Pulses in Automotive Environments

Based on IEC 61000-4-2 and ISO 7637-3

Presentation for IEEE 802.3ch

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Powered ESD (IEC 61000-4-2)

”Testing and measurement techniques - Electrostatic discharge immunity test”

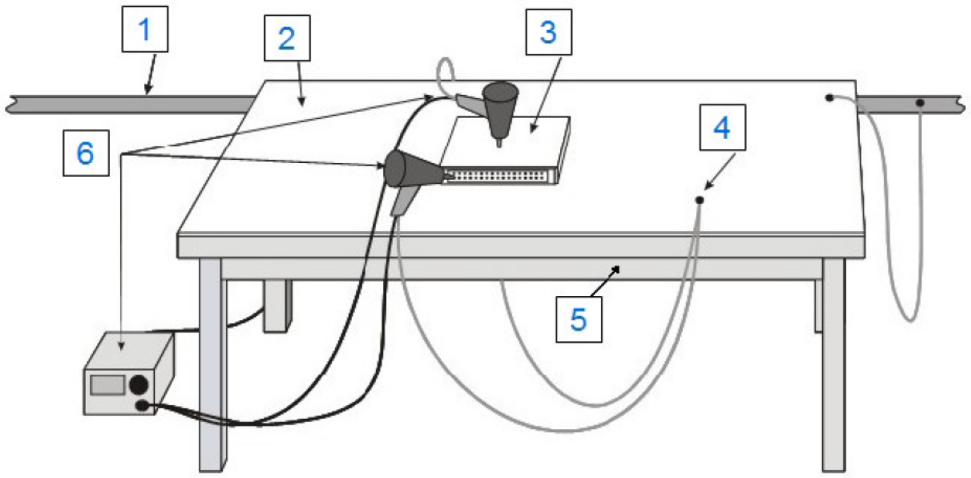
- The IEC 61000 describes test setups and limits for ESD tests (short pulses with high voltage).
- The same type of electrical discharges described in the standard happen during normal operation (typically with a lower voltage)

- During normal operation a discharge directly on the MDI should not be possible (connectors and wires are isolated)
  - Depending on the type of isolation (incl. shielding) the voltage on the MDI interface is much smaller but can still destroy PAM symbols or activate protection diodes or ESD structures.
  - The discharge is not a differential Signal

Powered ESD (IEC 61000-4-2)

	A: Assembly (packaging & handling)	Target: No damage Performed by: Contractor
1	All pins	Contact discharge (3 discharges per test step): ±2 kV, ±4 kV, ±6 kV where discharge network R = 330 Ω and C = 150 pF
2	Housing	A) Discharge point, plastic Air discharge (10 discharges per test step): ±4 kV, ±8 kV, ±15 kV where discharge network R = 330 Ω and C = 150 pF B) Discharge point, metal Contact discharge (5 discharges per test step): ±4 kV, ±8 kV where discharge network R = 330 Ω and C = 150 pF Air discharge (10 discharges per test step): ±15 kV[a)] where discharge network R = 330 Ω and C = 150 pF
	B: System level (laboratory setup)	Target: No malfunction or damage Performed by: Contractor
3	Discharge onto the coupling structure's discharge stations (indirect discharge)	Contact discharge (10 discharges per test step): ±4 kV, ±8 kV, ±15 kV where discharge network R = 330 Ω and C = 330 pF
4	Discharge onto DUT (ECUs, displays, associated controls and peripherals, and interfaces that can be used by the customer, including fuses, etc.) (direct discharge)	A) Discharge point, plastic Air discharge (10 discharges per test step): ±4 kV, ±8 kV, ±15 kV where discharge network R = 330 Ω and C = 330 pF B) Discharge point, metal Contact discharge (10 discharges per test step): ±4 kV, ±8 kV where discharge network R = 330 Ω and C = 330 pF Air discharge (10 discharges per test step): ±15 kV[a)] where discharge network R = 330 Ω and C = 330 pF

a) Additionally, in order to ensure sparkover resistance (e.g., insulated metallic surfaces).



