Proiect CAIF

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Filtru Analogic:

1. **Specificatii filtru:**
   Implementare Gm-C, Tow-Thomas 1, Banda de trecere = 0.85 MHz, aproximare Butterworth;

2. **Determinarea functiei de transfer**:

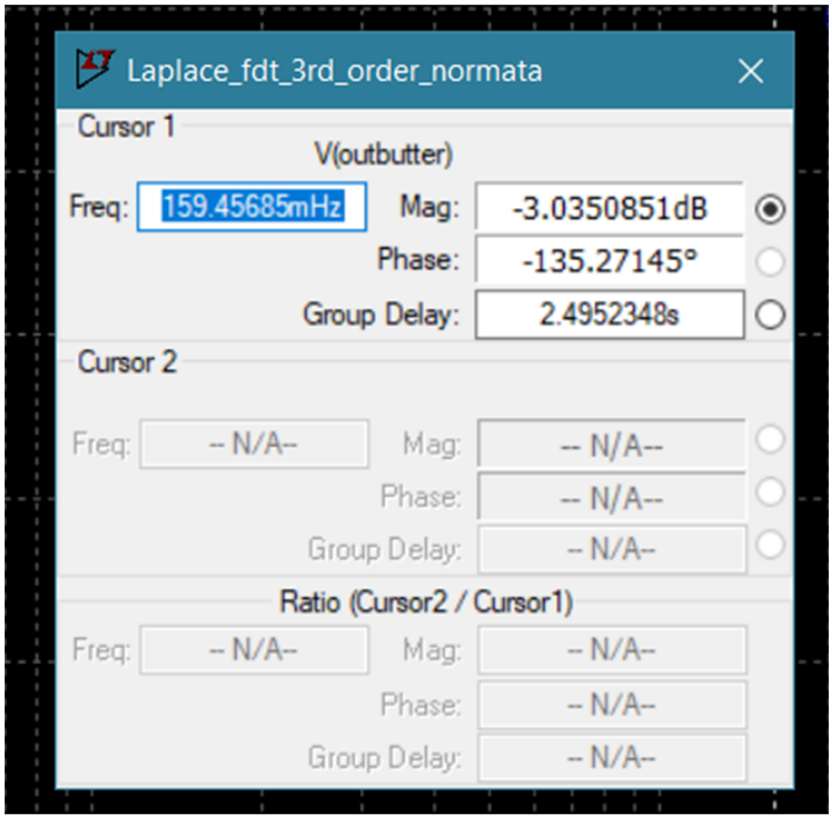
   Coeficientii functiei de transfer normate de ordin 3, tip Butterworth

   (banda = 1 rad/s):

   (s+1)(s^2+s+1) =>

   c1 = 1; c2 = 1; d2 = 1;

   La -3 dB obtinem o banda de 159 mHz, avem nevoie de Denormare:



