EMC LABORATORY
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IMMUNITY TO TRANSIENTS ON POWER LINES PULSE #2A TEST PROCEDURE

ISO-7637-2:2004 PULSE #2A & OEM EQUIVALENT PULSE

1. PURPOSE

1.1. To provide specific test method setup configuration instructions in full compliance with OEM specifications and international standards.

2. SCOPE

2.1. To establish consistency and repeatability in test method results using the equipment and technical resources available in EMC laboratory inventory.

3. RESPONSABILITY

3.1. EMC laboratory authorized personnel.
See **201709** *EMC LAB TEST EQUIPMENT COMPETENCY MATRIX* and **201705** *EMC LAB COMPETENCY MATRIX*.

4. EQUIPMENT & MATERIALS

4.1. All test equipment that requires calibration shall be within its calibration period and shall be traceable to A2LA certified labs. EMC lab personnel must ensure that certificates of calibration are obtained when equipment is sent out for calibration or repair. *(See REFERENCES section in document for equipment specific internal procedures and records).*

4.2. **Power supply**
* Ri of less than 0,01 Ω d.c.
* Zi = Ri for frequencies less than 400 Hz.
* output deviation =< 1 V from 0 to maximum load (including inrush current) and shall recover 63% of its maximum excursion within 100 µs.
* superimposed ripple voltage Ur =< 0,2 V peak-to-peak and shall have a minimum frequency of 400 Hz.
* simulates the low internal impedance of the battery
* battery voltages 13,5 V and 27 V, respectively.

4.3. **Oscilloscope:**
* digitizing oscilloscope (single sweep sampling rate >=2 GHz/s, bandwidth 400 MHz, input sensitivity: at least 5 mV/div.)
* analog storage oscilloscope may be used if:
  - bandwidth d.c. to at least 400 MHz;
  - writing speed of at least 100 cm/µs;
  - input sensitivity of at least 5 mV/division.

4.4. **Voltage probe:**
* attenuation of 100/1,
* maximum input voltage of at least 1 kV,
* input impedance Z and capacitance C according to Table 2 ;
* maximum probe cable length of 3 m;
* maximum probe ground length of 0,13 m.

f[MHz]	z[kΩ]	C[pF]
1	>40	<4
10	>4	<4
100	>0.4	<4

4.5. **Test pulse generator:**
* peak voltage U_s tolerance of +10% / -0%
* timing (t) tolerance of ± 20%
* internal resistance (Ri) tolerance of ± 20%

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Fig.4-1

ISO Pulse 2 (12V/24V)	
Rise time tr (10 - 90%)	1µs + 0% // - 50%
Pulse duration td (10 - 10%)	50µs ± 10%
Internal resistor	2Ω ± 10%
Trigger	
Automatic	Automatic release of the pulses
Repetition rate	0.2s – 99.0s
Manual	Manual release of a single pulse
External	External release of a single pulse
Battery supply switch	Selectable Off time, to = 0 – 10.000ms
Output	
+/- output	Safety laboratory plugs
Coupling	To the battery +line
Decoupling	Via diode and battery supply switch
DUT supply	max. 60V / 25A

Tbl.4-1

Idx	Equipment Description	Model	Maker	INV#
1.	Coupling Network	CNA200B2	EMTEST	2167
2.	Pulse #1 & #2a Micropulse Generator	MPG200B	EMTEST	2162
3.	Power Supply 0V – 60V, 0A – 50A	VDS200B2	EMTEST	2171
4.	Oscilloscope	TDS784A	TEKTRONIX	2161
5.	Voltage probe	CNA200B2	TEKTRONIX	2167
6.	ISMISO software	Rev 4.22	EMTEST	2176

5. SUMMARY OF TEST METHOD

5.1. Evaluates DUT's immunity from conducted transients on power and control circuits connected directly to the vehicle's battery or indirectly by a switch or load (e.g. pull-up resistor).

5.2. The switching of inductive loads connected to the battery supply of vehicles creates both positive and negative pulses which electronics connected to the battery supply must be able to withstand. An example of transient would be the release of stored energy during the operation of a relay and/or other loads connected to the battery while starting and/or turning off the vehicle.

6. SAFETY PRECAUTIONS

6.1. Only EMC laboratory personnel mentioned in 201709 EMC LAB TEST EQUIPMENT COMPETENCY MATRIX is allowed to handle the EMTEST equipment.

7. TEST PLAN

7.1. For FlexAutomotive products the EMC test plan is generated using LMS004 and OEM template.

7.2. The test plan should indicate:
1) DUT, harness, I/O loads configuration and position relative to ground plane.
2) DUT activation and monitoring method, expected FPSC, and pass/fail criteria.

7.3. In the absence of an EMC test plan use information provided by the test requester in 201696 INTERNAL TEST REQUEST FORM. This approach is applicable for "engineering development" testing.

8. RECORDS

8.1. **Test reports** including plots and data files are saved over over the LAN in a dedicated folder:
\\nmknt062\apps\e-ecn\emclab\tresult\project#\job#\test group
Example of grouping test results per job#: CTI, CTE, RE, CE, BCI, ESD, TP, PT, TRENDS.

8.2. In a similar manner the EMC **test plans** (TP), **proficiency testing** (PT), **trends** are stored under a **project#\job#** folder.

