SPITZENBERGER SPIES

ISO 16750-2 (2012)

at a glance

Road vehicles. Environmental conditions and testing for electrical and electronic equipment
Part 2:
Electrical loads

The relating standards:
ISO 16750 -2 (2003)
ISO 16750 -2 (2006)
ISO 16750 -2 (2010)
ISO 16750 -2 (2012)
ISO 16750 -1

THE ISO16750 STANDARDS:

ISO 16750 consists of the following parts, under the general title Road vehicles — Environmental conditions and testing for electrical and electronic equipment	*Part 1: General* *Part 2: Electrical loads* *Part 3: Mechanical loads* *Part 4: Climatic loads* *Part 5: Chemical loads*

The ISO 16750-2 describes the electrical loads. Electromagnetic compatibility (EMC) is not covered by this part of ISO 16750. Electrical loads are independent from the mounting location, but can vary due to the electrical resistance in the vehicle wiring harness and connection system.

TEST PROCEDURES ACCORDING TO ISO16750-2:

If not otherwise specified, the following tolerances shall apply for all tests: *- frequency and time: ±5 %;* *- voltages: ±0,2 V;* *- resistance: ±10 %;* All voltage curves are shown without load. If not otherwise specified, measure all voltages at the relevant terminals of the device under test (DUT)	*4.2* *4.3* *4.4* *4.5* *4.6* *4.7* *4.8* *4.9* *4.10* *4.11* *4.12*	*Direct current supply voltage* *Overvoltage* *Superimposed alternating voltage* *Slow decrease and increase of supply voltage* *Discontinuities in supply voltage* *Reversed voltage* *Ground reference and supply offset* *Open circuit tests* *Short circuit protection* *Withstand voltage* *Insulation resistance*

4.2 DIRECT CURRENT SUPPLY VOLTAGE

Set the supply voltage as specified in the table to all relevant inputs of the DUT.

All DUT functions shall remain class A as defined in ISO 16750-1

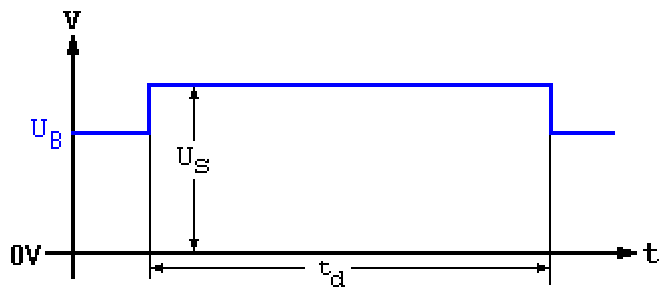
*Table: Supply voltages U_A for **12V** / **24V** nominal voltage*

Code	*Min Supply voltage*	*Max supply voltage*
A / ***E***	***6*** / ***10***	***16*** / ***32***
B / ***F***	***8*** / ***16***	***16*** / ***32***
C / ***G***	***9*** / ***22***	***16*** / ***32***
D / ***H***	***10.5*** / ***18***	***16*** / ***32***

4.3 OVERVOLTAGE / JUMP START

Simulates the condition where the generator regulator fails, so that the output voltage of the generator rises above normal values

