Disruption of COTS PC's due to microwave illumination

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ABSTRACT
The possibility of intentionally disrupting a communications or computing facility using a very short burst of microwave energy makes electromagnetic terrorism a real threat. It is important to know the susceptibility of typical commercial computing equipment such as the personal computer in order to evaluate this threat. In order to show the impact of an High Power Microwaves (HPM) threat, the combination of a working HPM device and a realistic target is demonstrated. We show the results of susceptibility experiments on a PIII 733 MHz and a PIV 1.6 GHz PC illuminated by a small portable HPM device.

INTRODUCTION
The use of High Power Microwaves (HPM) to intentionally disrupt and/or damage communications and information processing equipment is an area of concern, which is receiving growing attention in the electromagnetic compatibility community. At TNO-Physics and Electronics Laboratory (TNO-FEL), a research program on susceptibility thresholds has been started several years ago. Various desktop, tower and laptop systems have been subjected to microwave illumination. We have used a number of different illumination conditions. As a starting point, we took the EN 6100-4-3 (IEC 1000-4-3) and increased the field strength and pulse repetition rate. The impinging electromagnetic fields are pulsed with various repetition rates and pulse lengths.

The experiments have been performed outdoors due to the limited dimension of the available Anechoic chambers at TNO-FEL. The HPM device has been designed and constructed in such a way that it can be carried by hand and operated without endangering the operator. Also, the appearance does not suggest that the device is an HPM device. The weight has been kept within an acceptable level.

In this paper, measurements are described performed on a PIII 733 MHz and a PIV 1.6 GHz. The experiments were performed in a large metal free tent to minimize reflections. The PC was placed on a table and was fully operational. The source was put on a metal free pedestal or held by the operator.

SOURCE DESCRIPTION
The used source is equipped with a transmitter, a control circuit, an antenna and a power supply. The transmitter emits a narrow band EM signal. The transmitter combined with the

antenna is capable of surpassing the levels mentioned in the EMC guidelines considerably. The control circuit offers three fixed sets of pulse length and PRF ”short pulse/high PRF, medium pulse/medium PRF and long pulse/low PRF”. The field levels outside the main beam pose no danger to the carrier of the briefcase.

RESULTS

The first series of experiments were done on a PIII 733 MHz system. In fig. 1, the results of the measurements are given. A susceptibility threshold means that a PC is in a frozen state and no more activities take place: it does not respond to the keyboard or reset switch or power switch on the front of the PC. Unplugging the system for several seconds is necessary to regain access to the system. When the PC is in a frozen state and illuminated again it powers down. The 733 MHz system does not respond to very short pulses at the available field levels.

The next series of experiments were done on a PIV 1.6 GHz PC. Now, the short pulses are able to upset the PC at a large distance. The medium and long pulses show a slight difference in upset distance. The maximum distance in the unshielded case could not be determined because the test area was limited in size.

Although the measurements directed to the front of the PC and the measurements on the unshielded PC show repeatable and clear results, the measurements directed to the back of the PC are not in all case fully predictable. In most cases, no effect was observed. However, occasionally the PC was shut down at intermediate distances.

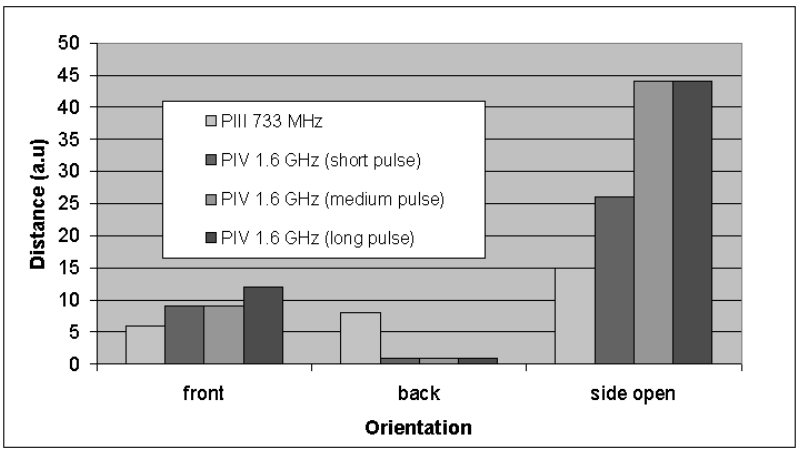

Fig. 1: Susceptibility thresholds as a function of distance in the main beam of the HPM demonstrator.

