The Automotive EMC Network
(www.AutoEMC.net)

A Generic Automotive EMC Test Standard

Project	A Generic Automotive EMC Test Standard
Customer	OPEN SOURCE SPECIFICATION
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Revision	DRAFT

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A GENERIC AUTOMOTIVE EMC TEST STANDARD

Introduction

This specification is published as a freely available "open source" specification. It is the result of an attempt by the Automotive EMC Network to produce a specification that is an approximation to a generic specification that is close to the majority of automotive vehicle manufacturers (VM) own specifications. It was produced to enable automotive electronic circuit designers and producers to develop and test products prior to obtaining specific VM approvals. The test levels and testing methods used within this specification should also be acceptable as "e-mark" testing for the European Union Automotive EMC directive (2004/104/EC) if performed by a suitable test laboratory.

There are no detailed descriptions of the test set-up or methods contained in this document, these are all in the international standard the tests refer to in this document.

Caveat

The specification was developed without the assistance or approval of any VM, therefore compliance to this test specification is not a guarantee of acceptance by any specific VM.

Test Conditions

Unless specifically stated in the referenced test document, the following basic test conditions will apply.

Test Laboratory Accreditation

All testing should be performed in an EMC test facility that has been accredited under the Automotive EMC Laboratory Recognition Program (AEMCLRP) to be compliant with the letter of this specification. The facility may be an independent test laboratory or a supplier owned test facility. Details on this program and steps for laboratory recognition may be found at check www.a2la.org.

Supply Voltage

It is assumed that the majority of tests will be conducted using a typical vehicle battery as used in the final application. Alternatively a linear power supply with very low ripple (less than 10mV at 12V output with 1A DC load) or a stabilised output power supply can be used to provide a trickle charge to a suitable car battery/accumulator. The nominal voltage will be dependant on the nominal operating voltage of the powernet of the vehicle, but for the 3 standard supply levels most commonly found these are;

Table 1: Operating Supply Voltage Limits

Nominal Battery Voltage	Minimum	Typical	Maximum	Units
12V (14V Powernet)	11	12	14	V
24V	22	24	28	V
36V (42V Powernet)	33	36	42	V

Environmental Test Conditions

The equipment under test (EUT) and measurement instrumentation should be acclimatised to the test environmental conditions for a minimum of 30 minutes and preferably 1 hour before commencing testing.

Table 2: Environmental Test Conditions

Parameter	Minimum	Typical	Maximum	Units
Temperature	18	23	28	°C
Relative Humidity	30	45	60	%

Measurement Tolerances

Where not explicitly stated, a tolerance of ±5% on any parametric value is assumed.

Table 3: Parametric Measurement Tolerances

Parametric Measurement	Minimum	Maximum	Units
Current	-5	5	%
Voltage	-5	5	%
Impedance (R, C or L)	-10	10	%
Field Strength	0	10	%

Resolution Bandwidth

The resolution bandwidth (RBW) for all emissions testing should be specified in the international (CISPR or ISO) standard that the individual test schedules specify. Where the tests use frequencies that are not covered by the specific international standard the following is applicable.

Table 4: Applicable Resolution Bandwidth

Frequency Range	RBW	Units
Below 30MHz	9	KHz
30MHz – 1GHz	120	KHz
Above 1GHz	1	MHz

Frequency Step Size

The frequency step size for all immunity testing can be as specified in the international (CISPR or ISO) standard that the individual test schedules specify. Where the tests use frequencies that are not covered by the specific international standard the following is applicable.

Table 5: Applicable Frequency Step Sizes

Frequency Range	RBW	Units
Below 10MHz	10	KHz
1MHz – 1GHz	100	KHz
Above 1GHz	1	MHz

Application Classification

Only two application classes have been adopted for this standard, in common with the majority of vehicle manufacturer standards.

Table 6: Application Classifications

Application Group	Typical In-Vehicle Applications
I	Powertrain and Safety: engine management unit (EMU), ABS, SRS, immobiliser, body control modules (BCM), exterior lighting, central locking, wiper controls
II	Comfort and Convenience: in-car entertainment (ICE), HVAC, telematics (satellite-navigation, phone-kit), instrument illumination, auto dimming mirrors

Failure Mode Severity Classification

There are two classifications within the five ISO classifications (see appendix A for full list) that have been adopted in this standard; class A for application group I products and class C for application group II products.

