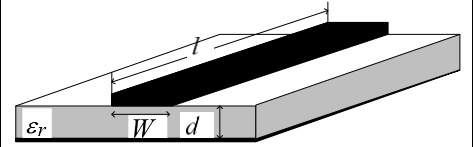


Microwave Review Quiz #2 Solution 2016.10.18

1. A microstrip line is shown in the right side. A conductor of width W is printed on a grounded dielectric of substrate of thickness d and relative permittivity ϵ_r . Based on the design parameters given in Ex. 3.7 of the text book $f=10GHz$, $\epsilon_r = 9.9$, $\tan \delta = 0.001$, $d = 0.5mm$, $W = 0.483mm$, and $l = 8.72mm$, a microstrip line has a characteristic impedance of $Z_o = 50\Omega$ with $\epsilon_{eff} = 6.665$, $\alpha_d = 0.022\text{dB/cm}$, $\alpha_c = 0.054\text{dB/cm}$ and electrical length of $\theta_e = 270^\circ$. After the fabrication, the following three cases are given without changing the substrate.



(1) Further reduce the top metal width W by properly etching. What are the resulted Z_o , ϵ_{eff} , α_d , α_c , θ (increase or decrease) and reasons?

Z_o	ϵ_{eff}	$\alpha_d = \frac{k_o \epsilon_r (\epsilon_{eff} - 1) \tan \delta}{2\sqrt{\epsilon_{eff}} (\epsilon_r - 1)}$	$\alpha_c = \frac{R_s}{Z_o W}$	$\theta = \beta_{eff} l = \sqrt{\epsilon_{eff}} l$
increase $\because C$ decrease	decrease $\because q$ decrease	\sim decrease $\because \epsilon_{eff}$ decrease	\sim increase $\because Z_o W$ decrease $(Z_o \propto \frac{1}{\sqrt{C}} \propto \frac{1}{\sqrt{W}},$ $\rightarrow Z_o W \propto \sqrt{W},$ $\Rightarrow W \downarrow \rightarrow Z_o W \downarrow)$	decrease $\because \epsilon_{eff}$ decrease

(2) Further add the top copper thickness by properly electrical plating. What are the resulted Z_o , ϵ_{eff} , α_d , α_c , θ (increase or decrease) and reasons?

Z_o	ϵ_{eff}	α_d	α_c	θ
decrease $\because C$ increase	decrease $\because q$ decrease	\sim decrease $\because \epsilon_{eff}$ decrease	\sim increase $\because Z_o$ decrease	decrease $\because \epsilon_{eff}$ decrease

(3) Further cover the microstrip line with the same substrate. What are the resulted Z_o , ϵ_{eff} , α_d , α_c , θ (increase or decrease) and reasons?

Z_o	ϵ_{eff}	$\alpha_d = \frac{k_o \epsilon_r (\epsilon_{eff} - 1) \tan \delta}{2\sqrt{\epsilon_{eff}} (\epsilon_r - 1)}$	$\alpha_c = \frac{R_s}{Z_o W}$	$\theta = \beta_{eff} l = \sqrt{\epsilon_{eff}} l$
decrease $\because C$ increase	increase $\because q$ increase	\sim increase $\because \epsilon_{eff}$ increase	\sim increase $\because Z_o$ decrease	increase $\because \epsilon_{eff}$ increase