General Specification for Electrical/Electronic Components and Subsystems; Electromagnetic Compatibility

Requirement Part

1 Introduction

In the event of a conflict between the text of this specification and the documents cited herein, the text of this specification takes precedence.

Note: Nothing in the specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

Note: In the event of a conflict between the English and the domestic language, the English language shall take precedence.

1.1 Scope. This document applies to the Electromagnetic Compatibility (EMC) of electrical/electronic components and subsystems for passenger vehicles, light duty trucks and medium duty trucks. It is accepted by all parts of General Motors (GM) and, therefore, applicable to all GM automotive products worldwide.

This document is one document out of a series of six global EMC documents which specify EMC test and validation requirements. The complete series consists of the following documents:

GMW3091, GMW3094, GMW3097, GMW3100, GMW3103 and GMW3106

Note: All six documents of equal revision are carrying the same release date.

Note: During development of this document it was first called GMW 12559 and then GMW 12002 R.

1.2 Mission / Theme. This document specifies the EMC requirements for all GM automotive products when evaluated in accordance with the test procedures of GMW3100.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 Normative.

ISO 7637-2
ISO 10605
ISO 11452-2

2.2 GM.

GMW3091
GMW3100
GMW3106
GMW3094
GMW3103

3 Requirements

3.1 System / Subsystem / Component / Part Definition. Not applicable.

3.2 Product Characteristics.

3.2.1 Performance Requirements. The DUT (Device Under Test) shall pass both, the component level tests according to GMW3097 and GMW3100 and the vehicle level tests according to GMW3091 and GMW3094. In the event that a device passes the component level EMC test but does not pass the vehicle level EMC tests, the vehicle level test results will be the determining factor for validation test pass/fail status.

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

All deviations which occur during immunity testing shall be recorded.

General Motors will use the following criterion to determine the performance of a DUT during immunity testing according to paragraphs 3.2.1.2.1, Reverberation Chamber Test, Mode Stirring, 3.2.1.2.2 Reverberation Chamber Test, Mode Tuning, 3.2.1.2.3, Anechoic Chamber Test, and 3.2.1.2.4, Bulk Current Injection on component and subsystem level.

If a deviation occurs during these immunity tests, the deviation will be classified according to Figure 1:

Figure 1: Performance Criteria for Radiated Immunity Testing

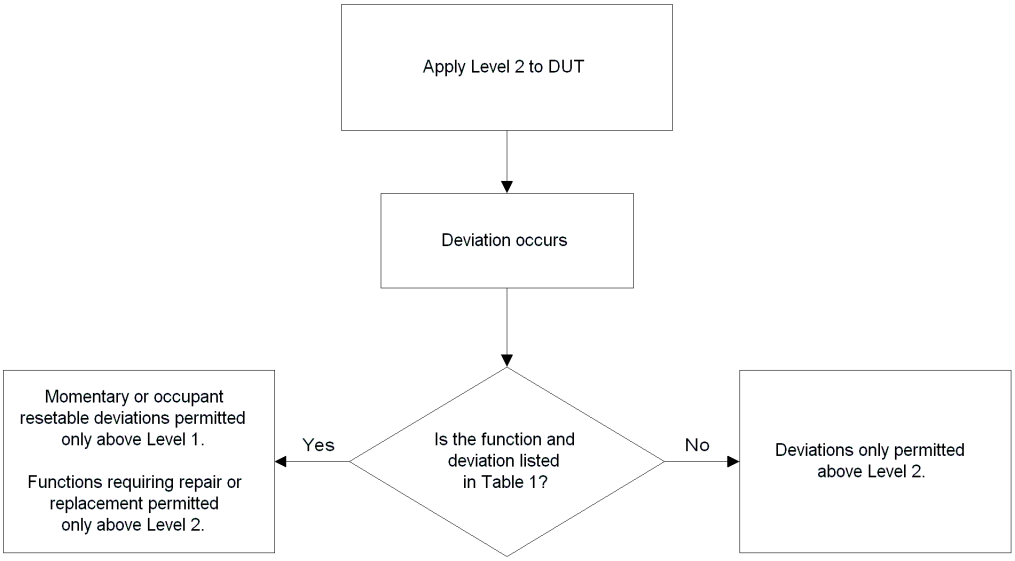


Table 1: List of Level 1 deviations

A deviation of a function which provides convenience or comfort and does not impair or impede the drivers ability to operate and/or control the vehicle and does not require repair or replacement
• Front and rear radio display (non-multifunction)
• Front and rear radio and telephone audio distortion
• Front and rear radio mode change
• CD changer mode change
• Navigation/compass display (non-multifunction) change (except OnStar GPS functions)
• Clock display change
• Trip odo display change
• Courtesy lighting change (except inadvertent illumination)
• Fuel consumption display
• HVAC display (non-multifunction) change
• HVAC mode change (Exception: Must not prevent activation and deactivation of defog function)
• Rear HVAC mode change
• Keyless entry functions (Exception: Inadvertent unlocking or when used as only means of entry, remote start, remote stop)
• Inability to open Sunroof
• Heated windshield operation (when used as redundant defog)
• Cell phone display (non-multifunction) change
• Entertainment audio & display change (VCR, TV, DVD, etc.)