Table 7: Generic Test Classifications

Classification	Description
A	all functions of a device or system perform as designed during and after exposure to interference.
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.

Test Methods and Levels

Where available the tests discussed as "generic" below are all based on the available international standards with no deviation from test conditions as defined in these standards. The VM specifications almost always make what initially appear as small deviations from some of the generic set-ups and conditions, maybe a slightly different harness length or pulse rise time and sometimes a different resolution bandwidth (RBW) for signal measurement. In providing a generic specification the tests noted here are all reverted to the original set-up of their base standard with no deviations in set-up or method. Some deviations for extended frequency or applied level may be made, but not for the set-up itself.

Radiated Emissions

Base Standard: CISPR-25 [1]

Only the free-field testing method of CISPR-25 (measured in an absorber-lined screened enclosure; ALSE) is used for radiated emissions measurement in this standard, at the class 3 limit levels. There are three deviations from the basic CISPR-25 standard:

1. the omitted test bands are included with limit lines derived from joining the end-of-band limits
2. the upper frequency limit is extended to 5GHz from the standard limit of 960MHz, with an increase in the limit level above 1GHz to account for the wider RBW used
3. the narrowband limits are derived from the quasi-peak limits of CISPR-25

Table 8: Radiated Emission Limits

Band	Frequency Range (MHz)	Broadband (Peak) Limit (dBuV/m)	Narrowband (Quasi-Peak) Limit (dBuV/m)
1	0.15 – 0.30	76	63
2	0.30 – 0.53	76 - 36.41 log (f / 0.3)	63 – 36.41 log (f / 0.3)
3	0.53 – 2.0	67	54
4	2.0 – 5.9	76 - 40.44 log (f / 2)	63 – 40.44 log (f / 2)
5	5.9 – 54	48	35
6	54 – 76	48 – 97.60 log (f / 54)	35 – 97.60 log (f / 54)
7	76 – 1000	37	24
8	1000 – 5000	48	35

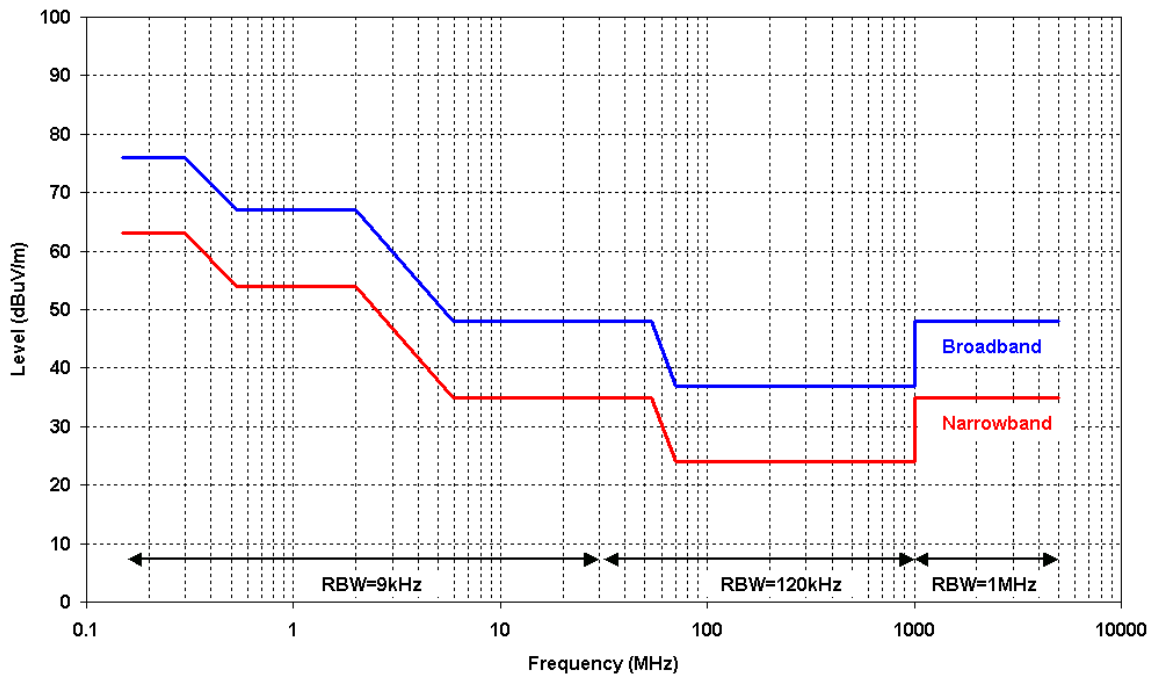

Figure 2: Generic Limits based on CISPR-25 Level 3

Radiated Immunity

Base Standards: ISO11452-2, ISO 11452-4 [3]