Observing the back of the PC, one thing can be noted which is different from all other measured PCs up till now. The meshing over the fans was much smaller in case of the 1.6 GHz PC as compared to the other PCs. The openings, which were in the order of several cm at the older PCs, decreased to about 0.5 cm on the PIV 1.6 GHz (see fig. 2).

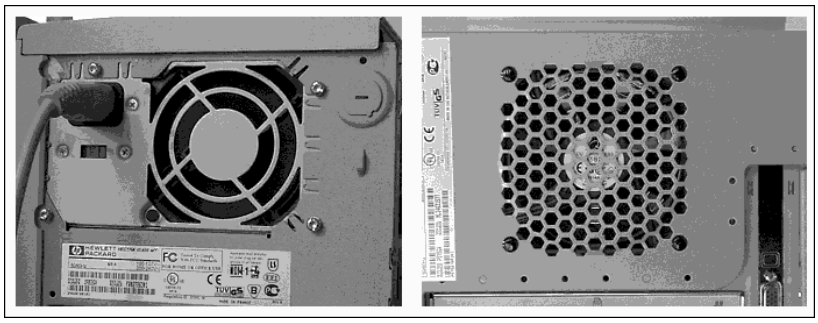

Fig. 2: Fan grids of a PIII 733 MHz (left) and PIV 1.6 GHz (right) PCs.

The back of the 1.6 GHz is obviously shielded better when it is in mint condition. To investigate the importance of the shielding, some extension slot covers were removed. This resembles the condition when an extension card is inserted and after a while is removed again. In almost all cases, we have observed that the cover is lost and the back of the PC remains open.

In fig. 3, the extension slots and covers can be seen of the system under test. As can be observed from the figure, shielding is obtained through various contacts every centimeter. The slots are numbered from top to bottom. Removing slot cover number 3 (corresponding to the lowest PCI connector), increases the threshold distance between the HPM source and the PC by a factor of 3. Removing the lowest cover and then all covers, further increases the threshold distance as can be seen in fig. 4.

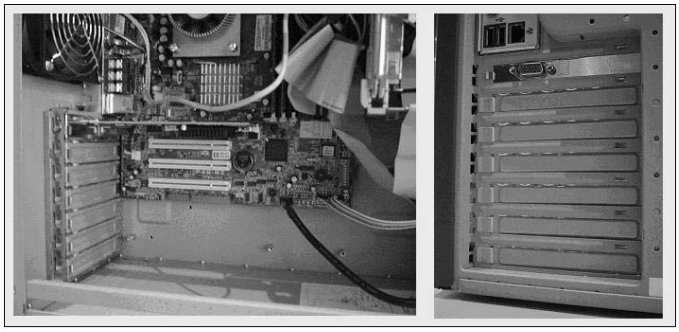

Fig. 3 Extension slots at the back of the 1.6 GHz system.

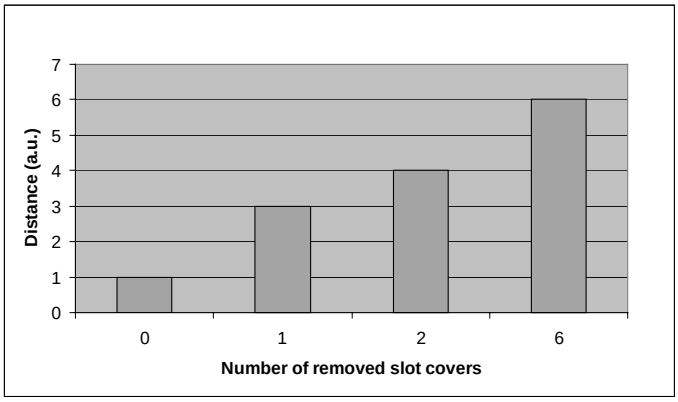

Fig. 4 Threshold distance as a function of slot cover removal.

CONCLUSIONS

Based on the results presented here, it is clear that a potential HPM threat exists for PC-systems. Shielding is only effective when used properly. Examining the construction of a PC cover reveals several weak spots that could have been constructed properly. Especially the removable drive bays at the front of the PC are constructed carelessly with respect to good shielding practice. When an extension card is removed from the system, the slot cover at the back must be put in place.