

# 5 $\mu$ H Line Impedance Stabilisation Network

## 1 Introduction

The TBL0550-1 5 $\mu$ H LISN is a device required to setup conducted noise measurements of DC-powered electronic equipment. It 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 LISN is inserted into the supply line of the DUT (Device Under Test). Conducted noise which is present at the supply terminals of the DUT can be measured at the BNC connector using a spectrum analyzer or a measurement receiver. The source (supply) terminal and the DUT terminal are decoupled by a 5 $\mu$ H inductor. Two TBL0550-1 in combination with the Tekbox LISN Mate enable separate measurement of common mode and differential mode noise.

The unit comes equipped with a BNC-male to N-male RG232 cable, mating connectors and ground brackets to attach it to a ground plane.



## 2 Parameters

Frequency range: 100 kHz – 150 MHz

DC Resistance: < 5 m $\Omega$

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

## 5 $\mu$ H Line Impedance Stabilisation Network

### 3 Warning

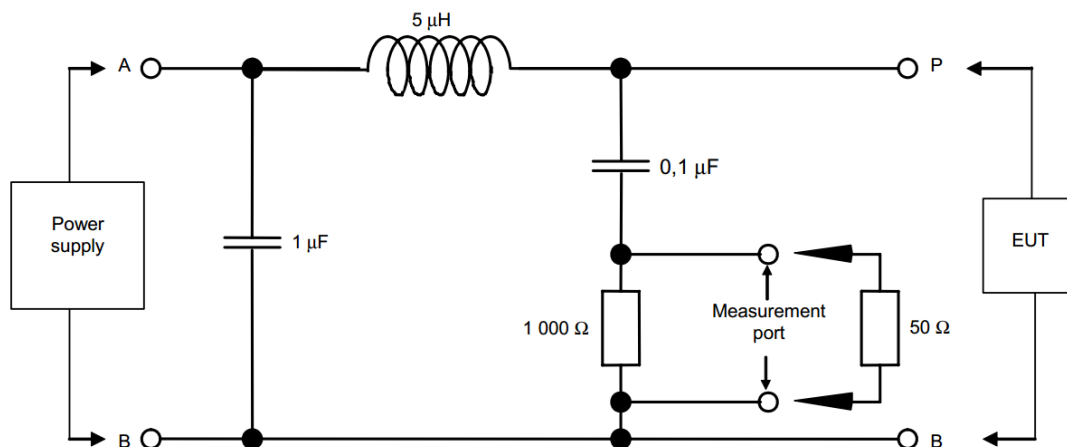
#### **Spectrum Analyzer / Measurement Receiver protection:**

The TBL0550-1 LISN does not contain any protective elements in the RF path. Use an external attenuator and/or limiter, if your DUT may produce harmful transients or high RF noise levels, in order to protect the spectrum analyser / measurement receiver input.

#### **Safety:**

The LISN housing is connected to the negative / ground SOURCE and DUT pin of the terminal block and the ground of the RF connector. Inadvertently connecting the positive voltage to the ground pin will expose you to the risk of electric shock. Consequently, for safety reasons, the nominal operating voltage range is specified as 0V - 60V. The maximum voltage rating with respect to component rating is 250V.

