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MEASUREMENT OF SHIELDING EFFECTIVENESS OF THE COMPUTER AIDS RADIATION

Alexandr KAZEKA, Timofey BORBOTKO, Alexander PROUDNIK
Belarusian State University of Informatics and Radioectronics

Summary: In this paper a technique to measure the electromagnetic radiation (EMR) of personal computers (PC) and cellular phones in the range from 100 MHz to 1 GHz was proposed. The technique was used to evaluate the decrease of electromagnetic radiation level when shielding materials containing nano-sized aqueous solution volumes are applied to PC and cellular phone.

Keywords: shielding effectiveness, electromagnetic radiation, measurement.

I. Introduction

Operation of information and communications equipment is accompanied by electromagnetic radiation. This electromagnetic radiation affects human organism and creates the problem of electromagnetic compatibility of electronic equipment. The spurious emission from PC system units and monitors can result in data interception by different technical devices. These cases require appropriate suppression of electromagnetic radiation and it can be obtained by installation of shielding tools, application of grounding and use of filtering techniques. The shielding tools enclose the radiation sources, increase the grounding level, and suppress the electromagnetic interference. Dielectric, magnetic and resistive losses of shielding materials must be maximized to increase the EMR absorption within the material and the total shielding efficiency [1].

II. Methodology

The evaluation of effectiveness of shielding materials developed for suppression of the PC electromagnetic radiation was carried out by the analysis of spectrum characteristics of electromagnetic radiation in the frequency band from 100 MHz to 1 GHz produced by shielded and not shielded PC. To perform this task the hardware-software system was used which contains measuring antenna, measuring tool and PC with special software.

The experiment was carried out in an anechoic chamber to eliminate influence of exterior electromagnetic noise on measurement results. All electronic devices and tools which can reflect electromagnetic radiation were placed at the appropriate distance from the source of electromagnetic waves to reduce measurements inaccuracy.

Reliable results of electromagnetic radiation level measurement can be obtained using three kinds of measurement equipment: selective voltage meters, radiometers and spectrum analyzers. Selective voltage meters are used to measure low strength electric and magnetic fields, however they are characterized by a narrow frequency band, and therefore can not be applied to observe a spectrum characteristic in the wide frequency band. Radiometers allow to measure electric field strength in the wide frequency band and provide high measurement accuracy but they are rather expensive. Spectrum analyzers are comparable to the radiometers due to their functional characteristics. The disadvantage of most spectrum analyzer models is the lack of preselector. However spectrum analyzers are cheaper than radiometers of respective frequency band [2].

An antenna with narrow antenna pattern was used to determine the level of electromagnetic radiation from a source of electromagnetic noise. It allows reducing the time for detection of electromagnetic radiation peak values and decreasing electromagnetic disturbance from other experimental devices. The antenna must be placed at a distance that doesn't exceed three wavelengths from an electromagnetic radiation source. The operator's workplace should be placed from an electromagnetic radiation source as far as possible to increase the measurement accuracy.

Operating procedure of hardware-software system includes measuring the electric and magnetic fields strength and transmitting the obtained results to the operator's PC for their visualization, processing and saving. Spectrum analyzer and operator's PC can be connected through logical interfaces RS-232 or GPIB. The functions of visualization, processing and saving of obtained data are executed by the special software. The interface panel of the developed software SCANF is given in Fig. 1. In addition the program SCANF is capable of automatic measuring and manual searching of PC electromagnetic radiation using spectrum analyzer Agilent.

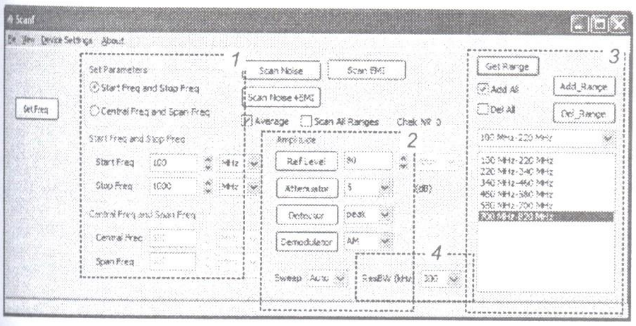

Fig. 1. The interface panel of software SCANF, where *1* — panel of frequency band control; *2* — panel of spectrum analyzer response control; *3* — panel of sub-bands control; *4* — panel of pass-band control