3.2.1.1 Radiated Emissions, Component Tests.

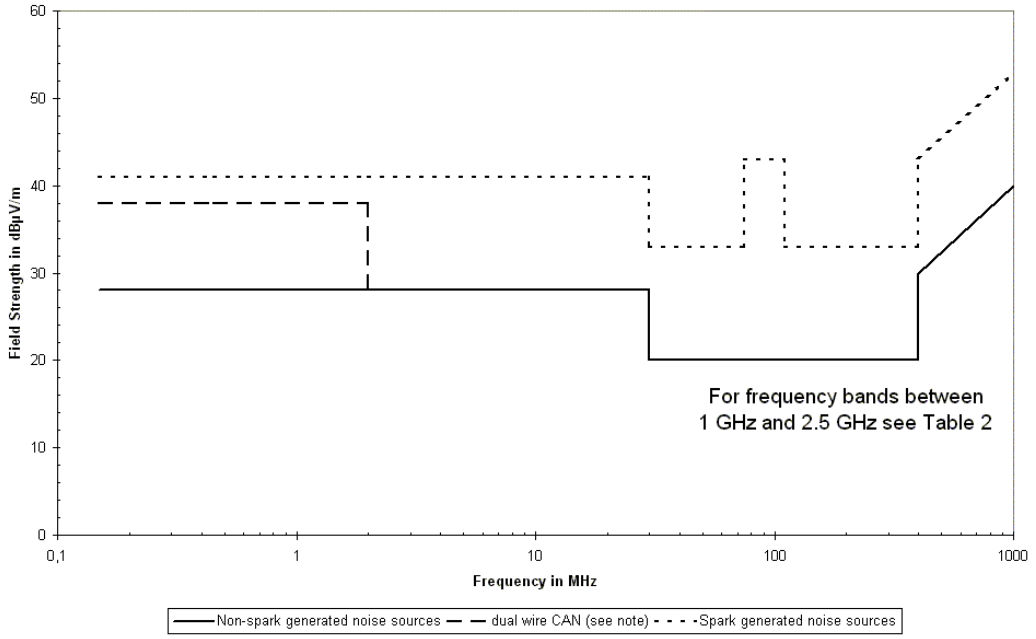
3.2.1.1.1 Reverberation Chamber Test.

3.2.1.1.1.1 Requirements. The field strength of the spark generated and non-spark generated radiated emissions measured with Pk+ detector shall not exceed the levels of Table 2 (and Figure 2) when the DUT is evaluated in accordance with GMW3100, 3.2.1.1.1.

Table 2: Maximum Field Strength for Radiated Emissions measured in the Reverberation Chamber

Frequency Range MHz	Amplitude dBµV/m		Comments
	Non-spark generated noise sources	Spark generated noise sources	
0.15...0.45	28 [38]	41	only if LW is available in entertainment system Values in [ ] apply to Dual Wire CAN only
0.45...2	28 [38]	41	Values in [ ] apply to Dual Wire CAN only
2...30	28	41	
30...74.5	20	33	
74.5...110	20	43	
110...400	20	33	
400...1000	30...40	43...53	
1447...1503	40	53	
1543...1561	40	53	
1567...1583	24	40	Use of high gain low noise amplifier necessary
1803...1882	40	53	
1928...1992	40	53	
2108...2172	40	53	
2308...2362	18	53	
2398...2499	40	53	

Figure 2: Maximum Field Strength for Radiated Emissions measured in the Reverberation Chamber



Caution: Spark generated noise sources and non-spark generated noise sources requirements have different RBW in the VHF Band!

Note: The Dual Wire CAN requirement applies only to those emissions resulting from the differential, dual-wire CAN databus transmissions. All other emissions measured from the DUT (when not transmitting CAN messages) shall comply with the lower, more stringent non-spark generated noise sources requirement.

Note: Requirements > 1 GHz assume 0 dBi gain for the antenna, therefore manufacturers antenna gain figures need to be corrected.

AF(dB) = 20 log(F) - 10 log(G) - 29.78

where

AF = Antenna Factor

F = Frequency in MHz

10 log(G) = Gain in dBi

Additionally, all noise sources have to fulfill the requirements according to paragraph 3.2.1.1.3 Conducted Emissions, Test with the Artificial Network.

