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data from table 9.4

$$c := 299.8\cdot 10^{6} \quad \text{m/s}$$

$$data := \begin{pmatrix} 0.01 & 10 \\ 0.1 & 10 \\ 0.1 & 10 \\ 0.5 & 10 \\ 0.5 & 10 \\ 1.6 & 10 \\ 1.6 & 560 \\ 5 & 560 \\ 5 & 380 \\ 10 & 380 \\ 10 & 200 \\ 30 & 200 \\ 30 & 200 \\ 100 & 200 \\ 100 & 60 \\ 200 & 60 \\ 200 & 70 \\ 700 & 70 \\ 700 & 60 \\ 1000 & 60 \end{pmatrix}$$

$$l := 15 \quad \text{m}$$ length of cable

$$fq := \frac{c}{4\cdot l} = 4.997\times 10^{6} \quad \text{Hz}$$

$$n := 100 \qquad N := 20\cdot n \qquad i := 1 .. N$$

$$F_i := i\cdot\frac{fq}{n}$$

$$fnd(thres) := \left| \begin{array}{l} j \leftarrow 1 \\ \text{while } \left|data_{j,1}\right| \le thres \\ \quad j \leftarrow j+1 \\ k \leftarrow j-1 \\ data_{k,2} \end{array} \right.$$

$$E(i) := \left| \begin{array}{l} f \leftarrow F_i \\ thres \leftarrow f\cdot 10^{-6} \\ fnd(thres) \end{array} \right.$$ see figure 9.4.1

$$Vthreat(i) := \left| \begin{array}{l} f \leftarrow F_i \\ \lambda \leftarrow \frac{c}{f} \\ Va \leftarrow E(i)\cdot\frac{\lambda}{\pi} \\ Vb \leftarrow Va\sin\left(2\cdot\pi\cdot\frac{l}{\lambda}\right) \\ Vb \leftarrow Va \quad \text{if } l > \frac{\lambda}{4} \end{array} \right.$$

Function based on figure 5.3.6.
Displayed on fig 9.4.2

Figure 9.4.4 Calculating the threat voltage for a 15 m cable

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$\mu_o := 4 \cdot \pi \cdot 10^{-7}$ $\quad \varepsilon_o := 8.854 \cdot 10^{-12}$ $\quad \rho := 1.7 \cdot 10^{-8}$

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

$Rss_1 := \dfrac{\rho \cdot l}{\pi \cdot r^2}$ $\quad Rss_2 := Rss_1$ $\quad Rss_3 := 0.005$ $\quad$ equation (2.5.11)

$Fx := \dfrac{4 \cdot \rho}{\mu_o \cdot \pi \cdot r^2}$ $\quad Fx = 1.077 \times 10^5$ $\quad$ equation (2.5.14)

$$Lc_1 := \frac{\mu_o \cdot l}{2 \cdot \pi} \cdot \ln\left(\frac{2 \cdot h \cdot s}{r \cdot \sqrt{s^2 + 4 \cdot h^2}}\right) \qquad Lc_2 := Lc_1$$

$$Lc_3 := \frac{\mu_o \cdot l}{2 \cdot \pi} \cdot \ln\left(\frac{\sqrt{s^2 + 4 \cdot h^2}}{s}\right)$$

equation (2.11.3)

$$Cc := \frac{1}{Lc} \cdot \left(\frac{l}{c}\right)^2$$

equation (2.3.8)

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

$$\frac{Rss}{2} = \begin{pmatrix} 0.254 \\ 0.254 \\ 2.5 \times 10^{-3} \end{pmatrix} \qquad \frac{Lc}{2} = \begin{pmatrix} 1.645 \times 10^{-6} \\ 1.645 \times 10^{-6} \\ 4.223 \times 10^{-6} \end{pmatrix} \qquad Cc = \begin{pmatrix} 7.608 \times 10^{-10} \\ 7.608 \times 10^{-10} \\ 2.964 \times 10^{-10} \end{pmatrix}$$

$$Zn := \begin{pmatrix} 132 \\ 0 \\ 0 \end{pmatrix} \qquad Zf := \begin{pmatrix} 132 \\ 0 \\ 0 \end{pmatrix} \qquad Gc := \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \qquad Rrad := 50$$

