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Electromagnetic compatibility testing of electromagnetic measurement system

***Abstract**. The paper presents the results of experimental studies of the emission of electromagnetic interference radiated by the prototype of the measuring system of the electric component of the electromagnetic field and its immunity to electromagnetic interference. The experimental studies were carried out in the GTEM 1000 chamber. The obtained results were compared with the EN 55014 standard, which specifies the requirements for electromagnetic compatibility. It has been demonstrated that the proposed prototype measuring system meets the standard requirements.*

***Streszczenie.** W artykule przedstawiono wyniki badań eksperymentalnych emisji zakłóceń elektromagnetycznych emitowanych przez prototypowy układ pomiarowy składowej elektrycznej pola elektromagnetycznego oraz jego odporności na zakłócenia elektromagnetyczne. Badania eksperymentalne przeprowadzono w komorze GTEM 1000. Uzyskane wyniki porównano z normą EN 55014, która określa wymagania dotyczące kompatybilności elektromagnetycznej. Wykazano, że proponowany prototyp układu pomiarowego spełnia wymagania normy. (**Badanie kompatybilności elektromagnetycznej układu pomiarowego elektromagnetycznego**)*

Keywords: Gigahertz Transverse Electro Magnetic (GTEM),. electromagnetic compatibility (EMC), measurement system
Słowa kluczowe: wysokoczęstotliwościowa komora z poprzeczną falą elektromagnetyczną (GTEM), kompatybilność elektromagnetyczna (EMC), system pomiarowy

Introduction

The influence of electromagnetic fields on the human body and electronic devices is the subject of research in many research centres around the world. Sustainable technological progress in the construction of measurement systems together with information technologies enable environmental monitoring using low cost devices.

Numerous studies are being conducted worldwide on the use of low-cost sensors to monitor and assess, among others, radio frequencies in the context of exposure to electromagnetic fields, electromagnetic environmental pollution (CO, PM, NO2) or water level. Appropriate recommendations for the use of such sensors can be found in literature [1-5]. The permissible levels of emitted interference were determined so that the devices do not interfere with the operation of other objects. Therefore, the emission of devices must be monitored. Based on literature reports, it appears that manufacturers of electronic or electrical equipment have considerable problems to meet the requirement that a device does not emit electromagnetic interference [6-8]. Before placing an electronic device on the market, every manufacturer has to carry out studies of emitted electromagnetic interference by newly created devices and their immunity to external interference [9,10].

The newly created measurement system was designed to conduct research, among others, in the cockpit during training flights. (Fig.1). Radiated emission and immunity tests were performed in accordance with EN 61000-4-20 [11]. The development of such a relatively simple and cheap device enabled measurements to be taken by pilots and aircraft crews to quantitatively determine the field strength they are in. Due to flight safety, in which the correct operation of avionics devices is important, such studies were also carried out.

The aim of the work was to assess the correctness of the operation of the prototype of the proposed measurement system for measuring the effective value of the electric component of the electromagnetic field (fig 2) in the GTEM 1000 chamber.

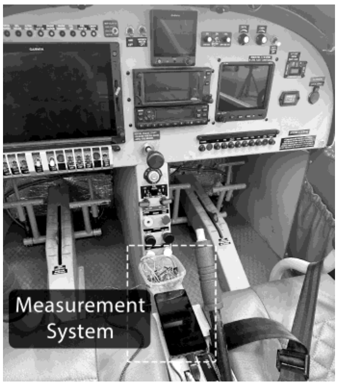
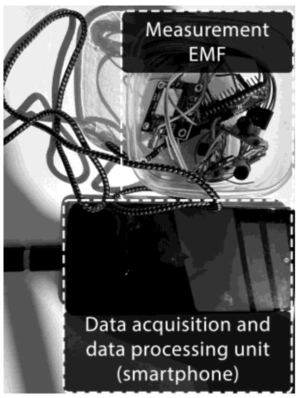


Fig. 1. Installation of the measurement system during a test flight: Aero AT-3

Method and Materials

The paper presents the measurement results of the emission of the electromagnetic interference by the measuring system of the electric component of the electromagnetic field and tests of its immunity to the electromagnetic interference. The technical parameters of the measuring system are presented in [12].

a)



