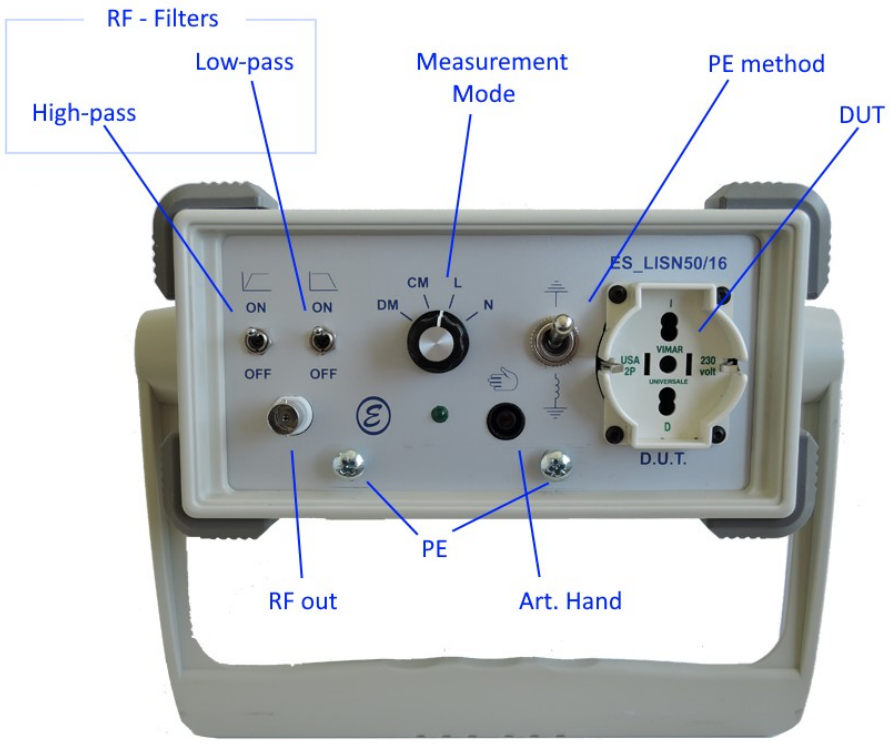
LISN50/16 AC

The LISN50/16 is an Artificial Main or Line Impedance Stabilization Network (LISN) for pre-compliance conducted EMI testing in the range of 9kHz till 30MHz and is compliant with CISPR 16-1-2, DIN/VDE 0876 and FCC part 15.
The extended frequency range (till 110MHz) and the use for V-, Δ- and T-networks make it ideal for developers for testing and solving EMC problems.



Specifications

- 50µH / 250µH + 5Ω network
- Differential mode (DM)
- Common mode (CM)
- L or N
- Artificial hand
- Low-pass filter 35MHz
- High-pass filter 9kHz
- Built-in limiter
- Measurement range 9kHz - 110MHz
- Attn 10dB
- Universal outlet
- Power 200-250Vac 50/60Hz IEC 60320 C19
- 22 x 10 x 24 cm

ELab-Tools

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Warning

Make sure the LISN is grounded. If not, the metal parts will be live!

The AC LISN is connected to the Mains power lines. This makes it potentially dangerous. Operating a setup with a the LISN50/16 shall only be done by qualified staff.

Protective measures:

- **Connect the ground bolts securely to the protective earth conductor.**
- **Always use an isolation transformer between the Mains and the LISN. See page 6.**
- **Do not modify the LISN50/16.**

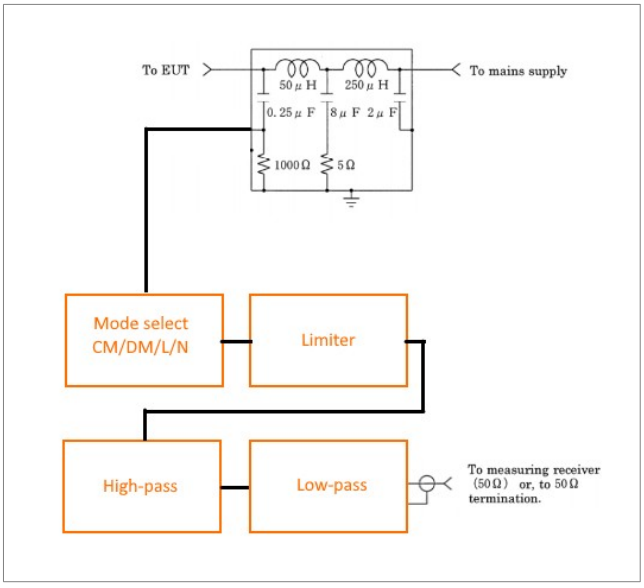
LISN Internals

The circuit of a LISN is described in the standard CISPR 16-1-2. Important are the series inductance and the filter capacitance.