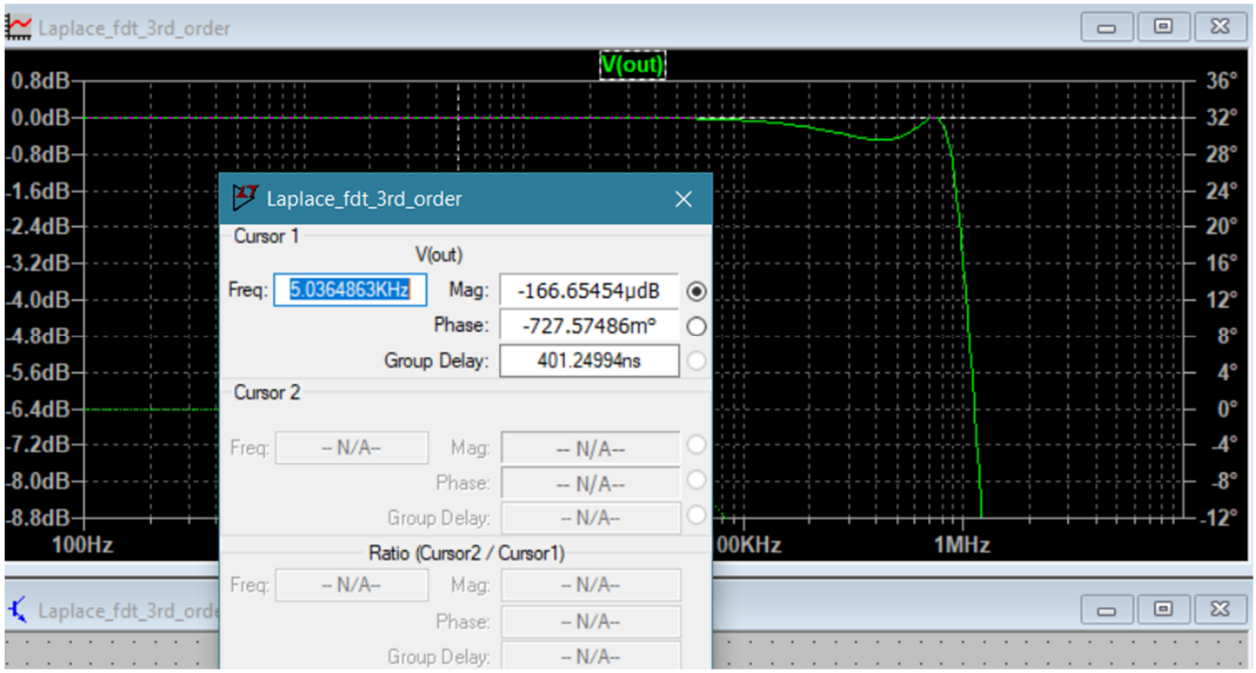
3. **Denormare:**

Denormalized transfer function

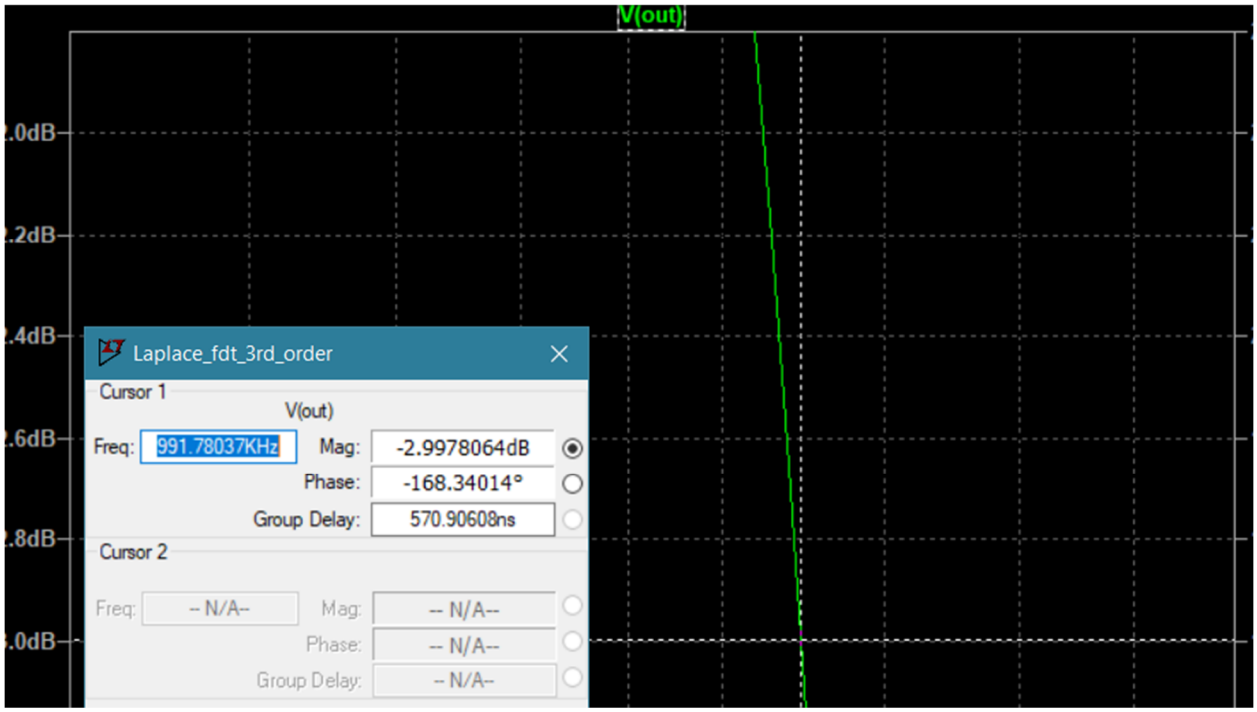
$$H(s) = H_0 \cdot \frac{c_{1d}}{s + c_{1d}} \cdot \frac{d_{2d}}{s^2 + c_{2d}s + d_{2d}}$$

fc=fn [Hz]	wn [Hz]	c1d	c2d	d2d
8.50E+05	5.34E+06	3.35E+06	3.35E+06	3.26E+13

Obtinem la joasa frecventa castig apropiat de 0:



Banda la -3dB este de 991kHz :



Parametrii bicuadului :

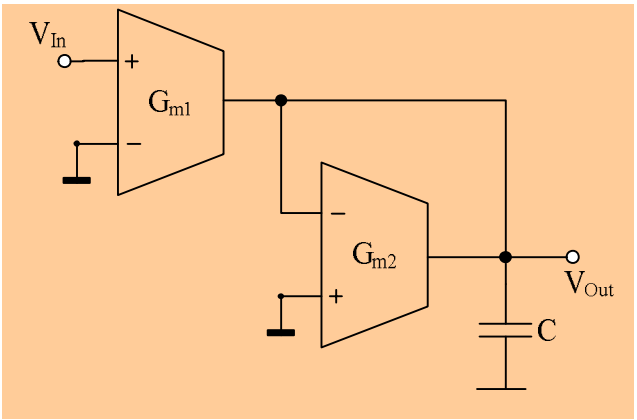
Gm1=Gm2= Gm3 [S]	Gm4 [S]	C2 [F]	C1 [F]
1.00E-04	1.00E-04	2.99E-11	1.03E-11

4. **Dimensionarea elementelor pasive pt. integratorul Gm-C si bicuadul Tow-Thomas 1:**

Pentru integrator Gm-C:

aleg (to be chosen) calculez (to b

Gm1=Gm2	C
1.00E-04	2.99E-11



Pen

choose the value of G_{m1} =>

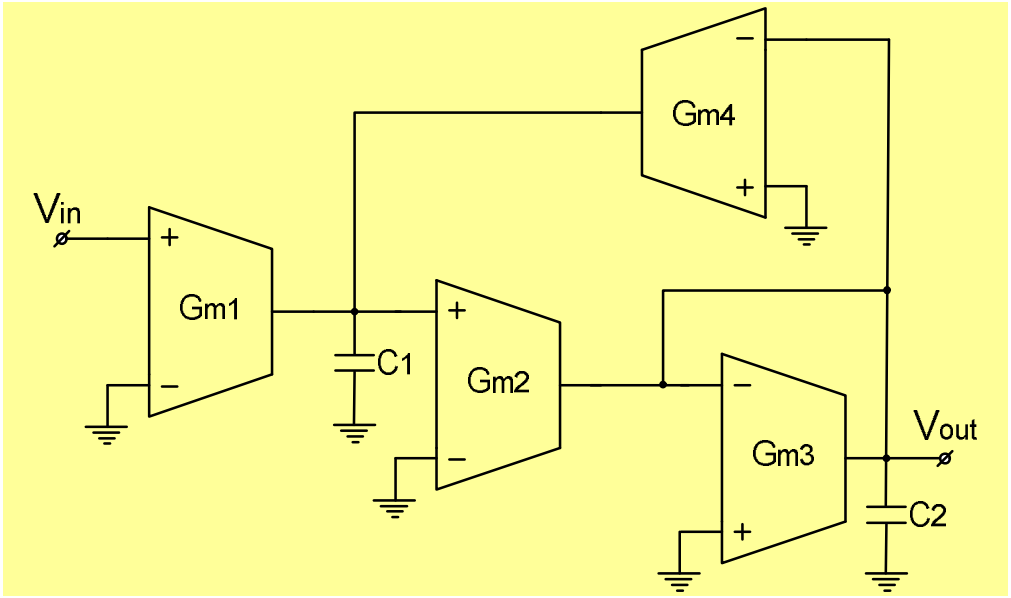
$$C = \frac{G_{m1}}{\omega_{01}}; G_{m2} = \frac{G_{m1}}{H_0}.$$

