This code solves the Laplace equation for the geometry of the microstrip line and calculates its electric field in the electrostatic approximation

The calculations are carried out on a rectangular mesh of NxN points covering the cross-section of the microstrip line. The sides (walls) of this box are kept at a zero potential. The microstrip line should be located in the middle of the box, well away from its walls. The ground plane of the microstrip line (MSL) should not be touching the walls. Thus, its width w_g is assumed to be finite. In our example the width of the ground plane is 6 times the width *w* of the micorstrip w_g=6w*. The size of the box is 8*w* x 8h**.

Number of mesh points along one of the sides of the grounded box:

$$N := 128$$

The relative electric permittivity of the substrate of MSL:

$$\varepsilon_r := 9.6$$

Thickness of the substrate (in mm)

$$h := 1$$

Width of the microstrip (in mm, its thickness is assumed to be zero)

$$w := 1$$

Width of the ground plane (in times of w)

$$w_g := 6 \cdot w$$

Size of the box along the width of the microstrip (x-direction)

$$X := 8 \cdot w$$

Size of the box along the thickness of the substrate (y-direction)

$$Y := 8 \cdot h$$

The code solves the Laplace equation with the relaxation method. The maximum number of iterations:

$$N_{it} := 2000$$

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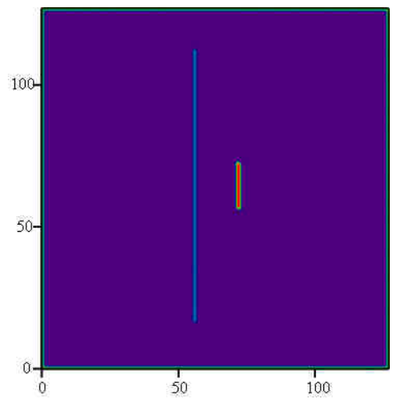
Resultant geometry of the problem. Red line: microstrip; blue line: MPS ground plane



A

Mesh step along x: $\Delta x = 0.063$

Mesh step along y: $\Delta Y = 0.063$

Point number for the x co-ordinate of the ground plane: $n_g = 56$

Point number for the x co-ordinate of the microstrip $n_h = 72$

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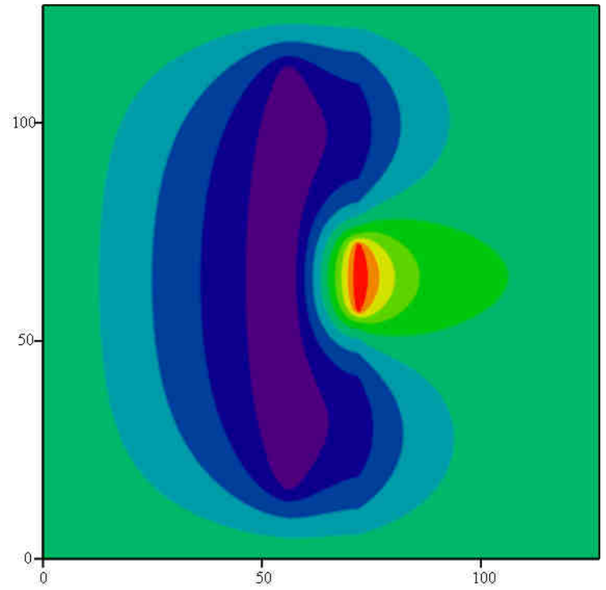
The calculated distribution of the electric potenital is in the form of a 2D array $BBB_{n,m}$. It is visualised below. n stands for the mesh point number along y and m along x.

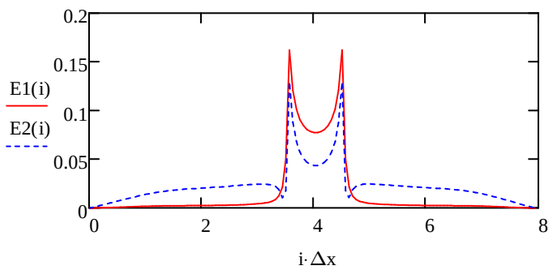


BBB

You can play around with this array. Example of possible calculations.

Electric field near the microstrip surface:

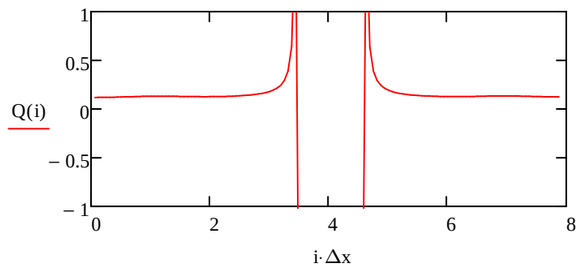
$$E1(i) := \left| BBB_{n_h, i} - BBB_{n_h - 1, i} \right| \qquad E2(i) := \left| BBB_{n_h + 1, i} - BBB_{n_h, i} \right|$$



Charge density at the substrate surface:

$$Q(i) := \frac{BBB_{n_h,i} - BBB_{n_h-1,i}}{BBB_{n_h+1,i} - BBB_{n_h,i}}$$

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



Cross-sectional maps of the two components of the electric field:

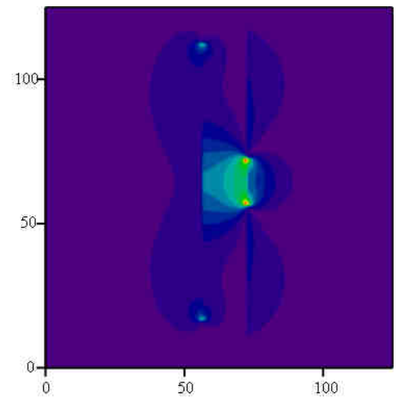
$i := 1, 2 .. N - 3$ $\qquad$ $j := 1, 2 .. N - 3$

Out-of-plane component:

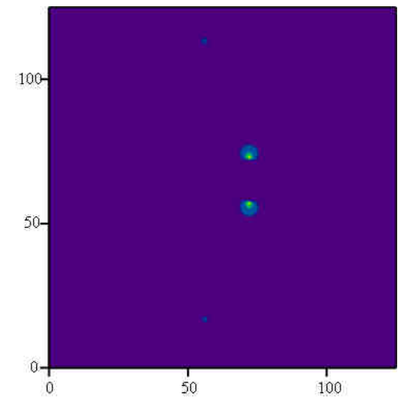
$$En_{i,j} := \left| BBB_{i,j} - BBB_{i-1,j} \right|$$

In-plane component:

$$Et_{i,j} := \left| BBB_{i,j} - BBB_{i,j-1} \right|$$



En



Et