The hardware-software system for the experimental testing was arranged according to the layout shown in Fig. 2. Operator's PC with software SCANF was connected to the spectrum analyzer and its operation mode set as follows: frequency band was set from 100 MHz to 1 GHz (Fig. 1), pass-band value (ResBW) was set equal to *300 kHz*, attenuation was set equal to 0 dB and response (Ref Level) was set equal to 80 dBuV. The frequency band of measurements was divided into sub-bands corresponding to the frequency band observed by the spectrum analyzer. The observed frequency band is automatically adjusted to the pass-band of the filter. Operator can choose the automatic mode of electromagnetic radiation level measurement in the preset sub-bands. Setting the Average mode operator enables storage and averaging of measured values of the electromagnetic radiation.

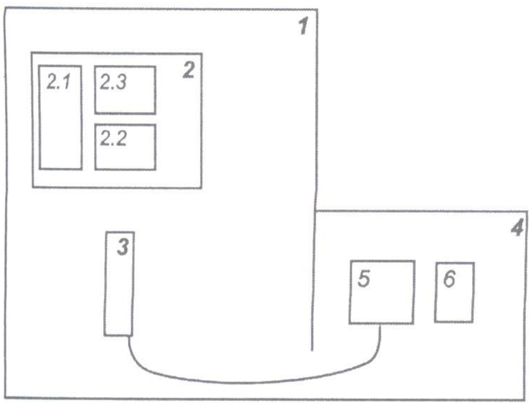

Fig. 2. Layout of hardware-software system: *1* — anechoic chamber; *2* — operator's PC; *2.1* — system unit; *2.2* — input block; *2.3* — monitor; *3* — antenna; *4* — operator's room; *5* — spectrum analyzer; *6* — operator's place

The procedure of determination of shielding materials effectiveness using PC as EMR source is described below.

1. Measure the electromagnetic radiation level in the anechoic chamber when the PC system unit and monitor are turned off. Experimental results are used as reference data.
2. Measure the electromagnetic radiation level in the anechoic chamber when the PC system unit and monitor are operating.
3. Change the antenna position to determine maximum PC signal amplitude.
4. Repeat steps 1 and 2 to improve the measurement accuracy and eliminate other electromagnetic sources interference.
5. Install shielding means and repeat measurements as in steps 1 and 2.
6. Save the measurement results onto hard drive of operator's PC.

III. Results

The shielding effectiveness measurement results of the sheet metal with 0.5 mm thickness, honeycomb polycarbonate filled with aqueous solution, two-layered combination of honeycomb polycarbonate with aqueous solution and aluminum foil reflector, two-layered combination of honeycomb polycarbonate with aqueous solution and textolite with copper foil are presented in Fig. 3–6, respectively.

In [3] composite shielding materials based on capillary-porous matrixes filled with liquid polar dielectric are described. Their electromagnetic characteristics *(EMR attenuation and reflection) depend on solution* composition, its content and the operation conditions (temperature, humidity). It is also possible to vary the structure of a porous matrix obtaining liquid volumes of different dimensions (from millimeter to nanometer in dimensions) and spatial distribution and to form a non-uniform surface of the material to provide certain shielding parameters [4].

Liquid is retained in the capillary-porous matrix by capillary forces on the steam-water interface forming thin molecular films which cover pore surface as well as forming drops [5] and this interface has the shape of meniscus. Additional meniscuses are formed within the pores volume by the air which was not displaced by aqueous solution. As a result of impregnation capillary-porous materials contains local micro- and nano-sized volumes of aqueous solution on the interfaces between steam, liquid and capillary-porous material. The spatial structure of the liquid is complex and in the general case modeling can be described as a system of linked capillaries.

