

Расчёт аппроксимированной АЧХ ППФ фильтров 2 и 4 порядка

$$f_0 := 950 \cdot 10^6 \quad L_n := 3 \quad \varepsilon \varepsilon \phi \phi := 1.4 \quad W50 := 11 \quad j := \sqrt{-1} \rightarrow 1i \quad c := 3 \cdot 10^8$$

$$\Delta f := 150 \cdot 10^6 \quad \lambda_0 := \frac{c}{f_0} = 0.316 \quad \lambda_l := \frac{\lambda_0}{\sqrt[2]{\varepsilon \varepsilon \phi \phi}} = 0.267$$

$$f_H := f_0 - \frac{\Delta f}{2} = 8.75 \cdot 10^8$$

$$f_{HH} := f_0 - \frac{3 \cdot \Delta f}{2} = 7.25 \cdot 10^8$$

$$f_{\theta} := f_0 + \frac{\Delta f}{2} = 1.025 \cdot 10^9$$

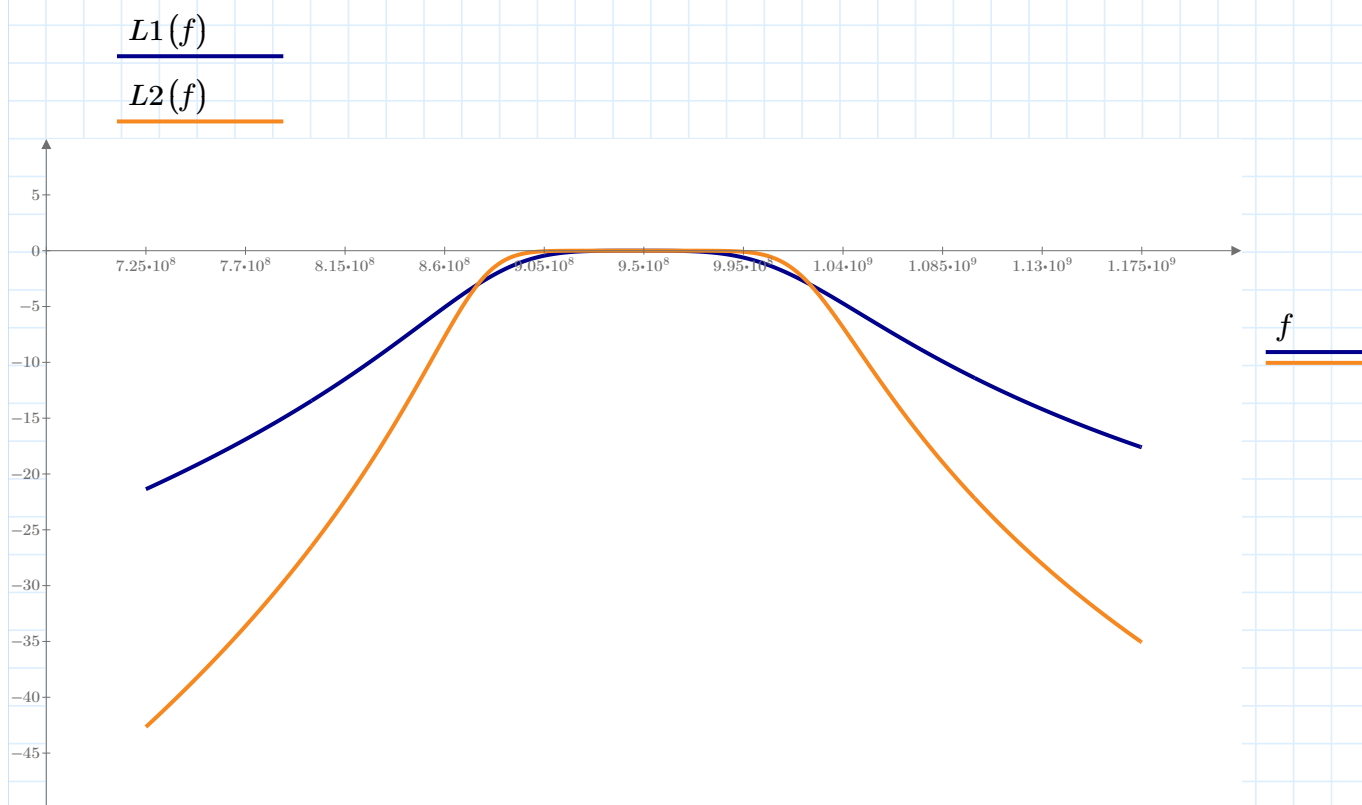
$$f_{\theta\theta} := f_0 + \frac{3 \cdot \Delta f}{2} = 1.175 \cdot 10^9$$

