Class. No.: 8MD00
Descriptors: electronic component, interference, EMC, coupled interference, sensor, sensor cable, sensor interference

Electromagnetic Compatibility of Automotive Electronic Components

Coupled Interferences on Sensor Cables

Previous issues

TL 82366: 1994-03, 2003-03

Changes

The following changes have been made as compared to Technical Supply Specification TL 82366: 2002-03:

- Adaptation to ISO/DIS 7637-3 (September 2006)
- Functional statuses adapted
- Section "Test documentation" deleted (requirement exists in Component Performance Specifications)
- Capacitive coupling clamp
  - Pulses 1 and 2 omitted
  - If there are 20 or more sensor cables in the wiring harness, individual testing with reduced test voltage is required.

QUELLE: NOLIS

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Numerical notation acc. to ISO practice.
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Contents

Page
1 Scope ... 2
2 Definitions ... 2
3 General test conditions ... 4
4 Description of functional statuses ... 4
5 Tests ... 4
6 Test equipment ... 9
7 Referenced documents ... 14

1 Scope

Technical Supply Specification TL 82366 contains requirements and tests to ensure electromagnetic compatibility (EMC) of electronic assemblies with respect to coupled interferences in cables.

Excluded are cables considered part of the power supply, which are subject to TL 82066.

2 Definitions

Vehicle power supply system

The vehicle power supply system is the wiring system present in a motor vehicle to provide electrical power, including the attached battery and the generator with regulator.

Supply voltage

The supply voltage is the voltage that occurs at any arbitrarily chosen pair of terminals of the power supply system, one terminal may also be a ground connection.

Nominal voltage of the power supply system

The nominal voltage of the power supply system is specified in order to achieve independence from the respective battery technology.

Coupling

Coupling is the disturbance of cables due to energy transfer from one cable to another.

Coupling clamp

A coupling clamp is a device of defined dimensions and characteristics for common mode coupling of a disturbance to the circuit under test without any galvanic connections to it.

Interference pulse

An interference pulse is a non-periodic, short-term positive and/or negative disturbance (voltage or current) between two steady conditions.

Pulse sequence

A pulse sequence is a number of repeated pulses during a given time interval.

Signal or sensor cables

Signal or sensor cables in the sense of TL 82366 are all cables that are not galvanically connected either directly or indirectly (via switch or relay contacts or valves/actuators/sensors) to the power supply cables. TL 82066 applies to the cables excluded here.

Interfering circuits

An interfering circuit is the circuit that emits electromagnetic interferences.

Electromagnetic compatibility (EMC)

The ability of electrical equipment to function satisfactorily in an electromagnetic environment without unduly influencing its environment (including other equipment).

Electromagnetic interference

Electromagnetic effects (e.g., fields) on circuits, components and systems (e.g., of a vehicle).

Disturbance of function

Undesired impairment of a device's function.

Degradation

A function is degraded if the function of a device is impaired in a way that cannot be disregarded but nevertheless can be accepted as being permissible. A degradation ends when the disturbance subsides.

Malfunction

Impairment of the device's function that is beyond permissible. A malfunction ends when the disturbance subsides.

Function failure

Impairment of a device's function that is beyond permissible and in which the function can be restored only by technical measures.

Disturbance

Electromagnetic quantity that can cause an undesirable effect in electronic equipment.

Interference source

Origin of disturbances.

Interference sink

Electronic equipment whose function can be influenced by disturbances.

Interference emission

Disturbance emitted by an interference source.

Interference threshold

Minimum disturbance value that causes a malfunction in an interference sink.

Interference immunity

Ability of an electronic device to tolerate disturbances of a defined magnitude without malfunction.

Parallel routing

Here, parallel routing describes the common course of cables within a wiring harness.

Current injection probe

The current injection probe is a current transformer for differential mode-coupling of a disturbance into the test circuit without any galvanic connections to it.

3 General test conditions

Deviations from the following test conditions shall be recorded in the test report.

3.1 Environmental conditions

3.1.1 Temperatures

Operating temperatures	According to drawing, TL and/or performance specifications
Test temperature	(23 ± 5) °C, at operating temperature in special cases

3.2 Voltages

Table 1 – Nominal voltages

	Power supply system, nominal voltage (in V)		
	12	24	42
Operating voltage	10,8 to 15	21 to 30	32 to 45
Test voltage	13,5 ± 0.5 V	27 ± 1	42 ± 1,5

4 Description of functional statuses

The following functional statuses can occur during the course of and as a result of the test:

Functional status A

All device/system functions perform as specified during and after exposure to the disturbance.

