Q/FPT

BEIQI FOTON MOTOR CO.,LTD ENTERPRISE STANDARD

Q/FPT 2800002—2011

General Specification for Electrical / Electronic Components and Subsystems, Electromagnetic Compatibility (EMC)

电子电器通用 EMC 标准

（报批稿）

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FOREWORD

The standard is edited according as national and industry standard.

The standard is advanced by engineering research institute of BEIQI foton motor CO.,LTD.

The standard is draft out by: engineering research institute electrical & electrics Dept. for passenger vehicle of BEIQI foton motor CO.,LTD.

The standard is draft out by: Wang Qinping; Zhu Chuangan; liu Xiangyu.

CONTENTS

General Specification for Electrical / Electronic Components and Subsystems, Electromagnetic Compatibility (EMC)

1 Scope

This standard provides FOTON Passenger vehicle electronics, electrical components, the system electromagnetic compatibility (EMC) requirements, test methods and test sequence.

The standard basis for the development of technical standards, suppliers have developed products subject to the requirements of this standard.

2 Referenced Standard

Only the latest approved standards are applicable unless otherwise specified.

IEC CISPR 25-2008 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers

ISO 7637-1-2002 Radio vehicles - Electrical disturbances from conduction and coupling - Part 1: Definitions and general considerations

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

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

ISO 10605-2008 Road vehicles - Test methods for electrical disturbances from electrostatic discharge

IEC 61000-4-2 Electromagnetic compatibility (EMC) - Part 4-2: testing and measuring techniques - Electrostatic discharge immunity test

ISO 11452-1-2005 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 1: General principles and terminology

ISO 11452-2-2004 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Absorber-lined chamber

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

ISO 11452-8-2007 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 8: Immunity to magnetic fields

3 Term and Definition

See IEC CISPR 25, Edition 3.0, Section 3;
See 7637-1: 2002, Section 3;
See 11452-1: 2005, Section3.

Function performance class

Table 1: Function Performance Class

Class A	The function shall operate as designed (or meet specified limits) during and after exposure to a disturbance.
Class B	All functions of a device or system perform as designed during exposure; however, one or more of them may go beyond the specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain class A.
Class C	One or more functions of a device or system do not perform as designed during exposure but return automatically to normal operation after exposure is removed. Permanent memory functions shall remain class A.
Class D	One or more functions of a device or system do not perform as designed during exposure and do not return to normal operation until exposure is removed and the device or system is reset by a simple “operator/use” action.
Class E	One or more functions of a device or system do not perform as designed during and after exposure and cannot be returned to proper operation without repairing or replacing the device or system.

4 General Requirement

4.1 Power Voltage

The supply voltage shall be 12V, unless otherwise stated in the test plan.

4.2 Performance Requirement

The DUT (Device Under Test) shall pass both the component level tests according to this specification and the vehicle level tests. Component tests are not intended to take the place of vehicle tests. Exact correlation between component and vehicle test performance is dependent on component mounting location, harness length, routing and grounding, as well as antenna system. Component testing, however, permits components to be evaluated prior to actual vehicle availability.

Deviations from the requirements and/or test procedures shall have been agreed upon prior to testing. Such deviating requirements shall be specified in the test plan and on component drawings, test certificates, reports etc.

Table 2 is supplied as a guide for the selection of the minimum tests applicable to electrical / electronic components and subsystems.

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

For all tests the more stringent requirement applies at frequency breakpoints and overlaps.

Table 2: EMC Test Selection Matrix

Section No.	Test requirement	Component Category								
		Passive module	Inductive component	Electric Motors		Active Electronic Module				
		P[1)]	R	BM	EM	A	AS	AM	AX	AY
Emission										
5.2	Radiated Emission			√	√	√	√	√	√	√
5.3	Conducted Emission			√	√	√	√	√	√	√
Immunity										
6.1	Radiated Immunity				√	√	√	√	√	√
6.2	Magnetic Field				√[2)]			√		
Transients										
7.1	CE, Transients		√	√	√				√	√
7.2	CI, Transients on Power Lines	√	√	√	√	√	√	√	√	√
7.3	CI, Transients on general input/output lines				√	√	√	√	√	√
7.4	CI, Direct Capacitor Coupling to Sensor Lines						√			
ESD										
8.1	Power off mode	√			√	√	√	√	√	√
8.2	Power on mode	√			√	√	√	√	√	√

P: A passive electrical module consisting of only passive components. Examples: resistor, capacitor, inductor, blocking or clamping diode, Light Emitting Diode (LED), thermistor.