The circuit presented, shows the network for 1 phase. The LISN has this network for both phases and the RF tap can be switched.

The 50uH inductor is important for the actual measurement. The 250uH pre-filter reduces noise coming from the Mains supply.

The RF measurement output in the LISN50/16 has extended functionality to make it more safe and allow different measurements.



By using RF-relays to switch filters and optimized layout, the RF path has been made flat upto 110MHz.

Connections & Controls

Names are shown in the picture of page 1.

PE terminals

Connect both PE terminals to the ground reference plane using a broad and short conductor, preferably metal strip(s). This reduces the impedance to the reference plane, which is important for the higher frequencies.

PE Method

The connection from the LISN to the Main PE is either directly coupled, or through an inductor (700uH). This simulates the use of the equipment on a non-grounded Main socket.

Artificial Hand

The Artificial Hand simulates the influence of the human hand on the EMC behaviour of devices, which are held in hand during use (for example: electrical drilling machines, hairdryer etc.).
If the DUT has a plastic housing, a conductive film should be used to cover the housing at the location, where it is held in hand. A test lead is used to connect the film to banana jack ‘Art. Hand’. DUTs with a metal housing are connected directly to banana jack 1, if they don’t have a protective ground connection according to Class 1.

DUT connections

The DUT (Device Under Test) is connected with the Mains cord that will be supplied with the device. The connection on the LISN is universal and supports EU and US plugs.

Measurement mode

The ‘measurement mode’ selects which signal is fed to the Spectrum analyzer connection. Conducted noise can be measured on the phase and on the neutral conductor.
The Common Mode (CM) provides a combined signal and Differential mode (DM) provides a difference signal.

- N: one of the phases (Neutral)
- L: one of the phases (Line)
- CM: Common mode signal: $\frac{V_L + V_N}{2}$
- DM: Differential mode signal $V_L - V_N$

The L and N are used for a measurement according to the standard (CISPR/VDE). The DM and CM modes are used to find the root of any interference. If the L or N measurement gives high levels, there are several cases:

CM levels	DM Levels	Possible cause
High	Low	High coupling of the circuit to PE or environment. Check the circuits other connections for proper filtering.
High	High	Possibly insufficient filtering inside the circuit (between power lines with switching elements) and possible insufficient I/O line filtering.
Low	High	Possibly insufficient filtering inside the circuit (between power lines with switching elements).

High-pass and Low-pass filter

The high-pass filter attenuates frequencies below 100kHz, the Low-pass filter starts attenuation above 30MHz.
If your measurement range is 150kHz to 30MHz, out-of-band noise may introduce cross-modulated signals if the spectrum analyzer is over-driven. If there is a significant difference when using or not using the filters, the cause should be investigated.

The frequency curves without and with filtering are shown in fig. 1.

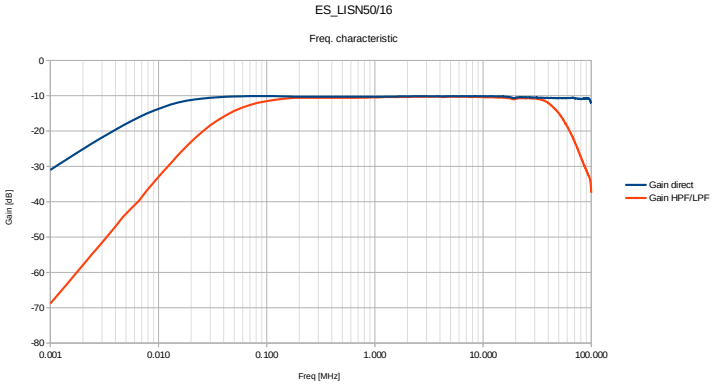


Figure 1: Frequency response with and without filtering

Built-in Limiter

The built-in limiter protects the connected spectrum analyzer from high voltage transients that occur when the Mains is switched on or off. In such an event, the Mains voltage step (may be 300V) would propagates directly through the coupling capacitor to the BNC output. The limiter is permanently placed in the path, reducing such spikes to below 800mV (~120dBuV / 11 dBm).