Functional status B

All device/system functions perform as specified during exposure. However, one or more functions may be outside the specified limit deviation. All functions automatically return to the specified limits once exposure has ended. Memory functions shall remain in functional status A.

Functional status C

One or more device/system functions do not perform as specified during exposure, but return to normal operation once exposure has ended.

Functional status D

One or more device/system functions do not perform as specified during exposure, and do not return to normal operation before exposure has ended and the device/system has been restarted ("reset") by user intervention.

Functional status E

One or more device/system functions do not perform as specified during and after exposure and cannot be returned to normal functioning without repairing or replacing the respective device/system.

5 Tests

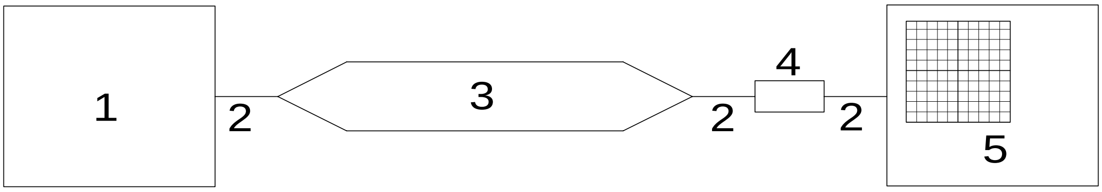
A coupling clamp is used to implement capacitive coupling of a disturbance into the interference sink. In the case of inductive coupling, the current injection probe is used. Thus, reproducible and comparable results can be achieved.

During the bench test, the interferences are coupled into the cables, which are designed as a test wiring harness, using a coupling clamp and current injection probe.

5.1 Capacitive coupling clamp

5.1.1 Setting of test voltage

No lines are routed through the coupling clamp during calibration of the pulse generator.



Legend:

1 Test pulse generator
2 50 Ω cable
3 Coupling clamp
4 50 Ω attenuation device
5 Oscilloscope (50 Ω)

Figure 1 - Measuring setup for voltage setting

5.1.2 Test setup for capacitive coupling clamp

The test setup in Figure 2 shall be followed in principle.

The device under test (DUT) shall be connected to its original operating environment, to loads and sensors or equivalent loads, etc., by means of a test wiring harness. Only the cables necessary for connecting the DUT to its peripheral devices shall be connected in the test wiring harness. Lines in the test wiring harness that are not used must not be terminated. Supply lines necessary for peripheral devices and the DUT shall be routed outside the coupling clamp. If power is supplied for the peripheral devices together with the sensor cables from the same control unit, e.g., sensors with 3,3 V or 5 V power supply, these cables shall be routed within the coupling clamp (refer to the EMC test plan for an exact definition). The cover shall be placed flat on the coupling clamp.

If the wiring harness contains more than 20 cables to be tested, the individual sensor cables shall also be tested.

The test wiring harness shall be placed outside the coupling clamp, (100 ± 20) mm above the ground plane, and preferably perpendicular to the longitudinal axis of the coupling clamp.

The minimum distance between the DUT and all other conductive structures, such as the walls of a shielded room (with the exception of the ground plane, see Section 6.6) shall exceed 0,5 m. Ground connections of the DUT shall be identical with those in the vehicle. If the housing of the DUT is not connected to the vehicle ground, but rather is connected to a separate ground connection, the DUT shall be placed on the ground plane and shall be separated from it by an insulated support.

Both the pulse generator and DUT shall be connected on the same side of the coupling clamp.

The ground plane serves as reference ground. All individual devices shall be connected to this plane using cables as short as possible.

The coaxial cable between the coupling clamp and pulse generator must not exceed a length of 0,5 m.

In order to ensure that the test results are reproducible, the test setup shall be mechanically fixed in an exact manner.

The test setup shall be documented.