R: Relays, solenoids and horns.

BM: A brush commutated dc electric motor

EM: An electronically controlled electric motor.

A: A component that contains active electronic devices without magnetically sensitive elements and inductive elements.

AS: An electronic component or module operated from a regulated power supplier located in another module. This is usually a sensor providing input to a controller.

AM: An electronic component or module that contains magnetically sensitive elements or is connected to an external magnetically sensitive element.

AX: An electronic module that contains an electric or electronically controlled motor within its package or controls an external inductive device including electric or electronically controlled motor(s).

AY: An electronic module that contains a magnetically controlled relay within its package.

Note:

1) Applies only to devices connected to the vehicle power supply (direct or switched connections)
2) Applies only to motors with integral Hall Effect sensors

4.3 Load

The actual load should be used during the immunity test and the simulated load should be used in the emission test unless otherwise stated within this specification. The DUT according to the motor category should be tested in the max. load which should not be interfered the test results.

It is very important to describe the load information in the test plan.

4.4 Test Harness

The actual wiring harness (include the radius material etc.) which used in the vehicle should be used in the test unless otherwise stated within this specification, and the length of test harness should be according to this specification.

It is very important to describe the test harness information in the test plan.

4.5 DUT Grounding Configuration

DUT shall be placed on an insulated support 50mm above the ground plane. However, if the outer case of the DUT is metal and, when installed in the vehicle is electrically connected to the vehicle's sheet metal, the DUT shall be mounted and electrically connected to the ground plane during the test in a manner representative of the vehicle application.

Magnetic Immunity test and ESD test don't apply to the requirement.

The DUT grounding configuration shall be documented in the EMC test plan and test report.

4.6 Sample Size

A minimum of two samples shall be tested. All applicable tests are performed on each of the samples.

4.7 Sequence of Testing

ESD handling tests shall be performed prior to any other testing. All other tests may be performed in any order.

Note that extra test samples are recommended in the event of damage due to ESD. However, any corrective design actions required to mitigate ESD issues will require retesting. The FOTON development engineer shall be contacted immediately in the event that any issues are encountered.

4.8 Test Plan

Any additions or deviations from this specification shall be documented in the Test Plan and shall be approved by the Foton Group EMC engineering department prior to commencement of EMC testing. Acceptance of the Test Plan by Foton does not relinquish the supplier from responsibility, if latter review shows deficiencies in the test setup and/or the acceptance criteria. The supplier shall work with Foton EMC department to correct any deficiency and repeat testing if required by Foton.

All test plan shall include the following elements in addition to the requirements specified in each section:

- Part number and description of the DUT, Hardware and Software Version.
- The precise test setup (measuring equipment involved, harness and its length, etc)
- Load and test support equipment requirement (CAN or LIN bus, motor, etc)
- The tests to be performed specifying any available options and including test levels.
- Failure criteria (to determine functional status and monitoring)

4.9 Report

All test reports shall include the following elements in addition to the report elements specified in each section:

- Internal unique test report number.
- Part number and description of the DUT, Hardware and Software Version.
- Date of test.
- Facility name.
- Requesting engineer.
- Requesting division/company.
- Type of test (Design Validation or Product Validation).
- Test Equipment Software Revision (if test equipment is software controlled).
- Copy of the original test plan.
- Any deletion from or addition to the test procedure.
- Description of the test setup and equipment used.
- Photograph of the test setup.
- Part number and description of the harness.
- Equipment calibration data, if required by the test plan, unless available in the facility records.

