Implementation of Universal RF-shielded Enclosure for IT Equipment Protection

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Abstract— In order to decrease the level of radiated emissions from information technology (IT) equipment and in order to protect the IT equipment in high level of electric field strength environment the RF shielded enclosures are needed. In the paper the implementation of universal RF shielded enclosure is presented. The description and the block diagram of the RF-shielded enclosure is presented. In the article the shielding efficiency (SE) of real RF-shielded enclosure is presented. Furthermore the paper presents the methodology and block diagram of laboratory stand for SE measurements conducted in anechoic chamber.

1. THE DESCRIPTION OF THE RF-SHIELDED ENCLOSURE

In order to decrease the level of radiated emissions from information technology (IT) equipment and in order to protect the IT equipment in high level of electric field strength environment the RF-shielded enclosure are needed. Moreover, even pervasive equipment (e.g., smartphones, handsets) with build-in software should be taken into consideration in terms of radiated emission [14, 15]. Below the implementation of universal RF shielded enclosure is presented. The references connected with the topic of this article are [1–3, 6, 8, 10, 12, 13].

The RF-shielded enclosure has dimensions: $0.440\,\mathrm{m} \times 0.300\,\mathrm{m} \times 0.550\,\mathrm{m}$ and is made of galvanized steel sheet. The view of the RF-shielded enclosure along with the terminal panels is shown in Fig. 1. Interface panel has a special hole which allows to insert light pipe inside a shielded cubicle. The shielded enclosure is equipped with the power supply and signal filters which increase the system immunity for conducted interferences. On the panel there are interfaces for connection of auxiliary equipment: N-connectors (female), VGA filter and D-Sub filter (9-pin). The interfaces of RF-shielded enclosure ensure the proper communication with external devices via the cable and fiber-optical connections. The block diagram of the elaborated RF-shielded enclosure is presented in Fig. 2. Enclosure also provide of shielding effectiveness. In order to ensure the proper air exchange the special honeycomb filters were used.

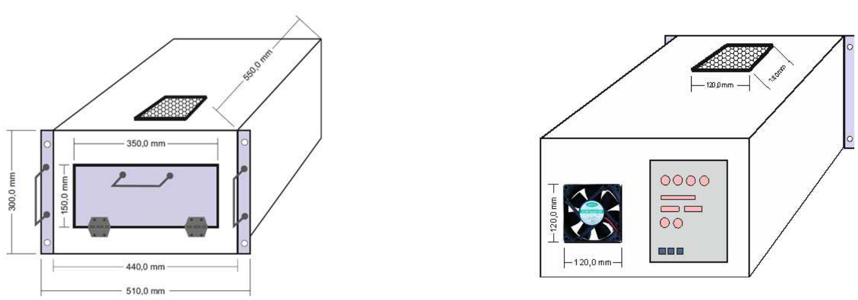

Figure 1: The view of the studied RF-shielded enclosure.

2. THE METHODOLOGY AND BLOCK DIAGRAM OF LABORATORY STAND

In order to measure the shielding efficiency (SE) of RF-shielded enclosure the measuring set is required which includes the measuring signal transmitter and the meter of electromagnetic field strength. Particular parts of the measuring set also consist of software, which activated on an operating computer makes automation of the SE measuring process possible.

The measurement of SE contributed by the RF-shielded enclosure comes down to make two measurements of the level of electromagnetic field strength for particular probing frequencies. The first measurement is carried out as so called standardization measurement. With determined value of the signal level generated by the probing signal transmitter, the level of electromagnetic field

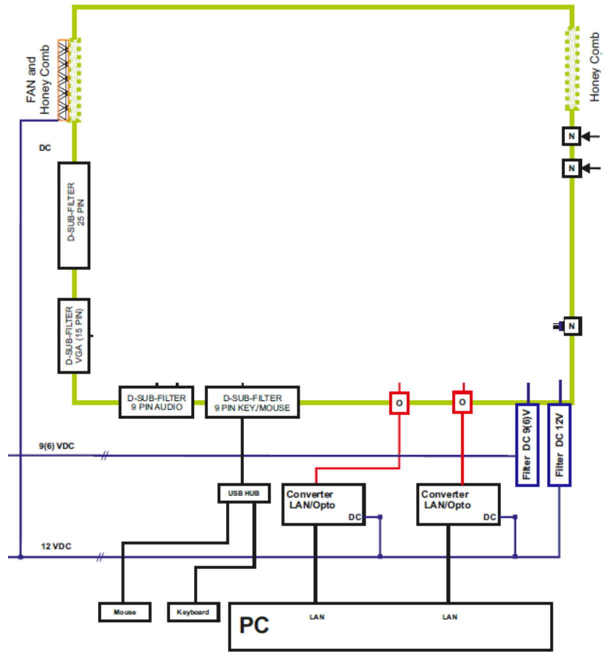

Figure 2: The block diagram of the elaborated RF-shielded enclosure.

strength is measured in the place of installation of receiving antenna connected to the measuring receiver, which functions as a meter of electromagnetic field strength. During standardization measurement the transmitting antenna of the probing signal transmitter and the receiving antenna are located opposite each other (without the RF-shielded enclosure under test) within the distance equal to a required distance, due to structural reasons of the tested RF-shielded enclosure, when the receiving antenna is situated inside the tested RF-shielded enclosure. The measurements can be made on discrete frequencies or in a given band with determined step. The measured values of electromagnetic field strength corresponding with particular measuring frequencies should be remembered.

