THE IMPACT OF THE ELECTROMAGNETIC FIELD RADIATIONS FROM THE GADGETS TO THE USERS

Darko Brodić, Čedomir A. Maluckov

University of Belgrade, Technical Faculty in Bor
Vojske Jugoslavije 12, 19210 Bor, Serbia
e-mail: dbrodic@tf.bor.ac.rs

Ivo R. Draganov, Agata H. Manolova

Laboratory of Audio and Video Technologies
Radiocommunications and Videotechnologies Dept.
Faculty of Telecommunications, Technical University of Sofia
8 Kliment Ohridski Blvd., 1756 Sofia, Bulgaria

Abstract

The paper considers the impact of the magnetic field from the gadgets to its users. Accordingly, the impact of the magnetic field characterized by the low frequencies (up to 300 Hz) has been examined. The experiment consists of the electromagnetic field (EMF) measurement in the adjacent neighborhood of the gadgets. The measured data are presented and discussed as well. Therefore, they are compared with the critical values suggested by the Serbian Ministry of Environment, Mining and Spatial Planning. It is shown that some of them get a very strong EMF. Hence, it is recommended to be used with caution.

1. INTRODUCTION

The increasing growth of the gadgets use is world widespread. The gadgets typically include cell phones (recently touchscreen models) and tablets. Hence, the raised concern because they might cause detectable impairment of the health of the exposed individual is evident [1]. It is based on the effect of the non-ionized electromagnetic radiation characterized by the low frequency up to 300 Hz. In this frequency region, the non-ionized radiation is the implication of the home and office appliances.

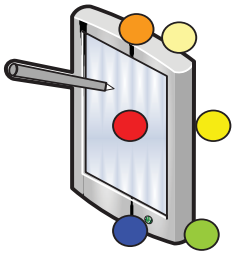
Recently, some scientists have recognized the occurrence of hypersensitivity to electromagnetic radiation stems from a common exposure, such as gadgets, wireless systems, computer systems and electrical appliances in the home or the office [2]. Similarly, World Health Organization (WHO) has reported that the electromagnetic hypersensitivity symptoms which are commonly experienced include dermatological symptoms as well as neurasthenic and vegetative symptoms [1]. Some symptoms of electromagnetic hypersensitivity are shortness of breath, arrhythmia, fatigue and nausea, memory and concentration problems, headache, blurred eyesight, limb pains, muscle stiffness, burning sensations, etc [3], [4]. In ref. [5], the authors address the problem of the cell phones use by the young adolescent. Furthermore, some researcher put to the test the cell phone use and its negative consequences to the user's health [6], [7]. Still, there are no tests made on the tablet computers.

According to the safety rules of the Serbian Ministry of Occupational Safety and Environmental Protection [8], the limit level of the magnetic induction for the EMF (up to 800 Hz) is $2/f$, where f represents the low level frequency. In this way, the referent limit level is defined as the critical level of the radiation above which the environmental conditions can be unsafe for humans. Hence, the referent limit level is up to 0.04 μT for the office appliances (f = 50 Hz). Consequently, the Serbian Ministery of Occupational Safety and Environmental protection brought the Law on the non-ionized radiation protection [9], which determines the risk conditions and protection measures in the critical situations.

In this paper, we addressed the problem of the EMR received from the gadgets. Furthermore, the measurement of the EMR is carried out. Then, the risk assessment of the low frequent magnetic induction from gadgets to the humans according to the Law is discussed. At the end, the conclusions are made as well as the future research work direction.

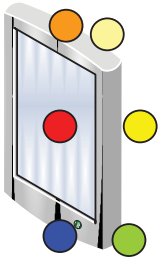
2. METHODS

The methods of the work consist of the EMF measurement of the gadgets. In the first experiment the tablet is tested. We propose 6 measurement points around the tablet. Figure 1 illustrates the measurement points.



Measurement at the top of the tablet (P1)
Measurement in the front of the tablet (P2)
Measurement at the bottom of the tablet (P3)
Measurement at the top of the tablet from back (P4)
Measurement from the back of the tablet (P5)
Measurement at the bottom of the tablet from back (P6)

Fig. 1. EMF measurement points in the neighborhood of the tablets



Measurement at the top of the cel phone (P1)
Measurement in the front of the cell phone (P2)
Measurement at the bottom of the cell phone (P3)
Measurement at the top of the cel phone from back (P4)
Measurement from the back of the cell phone (P5)
Measurement at the bottom of the cell phone from back (P6)

Fig. 2. EMF measurement points in the neighborhood of the cell phones (touch-screen model)

In the second experiment thetouchscreenn cell phone is tested. Similarly, 6 measurement points around the cell phone are proposed. Figure 2 illustrates these points.

