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ANALYSIS OF UNINTENDED ELECTROMAGNETIC FIELDS GENERATED BY SAFETY SYSTEM CONTROL PANELS

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Summary

Electronic devices, which are used in safety systems during operation, produce an unintended electromagnetic field. It can be a source of interference to other devices and systems used in the protected premises (the concept of internal and external compatibility). The value of the individual electromagnetic field components, which are produced by safety system control panels, depend on their operating state. Within the individual operating states, these devices consume different values of currents from basic or backup power supplies. The paper presents the research results of the unintended electromagnetic field generated by the safety system control panels. Measurements were carried out for two frequency ranges – a range of extremely low frequencies ELF (0÷2) kHz as well as a range of very low frequencies VLF (2÷100) kHz. The research was conducted according to the Polish standards on the measurement of electromagnetic fields in a range of low frequencies.

Keywords: operation, electromagnetic interference, control panels

ANALIZA NIEZAMIERZONYCH PÓL ELEKTROMAGNETYCZNYCH WYTWARZANYCH PRZEZ CENTRALE ALARMOWE SYSTEMÓW BEZPIECZEŃSTWA

Streszczenie

Urządzenia elektroniczne stosowne w systemach bezpieczeństwa podczas pracy wytwarzają niezamierzone pole elektromagnetyczne. Może ono być źródłem zakłóceń dla innych urządzeń i systemów wykorzystywanych w ochranianych pomieszczeniach (pojęcie kompatybilności wewnętrznej i zewnętrznej). Wartość poszczególnych składowych pola elektromagnetycznego, które wytwarzają centrale alarmowe systemów bezpieczeństwa, zależą od ich stanu eksploatacyjnego. W poszczególnych stanach eksploatacyjnych urządzenia te pobierają różne wartości prądów z zasilacza podstawowego lub rezerwowego. W artykule przedstawiono wyniki badań niezamierzonego pola elektromagnetycznego generowanego przez centrale alarmowe systemów bezpieczeństwa. Pomiary przeprowadzono dla dwóch zakresów częstotliwości - zakres ekstremalnie małych częstotliwości ELF (0÷2) kHz oraz zakres bardzo małych częstotliwości VLF (2÷100) kHz. Badania zostały przeprowadzone zgodnie z polskimi normami dotyczącymi pomiaru pól elektromagnetycznych w zakresie małych częstotliwości.

Słowa kluczowe: eksploatacja, zakłócenia elektromagnetyczne, centrale alarmowe

1. INTRODUCTION

The proper operation of electronic devices or equipment fitted with electronic circuits is possible by protecting them against the adverse electromagnetic fields effects [2]. At present, all kinds of structures designed to operate in peace conditions and hazardous states are equipped with electrical systems, as well as numerous electrical and electronic devices, including electronic safety systems [12]. On the basis of numerous observations, it is possible to conclude that artificially created electric and magnetic fields of different frequency ranges may adversely affect the electronic devices' operation [5,13]. It was found that the devices and electronic systems operation may be seriously interfered due to the adverse electromagnetic fields effects [19]. The group particularly susceptible to interference includes: measuring instruments, medical diagnostic devices, heart assist devices, hearing aids, computer systems [4,10], all types of devices containing electronic circuits with high input resistance elements [9]. Therefore, the issues related to the analysis of the electromagnetic fields, which are generated by the safety system control panels, are so important [11]. The paper presents the research results of the unintended electromagnetic field generated by the safety system control panels. Measurements were carried out for two frequency ranges – a range of extremely low frequencies ELF (0÷2) kHz as well as a range of very low frequencies VLF (2÷100) kHz. The research was conducted according to the Polish standards on the measurement of electromagnetic fields in a range of low frequencies.

2. INTRUSION DETECTION SYSTEM

The Intrusion Detection System (IDS) is designed to collect information from detectors, process them and signal the state of danger to property and people. European standard EN 50131-1:2006 "Alarm systems – Intrusion and hold-up systems – Part 1: System requirements", which at the same time has the status of the Polish standard PN-EN 50131-1:2009 "Alarm systems – Intrusion and hold-up systems – System requirements", contains a list of components (elements), which should be included in the Intrusion Detection System (IDS) [20]:

- control panel,
- one or more detectors,
- one or more signalling devices and/or alarm transmission systems,
- basic power supply,
- backup power supply.

