The effect of a right angled bend in a microstrip trace

A common discontinuity in PCB or IC design is the right angled bend in a metallic trace. This brief paper presents the effect this bend has on the electrical characteristic of the trace.

Please refer to Figure 1.0 below.

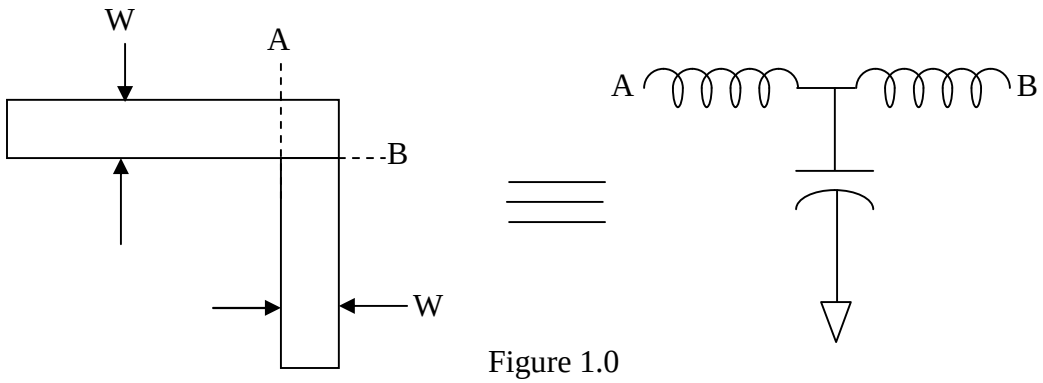

Figure 1.0

The capacitance is due to the extra charge accumulation at the corners . The inductance arises because of current flow interruption.

If the width of the microstrip (or trace) is W and the separation of the trace and the backplane is H, then the following equations provide the values of the normalized inductance and capacitance.

For W/H <1:

$$C_B/W = \frac{(14\varepsilon_r + 12.5)(W/H) - (1.83\varepsilon_r - 2.25)}{\sqrt{W/H}} \text{ pF/meter} \qquad (1)$$

For W/H >1:

$$C_B/W = (9.5\varepsilon_r + 1.25)(W/H) + 5.2\varepsilon_r + 7.0 \text{ pF/meter} \quad (2)$$

The inductance in each arm is:

$$L/H = 100\left[\left[4\sqrt{\frac{W}{H}}\right] - 4.21\right] \text{ nH/meter} \quad (3)$$

The accuracy of the equations (1) and (2) above are quoted within 5% over $2.5 \le \varepsilon_r \le 15.0$ and $0.1 \le W/H \le 2.0$.

The accuracy of equation (3) is quoted to be 3% for the range $0.5 \le W/H \le 2.0$.

Please note that much improvement can be obtained in the performance of right angled bent microstrip, by using a mitred bend. This forms the subject of a following post.

References:

Foundations of Interconnect and Microstrip Design, T.C Edwards and M.B Steer, Third edition, John Wiley and Sons,

Microstrip design using analytical expressions on a silicon substrate, Signal Processing Group Inc., technical memorandum. http://signalpro.biz/microstrip_si.pdf.