3. EXPERIMENTS

The measurements were performed in the office where the influence of the magnetic field is negligible, i.e. it is lower than 0.01 μT. EMF measurement was performed by Lutron EMF 828 device. It is shown in Figure 3.

Fig. 3. Lutron EMF 828 measurement unit

It measures the magnetic induction from 0.01 μT to 2 mT, which frequency range is between 30 and 300 Hz. The EMF 828 has three measurement extents: 20 μT, 200 μT and 2000 μT. The precision of the measurement heavily depends on the measurement extent. Consequently, it is of the order 0.01 μT for the measurement extent of 20 μT, 0.1 μT for 200 μT and 1 μT for 2000 μT, respectively. Lutron EMF 828 measures all three components of the magnetic induction, i.e. *x*, *y* and *z*. Hence, the total intensity of EMF is determined as follows:

$$\square = \sqrt{(\square_x^{\square} + \square_y^{\square} + \square_{\square}^{\square})} \, . \qquad (1)$$

4. RESULTS AND DISCUSSION

The results of the first experiment show that EMF appears at all six measurement points. Table 1 shows the EMF measured values at all six points around the tablets.

There exists the opinion that the tablet is free of EMF. However, it is not a valid. It is true that the tablet has no hard disk, CD-ROM or similar parts. Nevertheless, it has the central processing unit and graphics card. Furthermore, the tablet battery charger has a negligible EMF.

Figure 4 and 5 shows measured EMF components and the total value, respectively.

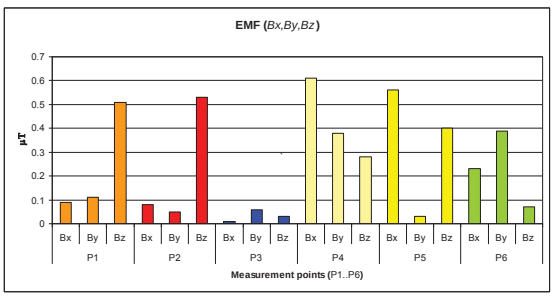


Fig. 4. EMF components at measured points (P1..P6) for tablets

Table 1. EMF measurement for the tablets (at all 6 points)

Position	P1				P2				P3			
EMF	B_x	B_y	B_z	B	B_x	B_y	B_z	B	B_x	B_y	B_z	B
typical	0.09	0.11	0.51	0.53	0.08	0.05	0.53	0.54	0.01	0.06	0.03	0.07
Position	P4				P5				P6			
EMF	B_x	B_y	B_z	B	B_x	B_y	B_z	B	B_x	B_y	B_z	B
typical	0.61	0.38	0.28	0.77	0.56	0.03	0.40	0.69	0.23	0.39	0.07	0.46

Table 2. EMF measurement for the cell phones (att all 6 points)

Position	P1				P2				P3			
EMF	B_x	B_y	B_z	B	B_x	B_y	B_z	B	B_x	B_y	B_z	B
calls off	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01
calls on	0.01	0.03	0.08	0.09	0.00	0.06	0.03	0.07	0.00	0.04	0.04	0.06

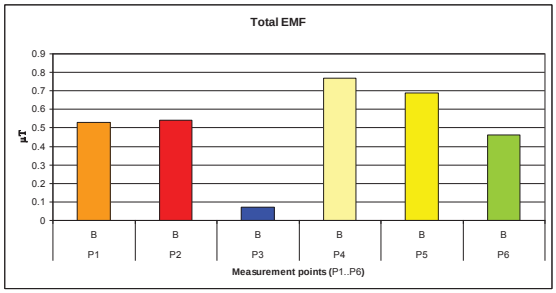


Fig. 5. Total EMF at measured points (P1..P6) for tablets

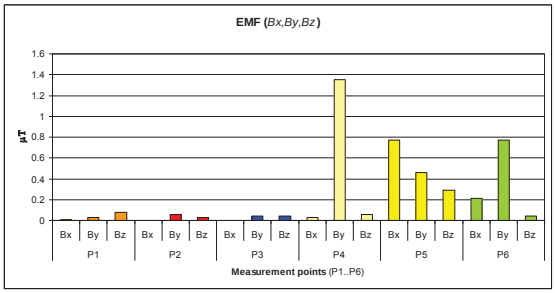


Fig. 6. EMF components at measured points (P1..P6) for cell phones

The tablet is characterized with the total intensity of the magnetic induction between B 0.07 and 0.77. The back of the device represents the more critical EMF position leading to maximum B of 0.77. Although, the EMF is considerably lower than in the laptop neighborhood [10], it still exists. It has to be noticed that according to the Law, the security level of the EMR is below 0.04 μT [8]. Hence, the caution during tablet use is necessary.

