URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Design of BPF Using Dielectric – tube Supported Metal Transmission Line for Beyond 5G Applications at 300GHz

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Beyond 5G research has already begun for ultra-speed and broadband communications. As the operational frequency band, the use of 300GHz having characteristics with relatively low absorption by oxygen molecules in atmosphere as well as wide available frequency range is being considered. The dielectric-tube supported metal rod transmission line (DTM-line) has been proposed for integrated circuit applications in submillimeter frequency band. This transmission line features a low transmission loss being 1/7th lower than those of conventional printed transmission lines and wide bandwidth from DC to submillimeter wavelength [1]. To apply the low loss nature, the bandpass filter (BPF) with essential for communications was considered in this study.

As shown in Fig. 1, the DTM-line consists of a metal rod supported a dielectric tube inserted in the below cutoff parallel metal waveguide. Figure 2 shows the BPF structure. In the filter portion, the dielectric tube was partially removed and the conductor block which assumed to be gold plated was attached to the metal rod to form a cutoff region for electromagnetic waves. In addition, dielectric blocks were attached on the opposite side of the conductor block to make tight contact between the metal rod and conductor block. The equivalent circuit of the cutoff regions is expressed by an impedance inverter circuit and an electric angle, and relationship between cutoff region length and impedance inverter circuit was calculated using EM. simulation software HFSS [2]. Based on the above consideration, the analytical model of the Chebyshev BPF with a center frequency of 300GHz and a bandwidth of 6GHz was implemented on the HFSS, and the transmission characteristics were calculated. The result is shown in Fig. 3. It could be confirmed that the BPF having the desired specification of insertion loss about 3dB and return loss 10dB in passband was designed.

In this study, the design of BPF with DTM-line at 300GHz was considered. As the result, it could be confirmed that the BPF satisfying specification was designed. The future work will be to confirm its effectiveness through experimentation since the production of this BPF has already been commissioned.

References

[1] Y. Shinhama, M. Sakamoto and F. Kuroki, "Transmission Characteristics of Dielectric-tube-supported Metal Rod Transmission Line THz Wave Band", IEICE Electronics Society Conf. 2021, C-2-45 (Sept. 2021)
[2] G. Matthaei, L. Young and E.M.T Jones "Microwave Filters, Impedance – Matching Networks, And Coupling Structures", Artech House, pp.100 – 101, 1980.

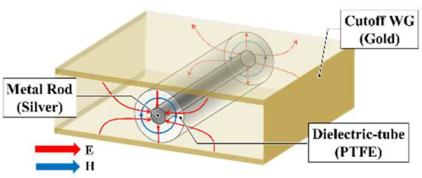


Figure 1. Structure of DTM-line.

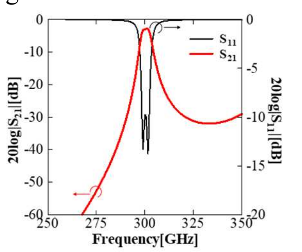
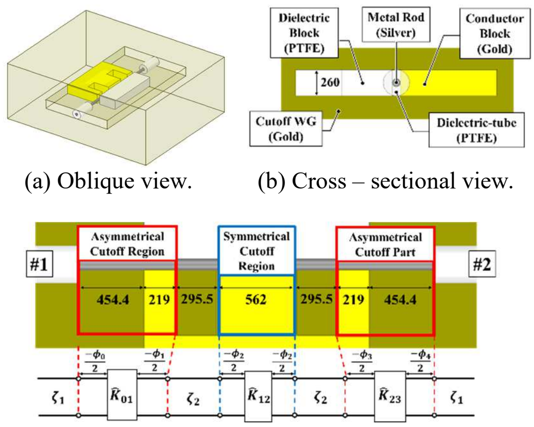


Figure 3. Calculated S-parameters of BPF versus frequency.



(a) Oblique view. (b) Cross – sectional view.

(c) Plane view and equivalent circuit.

Figure 2. DTM-line bandpass filter (Unit : um).