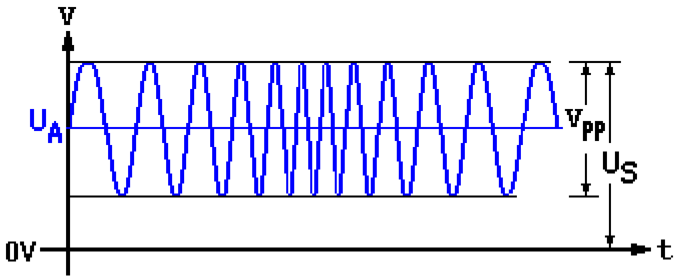
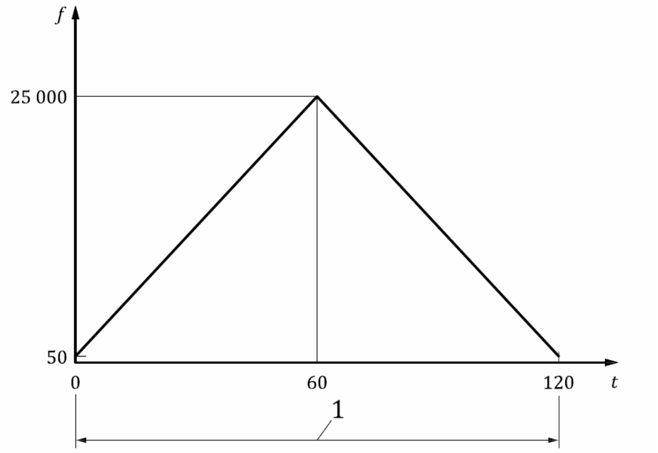
Testing at room temperature (jump start simulation) or testing at 20°C below the max. operating temperature



nominal voltage U_B = 12V: **U_S = 24V supply voltage** **td = 60s** **at room temperature**	*Jump start simulation* *The functional status shall be minimum class D as defined in ISO 16750-1. Functional status shall be class B where more stringent requirements are necessary.*
U_S = 18V supply voltage **td = 60min** **at T_{max} – 20°C operating temperature**	*"Heat the DUT in a hot air oven to a temperature 20°C below the maximum operating temperature, Tmax. The functional status for the DUT shall be minimum class C as defined in ISO 16750-1. Functional status shall be class A where more stringent requirements are necessary."*
nominal voltage U_B = 24V: **U_S = 36V supply voltage** **td = 60min** **at T_{max} – 20°C operating temperature**	*"Heat the DUT in a hot air oven to a temperature 20°C below the maximum operating temperature, Tmax. The functional status for the DUT shall be minimum class C as defined in ISO 16750-1. Functional status shall be class A where more stringent requirements are necessary."*

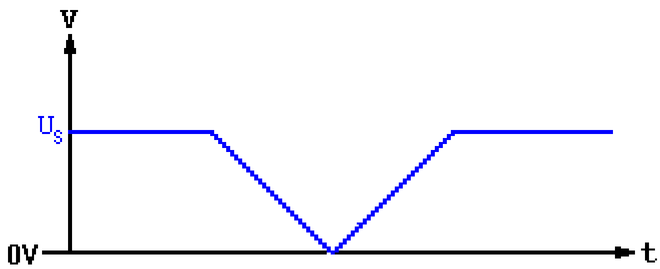
4.4 SUPERIMPOSED ALTERNATING VOLTAGE

Simulates a residual alternating current on the direct current supply

power supply internal resistance: *50mΩ ... 100mΩ*	
Maximum supply voltage U_S	*16V for systems with a nominal voltage of 12V U_A* *32V for systems with a nominal voltage of 24V U_A*
AC voltage superimposition as a sweep	*severity 1: V_{PP}, of 1 V, for U_A = 12 V and U_A = 24 V* *severity 2: V_{PP}, of 4 V, for U_A = 12 V and U_A = 24 V* *severity 3: V_{PP}, of 10 V, for U_A = 24 V only* *severity 4: V_{PP}, of 2 V, for U_A = 12 V only*
Sweep frequency range: *50Hz … 25kHz* Type of frequency sweep: *triangular, logarithmic* Sweep duration: *120s* Number of sweeps: *5 (continuously)*	

4.5 SLOW DECREASE AND INCREASE OF SUPPLY VOLTAGE

Simulates a gradual discharge and recharge of the battery

Decrease supply voltage from the minimum supply voltage, U_{Smin}, to 0V, then increase it from 0V to U_{Smin}, applying a change rate of (0.5 ± 0.1)V/min linear, or in equal steps of not more than 25mV.	
The functional status inside the supply voltage range shall be as specified in 4.2. Outside that range, it shall be minimum class D as defined in ISO 16750-1. The functional status of class C may be specified where more stringent requirements are necessary.	