Gm1=Gm2= Gm3 [S]	Gm4 [S]	C2 [F]	C1 [F]
1.00E-04	1.00E-04	2.99E-11	1.03E-11

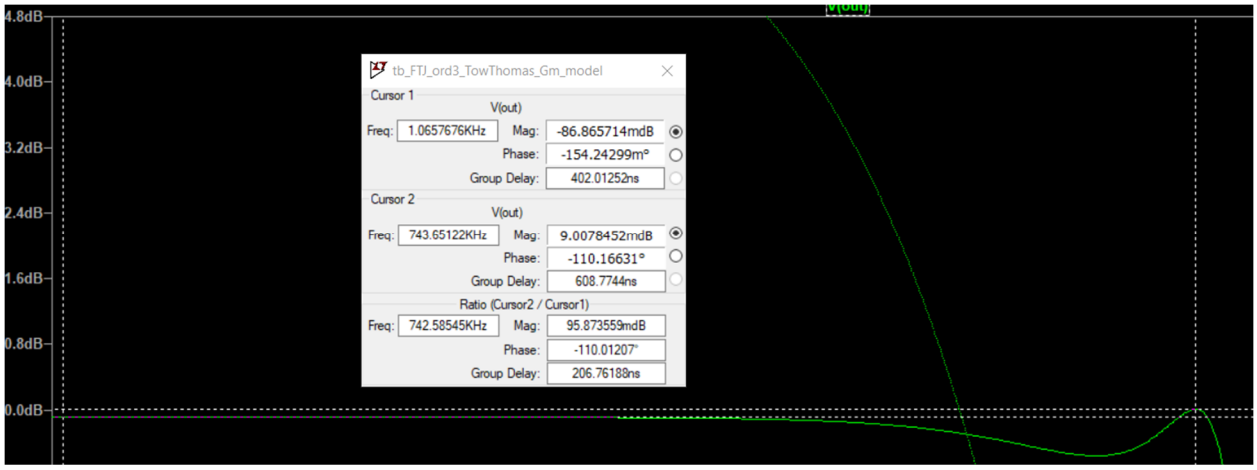
$$G_{m1} = G_{m2} = G_{m3}; \qquad \text{choose the value of } G_{m1};$$

$$C_2 = \frac{G_{m1} \cdot Q}{\omega_{02}}; C_2 = \frac{G_{m1}}{\omega_{02} \cdot Q};$$

