6.3.3)

$$\vec{E}_{01} \rightarrow \vec{E}_z(\rho,\varphi,z) = \rho\, J_0\left(2{,}401 \frac{\rho}{R}\right) e^{-j\beta z}$$

$$\rightarrow \vec{E}_\rho(\rho,\varphi,z) = j \cdot \frac{\beta}{\rho_{01}^{E}}\, \rho\, J_1\left(2{,}401 \frac{\rho}{R}\right) e^{-j\beta z}$$

$$\rightarrow \vec{E}_\varphi = 0$$

$$|E_{max}| = |Re\{E(\rho,\varphi,z)\, e^{j\omega t}\}|$$

$$= \rho \sqrt{\underbrace{J_0^2\left(2{,}401 \frac{\rho}{R}\right)}_{c_z} \cos^2\beta z + \underbrace{\left(\frac{\beta}{\rho_{01}^{E}}\right)^2 J_1\left(2{,}401 \frac{\rho}{R}\right)^2}_{c_\rho} \cdot \sin^2\beta z}$$

⇒ somit muss der Ort gefunden werden, für den der größte Wert c_z oder c_ρ sich ergibt

$c_{z\,max} = J_0^2(0) \rightarrow$ d.h. für $\rho = 0 \Rightarrow c_z|_{max} = 1$

$c_{\rho\,max} = \frac{\beta^2}{\rho_{01}^2} \cdot J_1^2(1{,}841) \rightarrow$ d.h. für $\rho = \frac{1{,}841 R}{2{,}405}$

mit $\beta = \frac{2\pi}{\lambda_H} = \frac{2\pi}{\frac{c_0}{f_0} \frac{1}{\sqrt{1-\left(\frac{2{,}25}{3}\right)^2}}} = 25{,}13$

mit $\rho_{01}^{E} = \frac{2{,}405}{R} = 57{,}536$

$c_{\rho\,max} = 0{,}0646$

d.h. bei $\rho=0$ ergibt sich das Max. $|E_{max}| = G = \frac{1kV}{cm}$

$$P_{E01} = \frac{1}{2}\int_0^{2\pi}\int_0^{\frac{D}{2}} \frac{|E_\rho|^2}{Z_{FE01}}\,\rho\,d\rho\,d\varphi$$

$$= \frac{\pi}{Z_{FE01}} \int_0^{D/2} \left(\frac{\beta}{\rho_{01}^c}\right)^2 G^2\, J_1\left(2{,}401\,\frac{\rho}{R}\right)\rho\,d\rho$$

mit $Z_{FE01} = Z_0\sqrt{1-\left(\frac{f_c}{f}\right)^2} \approx 151\,\Omega$

$$P_{E01} = \underbrace{\frac{\pi\beta^2}{Z_{FE01}(\rho_{01}^c)^2}\cdot G^2}_{S'} \int_0^{D/2} J_1^2\left(2{,}401\,\frac{\rho}{R}\right)\rho\,d\rho$$

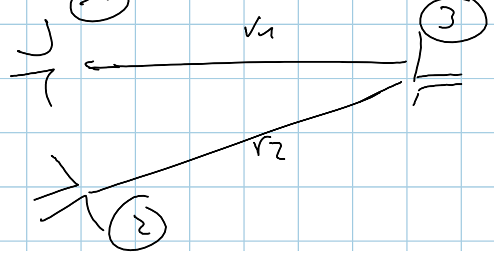
mit $S' = 91\times 10^6\ W/m^2$

und Hinweis:

$$P_{E01} = S'\,\frac{\rho^2}{2}\cdot\left[J_1^2\left(2{,}405\,\frac{\rho}{R}\right) - J_0\left(2{,}405\,\frac{\rho}{R}\right)\cdot J_2\left(2{,}405\,\frac{\rho}{R}\right)\right]_0^{D/2}$$

$$\Rightarrow S'\,\frac{(D/2)^2}{2}\cdot J_1^2(2{,}405) = 21{,}43\,kW$$

<u>Aufgabe 5</u> H01



Verlustlos!

$$\eta = 1 \Rightarrow D_{max} = G_{max}$$

$$S_1 = \frac{P_1}{4\pi r_1^2} \cdot G$$

$$= \frac{10W}{4\pi (5km)^2} \cdot (1.64) = 5.22 \cdot 10^{-8} \frac{W}{m^2}$$

5.2)

$$P_{e3,verf.} = S_1 \cdot A_{W3}$$

$$A_{W3} = \frac{\lambda^2}{4\pi} G = \frac{3^2}{4\pi} \cdot 1{,}64$$

$$= 1{,}175$$

$$\Rightarrow P_{e3,verf} = (5{,}22 \times 10^{-8})(1{,}175) = 6{,}13 \cdot 10^{-8} W$$

5.2.1)

$$\frac{P_{e3}}{P_{r3}} \geq 100$$

$$P_{r3} = S_2 \cdot A_{W3} = \underbrace{\frac{P_{S2}}{4\pi r_2^2} \cdot D_{max}}_{S_2} \cdot \frac{\lambda^2}{4\pi} D_{max} \cdot C^2(\theta, \varphi)$$

