Jozef HALLON, Mikuláš BITTERA, Karol KOVÁČ

Slovak University of Technology in Bratislava

doi:10.15199/48.2016.02.09

The interface set for the EMC testing shielded chamber

***Abstract**. Modern electronic systems including wired and wireless communication ports impose the requirement to equip EMC test lab with various additional interfaces which are necessary to support all operational modes of device under test during test procdures. The paper describes such EMC testing chamber interfaces, which allow bidirectional wired and wireless data transfer between the tested device and auxiliary technical means placed outside the testing space.*

***Streszczenie.** Współczesne systemy elektroniczne zawierające porty komunikacji przewodowej i bezprzewodowej narzucają wymagania w zakresie wyposażenia stanowiska badawczego laboratorium EMC w różnorodne interfejsy komunikacyjne niezbędne do zapewnienia wszystkich wymaganych trybów pracy urządzenia poddawanego badaniom. W artykule opisano interfejsy komunikacyjne do komory bezodbiciowej EMC, które pozwalają na dwukierunkowy, przewodowy i bezprzewodowy przesył danych pomiędzy urządzeniem poddanym badaniom a aparaturą pomocniczą zlokalizowaną na zewnątrz komory. (**Układ interfejsów do komory bezodbiciowej EMC**).*

Keywords: EMC shielded chamber; EMC testing, communication interface; wireless communication port.
Słowa kluczowe: komora bezodbiciowa EMC, badania EMC, interfejs komunikacyjny, port komunikacji bezprzewodowej.

Introduction

All electronic devices have to fulfill given EMC requirements. As the modern electrical equipment increasingly use both wired and wireless transmission paths for communication with other devices and systems, there arises a problem to ensure the necessary data transfer during EMC testing in closed shielded chamber. So the test laboratory has to be equipped by the various wired (current and voltage inputs/outputs, serial communication standards - LAN, USB, RS232, RS485...) and wireless (Wi-Fi, WiMAX, Bluetooth, GSM/GPRS, GPS etc. [1, 2]) transmission paths to be able to operate equipment under test (EUT) in all operational modes [3] including interactive communication with external cooperating devices or systems. The EUTs, which use modern transmission paths for their operation, affect the measurement conditions or conditions of EMC test. A shielded chamber prevents the wireless communication in principle. Wired signal transfer path between devices located inside and outside the chamber requires filtering in wide frequency range to suppress undesired propagation of measured or testing fields and signals. Then modification of the measurement procedure is necessary and the anechoic shielded chamber, as site for radiated emission measurement and immunity test, has to be equipped with an additional apparatuses that enable wired or wireless data transfer through chamber walls.

At our institution the shielded chamber with the cable and wireless interfaces is used not only for EMC testing but also for applied research [4, 5, 6].

The EMC tasks performed

A. Radiated emissions measurement

During this measurement the EUT is placed on the supporting table or on the floor of the shielded chamber. The chamber is in a semianechoic configuration – conducting metallic floor creates reflective plane [7]. The antenna and the EUT form the two foci of imaginary ellipse, creating an obstruction-free area, which defines a minimum area free from scatterers of electromagnetic (EM) field. Technical equipment in the chamber must enable EUT to rotate around its axis and antenna to adjust the height in the range of 1 ÷ 4 m above a conductive floor of the chamber (Fig. 1). The automated measuring system measures radiated emissions at various positions of the EUT and the antenna. Then it compares the measured emissions with the limit values given in the relevant standard [7].

