

# 50 $\mu$ H Line Impedance Stabilisation Network

## 1 Introduction

The TBL5016-1 50 $\mu$ H LISN is a device required to setup conducted noise measurements of DC or AC-powered electronic equipment. It is designed according to CISPR 16-1-2 and MIL-STD-461F standard and characterized in the frequency range of 150 kHz to 100 MHz. Jumpering a 5 Ohm resistor enables using the LISN from 9 kHz -30 MHz.

Apart from carrying out conducted noise measurements, LISNs are also used to establish a defined impedance for various other standardized tests.

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 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 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 50 $\mu$ H inductor. DC or single phase measurements typically require a pair of TBL5016-1. Combining it with the Tekbox LISN Mate 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.

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



## 2 Parameters

LISN type: V-AMN, configurable as 50 $\Omega$ /50 $\mu$ H+5  $\Omega$  or 50 $\Omega$ /50 $\mu$ H; no 250 $\mu$ H pre-filter

Frequency range: 9/150 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

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### 2.1 Conformity

The TBL5016-1 is compliant with CISPR 16-1-2.

In line with the CISPR 16-1-1 standard compliant design and setup specification, the TBL5016-1 LISN exhibits high ground leakage currents and non-standard isolation and consequently cannot meet the safety requirements of EN 61010-1.

Furthermore CISPR 16-1-2 specifies high capacitance values for the capacitors from Line / + to Ground. These capacitance values are not commercially available in Y2 rating and are implemented using AC rated capacitors with suitable voltage rating.

In order to prevent the danger of lethal electric shock, the operator is responsible for ensuring protective measures in line with IEC 60364-4-41 and IEC 60364-5-54 and to follow all safety related information of this manual.

### 2.2 Safety

To ensure safe operations, the user must adhere to all safety-related information in this manual. All metal parts of the housing are connected to the earth pins of the Source and DUT sockets. Before connecting any other conductor to the LISN, connect the Earth brackets to protective Earth.

Protective Earth must not be disconnected from the Earth brackets unless all other wiring has been disconnected first. Special care must be taken to avoid connecting AC - line or VDC+ to the EARTH pin of the SOURCE connector by mistake.

When operating the LISN with alternating current, use an isolation transformer.

While the source connector is under voltage, do not connect or disconnect it.

The TBL5016-1 shall be operated by qualified laboratory staff only.

## 3 Warning

### Spectrum Analyzer / Measurement Receiver protection:

The TBL5016-1 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. If using without transient limiter and testing AC supplied products, it is highly recommended to protect the input of the connected analyzer with TBHPF1-9kHz or TBHPF1-150 kHz highpass filters or to insert the internal highpass jumper.

### Safety:

Operating an AC LISN involves dealing with potentially lethal voltages and high ground leakage currents. The LISN shall only be operated by qualified staff.



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Read this manual carefully and be sure to understand the operation of the LISN. Make sure that the conducted noise pre – compliance test equipment is set up correctly and that the necessary earth connections are reliably bonded to avoid the risk of lethal electric shocks. The ground brackets must be securely connected to the protective earth conductor available on site, before making any other electrical connection. This connection must not be separated, until the mains supply is disconnected from the LISN setup.

When connecting the LISN to AC mains voltage, always use an isolation transformer.

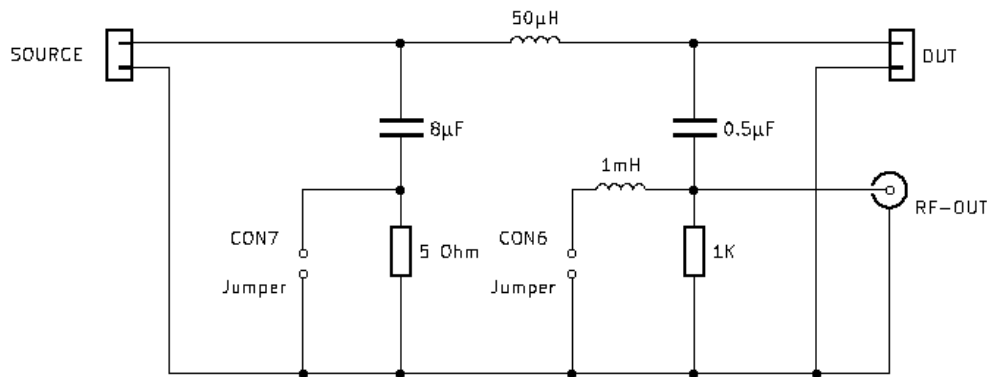
Take precautions, such as validating the signal amplitude at the RF output prior to connecting a spectrum analyzer or using attenuators and/or limiters to prevent damage to your test receiver or spectrum analyzer.

Do not carry out any modifications or manipulations of the TBL5016-1.

Avoid touching the housing, when operating the LISN at maximum current over extended time. The housing temperature may rise up to 50°C. Turn off the DUT after measurements to avoid unnecessary dissipation.

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. The maximum source voltage rating with respect to component ratings is 250V.

