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Improvements in Schneider's ε_{eff} made by Hammerstad and Bekkadal [22] are given here. For $w/h \le 1.0$:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[\left(1 + \frac{12\,h}{w}\right)^{-0.5} + 0.04\left(1.0 - \frac{w}{h}\right)^2\right] \qquad (3.5.1.2)$$

and for $w/h \ge 1$:

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The equations for ε_{eff} are accurate to within 1% for:

$\varepsilon_r \le 16$ ($<2\%$ error $\varepsilon_r > 16$)

$0.05 \le \frac{w}{h} \le 20.0$ ($<2\%$ error $\frac{w}{h} < 0.05$)

The thickness of the trace can be corrected for by relating it to an equivalent change in the width. Owens and Potok [40] examined a number of formulas for this correction and show that Wheeler's is the most accurate:

$$\frac{\Delta w}{t} = \frac{1.0}{\pi}\ln\left[\frac{4\,e}{\sqrt{(t/h)^2 + \left(\frac{1/\pi}{w/t + 1.1}\right)^2}}\right] \qquad (3.5.1.4)$$

$$w' = w + \Delta w' \qquad (3.5.1.5)$$

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