RESISTANCE TO TRANSIENT INTERFERENCE AND VOLTAGE CHANGE IN SUPPLY LINES OF OFF-VEHICLE ELECTRICAL AND ELECTRONIC SYSTEMS

Origin: ISO 7637/1 and 7637/2 with modifications

Supervisor: IVECO STD. 19-0201

Manager: IVECO STD. 19-0201

1 PURPOSE

To define equipment and test procedures for off-vehicle testing of resistance to transient interference and voltage change in supply lines for electrical and electronic systems.

2 SUBJECT

This standard applies to equipment installed on vehicles with 12 V and 24 V electrical systems equipped with either ”Diesel” or ”Otto” cycle internal combustion engines.

3 GENERAL TEST CONDITIONS

Tests shall be performed for electronic devices already succesfully submitted to functional tests as specified in general IVECO procurement specification 18-2252 and in appropriate standards.

3.1 **Test environment** (unless otherwise specified)

Ambient:
room of suitable size to house instrumentation and test setup of 2 x 1 m min.

Test environment:
to be free from interference which might adversely affect test results and set to the following parameters:

- Temperature: 23 ± 5 °C-
- Relative humidity: 45 - 70 %.
- Atmospheric pressure: 860 thru 1060 mbars.

Edition	Date	Description of modifications	Group
1	13.09.1989	New.	PEL
9	18.01.2002	Changed paras. 4.3.2 (Table I with relevant references) and para. 6.5.2.	
10	04.04.2003	Supervisor and Manager introduced. Changed paras 4.3.2, 5.7.2 and Table at para. 6.5.2..	
11	01.04.2006	Revised for updating to Technical Advances ISO 7637/1 and ISO 7637/2.	
12	05.04.2007	Table 12 updated.	
13	02.02.2009	Supervisor changed, paras.: 4, 5.1.4, 5.2, 5.2.8 and 7. Updated Manager function and added para. 5.2.8.3.	
14	15.05.2010	Supervisor and Manager changed.	
15	05.07.2010	Supervisor and Manager changed. Changed paras.: 3.2, 4, 5.1.3.3, 5.1.4.1.1, 5.1.4.2.1, 5.1.4.3.1, 5.2, 5.2.6, 5.2.8.1, 5.2.8.2, 7 and References. Added paras.: 5.2.8.4, 5.2.8.5, 5.2.8.6 and 5.2.8.7.	

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3.2 Test voltage

As specified on drawing or on specific Standard of device under test.
For test pulses (**Figures 3 - 4 - 5 - 6 - 7 - 8 - 9 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22**) system voltage or battery voltage are as shown in**Table 1** below:

Table 1

Voltage	For 12 V systems [V]	For 24 V systems [V]
U_A	13.5 ± 0.5	27 ± 1
U_B	12 ± 0.2	24 ± 0.4

Where: U_A system voltage (engine on);
U_B battery voltage (engine off);

4 TEST PULSE LEVEL AND THEIR FUNCTIONAL CLASS

Use test levels shown in **Table 2**. If malfunction is found, test starting from lower ratings up to the value threshold at which it is immune.

Table 2

Type of pulse	N°of pulses and duration of test	Type of function	Test level		Class of acceptability	Description of pulses
			Device power supply			
			12 V	24V		
1 Spike (-)	500	NP	Vs = - 100 V	Vs = - 450 V	C	para. 5.1.4.1
		P	Vs = - 300 V	Vs = - 600 V		
0.05acres Spike (-)	500	NP	Vs = + 50 V	Vs = + 50 V	B	para. 5.1.4.2
		P	Vs = + 100 V	Vs = + 100 V	A	
2b Spike (-)	10	NP	Vs = + 10 V	Vs = + 20 V	B	para. 5.1.4.3
		P	Vs = + 10 V	Vs = + 20 V	A	
3a Burst (-)	30 min.	NP	Vs = - 112 V	Vs = - 150 V	B	para. 5.1.4.4
		P	Vs = - 150 V	Vs = - 200 V	A	
3b Burst (+)	30 min.	NP	Vs = + 75 V	Vs = + 150 V	B	para. 5.1.4.4

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Type of pulse	N°of pulses and duration of test	Type of function	Test level		Class of acceptability	Description of pulses
			Device power supply			
			12 V	24V		
3b Burst (+)	30 min.	P	Vs = + 100 V	Vs = + 200 V	A	para. 5.1.4.4
4 **Cranking**	5	Devices on at cranking	U_B = 13.5 V Vs = 4.5 V Va = 6 V T_6 = 15 ms T_8 = 2 s		B	para. 5.2.8.1
			U_B = 13.5 V Vs = 5 V Va = 9.5 V T_6 = 40 ms T_8 = 20 s	U_B = 27 V Vs = 8 V Va = 12 V T_6 = 100 ms T_8 = 20 s	A	
		Devices off at cranking	U_B = 13.5 V Vs = 5 V Va = 6 V T_6 = 40 ms T_8 = 500 ms	U_B = 27 V Vs = 8 V Va = 12 V T_6 = 50 ms T_8 = 500 ms	C	
Starting profile	10	Devices on at cranking	See Figure 21 Table 12	See Figure 21 Table 13	A	para. 5.2.8.6
		Devices off at cranking			C	
Sinusoid changes of supply voltage	5 s each frequency	Devices on at cranking	6 - 8 V	8 - 10 V	A	para. 5.2.8.7
		Devices off at cranking			C	
Micro breaks	15 cycles each time	All (NP/P)	0 V per 2 ms with duty cycle 1:9		A	para. 5.2.8.2
			0 V per 10 ms with duty cycle 1:9		B	
			0 V per 50 ms with duty cycle 1:9		C	

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Type of pulse	N° of pulses and duration of test	Type of function	Test level		Class of acceptability	Description of pulses
			Device power supply			
			12 V	24V		
Drop of supply voltage	15	All (NP/P)	12 V to 4.5 per 10 ms	24 V to 9 per 10 ms	B	para. 5.2.8.4
Performance on **restoring** power supply after voltage drop	15	Devices on at cranking	See Figures 18 - 19 - 20		A	para. 5.2.8.5
		Devices off at cranking			C	
0.12acres Load dump without zener	10	Systems with alternator without anti load dump centralized protection diodes	87 V	173 V	A	para. 5.1.4.5
			400 ms	350 ms		
			R_i = 1 Ω	R_i = 1.4 Ω		
5b Load dump with zener	10	Systems with alternator and anti load dump centralized protection zener diodes	40 V	58 V	A	para. 5.1.4.6
Key off/on cycle	200	cycle 1 Ta = 10 s Ts = 12 s	Td = 200 - 800 ms per step 10 ms Tp = 3 x Td		A	para. 5.2.8.3
	200	cycle 2 Ta = 10 s Ts = 12 s	Td = 1.7 - 4.9 ms per step 50 ms Tp = 5.7 s			

4.1 **Functional classes**

Electronic device operation conditions during EMC tests refer to classes below:

- CLASS A: All functions comply with requirements, both during and after test.
- CLASS B: All functions comply with requirements both during and after tests; however, one or more of them may be out of tolerance within limits as per specific Procurement Specification or Product Specification.

However, these functions will return within tolerance as soon as interference disappears.

- CLASS C: A function may have failed but it will be brought back within tolerance when interference stops through an automatic reset function setting device back to a condition consistent with selected parameters.
- CLASS D: A function may have failed and will not be brought back within tolerance when interference ceases till an -external reset occurs.
- CLASS E: One or more device functions may have failed both during and after test

These functions are not brought back within tolerance when interference ceases, until device is repaired or replaced.

NOTE **:** ***It is not acceptable*** *that devices under test subjected to max. test severity will irreversibly fail (Functional Class E).*

4.2 **Classification of component/system defects and their test levels**

4.2.1 **Defect classification**

- **P**: Prioritary defect affecting vehicle control that may be perceived by driver or other road user, or generating operational downgrading which may cause confusion to other road users.
- **NP**: Non priority defect which does not impact vehicle control or any secondary function for system under test .

5 IMMUNITY TO TRANSIENT INTERFERENCE ON POWER SUPPLY LINES

5.1 **Test procedure to check immunity to transient interference on power supply lines**
(for pulses specified in paras. 5.1.4.1, 5.1.4.2, 5.1.4.3, 5.1.4.4, 5.1.4.5, 5.1.4.6)

5.1.1 **Test Apparatus**

5.1.1.1 Pulse generator: must be able to generate pulses as defined in **Figures 3**, **4**, **5**, **6, 7**, **8**, **9**.
Tthe tolerances on specifications are ± 10% for time, ± 2% for resistance Ri and + 10% for voltage.

5.1.1.2 0 - 40 V, 80 A uninterruptible adjustble voltage power supply, as per IVECO STD. 16-2108 , coupled to 12 V, 70 Ah, 350 A battery. (1 battery for 12 V tests - 2 batteries in series for 24V tests).

5.1.1.3 Digital oscilloscope with memory, pass band F ≥ 200 MHz; sampling by single pulse: 4 x 10 sampling/s per channel.
Voltage probes with following characteristics:

- attenuation: 10 x (R ≥ 10 MΩ, C ≤ 12 pF, 500 V max, pass band F ≥ 200 MHz);
- attenuation: 10 x (R ≥ 10 MΩ, C ≤ 2.5 pF, 1500 V max, pass band F ≥ 120 MHz).

5.1.1.4 Ground: high-conductivity sheet metal (Cu, Al, Brass).
Min. thickness 1 mm, min. size 2 x 1 m. Ground shall be connected to building ground through suitable conductor (copper braid or strip welded to ground mass).

5.1.1.5 Test setup in insulating material (wood) of suitable size to support ground mass.

5.1.1.6 Simulator to reproduce system sensors and actuators. Simulator signals shall not be affected by interference such as test pulses of **Figures 3**, **4**, **5**, **6, 7**, **8**, **9**. **12** , but must transfer supply line interference (from generator) to actuators and/or sensors conmcerned.

5.1.2 **Test setup preparation**

5.1.2.1 Place equipment as per para. 5.1.1 on test setup as shown in **Figure 1** or **Figure 2** (GENERAL PURPOSE system).

5.1.2.2 Device under test (D.U.T.) shall be placed 50 ± 5 mm away from test setup surface and insulated from it, unless direct grounding to frame is specifically required, in which case connection with test surface shall be as short as possible.

5.1.2.3 Prepare the power supply line (positive or negative) across device under test and interference generator using 2 off Cu 2.5 mm section cables^2, 500 ± 50 mm long parallel to one another 20 ± 2 mm away, 50 ± 5 mm removed from ground.

