RIGID ELECTROMAGNETIC SHIELDING STRUCTURES FOR VIDEO DISPLAY TERMINALS

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Introduction

Wide development and application of electronic devices in information processing, transmission and storage, in particular, personal computers, mobile phones, integrated systems etc. result in increase of electromagnetic radiation (EMR) level, causes problems of electromagnetic (EM) compatibility and radioecology.

All functional parts of the computer produce electromagnetic radiation, at that display possesses the highest radiation level. Frequency range of monitor electromagnetic radiation occupies broad band from tens of Hertz to several Giga Hertz [1]. Maximum radiation levels of video display terminals and operating period for users are normalized by hygienic standards (for example, maximum permissible level for professional users in Russia amounts 10 $\mu W/cm^2$; in comparison in USA – 10 mW/cm^2) [2,3]. Unified approach of maximum permissible radiation level determination has not been formed yet. Maximum radiation level rationing in most of countries is realized on the basis of heat exposure value EMR [4, 5].

At the same time existence of living organisms response to EMR irradiation of below heat exposure value is proven [6]. Taking into consideration, that interaction between EMR and biological organisms is of integrated character and is connected with adaptation, cumulative and sensitizative abilities of organism, consequences of such interaction can be positive or negative. Nonthermal or specific exposure of electromagnetic field brings to delicate changes in organism, caused by strong and weak interactions between EMR and irradiated surroundings. To the first type belong effects of dielectric saturation, field orientation and others, which occur in strong fields. Resonant absorption of electromagnetic energy by protein molecules, concerned with particularly SHF waves mutagenic activity is a possible physical mechanism of nonthermal weak interaction.

Degree of functional changes and harm depends both on field strength or energy-flux density and irradiation duration, and also on organism personalities. In spite of electromagnetic radiation exposure levels are much lower than directly impacting organisms vitality, they matter for humans vital-functions.

The most popular protection means from video display terminals radiation are metal films deposition on the screen surface and use of metalized fine patterns. Shielding effectiveness of such constructions comes to 40–50 dB at the frequency of 500 MHz. Besides their essential shortcomings are low optical transparency (up to 50% decrease) and necessity of good electrical contact to ground [7].

Exploration of negative effects of computer electromagnetic radiation [8, 9] proves the need of development and use of highly effective shielding constructions that don't worsen display ergonomic characteristics and provide safe work for computer user.

Experimental part

Shielding parameters of rigid structures made of optically and radio transparent material containing liquid were estimated by measuring the EM radiation level attenuation in the frequency range from 10 to 500 MHz. Shielding under test was placed between radiator and receiver tightly to source of radiation. Measurements of electromagnetic field strength levels before and after shielding were taken by Spectrum Analyzer E74–02A Agilent A and receiving antenna RDA 5-0.

RF-generator G4-151 with horn antenna was used as a source of electromagnetic signal. First, measuring devices were calibrated with free space and radiation level was recorded. Then shielding construction samples were installed before radiator and signal level was measured again. Electromagnetic radiation attenuation coefficient was calculated as a

difference between signal levels of corresponding frequencies. Attenuation characteristics are shown in Fig. 1.

