Application of the shielded loop antenna for measurements of UWB signals

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Measurements of short electromagnetic (EM) pulses in time domain require utilization of ultra wideband sensors for electromagnetic field (M. Kanda, *Time-Domain Measurements in Electromagnetics*, Van Nostrand Reinhold Company, New York, 122-174, 1986). The majority of commercially available sensors are so-called B-dot or D-dot sensors, which measure time derivative of B or D component of EM field correspondingly (J.P. Castillo and L. Marin, *Time-Domain Measurements in Electromagnetics*, Van Nostrand Reinhold Company, New York, 268-295, 1986). To recover the EM-waveform field from data obtained with these sensors, numerical integration is needed. For weak signals with small signal-to-noise ratio (this is a typical situation with B-dot or D-dot sensors) this integration causes numerous artifacts. That is why recently several non-differentiating (replicating) sensors have been developed based on TEM-horn (E. Farr and L. Bowen, *Book of Abstracts, Euro Electromagnetics'2000*, 65, 2000) or on dipole with curved arms (S. Tyo and J. Buchenauer, *Book of Abstracts, Euro Electromagnetics'2000*, 66, 2000). Providing large sensitivity and ultra-wide band performance these sensors suffer from large (in comparison with the smallest wavelength in their bandwidth) physical dimensions.

Over years we successfully use the shielded loop antenna (A.G.Yarovoy, R.V. de Jongh, and L.P.Ligthart, *Electronics Letters*, **36**, 1679-1680, 2000) for antenna measurements in time domain. This sensor is a compact sensor with almost replicating behavior. The relative bandwidth of this sensor is typically 20:1 (on –10dB level). We use this sensor for far-field antenna measurements as well as for near-field antenna measurements. We also use this sensor in a test range for Ground Penetrating Radar. In the latter case the sensor is used to recover the waveforms of electromagnetic field in the ground.

The developed theoretical model of the sensor allows to optimize the probe for desirable bandwidth and sensitivity. Using this theoretical model we have developed and manufactured in house a number of different modifications of this sensor, which are used in different bands (particularly, we are interested in 300MHz-3000MHz and 1GHz-6GHz bandwidth). These sensors are calibrated and the probe compensation techniques have been developed. The latter have been tested on basic antennas; it was found excellent agreement with measurement results in frequency domain and results of numerical simulations. The probe compensation technique for the measurement in the ground (dry sand) has been developed and successfully tested as well. This probe compensation technique is based purely on theoretical model.

Finally we have successfully used the probe in Ground Penetrating Radars dedicated for landmine detection (R.V. de Jongh, A.D. Schukin, A.G. Yarovoy, L.P. Ligthart, and I.L.Morrow, *patent WO 01/38902 A2*, 2001). For such radar it is essential not only to detect the scattered by the object field, but correctly record the waveform of this field. This waveform is used later on for classification and identification of detected targets.