$$G_{m4} = \frac{G_{m1}}{H_0}.$$

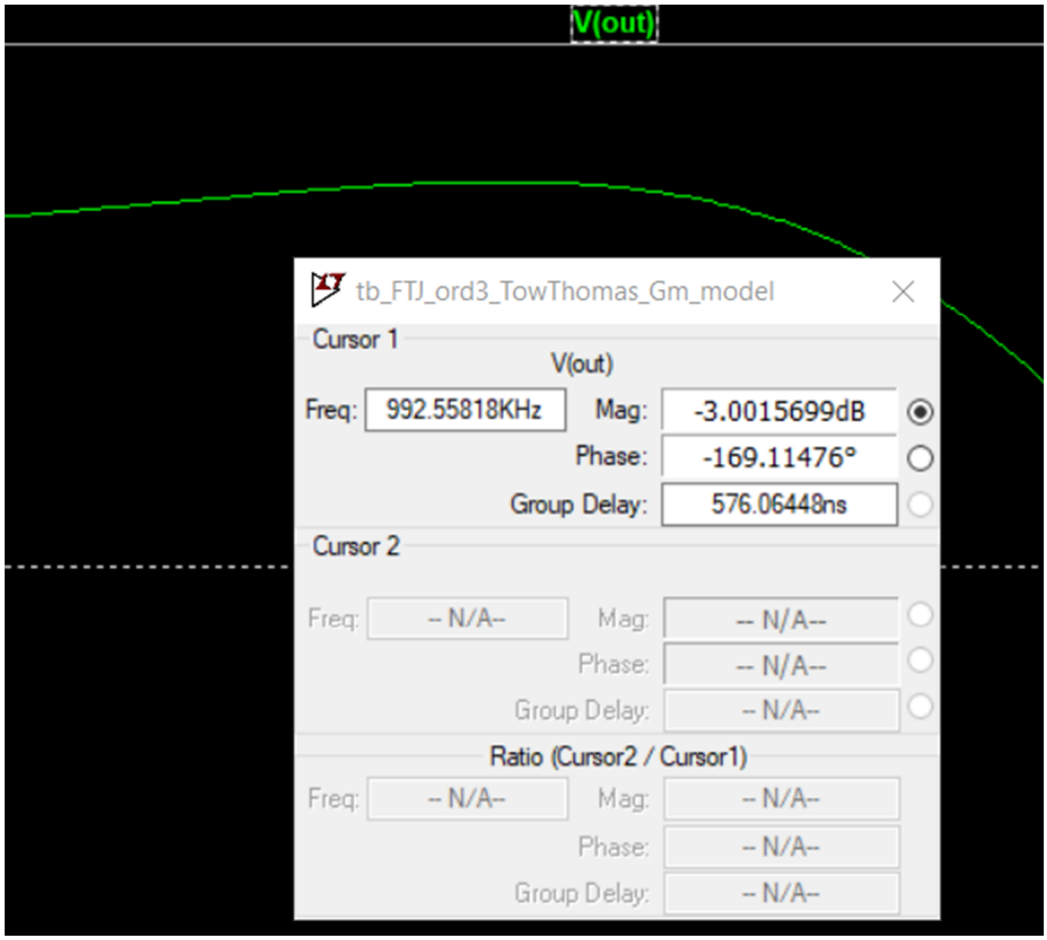


Dupa incercarea mai multor variante pentru Rout si Fpol intern, am ales sa dimensionez **Rout = 4 Meg** si **Fpol intern = 100 Meg**, **astfel obtinand o eroare de 86 mdB a castigului la joasa frecventa, si a unui gain peak de 9 mdB** :

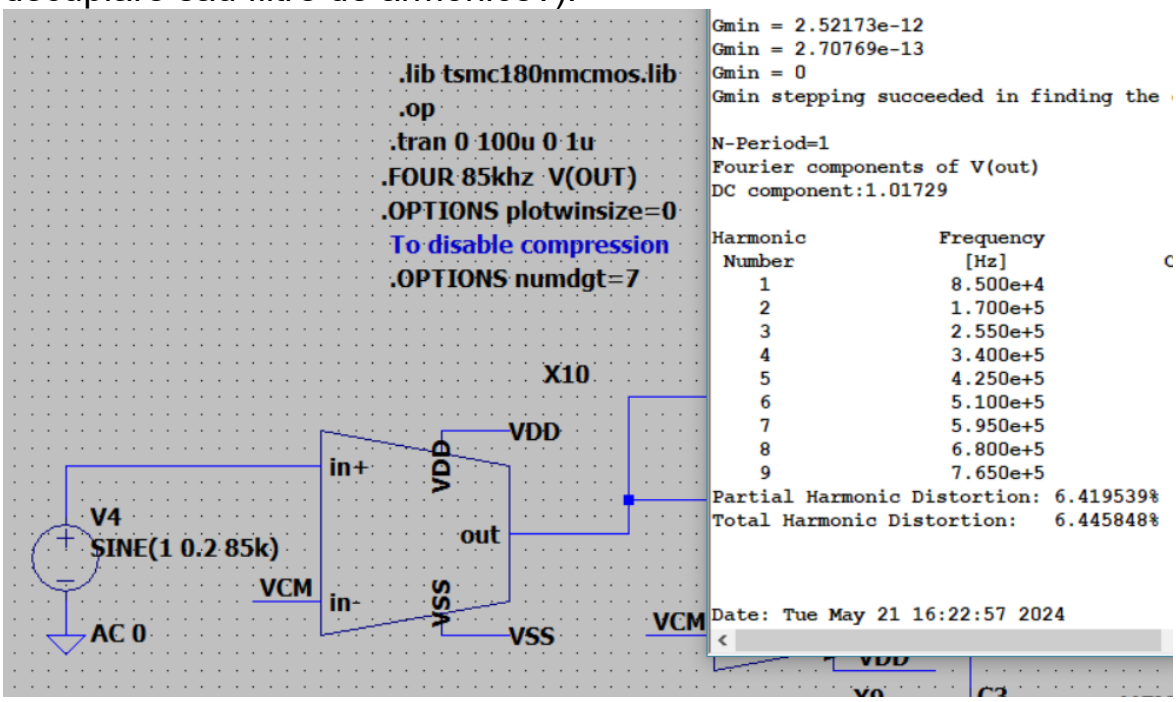


GBW = Fpol*Av(joasa frecventa) = 100 Meg;

Banda la -3dB de 992 kHz:



Nu am putut obtine un THD<1% la Fc/10 = 85 kHz si output amplitude 400 mV, am obtinut 6.445% (oare trebuie sa adaug in circuit condensatori de decuplare sau filtre de armonice?):

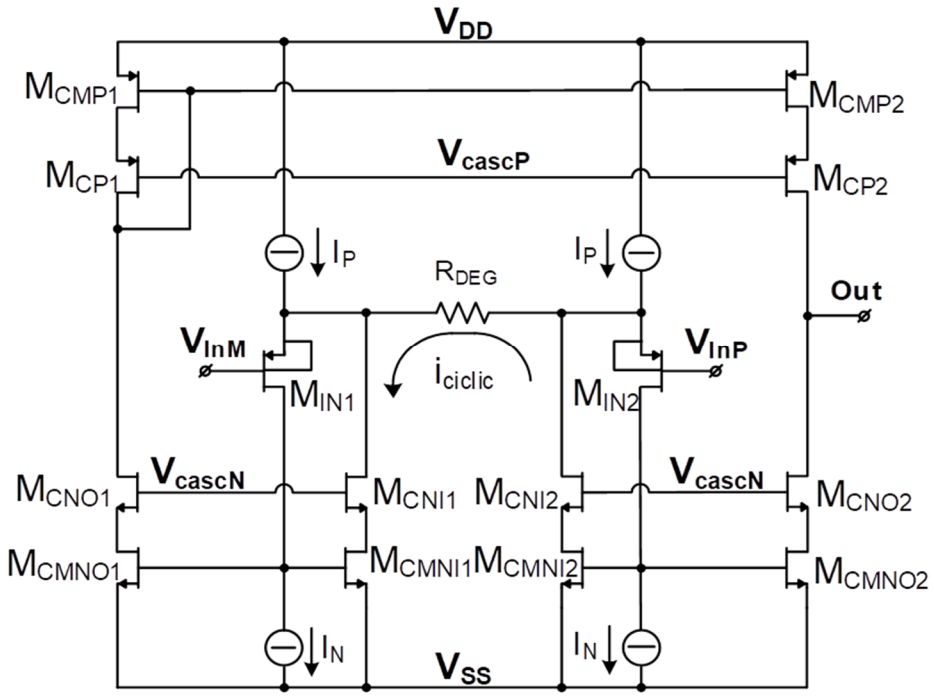


Implementare celula active pentru filtru analogic

1. **Specificatii:**

   Tipul celulei Gm, implementare Kwan-Martin, IDD_max = 2 mA, Tranzistori de intrare PMOS;

