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Monograph in Remembrance of Professor Dr. Habil. Zenonas Vainoris

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1925–2009

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Darbinė veikla. 1945–1947 – Šiaulių 2-osios prad. m-klos mokyt., ved., 1952 – Šiaulių sr. radiotransliacinių tinklų direkcijos vyr. inž., 1952–1964 – Charkovo (Ukraina) karinės radiolokacinės akademijos dėstytojas, vyr. dėstytojas, 1964–1980 – VISI Radijo aparatūros technologijos k-dros ved., 1978–1980 – dekanas, 1980–1989 – LTSR aukšt. ir spec. vid. mokslo m-jos Mokslo v-bos virš., 1989–1991 – VTU (VGTU) Radijo aparatūros technologijos katedros vedėjas, 1991–2002 – Radioelektronikos katedros profesorius.
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"Technika", the press-office of Vilnius Gediminas Technical University, published the monograph "Simulation and Application of Super-Wide-Band Slow-Wave Structures" [1]. Authors of the monograph dedicated it to remembrance of Professor Dr. Habilitus Zenonas Vainoris (1925 02 19 – 2009 03 25).

The slow-wave devices with super-wide pass-band are necessary for electromagnetic delay lines (DL) and traveling-wave cathode-ray tubes (TW CRT). TW CRTs are developed for traveling-wave oscilloscopes that are used for investigation of single high-speed processes. Traveling-wave deflection systems must ensure the pass-band of tubes and oscilloscopes from 0 to some gigahertz.

In 1965, professor Zenonas Vainoris initiated research in the field of electrodynamic slow-wave devices at Vilnius Gediminas Technical University. As a result of research in the period 1965–95, important problems, related to investigation and design of super-wide band delay lines and traveling-wave deflecting systems, are solved. The generalized theory of super-wide band helical and meander systems is developed. Processes in traveling-wave deflecting systems are revealed, and theory of TW CRTs is developed. New technical solutions in the field of super-wide band delay lines and traveling-wave deflecting systems are proposed. Main results of investigations are presented in [2–5].

Approximately from 1990, intensive investigations in the field of electromagnetic began. It was based on wide application of numerical methods for investigation of

electromagnetic fields, microwave and other electrodynamic devices.

The authors of the monograph "Simulation and Application of Super-Wide-Band Slow-Wave Structures" used electrodynamic, multiconductor line and numerical methods for modeling, simulation, analysis and design of super-wide band slow-wave structures.

The monograph consists of introduction and nine chapters.

Inhomogeneous helical slow-wave systems are considered in Chapter 1. The generalized models of the systems with rectangular cross-section are proposed. The electrodynamical method is applied for analysis. The expressions for retardation factor and input impedance are derived. Simulation of the systems revealed ways for reduction of dispersion and widening of the pass-band.

The fundamentals of the multiconductor line method are presented in Chapter 2. The method is applied for investigation of complex meander and helical structures. The numerical methods and algorithms based on iterations and application of scattering transmission-line matrices are developed.

At application of the multiconductor line method, values of characteristic impedances of the multiconductor lines are necessary. Methods of calculation of characteristic impedances are described in Chapter 3. The fundamentals of finite difference, finite element and integral equation numerical methods are presented. The moment method is applied for calculation of parameters of microstrip multiconductor lines consisting of finite number of conductors.

The twined helical, quasi-symmetrical and gutter-type helical and meander systems are considered in Chapter 4. Models of the systems based on the multiconductor line method are proposed. Frequency properties of the systems are revealed and described. Besides the multiconductor line method, the *CST Microwave Studio* software system is used for simulation of the quasi-symmetrical and gutter-type systems.

Many commercial software packages are developed for simulation of electromagnetic fields, research and design of microwave devices. Possibilities of application of *AWR* software package *Microwave Office* and *CST* software system *Microwave Studio* for investigation of super-wide band periodical structures are considered in Chapter 5. The *Microwave Office* package is used for investigation of the helical system, twined helical system properties, research and elimination of resonances in the system of shields in helical systems. The *Microwave Studio* system is used for 3D modeling of helical delay lines and traveling-wave deflection systems.

Using the multiconductor line method, it is possible to reveal general properties of the super-wide band slow-wave structures and relatively easily find solutions for improving properties of the systems. On the other hand, the multiconductor line method generally allows investigation of infinitively long structures. Using software packages like *Microwave Studio*, it is possible to simulate the systems with the finite length and take into account finite conductances of metallic parts, losses in dielectric elements, reflections from inhomogeneities in the signal path, etc. Unfortunately, calculated characteristics depend on the total influence of various factors and it is difficult to evaluate the influence of a separate factor in order to improve properties of the structure in this instance. For these reasons, the idea to use the synergy of various methods is proposed and used for investigation of slow-wave systems in Chapter 6.

Specific problems related to application of the slow-wave structures for deflection of electron beam in the TW CRTs are solved in Chapter 7. Here frequency responses (amplitude frequency and phase frequency characteristics) and transient responses of traveling-wave deflecting systems and cathode-ray tubes are considered. Possibilities of compensation of phase frequency distortions are discovered. Distribution of electric field in various types of deflection systems is analyzed. Non-linear frequency distortions of harmonic signals and electrical pulses are estimated. The model of the signal path of TW CRTs is proposed. It is applied to estimate the influence of transitions to slow-wave deflecting system onto characteristics of deflecting systems and cathode-ray tubes. At last, the methods that allow improving dynamic properties of TW CRTs are discovered.

Various types of the microstrip meander lines for delay of wide-band electrical signals are considered in Chapter 8. Proposed models and methods allow estimating the influence of variation of conductors step, shields and properties of dielectric materials onto frequency characteristics of meander DLs. The best results can be achieved using modified gutter-type meander DLs.

The problems related to automatization of design and optimal design of meander and helical slow-wave systems and delay lines are considered and solved in Chapter 9.

The results of research presented in the monograph can be used for analysis, synthesis and design of slow-wave structures for modern electronic devices with super-wide pass-band.

The monograph "Simulation and Application of Super-Wide-Band Slow-Wave Structures" is the important work dedicated to remembrance of Professor Dr. Habilitus Zenonas Vainoris, famous researcher in the field of Electronic Engineering, Initiator of research of slow-wave structures in Lithuania, Generator of ideas, Scientist and Teacher.

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