5.1.2.4 Connect device under test, all input and output lines (supply, sensors, co-ntrols, actuators, etc...) as specified on drawing; if a common connector is used for supply lines, control lines and power lines, the cables of the latter shall be 90° ± 15° to supply cables and as close as possible to the terminals.

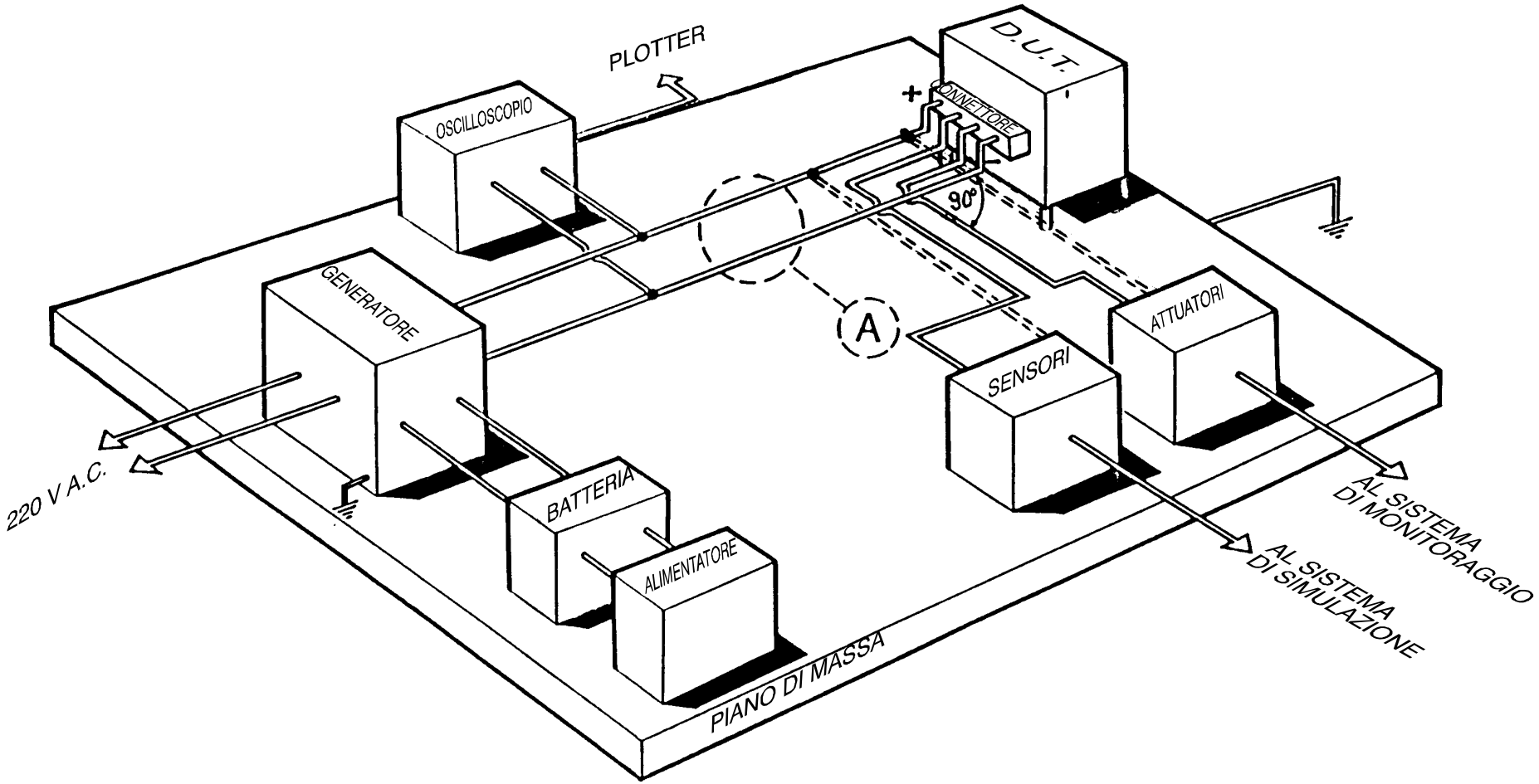
5.1.2.5 Connect battery/ies (with 13.5 ± 0.1 V or 27 ± 0.2 V uninterruptible power supply) to pulse generator. ”Negative” battery/ies terminal to be directly connected to ground.

5.1.2.6 Connect oscilloscope to generator output.

5.1.2.7 Select test pulses and adjust both pulse width and pulse frequency with device under test not connected to generator.

Figure 1
Injection of transient interference in supply line

Placement of equipment

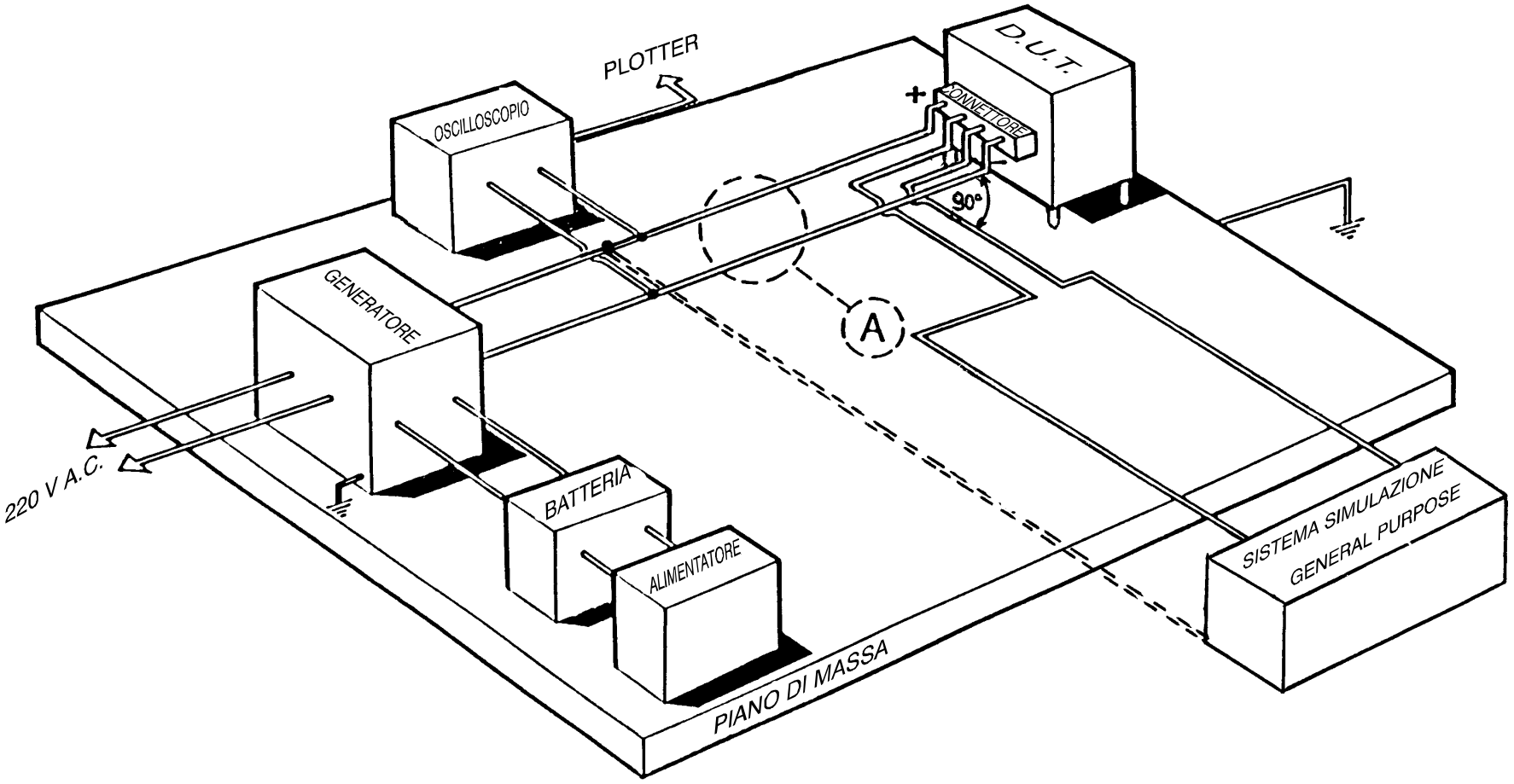


NOTE **:**

(A) : 2 cables 20 ±2 mm away from each other, 500 ±50 mm long, Cu 2.5 mm^2 section and 50 ± 5 mm from ground mass.

Connect battery “negative” terminal directly to ground

Figure 2
Injection of transient interference in supply line
Placement of equipment



NOTE **:**

(A) : 2 cables 20 ±2 mm away from each other,
500 ±50 mm length, Cu 2.5 mm^2 section and
50 ± 5 mm from ground mass.

Connect battery “negative” terminal directly to ground

5.1.3 **Measurement procedure**

5.1.3.1 Connect supply line of device under test to pulse generator, set device to standard operating conditions as specified by Supplier or relevant procurement specification and apply preferably a physical stimulation to sensors.

5.1.3.2 Apply specified pulses to device under test and take note of behavior of component under test.

5.1.3.3 For test pulses 1 (para. 5.1.4.1), 2a (para. 5.1.4.2) and 2b (para. 5.1.4.3), apply interference to supply terminals undergoing opening at position +15 (key on) and + 30 if required by project manager (battery direct line).
Other interference 3a (para. 5.1.4.4), 3b (para. 5.1.4.4), 5a (para 5.1.4.5), 5b (para. 5.1.4.6) shall be applied both at position +15 (key on) and +30 (battery direct line).

5.1.4 **Test pulses**

5.1.4.1 **Test pulse 1**

Applicable to equipment which on board the vehicle remain connected in parallel to inductive load when power supply is not on.

5.1.4.1.1 Apply test pulse to +15 (under key) and, if requested by project manager, to + 30 (battery direct) as shown in **Figure 3** with amplitude, number of cycles and time specified for class of equipment under test (see **Table 2**).

