Measurement System of Electric Field Strength in Free Space with Flat Frequency Response

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***Abstract*— A system for the measurement of electric field strength in free space was developed. It consists of a resistive sensor connected to a wide band horn antenna and matched load. The characteristics of the resistive sensor were chosen enabling the compensation of frequency response of the overall measurement system. It was implemented in WRD250 double ridge waveguide covering frequency range 2.6 – 7.8 GHz.**

Keywords-resistive sensor; high power microwaves; horn antenna.

I. INTRODUCTION

A resistive sensor (RS) is a device based on electron heating effect in semiconductors. It found applications for high power microwave (HPM) pulse measurements [1]. Some advantages of the RS can be mentioned when comparing it with a semiconductor diode, which is also sometimes used for HPM pulse measurement. The RS measures HPM pulses directly, is overload resistant and demonstrates perfect long-term stability [1]. The RS is usually mounted in a rectangular waveguide and this confine the frequency range where particular device can be employed. It is possible to widen this frequency range more than two times by employing a double ridge waveguide for the RS implementation. Connecting the developed RS to a wide band horn antenna, electric field strength measurements in free space can be performed, broadening application of the sensor in electromagnetic susceptibility experiments.

In this work, a measurement system was developed for the measurement of microwave pulse electric field strength in free space. It is comprised of the RS mounted in a double ridged waveguide WRD250 connected to a wide band horn antenna and matched load. The pass band of the system is from 2.6 to 7.8 GHz. The layout of the sensing elements differs from the cross waveguide type RS earlier investigated in this frequency band [2]. The RS was made of two sensing elements, which are separated from each other. This configuration was chosen since it allows us to achieve smaller sensitivity variation on frequency.

II. SENSITIVITY OF THE MEASUREMENT SYSTEM

In order to measure the electric field strength in free space, the RS should be connected to the horn antenna. Sensitivity of such measurement system can be written down as follows:

$$\chi = \zeta \cdot S_{eff} \ , \qquad (1)$$

where S_{eff} is an effective area of the wide band horn antenna and ζ is sensitivity of the RS when measuring microwave power in a double ridged waveguide.

The effective area of the horn antenna, in turn, depends on a gain of the antenna and wavelength of the electromagnetic wave. Therefore, accounting for the dependence of the antenna gain on frequency, when choosing the dimensions and specific resistance of the sensing elements of the RS, the system for electric field measurement in free space can be designed, the sensitivity of which is independent of frequency.

In this work we demonstrated such approach for the RS implemented in WRD250 waveguide. Simulation and experimental results are shown in Figure 1. From experimental results it is seen that the sensitivity variation within ±21.3% in the frequency band of the WRD250 waveguide can be achieved. It is very promising result for the system of the electric field measurement in free space in a wide frequency range. Similar system for the measurement in a frequency range 0.8-2 GHz is under development.

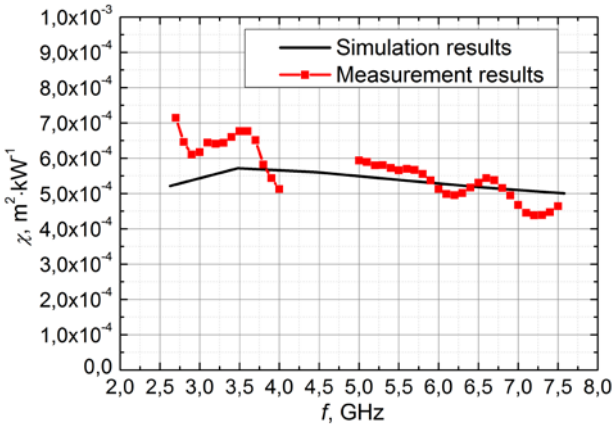

Figure 1. Dependence of the sensitivity on frequency for the measurement system comprised from the RS implemented in waveguide WRD250, horn antenna and matched load.

REFERENCES

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This work was in part supported by 7th EU program HIPOW.