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IMMUNITY TO TRANSIENTS ON POWER LINES PULSE #1 TEST PROCEDURE

ISO-7637-2:2004 & 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 1 (12V)	
Rise time tr (10 - 90%)	1µs + 0% // - 50%
Pulse duration td (10 - 10%)	2ms ± 10%
Internal resistor	10Ω ± 10%
ISO Pulse 1 (24V)	
Rise time tr (10 - 90%)	3µs + 0% // - 50%
Pulse duration td (10 - 10%)	1ms ± 10%
Internal resistor	50Ω ± 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	VDS200B2	EMTEST	2171
4.	Oscilloscope	TDS784A	TEKTRONIX	2161
5.	Voltage probe	CNA200B2	TEKTRONIX	2167
6.	ISMISO software	Rev 4.24	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.

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. The OEM specific EMC test plan template is downloadable from EMCLAB subfolder under DOCUMENT CONTROL network shared folder.

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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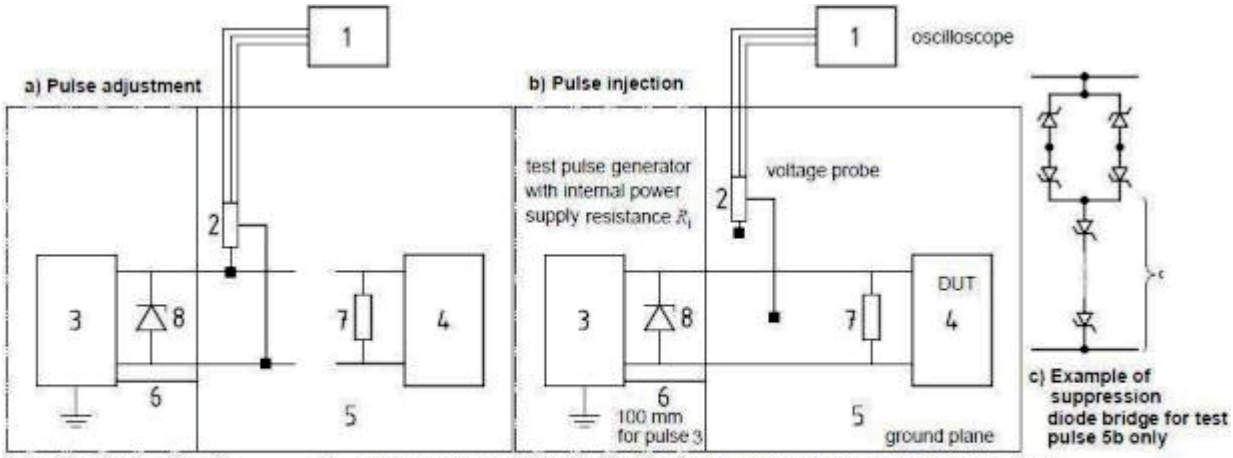
9. TEST SETUP

9.1. Prior to start testing all samples must be labeled per 900712 EMC LAB LABELS.

9.2. A 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



7 optional resistor (R_v) [a]
8 optional diode bridge [b]

a For simulation of vehicle system loading for load dump test pulses 5a and 5b only. If used, the value of R_v shall be specified in the test plan (typical value 0,7 Ω to 40 Ω).
b For simulation of load dump waveform for alternator with centralized load dump suppression for pulse 5b only
c Add forward biased diodes as required to achieve max. open-circuit (suppressed) voltage.

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10. ISO-7637-2:2004 PULSE#1

10.1. This test is a simulation of transients due to supply disconnection from inductive loads. It is applicable to DUTs which, as used in the vehicle, remain connected directly in parallel with an inductive load (see ISO-7637-2:2004 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.