This includes the following:

- Location and length of supply lines

- Type and location of ground connection
- Type and arrangement of peripheral devices
- Design of test wiring harness

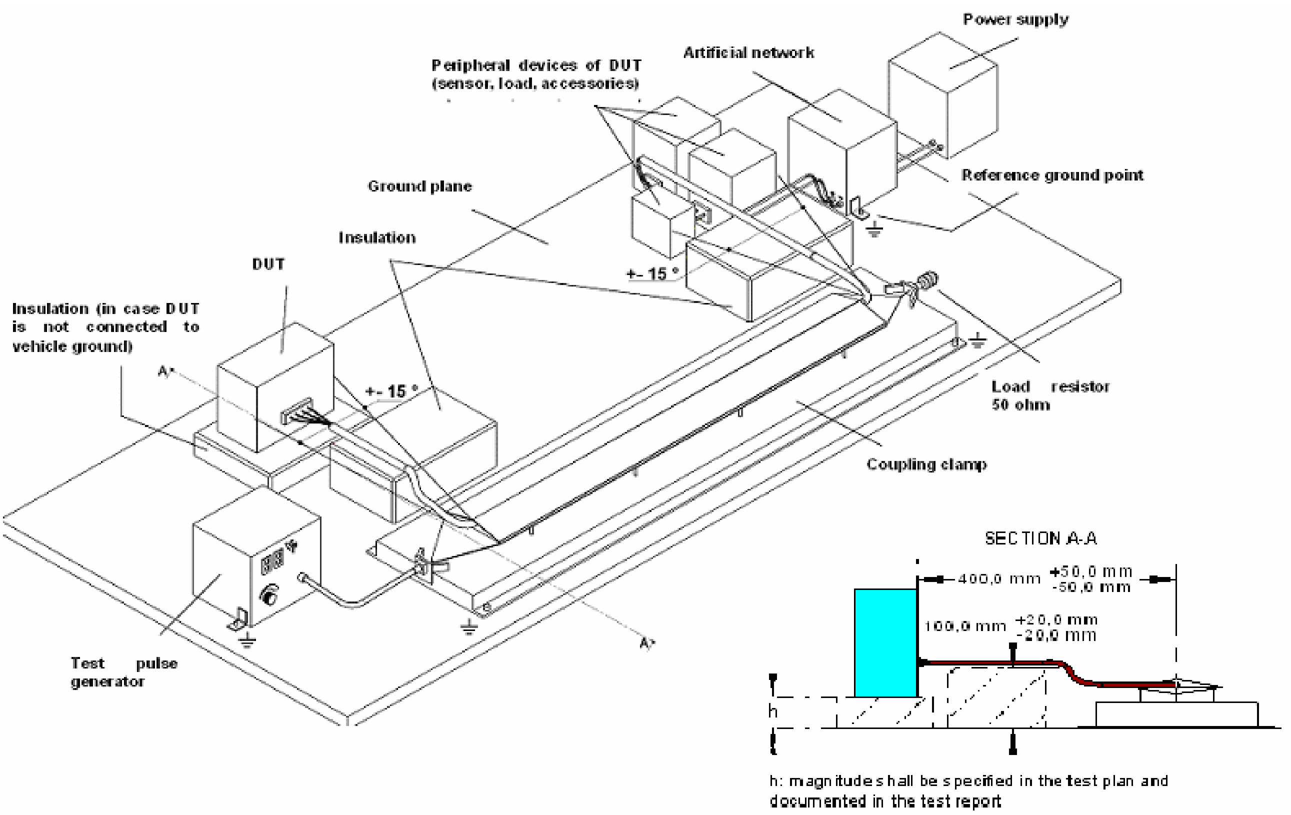


Figure 2 – Test setup (according to DIN ISO 7637-3)

5.2 Current injection probe (BCI probe)

5.2.1 Setting of test voltage

The induced test voltage is measured by means of a calibration bracket as depicted in the setup in Figure 3.

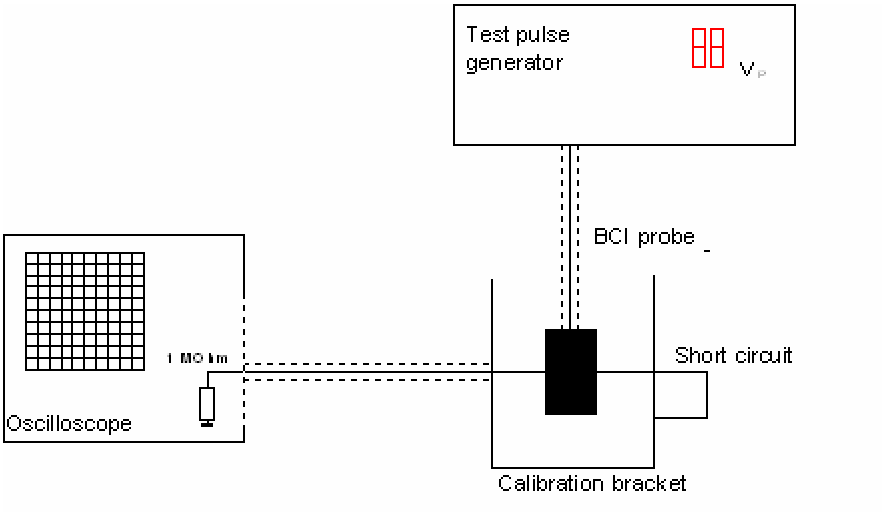


Figure 3 – Measuring setup for voltage setting in a calibration bracket according to ISO 11452-4:2000-3