5 Emission Requirements

5.1 Test Sequence

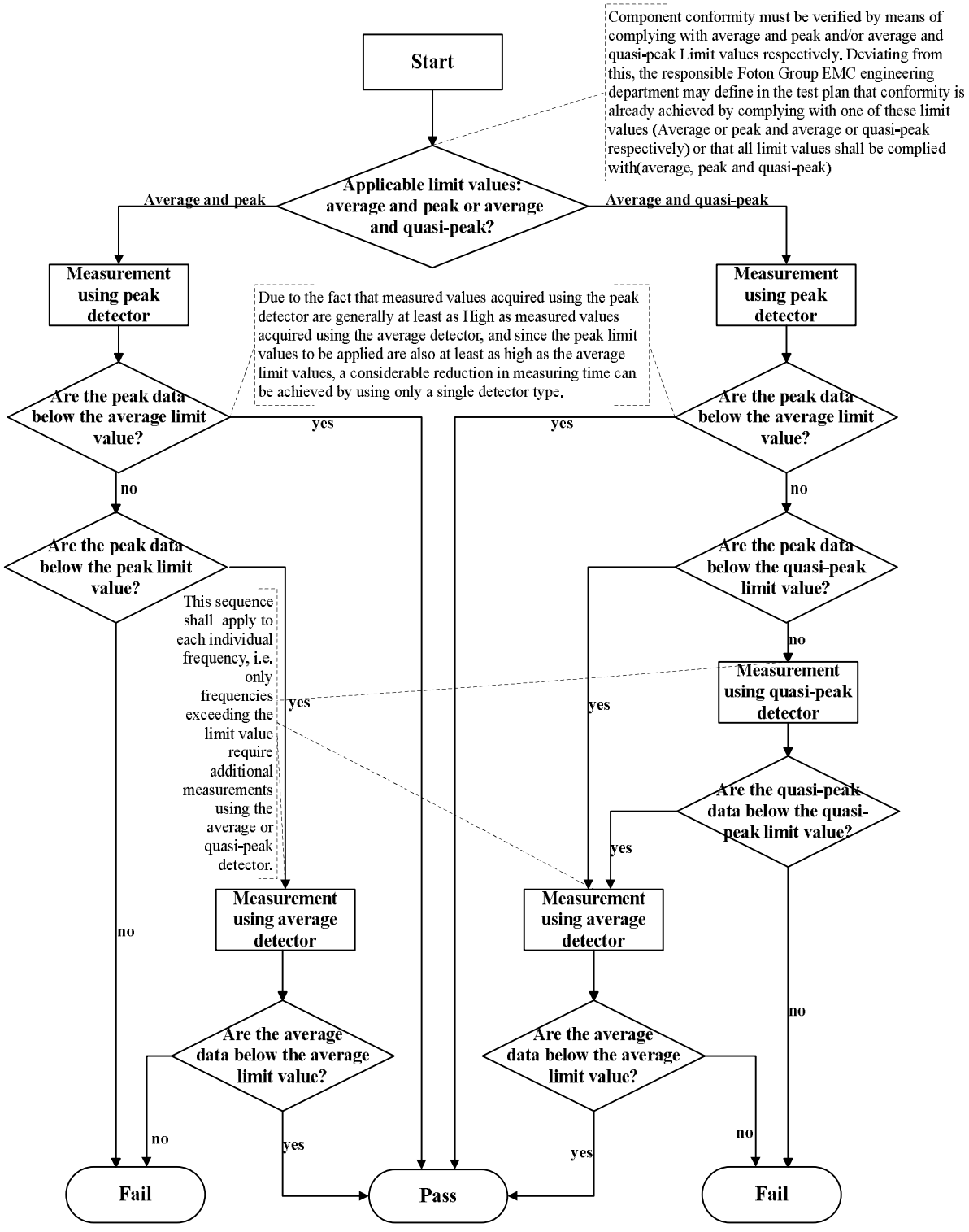

Figure 1 - Test Sequence for frequency for range 150kHz to 2.5GHz (exception LF-MF-VHF)

