Fachbereich Ingenieurwissenschaften
Wissenschaftliche Einrichtung
Telekommunikation und Multimedia
Labor für elektromagnetische Verträglichkeit
Prof. Dr.-Ing. Jens Werner
Dipl.-Ing. H.-H. Blikslager

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

Electromagnetic Compatibility

Exercise 2 Measurement of Radiated Emissions (Room H402)

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

Exercise 2 – Measurement of radiated emissions

Introduction

Manufacturers of electric systems or electronic circuits should consider aspects of electromagnetic compatibility already during the development process of their equipment. This helps reducing the probability that the equipment might fail in the market or violate the EMC regulations. The legal framework based on DIRECTIVE 2014/30/EU[1] is complemented by guidelines and harmonised standards, which specify test methods and limits for immunity and emission. The latter is the subject of this lab exercise: The radiated electromagnetic emission of a device under test (DUT) shall be measured and characterized. In order to suppress unwanted emissions from TV/radio broadcast transmitters or wireless communication systems (e.g. GSM, UMTS, LTE, WLAN) the measurement is performed in a shielded room. The walls are equipped with absorbing material to avoid multiple reflections. Similar to an open area test site (OATS) the floor is not equipped with absorbing material, therefore this room is called semi-anechoic chamber (SAC). The absorber pyramids as used in the SAC of the Jade University perform quite well for frequencies above 200 MHz. Due to their geometrical size they absorb less electromagnetic energy at lower frequencies. Thus, the measurement in the SAC can be affected by reflections and resonances for frequencies below 200 MHz.

Exercise

The radiated emission of a DUT shall be measured according to DIN EN55022 (CISPR22) in the frequency range 30 MHz up to 1 GHz. Compare the results against the limits! Take the measurement distance of 3 m into account!

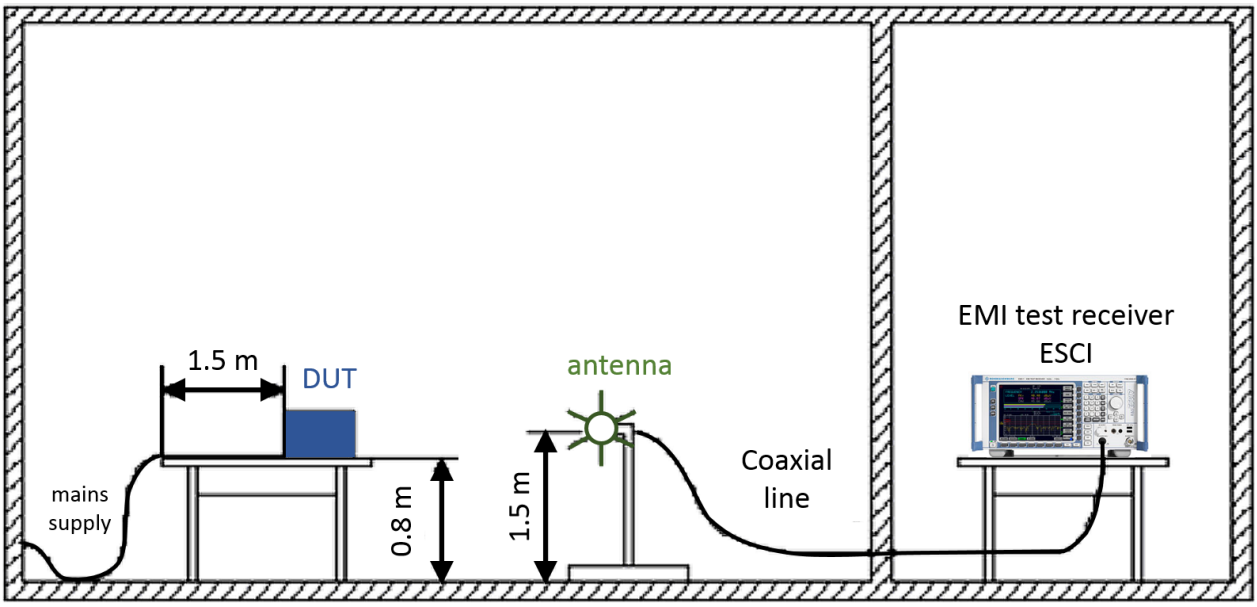

Figure 1 – Test setup in SAC (absorber pyramids not depicted)

[1] DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0030&from=EN

Note about test setup
This lab exercise is done in the SAC and the shielded control room where the EMI test receiver is located. With respect to the dimensions of the SAC it is not possible to test with 10 m measurement distance. Instead the test is done for 3 m distance between DUT and antenna. DUT position and routing of mains cable is done according to Figure 1:

- The DUT shall be placed upon a non-conductive table 0.8 m above the horizontal ground reference plane of the test site.
- The mains supply cable is routed horizontally backwards and finally vertically towards the ground reference plane.

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/m
- Detector max. peak
- Configuration table active
- Transducer range active

The configuration table includes settings for filter bandwidth and frequency step size according to DIN EN55016-1-1 (CISPR 16-1-1). The data for the transducer includes frequency dependent antenna factor and attenuation loss of the coaxial antenna cable. Both is needed to calculate the electric field strength based on the measured RF voltage at the test receiver input.

Measurement of radiated emission:
Attach the coaxial line (coming from the antenna) to the EMI test receiver input and switch on the DUT. Record the emissions in the frequency range 30 MHz to 1 GHz. For the frequency range 30 MHz to 200 MHz the biconical antenna should be used (and the appropriate transducer factor must be applied). For frequency range 200 MHz to 1 GHz the Log-Per antenna will be used.

Verify proper choice and connection of antenna!

After an initial scan with the max peak detector the test receiver checks those frequencies with highest emission level in detail with quasi-peak detector. See also written manual in control room.
After each measurement the DUT shall be rotated by 90° and re-tested in the new orientation.

Evaluation

- Summarize frequencies and levels with high emissions in a table.
- Adopt the test limits given in EN55022 for 10 m measurement distance to the 3 m distance as used in your exercise.
- Create a graphical chart that depicts the calculated limits and the highest measured emission levels versus their respective frequency. Discuss these results!
- In EN55022 the section “Method of measurement of radiated disturbance” states: “The antenna shall be adjusted between 1 m and 4 m in height above the ground plane for maximum meter reading at each test frequency.”
    - What is the purpose of the antenna height scan?
    - Why is this not done during this exercise?
    - What could be the consequence?

Table 1 – Limits for radiated disturbance of class B ITE at a measuring distance of 10 m

Frequency range MHz	**Quasi-peak limits** dB(µV/m)
30 to 230	30
230 to 1000	37
NOTE 1 The lower limit shall apply at the transition frequency. NOTE 2 Additional provisions may be required for cases where interference occurs.	

Note about adoption of 3 m measurement distance

If the field-strength measurement at 10 m cannot be made because of high ambient noise levels, or for other reasons, measurement of class B DUTs may be made at a closer distance, for example 3 m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance. Care should be taken in the measurement of large DUTs at 3 m at frequencies near 30 MHz, due to near field effects.

L_1 is given limit level (in µV/m, i.e. **linear value**!) at distance d_1.
L_2 is new limit level (in µV/m, i.e. **linear value**!) at distance d_2.

$$L_2 = L_1 (d_1 / d_2)$$