EMC laboratory at Campus of Alba Regia Technical Faculty

Jobbágyi Dániel, Nemeskéri Istvánné
Óbuda University Alba Regia Technical Faculty – Székesfehérvár, Hungary

EMC LABORATORY AT CAMPUS OF ALBA REGIA TECHNICAL FACULTY

tokmany@gmail.com
nemeskeri.istvanne@arek.uni-obuda.hu

***Abstract*: The EMC is a new discipline formed in 1980's. The object of EMC is diversified, it deals with the compatibility of weak current and strong current, low voltage and high voltage, low frequency and high frequency devices. The EMC laboratory is designed in 2004 at our institute. The laboratory equipped with modern instrumentation, capable of bearing that electrical engineers insights into the mysteries of this modern discipline. In this article we describe the structure of the laboratory and the application possibilities.**

I. INTRODUCTION

The EMC is a newfangled multidisciplinary science, which deals with electromagnetic noise protection and in a wider sense can be called as electromagnetic environmental protection too. It is a summing of electric sciences which studies the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects that such energy may induce. The goal of EMC is the correct operation, in the same electromagnetic environment, of different equipment which use electromagnetic phenomena and the avoidance of any interference effects.

II. EMC - ELEKTROMAGNETIC COMPETIBILITY[1]

In operation of every electronic equipment, occurs an electromagnetic energy radiation. The amount and type of this radiation defines the effects of produced by the equipment in well defined environment. The primal attributes of this radiated energy is the frequency spectrum and the field strength, of course these attributes are coherent to each other, because a complex noise source radiates with different field strength in different frequencies. Can be important the geometrical direction and the temporal continuity of the radiation. This radiation can be caused by normal operation (equipments operating by radiofrequency signals like cell phones, WiFi devices, RF remote controllers…) in this case the emitted radiation contains useful information, but the aspect of other equipment it's just a noise. Nowadays the electronic devices contain more and more complex and noise sensitive microelectronics, which need to be protected from the noise which present in the environment all the time. If the radiation produced by equipment doesn't contain useful information it's a noise in every aspect.

Another important region of EMC is the noise immunity of equipments; it's called EMS (Electro Magnetic Sensitivity). It means equipment how well protected from the noise of its environment. This noise can get into to the equipment thru the disturbance propagation channels. Every electromagnetic energy needs to be blocked or shielded what reaches the equipment and influencing the normal operation. The EMC defines different disturbance propagation modes, which called coupling modes. The two important coupling modes is the radiated and the conducted coupling. To equipment any kind of noise can get into so-called gates. The size of electromagnetic field investigated by EMC can be a part of an equipment (like TEM cell) to a building.

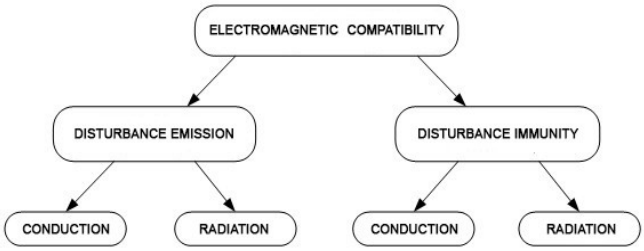

Figure 1 – The specialties of EMC and it's relationships

If someone speaks noise protection, the most of specialists thinks to the radiofrequency noise protection and the pulse kind overvoltage protection. These are just subdivisions of EMC; it can be seen in following table. The phenomena dealed by EMC coeval the electronics and radio communications and extends far back in 100 years past. The making of this kind of overall science is needed because the development of electronics in last 10-20 years increased the number and the power of noise sources. The immunity of increasingly smaller and miniaturized electronics equipment is decreasing too. For that reason the EMC became important, and international and local standards made for EMC around the world. These standards are concerning the manufacturing and the operating of electronics equipments.

The disturbances of an environment (EMI – Electro Magnetic Interference):

- LFI (Low Frequency Interference)
- RFI (Radio Frequency Interference)
- SEMP (Switching Electro Magnetic Pulse)
- LEMP (Lightning Electro Magnetic Pulse)
- NEMP (Nuclear Electro Magnetic Pulse)
- ESD (Electro Static Discharge)

There is hundreds of EMC subject standards (ISO, IEC, MSZ, EN) and EMC related product family standard more than thousand, in spread of thousands of pages.

