

## Line Impedance Stabilization Networks – Basics and Overview

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# Line Impedance Stabilization Networks – Basics and Overview

## 1 Introduction

A **line impedance stabilization network** (LISN) is a device used in conducted and radiated radio-frequency emission and susceptibility tests, as specified in various EMC/EMI test standards. LISN are also sometimes referred to as artificial networks (AN) or artificial mains networks (AMN).

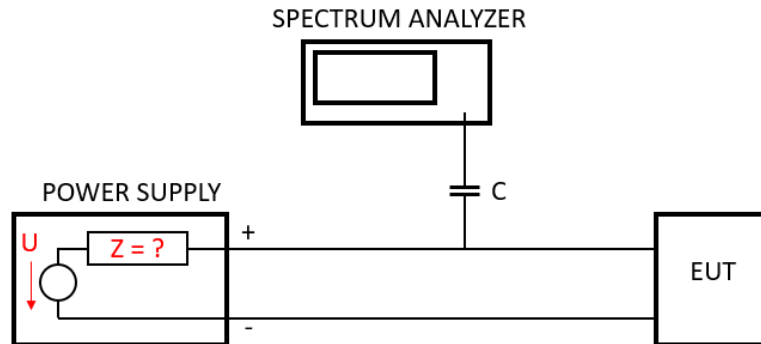
In conducted emission measurements, LISN are inserted into the supply lines of the equipment under test and provide an RF output to measure conducted emissions.

In many other test set-ups, LISN are inserted into the EUT supply lines just for the purpose of creating a defined source (supply) impedance.

The output impedance of a power supply (source) is hardly ever known and varies from source to source. EMC testing requires a well-defined and repeatable set up, which is created by placing a LISN in series with the source. The equipment under test does no longer see the output impedance of the source, but instead the specified impedance of the LISN.

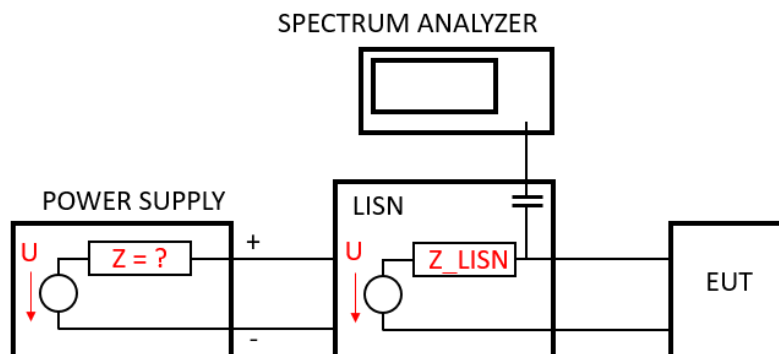
## 2 How does it work?

If you want to measure conducted noise emissions, you could do it as simple as below:



It is definitely possible, to measure conducted emissions produced by the EUT, using this simple set up. However, the amplitude of the conducted emissions will be influenced by the impedance of the source. The source impedance is part of a voltage divider in the overall system and has a significant influence on the amplitude of the measured amplitude of the conducted emissions. As it is necessary to get the same results for the same EUT in any lab, anywhere, it is necessary to remove the impedance of the supply source from the equation.

The picture below shows how a LISN is inserted into the setup, in order to provide a defined impedance for the conducted emissions travelling on the supply lines of an equipment under test:



A LISN can be connected to any power supply and provide the same voltage and current capability as the power supply at the EUT terminals. However, the source impedance of the LISN is specified by EMC standards and enables repeatable conducted emission measurements in any laboratory.

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### 3 How is it implemented?

The below impedance curve of a  $5\mu\text{H}$  LISN is copied from CISPR 25, Annex C, one of the EMC standards that specifies LISN:

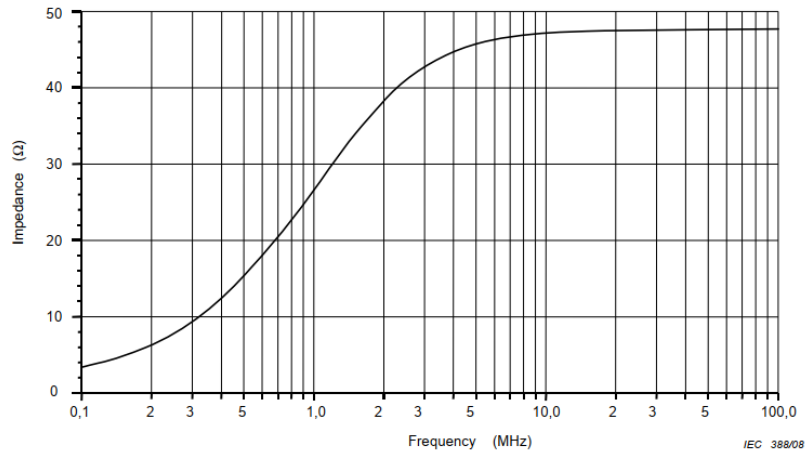


Figure E.1 – Characteristics of the AN impedance

For the most part of the specified frequency range, the LISN impedance is close to 50 Ohm. At frequencies below 5 MHz, the impedance starts to decrease and at DC, the impedance will be close to 0 Ohm.

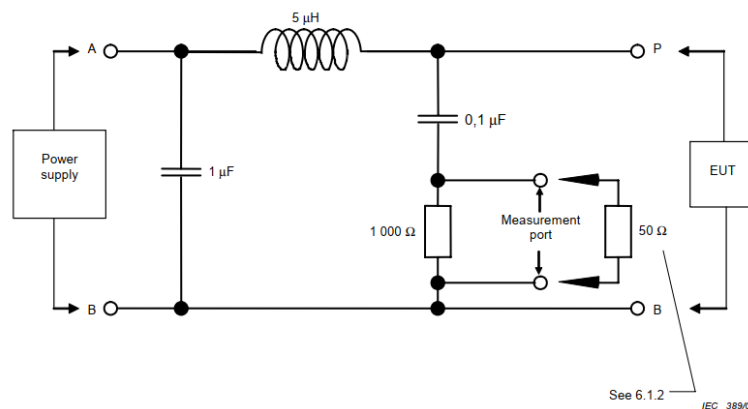


Figure E.2 – Example of  $5\mu\text{H}$  AN schematic

The simplified schematic reveals, how the LISN is implemented. At frequencies above 5 MHz, the impedance of the  $5\mu\text{H}$  inductor is high. The LISN impedance at the EUT port is dominated by the 50 Ohm load resistance. In fact, when the LISN is used for conducted noise measurement, the 50 Ohm impedance is actually the input impedance of the connected spectrum analyzer or measurement receiver. This also explains, why the RF output of a LISN has to be terminated with 50 Ohm, when used without measurement equipment connected.

At frequencies below 5 MHz, the impedance of the inductor combined with the  $1\mu\text{F}$  capacitor starts loading the 50 Ohm resistor and the overall LISN impedance decreases according to the specified impedance curve.

The LISN impedance must follow the specification independently of the source terminals shorted or open or whatever impedance connected to it. The impedance of the connected power supply does not have any influence on the impedance of the LISN within its specified frequency range.

This is just an example of a LISN. There are several specified variants, but the underlying principle is same for all.

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### 4 LISN variants

There are three types of LISN when categorized in terms of **topology**:

- V LISN
- Delta LISN
- T-ISN

The V-LISN measures the disturbance voltage between one supply line and ground (e.g. positive supply line and ground) or two lines and ground (e.g. phase/neutral and ground). The disturbance voltage is the sum of differential mode and common mode disturbance voltage. The V-LISN is by far the most commonly used LISN.

The Delta LISN provides separate outputs for common mode disturbance voltage and differential mode voltage. A pair of LISN connected to a “LISN-Mate” will do the same.

The T-ISN misses the “L” because it is not used for monitoring supply lines, but twisted pairs connected to telecommunication and data transmission lines. It measures common mode disturbance voltage only.

Furthermore, LISN are categorized in terms of **inductance**:

- 5  $\mu$ H LISN
- 50  $\mu$ H LISN

5  $\mu$ H LISN are primarily used for testing equipment installed in vehicles. 5  $\mu$ H mimics the inductance of supply lines with a length of 5 meters, as wiring harnesses in vehicles hardly exceed this length. 5  $\mu$ H LISN are primarily used for conducted noise measurements in the frequency range of 150 kHz to 110 MHz. 5 $\mu$ H LISN designed for testing according to DO-160 and MIL-STD 461 standard, cover the frequency range 10 kHz to 400 MHz.

50  $\mu$ H are primarily used for equipment installed in domestic or industrial environment. 50  $\mu$ H mimics the inductance of 50 meters of supply wiring inside a building.

50  $\mu$ H LISN are again divided into two groups:

50 Ohm // 50  $\mu$ H for the majority of applications, where conducted noise is measured from 150 kHz to 30 MHz.

50 Ohm // (50  $\mu$ H + 5 Ohm), for applications, where conducted noise is measured from 9 kHz to 30 MHz.

Many 50  $\mu$ H LISN fulfill the requirements of both variants.

At frequencies above 3 MHz, the 5 $\mu$ H LISN and the 50 $\mu$ H LISN have the same impedance. Note that LISN inductors must be implemented as air core inductors. Using ferrite cores could result in saturation and cause incorrect measurement results due to harmonic distortions.

LISN also differ in the number of **paths**:

5  $\mu$ H LISN always have a single supply line path.

If the equipment under test is chassis grounded with the negative supply line shorter than 20 cm, a single LISN is inserted into the positive supply line.

