

# 5 $\mu$ H Line Impedance Stabilisation Network

## 1 Introduction

The TBL0510-1 is an affordable 5 $\mu$ H LISN designed for conducted emission measurements in the frequency range of 100 kHz to 400 MHz. It complies with CISPR-25 (EN 55025), numerous automotive manufacturer standards, MIL-STD-461F, DO-160, AECTP-500 and ISO 7637-2.

LISNs are inserted into the supply lines of the EUT (Equipment Under Test). Conducted noise which is present at the supply terminals of the DUT can be measured at the BNC connectors 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 TBL0510-1 in combination with the Tekbox LISN Mate enable separate measurement of common mode and differential mode noise.



### 1.1 Parameters

Frequency range: 10 kHz – 400 MHz; depending on standard and external capacitor

DC Resistance: 40 m $\Omega$

Continuous current: 10A

Nominal operating voltage range: 0 – 60V DC

Absolute maximum rating of internal components: 200V DC; external 1 $\mu$ F capacitor: 100V

Built in surge protection

External 1 $\mu$ F source capacitor, for easy removal when using the LISN for 7637-2 tests

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### 1.2 Principle schematic

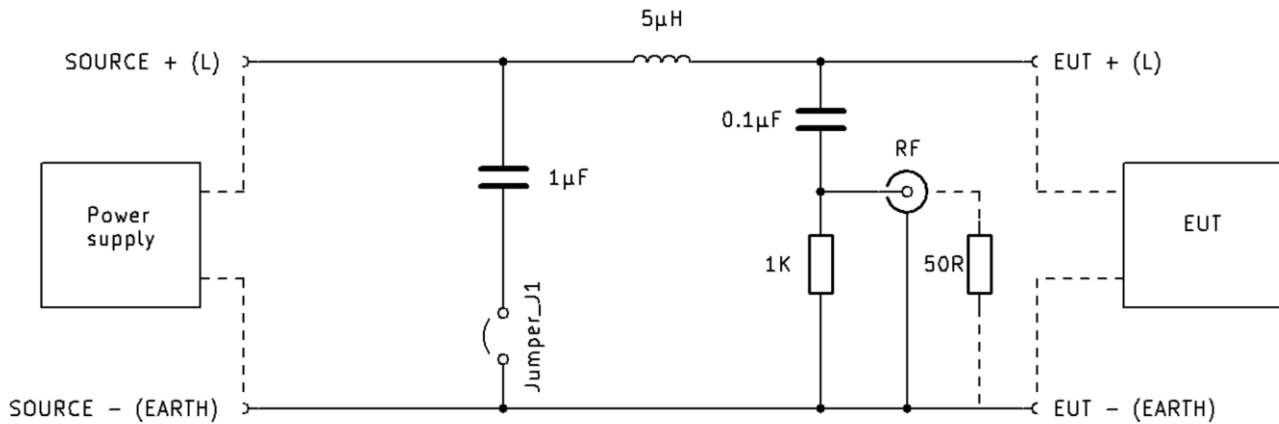


Figure 1: simplified schematic

### 1.3 Impedance

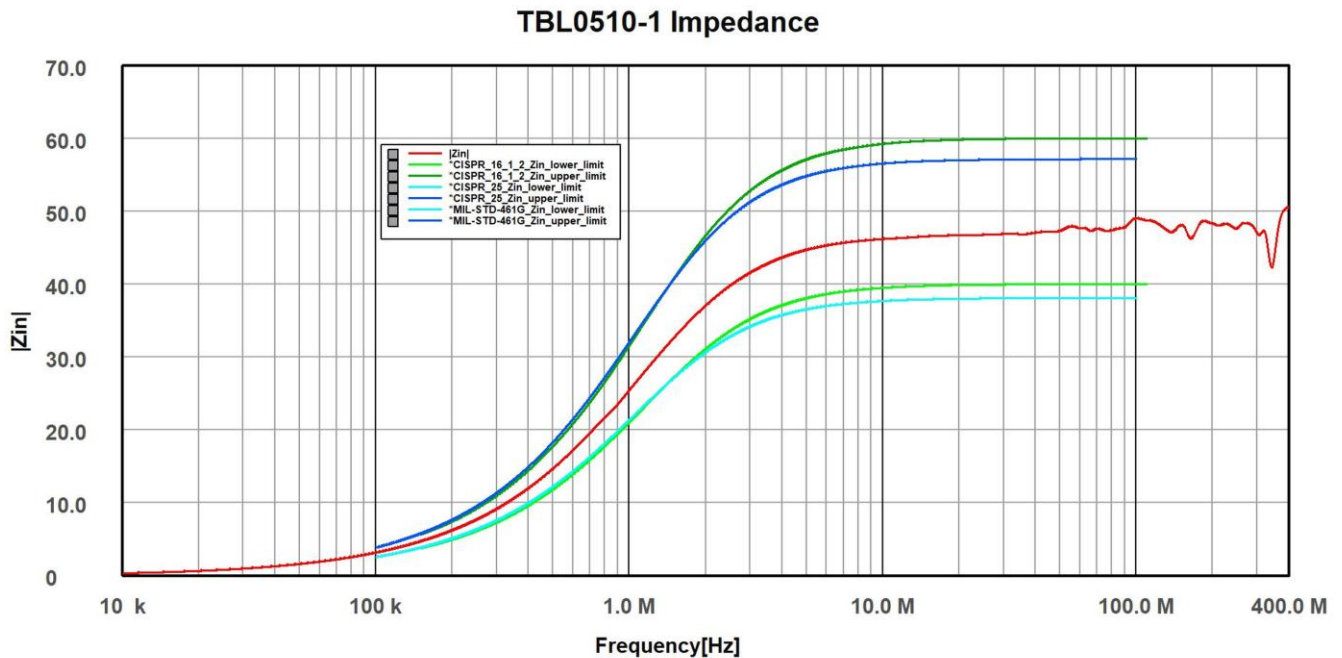


Figure 2: 100 kHz – 110 MHz, measured impedance of the TBL0510-1 5 $\mu$ H LISN, source terminals shorted

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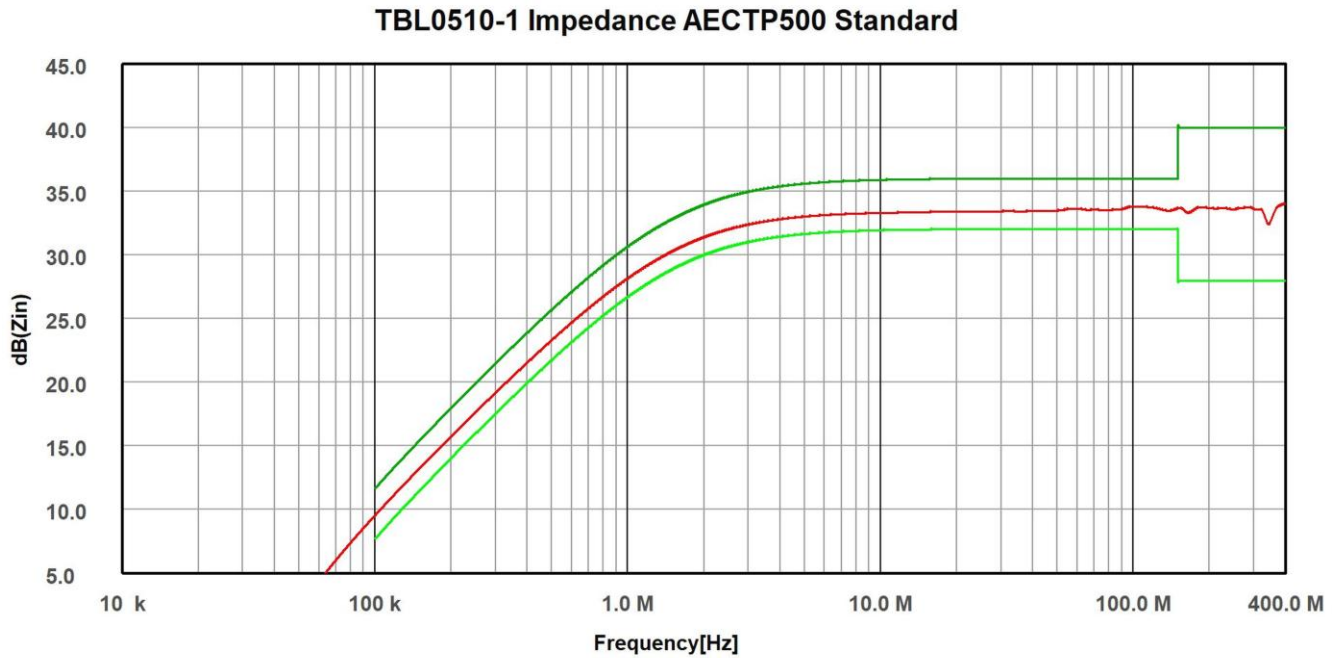