Testing for radiated immunity utilises just 2 test methods from ISO 11452; BCI for the lower frequency range (1MHz-400MHz) and free field (ALSE) for higher frequencies (20MHz-5GHz). There is a considerable cross-over in these ranges, but this is to enable test costs to be optimised and at the same time keep an eye to the EU automotive directive and meeting it's requirements with the same data. In practice what this means is that ALSE testing can commence at 400MHz rather than 20MHz if it is a lower cost option or there is some benefit to using BCI for the lower frequencies.

Table 9: Radiated Immunity Limits

Frequency Range (MHz)	Test Method	Modulation	Polarisation	Application Group I		Application Group II	
				Limit	Pass Criteria	Limit	Pass Criteria
1 - 400	ISO 11452-4: BCI	CM/AM	Not applicable	200mA	A	100mA	C
20 - 1000	ISO 11452-2: ALSE	CW/AM	Vertical & Horizontal	200V/m	A	100V/m	C
800 - 5000		PWM	Vertical				

Continuous Wave (CW) applied only below 1GHz.

Amplitude Modulated (AM) using 80% modulation with a 1kHz sine wave.

Pulse Width Modulated (PWM) with a pulse width of 577us and a period of 4600us.

Conducted Emissions

Base Standard: CISPR-25 [1]

Specified levels are class 3 limit levels of the CISPR-25 standard. There are three deviations from the basic CISPR-25 standard:

1. the omitted test bands are included with limit lines derived from joining the end-of-band limits
2. the upper frequency limit is extended to 200MHz from the standard limit of 108MHz
3. the narrowband limits are derived from the quasi-peak limits of CISPR-25

Table 10: Conducted Emission Limits

Band	Frequency Range (MHz)	Broadband (Peak) Limit (dBuV/m)	Narrowband (Quasi-Peak) Limit (dBuV/m)
1	0.15 – 0.30	76	63
2	0.30 – 0.53	76 - 36.41 log (f / 0.3)	63 – 36.41 log (f / 0.3)
3	0.53 – 2.0	67	54
4	2.0 – 5.9	76 - 40.44 log (f / 2)	63 – 40.44 log (f / 2)
5	5.9 – 54	48	35
6	54 – 76	48 – 97.60 log (f / 54)	35 – 97.60 log (f / 54)
7	76 – 200	37	24