The definition of EMC basic standard by MSZ-IEC 1000-1-1:

„In the means of electromagnetic compatibility everything is consistent in the electromagnetic environment. If an equipment can be added to this environment without causing disturbance, that means the equipment compatible. Accordingly to that the definition of EMC is the following:

The ability of any kind of equipment or system to working satisfactory in (it's own) electromagnetic environment without expose to unacceptable disturbance of any other equipment in the same environment."

The designing, manufacturing, installing and operating of different electronics equipment the above-mentioned conditions – which described in international, European and Hungarian standards - needs to be taking into account. Naturally the harmonization of different standards is essential between nations, and it's done in the most of standards.

III. OUR DEVICES

The EMC laboratory located at the Campus of Alba Regia Technical Faculty of Óbuda University suitable for the measuring of radiated and conducted electromagnetic disturbances emitted by equipment. In the laboratory professional instruments and measuring equipment are available for the measurements. The EMC laboratory placed in the basement of the building of institutional labs. The laboratory contains an electromagnetically shielded „deaf room" and an instrument room. The „deaf room" is the housing of the measuring antenna and the network mapping unit, and the Equipment under Test (further EUT) can be placed here. The test receiver and the controlling PC with the measuring software is located at the instrument room. The actual equipment of the lab does not allow the immunity measurement, but it can be complemented with a noise source signal generator which can be controlled by the measuring software.

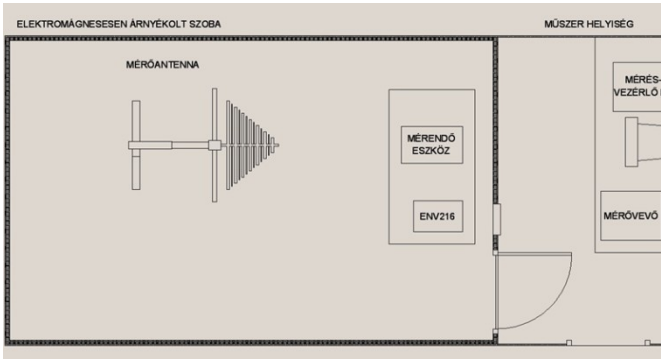

Figure 2 – The layout of EMC laboratory

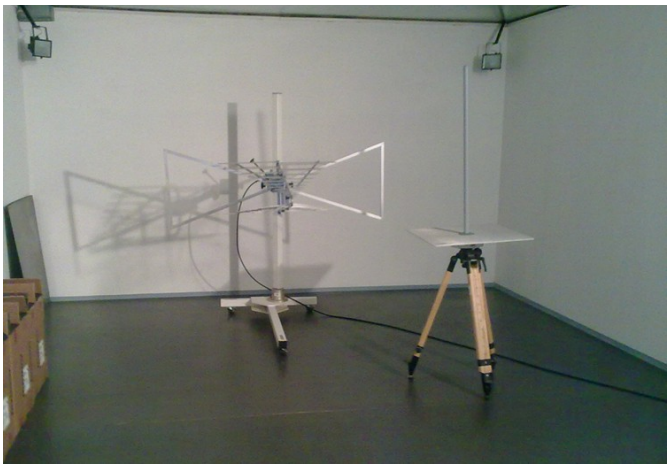

Figure 1 – Inside of the electromagnetically shielded room

The electromagnetically shielded „deaf room" is equipped with a special radiofrequency and electric shielding system. The floor, the walls and the ceiling are shielded with multi-layer and different technology shielding devices. The important of these is the metalized mesh, the ferrite tiles, the absorber paint and the iron plates under the ESD plastic floor. The power is supplied to the EUT through a power line filter which excludes the noise comes from the outer power network. The measuring cables goes trough a connection panel, which equipped with 4 pieces of N-type coaxial connector for test leads and a so-called 10 wire filter. The door of the room is made of stainless steel, the electrical contact of the door and the room shielding is provided by plate springs. The technical specification applied to the external disturbance the conformity of the measurement conditions of EN55022 standard. Regarding the measurement site transmission attenuation the room fulfills the requirements of the prEN50147-3 standard.

The test receiver is a Rohde&Schwarz ESPI3 type instrument, which works in 9kHz…3GHz frequency domain, and specially configured to do an EMC measurements. The instrument contains a high-end spectrum analyzer, with this analyzer and the controlling port the test receiver is capable to do fully automated measurement series. The test receiver is controlled by the measurement control software.

Figure 4 – Rohde&Schwarz ESPI3 test receiver

To measure a radiated disturbances available the Rohde&Schwarz HL562 type ultra wideband, directional measuring antenna. This is a special wideband so-called ULTRALOG characteristic antenna, which combines the characteristics of a biconical and a log-periodical antenna.