Fig.10-1

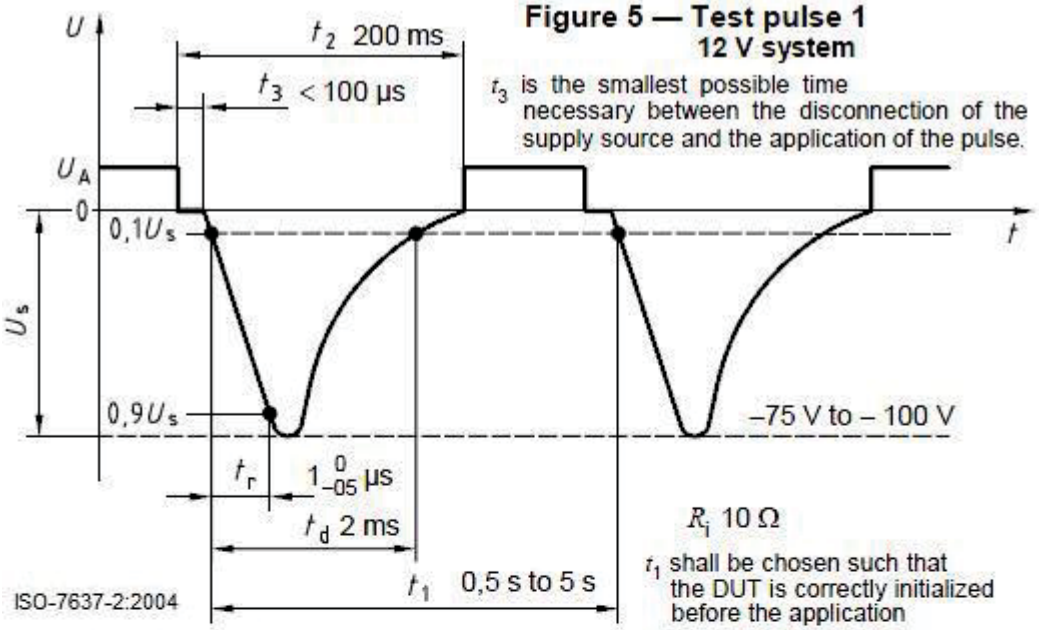

Figure 5 — Test pulse 1
12 V system

t_3 is the smallest possible time necessary between the disconnection of the supply source and the application of the pulse.

ISO-7637-2:2004

Table 3 — Parameters for test pulse 1

Parameter	12 V system	24 V system
U_s	–75 V to – 100 V	– 450 V to – 600 V
R_i	10 Ω	50 Ω
t_d	2 ms	1 ms
t_r	$1^{\ 0}_{-05}$ µs	$3^{\ 0}_{-1,5}$ µs
t_1 [a]	0,5 s to 5 s	
t_2	200 ms	
t_3 [b]	< 100 µs	

[a] t_1 shall be chosen such that the DUT is correctly initialized before the application of the next pulse.

[b] t_3 is the smallest possible time necessary between the disconnection of the supply source and the application of the pulse.

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11. DC10614:2005 PULSE#1

11.1. 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.

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 DC-10614

Transient Pulse	Performance Status Group A	Performance Status Groups B, C and D
Pulse #1	II	II

Table 31: Test Pulse 1 - Parameters

Parameters	12 V System	24 V System	42 V System
U_p in V	13.5	27	42
U_s in V	-100	-300	-100
t_r in µs	1	1	1
t_d in ms	2	2	2
t_1 in s	5	5	5
t_2 in ms	200	200	200
t_3 in µs	≤ 100	≤ 100	≤ 100
R_i in ohms	10	10	10
Test duration in h	1	1	1

