EMC LABORATORY
213 Harry Walker Parkway South
NEWMARKET, ON, L3Y 8T3
Tel: 905-952-1242

IMMUNITY TO TRANSIENTS ON POWER LINES PULSE #4 TEST PROCEDURE

ISO-7637-2:2004 PULSE #4 & OEM EQUIVALENT

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

Technical data	VDS 200B2
Output voltage	0V – 60V
Output current continous	0A – 50A
Output current peak	100A for max 500ms
Source impedance	Zq = < 10mΩ
Bandwidth	DC to 30kHz for Vpp max 12V
Test Routines for arbitrary waves	
DC source	60V / 15A//30A//50A//100A//150A//200A
Functions	1. Sine Wave
	2. Jump Start
	3. Extern
	4. GM 9105P Pulse 4
	5. Drop and Jump pulse
Standard Test Routines	1. ISO 7637
	2. ISO 16750-2
	3. Jaso Test 1

Tbl.4-1

Idx	Equipment Description	Model	Maker	INV#
1.	Coupling Network	CNA200B2	EMTEST	2167
2.	Pulse #2b & #4 Voltage Dump Simulator	VDS200B2	EMTEST	2171
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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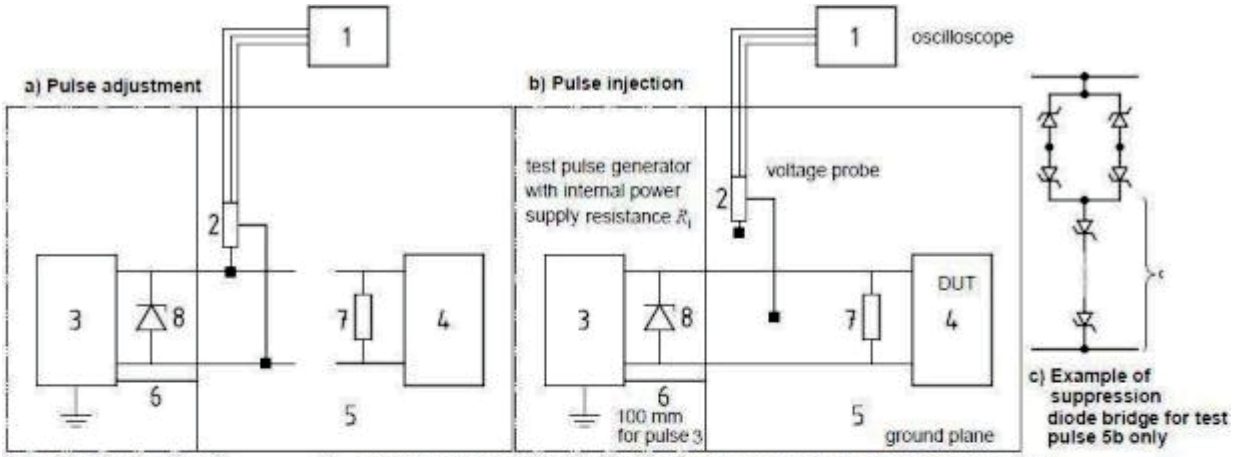
9. TEST SETUP

9.1. Prior to start testing verify that all samples are 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).

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).

9.3. The EMC test operator must ensure the testing is carried out based on the latest OEM specifications. In case of conflict the following documents may over-ride this procedure in order:
1) The latest revision of OEM specification (including corrections).
2) OEM approved EMC test plan, which can over-ride the OEM specification.

Fig.9-1



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10. ISO-7637-2:2004 PULSE #4

10.1. Pulse #4 simulates supply voltage reduction caused by energizing the starter-motor circuits of internal combustion engines, excluding spikes associated with starting (see ISO-7637-2:2004 Annex F).