Figure 3

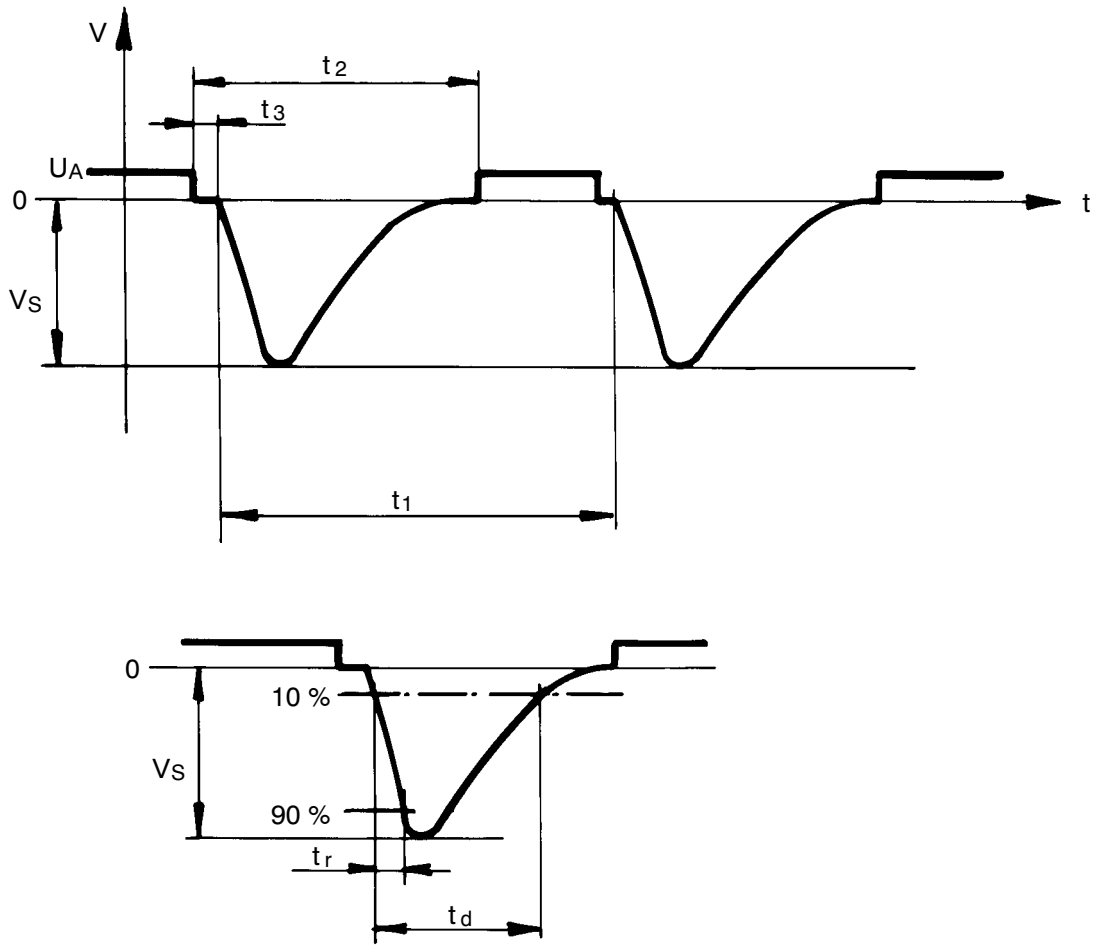


Table 3

Parameters	12 V	24 V
V_s	- 50 V to - 300 V	- 150 V to - 600 V
U_a	13,5 ± 0.5 V	27 ± 1 V
R_i	10Ω	50Ω
t_d	2 ms	1 ms
t_r	$1\,(^{0}_{-0,5})$ µs	$3\,(^{0}_{-1,5})$ µs
t_1	0.5 s to 5 s	0.5 s to 5 s
t_2	200 ms	200 ms
t_3	≤ 100 µs	≤ 100 µs

5.1.4.2 **Test pulse 2a**

Applicable to devices which on board the vehicle remain connected in parallel to inductive load when power supply is discontinued due to wiring inductance.

5.1.4.2.1 Apply test pulse to +15 (under key) and, if requested by project manager, to + 30 (battery direct) as shown in **Figure 4** with amplitude, number of cycles and time specified for class of equipment under test (see Table **2**).

Figure 4

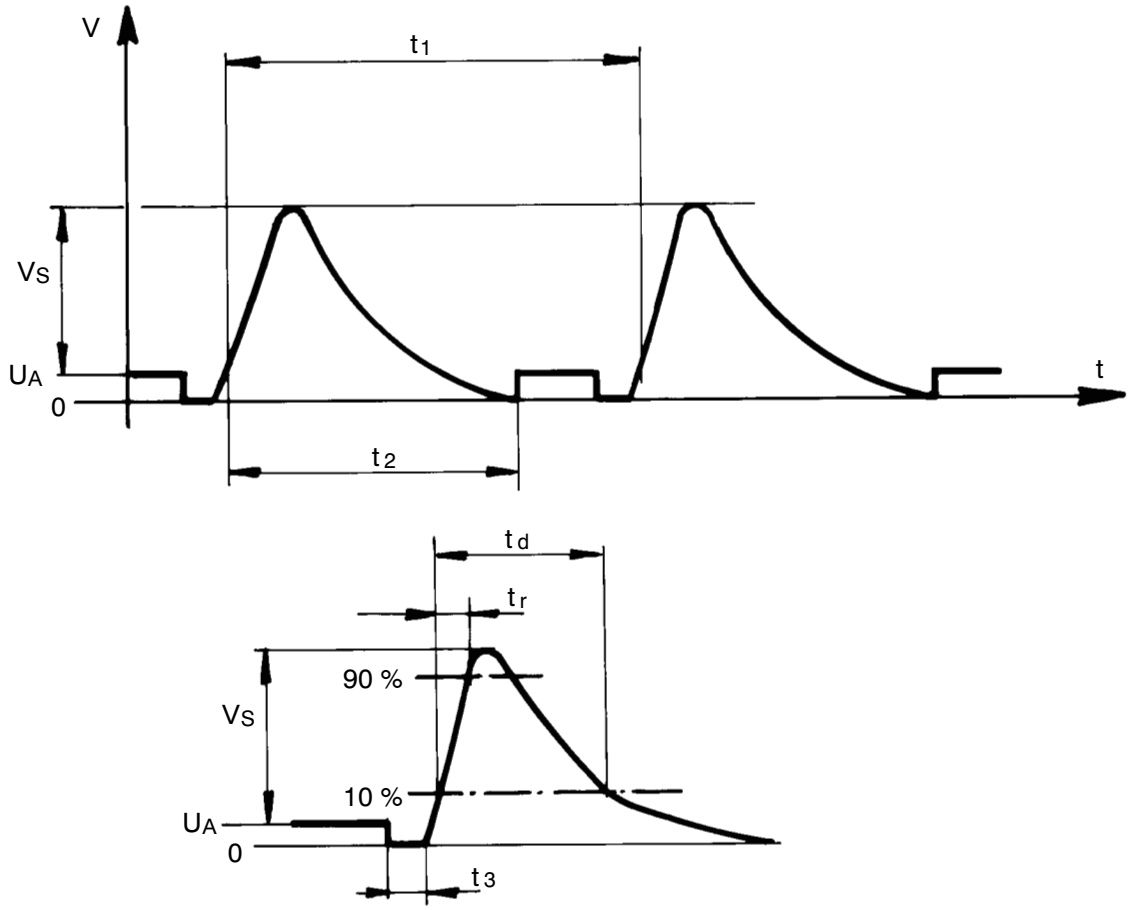


Table 4

Parameters	12 V	24 V
V_s	25 V to 100 V	25 V to 100 V
U_a	13,5 ± 0.5 V	27 ± 1 V
R_i	2Ω	2Ω
t_d	0.05 ms	0.05 ms
t_r	$\binom{0}{1\,0,5}$ µs	$\binom{0}{1\,0,5}$ µs
t_1	0.2 s to 5 s	0.2 s to 5 s
t_2	200 ms	200 ms
t_3	≤ 100 µs	≤ 100 µs

5.1.4.3 **Test pulse 2b**

Applicable to devices which on board the vehicle remain connected to inductive load (DC motors) acting as generators when power supply is discontinued.

5.1.4.3.1 Apply test pulse to +15 (under key) and, if requested by project manager, to + 30 (battery direct) as shown in **Figure 5** with amplitude, number of cycles and time specified for class of equipment under test (see **Table 2**).

Figure 5

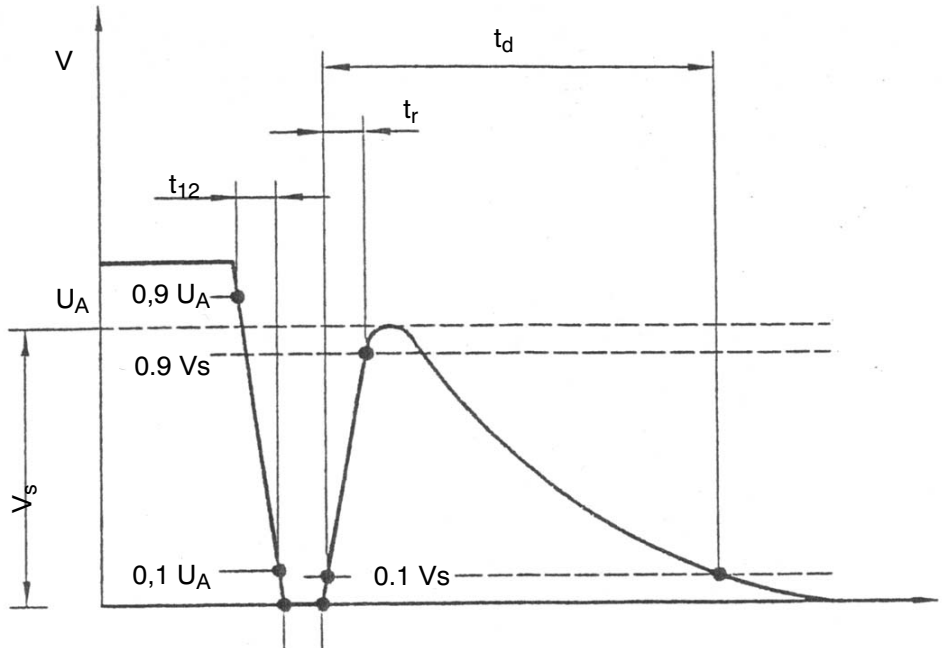


Table 5

Parameters	12 V	24 V
V_s	10 V	20 V
U_a	13,5 ± 0.5 V	27 ± 1 V
R_i	0Ω to 0.05 Ω	
t_d	0.2 to 2 s	
t_{12}	1 ms ±0.5 ms	
t_r	1 ms ±0.5 ms	
t_6	1 ms ±0.5 ms	

5.1.4.4 **Test pulse 3a and 3b**
(Negative and positive bursts)

The features of these interference pulses due to opening/closing of circuits are linked to both capacity and inductance of vehicle wiring harness.

5.1.4.4.1 Apply test pulse shown in **Figure 6** and in **Figure 7** with amplitude, test cycle time and test time specified for class of equipment under test on both +15 (under key) and +30 (battery direct)(see **Table 2**).

