm, of which 1500 ± 75 mm is parallel to the edge of the table, shall preferably be used (if necessary, the real harness may be used). The test harness is placed on a 50-mm thick insulating support.
- The EUT is placed on a 50-mm thick insulating support. It is connected to the earth plane in conformity with its real connections to the vehicle, and no other earth connection is permitted.
- The LISN is placed at maximum 2000 mm from the EUT.

Calibration:

- This test does not require any special calibration.

Test:

- Run the EUT for a minimum duration of 10 minutes.
- Carry out the measurements for horizontal and vertical polarisation, in peak (quasi-peak) detection mode and in average value detection mode.
- The measurements shall be carried out for two antenna positions: facing the middle of the harness (position ❶) from 150 kHz to 800 MHz and facing the EUT (position ❷) from 800 MHz to 2.5 GHz.

Test report:

Amongst other information, the test report shall include the following:

- Test set-up used: harness, EUT environment.
- Spectrum curves and limits required for the various frequency bands.

6.6.2.6.REQUIREMENTS

The values measured in peak detection mode and in average value detection mode (unless otherwise specified) must not exceed the following values (both the peak requirement and the average value requirement must be met):

Frequency band (MHz)	Limits with peak detector – permanent noise (dBµV/m) (3)	Limits with peak detector – "short duration" noise (dBµV/m) (3)	Bandwidth for peak detector measurements (1)	Limits with average value detector (dBµV/m)	Bandwidth for average value detector measurements (1)
0.1 – 0.15	86	92	9 kHz	41	9 kHz
0.15 – 0.3 (2)	66 53 (Quasi-peak) (6)	72 59 (Quasi-peak) (6)	9 kHz	31	9 kHz
0.3 – 0.53	86	92	9 kHz	41	9 kHz
0.53 – 2 (2)	59 46 (Quasi-peak) (6)	65 52 (Quasi-peak) (6)	9 kHz	26	9 kHz
2 – 5.9	75	81	9 kHz	34	9 kHz
5.9 – 6.2	54	60	9 kHz	34	9 kHz
6.2 – 26	54	60	9 kHz	34	9 kHz
26 – 54	54	60	120 kHz	34	9 kHz
54 – 68	67 – 25.13 x log (F/30)	67 – 25.13 x log (F/30)	120 kHz	44 – 25.13 x log (F/30)	9 kHz
68 - 76(5)	37	43	120 kHz	18	9 kHz
76 -108 (2)	31 18 (Quasi-peak) (6)	37 24 (Quasi-peak) (6)	120 kHz	18	120 kHz
108 – 138	57 + 15.13 x log (F/75)	57 + 15.13 x log (F/75)	120 kHz	34 + 15.13 x log (F/75)	9 kHz
138 – 175	43	49	120 kHz	24	9 kHz
175 – 370	57 + 15.13 x log (F/75)	57 + 15.13 x log (F/75)	120 kHz	34 + 15.13 x log (F/75)	9 kHz
370 – 430(5)	50	56	120 kHz	31	9 kHz
430 - 436(7)	50	56	120 kHz	18(7)	9 kHz
436 – 512 (5)	50	56	120 kHz	31	9 kHz
512 – 820	68	68	120 kHz	45	9 kHz
820 – 960	44	50	120 kHz	31	9 kHz
960 – 1000	68	68	120 kHz	45	9 kHz
1447-1494 (4)	44	50	120 kHz	31	9 kHz
1559 – 1610 (4)	31	37	120 kHz	18	9 kHz
1800– 2170 (4)	44	50	120 kHz	31	9 kHz
2400 – 2500 (4)	44	50	120 kHz	31	9 kHz

(1) These bandwidths are given for cases of acquisition with a measuring receiver. If a spectrum analyser is used, 10 kHz (instead of 9) and 100 kHz (instead of 120) resolutions may be used.

(2) For equipment located in the rear (back seats and doors, boot) of a vehicle equipped with an AM and/or FM reception window antenna (back window, rear quarter panel, etc.), these levels should be tightened by 10 dB in the frequency bands in questions.
For example: radiation from a park-assist-system located in the boot, in relation to the window antenna in the rear window. This situation should be specified in the STN/ST or EMC test plan.

(3) Unless otherwise specified, the term "short duration" corresponds to equipment which is used for less than one minute (examples of short-duration noises: automatic windows, windscreen washer pump; examples of permanent noises: windscreen wipers, Motor-driven fan, etc.)

(4) The field measurement from 1 GHz to 2.5 GHz is not mandatory for equipment with a frequency oscillator of less than 15MHz, or with levels showing at least a 20 dB margin in relation to the specified limits of 512 MHz to 1 GHz.

(5) The limits specified are those to be used in cases where the sensitivity of the specific receiver (police, gendarmerie, etc.) on board the vehicle is unknown. If it is specified, the limits to be used for these tests must be adapted appropriately.

(6) The levels given with the quasi-peak detector apply to special demands (for example: PWM signals, etc …).

(7) For the bandwidth 430-436Mhz, a limit of 18dBµV/m applies to equipment which can be power supplied prior to start-up or after cut-off of the +APC. In the case of equipment which is not power supplied, from cut-off of the +APC (and prior to placing the network in stand-by mode), a limit of 31dBµV/m applies.

7.VEHICLE TEST APPLICATION GUIDE

The EMC official defines the type of tests and test configurations to which vehicles are to be submitted in agreement with the system officials involved.

The tests to be performed depend on the type of equipment and how it is fitted in the vehicle.

7.1.TEST CONDITIONS

The vehicle used must be representative of production manufacture in terms of the electrical / electronic architecture, in particular for engine size, harness routing, locations of electrical and electronic equipment, transceiver antenna systems and hardware and software definition of electrical and electronic equipment.

The vehicle must be unladen, with the exception of the necessary test equipment. It must not be electrically connected to the test area and there should be no connection between the vehicle and any test equipment item.

7.2.TEST REPORT

The test report must contain at least the following items:

- Title of the test report.
- Report references (number, review, date).
- Location and date of the tests.
- Identification of the method used.
- Characteristics of the vehicle tested (model, identification, engine, steering, gearbox, special features).
- Reference(s) of the electrical and electronic equipment fitted to the vehicle.
- Vehicle and EUT operating conditions.
- Exact test results as well as compliance / non-compliance to the requirements.
- Information required by each test procedure.
- Information required by the EMC test plan.

The test facility calibration files must be archived.

8.TEST PROCEDURES FOR VEHICLES AND REQUIREMENTS

8.1.IMMUNITY TO RADIATED DISTURBANCE TEST

8.1.1.VH/IR 01: IMMUNITY TO RADIATED FIELDS (SEMI-ANECHOIC OR ANECHOIC CHAMBER)

8.1.1.1.REFERENCE DOCUMENT

This procedure conforms to the ISO/DIS 11451-1 and ISO/DIS 11451-2 projects with the following indications.

8.1.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity from exterior sources of a vehicle equipped with its operational electrical and electronic equipment and devices associated with the electromagnetic field within the [100 kHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands.

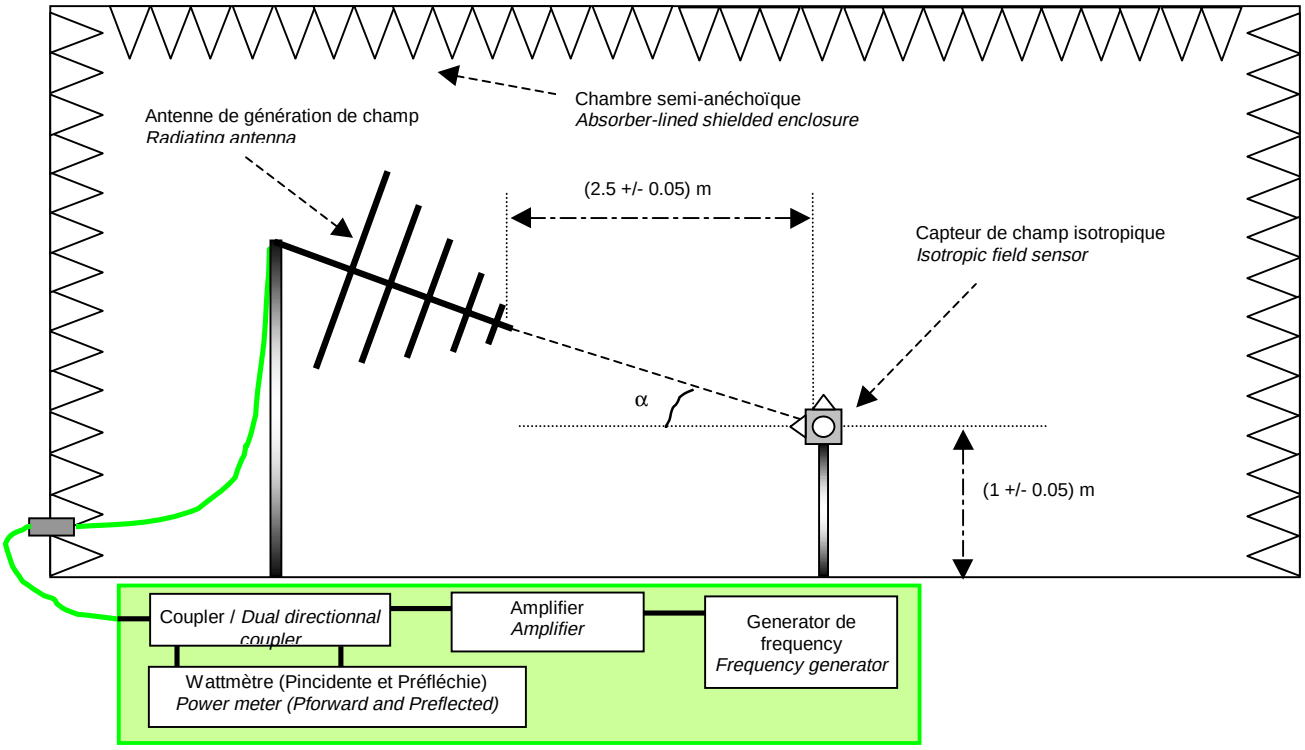
Its principal characteristics are as follows:

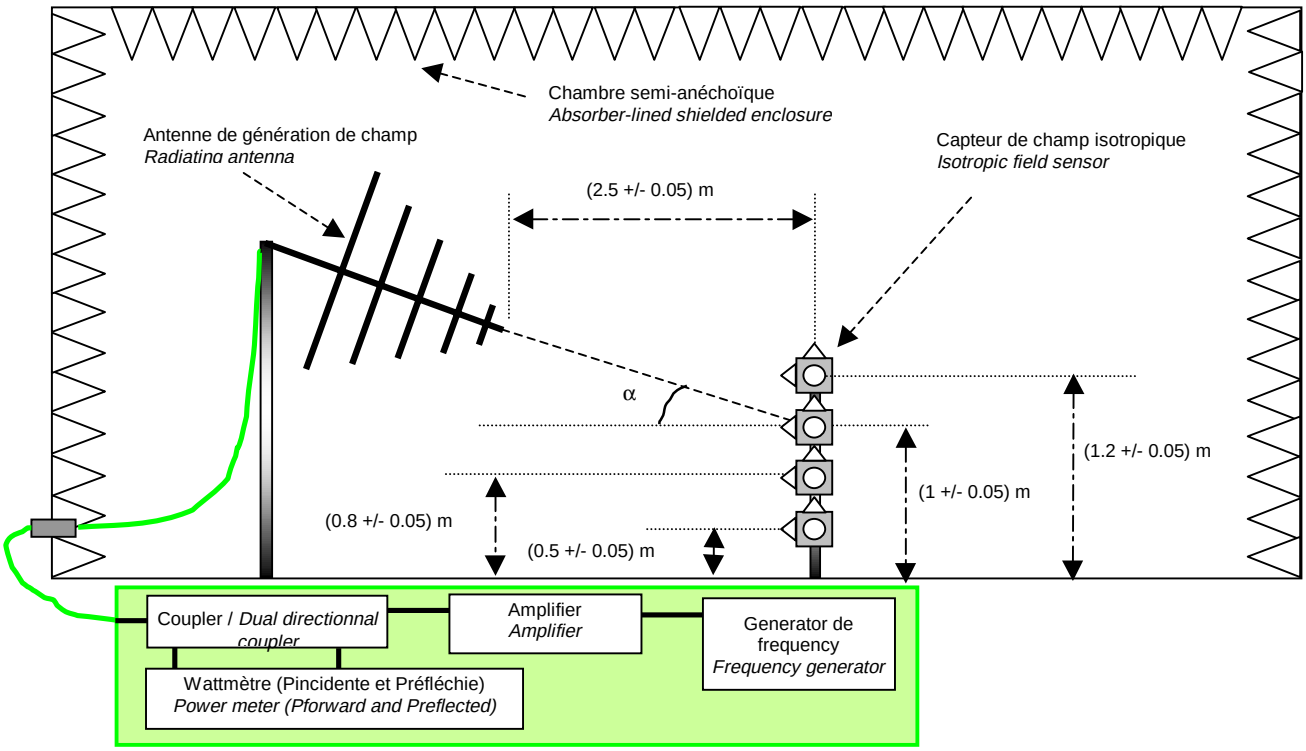
- Modulations
  - CW and AM in the [100 KHz – 800 MHz] frequency band.
  - CW, AM and PM1 in the [800 MHz – 1 GHz] frequency band.
  - CW and PM1 in the [1 GHz – 1.2 GHz] frequency band.
  - CW and PM2 in the [1.2 GHz – 1.4 GHz] frequency band.
  - CW and PM1 in the [1.4 GHz – 2.5 GHz] frequency band.
  - CW and PM2 in the [2.07 GHz – 3.2 GHz] frequency band.
- Single-sensor substitution method in the [100 kHz - 20 MHz] band
- Four-sensor substitution method in the [20 MHz – 3.2 GHz] band
- Vertical polarisation in the [100 kHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] bands.
- Horizontal polarisation in the [20 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] bands