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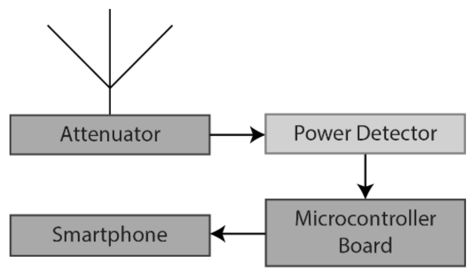

Fig. 2. The proposed measurement system to measure the electric field: a) a picture of the measurement system; b) its block diagram

The basic components of the measurement system are as follows:
• GTEM chamber (Gigahertz Transverse Electromagnetic),
• measuring transducer.
Alternatively, measurements of interference radiated by electronic devices are performed in the Open Area Test Site (OATS).

Research on radiated interference in the frequency range from 30 MHz to 1 GHz was carried out in the GTEM 1000 chamber with the Gauss Instruments TDEMI measurement receiver. The measurements were performed in accordance with EN 61000-4-20 and EN 55014-1 in the entire measurement range, i.e. from 30 MHz to 1 GHz, using a quasi-peak detector (QP) at a maximum permissible measurement step of 120 kHz (fig.3) [13]. The test measurement system is in accordance with class B devices (devices designed to work anywhere). The measurements in accordance with the standard were carried out for three orthogonal positions of the tested device in the measurement space of the chamber. The test methodology is presented in [14,15].

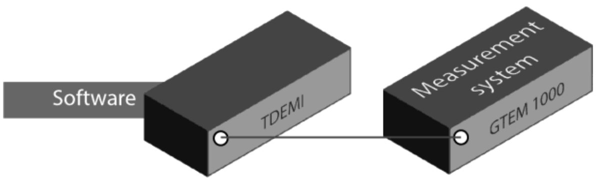

Fig. 3. The functional block diagram of Radiated Emission Test

Tests of immunity to radiated electromagnetic field disturbances were carried out in the frequency range of 30 MHz - 1 GHz, field strength up to 10 V/m in order to verify the correct operation of the device in the electromagnetic environment in accordance with the EN 55014-2 standard. Tests of immunity to radiated electromagnetic field disturbances were carried out in the frequency range of 30 MHz - 1 GHz, field strength up to 10 V/m in order to verify the correct operation of the device in the electromagnetic environment in accordance with the EN 55014-2 standard.

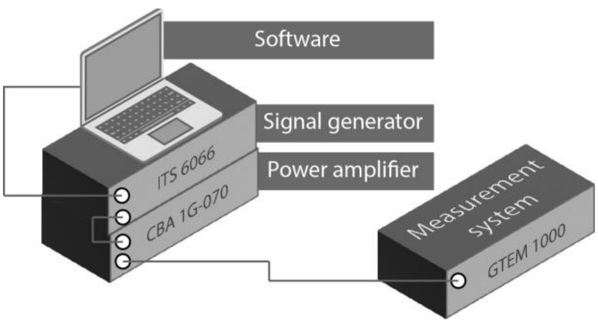

Fig. 4. The functional block diagram of Radiated Immunity Test

The newly developed measurement system was tested in accordance with the methodology included in the EN 55014-2 standard [16] in the GTEM 1000 chamber using the ITS 6006 generator from Teseq. The radio frequency (RF) signal generator in the range from 80 MHz to 1 GHz is connected directly to the CBA 1G-070 power amplifier from Teseq (Fig. 5). The exposure levels of 3 V/m (Fig. 6) and 10 V/m (Fig. 7) were applied.

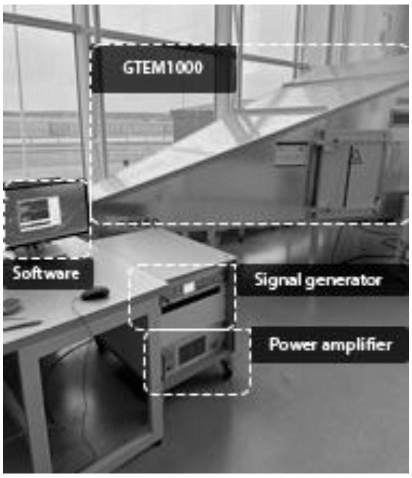

Fig. 5. Set of Radiated Immunity Test

Results

Figure 6 shows the result of the emission tests of the developed measurement system.