Likewise, the consequences of the second experiment show that EMF appears only in some measurement points. Furthermore, the second experiment is enlarged by measuring EMF for the cell phones during receiving calls. Table 2 shows the EMF at all six positions in the cell phones neighborhood during the calls off and on.

We have to point out that the EMF measurement is made exclusively for the low frequencies case. It means that the cell phones are not tested on the high frequencies EMF. Furthermore, it can be noted that the cell phones do not emit EMR when there is no calls. During the phone rings, EMR is significantly increased. Figure 6 shows measured EMF components.

Figure 7 shows total EMF.

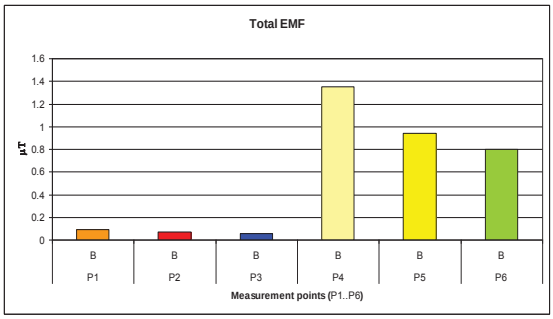


Fig. 7. Total EMF at measured points (P1..P6) for cell phones

From the above figures it is clear that EMF radiation appeared at the front side of the cell phone is noticeably lower than on its back side. It is a consequence of the EMF radiation protection that is put on the front side of the cell phones. Still, during the phone calls the emitted EMF radiation is slightly higher than the referent limit level proposed by the Law. Hence, it is recommended to be used with caution, especially by children or pregnant woman.

4. CONCLUSION

The paper addresses the problem related to the EMF radiation, which exists in the neighborhood of the

gadgets like tablets and the cell phones. The measurements of EMF characterized by the low level frequencies are carried out by Lutron EMF 828 device. The obtained results show the critical levels of the EMF, which are sometimes above the law limits [8]. Consequently, they pointed out the gadget positions where the EMF radiation is vital. This information can be exploited for their safe use.

Future research work will extend to the EMF measurements of the portable and stationary computer office appliances such as: laptop, desktop computers, printers, scanners, and so on.

Acknowledgments

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project III43011 and TR33037) and Contract № 141ПР0011-07 of Technical University-Sofia, Research Sector. Research project: «System for recognition and visualization with gesture control» - 2014.

References

[1] World Health Organization (WHO), *Extremely Low Frequency Fields*, Environmental Health Criteria Monograph No. 238.

[2] Hallberg O., Oberfeld G., ,"Letter to the editor: will we all become electrosensitive?," Electromagnetic, Biology and Medicine, vol.25, no.3, 2006, pp.189-191.

[3] Lonn S., Ahlbom A., Hall P., Feychting M., "Mobile phone use and the risk of acoustic neuroma, Epidemiology," vol.15, 2004, pp.653-659.

[4] Nordström G., *The Invisible Disease - The Dangers of Environmental Illnesses caused by Electromagnetic Fields and Chemical Emissions*, O'Books, Hants and New York, 2004.

[5] Abramson M. J, Benke G. P., Dimitriadis C., Inyang I. O., Sim M. R., Wolfe R. S., Croft R.J., "Mobile telephone use is associated with changes in cognitive function in young adolescents, Bioelectromagnetics," vol.30, no.8, 2009, pp.678-686.

[6] Agarwal A., Deepinder F., Sharma R. K., Ranga G., Li J., "Effect of cell phone usage on semen analysis in men attending infertility clinic, Fertility and Sterility," vol.89, no.1, 2008, pp.124-128.

[7] Ahlbom A., Feychting M., Green A., Kheifets L., Savitz D. A., Swerdlow A. J., "Epidemiologic evidence on mobile phones and tumour risk: a review," Epidemiology, vol.20, no.5, 2009, pp.639-652.

[8] Safety Rules, Possed by the the Ministry of Occupational Safety and Environment Protection (in Serbian), *Pravilnik o granicama izlaganja nejonizujućim zračenjima, Službeni glasnik Republike Srbije 36/09*, 2009.

[9] Low on the Non-Ionized Radiation Protection, Brought by the Ministery of Occupational Safety and Environment Protection (in Serbian), *Zakon o zaštiti od nejonizujućeg zračenja*, 2009.

[10] Bellieni C. V., Pinto I., Bogi A., Zoppetti N., Andreuccetti D., Buonocore G., "Exposure to Electromagnetic Fields From Laptop Use of "Laptop" Computers," Archives of Environmental & Occupational Health, vol. 67, no. 1, 2012, pp. 31-36.