Figure 6
Pulse 3a – Negative burst

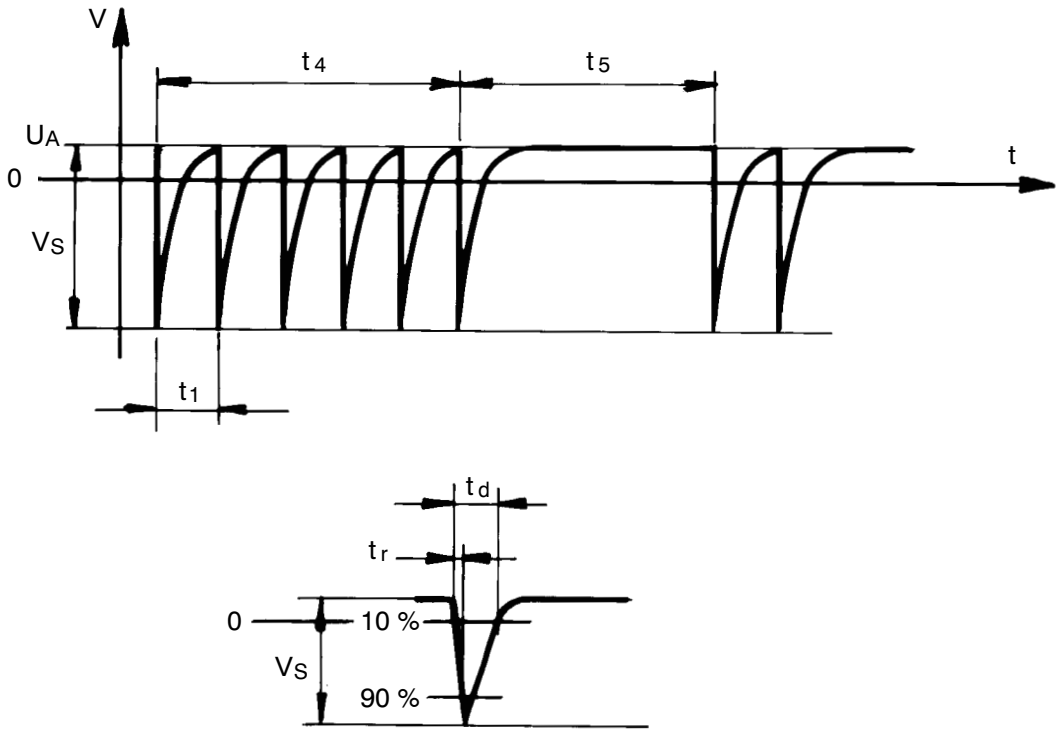
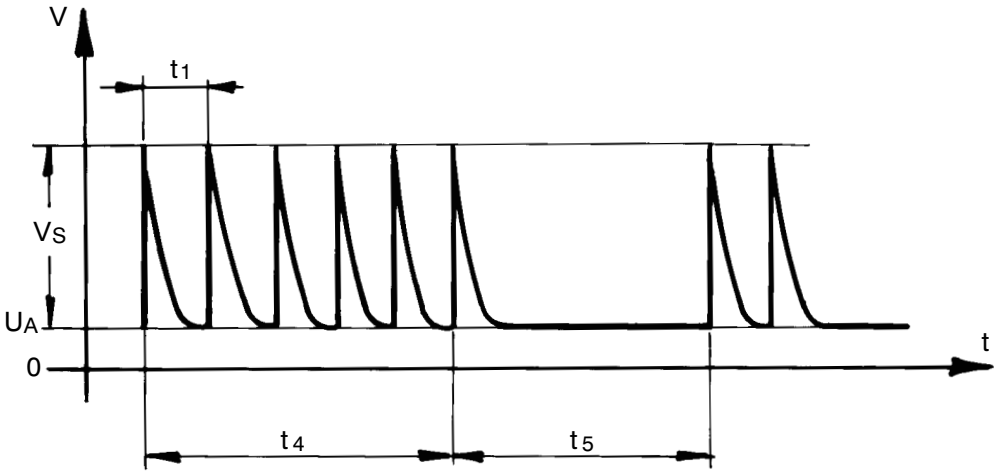


Table 6

Parameters	12 V	24 V
V_s	-37 V to -150 V	-50 V to -200 V
U_a	13,5 ± 0.5 V	27 ± 1 V
R_i	50Ω	50Ω
t_d	$0,1\ ^{(+0,1}_{0)}$ µs	$0,1\ ^{(+0,1}_{0)}$ µs
t_r	5 ns ±1.5 ns	5 ns ±1.5 ns
t_1	100 µs	100 µs
t_4	10 ms	10 ms
t_5	90 ms	90 ms

Figure 7
Pulse 3b – Positive burst



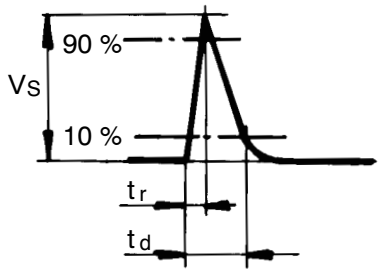


Table 7

Parameters	12 V	24 V
V_s	25 V to 100 V	50 V to 200 V
U_a	13,5 ± 0.5 V	27 ± 1 V
R_i	50Ω	50Ω
t_d	$0,1\ ^{(+0,1}_{0)}$ µs	$0,1\ ^{(+0,1}_{0)}$ µs
t_r	5 ns ±1.5 ns	5 ns ±1.5 ns
t_1	100 µs	100 µs
t_4	10 ms	10 ms
t_5	90 ms	90 ms

5.1.4.5 **Test pulse 5a (load dump without centralized protection)**

Applicable to devices which remain connected to source alternator, with engine running, when circuit for connection to battery is opened.

5.1.4.5.1 Apply test pulse shown in **Figure 8** when using alternators without centralized protection during load dump (i.e., without Zener diodes) with amplitude, number of cycles and time corresponding to class of equipment under test both on +15 (under key) and on +30 (battery direct) (see **Table 2**).

Figure 8
Pulse 5a

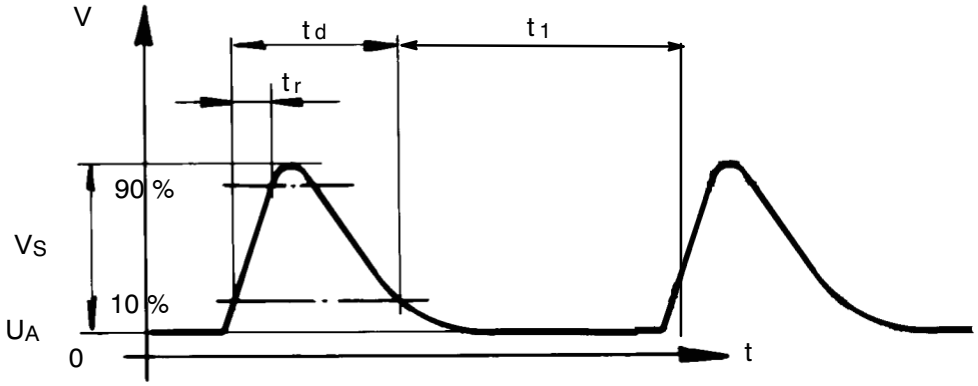


Table 8

Parameters	12 V			24 V		
V_s	22 V	to	87 V	43 V	to	173 V
U_a	13,5 ± 0.5 V			27 ± 1 V		
R_i (1)	0,5Ω	to	4Ω	1Ω	to	8Ω
t_d	400 ms			350 ms		
t_r	$\binom{0}{-5}$ 10 ms			$\binom{0}{-5}$ 10 ms		
t_1	60s			60s		

(1) Internal resistance of an alternator during load dump is basically a function of speed and excitation current.
Internal resistance (R_i) of pulse simulator can be calculated using the following formula:

$$R_i = \frac{10 \times V_n \times N_R}{0.8 \times I_R \times 12000\ giri/min}$$

V_n = Nominal generator voltage
N_r = Actual alternator speed
I_r = Generator current rating at 6000 RPM.

5.1.4.6 **Test pulse 5b (Load Dump with centralized protection through Zener diodes)**

5.1.4.6.1 Apply test pulse shown in **Figure 9** load dump generated by alternators with centralized protection through Zener diodes on both +15 (key on) and +30 (battery direct line).

Figure 9
Pulse 5b

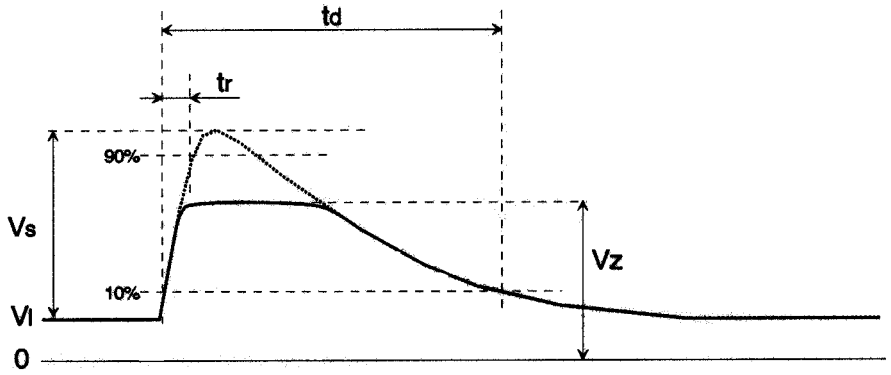


Table 9

Parameters	12 V			24 V		
V_s	87 V			173 V		
U_a	13,5 ± 0.5 V			27 ± 1 V		
V_z (2)	40 V			58 V		
R_i	0,5Ω	to	4Ω	1Ω	to	8Ω
t_d	400 ms			350 ms		
t_r	4 ms	to	5 ms	10 ms		
t_1	60s			60s		

(2) Value of V_z is obtained by adding 2 V to reverse voltage of Zener diodes on vehicle alternator where component/system under test will be placed.

5.2 **Test procedure for monitoring performance under supply voltage fluctuations** (for pulses specified in paras. 5.2.8.1, 5.2.8.2, 5.2.8.3, 5.2.8.4, 5.2.8.5, 5.2.8.6 and 5.2.8.7)

Above pulses involve the following tests:

- temporary voltage drop immunity test on power lines;
- microbreaks immunity tests;
- tests of changes due to incorrect operation of key switch (on/off key cycle).
- Performance on restoration of power supply after voltage drop;
- Sinusoidal changes of supply voltage;
- Start cycle;
- Temporary drop of supply voltage.

5.2.1 **Test apparatus**

For this type of pulse, further to equipment of paras. 5.1.1.3, 5.1.1.4, 5.1.1.5, 5.1.1.6, the following must be available:

5.2.1.1 Signal generator, with arbitrary wave forms and the following characteristics: frequency band 0.001 Hz to 20 KHz, horizontal resolution ≥ 4000 points, vertical resolution ≥ 10 bits.

