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P r a c t i c a l E x e r c i s e

Electromagnetic Compatibility

Exercise 3 Measurement of Conducted Emissions (Room H402)

Group-Nr.: Minute taker:	Participant names:
Reviewed and approved by participants: (signed by all participants)	Stamp

Exercise 3 – Measurement of conducted emissions

Introduction

For frequencies below 30 MHz the dominant coupling path for electromagnetic emissions is the “conducted emission” via signal and supply lines. With respect to typical line lengths, the radiated emission is not significant considering that the lines can be regarded as “electrical short”. The disturbance currents on the lines result in a voltage drop across the impedance of the attached network. In a standard test environment a Line Impedance Stabilisation Network (LISN) is used to ensure a well-defined network impedance.

Exercise

The conducted emissions on the mains supply of a DUT shall be measured and referenced against the applicable limits.

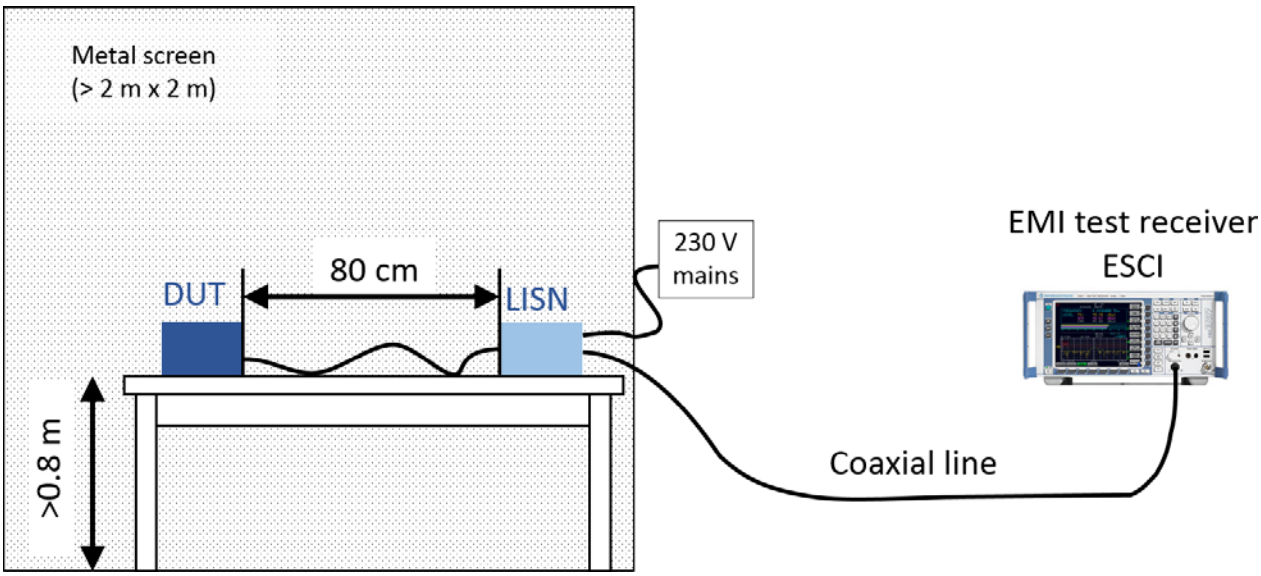

Figure 1 – Test setup with DUT, LISN and EMI test receiver (side view)

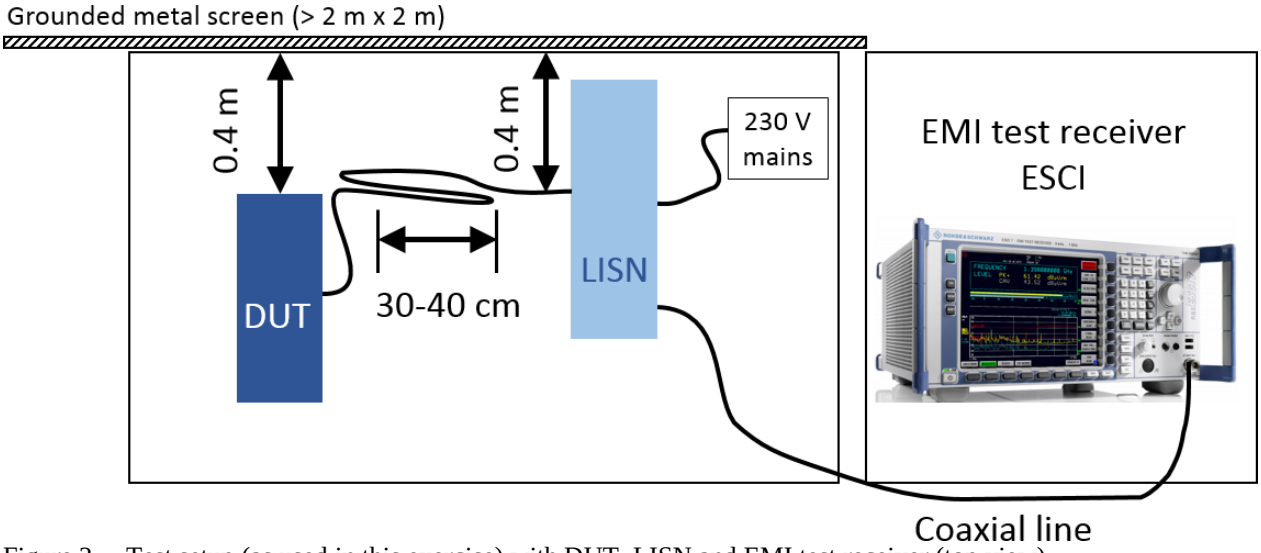

Figure 2 – Test setup (as used in this exercise) with DUT, LISN and EMI test receiver (top view)