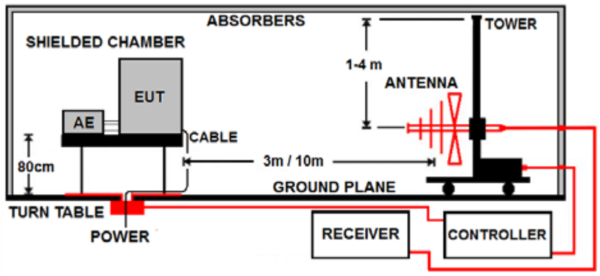

Fig. 1: Test setup for measurement of radiated emissions

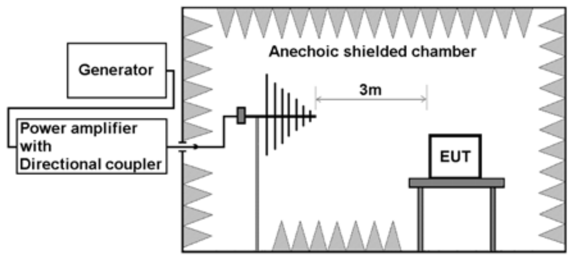

Fig. 2: Test setup for Immunity test against RF EM field

B. RF electromagnetic field immunity tests

The workplace for testing immunity against RF EM field is in Fig. 2. In anechoic shielded chamber (there are absorbers arranged on the floor between the antenna and the EUT), the chain "generator – power amplifier – antenna" creates quasi-homogeneous EM field of intensity 3 or 10 V/m. Field frequency has to change by 1 % step in the frequency range from 80 to 1000 MHz (event. 6000 MHz). The EM wave polarization is changed by antenna rotation. The EUT is situated on the non-conducting table so that feed, power and signal cables (terminated to auxiliary equipments (AE)) of length 1 m are situated on the table orthogonally to EM wave propagation [8].

Cable interfaces of shielded chamber

Various metallic data transmission paths, which connect the EUT and the AEs, are often combined in electrical practice. The design of transmission path goes out the supposed transmission distance, the volume of transmitted data, the operating environment and application of the technical standards. In view of the EMC requirements the EM emission elimination and immunity of transmission path

and its interfaces against EM disturbance come to the foreground.
By the EMC tests some of AEs is located in the shielded chamber but in many cases some of AEs is located outside the chamber. Moreover, the behavior of the EUT often needs to be monitored during the tests. This means that it is required to lead out of the chamber any of the EUT signal transmission paths and connect it to the relevant technical equipment. Then the shielded chamber should be equipped with various interfaces to perform the data transmission. They are described in the following text.

A. LAN interface

The LAN interface is used very often in technical practice. Our chamber has a LAN interface with appropriate filter supplemented by POE power system (Power over Ethernet) located on the chamber wall. The interface allows testing for example: the Web cameras with LAN, the Wi-Fi access-points, the IP phones, the sensors of electric and nonelectric quantities which are powered via the LAN interface exclusively, etc.

B. USB interface

USB is very popular connection method of peripherals to the computer, or other technical equipment, which includes any computer or microcontroller. So the USB hub and appropriate commercial filter set is another interface of our chamber. The USB interface allows connection of USB data channel of EUT and moreover it gives possibility to connect some convertors, which use the bus RS485, RS422 or RS232.

C. Signal feed through filters

Another part of the wired interfaces is a set of six feed through filters placed on the wall of the chamber. They can be used for bidirectional transmission of voltage and current signals between the EUT and the AEs located outside the chamber. A typical example of their application is the measurements of EUT output voltage or current by multimeter, which is part of an automated measuring system. The system allows error quantification of EUT behavior in case of the tests of immunity against RF EM field according to EN 61000-4-3 [9]. Each filter consists from a cascade of two coaxial filters (rated to 16 A, 250 V AC). The attenuation in the frequency range from 30 to 1000 MHz is more than 80 dB (Fig. 3). Another application of these filters is the transfer of an atypical supply voltage for EUT from outside the chamber (there is a standard 3 × 230V AC/40 A inside of the chamber).

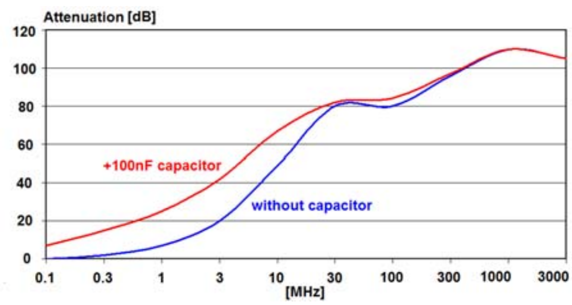

Fig. 3: attenuation of signal feed through filters

D. Coaxial feed throughs

Some coaxial feed throughs (by N-type connectors) located on the wall of the chamber use to transfer signals via coaxial shielded cables. Cables terminated with other types of connectors can be connected by various types of connector reductions. Location of the throughs is designed so that the most of the coaxial cables can be placed in the cable conduit under the chamber floor. The most of them are intended for measuring systems of the chamber but some may be intended for the operation of the EUT.

E. Throughs for optical cables

Some throughs for optical cables are located on the wall of the chamber. Their geometrical dimensions provide attenuation (between the chamber and the outside of it) in the working frequency band of the chamber over 100 dB.

