Transmission Characteristics of Bilaterally Metal-Loaded Tri-Plate Strip Transmission Line at Millimeter-wavelengths

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Printed transmission lines such as a microstrip line and a coplanar waveguide are preferable for applications at centimeter wavelengths, but they suffer from considerable transmission loss at millimeter-wave frequencies. It is well known that reasons why the transmission loss increases are smaller skin depth at this frequency region, roughness of metal surfaces, high current density at edges of the metal strips, and so forth. Recently, it was found out that an effective conductivity of a surface of the metal strip, attaching on the dielectric substrate, more degraded than that of the opposite surface of the metal strip, facing an air region, at centimeter waves since surfaces of the dielectric substrates are usually roughened due to tight copper-coating. This fact may drastically degrade the transmission losses of the printed transmission lines.

To overcome such difficulty, the bilaterally metal-loaded tri-plate strip transmission line was proposed at millimeter-wave frequencies as shown in Fig. 1. By symmetrically-loading metal patterns on both sides of the dielectric substrate and by biasing equi-voltage to both metal patterns as shown in Fig. 2, the current density on the under surface of the metal pattern decreases, and thus the transmission loss is relatively unaffected by the roughness of the dielectric surfaces. Figure 3 shows the calculated transmission characteristics. Assuming the popular glass-Teflon as the dielectric substrate, the transmission loss, calculated to be 5dB/m, was drastically improved compared with that of the microstrip line. The Q factor was also improved to be 400 as well. If we choose a cost effective FR-4 as the dielectric substrate, a reasonable transmission loss was obtained to be 20 dB/m.

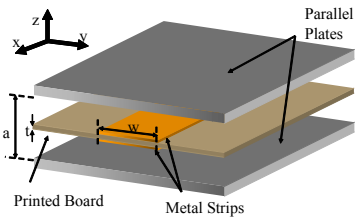


Fig.1 Structure of bilaterally metal-loaded tri-plate strip transmission line

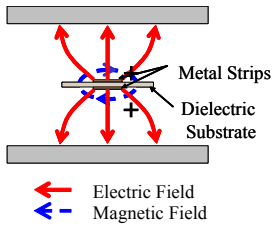
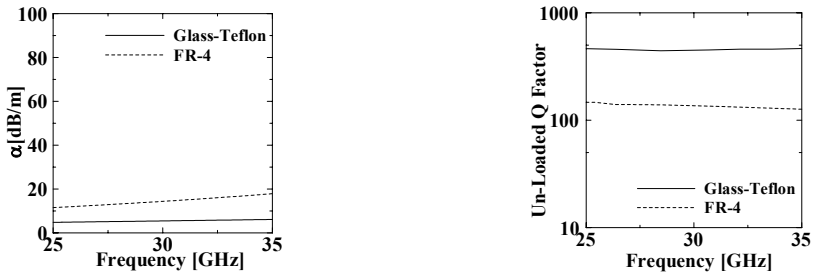


Fig.2 Field distribution of bilaterally metal-loaded tri-plate strip transmission line



(a) Transmission loss (b) Unloaded Q facoter

Fig. 3 Transmission characteristics