DESIGN OF A MONITORING SYSTEM FOR ELECTROMAGNETIC RADIATION MEASUREMENTS

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Abstract

The design of a monitoring system for measuring on a 24-hour basis the total electric field radiated from broadcasting and radio-communications systems is presented. An omni-directional sensor antenna and the appropriate electronic circuits have been implemented. In the system various digital and analog peripherals are connected with a low-power, 8bit RISC microcontroller of Microchip, running at 10MHz. The measured data can be sending to a personal computer through a USB interface or through a GSM modem. Low cost electronics and high reliability of the system can deploy trustworthy electromagnetic radiation monitoring networks which will offer a security feeling to the public. The sensor's pattern, the response linearity and the frequency response have been tested and have shown the appropriate specifications.

Keywords: Broadband probes, isotropic probes, monitoring systems, electromagnetic fields.

1. Introduction

Nowadays there is a tremendous increase in the number of mobile communications and broadcasting radio and TV systems. Obviously public concerns of repercussions of wireless phones, antenna masts and other environmental RF transmitters to the health have increased. There is a strong opposition to the acceptance of RF transmitters operation near or inside urban areas. It is believed that a systematic and continuous monitoring of the EM radiation can help to stop the mistrust of the public about its existing level.

The designed system records the electromagnetic radiation and stores and/or transfers the data to specific central control servers. In the market various types of equipment, [1-6], with different characteristics are available. To reduce the total cost, it was designed and implemented the present system that can be used for electromagnetic radiation measurements in a broad frequency spectrum, where most of telecommunication applications operate (radio, TV, mobile telephony, wireless communication networks).

The measured data after post-processing can be transferred on a 24-hour basis. It is believed that the massive production of the system combined with low cost and high reliability will allow the establishment of a measuring network resulting to continuous control of electromagnetic radiation and direct information flow to the citizens.

2. Monitoring System Structure

The circuit with most of the stages of the system is shown in Fig.1. A microcontroller, a USB controller and port, a flash memory, humidity and temperature sensors, a real time clock, a GSM modem and three DC amplifiers constitute the parts on the PCB of the system. The electric field sensor is on the upper side of the monitor. It

contains three mutually orthogonal dipoles, each one with the appropriate diode, connected to the three DC amplifiers through a high resistance transmission line (see Fig.2). Fig.2b presents the geometrical arrangement for the dipoles. The electronic circuits, the battery and the electric field sensors were installed inside a waterproof plastic cylindrical tube of 65cm total length (see Fig.2c).