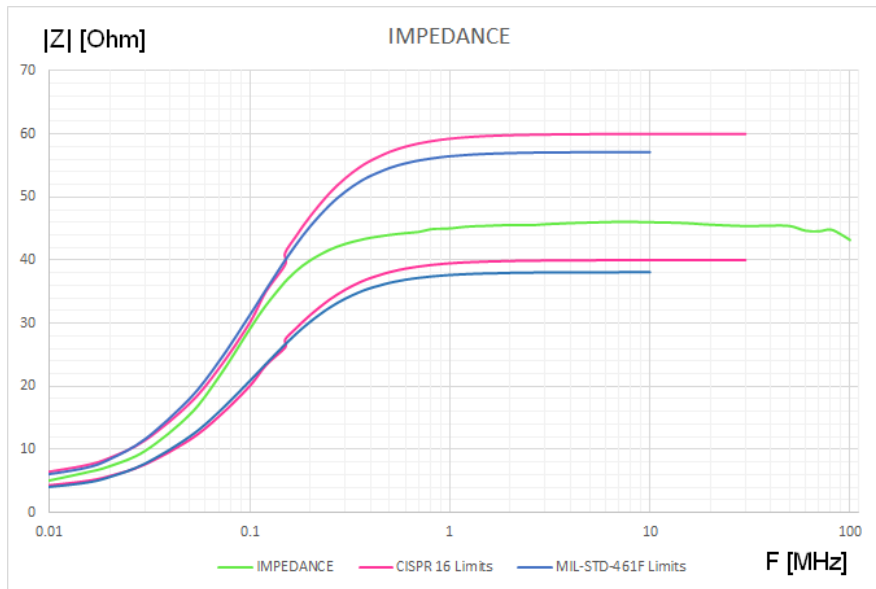
### 4 Principle schematic



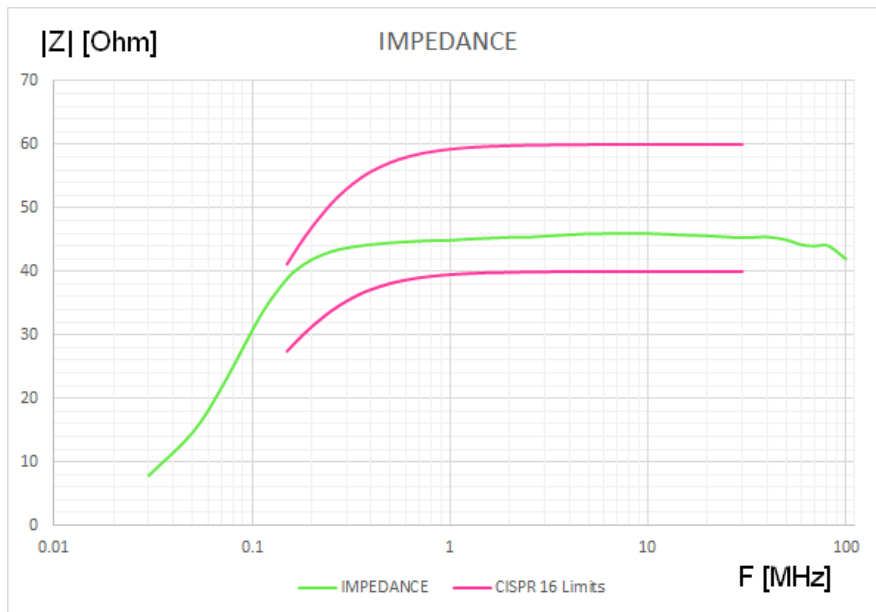
Picture 1: principle schematic

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### 5 Impedance



Picture 2: LISN impedance, 50 $\Omega$  // 50 $\mu$ H + 5 $\Omega$

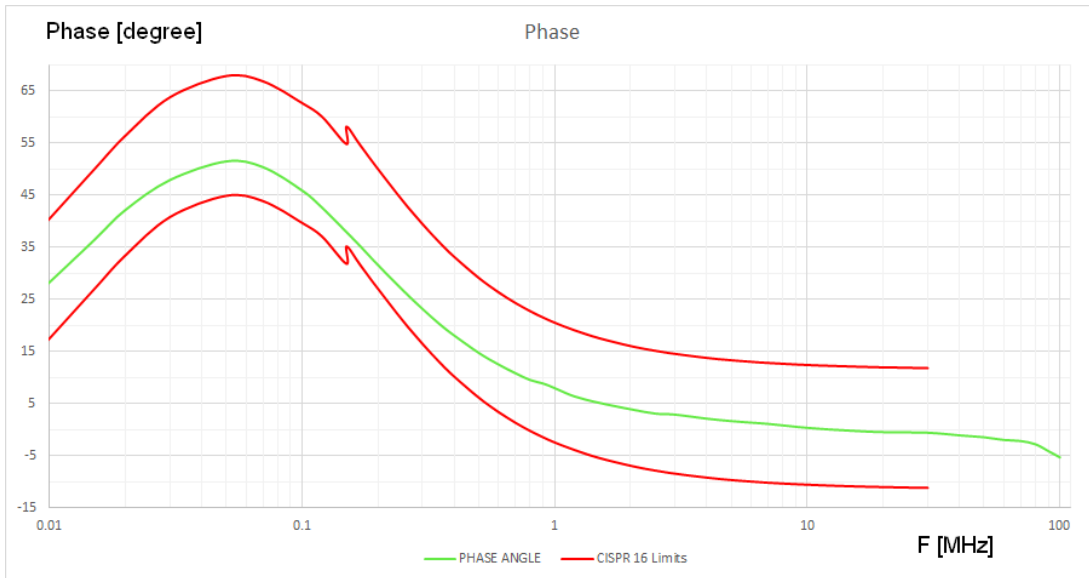