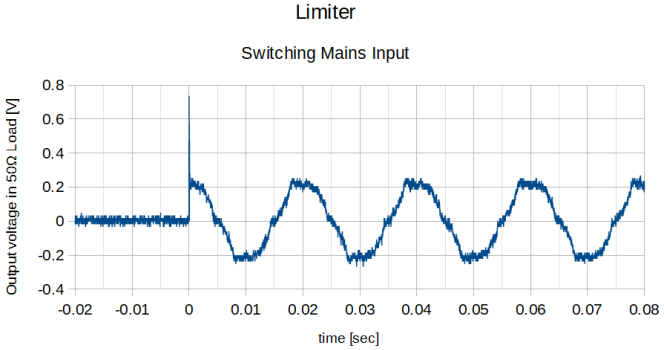


Figure 2: Effect of the limiter

The limiter has a fixed attenuation of 10dB.

Automation control

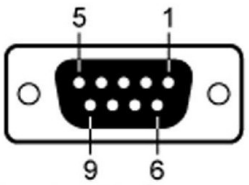
The LISN may be operated remotely through the 9pol (Female) Sub-D connector on the back. The remote functions are:

- Measurement Mode (CM/DM/L/N)
- High-pass filter
- Low-pass filter

Note that the filters are 'bridged' if the relay is activated.

To operate remotely set:

- Measurement Mode to DM (on front panel)
- High-pass filter ON
- Low-pass filter ON



Pin Nr	Function	Level
1	CM mode	Act. Low
2	L mode	Act. Low
3	HP filter	Act. High/Open
4	LP filter	Act. High/Open
5	+24V	
6	N mode	Act. Low
7	Ret (GND)	
8	Ret (GND)	
9	Ret (GND)	

Signal levels

By pulling a signal line one of the CM mode, L mode, N mode low, that function is activated. By pulling HP filter or LP filter low the filter is disabled.

Calibration

For calibration, power must be provided to activate the relays. Since powering the Mains input is not convenient for the measurement, an external 24V (and GND) may be provided on the Remote control connector (remember to pull HP/LP low to deactivate the filter).

Subsequent calibration shall be done according to CISPR 16-1-2 annex A8. Since only L and N mode is defined in the standard, these lines must be controlled or manual selection must be done from the front panel.

Measurement setup

Mains power connection

The Isolation transformer is essential for safety and for the blind-current flowing from the L and N terminal to PE through the capacitors of 8 + 5uF. Make sure that the PE is passed through.

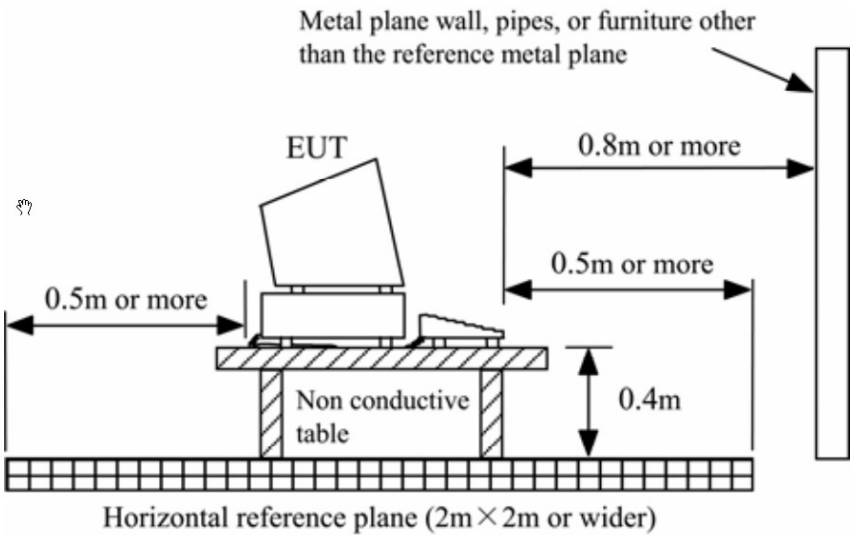
RF setup and connections

The measurement setup is described in the CISPR 16 and EN55011 and other relevant documents. Most important is de use of a ground reference plane and solid connections to it.