Fig.10-1

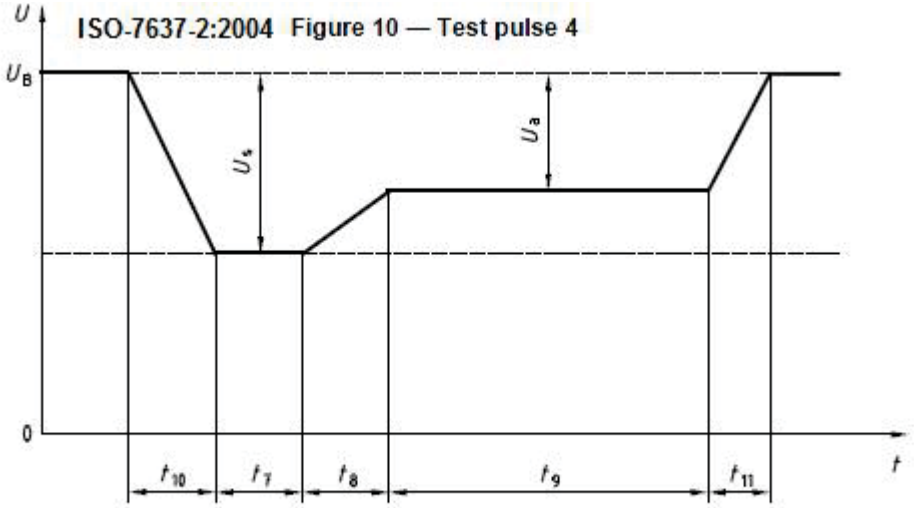

Table 8 — Parameters for test pulse 4

Parameter	12 V system	24 V system
U_s	– 6 V to – 7 V	– 12 V to – 16 V
U_a	– 2,5 V to – 6 V with $\lvert U_a \rvert \leqslant \lvert U_s \rvert$	– 5 V to – 12 V with $\lvert U_a \rvert \leqslant \lvert U_s \rvert$
R_i	0 Ω to 0,02 Ω	
t_7	15 ms to 40 ms [a]	50 ms to 100 ms [a]
t_8	$\leqslant$ 50 ms	
t_9	0,5 s to 20 s [a]	
t_{10}	5 ms	10 ms
t_{11}	5 ms to 100 ms [b]	10 ms to 100 ms [c]

[a] The value used should be agreed between the vehicle manufacturer and the equipment supplier to suit the proposed application.

[b] t_{11} = 5 ms is typical of the case when engine starts at the end of the cranking period, while t_{11} = 100 ms is typical of the case when the engine does not start.

[c] t_{11} = 10 ms is typical of the case when engine starts at the end of the cranking period, while t_{11} = 100 ms is typical of the case when the engine does not start.

11. DC10614:2005 (ISO-7637-2:2004 PULSES #4 NOT REQUIRED)

11.1. N/A

12. DC11224:2007 (ISO-7637-2:2004 PULSE #4 NOT REQUIRED)

12.1. N/A

13. CS-11809:2009 (ISO-7637-2:2004 PULSE #4 NOT REQUIRED)

13.1. N/A

14. CS-11979:2010 (ISO-7637-2:2004 PULSE #4 NOT REQUIRED)

14.1. N/A

15. ES-XW7T-1A278-AC:2003 (ISO-7637-2:2004 PULSE #4 NOT REQUIRED)

15.1. N/A

16. EMC-CS-2009:2010 (ISO-7637-2:2004 PULSE #4 NOT REQUIRED)

16.1. N/A

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17. DC-10615:2007 COLD & WARM CRANKING PULSES

17.1. ENGINE COLD CRANKING: During starting (cranking of the engine) the battery voltage will fall to a low voltage for a short time period and then rise slightly. Most components will be briefly energized just prior to cranking and some will be deactivated during the crank and subsequently re-energized after the start when the engine is running. If the DUT has stored initialization data or memory data in volatile storage then initialize and/or store data before beginning the test. With the run only and accessory lines at 0 V, subject the DUT to the Engine Cranking Test Pulse in Figure 2 on battery, run/start and start lines simultaneously. The DUT operation shall be monitored during the test. Return all DUT supply voltage lines to V_B and confirm normal functioning after each test. This is one (1) cycle; five (5) test cycles are required.

17.2. ENGINE WARM CRANKING: This test simulates the power supply conditions in case of a warm cranking procedure coming from an engine stop situation and a battery, current is drawn from. The Voltage does not drop as deep as in the Cold cranking procedure, also the pulse does not last that long. The duration of the dip from start until the voltage returns into the range above 9 V is 200 ms, but the voltage keeps rising linearly until VWC start = 10 V are reached. After another t_8 = 2 s at VWC start the the voltage returns to the origin of 11 V. Figure 3 shows one pulse, 5 pulses must be passed, a minimum of 2 min apart.

