Directed Energy Applications to the Destruction of Informatic Devices

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Abstract— The article concerns the problems of high energy electromagnetic environment. The article describes an high power electromagnetic pulse and discusses the laboratory stand for generate HPEM pulses. In addition, the paper presents an analysis of possibilities of shaping the pulses spectrum generated for the destruction of IT devices, and presents the results of measurements.

1. INTRODUCTION

The IT infrastructure and personal computers (especially PC) are an integral part of our business and everyday life. If you use the IT equipment in critical infrastructure or use for the preservation IT security is not acceptable appearance of any disturbances in the electromagnetic environment. In an environment of high power electromagnetic microwave source is a relatively new kind of risks, both for military systems, and civilian systems. Operation using this type of source is generally referred to as intentional electromagnetic disturbance. HPEM radiated environment, which is naturally harmful, can also occur at frequencies up to several tens MHz. Generate a high-power electromagnetic pulse in the direction of the electronic system makes that on the electronic circuits accumulates very high voltage. This phenomenon causes damage to the circuit elements which makes the device unfit for further operation. In the case of a purposeful interaction an impulse is very important in terms of its effectiveness to generate sufficiently strong impulse at the required frequency.

2. HIGH POWER ELECTROMAGNETIC PULSE

High-power electromagnetic pulse called HPEM is a very short duration pulse (of the order of nanoseconds) and high power (order of tens of gigawatts). HPEM pulse is also often called a E bomb, due to its potential to cause irreversible damage to all electronic equipment located within destruction range an impulse. Also, it should be noted that as yet there were no adverse effects of such a pulse on living organisms by which electromagnetic pulses were known as a humanitarian weapon. HPEM pulses for the first time were observed as a side effect in outbreaks of atomic bombs, it was also found that the extent of such radiation greatly exceeds the means of destruction yet. Currently, several generation methods of HPEM pulse were developed through dedicated generators of electromagnetic radiation. Destructive action of E bombs depends on the destruction of all electronic equipment based on semiconductor technology, and in particular cases of destroying whole infrastructure of communications and power transmission. Figure 1 shows an appearance of HPEM pulse in the time domain, while Figure 2 shows the frequency spectrum of the pulse.

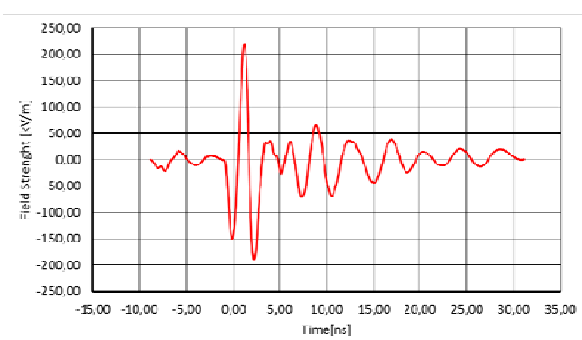

Figure 1: An example of a graphical representation of the HPEM pulse in the time domain.

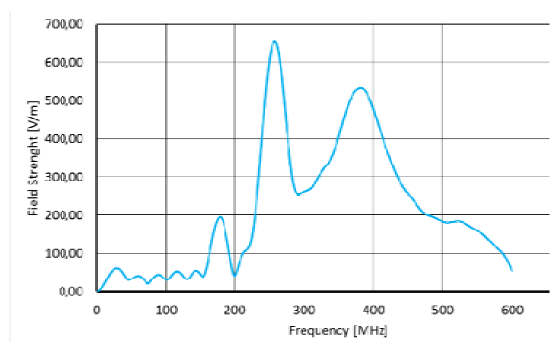

Figure 2: An example of frequency spectrum for sample HPEM pulse.

3. THE LABORATORY STAND OF THE GENERATION AND MEASUREMENT OF HPEM PULSE

The main element responsible for the generation of a HPEM pulse is a generator Diehl DS 110, which is shown in Figure 3. It is compact enclosed equipment, looks like a suitcase. Components of the generator are high-voltage power supply, 300 kV Marx generator and a resonant antenna. High voltage power supply system supplies the Marx generator by 50 kV voltage (symmetrical voltage ±25 kV), he is charged until the threshold set by the switch that sets pressure gas N_2 in the generator. When changing the position of the switch, antenna is fed a 300 kV voltage, the sparker contained in the air is isolated by the pressure gas N_2 [15–18].