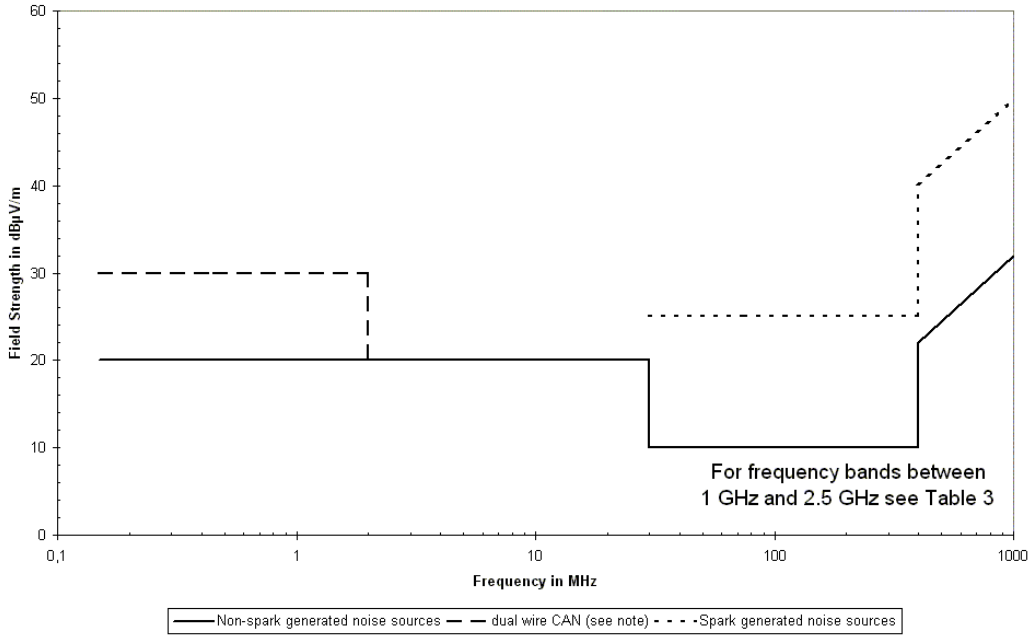
3.2.1.1.2 Anechoic Chamber Test.

3.2.1.1.2.1 Requirements. The field strength of the spark generated and the non-spark generated noise sources radiated emissions measured with Pk+ detector shall not exceed the levels of Table 3 (and Figure 3) when the DUT is evaluated in accordance with GMW3100, 3.2.1.1.2.

Table 3: Maximum Field Strength for Radiated Emissions measured in the Anechoic Chamber

Frequency Range MHz	Amplitude dBµV/m		Comments
	Non-spark generated noise sources	Spark generated noise sources	
0.15...0.45	20 [30]	requirement according to 3.2.1.1.3	only if LW is available in entertainment system Values in [ ] apply to Dual Wire CAN only
0.45...2	20 [30]	requirement according to 3.2.1.1.3	Values in [ ] apply to Dual Wire CAN only
2...30	20	requirement according to 3.2.1.1.3	
30...400	10	25	
400...1000	22...32	40...50	
1447...1503	32	50	
1543...1561	32	50	
1567...1583	10	30	Non-spark generated noise sources measured with AV detector, use of a high gain low noise amplifier necessary
1803...1882	32	50	
1928...1992	32	50	
2108...2172	32	50	
2308...2362	10	45	Non-spark generated noise sources measured with AV detector
2398...2499	32	50	

Figure 3: Maximum Field Strength for Radiated Emissions measured in the Anechoic Chamber



Note: The Dual Wire CAN requirement applies only to those emissions resulting from the differential, dual-wire CAN databus transmissions. All other emissions measured from the DUT (when not transmitting CAN messages) shall comply with the lower, more stringent non-spark generated noise sources requirement.

Additionally all noise sources have to fulfill the requirements according to paragraph 3.2.1.1.3 Conducted Emissions, Test with the Artificial Network.

3.2.1.1.3 Conducted Emissions, Test with the Artificial Network.

3.2.1.1.3.1 Requirements. The voltage level of the conducted emissions shall not exceed the levels of Table 4 when measured with the Pk+ detector when the DUT is evaluated in accordance with GMW3100, 3.2.1.1.3. The limits apply for artificial networks without correction factors applied.

Table 4: Requirement Table for Spark-generated Noise and non-spark generated noise measured with the Artificial Network using Pk+ Detector

Frequency Range MHz	Amplitude dB(µV)		Comments
	Spark generated noise sources	Non-spark generated noise sources	
0.15...0.45	78	60	only if LW is available in the entertainment system
0.45...1.75	63	42	
1.75...30	53	39	

3.2.1.2 Radiated Immunity, Component Tests.

3.2.1.2.1 Reverberation Chamber Test, Mode Stirring.

3.2.1.2.1.1 Requirements. DUT functions may only deviate above the levels according to Table 5 when evaluated in accordance with GMW3100, 3.2.1.2.1.