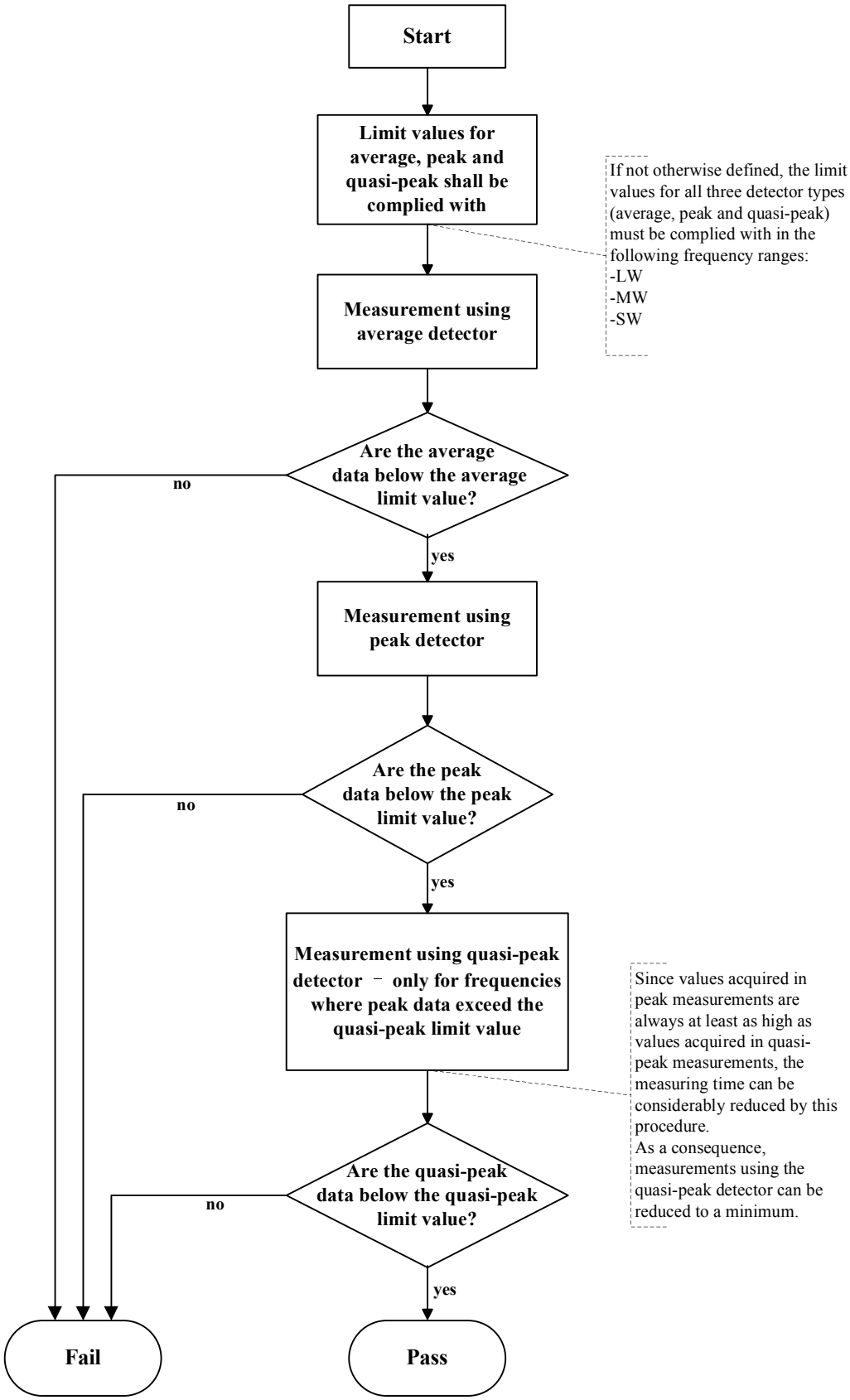

Figure 2 - Test Sequence for Broadcasting Ranges LF-MF-HF-VHF

5.2 Radiated Emission

For detailed instructions concerning the arrangement of the measuring devices and the DUT including its periphery as well as information on the measuring method itself:

See IEC CISPR 25, Edition 3.0 (Committee Draft 2008-03), Section 6.4, ALSE method. The requirement defined in CISPR 25, Edition3.0 (2008-03), Section 4 should be met.

In this standard the limit values for radiated emission by components are defined in the following Table 3 and Table 4.

5.2.1 Limit values for Radiated Emission in the Anechoic Chamber

Table 3 Limit values for radiated Emission in the anechoic chamber

Frequency Range (MHz)	Limit Value (dB μ V/m)		
	P	QP	AV
0,15 - 0.3 MHz(LF)	66	53	31
0,50 - 1.8MHz(MF)	59	46	26
2,3 - 30MHz(HF)	42	29	28
41 - 68 MHz	31	18	18
68 - 108MHz(4m/VHF)	31	18	18
144 - 170MHz	31	18	18
170 - 240MHz	31	18	18
300 - 330MHz	38	25	25
380 - 470MHz	38	25	25
470 - 891MHz	38	25	25
891 - 960MHz	44	31	31
1452 - 1468MHz	32	26	26
1565 - 1585MHz	\	\	10
1805 - 2170MHz	44	\	31
2310 - 2360MHz	44	\	31
2400 - 2500MHz	44	\	31
1, In the LW,MW,SW and VHF frequency ranges, the limit values for average, peak and quasi-peak must be complied. 2, For short-term interference (e.g. rearview mirror actuator motors), limits may be increased by 10dB by only agreement with the FOTON engineering department.			

