Method for Measuring Parasitic Electromagnetic Emissions with Automated System for Measurement Management

Chavdar Levtchev[1], Nikolay Stoyanov[2] and Georgi Georgiev[3]

Abstract: **In the paper the block scheme of an automated system for measurement management with parallel processing the information is presented. A methodology for measurements and the order for conducting the measurements is described and developed. The function of each single measuring equipment is explained. The main correlations are given for calculation of each component that is part of the information processing automated measurement. Using specially designed software for automation of the measurements and parallel info processing graphics and diagrams of the measurements conducted are shown.**

Keywords: **Anechoic Chamber, Automated Measurements, Antenna Measurement.**

I. Introduction

The measurement of electromagnetic radiations realize by using concrete standards. In the last few years the measurements are automated. The antennas, the measurement instruments, amplifiers and cables are calibrated and certificated and their parameters are under permanent control [1]. The antenna which we measure put into anechoic chamber on a special roll-over-azimuth positioner. The measurement is realized outside of anechoic chamber. In this work is given short description at automated system of control the measurements with parallel computations of the information. By using of hundred measurements amplitude-frequency PC model is made. The model is presented in cylindrical coordinate system and shows the space propagation of the radiated parasitic waves (interferences).

II. Automated System of Control the Measurements and Parallel Computations of the Information

In everyone device in which has electrical current is formed electromagnetic field – a wave which is propagated inside of the device and around him. In some cases the propagation is up to hundred meters from the place where the device is.

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If there are a few devices at one place each of them has electromagnetic field which interferes and radiate in the ambient space. These electromagnetic interferences are undirected, they formed accidently, has different intensity and they are propagates in the all directions in ambient space with different polarization (1). Because of this that the interferences are accidently and undesired they are called parasitic. Frequently these electromagnetic waves are with very high power which is dangerous about human health.

The block scheme at automated system of control the measurements with parallel computations of the information is shown at fig.1.The screening of the chamber together with microwave absorber can provide suitable environment. This type measurement chamber is trying to stimulate the conditions of the free space. The screening reduces the noise level from the surround area and other external influences. The microwave absorbers minimize the unwanted reflected waves from the walls which can have influence at the measurements. In the practice is comparatively easily by screening to be reached high levels of attenuation (from 80 dB to 140 dB) at the interferences in the surrounding area which usually makes these interferences negligible[1,5]. The special roll-over-azimuth positioner is able to rotate at 360° in horizontal plane and can be used for supporting at the tested antenna on a suitable high, in this case 0.80 m over the floor.

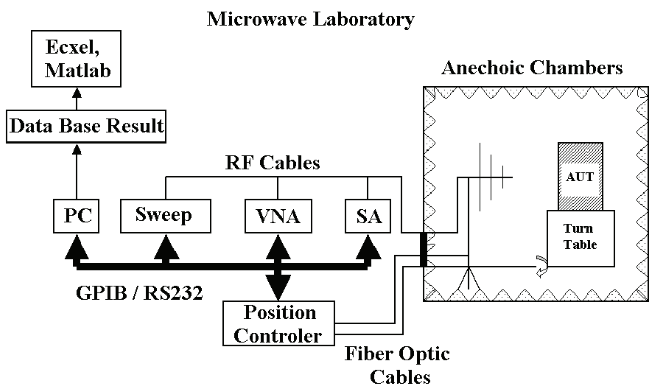

Fig.1 Block scheme at automated system of control the measurements

Inside of the anechoic chamber on a roll-over-azimuth positioner the measurement antenna is put. In the chamber is mounting a measurement antenna over control mast which allows changing the polarization. The control of the roll-over-azimuth positioner and the mast realized by helping of positioner-controller which one is controlled by a computer. The connection between positioner and the mast realizes by optic cables which ones together with antenna RF cables go out and go into the camera through a special panel with suitable couplings. Special software for control and treatment of the results is developed and introduced for this whole measurement process. A software fragment which control the positioner is shown at fig. 2.

