Transmission Characteristics of Dielectric-coated Metal Rod Transmission Line for a Flexible Transmission Medium at Millimeter-wave Frequencies

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High bit rate data transmission systems have come to a key technology for millimeter-wave applications. Actually, the gigabit class data transmission was successfully performed for the high definition TV signal distribution systems. To distribute such video signal between point and point terminals or among multi-point terminals with wire transmission line in TX and RX modules, the wire transmission line has to have a low dispersion characteristics, a wide bandwidth from DC to 100 GHz, and flexibility. Having these facts in mind, we proposed a new type of flexible transmission medium termed “dielectric-tube-supported metal rod transmission line (DTM line)” in this paper.

The DTM line consists of circular shaped metal rods inserted in a below cutoff parallel metal plate to prevent undesired radiation. To support the metal rod at the horizontally-symmetrical mid-plane of the parallel metal plate, a circular dielectric material was installed coaxially between the metal rod and parallel metal plate. The circular shape has good advantage to moving the cutoff frequencies of the higher modes generating in the dielectric region away from an operating frequency compared with the square and other shapes, and moreover keeps good flexibility because the dielectric region can contact with the upper or lower metal plates at one point. The parallel metal plate separation was set at 1.18mm so as to be less half a free space wavelength at 100 GHz. The dielectric material was assumed to be PTFE having a relative dielectric constant of 2.04 and a loss tangent of 1.5×10^{-4} due to the low loss nature at millimeter wavelengths. The conductor material of the metal rod was set at the silver with a conductivity of 6.1×10^{7} S/m or the brass with that of 1.5×10^{7} S/m. The parallel metal plates was assumed to be the hard aluminum having conductivity of 3.84×10^{7} S/m.

It was verified that good low dispersion performance of the operating mode, that is quasi-TEM wave was obtained. And moreover, the transmission loss was calculated to be less than 10 dB/m in the frequency ranges from DC to 100 GHz and the mode conversion in the bend portion was sufficiently negligible.