5.2.1.2 Programmable power supply unit with 0 - 40 V output voltage, current output over 80 A, internal resistance R_i = 0.01 Ω, pass band above 10 kHz and pilot voltage through signal generator.

5.2.1.3 Graphic plotter with recording capability of slow events.

5.2.2 **Test setup layout**

5.2.3 Place equipment as per para. 5.2.1 on test setup as shown in **Figure 10** or **Figure 11** (GENERAL PURPOSE system) overleaf.

5.2.4 Perform operations as per paras 5.1.2.2 - 5.1.2.3 - 5.1.2.4.

5.2.5 Connect oscilloscope or graph plotter to programmable power supply unit output.

5.2.6 *Set test instrumentation of programmable power supply unit to obtain voltage changes as shown in **Figure 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22**, and in **Table 12** and **13**.*

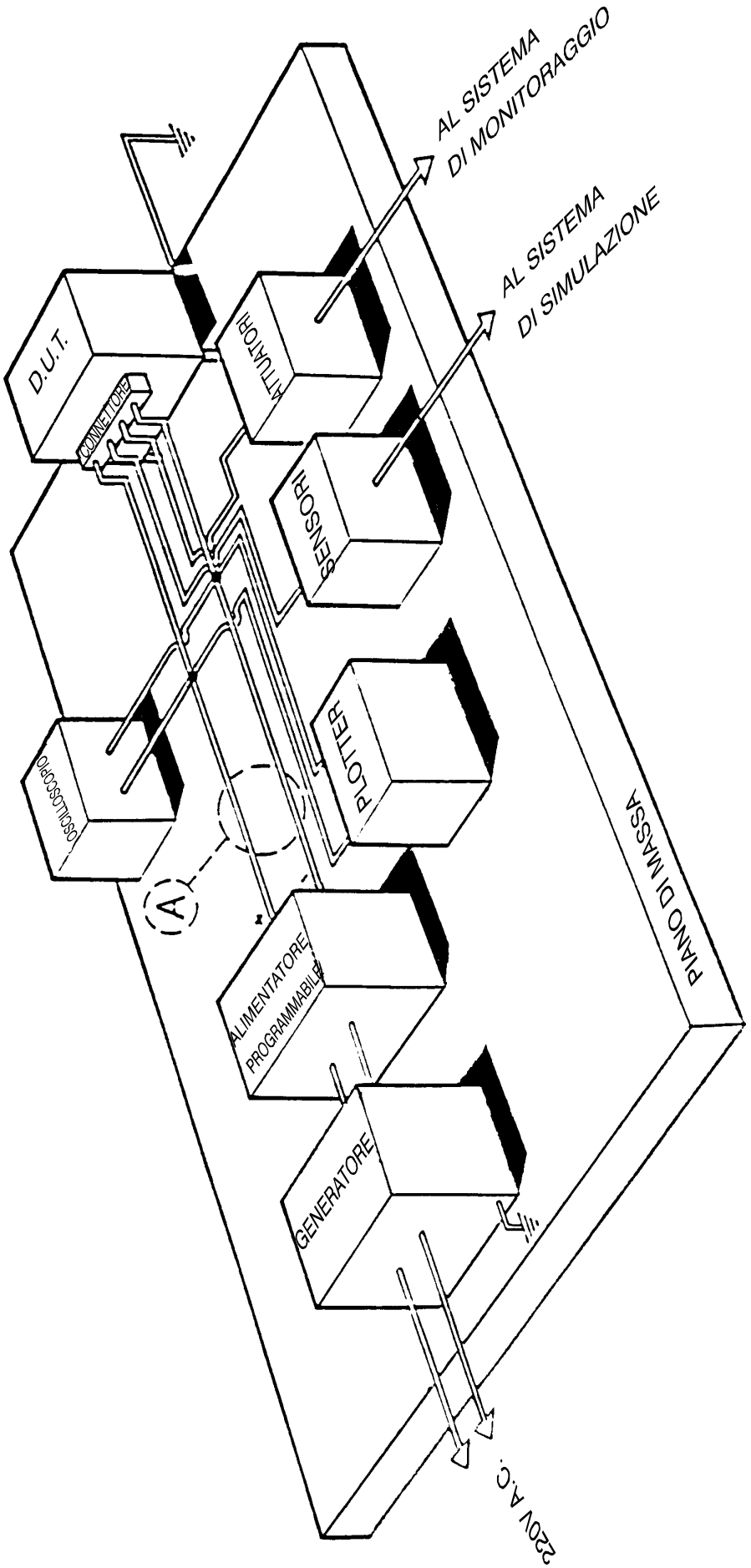


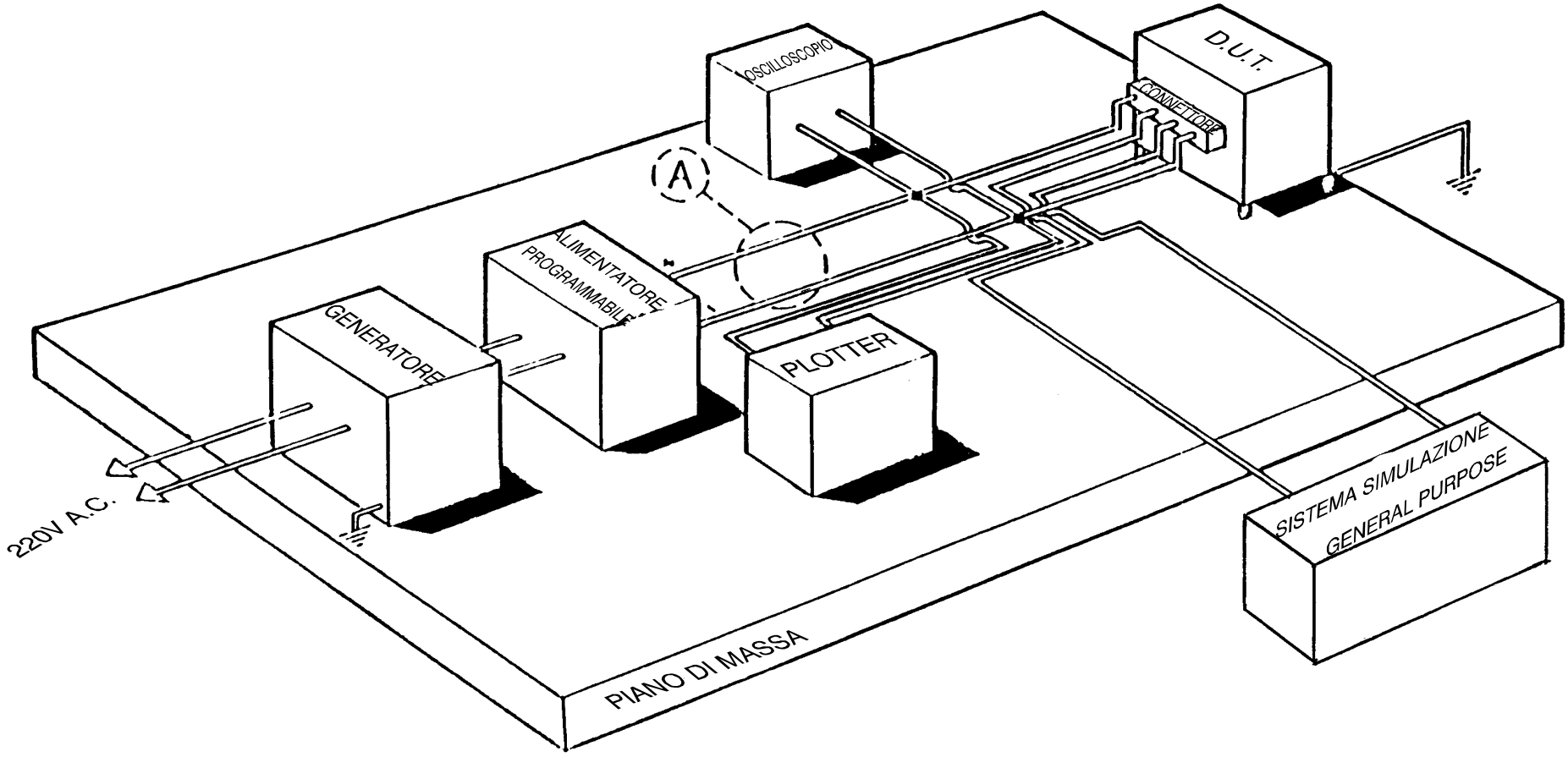
Figure 10
Slow voltage change in supply lines
Placement of equipment

NOTE :

(A) : 2 cables 20 ± 2 mm away from each other, 500 ± 50 mm long, Cu 2.5 mm^2 section and 50 ± 5 mm away from ground.

Figure 11
Slow voltage change in supply lines

Placement of equipment



NOTE **:**

(A) : 2 cables 20 ±2 mm away from each other, 500 ±50 mm long, Cu 2.5 mm^2 section and 50 ±5 mm away from ground.

5.2.7 **Test procedure**

5.2.7.1 Connect device under test to the programmable supply and set unit to standard usage conditions as specified by Supplier or procurement specification preferably applying physical stimulation to sensors.

5.2.7.2 Apply specified voltage changes to the device under test, both on supply terminals not subjected to opening (position +15 under key control) and on terminals connected to battery direct line (position +30). If not specified, apply test parameters applicable to similar devices.

5.2.8 **Test pulses**

5.2.8.1 **Test pulse 4 (Cranking)**

Applicable to electronic devices connected to power supply during engine cranking to simulate supply voltage drop.

5.2.8.1.1 Apply test pulse as shown in **Figure 12** with amplitude, number of cycles and time specified for class of device under test (see **Table 2**) both to +15 (under key) and to +30 (battery direct).

