

Problem 8.39 A hollow rectangular waveguide is to be used to transmit signals at a carrier frequency of 6 GHz. Choose its dimensions so that the cutoff frequency of the dominant TE mode is lower than the carrier by 25% and that of the next mode is at least 25% higher than the carrier.

Solution:

For $m = 1$ and $n = 0$ (TE₁₀ mode) and $u_{p_0} = c$ (hollow guide), Eq. (8.106) reduces to

$$f_{10} = \frac{c}{2a}.$$

Denote the carrier frequency as $f_0 = 6$ GHz. Setting

$$f_{10} = 0.75f_0 = 0.75 \times 6 \text{ GHz} = 4.5 \text{ GHz},$$

we have

$$a = \frac{c}{2f_{10}} = \frac{3 \times 10^8}{2 \times 4.5 \times 10^9} = 3.33 \text{ cm}.$$

If b is chosen such that $a > b > \frac{a}{2}$, the second mode will be TE₀₁, followed by TE₂₀ at $f_{20} = 9$ GHz. For TE₀₁,

$$f_{01} = \frac{c}{2b}.$$

Setting $f_{01} = 1.25f_0 = 7.5$ GHz, we get

$$b = \frac{c}{2f_{01}} = \frac{3 \times 10^8}{2 \times 7.5 \times 10^9} = 2 \text{ cm}.$$