5.2.2 Continuous Limits Values for Radiated Emission in the Anechoic Chamber

The DUT radiated emission should also be satisfied the limits are listed in Table 4.

Table 4 Continuous Limit values for Radiated Emission in the anechoic chamber

Frequency range (MHz)	QP Limit Value (dBuV/m)	AV Limit Value (dBuV/m)
30 - 75MHz	62 - 25.13*Log(f /30)	52 - 25.13*Log(f /30)
75 - 400MHz	52 + 15.13*Log(f /75)	42 + 15.13*Log(f /75)
400 - 1000MHz	63	53
1, f = test measure frequency. 2, The BM parts shall be met Quasi Peak limits, the other parts shall be met Quasi Peak limits and Average Peak limits.		

5.2.3 Measuring Instruments Requirements

For the parameters settings of measurement receiver (spectrum analyzer or stepped receiver), see IEC CISPR 25, Edition 3.0 (2008-03), section 4.4, Table 1 and Table 2.

5.3 Conducted Emission

For detailed instructions concerning the arrangement of the measuring devices and the DUT including its periphery as well as information on the measuring method itself:

See CISPR 25, Edition 3.0 (2008-03), Section 6.2,Voltage method. The requirement defined in CISPR 25, Edition3.0 (2008-03) should be met.

In this standard the limit values for conducted emission by components are defined in the following Table 5.

5.3.1 Limit Values for Conducted Emission with Artificial Network (AN)

Table 5: Limits values for Conducted Emission with AN

Frequency Range (MHz)	Limit Value (dB μ V/m)		
	P	QP	AV
0,15 - 0.3 MHz(LF)	83	70	60
0,50 - 1.8MHz(MF)	63	50	34
2,3 - 30MHz(HF)	59	46	30
41 - 68 MHz	30	\	30
68 - 108MHz(4m/VHF)	31	18	12
1, In the LF, MF, HF and VHF frequency ranges, the limit values for average, peak and quasi peak shall be complied with!			

5.3.2 Measuring Instruments Requirements

For the parameters settings of measurement receiver (spectrum analyzer or stepped receiver), see IEC CISPR 25, Edition 3.0 (2008-03), section 4.4, Table 1 and Table 2.

6 Immunity

6.1 Radiated Immunity

Any combination of the test methods specified in the standards ISO 11452-2, ISO 11452-4 and ISO 11452-5 shall be applied to test interference immunity from 1MHz to 3100MHz. The deviations listed in Table 6 shall apply.

Table 6: the requirement for Radiated Immunity

	ISO 11452-2 Anechoic chamber	ISO 11452-4 BCI	ISO11452-5 Stripline
Frequency range	80 - 3100MHz	1 - 400MHz	1 - 400MHz
Increment △f	1 - 200MHz 1MHz 200 - 400MHz 2MHz 400 - 1000MHz 5MHz 1000 - 3100MHz 10MHz		
Stay time per △f	⩾2s(depending on the response time of the system under test)		
Test modulation	1 - 800MHz CW and AM 800 - 2000MHz CW and PM (217Hz, 577μs) 1200 - 1400MHz CW and PM (300Hz, 3μs) 2000 - 2700MHz CW 2700 - 3200MHz CW and PM (300Hz, 3μs)		
	AM modulation: 1kHz(sinusoidal), m =80% acc. to ISO 11452-1; PM modulation: a.) a repetition rate of 217Hz and a duration time of 577μs; b.) a repetition rate of 300Hz and a duration time of 3μs.		
Testing field strength and current (Functional state)			
Standard Requirement	100V/m Class A	200mA Class A	200V/m Class A
Reduced requirement	100V/m Class C 60V/m Class A	200mA Class C 100mA Class A	200V/m Class C 100V/m Class A
Note	1) For Anechoic chamber: Vertical polarization; above 400MHz on additional horizontal polarization. 2) DUT shall satisfy standard requirement. Reduced requirement can only be used if it is accepted by Foton Group EMC engineering department.		

6.2 Magnetic Immunity

For detailed instructions concerning the arrangement of the measuring devices and the DUT including its periphery as well as information on the measuring method itself:

See ISO 11452-8, section 5, section 6 and section 7.

