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Microstrip transducer for UWB EMP characterization

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***Abstract* – The microstrip transducers for UWB EMP characterization have been described. The microstrip transducers have a step transient response and it means that their output signal replicates the E-field waveform. The rise time of transient response is up to 8 ps at the time window duration of order 3-5 ns.**

Keywords* – *HPEM measurement, microstrip line, E-field, transducer, UWB, EMP

I. Introduction

In the 1980–90's researchers at VNIIOFI suggested using the microstrip lines for the measurement of EMP waveform parameters. They developed the theory of the microstrip transducers (Russian acronym – IPPL), carried out the experimental investigations and worked out the production technology [1-3]. More than 20 years the Russian leading test laboratories apply the microstrip transducers to determine the EMP waveform parameters in the different HPEM simulators.

II. Design and Characteristics

The incident electromagnetic field excites the traveling TEM-wave propagation along non-symmetrical strip line. The design and external view of IPPL are presented in Fig. 1: the dielectric base *2* with thickness *d* and relative dielectric constant ε > 1 separates the potential electrode *1* and grounded electrode *3* of the microstrip line. The ends of the microstrip line are loaded on the matched impedances $Z_1 = Z_2 = 50$ Ohm.

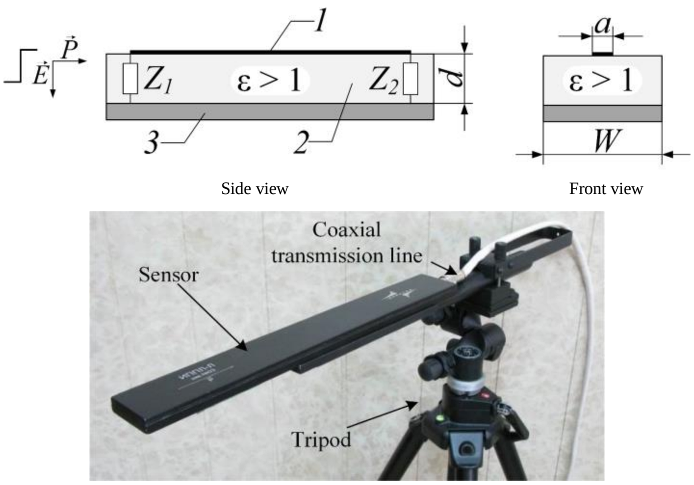

Figure 1. IPPL design and external view

The main advantage of IPPL is its step transient response. This means that *the sensor output signal replicates the waveform of the radiated pulsed electric field*. There is need not an integration of sensor output signal (as in D-dot and B-dot sensors). Consequently, the measurement error decreases and the measurement procedure is essentially simplified.

The signal pick-off is realized from the beginning of the microstrip line and it means that unwanted interference on the coaxial transmission line comes to the recorder after the wanted measuring signal. This solution increases accuracy of measurement. The high-frequency losses in the coaxial line could be compensated with the change of the strip line geometry without the broadband deterioration (for example, with the change of *a* width of the potential electrode in Fig. 1).

The IPPL bandwidth is determined with the *d* fit of the microstrip line. At present the values of rise time of transient response $t_r \approx$ 8-10 ps are reached (pass band upper-frequency F = 35-40 GHz). The t_w time window duration of the transducer is determined with the strip line length and in practice it is 3-5 ns. The oscillograms of step signal recorded by the IPPL are presented in Fig. 2 (the rise time of radiated standard step EMP is t_{rad} = 15 ps [4]). Taking in account rise time of oscilloscope t_{osc} = 7 ps and using root sum of squares approximation, the IPPL's rise time of transient response is

$$t_r = \sqrt{t_f^2 - t_{rad}^2 - t_{osc}^2} = \sqrt{18{,}5^2 - 15^2 - 7^2} = 8{,}3 \text{ ps},$$

where t_f = 18,5 ps is pulse rise time measured by IPPL.

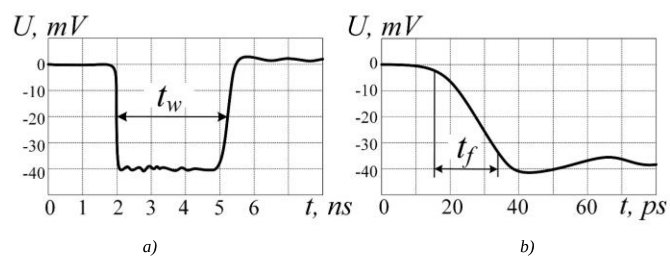

Figure 2. Standard step signal recorded by IPPL:
a) time window, *b)* initial part

The IPPL calibration is realized with the National Primary Special Standard of the unit of electric and magnetic field strength [4].

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