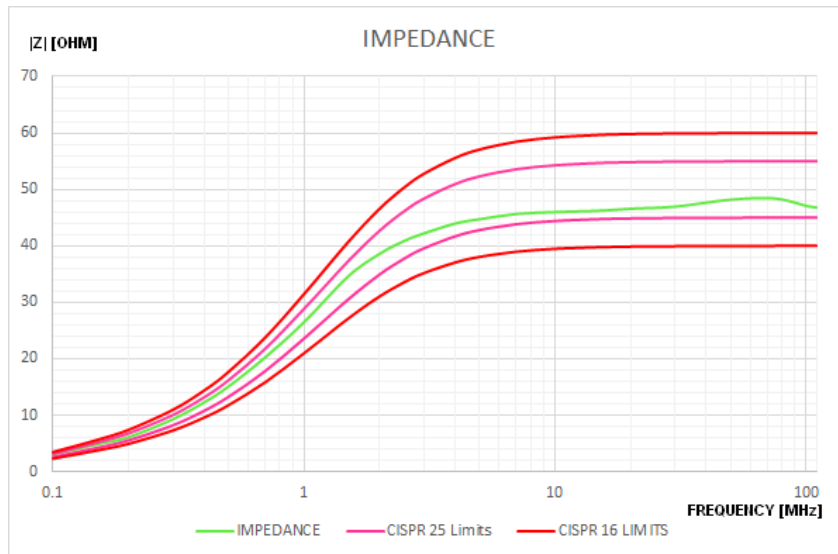
### 4 Principle schematic



Picture 1: principle schematic

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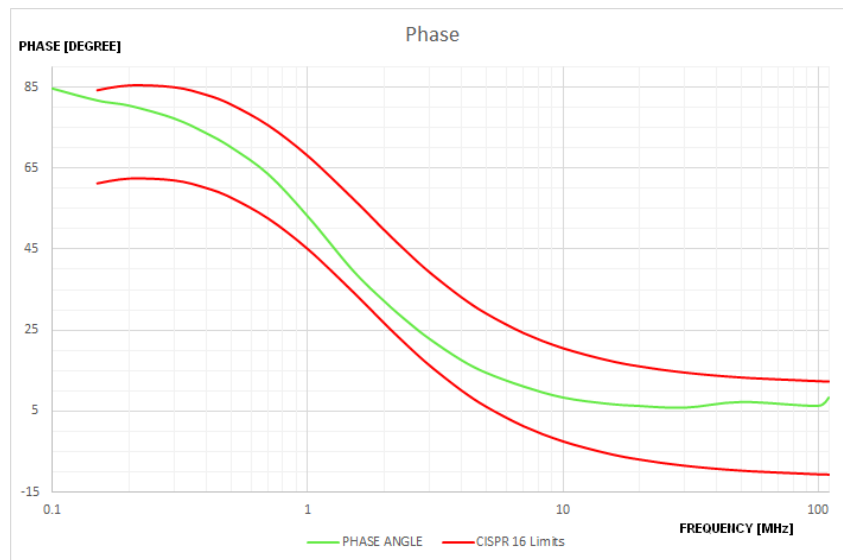
### 5 Impedance



Picture 2: LISN impedance, 100 kHz – 110MHz; Source port shorted, RF port terminated with 50 $\Omega$

The impedance is referenced to the PCB edge, not including the Phoenix terminal blocks. The male + female terminal block combination can be considered being equivalent to 5cm of additional wiring in the entire set up.

### 6 Phase

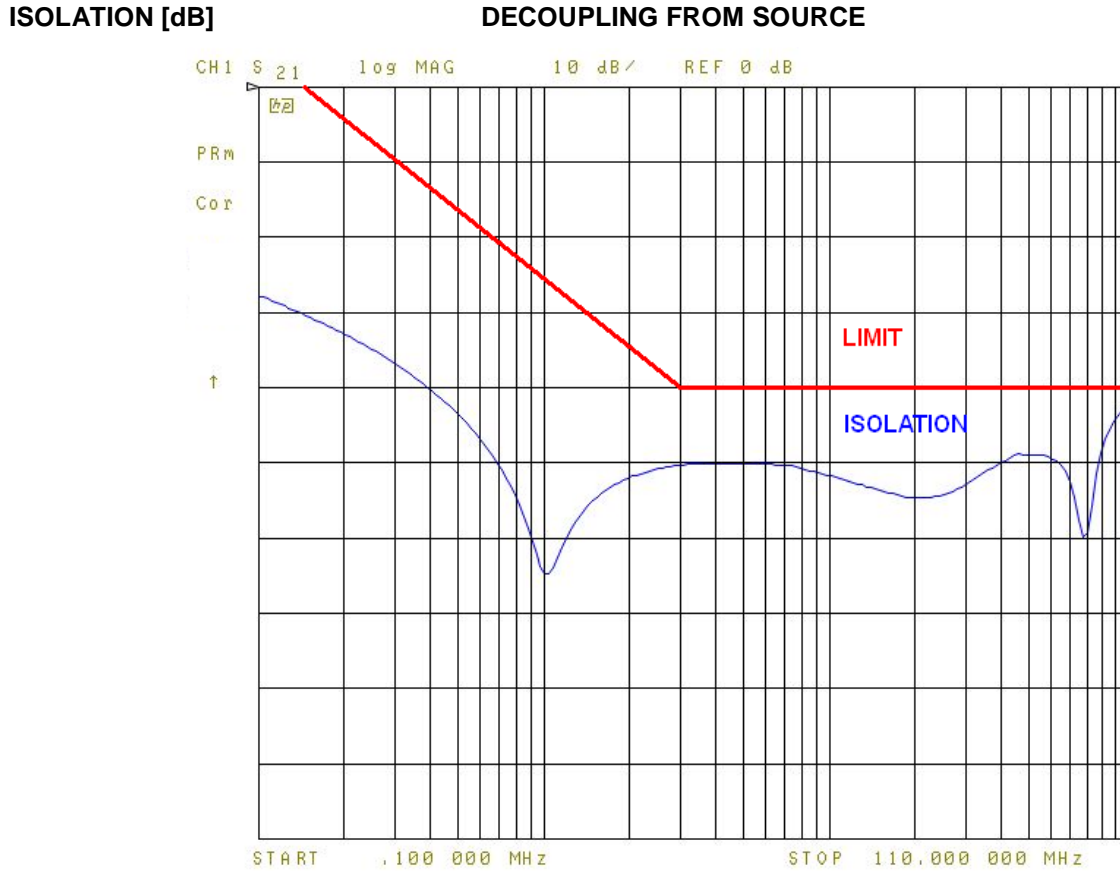


Picture 3: LISN phase, 100 kHz – 110MHz, Source port shorted, RF port terminated with 50 $\Omega$