Figure 3: 100 kHz – 400 MHz, logarithmic impedance of the TBL0510-1 5 $\mu$ H LISN, AECTP-500 limits

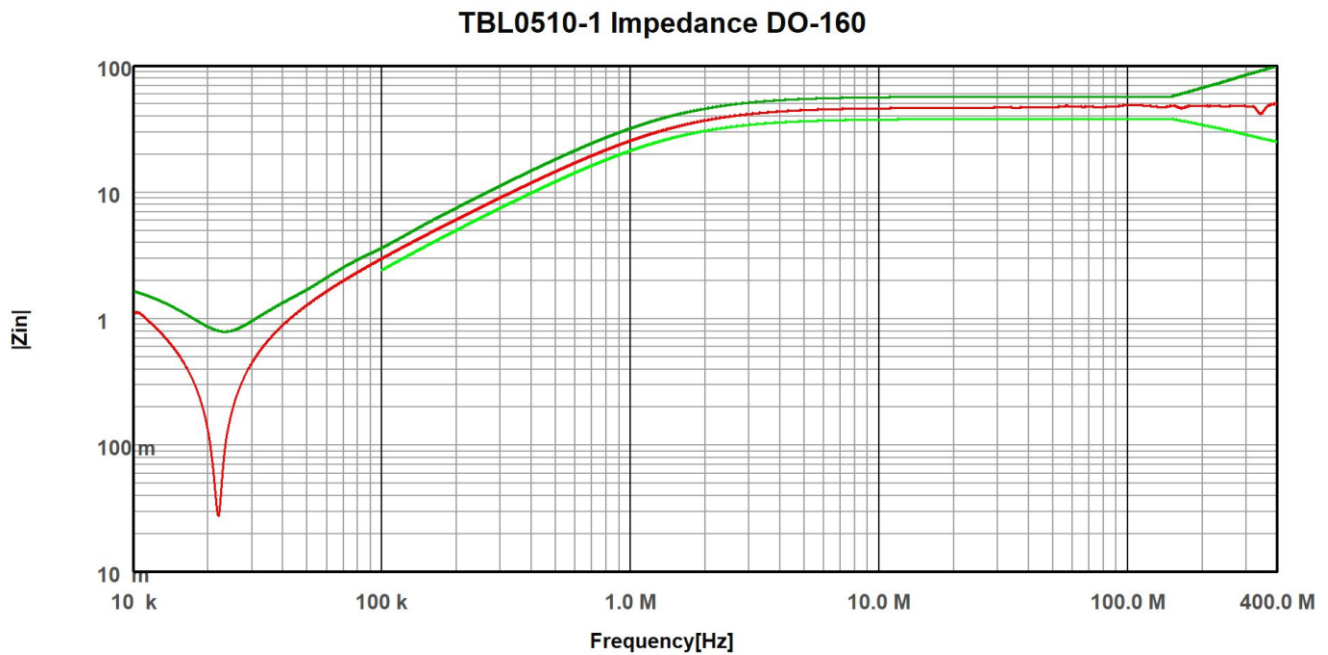


Figure 4: 100 kHz – 400 MHz, impedance of the TBL0510-1 5 $\mu$ H LISN with additional 10 $\mu$ F capacitor clamped to the source terminals, DO-160 limits