If the equipment under test is connected to the power source with a negative supply line longer than 20 cm, two LISN must be used. One LISN is inserted into the positive supply line and a second LISN is inserted into the negative supply line. Separate measurements need to be carried out, one on the positive supply line and another one on the negative supply line. While measuring on one path, the LISN in the other path must be terminated by 50 Ohm. Both measurements need to be below the applicable limits.

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The DO-160 standard for aircraft equipment requires a 10 $\mu$ F capacitor to be attached to the source side of 5 $\mu$ H LISN. This is typically implemented by adding the capacitor externally to the source side terminals. When using a 5 $\mu$ H in the test set-up for automotive pulse testing according to ISO 7637-2, the 1 $\mu$ F capacitor needs to be removed. In case of the TBOH01 5 $\mu$ H LISN, there is no internal 1 $\mu$ F capacitor. This means that it has to be added externally for most of the tests. In case of the TBL0550-1, there is an internal high current jumper which can be pulled to disconnect the 1 $\mu$ F capacitor. Other LISN may provide a switch to isolate the 1 $\mu$ F capacitor.

50  $\mu$ H LISN are available with one, two and four paths.

50 $\mu$ H LISN used for conducted emission measurements of DC supplied equipment typically have one path, though normally a pair is being set up. One LISN is inserted into the positive supply line and another one is inserted into the negative supply line. These LISN are typically equipped with binding posts or terminal blocks to connect the wiring.

50  $\mu$ H LISN for conducted emission measurements of single phase AC supplied equipment typically contain two paths in one housing. Both Line and Neutral are fed through a 50 $\mu$ H LISN path. These LISN are typically equipped with standard mains AC sockets to connect source and equipment under test. The LISN may have separate RF outputs for Phase and Neutral or a selection switch to either connect phase or neutral to the RF connector.

50  $\mu$ H LISN for 3-phase supplied equipment typically contain 4 paths. One path for each phase plus a fourth path for Neutral.

50  $\mu$ H LISN used for AC supplied EUTs, typically contain a 250  $\mu$ H pre-filter for the suppression of line noise and line harmonics.

50  $\mu$ H LISN contain high inductance capacitors as per specification. These capacitors cause a high ground leakage current. In order to avoid tripping the ground fault switch and for safety reasons, these LISN should always be supplied through an isolation transformer. Safety considerations are another reason for using isolation transformers. LISN contain capacitors from phase and neutral to ground, which in standard equipment must be Y2 rated. However as CISPR 16 specifies far higher capacitance values than commercially available in Y2 technology, large Y2 capacitor banks would be required to achieve the necessary capacitance. This would significantly increase the price and dimensions of LISNs. Consequently most LISN are implemented using AC motor capacitors and supplied through isolation transformers.

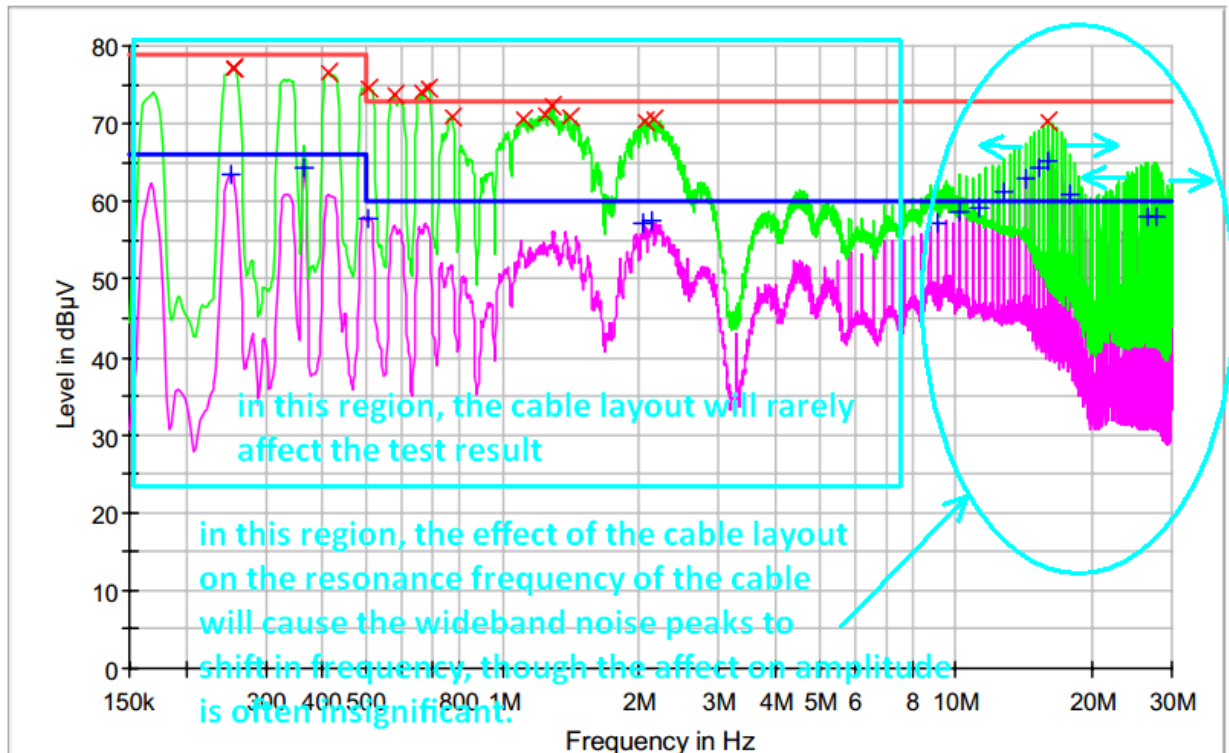
50  $\mu$ H LISN designed for AC supplied EUTs can also be used for DC supplied equipment. However consider that wiring needs to be improvised to interface with AC sockets. Not every 50 $\mu$ H LISN may be suitable for 400Hz supplies such as used for certain aircraft equipment. Some of the capacitors are combined with a series resistor. The resistor may be only rated for the current flowing at 50 Hz, when the maximum rated supply voltage is applied. These LISN may still be used for 400Hz supplies, however at a reduced maximum supply voltage. Check the LISN datasheets with respect to 400 Hz ratings.

50  $\mu$ H single path LISN designed for DC equipment can be combined for single phase or 3-phase measurements, however consider that these LISN typically do not contain 250 $\mu$ H pre-filters. Consequently it may be a good idea to connect a 9 kHz or 150 kHz high pass to the RF output for additional suppression of 50 Hz / 50 Hz harmonics.

The way that LISN have to be positioned within a test set-up differs from standard to standard. Chapter 6 gives some example of test set-ups. Always check your standard on how to make a standard conformant set-up. The cable layout may influence the resonance frequency of the cable. Typically it will not affect the measurement at lower frequencies, however you may see a difference at frequencies above 10 MHz,

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where Common Mode noise is dominant. If you modify the cable layout, you will most likely see wideband noise peaks shifting in frequency, though the amplitude often remains at the same level.



*Effect of the cable layout on measurement results*

## 5 LISN limitations

LISN are limited with respect to its frequency range, both on the low end and towards higher frequencies. Consequently LISN cannot be used to measure conducted emissions on most data lines. This is the domain of RF current monitoring probes.

LISN are limited with respect to current and voltage ratings. LISN cannot be practically implemented for very high voltages and high currents. LISN for currents up to 800A and voltages up to 1500 V is about as far as you can go. In cases where LISN cannot be applied or suitable LISN are not available, capacitive voltage probes (CVP), capacitive foil probes (CFP), EFT and current probes may be used instead.

## 6 LISN applications

LISN are not only used for conducted emission measurement, but for establishing a defined supply line impedance in numerous measurement set ups. The following examples are just a few out of many.

### 6.1 Conducted emission measurements, voltage method

In EMC pre-compliance testing, LISN are primarily used for conducted emission measurements on supply lines.

Chapter 6 shows examples of conducted emission measurement set-ups for various standards.

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DC powered equipment is measured on its DC supply lines and AC-mains powered equipment is measured on its mains supply lines.

In case of a device with an external power supply, such as a laptop, a 3D-printer or a mobile phone with charger, just to name a few, the standard only requires testing at the AC-mains side and does not bother the interconnecting supply cable from the power supply or charger to the connected device. This does not mean that noise on these lines will go unpunished. Noise on any interconnecting supply lines will radiate from the cable and potentially cause failing the radiated noise tests of the product.

Hence it is good practice to insert a pair of 5µH LISN in between the power supply and the attached device and to check conducted emissions on the interconnecting cable. As both the power supply and the associated device may produce conducted emissions, make a first measurement with the EUT terminals connected to the power supply terminal and thereafter flip the LISN to check the emissions on the supply input terminals of the connected device. There are no limits specified for this case, so apply the limits specified for the mains powered side and ensure that the emissions are within limits to avoid a bad surprise at the test house.