The ULTRALOG is mainly used for measuring emissions in the extremely wide frequency range from 30 MHz to 3 GHz with a single antenna. The antenna is fitted to a R&S HL562Z1 antenna stand, which provides an easily precise positioning and polarization setting of the measuring antenna. Furthermore an other antenna is located in the lab. This is a Rohde&Schwarz HFH2-Z6 type active, omnidirectional rod antenna. This antenna is capable to use in 9kHz to 30MHz frequency range. The antenna is primarily useable for a measurements according to the MIL-STD-461/462 and similar standards.

To measure a conducted disturbances available the Rohde&Schwarz ENV216 type network mapping unit. This is a two-line V-network which capable to measure EUT's disturbance coupled to the power line in the frequency range of 9kHz to 30MHz. The V-network can powering up a device which have a maximal current consumption of 16 Amperes in a one phase 230V~ power network. There is a possibility to connect an artificial hand, and the V-network is equipped with selectable Live or Neutral conductor measurement, and a switchable 150kHz high-pass filter.

Figure 5 – Rohde&Schwarz ENV216 network mapping unit

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The measurement control software is the Rohde&Schwarz EMC32 software, which controls the test receiver from the controller PC through GPIB bus. The software have a lot of options and many pre-programmed EMC and EMS measurements. To do an EMC certification measurement we have to set up the program and press the start button, the test receiver is controlled automatically.

Furthermore the lab is equipped with a Rohde&Schwarz HZ-14 type near field test set. This set is useable for finding the EMC problematic spots in equipment. The set contains two magnetic field (H-field) probes (9kHz…1GHz and 30MHz…1GHz), one electric field probe (9kHz…30MHz), a preamplifier, a power coupler for active probes, a calibration adapter, and the necessary cabling for that equipment.

IV. MEASUREMENTS IN THE LABORATORY

The two basic measuring configuration of the EMC laboratory for the conducted and radiated EMC measurements is the following:

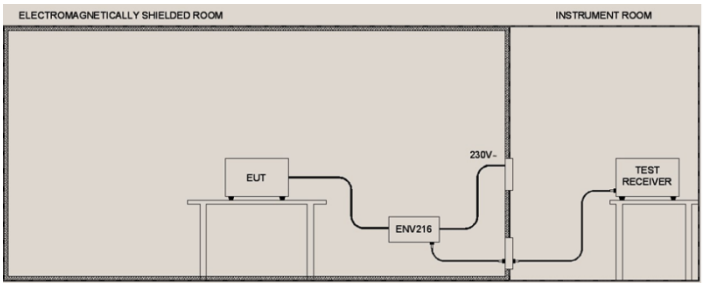

Figure 6 – Measurement setup for conducted disturbance measurement

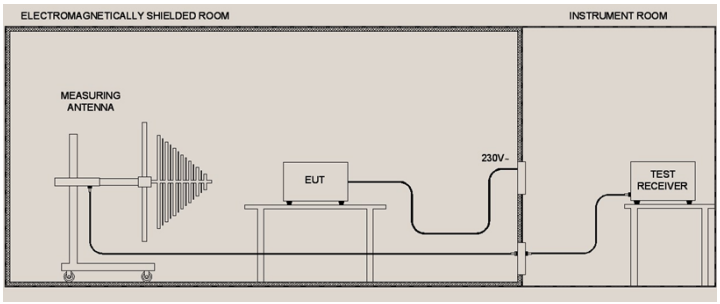

Figure 7 - Measurement setup for radiated disturbance measurement

To an EMC measurement needs to be execution of the following steps:

1. Powering on the test receiver and the PC, selecting the type of measurement
2. Placing the Equipment Under Test in the „deaf room"
3. Positioning of the measuring antenna or setting-up the network mapping unit
4. Starting of the selected pre-programmed measurement in EMC32 software
5. Evaluation of the measurement

To introduce an EMC measurement, the simplest method is the presentation of a practical example. The Equipment under Test is a cheap and everywhere common PC power supply unit. With this kind of switching mode power supply the measurement method of radiated and conducted disturbance also can be well illustrated. An AC switching power supply has tens of kilohertz switching frequency. The housing of unit is responsible to avoid this frequency (and its harmonics) to escape from the power supply. The PSU has an EMC line filter too, which provides noise attenuation to the power line network. If this filter works well, the conducted disturbance measurement needs to be passed. If the manufacturer has electronics equipment, and wants to place on the market, the equipment needs to be meeting the EMC standards in the country where he wants to sell it. The measurement of the conducted and radiated disturbance we will use the EN55022 standard's limit lines.