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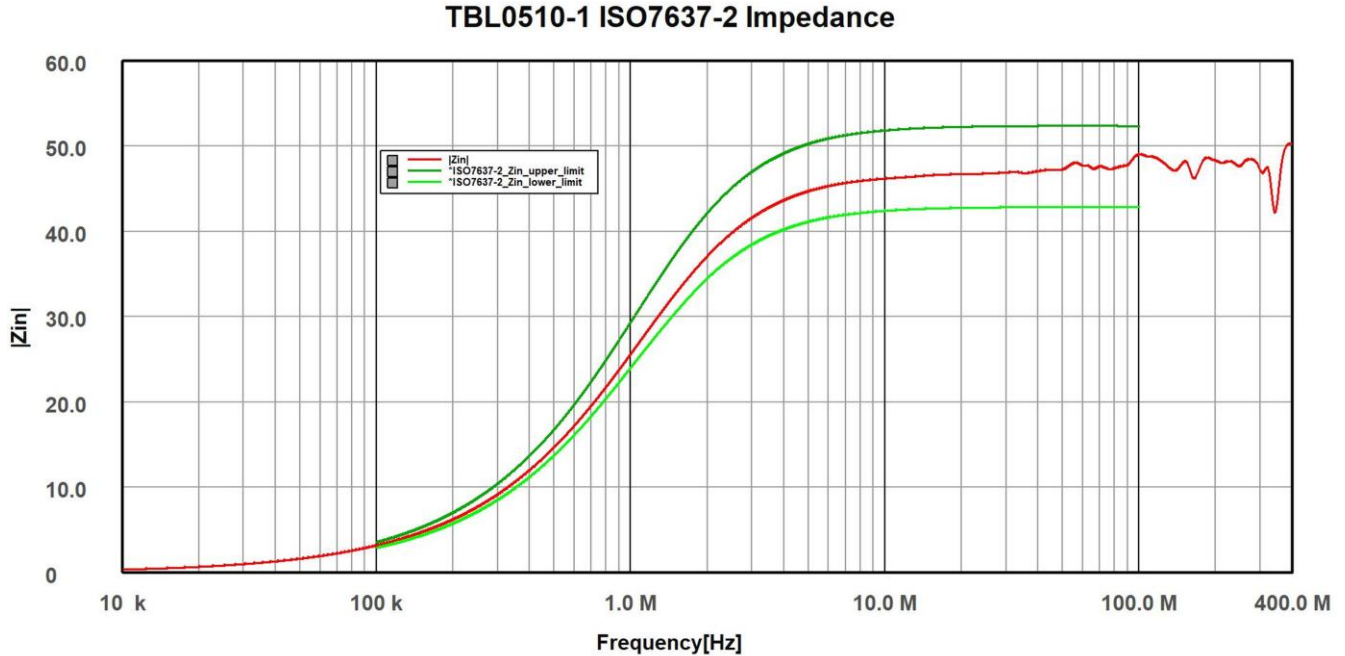


Figure 5: 100 kHz – 100 MHz, impedance of the TBL0510-1 5 $\mu$ H LISN, ISO 7637-2 impedance\*

\*)The TBL0510-1 is an entry level LISN and as such has a transient limiting diode and a gas discharge tube in parallel to the BNC connector. It is recommended to remove it for ISO 7637-2 testing. Upon request, we will also deliver the LISN without transient protection.

### 1.4 Isolation

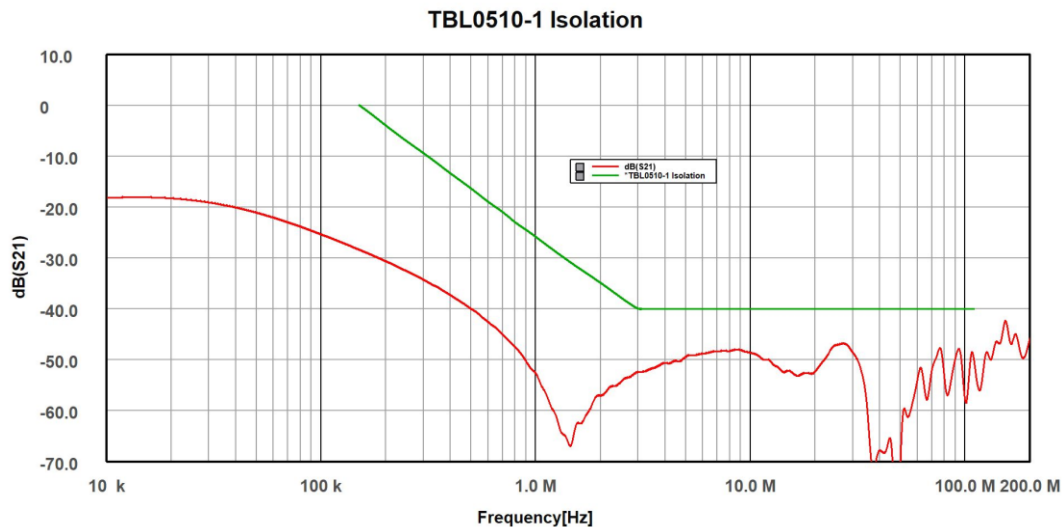


Figure 6: 150 kHz - 110MHz, isolation measured between DUT and source terminals; BNC connector terminated with 50 $\Omega$