3.2.1.2.2 Reverberation Chamber Test, Mode Tuning.

3.2.1.2.2.1 Requirements. DUT functions may only deviate above the levels according to Table 5 when evaluated in accordance with GMW3100, 3.2.1.2.2.

3.2.1.2.3 Anechoic Chamber Test.

3.2.1.2.3.1 Requirements. DUT functions may only deviate above the levels according to Table 6 when evaluated in accordance with GMW3100, 3.2.1.2.3.

3.2.1.2.4 Bulk Current Injection.

3.2.1.2.4.1 Requirements. DUT functions may only deviate above the levels according to Table 7 (and Figure 4) when evaluated in accordance with GMW3100, 3.2.1.2.4.

Table 5: Requirement Levels for the Immunity to Electromagnetic Fields for Components and Subsystems measured in the reverberation chamber

Frequency range	Level 1	Level 2	Modulation
400 MHz...1 GHz	50 V/m	100 V/m	CW, AM 80%
1 GHz...1.3 GHz	15 V/m	30 V/m	CW, AM 80%
1.3 GHz...2.4 GHz	15 V/m	30 V/m	CW
800 MHz...2.4 GHz	70 V/m	70 V/m	Pulse PRR=50 Hz, PD=6.67 ms and Pulse PRR=217 Hz, PD=0.57 ms
1.15 GHz...1.45 GHz	170 V/m	600 V/m	Pulse PRR=300 Hz, PD=6 µs
2.6 GHz...3.2 GHz	105 V/m	210 V/m	Pulse PRR=300 Hz, PD=6 µs
5.2 GHz...5.9 GHz	55 V/m	110 V/m	Pulse PRR=300 Hz, PD=6 µs
8.9 GHz...10 GHz	125 V/m	250 V/m	Pulse PRR=300 Hz, PD=6 µs

Note: The fieldstrength requirements are peak levels.

Table 6: Requirement Levels for the Immunity to Electromagnetic Fields for Components and Subsystems measured in the anechoic chamber

Frequency range	Level 1	Level 2	Modulation
400 MHz...1 GHz	50 V/m	100 V/m	CW, AM 80%
1 GHz...1.3 GHz	15 V/m	30 V/m	CW, AM 80%
1.3 GHz...2.4 GHz	15 V/m	30 V/m	CW
800 MHz...2.4 GHz	70 V/m	70 V/m	Pulse PRR=50 Hz, PD=6.67 ms and Pulse PRR=217 Hz, PD=0.57 ms
1.15 GHz...1.45 GHz	170 V/m	600 V/m	Radar pulse packets PRR=300 Hz, PD=3 µs, with only 50 pulses output every 1 s
2.6 GHz...3.2 GHz	105 V/m	210 V/m	Radar pulse packets PRR=300 Hz, PD=3 µs, with only 50 pulses output every 1 s
5.2 GHz...5.9 GHz	55 V/m	110 V/m	Radar pulse packets PRR=300 Hz, PD=3 µs, with only 50 pulses output every 1 s
8.9 GHz...10 GHz	125 V/m	250 V/m	Radar pulse packets PRR=300 Hz, PD=6 µs, with only 25 pulses output every 1 s

Table 7: Requirement Levels for the Immunity to Electromagnetic Fields for Components and Subsystems measured using the CBCI and DBCI method