12. DC11224:2007 PULSE#1

12.1. In addition to ISO-7637-2 DC11224 requires pulse#1b, shows 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.

Fig.12-1

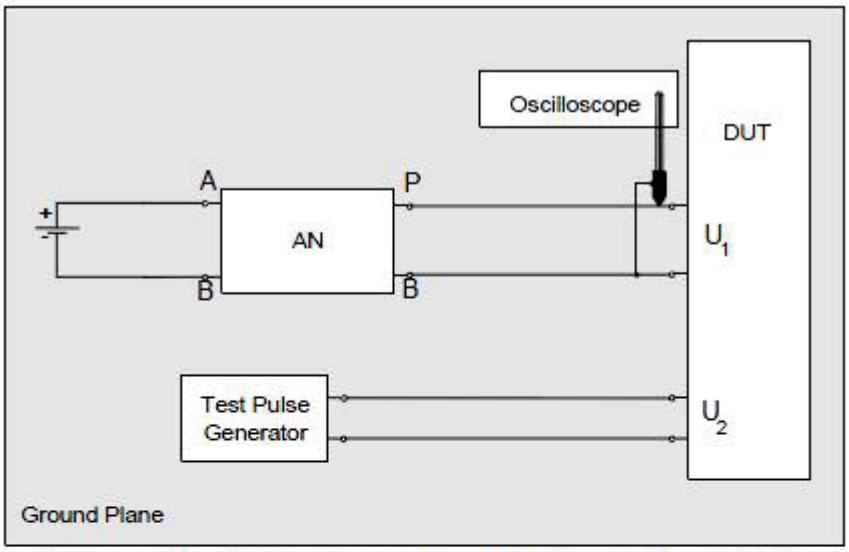
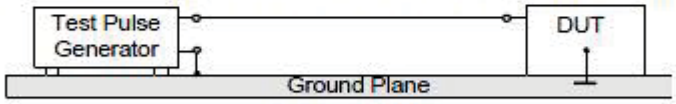
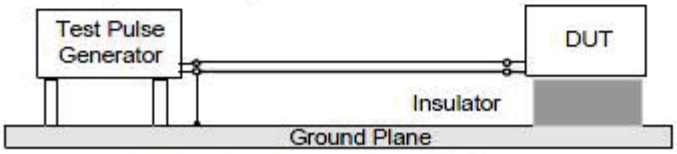


Figure 19: Test Setup for Devices with Two Voltage Supply Connections



a) DUT with Asymmetrical Connection



b) DUT with Symmetrical Connection

Figure 20: Connection of the DUT DC-11224

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13. CS-11809:2009 PULSE#1

13.1. In addition to ISO-7637-2 transient immunity pulses Chrysler requires Pulse#1b, specifies that 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.

13.2. Note the change from DC-11224: **Level 1** (non-critical functions) and **Level 2** (critical functions).

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.

FIGURE 13: TEST PULSE 1B

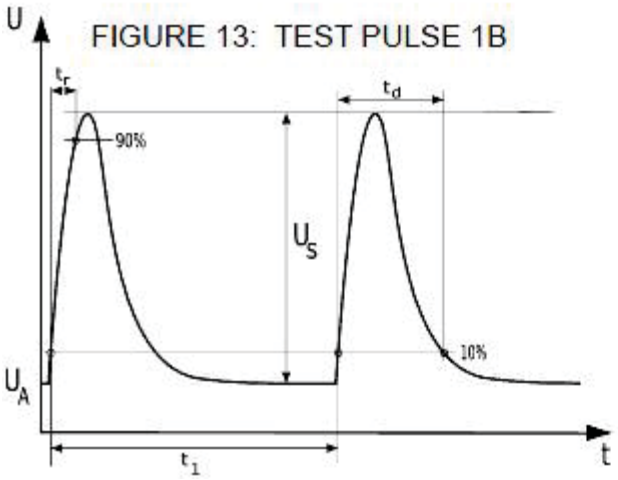

TABLE 21: PARAMETERS OF TEST PULSE 1b

Parameters	12 V System	24 V System
U_A [V]	13.5	27
U_s[V]	30	50
t_r [µs]	1	1
t_d [ms]	2	2
t_1 [s]	5	5
R_i [Ω]	10	10

14. CS-11979:2010 PULSE#A

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

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.