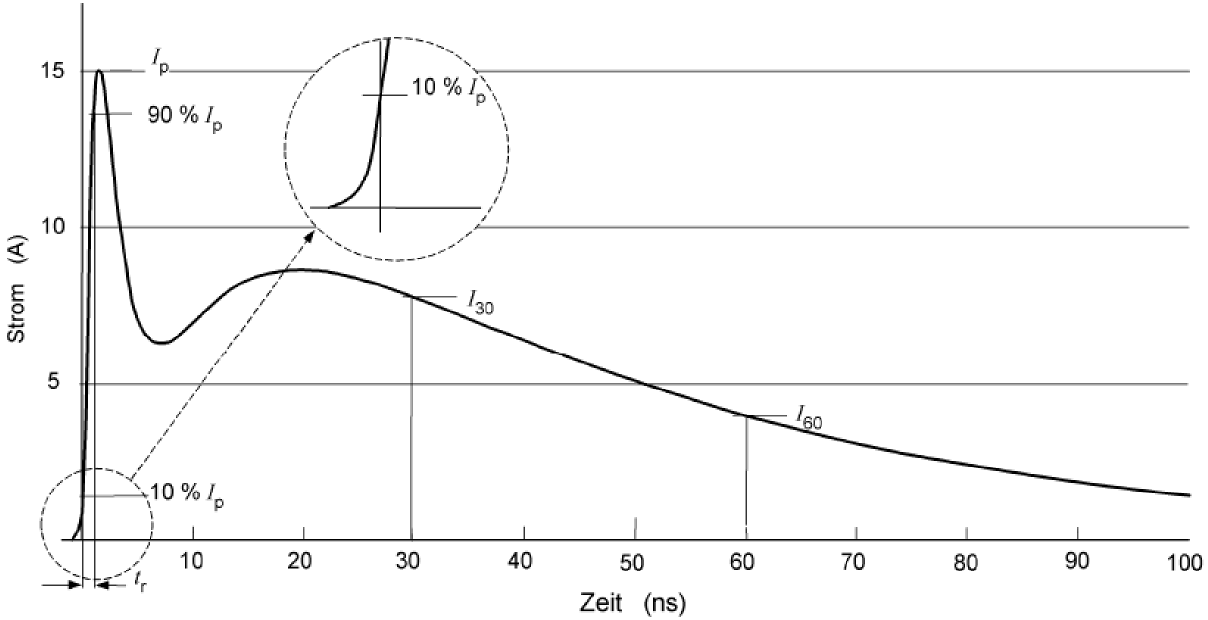
Legend

1 Ground bus
2 Ground plate
3 DUT
4 Ground point
5 Wooden table
6 ESD generator

[source: Volkswagen Group Standard TL81000]

Powered ESD (IEC 61000-4-2)

Test impulse



t_r = 0.8 ns ➔ 1.25 GHz
t_{60} = 60 ns ➔ 16.7 MHz

➔ Short broadband noise signal

Pulses from switching inductive load and relay contact bouncing (ISO 7637-3)

INTERNATIONAL STANDARD — ISO 7637-3:2016(E)

Road vehicles — Electrical disturbances from conduction and coupling —

Part 3:
Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

1 Scope

This part of ISO 7637 defines bench test methods to evaluate the immunity of devices under test (DUTs) to transient pulses coupled to lines other than supply lines. The test pulses simulate both fast and slow transient disturbances caused by the switching of inductive loads and relay contact bounce.

The following three test methods are described in this part of ISO 7637:

— capacitive coupling clamp (CCC) method;

— direct capacitive coupling (DCC) method;

— inductive coupling clamp (ICC) method.