The phase is referenced to the PCB edge, not including the Phoenix terminal blocks. The male + female terminal block combination can be considered being equivalent to 5cm of additional wiring in the entire set up.

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## 7 Isolation

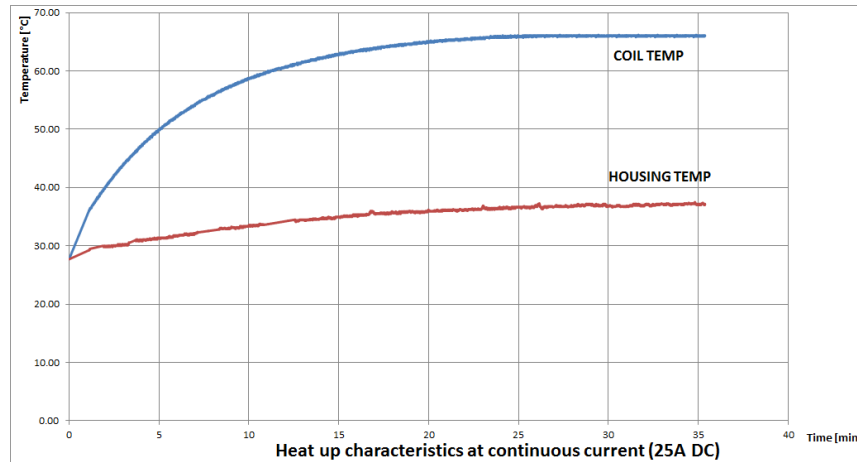


Picture 4: LISN Isolation, 100 kHz – 110MHz

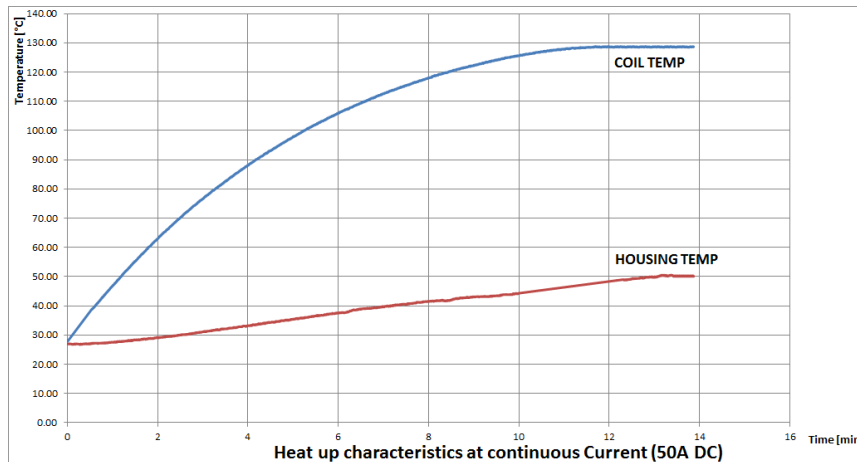
The isolation is measured between SOURCE terminal and RF port, with the DUT port terminated with 50 Ohm.

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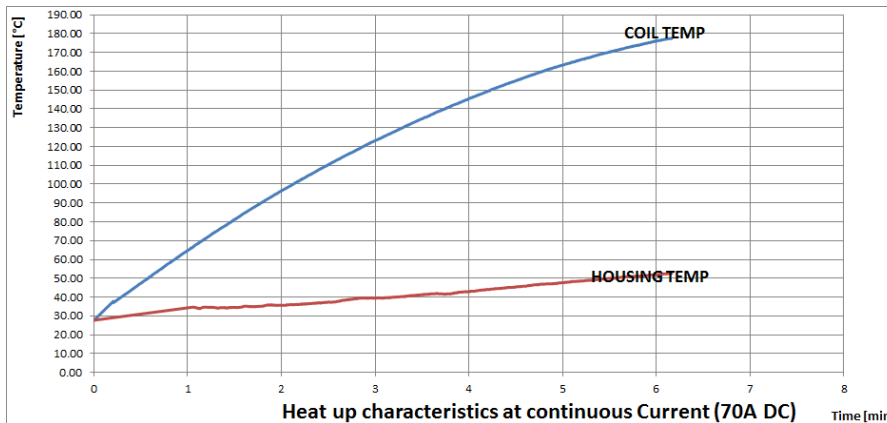
## 8 Thermal characteristics