Note about test setup

The LISN is required to provide a defined impedance at high frequencies between the terminals of the equipment under test and reference ground, and also to isolate the test circuit from unwanted radio-frequency signals on the supply mains.
The DUT shall be placed 0,4 m above an earthed conducting surface of at least 2 m × 2 m in size and at a distance of 0,8 m from the artificial mains network (LISN) and shall be kept at least 0,8 m from any other earthed conducting surface. If the measurements are made **in a screened enclosure** (like in this exercise!), the distance of **0,4 m** may be referred to one of the walls of the enclosure (see Figure 2). For the coaxial line between LISN and test receiver the position should not affect the measurement result! Same aspect holds for the mains cable between LISN and external mains supply.

DUTs which have a removable mains line are connected by a line of 1 m length with the LISN terminals. For DUTs with fixed lines exceeding 1 m length, the line should be folded in a serpentine pattern with 30 to 40 cm length of the folded line segments. The total length should not exceed 1 m.

Initial settings for EMI test receiver:

The recommended settings for the test receiver can be recalled from a stored configuration file. A written manual in the control room provides details how to recall those settings. They include:

- Displayed amplitude unit dBµV
- Detector max. peak
- Configuration table active

The configuration table includes settings for filter bandwidth and frequency step size according to DIN EN55016-1-1 (CISPR 16-1-1).

Measurement of conducted emission:

Attach the coaxial line (coming from the LISN 50-Ohm output) to the EMI test receiver input and switch on the DUT. (The input of the test receiver is protected by an external limiter. Do not remove this device, since it will protect the receiver input from destruction by transients and accidental overloads!)

Standardized measurements would be done with quasi-peak (QP) and average (AVG) detector. Since the time constant of the QP detector yields a very long test time, the peak detector will be used for an initial scan of the spectrum. Following this initial scan the test receiver checks those frequencies with highest emission levels (close to the limit line) in detail with the quasi-peak detector. See also written manual in control room.

The measurement shall cover the frequency range 150 kHz to 30 MHz. Conducted emissions should be measured on both lines (phase and neutral conductor) using the switch at the LISN front panel.

The disturbance spectrum showing the highest emission should be plotted and documented in the written report.

Evaluation

- Discuss and asses the observed spectra
  - In general,
  - With respect to the applicable limits.

- Give a description of the LISN
  - What is its purpose?
  - How is the internal structure?

- The LISN used in this exercise is also called V-LISN or V-ANM (artificial mains network).
  - What is the reason for the “V” in the naming?
  - What alternative LISNs are available and for which purpose?

Appendix

The relevant standard for emission testing depends on the characteristic of the DUT. The appropriate limit is defined in a specific standard, which needs to be identified based on the given DUT.

Table 1 Terminal voltage limits for the frequency range 148,5 kHz to 30 MHz

HOUSEHOLD APPLIANCES AND EQUIPMENT CAUSING SIMILAR DISTURBANCES AND REGULATING CONTROLS INCORPORATING SEMICONDUCTOR DEVICES

Frequency range	At mains terminals		At load terminals and additional terminals	
1	2	3	4	5
(MHz)	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*
0,15 to 0,50	Decreasing linearly with the logarithm of the frequency from: 66 to 56	59 to 46	80	70
0,50 to 5	56	46	74	64
5 to 30	60	50	74	64

MAINS TERMINALS OF TOOLS

1	6	7	8	9	10	11
Frequency range	Rated motor power not exceeding 700 W		Rated motor power above 700 W and not exceeding 1 000 W		Rated motor power above 1 000 W	
(MHz)	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*
0,15 to 0,35	Decreasing linearly with the logarithm of the frequency from: 66 to 59	59 to 49	70 to 63	63 to 53	76 to 69	69 to 59
0,35 to 5	59 49 63	53 69 59				
5 to 30	64 54 68	58 74 64				

* If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.

NOTE The limits for the measurement with the average detector are tentative and may be modified after a period of experience.

Table 2 Mains terminal disturbance voltage limits for class B equipment measured on a test site (EN55011 – ISM equipment)

Class B ITE equipment limits dB(µV)		
Frequency band MHz	**Groups 1 and 2**	
	Quasi-peak	**Average**
0,15 – 0,50	66 decreasing linearly with logarithm of frequency to 56	56 decreasing linearly with logarithm of frequency to 46
0,50 – 5	56	46
5 – 30	60	50

Table 3 Disturbance voltage limits at mains terminal for electrical lighting and similar equipment (EN55015)

Frequency range	**Limits** dB(µV)[a]	
	Quasi-peak	**Average**
9 kHz to 50 kHz	110	–
50 kHz to 150 kHz	90 to 80[b]	–
150 kHz to 0,5 MHz	66 to 56[b]	56 to 46[b]
0,5 MHz to 5,0 MHz	56[c]	46[c]
5 MHz to 30 MHz	60	50

[a] At the transition frequency, the lower limit applies.

[b] The limit decreases linearly with the logarithm of the frequency in the ranges 50 kHz to 150 kHz and 150 kHz to 0,5 MHz.

[c] For electrodeless lamps and luminaires, the limit in the frequency range of 2,51 MHz to 3,0 MHz is 73 dB(µV) quasi-peak and 63 dB(µV) average.

NOTE In Japan, the limits in the frequency range 9 kHz to 150 kHz do not apply.

Table 4 Limits for conducted disturbance at the mains ports of class B ITE (EN55022)

Frequency range MHz	**Limits** dB(µV)	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50