Helmholtz coil method or Radiated Loop Method can be used. For detailed test setup and procedure, see section7.3.1 and section 7.3.2.

6.2.1 Frequency Increment

The test shall be conducted at the following frequencies: 16.67Hz, 50Hz, 60Hz, 83.3Hz, 150Hz, 180Hz, 250Hz, 300Hz and with frequency increment as specified in Table 7.

Table 7: Frequency Increment

Frequency Range (Hz)	Increment (Hz)
15 - 100Hz	10
100 - 1000Hz	100
1000 - 10000Hz	1000
10000 - 150000Hz	10000

6.2.2 Test Severity levels

DUT functions may only deviate from the designed performance below the levels according to Tables 8. Dwell time shall be at least 2 seconds (depending on the response time of the system under test). DUT shall satisfy standard requirement. Reduced requirement can only be used if it is accepted by Foton Group EMC engineering department.

Table 8: Test Severity Levels

Frequency Range (Hz)	Standard Requirement		Reduced Requirement	
	Test Level (A/m)	Functional Status	Test Level (A/m)	Functional Status
15 - 1000Hz	1000	Class A	300	Class A
1000 - 10000Hz	$1000/(f/1000)^2$	Class A	$300/(f/1000)^2$	Class A
10000 - 150000Hz	10	Class A	3	Class A

7 Transient, Conducted Emissions (CE) and Conducted Immunity (CI)

7.1 CE, Transients

For detailed instructions concerning the arrangement of the measuring devices and the DUT including its periphery as well as information on the measuring method itself:

The test equipment shall comply with ISO 7637-1 and ISO 7637-2, Section 4.3, but in the figure 1b there is no shunt resistor R_s.

The component shall not produce positive transient voltages exceeding +75 volts or negative transient voltages exceeding –100 volts on its power supply circuits.

7.2 CI, Transients on Power Lines

The test equipment shall comply with ISO 7637-1 and ISO 7637-2. Verification of component performance shall be in accordance with ISO 7637-2 except where noted in the Component Technical Specification.

DUT functions may only deviate from the designed performance above the levels according to Tables 9 and Table 10.

Table 9: Requirements Levels for the Conducted Transient immunity on Power lines for 12v-system

Pulse No.	Parameter	Test requirement	Functional status
1	U_s=-100V, t_d=2000μs, t_r=1μs, R_i=4ohm	5000 pulses	Class C
2a	U_s=+75V, t_d=50μs, t_r=1μs, R_i=4ohm	5000 pulses	Class A
2b	U_s=+10V, t_d=0.2s, t_r=1000μs, t_{12}=1000μs, R_i=0.05ohm	10 pulses	Class C
3a	U_s=-150V, t_d=0,1μs, t_r=0,005μs, R_i=50ohm	1h	Class A
3b	U_s=+100V, t_d=0,1μs, t_r=0,005μs, R_i=50ohm	1h	Class A
5b	+34V, t_d(5a)=400ms, R_i=2ohm	10 pulses at 1 minute intervals	Class B

Table 10: Requirements Levels for the Conducted Transient immunity on Power lines for 24v-system

Pulse No.	Parameter	Test requirement	Functional status
1	U_s=-450V,t_d=2000μs, t_r=1μs, R_i=10ohm	5000 pulses	Class C
2a	U_s=+150V, t_d=200μs, t_r=1μs, R_i=10ohm	5000 pulses	Class A
2b	U_s=+20V, t_d=0.2s, t_r=1000μs, t_{12}=1000μs, R_i=0.05ohm	10 pulses	Class C
3a	U_s=-450V, t_d=0,1μs, t_r=0,005μs, R_i=50ohm	1h	Class A
3b	U_s=+150V, t_d=0,1μs, t_r=0,005μs, R_i=50ohm	1h	Class A
5b	+55V, t_d(5a)=400ms, R_i=4ohm	10 pulses at 1 minute intervals	Class B

7.3 CI, Transients on General Input/Output Lines

The purpose of this test is to ensure conducted transients inductively or capacitively coupled to inputs and outputs (I/O), other than battery, ignition or accessory inputs, do not disturb module functionality. The Coupling Clamp (CCC) and (optional) Direct Pin Capacitive Coupling (DCC) method using a 220 pF capacitor can be used.

