LSE-NRD Guide Primary Radiator Compatible with Dielectric-tube Supported Metal Rod Transmission Line at 140 GHz

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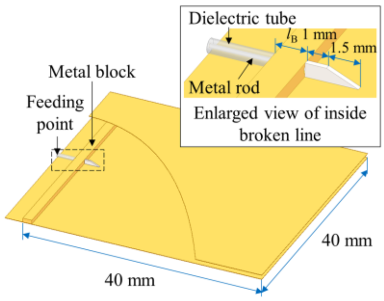
Automotive radar techniques are being researched in 140 GHz bands instead of 77 GHz to obtain more narrower antenna beam [1]. The quasi-optical antenna has an advantage over the printed antennas to keep low loss nature even with larger aperture antennas. In this paper, a primary radiator was investigated at 140 GHz to excite a quasi-optical antenna installed in integrated circuits using the dielectric-tube supported metal rod transmission line (DTM line) which features low loss nature at millimeter wave frequency [2].

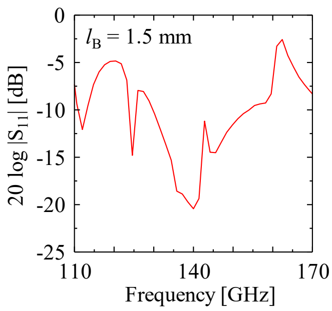
Figure 1 (a) shows the LSE-NRD guide primary radiator [3] which consists of a tapered high dielectric permittivity strip inserted in a below cutoff parallel metal plates. The spacing between the parallel metal plates was set at 680 μm so as to be less than half a wavelength at 140 GHz. Assuming the relative permittivity and the width of the high dielectric permittivity strip to be 10.2 and 254 μm, respectively, the only LSE_{01} mode propagation bandwidth can be guaranteed from 104 GHz to 164 GHz. The primary radiator was fed by the DTM line with a metal rod diameter of 205 μm through a hole with a diameter of 480 μm dug in the metal block to prevent the backward radiation.

At first, the reflection coefficient was calculated versus the taper length at 140 GHz when the feeding point was set at the end of the LSE-NRD guide. It was calculated at approximately −17 dB when a taper length was set at 1.5 mm.

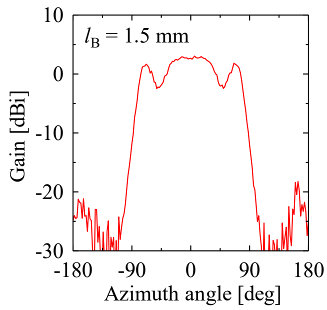
By fixing the taper length at 1.5 mm, the reflection coefficient and the antenna gain were calculated by varying the length of the metal block l_B, and it was clear that l_B of 1.5 mm was suitable at 140 GHz because the calculated reflection coefficient was approximately −20 dB at 140 GHz as shown in Fig.1 (b). Figure 1 (c) shows the radiation pattern in azimuth angle. It is obvious that this primary radiator has an omni radiation pattern having the calculated antenna gain of approximately 2.7 dBi to the forward direction. The next step of this research will be to apply this primary radiator to quasi-optical antenna to achieve a pencil beam antenna at 140 GHz.



(a) Structure.



(b) Calculated reflection coefficient.



(c) Calculated radiation pattern.

Figure 1. Analytical model of primary radiator fed by DTM line at 140 GHz.

References

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