8.1.1.3.TEST FACILITIES

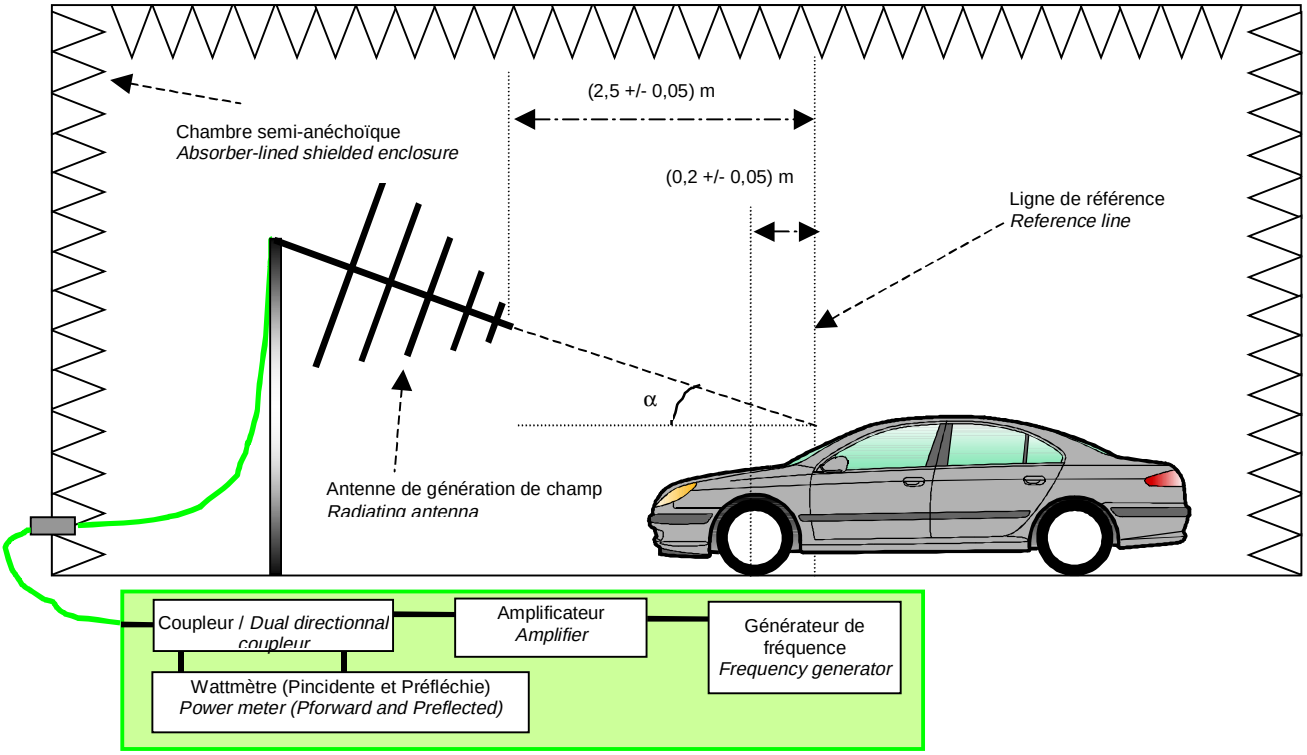
- Equipment required to check the correct operation of the EUT on the vehicle.
- HF signal generator.
- Broadband power amplifiers.
- 50 Ω couplers.
- Power meter and related power probes.
- TLS, log-periodical and/or horn antennas.
- Isotropic field sensor(s) equipped with optical fibre(s).
- Roller test bench on a rotating platform.
- Semi-anechoic or anechoic shielded enclosure.

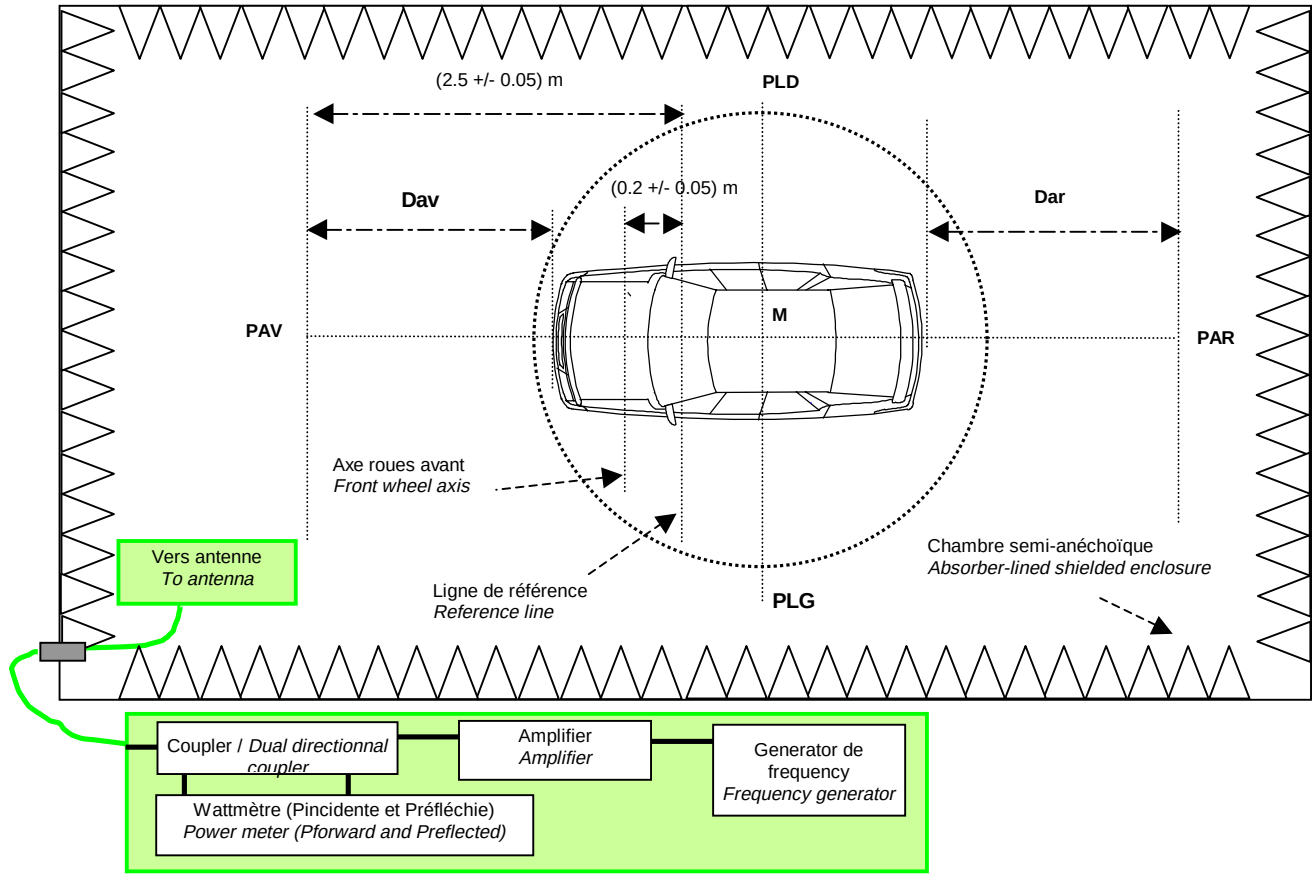
8.1.1.4.TEST ASSEMBLY





Single and four-sensor calibration configurations





Vehicle test configuration (front radiation and other radiations)

8.1.1.5.PROCEDURE

The method used is the substitution method based on the measurement of forward power. Unless there is a special specification, the tests are carried out in the [100 kHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands for vertical polarisation and the [20 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands for horizontal polarisation.

- The tests are carried out for each modulation defined in paragraph 8.1.1.2.
- All tests are carried out preserving the peak level between the sine wave and modulated signals. The peak value of the field during the vehicle test (CW, AM, PM1 and PM2) must be equal to the maximum envelope of the level of the field during the calibration phase in CW.
- Preparation:
- Field generation:
- The field generating system(s) must be chosen so that the required field level is obtained on the reference point or line.
- The field generating systems may be one or more antennas or a transmission line system (mainly in the [100 kHz - 20 MHz] frequency band).
- No part of the radiating items in the field generating system should be located less than 0.25 m from the earth plane on which the vehicle stands and less than 0.5 m from the surface of the vehicle body.
- The parts of the field generating system must not be located less than 0.5 m from any absorbent material and no less than 2 m from the shielded chamber wall. There must not be any absorbent materials between the transmission antenna and the reference point.
- Unless there is a special specification in the vehicle EMC test plan, the tip of the antenna (log-periodical or horn) must be located 1.6 ± 0.07 m above the earth plane on which the vehicle stands. The antenna must be oriented so that the reference point is in the axis of its principal lobe.
- The field generating system must be positioned in the vehicle axis (median longitudinal plane). Unless there is a special specification in the vehicle EMC test plan, the antenna angle of inclination, α, (angle between the direction of propagation and the horizontal plane) must be 13°± 3°.
- Positioning the vehicle:

The vehicle being tested may be positioned in the 4 radiation configurations specified in paragraph 8.1.1.4: front antenna position (PAV), rear antenna position (PAR) and lateral antenna position (PLG, PLD):

- 1 front radiation position, PAV: the vehicle being tested must be placed on the EMC test rotating platform so that the front wheel axis of the vehicle is located 0.2 m ± 0.05 m behind the reference point.
- 1 rear radiation position, PAR, achieved by rotating the platform 180° so that Dav = Dar . PAR is symmetrical to PAV in relation to point M (with point M at the centre of the rotating platform).
- 2 lateral radiation positions, PLG and PLD, achieved by a +/- 90 ° rotation of the platform so that:
  - d(M,PLG) = d(M,PLD) = d(M,PAV)
  - PLG and PLD are symmetrical in relation to the M PAV axis
  - When the test resources have a rotating platform, point M coincides with the centre of the rotating platform. Thus, the use of the rotating platform avoids the need to move the antenna into different positions.

Calibration:

The reference point or reference line (PR1) defines the position in space for which the field level must be established (during the calibration phase):

- At 2.5 m ± 0.05 m horizontally from the antenna tip (log-periodical or horn) or 1 m ± 0.05 m vertically from the radiating parts of a transmission line system.
- In the vehicle axis (median longitudinal plane).
- At a height of 1 m ± 0.05 m above the earth plane on which the vehicle stands.
- At 0.2 m ± 0.05 m from the vehicle front wheel axis, measured towards the centre of the vehicle.

So as to produce the field required at the reference point or line for each frequency, the forward power required must be applied to the field generating system according to the procedure described in paragraph field generating system, with the vehicle absent from the test area. The forward power level, reflected power level and field level shall be measured and recorded. Calibration must be performed in CW within the [100 kHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz] frequency bands, using a maximum frequency step corresponding to that of the test.

Above 200MHz, the field amplitude must not vary by +0 / - 6dB for 80% of the calibration frequency points at 0.5 m ± 0.05 m on each side of the reference point on a line passing through the reference point perpendicular to the axis of propagation.

Single-sensor method [100 kHz - 20 MHz]

- Place the isotropic field sensor at the reference point.
- Record the forward power $P_{calibration}$ required to generate the field specified for each frequency.
-

Four-sensor method [20 MHz – 2.5 GHz] and [2.7 GHz – 3.2 GHz]

- Place the four isotropic field sensors at the following heights: 0.5 m, 0.8 m, 1 m and 1.2 m.
- Place the tip of the antenna at a distance of 2.5 m from the isotropic field sensor placed at a height of 1 m.
- Record the forward power $P_{calibration}$ required to generate the field (average value of the four isotropic field sensors) specified for each frequency.

The calibration phase shall be carried out under PAV radiation conditions. The PAR, PLG and PLD radiation tests shall be carried out with the same calibration file as that drawn up for the PAV radiation position.

Test:

- Place the antenna and the vehicle being tested in the configuration described in paragraph 8.1.1.5.
- Run the vehicle engine for 10 minutes.
- For each test frequency, gradually apply the test field level corresponding to the forward power level $P_{calibration}$ recorded in the calibration phase (the forward and reflected power levels must be recorded).
- Run the vehicle and the various electrical parts on the vehicle in accordance with the tests to be carried out.
- Check the correct operation at the test frequency. If operations are disturbed, search for the sensitivity threshold for the unit in question by decreasing the field level to a field level that is much lower than the malfunction level; then increase the field level to the malfunction level, this will be considered as the malfunction field level and must be recorded (the threshold can be sought out before moving on to the next frequency or at the end of the sweep operations on the frequency range).
- Gradually decrease the forward power applied to the antenna and change the frequency.