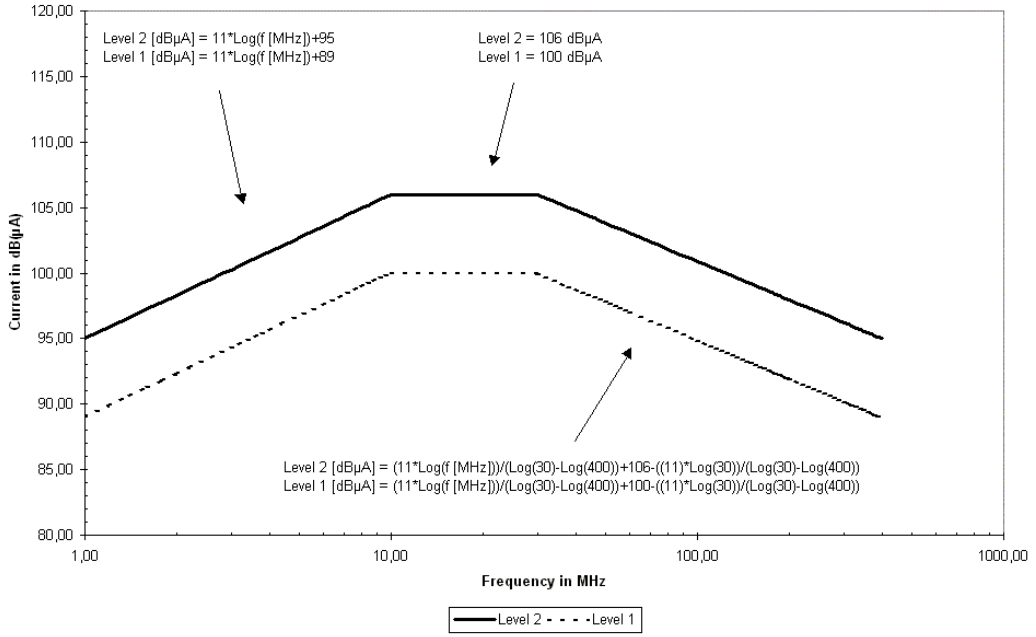
Frequency range	Level 1	Level 2	Method	Modulation
1 MHz...10 MHz	89...100 dB(µA)	95...106 dB(µA)	DBCI	CW, off/on, on/off, AM 80%
10 MHz...30 MHz	100 dB(µA)	106 dB(µA)	DBCI	CW, off/on, on/off, AM 80%
30 MHz...400 MHz	100...89 dB(µA)	106...95 dB(µA)	CBCI	CW, off/on, on/off, AM 80%

Note: For off/on and on/off modulation the following requirements apply: Maximum overshoot 0.5 dB, maximum rise time 3 ms, minimum power step 20 dB.

3.2.1.2.5 Immunity to Power Line Magnetic Fields.

3.2.1.2.5.1 Requirements. DUT functions may only deviate above 50 µT (RMS) when evaluated in accordance with GMW3100, 3.2.1.2.5.

Figure 4: Requirement Levels applicable to the Performance Criteria for the Immunity to Electromagnetic Fields for Components and Subsystems measured using the CBCI and DBCI method



3.2.1.3 Conducted Transient Emissions and Immunity (CE/CI), Component Tests.

3.2.1.3.1 Conducted Transient Emissions.

3.2.1.3.1.1 Requirements. The voltage levels of Conducted Transients shall not exceed the levels of Table 8 when the DUT is evaluated in accordance with GMW3100, 3.2.1.3.1.

Note: The conducted transient emissions requirements are established with the knowledge that they are not identical to the conducted transient immunity requirements.This difference is attributable to a) the emission measurements are obtained on the DUT side of the switch, and b) there is an attenuation of the DUT emission related to the switch contact arcing and the losses associated with wiring harnessing.

Table 8: Maximum Amplitude for Conducted Transients

Maximum amplitude of transient, positive polarity	+100 V
Maximum amplitude of transient, negative polarity	-150 V

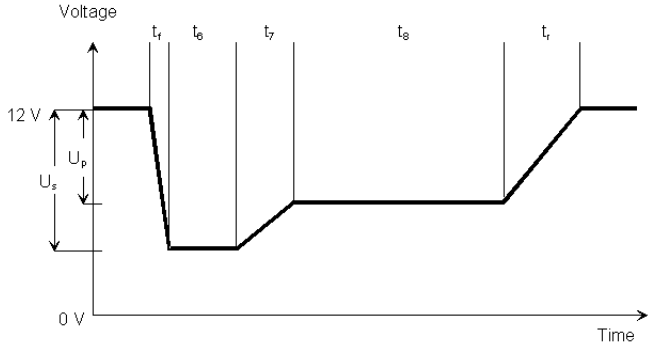
3.2.1.3.2 CI, Transients on Power Lines.

3.2.1.3.2.1 Requirements. DUT functions may only deviate from the designed performance above the levels according to Table 9 when evaluated in accordance with GMW3100, 3.2.1.3.2.

Table 9: Requirements levels for the Immunity to Transients on Power Lines

Pulse No.	Level	Comments
1	-100 V_{peak}	One or more functions of the DUT can go beyond specified tolerance as long as all functions return within normal limits after the exposure is removed. Memory functions shall perform as designed
2a	+50 V_{peak}	generator source impedance 2 Ω
2b	+10 V_{peak}	
3a	-150 V_{peak}	
3b	+100 V_{peak}	
4	see Figure 5	Waveform, voltage levels and Performance Criterion for pulse 4 (crank pulse) see Figure 5
5	(34 +0/-1) V	No permanent DUT performance deviations shall be observed after exposure to a load dump pulse with a suppressed open circuit voltage of (34 +0/-1) V
7a	-50 V_{peak}	

Figure 5: Performance Criterion for Pulse 4 (Crank Pulse)



Pulse severity	U_s	U_p	t_8	t_r	Performance Criterion
I	4 V	2.5V	1 s	40 ms	One or more functions of the DUT can go beyond specified tolerance as long as all functions automatically return within normal limits after the exposure is removed. Memory functions and functions required to start an engine shall perform as designed
II	5 V	3 V, 2.5 V	2 s	60 ms	
III	6 V	4 V, 3 V, 2.5 V	5 s	80 ms	
IV	7 V	5 V, 4 V, 3 V, 2.5 V	10 s	100 ms	

t_f, t_6 and t_7 as defined in ISO 7637-2. Default value for t_6 is 15 ms.