Pulse intensity change of the original pulse (test pulse 1 of the generator) and of the pulse induced in the calibration bracket shall be documented in order to document the current injection probe's suitability. Both signals have to display comparable rise times. For more information, see also Section 6.7.

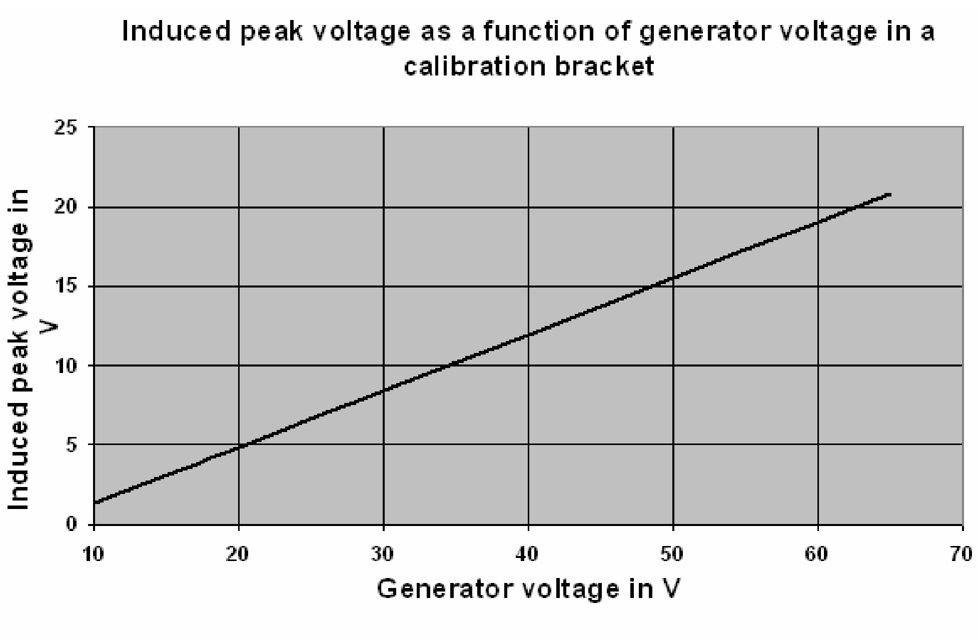


Figure 4 – Interdependence of generator voltage (set value) and induced voltage (peak value) in a calibration bracket

5.2.2 Test setup for current injection probe

The test setup in Figure 5 shall be followed.

The device under test (DUT) shall be connected to its original operating environment, to loads and sensors or equivalent loads, etc., by means of a test wiring harness. Only the cables necessary for connecting the DUT to its peripheral devices shall be connected in the test wiring harness. Lines in the test harness that are not used must not be terminated against the ground plane. Ground lines shall be routed outside the current injection probe. The distance between the DUT and BCI probe shall be (30 ± 3) cm.

The test wiring harness shall be arranged outside the current injection probe, (50 mm ± 10 mm) above the ground plane.

The minimum distance between the DUT and all other conductive structures, such as the walls of a shielded room (with the exception of the ground plane) shall exceed 0,5 m.

Ground connections of the DUT shall be identical with those in the vehicle. The DUT shall be placed on a ground plane and shall be separated from it by an insulated support having a thickness of (50 mm ± 10 mm), if the housing of the DUT is not connected to the vehicle ground but rather to a separate ground connection.

The ground plane serves as reference ground. All individual devices shall be connected to this plane using cables as short as possible.

The coaxial cable between the current injection probe and pulse generator must not exceed a length of 0,5 m.

In order to ensure that the test results are reproducible, the test setup shall be mechanically fixed in an exact manner.

The test setup shall be documented.

