

worksheet 5.5.1 page 1

$$\mu_o := 4 \cdot \pi \cdot 10^{-7} \text{ H/m} \quad \varepsilon_o := 8.854 \cdot 10^{-12} \text{ F/m} \quad \underline{c} := 2.998 \cdot 10^8 \text{ m/s}$$

$$\rho := 1.7 \cdot 10^{-8} \text{ } \Omega \text{ m} \quad l := 15 \text{ m} \quad h := 10 \cdot 10^{-3} \text{ m}$$

$$\underline{s} := 1.2 \cdot 10^{-3} \text{ m} \quad r := 0.4 \cdot 10^{-3} \text{ m} \quad \text{see figure 4.3.1}$$

$$R_{ss1} := \frac{\rho \cdot l}{\pi \cdot r^2} \text{ } \Omega \quad R_{ss2} := R_{ss1} \quad R_{ss3} := 0.005 \text{ } \Omega \quad \text{equation (2.5.11)}$$

$$F_x := \frac{4 \cdot \rho}{\mu_o \cdot \pi \cdot r^2} = 1.077 \times 10^5 \text{ Hz} \quad \text{equation (2.5.14)}$$

$$L_{c1} := \frac{\mu_o \cdot l}{2 \cdot \pi} \cdot \ln \left(\frac{2 \cdot h \cdot s}{r \cdot \sqrt{s^2 + 4 \cdot h^2}} \right) \quad L_{c2} := L_{c1}$$

$$L_{c3} := \frac{\mu_o \cdot l}{2 \cdot \pi} \cdot \ln \left(\frac{\sqrt{s^2 + 4 \cdot h^2}}{s} \right) \quad \text{equation (2.11.3)}$$

$$C_c := \frac{1}{L_c} \cdot \left(\frac{l}{c} \right)^2 \quad \text{equation (2.3.8)}$$

$$F_q := \frac{1}{4 \cdot \sqrt{L_{c1} \cdot C_{c1}}} = 4.997 \times 10^6 \text{ Hz} \quad \text{equation (2.3.9)}$$

Component values for three-conductor assembly of figure 5.5.2:-

$$\frac{R_{ss}}{2} = \begin{pmatrix} 0.254 \\ 0.254 \\ 2.5 \times 10^{-3} \end{pmatrix} \quad \frac{L_c}{2} = \begin{pmatrix} 1.645 \times 10^{-6} \\ 1.645 \times 10^{-6} \\ 4.223 \times 10^{-6} \end{pmatrix} \quad C_c = \begin{pmatrix} 7.608 \times 10^{-10} \\ 7.608 \times 10^{-10} \\ 2.964 \times 10^{-10} \end{pmatrix}$$

$$Z_n := \begin{pmatrix} 132 \\ 0 \\ 0 \end{pmatrix} \text{ } \Omega \quad Z_f := \begin{pmatrix} 132 \\ 0 \\ 0 \end{pmatrix} \text{ } \Omega \quad G_c := \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \text{ S} \quad R_{rad} := 50 \text{ } \Omega$$

Figure 5.5.3 Calculating parameter values for the three-conductor circuit model

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Zbranch(f) :=
  ω ← 2·π ·f
  for i ∈ 1..3
    Rci ← Rssi·√(1 + f/Fx)
    θ ← √((Rci + j·ω·Lci)·(Gci + j·ω·Cci))
    Zo ← √(Rci + j·ω·Lci / Gci + j·ω·Cci)
    Z1,i ← Zo·tanh(θ/2)
    Z2,i ← Zo·csch(θ)
  Z

Zloop(f) :=
  Z ← Zbranch(f)
  Z11 ← Zn1 + Z1,1 + Z2,1 + Z2,2 + Z1,2 + Zn2
  Z12 ← -(Z1,2 + Z2,2 + Zn2)
  Z13 ← -(Z2,1 + Z2,2)
  Z14 ← Z2,2
  Z22 ← Zn2 + Z1,2 + Z2,2 + Z2,3 + Z1,3 + Zn3 + Rrad
  Z23 ← Z2,2
  Z24 ← -(Z2,2 + Z2,3)
  Z33 ← Zf2 + Z1,2 + Z2,2 + Z2,1 + Z1,1 + Zf1
  Z34 ← -(Z1,2 + Z2,2 + Zf2)
  Z44 ← Zf3 + Z1,3 + Z2,3 + Z2,2 + Z1,2 + Zf2
  ( Z11 Z12 Z13 Z14
    Z12 Z22 Z23 Z24
    Z13 Z23 Z33 Z34
    Z14 Z24 Z34 Z44 )