All severity levels shall be tested.

3.2.1.3.3 CI, Coupling to other than Supply Lines (I/O Lines).

3.2.1.3.3.1 Requirements. DUT functions may only deviate below -150 V_{peak} and above +100 V_{peak} respectively when evaluated in accordance with GMW3100, 3.2.1.3.3.

3.2.1.4 Electrostatic Discharge (ESD), Component Tests.

3.2.1.4.1 Electrostatic Discharge, Test during Operation of the Device (Power-On Mode).

3.2.1.4.1.1 Requirements. The DUT must pass a full functional test prior to any application of ESD. After each voltage level and type of discharge the function and parametric values of the component shall be checked.

The DUT functions may deviate according to Table 10 and Table 11 when evaluated in accordance with GMW3100, 3.2.1.4.1.

Table 10: Requirements for components located in the passenger compartment of the vehicle for the Immunity to Electrostatic Discharge

Type of Discharge	Discharge Network	Level	Deviations
Air	C = 330 pF, R = 2 kΩ	±4 kV	No deviations allowed
Contact	C = 330 pF, R = 2 kΩ	±4 kV	No deviations allowed
Air	C = 330 pF, R = 2 kΩ	±6 kV	No deviations allowed
Contact	C = 330 pF, R = 2 kΩ	±6 kV	Momentary self-recoverable deviations allowed
Air	C = 330 pF, R = 2 kΩ	±8 kV	Momentary self-recoverable deviations allowed
Contact	C = 330 pF, R = 2 kΩ	±8 kV	Momentary self-recoverable deviations allowed
Air	C = 330 pF, R = 2 kΩ	±15 kV	Momentary self-recoverable deviations allowed
Air	C = 150 pF, R = 2 kΩ	±25 kV	Momentary self-recoverable deviations allowed

Table 11: Requirements for components located in the trunk of the vehicle for the Immunity to Electrostatic Discharge

Type of Discharge	Discharge Network	Level	Deviations
Air	C = 150 pF, R = 2 kΩ	±4 kV	No deviations allowed
Contact	C = 150 pF, R = 2 kΩ	±4 kV	No deviations allowed
Air	C = 150 pF, R = 2 kΩ	±6 kV	No deviations allowed
Contact	C = 150 pF, R = 2 kΩ	±6 kV	Momentary self-recoverable deviations allowed
Air	C = 150 pF, R = 2 kΩ	±8 kV	Momentary self-recoverable deviations allowed
Contact	C = 150 pF, R = 2 kΩ	±8 kV	Momentary self-recoverable deviations allowed
Air	C = 150 pF, R = 2 kΩ	±15 kV	Momentary self-recoverable deviations allowed
Air	C = 150 pF, R = 2 kΩ	±25 kV	Momentary self-recoverable deviations allowed

3.2.1.4.2 Electrostatic Discharge, Remote Inputs/Outputs.

3.2.1.4.2.1 Requirements. The DUT must pass a full functional test prior to any application of ESD. After each voltage level and type of discharge the function and parametric values of the component shall be checked.

The DUT functions may deviate according to Table 10 and Table 11 when evaluated in accordance with GMW3100, 3.2.1.4.2.

3.2.1.4.3 Electrostatic Discharge, Handling of Devices.

3.2.1.4.3.1 Requirements. The DUT must pass a full functional test prior to any application of ESD. After completion of the test the function and parametric values of the component shall be checked.

The DUT functions before and after the test may deviate according to Table 12 when evaluated in accordance with GMW3100, 3.2.1.4.3.

Table 12: Requirements for the Immunity to Electrostatic Discharge

Type of Discharge	Discharge Network	Level	Deviations
Contact	C = 150 pF, R = 2 kΩ	±4 kV	No deviations allowed
Contact	C = 150 pF, R = 2 kΩ	±6 kV	No deviations allowed
Air	C = 150 pF, R = 2 kΩ	±8 kV	No deviations allowed

4 Validation

4.1 General. This paragraph defines the acronyms, abbreviations and special terms used in this section.

Validation Method:

A = Analysis

D = Demonstration

I = Inspection

T = Test

Validation Type:

DV = Design Validation

PV = Product Validation

The subsystem and/or component level validation must precede the initiation of vehicle validation.