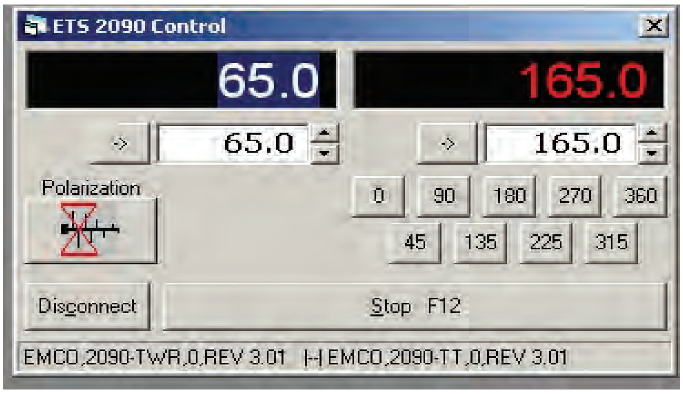

Fig. 2 Positioner Panel

Another basic element of measurement process is the measurement antenna. The antenna must be calibrated standard antenna with parameters – gain (G), antenna factor (AF), voltage state wave ratio (VSWR) and diagram pattern. A short description of developed methods of measurement at electromagnetic radiation in anechoic chamber is shown in fig. 3.

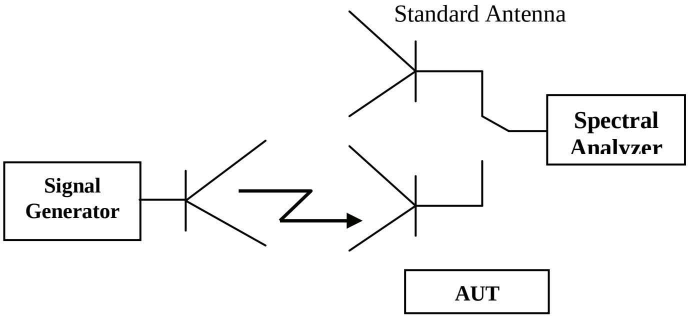

Fig.3 Comparison between the antennas

$$G_{aut} = L_1 - L_2 + C, \qquad (3)$$

where G_{aut} is the gain of the measurement antenna (dBi), L_1 – measured level of the received signal from the AUT (dB), L_2 – measured level of the received signal from etalon antenna (dB), C –gain of the etalon antenna (dBi).
The antenna factor [1, 2] is related with the gain of the antenna

$$AF = 20\log F - G - 29.8, \qquad (1)$$

where:
$AF, dB/m$ is the antenna factor
F, MHz - received frequency;
G, dB - antenna gain

This formula can be used for 50 Ω resistivity of the fider only. The "standard antenna method" is applying when the antenna factor is unknown or control check of the antenna. When the antenna gain is known it is easy to compute the antenna factor. Another basic antenna parameter is VSWR. It is necessary to by measured VSWR because it is connected with mishmash losses in the receiver input RETURN LOSS (RL).

$$RL = 20\log\left(\frac{1}{1-\left(\frac{VSWR-1}{VSWR+1}\right)^2}\right) \qquad (2)$$

VSWR must be measured at the cables and the amplifiers which are used in the measurement because there are losses from mish-mash. The attenuation losses in the cables and preamplifiers gain are measured also. All these measurements are made with the VNA (vector network analyzer) which give a chance to be measured the amplitude, the frequency and the phase of the different parameters at the measurement antennas. The mentioned above antenna parameters, amplifiers and cables are include in the computation algorithm about measured electromagnetic radiations. Periodically is necessary to make an examination at diagram pattern of measurement antennas. This examination can be made in the anechoic chamber where at the place of measurement antenna is put an etalon antenna for the necessary frequency diapason. The roll-over-azimuth positioner is rotating with fixed step up to 360°[7]. The measurement is automated and special software is developed.Fig.4.