The connections between the system elements should meet specific requirements included in the standards, and at the same time, they must be also included within the manufacturer's acceptable parameters. Generally, they can be divided into wired or wireless connections. Each of these solutions is characterised by specific values of the electromagnetic fields, which are produced by these devices.

The control panel is the most important part of the alarm system. Many electronic circuits, the role of which is to process signals received from individual devices, are used within the control panel. The information on the state of individual input lines (e.g. detectors), and output lines (e.g. signalling devices), as well as the data entered by a user or a maintenance engineer (e.g. with the use of the keypad), are also sent to the above-mentioned control panel. Depending on the control panel type, information can be sent directly to the control panel motherboard or to the modules implementing specific functions (e.g. input expansion, output expansion, printers interfaces, etc.).

Microprocessor-based digital panels with basic and backup power supply are currently the most commonly used in transport facilities [16,21]. In small facilities, the intrusion detection system may have a uniform structure, i.e. the one in which it is necessary to connect all detection circuits and output lines (signalling and controlling ones) directly to the control panel motherboard. It was shown in Fig. 1.

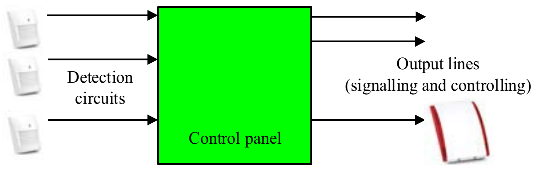

Fig. 1. Intrusion Detection System of the uniform structure

The electronic devices applied in transport are required to meet multiple criteria. They include, among others, miniaturization, electricity consumption reduction, high functionality [6,14,24], high reliability [7,17,22], possibility to diagnose [3,8,23] individual operating states [15,18], and vibration resistance [1]. The implementation of these requirements results in the fact that a level of useful device signals can be compared to a level of interference generated e.g. by static and mobile interference sources (e.g. medium- and high-voltage lines, transformer stations, electrical devices). Therefore, the issue of measuring the electric field strength values and magnetic field induction for the implemented or used safety systems becomes relevant.

3. THE STUDY OF THE ELECTROMAGNETIC FIELD GENERATED BY SAFETY SYSTEM CONTROL PANELS

The control panel is the most crucial electronic device in the safety system. Its role is to receive signals from detectors and then to produce an alarm signal (according to pre-programmed configuration). Currently, most of the control panels are built with the use of digital systems – microprocessors. They implement the individual alarm system functions (e.g. alarming, blocking, notification, etc.). In Fig. 2, the graph of the B induction and components (B_X, B_Y, B_Z) of the magnetic field in a range of ELF frequencies for the Galaxy 520 control panel at a distance of 5 and 35 cm from the interference source, were presented. The B induction of the magnetic field has large values at a distance of 5 cm – B induction of the magnetic field amounts to 28 [mT]. However, at a distance of 35 cm, the field value is 9.1 [mT]. Therefore, the electronic devices susceptible to the electromagnetic field impact (e.g. computer monitor, surveillance system) should not be installed near the control panel (at a distance of less than 50 cm – Fig. 3).

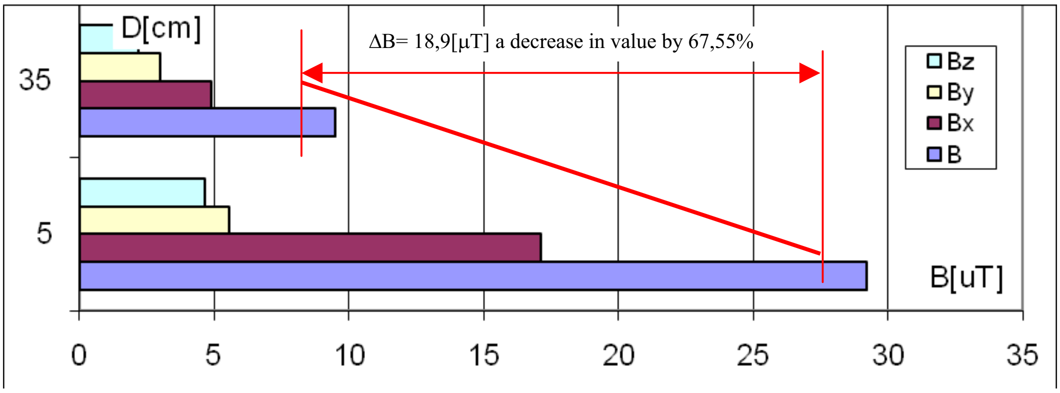

Fig. 2. The B induction graph of the magnetic field in the ELF frequency range for the Galaxy 520 control panel at a distance of 5 and 35 cm

The B induction value of the magnetic field was diverse in different measuring points, which were located near the control panel metal housing. The B induction changes graph of the magnetic field as the distance function from the measuring point for the maximum induction values was presented in Fig. 3. At a distance of 50 cm from the control panel metal housing, which also fulfils a role of the screen and tamper-resistant function, the B induction value was 1.7[mT]. Above 75 cm from the housing, the B induction value reached a level of the electromagnetic field background, which was in the examined facility i.e. B [0.09 ÷ max 0.12] mT. The B induction value of the magnetic field in the VLF frequency range was at a very low level and was included within the range from 0.02 – to max. 0.05 nT. Such a small B induction level value of the magnetic field of this frequency range shows the S high damping coefficient provided by the control panel metal housing. Electromagnetic interference of this frequency range are perfectly damped by the metal housing. The B induction value of the magnetic field in the ELF frequency range for the Satel CA 64 control panel are lower, and at the level of 22.3 [mT]. The decrease in the B induction of the magnetic field of this frequency range (marked in Fig. 2, 4) respectively amounts to 67.55% for the Galaxy control panel, and 53.8% for the Satel CA 64 control panel. The B induction of the magnetic field is shielded by the control panel metal housing, where, in addition to the control panel electronic components, the main power supply of the electronic safety system was placed. The B induction of the magnetic field, which was in the facility (another safety system) in the VLF frequency range, was also at a very low level and was respectively from 0.01 – to max. 0.03 nT.

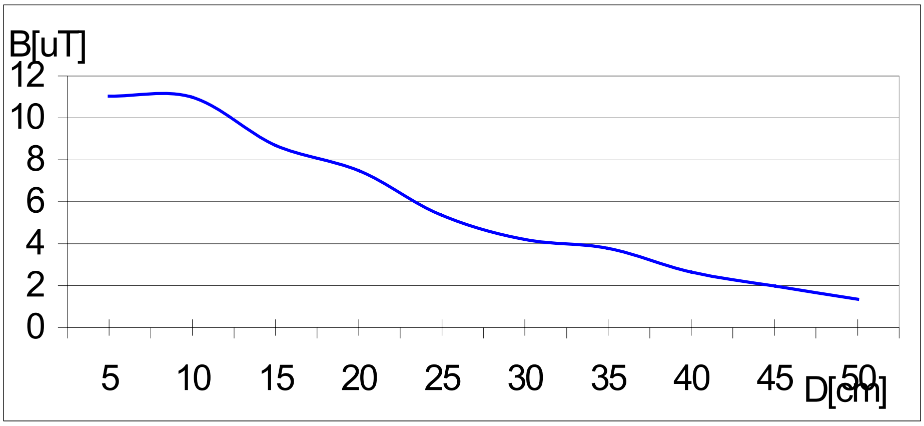

Fig. 3. The B induction change of the magnetic field in the ELF frequency range within the distance function from the measuring point for the Galaxy 520 control panel