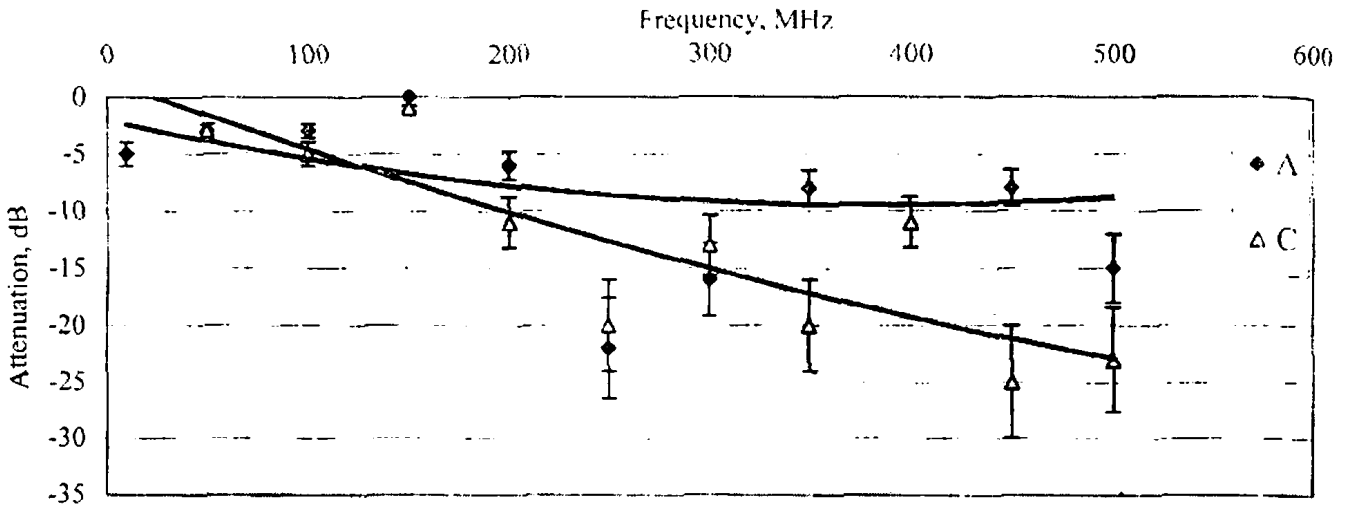


Fig. 1. Electromagnetic signal level lowering with the use of shielding structures: A – multilayered shielding with metal layer inside; C – transparent rigid liquid-containing structure.

Electromagnetic signal attenuation provided by transparent rigid structure containing liquid comes to about 5 dB at frequency 100 MHz. While frequency increase shielding efficiency comes to 25 dB at 450 MHz. Electromagnetic signal attenuation characteristic provided by rigid liquid-containing structure is equivalent or better comparing with multilayered shielding with metal layer inside.

Exploration of rigid liquid-containing structure shielding characteristics in the frequency range of 100...1900 MHz was carried out using multifunctional portable complex of radiomonitoring and leakage channels detection ARK-D1T, intended for determination of spectral distribution and electromagnetic background level in a certain point of space. Shielding structure was placed tightly to display (Fig.2). Electromagnetic environment at user workplace before and after shield installation was recorded in the distance of 50 cm from display (according to MPR II standard) (Fig.3).