Picture 5: Coil and housing temperature at 25 A DC current



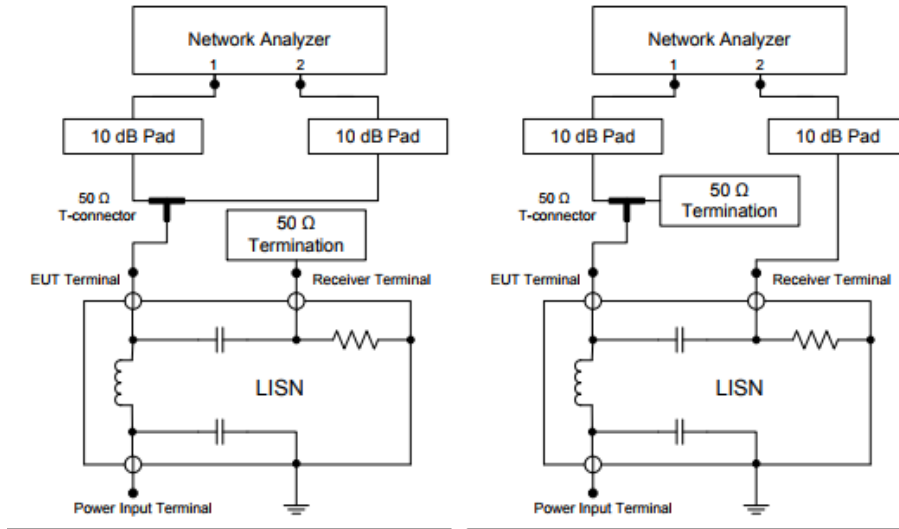
Picture 6: Coil and housing temperature at 50 A DC current



Picture 7: Coil and housing temperature at 70 A DC current

# 5 $\mu$ H Line Impedance Stabilisation Network

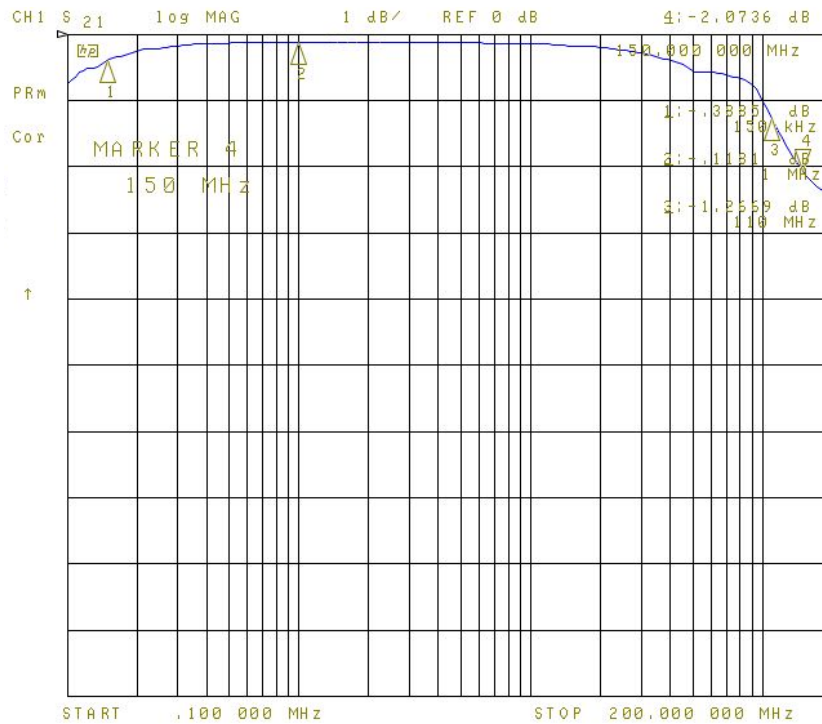
## 9 Calibration data according to CISPR 16 -1-2 Annex A8



**Reference measurement setup using network analyzer.**

**Transmission measurement setup using network analyzer.**

Picture 8: Calibration set up according to CISPR 16-1-2 Annex A.8.