Test report:

Amongst other information, the test report shall include the following:

- Transmission systems (antennas) used.
- Parameters observed and malfunctions encountered during the test: required sensitivity thresholds.
-

8.1.1.6.REQUIREMENTS

Test		Customer impact levels
30 V/m (effective)		0
50 V/m (effective)		1
100 V/m (effective)	80 V/m (effective) ***Note 1***	2
150 V/m (effective)	120 V/m (effective) ***Note 1***	3

General Note*: In the case of an EUT which includes a radio transmitter/receiver function (eg; remote control at F_0 Mhz), the function may be non-operational (to be specified in the test plan) in a frequency range of $F_0 \pm 5\%$.*

Note 1 *: these levels apply to the following frequency bands : 30-65 MHz, 88-140 MHz, 180-380 MHz, 520-1200 MHz and 1400-2700MHz.*

8.1.2.VH/IR 03: IMMUNITY TO ON-BOARD TRANSMITTERS WITH OUTSIDE ANTENNAS

8.1.2.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

8.1.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

- The purpose of this test is to evaluate the immunity of vehicle functions to radiated disturbances from the vehicle on-board transmitters with stationary transmission systems (antenna / adapter / cable).

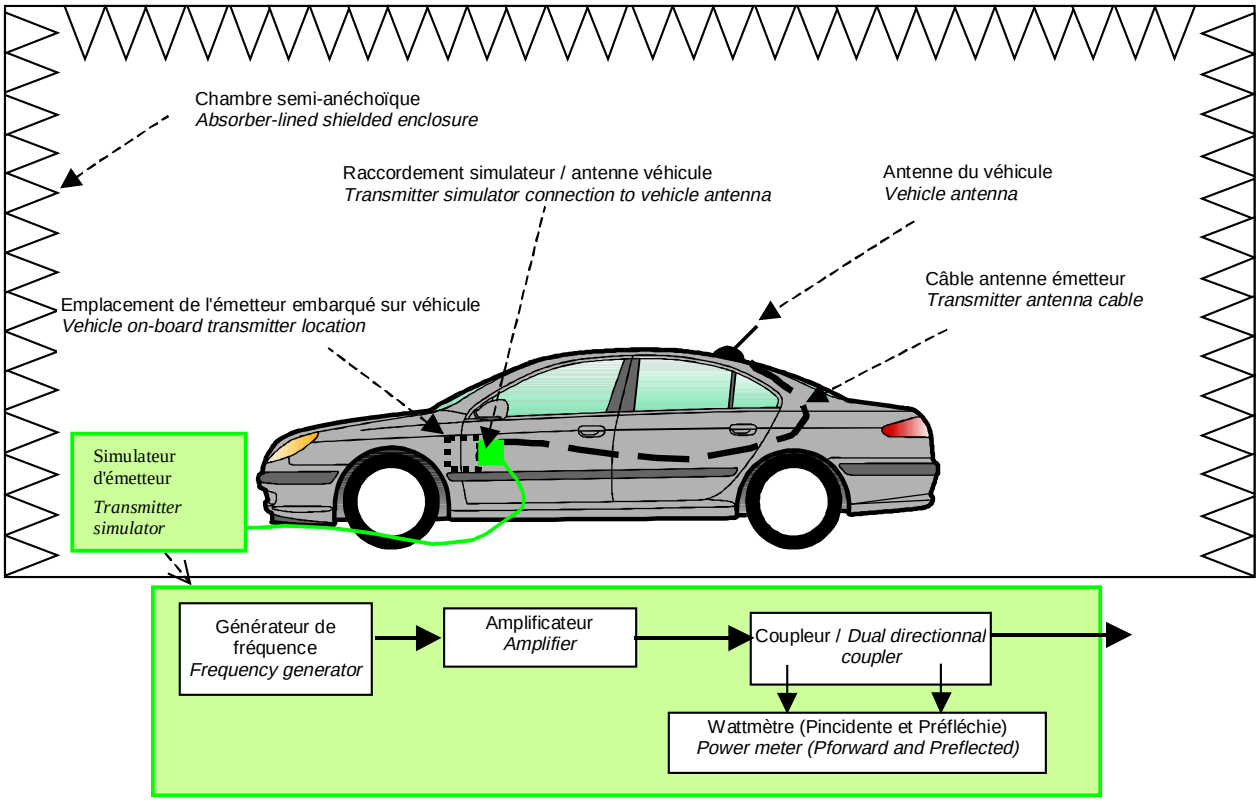
Its principal characteristics are as follows:

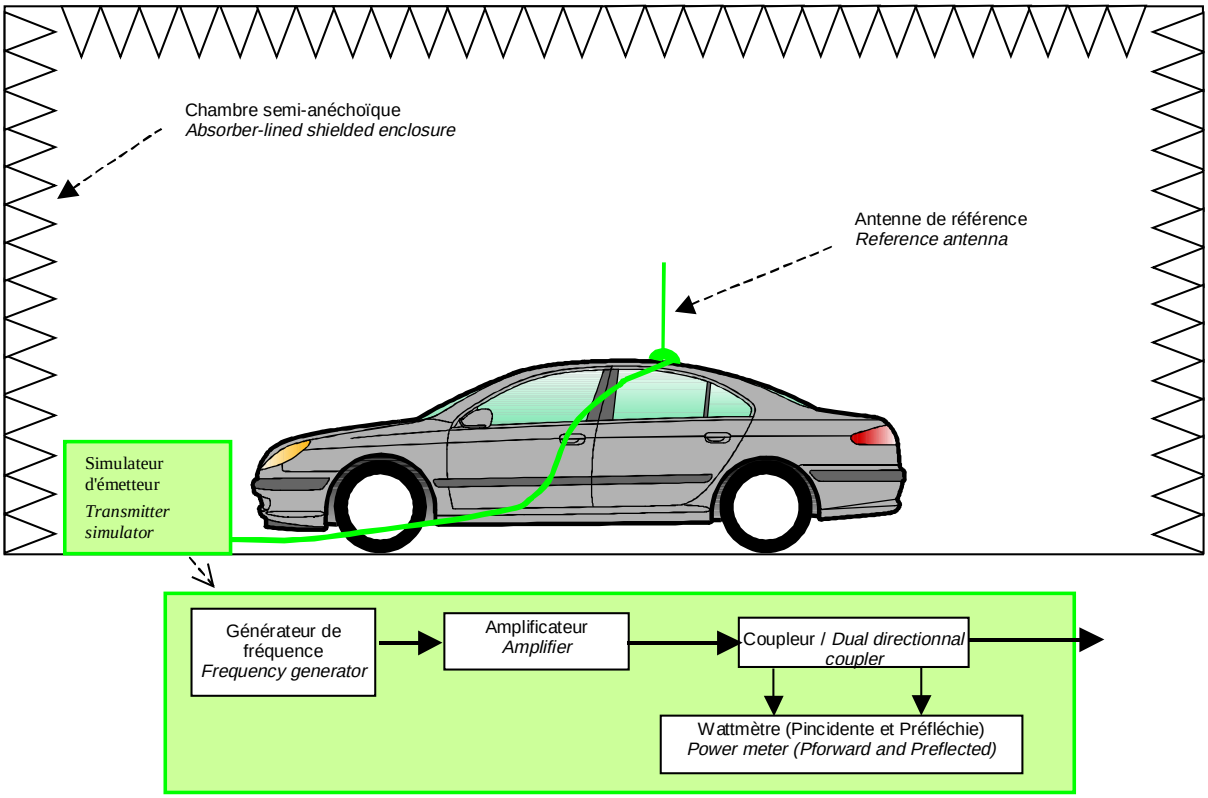
- Closed feedback loop on
  - forward power for on-board transmission systems that are mounted (transmitter, cable and antenna) or pre-arranged (cable and antenna) on the vehicle (for example: GSM, DCS, etc.);
  - transmitted power (forward power – reflected power) for on-board transmission systems that are not mounted on the vehicle (for example: CB, amateur radio, etc.).
- Generation of an electric field with an on-board transmitter on the vehicle or with an on-board transmitter simulator.

8.1.2.3.TEST FACILITIES

- Equipment required to check correct operation of the EUT on the vehicle.
- HF signal generator.
- Power amplifiers.
- 50 Ω couplers.
- Power meter and related power probes.
- Roller test bench.
- Semi-anechoic or anechoic shielded enclosure.
- Reference antennas
- Frequency ranges less than or equal to 60 MHz: tuned single pole antenna with a length of 1.25 ± 0.25m;
- Frequency ranges greater than 60 MHz: tuned antenna (single pole with a length of $\lambda/4$, patch, dipole, etc.).

8.1.2.4.TEST ASSEMBLY





Vehicle test configuration with an on-board transmission simulator (vehicle antenna or reference antenna)

8.1.2.5.PROCEDURE

- The method used is the closed feedback loop method on
  - forward power on scale with the transmission system (cable + antenna) for transmission systems mounted (transmitter, cable and antenna) or predisposed (cable and antenna) on the vehicle.
  - transmitted power (forward power – reflected power) at the terminal of the reference antenna for on-board transmission systems not mounted on the vehicle.

Preparation:
On-board transmission systems pre-arranged (cable and antenna) on the vehicle:

- Run with the transmission simulator and transmission system (antenna cable + antenna) on the vehicle.
- The transmission simulator is made up of a generator, an amplifier, a coupler and a power meter connected directly to the transmission system (cable + antenna) on the vehicle. All parts connected to the transmission simulator must be placed outside the vehicle at a distance of at least 1m from all points on the vehicle.

On-board transmission systems not mounted on the vehicle:

- Run with the transmission simulator and reference antenna.
- The transmission simulator is made up of a generator, an amplifier, a coupler and a power meter connected directly to the reference antenna. All parts connected to the transmission simulator must be placed outside the vehicle at a distance of at least 1m from all points on the vehicle.
- Unless there is a special specification in the vehicle EMC test plan, the reference antenna used is
  - a tuned antenna as defined in paragraph 8.1.2.3
  - positioned in vertical polarisation
  - centred on the roof of the vehicle, 0.2 m from the rear of the roof (if an original mounted antenna is present near this position, the reference antenna will have to be moved towards the front to ensure a distance of 0.2 m between the two antennas).

On-board transmission systems mounted (transmitter, cable and antenna) on the vehicle:

- Run with the vehicle transmitter and transmission system (antenna cable + antenna).
- The on-board transmitter on the vehicle is used without modifying the vehicle characteristics and architecture in one of the following configurations:
  - Run the vehicle on-board transmitter with its frequency, signal and power managed by a base station simulator (case of radio communication with GSM / DCS or Bluetooth);
  - Run the vehicle on-board transmitter with its frequency, signal and power managed manually (case of police transmitters).
- For a test with a base station simulator, all the parts connected to the base station simulator must be placed outside the vehicle. The simulator must be located at a distance of at least 1m from all points on the vehicle. The base station simulator antenna (tuned antenna) must be placed as far as possible from the vehicle transmission antenna so as not to significantly modify radiation from the latter while maintaining proper synchronisation between the base station simulator and the original mounted transmitter on the vehicle.
- For a manual test, the manual start-up of the on-board transmitter must not be performed by the operator but rather by a remote control system (pneumatic jack, etc.). This remote control system may be placed inside or outside the test assembly.

Test:

On-board transmission systems pre-arranged (cable and antenna) on the vehicle and on-board transmission systems not mounted on the vehicle:

- Place the vehicle and the transmission system according to the test configurations described in paragraphs 8.1.2.4 and 8.1.2.5.
- Start up the vehicle and its various electrical parts in accordance with the tests to be carried out.
- Set the HF generator to obtain the power level $P_{calibration}$ (measured in CW) corresponding to that indicated in the following table. Then apply the modulation indicated in the following table.

Frequency bands MHz[(1)]	Test frequencies MHz[(2)]	Effective power measured in CW ($P_{calibration}$)[(3)]	Signal to be applied
26.96 – 27.41[(4)]	27.2	12 W	CW and AM 1 kHz 80%
144 – 148[(4)]	146	12 W	CW and AM 1 kHz 80%
430 – 440[(4)]	435	12 W	CW and AM 1 kHz 80%
890 - 915[(5)]	902.4	6 W	PM 217 Hz T_{on} 577 µs
1710 - 1785[(5)]	1747.4	3 W	PM 217 Hz T_{on} 577 µs
2402 - 2480[(4)]	2441	300 mW	PM 700 kHz Duty cycle 0.5

(1) There are other frequency ranges on different markets which correspond to on-board transmitters (Ministry networks, professional mobile telephone networks, PDC Japan, AMPS USA, GSM 1900 USA, etc.).
The list of possible additional frequency ranges (with test frequency, power and signals to be applied) must be specified in the vehicle EMC test plan.

(2) Unless there is a special specification in the test plan or in the Specification specific to the equipment, the tests shall be carried out for the central frequency in the band.

- (3) **Forward power** at the terminal of the transmission system (cable + antenna) for on-board transmission systems predisposed (cable and antenna) on the vehicle. **Transmitted power** (forward power – reflected power) at the terminal of the reference antenna for on-board transmission systems that are not mounted on the vehicle.