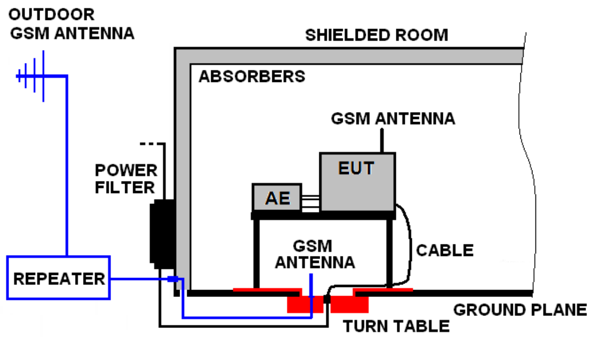

Fig. 4: GSM communication system

Wireless interfaces of shielded chamber

A. Radiated emissions measurement of EUT using wireless transmission paths

Wireless communication of the EUT requires creating a connection, which provides bidirectional data transmission between the EUT and AE situated outside the shielded chamber. In our case we tried to find a solution of a connection between the EUT and mobile phone/data networks (GSM). Technical realization for other wireless networks is similar. GSM connection to the EUT needs a communication system (outside shielded chamber) consisting of GSM antenna and repeater that receives and amplifies signal of nearby base stations. This signal is transferred via coaxial cables and feed-through to the GSM antenna inside the chamber. The communication system is shown in Fig. 4. Location of the GSM antenna inside the chamber and GSM signal level have to be chosen to enable EUT a reliable communication, while the measuring antenna should receive GSM signal of sufficiently low level (ideally less than relevant limit level, but definitely cannot exceed maximal input power of a measuring preamplifier). High level of signal can cause a malfunction of the measuring preamplifier and then a degradation of the measurement.

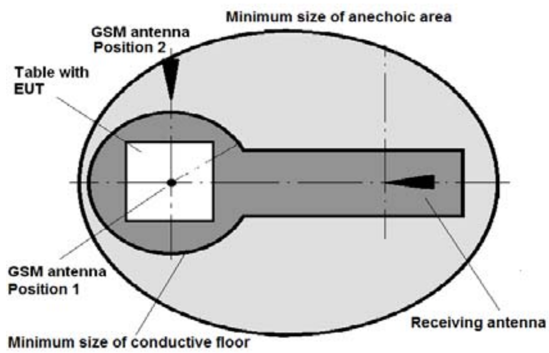

Fig. 5: Setup modifications for radiated emissions measuring

Several GSM antenna locations may be chosen in a shielded chamber (8.5×4.5×4.5 m): These locations have to fulfill following requirements: minimal interference with the obstruction-free area, antenna main lobe cannot direct to the receiving antenna and also a convenient connection of GSM signal to the antenna.

Our experiments were performed with several types of vertically polarized antenna (ROD, YAGI, HORN, LOG-PERIODIC) which were situated in the several positions in the chamber. The EM numerical simulator FEKO was used for analysis of optimal GSM antenna position and the simulation results were verified by measurements [10]. In Fig. 5 it is shown a plan of the chamber with a proven alternative placement of GSM antennas for measurement radiated emissions setup of EUT, which operates in GSM mode.

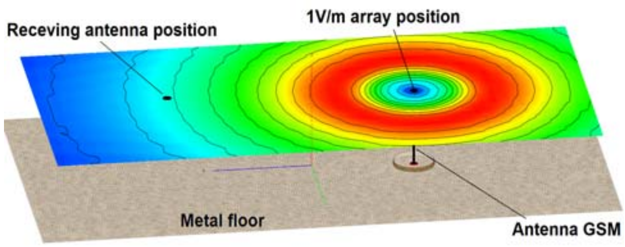

Fig. 6: ROD antenna at position 1 radiates to receiving antenna

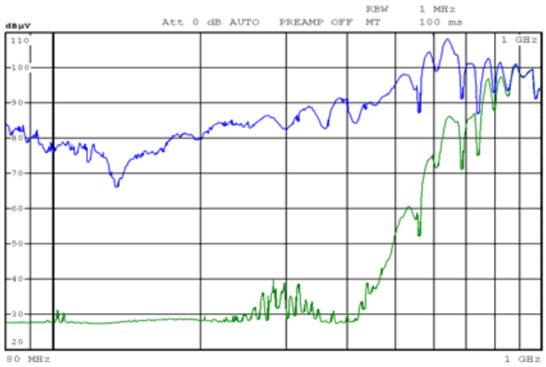

Fig. 7: Voltage at GSM antenna output
(blue colour – without filter, green colour – with filter)

Comparison of the EM field values in the receiving antenna positions shows using HORN or YAGI antenna in the position 2 suits for GSM field excitation best. The rod antenna at position 1 fairly radiates to the receiving antenna, but this is very practical solution. For example, in Fig. 6 is shown simulated EM field distribution when ROD antenna is used for the GSM-900. However it is necessary to be careful with output level of the GSM repeater, mainly not to exceed the input power of the antenna's preamplifier. The analysis in the [10] shows that values of EM field in a position of the receiving antenna may slightly exceed the limit values prescribed by general EMC standards, however there is no risk of preamplifier saturation or of the measurement distortion at these levels

.