8.3. The intranet application EMC LAB SCHEDULER database is used to maintain and provide fast access to testing related records. The application is available via this link: **http://nmknt063/emclab/labscheduler/**

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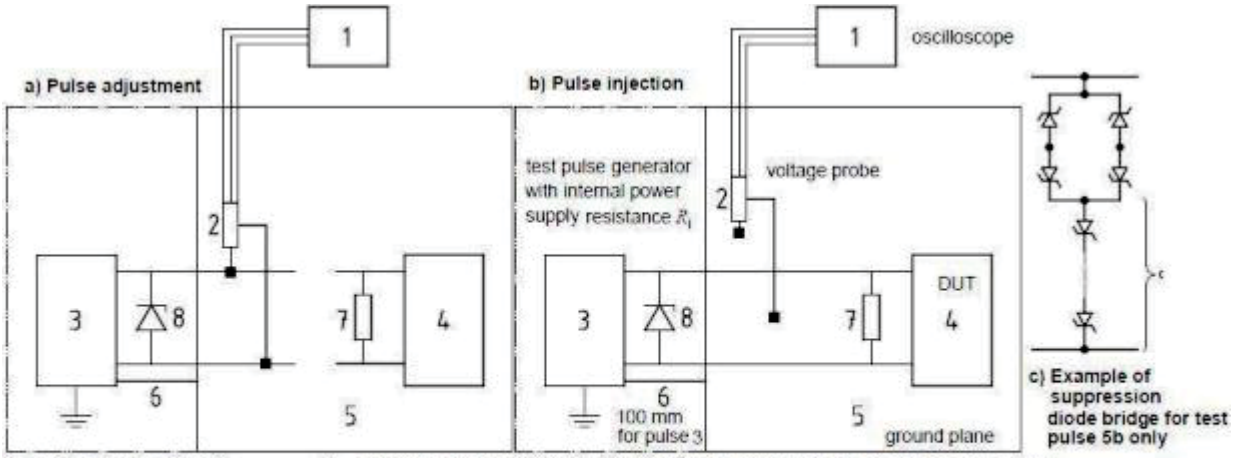
9. TEST SETUP

9.1. Prior to start testing all samples must be labeled per 900712 EMC LAB LABELS. The default list of required equipment is pull-out at the time the test method is selected (721179 EMC LAB, TEST REPORTS DATABASE).

Fig.9-1



Tbl.9-1

	Pulse Verification 12/24 V	U_s	t_r	t_d
1.	Pulse 2a - No load	+ 50 V ± 5 V		50 µs ± 10 µ
2.	Pulse 2a - 2 Ω load	+ 25 V ± 5 V	1 (+0/– 0,5) µs	12 µs ± 2,4 µ
3.	Pulse 2b - No load and 0,5 Ω load	+ 10 V ± 1 V (12 V system)	1 ms ± 0,5 ms	2 s ± 0,4 s
4.	Pulse 2b - No load and 0,5 Ω load	+ 20 V ± 2 V (24 V system)	1 ms ± 0,5 ms	2 s ± 0,4 s

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10. ISO-7637-2:2004 PULSE#2A

10.1. Pulse 2a simulates transients due to sudden interruption of currents in a device connected in parallel with the DUT due to the inductance of the wiring harness (see ISO7637-2:2004 Annex F).

10.2. ISO-7637-2 does not mention for pulse#1 to place the DUT and/or harness on an insulator 5 cm above the ground plane.

10.3. U_A = 13.5 ± 0.5 V (12 V system), 27 ± 1 ?(24 V system).

Fig.10-1

ISO-7634-2:2004

Figure 6 — Test pulse 2a

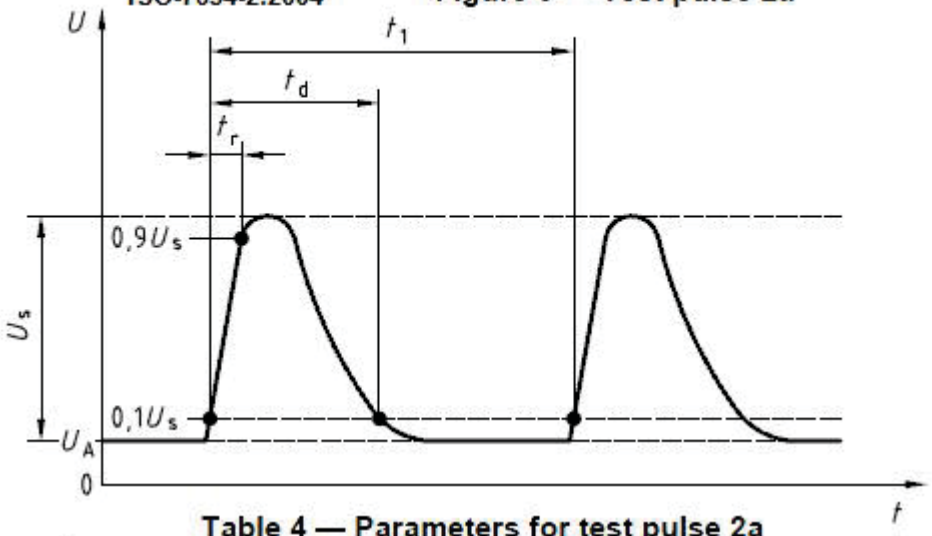


Table 4 — Parameters for test pulse 2a

Parameter	12 V system	24 V system
U_s	+ 37 V to + 50 V	
R_i	2 Ω	
t_d	0,05 ms	
t_r	$\left(10\ {}^{0}_{-0,5}\right)$ µs	
t_1 [a]	0,2 s to 5 s	

[a] The repetition time t_1 can be short, depending on the switching. The use of a short repetition time reduces the test time.