Fig.17-1

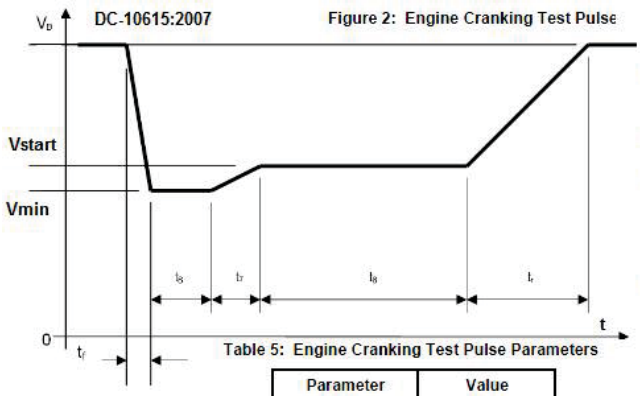

Table 5: Engine Cranking Test Pulse Parameters

Parameter	Value
V_B in V	12.6
V_{start} in V	6.5
V_{min} in V	5
t_f in ms	5
t_6 in ms	15
t_7 in ms	50
t_8 in s	10
t_r in ms	100
R_i in Ω	0.01
Test pulses	5

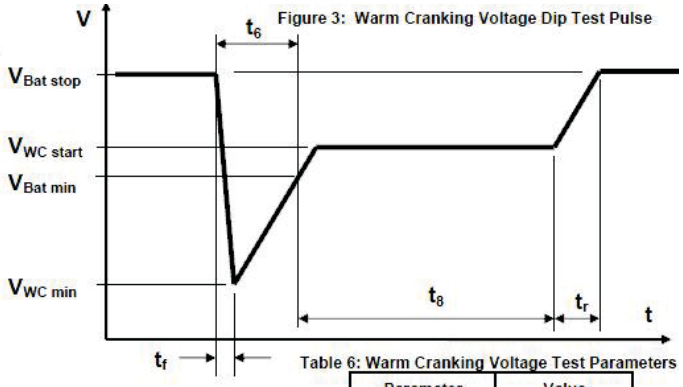

Table 6: Warm Cranking Voltage Test Parameters

Parameter	Value
$V_{Bat\ stop}$ in V	11
$V_{WC\ start}$ in V	10
$V_{Bat\ min}$ in V	9
$V_{WC\ min}$ in V	7
t_f in ms	1
t_5 in ms	200
t_8 in s	2
t_r in ms	100
R_i in Ω	0.01
Test pulses	5

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18. GMW3097:2006 PULSE #4

18.1. 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.

Fig.18-1 **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)

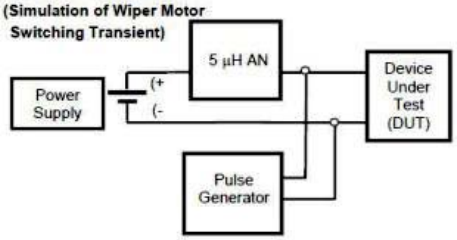

Table 19: Requirements Levels for the Immunity to Pulse 4: Crank Pulse

Pulse Severity	U_s Note 1	U_a Note 1	t_9 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_9 and t_7 as defined in ISO 7637-2. Default value for t_7 shall be 15 ms.
Default value for t_9 shall be 50 ms. All severity levels shall be tested.
Note 1: As defined in ISO 7637-2.