This includes the following:

- Location and length of supply lines
- Type and location of ground connection
- Type and arrangement of peripheral devices
- Design of test wiring harness

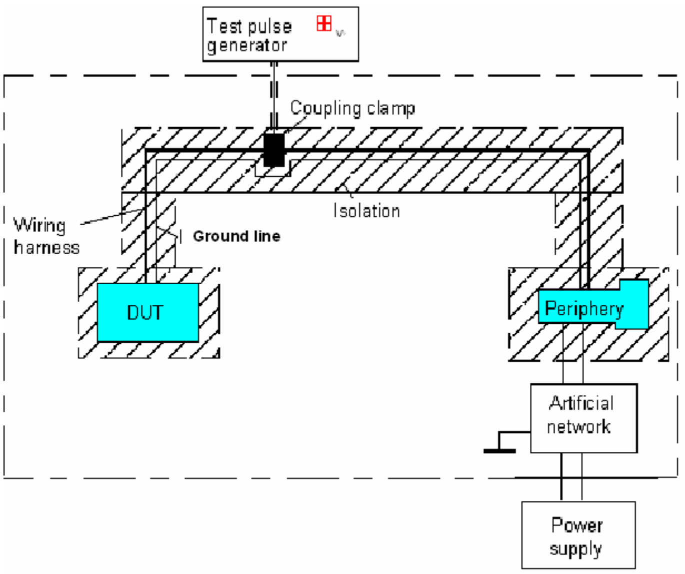


Figure 5 – Schematic test setup for current injection probe

5.3 Basic requirements for input circuitry

The input circuitry of control units shall be dimensioned such that

- The desired signals are not unduly affected
- Interfering signals above the tenfold maximum desired frequency[1)] can be attenuated using suitable filter structures, e.g., RC combinations.

5.4 Documentation of interference immunity

All requirements specified in this TL standard or in the respective performance specifications shall be met for EMC release.

Test scope and permissible functional statuses as well as their product-specific evaluation criteria shall be included in the Technical Supply Specification for the products. For tests according to TL 82366, only statuses A and B are permissible for the DUT.

To perform the interference immunity test, the test pulses shall be coupled into the sensor cables – which are implemented as a test wiring harness – using the coupling clamp and current injection probe.

The test pulses to be used are described in Section 5.3. The following test scope shall be adhered to:

5.4.1 Test with coupling clamp

a) Test pulses 3a and 3b

Test duration 10 min each

Repetition frequency 10 Hz $U_S = \pm 120$ V

If the wiring harness contains more than 20 sensor cables and the module components are applicable across the Group, the individual sensor cables shall also be tested with $U_s = +40$ V and -60 V

The voltages shall be measured at the 50 Ω termination of the coupling clamp (see Section 5.1.1, Figure 1).

5.4.2 Test with current injection probe

a) Test pulse 1 and 2: Repetition frequency 0,2 Hz to 5 Hz

500 pulses

Induced test voltage ± 5 V, if not otherwise specified

(for amplitude, see Section 5.2.1)

6 Test equipment

Tolerances: voltages and resistances ± 10%; times ± 30%

6.1 Measuring equipment for voltages

Oscilloscope (preferably with digital memory):

Bandwidth	At least 400 MHz
Writing time division	At least 5 ns/div

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[1] In order to reduce expenses, the designed upper limit frequency of the frequency does not have to be less than 10 kHz. Desired signals requiring filter frequencies above 1 MHz require special protection measures, which are outside the scope of TL 82366.

Note: Software filters are often not suitable because false signal values could be read in due to burst pulses lasting up to a few milliseconds. A hardware filter reduces the very short individual pulses independent of the burst duration.

Scanner head:

Division ratio	At least 10/1
Permissible input voltage	At least 1 kV
Length of connecting line	Maximum of 150 cm
Length of ground line	Maximum of 10 cm

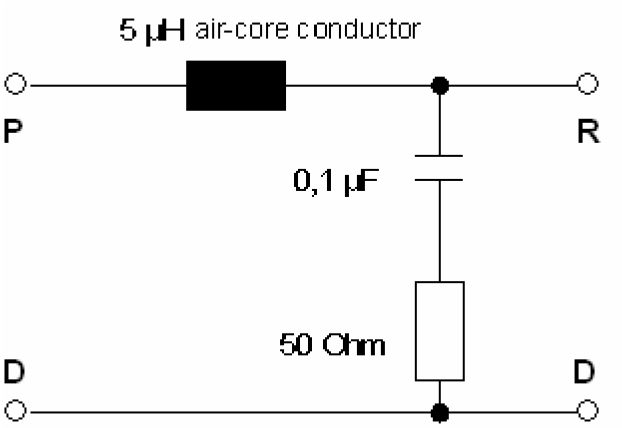
NOTE: Differing line lengths may affect the measuring result; they shall be noted in the report.