Picture 3: LISN impedance, 50 $\Omega$  // 50 $\mu$ H

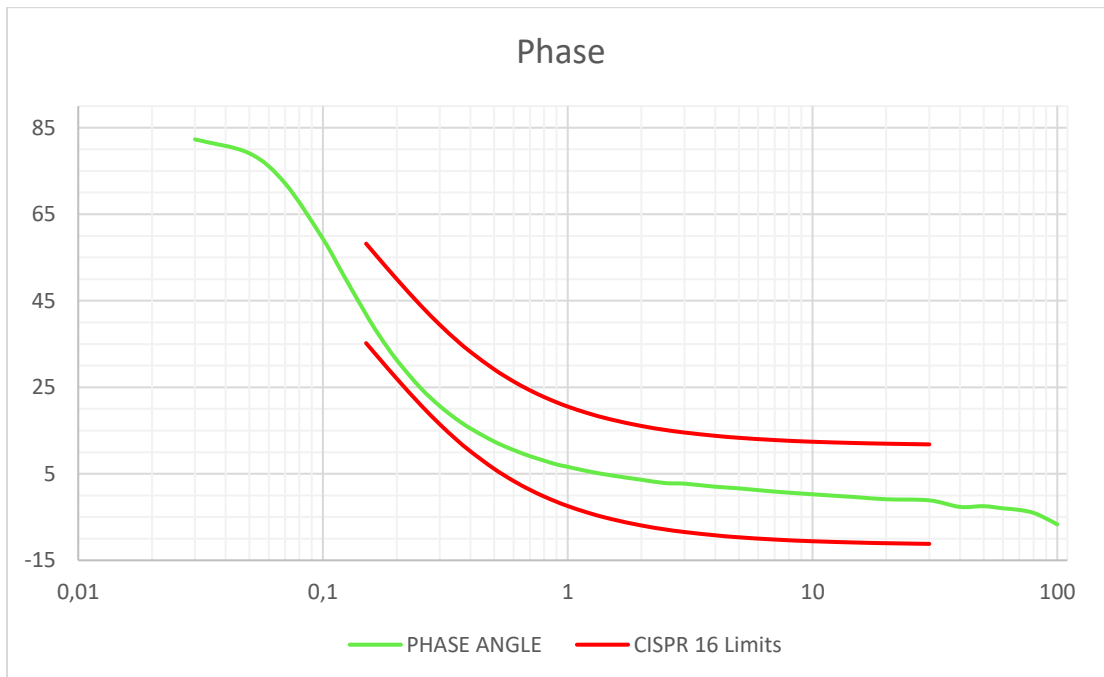
The impedance is referenced to the PCB edge, not including the Phoenix terminal blocks. The male + female terminal block combination can be considered being equivalent to 5cm of additional wiring in the entire set up.

