University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

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"Substrate Integrated Waveguide Antenna Systems"

Department of Electrical and Computer Engineering

Wednesday, January 9, 2019
11:00 A.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. Jens Bornemann, Department of Electrical and Computer Engineering, University of Victoria (Supervisor)
Dr. Poman So, Department of Electrical and Computer Engineering, UVic (Member)
Dr. Andrew Rowe, Department of Mechanical Engineering, UVic (Outside Member)

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Dr. Tayeb A. Denidni, Energie Materiaux Telecommunications, Institut National de la Recherche Scientifique

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Dr. James Lawson, Department of Political Science, UVic

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Abstract

Due to high demand for planar structures with low loss, a considerable amount of research has been done to the design of substrate integrated waveguide (SIW) components in the mm-wave and microwave range. SIW has many advantages in comparison to conventional waveguides and microstrip lines, such as compact and planar structure, ease of fabrication, low radiation loss, high power handling ability and low cost which makes it a very promising technology for current and future systems operating in K-band and above. Therefore, all the work presented in this dissertation focuses on SIW technology. Five different antenna systems are proposed to verify the advantages of using SIW technology.

First, a novel K-band end-fire SIW circularly polarized (CP) antenna system on a single layer printed-circuit board is proposed. A high gain SIW H-plane horn and a Vivaldi antenna are developed to produce two orthogonal polarizations in the plane of the substrate. CP antennas have become very popular because of their unique characteristics and their applications in satellites, radars and wireless communications.

Second, a K-band front-end system for tracking applications is presented. The circuit comprises an antenna array of two Vivaldi antennas, a frequency-selective power combiner, and two frequency-selective SIW crossovers, which eliminate the need for subsequent filtering. The integration of monopulse systems in planar, printed-circuit SIW technology combined with the added benefits of filtering functions is of great importance to the antennas and propagation community.

Third, a phased array antenna system consisting of 24 radiating element is designed as feed system for reflector antennas in radio astronomy applications. A Ku-band antipodal dipole antenna with wide bandwidth, low cross-polarization and wide beamwidth is suggested as the radiating element.

Fourth, four different right-angled power dividers including in-phase and out-of-phase dividers as feed systems for antenna arrays are introduced. TE_{10} - to - TE_{q0} mode transducers are used for obtaining two, three, and four output dividers with phase control ability at K- and Ka-band. This feature is practical, for instance, when designing tracking systems since they are employed to obtain controllable phase distributions over the output ports.

Fifth, a Ku-band beam steering antenna system which is applicable to use for wireless communications, radar systems, and also 5G applications is proposed. This antenna system uses variable reflection-type phase shifters which electrically steer the beam over a 50-degree scan range.

Therefore, the SIW technology's reliability and also promising behavior in the microwave frequency range is proven for different applications.