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### 1.5 Voltage Division Ratio

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

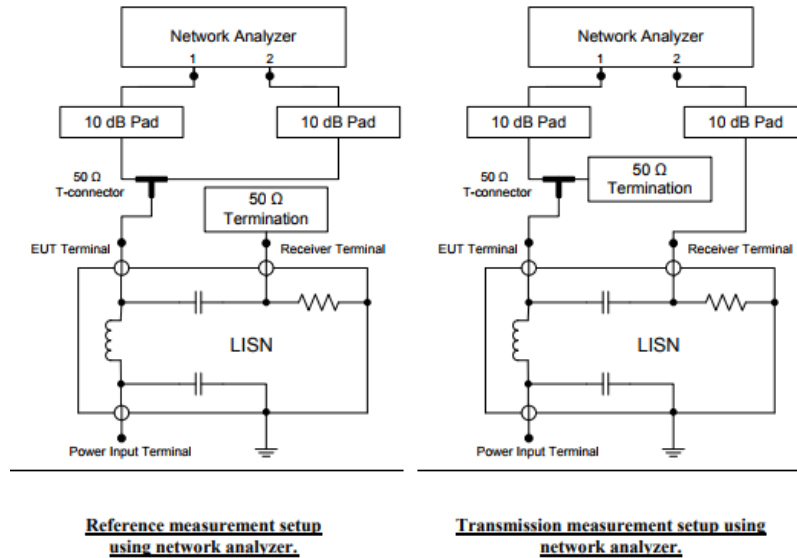


Figure 7 – Calibration set up according to CISPR 16-1-2 Annex A.8.

The voltage division ratio is a correction factor that needs to be applied to the levels measured at the LISN RF output.

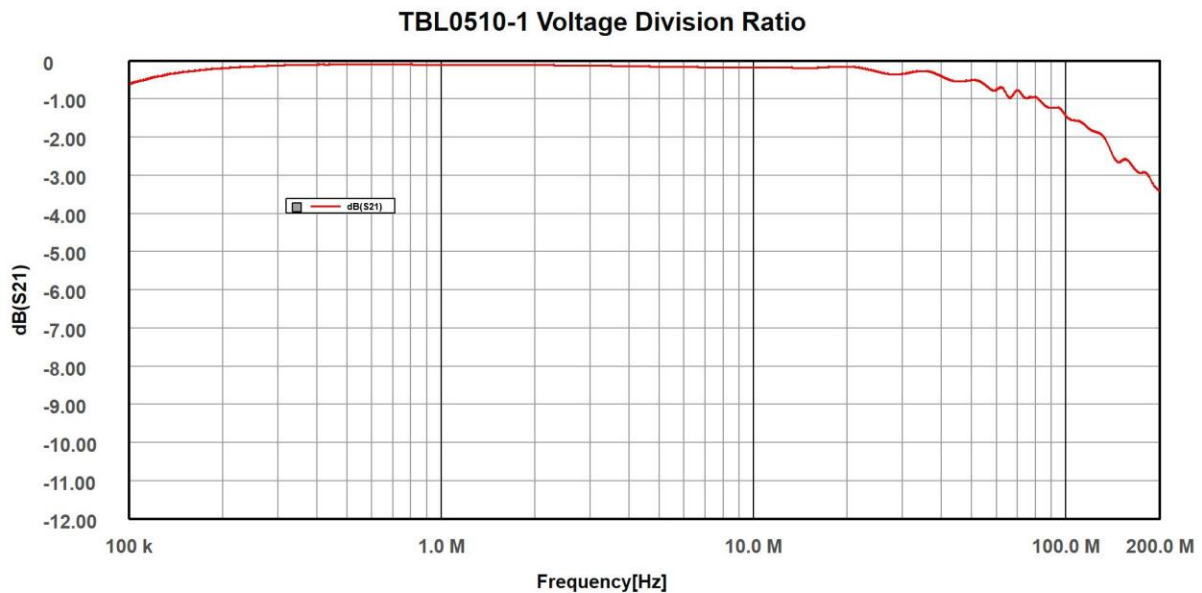


Figure 8: 100 kHz - 110MHz, voltage division ratio according to CISPR 16-1-2 Annex A8; source terminal 1 $\mu$ F