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### 6 Phase



Picture 3: LISN phase, 50 $\Omega$  // 50 $\mu$ H + 5 $\Omega$

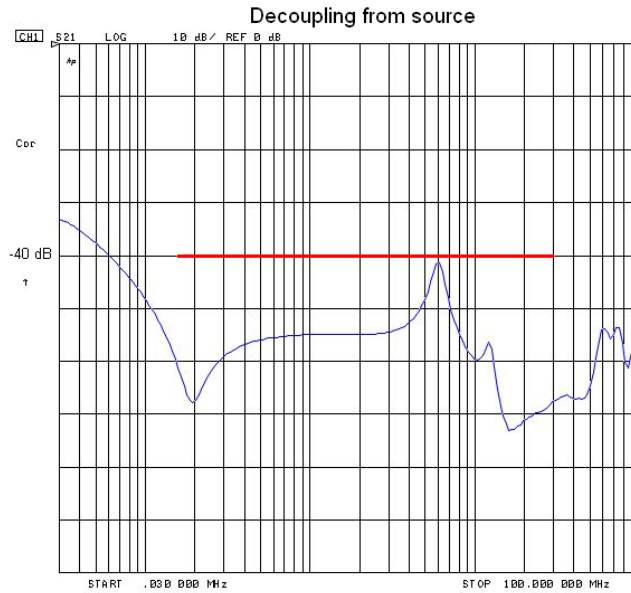


Picture 4: LISN phase, 50 $\Omega$  // 50 $\mu$ H

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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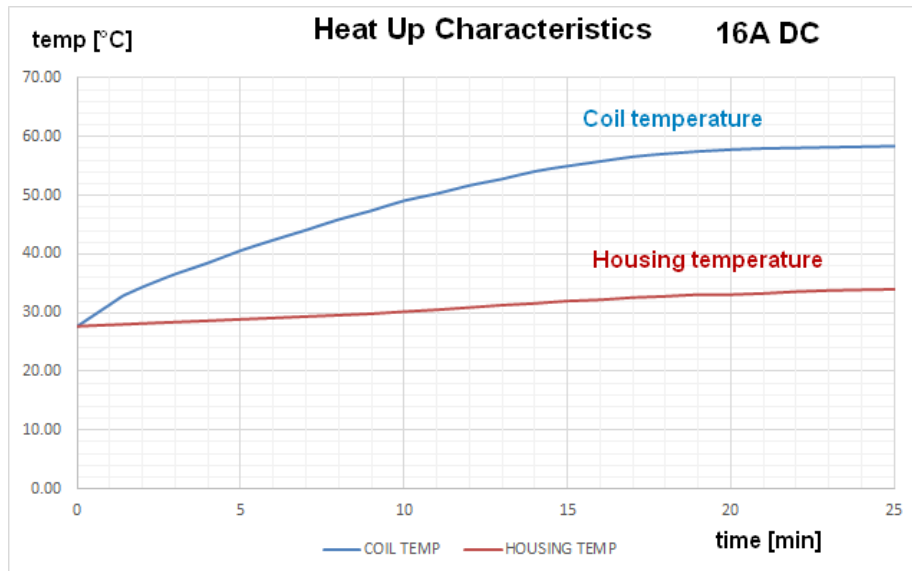
## 7 Isolation



Picture 5: LISN Isolation, Source to RF out, 50Ω // 50µH

The isolation is measured between SOURCE terminal and RF port, with the DUT port terminated with 50 Ohm. Note that the isolation is not within CISPR 16 limits below 3 MHz, when enabling the 5 Ohm resistor (50Ω // 50µH+5 Ω configuration), as the TBL5016-1 is not equipped with a 250µH pre-filter.

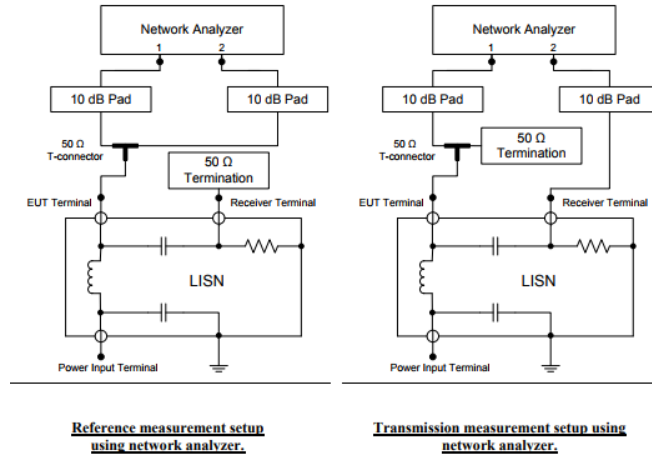
## 8 Thermal characteristics



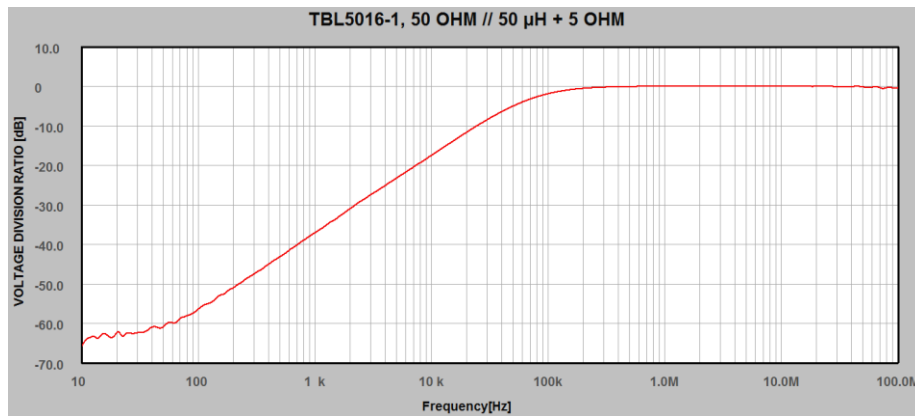
Picture 6: Coil and housing temperature at 16 A DC current

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



Picture 7: Calibration set up according to CISPR 16-1-2 Annex A.8.

