

Full band CP Ferrite-Based Satellite Feed Structure for LEO Satellite Applications

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Demand for broadband satellite communications in the Ka-band is growing consistently, especially due to the anticipated high data rate associated with future applications. The feeding structure represents a critical and challenging component of the LEO satellite system. Circularly polarized (CP) communication systems offer essential advantages over linearly polarized (LP) systems traditionally used in various applications. In satellite and ground station antennas, CP overcomes the need for alignment between transmitter and receiver terminals, maximizing the link's power budget. In addition, polarization diversity doubles the channel capacity and minimizes co-channel interference. However, the realization of these systems is associated with various challenges to cover wideband width while maintaining featured electric characteristics.

The linearly polarized Orthomode Transducer (OMT) is crucial in transmitting and/or receiving two orthogonal polarizations. Moreover, the integration of an OMT with a waveguide polarizer handles the circularly polarized wave. In this setup, the OMT separates orthogonal linearly polarized signals initially converted from circularly polarized waves by the waveguide polarizer. These polarizers are developed using circular or square waveguides, to support the propagation of two fundamental modes. The traditional configuration consists of irises/ diaphragms to provide the 90-degree phase shift. In the first mode, the diaphragms behave as inductive loads, while in the other mode, they have a capacitive effect. As a result, a phase difference is produced at the output of the device. This phase difference can be precisely 90 degrees, thereby transforming linear polarization into circular polarization. This classical configuration provides a limited bandwidth as is based on reactive elements. This paper presents a novel approach to provide the phase shift inside the polarizer using a corrugated ferrite-based configuration. This innovative approach satisfied the required phase shift over full band operation and maintained high power handling capability.

Here, we present for the first time a satellite feeding structure using a two-fold OMT and a ferrite-based waveguide polarizer. The OMT covers a full band operation (26.5-40) GHz, with a standard WR28 waveguide interface. The proposed OMT covers the required band in a very compact size with a deep matching level. The proposed design facilitates cascaded integration with successive subsystem assembly as its ports are aligned in the same plane and have the same orientation. The waveguide polarizer, developed with ferrimagnetic materials, achieves a precise 90-degree phase difference of a phase variation with ± 5 degrees over the full band operation. This ensures excellent polarization conversion with high cross polarization. This design delivers key performance metrics, including high isolation, good matching levels, and an axial ratio below 0.75 dB. This innovative feeding structure addresses the growing demands of broadband satellite communication systems, offering enhanced performance and reliability for future applications. Its compact size, high-power handling, and wideband coverage promote this novel configuration as a potential candidate for modern satellite communication systems.