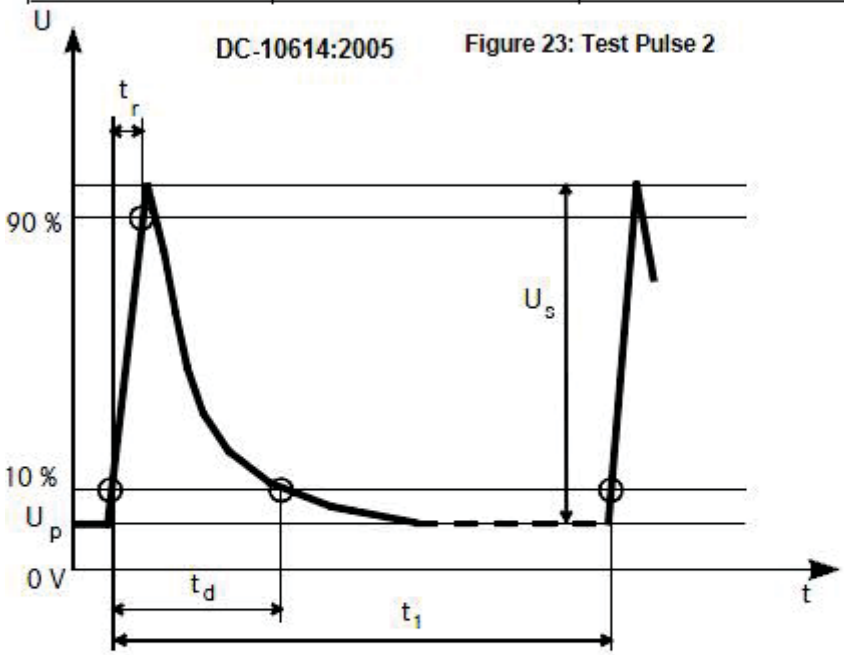
11. DC10614:2005 PULSE#2

11.1. DC-10614:2005 (9 Transient Immunity) - pulses are applied individually to each battery and ignition line and any inputs or outputs supplied from battery or ignition voltage. Check DUT for inadvertent turn-on, no damage, no lockups requiring power off reset, and no effect on stored data or false diagnostic indication.
Test pulse 2 simulates the interruption of a current through an inductance switched in series with the DUT.
Only switched supply lines shall be exposed to this test pulse.

11.2. Pulses #1 and #2 applied for 1 hour each (applications: 720 for pulse #1, 7200 for pulse #2).
Pulses #3a and #3b applied for one half hour each (1,800,000 applications each).

Fig.11-1 **Table 30: Supply Voltage Transients - Immunity Requirements**

Transient Pulse	Performance Status Group A	Performance Status Groups B, C and D
Pulse #2	II	I



DC-10614:2005 Figure 23: Test Pulse 2

Table 32: Test pulse 2 – Parameters

Parameters	12 V System	24 V System	42 V System
U_p in V	13.5	27	42
U_s in V	100	150	100
τ_r in µs	1	1	1
τ_d in µs	50	50	50
τ_1 in s	0.5	0.5	0.5
R_i in ohms	10	10	10
Test duration in h	1	1	1

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12. DC11224:2007 PULSE#2

12.1. DC11224:2007 Pulse #2 is the equivalent for ISO-7637-2:2004 Pulse #2A. Us = 100V.

12.2. DC11224:2007 (9. Transient Immunity) requires specific connections for electrically asymmetrical and electrically symmetrical devices, and mention that lines between the DUT and the test pulse generator must be routed at a height of 50 mm above the ground plane and shall be 500 mm in length.