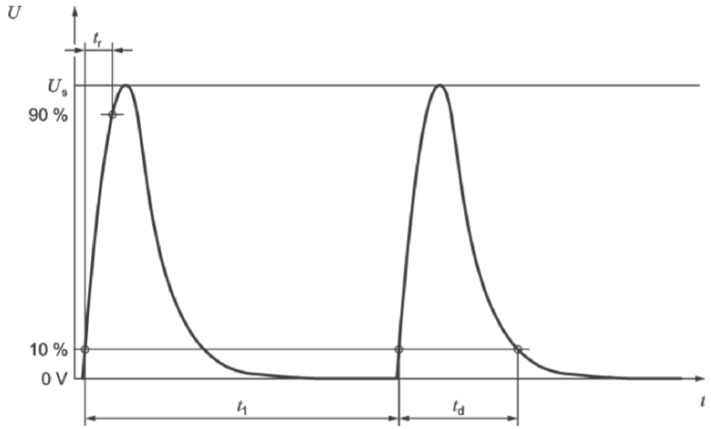
This part of ISO 7637 applies to road vehicles fitted with nominal 12 V or 24 V electrical systems.

[source: ISO 7637-3:2016]

The same type of electrical pulses described in the standard happen during normal operation (typically with a lower voltage)

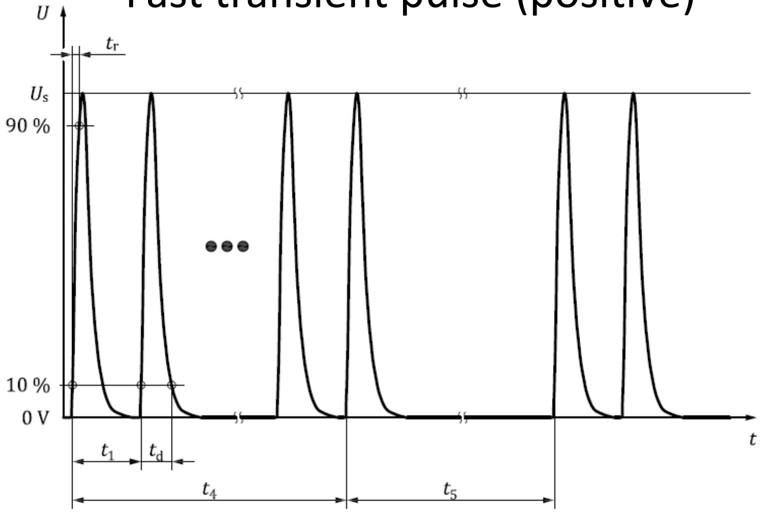
ISO 7637-3 slow and fast transient pulses

Slow transient pulse (positive)



Parameters	
U_s	To be defined in test plan
t_r	$(1^{\ 0}_{-0,5})$ µs
t_d	0,05 ms
t_1	0,2 s to 5 s
R_i	2 Ω

Fast transient pulse (positive)