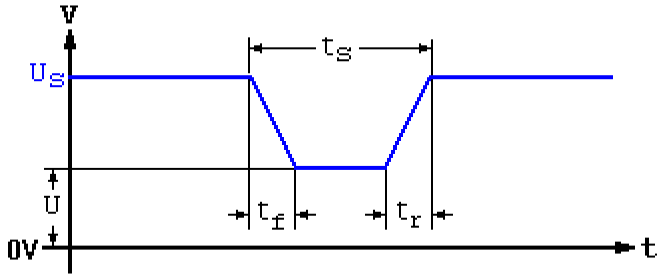
4.6 DISCONTINUITIES IN SUPPLY VOLTAGE

4.6.1 MOMENTARY DROP IN SUPPLY VOLTAGE

Simulates the effect when a conventional fuse element melts in another circuit
Apply the test pulse simultaneously to all relevant inputs (connections) of the DUT
The functional status shall be minimum class B as defined in ISO 16750-1. Reset is permitted upon agreement.

For **12V systems**:
$U_s = 9V$, $U = 4.5V$
t_f, t_r <10ms
t_s = 100ms

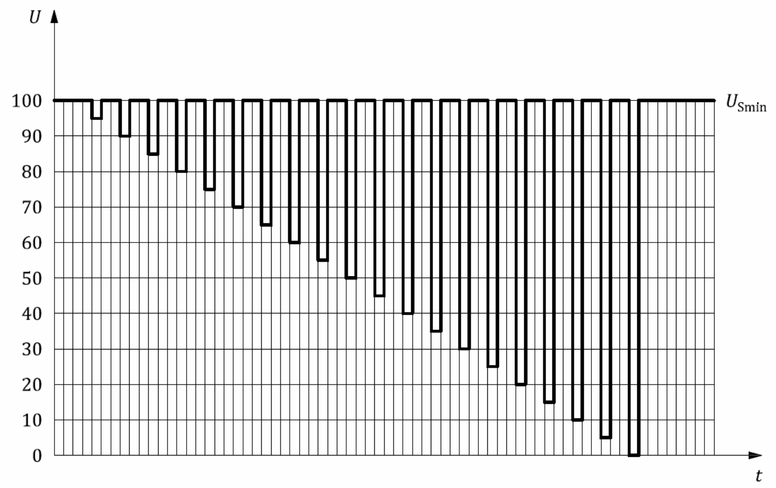
For **24V systems**:
$U_s = 18V$, $U = 9V$
t_f, t_r <10ms
t_s = 100ms



4.6.2 RESET BEHAVIOUR AT VOLTAGE DROP

Verifies the reset behaviour of the DUT at different voltage drops. This test is applicable to equipment with reset function, e.g. equipment containing microcontroller(s)
Apply the test pulse simultaneously to all relevant inputs (connections) and check the reset behaviour of the DUT

U_{smin} level	Duration
100% U_{smin}	10s
95% U_{smin}	5s
100% U_{smin}	10s
90% U_{smin}	5s
100% U_{smin}	10s
85% U_{smin}	5s
100% U_{smin}	10s
80% U_{smin}	5s
Continue with these steps down to	
20% U_{smin}	5s
100% U_{smin}	10s
15% U_{smin}	5s
100% U_{smin}	10s
10% U_{smin}	5s
100% U_{smin}	10s
5% U_{smin}	5s
100% U_{smin}	10s



4.6.3 STARTING PROFILE

Verifies the behaviour of a DUT during and after cranking.

Apply the starting profile 10 times simultaneously to all relevant inputs (connections) of the DUT.
A break of 1s to 2s between the starting cycles is recommended.
One or more profiles as described in Tables 3 and 4 shall be chosen in accordance with the application.

