Impedance Calcs, D. Shuman , 8/16/12

from http://www.daycounter.com/LabBook/Microstrip/Microstrip-Characteristic-Impedance.phtml

Microstrip Characteristic Impedance

There are two IPC documents which are frequently referenced for approximate microstrip and stripline impedance formulas:
The IPC-D-317A has been superseded by IPC-2251 which can be purchased from www.ansi.org for about $110.
The IPC-D-317A formulas seem to be good for RF4 to about 5% but fall apart for other dielectric constants.
FR4 has an wildly varying dielectric constant from 4.5 to over 5.0.
For calculators using IPC-D-317A see http://www.emclab.umr.edu/pcbtlc/.
The default impedance calculations for Protel 2004 are based on IPC-D-317A.
Microstrip impedance formulas from IPC-D-317A:
Embedded microstrip impedance formulas from IPC-D-317A:

Dimensions and materials

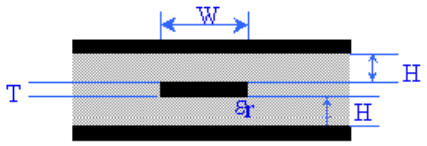
substrate
polyimide

dimensions

$\varepsilon_r := 3.4$ $t := 30\mu m$ $h := 100\mu m$ $w := 105\mu m$

Stripline:

Stripline impedance formulas from IPC-D-317A:

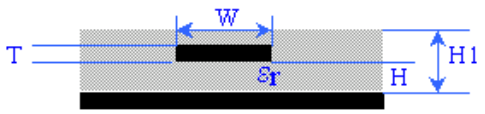


$$Z_o = \frac{60}{\sqrt{\varepsilon_r}} ln\left(\frac{1.9(2H+T)}{0.8W+T}\right) \text{ ohms} \qquad C_o = \frac{1.41\varepsilon_r}{ln\left(\frac{3.81H}{0.8W+T}\right)} \text{ pF/inch}$$

$$Z_{0\_sl} := \frac{60}{\sqrt{\varepsilon_r}} \cdot \ln\left[\frac{1.9(2t+h)}{0.8w+t}\right] \qquad Z_{0\_sl} = 31.916$$

Microstrip, embedded

Embedded microstrip impedance formulas from IPC-D-317A:



$$\varepsilon'_r = \varepsilon_r\left(1 - \exp\left(\frac{-1.55H_1}{H}\right)\right) \qquad Z_o = \frac{56}{\sqrt{\varepsilon_r'}}\ln\left(\frac{5.98H}{0.8w + t}\right) \text{ ohms}$$

coverlay thk $h_{cl} := 25\mu m$

$h_1 := h + t + h_{cl}$ $h_1 = 155\,\mu m$

$$\varepsilon'_r := \varepsilon_r\cdot\left(1 - e^{\frac{-1.55\cdot h_1}{h}}\right) \quad \varepsilon'_r = 3.092 \qquad Z_{0\_ms} := \frac{56}{\sqrt{\varepsilon'_r}}\cdot\ln\left(\frac{5.98h}{0.8w + t}\right) \quad Z_{0\_ms} = 52.78$$