$$h := 10^{\frac{L_n}{10}} - 1 = 0.995$$

$$\Omega(f) := \frac{f^2 - f_H \cdot f_{\theta}}{f \cdot (f_{\theta} - f_H)}$$

$$L1(f) := -10 \log \left(1 + \Omega(f)^{2 \cdot 2} \right)$$

$$L2(f) := -10 \log \left(1 + \Omega(f)^{2 \cdot 4} \right)$$



Расчёт фильтра-прототипа 2-ого порядка

$$n := 1 \dots 2 \quad g_2(n) := 2 \cdot {}^{2 \cdot 2} \sqrt{h} \cdot \sin\left(\frac{(2 \cdot n - 1) \cdot \pi}{2 \cdot 2}\right) \quad Q(n) := g_2(n) \cdot \frac{f_0}{2(f_B - f_H)}$$

$$g_2(n) = \begin{bmatrix} 1.413 \\ 1.413 \end{bmatrix} \quad Q(n) = \begin{bmatrix} 4.473 \\ 4.473 \end{bmatrix} \quad hru := \begin{bmatrix} 0.351 \\ 0.351 \end{bmatrix} \quad hru = \frac{2 \cdot l_1}{\lambda_l}, \text{ определяется по графику, вводится вручную}$$

$$l_1 := hru \cdot \frac{\lambda_l}{2} \quad l_1 = \begin{bmatrix} 0.047 \\ 0.047 \end{bmatrix} \quad l_2 := \frac{\lambda_l}{2} - l_1 = \begin{bmatrix} 0.087 \\ 0.087 \end{bmatrix} \quad \text{длина} := l_1 + l_2 = \begin{bmatrix} 0.133 \\ 0.133 \end{bmatrix}$$

$$\beta(f) := \frac{2 \cdot \pi \cdot f \cdot \sqrt{\varepsilon \phi \phi}}{3 \cdot 10^8}$$

$$Y_1(f) := j \cdot \tan(\beta(f) \cdot l_1(0)) + j \cdot \tan(\beta(f) \cdot l_2(0))$$

$$l := \frac{\lambda_l}{4} = 0.067$$

$$Y_2(f) := j \cdot \tan(\beta(f) \cdot l_1(1)) + j \cdot \tan(\beta(f) \cdot l_2(1))$$

$$A_1(f) := \begin{bmatrix} 1 & 0 \\ Y_1(f) & 1 \end{bmatrix}$$

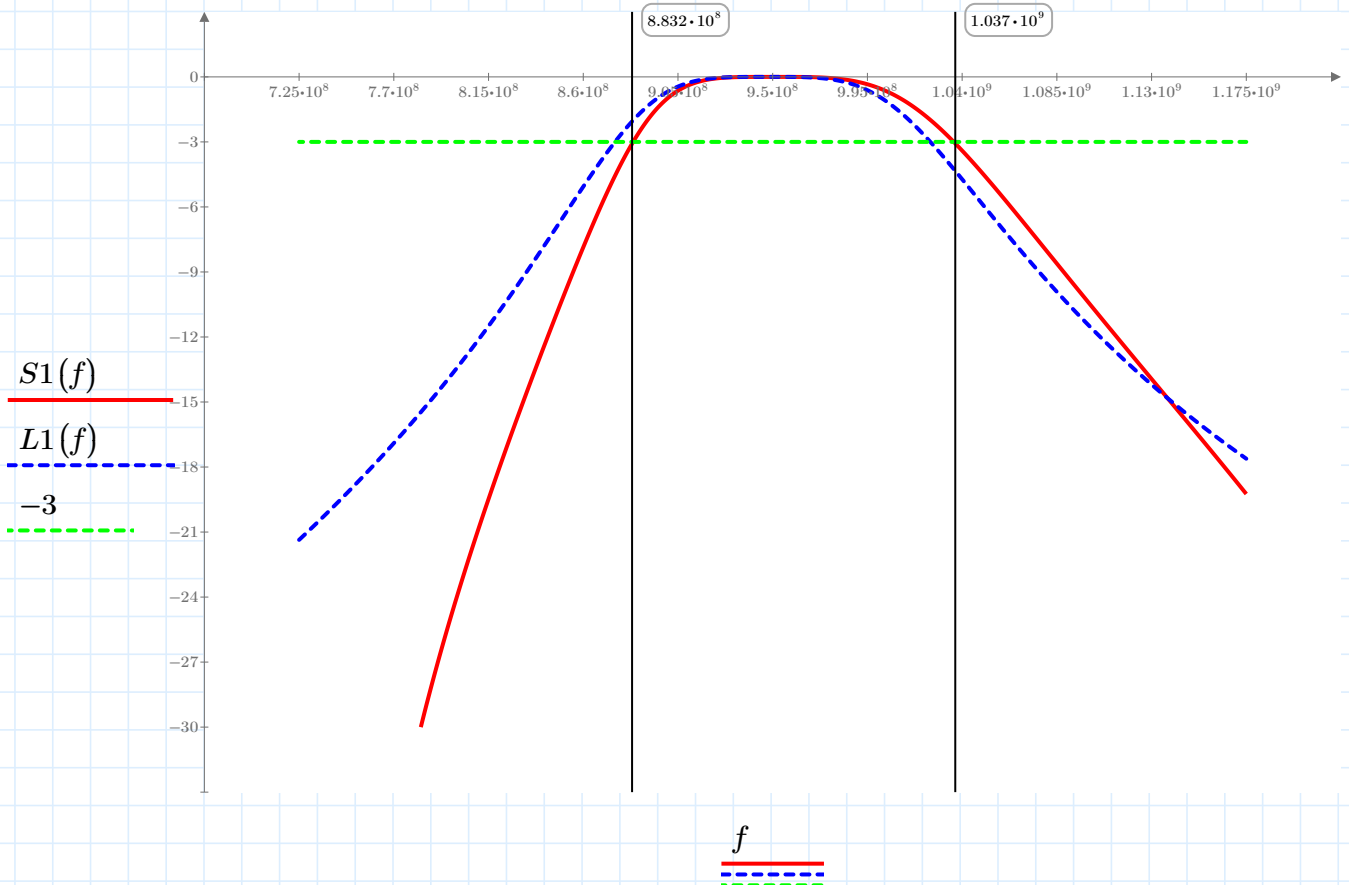
$$A_2(f) := \begin{bmatrix} 1 & 0 \\ Y_2(f) & 1 \end{bmatrix}$$