*(4) To be performed with the **reference antenna** unless there is a special specification in the vehicle EMC test plan.*

*(5) To be performed with priority using the **vehicle transmission system (antenna cable + antenna)** if present on the vehicle.*

- Check the correct operation at the test frequency. If operations are disturbed, search for the sensitivity threshold for the unit in question by decreasing the power level to a power level that is much lower than the malfunction level; then increase the power level to the malfunction level, this will be considered as the malfunction power level and must be recorded.
-
- On-board transmission systems mounted (transmitter, cable and antenna) on the vehicle :
-
- Place the vehicle and the transmission system according to the test configurations described in paragraphs 8.1.2.4 and 8.1.2.5.
- Start up the vehicle and its various electrical parts in accordance with the tests to be carried out.
- Start up the vehicle on-board transmission system under the nominal conditions (frequency, modulation and maximum power).
- Check the correct operation at the test frequency. If operations are disturbed, search for the sensitivity threshold for the unit in question by decreasing the power level to a power level that is much lower than the malfunction level; then increase the power level to the malfunction level, this will be considered as the malfunction power level and must be recorded

Test report:

Amongst other information, the test report shall include the following:

- Characteristics of the transmission simulators used.
- Position of the connection cable between the transmission simulation system and the antenna cable on the vehicle (or the reference antenna).
- Type and characteristics (TOS value at the central frequency in the band) of the reference antenna, if used.
- Parameters observed and malfunctions encountered during the test: required sensitivity thresholds.

8.1.2.6.REQUIREMENTS

Test	Customer impact levels
Power level (cf. table in paragraph 8.1.2.5)	1

8.1.3VH/IR 04: IMMUNITY TO MOBILE ON-BOARD TRANSMITTERS

8.1.3.1.REFERENCE DOCUMENT

There is no reference document concerning this test.

8.1.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

- The purpose of this test is to evaluate the immunity of a vehicle functions to radiated disturbances from “mobile” on-board transmitters (cellular telephones, Bluetooth transmitter, etc.) which can be used in the vehicle.

Its principal characteristics are as follows:

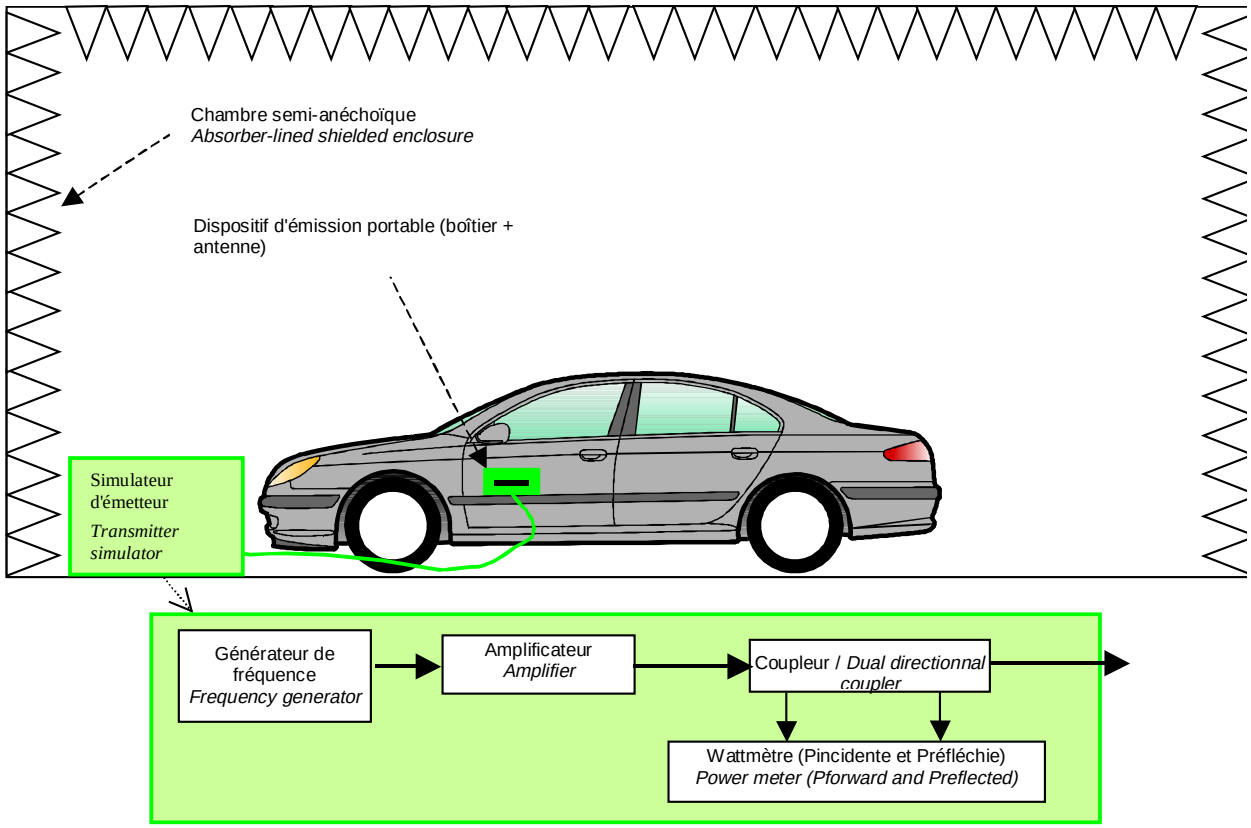
- Closed feedback loop on the transmitted power (forward power – reflected power) at the teminal of the mobile transmission device (housing + antenna).
- Generation of an electric field with the mobile transmission device.

8.1.3.3.TEST FACILITIES

- Equipment required to check the correct operation of the EUT on the vehicle.
- HF signal generator.
- Power amplifiers.
- 50 Ω couplers.
- Power meter and related power probes
- Roller test bench on a rotating platform.
- Semi-anechoic or anechoic shielded enclosure.
- Mobile transmission device with the following characteristics (by default):
- 890 – 915 MHz range: dipole antenna
- 1710 – 1785 MHz range: dipole or patch antenna
- 2402 – 2480 MHz range: patch antenna

Note: Use of a monopole antenna is not recommended (test feasibility with different polarisations).

8.1.3.4.TEST ASSEMBLY



Vehicle test configuration with an on-board mobile transmission simulator

8.1.3.5.PROCEDURE

- The method used is the closed feedback loop method on transmitted power (forward power – reflected power) at the terminal of the mobile transmission device (housing + antenna).

Preparation:

- The transmission simulation system is made up of a generator, an amplifier, a coupler and a power meter directly connected to the mobile transmission system. All parts connected to the transmission simulator must be placed outside the vehicle at a distance of at least 1m from all points on the vehicle.

Test:

- Place the vehicle and the transmission system according to the test configurations described in paragraphs 8.1.3.4 and 8.1.3.5.
- Start up the vehicle and its various electrical parts in accordance with the tests to be carried out.
- Set the HF generator to obtain the transmitted power level $P_{calibration}$ (measured in CW) at the terminal of the mobile transmission device which corresponds to that indicated in the following table. This setting must be made in an external configuration to the vehicle in which the mobile transmission device is positioned at a distance of at least 1 m from all metal parts (shell wall, equipment, earth plane) and 0.5 m from absorbents.
- Then apply the modulation indicated in the following table and place the mobile transmission device in the various positions (equipment, harness, other positions) in the vehicle. The mobile transmission devices must be used with an insulating support (or handle) at least 0.5 m in length to limit operator influence on tests carried out manually.

- The various positions of the mobile transmission system in the vehicle must be specified in the vehicle EMC test plan:
  - near equipment
  - near harness
  - other locations (occupants, door storage area, glove compartment, central console, area under seats, etc.)

Frequency bands MHz[(1)]	Test frequencies MHz[(2)]	Effective transmitted power measured in CW ($P_{calibration}$)[(3)]	Modulation to be superimposed (for test on the EUT)
890 - 915	902.4	6 W	PM 217 Hz T_{on} 577 µs
1710 - 1785	1747.4	3 W	PM 217 Hz T_{on} 577 µs
2402 - 2480	2441	300 mW	PM 700 kHz Duty cycle 0.5

(1) There are other frequency ranges on different markets which correspond to on-board transmitters with built-in antennas (PDC Japan, AMPS USA, GSM 1900 USA, etc.). The list of possible additional frequency ranges (with test frequency, power and signals to be applied) must be specified in the test plan or Specification specific to the equipment .

(2) Unless there is a special specification in the test plan or in the Specification specific to the equipment, the tests shall be carried out for the central frequency in the band.

(3) ***Transmitted power*** *(forward power – reflected power) at the terminal of the mobile transmission device.*

- Check the correct operation at the test frequency. If operations are disturbed, search for the sensitivity threshold for the unit in question by decreasing the power level to a power level that is much lower than the malfunction level; then increase the power level to the malfunction level, this will be considered as the malfunction power level and must be recorded.

Test report:

Amongst other information, the test report shall include the following:

- Characteristics of the transmission simulators used.
- Characteristics of the mobile transmission system : size of the housing, type of antenna, TOS value at the central frequency in the band.
- Position of the connection cable between the transmission simulation system and the mobile transmission system.
- Parameters observed and malfunctions encountered during the test: required sensitivity thresholds.

8.1.3.6.REQUIREMENTS

Test	Customer impact levels
Power level (cf. table in paragraph 8.1.3.5)	1

8.2.VH/IR 02: RESISTANCE TO ELECTROSTATIC DISCHARGES

8.2.1.REFERENCE DOCUMENT

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

8.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to check the immunity of equipment mounted on the vehicle to electrostatic discharges produced during operation or maintenance by the user.

Its principal characteristics are as follows:

- Contact discharges: ± 4 kV and ± 8 kV. These discharges apply to the accessible conductive parts of the equipment mounted on the vehicle.
- Air discharges: ± 4 kV, ± 8 kV , ± 15 kV and ± 25 kV. These discharges apply to the accessible insulating parts of the equipment mounted on the vehicle, as well as the accessible conductive parts of the equipment mounted on the vehicle for the 25kV level.
- Energy accumulation capacity: 150 pF for discharges on the exterior parts of the passenger compartment and 330 pF for discharges on the interior parts of the passenger compartment.
- Discharge resistance: 2 kΩ.
- 10 discharges spaced out by 1 s to10 s.
- Discharge application points (to be specified in the test plan): equipment surfaces which may be accessible and which must remain operational during simple maintenance operations with no special disassembly (housings, wiring, diagnostic plug pins, socket contact, etc.) and each point which may come into direct contact with equipment users (buttons, handles, screen, indicator light, display, etc.).
- Positive polarity and negative polarity.

8.2.3.DISCHARGE APPLICATION POINTS

- The discharge application points are categorised as follows:
- Type 1 h direct points: each point of the passenger compartment equipment (buttons, handles, screens, indicator lights, displays) which may be directly accessible (without disassembly) to users.
- Type 1 h indirect points: each point of the passenger compartment equipment which may be indirectly accessible (following disassembly, maintenance, etc.) in operating mode (fuse; wire harnesses and connectors, etc.).
- Type 1 m points: each point of the equipment under the engine compartment (connectors, battery terminal, housings, etc.), or accessible from outside the passenger compartment only (for example: parking aid sensor, etc.).
- Type 2 h direct points: every input-output pin which may be directly accessible to users in a remote manner (door socket connector, etc.).
- Type 2 h indirect points: every input-output pin accessible to users in a remote manner, after manipulation (diagnostic plug pins, etc.).

Accessibility and location		Equipment envelope	Pin or contact accessible in a remote manner
Directly accessible	Passenger compartment	1 h direct	2 h direct
	Engine compartment or outside the vehicle	1 m	Not applicable
Accessible after manipulation or dissassembly	Passenger compartment	1 h indirect	2 h indirect
	Engine compartment outside the vehicle	1 m	Not applicable

8.2.4.TEST FACILITIES

- Equipment required to check correct operation of the EUTs.
- Calibration equipment in compliance with the ISO 10605 standard.
- Electrostatic discharge generator.
- Shielded enclosure (if possible).

8.2.5.TEST ASSEMBLY

- Electrostatic discharge outside the vehicle (150 pF simulator):
  - The electrostatic discharge generator earth is connected directly to a metal plate placed under the wheel closest to the application point.
- Electrostatic discharge inside the vehicle (330 pF simulator):
  - The electrostatic discharge generator earth is connected directly to the negative terminal of the vehicle battery or, by default, to the nearest earthed part of the chassis.

8.2.6.PROCEDURE

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

Preparation:

- Connect the electrostatic discharge generator earth to the negative terminal of the battery or to the earth plate placed under the wheel using a low-impedance braid.

Calibration:

- Calibrate the electrostatic discharge generator according to the ISO 10605 standard.
- Air discharges: use a spherical-tipped electrode.
- Contact discharges: use a pointed-tipped electrode.

Test:

The tests are carried out with the vehicle stopped and engine idling configuration.

- Points accessible from inside the vehicle are tested with the gun earth connected to the negative terminal of the battery.
- Points inside and outside that are easily accessible from outside the vehicle are tested with the gun earth connected to the earth plate located under the wheel of the vehicle.