The test equipment shall comply with ISO 7637-1 and ISO 7637-3. Verification of component performance shall be in accordance with ISO 7637-3 except where noted in the Component Technical Specification. See the following table for requirement.

Table 11: The requirements of Coupling Clamp and (optional) Direct Pin Capacitive Coupling

Pulse No	V peak (Note 1)	Application Time	Interval between Cycles	(Optional) DCC Coupling Capacitance
3a	-150V	10 minutes	90ms	220pF
3b	+100V			
Note 1: Levels established into a 50ohm load.				

7.4 CI, Direct Capacitor Coupling to Sensor Lines

The purpose of this test is to identify potential sensitivities to transients that may occur as a result of wiring harness coupling (e.g. cross talk). The test equipment shall comply with ISO 7637-1 and ISO 7637-2.3.

The transient shall be capacitively coupled from generator to the applicable DUT pin by inserting a series ceramic capacitor between the generator (+) output pin and the applicable DUT pins. The generator (-) shall be directly connected to the DUT ground reference. The injection point shall be within 5 cm of the DUT connector, unless otherwise documented in the EMC Test Plan.

Sensor modules shall be subjected to repetitive voltage spikes that are capacitively coupled to the line under test, while monitoring the DUT during operation. These pulses shall be applied to all inputs, outputs, and power, line by line. The test pulse voltages are set open circuit and are referenced to module ground. They are applied for 5 minutes each.

Table 12: Requirements of Direct Capacitor Coupling to Sensor Lines

Pulse No.	Vpeak	Cycles No.	Interval between Cycles	Coupling Capacitance
2a	-30V	500cycles	0.5s	0.1μF
	+30V			
Note: 1, 2ohm transient generator internal source impedance. 2, U_A, the DC voltage for Pulse 2a, shall be set to 0V for this test.				

8 ESD

The test equipment shall comply with ISO 10605. Testing shall be performed in accordance with ISO 10605 except were noted in this specification. The test facility shall be maintained at an ambient temperature at (23±3)℃ and a relative humidity from 20% to 40% (20℃ and 30% relative humidity preferred).

The ESD simulator waveform verification shall comply with ISO 10605 with the following exceptions: Contact discharge rise time ≤ 1 ns, Air discharge rise time ≤ 20 ns. The RC time constant shall be verified by calculation using the exponentially decaying portion of the waveform after the leading edge and/or ringing.

8.1 ESD, Power-Off Mode

The requirement for ESD, Power-Off mode is defined in the following Table 13.

Table 13: Discharge parameters for ESD, Power-Off mode

Type of discharge	Test Level	Human body model	No. of discharges per test point and recovery time	Discharge points	Functional Status for all systems
Direct discharge	±8kv	2kΩ/150pF	+8kv 3times, -8kv 3times; 5s	Each connector pin, each separate exposed surface, seam and component	Class C
Air discharge	±8kv	2kΩ/150pF	+8kv 3times, -8kv 3times; 5s	Each connector pin, each separate exposed surface, seam and component	Class C

8.2 ESD, Power-On Mode

The test is done for the Components attached to data communication buses or to inputs/outputs (e.g. through switches, sensors, etc.) of devices that are accessible by vehicle occupants or may be subject to ESD from an indirect charged source (e.g. wheel speed sensor inputs, airbag control lines from mounting brackets, etc.)

Table 14: Discharge parameters for ESD, Power-On mode

Type of discharge	Test Level	Human body model	No. of discharges per test point and recovery time	Discharge points	Functional Status for all systems	
					Normal Requirements	Increased Requirement[1)]
Direct discharge	±6kv	2kΩ/330pF	+6kv 10 times, -6kv 10 times; 5s	All shafts, buttons, switches and surfaces accessible to vehicle occupants plus CAN termination s with 1m of harness	Class A	Class A
Direct discharge	±8kv	2kΩ/330pF	+8kv 10 times, -8kv 10 times; 5s		Class C	Class A
Air discharge	±8kv	2kΩ/330pF	+8kv 10 times, -8kv 10 times; 5s		Class A	Class A
Air discharge	±15kv	2kΩ/330pF	+15kv 10 times, -15kv 10 times; 5s		Class C	Class A
Air discharge	±25kv	2kΩ/150pF	+25kv 3 times, -25kv 3 times; 5s	The component can be touched outside the vehicle	Class C	Class C
Note: 1) applies to some components associated with safety.						