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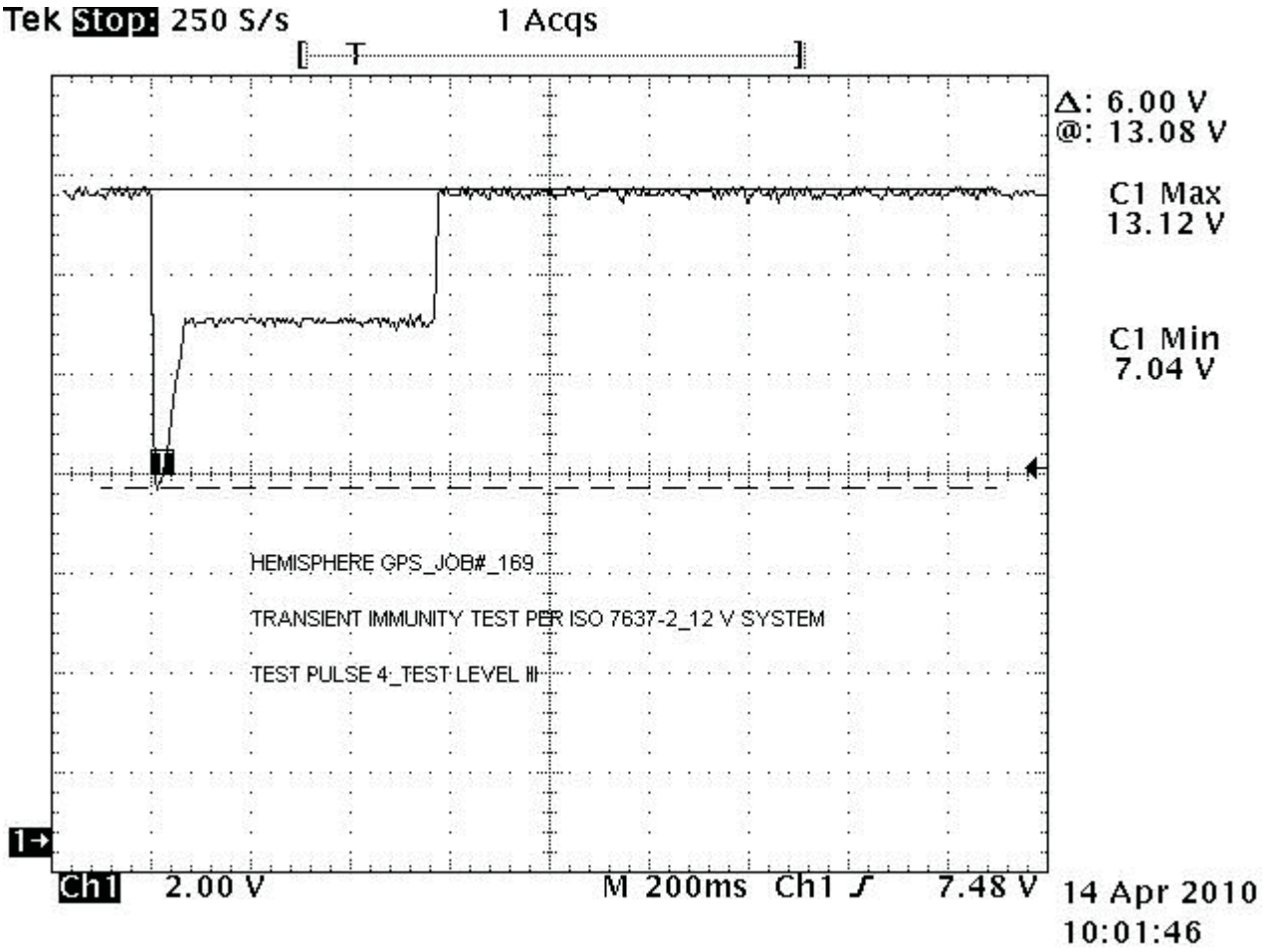
19. REPORT

19.1. 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.19-1



20. PROFICIENCY TESTING

20.1. Follow instructions and scheduler provided in LMS011 EMC LAB PROFICIENCY TESTING PROGRAM and ISO-7637-2:2004 Annex-D (Test pulse generator verification procedure). ISO-7637-2:2004 does not provide pulse #4 verification metod. For PT use the waveform aquired prior to pulse#4 application.

20.2. U_A = 0V.

21. TRENDS

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

22. DEFINITIONS

22.1. Use definitions per ISO 7637-1.

22.2. 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*
DC-10615	E	Dec 4, 2007	*Electrical System Performance Requirements for Electrical and Electronic Components*

REVISION CHANGES

Dec 14, 2009	A	Release		Christian Rosu
Apr 16, 2010	B	Updated references & CS-11979 addition		Christian Rosu
Apr 22, 2010	C	Update Test Setup section and typos.		Christian Rosu

FLEXTRONICS AUTOMOTIVE

Digitally signed by Christian Rosu
DN: cn=Christian Rosu, o=FLEXTRONICS AUTOMOTIVE INC., ou, email=christian.rosu@ca.flextronics.com, c=US
Date: 2012.12.30 19:13:30 -05'00'

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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