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15. EMC-CS-2009:2010 PULSE #E

15.1. FORD Pulse "E" represents the voltage transient produced during switching of a higher current (> 5 ampere) inductive load that shares the same circuit with the DUT. The test pulse is equivalent to Test Pulse 1 delineated in ISO 7637-2. Pulse E is similar to Pulse A-1 except that it occurs when higher current loads (> 5 amperes) share the same circuit as the inductive load. The pulse can also occur on circuits with high capacitive loads (> 2uf)

Fig.15-1

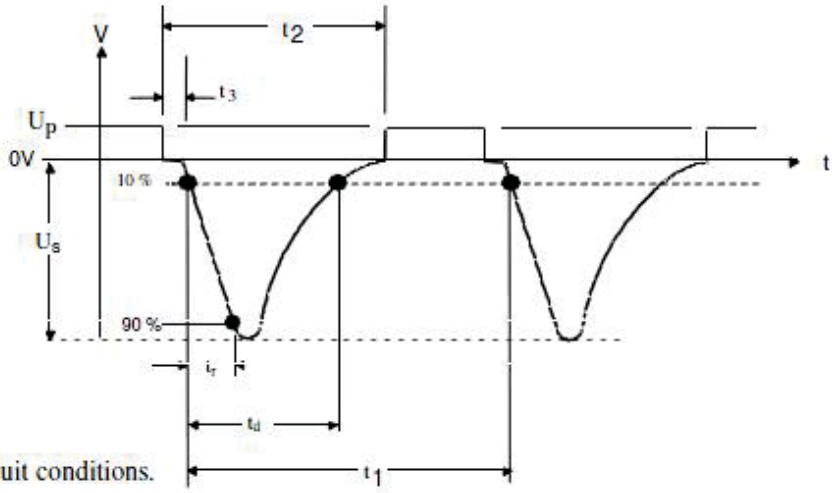
EMC-CS-2009.1 **Figure D-6: CI 220 Pulse E Characteristics**

Pulse E - Parameters

U_p	13.5 V
U_s	-100 V
t_r	1 us
t_d	2 ms
t_1	5 s
t_2	200 ms
t_3	≤ 100 us
R_i	10 ohms

Waveform voltage begins and ends at **Up**

Parameters listed are for open circuit conditions.