Discharge on contact:

- Place the electrostatic discharge gun in contact with each of the points defined and trigger a series of 10 discharges of +4 kV spaced out by 1 s to 10 s and then a series of 10 discharges of -4kV spaced out by at least 1s.
- Check EUT operation during and after application of all of the pulses.
- Repeat the test at ± 8 kV .

Discharge in air:

- Slowly bring the electrostatic discharge gun to flash-over 10 times in succession towards each of the points defined, with the gun loaded at +4 kV and then at -4 kV.
- Check EUT operation during and after application of all of the pulses.
- Repeat the test at ± 8 kV, ± 15 kV and ± 25 kV .

Test report:

Amongst other information, the test report shall include the following:

- Parameters observed and malfunctions encountered during the test.
- Climatic environmental conditions.

8.2.7.REQUIREMENTS

The operating classes and the related customer impact levels associated with each function are given in the following table :

Test		**Discharge on conductive parts**			**Discharge on insulating parts**			
Equipment location	**Discharge points (type of discharge)**	**± 4 kV (contact)**	**± 8 kV (contact)**	**± 25 kV (air)**	**± 4 kV (air)**	**± 8 kV (air)**	**± 15 kV (air)**	**± 25 kV (air)**
Passenger compartment direct	Type 1 h direct points	A0	C1	C1	A0	A0	C1	C1
	Type 2 h direct points				Not applicable			
Passenger compartment indirect	Type 1 h indirect points	C1	D2	D2	A0	C1	D2	D2
	Type 2 h indirect points	A0	C1	C1	Not applicable			
Engine compartment or outside passenger compartment	Type 1m points	C1	C1	NA	A0	C1	C1	NA
	Type 2 h indirect points	A0	C1	C1	Not applicable			

8.3.RADIATED EMISSION TESTS

8.3.1.VH/MR 01: MEASUREMENT OF EMISSIONS RECEIVED BY ANTENNA ON THE SAME VEHICULE

8.3.1.1.REFERENCE DOCUMENT

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

- Dropping the narrowband – broadband distinction: the evaluation of disturbances with two different detectors (peak / quasi-peak and average value) in relation to two different limits (peak / quasi-peak and average value).
- The use of the "narrowband" limits in CISPR 25 for measurements with a detector for the average value and the "broadband" limits in CISPR 25 for the measurements with the peak / quasi-peak detector
- Extension of the high frequency measurements to 2.5 GHz.

8.3.1.2.PRINCIPAL CHARACTERISTICS OF THE TEST

This test is intended to evaluate the level of radio-electric disturbances gathered by the antenna and the receiver connection cable.

Its principal characteristics are as follows:

- Peak detection to evaluate levels in relation to the “peak” limit, and average value detection to evaluate the levels in relation to the “average value” limit. Quasi-peak detection may be used (if requested) in the 150 kHz – 300 kHz, 530 kHz – 2 MHz and 76 – 108 MHz bands to evaluate the levels in relation to the “quasi-peak” limit.

Note: to reduce the sweep time, measurements can be taken with a peak detector only. If the measured value is below the “average value” limit, the result is accepted.

- Frequency band [150 kHz – 2.5 GHz].
- Analysis filter bandwidth at 6 dB (broadband and narrowband):
  - F < 26 MHz: 9 kHz (10 kHz for the spectrum analyser).
  - F ≥ 26 MHz: 120 kHz (100 kHz for the spectrum analyser) except for mobile transceiver bands with 9 kHz average value detection (10 kHz for the spectrum analyser)
  -

Note : *to reduce the sweep time in the mobile bands with the average value detector, measurements can be taken with a bandwidth of 120 kHz (100 kHz for a spectrum analyser) rather than 9 kHz. If the measured value is below the average value limit specified in the test plan, the result of the average value measurement is accepted. The value of the measurement bandwidth used in this frequency range must be specified in the test plan.*

- For the measurements with a spectrum analyser, the total time and speed of the sweep (or number of sweeps) must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. These parameters must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 100 ms/MHz (BW 9 kHz).
  - F ≥ 26 MHz:1 ms/MHz (BW 120 kHz) or 100 ms/MHz (BW 9 kHz).

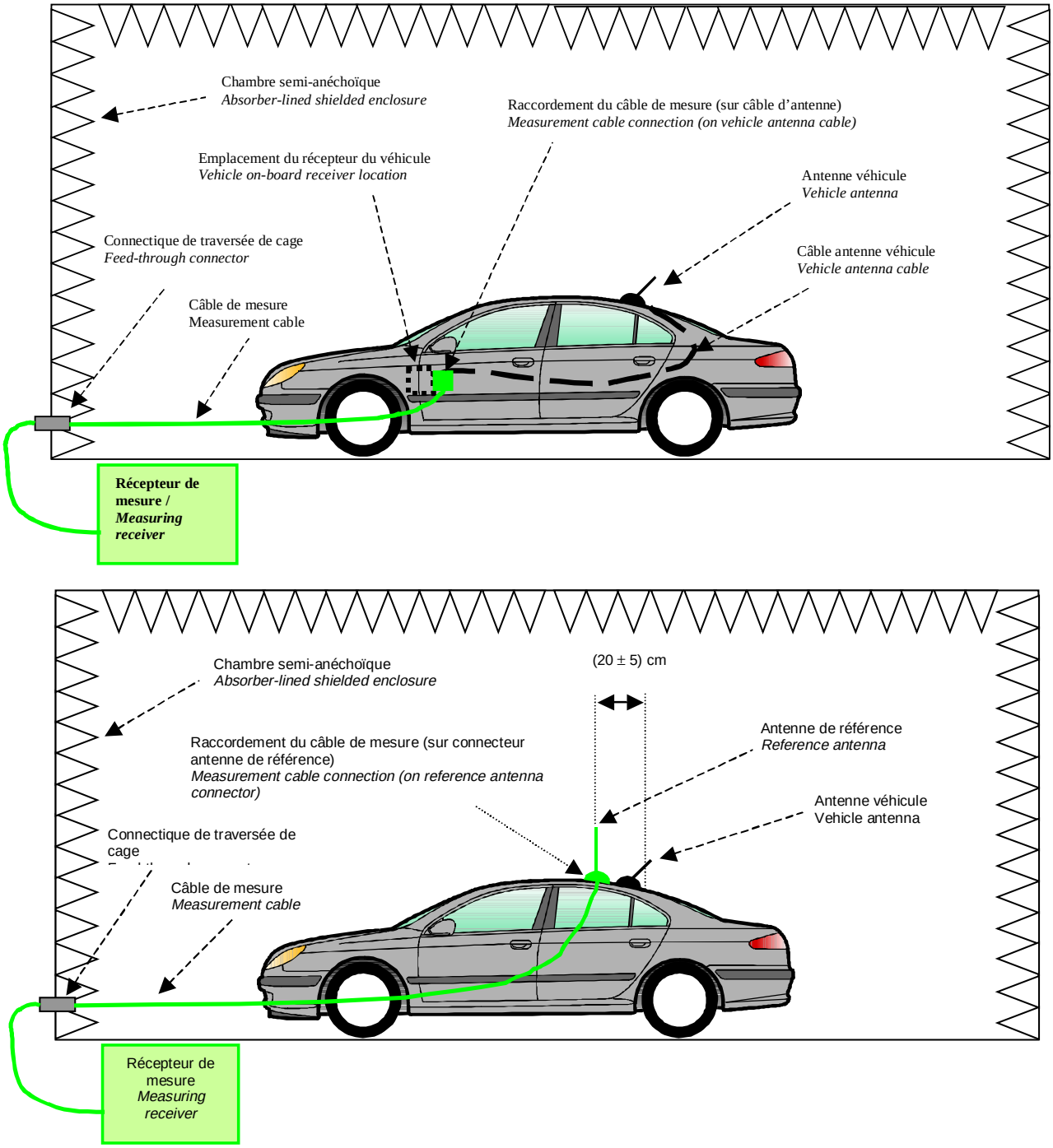
Higher values may be required for signals with low repetition rates.

- For the measurements with a receiver, dwell time must be adapted to the repetition rate of the disturbances emitted by the equipment being tested. The dwell time must be specified in the test plan. The following values should be taken by default:
  - F < 26 MHz: 100 ms (BW 9 kHz).
  - F ≥ 26 MHz: 10 ms (BW 120 kHz and BW 9 kHz).
- For the measurements with a receiver, maximum frequency step of 0.6 x BW.

8.3.1.3.TEST FACILITIES

- Semi-anechoic chamber in compliance with the CISPR 25 publication.
- 130 Ω / 50 Ω or 75 Ω / 50 Ω impedance adapter.
- Receiver or spectrum analyser in compliance with the CISPR 16-1 publication.
- Vehicle antenna and cable. By default, an adapted antenna must be installed at the most usual installation location(s).

8.3.1.4.TEST ASSEMBLY



Vehicle test configuration (vehicle antenna and reference antenna)

8.3.1.5.PROCEDURE

Preparation:

- Antenna:
  - Tilting roof antennas: with a whip of approximately 0.75 m, the height between the roof and the tip of the antenna is set at 0.55 m; with a whip of approximately 0.42 m, the height between the roof and the tip of the antenna is set at 0.35 m.
  - Non-tilting, stationary antennas: no setting is required.
  - Active antennas: the antenna amplifier power supply (wire or core) must be provided.
  - Antenna diversity: successive switching to each of the various antennas must be carried out.
- The position of the antenna cable and the earthing of the shielding must conform to the specification.
- Impedance adaptation: adaptation between the antenna cable impedance (130 Ω or 75 Ω) and the measuring devices (50 Ω) is performed:
  - From 76 MHz to 108:without adaptation or by a passive adapter if necessary.
  - From 150 kHz to 54 MHz: by an active adapter.

The impedance adapter housing earth should be connected to the antenna cable earth (either via the car radio cable earth or via the metal body of the car radio housing if it is present and connected during the measurements).

- Measuring system: the signal picked up at the impedance adapter output is, if necessary, amplified by a low noise amplifier.
- The measurement is carried out with a disturbance receiver or a spectrum analyser.

Calibration:

This test does not require any specific calibration, but the quality of the antenna installation should be ensured with a preliminary AM and FM reception test. This measurement may be carried out with a reference calibration source and/or the semi-anechoic chamber door open.

Test:

This consists in measuring the spectrum of the disturbances from the vehicle and picked up by the receiver antenna and the related cable in the car.

***Ambient measurements*:**

- Place the vehicle and the measuring devices according to the test configurations described in paragraph 8.3.1.4.
- Disconnect the battery from the vehicle.
- Supply power to the antenna amplifiers if active antennas are used (battery power).
- Measure the disturbing voltage at the base of the antenna in question with the peak detector and the average value detector for the various measurement configurations (vehicle antenna, diversity, reference antenna) and the various frequency ranges.

***Vehicle measurements**:*

- Place the vehicle and the measuring devices according to the test configurations described in paragraph 8.3.1.4.
- Supply power to the antenna amplifiers if active antennas are used (battery power).
- Start up the vehicle and its various electrical parts in the different configurations defined in the vehicle EMC test plan: various ignition key positions to identify the permanent sources of disturbance, actions on the parts which may generate disturbances (including parts with periodical or conditional operations).
- Measure the disturbing voltage at the base of the antenna in question with the peak detector (quasi-peak if requested) and the average value detector for the various measurement configurations (vehicle antenna, diversity, reference antenna) and the various frequency ranges.

Test report:

Amongst other information, the test report shall include the following:

- Spectrum curves and limits required in the various frequency bands.

8.3.1.6.REQUIREMENTS

The values measured in peak detection mode and in average value detection mode (unless otherwise specified) must not exceed the following values (both the peak requirement and the average value requirement must be met):

Frequency band (MHz)[1]	Limits with peak detector –permanent noise (dBµV) [3]	Limits with peak detector – "short duration" noise (dBµV) [3]	Bandwidth for peak detector measurements [2]	Limits with average value detector (dBµV)	Bandwidth for average value detector measurements [2]
0.15 – 0.3 [3]	22 9 (Quasi-peak) [5]	28 15 (Quasi-peak) [5]	9 kHz	6	9 kHz
0.53 – 2 [3]	19 6 (Quasi-peak) [5]	28 15 (Quasi-peak) [5]	9 kHz	0	9 kHz
5.9 – 6.2	19	19	9 kHz	0	9 kHz
26 – 28	28	28	9 kHz	0	9 kHz
30 – 54	28	28	120 kHz	0	9 kHz
68 – 87[4]	28	28	120 kHz	0	9 kHz
76 –108	28 6 (Quasi-peak) [5]	28 15 (Quasi-peak) [5]	120 kHz	6	120 kHz
138 – 175	28	28	120 kHz	0	9 kHz
370 – 512[4]	28	28	120 kHz	0	9 kHz
935 - 960	28	28	120 kHz	0	9 kHz
1559 – 1610	28	28	120 kHz	0	9 kHz
1805 – 1880	28	28	120 kHz	0	9 kHz

[1] There are other frequency ranges on different markets which correspond to on-board transmitters (PDC Japan, AMPS USA, GSM 1900 USA, UMTS etc.). The list of possible additional frequency ranges and related limits must be specified in the vehicle EMC test plan.

