# Measurement and Analysis of Compromising Emanation for Laser Printer

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**Abstract**— The article concerns problems connected with electromagnetic compatibility and compromising emanation, i.e., information security. In the article channels of electromagnetic information permeability have been de-scribed and then there has been the focus on laser printers for which forcing signals used during measurements of compromising emanation have been presented and measurement results of compromising emanation deriving from laser printer have been described.

## 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 emanation and its use by intelligence-penetration or electromagnetic infiltration. Undertakings which aim is to hinder system recognition on the basis of compromising emanation are called information protection against electromagnetic penetration or emission safety.

Electromagnetic emissions with the feature of compromising emanation 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. LASER PRINTER

Monochromatic laser printers are probably the most popular devices in our workplaces which allow to obtain perfect quality printouts at little cost. Just like in case of VGA monitors, the following features of information signal converted in that device prove the possibility of information interception from laser printer:

- information about the colour of each printout point is encoded in the form of rectangular pulses, high contents of harmonics increases probability of formation of electromagnetic emissions.
- data are encoded in analogue way through regulation of level of particular signals corresponding with two basic colours which makes easy information reconstruction possible
- data are sent in serial way.

## 3. MEASURING POSITION FOR MEASURING COMPROMISING EMANATION

In order to determine sources of compromising emanation deriving from laser printer it is necessary to estimate a contents degree of test signal intentionally generated by laser printer in the signal received by measuring position as radiated or conducted compromising emanation. Measuring position for conducting tests of determining sources of compromising emanations should make reception of generated test signal propagating as radiated or conducted compromising emanation possible. In this article attention has been paid to radiated compromising emanation. Printout of selected images on paper sheets was used for laser printer as enforcement for compromising emanation. With the use of receiving antennas [5–9] signal received by antenna gets through commutator which switches antennas to FSET 22 broad-band 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 [1–4].

## 4. MEASUREMENT RESULTS

Common observation of spectrum obtained during printer operation in the printing and stand-by mode does not give the answer about the possibility of occurrence of compromising emanations. Since it turns out that significant sources of electromagnetic emissions of laser printer are stepper motors and other electric elements which do not process signals carrying information about a printed document. Those elements are e.g., all kinds of paper end sensors, paper jam sensors, toner state etc.. Therefore during classification of printers from the perspective of levels of electromagnetic emissions correlated with classified information an evaluation method allowing to state presence of such emissions should be taken. One of the methods can be conducting measurements of radiated emissions from printer during printing documents significantly differing in contents.

In order to determine distinctive features for laser printer during operation reflected in components of frequency spectrum or in time domain test patterns used during tests conducted with printing operation of laser printer have been chosen. The following images have been chosen as test signals generated to the printout process by laser printer: White image on A4 sheet, A4 sheet filled with three lines placed in the middle of the sheet, A4 sheet filled with three lines placed outside the sheet, A4 sheet filled with eight lines placed in the middle of the sheet. The look of test patterns generated during printing by laser printer has been shown in Figure 1. Measurement results for the two mentioned test patterns (white image on A4 sheet and A4 sheet filled with three lines placed in the middle of the sheet) have been presented in Figures 2–4.

Very often evaluation of spectrum itself is insufficient due to difficulties resulting from rating of appearing signals at particular frequencies. Those signals often inform only about the moment of taking paper from sheet feed unit, heater operation or they are connected with work of elements demagnetizing roller. 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 [10–13].

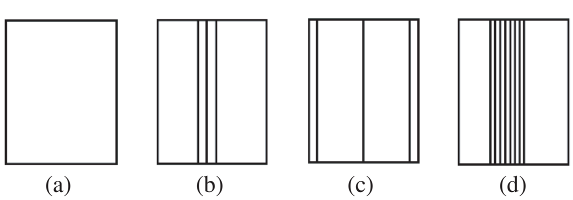


Figure 1: Test patterns used during tests of compromising emanation deriving from laser printer.