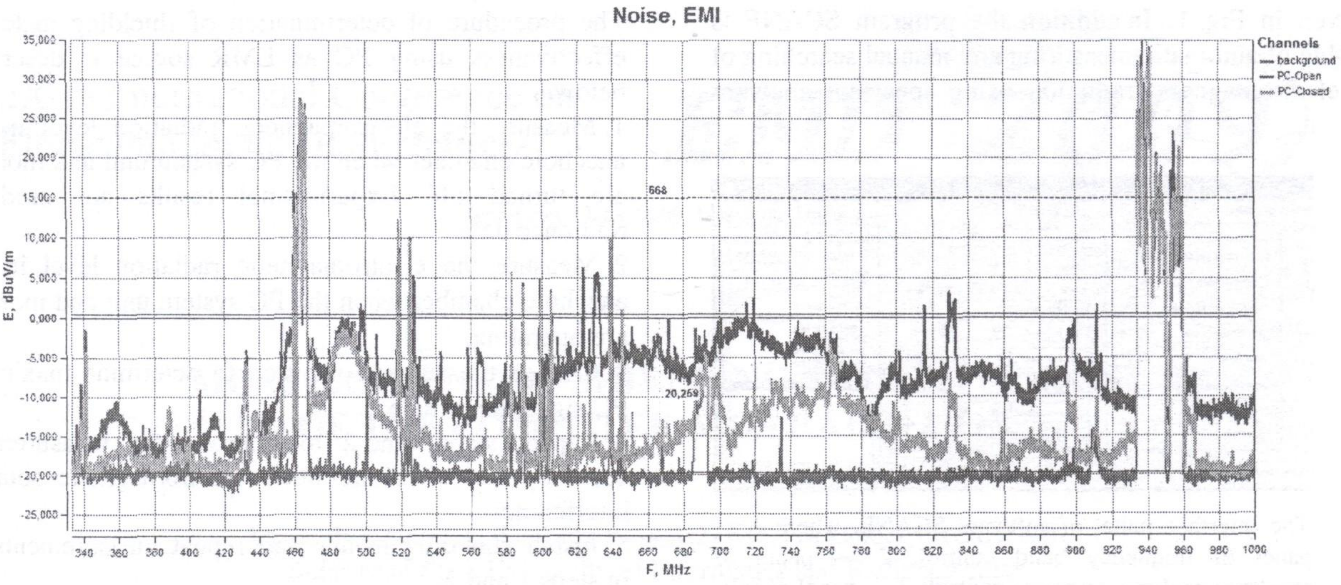

Fig. 3. Measurement of shielding effectiveness of PC shielded by sheet metal: *1* — EMR background level; *2* — EMR level of
3 — electromagnetic radiation level of shielded PC

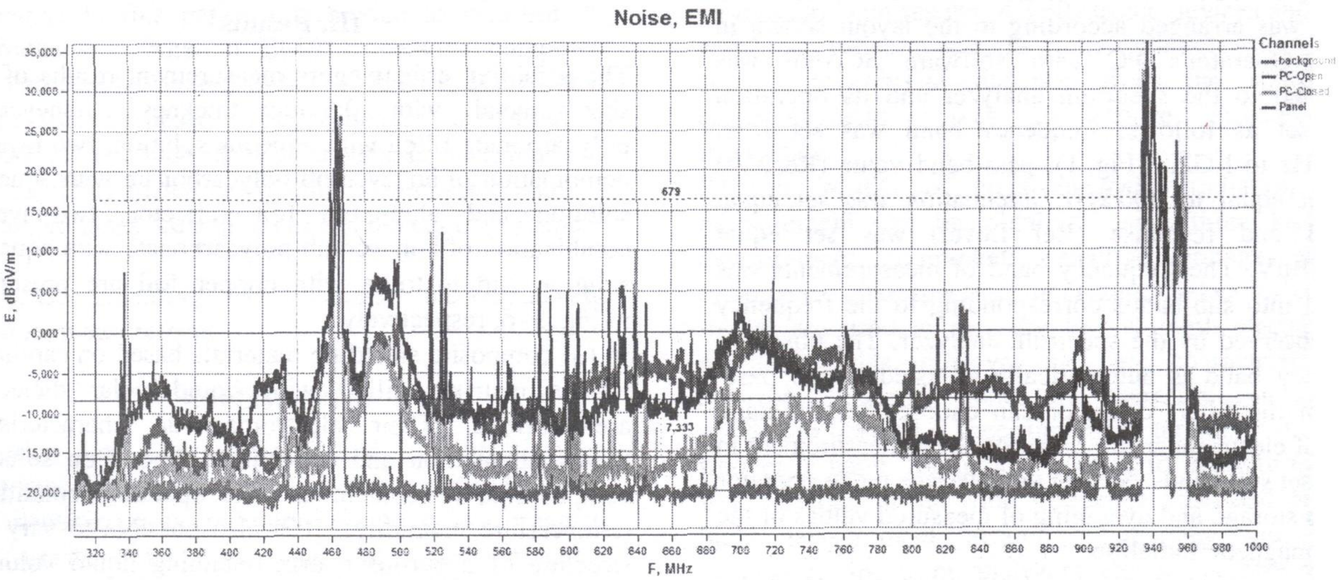

Fig. 4. Measurement of shielding effectiveness of PC shielded by honeycomb polycarbonate filled with aqueous solut
1 — EMR background level; *2* — EMR level of PC; *3* — EMR level of PC shielded by sheet metal; *4* — EMR leve
PC shielded by honeycomb polycarbonate

