0. Basic data :

$T := 300.15K$ $k := 1.38065 \cdot 10^{-23} V \cdot A \cdot s \cdot K^{-1}$ $B_{20k} := 19980Hz$ $B_1 := 1Hz$

$f := 1Hz, 2Hz .. 100kHz$ $B_{100k} := 99999Hz$ $B_{1k} := 999Hz$ $TOL := 10^{-24}$

succ-apps = succesive approximations, subscript s = simulated

1. Math simulation of the current noise density trace :

Guessed white noise level : $i_{n.wn} := 0.35 \cdot 10^{-12} A$

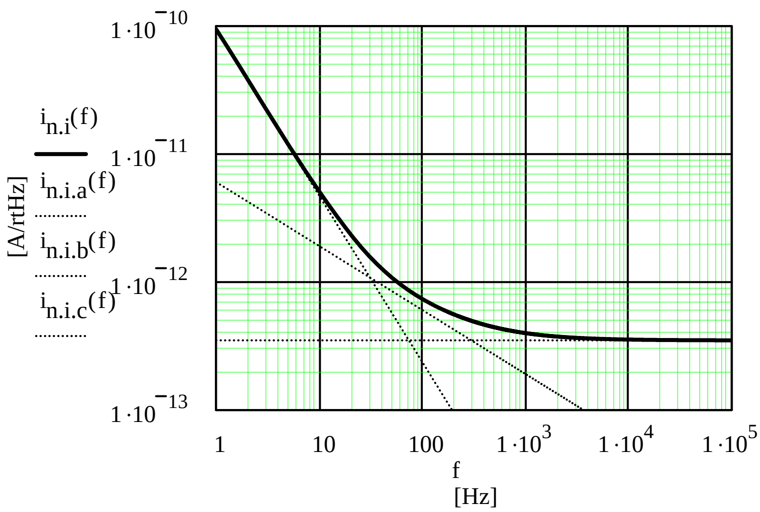
Succ-apps of the corner frequencies and slopes a & b leads to : $f_{c.i1} := 298Hz$ $f_{c.i3} := 74Hz$

$a := -1.0$ $b := -2.6$

Curve equation : $$i_{n.i}(f) := i_{n.wn} \cdot \sqrt{1 + \left(\frac{f}{f_{c.i1}}\right)^a + \left(\frac{f}{f_{c.i3}}\right)^b}$$

Tangents :

$i_{n.i.a}(f) := i_{n.wn}$ $i_{n.i.b}(f) := i_{n.wn} \cdot \sqrt{\left(\frac{f}{f_{c.i1}}\right)^a}$ $i_{n.i.c}(f) := i_{n.wn} \cdot \sqrt{\left(\frac{f}{f_{c.i3}}\right)^b}$



$i_{n.i}(1Hz) = 94.4 \times 10^{-12} A$

$i_{n.i}(10Hz) = 5.1 \times 10^{-12} A$

$i_{n.i}(30Hz) = 1.6 \times 10^{-12} A$

$i_{n.i}(100Hz) = 737.3 \times 10^{-15} A$

$i_{n.i}(1kHz) = 399 \times 10^{-15} A$

$i_{n.i}(100kHz) = 351 \times 10^{-15} A$

$i_{n.i}(1MHz) = 350 \times 10^{-15} A$

Fig. 2.4 = Fig. 12

2. Slopes :

$$SL_{i1} := 20\cdot\log\left(\frac{i_{n.i.b}(10Hz)}{i_{n.i.b}(1Hz)}\right)$$ $SL_{i1} = -10.000$ [dB]

$$SL_{i2} := 20\cdot\log\left(\frac{i_{n.i.c}(10Hz)}{i_{n.i.c}(1Hz)}\right)$$ $SL_{i2} = -26.000$ [dB]

3. RMS current noise in the three bandwidths, Deltas D, plus average densities avg :

$$i_{N.i.1k} := \sqrt{\frac{1}{B_1}\cdot\int_{1Hz}^{1kHz}\left(\left|i_{n.i}(f)\right|\right)^2 df}$$ $i_{N.i.1k} = 76.94772\times10^{-12}A$

$i_{N.i.s.1k} := 76.9486\cdot10^{-12}A$

$$D_{e.1k} := 20\cdot\log\left(\frac{i_{N.i.1k}}{i_{N.i.s.1k}}\right)$$ $D_{e.1k} = -0.000$ [dB]

$$i_{n.i.1k.avg} := i_{N.i.1k}\cdot\sqrt{\frac{B_1}{B_{1k}}}$$ $i_{n.i.1k.avg} = 2.435\times10^{-12}A$

$$i_{N.i.20k} := \sqrt{\frac{1}{B_1}\cdot\int_{20Hz}^{20kHz}\left(\left|i_{n.i}(f)\right|\right)^2 df}$$ $i_{N.i.20k} = 52.39920\times10^{-12}A$

$i_{N.i.s.20k} := 52.3992\cdot10^{-12}A$

$$D_{e.20k} := 20\cdot\log\left(\frac{i_{N.i.20k}}{i_{N.i.s.20k}}\right)$$ $D_{e.20k} = -0.000$ [dB]

$$i_{n.i.20k.avg} := i_{N.i.20k}\cdot\sqrt{\frac{B_1}{B_{20k}}}$$ $i_{n.i.20k.avg} = 370.704\times10^{-15}A$

$$i_{N.i.100k} := \sqrt{\frac{1}{B_1}\cdot\int_{1Hz}^{100kHz}\left(\left|i_{n.i}(f)\right|\right)^2 df}$$ $i_{N.i.100k} = 134.969\times10^{-12}A$