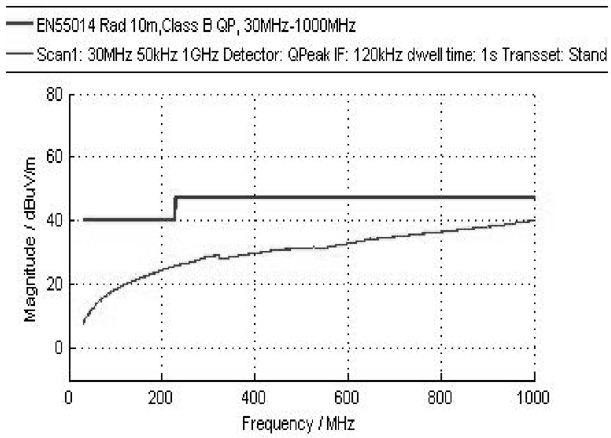

Fig. 6. Measurement of radiated emission of the measurement system with reference to the limit values (PN-EN55014)

The permissible emission level inside the cell should be at least 6 dB lower than the permissible level specified in the standard. The tests showed that the tested measurement system meets the requirements for electromagnetic compatibility in terms of radiated emissions.

The immunity tests also showed that under normal operating conditions the electromagnetic environment does not affect the operation of the analysed measuring system. Figure 7 shows the test for the exposure level of 3 V/m.

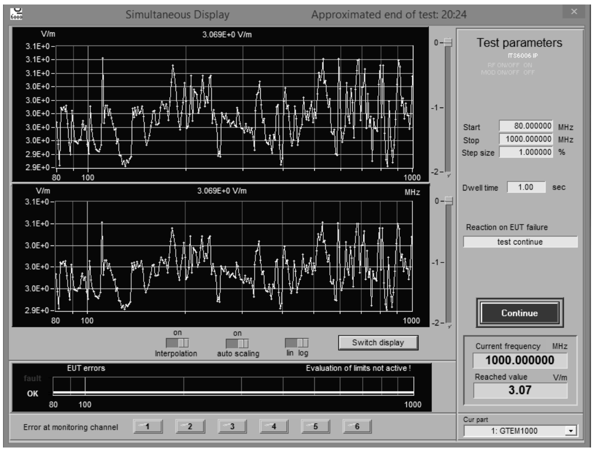

Fig. 7. Radiated Immunity Test – 3V/m

Figure 8 shows the test for a current of 10V/m.

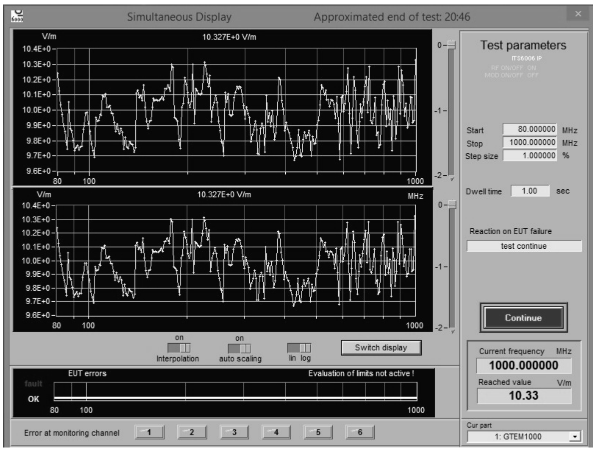

Fig. 8. Radiated Immunity Test – 10 V/m

Conclusion

The EMC Directive specifies that devices should be constructed in such a way that they remain immune to normal electromagnetic environment and their radiated interference do not exceed the permissible normative levels.

Based on the analysis carried out, it can be seen that the tested device meets the requirements for the maximum permissible levels of radiated electromagnetic interference in accordance with the PN-EN55014 standard, in the entire measurement range and is immune to interference.

Due to the lower cost of the prototype measurement system compared to professional measurement systems and its commensurable accuracy, researchers can use the proposed measurement system, among others, for environmental research. Data obtained from the proposed measurement system ensure that measurement results will be accessible to both the scientific community and society, as well as regulatory organizations.

The studies carried out in this paper showed that the developed system is safe and reliable. Its compact size allows it to be used not only in a cockpit but also in many other locations inside the airplane.

The measurement system considered in this paper concludes the studies have been carried out since 2018.

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