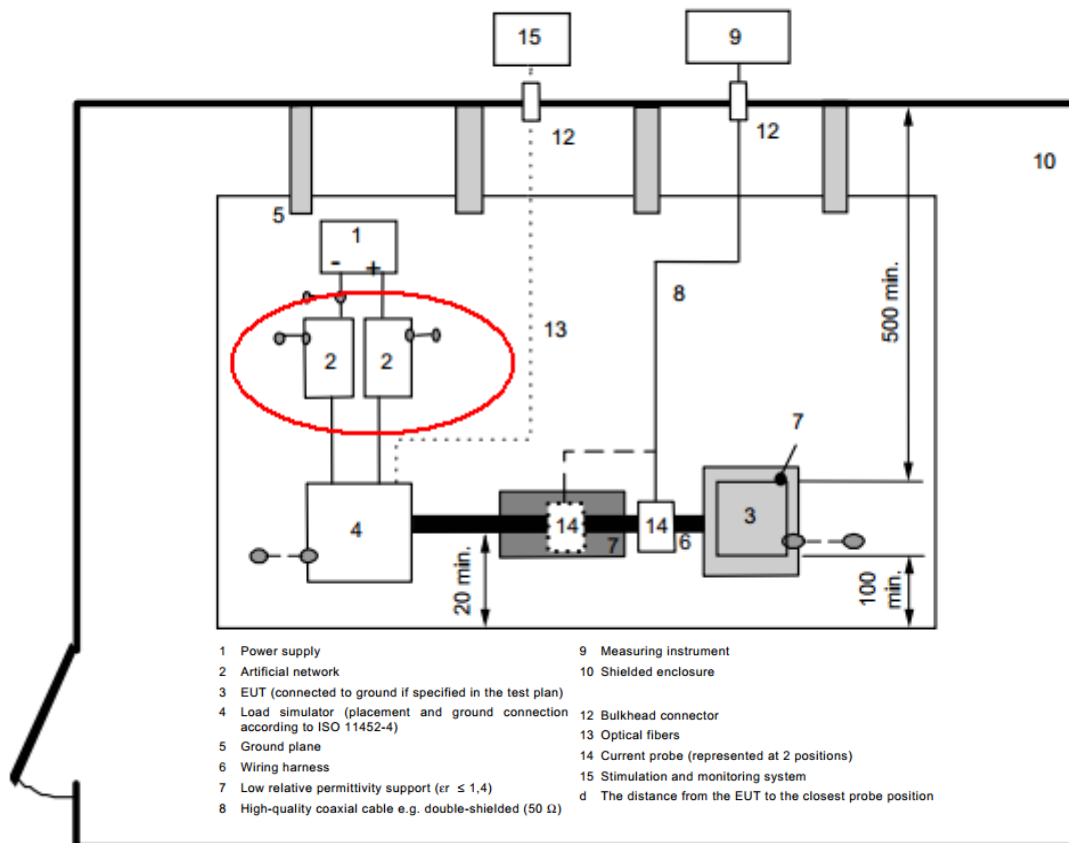
### 6.1 Conducted emission measurements, current method

Example set up from CISPR 25. LISN in the supply lines create a defined impedance level. The LISN RF outputs are terminated with 50 Ohm and not used for conducted noise measurement:

– 36 –

CISPR 25 © IEC:2008

Dimensions in millimetres – not to scale



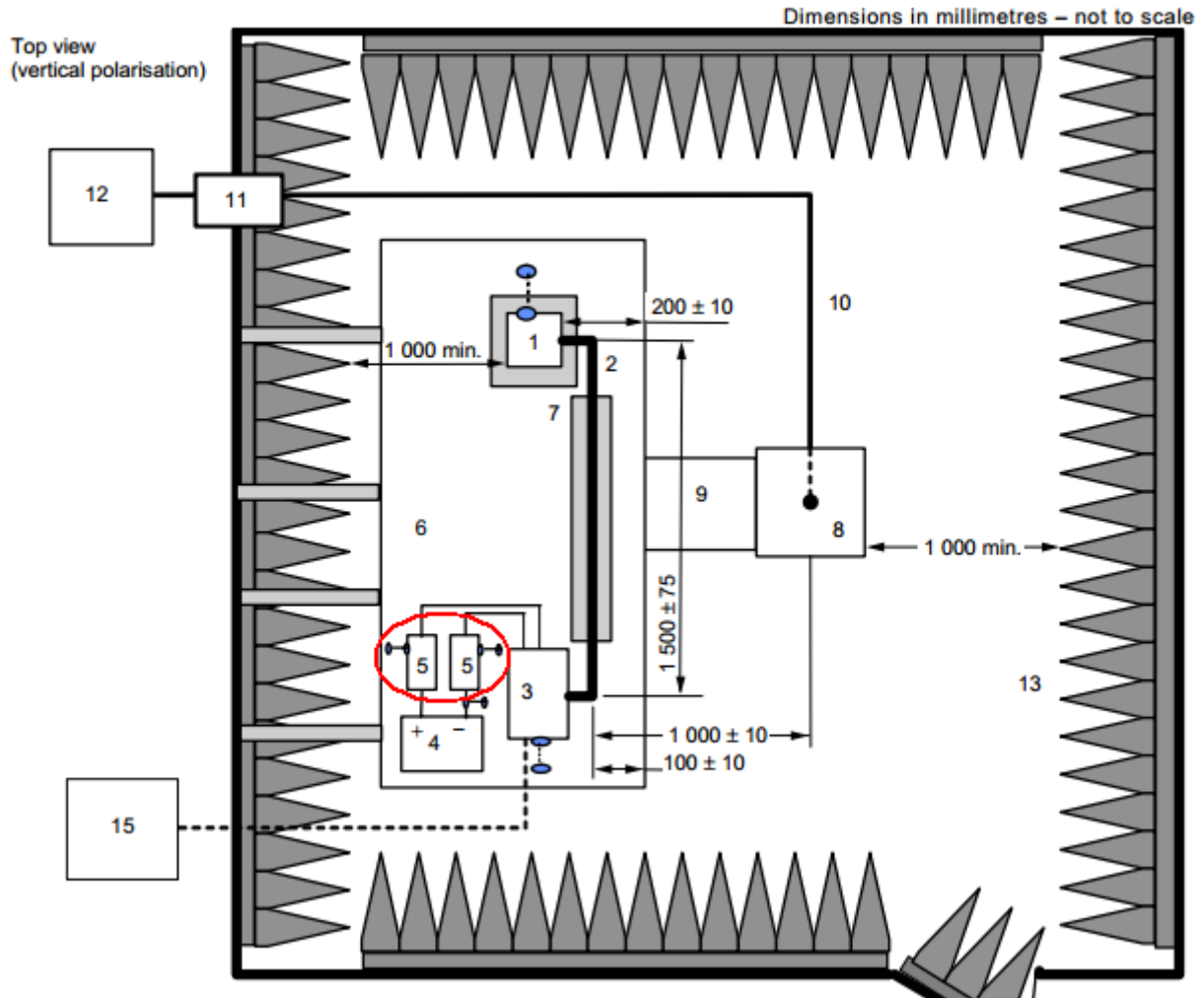
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## 6.1 Radiated emission measurements

Example set up from CISPR 25. LISN in the supply lines create a defined impedance level. The LISN RF outputs are terminated with 50 Ohm.

CISPR 25 © IEC:2008

– 43 –



- 1 EUT (grounded locally if required in test plan)
- 2 Test harness
- 3 Load simulator (placement and ground connection according to 6.4.2.5)
- 4 Power supply (location optional)
- 5 Artificial network (AN)
- 6 Ground plane (bonded to shielded enclosure)
- 7 Low relative permittivity support ( $\epsilon_r \leq 1,4$ )
- 8 Rod antenna with counterpoise (dimensions: 600 mm by 600 mm typical)
- $h = (900 \pm 100)$  mm
- $h_{cp} = h + (+10 / -20)$  mm
- 9 Grounding connection (full width bond between counterpoise and ground plane)
- 10 High-quality coaxial cable e.g. double-shielded ( $50 \Omega$ )
- 11 Bulkhead connector
- 12 Measuring instrument
- 13 RF absorber material
- 14 Antenna matching unit (the preferred location is below the counterpoise; if above the counterpoise then the base of the antenna rod shall be at the height of the ground plane)
- 15 Stimulation and monitoring system



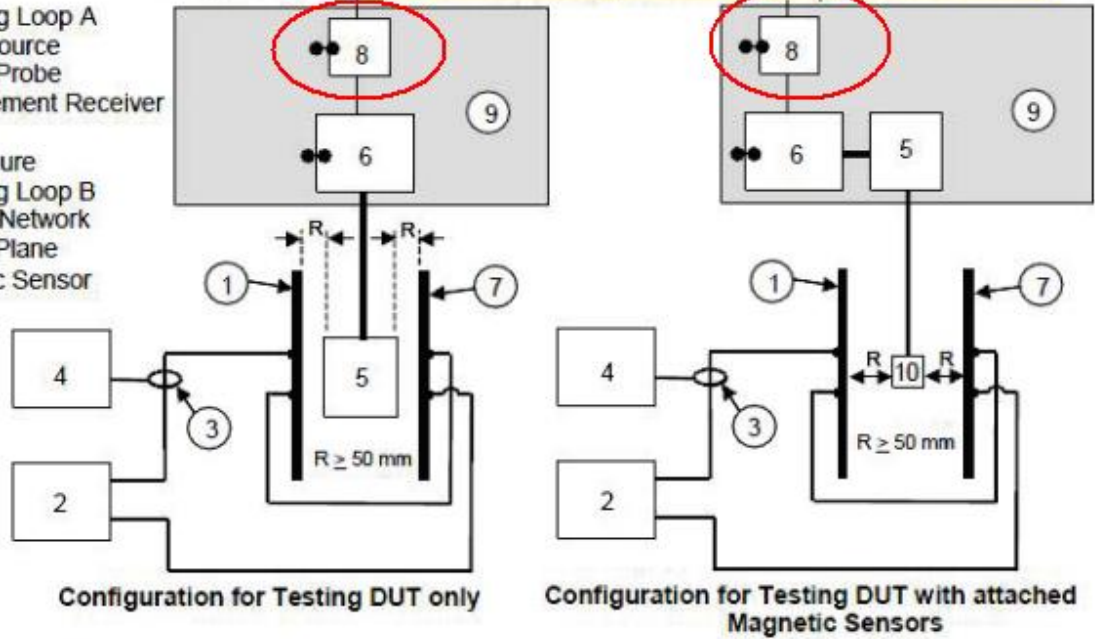
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## 6.1 Immunity testing