Picture 9: Voltage division ratio DUT terminals to RF connector

## 5 $\mu$ H Line Impedance Stabilisation Network

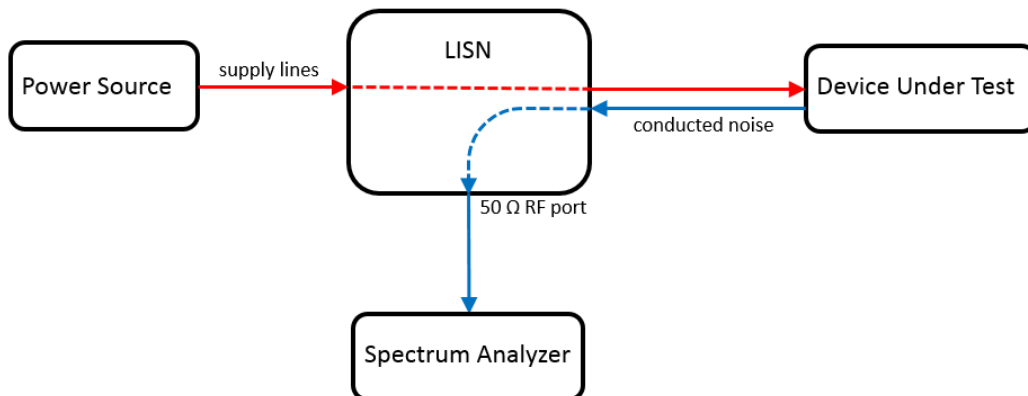
Frequency [MHz]	Voltage Division Ratio DUT port to RF port (1 $\mu$ F across source terminals) [dB]	Frequency [MHz]	Voltage Division Ratio DUT port to RF port (1 $\mu$ F across source terminals) [dB]
0.1	-0.72	110	-1.26
0.15	-0.39	120	-1.52
0.25	-0.21	130	-1.74
0.5	-0.13	140	-1.92
1	-0.11	150	-2.07
10	-0.13	160	-2.19
20	-0.25	170	-2.28
30	-0.28	180	-2.34
40	-0.38	190	-2.37
50	-0.55	200	-2.39
60	-0.56		
70	-0.62		
80	-0.67		
90	-0.76		
100	-0.98		

Table 1 - LISN calibration data

## 10 Application

The abbreviation LISN stands for Line Impedance Stabilisation Network.

- It is a low pass filter typically placed between a power source and the supply terminals of a device under test (DUT).
- It has a feed-through path to supply the DUT with power
- It provides a well-defined RF-impedance to the DUT
- It couples electrical noise generated by the DUT to a 50  $\Omega$  RF port, which can be connected to a spectrum analyser or measurement receiver
- It suppresses electrical noise from the supply side towards the DUT
- It suppresses electrical noise from DUT side towards the supply



Picture 10: Basic diagram of a conducted emission measurement setup with a LISN

## 5 $\mu$ H Line Impedance Stabilisation Network

Further applications such as conducted noise measurements using RF current monitoring probes, BCI tests and voltage transient tests require LISNs to establish a defined supply line impedance.

### 10.1 Conducted Emission Measurement Setup, Voltage Method

CISPR 25 specifies two measurement configurations:

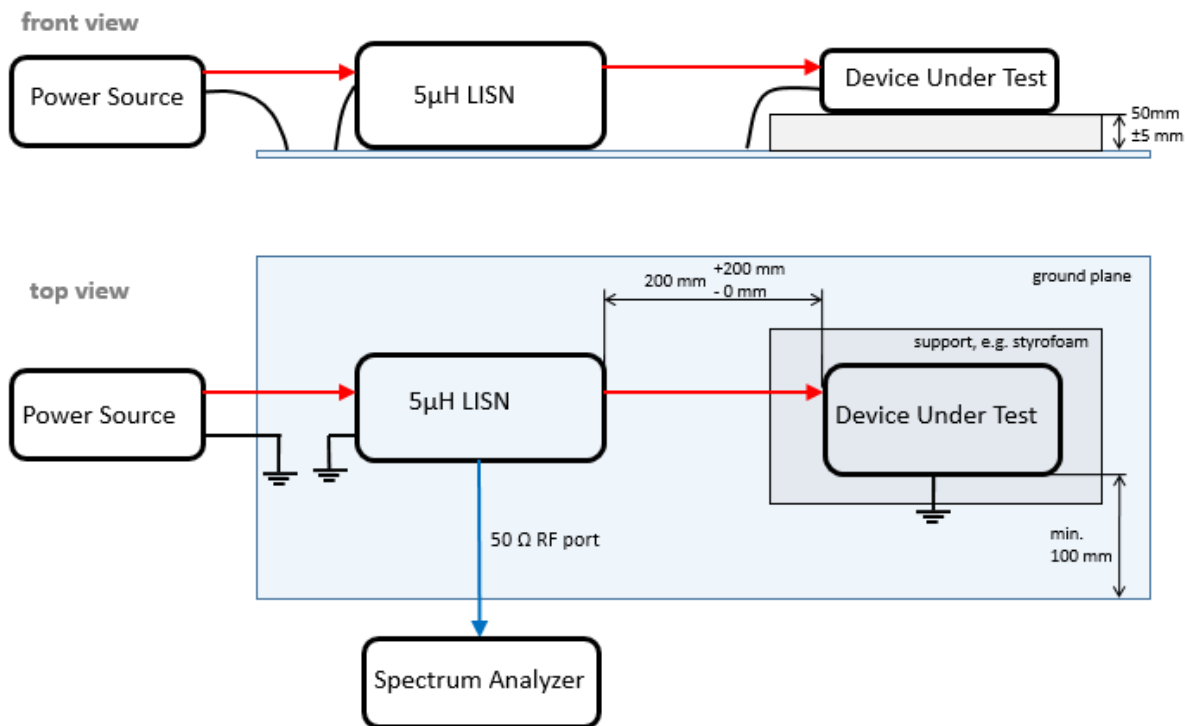
If the DUT is grounded to the vehicle chassis with a power return line shorter than 20 cm, a single 5 $\mu$ H LISN is sufficient and the conducted noise will only be measured on the positive supply line.