Figure 12

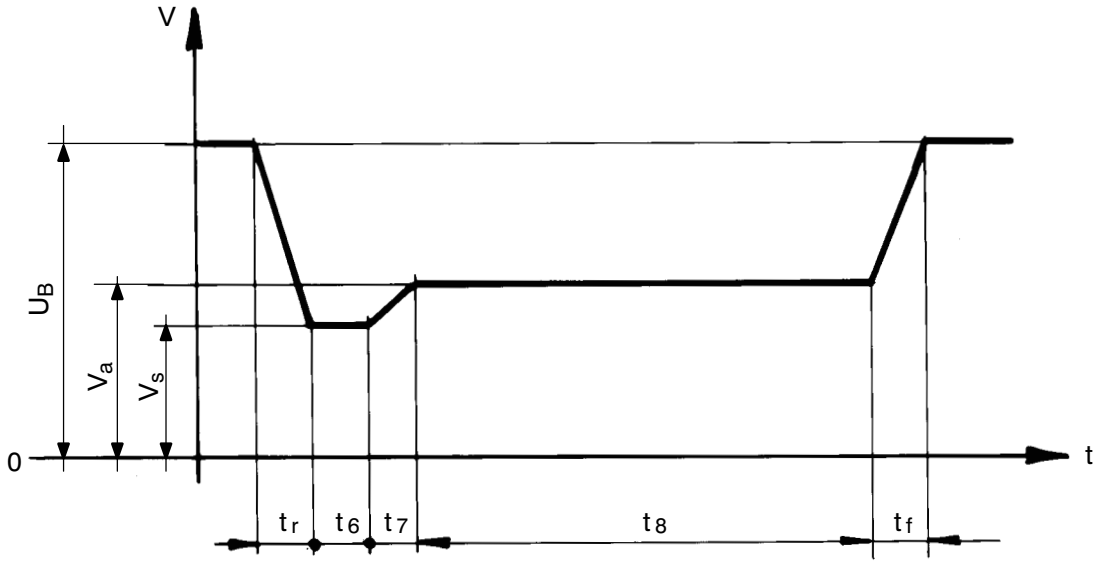


Table 10

Parameters	12 V			24 V		
U_b	12 ± 0.2 V			24 ± 0.4 V		
V_s	4.5 V	to	5 V	8 V	to	12 V
V_a ($V_a > V_s$)	6 V	to	9.5 V	12 V	to	19 V
R_i	0Ω	to	0,02Ω	0Ω	to	0,02Ω
t_6	15 ms	to	40 ms	50 ms	to	100 ms
t_7	≤ 50 ms			≤ 50 ms		
t_8	0.5 s	to	20 s	0.5 s	to	20 s
t_r	≤ 5 ms			≤ 10 ms		
t_f	5 ms	to	100 ms	10 ms	to	100 ms

5.2.8.2 **Microbreaks of power supply line**

5.2.8.2.1 Applicable to devices connected to power supply to simulate microbreaks generated by bounce-back on key switch and/or loose contacts on connectors, verifying that the system is still properly operating at interference injection (unless otherwise specified).

5.2.8.2.2 Apply test pulse, both +15 (under key) and +30 (battery direct), with parameters shown in **Figure 13** with amplitude, number of cycles and time specified for class of device under test (see **Table 2**).

Figure 13

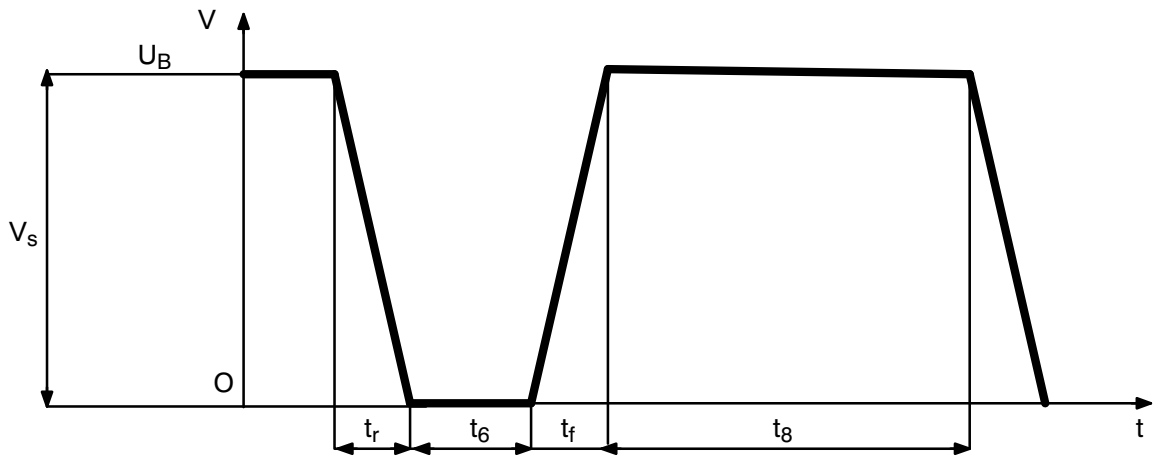


Table 11

Parameters	**V_s** = 12 V	**V_s** = 24 V
V_s	- 12 V	- 24 V
R_i	0,01Ω	0,01Ω
t_6	2 - 10 - 50 [ms]	2 - 10 - 50 [ms]
t_8	18 - 90 - 450 [ms]	18 - 90 - 450 [ms]
t_r	≤ 100 µs	≤ 330 µs
t_f	≤ 20 µs	≤ 20 µs

The duty-cycle between t_6 and t_8 must always be 1 : 9.

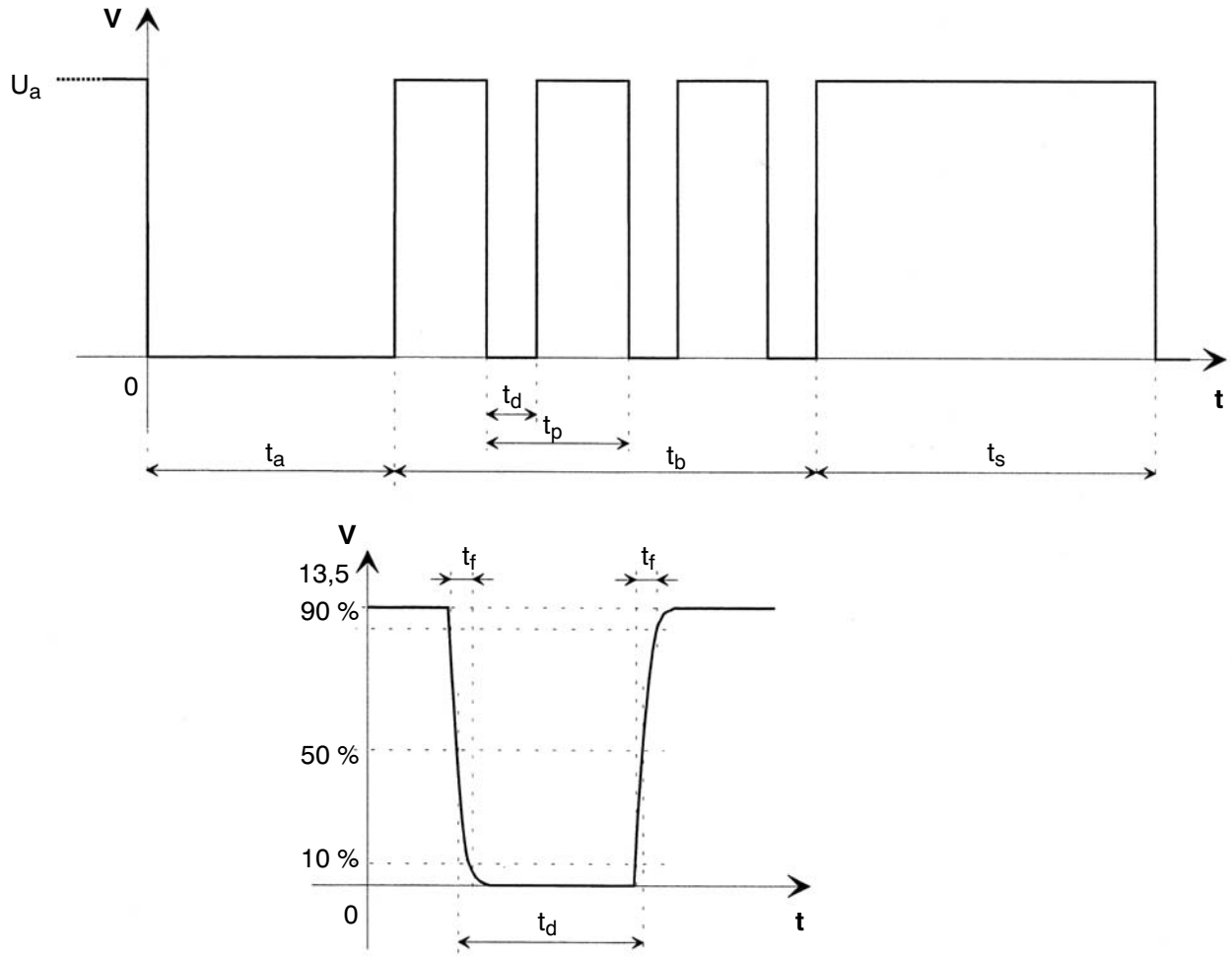
5.2.8.3 **Key on/off operation.**

To simulate voltage interference on power supply lines due to incorrect operation of ignition key switch.

5.2.8.3.1 **Application of specified interference to key + (+ 15)**

- Set signal generator to have voltage electrical characteristics and interference times at programmable power supply unit output, as specified in **Figure 14** first, then in **Figure 15**.
- Check for proper operation of device under test under the specific operating condition tested comparing characteristic parameters of signals from sensors to reference parameters.
- At the end of interference application, after achieving or exceeding application time or number of required pulses, enter test results with actual test time and malfunctions identified, if any.