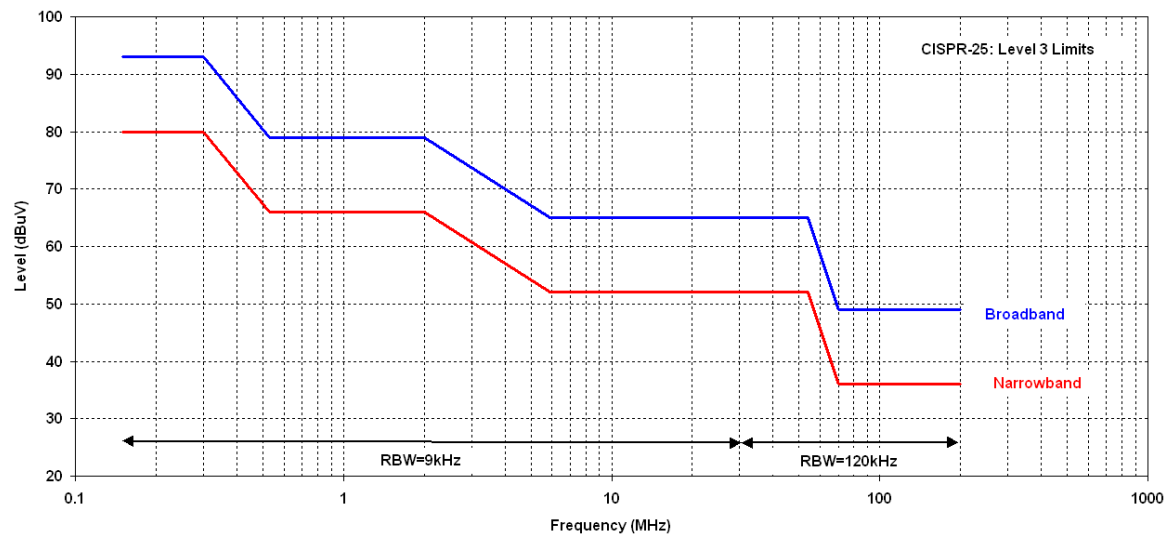

Figure 6: Generic Conducted Emissions Limits based on CISPR-25 Level 3

Conducted Transient Immunity

Power Line

Base Standard: ISO 7637-2 [2]

The chosen level adopted are from level IV of the ISO 7637-2 standard, with 2 exceptions. The first exception is the use of 100V for the pulse 2b. The ISO 7637 level IV setting for pulse 2b is 50V, this is relatively benign and even 100V is not especially onerous to meet. The other difference is the load dump (pulse 5) lower level for group II application circuits at 24V.

Table 11: 12V Power Line Transient Immunity Test Parameters

Pulse	Application Group I		Application Group II	
	Test Level (V)	Functional Class	Test Level (V)	Functional Class
1	-100	A	-100	C
2a	100		100	
2b	10		10	
3a	-150		-150	
3b	100		100	
4	7		7	
5	87		24	

Signal Line

Base Standard: ISO 7637-3 [2]

The chosen level adopted are from level IV of the ISO 7637-3 standard, with one exception;the use of 100V for the pulse 3b.

Table 12: Signal Line Transient Immunity Test Parameters

Pulse	Application Group I		Application Group II	
	Test Level	Functional Class	Test Level	Functional Class
3a	-150	A	-150	C
3b	100		100	

Electrostatic Discharge

Base Standard: ISO 10605 [4]

Table 13: ESD Test Parameters

Test	Discharge Method	Network	Test Severity Level	No. of Discharges	Functional State
Unpowered or Handling	Contact	150pF/2kΩ	±8kV	5	A (I) C (II)
	Air	330pF/2kΩ	±15kV		
Powered	Contact	150pF/2kΩ	±8kV		
	Air	330pF/2kΩ	±25kV		

Tests may gradually be raised to the values shown in the above table in steps suggested in ISO 10605.

Although only 5 discharges are required (in both positive and negative polarities), this is for any single pin or any discharge point.

A period of between 5s and 10s between discharges should be observed.

Test Report

As well as the target levels as specified here, a photograph of the test set-up for each test should be included, plus spectra for emissions measurements and finally a simple PASS or FAIL statement per test regime. As in this document it is not necessary to draw a detailed plan of the test, this is contained in the referring CISPR and ISO standard, only deviations from this may be noted (e.g. use of different harness length due to availability or pulse shape due to loading).

References

1. CISPR-25: 2002 - Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicles.

2. ISO 7637: Electrical disturbance by conduction and coupling
Part 1: Definitions and general consideration (2002)
Part 2: Electrical transient conduction along supply lines only (2004)
Part 3: Vehicles with nominal 12V and 24V supply voltage – electrical transient transmission by capacitive and inductive coupling via lines other than supply lines (1995)

3. ISO 11452: Road vehicles – electrical disturbances by narrowband radiated electromagnetic energy – component test methods
Part 1: General and definitions (2001)
Part 2: Absorber-lined chamber (1995)
Part 3: Transverse electromagnetic mode (TEM) cell (2001)
Part 4: Bulk current injection (BCI) (2001)
Part 5: Stripline (2002)
Part 6: Parallel plate antenna (1997)
Part 7: Direct radio frequency (RF) power injection (1995)

4. ISO 10605: Road vehicles – electrical disturbances from electrostatic discharges (2001)

5. A Generic Automotive EMC Test Specification, Martin O'Hara, Automotive EMC 2006, p81-92, NEC Birmingham, UK, 17th May 2006 (available via the Automotive EMC Network, www.autoemc.net)

Appendix A: ISO Failure Mode Severity Classification

All classifications given below are for the total device/system functional status.

Note: The word "function" as used here concerns only the function performed by the electronic system.

Class A: all functions of a device or system perform as designed during and after exposure to interference.

Class B: all functions of a device/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.

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.