12.3. Note that the test duration and Ri are lowered from DC-10614 requirements.

Fig.12-1

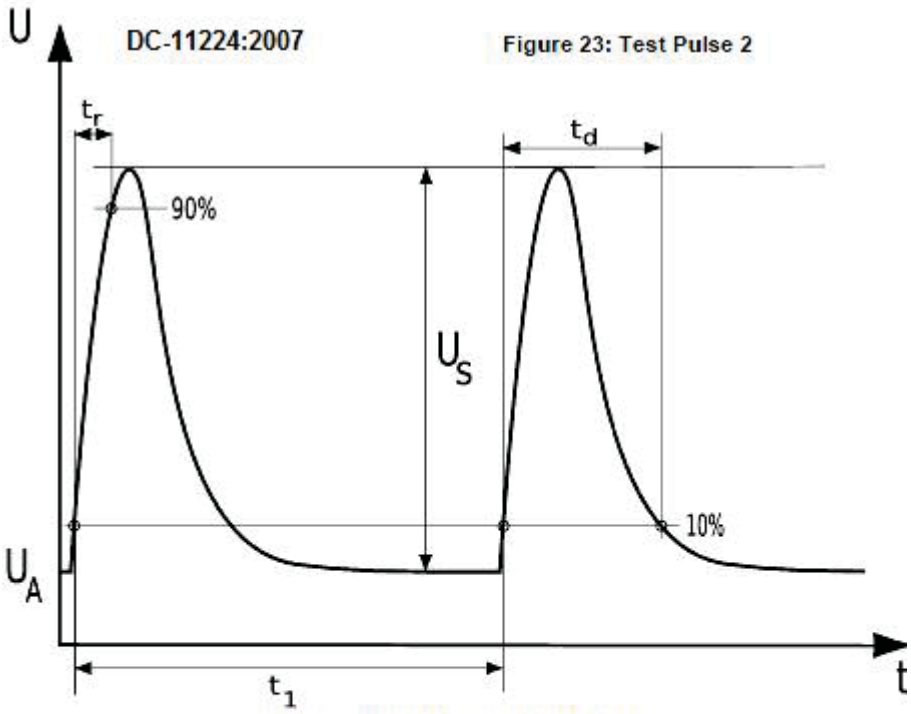

Table 22: Test pulse 2 – Parameters

Parameters	12 V System	24 V System	42 V System
U_A in V	13.5	27	42
U_s in V	100	150	100
t_r in µs	1	1	1
t_d in µs	50	50	50
t_1 in s	0.5	0.5	0.5
R_i in ohms	2	2	2
Test duration in min	10	10	10

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13. CS-11809:2009 PULSE#2A

13.1. Chrysler Pulse#2a is higher in amplitude (Us=100V) than than ISO-7637-2:2004 (Us = 37V).

13.2. The test pulses are applied individually to all DUT battery, ignition, accessory and appropriate I/O lines and mention that lines between the DUT and the test pulse generator wires must be routed at a height of 50 mm above the ground plane and shall be less than or equal to 500 mm in length.

13.3. Note the change from DC-11224: **Level 1** (non-critical functions) and **Level 2** (critical functions). Pulse name is identical with ISO-7637-2:2004.

Fig.13-1

TABLE 20: TRANSIENT CONDUCTED IMMUNITY ON SUPPLY LINE LIMITS

Pulse No.	Test Voltage U_s [V]		Level 1 Status	Level 2 Status	Test Duration (min)
	12 V	24V			
1	-100	-600	II	II[1)]	10
1b	30	50	I	I	10
2a	100	150	I	I	10
3a	-150	-200	I	I	10
3b	100	200	I	I	10

NOTE 1: Powertrain controllers shall return to normal operation after the disturbance is removed. A reset upon application of one key cycle is not allowed.

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14. CS-11979:2010 PULSE#B

14.1. Note that CS-11979:2010 6.4.1 Transient Immunity of Supply Lines changes the pulse title (number).

14.2. Note that the pulse name has changed to Pulse #B and the test duration is further reduced in CS-11979.

Fig.14-1 CS-11979, Change A, 2010-04-13

TABLE 26: TRANSIENT IMMUNITY PULSE REQUIREMENTS

#	Reference	Internal generator resistance Ri	Amplitude Vs (Us)	Pulse parameter	MINIMUM Number of pulses (MINIMUM test time)	Permitted behavior
A	**Pulse 1 :** generated at key-off with inductive loads present (ISO 1)	10 Ω	-100 V	td=2 ms	500 pulses	M1(1)
A1	**Pulse 1b :** generated at key-off with inductances in series with loads or electrical motors running	10 Ω	+43.5 V	td=2 ms tr=0.001ms t_1=5s	500 pulses	M1
B	**Pulse 2 :** generated at key-off with inductances in series with loads or electrical motors running (ISO 2a)	2 Ω	+100 V	td=0,05 ms	500 pulses	M1
C	**Pulse 3a :** generated by bounces and/or arcs at activation of switches or relays (ISO 3a)	50 Ω	-150 V	tr=5 ns td=100 ns t1=0,1 ms t4=10ms t5=100ms	15 min	M1
D	**Pulse 3b :** generated by bounces and/or arcs at activation of switches or relays (ISO 3b)	50 Ω	+100 V	tr=5 ns td= 100 ns t1=0,1 ms t4=10ms t5=100ms	15 min	M1
E	**Pulse 5b :** generated by a disconnected battery terminal while current is supplied from generator to battery (load-dump) (ISO 5b)	1 Ω	+ 40 V(2)	td=400 ms	15 pulses	M1, M2(3)