Richtwirkung von 3

Für $\frac{\lambda}{2}$ Dipol $\Rightarrow C(\theta, \varphi) = \dfrac{\cos(\frac{\pi}{2} \cos\theta)}{\sin\theta}$ $\qquad \theta = 60°$

$$= 2/3$$

$$P_{e3} = S_1 \cdot A_{W3}$$

$$= \frac{P_{S1}}{4\pi r_1^2} D_{max} \cdot \frac{\lambda^2}{4\pi} \cdot D_{max}$$

$$\frac{P_{e3}}{P_{r3}} = \frac{r_2^2}{r_1^2} \cdot \frac{1}{C^2(\Theta,\varphi)} \geq 100$$

$$r_2 \geq 40{,}82\,km$$

5.2.2)

Empfangsantenne um $60°$ drehen (bzw $\Theta = -30$)

somit wird $P_{r3} = 0$

5.2.3)

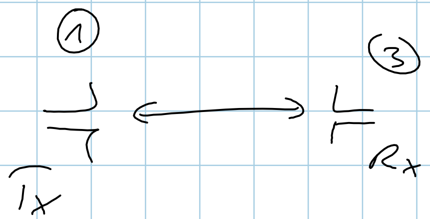
$$P_{e3}' = P_{e3}\, C^2(\Theta,\varphi)$$

$$= P_{e3} \cdot C^2(30°,\varphi)$$

mit $C(30,\varphi) = \frac{\cos\left(\frac{\pi}{2}\cos 30°\right)}{\sin 30°} = 0{,}418$

$$P_{e3}' = 6{,}13\cdot 10^{-8}\,(0{,}418)^2 = 1{,}07\cdot 10^{-8}\,W$$

5.3.1)

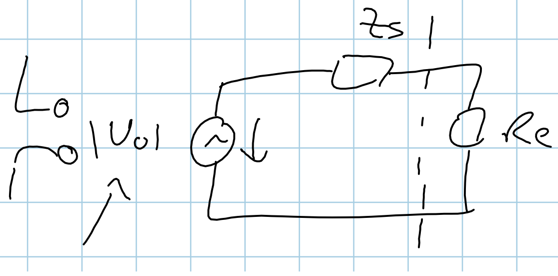


$$\Omega = 2\ln\frac{L}{a}$$

mit $a = L e^{-3.5}$

$$\Omega = 2\ln e^{3{,}5} = 7$$

5.3.2)

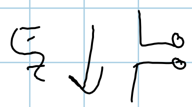


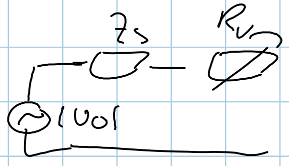
LL-U

mit $\frac{\beta_0 l}{2} \Rightarrow \frac{\frac{2\pi}{\lambda} \cdot \frac{\lambda}{\pi}}{2} = 1$ Aus Abb. 7.8

$\left.\begin{matrix} R_S = 25 \\ X_S = -130 \end{matrix}\right\} \Rightarrow Z_S = (25 - j\,130)\,\Omega$

$R_e = 73{,}2\,\Omega \rightarrow$ Anpassung für $\frac{\lambda}{2}$-Dipol





$|U_0| = L_W\,|E_z|$

$\Rightarrow |E_z| = \sqrt{\frac{P_{e,verf} \cdot 8 R_S}{l_{W alt}}}$

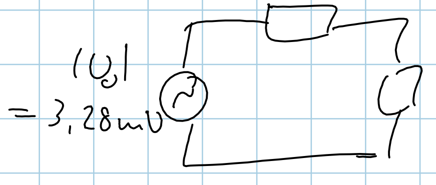
mit $l_{W alt} = 2\sqrt{\frac{A_W \cdot R_{S alt}}{Z_0}} = 0{,}95$

$|E_z| = 6{,}3 \cdot 10^{-3}\ V/m$

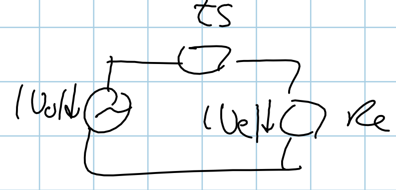
$|U_0| = L_W\ |E_z|$

$L_W = 0{,}5463 \cdot L$

$\Rightarrow |U_0| = 0{,}5463 \cdot \frac{\lambda}{\pi} \cdot 6{,}3 \cdot 10^{-3} = 3{,}28\ mV$



5.3.3) $\frac{P_{Re}}{P_{verf}} = ?$



$P_{Re} = \frac{1}{2}\ \frac{|U_{Re}|^2}{R_e} = \frac{1}{2}\ \left|\frac{R_e}{R_{e+s}}\right|^2\ |U_0|^2$

$$\frac{\quad}{Re} = \frac{\frac{1}{2}\left|\frac{\quad}{Re+Z_s}\right| \quad |U_0|^2}{Re}$$

$$P_{verl} = \frac{|U_0|^2}{8 \cdot R_s}$$

$$\frac{P_{re}}{P_{verl}} = \frac{4 \cdot Re \; R_s}{(Re+R_s)^2 + X_s^2} = 0{,}275 = 27{,}5\,\%$$

5.3.4) Die restliche Leistung wird reflektiert und von der Antenne wieder abgestrahlt!