Abstract

This doctoral dissertation focuses on the possibility of detecting high-power electromagnetic pulses propagating within a free space, using the magneto-optical method, where the sensor is constructed in a fully dielectric technology. Currently, high-power electromagnetic pulse detection is conducted using D-dot and B-dot probes. This causes numerous problems. An output signal from such sensors is a derivative of the measured field. Unfortunately, a measurement using such sensors requires the application of additional elements, such as a balun, coaxial cable and attenuators. A passive integrator and a fibre-optic link are also used quite often. All additional components present within a measurement chain modify the frequency characteristics of the entire measuring system. Metal elements of the probes lead to the modification of the electromagnetic field distribution. A key issue in this regard is the selection of a proper attenuation value in the case of measuring radiation sources with unknown parameters. Choosing an insufficient attenuation value may result in damaging the recording system, e.g. an oscilloscope or an analogue-digital converter. An important aspect is also ensuring efficient screening, to protect the measuring system's elements, which are most susceptible to electromagnetic radiation. There is ongoing global research focusing on the application of optical sensors, which hold many advantages compared to traditional probes.

The main achievement presented in the work is the development of an original detector based on the Faraday effect, which utilizes multi-mode optical fibers (step index and graded index). The sensor was constructed in a fully dielectric technology, and based on commercially available elements. Designing a detector model was preceded by the execution of laboratory stands and conducting measurements necessary to formulate the requirements for selected components of the measuring system. The dissertation reviews the results of many laboratory tests. The measurements were conducted using both the original stands for generating variable low-frequency fields, as well as commonly available generators, including the DS110 by Diehl BGT Defence. A significant part of the dissertation is of experimental nature.