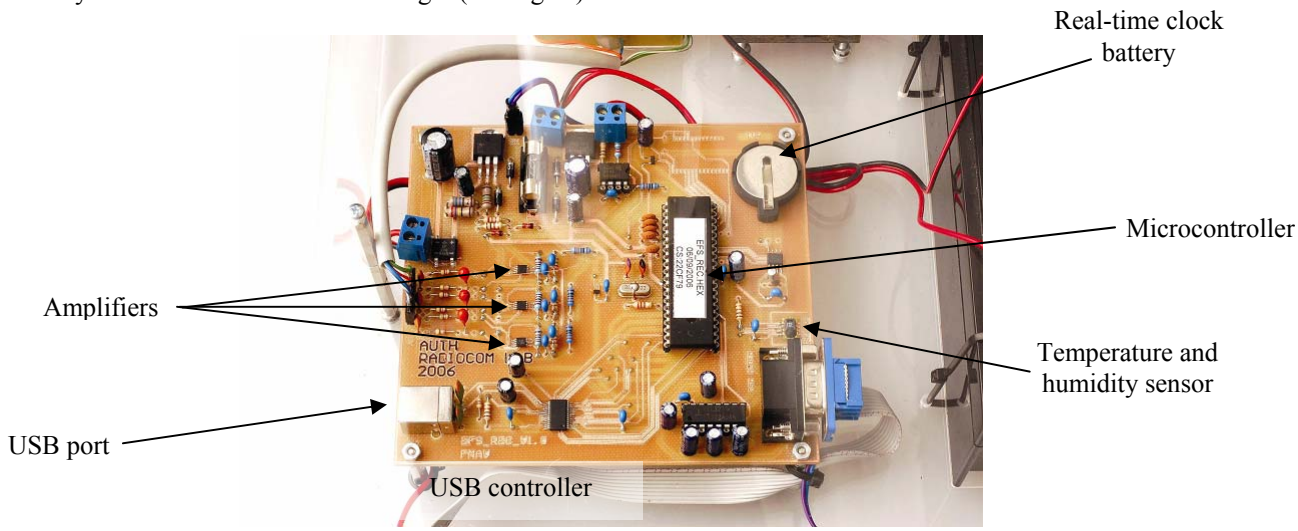
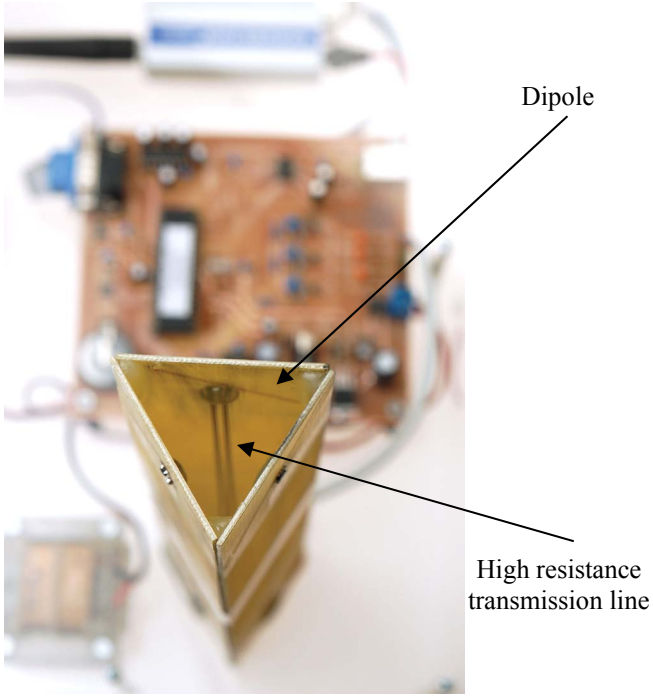
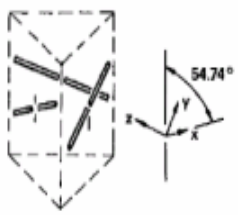


Figure1. The electronic circuit of the designed monitoring system



(a) The field sensor of the system



(b) Three mutually orthogonal dipoles

(c) The system in a plastic tube

Figure2. The electric field sensor and the plastic tube of the system

Measured data are stored in the memory and can be extracted through the USB to a PC. Also, through the GSM modem data are sending to a central server. The modem can also send an SMS with the measured data at a specific time to a mobile phone by responding to its call. Bilingual (Greek/English) software has been implemented to represent the total electric field. The measured electric field strength is given in a diagram versus time or in an

analog or a digital indication gauge. Also, the last maximum value and the mean value of the electric field the last 6 minutes are shown. The representation on a PC of the electric field is shown in Fig.3.

Figure3. The screen of a PC showing the electric field strength versus time

The measured incident electric field of the probe is given in the following form, [7 - 8]:

$$|E_{inc}| = \sqrt{k_x V_x + k_y V_y + k_z V_z} \quad (1)$$

V_x, V_y, V_z are the voltages at the input of the three dipoles of the sensor and k_x, k_y, k_z are the coefficients which are used for calibration.

The isotropic behaviour of the sensor and its comparison with other monitoring systems were made both at controlled environment and at the Open Area Test Site (OATS). Fig.4a shows the measured electric field versus the azimuth angle for 1000MHz of our probe and the E-field probe HI-4455 of Holaday. Linearity tests of the estimated equivalent radiation power density versus the transmitted power have been made in different frequency bands. Fig.4b shows a representative example. Frequency response in UMTS of the system and the HI-4455 is given in Fig.4c. Measurements have been implemented in several distances near the Antenna Park of the city of Thessaloniki. In all cases measurements were in agreement with other broadband probes and a maximum difference no more than 4.5% was found.

3. Conclusion

A broadband monitor of electromagnetic radiation has been implemented. The electronic circuit and the tests of the monitor have been presented. The system, called SMS-K, has acceptable isotropy and linearity. It measures the electric field with similar accuracy to other commercially available systems and can be used to monitor 24 hours a day. The massive production of the SMS-K combined with low cost and high reliability will allow the establishment of a broad network of measurement points resulting to continuous control of electromagnetic radiation and direct information flow to the public.