4.2 Validation Cross Reference Index. The Validation Cross Reference Index (VCRI), Table 13, maps the component requirements to the associated validation pocedures. The VCRI identifies the applicable validation procedures, the method of validation and the validation type. The VCRI is to be used as an input in developing a complete validation plan.

Table 13: Validation Cross Reference Index (Electromagnetic Compatibility, Component Tests)

GMW3097 Requirement Paragraph	Title	GMW3100 Procedure Paragraph	Validation Method	Validation Type
3.2.1.1.1	Reverberation Chamber Test	3.2.1.1.1	T	DV, PV
3.2.1.1.2	Anechoic Chamber Test	3.2.1.1.2	T	DV, PV
3.2.1.1.3	Conducted Noise Emissions, Test with the Artificial Network	3.2.1.1.3	T	DV, PV
3.2.1.2.1	Reverberation Chamber Test, Mode Stirring	3.2.1.2.1	T	DV, PV
3.2.1.2.2	Reverberation Chamber Test, Mode Tuning	3.2.1.2.2	T	DV, PV
3.2.1.2.3	Anechoic Chamber Test	3.2.1.2.3	T	DV, PV
3.2.1.2.4	Bulk Current Injection	3.2.1.2.4	T	DV, PV
3.2.1.2.5	Immunity to Power Line Magnetic Fields	3.2.1.2.5	T	DV, PV
3.2.1.3.1	Conducted Transient Emissions	3.2.1.3.1	T	DV, PV
3.2.1.3.2	CI, Transients on Power Lines	3.2.1.3.2	T	DV, PV
3.2.1.3.3	CI, Coupling to other than Supply Lines (I/O Lines)	3.2.1.3.3	T	DV, PV
3.2.1.4.1	ESD, Test during Operation of the Device (Power-On Mode)	3.2.1.4.1	T	DV, PV
3.2.1.4.2	ESD, Remote Inputs/Outputs	3.2.1.4.2	T	DV, PV
3.2.1.4.3	ESD, Handling of Devices	3.2.1.4.3	T	DV, PV

5 Provisions for Shipping

Not applicable.

6 Notes

6.1 Glossary. Not applicable.

6.2 Acronyms, Abbreviations and Symbols.

AV	Average
CAN	Controller Area Network
CBCI	Common Mode Bulk Current Injection
CD	Compact Disc
CE	Conducted Transient Emissions
CI	Conducted Transient Immunity
CTS	Component Technical Specification
DBCI	Differential Mode Bulk Current Injection
DC	Direct Current
DUT	Device under Test
DVD	Digital Versatile Disc
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
GM	General Motors
GMW	General Motors Worldwide
GPS	Global Positioning System
HVAC	Heating Ventilation and Air Conditioning
I/O	line: Input/Output line
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITDC	International Technical Development Center

LISN	Line Impedance Simulation Network
LW	Long Wave
Pk+	Positive Peak
PWM	Pulse Width Modulated
RBW	Resolution Bandwidth
RMS	Root Mean Square
SAE	Society of Automotive Engineers
SSTS	Subsystem Technical Specification
VCR& TV	Video Cassette Recorder & Television
VCRI	Validation Cross Reference Index
VHF	Very High Frequency
VTS	Vehicle Technical Specification

7 Additional Paragraphs

Not applicable.

8 Coding System

This specification shall be referenced in other documents, drawings, VTS, CTS, etc. as follows:

GMW3097	
Where	
GMW	Validation Area (GM Worldwide)
3097	Sequential number
	Class: General Specification
	Type: All Vehicle
	Category: Electrical Architecture

Example:

“Requirements to GMW3097”

9 Release and Revisions

9.1 Release. This specification was first approved in APR 1999.

It has been prepared by the GM Global EMC Committee.

9.2 Revisions.

Rev.	Date	Description (Org.)
A	APR 1999	New, was also called "revision 1" (ITDC)
B	MAR 2000	Editorial, was also called "revision 1" (GMNA)
C	OCT 2000	Reworked, was also called "revision 2" (ITDC)
D	AUG 2001	Reworked, is also called “revision 3”. Changes against revision October 2000 (revision 2): Radiated Emissions: GPS and SDARS requirements changed, Requirements for non-spark generated noise sources added in test with artificial network. Radiated Immunity: List of Level 1 deviations changed, Reverberation Mode Tuning added, BCI requirements changed. Conducted Immunity: Pulse 2a changed, pulses 6, 7b and 8 eliminated. Electrostatic Discharge: Requirements for components located in the trunk changed, Handling requirements changed, Packaging recommendations eliminated. All paragraphs: Editorial changes and clarifications (ITDC)

