Vertical Strip Transmission Line Primary Radiator as a Beam Scanning Antenna at 60 GHz

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We devised a primary radiator made by the vertical strip transmission line whose center conductor was bent as an L-shape to transform the guided mode to radiated waves. This primary radiator, sandwiched by the parallel metal plates with a spacing of 2.25 mm, was fed by a coaxial cable having the reflection plate, quarter-wavelength choke circuits being installed on the upper and lower surface to suppress the radiation to the back direction. The vertical strip transmission line was etched on the FR-4 having a thickness of 0.1 mm, a relative dielectric constant of 4.21 and a dielectric loss tangent of 0.0135. The width of the center conductor was set at 0.2 mm in consideration of the etching accuracy and the change rate of the height.

While the guided mode in the vertical strip transmission line is a non-radiating TEM-wave, the radiating TEM-wave was generates in the L-shaped section because of its discontinuity for the horizontal mid-plane of the parallel metal plates. To prevent the reflection from the L-shaped section, the vertical strip transmission line was installed behind the L-shaped section. The half power beam width of this radiator was broad to be 60^{o}, and thus this radiator is quite satisfactory to construct a beam scanning antenna.

By using the radiator, we devised the phased array antenna. The arrayed radiators consisted of the nine elements of the L-shaped vertical strip transmission line radiators with a period of 4.5 mm, and each radiator was fed by a coaxial cable having a characteristic impedance of 50 Ω, being inserted in the reflection plate. The offset phase being set at the phase difference from -50^{o} to 50^{o}, the radiation patterns were calculated, where the field distribution of the arrayed radiators was assumed so as to be the square of cosine shape. The direction of the main-lobe can be scanned at 1.6^{o} by a phase difference between two adjacent radiators of 10^{o} while keeping the first side-lobe level of less than –22.5 dB and the antenna gain of larger than 13 dBi, respectively.

The next step of this research will be to install this array antenna into our-developing phase shifter network.