4. References

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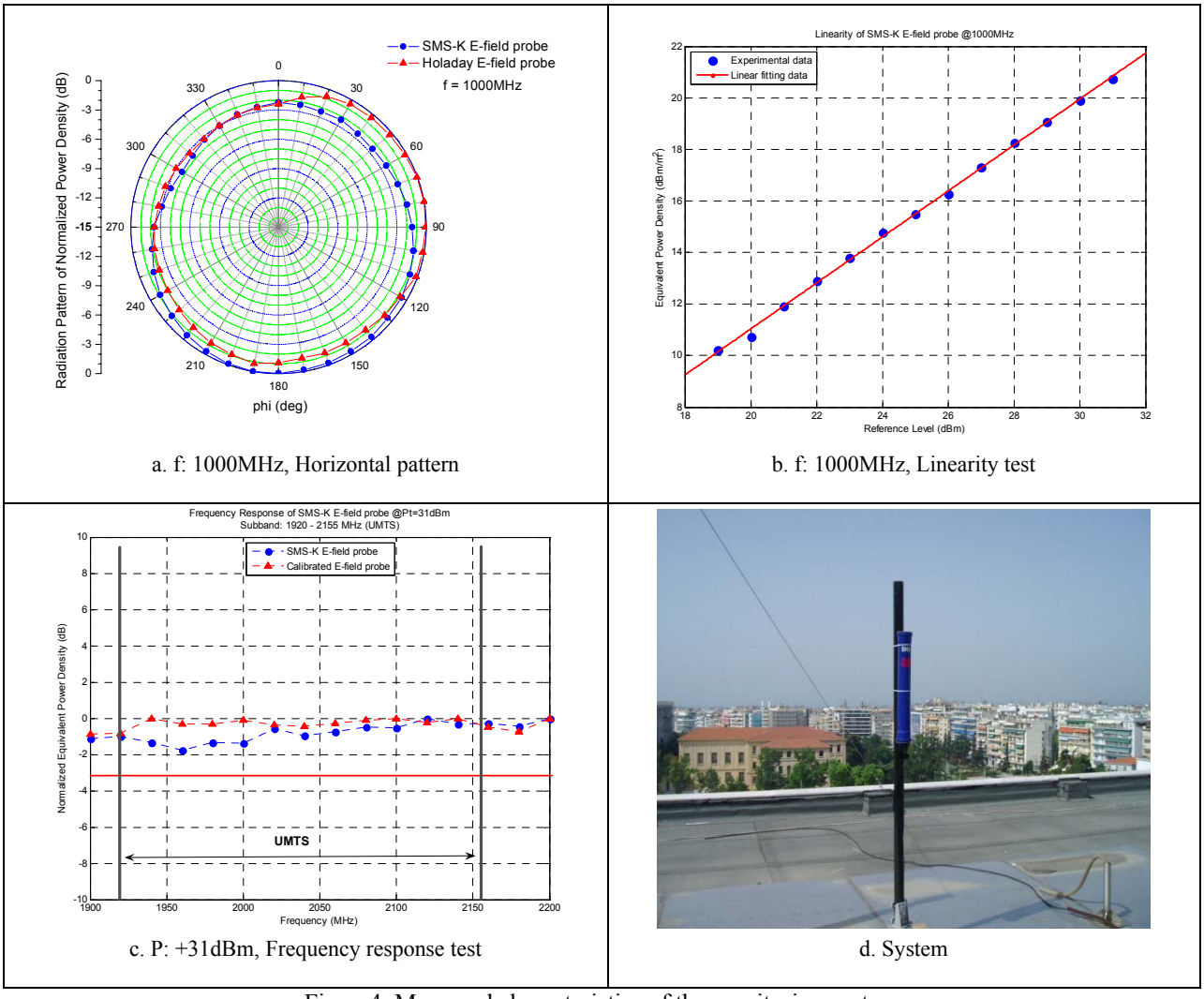

a. f: 1000MHz, Horizontal pattern

b. f: 1000MHz, Linearity test

c. P: +31dBm, Frequency response test

d. System

Figure4. Measured characteristics of the monitoring system