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| Frequency [MHz] | Voltage division ratio [dB];<br>source terminals: 1 $\mu$ F |
|-----------------|-------------------------------------------------------------|
| 0.1             | -0.62                                                       |
| 0.15            | -0.29                                                       |
| 0.175           | -0.23                                                       |
| 0.2             | -0.2                                                        |
| 0.25            | -0.15                                                       |
| 0.5             | -0.1                                                        |
| 0.75            | -0.1                                                        |
| 1               | -0.1                                                        |
| 1.5             | -0.11                                                       |
| 2               | -0.11                                                       |
| 2.5             | -0.12                                                       |
| 5               | -0.15                                                       |
| 7.5             | -0.17                                                       |
| 10              | -0.17                                                       |
| 20              | -0.15                                                       |
| 30              | -0.34                                                       |
| 40              | -0.41                                                       |
| 50              | -0.51                                                       |
| 60              | -0.76                                                       |
| 70              | -0.77                                                       |
| 80              | -0.96                                                       |
| 90              | -1.23                                                       |
| 100             | -1.44                                                       |
| 110             | -1.58                                                       |

Table 1: 100 kHz – 110 MHz, voltage division ratio according to CISPR 16-1-2 Annex A8; source terminal 1 $\mu$ F

A correction file with the voltage division ratio for use with the EMCview software can be downloaded from the TBL0510-1 product page.

### 1.6 Phase

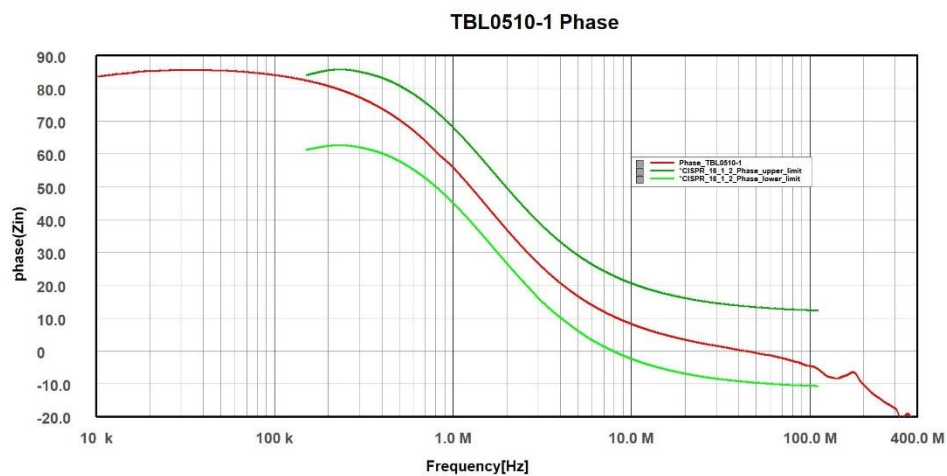


Figure 9: 150 kHz – 110 MHz, Phase angle of impedance with CISPR-16-1-2 limits; the other standards do not specify phase requirements

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### 1.7 Heat up characteristics