   Aleg : Gm = 100 uS;
   Rout >= 10 MegOhmi;
   Aii = 1;
   Banda > 10*Fc = 8.5 MegHz;
   Vdd = 3 V;
   Tensiune de intrare 0.3 peak => 0.6 V peak-to-peak;



Rdeg = 2*Aii/Gm = 20 kOhmi;

Iciclic_max = 0.3/Rdeg = 15 uA;

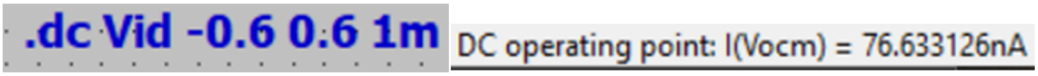
Idcmni = (1.5 : 2) * Iciclic_max = 30 uA;

In = Idcmni / (2 : 5) = 15 uA;

Ip = In +Idcmni = 45 uA;

Bugetul de current : 2*Idcmni*Aii + 2* Ip = 150 uA < 2 mA;

Pentru Vid = [-0.6 V; 0.6 V], curentul DC de l iesire este de 76.nA:



7. Se aleg Vdsat-urile pentru tranzistorii din calea de semnal: tranzistorii de intrare, din oglinzi de curent (bias); se alege o valoare intre (100mV-200mV)

   VDsatMIN=100mV

   Vdsat_Bias_NcurrentMirror=VDsatCMNI=VDsatCMNO=180mV

   Vdsat_Bias_PcurrentMirror=VDsatCMP=180mV

Se aleg lungimile pentru tranzistorii de intrare.

L_MIN=450nm

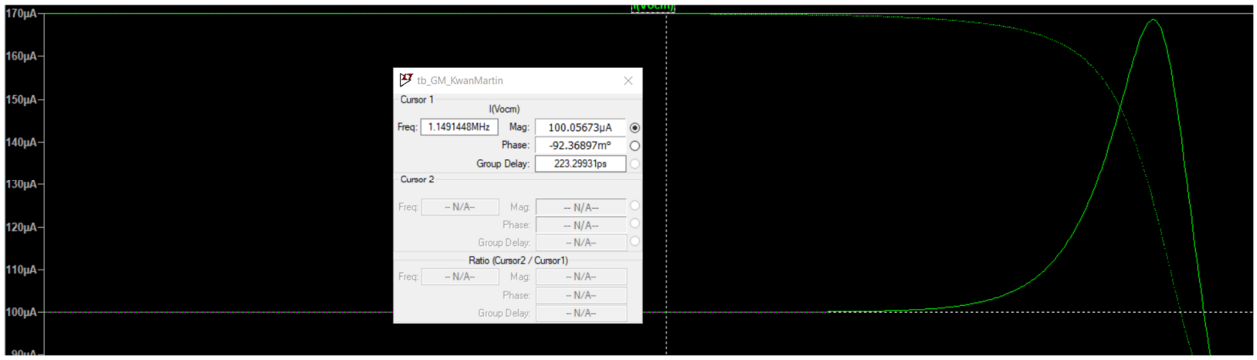
8. Se dimensioneaza tranzistorii cascoda din calea de semnal. Se alege VDsat =100mV – 150mV si L=Lmin