Figure 14 - First Key Off/On cycle



Ri ≤ 0,01 Ω (power supply unit internal resistance);

t_a = 10 s (power supply time OFF);

t_d = 200 - 800 ms (time) increased in 10 ms steps;

t_p = 3*td (period);

t_b = 10 s (burst time);

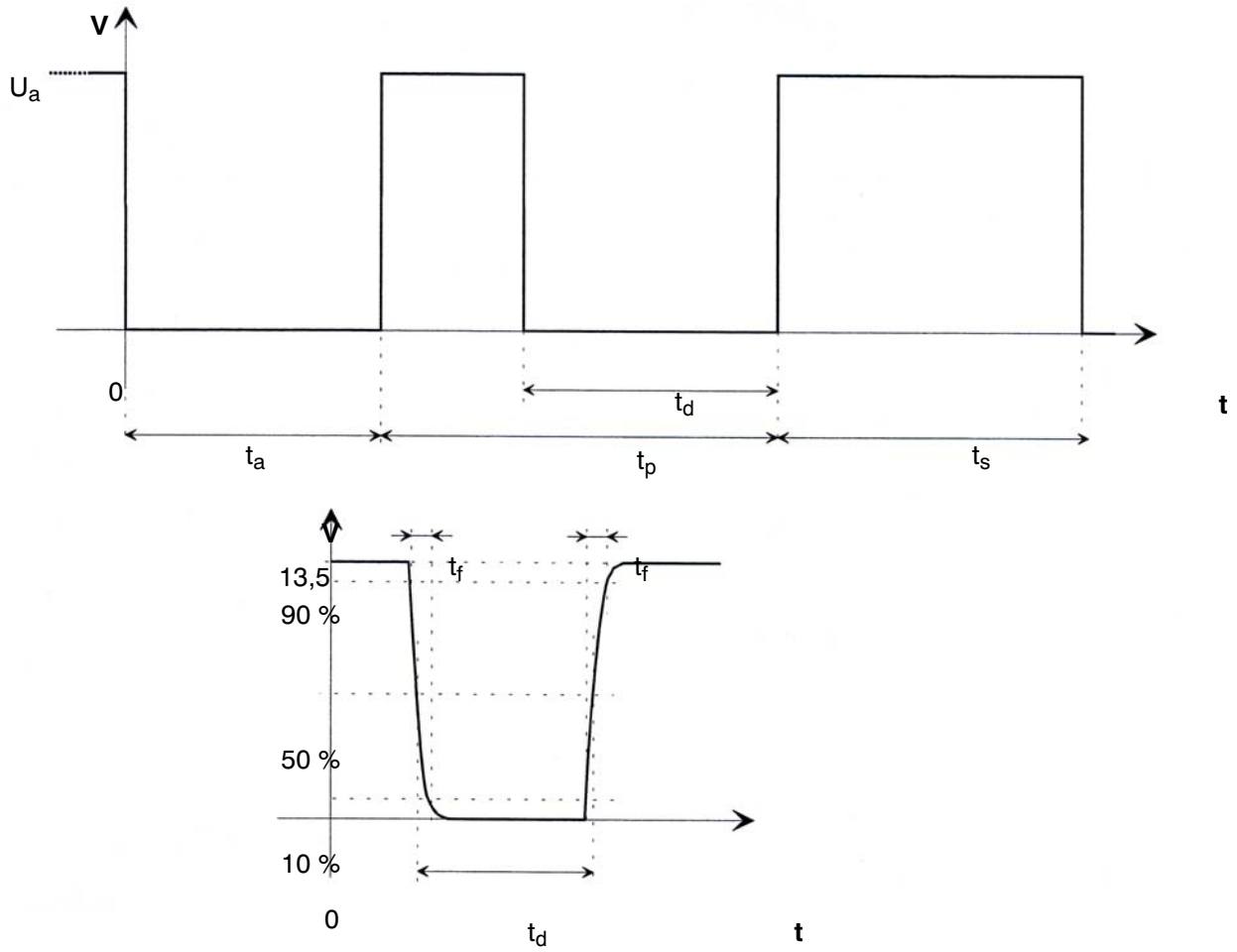
t_a = 12 s (power supply time ON);

t_r ≤ 100 µs;

t_f ≤ 100 µs;

U_{at} = 13.5 ± 0.5 V for 12 V supply systems;
27 V ± 1 V for 24 V supply systems.

Figure 15 - Key Off/On cycle



Ri ≤ 0,01 Ω (power supply unit internal resistance);

t_a = 10 s (power supply time OFF);

t_d = 1.7 - 4.9 s (time) increased in 50 ms steps;

t_p = 5.7 s (period);

t_a = 12 s (power supply time ON);

t_r ≤ 100 µs;

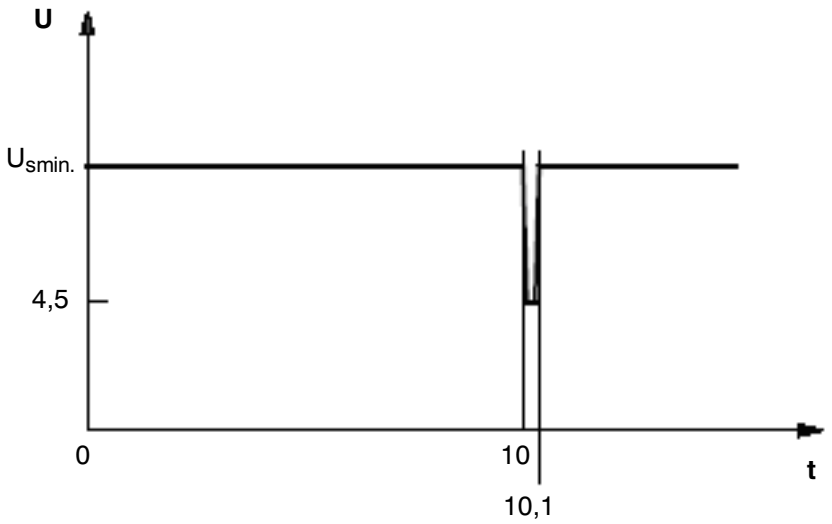
t_f ≤ 100 µs;

U_{at} = 13.5 ± 0.5 V for 12 V supply systems;
27 ± 1 V for 24 V supply systems.

5.2.8.4 **Temporary drops in supply voltage.**

To be applied simultaneously to all relevant inputs of device under test as specified in **Figure 16** and **17**, with increase and decrease time of < 10 ms.

Figure 16 - Short voltage drop for 12 V nominal voltage system.

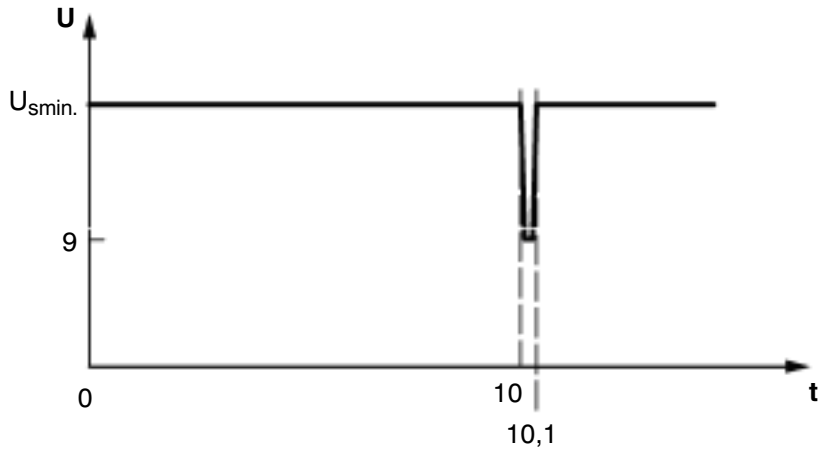


t = time in seconds;

U = test in volts;

Usmin. = min. supply voltage.

Figure 17 - Short voltage drop for 24 V nominal voltage system.



t = in seconds;

U = in V.

5.2.8.5 **Performance after on restoration of power supply after voltage drop**

To verify the behavior of the device/system at power supply restoring after repeated voltage drops.

The test can be used for systems having reset functions, e.g. systems equipped with microcontrollers.

The systems/components for which this test is required shall undergo the following procedure:

- supply the system/component at constant voltage for 10 s at least, at a variable value each time, with decrement intervals of 0.5 V, from min. operating voltage to 0 V.
- after 10 s at each test voltage, restore supply voltage to min. operating value, keep it unchanged for 10 s, then check if behavior of system/component complies with requirements, as specified for the function to be performed.

Figure 18
Voltage drop test for systems/components included in start-up chain

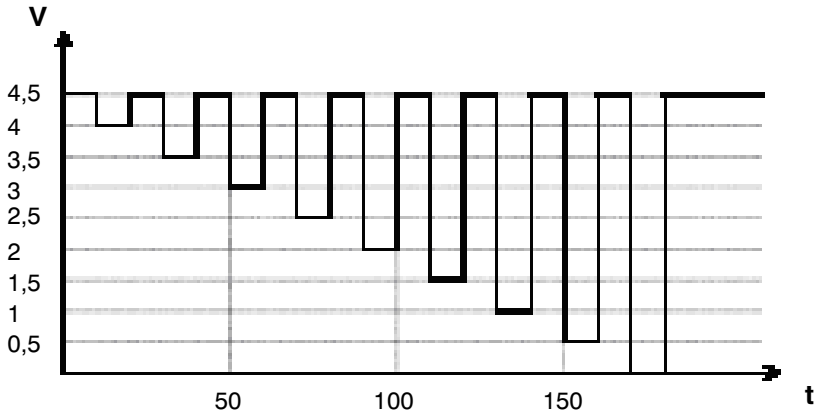


Figure 19
Voltage drop test for systems/components non operating at the first start-up step

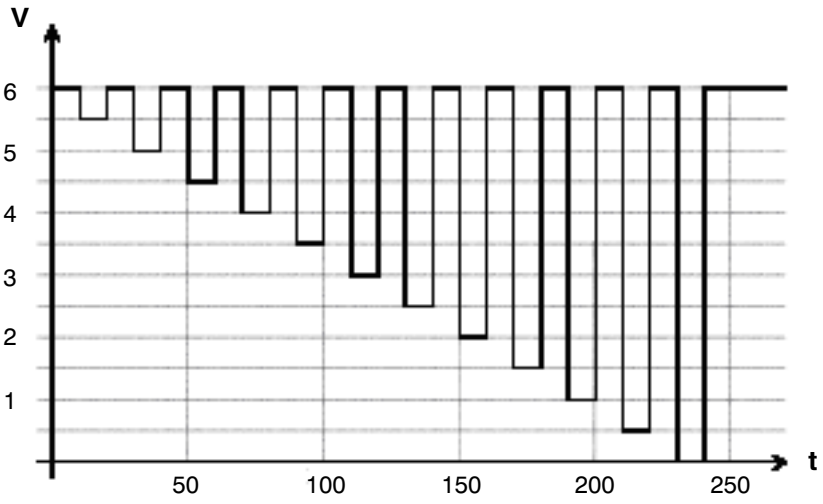
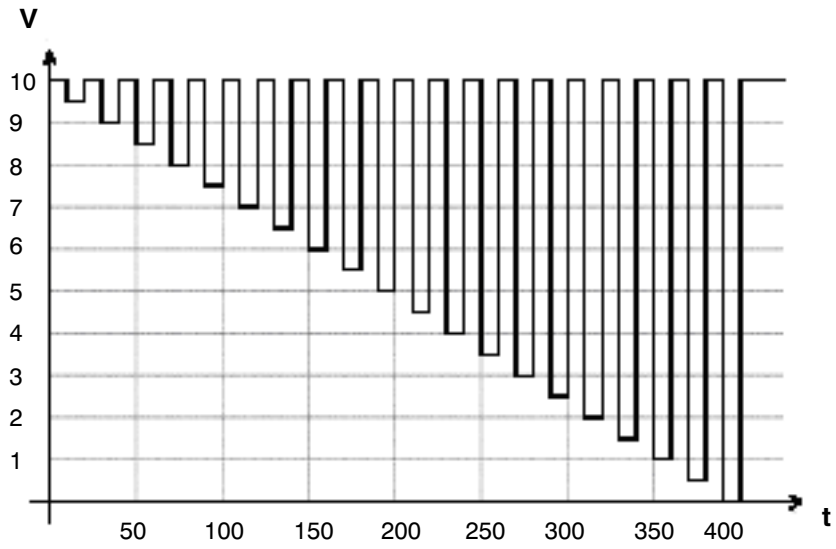


Figure 20
Voltage drop test for systems/components not operating during the start-up step



5.2.8.6 **Start cycle**

This test is to check the behaviour of device both at and after cranking.