There are 2 ‘standard’ setup methods:

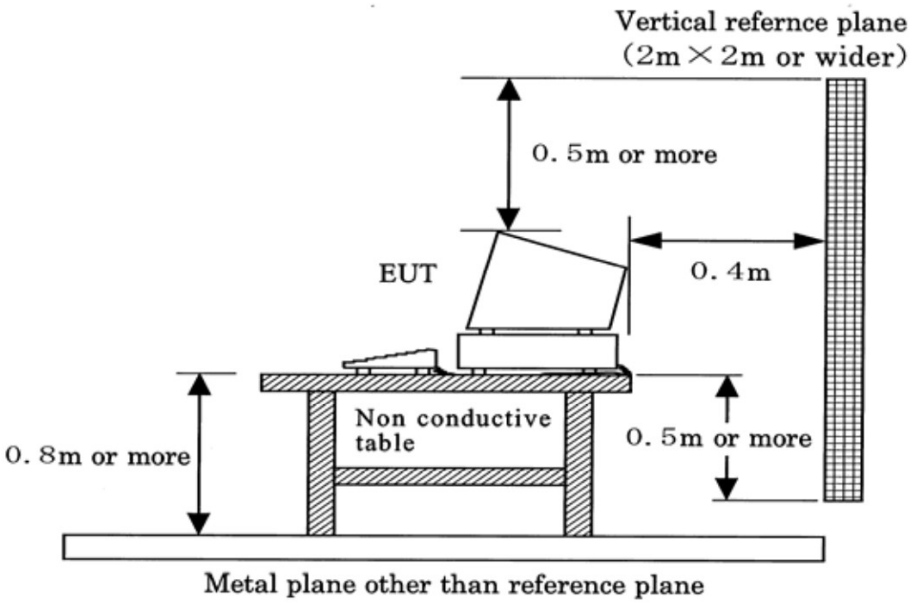
A floor reference plane

All equipment is placed above and inside the plane. Any other influences shall be kept at a distance.



Wall mount reference plane

Now the reference plane is on the wall. In all cases, use a fully non conductive table.



Initial settings for Spectrum analyzer

The recommended settings for the spectrum analyzer can be recalled from a stored configuration file.

- Frequency span: 150kHz – 30MHz (depending on the requirements)
- Detector max. peak
- Displayed amplitude unit dBµV
- Compensate the reading for the 10dB attenuation of the LISN.

kHz	No filter	HP + LP
0.050	-56.8	-87.7
0.059	-55.4	-87.8
0.070	-53.9	-87.8
0.083	-52.5	-87.7
0.098	-51.0	-87.7
0.116	-49.6	-87.6
0.137	-48.1	-87.4
0.162	-46.7	-87.1
0.192	-45.2	-86.7
0.227	-43.8	-86.0
0.269	-42.3	-84.9
0.318	-40.9	-83.7
0.376	-39.4	-82.0
0.445	-38.0	-80.1
0.527	-36.5	-78.0
0.624	-35.1	-75.7
0.738	-33.6	-73.4
0.873	-32.1	-70.9
1.033	-30.7	-68.3
1.222	-29.3	-65.7
1.446	-27.8	-63.1
1.711	-26.4	-60.4
2.025	-25.0	-57.7
2.396	-23.6	-55.1
2.835	-22.2	-52.4
3.354	-20.9	-49.8
3.969	-19.7	-47.1
4.696	-18.4	-44.2
5.556	-17.2	-42.0
6.574	-16.1	-39.8
7.778	-15.0	-36.9
9.204	-14.1	-34.3
10.89	-13.3	-31.7
12.88	-12.5	-29.2
15.25	-11.9	-26.7
18.04	-11.4	-24.4
21.34	-11.1	-22.2
25.25	-10.8	-20.2
29.88	-10.6	-18.4
35.36	-10.4	-16.9
41.83	-10.3	-15.6
49.50	-10.2	-14.4
58.57	-10.2	-13.4
69.30	-10.1	-12.7
81.99	-10.1	-12.0
97.02	-10.1	-11.6
114.79	-10.1	-11.2
135.82	-10.2	-10.9
160.71	-10.2	-10.7
181.95	-10.3	-10.6
263.90	-10.3	-10.6
345.86	-10.3	-10.6
427.81	-10.3	-10.6
509.76	-10.3	-10.6
673.66	-10.3	-10.6
837.57	-10.3	-10.5
1001.5	-10.3	-10.5
1165.4	-10.3	-10.4
1329.3	-10.2	-10.4
1493.2	-10.2	-10.4
1657.1	-10.2	-10.4
1821.0	-10.2	-10.4
1984.9	-10.2	-10.4
2148.8	-10.2	-10.4
2312.7	-10.1	-10.3
2476.6	-10.1	-10.3
2640.5	-10.1	-10.3
2804.4	-10.1	-10.3
2968.3	-10.1	-10.3
3132.2	-10.2	-10.3
3296.1	-10.2	-10.3
3460.0	-10.2	-10.3
3623.9	-10.2	-10.3
3787.8	-10.1	-10.2
3951.7	-10.1	-10.3
4115.6	-10.2	-10.4
4279.6	-10.2	-10.4
4443.5	-10.2	-10.4
4607.4	-10.1	-10.3
4771.3	-10.1	-10.3
5017.1	-10.1	-10.3
5263.0	-10.1	-10.3
5508.8	-10.1	-10.3
5754.7	-10.2	-10.3
6000.5	-10.1	-10.3
6246.4	-10.1	-10.3
6492.3	-10.1	-10.3
6738.1	-10.1	-10.3
6984.0	-10.1	-10.3
7229.8	-10.1	-10.3
7475.7	-10.1	-10.4
7721.5	-10.1	-10.4
7967.4	-10.1	-10.4
8213.2	-10.1	-10.4
8459.1	-10.1	-10.3
8705.0	-10.1	-10.4
8950.8	-10.1	-10.4
9196.7	-10.1	-10.4
9442.5	-10.1	-10.4
9688.4	-10.1	-10.4
9770.3	-10.1	-10.4
10016	-10.1	-10.4
10426	-10.1	-10.4
10836	-10.2	-10.4
11245	-10.2	-10.4
11655	-10.1	-10.4
12065	-10.1	-10.4
12475	-10.1	-10.4
12885	-10.2	-10.5
13294	-10.2	-10.5
13704	-10.2	-10.5
14114	-10.2	-10.5
14524	-10.2	-10.5
14933	-10.2	-10.5
15343	-10.2	-10.5
15753	-10.2	-10.6
16163	-10.2	-10.6
16572	-10.3	-10.7
16982	-10.3	-10.6
17392	-10.3	-10.7
17802	-10.4	-10.7
18211	-10.5	-10.8
18621	-10.6	-10.9
19031	-10.7	-11.0
19441	-10.7	-11.0
19850	-10.6	-11.0
20260	-10.5	-10.8
20670	-10.5	-10.8
21080	-10.4	-10.7
21489	-10.4	-10.7
21899	-10.4	-10.7
22309	-10.4	-10.7
22719	-10.4	-10.7
23129	-10.4	-10.7
23538	-10.4	-10.7
23948	-10.4	-10.7
24358	-10.4	-10.7
24768	-10.4	-10.7
25177	-10.4	-10.7
25587	-10.4	-10.7
25997	-10.4	-10.7
26407	-10.4	-10.7
26816	-10.4	-10.7
27226	-10.5	-10.8
27636	-10.5	-10.8
28046	-10.5	-10.8
28455	-10.5	-10.8
28865	-10.5	-10.8
29275	-10.5	-10.8
29685	-10.5	-10.8
30094	-10.5	-10.8
30504	-10.5	-10.8
30914	-10.5	-10.8
31324	-10.5	-10.9
31733	-10.5	-10.9