[2] These bandwidths are given for cases of acquisition with a measurement receiver. If a spectrum analyser is used, 10 kHz (instead of 9) and 100 kHz (instead of 120) resolutions may be used.

[3] Unless there is a specification to the contrary in the STN/ST or EMC test plan, the term "short duration" corresponds to equipment which is used for less than one minute. (examples of short-duration noises: automatic windows, windscreen washer pump, convertible roof, etc.; examples of permanent noises: windscreen wipers, air conditioning motor, Motor-driven fan, etc.).

[4] The limits specified are those to be used in cases where the sensitivity of the specific receiver (police, gendarmerie, etc.) on board the vehicle is unknown. If it is specified, the limits to be used for these tests must be adapted appropriately.

[5] The levels given with the quasi-peak detector apply to special demands (for example: PWM signals, etc.).

8.3.2.VH/MR 02: MEASUREMENT OF RADIO FREQUENCY RADIATED NOISE

8.3.2.1.REFERENCE DOCUMENT

This test procedure conforms to directive 95/54/CE, except for:

- Extension of high frequency measurements to 2 GHz.

8.3.2.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to evaluate the radiated electromagnetic quietness of the vehicle in broadband and in narrowband.

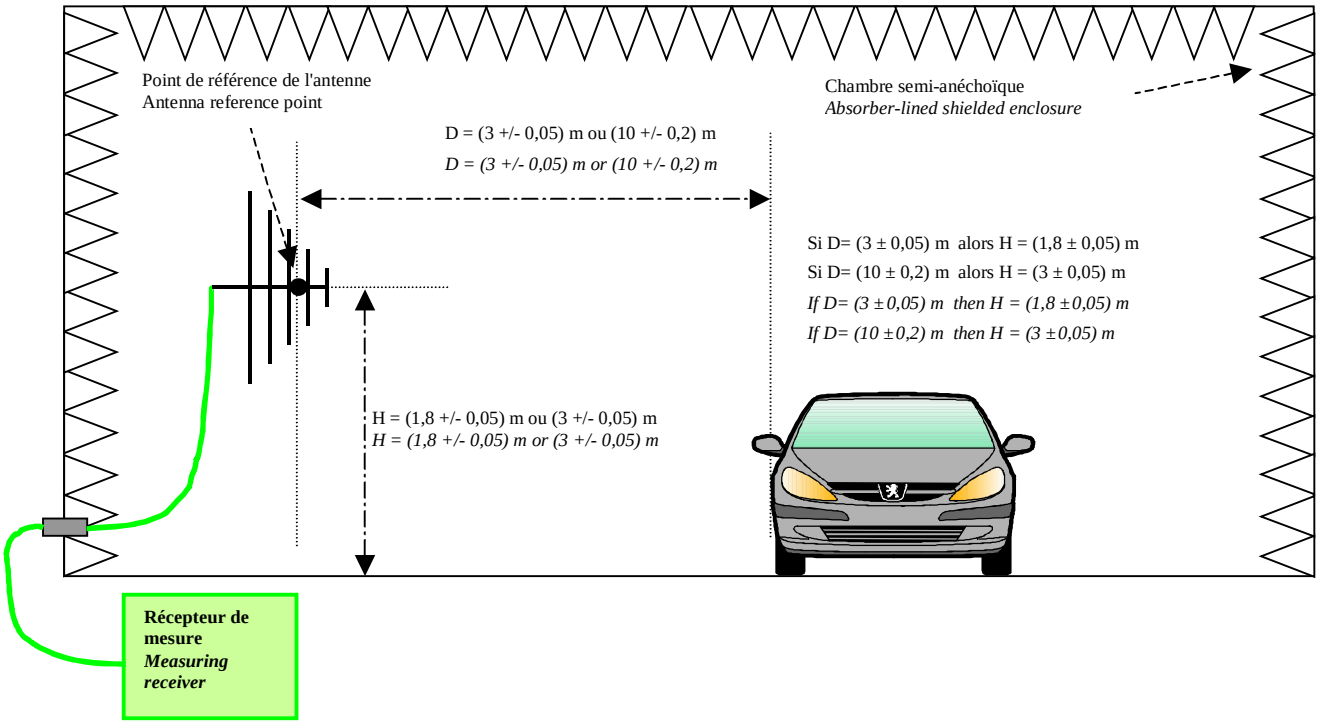
Its principal characteristics are as follows:

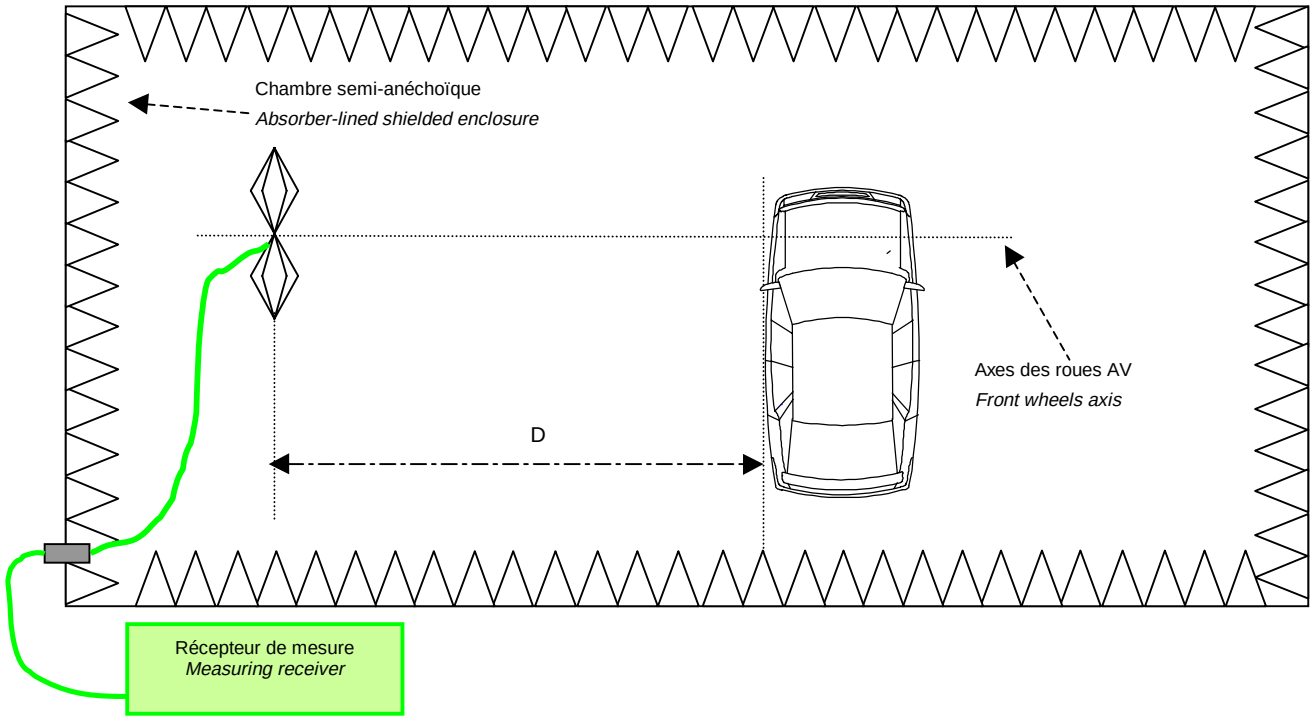
- Peak / quasi-peak detection (average value detection is only used for broadband/narrowband discrimination).
- Frequency band: [30 MHz - 2 GHz].
- Horizontal and vertical polarisations.
- Analysis filter bandwidth at 6dB (broadband and narrowband):
  - $F \geq 30$ MHz: BW = 120 kHz.
- The results of the measurements must be expressed in dBµV/m for a bandwidth of 120 kHz. If the bandwidth BW (in kHz) of the measuring equipment is other than 120 kHz, the values recorded must be normalised on the 120 kHz band and therefore multiplied by a factor of 120/BW.
- Increment: 0.9 x BW.

8.3.2.3.TEST FACILITIES

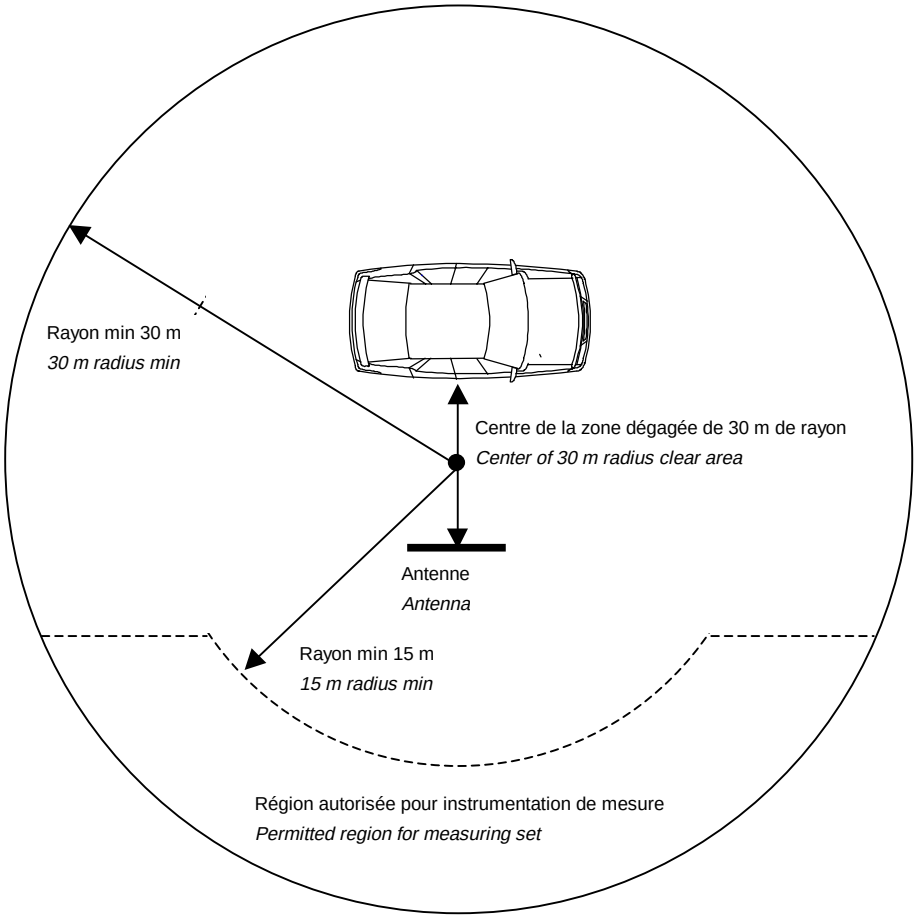
- Semi-anechoic chamber or test area free from reflecting electromagnetic surfaces within a radius of at least 30 m measured from a point located half way between the vehicle and the antenna.
- Antennas calibrated according to the CISPR 12 publication.
- Receiver or spectrum analyser equipped with a pre-selector in compliance with the CISPR 16-1 publication.

8.3.2.4.TEST ASSEMBLY





Antenna position in relation to the vehicle



Vehicle test area (for measurement in clear space)

8.3.2.5.PROCEDURE

Preparation:

- If rain or any other form of precipitation is falling on the vehicle, the test cannot be carried out and cannot be resumed until 10 minutes after the end of said precipitation.
- Narrowband measurement:
  - All of the vehicle electronic equipment must be in normal operating mode with the vehicle stationary. The ignition key must be inserted but the engine must not be started.
- Broadband measurement:
  - The engine must be running at its normal operating temperature and the transmission must be in neutral. The device used to obtain the engine speed required for the tests must not affect the radiated electromagnetic disturbances.
  - For each measurement, the engine must be operating as follows:

Diesel engine	Test not applicable
Petrol or gas engine	1500 rpm ± 10%

Calibration:

To ensure that no interfering external signal or noise of sufficient amplitude might materially affect the test, measurements must be carried out before the main test. If the vehicle is present during the environmental measurements, it will be necessary to ensure that no disturbance originating from the vehicle significantly affects the environmental measurements, for example by removing the vehicle from the test area or disconnecting the battery. In both measurements, the noises or interfering signals must be at least 10 dB lower than the appropriate reference limits, with the exception of the intentional narrowband emissions inherent to the environment.

Test:

- Two antenna reference distances are permitted: 10 m or 3 m in relation to the vehicle.
  - For the 10 m measurements, the antenna phase centre must be 3 m ± 0.05 m above the plane on which the vehicle is standing.
  - For the 3 m measurements, the antenna phase centre must be 1.8 m ± 0.05 m above the plane on which the vehicle is standing.
- The antenna must be successively placed on the left side and the right side of the vehicle, with the antenna parallel to the longitudinal plane of the vehicle and in alignment with the centre of the engine.

  Note: *If the centre of the engine cannot be practically determined, the antenna shall be aligned*:
  - *along the front wheel axis for an engine located in the front compartment.*
  - *along the central axis of the vehicle for an engine located in the central compartment.*
  - *along the rear wheel axis for an engine located in the rear compartment.*
- For each measurement, the values recorded must be for horizontal and vertical antenna polarisations.
- Narrowband disturbances are evaluated with a peak detector. Broadband disturbances are evaluated with a peak detector (broadband disturbance evaluation with a quasi-peak detector will only be performed if the broadband requirements with the peak detector are not met).

