Experimental Verification of Higher Mode Propagation in Shielded Slot Transmission Line

Futoshi Kuroki* and Kazuya Miyamoto
Kure Nat'l. Coll. of Tech., Japan

The shielded slot transmission line consists of slotted metal strips inserted in a below cutoff parallel metal plate waveguide as shown in Fig. 1, and the guided modes have been analyzed for the purpose of use of reactance elements in the higher mode tri-plate transmission line (HS line). It is obvious that the TEM mode can propagate in the slot area as the lowest dominant mode as shown in Fig. 2 (a), while the higher modes can propagate in the metal strip regions as shown in Fig. 2 (b) from the calculated results based on the transverse resonant method. To confirm this fact, we experimentally investigated these guided modes from the viewpoint of the dispersion characteristics. Parallel metal separation was set at 2.3 mm so as to be less than half a wavelength in dielectric material filling at 40 GHz. Teflon with a relative dielectric constant of 2.04 was selected as the filling due to its low loss nature in the millimeter-wave frequency, and a width of the metal strip was selected at 3.4 mm. As shown in Fig. 1, a resonator was fabricated by cutting the slotted metal strip, and its resonant frequencies were measured as a function of the length of the slotted metal strip. Because the length of the resonator was chosen to be longer than a guided wavelength, multi-order resonant frequencies were observed. Figure 3 shows the measured resonant frequencies versus the length of the resonator, where the width of the slot was set at 0.25 mm so as to exit the higher mode. From this result, guided wavelengths of the higher mode and a TEM wave can be found out by subtracting the resonator length of the 1st order resonance from that of the higher order resonance.

Figure 4 shows the estimated dispersion curves of the TEM and the higher modes based on this measurement method. The calculated results are also plotted as solid curves. Good agreement between theoretical and measurement results can be achieved, so that existence of the higher mode was confirmed.

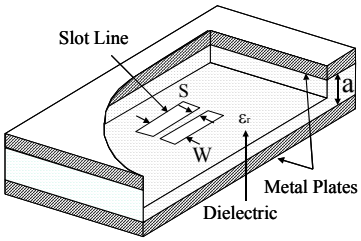
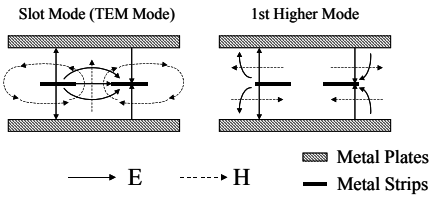


Fig. 1. Structure of shielded slot transmission line.



(a) TEM mode. (b) The 1st higher.

Fig. 2 Field distributions of guided modes in shielded slot transmission line.

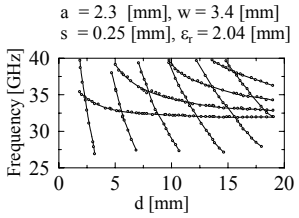


Fig. 3 Measured resonant frequency versus length of resonator.

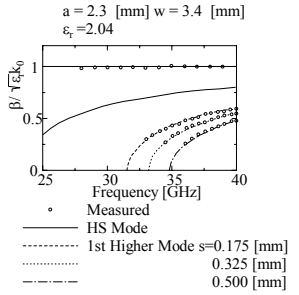


Fig. 4 Measured and calculated dispersion curves in shielded slot transmission line.