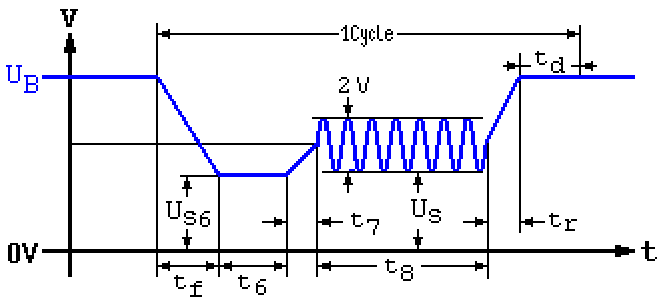


Table 3 — Starting profile values for systems with 12 V nominal voltage (U_N)

Parameter		Level			
		I	II	III	IV
Voltage V	U_{S6}	8 (−0,2)	4,5 (−0,2)	3 (−0,2)	6 (−0,2)
	U_S	9,5 (−0,2)	6,5 (−0,2)	5 (−0,2)	6,5 (−0,2)
Duration ms	t_f	5 (± 0,5)	5 (± 0,5)	5 (± 0,5)	5 (± 0,5)
	t_6	15 (±1,5)	15 (± 1,5)	15 (± 1,5)	15 (± 1,5)
	t_7	50 (± 5)	50 (± 5)	50 (± 5)	50 (± 5)
	t_8	1 000 (± 100)	10 000 (± 1 000)	1 000 (± 100)	10 000 (± 1 000)
	t_r	40 (± 4)	100 (± 10)	100 (± 10)	100 (± 10)
Minimum functional status		A[a]	B[a]	B[a]	A[a]
		A[b]	B[b]	C[b]	B[b]
		B[c]	C[c]	C[c]	C[c]
		B[d]	C[d]	C[d]	C[d]

a U_{Smin} = 6 V; U_{Smax} = 16 V (see Table 1, Code A).
b U_{Smin} = 8 V; U_{Smax} = 16 V (see Table 1, Code B).
c U_{Smin} = 9 V; U_{Smax} = 16 V (see Table 1, Code C).
d U_{Smin} = 10,5 V; U_{Smax} = 16 V (see Table 1, Code D).

Table 4 — Values for systems with 24 V nominal voltage (U_N)

Parameter		Level		
		I	II	III
Voltage V	U_{S6}	10 (−0,2)	8 (−0,2)	6 (−0,2)
	U_S	20 (−0,2)	15 (−0,2)	10 (−0,2)
Duration ms	t_f	10 (± 1)	10 (± 1)	10 (± 1)
	t_6	50 (± 5)	50 (± 5)	50 (± 5)
	t_7	50 (± 5)	50 (± 5)	50 (± 5)
	t_8	1 000 (± 100)	10 000 (± 1 000)	1 000 (± 100)
	t_r	40 (± 4)	100 (± 10)	40 (± 10)
Minimum functional status		A[a]	B[a]	B[a]
		A[b]	B[b]	C[b]
		B[c]	C[c]	C[c]
		B[d]	C[d]	C[d]

4.6.4 LOAD DUMP

Simulation of load dump transient occurring in the event of a discharged battery being disconnected while the alternator is generating charging current with other loads remaining on the alternator circuit.
The test pulse generator shall be capable of producing the load dump test pulse according to 4.6.4.2.2 and 4.6.4.2.3. A verification procedure for the generator performance and tolerances is given in Annex A.