Test report:

Amongst other information, the test report shall include the following:

- Spectrum curves and limits required for the various frequency bands.
- Ambient noise on the test site.

8.3.2.6.REQUIREMENTS

The values measured (in the semi-anechoic chamber or clear space) must not exceed the following limits:

Measurements at 3 m:

Frequency band (MHz)	Broadband limits with peak detector (dBµV/m)	Broadband limits with quasi-peak detector (dBµV/m)	Bandwidth for broadband measurements	Narrowband limits with peak detector (dBµV/m)	Bandwidth for narrowband measurements
30 -75	62	42	120 kHz	32	120 kHz
75 - 400	62 + 15.13 x log(F/75)	42 + 15.13 x log(F/75)	120 kHz	32 + 15.13 x log(F/75)	120 kHz
400 - 2000	73	53	120 kHz	43	120 kHz

Note: For tests performed during the vehicle production life (production inspections), the requirements are obtained by adding 4 dB to the requirements defined above.

Measurements at 10 m:

Frequency band (MHz)	Broadband limits with peak detector (dBµV/m)	Broadband limits with quasi-peak detector (dBµV/m)	Bandwidth for broadband measurements	Narrowband limits with peak detector (dBµV/m)	Bandwidth for narrowband measurements
30 -75	52	32	120 kHz	22	120 kHz
75 - 400	52 + 15.13 x log(F/75)	32 + 15.13 x log(F/75)	120 kHz	22 + 15.13 x log(F/75)	120 kHz
400 - 2000	63	43	120 kHz	33	120 kHz

Note: For tests performed during the vehicle production life (production inspections), the requirements are obtained by adding 4 dB to the requirements defined above.

8.3.3.VH/MR 03: MEASUREMENT OF MAGNETIC FIELDS PRESENT ON THE VEHICLE

8.3.3.1.REFERENCE DOCUMENT

European recommendation 1999/519/CE and decree No. 2002-775 dated 03 May, 2002.

8.3.3.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to evaluate the levels of magnetic fields present on the vehicle radiated by electrical/electronic parts and harnesses of the vehicle so as to limit human exposure.

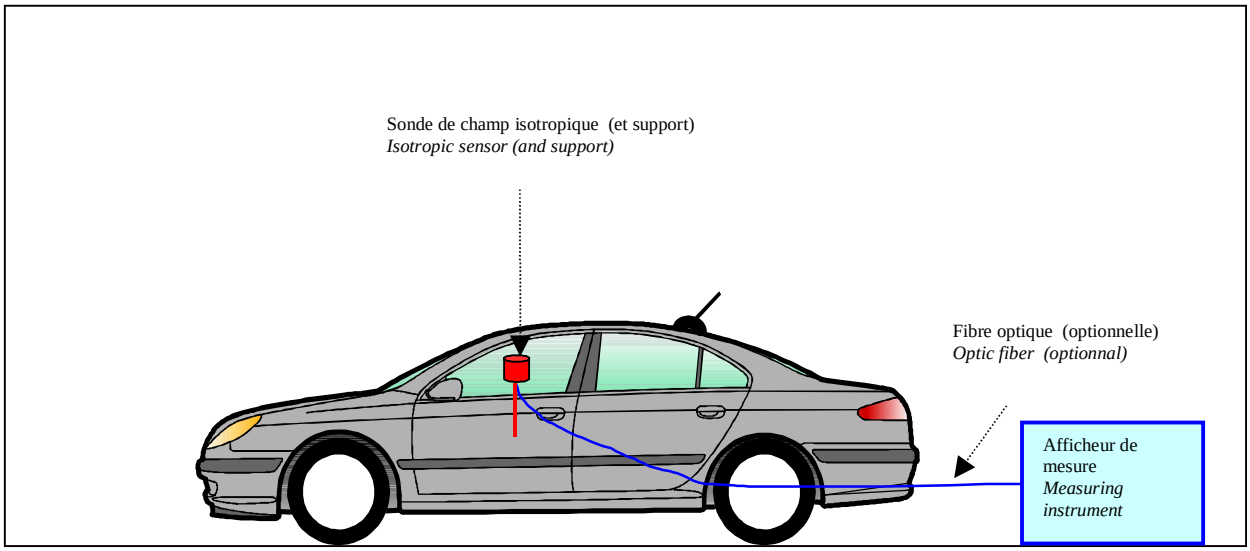
Its principal characteristics are as follows:

- Magnetic induction or magnetic field measurement.
- RMS value detection.
- Frequency band: [5Hz – 150kHz].
- Minimum bandwidth compatible with the disturbances to be evaluated.

8.3.3.3.TEST FACILITIES

- Test area with no high magnetic field source.
- Isotropic magnetic field sensor or measurement coil with spectrum analyser

8.3.3.4.TEST ASSEMBLY



8.3.3.5.PROCEDURE

Preparation:

- The measurements must be carried out with the following vehicle configurations:
- +APC ON with radio
- engine idling with radio
- engine at 2800 rpm with consumers at the maximum rate

Measurement area:

- The measurements must be carried out in the following two measurement areas:
- passenger compartment: pedals, steering wheel, central console, passenger foot area, passenger and driver seats, back seats.
- engine compartment: surface 20cm above the engine equipment.

Test:

- Test on vehicle must be carried out according to the following procedure:
- Place the vehicle and the field sensor according to the test configurations in paragraph 8.3.3.4.
- Place the field sensor in the measurement area(s) defined in the test plan.
- Start up the vehicle and leave running for at least 10 minutes.
- Apply the vehicle operating modes defined in the test plan.
- Perform the magnetic field measurements on the vehicle by sweeping the first measurement area selected, seeking the maximum level and following the measuring device response time characteristics. This search must be more precisely applied near the electrical/electronic parts (engine, pulse motor, power element, etc.) and harnesses located in or near the analysis areas.
- Move on to the next measurement area and sweep the area to find the maximum level.

Test report:

Amongst other information, the test report shall include the following:

- The maximum magnetic induction levels (or magnetic field) and the corresponding frequencies in each area.
- The location of the maximums and the prevalent sources in each area.

8.3.3.6.REQUIREMENTS

The following levels must 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

8.3.4.VH/MR 04: MEASUREMENT OF ELECTRICAL FIELDS PRESENT ON THE VEHICLE

8.3.4.1.REFERENCE DOCUMENT

European recommendation 1999/519/CE and decree No. 2002-775 dated 03 May, 2002.

8.3.4.2.PRINCIPAL CHARACTERISTICS OF THE TEST

The purpose of this test is to evaluate the levels of electrical fields present on the vehicle radiated by on-board transmitters from the vehicle so as to limit human exposure.

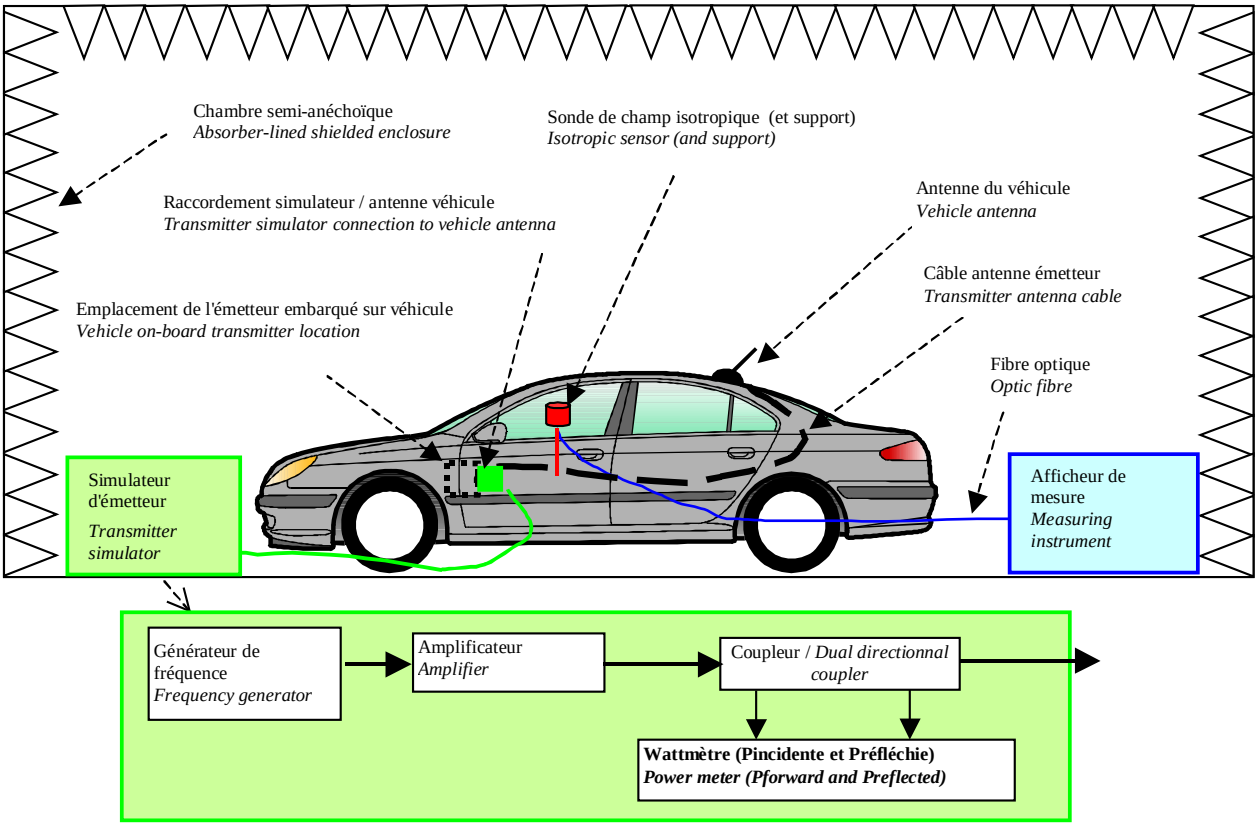
Its principal characteristics are as follows:

- Closed feedback loop on the forward power for on-board transmission systems that are mounted (transmitter, cable and antenna) or pre-arranged (cable and antenna) on the vehicle (for example: GSM, DCS, etc.).
- Generation of an electric field with a transmitter on board the vehicle or with an on-board transmission simulator.
- Measurement of the electrical field in the passenger compartment area with an isotropic field sensor.
- Frequency band: that used by the transmitters on board the vehicle

8.3.4.3.TEST FACILITIES

- HF signal generator.
- Power amplifiers.
- 50 Ω couplers.
- Power meter and related power probes.
- Isotropic field sensor(s) equipped with optical fibre(s).
- Shielded semi-anechoic or anechoic enclosure.
- Reference antennas
    - Frequency ranges less than or equal to 60 MHz: tuned single pole antenna with a length of 1.25 ± 0.25m;
    - Frequency ranges greater than 60 MHz: tuned antenna (single pole with a length of λ/4, patch, dipole, etc.).

8.3.4.4.TEST ASSEMBLY



Vehicle test configuration with on-board transmission simulator and vehicle antenna

8.3.4.5.PROCEDURE

- The method used is the closed feedback loop method on the forward power at the terminal of the transmission system (cable + antenna) for on-board transmission systems mounted (transmitter, cable and antenna) or pre-arranged (cable and antenna) on the vehicle and measurement of the electric field in the passenger compartment.

Preparation:
Measurement area:

The measurements must be carried out in the following measurement areas:

- passenger compartment: pedals, steering wheel, central console, passenger foot area, passenger and driver seats, back seats.

Note: *additional measurements may be carried out within a safety perimeter around the vehicle at a distance of 1 m from the vehicle and a height of 1 m from the ground if these measurements are requested in the vehicle EMC test plan.*

On-board transmission systems pre-arranged (cable and antenna) on the vehicle:

- Run with the transmission simulator and transmission system (antenna cable + antenna) on the vehicle.
- The transmission simulator is made up of a generator, an amplifier, a coupler and a power meter connected directly to the transmission system (cable + antenna) on the vehicle. All parts connected to the transmission simulator must be placed outside the vehicle at a distance of at least 1m from all points on the vehicle.
- An isotropic field sensor is placed on an insulating support for use in the different vehicle measurement areas.

On-board transmission systems mounted (transmitter, cable and antenna) on the vehicle:

- Run with the vehicle transmitter and transmission system (antenna cable + antenna).
- The on-board transmitter on the vehicle is used without modifying the vehicle characteristics and architecture in one of the following configurations:
  - Run the vehicle on-board transmitter with frequency, signal and power managed by a base station simulator (case of radio communication with GSM / DCS or Bluetooth);
  - Run the vehicle on-board transmitter with frequency, signal and power managed manually (case of police transmitters).
- For a test with a base station simulator, all the parts connected to the base station simulator must be placed outside the vehicle. The simulator must be located at a distance of at least 1m from all points on the vehicle. The base station simulator antenna (tuned antenna) must be placed as far as possible from the vehicle transmission antenna so as not to significantly modify radiation from the latter while maintaining proper synchronisation between the base station simulator and the original mounted transmitter on the vehicle.