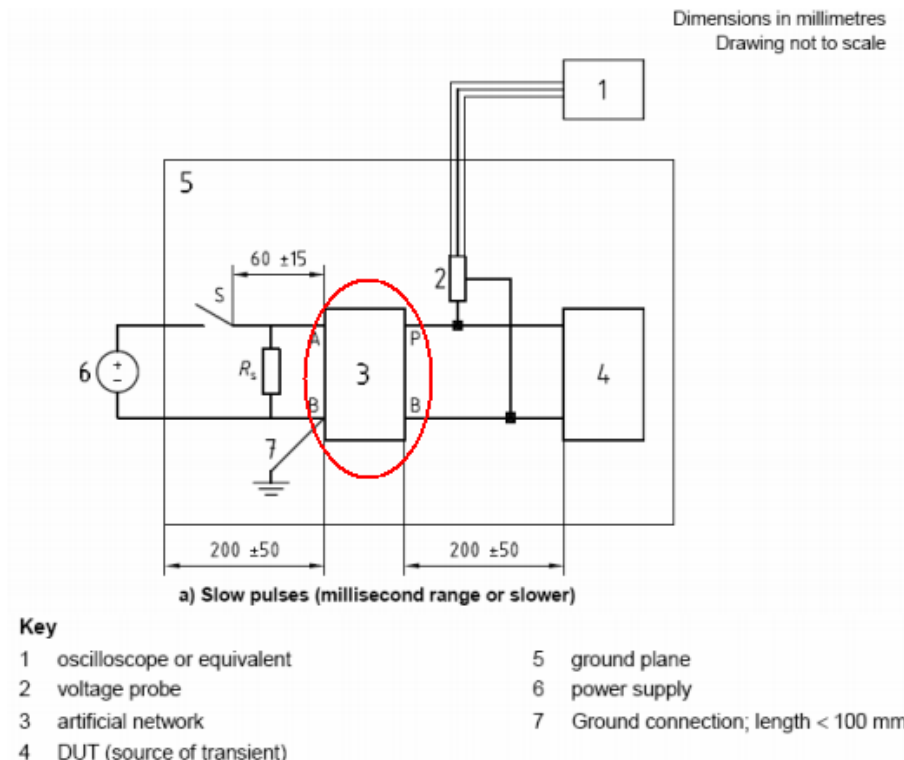
Immunity to magnetic field:

**Figure 11- 2: Magnetic Immunity Test Set-ups for Helmholtz Coil**

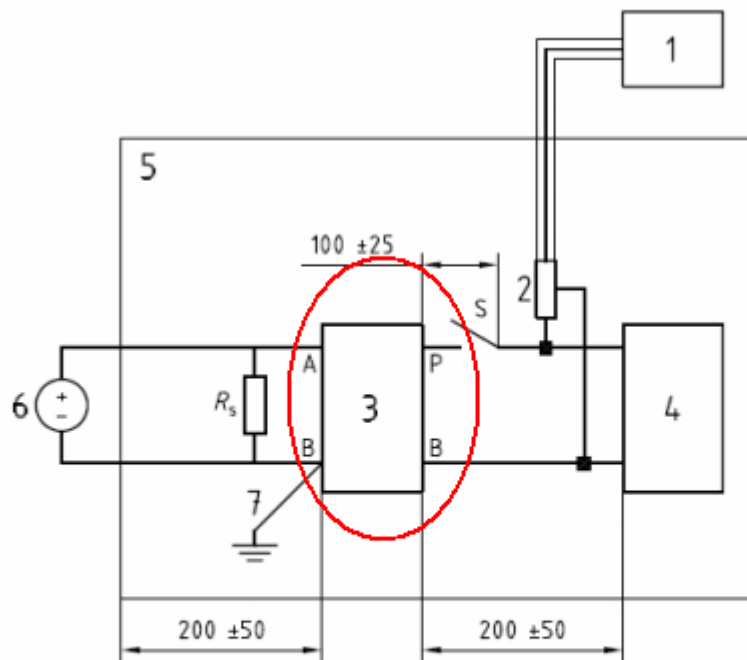
- 1 Radiating Loop A
- 2 Signal Source
- 3 Current Probe
- 4 Measurement Receiver
- 5 DUT
- 6 Test Fixture
- 7 Radiating Loop B
- 8 Artificial Network
- 9 Ground Plane
- 10 Magnetic Sensor



Immunity to voltage transients:



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b) Fast pulses (nanosecond-to-microsecond range)

### Key

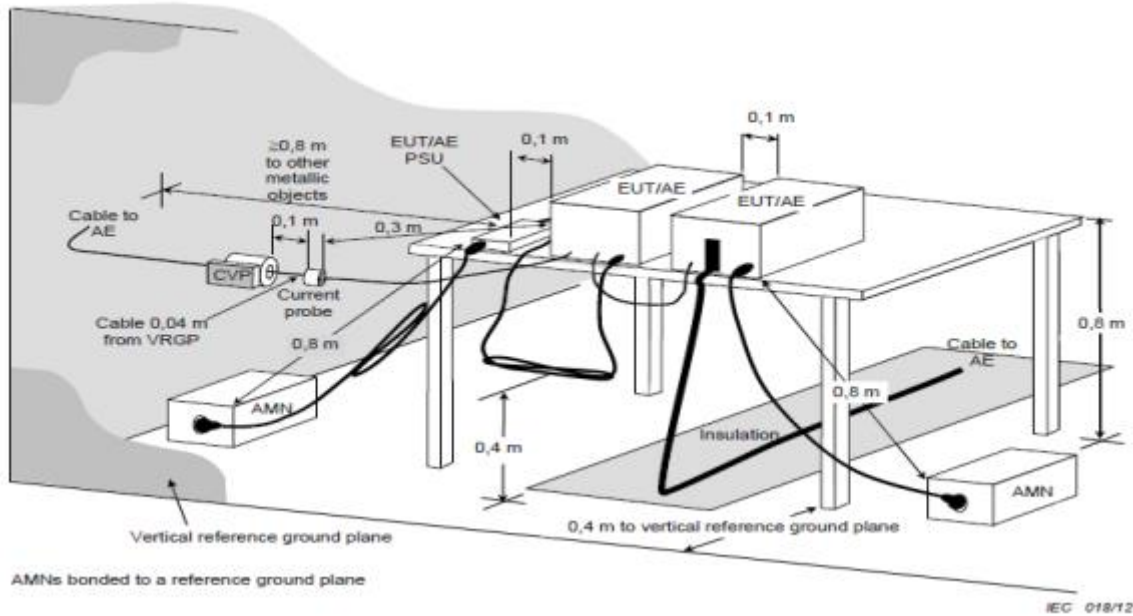
- |   |                            |   |                                    |
|---|----------------------------|---|------------------------------------|
| 1 | oscilloscope or equivalent | 5 | ground plane                       |
| 2 | voltage probe              | 6 | power supply                       |
| 3 | artificial network         | 7 | Ground connection; length < 100 mm |
| 4 | DUT (source of transient)  |   |                                    |

Note that some immunity standards have special requirements with respect to the LISN capacitors.

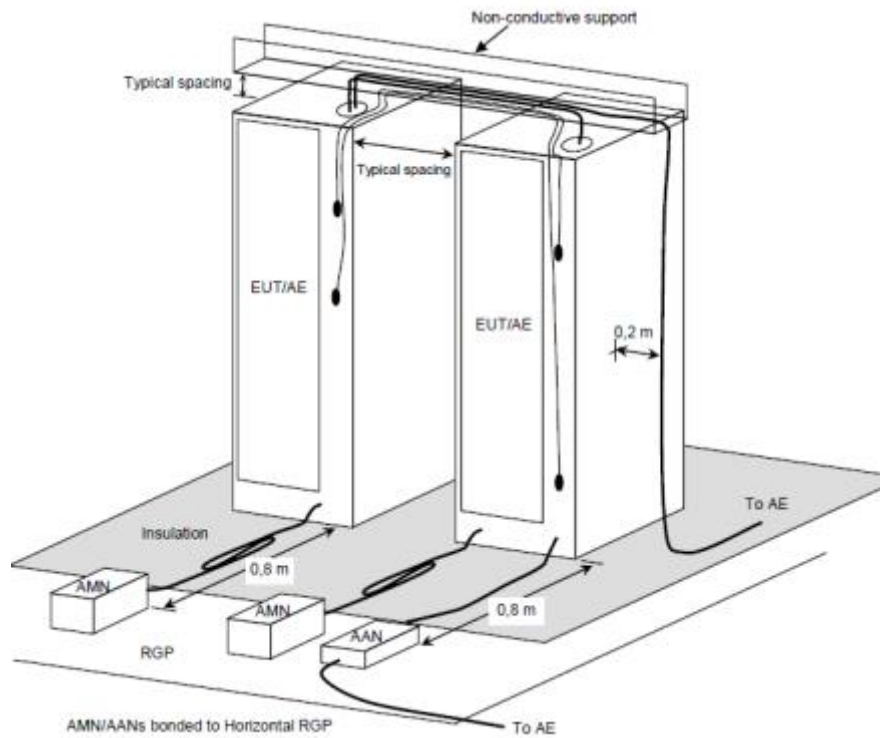
# Line Impedance Stabilization Networks – Basics and Overview