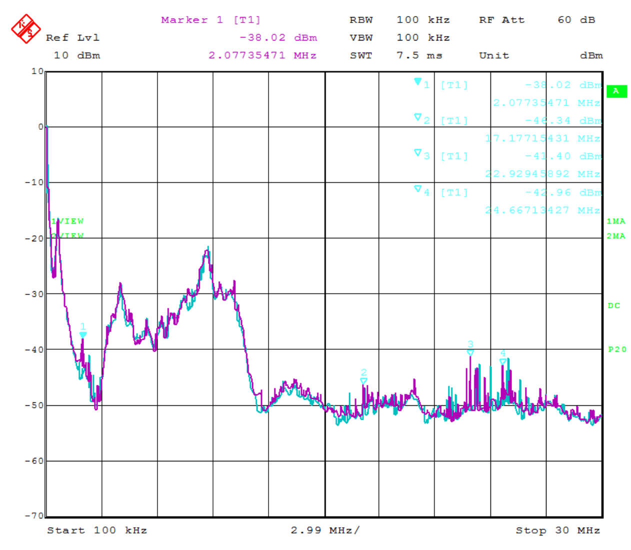


Figure 2: Radiated emissivity deriving from laser printer printing white image (blue colour) and test pattern (violet colour) within frequency range 100 kHz–30 MHz.

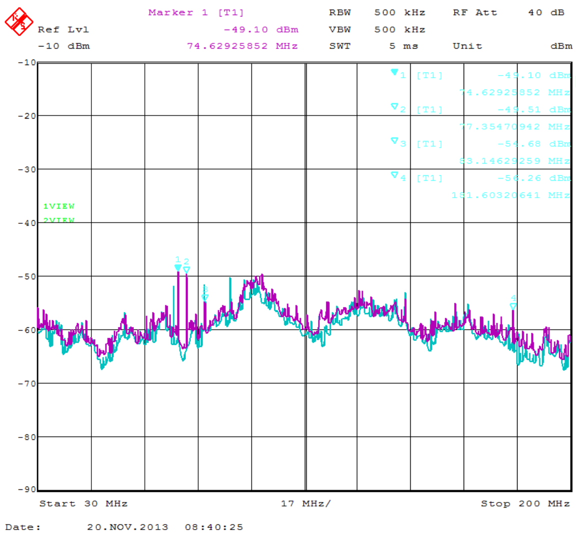


Figure 3: Radiated emissivity deriving from laser printer printing white image (blue colour) and test pattern (violet colour) within frequency range 30 MHz–200 MHz.

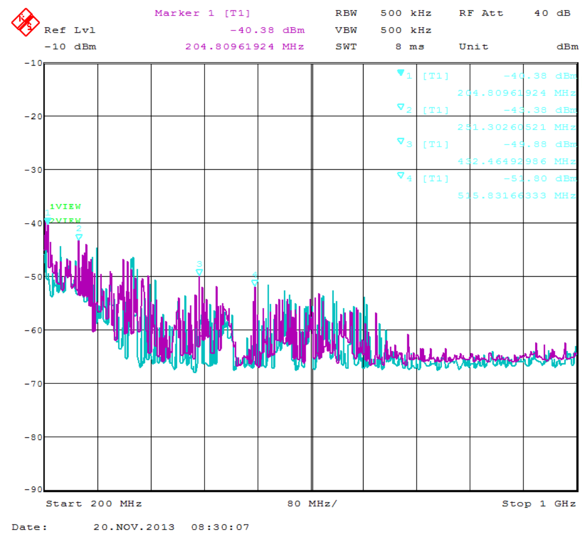


Figure 4: Radiated emissivity deriving from laser printer printing white image (blue colour) and test pattern (violet colour) within frequency range 200 MHz–1000 MHz.

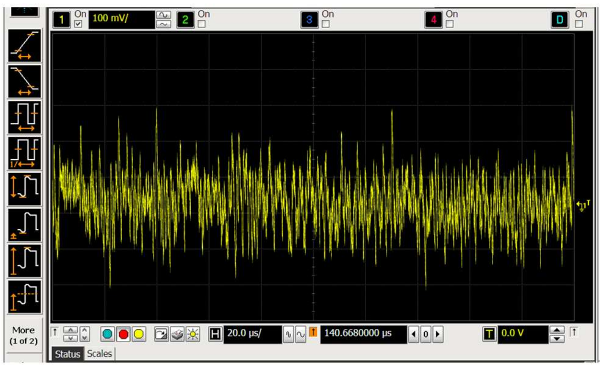


Figure 5: Oscillogram for laser printer connected to PC and printing test pattern a). The signal received by antenna for $f = 220$ MHz from VIDEO output of FSET22 receiver.