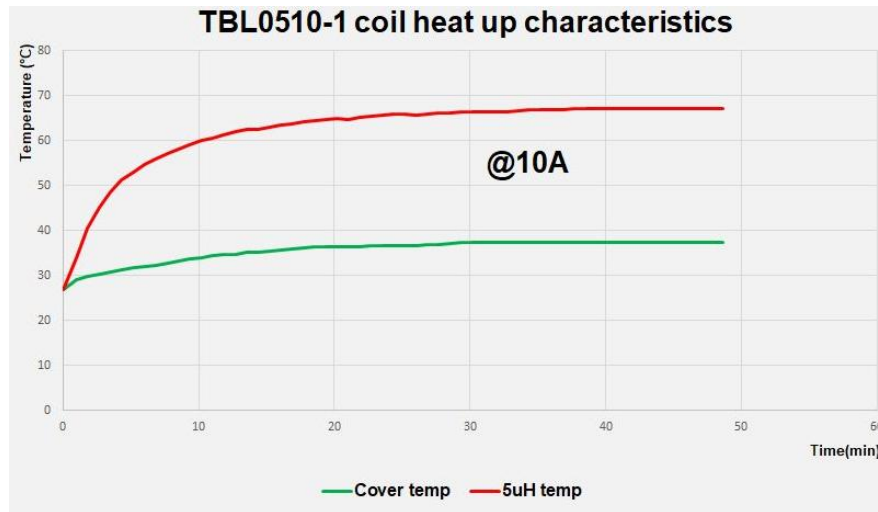


Figure 10: Heat up characteristics of LISN housing and 5 $\mu$ H inductor

The LISN can be continuously loaded with 10A supply current. For up to 15 minutes, the LISN can be loaded with 15A.

### 1.8 Source capacitors:

For CISPR 25 and ISO 11452-2/4/5 conducted emission tests, use the supplied 1 $\mu$ F capacitor at the source terminals. The TBL0510-1 terminals have perpendicular holes to easily insert and clamp the pins external capacitors. DO-160 specifies a 10 $\mu$ F capacitor in parallel to the source terminals. ISO7637-2 does not specify an external capacitor.

## 2 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

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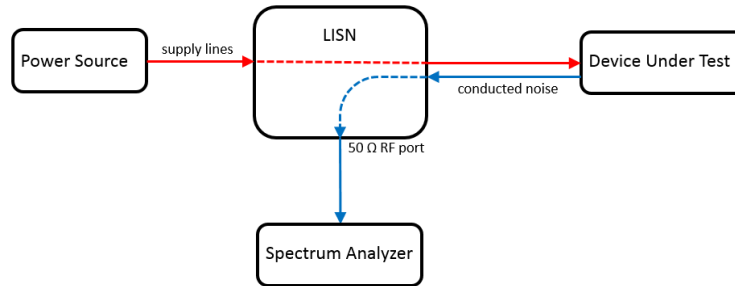


Figure 11: Basic diagram of a conducted emission measurement setup with a LISN

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.

### 2.1 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.

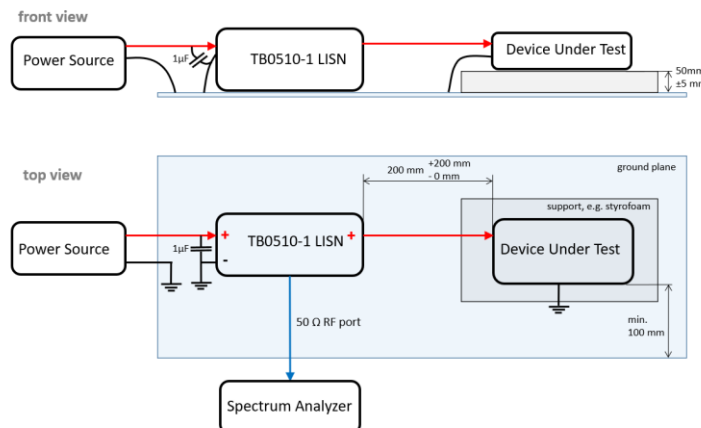


Figure 12: conducted emission measurement, voltage method, DUT with power return line locally grounded



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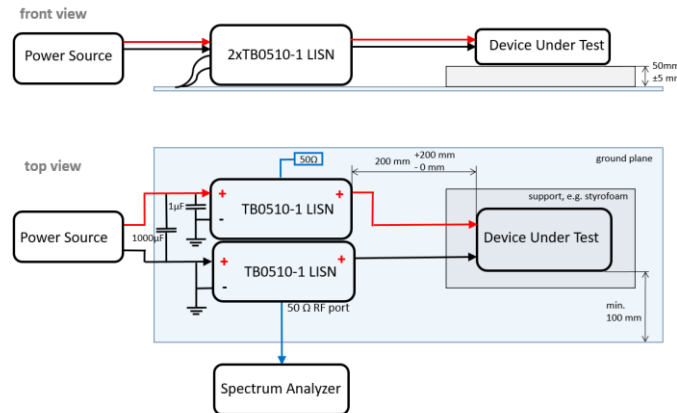


Figure 13: conducted emission measurement, voltage method, DUT with power return line remotely grounded

Figure 12 and figure 13 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 requires an additional 10 $\mu$ F capacitor across the source terminals of the LISN.