## 7 LISN set-up examples for conducted emission measurements

### CISPR xx, other than CISPR 25

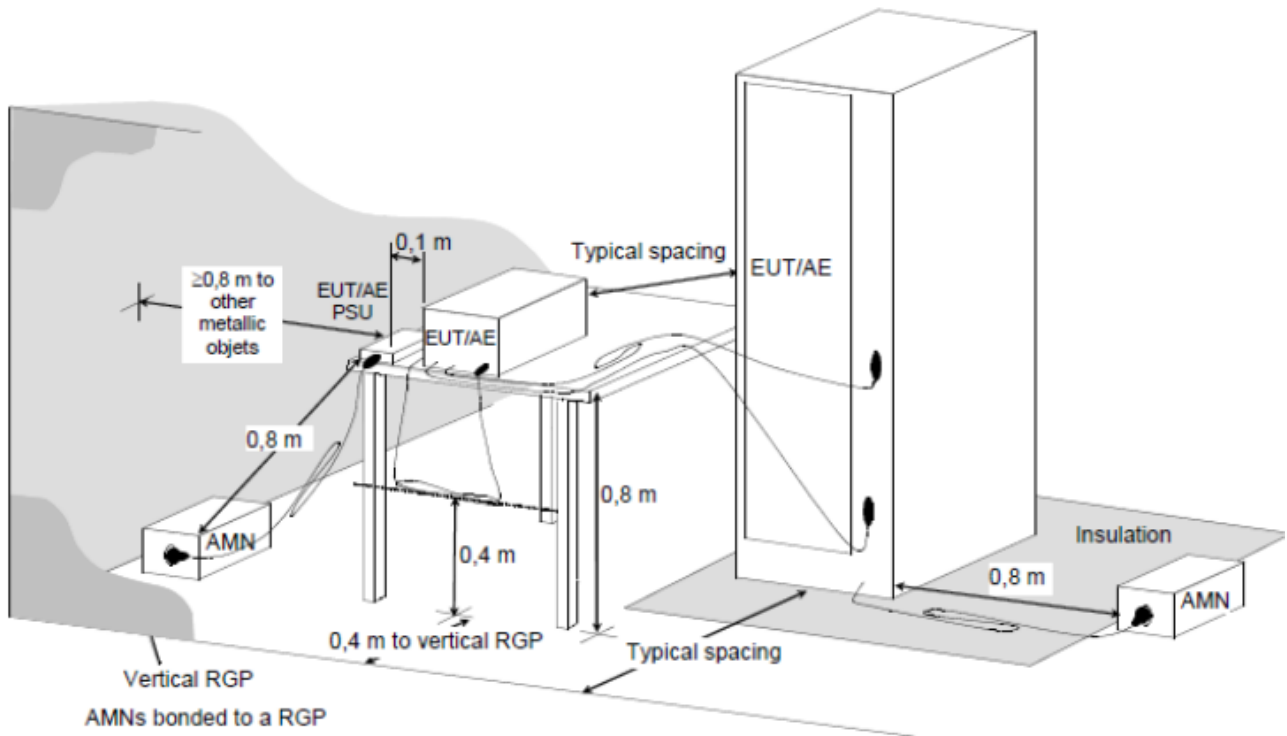


Set up for table top equipment



Set up for floor standing equipment

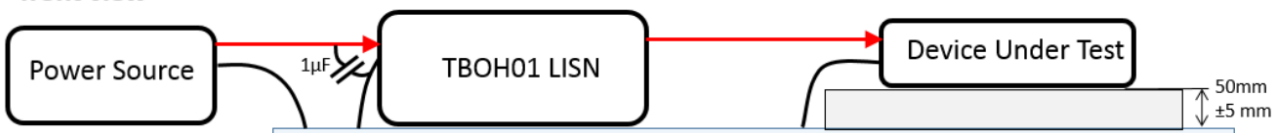
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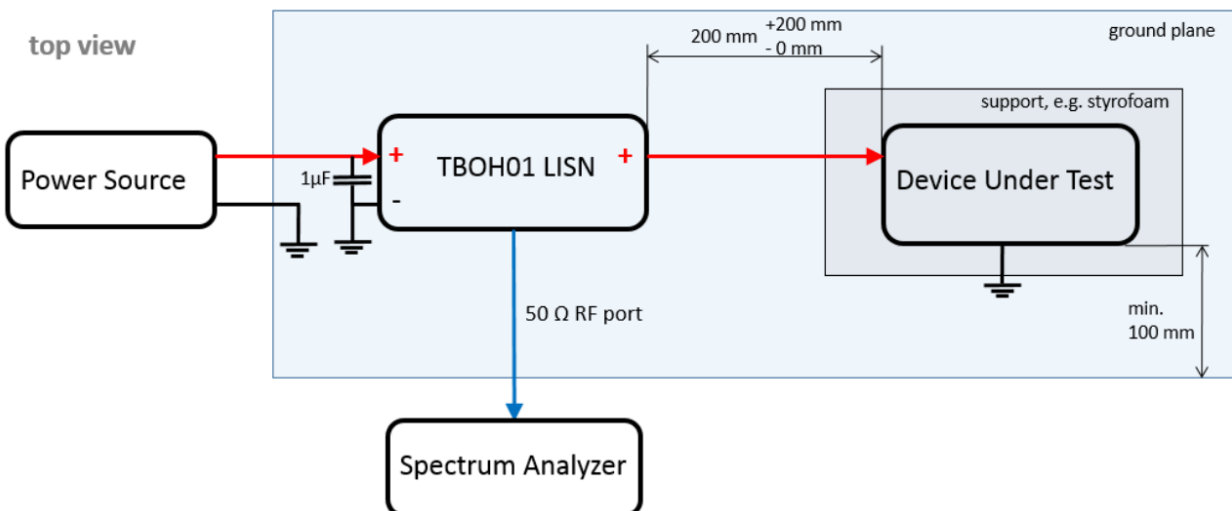
Set up for combination equipment

## CISPR 25

front view



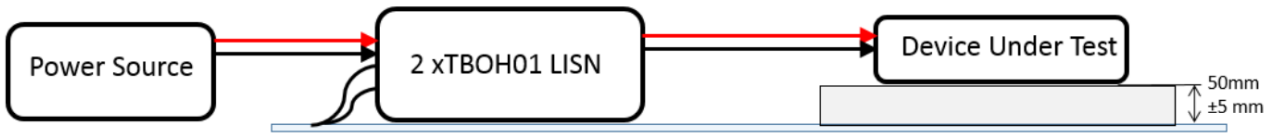
top view



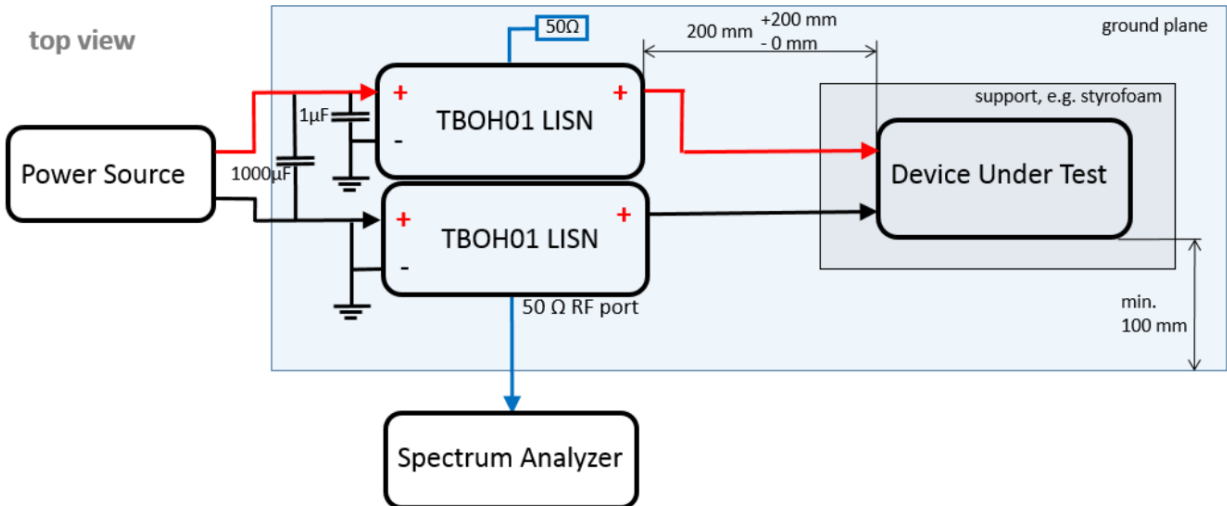
CISPR 25, voltage method, EUT (DUT) locally grounded

