SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
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AN OPTICALLY CONTROLLED BEAM FORMING NETWORK FOR KA-BAND ANTENNA

Abstract

For the future broad band satellite communications, a large number of multiple scanning spot beam antenna will be important role for a satellite antenna. The frequency band for broad band communications will be used higher frequency band such as Ka-band. However, a large number of multiple scanning spot beam antenna should need a large scale and complex beam forming network(BFN). Beside, Ka-band satellite communications has a defect of rain attenuation. For the solution to those problems, we propose a transmit antenna of multiple scanning spot beam having adjustable beam-width and a new concept of optically controlled BFN to minimize its scale and complexity. To make sure such concept, we have developed a test model of the optically controlled BFN. For the design of a transmit antenna of multiple scanning spot beam, we assumed 20 multiple spot beams to cover the northeast Asia including Japanese islands. Based on this assumption, the antenna was adopted an offset paraboloidal reflector antenna of two meters diameter with 404 primary radiators. The test model of the optically controlled BFN has two beams having 64 output ports. The optically controlled transmit BFN comprises electro-optic converters, an optically controlled BFN and opto-electronic converters. The electro-optic converter comprises a laser, an optical modulator and an optical amplifier. The optically controlled BFN comprises an optical filter, an amplitude-only spatial light modulator, a phase-only spatial light modulator, a microlens array and a 2-D fiber array, and WDM couplers. In the electro-optic converter, an optical carrier is modulated by Ka-band radio frequency signal with carrier residual single-side-band (SSB) modulation technique, and amplified to proper level. In the optically controlled BFN, the residual carrier and the SSB signal are divided by passing an optical etalon filter, where the carrier passes through the filter but the SSB signal is reflected. Then, the spatial distribution of the carrier amplitude and the spatial distribution of the SSB signal phase are respectively controlled by using a Liquid-Cristal based spatial optical modulator for generating a desired antenna beam direction and width. Spatially combining and photo-detection of them in the opto-electronic converter finally generates Ka-band radio frequency signal for the scanning spot beam antenna. We have developed the test model of an optically controlled BFN with 64 output ports, and confirmed good agreement between expected radiation patterns and calculated radiation patterns using measured data.