4.6.4.2.2 Test A – without centralized load dump suppression

Parameters:
t time
U test voltage
td duration of pulse
tr rising slope
U_A supply voltage for generator in operation (ISO 16750-1)

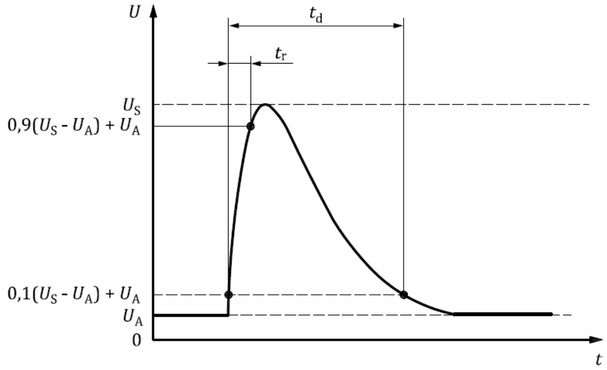


Table 5 — Pulse for test A in systems with 12 V and 24 V nominal voltage

Parameter	Type of system		Minimum test requirements
	U_N = 12 V	U_N = 24 V	
U_S[a] (V)	$79 \le U_S \le 101$	$151 \le U_S \le 202$	10 pulses at 1 min intervals
R_i[a] (Ω)	$0,5 \le R_i \le 4$	$1 \le R_i \le 8$	
t_d (ms)	$40 \le t_d \le 400$	$100 \le t_d \le 350$	
t_r (ms)	$10^{\,0}_{-5}$	$10^{\,0}_{-5}$	

4.6.4.2.3 Test B – with centralized load dump suppression

Parameters:
t time
U test voltage
td duration of pulse
tr rising slope
U_A supply voltage for generator in operation (ISO 16750-1)
US supply voltage
US supply voltage with load dump suppression*

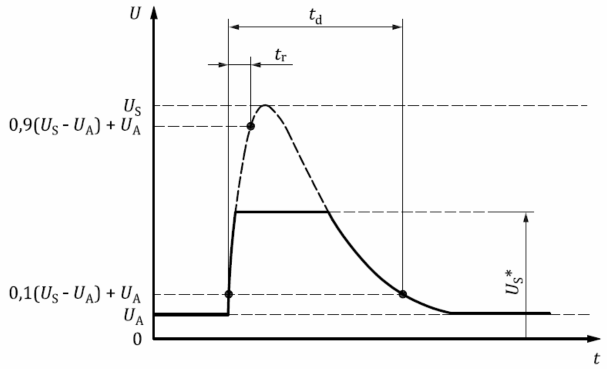


Table 6 — Pulse for test B in systems with 12 V and 24 V nominal voltage

Parameter	Type of system		Minimum test requirements
	U_N = 12 V	U_N = 24 V	
U_S[a] (V)	$79 \le U_S \le 101$	$151 \le U_S \le 202$	5 pulses at 1 min intervals
U_S^* (V)	35	As specified by customer (typical value 58)	
R_i[a] (Ω)	$0,5 \le R_i \le 4$	$1 \le R_i \le 8$	
t_d (ms)	$40 \le t_d \le 400$	$100 \le t_d \le 350$	
T_3 (ms)	$10^{\,0}_{-5}$	$10^{\,0}_{-5}$	

$$R_i = \frac{10 \times U_{nom} \times N_{act}}{0,8 \times I_{rated} \times 12\,000\ \text{min}^{-1}}$$

The internal resistance of the load dump test pulse generator:
U_{nom} is the specified voltage of the alternator;
I_{rated} is the specified current at an alternator speed of 6 000 min−1, as given in ISO 8854;
N_{act} is the actual alternator speed, in reciprocal minutes.

4.7 REVERSED VOLTAGE

Checks the ability of a DUT to withstand against the connection of a reversed battery in case of using an auxiliary starting device.

Connect and fuse the DUT as in the real vehicle, but without generator and battery. Choose the applicable voltages from the following cases and apply them simultaneously to all relevant power terminals with reversed polarity.

Case 1: 12V nom. voltage
The alternator circuit is not fused and the rectifier diodes withstand a reversed voltage for 60s
Apply a reversed test voltage of 4V simultaneously to all relevant input terminals of the DUT for a duration of (60 ± 6) s.