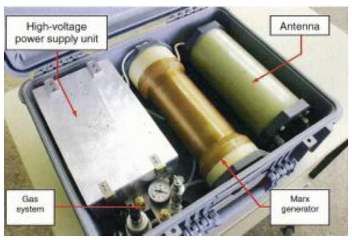

Figure 3: View from inside the generator Diehl DS 110.

Figure 4: Remote control switch generator Diehl DS 110.

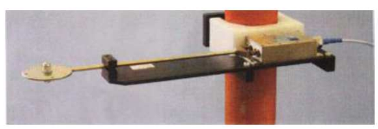

Figure 5: The measuring probe D-dot probe Prodyn AD-70 with matching system Prodyn BIB-170F.

Trigger pulse generator can be done by direct actuation by means of a button on the device, or by using the remote control switch (Figure 4) connected to the generator by optical fiber. The main elements of the receiving side of HPEM pulse is D-dot probe AD-70 shown in Figure 5 and Tektronix oscilloscope DPO70404C. The D-dot probe is a detector of electromagnetic induction, it serves as an antenna in a changing electromagnetic pulse electrical signal [7–14]. This is a passive element, and the output signal is derived from the electric field changes over time. The effective electric surface probe is 10^{-3} [m^2].

Oscilloscope receives a signal from the probe and using the Ethernet interface to transmits to the computer a measurement samples, where using a dedicated software is integrated signal so we get the form of a time signal from the generator actually generated. In order to prevent damage to the oscilloscope input signal should be suppressed using the faders of adequate (selected experimental) values. Tektronix oscilloscope characterized by high bandwidth (4 GHz) and a sampling time of 25 GS/s.

The Figure 8 has been presented a block diagram of the laboratory stand of the generation and measurement HPEM pulse. The main elements of this laboratory stand are the generator and receiving antenna, which they are placed in an anechoic chamber so that the probability of damage other electronic devices located near the generator is very small. In addition, they have been placed on the metal floor thus ensuring that a common reference mass. Devices in the measurement room allow their safe operation by authorized persons.

Also in this case a common reference mass of the measuring devices is ensured by a protective metal casing [4–6]. Components of the laboratory stand located in the anechoic chamber arranged in accordance with block diagram of Figure 6 is shown in Figure 7. In this case, the generator is enclosed by reflector for greater concentration of radiation in a one direction (this is optional).

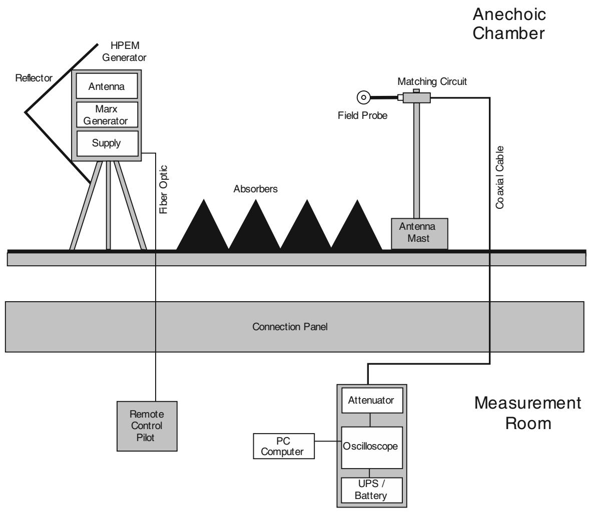

Figure 6: The block diagram of laboratory stand for measurement of HPEM pulse.

Figure 7: The view of laboratory stand for measurement of HPEM pulse in anechoic chamber.

4. ESTIMATION OF SUSCEPTIBILITY THRESHOLDS FOR INFORMATICS DEVICE

Estimating the susceptibility thresholds for the information device is to determine the threshold of susceptibility to the impact of this device by pulsed electromagnetic field. Estimation of susceptibility thresholds will be presented on the example of the PC unit. Before proceeding to determining the threshold of susceptibility, we must refer to the properties of the device. When we more data collect about the components and construction of the device we can more precisely specify the thresholds for immunity [1–3]. Knowing all of elements which can affect the thresholds of susceptibility/immunity PC to the impact of pulsed electromagnetic field we can presented by points on the frequency graph. In this case, have been measured at a distance of 3 m radiated emissions for the PC, and then these values have been converted into radiated emission values derived from the PC test inside the machine. The values of the above-mentioned radiated emissions is shown in Figure 8.