射 频 和 天 线 设 计 培 训 课 程 推 荐

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射频工程师养成培训课程套装

该套装精选了射频专业基础培训课程、射频仿真设计培训课程和射频电路测量培训课程三个类别共 30 门视频培训课程和 3 本图书教材；旨在引领学员全面学习一个射频工程师需要熟悉、理解和掌握的专业知识和研发设计能力。通过套装的学习，能够让学员完全达到和胜任一个合格的射频工程师的要求…

课程网址：http://www.edatop.com/peixun/rfe/110.html

手机天线设计培训视频课程

该套课程全面讲授了当前手机天线相关设计技术，内容涵盖了早期的外置螺旋手机天线设计，最常用的几种手机内置天线类型——如 monopole 天线、PIFA 天线、Loop 天线和 FICA 天线的设计，以及当前高端智能手机中较常用的金属边框和全金属外壳手机天线的设计；通过该套课程的学习，可以帮助您快速、全面、系统地学习、了解和掌握各种类型的手机天线设计，以及天线及其匹配电路的设计和调试...

课程网址： http://www.edatop.com/peixun/antenna/133.html

WiFi 和蓝牙天线设计培训课程

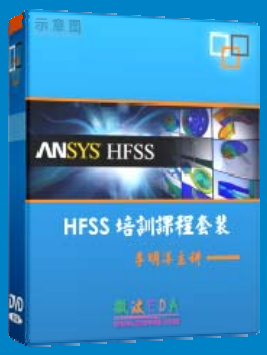
该套课程是李明洋老师应邀给惠普 (HP)公司工程师讲授的 3 天员工内训课程录像，课程内容是李明洋老师十多年工作经验积累和总结，主要讲解了 WiFi 天线设计、HFSS 天线设计软件的使用，匹配电路设计调试、矢量网络分析仪的使用操作、WiFi 射频电路和 PCB Layout 知识，以及 EMC 问题的分析解决思路等内容。对于正在从事射频设计和天线设计领域工作的您，绝对值得拥有和学习！…

课程网址：http://www.edatop.com/peixun/antenna/134.html

CST 学习培训课程套装

该培训套装由易迪拓培训联合微波 EDA 网共同推出，是最全面、系统、专业的 CST 微波工作室培训课程套装，所有课程都由经验丰富的专家授课，视频教学，可以帮助您从零开始，全面系统地学习 CST 微波工作的各项功能及其在微波射频、天线设计等领域的设计应用。且购买该套装，还可超值赠送 3 个月免费学习答疑…

课程网址：http://www.edatop.com/peixun/cst/24.html

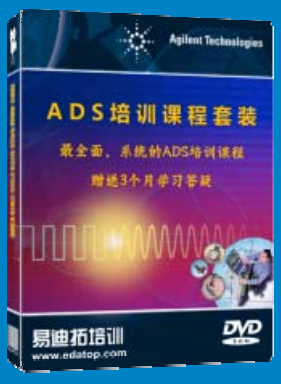


HFSS 学习培训课程套装

该套课程套装包含了本站全部 HFSS 培训课程，是迄今国内最全面、最专业的 HFSS 培训教程套装，可以帮助您从零开始，全面深入学习 HFSS 的各项功能和在多个方面的工程应用。购买套装，更可超值赠送 3 个月免费学习答疑，随时解答您学习过程中遇到的棘手问题，让您的 HFSS 学习更加轻松顺畅…

课程网址：http://www.edatop.com/peixun/hfss/11.html

ADS 学习培训课程套装



该套装是迄今国内最全面、最权威的 ADS 培训教程，共包含 10 门 ADS 学习培训课程。课程是由具有多年 ADS 使用经验的微波射频与通信系统设计领域资深专家讲解，并多结合设计实例，由浅入深、详细而又全面地讲解了 ADS 在微波射频电路设计、通信系统设计和电磁仿真设计方面的内容。能让您在最短的时间内学会使用 ADS，迅速提升个人技术能力，把 ADS 真正应用到实际研发工作中去，成为 ADS 设计专家...

课程网址： http://www.edatop.com/peixun/ads/13.html

我们的课程优势：

※ 成立于 2004 年，10 多年丰富的行业经验，

※ 一直致力并专注于微波射频和天线设计工程师的培养，更了解该行业对人才的要求

※ 经验丰富的一线资深工程师讲授，结合实际工程案例，直观、实用、易学

联系我们：

※ 易迪拓培训官网：http://www.edatop.com

※ 微波 EDA 网：http://www.mweda.com

※ 官方淘宝店：http://shop36920890.taobao.com