- For a manual test, the manual start-up of the on-board transmitter must not be performed by the operator but rather by a remote control system (pneumatic jack, etc.). This remote control system may be placed inside or outside the test assembly.
- An isotropic field sensor is placed on an insulating support for use in the different vehicle measurement areas

Test:

On-board transmission systems pre-arranged (cable and antenna) on the vehicle and on-board transmission systems not mounted on the vehicle:

- Place the vehicle and the transmission system according to the test configurations described in paragraphs 8.3.4.4 and 8.3.4.5.
- Set the HF generator to obtain the power level $P_{calibration}$ (measured in CW) corresponding to that indicated in the following table. Then apply the signals indicated in the following table.

Frequency bands MHz[(1)]	Test frequencies MHz[(2)]	Effective power measured in CW ($P_{calibration}$)[(3)]	Signal to be applied
890 - 915[(4)]	902.4	2 W	CW (no modulation)
1710 - 1785[(4)]	1747.4	1 W	CW (no modulation)

(1) There are other frequency ranges on different markets which correspond to on-board transmitters (CB, amateur radio, Ministry networks, professional mobile telephone networks, PDC Japan, AMPS USA, GSM 1900 USA, Bluetooth, etc.). The list of possible additional frequency ranges (with test frequency, power and signals to be applied) must be specified in the vehicle EMC test plan.

(2) Unless there is a special specification in the test plan or in the Specification specific to the equipment, the tests shall be carried out for the central frequency in the band.

(3) **Forward power** at the terminal of the transmission system (cable + antenna) for on-board transmission systems pre-arramged (cable and antenna) on the vehicle. **Transmitted power** (forward power – reflected power) at the terminal of the reference antenna for on-board transmission systems that are not mounted on the vehicle.

*(4) To be performed with priority using the **vehicle transmission system (antenna cable + antenna)** if present on the vehicle (an additional measurement with the **reference antenna** shall be performed if requested in the vehicle EMC test plan).*

- Place the field sensor in the measurement area(s) defined in the test plan.

- Perform the electric field measurements on the vehicle by sweeping the first measurement area selected, seeking the maximum level and following the measuring device response time characteristics. If the requirements are exceeded, search for the forward power of the transmission (for the corresponding on-board transmitter) so as to meet the requirements.

- Move on to the next measurement area and sweep the area to find the maximum level.

On-board transmission systems mounted (transmitter, cable and antenna) on the vehicle:

- Place the vehicle and the transmission system according to the test configurations described in paragraphs 8.3.4.4 and 8.3.4.5.
- Start up the vehicle on-board transmission system under the nominal conditions (frequency, modulation and maximum power).
- Place the field sensor in the measurement area(s) defined in the test plan.
- Perform the electric field measurements on the vehicle by sweeping the first measurement area selected, seeking the maximum level and following the measuring device response time characteristics.
- Move on to the next measurement area and sweep the area to find the maximum level.

Test report:

Amongst other information, the test report shall include the following:

- Characteristics of the transmitter simulators used.
- Positioning of the connection cable between the transmitter simulation system and the antenna cable on the vehicle (or the reference antenna).
- Type and characteristics (TOS value at the central frequency in the band) of the reference antenna, if used.
- The maximum electric field levels and the corresponding frequencies in each area.
- The location of the maximums.

8.3.4.6.REQUIREMENTS

The following levels must not be exceeded (in the frequency ranges of the on-board transmitters):

Frequency (MHz)	Electric field limit (E) in V/m
10 – 400	28
400 - 2000	$1.375\ F^{1/2}$
2000 - 3000	61

Appendix A
SUPPLIER'S TEST CONTROL / SUMMARY SHEET

At the end of his validation tests, the supplier must return the following summary sheet to PSA along with the complete test reports:

SUPPLIER		VEHICLE PROJECT	

PRODUCT	
Designation:	
Development phase:	
Hardware reference:	
Software reference:	
Approval ref.:	
PSA ref. (96XXXX):	Index:

ADDITIONAL INFORMATION (representative of production life, modifications, etc.)

TEST PLAN FOR EMC TEST § ELECTRICAL PARTS					
No	☐	Yes, but not validated by PSA	☐	Yes, validated by PSA	☐
Reference(s)					

SUPPLIER'S TESTS (C: Compliant, NC: Not compliant, NP: Not performed, NA: not applicable)									
Electrical tests									
Test reference	Requirement		Result		Conclusion (tick the appropriate box)				Comments
	Class	Impact	Class	Impact	C	NC	NP	NA	
EQ/TE 01: Resistance to usual power supply voltages									
EQ/TE 02: Resistance to slow decrease and increase of power supply voltage									
EQ/TE 03: Re-initialisation Test									
EQ/TE 04: Resistance to Unusual Power Supply Voltages									
EQ/TE 05: Resistance to earth and to the network positive terminal									
EQ/TE 06: Resistance to long-term overloads									
EQ/IC 01: Resistance to pulses 1 or 1 bis and 2a									
EQ/IC 02: Resistance to pulses 3a & 3b									
EQ/IC 03: Resistance to pulses 5b									
EQ/IC 04: Resistance to power supply micro-cut-offs									
EQ/IC 05: Resistance to pulses 4 or 4 bis									
EQ/IC 06: Resistance to on-board power network voltage ripples									
Reference document(s)									

SUPPLIER'S TESTS (C: Compliant, NC: Not compliant, NP: Not performed, NA: not applicable)										
EMC Immunity										
Test reference		Requirement		Result		Conclusion (tick the appropriate box)				Comments
		Class	Impact	Class	Impact	C	NC	NP	NA	
EQ/IC 06: Resistance to on-board power network voltage ripples										
EQ/IC 08: Immunity to bulk current injection (BCI)	60 mA									
	100 mA									
	200 mA									
	300 mA									
EQ/IC 09: Immunity to ignition high/low voltage										
EQ/IR 01: Immunity to radiated fields (semi-anechoic or anechoic chamber)	60 V/m									
	100 V/m									
	150 V/m									
	200 V/m									
EQ/IR 02: Immunity to low frequency magnetic fields										
EQ/IR 05: Immunity to on-board transmitters										
EQ/IR 03: Resistance to electrostatic discharges, equipment not powered	4 kV on contact									
	8 kV in air									
EQ/IR 04: Resistance to electrostatic discharges, equipment powered	2 kV on contact 4 kV in air									
	4 kV on contact 8 kV in air									
	8 kV on contact 15 kV in air									
	25 kV in air									
Reference document(s)										

SUPPLIER'S TESTS (C: Compliant, NC: Not compliant, NP: Not performed, NA: not applicable)

EMC emissivity

Test reference	Result		Conclusion (tick the appropriate box)				Comments
	Frequency band	Maximum level	C	NC	NP	NA	
EQ/MC 01: Measurement of switching noise							
EQ/MC 02: Measurement of low frequency conducted noise							
EQ/MC 03: Measurement of radio frequency conducted noise							
EQ/MR 01: Measurement of low frequency magnetic fields							
EQ/MR 02: Measurement of radio frequency radiated noise							
Reference document(s)							

PART CONFORMITY	YES ☐	NO ☐
Comments:		

Issued by				**Sent to**	
Name:		Supplier:		Name:	PSA Department:
Date		Signature			

9.RECORDS AND REFERENCE DOCUMENTS

9.1.RECORDS

9.1.1.CREATION

- OR: 11/07/2001 -

9.1.2.SUBJECT OF THE MODIFICATION

- A: 23/07/2004 – Overall revision of the standard
- OR: 11/07/2001
-

9.2.REFERENCE DOCUMENTS

9.2.1.PSA DOCUMENTS

9.2.1.1. NORMES

B21 7100	Specifications concerning the environment of electrical and electronic equipment – General characteristics.

9.2.1.2. OTHERS

Work instruction ELE-QCE03_0220/2	Resistance test to prolonged overload
Note : AEL_TDSE04_0091	Electrostatic discharges on diagnostic socket – BSI centralised protection – Validation test procedure

9.2.2. EXTERNAL DOCUMENTS

CISPR 12 Ed. 5 (09-2001)	LIMITS AND METHODS FOR MEASURING THE CHARACTERISTICS OF VEHICLES, MOTORBOATS AND SPARK-IGNITION MOTORISED DEVICES, CONCERNING RADIOELECTRIC DISTURBANCES
CISPR 16-1 Ed 2.1 (10-2002)	CISPR SPECIFICATION FOR DEVICES AND METHODS FOR MEASURING ELECTRIC DISTURBANCES
CISPR 25 Ed. 2 (08-2002)	LIMITS AND METHODS FOR MEASURING RADIOELECTRIC DISTURBANCE CHARACTERISTICS FOR THE PROTECTION OF RECEIVERS USED ON BOARD VEHICLES
ISO/DIS 7637-2.3 (2004)	ELECTRICAL DISTURBANCES BY CONDUCTION AND BY COUPLING – VEHICLES WITH 12 V OR 24 V RATED VOLTAGE – TRANSMISSION OF ELECTRICAL DISTURBANCES BY CONDUCTION ONLY ALONG POWER SUPPLY LINES
ISO 7637-2 : 2004	ROAD VEHICLES - ELECTRICAL DISTURBANCES FROM CONDUCTION AND COUPLING – PART 2 : ELECTRICAL TRANSIENT CONDUCTION ALONG SUPPLY LINES ONLY (STAGE DATE : 2004-06-28)
ISO 7637-3 : 1995/Cor 1 : 1995	ROAD VEHICLES - ELECTRICAL DISTURBANCE BY CONDUCTION AND COUPLING – PART 3 : VEHICLES WITH NOMINAL 12 V OR 24 V SUPPLY VOLTAGE –ELECTRICAL TRANSIENT TRANSMISSION BY CAPACITIVE AND INDUCTIVE COUPLING VIA LINES OTHER THAN SUPPLY LINES
ISO 10605 : 2001	ROAD VEHICLES – TEST METHODS FOR ELECTRICAL DISTURBANCES FROM ELECTROSTATIC DISCHARGE
ISO/DIS 11451-1 (2003)	ROAD VEHICLES – TEST METHOD OF A VEHICLE SUBJECTED TO ELECTRICAL DISTURBANCES BY ELECTROMAGNETIC ENERGY RADIATION IN NARROW BAND - PART 1 GENERAL PRINCIPLE AND TERMINOLOGY

ISO/FDIS 11451-2	ROAD VEHICLES – VEHICLE TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY– PART 2 : OFF-VEHICLE RADIATION SOURCES (STAGE DATE : 2004-06-10)
ISO 11452-2	ROAD VEHICLES – COMPONENT TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY – PART 2 : ABSORBER-LINED SHIELDED ENCLOSURE (STAGE DATE : 2004-08-31)
ISO/DIS 11452-4	ROAD VEHICLES – COMPONENT TEST METHODS FOR ELECTRICAL DISTURBANCES FROM NARROWBAND RADIATED ELECTROMAGNETIC ENERGY – PART 4 : BULK CURRENT INJECTION (BCI)
MIL STD 461 E	REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS OF SUBSYSTEMS AND EQUIPMENT
ISO 16750-1	ROAD VEHICLES – ENVIRONMENTAL CONDITIONS AND TESTING FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – PART 1: GENERAL
ISO 16750-2	ROAD VEHICLES – ENVIRONMENTAL CONDITIONS AND TESTING FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – PART 2: ELECTRICAL LOADS
ISSO/DIS 21848	ROAD VEHICLES – ELECTRICAL AND ELECTRONIC EQUIPMENT FOR 42V POWER NETWORKS – ELECTRICAL LOADS
ISO 8820	ROAD VEHICLES – FUSE LINKS
99/519/CE	COUNCIL OF THE EUROPEAN UNION RECOMMENDATION DATED 12 JULY 1999 CONCERNING LIMITS TO PUBLIC EXPOSURE TO ELECTROMAGNETIC FIELDS (0 HZ TO 300 GHZ)
2002-775	DECREE NO. 2002-775 DATED 03 MAY, 2002, ISSUED IN APPLICATION OF CLAUSE 12 OF ARTICLE I.32 OF THE POST AND TELECOMMUNICATIONS CODE CONCERNING THE LIMIT VALUES FOR PUBLIC EXPOSURE TO ELECTROMAGNETIC FIELDS EMITTED BY EQUIPMENT USED IN TELECOMMUNICATION NETWORKS OR BY RADIOELECTRIC INSTALLATIONS
95/54/CE	COMMISSION DIRECTIVE 95/54/CE, DATED 31 OCTOBER, 1995, PROVIDING ADAPTATION TO TECHNICAL PROGRESS FOR COUNCIL DIRECTIVE 72/245/CEE CONCERNING HARMONISATION OF MEMBER STATE LEGISLATION ON THE SUPPRESSION OF RADIOELECTRIC INTERFERENCE PRODUCED BY SPARK-IGNITION ENGINES EQUIPPING MOTOR VEHICLES AND MODIFYING COUNCIL DIRECTIVE 70/156/CEE CONCERNING HARMONISATION OF MEMBER STATE LEGISLATION ON RECEPTION OF MOTOR VEHICLES AND THEIR TRAILERS

9.3. EQUIVALENT TO:

9.4. CONFORMS TO:

9.5. KEY WORDS: