High Definition Multimedia Interface in the Process of Electromagnetic Infiltration

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Abstract— The article concerns problems of electromagnetic compatibility and compromising emission that is the information security. The article describes the electromagnetic channels of penetration information, and then focuses on High Definition Multimedia Interface for which shows signals of extortion used during of disclosing emission measurements. The article presents the results of compromising emissions measurements derived from High Definition Multimedia Interface. In addition, the article discusses the laboratory stand for measuring disclosing emissions.

1. INTRODUCTION

Information security against electromagnetic permeability of devices and electromagnetic systems (IT) is of great importance. This problem increases with a higher and higher use of ICT devices for processing and transmitting information which should not fall into the wrong hands. It results from the fact that each electronic device is the source of undesirable (secondary) emission of electromagnetic energy induced in surrounding space and in all close conductors and metal structures. When signals of undesirable emission are correlated with unclassified information, they can be used for reconstructing that information by intelligence services. The phenomenon of such undesirable emission is called compromising emission and its use by intelligence-penetration or electromagnetic infiltration. Undertakings which aim is to hinder system recognition on the basis of compromising emission are called information protection against electromagnetic penetration or emission safety. Electromagnetic emissions with the feature of compromising emission can arise at any stage of processing of encoded information in the form of electric current courses. There is also no possibility to conduct tests of the source itself and the channel of information permeability. However such tests can be conducted in laboratory conditions in which examined devices are introduced into operation mode allowing to learn their infiltration susceptibility. In this article an example of such experiments has been presented. It seems that most suitable for illustrating the issue of electromagnetic information permeability are devices or their components which process information in serial way and the rule of encoding is uncomplicated and well-known.

2. HIGH DEFINITION MULTIMEDIA INTERFACE

High Definition Multimedia Interface (HDMI) is an extension of Digital Visual Interface (DVI). HDMI standard developed by the Silicon Image company, which also developed a standard DVI. HDMI uses the same protocol TMDS (ang. Transition Minimized Differential Signaling)developed by Sillicon Image. TMDS protocol was used which was used first in the DVI interface. The difference between DVI and HDMI interface is the ability to transmit audio in digital form. Standard specification of digital image transmission between the graphics card and the monitor was set by the organization DDWG (ang. Digital Display Working Group) in 1999. The main aim of the TMDS protocol is to eliminate data transmission interference, through appropriate coding of transmitted data. The physical layer TMDS signal is a differential signal with a minimized number of logic changes. This property has been achieved by means of suitable coding algorithms, converting the data in 8-bit format to a 10-bit TMDS data. All signals are sent by three TMDS lines. Additional signals, other than the video is transmitted when it takes blanking the screen on TMDS1 and TMDS2 lines. In HDMI version 1.2 color transfer was held on 24 bits. Since version 1.3 introduced Deep Color mode which gives the possibility to send the color in the words of 30, 36 and 48 bit systems. In HDMI version 1.3 image is transmitted with a clock frequency of 25 to 340 MHz in Single-link (TMDS protocol). In the Dual-link is the maximum clock frequency are 2×340 MHz. At frequency 340 MHz bandwidth is 10.2 Gb/s.

3. THE LABORATORY STAND FOR MEASURING COMPROMISING EMISSION

In order to determine sources of compromising emission deriving from HDMI interface it is necessary to estimate a contents degree of test signal intentionally generated by HDMI interface (HDMI cable) in the signal received by measuring position as radiated or conducted compromising emission.The laboratory stand for conducting tests of determining sources of compromising emission should make reception of generated test signal propagating as radiated or conducted compromising emission possible. In this article attention has been paid to radiated compromising emission. HDMI interface as enforcing compromising emission used the selected imaged is play on the LED monitor screen.With the use of receiving antennas [7–14] signal received by antenna gets through commutator which switches antennas to FSET 22 broadband receiver. In the receiver those signals are filtered and their conversion into lower frequency range takes place. Signal after detection is passed to VIDEO output in the receiver and then it is passed to input of external channel of oscilloscope on which there is a possibility of displaying received information in time domain [1–6].

4. MEASUREMENT RESULTS

Common observation of spectrum obtained during HDMI interface operation display random images or movies can't give you an answer as to the possibility of occurrence of compromising emission. In order to determine the distinctive features of HDMI interface (on data lines) during operation reflected in components of frequency spectrum or in time domain test patterns used during tests conducted with HDMI interface working have been chosen. Measurements were made for Full HD resolution (1980 × 1080) [15, 16].

The following images have been chosen as test signals generated to the process of displaying the selected image on the monitor screen: white image on the monitor screen, two black and white horizontal stripes evenly spaced on the monitor screen, two black and white vertical stripes evenly spaced on the monitor screen, the black letter Hon a white background dealing with full screen. The look of test images generated during operation of the HDMI interface has been shown in Figure 1.

(a) (b) (c) (d)

Figure 1: Test images used during the test of the compromising emissions derived from HDMI.

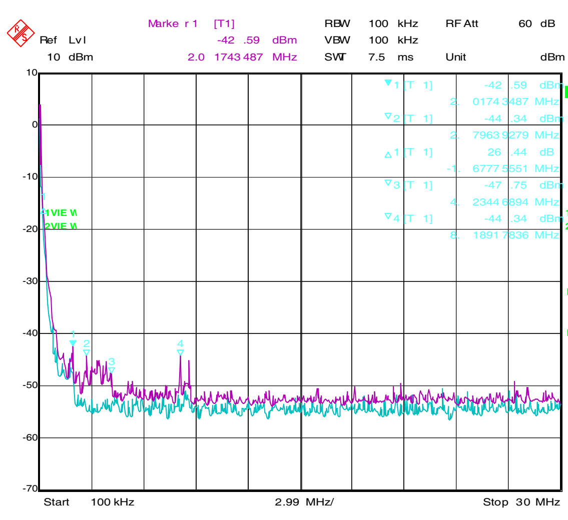


Figure 2: Radiated emission deriving from HDMI interface while displaying the white image on the monitor screen (blue colour) and test pattern (violet colour) within frequency range 100 kHz–30 MHz.

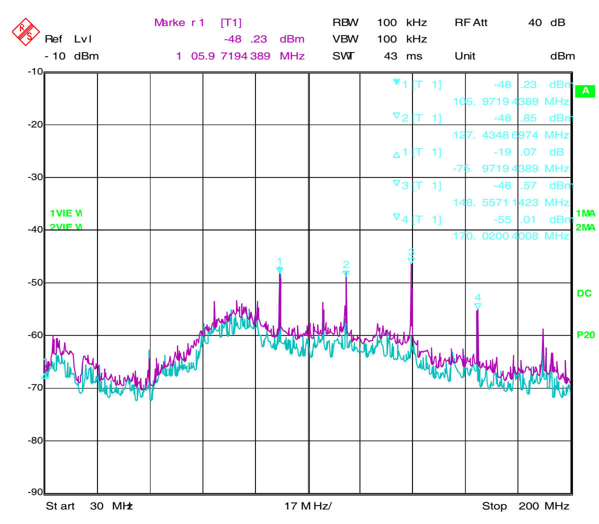


Figure 3: Radiated emission deriving from HDMI interface while displaying the white image on the monitor screen (blue colour) and test pattern (violet colour) within frequency range 30 MHz–200 MHz.

Measurement results for the two mentioned test patterns (white image on the monitor screen and the black letter Hon a white background dealing with full screen) have been presented in Figure 2, Figure 3, Figure 4 and Figure 5.

Very often evaluation of spectrum itself is insufficient due to difficulties resulting from rating of appearing signals at particular frequencies. Because of that it is necessary to use other methods consisting in the use of more advanced measuring devices. Anyway in most cases qualification of emissions occurs with the use of visual method. It should be remembered though that in doubtful cases or in such ones where visual assessment is impossible evaluation methods based on digital methods of processing of recorded signals are used [17–19].

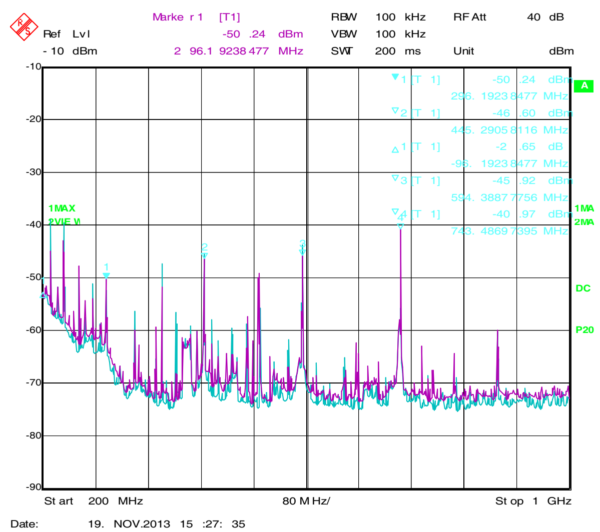


Figure 4: Radiated emission deriving from HDMI interface while displaying the white image on the monitor screen (blue colour) and test pattern (violet colour) within frequency range 200 MHz–1000 MHz.

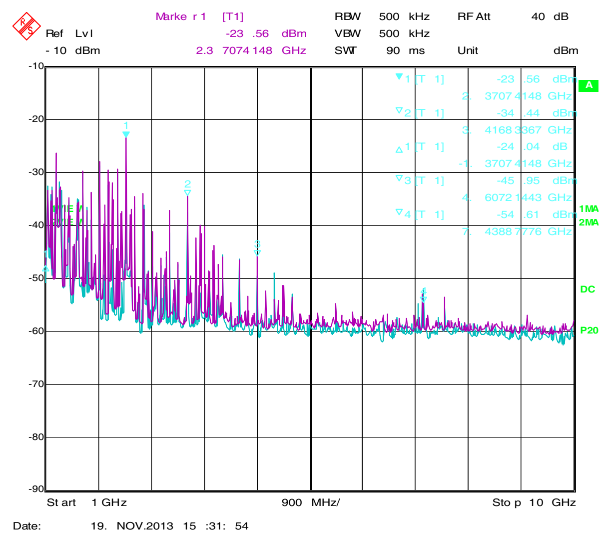
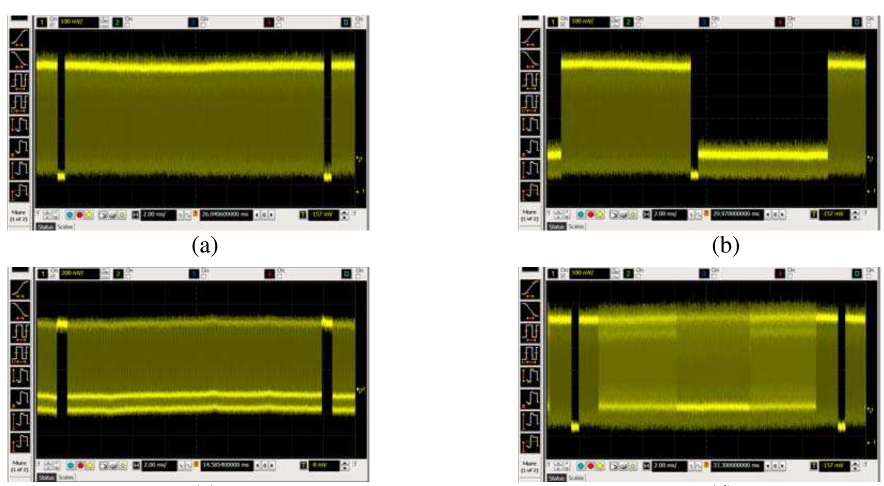


Figure 5: Radiated emission deriving from HDMI interface while displaying the white image on the monitor screen (blue colour) and test pattern (violet colour) within frequency range 1000 MHz–10000 MHz.



(a) (b) (c) (d)

Figure 6: Oscillogram for HDMI interface while displaying on the monitor screen: (a) a test pattern a; (b) a test pattern b; (c) a test pattern c; (d) a test pattern d. The signal received by antenna for $f = 743,48$ MHz given from VIDEO output of FSET22 receiver.

Identification is a process or a result of processes of identifying a particular object with other object. It may include distinguishing common features, capturing similarities between a tested object and other objects of the same category, estimating values of observed parameters of a particular object. Using any methods of signal identification of compromising emission requires determination of distinctive features characteristic for model information signals and determination of a similarity degree of those features for analogous parameters of tested signals. On the basis of an analysis of radiated emission levels by HDMI interface probable signal reception frequencies of compromising emission have been determined. To test whether radiated signals within that frequency range actually have the character of compromising emission, a series of recordings of those signals has been made with the use of digital oscilloscope and analyzed. The measurements have been made while displaying on the monitor screenthe images defined in Figure 1. The sample results have been placed in Figure 6 [20, 21].

5. CONCLUSION

The presented above time courses of radiated emission signals by HDMI interface show clearly that those signals have an evident connection with contents of displayed images and thus they have the character of compromising emission signals. Time courses directly identify the contents form of displayed images. On the basis of the measurements obtained from the oscilloscope waveforms appearing on the interface transmission lines and their spectrograms received using a spectrum analyzer and oscilloscope can be concluded that: by selecting the pattern image is generated on the computing device,the test form can be formed on the time course of signal transmission lines HDMI interface in such a way that it can be easily identified on the oscillogram, the test image should be black and white because the color of black and white are represented by extreme values in the signal voltage at the HDMI interface (This structure facilitates the identification signals on the oscillogram. This allows notice any change in the oscillogram for changing color in horizontal line son the screen), the test image should be static (stationary elements of the image), the test image should have aperiodic structure (repetitive components of image are easier to identification signals on the oscillogram).

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