6.2 Artificial network for 12 V/24 V/42 V vehicle power supply systems

The artificial network is used to simulate the average impedance of the vehicle power supply system lines in order to evaluate the behavior of equipment and electrical/electronic components under bench test conditions.

The circuit diagram is shown in Figure 6. Figure 7 shows how the impedance of the artificial network changes as a function of frequency.

Direct voltage drop at maximum power must not exceed 250 mV.



P: Power supply terminal
R: Reference ground terminal
D: DUT terminal

Figure 6 – Circuit diagram of artificial network

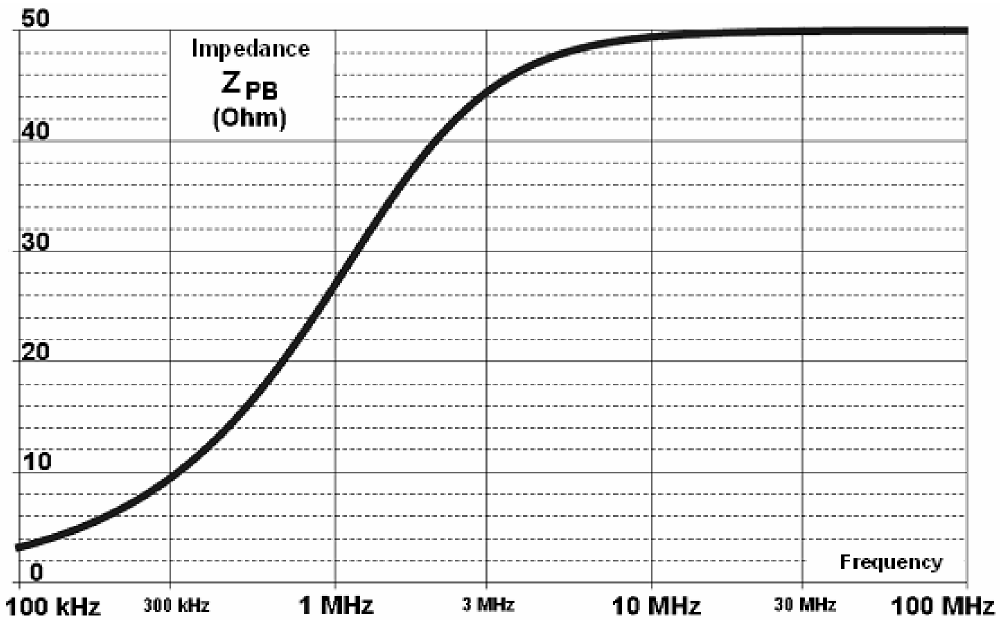


Figure 7 – Impedance Z_{DR} (Ω) of artificial network as a function of frequency

As seen from the DUT side (between terminals D and R); tolerance ± 10%; terminals P and R short-circuited.

6.3 Starter battery/power supply

There are two alternatives for power supply:

- A sufficiently high-capacity power supply unit to which an artificial network is connected downstream according to Section 6.2.
- A buffered starter battery common for the respective application, i.e., operating voltage is maintained at U_p by continuous loading.

6.4 Pulse generator

An interference pulse generator according to ISO 7637 shall be used as a substitute interference source. The specified values refer to the generator only. The procedure to be used is described in Section 5.