If the power return line of the DUT is longer than 20 cm, two 5 $\mu$ H LISNs are required. The positive supply line is connected to the DUT via one LISN and the power return line is connected to the DUT via another LISN.

Conducted noise is measured on both lines. In fact, it is measured on one LISN at a time, while the RF port of the other LISN is terminated with a 50  $\Omega$  resistor.

Professional conducted noise measurements are done in shielded chambers, as any RF smog picked up by the wires from LISN to DUT or by the DUT itself, will be present at the RF terminal. Consequently, a measurement with the DUT powered off should be done upfront in order to distinguish between real conducted noise generated by the DUT and RF smog from other sources (ambient noise).

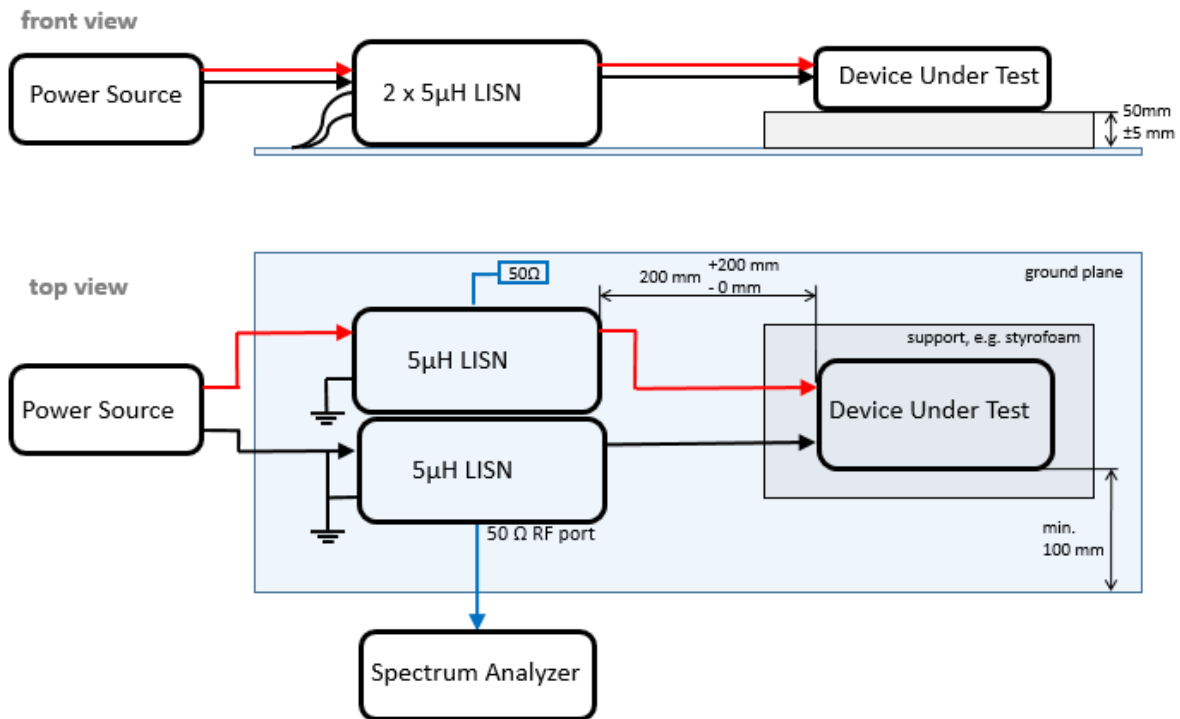
Tekbox offers low cost, desktop shielded tents or shielded bags to suppress ambient noise when carrying out pre-compliance conducted noise measurements.



