TTT 4280 - Øving 5

- Oppgave 1:

$G = 32\,dB$, $B = 6\,MHz$

$NF = 1{,}9\,dB$, $T_0 = 120\,k$, $T_e = (F-1)\,290k = 159k$ $\quad F = 10^{1{,}9/10}$

Input noise power: $N_i = kT_0B$

output noise power: $N_o = kGB(T_0 + T_e)$

$N_o = 1{,}38 \cdot 10^{-23} \cdot 10^{\frac{32dB}{10}} \cdot 6 \cdot 10^{6} \cdot (120k + 159k)$

$= 3{,}66 \cdot 10^{-11}\,W \Rightarrow 10\log\left(\frac{3{,}66 \cdot 10^{-11}}{10^{-3}}\right)$

$\underline{= -74{,}365\,dBm}$

Inngangsimpedans $\quad Z_i = 100\,\Omega$

$\boxed{SNR = \frac{S_o}{N_o}}$

for sinussignal vi har:

$V_{rms} = V_p \cdot 0{,}707 = 18\,\mu V \cdot 0{,}707 = 12{,}73\,\mu V$

$S_i = \frac{(V_{rms})^2}{R} = \frac{(12{,}73\,\mu V)^2}{100\,\Omega} = \underline{1{,}62 \cdot 10^{-12}\,W}$

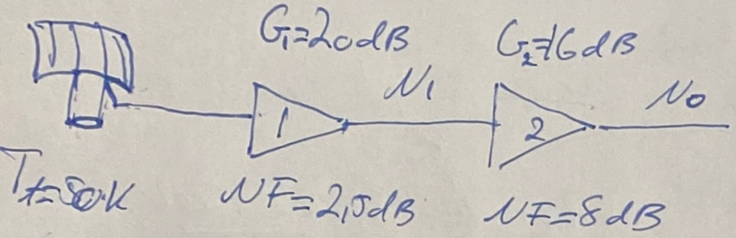
Må så finne $\quad S_o = G \cdot S_i = 32\,dB \cdot S_i = 10^{32/10} \cdot 1{,}62 \cdot 10^{-12}\,W$

$\underline{S_o = 2{,}568 \cdot 10^{-9}\,W}$

$SNR = \frac{2{,}568 \cdot 10^{-9}\,W}{3{,}66 \cdot 10^{-11}\,W} = 70{,}14$

$SNR_{DB} = 10\log SNR = \underline{\underline{18{,}46\,dB}}$ $\quad$ På utgangen av forsterkeren

Oppgave 2 :



Total Støy Båndbredde, $B=3MHz$:

Effektiv støytemperatur er gitt av:

$$T_{eff} = (F_n - 1)T_0 \qquad T_0 = 290K$$

$$\hookrightarrow F_n = 10^{NF/10}$$

Dermed får vi:

$$T_{e1} = (10^{\frac{2,5dB}{10}} - 1)\, 290K = \underline{225,7K}$$

$$T_{e2} = (10^{8dB/10} - 1)\, 290K = \underline{1539,8K}$$

$$S_i = -90\,dBm \qquad N_i = k\overset{T_A}{T_0}B$$

$$N_1 = G_1 N_i + G_1 k T_{e1} B = G_1 k B (T_A + T_{e1}) = 10^{20/10} \cdot 1,38\cdot 10^{-23} \cdot 3\cdot 10^{6} (50K + 225,7K)$$

$$N_1 = 1,14\cdot 10^{-12}\, W = -89,4\, dBm$$

For the output we have:

$$N_o = G_2 N_1 + G_2 k T_{e2} B = G_1 G_2 k B \left(T_A + T_{e1} + \frac{T_{e2}}{G_1}\right)$$

$$N_o = 10^{16/10} \cdot 1,14\cdot 10^{-12} + 10^{16/10} \cdot 1,38\cdot 10^{-23} \cdot 3\cdot 10^{6} \cdot 1539,8K$$

$$= 4,80\cdot 10^{-11}\, W = \underline{-73,2\, dBm}$$

For systemet blir den effektive støytemperaturen:

$$T_{sys} = T_{e1} + \frac{1}{G_1} T_{e2} = \underline{241,1K}$$

$$S_o = (G_1 + G_2) S_i = (10^{20/10} + 10^{16/10}) \cdot 10^{\frac{-90dBm}{10}} \cdot 10^{-3} = 3,98 \cdot 10^{-9}$$

Dermed blir:

$$SNR = \frac{S_0}{N_0} = \frac{3{,}98\cdot10^{-9}}{4{,}80\cdot10^{-11}} = \underline{82{,}91}$$

$$SNR_{dB} = 10\log(82{,}91) = \underline{\underline{19{,}2\,dB}}$$

Flytte forsterker 2 40m unna antennen:

Koaksialkabel med et tap $L = 0{,}25\,dB/m = 1{,}06/m$

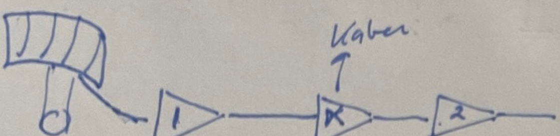
$T_K = 290K$, $l = 40m$

$$NF_L = 1 + (L-1)\frac{T_K}{T_0} = 0{,}25\,dB/m$$

$1/G_K = L\cdot l$

$G_K = \frac{1}{L\cdot l} = 0{,}1\,dB$ (?)

$G_K = -0{,}25\cdot 40 = -10dB$



$$N_0 = G_1G_2G_L kB(T_{sys}+T_0)$$

$T_0 = \cancel{T_A} = 50K$

$$T_{sys} = T_{e1} + \frac{T_K}{G_1} + \frac{T_{e2}}{G_1G_K} = 382{,}58K$$

$$N_0 = 10^{20/10}\cdot 10^{16/10}\cdot 10^{-10/10}\cdot 1{,}38\cdot10^{-23}\cdot 3\cdot10^{6}(382{,}58K + 50K)$$
$$= 7{,}13\cdot10^{-12}W$$

$$S_0 = G_1G_2G_L\cdot S_0 = 10^{20/10}\,10^{16/10}\,10^{0{,}1/10}\cdot10^{-90/10}\cdot10^{-3} = 3{,}98\cdot10^{-10}$$

$$SNR_{dB} = 10\log\frac{S_0}{N_0} = \underline{17{,}47dB}$$