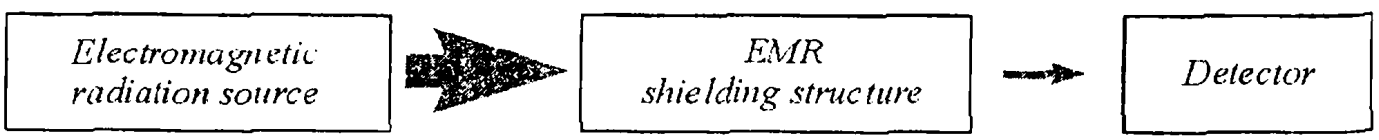
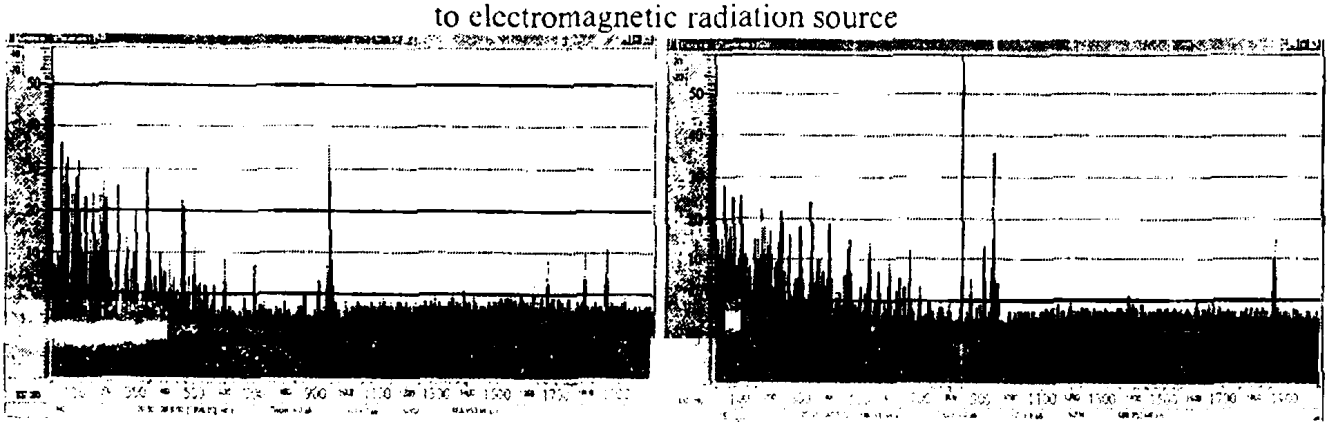
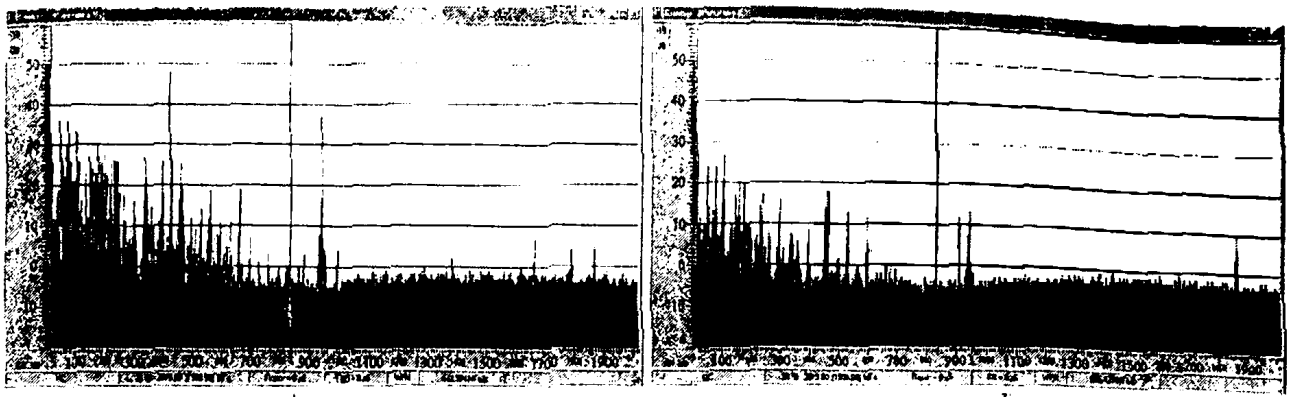


Fig. 2. Block diagram of measurements. Rigid liquid-containing shielding structure is applied to electromagnetic radiation source



a) *в)*



c) *d)*

Fig. 3. Electromagnetic environment at user workplace: a) nonworking (switched off) computer techniques; в) with working personal computer (display is turned off); c) with working display (blanc sheet of text editor Microsoft Word); d) rigid liquid-containing shielding structure is applied to display of personal computer

When turning on computer a great number of components appears in the electromagnetic environment at user workplace (Fig.3, в). Shielding display reduces level of single spectrum components, apparently belonging to display radiation harmonics (Fig.3, d).

Important characteristic of shielding materials and structures used for reducing EMR of displays are optical parameters (optical transparency, intensity, luminance, visibility, flashes) affecting. Decreasing of optical transparency for most contemporary shieldings can come to 50 percent, this can negatively affect users visual function, causes stresses and fatigability of eyes.

Display optical characteristics changes by rigid liquid-containing electromagnetic shielding structures were explored. Estimation was carried out using illumination index at a distance of 40 cm from the display of working computer in the absence of other light sources. Distance was chosen under average between display and user. Transmission spectral selectivity of shielding structure was also studied.