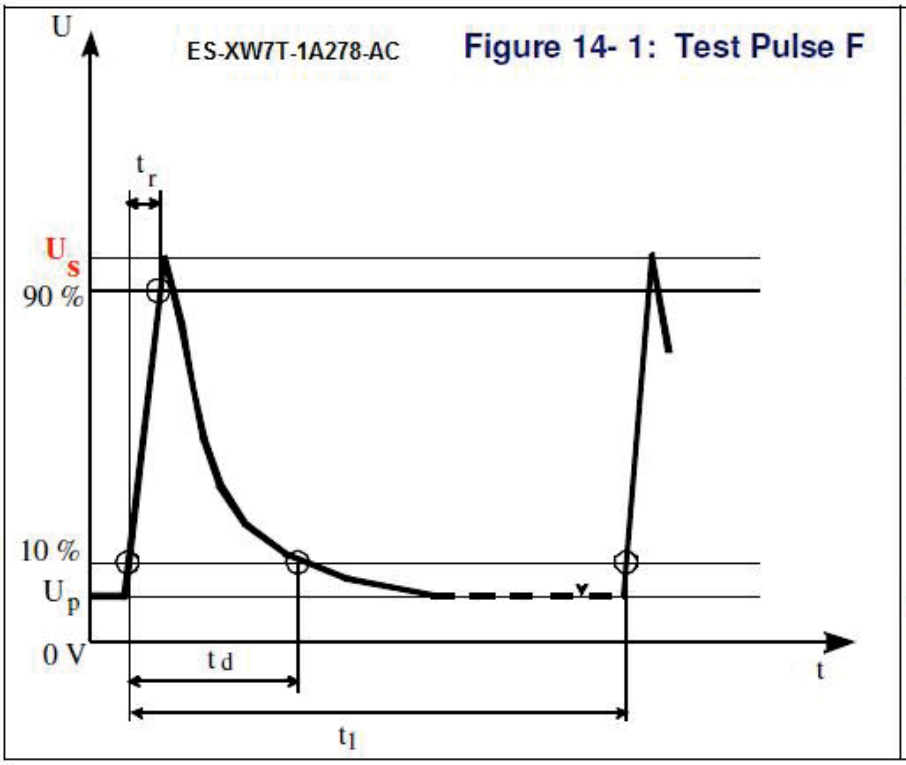
NOTE 1: Operation M3 permissible during negative portion of pulse.
NOTE 2: Test shall be carried out with a suppressor at Load Dump generator output clamping the pulse (Us=70V according Figure 11 of ISO 7637-2:2004) to +40V peak (ISO 5b).
NOTE 3: Where required, M1 operating mode to be ensured.

NOTE: The test duration in Table 26 is the minimum for testing against damage. It is responsibility of the supplier to test thoroughly against functional sensitivity to these types of disturbances.

15. ES-XW7T-1A278-AC:2003 PULSE#F

15.1. Pulse #F is the equivalent for ISO-7637-2:2004 Pulse #2a

Fig.15-1



Test pulse F simulates the interruption of a current through an inductance switched in series with the DUT. Only power supply and control circuits with direct connection to battery shall be exposed to this test pulse. The test pulse is equivalent to Test Pulse 2 delineated in ISO 7637-2.

Test pulse F - Parameters

U_p	13.5 V
U_s	150 V
t_r	1 us
t_d	50 us
t_1	200 –500 ms
R_i	4 ohms

Waveform voltage begins and ends at Up

16. EMC-CS-2009:2010 PULSE#F1

16.1. Pulse F1 simulates the interruption of a current through an inductance switched in series with the DUT. The test pulse is equivalent to Test Pulse 2a delineated in ISO 7637-2. Application of this test pulse is limited only for power supply circuits and only for components required to meet the ESA requirements of European directive 72/245/EEC.

Fig.16-1

Pulse F1 - Parameters

U_p	13.5 V
U_s	37 V
t_r	10 (-0.5 / +0) us
t_d	50 us
t_1	0.2 - 5 s
R_i	2 ohms

Waveform voltage begins and ends at Up

Parameters listed are for open circuit conditions.