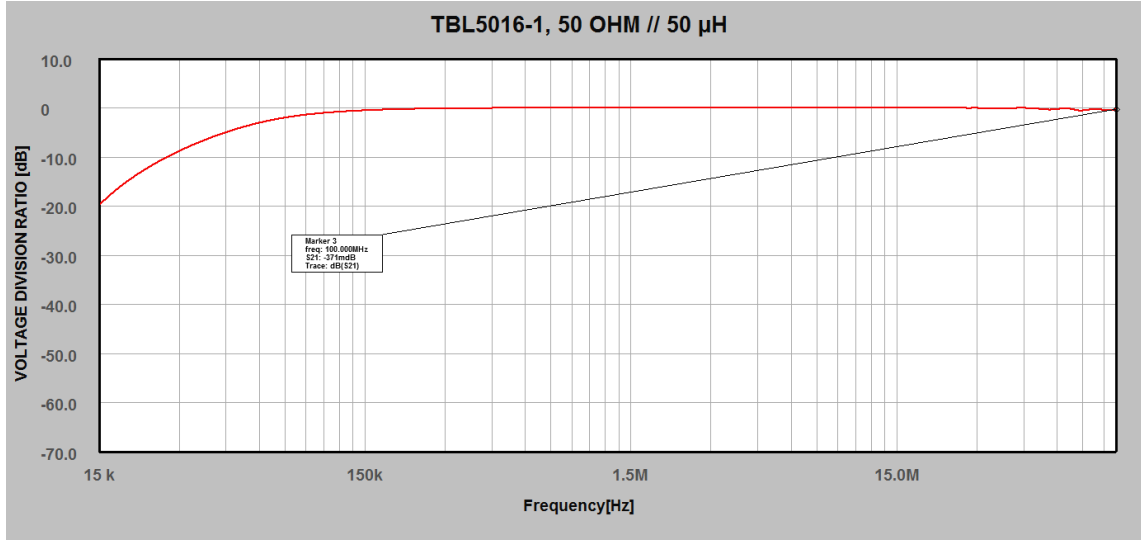


Picture 8: Voltage division ratio DUT terminals to RF connector, 50Ω // 50µH + 5Ω

Frequency [MHz]	Voltage Division Ratio DUT port to RF port [dB]	Frequency [MHz]	Voltage Division Ratio DUT port to RF port [dB]
0.0001	-55.66	2	-0.04
0.0005	-43.21	5	-0.04
0.001	-37.09	7	-0.04
0.005	-23.2	10	-0.03
0.01	-17.48	20	-0.05
0.015	-14.06	30	-0.03
0.03	-8.46	40	-0.03
0.05	-5.01	50	-0.09
0.1	-1.88	60	-0.03
0.15	-0.95	70	-0.11
0.3	-0.27	80	-0.05
0.5	-0.11	90	-0.04
0.75	-0.05	100	-0.03
1	-0.04		

Table 1 - LISN calibration data, voltage division ratio, 50Ω // 50µH + 5Ω

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Picture 9: Voltage division ratio DUT terminals to RF connector, 50Ω // 50µH

Frequency [MHz]	Voltage Division Ratio DUT port to RF port [dB]	Frequency [MHz]	Voltage Division Ratio DUT port to RF port[dB]
0.015	-19.86	7	-0.03
0.03	-8.85	10	-0.04
0.05	-4.25	20	-0.06
0.1	-1.19	30	-0.08
0.15	-0.56	40	-0.13
0.3	-0.16	50	-0.21
0.5	-0.07	60	-0.31
0.75	-0.03	70	-0.45
1	-0.03	80	-0.39
2	-0.02	90	-0.48
5	-0.02	100	-0.37

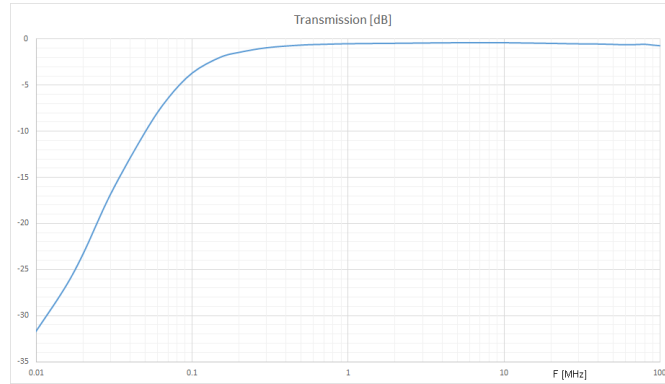
Table 2 - LISN calibration data, voltage division ratio, 50Ω // 50µH

The voltage division ratio 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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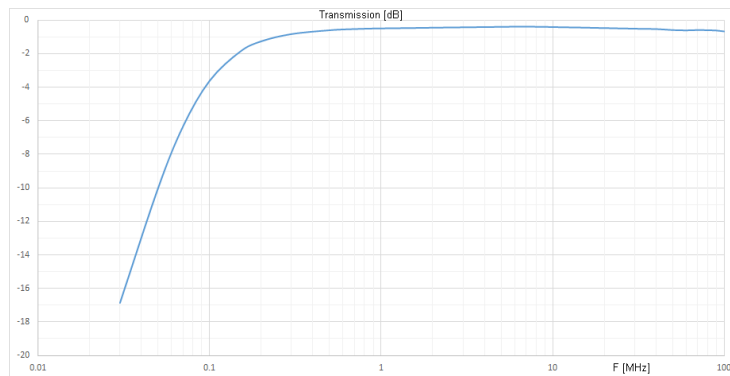
### 10 Transmission loss