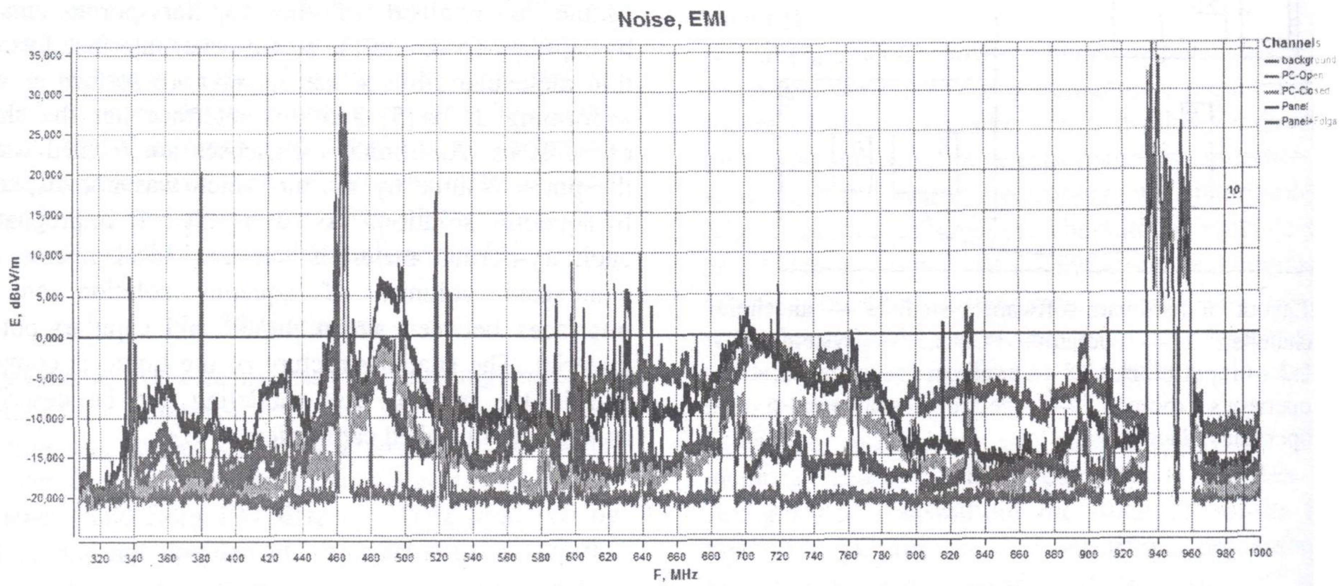

Fig. 5. Measurement of shielding effectiveness of PC shielded by two-layered combination of honeycomb polycarbon
with aqueous solution and aluminum foil reflector: *1* — EMR background level; *2* — EMR level of PC; *3* — EMR le
of PC shielded by sheet metal; *4* — EMR level of PC shielded by honeycomb polycarbonate; *5* — EMR level of PC shiel
by combination of polycarbonate with aqueous solution and foil reflector