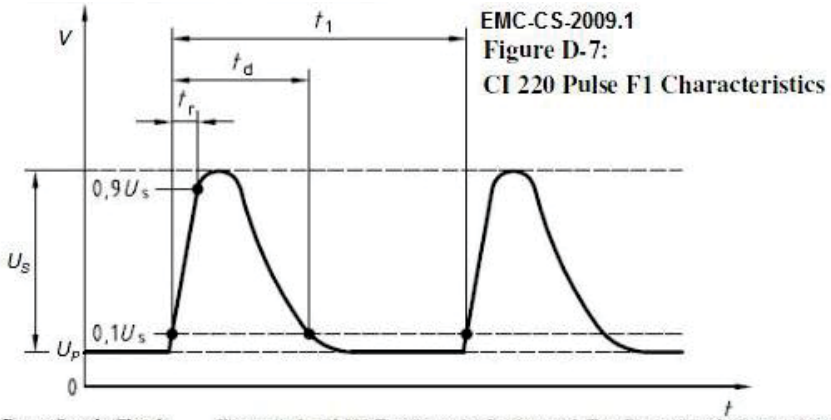


Figure 16-1: CI 220 Test Setup for Devices with a Single Power Supply Circuit

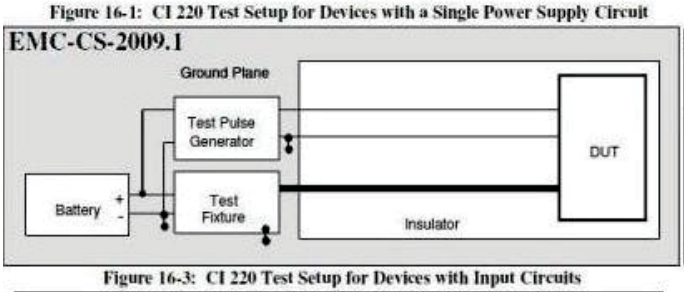


Figure 16-2: CI 220 Test Setup for Devices with Two Power Supply Connections

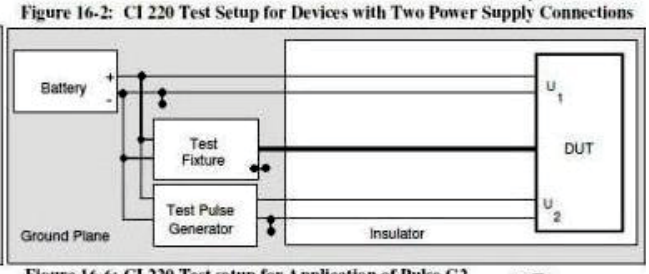


Figure 16-3: CI 220 Test Setup for Devices with Input Circuits

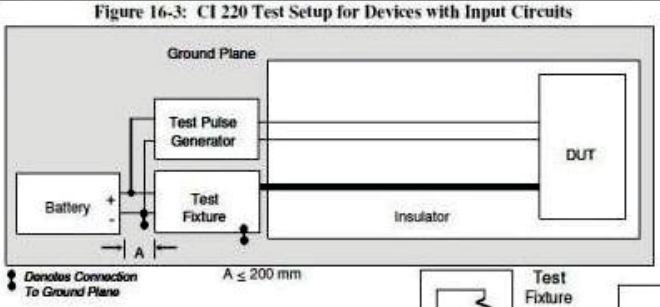


Figure 16-6: CI 220 Test setup for Application of Pulse G2

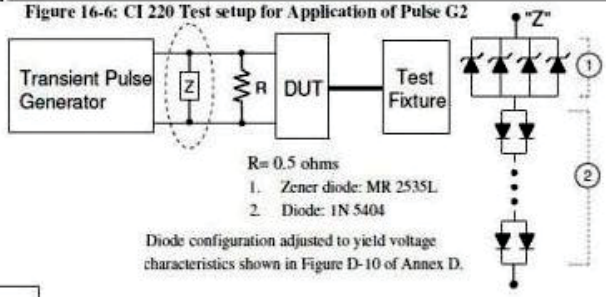


Figure 16-4: CI 220 Test Setup Detail (Input Circuits with Remote External Pull-Up Resistor)

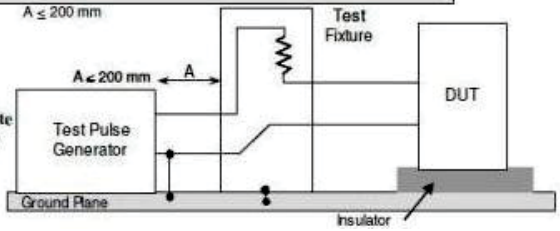
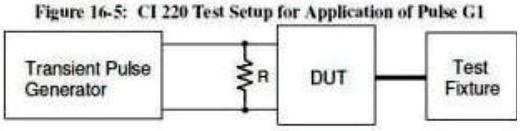


Figure 16-5: CI 220 Test Setup for Application of Pulse G1



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IMMUNITY TO TRANSIENTS ON POWER LINES
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17. GMW3097:2006 PULSE #2A & #7

17.1. GMW3097:2006 3.5.2 CI, Transients on Power Lines applies to battery+ (B+) and switched battery lines (e.g. Ignition, Accessory). It also applies to I/O lines that are connected to an inductive load, where that load is fed by B+ or switched battery. The test pulses shall be applied to B+, each switched battery line and I/O lines fed by either B+ or switched battery separately. In addition, B+ and switched battery lines and I/O lines fed by either B+ or switched battery shall be tested simultaneously.

17.2. • Perform the test using pulses 1, 2a, 2b, 3a, 3b, and 4 in accordance with ISO 7637-2.
• Pulse 1 and 2b are only applicable to switched battery lines.

17.3. Test Pulse 7 (Negative Polarity), Simulation of Wiper Motor Switching Transient: Use the test setup in Figure 4 with the following specifications:
• Use ISO pulse 2a with negative polarity.
• The supply voltage is not switched off during application of the pulse.

Fig.17-1

GMW3097:2006 Table 18: Requirements Levels for the Immunity to Transients on Power Lines

Pulse No.	Level	Minimum Number of Pulses or Application Time	Pulse Cycle Time (min.) default	Pulse Cycle Time (max.)	Comments
1	-150 Vpeak	500 pulses	0.5 s Note 1	5 s	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 Vpeak	500 pulses	0.5 s	5 s	2Ω transient generator internal source impedance
2b	+10 Vpeak	10 pulses	0.5 s Note 1	5 s	There shall be 10 pulses, beginning at 200 ms pulse width, then increasing pulse width by 200 ms steps until 2000 ms is achieved
3a	-200 Vpeak	10 minutes	90 ms	110 ms	Injection level established into a 50 ohm load (as opposed to the open-circuit measurement as specified in ISO 7637-2)
3b	+100 Vpeak	10 minutes	90 ms	110 ms	Injection level established into a 50 ohm load (as opposed to the open-circuit measurement as specified in ISO 7637-2)
4	See Table 19	1 pulse of each severity level	0.5 s	15 s	Voltage levels and Performance Criterion for Pulse 4 (crank pulse) see Table 19.
5b	(34 +0/-1) Vpeak	10 pulses	15 s	2 min	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, Ri=2 Ω
7	-50 Vpeak	500 pulses	0.5 s	5 s	2 Ω transient generator internal source impedance

Note 1: the minimum time must be long enough for the DUT's return to normal operation.