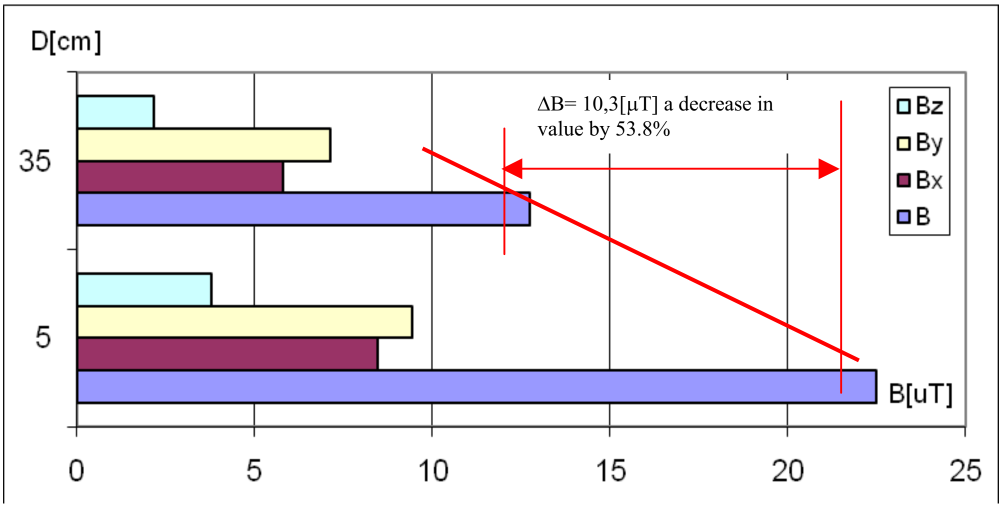

Fig. 4. The B induction graph of the magnetic field in the ELF frequency range for the Satel CA 64 control panel at a distance of 5 and 35 cm

The E electric field strength near the control panel metal housing was at a high level – at a distance of 5 cm respectively 63 [V/m] for the Galaxy control panel and 43 [V/m] for the Satel control panel. At a distance of 40 cm from the control panel housing, the E electric field strength in the ELF frequency range was at a level of the field background, which was in both protected facilities ~ (13 – 7) [V/m] – Fig. 5. The electric field of this frequency range is very well-damped (shielded) by the control panel metal housing.

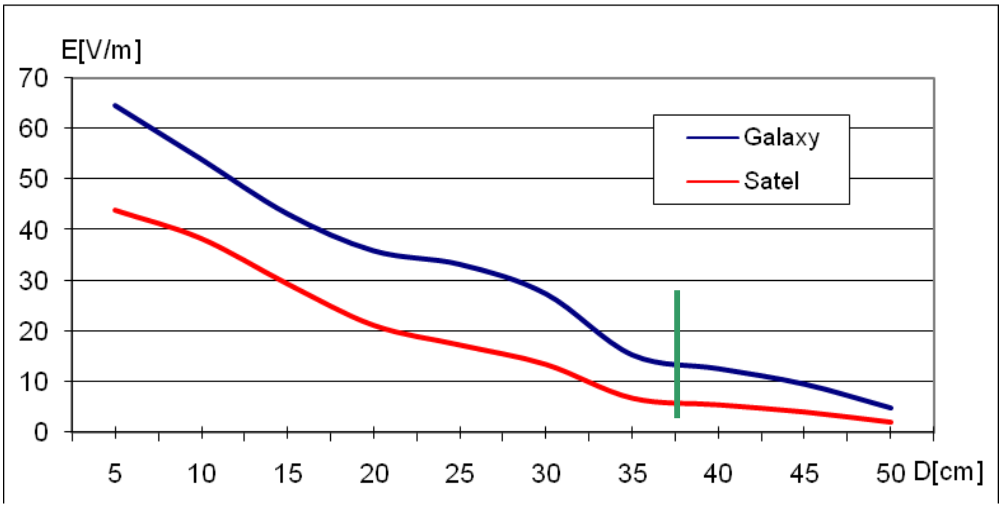

Fig. 5. The E electric field strength measurement results in the ELF frequency range for the Galaxy 520 and the Satel CA 64 control panels

4. SUMMARY AND CONCLUSIONS

The values of individual components of the electromagnetic field, i.e. the B induction magnetic component as well as the E electric field strength are different for the individual safety system control panels. These are the electronic safety system devices, which generate one of the highest unintended levels of electromagnetic radiation. The B induction of the magnetic field as well as its components (B_X, B_Y, B_Z) in the ELF frequency range for the Galaxy 520 and CA 64 control panels reaches great values at a distance of 5 cm from the metal housing. However, at a distance of 35 cm from the interference source, the B induction value of the magnetic field is 9.1 [mT]. Therefore, the electronic devices susceptible to the electromagnetic field impact should not be installed near the control panel (below 75 cm). It is certainly possible to use various types of solutions, the aim of which is to minimise the electromagnetic interference impact (the source of which are control panels) on other electronic devices operating nearby. One of the methods is to minimise the transfer of interference by the feedback circuit (e.g. decoupling filters, groundings, gate drives, shielding, etc.). At the same time, external interference sources should not affect the operating control panels. The control panels should also not be a source of interference (a concept of external and internal electromagnetic compatibility).

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