When measuring radiated disturbances the placement and the polarization of the antenna respect to the EUT is very important, and the operating status (standby, normal

operating…) of the EUT is important too. These antenna parameters are showed by the EMC32 software respect to selected standard, so the person carrying out the measurement is informed about the antenna placement and polarization by the software. The software can control a motorized antenna so the antenna setting can be involved to the measuring automation if it's necessity.

When measuring conducted disturbances we can select many measurement configurations as seen in the figure 10 and 11. With the V-network the voltage applied to live (respect to ground) and the voltage applied to neutral (respect to ground) can be measured. The V-network is capable to current measurements too, and it have an artificial hand connection, contains a switchable 150kHz and equipped with a control input port, to connect the unit to the measurement automation system.

In the following figure, we can see a standard EMC 32 test diagram. This is a radiated disturbance measurement of the empty measuring room with the ULTRALOG antenna placed to middle of the room. Unfortunately the despite of careful shielding there is two disturbance frequencies present in the room. Refer to figure 8 we can see a frequency around 100MHz, it's source is seems to be one of the local radio station's transmitter, and the other undesired frequency peak is the two line around 950MHz. This is clearly the GSM900 band and the source of this probably the GSM base station on the top of opposite building. During the certification measurements if these two frequency exceeds the limit line of the selected standard should be considered as a normal phenomenon.

The conclusion of the measurements carried out is the following:

In Figure 9. clearly visible the noise generated and emitted by the EUT. At frequency of 70MHz it exceeds the standard's limit line. This is probably because the normal operating place of this kind of PSU is inside the personal computer's metal housing, where due to double shielding the unit is not emitting disturbance more than permitted by the standard. In the measurements of conducted disturbances (Figure 8 and 9) the noise voltage not exceeds the limits, so the power supply unit is corresponded to the selected EMC standard.

Inn the EMC lab of our institution the students can carry out measurements in small groups in contact of digital measurement techniques course, but the teaching faculty welcomes individual visitors and any well informed students can get to know opportunities provided by the EMC lab.

In our lab has taken place a testing for product has developed for series production which provides a great help for the developer because he can check whether his product will meet the EMC certification. Unfortunately the shielding of the measuring room is not good enough to do a legal effect on certification measurements in the lab. To do a legal effect on certification measurements it needs to be developed with one more absorber layer, but it's quite expensive. Nevertheless as well as past experience shows very useful, manifold and exciting measurements can be performed. These measurements can serve educational purposes or dissemination purposes but useful help when someone developing and production preparation an electronics equipment.

REFERENCES

[1]. Rejtő Ferenc:EMC ALAPOK. Bp.:Magyar Elektrotechnikai Egyesület, 2006

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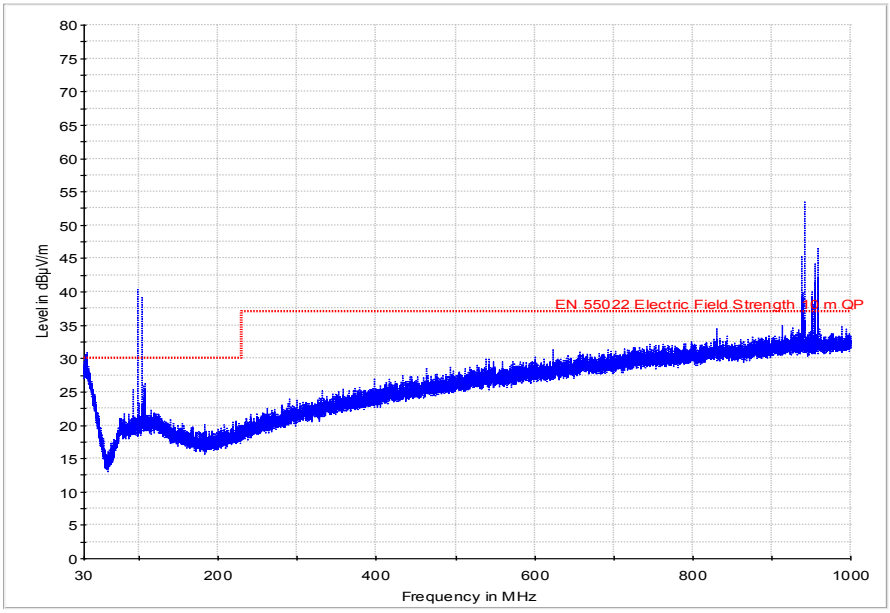