32143	-10.5	-11.0
32553	-10.6	-11.0
32963	-10.6	-11.0
33373	-10.6	-11.0
33864	-10.5	-11.0
34356	-10.5	-11.1
34848	-10.6	-11.1
35339	-10.6	-11.2
35831	-10.6	-11.2
36323	-10.6	-11.3
36814	-10.6	-11.4
37306	-10.7	-11.5
37798	-10.7	-11.6
38290	-10.6	-11.6
38781	-10.6	-11.7
39273	-10.6	-11.8
39765	-10.6	-11.9
40256	-10.7	-12.1
40748	-10.7	-12.2
41240	-10.6	-12.3
41732	-10.6	-12.5
42223	-10.6	-12.6
42715	-10.6	-12.8
43207	-10.6	-12.9
43698	-10.7	-13.1
44190	-10.7	-13.2
44682	-10.7	-13.4
45174	-10.7	-13.5
46567	-10.7	-13.9
48042	-10.7	-14.3
49435	-10.7	-14.7
50828	-10.7	-15.2
52221	-10.7	-15.7
53615	-10.7	-16.2
55008	-10.7	-16.7
56401	-10.7	-17.3
57794	-10.7	-17.9
59187	-10.7	-18.4
60581	-10.7	-19.0
62056	-10.6	-19.6
63613	-10.7	-20.3
65170	-10.6	-20.8
66727	-10.6	-21.5
68448	-10.7	-22.2
70169	-10.7	-23.0
71890	-10.8	-23.8
73611	-10.8	-24.5
75332	-10.8	-25.2
77053	-10.9	-26.1
79020	-10.9	-26.9
80741	-10.9	-27.6
82626	-10.9	-28.4
84347	-10.9	-29.1
86232	-10.9	-29.8
88362	-10.8	-30.5
90493	-10.8	-31.2
92624	-10.8	-32.0
94755	-10.8	-32.7
96885	-11.1	-33.5
99016	-11.9	-35.5
99918	-12.2	-37.5