Case 2: 12V/24V nom. voltage
In all other cases, apply the test voltage, U_A (see ISO 16750-1 and Table 7), with reversed polarity simultaneously to all relevant input terminals of the DUT for a duration of (60 ± 6) s.

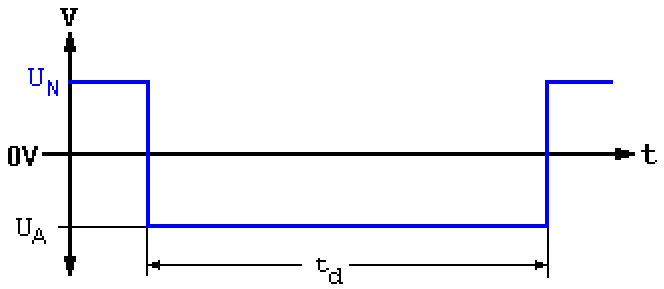


Table 7 — Test voltage

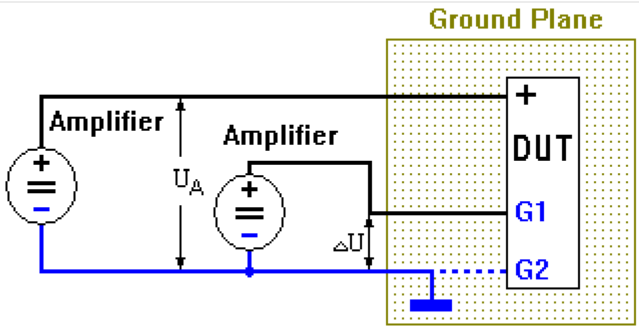
Nominal voltage, U_N V	Test voltage, U_A V
12	14
24	28

4.8 GROUND REFERENCE AND SUPPLY OFFSET

Verifies reliable operation of a component, if two or more power supply paths exist
A component may have a power ground and a signal ground that are outputs on different circuits.

All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. Apply U_A to the DUT and confirm normal operation.

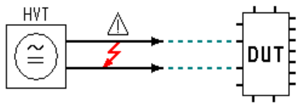
The ground/supply offset test applies to ground/supply lines.
The offset shall be applied to each ground/supply line and between each ground/supply line separately in sequence.
For all DUTs, the offset voltage shall be (1,0 ± 0,1) V.



With regard to the functional performance status class A for all functional groups, there shall be no malfunction or latch up of the DUT.

4.11 WITHSTAND VOLTAGE

Ensures the dielectric withstand voltage capability of circuits with galvanic isolation. This test is required only for systems/components which contain inductive elements (e.g. relays, motors, coils) or are connected to circuits with inductive load.

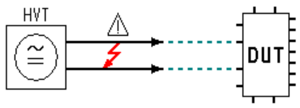


Apply a sinusoidal test voltage of 500 V_{rms} (50Hz … 60 Hz) to devices in systems with 12V and 24V nominal voltage for a duration of 60 s between:
- *terminals with galvanic isolation*
- *terminals and housing with electrically conductive surface with galvanic isolation*
- *terminals and an electrode wrapped around the housing (e.g. metal foil, sphere bath) in the case of plastic housing*

The functional status shall be minimum class C as defined in ISO 16750-1. Neither dielectric breakdown nor flash-over shall occur during the test.

4.12 INSULATION RESISTANCE

Ensures a minimum value of ohmic resistance required to avoid current between galvanically isolated circuits and conductive parts of the DUT. The test gives an indication of the relative quality of the insulation system and material.



Apply a test voltage of 500V_{DC} to the DUT for 60s between:
- *terminals with galvanic isolation*
- *terminals and housing with electrically conductive surface with galvanic isolation*
- *terminals and an electrode wrapped around the housing (e.g. metal foil) in the case of plastic material housing*

The insulation resistance shall be greater than 10 MΩ.