Figure 8 – Control measurement in empty room with measuring antenna

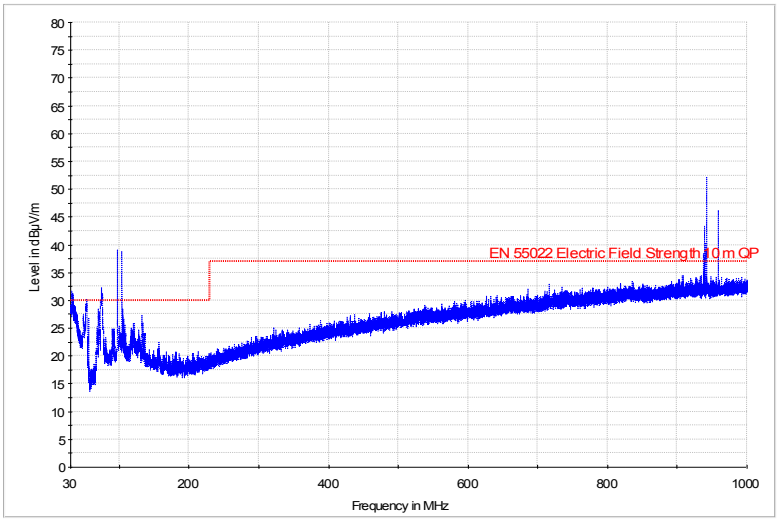

Figure 9 – Radiated disturbance measurement of EUT (30MHz…1GHz)

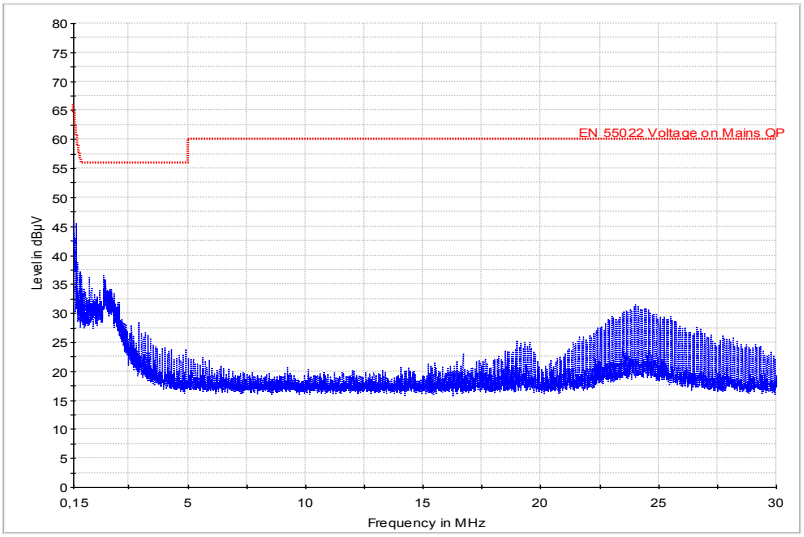

Figure 10 – Conducted disturbance measurement of EUT with V-network (150kHz…30MHz)

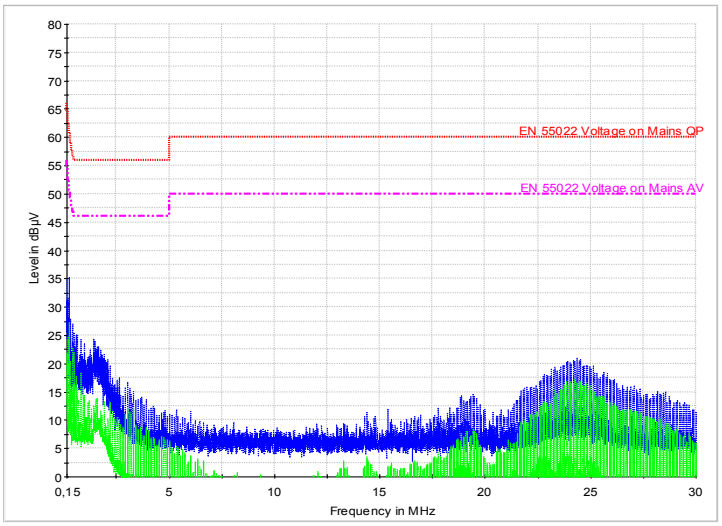

Figure 11 - Conducted disturbance measurement of EUT with V-network (150kHz…30MHz)