   Vdsat_CascodaN = Vdsat_CN = 100mV

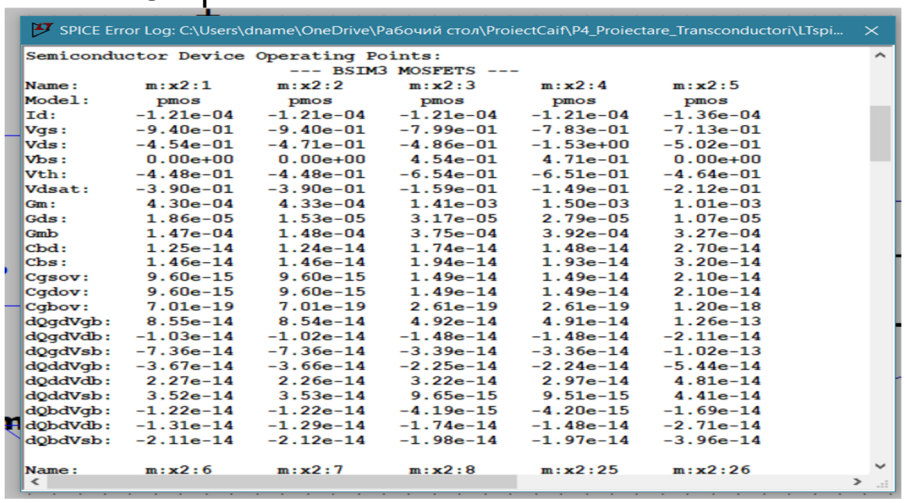
   Vdsat_CascodaP = Vdsat_CP = 100mV

   L_CN = L_CP = 180nm

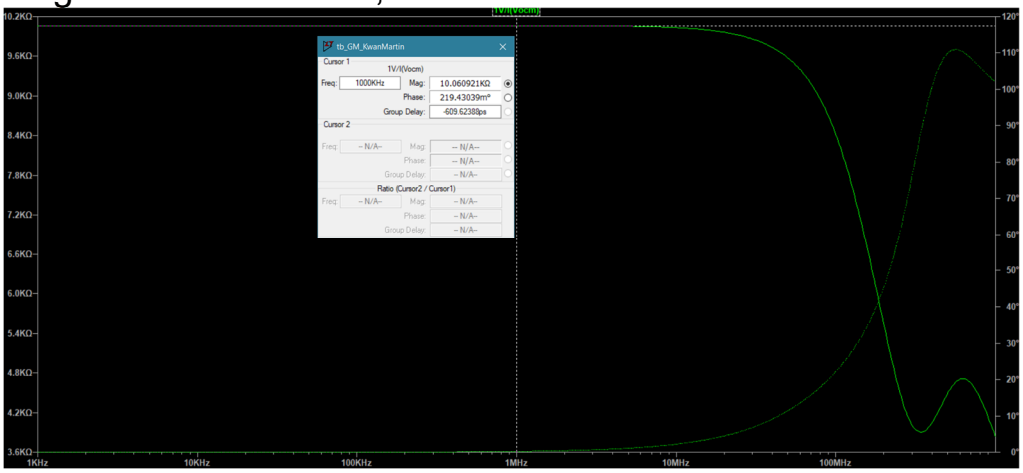
Am obtinut o transconductanta de 100uS:



Analiza OP pentru tranzistori in saturatie:



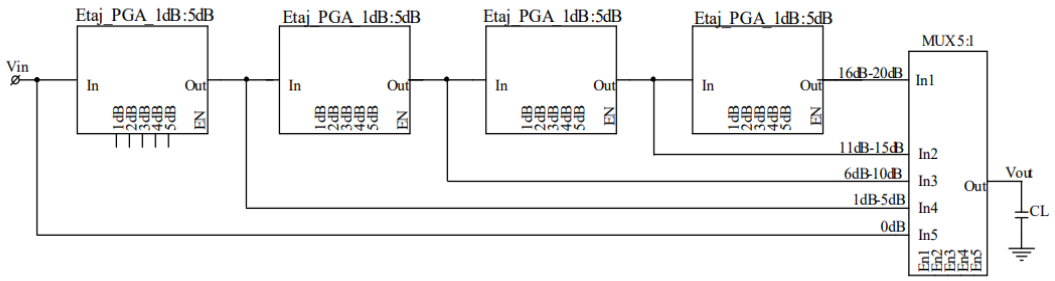
Rezistenta de iesire am obtinut de 10KiloOhmi, am modificat valorile lungimilor tranzistorilor, dar rezistenta nu se modifica.



PGA

Cerinte: Switch-uri in calea de semnal, amplificare [0 dB; 24 dB] cu pas de 2 dB, Banda de PGA > 10 MegHz, implementare cu AO;

Folosesc urmatorul model:

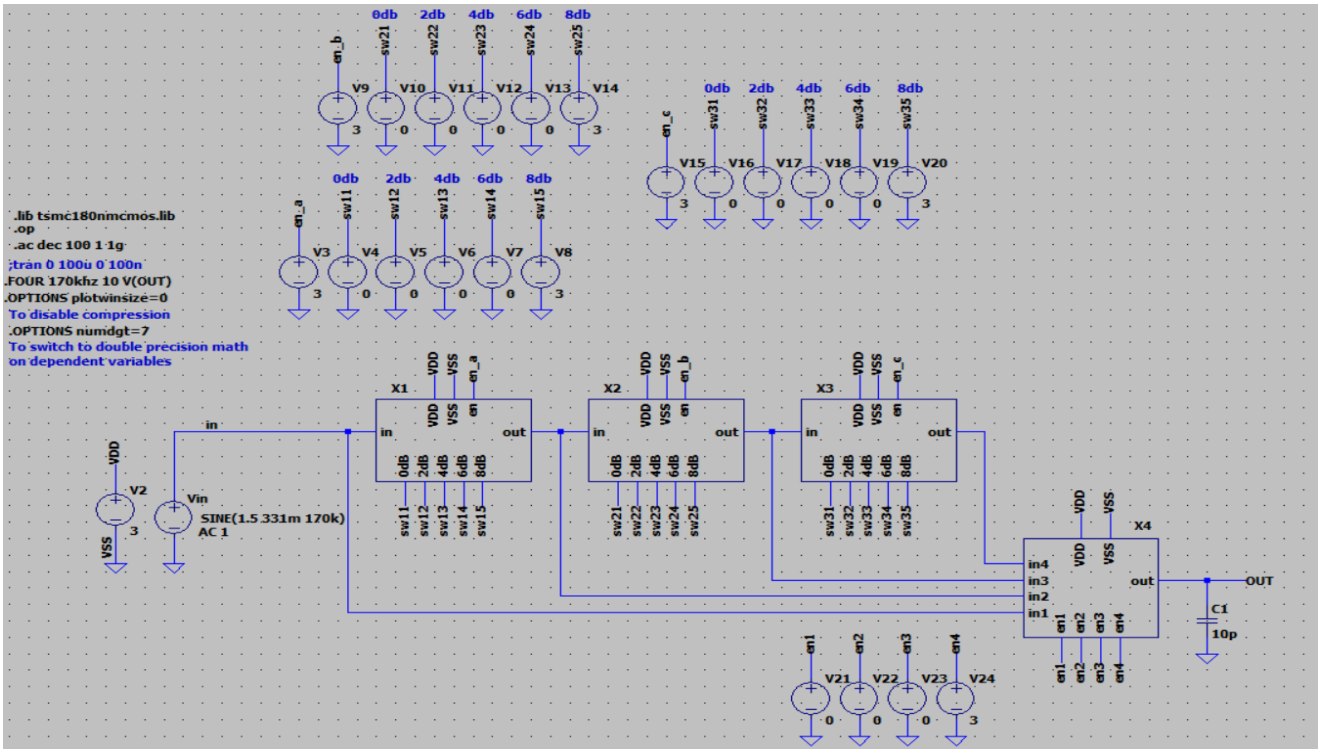


Bineinteles,in cazul meu am nevoie dor de 3 blocuri cu amplificari de (0 dB, 2 dB, 4 dB, 6 dB, 8 dB), pentru atinge amplificarea maxima 8 dB *3 = 24 dB). Aleg rezistenta de intrare de 20 kOhmi.