After performing standardization measurement it is necessary to conduct basic measurement during which the transmitting antenna of the probing signal transmitter is placed outside the tested RF-shielded enclosure whereas the receiving antenna is situated inside the RF-shielded enclosure. With determined value of the signal level generated by the probing signal transmitter, the level of electromagnetic field strength is measured in the place of installation of receiving antenna. The measurements ought to be made in the same way as during standardization measurement on discrete frequencies or in a given frequency band with determined step. The measured values of electromagnetic field strength corresponding with particular measuring frequencies should be remembered. After subtracting the recorded levels of electromagnetic field strength levels corresponding with particular frequencies of the probing signal, during standardization $(E(f)_{stand})$ and basic $(E(f)_{basic})$ measurement we will receive the difference of levels of received signals in [dB], which makes the value of SE contributed by the tested RF-shielded enclosure. In this way we can obtain characteristics of shielding effectiveness in the frequency function.

$$\mathrm{SE} = 20\log_{10}\left(E(f)_{stand}/E(f)_{basic}\right)\ [\mathrm{dB}]. \tag{1}$$

Measurements of shielding effectiveness should be conducted for each of the four sides of the RF-shielded enclosure. As the final result of SE results measurements with the SE lowest value should be chosen from the set of four values corresponding with each side of the RF-shielded enclosure, for each frequency of test signal. The SE depends on the parameters of the material used for tested enclosure. The parameters of materials can be obtained by using measurement methodology described in literature items.

A simplified block diagram of the measuring position for SE of RF-shielded enclosure measurement is shown in Fig. 3. The position consists of the measuring signal transmitter and the meter of electromagnetic field strength. The measuring signal transmitter and the meter of electromagnetic

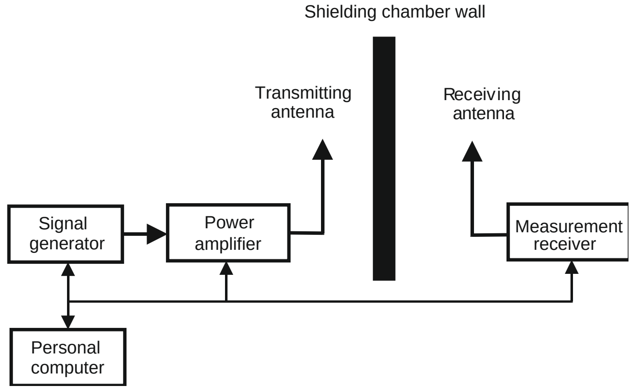

Figure 3: Simplified block diagram of the SE measuring position.

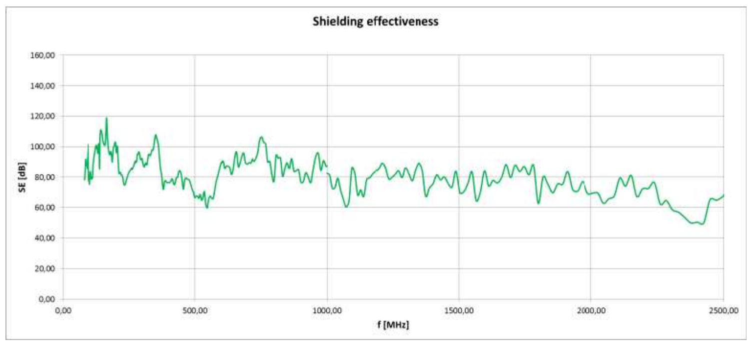

Figure 4: Shielding effectiveness in the range of 80 MHz to 2500 MHz.

field strength have to be equipped with the measurement antennas [4, 5, 7, 9, 11].

3. MEASUREMENT RESULTS

In order to present measuring possibilities described in Chapter 2 measurements of SE the RF-shielded enclosure described above have been conducted. The measurements show that the level of SE for the RF-shielded enclosure does not exceed 50 dB for radiated disturbances in the frequency range from 80 MHz to 2,5 GHz. Characteristic of SE made in anechoic chamber are shown in Fig. 4.

4. CONCLUSIONS

In order to decrease the level of radiated emissions from information technology (IT) equipment and in order to protect the IT equipment in high level of electric field strength environment the RF shielded enclosures are needed. In the paper the implementation of universal RF shielded enclosure is presented. The description and the block diagram of the RF-shielded enclosure are presented. The shielding efficiency (SE) of elaborated RF shielded enclosure does not exceed 50 dB for radiated disturbances in the frequency range from 80 MHz to 2,5 GHz. The elaborated universal RF shielded enclosures can be used for decrease the level of radiated emissions from information technology (IT) equipment.

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