Picture 11: conducted emission measurement, voltage method, DUT with power return line locally grounded



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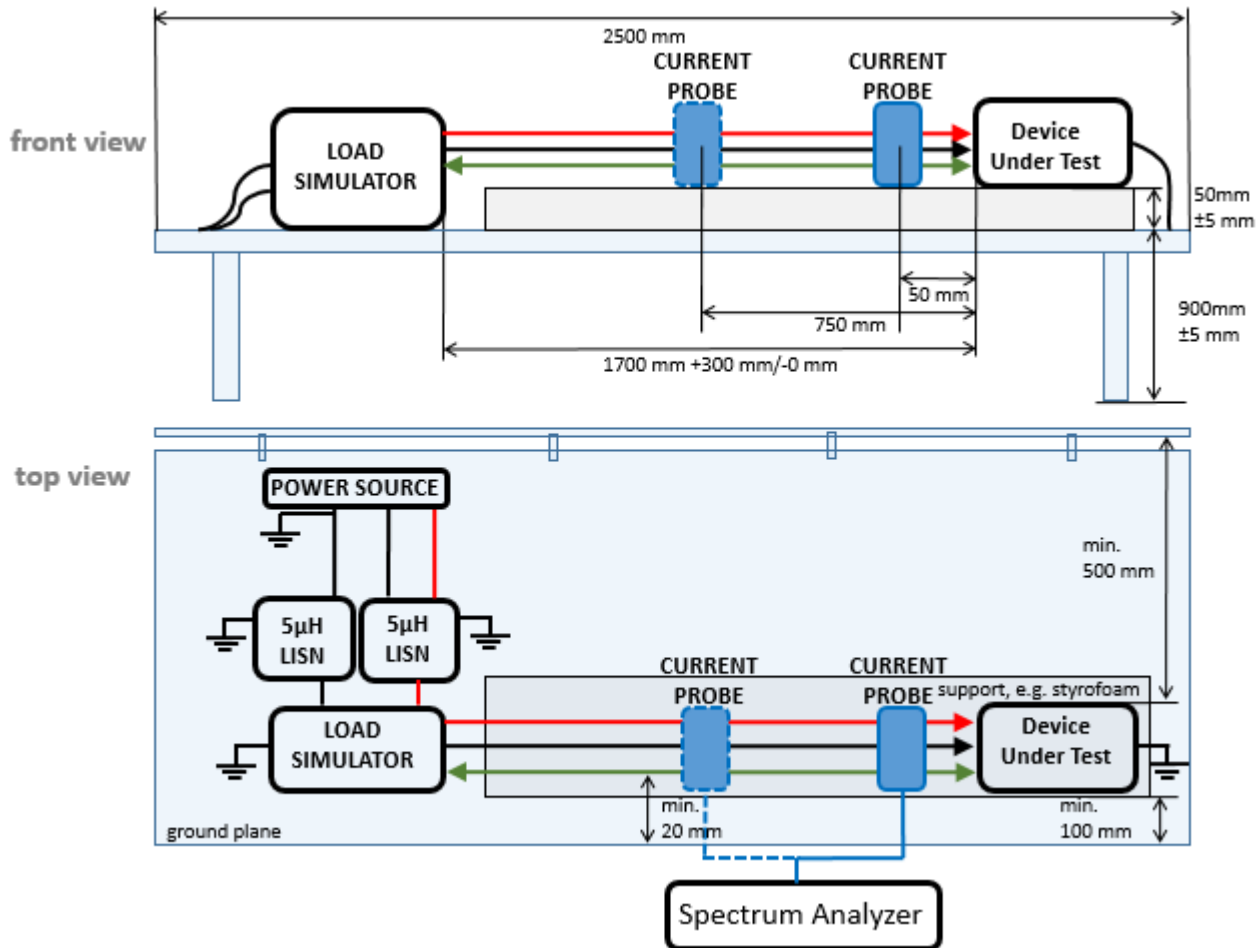


Picture 12: conducted emission measurement, voltage method, DUT with power return line remotely grounded

Figure 3 and figure 4 show conducted noise measurement set ups, voltage method, according to CISPR 25. In case that the DUT is connected to other peripheral devices, they should be connected as well, or simulated with a load box. If the housing of a remotely powered DUT foresees chassis grounding, it should be grounded to the ground plane as well. The grounding lead should not be longer than 150mm then. A set up according picture 4 is more common, as most devices are remotely grounded. The measurement needs to be alternatively carried out on both the positive and negative power line then. The unused RF port is always terminated with 50 Ohm. Note that conducted noise testing according to DO160 require an additional 10 $\mu$ F capacitor across the source terminals of the LISN.