$i_{N.i.s.100k} := 134.970\cdot10^{-12}A$

$$D_{e.100k} := 20\cdot\log\left(\frac{i_{N.i.100k}}{i_{N.i.s.100k}}\right)$$ $D_{e.100k} = -0.000$ [dB]

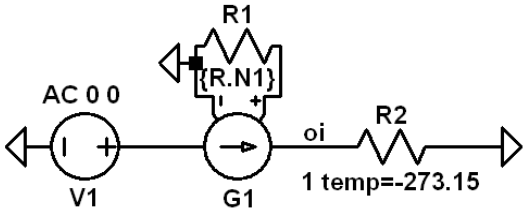
$$i_{n.i.100k.avg} := i_{N.i.100k}\cdot\sqrt{\frac{B_1}{B_{100k}}}$$ $i_{n.i.100k.avg} = 426.812\times10^{-15}A$

4. Simulation approach :

Note : $i_{n.i}(f) = V(oi)/1\ \mathrm{Ohm}$

.noise V(oi) V1 oct 100 1 100k

.param i.n.oi = 0.35e-12 R2=1 f.c.i1=298 f.c.i3=74
.param e.n.oi=i.n.oi*R2 T=300.15 k=1.38065e-23
.param R.N1=(pow(e.n.oi,2))/(4*k*T) G1=1



Laplace=G1*sqrt(1+pow((abs(s)/(2*pi*f.c.i1)),-1)+pow((abs(s)/(2*pi*f.c.i3)),-2.6))

Fig. 2.5 = Fig. 14

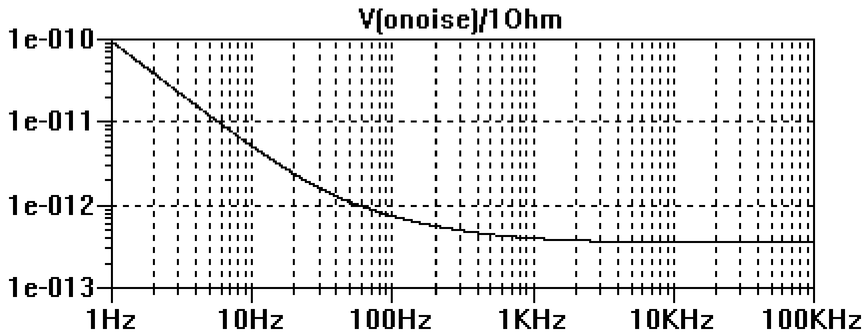


Fig. 2.6 = Fig. 13

5. Fast Correlation Check - if we would use T I's 5534 model :

$R1 := 1 \cdot 10^{6}\Omega$ $\quad R2 := 1 \cdot 10^{6}\Omega$ $\quad T := 0.00K$

$e_{n.R1} := \sqrt{4 \cdot k \cdot T \cdot B_1 \cdot R1}$ $\qquad e_{n.R1} = 0.000 \times 10^{0}\,V$

$e_{n.R2} := \sqrt{4 \cdot k \cdot T \cdot B_1 \cdot R2}$ $\qquad e_{n.R2} = 0.000 \times 10^{0}\,V$

$e_n := 6.451 \cdot 10^{-9}V$ $\qquad i_{n.i1} := 400.111 \cdot 10^{-15}A$ $\qquad i_{n.i2} := i_{n.i1}$

Note: Here, no frequency dependency because of constant noise values!

Correlation Factor : $\qquad CF := -1, -0.999 .. 1$

$$e_{n.o1}(CF) := \sqrt{e_n^{\,2} + e_{n.R1}^{\,2} + e_{n.R2}^{\,2} + i_{n.i1}^{\,2} \cdot R1^2 + 2 \cdot CF \cdot i_{n.i1} \cdot i_{n.i2} \cdot R1 \cdot R2 + i_{n.i2}^{\,2} \cdot R2^2}$$

$e_{n.o1}(-1) = 6.5 \times 10^{-9}\,V$ $\qquad e_{n.o1}(0) = 565.88 \times 10^{-9}\,V$ $\qquad e_{n.o1}(1) = 800.2 \times 10^{-9}\,V$

simulated : $\qquad e_{n.o1.s} := 569.76 \cdot 10^{-9}V$

$D_e(CF) := 20 \cdot \log\left(\frac{e_{n.o1}(CF)}{e_{n.o1.s}}\right)$ $\qquad D_e(0.0138) = 0.000 \quad$ [dB]

Hence, with CF = 0.0138 we get a correlation of 1.38 %

=> practically 100 % un-correlated current noise sources

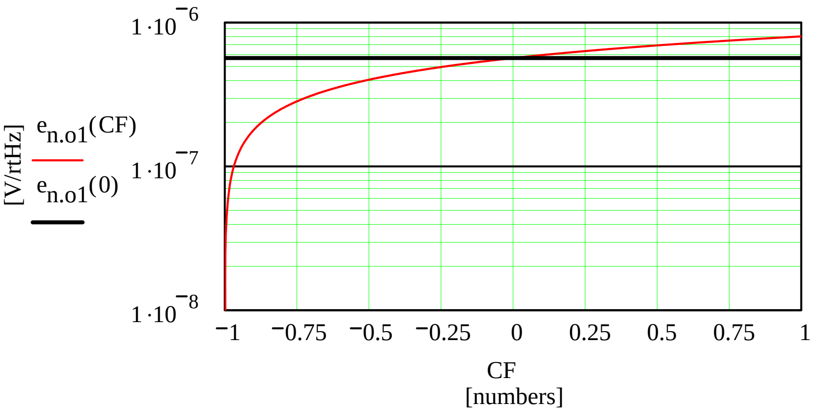


Fig. 2.7 = Fig. 23