Apply the start cycle 10 times to all significant inputs simultaneously, as specified in **Figure 21** e **Tables 12** or **13** an interval of 1 or 2 s between one cycle and the next, as recommended.

One or more profiles can be selected according to the type of application as specified in table.

Figure 21

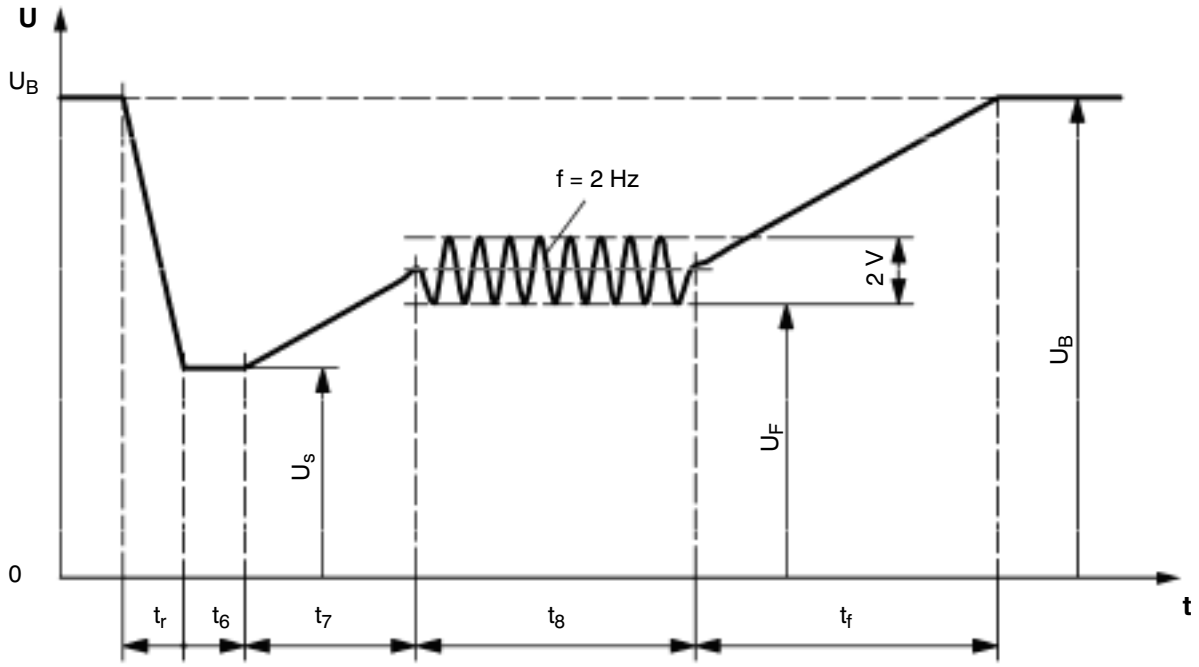


Table 12 - Initial profile values for 12 V nominal voltage systems.

Parameter		Level/voltage/time of starting profile				
		I	II	III	IV	Tolerances
Voltage	U_S [V]	8	4,5	3	6	− 0,2
	U_F [V]	9,5	6,5	5	6,5	
Life test	t_r [ms]	5				± 10 %
	t_6 [ms]	15				
	t_7 [ms]	50				
	t_8 [ms]	1000				
	t_f [ms]	40	100			
Power supply voltage [V]		**Min. operating status**				
$U_{smin.}$	**$U_{smax.}$**					
6	16	A	B	B	A	
8	16	A	B	C	B	
9	16	B	C	C	C	
10,5	16	B	C	C	C	

Table 13 - Initial profile values for 24 V nominal voltage systems.

Parameter		Level/voltage/time of starting profile			
		I	II	III	Tolerances
Voltage	U_S [V]	10	8	6	+ 0,2
	U_F [V]	20	15	10	
Life test	t_r [ms]	10			± 10 %
	t_6 [ms]	50			
	t_7 [ms]	50			
	t_8 [s]	1	10	1	
	t_f [ms]	40	100	40	
Power supply voltage [V]		**Min. operating status**			
$U_{smin.}$	**$U_{smax.}$**				
10	32	A	B	C	
16	32	B	C	C	
22	32	B	C	C	

5.2.8.7 **Sinusoid changes of supply voltage**

Voltage decrease at startup of engine:

Figure 22

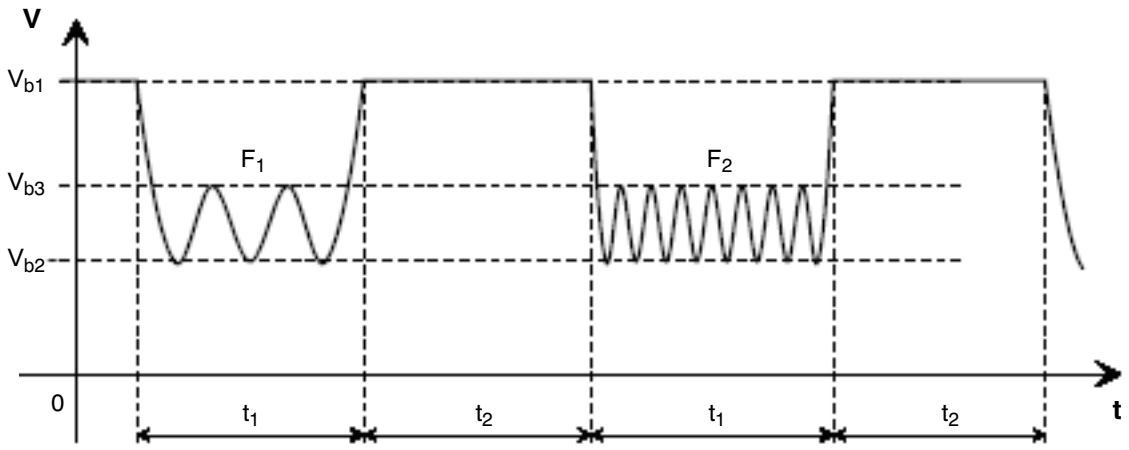


Table 14

Test level	Nominal power supply voltage of the device	
	12	**24**
V_{b1}	12 V	24
V_{b2}	6 V	8
V_{b3}	8 V	10
$R_i \leq 0{,}01\ \Omega$ (internal resistance of power supply unit); t_1 = 5 s, 2 s; t_2 = 2 s; F_1 = 1 Hz; F_2 = 5 Hz; Application point: + 15 key and + 30 battery.		

6 ACCESSIBILITY LIMITS

The functional class achieved (A - B - C - D - E) for the product under test at **application of pulses** shall be equivalent to or higher than requirements for all test levels. In case of device malfunction, perform a manual check of minimum levels **of parameters set for pulses** to which the device starts operating again properly (sensitivity limit search).

7 PRESENTATION OF RESULTS

Results shall be reported for each test level (≤ at the level defined), for each type of pulse and limit value t_1 (repetition time) identifying malfunctions, if any, and specifying whether temporary or permanent, together with their functional classes. E.g., see the **Table 15** overleaf.

Table 15

Type of pulse	N°of pulses and duration of test	Type of function	Test level		Class of acceptability	RESULT
			Device power supply			
			12 V	24V		
1 Spike (-)	500	NP	Vs = - 100 V	Vs = - 450 V	C	A - B - C
		P	Vs = - 300 V	Vs = - 600 V		
0.05acres Spike (-)	500	NP	Vs = + 50 V	Vs = + 50 V	B	A - B
		P	Vs = + 100 V	Vs = + 100 V	A	A
2b Spike (-)	10	NP	Vs = + 10 V	Vs = + 20 V	B	A - B
		P	Vs = + 10 V	Vs = + 20 V	A	A
0.07acres Burst (-)	30 min.	NP	Vs = - 112 V	Vs = - 150 V	B	A - B
		P	Vs = - 150 V	Vs = - 200 V	A	A
3b Burst (+)	30 min.	NP	Vs = + 112 V	Vs = + 150 V	B	A - B
		P	Vs = +150 V	Vs = + 200 V	A	A
4 Cranking	5	Devices on at cranking	U_B = 13.5 V Vs = 4.5 V Va = 6 V T_6 = 15 ms T_8 = 2 s		B	A - B
			U_B = 13.5 V Vs = 5 V Va = 9.5 V T_6 = 40 ms T_8 = 20 s	U_B = 27 V Vs = 8 V Va = 12 V T_6 = 100 ms T_8 = 20 s	A	A
		Devices off at cranking	U_B = 13.5 V Vs = 5 V Va = 6 V T_6 = 40 ms T_8 = 500 ms	U_B = 27 V Vs = 8 V Va = 12 V T_6 = 50 ms T_8 = 500 ms	C	A - B - C
Starting profile	10	Devices on at cranking	See Figure 21 Table 12	See Figure 21 Table 13	A	A
		Devices off at cranking			C	A - B - C
Sinusoidal changes of supply voltage	5 s each frequency	Devices on at cranking	6 - 8 V	8 - 10 V	A	A
		Devices off at cranking			C	A - B - C

(continued ☞)

(☞ continued)

Type of pulse	N°of pulses and duration of test	Type of function	Test level		Class of acceptability	RESULT
			Device power supply			
			12 V	24V		
Micro breaks	15	All (NP/P)	0 V per 2 ms with duty cycle 1:9		A	A
			0 V per 10 ms with duty cycle 1:9		B	A - B
			0 V per 50 ms with duty cycle 1:9		C	A - B - C
Drops	15	All (NP/P)	12 V to 4.5 per 10 ms	24 V to 9 per 10 ms	B	A - B
Performance on**restoration** of power supply after voltage drop	15	Devices on at cranking	See Figures 18 - 19 - 20		A	A
		Devices off at cranking			C	A - B - C
Key off/on cycle	200	All (NP/P)	cycle 1 Ta = 10 s Ts = 12 s Td = 200 - 800 ms per step 10 ms Tp = 3 x Td		A	A
	200		cycle 2 Ta = 10 s Ts = 12 s Td = 1.7 - 4.9 ms per step 50 ms Tp = 5.7 s			

REFERENCES

IVECO STD.: 16-2108, 18-2252, 19-0201.

ISO: 7637/1, 7637/2