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front view

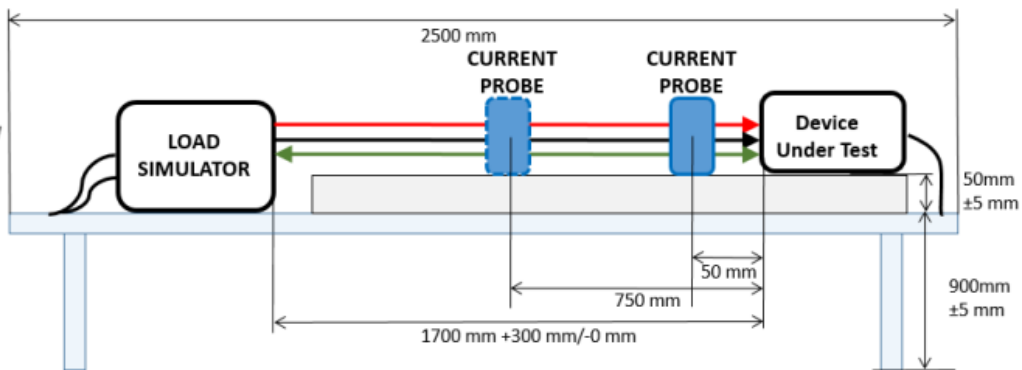


top view

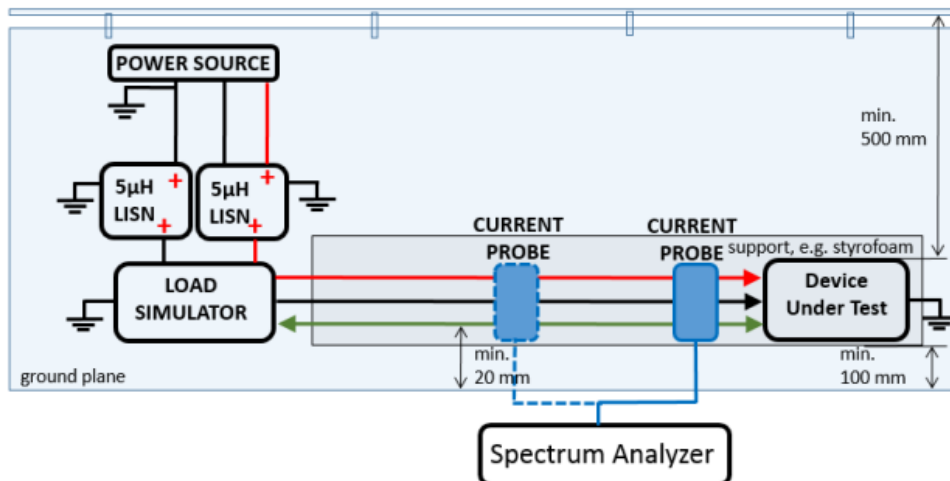


CISPR 25, voltage method, EUT (DUT) remotely grounded

front view



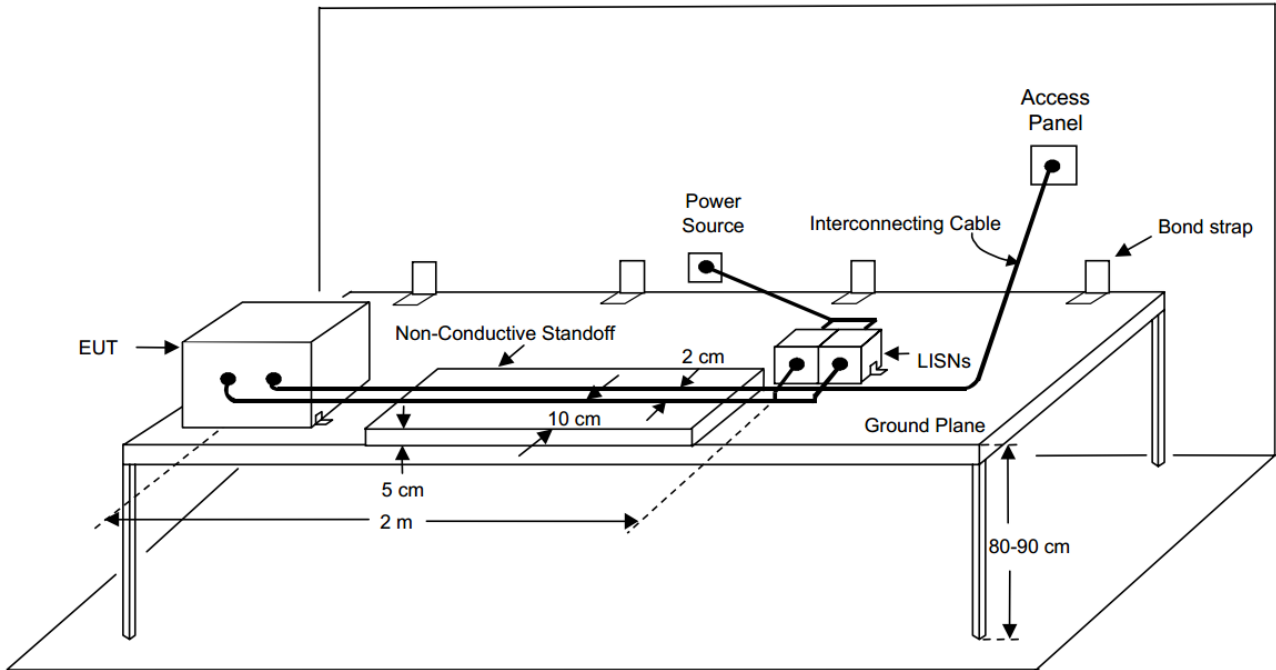
top view



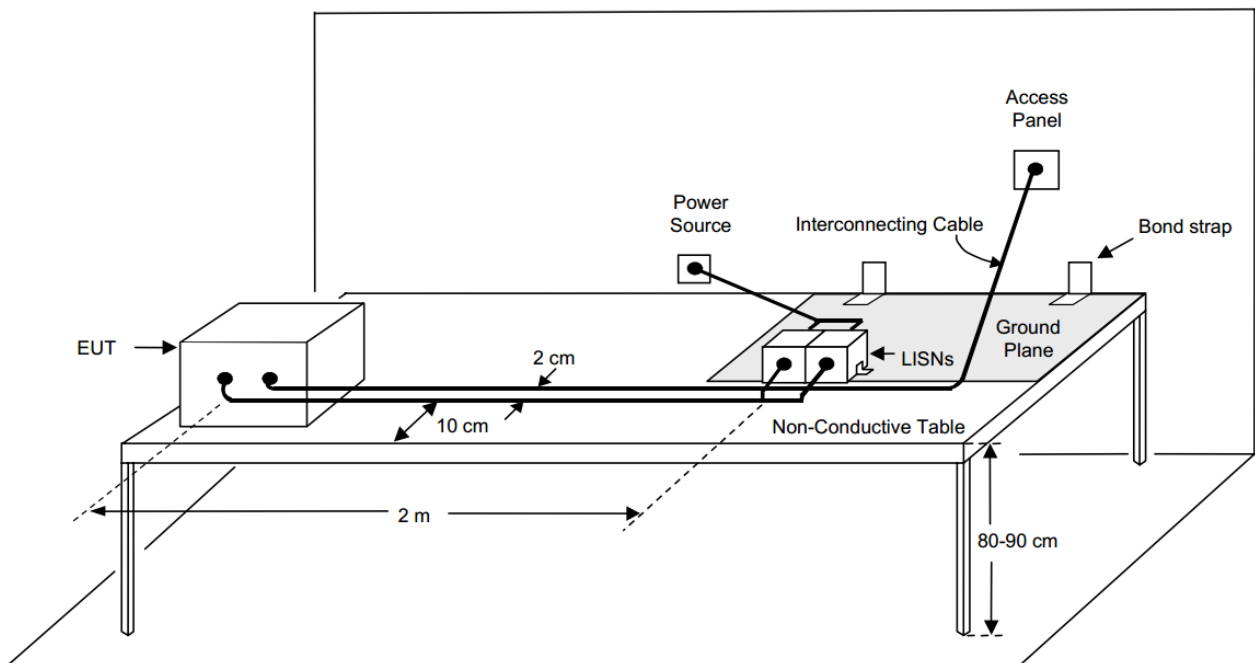
CISPR 25, current method

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## MIL-STD-461F

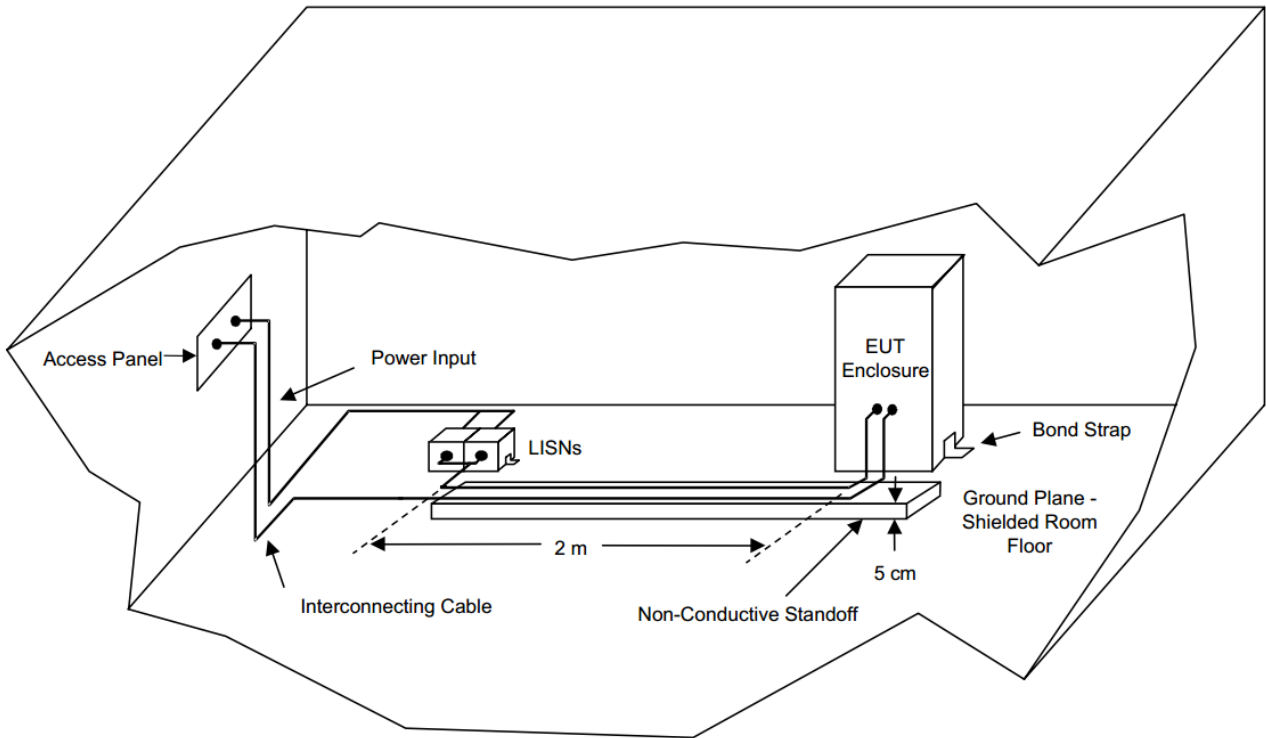


MIL-STD-461F general test setup

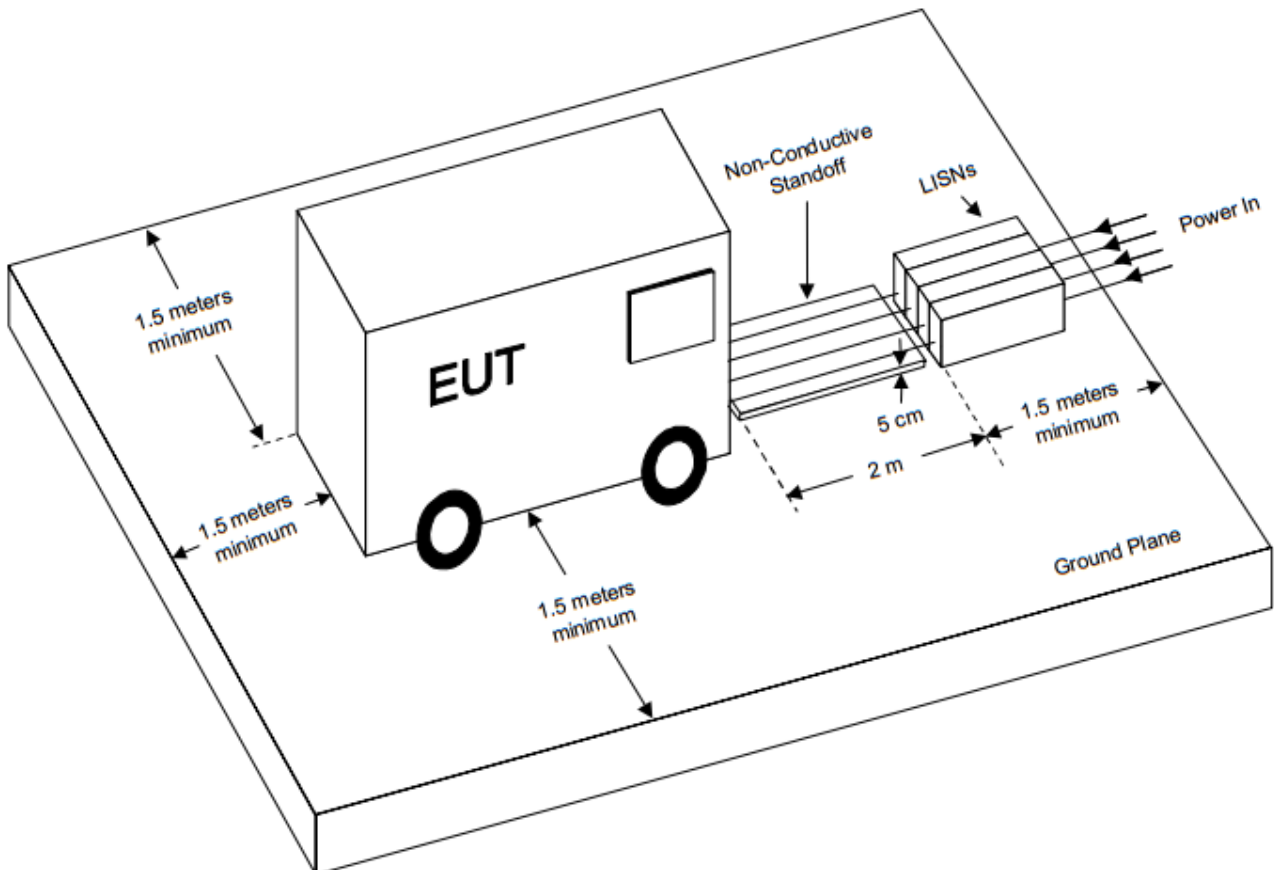


MIL-STD-461F setup for non-conductive surface mount EUT

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MIL-STD-461F setup for free standing EUT in shielded enclosure



MIL-STD-461F test setup for free standing EUT

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### 8 Input protection

When carrying out conducted noise tests of switched mode power supplies, the highest spurious levels occur at relatively low frequencies. Sub-harmonics are even more critical. These are typically at frequencies significantly below 100 kHz and often go completely unnoticed, as most tests start at 150 kHz. You may carry out a conducted noise test and wonder, why the analyzer beeps and displays an ADC overflow warning, despite all spurious being well below limits. What drives the attenuator into saturation may be a very high amplitude sub harmonic at 6 kHz.

In case that you notice that your signals are in the range of 20 dB lower than what they actually are, disaster already happened. The first GaAs switch is already damaged. In most cases it fails with a short on the RF path and protects the following components, but in extreme cases, the damage will reach as far as to the first mixer.

In order to prevent such things happen, you always should start investigating any new EUT, using external attenuators or a combined attenuator / limiter, both also available from Tekbox. With an external 20 dB attenuator or limiter attached to the analyzer input, have a look at the spectrum at very low frequencies and ensure that there are no signals with critically high amplitude.

Alternatively, you can first connect an oscilloscope to the LISN RF output and check the EUT emissions in the time domain. In order to establish the same impedance level as with a connected spectrum analyzer, terminate the oscilloscope input with a 50 Ohm feed-through or switch the input to 50 Ohm, if the scope offers this feature.

Follow following sequence, when doing conducted emission measurements with a LISN:

- 1) Leave the RF output of the LISN unconnected
- 2) Connect the EUT to the LISN
- 3) Connect the LISN to the isolation transformer
- 4) Power on the EUT
- 5) Check the RF output of the LISN using a scope and / or the analyzer with an external 20 dB attenuator or combined attenuator/limiter
- 6) Connect the RF cable from LISN output to the spectrum analyzer input
- 7) Carry out the conducted noise scan
- 8) Disconnect the RF cable
- 9) Power off the EUT

Purpose of having the analyzer disconnected during powering ON/OFF the EUT is avoiding voltage transients due to back EMF, especially of highly inductive loads such as motors or switched mode power supplies.

In case that your EUT produces sub-harmonics, place a suitable high pass filter at the RF input of the spectrum analyzer. The Tekbox TBFL1 transient limiter not only contains a combined attenuator / limiter, but also a 9 kHz high pass filter. If the sub-harmonic frequency is above 9 kHz, connect a 150 kHz high pass.