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### 10.2 Conducted emission measurement set up, current probe method



Picture 13: conducted emission measurement according to CISPR 25, current probe method

The current probe measurement according to CISPR 25 is used to measure conducted emissions on a wire harness including control/signal lines of a DUT. However, it is also used by some automotive manufacturers to measure power supply lines instead of applying the voltage method. Measurements are typically taken on various lines – plus, minus, control signals, plus + minus, plus + minus + control lines. The current probe measurement is carried out in 50 mm distance and in 750 mm distance from the EUT in order to cover resonance effects of the cable harness. The RF output of each LISN must be terminated with 50 Ohm. A current probe picks up the conducted emissions. Two LISNs are required to establish a defined impedance on the power lines. The load simulator is a customized device that simulates the load present at the signal/control interface of the DUT.

### 10.3 Bulk Current Injection

Immunity tests according to ISO11452-4 use a similar setup as for current probe based conducted emission measurements. However, instead of using a current probe to measure conducted emissions, a signal generator / power amplifier feeds an interferer signal into the current probe. Again, two 5 $\mu$ H LISNs are required to establish

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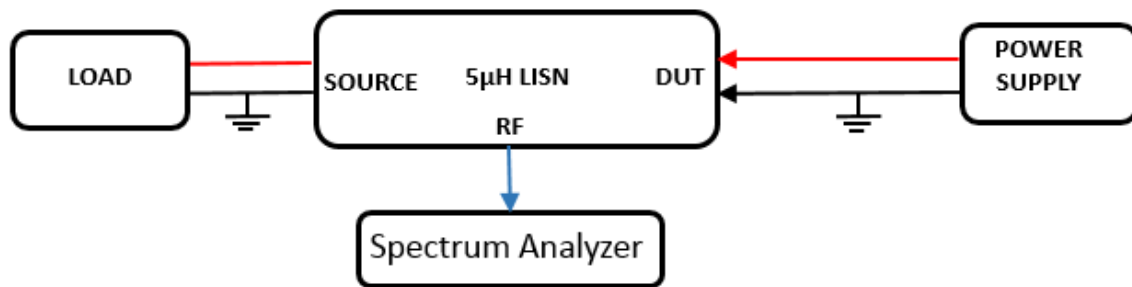
a defined supply impedance. The RF output of the LISN needs to be terminated with an external 50 Ohm termination of suitable power handling capability.

### 10.4 Voltage transient testing

When using the LISN for voltage transient testing according to ISO 7637-2, the 1 $\mu$ F capacitor at the source input of the LISN needs to be disconnected in order to avoid shorting the transient. To do so, the top cover of the LISN housing needs to be opened in order to remove the Harwin jumper next to the source terminal block. Note that the TBL0550-1 impedance is slightly outside the very tight limits specified by ISO 7637-2.

### 10.5 Setup for measuring power supply noise spectrum of power supplies

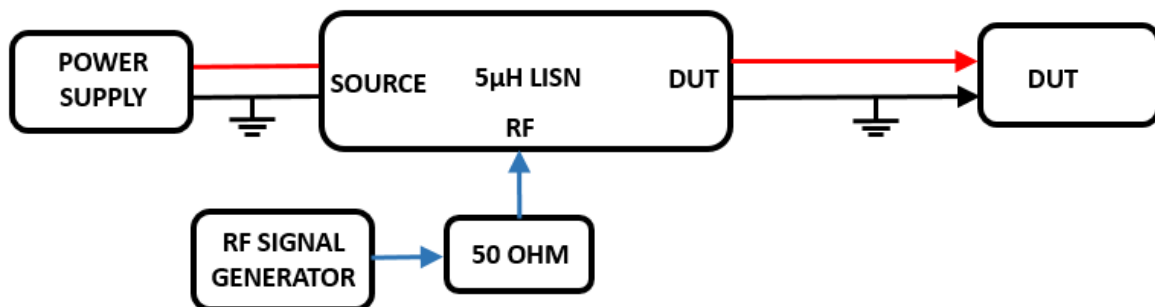
During product development, LISNs are useful to investigate the noise spectrum at the output terminals of power supplies or switched mode regulators.



Picture 14: setup for measuring power supply noise spectrum

### 10.6 Setup for RF immunity testing

By adding a 50 Ohm feed through termination, the LISN can also be used to inject RF into the supply line of the DUT. The power rating of the feed through termination has to match the injected RF power level.



Picture 15: setup for RF injection

## 5 $\mu$ H Line Impedance Stabilisation Network

### 11 Ordering Information

Part Number	Description
TBL0550-1	5 $\mu$ H LISN, 2 pcs. ground brackets, 2pcs. female terminal blocks Phoenix Contact 1967375, 1 pc. 75 cm BNC-male to N-male RG223 cable

### 12 History

Version	Date	Author	Changes
V1.0	1.10.2019	Mayerhofer	Creation of the document

Table 2 – History