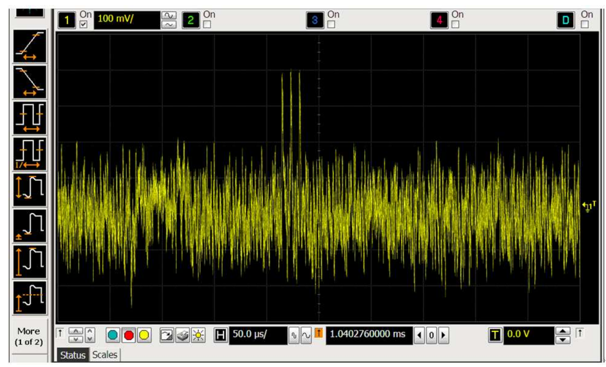


Figure 6: Oscillogram for laser printer connected to PC and printing test pattern b). The signal received by antenna for $f = 220$ MHz from VIDEO output of FSET22 receiver.

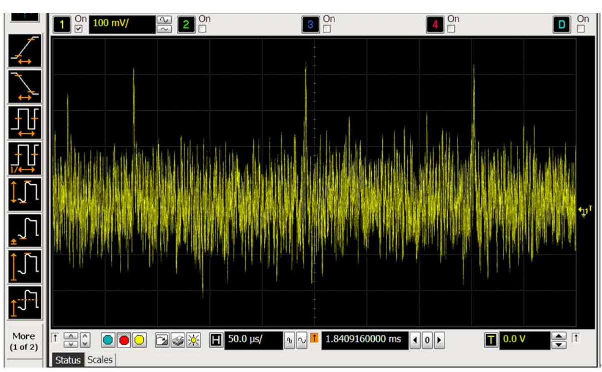


Figure 7: Oscillogram for laser printer connected to PC and printing test pattern c). The signal received by antenna for $f = 220$ MHz from VIDEO output of FSET22 receiver.

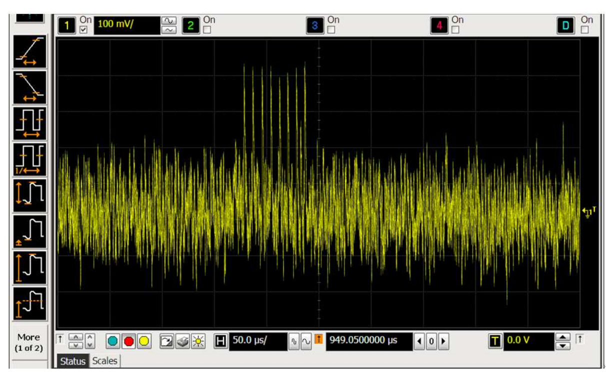


Figure 8: Oscillogram for laser printer to PC computer and printing test pattern d). The signal received by antenna for $f = 220$ MHz from VIDEO output of FSET22 receiver.

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 emanation [18] 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 laser printer probable signal reception frequencies of compromising emanation have been determined. To test whether radiated signals within that frequency range actually have the character of compromising emanation, a series of recordings of those signals has been made with the use of digital oscilloscope and analysed [14–17]. The measurements have been made while printing sheets containing particular content(number of vertical lines) for images defined in Figure 1. The sample results have been placed in Figures 5–8.

## 5. CONCLUSIONS

The presented above time courses of radiated emission signals by laser printer show clearly that those signals have an evident connection with contents of printed pages and thus they have the character of compromising emanation signals. Time courses directly identify the contents form of printed page. Of course it happens when a sheet with simple graphics in the form of vertical lines is printed. A number of 'pins' in time course informs about a number of lines in a document. However visual view from time course starts getting complicated when a printed page contains graphics or text. Then one can only distinguish printout of blank paper sheet from filled one. So the question arises: is it possible to reconstruct, with the use of electromagnetic emissions, contents of a printed document just like it is in case of information displayed on a computer monitor? It turns out to be possible and quality of reconstructed data is so high that it can be read out immediately.

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