Derivation of equations for thick CPWG

What we have:

- Equations for thick CPWG without dielectric * Usual equations for thin CPW * Correction for metal thickness
- Equations for thin CPWG with dielectric

Assumptions:

- Quasistatic approximation
- Additional capacitance due to thick metal is the same for the cases with and without dielectric
- Dielectric does not have magnetic properties so that line inductance does not change with dielectric

Basic equations:

$$v = \frac{1}{\sqrt{LC}}$$

$$Z = \sqrt{\frac{L}{C}}$$

$$\Rightarrow C = \frac{1}{Zv}$$

where v is phase velocity

Let c=speed of light

For air dielectric;

$$C = \frac{1}{cZ_{thin,air}}$$

$$C + C_x = \frac{1}{cZ_{thick,air}}$$

$$\Rightarrow C_x = \frac{1}{cZ_{thick,air}} - \frac{1}{cZ_{thin,air}}$$

where C_x is the extra capacitance due to the thickness of the strip.

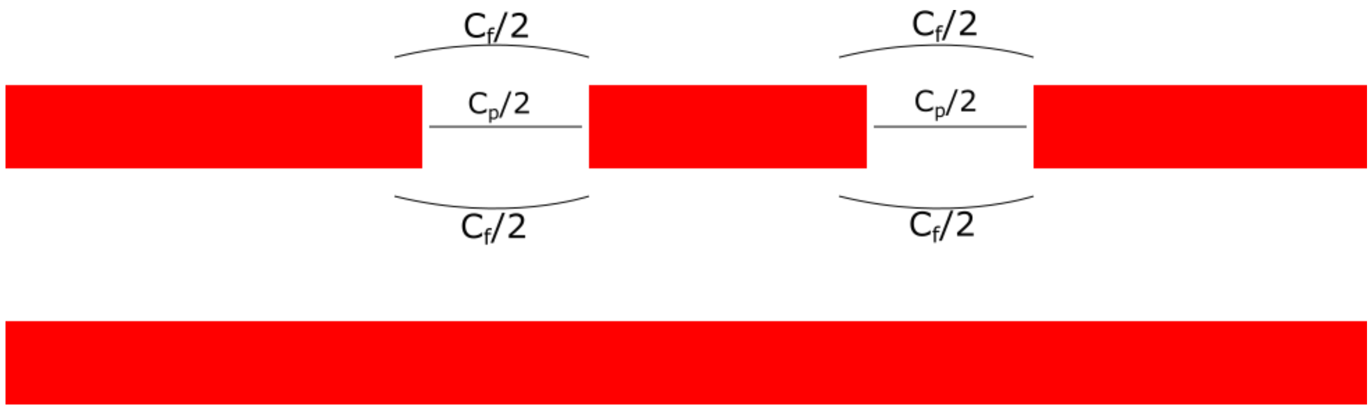
This capacitance is the result of 3 factors. Parallel-plate capacitance between the line and side ground (C_p) and fringing fields above the line ($C_{f,above}$) and below the line ($C_{f,below}$).

$$C_p = 2\epsilon_r\epsilon_0\frac{t_h}{s}$$

We assume that:

$$C_{f,above} = C_{f,below} = C_f$$

$$\Rightarrow C_x = 2C_f + C_p$$



In the presence of dielectric, only $C_{f,below}$ is multiplied by ϵ_r. So the additional capacitance due to thickness in the presence of dielectric is:

$$C_{x,diel} = (1+\epsilon_r)C_f + C_p$$

For CPW with dielectric and thin metal;

$$C_{thin,diel} = \frac{1}{v_{thin} Z_{thin,diel}}$$

$$L_{thin} = \frac{Z_{thin,diel}}{v_{thin}}$$

For CPW with dielectric and thick metal;

$$L_{thick} = \frac{Z_{thick,air}}{c}$$

$$v_{thick} = \frac{1}{L_{thick}(C_{thin,diel} + C_{x,diel})}$$

$$Z_{thick,diel} = \frac{L_{thick}}{(C_{thin,diel} + C_{x,diel})}$$