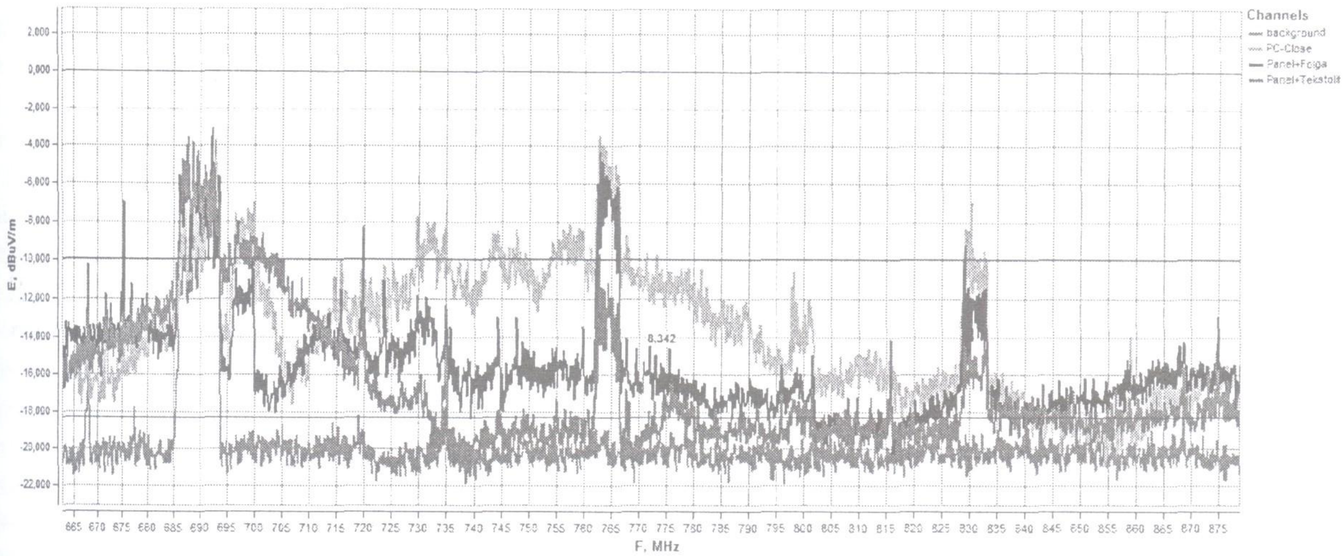

Fig. 6. Shielding effectiveness of personal computer by two-layered combination of honeycomb polycarbonate with aqueous solution and textolite with copper foil: *1* — EMR background level; *2* — EMR level of PC; *3* — EMR level of PC shielded by sheet metal; *4* — EMR level of PC shielded by combination of polycarbonate with aqueous solution and textolite with copper foil

As shown on the Fig. 3 the shielding effectiveness of the sheet metal with 0.5 mm thickness is 6–12 dB. The values of shielding effectiveness of honeycomb polycarbonate with aqueous solution according to the Fig. 4 are lower than 7 dB for those of sheet metal in the range 710–820 MHz. The shielding effectiveness of honeycomb polycarbonate with aqueous solution and aluminum foil reflector is lower 2–5 dB in the frequency range 710–820 MHz and doesn't exceed 3 dB in the range 345–450 MHz.

The results of capillary-porous composite material shielding effectiveness measurement reveal the PC electromagnetic radiation level decrease in comparison to the not shielded PC up to 10 dB in the respective bandwidth.

IV. Conclusion

The proposed technique allows measuring EMR level of PC in the wide frequency range from 100 MHz to 1 GHz and involves antenna, spectrum analyzer and PC with developed software SCANF. The results of capillary-porous composite material shielding effectiveness measurement under the developed technique reveal the PC electromagnetic radiation level decrease in comparison to the not shielded PC up to 10 dB in the frequency band 460 MHz to 1 GHz.

References

1. Lynkov L., Bogush V., Glybin V. Flexible shields of electromagnetic radiation // Minsk, 2000. (in Russian).
2. Mikhaliov L.A., Novichkov I.S., Sergeev A.A., Stalenkov S.E. Research of electromagnetic emanation from technical equipment // Communication security systems. 2001. No. 39. P. 50–53. (In Russian).
3. Bogush V., Borbot'ko T., Kolbun N., Lynkov L. Novel composite shielding materials for suppression of microwave radiation // Proc. of the 16th Intern. conf. on microwaves, radar and wireless communications (MICON 2006), Krakow, Poland, 22–24 may, 2006. Vol. 2. P. 345–348.
4. Kolbun N.V., Lynkov L.M., Borbotko T.V., Bogush V.A. Porous fibrous materials with liquid fillings for electromagnetic radiation shielding / Vestnik Polotskogo Gosudarstvennogo Universiteta. Ser. B. Applied Sciences. 2004. No. 12. P. 30–34. (In Russian).
5. Lynkov L., Kolbun N., Proudnik A. Physical fundamentals of capillary-porous materials impregnation for liquid-containing EMR shields // Proc. of the 8th Intern. conf. on Modern means of communications. Naroch, 2003.P 133–135. (In Russian).