Table 16: Open Circuit Load Dump Pulse Parameters Specifications

Parameter	Unsuppressed	Suppressed
Transient Amplitude	+100 V ± 10%, (U_a + U_s)	(+34 +0/-1) V, (U_a + U_s')
t_d	400 ms ± 30%	400 ms ± 30%
t_r	≤ 10 ms	≤ 10 ms

Table 17: Two Ohm Loaded Load Dump Voltage Pulse Parameter Specifications

Parameter	Suppressed
U_a + U_s'	(+34 +0/-1) V

Figure 4: Setup for Pulse 7 (Simulation of Wiper Motor Switching Transient)

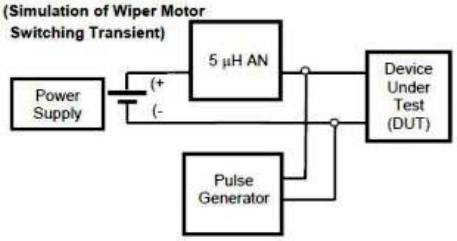


Table 19: Requirements Levels for the Immunity to Pulse 4: Crank Pulse

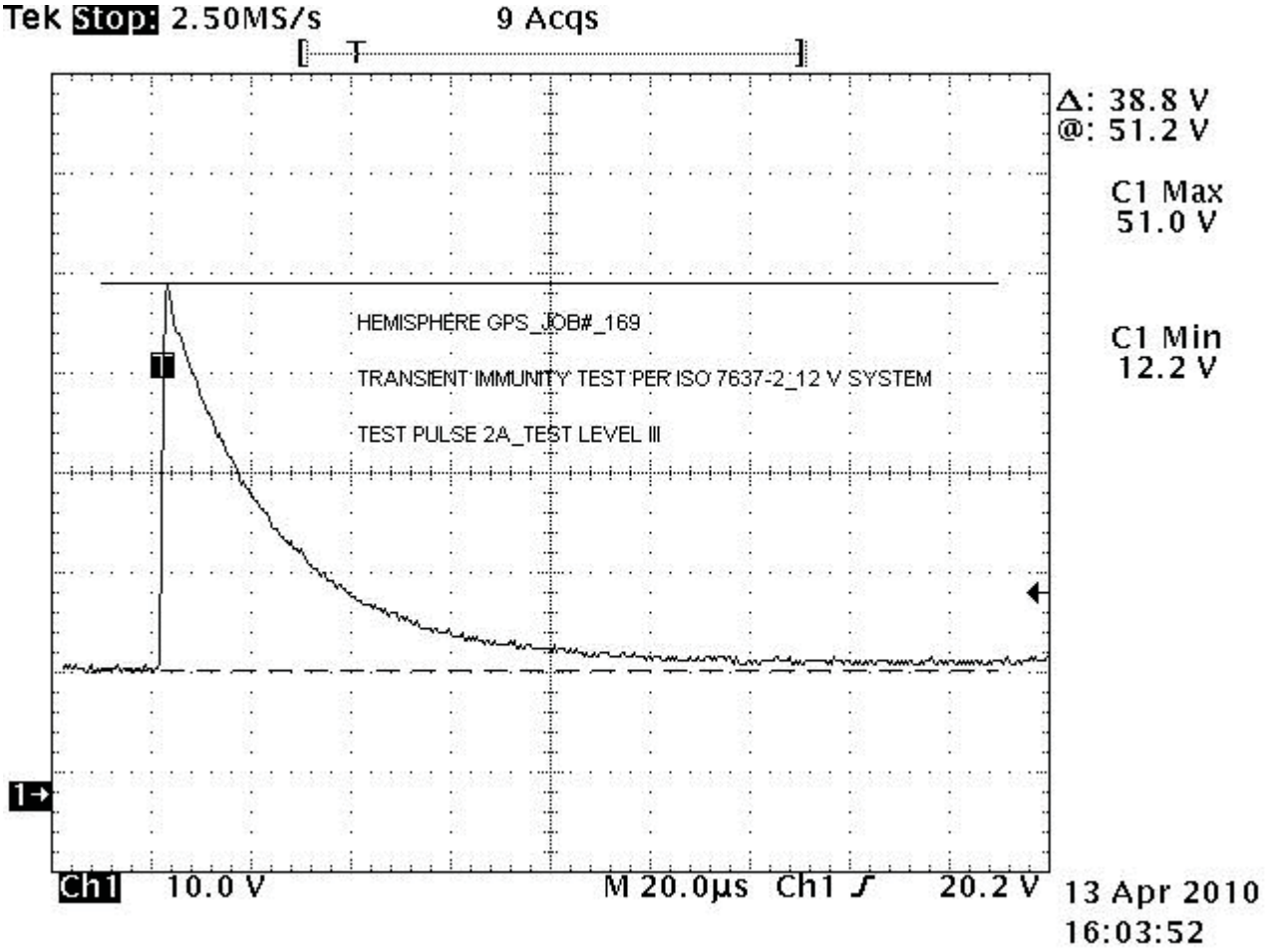
Pulse Severity	U_s Note 1	U_a Note 1	t_6 Note 1	t_{11} Note 1	Performance Criterion
I	4 V	2.5V	1 s	40 ms	One or more functions of the DUT can go beyond specified tolerance as long as all functions automatically return within normal limits after the exposure is removed. Memory functions and functions 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_{10}, t_6 and t_7 as defined in ISO 7637-2. Default value for t_7 shall be 15 ms.
Default value for t_6 shall be 50 ms. All severity levels shall be tested.
Note 1: As defined in ISO 7637-2.