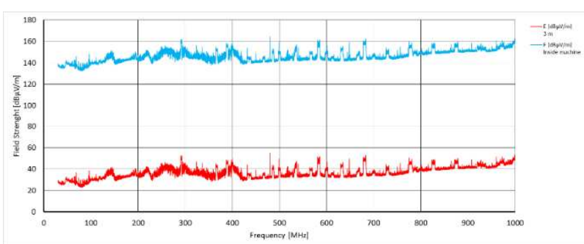

Figure 8: Radiated emission values for PC.

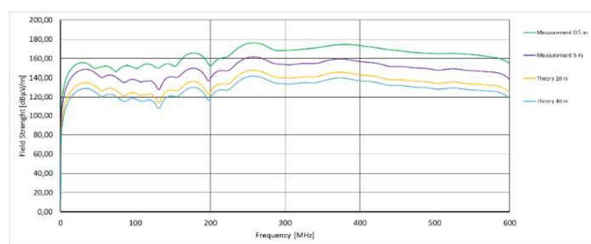

Figure 9: The amplitude-frequency values of HPEM generator for distance: 0.5 m, 5 m, 20 m, 40 m.

5. ANALYSIS OF IMPACT HPEM PULSE ON THE COMPUTER UNIT

The laboratory tests consisted of checking the behavior of the device in pulse high power electromagnetic field. The test object (information device) was placed in an anechoic chamber at a height of 80 cm above the ground and moves away from the HPEM generator to compensate different distances. The laboratory test was performed for the distance of 0.5 m and 5 m, while for longer distances (due to the size of an anechoic chamber), only we estimated values of pulsed electromagnetic field. For a distance of 0.5 m and 5 m, the values of electric field strength respectively: 220 kV/m and 35 kV/m. And for distance 40 m and 20 m we calculated the expected value of the electric field and was obtained, respectively: 7.5 kV/m and 3.6 kV/m. In Figure 9 shown the amplitude-frequency graph in dB for the HPEM generator in the above-mentioned distances [19–21].

PC operation as tested with BurnInTest program in which we can make the choice of tests used for testing software and hardware. Each test is designed to test the different components of the computer system. These tests can be performed simultaneously. At a distance of 0.5 m the PC crashed and was necessary reset the device by switching off and on the power again after a few minutes. At a distance of 5 m work PC has been disrupted. PC reset the central unit after stopping of exposure, and the basic functions of the PC operation returned to normal. On the basis of the estimated value of the generated pulse electromagnetic field, this phenomenon will be present to the distance from the HEMP source of the device approx. 20–40 meters. However, for a distance of over 40 m the PC should run without interruption during exposing pulse electromagnetic field. For this distance the susceptibility thresholds of computer are above the value of the intensity of the electromagnetic field from a HPEM source. The amplitude-frequency characteristics of the HPEM generator in dB for distances of 0.5 m, 5 m, 20 m, 40 m with plotted susceptibility thresholds of PC computer shown in Figure 10.

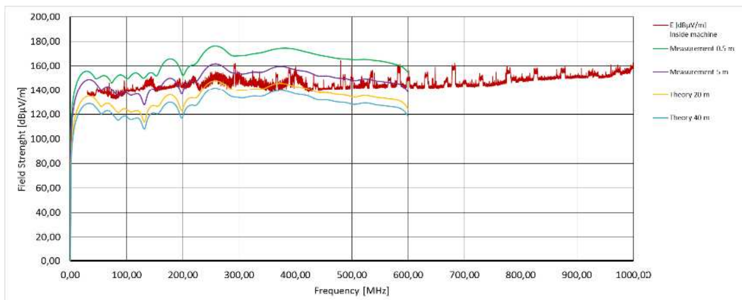

Figure 10: The amplitude-frequency values field strength of HPEM generator with susceptibility thresholds of PC computer.

6. CONCLUSIONS

The possibility of an attack on information technology equipment which work only on a specific frequency significantly restricts the use of this equipment in critical infrastructure. Generate an electromagnetic pulse located in the working range of PC computer can result burnout internal circuits which will make it will be completely unsuitable for further work. Remember to adequately protect the device information. The article presents the intensity of pulsed electromagnetic field for which the PC computer is not susceptible to exposure HEMP pulses. These values are valid for electromagnetic pulse characterized as a high power. When setting these values were used thresholds of susceptibility of computer designated for a single PC computer.

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