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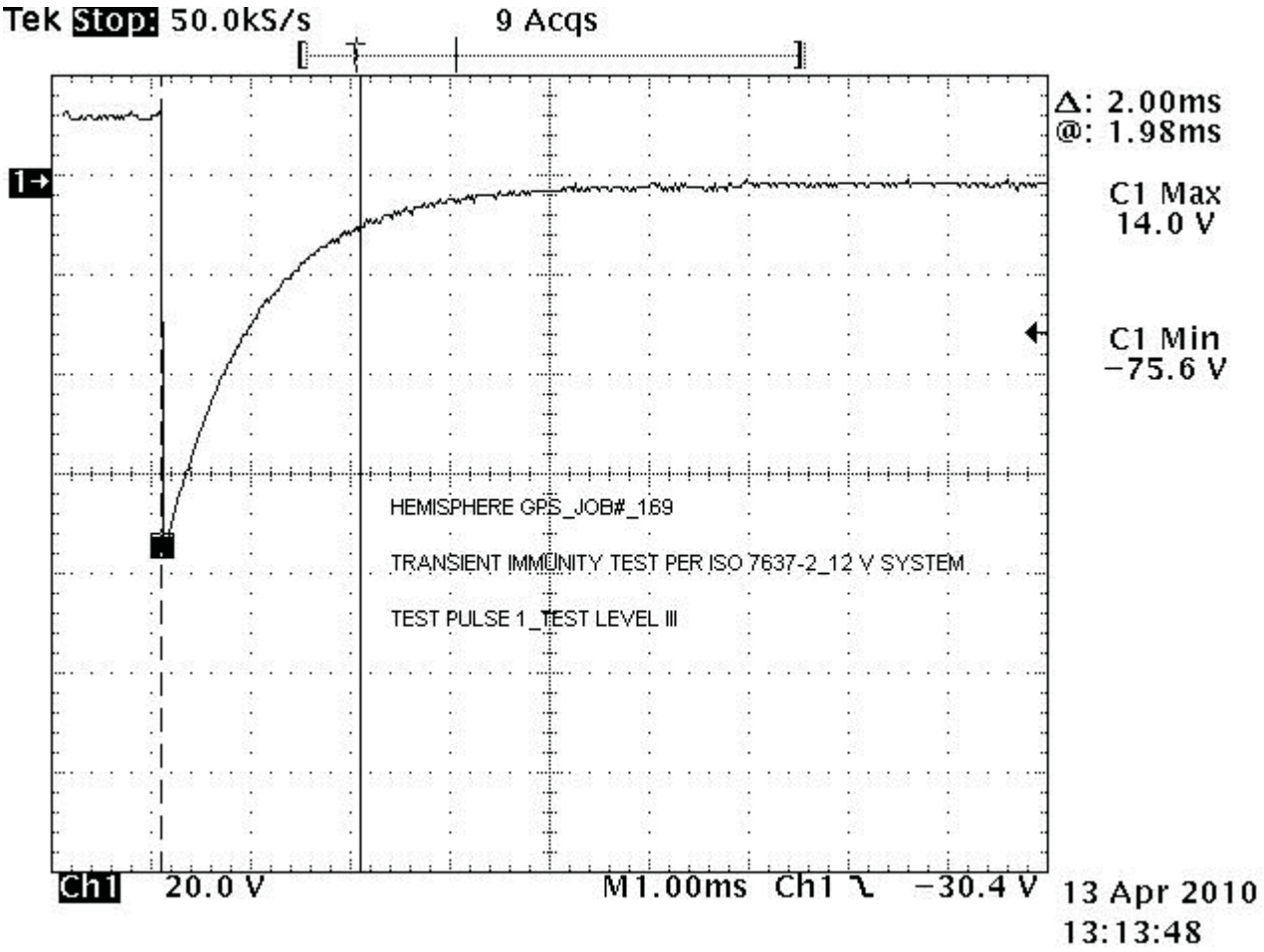
16. REPORT

16.1. 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.16-1



Tbl.16-1

	Parameter	12V system	Tolerance
1.	U_s	-75.6V	+/- 10%
2.	R_i	10 Ω	
3.	t_d	2 ms	+/- 400 us
4.	t_r	1 us	1 (+0/-0.5) us
5.	t_1	0.5 s	0.5 s to 5s
6.	t_2	200 ms	
7.	t_3	< 100 us	

17. PROFICIENCY TESTING

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

17.2. U_A = 0V.

Tbl.17-1

	Pulse Verification	U_s	t_r	t_d
1.	Pulse #1 No load (12 V system)	–100 V ± 10 V	1 (+0/– 0.5) µs	2 000 µs ± 400 µs
2.	Pulse #1 10 Ω load (12 V system)	– 50 V ± 10 V	-	1 500 µs ± 300 µs
3.	Pulse #1 No load (24 V system)	– 600 V ± 60 V	3 (+0/– 1.5) µs	1 000 µs ± 200 µs
4.	Pulse #1 50 Ω load (24 V system)	– 300 V ± 30 V	-	1 000 µs ± 200 µs

18. TRENDS

18.1. Follow instruction provided in 721179 EMC LAB, TEST REPORTS DATABASE and 721186 EMC LAB, TRENDS AND STATISTICS. Perform trends on t_d and t_r.

19. DEFINITIONS

19.1. Use definitions per ISO 7637-1.

19.2. 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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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