B. RF electromagnetic field immunity test of EUT using wireless transmission

In this case the situation is more complicated because antenna (in the same position as the receiving antenna in the previous case) creates EM fields with intensity up to tens of V/m. Although the GSM antenna, which is connected to the GSM router, is not situated directly in area with a nominal value of EM field, relatively high voltage at antenna output can disrupt the operation of the GSM, or even damage the router. An example of the measured output voltage of the GSM antenna situated in the EM field of 10 V/m is shown in Fig. 7. This situation occurs in case of all the tested antennas and in both positions. In regard to absence of narrow band antenna it is necessary to use high pass microwave filter at the GSM antenna output. Thus, it is possible to test the EUT in 80 – 600 MHz range. From many years of EMC testing experience, one can conclude that the most of failures is rising in this range due to the prescribed cabling length.

On the other side by testing at frequencies close to GSM900 it is necessary to transfer GSM signal directly by shielded cable to the EUT port for GSM antenna. Usually the frequencies above 1 GHz are not important, because the most of standards does not include them and moreover the most of EUT does not have problems in this band.

Conclusion

In this paper the EMC shielded chamber interfaces of wired and wireless signal transmission path are described. Only this important additional supporting equipment allows the measurement and testing of EMC properties of modern electronic devices using sophisticated communication services for their operation by preservation of correct real operational conditions of the EUT.

Acknowledgment

Work presented in this paper was supported by the Slovak Grant Agency VEGA under grant No. VEGA 1/0431/15.

***Authors**: Jozef Hallon, PhD., Assoc. Prof. Mikuláš Bittera, PhD., Assoc. Prof. Karol Kováč, PhD., Slovak University of Technology in Bratislava, Faculty of Electrical Engineering and Information Technology, Institute of Electrical Engineering, Ilkovičova 3, 812 19 Bratislava, Slovakia, E-mails: jozef.hallon@stuba.sk, mikulas.bittera@stuba.sk, karol.kovac@stuba.sk*

REFERENCES

[1] Rappaport T.S. , Wireless Communications: Principles and Practice. 2nd Ed., *Prentice-Hall,* Upper Saddle River, NJ, 2002.

[2] Przesmycki, R., Nowosielski L., Bugaj M., Piwowarczyk K., Analysis of radiated emission from IT devices, *Przeglad Elektrotechniczny*, 88 (2012), No.2, 4-6

[3] IEC 61000-1-2:2001 Electromagnetic compatibility (EMC) - Part 1-2: General - Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena. 2001.

[4] Harťanský R. , Smieško V., Maršálka L., Numerical Analysis of Isotropy Electromagnetic Sensor Measurement Error, *Measurement Science Review*, Vol. 13, No. 6 (2013), 311-314.

[5] Harťanský R. , Slížik J., Maršálka L., Dipole Near Field Analysis - A Closed Form Calculation in Cartesian Coordinates, J*ournal of Electrical Engineering*. Vol. 64, No. 5 (2013), 327-330.

[6] Mikuš P., Harťanský R., Smieško V., Influence of the Environment on the Accuracy of Measurement with Radar Level Gauges, *Measurement 2015: Proceedings of the 10th International Conference on Measurement*. Smolenice, Slovakia, May 25-28, 2015.

[7] EN 55016-2-3:2010 Specification for radio disturbance and immunity measuring apparatus and methods –Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements.

[8] Bittera M. , Hallon J., Rév D., Szolik I., Automatizácia meracieho pracoviska na meranie elektromagnetických emisií, *Elektrotechnika a energetika 2002*, Trenčín, Slovak Republic, 2002, 117-118.

[9] EN 61000-4-3:2006 Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.

[10] Hallon J., Harťanský R., Bittera M., Testing EMC properties of electrical devices equipped wireless communication, *Measurement 2015: Proceedings of the 10th International Conference on Measurement*. Smolenice, Slovakia, May 25-28, 2015.