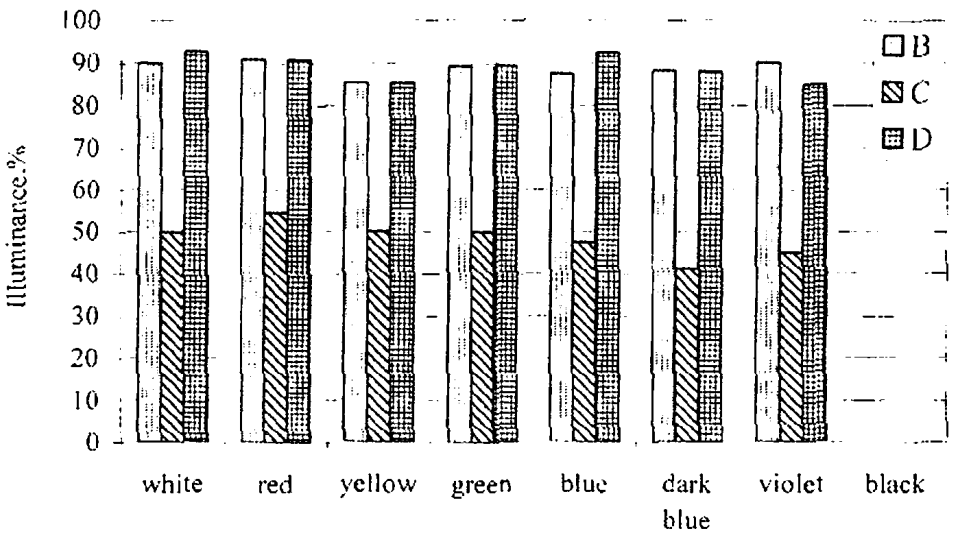


Fig. 4. Optical characteristics changes of display with applied rigid liquid-containing electromagnetic shielding structures in percents of illuminance without shielding (B – multilayered liquid-containing shield; C – rigid liquid-containing structure with toned glass surface; D – single layer rigid liquid-containing structure with transparent glass)

Illuminance changes while applying transparent rigid liquid-containing structures comes up to 15 % maximum. Toning the surface of transparent material rigid structure

has a great influence on optical characteristics of shield (C). Composition of liquid, layers number and thickness practically do not affect display picture parameters. Besides, using toning and multi-layered structures permits ergonomic picture parameters enhancing (reduce flashes). Suggested shielding structures perform small spectral selectivity for different light colors. It can be caused by features of optical properties either of liquid or glass.

Conclusions

Rigid liquid-containing structures can be used for shielding videodisplay terminals electromagnetic radiation to improve electromagnetic environment at computer user workplace. Such constructions perform effectiveness of 5–20 dB in the frequency range of 100–500 MHz and practically do not worsen display optical characteristics.

References

1. Lynkov L.M., Bogush V.A., Glybin V.P. et al. Flexible electromagnetic radiation shielding structures / Ed. L.M. Lynkov. Minsk, 2000. 284 p. (in Russian)
2. National Standard 12.1.006-84 Radio-frequency electromagnetic fields. Permissible levels at workplaces and testing processes requirements. Moscow, 1984. 8 p. (in Russian)
3. The Swedish Confederation of Professional Employees (TCO) [Electronic resource]. Mode of access: tco-info.com.
4. Lynkov L.M., Borbotko T.V., Bogush V.A. et al. Electromagnetic radiation. Protection tools and means. Minsk, 2003. 398 p. (in Russian)
5. Temporal permissible levels electromagnetic radiation exposure of cellular communication systems: hygienic standard. HS 2.1.8 / 2.2.4.019-94. — Moscow, 1995. – 7 p. (in Russian)
6. Gapochka L.D., Gapochka A.F., Korolev A.F. et al // Biomedical radioelectronics, 2000. N 3. Pp.48–55. (in Russian)
7. Lynkov L.M., Bogush V.A., Kolbun N.V. et al. // PROC. BSUIR. **V.2.** №5. Pp.152–167. (in Russian)
8. Zhurakovskaja A.L. // Orenburg State University bulletin, 2002. N 2(12). Pp.169–173. (in Russian)
9. Kuraev G.A., Vojnov V.B., Morgalev J.N. // Tomsk State University bulletin, 2000. N 269. Pp.8–14 (in Russian)