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Figure 5.5.6 Calculating the values of the branch and loop parameters

$\underline{S} := 1$	$V_{threat}(f) :=$	$\lambda \leftarrow \frac{c}{f}$	<p>Calculating the threat voltage for a power density S at a frequency f.</p> <p>See figure 5.3.6.</p>
		$V_a \leftarrow \sqrt{S \cdot 377} \cdot \frac{\lambda}{\pi}$	
		$V_b \leftarrow V_a \sin\left(2 \cdot \pi \cdot \frac{l}{\lambda}\right)$	
		$V_b \leftarrow V_a \text{ if } l > \frac{\lambda}{4}$	

$n := 100$	$\underline{s} := 1 .. 20 \cdot n$	$\underline{F_s} := s \cdot \frac{F_q}{n}$	<p>defining the frequency range</p>
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$I_{out_s} :=$	$f \leftarrow F_s$	<p>Main program</p>
	$Z \leftarrow Z_{loop}(f)$	
	$V \leftarrow \begin{pmatrix} 0 \\ V_{threat}(f) \\ 0 \\ 0 \end{pmatrix}$	
	$I \leftarrow lsolve(Z, V)$	
	$ I_2 $	

Figure 5.5.7 Calculating the frequency response of the common-mode current

$$\max(I_{out}) = 11.476$$

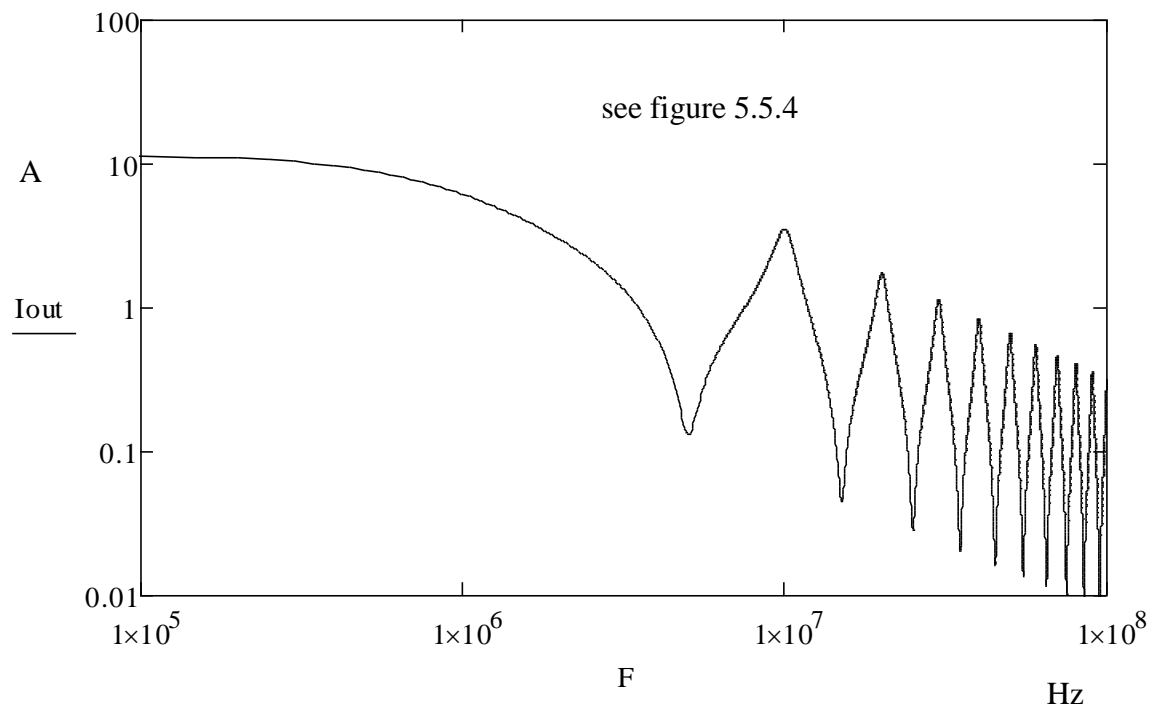


Figure 5.5.8 Frequency response of current in the common-mode loop