$$Z(f) := \begin{bmatrix} \cos(\beta(f) \cdot l) & j \cdot \sin(\beta(f) \cdot l) \\ j \cdot \sin(\beta(f) \cdot l) & \cos(\beta(f) \cdot l) \end{bmatrix}$$

$$A(f) := A_1(f) \cdot Z(f) \cdot A_2(f)$$

$$S_{12}(f) := \frac{2}{A(f)_{1,1} + A(f)_{1,2} + A(f)_{2,1} + A(f)_{2,2}}$$

$$S_1(f) := 20 \cdot \log(|S_{12}(f)|)$$



Расчёт фильтра-прототипа 4-ого порядка

$$k := 1 \dots 4$$

$$g2(k) := 2 \cdot \sqrt[2.4]{h} \cdot \sin\left(\frac{(2 \cdot k - 1) \cdot \pi}{2.4}\right) \quad Q(k) := g2(k) \cdot \frac{f_0}{2(f_0 - f_H)}$$

$$g2(k) = \begin{bmatrix} 0.765 \\ 1.847 \\ 1.847 \\ 0.765 \end{bmatrix}$$

$$Q(k) = \begin{bmatrix} 2.422 \\ 5.848 \\ 5.848 \\ 2.422 \end{bmatrix}$$

$$hru := \begin{bmatrix} 0.29 \\ 0.355 \\ 0.355 \\ 0.29 \end{bmatrix}$$

$$hru = \frac{2 \cdot l1}{\lambda_l}, \text{ определяется по графику, вводится вручную}$$

$$l1 := hru \cdot \frac{\lambda_l}{2} = \begin{bmatrix} 0.039 \\ 0.047 \\ 0.047 \\ 0.039 \end{bmatrix}$$

$$l2 := \frac{\lambda_l}{2} - l1 = \begin{bmatrix} 0.095 \\ 0.086 \\ 0.086 \\ 0.095 \end{bmatrix}$$

$$\text{длина} := l1 + l2 = \begin{bmatrix} 0.133 \\ 0.133 \\ 0.133 \\ 0.133 \end{bmatrix}$$

$$Y1(f) := j \cdot \tan(\beta(f) \cdot l1(0)) + j \cdot \tan(\beta(f) \cdot l2(0))$$

$$Y2(f) := j \cdot \tan(\beta(f) \cdot l1(1)) + j \cdot \tan(\beta(f) \cdot l2(1))$$

$$Y4(f) := j \cdot \tan(\beta(f) \cdot l1(3)) + j \cdot \tan(\beta(f) \cdot l2(3))$$

$$Y3(f) := j \cdot \tan(\beta(f) \cdot l1(2)) + j \cdot \tan(\beta(f) \cdot l2(2))$$

$$A1(f) := \begin{bmatrix} 1 & 0 \\ Y1(f) & 1 \end{bmatrix}$$

$$A3(f) := \begin{bmatrix} 1 & 0 \\ Y3(f) & 1 \end{bmatrix}$$

$$A2(f) := \begin{bmatrix} 1 & 0 \\ Y2(f) & 1 \end{bmatrix}$$

$$A4(f) := \begin{bmatrix} 1 & 0 \\ Y4(f) & 1 \end{bmatrix}$$

$$l := \frac{\lambda_l}{4} = 0.067$$

$$\beta(f) := \frac{2 \cdot \pi \cdot f \cdot \sqrt{\epsilon \phi \phi}}{3 \cdot 10^8}$$

$$Z(f) := \begin{bmatrix} \cos(\beta(f) \cdot l) & j \cdot \sin(\beta(f) \cdot l) \\ j \cdot \sin(\beta(f) \cdot l) & \cos(\beta(f) \cdot l) \end{bmatrix}$$

$$A(f) := A1(f) \cdot Z(f) \cdot A2(f) \cdot Z(f) \cdot A3(f) \cdot Z(f) \cdot A4(f)$$

$$S_{21}(f) := \frac{2}{A(f)_{1,1} + A(f)_{1,2} + A(f)_{2,1} + A(f)_{2,2}}$$

$$S2(f) := 20 \cdot \log(|S_{21}(f)|)$$