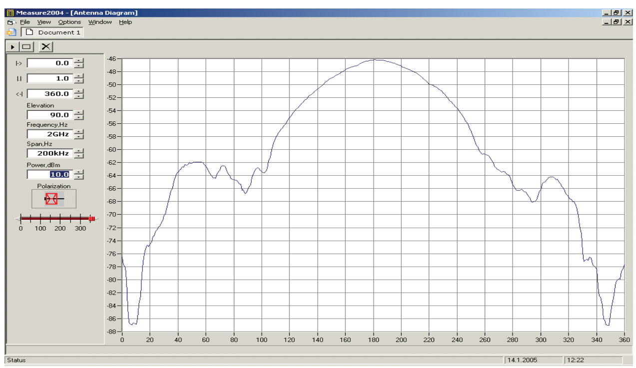

Fig.4 Measured antenna pattern

The basic part in this system is the receiver. The SA have a determine sensitivity which define the general sensitivity at the whole system[4]. SA measures the amplitude-frequency characteristics at the electromagnetic field. The measurement with SA is automated also and a fragment from this software is shown at fig. 5.

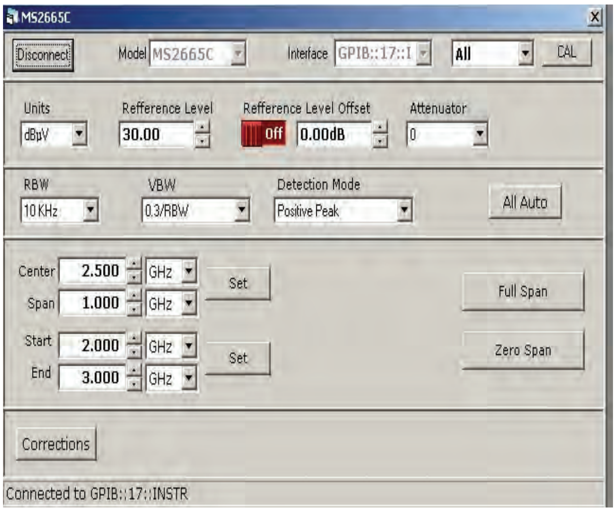

Fig. 5 Spectral Analyzer Panel

III. Method for Measuring Parasitic Electromagnetic Emissions with Automated System for Measurement Management

A short description of developed methods of measurement at electromagnetic radiation in anechoic chamber is shown in fig. 6[6].

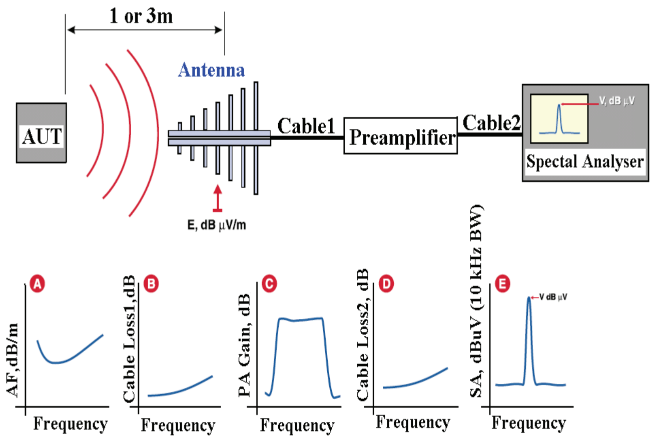

Fig.6 methods of measurement at electromagnetic radiation in anechoic chamber

$$E(dB\mu Vm^{-1}) = V(dB\mu V) + CL_1(dB) + CL_2(dB) + \\ + AF(dBm^{-1}) - PAG(dB) \qquad (6)$$

AF, dB/m – antenna factor as frequency function.
AF is ratio of the electrical field strength of an incident plane wave at a specified point of the antenna to the voltage induced across a specified load (typically 50 Ω) connected to the antenna. Usually, the antenna factor is defined for the plane wave incident from the direction corresponding with the maximum gain of the antenna [7].
B, D – are signal correlations due to of the cable loss from mishmash and attenuation.