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### 9 Tekbox LISN overview

All Tekbox LISN are built using only high quality components from manufacturers such as Vishay, EPCOS, Illinois Capacitor and other reputed brands. All our LISN use air core inductors manufactured in the Tekbox factory. Our EMCview software contains voltage division ratio correction files for all of our models and makes conducted noise measurement easy, efficient and affordable for every budget.

#### 9.1 5 $\mu$ H LISN TBOH01



The TBOH01 5 $\mu$ H LISN is designed to be used for EMC pre-compliance testing in the frequency range of 150kHz to 110 MHz according to the CISPR-25 standard, ISO 7637-2, ISO11452-2/4/5 and with limitations DO-160/ED-14G.

The TBOH01 is also very useful to measure conducted noise in between power supplies and connected devices.

With a maximum current rating of 10A it is suitable for most automotive electronic devices.

For safety reasons, the nominal voltage is rated to 60V DC, however the hardware is designed to handle a source voltage up to 200V DC.

The TBOH01 has no internal 1 $\mu$ F capacitor. A 1 $\mu$ F foil capacitor with suitable voltage rating needs to be clamped to the banana posts at the source side.

With several protective elements built in, risk of overloading or damaging a spectrum analyzer frontend is very low. The TBOH01 is ideal for engineers making their first experience with EMC pre-compliance testing.

- Frequency range: 100 kHz – 110 MHz (characterized up to 1 GHz)
- DC Resistance: 40 m $\Omega$
- Maximum current: 10A
- Nominal operating voltage range: 0 – 60V DC;
- Absolute maximum rating: 200V
- Built in surge protection
- Terminals suitable to clamp external source capacitors

Note that the majority of tests require a pair of 5  $\mu$ H LISN.

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### 9.2 5 $\mu$ H LISN TBL0550-1



The TBL0550-1 5 $\mu$ H LISN is designed to be used for measurements in the frequency range of 150kHz to 110 MHz according to CISPR 16-1-2, CISPR-25, EN55025, MIL-STD-461F, ISO11452-4 and with limitations DO-160/ED-14G and ISO 7637-2.

The TBL0550-1 is also very useful to measure conducted noise in between power supplies and connected devices.

With a maximum current rating of 50A it is suitable for most automotive electronic devices.

For safety reasons, the nominal voltage is rated to 60V DC, however the hardware is designed to handle a source voltage up to 250V DC.

The TBOH01 has an internal 1 $\mu$ F capacitor. For ISO 7637-2 tests it can be separated by pulling a high current jumper on the PCBA.

- Frequency range: 100 kHz – 150 MHz
- DC Resistance: < 9 m $\Omega$  Source+ to DUT+; < 2 m $\Omega$  Source- to DUT-
- Maximum current: 50A continuous, 70 A for 3 minutes
- Nominal operating voltage range: 0 – 60V DC;
- Component rating: 250V
- High current plug/screw terminals - male: Phoenix Contact 1998933, female: Phoenix Contact 1967375
- 1 $\mu$ F capacitor can be disconnected internally by removing a jumper
- Dimensions: 120 mm x 100 mm x 225 mm (270 mm including ground brackets); weight: 1.6 kg

Note that the majority of tests require a pair of 5  $\mu$ H LISN.

Combining two TBL0550-1 LISN with the Tekbox LISN Mate TBLM1 enables separate measurement of common or differential mode emissions.