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

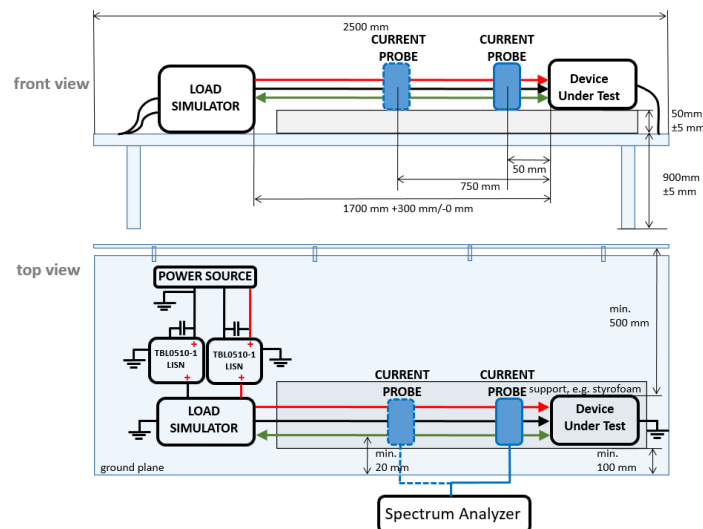


Figure 14: conducted emission measurement according to CISPR 25, current probe method

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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.

For more details refer to our application note AN Conducted Noise Measurement \_Tekbox LISN TBL0510-1 and EMCview\_V1\_2.

### 2.3 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 a BCI probe. Again, two 5 $\mu$ H LISNs are required to establish 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.

### 2.4 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. Furthermore, depending on the voltage level of the applied pulses, it may be necessary to remove the protective (voltage limiting) components such as the TVS diodes, gas discharge tube and MOV.

### 2.5 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. Note that this measurement is not covered by EMC standards.

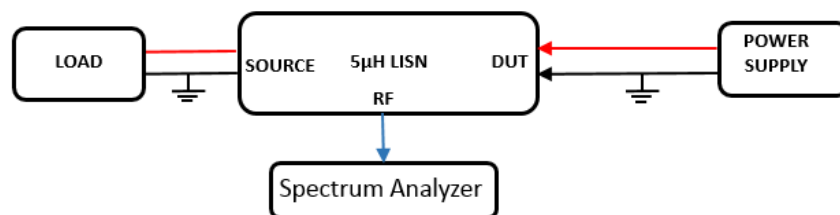


Figure 15: setup for measuring power supply noise spectrum

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### 2.6 Setup for RF immunity debugging

By adding a 50 Ohm feed through termination, the LISN may be utilized as an improvised means of injecting RF into the supply line of the DUT. The power rating of the feed through termination has to match the injected RF power level. Note that this is not a standard conformant method. These inject RF via CDN or BCI probes.

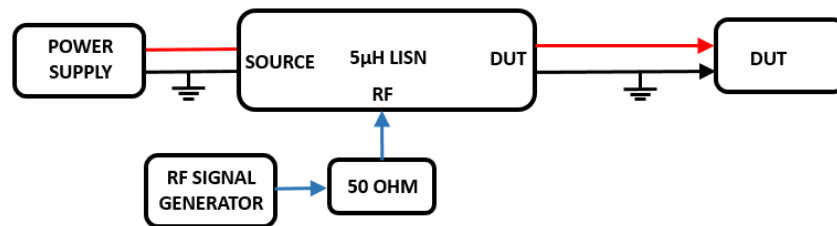


Figure 16: setup for improvised RF injection

## 3 Ordering Information

| Part Number | Description    |
|-------------|----------------|
| TBL0510-1   | 5 $\mu$ H LISN |

Table 3 – Ordering information

## 4 History

| Version | Date      | Author     | Changes                  |
|---------|-----------|------------|--------------------------|
| V1.0    | 8.10.2025 | Mayerhofer | Creation of the document |
|         |           |            |                          |
|         |           |            |                          |

Table 4 – History