Figure 5.5.3 Calculating paramater values for the thrree-conductor circuit model

Worksheet 9.4 page 3: Copied from worksheet 5.5 page 2

$$
\mathrm{Zbranch}(f) := \left|
\begin{array}{l}
\omega \leftarrow 2\cdot\pi\cdot f \\
\text{for } i \in 1..3 \\
\quad \left|
\begin{array}{l}
Rc_i \leftarrow Rss_i\cdot\sqrt{1+\dfrac{f}{Fx}} \\
\theta \leftarrow \sqrt{(Rc_i + j\cdot\omega\cdot Lc_i)\cdot(Gc_i + j\cdot\omega\cdot Cc_i)} \\
Zo \leftarrow \sqrt{\dfrac{Rc_i + j\cdot\omega\cdot Lc_i}{Gc_i + j\cdot\omega\cdot Cc_i}} \\
Z_{1,i} \leftarrow Zo\cdot\tanh\left(\dfrac{\theta}{2}\right) \\
Z_{2,i} \leftarrow Zo\cdot\mathrm{csch}(\theta)
\end{array}
\right. \\
Z
\end{array}
\right.
$$

$$
\mathrm{Zloop}(f) := \left|
\begin{array}{l}
Z \leftarrow \mathrm{Zbranch}(f) \\
Z11 \leftarrow Zn_1 + Z_{1,1} + Z_{2,1} + Z_{2,2} + Z_{1,2} + Zn_2 \\
Z12 \leftarrow -(Z_{1,2} + Z_{2,2} + Zn_2) \\
Z13 \leftarrow -(Z_{2,1} + Z_{2,2}) \\
Z14 \leftarrow Z_{2,2} \\
Z22 \leftarrow Zn_2 + Z_{1,2} + Z_{2,2} + Z_{2,3} + Z_{1,3} + Zn_3 + Rrad \\
Z23 \leftarrow Z_{2,2} \\
Z24 \leftarrow -(Z_{2,2} + Z_{2,3}) \\
Z25 \leftarrow -Z_{1,3} \\
Z33 \leftarrow Zf_2 + Z_{1,2} + Z_{2,2} + Z_{2,1} + Z_{1,1} + Zf_1 \\
Z34 \leftarrow -(Z_{1,2} + Z_{2,2} + Zf_2) \\
Z44 \leftarrow Zf_3 + Z_{1,3} + Z_{2,3} + Z_{2,2} + Z_{1,2} + Zf_2 \\
\begin{pmatrix}
Z11 & Z12 & Z13 & Z14 \\
Z12 & Z22 & Z23 & Z24 \\
Z13 & Z23 & Z33 & Z34 \\
Z14 & Z24 & Z34 & Z44
\end{pmatrix}
\end{array}
\right.
$$

Figure 5.5.5

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$$
Iout_i := \left|
\begin{array}{l}
f \leftarrow F_i \\
Z \leftarrow Zloop(f) \\
V \leftarrow \begin{pmatrix} 0 \\ Vthreat(i) \\ 0 \\ 0 \end{pmatrix} \\
I \leftarrow lsolve(Z, V) \\
\left| I_1 \right|
\end{array}
\right.
$$