Picture 10: Transmission , DUT terminals to RF connector, 50Ω // 50µH + 5Ω

Frequency [MHz]	Transmission DUT port to RF port [dB]	Frequency [MHz]	Transmission DUT port to RF port [dB]
0.009	-32.76 (-34.89 with High Pass jumpered)	2	-0.45
0.015	-27.13 (-27.53 with High Pass jumpered)	5	-0.39
0.02	-23.22	7	-0.39
0.03	-16.75	10	-0.39
0.05	-10.02	20	-0.46
0.07	-6.39	30	-0.51
0.1	-3.66	40	-0.53
0.15	-1.99	50	-0.57
0.2	-1.43	60	-0.61
0.3	-0.93	70	-0.59
0.5	-0.64	80	-0.56
0.7	-0.56	90	-0.64
1	-0.5	100	-0.71
1.5	-0.47		

Table 3 - LISN calibration data, transmission, 50Ω // 50µH + 5Ω



Picture 11: Transmission , DUT terminals to RF connector, 50Ω // 50µH

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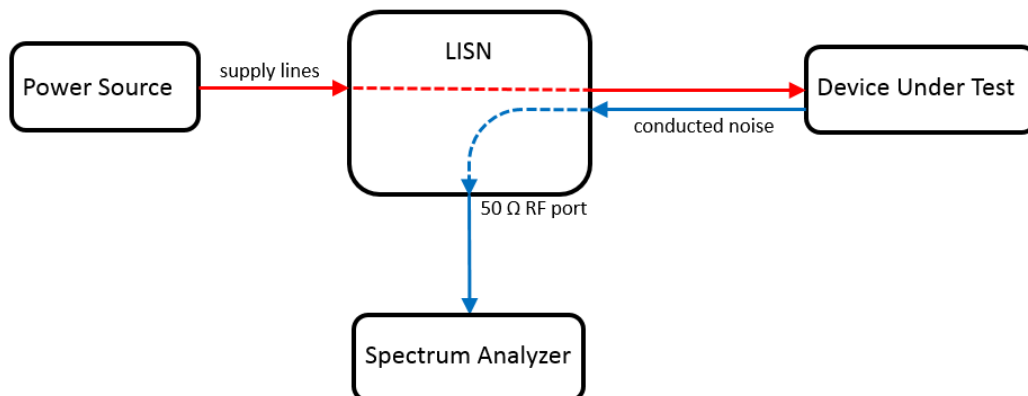
Frequency [MHz]	Transmission DUT port to RF port [dB]	Frequency [MHz]	Transmission DUT port to RF port [dB]
0.03	-16.86	7	-0.39
0.05	-10.03	10	-0.41
0.07	-6.33	20	-0.47
0.1	-3.61	30	-0.51
0.15	-1.89	40	-0.53
0.2	-1.26	50	-0.59
0.3	-0.83	60	-0.61
0.5	-0.6	70	-0.59
0.7	-0.53	80	-0.6
1	-0.49	90	-0.62
2	-0.47	100	-0.67
5	-0.45		

Table 4 - LISN calibration data, transmission, 50Ω // 50µH

## 11 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 Ω 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 12: Basic diagram of a conducted emission measurement setup with a LISN

Note that the above basic diagram is simplified. Typically, a standard conformant setup needs two TBL5016-1. One LISN is inserted in the positive supply line and the other LISN is inserted in the negative supply line. Conducted noise measurements have to be carried out on both supply lines. While measuring the noise on one

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of the supply lines, the RF output of the other LISN must be terminated with 50 Ohm. Similarly, when testing an AC supplied product, one LISN must be inserted in the phase line and the other LISN in the neutral line. Products with 3 phase AC supply can be tested using three (delta configuration) or four (star configuration) TBL5016-1.

### 11.1 Operation

The TBL5016-1 LISN does not contain a 250 $\mu$ H pre-filter. It contains a high pass at the BNC output, but no transient limiter. Consequently 50 Hz harmonics with high amplitude may appear at the RF output and overdrive or even damage the measurement receiver / spectrum analyser. It is highly recommended to use an external filter/attenuator/transient limiter such as the TBFL1 or similar. External attenuators may also be necessary, depending on the behaviour of the DUT.