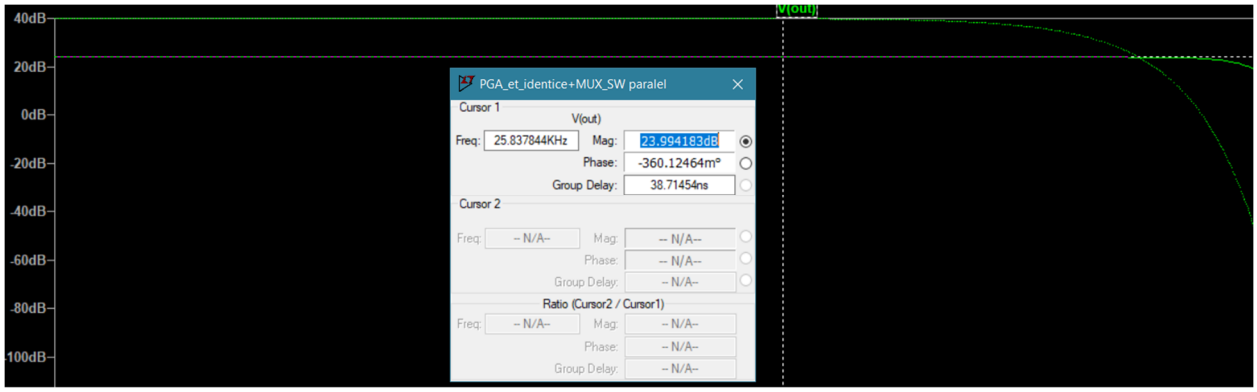
Apoi transform amplificarile din dB in linear si aflu rezistentele de reactie:

- Pentru 0 dB: $R_f = 20\ \text{k}\Omega$
- Pentru 2 dB: adăugăm $25.18\ \text{k}\Omega - 20\ \text{k}\Omega \approx 5.18\ \text{k}\Omega$
- Pentru 4 dB: adăugăm $31.70\ \text{k}\Omega - 25.18\ \text{k}\Omega \approx 6.52\ \text{k}\Omega$
- Pentru 6 dB: adăugăm $39.91\ \text{k}\Omega - 31.70\ \text{k}\Omega \approx 8.21\ \text{k}\Omega$
- Pentru 8 dB: adăugăm $50.24\ \text{k}\Omega - 39.91\ \text{k}\Omega \approx 10.33\ \text{k}\Omega$

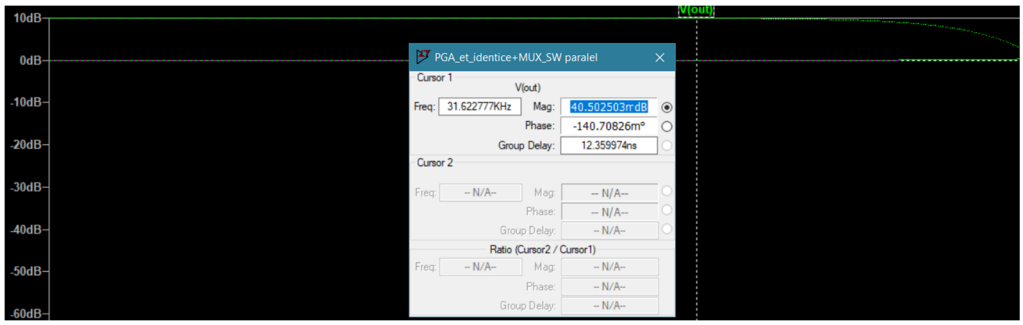
Schema electrica a circuitului:



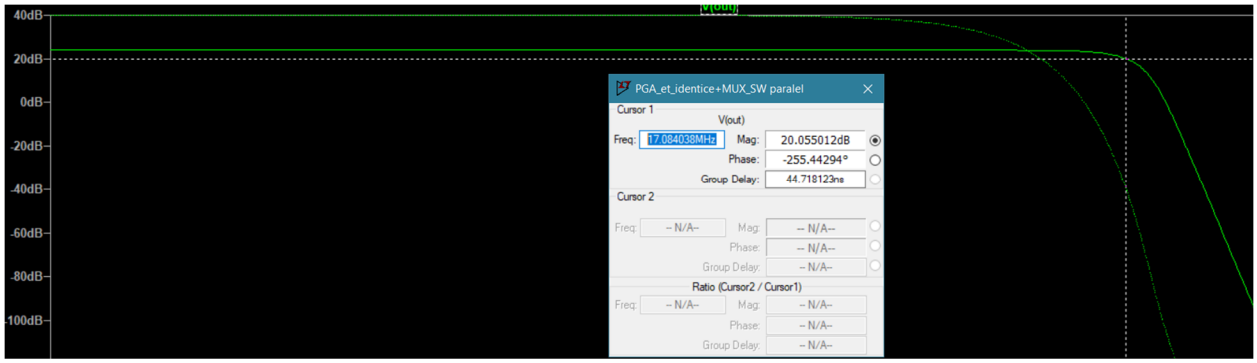
Amplificarea maxima (23.99dB):



Amplificarea minima (40 mdB):



GBW(17 MHz):



Proiectare AO Cascoda-Pliata

1.Specificatii: IDD_max = 1.5 mA, implementare celula activa cascoda-plita + SC, tip tranzistori de intrare PMOS, tipul celulei active AO;

Aleg VDSsatIn = 200 mV;

Cc = 2.5pF;

Verific daca IbiasIN/Cc > 60 V/us; IbiasIN/Cc = 119 V/us;

Aleg IbiasPIN = 298 uA;

Si aleg IbiasNIN = 380 uA (considerabil mai mare);

Obtin ICM = 231 uA;

Aleg VDSsatOUT = 200 mV;

IBIASOUT/(Cc+CL) > SR;