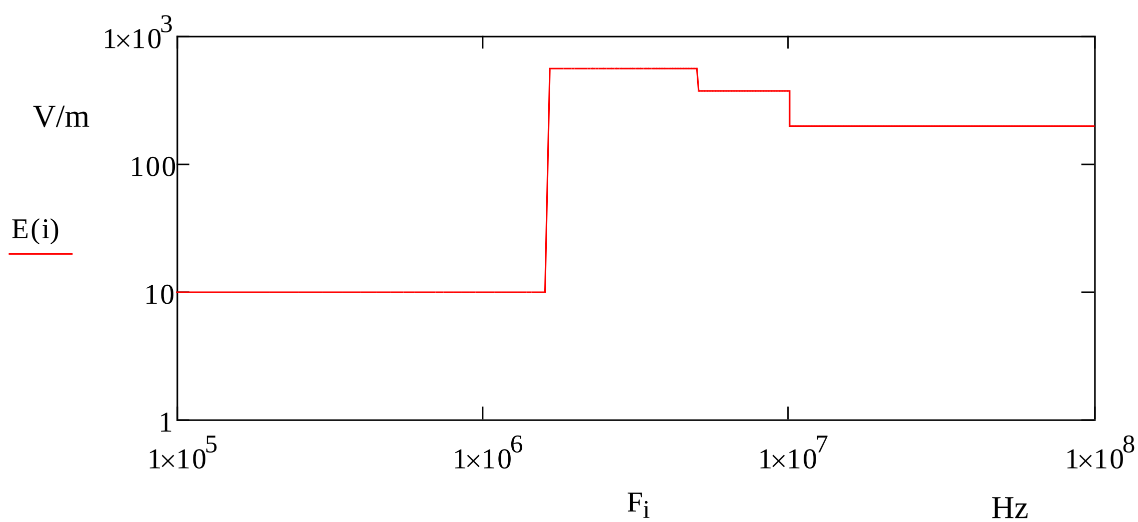

Figure 9.4.1 Military threat environment over the range 100 kHz to 100 MHz

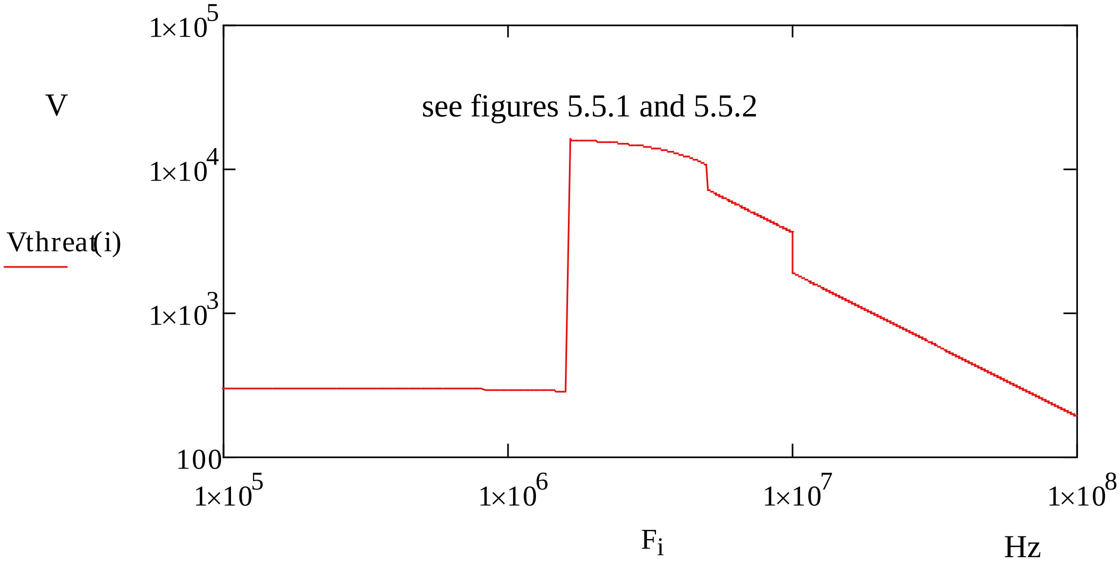

Figure 9.4.2 Threat voltage induced in the common-mode loop

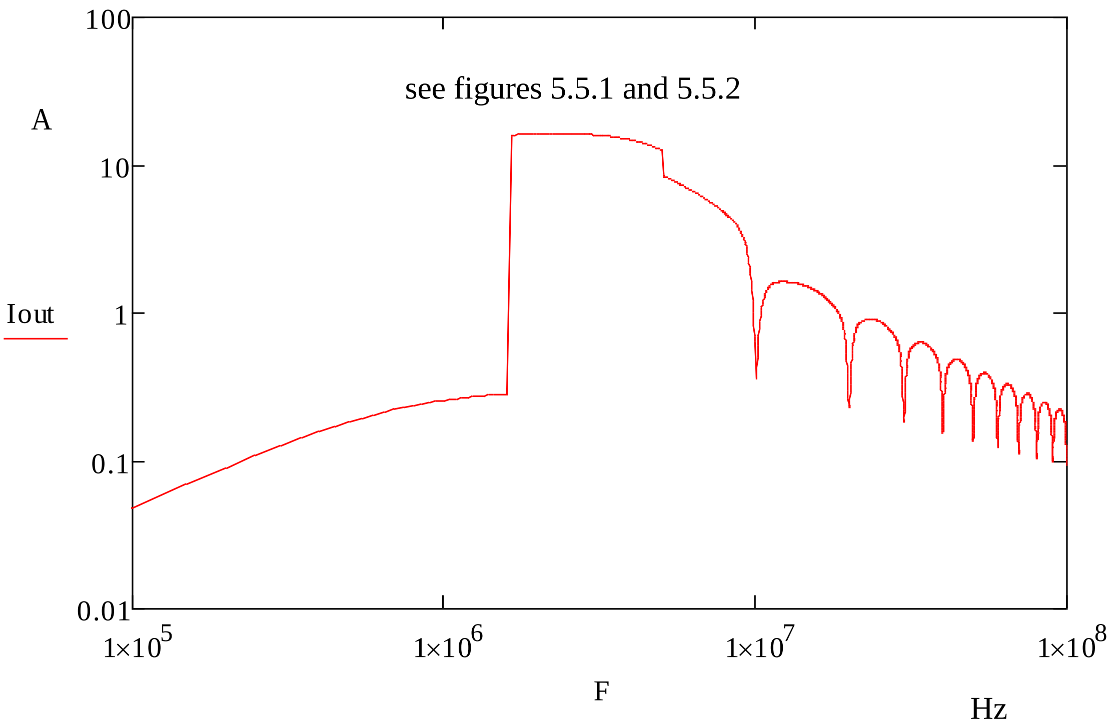

Figure 9.4.3 Frequency response of current in the differential-mode loop