This code is based on P. Silvester, Proc. IEEE* 115, 43 (1968). *It calculates cross-sectional distributions of BOTH microwave magnetic and electric fields of a microstrip line.

Electric permittivity and magnetic permeability of vacuum:

$\varepsilon_0 := 8.86 \cdot 10^{-12}$ $\mu_0 := 4 \cdot \pi \cdot 10^{-7} = 1.257 \times 10^{-6}$

Number of mesh steps

$N := 80$

Thickness and of the dielectric substrate (in metres) and its relative permittivitity:

$h := 0.5 \cdot 10^{-3}$ $\varepsilon_1 := 3.55$

Thickness of the metallic strip:

$a := 0. \cdot h$

Width of the metallic strip in metres:

$w := 1.50 \cdot 10^{-3}$

Co-ordinate along the stripe width is x. Co-ordinate in the direction perpendicular to the surface of the microstrip line is y (the axes are swapped with respect to Silvester's notations).
Co-ordinate of the substrate metallisation is y=0. Co-ordinate of the substrate surface carying the microstrip is y=h. If the microstrip has a finite thickness a, the co-ordinate of the microstrip surface facing away from the substrate is y=h+a. (For simplicity one may assume a=0). The longitudinal axis of the microstrip is at x=0. The edges of the microstrip are at +-w/2.

Wed Mar 26 12:46:15 2014

Calculation results: microwave electric field

Calculated Capacitance per unit length of the microstrip line (F/m):

$C = 1.359 \times 10^{-10}$

Electric potential at the position (x,y) is F(y,x) for the amplitude of the wave of potential of 1 Volt.

Below you may add your own code to play arround with F(y,x). Examples of possible calculations:

$i := 0, 1 .. N - 1$

Potential at the microstrip axis (x=0) as a function of y/h:

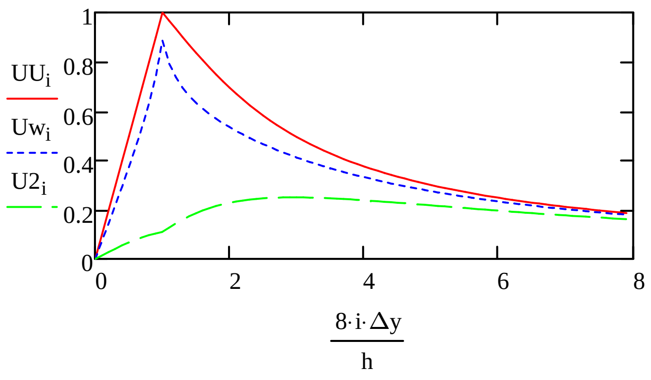
Potential at the edge of the microstrip (x=w/2) as a function of y/h:

Potential at the the distance w from the microstrip axis (x=w) as a function of y/h:

$UU_i := F(8 \cdot i \cdot \Delta y, 0)$

$Uw_i := F\left(8 \cdot i \cdot \Delta y, \frac{w}{2}\right)$

$U2_i := F(8 \cdot i \cdot \Delta y, w)$

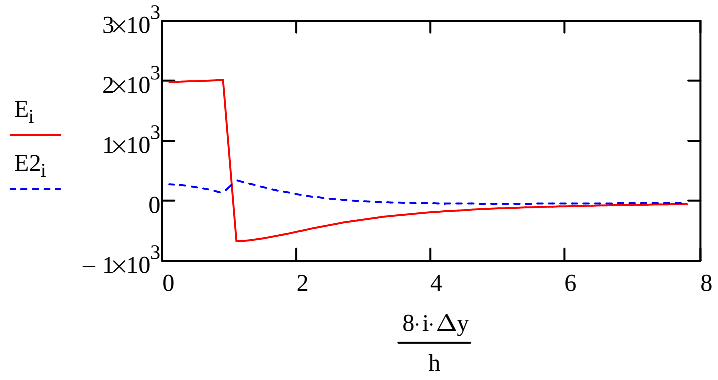


The microwave electric field is the 1st derivative of the potential. An example of calculation. The electric field at x=0 and x=w as a function of y/h:

$i := 1, 2 .. N - 2$

$E_i := \frac{UU_{i+1} - UU_{i-1}}{2 \cdot \Delta y \cdot 8}$

$E2_i := \frac{U2_{i+1} - U2_{i-1}}{2 \cdot \Delta y \cdot 8}$



Wed Mar 26 12:46:31 2014

Calculation results: microwave magnetic field

Calculated inductance per unit length of the microstrip line (F/m):

$L = 2.34 \times 10^{-7}$

Acordingly, the characteristic impedance z0 (in Ohms) and the propagation constant γ (in m^{-1}) are:

$z0 := \sqrt{\frac{L}{C}} = 41.499$ $\gamma := \sqrt{L \cdot C} = 5.639 \times 10^{-9}$

Vector magnetic potential distribution for the microwave current amplitude *I*=1Volt/z0 is given by Fm(y,x).

Below you may add your own code to play arround with Fm(y,x). Examples of possible calculations:

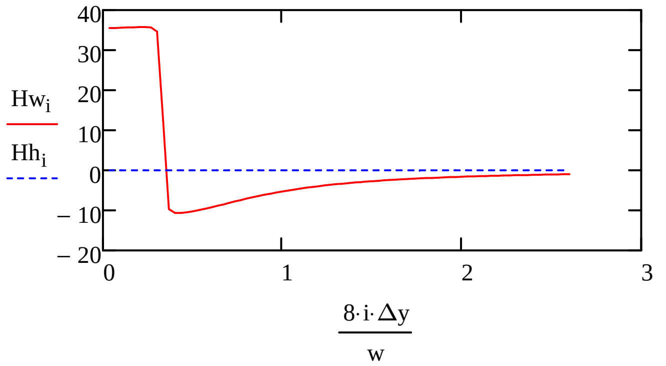
In-plane (Hw) and out-of-plane (Hh) components of magnetic field are given by curl of the potential. Let us calculate them for x=0 as a function of y/h:

$i := 0, 1 .. N-1$

$AA_i := Fm(8 \cdot i \cdot \Delta y, 0)$ $AAp_i := Fm(8 \cdot i \cdot \Delta y, \Delta x \cdot 0.01)$ $AAm_i := Fm(8 \cdot i \cdot \Delta y, -\Delta x \cdot 0.01)$

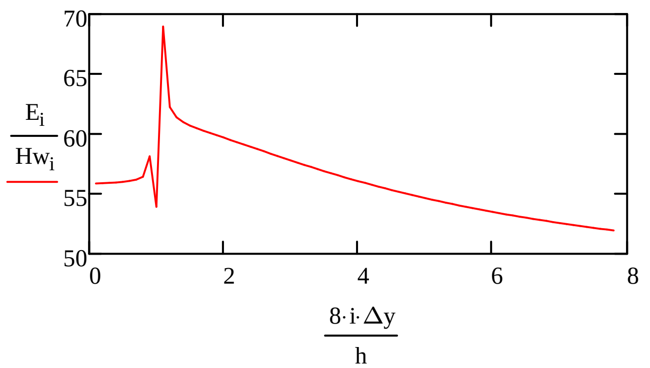
$i := 1, 2 .. N-2$

$$Hw_i := \frac{AA_{i+1} - AA_{i-1}}{\mu_0 \cdot 2 \cdot \Delta y \cdot 8} \qquad Hh_i := \frac{AAp_i - AAm_i}{\mu_0 \cdot 2 \cdot \Delta x \cdot 0.01}$$



One sees that the out-of-plane component is precisely zero on the axis of the microstrip which is consistent.

Ratio of the electric and the magnetic fields:



One sees that the ratio is close to z0 but is not precisely z0 and is not constant as a function of y.