Curentul consumat ii mai mic de 1.5 mA;

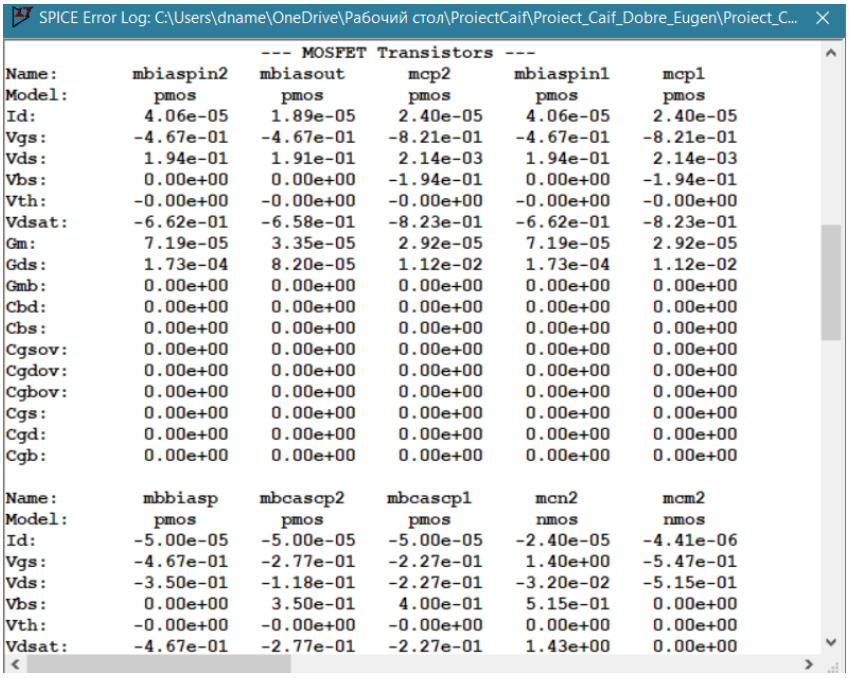
Av2 = 29.2 V/V;

VDsSatCasc = 100 mV;

Si lungimea minima a tranzistorilor cascodei 180 nm;

Mai departe dimensionez circuitul in LTSpice;

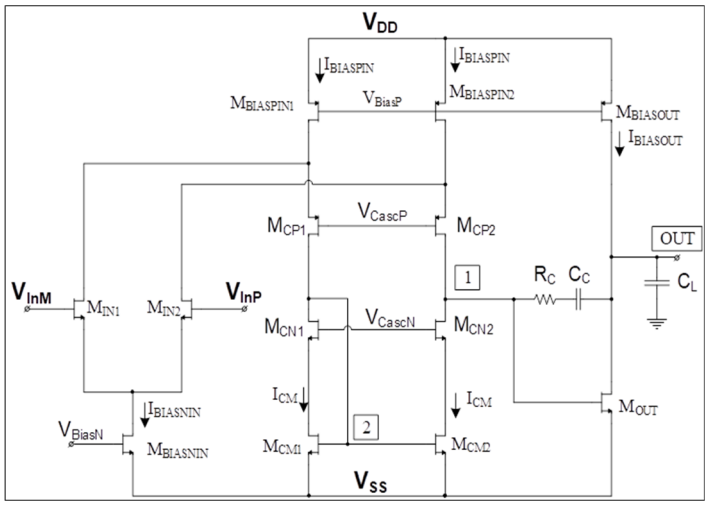
Analiza OP pentru verificarea tanzistorilor in saturatie:



--- MOSFET Transistors ---

Name:	mbiaspin2	mbiasout	mcp2	mbiaspin1	mcp1
Model:	pmos	pmos	pmos	pmos	pmos
Id:	4.06e-05	1.89e-05	2.40e-05	4.06e-05	2.40e-05
Vgs:	-4.67e-01	-4.67e-01	-8.21e-01	-4.67e-01	-8.21e-01
Vds:	1.94e-01	1.91e-01	2.14e-03	1.94e-01	2.14e-03
Vbs:	0.00e+00	0.00e+00	-1.94e-01	0.00e+00	-1.94e-01
Vth:	-0.00e+00	-0.00e+00	-0.00e+00	-0.00e+00	-0.00e+00
Vdsat:	-6.62e-01	-6.58e-01	-8.23e-01	-6.62e-01	-8.23e-01
Gm:	7.19e-05	3.35e-05	2.92e-05	7.19e-05	2.92e-05
Gds:	1.73e-04	8.20e-05	1.12e-02	1.73e-04	1.12e-02
Gmb:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cbd:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cbs:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgsov:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgdov:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgbov:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgs:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgd:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgb:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Name:	mbbiasp	mbcascp2	mbcascp1	mcn2	mcm2
Model:	pmos	pmos	pmos	nmos	nmos
Id:	-5.00e-05	-5.00e-05	-5.00e-05	-2.40e-05	-4.41e-06
Vgs:	-4.67e-01	-2.77e-01	-2.27e-01	1.40e+00	-5.47e-01
Vds:	-3.50e-01	-1.18e-01	-2.27e-01	-3.20e-02	-5.15e-01
Vbs:	0.00e+00	3.50e-01	4.00e-01	5.15e-01	0.00e+00
Vth:	-0.00e+00	-0.00e+00	-0.00e+00	0.00e+00	0.00e+00
Vdsat:	-4.67e-01	-2.77e-01	-2.27e-01	1.43e+00	0.00e+00


VDD
IBIASPIN
IBIASPIN
MBIASPIN1
VBiasP
MBIASPIN2
MBIASOUT
IBIASOUT
VCascP
MCP1
MCP2
OUT
1
RC
CC
CL
VInM
MIN1
MIN2
VInP
MCN1
VCascN
MCN2
ICM
ICM
IBIASNIN
MOUT
VBiasN
2
MBIASNIN
MCM1
MCM2
VSS