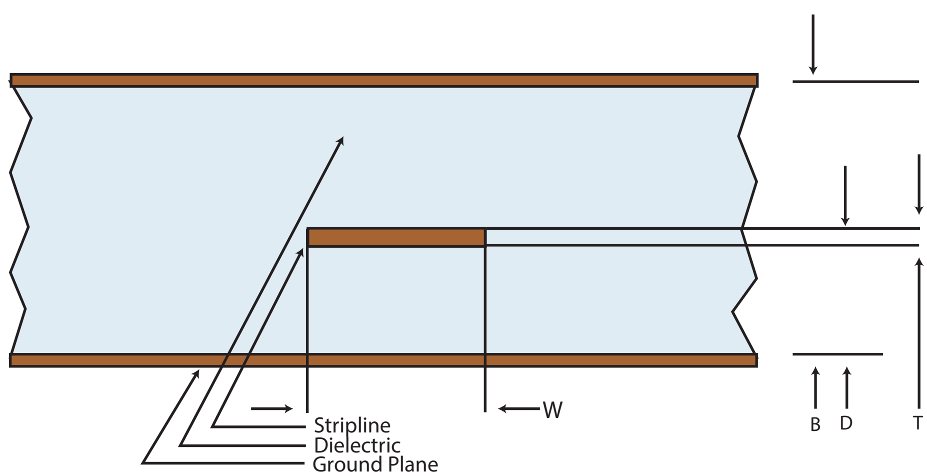
Design

Line Widths for Various Characteristic Impedances of Centered Stripline Devices in a Variety of RT/duroid® High Frequency Laminates

Closed form formulas [1,2] for the calculation of the characteristic impedance of a strip transmission line provide accurate designs if the following conditions are met: The center strip is centered between ground planes. The dielectric medium is homogeneous and isotropic in dielectric constant.

Stripline (triplate) board assemblies which have been bonded to exclude air at the edges of the conductor strip may be designed effectively with the use of these formulas. When assemblies are clamped, the impedance and effective dielectric constant will be somewhat lower due to the void at the interface.

Variables of line width W, line thickness T, ground plane spacing B and dielectric constant ε_r are taken into account. Cohn indicates that narrow strip cases where the ratio W/(B-T) is less than 0.35 should use a calculation based on equivalent round conductor. The wide case should use a calculation with fringing capacitance based on a conformal mapping derivation. These two formulas result in a discontinuity at the W/(B-T) = 0.35 point when Z_o is plotted versus W. In our tabulation a weighted average result of the two formulas is used when W/(B-T) is between 0.3 and 0.4. B is assumed to be twice the dielectric thickness plus foil thickness T. *The round conductor approximation [3] is considered inaccurate when the T/W ratio exceeds 0.11.* Errors due to etching variables on such narrow lines probably exceed the computational errors.



The following formulas can be used to generate tables:

Description of Symbols

B = ground plane spacing = 2 D + T
T = copper thickness
D = dielectric thickness
W = line width
ε_r = relative permittivity
Z_0 = characteristic impedance on ohms
p = pi = 3.14159265
A = W/(B-T)
Note that B,T,D, and W must all be in the same dimensional units.

Narrow stripline traces

For narrow traces (A< 0.35)
$Z_0 = 60 \log_e (4 B / [\pi W Y]) /\sqrt{(\varepsilon_r)}$
where
$Y = (1 + T [1 + \log_e (4\pi / X)+ 0.51\pi X^2] / [W\pi])$
$/ 2 X = T / W$
The function for Y is according to J.F. White[3], rather than the chart provided by Cohn. Accuracy is questionable when T/W exceeds 0.11, in either case.

Wide Stripline Traces

For wide traces (A>=0.35)
$Z_0 = 94.15 / [(\sqrt{\varepsilon_r}) \{CF + W/(B-T) \}]$
where CF is a fringing capacitance term
$CF = [2 X \log_e (X + 1) - (X - 1) \log_e (X^2 -1)] /\pi$
where
$X = B / (B-T)$

Other combinations of copper foil thicknesses and dielectric thicknesses in RT/duroid® laminates or characteristic impedance values may become of interest. Our Impedance calculation program is available on our website at http://www.rogerscorp.com. Refer to 3.1.1 when contacting Rogers, Internal/Technical/Applications Engineer, 100 S. Roosevelt Avenue, Chandler, AZ 85226 (480) 961-1382 or your local Rogers Application Engineer.

REFERENCES:

1. S.B. Cohn,"Characteristic Impedance of the Shielded-Strip Transmission Line", IRE Trans MTT, (July 1954), pp 52-57.
2. S.B. Cohn, "Problems in Strip Transmission Lines", IRE Trans MTT, (March 1955).
3. J.F. White, "Semiconductor Control", p 521-2 (1977) Artech House.

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