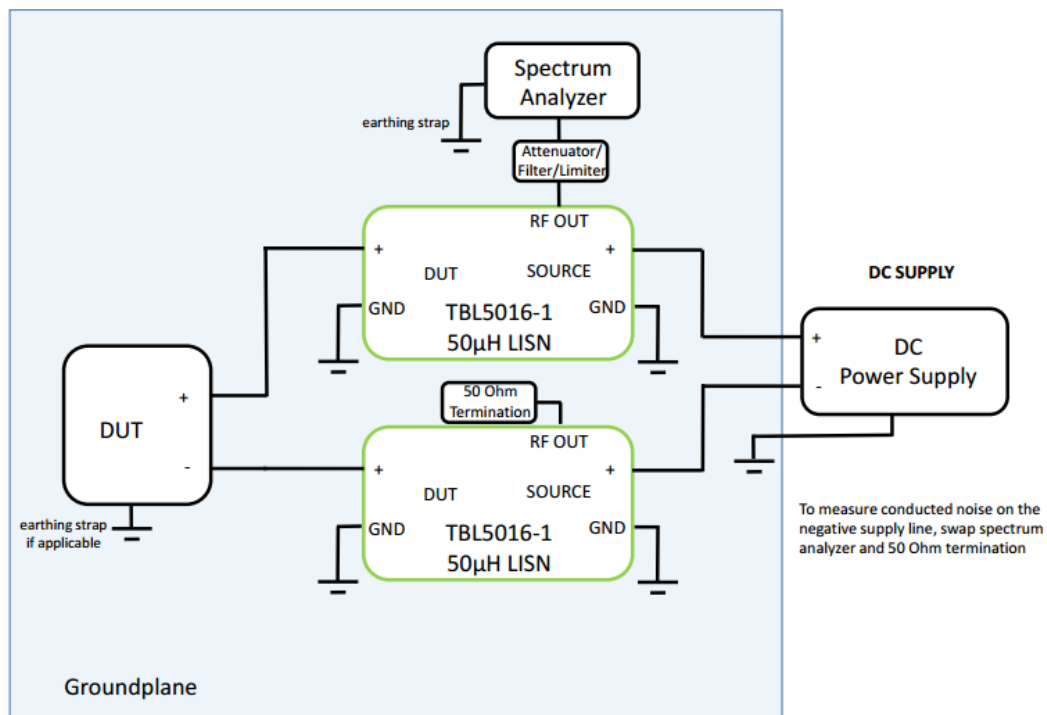
50 Hz suppression without high pass jumpered: 57 dB

50 Hz suppression with high pass jumpered: 78 dB

Furthermore, the TBL5016-1 LISN has an 8 $\mu$ F capacitor to ground. In AC applications, the capacitor draws a significant amount of blind current, which would trip the mains ground fault switch. Hence, the TBL0550-1 must be supplied through an isolation transformer.

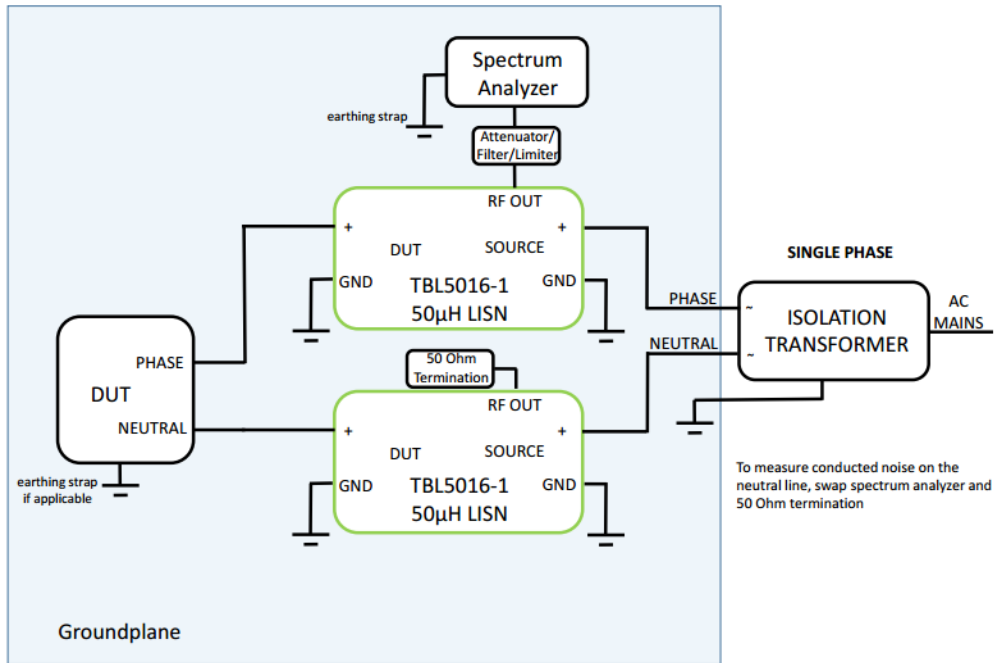
Though the TBL5016-1 LISN is designed for both AC and DC supplied DUTs, a 50 $\mu$ H LISN with 250 $\mu$ H pre-filter is the better choice when testing AC supplied DUTs in most cases. The TBL5016-1 is primarily targeting conducted noise measurements of DC supplied ISM, Telecom or IT products in the range 150 kHz – 30 MHz. Separate measurement of differential and common mode noise can be carried out using two TBL5016-1 in combination with the Tekbox LISN Mate TBLM1.