18. REPORT

18.1. Report pulse parameters, severity level, and DUT FPSC response. Include pulse verification waveform (no load, U_A = 13.5 ± 0.5 V) acquired prior to test and test setup pictures, order of injection for each of the waveform amplitudes, number (repetitions) of the pulse applied, pulse period (interval between pulses), any deviation from a standard pulse waveform, point of application of pulse (pin number, letter, or name), exact characteristics of any disturbance during injection of the pulse.

Fig.18-1



Tbl.18-1

	Parameter	12V system	Tolerance	
1.	U_s	38.8 V	+/- 10%	
2.	R_i	2 Ω		
3.	t_d	0.05 ms	+/- 10 us	
4.	t_r	1 us	1 (+0/-0.5) us	
5.	t_1	0.2 s	0.2 s to 5 s	per test plan

19. PROFICIENCY TESTING

19.1. Follow instructions and scheduler provided in LMS011 EMC LAB PROFICIENCY TESTING PROGRAM and ISO-7637-2:2004 Annex-D (Test pulse generator verification procedure).

19.2. U_A = 0V.

Tbl.19-1

	Pulse Verification	U_s	t_r	t_d
1.	Pulse 2a - No load (12/24 V system)	+ 50 V ± 5 V	1 (+0/– 0,5) µs	50 µs ± 10 µs
2.	Pulse 2a - 2 Ω load (12/24 V system)	+ 25 V ± 5 V	-	12 µs ± 2,4 µ
3.	Pulse 2b - No load and 0,5 Ω load	+ 10 V ± 1 V (12 V system)	1 ms ± 0,5 ms	2 s ± 0,4 s
4.	Pulse 2b - No load and 0,5 Ω load	+ 20 V ± 2 V (24 V system)	1 ms ± 0,5 ms	2 s ± 0,4 s

20. TRENDS

20.1. Follow instruction provided in 721179 EMC LAB, TEST REPORTS DATABASE and 721186 EMC LAB, TRENDS AND STATISTICS.

21. DEFINITIONS

21.1. Use definitions per ISO 7637-1.

21.2. FPSC = Function Performance Status Classification

REFERENCES

LMS007			*EMC LAB, EQUIPMENT CONTROL*
LMS011			*EMC LAB, PROFICIENCY TESTING PROGRAM*
201707			*EMC LAB, APPROVED EQUIPMENT SUPPLERS LIST*
201711			*EMC LAB, EQUIPMENT INVENTORY*
201728			*EMC LAB, APPROVED CALIBRATION SUPPLIERS LIST*
201709			*EMC LAB, TEST EQUIPMENT COMPETENCY MATRIX*
201705			*EMC LAB, COMPETENCY MATRIX*
201696			*INTERNAL TEST REQUEST FORM*
900712			*EMC LAB LABELS*
721179			*EMC LAB, TEST REPORTS DATABASE*
721186			*EMC LAB, TRENDS AND STATISTICS*
201724			*CALIBRATION SUPPLIER EVALUATION FORM*
ISO 7637-1	2-nd Ed	Mar 15, 2002	*Road vehicles - Electrical disturbances from conduction and coupling - Part 1: Definitions and general considerations*
ISO 7637-2	2-nd Ed	Jun 15, 2004	*Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*
DC-10614	B	Dec 1, 2005	*EMC Performance Requirements --- Components*
DC-11224	A	Jun 1, 2007	*EMC Performance Requirements --- Components*
CS-11809	A	May 29, 2009	*ELECTRICAL AND EMC PERFORMANCE REQUIREMENTS - E/E COMPONENTS*
CS-11979	A	Apr 13, 2010	*CHRYSLER/FIATELECTRICAL AND EMC PERFORMANCE REQUIREMENTS - E/E COMPONENTS*
ES-XW7T-1A278-AC & corrections	AC	Oct 10, 2003	*Component and Subsystem Electromagnetic Compatibility, Worldwide Requirements and Test Procedures*
EMC-CS-2009.1	1	Feb 11, 2010	*Electromagnetic Compatibility Specification For Electrical/Electronic Components and Subsystems*
SAE J1113-11		Jun 2007	*Immunity to Conducted Transients on Power Leads*

REVISION CHANGES

Dec 14, 2009	A	Release		Christian Rosu
Apr 16, 2010	B	Updated references & CS-11979 addition		Christian Rosu

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IMMUNITY TO TRANSIENTS ON POWER LINES
PULSE #2A TEST PROCEDURE

END-USER FEEDBACK

○ very satisfied ○ satisfied ○ neutral ○ dissatisfied ○ very dissatisfied

Please rate your overall satisfaction with this LMS document and input your suggestions or comments.
Your opinion is very important for us.

Survey Date