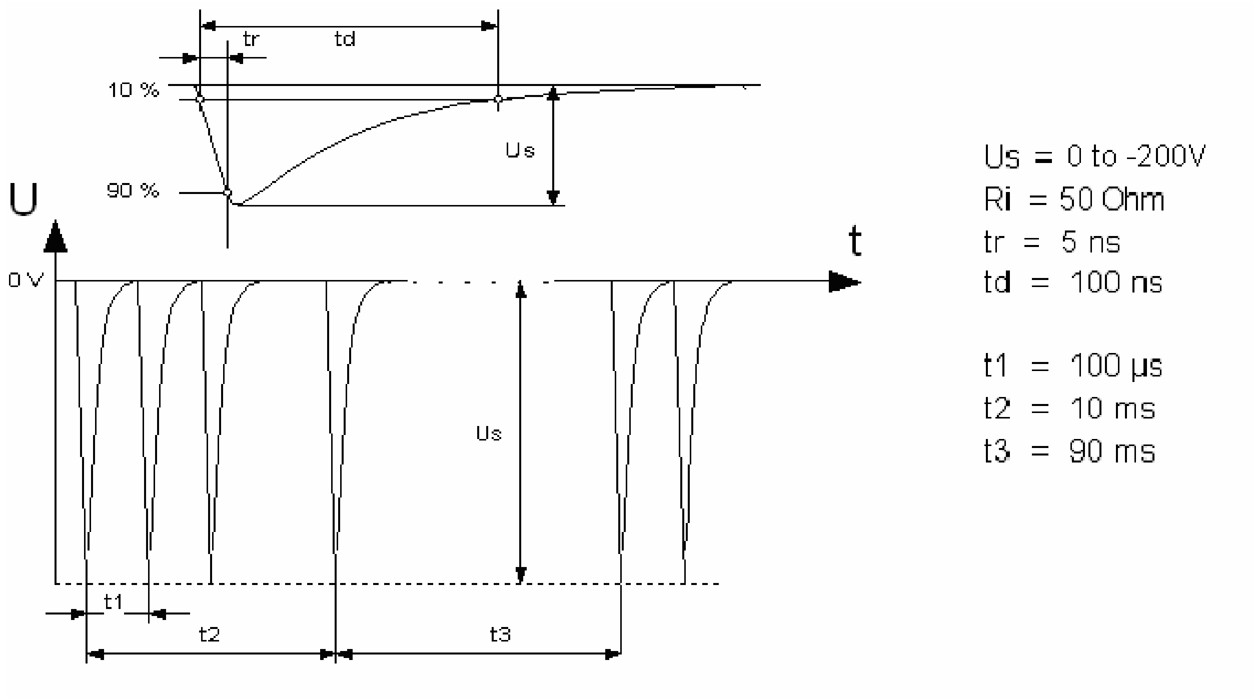


Figure 8 – Test pulse 3a

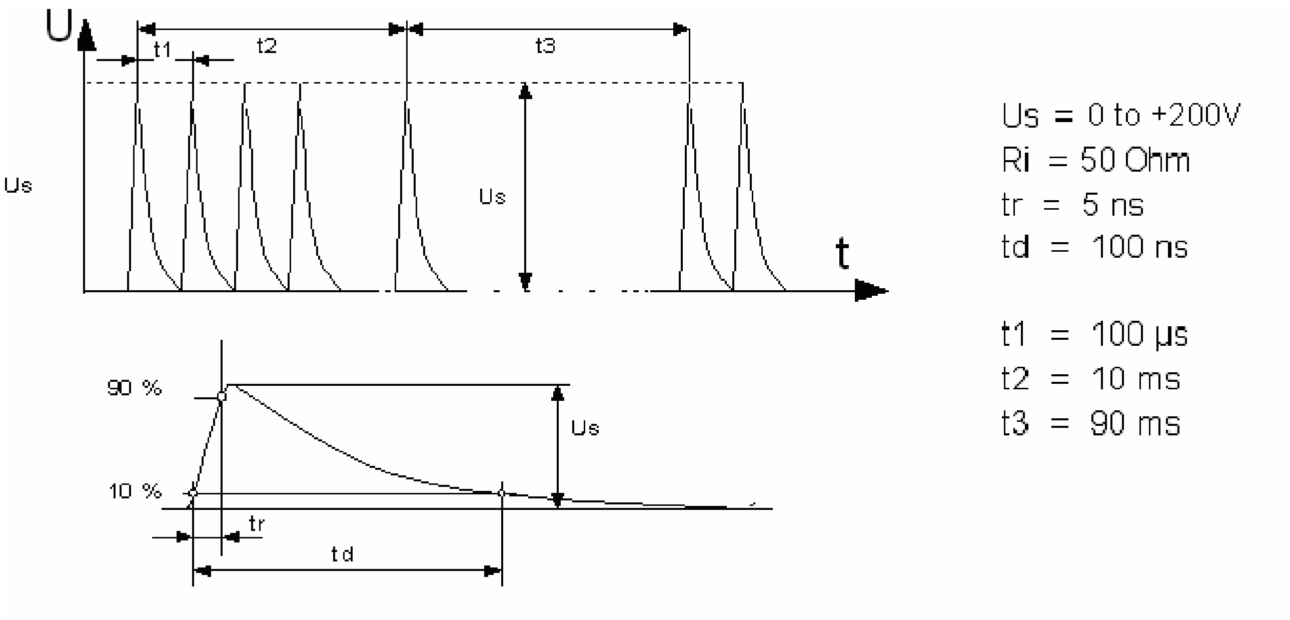
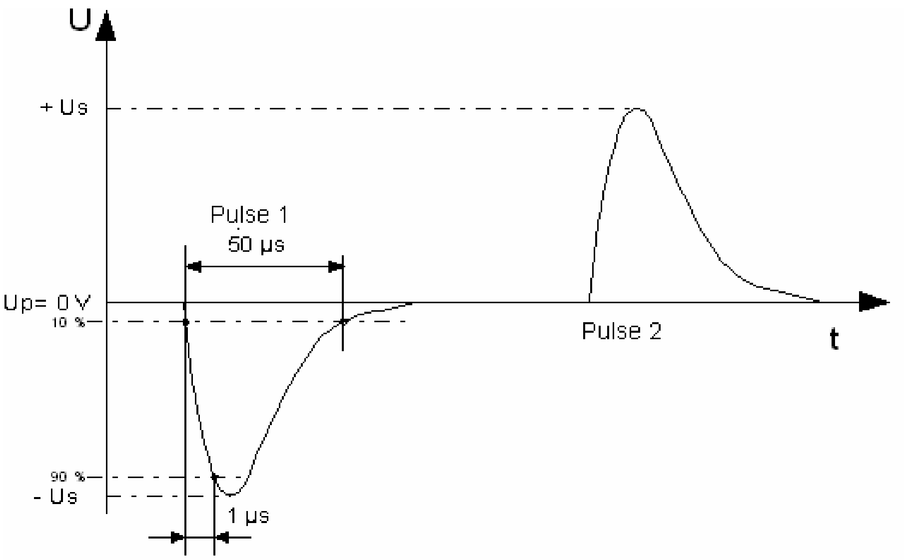