### 11.2 Wiring Variants

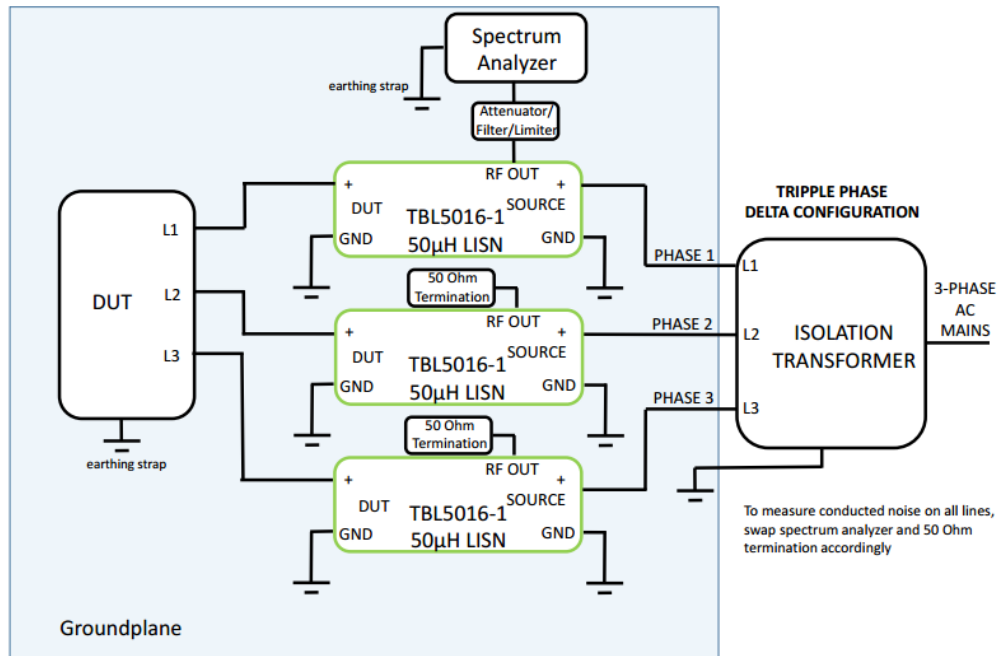


Picture 13: Measurement set up for DC supplied equipment

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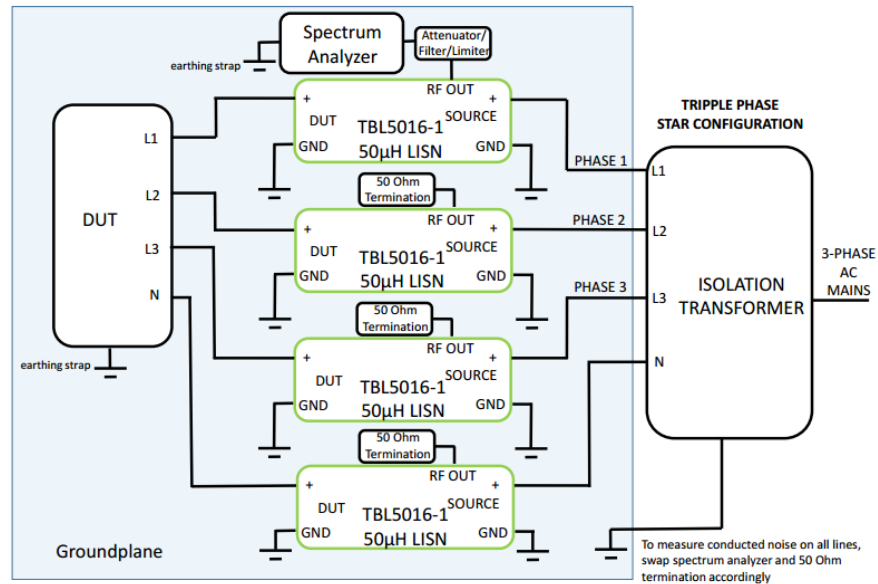


Picture 14: Measurement set up for single phase AC supplied equipment



Picture 15: Measurement set up for triple phase AC supplied equipment in Delta configuration

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Picture 16: Measurement set up for triple phase AC supplied equipment in Star configuration

## 12 Ordering Information

Part Number	Description
TBL5016-1	50µH LISN, 2 pcs. ground brackets, 2pcs. female terminal blocks Phoenix Contact 1967375, 1 pc. 75 cm BNC-male to N-male RG223 cable, 1 pc jumper Harwin D3087-98

By default, the LISN is jumpered to 50Ω // 50µH. In order to configure the LISN to 50Ω // 50µH + 5 Ω, remove the two plastic frames of the housing and then remove the top cover. Remove the supplied jumper from PCB position, marked CON7 in silk screen. In order to jumper the high pass filter, insert the supplied jumper into PCB position CON6.

## 13 History

Version	Date	Author	Changes
V1.0	5.11.2019	Mayerhofer	Creation of the document
V1.1	4.02.2020	Mayerhofer	Graphs updated
V1.2	4.02.2020	Mayerhofer	Chapter 11.2 added
V1.3	27.11.2021	Mayerhofer	Chapter 9 updated
V1.4	28.02.2022	Mayerhofer	Safety information updated
V1.5	7.12.2022	Mayerhofer	Ordering information corrected
V1.6	4.01.2023	Mayerhofer	Chapter 7 and 12 updated
V1.7	11.04.2023	Mayerhofer	Chapters 1, 2, 11 updated

Table 5 – History