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### 9.3 50 $\mu$ H LISN TBL5016-1



The TBL5016-1 50 $\mu$ H LISN is a versatile device for measuring conducted noise of DC, AC single phase or 3-phase powered electronic equipment. It is designed according to CISPR 16-1-2 and MIL-STD-461F standard and characterized in the frequency range of 9 kHz to 100 MHz.

The LISN is a 50 $\Omega$ /50 $\mu$ H+5  $\Omega$  single line design with a high current jumper to short the 5 Ohm resistor and configure it as a 50 $\Omega$ /50 $\mu$ H LISN according to CISPR 16-1-2. The LISN is characterized up to 100 MHz which means that the LISN can be used for the combined range of 9 kHz to 100 MHz.

The TBL5016-1 50 $\mu$ H LISN is primarily used for stationary, DC supplied equipment. It can also be used for AC supplied single phase or 3-phase equipment.

DC or single phase measurements typically require a pair of TBL5016-1. Combining it with the Tekbox LISN Mate TBLM1 enables separate measurement of common mode and differential mode noise. DUTs with 3-phase supply require three or four pieces of TBL5016-1, depending on whether the product is supplied in delta or star configuration.

Chapter 11.2 of the TBL5016-1 manual gives detailed wiring diagrams for DC, single phase, 3-phase star configuration and 3-phase delta configuration set ups.

The TBL5016-1 does not contain a 250  $\mu$ H pre-filter for suppression of 50 Hz harmonics. However, if additional 50 Hz suppression is required, setting a jumper on the PCBA will enable a 9 kHz high pass filter in the RF path.

- LISN type: V-AMN, configurable as 50 $\Omega$ /50 $\mu$ H+5  $\Omega$  or 50 $\Omega$ /50 $\mu$ H
- Frequency range: 9 kHz – 100 MHz
- DC Resistance: < 45 m $\Omega$
- Maximum current: 16A continuous
- Operating voltage range: 0 – 250V DC; 0 - 250V AC (50/60 Hz), 0 – 90V AC (400 Hz)
- Fuse: 2 x 16A slow
- High current plug/screw terminals - male: Phoenix Contact 1998933, female: Phoenix Contact 1967375
- Dimensions: 250 mm x 225 mm x 140 mm (including ground brackets); weight: 2.7 kg

## Line Impedance Stabilization Networks – Basics and Overview

### 9.4 50 $\mu$ H LISN TBLC08



The TBLC08 is a Line Impedance Stabilization Network for the measurement of conducted emissions within the range of 9 kHz to 30MHz, according to the CISPR 16 standard. The device is designed for testing single phase, AC-powered equipment with supply voltages up to maximum of 240V. Conducted noise can be measured on the phase and on the neutral conductor. The TBLC08 is equipped with a switchable limiter/attenuator and an artificial hand connection.

The device is available with country-specific DUT connectors.  
The LISN is equipped with 250 $\mu$ H pre-filters.

- Frequency range: 9 kHz to 30 MHz
- Impedance: 50  $\Omega$  || (50  $\mu$ H + 5  $\Omega$ )
- Artificial hand: 220 pF + 511  $\Omega$
- Switchable PE: 50  $\Omega$  || 50  $\mu$ H
- Limiter / attenuator: 150 kHz to 30 MHz; 10 dB
- Air core inductors; 250 $\mu$ H pre-filter
- Line voltage: max. 240V / 50 – 60 Hz, CAT II
- Max. current: 8A @ 23°C
- DUT socket: country specific
- Measurement connector: 50  $\Omega$  BNC
- Power connector: IEC 60320 C13

The LISN has a single BNC output which either can be switched to monitor conducted emissions on Phase or on Neutral. Consequently it cannot be paired with a LISN Mate.

## Line Impedance Stabilization Networks – Basics and Overview

### 9.5 50 $\mu$ H LISN TBL5016-2



The TBL5016-2 is a Line Impedance Stabilization Network for the measurement of conducted emissions within the range of 9 kHz to 30MHz, according to the CISPR 16 standard. The device is designed for testing single phase, AC-powered equipment with supply voltages up to maximum of 240V. Conducted noise can be measured on the phase and on the neutral conductor. The TBL5016-2 is equipped with a switchable limiter/attenuator and an artificial hand connection.

The device is available with country-specific DUT connectors.  
The LISN is equipped with 250 $\mu$ H pre-filters.

The TBL5016-2 has the same features as the TBL5016-1, except that it has a higher current rating, 16 A.

- Frequency range: 9 kHz to 30 MHz
- Impedance:  $50 \Omega \parallel (50 \mu\text{H} + 5 \Omega)$
- Artificial hand:  $220 \text{ pF} + 511 \Omega$
- Switchable PE:  $50 \Omega \parallel 50 \mu\text{H}$
- Limiter / attenuator: 150 kHz to 30 MHz; 10 dB
- Air core inductors; 250 $\mu$ H pre-filter
- Line voltage: max. 240V / 50 – 60 Hz, CAT II
- Max. current: 8A @ 23°C
- DUT socket: country specific
- Measurement connector: 50  $\Omega$  BNC
- Power connector: IEC 60320 C19

The LISN has a single BNC output which either can be switched to monitor conducted emissions on Phase or on Neutral. Consequently it cannot be paired with a LISN Mate.

## Line Impedance Stabilization Networks – Basics and Overview

### 9.6 50 $\mu$ H LISN TBL5016-3



The TBL5016-3 is a 3-phase / single phase 50 $\mu$ H LISN Line Impedance Stabilization Network for the measurement of conducted emissions within the range of 9 kHz to 30MHz, according to the CISPR 16 standard. The device is designed for testing single phase, AC-powered equipment with supply voltages up to maximum 240V line to neutral or 420V between lines. Conducted noise can separately be measured on the neutral line and on all three phase lines. The TBL5016-3 is equipped with an artificial hand connection and separate BNC RF-outputs for L1, L2, L3 and Neutral. The device is equipped with IEC 60309 3 phase connectors and country-specific DUT connectors.

The LISN is equipped with 250 $\mu$ H pre-filters.

The TBL5016-2 has the same features as the TBL5016-3, except that it has a higher current rating, 16 A.

- Frequency range: 9 kHz to 30 MHz
- Impedance: 50  $\Omega$  || (50  $\mu$ H + 5  $\Omega$ )
- Artificial hand: 220 pF + 511  $\Omega$
- Switchable PE: 50  $\Omega$  || 50  $\mu$ H
- Limiter / attenuator: 150 kHz to 30 MHz; 10 dB
- Air core inductors; 250 $\mu$ H pre-filter
- Line voltage: max. 240V Line-Neutral, 420V Line-Line / 50 – 60 Hz, CAT II
- Max. current: 16A on every line, 16A on neutral @ 23°C
- DUT socket single phase: country specific
- DUT socket 3-phase: IEC 60309 3L+N+PE, 6h, 16A, female
- Measurement connector: 50  $\Omega$  BNC
- Power connector: IEC 60309 3L+N+PE, 6h, 16A, male

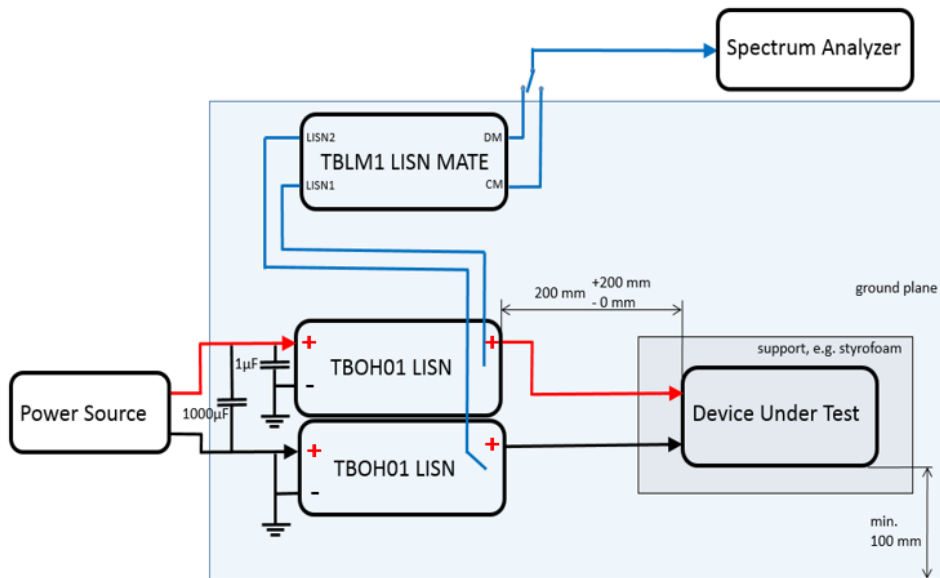
The TBL5016-3 can be combined with a TBLM1 LISN Mate in order to separately measure common mode or differential mode conducted emissions. Unused RF outputs must be terminated with 50 Ohm.



# Line Impedance Stabilization Networks – Basics and Overview

## 9.7 LISN-Mate TBLM1

The TBLM1 is a companion device for LISNs, which splits the conducted noise signal into its common mode and differential mode components. The LISN Mate is connected to the output of a LISN inserted into the positive supply line and to a second LISN inserted into the negative supply line. The conducted noise signal at the output of a LISN is the sum of common mode and differential mode noise. The LISN mate splits it into the common mode and differential mode components, with each signal component available at a separate BNC port.



Measurement of differential mode and common mode conducted noise

Terminate the unused LISN mate output port with 50 Ohm

## 10 History

Version	Date	Author	Changes
V 1.0	22.11.2021	Mayerhofer	Creation of the document