Resistive sensor for short-pulse HPM measurements

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Abstract— Resistive sensors for WRD250 and WRD750 double ridged waveguides were developed. The flat frequency response of the sensors was sacrificed in order to be able to measure short high power microwave pulses but still maintain wide operating frequency band. Using the developed sensors HPM pulses covering frequency ranges 2.6 – 7.8 GHz and 7.5 – 18 GHz can be directly measured.

Keywords- resistive sensor; high power microwaves, short pulses.

I. INTRODUCTION

The resistive sensor (RS) is a device based on the 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 frequency band these sensors can be used in is limited only by the waveguide in which they are mounted. In order to measure HPM pulses over a wide frequency range, a few RSs mounted in rectangular waveguide should be used.

In this study, a RS mounted in double ridged WRD250 and WRD750 waveguides was investigated. The RS is made of two sensing elements that are separated from each other. On the top of them there is a dielectric concentrator [2] (ref. to Figure 1). This configuration was chosen since it allowed us to use smaller sensing elements, thus allowing to reduce VSWR of the whole sensor.

II. RESPONSE TIME

In our previous paper [2] we presented resistive sensors implemented in WRD840 and WRD250 waveguides. With these sensors it is possible to measure HPM pulses in the frequency ranges 0.84 – 2.0 GHz and 2.6 – 7.8 GHz, respectively, for WRD840 and WRD250 waveguides. Parameters of the sensing elements of these sensors were chosen in such a way that the frequency response of the sensor shall be as flat as possible.

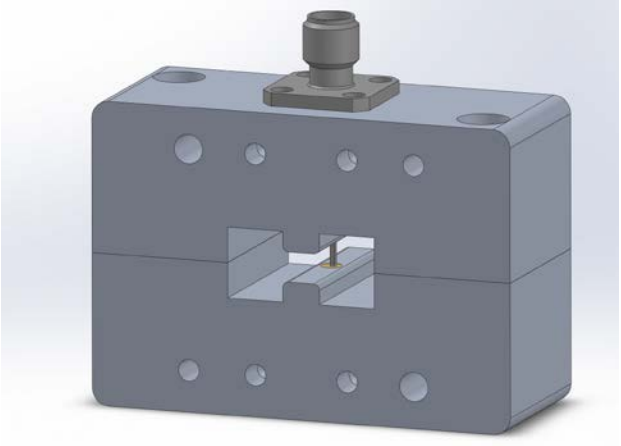

Figure 1. Resistive sensor for WRD750 waveguide.

Traditionally, the sensitivity of the RSs is written down as a its relative resistance change in a microwave electric field $\Delta R/R$ divided by a power pulse P of a HPM pulse:

$$\zeta = \frac{\Delta R}{R} / P \ . \qquad (1)$$

The sensitivity variation of the previously designed sensors [2] was less than ± 10% for WRD840 and ± 15% for WRD250 sensors. Unfortunately, the resistance of the sensing elements was rather high (roughly 1000 Ω) and the designed sensors are of little use for the measurement of short (a few tens of ns) duration HPM pulses. In order to measure ultra-short HPM pulses the total resistance of the sensing elements should match the impedance of the measurement circuit. There is no other solution to fulfill this condition than to sacrifice the flatness of the frequency response of the sensor. The sensitivity variation of newly designed WRD250 and WRD750 sensors, applicable for the measurement of short HPM pulses, can be as large as 1.8 times within a frequency pass band range.

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