Figure 9 – Test pulse 3b



U_S = -200 V to +200 V, R_i = 10 Ohm

Figure 10 – Test pulses 1 and 2

6.5 Coupling clamp

The coupling clamp provides the means of coupling the disturbance into the interference sink without any galvanic connection of the interference source to the DUT.

The coupling clamp design is specified in detail in ISO 7637-3.

Deviating properties: compared with ISO 7637-3

Dielectric strength of the insulation for pulse voltage ≥ 240 V

6.6 Ground plane

The ground plane serves as a support and ground plane for the test setup with coupling clamp. It constitutes a metal plate (e.g. copper/zinc alloy, brass, copper) with a nominal thickness of 1,0 mm. The minimum size is 2 m x 1 m.

The ground plane is connected to the grounding system's protective ground.

6.7 Current injection probe

The current injection probe provides the means of coupling the disturbance into the interference sink without any galvanic connection of the interference source to the DUT.

For sufficient transmission of the test pulses stated in this standard, the transmission frequency response shall cover the range 200 kHz to 30 MHz at a minimum.

The dielectric strength of the insulation shall be greater than 100 V.

6.8 Test wiring harness

The test wiring harness consists of a number of sensor cables necessary for the electrical connection of the DUT to its peripheral devices. It has a length of (1,8 ± 0,1) m.

6.8.1 Position in the coupling clamp

The test wiring harness is engaged in the coupling clamp symmetrically. There are no requirements for the setup or the line diameters of the test wiring harness concerning EMC.

6.8.2 Position in the current injection probe

All lines except the ground lines are enclosed in the current injection probe. The ground line shall be routed externally around the current injection probe using the most direct path possible.

7 Referenced documents

The following documents cited in this standard are necessary for application.

In this Section, terminological inconsistencies may occur as the original titles are used.

TL 82066 Electromagnetic Compatibility of Automotive Electronic Components; Conducted Interference

DIN 40839-3 Elektromagnetische Verträglichkeit (EMV) in Straßenfahrzeugen; Eingekoppelte Störungen auf Geber- und Signalleitungen in 12 V- und 24 V Bordnetz (Electromagnetic Compatibility (EMC) in Road Vehicles, Electrical Transient Transmission by Capacitive and Inductive Coupling via Lines in 12 V and 24 V Power Supply Systems - only available in German)

ISO 7637-3 Road Vehicles - Electrical Disturbances from Conduction and Coupling – Part 3: Electrical Transient Transmission by Capacitive and Inductive Coupling via Lines Other than Supply Lines

ISO 11452-4 Road Vehicles - Component Test methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 4: Bulk Current Injection (BCI)