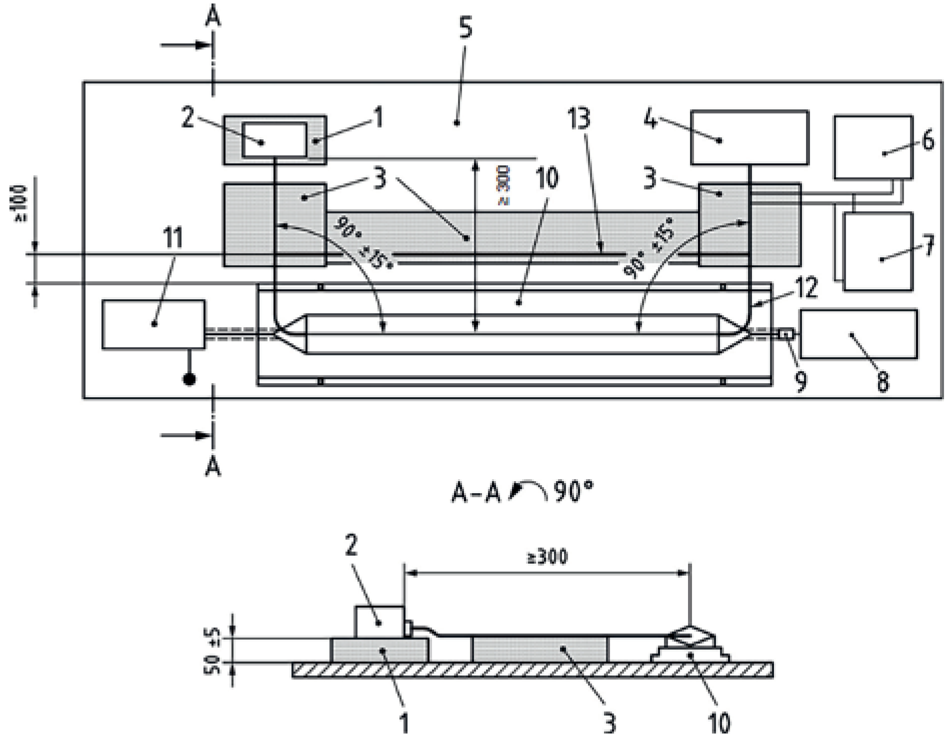


Parameters	12 V system	24 V system
U_s	See Table B.1	See Table B.2
t_r	(5 ± 1,5) ns	(5 ± 1,5) ns
t_d	(0,15 ± 0,045) µs	(0,15 ± 0,045) µs
t_1	100 µs	100 µs
t_4	10 ms	10 ms
t_5	90 ms	90 ms
R_i	50 Ω	50 Ω

[source: ISO 7637-3:2016]

ISO 7637-3 test setup

Test setup for CCC method (Fast transient pulse)

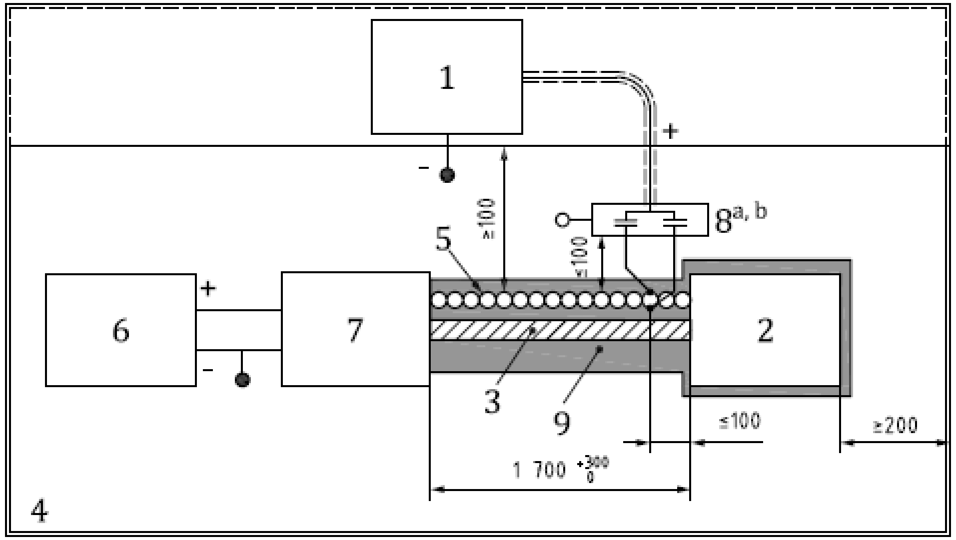


Key

1 insulation support
2 DUT (grounding as specified in test plan)
3 insulating supports for test harness
4 load simulator
5 ground plane
6 power supply
7 battery
8 oscilloscope (50 Ω input)
9 50 Ω attenuator
10 CCC
11 transient pulses generator
12 lines to be tested
13 lines not to be tested

[source: ISO 7637-3:2016]

Test setup for DCC method (Fast transient pulse)



Key

1 transient pulses generator
2 DUT
3 wiring harness
4 ground plane
5 balanced symmetrical lines
6 power supply
7 load simulator
8 high-voltage non-polarized leaded capacitor (see Table 2)
9 50 Ω coaxial cable (length not greater than 500 mm)
10 insulation support with low relative permittivity material ($\varepsilon_r \leq 1{,}4$)
a For fast transient pulses test, the recommended capacitor value is 100 pF.
b The capacitor values are selected to ensure that the communication signals are not disturbed and that the transient pulses can still be coupled to these lines.

Fast transients: 100pF
Slow transients: 0.1 µF

Questions?