$$CL_1, dB = L_1, dB + RL_1, dB \qquad (4)$$

$$CL_2, dB = L_2, dB + RL_2, dB \qquad (5)$$

C – preamplifier gain as frequency function.
E – measured value for a fixed frequency from SA c RBW=10 kHz, VBW=3kHz

The distance between the antenna and device under test (DUT) is 1m or 3m, and high of the turn-table above the ground plane is 80 cm [2, 3 and 4]. The measurement antenna is mounted on rotating mast. The field strength measures for both horizontal and vertical polarization. The table rotates through 45 degrees. The measurements are in frequency diapason 30 MHz – 3 GHz, in depend on processor clock frequency. The measurements make for two highs. It is necessary to find the maximal peak value of field strength. The method of measurement for one frequency is shown on fig. 6. Usually these measurements conduct for different frequency diapasons. The specialized software is developed and used for fast and parallel data acquisition and computing. In the developed algorithm are used the antenna parameters (VSWR, AF), the cables (attenuation loss and RL) and preamplifier (gain). The current limits for EMC standards are included also. The data acquisition and computing is in real time. The files from the measurements save in data base for everyone user. Software fragment visualizing measurement of DUT in frequency band 30MHz – 1GHz is shown on fig 7.

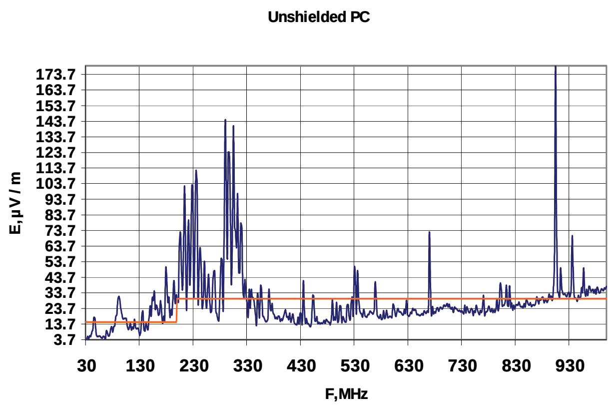

Fig. 7

The table rotating in azimuth allows to be finding all interferences and to be defining the direction of their radiation. Based on 100 measurements (fig. 8) is made amplitude – frequency model of the PC. This model is presented in cylindrical coordinate system and shows space propagation of the radiated electromagnetic interferences.

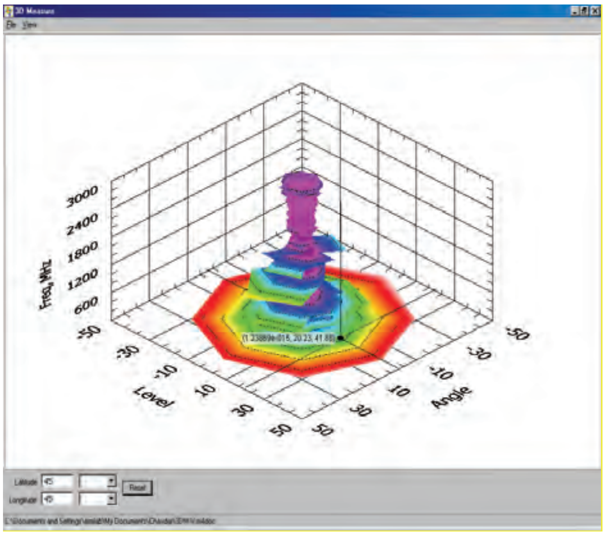

Fig. 8. Amplitude-frequency model of parasitic electromagnetic radiations from a PC.

IV. Conclusion

Automated control system of measurements and parallel computation of the information, which is created, give a chance for continuously measurement elaboration. The measurement precision improves and the measurement time and the following treatment of the received results reduce. This type of work allows receiving enough experimental data about aposterior analysis and measurement microwave surface waves.

The accumulated measurement dates and mathematical treatments and modeling allow realizing the real action of improvement at diagram pattern of the microstrip antennas and suppressing of surface waves.

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